

Multi-model seasonal forecasting

F. J. Doblas-Reyes

R. Hagedorn

T. Palmer

ECMWF



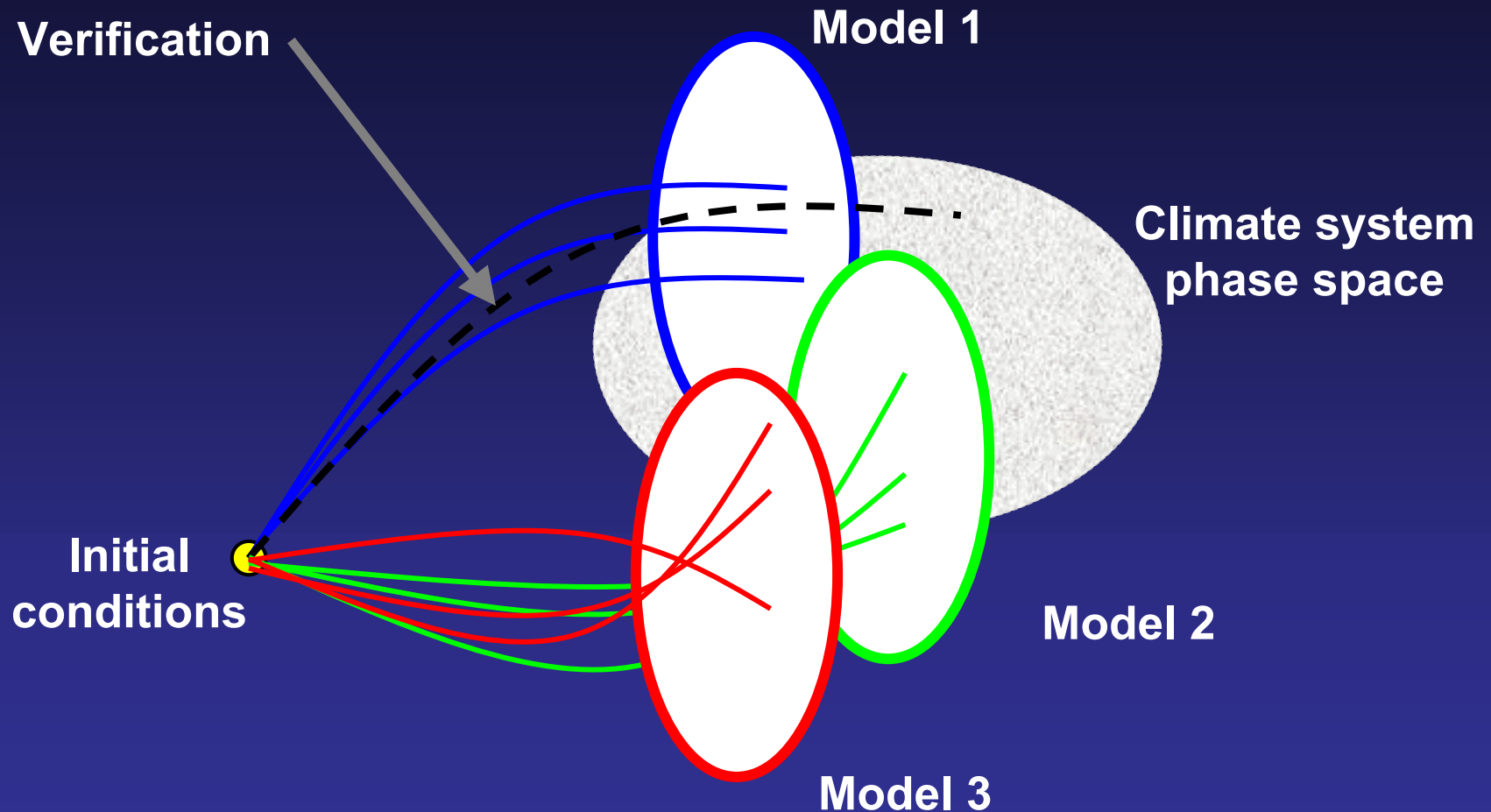
Outline

- Introduction
- Multi-model forecasting basics
- Multi-model hindcasts
- Skill of the multi-model
- Model combination
- Summary

Ensemble forecasting: the multi-model perspective

- Ensemble forecasting runs the same model several times with slightly different initial and/or boundary conditions
- Multi-model forecasting runs different models, with the same initial and/or boundary conditions
- Ensembles may also be used with different models (super-ensemble)
- The multi-model approach looks for consensus forecasts. Blending is based in past model performance. Main problem: robustness of the weighting coefficients
- Consensus performs better if the individual models 1) have some skill and 2) are independent

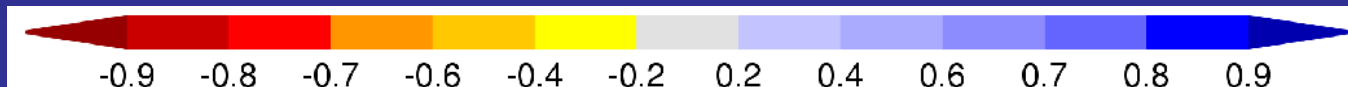
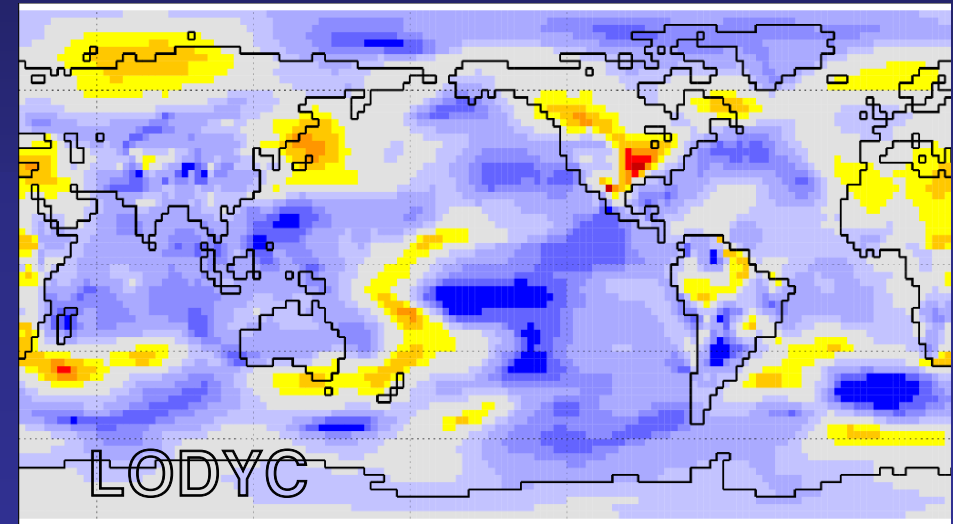
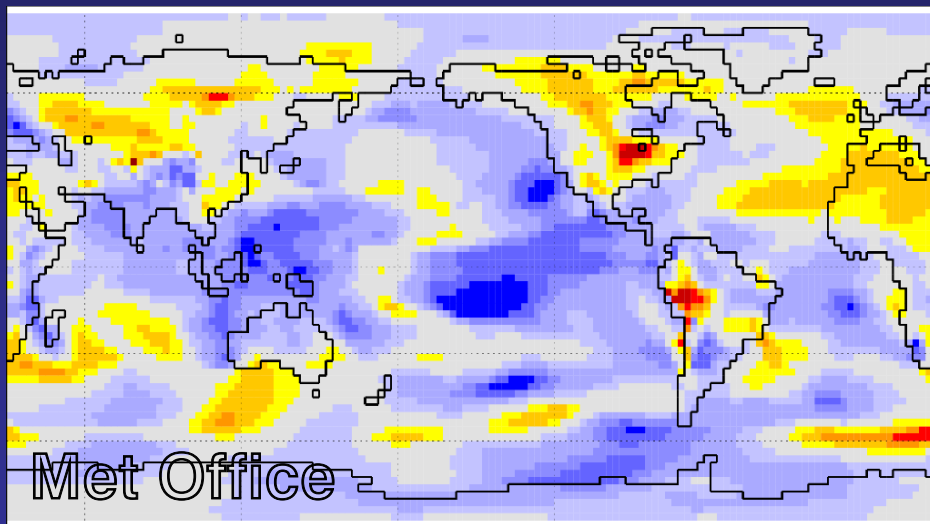
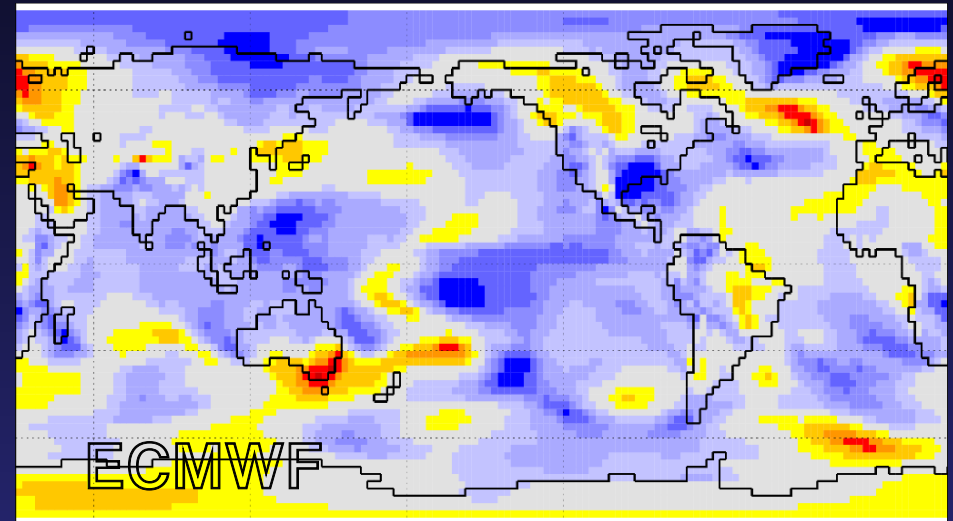
Multi-model: forecasting an event



