Seasonal Climate Prediction in a Climate Services Context

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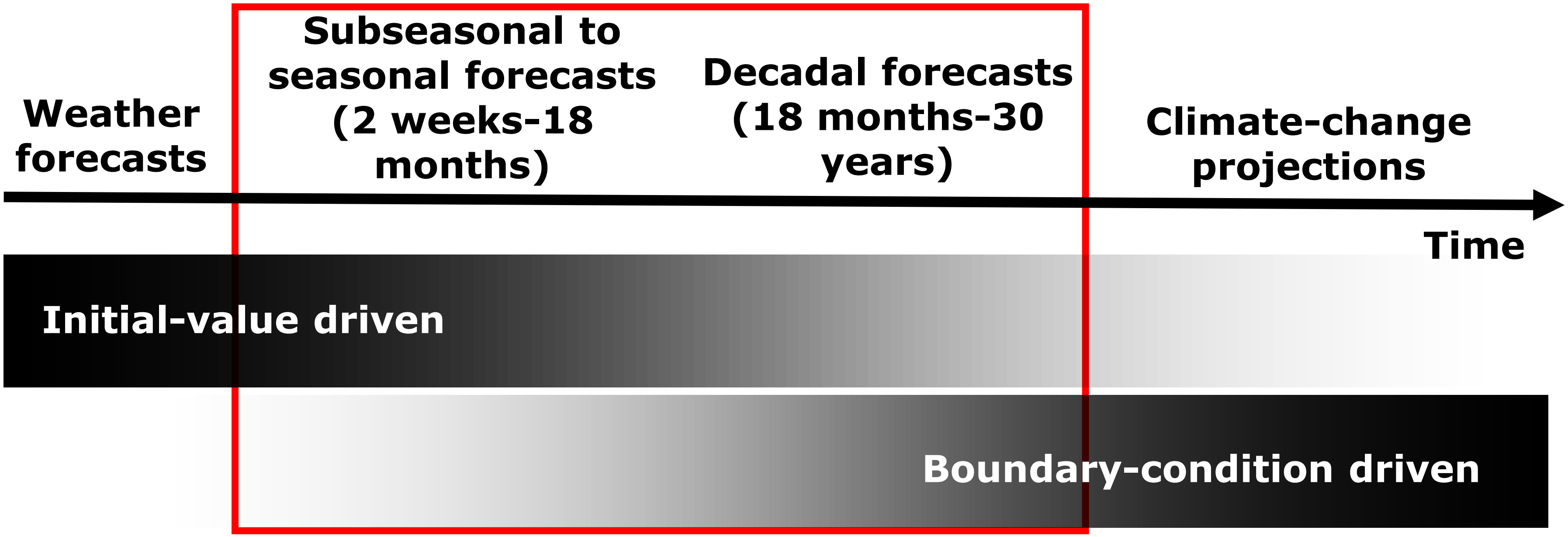
SEVENTH FRAMEWORK PROGRAMME

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

Prediction on climate time scales

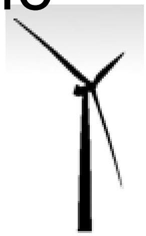
Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialization and systematic comparison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



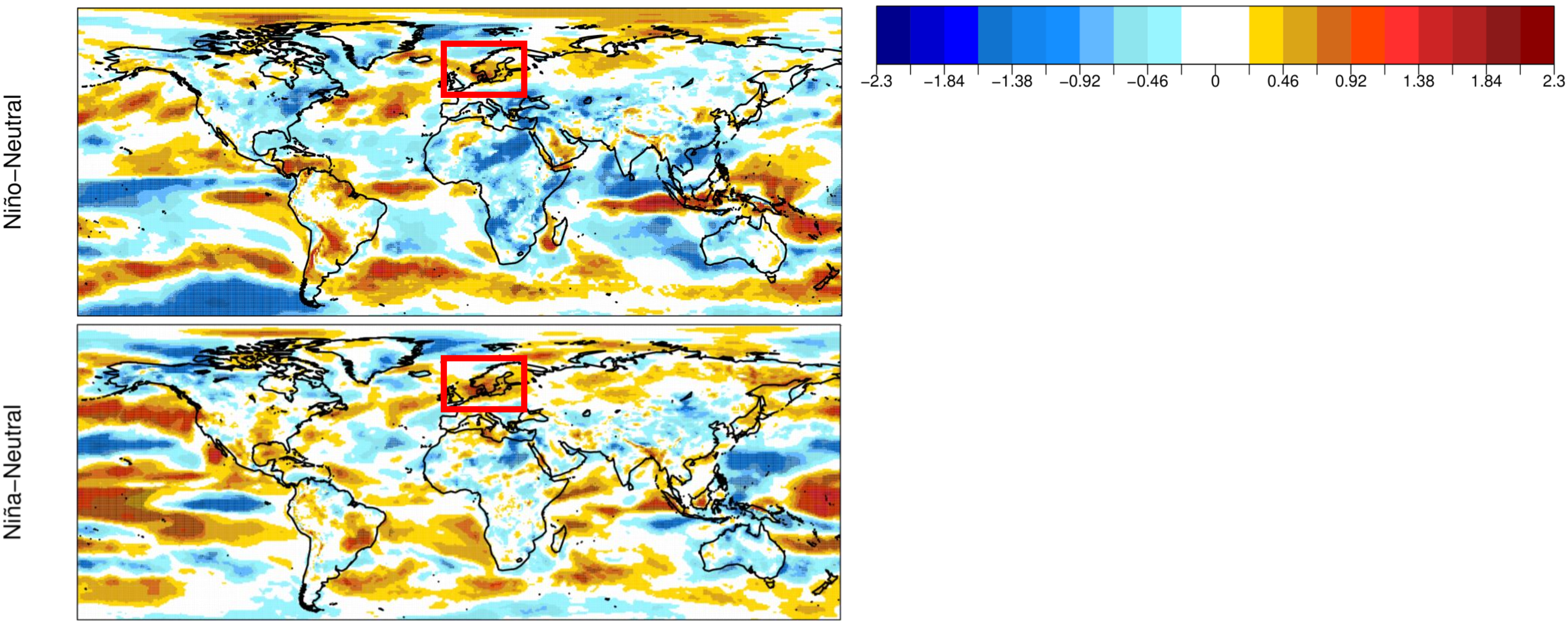
Adapted from Meehl et al. (2009)

Climate services: wind energy

Change in normalised 10-metre wind speed between El Niño (top) and neutral years for SON; for La Niña (bottom).

