The Madden-Julian oscillation in the ECMWF monthly forecasting system

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Monthly Forecasting System (1)

• **Coupled ocean-atmosphere integrations:** a 51-member ensemble is integrated for 32 days every 2 weeks.

• **Atmospheric component:** IFS with the latest operational cycle and with a T159L40 resolution

• **Oceanic component:** HOPE (from Max Plank Institute) with a zonal resolution of 1.4 degrees and 29 vertical levels

•**Coupling:** OASIS (CERFACS). Coupling every ocean time step (1 hour)

Monthly Forecasting System (2)

• **Atmospheric initial conditions:** ERA40 and ECMWF operational analysis

• **Oceanic initial conditions:** Last ocean analysis + real time forecast

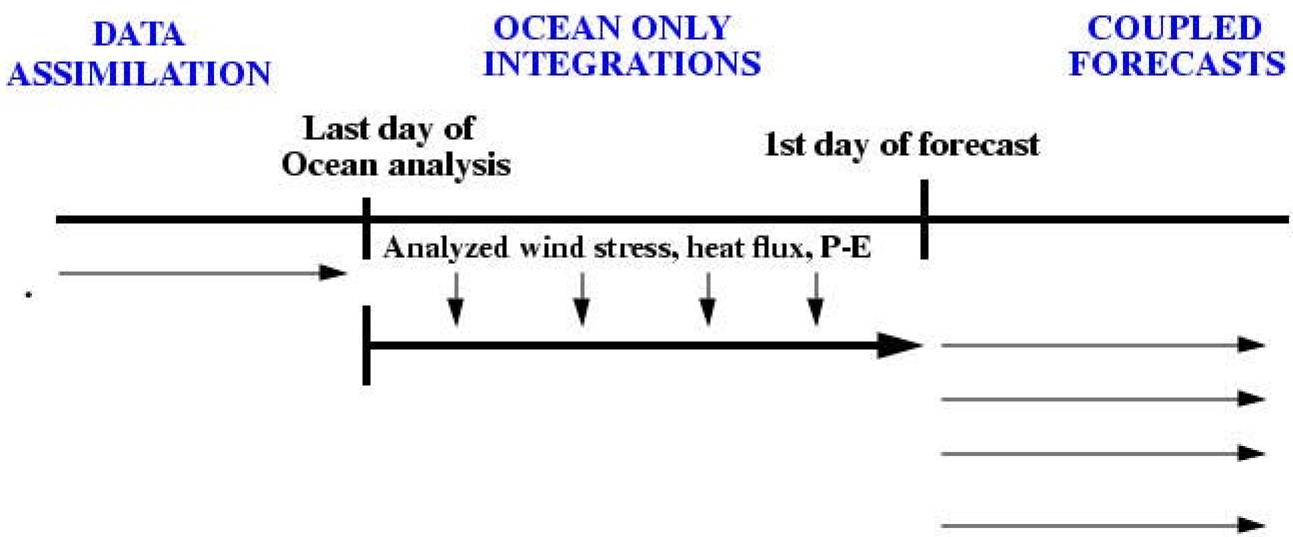
• **Perturbations:**

- **Atmosphere:** Singular vectors + stochastic physics

- **Ocean:** SST perturbations in the initial conditions + wind stress perturbations during data assimilation.

Real-time Ocean Forecast

Problem: the last oceanic analysis is about 12 days behind real-time.



Monthly Forecasting System (3)

Background statistics:

- 5-member ensemble integrated at the same day and same month as the real-time time forecast over the past 12 years.

- This represents a 60-member ensemble.

- It is running once every 2 weeks (alternatively with real time forecast)

Verification

. The monthly forecasting system is semi-operational since

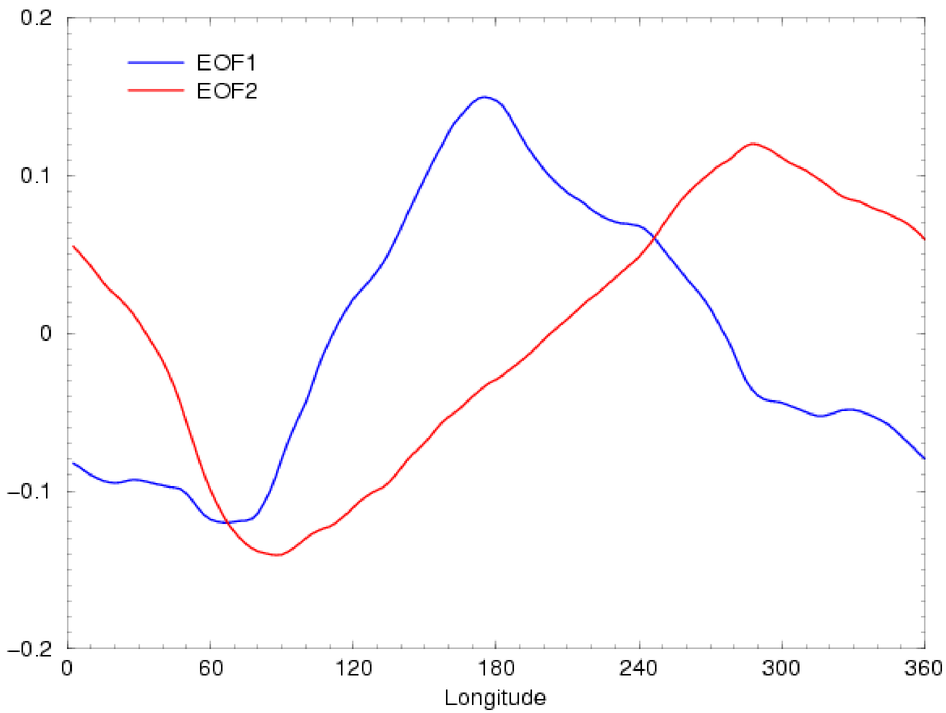
27 March 2002

. 30 cases have been verified.

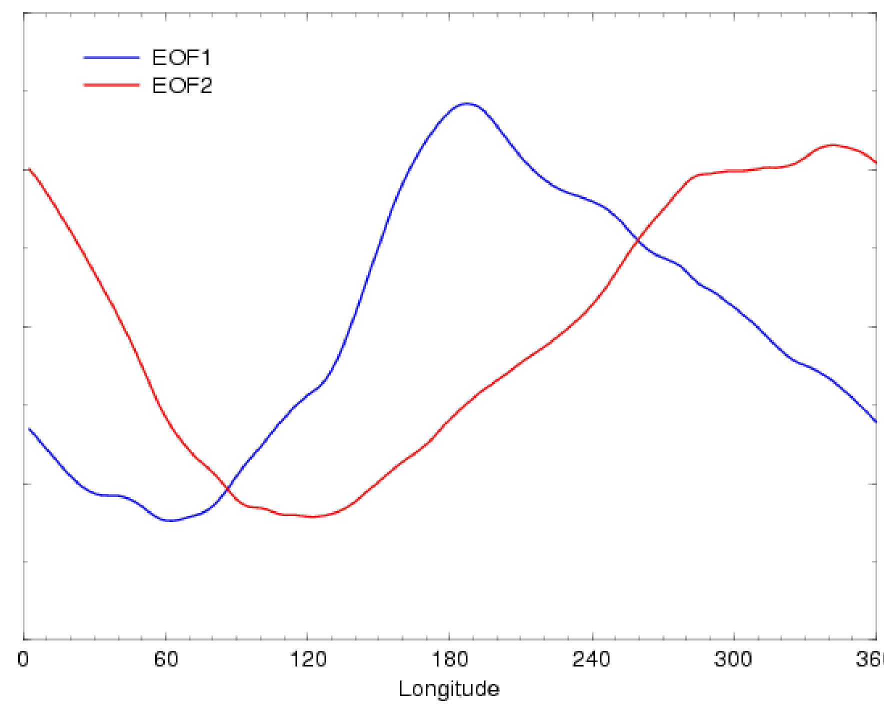
Madden Julian Oscillation (1)