Model independence

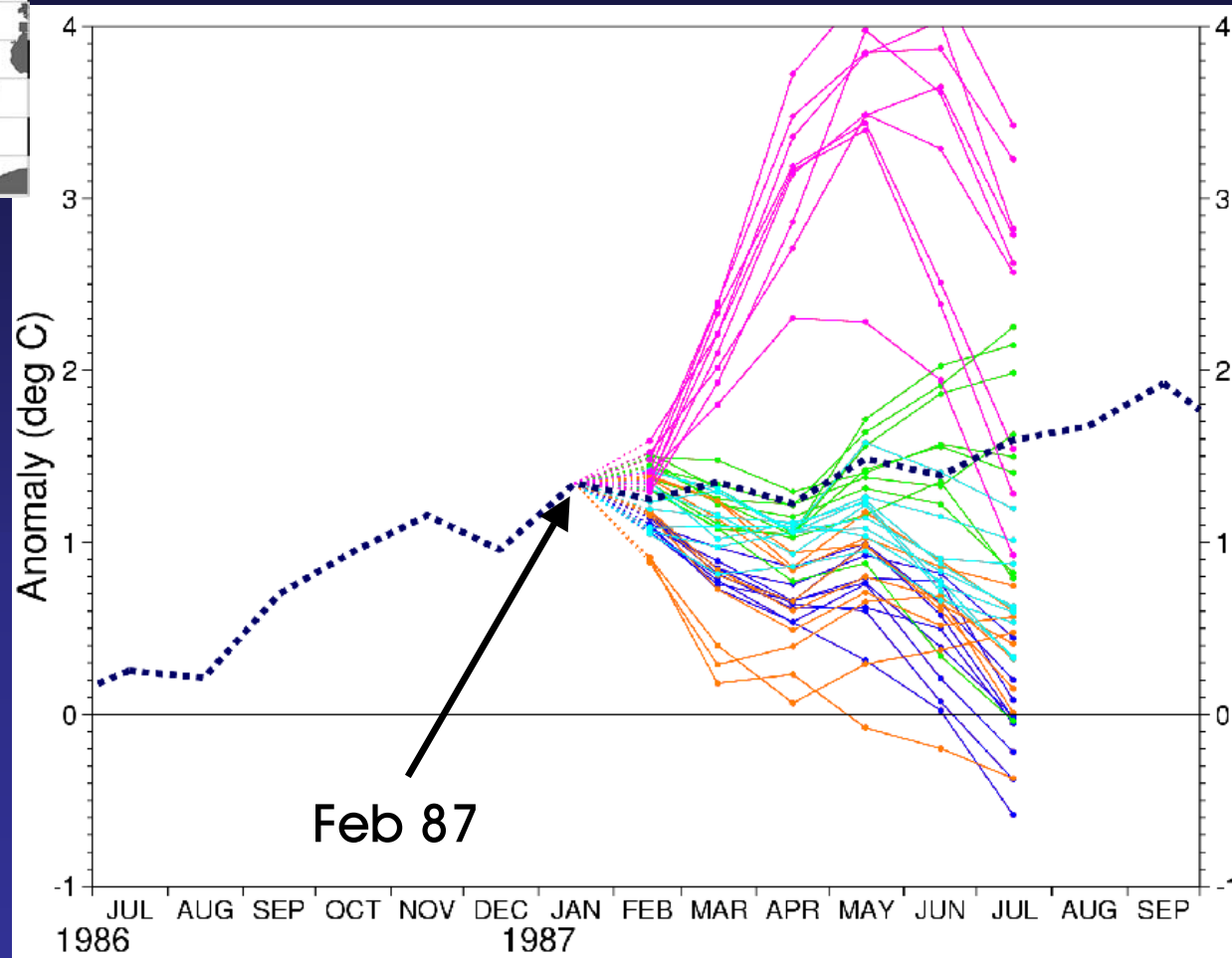
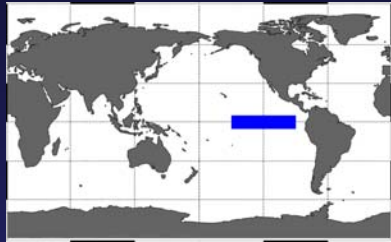
These models have:

- skill
 - independence
- ACC, MSLP,
Nov starts



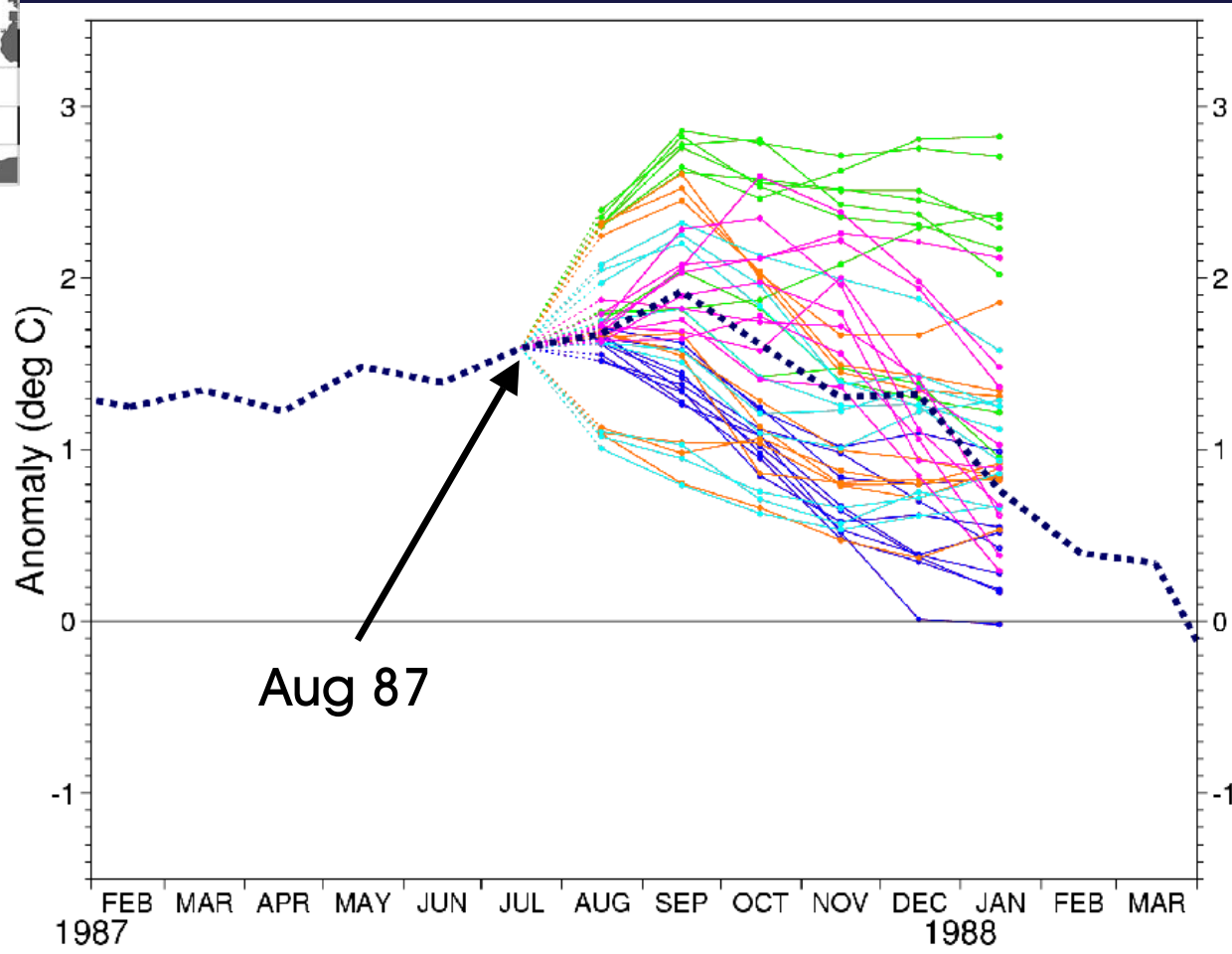
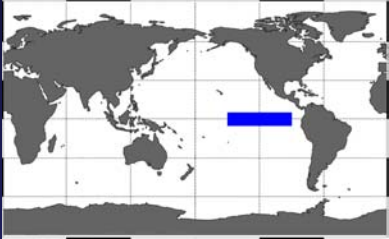
Multi-model SST hindcasts (1)

