

Seasonal prediction and coupled model development activities at JAMSTEC

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The SINTEX-F Coupled GCM

(Luo et al. GRL 2003, J. Clim. 2005a; Masson et al. GRL 2005)

1. Model components:

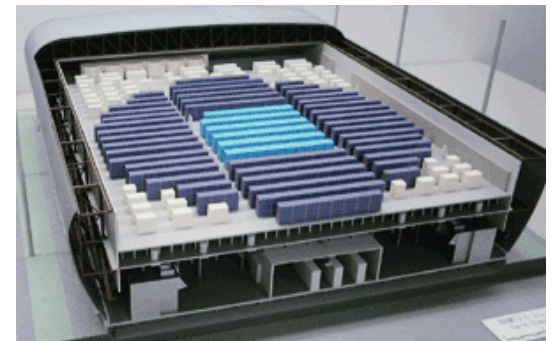
AGCM (MPI, Germany):	ECHAM4 (T106L19)
OGCM (LODYC, France):	OPA8 ($2^\circ \times 0.5^\circ \sim 2^\circ$, L31)
Coupler (CERFACS, France):	OASIS2

* *No flux correction, no sea ice model*

2. International collaborators:

<i>LODYC:</i>	OPA model group
<i>INGV (Italy):</i>	Antonio Navarra's group
<i>MPI-Met:</i>	ECHAM model group
<i>CERFACE:</i>	OASIS coupler group
<i>PRISM project group</i>	

[Developed on the Earth Simulator](#)

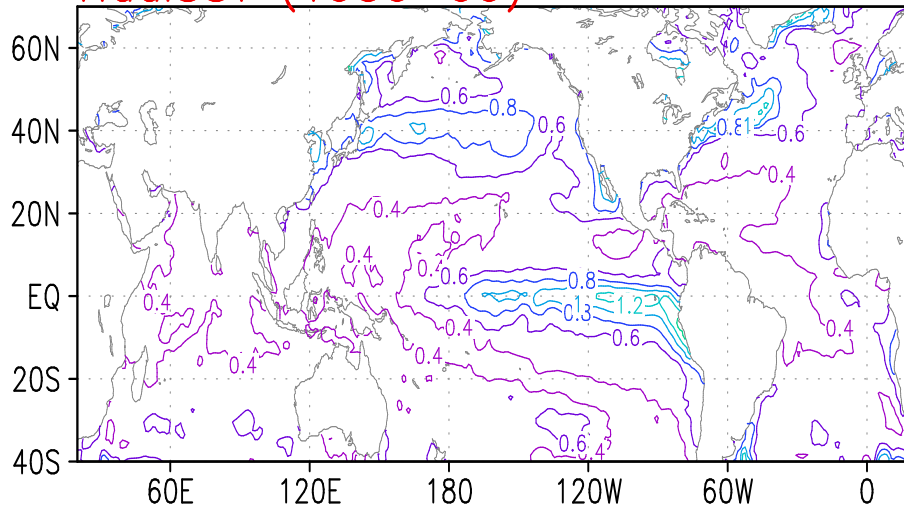


ENSO simulation

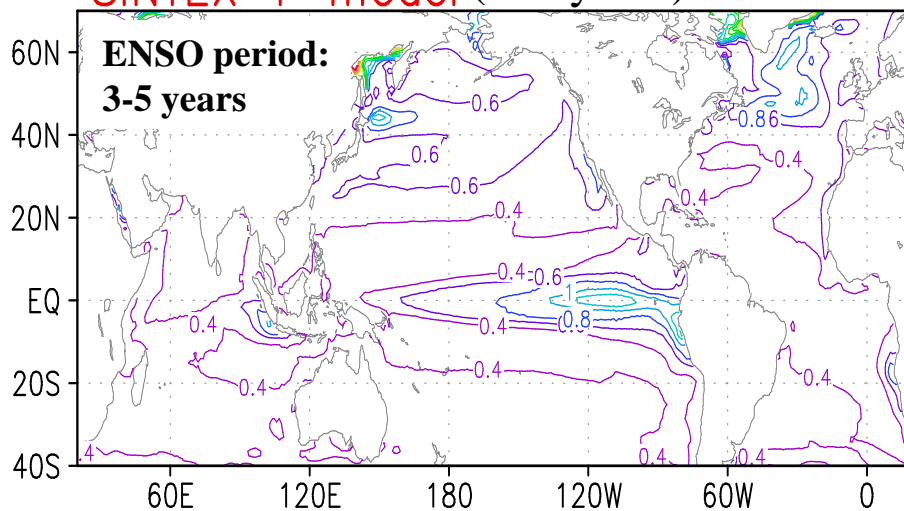
Luo et al. 2003

Standard deviation of SST

HadISST (1950-99)

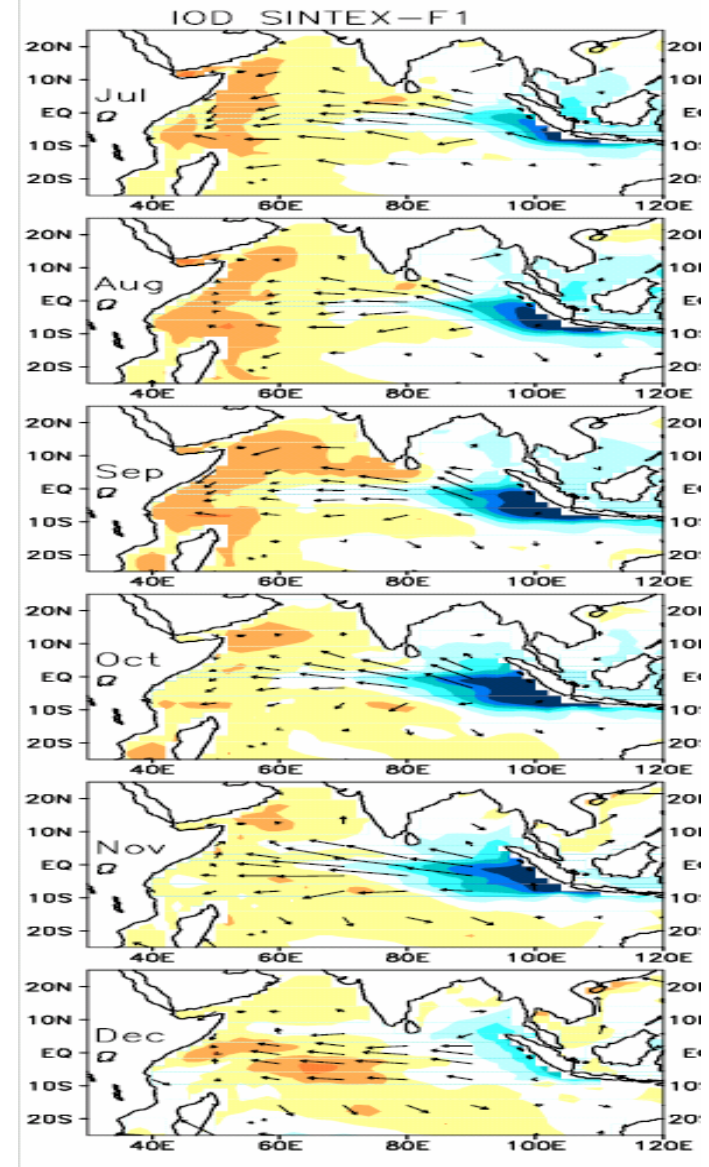


SINTEX-F model (200 years)



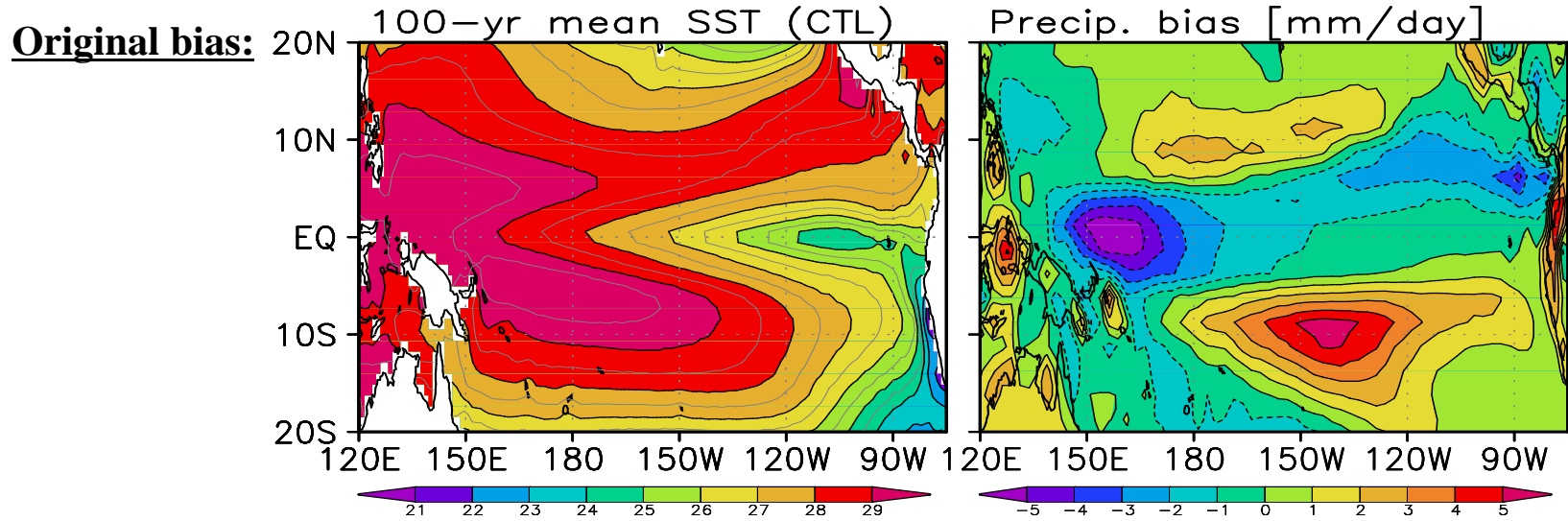
IOD simulation

Yamagata et al. 2004

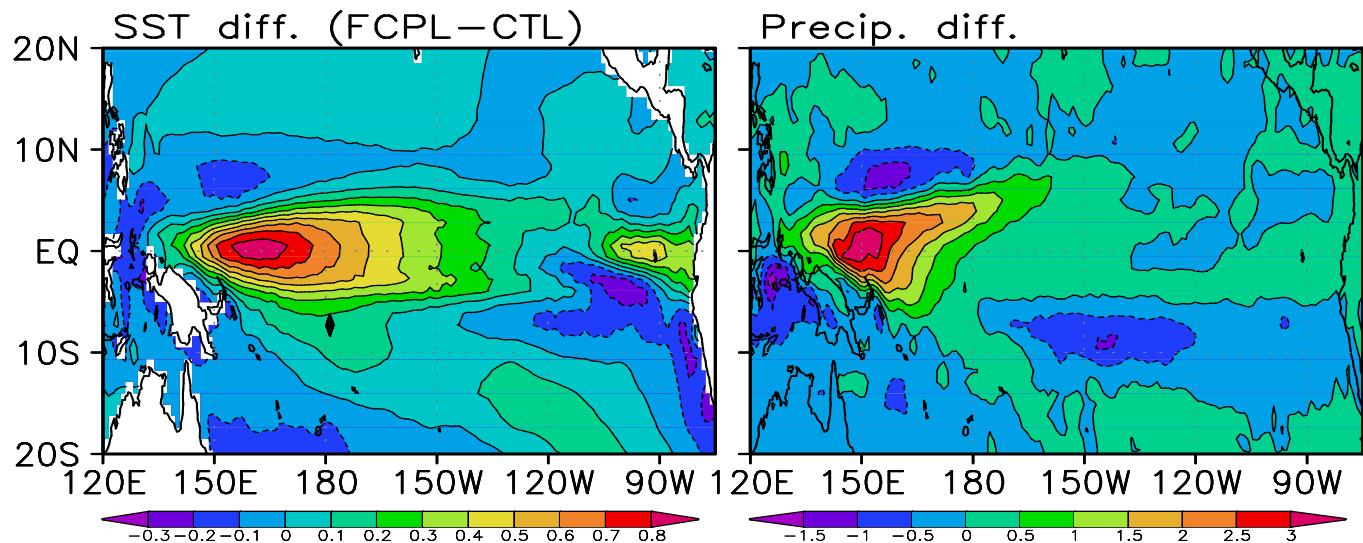


Reducing the model climatology bias

Luo et al. J. Climate 2005a



After improving the coupling physics (velocity is now continuous across the air-sea interface):



Climate studies using the SINTEX-F coupled model (>40 papers published/accepted)

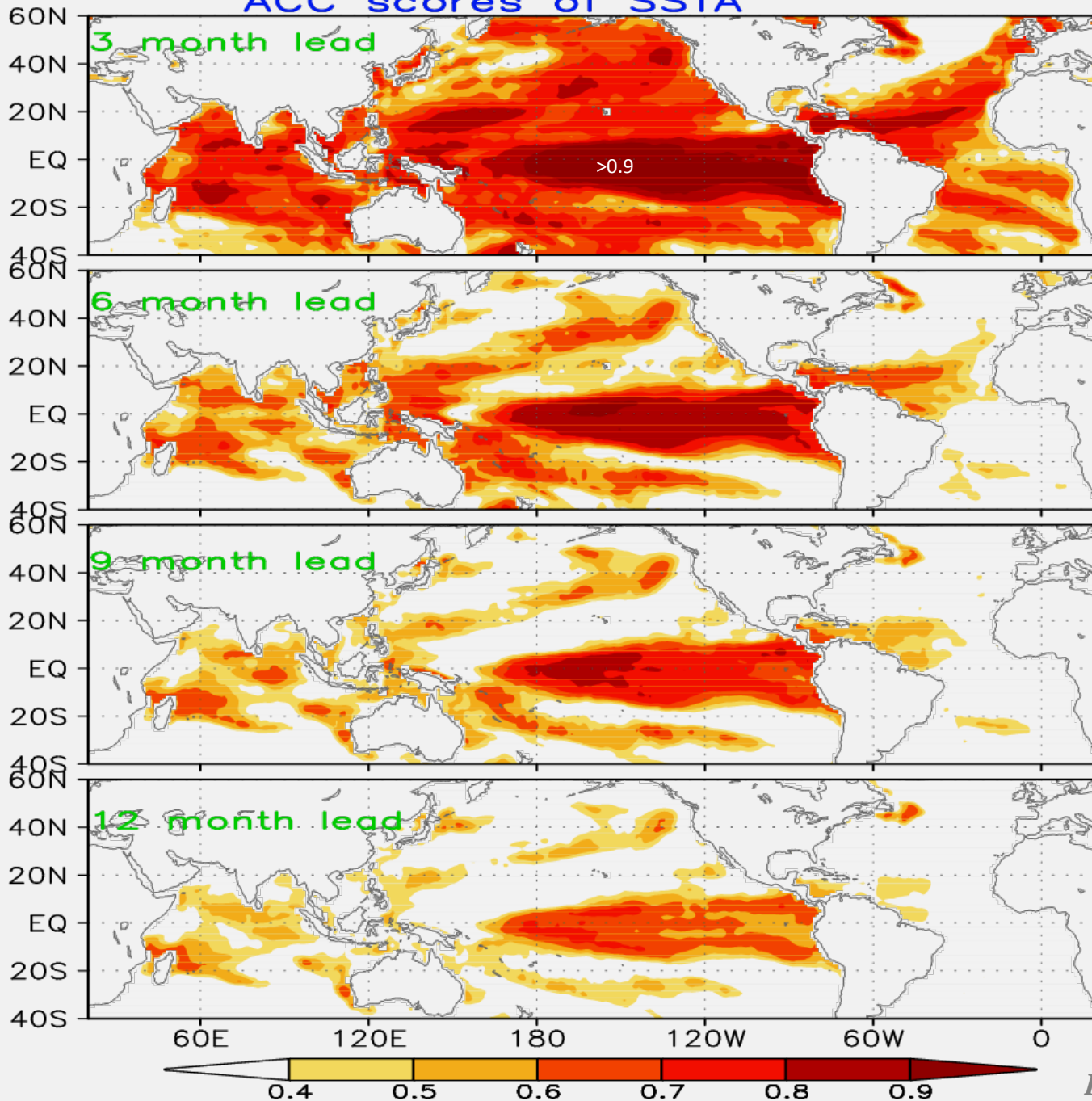
- Asian monsoon (onset and variations)
- Intraseasonal oscillations (winter and summer)
- El Niño-Southern Oscillation (ENSO)
- Indian Ocean Dipole (IOD)
- Decadal variations
- **Seasonal-to-interannual predictions**

Dynamical climate prediction

To achieve good prediction skills:

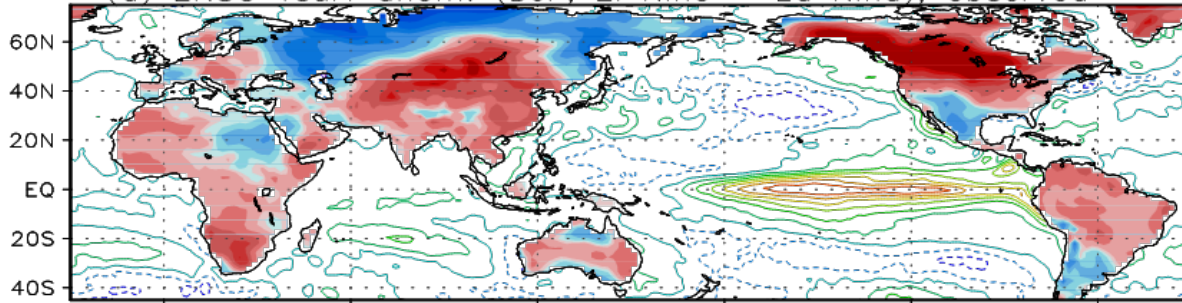
1. **Develop a good coupled OAGCM:**
Realistic simulations of ENSO & IOD.....;
Realistic climatology.
2. **Generate good initial conditions:**
Close to the observations;
Compatible between the ocean and atmosphere.
3. **Design a good ensemble forecast scheme:**
Uncertainties: initial conditions & model physics.

