Latest Developments in Short-Term Climate Predictions

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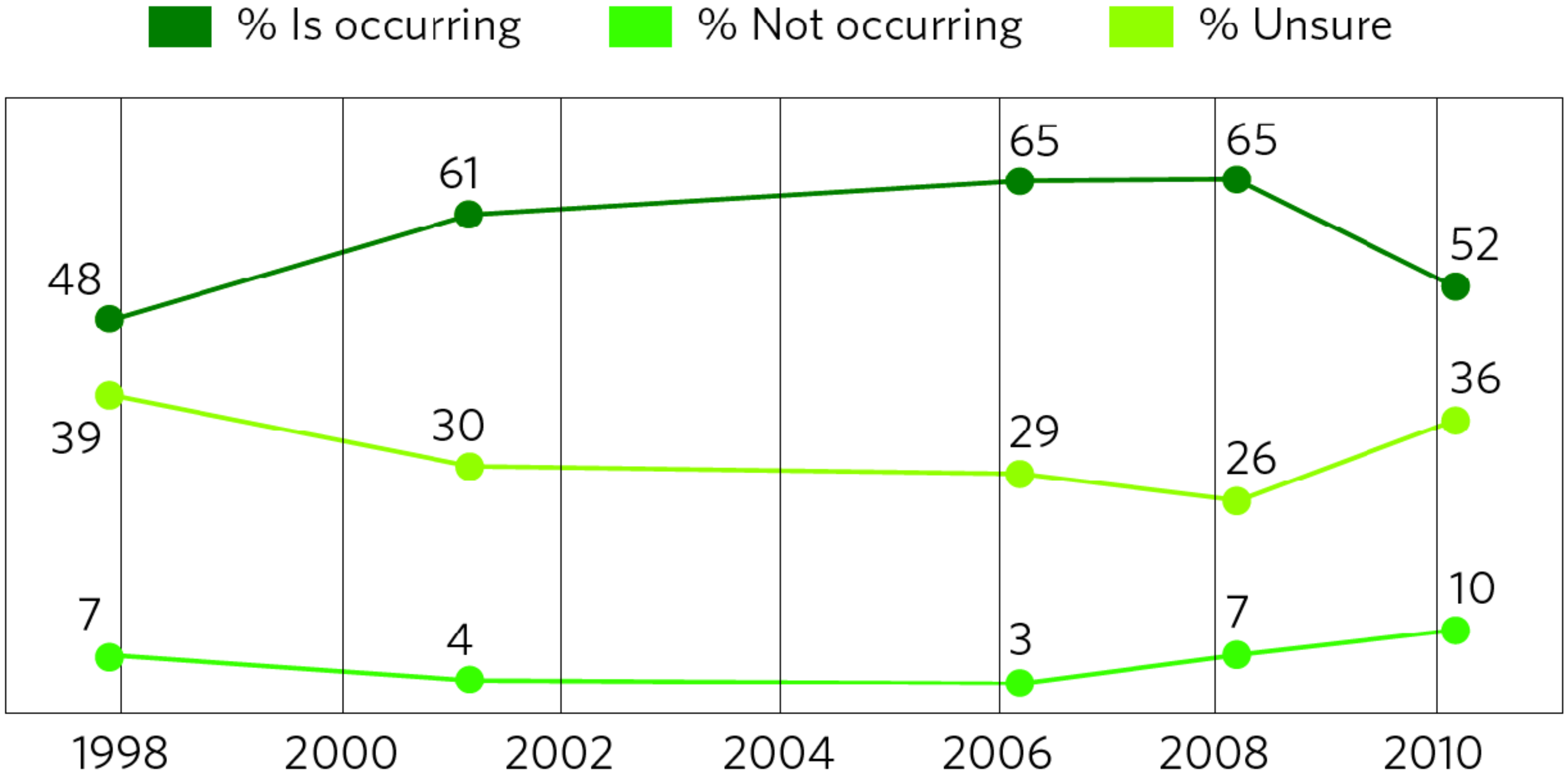
What this presentation is not about

Results to asking the question "which one of the following statements is most accurate: most scientists believe that global warming is occurring, most scientists believe that global warming is not occurring, or most scientists are unsure about whether global warming is occurring or not?"



Pidgeon and Fischhoff (2011)

THE TIMES

Friday March 25 2011 timesonline.co.uk No.70216

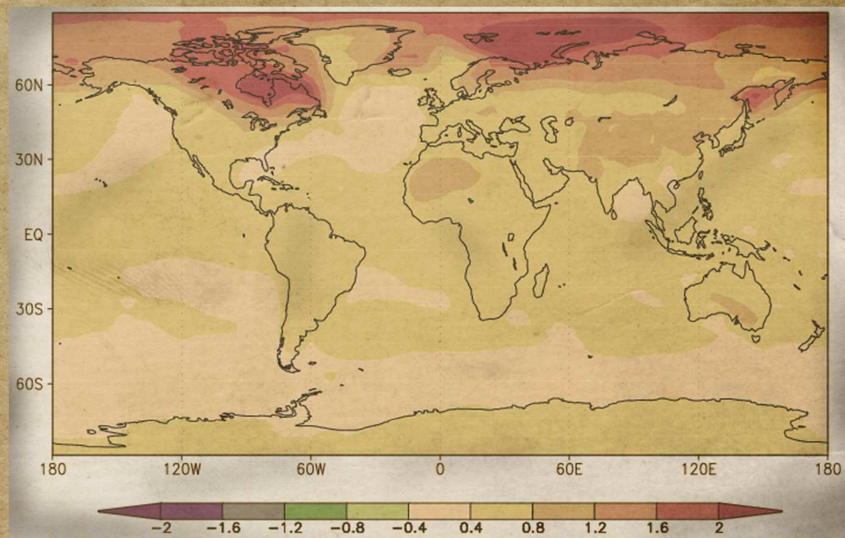
News

Environment

First predictions of regional warming

Northern Europe is warming more than Southern Europe

From our scientific correspondent



Temperature anomalies with respect to 1981-2000 forecast for 2011-2020

The first predictions of the expected warming from antropogenic origin at the regional scale have been released.

