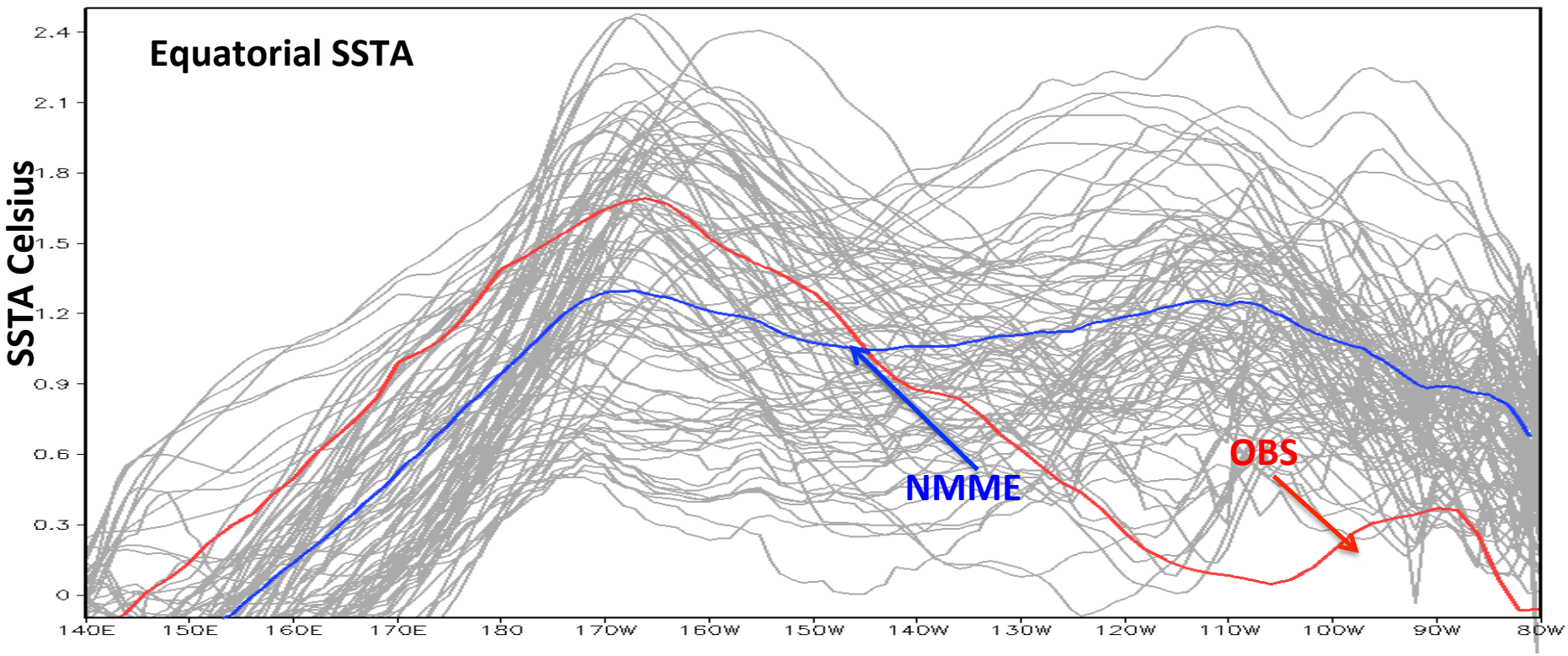
UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE & ATMOSPHERIC SCIENCE

CENTER FOR COMPUTATIONAL SCIENCE
UNIVERSITY OF MIAMI

# Diversity of ENSO in the North American Multi-Model Ensemble (NMME)

**0.5T JFM1995**

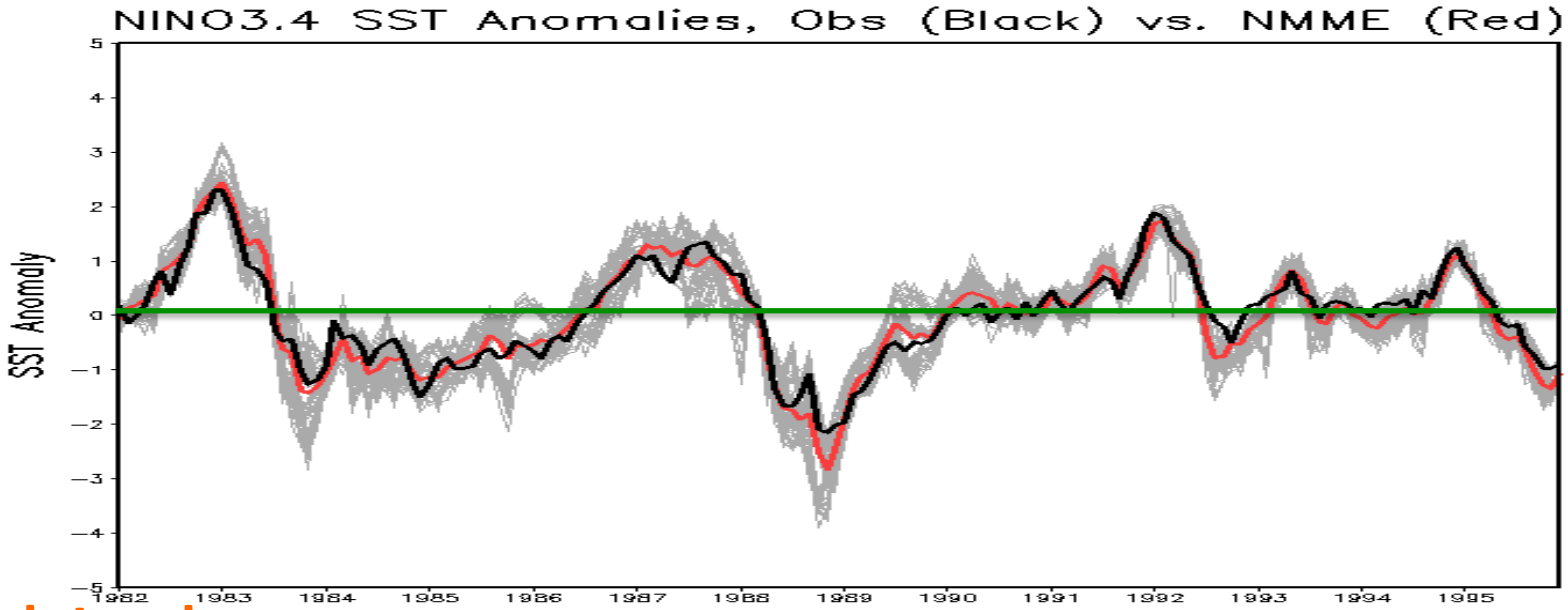


# Outline: NMME Captures Diversity of ENSO?

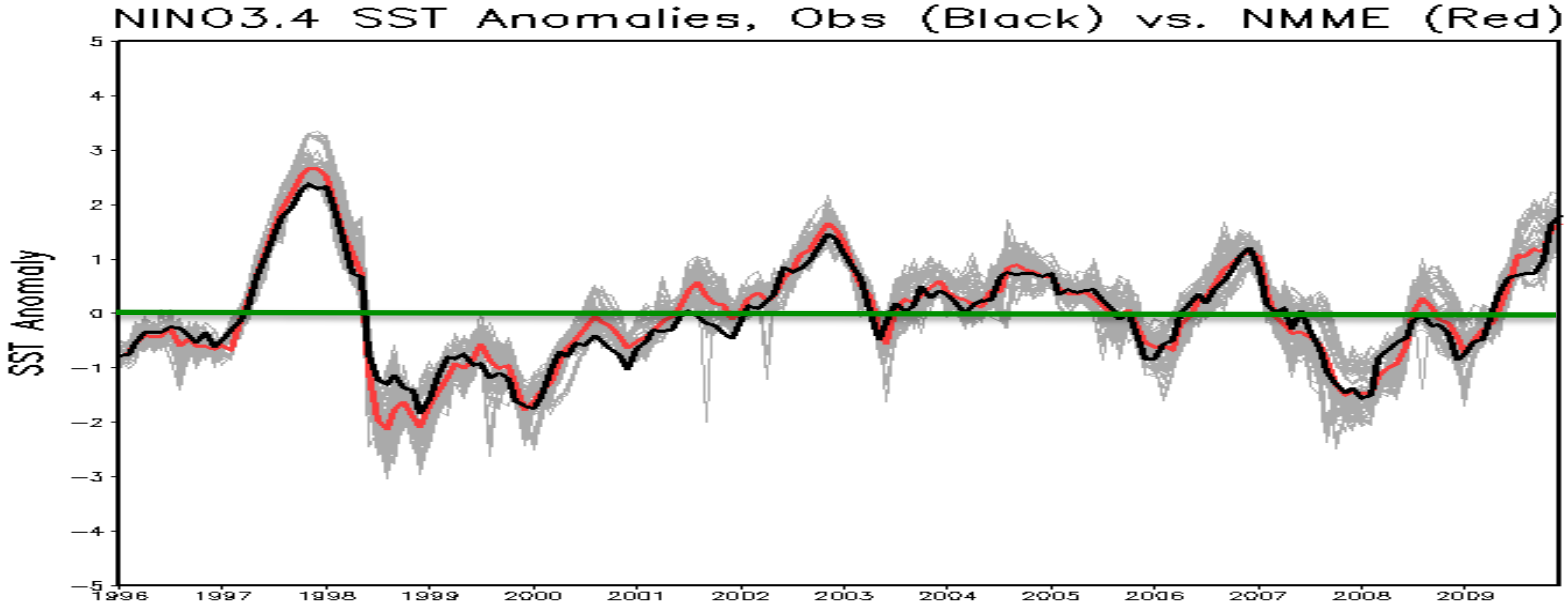
- Very Brief Description of NMME System
- Diversity of ENSO in NMME
  - "Agnostic" view
  - Event Based: SST, Precipitation
    - Pattern Correlation
    - Lead Time
- Forecast
- Conclusions

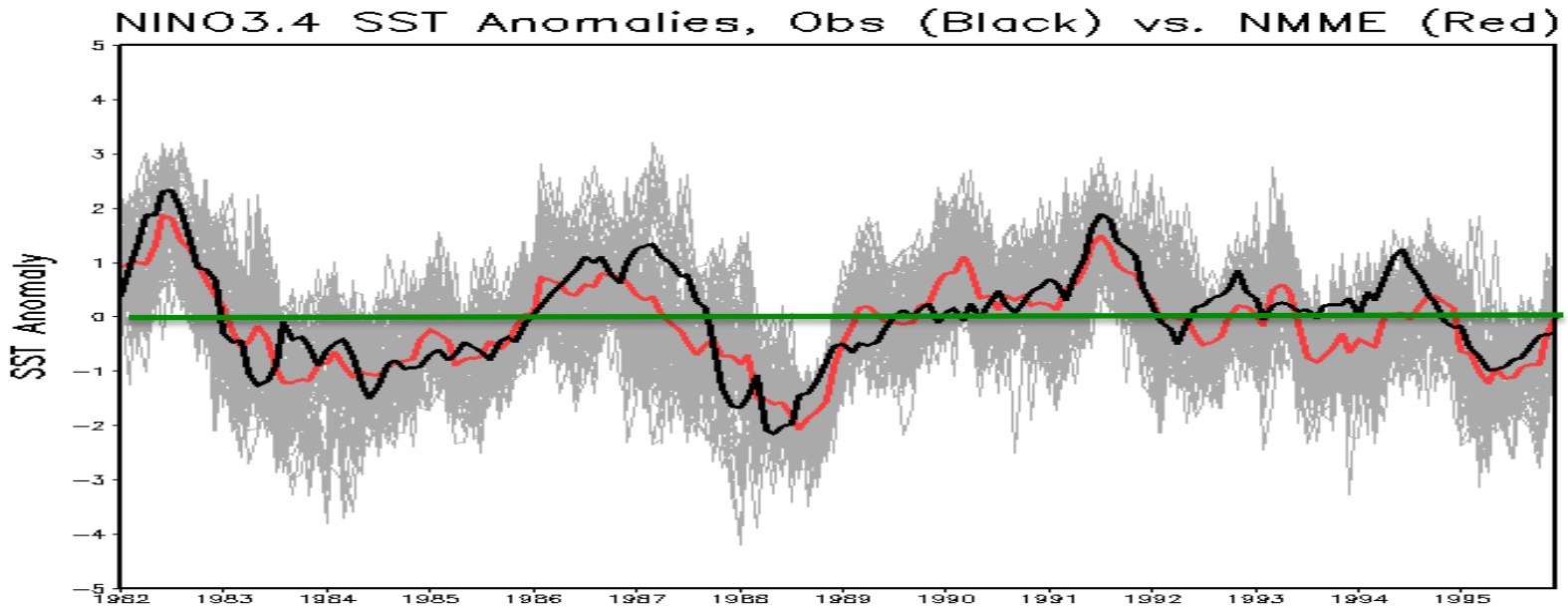
| Model | Hindcast Period | Ensemble Size | Lead Times | Arrangement of Ensemble Members | Contact and reference |
|---|---|---|---|---|---|
| CFSv1 | 1981-2009 | 15 | 0.5-8.5 Months | 1st 0Z +/-2 days, 21st 0Z +/-2d, 11th 0Z+/- 2d | Saha (Saha et al. 2006) |
| CFSv2 | 1982-2010 | 24(28) | 0.5-9.5 Months | 4 members (0,6,12,18Z) every 5th day | Saha (Saha et al. 2010) |
| GFDL-CM2.2 | 1982-2010 | 10 | 0.5-11.5 Months | All 1st of the month 0Z | Rosati (Zhang et al. 2007) |
| IRI-ECHAM4-f[1] | 1982-2010 | 12 | 0.5-7.5 Months | All 1st of the month 0Z | DeWitt (DeWitt 2005) |
| IRI-ECHAM4-a[2] | 1982-2010 | 12 | 0.5-7.5 Months | All 1st of the Month 0Z | DeWitt (Dewitt 2005) |
| CCSM3.0 | 1982-2010 | 6 | 0.5-11.5 Months | All 1st of the Month 0Z | Kirtman (Kirtman and Min 2009) |
| GEOS5 | 1981-2010 | 11[2] | 0.5-9.5 Months | 1 Member every 5th day | Schubert (Vernieres et al. 2011) |
| CMC1-CanCM3 | 1981-2010 | 10 | 0.5-11.5 | All 1st of the month 0Z | Merryfield Merryfield et al. (2013) |
| CMC2-CanCM4 | 1981-2010 | 10 | 0.5-11.5 | ALL 1st of the month 0Z | Merryfield Merryfield et al. (2013) |