ACC scores of SSTA



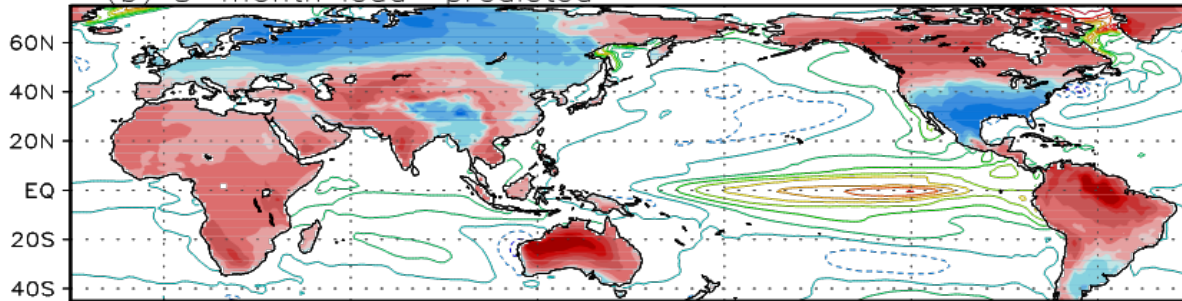
9-member mean hindcast experiment (1982-2004) based on the JAMSTEC semi-multi-model ensemble scheme (only observed SSTs are assimilated for coupled model initialization)

(a) ENSO Tsurf anom. (DJF, El Nino - La Nina); observed



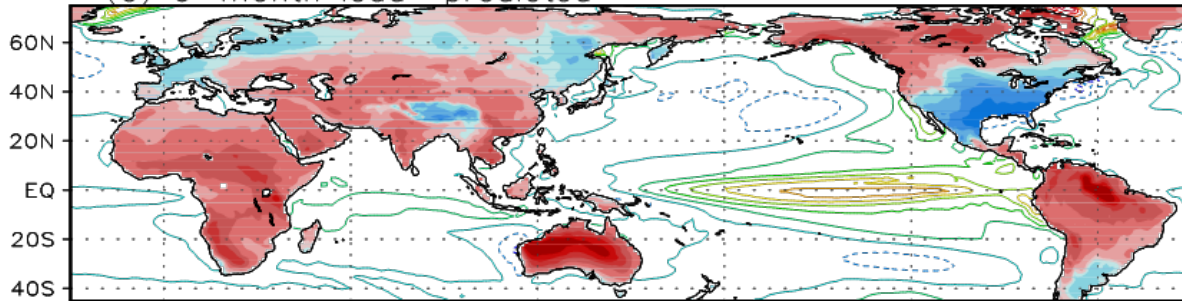
NCEP
obs.

(b) 3-month lead predicted



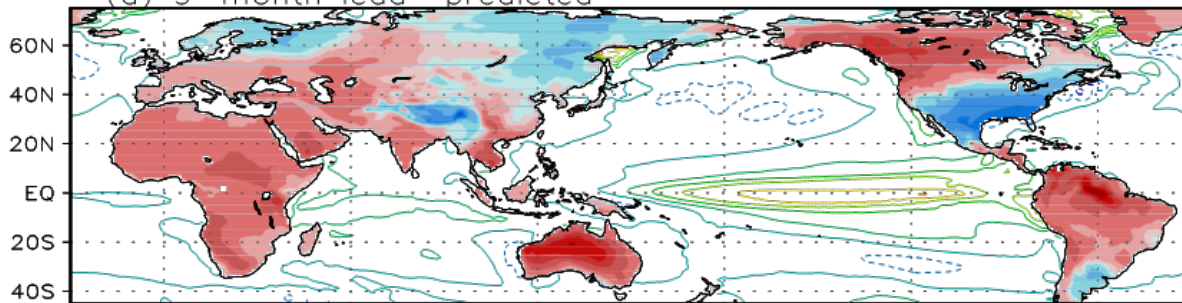
3-month
lead

(c) 6-month lead predicted

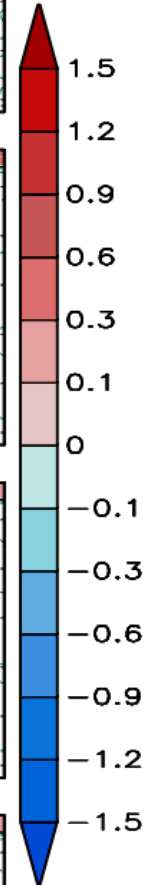


6-month
lead

(d) 9-month lead predicted



9-month
lead



El Nino:

1986/87

1991/92

1997/98

2002/03

La Nina:

1984/85

1988/89

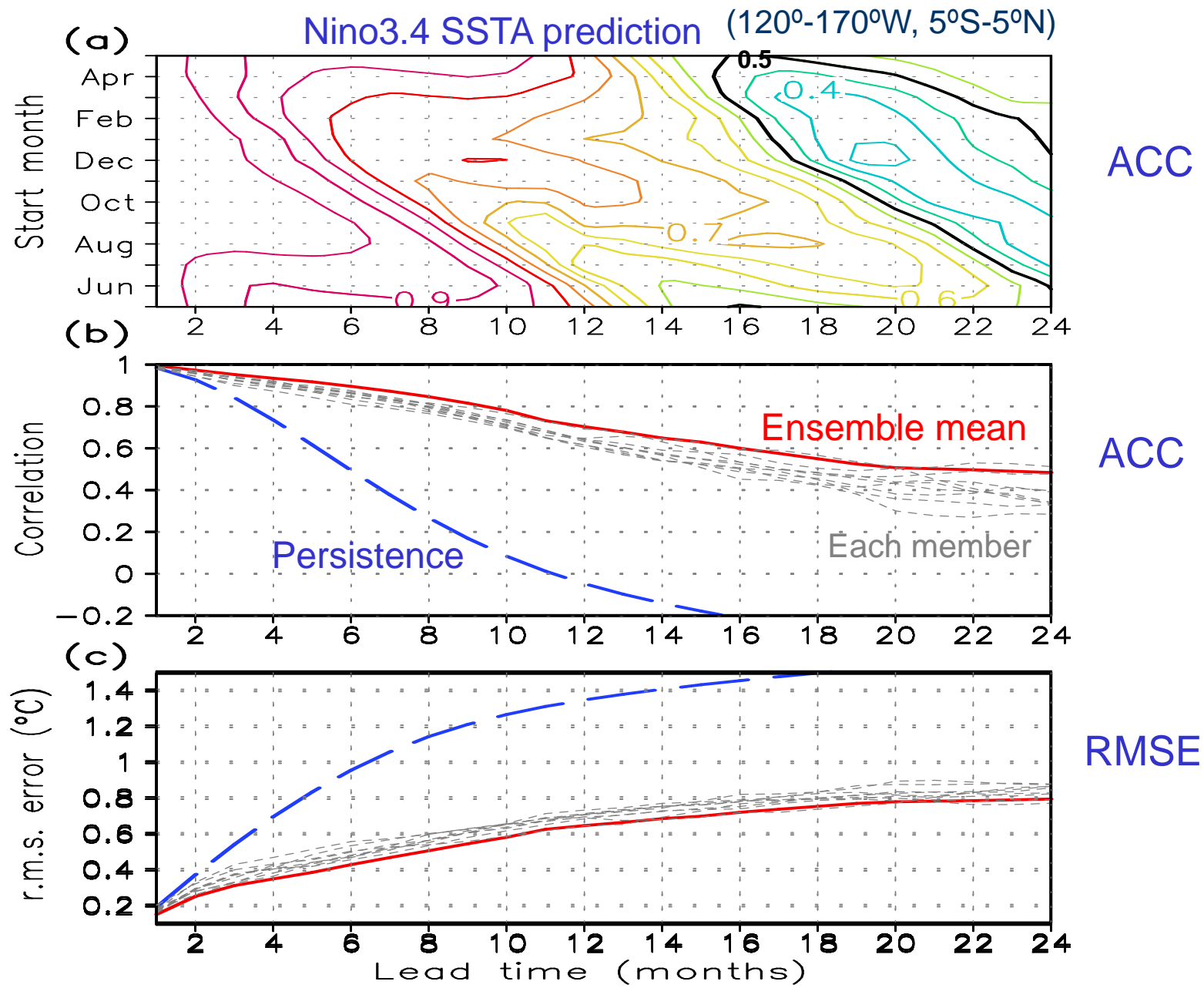
1995/96

1999/2000

CI: 0.3°C

0 60E 120E 180 120W 60W

2-year lead ENSO prediction:



IOD-related anomalies (Sep-Nov)

pIOD:

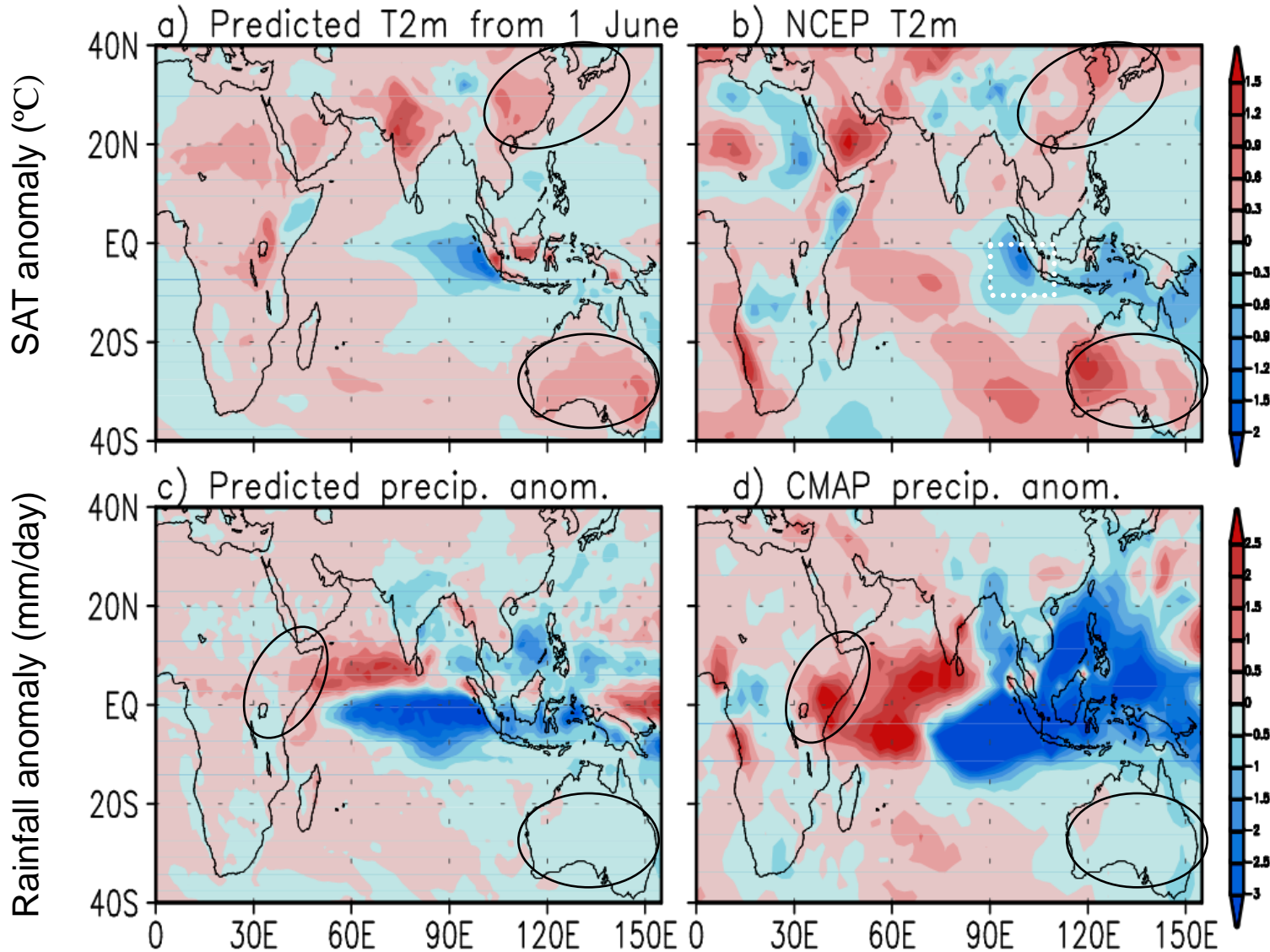
1994

1997

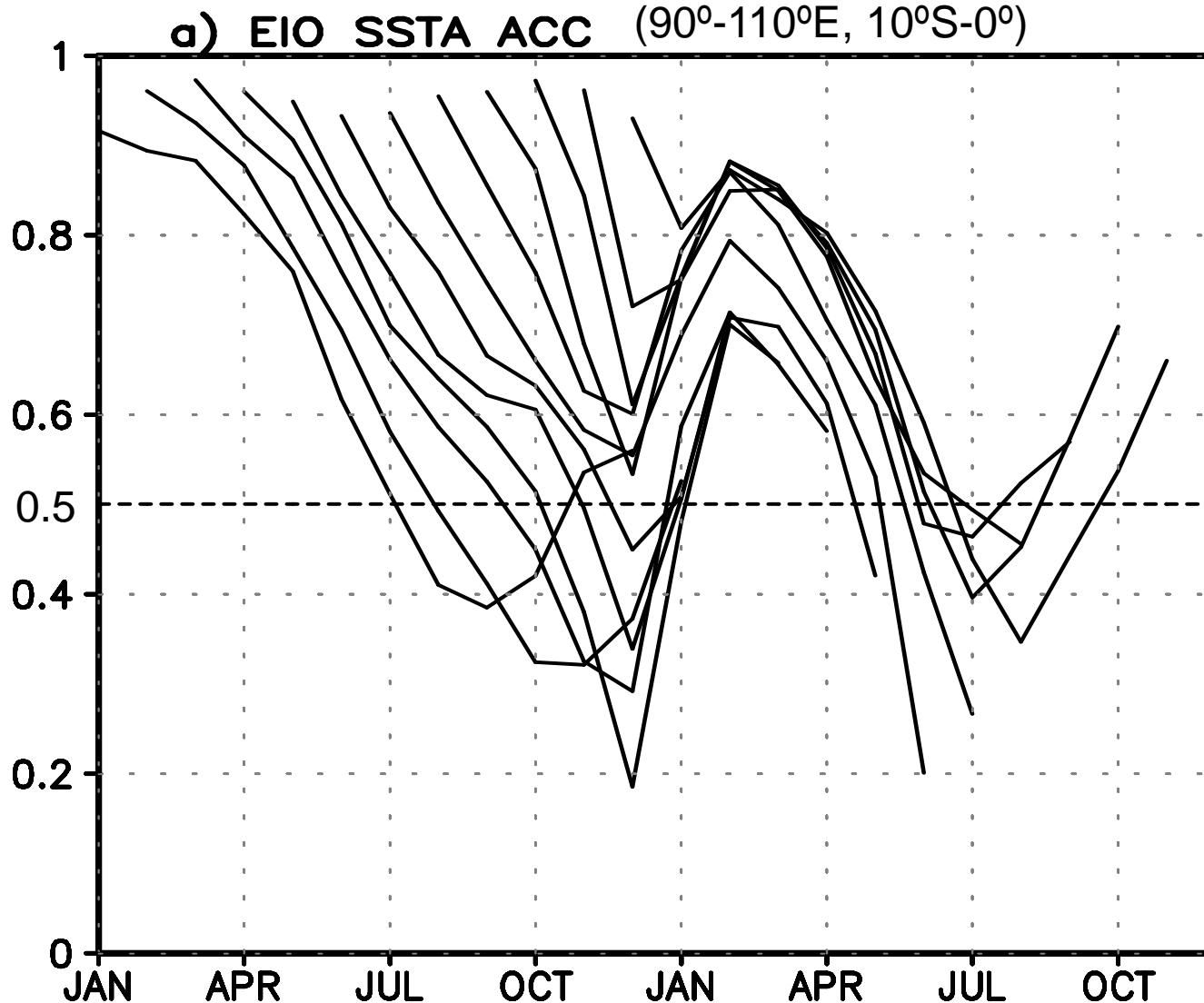
2006

Predictions from 1 June
(9 members)

