Climate Information for the Next 30 Years

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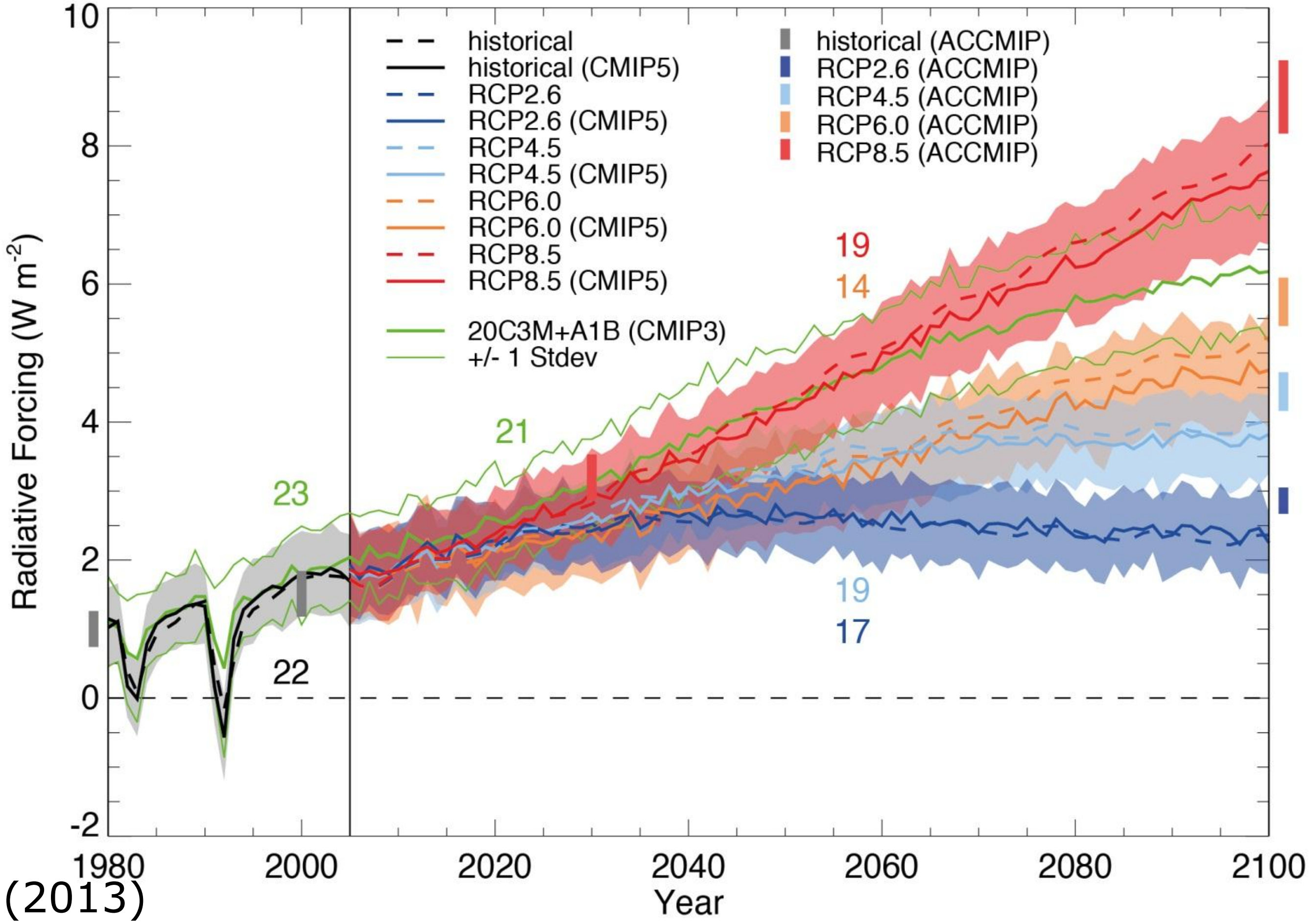
Radiative forcing and climate change

Global mean radiative forcing (Wm^{-2}, dashed) and effective radiative forcing (solid) between 1980 and 2100 with 1850 as baseline.

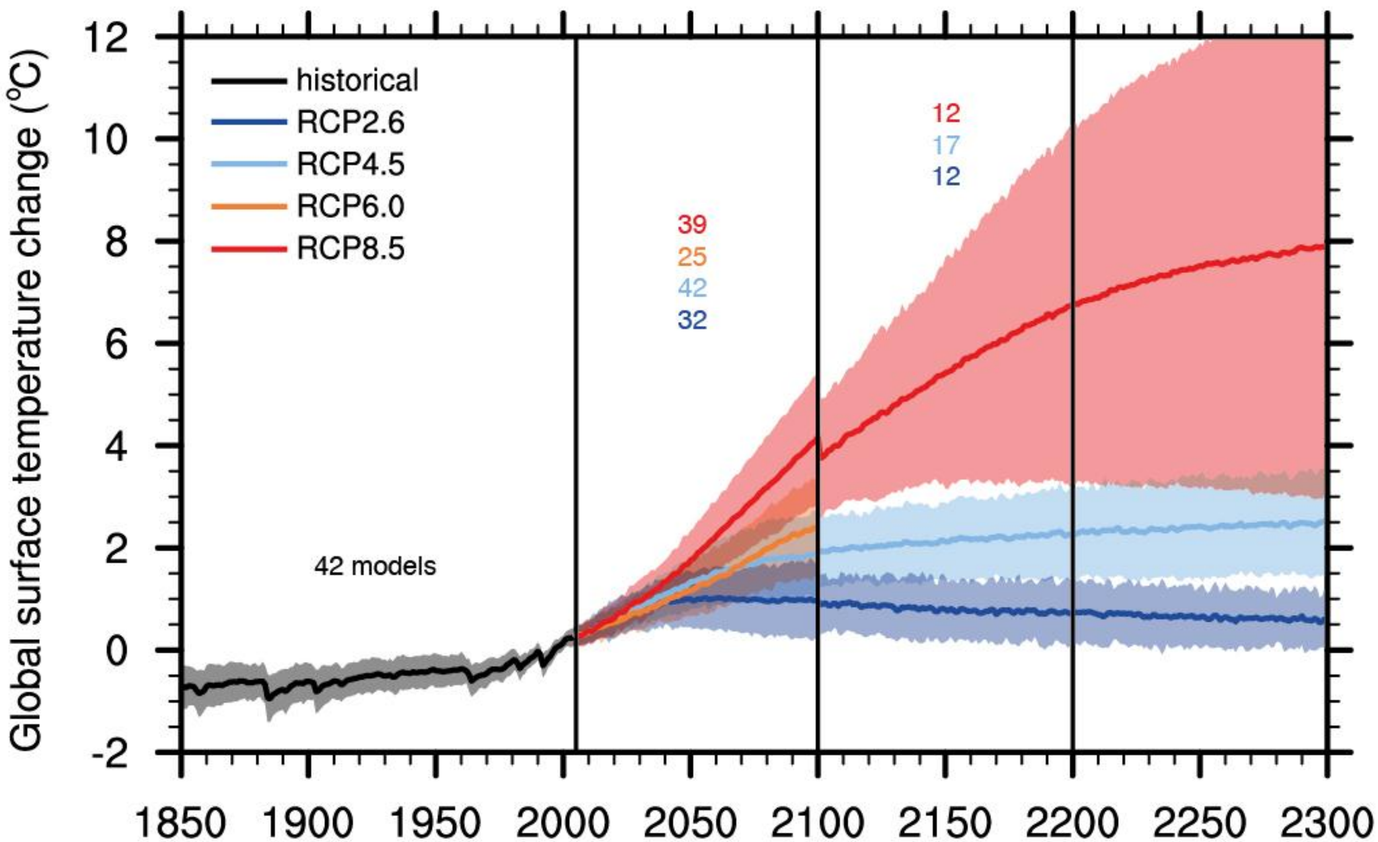
There is little difference between the RCPs before 2040.