The strongest warming is concentrating around the Arctic. Northern Europe is

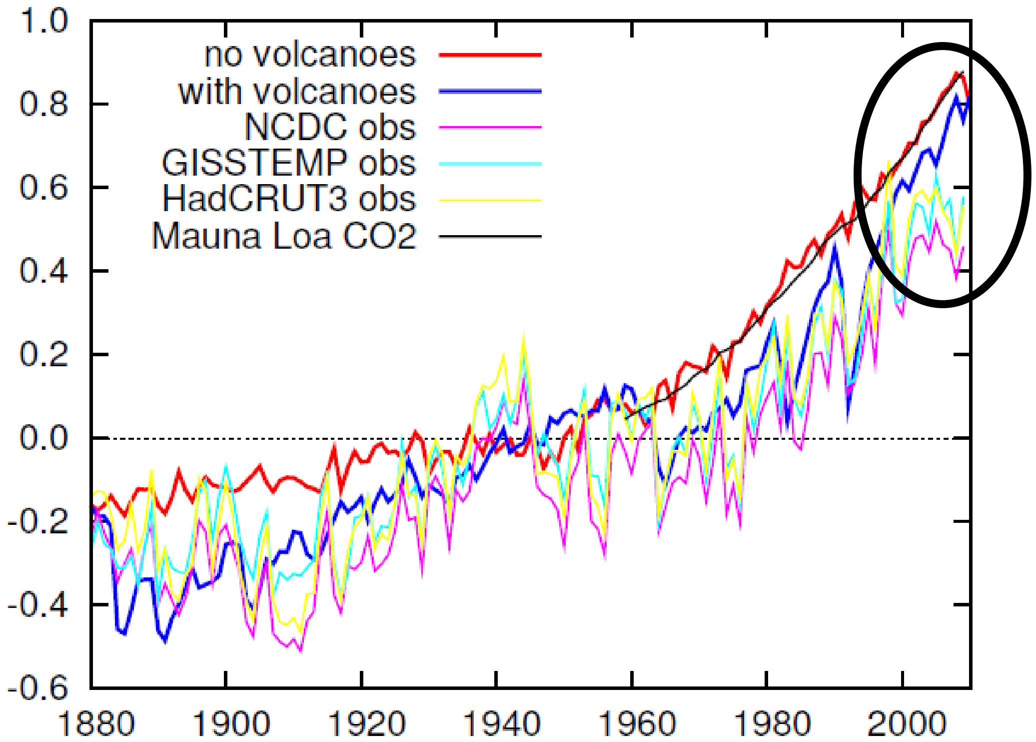
Southern Europe is warming less than regions in the

Motivation: near term

- What do we mean?
  - The time scales between seasonal-to-interannual prediction (e.g. the effect of El Niño/La Niña) and long-term anthropogenic climate change
  - The way slow changes in low-frequency natural variability and atmospheric composition affect the risk of climate impacts
- What do we look at?
  - Multi-year averages (ranging from three to 30 years) of significant variables (temperature and precipitation) and of climate indices (global-mean temperature, AMO, PDO, …)
- What questions do we face?
  - Will the current trend continue?
- Where are we?
  - Very early stages
- Challenges
  - Many: need to clarify what is predictable, what is the best way to predict, what forecast quality level is useful, …

Decadal variability: global-mean T_s

Anomalies of global-mean surface air temperature for different observational datasets and ensemble-mean of sets of CMIP3 historical simulations with (blue) and without (red) volcanic aerosol.



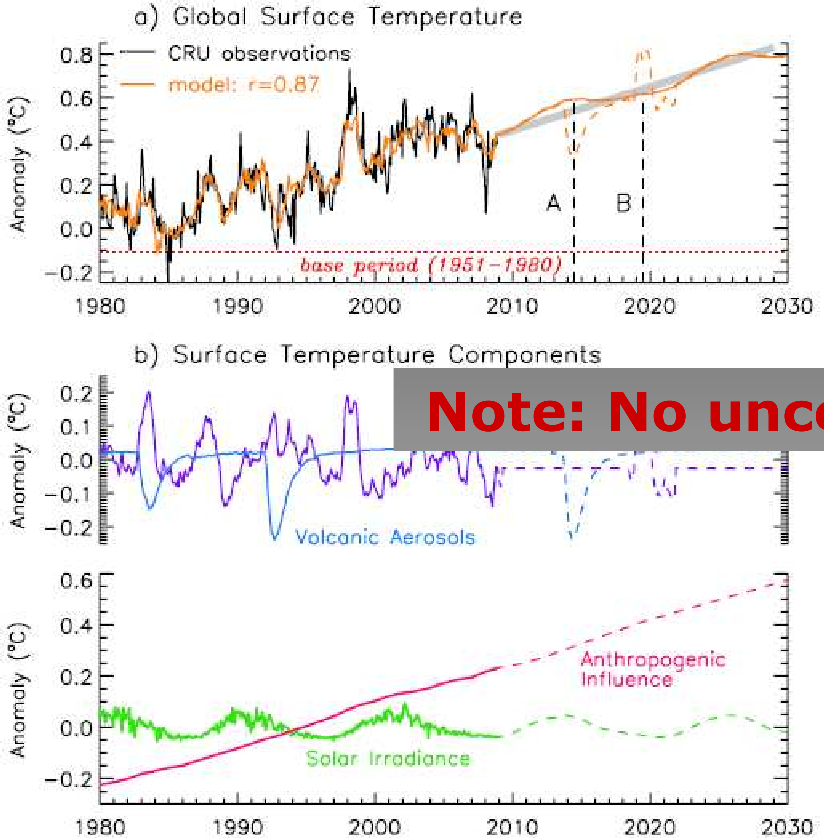
van Oldenborgh et al. (2011)

