EUROPEAN COMMISSION
Executive Agency for Small and Medium-sized Enterprises (EASME)

H2020 Environment & Resources

ANNEX 1 (part A)

Research and Innovation action

NUMBER — 727852 — Blue-Action

Table of Contents

1.1. The project summary

Project Number [1]	727852	Project Acronym [2]	Blue-Action

One form per project

General information	
Project title [3]	Arctic Impact on Weather and Climate
Starting date [4]	01/12/2016
Duration in months [5]	51
Call (part) identifier [6]	H2020-BG-2016-1
Topic	BG-10-2016 Impact of Arctic changes on the weather and climate of the Northern Hemisphere
Fixed EC Keywords	Meteorology, atmospheric physics and dynamics, Meteorology, Climatology and climate change
Free keywords	Weather and climate prediction, long range, extreme weather, hazardous events, Arctic, climate services, co-design of services with end-users, transdisciplinarity, innovation, societal engagement

Abstract [7]

Blue-Action will provide fundamental and empirically-grounded, executable science that quantifies and explains the role of a changing Arctic in increasing predictive capability of weather and climate of the Northern Hemisphere.To achieve this Blue-Action will 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; leading to the co-design of better services.This bridge will build on innovative statistical and dynamical approaches to predict weather and climate extremes. In dialogue with users, Blue-Arctic will take 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. Modeling and prediction capabilities will be enhanced by targeting firstly, lower latitude oceanic and atmospheric drivers of regional Arctic changes and secondly, Arctic impacts on Northern Hemisphere climate and weather extremes. Coordinated multi-model experiments will be key to test new higher resolution model configurations, innovative methods to reduce forecast error, and advanced methods to improve uptake of new Earth observations assets are planned.
Blue-Action thereby demonstrates how such an uptake may assist in creating better optimized observation system for various modelling applications. The improved robust and reliable forecasting can help meteorological and climate services to better deliver tailored predictions and advice, including sub-seasonal to seasonal time scales, will take Arctic climate prediction beyond seasons and to teleconnections over the Northern Hemisphere. Blue-Action will through its concerted efforts therefore contribute to the improvement of climate models to represent Arctic warming realistically and address its impact on regional and global atmospheric and oceanic circulation.

1.2. List of Beneficiaries

Project Number [1]	727852	Project Acronym [2]	Blue-Action

List of Beneficiaries

No	Name	Short name	Country	Project entry date[8]	Project exit date
1	DANMARKS METEOROLOGISKE INSTITUT	DMI	Denmark		
2	LAPIN YLIOPISTO	AC UoL	Finland		
3	CAMARA MUNICIPAL DE ALMADA	ALM	Portugal		
4	FONDAZIONE CENTRO EURO-MEDITERRANEO SUI CAMBIAMENTI CLIMATICI	CMCC	Italy		
5	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	CNRS	France		
6	YONSEI UNIVERSITY	CTL	Korea (Republic of)		
7	DNV GL AS	DNV	Norway		
8	DANMARKS PELAGISKE PRODUCENTORGANISATION FORENING	DPPO	Denmark		
9	DANMARKS TEKNISKE UNIVERSITET	DTU	Denmark		
10	FORESIGHT INTELLIGENCE GBR	FI	Germany		
11	HELMHOLTZ ZENTRUM FUR OZEANFORSCHUNG KIEL	GEOMAR	Germany		
12	HAVSTOVAN	HAV	Faroe Islands		
13	INSTITUTE OF ATMOSPHERIC PHYSICS OFCHINESE ACADEMY OF SCIENCES	IAP NCZ	China (People's Republic of)		
14	ORGANIZATION OF THE RUSSIAN ACADEMYOF SCIENCES A.M. OBUKHOV INSTITUTEOF ATMOSPHERIC PHYSICS RAS	IAP RAS	Russian Federation		
15	INSTITUTE FOR ADVANCED SUSTAINABILITY STUDIES EV	IASS	Germany		
16	FUNDACIO INSTITUT CATALA DE CIENCIES DEL CLIMA	IC3	Spain		the day after the notification of termination
17	FEDERAL STATE BUDGETARY INSTITUTION - INSTITUTE OF WORLD ECONOMY AND INTERNATIONAL RELATIONS OF THE RUSSIAN ACADEMY OF SCIENCES	IMEMO	Russian Federation		

1.2. List of Beneficiaries

No	Name	Short name	Country	Project entry date[8]	Project exit date
18	KONSORTIUM DEUTSCHE MEERESFORSCHUNG e.V.	KDM	Germany		
19	MEOPAR INCORPORATED	MEOPAR	Canada		
20	MERCATOR OCEAN	MERCATOR	France		
21	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	MPI	Germany		
22	HAFRANNSOKNASTOFNUNIN	MRI	Iceland		
23	MARINE SCOTLAND	MSS	United Kingdom		
24	UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH NONPROFIT CORPORATION	UCAR	United States		
25	STIFTELSEN NANSEN SENTER FOR MILJOOG FJERNMALING	NERSC	Norway		
26	STICHTING NIOZ, KONINKLIJK NEDERLANDS INSTITUUT VOOR ONDERZOEK DER ZEE	NIOZ	Netherlands		
27	STICHTING NETHERLANDS ESCIENCE CENTER	NLeSC	Netherlands		
28	NATURAL ENVIRONMENT RESEARCH COUNCIL	NERC	United Kingdom		
29	PELAGIC FREEZER TRAWLER ASSOCIATION	PFA	Netherlands		
30	RUKAKESKUS OY	RUKA	Finland		
31	THE SCOTTISH ASSOCIATION FOR MARINESCIENCE LBG	SAMS	United Kingdom		
32	SAMS RESEARCH SERVICES LIMITED	SRSL	United Kingdom		
33	UNIVERSITAET HAMBURG	UHAM	Germany		
34	UNIVERSITETET I BERGEN	UiB	Norway		
35	UNI RESEARCH AS	UNIRES	Norway		
36	UNIVERSITY OF SOUTHAMPTON	UoS	United Kingdom		
37	UNIVERSITY OF WASHINGTON	UoW	United States		
38	THE UNIVERSITY OF READING	UREAD	United Kingdom		
39	WOODS HOLE OCEANOGRAPHIC INSTITUTION	WHOI	United States		
40	WOC - WORLD OCEAN LIMITED	WOC	United Kingdom		
41	FUNDACION PRIVADA INSTITUTO DE SALUD GLOBAL BARCELONA	ISGlobal	Spain	01/12/2016	

1.3. Workplan Tables - Detailed implementation

1.3.1. WT1 List of work packages

WP Number[9]	WP Title	Lead beneficiary[10]	Person-months[11]	Start month[12]	End month[13]
WP1	Improving seasonal long range forecast skill of risks for hazardous weather and climate events	33 - UHAM	118.00	1	48
WP2	Lower latitude drivers of Arctic changes	12 - HAV	165.00	1	48
WP3	Linkages of Arctic climate changes to lower latitudes	25 - NERSC	179.00	1	36
WP4	Enhancing the capacity of seasonal-to-decadal prediction in the Arctic and over the Northern Hemisphere.	21 - MPI	170.00	1	48
WP5	Developing and Valuing Climate Services	9 - DTU	156.00	1	48
WP6	Clustering for blue growth	1 - DMI	31.00	1	51
WP7	Management	1 - DMI	65.00	1	51
WP8	Communication, Dissemination, Engagement and Exploitation (CDEE)	32 - SRSL	75.50	1	51
		Total	959.50		

1.3.2. WT2 list of deliverables

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Technical report: How to identify weather patterns associated with occurrences of extreme events in models	WP1	33 - UHAM	Report	Public	24
D1.2	Technical report or paper: Attribution of extremes to climate phenomena	WP1	1 - DMI	Report	Public	48
D1.3	Technical report or paper: Quantified skill in weather patterns associated with extreme events	WP1	33 - UHAM	Report	Public	48
D1.4	A report on the predictability of marine cold air outbreaks and polar lows with dynamical s2s forecasts	WP1	35 - UNIRES	Report	Public	48
D2.1	Model-observation and reanalyses comparison at key locations for heat transport to the Arctic	WP2	28 - NERC	Report	Public	36
D2.2	Seasonal to decadal variability of the subpolar gyre	WP2	31 - SAMS	Report	Public	36
D2.3	Processes and flow over the Iceland-Faroe Ridge	WP2	1 - DMI	Report	Public	36
D2.4	Synthesis and dissemination of ocean and atmosphere heat transport to the Arctic	WP2	27 - NLeSC	Report	Public	36
D2.5	Assessment of Oceanic anomalies of predictive potential	WP2	34 - UiB	Report	Public	30
D2.6	Oceanic heat anomalies and Arctic sea-ice variability	WP2	5 - CNRS	Report	Public	30
D2.7	Cost-benefit analysis of the RAPID and OSNAP arrays	WP2	11 - GEOMAR	Report	Public	42
D2.8	Optimization of the GSR inflow arrays	WP2	12 - HAV	Report	Public	42
D3.1	Identification of the surface state influence in representing the	WP3	25 - NERSC	Report	Public	24

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	Arctic warming by coordinated atmosphere-only simulations					
D3.2	Identification of key processes in bridging the Arctic warming impact and its variation on decadal timescales	WP3	21 - MPI	Report	Public	24
D3.3	Role of ocean-atmosphere coupling in bridging the Arctic warming over lower latitudes	WP3	5 - CNRS	Report	Public	36
D3.4	Oceanic and climatic impacts of freshwater release over the last few decades	WP3	5 - CNRS	Report	Public	36
D3.5	Improved key process in representing Arctic warming	WP3	25 - NERSC	Report	Public	24
D4.1	Selected baseline prediction data for impact studies	WP4	21 - MPI	Report	Public	6
D4.2	Benchmark performance of state-of-the-art prediction systems	WP4	21 - MPI	Report	Public	24
D4.3	Impact of Arctic on Northern Hemisphere predictability	WP4	1 - DMI	Report	Public	36
D4.4	Sensitivity predictions performed	WP4	34 - UiB	Report	Public	36
D4.5	Best practices for enhancing user relevant prediction skill	WP4	27 - NLeSC	Report	Public	48
D5.1	CS1 End User Needs Report	WP5	30 - RUKA	Report	Confidential, only for members of the consortium (including the Commission Services)	4
D5.2	CS1 Model Information Utilization Report	WP5	2 - AC UoL	Report	Public	11
D5.3	CS1 Assessment Methodology Report	WP5	2 - AC UoL	Report	Public	11

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.4	CS1 Assessment and Evaluation Report	WP5	2 - AC UoL	Report	Public	46
D5.5	CS1 leaflet	WP5	2 - AC UoL	Websites, patents filling, etc.	Public	46
D5.6	CS1 Regional dissemination seminar	WP5	2 - AC UoL	Websites, patents filling, etc.	Public	47
D5.7	CS2 End-user requirements report	WP5	41 - ISGlobal	Report	Public	12
D5.8	CS2 Product Development Report	WP5	41 - ISGlobal	Report	Public	36
D5.9	CS2 Evaluation of the product	WP5	41 - ISGlobal	Report	Public	48
D5.10	CS2 Dissemination of the TRM product	WP5	41 - ISGlobal	Websites, patents filling, etc.	Public	48
D5.11	CS3 Requirements specifications report	WP5	7 - DNV	Report	Public	12
D5.12	CS3 Product on polar lows	WP5	7 - DNV	Websites, patents filling, etc.	Public	48
D5.13	CS3 Evaluation of the polar lows forecast system	WP5	35 - UNIRES	Report	Public	48
D5.14	CS3 End-user workshop on polar lows prediction Japan	WP5	7 - DNV	Websites, patents filling, etc.	Public	46
D5.15	CS3 End-user workshop on polar lows prediction Norway	WP5	7 - DNV	Websites, patents filling, etc.	Public	48
D5.16	CS4 Report on Marine Fisheries Climate services workshop	WP5	29 - PFA	Report	Public	12
D5.17	CS4 Marine Fisheries forecasts products	WP5	9 - DTU	Report	Public	36
D5.18	CS4 Report on the evaluation and valuation of Marine fisheries products	WP5	9 - DTU	Report	Public	45
D5.19	CS4 Dissemination of products/end-user workshops for marine fisheries	WP5	9 - DTU	Websites, patents filling, etc.	Public	48

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.20	CS5 Arctic stakeholder Map	WP5	15 - IASS	Report	Public	12
D5.21	CS5 Environment scanning workshop and report 1	WP5	15 - IASS	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	18
D5.22	CS5 Environment scanning workshop and report 2	WP5	15 - IASS	Websites, patents filling, etc.	Public	30
D5.23	CS5 Quantitative and qualitative analysis of the engagement of stakeholders	WP5	15 - IASS	Report	Public	48
D5.24	Future Prospects for Climate Services	WP5	9 - DTU	Report	Public	48
D6.1	First Joint workshop to (re)formulate open research questions of joint interest	WP6	1 - DMI	Websites, patents filling, etc.	Public	13
D6.2	Second Joint workshop to (re)formulate open research questions of joint interest	WP6	1 - DMI	Websites, patents filling, etc.	Public	30
D6.3	Third Joint workshop to (re)formulate open research questions of joint interest	WP6	1 - DMI	Websites, patents filling, etc.	Public	40
D6.4	Inputs to AtlantOS project (BG8 H2020 project)	WP6	11 - GEOMAR	Websites, patents filling, etc.	Public	36
D6.5	Inputs to AORAC-SA project (BG14 H2020 project)	WP6	1 - DMI	Websites, patents filling, etc.	Public	36
D7.1	Structure and detailed tasks of the Project Office	WP7	1 - DMI	Websites, patents filling, etc.	Public	1
D7.2	Risk register system and procedures	WP7	1 - DMI	Websites, patents filling, etc.	Public	3
D7.3	Data management plan (DMP)	WP7	1 - DMI	ORDP: Open Research Data Pilot	Public	6
D7.4	Minutes from the first annual meeting	WP7	1 - DMI	Report	Confidential, only for members	14

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
					of the consortium (including the Commission Services)	
D7.5	Minutes from the second annual meeting	WP7	1 - DMI	Report	Confidential, only for members of the consortium (including the Commission Services)	26
D7.6	Minutes from the third annual meeting	WP7	1 - DMI	Report	Confidential, only for members of the consortium (including the Commission Services)	38
D8.1	Communication and Dissemination plan: Matrix update	WP8	32 - SRSL	Report	Public	3
D8.2	Intranet for internal communication	WP8	21 - MPI	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D8.3	Project website	WP8	21 - MPI	Websites, patents filling, etc.	Public	1
D8.4	Communication and Dissemination plan	WP8	9 - DTU	Report	Confidential, only for members of the consortium (including the Commission Services)	6
D8.5	Presence at SOS 2016 for networking and visibility	WP8	40 - WOC	Report	Public	1
D8.6	Programme on Professional Development	WP8	32 - SRSL	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	6
D8.7	SEG Knowledge exchange 1	WP8	1 - DMI	Websites, patents filling, etc.	Public	12

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D8.8	SEG Knowledge exchange 2	WP8	1 - DMI	Websites, patents filling, etc.	Public	24
D8.9	SEG Knowledge exchange 3	WP8	1 - DMI	Websites, patents filling, etc.	Public	36
D8.10	SEG Knowledge exchange 4	WP8	1 - DMI	Websites, patents filling, etc.	Public	48
D8.11	Policy briefing 1	WP8	18 - KDM	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	15
D8.12	Exploitation plan	WP8	32 - SRSL	Report	Public	12
D8.13	Roadshow showing the mid-term results of WP5 to larger business audiences	WP8	9 - DTU	Websites, patents filling, etc.	Public	24
D8.14	Meet and Pitch- Co-working edition	WP8	9 - DTU	Websites, patents filling, etc.	Public	46
D8.15	Industry-science panel session on “Industry Developments, Opportunities and Challenges in the Arctic: Sustainable Arctic Business Development”	WP8	9 - DTU	Websites, patents filling, etc.	Public	50
D8.16	Policy briefing 2	WP8	18 - KDM	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	50

1.3.3. WT3 Work package descriptions

Work package number [9]	WP1	**Lead beneficiary** [10]	33 - UHAM
Work package title	Improving seasonal long range forecast skill of risks for hazardous weather and climate events		
Start month	1	**End month**	48

Objectives

Objectives: This WP will contribute to the following project objectives and expected impacts (Section 1.1):
Objective 1: Improving long range forecast skill for hazardous weather and climate events;
Objective 3: Quantifying the impact of recent rapid changes in the Arctic on Northern Hemisphere climate and weather extremes;
Objective 5: Improving the description of key processes controlling the impact of the polar amplification of global warming in prediction systems

