SPECS
Climate Prediction for Climate Services

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

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

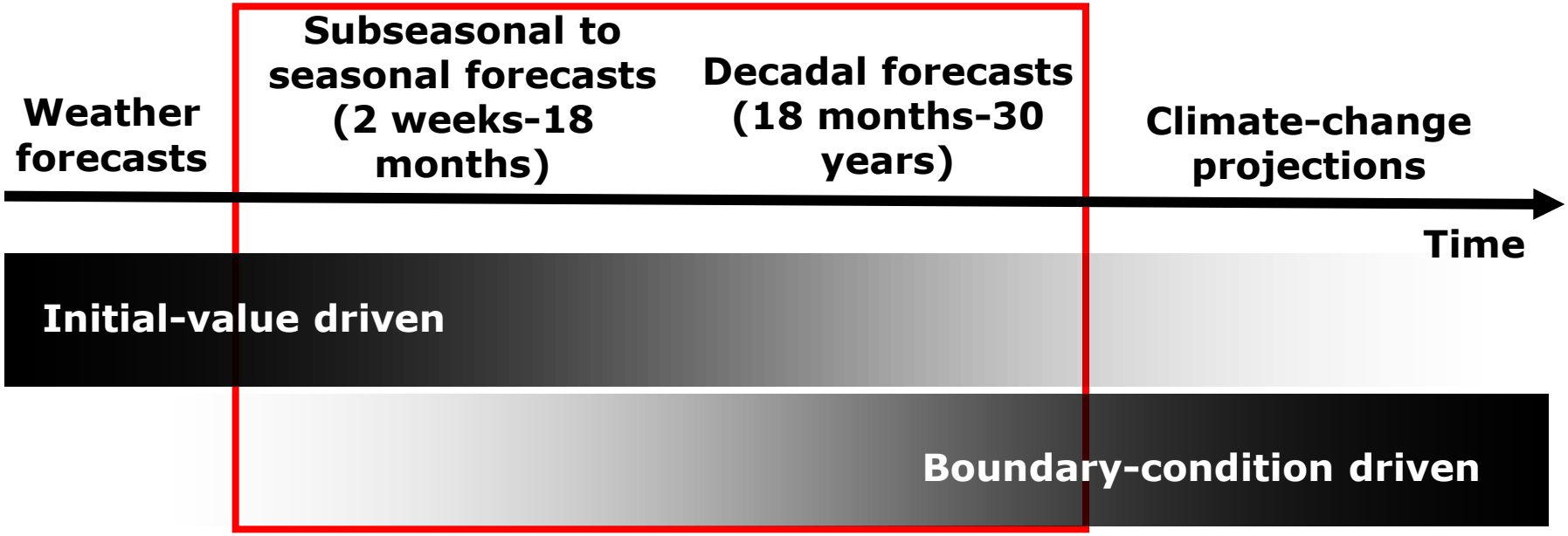
BSC iCrea IC3

Motivation of this meeting

- It is a SPECS milestone (MS62), and an opportunity to bring together two projects aiming at illustrating the benefits of decadal predictions.
- The meeting allows sharing recent results from the coordinated experiments and should help identifying the main challenges of decadal prediction for the 20 months remaining of SPECS.
- It offers a unique occasion for institutions interested in the definition of the DCPP MIP for CMIP6, bringing together representatives of DCPP and CLIVAR DCVP, plus other national and FP7 projects (MORDICUS, PREFACE): component C definition, strategy for experiment definition, list of variables, relationship with the DECK experiments, etc.

Climate prediction

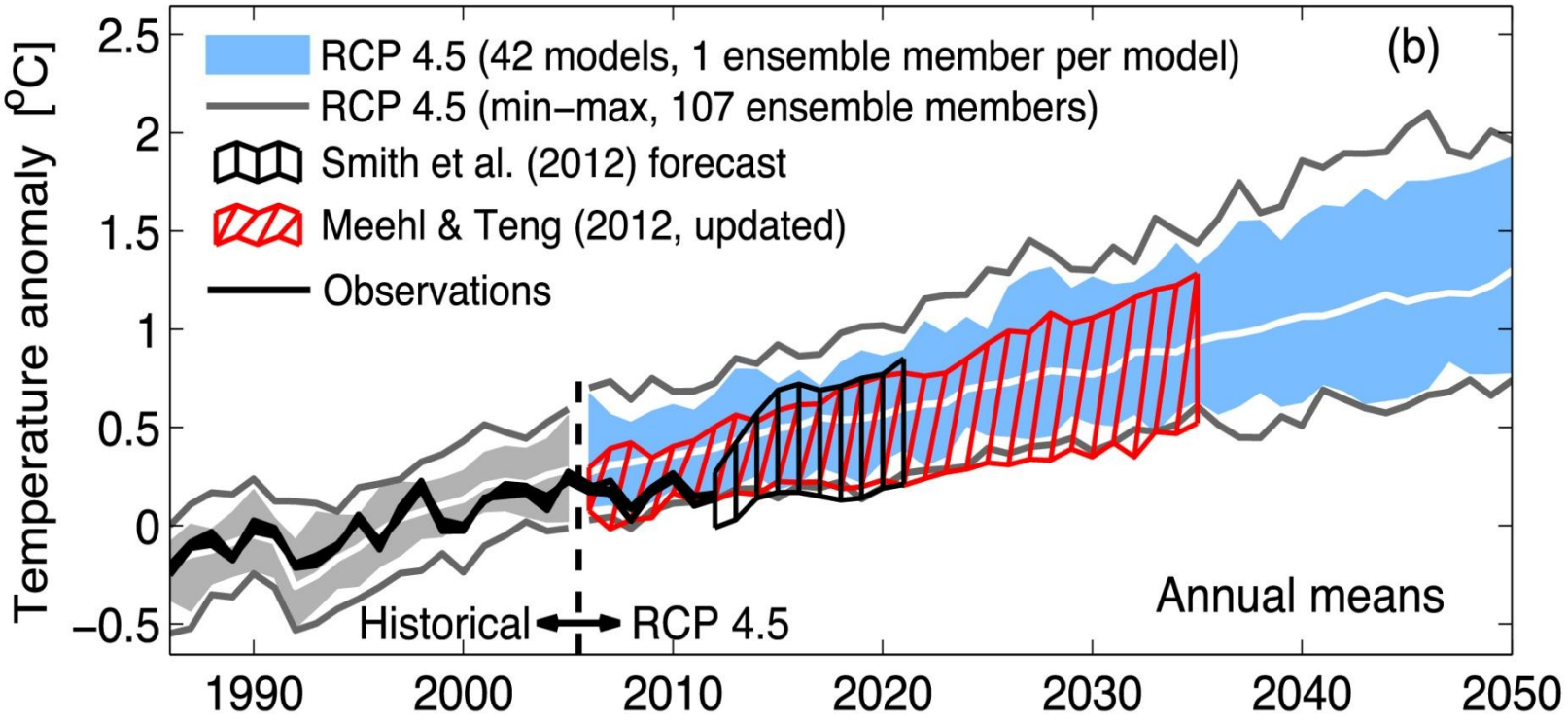
Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialization and systematic comparison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



Adapted from Meehl et al. (2009)

