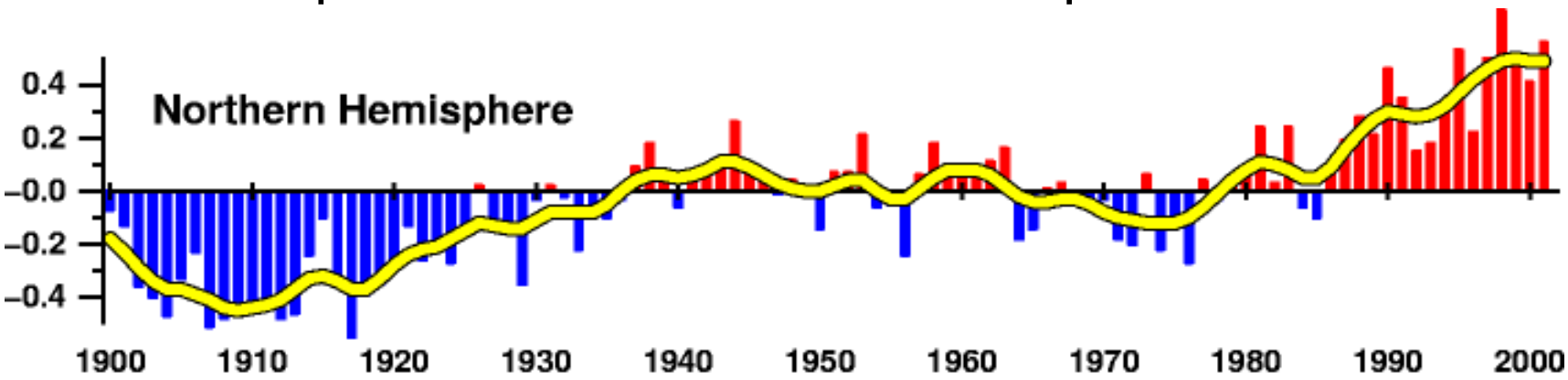
Developments in Seasonal to Decadal Prediction

Daniela Jacob, Kevin Sieck, Wolfgang Müller

Max-Planck-Institute for Meteorology, Hamburg

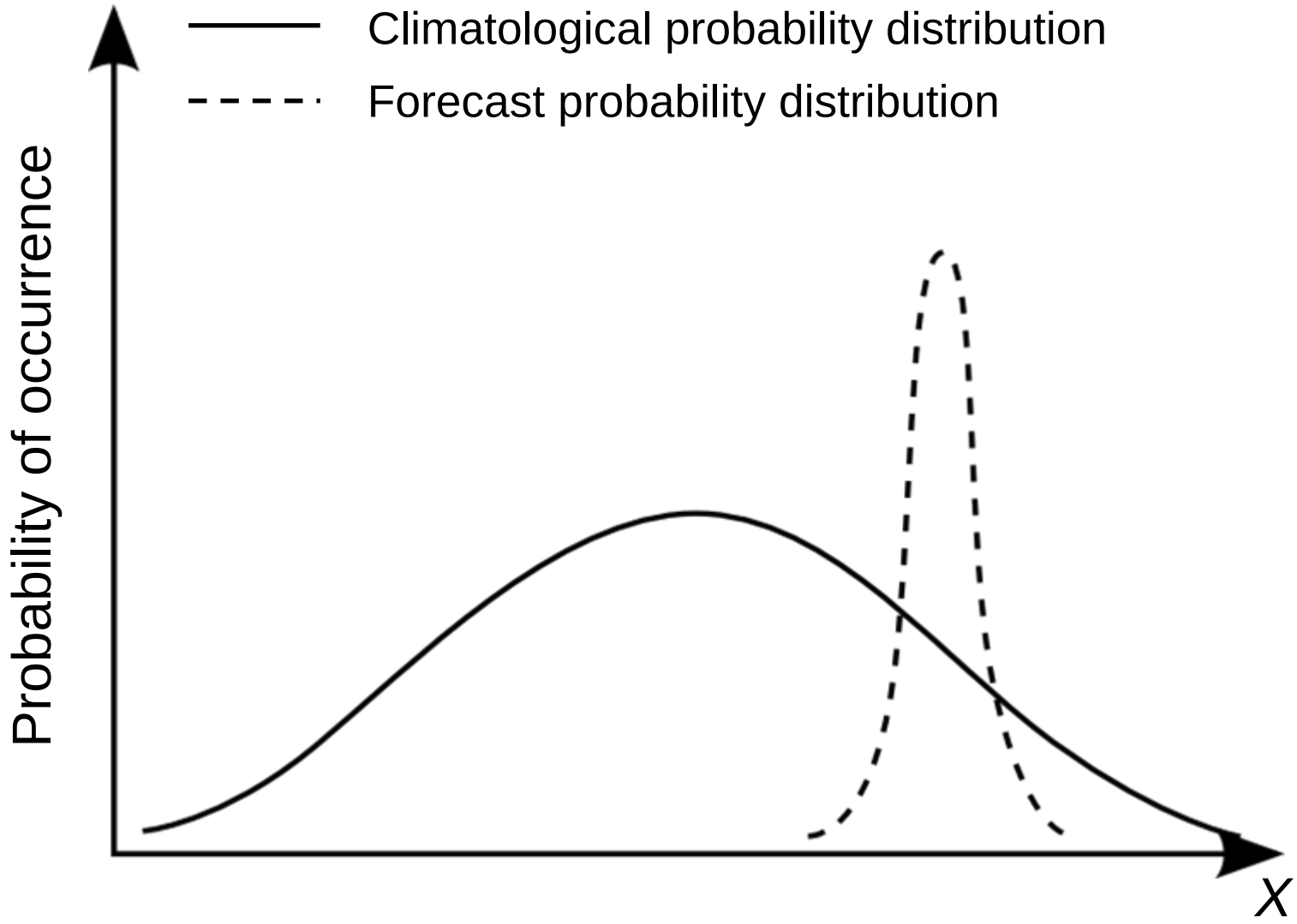
Natural climate variability

- C Temperature anomalies from the period 1961-1990



Source: http://www.cru.uea.ac.uk/cru/demos/temrec/graph.htm

What is predictability?