Description of work and role of partners

WP1 - Improving seasonal long range forecast skill of risks for hazardous weather and climate events [Months: 1-48]
UHAM, DMI, CMCC, CNRS, CTL, GEOMAR, UNIRES, UREAD
WP Leader: Johanna Baehr/UHAM. WP Co-leader: Jens Hesselbjerg Christensen/DMI.
Description of work
Task 1.1 Extremes at different spatial and temporal scales [Lead: UREAD, Participants: UHAM, DMI, Month 1-36, Deliverables associated: D1.1]
While the statistical analysis of extremes can be framed rigorously in the context of the extreme value theory (EVT) and solid mathematical foundations exist for its applicability in chaotic systems, basic understanding of the properties of extremes in spatially extended fields like those relevant for climate is much less developed mathematically. A major issue is to understand the time-clustering of extreme events and their degree of spatial coherence: Regional climates are the complex outcome of local physical processes and non-local response (teleconnections) to large-scale phenomena such as the El Niño-Southern Oscillation (ENSO) and other dominant modes of variability, including the Pacific Decadal Oscillation (PDO) and the North Atlantic Oscillation (NAO) or Arctic Oscillation (AO). These modes strongly influence atmospheric dynamics and hence the frequency and geographical occurrence of extreme weather events (e.g. wind storms, cold and heat waves, floods and droughts). Hence, both the spatial and temporal variability have great relevance for impacts. We will address this problem using EVT and analyze how the properties of extremes change when considering averages in space and in time for the fields of interests. This will be relevant also for being able to perform fair comparisons of models having different spatial resolutions and between models and observations. We will analyse observations, reanalyses datasets, as well as the outputs of both CMIP5/CMIP6 models (basis for task 1.2 and 1.3) and of seasonal prediction systems (as a basis for task 1.4).
Task 1.2 Process-oriented diagnosis of weather systems [Lead: UHAM, Participants: UREAD, GEOMAR, DMI, CNRS, CMCC, Month 1-48, Deliverables associated: D1.1]
Based on re-analysis and existing long control simulations with climate and earth system models (CMIP5 and forthcoming CMIP6), the occurrence of extreme and hazardous weather and climate events influencing the Arctic and the North Atlantic sector will be characterized and analysed using the results of task 1.1. We will identify and compare the weather patterns associated with the occurrence of weather extremes. Uniquely, we will relate the occurrence, strength, and frequency of the weather systems to the state of the climate and its decadal variability, for example that of arctic sea-ice, the North Atlantic ocean, the stratosphere, the atmospheric stability. For example, we will use a set of diagnostic indices relating the frequency of polar lows occurrence to large scale meteorological features (such as marine cold-air outbreaks), exploiting the extended statistics of long simulations and re-analyses. By taking into account both low level static stability and upper level forcing, such indices can be used to infer the statistical properties of polar lows even when the underlying dataset do not have a resolution high enough to directly count the number of storms in the model. The occurrence of such weather systems in relation to the state of the arctic sea-ice will be investigated taking information and co-ordinated model experiments from WP3.1, where the links identified on seasonal timescales will be tested at decadal time scales. The specific characterization of the weather systems will be conducted in close exchange with task 1.3. We will analyse CMIP5/CMIP6 model simulations of natural variability as well as historical simulations, in

particular taking advantage of long time series, allowing us to investigate processes, teleconnections and also different states of climate modes.
Task 1.3 Detection and attribution of weather systems and extremes [Lead: DMI, Participants: UHAM, CTL, Month 1-48, Deliverables associated: D1.2]
To determine whether the probability of occurrence of a particular extreme event might be related to a climate change signal or is merely preconditioned by the phase of certain climate phenomena or major modes of variability (e.g. ENSO, PDO, AO, AMO, including their neutral stage), we need further statistical methods that build on the identification of weather systems in task 1.2. The actual methodology may need to be adjusted to account for different weather extremes. Such statistical tools will be identified and further developed and applied to both observations (re-analyses) and model results. The implied mapping of extremes conditioned by phases of climate phenomena will be used to compare models with observed conditions and defining a new metric characterizing the ability of models to represent the implied observed teleconnections. Building on the improved statistical description a formal detection and attribution study will be conducted, with novel focus on allowing for likelihood attributional statements of the occurrences of particular extremes. These statements will be compared for control simulations, historical simulations, observations and future climate change scenarios.
Task 1.4 Weather systems and extremes in seasonal prediction systems [Lead: GEOMAR/UHAM, Participants: UREAD, DMI, CMCC, Month 1-48, Deliverables associated: D1.3]
Building on tasks 1.1 to 1.3, the identified weather systems will be analysed and compared across seasonal prediction systems, investigating their predictability and predictive skill on subseasonal-to-seasonal time scales. Both for weather systems and extreme events themselves, but also for the impact on the predictive skill of related variables, hindcast skill will be assessed in relation to the state of the climate and its decadal variability (as in task 1.2). Since different remote connections tend to be important for different parts of the Northern Hemisphere with special focus on the Arctic and the North Atlantic region, the respective importance of these connections and their representation in the Arctic will be analysed. For example, the stratosphere tends to affect various parts of the Arctic, with a strong signature in the polar North Atlantic, which will be one focus of the project. The skill of seasonal prediction systems in reproducing seasonal anomalies, e.g. in the formation rate of polar lows will be assessed. We will analyse initialized seasonal prediction experiments in hindcast/re-forecast mode in large enough ensembles to enable the quantification hindcast skill. In particular, we will focus on initialized simulations with EC-Earth, NorESM and those CMIP5/CMIP6 models for which initialized near-operational seasonal predictions systems exist (CMCC, MPI-ESM). For the latter, the baseline ensemble 10 members will be extended to at least 30 members/start date.
Task 1.5 Subseasonal-to-seasonal forecasting of severe weather [Lead: UNIRES, Participants: DMI, CTL Month 1-48, Deliverables associated: D1.4]
Building further on the findings in tasks 1.1–1.4, the potential for probabilistic forecasts of risks of certain severe weather events will be assessed and quantified by means of historical monthly and seasonal forecasts, as well as re-forecasts with in-house prediction models such as NorCPM. The rationale behind this task is that while severe weather features such as polar lows and other kinds of extreme or hazardous weather are not predictable beyond the synoptic time scale, the environment in which they form, i.e. outbreaks of Arctic air masses over warm ocean surfaces, are larger-scale features and may be predictable on s2s time scales (10–90 days), as could be likely preconditioners such as ENSO and the AO/NAO (Kolstad et al. 2010; cf. task 1.3). An important subtask is to assess and quantify empirical relationships between large-scale atmospheric and lower boundary (ocean surface, sea ice) drivers and polar lows. This task is tightly linked to Task 5.3 in WP5, where an applied hybrid dynamical/statistical model for s2s prediction of polar lows, aimed at limiting risks for humans and the environment in the Arctic, will be developed in collaboration with DNV GL. The analysis will be based on the presently near-operational systems used in task 1.4, and complemented by the freely available S2S data set (http://apps.ecmwf.int/datasets/data/s2s/), and NorCPM (in collaboration with WP3).

Participation per Partner

Partner number and short name	WP1 effort
1 - DMI	24.00
4 - CMCC	16.00
5 - CNRS	6.00
6 - CTL	6.00
11 - GEOMAR	16.00

Partner number and short name	WP1 effort
33 - UHAM	24.00
35 - UNIRES	10.00
38 - UREAD	16.00
Total	118.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Technical report: How to identify weather patterns associated with occurrences of extreme events in models	33 - UHAM	Report	Public	24
D1.2	Technical report or paper: Attribution of extremes to climate phenomena	1 - DMI	Report	Public	48
D1.3	Technical report or paper: Quantified skill in weather patterns associated with extreme events	33 - UHAM	Report	Public	48
D1.4	A report on the predictability of marine cold air outbreaks and polar lows with dynamical s2s forecasts	35 - UNIRES	Report	Public	48

Description of deliverables

Deliverables
D1.1 Technical report: How to identify weather patterns associated with occurrences of extreme events in models, UHAM, M24
D1.2 Technical report or paper: Attribution of extremes to climate phenomena, DMI, M48
D1.3 Technical report or paper: Quantified skill in weather patterns associated with extreme events, UHAM (co-lead GEOMAR), M48
D1.4 A report on the predictability of marine cold air outbreaks and polar lows with dynamical s2s forecasts, UNIRES, M48

D1.1 : Technical report: How to identify weather patterns associated with occurrences of extreme events in models [24]

Technical report: How to identify weather patterns associated with occurrences of extreme events in models

D1.2 : Technical report or paper: Attribution of extremes to climate phenomena [48]

Technical report or paper: Attribution of extremes to climate phenomena

D1.3 : Technical report or paper: Quantified skill in weather patterns associated with extreme events [48]

Technical report or paper: Quantified skill in weather patterns associated with extreme events. Partners in charge: UHAM and GEOMAR

D1.4 : A report on the predictability of marine cold air outbreaks and polar lows with dynamical s2s forecasts [48]

A report on the predictability of marine cold air outbreaks and polar lows with dynamical s2s forecasts

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS4	Guidelines how to quantify extremes in models using EVT	38 - UREAD	18	analysis routines uploaded to data server
MS5	Intellectual Property Records	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners

Work package number [9]	WP2	Lead beneficiary [10]	12 - HAV
Work package title	Lower latitude drivers of Arctic changes		
Start month	1	End month	48

Objectives

Objectives: This WP will contribute to the following project objectives and expected impacts (Section 1.1):
Objective 2: Enhancing the predictive capacity beyond seasons in the Arctic and over the Northern Hemisphere;
Objective 5: Optimizing observational systems for predictions;
Objective 6: Reducing and evaluating the uncertainty in prediction systems

Description of work and role of partners

WP2 - Lower latitude drivers of Arctic changes [Months: 1-48]
HAV, DMI, CNRS, GEOMAR, MEOPAR, MPI, MRI, MSS, UCAR, NERSC, NIOZ, NLeSC, NERC, SRSL, UHAM, UiB, UNIRES, UoS, UoW, WHOI
WP Leader: Karin M. Larsen/HAV. WP Co-leader: Gerard McCarthy/NERC.
Description of work
Task 2.1 Assessment of key lower latitude influences on the Arctic and their simulation [Lead: NERC; Participants: UoS, NLeSC, MPI, HAV, GEOMAR, NIOZ, SAMS, MRI, MSS, UHAM, UNIRES, CNRS, DMI, UIB, NCAR, WHOI, MEOPAR] [Start: Month 1, End: Month 36; Deliverables associated to this task: D2.1, D2.2, D2.3, D2.4]
At key locations, Blue-Action will compare observations of heat and freshwater transport to state-of-the-art coupled climate models (HadGEM-Charisma, IPSL, CESM) and high resolution ocean-only models (e.g., NEMO (1/24°)). In-situ ocean data originating from transport mooring arrays (TMAs) and hydrographic GO-SHIP sections will be complimented with remote sensed data from Argo profiling floats, from underwater gliders and satellite data (including existing missions, and new missions data from Jason-3 and Sentinel-3, when they are operational). Correspondence, compensation or feedback between these ocean heat transport estimates and atmospheric heat transport will be examined in the coupled model simulations (D2.1) [NERC, MPI, UoS, NLeSC, GEOMAR, SAMS, NIOZ, MRI, HAV, MSS, UHAM, CNRS, UNIRES, UIB, NCAR, WHOI].
Blue-Action will investigate the propagation of warm ocean waters from the subpolar gyre over the GSR and towards the Arctic. The subpolar gyre circulation will be assessed in order to quantify the atmospheric and oceanic mechanisms that influence its seasonal to decadal-scale variability. The link between the warm and saline eastern waters and colder and less saline western waters as well as the mechanisms controlling the heat and freshwater transfer from the eastern subpolar gyre to the Greenland-Scotland Ridge will be established through an integrated model-observation analysis, relying on the OSNAP array, the EEL, the OVIDE line and other data sets (D2.2) [SAMS, GEOMAR, NIOZ, HAV, UHAM, NERC, NCAR, CNRS, MEOPAR].
Using results from a nationally funded experiment 2016-2017 and other observations on the Iceland-Faroe Ridge, we will develop methods for improving simulations of Iceland-Faroe warm-water poleward flow in ocean and climate models, which have been shown to be biased. (D2.3) [DMI, HAV, UHAM, MRI, UNIRES].
The key processes regulating both atmospheric and ocean heat transport will be estimated from the newest atmospheric and ocean reanalysis products (MERRA, ERA5, ERA20CM, ORAS5) and compared with the results of climate models (IPSL, CESM1, HadGEM). Any compensation or feedback between oceanic and atmospheric heat, moisture or energy transport impacts on the Arctic will be investigated in the climate models and diagnosed in close collaboration with WP3 and the Copernicus Climate Change Service (C3S). The CESM Large Ensemble simulation will be used to investigate the respective role of the natural climate variability and externally forced climate change (D2.4) [NLeSC, UoS, CNRS, MPI, NERC, NCAR, WHOI].
Task 2.2 Pathways and interactions sustaining Arctic predictability [Lead: UIB; Participants: CNRS, NERSC, HAV, UNIRES, NCAR, Month 1-30, Deliverables associated: D2.5, D2.6]
This task takes Blue-Action and ocean-related predictability into the Arctic proper; it provides both an immediately "upstream" and a maritime basis for WP3, and a mechanistic benchmark for WP4 (Tasks 4.1–4.4). The task will be achieved by using a combination of climate and ocean-sea-ice models – including the novel aspect of coupled climate model reanalysis – all informed by observations and historical reanalysis (1870—present). This integrated effort, like Task 2.1, capitalizes fundamentally on previous investments by the EU, national agencies, and international collaborative efforts in observational, modeling, and synthesizing capabilities.

In order to enhance climate predictability provided by the ocean, the observed thermohaline anomalies travelling the Nordic Seas and into Arctic Ocean will be assessed and compared with their representation in state-of-the-art models and the underlying mechanisms will be scrutinized. Particular emphasis will be on the models' representation of the flow through key hydrographic sections in the GSR, the Norwegian Sea and into the Arctic (Barents Sea Opening, Fram Strait), as well as the air-sea interaction associated with persistent anomalies identified accordingly – and thus including also potential impact by and on atmospheric circulation (D2.5). [UIB, CNRS, HAV, NERSC, UNIRES, NCAR]
The link between the oceanic heat transport (through the Nordic Seas and into the Arctic proper) and sea-ice in the Arctic will be investigated, including associated Arctic oceanic and atmospheric changes. Climate models will particularly be scrutinized with respect to the predictability in Arctic Sea ice cover that relates to the poleward extension of an Atlantic surface layer. The variability of the ocean heat content under the ice cover will be assessed using available information from existing Arctic observing networks. High resolution ocean simulations of the Arctic Ocean will be used to evaluate the mechanisms controlling the availability of the ocean heat to the ice, including upper layer stratification, vertical mixing, and exchanges between the basin interiors, the boundary currents and the surrounding shelves. The Pacific influence via the Bering Strait inflow will be assessed. (D2.6). [CNRS, NERSC, UIB]
We will deliver "coupled" reanalysis of both the recent and longer-term variations of the Arctic climate combining available observation-based data sets with climate simulations. Given the large uncertainty in oceanic reanalysis covering the last 50 years, emphasis will be put on the use of surface and/or atmospheric data. The reanalysis will be compared and validated against oceanic flow products from Task 2.1, and the reconstructed Arctic climate variability will be described. Two reanalyses will be assessed, based on the IPSL climate model (1950–present) and the NorCPM climate prediction model (1870–present), with the former to be produced within the project. The reanalyses will serve as input to WP4 [CNRS, UIB]
Task 2.3 Optimization and coordination of existing TMA systems, improved data delivery for predictions and identification of gaps [Lead: HAV; Participants: NERC, MRI, MSS, UNIRES, GEOMAR, NIOZ, SAMS, UOW, MEOPAR, Month 1-42, Deliverables associated: D2.7, D2.8]
The RAPID and OSNAP array will be inspected to report on the minimum data necessary to recover key ocean circulation changes from these arrays. For both arrays near real time data access using telemetry development (funded under FP7 NACLIM project, under H2020 by AtlantOS and by NERC in the UK) and the integration of this information with operational climate services such as Copernicus will be examined (D2.7) [GEOMAR, NERC, NIOZ, SAMS, MEOPAR]
Better and less resource demanding estimates of volume- and heat transport in the Atlantic inflow to the Nordic Seas will be obtained by better integration of satellite data with the existing GSR observatory. This will also allow more rapid data availability and access for a wider modelling community. Improvements in estimates will be achieved by developing algorithms integrating new Earth Observations when operational (Jason/Sentinel). (D2.8) [HAV, MSS, UNIRES, MRI].
We will build on the initiative taken by AtlantOS to establish a web site for high-level TMA products in order to ensure that all the monitored gateways between the Arctic and the Atlantic/Pacific are included. Gateways that presently are not or are insufficiently monitored will be identified. This work will involve Blue-Action non-EU partners and should be coordinated with BG9. [HAV, NERC, MRI, MSS, GEOMAR, NIOZ, SAMS, UOW]

