Climate prediction at regional and local scales for the benefit of climate services

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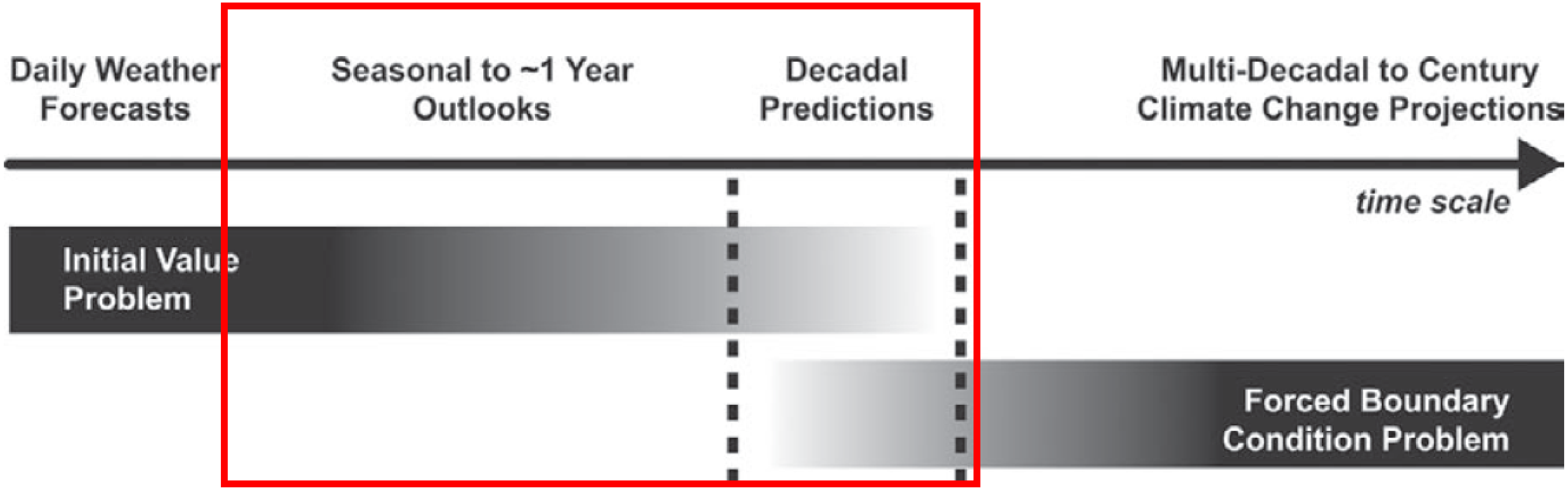
GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMIA Y COMPETITIVIDAD
SEVENTH FRAMEWORK PROGRAMME
SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Prediction on climate time scales

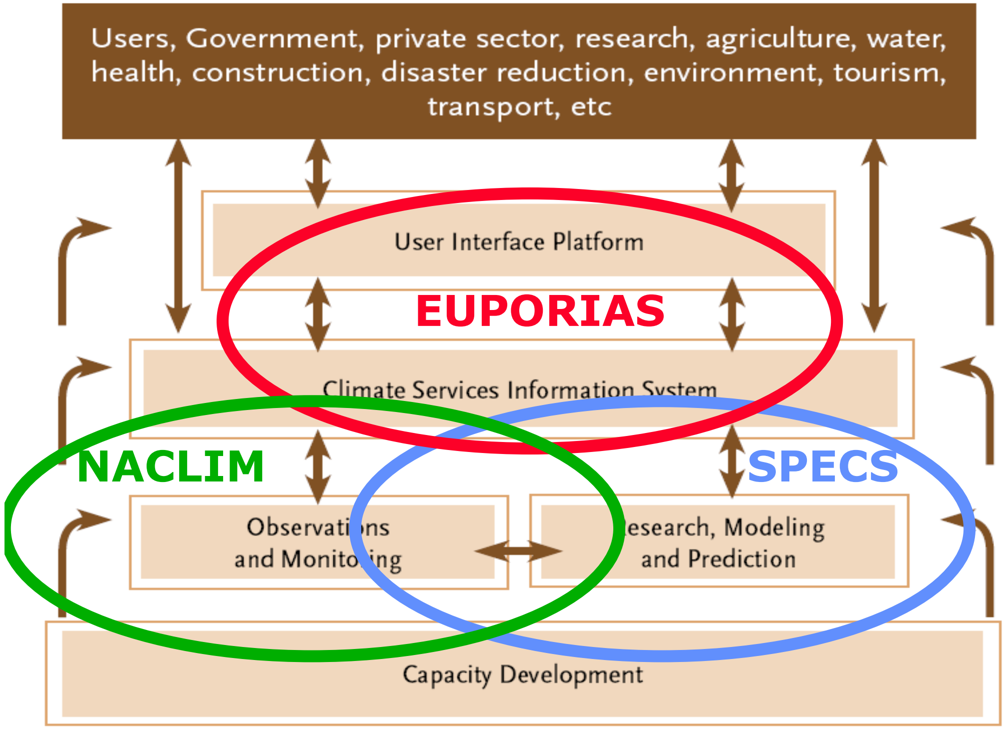
Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialization and systematic comparison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

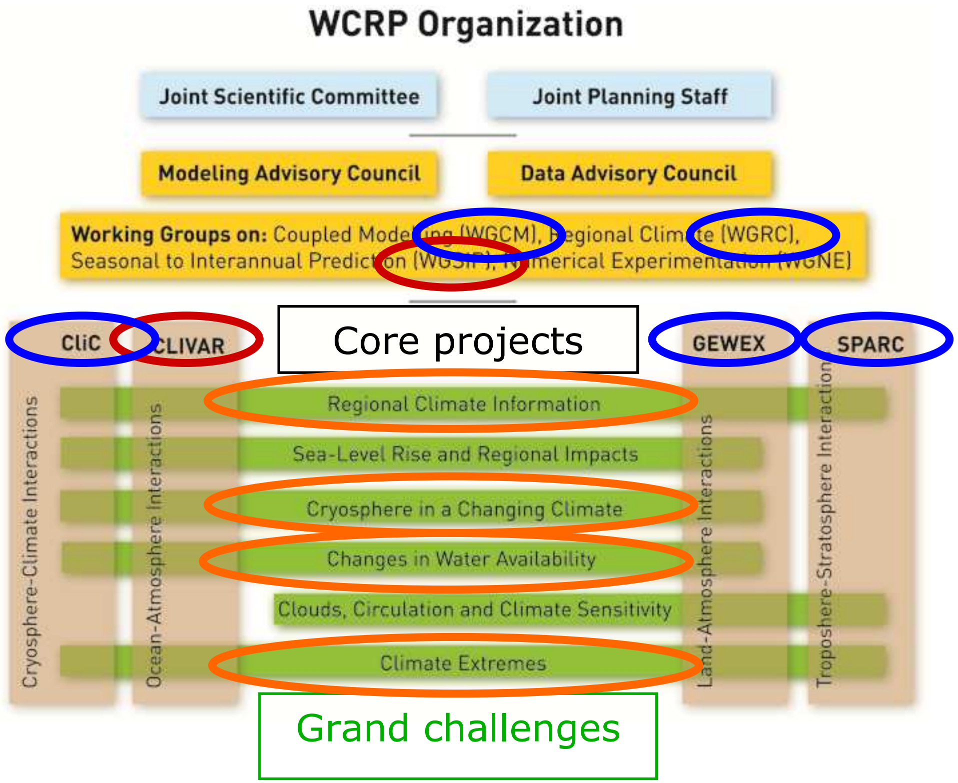


Meehl et al. (2009)

The international context

Climate prediction is central to climate services, not only for GFCS but also for other international initiatives (e.g. CSP) and contributes to all core projects and is a key aspect to achieve success in the WCRP grand challenges.