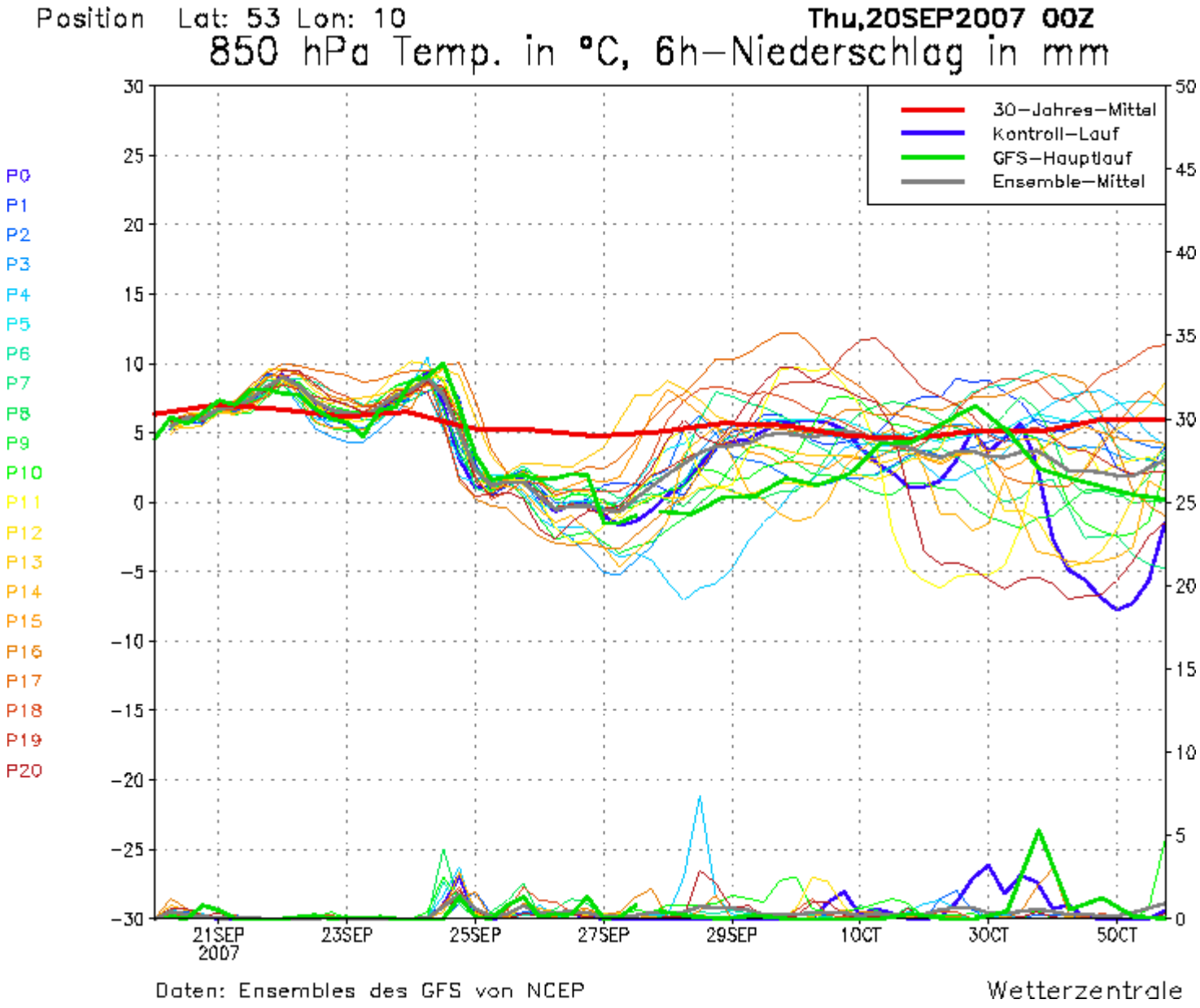


Reference: Palmer and Hagedorn 2006

Predictability of the first kind

- sensitive to the initial state of the system
- Example: weather forecast

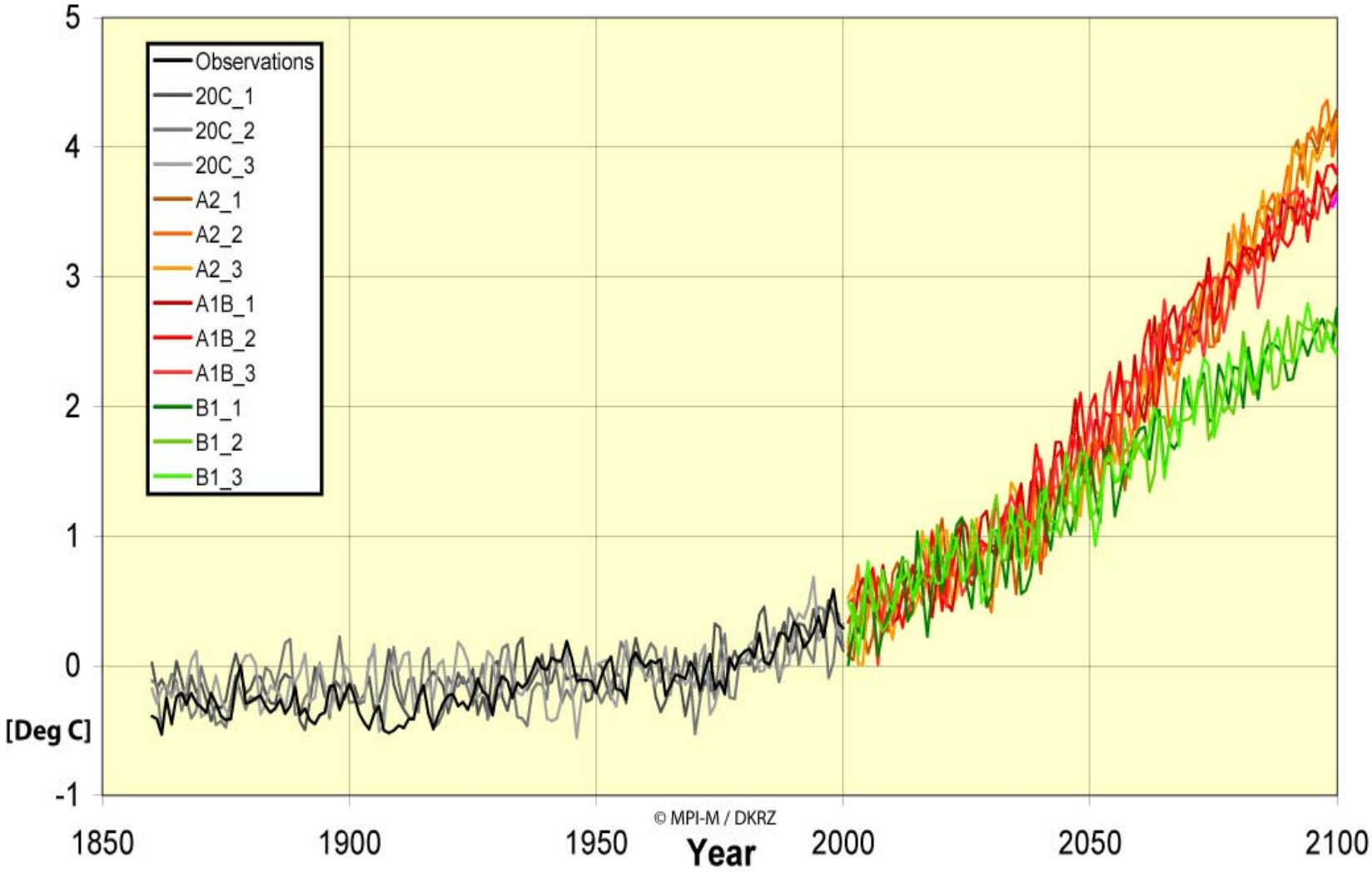
Weather forecast



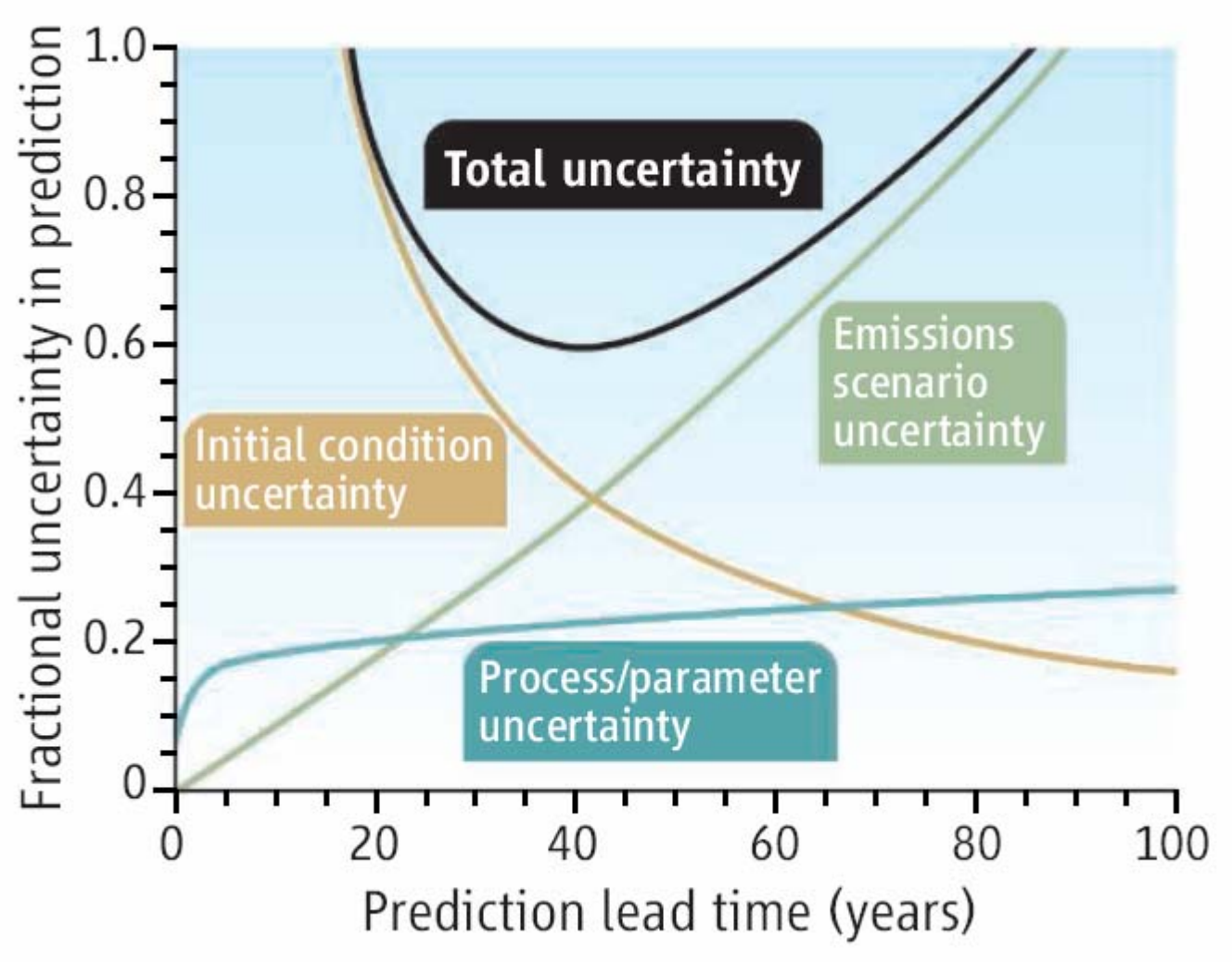
Predictability of the second kind

- Sensitive to boundary conditions
- Example: Climate projections

