# EXTENDED RANGE FORECASTING AT ECMWF

DAVID ANDERSON

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# New strategy for 2006-2015

GOALS:

- The principal goal of ECMWF in the coming ten years will be to maintain the current, rapid rate of improvement of its global, medium-range weather forecasting products, with particular effort on early warnings of severe weather events.

- Complementary goals are:
  - To improve the quality and scope of monthly and seasonal-to-interannual forecasts
  - To enhance support to Member States ..
  - To deliver real-time analyses and forecasts of atmospheric composition
  - To carry out climate monitoring through regular re-analyses of the Earth-system
  - To contribute towards the optimization of the Global Observing System

# Forecasts made currently

- A high resolution (T511L60) out to 10 days, twice per day
- A 51 member ensemble (T255L40) out to 10 days, twice per day.
- A 51 member (T159, L40) ensemble out to 32 days, once per week
- A 41 member ensemble (T95, L40) ensemble out to 200 days, once per month.

# These resolutions and ranges will change in the next few months-

- Deterministic forecast will be extended to 15 days at T799L90
- The EPS will be extended to 15 days at T399L62 to day 8, dropping to T255L62.
- The monthly will be increased to T255L62.
- The seasonal will be increased to T159,L62
- Some forecasts will be extended to 13 months.
- Multi-annual forecasts will be explored (ENACT, ENSEMBLES).

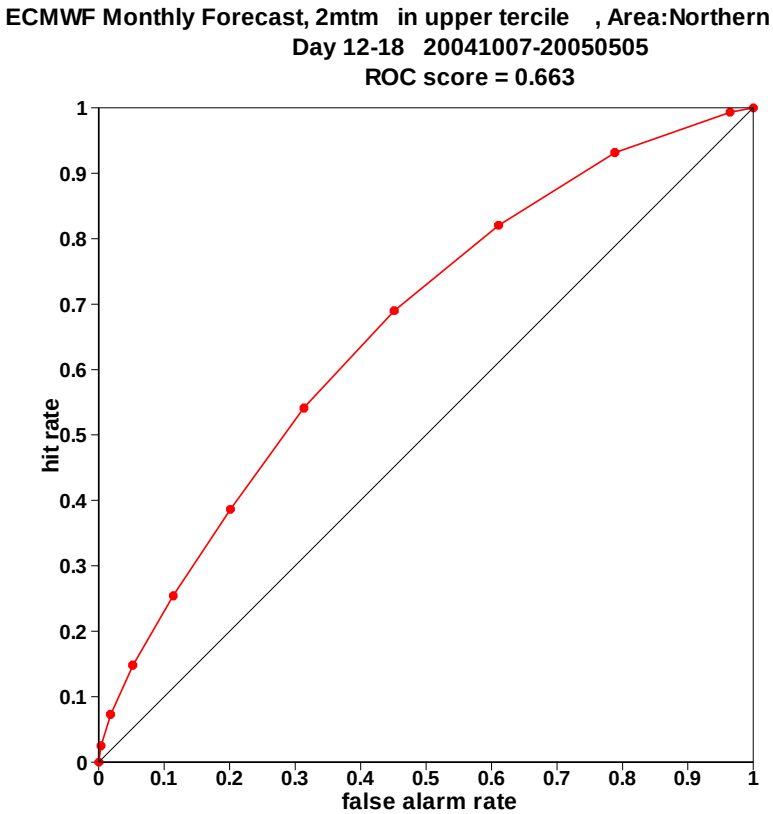
# Monthly forecasts

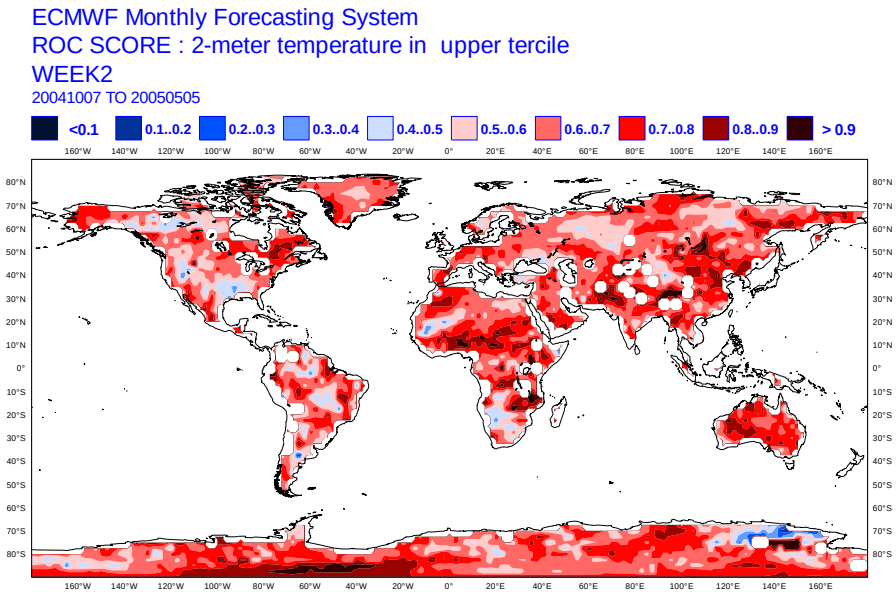
Monthly forecasts plots are courtesy of Frederic Vitart

Contact: F.Vitart@ecmwf.int

# ROC scores- day 12-18

## Probability that 2-meter temperature is in upper tercile



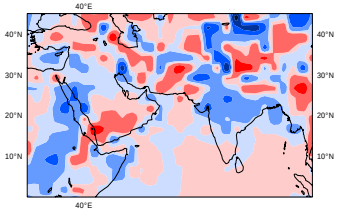




On average there is skill at the extended range (red). How useful depends on the application.

# Indian monsoon

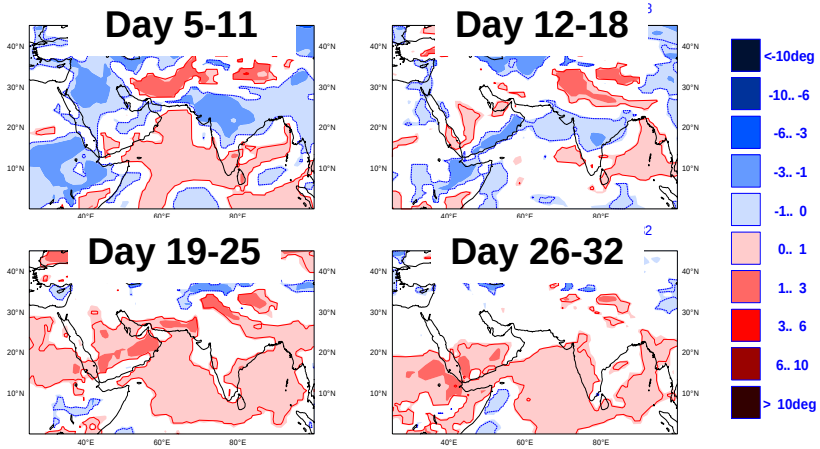
## 2-meter temperature anomaly

### Analysis



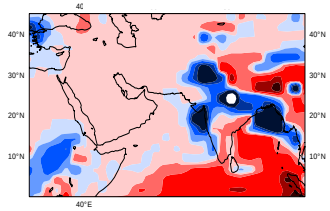
Analysis and ECMWF Monthly Forecasting System
2-meter Temperature anomaly
Verification period: 27-06-2005/TO/03-07-2005

ensemble size = 51 ,climate size = 60
Shaded areas above 90% significance
Solid contour at 95% significance




## Precipitation anomaly

### Analysis



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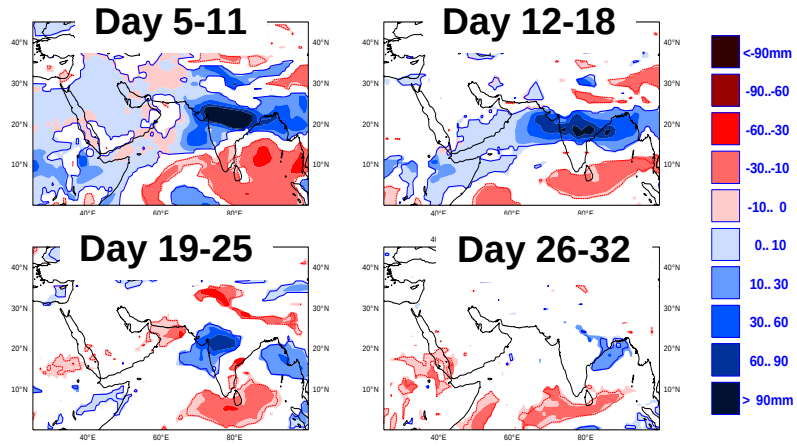
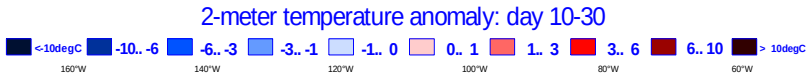
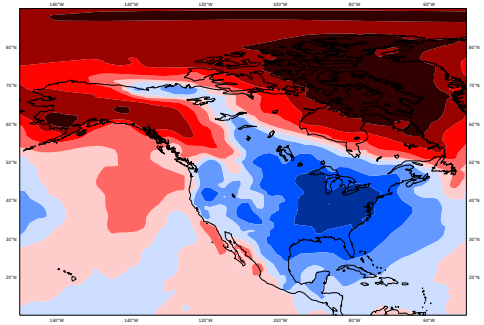


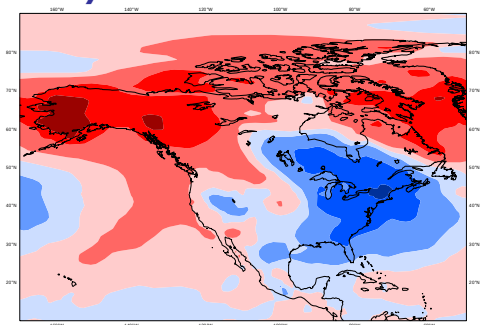
# Special Topic: North America
# Revisiting the January 1977 case (Miyakoda et al 1983)