Other initiatives

- Polar Prediction Project (PPP), two challenges:
  - Year Of Polar Prediction (YOPP).
  - Polar/extra-polar linkages (meeting in Barcelona in early 2015).
- Sub-seasonal-to-Seasonal Project (S2S):
  - Extension of TIGGE using ESMs.
  - Quasi-operational character, but with mainly research focus.

How are climate predictions used?

Alarm in Europe: 2013's summer predicted as the closest to 1816, the year without summer. Canal Météo used external sources.

Actualité > **Société**

Météo : l'été sera-t-il vraiment «pourri» ?

Publié le 28.05.2013

Recommander | 3 395 personnes le recommandent. | Tweeter 155 | +1 | Share

A A | 77 réactions

Hiver froid, printemps frais, été gâché ? A en croire certains prévisionnistes, le temps maussade qui s'est abattu sur la France depuis plusieurs mois... ne devrait pas être chassé par les doux rayons du soleil estival. Pis, Météo Consult table carrément sur «un été pourri» en France.

AUDIO. Du soleil en été ? «Il y a de l'espoir» pour Frédéric Decker, de Météo News.

Le Parisien, 28 May 2013

Météo 2013 : une année sans été ?

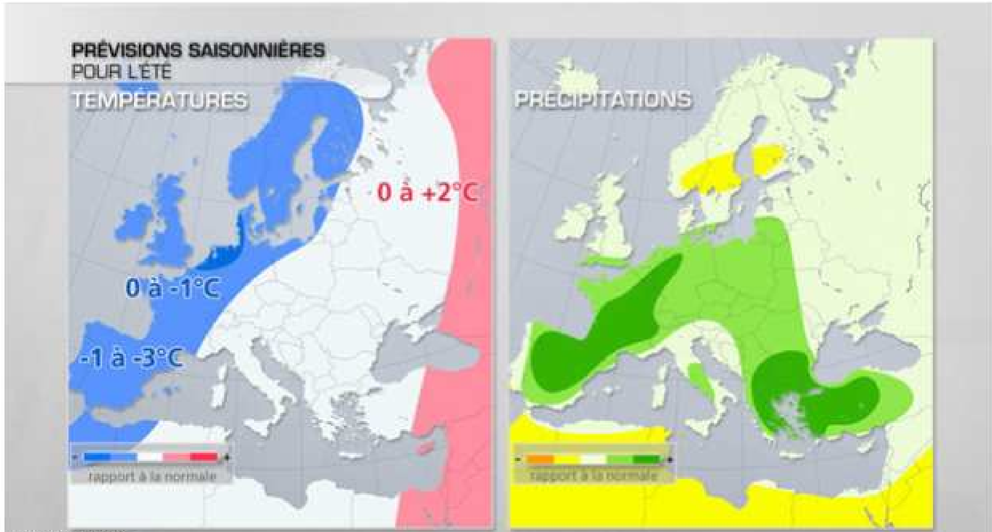
France

Dernière modification le samedi 25 mai 2013 à 16h29

Commenter cet article

+1 24 | Tweeter 99 | Like 151 | Evaluer l'article 19

Climat

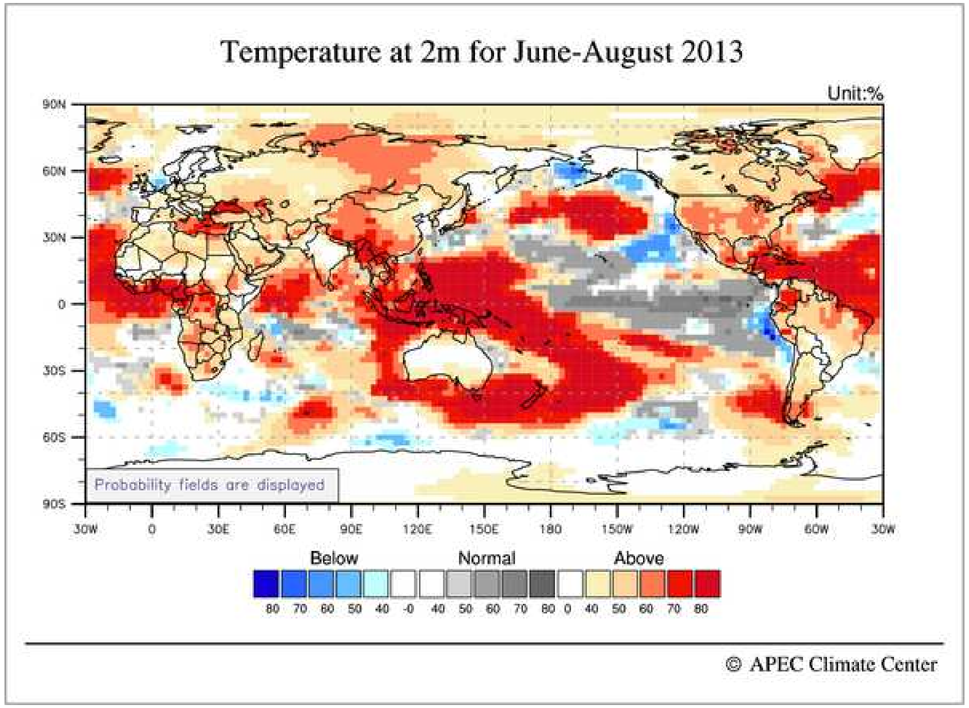


Crédit Photo :

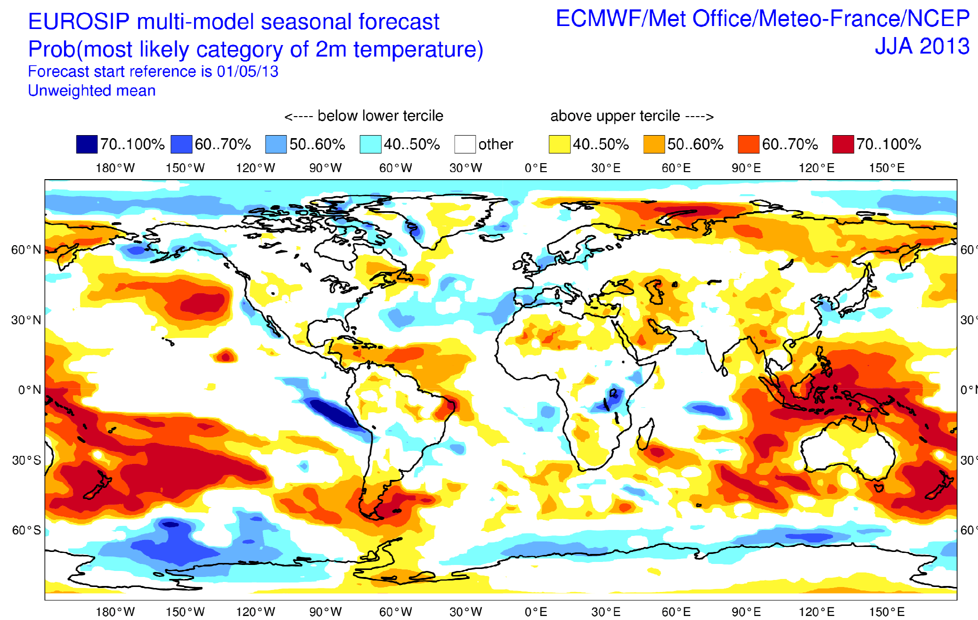
Canal Météo, 25 May 2013

Some summer 2013 forecasts

Near-surface temperature multi-model forecasts for JJA 2013 with start date May 2013.



APCC



EUROSIP

But no forecast quality assessment is easily found (it's either not available or password protected).