Participation per Partner

Partner number and short name	WP2 effort
1 - DMI	4.00
5 - CNRS	18.00
11 - GEOMAR	9.00
12 - HAV	18.00
19 - MEOPAR	6.00
21 - MPI	4.00
22 - MRI	6.00
23 - MSS	3.00
24 - UCAR	4.00
25 - NERSC	4.00

Partner number and short name	WP2 effort
26 - NIOZ	7.00
27 - NLeSC	9.00
28 - NERC	18.00
32 - SRSL	9.00
33 - UHAM	3.00
34 - UiB	18.00
35 - UNIRES	4.00
36 - UoS	5.00
37 - UoW	4.00
39 - WHOI	12.00
Total	165.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.1	Model-observation and reanalyses comparison at key locations for heat transport to the Arctic	28 - NERC	Report	Public	36
D2.2	Seasonal to decadal variability of the subpolar gyre	31 - SAMS	Report	Public	36
D2.3	Processes and flow over the Iceland-Faroe Ridge	1 - DMI	Report	Public	36
D2.4	Synthesis and dissemination of ocean and atmosphere heat transport to the Arctic	27 - NLeSC	Report	Public	36
D2.5	Assessment of Oceanic anomalies of predictive potential	34 - UiB	Report	Public	30
D2.6	Oceanic heat anomalies and Arctic sea-ice variability	5 - CNRS	Report	Public	30
D2.7	Cost-benefit analysis of the RAPID and OSNAP arrays	11 - GEOMAR	Report	Public	42
D2.8	Optimization of the GSR inflow arrays	12 - HAV	Report	Public	42

Description of deliverables

Deliverables

D2.1 Model-observation and reanalyses comparison at key locations for heat transport to the Arctic, NERC, M36
D2.2 Observed ocean processes, mechanisms of subpolar gyre circulation and propagation of heat anomalies, SAMS, M36
D2.3 Processes and flow over the Iceland-Faroe Ridge, DMI, M36
D2.4 Synthesis and dissemination of ocean and atmosphere heat transport to the Arctic, NLeSC, M36
D2.5 Assessment of Oceanic anomalies of predictive potential, UIB, M30
D2.6 Oceanic heat anomalies and Arctic sea-ice variability, CNRS, M30
D2.7 Cost-benefit analysis of the RAPID and OSNAP arrays, GEOMAR, M42
D2.8 Optimization of the GSR inflow arrays, HAV, M42

D2.1 : Model-observation and reanalyses comparison at key locations for heat transport to the Arctic [36]

Model-observation and reanalyses comparison at key locations for heat transport to the Arctic

D2.2 : Seasonal to decadal variability of the subpolar gyre [36]

Seasonal to decadal variability of the subpolar gyre

D2.3 : Processes and flow over the Iceland-Faroe Ridge [36]

Processes and flow over the Iceland-Faroe Ridge

D2.4 : Synthesis and dissemination of ocean and atmosphere heat transport to the Arctic [36]

Synthesis and dissemination of ocean and atmosphere heat transport to the Arctic

D2.5 : Assessment of Oceanic anomalies of predictive potential [30]

Assessment of Oceanic anomalies of predictive potential

D2.6 : Oceanic heat anomalies and Arctic sea-ice variability [30]

Oceanic heat anomalies and Arctic sea-ice variability

D2.7 : Cost-benefit analysis of the RAPID and OSNAP arrays [42]

Cost-benefit analysis of the RAPID and OSNAP arrays

D2.8 : Optimization of the GSR inflow arrays [42]

Optimization of the GSR inflow arrays

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS5	Intellectual Property Records	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners
MS8	Assessment of heat transport and distribution in the high Arctic in eddy resolving model	5 - CNRS	24	Identification of robust metrics

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS9	Coupled reanalysis of the Arctic climate	5 - CNRS	24	Two novel climate reanalyses made available to the project for evaluation (WP2), process analysis (WP3) and predictability studies (WP4).

Work package number [9]	WP3	Lead beneficiary [10]	25 - NERSC
Work package title	Linkages of Arctic climate changes to lower latitudes		
Start month	1	End month	36

Objectives

Objectives: This WP will contribute to following objectives and expected impacts (Section 1.1):
Objective 2: Enhancing the predictive capacity beyond seasons in the Arctic and over the Northern Hemisphere;
Objective 3: Quantifying the impact of recent rapid changes in the Arctic on Northern Hemisphere climate and weather extremes;
Objective 4: Improving the description of key processes controlling the impact of the polar amplification of global warming in prediction systems;
Objective 5: Optimizing observational systems for predictions;
Objective 6: Reducing and evaluating the uncertainty in prediction systems

Description of work and role of partners

WP3 - Linkages of Arctic climate changes to lower latitudes [Months: 1-36]
NERSC, DMI, CMCC, CNRS, IAP NCZ, IAP RAS, MPI, NLeSC, UNIRES, UoS, WHOI
WP Leader: Yongqi Gao/NERSC. WP Co-leader: Guillaume Gastineau/CNRS.
Description of work
Task 3.1 Arctic warming impacts by atmospheric pathway [Lead: NERSC; Participants: CNRS, UoS, MPI, UNIRES, DMI, CMCC, NLeSC, WHOI, IAP-NZC, IAP-RAS. Month 1-24. Deliverables associated: D3.1, D3.2]
We will focus on the atmospheric pathway which likely link extreme weather events (cold air outbreaks, precipitation, and storms) over northern continents and Arctic warming on intra-seasonal to seasonal time scale. We will in particular study the role of stratosphere-troposphere coupling and that of troposphere dynamics with the interplay between the Arctic warming, the polar vortex, the jet stream and atmospheric planetary-waves. Lastly, we will assess how the linkages evolve at interannual to multi-decadal time scales due to the change of AMO and IPO over past decades. This task will be based on the analysis of coordinated atmosphere-only model experiments that will be performed by the partners, with large ensemble to estimate a relative role of internal atmospheric variability and boundary forcing in driving recent climate changes in high latitudes. In contrast to state-of-the-art atmosphere-only model exercises, we will use both temporally and spatially high-resolution boundary forcing (daily, ~0.25º), which will improve the representation of Arctic warming impacts, especially in high-resolution models.
The experimental protocol will first use daily SIC and global SST from 1979 to present for a control simulation (A-Exp1). To study the SIC impact, we will replace daily Arctic SIC of the A-Exp1 with daily climatology of Arctic SIC (A-Exp2). Two other coordinated experiments will focus on the modulation of the impacts of a warming Arctic by the transition of both AMO and IPO. For this, daily SST in the North Atlantic or in the Pacific Ocean will be fixed to a daily climatology, while the rest of the protocol is identical to A-Exp2 (A-Exp3 and A-Exp4 respectively). Experiments performed will use the atmospheric components of the following climate models: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].
We will investigate the atmospheric response to the rapid change in the observed Sea Ice Concentration (SIC) and the associated SST anomalies using available observation including the data from H2020 BG-9 project. By analysing the coordinated atmosphere-only experiments, we will assess the relative roles of Arctic sea ice and remote SST in Arctic warming (similarity between A-Exp1 and A-Exp2) and the impact of Arctic warming (difference between A-Exp1 and A-Exp2). The model diversity will allow exploring the effect of the resolution and model physics on the simulated response to Arctic warming, in particular the representation of the atmosphere boundary layer, clouds/moisture, changes of the surface energy budget and the influence on the lower troposphere baroclinicity (D3.1) [NERSC, MPIM, CNRS, UoS, DMI, NLeSC, CMCC, IAP-NZC, IAP-RAS].
The influence of Arctic warming and its variability on the main teleconnection patterns of the Northern Hemisphere will be studied in available observations and in the coordinated atmosphere-only experiments to understand the changes of extreme weather in the observations and model simulations. We will focus on the NAO/AO, but also on other weather regimes such as the Atlantic and Scandinavian blocking, that are known to be dependent on model resolution (UNIRES). We will also identify the Arctic warming impact on the jet stream displacement and intensity and on the tropical

circulation (e.g., Hadley cell and Inter-tropical Convergence Zone) (MPI). We will establish the role of stratosphere/ troposphere coupling versus fully troposphere dynamics in bridging the Arctic warming impact over lower latitudes on sub-seasonal to seasonal scales, and its variation on decadal timescales due to the transitions of both AMO and IPO during past several decades (D3.2) [MPI, UNIRES, NERSC, CNRS, UoS, DMI, NLeSC, CMCC, NCAR, WHOI, IAP-NZC, IAP-RAS].

Task 3.2Arctic warming impacts: role of air-sea coupling [Lead: CNRS; Participants: NERSC, MPI Month 1-36. Deliverables associated: D3.3]

The amplification/damping effect of active air-sea coupling in establishing the Arctic warming impact on the extreme weathers and climate over northern continents will be investigated using dedicated, coordinated coupled model experiments which will include the influence of external forcings following the CMIP6 protocol. To represent the observed Arctic warming, we will restore the surface heat flux/sea surface temperature in the Arctic Ocean to the observations in the coupled climate models NorESM ,IPSL-CM and MPI-ESM (AO-Exp1). Additional experiments will distinguish between the role of the ocean-atmosphere coupling for the Atlantic and Pacific oceans by prescribing an AMO phase in the Atlantic (AO-Exp2) or an IPO phase in the Pacific (AO-Exp3), using heat flux anomalies or SST-restoring. The coordinated experiments will enable us to investigate the role of ocean-atmosphere coupling in amplifying or damping the Arctic warming impact on intra-seasonal to inter-seasonal time scales, and in affecting the ocean circulation, in particular, the Atlantic Meridional overturning circulation (AMOC) [CNRS, NERSC, MPIM] (D3.3)

Task 3.3 Impact of Arctic Ocean freshening on Northern Hemisphere climate [Lead: CNRS; Participants: CNRS. Month 1-36. Deliverables associated: D3.4]

The Arctic Ocean and the North Atlantic sector have experienced an important freshwater release over the recent decades, with significant changes in the fresh water distribution in this sector, raising some speculations about its potential impact on the ocean circulation and thus climate, notably the recent strong cooling observed in the subpolar gyre. We will perform coupled model and high-resolution ocean-only simulations to estimate the impact of freshwater inputs into the Arctic and North Atlantic over the last few decades as well as their potential climatic impacts. We will establish how the freshwater input over the last few decades has contributed to modify the ocean stratification in the Arctic and North Atlantic as well as the dynamics of the subpolar gyre and the AMOC. The analysis will be performed by releasing estimated freshwater amounts from various sources in the new reanalysis from the IPSL model (cf. WP2) [CNRS], as well as in a regional high-resolution (1/24°) Arctic-North Atlantic model [CNRS]. The comparison of these different simulations will allow evaluating the fresh water pathways, the sensitivity to the different fresh water sources and the impact of coupling and oceanic resolution for the ocean response to the freshwater. Comparison to observation-based estimates from WP2 (notably overflows) will allow us to understand and validate the processes that have potentially affected the AMOC over the last few decades. Finally, the anomalous heat exchanges with the atmosphere and changes in the jet stream location in response to AMOC changes will be analysed in the coupled reanalysis to estimate climatic impact associated with the freshwater release linked with WP3. The outcome from this task will contribute to a better initialization for prediction systems (WP4) (D3.4).

Task 3.4 Improve representation of surface heat flux in Arctic [Lead: NERSC; Participant: CNRS, MPIM, IAP-NZC Month 1-24. Deliverables associated: D3.5]

We will use results from existing turbulence-resolving simulations over cracks to establish an empirical relationship between the crack-sizes and the net heat flux from a region. Estimates of the crack-size distribution are available from high-resolution SPOT satellite observations of the sea-ice cover, which were used for earlier attempts to quantify the fluxes from cracks. Then by combining the empirical relationship with the observed distribution of crack-sizes, we can parameterise the surface fluxes as a function of the open water fraction. This will allow us to establish the link between sea-ice concentration and anomalous heat flux equivalent to those found from observed SIC maxima [NERSC] (D3.5). This new parameterization will be tested using ensemble simulations with atmosphere components of NorESM IPSL-CM, MPIM-ESM (to repeat A-Exp1), to assess the effect of the changed surface heat flux taking into account the crack-sizes and fundamental thermodynamics and dynamics of the Arctic. If the benefits are clear, the corresponding modelling centres may adopt the new parameterisations scheme as part of their standard systems. [NERSC, CNRS, MPI, IAP-NZC] (D3.5)

Participation per Partner

Partner number and short name	WP3 effort
1 - DMI	9.00
4 - CMCC	9.00

Partner number and short name	WP3 effort
5 - CNRS	36.00
13 - IAP NCZ	20.00
14 - IAP RAS	12.00
21 - MPI	22.00
25 - NERSC	34.00
27 - NLeSC	10.00
35 - UNIRES	5.00
36 - UoS	10.00
39 - WHOI	12.00
Total	179.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D3.1	Identification of the surface state influence in representing the Arctic warming by coordinated atmosphere-only simulations	25 - NERSC	Report	Public	24
D3.2	Identification of key processes in bridging the Arctic warming impact and its variation on decadal timescales	21 - MPI	Report	Public	24
D3.3	Role of ocean-atmosphere coupling in bridging the Arctic warming over lower latitudes	5 - CNRS	Report	Public	36
D3.4	Oceanic and climatic impacts of freshwater release over the last few decades	5 - CNRS	Report	Public	36
D3.5	Improved key process in representing Arctic warming	25 - NERSC	Report	Public	24

Description of deliverables

Deliverables
D3.1 Identification of the surface state influence in representing the Arctic warming by coordinated atmosphere-only simulations, NERSC, M24
D3.2 Identification of key processes in bridging the Arctic warming impact and its variation on decadal timescales, MPI, M24

D3.3 Role of ocean-atmosphere coupling in bridging the Arctic warming over lower latitudes, CNRS, M 36
D3.4 Oceanic and climatic impacts of freshwater release over the last few decades, CNRS, M36
D3.5 Improved key process in representing Arctic warming, NERSC, M24

D3.1 : Identification of the surface state influence in representing the Arctic warming by coordinated atmosphere-only simulations [24]

Identification of the surface state influence in representing the Arctic warming by coordinated atmosphere-only simulations

D3.2 : Identification of key processes in bridging the Arctic warming impact and its variation on decadal timescales [24]

Identification of key processes in bridging the Arctic warming impact and its variation on decadal timescales

D3.3 : Role of ocean-atmosphere coupling in bridging the Arctic warming over lower latitudes [36]

Role of ocean-atmosphere coupling in bridging the Arctic warming over lower latitudes

D3.4 : Oceanic and climatic impacts of freshwater release over the last few decades [36]

Oceanic and climatic impacts of freshwater release over the last few decades

D3.5 : Improved key process in representing Arctic warming [24]

Improved key process in representing Arctic warming

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS5	Intellectual Property Records	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners
MS8	Assessment of heat transport and distribution in the high Arctic in eddy resolving model	5 - CNRS	24	Identification of robust metrics
MS9	Coupled reanalysis of the Arctic climate	5 - CNRS	24	Two novel climate reanalyses made available to the project for evaluation (WP2), process analysis (WP3) and predictability studies (WP4).