Global temperature change (° C, 1860-2100 relative to 1961 -1990, ECHAM5/MPI-OM)



Uncertainty



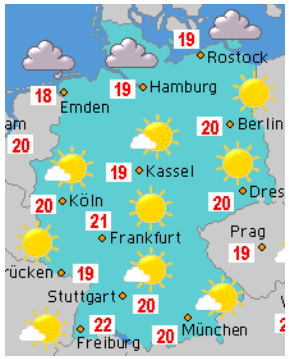
Source: Cox & Stephenson 2007

The gap in the forecasts

Weather forecast

s2d predictions

Climate projections



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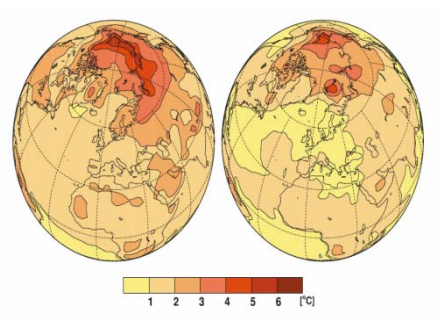
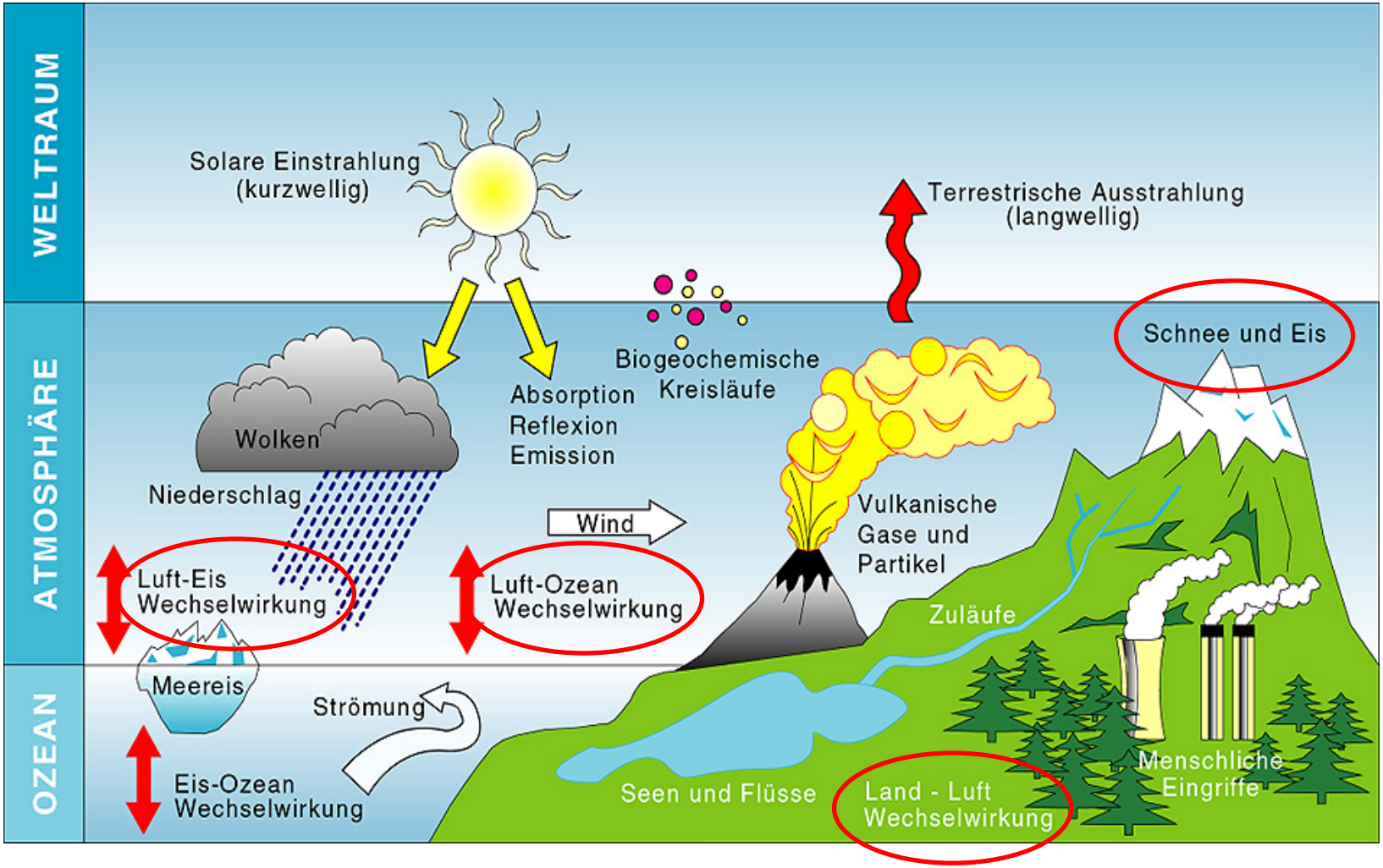
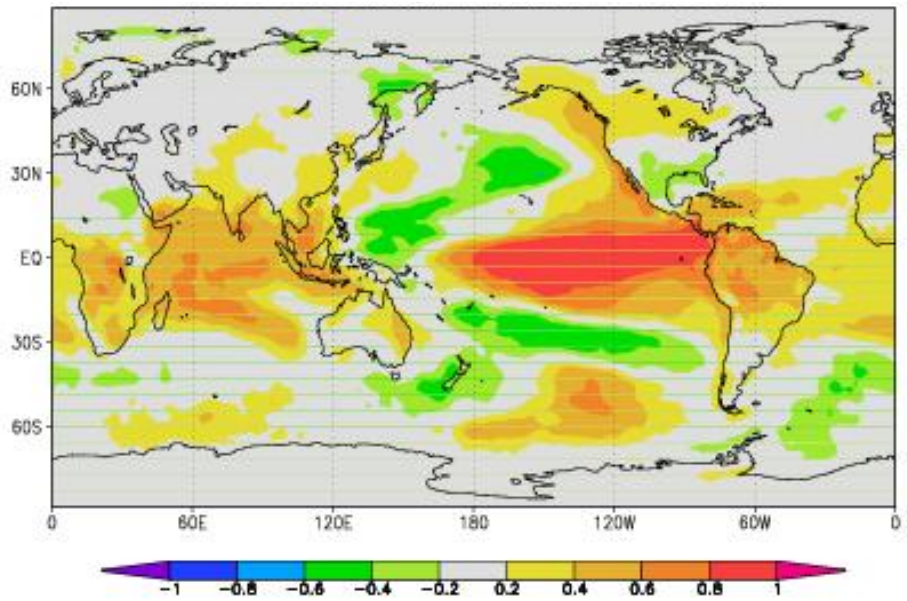