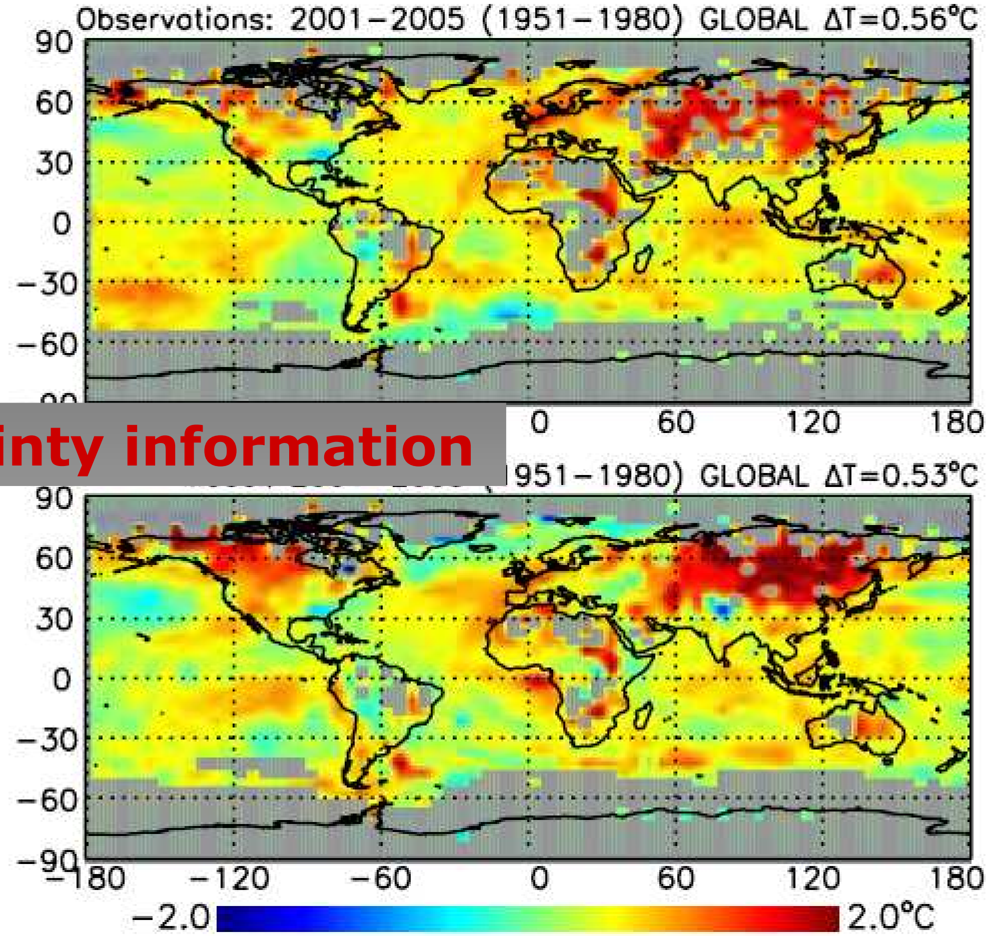
Formulating near-term predictions

- Near-term climate predictions should make use of information about both anthropogenic climate change and natural decadal variability
- Empirical models
  - Characterize the observed variability of the past
  - Relies on reasonably good and long observational datasets
- Long-term climate change simulations
  - Ensembles of historical simulations and long-term projections, preferably multi-model
  - All bells and whistles forcings, but no initial-condition information
- Initialized predictions
  - Made with coupled Earth System Models with initialization of the climate system, particularly the oceans
  - Include observed and projected changing atmospheric composition

Empirical methods

Empirical predictions from fitting the model $T(t)=a+b*E(t-\Delta t_E)+c*V(t-\Delta t_V)+d*S(t-\Delta t_S)+e*A(t-\Delta t_A)$ (ENSO, volcanic, solar and anthropogenic influences) to monthly mean data, with Δt being 4, 7, 1, and 120 months.



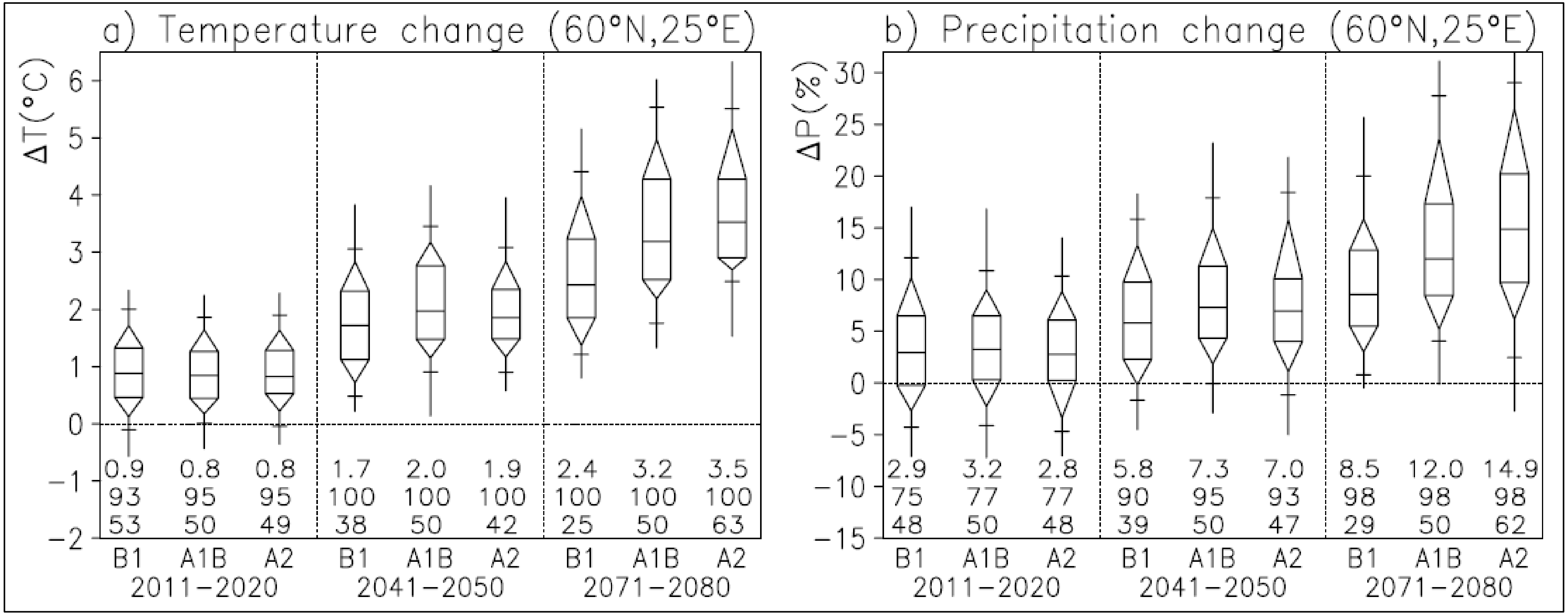


Note: No uncertainty information

Lean and Rind (2009)

Long-term climate change simulations

CMIP3-based predictions for southern Finland for several scenarios and three different decades wrt the average over 1971-2000. Note the similarity of the results for the three SRES scenarios in the near-term (2011-2020) climate predictions.



