Arctic Impact on Weather and Climate
Proposal acronym:
Blue-Action
Types of action:
RIA Research and Innovation action
Work programme topics addressed:
BG-10-2016
Impact of Arctic changes on the weather and climate of the Northern Hemisphere

Coordinating persons: *Steffen M. Olsen and Daniela Matei*

Versioning of modifications (GAP phase)

Part changed	Description of the change & justification	Date	Who
B	Table for tracking modifications added to the text **Justification:** as indicated by the guidelines of the EC	28 June 2016	Chiara Bearzotti for DMI
B	Tables of WP description, deliverables, milestones, risks deleted from this version of the document and added to the Participant Portal, section on Grant Data **Justification:** as indicated by the guidelines of the EC	28 June 2016	Chiara Bearzotti for DMI
B	The table appearing originally under description of Task 3.1 in Section 3 could not be transferred to the Participant Portal, thus it is now listed under Section 1.3.4 **Justification:** as indicated by the guidelines of the EC	28 June 2016	Chiara Bearzotti for DMI
B	List of the participants removed **Justification:** as per instructions received by the EC	28 June 2016	Chiara Bearzotti for DMI
B	Table 3.4a removed from section 3.4 **Justification:** as per instructions received by the EC	28 June 2016	Chiara Bearzotti for DMI
B	Include the following information at the bottom of each page (e.g. in a footer): "[Proposal number] [Proposal acronym] – Part B – [Page number (starting at 1 for Part B)]" **Justification:** as indicated by the guidelines of the EC	28 June 2016	Chiara Bearzotti for DMI
B	Table of contents with page numbers is updated **Justification:** as indicated by the guidelines of the EC	28 June 2016	Chiara Bearzotti for DMI
B	Section 4, 5, 6 and 7 added to current version of part B **Justification:** as indicated by the guidelines of the EC	28 June 2016	Chiara Bearzotti for DMI
B	Gantt chart to be replaced because the reporting periods indicated by the EC in the portal are different than the ones we had planned and indicated in the Gantt. Reporting periods in the Gantt are now matching with those indicated by the EC. Deliverables 7.4, 7.5 and 7.6 delivery dates have been changed to months 18, 36 and 51 respectively **Justification:** to reflect the reporting period indicated by the EC.	29 June 2016	Chiara Bearzotti for DMI
B and Portal	Partner SIO (former partner Nr. 32) dropped out and it has been deleted from the list of the beneficiaries. **Justification:** Because of difficulties in committing to the legal	5 July 2016	Chiara Bearzotti for DMI

	framework of the model grant agreement, partner SIO (former partner Nr. 32) dropped out. The collaboration with the scientist Dr. Xie involved at SIO will be granted through a memorandum of understanding between DMI and the scientists as a person. The action will be implemented as it was indicated in the original proposal, with the involvement of Dr. Xie in WP 1 and his contribution to WP8, but at personal title. DMI budget for travel costs under WP1 and WP8 will allow to invite Dr. Xie to join the annual meetings of this project, have a regular exchange with the Blue-Action teams, and liaising with the activities he runs in the US (i.e. National Science Foundation funded project: Mechanisms and Effects of Tropical Indian Ocean Variability PI: Dr. Xie duration: 08/2009 –09/2016) related to the following topics of interest for Blue-Action: ocean-atmosphere interactions and their role in climate variability and change. Changes are implemented both in this text and in the portal (tabs Beneficiaries, text and efforts of WP 1 and WP8)		
B and Portal	Re-numbering of the Partners from Nr. 32 to 40. **Justification:** Due to the deletion of the former partner nr. 32 (SIO), a new numbering has been assigned to partners Nr. 32 (SRSL) to Nr. 40. This change has been implemented both in this text and in the Portal.	5 July 2016	Chiara Bearzotti for DMI
Part B, Section 4.1	• Beneficiary 16 IC3: **Two profiles have been deleted from section 4.1 because two scientists left IC3.** No impact on the project, since the leads for IC3 are still in place. • Beneficiary 33 UHAM: Profile of **Armin Koehl has been deleted, as he will not be involved in this project.** No impact for the project, as the lead is still in place. **Justification**: updates from the Project partners	9 August 2016	Chiara Bearzotti for DMI
Portal WP 6	References to the following project added to WP6: "Clustering with project IMPREX (www.imprex.eu) lead by KNMI which also aims at improving the predictability of extreme weather events in current and future climate. This is relevant for WP1 and/or WP6" **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Portal WP 6	References to the following projects added to WP6: "Blue-Action will ensure that the legacy of the FP7 project EMBRACE is taken into account concerning the impact of different spatial resolutions and of the FP7 project EUPORIAS with respect to medium range forecasts and end-user needs" **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Portal list of risks	Risk Nr. 7 "Hickups in the internal communication" added in the portal.	9 August 2016	Chiara Bearzotti for DMI

	Justification: requested by EC officer.		
Portal, in WP 7 description	We will use the annual meeting to monitor the progress of work in these case studies. Minutes of the meeting will foresee a report for WP5 for each of the case studies, and will be made available to the EC. This explanation has been added to Task 7.6. **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Part B	I've added a sentence on page 28 "This will be pursued during the lifetime of the project and after its closure." **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Portal, in WP7 and list of the deliverables	These deliverables have been deleted in the portal from the list of the deliverables and the WP7 • D7.4 First Progress & financial report, DMI, M18 • D7.5 Second Progress & financial report, DMI, M36 • D7.6 Third progress & financial report, DMI, M51 **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Portal, in WP7 and list of Deliverables	New wording for describing D7.1: "Structure and detailed tasks of the Project Office" changed in the list of the deliverables and in the description of WP7. **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Part B	Page 72 sentence in blue added to Part B to specify that RIAG minutes will be made available to the EC. **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Part B	Chiara: integration of two sentences on page 71 for the innovation management by Steering Committee and Project Office. **Justification:** requested by EC officer.	9 August 2016	Chiara Bearzotti for DMI
Part B	In the section "Resources to be committed", table of the "Other direct costs": • **Beneficiaries 16 – IC3**: total is now correct. • **Beneficiaries 18 - KDM**: total is now correct. • **Beneficiaries 33 – SRSL:** costs of audit have been deleted, the budget will be allocated to the budget line "Other" for increasing the the amounts of the other items listed there **Justification:** requested by EC officer. Thanks!	9 August 2016	Chiara Bearzotti for DMI
Part B	In section 1.3.3 we explain how Blue-Action take up advances from recent FP7 programs	11 August 2016	Steffen Olsen, DMI
Part B	In section 1.3.4 we have detailed the description of the central interactions, knowledge and dataflow between WP's.	11 August 2016	Steffen Olsen, DMI
Part B, point point 4.1	Beneficiary 22 deletes the profile of Steingrimur Jonsson from section 4.1.	11 August	Chiara Bearzotti

	Justification: This person is not employed by partner 22.	2016	for DMI
Part B, point point 4.2	Third parties linked to CNRS deleted from Section 4.2 **Justification:** Beneficiary CNRS decided not to involve third-parties.	11 August 2016	Chiara Bearzotti for DMI
Portal, WP1	Small typo on Objective 3 stated twice removed from the text. **Justification:** as indicated by the EC officer.	11 August 2016	Chiara Bearzotti for DMI
Portal, WP8 and Deliverables' list, Gantt updated in part B	D8.5 reworded as follows "Presence at SOS 2016 for networking and visibility" and taking place in PM1. **Justification:** SOS2016 is taking place in PM1. SOS current timing is unfortunately not matching with the timing we had planned in the application.	11 August 2016	Chiara Bearzotti for DMI
Portal, WP7	Task 7.6: the project kick-off will be organised not in PM1, but "at the latest in PM4". **Justification**: We prefer to have an official kickoff in the first quarter of 2017, possibly back to back with the another major or the EC event on Blue-Growth announced for early 2017.	11 August 2016	Chiara Bearzotti for DMI
Portal, Milestones	Milestone MS1 reworded as follows: "Kick-off held" **Justification:** unfortunately, SOS2016 earlier start can no longer match with the kick-off, as we had planned in the application.	11 August 2016	Chiara Bearzotti for DMI
Portal, WP3	Description of systems improved, originally a table: NorESM [100km@NERSC], IPSL-CM [100km@CNRS], EC-Earth [100km@DMI, 40km@NLeSC], CMCC-CM [100km@CMCC], ECHAM5 [100km@IAP-RAS]), IAP-AGCM [100km@IAP-NZC], HadGEM [40km@UoS], ECHAM6 or ICON [10 or 40km@MPI] **Justification**: requested by EC officer.	25 August 2016	Steffen Olsen, DMI
PartB	We have corrected the misspellings in 1.3.3 and 1.3.4. **Justification**: requested by EC officer.	25 August 2016	Steffen Olsen, DMI
Portal, deliverables	The following deliverables have been added to WP7: • D7.4 Minutes from the first annual meeting, DMI M14 • D7.5 Minutes from the second annual meeting, DMI M26 • D7.6 Minutes from the third annual meeting, DMI M38 **Justification:** The miniuts allow us to share information with EC during the course of the project including guidance from the RIAG	25 August 2016	Steffen Olsen, DMI
Part B	Wording from "DMI other costs" referring to the travel expenses of the international partners in table 3.4b removed. **Justification:** as requested by EASME.	25 August 2016	Chiara Bearzotti for DMI
Part B, Table "Other direct costs"	Breakdown of beneficiary NERC The costs of Ben "NERC" were duplicated.	25 August 2016	Chiara Bearzotti for DMI

	<table><tr><th>NERC</th><th>Cost (€)</th><th>Justification</th></tr><tr><td>Travel</td><td>1700</td><td>Travels to annual meetings and international meetings, and to join the clustering activities with the other projects in the cluster WP6</td></tr><tr><td>Equipment</td><td>0</td><td>//</td></tr><tr><td>Other</td><td>6900</td><td>Publications in open access and computing costs</td></tr><tr><td>Total</td><td>23900</td><td></td></tr><tr><td>Travel</td><td>23900</td><td>Travels to annual meetings and international meetings , and to join the clustering activities with the other projects in the cluster WP6</td></tr><tr><td>Equipment</td><td>0</td><td>//</td></tr><tr><td>Other</td><td>0</td><td>//</td></tr><tr><td>Total</td><td>23900</td><td></td></tr></table> **Justification**: the table was duplicated, as the EASME indicated.		
Part B, Table "Other direct costs"	Number of the beneficiary is included in table 3.4 as from the GA template. **Justification:** Comment by EASME.	25 August 2016	Chiara Bearzotti for DMI
Portal/WP7 description, Portal /List of deliverables, Part B/Gantt chart	We add the following deliverables to WP7 which will enable us to share information with EC during the course of the project including guidance from the RIAG: • D7.4 Minutes from the first annual meeting, DMI M14 • D7.5 Minutes from the second annual meeting, DMI M26 • D7.6 Minutes from the third annual meeting, DMI M38 **Justification**: request by EASME.	25 August 2016	Chiara Bearzotti for DMI
Portal /WP6 description	D8.11 and D8.16 are the policy briefings which consist of written reports including the GAP MAPS. The reports will be then used for oral briefings. Reference to these two deliverables has been added in Task 6.2 in the Portal. **Justification**: request by EASME.	25 August 2016	Chiara Bearzotti for DMI
Portal /WP8 description Part B/Gantt chart	Numbering of the deliverables and the corresponding text in WP8 has been made coherent now. The Gantt is also coherent with the Portal and the WP8 description text now. **Justification**: request by EASME.	25 August 2016	Chiara Bearzotti for DMI
Part B, Table 3.4	Table 3.4 "Other Goods and Services" completed for partner 5/CNRS as Other Direct Costs are over the 15% of Personnel Costs **Justification**: Pointed out by EC officer	6 Sep. 2016	Steffen Olsen, DMI
Part B, Table 3.4	'Audit costs' included under 'other goods' for partner 5/CNRS **Justification:** required.	9. Sep 2016	Steffen Olsen, DMI

History of changes introduced with the Amendment AMD-727852-9

Part changed	Description of the change & justification	Date	Who
Portal (WP descriptions, deliverables, budget)	IC3 terminates its participation and ISGlobal takes over the research unit involved in Blue-Action: the "Climate Dynamics and Impacts Unit" (UDIC). WP descriptions, deliverables have been changed to the name of ISGlobal. Budget of the IC3 is transferred to ISGlobal. **Justification:** The IC3 team involved in Blue-Action, the research unit UDIC, is going to be transferred to the ISGlobal, the	15 December 2016	Chiara Bearzotti for DMI

	Barcelona Institute for Global Health from 1 January 2017. The IC3 will cease to exist in the first months of 2017.		
Part B Section 4 and Table 3.4b	• IC3 (PP13) profile has been deleted, as the participation is terminated. The profile of ISGlobal (PP41) has been added in Section 4, transferring there the information related to the research unit UDIC. • Original budget breakdown for Other direct costs (table 3.4b) planned for IC3 (PP16) is now listed under ISGlobal (PP41) **Justification:** The IC3 team involved in Blue-Action, the research unit UDIC, is going to be transferred to the ISGlobal, the Barcelona Institute for Global Health from 1 January 2017. The IC3 will cease to exist in the first months of 2017.	15 December 2016	Chiara Bearzotti for DMI
Portal, WP Description Part B	WP8 leadership has been taken over by Dr. Raeanne Miller **Justification:** Joanne Allday left the project and Dr. Raeanne Miller has replaced her.	15 December 2016	Chiara Bearzotti for DMI

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1. Excellence

1.1 Objectives

Blue-Action builds on growing scientific evidence of the impact of the Arctic and its changes on the weather and climate of the Northern Hemisphere, and recognizes the need to better respond and adapt to climate changes for the benefit of society, securing safety and growth. The **overarching objective** of Blue-Action is

> **To actively improve our ability to describe, model, and predict Arctic climate change and its impact on Northern Hemisphere climate, weather and their extremes, and to deliver valuated climate services of societal benefit.**

This will be achieved through coordinated research and innovation activities focussing on oceanic and atmospheric processes, and feedbacks that control Arctic changes and their impact on hazardous weather and climate, thereby improve the ability to predict Arctic changes and related climatic extremes. Blue-Action boosts Blue Growth by bridging the gap between the climate prediction community and the business sectors, and will develop climate services exploiting advances in predictive capacity. Blue-Action builds ocean-climate monitoring efforts and collaboration across the weather and climate prediction communities, essential climate services and stakeholders.

Blue-Action has **8 top level objectives:**

Objective 1 Improving long range forecast skill for hazardous weather and climate events by innovative representation of weather and climatic extremes, process-oriented diagnostic of weather systems in observations and climate simulations, and establishment of their links to Arctic changes and dominant climate variability modes. Work packages addressing this objective WP1, WP4, WP5

Objective 2 Enhancing the predictive capacity beyond seasons in the Arctic and the Northern Hemisphere by improved representation of the oceanic impacts on sea-ice formation and melting, by synthesising observations, assessing model performance, better representing northward propagating oceanic heat anomalies in the Atlantic and Pacific, and by quantifying the impact of Greenland Ice Sheet melting. (WP2, WP3, WP4)

Objective 3 Quantifying the impact of recent rapid changes in the Arctic on Northern Hemisphere climate and weather extremes by performing coordinated multi-model sensitivity experiments with atmospheric and climate models and assessing their ability to represent the observed changes, and by disentangling the effect of Arctic sea-ice retreat from the influence of the main modes of climate variability in the Northern Hemisphere. (WP1, WP3, WP4)

Objective 4 Improving the description of key processes controlling the impact of the polar amplification of global warming in prediction systems through skilful simulation of the stable Arctic atmospheric planetary boundary layer, implementing the effects of varying runoff into the Arctic, and establishing the impact of increasing horizontal and vertical model resolution, including in the stratosphere, needed to improve predictive skills. (WP3, WP4)

Objective 5 Optimizing observational systems for predictions by delivering an optimized oceanic monitoring system based on an integrated understanding of low latitude drivers of Arctic change, and by assessing its suitability and benefit for initializing climate predictions, with a focus on recent climatic extremes. (WP2, WP3, WP4)

Objective 6 Reducing and evaluating the uncertainty in prediction systems through innovative initialization techniques, by facilitating the uptake of new Earth Observations, and by assessing influences on Arctic cryosphere changes. (WP2, WP3, WP4)

Objective 7 Fostering the capacity of key stakeholders to adapt and respond to climate change and boosting their economic growth by developing and delivering valuated climate services. (WP5, WP8)

Objective 8 Transferring knowledge to a wide range of interested key stakeholders by engaging with the scientific community, business actors, policy and decision makers, indigenous communities, and the not-for-profit sector in a dialogue allowing exploitation of our results, and providing free and open access and re-use of all data. (WP6, WP5, WP8)

1.2 Relation to the work programme

Blue-Action responds to Topic BG-10-2016: "Impact of Arctic changes on the weather and climate of the Northern Hemisphere" and addresses all the expected impacts (Sec. 2.1), focusing on the ocean role in Arctic changes, in view of the predictability it provides on interannual and longer time scales.

The specific challenge of this topic underpins the need for **improved representation of processes specific for the Arctic** in weather and climate prediction models. Blue-Action will take an innovative approach to advance the characterisation of hazardous weather and climatic extremes (WP1, Objective 1) and improve the representation of northward propagating heat anomalies in the Atlantic sector in climate prediction systems, including their impact in the Arctic region, based on a wide range of observations (WP2, Objective 2). We will assess climate models, and develop both improved configurations to reduce model errors and advanced methods to incorporate new Earth Observations (WP2, WP3 and WP4, Objectives 5, 6).

Blue-Action will advance our knowledge on **the role of the Arctic in the global Climate system** and in particular **the Arctic role in the generation of extreme weather events** across the Northern Hemisphere by employing coordinated multi-model sensitivity experiments to evaluate the impact of Arctic warming in the Northern Hemisphere (WP3, Objective 3). Focussing specifically on weather patterns that are associated with hazardous conditions or climatic extremes (WP1, WP3, Objective 1); Blue-Action will contribute to enhancing the safety of people in the Arctic and reducing the risks associated with arctic operations and exploitation. Arctic impacts on the global climate system include two-way oceanic and atmospheric linkages between the Arctic, Pacific and Atlantic sectors, which will be assessed (WP2, WP3). Blue-Action will develop an integrated understanding of low latitude drivers of Arctic change and will lead to enhanced predictability of its impact, based on **assessment of model performance** (WP2,3,4), identification of **model limitations** using extended observations, and model improvement (WP2,3,4) via a better representation of critical linkages and **feedbacks** between sea ice and the atmospheric planetary boundary layer, and between melting Greenland ice sheet and Arctic climate (WP3,4). Critically we will develop novel techniques to reduce forecast drift and advanced methodologies to consistently treat sea ice-ocean interaction to enhance climate prediction in the Arctic (WP4).

Through Blue Action's combined efforts, **our capacity to predict weather and climate over the Northern Hemisphere will be enhanced** (WP4, Objective 2), and exploited to the benefit of a broad range of stakeholders (WP5, Objective 7, 8). This will allow us to provide better and more innovative services and products to stakeholders, including businesses, indigenous communities and policy makers, for enhancing their adaptation, **boosting economic growth** and improving their skills and competences (WP5, WP8). Blue-Action will engage directly with the business sector, including emerging business actors relying on climate and weather data for their core activities, while also targeting established industries in order to support them in developing **sustainable business strategies** and focussing on the Arctic (Climate KIC[1] and World Ocean Council in WP8) and enhancing their response capacity to the challenges of climate change. Active engagement with **policy and decision-makers** is key to enhance response capacity, and foster transfer and exploitation of project results. Blue-Action (WP8) targets policymakers at a European level involved in developing **climate change policy and climate actions for adaptations**, in particular European parliamentarians, European services such as the European Commission, the European Environment Agency and the Joint Programming Initiatives of the European Commission (i.e. JPI Climate, JPI Oceans).

The objectives of Blue-Action are aligned with and contribute to the implementation of and mission of international research coordination efforts. This includes the Polar Prediction Project (PPP) and the Year of Polar Prediction 2017-2019 (**YOPP**), major initiatives of the World Meteorological Organization (WMO) within the framework of the World Weather Research Programme (WWRP). Blue-Action will contribute

[1] The Climate KIC is one the Knowledge and Innovation Communities (KIC) set up by European Institute of Innovation and Technology (EIT) for bringing together major players from higher education, research and business to stimulate innovation via the full integration of the Knowledge Triangle

directly to the **IPCC** assessment through the execution and evaluation of coordinated experiments and indirectly through development of improved weather and climate prediction capacity for the Polar Regions. Blue-Action clearly provides input to short- to medium-term predictions and **Copernicus** through the initiatives funded by the **Copernicus Climate Services** (tender for Seasonal Forecasts C3S_433), through the Copernicus Marine Environment Monitoring Services (*CMEMS*) and projects resulting from the **Belmont Forum/JPI Climate** call on climate predictability (WP6, WP8)[2].

Blue-Action will cluster with projects funded by **Horizon 2020** and specifically by the **Blue Growth** call together with other relevant players to ensure smooth exchange of data and results between projects having common goals, especially **AtlantOS**, **EU-PolarNet**, **AORAC-SA** and **CERES** (WP6). Blue-Action takes a proactive role to structure the exchange between the scientific user communities in Europe, the US and Canada as well as in other non-EU countries, contributing to the implementation of the **Transatlantic Ocean Research Alliance**. This ambition is further strengthened by the direct involvement in Blue-Action of central partners from USA and from Canada, in addition to cooperation with strong partners from Arctic and non-Arctic third countries (Norway, Faroe Islands, Iceland), Russia and Eastern Asia (South Korea, Japan, China).

1.3 Concept and approach

1.3.1 Overall concept underpinning the project

Blue-Action aims to provide an advanced understanding of the Arctic's potential to increase the predictive capability of weather and climate change of the Northern Hemisphere. To achieve this we will bridge scientific understanding in Arctic climate, weather and risks research with key stakeholder needs. Activities in these research and stakeholder communities have been largely disconnected, and the interactions among these disciplines is poorly understood and exploited. Closing these knowledge gaps is at the center of Blue-Action's overall concept.

The novelty of Blue-Action rests in part in the active alliance between weather and climate prediction centres, the ocean climate community, academic researchers, and stakeholders and end-users of climate services. By defining the research priorities in this context and by facilitating ongoing interaction across different user levels and needs both within and outside of the project, we wish to ensure the relevance, direct and immediate uptake of scientific advances.

Weather and climate prediction in the Arctic and northern regions remains a challenge. Even if climate change in this region is notably faster than elsewhere, year-to-year and longer time variability suppress the signal-to-noise level of these changes (e.g. IPCC, 2013). Existing modelling tools and methods do not account for such conditions; for example, most risk impact assessments for extreme events assume that the climate is actually invariant. Furthermore, impact assessments typically take a sectoral, single-scale approach. Thus, there is an urgent need for decision-makers to have access to more reliable scientific knowledge on these highly uncertain but socio-economically important futures. This knowledge must address the possibility of greater cross-sectoral and cross-scale impacts, as well as amplified interdependencies – or shared vulnerabilities – with countries beyond the EU's borders.

Blue-Action will address these challenges to deliver a stepwise advance in the representation, quantification and mapping of predictive capability with respect to the occurrence of extreme and hazardous events with cross-sectoral impacts and vulnerabilities associated with near term weather and climate predictions. It will develop and combine innovative methods for risk awareness, impact and adaptation assessment across pan-Arctic, continental and regional/local scales, and evaluate how such knowledge can be embedded within effective and integrated adaptation and decision-making processes. It will build on state-of-the-art research within global, European and national climate prediction expertise and its users (e.g. IPCC: WG1, WG2 & WG3) and the methods, models and datasets developed in other research

2 Blue-Action partners are involved in all these projects (CMCC; UHAM, MERCATOR, MPI).

projects and whose results are underexploited in terms of their usefulness for decision-makers. Thus, Blue-Action brings together a set of European and international centres of excellence with their unique interdisciplinary and transdisciplinary expertise and in-depth understanding to *expand* on previous research **in seven important areas**:

Firstly, from its kick-off, **Blue-Action will work with public and private decision-makers and users of climate information to better understand their needs** for incorporating uncertain scientific evidence into real-world decision-making processes. A case study-driven approach will be used in order to work directly with influential decision-makers who act at the Arctic, European and regional/local levels. The case studies will enable all scientific advancements to be rooted in a thorough understanding of real-world decision-making, including detailed insights into how climate prediction capacity relates to current decision-making conflicts. Thus, Blue-Action builds on over a decade of research findings that show the usefulness of long term predictions in a decision making context. This will improve the capacity of stakeholders to respond and adapt to the impact of climatic change on the environment and human activities in the Arctic, both in the short and longer term. Through close stakeholder dialogue and involvement, and by training sessions, Blue-Action intends to improve the professional skills and competences for those working and being trained to work within this subject area.

Secondly, **Blue-Action will assemble and test new climate system variables** including those from emerging new Earth observations in its climate prediction modelling systems. Thus, Blue-Action will improve the uptake of these measurements and demonstrate how it will assist in creating an optimized observation system for various modelling applications.

Thirdly, **Blue-Action will develop novel methodologies to characterize extreme weather** under prevailing atmospheric circulation conditions, e.g. different phases of NAO, ENSO and PDO, including their neutral phases as well as their mutual interactions. Through carefully designed experiments, the intention is to improve the capacity to predict the weather and climate of the Northern Hemisphere, and make it possible to better forecast extreme weather phenomena. These will also provide new understanding of linkages between Arctic Ocean and far reaching teleconnections, as several opposing scientific views on the role of some of these teleconnection are currently hindering a proper assessment of the models' forecasting capacity. Blue-Action will through its concerted efforts therefore seek to improve the capacity of climate models to represent Arctic warming and its impact on regional and global atmospheric and oceanic circulation. This will be demonstrated through comparative studies involving four climate prediction models (NorESM, MPI-ESM1, EC-Earth, CMCC-CM2).

Fourthly, building on the scientific achievements shared broadly within its consortium and with a wider stakeholder community, **Blue-Action will contribute to robust and reliable forecasting** that can help meteorological and climate services to deliver better predictions, from sub-seasonal to decadal.

Fifthly, **Blue-Action will embed the scientific developments and improved model capacities within international programs** such as those spearheaded by WMOs World Weather Research Programme (WWRP) and World Climate Research Programme (WCRP). In particular Blue-Action will engage in activities related to the endorsed Grand Science Challenges within CLIVAR, CliC, GEWEX and SPARC as supervised by WCRPs Joint Scientific Committee (JSC) thereby making a demonstrable contribution to the Year of Polar Prediction (YOPP) and IPCC scientific assessments, as well as to the Copernicus Climate Change (C3S) services.

Sixthly, through its developed stakeholder-driven impacts analyses within each of its case studies, **Blue-Action will go beyond current mainstream analysis to assess the value of climate-services**, and quantify the potential of new simulation and modelling techniques to contribute to better servicing the economic sectors that rely on improved forecasting capacity.

Seventhly, **Blue-Action will communicate its new insights, results, messages – as well as data, model improvements and storylines –to a broad community of stakeholders** (beyond the case studies) for whom climate change, and other near- and long-term trends and risks, are important.

The Blue-Action methodology will advance the seven research areas stated above within a set of linked case studies at European, Arctic and regional/local scales to ensure that the research is grounded in the relevant multi-sectoral and institutional contexts. Decision-makers within these case studies will be fully engaged in the research process from the outset and encouraged to become part of an extended community of practice so as to support mutual learning.

The **Blue-Action concept** to go forward is depicted in Figure 1.1 and can be concretely summarized in the following way:

Take a **transdisciplinary approach**, bridging scientific understanding within Arctic climate, weather and risk management research, with key stakeholder knowledge of the impacts of climatic weather extremes and hazardous events will lead to the co-design of better services of economic sectors.

Build this bridge on innovative statistical and dynamical approaches to predict weather and climate extremes taking stock in existing knowledge about cross-sectoral impacts and vulnerabilities with respect to the occurrence of these events when associated to weather and climate predictions.

Enhance **modeling and prediction capabilities** by targeting lower latitude oceanic and atmospheric drivers of regional Arctic changes and Arctic impacts on Northern Hemisphere climate and weather extremes. Coordinated multi-model experiments will be central to test new higher resolution model configurations, innovative methods to reduce forecast error, and advanced methods to improve uptake of new Earth observations assets. This establishes how such an uptake may assist in creating better optimized observation system for various modelling applications.

Help national meteorological and climate services to better deliver tailored predictions and advice, including sub-seasonal to seasonal time scales providing improved robust and reliable forecasting. Through concerted efforts this contributes to the improvement of climate models to represent Arctic warming realistically and address its impact on regional and global atmospheric and oceanic circulation

Transdiciplinarity of the Blue-Action

Appropriate consideration of interdisciplinary approaches has been paid in the project by building mixed teams including climate scientists (WP1-5), political scientists, social scientists, economists, marketing experts, business developers (WP5, WP8), legal advisors (WP8). Adopted methodologies integrate several scientific disciplines, and non-academic and non-formalized knowledge for proposing solutions for complex societal problems such as the response to climate changes, and for delivering innovation to societal actors, fostering economic growth. The project see thus the contributions from more Social Sciences and Humanities (SSH) disciplines, i.e. economics and business models, legal and institutional frameworks,

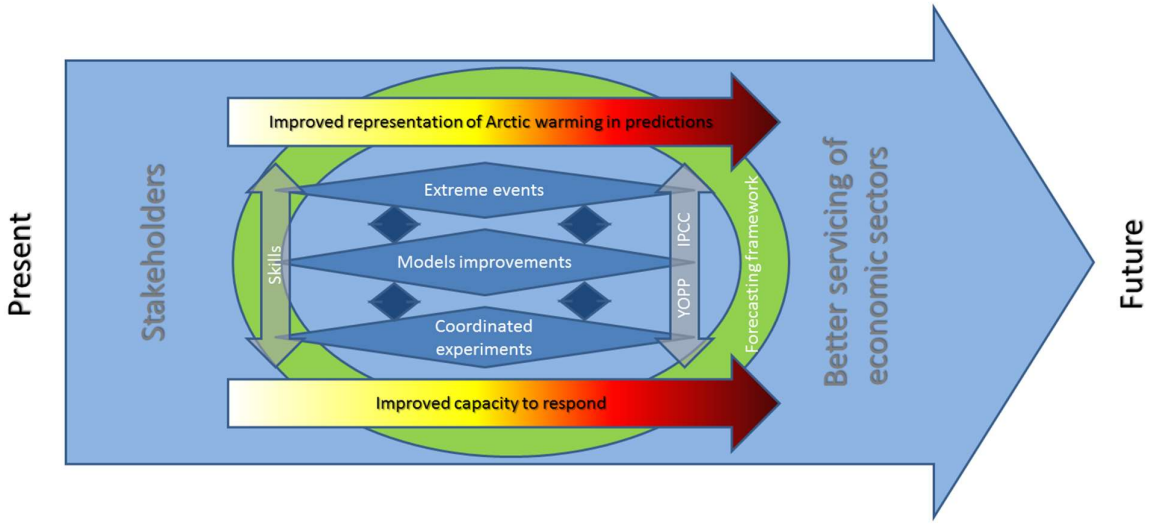


Figure 1.1 Conceptual illustration of the Blue-Action project.

policy-making and governance issues, demographic realities and trends, cultural values and historical dimension among other non-SSH related.

Use of stakeholder knowledge for co-creation of improved services

A strong effort for greater involvement of small, medium and large sized enterprises in the project activities has been pursued in Blue-Action, in line with the Horizon 2020 strategy. Blue-Action makes use of stakeholder knowledge for co-design and co-creation of better services and products, fully embedding them in the work plan of WP5, and in the advisory boards to the project. Enterprises are also actively involved in exploiting business opportunities provided by Blue-Action innovations (WP8). Additionally, public engagement measures in the project guarantee iterative/participatory multi-actor dialogues to co-create research and innovation outcomes and policy agendas (WP8).

1.3.2 Positioning of the project in terms of technology readiness levels (TRL)

Blue-Action covers the whole spectrum of innovation, from scientific insight and ideas to prototype products. The core of the work packages 1-4 is mostly aligned on lower **Technology Readiness Level (TRL) 1-3,** while with WP5 Developing and Valuing Climate Services and WP8 Communication, Dissemination, Engagement and Exploitation we will stretch up to **TRL 5-6** for both Research and Innovation and Engagement with Users activities.

The Research & Innovation in WP5 involves testing our process understanding of the value of the climate services set up with the inputs of WP1-4 and this is a necessary first step to operational applications such as seasonal forecasting. Firstly, for the stakeholders and end-users in the project, Blue Action will produce prototypes of products and services for specific sectors (marine fisheries, tourism, shipping, oil and gas extraction, health) to meet the requirements for decision-making derived from co-design. Secondly, with the support of the key partners Climate KIC and World Ocean Council, WP8 will bring the results of WP5 to a broader European business community including shipping, oil and gas, fisheries, aquaculture, tourism, renewable energy (wind, wave, tidal), ports, dredging, cables and pipelines, carbon capture and storage, as well as the maritime legal, financial and insurance communities, maximising impact, multiplying the opportunities for a greater number of business actors to enhance their responsive capacity and boosting economic growth.

1.3.3 National or international research and innovation activities linked to the project

Close connections with all the projects and initiatives listed below ensures that the developments of Blue-Action are at the forefront of current knowledge and also reduces the need for duplication of efforts. Furthermore, the Blue-Action contribution will be of benefit to the following wider communities.

YOPP and PPP: The cooperative international research efforts within Blue-Action align with the mission of the World Meteorological Organization's **Polar Prediction Project (PPP)** within the World Weather Research Programme (**WWRP**); to support and coordinate development of improved weather and environmental prediction services for the Polar Regions. The **Year of Polar Prediction (YOPP)** is a flagship activity within PPP in three phases, respectively preparation, execution and consolidation, of a period of intensive observing, modelling, verification, and user-engagement and education activities. Blue-Action will seek endorsement as a YOPP initiative and close coordination with PPP and YOPP is secured through DMI's membership (Director *Katrine Krogh Andersen*) of **the international steering group**.

Close links to **IOC (UNESCO), EuroGOOS** and **ArcticROOS** exists via coordination office at DMI (Steffen M. Olsen, national IOC delegate, represents DMI in the EuroGOOS and in ArcticROOS). EuroGOOS is the leading organisation on operational oceanography in Europe and actively collaborates with Blue-Action (WP6).

EU H2020 AORAC-SA (BG14 H2020 project) *Atlantic Ocean Research Alliance Support Action: Blue-Action* could support this project by providing additional access to the right stakeholders and fora for discussion through our partner WOC and KDM, who are already in the AORAC consortium. **EU H2020 AtlantOS** (BG8 H2020) *Optimizing and Enhancing the Integrated Atlantic Ocean Observing System*: Blue Action has contact through our partners GEOMAR, coordinating the AtlantOS project, DMI, KDM and SAMS, among many others. AORAC-SA and AtlantOS work together to convene a mechanism that facilitates the discussion about observing system coordination under the Galway process. Blue-Action will profit from this exchange

and further concentrate on the Arctic area. **EU H2020 EU-PolarNet** (BG15 H2020 project) led by Nicole Biebow at AWI, the world's largest consortium of expertise and infrastructure for polar research, is linked to Blue-Action via partners DMI, NERC, CNRS, WOC. **EU H2020 SPICES** (2015-2018) *Space-borne observations for detecting and forecasting sea ice cover extremes* whose main objective is to develop new methods to retrieve sea ice parameters from existing and upcoming satellite sensors to provide enhanced products for polar operators and prediction systems, specifically addressing extreme and unexpected conditions is linked to Blue-Action through UHAM, MPI and DMI. Blue-Action builds on the legacy of a number of recent projects including EMBRACE and EUPORIAS. The former aimed at reducing the known biases in a number of European Earth System Models and to, increase their realism in representing interactions in the earth systems. EUPORIAS addressed the impact of resolution medium range forecasts. Several Blue-Action partners contributed to these projects.

Additionally, we have already established successful collaboration to European Earth observation programme, **Copernicus**, in its several components, at different levels bothvia our partners and our Research and Innovation Advisory Group: 1) **Copernicus Climate Change Service**, in particular the Seasonal Forecasts Pre-Operational Phase (C3S_433) through the two projects led by Silvio Gualdi (CMCC) and by Barbara Früh (DWD) and our partners CMCC, UHAM, MPI involved in these contracts[3]. 2) The **Copernicus Marine Environment Monitoring Service** (CMEMS) is managed, implemented and operated by MERCATOR OCEAN, officially appointed by the European Commission in 2014 in this role in the multi-annual financial framework 2014-2020. MERCATOR OCEAN also defines and manages the service evolution and user uptake of the CMEMS activities. 3) **Arctic MFC element in the Copernicus Marine Environment Monitoring Services** (CMEMS) led by Laurent Bertino at NERSC. 4) Moreover the Head of the Copernicus Climate Change Service (J.-N. Thepaut at ECMWF) is one of the external advisors to this project and member of the RIAG (Section 3.2.1).

Other important projects we are linked to include: **H2020 PRIMAVERA** project investigates in a multi-model framework the benefit of high-resolution grid configurations and improved model physics on the simulation of the climate in the North Atlantic / European sector as well as the drivers of European climate variability. The high-resolution historical and scenario simulations performed within the framework of PRIMAVERA and CMIP6 HighResMIP will be complemented by the high-resolution prediction experiments performed within WP4. **German HIPRED RACE** project investigates case studies with high-resolution prediction experiments. The case studies considered within HIPRED RACE and Blue-Action WP4 will complement each other. **German MiKLiP** project develops a routine decadal forecast system. Sea ice initialization developed within BAC WP4 will be of high interest for MiKLiP. **APPOSITE** project investigates predictive capacity in the Arctic sector based on multi-model prediction experiments. This activity is of high interest for the attempt within Blue-Action WP4 to enhance predictive capacity in the Arctic sector and over Northern Hemisphere continental regions. **INTERDEC project** [4]investigates bidirectional linkages between Arctic and mid-latitudes/Tropics based on coordinated multi-model DCPP pacemaker-type historical experiments. The latter will be complemented by the Arctic pacemaker-type prediction experiments performed within Blue-Action WP4. **EPOCASA** (NFR) Enhancing seasonal-to-decadal Prediction Of Climate for the North Atlantic Sector and Arctic, involves UiB, NERSC, and UniRes. **GREENICE** (NordForsk) Impact of Future Cryospheric Changes on Northern Hemisphere. Climate, Green Growth and Society, involves UiB, NERSC, DMI, IORAS. **ARCPATH** (NordForsk, NCoE) Arctic Climate Predictions: Pathways to Resilient, Sustainable Societies involves UiB, NERSC, DMI, IORAS. **SNOWGLACE** (NFR) The changing Arctic cryopshere: snow and sea impact on prediction and climate over Europe and Asia, involves NERSC and UniRes- 2013-2017. **NORTH** (NFR), Northern constraints on the Atlantic thermohaline circulation involves UiB, DMI and NERSC. **EUCLIA** (FP7) works closely with stakeholders to establish their requirements for event attribution products, and to help develop climate attribution strategies, involves DMI, CNRS, ISGLOBAL, UREAD. **ENGAGE 2020** (H2020

[3] See letter of support of Barbara Früh and Silvio Gualdi in Section 6.
[4] Subject to funding decision by JPI-Climate.

project) http://engage2020.eu/home/Engage2020 is a project looking at research, innovation and related activities and exploring how members of society are involved today, and how they could be in the future. The project is mapping how, where and why members of the public, stakeholders, consumers and other groups are engaged in the research process, from early policy development to the delivery of research activity. **FOSTER project** (FP7) https://www.fosteropenscience.eu/ The FOSTER portal is an e-learning platform that brings together the best training resources for those who need to know more about Open Science, or who need to develop strategies and skills for implementing Open Science practices in their daily workflows. FOSTER offers a growing collection of training materials to meet the needs of many different users. Links are established through our partner DTU. **ZENODO** http://zenodo.org/ is an open dependable home for the long-tail of science, enabling researchers, EU projects and institutions to share and preserve any research outputs in any size, any format and from any science and receive credit by making the research results. **European IPR Helpdesk** whose team has committed to support WP8 training services of scientists in the areas of IP management and capacity building for our project through ad hoc web sessions on IPR.

1.3.4 Overall approach and methodology

Blue-Action has setup a detailed methodology which includes splitting into eight interlinked Work Packages (WP's) to tackle the complex efforts required to and ambitiously address the scope and expected impacts. In doing so we have prioritized independent scientific foci corresponding to the needs of the call, but that also are manageable in their scope and having well-defined linkages.

Figure 1.2 illustrates the project organization and structure with eight work-packages and overarching layers. The philosophy behind creating this structure has been *i)* **to maintain scientific and strategic foci** within each WP while still acknowledging the clearly interdisciplinary challenge of the call and *ii)* to allow to the greatest extent possible **to reach a level of synthesis or innovation within each work-package**. The attractive effects and criteria for success of this philosophy are i*)* **a manageable number of essential two-way interactions** between work-packages, *ii)* **key joint deliverables** only and, *iii)* well defined **flow of knowledge, developments and data across WP interfaces**. Targeted and efficient internal communication

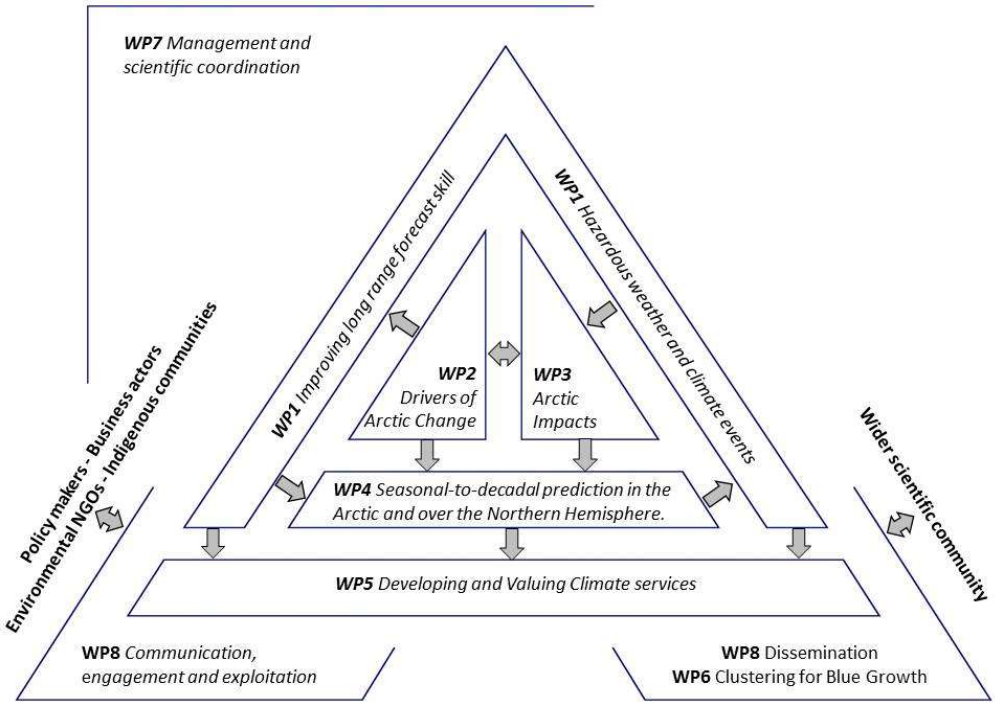


Figure 1.2 Schematic showing how the WorkPackage (WP) structure within Blue-Action interacts, outlining the core activities in WP1-5 leading from research to innovation and, visualizing the overarching nature of the clustering activity (WP6) and the exploitation, communication and engagement organized through WP8. The underlying management and coordination (WP7) embrace the entire project and cooperate with the external advisory boards.

and dissemination activities within the overarching WP 8 ensure the effectiveness of this virtual research and collaboration structures. A further advantage of this structure is the broad contribution of science teams and prediction groups across WP's which by itself ensures awareness of overarching objectives and amplifies the exchange of knowledge.

Work packages 1 to 4 form a science core which jointly addresses **Objective 1 to 6**. Strong interactions exist between WP2 and WP3 focussed on drivers and impacts of Arctic Change (**Objective 2, 3 & 4**), improved descriptions of processes, Arctic-lover latitude linkages and the uptake of data (**Objective 5 & 6**). WP4 builds on achievements of WP2 and WP3 for delivering an enhanced predictive capacity (**Objective 2**). WP4 also contributes generic prediction system improvements (**Objective2 & 4**) and in particular on aspects of model initialization and uptake of data (**Objective 6**). Essential to Blue-Action is the inclusion of WP1, advancing the forecast skill of hazardous weather and climate events (**Objective 1**), and linking the time-scales of approach across the project. This facilitates the full uptake of enhanced capacity for a range of stakeholder. WP5 showcase this by distilling and synthesizing the technical model developments and novel analyses carried out within WP 1 to 4 through the development and valuation of climate services, fostering capacity to adapt (**Objective 7**). The central data and knowledge flow to WP5 is synthesized by and mediated through WP1 and WP4 and includes both interim and final datasets from predictions experiments (WP4 to WP5). Reports delivered from WP1 are aimed at WP5 and ensures exploitation of improved forecast skill of hazardous weather, hazardous weather and events. WP2 and WP3 address different aspects and time-scales of Arctic linkages with the lower latitudes and will have a close scientific interaction. WP2 specifically rely on model data repositories within the project (WP3); contribute optimized observational datasets for prediction experiments (WP4) and improvements in model representations of key processes. Central developments related to improved representation of Arctic warming and the representation of the surface heat flux in the Arctic in WP3 will be utilized in WP4 and the coordinated experiments in WP3 contribute both a scientific basis and model data repository for WP1 and WP4. Both WP2 and WP3 contribute to improved means of initializing prediction systems (WP4). Complementary to the specific interactions planned, close scientific coordination (WP7 and WP8) between WP3 and WP4 and between WP2 and WP3 is particularly essential. Two work packages, WP6 and WP8 embrace the core of the project (WP 1 to 5) and ensure transparency of the project internally (WP8), to the wider scientific community and related project (WP6, 8). Efficient transfer of knowledge to Arctic and non-Arctic stakeholders is at the core of WP8 (**Objective 8)**, which engages directly with the Societal Engagement Board (SEG) and with policy makers, business actors environmental NGO's and organizations representing indigenous, Arctic communities. The overarching coordination and management of the project (WP7) includes an internationally renowned Research and Innovation Advisory Group (RIAG) working close together with the management to ensure the scientific excellence of Blue-Action. Below is a brief synopsis of individual work-packages.

Work package synopsis

WP1 Improving long range forecast skill of risks for hazardous weather and climate events

WP1 aims to use a process-oriented diagnostic of weather systems in climate models to enhance the potential for predicting seasonal climate variations; in particular conditions associated with hazardous weather events under present and future climate conditions, duly reflecting potential changes in large scale modes of variability and teleconnections. Specifically, WP1 will develop an innovative representation of hazardous weather and climatic extremes by focusing on the weather systems that are associated with such events in state-of-the-art characterization and in a climate prediction context. We will detect changes in their occurrence and if feasible, attribute their cause, and investigate the skill of representing these in seasonal predictions to limit risks to humans and the environment.

WP2 Lower latitude drivers of Arctic changes

WP2 will enhance our understanding of the formation and northward propagation of heat anomalies in the crucial Atlantic and also Pacific sectors and their contribution to observed and modelled future Arctic climate change. WP2 will deliver improved and optimized input for forecasting systems on the effects of low latitude drivers on Arctic change using results from models and existing observational systems. WP2

will identify limitations of climate models in representing these drivers and assess the suitability of the observing system for initializing prediction systems.

WP3 Linkages of Arctic climate changes to lower latitudes

WP3 will improve the understanding on the impact of recent rapid changes in the Arctic (e.g., amplified warming, sea-ice decline, Greenland ice sheet melting) on weather extremes and climate over continents of the Northern Hemisphere. This will be achieved through analyses of the Arctic changes impact on Northern Hemisphere atmospheric and oceanic circulation using observations, coordinated multi-model sensitivity experiments and through improved representation of surface heat flux in Arctic.

Experiments performed will use the atmospheric components of the following climate models.

Model	NorESM	IPSL-CM	EC-Earth	CMCC-CM	ECHAM5	IAP-AGCM	HadGEM	ECHAM6 or ICON	EC-Earth
Horiz. Res.	100km	100km	100km	100km	100 km	100km	40km	10 km or 40km	40km
Partner	NERSC	CNRS	DMI	CMCC	IAP-RAS	IAP-NZC	UoS	MPI	NLeSC

WP4 Enhancing the capacity of seasonal-to-decadal prediction in the Arctic and over the Northern Hemisphere

WP4 will use coordinated model experiments to investigate mechanisms of seasonal-to-decadal climate variability and uncertainties in model representation of these critical processes. WP4 will i) provide a benchmark assessment of current predictive skill from sub-seasonal to decadal time scales, focusing on processes that link the Arctic and lower latitudes and extremes over continental regions, ii) determine the impact of key oceanic regions and processes in providing predictive skill in the Arctic, and iii) improve predictive capacity with innovative initialization techniques, increased resolution and post-processing calibration techniques.

WP5 Developing and Valuing Climate Services

WP5 will showcase how bringing scientists together with stakeholders (and SMEs) boosts innovation by "translating" an enhanced capacity to predict weather, climate and its extremes (WP1-4) into societal-and sector-relevant products and services. The value of these products to both stakeholders and end-users will be quantified, preferably in financial terms where possible. Case-studies address the following sectors 1) tourism, 2) Temperature-related Human Mortality, 3) Polar-low risks to shipping, 4) Fisheries and 5) Arctic Resource extraction. Each case study follows a broadly similar pattern, involving: i) identification of end-user requirements, ii) development of products, iii) evaluation and valuation of products and the increased skill delivered by Blue-Action and iv) dissemination of results. Finally, an over-arching activity ties the individual lessons learned in each of the studies together and identifies future needs for climate services.

WP6 Clustering for Blue Growth

WP6 will organize a series of joint activities for i) **Clustering** with communities behind projects funded by Horizon 2020, specifically **Blue Growth calls**, and other relevant players to ensure smooth exchange of data and results between projects having common goals, ii) **Active engagement** with the **potential scientific users of Blue-Action data and information**, and iii) Taking a proactive role to **structure the exchange** between scientific user communities in Europe, the US and Canada as well as in other non-EU countries.

WP7 Management

WP7 will ensure the successful completion of all deliverables, achievement of milestones and reporting of progress. The governance structure of the project comprises a Steering Committee (SC), a General Assembly (GA), a coordinator and a project office. Two external advisory bodies, the Research and Innovation Advisory Group (RIAG) and Societal Engagement Group (SEG), will provide guidance to the project and foster dissemination and uptake of project results. Specific goals are to i) **ensure effective organization and supervision** of the project and communication among partners, coordinate project activities and monitor targets, ii) **facilitate completion** of the outlined objectives and activities to the

highest possible standard and iii) **facilitate communication** between the project partners and the Commission.

WP8 Communication, Dissemination, Engagement and Exploitation

WP8 will actively engage potential users of data and information in both commercial and public sectors, WP8 will amalgamate the case studies from the 'lighthouse' case studies created in WP5 with the clustering activities and best practice from WP6 to reach mass audiences and maximise impact from the project. WP8 will i) **provide effective communication** between partners and stakeholders, ii) **promote the project and disseminate its findings**, results and achievements, iii) **protect the IP and foster its exploitation**; facilitating the dissemination and exploitation of the projects results, iv) **improve the professional skills and competencies for those working and being trained to work within this subject area**, and v) **engage at policy-making level** with focus on how the project results are taken up by decision makers at several levels and influence policymaking.

1.3.5 How sex and/or gender analysis is taken into account in the project's content

The BG-10 call does not have a gender dimension explicitly integrated into it; however careful thought has been given to how gender considerations are applicable to the project. The nature of the work within the research themes of Blue-Action is considered to be **gender neutral**. The consortium does recognise, however, that gender considerations can be highly relevant when engaging with end-users and other target audiences, when providing role models to a younger generation of scientists and when designing information and services that will have a societal impact. Gender aspects will be considered within the context of the end-users that will be targeted, the range of sectors that may have an interest in the project results and in the project Dissemination, Exploitation, Engagement and Communication measures. A **Gender Strategy** (MS3) will detail how the consortium will manage gender considerations (see Section 3.2). The project office promotes and monitors gender and diversity equality throughout the lifetime of the project**,** takes a proactive role in ensuring that gender is taken into consideration with respect to the delivery of the project e.g. allowing flexible working practices and avoiding unconscious bias, ensuring that the project acts upon the EC recommendations listed in "**Gendered Innovation**" to stimulate and promote the progress of women in scientific careers.

1.4 Ambition

The Arctic Sector is one of the key global regions exhibiting a strong disjunction between the estimated multiyear predictive potential of perfect model studies (Guemas et al. 2014, Blanchard-Wrigglesworth et al, 2011) and the realised near-term predictive skill of about 3-5 months in current forecast systems. This limited predictive capability may have multiple causes including the lack of good quality observational data to be assimilated or used for forecast verification, shortcomings in the representation of key processes or inadequate (non-Arctic optimized) initialization approaches. The implications of (at present limited) Arctic predictive skill for the subseasonal-to-decadal predictability of climate and especially of extreme events at lower latitudes is unknown. Furthermore, the current lack of interactions between the research community and potential end-users of Arctic predictions hinders full exploitation of any predictive capabilities. Blue-Action will go well beyond the state-of-the-art in several critical ways in order to deliver improved capability to predict Arctic and associated Northern Hemisphere climate, and to demonstrate the value of such predictions:

Novel statistical and dynamical approaches to quantify predictability of weather and climate extremes

Although extreme or hazardous weather events themselves have low predictability, the conditions in which they form might be predictable at subseasonal-to-seasonal (S2S) time scales (Kolstad et al., 2010), and identifiable in global climate models (Ramos et al., 2015). In addition, future Arctic warming may drive atmospheric and oceanic teleconnections that precondition the occurrence of such extremes, providing a degree of predictability (Yang and Christensen, 2012). In Blue-Action we will conduct – building on a formal statistical framework (Lucarini et al., 2016) – a unique analysis that investigates the occurrence of weather patterns associated with extreme events in a **consistent model framework** ranging from CMIP-type simulations to initialized seasonal prediction experiments. Such a **process-oriented description of the weather systems in which extremes are likely to form** will improve the ability to both detect, attribute and

predict (Stott et al., 2013) seasonal climate variations that might result in potentially hazardous events, improving adaptive societal adaptive capacity and resilience.

Lower latitude drivers of regional Arctic changes

The impact of the ocean on climatic-timescale Arctic variability is clear in the current generation of climate models (Zhang, 2015). Questions however remain about the ability of models to correctly simulate oceanic transports in key regions, such as over shallow ocean ridges and in strong boundary currents, and how their relatively low resolution impinges on the representation of key ocean-atmosphere processes (Minobe et al., 2008). Blue-Action will perform a coordinated analysis of climate models, coupled model reanalyses and direct observations to better understand the formation and northward propagation of heat anomalies in the Atlantic/Pacific sectors and their contribution to Arctic climate changes: observed rapid Arctic warming, recent abrupt sea-ice decline or projected summer ice-free Arctic. We will assess the ability of the next generation of models, both from the CMIP6 project and high resolution coupled models via the PRIMAVERA project, to reproduce observed atmospheric and oceanic low-latitude impacts on the Arctic region. We will improve the next generation of climate models, as well as enhance the ocean observations that inform them. We focus on the discrepancies in the representation of the ocean circulation estimated from ocean observations and ocean reanalysis. We will do so by assessing the observing systems' efficiency and ability to deliver key information, and in turn reducing the diversity in ocean reanalyses (Karspeck et al., 2015)—a problem not present in atmospheric equivalents. This improved understanding of the ocean's variability and influence on Artic climate and its representation in observations and models can enhance short and long-term climate predictions.

Arctic warming impacts on Northern Hemisphere climate and weather extremes

While the direct impact of Arctic sea ice variations on the lower latitudes atmosphere is well documented (Cohen et al., 2014, Garcia-Serrano et al., 2015), Arctic warming impacts vary regionally and seasonally and there is no consensus concerning their robustness, neither from observations or individual modelling studies (Gao et al., 2015). **Blue-Action will use coordinated multi-model (atmosphere-only and coupled) experiments** to increase understanding of Arctic-lower latitude teleconnections and assess the impact of forced versus intrinsic variability on these linkages. Such a coordinated experimental approach is paramount to isolate the impact of model uncertainty (physics, resolution). Atmosphere-only experiments will distinguish the influence of historical Arctic sea ice loss on Northern Hemisphere weather extremes and climate from the masking effects of sea surface temperature variations in the Atlantic and Pacific oceans. These experiments will also clarify the atmospheric pathways through which remote oceanic forcing could shape (drive) the regional Arctic warming. The novelty in these experiments will be the improved detection through increased signal to noise ratio due to the use of large ensemble (at least 30 members) and daily varying high resolution (25Km) surface boundary conditions (Zhou et al, 2015). Coupled model experiments will identify the role of active air-sea coupling in modulating the Arctic warming impacts on the mid-latitudes. Specific climate model simulations will assess the impact of freshwater input in the Arctic region in initiating rapid strong cooling events over the North Atlantic Subpolar Gyre with far reaching consequences for the Northern Hemisphere climate. Poor representation of the atmospheric boundary-layer dynamics leads to biased simulation of Arctic warming (Davy and Esau, 2014), inherently limiting the forecast potential of Arctic-lower latitude linkages. Thus, we will address the representation of leads in Arctic sea ice, their impact on the surface heat flux and atmospheric boundary layer stability, in order to better constrain the role of Arctic warming in global climate system.

