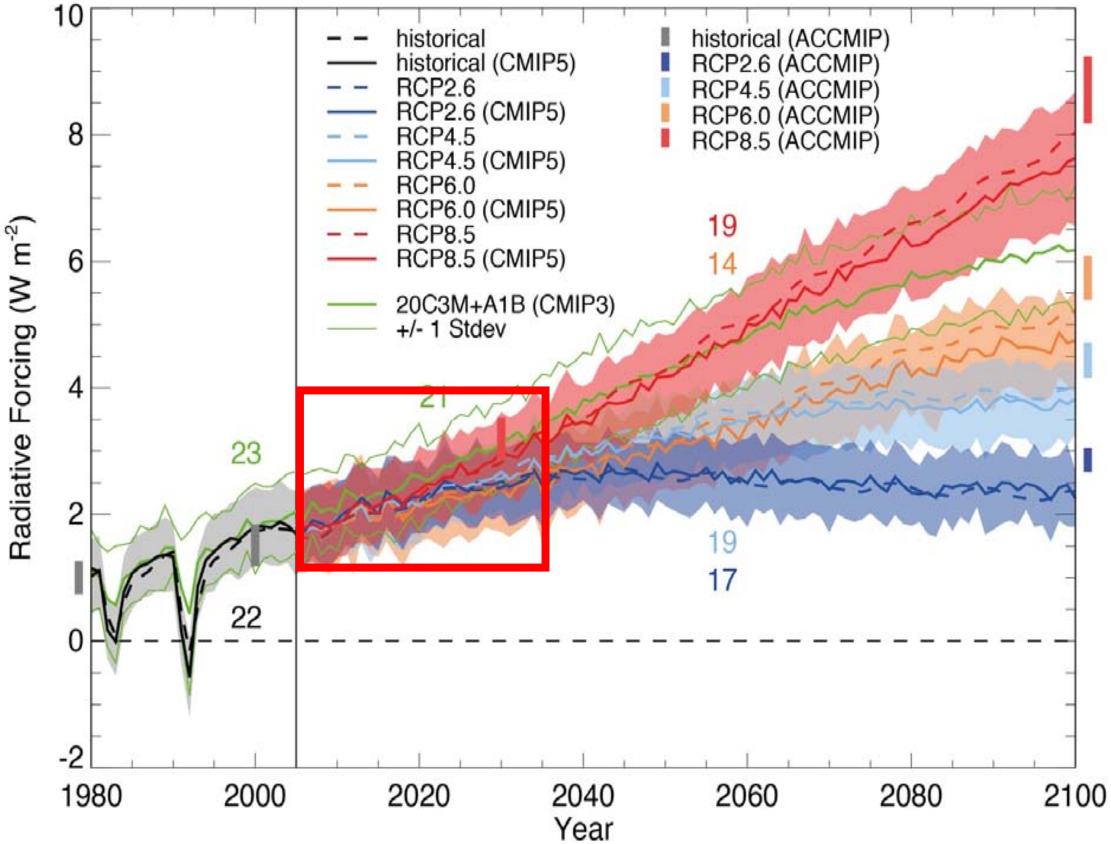
Near-term predictions and projections as sources of climate information

F.J. Doblas-Reyes
ICREA, BSC and IC3, Barcelona, Spain

Relative scenario independence

Global mean radiative forcing (Wm^{-2}, dashed) and effective radiative forcing (solid) with 1850 as baseline.

There is little difference between the RCPs before 2040.

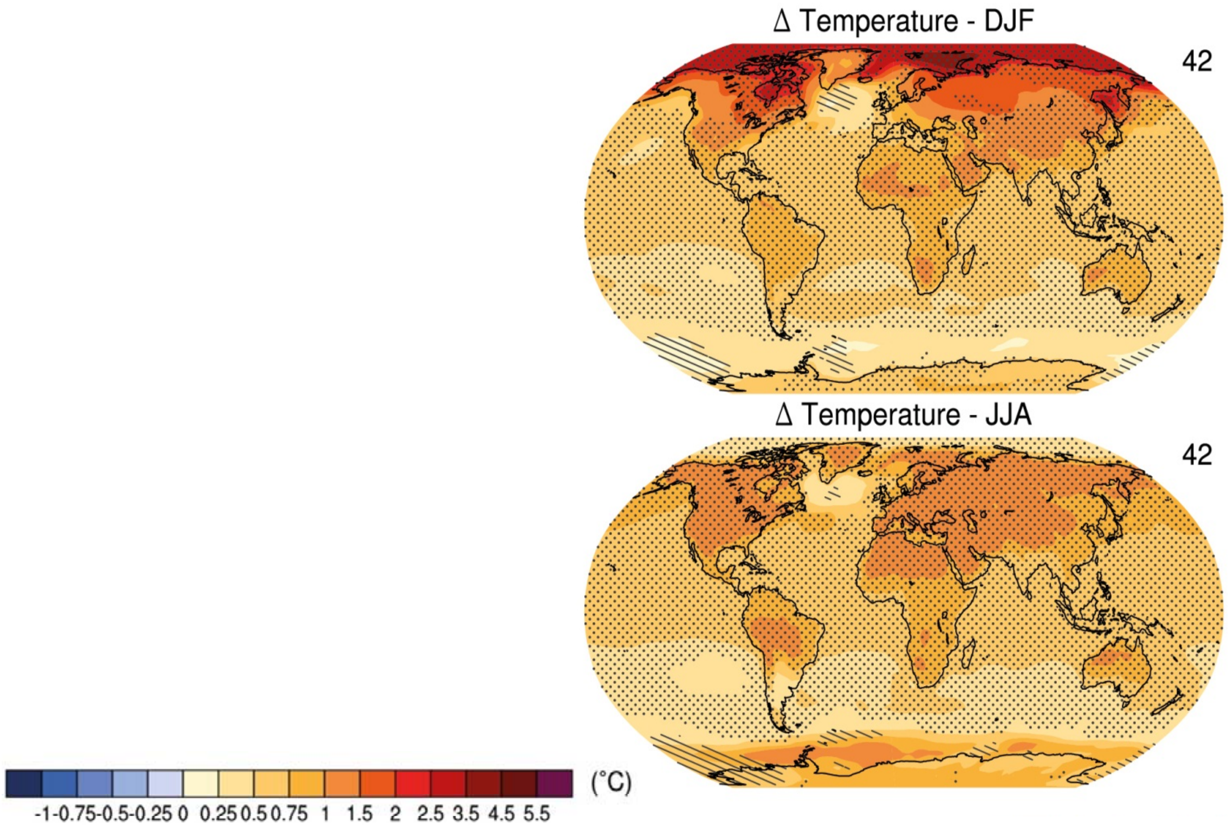


IPCC AR5 WGI (2013)

Near-term projections

Seasonal-mean air temperature change for the RCP4.5 scenario over 2016-2035 (wrt 1986-2005). Stippling for significant changes, hatching for non-significant.

The meridional gradient decreases (it increases at the tropopause).