Predictions and projections

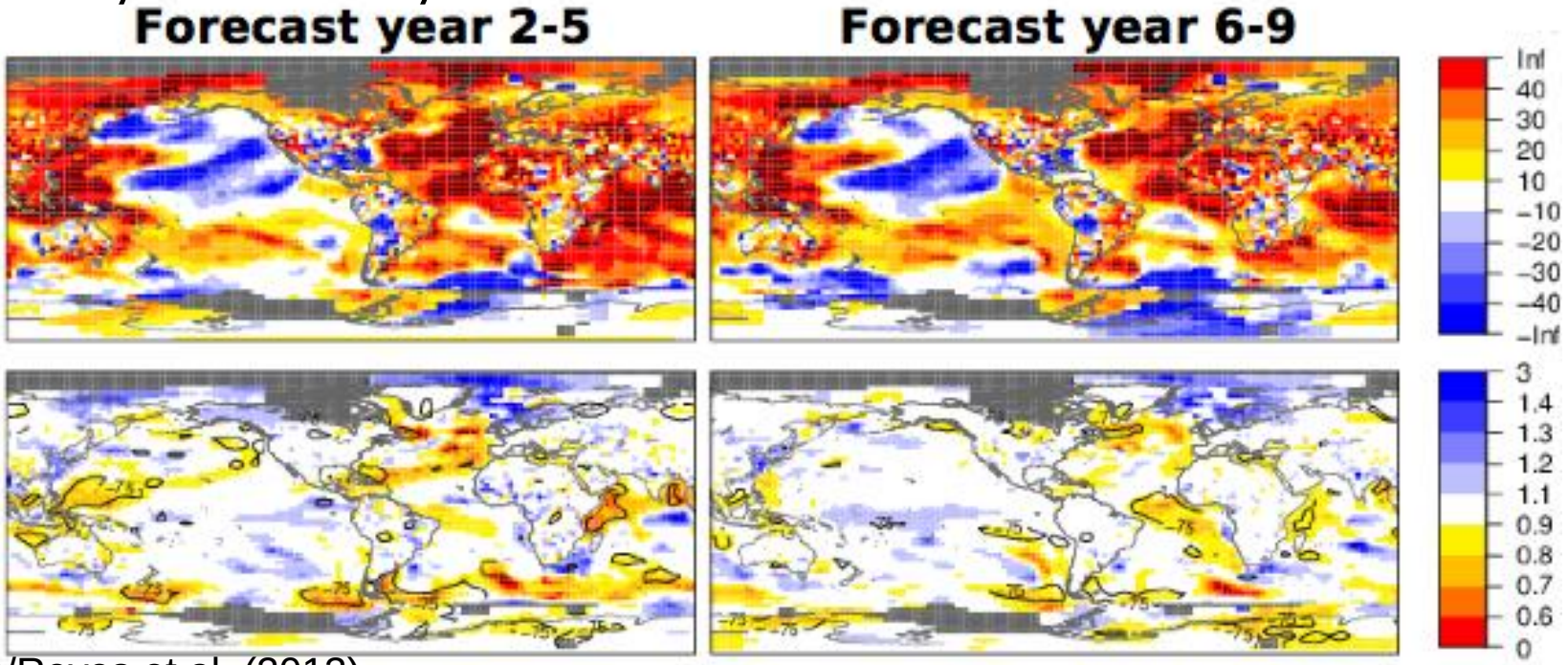
Annual-mean global-mean temperature predictions and projections from CMIP5.



IPCC AR5 WGI (2013)

Decadal forecast quality CMIP5

(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.

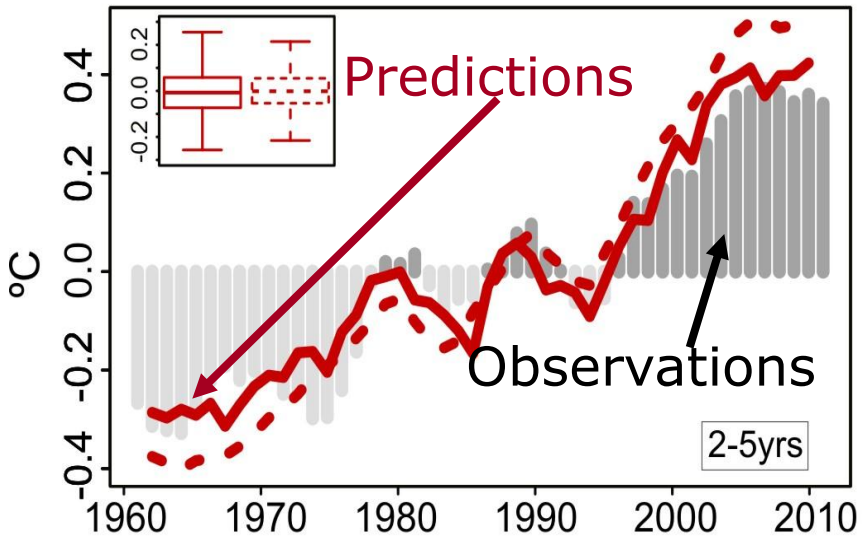


Doblas/Reyes et al. (2013)

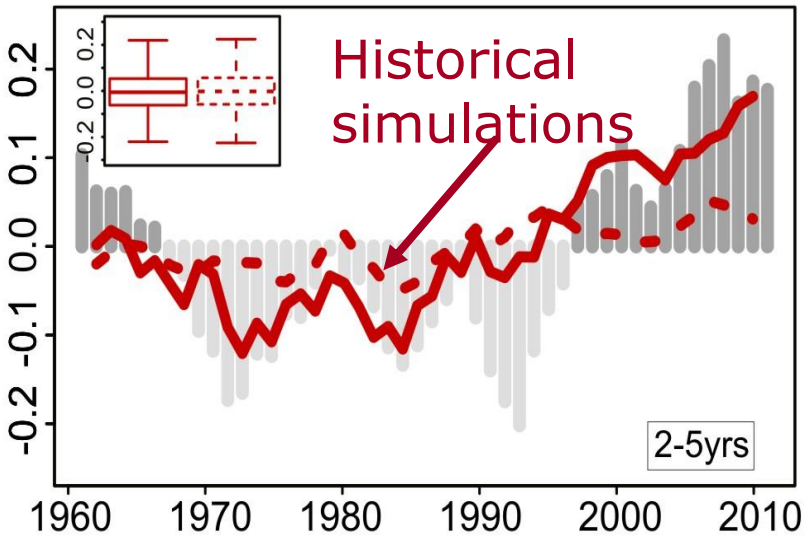
Decadal forecast quality CMIP5

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



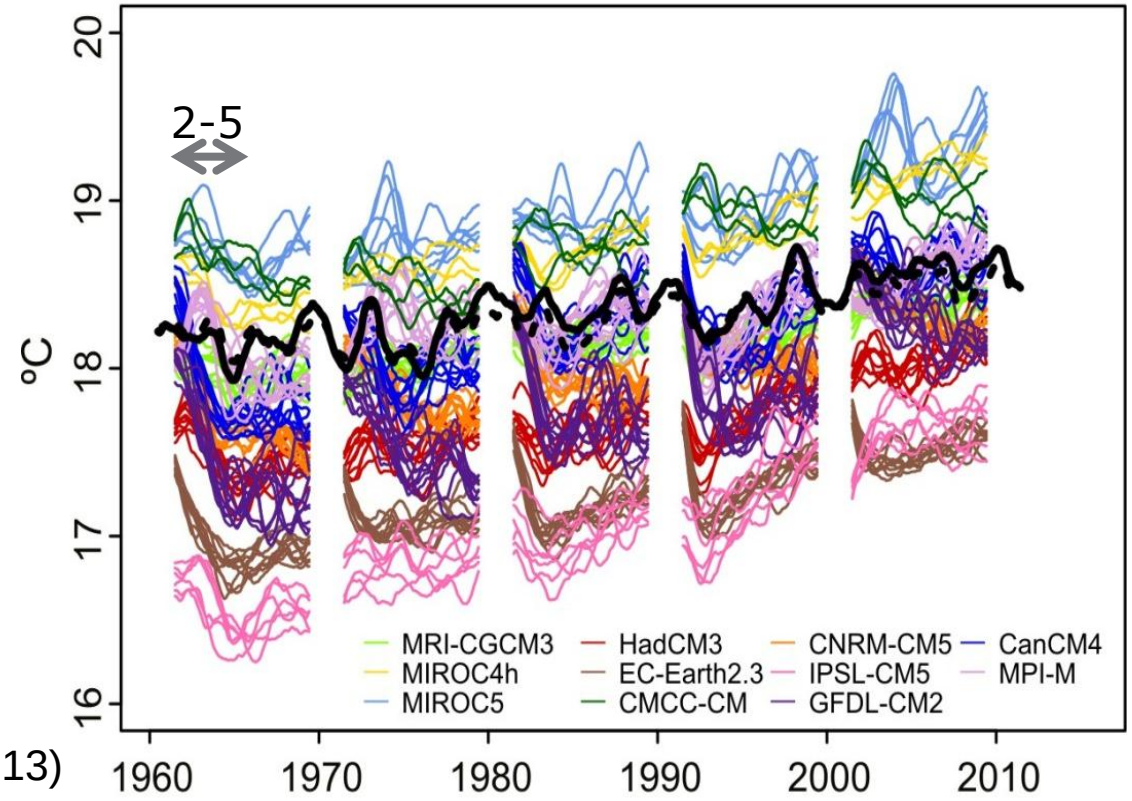
Atlantic multidecadal variability (AMV)



Doblas/Reyes et al. (2013)

Decadal forecast quality CMIP5

Global mean near-surface air temperature over the ocean (one-year running mean applied) from CMIP5 hindcasts. Each system is shown with a different colour. NCEP and ERA40/Int used as reference. **Examples of shock, drift and large systematic error can be found.**