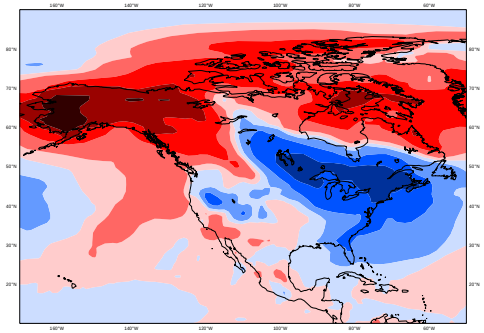

## a) ERA40



## b) Ensemble mean



## c) Control forecast



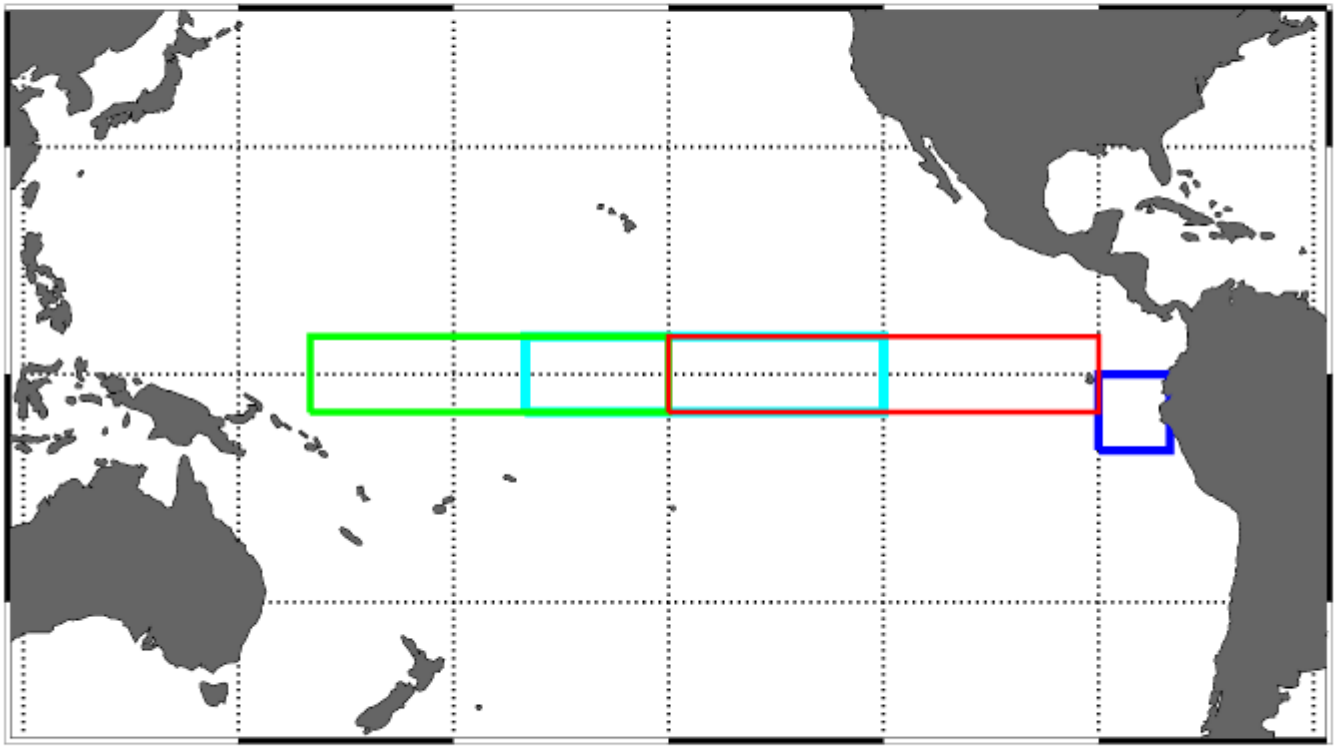
# Seasonal forecasting: preparations for System 3

- **41-member ensemble forecast to 6 months**
  - SST perturbations added to each member
  - Atmos. perturbations from singular vector computations
  - Ensemble of perturbed ocean analyses
- 11-member ensemble forecast to 13 months. Designed to give an ‘outlook’ for ENSO
- Back integrations from 1981-2005
  - 11 member ensemble every month
  - Once per quarter, 5 members extended to 13 months

# Issues for system 3

- Snow depth initial conditions still need improvement
- The evolution of greenhouse gases is represented but not of aerosol. (The effect of neglecting volcanic aerosols is visible in our forecasts.)
- The atmospheric model still has winds biased-low in tropical regions. This is affecting the performance of System 3 in June.

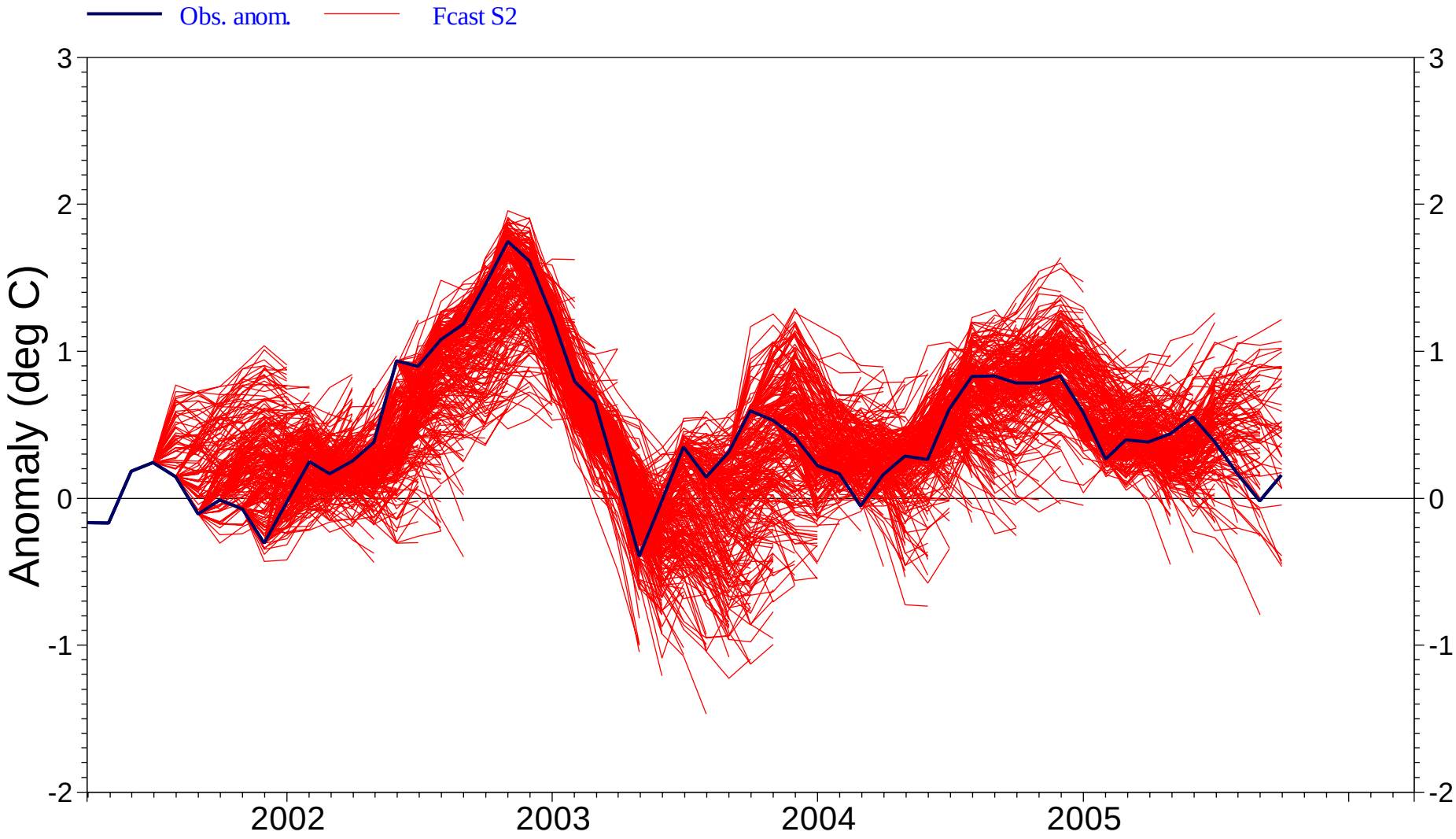
Nino3.4, Lon = [-170, -120], Lat = [ -5, 5]
Nino12, Lon = [ -90, -80], Lat = [-10, 0]
Nino4, Lon = [ 160, -150], Lat = [ -5, 5]
Nino3, Lon = [-150, -90], Lat = [ -5, 5]