EOF analysis of velocity potential at 200 hPa along the 5N-5S equatorial band

EOF1 and EOF2 from analysis

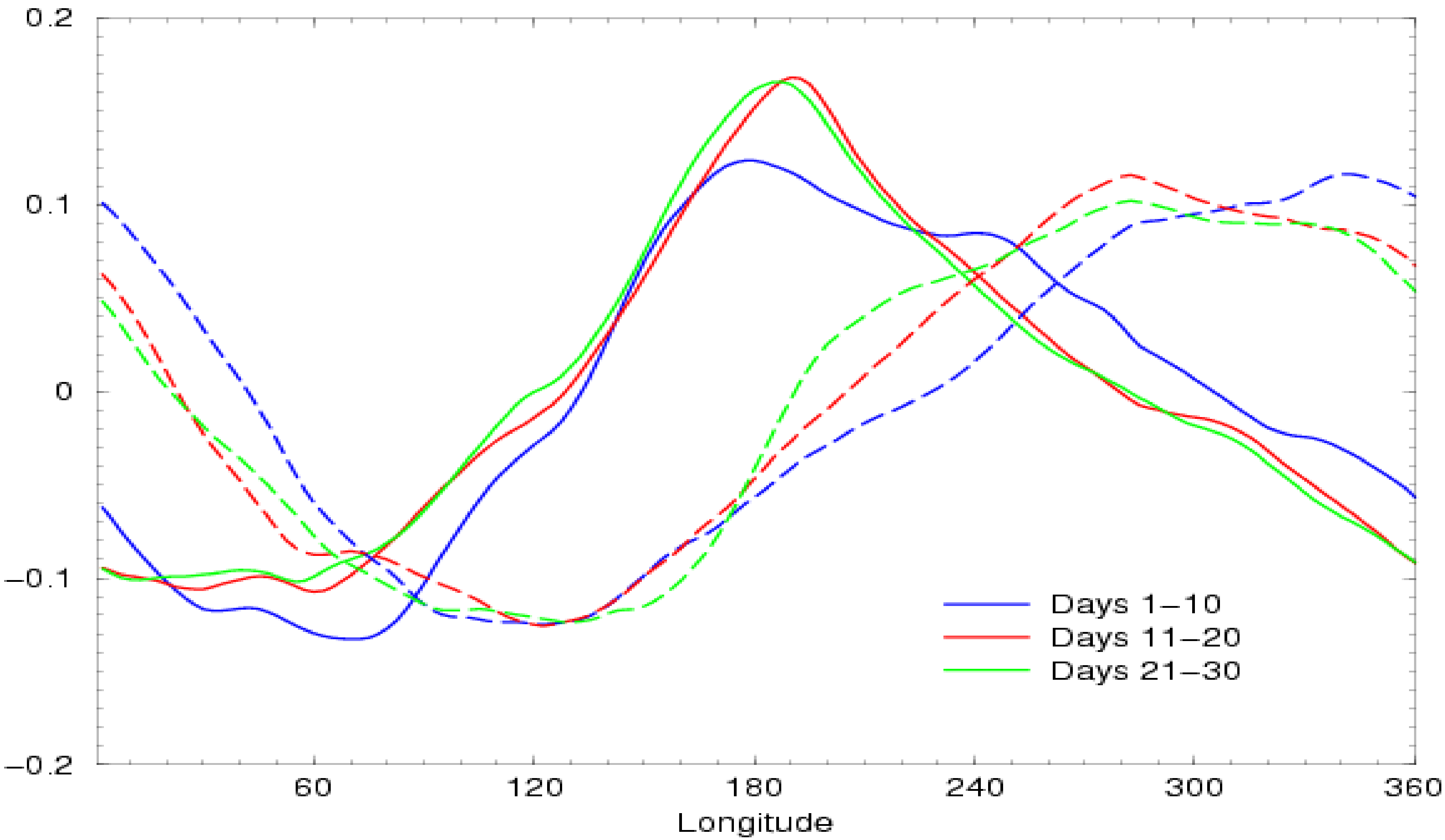


EOF1 and EOF2 from MOFC

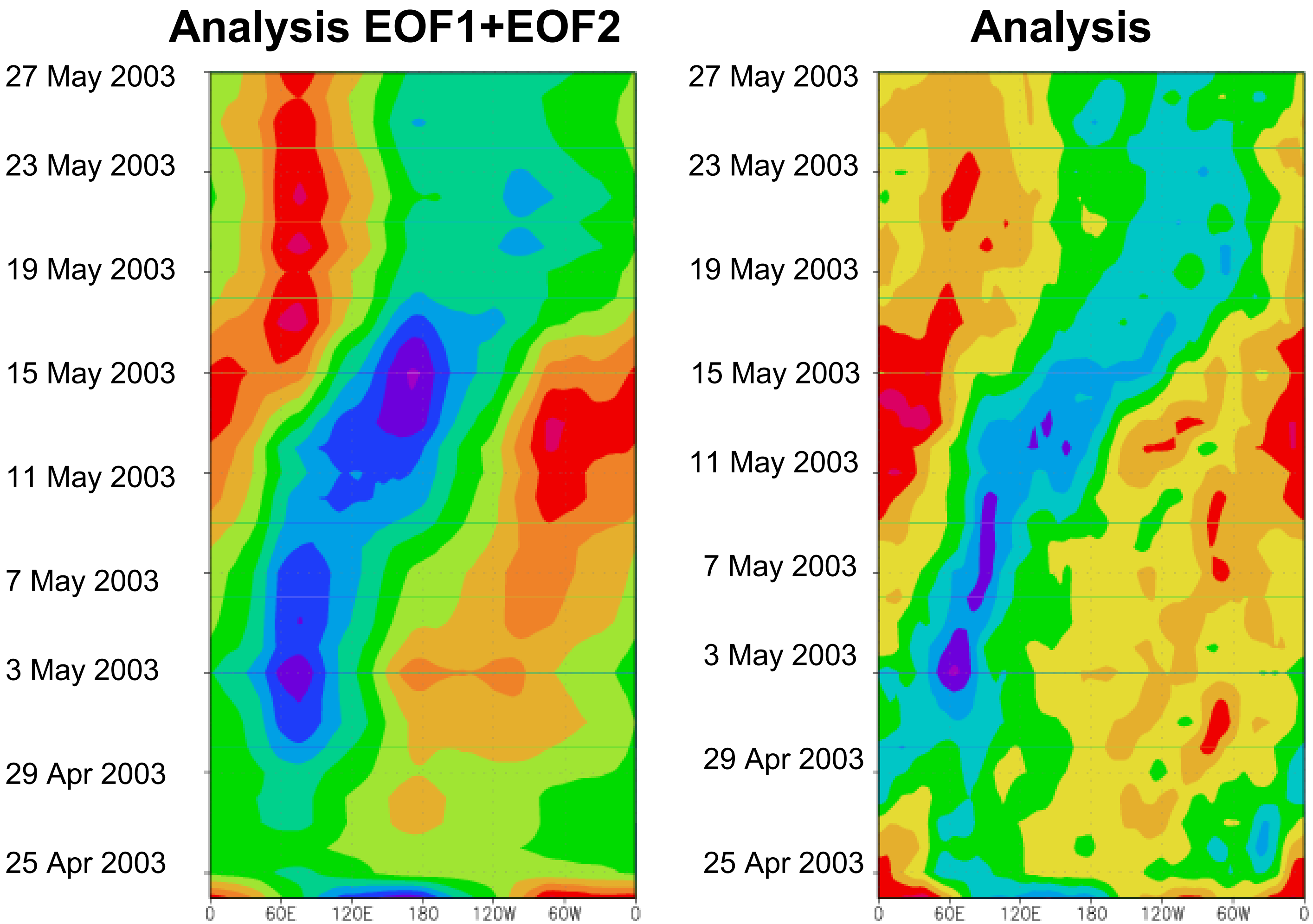


Madden Julian oscillation

EOF1-EOF2 : 33%-30% 26%-21% 30%-20%

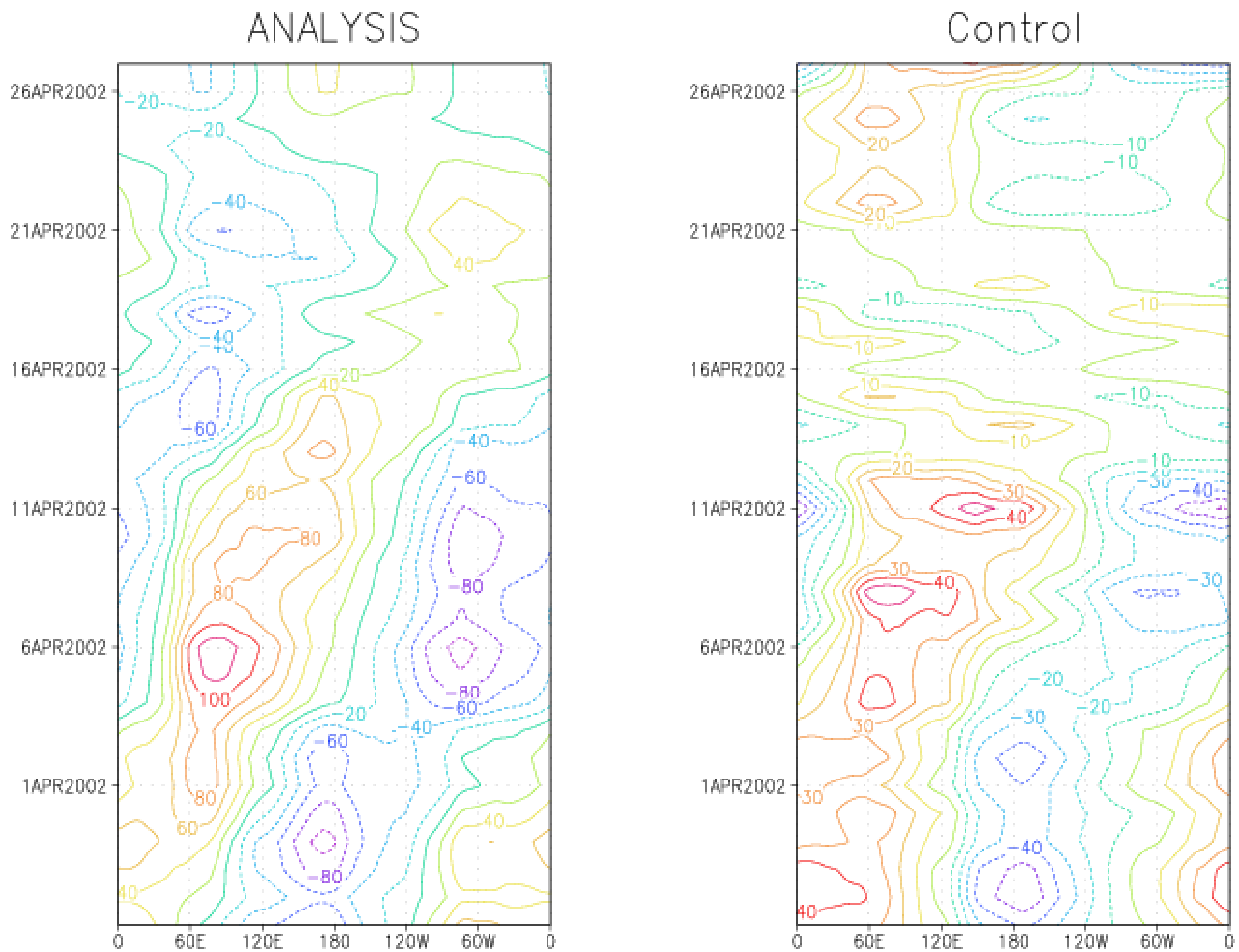


Madden Julian Oscillation (2)



ECMWF

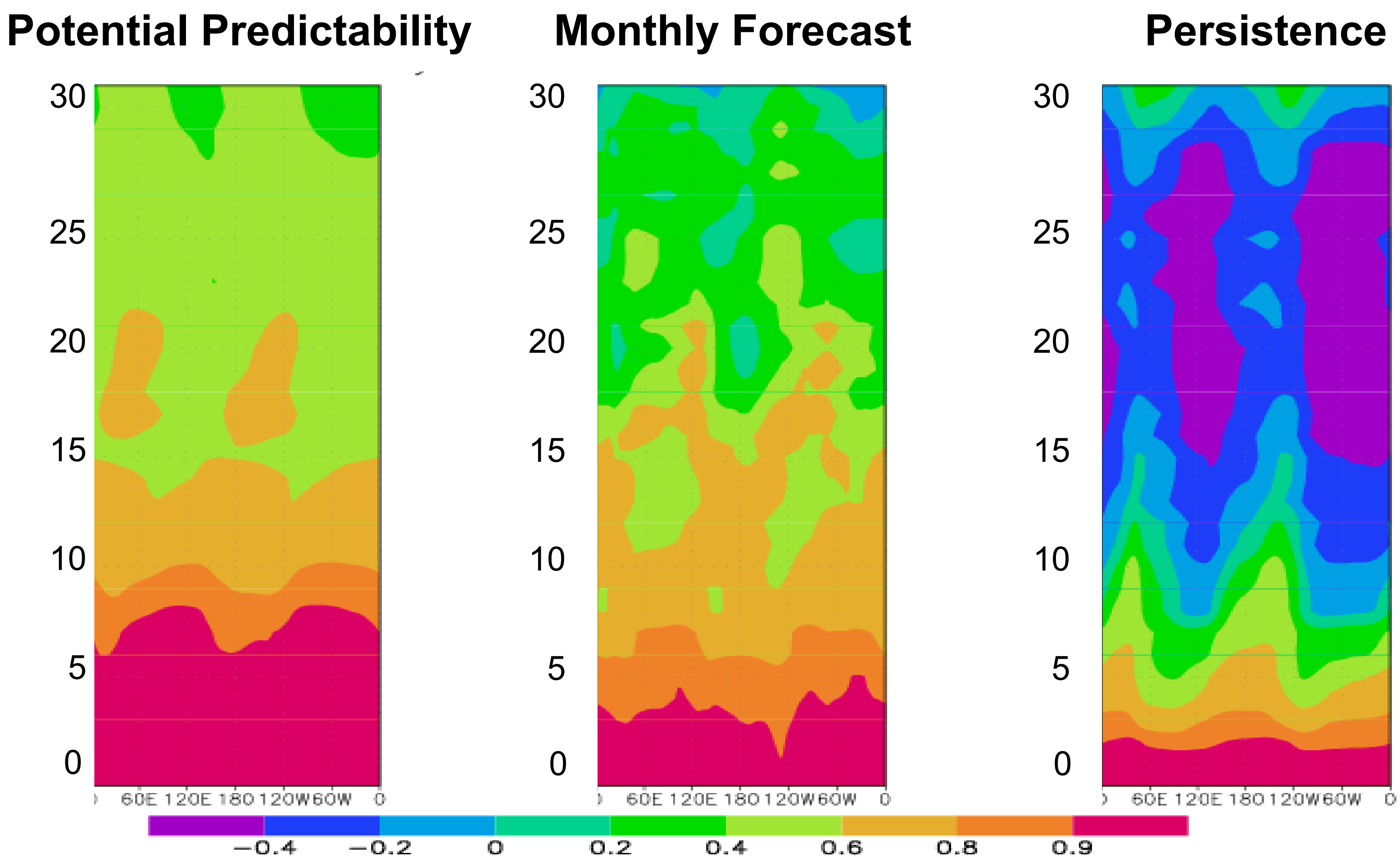
Madden julian Oscillation (3)