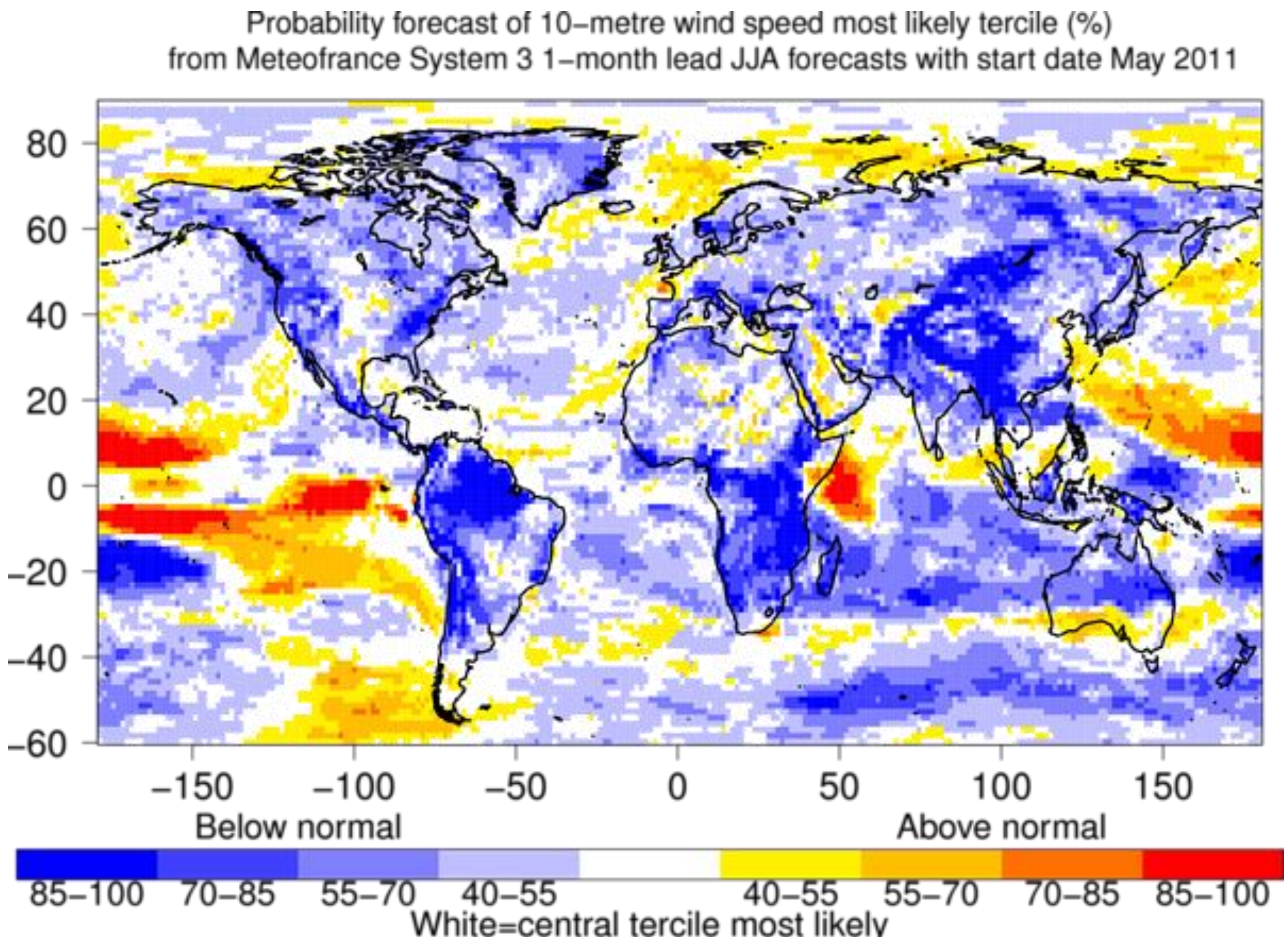


ERA-Int over 1979-2013 stratified using the Niño3.4 (5ºN-5ºS, 120º-170ºW) SST index with a 0.5 threshold.



Climate services: wind energy

What climate forecasters typically offer



Doblas-Reyes et al. (2013)

Climate services: wind energy

What is actually requested in terms of forecasts:

- Forecasts for locations where the mean is large (wind speed above a threshold), and both variability (something to predict) and skill (something useful to say) are high
- Need energy generated over a period (month, season, etc), with uncertainty estimates, at the wind farm level
- Information for off-shore maintenance (at least 3 weeks lead time)
- Also, energy and consumption in other regions to balance network
- Take into account
  - ➢ Management strategies
  - ➢ Development plans

Some of the things missing

- Better understanding of the impact models, and the best way to adapt them to the useful climate information available
- Bias correction, calibration and combination
- Downscaling, when necessary
- Documentation (some stakeholders are used to the IPCC calibrated language, which is different to the climate forecasting language), demonstration of value and outreach
- The EUPORIAS FP7 project, working alongside the SPECS project, is considering solutions to address some of these problems.

Back to the wind energy problem

To satisfy the users' requirements for sub-seasonal to seasonal forecast information:

- High-frequency wind forecasts at ~100 metre height
- Bias-corrected and calibrated forecast data, i.e. whose statistical properties mimic those of the data measured at the wind turbine height -> Bias correcting and calibrating high-frequency data is extremely complicated and could destroy the little skill available

On top of this:

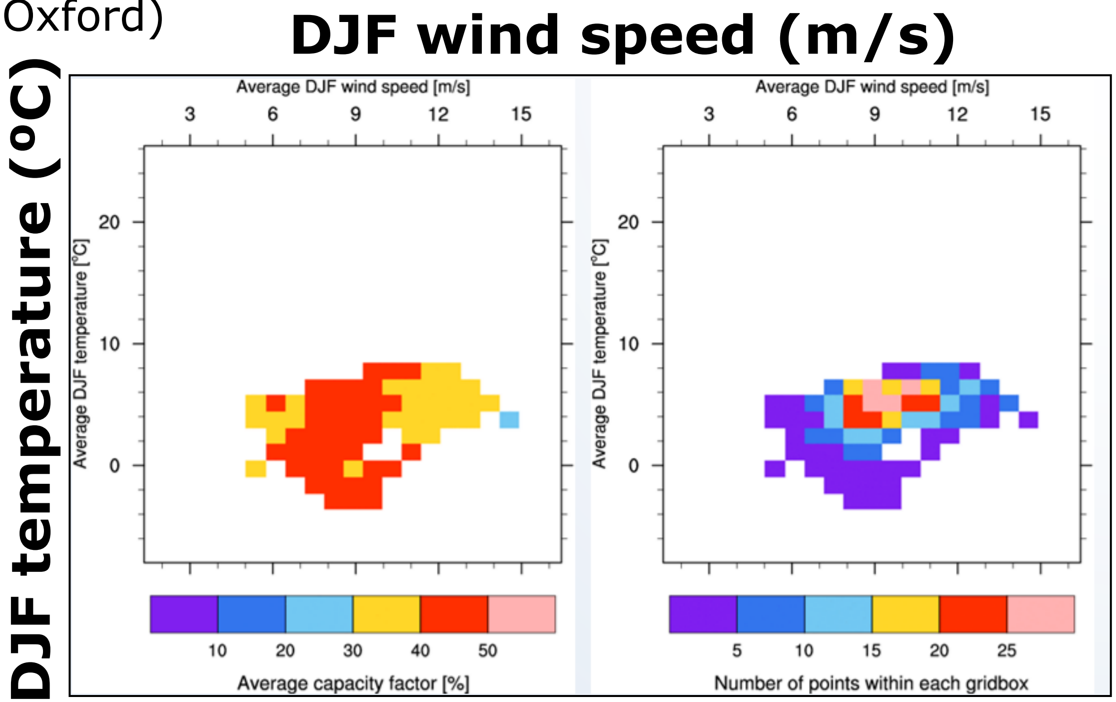
- Local measurements are not long
- They are not even made available

Adapting impact models

Impact surfaces of a simple wind-energy model over the North Sea for DJF as function of the mean seasonal 10 m wind speed and temperature.