Enhancing Arctic climate predictions and their impacts beyond seasons

Blue-Action will explore two ambitious strategies to enhance the predictive skill in the Arctic and (subsequently) over Northern Hemisphere continental regions: (1) to achieve a better representation of processes critical for Arctic – lower latitude linkages, we will employ **frontier high-resolution grid configurations** comparable to HighResMIP, improved surface flux parameterisations over sea-ice, and account for freshwater fluxes from Greenland Ice Sheet Melt. (2) to reduce the impact of model drift on the accuracy of predictions, we will develop innovative initialization techniques, including **strongly coupled ocean-sea ice data assimilation** to provide dynamically consistent initial state estimates (Lisaeter et al. 2003); flow dependent bias corrections (Drews et al. 2015) and alternate anomaly initialization methods.

Blue-Action will quantify the additional predictive potential from these two strategies in coordinated state-of-art multi-model ensemble predictions. A seamless approach in skill assessment will target time scales from seasonal to decadal, while a mechanistic attribution of skill will overcome the great challenge of robustly assessing prediction skill under limited amount of observed independent events. Source regions of skill will be further confirmed through innovative **pacemaker (data-withholding) prediction experiments**, while sensitivity experiments will explore the role of (at present) unaccounted freshwater input (runoff, Greenland Ice Sheet melt) into the Arctic and North Atlantic Ocean in seasonal-to-decadal predictions. The **role of atmospheric and oceanic teleconnections in transferring the skill and uncertainty** from the Arctic to lower latitudes will be assessed from the coordinated multi-model (atmosphere-only and coupled) experiments and the Blue-Action multi-model multi-approach forecast ensemble with improved configuration. Special attention will be given to the ensemble predictions initialised from conditions representative of YOPP CORE Phase (Jung et al., 2016). The newly available Earth System Observations, Arctic analyses (e.g., Christensen et al., 2016) and YOPP data will be used to both initialise forecasts and evaluate predictions, mechanistically, in their ability to reproduce the observed variability and linkages. Finally, an updated forecast ensemble will be performed with the improved systems and delivered to the impact case studies.

Developing climate services for stakeholders-relevant applications

Blue-Action will develop and value climate services that are relevant to stakeholders and end-users. Although high-quality operational weather and climate models have been available for multiple decades now, the concept of climate-service products remains relatively novel, and there are few such products available on medium- to long-raging time scales, particularly at higher latitudes. Blue-Action will bring scientists together with carefully selected stakeholders (including governing bodies and SMEs) to co-develop novel climate-service products that "translate" the new methodologies, model outputs and improved modelling skill developed in the project into societal- and sector-relevant outputs providing the user oriented and driven basis for a wider climate-service scope. Five case studies address tourism, temperature-related Human Mortality, risks of extreme weather for shipping, fisheries and Arctic Resource extraction. For each case study and sector, new and innovative climate-service products will be developed based on beyond-state-of-the-art models that link the physical environment with the relevant outcome. The close dialogue with relevant end-users (stakeholders) initiated in the early stages will increase the value of these products to both stakeholders and end-users will be quantified, preferably in financial terms where possible. These products will then be used as a platform for communicating the results of Blue-Action and the potential of climate services to the sector and the wider-community in WPs 6 and 8.

Innovating the communication, stakeholder-engagement and exploitation of climate services

The engagement activities involve all key actors (businesses, policymakers NGOs and communities) and exploitation routes maximise outputs for both emerging businesses and established industries reliant on improved forecasting capacity. The Blue-Action ambition is to **push beyond current state of the art** communication and dissemination strategies. To this end, the communications will maximise the use of **emerging marcomms (marketing communications) methods, such as new social media tools**. Dissemination methods will include video/online conferencing, and sessions will be recorded to maximise accessibility and inclusivity. The project's Societal Engagement Group will amplify key outputs and includes representatives from often leap-frogged groups, such as indigenous communities and NGOs. Match making activities led by the Climate KIC and World Ocean Council will accelerate impact in jobs, growth and enhanced climate adaptation capability for both new and established industries.

1.4.1 Innovation potential: The benefits Blue-Action can potentially deliver

Blue-Action will innovate - through a holistic approach - how scientific understanding of Artic climate can be augmented and how societal demands can be addressed. In Blue-Action, the Artic is considered as part of the climate system spanning the atmospheric, the oceanic as well as the sea-ice component, being influenced by local and remote changes on time scales ranging from weather to climate. This holistic view enables us specifically to:

- **innovate the understanding of the role and representation of atmospheric and oceanic processes** governing Arctic climate variability in the presence of decadal climate variability and global warming

(WP 2 and 3), resulting in specific tests for successive improvements of current decadal prediction systems (WP4),

- **develop innovative tools to quantify the predictability and the detectability** of Arctic climate variability at S2S and climate-change timescales, respectively (WP1),
- **deliver tangible benefits to stakeholders and their associated sectors**, where the developed tools and acquired understanding will be applied to developing climate services that are tailored to the needs and wants of specific end-users (WP5).

The understanding of the role of the Arctic in the climate system will be improved by a better representation of processes specific for the Arctic, in particular the representation of these processes in the presence of Arctic warming. To that end, we will improve the parameterization of surface heat flux taking into account cracks in Arctic sea ice cover. Further, we will use temporally and spatially high-resolution boundary forcing to the coordinated high-resolution atmosphere-only simulations to improve the representation of the Arctic warming and its impact at the regional and global scales.

The interplay of Arctic warming with natural climate modes of variability and the impacts on the weather and climate over the Northern Hemisphere will be specifically addressed, both with respect to the state of climate variability and the changing sub-seasonal-to-decadal predictability of climate variability over the Arctic.

These insights will allow Blue-Action to conduct dedicated investigations of the limitations to predictive skill in the current generation of prediction systems. Specifically, the role of ocean initialization and sea-ice initialization will be considered, focusing on processes that link the Arctic and lower latitudes and extremes over continental regions, as will the role of the resolution in the prediction systems.

Blue-Action will innovate the detectability and predictability of Artic climate and in particular the representation of hazardous weather and climatic extremes by focusing on the weather systems that are associated with such events in state-of-the-art characterization and in a climate prediction context. Improved analysis tools will be built using established mathematical methods, now uniquely applied to a coherent model framework seamlessly representing the sub-seasonal variability to climate change, allowing us to improve the quantification of predictability and detectability.

The improved understanding and tools will be applied in case studies that target tourism, shipping, fisheries, resource extraction and human health sectors with a strong focus on **co-developing products to deliver benefits to specific users**. Blue-Action will therefore **drive innovation in these fields and strengthen the competitiveness of European businesses**. In addition, each case study will quantify the benefits of these innovations in quantitative terms. The approach will, of necessity, vary between the various cases studies, but will include assessments of stakeholder engagement and improvements in management and economic performance: where possible, these benefits will be cast in financial terms.

Overall, Blue-Action will foster the development of improved climate services by better understanding and meeting end-user needs. Blue-Action will widen the portfolio of climate services building on operational S2S predictions. In particular, Blue-Action will provide the tools that climate services can deliver for the Arctic region, not only statistical mean hindcast skill, but forecasts that take into account the current state of weather systems as well as decadal variability/climate modes, teleconnections and linkages (through both atmosphere and ocean), and currently ongoing climate change. The improvements in climate services also have a substantial “capacity for innovation” i.e. to stimulate further innovations and to increase the benefits generated beyond the scope of this project.

2. Impact

2.1 Expected impacts

2.1.1 Expected impacts of the programme

Blue-Action will attain all the expected impacts indicated in the BG10 call text.

Improve capacity to predict the weather and climate of the Northern Hemisphere, and make it possible

to better forecast of extreme weather phenomena

Blue-Action will realize better the potential skill of weather and climate predictions systems along four lines of coordinated research and development activities;

- Improved representation of process specific to the Arctic (WP3, WP4)
- Optimized use of data, closing data gaps, increased operability and utility (WP2,WP3,WP4)
- Improved representation of Arctic-lower latitude linkages (WP1, WP2, WP3, WP4)
- Interaction with business stakeholders will be enhanced by testing the delivering of new downstream products and services (WP1,WP4, WP5)

Specific efforts include; **optimized initialization strategies** that limit the forecast shock and facilitate the uptake of Earth Observations (WP4); developing new, **optimized data products** by combining measurements from ocean monitoring systems with satellites information to meet the needs of the predictive community, in part by assuring near-real time data provision (WP2); **improved simulation of Arctic-lower latitude ocean linkages**, heat anomaly propagation and the modulation of Arctic sea-ice in the marginal ice zone (WP2); new **novel approaches and parameterizations** to represent the effects on turbulent vertical heat fluxes of cracks and leads in arctic sea ice cover (WP3); **improved representation of the stable arctic boundary layer** over ice (WP3, WP4) critical for the development of arctic weather systems (WP1,WP5); improved, initialized **multi-model seasonal-decadal ensemble predictions** (WP4); representation of the **effects of runoff from Greenland** in ocean initial conditions (WP4) presently not included due to sparse observations along the Greenland east coast.

Capitalizing on these advances in predictive capacity, Blue-Action develops risk-based forecasts of **extreme weather phenomena** at sub-seasonal-to-seasonal (s2s) time scales through an innovative, process-oriented description of the weather systems in which extremes are likely to form (WP1). The improved ability to both detect and predict seasonal climate variations that might result in potentially **hazardous events** serve to enhance the societal coping capacity and resilience (WP5).

Improve the capacity to respond to the impact of climatic change on the environment and human activities in the Arctic, both in the short and longer term

The project focus is to enhance the response capacity of specific stakeholders in the Northern Hemisphere by delivering in an open dialogue with specific end-users the results of the research activities to the society and testing the value of the climate services through joint activities with societal players (business, policy makers, NGOs, indigenous communities). Thus the project goes beyond the specific Arctic area, as the consequences of the changes in the Arctic affect not only the Arctic. Nevertheless we have strategically planned to have *i)* four (of the five) lighthouse projects in WP5 to focus on **specific Arctic business**, i.e. the tourism industry in Lapland (Finland), the forecasting of polar lows (Scandinavia), the resource-extraction in the Russian Arctic, climate services for the marine fisheries (North Atlantic); and *ii)* the joint-work with key decision-makers of the **Inuit and Sami community** and representatives of **environmental NGOs** in the Societal Engagement Group (WP8).

Improve the capacity of climate models to represent Arctic warming and its impact on regional and global atmospheric and oceanic circulation

The climatology of the stable planetary boundary layer over sea-ice and snow covered regions in the Arctic and at high latitudes has been shown to be one of the leading factors affecting simulated Arctic surface warming in present day climate models and the likely cause for their **limited direct skill to represent the observed Arctic amplification** of global warming. Blue-Action targets this deficit through **improved descriptions of the effects of leads** (WP3). Although leads and cracks in sea-ice make up a small fraction of the surface area, the very large temperature differences between the ocean and atmosphere result in strong fluxes of heat and water-vapour from these cracks and, the net flux from an area has a strongly non-linear dependence on the fraction of open water. Accounting for these effects has been shown to lead to radically different surface energy budgets, as compared to simple flux-gradient approximations of the dynamics. Currently these effects are not included in most of CMIP5 models. Blue-Action develops new, **novel approaches and parameterizations to represent the effects on turbulent vertical heat fluxes** of cracks and leads in arctic sea ice cover (WP3). A proper understanding of two-way linkages between the

Arctic and lower latitudes are key to achieve more realistic representation in model systems *i)* for predictive skill beyond seasons through propagating thermohaline anomalies, *ii)* a requisite for realistic **impact of arctic changes on global ocean and atmospheric circulation**, iii) a requirement for communicating ocean low-latitude warming to the Arctic where it activates feedbacks leading to Arctic amplification and *iv)* a necessity to capture realistically atmospheric teleconnections that may serve as an additional amplification of Arctic feedback mechanisms. Climate models have been shown to have **limited skill** in simulating the ocean exchanges in complex oceanographic setting and Blue-Action will improve the representation of two-way ocean linkages (WP2, WP4) with the potential improvements on *i)* to *iv)*. The urgency of responding to these deficits in representing ocean and atmospheric linkages is emphasized by ongoing changes in the Arctic hydrological cycle, accelerated mass loss from glaciers and ice-sheets and dramatically enhanced liquid storage of freshwater in the Arctic Ocean.

Improve the uptake of measurements from satellites by making use of new Earth observation assets

Earth observations from space of the cryosphere and ocean surface state in particular are essential assets in model initialization (WP4), for evaluation of skill (WP1,4), for identification of hazardous weather phenomena (WP1), for assessing model performance (WP2,3) and the basis for developing improved process representation (WP2,3). In Blue-Action the uptake of available near-real-time Earth observations is in part ensured through the integration of operational Copernicus products and services for initialization (ocean, cryosphere and atmosphere, WP1,2,3,4). Blue-Action **improves the uptake** of both operational and delayed mode data through a number of specific activities:

- By exploring more advanced methods to **initialize snow cover, sea-ice extent and thickness** over the Arctic (WP4) assuming advances in observational capabilities (reduced uncertainty and new missions).
- By optimizing the flux estimates from moored ocean observing systems to serve the specific needs of the predictive community. This is a achieved by identification of gaps and by developing new algorithms, taking advantage of new, high latitude Earth Observation assets (WP2).
- By the use of high-resolution SPOT satellite observations of the sea-ice cover to improve the representation of surface heat flux in Arctic and planetary boundary layer in climate models.
- By the combination of in-situ measurements from ocean mooring systems, new ocean observing platforms and data from existing and upcoming satellite missions to produce a valid view of ocean heat anomaly propagation towards the Arctic (WP2).

Lead to optimised observation systems for various modelling applications

Blue-Action will assess the **suitability and utility** of parts of the ocean observing system for initializing prediction systems (WP2, WP4). Targeted systems for optimisation (WP2) include the comprehensive moored observatories designed to monitor ocean exchanges and operated semi-operationally in the Atlantic and at the gateways to the Arctic. Optimization will facilitate enhanced exploitation and is focussed on operability, fast data return and closing data gaps. Coordination of efforts and the added value of estimates (near-real-time and delayed) will further enhance their utility for validation of model systems.

Contribute to a robust and reliable forecasting framework that can help meteorological and climate services to deliver better predictions, including at sub-seasonal and seasonal time scales

Blue-Action will establish a robust and reliable forecasting framework for probabilistic **predictions of extreme weather phenomena** at subseasonal-to-seasonal (s2s) time scales and beyond (WP1). Key to this is development of innovative, process-oriented description of the weather systems in which extremes are likely to form, building on assessment and quantification of empirical relationships between large-scale atmospheric and lower boundary (ocean surface, sea ice) drivers.

Blue-Action specifically contributes to develop arctic climate services (WP5) by providing a targeted forecasting framework which by the means of maps tailored to high-level end-users provide practical application of medium-to-long-range prediction of marine cold air outbreaks and polar lows, to limit risks for humans, business activities and the environment in the Arctic.

Improve stakeholders' capacity to adapt to climate change

In Blue-Action a wide range of societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align

both the process and the project outcomes with the values, needs and expectations of society, in line with the European strategy for Responsible Research and Innovation.
We have identified a number of stakeholders in the project whose adaptive capacity is to be improved: 1) Key **business stakeholders** will be enhanced by testing the delivering of new services and products (WP5) to marine fisheries, tourism, shipping, oil and gas extraction, health sector. Additionally, Climate KIC and the WOC will be transferring the achievements of WP5 to a larger number of business actors (WP8) amplifying the impacts achieved in WP5. 2) Key representatives of the **Inuit and Sami community (policy and decision makers)**, engaging with the project and opening up for a dialogue and their critical review of the project results through the participation in the Societal Engagement Group. 3) **Policy makers at European and national level** will be timely involved in the project and requested to express their needs/provide feedback to the project and use/re-use of results at EU and national level (WP8). 4) Key representatives of **environmental NGOs** such as Greenpeace and BirdLife International who will be engaged in the project through the Societal Engagement Group and requested to review project results and activities on a regular basis (WP8).

Contribute to better servicing the economic sectors that rely on improved forecasting capacity (e.g. shipping, mining)

Through the case studies in WP5, selected stakeholders and scientists will jointly work to test the value of improved climate services for specific sectors - marine fisheries, tourism, shipping, oil and gas extraction, health sector- relying on improved forecasting capacity for implementing joint-measures and improving their services to customers. In WP8 the results of these lighthouse projects will be brought to a wider audience of companies:shipping, oil and gas, fisheries, aquaculture, tourism, renewable energy (wind, wave, tidal), ports, dredging, cables and pipelines, carbon capture and storage, maritime legal, financial and insurance communities.

Contribute to the Year of Polar Prediction (YOPP) and IPCC scientific assessments, and to the Copernicus Climate Change (C3S) services

The mutual exchange of information on on-going and planned research activities of each participant is crucial. The impacts of climate change are borderless and therefore climate research is an international challenge and can only be addressed by working together on an international level[5]. The objectives of Blue-Action are aligned with and contribute to the implementation of and mission of international research coordination efforts. This includes the Polar Prediction Project (PPP) and the Year of Polar Prediction 2017-2019 (**YOPP**), major initiatives of the World Meteorological Organization (WMO) within the framework of the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP). Blue-Action will contribute directly to the **IPCC** assessment through the execution and evaluation of CMIP6 type coordinated experiments and indirectly through development of improved weather and climate prediction capacity for the Polar Regions in a way that is set to go beyond what was achievable in time for the IPCC SREX as well as for AR5. Blue-Action provides input to short- to medium-term predictions and **Copernicus** through the initiatives funded by the tender **C3S_**433 Seasonal Forecasts (WP1) and projects resulting from the **Belmont Forum/JPI Climate** call on climate predictability (WP6, WP8).

Improve the professional skills and competences for those working and being trained to work within this subject area

Improved professional skills and competences are key for understanding climate change constraints, challenges, and for boosting growth and adaptation at several levels (business, policy makers, local communities). Growth in the blue economy requires an appropriately skilled workforce, able to apply the latest technologies in engineering and a range of other disciplines. There is currently a skills gap that must

[5] Arctic ECRA, Strategy and Work Plan, 19 June 2014

be tackled[6]. We have defined a multi-layered strategy for ensuring the achievement of this impact, targeting key audiences with customized tools (WP8). Starting with 1) **career development and training modules for scientists** (early stage researcher and senior), through the direct involvement of European higher education course leaders and meteorological offices training facilities, for increasing knowledge, and skills in knowledge transfer, Intellectual Property Rights and dissemination strategies, in synergy with existing ERASMUS+ Programme Knowledge Alliance schemes[7], Marie Sklodowska Curie Actions (MSCA) European Training Networks[8], doctoral schools[9], summer school programmes[10]; 2) **Industry-focused training** sessions training on how to use scientific data and on bridging language barriers in the interaction with the scientific community (WP5, WP8) through the support of our partner Climate KIC and WOC; 3) **collaborative policy briefings addressing policymakers** involved in determining key policy issues relating to weather and oceanic observation systems, prediction, climate change response and adaptation as well as mitigation (WP8).

Improving innovation capacity and the integration of new knowledge

The variety of exploitation measures of Blue-Action products and results will foster their utilization for further development, creation and marketing of products/services and processes (WP5, WP8) for business stakeholders, and for improved information to policy makers, NGOs and indigenous communities (WP8). Open access to results i.e. data and publications is a high priority in this project for allowing re-utilization and transfer of know-how at all levels (WP7). This will be pursued during the lifetime of the project and after its closure. Integration of knowledge at scientific level will be achieved under the drive of the WP6 Clustering for Blue Growth.

Strengthening the competitiveness and growth of companies by developing innovations meeting the needs of European and global markets; and, where relevant, by delivering such innovations to the markets

The project opens a match making dialogue between the users of the project modelling data, their analyses and the core scientific groups (WP1-4) with the goal of strengthening the competitiveness and growth of **emerging business actors** i.e. Climate-KIC's startups' community and **established industries** through the consolidated World Ocean Council network[11]. These companies need climate and weather data or analysis for 1) developing new innovative services/products, and for 2) enhancing their existing core business activities that rely on improved forecasting capacity. The match making is seen to support business actors in rethinking and redesigning/shaping their business model, boosting new ideas which can stimulate growth, enhancing innovation capacity and creating new market opportunities by establishing new products and services for the market, with the support of the spatial hemispheric climate data received from this project and the scientific network behind the project.

2.1.2 Barriers and obstacles that may determine whether impacts will be achieved

Blue-Action operates in a dynamic environment at the interface between science, policy and stakeholders: it is therefore natural that the project is exposed to external and unforeseeable factors that may influence its ability to achieve the expected impacts. The project has identified the most important of these together with measures to minimize and mitigate their impact (Section 3.2.4) on the project as shown below.

Barrier or obstacle	Blue-Action assessment and strategy for resolution or mitigation

[6] COM(2014) 254 final/2, Innovation in the Blue Economy: realising the potential of our seas and oceans for jobs and growth and COM(2012) 494 final, Blue Growth, opportunities for marine and maritime sustainable growth.

[7] Such as the postgraduate education programmes ACES (SAMS is part of it).

[8] Such as the H2020 funded C-CASCADES, COMPLETE and AMOR (MSCA ITN/European Training Networks), several Blue-Action partners involved in these.

[9] Such as the IMPRS at Max Planck Institute for Meteorology.

[10] In Earth System Modelling, by IS-ENES2, several partners involved.

[11] Corporate and associate members of WOC: http://www.oceancouncil.org/site/members.php

Rapidly evolving hardware	Systems and software of weather and climate services are ill-equipped to adapt to the rapidly evolving computing hardware. Blue-Action is aware of the need to modernize code, model systems and applications and partners take active part in initiatives and projects within the community that actively engage with high performance computing centres[12] and leading hardware companies to advance on these issues to the benefit of the community.
Failure of project results to be taken up by stakeholders	Blue-Action has fostered close collaboration with stakeholders and end-users from key relevant sectors. In WP5, climate service-products will be designed in collaboration with stakeholders to satisfy specific needs and information requirements: given the co-development aspect and specific focus of these products, it is seen as *unlikely* that they will not be adopted. It is *possible* that these results will not be adopted more widely: however, Blue-Action features a comprehensive dissemination scheme (WP8) to bring its results to the wider sector and, as many of these results represent opportunities for financial gains, a strong uptake is likely.
Data standards and open data	Blue-Action *will comply* with open data policy to maximize the impact and ensure exploitability of data by other scientific communities and business user. Activities related to Earth observation data and other spatial data should comply at best with and build upon the existing Infrastructure for Spatial Information in the European Community (INSPIRE)". Blue-Action *will ensure* awareness on and knowledge sharing with the parts of the scientific community, weather or climate services that are challenged to comply with this policy.
Others	A number of barriers or obstacles to realize impacts have been identified but with *preventive measures identified to mitigate* these risks (Table 3.2).

2.2 Measures to maximise impact

a) Dissemination and exploitation of results

In order for Blue-Action to realise its full potential, and achieve all of the expected impacts, considerable effort will be made to enable effective engagement with all relevant target audiences, ranging from governments at national and European level to indigenous communities and to specific end-users. Appropriate methods of dissemination, communication and exploitation of the project results to these target audiences have been identified. Making these things integral to the way in which Blue-Action will be run will ensure maximum benefit for society.

Several work packages across the project will have responsibility for establishing processes for:

- **Engagement** with business sector end-users (WP5 and WP8), indigenous communities (WP8), Government and policy makers (WP8) and the public (WP8), with the specialist research community (WP1-4), wider scientific community (WP6),
- **Dissemination and Exploitation of the project results** to business sector end-users (WP5 and WP8), to Government (WP8) and scientific communities (WP1-4, 6) and to the public and other target audiences (WP8). WP8 will oversee the project strategies and WP7 leads on Data Management (D7.3)
- **Communicating** the overall project and the results to business sector end-users (WP8), to policymakers and scientific communities (WP1-4,6) and to the public and other target audiences (WP8).

a1) Draft plan for dissemination and exploitation

Blue-Action will follow the definition of dissemination as "*the public disclosure of the results by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific*

[12] MPI is the major shareholder of the German Climate Computing Center (DKRZ Gmbh).

publications in any medium"[13]. Project results will be disseminated throughout the course of the project, as well as after the completion of the project. Table 2.2 a1) shows the multi-layered dissemination strategy to be followed, which identifies clearly delineated strategies for each target audience. The translation of Table 2.2 a1) to the work programme is in the WP deliverables for WP5, 6 and 8.

The draft '**Plan for the dissemination and exploitation of Blue-Action results'** is given below. During the project, this draft plan will be used as the basis on which to develop 4 separate plans: one for engagement, one for dissemination/exploitation and one for communication. These individual plans will be consistent with each other, and will be overseen ultimately by the Project Office.

They are as follows:

- Communication and Dissemination Plan (D8.1 and D8.4) including the Engagement Strategy
- Exploitation plan (D8.12)
- Data Management Plan (D7.3)

Within these updated plans, much more detail will be given about specific requirements, target audiences, deadlines, methods, procedures and evaluation measures. These will then be used as working documents to ensure effective management of these activities and their integration into the project as a whole

Exploitation measures: The variety of dissemination measures outlined in the section above and the communication measures outlined in Section 2.2.5 will aid in the exploitation of Blue-Action products and results, in particular for:

- utilization in research activities which are not part of the project, as well as
- utilization for further development, creation and marketing of products/services and processes.

All partners will be actively involved in the exploitation activities. Indicatively, at this stage, the following exploitation measures will be adopted:

- Organisation of clustering activities with other scientific communities and projects (WP6)
- Open access of peer-reviewed publications
- Open access of Research Data (Pilot project of the EC)
- Transfer/Licensing of results

[13] EC Definition.

Table 2.2 a1) BLUE-ACTION Communication, engagement and dissemination matrix

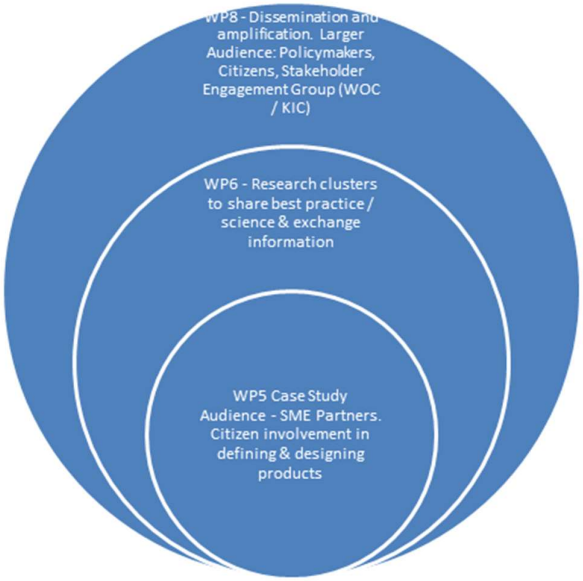
Target Audience	Objectives	Content / Message	Tools	Expected frequency	Responsibility
National and European governments, policy makers, European Commission services, national services, **Transatlantic Ocean Research Alliance**	Inform future climate policy, Provide tools for greater understanding of the impact of Arctic changes on the weather and climate of the Northern Hemisphere, fostering use of results for policy action	Project progress and results, Contribution to international committees e.g. IPCC	Policy briefings to Members of European Parliament, Face to face contact via existing members of e.g. IPCC steering groups / committees	See WP8 planned deliverables	WP8, Project office
Indigenous communities (Sami and Inuit)	Receive critical feedback, Enhance adaptation, Ensure maximum societal benefit through the provision of improved climate information, Raise awareness	Project results and implications tailored for a broader non specialistic audience, Feedback from the communities involved	Feedback from Societal Engagement Group (SEG)	See WP8 planned deliverables	WP8, Project office
Environmental NGOs Such as Greenpeace and BirdLife	Receive critical feedback, fostering use of results for societal action, Ensure maximum societal benefit through the provision of improved climate information	Project results and implications tailored for a broader non specialistic audience, Feedback from the NGOs involved	Feedback from Societal Engagement Group (SEG)	See WP8 planned deliverables	WP8, Project office
Business sector end users (emerging business actors and established business actors)	Ensure project outcomes are relevant and in a useable format, Create market demand for products/services developed, Ensure weather-dependent industries quickly understand the project objectives and potential impacts, Exchange knowledge, Ensure maximum societal benefit	End user products and services available, Project progress and results, Relevant end user documentation, literature and/or publications	Case studies and reports of these (WP5), Website and social media, Roadshow, Meet and Pitch, Panel discussions at business events, Product /service specification sheets	See WP8 planned deliverables	WP5 and WP 8, Project Office All partners
Specialist and wider scientific community	Exchange knowledge, Maximise impact and exploitation, Integration of the project with other projects	Project progress and results	Scientific conferences and project annual meetings, peer-reviewed journal articles	Regular publication of scientific findings (open access), Annual project meetings	WP6, WP8, Project office, All partners

Target Audience	Objectives	Content / Message	Tools	Expected frequency	Responsibility
European and, international initiatives and projects such as YOPP, Copernicus World Climate research programme and	Share resources, ensure synchronisation of activities for addressing open science questions, develop a shared understanding of the project and results, demonstrate the value added through collaborative working	Project progress and results, Feedback from the communities involved	Two-way flow of information with existing projects: Joint activities planned in WP6 such as Gap Maps, joint-seminars and contribution to specific deliverables	See WP6 planned deliverables	WP6, Project Office
Higher education course leaders and **Meteorological Office Training facilities** delivering climate science	Ensure knowledge is passed on through education, Improve the professional skills and competencies of those working in the specific topic areas covered by the project, tackling skills gap of workforce	Project progress and results, Open access to publications and data	Training sessions and webinars, combined with project meetings, Annual meetings, Webinars, Training modules, Summer schools, existing European Training Networks	See WP8 planned deliverables	WP8, All, Project Office
Public and wider society interested in science projects and results, and/or climate change research	Enhance adaptation, Ensure the project visibility, Ensure maximum societal benefit through the provision of improved climate information, Raise awareness, Achieve visibility for the project and its results	Project results and implications tailored for a broader non specialistic audience	Website, Social Media (Twitter and other social media platforms), Public lectures and presentations, Press releases and media coverage	See WP8 planned deliverables	WP8, Project Office
Project partners	Ensure an effective and integrated project, Keep all partners actively involved in the project, Timely identify and protect any Intellectual Property	Communication and dissemination Plan (internal communication section), Progress and results of WP, Complementary research / project results	Intranet, Web and teleconferencing, Project meetings, Work Package meetings	Regular updates to intranet and email communications, Annual project meeting, , Quarterly video/tele-conference on scientific updates	Project office (WP7) and WP8

Early in the project we will define a strategy for *knowledge management, protection and for the exploitation of results,* i.e. the **Exploitation Plan** (D8.12). The Plan will contain a more detailed list of the measures for the set up and the implementation of an exploitation strategy to be adopted by the entire consortium, defining procedures and responsibilities within the consortium. Regular updates of the Plan will be submitted to the European Commission as an integral part of the Progress Reports.

End-user engagement: The end-users will be central to the work done and will provide the expert sector knowledge which will determine the way in which their project develops, assist in determining the most effective dissemination and communication methods for their groups, enabling maximum exploitation, ensuring that their feedback is incorporated at the decision making level. They will be actively involved in Blue-Action in three complementary ways:

How we work with end-users	Users involved	Work package
Directly taking part in the creation of new services and products for their specific sectors, sitting directly in the decision-making body of the project (General Assembly)	Marine fisheries, tourism, shipping, oil and gas extraction, health sector	In WP5 (all tasks)
By engaging with them through the Climate KIC and the WOC (business sector) and by targeting actions at the European Parliament level (KDM)	Business sector, and policy makers through joint activities	In WP8 Task 8.5 and 8.6
By engaging key representatives of the Inuit and Sami community at SEG level, opening up for a dialogue and their a critical review of the project results	indigenous communities	In WP8 Task 8.7
By engaging key representatives at SEG level, opening up for a dialogue and their a critical review of the project results	Environmental NGOs such as Greenpeace and BirdLife International	In WP8 Task 8.7



Public Engagement: Public engagement is a two-way dialogue, in which researchers converse with members of the general public in a mutually beneficial manner. Any activity that involves engagement with businesses, public and third sector services, the community and the wider public, and which is monitored for funding purposes falls within this category. Within Blue-Action there are specific actions under WP8 that envision public engagement as part of the delivery of the project

a2) Measures for achieving impacts

The innovation of products, services and business is deeply linked to Europe's future economic growth. Target, audience and messages of the communication strategy will be clarified before deciding on the most appropriate media. With the appropriate choice of the tools Blue-Action aims to demonstrate how research contributes to an **European Innovation Union** and how the public spending through collaborative research and innovation actions add value by 1) showing how the European collaboration achieves more than would have been otherwise possible, contributing to competitiveness and solving societal issues; 2) showing how the outcome are relevant for our lives by introducing novel technologies and creating new jobs; 3) making better use of the results by making sure that they are taken up by decision makers to influence policy making and by the business sector and the scientific community to ensure impact.

a3) Management of Research Data generated/collected during the project

The consortium agreement (CA) will regulate the ownership and access to key knowledge (IPR, data etc.), open access to research data collected and generated during the project, and scientific foreground. The CA will be set up after the communication of the approval of the project by the European Commission and in principle before the signature of the Grant Agreement with the European Commission. For the management of research data we have established a specific task in WP7: our project participates in the pilot on open research data and thus follows **the Global Earth Observation System of Systems (GEOSS) Data Sharing Principles**. We will thus **register in GEOSS the geospatial data, metadata and information generated as part of the project**. The table below shows a summary presenting per WP which data will be generated, stored, standards applied, curation and preservation and exploitation measures.

WP1-4	What types of data will the project generate/collect?	Predefined, defined model output and reanalysis data will be generated by adhering to open standards, netcdf CF and CMIP6 conventions.
	Where do you expect to store these data? (repositories)	These data will be mainly stored using computing facilities available for the partner institutions. A subset of outputs will be stored at Earth System Grid Federation (ESGF) nodes stores. Reanalysis data stored by ECMWF and Climate Data Store of C3S.
	What standards will be used?	Netcdf standard will be used, with the CF convention. Metadata will be provided according to CMIP6 standards with CMOR for most outputs.
	How will this data be exploited and/or shared/made accessible? If data cannot be made available, explain why.	Model and reanalysis data will be distributed using existing repositories (ESGF, C3S), or through other distribution procedures supported by participating institutions or national facilities (BADC, DKRZ), also beyond the lifetime of the project. Derived data will be described in publications.
	How will this data be curated and preserved?	The derived model and reanalyses data will be preserved by using computing facilities available at each of the participating institutions or national facilities (BADC, DKRZ).
WP5	What types of data will the project generate/collect?	Model-based projections of case-study specific variables e.g. temperature related human mortality, polar low probabilities, distribution of pelagic fish. Stakeholder data requirements. Economic data used to estimate the value of climate services.
	Where do you expect to store these data? (repositories)	Data generated in this work package will be stored by the individual PIs.
	What standards will be used?	Gridded model outputs will use the netcdf standard with the CF convention where appropriate.
	How will this data be exploited and/or shared/made accessible? If data cannot be made available, explain why.	Generated data will be described in publications, where possible such that the provenance and procedures for accessing the data are clear. Data confidential to business partners will follow the projects data policy.
	How will this data be curated and preserved?	Generated data will be curated and preserved by the individual case-study PI's.
WP8	What types of data will the project generate/collect?	Customer contact data and a centrally held record of intellectual property created under the project
	Where do you expect to store these data? (repositories)	Customer contact details will be stored in a password protected Excel spreadsheet on the online system PowerFolder which will enable the project partners to access and update the information. Intellectual property will be recorded by each partner and also stored in the PowerFolder structure
	What standards will be used?	EU Data Protection Directive will be used to control the use of

		personal information and an opt-in process will be utilised for contacts wanting additional information about the project. PowerFolder is a secure storage facility, providing Industrial standard AES/RSA encrypted transfers between servers and clients, RSA device authentication and verification and password protection.
	How will this data be exploited and/or shared/made accessible? If data cannot be made available, explain why.	The data will be securely stored in the cloud and accessible to work package leaders and project partners
	How will this data be curated and preserved?	Contacts will be given the opportunity to 'opt-out' of communication each time they are contacted using email communications. Opt-in requests (new contacts) will be added to the customer database by individual project partners. Opt-out requests will be handled centrally by the communications manager. At the end of the project, data will be returned to the partner with whom the initial contact was made (or the most relevant partner if the contact was generated through WP8 communications activities e.g. the project website). The IP data will be reviewed on a quarterly basis by the communications and project managers to ensure all outputs are captured and exploitation opportunities are maximised.

a4) Strategy for Knowledge Management and Protection

Intellectual property is a valuable asset for Blue-Action partners. It is anticipated that the value of the Intellectual Property (IP) produced by this project lies in the ability to produce a number of diverse tools/ products. The strategic use and management of IP is essential for strengthening the European scientific and technological base, boosting innovation and ensuring growth in the EU. The impact of the project is dependent on an informed and consistent approach to the management of Intellectual Property generated by the different teams. The strategy will be modulated to cover the entire lifecycle of the project:

- Before the start of the project
- During the implementation phase
- After the closure of the project

Before the start of the project: A **Consortium Agreement** (CA) will be worked out by the project office as soon as the project is invited by the EC to "grant preparation" and its preparation[14] will run in parallel with the preparation of the grant agreement. The partners have agreed to adopt the **DESCA** Model Consortium Agreement for Horizon 2020 project. The CA will regulate the relation between consortium members and:

- **Regulate Intellectual Property Rights** (IPR); responsibilities for the internal management of IP, additional rules on future exploitation and dissemination of results, access rights to Background IP and results;
- Contain a list of the **identified background IP:** In the CA the partners will identify the background in writing (i.e. tangible or intangible inputs such as data, knowhow, information which is held by the project partners prior to their accession to the CA);
- **Regulate use of Foreground generated and ownership of results,** indicating appropriate measures to properly manage ownership issues, such as keeping documentary evidence (e.g. a properly completed Invention Disclosure Form) and how to regulate joint ownership, should the situation arise;
- **Regulate liability, indemnification and confidentiality arrangements**;

[14] The CA will be drafted in compliance with the European Commission Guidance on "How to draw up your consortium agreement". V2.0, 23 February 2015

- **Indicate how to settle possible internal disputes**.

Each project partner has the right to request access rights to the other project partner's background and results as long as it **needs** them in order to carry out its work under the project or to use its own results (these are **minimum access rights**). To avoid conflicts, partners will agree in the CA on a common interpretation of what is "needed". Access rights are granted throughout the duration of the project for exploitation needs. Once requested, access rights may be exercised as long as they are needed for exploiting the results (e.g. until the background patent expires). Access to **background IP** and to the **results** needed for the project implementation will be granted **royalty-free** to the partners.

During the implementation phase: As indicated in Section 2.2, the Exploitation Plan (D8.12) will be defined for the entire consortium in the early stage of the project. The strategy will be devised with the focus on the objective of practical development and exploitation, but always taking into account the legitimate interests of the beneficiaries where there may be good reasons for wider dissemination and academic publication of aspects of the work. The strategy will be based on the following **principles:**

- **Disseminate and share:** Project partners will be obliged to disseminate the results swiftly (i.e. to scientific community/broader public) by any appropriate means and including the publication of results in any medium. A dissemination checklist will be developed in the early stage in WP8 for the use of the partners to reminder them of the steps and actions to be undertaken for dissemination of results.
- **Exploit and protect:** We will set up clear and efficient procedures for rapidly protecting new results and agreeing on dissemination, hereby ensuring that no information is published which could be detrimental to the protection of some results. Project partners will be supported by the project office in examining the possibility of protecting their results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if (a) the results can reasonably be expected to be commercially or industrially exploited and (b) protecting them is possible, reasonable and justified (given the circumstances).
- **Identification and collaboration with potential users** for multiplying the effects of exploitation.

The choice of the most suitable form for protection of IP will be made on the basis of the specificities of the results. Indicatively, for the protection of the intellectual property we will focus on the following measures:

Protection measures / **Expected IP**	Patent	Utility model	Industrial design	Copyright	Trade mark	Confidential information
Scientific articles				X		
Name of the tools					X	
Design of the products/services in WP5			X	X		
Tools in WP5	X	X				X
Know-how	X	X				X

In some cases (case studies in WP5 for instance), we will keep the information confidential for allowing further development while avoiding the negative consequences related to premature filing. Income generated by exploiting the results of the project (e.g. the IPR) is not considered a receipt since successfully exploiting the results is one of the main objectives of the action.[15] Applications for protection will include mentioning of the reference to the EU funding set out in the Grant Agreement.

a5) Measures to provide open access

Open access to peer-reviewed scientific publications

As stated by the European Commission in the Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020 "*Modern research builds on extensive scientific dialogue and advances by*

[15] Annotated Grant Agreement, Art. 30.

improving earlier work". The Europe 2020 strategy for a smart, sustainable and inclusive economy underlines the central role of knowledge and innovation in generating growth. Fuller and wider access to scientific publications and data therefore help to build on previous research results (improved quality of results); foster collaboration and avoid duplication of effort (**greater efficiency**); accelerate innovation (**faster to market = faster growth**); involve citizens and society (**improved transparency of the scientific process**). For these reason, Blue-Action scientists will ensure that electronic copies of peer-reviewed scientific publications become freely available to anyone as soon as possible and in all cases **no later than six months after publication.**

As a general rule, we will privilege Open Access Journals for publishing our articles. A comprehensive list of the journals is provided by the Directory of Open Access Journals http://www.doaj.org. Authors will avoid signing any copyright agreements with publishers that do not allow them to fulfil the EC Open Access requirement. If, for any reason, our scientists prefer to publish their articles in journal which are not Open Access Journals, authors will pay the extra fee for fulfilling the EC Open Access requirement, opting thus for the so called **Golden OA option**. The publisher will provide open access to the article and the authors can deposit it immediately in open repositories. The authors will send a copy of the publication to the project office, for its publication on the project website and for dissemination within the consortium. If the Golden OA is considered too expensive for the budget of the partner, or if it is not offered by the chosen publisher, the **Green OA option** will be applied. In this case, authors deposit their final manuscript or the published article in an institutional or subject-based repository. In this case, the publisher's policy allows the author to archive the final manuscript in a repository, before peer review (pre-print version) or after peer-review (post-print version). In order to apply this option, authors will first retain their copyright and provide the publisher with a license to publish, instead of signing a simple copyright transfer agreement (CTA).

Articles will be made available: 1) in the **institutional repository** of the institutes where the authors work. Scientists will provide communication to the project office with indication of the open repository used; 2) in the **subject repository for the specific topic of the article**, when available; 3) on **OpenAIRE** www.openaire.eu and on **Zenodo** www.zenodo.org; 4) on the Blue-Action website.

Open Access Data Pilot for Research Data: Open access to research data refers to the right to access and re-use digital research data under the terms and conditions set out in the Grant Agreement. Openly accessible research data can typically be accessed, mined, exploited, reproduced and disseminated free of charge for the user. **We agree to participate on the Open Access to Data Pilot established by the European Commission on a voluntary basis and agree to include the Art.29.3 to the Grant Agreement.** A Data Management Plan (D7.3) will be established in project month 6 and based on the consensus and inputs of all partners. The document will outline how the research data collected or generated will be handled during the project, and after it is completed, following what methodology and standards, whether and how these data will be shared and/or made open, and how they will be curated and preserved.

At the end of the project and after its closure: All results from the project will be published after exploration of possibilities for patenting specific products produced in Blue-Action. Blue-Action will close with a number of publications, all project results will be published on the Blue-Action website.

- **Dissemination measures *in the closing phase* of the project:** The final report of the project will include a plan for the use and dissemination of foreground, to demonstrate the added value and positive impact of the project on the European Union. A final publishable summary of the results will be made available to the European Commission for dissemination in the public domain. This will include information on expected results, and their wider societal implications. The text will be drafted in a way to be understandable for a lay audience. In addition, a major closing event, including all stakeholders, and a possible event in Brussels for stakeholders on the European level will be conducted.
- **Dissemination measures *after the closure* of the project:** After the official end of the project, the foreground of the project will be available as a web-based archive for all interested actors. The domain name of the project website will be assigned to the Coordinator. The website archives all documentation related to the project, including publications, and will be accessible for a minimum of 5 years after the end of the project.

- **Exploitation *after the closure* of the project:** Each beneficiary must - *up to four years after the project completion*- take measures aiming to ensure 'exploitation' of its results (either directly or indirectly, in particular through transfer or licensing by: (a) using them in further research activities (outside the action); (b) developing, creating or marketing a product or process; (c) creating and providing a service, or (d) using them in standardization activities (**General obligation to exploit)**
- **Transfer/Licensing of results**: Each beneficiary may transfer ownership of its results within the EC rules. A beneficiary that intends to transfer ownership of results must give at least 45 days advance notice to the other beneficiaries that still have (or may request) access rights to the results. Unless agreed otherwise, any other beneficiary may object within 30 days of receiving notification, if it can show that the transfer would adversely affect its access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

b) Communication activities

Communication goals in Blue-Action are the following:

- **showing how European collaboration has achieved more than would have otherwise been possible**, notably in achieving scientific excellence, contributing to competitiveness and solving societal challenges;
- **showing how the outcomes are relevant to our everyday lives**, by creating jobs, introducing novel technologies, or making our lives more comfortable in other ways;
- **making better use of the results, by making sure they are taken up** by decision-makers to influence policy-making and by industry and the scientific community to ensure follow-up.

Our communication activities will start at the outset of the action and continues throughout its entire lifetime, will be strategically planned, identify and set clear communication objectives, choose pertinent messages targeting and being adapted to audiences that go beyond the project's own community, by using relevant medium and means. Communication covers:

- **Internal Communication** (e.g. collaboration platforms, etc): an intranet will ensure smooth and timely communications between the project partners and to capture and share the project outputs, to ensure the project maintains scientific excellence and all partners remain abreast of new developments in the sector. The partners will post details of new intellectual property or associated applications as they become known.
- **Communication of the project**: making the project visible through the website and social media.
- **Communication of project results (e.g. dissemination)**: The tools previously outlined in the Matrix in Section2 will be used for disseminating project results as soon as these are available.

WP8 will provide an update to the outline below by producing a Communication and Dissemination plan (D8.1 and D8.4). The updated plan will contain more detail about targeted audiences and activities, and will include monitoring and evaluation measures. Those measures will then be reported against when updates are provided to EC as part of the periodic reports. The results are likely to be of interest to the media, and so in co-ordination with the Press Offices of the partner institutions and in line with Open Data principles, the project will decide how to manage ad hoc media enquiries, routine communication of research results and negative media coverage, amongst others.

Information of EU funding: In compliance with the Grant Agreement (Art. 27, 29.4 and 38), all partners will ensure that every dissemination result will display the EU emblem and indicate clearly that the project has received funding from the Horizon 2020 research and innovation programme.

3. Implementation

3.1 Work plan — Work packages, deliverables and milestones

3.1.1 Brief presentation of the overall structure of the work plan

Aligned with the objectives in Section 1, the programme will be delivered by 8 Work Packages, where work packages 1 to 4 form a science core to address **Objective 1 to 6**. Central interactions exist between WP2 and WP3 focussed on drivers and impacts of Arctic Change (**Objective 2, 3 & 4**), improved descriptions of

processes, Arctic-lover latitude linkages and the uptake of data. WP4 builds on achievements of WP2 and WP3 for delivering an enhanced predictive capacity (**Objective 2**). WP4 also contributes generic prediction

Table 3.1a – Work Package Titles and Leads

WP	WP title	Lead Scientist	Lead Institution		Co-leads
			Abbr.	Full Name	
1	Improving seasonal long range forecast skill of risks for hazardous weather and climate events	Johanna Baehr	UHAM	Universität Hamburg	Jens Hesselbjerg Christensen /Danish Meterorological Institute
2	Lower latitude drivers of Arctic changes	Karin M. H. Larsen	HAV	Faroe Marine Research Institute	Gerard McCarthy/NERC-National Oceanographic Center
3	Linkages of Arctic climate changes to lower latitudes	Yongqi Gao	NERSC	Nansen Environmental and Remote Sensing Center	Guillaume Gastineau/CNRS
4	Enhancing the capacity of seasonal-to-decadal predictions in the Arctic and over the Northern Hemisphere	Daniela Matei	MPI	Max Planck Gesellschaft zur Foerderung der Wissenschaften e.V.	Noel Keenlyside/University Bergen
5	Developing and Valuing Climate Services	Mark R. Payne	DTU	Technical University of Denmark	Kathrin Keil/ Institute For Advanced Sustainability Studies e.V.
6	Clustering for blue growth	Steffen M. Olsen	DMI	Danmarks Meteorologiske Institut	Jens Hesselbjerg Christensen /Danish Meterorological Institute
7	Management	Steffen M. Olsen	DMI	Danmarks Meteorologiske Institut	Jens Hesselbjerg Christensen /Danish Meterorological Institute
8	Communication, Dissemination, Engagement and Exploitation	Raeanne Miller	SRSL	SAMS Research Services Ltd	Peter Vangsbo Normann/Climate KIC

Table 3.1b. List of work packages

WP	Work Package Title	Lead participant		Person-Months	Start Month	End month
		Num	Short name (lead, co-lead)			
1	Improving seasonal long range forecast skill of risks for hazardous weather and climate events	33	UHAM / DMI	124	1	48
2	Lower latitude drivers of Arctic changes	12	HAV / NERC	165	1	48
3	Linkages of Arctic climate changes to lower latitudes	28	NERSC / CNRS	179	1	36
4	Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere	21	MPI / UIB	170	1	48
5	Developing and Valuing Climate Services	9	DTU-AQUA / IASS	156	1	48
6	Clustering for blue growth	1	DMI	31	1	51
7	Management	1	DMI	65	1	51
8	Communication, dissemination, engagement and exploitation	32	SRSL / Climate KIC	76	1	51
			Total months	966		

system improvements (**Objective 2 & 4**) and in particular on aspects of model initialization and uptake of data (**Objective 6**). WP1 advances the forecast skill of hazardous weather and climate events (**Objective 1**), linking the time-scales of approach across the project. This facilitates the full uptake of enhanced capacity for a range of stakeholder (WP5, **Objective 7**). WP6 and WP8 embrace the core of the project and ensure transparency internally (WP8), to the wider scientific community and related projects (WP6, 8). Efficient transfer of knowledge to arctic and non-arctic stakeholders is at the core of WP8 (**Objective 8)**. The overarching coordination and management of the project (WP7) includes an internationally renowned Research and Innovation Advisory Group (RIAG) working close together with the management.

3.1.2 Gantt chart: Timing of the Work Packages. Deliverables, Milestones and Reports

	Month	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8		Control points	Project meetings	Reviews RIAG	Reviews SEG
Year 1	1							D7.1	D8.3, D8.5	Reporting Period 1				
	2											KO		
	3							D7.2	D8.1, D8.2		MS2			
	4					D5.1					MS1			
	5							D7.3						
	6								D8.4, D8.6		MS3			
	7													
	8													
	9													
	10													
	11					D5.2, D5.3								
	12					D5.7, D5.11, D5.16, D5.20			D8.7, D8.12			AM		
Year 2	13						D6.1							
	14							D7.4						
	15								D8.11					
	16													
	17													
	18					D5.21								
	19													
	20									Reporting Period 2				
	21													
	22													
	23													
	24	D1.1		D3.1, D3.2, D3.5	D4.1		D6.5		D8.8 , D8.13			AM		
Year 3	25													
	26							D7.5						
	27													
	28													
	29													
	30		D2.5, D2.6			D5.22	D6.2							
	31													
	32													
	33													
	34													
	35													
	36		D2.1, D2.2, D2.4	D3.3, D3.4	D4.2, D4.3	D5.8, D5.17	D6.4		D8.9			AM		
Year 4	37													
	38							D7.6						
	39													
	40						D6.3							
	41													
	42		D2.7, D2.8											
	43													
	44													
	45					D5.18								
	46					D5.4, D5.5, D5.14			D8.14					
	47					D5.6								
	48	D1.2, D1.3, D1.4			D4.4	D5.9, D5.10, D5.12, D5.13, D5.15, D5.19, D5.23, D5.24			D8.10			AM		
Year 5	49													
	50								D8.15, D8.16					
	51													

Legend D= deliverables MS= milestones WP= work packages AM= project annual meeting

Pert Chart: A graphical presentation of the components showing how they inter-relate is presented in section 1 (Figure 1.2) and will not be repeated here.

3.2 Management structure and procedures

3.2.1. Organizational structure and decision-making

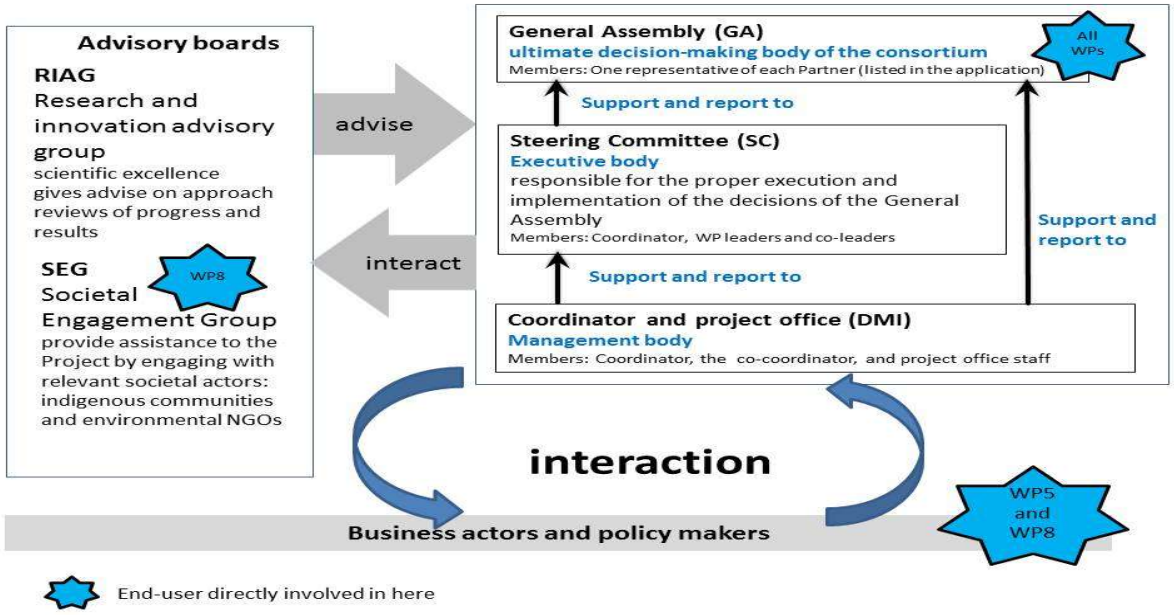


Figure 3.1 Organisational structure and interaction with the end -users

The structure that has been adopted follows the DESCA Model Consortium Agreement for Horizon 2020 projects (the model favoured by the Coordinator's Institution), and specific roles and decision making responsibilities have been assigned accordingly. Further detail about these, and all of the components illustrated in Figure 3.1 are given below. In summary:

- The **General Assembly** is the ultimate decision making body. This will be chaired by the Coordinator and will consist of all partner organisations.
- The **Steering Committee** will be the supervisory body ensuring successful execution of the project, and will be accountable to the General Assembly. This will be chaired by the Coordinator.
- The **Coordinator** is responsible for the overall coordination of the project and will act as the point of contact for the European Commission (EC). The Coordinator has ultimate responsibility for ensuring that the project delivers what is expected and oversees the scientific content of the project and ensuring that all work packages are contributing to the outcomes and scientific excellence
- The **Project Office will co**nduct the routine management of on behalf of the General Assembly.
- The **Work Package Leaders and their co-leaders** have a responsibility to ensure delivery of their Work Pa**ckage objectives**, deliverables and milestones, working closely with the Coordinator to support the outcomes of the project.
- The **Research and Innovation Advisory Group (RIAG)** is a group of independent experts, whose role is to provide advice on project progress and plans.
- The **Societal Engagement Group (SEG)** will influence the direction of research and advice on project activities and priorities from a societal perspective with a specific focus on involvement of indigenous communities and environmental NGOs.

Given the size of the project, in terms of content and of number of partners, there is a strong need for an organization structure which allows well-defined decision-making mechanisms and flexibility in the management/implementation of the activities at different levels (work package and tasks), as well as coordination across WPs.

Decision making: The General Assembly (GA): The GA is the top-level decision-making body. It is composed of one representative from each of the consortium partners and chaired by the coordinator. The GA is reported to by the SC and makes the final decisions on issues presented by the SC. The GA will meet at the annual project meetings, in addition to communication through conference calls and email as necessary. Any decisions affecting the overall course of the project will need to be approved by the GA.

Executive: The Steering Committee (SC): The SC is the core executive body that deals with the supervision and execution of the project and will meet every 3 months (telcos). It is composed of the WP leaders and the co-leaders, and chaired by the coordinator (Figue 3.1). The SC retains an overview of the project activities, identifies issues and suggests decisions to the GA. It coordinates communication and execution of GA decisions to the consortium and reports to the GA regarding the status of deliverables, milestones, reporting, risk management and general progress. The SC makes sure that communication is running smoothly within the project, and also to the advisory bodies. It is responsible for tracking the progress of individual deliverables, milestones, and regular reporting, capturing IP, managing and protecting the project outputs. The steering committee will also oversee the promotion of the ethical aspects and the gender equality in the project.

Management: the Project Office and the work package leaders
The management is carried out by the **Project Office**; this is composed of the following**: Project Coordinator** Steffen M. Olsen (DMI), **Deputy Project Coordinator** Daniela Matei (MPI), **Project Manager** (to be recruited, at DMI) **and a Financial Manager,** Katrine Sandvad (DMI).