**Kirtman et al. (2013, BAMS Submitted)**

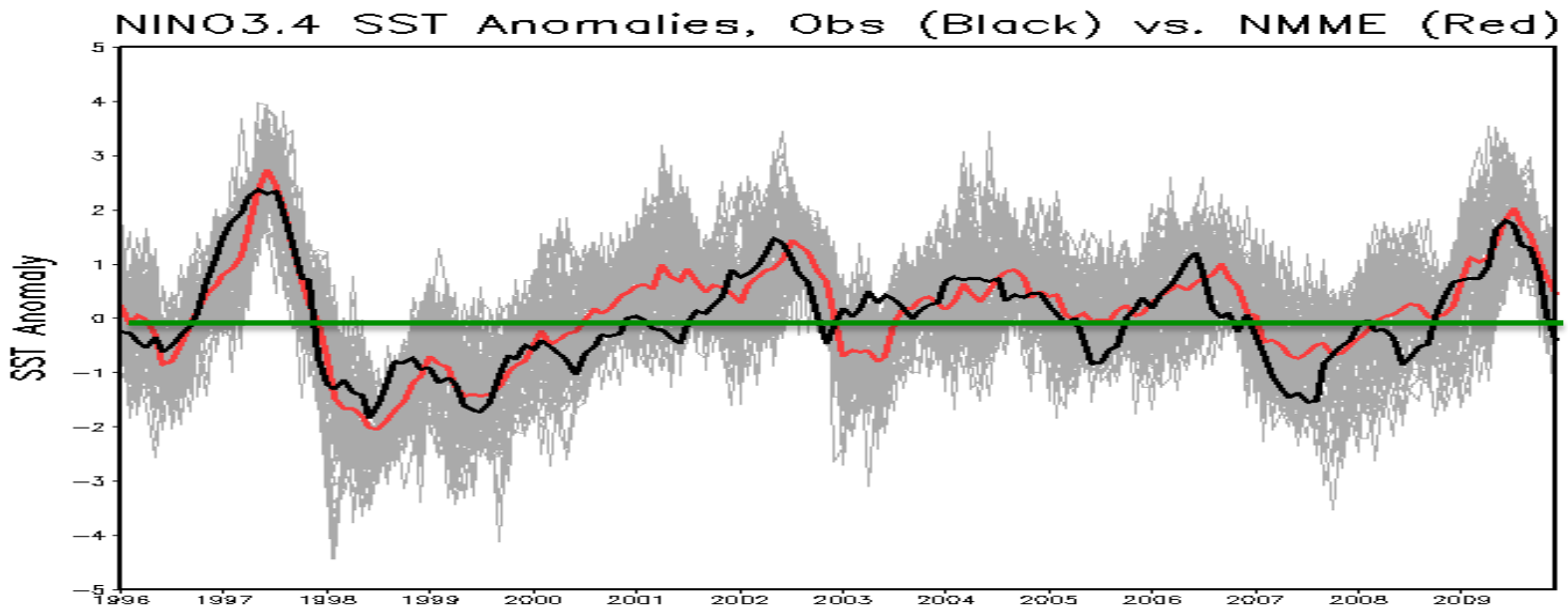

NINO3.4 SST Anomalies, Obs (Black) vs. NMME (Red)
SST Anomaly
5
4
3
2
1
0
−1
−2
−3
−4
−5
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995

**1-month Lead**

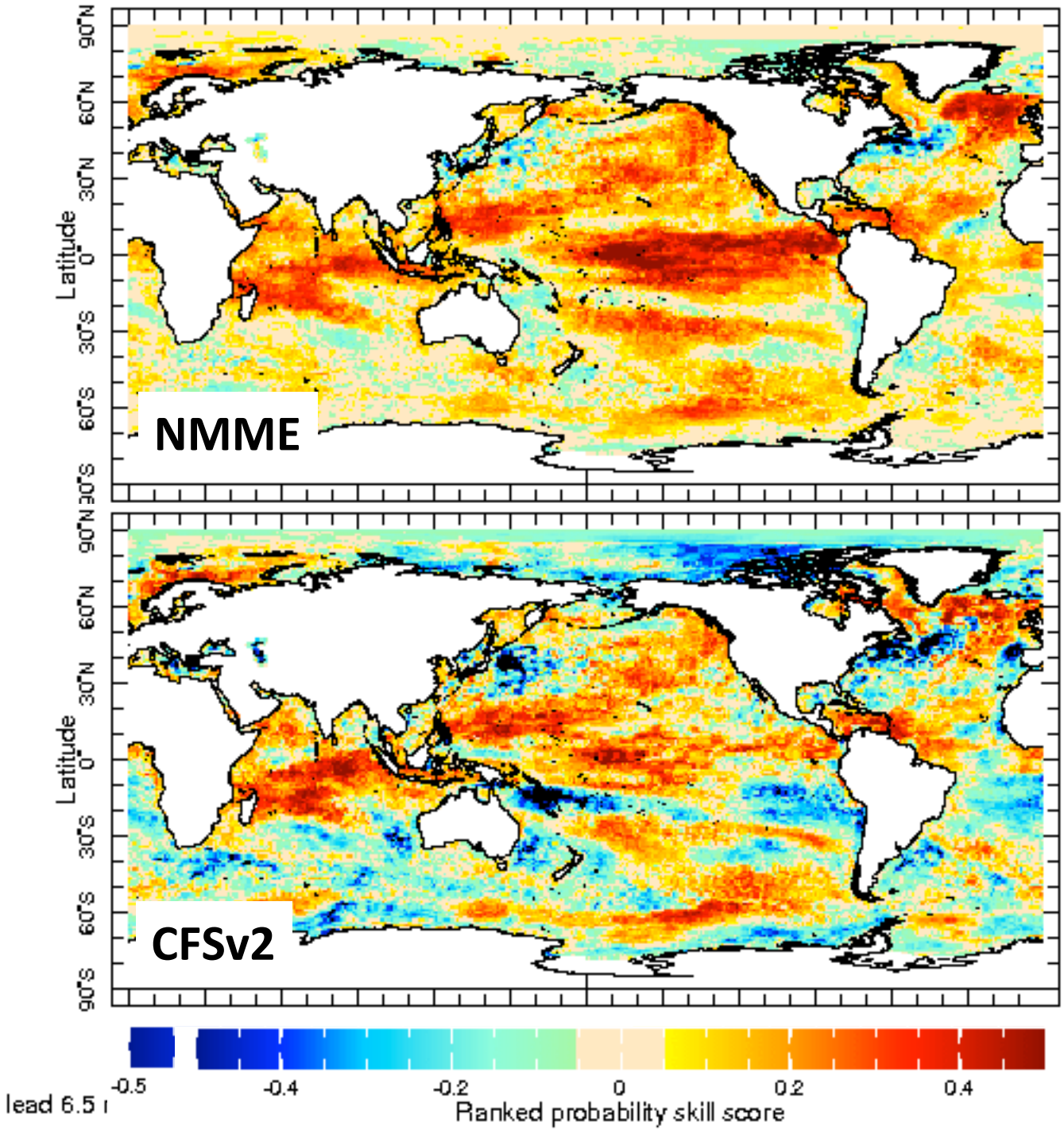

NINO3.4 SST Anomalies, Obs (Black) vs. NMME (Red)
SST Anomaly
5
4
3
2
1
0
−1
−2
−3
−4
−5
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


NINO3.4 SST Anomalies, Obs (Black) vs. NMME (Red)
SST Anomaly
5
4
3
2
1
0
−1
−2
−3
−4
−5
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995

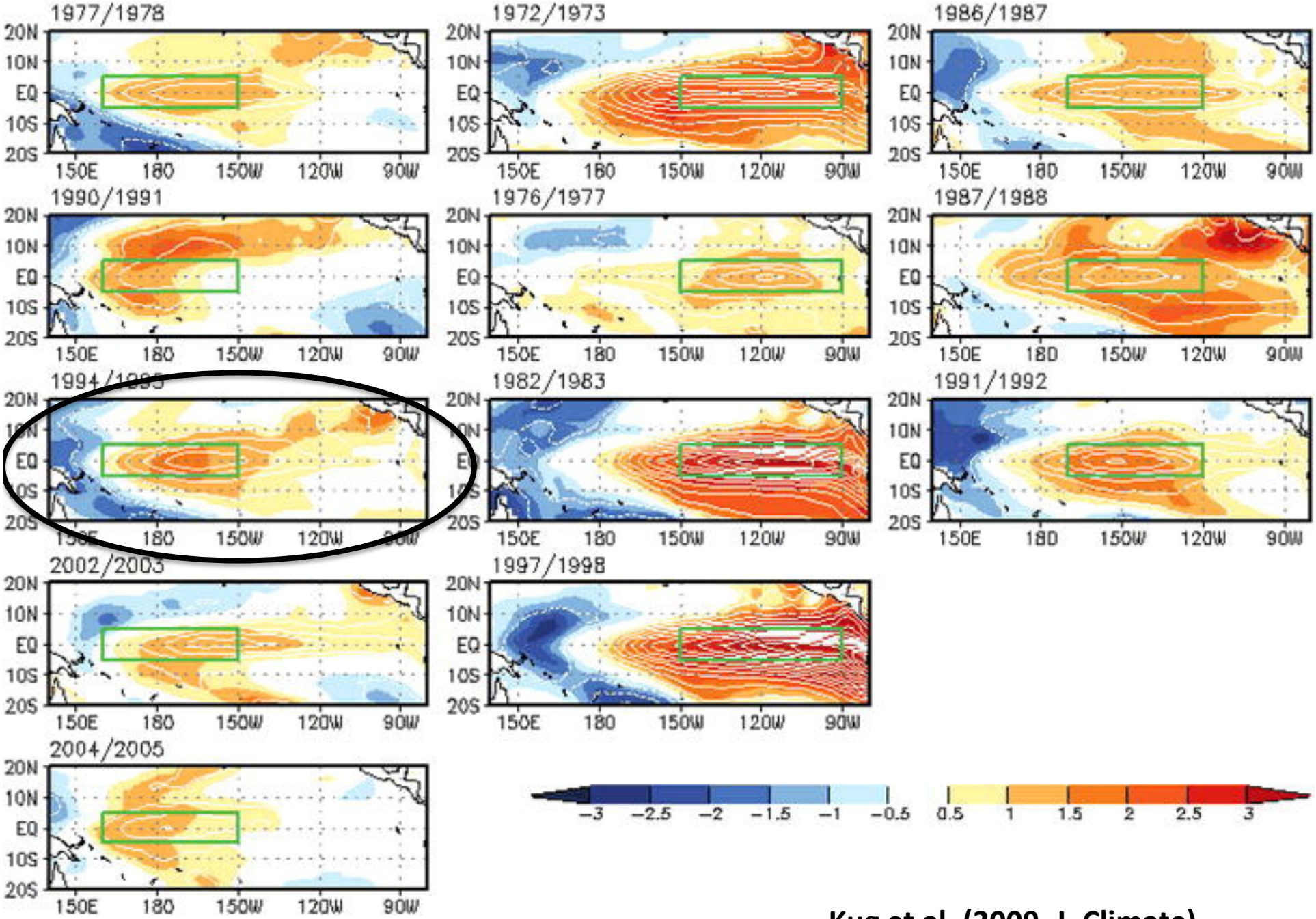
## 6-month Lead


NINO3.4 SST Anomalies, Obs (Black) vs. NMME (Red)
SST Anomaly
5
4
3
2
1
0
−1
−2
−3
−4
−5
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