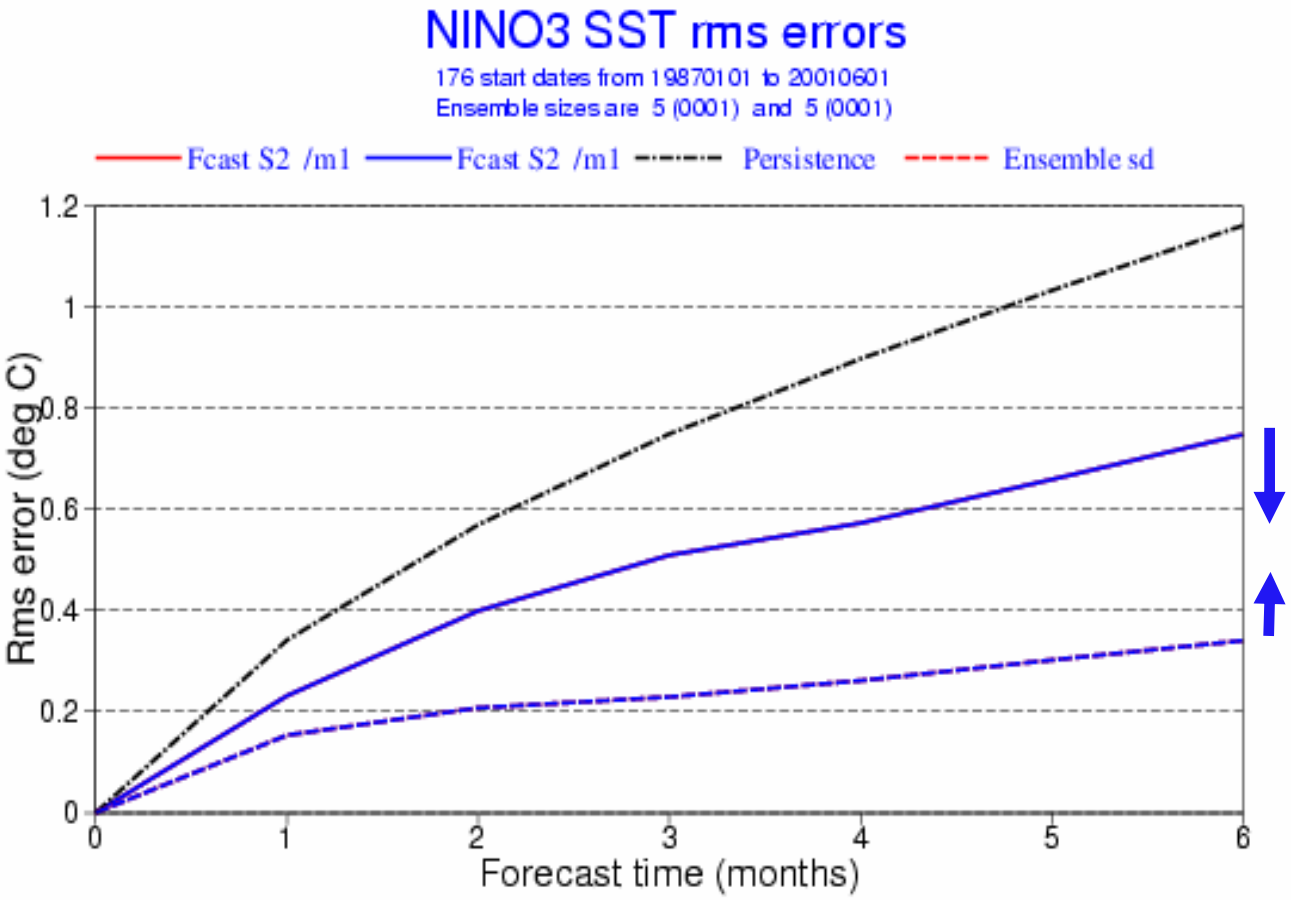


# NINO3.4 SST forecast anomalies

ECMWF forecasts at month 6

Ensemble size is 40  SST obs: NCEP OIv2






**Forecast System is not reliable:**

**RMS > Spread**

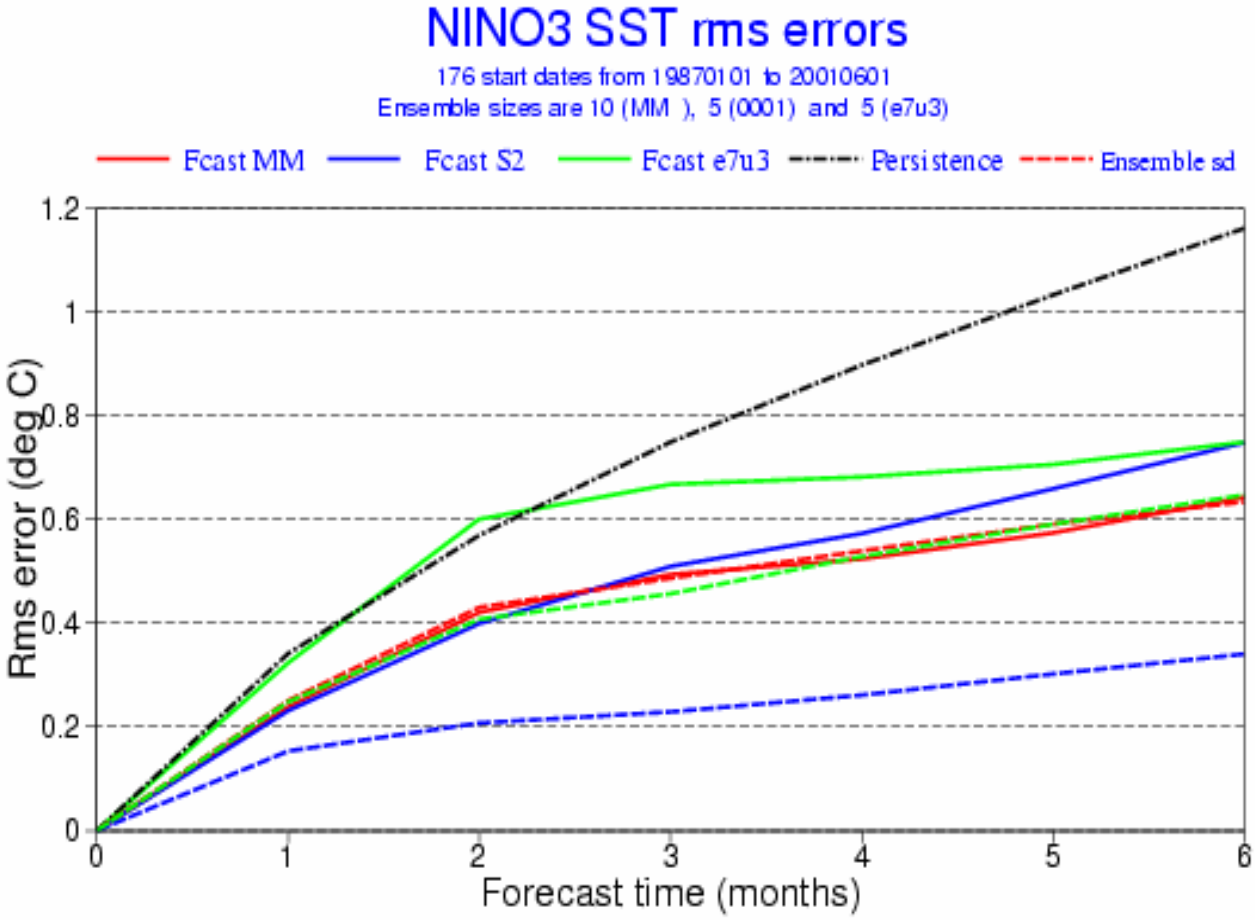
**A) Can we reduce the error? How much?**