Observations



Both winter and spring barrier exist



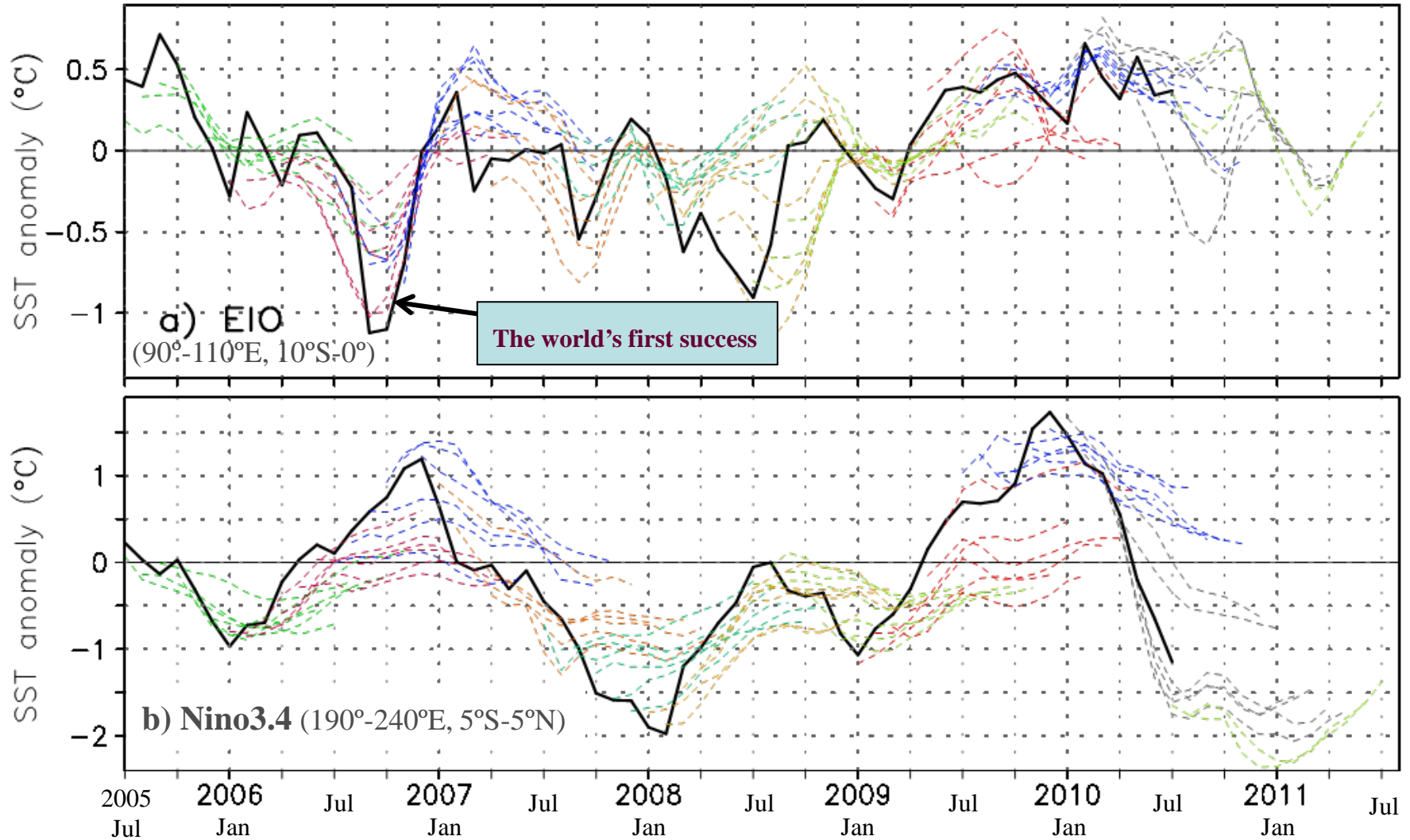
Indian Ocean
Dipole

9-member
ensemble
hindcasts
(1982-2004)

**Predictable up
to ~2 seasons
ahead.**

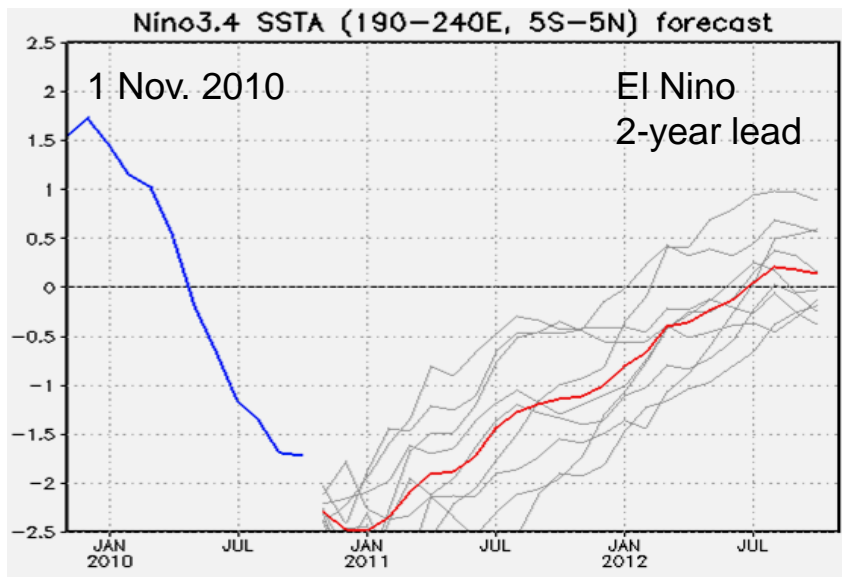
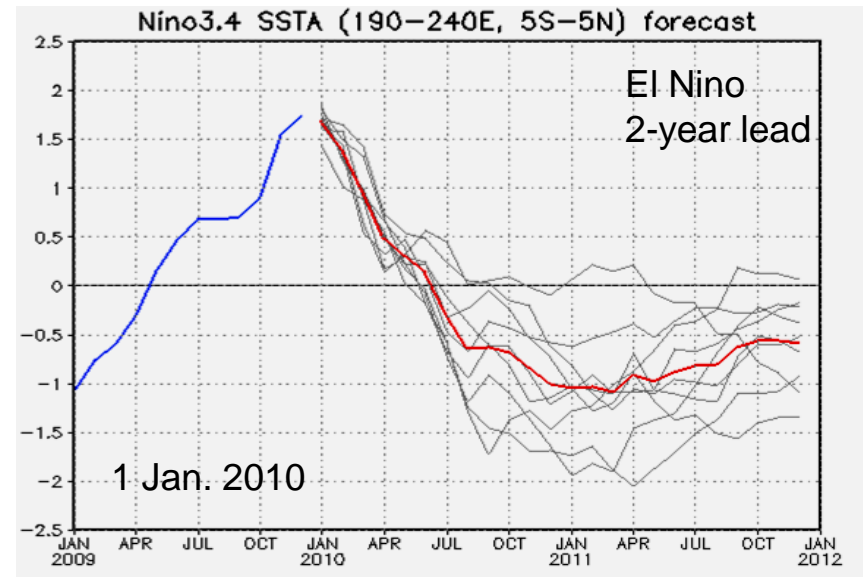
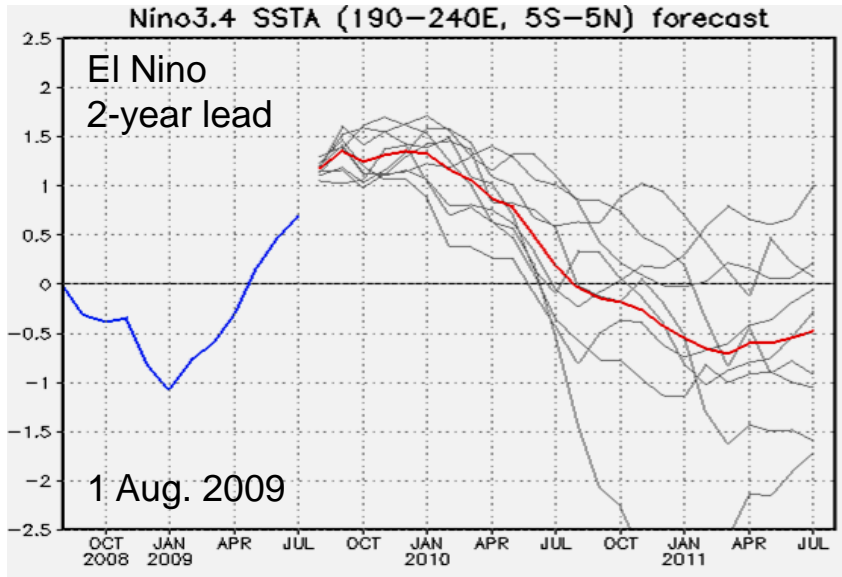
Real time forecasts (SINTEX-F CGCM, 27-member mean)

<http://www.jamstec.go.jp/frcgc/research/d1/iod/index.html>

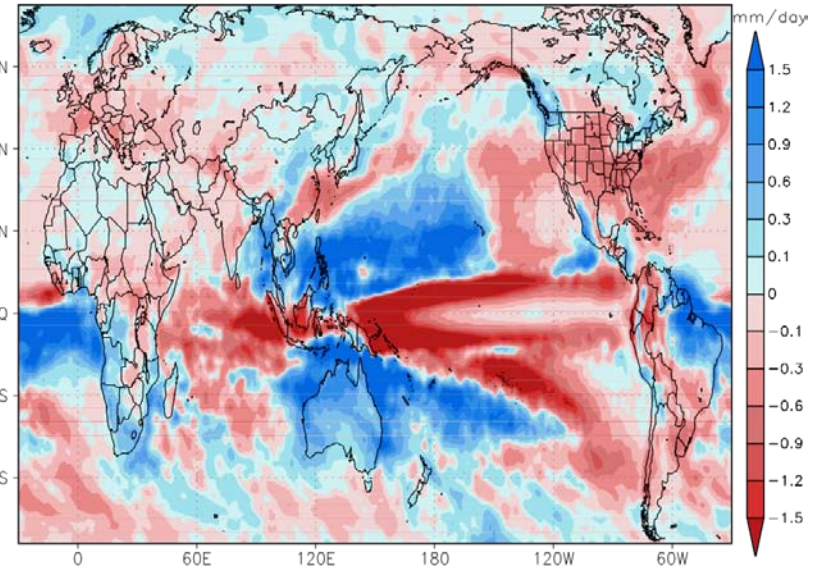


Real time forecasts

(http://www.jamstec.go.jp/frcgc/research/d1/iod/sintex_f1_forecast.html.en)



Predicted MAM2011 tprep anom. from 1nov2010 (27-member)



Global warming:

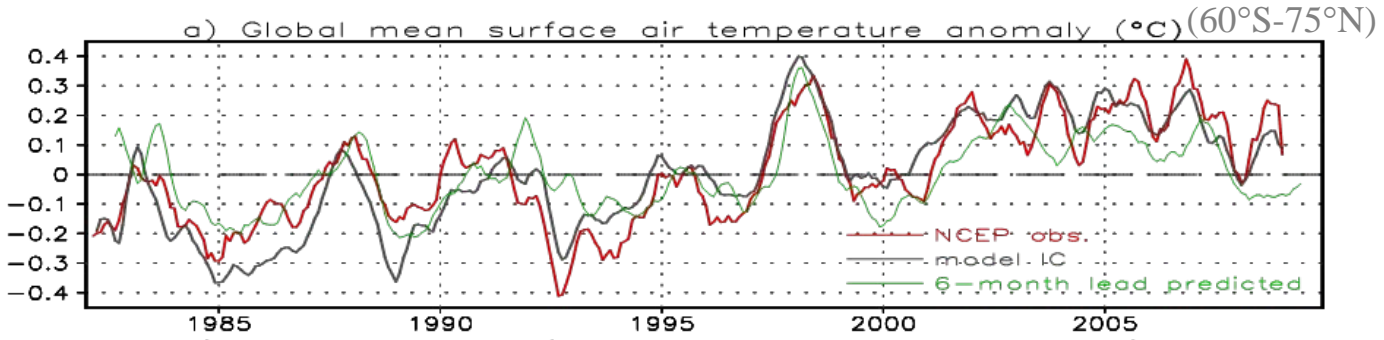
Warming rate

(°C/10-yr):