1 10 100 1000 10000 days

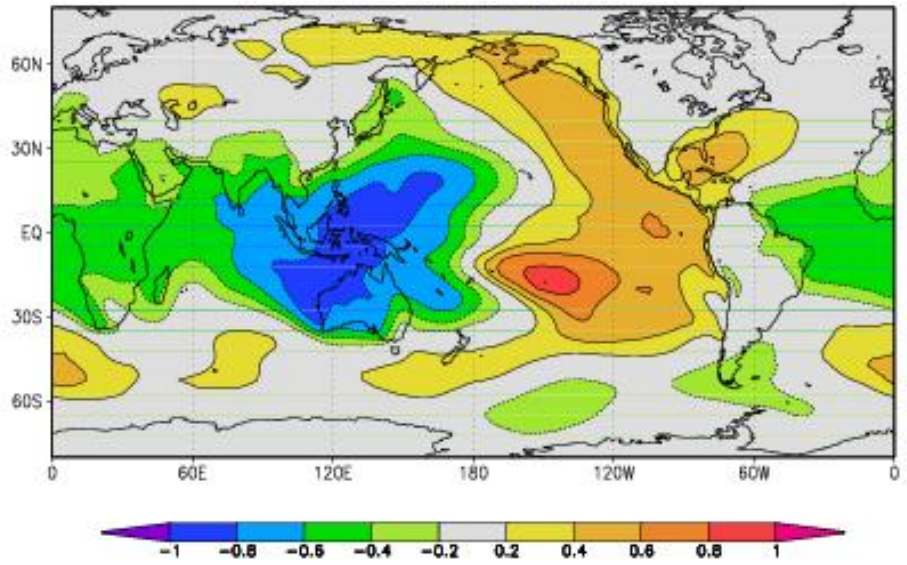
Boundary conditions for s2d predictions



Seasonal climate predictability – e.g. ENSO

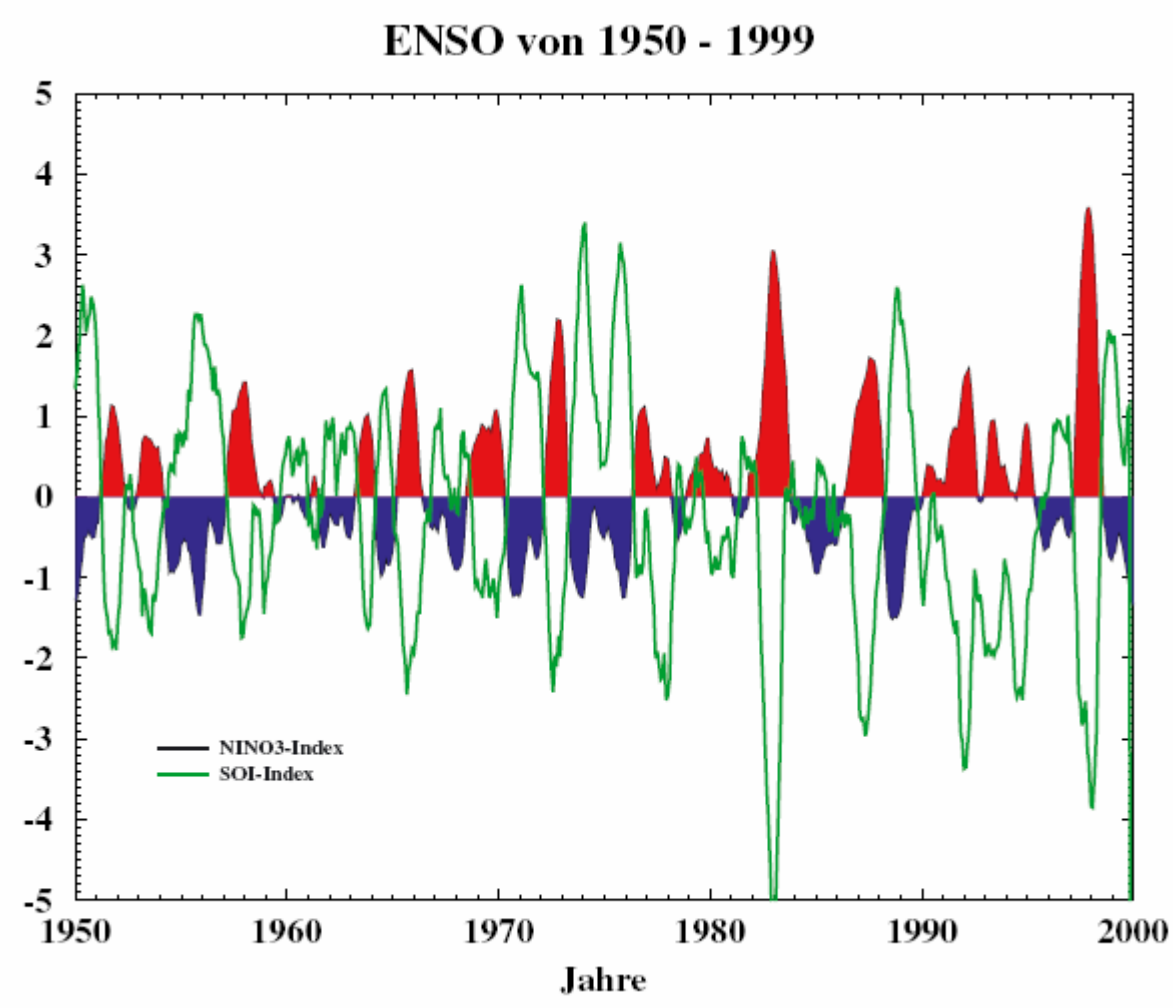


El Niño
Winter (DJF) Sea Surface Temperature

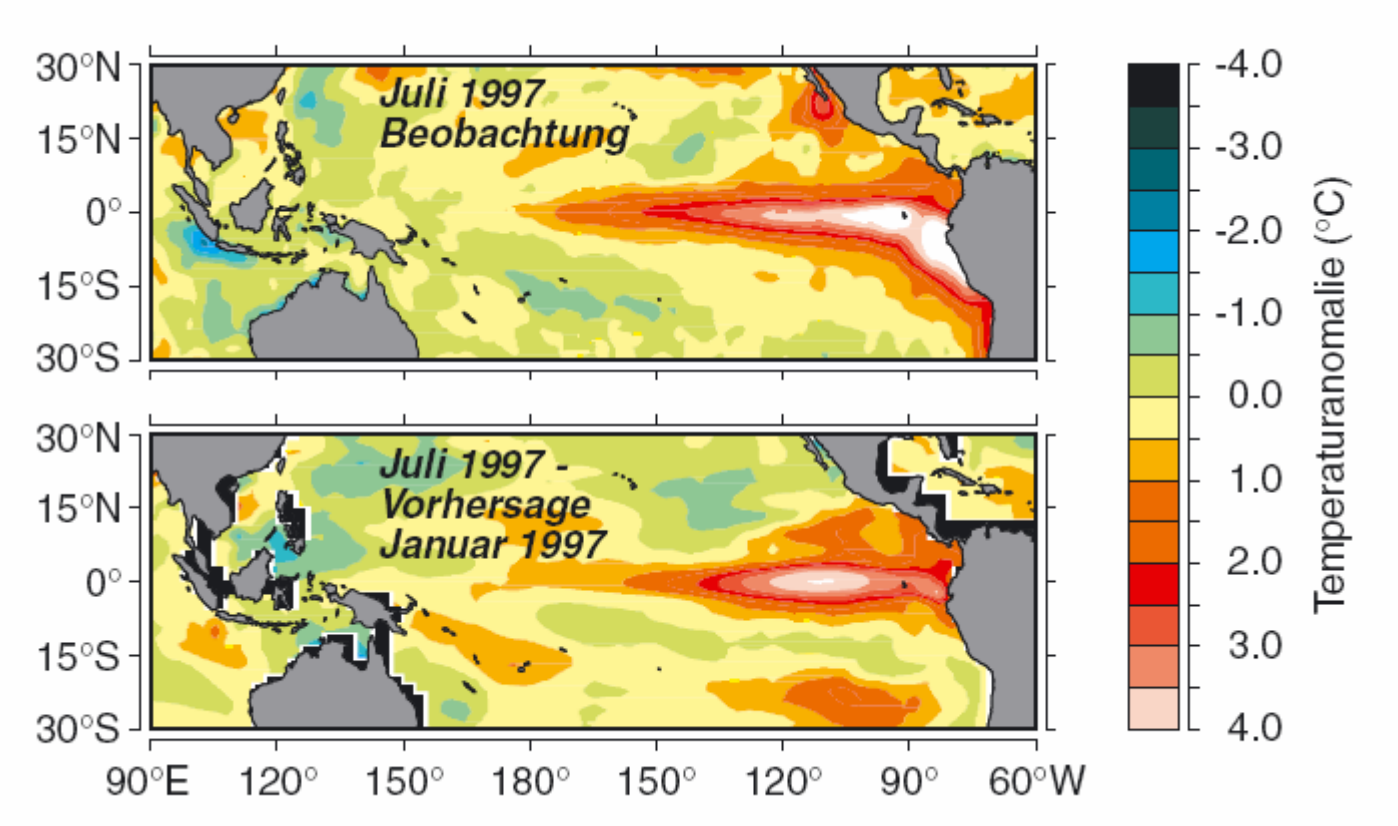


Southern Oscillation
Winter (DJF) Sea Level Pressure

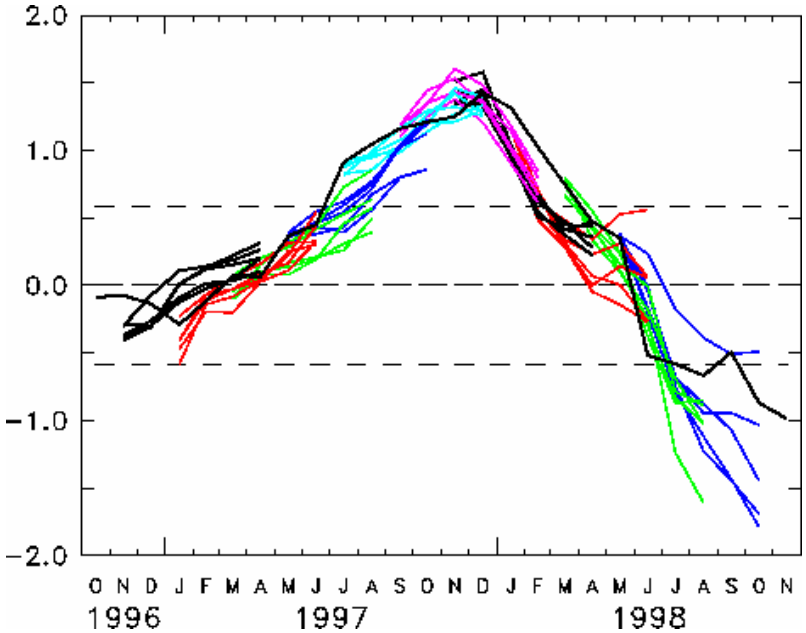