**(Predictability limit)**

***B)*Or can we only increase the spread?**

**A) Improve the ensemble generation: Need to sample model error**

**B) Improve calibration: A posteriori use of all available information**




**ECMWF**

**UKMO**

**Multi-Model**

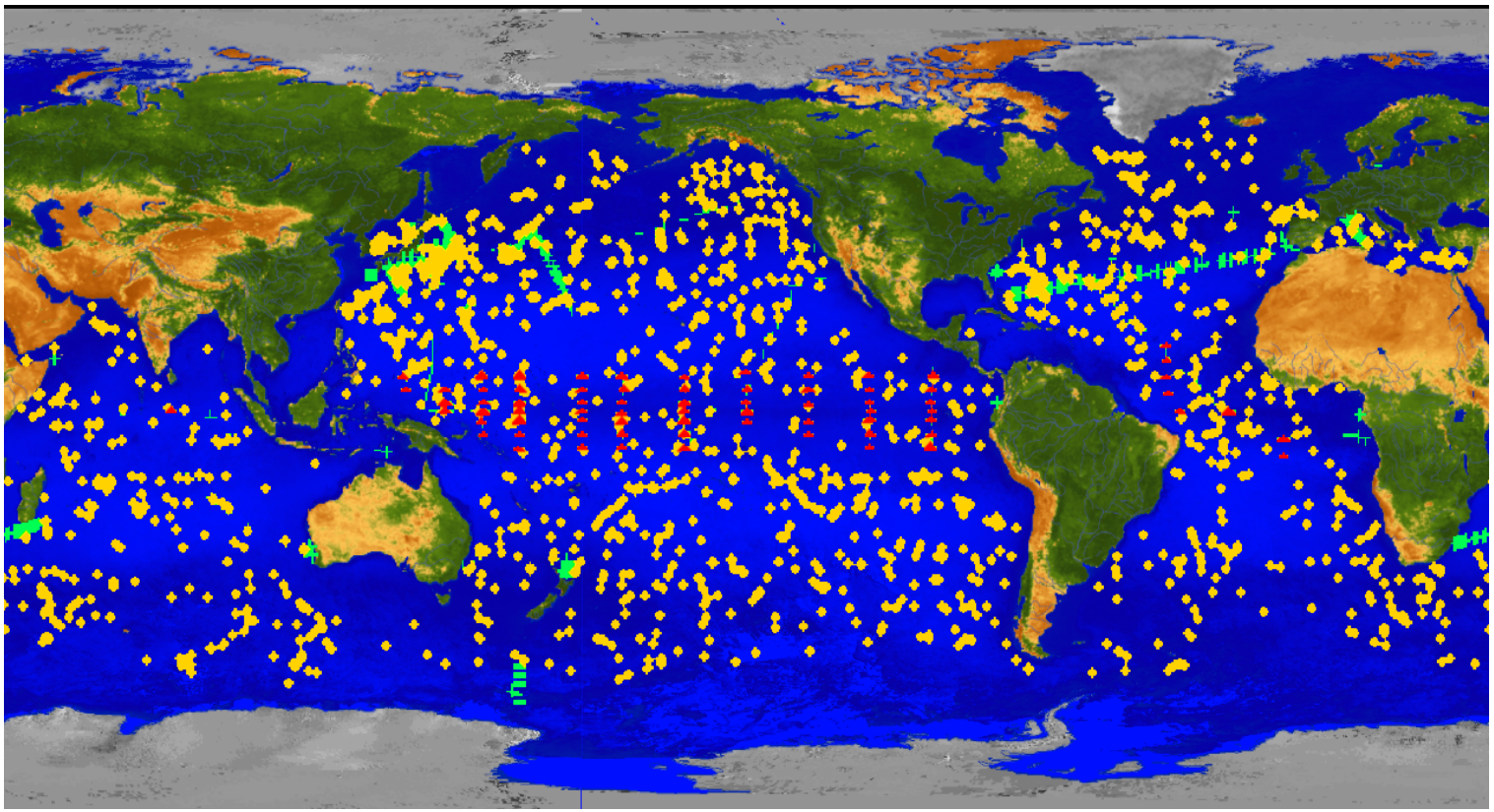
**Multi-model:**

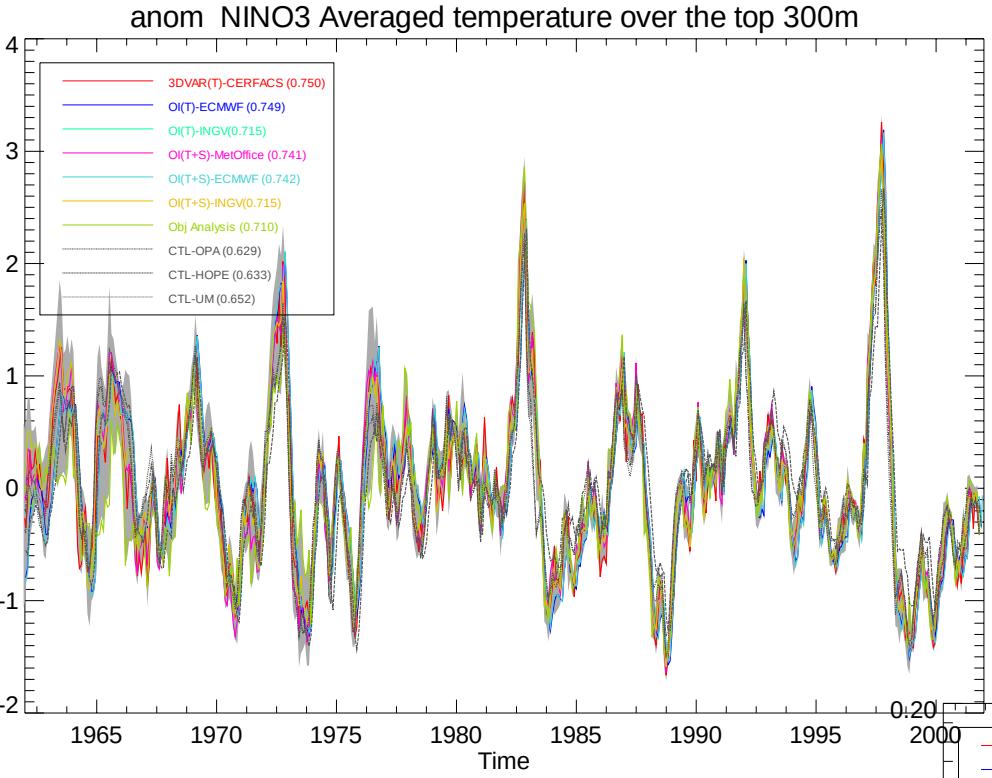
**RMS=SPREAD !!**

**and RMS is reduced**

# Build up of ARGO: Data coverage for February 2005

- XBT, MOORINGS, ARGO floats

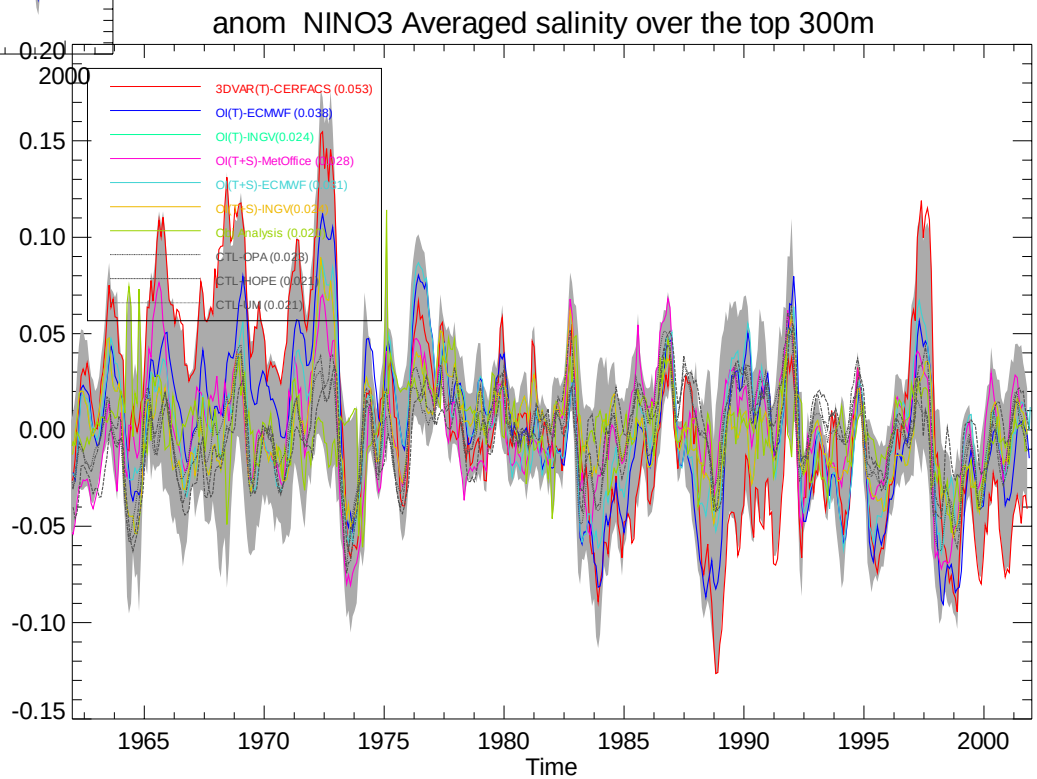





ENACT

(Ocean data assimilation)