ECMWF

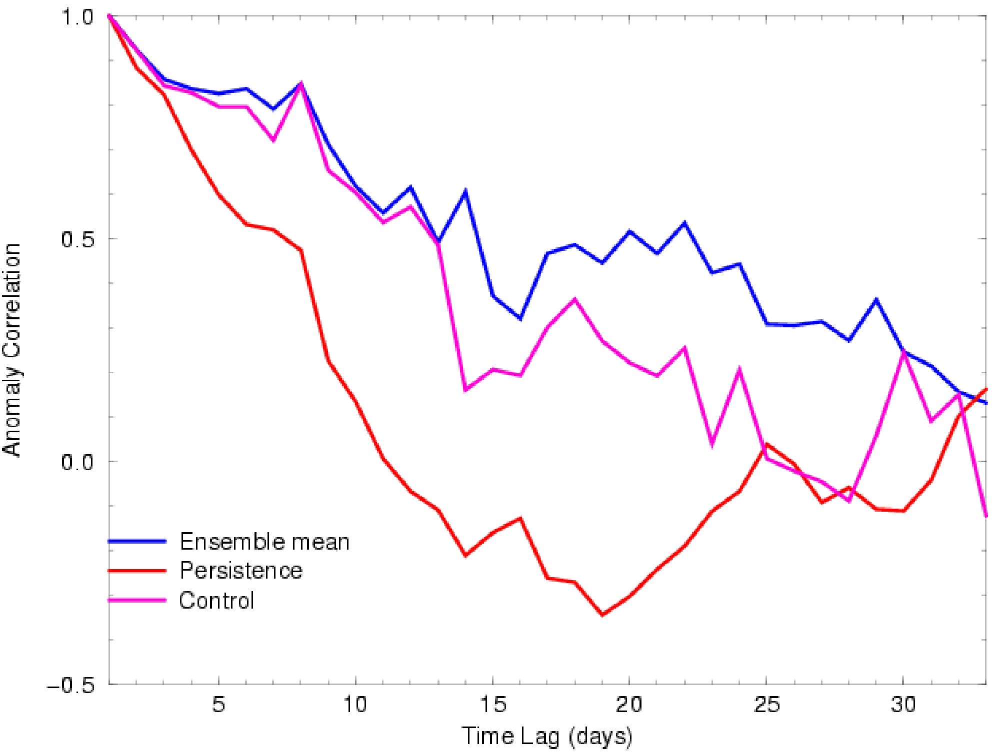
Madden-julian Oscillation (3)

Temporal correlation

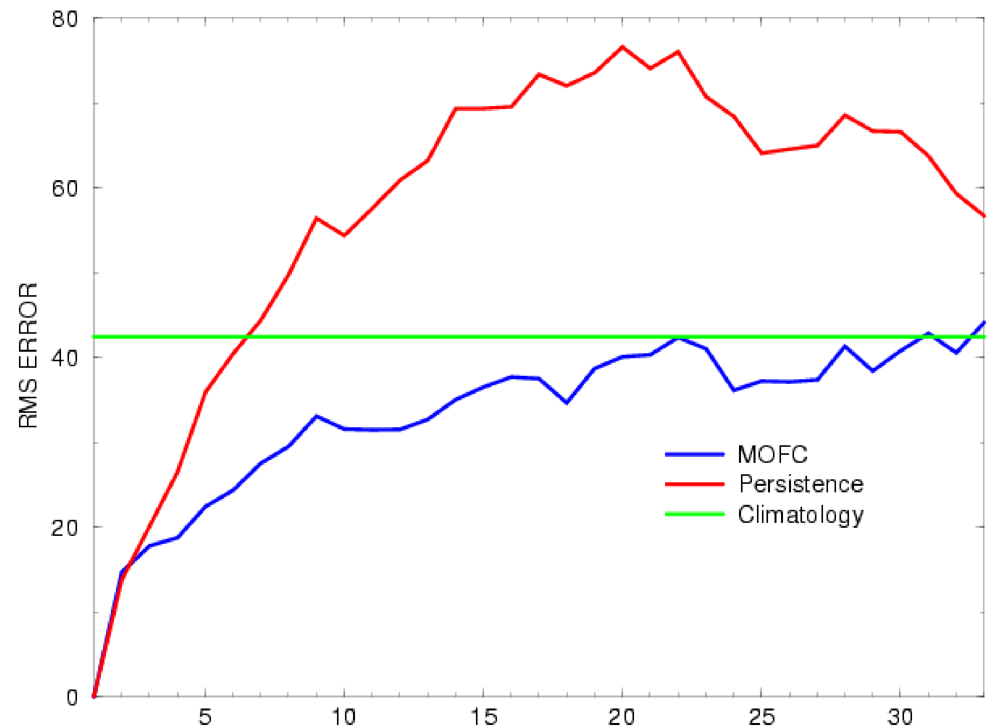


Madden Julian Oscillation (4)