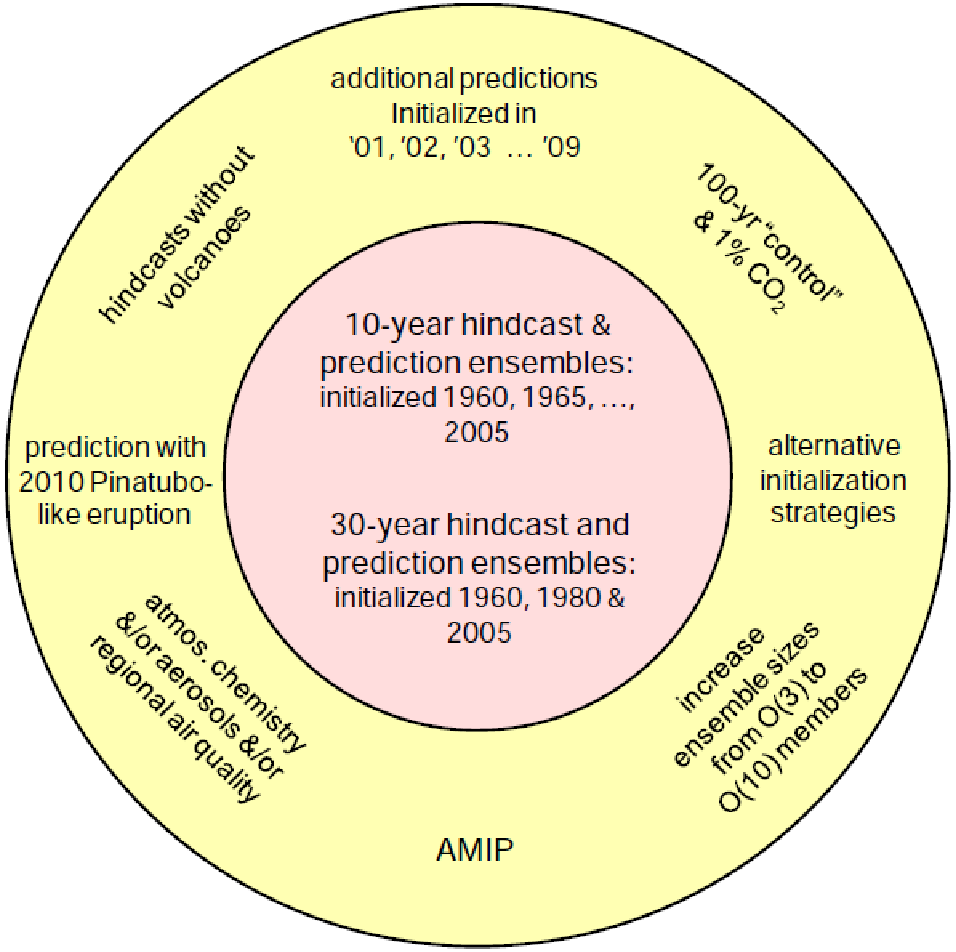
Räisänen and Ruokolainen (2006)

Initialized dynamical forecasts

- Build a global coupled model.
- Prepare initial conditions.
- Initialize coupled system
  - The aim is to start the system close to reality. Accurate SST and ocean sub-surface is crucial. If worry about "imbalances" use anomaly initialization, otherwise full initialization.
- Run an ensemble forecast
  - Explicitly generate an ensemble on the e.g. 1st of a given month, with perturbations to represent the uncertainty *in the initial conditions*; run forecasts for 10-30 years.
- Worry about model error a posteriori (full initialization) or a priori (anomaly initialization), linear approach.
- Produce probabilities from the ensemble.

CMIP5 near-term experiments

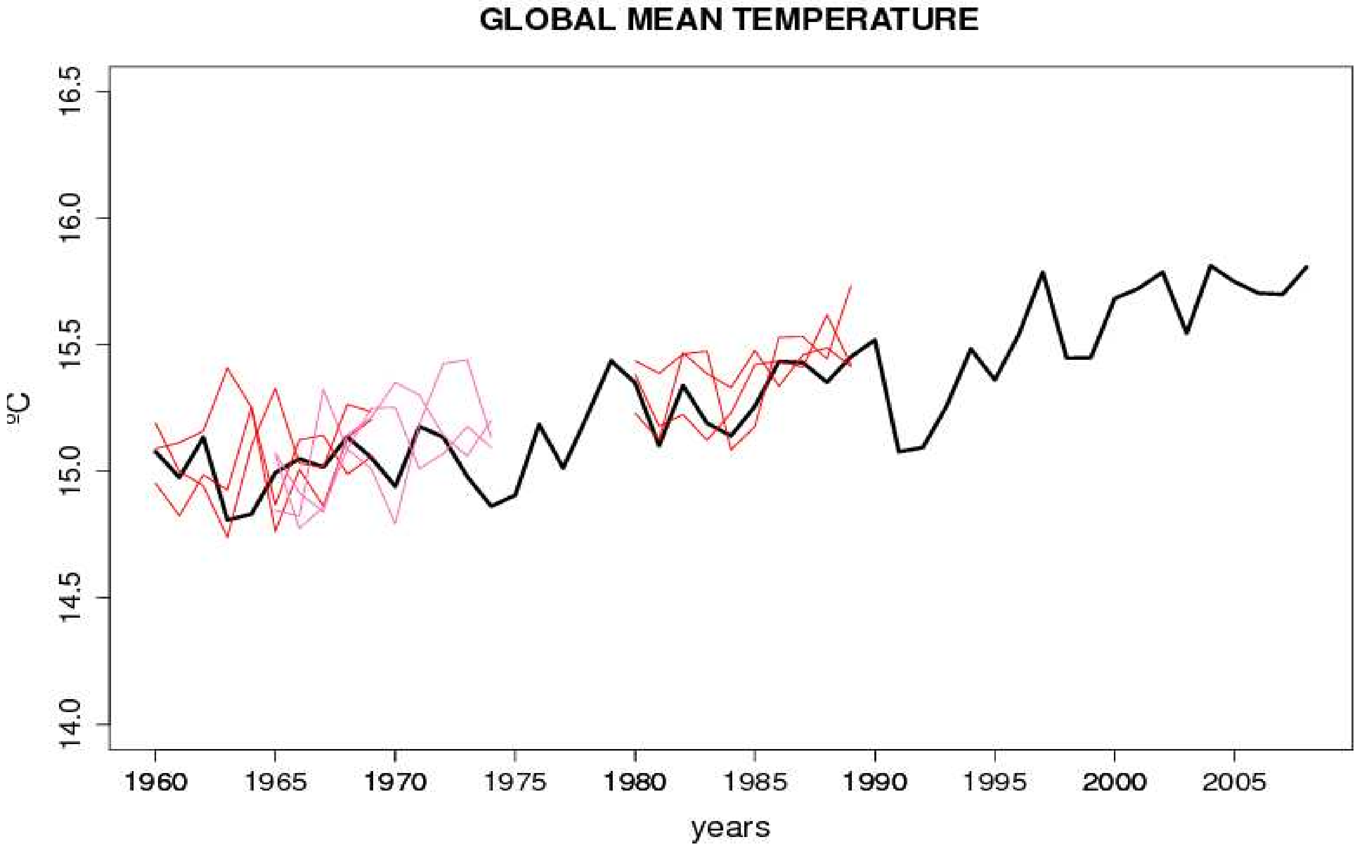
CMIP5 core (inner circle) and tier 1 (outer circle) experiments. For the core experiments, the atmospheric composition should be prescribed as in the historical run and then follow the RCP4.5.