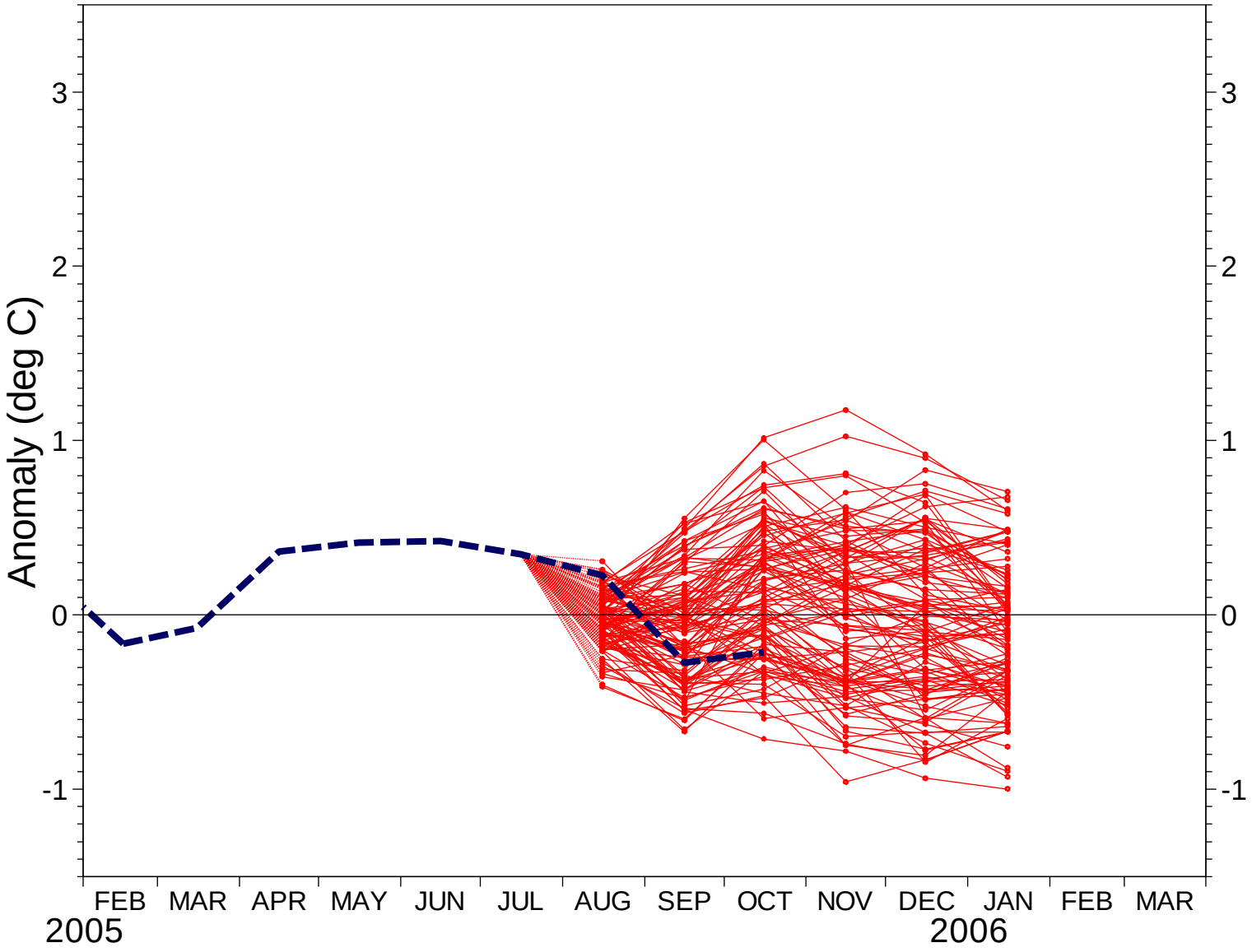
Multi model, multi analysis



# NINO3 SST anomaly plume
# EUROSIP multi-model forecast from 1 Aug 2005

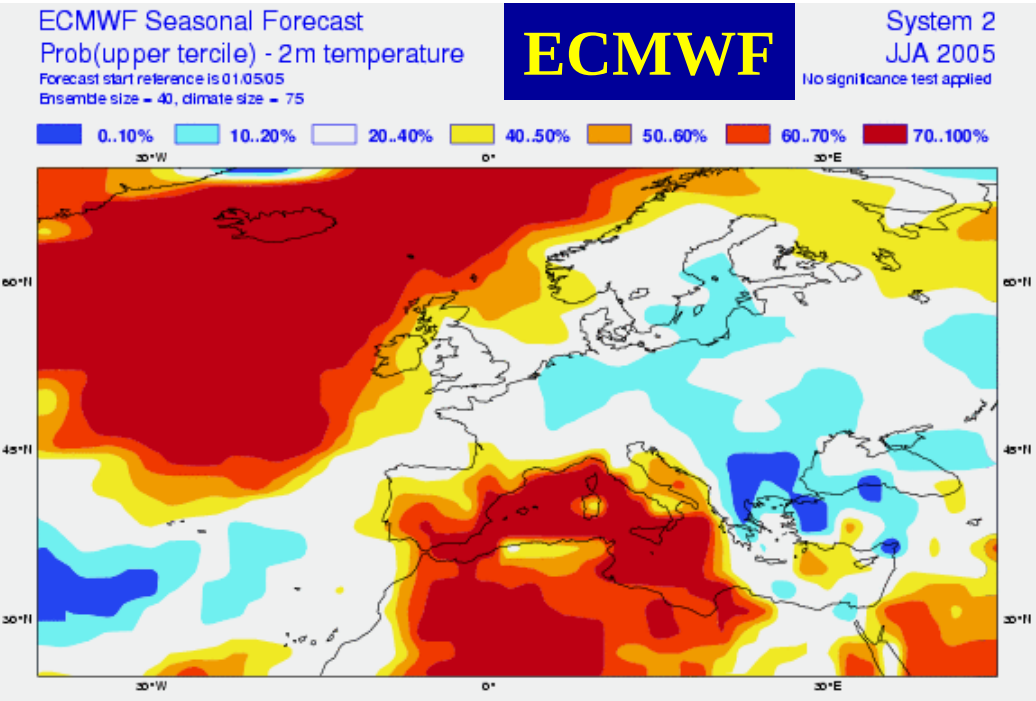
ECMWF, Met Office, Météo-France

Monthly means plotted using NCEP adjusted OIv2 1971-2000 climatology

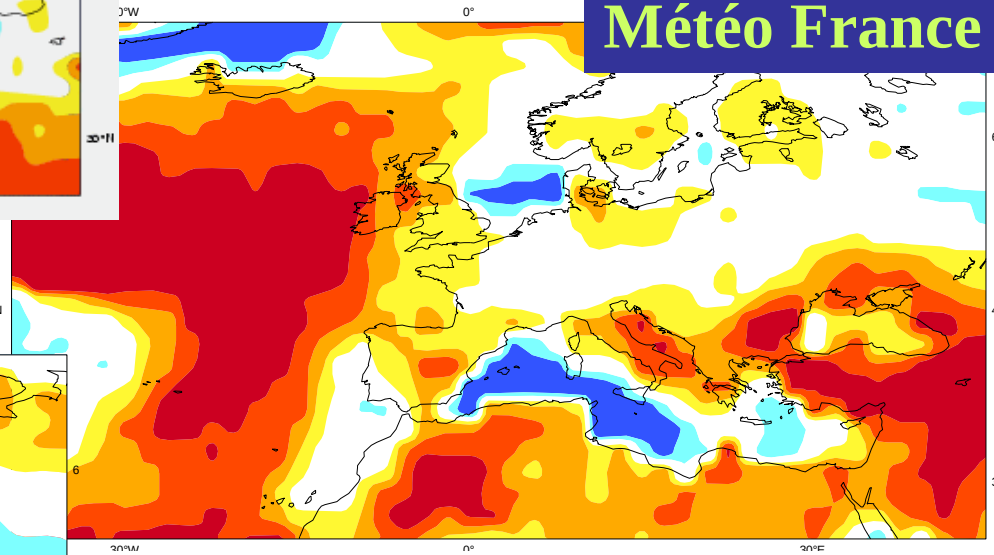



Produced from real-time forecast data

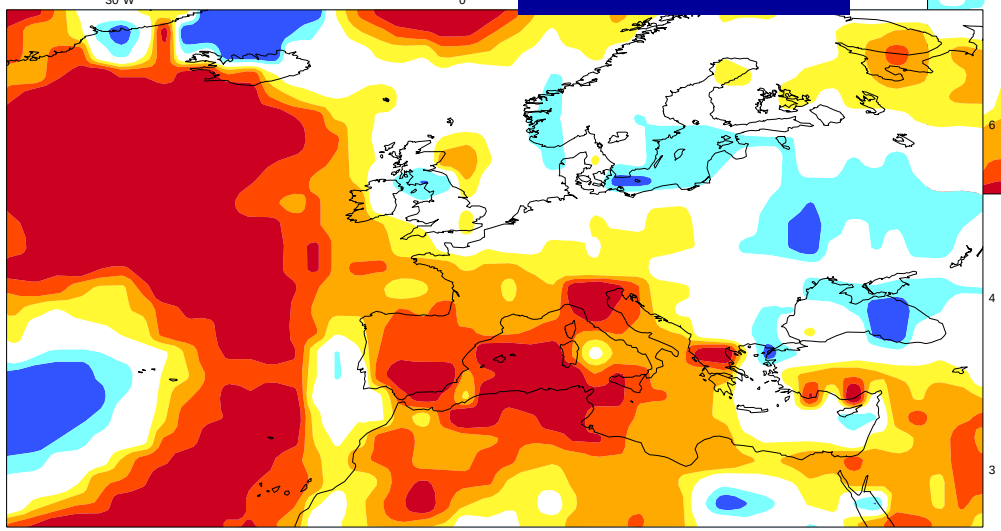
# Probability of 2m Temp > upper tercile of the model climate for JJA 2005