IPCC AR5 WGI (2013)

CMIP5 projections

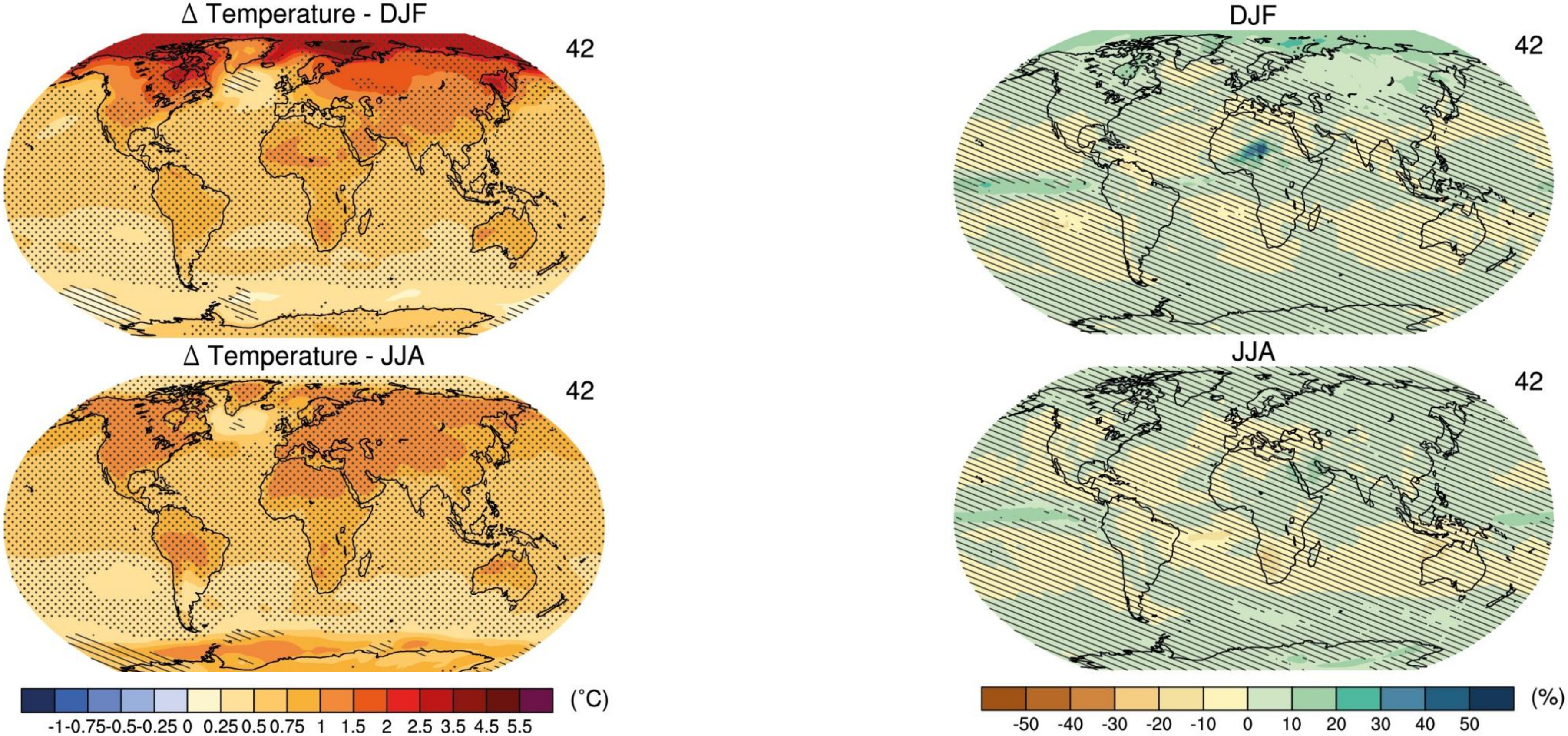
Time series of global annual mean surface air temperature anomalies (relative to 1986-2005) from CMIP5 concentration-driven experiments.



IPCC AR5 WGI (2013)

CMIP5 near-term projections

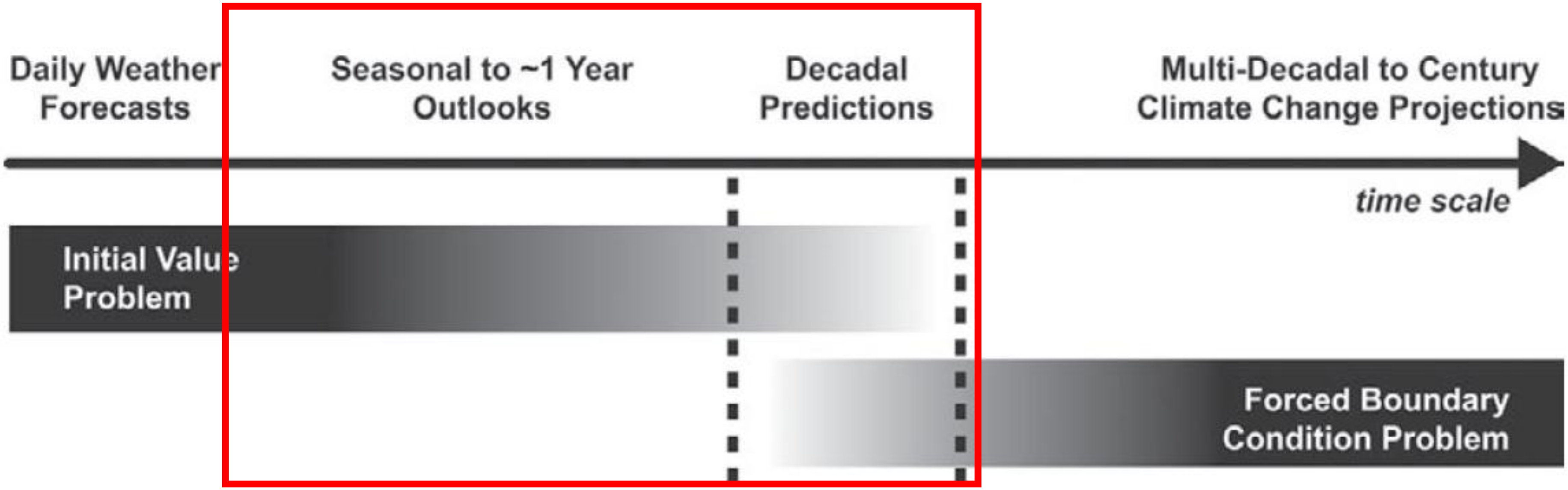
Seasonal-mean air temperature and percentage precipitation change for the RCP4.5 scenario over 2016-2035 (wrt 1986-2005). Stippling for significant changes, hatching for non-significant.