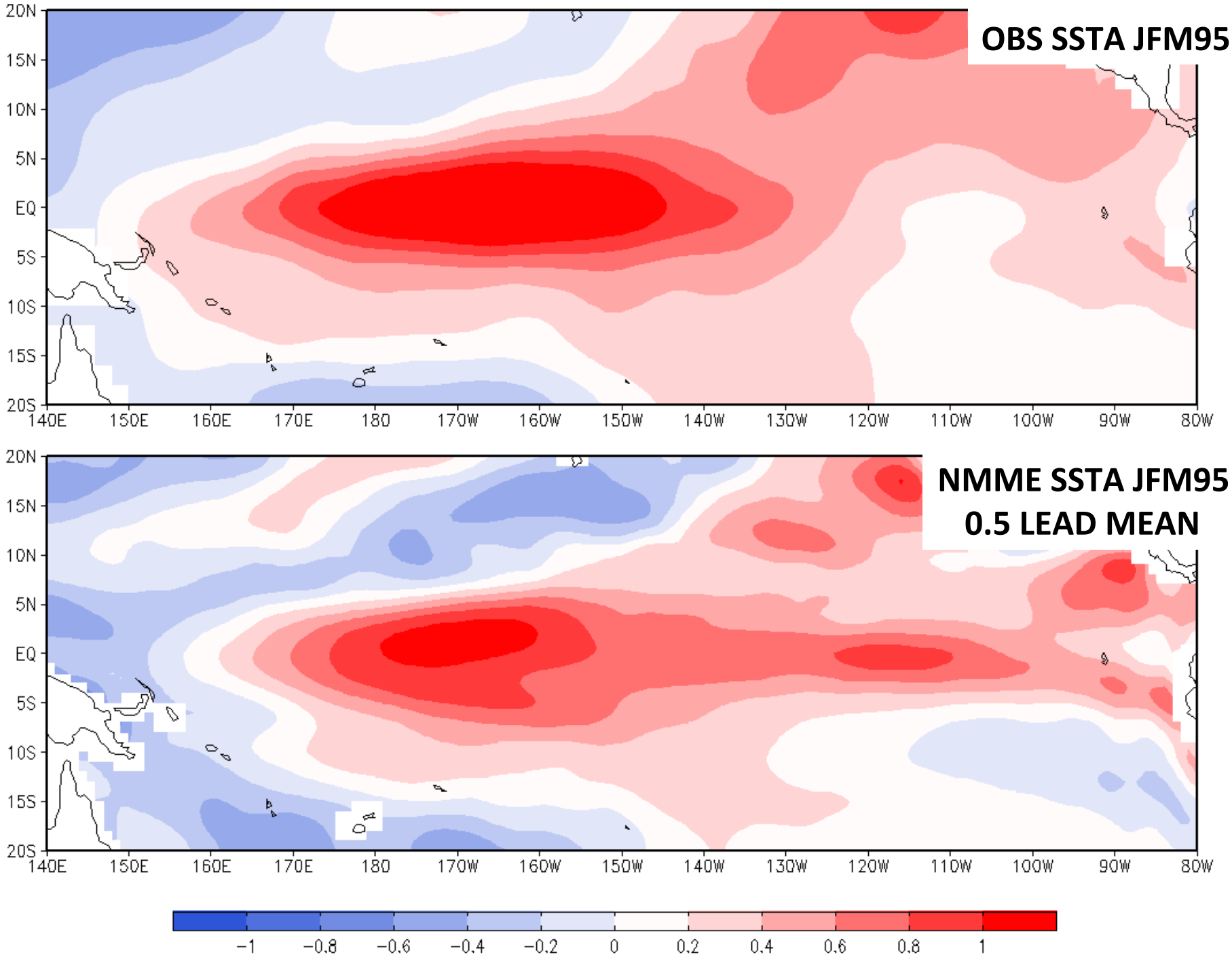
**July 1 start DJF SST forecast RPSS**

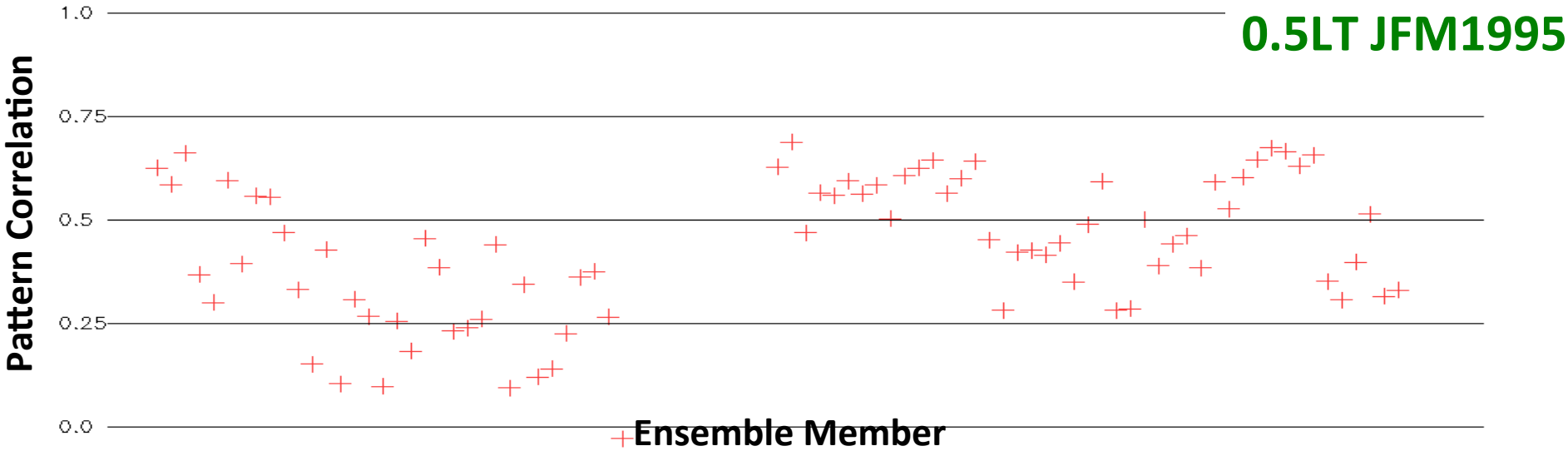


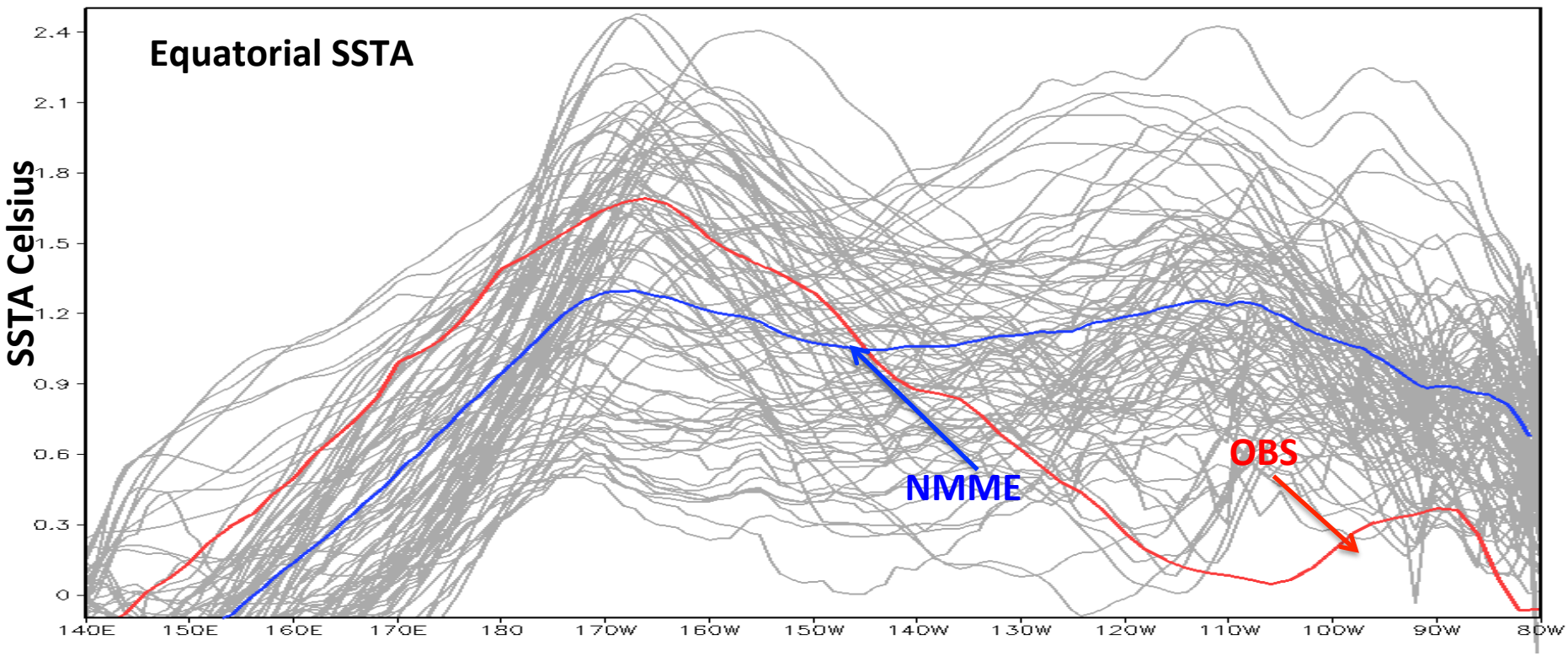

lead 6.5

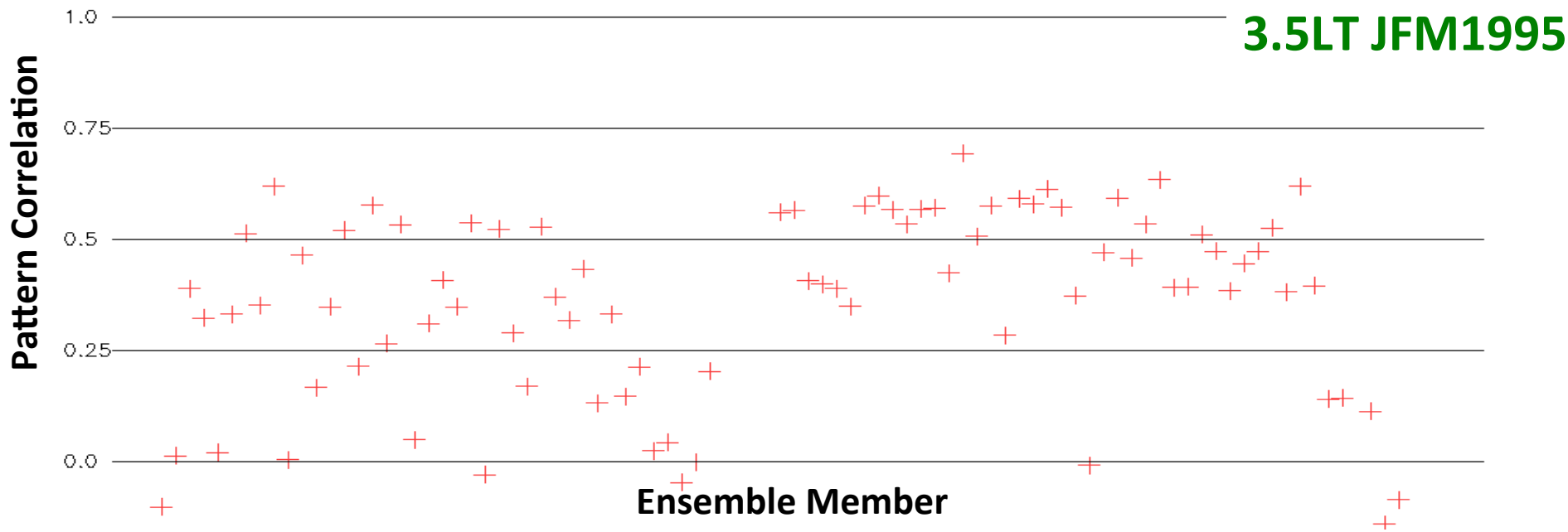


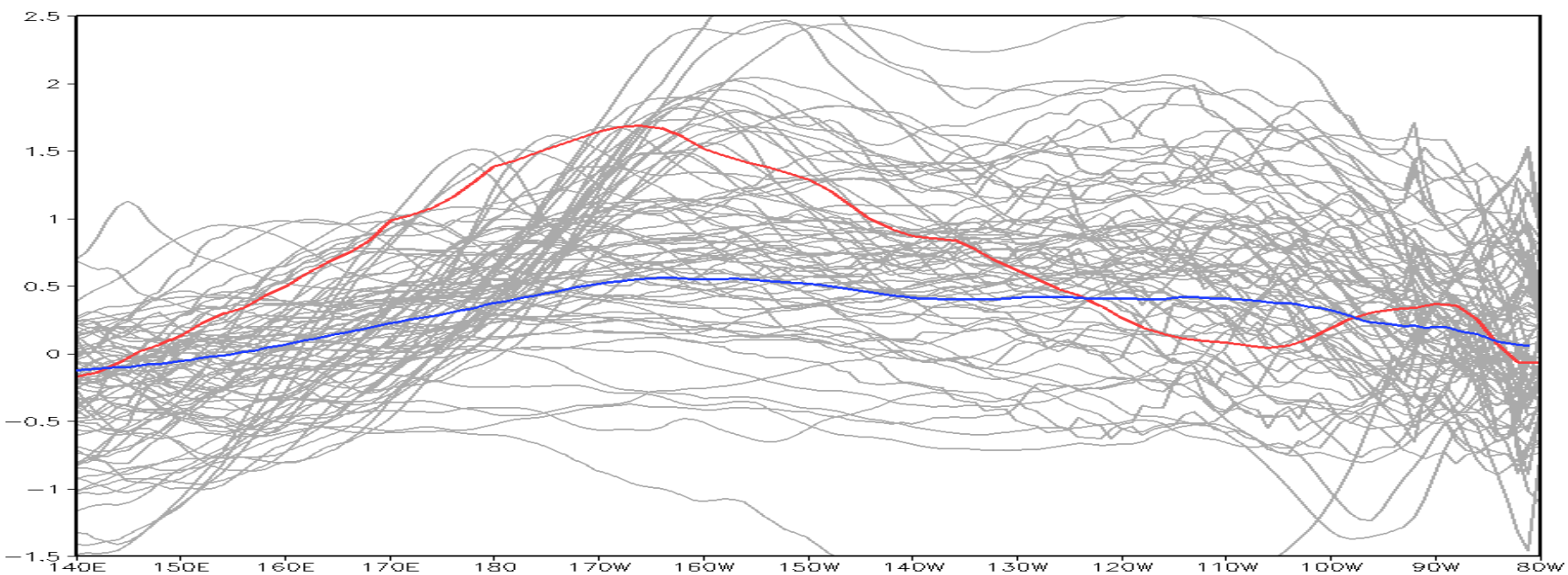

**Kug et al. (2009, J. Climate)**

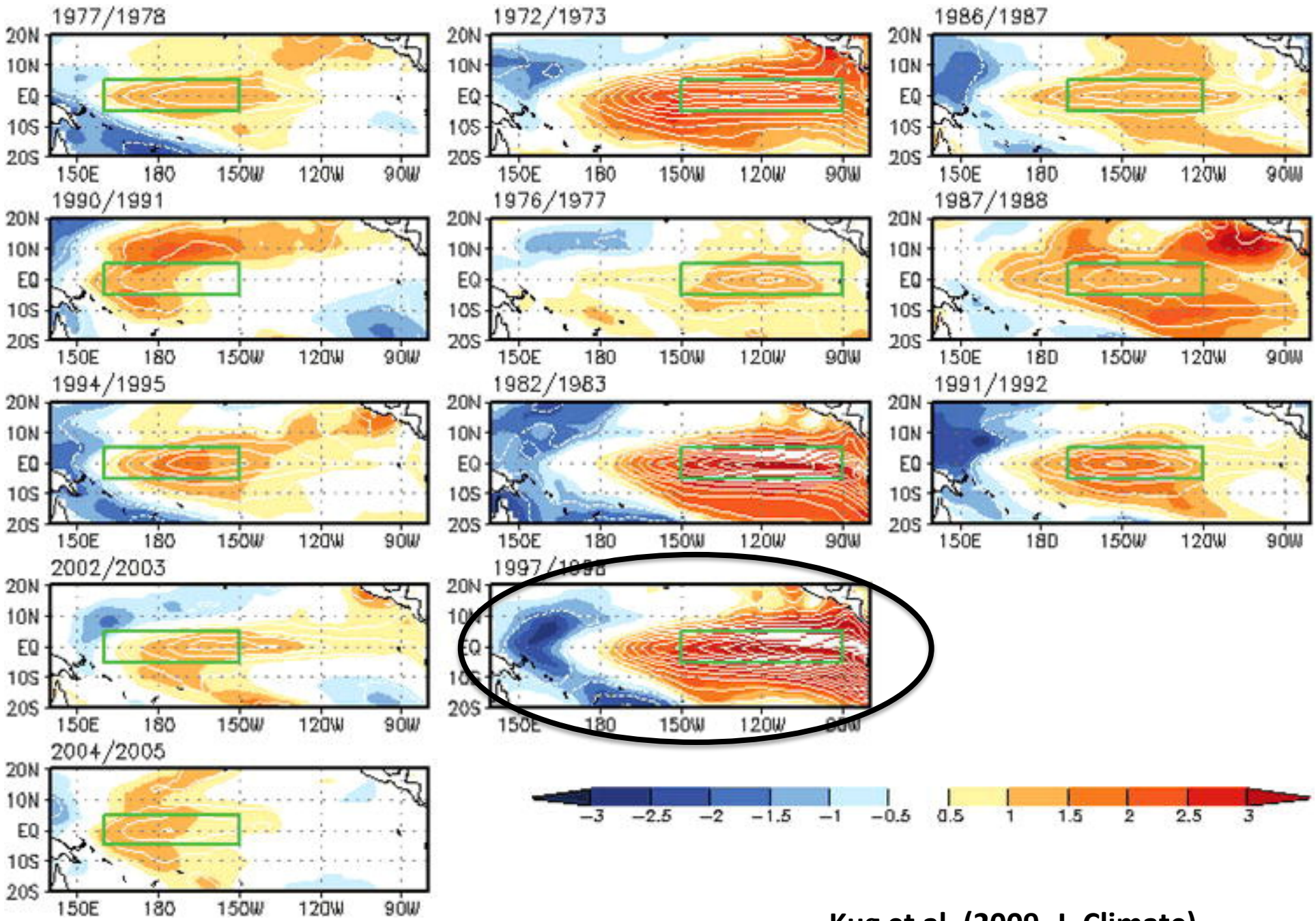

OBS SSTA JFM95
NMME SSTA JFM95
0.5 LEAD MEAN
20N
15N
10N
5N
EQ
5S
10S
15S
20S
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1