Anomaly Correlation

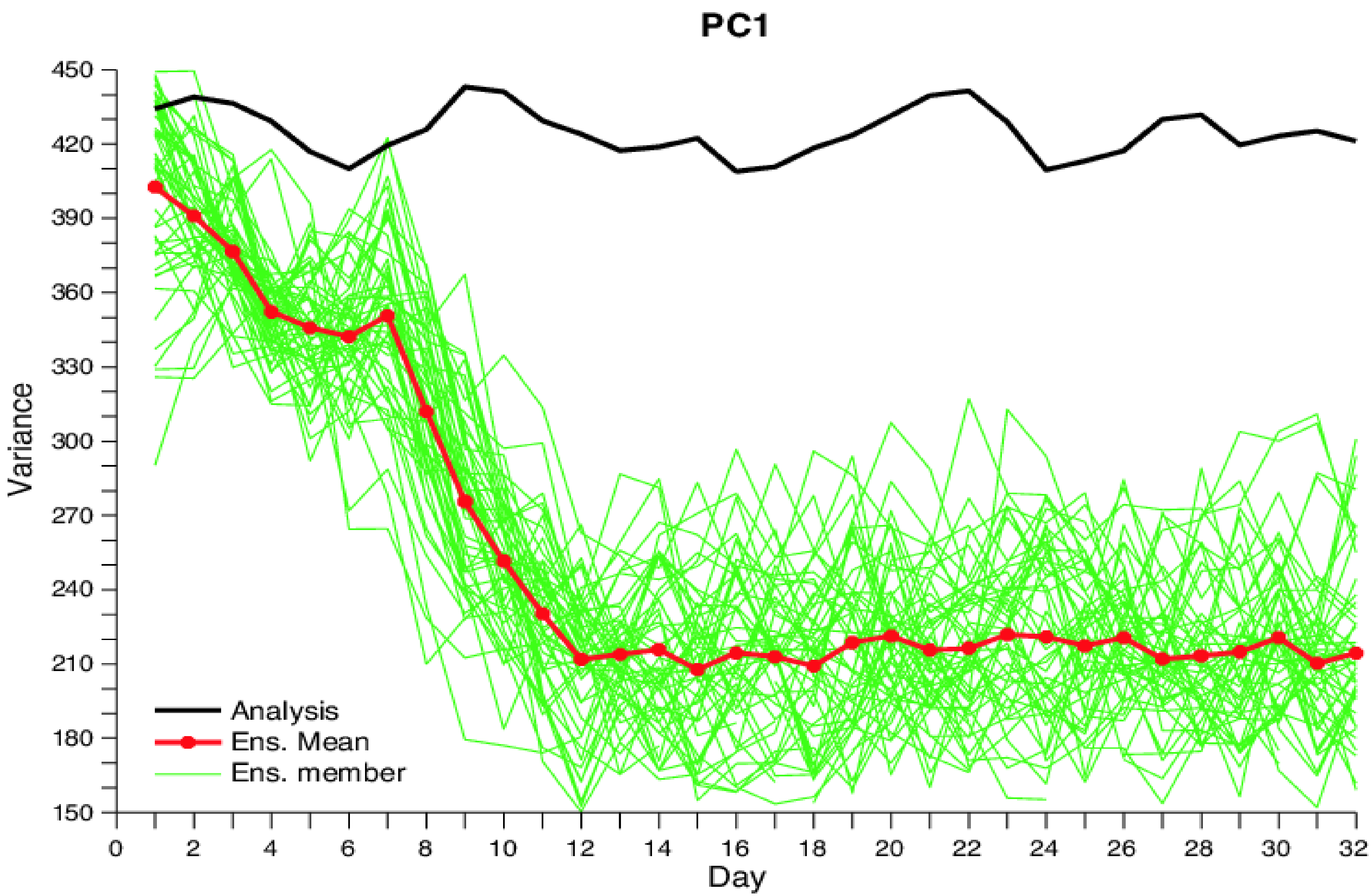


RMS Error

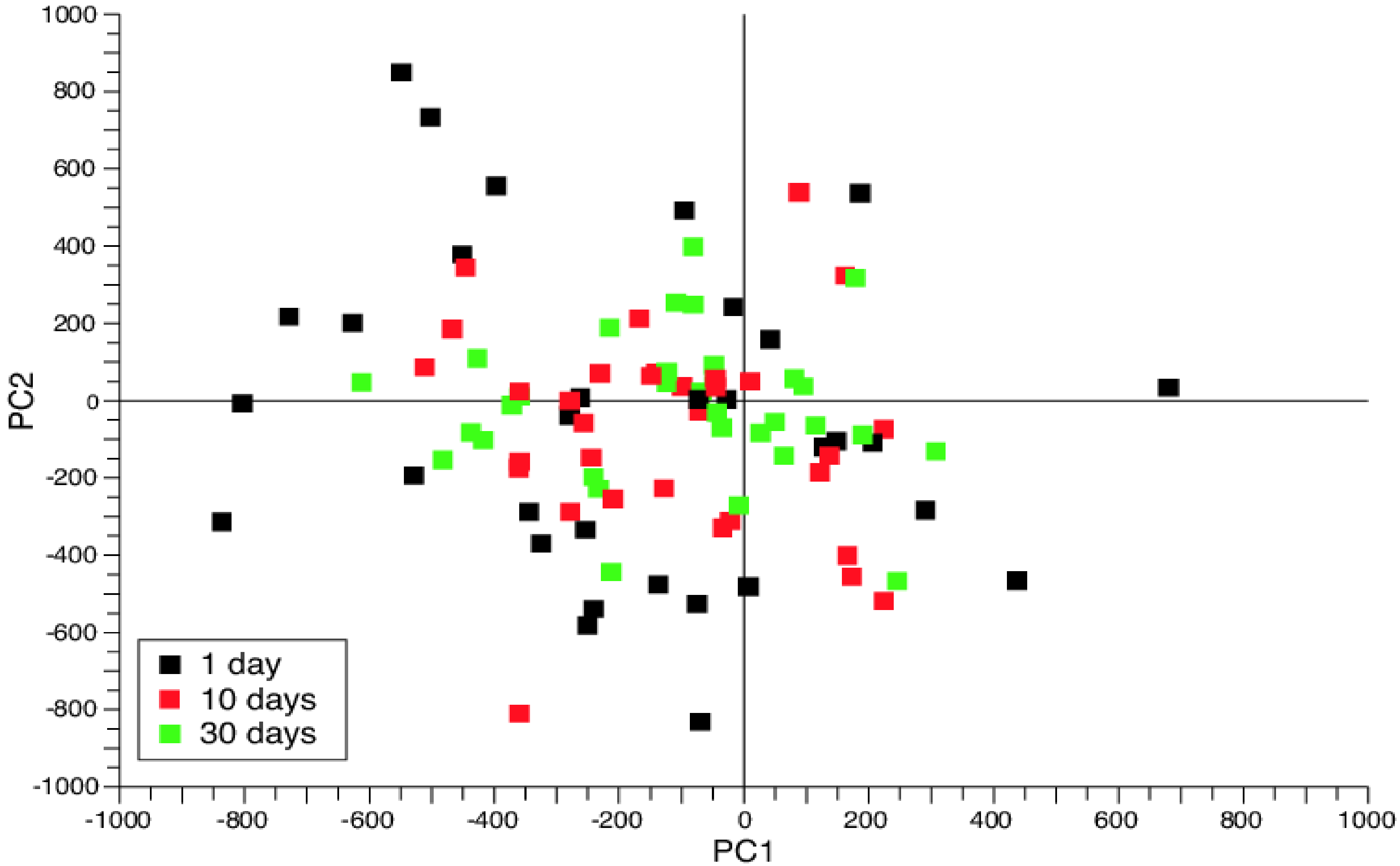


Madden-Julian Oscillation (5)

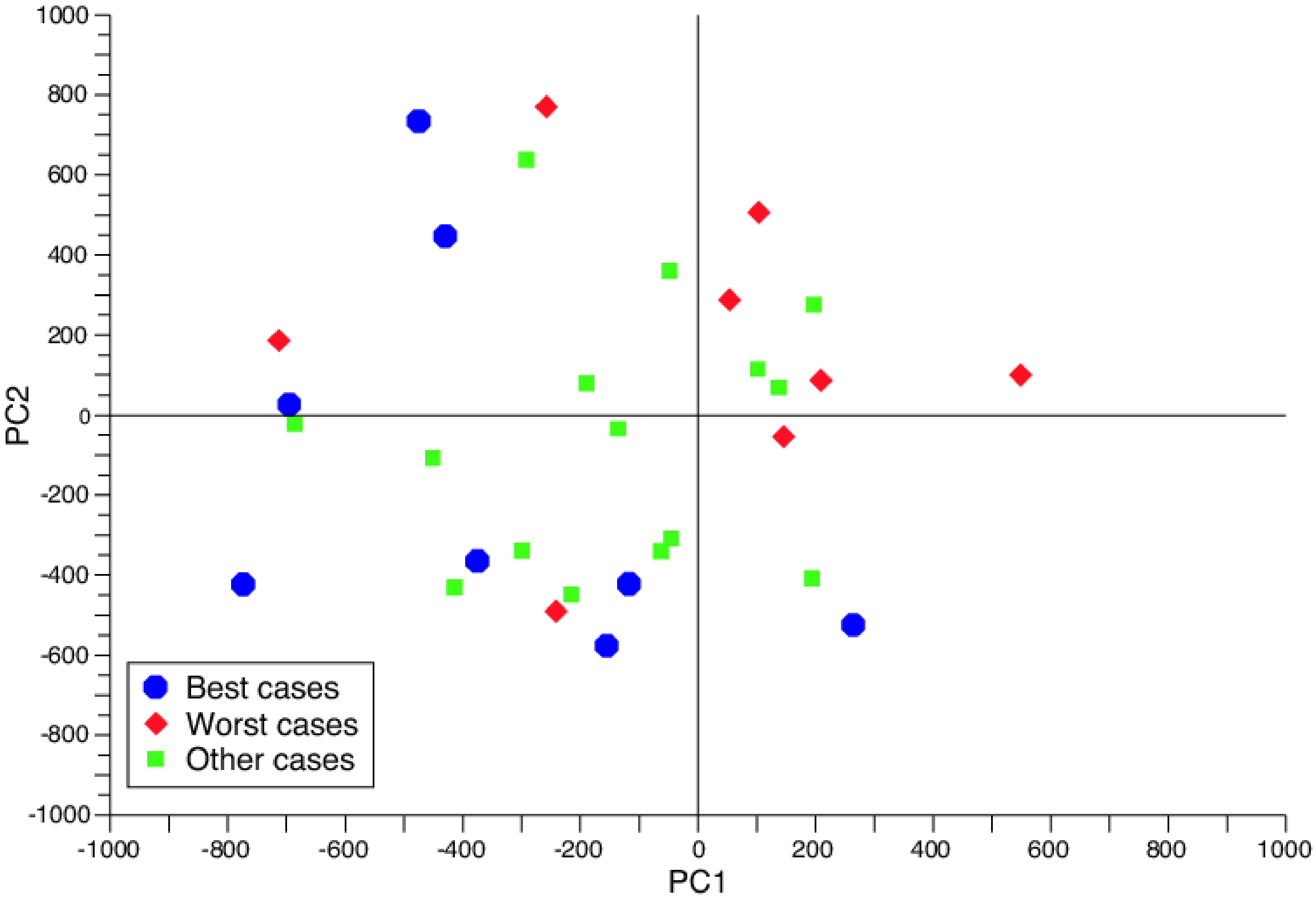
Time evolution of the variance of PC1



Madden-Julian Oscillation (6)

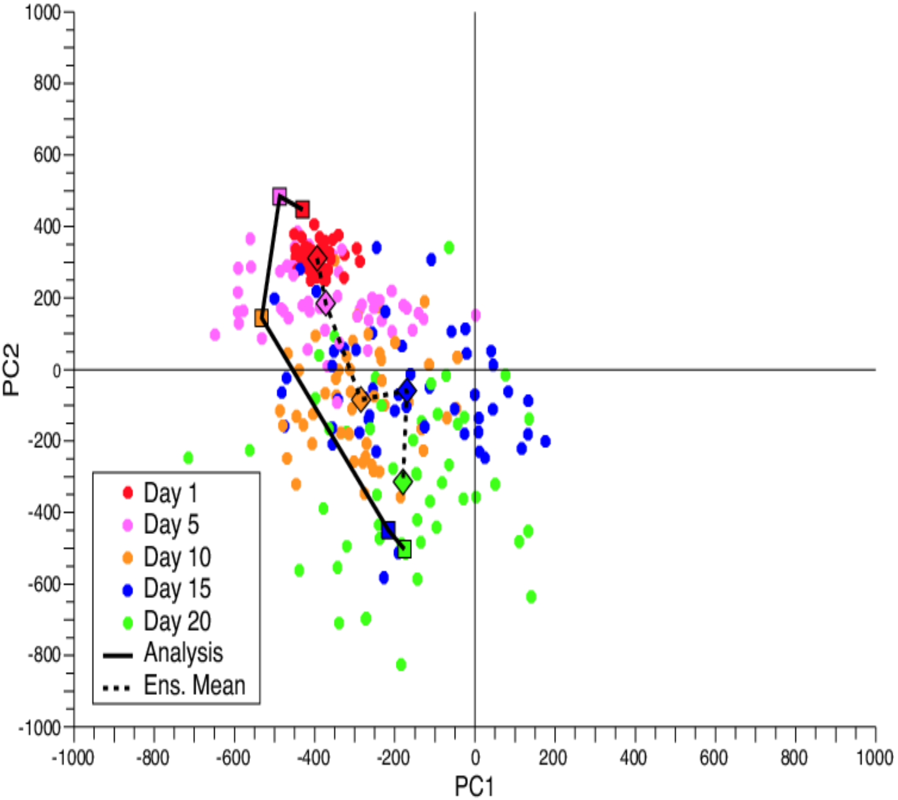


Madden-Julian Oscillation (7)

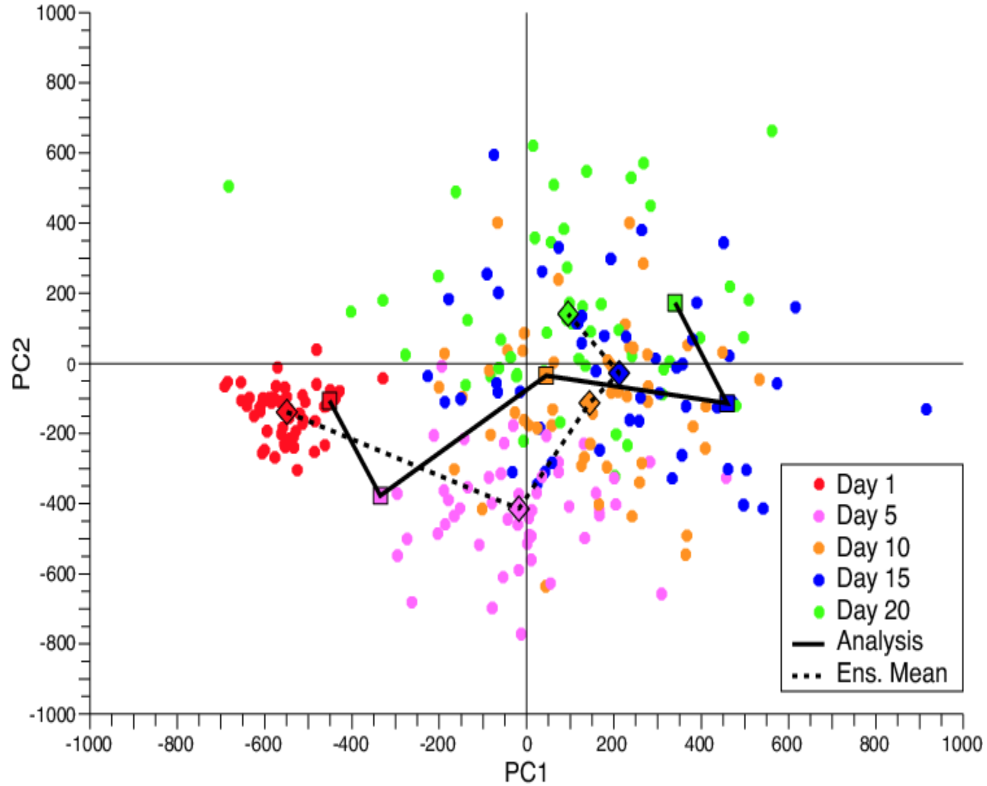


Madden-Julian Oscillation (9)