Niño3 SST for ECMWF, MetFr, MetOf, LODYC, and MPI



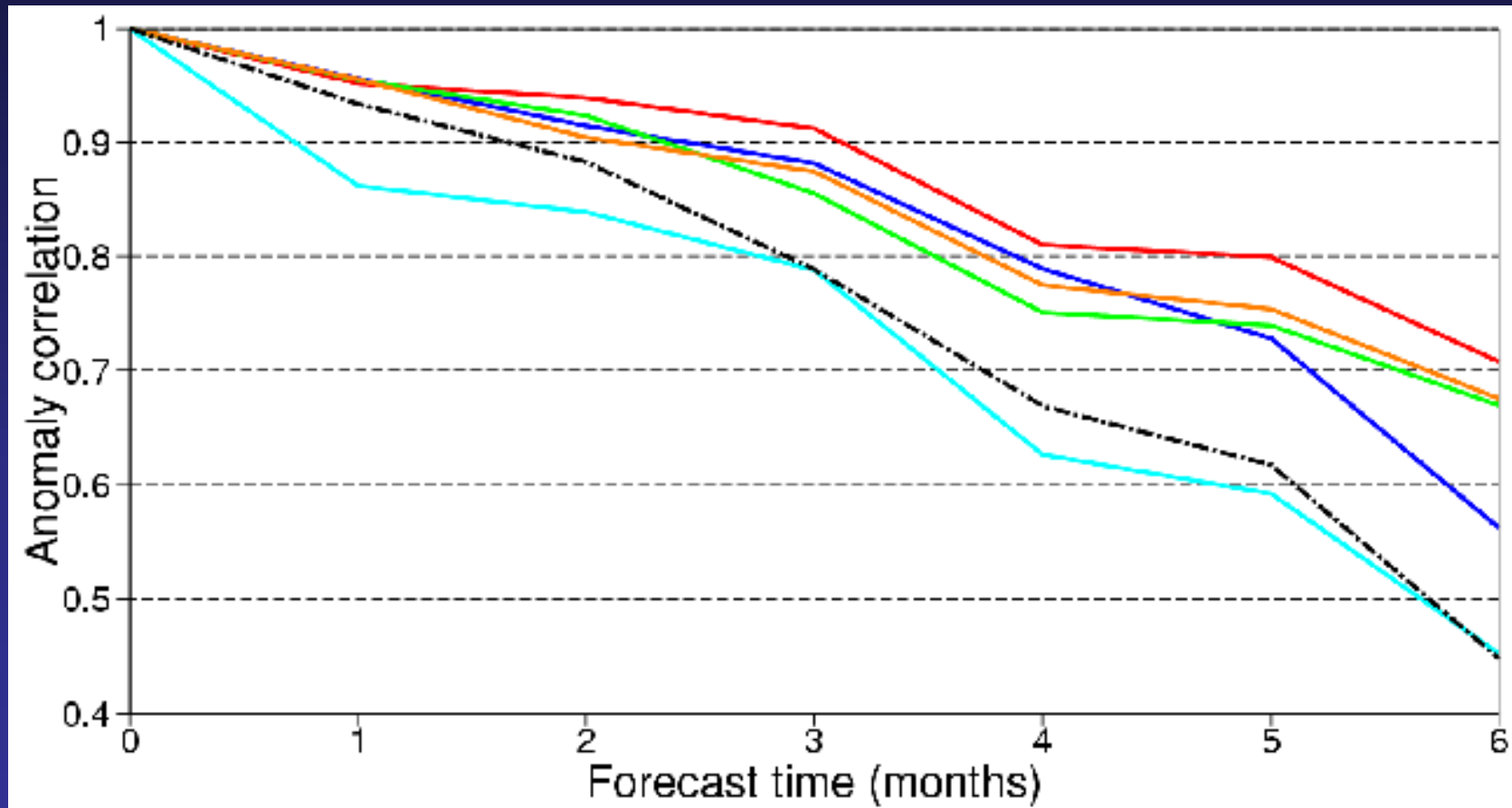
Multi-model SST hindcasts (2)

Niño3 SST for ECMWF, MetFr, MetOf, LODYC, and MPI



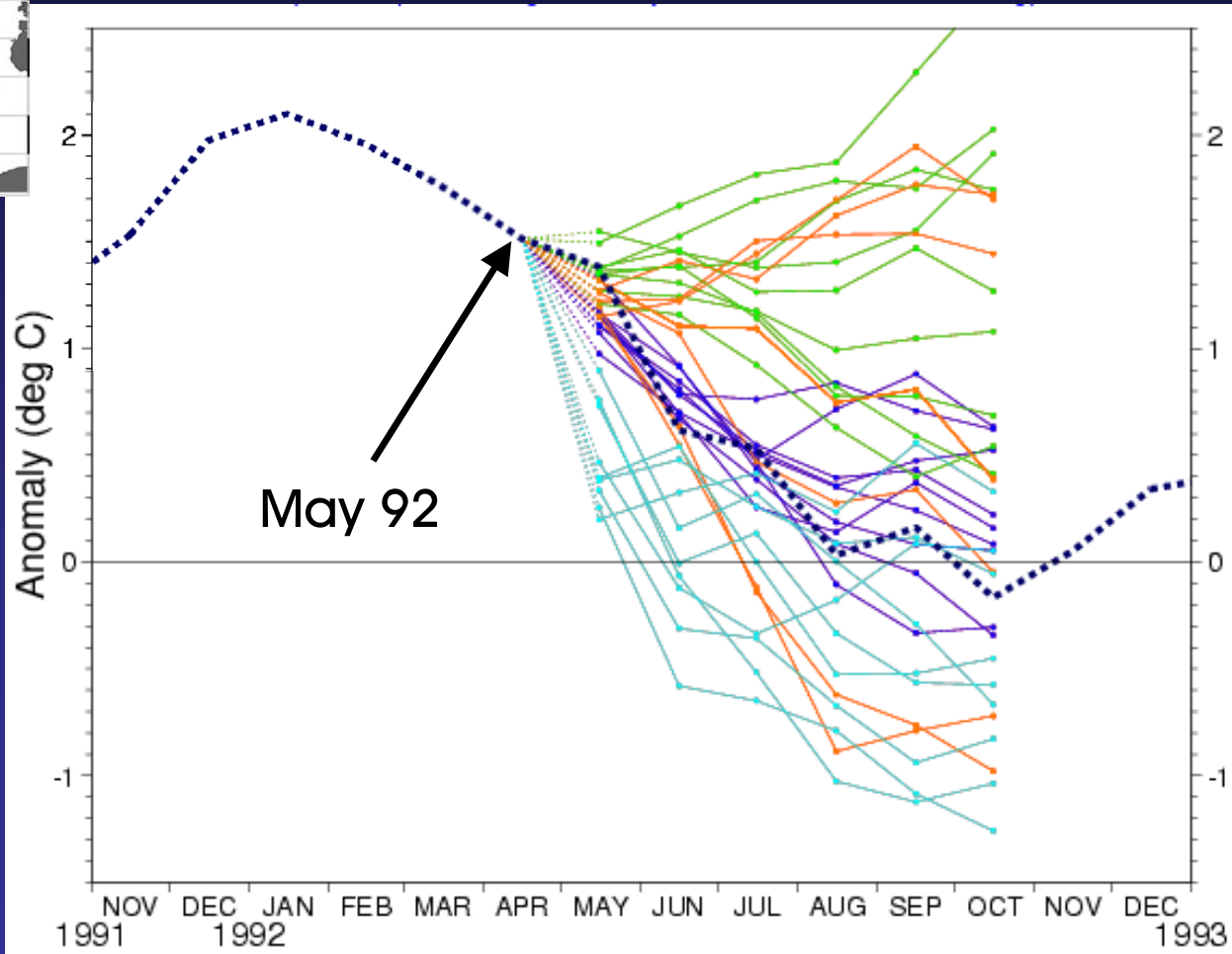
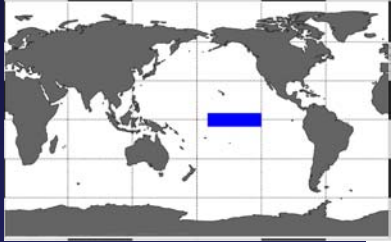
Multi-model DEMETER hindcasts (3)