0.5LT JFM1995
Pattern Correlation
1.0
0.75
0.5
0.25
0.0
Ensemble Member

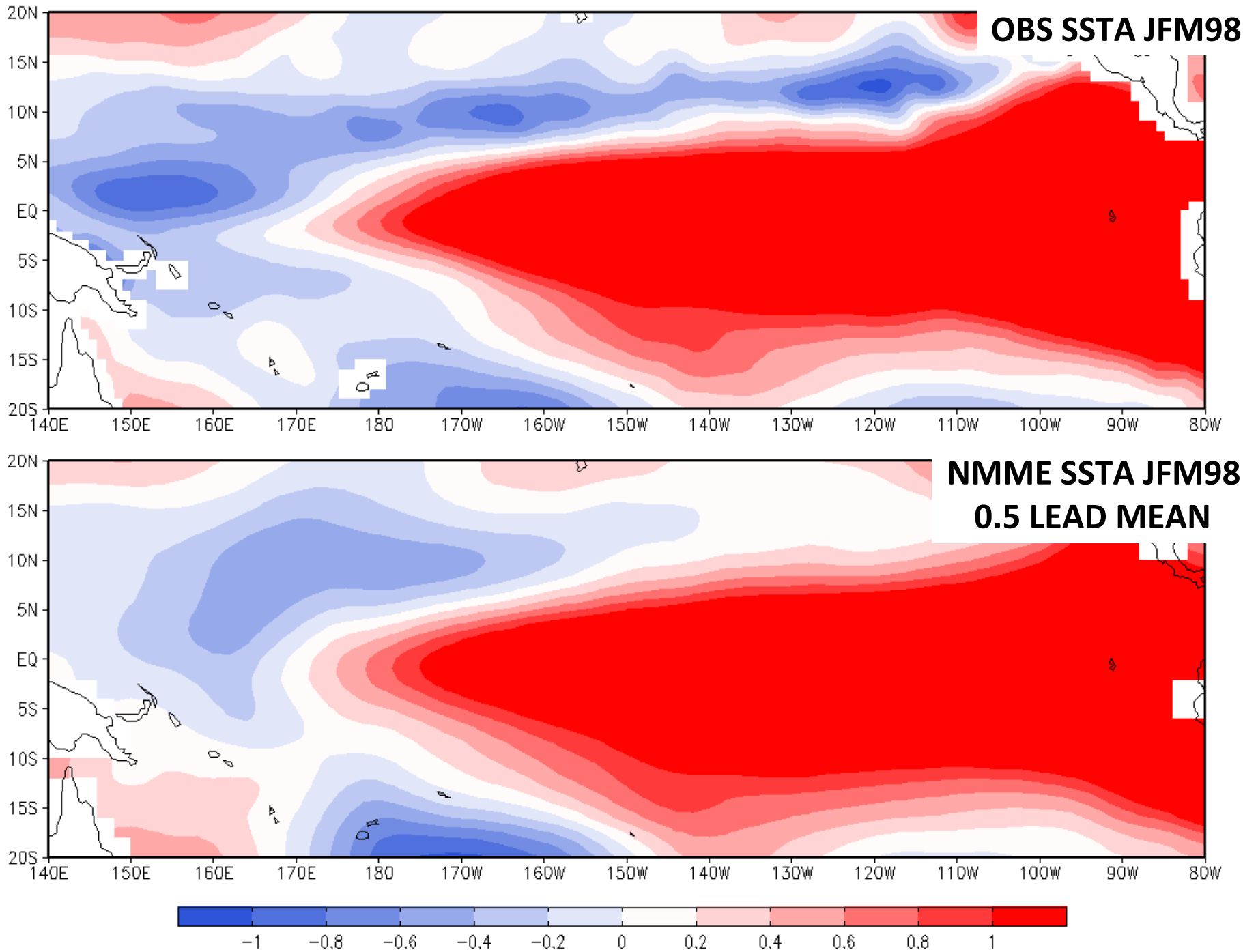

Equatorial SSTA
SSTA Celsius
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
NMME
OBS