Starting date: 1 January 2003

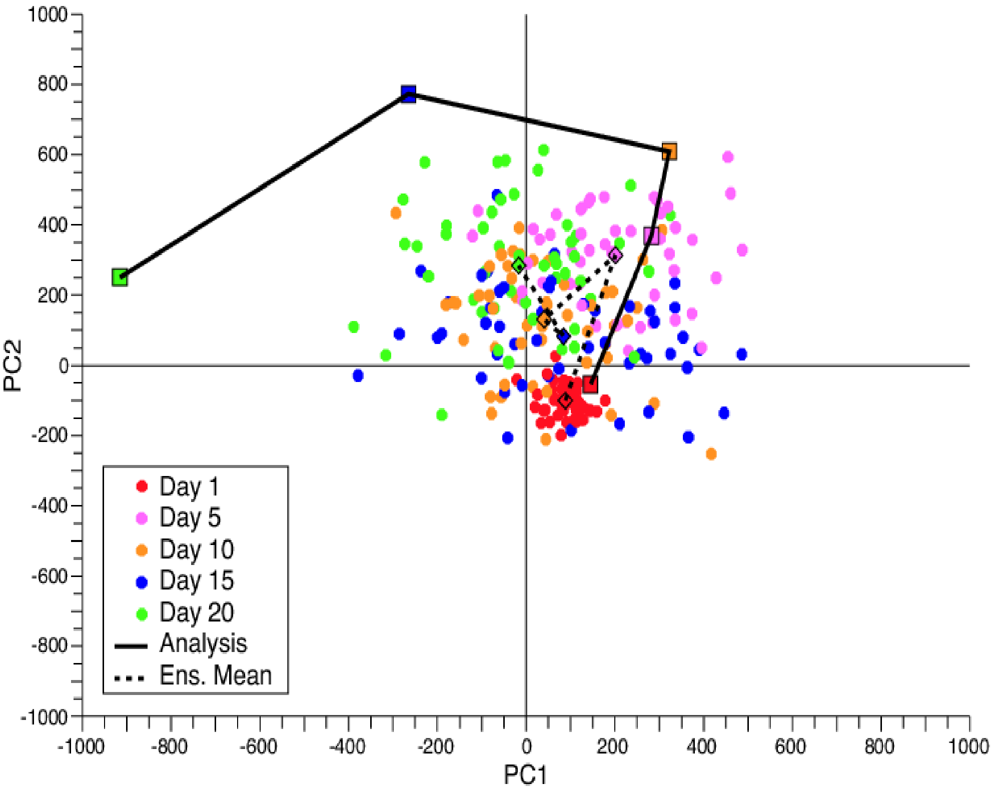


Starting date: 4 June 2003

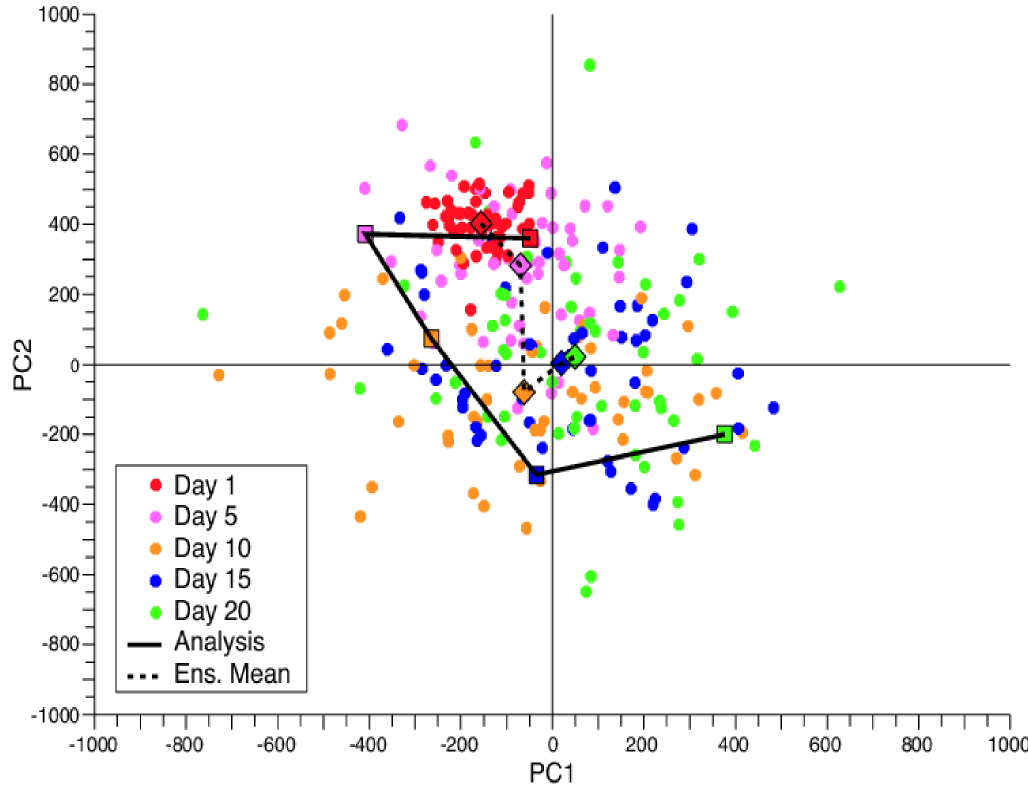


Madden-Julian Oscillation (8)