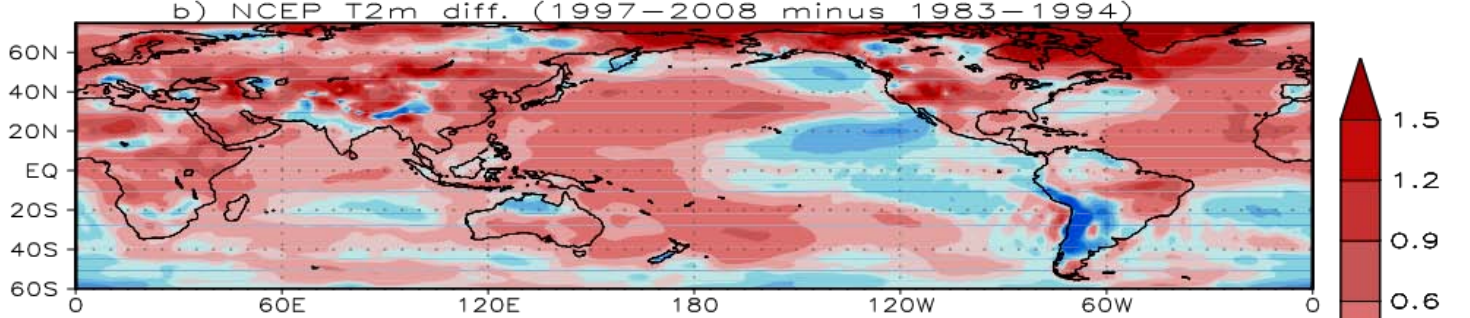
0.14

0.18

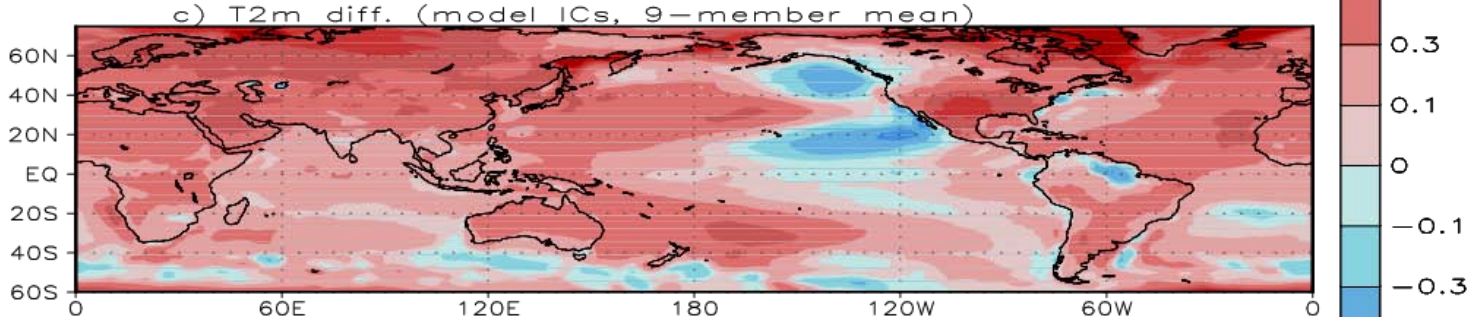
0.06



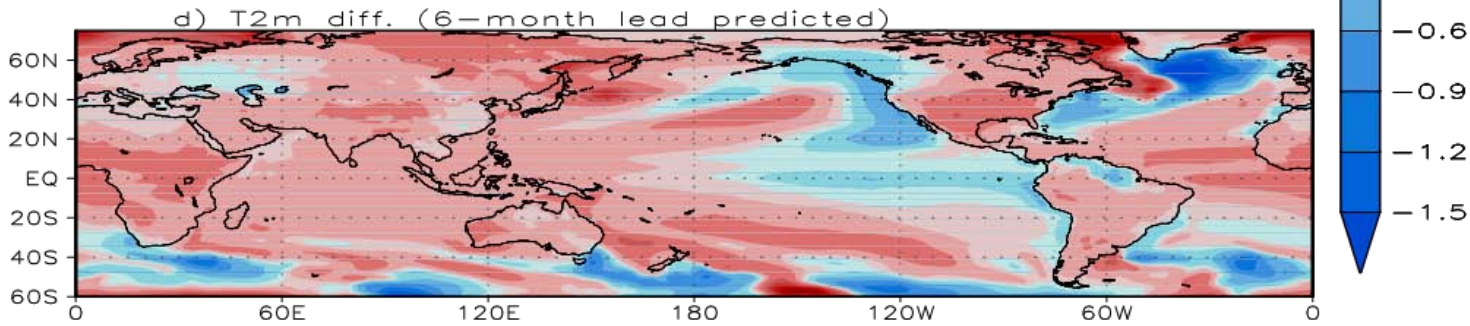
Land: 0.36°C
Ocean: 0.20°C



Land: 0.45°C
Ocean: 0.24°C
(SST forcing with fixed GHGs)

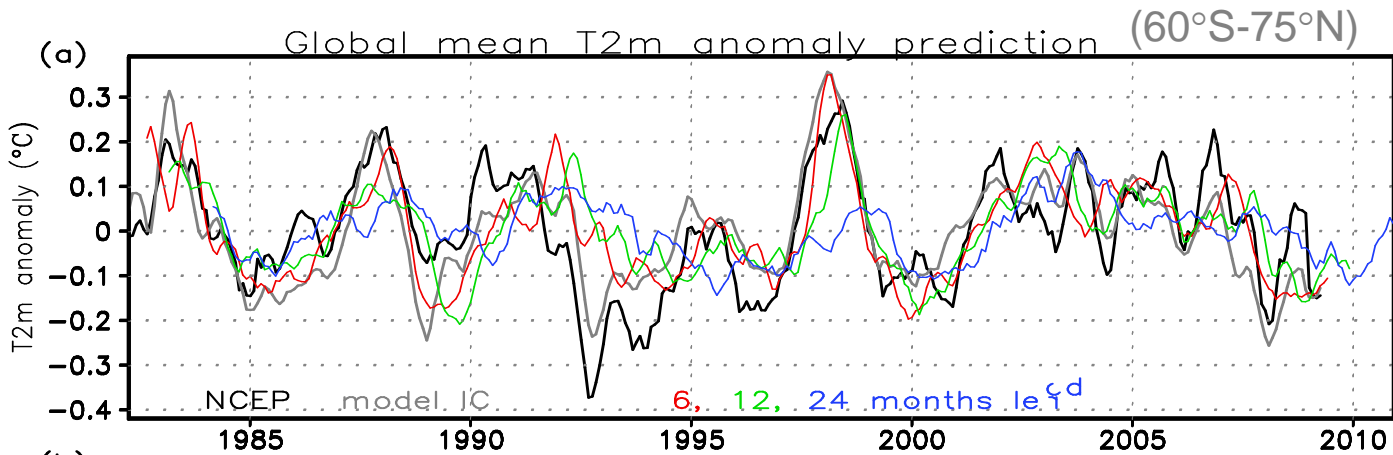


Land: 0.20°C
Ocean: 0.09°C
(with fixed GHGs)

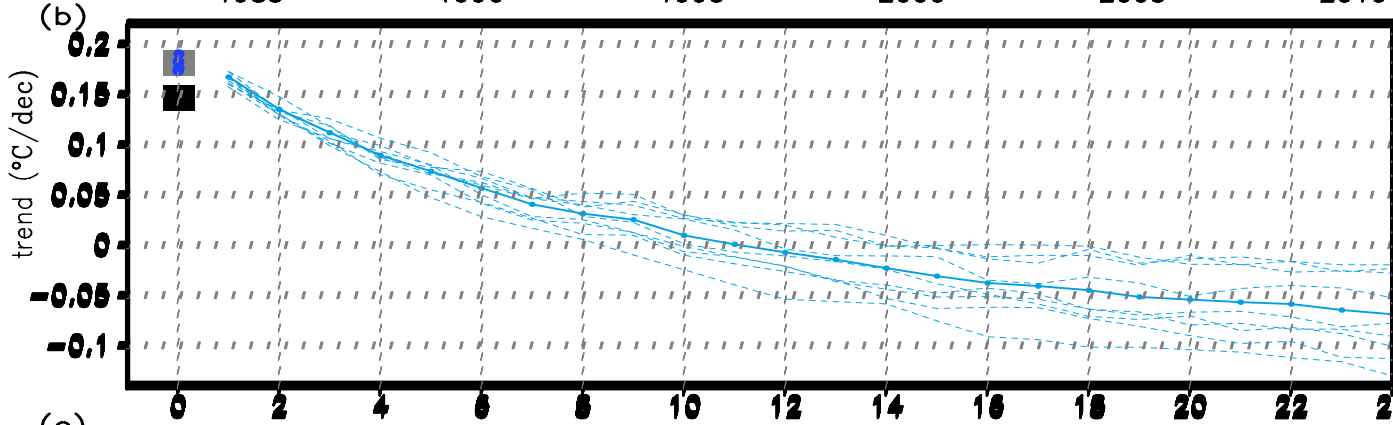


Impact of global warming:

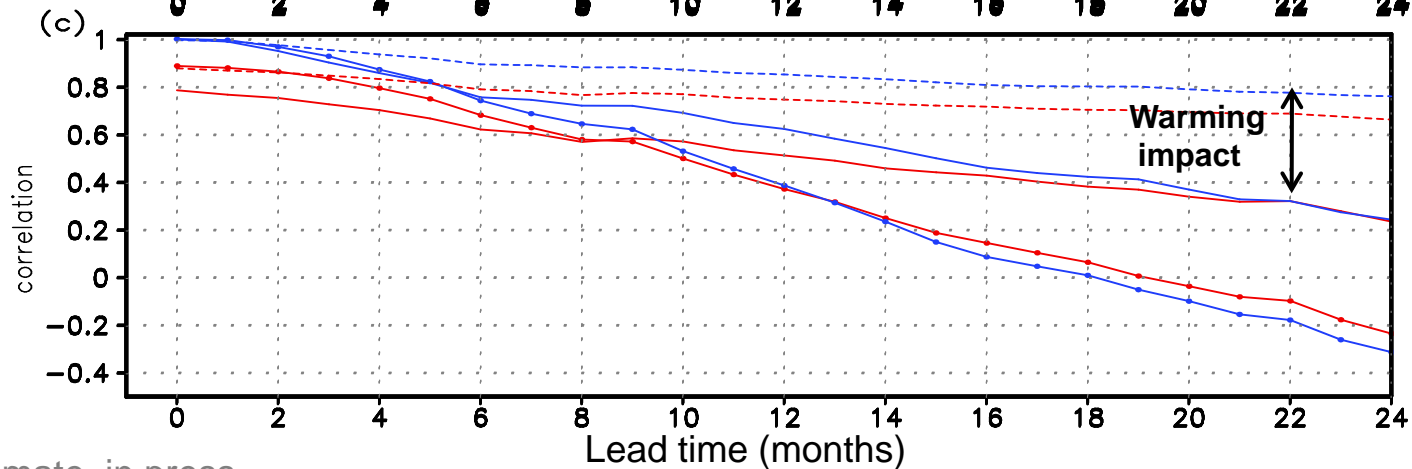
Detrended
global mean
surface air
temperature
(5-month
running mean)



Trend
(1982-2008)



Skills for original,
detrended, and
“perfect trend”
time series

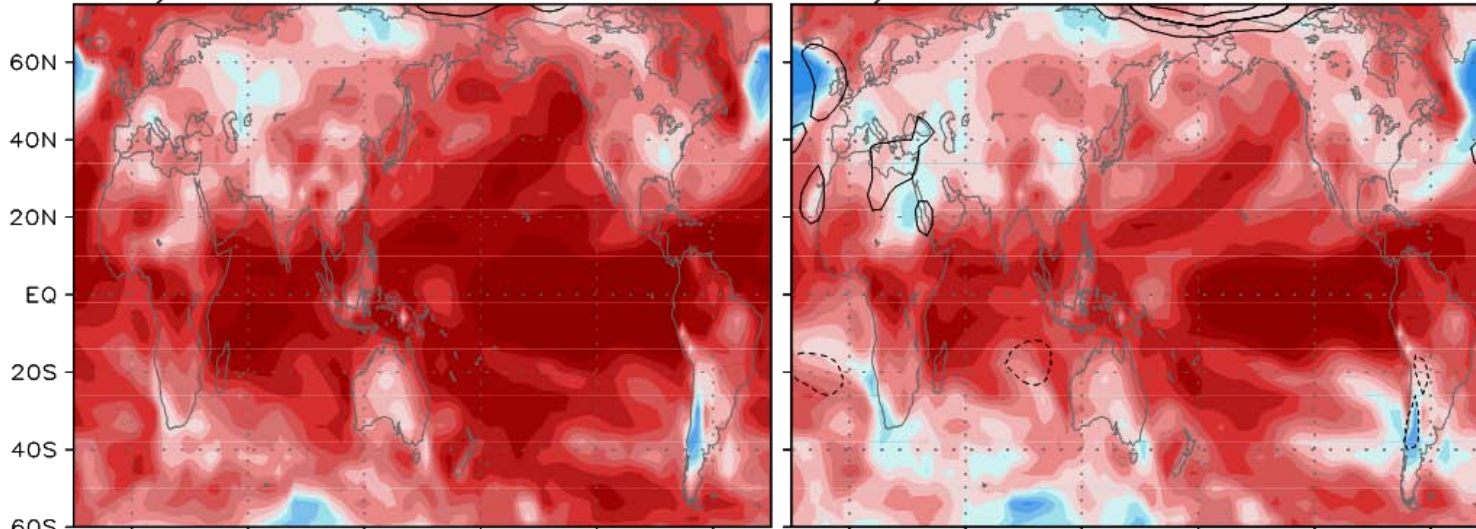


Impact of global warming on climate predictability

ACC of global T2m anomaly

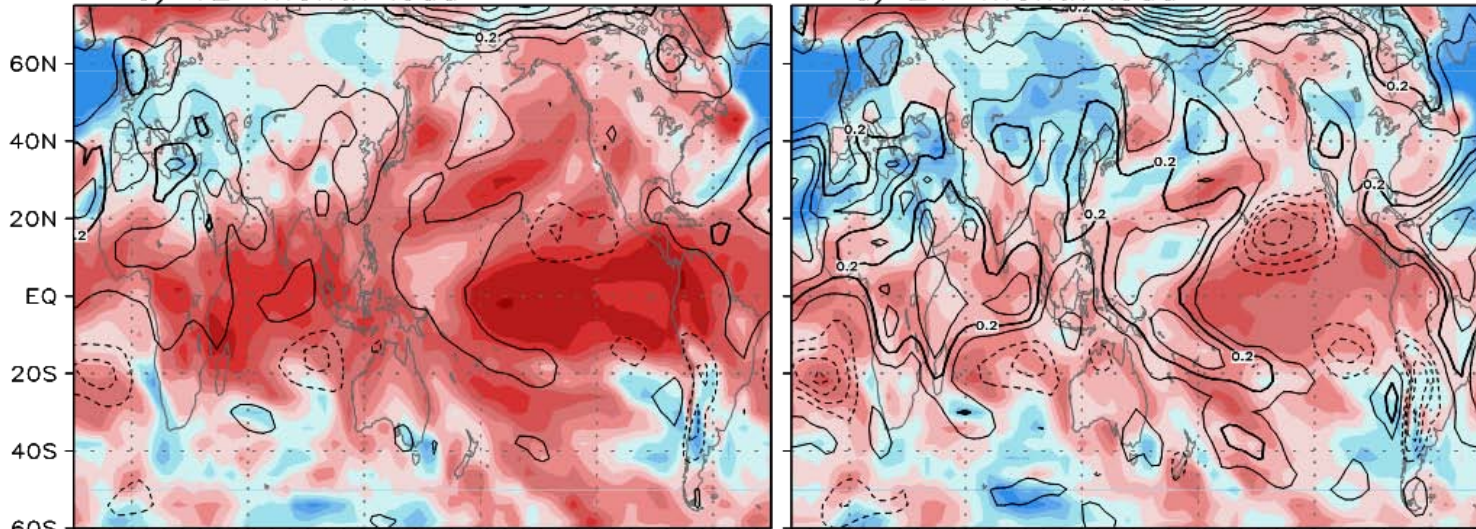
a) 3-month lead

b) 6-month lead



c) 12-month lead

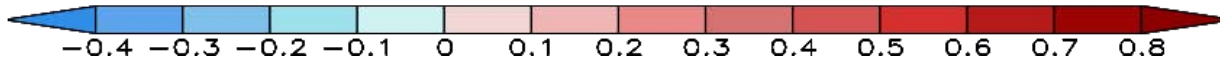
d) 24-month lead



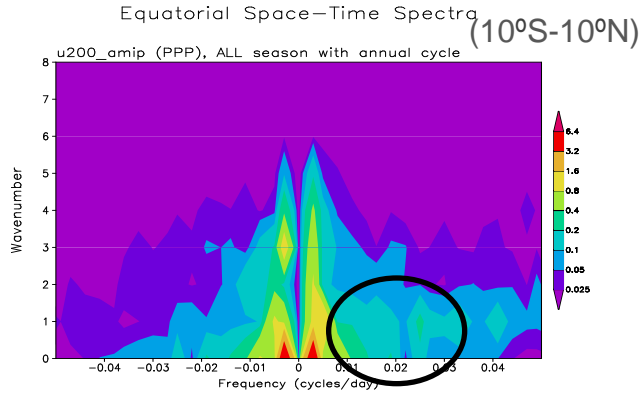
9-member ensemble hindcast (1982-2008) with fixed GHGs