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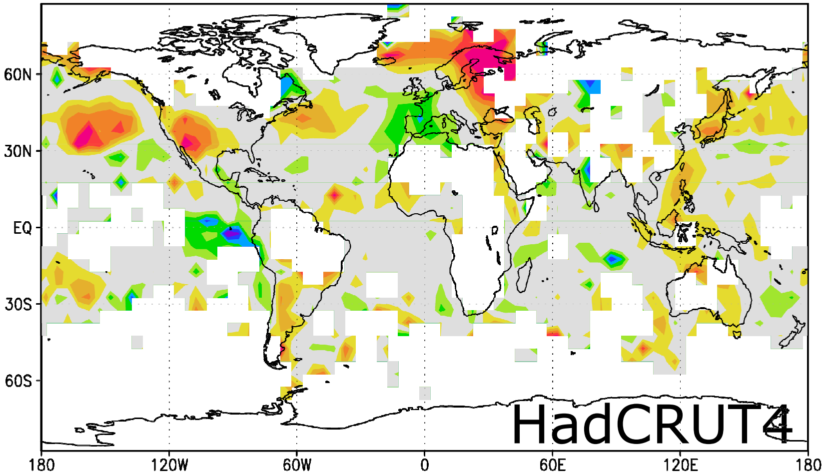
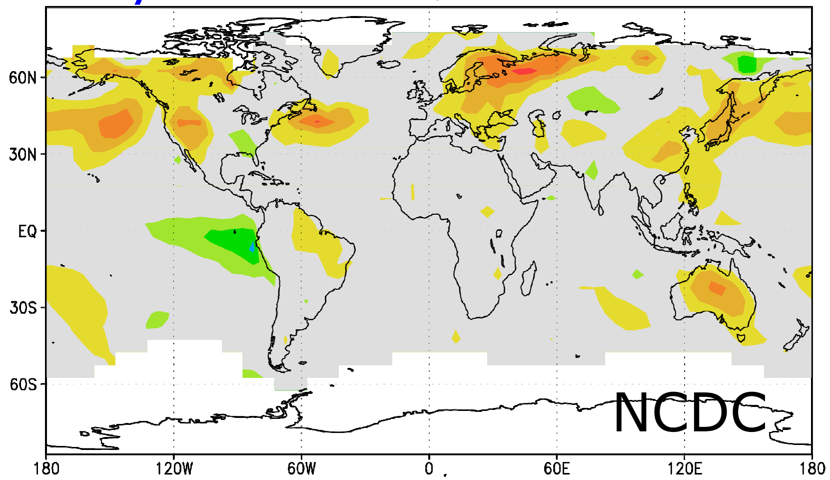
What did actually happen?

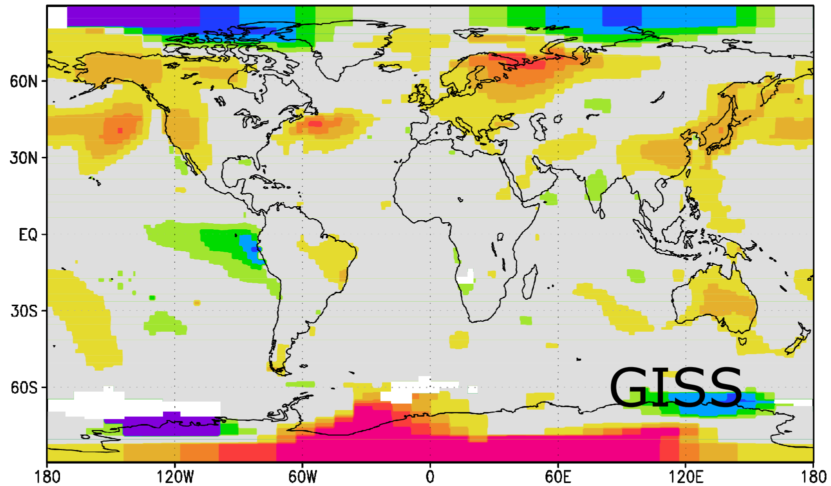
Near-surface temperature (K) observational reference for JJA 2013 wrt to 1981-2010: an additional source of uncertainty.





An unacceptable situation:

- Social alarm due to miscommunication of probability forecasts
- Lack of appropriate skill assessment
- Confusion with the forecast origin
- Cognitive illusions at play: persistence, anchoring, etc.
- Need to learn from IPCC language