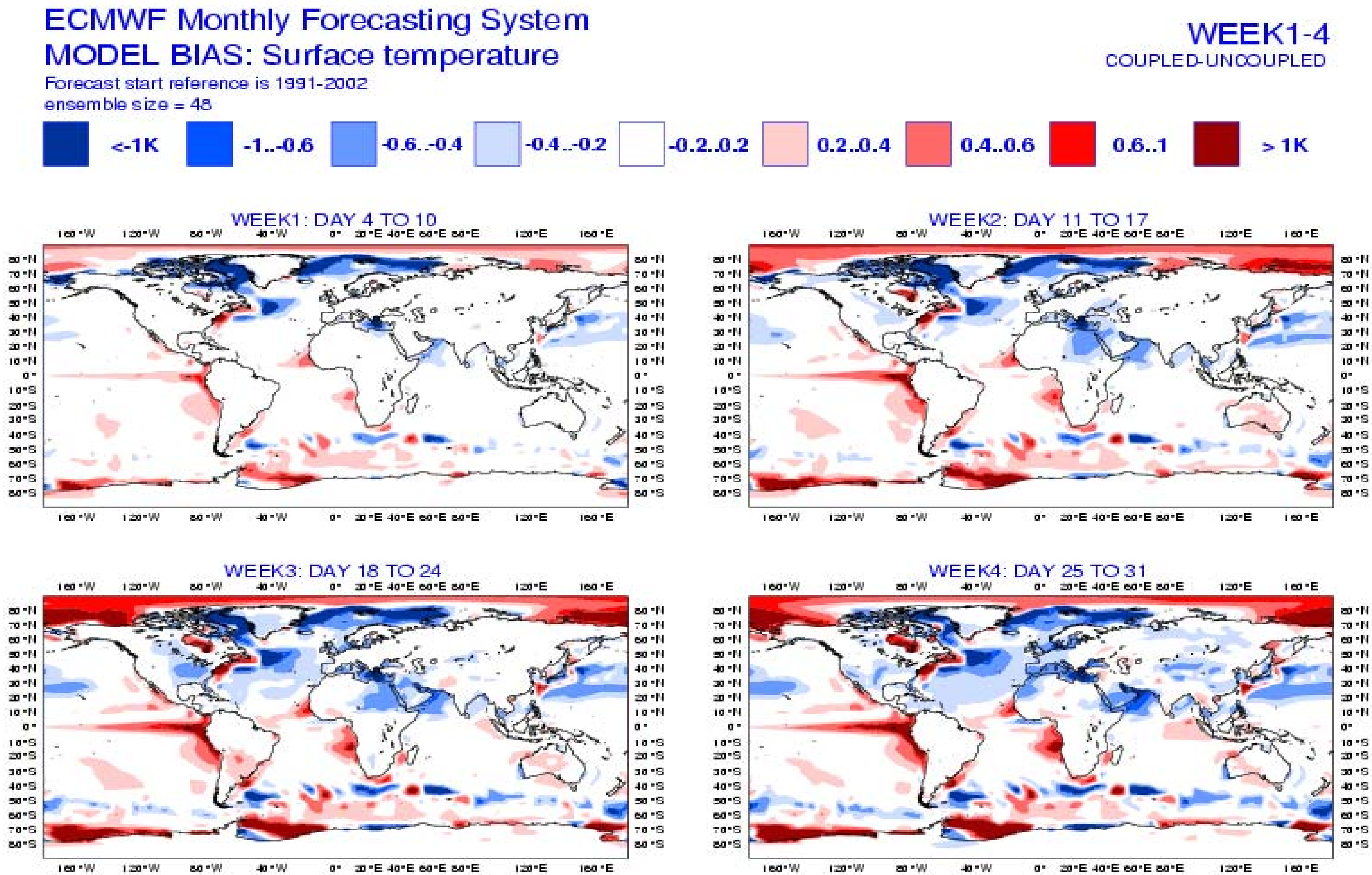
Starting date: 24 April 2002



Starting date: 26 March 2003

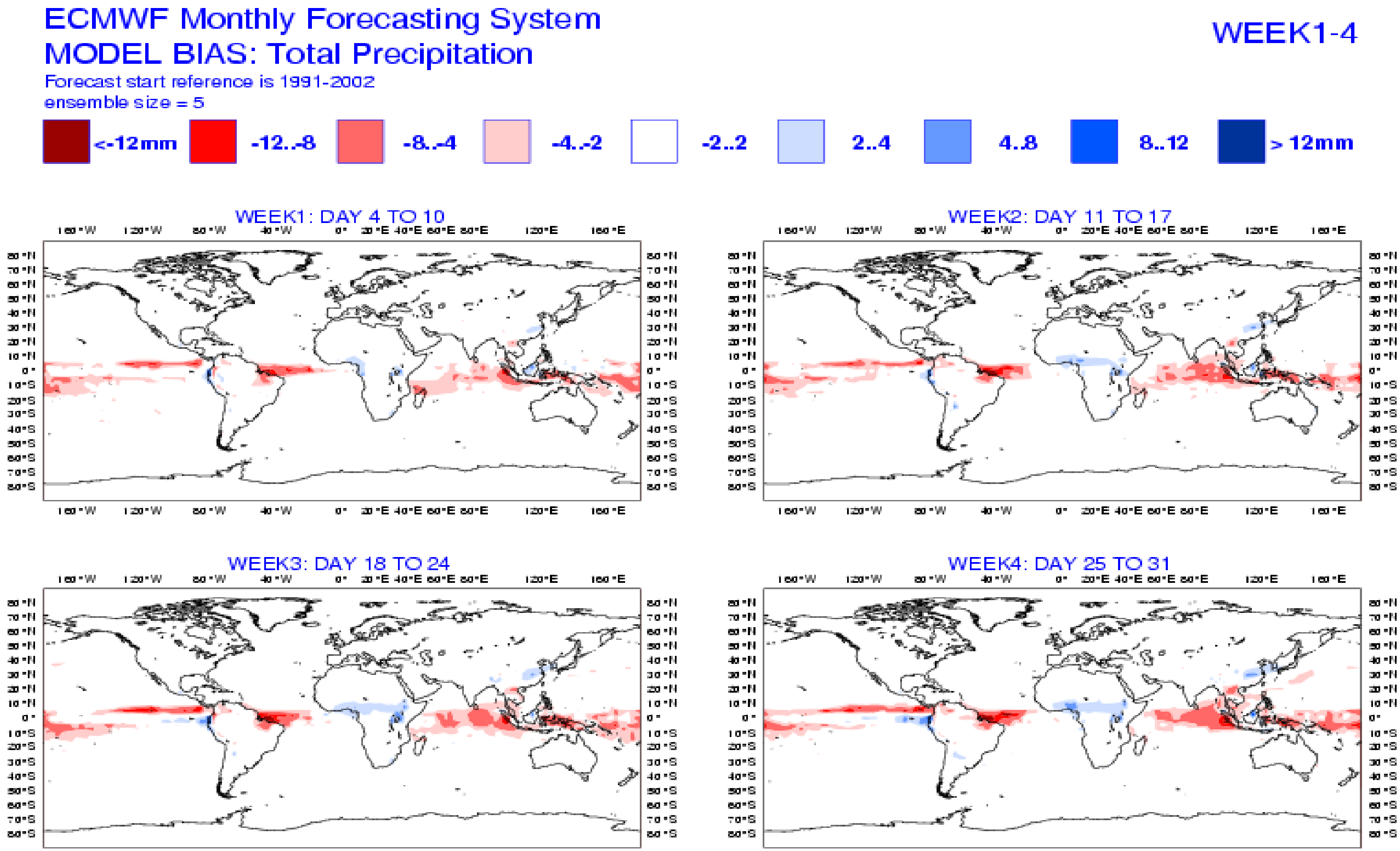


Monthly Forecasting. Bias Surf. Temp.



ECMWF

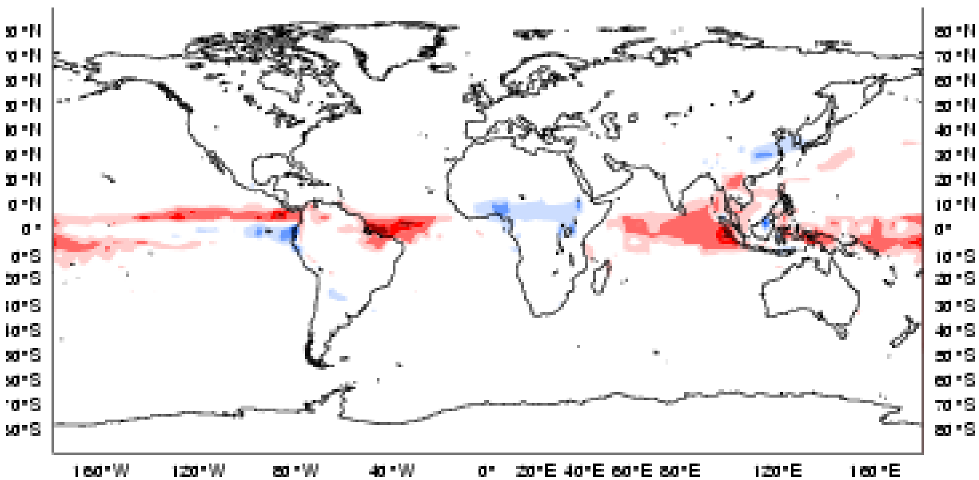
Model Bias



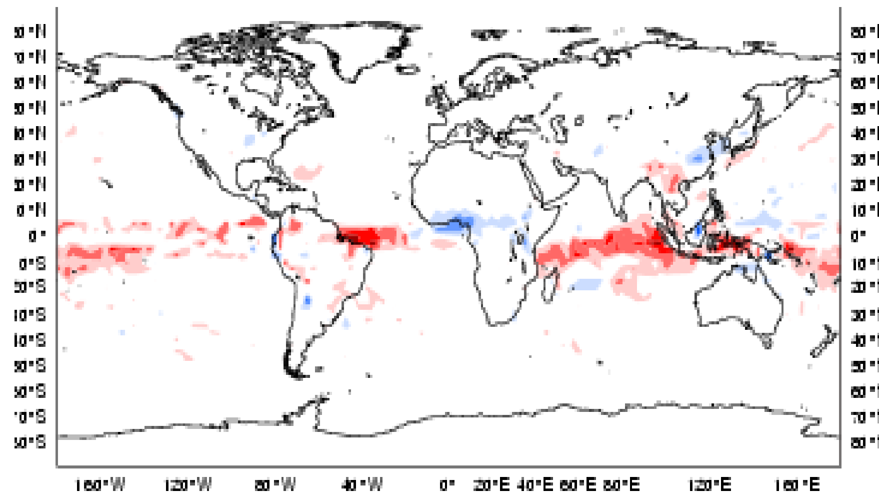
ECMWF

Model Bias (Total Precipitation)

Ocean-atmosphere Coupled



atmosphere only



<-12mm | -12..-8 | -8..-4 | -4..-2 | -2..2 | 2..4 | 4..8 | 8..12 | > 12mm

Conclusion

-The model displays some skill in predicting the time evolution of the MJO.

- After about 10 days, the amplitude of the MJO simulated by the coupled GCM is reduced by a factor 2.

-The model has some problems in propagating the MJO across the maritime continent.

- The model displays some significant systematic errors in SSTs and precipitation. The atmospheric bias comes from the atmospheric model, rather than from the bias in SSTs.

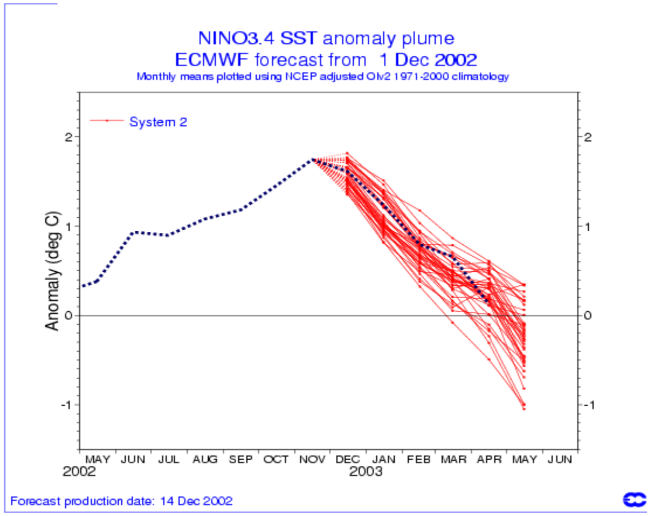
Considerations

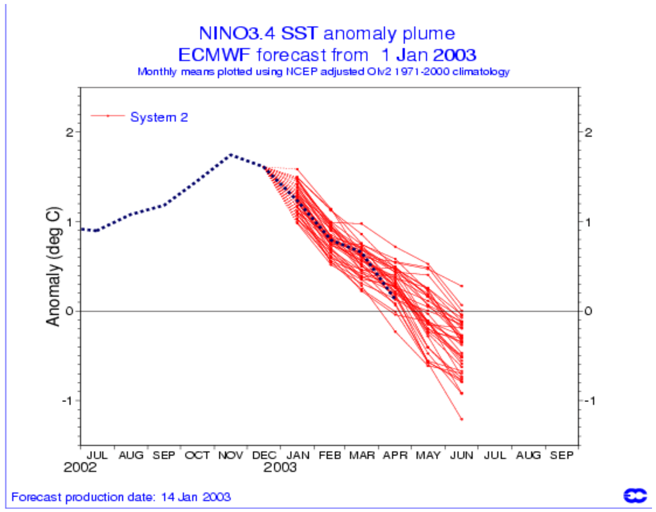
- What is the effect of the MJO? On El Nino, on lower frequencies.
- What about the Indian ocean?
- What about the extratropics.
- Can we extend the climate record?
- Intermediate models can be useful.

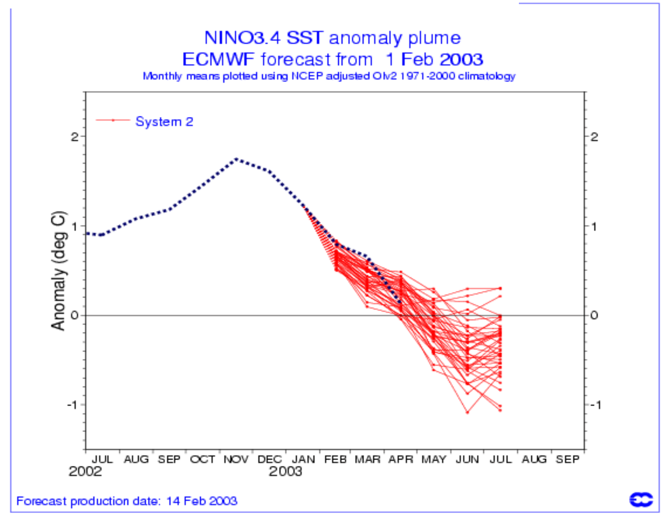
WWB/MJO debate 2nd Dec 02

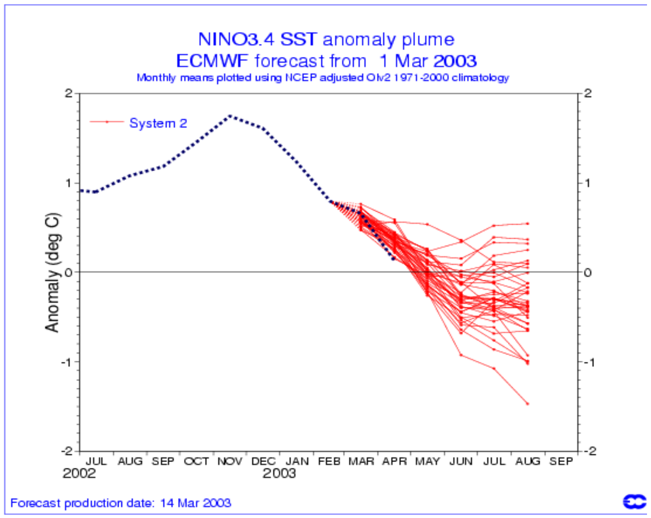
- “..forecast models showing El Nino near its peak. ECMWF shows this particularly strikingly.”
- “My conjecture is that these weak forecasts would be correct in the absence of stochastic kicks from the MJO but that the next few months will show them to be wrong: this El Nino is going to grow more and continue to be strong for several more months than forecast. Further, the model forecasts will change decisively once the new westerlies are assimilated.”
- Comparison with Nov 1991