IPCC AR5 WGI (2013)

SPECS motivation

What: to produce quasi-operational and actionable local climate information

Why: need information with improved forecast quality, a focus on extreme climate events and enhanced communication and services for RCOFs, NHMSs and a wide range of public and private stakeholders

How: with a new generation of reliable European climate forecast systems, including initialised ESMs, efficient regionalisation tools and combination methods, and an enhanced dissemination and communication protocol

Where: over land, focus on Europe, Africa, South America

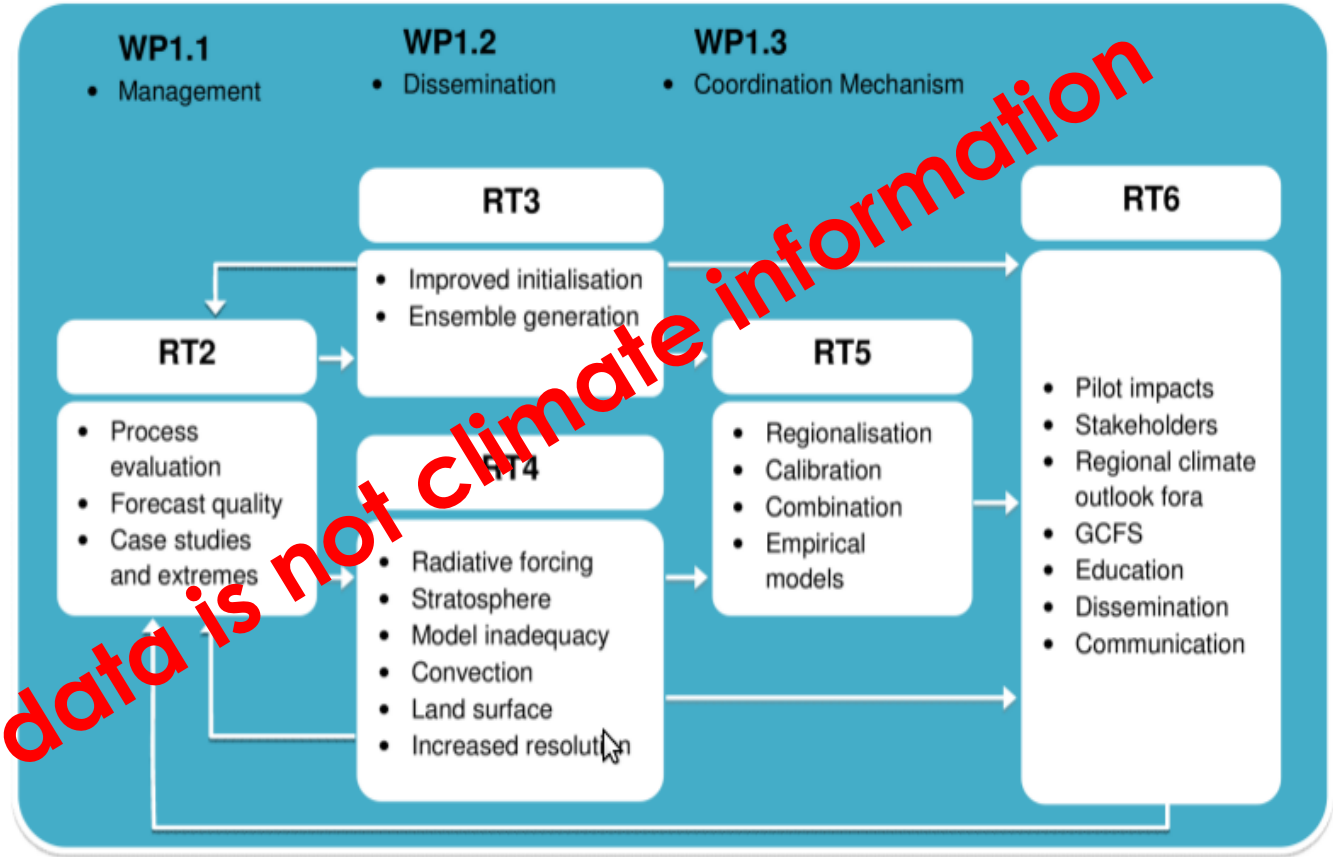
When: seasonal-to-decadal time scales over the longest possible observational period

http://www.specs-fp7.eu

SPECS: Overall strategy

Links to EUPORIAS/NACLIM, but also IS-ENES2, PREFACE, EUCLEIA, CLIPC, …

Forecast System	Project Partners
CNRM-CM5	CNRM, CERFACS
EC-Earth	KNMI, SMHI, IC3, ENEA
IFS/NEMO	ECMWF, UOXF
IPSL-CM5	CNRS
MPI-ESM	MPG, UniHH
UM	UKMET



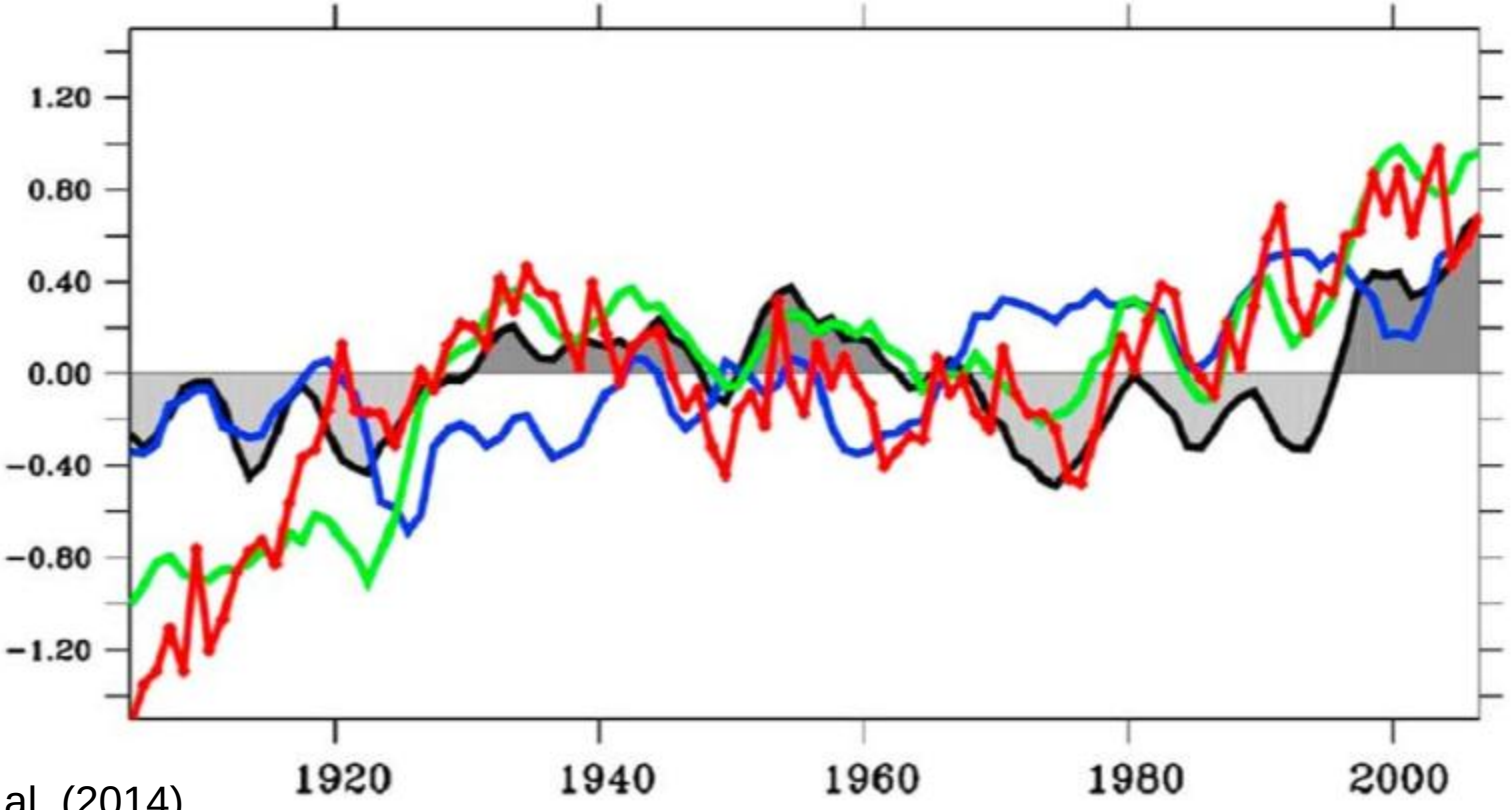
WP1.1: Management
WP1.2: Dissemination
WP1.3: Coordination across EUPORIAS, NACLIM & SPECS
RT2: Evaluation of current s2d forecast systems
RT3: Forecast strategies
RT4: Improved systems
RT5: Calibrated predictions at the local scale