Typical seasonal forecast skill

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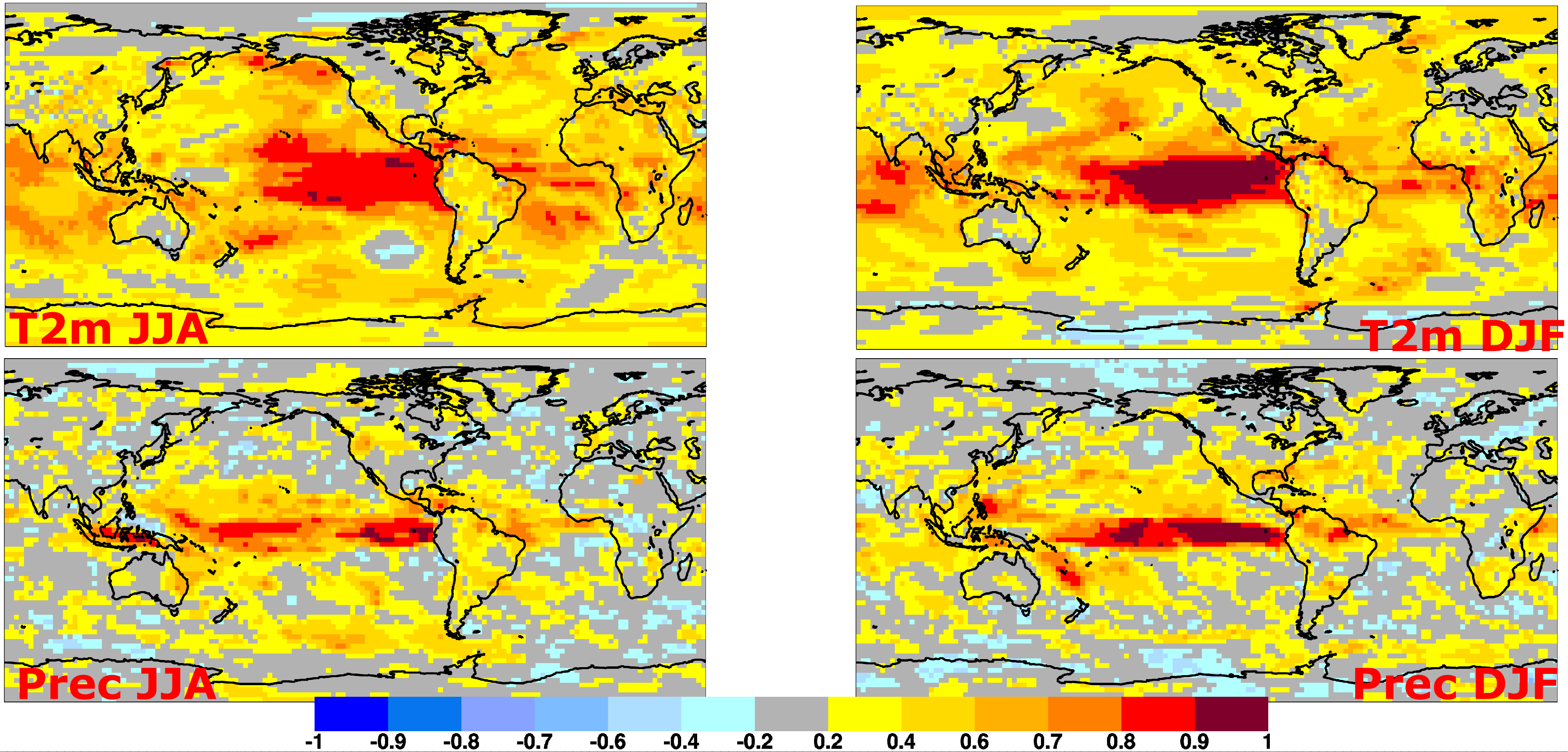
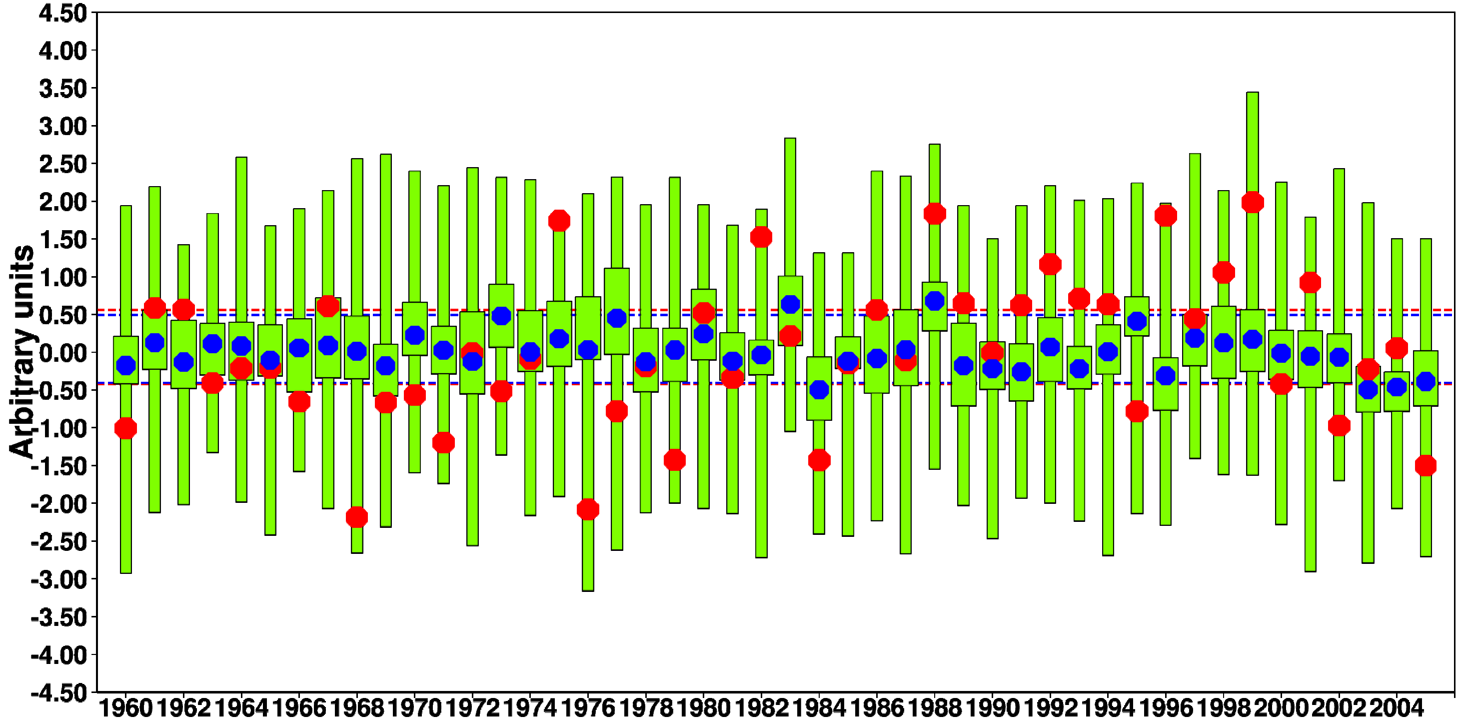
Correlation of the ensemble mean for the ENSEMBLES multi-model (45 members) wrt ERA40-ERAInt (T2m over 1960-2005) and GPCP (precip over 1980-2005) with 1-month lead.



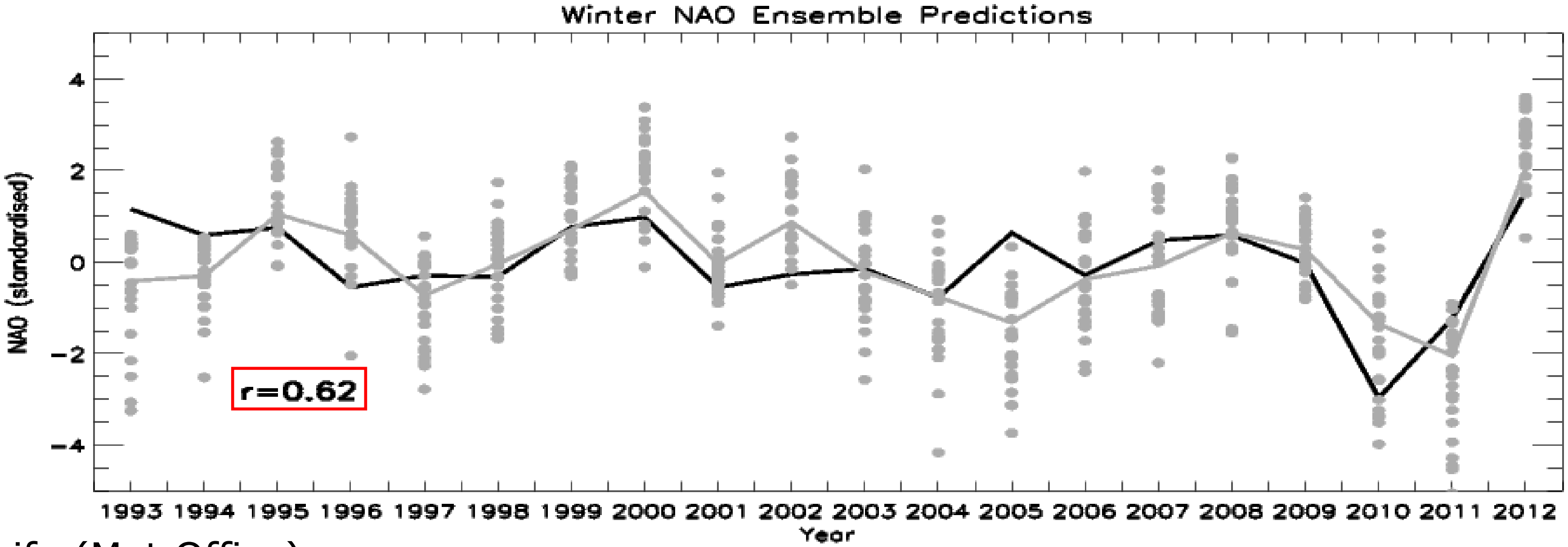
Predicting atmospheric circulation

Winter (DJF) NAO ENSEMBLES multi-model seasonal forecasts, start date 1st of November. Green for ensemble range, blue for the ensemble mean and red for the ERA40-ERAInt reference. Winter NAO correlation of the ensemble mean 0.16. Note the low signal-to-noise ratio.