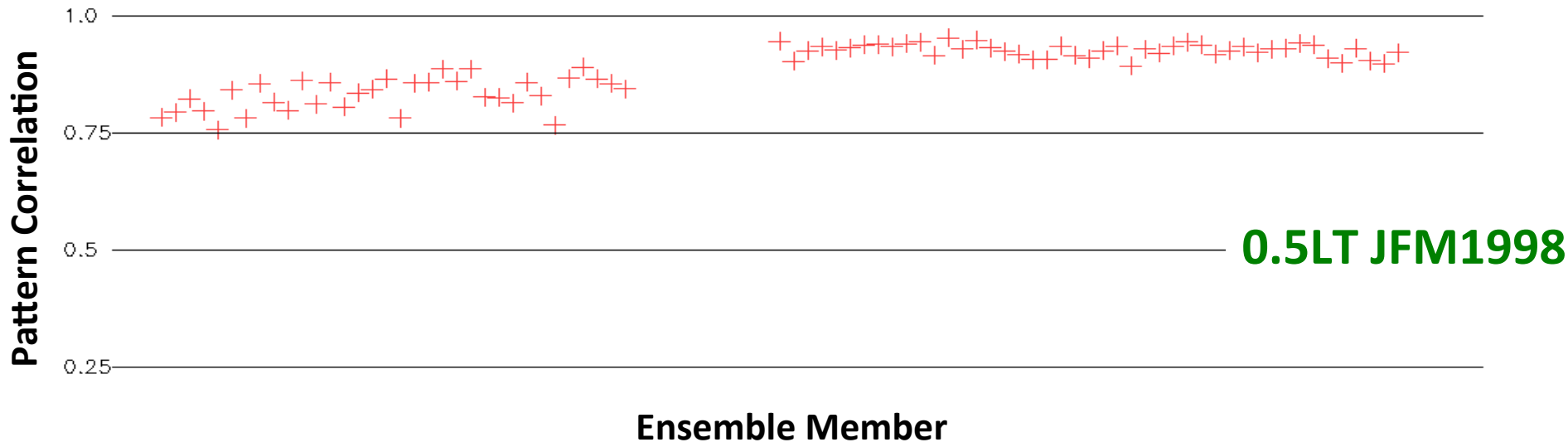

3.5LT JFM1995
Pattern Correlation
1.0
0.75
0.5
0.25
0.0
Ensemble Member

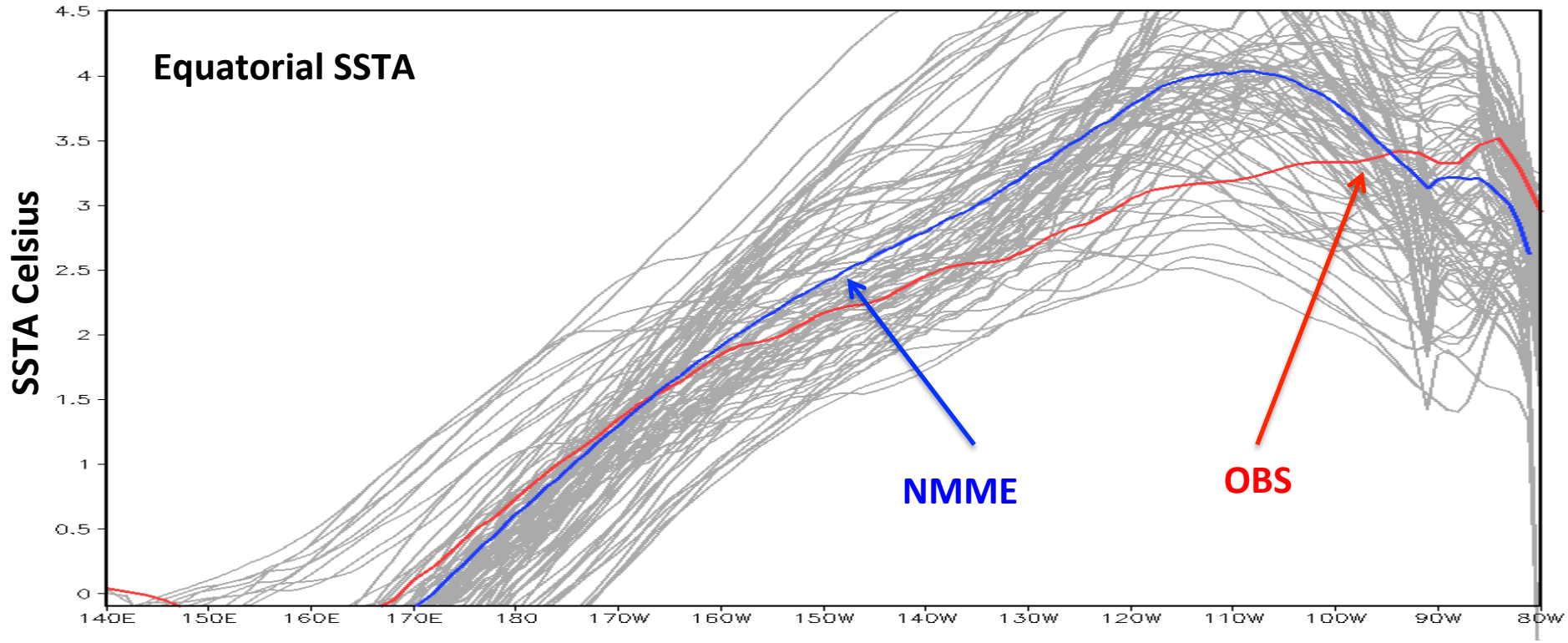

2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W

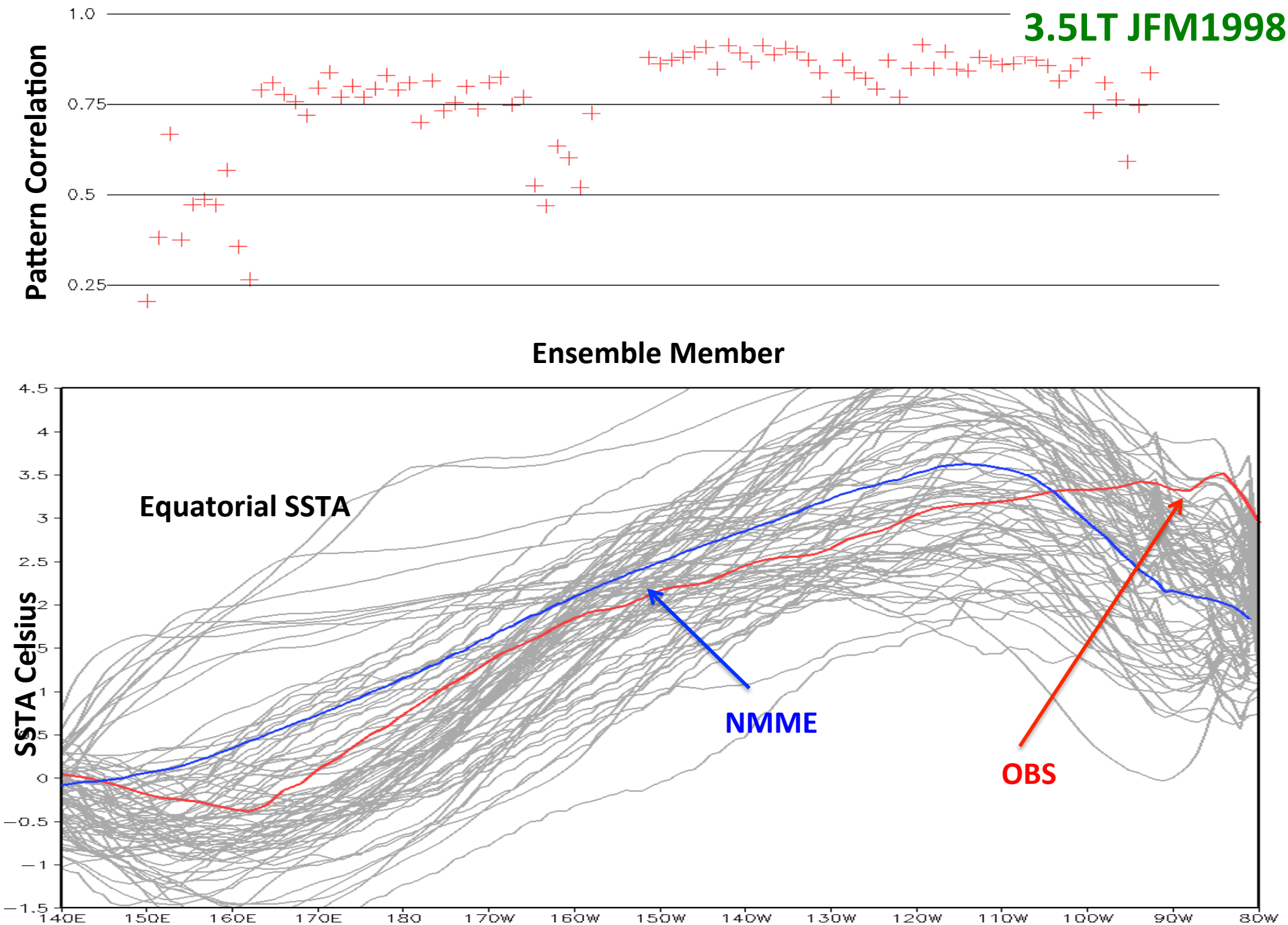



**Kug et al. (2009, J. Climate)**

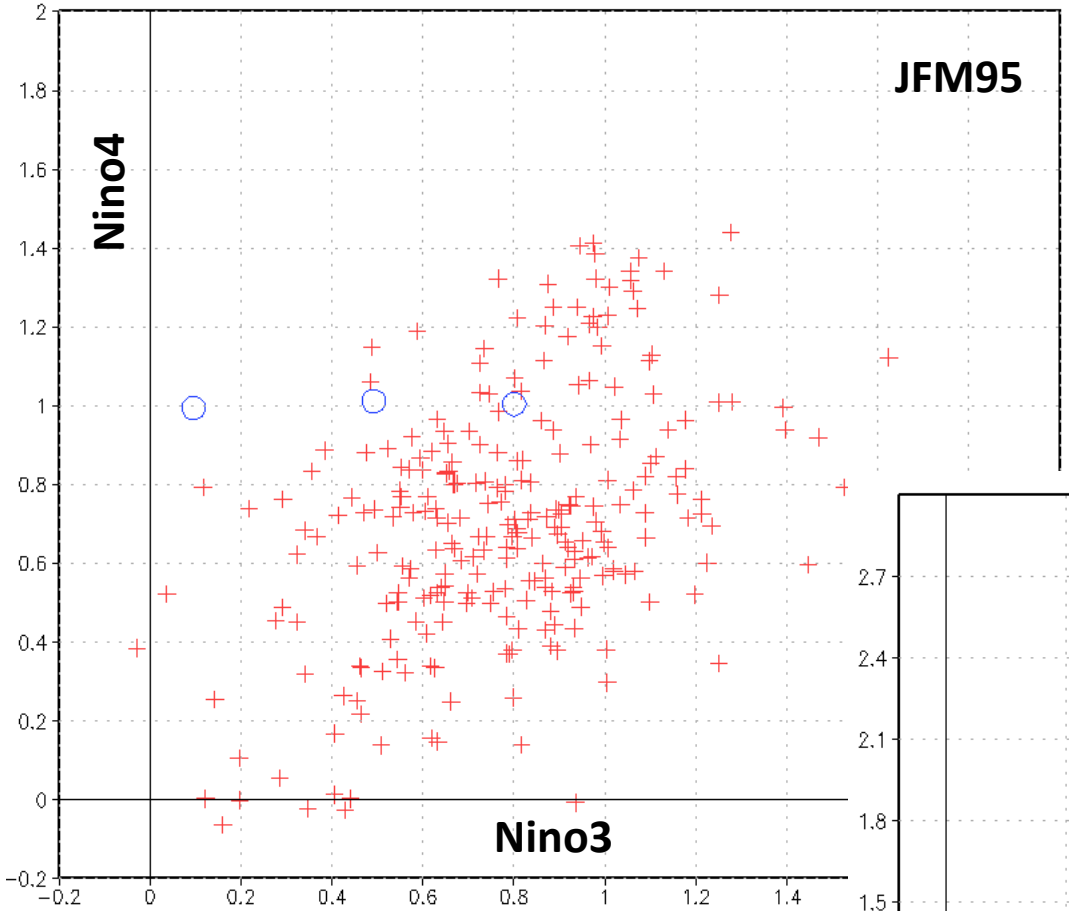

OBS SSTA JFM98
NMME SSTA JFM98
0.5 LEAD MEAN
20N
15N
10N
5N
EQ
5S
10S
15S
20S
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1

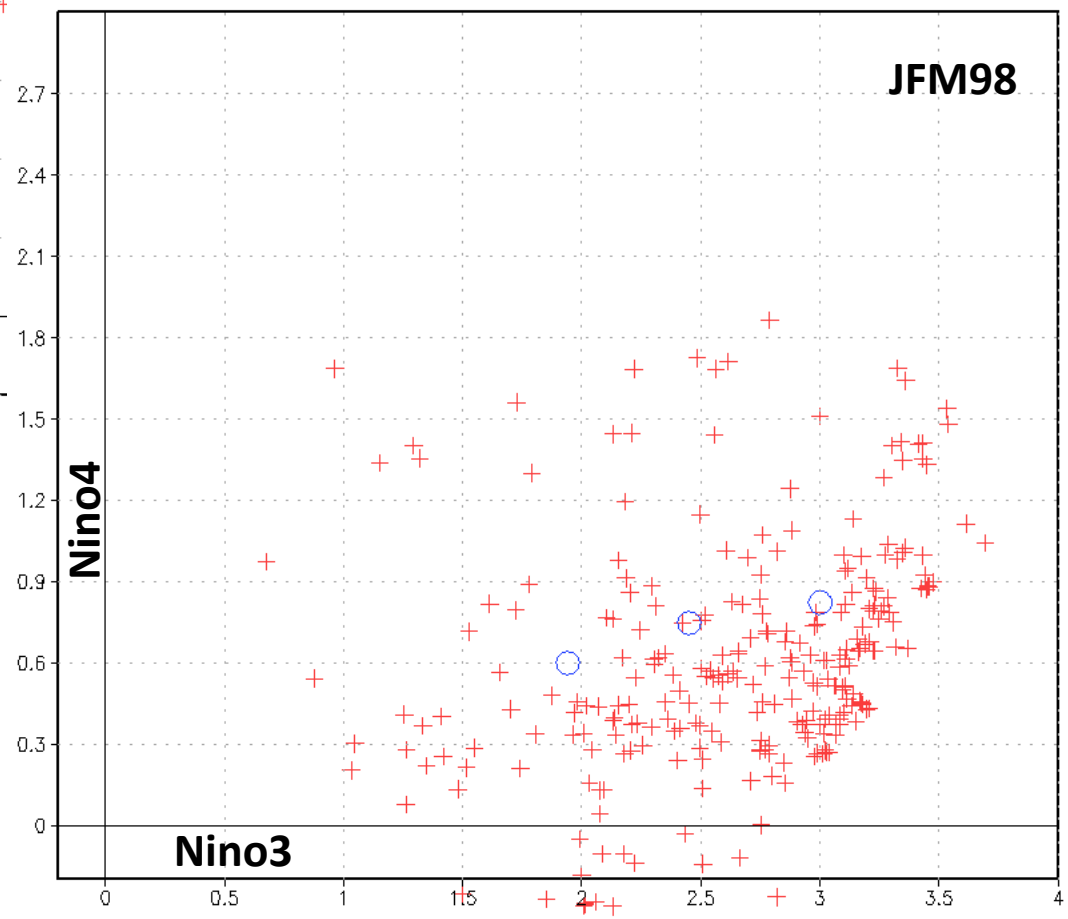

Pattern Correlation
1.0
0.75
0.5
0.25
0.5LT JFM1998
Ensemble Member


Equatorial SSTA
SSTA Celsius
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
NMME
OBS


3.5LT JFM1998
Pattern Correlation
1.0
0.75
0.5
0.25
Ensemble Member
Equatorial SSTA
SSTA Celsius
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
NMME
OBS