IPCC AR5 WGI (2013)

Climate prediction

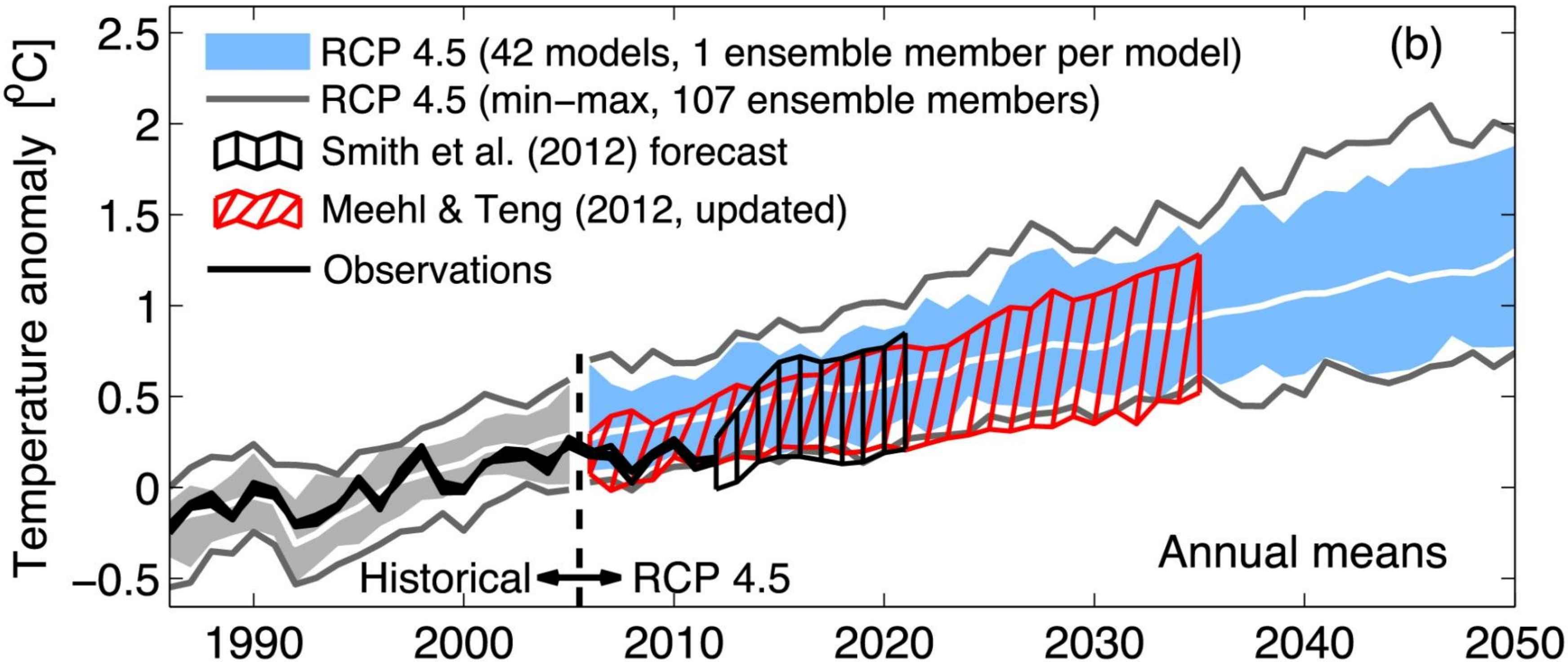
Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialisation and systematic comparison with a simultaneous reference.



Meehl et al. (2009)

Predictions and projections

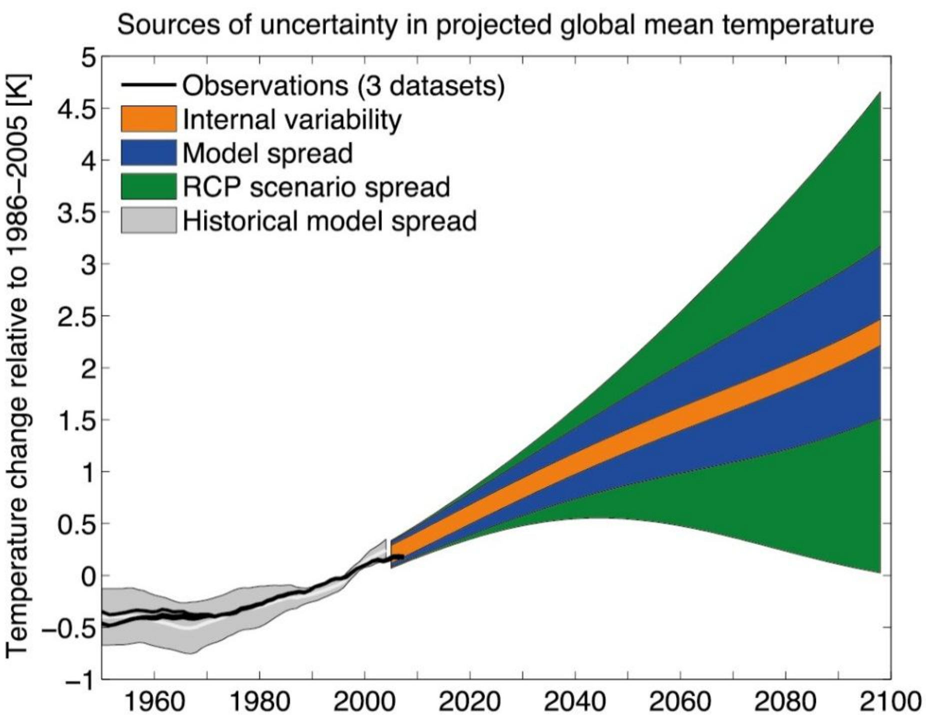
Annual-mean global-mean temperature predictions and projections from CMIP5.

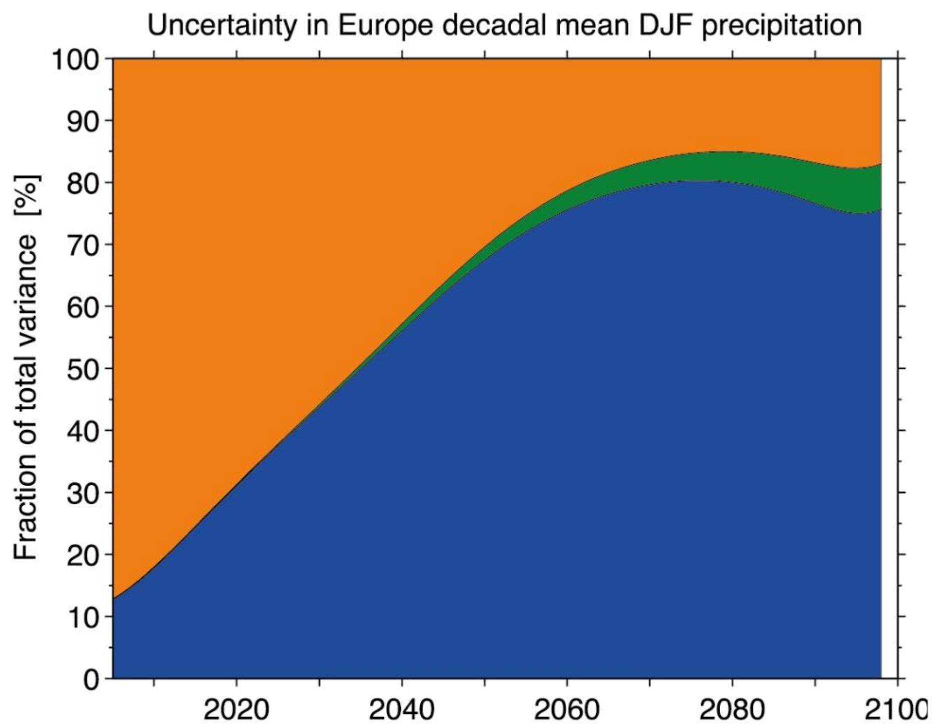


IPCC AR5 WGI (2013)

The hope to predict

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.