Predicting atmospheric circulation

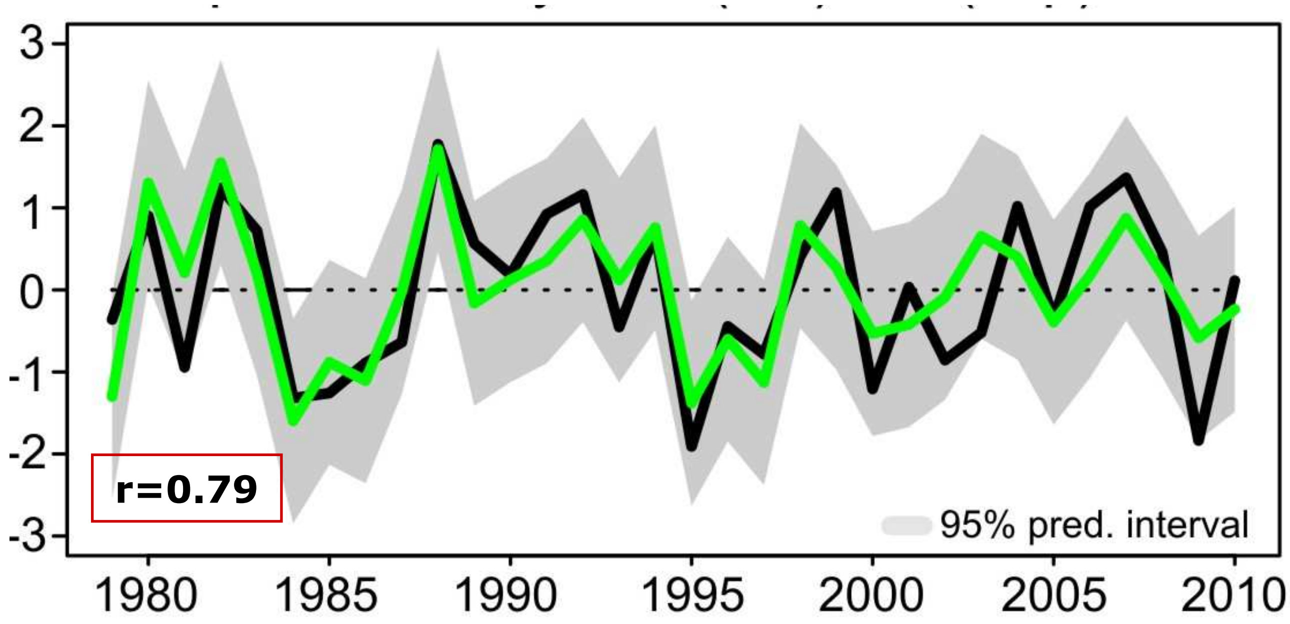
DJF NAO Met Office operational seasonal forecasts with HadGEM3H N216L85O(0.25) with initial conditions from operational atmospheric analyses and NEMOVAR, 24 members, start date around the 1st of November (lagged method). Winter NAO correlation significant at the 98% confidence level.



A. Scaife (Met Office)

Predicting atmospheric circulation

DJF NAO seasonal forecasts using a multiple linear regression method (one-year-out crossvalidation) with the September sea-ice concentration over the Barents-Kara sea and the October snow cover over northern Siberia (one month lead time).



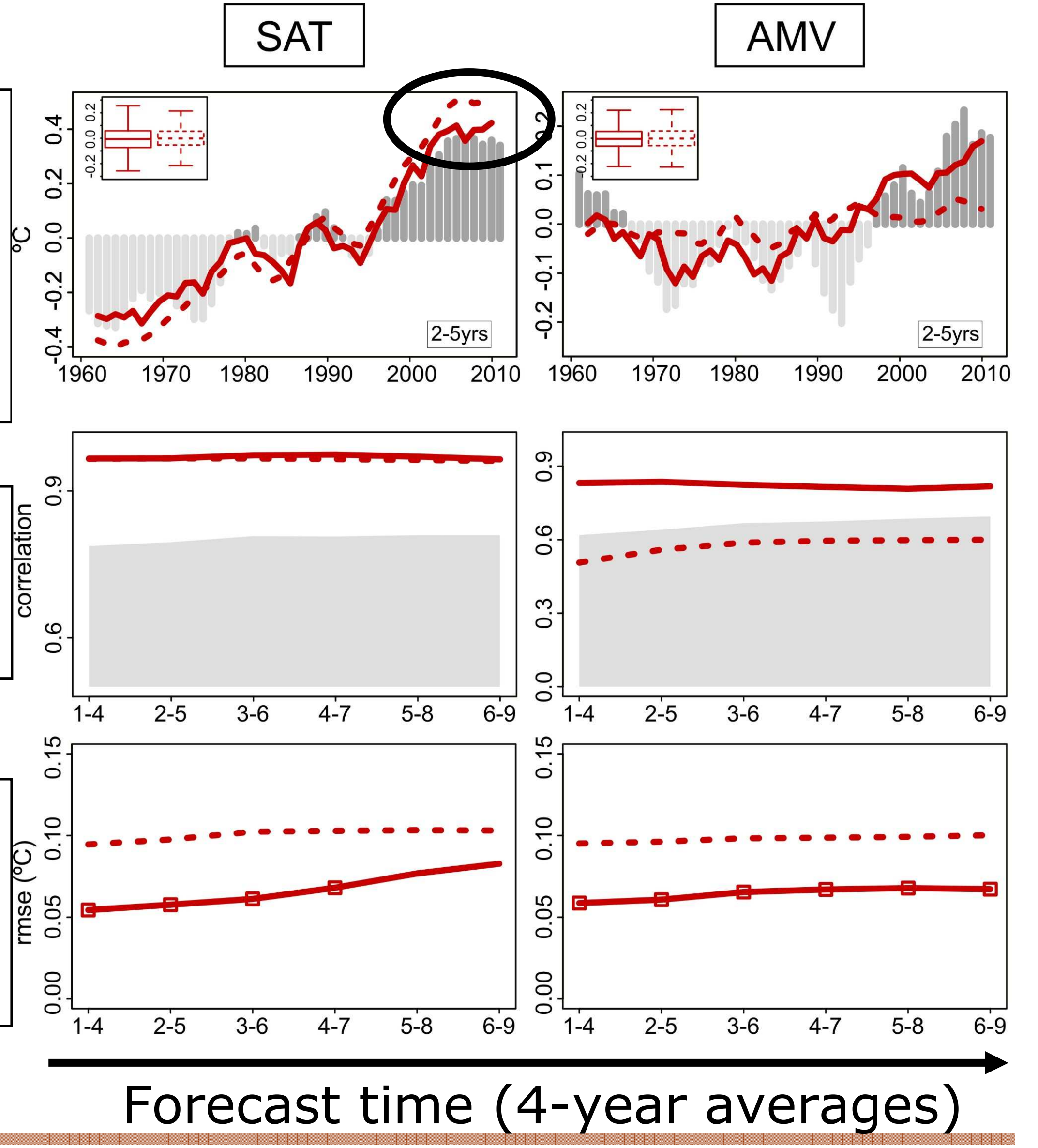
J. García-Serrano (IPSL)

CMIP5 decadal predictions

Predictions (2-5 forecast years) from the CMIP5 multi-model (6 systems, initialized solid, historical and RCP4.5 dashed) over 1960-2005 for global-mean temperature and the Atlantic multi-decadal variability. GISS and ERSST data used as reference.

Correlation of the ensemble-mean prediction as a function of forecast time. Grey area for the 95% confidence level.

Root mean square error, where dots represent the forecast times for which Init and NoInit are significantly different at 95% confidence level.