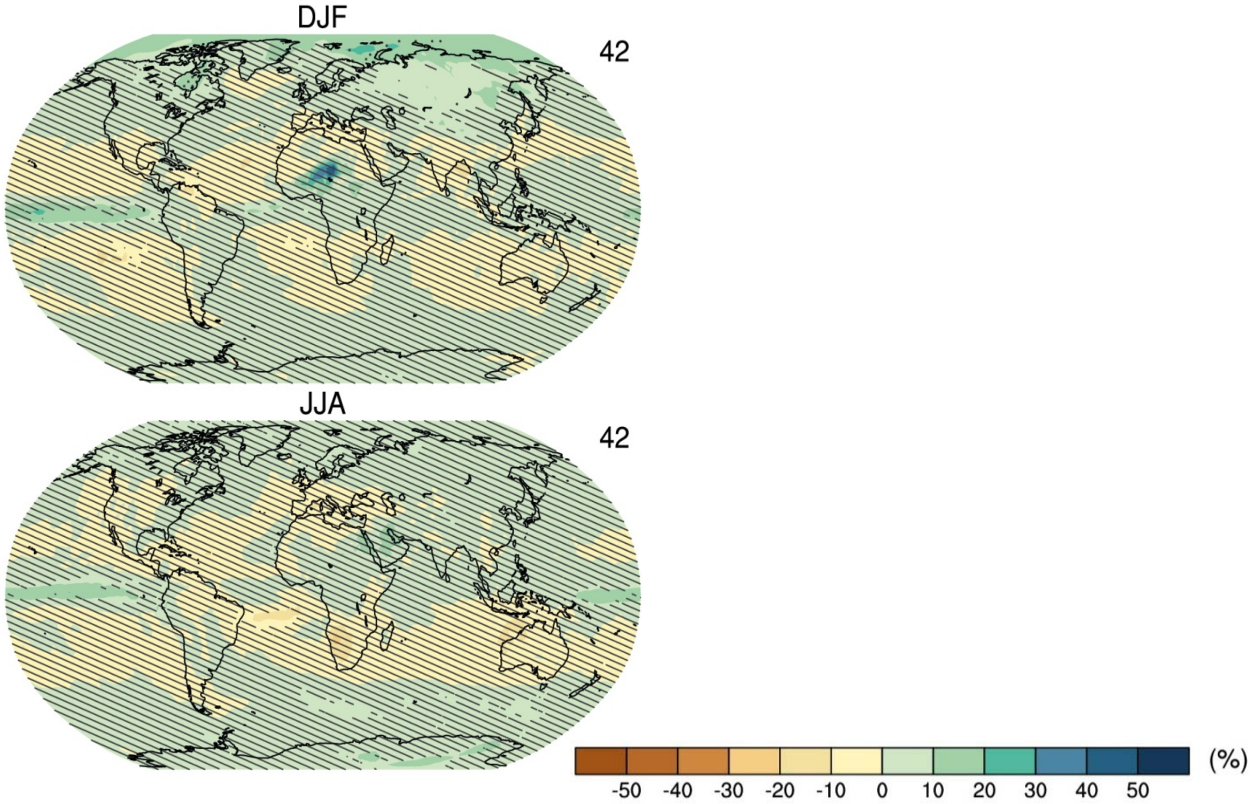


IPCC AR5 WGI (2013)

Near-term projections

Seasonal-mean precipitation change for the RCP4.5 scenario over 2016-2035 (wrt 1986-2005). Stippling for significant changes, hatching for non-significant.

Larger uncertainty, moister Arctic in winter.



IPCC AR5 WGI (2013)

Climate services as the driver

Climate data is not climate information

Near-term requests from users

Bodegas Torres (a Spanish winery) is looking for new locations for its vineyards (and it's not the only one doing it).

Land is being purchased closer to the Pyrenees, at higher elevation. They are considering acquiring land in South America too, in areas where wine is currently not produced.

Bodegas Torres requests local climate information (including appropriate uncertainty assessments) for the vegetative cycle of the vine, which lasts 30-40 years.

The user needs to make the decision now.

Near-term requests from users

The Catalan government has requested the climate community the preparation of the Third Report on Climate Change for Catalonia.

A broad range of socio-economic sectors (including private actors) are involved: agriculture, energy, tourism, ecosystems, etc.

Users requested a focus on 2031-2050, but also 2015-2024.

How should we merge the information from global and regional projections? How to build stories from the short to the mid term?

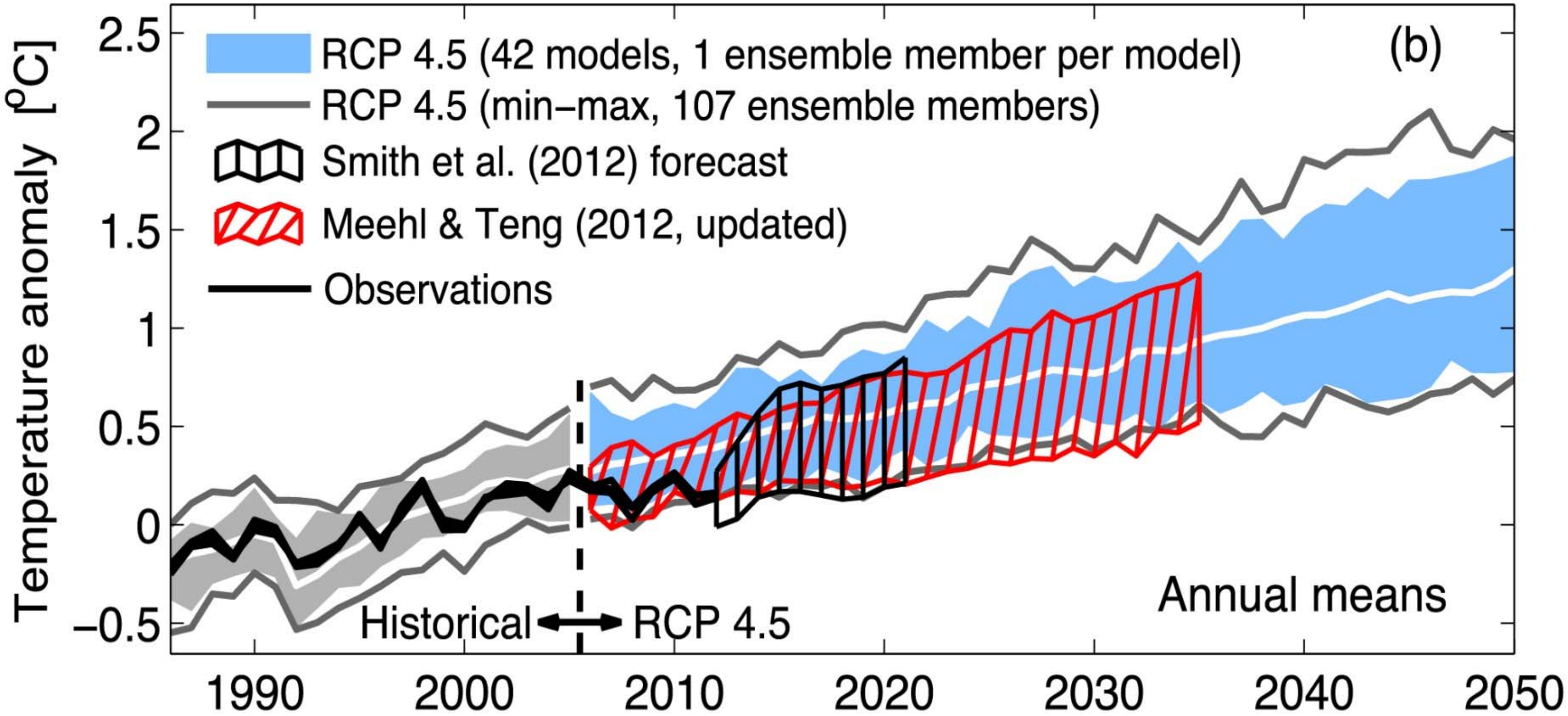
2031-2050	Winter	Spring	Summer	Autumn	Annual
Litoral	0.6 (0/1.2)	0.7 (0.3/1.1)	0.9 (0.3/1.5)	0.8 (0.3/1.2)	0.8 (0.5/1)
	0.4 (-27/22.4)	-5.7 (-27.9/22.6)	-4.1 (-19.5/20.7)	-7.9 (-26/25.2)	-2.6 (-20.1/5.7)
Interior	0.6 (0/1.1)	0.7 (0.2/1.4)	0.8 (0.4/1.7)	0.9 (0.2/1.2)	0.8 (0.5/1)
	2.5 (-17.6/29.1)	-6.6 (-24.6/24.6)	-3.4 (-21.4/13.9)	-5 (-21.6/25.4)	-0.2 (-14.3/8.3)
Pirineu	0.7 (-0.1/1.2)	0.8 (0.3/1.5)	0.9 (0.5/1.7)	0.9 (0.3/1.3)	0.8 (0.5/1.2)
	2.4 (-13.8/35.3)	0.0 (-22.7/17.4)	-3.3 (-21.2/11.8)	-0.8 (-21.9/18.8)	-1.2 (-8.8/7.8)
Catalunya	0.7 (0/1.2)	0.7 (0.3/1.4)	0.8 (0.4/1.6)	0.8 (0.3/1.2)	0.8 (0.5/1)
	1.0 (-18.7/19.8)	-3.9 (-24.9/17.9)	-4.1 (-19.8/13.8)	-5.4 (-22.9/21.8)	-2.4 (-13.6/5.4)

GECCC Grup d'Experts en Canvi Climàtic de Catalunya

Predictions and projections

Annual-mean global-mean temperature predictions and projections from CMIP5.

