The Use of CERES/ERBE data at NCEP/CPC

** AO/AAO and ERBS OLR*

** MRF and CERES*

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A. Jim Miller
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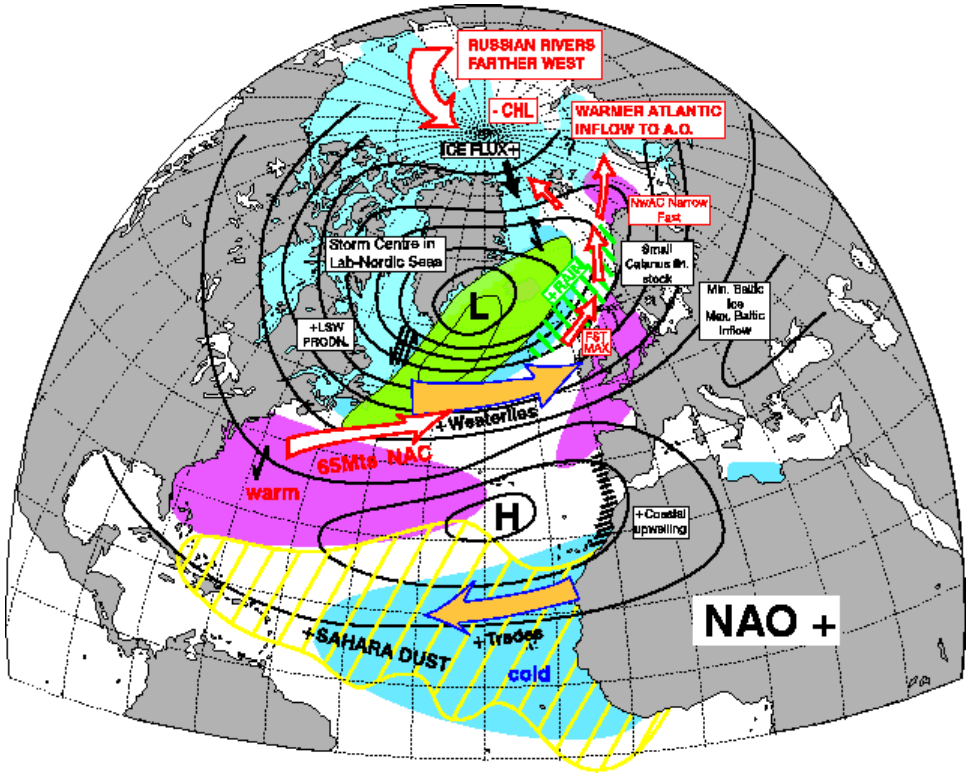
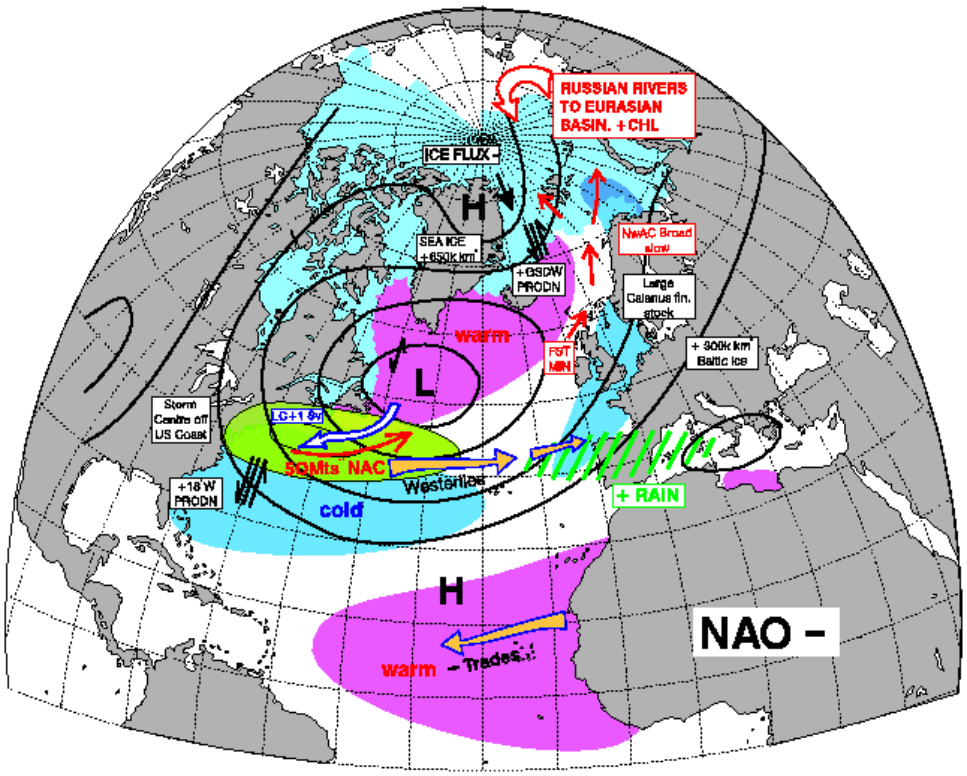