Contour: ± 0.1 , ± 0.2 , ± 0.3 ,

4° x 4° grid cells

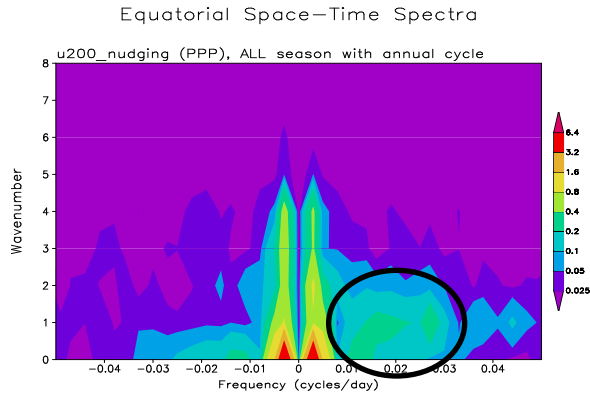


Toward seamless climate prediction (intraseasonal-seasonal-interannual-decadal)

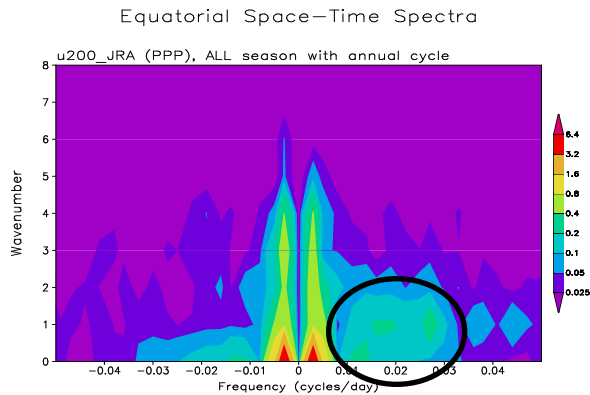


U200
(1990-1999)

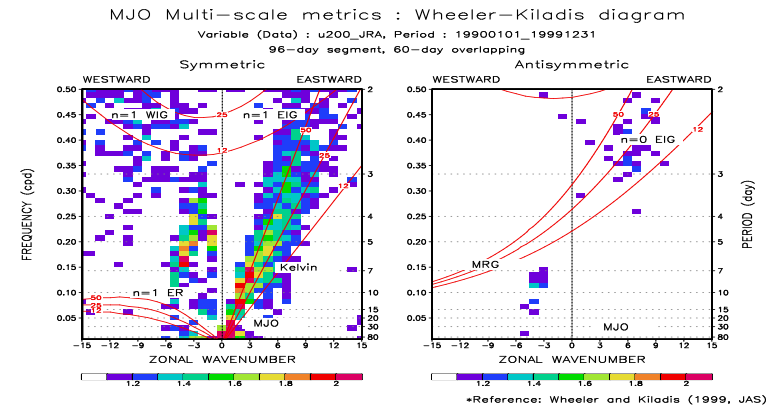
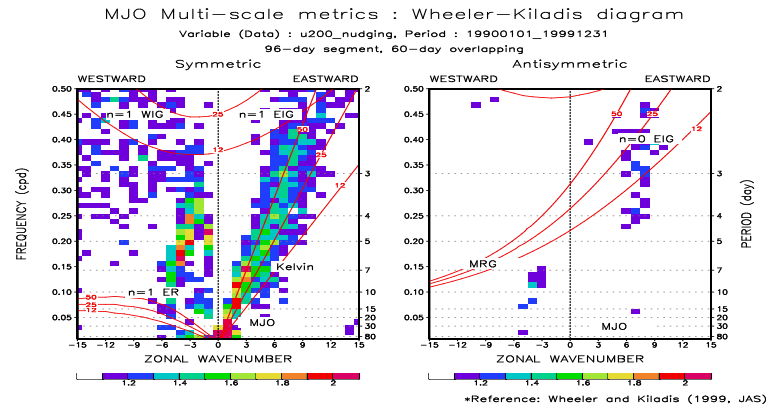
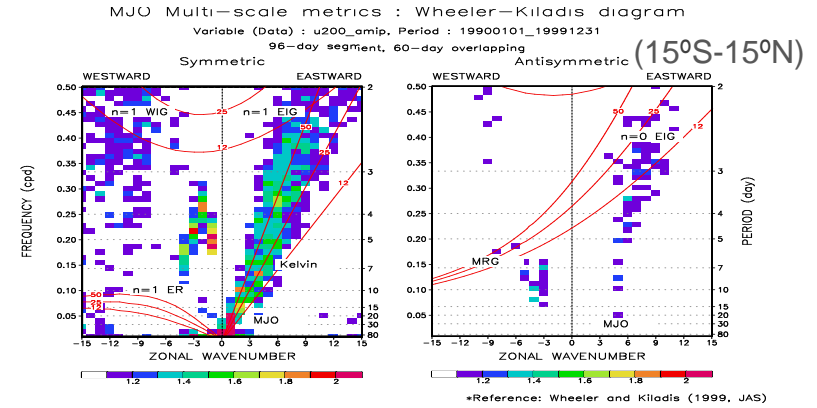
AMIP run



Nudging



JRA-25



MJO Life cycle (OLR, U10) (Nov-Apr, 1990-1999)

AMIP run

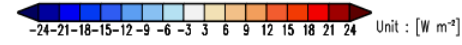
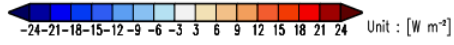
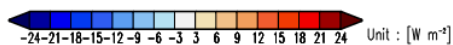
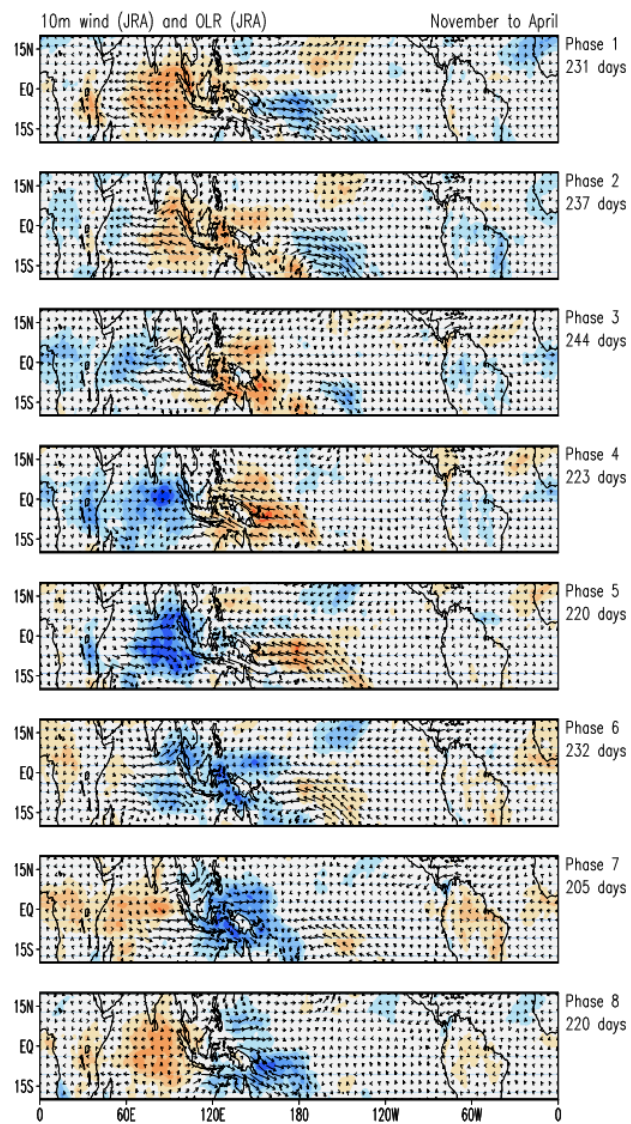
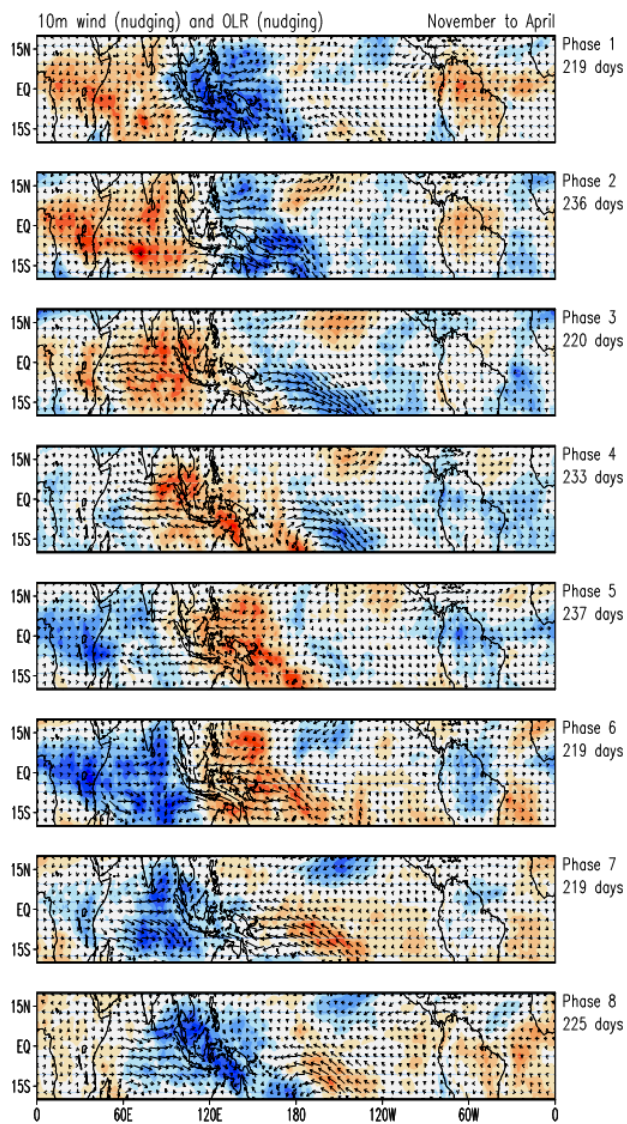
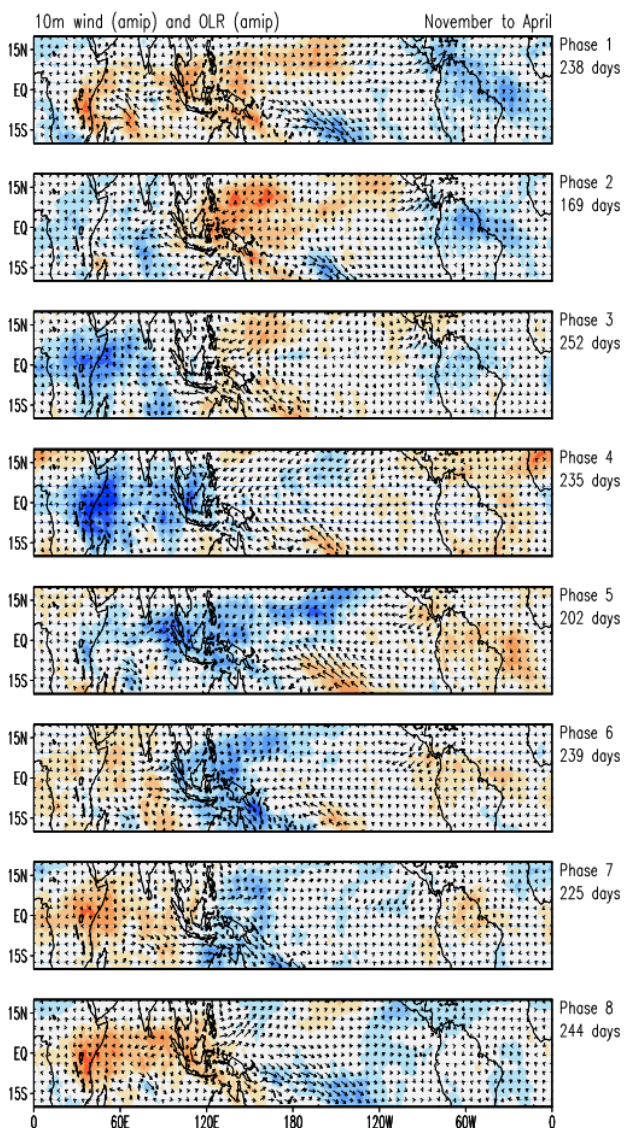
MJO Life cycle composite

Nudging

MJO Life cycle composite

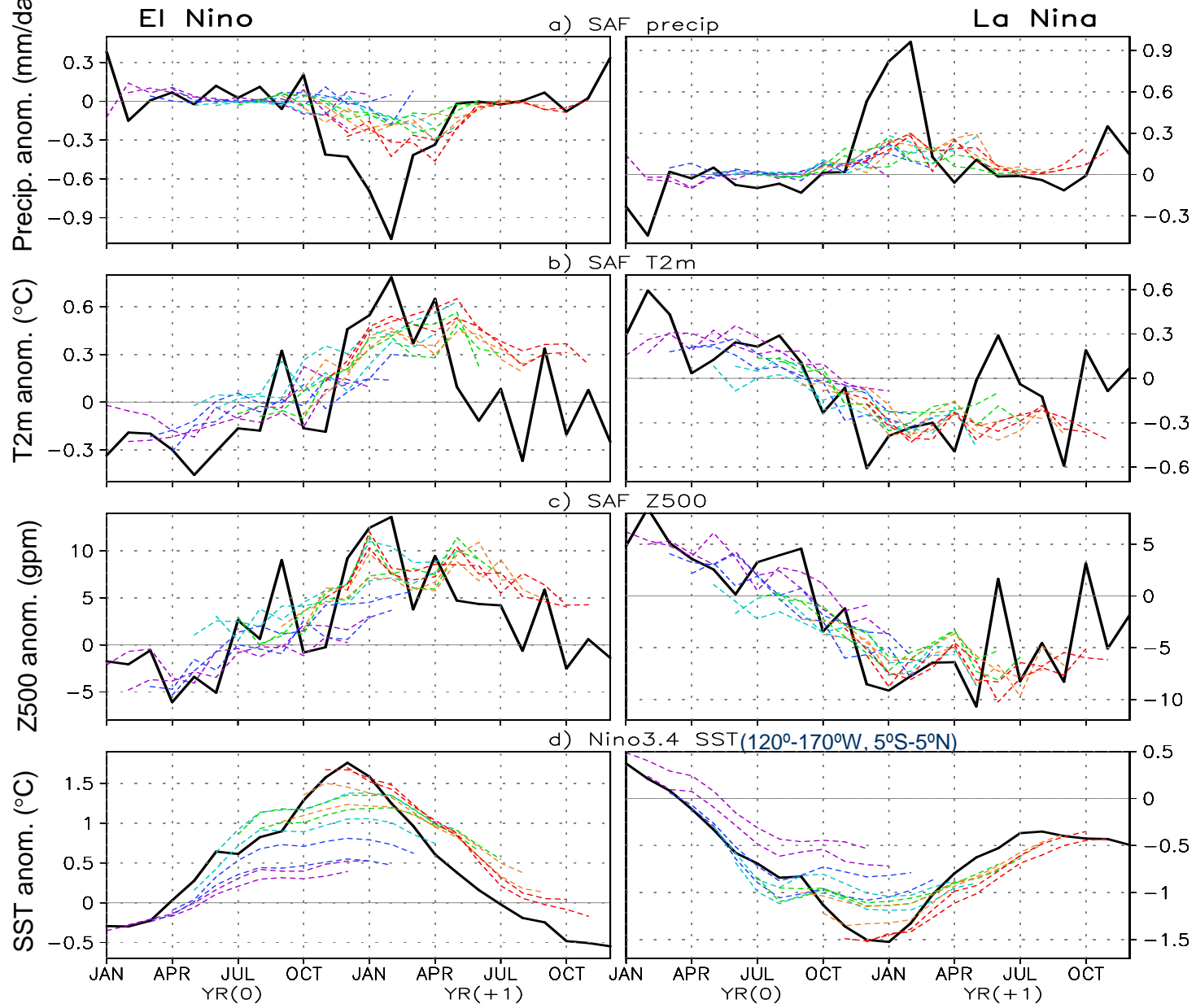
JRA-25

MJO Life cycle composite



Application study:

South Africa (10°-40°E, 35°-15°S)



El Nino:

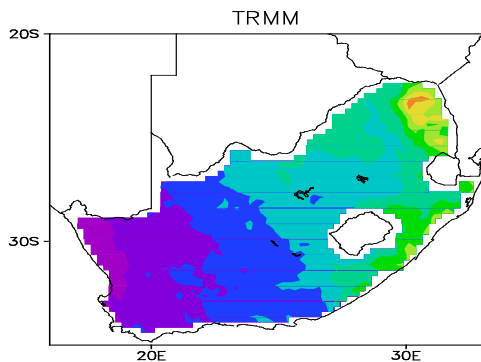
- 1982/83
- 1986/87
- 1991/92
- 1994/95
- 1997/98
- 2002/03
- 2006/07

La Nina:

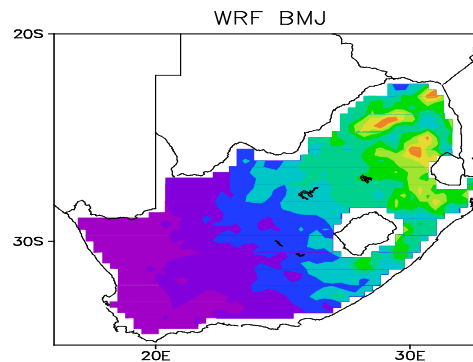
- 1984/85
- 1988/89
- 1995/96
- 1998/99
- 1999/2000
- 2005/06
- 2007/08

Standard Deviation of Daily Precipitation (SIOD years; DJF)

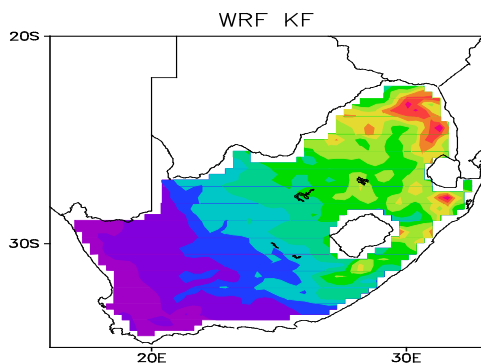
TRMM



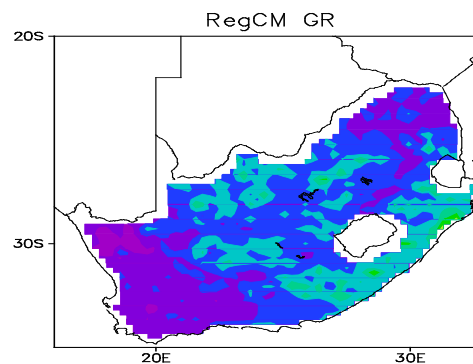
WRF BMJ



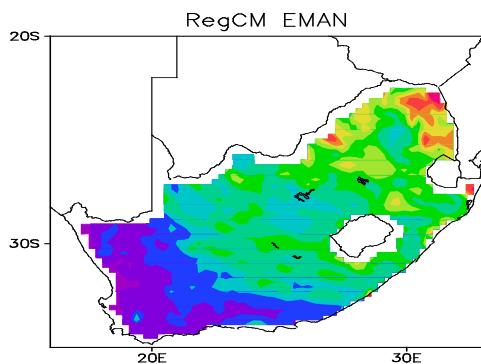
WRF KF



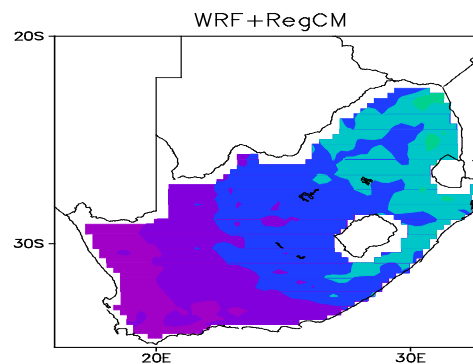
RegCM GR



RegCM EMAN



**WRF +
RegCM**



Model development:

Developing SINTEX-F2 model (new version)

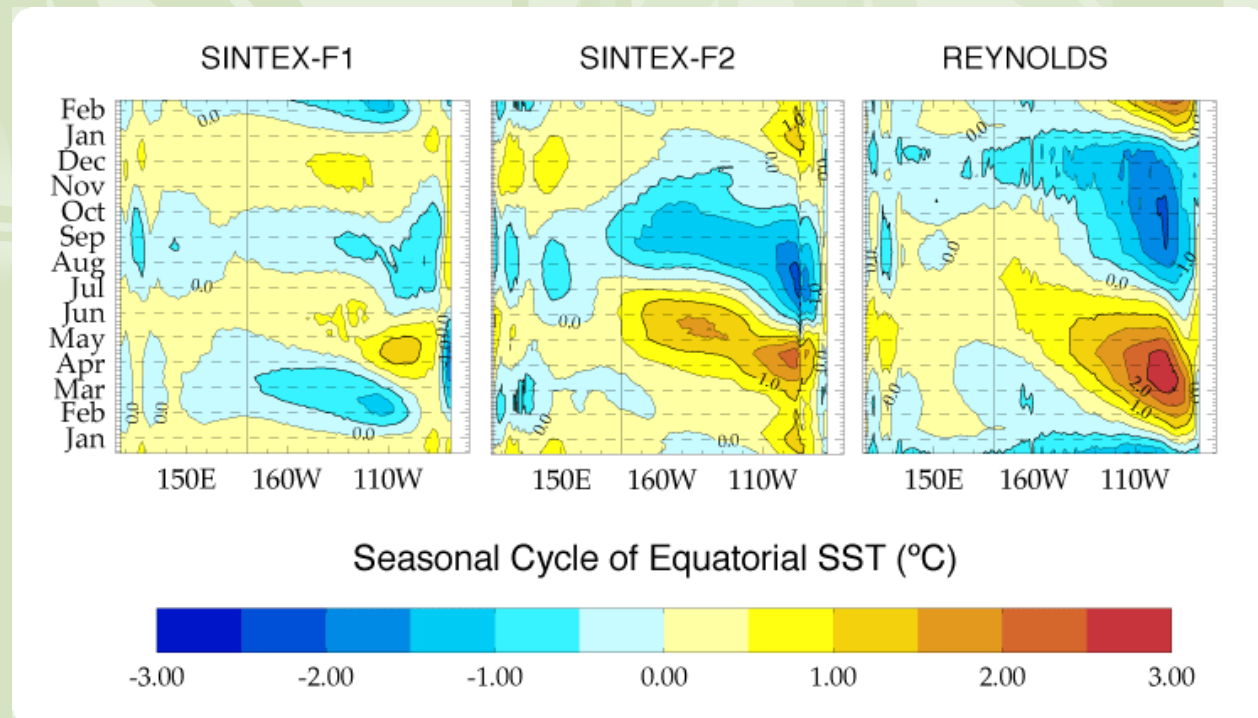
(Collaborated with MPI-Met, LOCEAN, CERFACE,...)

AGCM: ECHAM5 (T106,159,213,319; L31,60,90,191)

OGCM: OPA9 + sea ice (NEMO, 0.5°x0.5°, 0.25°x0.25°)

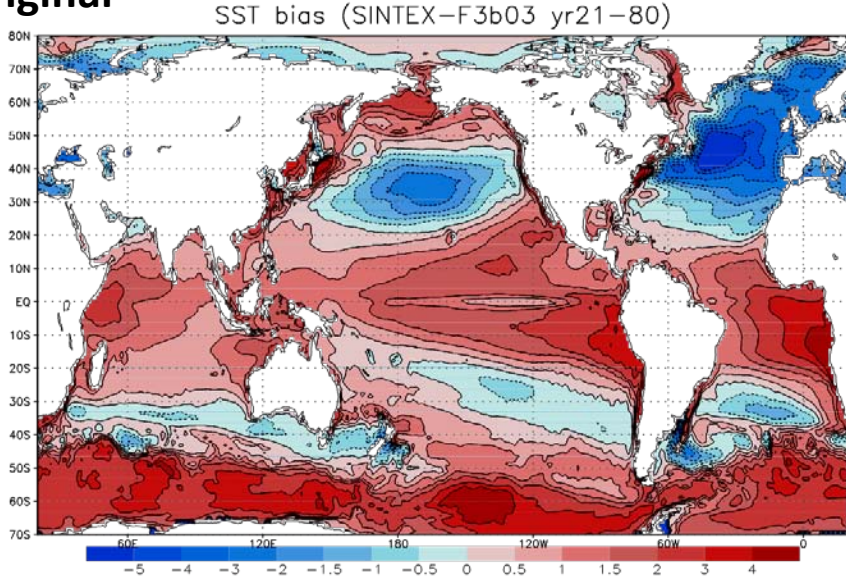
Coupler: Oasis3

Improved
simulation of
the Pacific SST
seasonal cycle

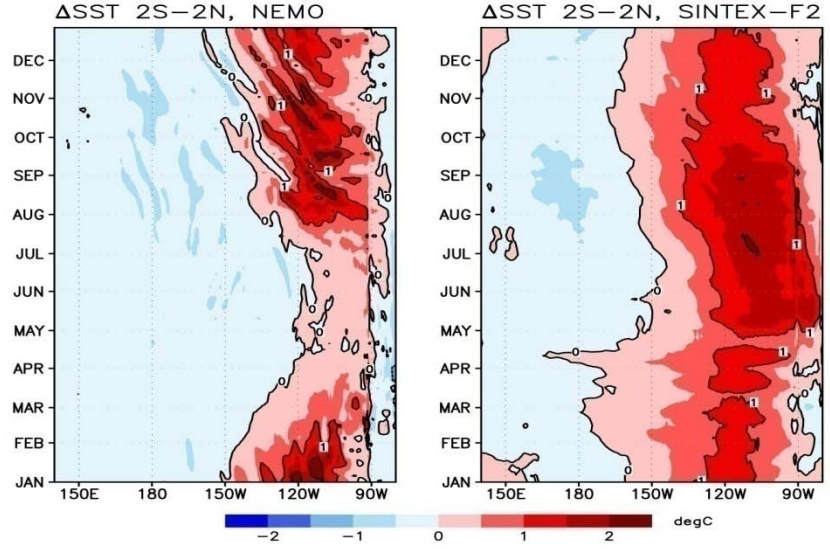


Improving SINTEX-F2 model (ECHAM5+NEMO3+OASIS3)

Original

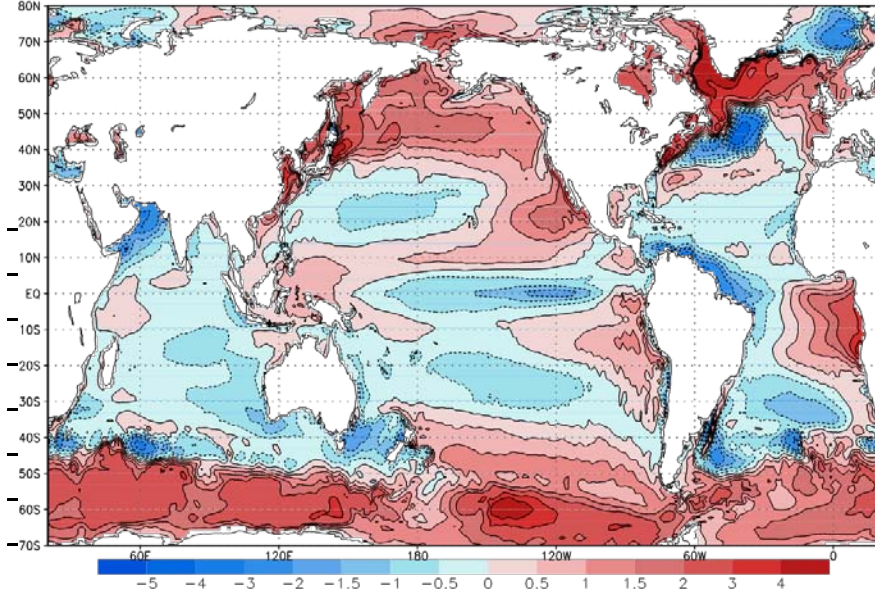


Further improvement with better small scale mixing



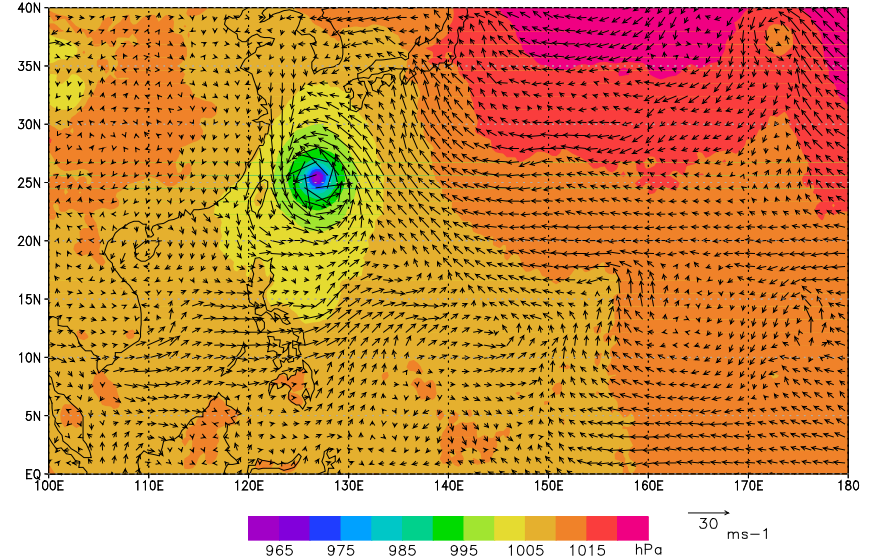
After improvement

bias (TST78 yr51-100)



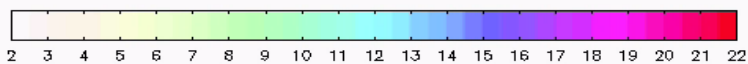
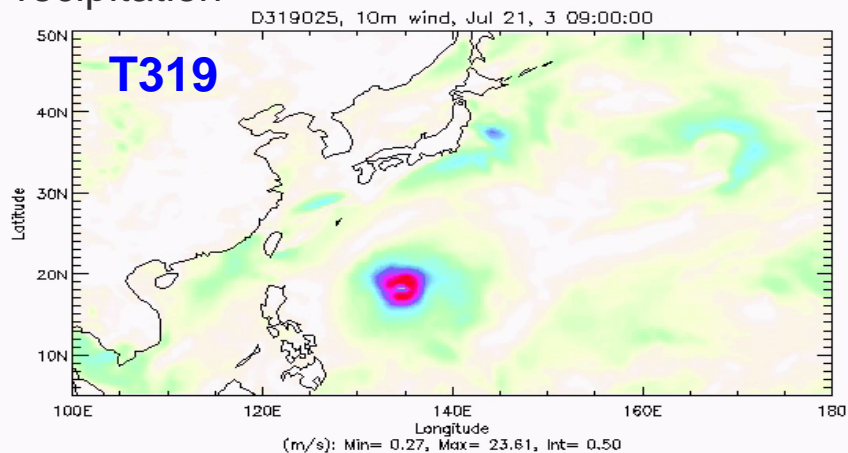
High-resolution typhoon simulation