Météo France

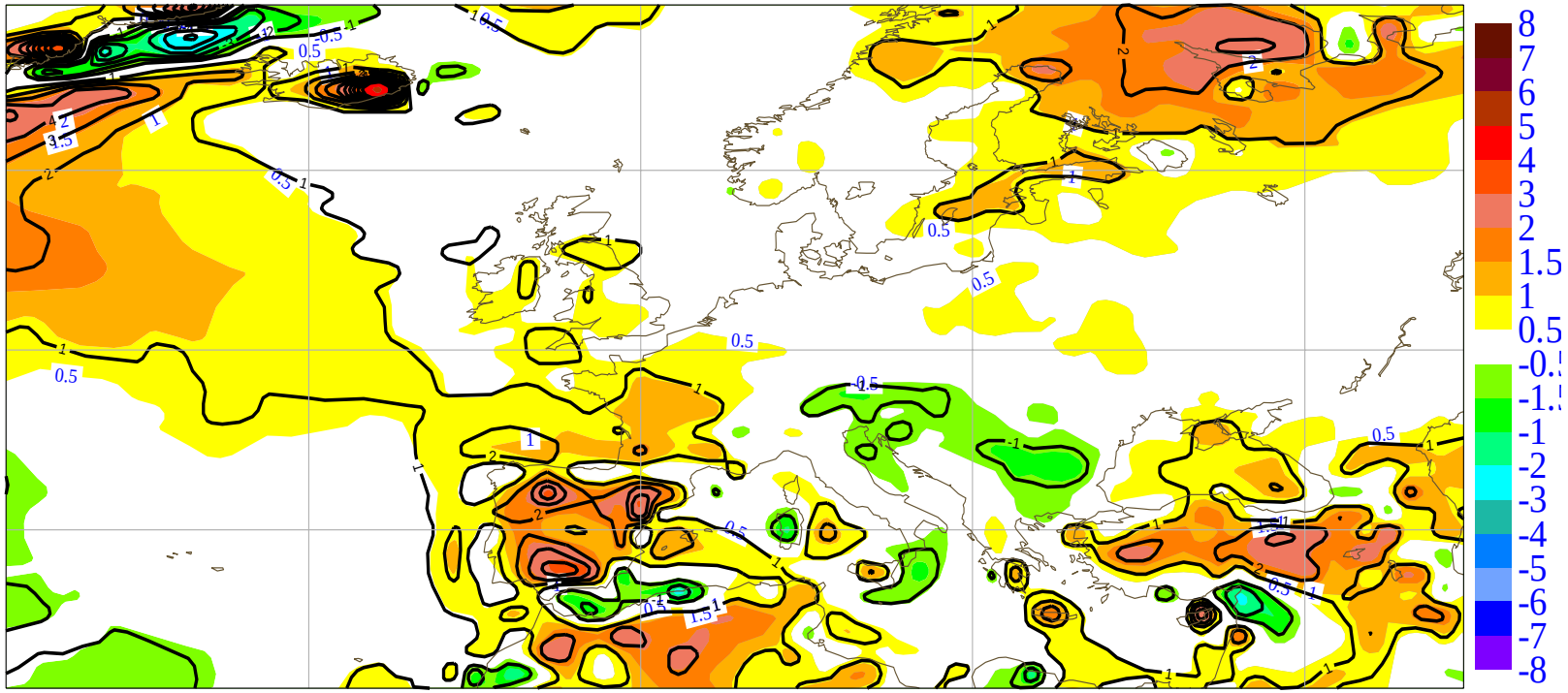


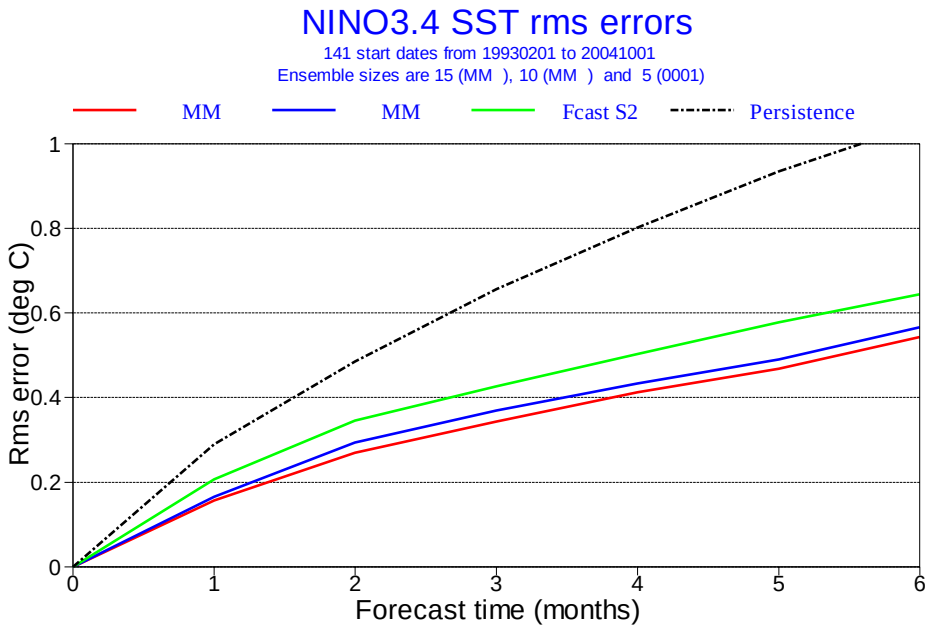
Met Office

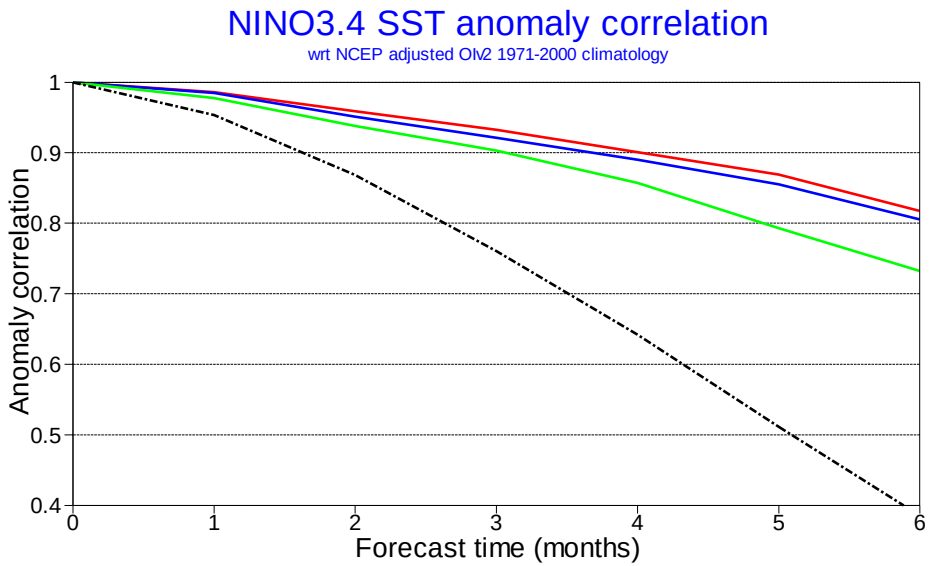



Forecasts start 1 May 2005

# 2m T anomaly JJA 2005 (1979-2001)






MAGICS 6.9.1 cumal - net Mon May 9 14:58:43 2005

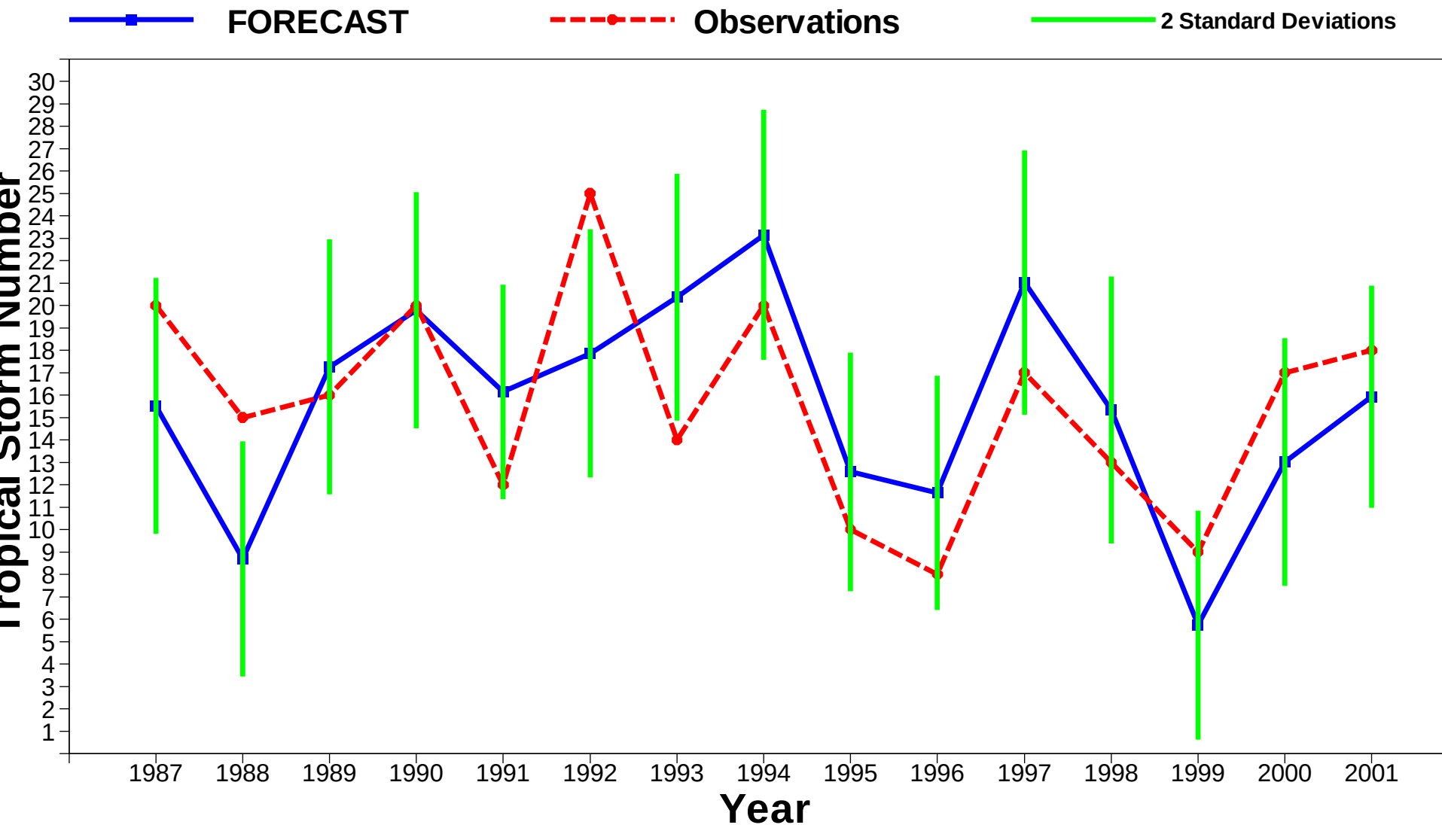
Results from the real-time multi-model forecast system. Three different models, using three different analysis strategies.

Green is ECMWF, blue ECMWF + MO, red ECMWF+MO+MF.