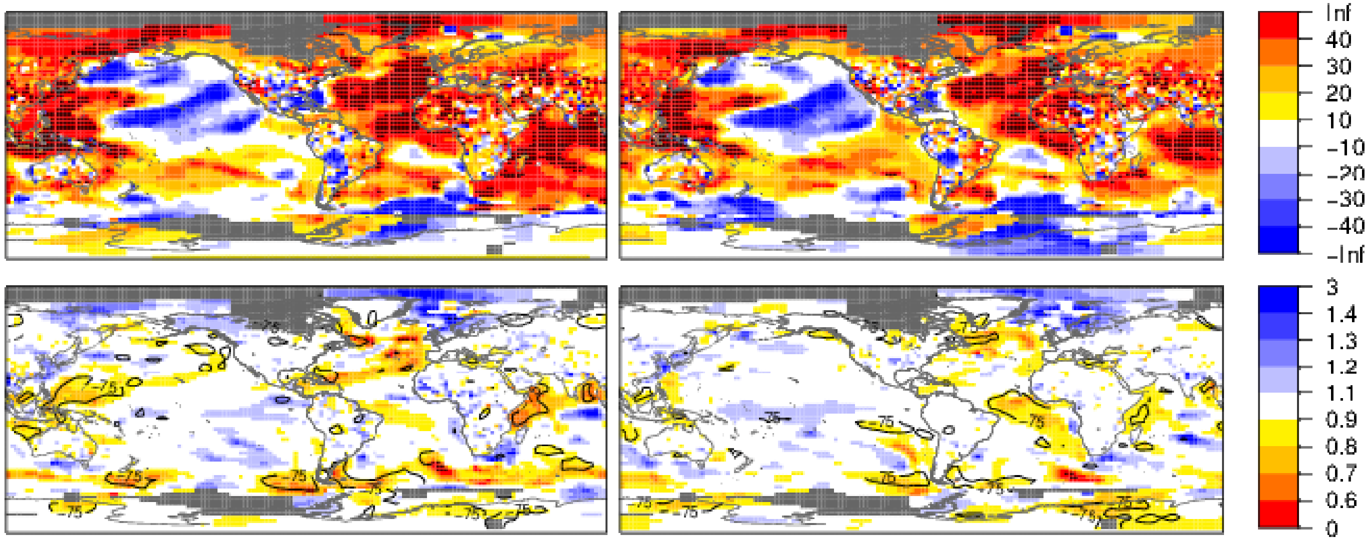
Doblas-Reyes et al. (2013)

Five-year start date temperature

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

Init RMSSS of ensemble mean

Ratio RMSE Init/NoInit



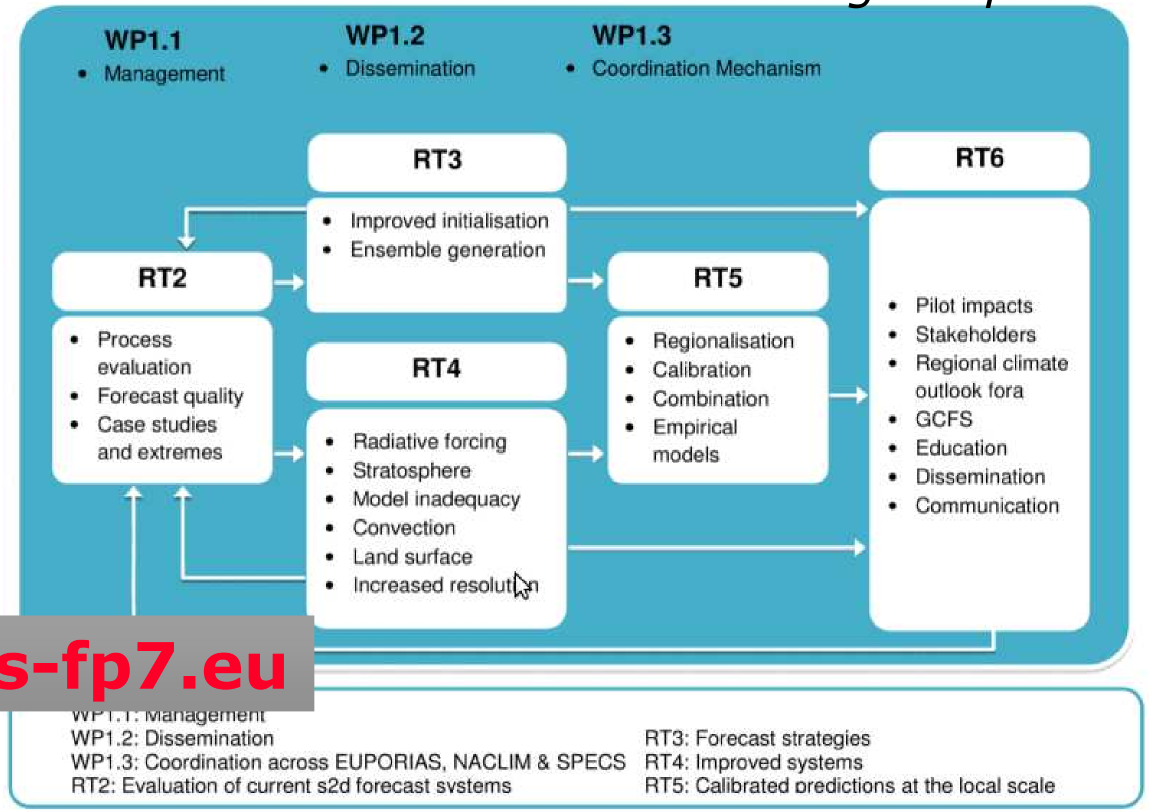
Doblas-Reyes et al. (2013)

Progress needed: 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*.

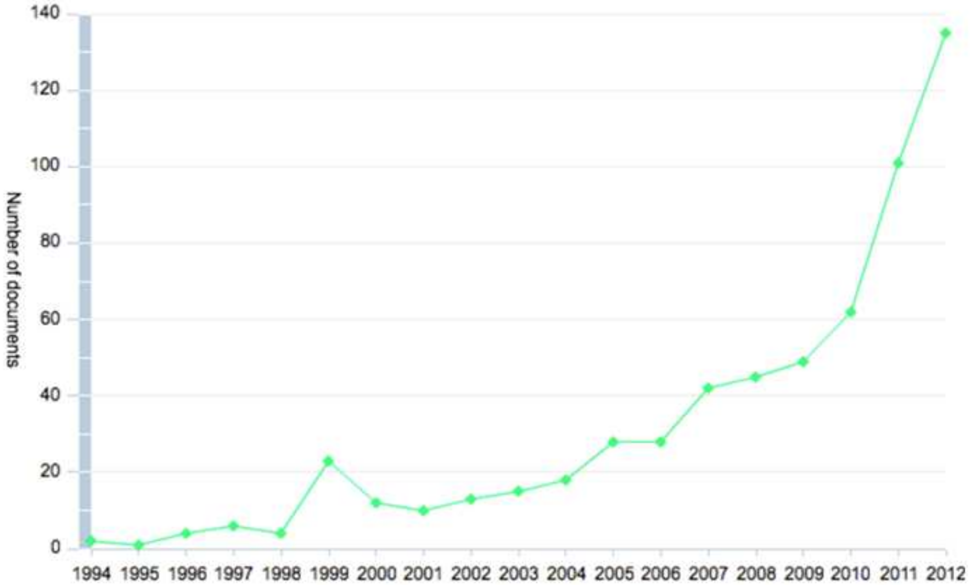
Forecast System	Project Partners
CNRM-CM5	CNRM, CERFACS
EC-Earth	KNMI, SMHI, IC3, ENEA
IFS/NEMO	ECMWF, UOXF
IPSL-CM5	CNRS
UM	UKMET

http://www.specs-fp7.eu



Downscaling in SPECS

(Left) Number of papers published every year with the term "statistical downscaling" in the title, abstract or keywords, source Scopus. (Right) Classification framework for statistical downscaling in terms of the techniques and the approaches used, where generative or non-generative techniques mean whether they rely on a explicit mathematical model or on an algorithm, and eventwise or distributional approaches reflect where the downscaling is performed on time series or the PDF parameters.



Appro. \ Tech.		Generative		non-Generative	
		Deterministic	Stochastic	Deterministic	Stochastic
PP	Eventwise	Regression, Neural Nets.	GLMs	Analogs, weather types	Analog resampling
	Distribution	Regression on PDF parameters			
MOS	Eventwise	Regression, Neural Nets.	GLMs	Analogs	Analog resampling
	Distribution	Bias correction, parametric q-q map	Nonhomogeneous HMM	q-q map	

J.M. Gutiérrez (Univ. Cantabria)

Downscaling in SPECS

Publications applying any form of statistical downscaling to seasonal forecast products. TAO means "temporal aggregation of the output".