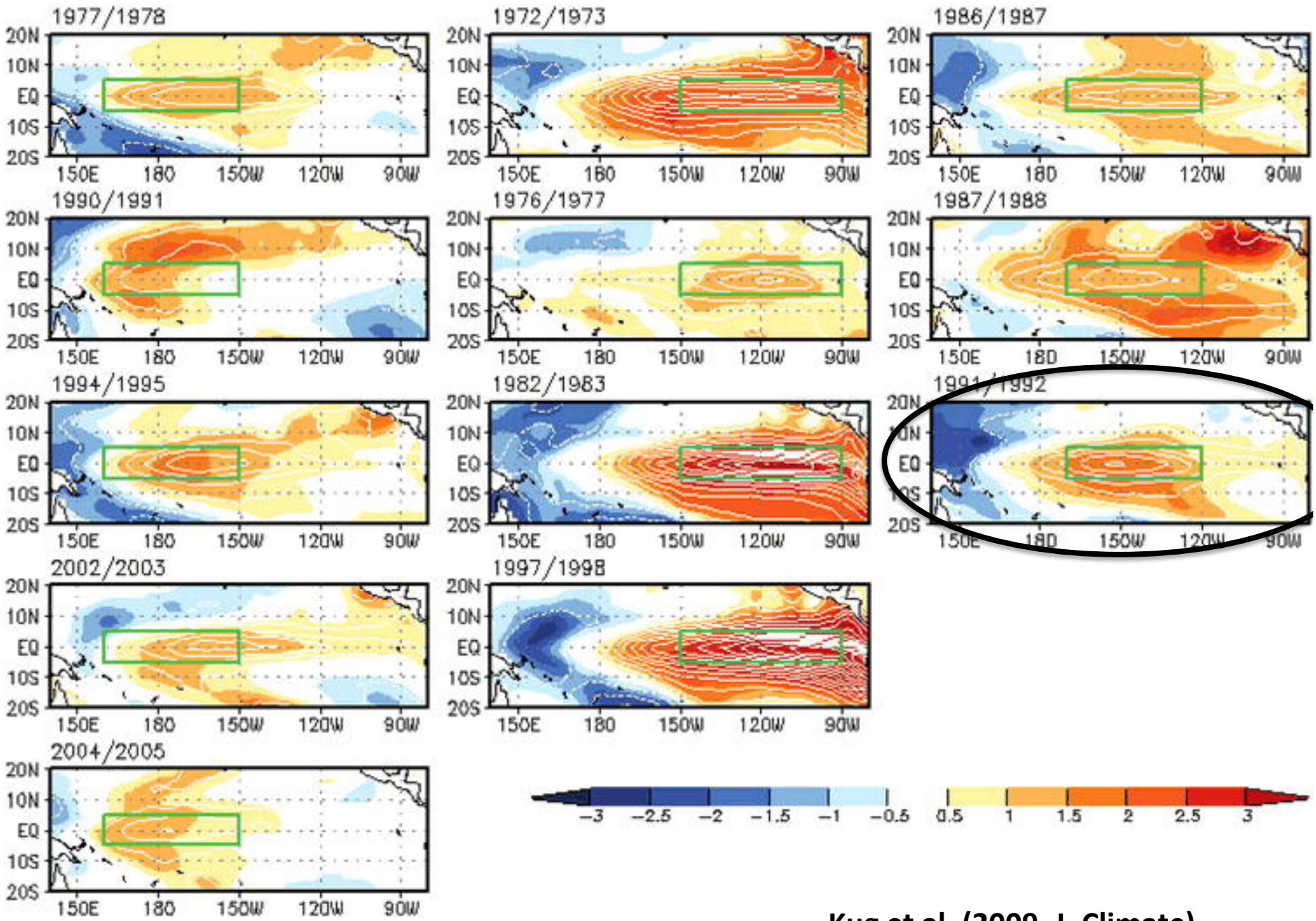
# NINO3 vs. NINO4 SSTA



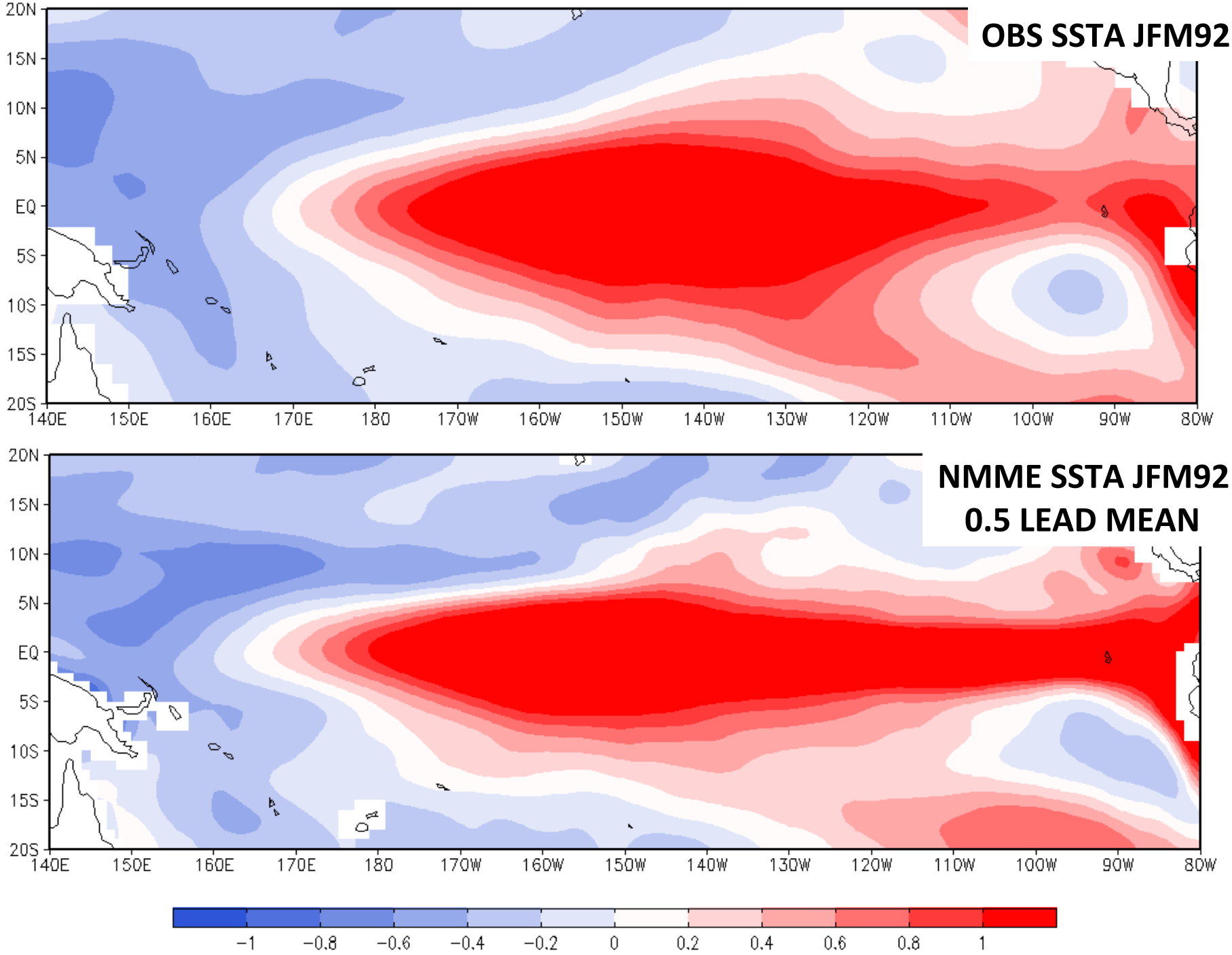



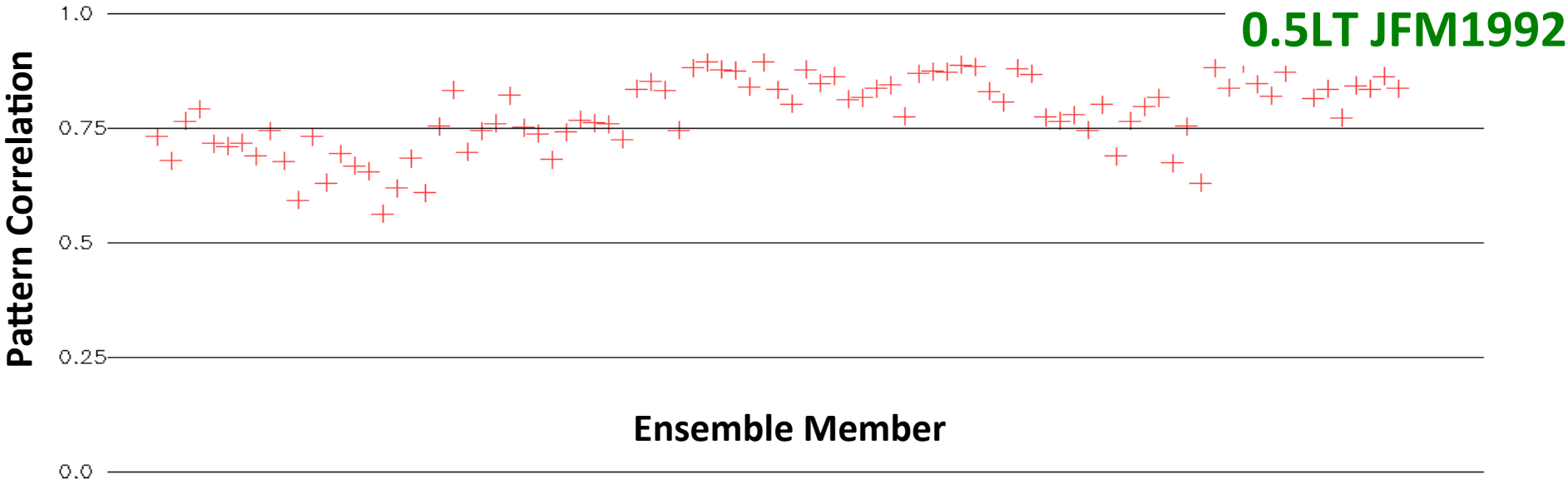

Observational Estimate

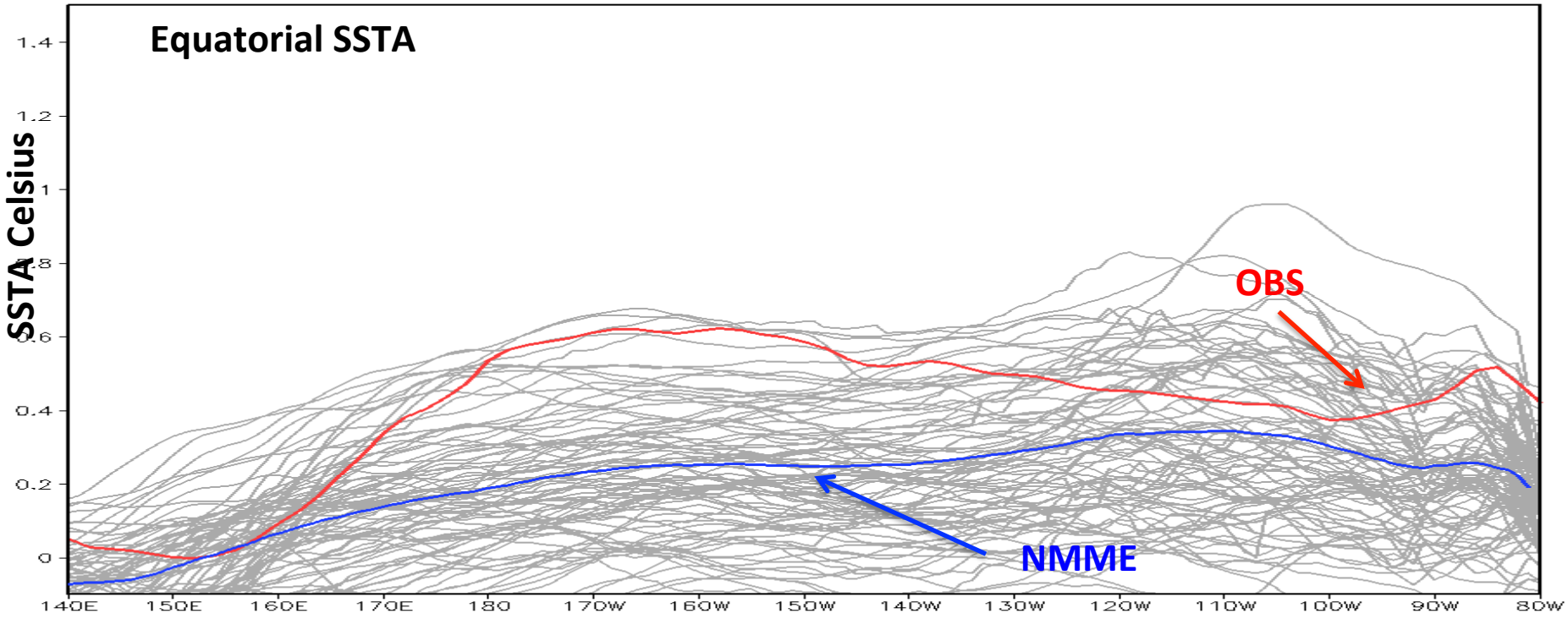
NMME Hindcast

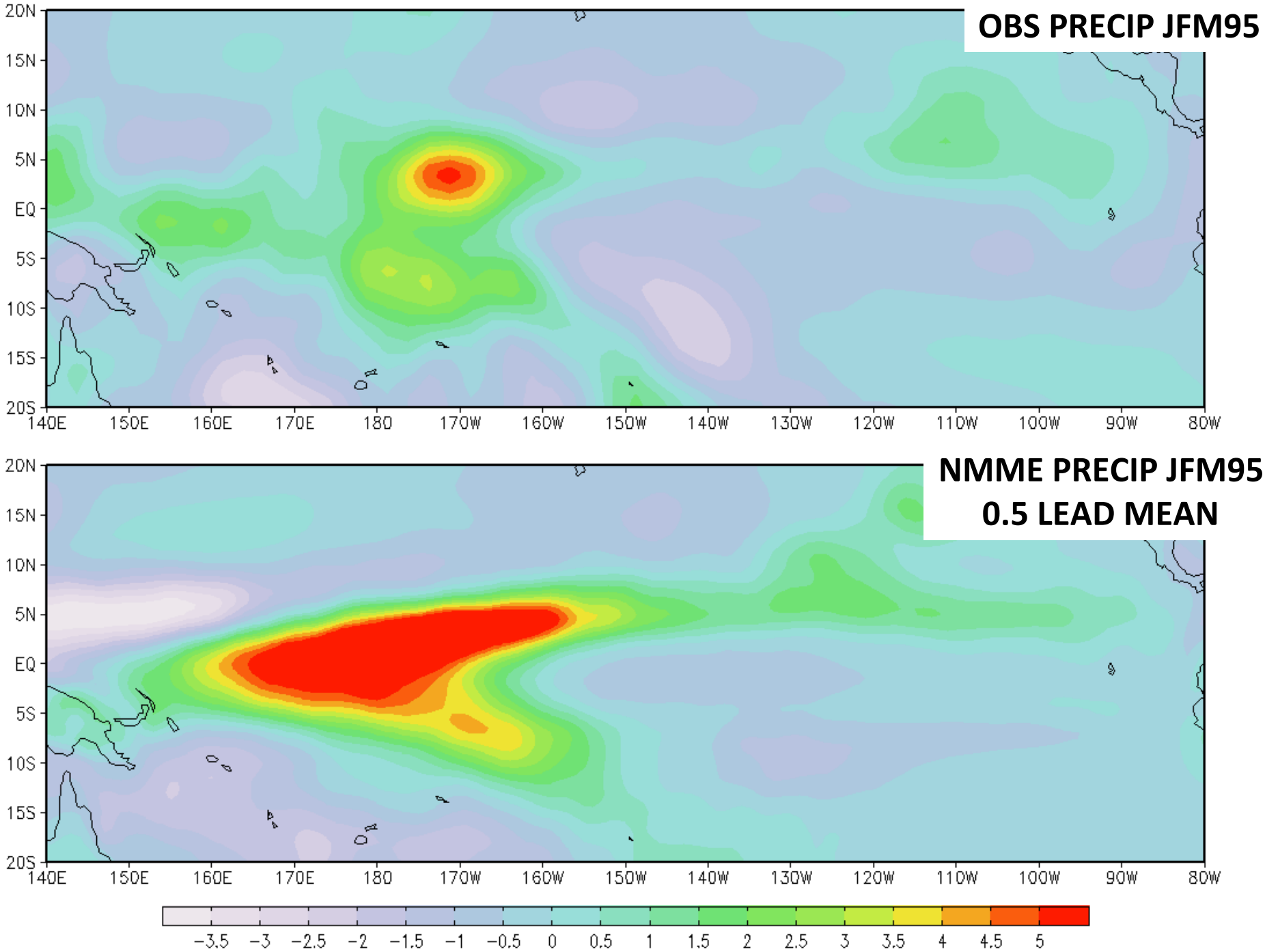


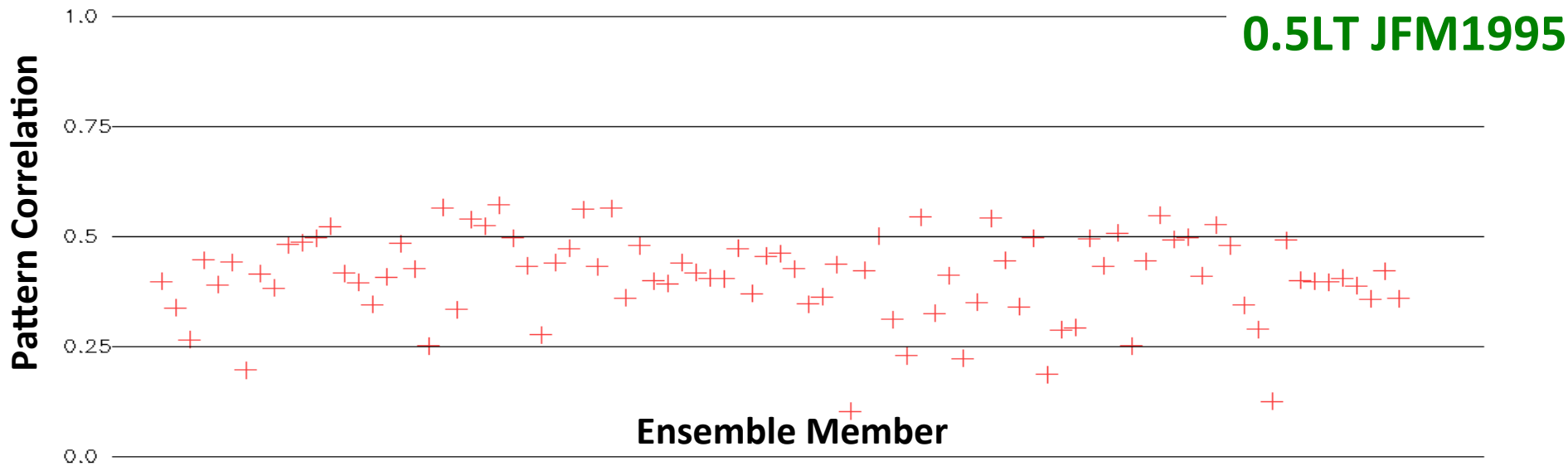

**Kug et al. (2009, J. Climate)**

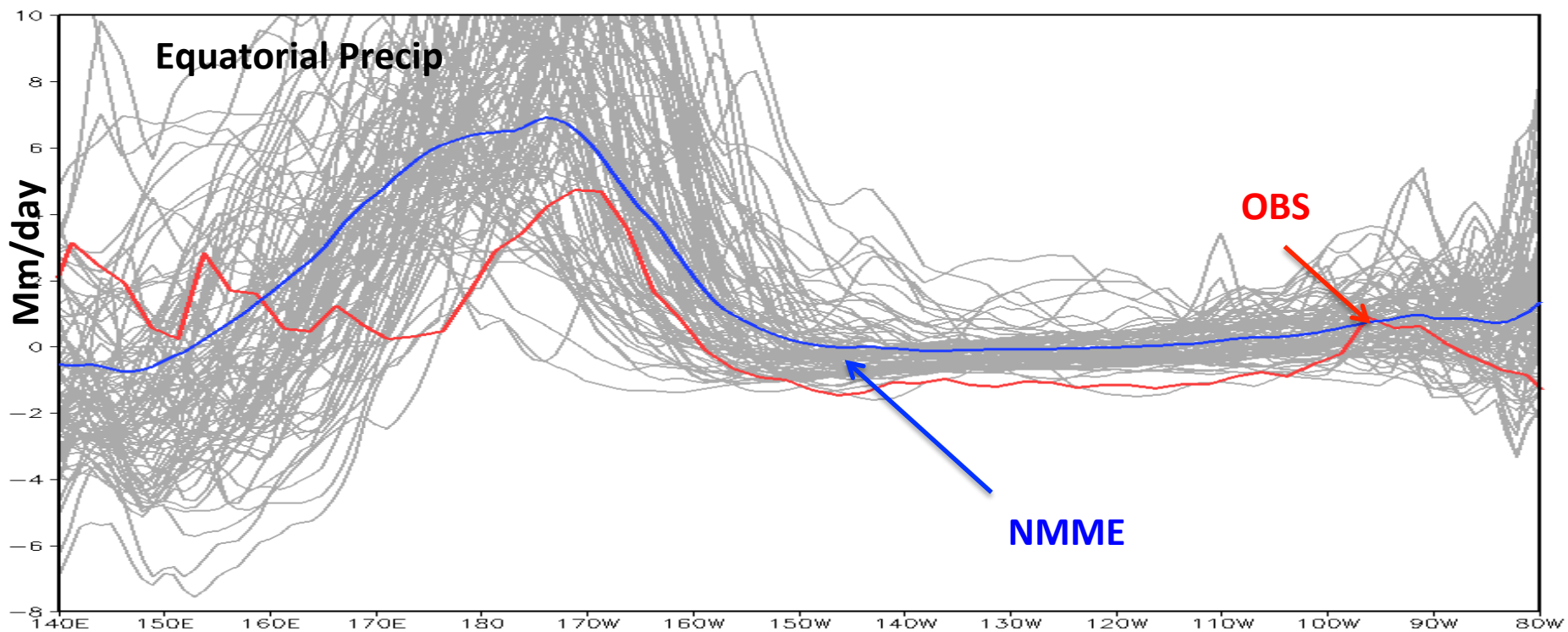

OBS SSTA JFM92
NMME SSTA JFM92
0.5 LEAD MEAN
20N
15N
10N
5N
EQ
5S
10S
15S
20S
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1

