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CS2 Temperature-related human mortality (TRM) in European regions

ISGlobal has been interviewing many potential (both European and non-European) international end-users including international organisations, and fitting models with observational datasets (E-OBS dataset) and climate change simulations (ISIMIP2b experiment) from outside the project.

As a first step, ISGlobal gave a general overview of the objectives and methodologies of the project to scientists from outside the climate community, and explained the main characteristics of the prototype of a heat-health early warning system that is going to be created within the temperature-related mortality case study.

Secondly, ISGlobal have compiled information from previous and ongoing initiatives in the domain of heat stress and human health.
This point has been oriented towards three main areas:

- which are the main requirements in terms of climate observations and simulations for the development of a heat-health action plan?,
- which are the best statistical or epidemiological methods to fit the climate and mortality data?, and
- which is the best way to depict the information derived from the product so that it is easily understood by decision-makers and the general public?

ISGlobal found that the heat-health action plans in the United States, England and Germany are some of the most advanced operational systems available to date. The most sophisticated system is found in Germany, which is based on a human energy balance model of a human body used to compute the perceived temperature. Systems based on regionally-dependent temperature thresholds are however more widespread, such as in England, which uses temperature as the only climate variable. Most of the European countries have similar heat-health action plans, but they only provide information at the regional scale, and do not use weather or climate forecasts with lead times beyond 1 to 2 days.

Requirements of ISGlobal

In past projects, the ISGlobal team used seasonal and subseasonal forecasts of ECMWF System4 at lead times 1, 4, 8, 11, 15 and 18 days and 1 and 3 months before August 1st 2003 to predict the mortality excess in Europe for the 2003 heat wave (period 1-15 August 2003), expressing the prediction skill as a function of the above-mentioned 8 lead times (Lowe et al. 2015, 2016). Optimally, at some point during the project, ISGlobal would like to expand the work done for that paper and systematically predict all summers at different lead times and, if possible and time allows, also for winters. For ISGlobal, it is crucial that the daily time series of the forecasts are available because the ISGlobal models use the (lagged) relationships between daily climate variables and daily mortality, even if this is only used to infer at the end the overall seasonal (subseasonal) mortality exceedance.

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The ISGlobal team normally works with the gridded E-OBS (regular grid) at a resolution of 0.25º, another possibility is to work 0.5º (e.g. ISIMIP). Coarser resolutions would not be however fine enough for some of the smaller European regions to work with. If the resolution is 1º, but still, regions to work with can be reformulated. The ISGlobal team has mortality data at the NUTS2 level in 16 European countries, but can work at the NUTS1 level if necessary https://en.wikipedia.org/wiki/Nomenclature_of_Territorial_Units_for_Statistics
On this item, the discussions are still ongoing and the unit of analysis will depend on the climate or weather forecast service that is going to be finally used.

The essential variable we need is daily mean 2m temperature, and would appreciate to have either daily mean surface relative humidity or daily mean 2m dew point temperature. Other potentially useful variables are daily maximum and minimum 2m temperature, although they are not key if the dataset size is too big. ISGlobal is only interested in land values (need for a land-sea mask, or files could be provided with the mask already applied).

The more issuing dates of the forecasts, and the longer the time period with forecasts, the better. The ISGlobal team has mortality data for 1998-2012, so at the very least it would be preferable to have access to data for this period (including hindcast). There is the possibility to be open to longer periods, and work with all the target seasons, but ISGlobal has particular interest with especially JJA (June-July-August) and, to a lesser extent, DJF (December-January-February), given that winter mortality is affected by external factors with largely independent dynamics such as the seasonal spread of infectious diseases (e.g. influenza).

ISGlobal is evaluating different climate and weather services that can be used. On the one hand, seasonal (subseasonal) forecasts can be provided by WP1. One the other hand, ISGlobal will explore alternative weather services, such as the European Centre for Medium-Range Weather Forecasts (ECMWF), which provides ensemble weather forecasts for Europe. One of the potential ECMWF products to be used is the Atmospheric model Ensemble 15-day forecast (ENS). More specific information for each is described in the next section.

If climate data is finally obtained from WP1, and depending on the size of datasets, ISGlobal might need that WP1 to extract the data only for the European domain (the smallest domain would be 15ºW-25ºE, 35ºN-60ºN). And if the files are still too big, ISGlobal might need to provide partners UHAM/CMCC with a R script that computes the regional averages of the main climate variables (although we would prefer to avoid that and have the original files). An easy way to download the data (e.g. linux script similar to that available to download data from CMIP, ISIMIP or EURO-CORDEX) would also be preferred.

Data source Nr. 1

Provider:

ISGlobal identifies different climate and weather forecast data providers:

- Climate forecast data: WP1 can offer model output that covers time-scales of seasonal variability. The two groups that offer such data in WP1 are CMCC and UHAM. Specifically, UHAM has

experiments (hindcasts) starting every November and May (between about 1980 to 2016) for 6 months each. We have differing spatial, temporal resolution.
One of the main limitations of using data from WP1 is the relatively lower frequency of forecast issuing dates (once per month), which does not allow to comprehensively perform a predicatibility skill analysis at lead times of up to 1 or 2 weeks, as stressed by the end-users.