Reference	Country	Affiliation	Source model(s)	Approach[1]	Technique[2]	Var	Region	TAO[3]
Landman and Tennant (2000)	S. Africa	S. Africa Weather Bureau	COLA GCM	MOS-E	G-D (CCA)	P	South Africa	M
Robertson et al. (2004)	USA	Columbia University	ECHAM 4.5	MOS-D	G-S (HMM)	P	Brazil	D
Díez et al. (2005)	Spain	National Institute of Meteorology	DEMETER (2 models)	PP-E (ERA-40)	NG-D (Analogs)	P	Spain	D
Pavan et al. (2005)	Italy	ARPA-SIMC	DEMETER (6 models)	PP-E (ERA-40)	G-D (MLR)	T, P	Italy	M
Gutiérrez et al. (2005)	Spain	University of Cantabria	DEMETER (4 models)	PP-E (ERA-40)	NG-D (Analogs)	P	Northern Peru	S
Frías et al. (2005)	Spain	University of Cantabria	DEMETER (7 models)	PP-E (ERA-40, NNR)	G-D (CCA)	T	Iberian Peninsula	M
Feddersen and Andersen (2005)	Denmark	Danish Meteorological Institute	DEMETER	MOS-E	G/NG-D (SVD+WT)	P, T	Europe, N America, Australia	S
Chu et al. (2008)	Taiwan	National Taiwan Normal University	SMIP (6 GCMs)	MOS-E	G-D (SVD)	P	N Taiwan	S
Sordo et al. (2008)	Spain	University of Cantabria	ECMWF's System2	PP-E (ERA-40)	NG-D (Analogs)	P	Spain	D
Landman et al. (2009)	S. Africa	South African Weather Service	ECHAM4.5	MOS-E	G-D (CCA)	P	S Africa	S
Juneng et al. (2010)	Malaysia	Universiti Kebangsaan	APCC-MME (7 models)	MOS-E	G-D (CCA)	P	Malaysia	M
Frías et al. (2010)	Spain	University of Cantabria	DEMETER	PP-E (ERA-40)	NG-D (Analogs)	P, T	Spain	D
Min et al. (2011)	S. Korea	APEC Climate Center	APCC MME (6 models)	MOS-E	G-D (LR)	P, T	S Korea	S
Wu et al. (2012)	USA	NCAR	CFS	MOS-E	NG-D (Analogs-KNN)	P	SE Mediterranean	M
Sun and Chen (2012)	China	Institute of Atmospheric Physics	DEMETER (7 models)	MOS-E	G-D (LR)	P	Global (CRU data)	S
Kryzhov (2012)	Russia	Hydrometeorological Research Center	SLAV GCM	MOS-E	G-D (LR)	T	N Eurasia	M
Robertson et al. (2012)	USA	International Research Institute for Climate and Society	RegCM3 / ECHAM4.5	MOS-E	G-D (PC-LR)	P	Philippines	D
Ying and Ke (2012)	China	Institute of Atmospheric Physics	DEMETER (3 models)	PP-E (ERA-40)	G-D (LR)	P	SE China	S
Johnson (2012)	USA	Florida State University	DEMETER (and others)	MOS-E	G-D (LR)	P	S America	M
Tian and Martinez (2012)	USA	University of Florida	GFS / DOE	PP-E (NARR)	NG-D (Analogs)	ET_0	Florida	D
Shao and Li (2013)	Australia	CSIRO	POAMA	PP-E (NNR)	NG-D (Analogs)	P	SE Australia	D
Sinha et al. (2013)	India	Indian Institute of Technology	In-GLM1 (NCMRWF)	PP-E (NNR)	G-D (CCA)	P	India	S
de Castro et al. (2013)	Brazil	Federal University of Ceara	RSM / ECHAM4.5	MOS-E	G-D (ANN)	P	Brazil	M
Charles et al. (2013)	Australia	Bureau of Meteorology	POAMA	MOS-E	NG-D (Analogs)	P	SE Australia	D
Sohn et al. (2013)	Korea	APCC	APCC MME (10 models)	MOS-E	G-D (LR)	P	S Korea	M
Silva and Mendes (2013)	Brazil	University Federal of Rio Grande do Norte	CFS	MOS-E	G-D (ANN)	P	NE Brazil	M
Tung et al. (2013)	China	City University of Hong Kong	APCC MME	MOS-E	G-D (SVD)	P	S China	S
Pavan and Doblas-Reyes (2013)	Italy	ARPA-SIMC	ENSEMBLES (5 models)	MOS-E	G-D (MLR)	T	Italy	M

J.M. Gutiérrez (Univ. Cantabria)

Climate services: renewable energy

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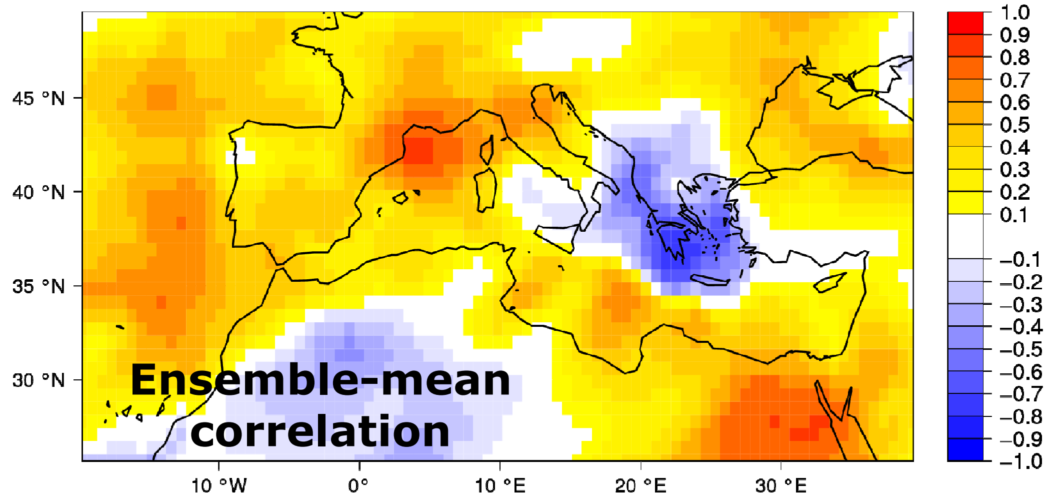
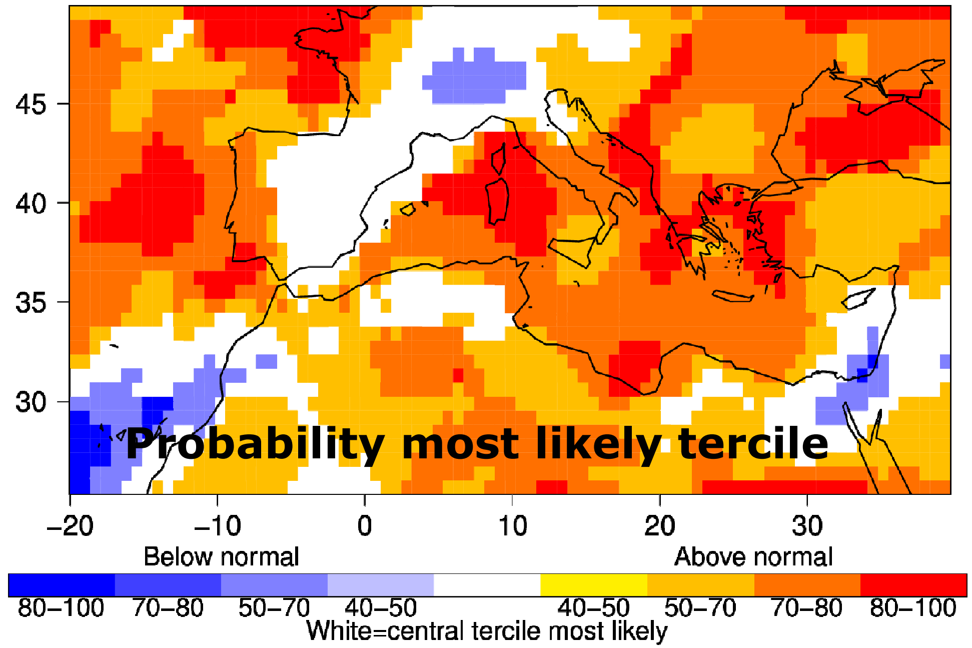
Decadal predictions of downward surface solar radiation near-surface temperature from EC-Earth for the Nov 2012 start date, first five years of the forecast, with the climatology computed from 1979-2010 (reference ERA-Interim):