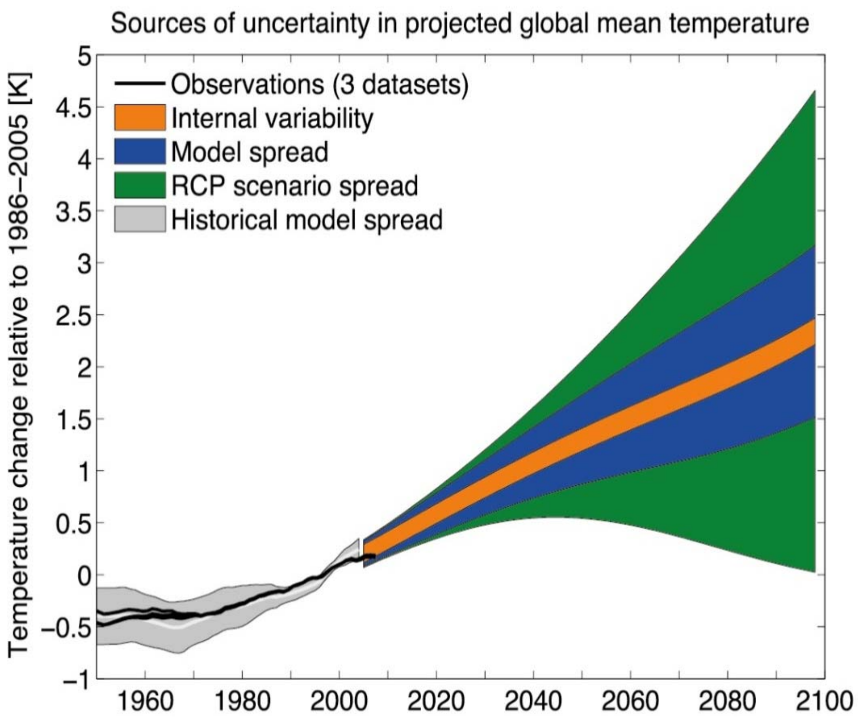
Decadal predictions allow to phase in the internal variability and to correct the forced model response, aspects that a priori make it superior to projections in the near term.

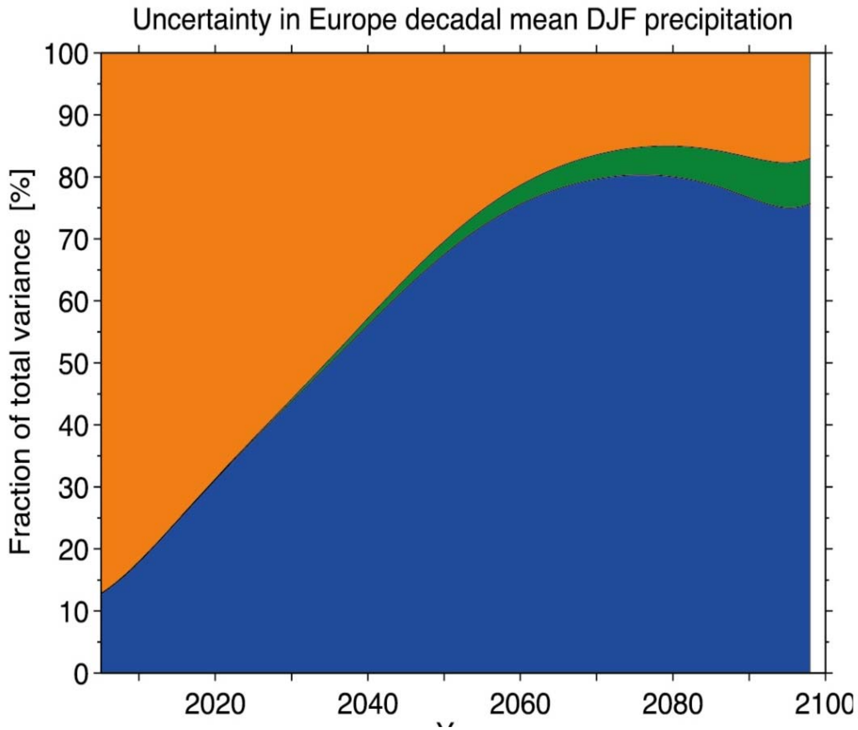


IPCC AR5 WGI (2013)

Predictions and projections

The sources of uncertainty include the internal variability, model differences and scenario spread. The internal variability is an uncertainty source particularly important for the near term that could be reduced, especially at regional scales.



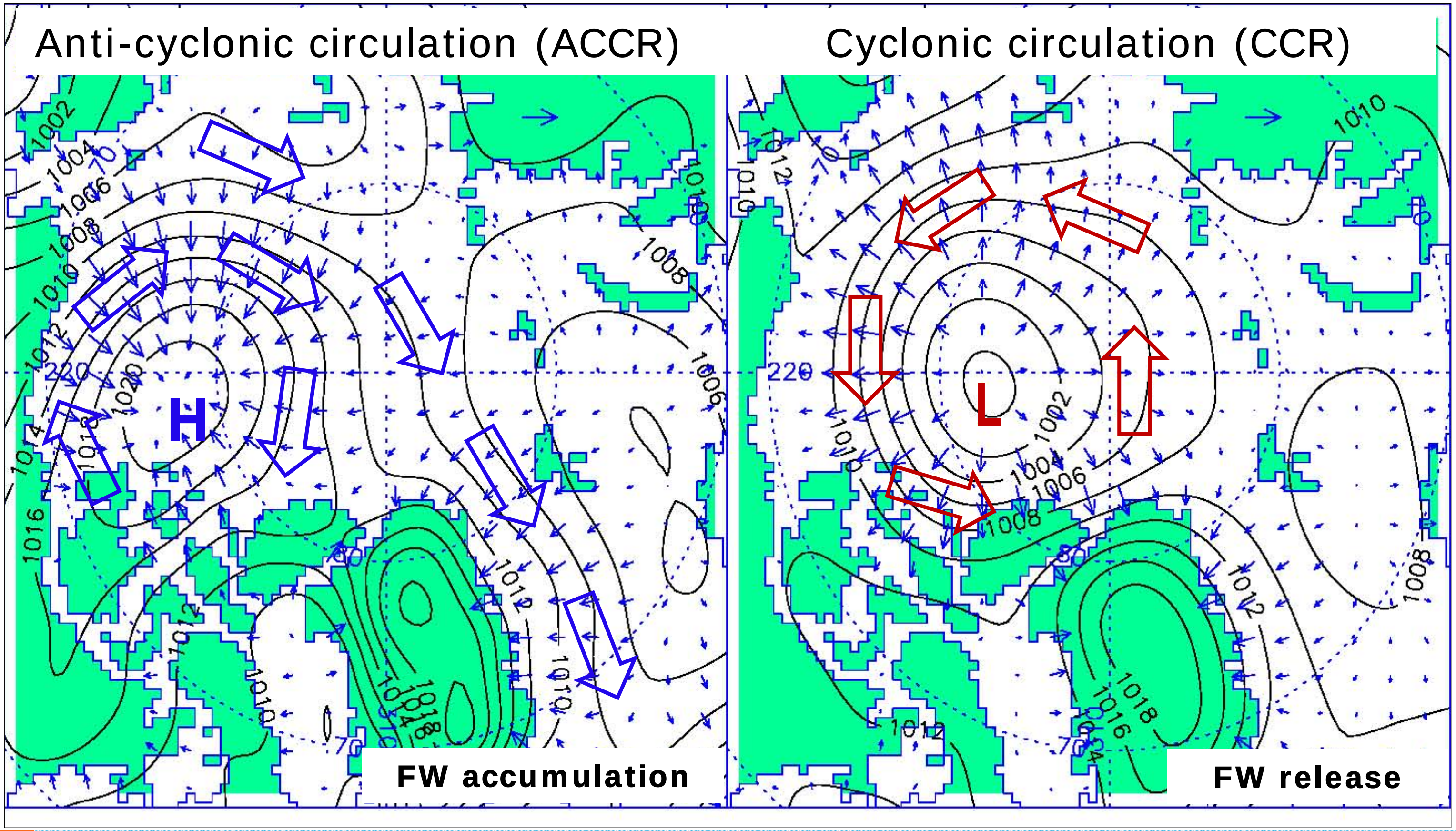


IPCC AR5 WGI (2013)

Sudden coupled phenomena

Changes in atmospheric circulation will advect the freshwater accumulated in the Arctic Ocean in the last 15 years (e.g. the GSA).