Taylor et al. (2011)

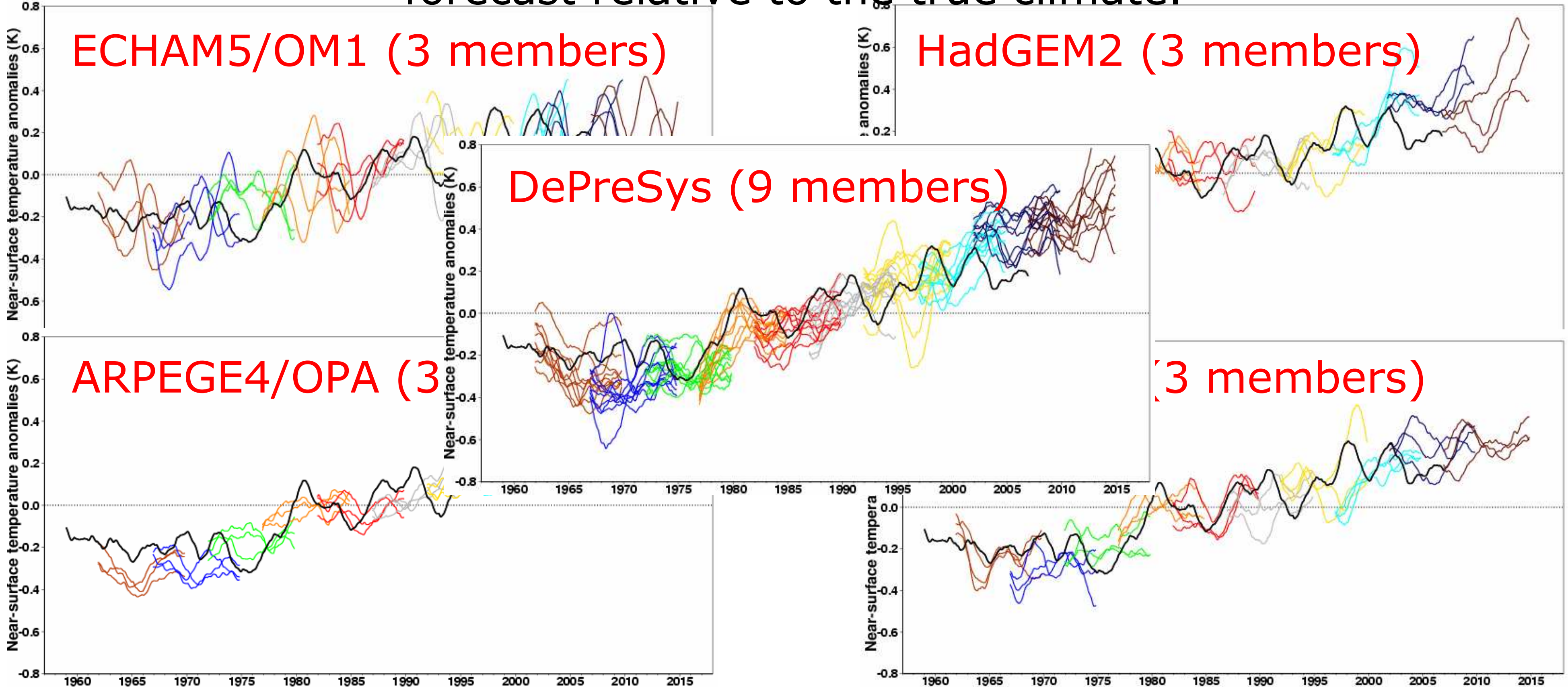
Ensemble initialized near-term predictions

Idealized ensemble forecast system with an initialized ESM



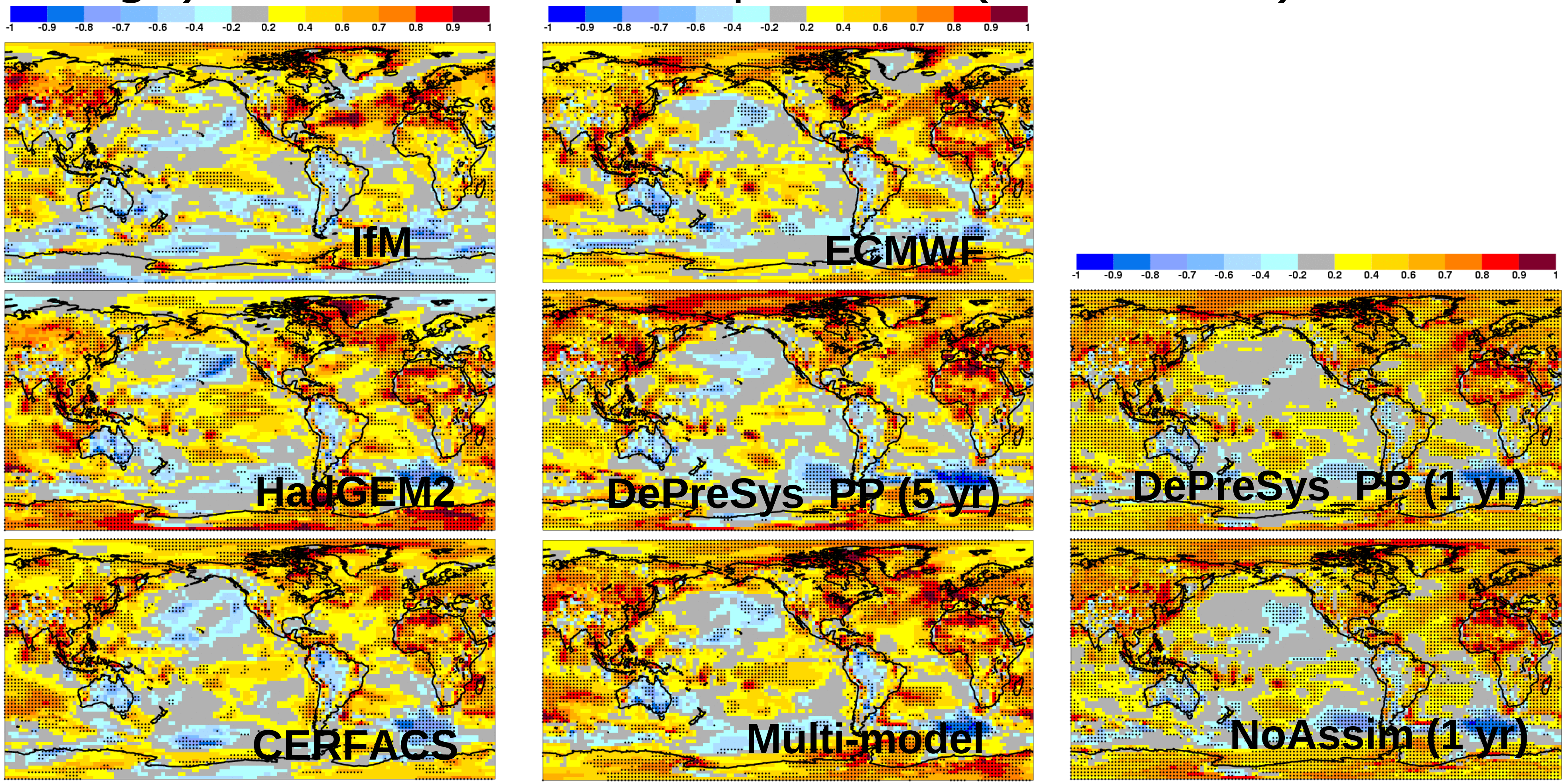
ENSEMBLES forecasts: global T_s

Global mean near-surface air temperature anomaly (2-year running mean applied) from the ENSEMBLES re-forecasts. ERA40/OPS is used as a reference. We implicitly assume that a linear shift in the model forecast relative to the model climate corresponds to the expected shift in a true forecast relative to the true climate.