Correlation between Atmosphere and Ocean



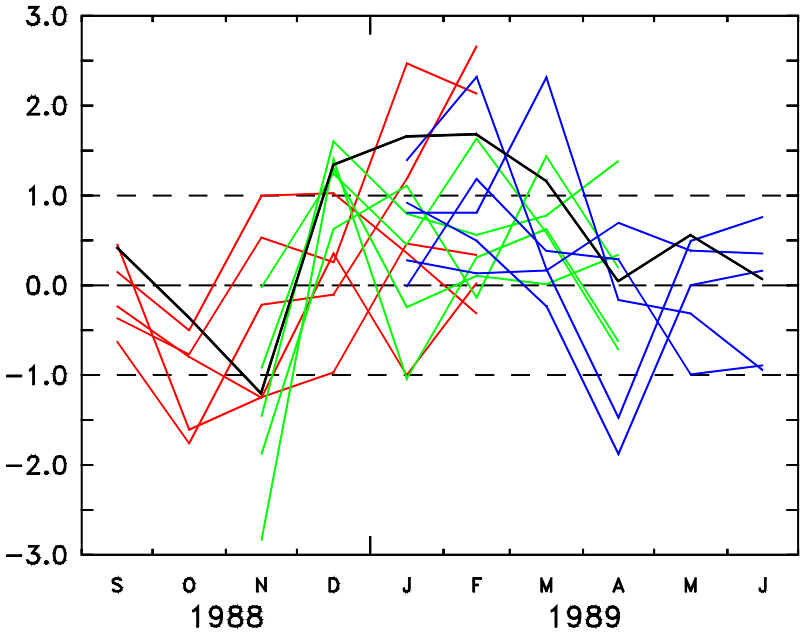
Prediction of El Niño



Seasonal climate prediction

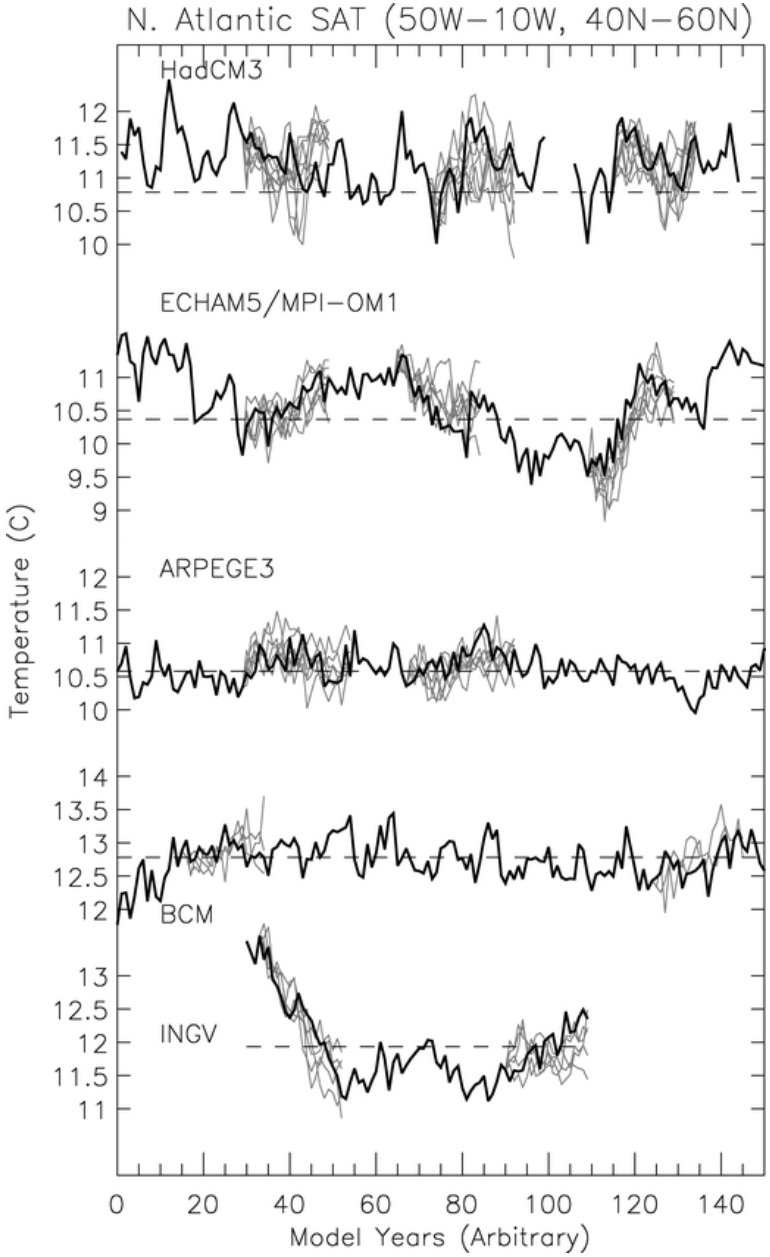


Tropics
El Niño Winter 1997/98
Temperature anomaly



Europe
NAO Winter 1988/89
Dimensionless index

Decadal potential predictability



Surface Air Temperature (SAT) over the North Atlantic from a multimodel ensemble study