(Left) Capacity factor (average power generated divided by the maximum power of a specific turbine) estimates obtained using the XXth Century Reanalysis, a Rayleigh function to estimate high-frequency winds from mean daily values and a wind profile power law to obtain 100 m winds from 10 m winds. (Right) Frequency of occurrence of each bin.

D. MacLeod (Univ. Oxford)

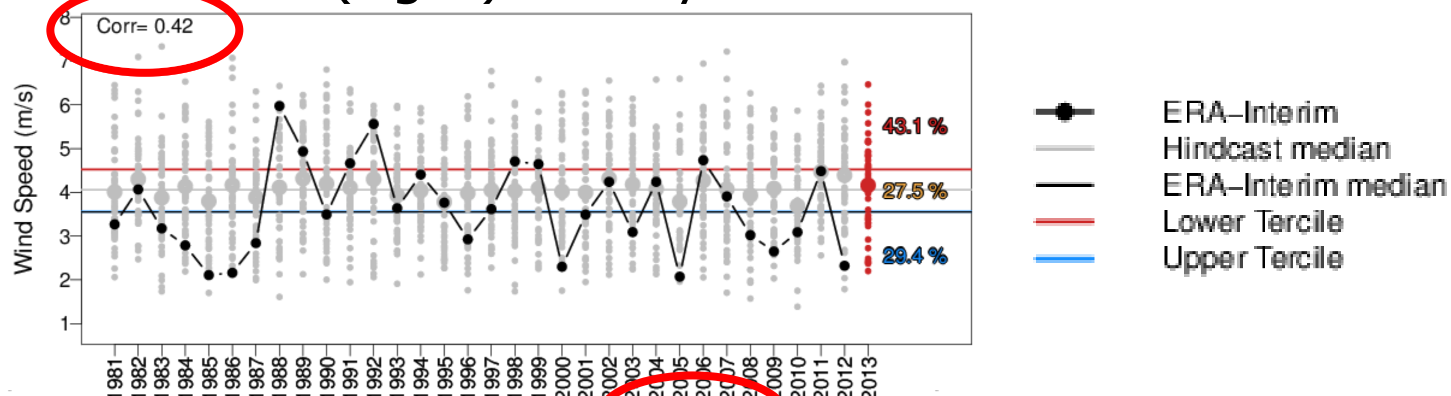


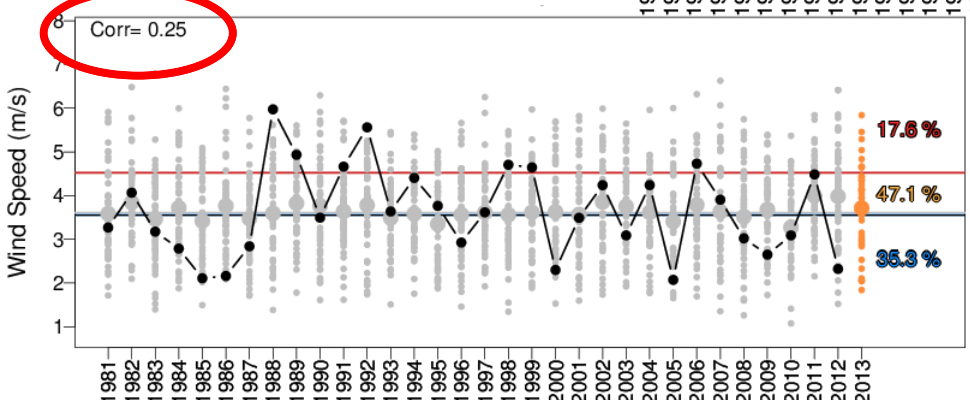
It only needs seasonal-average bias-corrected forecast data to make predictions of the capacity factor!

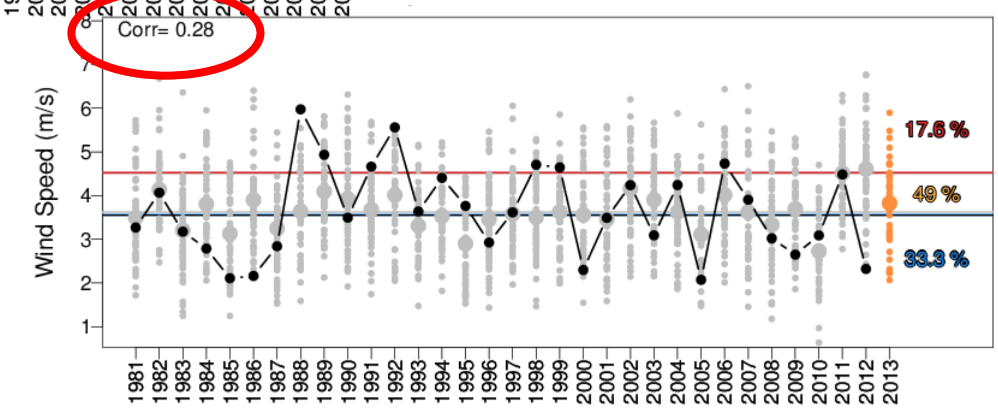
Bias correction and calibration

Bias correction is unavoidable, but it has an impact on skill. Bias correction and calibration have different effects.

DJF 10-m wind speed ECMWF S4 predictions over the North Sea starting in November. Raw output (top), bias corrected (simple scaling, left) and ensemble calibration (right). One-year-out cross-validation applied.