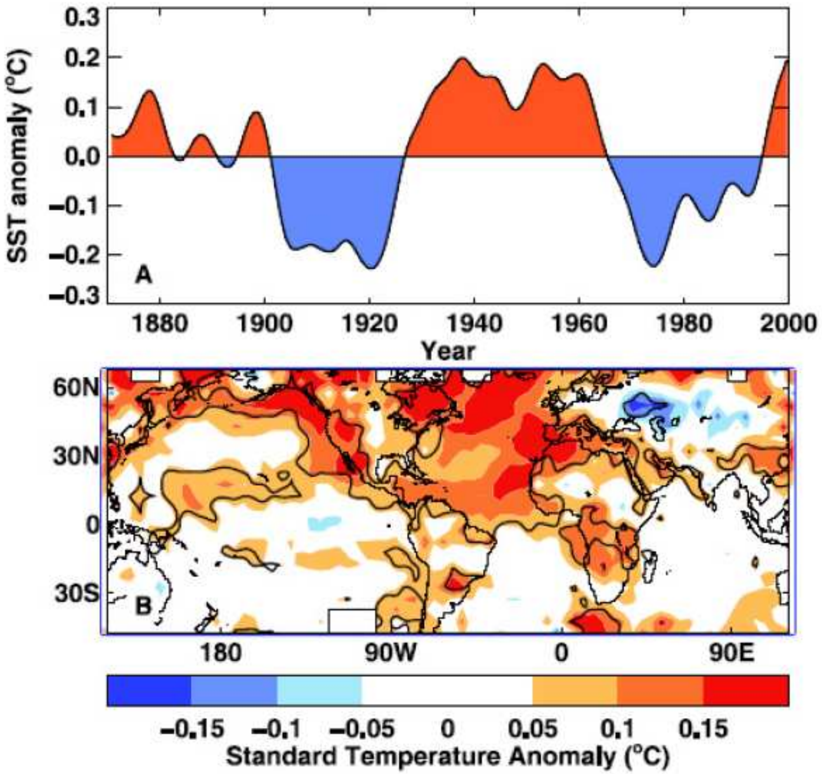
Ensemble-mean temperature skill

Ensemble-mean correlation for decadal forecasts (2-5 year average) of near-surface temperature (1960-2005) wrt ERA.

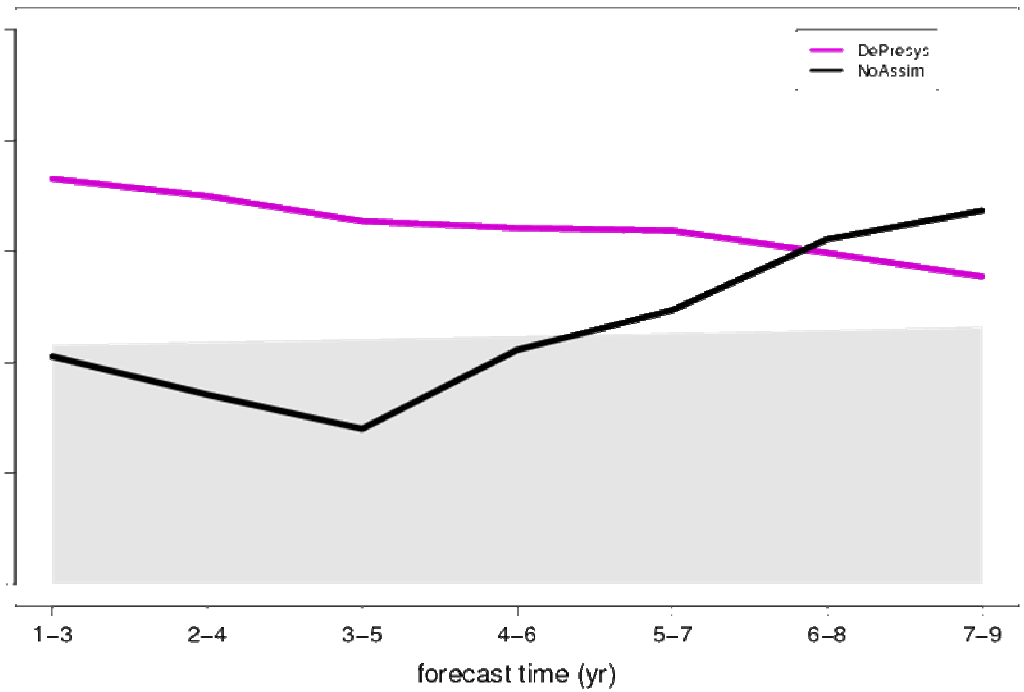


AMO decadal predictions

(Left) Atlantic multidecadal oscillation (AMO) and the temperature changes associated with a one standard deviation in the AMO index. (Right) Ensemble-mean correlation of three-year running-mean AMO re-forecasts from DePreSys and NoAssim. ERSST is used as reference. One-year intervals between start dates are assessed.



Knight et al. (2005)

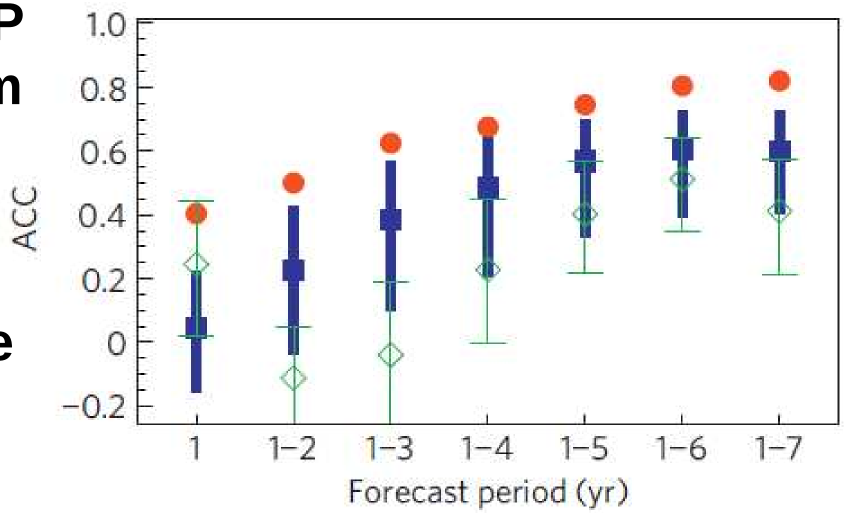


García-Serrano et al. (2011)