SLP (black lines, hPa), wind (large arrows) and Ekman transport (blue small arrows) typical for ACCRs (left, Ekman transport converging) and CCRs (right, Ekman transport diverging).

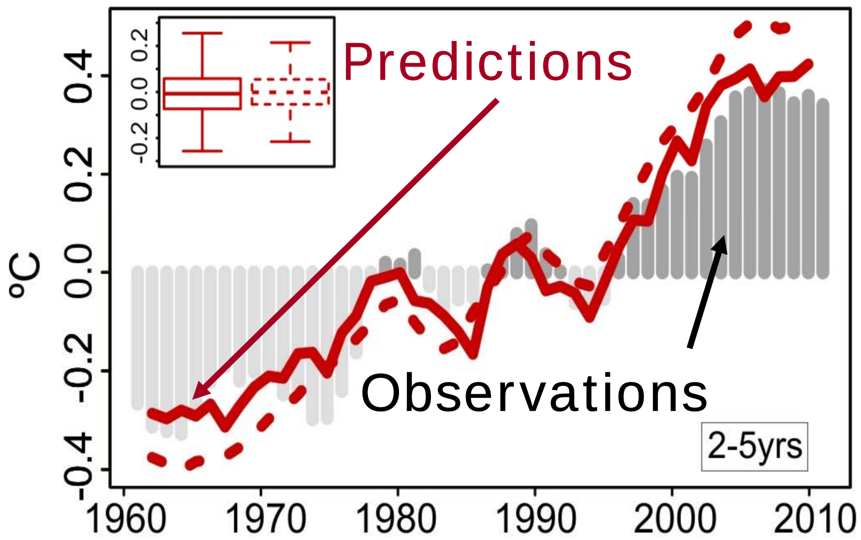


A. Proshutinsky (Woods Hole)

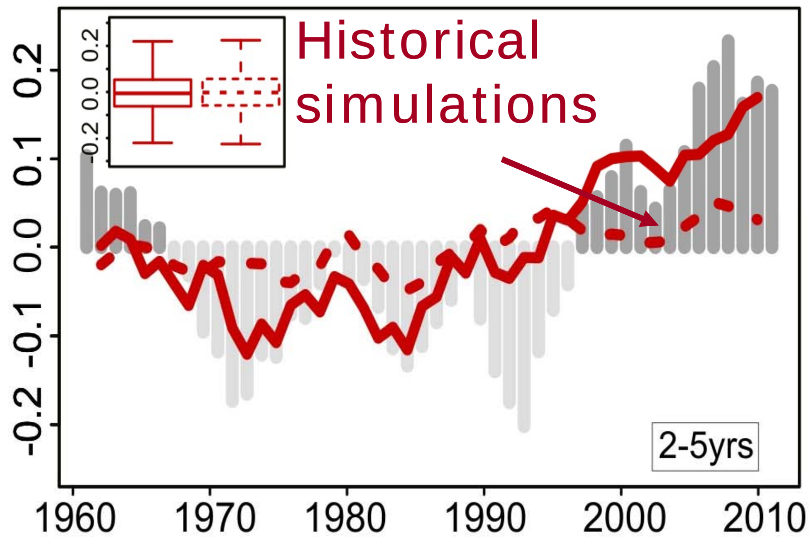
CMIP5 decadal predictions

CMIP5 decadal predictions. Global-mean near-surface air temperature and AMV against GHCN/ERSST3b for forecast years 2-5.
The initialized experiments reproduce the GMST trends and the AMV variability and suggest that initialization corrects the forced model response and phases in some of the internal variability.

Global mean surface air temperature (GMST)



Atlantic multidecadal variability (AMV)

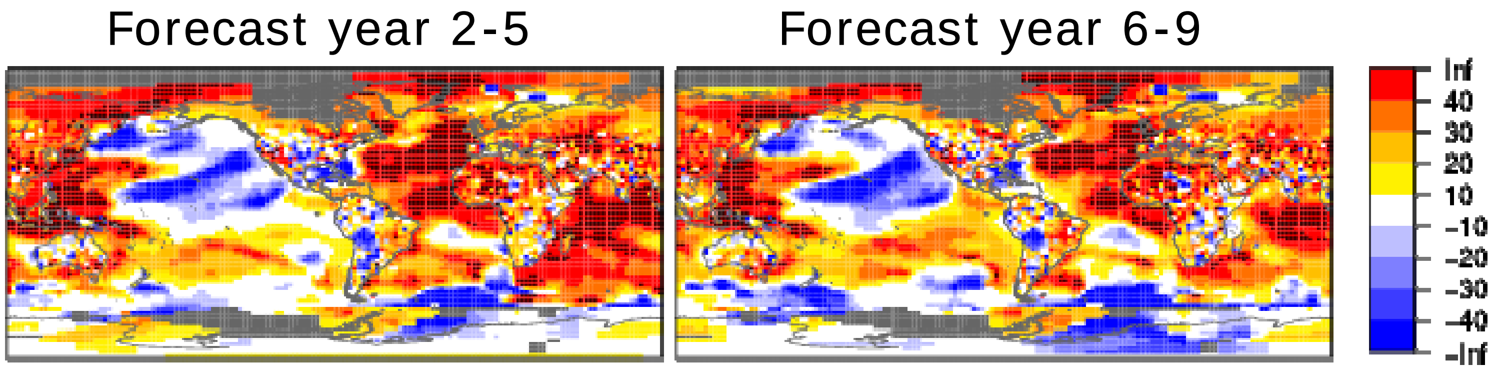


Doblas-Reyes et al. (2013, Nat. Comms.)

Do predictions have skill?

(Top row) Root mean square skill score (RMSSS) of the ensemble mean of the initialised predictions and (bottom row) ratio of the root mean square error (RMSE) of the initialised and uninitialised predictions for the near-surface temperature from the multi-model CMIP5 experiment (1960-2005) for (left) 2-5 and (right) 6-9 forecast years. Five-year start date interval.