Coordinated experiments

- Core (all forecast systems are expected to contribute to) and tier1.
- Most experiments with two phases: development (quick to run and analyse) and production (redesign depending on development phase).
- Standard set up:
  - Seasonal: 10 members, May and November starts, 1981-2012, seven-month forecast length.
  - Decadal: 5 members, starts in 1960, 63, 65, 68, 70, 73, 75, 78, 80, 83, 85, 88, 90, 93, 95, 98, 2000, 03, 05, 08, 10, 13, five-year forecast length
- For decadal: extension of start dates (before 1960), comparison full-field and anomaly initialisation, increasing resolution, predictability linked to the interactive vegetation, impact of solar irradiance and volcanic aerosol.
- Focus on case studies and processes.
- Some of the experiments can be used, along with recent observations, for attribution studies.
- Common archiving and dissemination.

Starting before 1960

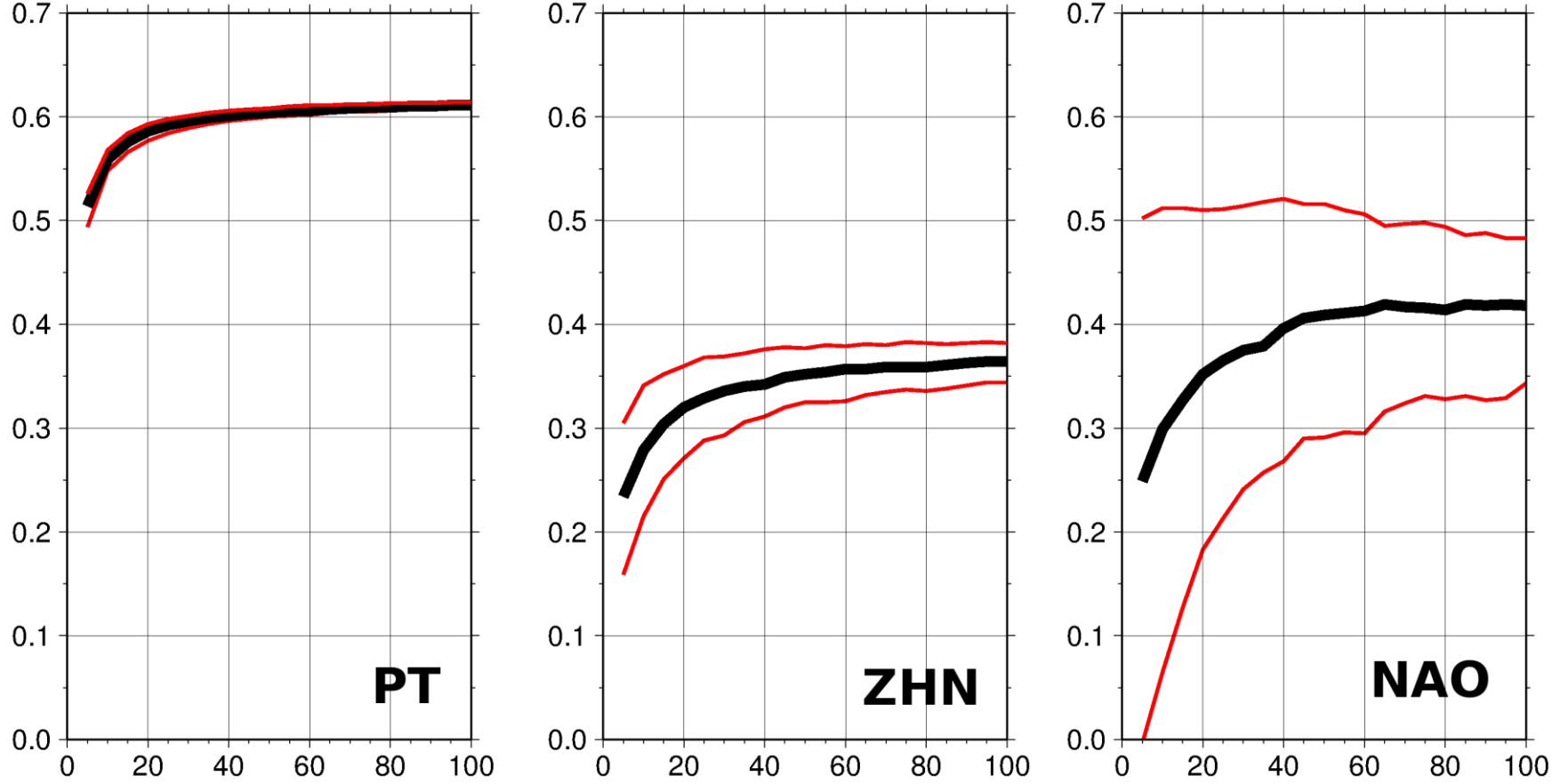
Four-year average SST over the North Atlantic (80ºW-10ºW,40ºN-60ºN) of (black) 20CR, (green) the assimilation simulation, (red) the 2-5 year MPI extended hindcasts and (blue) the uninitialzed run. The extended period improves the robustness of the results.



Müller et al. (2014)

No shortcuts: ensemble size

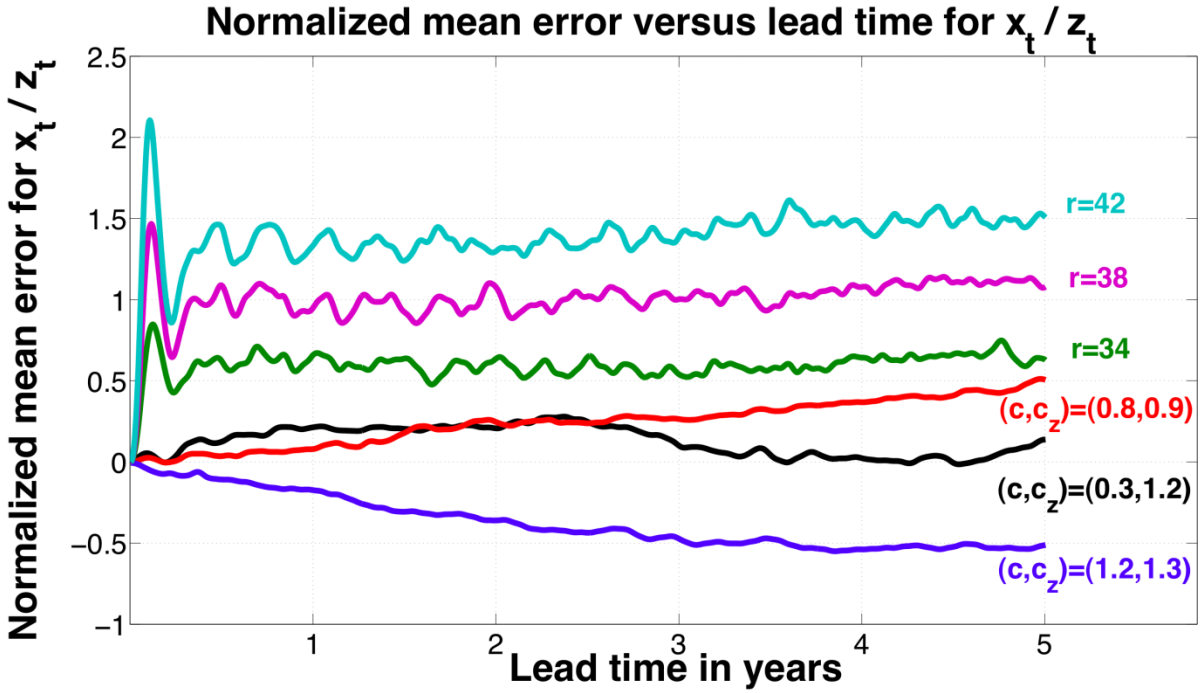
CNRM-CM's correlation for ensemble-mean predictions of DJF (one-month lead time) tropical precipitation, Northern Hemisphere Z500 and NAO as a function of the ensemble size. Red lines for 90% confidence interval.