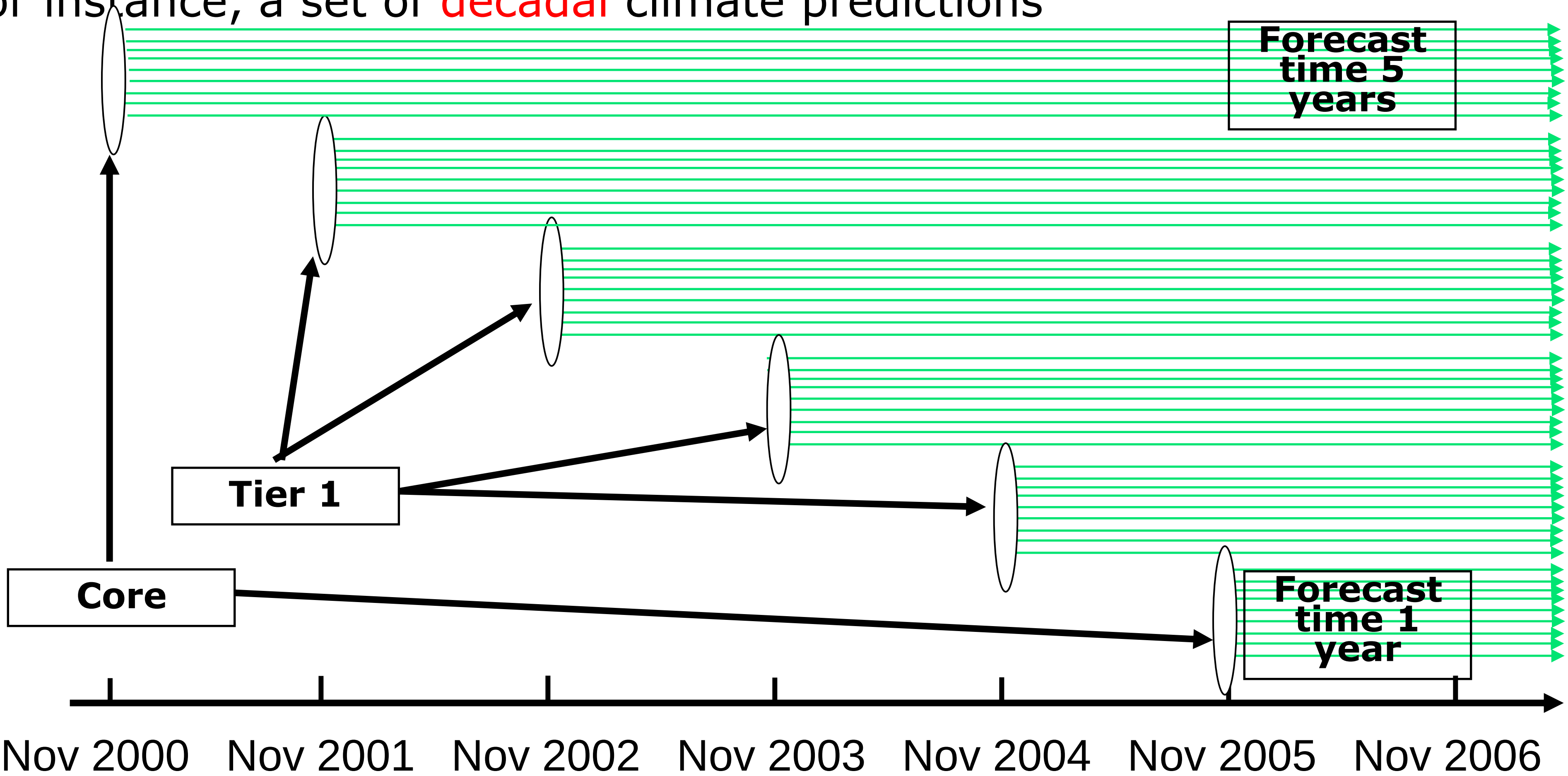




IPCC AR5 WGI (2013)

Climate predictions

Assume an ensemble forecast system with an initialized ESM to perform, for instance, a set of decadal climate predictions

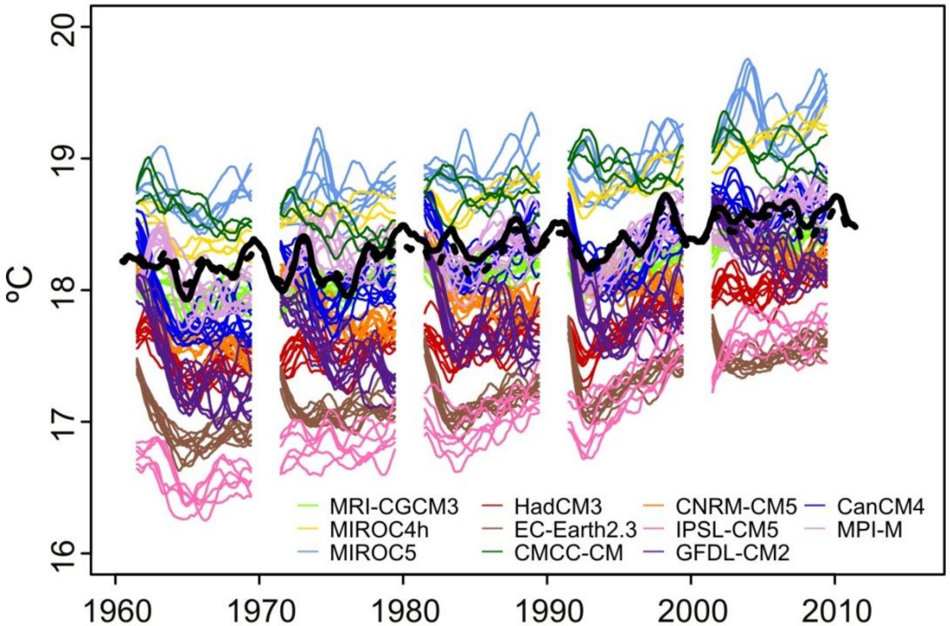


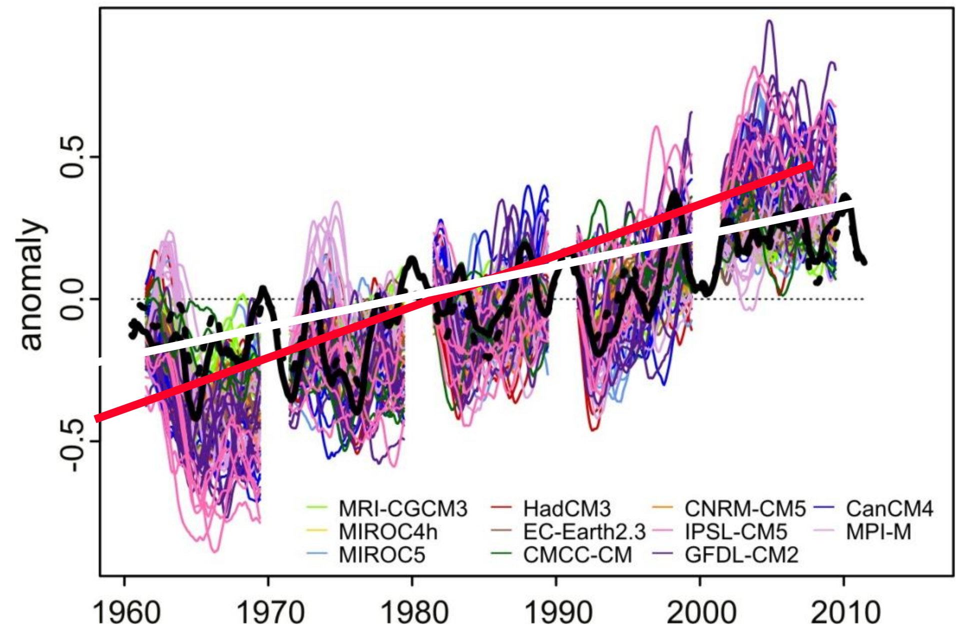
Predictions are also made with empirical forecast systems to be used as benchmarks and to detect untapped sources of predictability.