RMSSS of the ensemble mean of decadal predictions

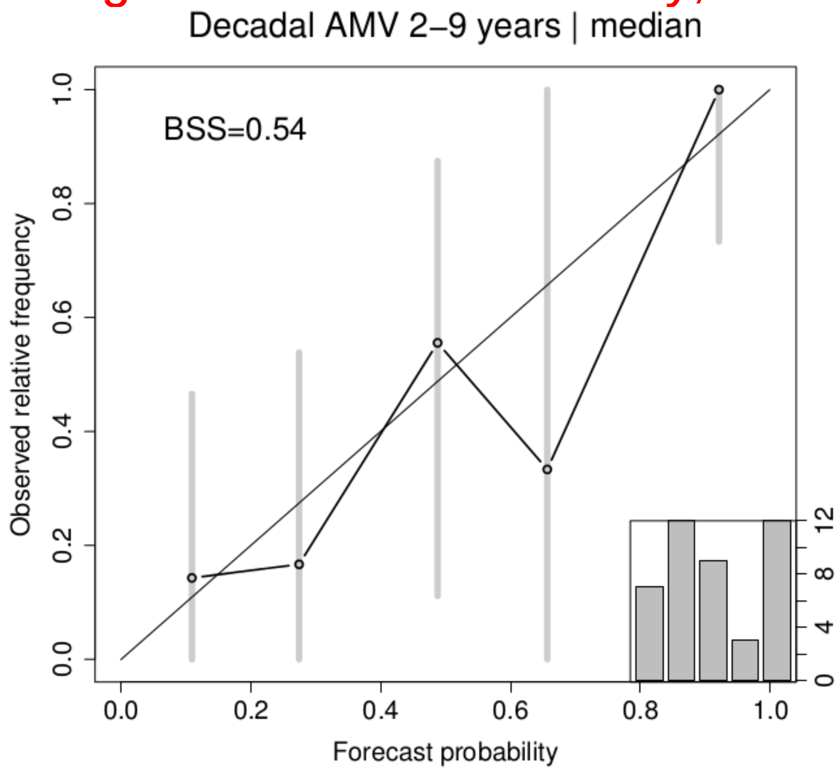


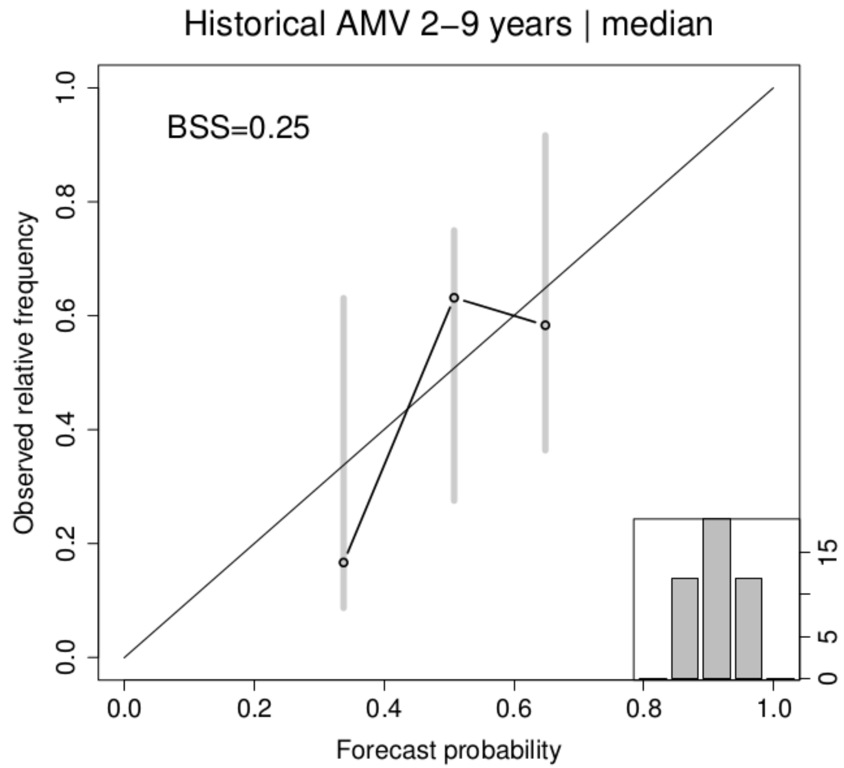
Doblas-Reyes et al. (2013, Nat. Comms.)

Reliability, a key piece for users

Reliability diagrams of left) initialised and right) uninitialised MME simulations for the **Atlantic multi-decadal variability**. Results for 2-9 year averages above the climatological median over 1961-2009.

Some of the added value of the predictions is their better management of uncertainty, which leads to increased **credibility**.

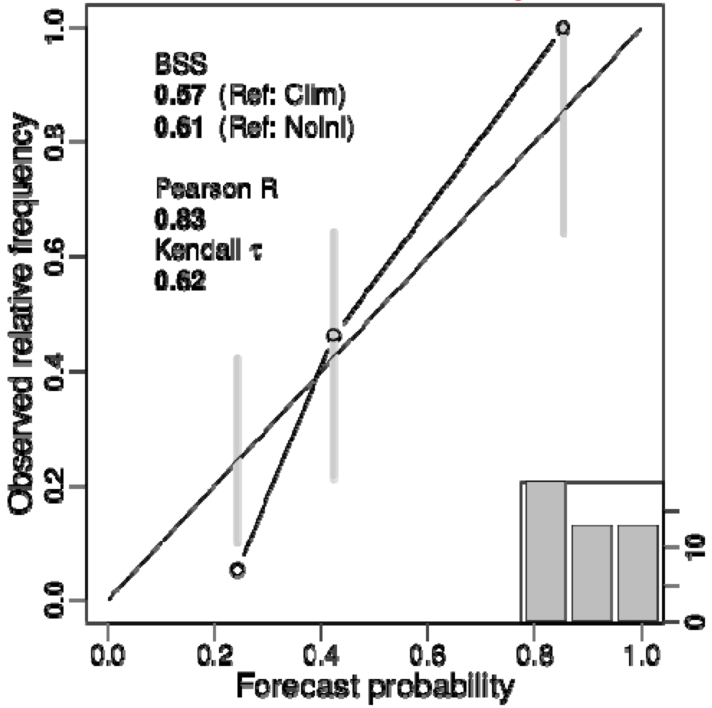


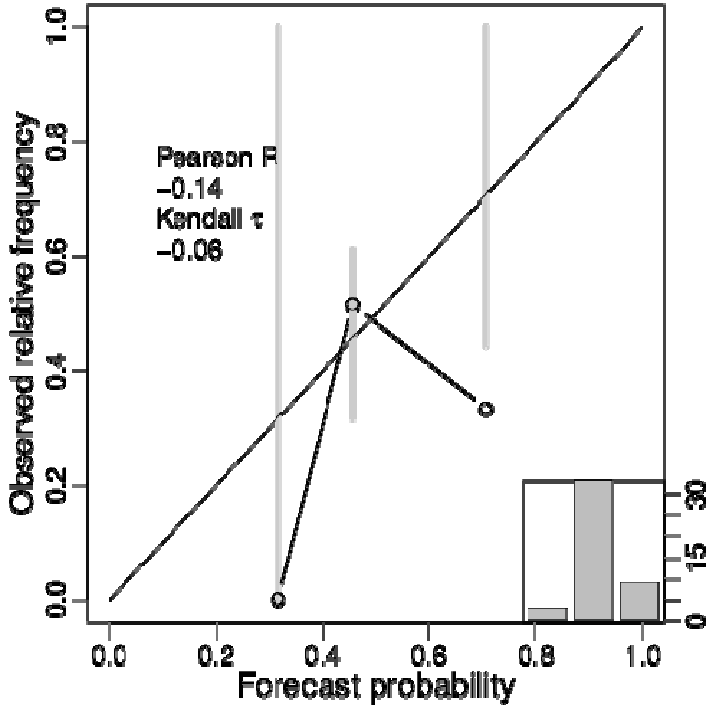


Service-driven predictions

Reliability diagrams of left) initialised and right) uninitialised MME simulations for basin-wide **accumulated cyclone energy** (ACE). The results are for 2-9 year averages above the climatological median over 1961-2009. Statistically significant values are in bold.

Some of the added value of the predictions is their better management of uncertainty, which leads to increased **credibility**.

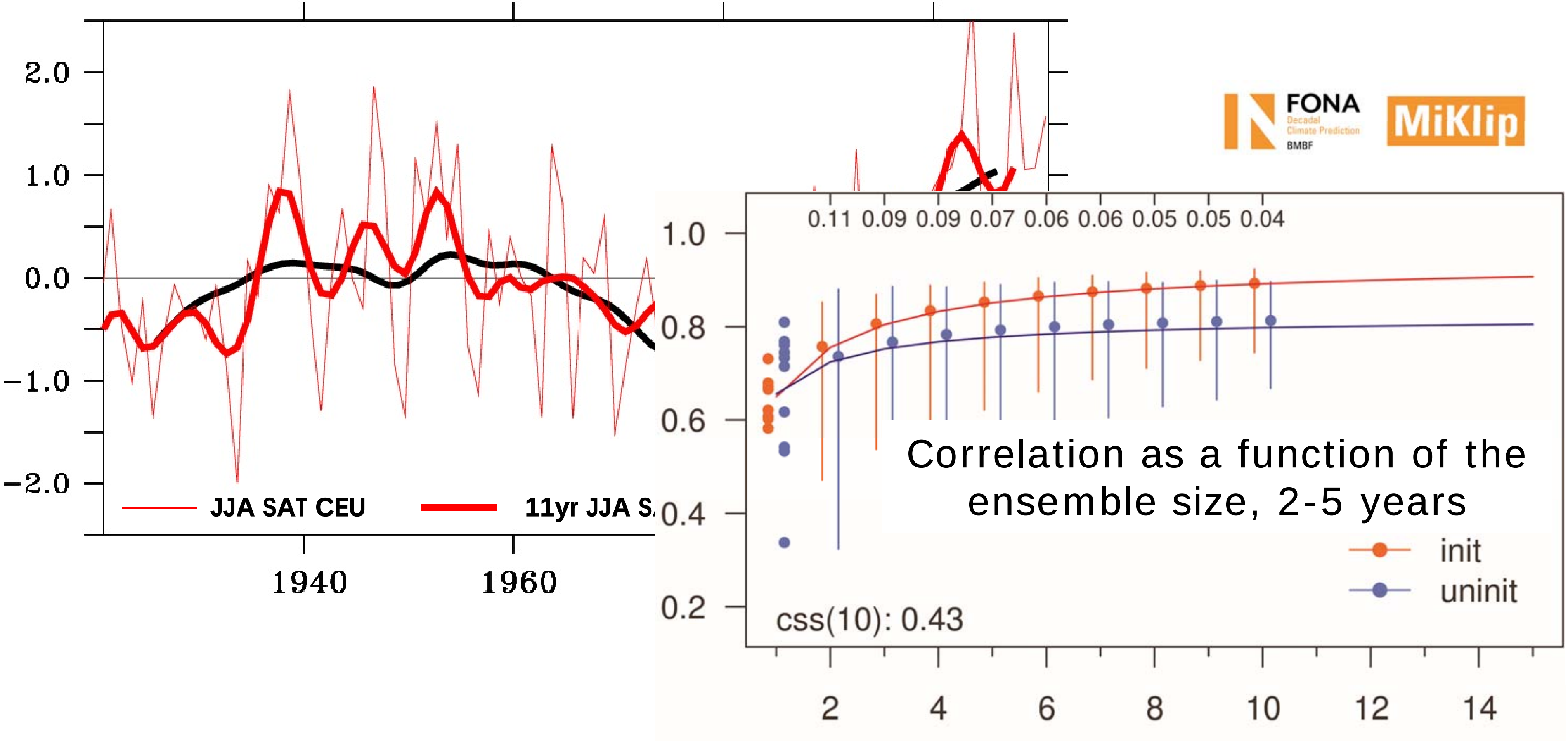




Caron et al. (2015, GRL)