ACC for Niño3 SST for **Super-ensemble**, **ECMWF**, **MetFr**, **MetOf**, and **LODYC**



Multi-model hindcasts: An example (1)

Niño3.4 SST for ECMWF, MetFr, MetOf, and LODYC



Multi-model hindcasts: An example (2)

Niño3.4 SST for **ECMWF**, **MetFr**, **MetOf**, and **LODYC** (left), and **ECMWF 36-member ensemble** (right)

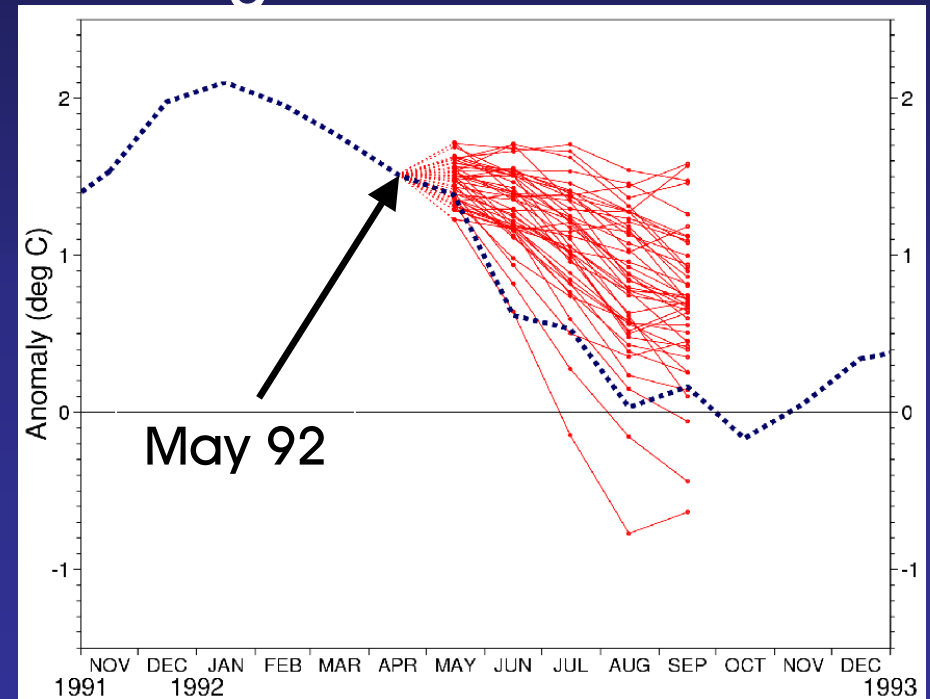
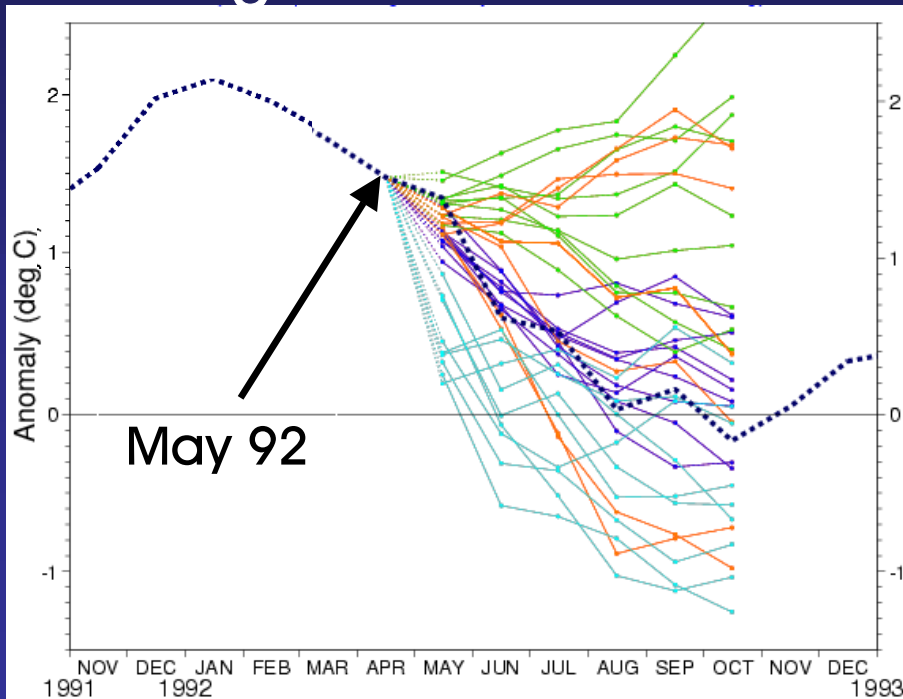
Scores for ensemble mean – JJA

Super-ensemble

Absolute Error 1992: 0.25 K
Average 1991-1995: 0.20 K

36-member ensemble

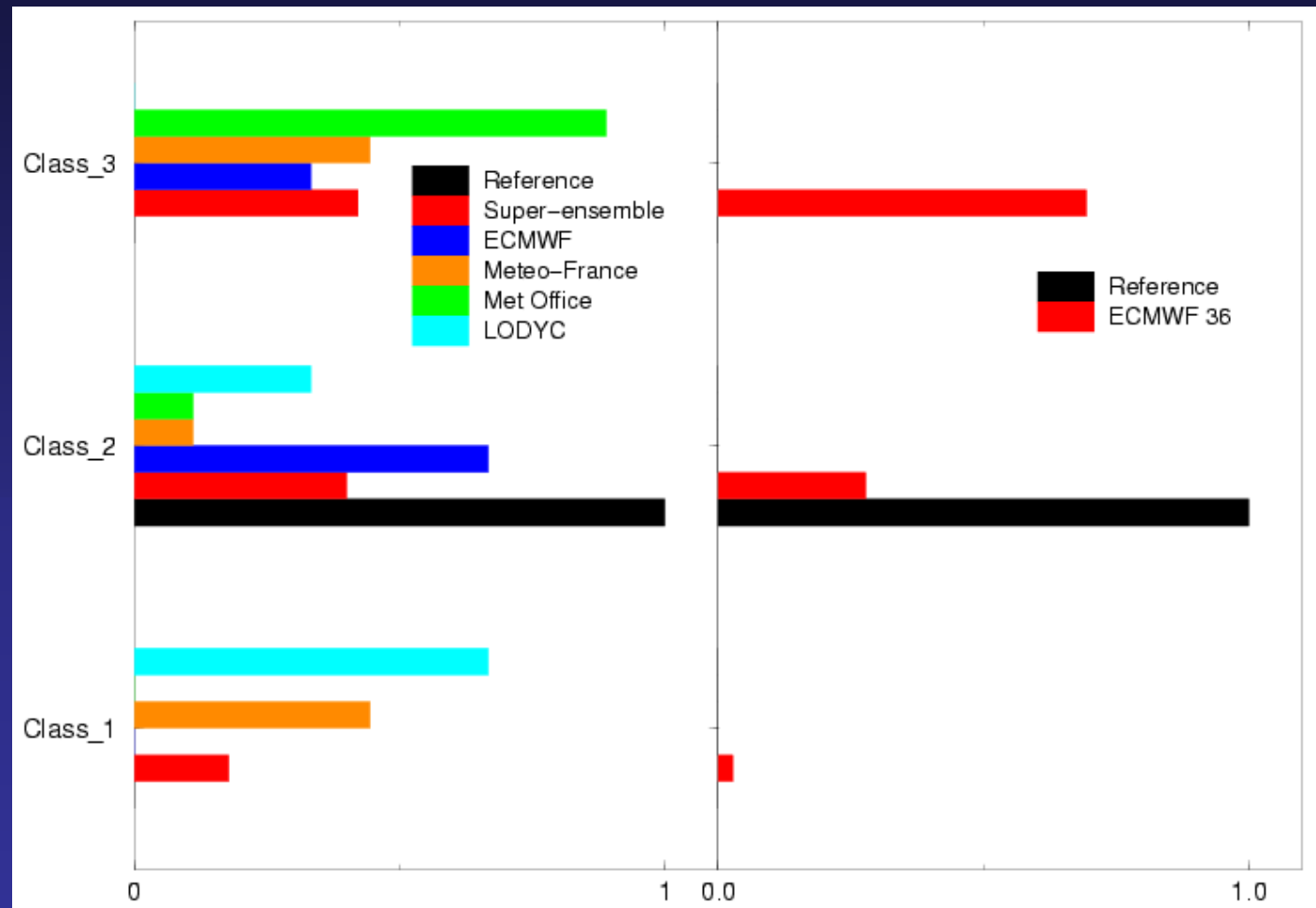
Absolute Error 1992: 0.40 K
Average 1991-1995: 0.27 K