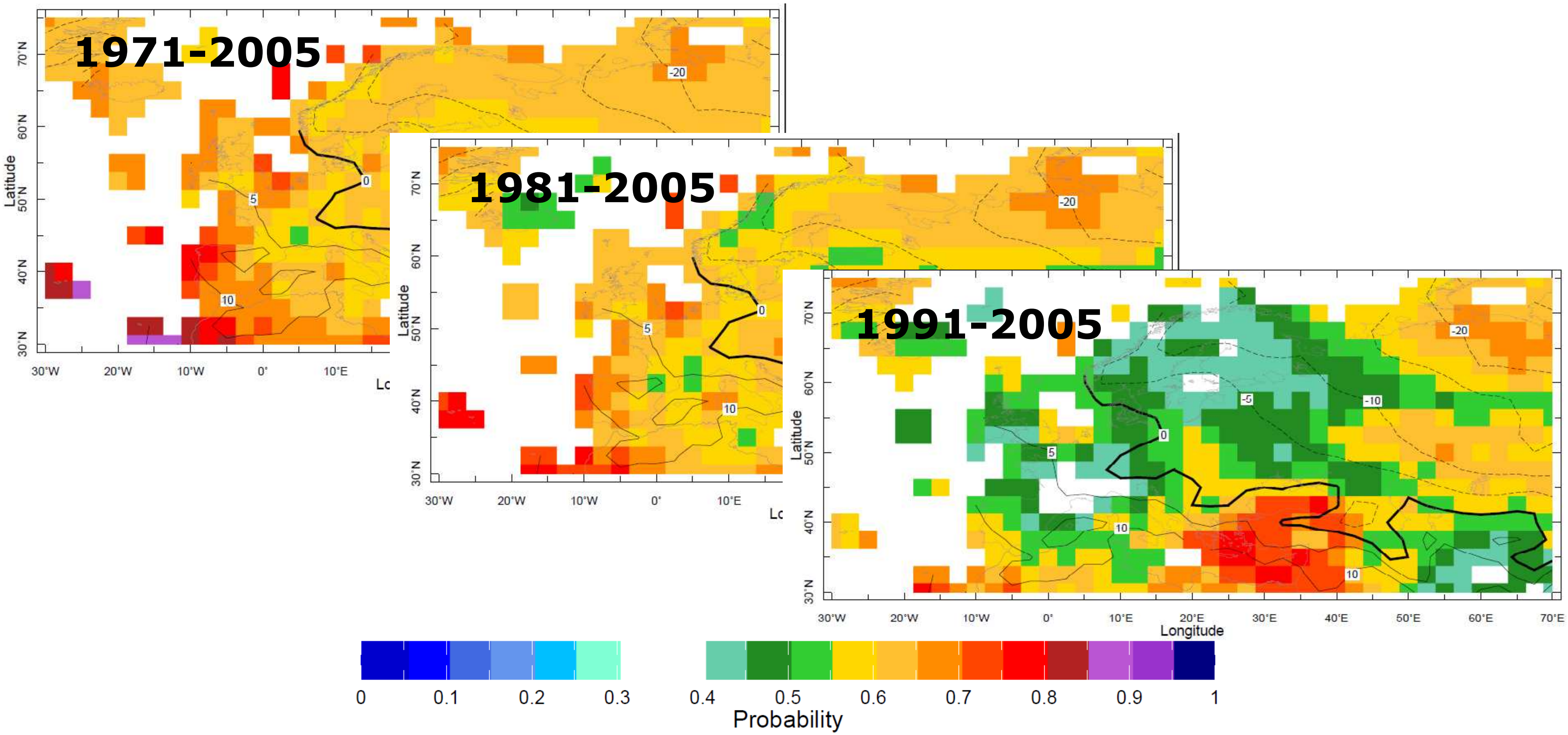
- Large areas with 50-100% probability to be above normal
- Consistent signal across Mediterranean
- Mostly positive correlation (largely non statistically significant)





Trends in predictions

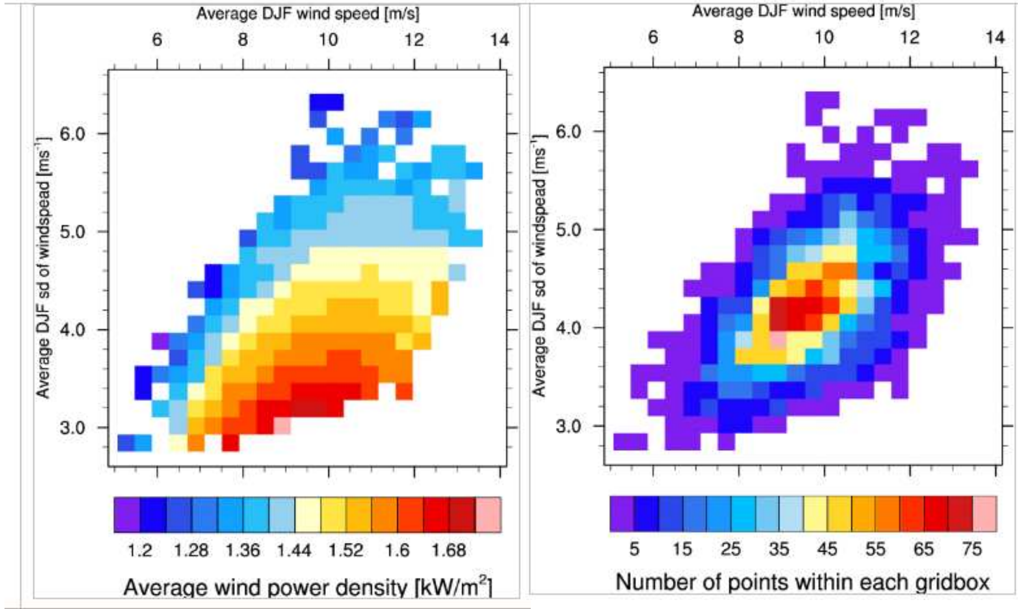
One-month lead DJF 2009-10 IRI temperature forecasts (flexible format) for event “anomalies above upper tercile”.



A different approach for users

Users could adapt their models and conceptual approaches

Impact surfaces of a simple wind-energy model over the North Sea for DJF as a function of the mean seasonal wind and the wind intraseasonal variability. Power density 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. Still require calibration and combination.



D. Macleod (Univ. Oxford)

Summary

- Climate prediction is making steady progress: by improving the representation of many processes (sea ice, projections of volcanic and anthropogenic aerosols, vegetation and land, coupling, etc) and by leveraging knowledge from other sectors of climate research.
- More effort on statistical than dynamical downscaling: dynamical very expensive, statistical less affected by non-stationarity of the relationships than climate change.
- Reliable and robust calibration and combination is absolutely needed: include empirical prediction (better use of current benchmarks), local knowledge, RCOFs.
- Forecast quality assessment should always be included: reliability as 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, capability and outreach.