Shock, drift and systematic error

Global mean near-surface air temperature over the ocean (*one-year running mean applied*) from the CMIP5 hindcasts. Each system is shown with a different colour. NCEP and ERA40/Int used as reference.

The systematic error is very different from one system to another and there are serious issues with the initial shock and the drift.





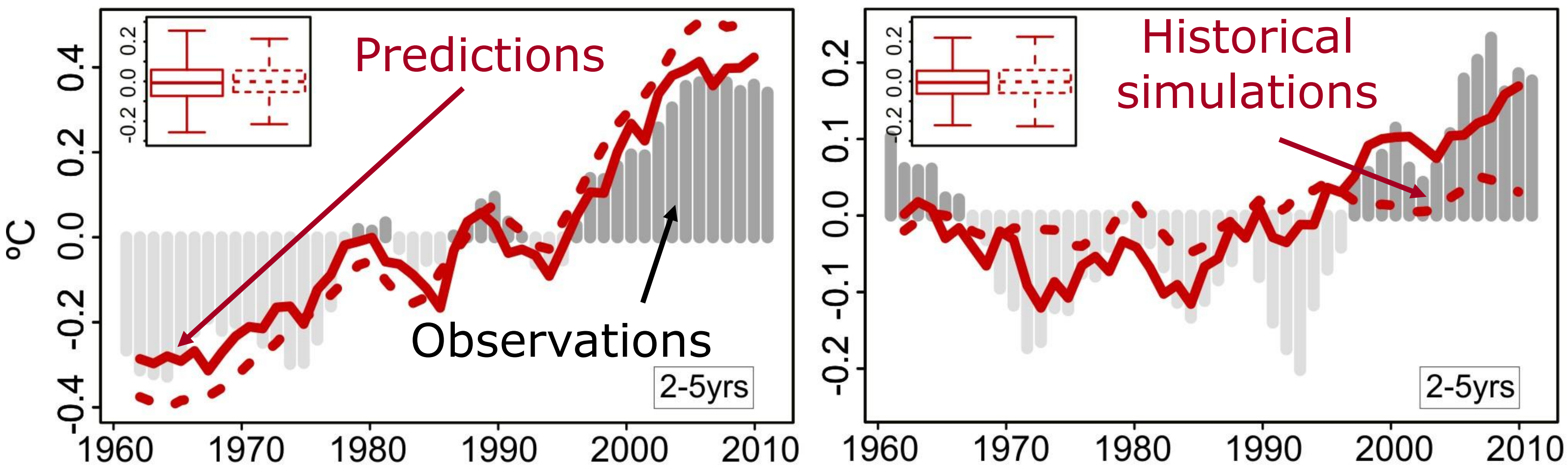
IPCC AR5 WGI (2013)

CMIP5 decadal predictions

CMIP5 decadal predictions. Global-mean t2m 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 trend and phases in some of the internal variability.**

Global mean surface atmospheric temperature

Atlantic multidecadal variability (AMV)



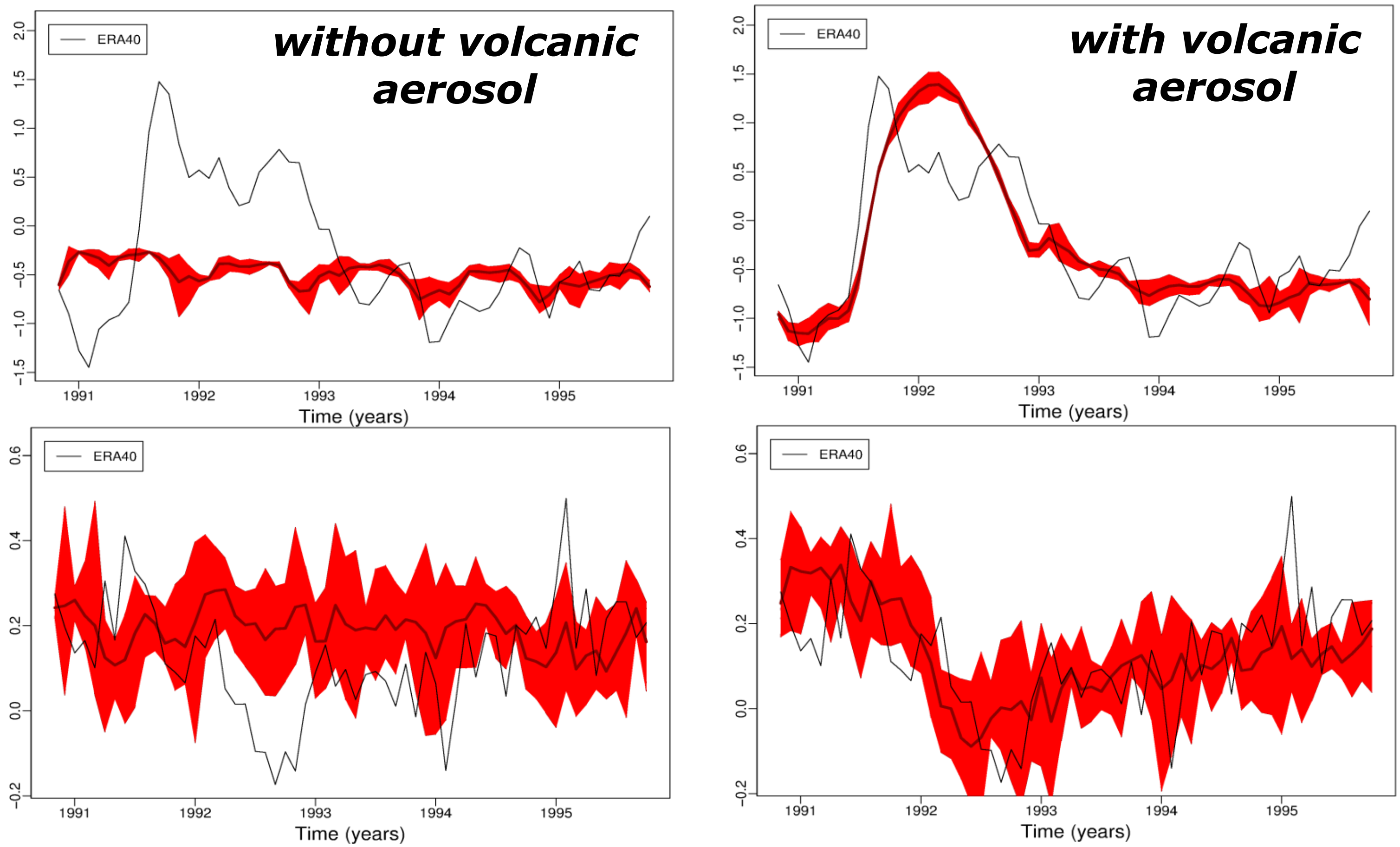
Doblas-Reyes et al. (2013)

Eruptions and predictions

EC-Earth2.3 simulations of volcanic aerosol impact for Pinatubo. Five-member ensembles initialised on the 1 November 1990. No consistent treatment of volcanic aerosol and ozone.