Work package number [9]	WP4	Lead beneficiary [10]	21 - MPI
Work package title	Enhancing the capacity of seasonal-to-decadal prediction in the Arctic and over the Northern Hemisphere.		
Start month	1	End month	48

Objectives

Objectives This WP will contribute to the following objectives and expected impacts (Section 1.1):
Objective 1: Improving long range forecast skill for hazardous weather and climate events;
Objective 2: Enhancing the predictive capacity beyond seasons in the Arctic and over the Northern Hemisphere;
Objective 3: Quantifying the impact of recent rapid changes in the Arctic on Northern Hemisphere climate and weather extremes;
Objective 4: Improving the description of key processes controlling the impact of the polar amplification of global warming in prediction systems;
Objective 5: Optimizing observational systems for predictions;
Objective 6: Reducing and evaluating the uncertainty in prediction systems

Description of work and role of partners

WP4 - Enhancing the capacity of seasonal-to-decadal prediction in the Arctic and over the Northern Hemisphere. [Months: 1-48]
MPI, DMI, CMCC, CNRS, MERCATOR, UCAR, NERSC, NLeSC, UiB, UoS
WP Leader: Daniela Matei/MPI. WP Co-leader: Noel Keenlyside/UiB.
Description of work
Task 4.1: Mechanistic and statistical skill assessment of baseline subseasonal-to-decadal multi-model predictions [Lead: MPI, Participants: NLeSC, NERSC, DMI, CMCC, NCAR, CNRS, UoS, MERCATOR, Month 1-24, Deliverables associated: D4.1 and D4.2]
We will make a mechanistic assessment of key processes responsible for the Arctic-lower latitude predictive linkages and their representation in the current state-of-art prediction systems. To this end, we will perform a coordinated (common metrics, methods, regions) process-based evaluation of existing (CMIP5 and post-CMIP5) and to be performed (e.g. CMIP6) retrospective seasonal-to-decadal predictions systems (suites) that will constitute the benchmark prediction ensemble of the project. The performance skill shall be assessed with a strong emphasis on attribution – i.e., assessing the representation of mechanisms responsible for the two-way connections between Atlantic region (including the nearby continents) and Arctic (linking to WP2 and WP3). Linking with WP2 and MERCATOR activities, uncertainties in relevant aspects of ocean and sea-ice reanalysis products used to initialize predictions will also be assessed. A special focus will be given in linking the systematic model errors to current predictability limitations and how these may impact the mechanisms behind the predictive skill (linking to WP2 and WP3). [MPI, NERSC, DMI, CMCC, NCAR, CNRS, UoS, MERCATOR]. We will also assess in a seamless approach whether any atmospheric responses to Arctic/high-latitude changes identified in WP3 are found in the initialized predictions, including temperature and precipitation extremes over continents and circulation patterns associated with extremes (such as blocking, NAO+, NAO- and linking to WP1) at sub-seasonal-to-interannual time scales [NLeSC, MPI]. The skill assessment will include both deterministic and probabilistic evaluation methods; innovative statistical techniques (calibration approaches) to process forecasts will be developed to correct for biases (and particularly biases in trends) to increase the skill in the current and new forecast systems and ensembles [NLeSC]. We will perform composite analyses of the ensemble prediction systems, where the predictability of one part of the system is conditioned on the initial state of another part of the system. For instance, cases where the initial states have particularly strong/weak Fram Strait freshwater exports will be chosen and their predictability compared to the baseline predictability (assessed by the ensemble error growth). Such anomalous Arctic-North Atlantic exchange can potentially lead to large surface changes in the North Atlantic, as hypothesized during GSA events, thereby leading to changes in the AMOC and longer-term impact on climate predictability of surrounding continents. This analysis will allow a quantification of the conditional predictability associated with Fram Strait export, and particularly relevant to the currently observed conditions (link to WP2). [CNRS, DMI].
An important part of this task will be to define key cases for the following tasks in the WP. Potential case studies include the strong Arctic sea ice cover loss in 2007, Barents Sea winter ice free potentially connected to strong UK flooding events, the 2012 and 2013 as Arctic sea ice minimum and rebound years, the current SPG cooling event. Connection to

YOPP will also be attempted with forecasts started during YOPP CORE Phase 2018-2019. The cases will be defined in discussion with WP2 and WP3. [all partners]

Task 4.2 Coordinated experiments to quantify the contribution of the Artic and high latitude North Atlantic in predictability of Northern Hemisphere extreme weather and climate [Lead: DMI; Participants: MPI, UiB, CNRS, CMCC, UoS, NCAR, Month 12-36, Deliverables associated: D4.3]

The impact of the mechanisms identified in WP2, WP3, and assessed in Task 4.1 will be further confirmed through two types of prediction experiments: 1) We will perform retrospective seasonal-to-multiyear hindcasts experiments for selected case studies (Task 4.1, M4.2) in which the prediction model's state is restored to model's climatology (data with-holding) or observed/reanalysis variations (data inclusion) over key regions (pacemaker prediction experiments) so as to quantify the impact of the Nordic Seas/Arctic on the Atlantic/Pacific and Northern Hemisphere climate predictability and vice versa. Thus we aim at identifying the dominant source region of skill and quantify its contribution to total predictive skill. Key regions/processes that could be considered are the North Atlantic Subpolar Gyre, the pathway of the North Atlantic Inflow though the Nordic Seas and into Arctic, the freshwater transport through the Fram Strait, Pan-Arctic or more regional sea ice extend (e.g. Barents Sea). Thus, we will help to assess the potential impact of the new Arctic observations. [MPI, UiB, DMI, CMCC, UoS, NCAR]. 2) Greenland Ice Sheet (GrIS) runoff may play a role for predictability on seasonal to decadal timescales: Due to sparse observations along the Greenland east coast, the runoff is not properly represented in reanalyses, and we will evaluate the improvement in seasonal climate predictability associated with a better initial representation of the runoff. Case studies of ensemble prediction experiments will be started in years identified in WP3 as having extreme GrIS runoff and initialized from reanalyses including the estimated anomaly as a flux along the Greenland coast (cf. WP2 and WP3.3). Predictability assessment of the Arctic region, surrounding continents, and linkages to the lower latitudes in these improved hindcasts will be benchmarked to the baseline ones (Task 4.1) and compared with freshwater transport estimates from WP2 and WP3. Improvements in predictability may derive from the sea-ice response to the freshening, and the design will further indicate the likelihood of crossing a threshold in SPG stratification, possibly leading to abrupt changes in the subpolar region. Furthermore, the future trend in GrIS freshwater release estimated from an ice sheet – climate model [DMI] will be used for future predictions and again compared to baseline predictions. These experiments will highlight the benefit of observational campaigns in the Arctic and Nordic seas for improving predictions by accounting for freshwater release and exchanges. [CNRS, DMI, NCAR]

Task 4.3 Explore alternative ways of enhancing predictive skill through improved model configurations and innovative initialisation techniques [Lead: UiB; Participants: MPI, NERSC, NLeSC, DMI, CMCC, UoS, NCAR, Month 12-36, Deliverable associated: D4.4]

The knowledge developed in WP2 and WP3 and also in Tasks 4.1 will be used as guidance to improve the prediction system further. The potential of the following three approaches to enhance skill will be investigated by repeating prediction experiments for selected cases (Task 4.1):

1) Role of high atmospheric and oceanic resolution, and representation of surface heat flux in Arctic. Evidence exists that oceanic resolution is important to capture both the North Atlantic inflow to the Nordic Seas and the Arctic. Higher atmospheric resolution has also been related to a substantial increase in skill of atmospheric processes at seasonal-to-interannual time scales and more realistic ocean-atmospheric interactions and remote teleconnections. We will perform coordinated multiyear prediction experiments for the selected case studies with a set of very high-resolution models in both oceanic and/or atmospheric components (targeted grid configuration 25Km-40Km as in CMIP6 HighResMIP) to test the dependence of seasonal-to-interannual predictive skill on model resolution. [UiB, MPI, NLeSC, UoS, CMCC, NCAR] Depending on the results from the experiments performed in WP3, we may consider testing the role of the improved parameterisation for surface heat fluxes in the Arctic in a subset of prediction systems.

2) Role of Arctic Sea Ice and Atmospheric initialisation on the accuracy of Northern Hemispheric climate predictions. Many state-of-the-art prediction systems do not use observations of sea ice for initialling forecasts, introducing inconsistencies at the initial time. Several modelling partners will explore more advanced ways of initialising the sea ice (extent and thickness) and atmosphere over the Arctic that aim at reducing the prediction drift. The Ensemble Kalman Filter (EnKF) data assimilation will be used in NorESM [UiB] and EC-EARTH [DMI] to consistently initialise both sea ice and the ocean state, and hence minimise forecast drift. The EnKF is an advanced data assimilation method that provides flow-dependent and multivariate covariance (i.e., to extrapolate the correction to unobserved variables) based on a model ensemble.MPI will implement nudging to observed sea ice conditions, accounting for ocean temperature and salinity conditions. Repeating the selected predictions with and without sea ice initialisation will allow the impact of sea ice initialisation on predictive skill. We will include initialization of sea ice using the new OSISAF merged IST/SST product for the Arctic (developed at DMI). NCAR will test the prediction sensitivity to sea ice thickness by comparing predictions initialised from different historical sea ice states that have similar ice extent, but different ice thickness distributions. [UiB, DMI, MPI, UoS, NCAR].

3) Innovative bias reduction and initialisation strategies. Innovative initialisation strategies employing empirical bias corrections [UoS] aiming at reducing the impact of model errors on the accuracy of predictions will be attempted.

Promising results have been obtained by using ocean-only high-resolution hindcasts forced with meteorological reanalysis data and use these ocean states as initial states for the ocean in coupled climate models. Especially when the climate model uses the same ocean component as the stand-alone model used for hindcast runs. In this way the adjustment shock and drift from initialisation is significantly reduced as the initialised state is on the attractor of the ocean model, although not on the attractor of the coupled model, because the atmospheric reanalysis has a different climatology than the atmosphere in the coupled model. A way to improve on this procedure is to rerun the hindcast with observed anomalies from the reanalysis, added to the coupled model's climatology instead of the reanalysis climatology, and use these states for ocean initialisation. This procedure would (almost) completely reduce the adjustment shock after initialisation, apart from nonlinearities and rectification effects of the internal variability. Again, repeating the selected predictions will assess the impact of these corrections. [UoS, NCAR] We will explore the potential for ameliorating the effects of biased air-sea exchange in coupled predictions by using techniques to reduce the large SST biases in the northwest Atlantic region that are associated with poorly-represented North Atlantic Current pathways in non-eddying ocean models. Flow correction methods based on non-interactive pressure gradient adjustment and/or surface flux correction will be tested, both in forced runs and in fully-coupled predictions [NCAR].
Task 4.4 Developing a protocol for improved seasonal-to-decadal prediction systems in the Arctic and over the Northern Hemisphere. [Lead: NLeSC; Participants: MPI, UiB, NERSC, DMI, CMCC, UoS, NCAR, MERCATOR, Month 24-48, Deliverables associated: D4.5]
This synthesis task will investigate how the efforts carried within Blue-Action WP4 towards more realistic initialisation methods, improved model configurations and substantially increased resolution and the potentially associated enhanced predictability in the Arctic could lead through both fast atmospheric and slower oceanic linkages to more realistic predictions of climate and extreme weather events over the Northern Hemisphere continental regions. The more advance statistical bias correction and calibration techniques developed in Task 4.1 for forecast evaluation/verification will be applied to the improved prediction systems (Task 4.3). Furthermore, the outcomes of specific case analysis performed in tasks 4.2 and 4.3 will be combined in order to give the most robust possible assessment of future Arctic and surrounding continents climate variations. We will also use the innovative process-oriented statistical tools developed in WP1 to evaluate in a seamless and probabilistic approach the predictability and potential changes in intensity frequency of selected extreme weather phenomena. The ultimate goal is to identify the suitability of prediction systems for predicting stakeholder relevant climate variations in the Arctic and their impact on lower latitudes. Associated forecast uncertainty will be estimated from the Blue Action multi-model multi-approach forecast ensemble with improved configuration performed in Task 4.3. The role of atmospheric and oceanic teleconnections in transferring the skill and uncertainty from the Arctic to lower latitudes will be assessed. Specific attention will be given to the ensemble predictions initialised from conditions representative of mid/end 2018 (during YOPP). A key aspect will be to utilise the newly available Earth System Observations and YOPP data to evaluate in a mechanistic way if the predictions are able to reproduce the observed variability and linkages (e.g. between regional Arctic sea ice variation and waviness of the jet and associated weather extremes).

Participation per Partner

Partner number and short name	WP4 effort
1 - DMI	23.00
4 - CMCC	11.00
5 - CNRS	19.00
20 - MERCATOR	1.00
21 - MPI	34.00
24 - UCAR	12.00
25 - NERSC	6.00
27 - NLeSC	23.00
34 - UiB	25.00
36 - UoS	16.00
Total	170.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.1	Selected baseline prediction data for impact studies	21 - MPI	Report	Public	6
D4.2	Benchmark performance of state-of-the-art prediction systems	21 - MPI	Report	Public	24
D4.3	Impact of Arctic on Northern Hemisphere predictability	1 - DMI	Report	Public	36
D4.4	Sensitivity predictions performed	34 - UiB	Report	Public	36
D4.5	Best practices for enhancing user relevant prediction skill	27 - NLeSC	Report	Public	48

Description of deliverables

Deliverables
D4.1: Datasets from selected baseline prediction experiments available in standard data format to impact case studies in Task 5.1 and Task 5.4 [M6, MPI]
D4.2: Report describing the benchmark performance of state-of-the-art prediction systems on seasonal-to-decadal timescales, focusing on mechanisms and including forecast calibration techniques [M24, MPI]
D4.3: Report summarising the impact of the Arctic and high-latitude North Atlantic, and Greenland ice sheet melt on predictability of the Arctic, North Atlantic, and climate of surrounding continents [M36, DMI]
D4.4: Datasets from all sensitivity prediction experiments available in standard data format, and fully documented to Blue Action modelling partners and impact case studies in Task 5 [M36, UiB]
D4.5: Report on the best practices for enhancing seasonal-to-decadal prediction skill in the Arctic with user-relevant linkages over the NH continents [M48, NLeSC]

D4.1 : Selected baseline prediction data for impact studies [6]

Selected baseline prediction data for impact studies

D4.2 : Benchmark performance of state-of-the-art prediction systems [24]

Benchmark performance of state-of-the-art prediction systems

D4.3 : Impact of Arctic on Northern Hemisphere predictability [36]

Impact of Arctic on Northern Hemisphere predictability

D4.4 : Sensitivity predictions performed [36]

Sensitivity predictions performed

D4.5 : Best practices for enhancing user relevant prediction skill [48]

Best practices for enhancing user relevant prediction skill

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS5	Intellectual Property Records	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners
MS6	Workshop on results benchmark multi-model ensemble prediction and select case studies for the following tasks	25 - NERSC	18	Short report synthesising the results and describing the selected case studies to all WP4 partners
MS7	Design the coordinated sensitivity prediction experiments	36 - UoS	18	Design protocol available to all Task 4.3 partners
MS9	Coupled reanalysis of the Arctic climate	5 - CNRS	24	Two novel climate reanalyses made available to the project for evaluation (WP2), process analysis (WP3) and predictability studies (WP4).

Work package number [9]	WP5	Lead beneficiary [10]	9 - DTU
Work package title	Developing and Valuing Climate Services		
Start month	1	End month	48

Objectives

Objectives This WP will contribute to the following objectives and expected impacts (Section 1.1):
Objective 1: Improving long range forecast skill for hazardous weather and climate events;
Objective 7: Fostering the capacity of key stakeholders to adapt and respond to climate change and boosting their economic growth

Description of work and role of partners

WP5 - Developing and Valuing Climate Services [Months: 1-48]
DTU, AC UoL, ALM, DNV, DPPO, FI, HAV, IASS , IMEMO, PFA, RUKA, SRSL, UNIRES, ISGlobal
WP Leader: Mark R. Payne/DTU. WP Co-leader: Kathrin Keil/IASS.
Description of work
This work package consists of a set of five case studies that bring scientists together with stakeholders (and often SMEs) to co-develop products that "translate" the model outputs and improved modelling skill developed in WPs 1-4 into societal- and sector-relevant products. The value of these products to both stakeholders and end-users will be quantified, preferably in financial terms where possible. The 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/stakeholder 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 task, 5.6, ties the individual lessons learned in each of the studies together and identifies future needs for climate services.