Central European summer T

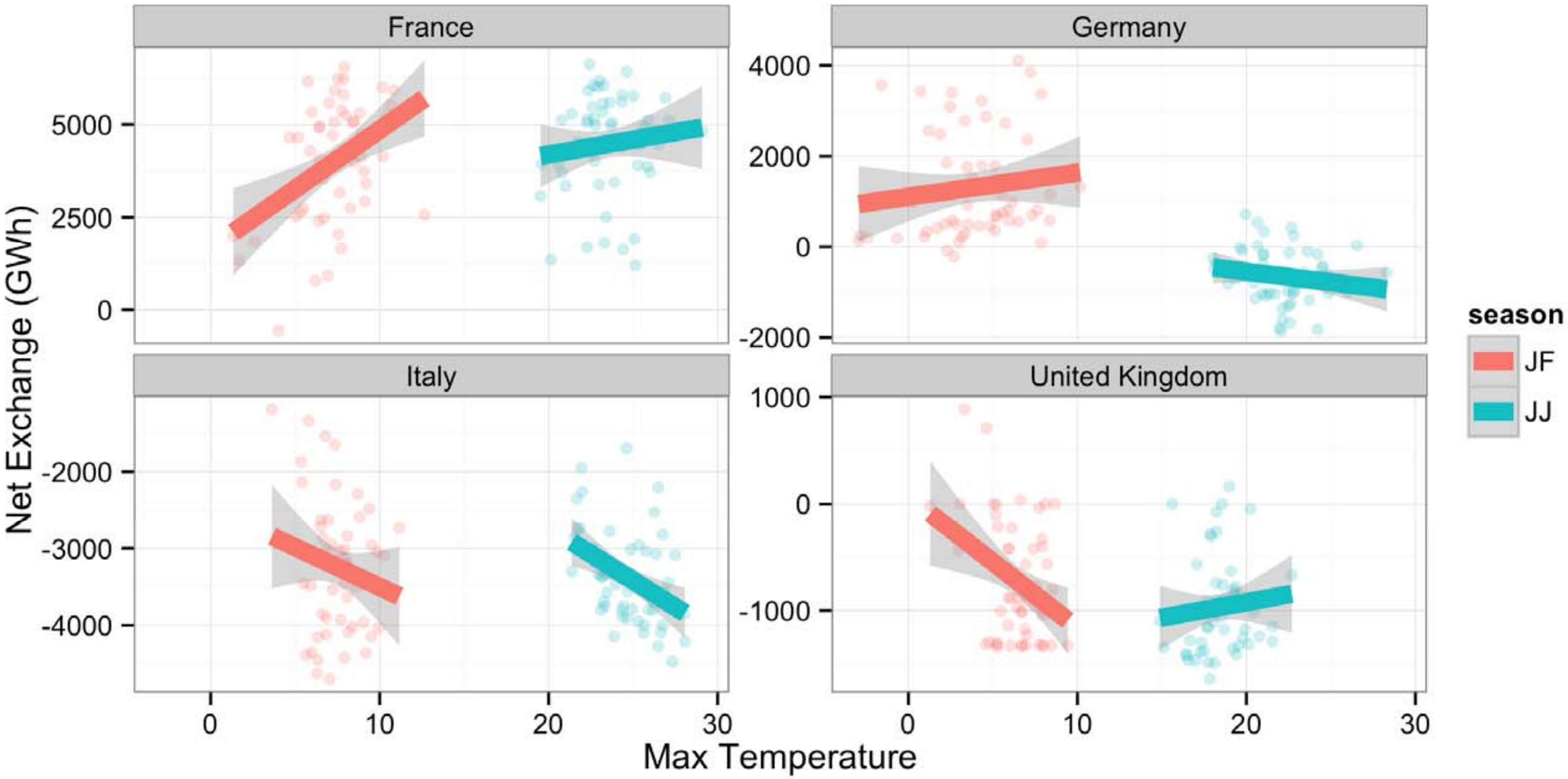
Time series of central European summer temperature and skill of the MiKlip system.



W. Müller (MPI)

Climate and energy export

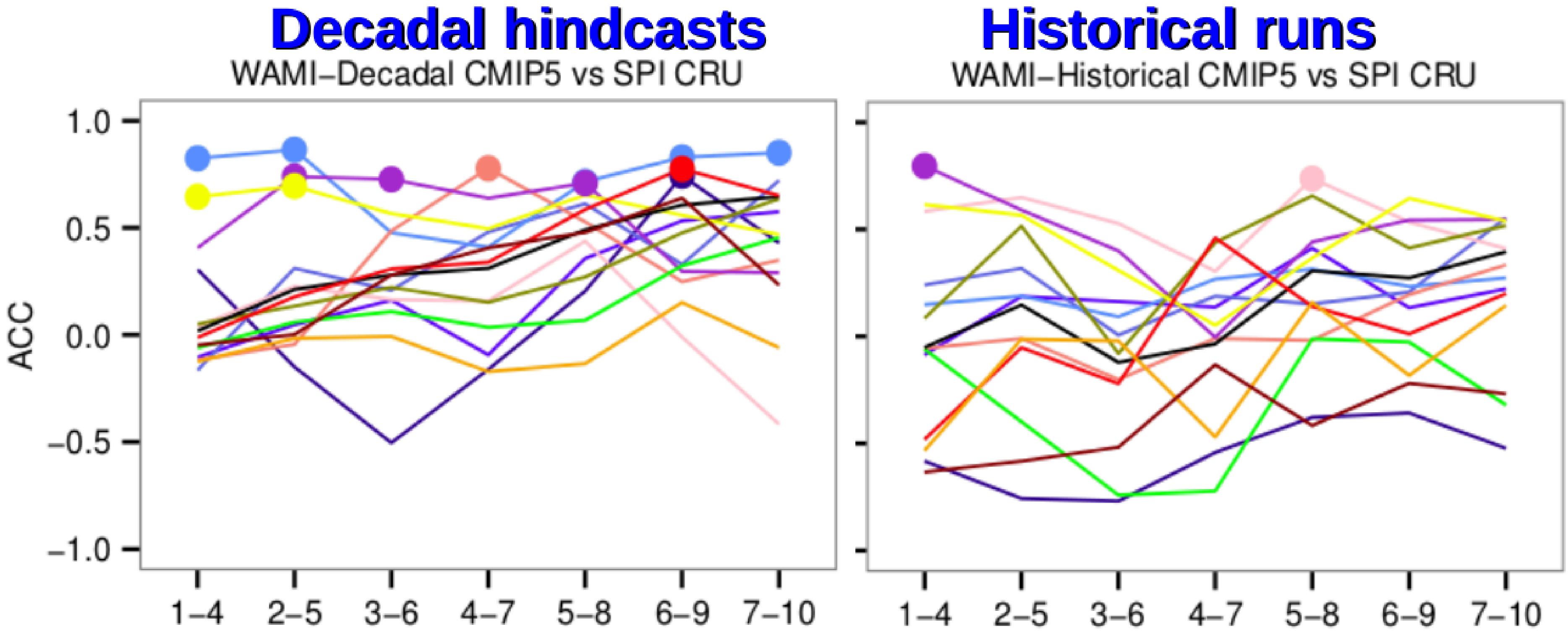
Climate affect exchanges via electricity demand (heating or cooling, from the customer point of view) and renewable-energy production.