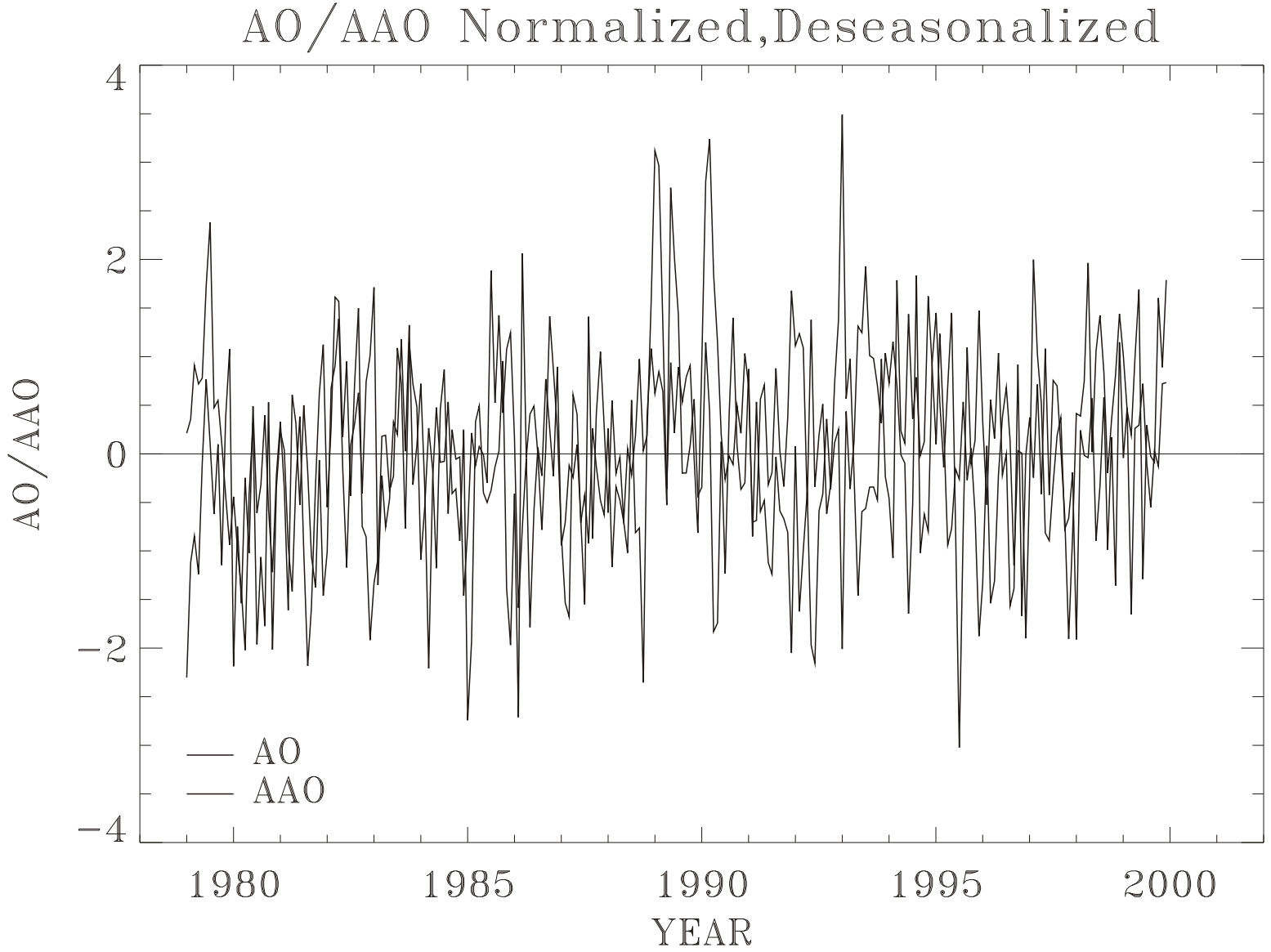
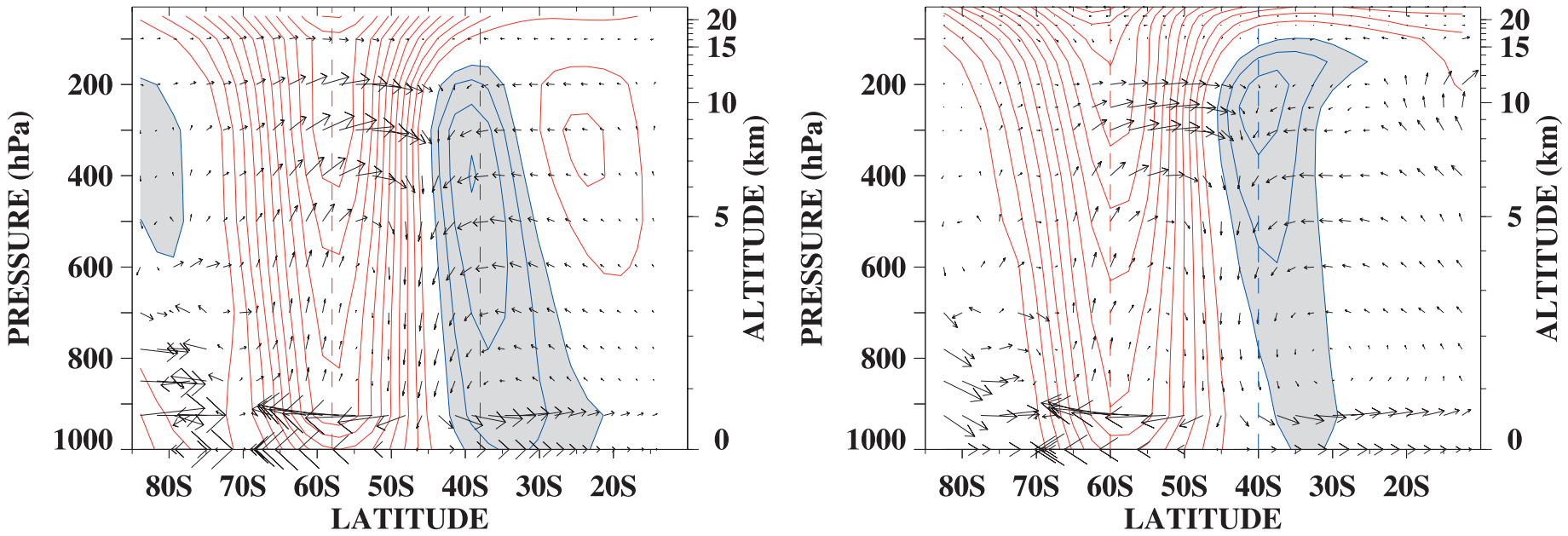
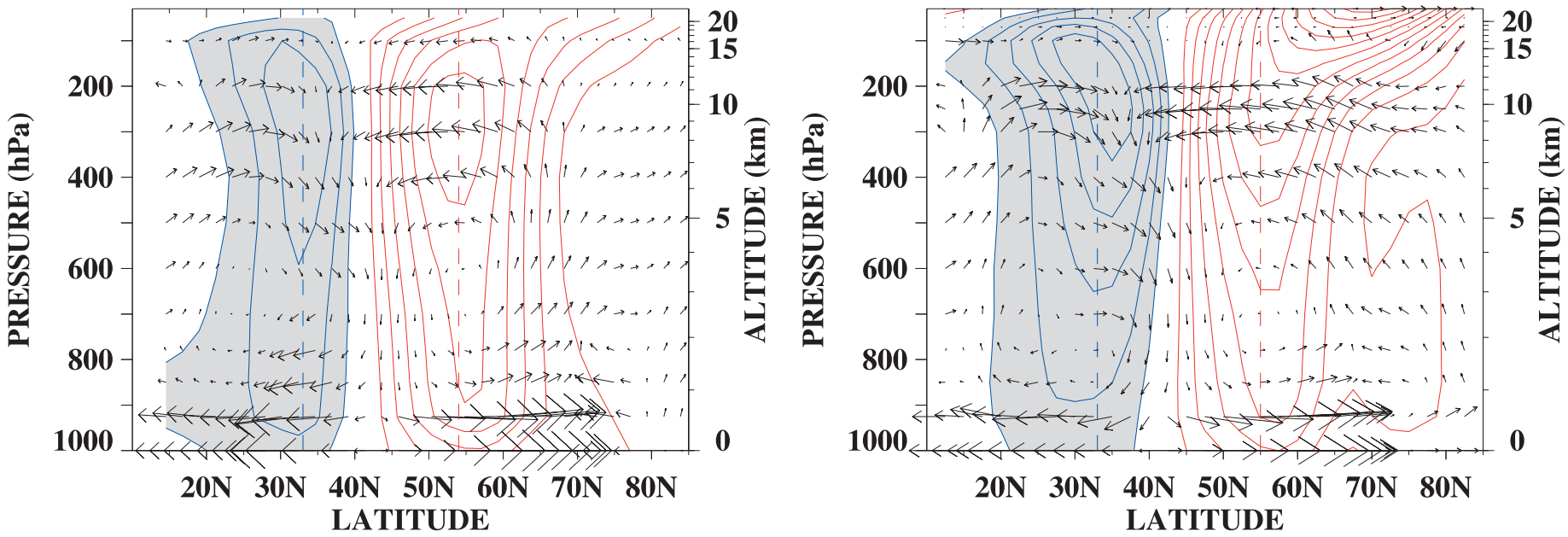