Task 5.1 Case study 1: Weather and climate data for Northern Finnish winter tourism centers [AC UoL, Ruka, SRSL, Month 1-48, Deliverables associated: D5.1-D5.6]
State-of-the-art: Northern Finland is one of the fastest warming regions in Europe with the greatest increases in temperature being seen in November, December and January. For the winter tourism sector, proper winter conditions are key to commercial success: information on future climate and specific local weather conditions is fundamental for preparing and adapting to future change. Long-term business planning for Northern Finnish winter tourism industry therefore needs to account for the increased likelihood of the October-December season being too warm and plan for alternatives to winter sports. Forecast data is required to i) plan for the next season , especially at the beginning of the season with the need for snow making and snow storage and ii) plan mid-term operations and investments that allow their businesses to adapt to the changing and variable climate (semi-decadal scale). Furthermore, weather and climate information is required to assess the competitive position of Northern Finland relative to other major European Ski Centres.
Goal: To assess the value of improved weather and climate predictions for short-term and mid-term planning of operations for ski centres in Northern Finland (Lapland and Northern Ostrobothnia).
Defining end-user information requirements: An iterative information exchange between Blue Action scientists and stakeholders will clarify the needs of the end-user, Ruka, and the exact scope of the data to be provided by the case study. An "End-user Needs Report" (D5.1) will be produced in collaboration with Ruka, specifying the information needs of the company, including precision, and the feasibility of conducting a competitiveness assessment for the ski resort. A detailed procedure for generating and delivering data and associated uncertainties in a format useful for the company will be developed in collaboration between task participants and result in a "Model Information Utilisation Report" (D5.2). Based on end-user needs and a review of existing methods for economic feasibility analysis, a methodology for estimating the added value of information and reductions in uncertainties will be identified. The methodology will include qualitative and econometric tools and will be summarized in the "Assessment and Evaluation Methodology Report" (D5.3) These reports will be revisited during the course of the project and potentially refined if necessary.
Utilising model information: This case-study is closely linked to the annual operational cycle of the skifield end-user and the schedule will be adjusted to coincide with the winter operating season, with the aim of following two complete operating cycles. Model outputs forecasting the evolution of key parameters (e.g. October-December snow cover, summer snow-storage conditions) over the coming year and coming five-years will be collated for the end-user

in January- March, with uncertainties in these predictions receiving particular emphasis. The end-user will then use their forecasts in their seasonal and mid-term planning activities for the remainder of the year and into the new winter season, with guidance from the science groups. At the end of the year, the use and value of the data will be examined and refinements made to the procedure prior to the next forecasting cycle.
Assessment and evaluation: assessment will focus on i) the value of the information for the end user, particularly in terms of competitiveness, and ii) the capacity of the end user to adjust business operations to improved information, both in short-term and mid-term perspective. Furthermore, model skill for the regions and variables of interest will be quantified based on hindcasts from the baseline (D4.1) and improved (D4.4) model configurations: the methodology proposed in D5.3 will then be to quantify the economic value of improved weather and climate information to the end user. The practical and qualitative value of the data for Ruka will be assessed in team meetings led by the resort director or the ski operations manager. The results of these analyses will be summarised in the "Assessment and Evaluation Report" (D5.4) co-drafted by scientists and end-user staff and a scientific manuscript to a high-level journal.
Regional dissemination: Based on D5.4, a leaflet will be produced in English and Finnish with basic information about the case study and its results (D5.5), targeting a broad audience, and presented in a manner such that it can be easily understood by non-scientific partners. A seminar for the Northern Finland tourism industry to share the outcomes of the project will be organized (D5.6) The invitees will include representatives of other skiing centres, representatives of other winter-based tourism companies, representatives of Lappish and Northern Ostrobothnian tourism associations, representatives of other European tourist resorts, Oulu and Lapland Chambers of Commerce, officials from the Regional Councils of Northern Ostrobothnia and Lapland and chosen municipalities, researchers (e.g., from the Lapland Multidimensional Tourism Institute). The seminar is planned to be organized in the Ruka Ski Centre: Rukakeskus will charge only running costs and refrain from generating profit from the event.

Task 5.2 Case study 2: Temperature Related Mortality (TRM) [ISGlobal, Almada, Month 1-48, Deliverables associated: D5.7-D5.10]
State-of-the-art: Europe emerges as an especially sensitive area to climate change with more frequent, longer and harsher summer heat waves. Temperature-Related Mortality (TRM) can be largely avoided if informed decisions are made prior to extreme climate events to protect vulnerable populations.
Goal: This case study aims to develop in collaboration with end-users a prototype forecast scheme of TRM for a very large ensemble of regions in Europe.
Identification of end-user requirements The design the prototype TRM forecasting scheme will be developed around the requirements of the end-user (Almada), who will represent the needs of the public health sector by producing an initial "wish list" for the output of the forecast scheme. IISGlobal will assess the viability of these requirements based on the available climate information within the project. A final list of viable and useful information requirements will be produced (D5.7).
Development of the statistical TRM model. In addition to apparent, dew point, daily minimum, mean and/or maximum temperature, the delayed effect of heat stress and the added impact of thermal persistence will be included in the model, and the role of relative humidity and surface winds may also be considered. ISGlobal will use its own database of mortality to develop the model, with daily counts for more than 160 regions in 16 European countries representing more than 400 million people. Note that this mortality dataset is of restricted use and will not be made open, neither to project partners nor to the general public. "State-of-the-art" (or control) model simulations generated in other work packages (D4.1, D4.4) will be used as input climate data for the model. A report will describe the methodology underlying the product (D5.8).
Evaluation of the product The evaluation process will be threefold, and it will examine TRM predictions driven with climate data from 1) observations or reanalyses, 2) "state-of-the-art" (or control) model simulations, and 3) "beyond state-of-the-art" model simulations. "State-of-the-art" (or control) and "beyond state-of-the-art" model simulations generated in other work packages (D4.1, D4.4) will be used as input data for this evaluation process. In each case, the value of the product to the end-user will be evaluated through standard metrics used to assess the skill and spread of the forecasts. Comparing the three types of climate input data allows conclusions to be drawn about the predictive power of the models, as well as the additional predictive skill gained in Blue-Action. Only models providing "state-of-the-art" (or control) and "beyond state-of-the-art" simulations, as well as all the variables mentioned above at daily time resolution and at a spatial resolution equal or higher than 0.75x0.75 degrees, will be considered. The results will be summarised in a report describing the results of the three-way comparison (D5.9).
Dissemination of the product A website will be developed (D5.10) where the aim, methodology and output of the product is explained in simple and user-friendly language. The website will provide information that can be understood by a broad audience, using simple words, diagrams, illustrations and a general description of the context and the state of the art in the fields of climate variability, climate change and human health. Emphasis will be put on the usefulness of the product for stakeholders and public health agencies in Europe, and how and under which conditions this product could be implemented in order to improve the quality of life of European citizens and societies.

Task 5.3 Case study 3: Forecasting of Polar Lows [UNIRES, DNV GL, Month 1-48 Deliverables associated: D5.11-D.15]
State-of-the art: The open waters of the Nordic Seas are one of the main breeding grounds of polar lows, intense polar mesocyclones engendering strong winds and intense snowfall that have caused numerous fatal shipwrecks. While polar-low predictability is poor on the subseasonal-to-seasonal (s2s) time scale (10–90 days), the environments in which they form, (marine cold air outbreaks), may be predictable on those time scales: such extreme weather may therefore be predictable, at least in a probabilistic context.
Goal: The aim of this task is to communicate and disseminate risks of polar lows by means of maps that will be tailored to high-level end-users and thus providing 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.
Scoping of stakeholder and end-user requirements An initial requirements specification will investigate how increased understanding and predictability of polar lows in the Arctic can be used in risk reduction planning and advisories to maritime activities, including shipping, and to define the requirements for polar-low predictability. Pursuing a user-driven process, requirement identification will be distributed to regional hubs within DNV GL focusing on the Nordic Seas, Japanese waters, and the North-East passage in order to ensure alignment with different operating environments and international regulations and will include stakeholder workshops with target SMEs in shipping. A requirements specification report (D5.11) will list data, product and operational requirements, and identify how these model results can be used to improve safety and performance of operations at sea.
Development of polar-low risk products The Arctic Risk Map (https://maps.dnvgl.com/arcticriskmap) is an online interactive map portraying the Arctic risk picture that provides a transparent basis on which to communicate risks to the industry, and to identify the main drivers behind the heightened risk level. Blue-Action will integrate polar low information into the Arctic Risk Map by developing methodology for utilizing predictive skill of polar lows. Task 1.5in WP1 examines the skill of probabilistic forecasts of polar lows and related severe weather on s2s time scales. We will address the predictability in more practical terms by developing a hybrid dynamical-statistical model, in which forecasts from dynamical s2s models are “translated” to risks of polar low formation. The results of the model will then be communicated to stakeholders via implementation in the Arctic Risk Map structure (D5.12).
Evaluation of products The predictive skill of the product will be evaluated and its applicability to risk assessment demonstrated. We will develop a simple classification system for polar lows in collaboration to users, similar to the Saffir-Simpson hurricane wind scale e.g. where polar lows are divided into categories. Having developed a classification scheme, we will define a baseline, using climatological data for polar lows. The evaluation of the forecast model (D5.13) will be based on comparisons between the baseline, the forecasts, and the actual occurrence of polar lows in the forecast period. We will use standard verification methodology tailored to the classification and the needs of the users.
Dissemination of products/end-user workshop on polar lows prediction To ensure efficient dissemination of results, we will plan two stakeholder meetings, one in Japan (D5.14), and one in Norway (D5.15), to share key findings and inspire to further work. Our goal will be to promote increased understanding of polar lows in the public, as well as their relevance in Arctic risk assessments. The project will share results in a public and interactive format, in the form of a map or a dynamic and geographic risk feature layer, enabling direct and data-smart integration into maritime risk reduction systems of ships operating in the Arctic.

Task 5.4 Case study 4: Climate Services for Marine Fisheries [DTU-Aqua, HAV, PFA, DPPO, Month 1-48, Deliverables associated: 5.16-5.19]
State-of-the-art: Tremendous advances in oceanographic observing and modelling systems over the last decade now mean that in some areas (e.g. NE Atlantic) statistically meaningful predictive skill of variables such as sea-surface temperature out to five years or more is feasible. Exploiting this new predictive skill to support marine fisheries is emerging as one of the new opportunities and challenges of marine science. Translating these predictions of the physical environment into biological outcomes, however, is not straightforward and forecasting marine ecosystems is a scientific field still in its infancy.
Goal: We aim to pioneer annual and multi-annual fisheries-related predictions by developing and operationalizing the first such products in collaboration with stakeholders. Furthermore, we will estimate their value of these products to both end-users and the sector in general.
Scoping of stakeholder and end-user requirements A workshop will be coordinated in the first six months of the project to bring stakeholders together with scientists to identify potential operational products that could be developed. Such a workshop will enable a two-way communication between stakeholders and scientists, with the aim of 1) clarifying what can and cannot be monitored and forecast by existing observational and modelling systems and 2) clarifying what potential products are, and are not, potentially useful to end-users. The workshop will identify a small set (2-3) of potential products to be developed in the remainder of the project and develop criteria for their evaluation and valuation (D5.16).

Development of products The operational products to be developed will be defined during the course of the project based on the stakeholder scoping process. However, two candidate products have already been proposed by stakeholders as follows: 1) Spatial distributions of migratory fish: Many commercially important fish species, such as mackerel, blue whiting and herring, migrate thousands of kilometres annually, challenging the scientists trying to monitor these species, the fishers trying to catch them and giving rise to interactional conflicts over fishing rights. Blue-Action will develop both empirical and mechanistic species distribution models to forecast the distributions of these fish. By coupling these models to Blue-Action's physical forecast models, it becomes possible to forecast the distribution of these fish resources. 2) Timing of sandeel spring-reemergence: Sandeel is a small fish species primarily used for aquaculture and fishmeal that nevertheless supports one of the largest fisheries in Europe by weight. The species "hibernates" by burying itself in the sand and is only available to fisheries during spring feeding periods. The timing of this re-emergence is variable and critical for the processing plants that need to achieve full capacity in a very short and unforeseeable time. Blue-Action will use Bayesian hierarchical space-time models to identify the variables (e.g. winter temperatures) that influence re-emergence. An operational prediction system will then be developed by coupling these statistical models to Blue-Action's physical forecast models. The development and initial validation of these products will be described in a report (D5.17).
Evaluation and valuation of products The value of these predictive systems to end-users will be quantified, including the predictive time-horizon, the gain in predictive skill attributable to the Blue-Action models, and where possible, the financial value of these predictions (D5.18). For the proposed migratory fish example this could include quantifying improvements in scientific advice (reduced uncertainty); demonstrating early-warning indicators for shifts in the distribution of fish; and estimating potential fuel savings by optimising fishing patterns. For the proposed sandeel example, this could include estimating processing efficiency improvements resulting from potential planning improvements.
Dissemination of products/end-user workshops Collaborative workshops D5.19 will be held to introduce the products to stakeholders outside of the project, including their scientific basis, assumptions, and limitations. Workshop feedback will help to improve the products further and identify future needs for climate services in marine fisheries.

Task 5.5 Case study 5: Oil and Gas Development in the Russian Arctic [IASS, IMEMO, FI, Month 1-48, Deliverables associated: D5.20-D5.23]
State-of-the-art: Changes in the Arctic bring risks and opportunities, which strongly affect local ecosystems, people and communities. This case study focuses on potential social, economic and environmental impacts of changes in opportunities and risks of energy resource development at three sites in the Russian Arctic. These sites will provide valuable insights and comparisons of impacts of changes in the Arctic and relate them to interdependencies with stakeholders based in the Arctic or elsewhere (especially in Europe). The sites share the potential for affecting local communities, including indigenous people and the fact that they are all are affected by Arctic climate change. However, the sites involve development of different commodities (oil, gas) in different environmental and social contexts and are thus expected to produce different socio-economic and environmental impacts.
Goal: To produce an analyses and evaluation of possible outcome scenarios in resource extraction in the Russian Arctic, and develop greater capacity among stakeholders to use climate information in their decision making at various levels of governance and spatial scales.
Stakeholders' views and needs Blue-Action will characterize ("map") D5.20 relevant stakeholders, both locally at the Russian case study sites as well as relevant European business actors, together with their needs for climate information, and views about resource development. We aim to elaborate stakeholders' criteria for sustainable development in their own contexts: these criteria are then used in the scenario exercises as the basis for assessing scenarios. The stakeholder groups will be invited to collaborate in data gathering, including biophysical data (e.g., emissions and health) from measurements and social data from interviews, and in co-design, discussion and assessment of findings of the impact studies and of the capacity building workshops for scenario-based decision making.
Economic and policy analysis The likelihood, extent, and consequences of the three energy resource development projects will be analysed by utilising projections of climate change impacts together with international market conditions, consideration of the legal, regulatory, and political situation, and expectations and perceptions of relevant stakeholders (i.e. described in D5.20). These items will then provide the basis for development of scenarios for decision making (D5.21 and D5.22). We will utilise multiple sources to detect the economic and political factors influencing energy resource development in the three study sites, since thus far only very little research has been conducted in this field .
Developing and using scenarios for decision making Blue-Action will iteratively develop and test sets of single and combined scenarios outlining scientifically plausible climate, environmental, social, economic and health impacts of changes in the Arctic on local Arctic stakeholders. The scenario development process will consist of four phases: 1) Definition of core assumptions, timeframe and scope of the scenarios to be developed 2) Two scenario definition workshops (D5.21 & D5.22) using state-of-the-art scenario-generation tools. 3) Creation of fully-fledged descriptions

and presentations of the thought experiments previously conducted. 4) The results will be the input for capacity-building or transfer workshops in which stakeholders use the scenarios to explore the opportunities and risks of alternative decisions and either test their existing strategies under alternative scenario conditions (wind tunnelling) or create new strategic options.
Quantifying scenario uptake and impact Blue-Action will produce qualitative and quantitative analyses (D5.23) of the engagement of stakeholders in the scenario building process, including the number of groups represented and individuals engaged, their time engaged in design, development, learning to use, and communicating results, and number and type of decision-making processes undertaken.

Task 5.6 Future prospects for Climate Services [DTU-Aqua, IASS, AC UoL, RUKA, ISGlobal, Almada, IASS, IMEMO, FI, PFA, DPPO, HAV, MPI, SRSL, DNV, UNIRES, Month 36-48, Deliverables associated: D5.24]
The conclusions drawn across the five individual case studies will be brought together in this final over-arching task that produces a report about the future prospects and requirements for Climate Services in Europe (D5.24). Each participant in the work-package will contribute to this deliverable, with a primary focus on the important lessons learnt from their perspective. Knowledge gaps and practical limitations that currently hinder the development and uptake of climate services will be highlighted, and recommendations for future research made. Comparisons will be made between the individual sectors (case studies) and also between the different roles within the case studies (e.g. scientists versus stakeholders).