Precipitation

Correlation of the ensemble mean of a set of CMIP5 predictions and historical simulations for the post-processed West African monsoon precipitation index.

Skill for initialized simulations is shifted to higher values for all forecast times.

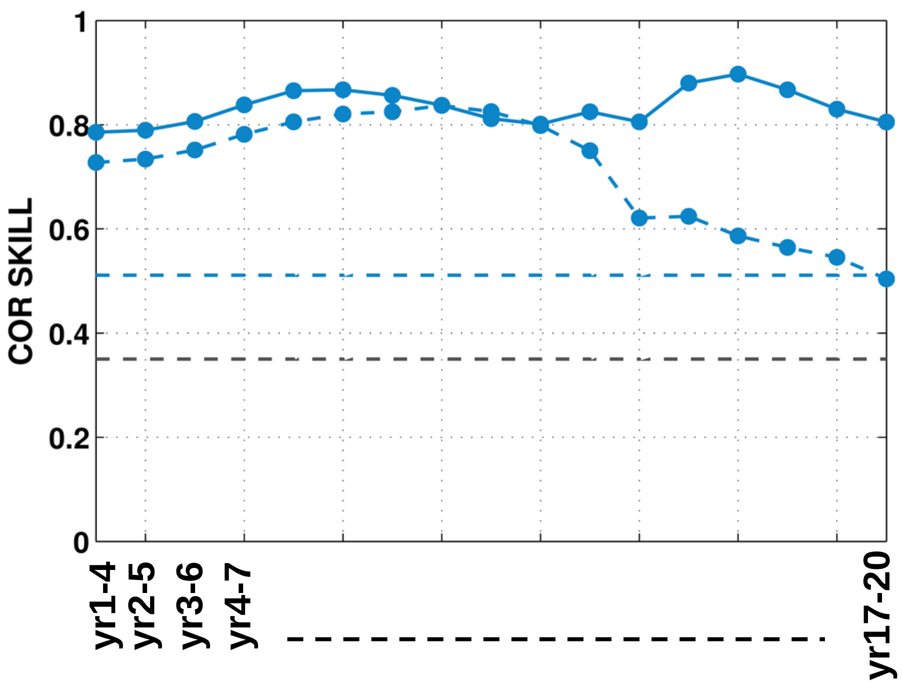


Otero et al. (2015, Clim. Dyn.)

20-year predictions

Correlation of the ensemble mean of North Atlantic subpolar gyre SST for initialised (solid) and uninitialised (dashed) six-member ensemble simulations made with the MPI-ESM-LR. The results are for four-year averages over 1961-2012.

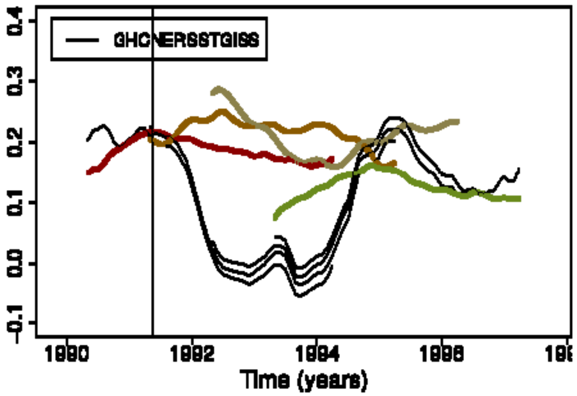
Added value of the initialisation is found beyond 10 forecast years.



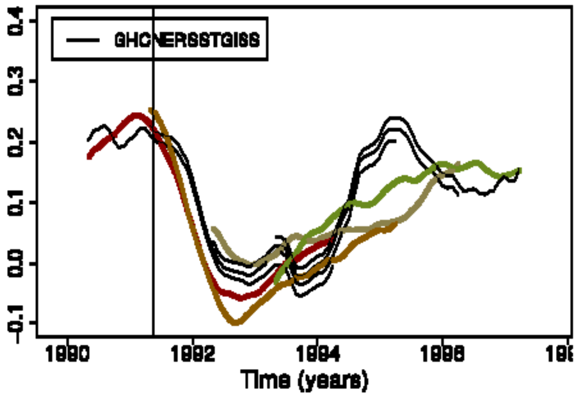
Volcanic aerosol

Global-mean surface temperature before and after the Pinatubo eruption simulated by EC-Earth 2.3 with five-member ensemble hindcasts. Observational data is a mix between GHCN, ERSST and GISS.

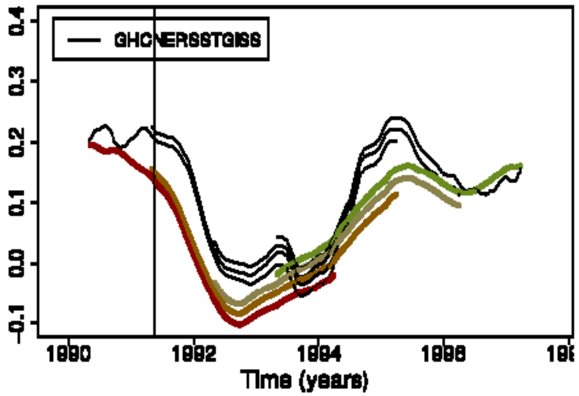
Both the initialisation and the volcanic forcing specification improve the simulations.



Initialisation and no volcanoes

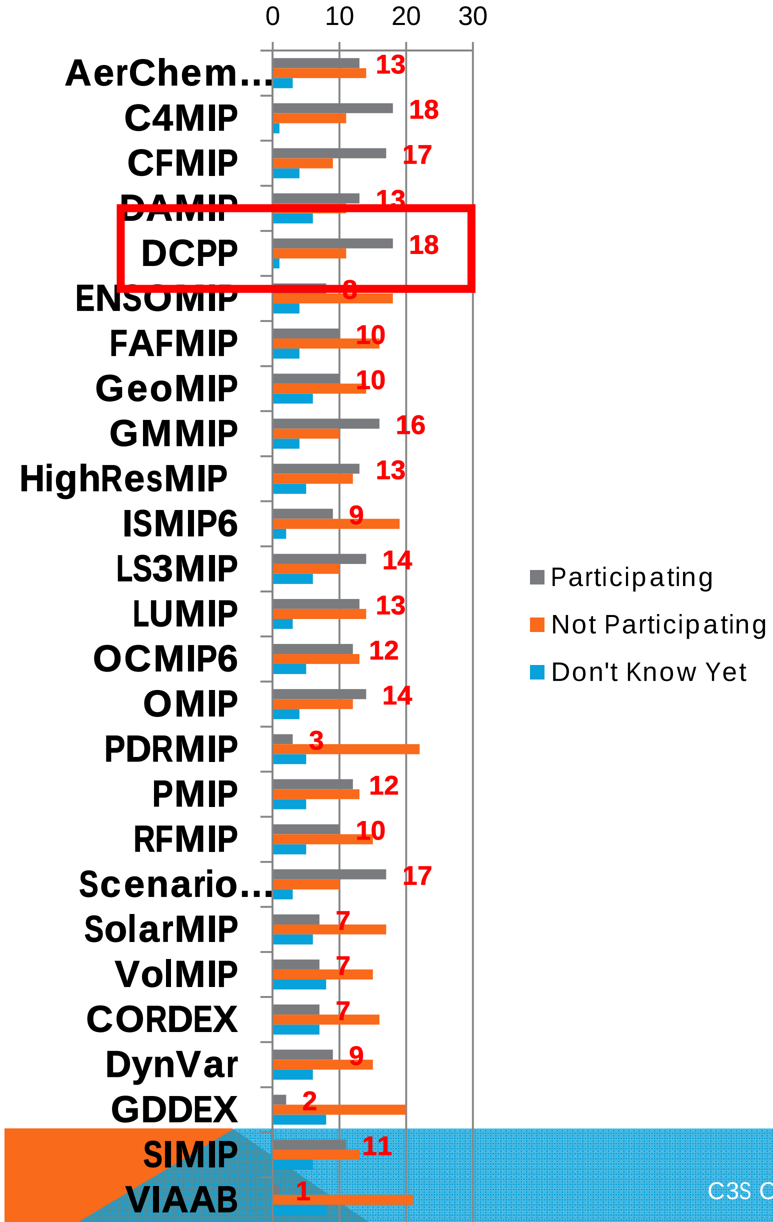


Initialisation and volcanoes



No initialisation and volcanoes

Decadal prediction is in CMIP6



- The CMIP6 decadal contribution is managed by DCPP (WGSIP, WGCM, DCVP-CLIVAR).
- Three components: hindcasts, forecasts and predictability exercise.
- DCPP benefits from joining CMIP6:
  - Better understanding of model error
  - Control runs for predictability
  - Infrastructure
- Other MIPs benefit from DCPP:
  - Reduction of model errors by understanding drift sources
  - Forecast quality assessment
- Interest to participate expressed by a large number of institutions.