Multi-model hindcasts: An example (3)

Niño3.4 SST for Super-ensemble, ECMWF, MetFr, MetOf, LODYC (Left) and ECMWF 36-member ensemble (Right)

Probabilities for
the terciles of
the JJA
hindcasts
started in May
1992



Multi-model hindcasts: An example (4)

Niño3.4 SST for **ECMWF**, **MetFr**, **MetOf**, and **LODYC** (left), and **ECMWF 36-member ensemble** (right)

Probabilistic scores – JJA

Super-ensemble

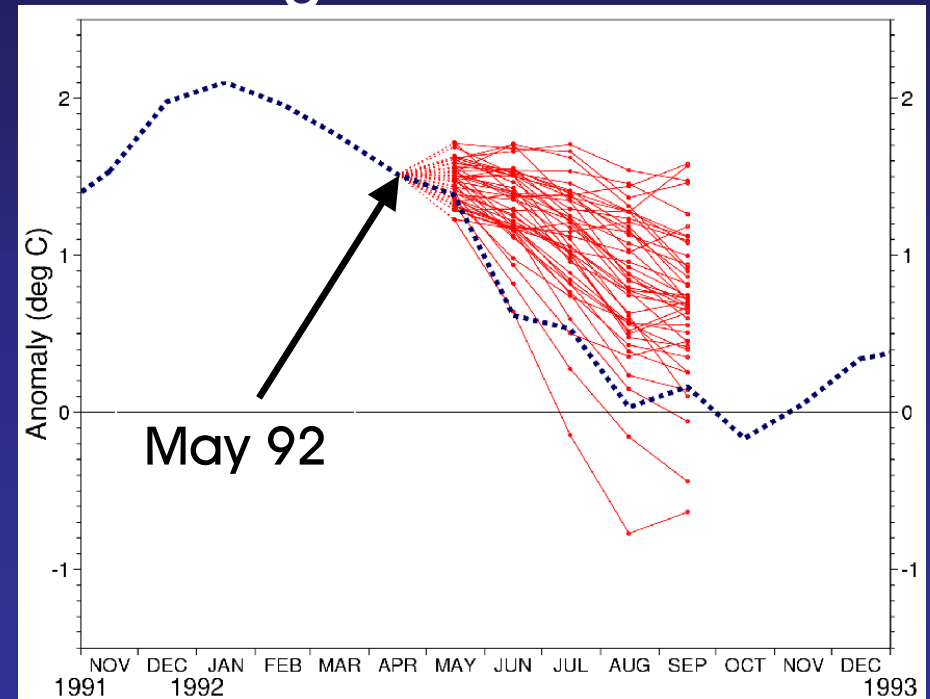
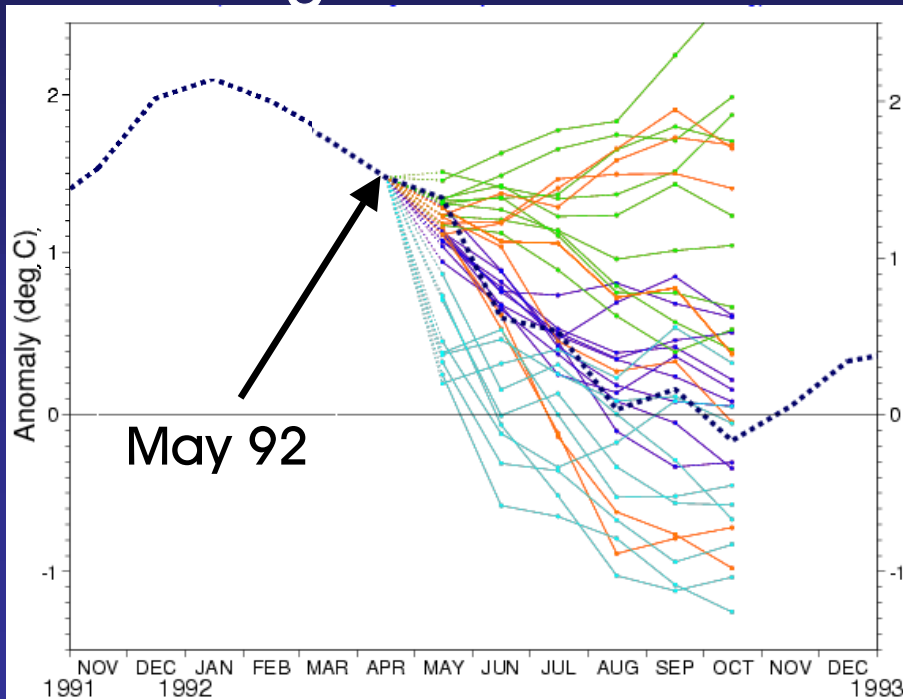
RPSS 1992: 5

Average 1987-1994: 67

36-member ensemble

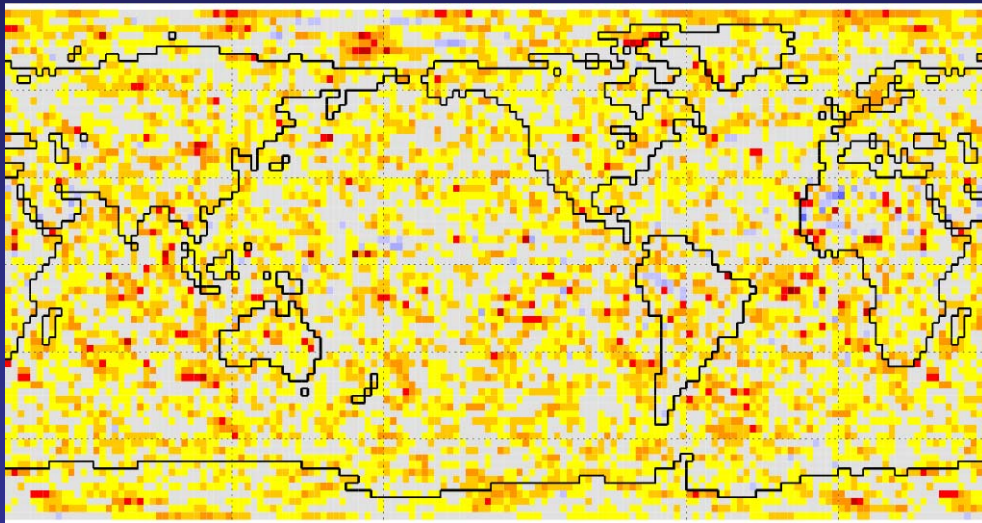
RPSS 1992: -117

Average 1991-1996: 32

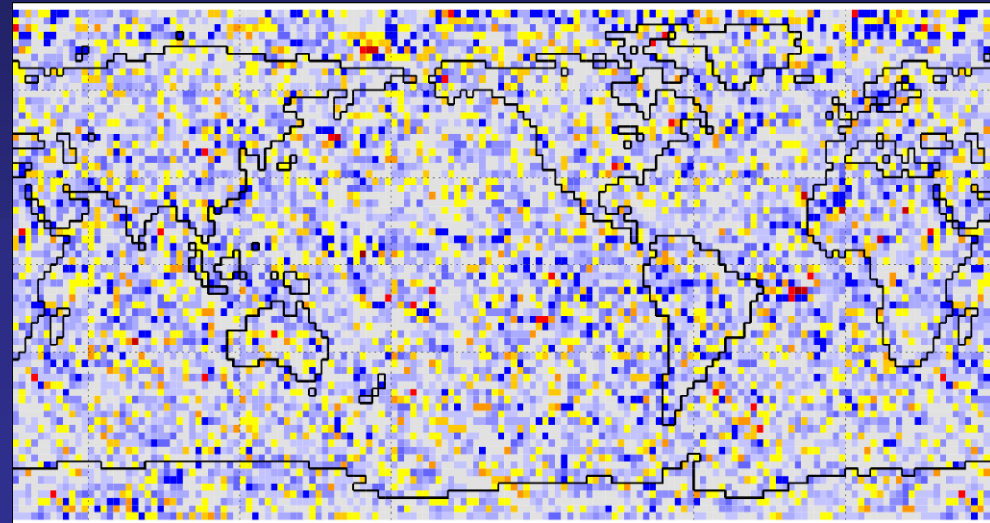


Multi-model skill (1)