Participation per Partner

Partner number and short name	WP5 effort
2 - AC UoL	25.00
3 - ALM	14.00
7 - DNV	10.00
8 - DPPO	3.00
9 - DTU	25.00
10 - FI	4.50
12 - HAV	6.00
15 - IASS	23.00
17 - IMEMO	4.50
29 - PFA	3.00
30 - RUKA	7.00
32 - SRSL	2.00
35 - UNIRES	5.00
41 - ISGlobal	24.00
Total	156.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.1	CS1 End User Needs Report	30 - RUKA	Report	Confidential, only for members of the consortium (including	4

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
				the Commission Services)	
D5.2	CS1 Model Information Utilization Report	2 - AC UoL	Report	Public	11
D5.3	CS1 Assessment Methodology Report	2 - AC UoL	Report	Public	11
D5.4	CS1 Assessment and Evaluation Report	2 - AC UoL	Report	Public	46
D5.5	CS1 leaflet	2 - AC UoL	Websites, patents filling, etc.	Public	46
D5.6	CS1 Regional dissemination seminar	2 - AC UoL	Websites, patents filling, etc.	Public	47
D5.7	CS2 End-user requirements report	41 - ISGlobal	Report	Public	12
D5.8	CS2 Product Development Report	41 - ISGlobal	Report	Public	36
D5.9	CS2 Evaluation of the product	41 - ISGlobal	Report	Public	48
D5.10	CS2 Dissemination of the TRM product	41 - ISGlobal	Websites, patents filling, etc.	Public	48
D5.11	CS3 Requirements specifications report	7 - DNV	Report	Public	12
D5.12	CS3 Product on polar lows	7 - DNV	Websites, patents filling, etc.	Public	48
D5.13	CS3 Evaluation of the polar lows forecast system	35 - UNIRES	Report	Public	48
D5.14	CS3 End-user workshop on polar lows prediction Japan	7 - DNV	Websites, patents filling, etc.	Public	46
D5.15	CS3 End-user workshop on polar lows prediction Norway	7 - DNV	Websites, patents filling, etc.	Public	48
D5.16	CS4 Report on Marine Fisheries Climate services workshop	29 - PFA	Report	Public	12
D5.17	CS4 Marine Fisheries forecasts products	9 - DTU	Report	Public	36

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.18	CS4 Report on the evaluation and valuation of Marine fisheries products	9 - DTU	Report	Public	45
D5.19	CS4 Dissemination of products/end-user workshops for marine fisheries	9 - DTU	Websites, patents filling, etc.	Public	48
D5.20	CS5 Arctic stakeholder Map	15 - IASS	Report	Public	12
D5.21	CS5 Environment scanning workshop and report 1	15 - IASS	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	18
D5.22	CS5 Environment scanning workshop and report 2	15 - IASS	Websites, patents filling, etc.	Public	30
D5.23	CS5 Quantitative and qualitative analysis of the engagement of stakeholders	15 - IASS	Report	Public	48
D5.24	Future Prospects for Climate Services	9 - DTU	Report	Public	48

Description of deliverables

Deliverables
D5.1 CS1 End User Needs Report, Ruka, M4
D5.2 CS1 Model Information Utilization Report, AC UoL, M11
D5.3 CS1 Assessment Methodology Report , AC UoL, M11
D5.4 CS1 Assessment and Evaluation Report, AC UoL, M46
D5.5 CS1 leaflet, AC UoL,46
D5.6 CS1 Regional dissemination seminar, AC UoL, M47
D5.7 CS2 End-user requirements report, ISGlobal, M12
D5.8 CS2 Product Development Report, ISGlobal, M36
D5.9 CS2 Evaluation of the product , ISGlobal, M48
D5.10 CS2 Dissemination of the TRM product, ISGlobal, M48
D5.11 CS3 Requirements specifications report, DNV GL, M12
D5.12 CS3 Product on polar lows, DNV GL, M48
D5.13 CS3 Evaluation of the polar lows forecast system, UNIRES, M48
D5.14 CS3 End-user workshop on polar lows prediction Japan, DNV GL, M46
D5.15 CS3 End-user workshop on polar lows prediction Norway, DNV GL, M48
D5.16 CS4 Report on Marine Fisheries Climate services workshop, PFA, M12
D5.17 CS4 Marine Fisheries forecasts products, DTU-AQUA, M36
D5.18 CS4 Report on the evaluation and valuation of Marine fisheries products, DTU-AQUA, M45
D5.19 CS4 Dissemination of products/end-user workshops for marine fisheries, DTU-AQUA, M48
D5.20 CS5 Arctic stakeholder Map, IASS, M12
D5.21 CS5 Environment scanning workshop and report 1, IASS, M18

D5.22 CS5 Environment scanning workshop and report 2, IASS, M30
D5.23 CS5 Quantitative and qualitative analysis of the engagement of stakeholders, IASS, M48
D5.24 Future Prospects for Climate Services, DTU-AQUA and IASS, M48

D5.1 : CS1 End User Needs Report [4]

CS1 End User Needs Report

D5.2 : CS1 Model Information Utilization Report [11]

CS1 Model Information Utilization Report

D5.3 : CS1 Assessment Methodology Report [11]

CS1 Assessment Methodology Report

D5.4 : CS1 Assessment and Evaluation Report [46]

CS1 Assessment and Evaluation Report

D5.5 : CS1 leaflet [46]

CS1 leaflet

D5.6 : CS1 Regional dissemination seminar [47]

CS1 Regional dissemination seminar

D5.7 : CS2 End-user requirements report [12]

CS2 End-user requirements report

D5.8 : CS2 Product Development Report [36]

CS2 Product Development Report

D5.9 : CS2 Evaluation of the product [48]

CS2 Evaluation of the product

D5.10 : CS2 Dissemination of the TRM product [48]

CS2 Dissemination of the TRM product

D5.11 : CS3 Requirements specifications report [12]

CS3 Requirements specifications report

D5.12 : CS3 Product on polar lows [48]

CS3 Product on polar lows

D5.13 : CS3 Evaluation of the polar lows forecast system [48]

CS3 Evaluation of the polar lows forecast system

D5.14 : CS3 End-user workshop on polar lows prediction Japan [46]

CS3 End-user workshop on polar lows prediction Japan

D5.15 : CS3 End-user workshop on polar lows prediction Norway [48]

CS3 End-user workshop on polar lows prediction Norway

D5.16 : CS4 Report on Marine Fisheries Climate services workshop [12]

CS4 Report on Marine Fisheries Climate services workshop

D5.17 : CS4 Marine Fisheries forecasts products [36]

CS4 Marine Fisheries forecasts products

D5.18 : CS4 Report on the evaluation and valuation of Marine fisheries products [45]

CS4 Report on the evaluation and valuation of Marine fisheries products

D5.19 : CS4 Dissemination of products/end-user workshops for marine fisheries [48]

CS4 Dissemination of products/end-user workshops for marine fisheries

D5.20 : CS5 Arctic stakeholder Map [12]

CS5 Arctic stakeholder Map

D5.21 : CS5 Environment scanning workshop and report 1 [18]
CS5 Environment scanning workshop and report 1
D5.22 : CS5 Environment scanning workshop and report 2 [30]
CS5 Environment scanning workshop and report 2
D5.23 : CS5 Quantitative and qualitative analysis of the engagement of stakeholders [48]
CS5 Quantitative and qualitative analysis of the engagement of stakeholders
D5.24 : Future Prospects for Climate Services [48]
Future Prospects for Climate Services. Partners in charge: DTU and IASS (lead and co-lead of WP5)

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS5	Intellectual Property Records	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners

Work package number [9]	WP6	Lead beneficiary [10]	1 - DMI
Work package title	Clustering for blue growth		
Start month	1	End month	51

Objectives

Objectives: This WP will contribute to the achievement of all objectives listed in Section 1.1 by ensuring a smooth exchange of data and results between projects having common goals and facing common challenges and facing research questions.

Description of work and role of partners

WP6 - Clustering for blue growth [Months: 1-51]
DMI, CMCC, CNRS, DTU, GEOMAR, HAV, KDM, MERCATOR, MPI, NERSC, NERC, SAMS, SRSL, UHAM, WOC, ISGlobal
The text of the BG10 call indicates that Blue-Action must "include a work package to cluster with other projects funded under this topic and if possible under other parts of Horizon 2020 and should build on projects funded under earlier calls". WP Leader: Steffen M. Olsen/DMI. WP co-lead: Jens Hesselbjerg Christensen/DMI

Description of work

Task 6.1: Clustering with research communities focusing on Blue Growth/Arctic impacts [Lead: DMI. Partners: CMCC, UHAM, NERSC, NERC, DTU, MPI, GEOMAR, SAMS, SRLS, Month 1-51, Deliverables associated: D6.1,D6.2, D6.3, D6.4, D6.5]
Blue-Action intends to establish a strong clustering activity with the European and international scientific communities focusing on Blue Growth/Arctic impacts (beyond our own community) and more specifically with: 1) projects funded by the Blue Growth strategy under current and earlier calls; 2) projects funded under other parts of the Horizon 2020 programme relevant for the Blue Growth strategy implementation; 3) Initiatives such as YOPP, PPP, Copernicus, and projects funded by the Belmont Forum/JPI Climate calls. Main outcome will be a series of joint activities for allowing the exchange of data and results between the scientific communities beyond the project.
These communities will be brought into Blue-Action through a process that enables a meaningful exchange and interaction between the products and services that Blue-Action can deliver and the demands and needs of the above mentioned communities. This high level binding framework would maintain coherence with pre-existing initiatives and offer additional possibilities for interaction and networking between existing projects and communities and upcoming ones. Clustering will be fostered to ensure smooth exchange of data and results between projects having common goals: see the list of the deliverables of this work package. So far, we have identified the following projects we intend to cluster with:
Projects funded under the Blue Growth topic under the work programme 2014-2015, especially AtlantOS , EU-PolarNet and AORAC-SA and CERES and by the work programme 2016-2017 especially the BG9 proposal Arctic UNION on Arctic observations and our competitor project under the BG10 call.
• Projects, programs and initiatives that contribute to the aims of Year of Polar Prediction (YOPP) and PPP. Copernicus Programme in its several components; 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) through our partners CMCC, UHAM, MPI involved in these contracts; 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.
• Projects funded under other parts of Horizon 2020 programme, such as e-infrastructures (in particular ESiWACE www.esiwace.eu), and societal challenge 5 relevant for Blue-Action (PRIMAVERA, CRESCENDO) and other societal challenges (SPICES). Clustering with project IMPREX (www.imprex.eu) led by KNMI which also aims at improving the predictability of extreme weather events in current and future climate is also foresee for its relevance for WP1 and/or WP6.
• Projects funded under other EU projects funded under earlier calls such as under the Environment topic (such as ICE-ARC and NACLIM). 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.

• Projects resulting from the JPI Climate call on climate predictability.

Joint workshops ("Mapping the gaps" events) will be organized with the actors listed above to (re)formulate open research questions of joint interest. Currently we have identified the following questions to address together, such as (list non-exhaustive): What are the optimal methods to initialize ocean heat content, snow cover and sea ice to and to represent the initial uncertainty in prediction systems? How is sub-seasonal to seasonal predictive skill modulated by decadal climate variability? Are predictive systems and the observational network adequate to fully exploit the predictive potential related to arctic freshwater storage and release through ocean linkages? How can long-term predictions be used in innovative fisheries and ecosystem services? How will improved representation of small-scale processes of particular relevance for the Arctic affect the two-way linkages between the Polar Regions and lower latitudes? Other topics can be defined with the cluster projects to provide feed to their existing activities and expected deliverables in particular in the case of the projects AtlantOS (D6.4) and AORAC-SA (D6.5).

Task 6.2: Mapping existing scientific knowledge gaps and defining best practice relating to the use of climate predictions in climate change response and adaptation [Lead: DMI, Partners: GEOMAR, KDM, DTU, CMCC, MPI, UHAM, NERSC, NERC, DTU-Aqua and Climate-KIC, ISGlobal, SRSL, Month 1-51, Deliverables associated: D6.1,D6.2, D6.3] As a result of the joint workshops, white papers, the GAP MAPS will be produced as input for the WP8. In WP8, collaborative policy briefings will be organized and the gap maps (D8.11 and D8.16) will be circulated to policymakers involved in determining key policy issues relating to weather, observation, prediction, climate change response and adaptation. This task delivers the "Gap Maps" to Task 8.6.

Participation per Partner

Partner number and short name	WP6 effort
1 - DMI	15.00
4 - CMCC	1.00
5 - CNRS	1.00
9 - DTU	2.00
11 - GEOMAR	1.00
12 - HAV	1.00
18 - KDM	1.00
20 - MERCATOR	1.00
21 - MPI	1.00
25 - NERSC	1.00
28 - NERC	1.00
31 - SAMS	1.00
32 - SRSL	1.00
33 - UHAM	1.00
40 - WOC	1.00
41 - ISGlobal	1.00
Total	31.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D6.1	First Joint workshop to (re)formulate open research questions of joint interest	1 - DMI	Websites, patents filling, etc.	Public	13
D6.2	Second Joint workshop to (re)formulate open research questions of joint interest	1 - DMI	Websites, patents filling, etc.	Public	30
D6.3	Third Joint workshop to (re)formulate open research questions of joint interest	1 - DMI	Websites, patents filling, etc.	Public	40
D6.4	Inputs to AtlantOS project (BG8 H2020 project)	11 - GEOMAR	Websites, patents filling, etc.	Public	36
D6.5	Inputs to AORAC-SA project (BG14 H2020 project)	1 - DMI	Websites, patents filling, etc.	Public	36

Description of deliverables

Deliverables (brief description and month of delivery)
D6.1 First Joint workshop to (re)formulate open research questions of joint interest, DMI, M13
D6.2 Second Joint workshop to (re)formulate open research questions of joint interest, DMI, M30
D6.3 Third Joint workshop to formulate open research questions of joint interest and white paper, DMI, M40
D6.4 Inputs to AtlantOS project (BG8 H2020 project), DMI, M36
D6.5 Inputs to AORAC-SA project (BG14 H2020 project), DMI, M24

D6.1 : First Joint workshop to (re)formulate open research questions of joint interest [13]

First Joint workshop to (re)formulate open research questions of joint interest

D6.2 : Second Joint workshop to (re)formulate open research questions of joint interest [30]

Second Joint workshop to (re)formulate open research questions of joint interest

D6.3 : Third Joint workshop to (re)formulate open research questions of joint interest [40]

Third Joint workshop to (re)formulate open research questions of joint interest

D6.4 : Inputs to AtlantOS project (BG8 H2020 project) [36]

Inputs to AtlantOS project (BG8 H2020 project)

D6.5 : Inputs to AORAC-SA project (BG14 H2020 project) [36]

Inputs to AORAC-SA project (BG14 H2020 project)

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS5	Intellectual Property Records	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners

Work package number [9]	WP7	Lead beneficiary [10]	1 - DMI
Work package title	Management		
Start month	1	End month	51

Objectives

Objectives This WP will contribute to the achievement of all objectives and linked expected impacts (Section 1.1) by supporting the other work packages in their implementation. Additionally, the WP7 will:
• Ensure effective organization and supervision of the project and communication among partners, coordinate project activities and monitor targets.
• Facilitate completion of the outlined objectives and activities to the highest possible standard.
• Facilitate communication between the project partners and the European Commission.

Description of work and role of partners

WP7 - Management [Months: 1-51]
DMI, CNRS, DTU, HAV, MPI, NERSC, NERC, SRSL, UHAM, UiB
WP Leader: Steffen M. Olsen WP co-lead: Daniela Matei MPI

Description of work
The governance structure of the project will comprise a Steering Committee (SC) and a General Assembly (GA), a coordinator and a project office. In addition, two external advisory bodies, in the form of a 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. More details on the organizational structure of the project have been provided in Section 3.2.
Please note:
• The management structure and procedures of the project are extensively described in Section 3.2
• Risk management and innovation management in Section 2
• Dissemination, engagement and exploitation measures as well as communication activities are already described in Sections 2.1-2.3 and further in WP8.
That information is not repeated here below.