T50

Near-surface air temperature



M. Ménégoz (IC3)

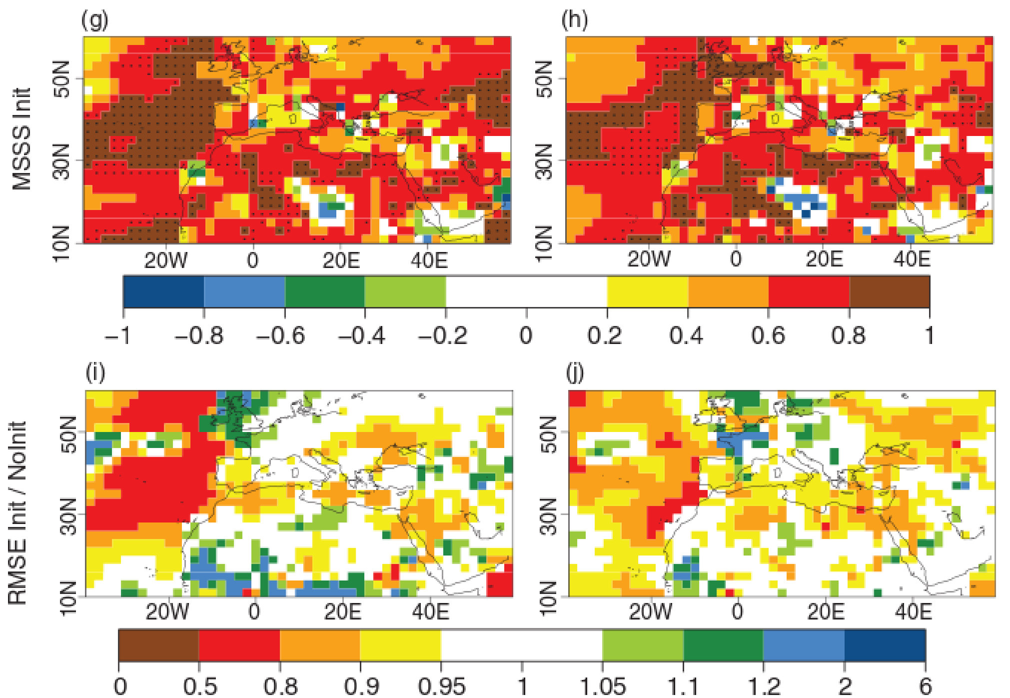
Impact of initialisation

(Top row) 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 initialized and uninitialized predictions for the near-surface temperature from the multi-model CMIP5 experiment (1960-2005) for (left) 2-5 and (right) 6-9 forecast years. Yearly start date interval.

Forecast year 2-5 **Forecast year 6-9**

Init MSSS of ensemble mean

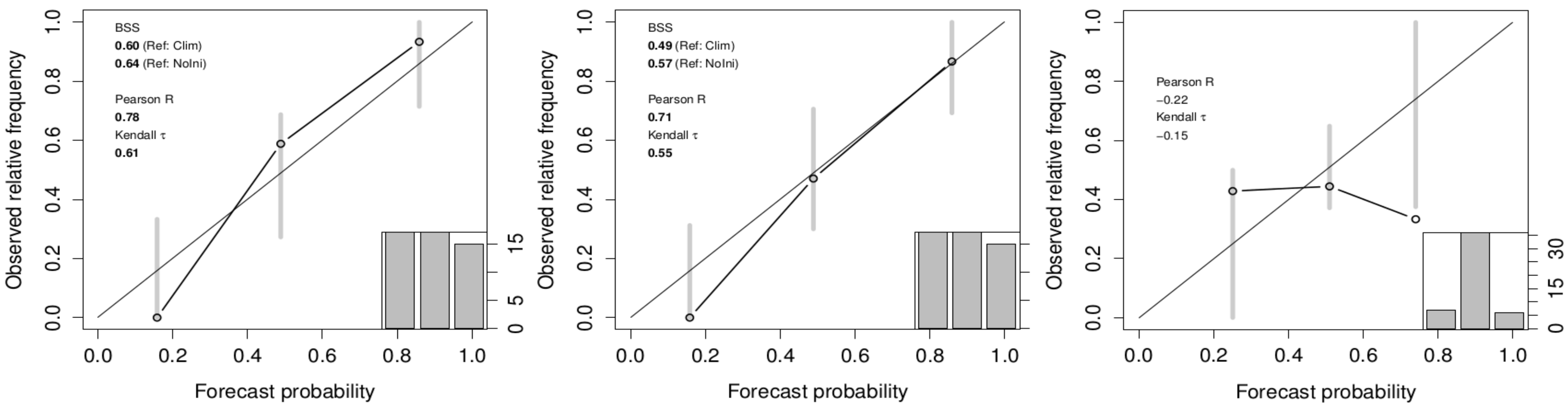
Ratio RMSE Init/NoInit



Guemas et al. (2014)

Service-driven forecasts: tropical cyclones

Reliability diagrams of initialized MME for left) basin-wide ACE and centre) U.S. ACE and right) uninitalized MME U.S. ACE 1-5 year forecasts for anomalies above the mean over 1961-2009. Statistically significant values are in bold.



Caron et al. (2015)

Communication: fact sheets

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 climate change.

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

SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Real-time decadal prediction

Multi-model real-time decadal prediction exchange will request additional support at CCl16. Very simple: research exercise, we can learn a lot from this; prevent over-confidence from a single model; equal ownership.

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.

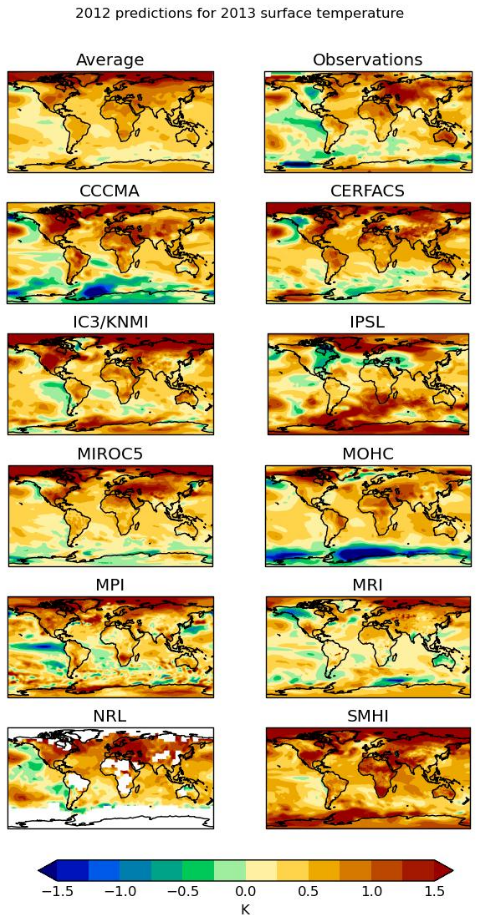
SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

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

Images last updated 2014-06-25

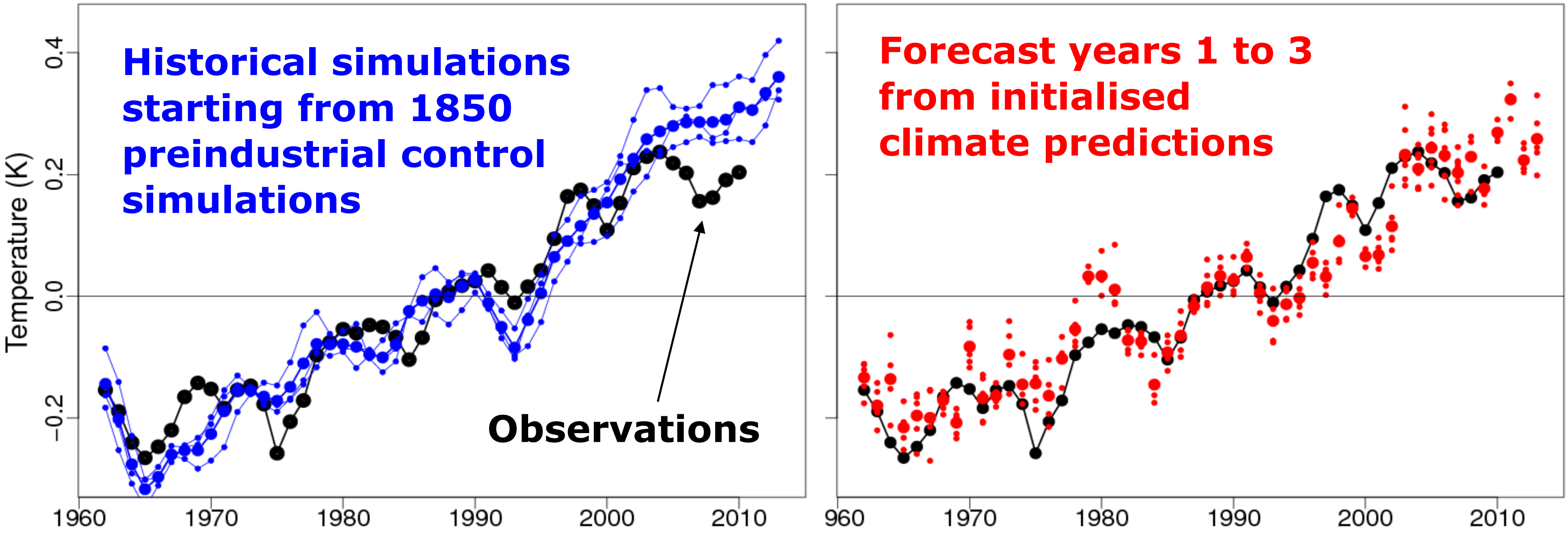
Issued	Period	Element
2013	year 1	surface air temperature