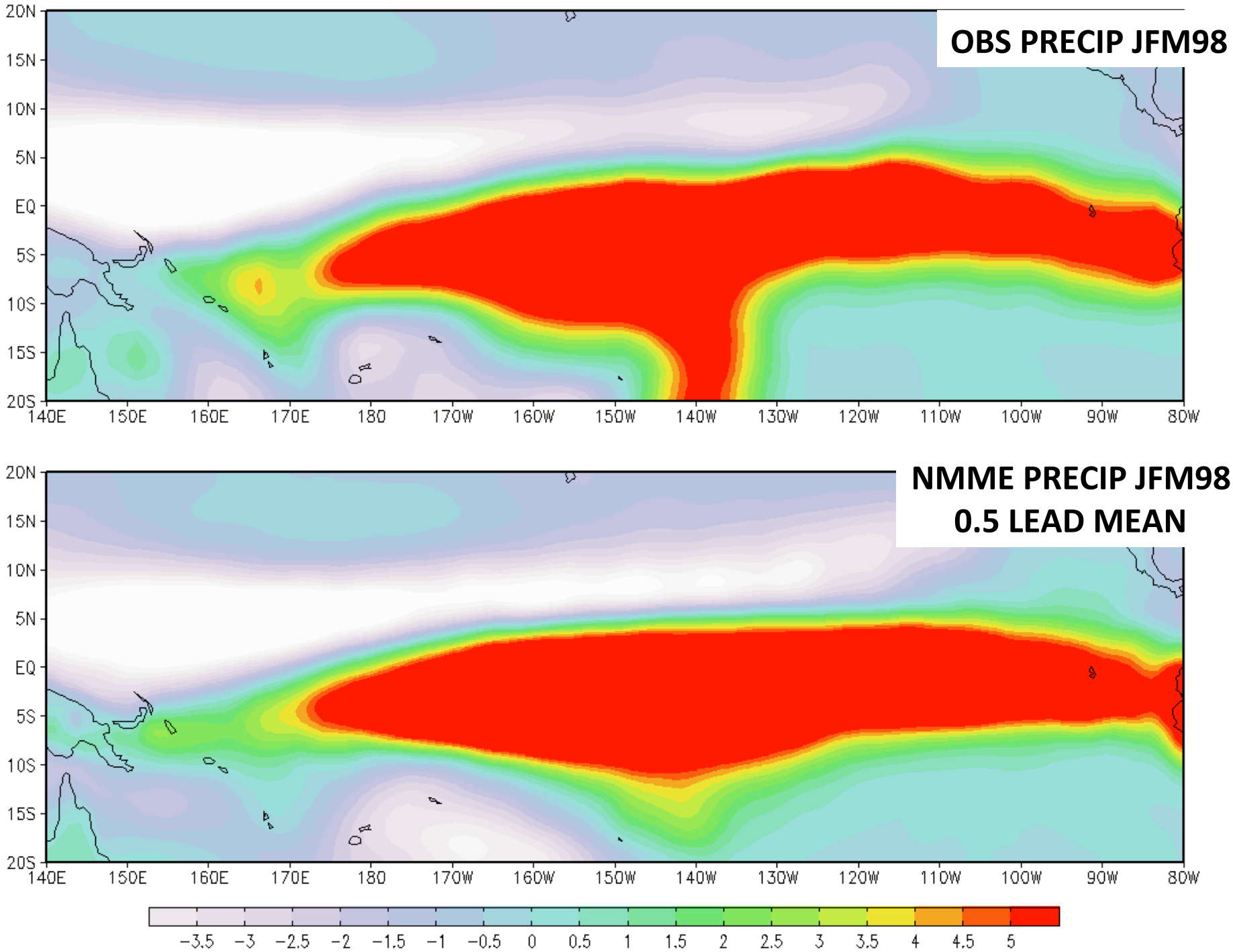

0.5LT JFM1992
Pattern Correlation
1.0
0.75
0.5
0.25
0.0
Ensemble Member

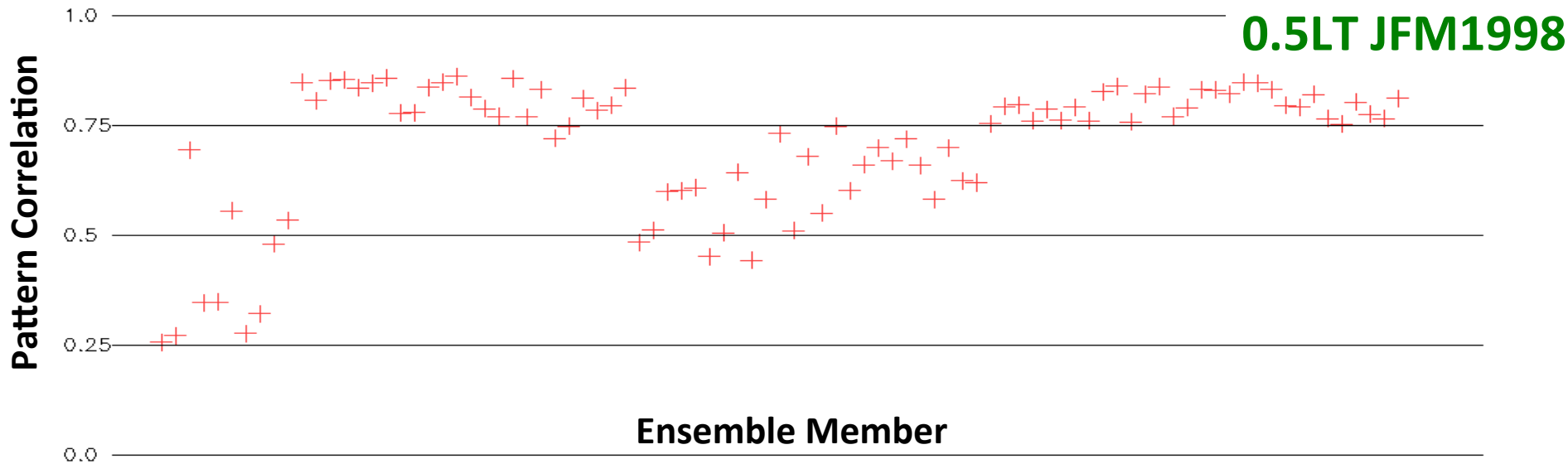

Equatorial SSTA
SSTA Celsius
1.4
1.2
1
0.8
0.6
0.4
0.2
0
OBS
NMME
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W

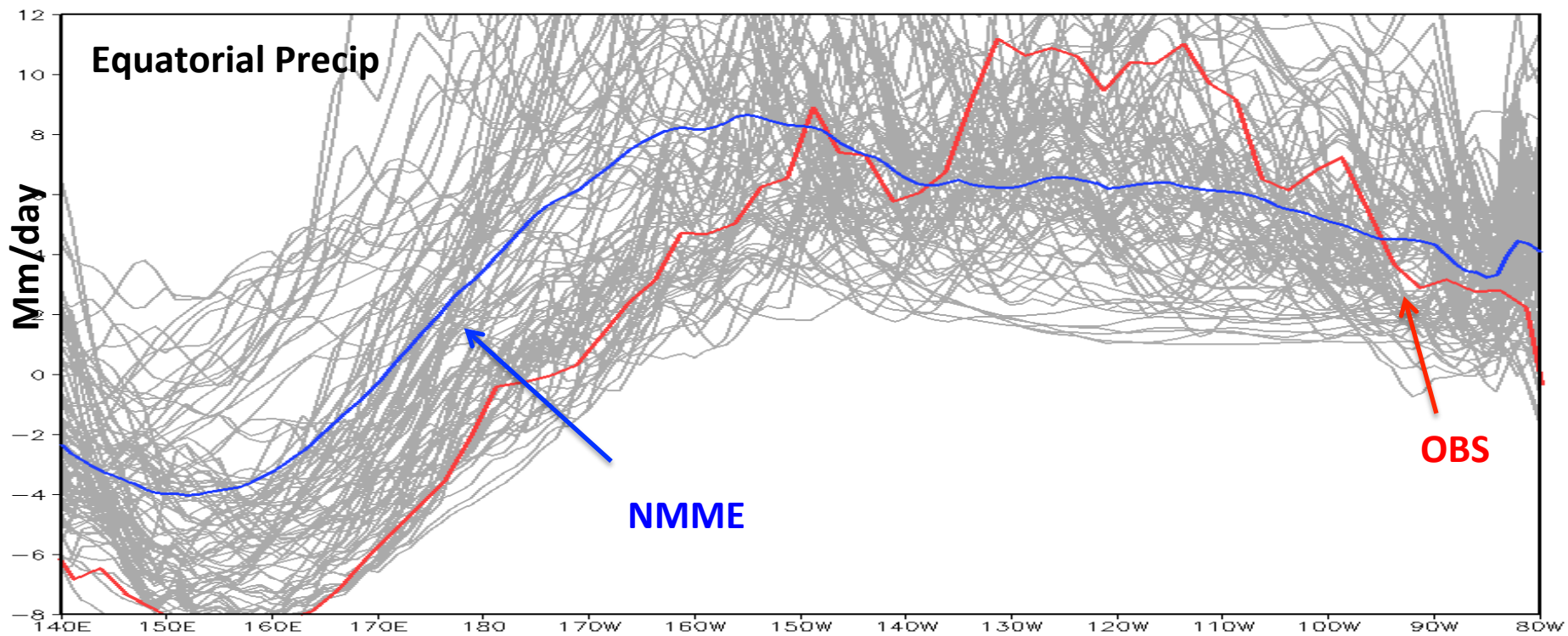

OBS PRECIP JFM95
NMME PRECIP JFM95
0.5 LEAD MEAN
20N
15N
10N
5N
EQ
5S
10S
15S
20S
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
−3.5
−3
−2.5
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

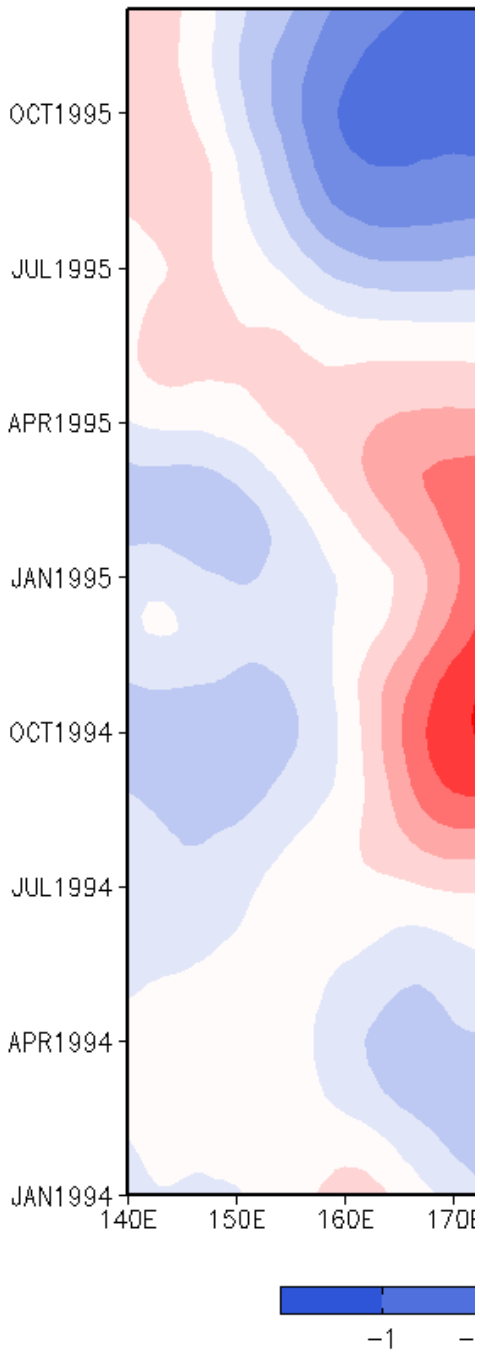

0.5LT JFM1995
Pattern Correlation
1.0
0.75
0.5
0.25
0.0
Ensemble Member

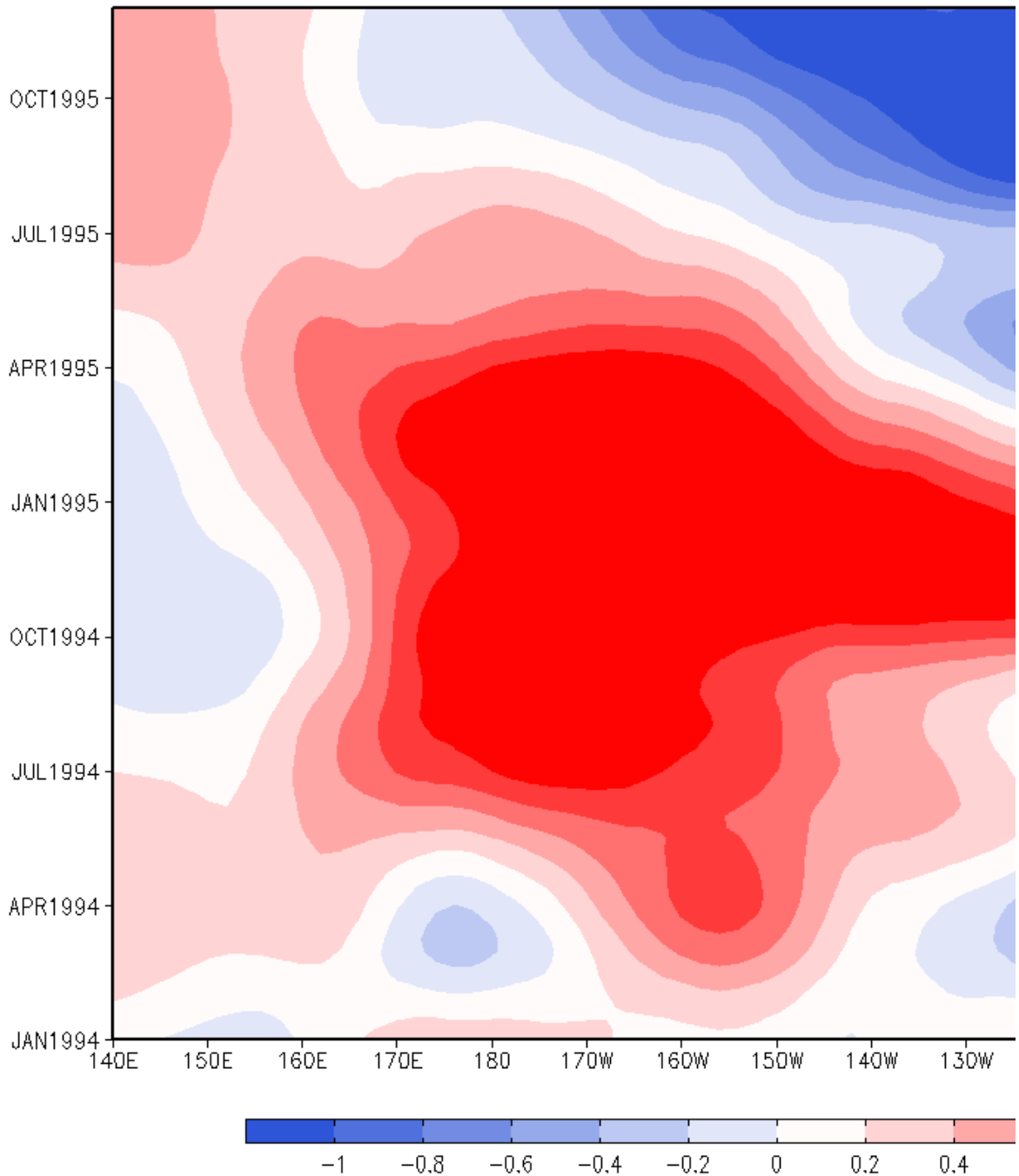

Equatorial Precip
Mm/day
10
8
6
4
2
0
−2
−4
−6
−8
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
OBS
NMME