V. Torralba (IC3)

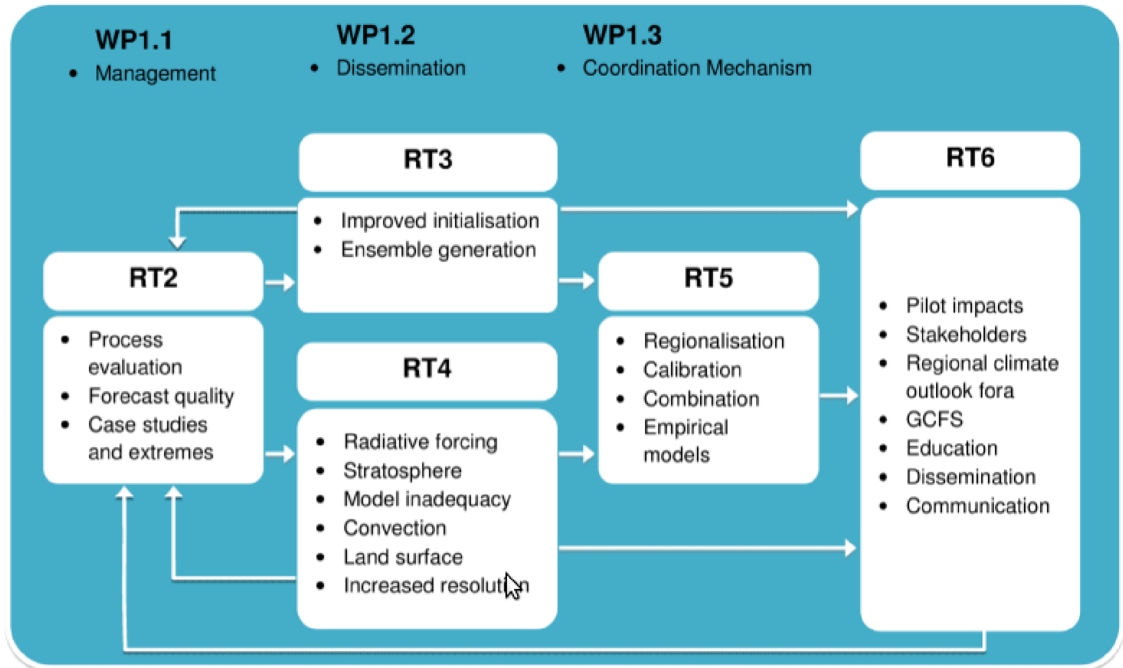
Some open fronts to improve forecasts

- 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 (improve sea ice, treatment of volcanic and anthropogenic aerosols, vegetation and land, etc); 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.
- More sensitivity to the users' needs: going beyond downscaling, better documentation (e.g. use the IPCC language), demonstration of value and outreach.

SPECS FP7

SPECS will deliver *a new generation of European climate forecast systems*, *including initialised Earth System Models (ESMs) and efficient regionalisation tools to produce quasi-operational and actionable local climate information over land at seasonal-to-decadal time scales with improved forecast quality and a focus on extreme climate events, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders*.

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

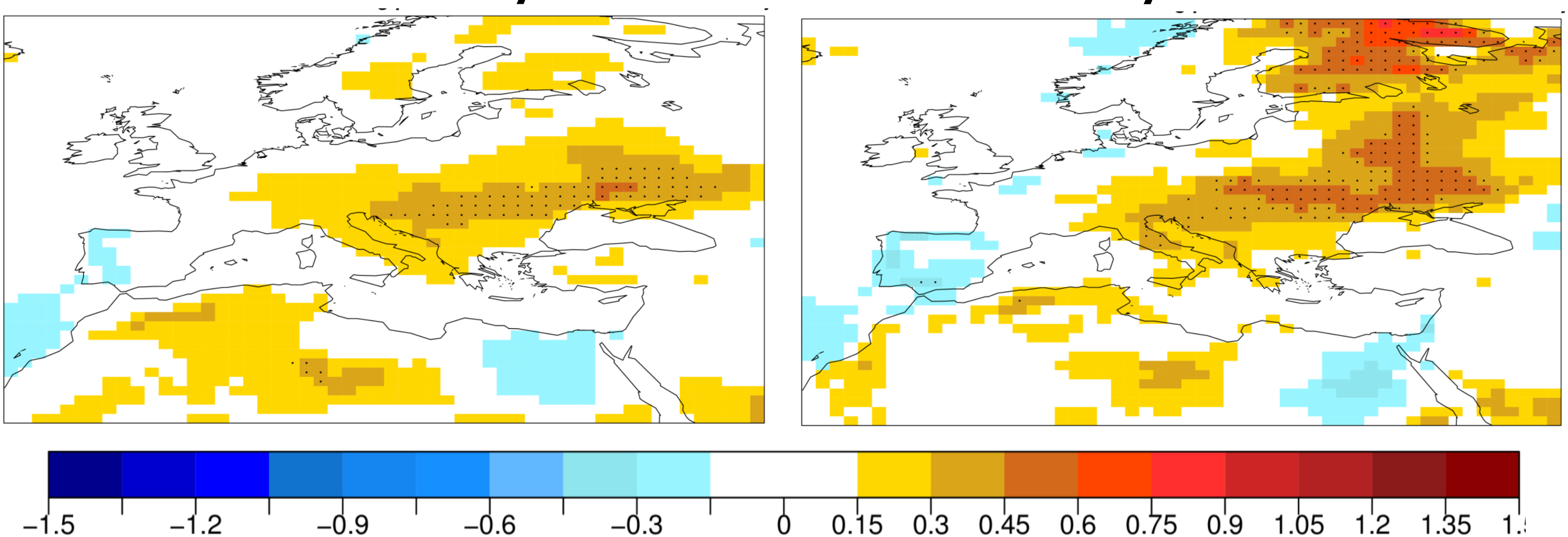
SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Impact of initialisation: Land surface

Difference in the correlation of the ensemble-mean near-surface temperature from two experiments, one using a realistic and another a climatological land-surface initialisation. Results for EC-Earth2.3 started every May over 1979-2010 with ERAInt and ORAS4 initial conditions and a sea-ice reconstruction.