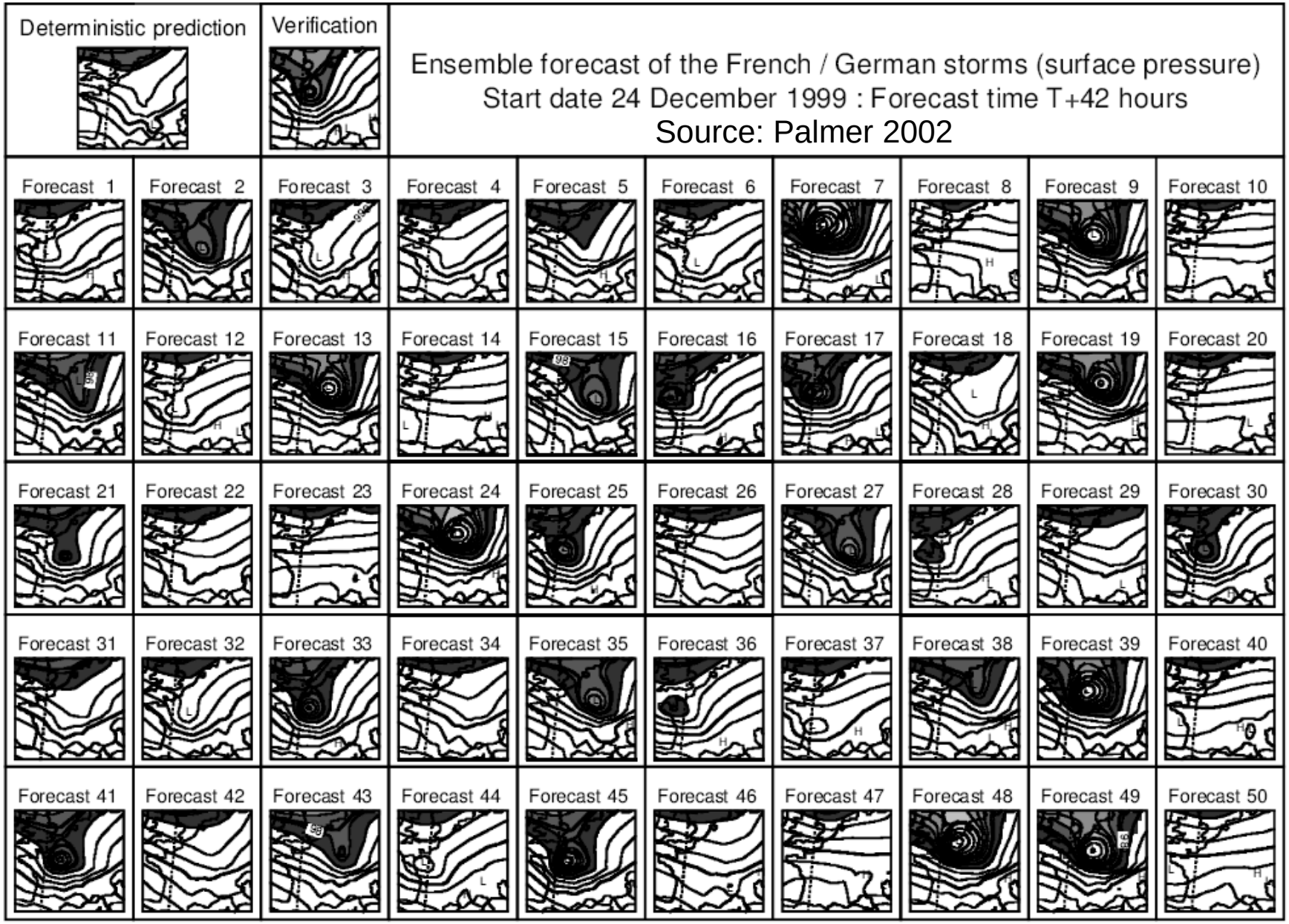
Black line: control
Grey lines: perfect-ensemble experiment

Source: Collins et al. 2006

Measuring the skill of predictions

- Skill scores
- Economic value of the forecast

Measuring the skill of predictions II



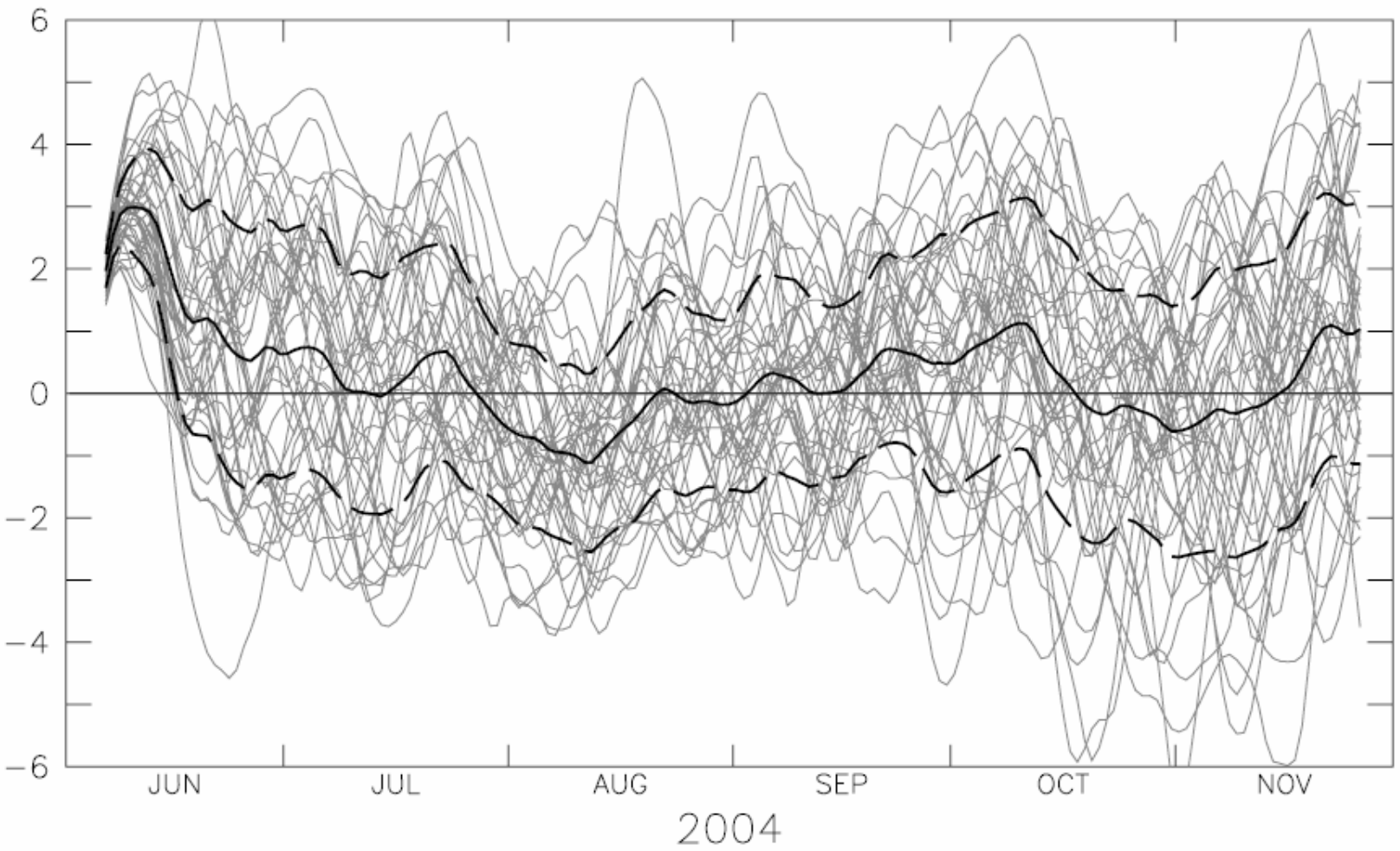
Why are forecasts uncertain?