A core team of staff with different profiles (i.e. scientific, management and financial) will be in charge of the project at the coordination level:

- lead and coordinate the different aspects of project management including the science, internal communication, administration (financial and legal services)
- Support innovation management (see Table 3.2.3)
- facilitate quick response times to any issues, requests, or needs for information and clarifications on the daily implementation of the activities
- providing support and planning tools for WP management
- scheduling and organising meetings for the project
- maintaining regular communication with the EC
- managing, monitoring and reporting of project finances and budget; management of risks, benefits and issues registers
- reporting on Gender strategy

Work Package leaders (WPL) and co-leads: WPLs play a key role in the scientific management at the WP level, which allows the Coordinator to use their feedback to successfully take the overview of the project. WPLs will also be supported by their Co-Leaders, Task Leaders and deliverable leaders, to make sure that all deliverables are provided according to the work plan. Work Package Leaders (WPL) and Co-Leaders have been appointed. WPLs will have autonomous responsibility for coordinating the tasks within their WP, which contribute to the delivery of objectives and impacts. The WPLs will:

- support the scientific coordination of the project as a whole.
- ensure that the planned work at WP level is carried out according to plan and budget and that the deliverables are produced and milestones are attained on time;
- monitor and report on progress of their WP including highlighting any departure from the work plan, disputes or difficulties as early as possible
- establish a link with the project coordination
- ensure that decisions taken at steering level are implemented at WP level
- assist with exchanges with other projects and the scientific community.

To achieve these aims, the WPLs will arrange annual face to face, and other more regular teleconference meetings between those involved in their WP, and will communicate regularly with the Coordinator.

External advisory bodies: RIAG and SEG

Research and Innovation Advisory Group (RIAG) is the advisory board meant to:

- provide guidance and support regarding the scientific quality and innovation
- provide high, strategic level guidance, support, and advice on innovation management issues, especially with respect to the scientific relevance and transferability of products and tools
- help maintain scientific excellence in the program
- perform yearly internal reviews of progress and results from an independent, external perspective. Minutes of the RIAG will be be available to the EC.
- help promote the project activities beyond the project own scientific community

Composition & members: internationally respected experts in a range of fields, reflecting the transdisciplinary nature of the project that can provide advice as to the project's scientific approach and activities. These experts have already been identified and have agreed to form the RIAG:

- **Darlene Langlois** (female), Chief of Operations at Canadian Ice Service, Chief of Satellite Analysis and Ice Forecasting. Darlene is an expert in Satellite image analysis for sea ice, lake ice, icebergs and oil on water, sea ice and lake ice forecasting.
- **Guy Brasseur** (male), Chair of the Joint Scientific Committee World Climate Research Programme (WCRP), former Director at the Max Planck Institute for Meteorology, associated director at NCAR, founding Director of the Climate Service Center (now GERICS) in Hamburg.
- **Mike Steele** (male) [16]is an expert in large-scale circulation of sea ice and water in the Arctic Ocean, and collaborates with biological oceanographers to better understand how changes in ocean salinity and temperature are affecting arctic plankton and thus the marine ecosystem
- **Francis Zwiers** (male), Director, President and CEO of the Pacific Climate Impacts Consortium (PCIC), a climate service organization at the University of Victoria that interacts extensively with stakeholders, providing them with the information they need to develop plans for reducing the risks associated with climate variability and change. PCIC has a range of research interests and capabilities that are relevant to Blue-Action project.
- **Jean-Noel Thepaut** (male) is the Head of the Copernicus Climate Change Service, a Service operated by the European Centre for Medium Range Weather Forecasts (ECMWF) on behalf of the European Union.
- **Tom Reynolds** (male)[17] is a legal advisor and manger at the Research and Enterprise Contracts unit at a major European university. Tom is an expert on management and commercialisation of research results and IPR, commercialisation opportunity reviews, IP audits and assessments; advising on policy, strategy, systems and structures; undertaking the IP commercialisation itself; and providing operational and negotiation support.
- **Katrine Krogh Andersen** (female) former senior Advisor on Climate Change, Danish Ministry of the Environment and Danish Ministry of Climate and Energy, Director of Research and Development, Danish Meteorological Institute. Kartrine is on the Executive Council Panel of Experts on Polar and High Mountain Observations, Research and Services (EC-PHORS) under WMO and recently joined the international steering committee for the Polar Prediction Project (PPP) and Year of Polar Prediction (YOPP). She is on the Danish delegation to the IPCC and has served on a number of internatioal research coordinating committees.

Societal Engagement Group (SEG) is the advisory board meant to:

- open up a dialogue between the represented communities and the project, for the project to receive **critical feedback** on development and results and how these can provide a feed from the communities' existing agendas.

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[16] Formally independent from the units involved in UoW involved in WP2 and WP8. Thus there is no conflict of interest for Mike to provide independent advice under the RIAG to the consortium.

[17] The Research and Enterprise Unit of UREAD is formally independent from the Mathematics Department involved in WP4. Thus there is no conflict of interest for Tom Reynolds to provide independent advise under the RIAG to the consortium.

- Providing an additional channel of communication for improve usage of data and information by the communities for enhancing climate adaptation.
- This approach of getting a SEG as independent advisor is consistent with both the EU's commitment to Science Education within the Responsible Research and Innovation (RRI) agenda and the wider aims of citizen science.

Composition & members: one representatives of the Inuit indigenous community, one of the Sami community and one representative of an environmental NGOs. The following have already accepted to become members of the SEG:

- **Liisa Holmberg** (female) rector of Sami Education Institute in Inari http://www.sogsakk.fi/) Liisa has a lot of experience with research projects in providing advice on societal impacts of research for the Sami community. Liisa is Vice Chairman of the Council of the University of the Arctic, member of the Advisor Board of the Arctic Centre, University of Lapland in Finland, and was Sámi Parliament MP in 2008-2011.
- **Lene Kielsen Holm** (female), Scientist and project leader in the climate centre's communication team and social science professorship, working for the Greenland institute of natural resources.
- **A representative of the Inuit Circumpolar Council (ICC)** Greenland. Contact has been made and a representative will be appointed as soon as the project is approved. The ICC carries out several activities related to public information tours in Greenland for raising awareness on rights and involvement of the Inuit society in Industrial development and on how to avoid possible damage of the environment, securing direct and meaningful participation of the civil-society and respect of human rights and at least the rights of the indigenous peoples.
- **Jon Burgwald** (male) representative for Greenpeace, has led Greenpeace's work in Greenland since 2010 and prior to this been involved in Danish as well as international climate work. He has furthermore led, coordinated and consulted on projects in all Arctic countries – both regarding environmental issues and sustainable development in Indigenous communities.
- **A representative of BirdLife International**. Contact has been made and a representative will be appointed as soon as the project is approved. BirdLife International is the partnership for nature and people, running a specific Programme on Climate Change and energy transition.

Milestones plan

In order to help the Steering committee and the coordination to chart progress of activities, the following **intermediary control points** (=milestones) have been selected:

3.2.2 Appropriateness of the organizational structure and decision-making mechanisms

Due to the number of partners contributing to the project, the consortium considers itself to be a large project by the DESCA definition. Therefore, having one executive body **Steering Committee** and an articulated management structure (**Project office and WPL and co-leaders**) within the project is appropriate and will ensure that the project is well governed. Given the size of the project in terms of number of partners and tasks there is a strong need for an organization structure which allows well-defined decision-making mechanisms and flexibility in the management/implementation of the activities at different levels (work package and tasks), as well as coordination across WPs.

The **General Assembly** ensures that all partners involved in the project can have a voice in the decision-making and the direction of project. The **Steering Committee** collects inputs on specific topics from the advisory bodies, preparing the ground for the decisions of the General Assembly and being responsible for the execution of these decisions within the Consortium. The role of the **Societal Engagement Group** has been extensively explained in Section 3.2.1 and in the WP7 description: we consider it crucial for bringing forth new ideas and concepts for engaging with the society, bridging the gap between society and research. A similar role but more focused on the advancement in science will be played by the **Research and Innovation Advisory Group**: with the inputs of high-profiled scientists and innovators outside the consortium we will ensure that targets and activities are accordingly independently reviewed on a regular basis by experts in the field of the project. For each work package we have appointed a **Work Package Leader and co-leaders:** these will play a key role in the scientific management at the work package level, ensuring that the project is implemented according to the plan and runs on time and in budget.

3.2.3 Innovation management

In Blue-Action we have set up a clear structure (responsibilities and tasks see section 2.2) to provide an effective innovation management[18] throughout the lifetime of the project. Innovation management starts at the point of capturing the creative works and finishes when a product or service is deployed.

Table 3.2.3 Innovation Management Structure

Steps	Objectives	Tools	Responsibilities
Step 1-Secure the foundations	Ensure good practices and record keeping	Consortium Agreement, Exploitation Plan	Lead: Steering Committee Support: Project Office and all partners
Step 2-Capture the project outputs	Proactive monitoring of research outputs, Ensuring that each researcher timely recognizes and captures her/his Intellectual Property	Adequate training on IP provided to all Blue-Action scientists (WP8) and standard disclosure forms (WP7)	Lead: WP managers Support: Project Office and all partners
Step 3-Manage and protect the project outputs	Assessment of opportunities for exploitation, and verification if the IPs benefit from protection	Timely involvement of the legal teams at partner and coordinator level	Lead: Steering Committee and Project Office Support: legal advisors of the partner institutions
Step 4-Disseminate, Exploit, and Communicate the project IP	Coordination of dissemination and exploitation plans to avoid conflict	Internal communication, Exploitation Plan (WP8)	Lead: WP8 and project office Support: public relations officers and legal advisors of the partner institutions

Key factors for successful innovation management are: 1) clear tasks and responsibilities in the governance structure; 2) highly motivated multidisciplinary teams involving industry, vertical integration and set up of tactical alliances with end-users; 3) the ability and willingness to act with flexibility for facilitating multiplication of potential applications and users (i.e. “freedom” of teams and “openness” to ideas).

3.2.4 Risks and risks management

The GA will be responsible for dealing with risks, issues and benefits realization of the project. The Coordinator will be responsible for management of the risks within the project (WP7) and day-to-day maintenance of the risk registers will be undertaken by the project office.

Critical risks to project implementation, which have the potential to impact the project objectives being achieved, have been identified and described in Table 3.2.b below. They are risks that have been considered and that will be actively managed and monitored throughout the project. Where there are risks that exist specifically within individual WPs, these have been identified already and the design of the WPs has taken account of preventative measures for each.

3.3 Consortium as a whole

To cover the topic “BG-10-2016: Impact of Arctic changes on the weather and climate of the Northern Hemisphere” calls for a truly EU wide and international approach. The scope of the call, “to develop innovative approaches to improving the descriptions and modelling of the mechanism, processes and

[18] EC definition “Innovation management is defined as the overall management of all activities related to understanding needs, with the objective of successfully identifying new ideas, and managing them, in order to develop new products and services which satisfy these needs”.

feedback affecting Arctic change and its impact on weather and climate of the Norther Hemisphere" goes beyond what any limited Arctic or climate prediction team can encompass. Only a rather large and complex consortium will be able to respond and actively involve relevant arctic and non-arctic stakeholders to boost innovation for Blue-Growth. The Blue-Action consortium consists of 32 partners from 12 different European countries (Member states and associated countries) and nine partners from elsewhere in the world (USA, Canada, China, Russia and South Korea); see Table 3.3a. The consortium participants display a wide diversity of types of actors in an alliance between weather and climate prediction centres, the ocean climate community, academic researchers, Arctic stakeholders and end-users of climate services. The consortium brings together some of the leading European Scientist within climate prediction, climate assessment, Arctic climate system modelling, atmospheric dynamics and marine climate research. They include large and small, public and private research institutes and universities, non-profit organisations and small, medium and large enterprises. This diversity supports the development of a strong public-private partnership in research and in linking research, policy and practice.

Table3.3a: Geographic distribution of the consortium broken down by region.

Region	Countries participating in the consortium
Northern Europe	Denmark, Faroe Islands, Finland, Iceland, Norway
Western Europe	Germany, France, Netherlands, UK
Southern Europe	Italy, Portugal, Spain
Other countries	Canada, China, Russia, South Korea, USA

Noting the competitive environment in addressing a European call, the composition of the consortium has been carefully constructed to ensure optimal balance and complementarity between partners in order to achieve the project objectives. It was assembled based on the quality of the research teams, the range of skills offered by the individuals within each team, previous experience of working within multi-disciplinary research projects, and diversity of locations offered by the teams (to ensure the partnership is able to develop comprehensive methods covering a range of scales and different locales). The consortium offers a wide range of complementary, disciplinary research skills, including: climate modelling, climate change impact and adaptation assessment, vulnerability hotspot analysis, probabilistic assessment, climatology, data assimilation, oceanography, meteorology, ecology, health, economics, applied mathematics, and geography. When overlapping in expertise exists this is intendedly so in order to enforced a broader coverage, e.g. by providing access to multiple models and a pluralism in applying different analyses expertise (see Table 3.3b, detailing complimentary partner expertise). The project combines these with skills in stakeholder engagement, system modelling, GIS and computer programming. The project combines these with skills in stakeholder engagement, translation of research findings for non-scientists and dissemination of policy recommendations to governments and other stakeholders.

This range of expertise and skills highlights the need for interdisciplinary and transdisciplinary nature of the consortium and demonstrates that the participants collectively constitute a consortium capable of achieving the project objectives. The composition of the consortium is well-balanced in relation to the project objectives, covering experience in the assessment of climate change and extreme event impacts, adaptation and vulnerability for a selected range of sectors using a wide variety of conceptual and practical methodologies and tools, plus numerous other relevant techniques such as modelling, GIS, economics, statistics, uncertainty assessment, decision support tools and stakeholder engagement. Combining, interpreting and communicating knowledge from such diverse scientific disciplines from the natural, engineering and social sciences is an essential pre-condition for climate prediction research. The consortium is confident that this will be achieved as all partners have a working knowledge in more than one of the disciplines listed above. This should lead to better integration and mutual understanding; indeed, many partners have worked productively together in the recent past on similar projects.

The consortium comprises highly committed scientists with international reputations for excellence from world-renowned institutes. The quality of the consortium is endorsed by the contributions many of the project participants have made to international programmes and key research and science-policy networks.

In addition, partners are Editors, Associated Editors or members of Editorial Boards of many international peer-reviewed journals.

Table 3.3b Complimentary partner expertise in- and contributions to Blue- Action

Industry and Society	Ocean dynamics, monitoring systems	Climate Change research	Climate Prediction Centres	Weather Services, Climate services	Atmospheric dynamics	Communi-cation and Innovation	Manage-ment and coordina-tion
		WHOI*					
		UoS					
		UiB				DNV GL	
Climate KIC	WHOI*	UHAM				IASS	
DNV GL	UoW					FI	
ISGLOBAL	UiB	NLeSC				Climate KIC	
IASS	UHAM	NERSC				KDM	
FI	SAMS	NCAR*				WOC	
ALM	NoC	MPI				UNIRES	
DTU AQUA	NIOZ	MERCATOR	UoS	NERSC	URED	SRSL	
KDM	NERSC	IAP-RAS*	UiB	MPI	UNIRES	KDM	
WOC	NCAR*	IAP-NZC*	NLeSC	MERCATOR	UHAM	IMEMO	
UNIRES	MSS	HAV	NERSC	ISGLOBAL		ISGLOBAL	
SRSL	MRI	GEOMAR	NCAR*	IASS	GEOMAR	IASS	
RUKA	MEOPAR*	CTL*	MPI	DTU	CTL*	FI	
PFA	HAV	CNRS	CNRS	DNV GL	CNRS	DTU AQUA	
DPPO	GEOMAR	CMCC	CMCC	AC UoL	CMCC	AC UoL	MPI
AC UoL	CNRS	DMI	DMI	DMI	DMI	DMI	DMI

3.3.1 Consortium

The overall approach and methodology to achieve the objectives is detailed in section 1.3.4 and introduces the eight interlinked Work Packages. This framework is also useful for understanding the composition of the consortium, how partners complement one another and how they contribute to the project.

WP 1 (Contributing to Objectives 1, 3 and 5) builds on focussed collaboration on aspects of climate, climate phenomena and weather extremes, between climate prediction groups, weather prediction centres and atmospheric dynamic scientists, in many cases represented at the same partner level [UHAM, DMI, GEOMAR, UREAD, UNIRES, CNRS, CMCC, CTL]. **WP2** (Contribution to Objectives 2, 4 and 6) has a set of partners with specialized, regional expertise in ocean marine climate monitoring and assessment [HAV, NERC, UIB, GEOMAR, NIOZ, SAMS, UHAM, MRI, MSS, WHOI, UOW, MEOPAR], which is essential to bridge and synthesise in Blue-Action. The ambition of WP2 is to engage with climate modelling centres to jointly evaluate and improve prediction systems; this includes [NERC, UIB, UoS, NERSC, UNIRES, CNRS, DMI, MPI, NLeSC, NCAR]. **WP3** (Contribution to Objectives 2 to 6) includes solely partners with the capacity to contribute to coordinated model experiments [NERSC, CNRS, MPIM, UniRes, UoS, NLeSC, CMCC, IAP-RAS, WHOI, DMI,IAP-NZC]. Linkages at partner and scientist level exist with WP2 and WP4, and ensure the cascade of knowledge envisioned and required to achieve the objectives. **WP4** (Contributing to Objectives 1 to 6) includes a set of mutually dependent tasks of demanding multi-model prediction experiments and system improvements. Partners contributing to these efforts are all distilled from WP1, WP2 and WP3 and include [MPI, UiB, DMI, CNRS, CNRS, NCAR, NERSC, NLeSC, UoS, CMCC]. MERCATOR's involvement ensures linkages to Copernicus for development and exploitation of ocean reanalysis data and ocean state estimates for initialization. **WP5** (Contributing to Objectives 1 and 7) is led by DTU-AQUA which has a strong

background in developing climate services and engaging with stakeholders. The 'lighthouse' cases developed incorporates targeted of Arctic and non-Arctic stakeholders [PFA, ALM, RUKA, DPPO, DNV, IMEMO, FI] led by leading research teams in their field [AC UoL, ISGLOBAL, UNIRES, DTU-AQUA, IASS]. Linkages to WP1-4 exist at partner level, but not necessarily the same research teams. Clustering for Blue Growth (**WP 6**, Contributing to all objectives) is led by DMI which also coordinates the project co-coordinated by MPI (**WP7**). Partners represented centrally in projects targeted under WP6 or identified as stakeholders actively contribute to the organization and coordination of activities [GEOMAR, WOC, CMCC, CNRS, MPI, SAMS, UHAM, MERCATOR, NERC, DTU, KDM, ISGLOBAL, SRSL]. **WP8** is led by SRSL and draw on the expertise from partners who have a strong track-record of successful strategic communication and engagement programmes [Climate KIC, KDM, DMI, AC UoL, MPI, UNIRES, WOC, DTU-AQUA, DNV, GL, ISGLOBAL, CNRS].

3.3.2 Industrial/commercial involvement in the project

The project outputs can be widened both in sectors and in applications, enabling more European and global companies to benefit from improved climate projections, risk assessments and other outcomes, encouraging exchanges of ideas and methods with larger sections of the business sector.

Direct involvement with business partners will be implemented in WP5 directly by developing joint products and services with their direct contribution: DNV GL in Norway and Japan, RUKA, PFA, DPPO, FI.

Engagement with larger business audiences will be implemented through engagement with other European-wide and world-wide organizations in WP8, such as Climate-KIC and the World Ocean Council:

i) Climate KIC is the Europe's largest public-private innovation partnership focused on climate innovation to mitigate and adapt to climate change; **ii) World Ocean Council** is an international, cross-sectoral industry leadership alliance planning, and developing science-based solutions to cross-cutting environmental challenges and engaging a wide range of ocean industries, including shipping, oil and gas, fisheries, aquaculture, tourism, renewable energy (wind, wave, tidal), ports, dredging, cables and pipelines, carbon capture and storage, as well as the maritime legal, financial and insurance communities.

3.3.3 Other countries

In our consortium, we have Partners from **USA, Canada, China, Russia, and South Korea** who are listed as fully fledged partners, but will not be beneficiaries of EC contribution, i.e. they are securing their own funding for implementing their activities within this project from own resources and public funding provided by their countries.

3.4 Resources to be committed

The total requested EC contribution for the project is 7.5 M€. The 41 partners have offered 966 person months to the project. The majority of the funding in the project is required for personnel costs, as the project will rely on the skills and many years of expertise of the partner organisations and scientists involved in the action.

Personnel costs: represent 74% of the overall budget. Table 3.4.a shows the amount of staff effort broken down by beneficiary and work package.

Resources required for engagement and dissemination activities: All partners have been given time within WP8 to allow them to undertake dissemination, engagement and communication activities for Blue-Action. Partners who are leading or co-leading WPs also have additional time to enable them to work with the Coordinator to synthesise all results for dissemination and communication.. Clustering activities for engaging with other project are planned in WP6, broader engagement activities for engaging with the business sector, policy makers, and the indigenous communities are planned in WP8. WP8 has 76 PMs dedicated specifically to engagement, dissemination and communication with end-users. In terms of budget, WP8 represents 7% and WP6 represents 2% of the total requested EC contribution respectively.

Management activities: 65 PMs are allocated for the Project Management, Coordination and Scientific Coordination (WP7). WP7 total budget corresponds to 7% of the requested EC contribution.

WP Nr.	Requested EC contribution in €	In % to the total

WP1	1,089,395	15%
WP2	1,330,000	18%
WP3	1,251,807	17%
WP4	1,400,000	19%
WP5	1,250,000	17%
WP6	138,424	2%
WP7	528,750	7%
WP8	511,625	7%
Grand total	7,500,000	100%

Other direct costs: represent 13% of the total requested contribution. They include the travel budget for the partners, costs for organising project meetings, costs for the cost financial statements, and for supporting the dissemination, communication, public engagement and exploitation of results. The Project Office has avoided any unnecessary travel and promoted the use of alternative forms of communication wherever practicable. A part of this budget covers the travels of the advisory boards (RIAG and SEG) and of the partners outside Europe (US, Canada, China, Russia, South Korea).
Large research infrastructure – None of the project participants will be declaring costs of large research infrastructure under Article 6.2 of the General Model Grant Agreement.
Sub-contracts – There is currently no sub-contracting planned.

Table 3.4b: 'Other direct cost' items (travel, equipment, other goods and services, large research infrastructure)

1/ DMI	Cost (€)	Justification
Travel	187039	Travels for project coordination team for management and coordination, travels for the external experts, travels to the annual project meeting, international conferences, travels to join dissemination and public engagement activities, travel and accommodation of the RIAG members, travels of scientists invited to connect with the WP6 cluster, travel costs for the Societal Engagement Group (SEG)
Equipment	0	//
Other goods and services	113500	Organisation for the kickoff and one annual project meeting per year (total 5 meetings), costs for certificates of financial statements, Organisation of meeting with projects in the cluster, organisation of special sessions at international scientific events such as YOPP and Blue Growth events, Publication fees in open access
Total	300539	
5/ CNRS	Cost (€)	Justification
Travel	59300	Travel to annual meetings, workshops & collaboration meetings
Equipment	0	//
Other	9000	Publication fees, catering & organisation of MEP ITRE parliamentary meetings and audit costs.
Total	68300	
8/ DPPO	Cost (€)	Justification
Travel	5000	Travel to annual meetings, workshops & collaboration meetings
Equipment	0	//
Other	0	//
Total	5000	
12/ HAV	Cost (€)	Justification
Travel	25000	Travels to project meetings, to join the clustering activities with the other projects in the cluster in WP6 and to support the WP8 activities

Equipment	0	//
Other	0	//
Total	25000	
15/ IASS	Cost (€)	Justification
Travel	15000	Travel budget for the Stakeholder-Workshops, visits to case study sites, other travel money to project meetings
Equipment	0	//
Other	25000	Organisation of stakeholder workshops
Total	40000	
18/ KDM	Cost (€)	Justification
Travel	8500	Travel and accommodation to join the project meetings and to join the clustering activities with the other projects in the cluster WP6 to ensure transfer of results to WP8
Equipment	0	//
Other	7500	Catering for the organisation of the policy briefings, prints of policy reports
Total	16000	
20/ MERCATOR	Cost (€)	Justification
Travel	5000	Travel and accommodation to join the clustering activities with the other projects in the cluster
Equipment	0	//
Other	0	//
Total	5000	
22/ MRI	Cost (€)	Justification
Travel	8000	Travels to annual project meetings and international meetings
Equipment	0	//
Other	0	//
Total	8000	
23/ MSS	Cost (€)	Justification
Travel	3500	Travels to annual project meetings and international meetings
Equipment	0	//
Other	0	//
Total	3500	
28/ NERC	Cost (€)	Justification
Travel	1700	Travels to annual meetings and international meetings, and to join the clustering activities with the other projects in the cluster WP6
Equipment	0	//
Other	6900	Publications in open access and computing costs
Total	23900	
29/ PFA	Cost (€)	Justification
Travel	5000	Travel to annual meetings, dissemination seminar & collaboration meetings
Equipment	0	//
Other	0	//
Total	5000	
30/ RUKA	Cost (€)	Justification
Travel	9000	Travel budget to project meetings
Equipment	0	//
Other	7500	Organisation of the dissemination seminar for the tourism case study
Total	16500	

31/ SAMS	Cost (€)	Justification
Travel	22000	Travels to annual meetings and international meetings, and to join the clustering activities with the other projects in the cluster WP6
Equipment	0	//
Other	0	//
Total	22000	
32/ SRSL	Cost (€)	Justification
Travel	19300	Travel attendance at annual project meetings and to dissemination events, Travel and accommodation to join the clustering activities with the other projects in the cluster WP6 and transfer of results to WP8
Equipment	0	//
Other	97000	Printing of project materials for communication, dissemination to diversified audiences, organisation of dissemination events, IP protection and associated fees
Total	116300	
33/ UHAM	Cost (€)	Justification
Travel	22300	Travels to the annual project meeting and dissemination activities and to join the clustering activities with the other projects in the cluster WP6
Equipment	0	//
Other	4000	Publication costs in open access
Total	26300	
40/ WOC	Cost (€)	Justification
Travel	2000	Meetings with Climate KIC and industry stakeholders
Equipment	0	//
Other	2000	Organisation of an Arctic session within the Sustainable Ocean Summit (SOS): Having the project as a SOS sponsor for a session on 'Business Development in the Arctic – opportunities and challenges'
Total	4000	
41/ ISGLOBAL	Cost (€)	Justification
Travel	22000	Travels to project meetings, to join the clustering activities with the other projects in the cluster in WP6 and to support the WP8 activities
Equipment	0	//
Other	10000	Publication costs, organisation of stakeholder workshops
Total	32000	

Contributions from beneficiaries: most of the partners have declared the availability of their permanent staff in public relations, communication, public engagement, legal units and technical and computational resources to support the project. For these, no costs will be charged to the project. These resources round up the resources included in the project budget.

Section 4: Members of the consortium

4.1 Participants (Applicants)

Partner 1 DANMARKS METEOROLOGISKE INSTITUT (DMI) Coordinator

DMI has a staff of 400 employees and more than 600 associated observers, and an annual turnover of 250 million Danish kroner (about 33M€). Founded in 1872, its main objectives are to make observations, provide forecasts and other information, communicate these to the public, and contribute to the development of the meteorological, oceanographic and related geophysical sciences. DMI provides

meteorological, oceanographic and climate related services for the community within the large geographical area of the Kingdom of Denmark (Denmark, Faroe Island and Greenland), including surrounding waters and airspace. The area of activity comprises forecasting and warning services, continuous monitoring of weather, sea state, climate, and related environmental conditions in the atmosphere, over land and in the sea. DMI purpose is to assist in the protection of life and property as well as to provide a basis for economic and environmental planning (aviation, national defence, shipping, agriculture, sporting and recreational events, etc.). DMI is responsible for the operational monitoring of sea ice, operational support for ship traffic for safe navigation, storm surge warnings, wave forecasts, sea ice drift forecasts and other operational oceanographic products in the Danish Waters, and the waters around Greenland and Faroe Islands.

The institute is part of the HIRLAM developing corporation and is operationally running a number of HIRLAM numerical forecast models for European and Arctic regions. Also regional and large scale ocean models (HIROMB-BOOS and HYCOM) are operational at the institute. DMI is part of a corporation developing a coupled atmosphere, ocean and sea ice climate model (EC-Earth). Further, a high resolution coupled ocean and ice forecast model (HYCOM/CICE) is implemented for operational use, to serve the public as well as the private sector, such as shipping and oil exploration companies with information about the ocean and ice conditions in the Arctic Ocean in general and Greenland waters in particular.

DMI has the national responsibility for ice charting in Greenland waters and uses satellite observations (primarily C- and X-band SAR) extensively to solve this task. In addition, DMI is responsible for the production of ice surface temperature products within the EUMETSAT Ocean and Sea Ice Application Facility (OSI-SAF) and Copernicus Marine Environmental Monitoring Service (CMEMS). DMI is part of the Arctic Regional Ocean Observing System (Arctic-ROOS) and holds a very large archive of satellite SAR observations and in-situ observations dating back from 1872. In addition, DMI is the real-time in situ sea level centre for the BOOS and NOOS. DMI operates a large number of automatic weather stations in Denmark and Greenland.

The DMI contribution to the proposal is from the Department of Research and Development. DMI has a long record in large national and international research projects, dealing with both operational tasks and user commitment.

Relevant personnel

Dr. Steffen M. Olsen (male) holds a position as research leader for coupled model systems at DMI and has a research profile within ocean and climate modelling with a Nordic and Arctic regional focus. His research is centered on properties of the North Atlantic, Nordic Seas and Arctic Ocean circulation. This includes in particular modelling and process understanding of the climatically important system of ocean exchanges between the North Atlantic and the Arctic Ocean. In his publications Steffen has combined in situ observations with model result building an understanding of the dynamics of this exchange system and model limitations. Steffen has further been the principal investigator on a number of experimental arctic oceanography and ocean-cryosphere interaction studies. He leads a core theme on modelling and predictions within the ongoing NACLIM EU-FP7 project (www.naclim.eu) and is strongly involved in the interdisciplinary research programs of EU-FP7 Ice-Arc (www.ice-arc.eu). Steffen coordinates DMI's activities within H2020 AtlantOS (www.AtlantOS-H2020.eu) and is on the international steering committee for the Copernicus Baltic Marine Forecasting Centre. Steffen represents DMI in Arctic ROOS and in EuroGOOS and has recently been appointed the Danish IOC delegate (UNESCO).

Prof. Jens Hesselbjerg Christensen (male) is a leading scientist and scientific head of regional climate research at the Danish Meteorological Institute. He has managed climate science at DMI as a scientific head for more than 10 years. In the beginning also as the coordinator of a very successful European FP5 project on regional climate change using multiple RCMs with a European focus with 21 partners, named PRUDENCE (2001-2004). He has been the PI in several large EU FP consortiums, including ENSEMBLES, WATCH and IMPRESSIONS. In the last 5½ years he directed the multi-disciplinary Centre for Regional Change in the Earth System (CRES) that received praise as a leading national (Danish) research centre in climate research. Alongside this; he was affiliated with the Greenlandic Climate Research Centre (GCRC) based in Nuuk, Greenland. Since 2014 he has been an Adjunct Professor in climate physics at the Niels Bohr Institute at the

University of Copenhagen. Together with colleagues at the University of Copenhagen and the University of Bergen, he received acknowledgement and financial support from an ERC-Synergy grant for the project Ice2Ice, which will aim at understanding the role of sea-ice in rapid climate change during the last ice age. He participated in the 2nd, 3rd, 4th and 5th Assessment Reports of the IPCC, in the latter two as coordinating lead author. He has more than 100 peer review publications with many papers as first author and an ISI web of science H-index of 34. In recent years, he published substantially with co-workers, PhD students and post docs. He is frequently cited in Danish media and has often appeared in radio and television programs.

Shuting Yang (female) is a senior scientist at DMI. She has a long experience in areas of climate modelling and research of climate variability from subseasonal/seasonal to decadal and centenniel time scales. She has worked extensively on the changes of cryosphere with a focus on the influence of Arctic sea ice to mid- and low latitudes and the atmosphere Greenland ice sheet couplings in climate system. She is currently involved in the EU FP7-ERC project "ice2ice" and the Nordic Research Board (NordForsk) project GREENICE (Impact of Future Sea-ice and Snow-Cover Changes on Climate, Green Growth and Society) and ARCPATH (Arctic Climate Predictions: Pathways to Resilient, Sustainable Societies).

Dr. Peter L. Langen (male) is climate scientist in the Climate and Arctic Research section at DMI and is an adjoint associate professor at the Niels Bohr Institute, University of Copenhagen. His research profile is directed toward both global and regional climate modeling with primary focus on the Arctic. Peter has worked extensively on atmospheric linkages between low and high latitudes as well as atmosphere-sea ice and atmosphere-ice sheet couplings. He is currently involved in the EU FP7-ERC project "ice2ice" and the Danish Council for Independent Research - Natural Sciences project "RETAIN".

Torben Schmith (male) holds a position as senior scientist at DMI and has a research profile within global ocean and climate modelling with a focus on the North Atlantic, Nordic Seas and Arctic Ocean circulation on interannual to decadal/centenniel time scales. Besides, he has attention to the application of more fundamental statistical analysis methods into climate research. He has been involved in a number of EU-funded project, such as MOEN, THOR (www.eu-thor.eu) and the ongoing NACLIM project (www.naclim.eu) as well as Danish nationally funded projects, like NAACOS. He actively participates in development of the global climate model within the pan-european EC-Earth (www.ec-earth.org) consortium. He has contributed to the 5th phase of the Coupled Model Intercomparison Project and is involved in the planning of the 6th phase of the Coupled Model Intercomparison Project. He has experience in the practical application of modelling results within environmental assessments. He publishes regularly in high-ranked journals, like Journal of Climate and give presentation at international conferences. He also contributes to informing the public on regional climate change in the national press (newspapers, radio, TV etc.)

Katrine Sandvad (female) is a controller of research projects and general financial management at DMI. Katrine holds a permanent position at DMI and has been working with FP7 and Horizon2020 projects for two years. At DMI, Katrine supports the scientists, mainly in financial issues, i.e., by preparing external and internal financial reports and providing financial information from the idea phase and throughout the remaining project life cycle. Within WP7, Katrine will devote part of her time to support the financial administration of the project.

Relevant publications, products, service and/or other achievements

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Relevant projects

- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu AtlantOS is a BG 8 (Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources) research and innovation project on the integration of ocean

observing activities across all disciplines for the Atlantic, considering European as well as non-European partners. The overarching target of the AtlantOS initiative is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System that goes beyond the state-of –the-art, and leaves a legacy of sustainability after the life of the project.

- **EU H2020 SPICES** (2015-2018) **Space-borne observations for detecting and forecasting sea ice cover extremes** whose main objective is to develop new methods to retrieve sea ice parameters from existing (and imminent) satellite sensors to provide enhanced products for polar operators and prediction systems, specifically addressing extreme and unexpected conditions.
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu *(S. Olsen is co-lead of WP 3.1 "Suitability of the ocean observing system components")* We have studied different measurements with respect to their impact on decadal predictability. It has been found that sea surface salinity measurements are crucial to reduce biases in climate models, which enhances the decadal predictability potential. Moreover, the deep ocean temperatures were found to be important in decadal predictability.
- **MyOcean** involves 59 **partners** from 28 countries: major centres in Europe involved in ocean operational monitoring & forecasting and partners from the European maritime community.
- **OSISAF.** Ocean and Sea Ice – Satellite Application Facility. EUMETSAT, ongoing since 1997. For complementing its Central Facilities capability in Darmstadt and taking more benefit from specialized expertise in Member States, EUMETSAT created Satellite Application Facilities (SAFs), based on co-operation between several institutes and hosted by a National Meteorological Service.
- **ESA_CCI,** Sea Ice and SST. Climate Change Initiative – Essential Climate Variable, Sea Ice and SST. ESA. 2012-2018. The aim of the project is: To realise the full potential of the long-term global Earth Observation archives that ESA, together with its member states, has established over the last thirty years, as a significant and timely contribution to the ECV databases required by United Nations Framework Convention on Climate Change (UNFCCC).
- **ICE-ARC.** (S. Olsen contributes to WP1 and WP3 on high arctic ocean-cryosphre interations and community engagement). Ice, Climate, Economics - Arctic Research on Change. EU FP7. 2014-2018. ICE-ARC (Ice, Climate, Economics – Arctic Research on Change) will look into the current and future changes in Arctic sea ice – both from changing atmospheric and oceanic conditions. The project will also investigate, in a robust way, the consequences of these changes both on the economics of the area, and social aspects such as on indigenous peoples.
- **GLOBTEMPERATURE.** ESA DUE. 2013-2016. The **DUE GlobTemperature** Project is a three-year project – with strong commitment to continue supporting all aspects of the Website, the Data Portal and User Needs beyond this – which developed following the successful first GlobTemperature User Consultation Meeting in Edinburgh (27-28 June 2012, see Meetings section).
- **PRUDENCE** (*JH Christensen coordinated*). Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects. EU FP5, 2001-2004. The project combined regional climate change information using dynamical downs scaling with impacts modelling for multiple disciplines.
- **ENSEMBLES** (*JH Christensen research theme co-leader on regional modelling system*). EU FP 6, 2004-2009. The project combined global and regional modelling with impacts modelling at different geographical scales and for seasonal to centennial time scales
- **WATCH** (*JH Christensen WP leader on regional climate*) WATer and global Change, EU FP6, 2007-2011. The project brought together hydrologists with climate and climate change impacts reserchers to address the changing water resources under climate change conditions.

- **IMPRESSIONS** (*JH Christensen WP leader on climate change*) IMPacts and Risks from high-End Scenarios: Strategies for Innovative solutiONS, EU FP7, 2013-2018. I**MPRESSIONS** aims to advance understanding of the implications of high-end climate change, involving temperature increases above 2°C, and to help decision-makers apply such knowledge within integrated adaptation and mitigation strategies.
- **CRES** (*JH Christensen coordinated*). Centre for Regional change in the Earth System, Danish Strategic Research Centre, 2009-2015. CRES was a multidisciplinary climate research platform, which brought together leading scientists with excellent and long track records of quality research in climate change and key Danish stakeholders and practitioners with a need for improved climate information.

Relevant significant infrastructure and/or technical equipment

- **ISAR**, Infrared Sea Surface Autonomous Radiometer
- **HPC**: DMI in-house Cray XT-5 high performance computer. This is used to conduct all model experiments at DMI.
- Access to the real time in situ observation network, **GTS** that is a global network under World Meteorological Organization.
- Operational infrastructure, including IT facilities for managing large data amounts.
- Ground receiving stations for satellite data in Denmark and Greenland.
- Operational coupled ice and ocean model for the Arctic Ocean and North Atlantic.
- Operational producer of OSI-SAF and MyOcean operational products.

Partner 2 Arctic Centre of the University of Lapland (Finland) (AC UoL)

The Arctic Centre is a national and international research centre of excellence and hosts the world's leading Arctic experts. It conducts high quality local, regional and international research on the Arctic, trains experts on Arctic issues, and conveys information and research results concerning the region. The research blends the perspectives of the natural and social sciences, and the Centre's multidisciplinary research groups study the social and environmental impacts of global climate change, as well as sustainable development, Arctic anthropology, and environmental and minority law in the region. The research is highly transdisciplinary and carried out throughout the whole of the Arctic region as well as in the Antarctic.

The Arctic Centre also provides environmental and social impact assessment and nature reporting services for business and public administration, particularly in Lapland and Arctic Russia. The Centre's high standards and up-to-date research results benefits science and administration as well as informs political decision making and management of various social and environmental problems. One essential aspect of the Arctic Centre's work is to convey scientific information. The Arctic Centre's Science Communications Unit and library services employ various forms of public relations (including developing technological tools via the internet) to convey information about the Arctic. The Centre is also involved in education: it trains new researchers as well as students and pupils with the aim of adding to the knowledge, general awareness and understanding of the Arctic. The Arctic Centre closely cooperates with major research institutes and other organisations, and the Centre's researchers serve as specialists on many international, national, and local assignments and processes. The Centre has an ongoing dialogue with indigenous peoples, local residents and other partners within the region. The Arctic Centre envisions becoming Finland's leading centre of excellence for the Arctic as well as a leading European expert on sustainable development, global climate change, and minority and environmental law. The Centre aims to increase knowledge and awareness based on sound scientific information and in this way support sustainable development, environmental protection and social, cultural and biological diversity in the Arctic and the High North.

The Arctic Centre is a part of the University of Lapland, the northernmost university in Finland and in the European Union, which focuses on Arctic issues, primarily in the area of humanities, social science, law and social welfare. The focus is on Arctic law and natural resources, indigenous peoples in the Arctic, northern social welfare services, Arctic design and arts, knowledge and learning environments in the Arctic, as well as northern politics and governance. University's small size is on an ongoing basis turned into a strength as teaching and research across disciplinary boundaries is easy. Thus, Arctic Centre and the University of Lapland at large are leaders in transdisciplinary teaching and research.

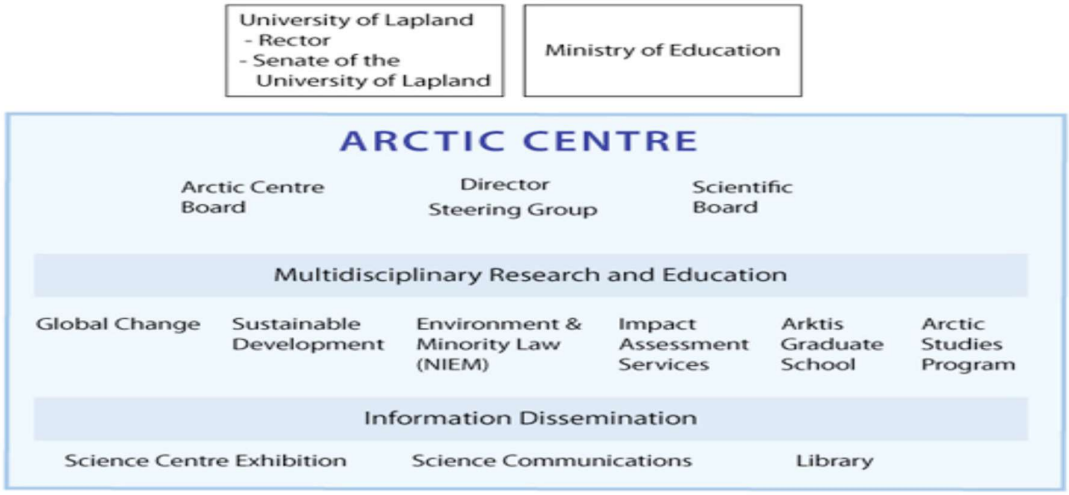

Figure 2 Organisation and institutional positioning of the Arctic Centre

In this project, AC UoL will be actively involved in

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Arctic Centre Project Team:

Professor John Moore (male) is a Research Professor at University of Lapland (Finland), Chief Scientist, College of Global Change and Earth System Science of Beijing Normal University (China), Guest professor, Polar Research Institute of China, and was Finnish representative on the International Arctic Science Committee, Glaciology Group. Chief scientist on 2007-2009 International Polar Year project: Kinnvika. Member of World Meteorological Organization (WMO) advisory panel on Geoengineering. Research Activities: Past sea level change and prediction; natural and anthropogenic climate forcing; impacts of extreme events, and geoengineering scenarios. Development of advanced statistical methods for time series analysis, with the aim of a mechanistic understanding of the climate system. Network analysis of climate system. Ice sheet and glacier flow modelling using sophisticated models. Socio-economic adaptation strategies to climate change in the Arctic. Extraction of paleoclimate information from physical and chemical analysis of Arctic and Antarctic ice cores. Professor Moore has authored 150 SCI articles (~6800 citations, H-index=38); 14 articles were cited in the IPCC AR5 reports; 16 articles published in "PNAS" & the "Nature" group. Member/leader of 6 Antarctic, 4 Greenland and 20 Svalbard expeditions.

Dr Roxana Contreras (female) has a PhD in physics, and is currently finishing a new specialization in environmental radioactivity (Master Programme in Radioecology-Norwegian University of Life Sciences). Contreras has experience in toxicology analysis of uranium, arsenic and effects of gamma radiation on biological systems, both experimental and models of ion channels. She also has experience with

groundwater models and from previous position at the Arctic Centre (University of Lapland), with ice-sheet models as well.

Pamela Lesser (female) is a researcher at the Arctic Centre, University of Lapland. Her main interest is in working with companies in Lapland to implement their Corporate Social Responsibility standards, especially with respect to environmental activities. One of her core focus areas is creating economic synergies between the mining and tourism industries as these sectors have historically been antagonistic toward one another. Other research interests and projects include the following themes: Environmental impact assessment in the Arctic; the relationship between the social license to operate and regulatory systems; economic compensation mechanisms and their role in reconciling conflicts arising from natural resource and tourism projects.

Ilona Mettiäinen (female) Arctic Centre, University of Lapland, Finland. She holds a Master's Degree from the University of Tampere, Finland in Regional Studies. Currently she is completing her doctoral research in Sociology at the University of Lapland. In her interdisciplinary PhD research she studies strategic planning as a method for regional level proactive adaptation to climate change in the Arctic, with an empirical case study on collaborative planning process of the regional climate change strategy of Finnish Lapland. Mettiäinen has contributed to the Barents Euro Arctic Council's work on regional climate strategies in the Barents region with her scientific expertise since 2012. Mettiäinen teaches annually Arctic human geography lessons for the international Arctic Studies Programme at the University of Lapland and gives lectures on sustainable Arctic tourism at the Lapland University of Applied Sciences. Other fields of expertise include regional development in Arctic and peripheral communities, project management, evaluation and assessment, and science communications. In additional to research work since 2005, her professional experience includes management experience as project manager at the Lapland University of Applied Sciences in 2007, part-time vice-coordinator or the ARKTIS doctoral programme 2012-2013 and as conference manager at the Arctic Centre, University of Lapland 2014-2015.

Adam Stępień (male) works a researcher in the Northern Institute for Environmental and Minority Law, in the Arctic Centre of the University of Lapland. He has obtained the Master degree in Political Science with specialization in European Studies (University of Warsaw, Poland, 2007) in 2007. He is currently completing a doctoral dissertation. Adam Stępień has taken part in a number of projects dedicated to the European Union's presence in the Arctic and EU policies relevant for the Arctic. These included assessment of EU's Arctic footprint and effectiveness of EU policies, examining the scope of Union's competences relevant for the Arctic, as well as studying the current status of Arctic developments, their implications for Europe, and the impact of EU policies on these developments (see the list of projects for details). His professional experience included internships and work in Polish and international NGOs, Polish national and municipal public administration, Brussels-based consultancy and the International Organization for Migration (regional office). He has experience in project management. Adam Stępień acted as the main editor of the assessment report in the project "Strategic Environmental Impact Assessment of development of the Arctic" carried out by the Arctic Centre and a network of 19 European institutions for the European Commission.

Relevant publications, products, service and/or other achievements

- **Moore J. C**., A. Grinsted, X. Guo, X. Yu, S. Jevrejeva, A. Rinke, X. Cui, B. Kravitz, A. Lenton, S. Watanabe, D. Ji, 2015 Atlantic hurricane surge response to geoengineering, Proceedings of the National Academy of Sciences, doi:10.1073/pnas.151053011.
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- Mettiäinen, Ilona. 2013. Climate Change Turn in the Regional Development Strategies of an Arctic Region, Case Finnish Lapland. In: Alfredsson, Gudmundur, Koivurova, Timo & Stepien, Adam. (eds.). The Yearbook of Polar Law V (2013): 143-183. Koninklije Brill NV.
- Jokinen, Mikko, Ilona Mettiäinen, Salla Sippola & Seija Tuulentie. 2009. Sosiaalinen kestävyys muuttuvissa matkailukylissä: Paikallisia näkemyksiä kehityksestä. [Social sustainability in changing tourism villages: Local views on the developments] p.60-85. In: Tuulentie, Seija (ed.). Turisti tulee kylään. Matkailukeskukset ja lappilainen arki. SoPhi Minerva.
- Tuulentie, Seija & Ilona Mettiäinen. 2007. Local participation in the evolution of ski resorts: The case of Ylläs and Levi in Finnish Lapland. *Forest, Snow and Landscape Research* 81, 1/2: 207–222 (2007). Swiss Federal Institute of Forest, Snow and
- Landscape Research.
- **Achievements of Professor John Moore.**
  - China "1000 talent" awardee 2010.
  - China Friendship medal 2014.
  - Inaugural Lapland University president's prize 2014.

Relevant Projects

- The combined effects of herbivory and warming on subarctic ecosystem carbon stocks (2013 -2015, Maj and Tor Nessling Foundation.) http://www.arcticcentre.org/EN/RESEARCH/Projects/Pages/The-combined-effects-of-herbivory-and-warming-on-subarctic-ecosystem-carbon-stocks
- RISES - Resilience in Social-Ecological Systems of Northwest Eurasia (2012-2016) http://www.arcticcentre.org/EN/RESEARCH/Projects/Pages/RISES

- Nordic Centre of Excellence Tundra (NCoE Tundra) (2011-2015) http://www.arcticcentre.org/EN/RESEARCH/Projects/Pages/NCoE-Tundra
- SVALI - Stability and Variations of Arctic Land Ice (2010-2015) http://www.ncoe-svali.org/
- Strategic Environmental Assessment of development of the Arctic (2013-2014, funded by the European Commission, 19 partners led by the Arctic Centre), which included production of a Strategic Assessment of Development of the Arctic report, which discussed in general terms the multidimensional changes occurring in European Arctic, presented an overview of EU regulatory framework of relevance for the Arctic, as well as the impacts of Arctic changes (environmental, economic, social) on Europe. www.arcticinfo.eu/sada
- Arctic Climate Change, Economy and Society (ACCESS) (2011-2015, funded under Seventh Framework Programme, Arctic Centre as a partner), where Arctic Centre researchers examined changes (environmental, social and economic) occurring in the Arctic fisheries and aquaculture (focus on Barents sea).
- Environmental Impact Assessment in the Arctic (2013-2015), which entailed examining with close cooperation with private sector, the application of EIA in practice in Finland and Russia and in more general terms in all jurisdictions around the circumpolar North. http://www.arcticcentre.org/EN/RESEARCH/NIEM/Projects/Improving-Finnish-EIA-in-Finland-and-Russia
- SUMILCERE – Sustainable Mining, Local Communities and Environmental Regulation in Kolarctic Area (2013-2014, ENPI CBC) http://www.ulapland.fi/InEnglish/Units/Faculty-of-Law/Research/Research-Projects/SUMILCERE
- Adaptation to Rapid Land-Use and Climate Changes on the Yamal Peninsula, Russia: Remote Sensing and Models for Analyzing Cumulative Effects (2009-2012)
- ARCSUS Urban Sustainability in the Russian Arctic (2012-2015)
- CAVIAR II - Critical aspects of adaptive capacity to climate change in northern regions http://www.arcticcentre.org/EN/RESEARCH/Projects/Pages/FIN--CAVIAR--research-project

Relevant significant infrastructure and/or technical equipment

Not applicable

Partner 3 City Council of Almada (ALM)

Almada is densely populated, and limited to the east by Seixal, south by Sesimbra, and bordered on the remaining cardinal directions by the Atlantic Ocean and the Tagus River. Covering an area of 70.2 km², its municipal population in 2008 was 164,844 inhabitants; the urbanized centre had a population of 102,357. Population density is 2,355 / km2 . Its location near the Atlantic Ocean on the one hand and near Lisbon metropolis on the other hand opens interesting research perspectives for Blue-Action.

Almada is located near to Lisbon, on the other side of the Tagus River. Almada is located the closest to the North Atlantic, at the coast. With a population of the order of 100,000 inhabitants, Almada is considered part of the greater Lisbon area, which is of course much larger. Mediterranean climate ("dry summer subtropical", denoted Csa/Csb in the Köppen map), which is found mainly along the Mediterranean coastal areas, extending from Portugal to Greece and beyond, and of which Almada is a study case.

Its location near the Atlantic Ocean on the one hand and near Lisbon on the other hand opens interesting research perspectives for the Blue-Action project, with its participation in the TRM case study (WP5), **Blue-Action will help Almada to produce future adaptation strategies.**

The City Council of Almada, Portugal, seems to have found a trade off between adaptation and mitigation. Nuno Lopes presented the inspiring concept of Nature Based Planning. This approach promotes ecological services and territorial resilience.

Scientists have described a wide range of potential negative impacts of climate change on many vulnerable aspects of natural systems and human populations, and particularly the sensitivity of our society to atmospheric temperatures. In particular, increasing attention has been paid to warm extremes, which are

expected to become more frequent, longer and more severe. The Euro-Mediterranean region emerges as an especially responsive area to temperature rise, particularly during the warm season. The record-breaking 2003 heat wave in western Europe has been described as an extremely unlikely event given the observed warming, and to share similar characteristics with future summers simulated by state-of-the-art climate models for the end of the 21st century. The event represented a major public health and societal challenge and revealed the lack of preparedness and coordination of governments, health agencies, doctors, care centres, families and citizens. The largest incidences were observed in France (with a mortality increase of 37%), Portugal (28%), Spain (23%) and Italy (22%). Nonetheless, these numbers are not representative of the degree of vulnerability of European societies, given that the magnitude of the heat wave was more than twice as large in France compared to the southern countries.

In this project, AC UoL will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Catarina Freitas (female), Head of the Department for Environment, Climate, Energy and Mobility at the Almada City Council, as well as the Executive Member of the Board of AGENEAL, Local Energy Management Agency of Almada. She has a M.Sc. in Chemical Engineering and PhD studies on environmental technology. She has been Head Officer for Energy and Environmental issues at the Municipality of Almada since 1997. She coordinates the development and implementation of the Local Agenda 21 of Almada and in that framework the Local Strategy for Climate Change, addressing mitigation and adaptation plans and its integration in urban planning. She is also responsible for the technical and financial management of several european projects and partnerships. Catarina Freitas has been very active in the ICLEI iniciatives and working groups on resilience and adaptation. Seh is author and co-author of several presentations and papers, namely on environmental management and urban planning, adaptation to climate change, energy efficiency and urban sustainable mobility.
Nuno Cunha Lopes (male), Head of Division – Environmental and Energy Studies and Management of the Department for Environment, Climate, Energy and Mobility at the City Council of Almada. Oceanographer by education, he has an M.Sc. in Ecology. Nuno Lopes is currently involved in EU project NACLIM project as one of the experts at the Almada City Council. Nuno Lopes is very active in the ICLEI Resilient Cities working groups on resilience and adaptation, and the EU project Green Surge and in the ICLEI community.

Sara Dionísio (female), senior officer of Department for Environment, Climate, Energy and Mobility at the City Council of Almada. She has an M.Sc in Engeneering Geology and has been involved in several national and international projects. She is currently involved in EU project NACLIM project as one of the experts at the Almada City Council.

Patrícia Silva (female), senior officer of Department for Environment, Climate, Energy and Mobility at the City Council of Almada, Biologist by education. She has an M.Sc in Nature Conservation and Management and has been involved in several national and international projects. She is currently involved in the EU project GreenSurge - Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy as one of the experts at the Almada City Council.

Relevant publications, products, service and/or other achievements

- Within a current EU FP7 project (NACLIM), Almada has successfully be able to enhance its adaptation strategy by getting support from scientific teams on the following topics:

- Impacts of green roofs linked to potential green roof map/plan for each city for the timeframe 2030 - 2040 onwards;
- Impacts of the change in albedo (reflectivity) of buildings (e.g. through change to green roof type);
- Impacts of city expansion on climate change (e.g. projected Land Use Land Cover (LULC)).
    - Effects of the densification of the population and development of new areas of settlement;
    - Impacts on the vulnerable population of the cities (e.g. focussing on young children in schools and areas of elderly populations).
    - Impact of the city of Lisbon on the UHI effect in Almada.

- Within another EU FP7 project (Green Surge) Nuno and Sara contributed to the report on *Case Study City Portrait; Almada. Part of a GREEN SURGE study on urban green infrastructure planning and governance in 20 European cities* http://greensurge.eu/products/case-studies/Case_Study_Portrait_Almada.pdf
- Within EEA Grants program, in the frework of the ClimAdaPT.Local Project, Catarina Freitas and Nuno Lopes contributed to the paper *The dynamics of local climate change adaptation in Portugal: tracking down action in front-runner municipalities*, http://www.ecca2015.eu/images/ECCA_Abstract_book._by_topic-FINAL.docx
- **Freitas, C**., Sousa, C.*, **Lopes, N**., Machado, P.. Tourist Destination Handling Climate Change: A Mediterranean Experience Article included in Advances in Global Change research 39, Local Governments and Climate Change, Sustainable Energy planning in Small and Medium Sized Communities, Springer, 2010
- The municipality is also a member of European and international associations and initiatives such as Energy Cities, ICLEI, the Mexico City Pact, Covenant of Mayors and World Mayors Council on Climate Change.

Relevant Projects

- **EU NACLIM**, supported by **FP7 of the European Commission**, investigating the predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. Almada is one of the three end-user cities of the WP4. NACLIM WP4 perfomed an analysis of the Urban Heat Island (UHI) for Almada, allowing the preparation of scenarios linked to urban planning and existing urban plans/projects, scenarios using projected population figures, scenarios specific to end-users.
- **EU Green Surge,** supported by **FP7 of the European Commission**, led by Univ. Copenhagen, Almada is taking part as a case study on urgan green infrastructure. Urban green infrastructure is part of the mitigation and adaptation strategy of the Almada City Council. http://greensurge.eu
- **EU Cities Adapt (2011.12 – 2013.06), supported by the European Commission** - Directorate General for Climate Action (DG Climate Action). The DG Climate Action commissioned this project to the development of "Adaptation Strategies for European Cities", The project was carried out 2013 by a consortium led by Ricardo-AEA and ICLEI, including Arcadis, adelphi, University of Manchester and Alexander Ballard Ltd.

Partner 4 Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (Fondazione CMCC)

The Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (Fondazione CMCC) is a non-profit research institution (www.cmcc.it). CMCC's mission is to investigate and model our climate system and its interactions with society to provide reliable, rigorous, and timely scientific results, which will in turn stimulate sustainable growth, protect the environment, and develop science driven adaptation and mitigation policies in a changing climate. CMCC collaborates with experienced scientists, economists, and technicians, which work together in order to provide full analyses of climate impacts on various systems such as agriculture, ecosystems, coasts, water resources, health, and economics. CMCC also supports policymakers in setting and assessing costs, mitigation, and adaptation policies.