Difference for monthly mean T

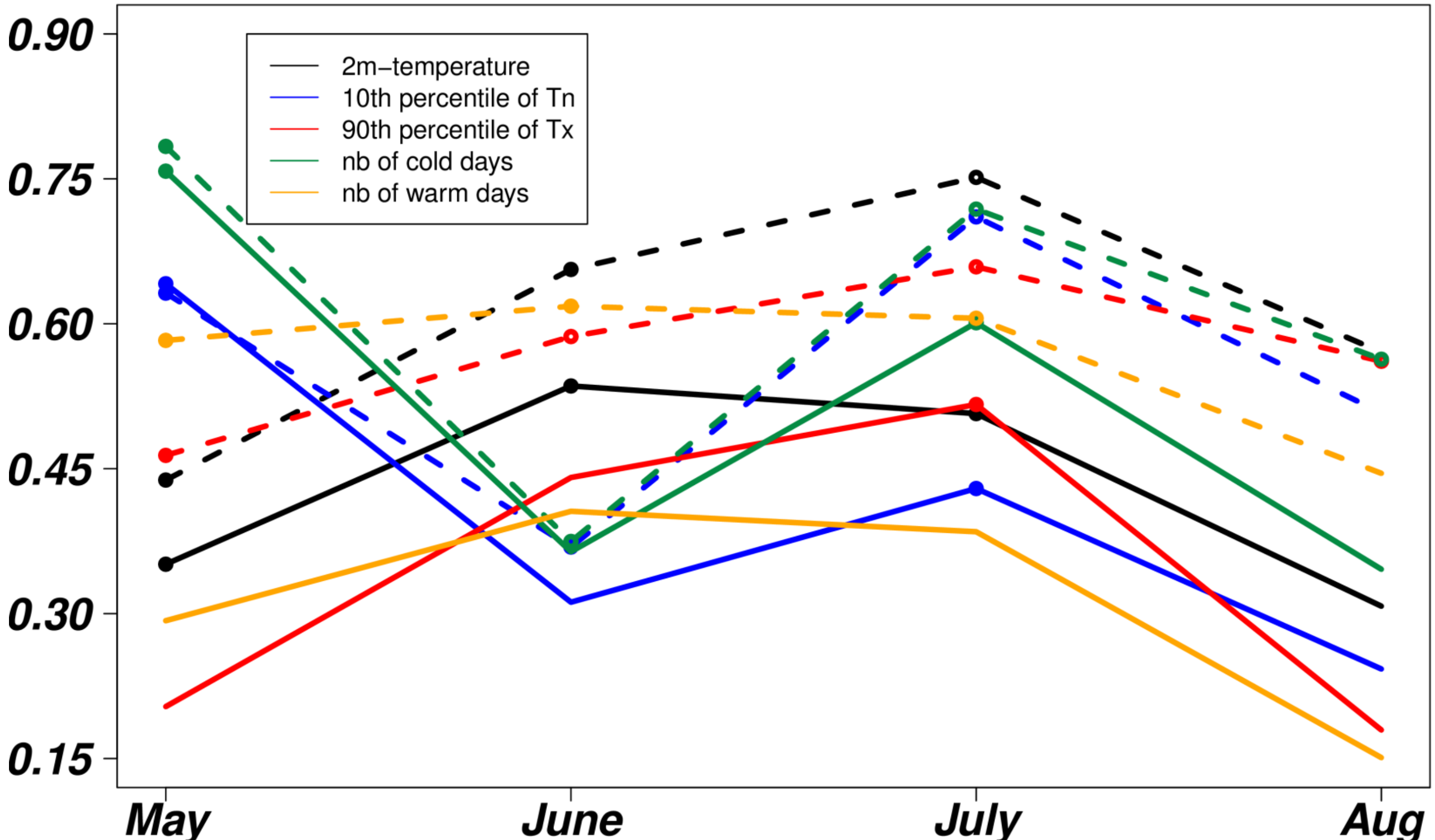
Difference for monthly mean daily Tmax



C. Prodhomme (IC3)

Impact of initialisation: Land surface

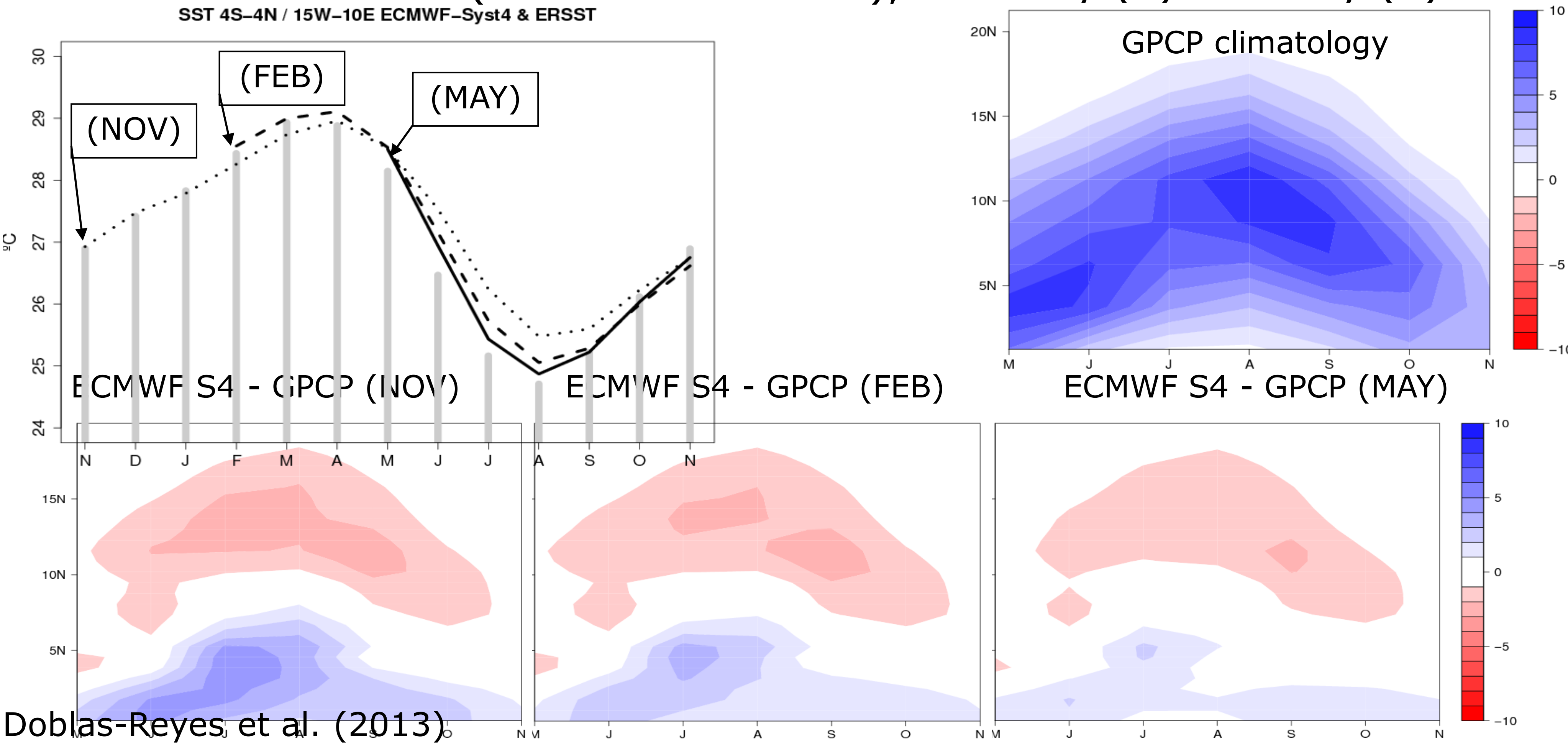
Correlation of the ensemble-mean from experiments with a realistic (dashed) and a climatological (solid) land-surface initialisation. Results for EC-Earth2.3 started in May with initial conditions from ERAInt, ORAS4 and a sea-ice reconstruction over 1979-2010 averaged over Europe.