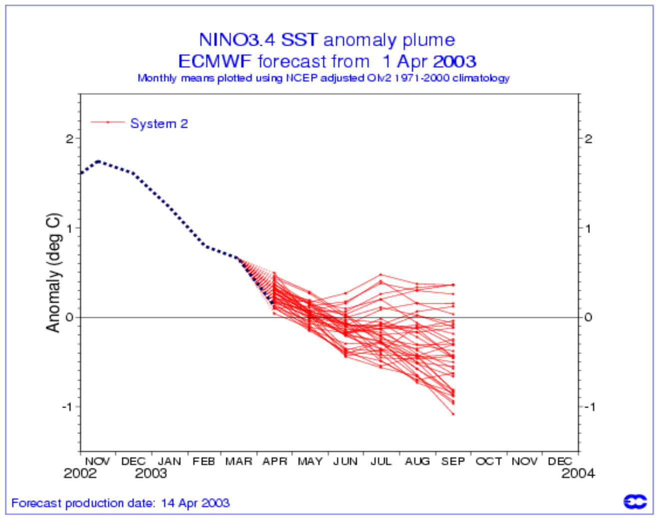
Forecasts for Nino3.4 from S2 Dec – May starts

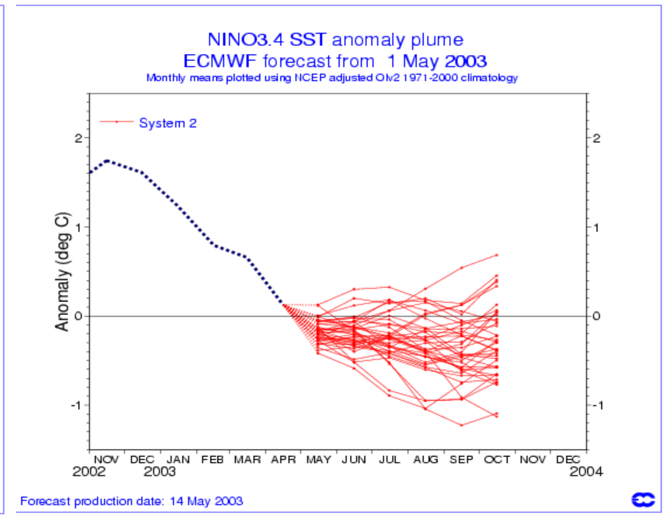


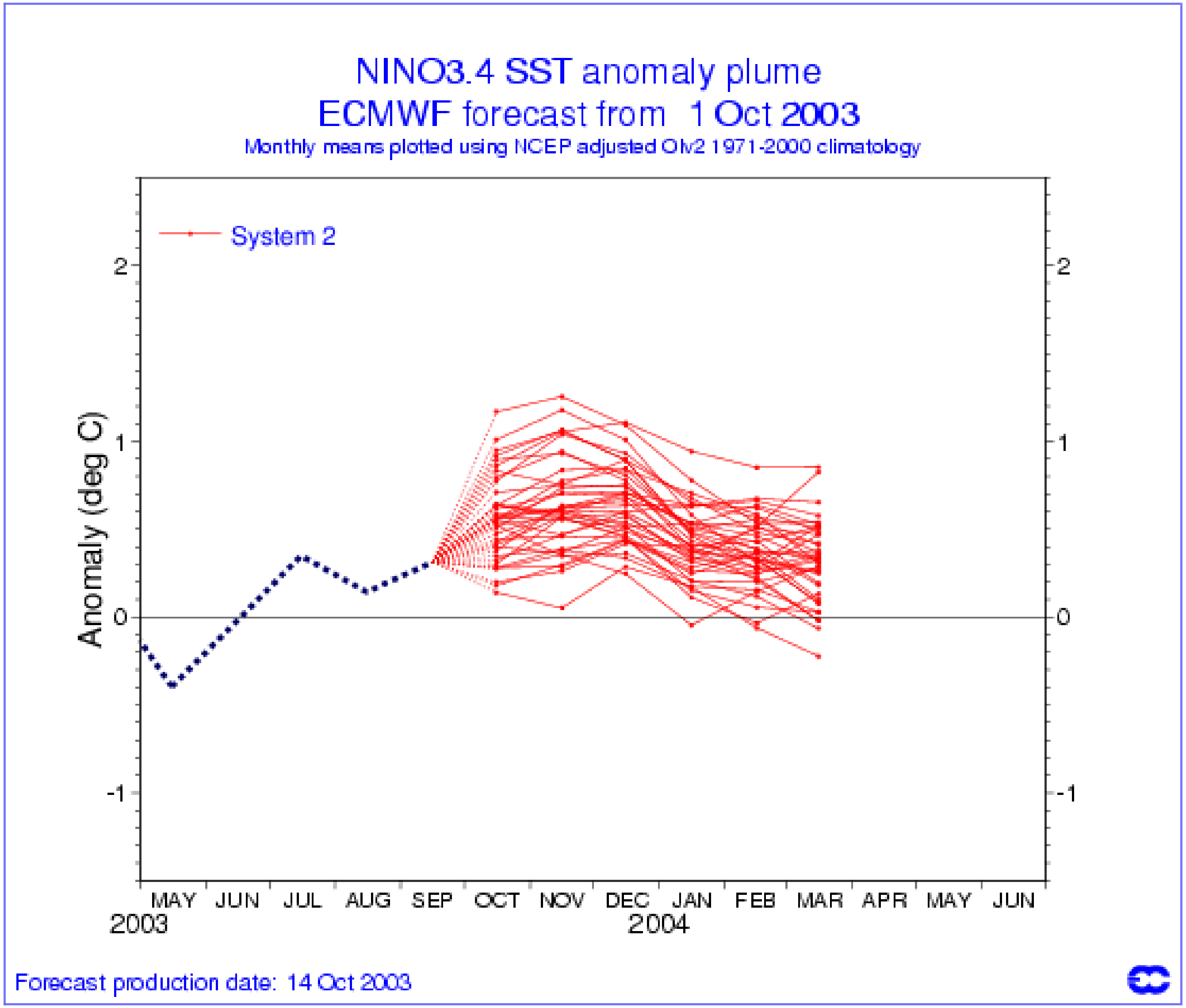




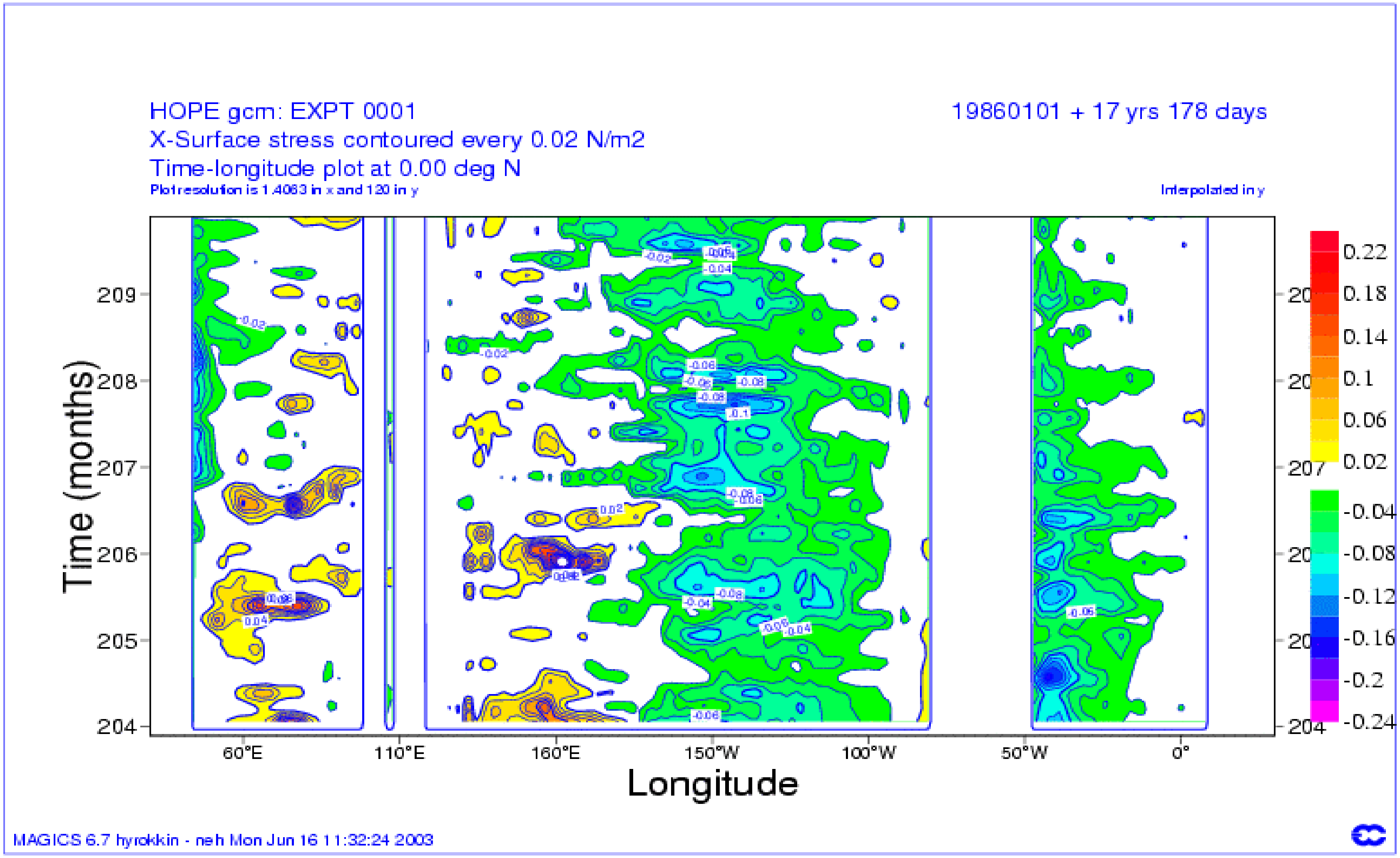




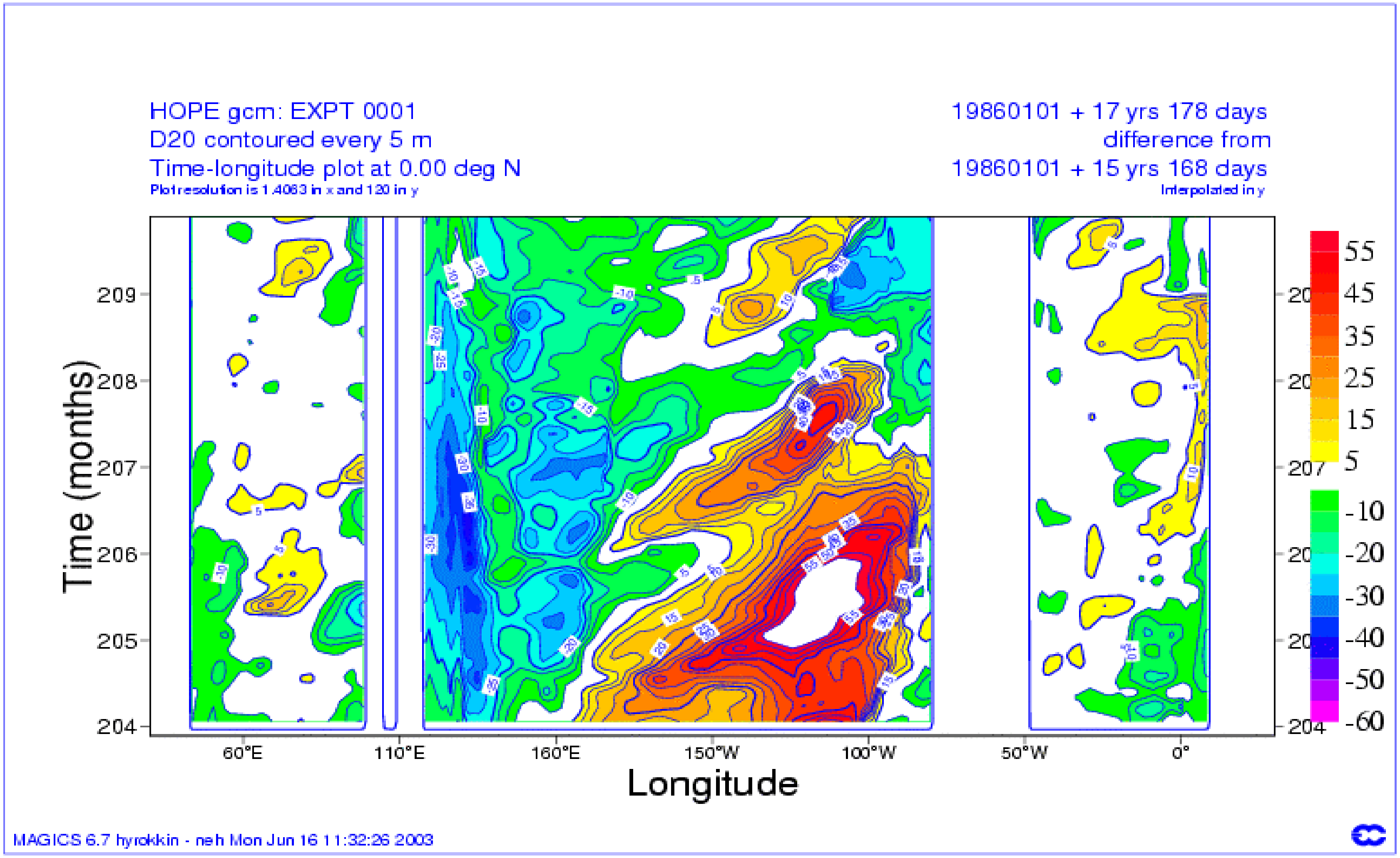


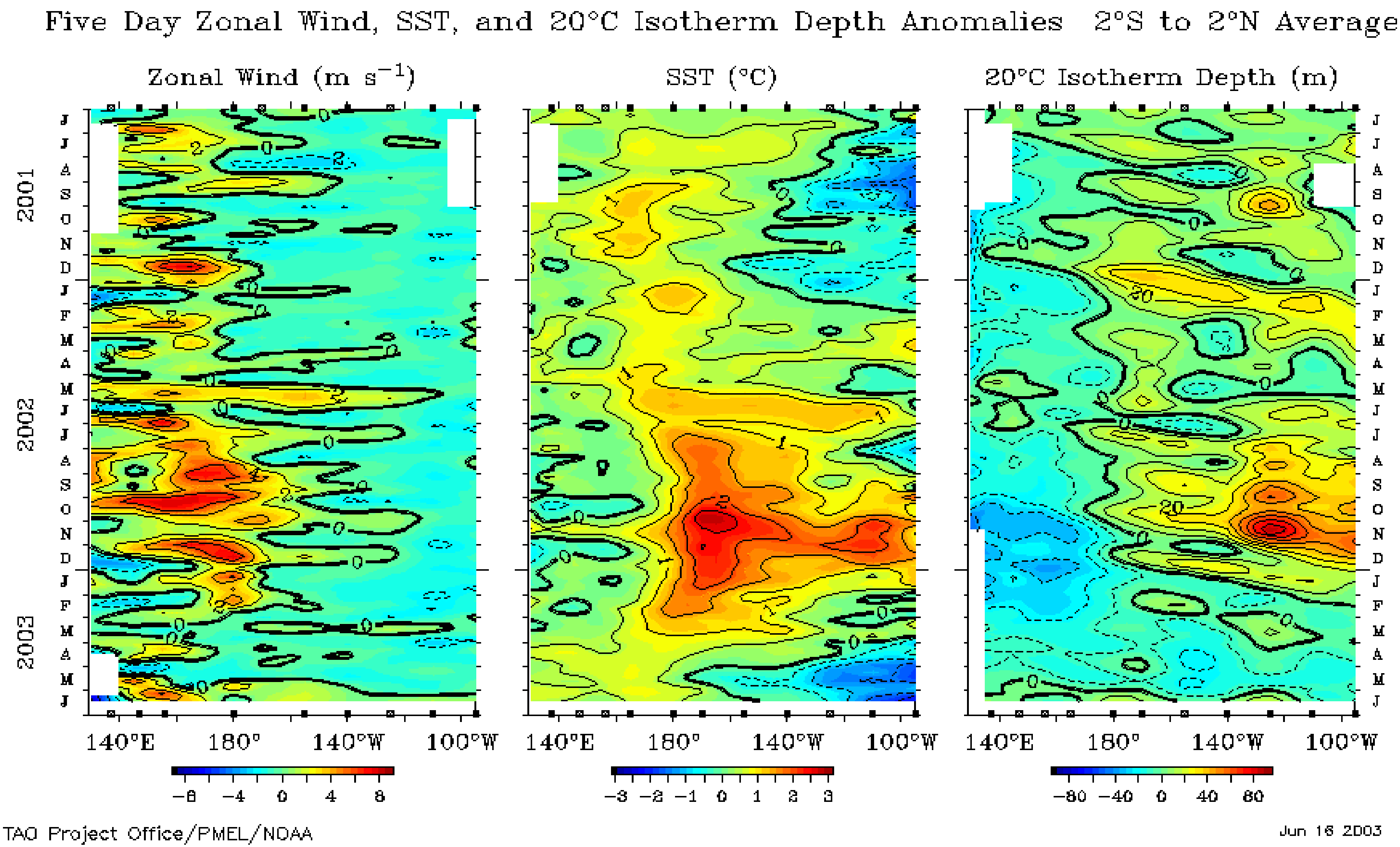

NINO3.4 SST anomaly plume
ECMWF forecast from 1 Oct 2003
Monthly means plotted using NCEP adjusted OIv2 1971-2000 climatology
System 2
Anomaly (deg C)
2
1
0
-1
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
2003
2004
Forecast production date: 14 Oct 2003

Wind stress from 1 Oct 2002 for 6 months