Task 7.1 Scientific Coordination of the project [Lead: DMI. Co-lead: MPI, Month 1-51, Deliverable associated: D7.1]
The Coordinator will ensure that planned work is carried out in time and budget. For this he will be supported by the deputy coordinator and the project office. The Coordinator will monitor the scientific review of reports and deliverables to the EC and ensure that any necessary scientific aspects are incorporated into the project. Coordinator is the contact person for the Commission and acts on behalf of the entire consortium. The Coordinator will carry out the coordination and management of the grant in compliance with Grant Agreement Art. 41.2, and is the central contact point of the EC. All beneficiaries will contribute to a smooth and successful implementation of the grant and support the coordinator in its obligations. The coordinator will monitor the scientific excellence within the project. This includes regular discussion with the internal and external advisory bodies. The management processes are described in more detail in Section 3.2. The Coordinator will ensure that planned work is carried out in time and budget. With the support of the deputy coordinator and the Project Office. The Project Office will be set up in month 1 [D7.1]. The Coordinator will monitor the scientific review of reports and deliverables to the EC and ensure that any necessary scientific aspects are incorporated into the project.

Task 7.2 Scientific Coordination of the work packages [Lead: WP Leaders and co-leaders from DMI, MPI, UHAM, HAV, NERC, NERSC, CNRS, UIB, DTU AQUA, DTU Climate KIC, Month 1-51]
The WP leaders will ensure that the progress of milestones and deliverables is actively monitored and that they are delivered on time. They report to the Coordinator and the Project Office.

Task 7.3 Project management and administration [Lead: DMI, Partners: all, Month 1-51]
The project office will be in charge of managing the project using effective management procedures based on the project cycle management formal methodology. The project office will provide administrative / financial / legal support to all partners involved during the implementation of the project, this can include administrative tasks involved in the preparation, executing of and post-processing of major project meetings of the committees and panels. Input from all partners is to be provided in the progress reports and financial reports.

Management: The setting up of a consortium agreement in the very early stage of the project and prior to the signature of the grant agreement. The consortium agreement will regulate the consortium, rules for participation, and ownership and access to key knowledge (IPR, results, etc.).
The Project Office will be in charge of managing the project using effective management procedures based on the project cycle management formal methodology. For more information on the tasks and composition of the Project Office, please refer to Section 3.2.
Administration: The Project Office will provide administrative / financial / legal support to all partners involved during the implementation of the project, this can include administrative tasks involved in the preparation, executing of and post-processing of major project meetings of advisory groups.
Management of the gender dimension: with support from the Project Office, the Coordinator will ensure that gender aspects of the project are fully considered within the research that is being undertaken, and that the project acts to promote gender equality wherever possible. For more details refer to Section 1 and 3.2. A gender strategy will be set up early in the project.
Liaison with the European Commission (EC) includes the preparation of Progress Reports, the Final Report and the Final Report on the EU Financial Contribution Distribution; regular and comprehensive contact with the EC; appropriate follow-up of project obligations from the Grant Agreement (formal reporting: of science results and finances, project reviews, communication, and management); ensuring that an appropriate EC representative is invited to the General Assembly meetings and any other relevant project meetings; If there are any major difficulties within the project that cannot be resolved using the appropriate management structure, the Coordinator will liaise with the EC to seek advice and a solution.

Task 7.4 Risk management [Lead: DMI, Partners involved: MPI, UHAM, HAV, NERC, NERSC, CNRS LOCEAN, UIB, DTU AQUA, DTU Climate KIC, all other partners, Month 1-51, Deliverables associated: D7.2]
Procedures in place for tracking foreseen and unforeseen risks, and implement corrective and mitigation measures. The General Assembly 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, and day-to-day maintenance of the risk registers will be undertaken by the PROJECT OFFICE (for more details refer to Section 3.2.4, para on Risk Management) 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.a.

Task 7.5 Innovation and IPR management [Lead: DMI, Participants: MPI, UHAM, HAV, NERC, NERSC, CNRS LOCEAN, UIB, DTU AQUA, DTU Climate KIC, all other partners, Month 1-51, Deliverables associate: D7.3]
Management of knowledge and innovation is an integral part of our project. We will focus on the role and synergies between partners' experiences, competences, capabilities, and on how partners will protect, share, manage IPR capital actual exploitation. Detailing of the exploitation plans and preparation for innovation activities will be continuously followed up throughout the project. The innovation management is well integrated in the management structure of the project and in the work plan (see Section 3.2.3). The consortium agreement will be set up for regulating the ownership and access to key knowledge (IPR, data etc.) and scientific results. A strategy for the knowledge management, protection and for the dissemination and exploitation of results will be defined for the consortium together with WP8 in the early stage of the project, based on the principles explained extensively in Section 2.2. The strategy will be regularly updated during the entire project. Updates will be submitted to the EC as an integral part of the Project Periodic Reports. In the final report, we will also highlight a strategy for IP exploitation for providing best practices in capturing and assessing the Intellectual Property and providing measures for exploitation after the end of the project. Blue-Action will provide open access to peer-reviewed scientific publications through a combination of golden open access and green open access, and it is taking part in the European Commission Open Access Data Pilot for Research Data (Section 2.2): we have included a Data Management Plan as a deliverable for project-month 6 [D7.3]. This deliverable will evolve during the lifetime of the project and represent faithfully the status of the project reflections on data management. Updates of the data management plan will be provided on a regular basis to the EC, together with the Project Periodic Reports.

Task 7.6: Organization of annual meetings [Lead: DMI, Participants: MPI, UHAM, HAV, NERC, NERSC, CNRS LOCEAN, UIB, DTU AQUA, DTU Climate KIC, all other partners, Month 1-51]
Annual meetings will be organized highlighting the progress achieved during the project for Blue-Action partners and stakeholders. A project kick-off will be organized at the latest in PM4. We will use the annual meetings to monitor the progress of work in these case studies. Minutes of the meeting will foresee a report for each work package and for its case studies, and minutes will be made available to the EC.

Participation per Partner

Partner number and short name	WP7 effort
1 - DMI	39.00
5 - CNRS	2.00
9 - DTU	5.00
12 - HAV	3.00
21 - MPI	3.00
25 - NERSC	3.00
28 - NERC	2.00
32 - SRSL	3.00
33 - UHAM	3.00
34 - UiB	2.00
Total	65.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D7.1	Structure and detailed tasks of the Project Office	1 - DMI	Websites, patents filling, etc.	Public	1
D7.2	Risk register system and procedures	1 - DMI	Websites, patents filling, etc.	Public	3
D7.3	Data management plan (DMP)	1 - DMI	ORDP: Open Research Data Pilot	Public	6
D7.4	Minutes from the first annual meeting	1 - DMI	Report	Confidential, only for members of the consortium (including the Commission Services)	14
D7.5	Minutes from the second annual meeting	1 - DMI	Report	Confidential, only for members of the consortium (including the Commission Services)	26
D7.6	Minutes from the third annual meeting	1 - DMI	Report	Confidential, only for members of the consortium (including the Commission Services)	38

Description of deliverables

Deliverables (brief description and month of delivery)
D7.1 Structure and detailed tasks of the Project Office", DMI, M1

D7.2 Risk register system and procedures, DMI, M3
D7.3 Data management plan, DMI, M6
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
As our project is taking part in the Pilot on Open Research Data, we include a 'data management plan' as a distinct deliverable within the first 6 months of the project. This deliverable will evolve during the lifetime of the project in order to present the status of the project's reflections on data management.

D7.1 : Structure and detailed tasks of the Project Office [1]

Structure and detailed tasks of the Project Office

D7.2 : Risk register system and procedures [3]

Risk register system and procedures

D7.3 : Data management plan (DMP) [6]

Data management plan (DMP): Our action takes part in the Pilot on Open Research Data, thus we have included the data management plan as a distinct deliverable within the first 6 months of the project. This deliverable will evolve during the lifetime of the project in order to present the status of the project's reflections on data management.

D7.4 : Minutes from the first annual meeting [14]

Minutes from the first annual meeting

D7.5 : Minutes from the second annual meeting [26]

Minutes from the second annual meeting

D7.6 : Minutes from the third annual meeting [38]

Minutes from the third annual meeting

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS3	Gender Strategy	1 - DMI	6	Report available online (project website)

Work package number [9]	WP8	Lead beneficiary [10]	32 - SRSL
Work package title	Communication, Dissemination, Engagement and Exploitation (CDEE)		
Start month	1	End month	51

Objectives

Objectives This WP will contribute to achieving the following objectives (Section 1.1):
Objective 7: Fostering the capacity of key stakeholders to adapt and respond to climate change and boosting their economic growth;
Objective 8: Transferring knowledge to a wide range of interested key stakeholders

Description of work and role of partners

WP8 - Communication, Dissemination, Engagement and Exploitation (CDEE) [Months: 1-51]
SRSL, DMI, AC UoL, ALM, CMCC, CNRS, CTL, DNV, DPPO, DTU, FI, GEOMAR, HAV, IAP NCZ, IAP RAS, IASS , IMEMO, KDM, MEOPAR, MERCATOR, MPI, MRI, MSS, UCAR, NERSC, NIOZ, NLeSC, NERC, PFA, RUKA, SAMS, UHAM, UiB, UNIRES, UoS, UoW, UREAD, WHOI, WOC, ISGlobal
WP Leader: Raeanne Miller/SRSL. WP Co-leader: Peter Vangsbo Normann/Climate KIC.
Description of work
The key stakeholder communities identified from the priorities in the call text have been identified as: Project partners, Business sector end users, Policy makers, Public and wider society, Wider scientific community, Environmental and scientific editors in trade publications and broader, public media, European Higher Education course leaders and Meteorological Office training facilities delivering climate science or related topics, European Commission services. WP8 will amalgamate the case studies from the 'lighthouse' projects created in WP5 with the clustering activities and best practice from WP6 to reach mass audiences and maximise impact from the project. This will amplify the communications at each stage; reaching larger audiences as the project progresses.

Task 8.1 Communication [Lead: Climate KIC; Participants: SRSL, MPI, All partners, Month 12-48, Deliverables associate: D81, D8.2, D8.3, D8.4]
The communication of the project will be a continuous process supported by all project partners, (and their PR staff and researchers,) and stakeholders to ensure integration, continuity and to maximise impact and reach. Currently, the communication and dissemination matrix in Section 2 is a draft plan for the first 6 months of the project. The matrix outlines the targeted strategy for each key target audience and addresses audiences on local, regional, national, European and global levels. It will be then updated and enhanced with the first progress report.
A Communication and Dissemination Plan: Matrix update (D8.1) will be further developed early in the project , detailing the matrix proposed in Section 2, and proposing measures for social media and press engagement. Key Marketing Communications Methods are also a project website (D8.3), and the communication and dissemination calendar (in each WP (e.g. events, speaking engagements and scientific publications) and be published in the intranet and on the website and disseminated to the partners. To further amplify key communication messages, activity will include feedback loops to members of the case study projects (WP5), and the activity through clustering activities (WP6), and combined efforts with other work packages will be explored and incorporated. The communications plan is a combination of two-way and one-way communications. The two-way methods will facilitate knowledge exchange to ensure the project outcomes are relevant and delivered in a way that maximises outcomes of the project. The one-way communication methods e.g. PR / website / policy briefs will reach a larger audience interested in science projects and results, and/or climate change research at lower cost. The project will further maximise impact by employing existing resources in place at each partner Institute (e.g. professional press and communication offices) and utilising scheduled, complementary scientific events for promotional activities (WP 1-6). Efficient internal communication will be ensured by the set-up of an intranet for the partners and stakeholders to share knowledge and let information flow (D8.2).

Task 8.2 Dissemination of results [Lead: SRSL; Participants: All Partners, Month 12-48, Deliverables associated: D8.1, D8.4]
Dissemination is understood as "the public disclosure of the results by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific publications in any medium". Project results will be disseminated to a full range of potential users and uses including research, commercial, investment, social, environmental, policy making, setting standards, skills and educational training, with the contribution of all partners.

Preliminarily we have outlined these audiences in the Section 2 communication and dissemination matrix. This will be further enhanced in the Communication and Dissemination Plan (D8.1 and D8.4).
Peer-reviewed scientific publications resulting from the project will be published in open access formats, to support further research projects. More information about the strategy for ensuring compliance with EC Open Access requirements is provided in Section 2 of the application.
Dissemination events will be accessible via video conference and/or recorded wherever possible for wider dissemination: This will broaden inclusion and allow remote access, especially for people unable to travel to meetings. This will also provide a bank of material available for educational purposes (Task 8.5).
Outcomes of the activities carried out specifically in WP5 and WP6 will be further proving feed for the dissemination activity for business audiences (Task 8.5) and policy-makers (Task 8.6), indigenous communities and environmental NGOs (Task 8.7)

Task 8.3 Exploit the project outputs [Lead: SRSL; Participants: All Partners, Month 12-48, Deliverables associate: D8.12]
Exploitation is understood as the "utilization Blue-Action products and results in research activities which are not part of the Blue-Action project, as well as their utilization for further development, creation and marketing of products/ services and processes". Blue-Action will secure foundations for maximising and protecting the intellectual property outputs in the consortium agreements (WP7). Additionally, early in the project we will define a more detailed strategy for knowledge management, protection and for the exploitation of results, 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. All partners will be actively involved in the exploitation activities, which go hand in hand with a proactive strategy for knowledge protection and management. Possible exploitation measures will be explored with the advice of the RIAG . Regular updates of the plan will be submitted to the European Commission as an integral part of the Progress Reports.

Task 8.4 Improve the professional skills and competences for those working and being trained to work within this subject area [Lead: SRSL; Participants: Climate KIC, KDM, SRSL, All university partners involved, Month 6-48, Deliverables associate: D8.6]
This task will target four key audiences, and for each of them we have planned detailed activities for improving their professional skills and competences.
1-Business stakeholders (Lead: Climate KIC, Partner: SRSL): maximising their capacity to understand and adapt to climate change. This will be achieved by reversing the results of the workplan in WP5 to larger business audiences (see the Task 8.5) in the form of training materials (documentation and videos).
2-Policymakers (Lead: KDM, Partner: SRSL) to enable them to make improved policy decisions based on the latest scientific knowledge: taking the results from the activities planned in WP6 and preparing policy briefings for policymakers involved in determining key policy issues relating to weather observation, prediction, climate change response and adaptation. An element of training and continuing professional development will be included in policy reports and briefings (D8.11 and D8.16) to bridge gaps between data-provider (WP1-4) and data users.
3-Higher education students and trainees (Lead: SRSL, Partner: All project partners in HE) preparing to work in meteorology and/or climate change. Scientific publications, technical articles, recorded workshops (WP5), infographics, results of the annual project meetings and of the project activities will be openly available in ZENODO and will also be transferred and shared with course leaders of higher education / meteorological training programmes operated/ implemented at the participating institutes e.g. Marie Sklodowska-Curie Actions (ITN/ETN C-Cascades, COMPLETE, AMOR, VOYAGE), ERASMUS+ and Doctoral Training Programmes.
4-Project partners, as part of their career development (Lead: SRSL, Partner: all) To ensure that IP created within the project can be transferred properly to stakeholders for enhancing their capacity to adapt to climate changes, we need to strengthen the competences of the scientist in dealing 1) with this tech-transfer process and 2) science communication. For 1) we have planned to have workshops on IP, IP Management and IP impact and innovation with the support of the trainers of the European IPR Helpdesk. For 2) we have planned to have training sessions and best practice guidance notes on Earth System science communication to public and policy makers with the support of special trainers. A plan of action (D8.6) will provide further detail on the specific measures to be implemented during the course of the project. Due to the nature of the University of the Highlands and Islands, of which SAMS and SRSL are a partner, there is already a large degree of expertise and experience in conducting day to day university work and successful events via videoconferencing.