- Weather forecast data: ENS provides weather forecasts that covers lead-times up to 15 days. ENS has ensemble weather post-processed forecasts available at 00/12 UTC and with a resolution of 0.2° x 0.2° lat/long grid (20 km approx.). Even though daily weather data is only available since October 2006, ISGlobal can use these forecasts to create and validate the prototype of the heat-health early warning system. Indeed, considering that the mortality database is available from 1998 to 2012, these weather forecasts cover six full summers and six full winters. Moreover, ISGlobal will also explore other alternatives products of ECMWF, in order to have a longer temporal domain that cover the whole mortality period.

Which data have been provided:

	Data provider UHAM	**Data provider CMCC**	**Data provider ENS-ECMWF**
Main variables ? Which of the variables specified in my email are available ? i.e. daily mean 2m temperature, daily mean surface relative humidity, daily mean 2m dew point temperature, daily maximum and minimum 2m temperature	All variables you listed are available as 6-hourly data, daily data need to be calculated, except the 2m daily mean temperature	All these variables should be available	All variables previously specified are available (2m mean, maximum and minimum temperature; 2m dew point temperature)
Temporal resolution:	6-hourly	6-hourly for T2m and Humidity (Tmax and Tmin are daily)	6-hours intervals
Are daily files available?	Daily files might not be available for all variables you needed, currently I have only 2m daily mean temperature	Yes.	Yes

	Data provider UHAM	**Data provider CMCC**	**Data provider ENS-ECMWF**
Do we need to access to 3h or 6h files and then make the daily averages?	Basically yes, you need an access to 6-hourly data, or we could post-process data for, depending on my time schedule it can take some time	We can provide daily averages.	Daily weather forecasts can be provided (more likely to use forecasts at 00h)
Spatial resolution: Which is the maximum resolution?	1.875 degrees	1 degree	0.2 degrees
Temporal domain: 1980-2016	1980-2017.04, due to first initialisation in 1979 we are not analysed our data before 1982	From 1993 onwards	From October 2006 onwards
Spatial domain: global?	Global.	Global	Global
Is it possible to have access to files showing information only for Europe?	no, we don't have any regional subdomains	No, we don't have any regional subdomains. Regional subdomains should be created ad hoc.	Yes
Number of ensemble members:	30	40	51
Issuing dates:	every year in Nov 1st and May 1st	Every month	00 UTC and 12 UTC
Model integration: 6 months?	6 months	6 months	15 days

	Data provider UHAM	**Data provider CMCC**	**Data provider ENS-ECMWF**
File size? Please give estimation per each 6-month model integration for each spatio-temporal resolution	About 3.8 Gb for one 6-hourly 2D field over full time (1979-2017.04) for one ensemble member about 0.9 Gb for a daily mean 2D field over full time for one ensemble member	Re-forecast data are huge: 40 members for each month (12) of the period 1993-2016 (24 years). 40 x 12 x 24 = 11520 simulations, each constituted of two tar zipped files that sum up to 16 GB. This means we stored about 190 TB of data (1° resolution for the atmosphere, 0.25° for the ocean). 1 file with 1 2D variable on daily basis, global domain, for 6 months is about 45 Mb (1 member only).	We are not able to provide this information yet
Data access: ftp only? Is there any other way to access to data? e.g. CMIP scripts?	our data are not on the CMIP server, ftp would be our preference	It will be possible to access our forecast and re-forecast data through Copernicus from January 2018.	Data can be downloaded by ftp after register is accepted. Register has been accepted after acknowledging that data is for the Blue-Action project.

Data source Nr. 2

Provider: City Council of Almada

What has been provided:

Population:

- Number of inhabitants of Almada in Census 1991, 2001, 2011 (Excel format):
  Resident population (No.) by Place of residence Sex and Age group; Decennial. (Official data from Statistics Portugal) *(Please see the metada in the file)*
- Annual estimates (1991 to 2017) (Excel format):
  Resident population (No.) by Place of residence (NUTS - 2013), Sex and Age group; Annual (Official data from Statistics Portugal) *(please see the metada in the file)*
- CM Almada Internal Study "The population - volume, structure and distribution - in the county of Almada, in 2031 from the application of the cohort-survival model" (pdf) (Draft version, in Portuguese)

Temperature data:

- Daily mean temperature report from 2000 to 2015, from a weather station located in Monte de Caparica (pdf and csv format). (*Daily mean temperature includes 24 hours of observations (hourly temperature, 09:00-09:00 UTC)*
- Weather station metadata (pdf)

Weather station name	Monte da Caparica
Station Code	22B/01C
Latitude and longitude coordinates	38.660921, -9.202774
Source	Portuguese Environment Agency, National Water Resources Information System (https://snirh.apambiente.pt)
Type of data:	non validated values

Georeferenced data:

Shapefile with the limits of Almada's civil parish

Specific analyses for Almada:

ISGlobal will conduct some analyses for the city Council of Almada:

- Calibration of the temperature-related mortality model, based on historical weather data already provided for Almada.
- Heat-health early warning system for the city of Almada, where climate (seasonal/subseasonal/weather) forecasts will be selected by interpolation or from the nearest grid-cell point to Almada city.

References

Lowe, R., Ballester, J., Creswick, J., Robine, J.-M., Herrmann, F. R., & Rodó, X. (2015). *Evaluating the Performance of a Climate-Driven Mortality Model during Heat Waves and Cold Spells in Europe*. International Journal of Environmental Research and Public Health, 12(2), 1279–1294. https://doi.org/10.3390/ijerph120201279

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