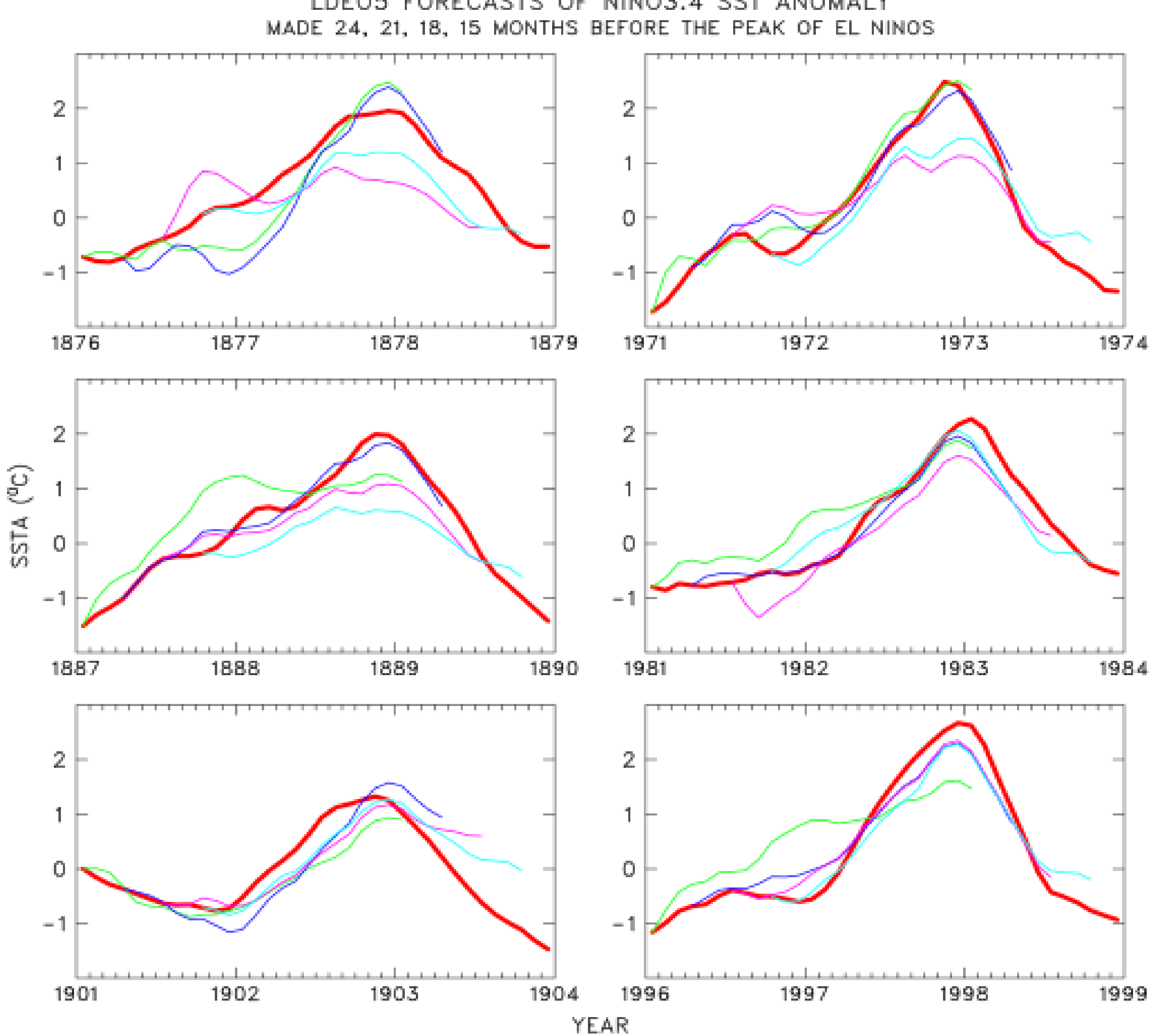


D20 for 6 months from Oct 2002





Five Day Zonal Wind, SST, and 20°C Isotherm Depth Anomalies 2°S to 2°N Average
Zonal Wind (m s^{-1})
SST (°C)
20°C Isotherm Depth (m)
2001
2002
2003
140°E
180°
140°W
100°W
TAO Project Office/PMEL/NOAA
Jun 16 2003



Chen, Kaplan and Cane, in prep

Balmaseda, Davey, Anderson, Decadal and seasonal prediction skill J Clim 95

- Marked variation in predictive skill as a function of decade (but only a few decades)
- Heat content does not have a ‘spring barrier’ as does SST. (Maybe a weaker winter barrier). Combination of heat content and SST should give better predictions.