RUSSIAN RIVERS FARTHER WEST
- CHL
WARMER ATLANTIC INFLOW TO A.O.
ICE FLUX+
NwAC Narrow Fast
Storm Centre in Lab-Nordic Seas
Small Calanus fin. stock
Min. Baltic Ice Max. Baltic Inflow
+LSW PRODN
L
FST MAX
+Westerlies
65Mls NAC
warm
H
+Coastal upwelling
+SAHARA DUST
+Trades
cold
NAO +


RUSSIAN RIVERS TO EURASIAN BASIN. +CHL
ICE FLUX -
H
SEA ICE +650k km
NwAC Broad slow
+GSDW PRODN
Large Calanus fin. stock
warm
FST MIN
+ 300k km Baltic ice
L
Storm Centre off US Coast
LC+1 Sv
50Mls NAC
Westerlies
+18°W PRODN
cold
+ RAIN
H
warm
- Trades
NAO -

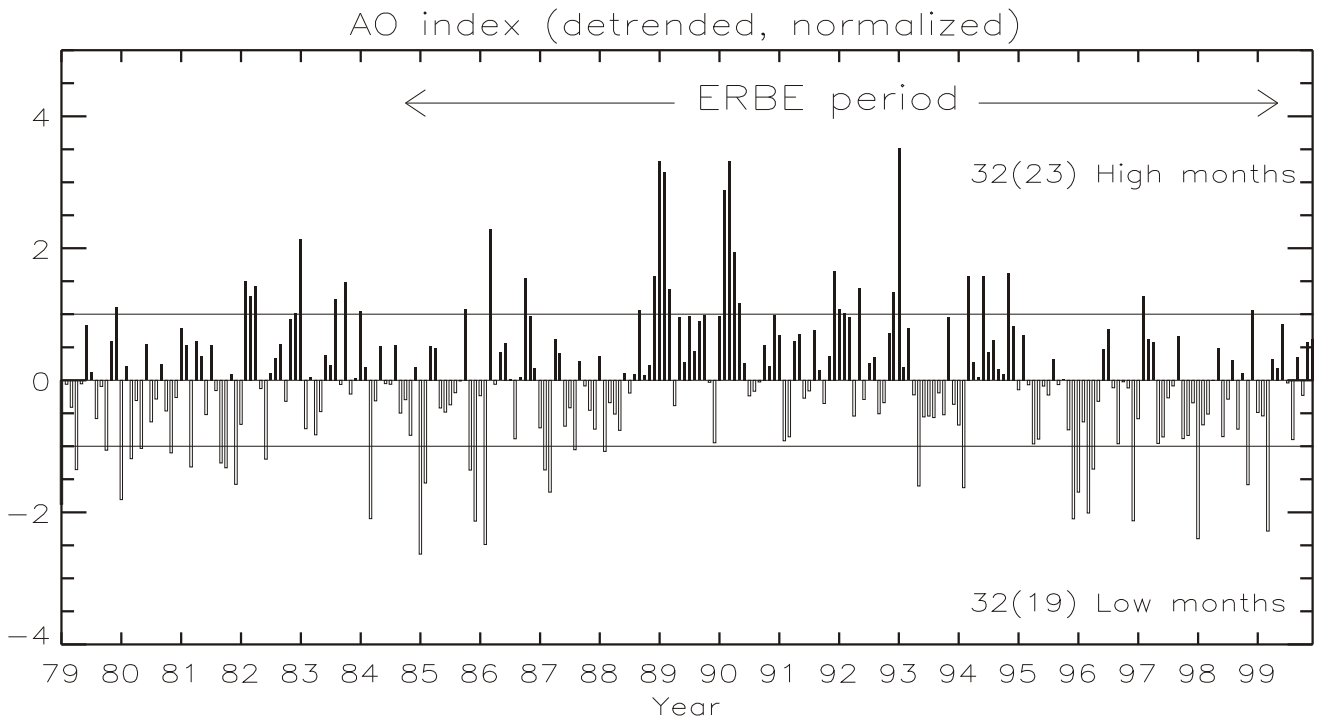

AO/AAO Normalized,Deseasonalized
AO/AAO
4
2
0
−2
−4
AO
AAO
1980
1985
1990
1995
2000
YEAR