# Tropical Storm Frequency over the Eastern North Pacific (JJASO)
## Forecast starting on 1st May

MULTIMODEL: ECMWF LODYC UKMO CNRM CERFACS MPI SCNR

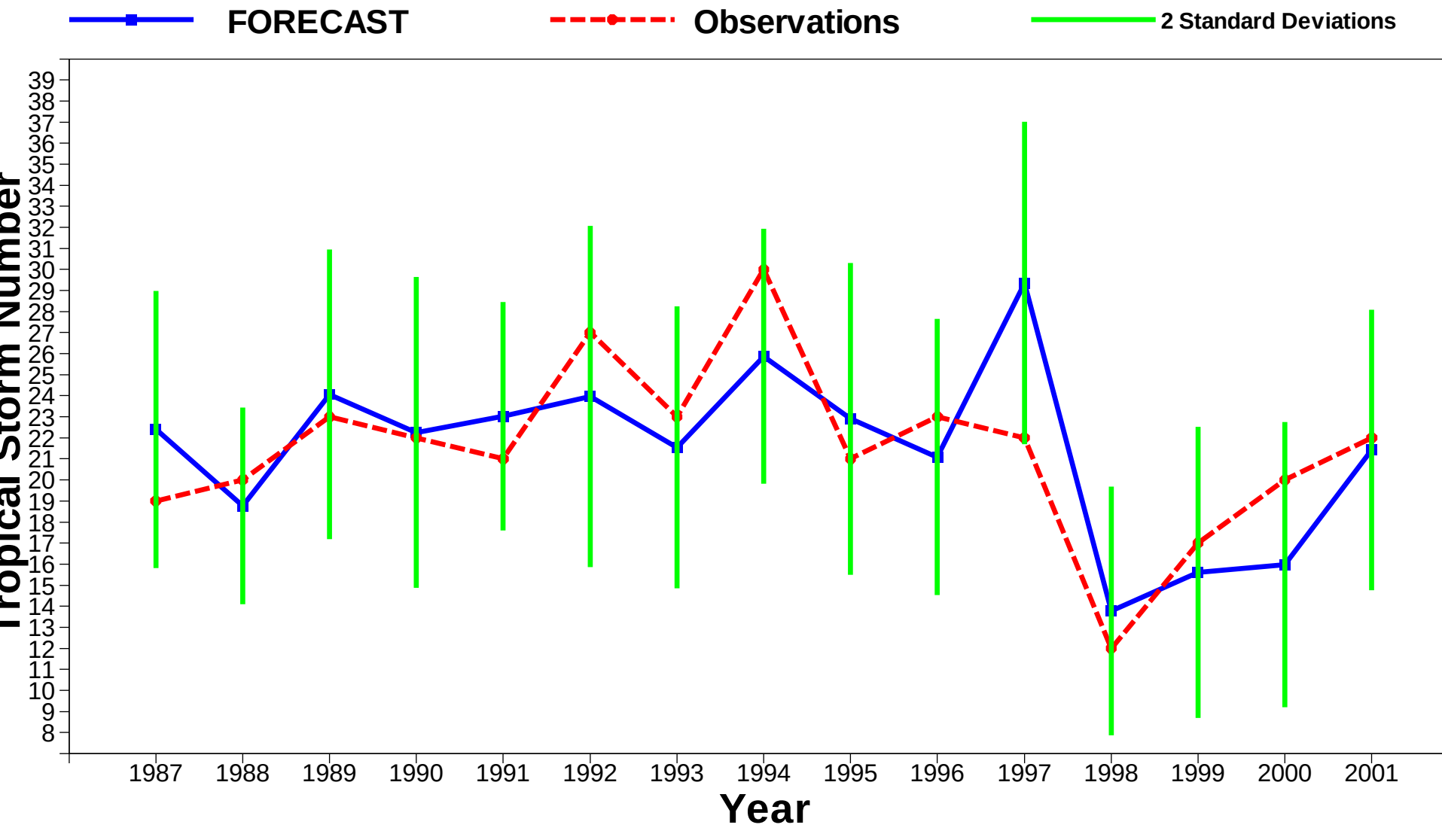
Correlation=0.59( 0.98)
RMS Error= 3.82( 4.56)



# Tropical Storm Frequency over the western North Pacific (JJASO)
## Forecast starting on 1st May

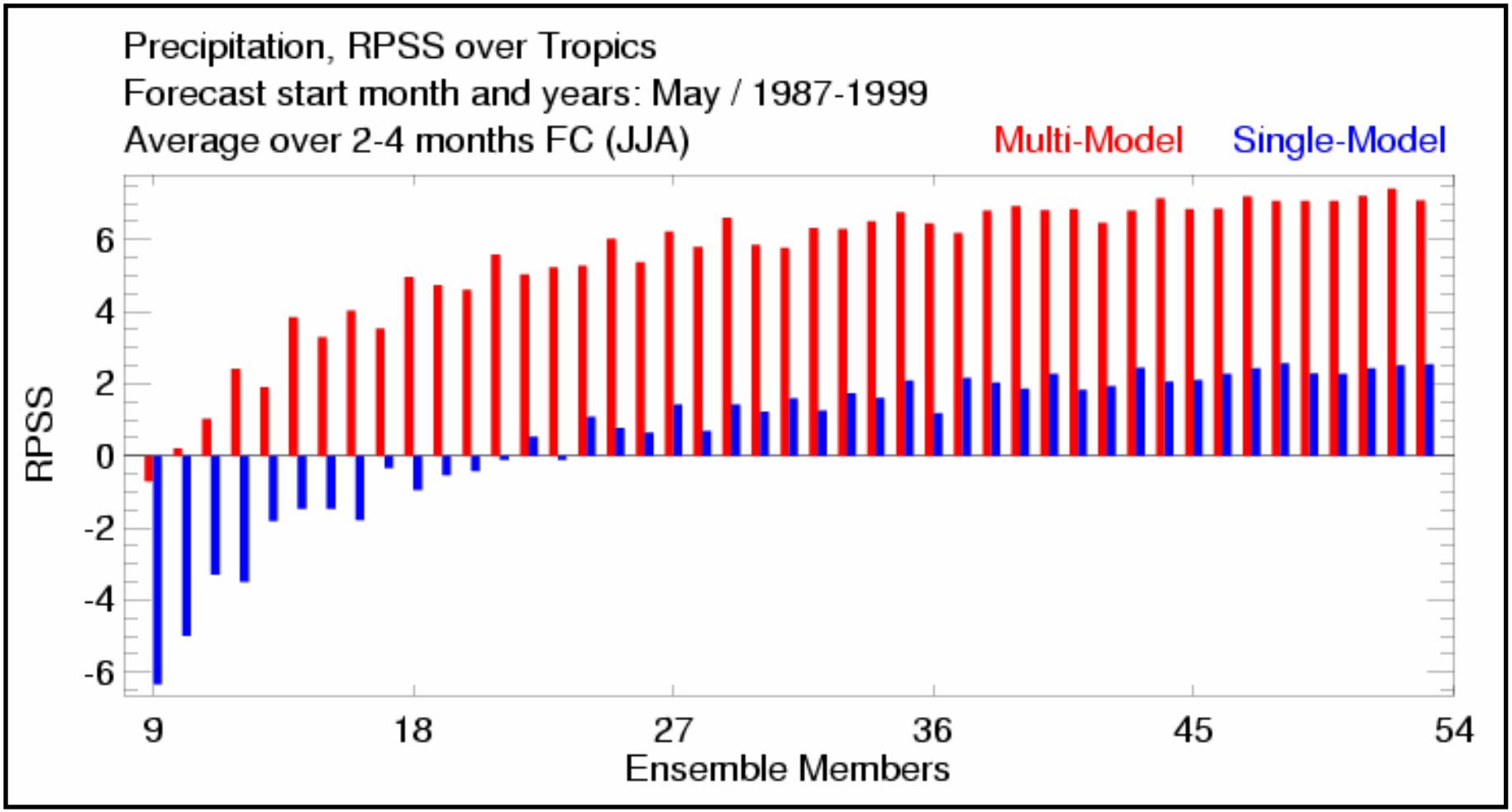
MULTIMODEL: ECMWF LODYC UKMO CNRM CERFACS MPI SCNR

Correlation=0.72( 1.00)
RMS Error= 2.73( 3.93)



# ensemble size versus multimodel

***From DEMETER***

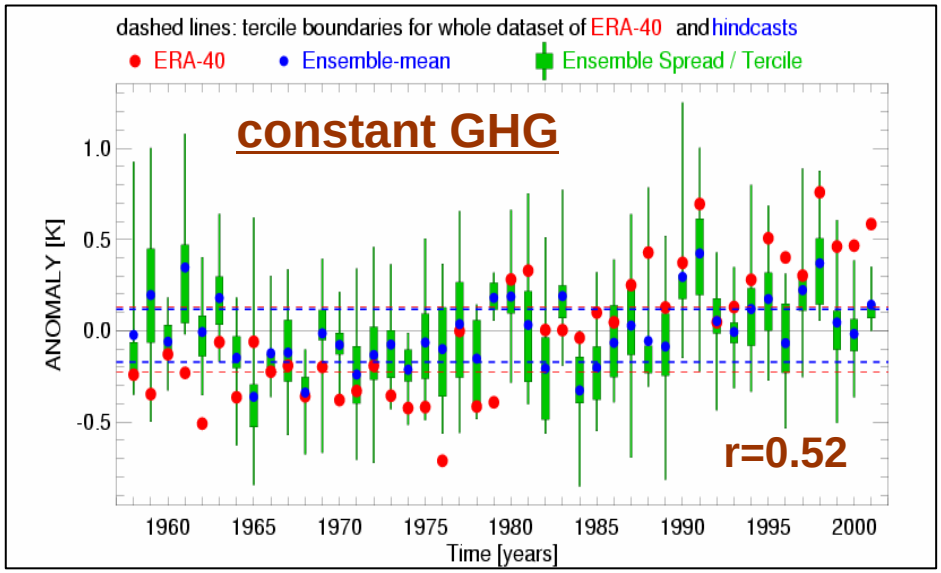


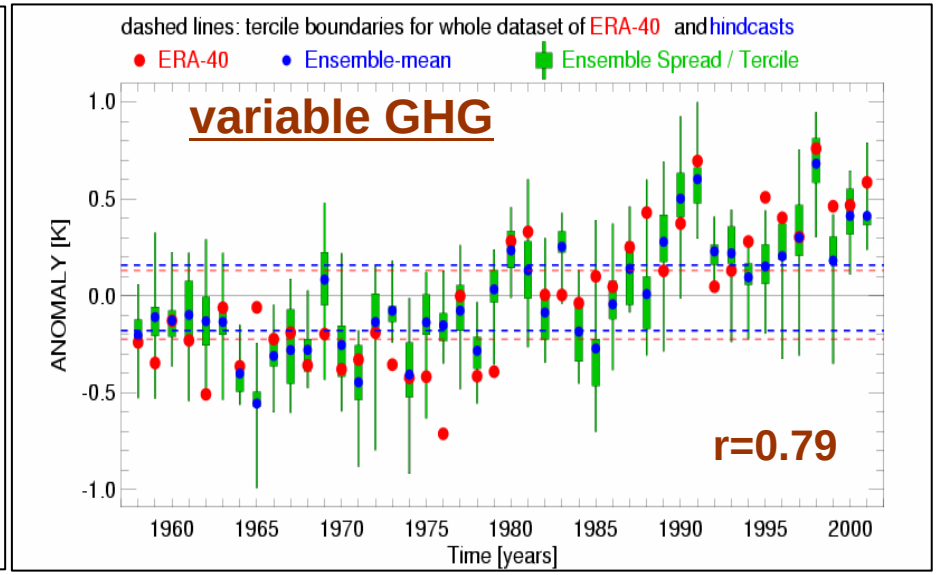

*Provided by Doblas-Reyes*

# Process understanding and evaluation/verification

- Predictability of mechanisms on seasonal and interannual timescales
- **Sensitivity to GHG forcing**