Real-time decadal prediction

The multi-model real-time decadal prediction exchange is a research exercise that guarantees equal ownership to the contributors.
WMO-CCl plans to sponsor this activity.
http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/long-range/decadal-multimodel

Multi-model decadal forecast exchange

The Met Office coordinates an informal exchange of near-real time decadal predictions. Many institutions around the world are developing decadal prediction capability and this informal exchange is intended to facilitate research and collaboration on the topic.

The contributing prediction systems are a mixture of dynamical and statistical methods. The prediction from each institute is shown below, alongside an average of all the models. When possible, observations for the period of the forecast are also shown. Currently three variables are included: surface air temperature, sea-level pressure and precipitation. These are shown as differences from the 1971-2000 baseline. More diagnostics, including ocean variables are planned for the future. Please use the drop-down menus below to explore the data collected to date.

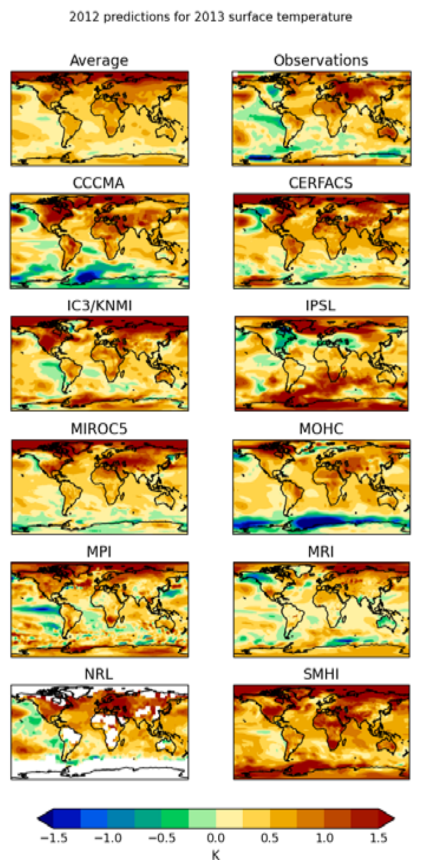
This work is supported by the European Commission SPECS project.

To learn more about decadal forecasts at the Met Office, see our current decadal forecast.

Images last updated 2014-06-25

Issued	Period	Element
2013	year 1	surface air temperature

Decadal forecast exchange 2013 predictions for year 1 surface air temperature



Communication

A series of fact sheets has been started (available from the SPECS web site). Common vocabulary with EUPORIAS, targeting a wide audience, mimicking some material already existing to explain what climate change is.

SPECS Fact sheet #2

What is a decadal prediction?

October 2014

Weather is chaotic which limits its predictability to one or two weeks This means that it will never be possible to extend normal weather forecasts to seasonal time-scales and beyond.

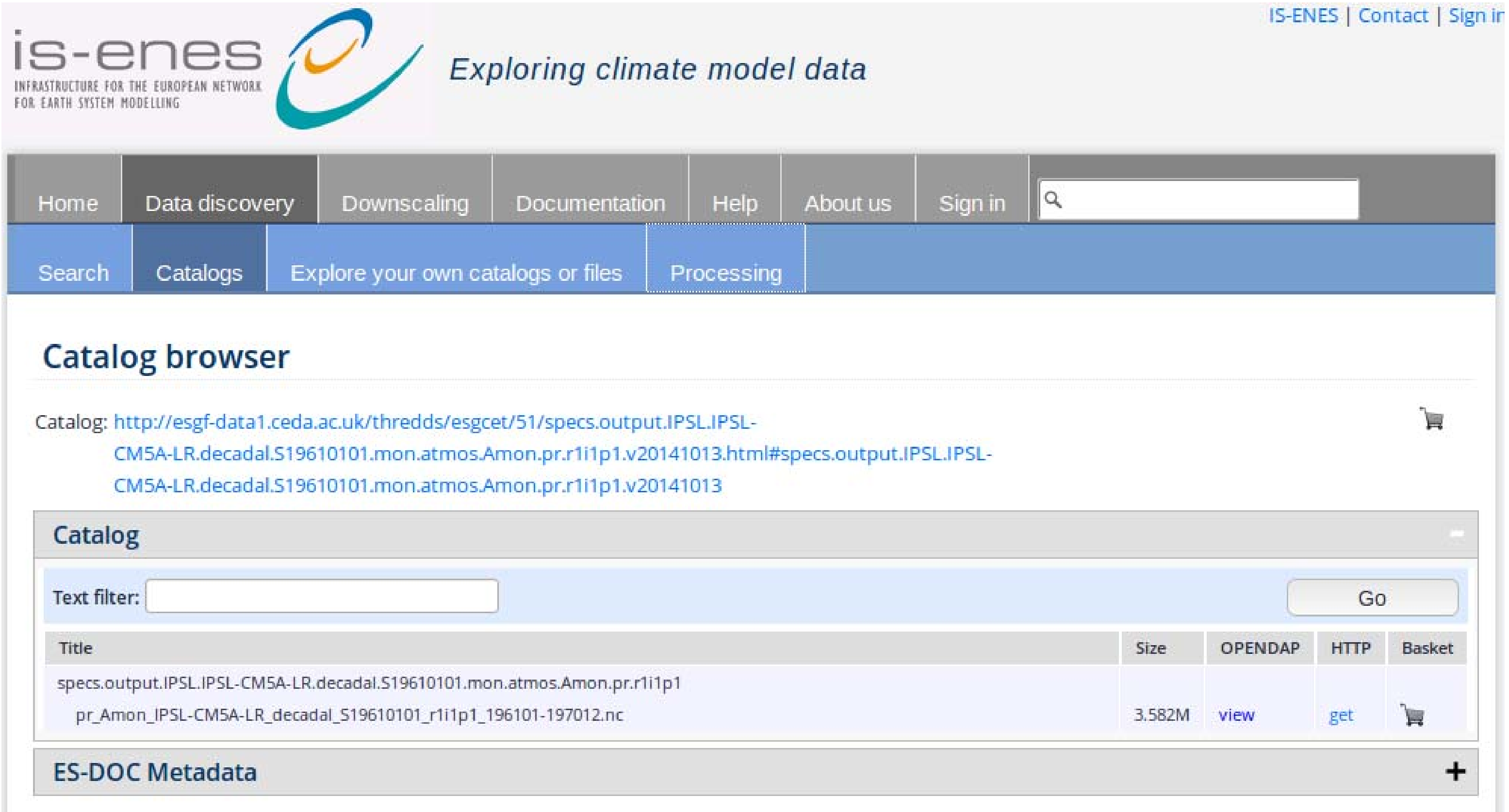
For example, we will never be able to predict the weather on a specific date in a specific place years in advance. However, **changes in *prevailing* weather over the course of several months to years are potentially predictable**. For instance we may be able to say if a particular region might expect, on average, colder winters or drier summers. Such changes in weather patterns occur due to the interaction of the atmosphere with more slowly varying parts of the Earth system.

Weather is a result of energy moving through the Earth system. Energy is originally radiated to the Earth from the Sun, with most being re-emitted or reflected back to space. The amount that remains in the Earth system is modulated by many things: some emerge naturally within the system (*internal variability*), whilst others are controlled by external factors such as variations in solar output, greenhouse gases, and atmospheric particles

Downstream services

The SPECS data are now visible from the Climate4impact portal http://climate4impact.eu.

Lots of work still missing: e.g. use cases and processing demonstration video for climate predictions, etc



Summary

- Requests for climate information for the next 30 years come from a broadening range of users and should be addressed from a climate services perspective.
- Different tools are available to provide near-term climate information (global and regional projections, decadal predictions, empirical systems, etc). Merging all this information into a reliable, unique source is a problem still not solved.
- The community is maturing quickly and there are successful stories of interactions with users. C3S might want to taken note of this because requests will come.
- None of this will materialize without appropriate investment in observational networks and reduction of all aspects of model error.