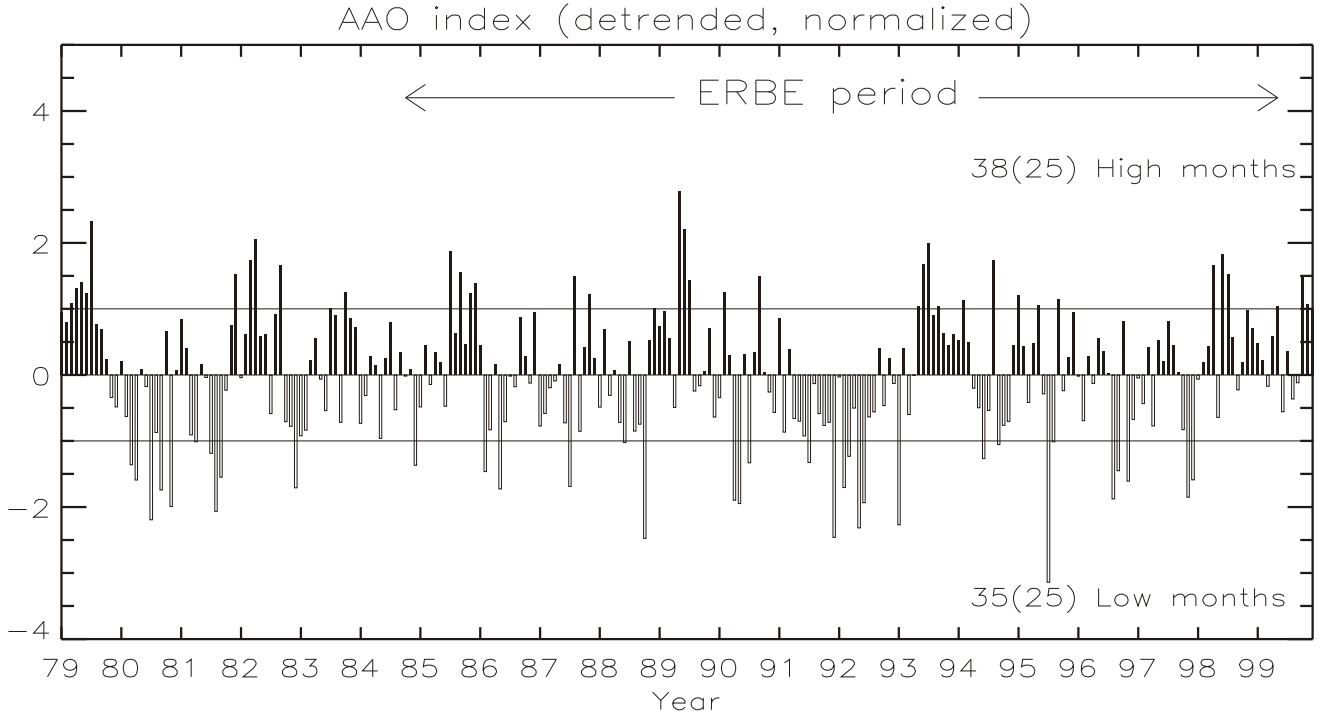


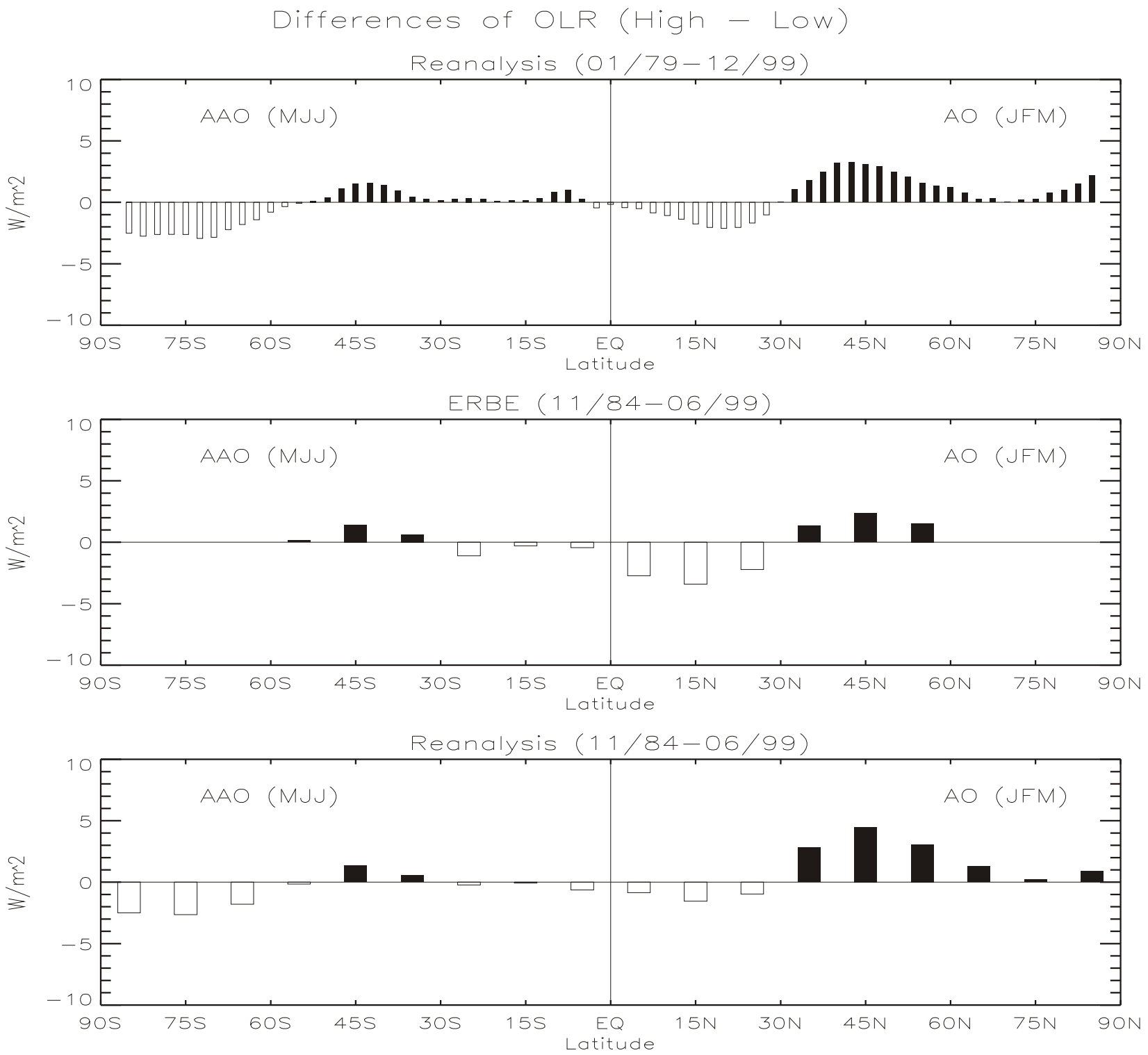
From L & H (2001), SAM wind (contours) and mean meridional circulation (vectors). High-Low composite. Left: GFDL; Right NCAR/NCEP