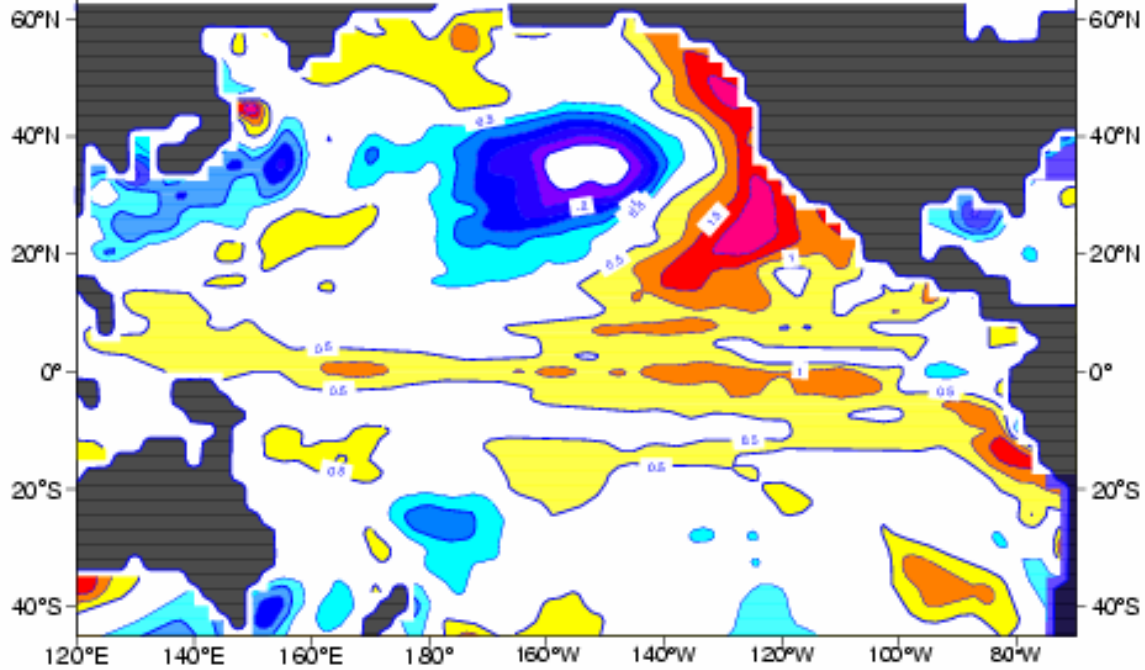
**global T2m JJA (1 month lead)**



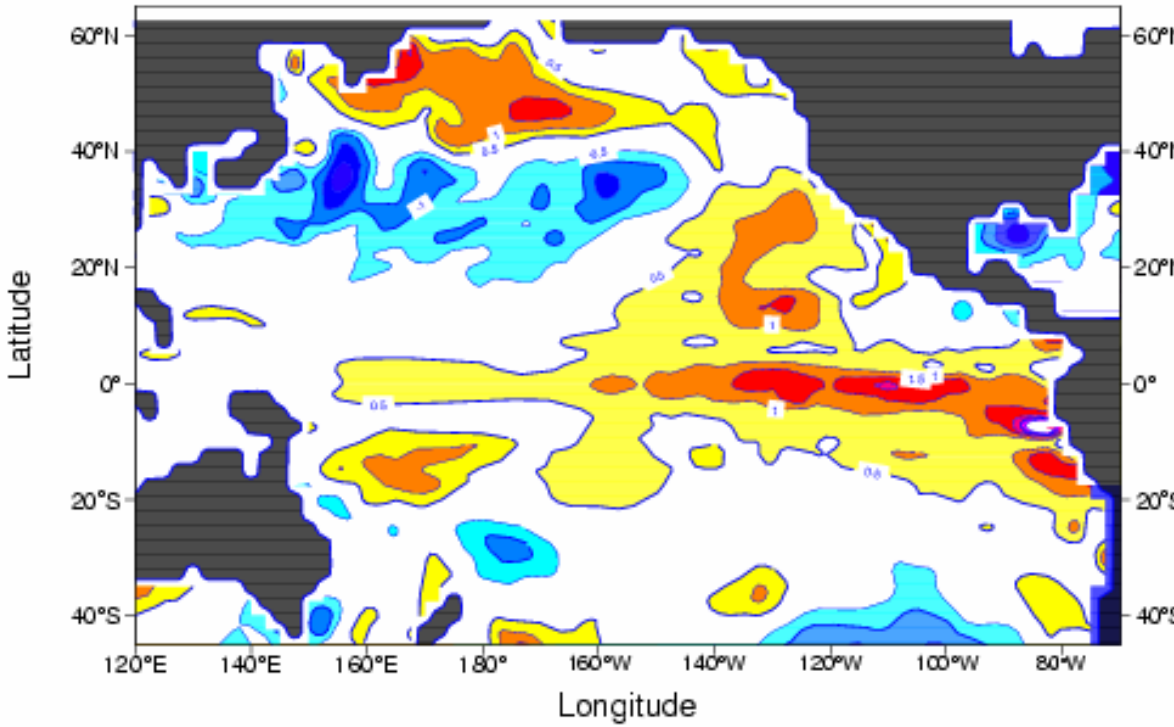



# Preparations for the interim reanalysis (Atmospheric)

- Period 1989-present and beyond…
- Candidate system tested with Cycle 29r2, 12h 4D-var and different bias corrections. (30r1 most likely).
- ERA-40 observations +Meteosat reprocessed winds and clear sky radiances.
- The main problems of ERA-40 seem to be solved:
  - The hydrological cycle is improved
  - The circulation of Brewer-Dobson is reduced
  - The global energy balance is improved
  - Forecast performance improved also.

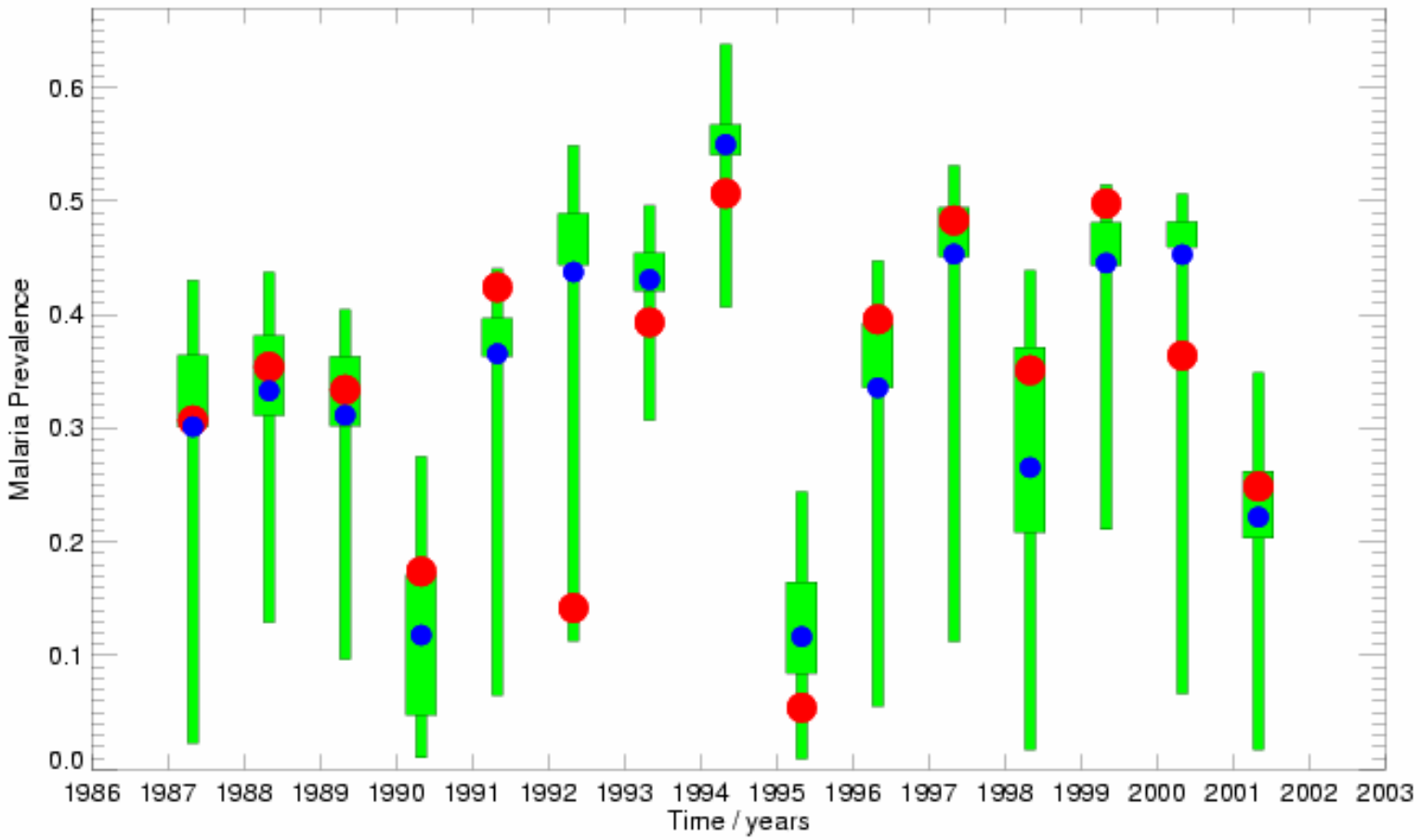



Two forecasts, starting from very similar initial conditions both predict El Nino but with rather different details and different mid-latitude anomalies, indicating the need for ensemble forecasts. Are the models too sensitive?



# DEMETER: malaria prediction

Verification DEMETER-MM: Ensemble-mean
Terciles




Time series for grid point in South Africa (17.5 S, 25.0 E)

Morse et al, 2005