M. Déqué (Météo-France)

Initialization approaches

Mean error of two variables from 360 decadal predictions performed with the Lorenz model with three compartments (ocean, tropical atmosphere and extra-tropical atmosphere). The configurations where AI outperforms FFI are associated with a strong initial shock and a larger bias.



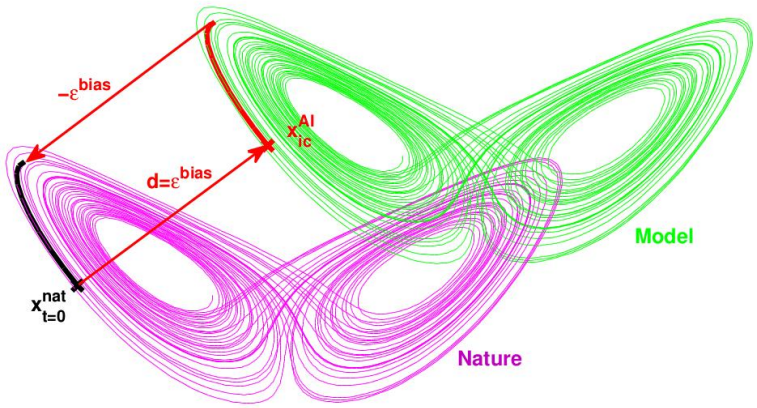
Model error "type #2"

Model error "type #1"

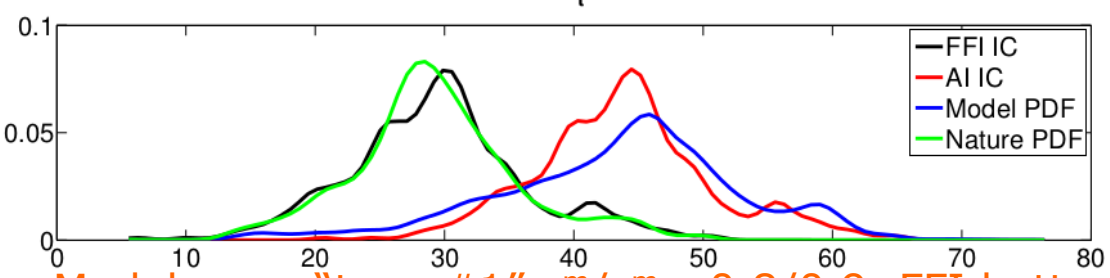
Carrassi et al. (2014)

Initialization approaches

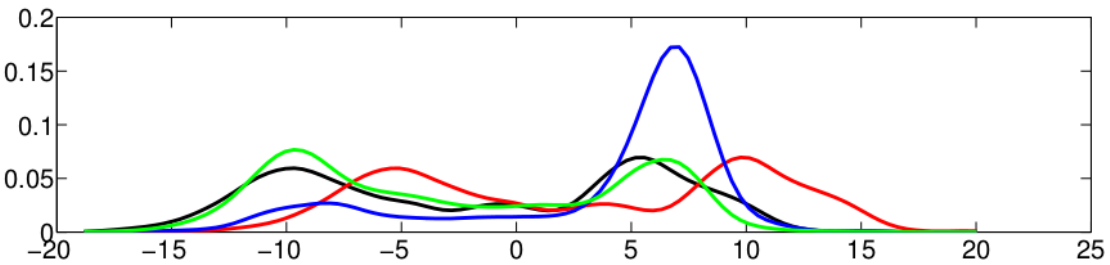
PDFs of initial conditions (black and red) and of the model and "nature" climatologies (blue and green) for the Peña and Kalnay model with three compartments (ocean, tropical atmosphere and extra-tropical atmosphere).



Model error "type #2" r^m=42, AI better



Model error "type #1" c^m/c^m_z=0.8/0.9, FFI better

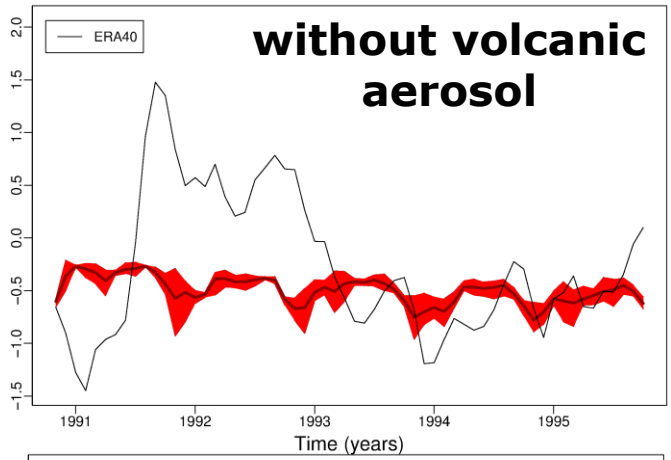


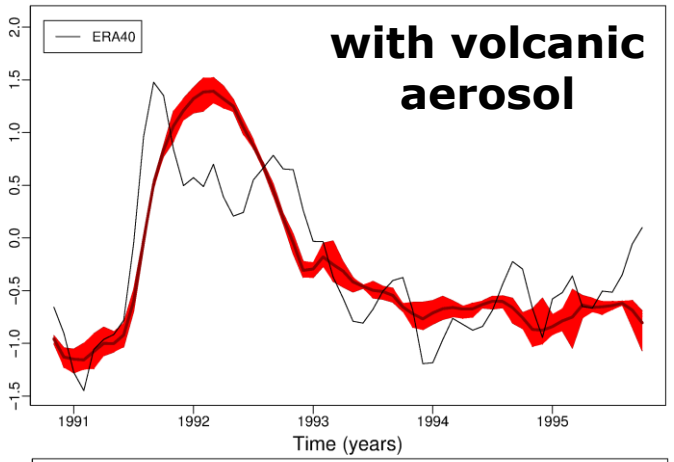
Weber et al. (2015)

Eruptions and predictions

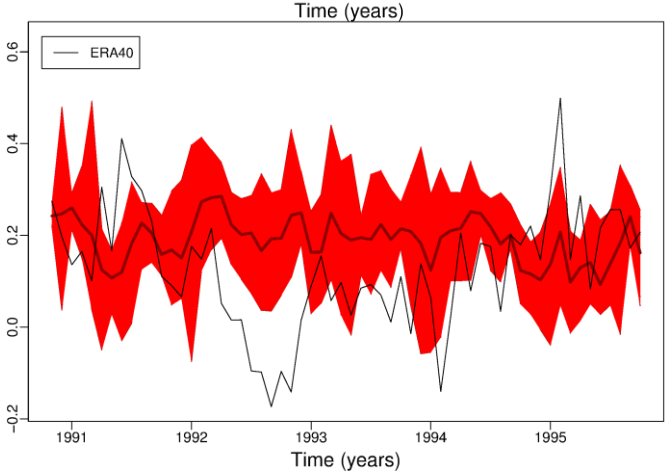
EC-Earth2.3 simulations of volcanic aerosol impact for Pinatubo. Five-member ensembles initialised on the 1 November 1990. **No consistent treatment of volcanic aerosol and ozone**.