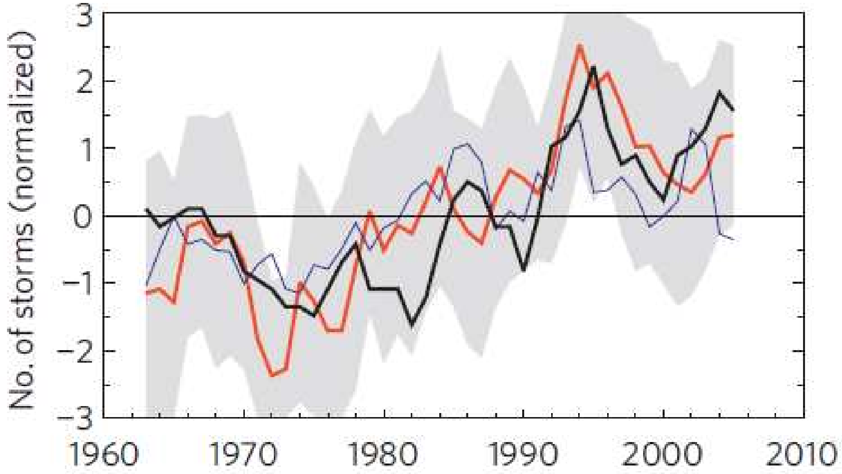
Tropical cyclone predictions

DePreSys North Atlantic tropical cyclone predictions.

ACC for DePreSys_PP (red circles), NoAssim (blue) and a persistence model (green). Bars are for the 5-95% confidence intervals



Five-year running mean of tropical cyclone number for the HURDAT dataset, DePreSys_PP (red) and NoAssim (blue)



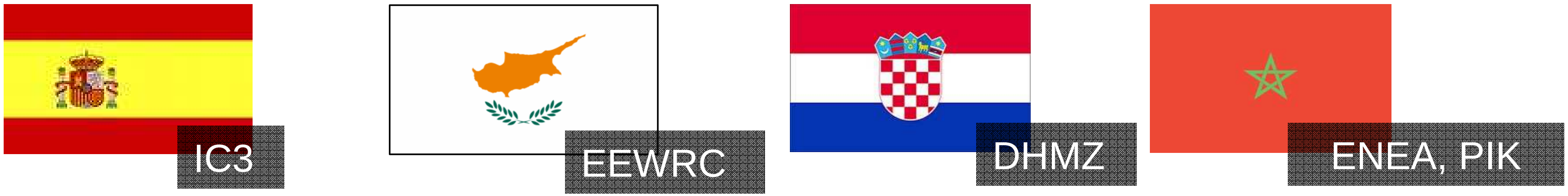
Smith et al. (2010)

Application: CLIMRUN WP7

- Aim: Illustrate how climate information can play a role in developments and management in the renewable energy sector.
- *We seek to reduce the risk for investors and facilitate long-term planning and decision-making for renewable energies and the associated smart-grid.*
- www.climrun.eu

CLIM-RUN

Partner case-study countries:



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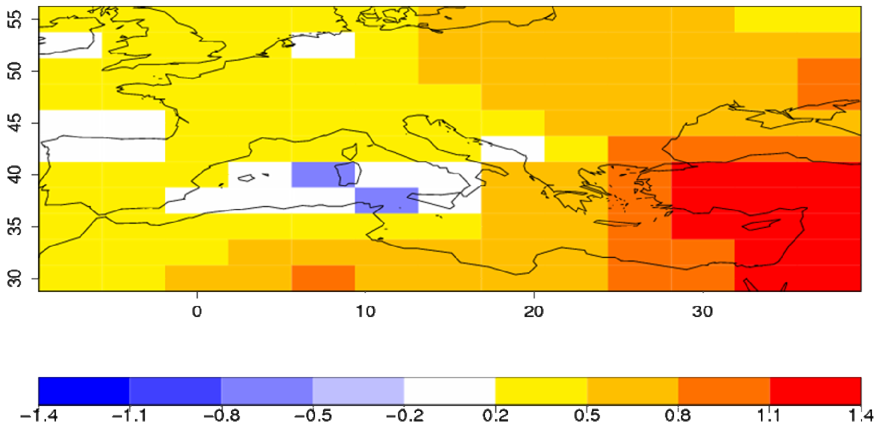
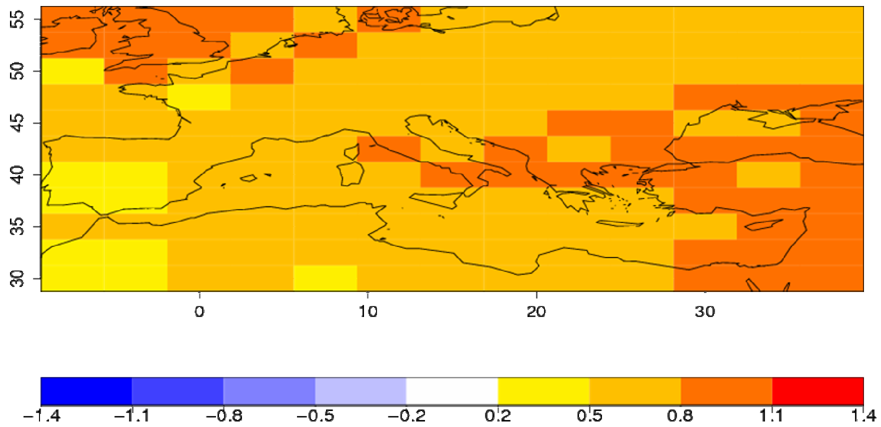
Application: CLIMRUN WP7

Observed (**2006-2010**)

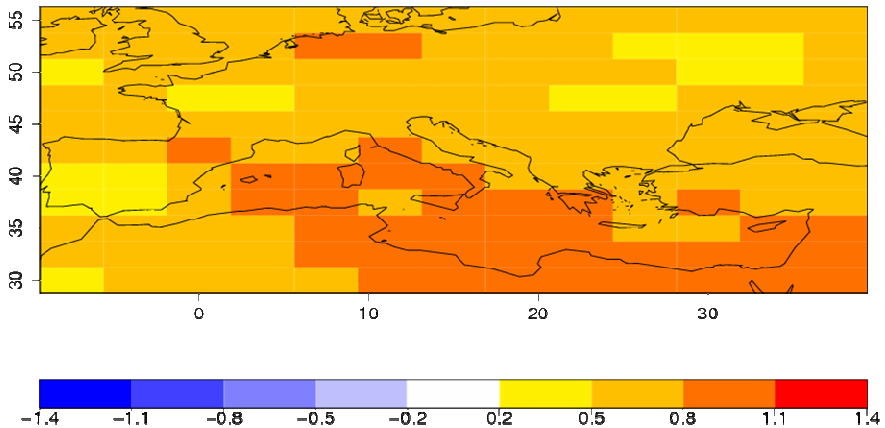


Forecast (**2006-2010**)