Decadal forecast exchange 2013 predictions for year 1 surface air temperature



Attribution of the XXIst century hiatus

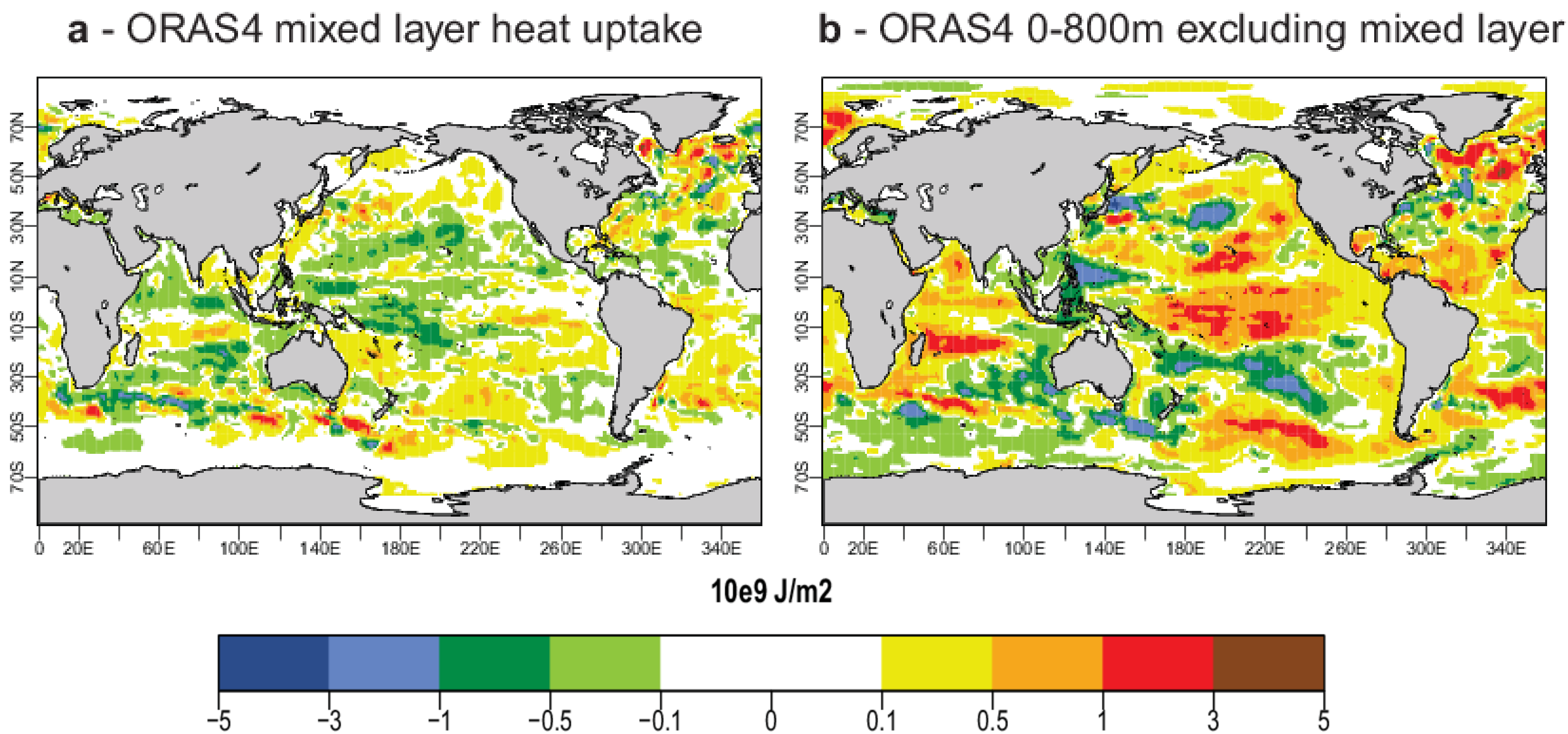
Predictions of the recent global-temperature slow down with EC-Earth 2.3. Global-mean SST from observations (ERSST) and simulations, three-year averages. The experiments suggest an important role of the internal variability, especially the oceans, in the hiatus.



Guemas et al. (2013)

Hiatus in the ocean

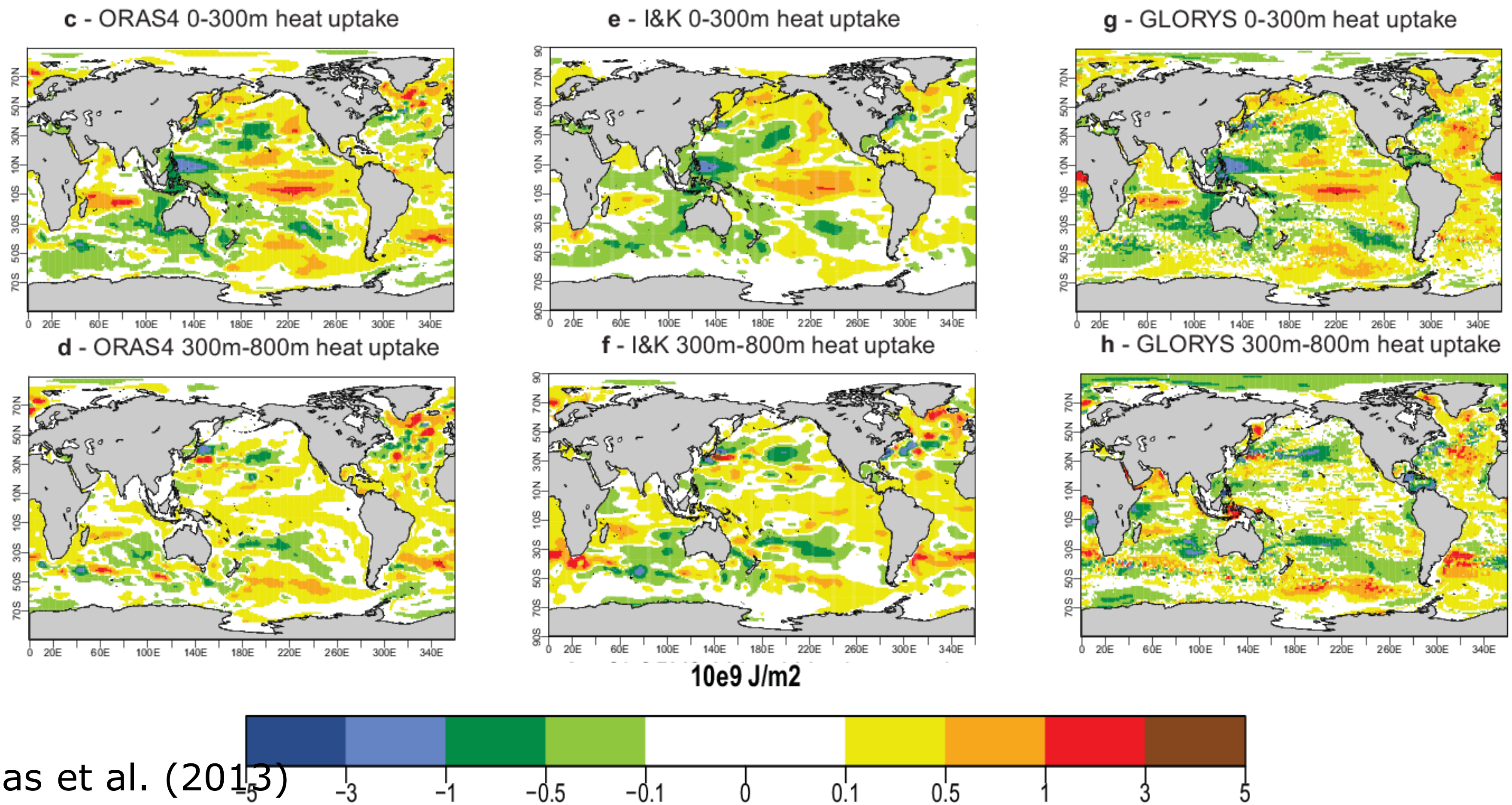
Ocean heat uptake computed as the average of the differences over the periods (2001,2003)-(1998-2000), (2002,2004)-(1999,2001) and (2003,2005)-(2000,2002) from the ORAS4 ocean reanalysis.