From L & H (2001), NAM wind (contours) and mean meridional circulation (vectors). High-Low composite. Left: GFDL; Right NCAR/NCEP

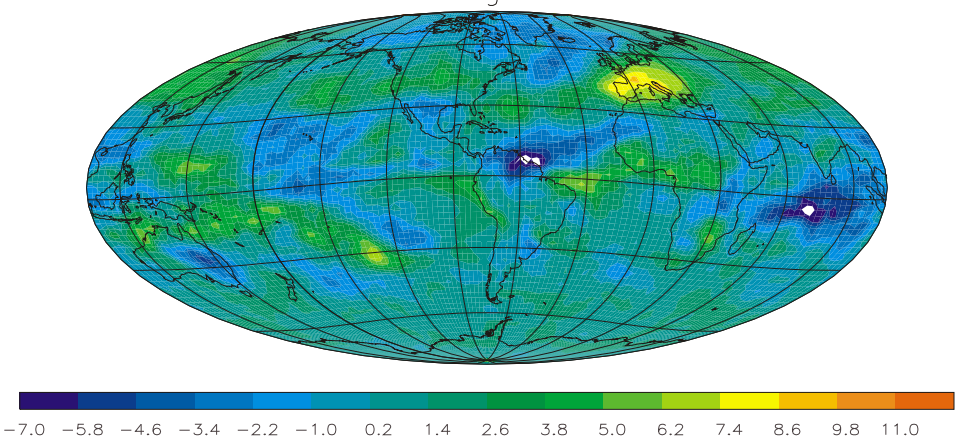

AO index (detrended, normalized)
ERBE period
32(23) High months
32(19) Low months
4
2
0
−2
−4
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99
Year


AAO index (detrended, normalized)
ERBE period
38(25) High months
35(25) Low months
4
2
0
−2
−4
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99
Year


Differences of OLR (High – Low)
Reanalysis (01/79–12/99)
AAO (MJJ)
AO (JFM)
W/m^2
10
5
0
–5
–10
90S 75S 60S 45S 30S 15S EQ 15N 30N 45N 60N 75N 90N
Latitude
ERBE (11/84–06/99)
AAO (MJJ)
AO (JFM)
W/m^2
10
5
0
–5
–10
90S 75S 60S 45S 30S 15S EQ 15N 30N 45N 60N 75N 90N
Latitude
Reanalysis (11/84–06/99)
AAO (MJJ)
AO (JFM)
W/m^2
10
5
0
–5
–10
90S 75S 60S 45S 30S 15S EQ 15N 30N 45N 60N 75N 90N
Latitude