SLP and surface wind vectors, 0004:09:23:12

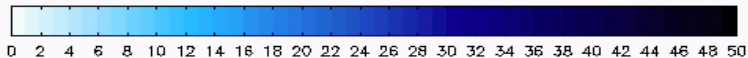
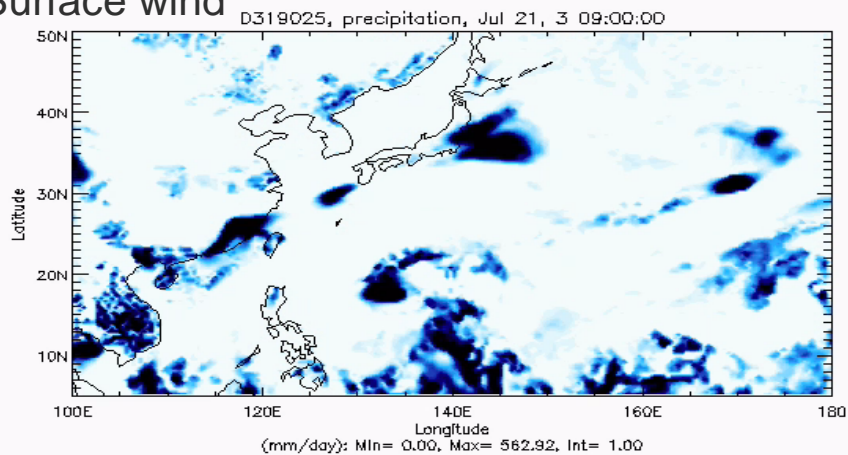


High-resolution model development:

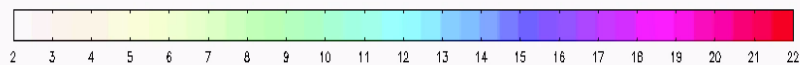
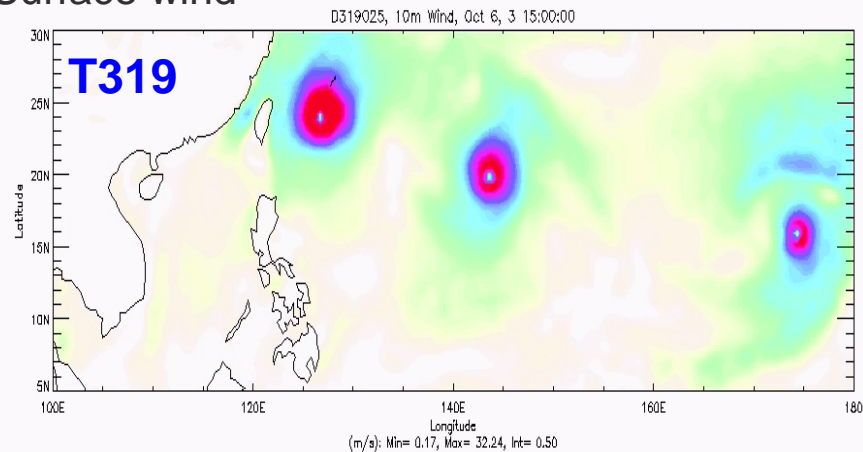
Precipitation



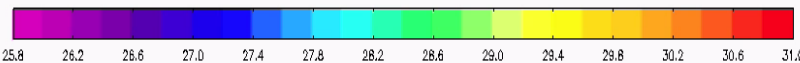
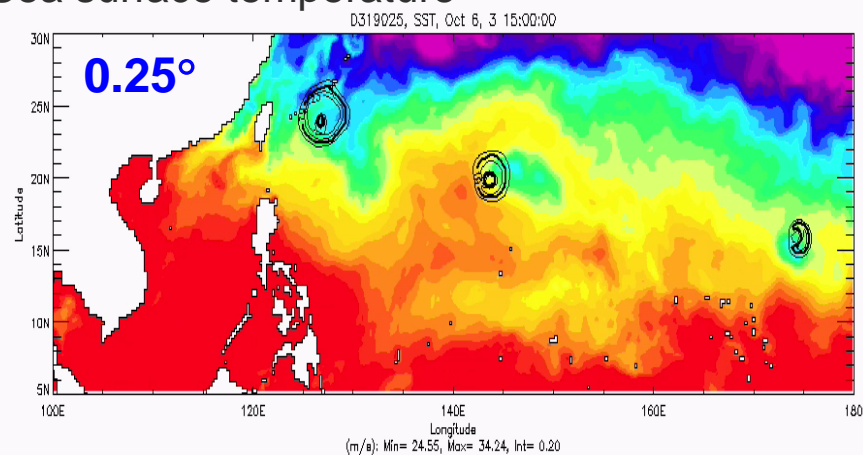
Surface wind



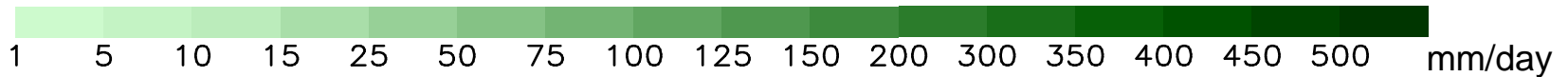
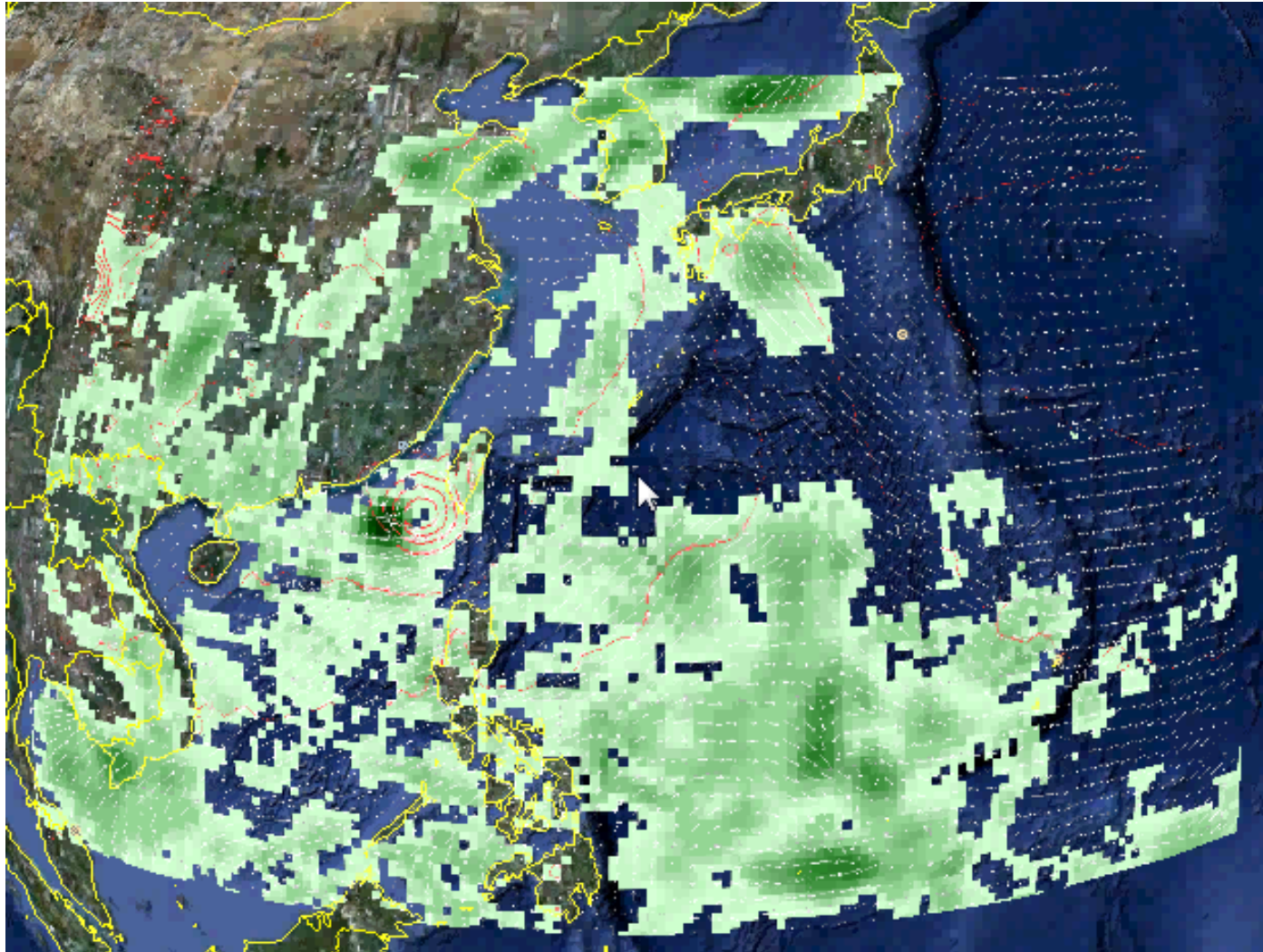
Surface wind



Sea surface temperature



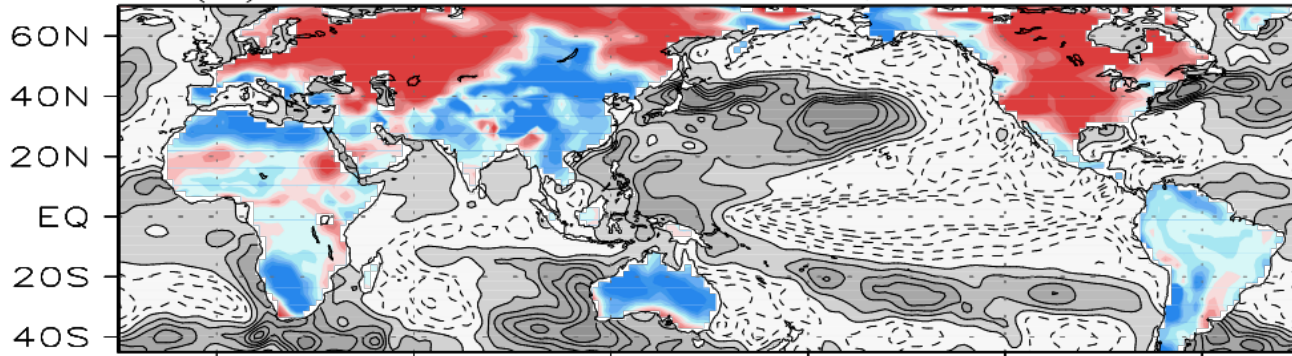
Typhoon animation (Jul-Oct 0019)



Summary:

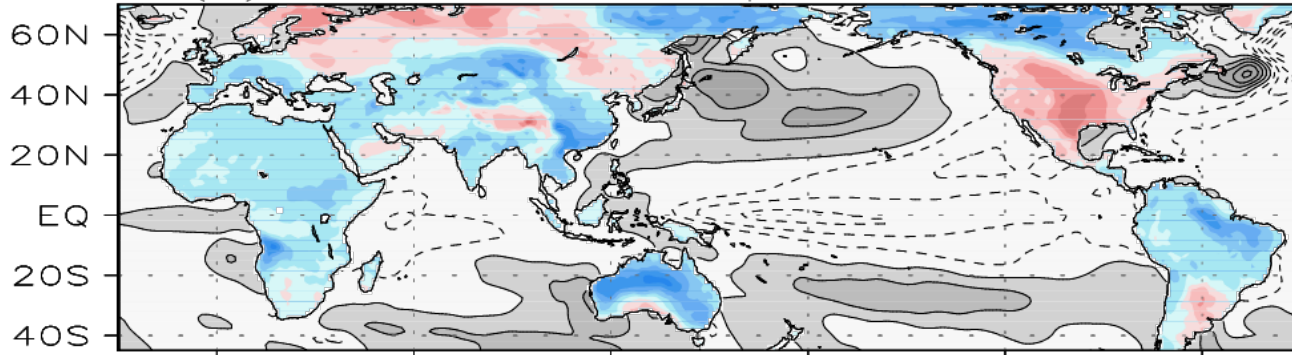
- **Developed SINTEX-F1 model for climate study and prediction** (ENSO: 1-2 years ahead; IOD: 6-12 months ahead)
- **Developing seamless climate prediction system** (intraseasonal-seasonal-interannual-decadal)
- **Increasing the societal value of climate information** (downscaling to South Africa and other areas)
- **Developing SINTEX-F2 model with high-resolution typhoon simulation** (serve as a better tool for climate studies and prediction)

(a) Dec 1999–Feb 2000; observed



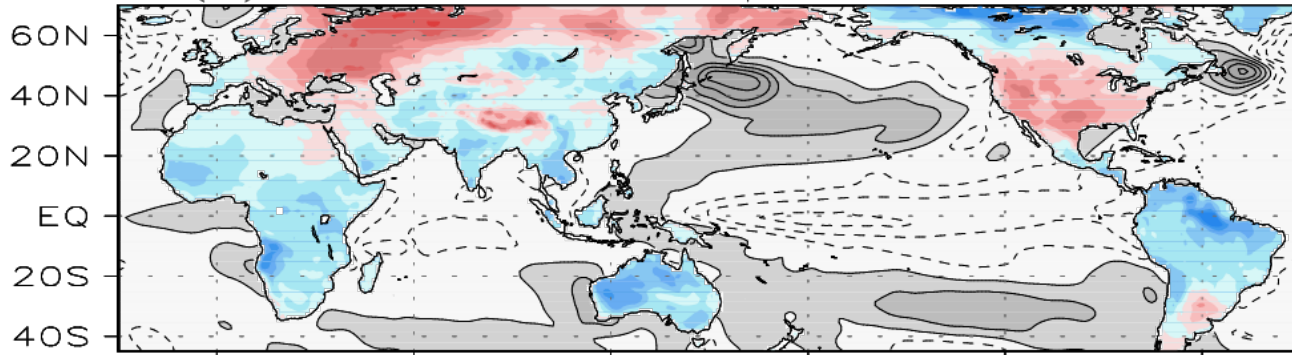
SSTA &
terrestrial 2-m
air temperature
anomaly

(b) 18-month lead predicted

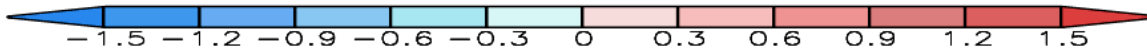


Contour interval
is 0.3°C

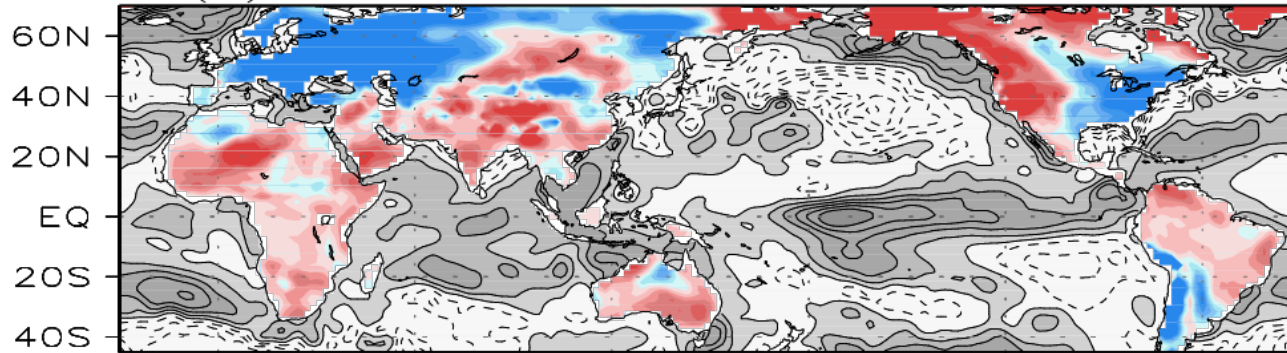
(c) 24-month lead predicted



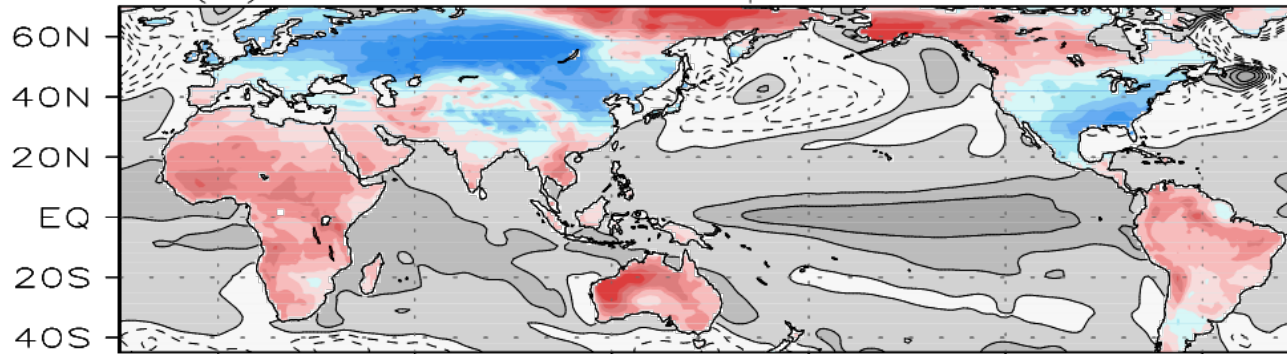
**Consistent with
classical ENSO
theory**