- Uncertainties in model-predictions are due to
  - Initial condition errors
  - Model errors
  - Boundary conditions/External parameters

Representing initial conditions uncertainty

- Data assimilation
- Perturbed initial conditions

Seasonal Prediction



2 m temperature anomaly for a point in NW-USA from the ECMWF seasonal forecast system 2

Source: Schwierz et al. 2006

Representing model uncertainty

- Conventional (pragmatic) approaches:
  - Multimodel ensemble
  - Multiparametrisation ensemble
  - Multiparameter ensemble

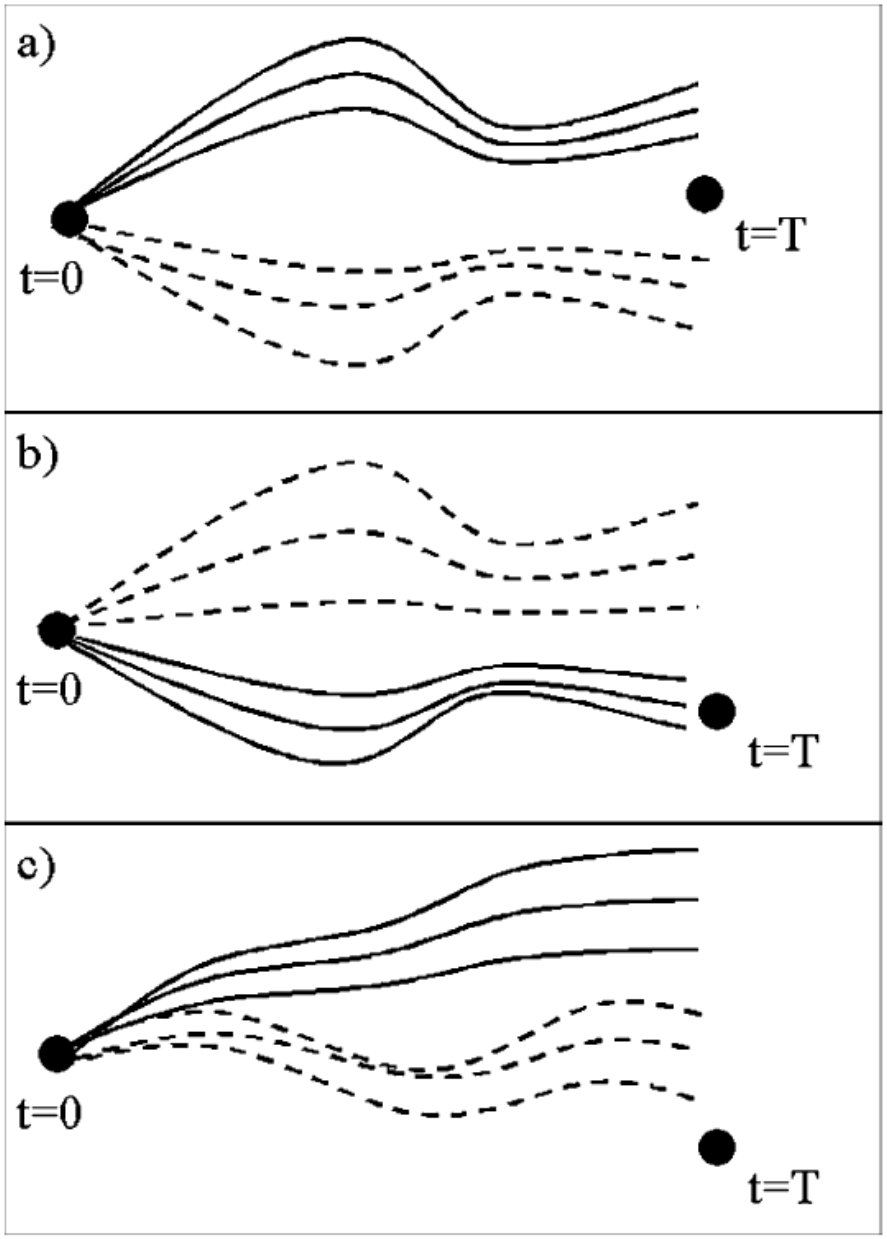
  } Perturbed physics

- New approach:
  - Stochastic parametrisation

Representing external parameter uncertainty

- SRES Scenarios
- Stochastic volcanos

Multimodel theory



Multimodel provides best prediction

A single model provides the best prediction

The verification lies outside The model predictions

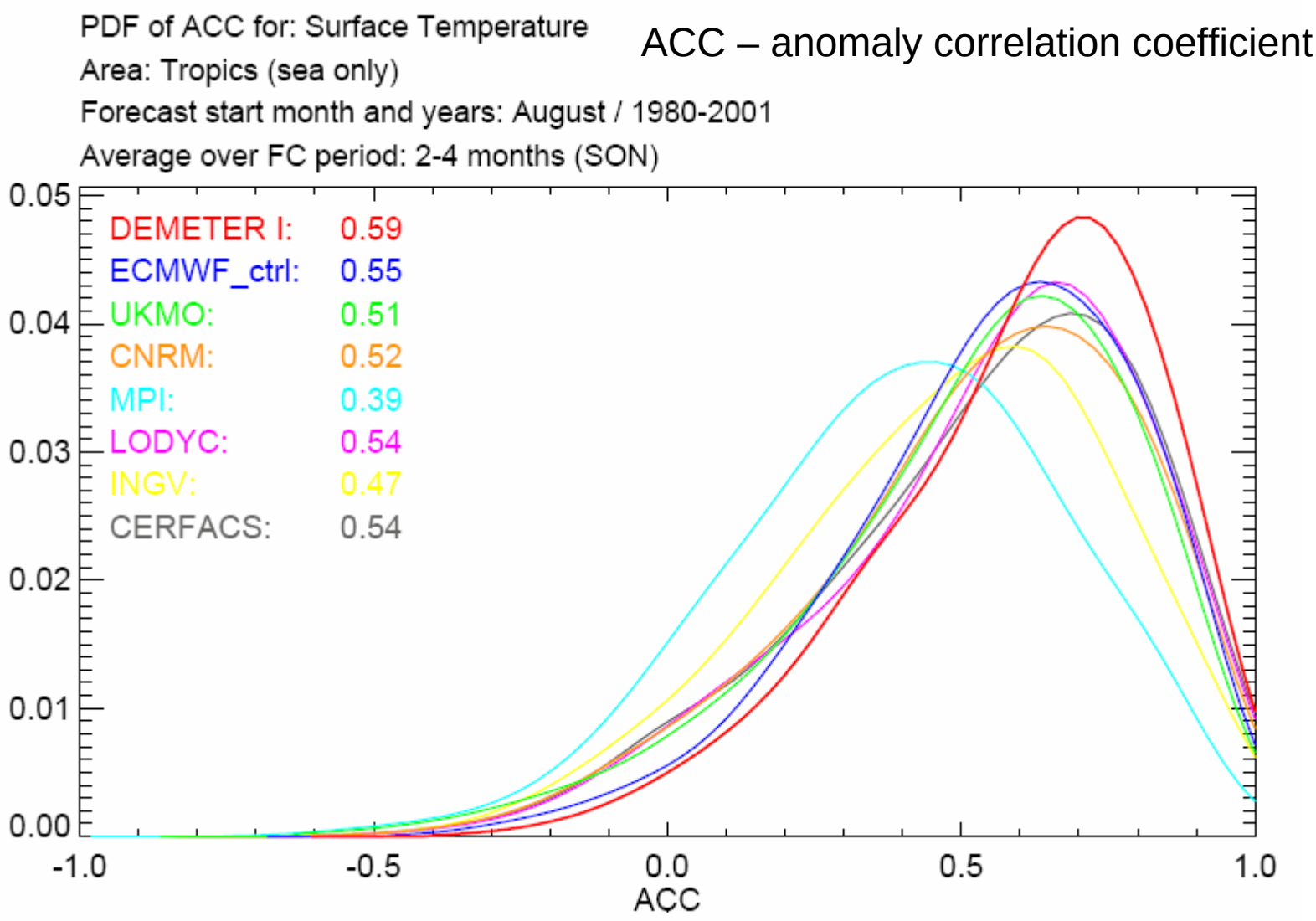
Source: Hagedorn et al. 2005

Multimodel in reality

- Every model has strengths and weaknesses
- A ranking of the model performances depends on the forecast situation, lead time and parameter of interest