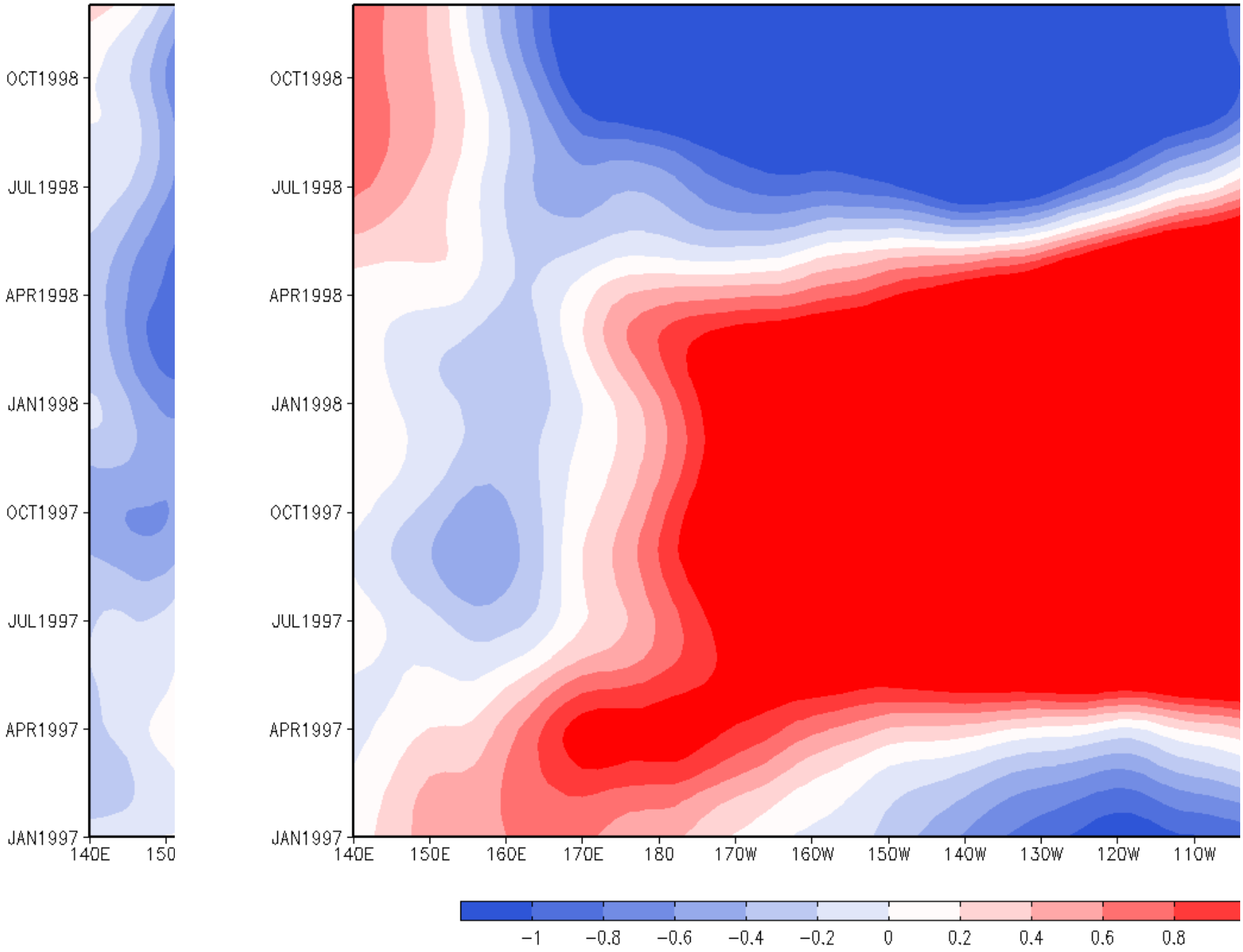

OBS PRECIP JFM98
NMME PRECIP JFM98
0.5 LEAD MEAN
20N
15N
10N
5N
EQ
5S
10S
15S
20S
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
−3.5
−3
−2.5
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


0.5LT JFM1998
Pattern Correlation
1.0
0.75
0.5
0.25
0.0
Ensemble Member


Equatorial Precip
Mm/day
12
10
8
0
−2
−4
−6
−8
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
NMME
OBS

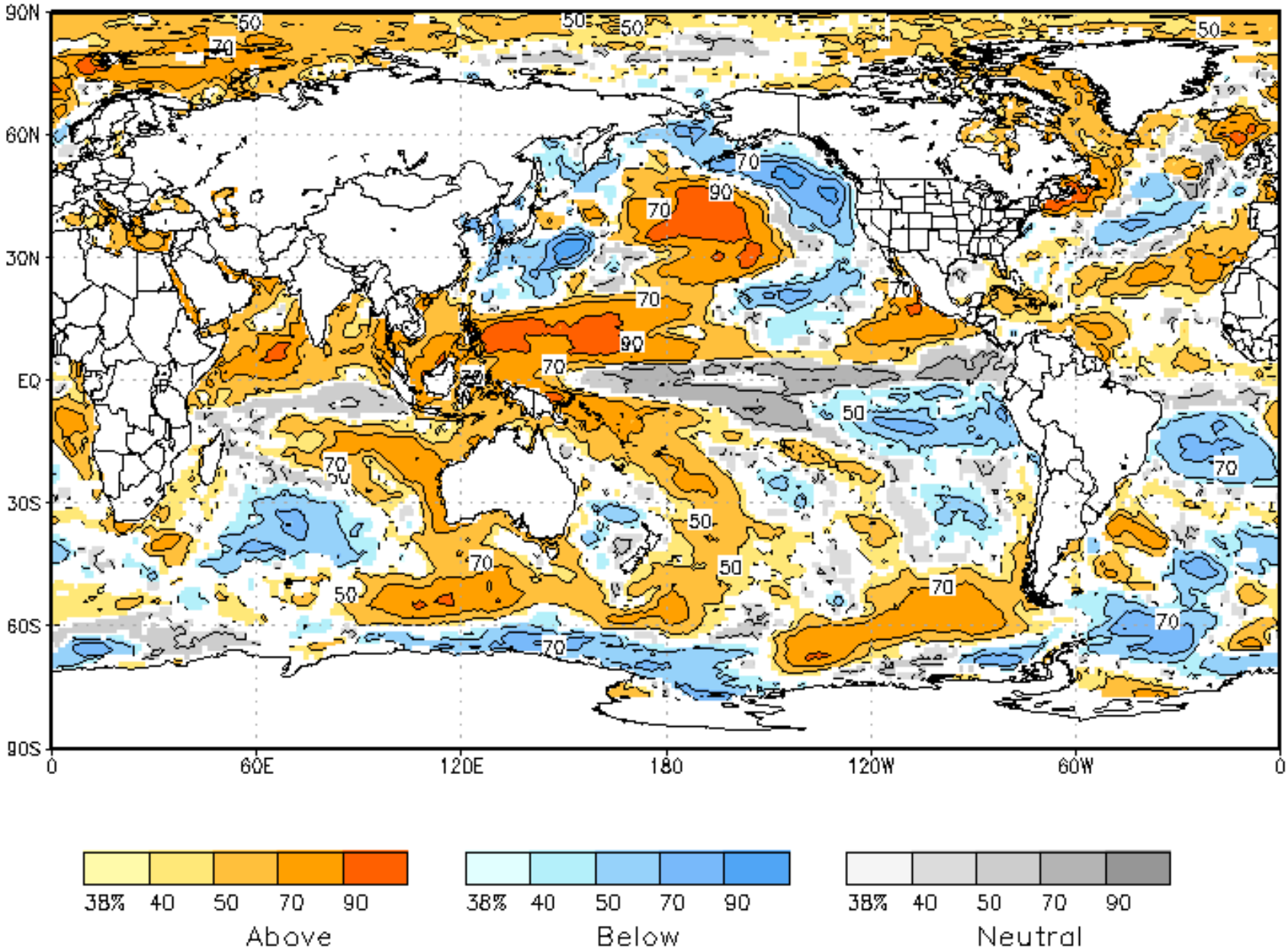

OCT1995
JUL1995
APR1995
JAN1995
OCT1994
JUL1994
APR1994
JAN1994
140E
150E
160E
170E
−1

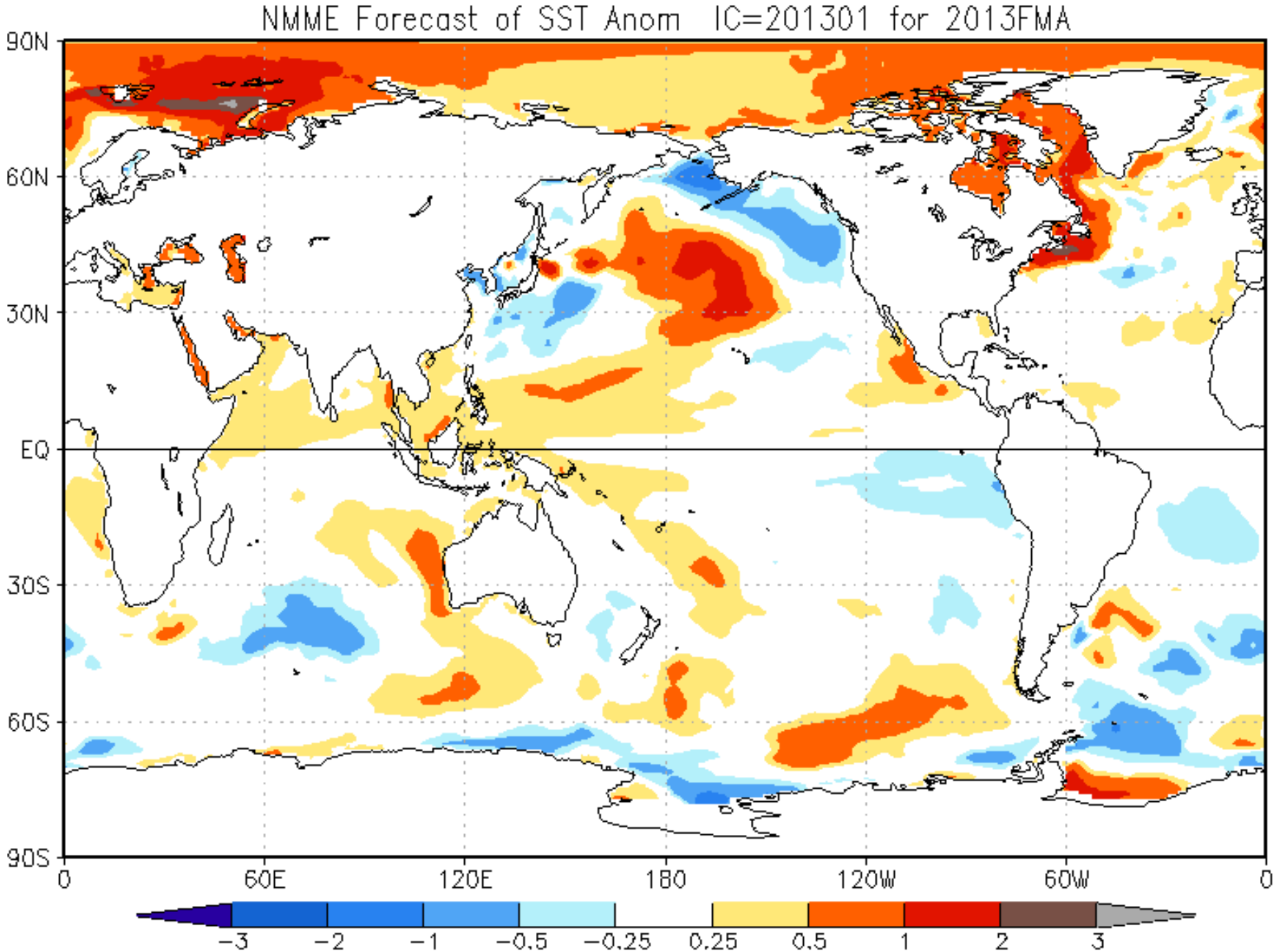

OCT1995
JUL1995
APR1995
JAN1995
OCT1994
JUL1994
APR1994
JAN1994
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4


OCT1998
JUL1998
APR1998
JAN1998
OCT1997
JUL1997
APR1997
JAN1997
140E
150
OCT1998
JUL1998
APR1998
JAN1998
OCT1997
JUL1997
APR1997
JAN1997
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8

# CURRENT NMME FORECAST

# NMME prob fcst SST IC=201301 for lead 1 2013 FMA




NMME Forecast of SST Anom IC=201301 for 2013FMA
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−3
−2
−1
−0.5
−0.25
0.25
0.5
1
2
3

# Concluding Remarks

- **NMME Captures Some Aspects of the Diversity of ENSO**
  - **SSTA and Rainfall at Short Leads**
  - **Longer Leads NMME Does Not Capture Diversity of ENSO**
- **East Pacific SSTA "Better" Predicted then East or Central Pacific**
- **Very Short Leads (0.5 Months) East vs. West Contrasts Not Captured**
  - **Warms too Readily in the East**