CMCC benefits from the extensive applied research experience of its members: Istituto Nazionale di Geofisica e Vulcanologia (INGV); Università del Salento; Centro Italiano di Ricerche Aerospaziali (CIRA S.c.p.a.); Università Ca' Foscari Venezia; Fondazione Eni Enrico Mattei (FEEM), Università di Sassari, Università della Tuscia, Università degli Studi del Sannio. CMCC research activities are distributed among eight research divisions that share different knowledge and skills in the field of climate science: Advanced Scientific Computing (ASC) Division; Climate Simulation and Prediction (CSP) Division; Economic analysis of Climate Impacts and Policy (ECIP) Division; Impacts on Agriculture, Forests and Ecosystem Services (IAFES) Division; Ocean modeling and Data Assimilation (ODA) Division; Ocean Predictions and Applications (OPA) Division; Risk Assessment and Adaptation Strategies (RAAS) Division; Regional Models and geo-Hydrological Impacts (REHMI) Division.
CMCC acquired portfolio of research projects includes 169 funded projects: 2 funded projects in FP6, 35 funded projects in FP7, 15 funded projects in H2020 and 117 funded projects under other EU and international research grants (tot. of ca. 50 M €). In about a half of the implemented projects, CMCC acted as the coordinator.
CMCC contributes to **JPI Climate** (Joint Programming initiatives Climate) module 2 – Researching Climate Service Development and Deployment and is member of the **Climate-KIC** partnership
For further information on CMCC please see Annual Report and CMCC Strategic Plan (www.cmcc.it/publications-type/annual-report).

In this project, CMCC will be actively involved in:

- WP1 Improving seasonal long range forecast skill of risks for hazardous weather and climate events (Lead: Johanna Baehr/UHH, Co-lead: Jens H. Christensen/DMI) – Alessio Bellucci/Leone Cavicchia
- WP3 Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/LOCEAN) – Annalisa Cherchi/Dorotea Iovino
- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Lead: Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB) – Alessio Bellucci/Annalisa Cherchi/ Dorotea Iovino / Leone Cavicchia
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI) Alessio Bellucci/Annalisa Cherchi/ Dorotea Iovino / Leone Cavicchia
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU) - Alessio Bellucci/Annalisa Cherchi/ Dorotea Iovino / Leone Cavicchia

Relevant Personnel

Dr. Annalisa Cherchi (female) Head of the "Earth System Modelling" research unit at CMCC ODA Division. Dr. Cherchi has graduated in Physics in 1998 and in 2004 she received a Ph.D. in Geophysics from Bologna University. She had research collaboration at Consiglio Nazionale delle Ricerche (CNR), and after that at the Istituto Nazionale di Geofisica e Vulcanologia (INGV). She has almost ten years of experience in the field of climate modelling and Asian summer monsoon variability, including predictability and teleconnections. The scientific interests of Dr. Cherchi focus on the climate variability of the tropical sector with specific emphasis on the Indo-Pacific region, where the dominant events are the Asian summer monsoon and the El Nino Southern Oscillation (ENSO), and their teleconnections. Another aspect of her research activity is dedicated to the study of the climate system and the processes associated with climatic states different from the present. Dr. Cherchi participated in several European and other international projects, including ENSEMBLES, DYNAMITE, CLARI-LPB and recently the EU-India cooperation INDO-MARECLIM.
Dr. Alessio Bellucci (male) holds a PhD in physical oceanography from the University of Southampton/NOCS and is a climate modeller. His major field of expertise is climate variability and predictability at decadal and interdecadal timescales. He is currently coordinating the activities of the Climate Variability and Prediction group at CMCC, working on seasonal-to-decadal predictions. He has been involved in the 5th Coupled Model Intercomparison Project (CMIP5) as the CMCC reference person for decadal prediction experiments. He has been involved in several EU-funded FP projects, including ENACT, ENSEMBLES, CIRCE, COMBINE (as WP-leader) and CLIM-RUN, and H2020 PRIMAVERA (as WP co-leader). As

of 2010, he is a lecturer in Geophysical Fluid Dynamics and (since April 2014) member of the scientific board for the PhD Programme in Science and Management of Climate Change, at the University of Venice

Dr. Dorotea Iovino (female) holds a PhD in physical oceanography from the Geophysical Institute (University of Bergen, Norway). Her main research interest is in the dynamics of sea ice and polar oceans with a focus on dense water formation, thermohaline circulation (THC) and the role of sea-ice processes in climate. Has almost 10 years of experience working on ocean and sea ice modeling, both on the technical and scientific aspects. She is currently involved in high-resolution ocean modeling, and is coordinator and principal investigator of a nationally funded project, CATARSI, which aims to investigate the mechanisms explaining Antarctic sea ice variability and its role on global THC. She has been involved in several EU-funded FP projects. She is the NEMO Officer for CMCC within the NEMO System Team. She is a lecturer in Polar Climate and Sea Ice, since a.y. 2012/2013, for the PhD Programme in Science and Management of Climate Change, at the Ca' Foscari University of Venice.

Dr. Leone Cavicchia (male) holds a degree in Physics and a PhD in "Science and management of climate change" from the University of Venice. His areas of expertise include regional climate modeling, and the analysis of changes in the statistics of extreme events. He has been studying for several years the properties of mesoscale tropical-like cyclones in the Mediterranean Sea, collaborating with the HZG in Geesthacht. He is currently a postdoc in the CSP division at CMCC, where he focuses on performing and analyzing climate projections using a coupled regional climate model for the Mediterranean region, in the framework of the MED-CORDEX regional model intercomparison initiative.

Relevant publications, products, service and/or other achievements

1. **Athanasiadis P. J.** , **A. Bellucci**, L. Hermanson, A. A. Scaife, C. MacLachlan, A. Arribas, S. Materia, A. Borrelli and S. Gualdi, 2014: The representation of atmospheric blocking and the associated low-frequency variability in two seasonal prediction systems, *Journal of Climate,* **27**(24), 9082-9100, DOI: http://dx.doi.org/10.1175/JCLI-D-14-00291.1.
2. **Bellucci, A.**, R. Haarsma, N. Bellouin, B. Booth, C. Cagnazzo, B. van den Hurk, N. Keenlyside, T. Koenigk, F. Massonnet, S. Materia and M. Weiss, 2015: Advancements in decadal climate predictability: the role of non-oceanic drivers, *Reviews of Geophysics*, 53,165–202, doi:10.1002/2014RG000473.
3. **Bellucci, A. ,** R. Haarsma, S. Gualdi, P. Athanasiadis and Co-Workers, 2015: An assessment of a multi-model ensemble of decadal climate predictions, *Climate Dynamics*, **44**(9), 2787-2806, DOI:10.1007/s00382-014-2164-y.
4. **Bellucci, A.,** S. Gualdi, S. Masina, A. Storto, E. Scoccimarro, C. Cagnazzo, P. Fogli, E. Manzini and A. Navarra, 2013: Decadal climate predictions with a coupled OAGCM initialized with oceanic reanalyses, *Climate Dynamics,* **40**(5-6),1483-1497, DOI: 10.1007/s00382-012-1468-z.
5. **Cherchi A,** Carril A, Menendez C, Zamboni L (2014) La Plata Basin precipitation variability in spring: Role of remote SST forcing as simulated by GCM experiments. Clim Dyn, 42, 219-236 DOI: 10.1007/s00382-013-1768-y
6. **Cherchi A**, Masina S, Navarra A (2012) Tropical Pacific – North Pacific teleconnection in a coupled GCM: Remote and local effects. International Journal of Climatology 32: 1640-1653 DOI: 10.1002/joc.2379
7. Ilicak M, Drange H, Wang Q, Gerdes R, Aksenov Y, Bailey D, Bent
8. Materia, S.**,** A. Borrelli, **A. Bellucci**, A. Alessandri, P. Di Pietro, **P. Athanasiadis**, A. Navarra and S. Gualdi, 2014: Impact of atmosphere and land surface initial conditions on seasonal forecast of global surface temperature, *Journal of Climate,* **27**(24), 9253-9271, doi:http://dx.doi.org/10.1175/JCLI-D-14-00163.1.
9. Wang Q, Ilicak M, Gerdes R, Drange H, Aksenov Y, Bailey DA, Bentsen M, Biastoch A, Bozec A, Boning C, Cassou C, Chassignet E, Coward AC, Curry B, Danabasoglu G, Danilov S, Fernandez E, Fogli PG, Fujii Y, Griffies SM, **Iovino D**, and co-workers (2016) An assessment of the Arctic Ocean in a suite of interannual CORE-II simulations. Part I: sea ice and solid freshwater. Accepted on Oc Modelling

10. Wang Q, Ilicak M, Gerdes R, Drange H, Aksenov Y, Bailey DA, Bentsen M, Biastoch A, Bozec A, Boning C, Cassou C, Chassignet E, Coward AC, Curry B, Danabasoglu G, Danilov S, Fernandez E, Fogli PG, Fujii Y, Griffies SM, **Iovino D**, and co-workers (2016) An assessment of the Arctic Ocean in a suite of interannual CORE-II simulations. Part II: Liquid freshwater. Accepted on Oc Modelling

Relevant Projects

- **EU H2020 PRIMAVERA** (2015-2019) https://www.primavera-h2020.eu/ funded to develop a new generation of advanced and well-evaluated high-resolution global climate models, capable of simulating and predicting regional climate with unprecedented fidelity, for the benefit of governments, business and society in general. CMCC is partner
- **CLIPC** (01.12.2013-30.11.2016), **FP7 EU-funded** to provide access to climate datasets, and software and information to assess indicators for climate impact. CMCC is partner
- **IS-ENES2** (01.04.2013-31.03.2017), **FP7 EU-funded** to provide Infrastructure for the European Network of Earth System Modelling. CMCC is partner
- **COPERNICUS C3S 433** (on-going), **EU-funded through ECMWF**. CMCC is additional provider of seasonal forecasts.

Relevant significant infrastructure and/or technical equipment

CMCC operates its own Supercomputing Center (located in the "Ecotekne" Campus in Lecce) whose HPC facilities have been ranked, since 2008, in the 500 most powerful supercomputing systems in the world (316th at November 2013). The CMCC HPC infrastructure is the third most powerful computational facility in Italy.

Partner 5 Centre National de la Recherche Scientifique (CNRS)

The Centre National de la Recherche Scientifique (CNRS) is a French public organization under the responsibility of the French Ministry of Education and Research. CNRS carries out research in all fields of knowledge and employ a large body of tenured researchers, engineers, and support staff. Three CNRS Joint Research Units, (Unités Mixtes de Recherche, UMR), are involved in Blue-Action :

(1) The Laboratoire d'Océanographie et du Climat: Expérimentations et Approches Numériques (LOCEAN) in Paris,
(2) The Laboratoire Environnements et Paléoenvironnements Océaniques et Continentaux (EPOC) in Bordeaux and
(3) the Laboratoire d'Océanographie Physique et Spatiale (LOPS) in Brest.

CNRS-LOCEAN (UMR 7159) is a leading laboratory in France employing about 100 permanent scientists in the field of climate research. The laboratory research activities address a wide range of topics contributing to better understanding the role of the ocean in the coupled climate system and its variability. Topics range from the ocean general circulation to ocean-atmosphere interactions, sea-ice physics and biogeochemistry, ocean dynamics and biogeochemistry at various scales and their coupling, ocean biology and ecology, and the ocean carbon cycle. CNRS-LOCEAN is a leading institute in ocean modelling, responsible for the development of the NEMO model system, which is widely distributed among climate institutes around the world. The LOCEAN is also part of the IPSL federation, which widely contribute to the IPCC assessments reports, in particular in the framework of the development of the IPSL ocean-atmosphere coupled model. CNRS-LOCEAN is much involved in sea-going observational programmes including a strong focus on the polar oceans. It has been involved in numerous international projects, in which LOCEAN senior scientists act

as Pis and/or coordinators. The LOCEAN is also leading many research programmes that evaluate the impacts of changing climate for human activities, and the improvement of climate services.

CNRS-EPOC (UMR 5805) is an interdisciplinary laboratory at the cutting-edge of environmental sciences that comprises more than 170 employees, whose expertise is going from ecotoxicology to paleoclimate and oceanography. A new group dedicated to climate modelling is emerging in this laboratory lead by the Didier Swingedouw, and including another CNRS researcher, one permanent assistant professor and two post-doctorate fellows. This group is focusing his research on Arctic and North Atlantic sector, both in the ocean and atmosphere, analysing recent period as well as a few key paleoclimatic periods (Holocene, Heinrich events…). It is developing new techniques of data assimilation in collaboration with LOCEAN laboratory, which could be applied to ocean-atmosphere complex models, both for the recent period and for deeper time scale.

CNRS-LOPS (UMR 6523; permanent staff: 50) is primarily involved in ocean dynamics research and the monitoring and understanding of the ocean variability. It is actively involved in the organization of large oceanographic cruises, monitoring of basin scale Atlantic Ocean variability and hosts the ARGO-France observing service.

In this project, CNRS will be actively involved in the following WPs with the following staff:

WP1 Improving seasonal long range forecast skill of risks for hazardous weather and climate events (Lead: Johanna Baehr/UHAM, Co-lead:: Jens H. Christensen/DMI)	Prof. Claude Frankignoul, Dr. Guillaume Gastineau
WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)	Dr. Francis Codron, Prof. Claude Frankignoul, Dr. Guillaume Gastineau, Dr. Eric Guilyardi, Dr. Christophe Herbaut, Dr. Marie-Noelle Houssais, Dr. Herlé Mercier, Dr. Juliette Mignot , Dr. Didier Swingedouw, A.-C Blaizot
WP3 Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/LOCEAN)	Dr. Guillaume Gastineau (co-leader), Dr. Francis Codron, Prof. Claude Frankignoul, Dr. Eric Guilyardi, Dr. Christophe Herbaut, Dr. Marie-Noelle Houssais, Dr. Anne Sophie Kremeur, Dr. Juliette Mignot, Dr. Didier Swingedouw, A.-C Blaizot
WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB)	Dr. Eric Guilyardi, Dr. Juliette Mignot , Dr. Didier Swingedouw
WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)	All
WP7 Management (Lead: Steffen M. Olsen /DMI)	The WP 3 co- leader, Dr. Guillaume Gastineau
WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)	All

Relevant Personnel

Dr. Francis Codron (male) is a Professor at Université Pierre and Marie Curie (Paris) working at LOCEAN. His research interests are atmospheric dynamics, ocean-atmosphere coupling and climate models. He has worked on the interaction between the atmospheric variability and the ocean, mainly in the Southern

Ocean and North Atlantic regions, in the context of interannual climate variability, future or paleo-climates.

Prof. Claude Frankignoul (male) is Emeritus Professor at the Université Pierre and Marie Curie, Paris, Honorary Member of the Institut universitaire de France, and Fellow of the American Meteorological Society. He has many years experience in physical oceanography, ocean dynamics, ocean-atmosphere interactions, climate variability, and statistical methods. He has been a PI in many EU projects, most recently MILLENNIA, SINTEX, PREDICATE, DYNAMITE, THOR, and NACLIM. In 2015 he was awarded the "Sverdrup Gold Medal" of the American Meteorological Society

Dr. Guillaume Gastineau (male) is Assistant Professor-Senior Lecturer at Université Pierre and Marie Curie (Paris) working at LOCEAN. His research interests are atmospheric dynamics, air-sea interactions, decadal climate variability and statistical methods. He has worked with climate models, performed sensitivities experiments, evaluated CMIP3 and CMIP5 coupled models and analyzed observations. He has been involved in the EU FP7 THOR and NACLIM project.

Dr. Eric Guilyardi (male) is Directeur de Recherche at CNRS. He holds a joint appointment between LOCEAN and NCAS Climate, University of Reading (UK). His research spans tropical climate variability, ocean and climate, climate change, decadal predictability. He has a great experience in multi-model analysis, ocean-atmosphere model development, and software infrastructures for Earth System Models. He is a Lead Author for IPCC AR5. He has been co-investigator of several EU-funded (FP5,6,7) and national (NERC, ANR) projects, and has coordinated the METAFOR FP7 project (2008-2011).

Dr. Christophe Herbaut (male) is a research scientist at CNRS working at LOCEAN. C. Herbaut has been working on the influence of the NAO on the subpolar gyre circulation, the exchanges between the Arctic and the North Atlantic oceans, and the variability of the Arctic sea ice. He has a strong experience in implementing coupled ocean sea-ice models. He has been involved in several national and European projects such as DYNAMITE, THOR, NACLIM.

Dr. Marie-Noelle Houssais (female) is Directeur de Recherche at CNRS and member of LOCEAN. She is a physical oceanographer. Her main research interests include the ocean circulation and water mass formation with a special focus on polar processes and sea ice ocean interactions and their role in the climate variability from models and observations. She has a long experience in the development of sea ice-ocean models. She has been participating in several EU projects such as DYNAMITE, THOR and is currently coordinating a work package in the FP7 NACLIM project.

Dr. Anne Sophie Kremeur (female) is an assistant professor at the Université de Bordeaux working at EPOC. Her research focuses on the study of mode water dynamics at a mean state to interannual-to-decadal time scales and how they control the biogeochemical distribution in the water column. Dr. Krémeur has experience in developing, running and using ocean general circulation models where physics forces the biogeochemical component. She has developed a new idealized double gyre configuration of the North Atlantic Ocean implemented in the NEMO code as well as model-data comparisons to assess the realism of global bio-physical simulations.

Dr. Herlé Mercier (male) is a research director at CNRS working in physical oceanography at LPO. His research focuses on understanding the dynamics of the large scale ocean circulation, water mass formation and transformation, and biogeochemical tracer transports from in situ and remote sensing observations and models with a focus on the North Atlantic subpolar gyre. He is an expert in inverse modelling applied to the estimation of oceanic transports of physical and biogeochemical properties. In the last ten years he has published papers on all these topics. He has been involved in the Gyroscope EU project, and is involved in AtlantOS H2020 project.

Dr. Juliette Mignot (female) is researcher at IRD working at LOCEAN. She is specialized in physical

oceanography and climate variability. Her objectives are to better understand the climatic low frequency variability and in particular the role of the ocean and of external forcing (e.g. role of volcanoes). She has worked on the decadal climate variability in the Atlantic, on decadal prediction and predictability assessment, on understanding and characterizing the role of salinity in the oceanic stratification. She uses several statistical tools and climate models. She has been one of the initiators of the decadal predictability activities at IPSL/LOCEAN. She is also a member of the steering committee of the IPSL modelling group.

Dr. Didier Swingedouw (male) has been a CNRS scientist since 2010. He is an expert in physical oceanography and climate dynamics especially of the high latitudes. In 2013, he moved to EPOC in Bordeaux, where he is now developing his own modelling group on climate dynamics of the North Atlantic and Southern Ocean. He has been involved in four European projects (on-going EMBRACE and SPECS), as well as four national projects like ANR-ESCARSEL or ANR-GREENLAND, as a work package leader in two of them. He received three awards, one from the French marine academy for his PhD thesis in 2008, one from the EGU as Young Scientists Outstanding Poster Paper in 2007 and, in 2015, the "Christian Le Provost" price from French *Académie des Sciences* recompensing outstanding early career oceanographers.

A.-C. Blaizot (MSc) (female) is a computer engineer at the Museum National d'Histoire Naturelle working at LOCEAN. She has a solid experience in design and analysis of regional configurations of the NEMO model, with a particular interest in sea ice covered regions.

Relevant Publications:

- Frankignoul, C., Gastineau, G., & Kwon, Y. O. (2015). Wintertime atmospheric response to North Atlantic Ocean circulation variability in a climate model. Journal of Climate, 28, 7659-7677.
- J. García-Serrano, C. Frankignoul, G. Gastineau, A. de la Cámara, On the Predictability of the Winter Euro-Atlantic Climate: Lagged Influence of Autumn Arctic Sea Ice, Journal of Climate 28, 13, 5195-5216
- Gastineau, G., & Frankignoul, C. (2015). Influence of the North Atlantic SST Variability on the Atmospheric Circulation during the Twentieth Century. Journal of Climate, 28, 1396-1416.
- Herbaut C, M.-N. Houssais, S. Close, A.-C. Blaizot, 2015: Two wind-driven modes of winter sea ice variability in the Barents Sea. Deep Sea Res. Part I, 2015, 106, pp.97-115. <10.1016/j.dsr.2015.10.005>.
- Mercier, H., P. Lherminier, A. Sarafanov, F. Gaillard, N. Daniault, D. Desbruyères, A. Falina, B. Ferron, T. Huck, V. Thierry, 2015: Variability of the meridional overturning circulation at the Greenland-Portugal Ovide section from 1993 to 2010. Progress in Oceanography, http://dx.doi.org/10.1016/j.pocean.2013.11.001.
- Mignot J., Garcia-Serrano J, Swingedouw D, Germe A, Nguyen S, Ortega P, Guilyardi E, Ray S (2015) Decadal prediction skill in the ocean with surface nudging in the IPSL-CM5A-LR climate model, Clim. Dyn. DOI 10.1007/s00382-015-2898-1.
- Swingedouw D., P. Ortega, J. Mignot, E. Guilyardi, V. Masson-Delmotte, P. G. Butler and M. Khodri (2015) Bidecadal North Atlantic ocean circulation variability controlled by timing of volcanic eruptions , Nature Communications, doi : 10.1038/ncoms7545.
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- Born A. Mignot J. Stocker T. (2015) Multiple Equilibria as a Possible Mechanism for Decadal Variability in the North Atlantic Ocean Journal of Climate 28, 8907-8922.
- Campagne P., Crosta X., Houssais M. N., Schmidt S., Devred E., Capo S., Marieu V., Closset I., Swingedouw D. and Masse, G. (2015) Relative role of glacial ice and atmospheric forcing on the Mertz Glacier Polynya over the past 250 years. Nature Communications, 6, pages: 6642.
- Close, S., Houssais, M.-N. and Herbaut, C. (2015), Regional dependence in the timing of onset of rapid decline in Arctic sea ice concentration. J. Geophys. Res. Oceans. doi:10.1002/2015JC011187.

- Desbruyères, D., H. Mercier, V. Thierry, 2015: On the mechanisms behind decadal heat content changes in the eastern subpolar gyre. Progress in Oceanography, http://dx.doi.org/10.1016/j.pocean.2014.02.005.
- García-Ibáñez, Maribel I., Paula C. Pardo, Lidia I. Carracedo, Herlé Mercier, Pascale Lherminier, Aida F. Ríos, Fiz F Pérez, 2015: Structure, transports and transformations of the water masses in the Atlantic Subpolar Gyre. Progress in Oceanography, 135, 18-36, http://dx.doi.org/10.1016/j.pocean.2015.03.0090079-661.
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- Frankignoul, C., Sennéchael, N., & Cauchy, P. (2014). Observed atmospheric response to cold season sea ice variability in the Arctic. Journal of Climate, 27, 1243-1254.
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Relevant Projects

- **EU FP7 NACLIM** (2012-2017) www.naclim.eu supported by FP7 of the European Commission, investigate predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. LOCEAN is partner
- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu of the European Commission. The goal is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System. LPO and LOCEAN are partner.
- **EU SPECS** (2012.11-2017.01) supported by FP7 of the European Commission investigates seasonal-to-decadal climate predictions for the improvement of European climate services, PI. F. Doblas Reyes (IC3, Spain). LOCEAN and EPOC are partners.
- **EU PREFACE** (2013-2016), supported by FP7 of the European Commission aims at enhancing prediction of tropical Atlantic climate and its impacts. LOCEAN is partner.
- **EU EMBRACE** (2012.04-2016.02) supported by FP7 of the European Commission aims at reducing Earth system model bias and assessing the possibility of abrupt climate changes in the near future. EPOC is partner.
- **ANR Green Edge** (2014-2017), supported by the French National Research Agency. The objective is to understand the dynamics of the phytoplankton spring bloom and determine its role in the "Arctic Ocean of tomorrow", including its impact on human populations. LOCEAN is partner.
- **ANR MORDICUS** (2013-2018) supported by the French National Research Agency. Oscillations et rétroactions climatiques aux échelles décennales : mécanismes, sensibilité et incertitudes, PI C. Cassou (Cerfacs). LOCEAN is partner.
- **ANR HAMOC** (2014.06-2018.05) supported by the French agency ANR aims at understanding climate variability around Greenland over the last millennium using both isotope records and climate simulations. EPOC (D. Swingedouw) is a workpackage leader in this project.

- **ANR GREENLAND** (2011.06-2014.05) supported by the French agency ANR aimed at understanding climate variability around Greenland over the last millennium using both isotope records and climate simulations. EPOC (D. Swingedouw) was a workpackage leader in this project.

Relevant significant infrastructure and/or technical equipment

CNRS is partner of the National Computing Facility GENCI the goal of which is to support the use of numerical simulations and high performance computing for French researchers. CNRS will apply for allocation of computer time and data storage to GENCI.
EPOC will apply for CPU quotas to the French computational service GENCI (*grand équipement national de calcul intensif*, http://www.genci.fr/en) in order to continue to use the petascale supercomputer called Curie (http://www-hpc.cea.fr/en/complexe/

Partner6 Department of Atmospheric Sciences at Yonsei University /Climate Theory Lab (CTL)

CTL is a research laboratory, under Department of Atmospheric Sciences at Yonsei University, since 2005. Yonsei University is one of leading university in Korea, and Department of Atmospheric Sciences is established in 1947. The main research concerns of CTL involve understanding of the climate changing mechanism from the pale to future, and intraseason-to-multi-decadal variability. The research in CTL is mainly supported from the governmental research foundations and Korea Meteorological Administration. CTL has total 10 members including one professor, and 9 researchers including one postdoc and eight graduate students.

In this project, CTL will be actively involved in:

- WP1/Task 1.3: Detection and attribution of weather systems and extremes
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Soon-Il An (male), Professor of Department of Atmospheric Sciences. Atmospheric and Climate scientist. In 1996 he completed a PhD in climate science focusing on the dynamical mechanism of ENSO. Currently, his research concerns involve understanding of the earth climate changing mechanism from the pale-climate to future climate, and of the intraseasonal-to-orbital timescale variability.

Relevant publications, products, service and/or other achievements

- Sung, M.-K., S.-I. An, B.-M. Kim, and J.-S. Kug, 2015: Asymmetric impact of Atlantic Multi-decadal oscillation on El Nino and La Nina characteristics, Geophy. Res. Lett., accepted. (Corresponding author)
- An, S.-I., and J. Choi, 2015: Why the Twenty-first Century Tropical Pacific Trend Pattern cannot significantly influence ENSO Amplitude. Climate Dynamics, 44, 133-146.
- Park, J.-H., and S.-I. An, 2014: Southward displacement of the upper atmosphere zonal jet in the eastern north Pacific due to global warming, Geophysical Res. Lett., 41, 7861-7867 (Corresponding author)
- Sung, M.K., S.-I. An, B.-M. Kim, and S.-H. Woo, 2014: A physical mechanism of the precipitation dipole in the western United States based on PDO-storm track relationship. Geophy. Res. Lett., 41, 4719-4726.
- Park, J.-H, and S.-I. An, 2014: The Impact of Tropical Western Pacific Convection on the North Pacific Atmospheric Circulation during the Boreal Winter, Climate Dynamics, 43, 2227-2238. (corresponding author)

- Sung, M.-K., B.-M. Kim, S.-I. An, 2014: Altered atmospheric responses to eastern Pacific and central Pacific El Ninos over the north Atlantic region due to stratospheric interference. Climate Dynamics, 42, 159-170
- Sung, M-K, Y-G Ham, J-S Kug, S-I An, 2013:An Alterative effect by the tropical north Atlantic SST in Intraseasonally varying El Niño teleconnection over the north Atlantic. Tellus A, 65, 19863 (corresponding author)
- Kim, H., and S.-I. An, 2013: On the subarctic North Atlantic cooling due to global warming, Theoretical and Applied Climatology, 114, 9-19 (corresponding author)
- An, S.-I., H.-R. Kim, B.-M. Kim, 2013: Impact of Freshwater Discharge from the Greenland Ice Sheet on North Atlantic Climate Variability, Theoretical and Applied Climatology, 112, 29-43.
- Sung, M.-K., G.-H. Lim, J.-S. Kug, and S-I. An, 2011: A linkage between the NAO and its downstream development due to the existence of blocking ridge. J. of Geophys. Res.- Atmosphere, 116, D11107, doi:10.1029/2010JD015006 (corresponding author) (June 4, 2011)
- Kug, J.-S, S.-I. An, Y.-G. Ham, and I.-S. Kang, 2010: Changes in El Niño and La Niña teleconnections over North Pacific-America in the global warming simulations. Theor. Appl. Climatol, 100, 275-282 (corresponding author, May, 2010)
- An, S.-I., 2008: A mechanism for the multi-decadal climate oscillation in the North Pacific. Theor. Appl. Climatol., 91, 77-84, 10.1007/s00704-006-0288-7. (Feb 2008)
- An, S.-I, J.-S. Kug, A. Timmermann, I.-S. Kang, and O. Timm 2007: The influence of ENSO on the generation of decadal variability in the North Pacific. J. Climate, 20, 667–680. (2007/2/15)

Relevant Projects

- **'Emergence mechanism of super El Nino and its impact on global warming'** - Explore the emergence mechanism of super El Nino and it impact on global warming, and propose the prediction method of super El Nino. Possibly expands to the higher latitudinal impact of El Nino, including arctic and northern oceans. **Funded by Korean Research Foundation.**
- **'Studies on the cryosphere variability using the climate prediction simulator'** – Diagnosis of the impact of cryosphere on the climate variability, and understanding of mechanism of cryosphere variability, particularly arctic sea ice and its impact. **Funded by Korean Research Foundation**

Relevant significant infrastructure and/or technical equipment

Not applicable.

Partner 7 DNV GL

DNV GL https://www.dnvgl.com is an independent foundation established in 1864. We are a company of 15.000 employees working out of 400 offices worldwide. DNV GL's global reach spans across industries from maritime, energy and renewables, to oil and gas. We deliver services within classification, verification, risk management, and technical advisory to the maritime industry and oil and gas companies across the world. Our commitment to safeguarding life, property and the environment is core to us in helping the industry transition into a safer, smarter, and greener future.
DNV GL has a long track record in the Arctic. We have over more than 4 decades helped pioneering partners and companies in the high North, ensuring safe passage and smarter operations by providing world class guidance and support in risk management and advisory services. Understanding operational challenges introduced by harsh climate and extreme physical conditions is important to our business and to our partners.

In this project, DNV GL will be actively involved in

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Øivin Aarnes (male) is a scholar of the University of Life Sciences in Norway with a major in Environmental Engineering and Forest Ecology. He holds a M.Sc. in Computer Science from Australia with a major in Geospatial Technologies. He was DNV GL lead on the GIS implementation of Integrated Environmental Monitoring for the Norwegian Continental Shelf. Øivin has 17 years' professional experience in numerical modelling, scientific data analysis, remote sensing, and environmental science. Øivin is currently pursuing work on climate change adaptation.

Dr. Kazuyoshi Mori (male) works for the DNV GL Technology Centre Japan in Yokohama (Associated partner to Blue-Action). He has extensive experience in Japanese shipping industry, and will serve as the key contact with small and medium enterprises in Japan.

Relevant Projects

The following is a list of projects thought relevant to the WP5 case study of this project:

- **Ice Mapper (2014-2015)** Designed to enable authorities and operators to gain a better understanding of change in sea ice conditions, the tool delivers advanced statistical ice analysis using the best available high resolution (satellite) ice data. Statistical ice analysis, such as mean, median, minimum, maximum and ice frequency, can be undertaken for larger areas, as well as for single locations (by grid cell) on different time scales. Funded by: DNV GL Environmental Risk Management
- **C-GEAR Climate Change & Adaptation (2015-)** DNV GL has developed a model- the C-GEAR core (Climate Geo-Enhanced Assessment of Risks) to help understand the implications of climate change scenarios. One use of the tool is to enable users to identify particular regions exposed to higher risk of hazards (e.g. flooding, drought, wildfires), by drawing a line to where extreme weather events are more likely to occur. Funded by: DNV GL Strategic Research & Innovation- Climate Change Programme, DNV GL Environmental Risk Management
- **Environmental Sensitivity Analysis of Arctic Ecosystems (2012-2014)** Assessment of seasonal environmental vulnerability to marine mammals, seabirds, and fish for the Arctic EBSAs (Ecologically or Biologically Significant Areas) identified in the Arctic Marine Shipping Assessment (AMSA) IIc report. Funded by: DNV GL Environmental Risk Management
- **Arctic Risk Map (2012-2014)** Strategic project in DNV GL run in conjunction with DNV GL's 150 year anniversary. The project developed a web based map to serve as a basis for transparent communication and shared understanding of the Arctic risk picture in the face of increased human activity in the Arctic. Funded by: DNV GL [Operations, Safety, and Environmental Risk]
- **Integrated Environmental Monitoring (2012-2014)** Integrated real-time environmental monitoring of sensitive areas for offshore operations. The project developed methodology to monitor and predict environmental risks to critical environmental components based on a continuous sensor feeds Funded by: Kongsberg Group, IBM, Statoil, DNV GL
- **Circum-Polar Oil Spill Response Gap Analysis (2016-)** Impact of metocean conditions on oil spill response viability in the Arctic. Arctic Council's Emergency Prevention, Preparedness, and Response (EPPR) Working Group Funded by: Norwegian Coastal Department, Nuka Research

- **Oil Spill Response Gap Analysis for the Barents Sea** (2013-2014) PREGA allows users to analyze, visualize and document the possibilities, challenges and limitations of an oil spill response contingency plan taking into account environmental conditions. It can be applied to a large area or smaller field-specific sites. It combines datasets, statistical modelling and GIS functionality in a web solution. Funded by: DNV GL [Oil Spill Response & Preparedness, Environmental Risk]
- **Global Risk Picture for Tankers (2012, 2015)** GIS based tool for calculation and visualization of risks from Statoil's global tankers' shipping activity. The tool provides decision support and better predictability in planning Statoil's tankers shipping routes. Risks in question are: Environmental Risk, Liability, Economic Risk, Loss of Life, and Operational Risk (collision and grounding) Funded by: Statoil ASA
- **Arctic Shipping Risk (2013-2014**) Major Arctic shipping routes and traffic schemes were modelled from AIS (Automatic Identification System) data. By joining maritime risk expertise with leading advisory on spatial planning, we developed a model for assessing risks to ships operating in Arctic waters. Funded by: DNV GL, Norwegian Coastal Department

Relevant significant infrastructure and/or technical equipment

Not applicable.

Partner 8 Danish Pelagic Producers Organisation (DPPO)

Representing the 12 largest Danish pelagic vessels the Danish Pelagic Producers' Organisation (DPPO) is as a key player and stakeholder in the management of fisheries, fish stocks and the marine environment.
The DPPO-vessels account for more than one third of the total turnover in Danish fisheries. Since most pelagic species are regulated through an ITQ system and the pelagic vessels target a range of different species; sustainability is crucial for their businesses. Hence a key objective of the DPPO is to enable a management, e.g. by providing alternative data sources, which will help secure a maximum sustainable yield (catches and economics) in the long term.

- At the international level DPPO is an active player in ICES work, RACs (Chair of WG1 in PRAC, member of ExCom PRAC and LDRAC), Northern Pelagic Working Group and has further been involved in the development of several long term management plans and EU funded projects.
- At the national level DPPO is involved in a number of projects and joint ventures, predominantly with DTU Aqua. As part of this, DPPO has supported both scientist and scientific surveys economically.

The staff of DPPO consists of a Chairman (economist), a CEO (M.Sc. natrural resource management) and a chief biologist (PhD in fisheries Science). Headquarter is in Copenhagen where the CEO and Chief biologist are located. DPPO also holds an office in Hirtshals where the Chairman resides. This setup secures both a tight relation to the fishery/fishermen and a close connection to the fishery management decision pathways.

DPPO will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Claus Reedtz Sparrevohn (PhD) is Chief Science Officer and was educated at Aarhus University, the Norwegian Fisheries School and at Wageningen University wherefrom he has his Ph. D. His professional

carrier has been at DTU Aqua doing research on stock enhancement projects, methods to monitor catches in the recreational fishery and fish population dynamics in the Danish waters in relation to climate changes. During Dr. Sparrevohn's career at DTU Aqua he chaired the ICES working group on recreational fisheries surveys. Dr. Sparrevohn has participated in a long range of ICES groups both as Chair, observer and bon fide scientist (nominated by Denmark) and has represented the Pelagic RAC at STECF meeting.

Relevant Projects

- **MyFish EU FP7** DPPO work is vital component of the partner line-up in Myfish. These organisations bring a wealth of experience and knowledge to the table when considering the effects of implementing Maximum Sustainable Yield (MSY)
- **Drones for fishing** is a project that aims to create a network for investigating and mapping out the possibilities of using drones and robotics in the search for fish shoals in Danish waters. The project will create a development basis for a subsequent product development of a robot solution for the Danish as well as global market. The Danish Ministry of Environment and Food supports the project, which in addition to Blue Ocean Robotics include the participation of, among others Aquamind, Danish Pelagic Producers Organisation (DPPO), National Institute of Aquatic Resources (DTU Aqua), and ISAFOLD
- **SAFMAMS (FP7)** raws insights from existing research projects and management processes on the most useful forms of scientific advice for marine environmental management and then communicates those insights to scientists and decision makers. The product will be an outline of the various forms that such advice can take and a description of the circumstances under which these various forms are the most useful and cost effective.

Relevant significant infrastructure and/or technical equipment

The DPPO-vessels account for more than one third of the total turnover in Danish fisheries.

Partner 9 Technical University of Denmark (DTU)

The Technical University of Denmark (DTU) is a self-governed, science and technology university ranked in the top 40 technical institutes internationally. At DTU we will have two teams involved: the **DTU Aqua and the Climate-KIC's Nordic centre.**

The Institute of Aquatic Resources (**DTU Aqua**) provides research, education and advice concerning sustainable exploitation of living marine and fresh water resources. DTU Aqua conducts research in the interactions between the aquatic environment, productivity and variation in fish stocks, methods for fish stock assessment, and develops methods for sustainable fisheries management and stock enhancement. The institute conducts the Danish national monitoring on fish and fisheries for the EU. DTU Aqua has a high international standing within marine sciences and technology and extensive experience in coordinating and managing scientific programmes, e.g. EFIMAS, PROTECT, EASE, DEFINELT, SEAFOOD+, FACTS, and EUROBASIN. The Centre for Ocean Life, a VKR centre of excellence within DTU Aqua, is pioneering the trait-based approach to marine ecology in order to develop a fundamental understanding and predictive capability of marine ecosystems.

DTU is also the legal entity behind the **Climate-KIC Nordic** (KIC): the Climate-KIC Nordic was launched on was launched on 7 February 2014. In international innovation and business competitiveness comparisons, the Nordic countries are consistently found at or near the top. The Nordic centre provides Climate-KIC's community with innovative and imaginative solutions to climate change via a dynamic alliance of Nordic partners drawn from academia, industry and the public sector. The partners of Climate-KIC's Nordic centre include five industrial partners, each world-leading within their branch, three top-performing universities, one municipality ranked as one of the ten most innovative cities in the world and one philanthropic

financial institution focused on environmental and resource sustainability. The ten founding partners of Climate-KIC Nordic are Chalmers University of Technology, Technical University of Denmark (DTU), the University of Copenhagen, City of Copenhagen, Grundfos, VELUX Group, Novozymes, COWI, Realdania and ROCKWOOL. Among the partners is the municipality, the City of Copenhagen, aiming to be an international test bed and showcase for new green solutions. For 2025, the City of Copenhagen has the ambitious goal to be the first carbon neutral capital in the world. Climate KIC is Europe's largest public-private innovation partnership focused on climate change, consisting of dynamic companies, the best academic institutions and the public sector. Climate-KIC is one of three Knowledge and Innovation Communities (KICs) created in 2010 by the European Institute of Innovation and Technology (EIT). The EIT is an EU body whose mission is to create sustainable growth. We support this mission by addressing climate change mitigation and adaptation. We integrate education, entrepreneurship and innovation resulting in connected, creative transformation of knowledge and ideas into economically viable products or services that help to mitigate climate change. We drive innovation in climate change through creative partnerships large and small, local and global, between the private, public and academic sectors. All partners bring their industry experience to the community and are connected through a national or regional centre. The Climate-KIC Accelerator is the only EU business acceleration programme focused on cleantech commercialisation. With fast track entrepreneurship education, top-notch tools & techniques and intensive coaching, we have set up the world's first real-life business school for cleantech entrepreneurs. Our activities are driven by four climate change themes:

- Urban Transitions
- Sustainable Production Systems
- Decision Metrics & Finance
- Sustainable Land Use

Our mission is to bring together, inspire and empower a dynamic community to build a zero carbon economy and climate resilient society. Our vision is to enable Europe to lead the global transformation towards sustainability.

DTU (Aqua and Climate KIC) will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr Mark R. Payne (male) is a senior researcher in the Centre for Ocean Life who focuses on developing predictive knowledge in marine ecosystems covering time scales from the seasonal and decadal to the climatic. Payne has published 30 peer reviewed publications (h-index 11) and a variety of other publications in journals including Nature, PNAS and Global Change Biology and has substantial experience providing scientific advice regarding the management of fish stocks. He has previously been the leader of WP4 in the EU FP7 project NACLIM, which focused on decadal-scale forecasts of the oceanic environment, and has helped pioneer the application of this knowledge to predict marine ecosystems. He is also the lead editor of a “research topic” in the journal “Frontiers in Marine Science” dedicated to this issue. His previous work has ranged across ecosystems (North Atlantic, North Sea) and trophic levels, including climate change impacts on plankton, small pelagic fish and top predators. He primarily works with statistical analysis of observational data sets, using inputs from satellite remote sensing and general circulation models to develop new insights into the underlying processes. Mark is the leader of WP5.

Dr. Peter Normann Vangsbo (male) Peter's background is within environmental health with more than 10 years of experience working as a researcher and consultant within sustainable urban development, urban

climate change adaptation and mitigation and strategic sustainable development for industries. Working focus has been centered on innovative urban environmental management and how sustainability can be linked to urban development in order to reduce environmental impact, energy consumption, improve urban life quality and economical development. Peter's experience has been gained through major environmental projects in Europe, Africa and Asia. Peter has also been Head of Fundraising at the Worldwatch Institute Europe. Peter is co-lead WP8.

Relevant publications, products, service and/or other achievements

- Payne, M. R. 2013. Climate change at the dinner table. Nature, 497, 320–321.
- Payne, M. R., Barange, M., Cheung, W. W. L., MacKenzie, B. R., Batchelder, H. P., Cormon, X., Eddy, T. D., et al. 2015. Uncertainties in projecting climate-change impacts in marine ecosystems. ICES Journal of Marine Science: Journal du Conseil. In press.
- Brun, P., Kiørboe, T., and Payne, M. R. 2015. Measuring evolutionary adaptation of phytoplankton with local field observations. Proceedings of the National Academy of Sciences, 112: E5223–E5224.
- Payne, M. R., et. al. 2009. Recruitment in a changing environment: the 2000s North Sea herring recruitment failure. ICES Journal of Marine Science, 66(2), 272–277. doi:10.1093/icesjms/fsn211
- MacKenzie, B. R., Payne, M. R., Boje, J., Høyer, J. L., & Siegstad, H. 2014. A cascade of warming impacts brings bluefin tuna to Greenland waters. Global Change Biology, 20(8), 2484–2491. doi:10.1111/gcb.12597
- Hátún, H., Payne, M.R. et al 2009. Large bio-geographical shifts in the north-eastern Atlantic Ocean: From the subpolar gyre, via plankton, to blue whiting and pilot whales. Progress In Oceanography, 80(3-4), 149–162.
- www.fishforecasts.aqua.dtu.dk DTU Aquas portal for delivering focused seasonal-to-decadal forecasts of marine living resource
- http://journal.frontiersin.org/researchtopic/4484 Frontiers in Marine Science Research Topic "Seasonal to decadal prediction of marine ecosystems: opportunities, approaches and applications"

Relevant Projects

- **EU H2020 EU CERES** (2016-2019) supported by the **H2020 framework of the European Commission**, investigates the expected impacts of climate change on both fisheries and aquaculture in European waters. DTU-Aqua is a partner.
- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu S is a BG 8 (Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources) research and innovation project on the integration of ocean observing activities across all disciplines for the Atlantic, considering European as well as non-European partners. The overarching target of the AtlantOS initiative is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System that goes beyond the state-of –the-art, and leaves a legacy of sustainability after the life of the project
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu supported by **FP7 of the European Commission**, investigating the predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. DTU-Aqua (Mark Payne) is the leader of Core-Theme 4 and WP4.1
- **FP7 EU BASIN** (2011-14),), supported by **FP7 of the European Commission**, advanced our understanding of the variability, potential impacts, and feedbacks of global change and anthropogenic

forcing on the structure, function and dynamics of the North Atlantic and associated shelf sea ecosystems as well as the key species influencing carbon sequestration and ecosystem function. DTU-Aqua was project leader.

Partner 10 Foresight Intelligence GbR (FI)

Foresight Intelligence http://www.foresightintelligence.de/ is a systemic consultancy company based in Berlin. It supports strategic foresight and planning processes in organizations and mainly serves public administration, research institutions, and think tanks. Foresight Intelligence conducts inter-departmental strategic planning processes for the German Federal Foreign Office, implements intercultural and multi-stakeholder strategic dialogues for the German Council on Foreign Relations and the German Institute for International and Security Affairs, and supports collaborative research projects with foresight methods for the Institute for Advanced Sustainability Studies. Since 2014, Foresight Intelligence conceptualized and implemented more than 30 scenario construction, visioning, road mapping, backcasting, and strategic conversation projects with more than 340 managers, officers and researchers.
In this project, FI will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Johannes Gabriel is the founder and managing director of Foresight Intelligence. He is also a non-resident fellow of the Global Public Policy Institute in Berlin and a non-resident fellow with the West Africa Institute (Praia). His research focus is on methods and theories of future studies and strategic foresight. He has authored and co-authored research articles for, among others, the yearbook of the German Council on Foreign Relations, International Politics and the European Journal of Futures Research. He received a master's degree with distinction in political science and economics as well as a certificate in modern Chinese language from the University of Trier. From 2009 to 2011 he was a PhD fellow with the Society and Technology Research Group in Berlin, the Daimler AG's foresight division. In 2011 he completed his PhD thesis on theoretical aspects of future studies. Johannes is going to be a visiting professor for future studies at the Central European University's School of Public Policy in Budapest in 2016.

Relevant publications, products, service and/or other achievements

- Gabriel, Johannes et al. (forthcoming): Solar Radiation Management – Foresight for Governance, IASS Workshop Report.
- Böttcher, Miranda/Gabriel, Johannes/Harnisch, Sebastian (2015): Scenarios on Stratospheric Albedo Modification Deployment in 2030, SPP 1689 Scenario Workshop Report, Hamburg.
- Gabriel, Johannes et al. (2015) Qualitative Szenarien als Tool des organisationalen Lernens, in: Strategische Vorausschau in der Politikberatung, Sondergutachten Projektnummer 56175, Bundesumweltamt.
- Gabriel, Johannes (2013): A scientific enquiry into the future, in: European Journal for Futures Research, 2:31, DOI: 10.1007/s40309-013-0031-4 (peer reviewed).
- Gabriel, Johannes (2013): Der wissenschaftliche Umgang mit Zukunft. Ein Ideologiekritik am Beispiel von Zukunftsstudien über China, Wiesbaden: Springer VS.
- Gabriel, Johannes/Sandhu, Joel (2012): GG2022 - New Thinking for Global Governance Needed, in: Global Policy, October 12 (www.globalpolicyjournal.com).

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Relevant Projects

- **SRM4G** (2015.04-2015.12) Foresight Intelligence conducted a scenario project for the Institute for Advanced Sustainability Studies (IASS) with 16 international experts. In three workshops, the participants created alternative scenarios and developed governance options, which then were cross-evaluated against scenarios in order to create robust governance frameworks. Dr. Johannes Gabriel was project manager and facilitator.
- **GGF 2025** (2014.05-2015.05) Foresight Intelligence is part of the Global Governance Futures (GGF) program team. The GGF program is a project series that started in 2010 (www.ggfutures.net). It brings together 25 young experts from China, India, Japan, the US and Germany to create scenarios in order to design future-oriented global governance concepts. The Global Public Policy Institute is the lead partner, Foresight Intelligence is responsible for the methodological support. Dr. Johannes Gabriel is the workshop facilitator and strategic foresight expert of the GGF team.
- **GGF 2027** (2016.05-2017.05) Foresight Intelligence is also part of the forthcoming round of the Global Governance Futures program.
- **SPP 1689** (2014.12-2015.06) Foresight Intelligence conducted a scenario workshop together with the University of Heidelberg in the context of the German Research Foundation (DFG) Priority Programme (SPP) 1689. Dr. Johannes Gabriel was coordinator and facilitator.
- **AA 2020** (06.2013-12.2014) Foresight Intelligence was the lead partner in a strategic foresight and policy planning project by the planning division of the German Federal Foreign Office. Dr. Johannes Gabriel was the coordinator and workshop facilitator.

Relevant significant infrastructure and/or technical equipment

Foresight Intelligence gets active support from its advisory board and from its international expert network. Analysts and researcher associates are regularly recruited from the Foresight Intelligence Network to work on specific projects.

Partner 11 GEOMAR Helmholtz Centre for Ocean Research Kiel (GEOMAR)

The GEOMAR Helmholtz Centre for Ocean Research Kiel (www.geomar.de) is one of the largest non-university research institutions in the field of marine sciences in Germany (950 staff, incl. 450 experienced scientists and about 200 doctoral candidates). It is a member of the Helmholtz Association, Germany's largest non-university scientific organisation. The centre's mandate is the interdisciplinary and multidisciplinary investigation of all aspects of modern marine sciences, from physical, chemical and biological oceanography to seafloor geology and marine meteorology. Research is conducted worldwide in all oceans. The main research topics are addressed in four divisions: Ocean Circulation and Climate Dynamics, Marine Biogeochemistry, Marine Ecology, and Dynamics of the Ocean Floor. GEOMAR's publication record and research funding is leading in these fields. GEOMAR cooperates closely with national and international research institutions and with a number of SMEs active in marine technology and science. GEOMAR supports modern research infrastructure, including four research vessels, the only manned research submersible in Germany, three deep-sea robots (two ROVs and an AUV) with diving depths up to 6000 m, one of the largest fleets of autonomously-operated underwater gliders in Europe, mooring facility,

a wide range of state-of-the-art analytical facilities and computer support for large data and ocean and climate models.
GEOMAR is very successful in acquiring external funding from both, national and international sources. With regard to EU programmes, GEOMAR has had about 45 EU-FP7-projects (about 10 still running) and coordinates three of ten new Horizon 2020 projects.
In this project, GEOMAR will be actively involved in:

- WP1: Improving seasonal long range forecast skill of risks for hazardous weather and climate events (Lead: Johanna Baehr/UHH, Co-lead: Jens H. Christensen/DMI)
- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant personnel

Dr Johannes Karstensen (male) is a Senior Scientist in the research unit Physical Oceanography. His scientific interests include the large scale ocean circulation with particular emphasis on upper ocean processes and on the interaction between physical processes and biogeochemical cycling. He is/has been involved in FP6 (ANIMATE, MERSEA IP, CarbOcean, ESONET, EMSO) and FP7 (EuroSITES, GROOM) projects, also as coordinator and WP leader. He is a member of OOPC, JCOMM OPA, DBCP, and the OceanSITES Steering Team & Data Management Team. He is member of the OSNAP steering committee; member of the DFG Kiel Cluster of Excellence ”The Future Ocean” and member of the DFG SFB 754 ”Climate-Biogeochemistry Interaction in the Tropical Ocean”. Johannes will be involved in WP2 and WP6, as deputy coordinator of AtlantOS.

Prof Daniela Domeisen (female) is Junior Professor in the research unit Maritime Meteorology. Her scientific interests include the large-scale stratospheric variability, prediction on sub-seasonal to seasonal timescales, as well as stratosphere – troposphere coupling. She has extensive experience working with the MPI-ESM initialized seasonal prediction system in terms of the model skill and the connection between stratospheric and Arctic variability. She is member of the DFG Kiel Cluster of Excellence “The Future Ocean”. Daniela will be involved in WP1.

Relevant publications, products, service and/or other achievements

- Fischer, J., **Karstensen, J.,** Zantopp, R. J., Visbeck, M., Biastoch, A., Behrens, E., Böning, C. W., Quadfasel, D., Jochumsen, K., Valdimarsson, H., Jónsson, S., Bacon, S., Holliday, N. P., Dye, S., Rhein, M. and Mertens, C., *Intra-seasonal variability of the DWBC in the western subpolar North Atlantic,* Progress in Oceanography. DOI 10.1016/j.pocean.2014.04.002, 2014
- Fan, X., Send, U., Testor, P., **Karstensen, J.** and Lherminier, P., *Observations of Irminger Sea Anticyclonic Eddies* Journal of Physical Oceanography, 43 (4). pp. 805-823. DOI 10.1175/JPO-D-11-0155.1., 2013
- **Karstensen, J.** and Lorbacher, K., *A practical indicator for surface ocean heat and freshwater buoyancy fluxes and its application to the NCEP reanalysis data* Tellus Series A, 63, pp. 338-347. DOI 10.1111/j.1600- 0870.2011.00510.x., 2011.
- **Domeisen**, D. I. V., Butler, A. H., Fröhlich, K., Bittner, M., Müller, W. A. und Baehr, J. (2015) Seasonal Predictability over Europe Arising from El Nino and Stratospheric Variability in the MPI-ESM Seasonal Prediction System Journal of Climate, 28 (1). pp. 256-271. DOI 10.1175/JCLI-D-14-00207.1.
- Baehr, J., Fröhlich, K., Botzet, M., **Domeisen**, D. I. V., Kornblueh, L., Notz, D., Piontek, R., Pohlmann, H., Tietsche, S. und Müller, W. A. (2015) The prediction of surface temperature in the new seasonal prediction system based on the MPI-ESM coupled climate model Climate Dynamics, 44 (9-10). pp. 2723-2735. DOI 10.1007/s00382-014-2399-7.

- Sheshadri, A., Plumb, R. A. und **Domeisen**, D. I. V. (2014) Can the Delay in Antarctic Polar Vortex Breakup Explain Recent Trends in Surface Westerlies? Journal of the Atmospheric Sciences, 71 (2). pp. 566-573. DOI 10.1175/JAS-D-12-0343.1.
- **Domeisen**, D. I. V., Sun, L. und Chen, G. (2013) The role of synoptic eddies in the tropospheric response to stratospheric variability Geophysical Research Letters, 40 (18). pp. 4933-4937. DOI 10.1002/grl.50943.
- Wu, Y. **M. Latif**, and W. Park (2015): Multiyear Predictability of Northern Hemisphere Surface Air Temperature in the Kiel Climate Model. Climate Dynamics, 1–12, doi: 10.1007/s00382-015-2871-z.
- Zhou, G., **M. Latif**, R. J. Greatbatch, and W. Park (2015): Atmospheric Response to the North Pacific Enabled by Daily Sea Surface Temperature Variability. Geophys. Res. Lett., DOI: 10.1002/2015GL065356.
- Semenov, V. A., and **M. Latif** (2015): Nonlinear Atmospheric Circulation Response to Multi-year Arctic Sea Ice Concentration Changes in 1966-2012. Environ. Res. Lett., 10, 054020, doi:10.1088/1748-9326/10/5/054020.
- Bordbar, M. H., Th. Martin, **M. Latif**, and W. Park (2015): Effects of long-term variability on projections of twenty-first century dynamic sea level. Nature Climate Change 5, 343–347, doi:10.1038/nclimate2569.

Relevant projects

- **EU H2020 AtlantOS** (J.Karstensen is deputy coordinator) AtlantOS is a BG 8 (Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources) research and innovation project on the integration of ocean observing activities across all disciplines for the Atlantic, considering European as well as non-European partners. The overarching target of the AtlantOS initiative is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System that goes beyond the state-of –the-art, and leaves a legacy of sustainability after the life of the project.
- **BMBF RACE I+II** (M. Latif) Regional climate impacts of ocean circulation changes and mechanisms of ocean circulation changes. In these projects, sophisticated coupled ocean-atmosphere-sea ice general circulation models have been and will be applied to study ocean circulation variability and how it shapes climate predictability on time scales up to decadal.
- **EU FP7 FixO3** *(J. Karstensen)* The Fixed point Open Ocean Observatory network (FixO3) seeks to integrate European open ocean fixed point observatories and to improve access to these key installations for the broader community. These will provide multidisciplinary observations in all parts of the oceans from the air-sea interface to the deep seafloor.
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu *(J. Karstensen is CT2 „Monitoring of North Atlantic parameters" & WP 2.2 „Transports in the subpolar North Atlantic" leader)* Global climate variability is to a large extent triggered by changes in the North Atlantic sea surface state. The quality and skill of climate predictions depends crucially on a good knowledge of the northern sea surface temperatures (SST) and sea ice distributions. On a regional scale, these parameters strongly impact on weather and climate in Europe, determining precipitation patterns and strengths, as well as changes in temperature and wind patterns.
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu *(M. Latif is lead of WP 3.1 "Suitability of the ocean observing system components")* We have studied different measurements with respect to their impact on decadal predictability. It has been found that sea surface salinity measurements are crucial to reduce biases in climate models, which enhances the decadal predictability potential. Moreover, the deep ocean temperatures were found to be important in decadal predictability.