C. Prodhomme (IC3)

Drift: West African Monsoon

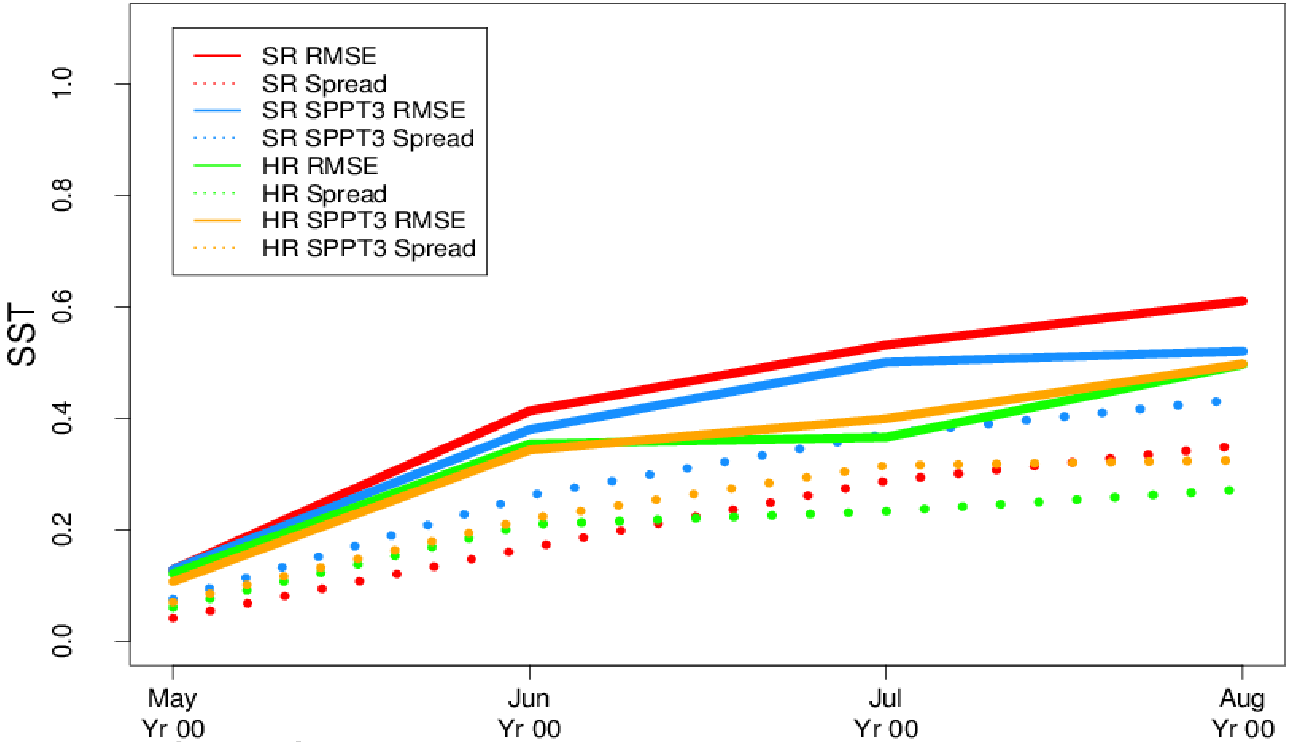
Averaged precipitation over 10ºW-10ºE for the period 1982-2008 for GPCP (climatology) and ECMWF System 4 (systematic error) with start dates of November (6-month lead time), February (3) and May (0).



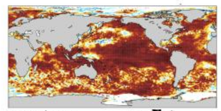
Doblas-Reyes et al. (2013)

Increase in resolution: stochastic physics

RMSE and spread of Niño3.4 SST (versus ERSST) from EC-Earth3 simulations: standard resolution (**SR**, **T255/ORCA1**), high resolution (**HR**, **T511/ORCA025**) without and with stochastic physics (**SPPT3**). May start dates over 1993-2009 using ERA-Interim and GLORYS and ten-member ensembles.

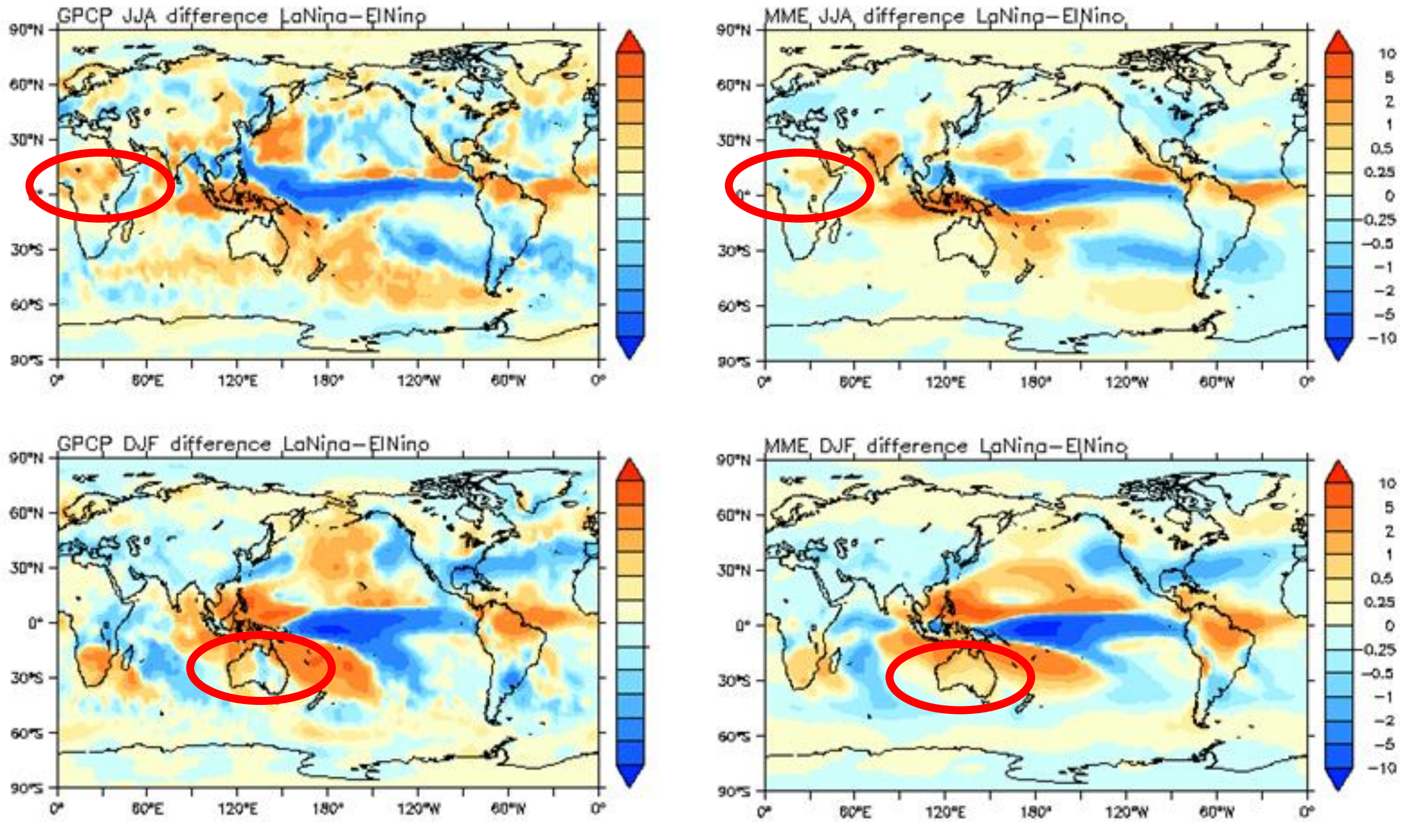


Batté and Doblas-Reyes (2014)