Example of CLIMRUN product: Observed and forecast temperature (could also be wind, solar radiation, etc.) anomalies from mean values across Europe and the Mediterranean (K)

Forecast (**2011-2015**)



The downscaling portal

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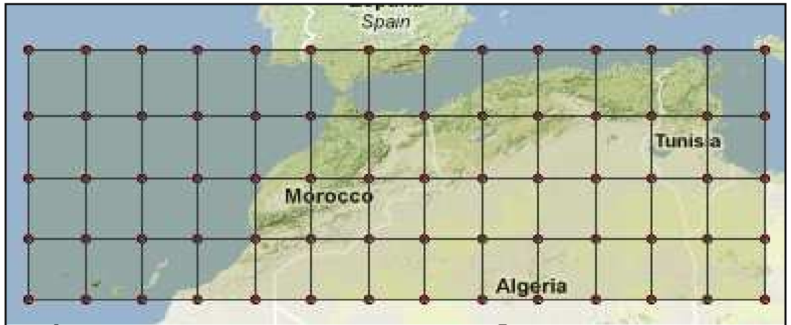
The ENSEMBLES downscaling portal of the Universidad de Cantabria (Spain) allows to friendly perform online statistical downscaling by defining a set of predictors (large scale reanalysis and GCM fields), predictands (local variables of interest for impact studies) and a statistical downscaling method such as analogs, regression and GLMs, SOM weather types and weather generators.

www.meteo.unican.es

Large scale predictors



(**Z**(1000 mb), ..., **Z**(500 mb);
T(1000 mb), ..., **T**(500 mb);
Q(1000 mb), ..., **Q**(500 mb)) } X_n

Downscaling Model

Analogs, reg., ...
$Y_n = f(X_n)$

Statistical methods based on historical data to link large scale circulation to local climates.

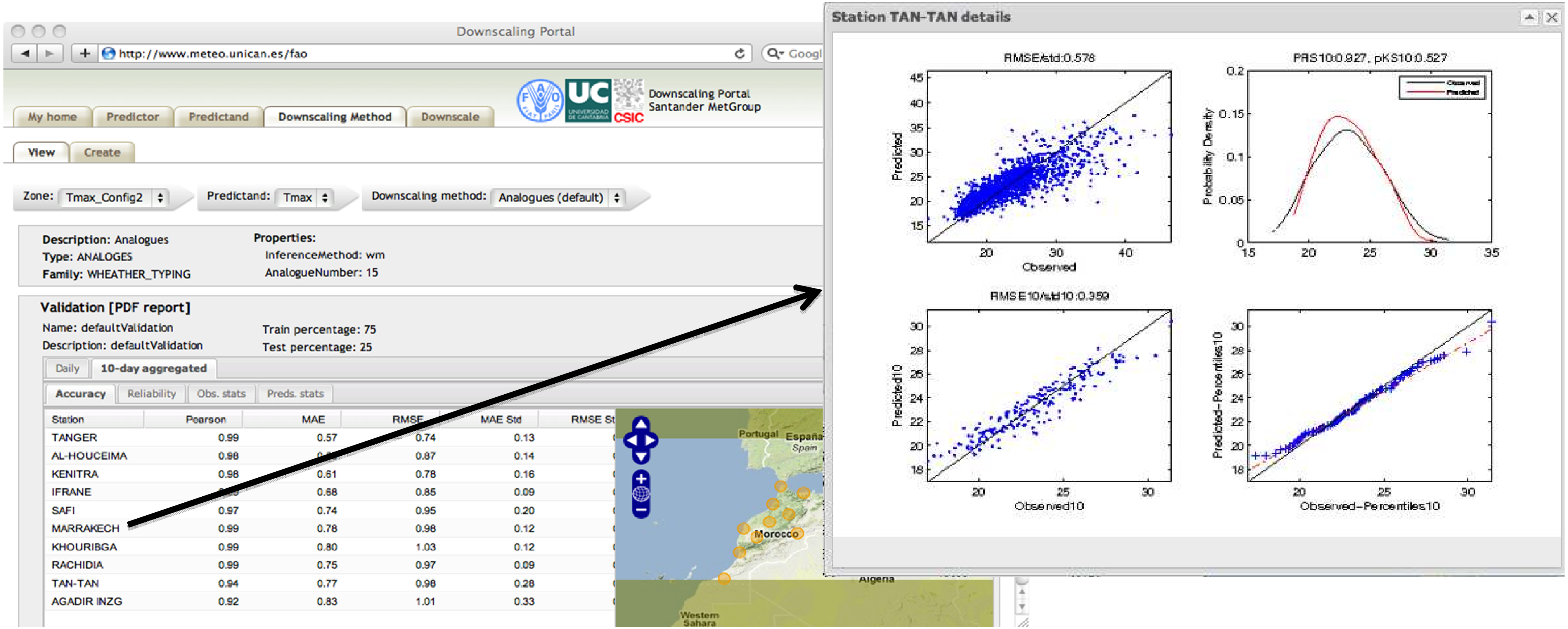
Local predictands

Y_n

Variables for impact studies:
Precipitation
Temperature
Others can be uploaded

The downscaling portal

The portal should not be used as a black-box tool. Some background knowledge is required and the limitations should be known (e.g. the assumptions of the statistical downscaling methodology). Users are requested to collaborate with downscaling experts. User tutorials and indications and recommendations for downscaling are provided.



Station	Pearson	MAE	RMSE	MAE Std	RMSE St
TANGER	0.99	0.57	0.74	0.13	[illegible]
AL-HOUCEIMA	0.98	[illegible]	0.87	0.14	[illegible]
KENITRA	0.98	0.61	0.78	0.16	[illegible]
IFRANE	[illegible]	0.68	0.85	0.09	[illegible]
SAFI	0.97	0.74	0.95	0.20	[illegible]
MARRAKECH	0.99	0.78	0.98	0.12	[illegible]
KHOURIBGA	0.99	0.80	1.03	0.12	[illegible]
RACHIDIA	0.99	0.75	0.97	0.09	[illegible]
TAN-TAN	0.94	0.77	0.98	0.28	[illegible]
AGADIR INZG	0.92	0.83	1.01	0.33	[illegible]

Summary short-term climate prediction

- CMIP5 near-term predictions will provide a substantial set of predictions for creating the first examples of climate services.
- Significant kill is found for near-surface temperature (mainly North Atlantic), tropical cyclone frequency and AMO. A large portion is due to the “trend”.
- Uncertainty in ocean circulation and thermal structure in re-analyses is large; this prevents having good reference datasets for initialization, validation and verification.
- Simple reference forecasts (e.g. persistence) are needed.
- General-purpose calibration and downscaling are being developed.