➔combining the models in a multimodel gives on average the best forecast

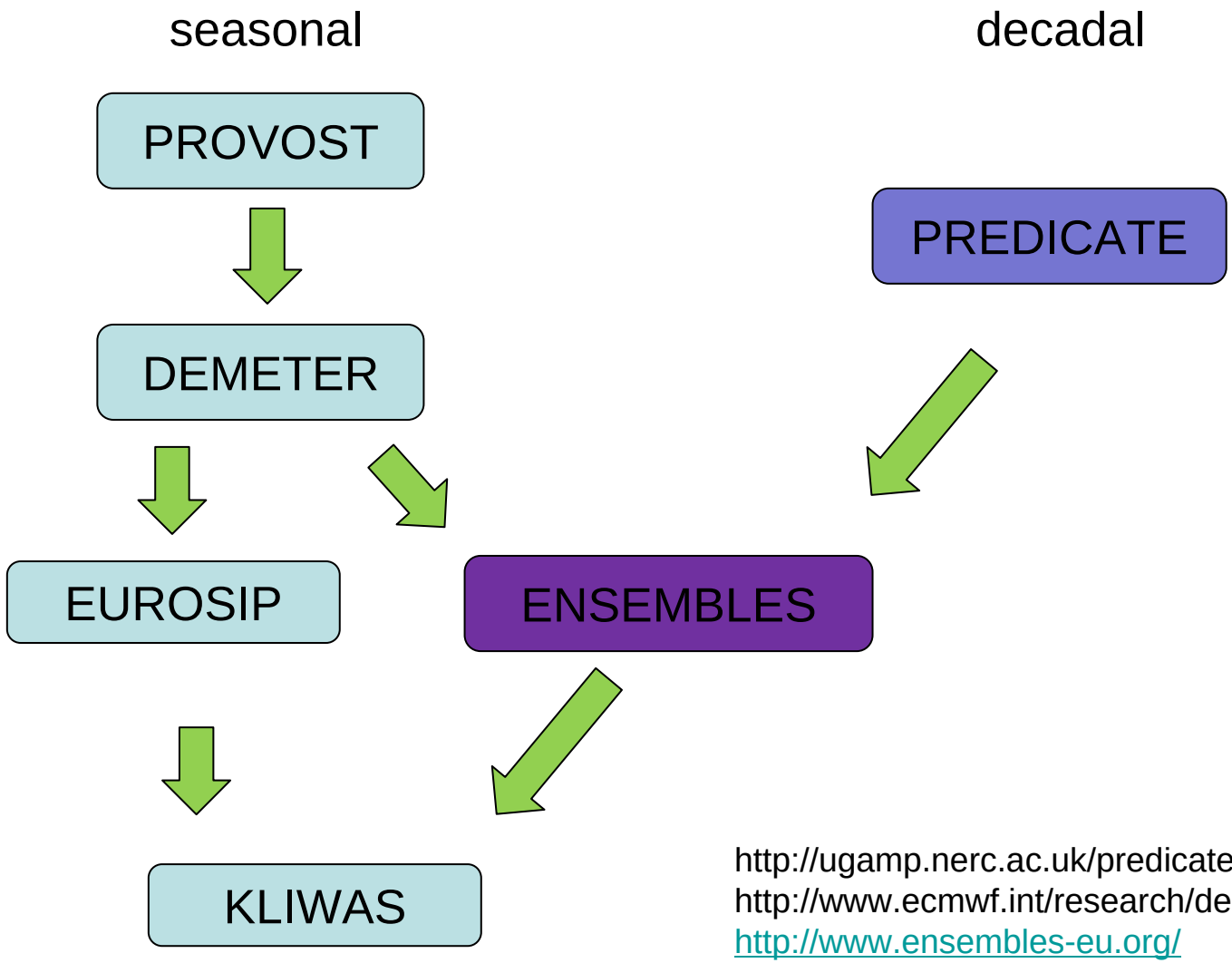
Multimodel in reality



ACC – anomaly correlation coefficient

Source: Demeter Project

some projects on s2d prediction



http://ugamp.nerc.ac.uk/predicate/
http://www.ecmwf.int/research/demeter/
http://www.ensembles-eu.org/
http://www.kliwas.de

PROVOST

Prediction of climate variations on seasonal to interannual timescales and sister project DSP (Dynamical Seasonal Prediction-USA)

Motivation: -reducing model uncertainty by combining independent models (pragmatic approach)

What was done?

-several GCMs were run 4 months with observed SSTs; each model building their own ensemble out of nine different initial conditions

Outcome:

-single-model ensembles showed model-to-model variability in the estimates of the seasonal signal and model noise

-probability scores based on **multimodel ensemble** were generally higher than those of single-model ensembles (PROVOST only)

DEMETER

Development of a European Multi-Model Ensemble System for Seasonal to Interannual Prediction

Motivation:

-based on the results of PROVOST a multi-model ensemble system should be established

Outcome:

-multi-model ensembles give enhanced reliability and skill compared to a conventional single-model ensemble

the DEMETER-System produces useful output for probabilistic prediction of crop yield or malaria incidence

ENSEMBLES

Motivation and Goals:

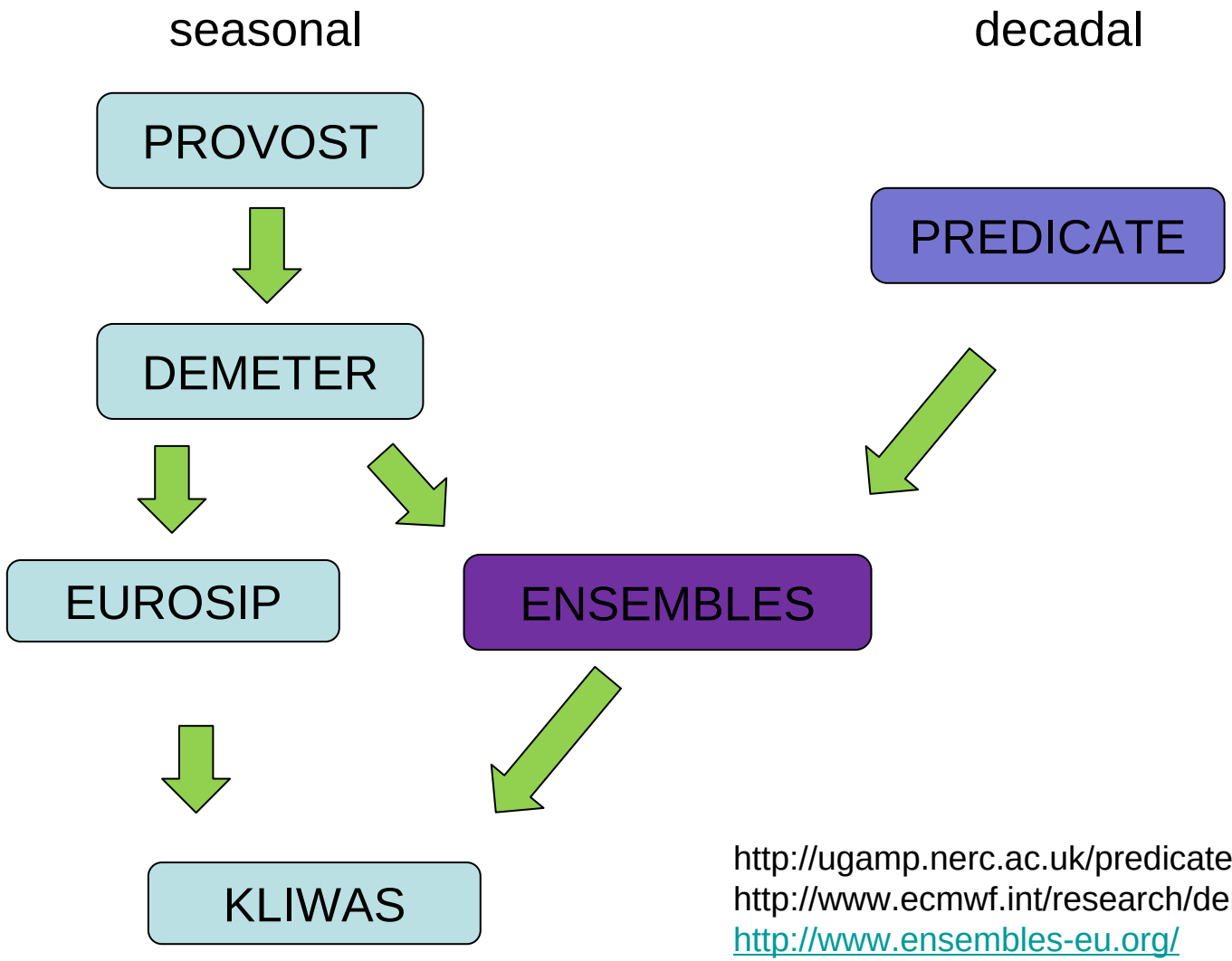
-development of a **multi-model system for climate change**

-getting an objective probabilistic estimate of uncertainty at s2d and longer timescales

-quantify and reduce the uncertainty in Earth System feedbacks

-linking the outputs of ensemble predictions to applications

some projects on s2d prediction



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