Predictions over land

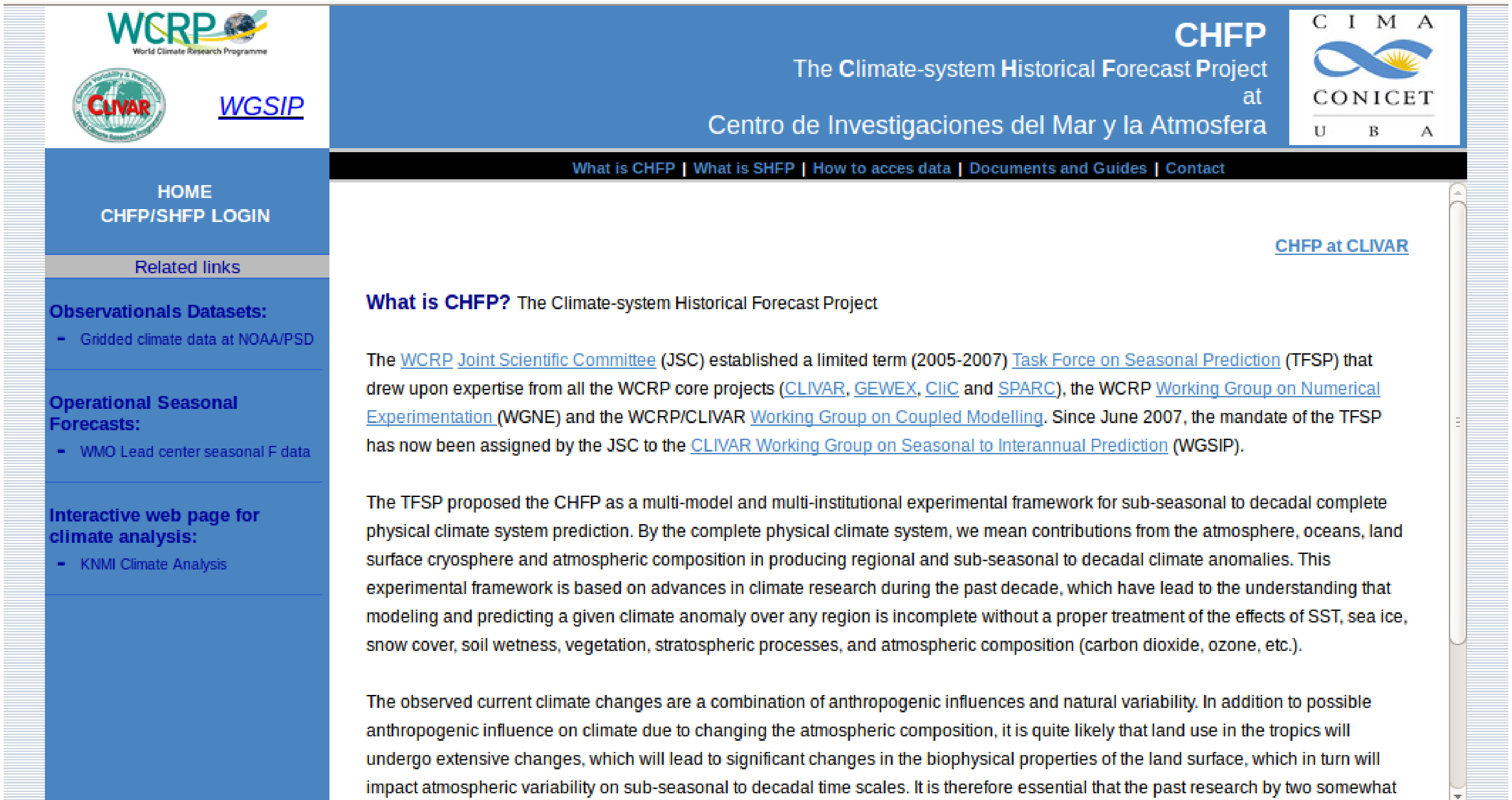
Composite precipitation differences (La Niña minus El Niño) based on years which observed seasonal mean Nino3.4 exceeds ±1 standard deviation over 1982-2009, from GPCP observations (left) and the CHFP ensemble at 1-month lead time (right), for JJA (top) and DJF (bottom).



Kirtman et al. (in prep.)

Climate Historical Forecast Project

- WGSIP's CHFP is the largest public repository of multi-model seasonal hindcasts.
- Data server at CIMA http://chfps.cima.fcen.uba.ar being transferred to an ESGF data node.


WCRP World Climate Research Programme
CLIVAR
WGSIP
CHFP
The Climate-system Historical Forecast Project
at
Centro de Investigaciones del Mar y la Atmosfera
CIMA CONICET UBA
What is CHFP | What is SHFP | How to acces data | Documents and Guides | Contact

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- Gridded climate data at NOAA/PSD
Operational Seasonal Forecasts:
- WMO Lead center seasonal F data
Interactive web page for climate analysis:
- KNMI Climate Analysis

CHFP at CLIVAR

What is CHFP? The Climate-system Historical Forecast Project

The WCRP Joint Scientific Committee (JSC) established a limited term (2005-2007) Task Force on Seasonal Prediction (TFSP) that drew upon expertise from all the WCRP core projects (CLIVAR, GEWEX, CliC and SPARC), the WCRP Working Group on Numerical Experimentation (WGNE) and the WCRP/CLIVAR Working Group on Coupled Modelling. Since June 2007, the mandate of the TFSP has now been assigned by the JSC to the CLIVAR Working Group on Seasonal to Interannual Prediction (WGSIP).

The TFSP proposed the CHFP as a multi-model and multi-institutional experimental framework for sub-seasonal to decadal complete physical climate system prediction. By the complete physical climate system, we mean contributions from the atmosphere, oceans, land surface cryosphere and atmospheric composition in producing regional and sub-seasonal to decadal climate anomalies. This experimental framework is based on advances in climate research during the past decade, which have lead to the understanding that modeling and predicting a given climate anomaly over any region is incomplete without a proper treatment of the effects of SST, sea ice, snow cover, soil wetness, vegetation, stratospheric processes, and atmospheric composition (carbon dioxide, ozone, etc.).