Task 8.5 Engagement with business sector [Lead: Climate KIC; Participants: DTU AQUA, SRSL, DNV GL, UNIRES, DMI, AC UoL, WOC, Month 6-48, Deliverables associate: D8.13, D8.14, D8.15]
Our action here will be two-fold:

1) Startup companies - emerging business actors - who need climate and weather data for developing new innovative services or products, or for enhancing their existing core business activities to better service their customer sectors that rely on improved forecasting capacity. The project will open a match making dialogue between them, (as users of the project modelling data) and the core scientific groups (WP1-4). The match making is seen to support emerging business actors in rethinking and redesign/shaping their business model, boosting new ideas which can stimulate growth and establishing new products and services in the market with the support of the spatial hemispheric climate data they can receive from this project and the scientific network behind the project.
2) Established businesses in 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, and others who rely on improved weather and climate forecasts. This will be achieved through both the Climate KIC and the World Ocean Council and will support their partner businesses in developing sustainable business models and/or strategies that improve their capacity to respond to the impact of climate change.
Engaging with emerging business actors: 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 integrates 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, bringing together, and empowering a dynamic community to build a zero carbon economy and climate resilient society. The vision with engaging with emerging business actors is to enable Europe to lead the global transformation towards sustainability. The Climate KIC provides Climate-KIC's startups' community with innovative and imaginative platforms for developing solutions to climate change via a dynamic alliance of Nordic partners drawn from academia, industry and the public sector. The project relies on this alliance and on the existing Climate KICs network of startups. A number of startups incubated by the Climate KIC will be involved in the project activities as potential users and testers of specific project results (WP5). The goal is to establish an Open Innovation and information flow –a dialogue- between the KIC startups and the project scientists, going beyond the cooperation achieved in WP5, and fostering cross-fertilisation of ideas, inspiration and synergies in other business sectors where companies incubated by the Nordic Climate KIC are establishing their products/services. (D8.13 and D8.14)
Engaging with established industries: Climate KIC and the WOC engage with 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. Ocean industries are not engaged in a systematic, comprehensive, coordinated, cross-sectoral way in many of the processes related to climate change. Existing business fora engage the diverse global business community in a number of events and in leading the development of an international, multi-industry Arctic business leadership groups involving established companies. Through targeted panel sessions at these events, (D8.5), the project will explore possibilities to explore ways for implementing a Sustainable Arctic Business Development strategy (D8.15) based on the results of this project. The purpose of this business development strategy is to contribute to an understanding of the opportunities and challenges for sustainable regional development with a focus on key private sector business activities in the Nordic Arctic.

Task 8.6 Engagement with policy and decision-makers [Lead: KDM, DMI, SRSL, DTU, MPI, CNRS, UNIRES, Month 1-51, Deliverables associate: D8.11 and D8.16]
To ensure the results are taken up by decision-makers at European and global levels, and being re-used at specific level, a number of engagement tools have been planned. This task will establish links to:
Policy-makers involved in developing climate and related policies and those charged with implementing those policies at European level. This includes representatives of all European Institutions, Joint Programming Initiatives (JPI Climate, JPI Oceans), International bodies, including both governmental and non-governmental, tasked with researching and combating climate change, Relevant actors of the Transatlantic Ocean Research Alliance. Via the clustering activity in WP6 (Clustering for blue growth) with other scientific communities beyond this project, and the GAP MAPS (Gap maps drafted as an outcome of the exchanges with the scientific communities in WP6, these maps indicate what we know and do not know in terms of forecasting and climate adaptation) we will provide policy makers, mostly at European level, with key scientific inputs for policy making. WP8 takes those gap maps and ensure they reach the right policymakers through policy briefing. It is envisaged that collaborative policy briefings and gap maps will be circulated to policymakers involved in determining key policy issues relating to weather observation, prediction, climate change response and adaptation. Policy reports -which contain the gap maps-and briefings will be prepared by the projects and presented at two briefings held in months 15 and 50 (D8.11 and D8.16). Activities will ensure regular dissemination of project outcomes using the methods above, ensuring adequate dialogue for use in policy action at local/national and European level to influence policy-making.

Task 8.7 Engagement with the indigenous communities and NGOs [Lead: DMI; Participants: AC UoL, SRSL, All partners, Month 6-48, Deliverables associate: D8.7-D8.10]

The Societal Engagement Group (SEG) is one of the advisory groups established for this project to advise the Blue-Action community on the basis of a circular / knowledge exchange process. It will ensure communities quickly understand the objectives of the project and the potential impacts of more reliable climate forecasting and re-use of the results for their own activities and strategies. The key engagement methods at this stage are two-way, designed to inform the research and ensure scientific excellence, and to share findings to maximise impacts through Knowledge Exchange meetings to be held at the project annual meeting. Reports provide the feed to the communities' agendas

Participation per Partner

Partner number and short name	WP8 effort
1 - DMI	10.00
2 - AC UoL	1.00
3 - ALM	0.50
4 - CMCC	0.50
5 - CNRS	1.00
6 - CTL	0.50
7 - DNV	1.00
8 - DPPO	0.50
9 - DTU	17.00
10 - FI	0.50
11 - GEOMAR	0.50
12 - HAV	0.50
13 - IAP NCZ	0.50
14 - IAP RAS	0.50
15 - IASS	0.50
17 - IMEMO	0.50
18 - KDM	6.00
19 - MEOPAR	0.50
20 - MERCATOR	0.50
21 - MPI	1.00
22 - MRI	0.50
23 - MSS	0.50
24 - UCAR	0.50
25 - NERSC	0.50
26 - NIOZ	0.50
27 - NLeSC	0.50
28 - NERC	0.50
29 - PFA	0.50
30 - RUKA	0.50
31 - SAMS	0.50

Partner number and short name	WP8 effort
32 - SRSL	20.00
33 - UHAM	0.50
34 - UiB	0.50
35 - UNIRES	1.00
36 - UoS	0.50
37 - UoW	0.50
38 - UREAD	0.50
39 - WHOI	0.50
40 - WOC	2.00
41 - ISGlobal	1.00
Total	75.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D8.1	Communication and Dissemination plan: Matrix update	32 - SRSL	Report	Public	3
D8.2	Intranet for internal communication	21 - MPI	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D8.3	Project website	21 - MPI	Websites, patents filling, etc.	Public	1
D8.4	Communication and Dissemination plan	9 - DTU	Report	Confidential, only for members of the consortium (including the Commission Services)	6
D8.5	Presence at SOS 2016 for networking and visibility	40 - WOC	Report	Public	1
D8.6	Programme on Professional Development	32 - SRSL	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	6
D8.7	SEG Knowledge exchange 1	1 - DMI	Websites, patents filling, etc.	Public	12

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D8.8	SEG Knowledge exchange 2	1 - DMI	Websites, patents filling, etc.	Public	24
D8.9	SEG Knowledge exchange 3	1 - DMI	Websites, patents filling, etc.	Public	36
D8.10	SEG Knowledge exchange 4	1 - DMI	Websites, patents filling, etc.	Public	48
D8.11	Policy briefing 1	18 - KDM	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	15
D8.12	Exploitation plan	32 - SRSL	Report	Public	12
D8.13	Roadshow showing the mid-term results of WP5 to larger business audiences	9 - DTU	Websites, patents filling, etc.	Public	24
D8.14	Meet and Pitch- Co-working edition	9 - DTU	Websites, patents filling, etc.	Public	46
D8.15	Industry-science panel session on “Industry Developments, Opportunities and Challenges in the Arctic: Sustainable Arctic Business Development”	9 - DTU	Websites, patents filling, etc.	Public	50
D8.16	Policy briefing 2	18 - KDM	Websites, patents filling, etc.	Confidential, only for members of the consortium (including the Commission Services)	50

Description of deliverables

Deliverables (brief description and month of delivery)
D8.1 Communication and Dissemination plan: Matrix update, SRSL, M3
D8.2 Intranet for internal communication, MPI, M3
D8.3 Project Website, MPI, M1
D8.4 Communication and Dissemination plan, Climate KIC, M6
D8.5 Presence at SOS 2016 for networking and visibility WOC, M1
D8.6 Programme of Continuing Professional Development, SRSL, M6
D8.7 SEG Knowledge exchange 1, DMI, M12
D8.8 SEG Knowledge exchange 2, DMI, M24
D8.9 SEG Knowledge exchange 2, DMI, M36
D8.10 SEG Knowledge exchange 4, DMI, M48

D8.11 Policy briefing 1, KDM, M15
D8.12 Exploitation plan, SRSL, M12
D8.13 Roadshow showing the mid-term results of WP5 to larger business audiences, DTU-AQUA, M24
D8.14 Meet and Pitch- Coworking edition, Climate KIC, M46
D8.15 Industry-science panel session on “Industry Developments, Opportunities and Challenges in the Arctic: Sustainable Arctic Business Development”, Climate KIC, M50
D8.16 Policy briefing 2, KDM, M50

D8.1 : Communication and Dissemination plan: Matrix update [3]

Communication and Dissemination plan: Matrix update

D8.2 : Intranet for internal communication [3]

Intranet for internal communication

D8.3 : Project website [1]

Project website

D8.4 : Communication and Dissemination plan [6]

Communication and Dissemination plan. Partners in charge: Climate KIC (DTU) and SRSL

D8.5 : Presence at SOS 2016 for networking and visibility [1]

Visibility action at the SOS2016 event in Rotterdam (beginning of December 2016) is planned to allow networking with the industrial sector. We will take advantage of the industry-science panel session on Arctic matters at the event. DMI and WOC to deliver on this together.

D8.6 : Programme on Professional Development [6]

Programme on Professional Development

D8.7 : SEG Knowledge exchange 1 [12]

SEG Knowledge exchange 1

D8.8 : SEG Knowledge exchange 2 [24]

SEG Knowledge exchange 2

D8.9 : SEG Knowledge exchange 3 [36]

SEG Knowledge exchange 3

D8.10 : SEG Knowledge exchange 4 [48]

SEG Knowledge exchange 4

D8.11 : Policy briefing 1 [15]

Policy briefing 1

D8.12 : Exploitation plan [12]

Exploitation plan

D8.13 : Roadshow showing the mid-term results of WP5 to larger business audiences [24]

Roadshow showing the mid-term results of WP5 to larger business audiences. Partner in charge is DTU Aqua.

D8.14 : Meet and Pitch- Co-working edition [46]

Meet and Pitch- Co-working edition. Partner in charge: Climate-KIC at DTU.

D8.15 : Industry-science panel session on “Industry Developments, Opportunities and Challenges in the Arctic: Sustainable Arctic Business Development” [50]

Industry-science panel session on “Industry Developments, Opportunities and Challenges in the Arctic: Sustainable Arctic Business Development”. Partner in charge: Climate-KIC at DTU.

D8.16 : Policy briefing 2 [50]

Policy briefing 2

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Kick-off held	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet

1.3.4. WT4 List of milestones

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
MS1	Kick-off held	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	1 - DMI	4	Report on kick-off, on internal procedures established, all materials available on the website, press releases of the event. PP in charge: DMI.
MS2	Risk monitoring procedures established	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	1 - DMI	3	Risk register and relevant procedures in place and available in the intranet
MS3	Gender Strategy	WP7	1 - DMI	6	Report available online (project website)
MS4	Guidelines how to quantify extremes in models using EVT	WP1	38 - UREAD	18	analysis routines uploaded to data server
MS5	Intellectual Property Records	WP1, WP2, WP3, WP4, WP5, WP6	32 - SRSL	45	Centrally held record of IP created under the project, built from annual IP submissions by partners
MS6	Workshop on results benchmark multi-model ensemble prediction and select case studies for the following tasks	WP4	25 - NERSC	18	Short report synthesising the results and describing the selected case studies to all WP4 partners
MS7	Design the coordinated sensitivity prediction experiments	WP4	36 - UoS	18	Design protocol available to all Task 4.3 partners
MS8	Assessment of heat transport and distribution in the high Arctic in eddy resolving model	WP2, WP3	5 - CNRS	24	Identification of robust metrics
MS9	Coupled reanalysis of the Arctic climate	WP2, WP3, WP4	5 - CNRS	24	Two novel climate reanalyses made available to the project for evaluation (WP2), process analysis (WP3) and predictability studies (WP4).

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	Key staff assigned to project become unavailable for any reason (all)	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	All consortium members to have appropriate succession planning, with deputies for all key roles appointed. Coordinate between partners to ensure expertise is available.
2	Individual partners are unable to complete their assigned tasks (all)	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	Regular communications led by Coordinator and the project office between WPs to monitor progress, gain early sight of issues and manage/ reassign work/resources as required.
3	Reporting: hiccups in the reporting (progress, finances, dissemination activities) to the coordination and to the EC because of the large partnership	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	Strong role of the project coordination and of the project office in providing the glue for the consortium, strong role of the WPL and co-leaders. Regular web meetings with WPL and co-leaders, intranet for facilitating the information flow within the consortium. Regular reminders to all partners to track down dissemination activity and inform about project status.
4	Societal Engagement Group Resignations, Members leaving	WP8	Every effort will be made to understand the objectives of each member organisation prior to the final set up of the groups; ensuring their involvement benefits to them, their organisation and the Blue-Action project. Expenses will be paid and communication will be regularly maintained.
5	Delay in coordinated prediction experiments: Individual partners cannot complete their prediction experiments in Tasks 4.2 and 4.3	WP4	Reducing number of ensemble members for individual partners or reassigning individual experiments to other partners will be considered. The multi-model approach ensures that research questions can be addressed even if individual partners cannot complete their experiments in time.
6	Coordinated prediction experiments give rather different results, not allowing robust conclusions	WP4	Predictive capacity assessment in the individual models will be done in a mechanistic approach, which can help to understand possible different responses in the models.
7	Hickups in the internal communication	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	1) strong role of the coordination in coordinating the flow of scientific information, 2) technical tools made available by WP8 (intranet) for allowing this flow, 3) strong role of the Project Office in pushing information through all channels within the consortium

1.3.6. WT6 Summary of project effort in person-months

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total Person/Months per Participant
1 - DMI	24	4	9	23	0	15	39	10	124
2 - AC UoL	0	0	0	0	25	0	0	1	26
3 - ALM	0	0	0	0	14	0	0	0.50	14.50
4 - CMCC	16	0	9	11	0	1	0	0.50	37.50
5 - CNRS	6	18	36	19	0	1	2	1	83
6 - CTL	6	0	0	0	0	0	0	0.50	6.50
7 - DNV	0	0	0	0	10	0	0	1	11
8 - DPPO	0	0	0	0	3	0	0	0.50	3.50
9 - DTU	0	0	0	0	25	2	5	17	49
10 - FI	0	0	0	0	4.50	0	0	0.50	5
11 - GEOMAR	16	9	0	0	0	1	0	0.50	26.50
12 - HAV	0	18	0	0	6	1	3	0.50	28.50
13 - IAP NCZ	0	0	20	0	0	0	0	0.50	20.50
14 - IAP RAS	0	0	12	0	0	0	0	0.50	12.50
15 - IASS	0	0	0	0	23	0	0	0.50	23.50
16 - IC3	0	0	0	0	0	0	0	0	0
17 - IMEMO	0	0	0	0	4.50	0	0	0.50	5
18 - KDM	0	0	0	0	0	1	0	6	7
19 - MEOPAR	0	6	0	0	0	0	0	0.50	6.50
20 - MERCATOR	0	0	0	1	0	1	0	0.50	2.50
21 - MPI	0	4	22	34	0	1	3	1	65
22 - MRI	0	6	0	0	0	0	0	0.50	6.50
23 - MSS	0	3	0	0	0	0	0	0.50	3.50

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total Person/Months per Participant
24 - UCAR	0	4	0	12	0	0	0	0.50	16.50
25 - NERSC	0	4	34	6	0	1	3	0.50	48.50
26 - NIOZ	0	7	0	0	0	0	0	0.50	7.50
27 - NLeSC	0	9	10	23	0	0	0	0.50	42.50
28 - NERC	0	18	0	0	0	1	2	0.50	21.50
29 - PFA	0	0	0	0	3	0	0	0.50	3.50
30 - RUKA	0	0	0	0	7	0	0	0.50	7.50
31 - SAMS	0	0	0	0	0	1	0	0.50	1.50
32 - SRSL	0	9	0	0	2	1	3	20	35
33 - UHAM	24	3	0	0	0	1	3	0.50	31.50
34 - UiB	0	18	0	25	0	0	2	0.50	45.50
35 - UNIRES	10	4	5	0	5	0	0	1	25
36 - UoS	0	5	10	16	0	0	0	0.50	31.50
37 - UoW	0	4	0	0	0	0	0	0.50	4.50
38 - UREAD	16	0	0	0	0	0	0	0.50	16.50
39 - WHOI	0	12	12	0	0	0	0	0.50	24.50
40 - WOC	0	0	0	0	0	1	0	2	3
41 - ISGlobal	0	0	0	0	24	1	0	1	26
Total Person/Months	118	165	179	170	156	31	65	75.50	959.50

1.3.7. WT7 Tentative schedule of project reviews

Review number [19]	Tentative timing	Planned venue of review	Comments, if any
RV1	21	TBD	
RV2	39	TBD	
RV3	51	TBD	

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent fillings, videos, etc.
OTHER	
ETHICS	Ethics requirement

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU	Public
CO	Confidential, only for members of the consortium (including the Commission Services)
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
EU-SEC	Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number:MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

VA	if virtual access,
TA-uc	if trans-national access with access costs declared on the basis of unit cost,
TA-ac	if trans-national access with access costs declared as actual costs, and
TA-cb	if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.