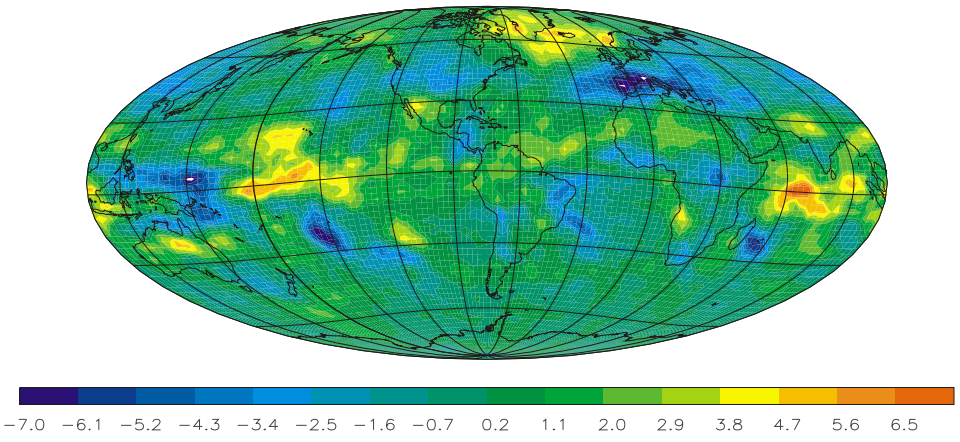
Composites of OLR anomalies by AO

High



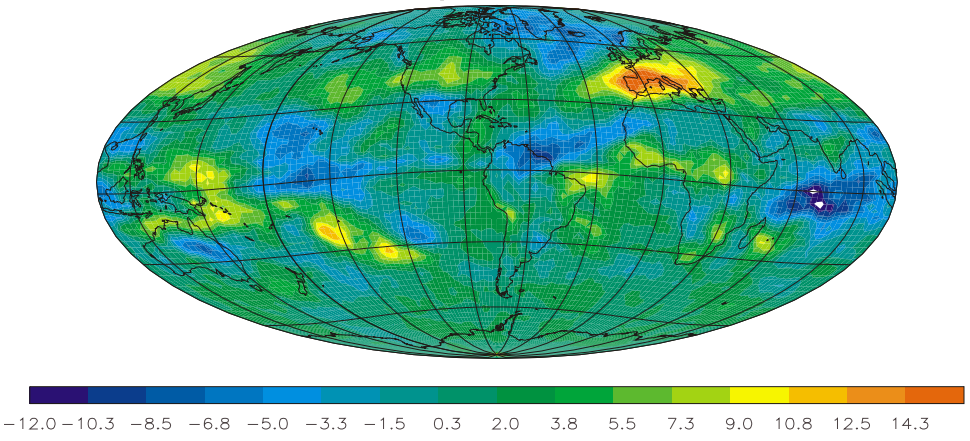
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

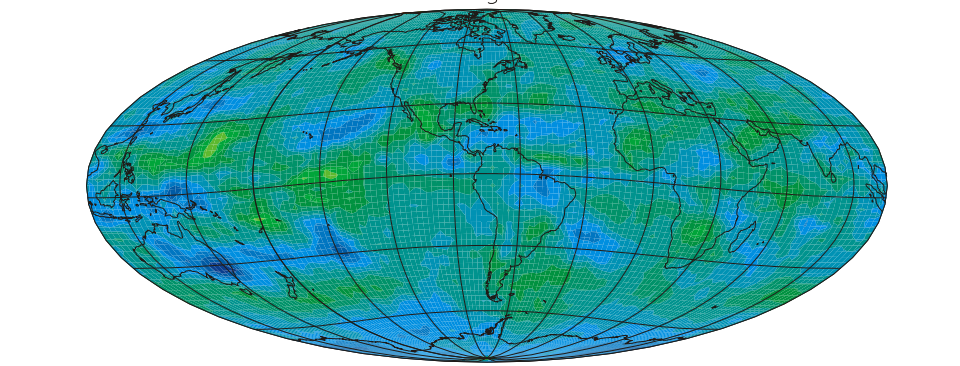
High − Low



−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

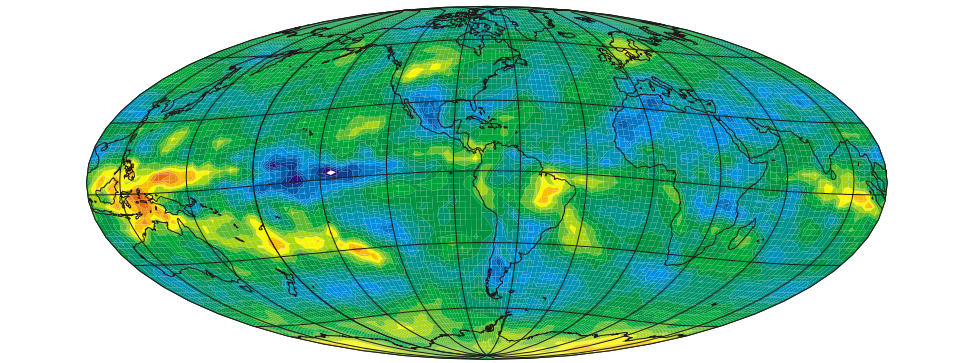
Composites of OLR anomalies by AAO

High



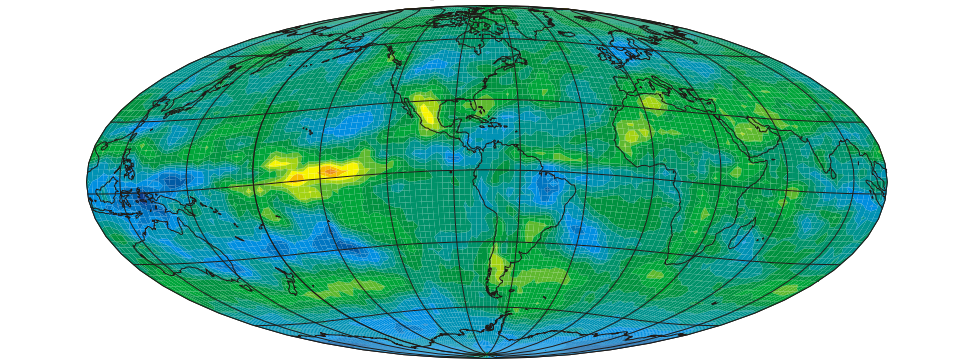
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