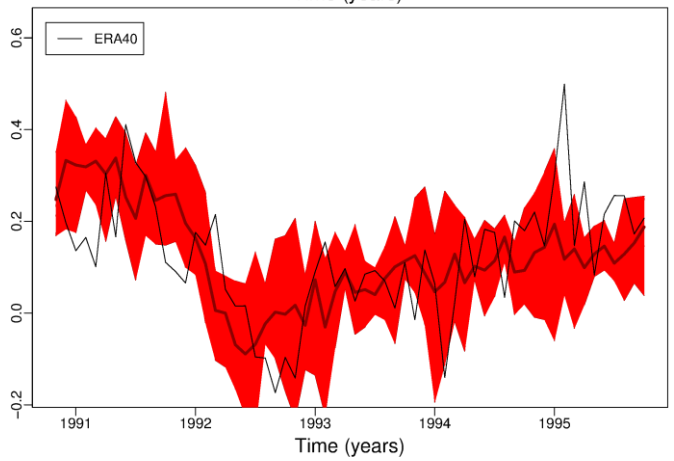
T50





Near-surface air temperature





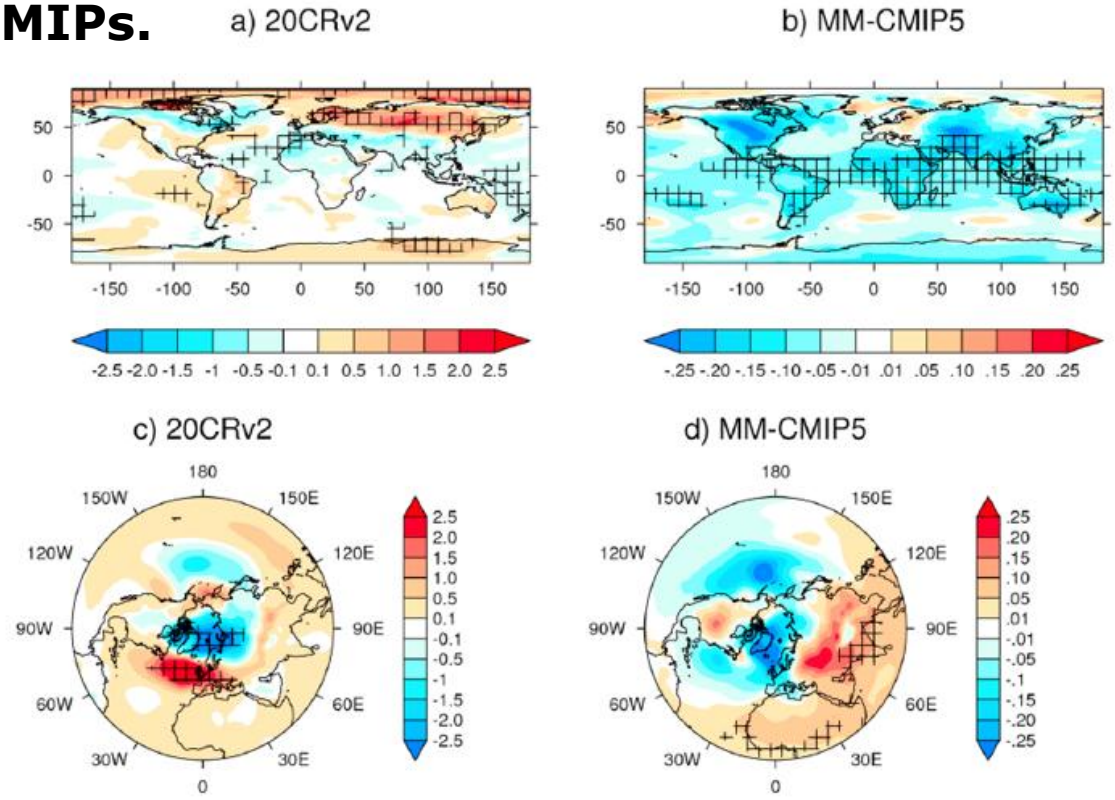
M.. Ménégoz (IC3)

Eruptions and predictions

Dynamical response: summer cooling and winter warming.

The winter warming could be explained by the warming of the tropical stratosphere that increases the meridional temperature gradient, intensifying the polar vortex and could lead to more frequent and intense NAO+ events. **CMIP5 models fail to do this -> Small sample -> Need connections to millennium MIPs.**

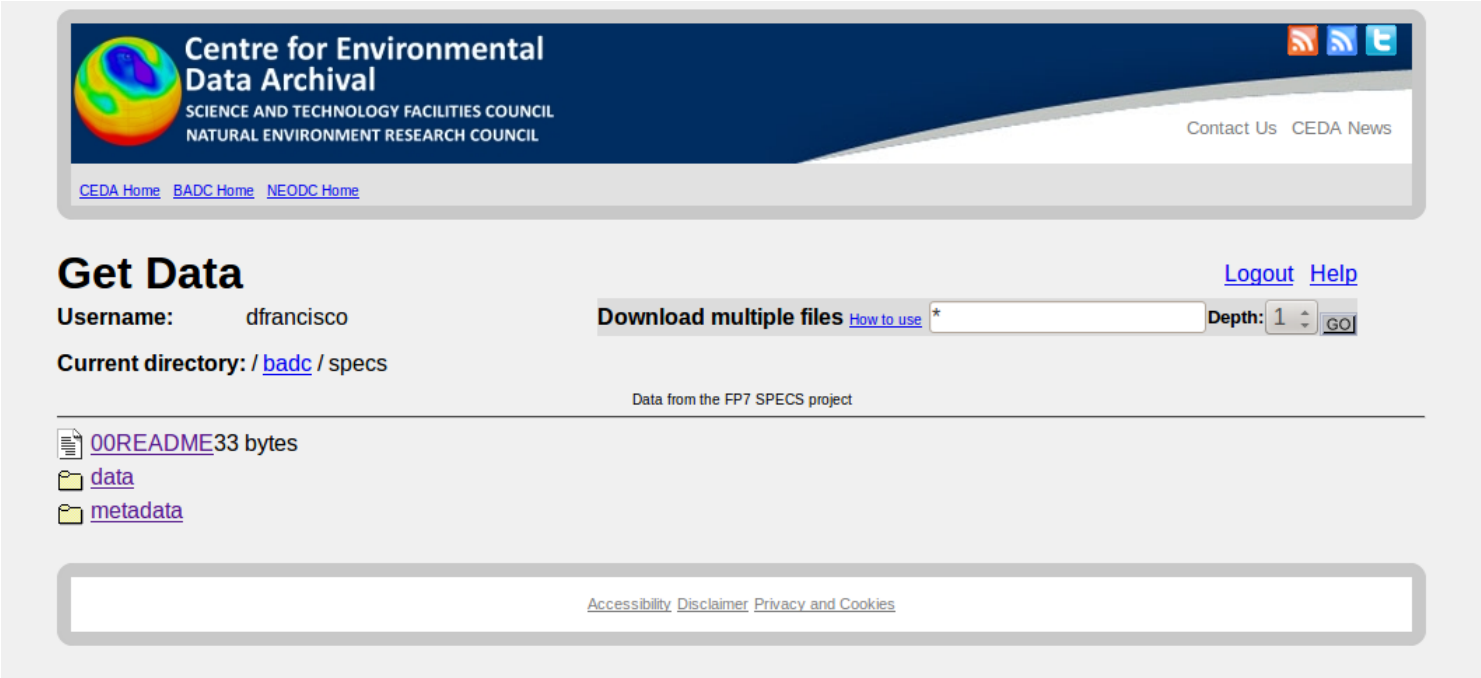
Surface temperature (top) and MSLP (bottom) anomalies averaged for two post-eruption winter over the XX Century.



Driscoll et al. (2012)