Relevant significant infrastructure and/or technical equipment

GEOMAR maintains a mooring array in the subpolar gyre (exit of Labrador Sea) that delivers the variability in strength and structure of the dense water overturning return flow (the array is part of the international OSNAP array); GEOMAR maintains a time series in the deep convection centre of the Labrador Sea (in collaboration with the Canadian VITALS project). The arrays provide in part near real-time data access. GEOMAR maintains a number of state-of-the-art climate models including high-resolution and atmosphere models as well as coupled ocean-atmosphere-sea ice general circulation models. The institute has access to a number of super computer facilities through Kiel University and to the super computer at the German Climate Computing Centre (DKRZ).

Partner 12 Faroe Marine Research Institute (HAV)

HAV is a research institute, funded by the Faroese government. Its responsibilities are to give advice on fisheries, and to carry out basic as well as applied research on both the biotic and the abiotic components of the marine ecosystems in Faroese waters. This includes research on the main ocean currents passing through the region, the warm Atlantic inflow towards the Arctic, and the returning cold overflow from the Arctic. HAV has a staff of about 35 persons. With its research vessel Magnus Heinason, HAV carries out regular observations of water mass characteristics and currents in the waters surrounding the Faroe Islands. Since 1987, the observational program has included cruises along four standard hydrographic sections three to four times a year carrying out CTD (Conductivity, Temperature, Depth) measurements. Since the mid-1990s, HAV has maintained an array of up to nine ADCP (Acoustic Doppler Current Profiler) moorings between Iceland and Scotland, as part of international and EU funded projects. In these projects, HAV has generally carried the responsibility for maintaining most of the moorings and research cruises in the Iceland-Scotland region, that monitor inflow of Atlantic water towards the Arctic and the Faroe Bank Channel overflow.
In this project, HAV will be actively involved in:

- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC).
- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI).
- WP7 Management (Lead: Steffen M. Olsen /DMI).
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Karin M. H. Larsen (female), Head of environmental department. Physical oceanographer. She has been involved in most of the major monitoring programs of the region that HAV has participated in since 1997. Within these projects, she has been responsible for the oceanographic equipment and data analysis. She is presently involved in the EU-FP7 NACLIM project regarding Greenland-Scotland Ridge exchanges. In 2009 she completed a PhD in coastal oceanography related to physical-biologial coupling. Main research interests are inflow of Atlantic water, exchanges between on-shelf and off-shelf waters and shelf physical-biological coupling.

Dr. Hjálmar Hátún (male) is a research scientist with expertise in physical oceanography. He has several years experience in studying the climatic effects on the marine ecosystem. Within the EU FP7 NACLIM project he is engaged in research on the impact of predicted North Atlantic upper ocean state changes on oceanic ecosystems. In 2004 he completed a PhD in the physics of the Faroe Current and in 2004-2005 he did a Post. Doc. at the University of Washington (Seattle, USA). Main research interests are climatic effects on marine ecosystems and physical-biological coupling.

Dr. Bogi Hansen (male) is a senior research scientist in physical oceanography. He has been active in the oceanography of the area for more than 40 years and has participated in all the major monitoring programs of the region. One of his main research interests is on the exchanges across the Greenland-Scotland Ridge, their effects on the global thermohaline circulation and AMOC and their effects on the oceanic heat and salt transports towards the Arctic.

Relevant publications, products, service and/or other achievements

1. Olsen, S. M., Hansen, B., Østerhus, S., Quadfasel, D., and Valdimarsson, H., (2015). Biased thermohaline exchanges with the arctic across the Iceland-Faroe Ridge in ocean climate models. Ocean Science Discussions, 12, 1471-1510, doi:10.5194/osd-12-1471-2015.
2. Hansen, B., Larsen, K. M. H., Hátún, H., Kristiansen, R., Mortensen, E., and Østerhus, S., (2015). Transport of volume, heat, and salt towards the Arctic in the Faroe Current 1993-2013. Ocean Science, 11, 743-757, doi:10.5194/os-11-743-2015.
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4. Larsen, K.M.H., Hátún, H., Hansen, B. and Kristiansen, R. (2012). Atlantic water in the Faroe area: sources and variability, *ICES Journal of Marine Science*, **69(5)**, 802–808. doi:10.1093/icesjms/fss028
5. Hansen, B., H. Hátún, R. Kristiansen, S. M. Olsen, and S. Østerhus (2010). Stability and forcing of the Iceland-Faroe inflow of water, heat, and salt to the Arctic. Ocean Science, 6, 1013–1026, 2010, doi:10.5194/os-6-1013-2010.
6. Hátún, H., M.R. Payne, G. Beaugrand, P.C. Reid, A.B. Sandø, H. Drange, B. Hansen, J.A. Jacobsen, D. Bloch (2009). Large bio-geographical shifts in the north-eastern Atlantic Ocean: From the subpolar gyre, via plankton, to blue whiting and pilot whales. Progress in Oceanography 80, 149-162.
7. Olsen, S.M., Hansen, B., Quadfasel, D., Østerhus, S., (2008). Observed and modelled stability of overflow across the Greenland-Scotland ridge. Nature 455, 519-522.
8. Hansen, B., S. Østerhus, B. Turrell, S. Jónsson, H. Valdimarsson, H. Hátún, S. M. Olsen. (2008). The inflow of Atlantic water, heat, and salt to the Nordic Seas across the Greenland-Scotland Ridge. In *Arctic–Subarctic Ocean Fluxes: Defining the role of the Northern Seas in Climate, 15 - 43* (eds Dickson, D., Meincke, J. & Rhines, P.), Ch. 1, Springer Science + Business Media B.V., 15-43.
9. Østerhus, S., T, Sherwin, D, Quadfasel, B, Hansen. (2008). The overflow transport east of Iceland. In *Arctic–Subarctic Ocean Fluxes: Defining the role of the Northern Seas in Climate, 427 - 441* (eds Dickson, D., Meincke, J. & Rhines, P.), Ch. 18, Springer Science + Business Media B.V., 427-441.
10. Hansen, B., Østerhus, S., (2007), Faroe Bank Channel overflow 1995 - 2005, Progress in Oceanography. doi: 10.1016/j.pocean.2007.09.004.
11. Hátún, H., Sandø, A.B., Drange, H., Hansen, B., and Valdimarsson, H. 2005: Influence of the Atlantic subpolar gyre on the thermohaline circulation. Science, 309, 1841-1844.

http://www.envofar.fo HAV observational data products are regularly updated on the Envofar homepage. These products include original quality controlled CTD and ADCP data and timeseries of Atlantic water inflow north of Faroes and overflow through the Faroe Bank Channel (volume fluxes), Atlantic water properties at Faroese standard sections and coastal water properties.

Relevant Projects

- **EU FP7 NACLIM** (2012-2017) www.naclim.eu Predictability of the climate in the North Atlantic/European sector related to N. Atlantic/Arctic Ocean sea surface temperature and sea ice variability and change. **Funded by EU-FP7.** Monitoring of transports across key sections in the N.

Atlantic. Quantifying the impact of predicted N. Atlantic upper ocean state changes on the oceanic ecosystem.

- **AtlantOS** – Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems. Funded by EU H2020. HAV is participating in WP3.3 on Transport Mooring Arrays (TMAs). Within the IAOOS the great value of TMAs is the acquisition of long time series of volume, heat and freshwater fluxes in key locations of strong flows (boundary currents), all of which are related to the Atlantic meridional overturning circulation. The TMAs enable the reliable estimate of these fluxes, including long time-series in the deep ocean. The overarching goal is the development of a sustainable, efficient and comprehensive network of TMAs.

Relevant significant infrastructure and/or technical equipment

HAV operates the research vessel "Magnus Heinason", which is a 669 BRT Stern trawler built in 1978 and converted to research vessel in 1982. Its scientific equipment include Seabird SBE911+ CTD, WP2 plankton net, Multi Plankton Sampler Net, bottom and pelagic trawls, EK-60 echo-sounder, etc. Scientific crew is max 5 persons. HAV currently has six Acoustic Doppler Current Profiler moorings in addition to various minor oceanographic equipment. The ADCPs are all operated within the EU-FP7 NACLIM project.

Partner 13 Institute of Atmospheric Physics of the Chinese Academy of Sciences (IAP-NZC)

Institute of Atmospheric Physics (http://english.iap.cas.cn/), Chinese Academy of Sciences (CAS) was established in 1928 and is the leading institute for meteorology in China. IAP has successively set up the theory of modern weather forecast, East Asia atmospheric circulation, cloud precipitation and weather modification, numerical weather forecast, satellite meteorology, atmospheric observation and related research and technology, climate dynamics and climate prediction, global change, etc. IAP currently employs more than 470 staff members, of whom 180 are professors, 120 are associate professors. IAP is one of the first CAS institutes that are qualified to grant a master's or doctoral degree approved by the Academic Degrees Committee of the State Council. IAP also operates programs for post-doc and international students. At present, there are 100 doctoral tutors, 70 graduate tutors, 47 doctoral co-tutors, 220 doctoral candidates, 168 graduate students. IAP has been devoting great efforts to international collaboration and academic exchange. In recent five years, IAP has signed a total of 17 cooperation agreements with foreign scientific institutions, and carried out more than 40 major international cooperation projects.

NZC (http://nzc.iap.ac.cn/) is a non-profit joint venture located at the Institute of Atmospheric Physics under the Chinese Academy of Sciences (IAP/CAS) in Beijing, China. Representatives from the Chinese and Norwegian authorities formally opened the NZC on 4 November 2003. The center has six founders now: IAP/CAS, Beijing, China, Nansen Environmental and Remote Sensing Center (NERSC), Bergen, Norway, the University of Bergen (UoB), Bergen, Norway, the Peking University (PKU), Beijing, China, Uni Research (UniRe), Bergen, Norway and Nanjing University (NJU), Nanjing, China.

NZC's strategy is to integrate theory and numerical modelling with field observations and remote-sensing products to develop research within three prioritized themes: Climate variability and interactions (past, present and future), Climate predictability and prediction, Regional climate and extremes (dynamic and statistical downscaling). In particular, NZC recent research is focusing on the Eurasian climate change: Arctic forcing versus tropical forcing, Arctic oscillation and Asian monsoon, which is targeted within the Blue-Action proposal.

At the end of 2015, NZC has a core staff of 95 persons. The staffs consist of 21 full-time members with 18 research scientists, 1 administration staff, and 2 joint members, 24 PhD students and 25 master students in addition to 25 collaborating scientists. And in the past 12 years, the research and development personnel of NZC published a total of 573 academic papers. In 2014, NZC has won the China National Natural Science Award (second class).

In this project, IAP-NZC will be actively involved in

- WP3: Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/LOCEAN)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Xuejie Gao (male) is a senoir reseacch scientist at NZC of the IAP. He has extensive experiences in climate modeling, climate change studies and climate services. His publications in the peer-reviewed scientific journals are frequently cited by the other authors (around 2,000 times based on Web of Science and 10,000 based on Google Scholar. As one of the leading scientist in climate modeling and climate change studies, he was selected as a member and served in IPCC TGICA (Task Group on Data & Scenario Support for Impact and Climate Analysis of the International Panel on Climate Change) during 2004-2008, and as the Lead Author of the IPCC Forth and Fifth Assessment Report (AR4 and AR5) during 2004-2007, and 2010-2013, respectively.

Dr. Ying Zhang (female) is a research scientist at NZC. Zhang's main interest is tropical cyclone (TC) over western North Pacific (WNP) and climate change. She has analyzed the TC activities over WNP in CMIP3 and CMIP5 models, both at present and in future, trying to validate the GCMs' performance of reproducing TC activities and estimate the possible impact of climate change on TC activities. She also has some experiences in climate projection about the 2℃ warming threshold over China and globe, and the change of water cycle over China.

Dr Yali Zhu (female) is a research scientist at NZC. Zhu has main interests and expertise in climate diagnosis using both observational and model output data. Zhu has taken part in several national and international projects supported by the National Natural Science Foundation of China which concern the tele-connections between high and low latitude atmospheric circulation and the climate impact of Arctic sea ice. Zhu's research mainly focus on the decadal climate variability and the related mechanisms.

Dr **Dong Guo** (male) is a research scientist at Nansen-Zhu International Research Centre. Guo has experience in climate modeling with Bergen climate models and climate diagnosis with observations. Guo has focused on the climate impact of Arctic sea ice on lower latitude, such as the teleconnection of Arctic sea ice and East Asian summer monsoon. Guo has been leader the projects of"Mechanism on the different key sector of spring Arctic sea ice impacts the East Asian summer monsoon" which is sported by National Natural Science Foundation of China and joined the project "BlurArc"sported by the Research Council of Norway, which all concern the tele-connections between Arctic regions and lower latitudes.

Dr **Jun Wang** (male) is research scientist at NZC/IAP. The main research interest of Wang is in natural disaster monitoring and forecasting by means of satellite remote sensing and numerical modelling. Wang has experience in using many kinds of satellite remote sensing data (including TRMM, GPM, MODIS, etc.) to retrieve precipitation estimation or to extract disaster information. For flood and landslide forecasting, he developed a simple distributed hydrological model and a dynamical landslide prediction model with colleagues, and use those models to build a flood and landslide disaster monitoring and forecasting system. Wang also has done some work in satellite and radar retrieved precipitation comparison and improvement.

Dr Jiehua Ma (female) is a research scientist at NZC/IAP. Ma is mainly interested in climate simulations and predictions. Ma has experience in using the Earth System Model developed by Chinese Academy of Sciences (CAS-ESM), and Community Earth System Model (CESM) developed by United States, and Weather Research and Forecasting Model (WRF).Ma has worked on the interannual to decadal climate variability, and the climate impacts of the Arctic sea ice changes.

Dr Fei Li (female) is a research scientist at NZC. In 2014, she started to work at NZC as research associate on understanding the recent climate change in the Arctic from the perspective of climate dynamics. She found that the recent winter sea ice change in the Arctic is partly attributed to an extra-tropical SST-related variability. For future research, her focus is on exploring polar-lower latitude interaction by using atmosphere-ocean-ice fully coupled GCM.

Relevant publications, products, service and/or other achievements

- Gao XJ, Shi Y, Zhang DF, Wu J, Giorgi F, Ji ZM, Wang YG, 2012. Uncertainties of monsoon precipitation projection over China: Results from two high resolution RCM simulations. Climate Research. 52, 213–226. doi: 10.3354/cr01084
- Gao XJ, Shi Y, Giorgi F, 2011. A high resolution simulation of climate change over China. Sciences in China D: Earth Sciences, 54(3), 462–472. doi:10.1007/s11430-010- 4035-7.
- Gao XJ, Shi Y, Song RY, Giorgi F, Wang YG, Zhang DF, 2008. Reduction of future monsoon precipitation over China: Comparison between a high resolution RCM simulation and the driving GCM. Meteorology and Atmospheric Physics, 100, 73–86. doi: 10.1007/s00703-008-0296-5
- Zhang, Y., 2012: Projections of 2.0°C warming over the globe and China under RCP4.5. Atmospheric and Oceanic Letters, 5(6), 514-520.
- Zhang, Y., Sun, J. Q., 2012: Model Projection of Precipitation minus Evaporation over China. Acta Meteorologica Sinica, 26(3), 376–388.
- Zhu, Y. L., Wang, H. J., Ma, J. H., Wang, T., Sun, J. Q., 2015: Contribution of the phase transition of Pacific decadal oscillation to the late 1990s' shift in East China summer rainfall. Journal of Geophysical Research, 120 (17), 8817-8827. DOI: 10.1002/2015JD023545.
- Zhu, Y. L., Wang, H. J., Zhou, W., Ma, J. H., 2011: Recent changes in the summer precipitation pattern in East China and the background circulation. Climate Dynamics, 36, 1463-1473. DOI: 10.1007/s00382-010-0852-9.
- Guo, D., Gao, Y.Q., Bethke, I., Gong, D.Y., Johannessen, O.M., Wang, H.J., 2014: Mechanism on how the spring Arctic sea ice impacts the East Asian summer monsoon. Theoretical and Applied Climatology, 115, 107-119, DOI: 10.1007/s00704-013-0872-6
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- Li, F., Wang, H.J., Gao, Y.Q., (2015): Extratropcial Ocean Warming and Winter Arctic Sea Ice Cover since the 1990s. J. Climate, 28, 5510–5522, doi: 10.1175/JCLI-D-14-00629.1
- Li, F., Wang H.J., (2014): Autumn Eurasian snow depth, autumn Arctic sea ice cover and East Asian winter monsoon. Int. J. Climatol., 34(13), 3616–3625, doi:10.1002/joc.3936
- Li, F., Wang H.J., (2013): Relationship between Bering Sea Ice Cover and East Asian Winter Monsoon Year-to-Year Variations. Adv. Atmos. Sci., 30(1), 48–56, doi: 10.1007/s00376-012-2071-2
- Li, F., Wang H.J., (2012): Autumn Sea Ice Cover, Winter Northern Hemisphere Annular Mode, and Winter Precipitation in Eurasia. J. Climate, 26(11), 3968–3981, doi:http://dx.doi.org/10.1175/JCLI-D-12-00380.1

Relevant Projects

- **NSFC-CCEU** (2013.01-2017.12),supported by **the National Natural Science Foundation of China,** investigated climate change over the Eurasian Continent and the projection. IAP is coordinator.
- **CMA-OceanEA** (2013.01-2015.12),supported by **the China Meteorological Administration,** investigate the role of the mid-to-high latitude ocean anomaly in the East Asian winter climate. IAP is coordinator.

Relevant significant infrastructure and/or technical equipment

IAP will provide CPU quotas and data storage for the project.

Partner 14 A.M. Obukhov Institute of Atmospheric Physics of Russian Academy of Sciences (IAP-RAS)

A.M. Obukhov Institute of Atmospheric Physics Russian Academy of Sciences is A.M. Obukhov Institute of Atmospheric Physics Russian Academy of Sciences is one of the leading research centers in the world in the field of atmospheric science. It was founded by Alexander Obukhov in 1956 to study basic processes in the atmosphere by means of achievements in physics, mechanics and applied mathematics. The atmosphere is studied by up-to-date experimental, observational, physical, mathematical and computational methods. Institute works on problems of turbulence of atmosphere are widely known. A.M. Obukhov together with A.N.Kolmogorov have formulated the theory of local homogeneous and isotropic turbulence for fluctuation of speed. Later (1949) Obukhov has developed the theory of fluctuations for pressure and a passive impurity, including temperature. Created by A.S.Monin and A.M.Obukhov, the theory of similarity (1953,1954) of turbulent ground layers of the atmosphere, passed the first experimental check at Tsimljansky scientific station IAP, and up to day it's the essential block of all existing climatic models. The total stuff of IAP RAS is currently 259 persons that include about 134 scientists. The Institute has three scientific stations: Zvenigorodskaya in the Moscow region, High-mountain around Kislovodsk and Tsimljansky in the Rostov region which provide carrying out of supervision, fields and scientific researches. More information at www.ifaran.ru.
In this project, IAP RAS will be actively involved in:

- WP3: Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/LOCEAN)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Dr. Vladimir A. Semenov (male), Lead Scientist of the Laboratory of Climate Theory, has expertise in climate diagnostics and modelling. Main research interests are mechanisms of Arctic climate changes, extreme weather and climate events, natural climate variability. He is a leader of the ongoing Russian national projects “Study of rapid climate change in the Arctic” (14-17-00647) supported by Russian Science Foundation, “Modelling of extreme weather events in Russia in the 21st century” (14-05-00518) supported by Russian Foundation for Basic Research, a PI (from IAP RAS) of collaborative GREENICE (Impacts of Sea-Ice and Snow-Cover Changes on Climate, Green Growth, and Society) project funded by NordForsk. When working at GEOMAR (at part-time position), he has been involved in EU-FP7 NACLIM project studying a contribution of Atlantic Multidecadal Variability to the observed climate trends.

Relevant publications, products, service and/or other achievements

- Semenov V.A. and Latif M. (2015) Nonlinear winter atmospheric circulation response to Arctic sea ice concentration anomalies for different periods during 1966–2012. Environ. Res. Lett. 10, 054020, doi:10.1088/1748-9326/10/5/054020.
- Meredith, E.P., Semenov, V.A., Maraun, D., Park, W., Chernokulsky A.V. (2015) Crucial role of Black Sea warming in amplifying the 2012 Krymsk precipitation extreme. Nature Geosceince 8, 615-620, doi: 10.1038/NGEO2483.
- Gelfan A., Semenov V.A., Gusev E., Motovilov Y., Nasonova O., Krylenko I. (2015) Large-basin hydrological response to climate model outputs: uncertainty caused by internal atmospheric variability. Hydrology and Earth System Sciences, 19, 2737–2754, doi:10.5194/hess-19-2737-2015.
- Semenov V.A. (2014) Role of sea ice in formation of wintertime Arctic temperature anomalies. Izvestiya, Atmosph. Oceanic Physics, 50, 343–349.

- Smedsrud L.H, Esau I.N., Ingvaldsen R.B., Eldevik T., Haugan P.M., Li C., Lien V., Olsen A., Omar A., Otterå O.H., Risebrobakken B., Sandø A.B., Semenov V.A., Sorokina S.A. (2013) The role of the Barents Sea in the Arctic climate system. Rev. Geophysics, 51, 415-449, doi:10.1002/rog.20017.
- Semenov, V.A. and M. Latif (2012) The early twentieth century warming and winter Arctic sea ice, The Cryosphere 6, 1231–1237, doi:10.5194/tc-6-1-2012.
- Semenov, V.A., Latif, M., Dommenget, D., Keenlyside, N.S., Strehz, A., Martin, T., Park, W. (2010): The Impact of North Atlantic-Arctic Multidecadal Variability on Northern Hemisphere Surface Air Temperature. J. Climate 23, 5668-5677, doi: 10.1175/2010JCLI3347.1.
- Petoukhov, V., Semenov, V.A. (2010): A link between reduced Barents-Kara sea ice and cold winter extremes over northern continents. J. Geophys. Res. - Atmospheres, 115, D21111, doi:10.1029/2009JD013568.
- Semenov, V.A., Park, W., Latif, M. (2009): Barents Sea inflow shutdown: A new mechanism for rapid climate changes. Geoph. Res. Lett. 36, L14709, doi: 10.1029/ 2009GL038911.
- Semenov, V.A., Latif, M., Jungclaus J.H., Park, W. (2008): Is the observed NAO variability during the instrumental record unusual? Geoph. Res. Lett. 35, L11701, doi:10.1029/2008GL033273.
- Bengtsson, L., Semenov, V. A., and O. M. Johannessen (2004): The early twentieth-century century warming in the Arctic – a possible mechanism. Journal of Climate 17, 4045-4057.
- Johannessen, O. M., Bengtsson, L., Miles, M. W., Kuzmina, S. I., Semenov, V. A., Alekseev, G. V., Nagurniy, A. P., Zakharov, V. F., Bobylev, L., Pettersson, L., Hasselmann, K., and H. P. Cattle (2004): Arctic climate change: observed and modeled temperature and sea-ice variability. Tellus 56A, 328-341.

Relevant Projects

- **EU FP7 NACLIM** (2012-2017) www.naclim.eu Predictability of the climate in the North Atlantic/European sector related to N. Atlantic/Arctic Ocean sea surface temperature and sea ice variability and change. **Funded by EU-FP7.** Studying a contribution of Atlantic Multidecadal Variability to the observed climate trends.
- **GREENICE** – Impacts of Sea-Ice and Snow-Cover Changes on Climate, Green Growth, and Society. IAP RAS is involved in WP3: Understanding the relation between climate change in the cryosphere and intensity of the extreme events in mid- and high-latitudes, and WP 1: Impact of cryosphere changes on the large-scale atmospheric circulation.
- **Russian Science Foundation project 14-17-00647 "Study of rapid climate change in the Arctic".** Investigation of mechanisms of climate variability in northern high latitudes and impacts of rapid climate changes on society and environment.
- **Russian Foundation for Basic Research project 14-05-00518 "Modelling of extreme weather events in Russia in the 21st century"**. Study of mechanisms of the recent extreme events in Russia (icluding those related to rapid Arctic climate change) using dedicated simulations with global and regional climate models.

Institute For Advanced Sustainability Studies e.V. (IASS)

The IASS http://www.iass-potsdam.de/de/ was officially founded in 2009 as a joint initiative of the German Federal Government, the State of Brandenburg and the research organizations of the German Science Alliance. Potsdam, Germany, was chosen as the location for the institute due to its excellent research landscape with world class research institutions such as the Potsdam Institute for Climate Impact Research (PIK) and the Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, as well as its close proximity to politics, media and non-governmental organisations in Berlin. In seeking

contextually appropriate and effective solutions to the urgent and critical global and local challenges and to help initiate and support transformations to sustainable futures for all, IASS aims to consider all relevant types of knowledge – both within and outside science. IASS brings its expertise in natural and social sciences and humanities in collaboration with a wide range of stakeholders from all parts of society in a transdisciplinary process, with the goal of producing socially appropriate and scientifically sound solutions. The IASS also applies its findings in dialogues with politicians, industry, researchers, and civil society and in turn learns from these interactions to further transformative processes.
In this project, IASS will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, **Co-lead: Kathrin Keil /IASS**)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Kathrin Keil (female) is a Project Scientist at the Institute for Advanced Sustainability Studies (IASS) and organizational Project Leader of the SMART project (Sustainable Modes of Arctic Resource-driven Transformations), which focuses on stakeholder engagement and governance challenges in the resource-driven transformations in the Arctic. A focus of her work is on the inter- and transdisciplinary causes and effects of regional and global change, with a special focus on economic, political and governance factors. Kathrin has a background in political science and international law, researching political and governance developments especially in relation to transformations and sustainability challenges. Kathrin received her Ph.D. in Political Science from the Freie Universität Berlin in 2013. In her dissertation she researched the international politics of the Arctic, with a focus on international regimes and institutions in the areas of energy, shipping and fishing. She especially looked at the interest constellations of various stakeholders in resource development, which possible conflicts could emerge from these interest constellations, and if appropriate governance mechanisms are in place in order to accommodate such possible conflicts. During her PhD work and her time at IASS, Kathrin has been building up extensive connections and networks with Arctic stake- and rights-holders. Next to her academic publication efforts, she has been engaged in dissemination efforts to groups outside academia, for example as Europe Director of *The Arctic Institute – Center for Circumpolar Security Studies*, a think tank which regularly writes about and comments on current Arctic developments in an open-access manner. Kathrin also regularly interacts with policy-makers, such as through formats as the *Arctic Dialogue* series with all German ministries, and as part of the official German observer delegation to the Sustainable Development Working Group (SDWG) of the Arctic Council.
Prof. Ilan Chabay (male) is Senior Fellow at the Institute for Advanced Sustainability Studies (IASS), Potsdam, which he joined in February 2012. In 2016, he will become Senior Advisor for Global Sustainability Research at IASS. He is the author or co-author of over 50 peer reviewed articles in major journals in both social science and natural science and has been invited as a keynote speaker in dozens of conferences and lectures at institutions worldwide. He was elected Honorary Member of the Swiss Academy of Humanities and Social Sciences in 2012. His current work is centered on understanding the interplay between knowledge production and systems, learning processes, and individual and collective actions at multiple temporal and spatial scales and governance levels. This is central to the work of the multi-disciplinary team on the SMART project (Sustainable Modes of Arctic Resource-driven Transformations), which he co-leads with Dr. Kathrin Keil. The aim of the project is to create stakeholder-relevant scenarios with plausible sets of options and consequences for use by stakeholders at multiple institutional levels and geographic scales leading to more effective governance and improved Arctic and global sustainable policies and practices. Ilan is also the founder and chair since 2011 of the Knowledge, Learning, and Societal Change international research alliance (www.KLASICA.org). KLASICA is an alliance of projects that directly or indirectly focus on understanding collective behavior change and social movements concerned with the challenges of global change and transformations to sustainable futures. Ilan was a member of the Scientific Committee of the International Human Dimensions Programme on Global Environmental Change (IHDP) from 2008-2014.

From 2006 until 2012, he was the Erna & Victor Hasselblad Professor of Public Learning and Understanding of Science in the Department of Sociology, University of Gothenburg, Sweden and in the Department of Applied Technology, Chalmers Univ. of Technology. From 2003 to 2006, he was a member of the Leadership and Planning Group for Education and Director of Design Team for NASA's Science Educational Framework. He was associate director of the Exploratorium Science Museum in San Francisco in 1982-1983 and Consulting Professor of Chemistry at Stanford University from 1984-1988. He received his Ph.D. in chemical physics from the University of Chicago in 1972, then after a postdoctoral fellowship in biophysical chemistry, he became research scientist for eight years at the National Institutes of Standards and Technology in Gaithersburg, MD, where he developed several new laser spectroscopic methods for environmental and biological analysis that have become widely-used and cited standard research methods.

Vilena Valeeva (female) is a Project Scientist at IASS and a PhD student at the University of Potsdam. Her research activities mainly focus on international cooperation in the Arctic, interactions among socio-economic, climatic and environmental changes in the Russian Arctic as well as stakeholders' perceptions of these changes. Vilena has been participating in international research projects such as the EU FP7 coordination action EuRuCAS (European-Russian Centre for Cooperation in the Arctic and Sub-Arctic Environmental and Climate Research) and the Arctic Council project AACA (Adaptation Actions for a Changing Arctic).

Silke Niehoff (female) Silke has worked at the IASS since 2013 and joined the Arctic team in 2015 as a project scientist. She holds a Staatsexamen (teaching degree) in Biology and Geography and a master's degree in environmental management from the Environmental Policy Research Centre (FFU) at Free University Berlin. Before joining the IASS she worked for the Nature And Biodiversity Conservation Union (a German environmental NGO) in different projects, for example on the vertical integration of sustainable development. Her research interest includes governance of sustainable development in the Arctic and sustainable resource management regarding different production and consumption patterns.

Relevant publications, products, service and/or other achievements

Journal articles

Kirstin Werner, **Kathrin Keil**, Michael Fritz, Nathalie Morata, Alexey Pavlov, Ilka Peeken, Anna Nikolopoulos, Helen Findlay, Monika Kędra, Sanna Majaneva, Angelika Renner, Stefan Hendricks, Mathilde Jacquot, Marcel Nicolaus, Matt O'Regan, Makoto Sampei, Carolyn Wegner, 2016 (forthcoming): "Arctic in Rapid Transition: Priorities for the Future of Marine and Coastal Research in the Arctic", *Polar Science*.

Keil, Kathrin, 2015: "Die Zukunft arktischer Öl- und Gasressourcen - Internationale Einflussfaktoren arktischer Energieressourcenentwicklung" [The Future of Arctic Oil and Gas Resources – International Influencing Factors of Arctic Energy Development], Sicherheit und Frieden/Security and Piece, Special Issue on The Arctic – Regional Cooperation or Conflict, 3/2015, pp. 132-138.

Keil, Kathrin, 2015. "Economic Potential", in: Jokela, Juha (ed.): Arctic security matters, Report No 24 – June 2015, EU Institute for Security Studies, Paris, p. 21-31. Available at: http://www.iss.europa.eu/uploads/media/Report_24_Arctic_matters.pdf.

Keil, Kathrin, 2015: "Spreading Oil, Spreading Conflict? Institutions Regulating Arctic Oil and Gas Activities", The International Spectator: Italian Journal of International Affairs, Vol. 50, Issue 1, pp. 85-110.

Albert Buixadé Farré, Scott R. Stephenson, Linling Chen, Michael Czub, Ying Dai, Denis Demchev, Yaroslav Efimov, Piotr Graczyk, Henrik Grythe, **Kathrin Keil**, Niku Kivekäs, Naresh Kumar, Nengye Liu, Igor Matelenok, Mari Myksvoll, Derek O'Leary, Julia Olsen, Sachin Pavithran .A.P., Edward Petersen, Andreas Raspotnik, Ivan Ryzhov, Jan Solski, Lingling Suo, Caroline Troein, **Vilena Valeeva**, Jaap van Rijckevorsel, Jonathan Wighting, 2014: "Commercial Arctic shipping through the Northeast Passage: Routes, resources, governance, technology, and infrastructure", Polar Geography, Vol. 37 (4).

Keil, Kathrin - Raspotnik, Andreas, 2014: "The European Union's Gateways to the Arctic", European Foreign Affairs Review, Vol. 19, Issue 1, pp. 101-120.

Keil, Kathrin, 2014: "The Arctic: A new region of conflict? The case of oil and gas", Cooperation and Conflict, Vol. 49, Issue 2, pp. 160-188.

Knecht, Sebastian – **Keil, Kathrin**, 2013: "Arctic Geopolitics Revisited: Spatialising Governance in the Circumpolar North", The Polar Journal, Vol. 3, Issue 1, pp. 178-203.

Keil, Kathrin, 2012: "Opening Oil and Gas Development in the Arctic: A Conflict and Risk Assessment", Tvergastein Interdisciplinary Journal of the Environment, 2nd issue, November 2012, pp. 36-43.

Books

(*forthcoming 2016*) **Keil, Kathrin** and Sebastian Knecht (Eds.) (Under Contract): Beyond Geo-Politics: Arctic Governance in Global Perspective. Basingstoke: Palgrave.

Book chapter

(*forthcoming 2016*) **Keil, Kathrin**: "The Arctic in a Global Energy Picture: International Determinants of Arctic Oil and Gas Development", in: Keil, Kathrin and Sebastian Knecht (Eds.): Beyond Geo-Politics: Arctic Governance in Global Perspective . Basingstoke: Palgrave.

Relevant recent publications for Ilan Chabay:

Chabay, I., Frick, M., Helgeson, J., eds. (2015) Land Restoration: reclaiming landscapes for a sustainable future, Elsevier Academic Press ISBN: 978-0-12-801231-4 (in print and online).

Chabay, I. (2015) "Responding To Challenges Of Rapid Global Change By Strengthening Local Science, Math, Engineering, and Technology Education" in International Science and Technology Education: Exploring Culture, Economy and Social Perceptions, Renn, O., Karafyllis, N.C., Hohlt,A., Taube, D. eds., Berlin-Brandenburg Academy of Sciences, Rutledge Press, July 2015.

Schmale, J., E. von Schneidemesser, I. **Chabay**, A. Maas, M. G. Lawrence (2015) "Building interfaces that work - A multi-stakeholder approach to air pollution and climate change mitigation" in Communicating the Relationship between Policy Sciences, Natural Hazards and Global Environmental Change, Springer Verlag.

Chabay, I., (2015) "Narratives for a Sustainable Future: Vision and Motivation for Collective Action" in B. Werlen editor Global Sustainability, Cultural Perspectives and Challenges for Transdisciplinary Integrated Research, Springer International Publishing, Switzerland.

Schmale, J., D. Shindell, E. von Schneidemesser, I. **Chabay**, M. G. Lawrence (2014) "Clean Our Skies: Coupled Human-Atmosphere-Systems: Improve air quality and mitigate climate-change simultaneously" Comment in *Nature* 515 335-337

C. Stöhr and I. **Chabay**, "From Shouting Matches to Productive Dialogue – Establishing Stakeholder Participation in Polish Fisheries Governance." *Int. J. Sustainable Development*, Vol. 17, No. 4, (2014)

C. Stöhr, C. Lundholm, B. Crona, I. **Chabay**, "Learning platforms and sustainable fisheries: An integrative framework for assessing adaptive co-management processes" *Ecology & Society* 19(3): 14 (2014)

J. D. Tàbara and I. **Chabay**, "Coupling Human Information and Knowledge Systems with social–ecological systems change: Reframing research, education, and policy for sustainability," *Environmental Science and Policy* 28 71–81 (2013)

Relevant Projects

- **SMART Project** (09/2013–12/2016) – Sustainable Modes of Arctic Research-driven Transformations, Project lead: IASS Potsdam, funded through IASS.
- **GRASP** (planned to start in 2016) – Governance of Resources for Arctic Sustainable Policy and Practice. Project lead: IASS Potsdam, Alfred Wegener Institute for Polar and Marine Research, Jade University of Applied Sciences.

- **ArcticABC** (2015 –2017) – Arctic Ocean ecosystems - Applied technology, Biological interactions and Consequences in an era of abrupt climate change, Project lead: Jørgen Berge (University of Tromsø, University Centre in Svaldbard), funded through Research Council of Norway. Kathrin Keil: Contribution to Part III "Geopolitics".

Partner 16 Institut Català de Ciències del Clima (Catalan Institute of Climate Sciences, IC3)- Participation terminated

Participation terminated with the Amendment 1.

Partner 17 Institute of World Economy and International Relations (IMEMO)

The Institute of World Economy and International Relations named after E.Primakov http://www.imemo.ru/en (IMEMO) is a non-profit organization within the Russian Academy of Sciences founded in 1956. The mission of the Institute is the elaboration of a reliable analytical basis for political decision-making. IMEMO is among the leading global think tanks in the field of international economic relations and global sustainable development. It has been actively involved in multidisciplinary research on socio-economic and geopolitical drivers of Arctic Change and in supporting the science-policy interface for international cooperation in and for Arctic regions. IMEMO has extensive research and stakeholder experience especially within Russia and with Russian industry actors working on Arctic projects.
In this project IMEMO will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Elena Nikitina (female) is a political scientist focusing on environmental policy, climate change and water governance, implementation and effectiveness of international environmental accords and national compliance. Over the last decade has been involved in research and consulting on sustainable development, environmental policy and adaptive governance in the Arctic. Participated as a member of the Russian delegation to the Arctic Council senior officials meetings and its expert committee for Sustainable development working group (SDWG). Lead author for the IPCC 4th and 3rd assessment reports. Took part in the AACA-B ("Adaptation action in the changing Arctic") and coordinated Russia's survey on the role of the northern regions in adaptation initiatives; currently is involved as a lead author in AACA-C assessment report. Coordinator of international research projects, including the EC research. Head of IMEMO Center on global economic problems; President of non-government non-profit organization EcoPolicy Research & Consulting. Publishes widely in Russia and in the West.

Relevant publications, products, service and/or other achievements

- Nikitina E., Poussenkova N., Loe J., Kelman I. , 2015. Sustainable oil and gas practices in the Arctic: Business responsibility towards communities and environment, *Arctic Herald*, N 3(15).
- Nikitina E., 2013. Changing Actic: Adaptation to climate change. *Arctic Herald*, N 1 (5)

- Nikitina E., 2011. Russian Arctic: Problems of environmentally sustainable development. In: Arctic: Interests of Russia. Energy & Environment, Simonia N. (ed), Moscow, INEK-Analytic: 182p
- 4. Russia and the World: 2016. Economy and Foreign Policy. Annual Forecast, 2015. Dynkin A., Baranovsky V., Adno U., Afonsev S.,Bogaevskaya O., Volodin A., Kydinova O., Kuznetsov A., Leontieva E., Lukonin S., Machavariani G., Mirkin Y., Nikitina E., Popov V., Sergeev P., Voitolovsky F., Voda K., Zuravleva V., Zviagelskaya I., Kanaev E., et al. IMEMO/Chamber of Trade and Commerce, Moscow
- Falkland T., Hansen J., Heath L., Jiang K., Kameyama Y., Kishi M., Lebel L., Meinke H., Nikitina E., Salinger M., Shukla P.R, and White I., 2014. Climate and Security in Asia and Pacific (Food, Water, Energy). Ch. 4. In: Climate in Asia and Pacific. Security, Society and Sustainability. Series: Advances in Global Change Research, Vol. 56. Manton M., Stevenson L.A. (eds.), Springer, 312p
- Pahl-Wostl C., A.Arthington, J. Bogardi, S. Bunn, H. Hoff, L. Lebel, E. Nikitina, M. Palmer, L. Poff, K. Richards, M. Schluter, A. St-Hilaire, R.. Tharme, K. Tockner, D. Tsegai, 2013. Environmental flows and water governance: Managing sustainable water uses. *Current Opinion on Environmental Sustainability*, Vol 5, N 3-4, p. 341-351
- Taking Stock of Adaptation Programs in the Arctic, 2013. Report for the Kiruna Ministerial Conference, Arctic Council, May (co-author of assessment report)
- 8.A Euro-Atlantic Action Plan for Cooperation and Enhanced Arctic Security, 2013. Carnegie Endowment for International Peace, Washington (co-authored assessment report)
- 9. Pahl-Wostl C., Knieper C., Lebel L., Nikitina E., 2012. From applying panaceas to mastering complexity: Toward adaptive water governance in river basins. *Environmental Science & Policy*, Elsevier Publishers, No 23: 24-34
- Lebel L., Nikitina E., Pahl-Wostl C., Knieper C., 2013. Institutional fit and river basin governance: A new approach using multiple composite measures. *Ecology and Society*, Vol.18, No 1
- Nikitina E., Kotov V., 2011. Russia's Climate Policy and the Kyoto Ratification Deal: Assessing the Science/Practice Interface. In: R.E.Kasperson, M.Berberian (eds.), Integrating Science and Policy. Vulnerability and Resilience in Global Environmental Change. Earthscan, London, Washington: 169-186
- Nikitina E., Kotov V., Lebel L., Sinh B.T., 2011. How better governance and stakeholder participation could reduce water insecurities in shared river basins. In J.Ganoulis, A.Aureli, J.Fried (eds.), Transboundary Resources Management. A Multidisciplinary Approach. WILEY-VCH VerlaG GmbH: 280-286
- Nikitina E., 2011. Russian Arctic: Environmental pollution and environmental thinking. *OstEuropa*, No 2-3: 95-210 (in German)
- Nikitina E., 2009. Pan-European cooperation as a response to environmental challenges. Coordinated actions in the context of climate change. In: *Architecture of the Euro-Atlantic Security.* Eds I. Jurgens, A. Dynkin, V. Baranovsky V. Institute for Modern Development. Econ-Inform, Moscow *(in Russian)*
- Halsnaes K., Shukla P., Akumu G., Beale J, Edmonds J., Gollier A., Grubler A., Ha Duong M., MArkandya A., McFarland E., Nikitina E., Sagiyama A., Villavicenciao A., Zou J., 2007. Framing issues. In *Climate Change 2007: Mitigation. Contribution of WG III to the Fourth Assessment Report of the IPCC* (B.Metz, O.Davidson, P.Bosch, R.Dave, L.Meyer, eds.), Cambridge University Press, Cambridge, UK and New York, NY, USA

Research Projects

- Sustainability and petroleum extraction: Corporate and community perspectives in Northern Norway and Russian Arctic, 2013-2016, Norwegian research Council
- Adaptation Action in the Changing Arctic, AACA-C, 2014-2017. AMAP/Arctic Council

- Energy security and sustainable development: Russia's national interests in the Arctic. Russian Scientific Fund on Humanities, 2009-2010 (*project coordinator)*.
- Arctic Governance Project. University of Tromsoe, OAK Foundation, Pacckard Foundation, Wilburforce, JM Kaplan Fund, Gordon Foundation, 2008-2010
- Coordinating twinning partnerships towards more adaptive governance in river basins, European Commission, 2009-2011 (*coordinator of the RF module*)
- Reducing water insecurity through stakeholder participation in river basin management in the Asia-Pacific, APN, 2008-2010 (*project coordinator*)
- Institutional coordination and cooperation between stakeholders in environmental risk management in large river basins in the EU and Russia, European Commission/INCO, 2004 -2007 (*project scientific coordinator)*
- Institutional Capacity in Natural Disasters Risk Reduction: A Comparative Analysis of Institutions, National Policies, and Cooperative Responses to Floods in Asia, APN, 2004-2006 (*project coordinator)*

Partner 18 Konsortium Deutsche Meeresforschung e.V. (KDM)

KDM - the German Marine Research Consortium is made up of sixteen institutions and universities of Germany in the field of marine and polar sciences as well as of coastal research. The members are part of a European and global network of such institutions. With approximately 2,200 scientists of basic and applied marine research, KDM provides comprehensive expertise to meet global challenges having to do with the sea and our environment. KDM is recognized by regional governments and by the federal government as the prime contact for strategic issues related to the future of the ocean sciences.
Our major goals are:

- advancement of science and research, in particular in the field marine sciences including polar and coastal research,
- fostering the collaboration of its member institutions and the development of joint research programmes,
- intensifying the cooperation within German, European and international marine research and the use of infrastructure and large equipment,
- joint public relations addressing decision makers in Germany and the European Union

KDM has established a national Strategic Working Group on scientific ocean observatories. The aim of this group is to articulate a German strategy for observatories in the European and global contexts. The KDM secretariat is tasked with science-policy relations in this context.

In this project, KDM will be actively involved in:

- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant personnel

Dr. Jan-Stefan Fritz (male) is Head of the Brussels Office of the German Marine Research Consortium (KDM). Since moving to Brussels in 2003 he has represented different German research organizations, mainly in the field of environmental research. Prior to moving to Brussels he worked the International Bureau of the German Federal Ministry of Education and Research (BMBF) and, before that, he was a consultant to UNEP and UNESCO. Stefan holds a Ph.D. from the London School of Economics and Political Science (LSE).

Stefan is a Member of the Board of Directors of the European Marine Board, a Member of the Operational Board of the Atlantic Ocean Research Alliance. He is also WP leader for foresight in the CSA OCEANS+ project.
Stefan is also a Senior Research Associate of the Institute of Intercultural and International Studies at the University of Bremen. His most recent publications relate to science-policy relations in European maritime policy as well as on deep-sea mining.

Relevant projects

- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu AtlantOS is a BG 8 (Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources) research and innovation project on the integration of ocean observing activities across all disciplines for the Atlantic, considering European as well as non-European partners. The overarching target of the AtlantOS initiative is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System that goes beyond the state-of –the-art, and leaves a legacy of sustainability after the life of the project. **KDM is leading the AtlantOS WP10: Engagement, Communication and Dissemination**
- **EU H2020 AORAC-SA** (BG14 H2020 project) Atlantic Ocean Research Alliance Support Action. Jan-Stefan Fritz is member of the Steering Committe of this project, and thus his presence in both projects constitutes a natural link for Blue-Action to further support AORAC by providing/getting additional access to the additional stakeholders and fora for discussion
- As the national representative body for the marine science institutions in Germany, KDM has represented the whole German community as partner in the European Multidisciplinary Seafloor Observatory (**EMSO**). Before EMSO KDM was also a partner in **ESONET**.

Relevant significant infrastructure and/or technical equipment

Through its office in Brussels, KDM is well-placed to take responsibility for science briefings to the European and international communities.

Partner 19 MEOPAR Incorporated (MEOPAR)

The Marine Environmental Observation Prediction and Response (MEOPAR) Network of Centres of Excellence was established in 2012 with $25 million of initial funding from the Canadian government. MEOPAR is a large-scale, academically-led Network which has established a nationwide team of researchers working within multisectoral, multidisciplinary partnerships to increase Canada's ability to manage and respond to risk in the marine environment. The Network is hosted by Dalhousie University in Halifax, Nova Scotia and presently comprises Principal Investigators and students from 12 member institutions across Canada. MEOPAR research is conducted in the Pacific, Arctic and Atlantic Oceans and supports multidisciplinary ocean and climate science and socio-economic studies of marine environmental risk and adaptation to climate change. MEOPAR has been active in coordinating a Canadian response to the Galway Agreement of May, 2013, with a focus on establishing partnerships between academic, government and private sector researchers in support of a Canadian contribution to an Integrated Atlantic Ocean Observing System. Given our mission and national representation (including participation of key Federal science departments on its Board), the Network is well suited to facilitating Canadian participation in H2020 project AtlantOS.

In this project, MEOPAR will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Brad deYoung (male) is a professor in the Department of Physics & Physical Oceanography at Memorial University, as well as a member of the MEOPAR Research Management Committee. His research focuses on the circulation and wind forced response in the Northwest Atlantic. He has an interest in shelf problems which led him to explore North Atlantic circulation and its influence upon the shelf. Dr. deYoung's research involves experimental work at sea, interpreting data and numerical modelling. Within ocean ecology, he also studies the dispersal of plankton and has worked on biological models, for example population models, but is most interested in coupling biological models with physical models to simulate the influence of the physical environment on these planktonic organisms. Presently Dr. deYoung is working on developing new sensors and new platforms for making iceberg and sea-ice measurements. He and his team have developed new autonomous surface craft, expanded the capability of ocean gliders and developed new sensors such as a short-range imaging radar.

Relevant publications, products, service and/or other achievements

- Ma, Z., G. Han and B. deYoung. 2015. Oceanic responses to Hurricane Igor over the Grand Banks: A modelling study. *Journal of Geophysical Research* , 120, 1276-1295, doi:10.1002/2014JC010322.
- Cui,J., R. Bachmayer, W. Huang, and B. deYoung. 2015. Wave Height Measurement Using a Short-range FMCW Radar for Unmanned Surface Craft *MTS IEEE Oceans'15* . Washington, United States, 1-3.
- Zhou, M., R. Bachmayer and B. deYoung. 2014. Initial performance of an Underwater Iceberg Profiler with an Autonomous Underwater Vehicle. IEEE Oceans, *Oceans '14 IEEE/MTS Conference* . St. John's, 1-8 pp.
- Wallace, D., B. deYoung et al. 2014. A Canadian Contribution to an Integrated Atlantic Ocean Observing System (IAOOS). IEEE Oceans, *Oceans '14 IEEE/MTS Conference* . St. John's, 1-10 pp.
- Salcedo-Castro, J., D. Bourgault, S.J. Bentley and **B. deYoung**. 2013. Non-hydrostatic modeling of cohesive sediment transport associated with a subglacial buoyant jet in glacia fjords: a process-oriented approach. *Ocean Modelling* doi: http://dx.doi.org/10.1016/j/ocemod.2012.12.005

Relevant Projects

- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems. Funded by EU H2020. MEOPAR facilitates the interaction and coordination of AtlantOS with relevant projects and activities including buoy-based measurements along Canada's Atlantic coast (e.g. SmartBay/SmartAtlantic) and the Federal government's ship-based monitoring programs (e.g. AZMP / AZOMP).
- **VITALS** - Ventilation, Interactions and Transports Across the Labrador Sea. A Canadian (NSERC) funded research network which addresses, with in-situ observations and modelling, how the deep ocean exchanges CO2, O2, and heat with the atmosphere through the Labrador Sea. VITALS involves scientists from 11 Canadian universities as well as federal government laboratories. (Paul Myers, coordinator).
- **GreenEdge**: a multinational (Canada, France, USA, Greenland) project that aims to improve understanding of the dynamics of Phytoplankton Spring Blooms in the Arctic through intense observation and modelling of such events in Baffin Bay (from onset under melting ice in May to its conclusion in the seasonal ice zone in July). (Marcel Babin, coordinator)

Relevant significant infrastructure and/or technical equipment

MEOPAR can facilitate coordination of Canadian infrastructure, including proposals for new infrastructure, with AtlantOS. MEOPAR is presently working to integrate Canadian ocean infrastructure including development of a national strategy for ocean glider operations and a Canadian Community of Practice for

Ocean Data Management. Both activities are likely to be of high value in fostering cooperation and infrastructure/data sharing within an Integrated Atlantic Ocean Observing System.

Partner 20 Mercator Ocean (MERCATOR)

Between observation infrastructures and users, Mercator Ocean is a non profit company employing a team of 50 persons which ensures the continuity from research to oceanographic operational services. Mercator Ocean has five research and operational governmental shareholders (Centre National de la Recherche Scientifique (CNRS), Institut pour la Recherche et le Développement (IRD), Météo France (the French meteorological organism), SHOM (Naval Hydrographic and Oceanographic Service) and IFREMER (Institut Français de Recherche pour l'Exploitation de la MER).

Over the last 15 years, Mercator Ocean has been playing a leading role in operational oceanography at international level and European level. After having successfully coordinated the European MyOcean projects since 2009, Mercator Ocean was officially appointed by the European Commission on November, 2014 to define, manage, implement and operate the "Copernicus Marine Environment Monitoring Service" (CMEMS) (as part of the European Earth observation programme, Copernicus) on its current multi-annual financial framework 2014-2020. Mercator Ocean also defines and manages the service evolution and user uptake of the CMEMS activities.

Since 2001, Mercator Ocean develops and runs operational systems able to describe, to monitor and to forecast the ocean at any location in the world, from the deep ocean to the surface. The R&D department at Mercator Ocean, composed of approximatively 30 fulltime researchers, carries out collaborative investigations at national and international (GODAE) levels aimed at developing, practical and robust operational activities for oceanography and at sustaining a reliable, global operational system that provides regular, timely and accurate forecasts and analyses for many different scientific, industrial and governmental applications. Mercator Ocean produces and updates regularly global and regional reanalysis in the CMEMS framework. The global reanalysis are currently used by the French meteorological office (Météo France) for his operational seasonal forecasts system.

The Mercator operational systems uses the state-of-the-art modelling framework NEMO (Nucleus for European Modelling of the Ocean) and the Mercator Assimilation System (SAM) based on local SEEK (Singular Evolutive Extended Kalman Filter) formulation with 3D-FGAT (First Guess at Appropriate Time) innovation method together with 3D-VAR Temperature and Salinity bias correction. All the systems assimilate altimetry, sea surface temperature and in situ temperature and salinity data. Eddy-resolving ocean modelling, multi-data assimilation, product quality assessment, multi-year variability, expertise on physical ocean & ice; data management; core service to users are the main fields of expertise.

MERCATOR will be involved in:

- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant personnel

Dr Gilles Garric (male) Ocean/Sea Ice Modeller, Head of Innovation Service . Gilles Garric, Dr. has a PhD from the University Paul Sabatier at Toulouse (1996) on the development of coupling ocean-atmosphere system. He has conducted various research post-doctoral projects on stability and the variability of the Earth climate, on ocean atmosphere interactions at high latitudes and on African monsoon seasonal forecasts in various academic institutions (Univ. Of Reading (UK), Univ. of Copenhagen (Denmark) and Météo France (France)). Since 2003, he works as a senior scientist in Mercator Océan in charge of setting up the model component of the global operational system. His research area includes high resolution

oceanic modelling, ocean atmosphere interface, climate variability and polar processes. He is now in charge of the innovation team in the R&D Department and is particularly involved in the global reanalysis set up. He is giving regular communications in dedicated workshops or in more general geophysics conferences at national and international levels. He has authored or co-authored some 25 publications.
Experience relating to the project: Originally, his PhD's work was dedicated to the high latitudes ocean-atmosphere system and the development of the coupling between sea ice and an overlying Atmospheric GCM. Since then, his work concentrated on numerical modelling of the ocean-sea ice-atmosphere system. In Mercator Ocean, he is in charge of setting up the model component of the global operational system and co-lead the design of the global reanalysis. He is deeply involved in the development of the sea ice component and on the design of the operational system at high latitudes.

Publications, and/or products, services or other achievements:

- Ferry N., Parent L., **Garric G.**, Barnier B. Jourdain N. C. and the Mercator Team. Mercator global eddy permitting ocean reanalysis GLORYS1V1: Description and results. Mercator Newsletter. 36, p. 15-27, 2010.
- J.-M. Lellouche, O. Le Galloudec, M. Drévillon, C. Régnier, E. Greiner, **G. Garric**, N. Ferry, C. Desportes, C.-E. Testut, C. Bricaud, R. Bourdallé-Badie, B. Tranchant, M. Benkiran, Y. Drillet, A. Daudin, C. de Nicola, Evaluation of real time and future global monitoring and forecasting systems at Mercator Océan, Ocean Science Discussions ; 9(2):1123-1185, 2013. 14)
- Chevallier M., Salas Y Mélia D., Voldoire A., Déqué M. and **G. Garric**. Seasonal forecast of the pan-Arctic sea ice extent using a GCM-based seasonal prediction system. Journal of Climate, 26(16), pp. 6092-6104, doi: http://dx.doi.org/10.1175/JCLI-D-12-00612.1, 2013.
- M. Chevallier, G.C. Smith, J.-F. Lemieux, F. Dupont, G. Forget, Y. Fujii, F. Hernandez, R. Msadek, K. A. Peterson, A. Storto, T. Toyoda, M. Valdivieso, G. Vernieres, H. Zuo, M. Balmaseda, Y.-S. Chang, N. Ferry, **G. Garric**, K. Haines, S. Keeley, R. M. Kovach, T. Kuragano, S. Masina, Y. Tang, H. Tsujino, X. Wang, Uncertainties in the Arctic sea ice cover in state-of-the-art ocean reanalyses from the ORA-IP project, Climate dynamics, 2016.
- V. S. Lien, S. S. Hjøllo, M. D. Skogen, E. Svendsen, H. Wehde, L. Bertino, F. Counillon, M. Chevallier and **G. Garric**, An Assessment of the added value from data assimilation on modelled Nordic Seas hydrography and ocean transports, Ocean Modelling, In Press, 2016.

Relevant projects, and/or activities linked to this project

- Mercator Ocean is officially appointed by the European Commission since November, 2014 to define, manage, implement and operate the "**Copernicus Marine Environment Monitoring Service**" (CMEMS) as part of the European Earth observation programme, Copernicus on its current multi-annual financial framework 2014-2020.
- **EU H2020 AtlantOS H2020 project** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu: Design and impact studies related to the different AtlantOS observing systems with CMEMS operational systems. In AtlantOS, Mercator Ocean contributes to WP1 (task 1.3) and leads Task 7.4. Main activities are on design (task 1.3) and impact (task 7.4) studies related to the different AtlantOS observing systems. These works use MyOcean/Mercator Ocean global and Atlantic modelling and data assimilation systems (physics and biogeochemistry
- **EU FP7 ERA-CLIM2**: Sea-ice assimilation and physical ocean and bio-geo-chemical model coupling.
- **EU FP7 ICE-ARC**: activities on modelling and data analysis for operation and sustainable applications.
- **EU H2020 Evaluation of Ocean Synthesis-COST Action**: activities on preparation and harmonization of data, and on downscaling issues (from global to regional synthesis)

Relevant infrastructure, and/or major items of technical equipment:

Mercator Ocean uses externals (Météo France and ECMWF) and its own supercomputers resources for operational applications and research purposes. As such Mercator Ocean provides excellent computing and network facilities to produce reanalysis with the global high resolution system which will be used in the context of the Blue-Action project. Real and delayed (reanalysis) time numerical ocean analysis and forecast data assimilation systems.