Difference between the super-ensemble and the most skilful individual model in terms of RPSS for precipitation (average 2-4 DJF)



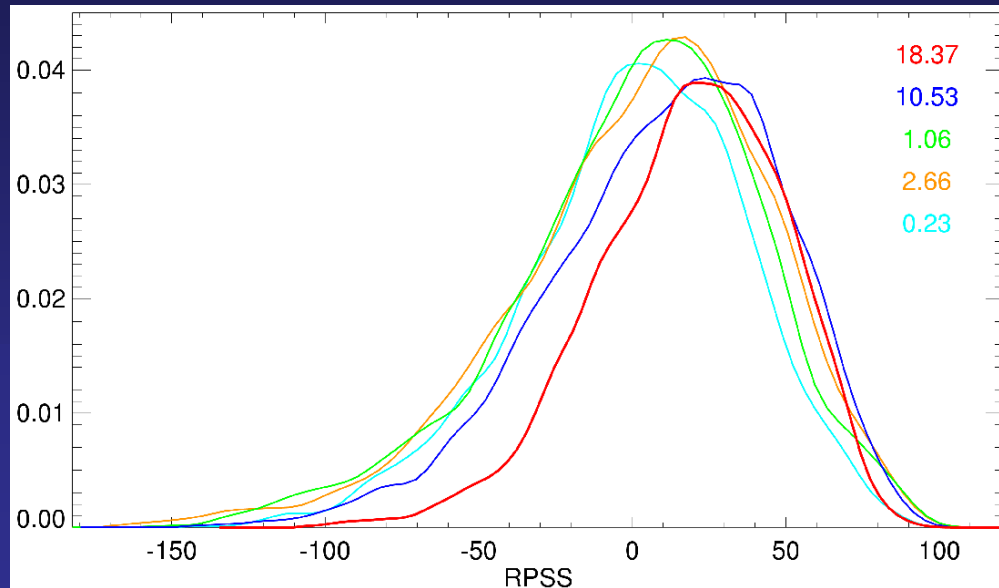
Difference between the super-ensemble and an individual model chosen at random in terms of RPSS for precipitation (average 2-4 DJF)



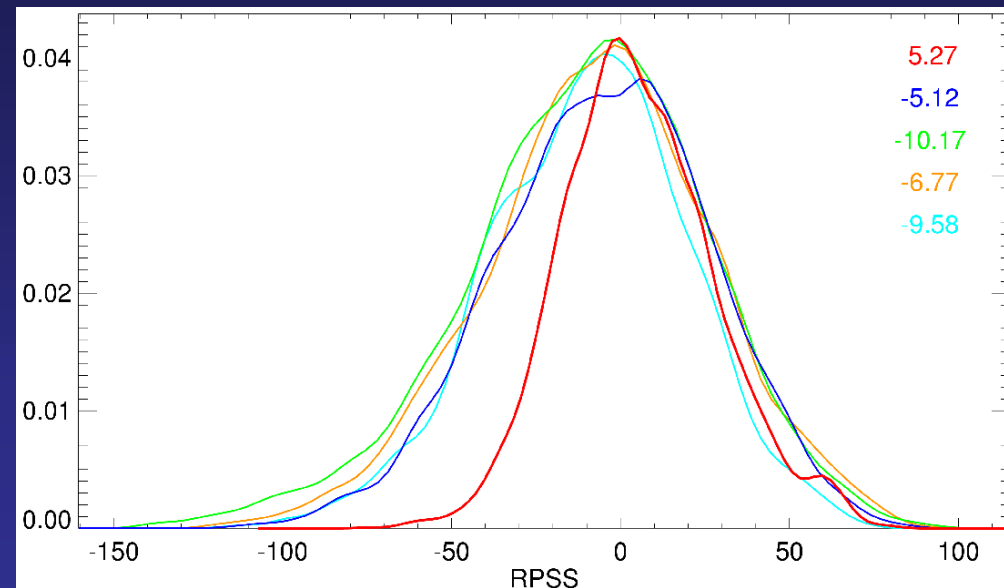
Multi-model skill (2)

RPSS (Tropics, JJA) for **Super-ensemble**, **ECMWF**, **MetFr**, **MetOf**, and **LODYC**

SST



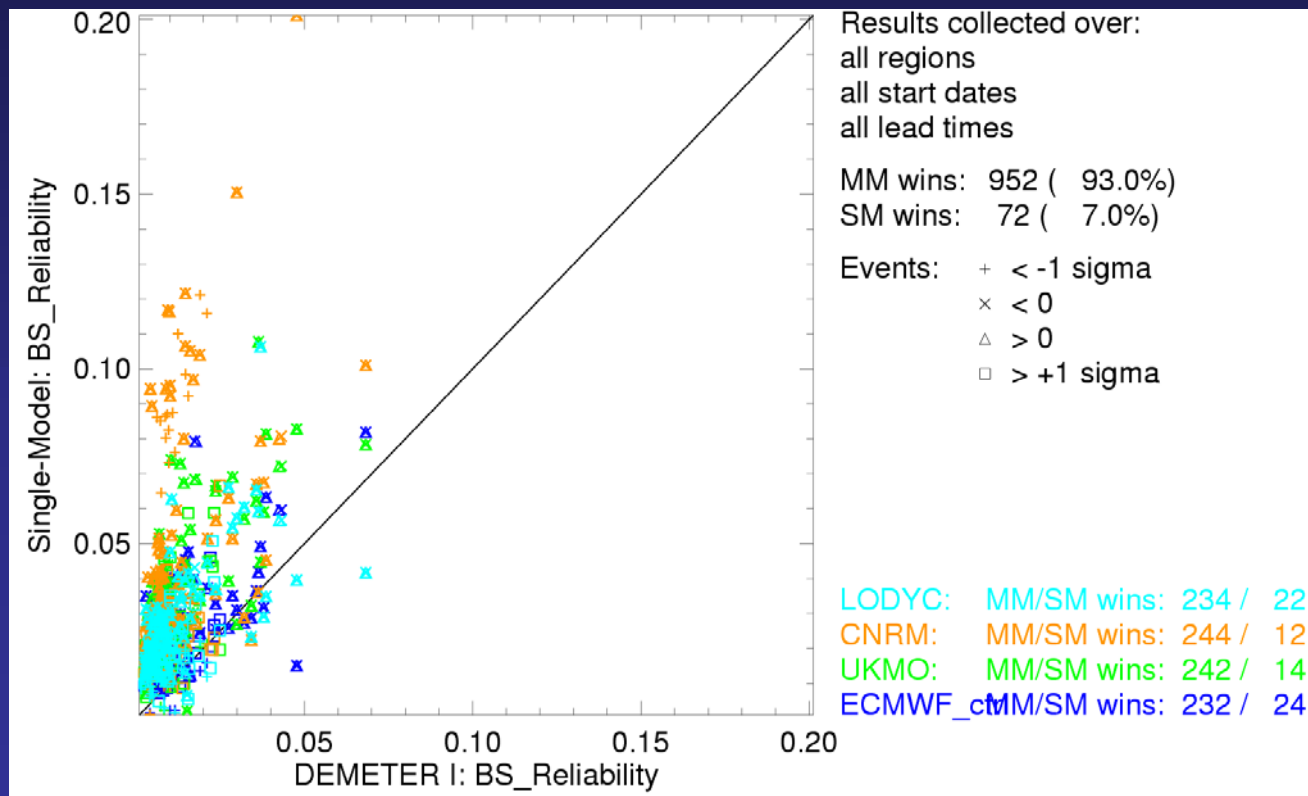
Precipitation



Multi-model skill (3)