Guemas et al. (2013)

Hiatus in the ocean

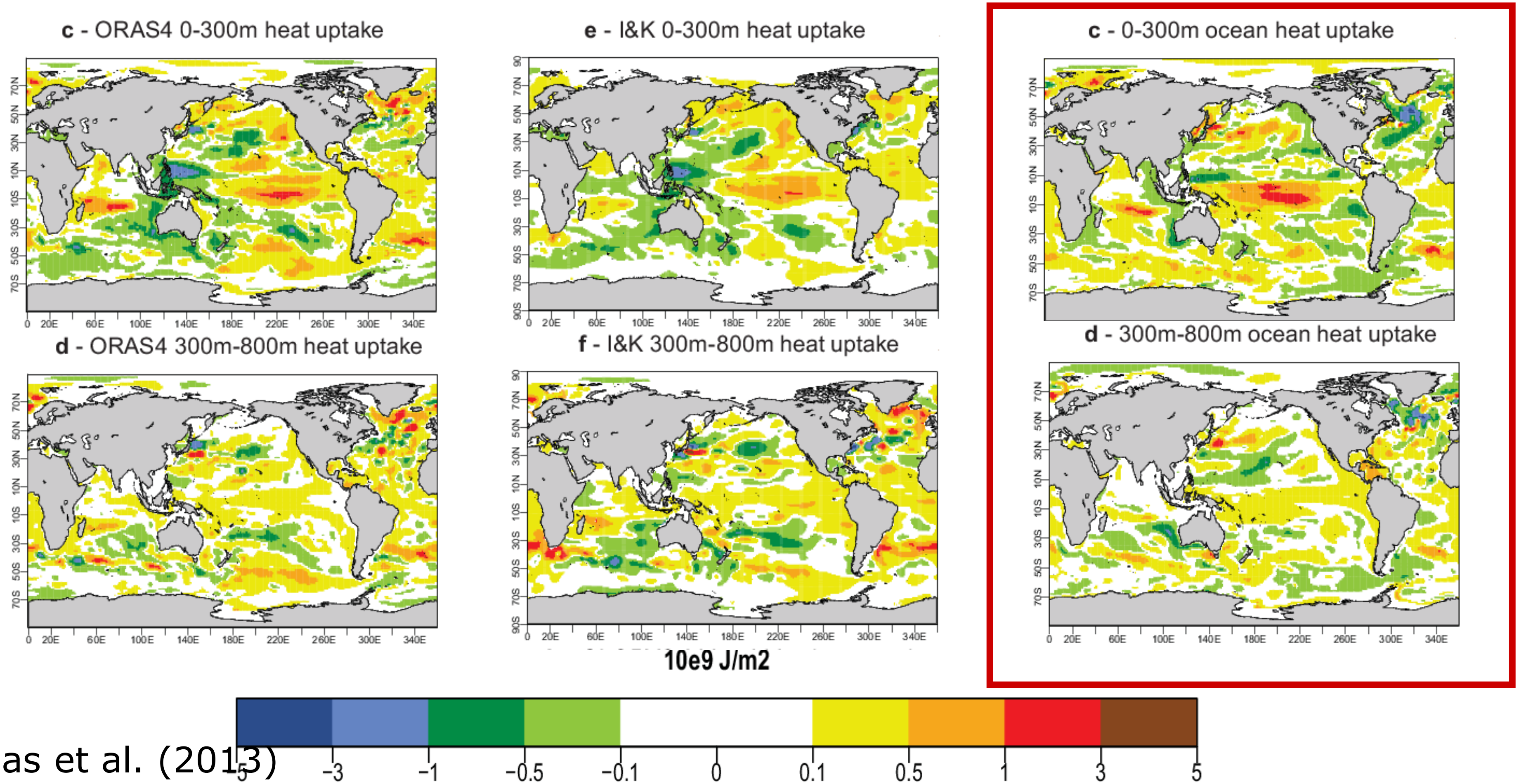
Ocean heat uptake computed as the average of the differences over the periods (2001,2003)-(1998-2000), (2002,2004)-(1999,2001) and (2003,2005)-(2000,2002) for two ocean layers and three reanalyses.



Guemas et al. (2013)

Hiatus in the ocean

Ocean heat uptake as the average of differences over (2001,2003)-(1998-2000), (2002,2004)-(1999,2001) and (2003,2005)-(2000,2002) for two ocean layers, two reanalyses and the EC-Earth2.3 2-4 year predictions.



Guemas et al. (2013)

Some open fronts

- Work on initialisation: initial conditions for all components (including better ocean), better ensemble generation, etc. Link to observational and reanalysis efforts.
- Model improvement: leverage knowledge and resources from modelling at other time scales, drift reduction. More efficient codes and adequate computing resources.
- Calibration and combination: empirical prediction (better use of current benchmarks), local knowledge.
- Forecast quality assessment: scores closer to the user, reliability as a main target, process-based verification.
- Improving physical processes: sea ice, projections of volcanic and anthropogenic aerosols, vegetation/land, …
- More sensitivity to the users' needs: going beyond downscaling, better documentation (e.g. use the IPCC language), demonstration of value and outreach.

CMIP6 decadal MIP: DCPP

- Formulate an appropriate and relevant scientific question.
- Three components: hindcasts, forecasts, predictability.
- Decadal prediction will benefit from being part of CMIP6:
  - Better understanding (to, hopefully, reduce the drift) the systematic error.
  - Control runs for predictability estimates.
  - Infrastructure: data dissemination, model documentation, diagnostics.
- Other MIPs could benefit from the decadal-prediction MIP:
  - Reduction of the systematic error by understanding the drift sources.
  - Continuous verification of the models.
- Decadal prediction could be a very expensive part of CMIP.
- Real-time decadal prediction exchange will continue and be enhanced (with more variables) whenever possible. Contribute to climate services and WCRP grand challenges.