Partner 21 Max Planck Institute for Meteorology (MPI-M)

The overall mission of the Max Planck Institute for Meteorology (MPI-M) is to understand how physical and biogeochemical processes, as well as human behaviour, contribute to the dynamics of the Earth system, and specifically how they relate to global and regional climate changes. In order to achieve this, MPI-M has developed a comprehensive Earth system model as well as a decadal prediction system. MPI-M has made major contributions to the simulation and analysis of a human influence on climate, including contributions to the fifth phase (and previous phases) of the Coupled Model Intercomparison Project (CMIP5). MPI-M is actively involved in the cluster of excellence "Integrated Climate System Analysis and Prediction" (CliSAP).

Regarding this project, MPI-M will act as deputy coordinator and leader of W4. MPI-M's scientific contribution is dedicated to

- interannual-to-decadal predictability aspects (WP4)
- the role of the stratosphere (WP3)
- heat and fresh water exchanges between North Atlantic and Nordic Seas / Arctic (WP2).

In Blue-Action, MPI will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP3 Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/LOCEAN)
- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Lead: Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Daniela Matei (female) is a climate scientist (education in atmospheric physics and climate dynamics) with over 10 years of experience in climate variability and predictability, with a focus on the North Atlantic/European and the tropical Pacific sectors. She played a leadership role in the MPI-M CMIP5 decadal prediction research efforts and has contributed to the EU projects DYNAMITE (FP6) and THOR (FP7). She continues her intense involvement in the field of near-term predictions, both at national (PI of German BMBF projects RACE and MiKlip on high-resolution decadal predictions of Atlantic/ European climate variations and drivers of predictability) and European level (NACLIM, SPECS, WMO "Real-Time Decadal Forecast Exchange", APPOSITE project on Arctic predictability). Additionally, she is substantially contributing to the FP7 NACLIM project and the H2020 PRIMAVERA projects. She is also the Lead-PI of the INTERDEC proposal "The potential of seasonal-to-decadal-scale inter-regional linkages to advance climate predictions" within the JPI Climate-Belmont Forum CRA call on Climate Services. Within this project, she will be deputy coordinator of Blue-Action and leader of W4 on "Enhancing the capacity of seasonal-to-decadal

prediction in the Arctic and over the Northern Hemisphere". Furthermore, she will be involved in WP2, WP3, WP6, WP7, WP8.

Dr. Jürgen Bader (male) is a senior scientist (education in physical meteorology) and Coordinator of Tropical VIBES Research Initiative at MPI-M. He has an extensive experience in leading (as PI) and contributing to projects at both national and international level. He has a long-standing expertise in the Arctic and Antarctic sea-ice impact on the large-scale circulation and storms, the impact of SSTs on monsoonal systems, tropical-extratropical interaction, the impact of hemispheric asymmetries on the ITCZ. Within this project, he will mainly be involved in WP3 and WP4.

Dr. Johann Jungclaus (male) is a senior scientist (education in physical oceanography) and research group leader at MPI-M. He played a key role in the development of the Max Planck Earth System Model and has coordinated its application in several phases of the Coupled Model Intercomparison Project. He has a long-standing expertise in North Atlantic/Arctic Ocean studies. Partly as deputy coordinator and core theme leader, he has contributed to the EU projects PREDICATE (FP5), ENSEMBLES (FP6) and THOR (FP7) and is currently contributing to the FP7 NACLIM project and the H2020 PRIMAVERA project. Within this project, he will mainly be involved in WP2 and WP4.

Dr. Katja Lohmann (female) is a climate scientist (education in physical oceanography) with 10 years of experience working with several different coupled climate models. Her particular focus lies on the subpolar North Atlantic and its exchanges with the Nordic Seas. She has contributed to the EU projects DYNAMITE (FP6) and THOR (FP7) and is currently contributing to the FP7 NACLIM project and the H2020 PRIMAVERA project. Within this project, she will mainly be involved in WP2 and WP4.

Dr. Elisa Manzini (female) is a senior scientist and leader of the independent research group "Stratosphere and Climate" at MPI-M. She pioneered the modeling of the stratosphere with advanced gravity wave parameterizations and models of ozone chemistry and authored one of the first middle atmosphere models worldwide. Her interests cover stratospheric dynamics and chemistry, and stratospheric pathways in climate variability and change. She has contributed to scientific assessments (WMO ozone, SPARC CCMVal, IPCC) in various roles; is/has been member of a number of scientific associations (currently of the CLIVAR Climate Dynamics Panel), including SPARC/WCRP 2005-2010; and contributed to EU projects, including COMBINE (scientific manager), SCOUT-03 and ENSEMBLES (work-package leader). Within this project, she will mainly be involved in WP3 and WP4.

Relevant publications, products, service and/or other achievements

- **Bader**, Jürgen, Michel D.S. Mesquita, Kevin I. Hodges, Noel Keenlyside, Svein Østerhus, and Martin Miles, 2011: “A Review on Northern Hemisphere Sea-Ice, Storminess and the North Atlantic Oscillation: Observations and Projected Changes.” *Atmospheric Research*, 101, 809–34. doi:10.1016/j.atmosres.2011.04.007.
- **Bader**,_Jürgen, Martin Flügge, Nils Gunnar Kvamstø, Michel D. S. Mesquita, and Aiko Voigt, 2013: “Atmospheric Winter Response to a Projected Future Antarctic Sea-Ice Reduction: A Dynamical Analysis.” *Climate Dynamics*, 40, no. 11–12, 2707–18. doi:10.1007/s00382-012-1507-9.
- **Bader, Jürgen**, 2014: “Climate Science: The Origin of Regional Arctic Warming.” *Nature*, 509, no. 7499, 167–68. doi:10.1038/509167a.
- **Bader, Jürgen** and Mojib Latif, 2005. North Atlantic Oscillation Response to Anomalous Indian Ocean SST in a Coupled GCM. *J. Climate*, 18, 5382–5389.doi: 10.1175/JCLI3577.

- Gao, Y., J. Sun, F. Li, S. He, S. Sandven, Q. Yan, Z. Zhang, **K. Lohmann**, N. Keenlyside, T. Furevik and L. Suo, 2015: Arctic sea ice and Eurasian climate: a review. *Advances in Atmospheric Sciences*, doi:10.1007/s00376-014-0009-6
- Jung, T., F. Doblas-Reyes, H. Goessling, V. Guemas, C. Bitz, C. Buontempo, R. Caballero, E. Jakobson, **J.H. Jungclaus**, M. Karcher, T. Koenigk, **D. Matei**, J. Overland, T. Spengler, and S. Yang, 2015: Polar Lower-Latitude Linkages and Their Role in Weather and Climate Prediction. *Bull. Amer. Meteor. Soc.*, 96, ES197–ES200.
- **Jungclaus, J.H.**, H. Haak, U. Mikolajewicz, and M. Latif, 2005: Arctic-North Atlantic interactions and multidecadal variability of the meridional overturning circulation. *Journal of Climate*, 18, 4016-4034
- **Jungclaus, J.H.,** and T. Koenigk, 2010: Low-frequency variability of Arctic climate: the role of oceanic and atmospheric heat transports. *Climate Dynamics*, 34, 265-279.
- **Jungclaus, J. H., Lohmann, K.,** and Zanchettin, D.: Enhanced 20th-century heat transfer to the Arctic simulated in the context of climate variations over the last millennium, Clim. Past, 10, 2201-2213, doi:10.5194/cp-10-2201-2014, 2014.
- **Lohmann, K.**, H. Drange and M. Bentsen, 2009b: A possible mechanism for the strong weakening of the North Atlantic subpolar gyre in the mid-1990s. *Geophysical Research Letters*, 36, L15602, doi:10.1029/2009GL039166.
- **Lohmann, K.,** H. Drange and M. Bentsen (2009a): Response of the North Atlantic subpolar gyre to persistent North Atlantic Oscillation like forcing. Climate Dynamics, 32, 273-285.
- **Lohmann, K., J.H. Jungclaus, D. Matei,** J. Mignot, M. Menary, H.R. Langehaug, J. Ba, O.H. Otterå, W. Park, and S. Lorenz, (2014): The role of subpolar deep water formation and Nordic Seas overflows in simulated multidecadal variability of the Atlantic overturning. Ocean Science, 10, 227-241
- **Manzini, E.**, C. Cagnazzo, P. G. Fogli, A. Bellucci, and W. Müller, 2012: Stratosphere - Troposphere coupling at inter-decadal time scales: Implications for the North Atlantic Ocean. *Geophysical Research Letters*, 39, L05801, doi:10.1029/2011GL050771
- **Manzini, E.**, et al., 2014: Northern winter climate change: Assessment of uncertainty in CMIP5 projections related to stratosphere-troposphere coupling. *Journal of Geophysical Research Atmosphere*, 119, 7979–7998
- **Matei, D.**, J. Baehr, **J.H. Jungclaus**, H. Haak, W. Müller and J. Marotzke, 2012a: Multiyear prediction of monthly-mean Atlantic Meridional Overturning Circulation at 26.5°N. *Science*, 355, 76-79
- **Matei, D.,** H. Pohlmann, **J.H. Jungclaus**, W. Müller, H. Haak, and J. Marotzke, 2012b: Two tales of initializing decadal climate prediction experiments with the ECHAM5/MPIOM model. *Journal of Climate*, 25, 8502-8523.
- W. A. Müller, **D. Matei**, M. Bersch, J. Jungclaus, H. Haak, K. Lohmann, G.P. Compo, D. Sardeshmukh, J. Marotzke, 2014: A twentieth-century reanalysis forced ocean model to reconstruct the North Atlantic climate variation during the 1920s. *Climate Dynamics*, 44,1935-1955.
- Omrani, N.E., **J. Bader**, N.S. Keenlyside, and **E. Manzini**, 2015: Troposphere–stratosphere response to large-scale North Atlantic Ocean variability in an atmosphere/ocean coupled model. *Climate Dynamics*, doi:10.1007/s00382-015-2654-6
- Park, J.-Y., **J. Bader**, and **D. Matei**, 2015: Northern-hemispheric differential warming is the key to understanding the discrepancies in the projected Sahel rainfall. *Nature Communications*, 5:5985
- Reichler, T., J. Kim, **E. Manzini**, and J. Kröger (2012): A stratospheric connection to Atlantic climate variability. *Nature Geoscience*, 5, 783-787
- Seierstad, Ivar A., and J. **Bader**. "Impact of a Projected Future Arctic Sea Ice Reduction on Extratropical Storminess and the NAO." *Climate Dynamics,* 33 (2009): 937–43. doi:10.1007/s00382-008-0463-x.

- Smith, D. M., A. A. Scaife, G. J. Boer, M. Caian, F. J. Doblas-Reyes, V. Guemas, E. Hawkins, W. Hazeleger, L. Hermanson, C. K. Ho, M. Ishii, V. Kharin, M. Kimoto, B. Kirtman, J. Lean, **D. Matei**, W. A. Müller, H. Pohlmann, A. Rosati, B. Wouters, K. Wyser, 2013: Real-time multi-model decadal predictions. *Climate Dynamics* doi:10.1007/s00382-1600-0.
- S. Tietsche, J. J. Day, V. Guemas, W. J. Hurlin, S. Keeley, **D. Matei**, R. Msadek, M. Collins and E. Hawkins, 2014: Seasonal to interannual Arctic sea ice predictability in current global climate models. *Geophys. Res. Lett. 41*, 1035–1043 doi: 10.1002/2013GL058755.

Relevant projects

- **German BMBF HIPRED RACE** (Regional Atlantic Circulation and Global Change): subproject HIPRED developing frontier high-resolution decadal predictions of Atlantic and European climate variations.
- **German BMBF MIKLIP II- Decadal Predictions project**: subproject MOVIECLIP on Modes of Ocean Variability and their Implication for European continent CLImate Predictions.
- **EU H2020 PRIMAVERA** (2015-2019) https://www.primavera-h2020.eu/ Process-Based Climate Simulation: Advances in High-Resolution Modelling and European Climate Risk Assessment Process-Based Climate Simulation: Advances in High-Resolution Modelling and European Climate Risk Assessment, on developing the next generation of ultra high-resolution atmospheric and coupled climate models to help improving our understanding of the key physical and dynamical drivers and mechanisms of decadal European climate variations.
- **EU FP7 SPECS project:** Seasonal-to-Decadal Climate Prediction for the Improvement of European Climate Services project that aims "to identify the main problems in climate prediction and investigate a battery of solutions from a seamless perspective". Focus on a multi-model evaluation of the current decadal prediction systems' ability to predict the evolution of abrupt extreme events over the North Atlantic, such as the strong mid1990s SPG warming shift or the 1960s' cooling event.
- **NFR EPOCASA** - Enhancing seasonal-to-decadal Prediction Of Climate for the North Atlantic Sector and Arctic. Collaboration with GFI (University of Bergen) on developing North Atlantic/Artic skilful decadal climate predictions.
- **EU FP7 NACLIM project:** focuses on improving our understanding of the predictability of the climate in the North Atlantic/European sector through oceanic observations and on the assessment of decadal climate forecasts. Pioneer work on poleward propagation of ocean temperature anomalies as a source for the Nordic Seas and Arctic inter-annual predictability.
- **APPOSITE project (Arctic Predictability and Prediction on Seasonal to Inter-annual timescales)** coordinated from University of Reading, UK. Focused on potential predictability and mechanisms responsible for Arctic Predictability in a multi-model framework.
- **KLIMAFORSK C-ICE** Counteracting effect of future Antarctic sea-ice loss on projected increases of summer Monsoon rainfall.

Relevant significant infrastructure and/or technical equipment

MPI-M is shareholder of the supercomputer at the German Climate Computing Center (DKRZ), allowing efficient performance of the numerous proposed model simulations.

Partner 22 Marine Research Institute (MRI)

Hafrannsoknastofnun or Marine Research Institute (MRI), in Iceland, was established in 1965. The Institute is governmental and is financed through the national budget mainly. It operates two ocean going vessels

and has about 150 employees. Its main role is the stock assessment and advice on sustainable yield of exploitable stocks in the ocean surrounding Iceland. It has also a long tradition in environmental monitoring and ecological studies, including physical, chemical, and biological oceanography. The Institute has a long history of physical oceanographic research in the areas around Iceland.

In this project, MRI will be actively involved in

- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Mr. Héðinn Valdimarsson (male) is a physical oceanographer and a senior scientist at the MRI in Reykjavik and is responsible for the project of monitoring climatic variability in Icelandic waters. He has been taking part in the oceanography at MRI for over 30 years. He has long experience of field work and numerous oceanographic cruises as a scientist and chief scientist. He has participated in several EU projects. Main fields of work are circulation, climate and their effect on biota.

Dr. Andreas Macrander (male) is a physical oceanographer. He has been working in the field of physical oceanography for some years in several areas a.o. the Nordic Seas and Denmark Strait. He has previously worked at IFM-GEOMAR in Kiel and AWI in Bremerhafen.

Relevant publications, products, service and/or other achievements

- Kjetil Vågea, G.W.K. Moore, Steingrímur Jónsson, Héðinn Valdimarsson. Water mass transformation in the Iceland Sea. Deep Sea Research, Part I, volume 101, july, pp 98-109. 2015.
- J. Fischer, J. Karstensen, R. Zantopp, M. Visbeck, A. Biastoch, E. Behrens, C.W. Böning, D. Quadfasel, K. Jochumsen, H. Valdimarsson, S. Jónsson, S. Bacon, N.P. Holliday, S. Dye, M. Rhein, C. Mertens. Intra-seasonal variability of the DWBC in the western subpolar North Atlantic. Progress in Oceanography, Volume 132, March 2015, Pages 233–249.
- Kerstin Jochumsen, Manuela Köllner, Detlef Quadfasel, Stephen Dye, Bert Rudels, Heðinn Valdimarsson. On the origin and propagation of Denmark Strait overflow water anomalies in the Irminger Basin. Journal of Geophysical Research, Oceans. Volume 120, Issue 3. Pages 1841–1855. 2015
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- Wilken-Jon von Appen, Inga M.Koszalka,Robert S.Pickart,Thomas W.N. Haine, Dana Mastropole,Marcello G. Magaldi, Héðinn Valdimarsson, James Girton, Kerstin Jochumsen, Gerd Krahman. The East Greenland Spill Jet as an important component of the Atlantic Meridional Overturning Circulation. Deep Sea Research Part I: Oceanographic Research Papers. Vol. 92. Pp 75-84, 2014.
- Andreas Macrander, Héðinn Valdimarsson and Steingrímur Jónsson. Improved transport estimate of the East Icelandic Current 2002-2012. Journal of Geophysical Research: Oceans. Vol. 119. Iss.6,pp 3407-3424. June 2014.

Relevant Projects

The group in physical oceanography has participated in many international projects such as the Greenland Sea Project, Nordic WOCE, and in several EU funded projects , NACLIM, various version of SEADATANET etc. **EU FP7 NACLIM** (2012-2017) www.naclim.eu investigate predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. MRI is partner

Relevant significant infrastructure and/or technical equipment

The Marine Research Institute is the only ship operating research institute in Iceland and has facitlities for oceaongraphic monitoring and research in the waters around Iceland.

Partner 23 Marine Scotland Science (MSS)

MSS (www.scotland.gov.uk/Topics/marine/science) was established as a division of Marine Scotland (a Directorate of the Scottish Government) on 1 April 2009, from its previous status as a Scottish Government Agency (Fisheries Research Services). Its purpose is to provide expert scientific, economic and technical advice and services on marine and freshwater fisheries, aquaculture, and the aquatic environment to support the Scottish Government. The Oceanography Group has been a key partner in monitoring the ocean circulation in the Faroe Shetland Channel (FSC), particularly the flow of Atlantic Water poleward. Hydrographic monitoring by Scottish scientists began in the early 20th century and the group has expertise in sea-going oceanography, with a particular focus on observing the circulation of the FSC. This has been achieved through involvement in several relevant projects, including Nordic WOCE and the EU-funded VEINS (FP4), MAIA (FP5), MOEN (FP5), THOR (FP7) & NACLIM (FP7). MSS is currently responsible (with Havstovan) for maintaining an ADCP mooring array in the FSC, and undertakes 3 dedicated research cruises per year to the area on the MSS owned *MRV Scotia*. The time series of current meter observations in the FSC has been almost continuous since its inception in 1994.

MSS will be involved in:

- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Barbara Berx (female), Physical Oceanographer, is the senior scientist responsible for the Shelf Seas and Offshore Circulation topic in the Oceanography Group. She coordinates Marine Scotland's hydrographic monitoring programme in the Faroe-Shetland Channel (FSC). Her interests include observational oceanography, circulation in the FSC and physical drivers of biological variability. She is the Scottish representative to the ICES Working Group on Operational Oceanographic products for Fisheries and Environment (WGOOFE), where she actively promotes the dissemination of oceanographic products to the wider ICES community.

Relevant publications, products, service and/or other achievements

- McKenna, C., Berx, B., Austin, W.E.N. (2016) The decomposition of the Faroe-Shetland Channel water masses using Parametric Optimum Multi-Parameter analysis. Deep-Sea Research Part I: Oceanographic Research Papers, 107: 9–21.
- Hansen, B., Larsen, K.M., Hátún, H., Kristiansen, R., Mortensen, E., Berx, B., Østerhus, S., Sherwin, T., Quadfasel, D., Jochumsen, K. (2013) Monitoring the flow of Atlantic water through the Faroe-Shetland Channel. Havstovan Technical Report nr. 13-13, pp. 24.
- Berx, B., Hansen, B., Østerhus, S., Larsen, K.M., Sherwin, T., Jochumsen, K. (2013) Combining in-situ measurements and altimetry to estimate volume, heat and salt transport variability through the Faroe Shetland Channel. Ocean Sci., 9 (4) 639–654, doi:10.5194/os-9-639-2013.
- Berx, B. contributor to: Task Team for an Integrated Framework for Sustained Ocean Observing (Editors) (2012) A Framework for Ocean Observing. IOC/INF-1284, UNESCO.

- Mauritzen, C., Hansen, E., Andersson, M., Berx, B., Beszczynska-M¨ oller, A., et al. (2011) Closing the Loop - Approaches to monitoring the state of the Arctic Mediterranean during the International Polar Year 2007-2008. Progress in Oceanography, 90 (1-4) 62–89.
- Berx, B., Dickey-Collas, M., Skogen, M. D., De Roeck, Y.-H., Klein, H., Barciela, R., Forster, R.M., Dombrowsky, E., Huret, M., Payne, M. Sagarminaga, Y., Schrum, C. (2011) Does operational oceanography address the needs of fisheries and applied environmental scientists? Oceanography, 24 (1) 166–171.
- Berx, B. and Hughes, S. L. (2009) Climatology of Surface and Near-bed Temperature and Salinity on the North-West European Continental Shelf for 1971–2000. Continental Shelf Research, 29: 2286-2292.

Relevant Projects

- **EU FP7 NACLIM** (2012-2017) www.naclim.eu monitor the exchanges across the Greenland-Scotland-Ridge in the Faroe-Shetland Channel. MSS is partner.

Relevant significant infrastructure and/or technical equipment

MSS will continue its efforts of monitoring the exchanges across the Greenland-Scotland Ridge (part of the GSR transport mooring array within AtlantOS), through provision of instrumentation (moored current meters and ship-based CTD) and ship time.

Partner 24 National Center for Atmospheric Research (NCAR)

The National Center for Atmospheric Research (NCAR) is a federally funded research and development institution, located in Boulder, CO. NCAR is sponsored by the US National Science Foundation (NSF) and devoted to service, research, and education in the atmospheric and related geo-sciences. Significant additional support is provided by other US government agencies, other national governments, and the private sector. NCAR is managed by the University Corporation for Atmospheric Research (UCAR) on behalf of the NSF. NCAR's mission is to understand the behavior of the Earth system, to support, enhance, and extend the capabilities of the university community and the broader scientific community (nationally and internationally), and to foster the transfer of knowledge and technology for the betterment of life on Earth. NCAR supports the community of geoscience researchers by providing access to observations of the Earth system and tools/technology/assistance to investigate and understand the Earth system (including supercomputer access, computer models, and user support). NCAR staff collaborates with scientists and researchers nationally and internationally in the academic, public, and private sectors. Primary areas of focus include: atmospheric chemistry, climate (including climate variability), weather science, weather hazards, weather impacts, interactions between the Sun and Earth, computer science innovation, and science communication and education.

In this project, NCAR personnel will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Gokhan Danabasoglu (male) is a Senior Scientist at NCAR. The general subjects of his research are understanding the role of the oceans in the Earth's climate system and computational modeling of the ocean as a geophysical fluid, including developing subgridscale parameterizations to represent unresolved physics in ocean general circulation models. During the last decade, Dr. Danabasoglu has focused on investigating mechanisms, prediction, and climate impacts of decadal-scale climate variability associated with the Atlantic Meridional Overturning Circulation (AMOC). He leads the efforts for establishing and maintaining a decadal prediction framework within the NCAR Community Earth System Model (CESM). He currently serves as a co-chair of the CESM Ocean Model Working Group (OMWG); chair of the US CLIVAR AMOC Science Team Executive Committee; a co-chair of the CLIVAR Ocean Model Development Panel (OMDP); a member of the WCRP Modeling Advisory Panel (WMAC); a member of the CLIVAR Decadal Climate Variability and Predictability Working Group; a member of the WCRP-WGCM-WGSIP Decadal Climate Prediction Panel; and an ex-offico member of the WCRP Working Group on Coupled Modeling.

Dr. Alicia Karspeck (female) is a Project Scientist II at NCAR. Her main research interests are ocean and ocean-atmosphere coupled data assimilation, understanding the role of basin-scale ocean circulation in contributing to seasonal to decadal climate predictability, and the development and evaluation of initialized near-term climate-prediction systems. Dr. Karspeck is currently a member of the International CLIVAR Decadal Climate Variability and Predictability Working Group; chair of the US CLIVAR AMOC Science Team Task Team on AMOC State, Variability, and Change; and a member of the Tropical Pacific Observing System (TPOS) Planetary Boundary Layer and Modeling and Data Assimilation Task Team.

Dr. Steve Yeager (male) is a Project Scientist II at NCAR with broad interests in ocean-related climate variability and prediction. Dr. Yeager's most recent work has focused on the dynamics of the large-scale Atlantic circulation, mechanisms of AMOC variability in climate models, and the feasibility of decadal climate and sea ice prediction using initialized coupled models. He has been a member of the Executive Committee of the US CLIVAR AMOC Science Team since 2013, and is currently the chair of the task team on AMOC Mechanisms and Predictability.

Relevant publications, products, service and/or other achievements

- Danabasoglu, G., 2008: On multi-decadal variability of the Atlantic meridional overturning circulation in the Community Climate System Model version 3 (CCSM3). *J. Climate*, **21**, 5524-5544, doi: 10.1175/2008JCLI2019.1.
- Danabasoglu, G., W. G. Large, and B. P. Briegleb, 2010: Climate impacts of parameterized Nordic Sea overflows. *J. Geophys. Res.,* **115**, C11005, doi: 10.1029/2010JC006243.
- Danabasoglu, G., S. G. Yeager, Y.-O. Kwon, J. Tribbia, A. Phillips, and J. Hurrell, 2012: Variability of the Atlantic meridional overturning circulation in CCSM4. *J. Climate*, **25**, 5153-5172, doi: 10.1175/JCLI-D-11-00463.1.
- Danabasoglu G., S. Yeager, and Co-authors, 2014: North Atlantic simulations in Coordinated Ocean-ice Reference Experiments phase II (CORE-II). Part I: Mean states. *Ocean Modelling*, **73**, 76-107, doi: 10.1016/j.ocemod.2013.10.005.
- Danabasoglu, G., S. Yeager, W. M. Kim, and Co-authors, 2016: North Atlantic simulations in Coordinated Ocean-ice Reference Experiments phase II (CORE-II). Part II: Inter-annual to decadal variability. *Ocean Modelling*, **97**, 65-90, doi: 10.1016/j.ocemod.2015.11.007.
- Karspeck, A., 2016: An ensemble method of estimating representativeness error. *Monthly Weather Review*, doi: 10.1007/s00382-015-2787-7 (in press).
- Karspeck, A., S. Yeager, G. Danabasoglu, and H. Teng, 2015: Evaluation of experimental initialized decadal predictions using CCSM4. *Clim. Dyn.,* **44**, 907-923.

- Karspeck A., …, G. Danabasoglu, and Co-authors, 2015: Comparison of the Atlantic meridional overturning circulation between 1960 and 2007 in six ocean reanalysis products. *Clim. Dyn.,* doi: 10.1007/s00382-015-2787-7.
- Kim, W. M., S. Yeager, P. Chang, and G. Danabasoglu, 2016: Atmospheric conditions associated with Labrador Sea deep convection: New insights from a case study of the 2006-2007 and 2007-2008 winters. *J. Climate* (submitted).
- Msadek, R., W. E. Johns, S. G. Yeager, G. Danabasoglu, T. L. Delworth, and A. Rosati, 2013: The Atlantic Meridional heat transport at 26.5N and its relationship with the MOC in the RAPID array and the GFDL and NCAR coupled models. *J. Climate*, **26**, 4335-4356, doi: 10.1175/JCLI-D-12-00081.1.
- Ruprich-Robert Y., F. Castruccio, R. Msadek, G. Danabasoglu, T. Delworth, and S. Yeager, 2016: Climate impacts of the Atlantic Multidecadal Variability in GFDL CM2.1 and NCAR CESM1 coupled models (in preparation).
- Yeager, S., 2015: Topographic coupling of the Atlantic overturning and gyre circulations, *J. Phys. Oceanogr.* , **45**, 1258-1284, doi: 10.1175/JPO-D-14-0100.1.
- Yeager, S. G., and G. Danabasoglu, 2012: Sensitivity of Atlantic meridional overturning circulation variability to parameterized Nordic Sea overflows in CCSM4. *J. Climate*, **25**, 2077-2103, doi: 10.1175/JCLI-D-11-00149.1.
- Yeager, S., and G. Danabasoglu, 2014: The origins of late 20th century variations in the large-scale North Atlantic circulation. *J. Climate*, **27**, 3222-3247, doi: 10.1175/JCLI-D-13-00125.1.
- Yeager, S. G., and M. Jochum, 2009: The connection between Labrador Sea buoyancy loss, Deep Western Boundary Current strength, and Gulf Stream path in an ocean circulation model. *Ocean Modelling,* **30**, 207-224, doi: 10.1016/j.ocemod.2009.06.014.
- Yeager, S., A. Karspeck, and G. Danabasoglu, 2015: Predicted slow-down in the rate of Atlantic sea ice loss. *Geophys. Res. Lett.*, doi: 10.1002/2015GL065364.
- Yeager, S., A. Karspeck, G. Danabasoglu, J. Tribbia, and H. Teng, 2012: A decadal prediction case study: Late 20th century North Atlantic Ocean heat content. *J. Climate*, **25**, 5173-5189.

Relevant Projects

- **Collaborative Research EaSM-3**: The Role of Ocean Eddies in Decadal Prediction. Supported by the NSF grant OCE-1419559; 07/2014 – 06/2019; NCAR PIs: Karspeck, Danabasoglu. The project aims to investigate the influence of ocean-eddies on decadal predictability and develop strategies for initializing eddy-resolving prediction systems.
- **Collaborative Research EaSM-2:** Mechanisms, Predictability, Prediction, and Regional and Society Impacts of Decadal Climate Variability. Supported by the NSF grant OCE-1243015; 03/13 – 02/18; PI: Danabasoglu. The goals of this interdisciplinary collaborative project are: i) to produce an improved and reliable decadal prediction system within the CESM framework, including predictive capabilities for marine ecosystems and biogeochemical constituents; and ii) to advance the use of decadal prediction simulations in regional and societal impact studies.

- **Collaborative Multi-Model Study**: Understanding AMOC Variability mechanisms and their impacts on decadal prediction. Supported by the National Oceanic and Atmospheric Administration (NOAA) grant NA13OAR4310138; 08/13 – 07/16; NCAR PIs: Danabasoglu, Karspeck, Yeager. This project aims to advance our understanding of simulated AMOC variability, the impact of that variability on the atmosphere (and climate), and the relevance of that variability to our ability to make decadal climate predictions.

- **Understanding Long-term Changes in the Atlantic Meridional Overturning Circulation** (AMOC) Using IPCC AR5 Model Ensembles Supported by NOAA grant NA13OAR4310137; 08/13 – 07/16; NCAR PIs: Danabasoglu, Yeager. The project goals are to understand the dominant ocean/atmosphere processes controlling the long-term AMOC change over the 20th century and examine how these processes are represented in IPCC models and to determine plausible causes of differences in long-term AMOC changes simulated by coupled climate models and forced ocean/sea-ice models during the late 20th century.
- **A Collaborative Investigation of the Mechanisms, Predictability, and Climate Impacts of Decadal-Scale AMOC Variability Simulated in a Hierarchy of Models**. Supported by NOAA grant NA09OAR4310163; 08/09 – 07/13; NCAR PI: Danabasoglu. The project investigated AMOC variability mechanisms and the Atlantic meridional heat transport.
- **NCAR-NOAA Cooperative Agreement to develop ocean initialization capabilities with CESM-DART**. Supported by NOAA; 06/10 – 05/12; PI: Danabasoglu.

Relevant significant infrastructure and/or technical equipment

NCAR modeling capabilities: The Climate and Global Dynamics Laboratory at NCAR, at which Drs. Danabasoglu, Karspeck, and Yeager work, maintains and utilizes the CESM. The CESM is a community developed, fully coupled IPCC-class global climate model that simulates the physics and dynamics of the Earth's atmosphere, ocean, land, and ice systems (as well as elements of climate-relevant biological and eco-systems). It is used extensively by climate researchers worldwide to simulate, investigate, and predict the Earth's climate system.

NCAR Computing, Data Storage and Dissemination: NCAR is the manager and primary user of the NSF-funded NCAR-Wyoming Supercomputing Center (NWSC) in Cheyenne, WY (U.S.A.). The NWSC houses the "Yellowstone" high-performance, peta-scale data-centric supercomputer environment, as well as two data analysis and visualization systems (Geyser and Caldera) to support large-scale data analysis and visualization activities for NCAR scientists and collaborators. A High Performance Storage System (HPSS), with capacity in excess of 10 PB, supports the long-term archiving of research data generated by NCAR scientists and collaborators. NCAR is also a member of the Earth System Grid Federation – providing a means through which curated data collections can be made available for public download and use.

Partner 25 Nansen Environmental and Remote Sensing Center (NERSC)

NERSC (http://www.nersc.no) is an independent non-profit research foundation established in 1986 affiliated with the University of Bergen. Since 2012 the Center is a national environmental research institute with basic funding from the Ministry of Climate and Environment. The Center performs interdisciplinary basic and applied scientific research in Earth system environmental and climate research, satellite remote sensing, modelling and data assimilation. Our four main research areas include Climate Processes, Variability and Change; Arctic and Marine Remote Sensing Studies; and Ocean Modeling, Data Assimilation and Forecasting. One of the research strategy of NERSC is '*To advance the insight into mechanisms causing teleconnections between the lower latitudes and the Arctic region*', which is targeted within the Blue-Action proposal.

The Centre is a project-based research centre with major funding from the Research Council of Norway, the research programs of the European Commission, European and Norwegian space agencies, industry and other governmental and international agencies. The staff includes 78 persons from 18 countries. The staff comprises of researchers and senior scientists, Post-docs, Ph.D. students and administrative/technical personnel. The Centre is the founding institution of the Nansen Group - a network of Nansen research centers - comprising about 200 scientists, including about 75 PhD and master students in Norway, Russia, China, India, South Africa and Bangladesh.

In this project NERSC will lead and be actively contributing to:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP3 Linkages of Arctic climate changes to lower latitudes (**Yongqi Gao/NERSC**, Co-lead: Guillaume Gastineau/LOCEAN)
- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Lead: Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Yongqi Gao (male) is a research director at NERSC, co-director and professor at Nansen-Zhu International Research Centre, and adjunct Prof. at University of Bergen. Gao has more than 15 years experience in climate simulations. Gao has been leaders of projects supported by the National Natural Science Foundation of China and the Research Council of Norway. Gao has been principal investigators at NERSC for various national and international projects such as Research Council of Norway supported Snowglace, NordForsk Greenice, EU THOR and EU NACLIM. Gao has published more than 70 scientific papers in peer-reviewed journals. Gao has been working with the exchange (volume, heat, sea ice) between the North Atlantic and the Nordic Seas, and between the Nordic Seas and the Arctic Ocean. In recent years, Gao has strong interest in the air-sea interactions with special focus on how climate in different regions (Arctic, Atlantic and Pacific Oceans) interact. Yongqi will lead and be involved in WP3.

Dr. Helene R. Langehaug (female) is a research scientist at NERSC. Langehaug's main interest is in analysis and inter-comparison of climate models, with attention on ocean circulation, air-sea interaction, and sea ice in the North Atlantic Ocean and the Nordic Seas on interannual-to-decadal time scales. Langehaug has experience in using the Norwegian Earth System Model, and other state-of-the-art climate models from the Coupled Model Intercomparison Project (e.g., CMIP5). More specifically, Langehaug's research activities focus on the understanding of Subpolar Gyre dynamics, Atlantic Meridional Overturning Circulation, and water mass structure and transformation in climate models. Langehaug is particularly interested in those mechanisms that give rise to predictability on interannual-to-decadal time scales in the North Atlantic and the Nordic Seas. Helene will be involved in WP3.

Dr. Lingling Suo (female) is a research scientist at NERSC. Suo has experience in both observational analysis and climate modeling. Suo has joined in several national and international projects which concern the tele-connections between Arctic regions and lower latitudes such as Research Council of Norway supported BlurArc, NordForsk GreenIce, EU NACLIM. Suo has worked on the stratosphere-troposphere interaction, the decadal climate variability and tele-connections in the northern hemisphere including the climate impacts of the Arctic sea ice changes. Lingling will be involved in WP3.

Relevant publications, products, service and/or other achievements

- Suo, L.L., Gao, Y.Q., Guo, D., Liu, J.P., Wang, H.J., Johannessen, O.M. (2015): Atmospheric response to the autumn sea-ice free Arctic and its detectability. Climate Dynamics, doi: 10.1007/s00382-015-2689-8
- Yu, L., Gao, Y.Q., Otterå, O.H. (2015): On the sensitivity of the Atlantic meridional overturning circulation to enhanced freshwater discharge along the entire, eastern and western coast of Greenland. Climate Dynamics , doi: 10.1007/s00382-015-2651-9

- Li, F., Wang, H.J., Gao, Y.Q. (2015): Extratropcial Ocean Warming and Winter Arctic Sea Ice Cover since the 1990s. Journal of Climate, 28, 5510-5522, doi: 10.1175/JCLI-D-14-00629.1
- Gao, Yongqi, Sun Jianqi, Li Fei, He Shengping, Sandven Stein, Yan Qing, Zhang Zhongshi, Lohmann Katja, Keenlyside Noel, Furevik Tore, Suo Lingling, 2015: Arctic sea ice and Eurasian climate: a review. Adv. Atmos. Sci. 32, 92-114. doi: 10.1007/s00376-014-0009-6.
- Yu, L., Furevik, T., Otterå, O.H., Gao, Y.Q. (2015): Modulation of the Pacific Decadal Oscillation on the summer precipitation over East China: A comparison of observations to 600-yrs control run of Bergen Climate Model. Climate Dynamics, 44:475–494 DOI 10.1007/s00382-014-2141-5
- Li, F., Wang, H.J., Gao, Y.Q., (2015): Modulation of Aleutian Low and Antarctic Oscillation co-variability by ENSO, Climate Dyn., 44 (5-6):1245–1256, doi:10.1007/s00382-014-2134-4
- Li, F., Wang, H.J., Gao, Y.Q., (2014): On the strengthened relationship between the East Asian winter monsoon and Arctic Oscillation: A comparison of 1950-1970 and 1983-2012. Journal of Climate, 27(13), 5075-5091, doi:10.1175/JCLI-D-13-00335.1
- Sandø, A.B., Gao, Y.Q., Langehaug, H. (2014): Poleward ocean heat transports, sea ice processes and Arctic sea ice variability in NorESM1-M simulations. Journal of Geophysical Research-Ocean, 119 (3), 2095-2108, http://dx.doi.org/10.1002/2013JC009435
- Cui, X.D., Gao, Y.Q., Sun,J.Q., Guo, D., Li, S.L., Johannessen, O.M. (2014): Role of external forcing factors in modulating the Indian summer monsoon rainfall, the North Atlantic Oscillation and their relationship on inter-decadal timescale Climate Dynamics, 43, 2283-2295, DOI: 10.1007/s00382-014-2053-4
- Guo, D., Gao, Y.Q., Bethke, I., Gong, D.Y., Johannessen, O.M., Wang, H.J. (2014): Mechanism on how the spring Arctic sea ice impacts the East Asian summer monsoon. Theoretical and Applied Climatology, 115, 107-119, DOI: 10.1007/s00704-013-0872-6
- Gong, D.Y., Gao, Y.Q., Guo, D., Mao, R., Yang, J., Hu, M., Gao, M.N., (2014): Interannual linkage between Arctic/NorthAtlantic Oscillation and tropical Indian Ocean precipitation during boreal winter. Climate Dynamics, 42, 1007-1027, DOI 10.1007/s00382-013-1681-4
- Suo, L.L., Otterå, O.H., Bentsen, M., Gao, Y.Q., Johannessen, O.M. (2013): External forcing of the early 20th century Arctic warming. Tellus A, 65, 20578, http://dx.doi.org/10.3402/tellusa.v65i0.20578
- Cui, X.D., Gao, Y.Q., Gong, D.Y., Furevik, T. (2013): Teleconnection between winter Arctic Oscillation and Southeast Asian summer monsoon in the pre-industry simulation of a coupled climate model. Atmospheric and Oceanic Science Letters (Special Issue), 6(5), 349-354, doi:10.3878/j.issn.1674-2834.12.0114
- Langehaug, H., Geyer, F., Smedsrud, L. and Gao, Y.Q. (2013): Arctic sea ice decline and ice export in the CMIP5 historical simulations. Ocean Modeling, 71, 114-126, http://dx.doi.org/10.1016/j.ocemod.2012.12.006
- Langehaug, H.R., Matei, D., Eldevik, T., Lohmann, K. and Gao, Y.Q.: On model differences and skill in predicting sea surface temperature in the Nordic and Barents seas. In revision, Climate Dynamics.
- Langehaug, H.R., Medhaug, I., Eldevik, T., and Otterå, O.H. (2012): Arctic/Atlantic exchanges via the Subpolar Gyre. Journal of Climate, 25, 2421 – 2439, doi: 10.1175/JCLI-D-11-00085.1
- Langehaug, H.R., Rhines, P.B., Eldevik, T., Lohmann, K., and Mignot, J. (2012): Water mass transformation and the North Atlantic Current in three multi-century climate model simulations. Journal of Geophysical Research, 117, C11001, doi: 10.1029/2012JC008021
- Raanes, P., A. Carrassi, and L. Bertino, 2015. Extending the square root method to account for model noise in the ensemble Kalman filter. *Mon. Weather. Rev.* – **143**, 3857-3873
- Weber, R., A. Carrassi, and F. Doblas-Reyes, 2015. Linking the anomaly initialization approach to the mapping paradigm: a proof-of-concept study. In Press - *Mon. Weather. Rev.* **143**, 4695-4713

Relevant Projects

- **NFR-BlueArc** (2011.01-2014.12), supported by the **Research Council of Norway,** investigated the climate response to the Blue-Arctic (autumn Arctic sea ice fully disappear). NERSC is coordinator.

- **NordForsk Greenice** (2014.02-2016.01), investigate the Arctic sea ice impact on weather and climate over northern hemisphere by multi-model experiments. NERSC is partner.
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu supported by **FP7 of the European Commission**, investigate predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. NERSC is partner.
- **NFR Snowglace** (2016.01-2018.12), supported by the **Research Council of Norway**, investigate the Arctic sea ice impact on the weather over Eurasian continent using the Norwegian Climate Prediction Model. NERSC is partner
- **NFR EPOCASA** (2014.01-2017.12), supported by the **Research Council of Norway**, investigate how to enhance seasonal-to-decadal prediction of climate for the North Atlantic sector and Arctic. NERSC is partner
- **NFR NORTH** (2014.01-2017.12), supported by the *Research Council of Norway*, investigate the northern constraints on the Atlantic thermohaline circulation. NERSC is partner
- **NFR India-Clim** (2012.01-2014.12), supported by the **Research Council of Norway**, investigate the impact of the Atlantic Multi-decadal Oscillation on the India summer monsoon precipitation. NERSC is coordinator

Relevant significant infrastructure and/or technical equipment

NERSC will apply for CPU quotas to the Norwegian center for computational science (NOTUR, www.notur.no) and apply for data storage to NorStore (www.norstore.no).

Partner 26 Royal Netherlands Institute for Sea Research (NIOZ)

NIOZ http:// www.nioz.nl is the national oceanographic research institution of the Netherlands with physics, chemistry, biology and geology as the four main research disciplines. It was founded in 1876 and is part of the Netherlands Organisation for Scientific Research (NWO). The multi-disciplinary institution also has the task to facilitate marine research and marine education at other research and academic institutions throughout the Netherlands and Europe. Royal NIOZ aspires to perform top-level curiosity-driven and society-inspired research of marine systems that integrates the natural sciences of relevance to oceanography. The ocean-going research vessel Pelagia, owned by Royal NIOZ, forms a central part in the national oceanographic research facilities. Royal NIOZ has, together with UHAM and NERC, carried out the WOCE/CLIVAR hydrographic section AR7E in the north-western North Atlantic Ocean and has maintained several tall oceanic moorings in the Irminger Sea since 2003 as part of the Dutch Long-term Ocean Climate Observations (LOCO) program, the EU funded THOR project, and at present the EU funded NACLIM project, and presently integrated with the international OSNAP program led by the US and UK.
In this project NIOZ will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Karin Larsen/FAMRI & Gerard McCarthy/NERC)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Laura de Steur (female) is a physical oceanographer with specific research interest in polar and sub-polar regional to large-scale oceanic processes. She has worked extensively with long-term oceanographic observations from moorings and shipboard data obtained at several key locations in the East Greenland Current (Fram Strait and Denmark Strait) and the Irminger Sea (Irminger Current and central Irminger Gyre). She aims at quantifying the freshwater, heat and volume transports of these currents, the observed

variations therein including the relation with large-scale ocean and atmospheric forcing, and their role climate variability. She also collaborates with ocean and climate modelers for that purpose. She has been working on this topic within several EU, US and Norwegian funded programs like DAMOCLES and iAOOS, NACLIM and OSNAP.

Dr. Femke de Jong (female) is a physical oceanographer studying the variability of the North Atlantic Subpolar Gyre with a focus on deep water formation and its relation to the Atlantic Meridional Overturning Circulation. She has participated in the AR7E hydrographic surveys and worked with the LOCO moorings in the Irminger Sea as well as a mooring in the Labrador Sea. She studies deep convection as well as restratification and interior-boundary exchange through mesoscale eddies and how variability in these can be attributed to either atmospheric forcing or ocean state. The Denmark Strait Overflow, another source of deep water, is also investigated by her through a Lagrangian study of pathways in the Iceland Sea. She worked on these topics within LOCO, THOR, NACLIM and OSNAP as well as a collaboration with a US and Norwegian Institution.

Relevant Publications, products, service and/or other achievements

- de Steur, L., R.S. Pickart, D.J. Torres, H. Valdimarsson. 2015. Recent changes in the freshwater composition east of Greenland. *Geophys. Res. Lett*. 42, 1-7, doi:10.1002/2014GL062759
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- de Jong, M. F., Bower, A. S. and H. H. Furey. Seasonal and inter-annual variations of Irminger Ring formation and boundary-interior heat exchange in FLAME. *J. of Phys. Oceanogr.*, in revision.
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- van Aken, H. M., and M. F. de Jong, 2012. Hydrographic variability of Denmark Strait Overflow Water near Cape Farewell with multi-decadal to weakly time scales. *Deep Sea Res. I*, 66, 41-50, doi:10.1016/j.dsr.2012.04.004.
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- van Aken, H. M., de Jong, M. F., and I. Yashayaev, 2011. Decadal and multi-decadal variability of Labrador Sea Water in the north-western North Atlantic Ocean derived from tracer distributions: heat budget, ventilation, and advection. *Deep Sea Res. I*, 58, 505-523, doi:10.1016/j.dsr.2011.02.008
- van Sebille, E., Baringer, M. O., Johns, W. E., Meinen, C. S., Beal, L. M., de Jong, M. F., and H. M. van Aken, 2011. Propagation pathways of classical Labrador Sea water from its source region to 26°N. *J. Geophys. Res.*, 116, C12, doi:10.1029/2011JC007171.

- de Jong, M. F., Drijfhout, S. S., Hazeleger, W., van Aken, H. M., and C. A. Severijns, 2009. Simulations of hydrographic properties in the northwestern North Atlantic Ocean in coupled climate models. *J. Climate*, 22, 1767—1786, doi:/10.1175/2008JCLI2448.1.

Relevant projects

- **EU FP7 NACLIM** (2012-2017) www.naclim.eu to investigate predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. NIOZ is partner.
- **OSNAP (2014-2018),** Overturning of the Subpolar North Atlantic Program; a large internationally coordinated effort to measure heat and freshwater fluxes in the subpolar gyre supported by NSF (US), NERC (UK), and national funding agencies of Canada, Germany

Partner 27 Netherlands eScience Center (NLeSC)

The NLeSC (www.esciencecenter.nl) coordinates and conducts a scientific program, working with both academia and industry, on the interface of e-infrastructure (computing, data) and domain sciences varying from climate science, astronomy, chemistry to humanities amongst others. The Center is primarily funded by the national research council (NWO) and the national e-infrastructure organization (SURF). NLeSC has expertise in data handling, big data analytics and efficient computing. In climate science the expertise of NLeSC is in efficient computing of large codes on heterogeneous (including accelerated hardware) and the combination of disparate compute resources as well as in visualization of large data sets. NLeSC coordinates a platform for national and European e-Science activities.
NLeSC maintains an escience technology platform containing tools, interfaces, and libraries to deal with and extract information from large amounts of (distributed) data, requiring large computing infrastructures, high-speed networks, and high-resolution visualization equipment. NLeSC has a staff of about senior scientists and about 30 eScience Research Engineers from varying background, including climate science.
In this project NLeSC will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Lead Karin Larsen/FAMRI, co-lead Gerard McCarthy/NERC)
- WP3: Linkages of Arctic climate changes to lower latitudes (Lead Yongqi Gao/NERSC, co-lead Guillaume Gastineau/LOCEAN)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Wilco Hazeleger (male) is Director/CEO of NLeSC and an expert in climate modelling and climate scenario development. He has a chair in climate dynamics at Wageningen University. He initated and led the EC-Earth consortium, a leading Earth system modelling consortium in Europe. He holds a chair in Climate Dynamics at Wageningen University. He has been involved in many EC funded FP7 projects, such as THOR, SPECS, COMBINE, IS-ENES, IS-ENES2 and EMBRACE, and the H2020 PRIMAVERA project. He has published over 90 peer-revied papers on climate variability, predictability, climate and sea level scenario's, extremes, modelling and climate adptation. He serves on advisory committees of ECMWF, the UK Met Office Hadley Centre and the Swedish eScience Center.

Dr. **Seinstra (male),** Dr**. Maassen** (male), Dr. **Bakhsk**i (female) and Dr**. van Werkhoven (male)** are computational scientists with expertise in heterogeneous and distributed computing.

Relevant publications, products, service and/or other achievements

- van der Linden, E.C., R. Bintanja, W. Hazeleger and R.G. Graversen, 2015: Low-frequency variability of surface air temperature over the Barents Sea. Accepted by *Clim Dyn.*
- B. van Werkhoven, J. Maassen, M. Kliphuis, H.A. Dijkstra, S.E. Brunnabend, M. van Meersbergen, F.J. Seinstra, and H.E. Bal, 2014. "A distributed computing approach to improve the performance of the Parallel Ocean Program (v2.1)". Geosci. Model Dev., 7, 267-281.
- Krikken, F. and W. Hazeleger, 2015: Arctic energy budget in relation to sea-ice variability on monthly to annual time scales. *J. Climate,* 28, 6335–6350.
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- Hazeleger, W. et al, 2015: Tales of Future Weather. *Nature Climate Change*, 5, 107-114
- van der Linden, E.C., R. Bintanja, W. Hazeleger, and C. A. Katsman, 2014: The Role of the Mean State of Arctic Sea Ice on Near-Surface Temperature Trends. *J. Climate*, 27, 2819–2841 DOI: 10.1175/JCLI-D-12-00617.1
- Bintanja, R., C. Severijns, R. Haarsma and W. Hazeleger, 2014: The future of Antarctica's surface winds simulated by a high-resolution global climate model. I. Model description and validation. *J. Geoph. Res., Atmos.,* 119, 7136–7159, DOI: 10.1002/2013JD020847
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- de Vries, H., R. Haarsma and W. Hazeleger, 2012: On the future reduction of snowfall in western and central Europe. *Clim Dyn* doi:10.1007/s00382-012-1583-x
- de Vries, H., T. Woolings, R. Haarsma and W. Hazeleger, 2012: Atmospheric blocking in a future climate. *Clim Dyn*. doi:10.1007/s00382-013-1699-7
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- Min, E., W. Hazeleger, G.J. van Oldenborgh, and A. Sterl, 2013: "Evaluation of trends in high temperature extremes in North-Western Europe in regional climate models." *Env. Res. Lett.*, **8**, 1, 014011
- Hazeleger W., and Co-authors, 2012: EC-Earth V2.2: description and validation of a new seamless Earth system prediction model. *Climate Dynamics,* 39, 2611-2629, doi:10.1007/s00382-011-1228-5
- Wouters, B., Drijfhout, D., Hazeleger, W., 2012: North-Atlantic interdecadal meridional overturning circulation variability in the EC-EARTH coupled model. *Climate Dynamics,* 39, 2695–2712. doi: 10.1007/s00382-012-1366-4
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- Hazeleger, W. and R. Bintanja, 2012: Studies with the EC-Earth seamless Earth system prediction model. *Climate Dynamics*, 39, 2609-2610, doi:10.1007/s00382-012-1577-8
- Oldenborgh, G.J. van, F.J. Doblas-Reyes, B. Wouters and W. Hazeleger, 2012: Skill in the trend and internal variability in a multi-model decadal prediction ensemble. *Climate Dynamics*, 38, 1263-1280, doi:10.1007/s00382-012-1313-4
- de Vries, H., R. Haarsma and W. Hazeleger, 2012: Western European cold spells in Current and Future

Climate. *Geoph. Res. Lett.* doi:10.1029/2011GL050665
- Bintanja, R., R.G. Graversen, and W. Hazeleger, 2011: Near surface greenhouse feedbacks amplify Arctic warming. *Nature Geosc.* 4*, 758-761*
- Hazeleger, W. et al, 2010: EC-Earth: seamless Earth system prediction in action." *Bull. American Met. Soc.*, 91, 1351-1356.
- Graversen R.G., S. Drijfhout, W. Hazeleger, R. van de Wal, R. Bintanja and M. Helsen, 2010: Greenland's contribution to global sea-level rise by the end of the 21st century. *Climate Dynamics.* doi:10.1007/s00382-010-0918-8.

Relevant Projects

- **IPOP-PPP@SEA.** Arctic seasonal to interannual prediction and applications, funded by Wageningen University (1 PhD student with Prof W. Hazeleger)
- **EU H2020 PRIMAVERA** (2015-2019) https://www.primavera-h2020.eu/ High resolution future climate modelling. NLeSC is subcontractor to KNMI (Dr. Bakhski and Prof. W. Hazeleger).
- **NWO Feedbacks in the Arctic**, funded by national research council (NWO), 1 PhD student with Prof. W. Hazeleger
- **NWO Arctic-lower latitude coupling**, funded by national research council (NWO), 1 PhD student with Prof. W. Hazeleger.
- **NLeSC eSalsa**. NLeSC funded project on high resolution coupled modelling with university of Utrecht.

Relevant significant infrastructure and/or technical equipment

NLeSC maintains the eStep software technology platform and makes use of SURF's national e-infrastructure (www.surf.nl)

Partner 28 Natural Environment Research Council/ National Oceanography Centre (NERC)

The National Oceanography Centre (NOC) is the UK's largest institution for integrated sea level science, ocean research and environmental technology development. It is wholly owned by the Natural Environment Research Council (NERC) and has two sites, one in Liverpool and the other in Southampton. The NERC provides the bulk of the UK's capability for the country's marine research community. This includes provision of major facilities (such as the Royal Research Ships and deep submersibles), and programmes of sustained observing, survey, mapping, data management and other functions. NERC has approximately 2500 employees and a turnover of ~£400M. 146 staff are at NERC and the turnover is ~£35M.

The Centre has a strong track record of working with the EC to deliver projects. NERC plays a leading role in E20 million AtlantOS Horizon 2020 project that has been running since 2015. Since 2010, NERC has been contracted to deliver 29 FP7 projects with an EC contribution of € 11 million, including 5 Environment and 3 Ocean projects as well as being involved in Space, ICT and Infrastructure projects. The Centre has successfully coordinated 2 FP7 Environment projects, HERMIONE and EUROSITES and is currently coordinating SenseOCEAN (FP7 Oceans of Tomorrow 2013.2, developing multifunctional chemical and optical sensors) and FixO3 (integrates European open ocean fixed point observatories and to improve access to these key installations for the broader community). In addition the Centre has made a major commitment to the FP7 individual science excellence programmes by hosting 1 ERC Fellow, 4 Marie Curie individual Fellows and has been involved in 3 Marie Curie ITNs, 1 of which, SENSEnet which has direct relevance to this specific project, was coordinated at NERC.

In this project, NERC will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/ HAV, **Co-lead: Gerard McCarthy/NERC**)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr Gerard McCarthy (male) is a senior research fellow at the National Oceanography Centre, UK. He is a leading observational oceanographer working on the UK-US RAPID project that measures the Atlantic overturning circulation. He has published 17 peer reviewed papers since 2011, including the first observations of large interannual variability in Atlantic circulation and work linking ocean circulation to decadal climate variability. He has worked on a number of EC funded projects including FP7-funded THOR and NACLIM, and H2020 funded Atlantos.

Dr Bablu Sinha (male) is a Senior Scientist at the National Oceanography Centre, UK. He leads the Climate and Uncertainty subgroup (6 staff) and is in charge of developing ocean model configurations for use in the UK climate model. He has co-authored around 50 peer reviewed papers, including work on the predictability and variability of the Atlantic Meridional Overturning Circulation, global and regional ocean heat uptake and North Atlantic ocean influences on UK and European weather patterns. He is a Principal Investigator/Co-Investigator on 5 UK-funded grants and is co-supervisor of 6 PhD students.

Dr Ben Moat (male) is a Research Fellow at the National Oceanography Centre, UK. He is A fellow of the Royal Meteorological Society and Fellow of the Institute of Mathematics and its Applications. He has many years experience in physical oceanography, ocean-atmosphere interactions and Computational Fluid Dynamics. He uses both observations and the results from high resolution OGCMs in his research. His most recent projects include RAPID-AMOC, Waves Aerosols and Gas Exchange Study (WAGES) and the Arctic Cloud Summer Experiment (ACSE).

Dr Aurélie Duchez (female) is a research scientist working in the modelling department at the National Oceanography Centre Southampton. She is working on the role of the ocean on the development of weather extremes, mainly focusing on European extremes, but also extremes around China. Her main research interests are understanding the variability of the Atlantic Meridional Overturning Circulation as well as the causes of its variability at different timescales and its impact on climate, using both model output and real observations. She is beneficiary of an AXA research fund postdoctoral grant. She was the PI on an earlier successful Climate Science Service Partnership-China (Newton Fund) Project investigating the relationship between atmospheric modes of variability and climate extremes over Europe and China.