Reliability for precipitation

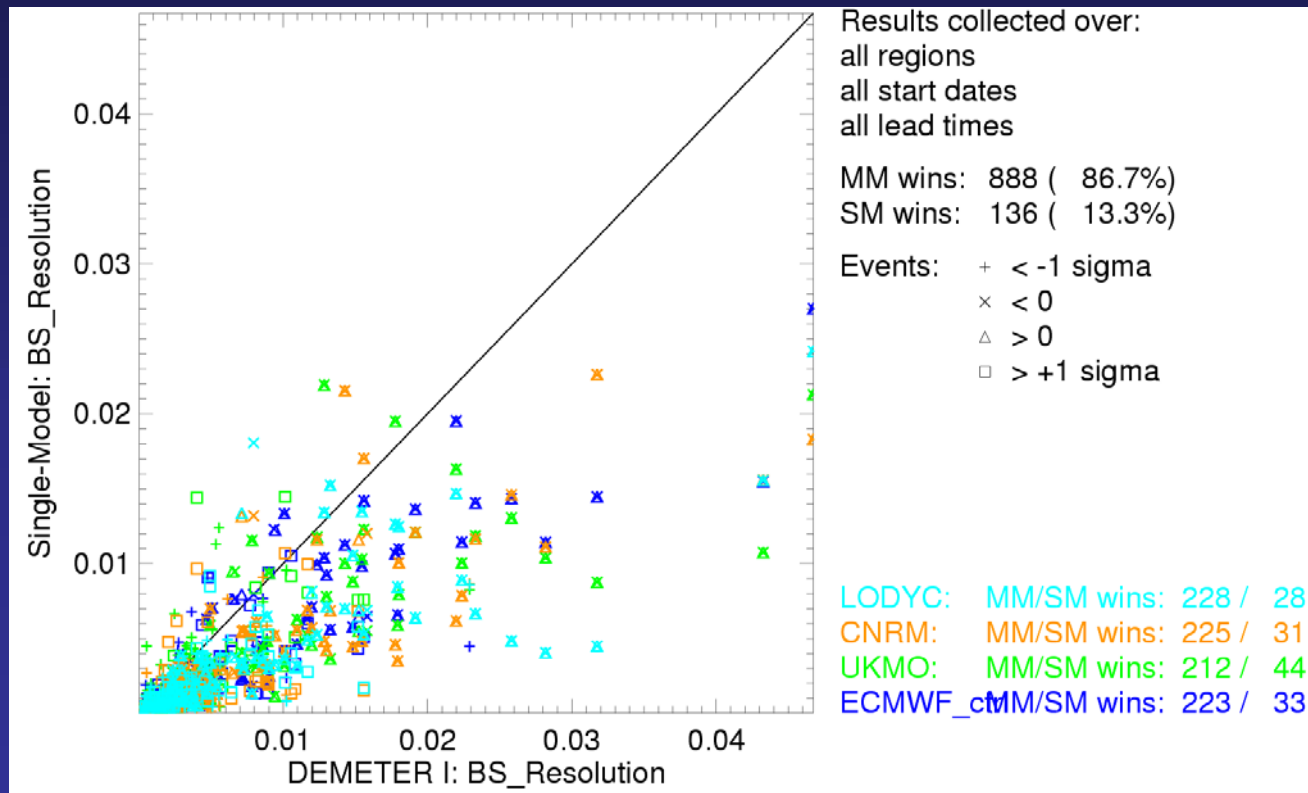
$$BSREL = \int_0^1 [p - o(p)]^2 g(p) dp$$



Multi-model skill (4)

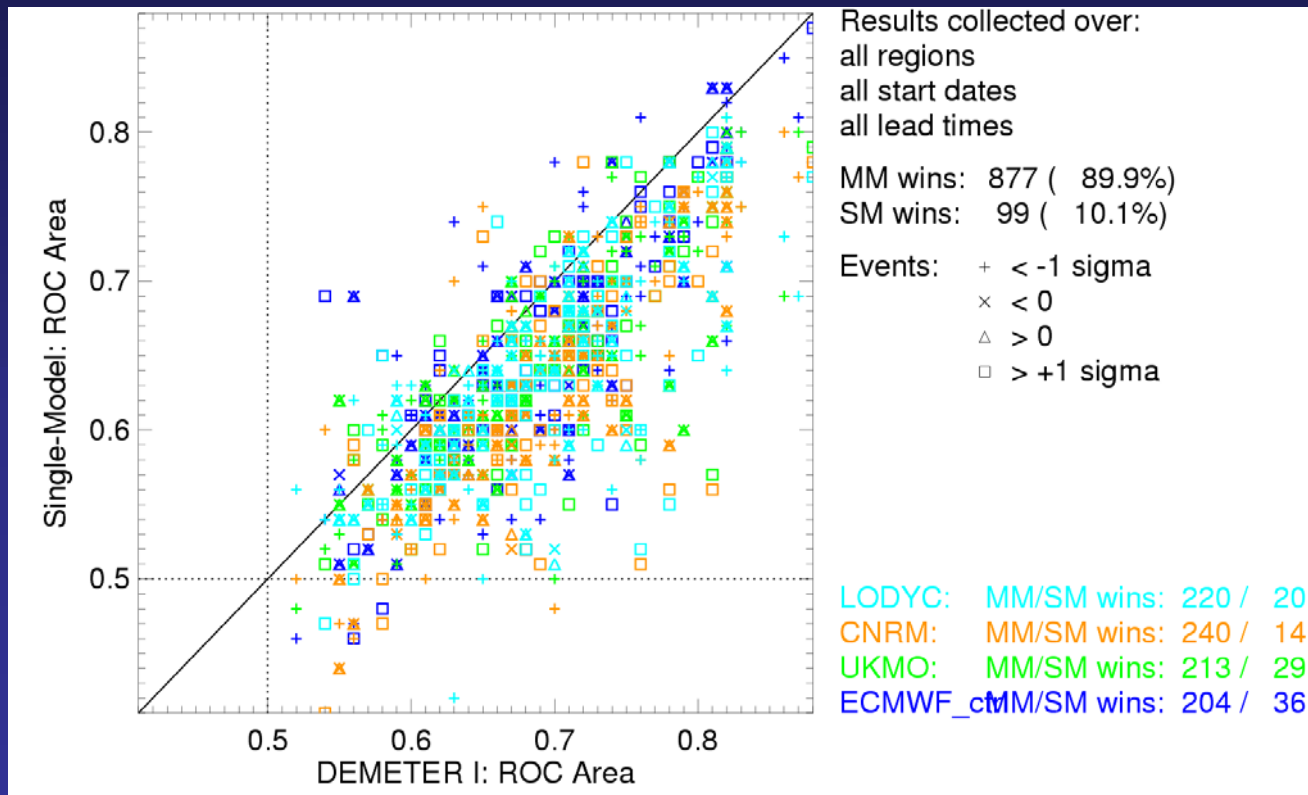
Resolution for precipitation

$$BSRSL = \int_0^1 [\bar{o} - o(p)]^2 g(p) dp$$



Multi-model skill (5)

ROC area for SST

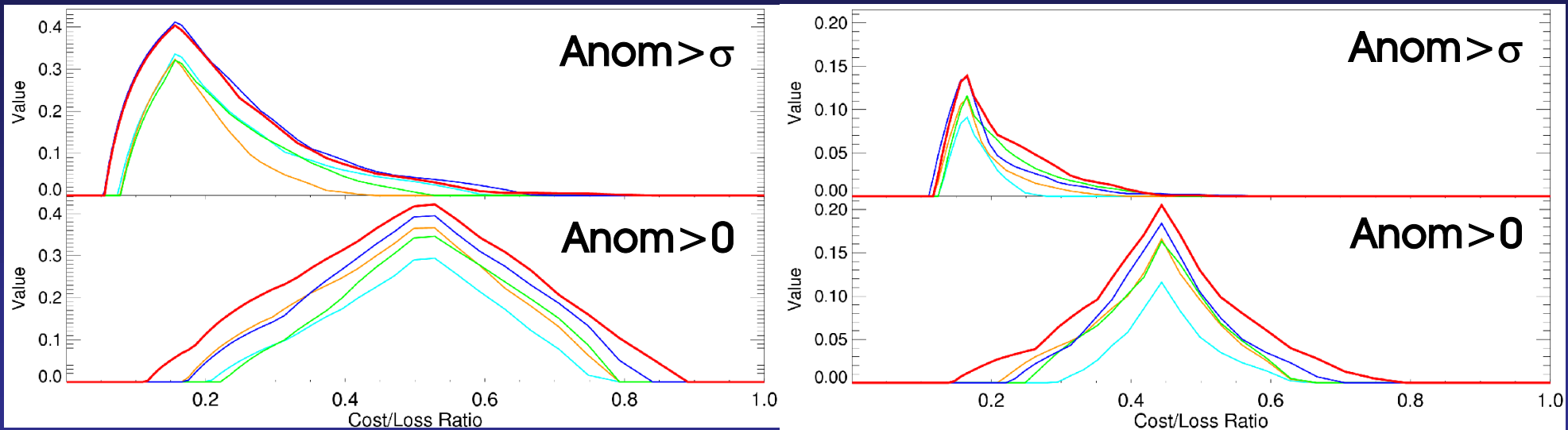


Multi-model skill (6)