Data dissemination

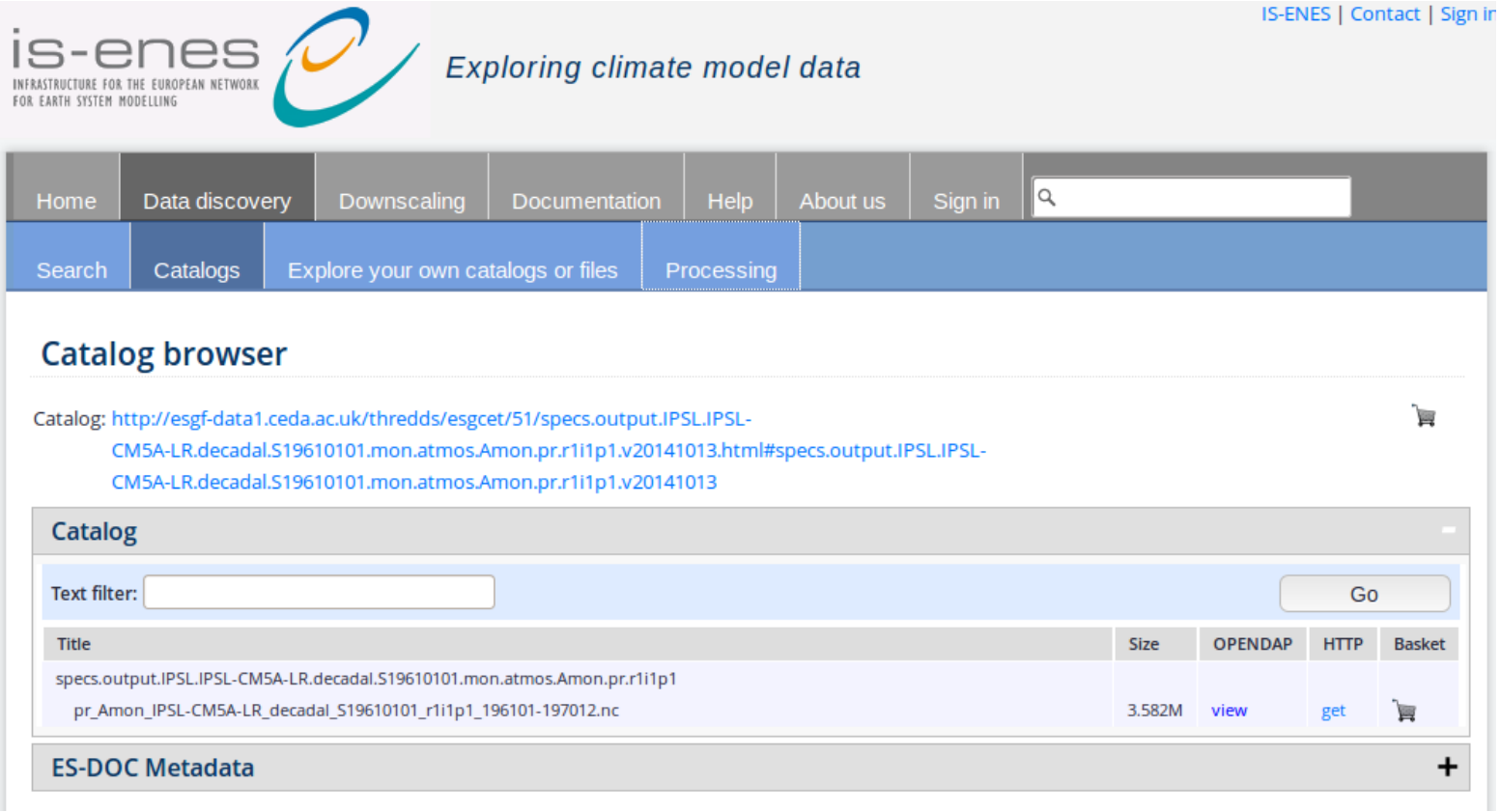
- Centralised data repository at BADC with files using a convention building on both CMIP5 and CHFP and that is expected to become the basis for CMIP6.
- Data published on the ESG after quality control reachable by other SPECS-related services (ECOMS UDG, Climate Explorer, etc).
- Multiple sensitivity experiments and NMME data available.



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



MiKlip Central Evaluation System

The common scientific infrastructure enables

Flexibility

A hybrid shell and …

Usability

web access for users

Reproducibility

Evaluations are saved

Transparency

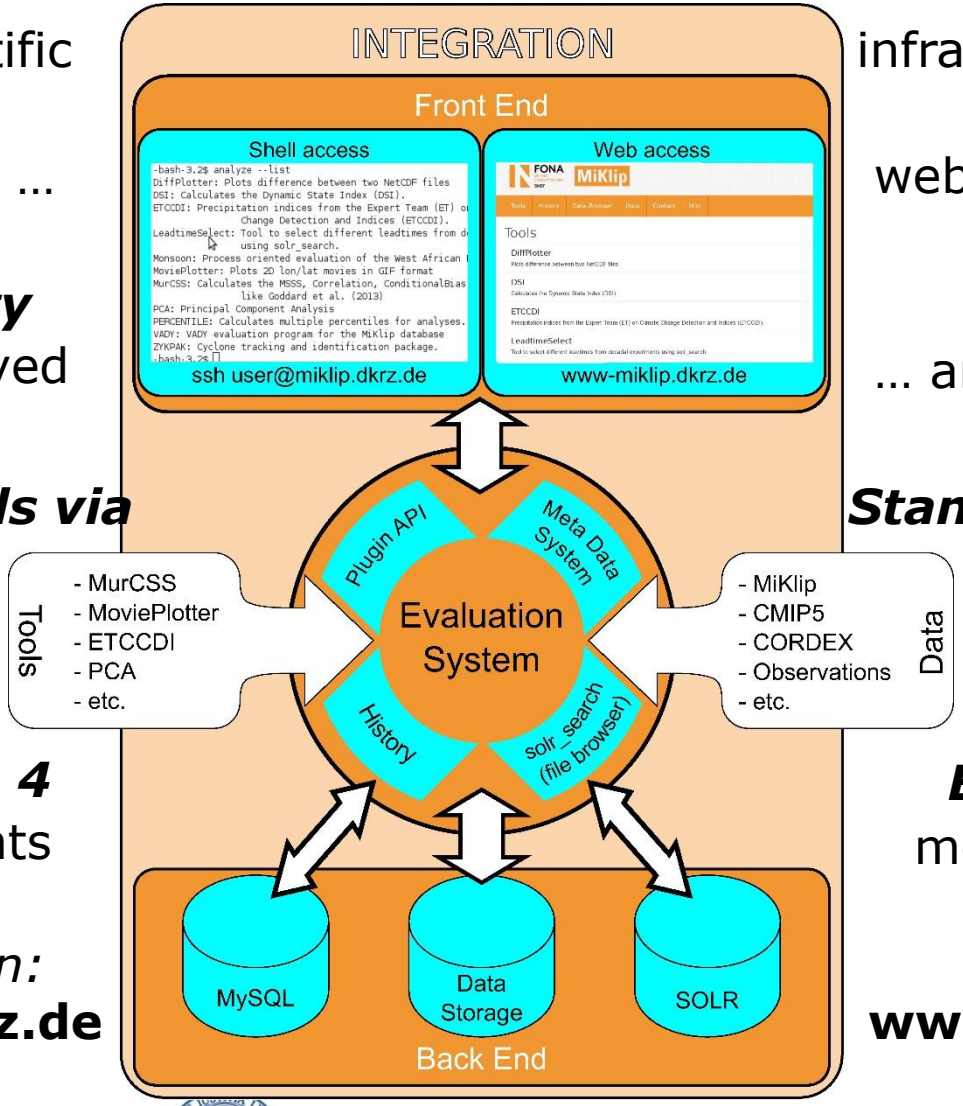
… and can be re-done

Standardized Tools via

plugin framework
„decadal" focus

Standardized Data via

ESGF & CMIP conventions



Big Advantage 4

model developments

Big Advantage 4

model comparisons

MiKlip Evaluation:
www-miklip.dkrz.de

MiKlip Project:
www.fona-miklip.de

Christopher Kadow

FONA Decadal Climate Prediction BMBF

Freie Universität Berlin

MiKlip

Common tools for verification

GA 2014 verification demo

Aims and Agenda for the 2nd SPECS Verification Workshop [edit]

The aims of this short workshop are to:

- demonstrate new software that has been developed for verification;
- allow participants try this out on their own laptops;
- have a brief discussion about future needs and plans.

The planned agenda for the workshop is as follows:

Time Activity
11:00-11:20 Demo of UNEXE SpecsVerification software
11:20-11:40 Demo of IC3 S2dverification software
11:40-12:00 Demo of Meteo-Swiss verification software
12:00-12:45 Hands on session for participants to try out software
12:45-13:00 Brief discussion about future needs and plans

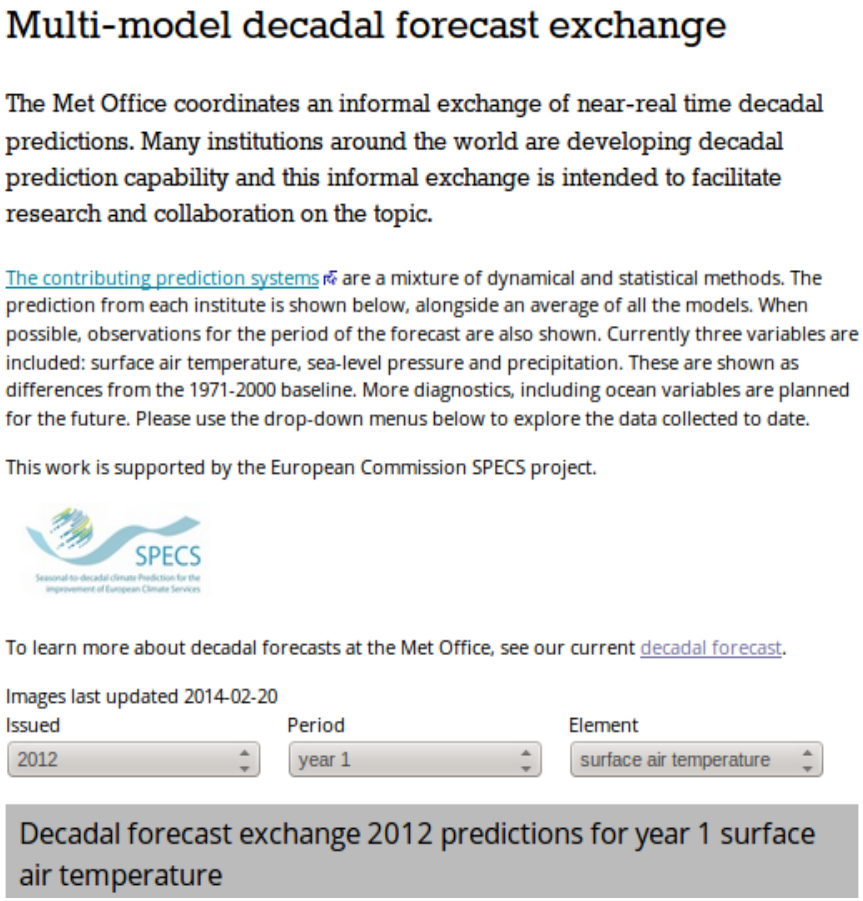
All these packages run in the freely available R language. See the R project site www.r-project.org to download R. Please also consider loading in your favourite forecast and observation data beforehand so that you can try out the verification on your own data.