Dr Penny Holliday (female) is a Senior Scientist at the National Oceanography Centre, Southampton. She is a physical oceanographer with over 20 years of experience of research in ocean climate change, with particular emphasis on the circulation, variability, and heat and freshwater transport of the North Atlantic subpolar gyre. She is PI for UK OSNAP and the UK's Extended Ellett Line, an annually repeated GO-SHIP section between Iceland and Scotland.

Relevant publications, products, service and/or other achievements

- Aksenov, Y., Bacon, S., Coward, A.C., Holliday, N.P. 2010. Polar Outflow from the Arctic Ocean: A high resolution model study. JMS, 83(1-2), 14-37, doi:10.1016/j.jmarsys.2010.06.007

- Bacon, S., Marshall, A., Holliday, N. P., Aksenov, Y., Dye, S. R.. 2014 Seasonal variability of the East Greenland Coastal Current. Journal of Geophysical Research: Oceans, 119 (6). 3967-3987. 10.1002/2013JC009279
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- Bryden, H. L.; King, B. A.; McCarthy, G. D.; McDonagh, E. L.; Impact of a 30% reduction in Atlantic meridional overturning during 2009-2010, Ocean Science, 11, 789-810, 2014.
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- Drijfhout SS Blaker AT Josey SA Nurser AGN Sinha B Balmaseda MA (2014) Surface warming hiatus caused by increased heat uptake across multiple ocean basins Geophys Res Lett 41 7868–7874 Doi:10.1002/2014GL061456
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- Marzocchi, A., Hirschi, J.J-M., Holliday, N.P., Cunningham, S.A., Blaker, A.T., Coward, A. C., 2015, The North Atlantic subpolar circulation in an eddy-resolving global ocean model, Journal of Marine Systems, 142. 126-143. 10.1016/j.jmarsys.2014.10.007
- McCarthy, G; Frajka Williams, E; Johns, WE; Baringer, MO; Meinen, CS; Bryden, HL; Rayner, D; Duchez, A; Roberts, C; Cunningham, SA; Observed interannual variability of the Atlantic meridional overturning circulation at 26.5 N, Geophysical Research Letters, 39, 19, 2012
- McCarthy, G. D.; Gleeson, E.; Walsh, S.; The influence of ocean variations on the climate of Ireland, Weather, 70, 8, 242-245, 2015
- McCarthy, G. D.; Smeed, D. A.; Johns, W. E.; Frajka-Williams, E.; Moat, B. I.; Rayner, D.; Baringer, M. O.; Meinen, C. S.; Collins, J.; Bryden, H. L.; Measuring the Atlantic Meridional Overturning Circulation at 26ºN, Progress in Oceanography, 130, 91-111, 2015
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- Sinha, B, B. Topliss, A. T. Blaker and J. J.-M. Hirschi (2013) A numerical model study of the effects of interannual timescale wave propagation on the predictability of the Atlantic meridional overturning circulation, J. Geophys. Res., 118, 131-146, doi:10.1029/2012JC008334.
- Smeed, DA; McCarthy, G; Cunningham, SA; Frajka-Williams, E; Rayner, D; Johns, WE; Meinen, CS; Baringer, MO; Moat, BI; Duchez, A; Observed decline of the Atlantic meridional overturning circulation 2004 to 2012, Ocean Sci. Discuss, 10, 5,1619-1645, 2013

Relevant Projects

- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 of the European Commission. The goal is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System. NERC are a leading partner.
- **EU H2020 Primavera** (2015-2019), supported by Horizon 2020 of the European Commission. To develop a new generation of advanced and well-evaluated high-resolution global climate models, capable of simulating and predicting regional climate with unprecedented fidelity, for the benefit of governments, business and society in general. NERC is a partner.
- **EU FP7 NACLIM** (2012.11-2016.11), supported by FP7 of the European Commission, investigate predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. NERC is partner.
- **ACSIS (2016-2021)** UK core multidisciplinary programme involving 6 Research Institutes and the Met Office. Objectives are to characterize and explain interannual to decadal variability in multiple variables (atmosphere, ice, ocean and atmospheric composition) in the North Atlantic sector using a combination of high quality observations and high resolution models.
- **RAPID-AMOC (2004-present),** supported by NERC in the UK, NSF and NOAA in the US. The RAPID project has provided the first observation of the strength of the Atlantic overturning circulation and has revolutionized our understanding of this crucial system of currents. The project has been running since 2004. NERC is the lead partner.
- **OSNAP** (initially 2013-2018), supported by NERC in the UK and NSF in the US, with partners in Netherlands, Canada, Germany and China. OSNAP has the overall aim of observing the subpolar gyre and overturning circulation and the associated heat and freshwater transport continually for 4 years. The array was first deployed in 2014, using moorings and autonomous vehicles.
- **Extended Ellett line** (1975-present), supported by NERC in the UK, this is a GO-SHIP section located between Iceland and Scotland. The goal is to observe and understand the causes and impact of long-term changes in temperature, salinity, nutrients, carbon and transport through repeat hydrography and glider sections.

Relevant significant infrastructure and/or technical equipment

The RAPID array consists of 23 sets of moored instrumentation funded by NERC stretching between the Canary Islands and the Bahamas and four sets of moored instrumentation funded by NSF. The array provides twice daily estimates of the Atlantic overturning circulation.

The OSNAP array consists of moored instrumentation from the UK, US, Germany, Canada, the Netherlands and China. Since 2013, it has been gathering data on the strength of the subpolar North Atlantic ocean circulation.

NERC operates NERC two global multi-disciplinary research vessels the **RRS Discovery** and the **RRS James Cook**. These ships are made available for an average total of 550 days per year to the UK marine science community and their international collaborators. Operating world-wide and often in extreme environments, they are world-class platforms for marine science. These vessels provide considerable opportunities for testing of technology at low cost by associating with an existing activities include science cruises, equipment trials or passage legs.

NERC has access to large scale Natural Environment Research Council computing infrastructure including the **UK's High Performance Computing Facility, ARCHER** (~100,000 computing cores) and the multi-petabyte storage and analysis facility JASMIN. In addition NERC has access to UK Met Office supercomputing facilities because of its role in providing ocean model configurations for UK climate and seasonal-decadal forecasting models. NERC also has its own ~700 core supercomputing cluster for in-house model development and analysis.

Partner 29 Pelagic Freezer-trawler Association (PFA)

The Pelagic Freezer-trawler Association (PFA) http://www.pelagicfish.eu is an association that represents the interests of trawler owners, occupied in pelagic fishing activities for human consumption, on a national, European and international level. N**ine trawler companies from five EU countries** are members of the PFA, each with a long history in the fishing industry: Cornelis Vrolijk's Visserij Maatschappij BV – The Netherlands, Doggerbank Seefischerei GmbH – Germany, France Pélagique s.a.r.l. – France, Interfish Ltd – United Kingdom, Jaczon BV – The Netherlands, North Atlantic Fishing Company Ltd – United Kingdom, Parlevliet & Van der Plas BV – The Netherlands, UAB Atlantic High Seas Fishing Company – Lithuania, W. van der Zwan & Zn BV – The Netherlands. These are mostly family businesses that have been active in the industry for 50 years or more, and which have grown to become fully-fledged companies operating world-wide.
Since the early seventies, all trawlers in membership of the PFA have been fitted out as standard with deep-freeze equipment. The PFA has anchored sustainability in the overall policy of the Association and the activities of its members. As a result, the PFA has developed an integral perspective and policy in which responsible entrepreneurship takes a central position. The Association aims to improve the transfer of knowledge on pelagic fishing activities between all those concerned, including the consumer. The members of the association employ a total work-force of around 1.500 people.
In this project PFA will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Martin Pastoors (male) is the Chief Science Officer at the PFA. In that capacity he is responsible for initiating and coordinating the involvement of the PFA in different research projects, for coordinating the extensive self-sampling programme and for bringing information from the fishery to the scientific domain

(e.g. stock assessments). He has an extensive background (~20 years) in marine science, fisheries stock assessment and scientific advice. He has worked for IMARES (The Netherlands) from 1997 until 2014. He has been the chair of the ICES Advisory Committee on Fishery Management (ACFM, 2006-2008) and he has chaired numerous ICES expert groups. He has coordinated and participated in several EU-funded projects (e.g. JAKFISH, MASPNOSE, GAP2, MYFISH, COEXIST, CEVIS, BENTHIS, DAMARA).

Gerard van Balsfoort (male) is the Chairman of the PFA. He is responsible for the policy aspects relevant to the PFA (quota, negotiations) and also for the media coverage. He has a broad background in fisheries management, including as vice-director of the department of fisheries and as chair of the Fish Producers Organization. He is currently member of the board of Europeche and EAPO and he is the chair of the Northern Pelagic Working Group. He is very well known in the fisheries policy circles in Brussels.

Relevant publications, products, service and/or other achievements

- Pastoors, M. A., Brunel, T., Skagen, D., Utne, K., Enberg, K., and Sparrevohn, C. R. 2015. Mackerel growth, the density dependent hypothesis and implications for the configuration of MSE simulations: results of an ad-hoc workshop in Bergen, 13-14 August 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015.
- Dörner, H., Graham, N., Bianchi, G., Bjordal, Å., Frederiksen, M., Karp, W. A., Kennelly, S. J., et al. 2014. From cooperative data collection to full collaboration and co-management: a synthesis of the 2014 ICES symposium on fishery-dependent information. ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu222.
- Pastoors, M. A., Van Helmond, A. T. M., Van Marlen, B., Van Overzee, H. M. J., and de Graaf, E. 2014. Pelagic pilot project discard ban, 2013-2014. Rapport C071.14.
- Pastoors, M. A. 2014. Exponential growth in the number of words used for the European Common Fisheries Policy (CFP): Does better management require more text? Marine Policy, 46: 101-104.
- Pastoors, M. A., Ulrich, C., Wilson, D. C., Rockmann, C., Goldsborough, D., Degnbol, D., Berner, L., et al. 2012. Judgement and Knowledge in Fisheries Management involving Stakeholders (JAKFISH) Deliverable 1.5 Final Report.
- Pastoors, M. A., Hommes, S., Maes, F., Goldsborough, D., de Vos, B., Stuiver, M., Bolman, B., et al. 2012. Maritime Spatial Planning in the North Sea (MASPNOSE) final report.

Relevant Projects

- **Pelagic Research Fleet** (2015 and beyond): Self-sampling approach for freezer-trawlers.
- **PelAcoustics II** (2013-2015): Implementation of the structural use of acoustic data from pelagic trawlers in scientific stock estimates (PelAcoustic II), funded through European Fisheries Fund (EFF).
- **Use of new broadband echosounder techniques for improved ocean imaging and selectivity in pelagic fisheries** (2014-2015), funded through European Fisheries Fund (EFF).

Relevant significant infrastructure and/or technical equipment

The freezer-trawlers that are members of the PFA have sophisticated equipment on board for finding fish. This includes acoustic equipment (sonar, echo sounder) but also equipment for e.g. temperature measurements. The freezer-trawlers could be used for (limited) trials during the course of the project if needed.

Partner 30 Rukakeskus Ltd. (RUKA)

Rukakeskus Ltd. has been running **Ruka ski resort** since 1973 and **Pyhä ski resort** since 1987. Rukakeskus is one of the leading tourism companies in Finland and industry leader with a 20 % share of the sold ski passes. The company also runs rental services, accommodation and retail business. Rukakeskus' turnover is 23 million euros and it employs 170 full time staff. The core business of Rukakeskus consists of ski resort operations. Subsidiaries of Rukakeskus Ltd are Pyhätunturi Ltd, which is in charge of Pyhä ski resort's slope services and side operations as well as TuottoOmistus Ltd, which is in charge of renting and maintaining TuottoOmistus apartments at Ruka and Pyhä.

Ruka Ski Resort is located in North-East part of Northern Ostrobothnia, 25 km north from the village of Kuusamo and close the border with Lapland region, with which the area shares many characteristics.

The skiing resort is owned by Rukakeskus Ltd. part of Aho Group Oy, Rukakeskus Ltd owns also ski centre in Pyhätunturi, in Finnish Lapland.
Ruka is characterized by one of the best snow conditions in the country and the aim of the company is to advertise Ruka as the place with the most certain snow conditions in Europe, a skiing resort that is always open for winter activities from October until May (Rukakeskus Ltd. 2013). Business success of Ruka depends to a great extent on winter conditions, appropriate temperatures and humidity. In the beginning of the season – when producing artificial snow or using the snow stored from the previous season is necessary – the knowledge of temperature, humidity and wind patterns is crucial. Better understanding of both the weather conditions at the beginning of next years' season as well as temperature and humidity data for the Spring-to-Autumn when the snow is stored (with high variability of winter conditions) is critical for the company to assess how much snow should be stored and how it should be covered during warm months.

In this project, RUKA will be involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Matti Parviainen (male), Ruka COO, Matti Parviainen has made a long career at Ruka ski resort and is currently responsible for Ruka ski resort's business operations. He is also responsible for Pyhä ski resorts ski operations. Matti Parviainen will carry the overall responsibility of the project.
Jusu Toivonen (male), Project manager, has worked for Ruka and Pyhä ski resorts for eight years. During that time he has run many projects from sustainability program to various marketing programs. Jusu Toivonen will be one the key members of personnel for the project.

Relevant achievements

- The Finnish Ski Area Association rewarded Ruka as Ski Resort of the Year 2014 and Ruka was rewarded as Finland's Best Ski Resort on World Ski Awards 2014.

- Rukakeskus is one of the leading tourism companies in Finland and industry leader with a 20 % share of the sold ski passes.
- Rukakeskus' turnover is 23 million euros and it employs 170 full time staff.
- The company is owned by Aho family, whose Aho Group was selected the Family Business of the Year 2008 in Finland.

Partner 31 Scottish Association for Marine Science (SAMS)

SAMS, founded in 1884, is one of the UK's leading marine laboratories. It employs about 150 staff members and students, and is a multidisciplinary research institute and a collaborative centre of the UK NERC. It runs an undergraduate honours degree course in Marine Science and trains PhD students as an academic partner of the University of the Highlands and Islands. SAMS has been a partner in about 70 EU projects and coordinated at least six. SAMS' Physics and Technology Department employs 18 people and has long-standing interest in monitoring the circulation in the northern North Atlantic. This interest is maintained with i) annual cruises between Scotland and Iceland (the Ellett Line); ii) annual seaglider deployments between Scotland and Iceland iii) a multidisciplinary mooring at Kongsfjord, Svalbard; and iv) supporting Marine Scotland Science with monitoring transport in the Faroe-Shetland Channel (FSC). SAMS has developed an international reputation for Atlantic ocean climate and process research using long endurance underwater glider missions in the northern North Atlantic, is a partner in the EU GROOM glider infrastructure project; EU NACLIM project; EU Atlantic Observing System project AtlantOS; EU ATLAS project and hosts the North Atlantic Glider Base in Oban. SAMSprovides an excellent environment for the proposed project in terms of a competent staff and student body, and provides access to key research infrastructure (give examples for key staff and infrastructure essential for your proposal).
In this project, SAMS will be actively involved in:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Raeanne Miller/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Stuart A. Cunningham (male) is a lead scientist in the SAMS Physics and Technology group. Cunningham is a physical oceanographer with twenty years experience in making observations of the physical properties and circulation of the ocean using ships and arrays of moored instruments. From 2003-2012 he was the lead principal investigator of the NERC's Rapid Climate Change programme to monitor the Atlantic overturning circulation at 26.5°N (http://www.noc.soton.ac.uk.rapidmoc). He is now a PI in the UK-OSNAP programme, contributing to the International array of moorings across the sub-polar North Atlantic (http://www.ukosnap.org/). He has also been a PI in EU Framework 7 projects: North Atlantic Climate: Predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic Ocean sea surface temperature and sea ice variability and change (NACLIM), EU FP7 and Thermohaline Circulation at Risk? (THOR), EU FP7 and is a WP leader in EU H2020-BG-2015-2 A Trans-AtLantic Assessment and deep-water ecosystem-based Spatial management plan for Europe (ATLAS).

Prof. Mark E. Inall (male) is leader of the Physical Ocenogrpahy group at SAMS and Associated Director for Research. Inall is a mid-career research scientist with authorship of 53 ISI listed research papers and two book chapters. His research focuses on studies designed to elucidate marine mixing processes. Specifically, internal wave generation by tidal flow over topography and subsequent decay to turbulence; in the Deep Sea (Mid-Atlantic Ridge, Wyville-Thomson Ridge), in Shelf Seas (Malin Shelf, Iberian Shelf, West Spitzbergen Shelf, SE Greenland), and in Coastal waters (NW European and Arctic fjords). Inall has been at the forefront of using technological innovation in physical oceanography: as part of the first UK team to make in situ marine turbulence measurements, initially from ships, and now from AUVs and Gliders; the first UK team to use Gliders for standard ocean sections (Extended Ellett Line). Inall is currently leader of the FASTNEt programmem a UK-wide programme studying the physics of ocean shelf exchange.

Dr. Stefan F. Gary (male) is a research associate in physical oceanography at SAMS. Gary has experience in making observations between Scotland and Iceland along the Extended Ellett Line (EEL) by leading wintertime glider missions and participating in summertime research cruises. He incorporates new and historical hydrographic observations into large, custom quality-controlled databases which are used to study water mass properties and pathways as well as create ocean climatologies. Furthermore, Gary is an expert in applying Lagrangian particle tracking to identify pathways in ocean model output. Along with Cunningham, Gary leads the SAMS contribution to the EEL programme and has contributed to the EU NACLIM project. Gary also played a role in planning the international OSNAP by developing a mooring and glider simulator for use with ocean model output to inform the design of the OSNAP array of moorings.

Dr. Clare Johnson (female) is an early career scientist in physical oceanography based at SAMS. She has conducted research in the subpolar North Atlantic both during her PhD and subsequent three years (FTE) postdoctoral experience. Johnson's research interests lie in large scale circulation patterns, interannual to decadal changes in water properties, and distribution and mixing of water masses. She is currently employed as a postdoctoral researcher in the EU FP7 North Atlantic Climate: Predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic Ocean sea surface temperature and sea ice variability and change (NACLIM).

Relevant publications, products, service and/or other achievements

- Gary, S. F., M.S. Lozier, Y.-O. Kwon, J.J. Park, (2014). The fate of North Atlantic Subtropical Mode Water in the FLAME model, J. of Phys. Oceanogr. 44, doi:10.1175/JPO-D-13-0202.1.
- Gary, S.F., M.S. Lozier, A. Biastoch, C.W. Böning, (2012). Reconciling tracer and float observations of the export pathways of Labrador Sea Water, Geophys. Res. Let. 39, doi:10.1029/2012GL053978.
- Johnson, C., M. Inall, and S. Hakkinen, 2013, Declining nutrient concentrations in the northeast Atlantic as a result of a weakening Subpolar Gyre, Deep Sea Research I, 82, 95-107. Johnson, C., T. Sherwin, D. Smythe-Wright, T. Shimmield, W. Turrell, 2010, Wyville Thomson Ridge Overflow Water: Spatial and temporal distribution in the Rockall Trough, Deep Sea Research I, 57, 1153-1162.

- Smeed, D. A., G. McCarthey, S. A. Cunningham, E. Frajka-Williams, D. Rayner, W. Johns, M. O. Barringer, A. Duchez, B. Moat and H. L. Bryden (2014). "Observed decline of the Atlantic meridional overturning circulation 2004 to 2012." Ocean Sci. 10(29-38): doi:10.5194/os-5110-5129-2014.
- Cunningham, S. A., C. D. Roberts, et al. (2013). "Atlantic Meridional Overturning Circulation slowdown causes widespread cooling in the Atlantic." Geophys. Res. Letters 40: 6202-6207, doi:6210.1002/2013GL058464.
- Cunningham, S. A., M. O. Baringer, et al. (2010). "The present and future system for measurning the Atlantic Meridional overturning circulation and heat transport." OceanObs'09: Sustained Ocean Observations and Information for Society (Vol 2) WPP-306.
- Inall, M. E. et al. Oceanic heat delivery via Kangerlugssuaq fjord to the south-east Greenland ice sheet. Journal of Geophysical Research in press (2014).
- Marzocchi, A., J. Hirschi, J.-M, N. P. Holliday, S. A. Cunningham, A. T. Blaker, and A. C. Coward (2015), The North Atlantic subpolar circulation in an eddy-resolving global ocean model, Journal of Marine Systems, 142, 126-143, doi:doi:10.1016/j.jmarsys.2014.10.007.
- Holliday, N. P., S. A. Cunningham, C. Johnson, S. F. Gary, C. Griffiths, J. F. Read, and T. Sherwin (2015), Multidecadal variability of potential temperature, salinity, and transport in the eastern subpolar North Atlantic, Journal of Geophysical Research: Oceans, 120(9), 5945-5967, doi:10.1002/2015JC010762.
- Sherwin, T. J., D. Alyenik, E. Dumont, and M. Inall (2015), Deep drivers of mesoscale circulation in the central Rockall Trough, Ocean Sci. Discuss., 11, 2607-2646, doi:10.5149/osd-11-2607-2014.

Relevant Projects

- **EU ATLAS** (proposal 678760-2, start date ~April 2016), supported by H2020. A Trans-AtLantic Assessment and deep-water ecosystem-based Spatial management plan for Europe. SAMS is a partner.
- **EU H2020 AtlantOS** (2015-2019), supported by Horizon 2020 www.atlantos-h2020.eu. Optimizing and Enhancing the Integrated Atlantic Ocean Observing System. SAMS is a partner.
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu. Predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. SAMS is partner.
- **EU THOR** (ended 31/1/13). Thermohaline Overturning – At Risk?. SAMS is a partner.
- **OSNAP** (RCUK-NERC, proposal NE/K010875/1, 1/9/13 to 31/8/18). Overturning in the subpolar North Atlantic Programme. SAMS is a lead partner.
- **FASTNEt** (RCUK-NERC, ended 31/10/15). **F**luxes **A**cross **S**loping **T**opography of the **N**orth **E**ast A**t**lantic. SAMS is a lead partner.

Relevant significant infrastructure and/or technical equipment

SAMS is the host for North Atlantic Glider Base (NAGB), a Natural Environment Research Council (UK) funded facility for the benefit of UK and International Glider and Marine Robotic users. It is closely linked with the MARS facility at NERC-NOC (Marine Autonomous Robotics Systems): both are funded by NERC as "National Capability". NAGB was set up in 2010 to formalise longstanding capacity of facilities at SAMS to support the testing, development and use of autonomous (smart) marine systems (dating back to the first ever autosub trials), and with the forward vision of the North Atlantic as an exemplar hub for networks of Gliders.

NAGB offers:

- Access to laboratory space for pre-mission, post-service Glider preparation (including buoyancy correction)
- Access to SAMS two coastal research vessels for sheltered deep water testing (to 200m).

- Arrangement of fast vessel hire for deployment and recovery for North Atlantic missions.
- Advice on scientific and operational aspects of Gliders mission planning and execution.
- Advice and software for real-time Glider data delivery to GTS or to data centres.

Partner 32 SAMS Research Services Ltd (SRSL)

SRSL is the technology transfer organisation of the Scottish Association for Marine Science (SAMS). As part of a learned society which comprises a 130-year old oceanographic research institute, a University campus and a commercial consultancy, SRSL provides independent, multi-disciplinary consultancy and services grounded in the latest scientific approaches. Its mission is to disseminate and exploit SAMS cutting-edge scientific research outputs to enable its customers (international Governments, regulatory authorities and large corporations) to understand and mitigate the risks involved in industry interaction with the marine environment.

SRSL is a small-medium sized enterprise (SME) with recognised expertise in the extractive industries, energy and aquaculture industries. The company also has a marine technology department and has been manufacturing and supplying sea ice mass balance arrays (SIMBAs) to the global polar academic and meteorological communities for over five years. The organisation directly employs professional communicators and project management experts. It also has the ability to subcontract expertise from SAMS research institute (e.g. their communications department and graphic designer) to increase flexibility and enhance capacity.

SAMS Group has a long track-record investigating the Arctic marine environment. A founding partner of the University of the Highlands and Islands (UHI), SAMS was a key player in UHIs previous successes in the Arctic Periphery Programme. The organisation also has established collaborations with the University of the Arctic and the University of Norway in Svalbard (UNIS), where their undergraduate students have the opportunity to spend a semester. As above, SRSL has been working with the international polar research community for over five years, counting the Polar Research Institute of China (PRIC), the Norwegian Polar Institute (NPI) and the Canadian Ice Service amongst its customers.

SRSL will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (**Lead: Raeanne Miller/SRSL**, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr **Raeanne Miller** (female) is an outstanding young marine scientist and a Knowledge Exchange (KE) Fellow for Wave and Tidal Energy, currently tasked with increasing the uptake of environmental research by industry, regulators, and policymakers. My recent projects are focused on the exchange of best practices for environmental survey and monitoring across several European tidal energy sites and developing research collaborations between scientists, industry, and other partners. Raeanne is a keen advocate of public engagement with science and actively collaborate with schools, develops activities for festivals, and deliver public lectures to develop an ongoing dialogue around renewable energy and marine science with a wider audience.

John Hausrath (male) is a professional programme/project manager with a background in engineering and science. His experience includes undertaking project management, programme management, contract

management (including NEC3), CDM coordination, planning and business case definition for a large number of high-profile clients across a number of different industries, including marine environmental survey.
John leads a team of project managers, responsible for overall delivery of all of SRSL's commercial contracts. Projects delivered personally include: Benthic and fish surveys (SSER); Etive MPA biotope survey and analysis (SNH); Basamuk environmental monitoring, Papua New Guinea; Development of Regulations and Sanitary surveys programme for the Food Standards Agency. Also, responsible for the development and production of SRSL's Sea Ice Mass Balance Array (SIMBA) product, which is sold internationally for the measurement of sea ice thickness. John and his team will lead the project management of work package 8 of the Blue-Action project; ensuring that the financial management of the assigned resources runs smoothly and in running the project within the budget assigned.

Euan Paterson (male) is a public relations and media professional with 13 years' experience. As a former journalist, he has extensive media contacts and strong networking skills. In his role as media and communications officer at SAMS, he is in regular contact with national and international media outlets across print, digital and broadcast formats. These outlets range from general content media through to trade and industry-specific publishers. Euan has generated a large amount of press coverage and has helped develop contacts and the social media presence for the ACES-ERASMUS+ Project. He will be managing the press engagement task within work package 8.

Sine Murray (female) is in charge of administration at SRSL. Sine has over 8 years' experience as a project administrator and has a background as a travel agent. She provides personal assistant services to SRSL's Managing Director and administrative and travel support to the whole team. Sine also account manages SRSL's key SIMBA customers; responding to enquiries and orders. She has an in-depth knowledge of this customer base and how best to interact with them. Sine is in charge of the administration, travel and logistics for WP8. She will also assist with communication to polar researchers and meteorological institutes.

Rory MacKinnon (male) is a graphic designer with over x years experience. Web design experience and examples, e.g. design and management of the SAMS website. He will be providing the branding, web design and graphic design services to support work package 8.

Relevant publications, products, service and/or other achievements

Sea Ice Mass Balance Buoys (SIMBA). These autonomous buoys are manufactured and sold by SRSL to polar researchers and meteorological institutes around the world. They measure temperature profiles and ice thickness and are used to produce real-time snow and ice monitoring in polar regions.

Relevant Projects

- **Assessing opportunities for economic diversification and sustaiable blue growth, including marine renewables, biotechnology and mariculture** for the Commonwealth Secretariat. This project involved a pragmatic assessment of opportunities available to the Republic of Seychelles for economic diversification, the preparation of advisory reports and communication and dissemination of results to key actors.
- **Review, interpretation and synthesis of scientific and environmental monitoring data relating to the mining industry in Papua New Guinea**. SRSL expertise allowed Newcrest Mining Ltd to effectively demonstrate and communicate scientifically defensible facts to all its stakeholders, regarding the status of the marine environment at the Lihir mine site.
- **AQUAASSESS**: Assessing and documenting the economic contribution of Scotland's aquaculture industry through a stakeholder engagement exercise. This report was commissioned by Marine

Scotland (MS) and Highlands and Islands Enterprise (HIE). It recommended policy actions to support skills development in the sector, to facilitate the creation of year-round jobs and to ensure long term, sustainable production and growth in line with Scottish Government targets. The report was welcomed by MS, HIE and the Scottish Salmon Producers Organisation.

- **ACES ERASMUS+** (Joint Master Degree in Aquaculture, Environment and Society, http://www.sams.ac.uk/erasmus-master-aquaculture, 2014-2019), funded by the EU Commission. The project developed and is delivering a masters degree, providing the practical and theoretical skills needed for a successful career in aquaculture. It provides students with a unique opportunity to study in the United Kingdom, Crete and France.

Relevant significant infrastructure and/or technical equipment

Not applicable

Partner 33 Center for Earth System Research and Sustainability of the University of Hamburg (UHAM)

The Center for Earth System Research and Sustainability (CEN) https://www.cen.uni-hamburg.de/en/about-cen.html brings together the expertise of nine university institutes and facilities and is part of the KlimaCampus Hamburg. The CEN is a recognized research center at the University of Hamburg (UHAM) in keeping with § 6(1) of the Faculty Charter from July 10, 2010. CEN Members include oceanographers, meteorologists, marine biologists, geophysicists, geologists, soil scientists, geographers and biogeochemists, as well as researchers in the business and social sciences, all of whom are actively engaged in climate, environmental and earth system research. As such, CEN links the natural and social sciences – in research, education, and in promoting and supporting the next generation of researchers – and combines resources to address far-reaching, cross-disciplinary questions. The oceanographic activities are closely coordinated with meteorological and climate research within this center.

The Institute of Oceanography (Institut für Meereskunde, IfM), as one of the members of CEN, performs basic research and academic education in physical oceanography. It has a staff of 60 researchers and is equipped for sea-going ocean work. It has access to the fleet of German research vessels. The observational activities have always been complemented by modelling studies, notably, but not exclusively, on circulation in the North Atlantic. Remote sensing and data assimilation is another expertise for which UHAM is well known. The institute performs the German ECCO effort (GECCO) by which global and regional data assimilation is being performed over the past 50 years. It has access to the university's computer centre and the German Climate Computing Centre (DKRZ). The institute's research plan calls for focus in the European Arctic and Sub-arctic Seas in the fields of experimental, modelling and remote sensing work.

UHAM has been actively participating in several European projects as well as in the North Atlantic field work for CLIVAR. UHAM has a well-established and reputed ability for coordinating EC research projects in different disciplines (VEINS, ASOF, PRIMO, MONARCH-A, THOR, NACLIM) and receives professional support by the financial and administrative staff of the University of Hamburg. UHAM is well prepared for procedures implemented in projects funded by European Commission and builds up on the experience made in coordinating the FP7 projects THOR and NACLIM since 2008 and participating in over two hundred EC funded projects from FP5 throughout H2020. UHAM provides experienced, skilled and significantly endowed technical and administrative resources.

In this project, CEN will be actively involved in:

- WP1 Improving seasonal long range forecast skill of risks for hazardous weather and climate events (Lead: Johanna Baehr/UHAM, Co-lead: Jens H. Christensen/DMI)
- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)

- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Johanna Baehr (female) is professor of physical oceanography, leading the 'climate modelling' group at IfM. She works on the combination of climate models and climate observations to initialize climate predictions at seasonal-to-decadal time scales. Since 2009, she is coordinating the joint work of the German Meteorological Service/Deutscher Wetterdienst (DWD), the Max-Planck-Institute for Meteorology (MPI-M) and UHAM on the development of a seasonal climate prediction system based on the coupled climate model MPI-ESM. The resulting German Climate Forecast System (GCFS 1.0) is currently running in near-operational mode, operated by DWD to deliver monthly seasonal forecasts. She is involved as a PI in CliSAP, the BMBF funded projects RACE and MiKliP, and also the FP7 project SPECS (WP lead). Starting in 2016, she is together with DWD (lead) and MPI-M also involved in the C3S project FourS2O. Johanna will lead WP1.

Dr. Kerstin Jochumsen (female) is an observational physical oceanographer with several years of experience. She has participated in a number of cruises on European research vessels and led a cruise on R/V Poseidon as chief scientist in 2014. Her scientific focus is on studying the variability of the circulation in the subpolar Atlantic, specifically on the Nordic Seas – Atlantic exchanges and on deep water variability. She was member of the EU FP7 project THOR and is currently contributing to the NACLIM project. She is also sub project leader in the BMBF funded projects RACE II and SACUS. Kerstin will be involved in WP2. Contract limited until 14 October 2017.

Dr. Detlef Quadfasel (male) is Professor of physical oceanography with longstanding experience in experimental oceanography. His main scientific interests include large scale ocean circulation, mixing and transformation of water masses and small scale oceanic processes relevant for climate variability. He was chief scientist on numerous research cruises in the North Atlantic and Indian Ocean. Detlef Quadfasel was editor of several journals and has been serving on a number of international committees, such as WOCE, TOGA-TAO, IPCC. Before joining UHAM he led the Physical Oceanography group at the Geophysical Department of the Niels Bohr Institut in Copenhagen, Denmark. He is also the coordinator of the EU FP7 projects THOR (2008 – 2012) and NACLIM (2012 – 2017). With his expertise Detlef Quadfasel will be advising and supporting WP2. Contract limited until 30 April 2017.

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Relevant Projects

- **EU FP7 NACLIM** (2012-2017) www.naclim.eu NACLIM aims at investigating and quantifying the predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature (SST) and sea ice variability and change on seasonal to decadal time scales. SST and sea-ice forcing have a crucial impact on weather and climate in Europe. Rather than running climate forecasts ourselves, we will analyze the multi-model decadal prediction experiments currently performed as part of the fifth Coupled Model Intercomparison Project (CMIP5) and critically assess the quality of predictions of the near-future state of key oceanic and atmospheric quantities relevant to the SST and sea-ice distribution and the related climate. Long-term observations of relevant ocean parameters will be carried out, necessary to assess the forecast skill of the model-based prediction results. We will identify those observations that are keys to the quality of the prediction and in turn optimize the present observing system. We will quantify the impact of North Atlantic/European climate change on high trophic levels of the oceanic ecosystem as well as on urban societies. NACLIM is a follow-up of the EU FP7 funded project THOR: "Thermohaline Overturning – at Risk?". The project addressed the call on Stability of the ThermoHaline Circulation/THC of the EU FP7 programme.
- **SPECS (funded by EU FP7, 2012 - 2017): Seasonal-to-decadal climate Prediction for the improvement of European Climate Services. SPECS** undertakes research and dissemination activities to deliver a new generation of European climate forecast systems, with improved forecast quality and efficient regionalisation tools to produce reliable, local climate information over land at seasonal-to-decadal time scales, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders. The improved understanding and seamless predictions will offer better estimates of the future frequency of high-impact, extreme climatic events and of the prediction uncertainty. New services to convey climate information and its quality will be used. SPECS will be, among other things, the glue to coalesce the outcome of previous research efforts that hardly took climate prediction into account. It will ensure interoperability so as to easily incorporate their application in an operational context, provide the basis for improving the capacity of European policy making, industry and society to adapt to near-future climate variations. Through SPECS, the development of GCFS1.0 is closely tied to the European activities.
- **SPICES (funded by EU H2020, 2015 - 2018): Space-borne observations for detecting and forecasting sea ice cover extremes.** Automatic remote sensing products traditionally provide general information of sea ice conditions, like extent and concentration. However, for tactical navigation, management of offshore activities, and initialization of forecasting models, parameters like sea ice thickness distributions, the fraction of multi-year, ice or anomalies in the timing of freezing and melting are urgently needed. The main objective of SPICES is to develop new methods to retrieve sea ice parameters from existing (and imminent) satellite sensors to provide enhanced products for polar operators and prediction systems, specifically addressing extreme and unexpected conditions.

- **MONRACH-A (funded by EU FP7, 2010 - 2014): Monitoring and Assessing Regional Climate change in High latitudes and the Arctic.** The project occupies an extremely important niche in the current structure of Earth observations projects at high latitudes.Adopting an Earth system approach the MONARCH-A project executes systematic provision of tailored information and products to assist climate change research. MONARCH-A generates and make available reliable, up-to-date scientific input for the elaboration and implementation of European and international policies and strategies on climate change and society. The MONARCH-A information package is based on generation of time series of observation datasets and reanalyses of past observational data enabling adequate descriptions of the status and evolution of the high latitude and Arctic region Earth system components.
- **RACE I and II (funded by BMBF Germany, 2012 – 2018): Regional Atlantic Circulation and Global Change**. The joint initiative RACE investigates the regional Atlantic circulation and global change. Changes of the future Atlantic circulation over the next 10 to 100 years are one of the foci. Results will help to quantify repercussions on the global ocean, the climate system and the European shelf area, including humans. Investigations include an improved process understanding which will enhance knowledge about the adaptation possibilities of a future ocean circulation. Hence, simulating regional processes may be improved.
- **SPP 1889 (funded by DFG large-scale priority programme, Germany, 2016 - 2022): Regional Sea Level Change and Society (SeaLevel)** within the SPP programme. SPP 1889 is proposed to advance the understanding of regional climate-related coastal sea level change and its interactions with socio-economic developments. Work focuses on two study regions, notably the North and Baltic Seas with potential impacts on Germany and the South-East Asia region encompassing several coastal mega cities and delta regions. The selected regions contrast developed and developing countries and thus differ fundamentally in their regional societal impact of and adaptation potential to sea level change. Developing successful strategies to cope with sea level change in these two regions largely depends on advancing our understanding of processes influencing regional sea level, on available scientific information on sea level change at the coastlines and their uncertainty, on available resources and economic power, and on adequate planning and effective local governance structures.
- **FOR1740 (funded by DFG Research Unit 1740, Germany, starting from 2013)**: Atlantic Freshwater Cycle. The overarching theme of the research unit's work is the analysis and understanding of the freshwater budget of the ocean, including the role, which surface freshwater fluxes (net evaporation minus precipitation plus run-off and sea ice melting) play in changing the salt content in the upper ocean. Hereby, the research unit focuses on the Atlantic Ocean, one of the key climate relevant regions. Specifically, the questions are addressed of how and how much the upper Atlantic Ocean contributes to the global hydrological cycle. These questions are of fundamental and long-standing scientific concern. Moreover the subject 'water' is central to many questions dealt with under climate impact studies, including precipitation over land, the availability of water for drinking and irrigation, but also sea level rise. The research topic is therefore essential for many climate-related and socio-economic questions.

Relevant significant infrastructure and/or technical equipment

- **CliSAP:** Universität Hamburg's Cluster of Excellence "Integrated Climate System Analysis and Prediction" (CliSAP) is a vital alliance among natural sciences and humanities, the cluster is funded by the German Research Foundation (DFG). Major CliSAP contributors are the Max Planck Institute for Meteorology (MPI-M), the Helmholtz-Zentrum Geesthacht (Centre for Materials and Coastal Research, HZG), and the German Climate Computing Center (DKRZ). CliSAP is aiming to cross academic boundaries and bringing academic disciplines together to answer questions in the context of climate and societal changes. The scientists from key research areas of meteorology, oceanography, geophysics, and ecology are working in unison with social scientists, economists, media experts, and peace researchers. The

cluster's primary focus is on climate variability and predictability; in particular, regional variations and the interaction between climatic change, economic, and social factors.

- **DKRZ:** the German Climate Computing Center (DKRZ), provides the facilities of supercomputer that is capable of addressing the complexity of world climate and the endless change in both its individual components and their manifold interaction with high performance computing platforms, sophisticated and high capacity data management, and superior service for premium climate science.
- **ICDC Data Center:** The CliSAP-Integrated Climate Data Center (ICDC) allows easy access to climate relevant data from in-situ measurements and satellite remote sensing. These data are important to determine the status and the changes in the climate system. Additionally some relevant re-analysis data are included, which are modeled on the basis of observational data.
- **Research vessel control station:** the control station of the German research vessels (METEOR and MARIA S. MERIAN and Sonne) is located at CEN/IfM. The control station organizes the scientific-technical, logistic and financial operations of the research vessels (RV), they work closely with the expedition coordinators and are partners with the contract ocean carrier.
- **Wind Tunnel Laboratory:** the boundary layer wind tunnels located at CEN/Meteorological Institute are specially designed for physical experiments. Here, researchers use models of streets, industrial plants or entire cities to investigate wind flows close to the ground, turbulences, and the spread of emissions.

Partner 34 University of Bergen (UIB)

The University of Bergen (UiB) is a young, modern university with about 14,000 students and 3,400 faculty and staff, making it a medium sized European University. The University is engaged in the European Union's Framework programmes for research and technological development and has been designated as a European Research Infrastructure and a Research Training Site in several scientific fields. Since 1997 more than 500 European researchers (professors, senior researchers, post docs and PhD candidates) have visited Bergen on EU grants, making Bergen one of the most international universities, setting out to attract both established and junior scientists to contribute to research teams and work in multidisciplinary research groups. UiB has completed more than 150 EU research projects, about 20% of them as coordinator. UiB is currently involved in 29 H2020 collaborative research projects, 8 of which it coordinates. UiB currently hosts 5 Marie Curie projects, 7 ERC Advanced Grants, 2 ERC Starting Grants, 2 ERC Consolidator Grants and 1 ERC Synergy Grant.

The Geophysical Institute (GFI) has attracted most EU funding of all institutes at UiB. GFI has completed a series of collaborative EU projects, many of them as coordinator, among others TRACTOR, PACLIVA, CYCLOPS, CARBOOCEAN, CARBOCHANGE. GFI currently coordinates the collaborative EU projects PREFACE and SEAMAN, the Marie Curie projects COCLIMAT, STEPS, HIMWARC, and SOCCLI, and one ERC consolidator grant (STERCP). GFI is currently partner in 11 collaborative EU projects. The Geophysical Institute at the University of Bergen is the largest such institute in Norway (and likely in the Nordic countries) in physical oceanography, and by hosting the collaborative Bjerknes Centre for Climate Research it is equally a leading contributor to international climate research. GFI has in its strategic plan to continue to lead in both observational and modeling oriented studies of oceans and climate, including climate prediction. The institute provides an excellent environment for the proposed project in terms of a competent staff and student body, and provides access to key research infrastructure (give examples for key staff and infrastructure essential for your proposal).

In this project, UIB will beactively involved in:

- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Daniela Matei/MPI, Co-lead: Noel Keenlyside/UiB)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP7 Management (Lead: Steffen M. Olsen /DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Noel Keenlyside (male) is a Professor at GFI, with extensive experience in climate variability, modeling, and prediction, and a particular focus on seasonal-to-decadal prediction in the North Atlantic Sector. He has authored and co-authored 70 peer review publications, including in the high-ranking Nature and PNAS journals, that have been cited a total of 3317 times (ISI Web of Knowledge). He holds an ERC Consolidator grant and currently coordinates several national and international projects, including EU-PREFACE, on climate prediction and the development of the Norwegian Climate Prediction Model (NorCPM). He currently supervises 6 postdoctoral researchers and 4 PhD students. He is internationally recognized for his contributions, serving on the CLIVAR Climate Dynamics and CLIVAR Atlantic Region panels.

Prof. Tor Eldevik (male) is the Deputy Director of the Bjerknes Centre. He is originally trained as an applied mathematician, but has been dedicated to climate research since 2001. His research focus is on the northern seas' role in past, present, and future climate variability and change, including predictability. Eldevik does research using a combination of theory, observations, and numerical models. The combination is also Eldevik's approach to supervising students, his involvement in research projects, and in communicating his research and other aspects of climate change to the public. Eldevik is an experienced research leader and has lead or participated in numerous national and international research projects, and lead research groups at the Bjerknes Centre since 2006. The latter includes strategic planning and the active coordination of research, resources, and personnel across disciplines and legal partners.

Dr. Marius Årthun (male) is a postdoctoral research scientist at UiB. Årthun's main interest is the basin-scale ocean circulation and air-sea interaction within the northern North Atlantic and Nordic Seas, and whether associated climate and sea ice variations are predictable on interannual-to-decadal time scales. Årthun has experience in analyzing both observational data sets and output from numerical models, as well as designing and performing more idealized model simulations for dedicated process studies. Currently, Årthun's research focuses on identifying the mechanisms and timescales involved in the poleward propagation of ocean heat anomalies and to what extent these anomalies imprint onto the atmosphere.

Dr. Francois Counillon (male) has a dual researcher position at UiB and NERSC. His main interest is in applying promising theoretical methods from data assimilation and modelling to enhance climate prediction. He has authored and co-authored 23 peer review publications. He leads the data assimilation and prediction group at NERSC, and is involved in the development of NorCPM and the TOPAZ system, which is the core marine system for the Arctic region in Copernicus (http://www.copernicus.eu), contributing to the Global Ocean Data Assimilation Experiment (GODAE).

Relevant publications, products, service and/or other achievements

- **Årthun, M.** and **T. Eldevik**, 2015: On anomalous ocean heat transport toward the Arctic and associated climate predictability. *J. Climate*. doi:10.1175/JCLI-D-15-0448.1, in press.
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- **Keenlyside, N. S.,** J. Ba, J. Mecking, N.-O. Omrani, M. Latif, R. Zhang, and R. Msadek, 2015: North Atlantic multi-decadal variability - mechanisms and predictability. *Climate Change: Multidecadal and*

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Relevant Projects

- **NordForsk GREENICE** (2014.02-2017.01), investigate the Arctic sea ice impact on weather and climate over northern hemisphere by multi-model experiments. UIB/Keenlyside is coordinator
- **NordForsk ARCPATH (**2016.03-2021.02), a Nordic Centre of Excellence, combines improved global and regional climate predictions with interdisciplinary understanding of environmental, societal, and economic interactions in order to aid sustainable development in the Arctic. UiB is partner
- **EU FP7 NACLIM** (2012-2017) www.naclim.eu supported by **FP7 of the European Commission**, investigate predictability of the climate in the North Atlantic/European sector related to North Atlantic/Arctic sea surface temperature and sea ice variability and change. UiB is partner
- **NFR EPOCASA** (2014.01-2017.12), supported by the **Research Council of Norway**, investigate how to enhance seasonal-to-decadal prediction of climate for the North Atlantic sector and Arctic. UIB/Keenlyside coordinator
- **NFR NORTH** (2014.01-2017.12), supported by the *Research Council of Norway*, investigate the northern constraints on the Atlantic thermohaline circulation. UIB/Eldevik coordinator

Relevant significant infrastructure and/or technical equipment

UIB is a main user of the governmental Norwegian High Performance Computing facilities (sigma2.no); Prof. Keenlyside is part of its "Resource Allocation Committee". UIB/GFI hosts the Bjerknes Centre for Climate Research.

Partner 35 Uni Research (UNIRES)

Uni Research AS https://uni.no/en is a non-profit research company in which the University of Bergen owns 85% of the shares.
Uni Research Climate is the climate research division of Uni Research. Uni Research Climate has particular strengths in understanding climate dynamics across multiple spatial and temporal scales, dynamical modelling of the climate system and understanding past-future climate variability and change. Uni Research Climate has extensive experience coordinating and leading large national and international projects (it is for example the coordinator of the European Research Council – funded project nr.610055, Ice2Ice). Uni Research Climate is also one of four partners in the Bjerknes Centre for Climate Research (BCCR). The BCCR is the largest climate research centre in the Nordic countries with a focus on the natural science aspects of climate change and established expertise in complex research projects (e.g. BCCR Centre of Excellence; EVA, The National Norwegian Earth System Modelling project). Uni Research Climate has a leading role in Norway for the use and further development of the Norwegian Earth System Model (NorESM), with expertise in global climate, atmosphere and ocean modelling, decadal prediction, regional downscaling and climate dynamics. Uni Research Climate plays an instrumental role in delivering future

Earth system model projections to the last CMIP5 project. Uni Research has access to the Norwegian national infrastructure of super-computing and long-term storage facilities (NOTUR and NorStore).
Uni Research Rokkan Centre is an interdisciplinary social science research centre, covering a broad range of social and cultural studies. The centre is the social science division of Uni Research. The centre employs approximately 60 researchers, conducting research on themes such as: democracy and politics, welfare and health care, health economics, management and organisational studies, culture, and technology and labour studies. In recent years, energy and climate has become an increasingly important part of the Centre's research portfolio.
In this project UNIRES will be actively involved in

- WP1 Improving seasonal long range forecast skill of risks for hazardous weather and climate events (Lead: Johanna Baehr/UHAM, Co-lead: Jens H. Christensen/DMI)
- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP3 Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/CNRS)
- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr Erik W. Kolstad (male) is a researcher at Uni Research Climate. After obtaining his PhD on extreme weather in the Arctic in 2007, he was PI of one of the work packages in the Norwegian IPY-THORPEX project in 2007–2010, where he studied the links between synoptic-scale weather and polar lows and cold air outbreaks. In 2010 he was head of the research group for global and regional climate projections at Uni Research Climate, before he started working for the R&D department of the commercial weather company StormGeo. This pause from academia led to a gap in his peer-reviewed publication record, but in August 2014 he returned to Uni Research Climate, and since then he has already published two papers and submitted three. He now leads a 3-year research project (Hordaklim), where the aim is to provide relevant future climate projections for local municipalities in Norway. He also serves as associate editor of the *Quarterly Journal of the Meteorological Society*.
Svein Østerhus (male) is a physical oceanographer with long standing experience in fieldwork, instrument development, data analysis and interpretation. He is author of more than 60 peer-reviewed articles. He has been involved in many international projects covering the southern and northern high latitudes, notably in the Nordic WOCE-programme, and several EU funded RTD projects. He has coordinated European (e.g. MOEN) and national (e.g. POCAHONTAS) funded projects and served as PI and co-coordinator in several other projects (e.g. Nordic WOCE, IPY-BIAC, EuroSITES, THOR, NACLIM). He is member of The Norwegian Scientific Academy for Polar Research, ICES WGOH (since 1986), the international science steering group for ASOF, the COST action project EGO Management Committee (MC), and has served as member of CLIVAR Atlantic sector Implementation Panel and the OceanSITES steering committee.
Dr. Odd Helge Otterå (male) is a research leader at the Climate Dynamics group at Uni Research Climate and is leading the research group on climate model development at the Bjerknes Centre in Bergen. Otterå has more than 10 years experience in working with analysis of climate model simulations. He is/has participated in several national (NFR BlueArc, NFR EVA) and international (EU Past4Future, EU ENSEMBLES, EU THOR). Otterå´s main interests lie in understanding the natural variability of the climate system on decadal to multidecadal time scales, both in terms of its internal variability and the responses to various external forcings. As part of this activity he is currently leading an internal project at the Bjerknes Centre in Bergen aimed at improving our understanding of possible mechanisms for multidecadal variability in the climate system through an integrated use of climate model simulations and observational based data for

the last millennium. Otterå also has a strong interest in air-sea interactions with special focus on how climate in different regions (Arctic, Atlantic and Pacific Oceans) interact through various teleconnections.

Dr. Ingo Bethke (male) is a research scientist at Uni Research Climate. Bethke has expertise in coupled climate modelling with a focus on high latitude processes and dynamics. His research interests are atmosphere-ocean-ice interaction, paleoclimate modelling and seasonal-to-decadal climate prediction using advanced data assimilation. He has long-term technical experience from the development of the Bergen Climate Model and the Norwegian Earth System Model, as well as from model data preparation for the Coupled Model Intercomparison Projects CMIP2+3+5 and the upcoming CMIP6. He is currently participating in ongoing national projects on Earth System model development (NFR EVA) and decadal prediction (NFR EPOCASA).

Dr. Simon Neby (male) is political scientist, with a PhD in administration and organization theory. His research experience and interests revolve around governance and organizational change of public sector organizations and systems, with a particular focus on multi-level complexity issues and the interface between politics, organization and implementation of policy. He has ample experience with different types of research projects, from small-scale case studies to the coordination of larger comparative, international projects. He has published articles about governance, organization and reform in journals such as *Public Policy and Administration, International Journal of Public Administration, International Review of Administrative Sciences,* and *Scandinavian Journal of Public Administration* among others. He heads the Norwegian network for organizational research (NEON) and is an associate editor of the journal *Nordiske Organisasjonsstudier.*

Dr. Ole Andreas Brekke (male) is a senior researcher and research manager of the research group Culture, power and meaning at the Uni Research Rokkan Centre. He has long been engaged in research on the interface between science and society. He did his PhD on democratic governance of new technology, studying the evolution of technology assessment as an intermediary institution between politics, science and the public. He has also done much work on the ethics and politics of biomedicine. In later years, he has been engaged in developing social scientific energy and climate research as a research field at the Rokkan Centre. He has been involved in two major research projects on renewable energy politics, «Governance of Renewable Energy Production- GOVREP» (2009-12) and «Sustainable Grid Development – SusGrid.» (2011-2014), financed by the Norwegian Research Council. His latest publication in this field is «Towards a Sustainable Grid Development Regime? A comparison of British, Norwegian and Swedish grid development", published in *Energy Research and Social Science* earlier this year. Brekke is well versed in different research methods and has a long experience in conducting and managing research projects.

Relevant publications, products, service and/or other achievements

- E. W. Kolstad, A global climatology of favourable conditions for polar lows. *Q. J. R. Meteorol. Soc.* **137**, 1749–1761 (2011).
- E. W. Kolstad, A new climatology of favourable conditions for reverse-shear polar lows. *Tellus*. **58A**, 344–354 (2006).
- E. W. Kolstad, A QuikSCAT climatology of ocean surface winds in the Nordic seas: Identification of features and comparison with the NCEP/NCAR reanalysis. *J. Geophys. Res. Atmos.* **113** (2008).
- E. W. Kolstad, Extreme small-scale wind episodes over the Barents Sea: When, where and why? *Clim. Dyn.* **45**, 2137–2150 (2015).
- E. W. Kolstad, T. J. Bracegirdle, Marine cold-air outbreaks in the future: an assessment of IPCC AR4 model results for the Northern Hemisphere. *Clim. Dyn.* **30**, 871–885 (2008).
- E. W. Kolstad, T. J. Bracegirdle, I. A. Seierstad, Marine cold-air outbreaks in the North Atlantic: temporal distribution and associations with large-scale atmospheric circulation. *Clim. Dyn.* **33**, 187–197 (2009).
- E. W. Kolstad, T. Breiteig, A. A. Scaife, The association between stratospheric weak polar vortex events and cold air outbreaks in the Northern Hemisphere. *Q. J. R. Meteorol. Soc.* **136**, 886–893 (2010).

- E. W. Kolstad, A. J. Charlton-Perez, Observed and simulated precursors of stratospheric polar vortex anomalies in the Northern Hemisphere. *Clim. Dyn.* **37**, 1443–1456 (2011).
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- Antuña-Marrero J. C., **Otterå O.H.**, Robock A., Mesquita M. (2015): Modelled and observed sea surface temperature trends for the Caribbean and Antilles, *Int. Jour. Clim.*, DOI: 10.1002/joc.4466.
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Relevant Projects

- **HordaKlim** (2015.01-2017.12), supported by the **Research Council of Norway:** Climate service for municipalities in Hordaland county in western Norway. Uni Research is project owner and Erik Kolstad is project manager.
- **R3** (2016.04-2019.03), supported by the **Research Council of Norway:** Relevant, reliable and robust local-scale climate projections for Norway. Uni Research is project owner and Erik Kolstad is WP leader.
- **IPY-THORPEX** (2008.01-2011.12), supported by the **Research Council of Norway:** One of the large IPY national flagship projects. Erik Kolstad was WP leader.
- **BlueArc** (2011.01-2014.12), supported by the **Research Council of Norway:** Investigated the climate response to the Blue-Arctic (autumn Arctic sea ice fully disappear). Uni Research is WP leader.
- **EPOCASA** (2014.01-2017.12), supported by the **Research Council of Norway**: Investigates how to enhance seasonal-to-decadal prediction of climate for the North Atlantic sector and Arctic.
- **EVA** (2014.01-2017.12) supported by the **Research Council of Norway**: The large national project for developing the next generation of the Norwegian Earth System Model (NorESM).

Partner 36 University of Southampton (UoS)

The University of Southampton (UoS) is one of the leading universities in the United Kingdom, was founded in 1952 and is a member of prestigious Russell Group of UK Universities. UoS has more than 19,000 undergraduate students and 4,000 postgraduates and is an excellent venue for conducting cutting-edge research and for providing high quality education. The university is truly international, drawing students from over 130 different countries and benefiting from a wide and varied culture. It is ranked in the top 1% of universities worldwide (QS world university rankings 2015-16) and in the top 15 research led universities in the UK (REF 2014), and is participating in a high number of collaborative research projects and related initiatives. UoS has a successful track record of industrial collaborations and is at the centre of a cluster of local high technology companies. It has an enviable track record in the generation of patentable work, with a portfolio of over 350 patents. To ensure the impact of its research projects, University of Southampton's Research & Innovation Services (R&IS) is responsible for professional protection of IP and supporting commercial development with industry. R&IS has had considerable success, licensing annual revenue in excess of €1million and launching 12 successful spin-out companies since 2000.

UoS has also a strong track record of working in European projects, especially within the Framework Programme. The EC 7th FP7 Monitoring Report ranked UoS 15th out of all higher and secondary education organisations for number of FP7 participations during 2007-2012. Throughout the FP7 UoS has received €132M in research grants and has been involved in 319 projects, including (delete as applicable: 17 HEALTH- 63 ICT - 8 INFRASTRUCTURES - 10 NMP - 7 ENERGY – 12 ENVIRONMENT - 17 AAT- 11 SST - 6 KBBE - 5 SSH – 5 SPACE - 4 SEC) Collaborative Projects. In 2013/14 alone UoS has received over €230M in research grants and contracts, including over €22M from the European Commission.