Relative value (Tropics, JJA) for **Multimodel**, **ECMWF**, **MetFr**, **MetOf**, and **LODYC**

SST

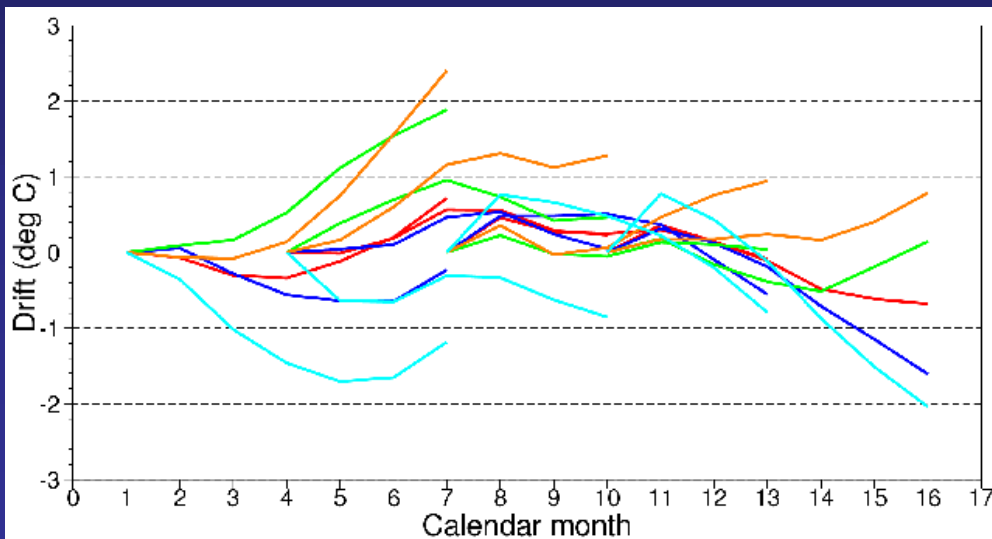
Precipitation



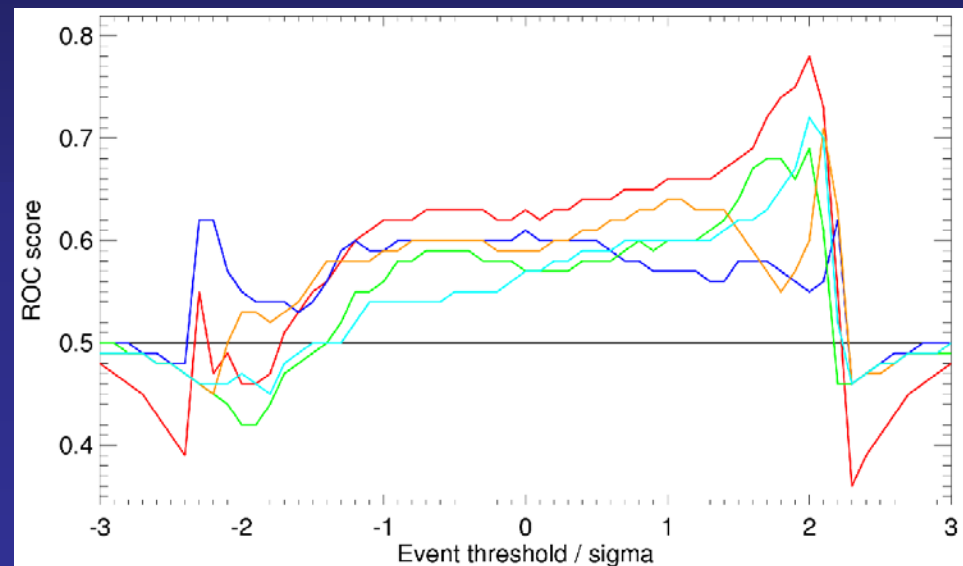
Problems to address

Some drawbacks have to be taken into account when building a multi-model system

Drift of the SSTs over the Nino3 area (four seasons)



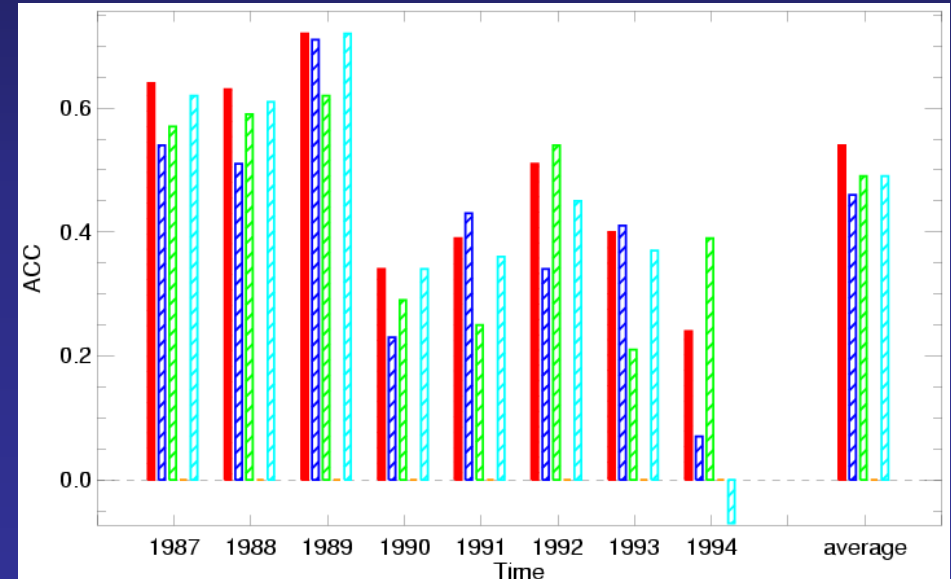
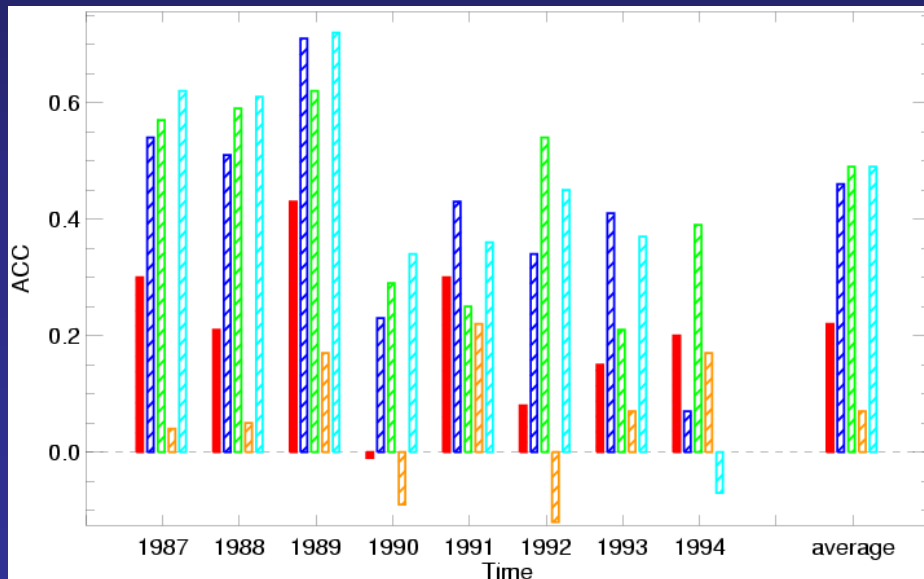
ROC area against event threshold for 500 hPa geopotential height over the Northern Hemisphere (DJF)



Model combinations

ACC of MSLP (Tropics, MAM) for **Multimodel**, **ECMWF**, **MetFr**, **MetOf**, and **LODYC**

MetFr Weight	1.00	0.75	0.50	0.25	0.00
Multi-model ACC	0.22	0.27	0.34	0.45	0.54



Summary

- The multi-model approach seeks to integrate the uncertainty due to the model formulation
- The super-ensemble presents improvements in skill over the individual models, mainly over the tropics (where skill is already high)
- Multi-model skill does not come only from the increase in ensemble size
- Results correspond to raw model merging. Model combination and ensemble calibration will provide some additional skill improvement