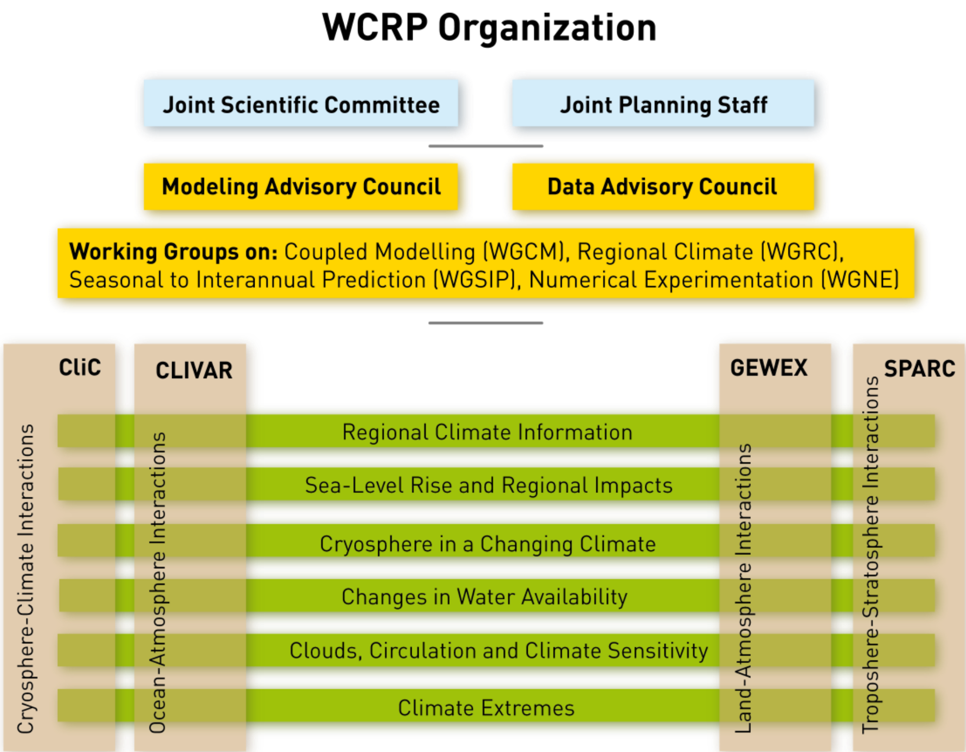
The observed current climate changes are a combination of anthropogenic influences and natural variability. In addition to possible anthropogenic influence on climate due to changing the atmospheric composition, it is quite likely that land use in the tropics will undergo extensive changes, which will lead to significant changes in the biophysical properties of the land surface, which in turn will impact atmospheric variability on sub-seasonal to decadal time scales. It is therefore essential that the past research by two somewhat

Summary

- Sub-seasonal and seasonal forecasting (s2s) are becoming well established operational activities with a solid research base and an increasing application in climate services and adaptation.
- The demand of action-relevant climate information on s2s time scales is growing. However, what forecasters provide is far from what the users demand (even in the absence of skill).
- Bias correction, calibration and combination are essential in the successful application of s2s climate information.
- EUPORIAS, SPECS and many other projects, along with the WWRP and WCRP initiatives (S2S, WGSIP, PPP), work together to bridge the gap and illustrate usefulness.

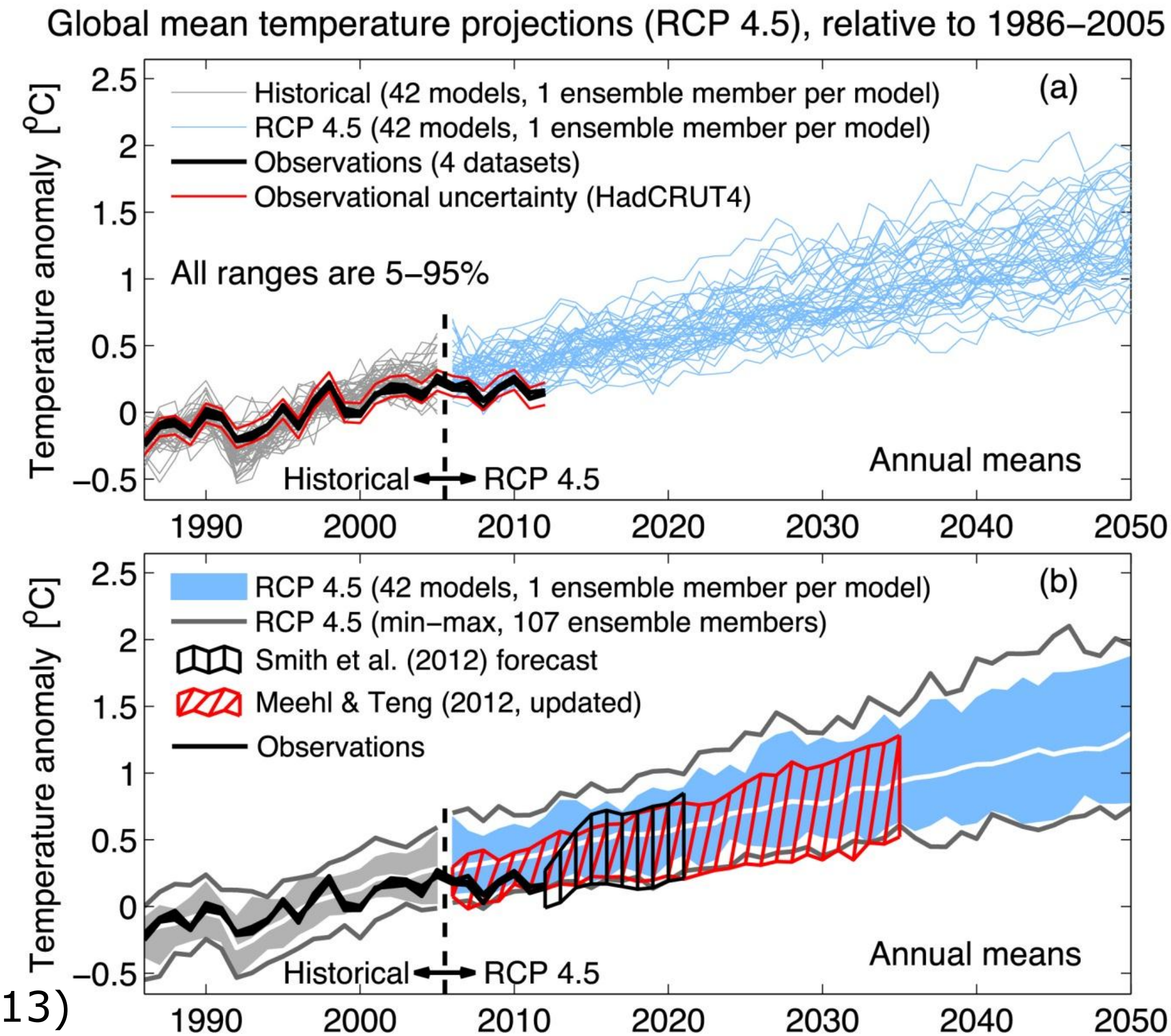
WCRP Grand Challenges

- 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), supported by Roberta Boscolo (WCRP)



CMIP5 predictions and projections

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



IPCC AR5 WGI (2013)