FNES

The Faculty of Natural and Environmental Science (FNES) is one of the largest and most successful natural and environmental science faculties in the UK, educating a range of professionals and generating research of the highest quality. The Faculty spans a wide range of disciplines including geochemistry, pharmacology, catalysis, electrochemistry, ocean dynamics, paleoceanography, paleoclimatology, ecology and molecular biology. In the 2014 REF all 3 FNES Academic Units (Biological Sciences, Chemistry and Ocean and Earth Science) have been ranked as among the very best in UK for quality and impact of research. FNES consists of 1,560 undergraduate, 50 taught and 340 research postgraduate students. It has 240 academic and 130 other staff. FNES has a strong background in working on international research projects, including 48 EU FP7 projects worth over €19M. In 2013/14 alone, FNES received over €28.5M in research grants and contracts, of which €2.7M from the European Commission. The Ocean and Earth Science (OES) department in FNES was formed in 1995 by co-locating the University of Southampton Department of Oceanography and Geology in a new facility in Southampton. Located within the National Oceanography Centre, Southampton (NOCS), OES has a strong research-led reputation and includes around 100 staff and 150 post-graduate. In the 2014 Research Assessment Exercise 93% of its research was ranked as 'world leading' or' internationally excellent'.

UoS will be actively involved in:

- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP3 Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/CNRS)
- WP4 Enhancing the capacity of seasonal (interannual) to decadal predictions in the Arctic and over the Northern Hemisphere (Daniela Matei/MPI, Co-lead: Noel Keenlyside/UIB)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Sybren Drijfhout (male) chairs the Physical Oceanography Group in the Ocean and Earth Sciences Department of FNES since January 2013. Before that time he was senior scientist at the Royal Netherlands Meteorological Institute (KNMI). He has supervised 8 PhD students and 6 postdocs. His research has focused on the role of the ocean in climate. He has over 100 publications in international journals; about 50 over the last 10 years. At present he is member of the Netherlands SCOR committee. He has won 7 Netherlands research grants as PI and 6 as Co-I. His international career started with winning a EU-grant on 'Human Capital and Mobility', which brought him to the Max-Planck-Institute in Hamburg. He was work package leader in the EU-program TRACMASS and participated in EU-program THOR. At present, he is work package leader of the work package 'Abrupt Climate Change', in the EU-program EMBRACE. He has taken part in several expert elicitations (Durham University, EEA Copenhagen, IPTS Seville). He is now establishing his own research group at OES. He runs a joint program with the UKMO Hadley centre by performing experiments with HadGEM3 at OES. He still works for 20% at KNMI and for 20% as extraordinary professor at the University of Utrecht.

Relevant publications, products, service and/or other achievements

- **Drijfhout, SS:** Competition between global warming and an abrupt collapse in the AMOC in Earth's energy imbalance**, Nature Scientific Reports,** 5, doi:10.1038/srep14877, 2015.
- **Drijfhout, SS**, Bathiany, S, Beaulieu, C, Brovkin, V, Claussen, M, Huntingford, C, Scheffer, M, Sgubin, G, and Swingedouw, D: Abrupt shifts in the Earth System at moderate warming, **Proc. Nat. Acad. Sci. USA**, doi:10.1073/pnas.1506378112, 2015.
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- Bintanja, R, van Oldenborgh, GJ, **Drijfhout, SS**, Wouters, B and Katsman, CA: Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion, ***Nature Geoscience***, 6, 376-379, 2013.
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Relevant Projects

Sybren Drijfhout is currently involved in:

- **EMBRACE (EU FP7**) Improving climate models and their simulation of abrupt change.
- **SMURPHS** (NERC highligh topic) Explaining hiatus and surge periods in global mean temperature change
- **ODYSEA** (NERC special topic) The role of North Atlantic sea-air coupling in causing extreme events in European midlatitudes.

And was previously involved in THOR Thermohaline circulation at risk (EU FP7).

Relevant significant infrastructure and/or technical equipment

Infrastructure: We will use the UoS/NERC High performance computing facility in Southampton
We will facilitate access to the the JASMIN supercomputing facility of the UK
We make available the HadGEM3 coupled climate model.

Partner 37 University of Washington (UoW)

The University of Washington (UoW), a public university founded in 1861 in Seattle in the state of Washington in the western USA, is now a leading research and teaching university, deemed the 4th most innovative university in the world (1st amongst public universities) by Thomas Reuters. The three campuses educate a total of around 55,000 students (about 40,000 undergraduate; 15,000 graduate). The UW consistently receives more federal research dollars than any other public university in the USA, with grants and contracts for fiscal year 2015 totalling $1.3 billion, mostly via federal research awards. Within the UW, the Applied Physics Laboratory (established in 1943 at the request of the US Navy) is one of only 5 Department of Defense-designated University Affiliated Reseach Centers, forging links between academic and Navy communities. Its approximately 300 staff support a broad research program excelling nationally and internationally in fields including ocean physics and engineering, polar science, acoustic and remote sensing, and environmental and informational systems.
APL-UW researchers in the Polar Science Center and Ocean Physics departments are integrally involved in numerous Arctic research projects, frequently funded by the US National Science Foundation (NSF) and Office of Naval Research (ONR), including key efforts towards the international Arctic Observing Network - in particular, the long-term observatories in the Bering Strait (the Pacific Gateway to the Arctic, PI: Rebecca Woodgate) and the Davis Strait (an Arctic exit into the Atlantic, PI: Craig Lee) are masterminded and run from the APL.
In this project, APL researchers will collabrate with this project via :

- WP2 Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Rebecca Woodgate (female), **Senior Principal Oceanographer (APL), Associate Professor (UW)** is a Principal Investigator in APL's Polar Science Center. With an undergraduate degree in Physics from the University of Cambridge (UK) and a DPhil in Oceanography (modelling) from the University of Oxford (UW), Woodgate currently specializes in *insitu* year-round observations in ice-covered regions, including the Bering Strait and Arctic Ocean, with a focus on understanding high latitude physical processes, their links to local and global climate, and Arctic interdisciplinary connections. As well as obtaining peer-reviewed funding for her research programs, she teaches undergraduate and graduate classes on "Arctic Change"; is co-chair of UW's new Arctic Studies Minor (an interdisciplinary academic program combining natural and social sciences to address issues facing the Arctic today); board member of UW's Future of Ice Initiative; and is on the steering committee of the international Arctic Sub-Arctic Ocean Fluxes Program. For over a decade she has led the international Bering Strait program (http://psc.apl.washington.edu/BeringStrait.html), acquiring funding from various US federal sources to maintain year-round measurements in the strait. These data quantify the changing properties of the oceanic fluxes from the Pacific into the Arctic, and her peer-reviewed publications address issues including local and Arctic impacts on water properties, sea-ice, communities, and global climate implications.

Dr. Craig Lee (male), Senior Principal Oceanographer (APL), Associate Professor (UW) Dr. Lee is a physical oceanographer specializing in observations and instrument development. His primary scientific interests include: (1) upper ocean dynamics, especially mesoscale and submesocale fronts and eddies, (2) interactions between biology, biogeochemistry and ocean physics and (3) high-latitude oceanography. With Dr. Jason Gobat, Lee founded and leads a team of scientists and technologists that pursues a wide range of oceanographic field programs, including intensive studies of the Kuroshio Current, coupled physical–biogeochemical studies such as the recent patch-scale investigation of the North Atlantic spring phytoplankton bloom, the marginal ice zone dynamics in the Beaufort Sea and studies aimed at quantifying and understanding Arctic change. An important component of this work involves identifying advances that could be achieved through novel measurements and developing new instruments to meet these needs. The team's accomplishments include autonomous gliders capable of extended operation in ice-covered waters, high-performance towed vehicles and light-weight, inexpensive mooring technologies. The team also pursues K-12 educational outreach and routinely employs undergraduate research assistants. Within the community, Lee provides leadership through service on the science steering committees for several large research programs and by serving on and chairing advisory panels for U.S. Arctic efforts. This includes chairing the Observing Panel for the US Study of Environmental Arctic Change, sitting on the University National Oceanographic Laboratories Council (which oversees the US oceanographic research fleet), serving as a long-standing member of the Arctic-Subarctic Ocean Flux Program steering group, and serving as chief scientist for the recent Office of Naval Research Marginal Ice Zone Program and as a member of the National Aeronautics and Space Administration Export Processes in the Ocean from Remote Sensing Science Definition Team. Lee supports and advises masters and doctoral students and teaches undergraduate and graduate level courses on observations of ocean circulation and instruments, methods and experimental design.

Relevant publications, products, service and/or other achievements

- Woodgate, R.A., K.M.Stafford, and F.G.Prahl, 2015, A Synthesis of Year-round Interdisciplinary Mooring Measurements in the Bering Strait 1 (1990-2014) and the RUSALCA years (2004-2011), Oceanography 28(3):46-67.
- Peralta-Ferriz and Woodgate, 2015, Seasonal and inter-annual variability of pan-Arctic surface mixed layer properties from 1979 to 2012 from hydrographic data, in press, Progress in Oceanography, 134, doi: 10.1016/j.pocean.2014.12.005
- Haine, T.W.N., B.Curry, R.Gerdes, E.Hansen, M.Karcher,C.Lee B.Rudels, G.Spreen, L. de Steur, K.D.Stewart, R.Woodgate, 2015, Arctic Freshwater Export: Status, Mechanisms, and Prospects, *Global & Planetary Change*, *125*(0), 13-35, doi: 10.1016/j.gloplacha.2014.11.013
- Danielson, S.L., T.J.Weingartner, K.S.Hedstrom, K.Aagaard, R.Woodgate, E.Curchitser, P.J.Stabeno, 2014, Coupled wind-forced controls of the Bering–Chukchi shelf circulation and the Bering Strait through-flow: Ekman transport, continental shelf waves, and variations of the Pacific–Arctic sea surface height gradient. Prog. Oceanogr. , http://dx.doi.org/10.1016/j.pocean.2014.04.006
- Woodgate, R.A, 2013, Arctic Ocean Circulation - going around at the Top of the World, invited paper for Nature Education Knowledge Project, 4(8):8.
- Hunt, G.L.Jr., A.L.Blanchard, P.Boveng, P.Dalpadado, K.Drinkwater, L.Eisner, R.Hopcroft, K.M.Kovacs, B.L.Norcross, P.Renaud, M.Reigstad, M.Renner, H-R.Skjoldal, A.Whitehouse, R.A.Woodgate, 2013, The Barents and Chukchi Seas: Comparison of two Arctic shelf ecosystems, J.Mar. Sys., 109-110, 43-68, doi: 10.1016/jmarsys.2012.08.003.
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- Alkire, M. B., C.M. Lee, E.D'Asaro, M.Jane Perry, N.Briggs, I.Cetini, and A.Gray (2014), Net community production and export from Seaglider measurements in the North Atlantic after the spring bloom, J. Geophys. Res. Oceans, 119, doi:10.1002/2014JC010105.
- Curry, B., C.M. Lee, B. Petrie, R. Moritz, and R. Kwok (2013). Multi-year volume, liquid freshwater, and sea ice transports through Davis Strait, 2004-2010. J. Phys. Oceanogr. doi:10.1175/JPO-D-13-0177.1.
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- Lee, C. M., E. Kunze, T. B. Sanford, J. D. Nash, M. A. Merrifield and P. E. Holloway, 2005: Internal Tides and Turbulence Along the 3000-m Isobath of the Hawaiian Ridge with Model Comparisons. Journal of Physical Oceanography, 36(6), 1165-1183.

Relevant Projects

- **A Bering Strait Ocean Observing System for the Pacific Inflow to the Arctic – a fundamental part of the Arctic Observing Network (2013.08 - 2018.07), Funded by the US National Science Foundation. Lead PI:** ***Rebecca Woodgate (UW). Co-PIs: Patrick Heimbach, An T. Nguyen (both University of Austin, Texas).*** This project supports year-round mooring observations in the Bering Strait region from summer 2014 to summer 2018; and combination of observations, modelling and native knowledge to study oceanic fluxes from the Pacific to the Arctic over this period, and back in time to at least 1990.
- **The Arctic Observing Network at Critical Gateways--A Sustained Observing System at Davis Strait**, Sep 2010 – August 2015, US National Science Foundation. Craig Lee, Jason Gobat, Kathleen Stafford and Richard Moritz. This project continues operation of the Davis Strait observing system, which uses moored instrumentation, long-endurance autonomous gliders designed for operation under full ice

cover, and chemical measurements to investigate exchange between the Arctic and the subpolar North Atlantic.

- **Long-term Observations in the Switchyard Region of the Arctic Ocean as part of the Arctic Observing Network**. Sep 2010 – August 2015, US National Science Foundation. Craig Lee, Michael Steele, Jason Gobat. This project employs aircraft-based hydrography and moorings to investigate (1) water mass characteristics and their effect on stratification, diapycnal heat fluxes, and transport of heat and salt; (2) freshwater inventories (including that stored in form of sea ice); (3) freshwater release to the North Atlantic Ocean; (4) heat budget of the upper water layers and its interplay with the sea ice cover; (5) sea ice circulation and thickness distribution; and (6) future circulation patterns in the Lincoln Sea, north of Nares Strait and the Canadian Arctic Archipelago.
- **Evolution of the Marginal Ice Zone: Adaptive Sampling with Autonomous Gliders**, Nov 2012 – Nov 2016, US Office of Naval Research. Craig Lee, Luc Rainville and Jason Gobat. This project focuses on the dynamics of the marginal ice zone of the Beaufort Sea, and how the processes change with changes in ice cover and open water extent to the south.

Relevant significant infrastructure and/or technical equipment

Through NSF funding, Woodgate maintains moorings year-round in the Bering Strait, measuring temperature, salinity and water velocity, ice thickness and motion, hourly or more frequently, as part of the Arctic Observing Network. These data are freely available, and the moorings may also be used as a platform for other studies (including currently marine mammal recorders and ocean acidification sensors).

Partner 38 The University of Reading (UREAD)

The **University of Reading** (UREAD) is a research intensive university with a substantial reputation for research excellence. Most recent results of the UK-wide Research Excellence Framework exercise (REF) conducted in 2014 to assess research quality, revealed 98% of University of Reading research is internationally recognised, and 78% of our research is classed as internationally excellent. 27% of our research is world leading. It is ranked as one of the top 19th research universities in the UK by research intensity (a measure of quality adjusted by the proportion of researchers submitted).
Over the last year, we have been awarded over £30 million in external research grant income, of which 63% is from Research The University of Reading (UREAD) is a research intensive university with a substantial reputation for research excellence. Most recent results of the UK-wide Research Excellence Framework exercise (REF) conducted in 2014 to assess research quality, revealed 98% of University of Reading research is internationally recognised, and 78% of our research is classed as internationally excellent. 27% of our research is world leading. It is ranked as one of the top 19th research universities in the UK by research intensity (a measure of quality adjusted by the proportion of researchers submitted).
Over the last year, we have been awarded over £30 million in external research grant income, of which 63% is from Research Councils. Our total research income over the last year has been over £50 million.
UREAD participated in over 130 FP7 and H2020 projects to date and received over €50M in research grants from the European Commission.

The **School of Mathematical and Physical Sciences** is home to the Department of Mathematics and Statistics, the Department of Meteorology and to much joint activity among these entities. It is one of the largest Schools at Reading and one of the largest and most successful Schools of its kind in the UK. The School has approximately 300 staff, including approximately 82 academic staff, 38 senior research staff (up to professorial level), and 84 other research staff. 85% of our research was rated internationally recognised, internationally excellent, or world class in the most recent (2008) Research Assessment Exercise.
The school hosts the NERC National Centre for Earth Observation, and the NERC National Centre for Atmospheric Science (NCAS Climate and NCAS Models and Data). The school leads the University's Walker

Institute for Climate System Research. Close collaboration exists with the MetOffice and the European Centre for Medium-Range Weather Forecasts (ECMWF), the latter located in Reading as well. Approximately 20 MetOffice scientists work in the school. The school hosts also the Environmental Analytics, a commercial consultancy and training unit, working globally. The university has a long tradition in knowledge transfer to and working with industry including a recently open state of the art dedicated business space.
Teaching activity includes a range of joint courses across the department and in particular two recently awarded highly prestigious Centre for Doctoral Training, "Mathematics of Planet Earth" jointly with the Mathematics department at Imperial college and the Grantham institute funded by EPSRC and ``SCENARIO'' funded by NERC consisting out of 76 PhD-fellowships throughout their life circle, 60 respectively.
The university of Reading and in particular the School of Mathematical and Physical Sciences provide the necessary infrastructure and equipment and a diverse range of highly recognised experts in meteorology and mathematics, the latter in particular with a strong focus on applications to Earth systems; expertise highly relevant for the core endeavour of the project.

In this project, UREAD will be actively involved in:

- WP1: Improving long range forecast skill of risks for hazardous weather and climate events (Lead: Johanna Baehr/UHH)
- WP6 Clustering for blue growth (Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Prof. Dr. Valerio Lucarini (male), Professor of Statistical Mechanics. He is leader of the activities in the area of Mathematics of Planet Earth at UREAD. He has been trained in theoretical physics and climate sciene and his research activities delve with the study of the mathematical and physical properties of the climate system, with a special emphasis on the analysis of extreme events, predictability, and analysis of sensitivity of the climate system to perturbations. He is author of about 100 papers in the geophysical, physical and mathematical literature and of two monographs, one of which (Wiley, 2016) dedicated to the analysis of extremes in complex systems. Former (2010-2015) ERC grantee, he is involved in various EU projects (Horizon 2020 and Climate-KIC) dealing with the analysis of climate response to forcings and with climate risk. He is actively involved in the organization of international training and dissemination events and in the activities of two international graduate schools.

Relevant publications, products, service and/or other achievements

- **V. Lucarini**, D. Faranda, A. Freitas, J. Freitas, M. Holland, T. Kuna, M. Nicol, M. Todd, S. Vaienti, Extremes and Recurrence in Dynamical Systems, Wiley, New York, 2016
- F. Ragone, **V. Lucarini,** F. Lunkeit, A new framework for climate sensitivity and prediction, Clim. Dyn. DOI 10.1007/s00382-015-2657-3 (2015)
- S. Schubert, **V. Lucarini**, Covariant Lyapunov Vectors of a Quasi-geostrophic Baroclinic Model: Analysis of Instabilities and Feedbacks, Q. J. R. Met. Soc. DOI 10.1002/qj.2588 (2015)
- **V. Lucarini**, R. Blender, C. Herbert, S. Pascale, F. Ragone, and J. Wouters, Mathematical and Physical Ideas for Climate Science, Rev. Geophys. DOI: 10.1002/2013RG000446 (2014)
- **V. Lucarini**, D. Faranda, D., T. Kuna, J. Wouters, Towards a General Theory of Extremes for Observables of Chaotic Dynamical Systems, J Stat. Phys. 154, 723 (2014)
- **V. Lucarini** and F. Ragone, Energetics of Climate Models: Net Energy Balance and Meridional Enthalpy Transports, Rev. Geophys. 49, RG101 (2011)

- **V. Lucarini** and S. Sarno, A Statistical Mechanical Approach for the Computation of the Climatic Response to General Forcings, Nonlin. Proc. Geophys. 18, 7 (2011)
- **V. Lucarini** Thermodynamic Efficiency and Entropy Production in the Climate System, Physical Review E, 80, 021118 (2009)

Relevant Projects

- **EU FP7 ERC-StG NAMASTE** (2010-2015) Thermodynamics of the Climate System. Analysis of the thermodynamics and dynamics of climate and of the mechanisms responsible for instabilitis and large scale heat transport. Investigation of climate change via methods of statistical mechanics and study of climate extremes.
- **EU H2020**. **CRESCENDO** (2015-2020) Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach. Lucarini is active in the investigation of the response of climate models to forcings in linking climate response and climate variability. The overarching goal of the project is to improve the process-realism and reliability of European ESMs and to fully evaluate these models against a range of observations.
- **WINnERS** (2015-2017) Weather Index-based Weather Driven Risk Services. **Funded by Climate-KIC**. Lucarini is active is the construction of climate indexes for Africa to be used in statistical models aimed at reconstructing and predicting crop prices and assessing the risk of food scarcity.

Relevant significant infrastructure and/or technical equipment

N/A

Partner 39 Woods Hole Oceanographic Institution (WHOI)

WHOI (www.whoi.edu) is a private, nonprofit research and higher education institution dedicated to the study of all aspects of ocean science and engineering and to the education of marine scientists. Established in 1930, it is the largest independent oceanographic research institution in the U.S., with staff and students numbering about 1,000. The Institution is organized into six departments, four ocean institutes (ocean and climate change, ocean life, coastal ocean, and deep ocean exploration institutes), the Cooperative Institute for Climate and Ocean Research, and a marine policy center. The bulk of the Institution's funding comes from grants and contracts from the National Science Foundation and other government agencies, augmented by foundations and private donations.
For nearly a century, WHOI has been one of the best known and most trusted names in ocean science and exploration. WHOI scientists and engineers have played a part in many of the discoveries that form the modern understanding of the ocean and how it interacts with other parts of the planet, including human society. In particular, WHOI has been at the forefront of advancement in the observational and theoretical understanding of the oceanography and climate of the North Atlantic and Arctic, as exemplified by WHOI's leadership in recent international observational programs in the subpolar North Atlantic (e.g. OSNAP http://www.o-snap.org/) and Arctic (http://www.whoi.edu/science/PO/arcticgroup/).

In this project, WHOI will collabrate with this project in:

- WP2: Lower latitude drivers of Arctic changes (Lead: Karin Margretha Larsen/HAV, Co-lead: Gerard McCarthy/NERC)
- WP3: Linkages of Arctic climate changes to lower latitudes (Yongqi Gao/NERSC, Co-lead: Guillaume Gastineau/LOCEAN)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Dr. Young-Oh Kwon (male) is a scientist in the Physical Oceanography Department at WHOI (http://www.whoi.edu/website/yokwon/). Kwon's research focuses on the dynamics of decadal climate variability and the role of the ocean-atmosphere interaction in the extratropics based on the global climate models and the observations from the last 100 years or so. Kwon has led the various projects to investigate the mechanism of decadal variability of the Atlantic Meridional Overturning Circulation (AMOC) and its impact on North Atlantic weather and climate. Kwon is a member of the international CLIVAR Atlantic Regional Panel (http://www.clivar.org/clivar-panels/atlantic) and a past member of the U.S. AMOC Science Team Executive Committee (http://usclivar.org/amoc).

Dr. Hyodae Seo (male) is a scientist in the Physical Oceanography Department at WHOI (http://hseo.whoi.edu/). Seo is a climate scientist with a specialty in the regional climate modeling, studying a broad range of topics related to climate and climate dynamics including: air-sea interactions; atmospheric boundary layer dynamics; synoptic meteorology; tropical meteorology and physical oceanography; climate dynamics; coupled climate modeling; global and regional climate variability and changes. He is the developer of the Scripps Coupled Ocean-Atmosphere Regional (SCOAR) model (http://hseo.whoi.edu/scoar/), which is one of the first and perhaps the most widely used regional coupled models for climate study. Seo's recent projects include an investigation of the relationship between the Atlantic Multidecadal Oscillation and North Atlantic blocking, as well as a study on the atmospheric boundary layer response to the sea-ice and surface temperature changes in Arctic Ocean.

Relevant publications, products, service and/or other achievements

- Frankignoul, C., G. Gastineau, and **Y.-O. Kwon**, 2015: Wintertime atmospheric response to North Atlantic ocean circulation variability in a climate model. *J. Climate*, 28, 7659-7677, doi: http://dx.doi.org/10.1175/JCLI-D-15-0007.1
- Oltmanns, M., F. Straneo, **H. Seo**, G. W. K. Moore, 2015: The role of wave dynamics and small-scale topography for downslope wind events in southeast Greenland. *J. Atmos. Sci.*, 72, 2786-2805, doi: http://dx.doi.org/10.1175/JAS-D-14-0257.1
- **Kwon, Y.-O.**, and C. Frankignoul, 2014: Mechanisms of Multidecadal Atlantic Meridional Overturning Circulation Variability Diagnosed in Depth versus Density Space. *J. Climate*, **27**, 9359-9376. doi: http://dx.doi.org/10.1175/JCLI-D-14-00228.1.
- Grist, J., S.A. Josey, R. Marsh, **Y.-O. Kwon**, R.J. Bingham, A.T. Blaker, 2014: The Surface-Forced Overturning of the North Atlantic: Estimates from Modern Era Atmospheric Reanalysis Datasets. *J. Climate*, **27**, 3596-3618, doi: http://dx.doi.org/10.1175/JCLI-D-13-00070.1.
- **Seo, H.**, **Y.-O. Kwon**, and J.-J. Park, 2014: On the effect of marginal sea SST variability on the North Pacific atmospheric circulation. *J. Geophys. Res. Atmos.*, **119**, doi: 10.1002/2013JD020523.
- **Seo, H**. and J. Yang, 2013: Dynamical response of the Arctic atmospheric boundary layer process to uncertainties in sea ice concentration. *J. Geophys. Res-Atmospheres*, 118, 12,383-12,402, DOI: 10.1002/2013JD020312.
- Frankignoul, C., G. Gastineau, and **Y.-O. Kwon**, 2013: The influence of the AMOC variability on the atmosphere in CCSM3. *J. Climate*, **26**, 9774-9790, doi: 10.1175/JCLI-D-12-00862.1.
- **Kwon, Y.-O.**, and T.M. Joyce, 2013: Northern Hemisphere Winter Atmospheric Transient Eddy Heat Fluxes and the Gulf Stream and Kuroshio-Oyashio Extension Variability. *J. Climate*, **26**, 9839-9859, doi:10.1175/JCLI-D-12-00647.1.
- Danabasoglu, G., S.G. Yeager, **Y.-O. Kwon**, J.J. Tribbia, A.S. Phillips, and J. Hurrell, 2012: Variability of the Atlantic Meridional Overturning Circulation in CCSM4. *J. Climate*, **25**, 5153-5172, doi:10.1175/JCLI-D-11-00595.1.
- **Kwon, Y.-O.**, and C. Frankignoul, 2012: Stochastically-Driven multi-decadal variability of the Atlantic meridional overturning circulation in CCSM3. *Climate Dyn.*, **38**, 895-876, doi:10.1007/s00382-011-1040-2.

- **Kwon, Y.-O**., C. Deser, and C. Cassou, 2011: Coupled Atmosphere – Mixed Layer Ocean Response to Ocean Heat Flux Convergence along the Kuroshio Current Extension. *Climate Dyn.*, **36**, 2295-2312, doi:10.1007/s00382-010-0764-8.
- **Kwon, Y.-O.**, M.A. Alexander, N.A. Bond, C. Frankignoul, H. Nakamura, B. Qiu, L. Thompson, 2010: Role of Gulf Stream and Kuroshio-Oyashio Systems in Large-Scale Atmosphere-Ocean Interaction: A Review. *J. Climate*, **23**, 3249–3281.
- Joyce, T.M., Y.-O. Kwon, and L. Yu, 2009: On the relationship between synoptic wintertime atmospheric variability and path shifts in the Gulf Stream and Kuroshio Extension. *J. Climate*, **22**, 3177-3192.
- **Seo, H.**, A. J. Miller and J. O. Roads, 2007: The Scripps Coupled Ocean-Atmosphere Regional (SCOAR) model, with applications in the eastern Pacific sector. *J. Climate*, 20, 381-402, DOI: http://dx.doi.org/10.1175/JCLI4016.
- **Kwon, Y.-O.**, and C. Deser, 2007: North Pacific decadal variability in Community Climate System Model Version 2. *J. Climate*, **20**, 2416–2433. Kwon, Y.-O., and S.C. Riser, 2004: North Atlantic Subtropical Mode Water: A history of ocean-atmosphere interaction 1961–2000. *Geophys. Res. Lett.,* **31**, L19307, doi:10.1029/2004GL021116.
- **Kwon, Y.-O.**, and S.C. Riser, 2005: The general circulation of the western subtropical North Atlantic observed using profiling floats. *J. Geophys. Res*., **110** (C10), C10012, doi:10.1029/2005JC002909.

Relevant Projects

- **Compensation Between Poleward Energy Transports in the Ocean and Atmosphere** (2015.8-2018.7), supported by the **U.S. Department of Energy**, WHOI is the lead institution and Young-Oh Kwon is the lead PI. Other participants are Clara Deser (NCAR) and Jian Lu (PNNL).
- **Decadal Variability in the North Atlantic Extra-Tropics: The Role of Coupling Between Atmospheric Blocking and the Atlantic Multidecadal Oscillation** (2014.3-2017.2), supported by the **U.S. National Science Foundation**, WHOI is the lead institution and Young-Oh Kwon and Hyodae Seo are co-PIs. Other participants are Caroline Ummenhofer (WHOI, Project lead-PI) and Terry Joyce (WHOI).
- **A Collaborative Multi-model Study: Understanding AMOC Variability Mechanisms and Their Impacts on Decadal Prediction** (2013.9-2016.8), supported by the **U.S. National Oceanic and Atmospheric Administration**, WHOI is a partner institution and Young-Oh Kwon is the WHOI lead-PI. Other participants are Gokhan Danabasoglue (NCAR, Project lead-PI), Alicia Karspeck (NCAR), Joe Tribbia (NCAR), Steve Yeager (NCAR), Tom Delworth (GFDL), Rym Msadek (GFDL), Anthony Rosati (GFDL), Claude Frankignoul (UPMC/IPSL).
- **Coupling Between the Atmospheric Intra-Seasonal Variability and Ocean Circulation in the Northern Hemisphere** (2013.7-2016.6), supported by the **U.S. National Aeronautics and Space Administration,** WHOI is the lead institution. Young-Oh Kwon is the lead-PI and Hyodae Seo is a co-PI. Other participant is Terry Joyce (WHOI).
- **Collaborative Research EaSM2: Mechanisms, Predictability, Prediction, and Regional and Societal Impacts of Decadal Climate Variability** (2013.3-2018.2), supported by the **U.S. National Science Foundation**, WHOI is a partner institution and Young-Oh Kwon is the WHOI lead-PI. Other participants are Gokhan Danabasoglue (NCAR, Project lead-PI), Jeff Anderson (NCAR), Grant Branstator (NCAR), Keith Lindsay (NCAR), Joe Tribbia (NCAR), Claude Frankignoul (UPMC/IPSL), Minghua Zhang (SUNY Stony Brook)

Relevant significant infrastructure and/or technical equipment

WHOI PIs have access to the NCAR high-performance computing facility (https://www2.cisl.ucar.edu/resources/yellowstone) through their National Science Foundation grants, as well as the WHOI's High Performance Computing Cluster (http://scicomp.whoi.edu) and WHOI's local file

server for the CMIP5 simulations (http://cmip5.whoi.edu).

Partner 40 World Ocean Council (WOC)

The World Ocean Council (WOC) is the international multi-industry business leadership alliance on ocean sustainability, science and stewardship, i.e. Corporate Ocean Responsibility. The WOC is registered in the UK as "WOC – World Ocean Ltd. The WOC brings together industries that use the oceans to catalyze global leadership and collaboration in addressing cross-cutting issues in support of improved business, continued access and reduced risk.

WOC Members include a growing number of companies from: shipping, shipbuilding, offshore oil/gas, marine technology and data management, fishing/seafood, seabed mining, mining, offshore renewable energy, submarine cable, and other companies from these and a range of other sectors.

With the growing use of marine areas by an increasing variety of commercial interests there are increasingly complex risks from environmental impacts and conflicts in the use of marine space and resources. The best efforts by a single company or whole industry sector will not be able to address the cumulative environmental impacts of the growing array of ocean industry operators. *The*

Profile relating to the project: The WOC is developing regional business leadership alliances for sustainable development in high priority geographic areas where there is a need and opportunity for industry to become more engaged in a systematic, cross-sectoral way. The WOC is fostering coordinated industry input to regional policy processes, marine science and observations, marine spatial planning and the development of solutions to operational and technical issues at the regional level.

WOC regional efforts to date have focused mainly on the Arctic, where there has been solid progress in developing the only multi-industry leadership group on responsible use of that rapidly changing region. The WOC developed a close working relationship with the Chair of Arctic Council and was invited to bring a delegation of companies to meet with the Chair. As a result, the WOC was subsequently requested by the Chair of Arctic Council to develop the first-ever "Business Dialogue" with the Arctic Council's Sustainable Development Working Group (SDWG).

In September 2012, WOC convened a workshop on developing the Arctic Business Leadership Council, which attracted over 30 industry participants to begin developing a multi-industry leadership group on responsible Arctic development. The next day, the first-ever "Business Dialogue" with the Arctic Council was co-chaired by the WOC CEO and the Chair of the Arctic Council's SDWG.

The WOC Sustainable Ocean Summit (SOS) in April 2013 (Washington DC) and November 2015 (Singapore) included very good, well-attended Arctic sessions to continue developing the WOC Arctic regional efforts. President Grimsson of Iceland and the other organizers of the Arctic Circle invited the WOC to engage the diverse global business community in the Arctic Circle event and lead the development of the business community aspects of the Arctic Circle event in October 2014 in Iceland. President Grimsson also announced that the Arctic Circle Forum in Singapore in 2015 would be organized in collaboration with the WOC SOS 2015 in Singapore.

Following from, and building on, the WOC's close working relationship with the government of Sweden while it chaired the Arctic Council, the WOC is also in regular contact with the government of Canada regarding their proposal to develop what has become the Arctic Economic Council (AEC). The WOC has subsequently applied to be part of the AEC working groups on Responsible Resource Development and on Arctic Stewardship.

The WOC has begun the development of a circumpolar, multi-industry business network to help lead the way to responsible and sustainable development of Arctic areas/resources. The WOC Arctic efforts in the near term are focused on the priorities identified in the 2012 workshop and 2013 SOS: a) developing circum-polar guidelines for responsible development, b) improving and expanding the role of industry in collecting and sharing ocean, weather and climate data in the region (as a regional project of the WOC

global Smart Ocean/Smart Industries program), and c) working with industry to document projected maritime traffic for the Bering Strait.

The WOC Ceo was an invited plenary speaker at the second convening of the Arctic Business Council (Oslo, June 2015). The WOC and the Arctic Business Council are now working as partners in developing a collaborative organization.

In this project, WOC will collabrate with this project via :

- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Relevant Personnel

Mr Paul Holthus (male)**,** CEO and President: Paul Holthus is the founding President and CEO of the World Ocean Council WOC. Mr Holthus initiated all of the WOC progams, including the WOC Arctic Program, which includes the WOC Arctic Business Leadership Council, which first met in 2012. Through Mr Holthus' efforts, this multi-industry Arctic business group held the first ever "Business Dialogue" with the Arctic Council's Sustainable Development Working Group.
Mr Holthus has previously held senior positions with the United Nations Environment Programme (UNEP) and international environmental organisations, including as Deputy Director for the IUCN Global Marine Programme. Among other things, he originated the "Coral Triangle" concept, a successful large seascape approach to international sustainable ocean development.
Since 1998, Mr Holthus has worked primarily with the private sector to develop practical solutions for the sustainable use of the marine environment. He has worked in over 30 countries with companies, communities, industry associations, UN agencies, international non-governmental organisations and foundations.
Mr Holthus is a frequent speaker at international ocean and industry conferences. He was one of 5 people invited to be a member of the UN Secretary General's Expert Group on Oceans for the 2012 Rio+20 conference, and is on the Advisory Committee of *The Economist* World Ocean Summit.

Ms Christine Valentin (female) Director for Strategy, Membership and Finance. Christine is Director of Strategy, Membership and Finance for the WOC. As such she is leading the WOC efforts to develop and drive strategically focused action to ensure sustainable business value to members, grow the WOC membership and visibility among ocean business community, and guide WOC budget development and financial management.
She has almost 30 years of senior positions (international business development, strategy, CFO) in multicultural contexts in S&P 500 companies and smaller management owned businesses. More specifically since 2002, she has worked in sustainability and environmental consulting, engineering and services firms designing environmentally friendly and climate change adapted solutions. Past positions include: VP International Business Development and Strategy Oranjewoud Group in the Netherlands; Senior VP Finance, HR and Business Development GED Group in France; Assistant VP Sales for Industrial Markets Veolia in France; Key Account Manager Otis Elevators in the USA; Business Strategy Manager Pratt & Whitney in the USA; Chief Financial Officer Waste Management France. Christine has a degree in business from Harvard Business School, as well as degrees in philosophy, literature, political science from the Sorbonne and Sciences Po. She is also the treasurer and a board member of the Professional Women's Network in Paris and a member of the Women's International Shipping & Trading Association (WISTA).

Relevant publications, products, service and/or other achievements

WOC Convening of the Arctic Business Community:

- WOC workshop on Developing an Arctic Business Leadership Council (Reykjavik, September 2012)

- WOC/Arctic Council's Sustainable Development Working Group (SDWG) "Business Dialogue" (Reykjavik, September 2012)
- Arctic Session - WOC Sustainable Ocean Summit (SOS 2013) (Washington DC, April 2013)
- Arctic Session - WOC Sustainable Ocean Summit (SOS 2015) (Singapore, November 2015)

WOC Involvement in Key Arctic Events:
The WOC is involved as a partner, co-organizer and speaker at general Artic events and Arctic Industry events, including:

- Invited speaker at Arctic Observations Summit (Vancouver, April 2013).
- Invited speaker and participant at East West Center Asia-Arctic Conferences (Honolulu, August 2012, 2013, 2014).
- Partner organization for the *Economist* Arctic Summit (2014, 2015).
- Speaker at the Arctic Council's Arctic Biodiversity Congress (Trondheim, December 2015).
- On Advisory Committee of the Arctic Circle Assembly (organized by the President of Iceland).
- Organized much of the business community participation in the Arctic Circle Assembly, and participated in the Arctic Circle Assemblies as session chair, speaker and panelist (Reykjavik, October 2013 and 2014).
- Convened roundtables at Arctic Shipping Forum (Helsinki, March 2014; St John's, October 2015).
- Conference Chair for the Arctic Exchange (Stockholm, September 2014).

Relevant publications, products, service and/or other achievements

- Holthus, P., Clarkin, C., and J Lorentzen. 2013. Emerging Arctic Opportunities: Dramatic increases expected in Arctic shipping, oil and gas exploration, fisheries and tourism. Coast Guard Journal of Safety and Security at Sea 70 (2): 10-13.
- **The Fractured Ocean: Current Challenges to Maritime Policy in the Wider Atlantic.** 2012. John Richardson, Armando Marques Guedes, Xavier de la Gorce, Anne-François de Saint Salvy, and Paul Holthus.
- Holthus, P. 2011. International Ocean Science and Industry Partnership Platform for Ocean Observations. Oceans 2011, Kona, Hawaii.
- Holthus, P. 2009. Marine Spatial Planning In Europe: Drawing The Lines On Access To Resources. Society of Petroleum Engineers. Offshore Europe, 8-11 September 2009, Aberdeen, UK.
- Holthus, P. 2009. Industry leadership in governance and sustainable use of the high seas.
- Océanis 35 (1-2): 271-276. Towards a New Governance of High Seas Biodiversity.

Relevant Projects

- 2013 – present FP7 Framework project OCEAN-CERTAIN
- 2015 – present Horizon 2020 project EU POLARNET

Relevant significant infrastructure and/or technical equipment

The WOC is establishing multi-industry working groups to tackle cross-cutting ocean priorities for industry, e.g. ocean governance/policy, marine spatial planning, marine sound, biofouling/marine invasive species, port reception facilities/marine debris, marine mammal impacts, adaptation of ports and coastal infrastructure to sea level rise/extreme weather events, ocean industry data collection and the Arctic.

Partner 41- Barcelona Institute for Global Health (ISGlobal)

The research unit led by Prof. Xavier Rodó, the "Climate Dynamics and Impacts Unit" (UDIC), set to model climate impacts on health will be transferred to ISGlobal (http://www.isglobal.org/en/) on 1 January 2017 as effective date.
Prof. Xavier Rodó, along with his team, including Dr. Joan Ballester, who is deeply involved in the Blue-Action project will be hired by ISGlobal, since the idea behind the transfer is that the activity of the unit will be fully incorporated into ISGlobal. Along with the staff, ongoing projects and equipment will also be moved to ISGlobal.

UDIC is the research unit set to model climate impacts on health. UDIC mandate is to perform cutting-edge research, education and derive translational science, products and services to help societies face and adapt current and future climate risks. UDIC members have published over 100 articles in international peer-review journals with high visibility between 2008 and 2014 (several articles about climate and human health in high-impact magazines such as Nature: Koelle et al., 2006; Ballester et al. 2011, Science: Pascual et al. 2000, The Lancet: Lowe et al. 2014) and PNAS (Rodó et al., 2002, 2014). UDIC is a leading center in the area of modelling climate-related impacts and diseases.

The most translational part of this accumulated experience has been gained within the framework of two EU-FP7 projects, CLIMRUN and EUPORIAS in which the UDIC centred in the simulation of extreme climate and in developing a health case study. As a result of this later project, Lowe et al. (2015) tested mortality forecasts for both heat and cold wave events derived from reanalysis data. This work took advantage of an unprecedented mortality database that is in exclusive control of UDIC covering the 1998-2010 period, containing more than 51 million deaths. It provides daily numbers of death, population size and birth rate by date, sex, age and region, being available for 168 NUTS2 regions in 16 European countries (Robine et al. 2008, Ballester et al. 2011).

Through the work with this impressive database UDIC is approaching stakeholders at the local, national and international levels and has gained expertise on bridging the gap between scientific knowledge and public health products and translational services. In relation to health and working closely with stakeholders, UDIC is or has participated in several FP7 European projects including VIROCLIME, QWECI (2009), CLIMRUN (2010), DENFREE (2011) and EUPORIAS (2012). UDIC also has been involved in many health related non-FP7 projects, funded either by the Spanish Ministry of Science (such as LEISHTOP-MED and NEW INDIGO), or by private foundations (Marató and DBravo Foundations). Our scientists are currently providers of real-time global seasonal-to-decadal climate predictions within the WMO's sponsored program and act as international leaders, also at the IPCC level. We act as European co-leaders in the development of climate-prediction services for the health sector, and our current activity as one of the international climate services providers for health places us among the leaders in this area, a role that has yielded great recognition and visibility such as after the forecast service for dengue in Brazil successfully developed for the 2014 Soccer World Cup and our current participation in the US dengue Challenge, set by the US White House Office.

Total funds obtained by UDIC within 2008-2013: 8.986.053€.

In this project UDIC will be actively involved in:

- WP5 Delivering and Valuating Climate Services (Mark Payne/DTU, Co-lead: Kathrin Keil /IASS)
- WP6 Clustering for blue growth(Lead: Steffen M. Olsen/DMI)
- WP8 Communication, dissemination, engagement and exploitation (Lead: Joanne Allday/SRSL, co-lead; Peter Normann Vangsbo Climate KIC at DTU)

Please note that the timely performance of the case study will be subject to the timely delivery of climate data in a common and simple data format across climate models that allows an easy implementation of the TRM case study, so that any delay in the delivery of climate model data will be followed by the same delay in the performance of these tasks.

Relevant Personnel

Dr Joan Ballester, sector lead (male), Climate and Health Modelling expert. Joan graduated from the Technical University of Catalonia with a Bachelor of Science in Mathematics (2004). He also received a Master's degree in Meteorology and Climatology from the University of Barcelona (2004), a Master's degree in Ocean, Atmosphere and Continental Surfaces from the Paul Sabatier University (2005), and a Master's degree in Marine Sciences from the University of Barcelona (2007). Joan has obtained his PhD in Climate Predictability for the University of Barcelona in 2011. He has worked in the Meteorological Service of Catalonia, the Centre National de Recherches Météorologiques (Toulouse, France), the Climate Research Laboratory of the Barcelona Science Park and was a Marie Curie fellow at Caltech. He has published around 20 articles, including in Nature Communications, Nature Climate Change and PNAS and holds a great amount of international experience in the modelling of temperature-related mortality and climate extremes.

Dr. Xavier Rodó (male), Dr. Rodó is the head of the Climate Dynamics and Impacts Unit and the former director of the Institut Català de Ciències del Clima. Dr. Rodó is a reputable scientist in the area of ENSO predictability, the modelling of impacts and its translation to societal products and services. He was indeed the first scientist in reporting a statistically significant forcing of ENSO in the European continent (Rodó et al. 1997). Dr. Rodó is the author of around 80 scientific articles in peer-reviewed journals, including Science, Nature, Nature Communications, Nature Climate Change, Nature Scientific Reports, PNAS and The Lancet. He has been a contributing author and expert reviewer in Intergovernmental Panel on Climate Change (IPCC) reports, and he has edited and contributed to several books. He has been co-chair of CLIVAR-Spain, and steering committee member of the MEDCLIVAR. Dr. Rodó has also proven his expertise in training experienced researchers His main area of research is devoted to the understanding and simulation of climate impacts and in this field, in particular, the modelling of climate-driven diseases and extremes. Dr. Rodó has worked extensively on different sorts of diseases ranging from waterborne (cholera, shigella, rotavirus, cryptosporidium and giardia), vector borne diseases (malaria, dengue, chikungunya), zoonotic vector borne diseases (leishmaniasis) and more recently with wind borne diseases, such as Kawasaki disease. Dr. Rodó will contribute through the coordination of the project and will provide his expertise in the design, integration and interpretation of translational products to firms and agencies involved.

Relevant Publications, products, service and/or other achievements

- Pascual et al (2000) Science 289, 1766-1769
- Rodó et al (2002) PNAS 99, 12901-12906
- Koelle et al (2005) Nature 436, 696-700
- Ballester et al (2011) Nature Communications 2, 358
- Rodó et al (2011) Nature Scientific Reports 1, 152
- Cash et al (2013) Nature Climate Change 3, 502-507
- Ballester al (2013) GRL 1, 152
- Rodó et al (2014) PNAS 111, 7952-7957
- Lowe et al (2014) The Lancet Infectious Diseases 14, 619-626

Relevant projects

- **EU FP7 European Climate and Weather Events: Interpretation and Attribution (EUCLEIA)** is developing a climate modelling system to investigate heatwaves, cold spells, floods, droughts and storm surges in Europe. The project aims to provide well-verified assessments of the extent to which such weather-related risks have changed due to human influences on climate and to identify those types of weather events where our scientific understanding is not advanced enough to make a robust assessment of attributable risk. UDIC's role is investigating how to apply measures developed in seasonal forecasting on assessing the reliability of attribution statements and to develop a prototype attribution system based on model ensembles generated with the HadGEM3-A, that will allow analysis immediately after the event.
- **EU FP7 European Provision of Regional Impact Assessment on a Seasonal-to-Decadal timescale (EUPORIAS)** Whilst societies have flourished or collapsed according to their ability of dealing with climate variability and change it is only recently that we have acquired the ability to predict future environmental conditions. EUPORIAS intends to improve our ability to maximise the societal benefit of these new technologies. Working in close relation with a number of European stakeholders this project want to develop a few fully working prototypes of climate services addressing the need of specific users. UDIC's role is to assess sector-specific vulnerability specifically in the field of energy and health, to assess user's needs, to impact relevant climate information indices, to quantify uncertainty in impact models, to develop climate information and Decision making and to engage with stakeholders processes to transform climate services as a business opportunity. http://www.euporias.eu/ **Period:** 2012 – 2017
- **EU FP7 Seasonal-to-decadal climate Prediction for the improvement of European Climate Services (SPECS)** undertake research and dissemination activities to deliver a new generation of European climate forecast systems, with improved forecast quality and efficient regionalisation tools to produce reliable, local climate information over land at seasonal-to-decadal time scales, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders. The improved understanding and seamless predictions will offer better estimates of the future frequency of high-impact, extreme climatic events and of the prediction uncertainty. New services to convey climate information and its quality will be used. SPECS will be, among other things, the glue to coalesce the outcome of previous research efforts that hardly took climate prediction into account. SPECS will ensure interoperability so as to easily incorporate their application in an operational context, provide the basis for improving the capacity of European policy making, industry and society to adapt to near-future climate variations and a coordinated response to some of the GFCS components. UDIC's role is to ensure an effective, smooth and high-quality implementation and dissemination of the project, to ensure close coordination between projects and activities in Europe in the area of seasonal to decadal climate predictions towards climate services, to provide thought leadership to the European Commission on future priorities in the area of seasonal to decadal climate predictions towards climate services. http://www.specs-fp7.eu **Period:** 2012 – 2017
- **EU FP7 Dengue research Framework for Resisting Epidemics in Europe (DENFREE)** WHO estimates that one of the main consequences of global warming will be an increased burden of vector-borne diseases. Among these, dengue appears to be particularly problematic, with tens of millions of cases of dengue fever estimated to occur annually, including up to 500,000 cases of the life-threatening dengue hemorrhagic fever/dengue shock syndrome. In recent years, the global burden of dengue disease has been rising dramatically and this prolific increase has been connected to societal changes such as population growth, urbanization and the transport of infected hosts and vectors. In addition, rising temperatures and global climate change may lead to the expansion of the range of major mosquito vectors, extension of the transmission season in areas with currently circulating dengue virus and increase in the mosquito spp. vectorial capacity. Active surveillance to detect in-coming dengue virus (DENV) in regions at the limits of DENV circulation are an important initial step in the prevention of dengue epidemics in Europe. Asymptomatic infections likely play a crucial role in the initial invasion process and DENV transmission and, although hitherto ignored, must be addressed. Using retrospective

and prospective data from Asia, the main objectives of the program are (1) to identify key factors determining dengue transmission, outcome of infection and epidemics; (2) the development of novel diagnostic tools to detect asymptomatic infections. We will estimate the risk of DENV spreading to uninfected areas, especially in Southern Europe where susceptible vector exists. The major tools generated will be predictive models that enable specific interventions to reduce epidemic probability and diagnostic methods for surveillance. Inherent in this approach is the belief that improved surveillance and diagnosis of the asymptomatic dengue carriers will contribute to effective intervention, especially during early stages of pathogen invasion into a naïve region.http://denfree.eu/
Period: 2012 – 2016

Relevant significant infrastructure and/or technical equipment

Not applicable

4.2. Third parties involved in the project (including use of third party resources)

4.2.1 Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)

No subcontracting in this project.

4.2.2 Does the participant envisage that part of its work is performed by linked third parties[19]

No.

4.2.3 Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)

No.

[19] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

Section 5: Ethics and Security

5.1 Ethics

Not applicable.
Only only organisational data will be collected as opposed to any personal data. Where commercially sensitive data is concerned, this will be identified and the relevant information will be withheld accordingly. All research information will be gathered in accordance with guidelines laid down by the European Commission, and in accordance with the guidelines of the partners involved in the research. The project office at DMI will monitor this and any other potential ethics issues throughout the duration of the project, and ensure that all of them are identified and appropriately handled.

5.2 Security

Please indicate if your project will involve:

- activities or results raising security issues: **NO**
- 'EU-classified information' as background or results: **NO**

Section 6: Letters of Support

6.1 Member of the Research and Innovation Advisory Group (RIAG)

The following have already accepted to become member of the RIAG.

Jean-Noel Thepaut (male)	ECMWF, Copernicus Climate Change Service	Head of the Copernicus Climate Change Service, a Service operated by the European Centre for Medium Range Weather Forecasts (ECMWF) on behalf of the European Union.
Mike Steele (male)	Universty of Washington[20]	Expert in large-scale circulation of sea ice and water in the Arctic Ocean, and collaborates with biological oceanographers to better understand how changes in ocean salinity and temperature are affecting arctic plankton and thus the marine ecosystem.
Francis Zwiers (male)	Pacific Climate Impacts Consortium	Director, President and CEO of the Pacific Climate Impacts Consortium (PCIC), a climate service organization at the University of Victoria that interacts extensively with stakeholders, providing them with the information they need to develop plans for reducing the risks associated with climate variability and change. PCIC has a range of research interests and capabilities that are relevant to Blue-Action project.
Tom Reynolds (male)	Univ. Reading [21]	Legal advisor and manger of the Research and Enterprise Contracts unit at a major European university. Tom is an expert on management and commercialisation of research results and IPR, commercialisation opportunity reviews, IP audits and assessments; advising on policy, strategy, systems and structures; undertaking the IP commercialisation itself; and providing operational and negotiation support.
Darlene Langlois (female)	Canadian Ice Service	Chief of Operations at Canadian Ice Service, Chief of Satellite Analysis and Ice Forecasting. Darlene is is an expert in Satellite image analysis for sea ice, lake ice, icebergs and oil on water, sea ice and lake ice forecasting.
Guy Brasseur (male)	WCRP	Chair of the Joint Scientific Committee World Climate Research Programme (WCRP), former Director at the Max Planck Institute for Meteorology, associated director at NCAR, founding Director of the Climate Service Center (now GERICS) in Hamburg.
Katrine Krogh Andersen (female)	WMO and YOPP	former senior Advisor on Climate Change, Danish Ministry of the Environment and Danish Ministry of Climate and Energy, currently Director of Research and Development, Danish Meteorological Institute. Kartrine is on the Executive Council Panel of Experts on Polar and High Mountain Observations, Research and Services (EC-PHORS) under WMO and recently

[20] Formally independent from the units involved in UoW involved in WP2 and WP8. Thus there is no conflict of interest for Mike to provide independent advice under the RIAG to the consortium.

[21] The Research and Enterprise Unit of UREAD is formally independent from the Mathematics Department involved in WP4. Thus there is no conflict of interest for Tom Reynolds to provide independent advice under the RIAG to the consortium.

		joined the international steering committee for the Polar Prediction Project (PPP) and Year of Polar Prediction (YOPP). She is on the Danish delegation to the IPCC and has served on a number of internatioal research coordinating committees.

6.2 Member of the Societal Engagment Group (SEG)

The following have already accepted to become member of the SEG.

Liisa Holmberg (female)	**Sami Education Institute**	Rector of Sami Education Institute in Inari http://www.sogsakk.fi/) Liisa has a lot of experience with research projects in providing advice on societal impacts of research for the Sami community. Liisa is Vice Chairman of the Council of the University of the Arctic, member of the Advisor Board of the Arctic Centre, University of Lapland in Finland, and was Sámi Parliament MP in 2008-2011.
Lene Kielsen Holm (female)	**Greenland institute of natural resources**	Scientist and project leader in the climate centre's communication team and social science professorship, working for the Greenland institute of natural resources.
Inuit Circumpolar Council Greenland representative	**Inuit Circumpolar Council Greenland**	The ICC carries out several activities related to public information tours in Greenland for raising awareness on rights and involvement of the Inuit society in Industrial development and on how to avoid possible damage of the environment, securing direct and meaningful participation of the civil-society and respect of human rights and at least the rights of the indigenous peoples. Contact has been made and a representative will be appointed as soon as the project is approved.
Jon Burgwald (male)	**Greenpeace International**	Jon has led Greenpeace's work in Greenland since 2010 and prior to this been involved in Danish as well as international climate work. He has furthermore led, coordinated and consulted on projects in all Arctic countries – both regarding environmental issues and sustainable development in Indigenous communities.
BirdLife international representative	**BirdLife international**	BirdLife international is the partnership for nature and people, running a specific Programme on Climate Change and energy transition. Contact has been made and a representative will be appointed as soon as the project is approved.

6.3 Clustering for Blue Growth (WP6)

The following have already accepted to cluster with the Blue-Action project in WP6 activities.

Letters of support attached to this proposal	Affiliateion	For her/his role as
Martin Visbeck	GEOMAR - Helmholtz Centre for Ocean Research Kiel	Coordinator of the H2020 project **AtlantOS**, Optimizing and Enhancing the Integrated Atlantic Ocean Observing System, Blue Growth call BG8
Nicole Biebow	Alfred Wegener Institute for Polar and Marine Research	Coordinator of the H2020 project **EU-PolarNet,** Connecting Science with Society, Blue Growth call BG15
Peter Heffernan	Marine Institute	Coordinator of the H2020 project **AORAC-SA**, Atlantic Ocean Research Alliance Support Action, Blue Growth call BG14
Barbara Früh	Deutscher Wetterdienst	Coordinator of the **Copernicus Climate Change Service tender 433** project funded by Copernicus ECMWF
Myron Peck	University Hamburg	Coordinator of the H2020 project CERES Blue Growth call BG2
Silvio Gualdi	Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)	Coordinator of the **Copernicus Climate Change Service 433** project funded by Copernicus ECMWF
Laurent Bertino	Nansen Environmental and Remote Sensing Center	Leader of the **Arctic MFC element in the Copernicus Marine Environment Monitoring Services** (CMEMS)
Erik Buch	EuroGOOS European Global Ocean Observing System	EuroGOOS Chair

Section 7 References

- ACIA. 2004. *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*. Cambridge University Press.
- AMAP. 2011. Snow, Water, Ice and Permafrost in the Arctic (SWIPA): Climate Change and the Cryosphere. Oslo: Arctic Monitoring and Assessment Programme (AMAP).
- AMAP. 2010. Assessment 2007: Oil and gas activities in the Arctic – Effects and potential effects. Oslo: Arctic Monitoring and Assessment Programme (AMAP).
- Arctic Futures Symposium 2015, 17-18 November 2015, Brussels, http://www.arcticfutures.org/assets/uploads/resources_files/afs_2015_video_index.pdf
- Arctic ECRA, Strategy and Work Plan, Version: 19.06.2014
- Climate Change and Tourism: Responding to Global Challenges. © 2008 World Tourism Organization and United Nations Environment Programme.
- Climate-KIC European Collaboration on User-driven Research and Innovation for Climate-Knowledge, 9 July, Paris Aled Thomas, Director -Regions http://www.jpi-climate.eu/media/default.aspx/emma/org/10863114/Bertrand+Slides+for+OCFCC+session+in+Paris+9+July+2015+-+draft.pdf
- Climate KIC Education Report 2013-2014 - Climate-KIC http://www.climate-kic.org/wp-content/uploads/2014/07/Climate-KIC-Education-Report.pdf
- Ballester J., Douville H., Chauvin F. Present-day climatology and projected changes of warm and cold days in the CNRM-CM3 global climate model. Climate Dynamics 32, 35-54 (2009).
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