More information about the new software is given below ...

- SpecsVerification Demo talk-Media:Specsverification.pdf
- S2dverification Demo talk-Media:s2dverification.pdf
- Meteo-Swiss verification Demo talk-Media:veri.pdf

Decadal prediction exchange

Real-time decadal prediction exchange (+component B of DCPP):
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.

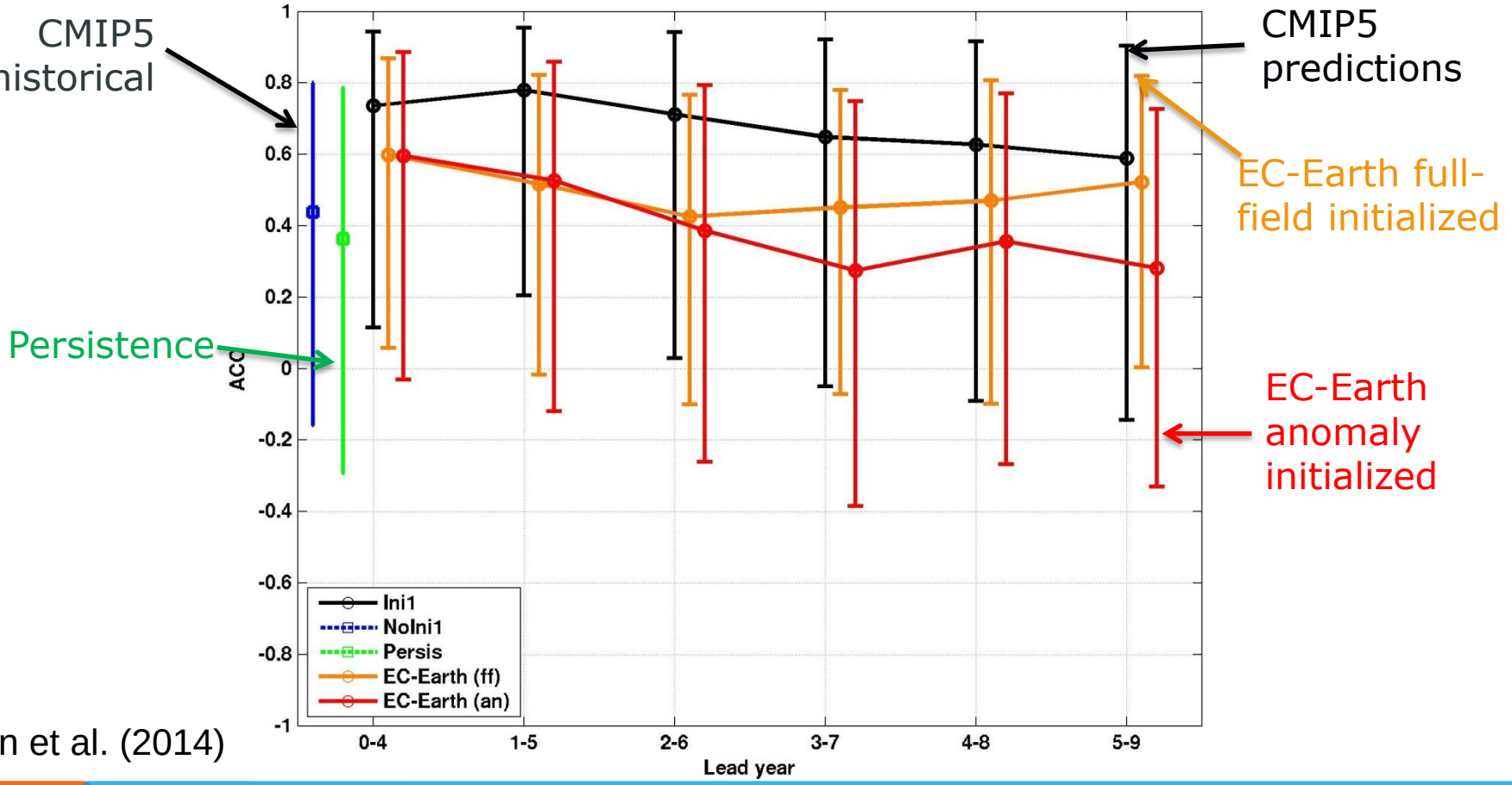
Images last updated 2014-02-20

Issued: 2012 | Period: year 1 | Element: surface air temperature

Decadal forecast exchange 2012 predictions for year 1 surface air temperature

Service-driven forecasts

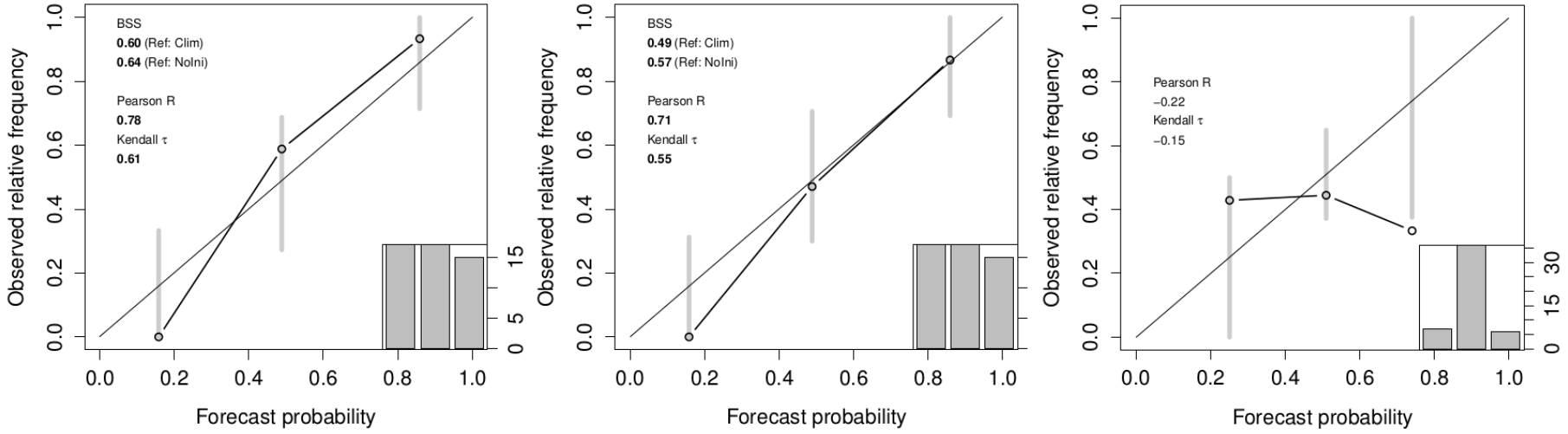
Correlation for the frequency of hurricanes over four years estimated from observations and from EC-Earth CMIP5 decadal predictions. Correlation shown with 95% confidence intervals.



Caron et al. (2014)

Service-driven forecasts

Reliability diagrams of initialised MME for left) basin-wide ACE and centre) U.S. ACE and right) uninitalised 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)

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 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

WCRP RC Grand Challenge

Grand Challenge on Regional Climate Information: What gaps in our scientific understanding and information, if addressed, would maximise the value content of regional climate information?

Steering group: Clare Goodess (WGRC), Francisco Doblas-Reyes (WGSIP), Lisa Goddard (CLIVAR), Bruce Hewitson (WGRC), Jan Polcher (GEWEX & WGRC) and WCRP support.