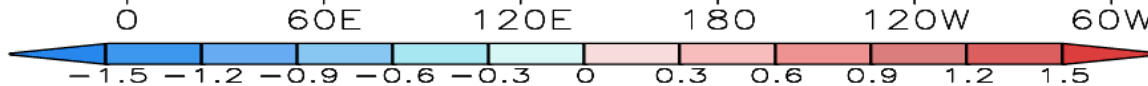
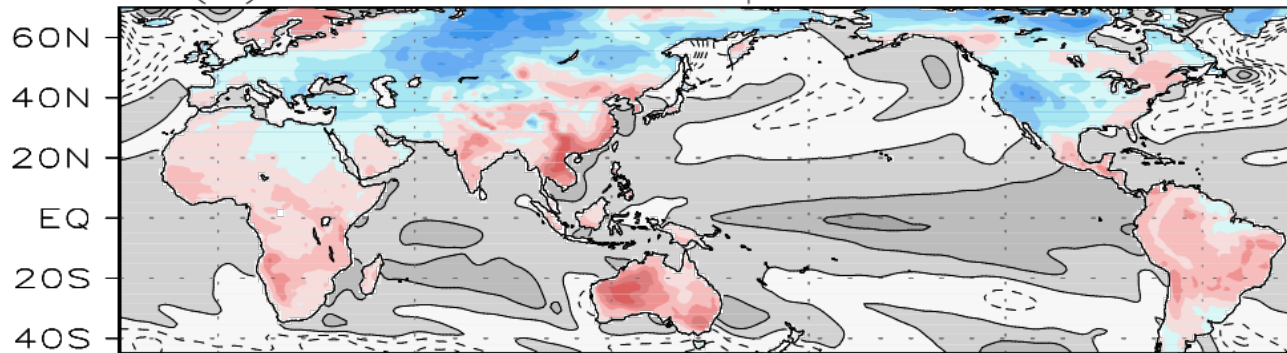
(a) Dec 2002–Feb 2003; observed



(b) 18-month lead predicted



(c) 24-month lead predicted

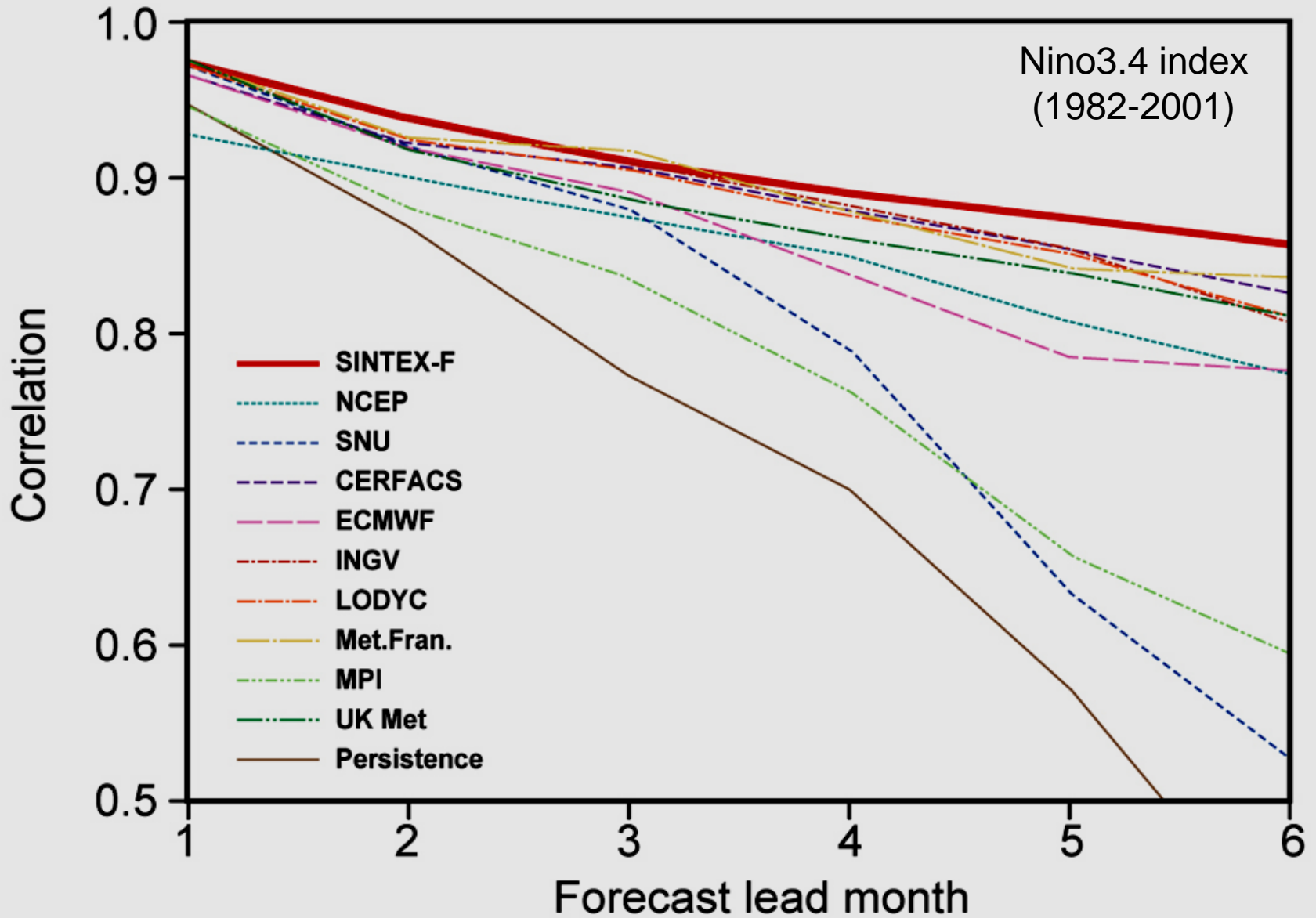


SSTA &
2-m air
temperature
anomaly

Contour interval
is 0.3°C

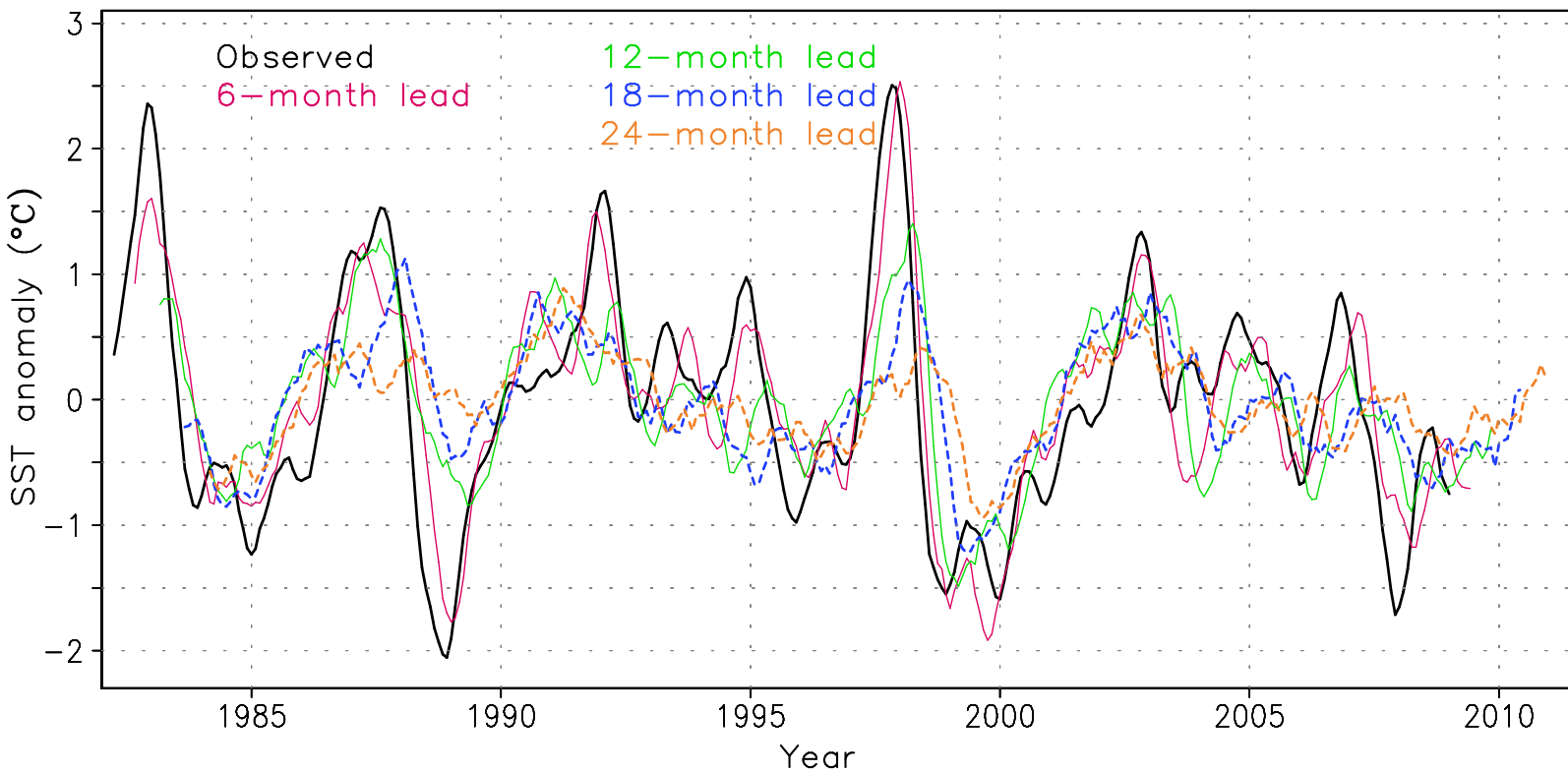
**Related to
decadal ENSO
variations.**

ENSO prediction skill of 10 coupled GCMs



Nino3.4 SSTA prediction up to 2-year lead

(correlation skill >0.6 up to 16 months lead, ~0.5 at 2-year lead)

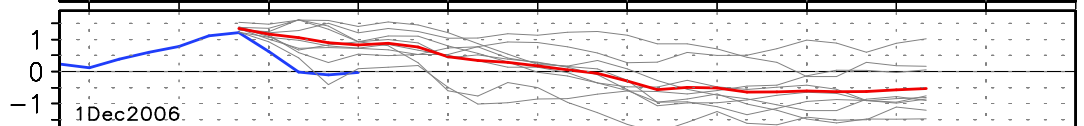
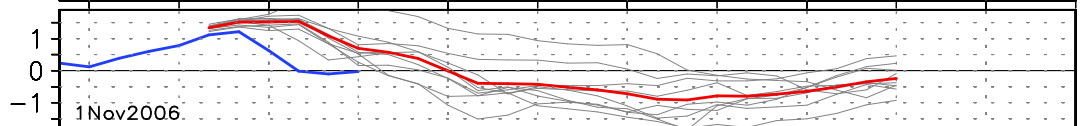
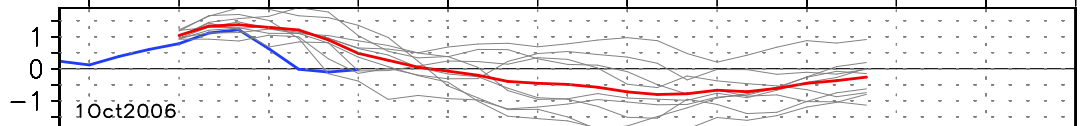
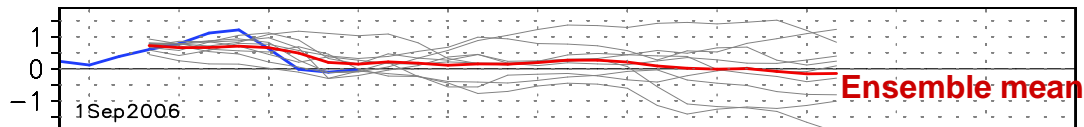


Decadal ENSO: ~12-yr period

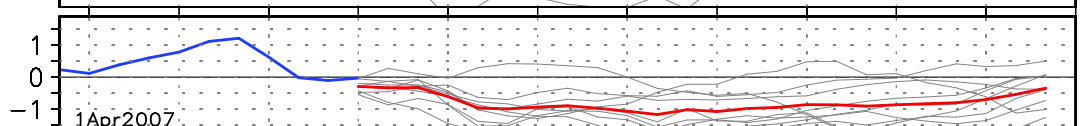
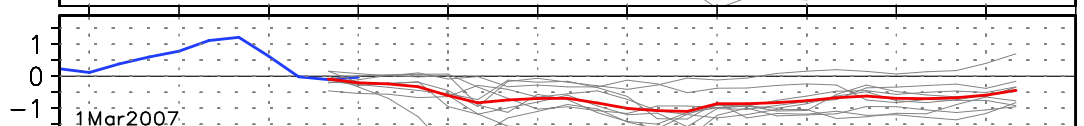
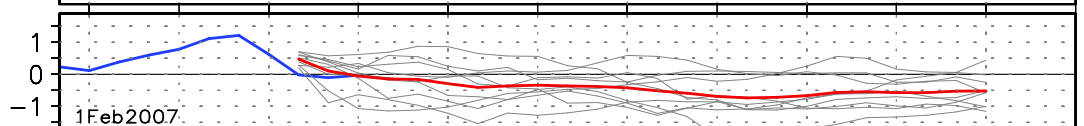
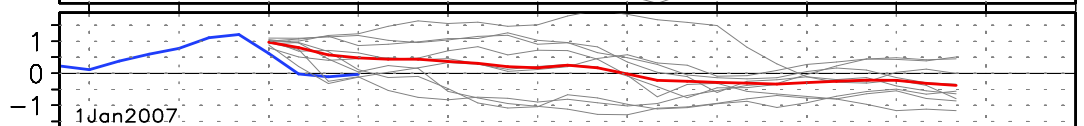
(Luo and Yamagata JGR-Ocean 2001; Luo et al. GRL 2003)

Nino3.4 SSTA forecast up to 2-year ahead (9-member)

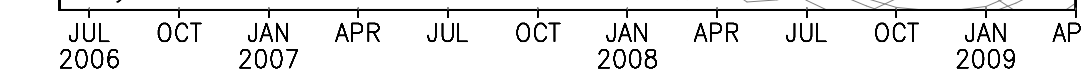
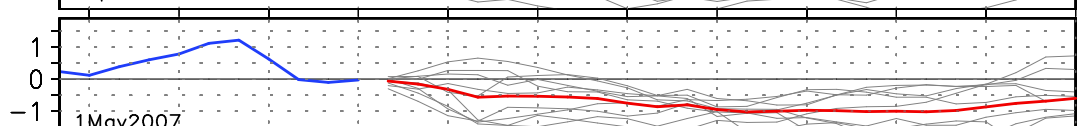
1 Sep. 2006



1 Jan. 2007



1 May 2007



The La Nina condition would be long-lived according to the model forecast.

Presented at "WCRP 1st workshop of seasonal prediction" held in Barcelona in June 2007