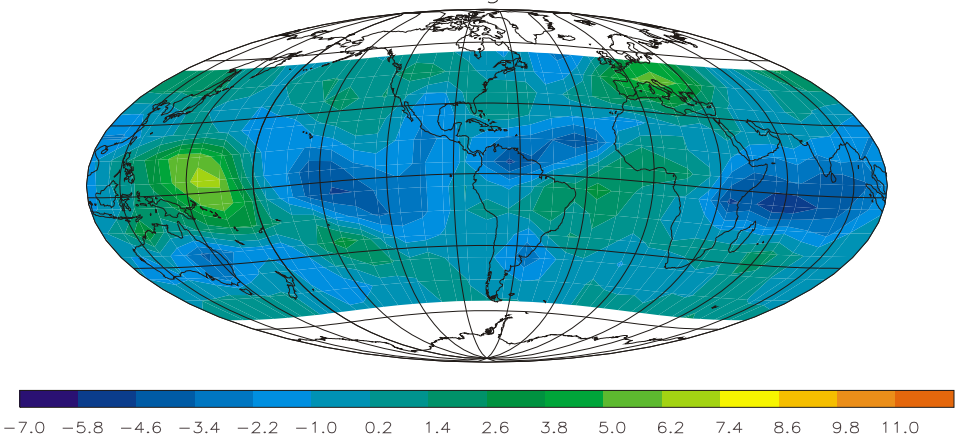
High − Low



−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

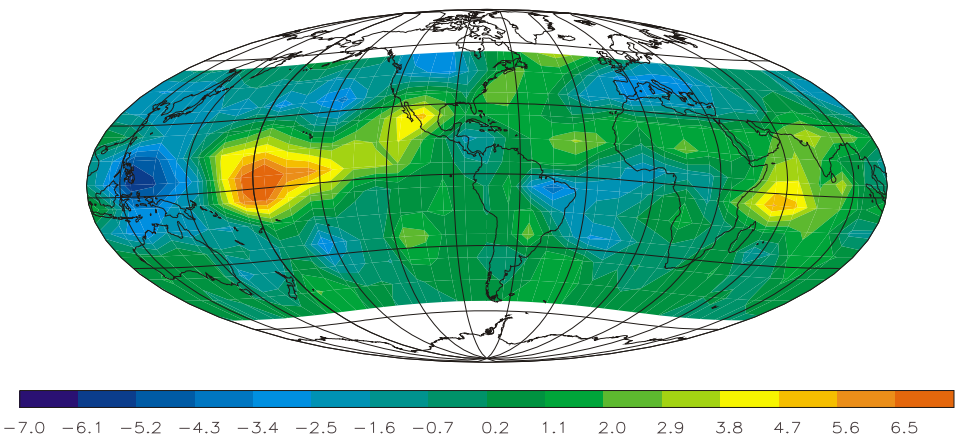
Composites of OLR anomalies by AO

High



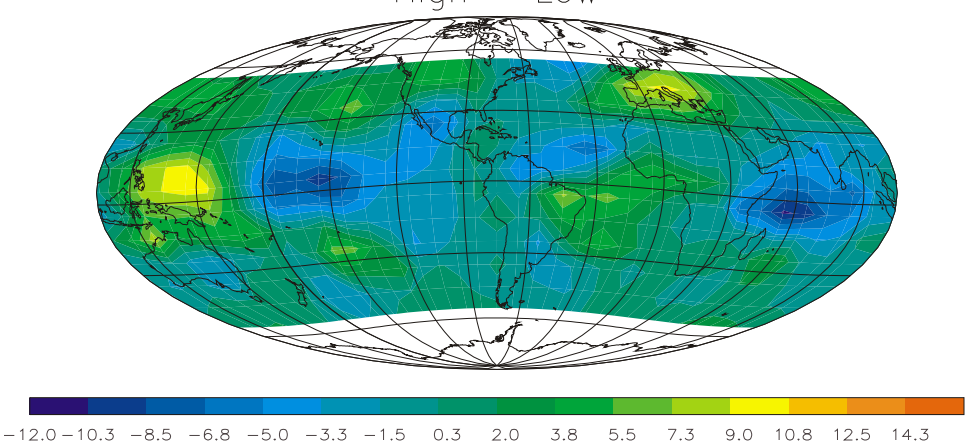
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

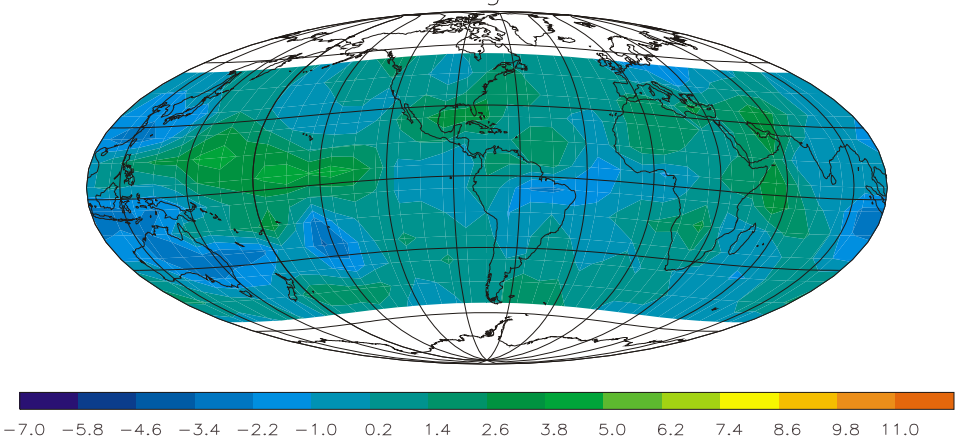
High − Low



−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

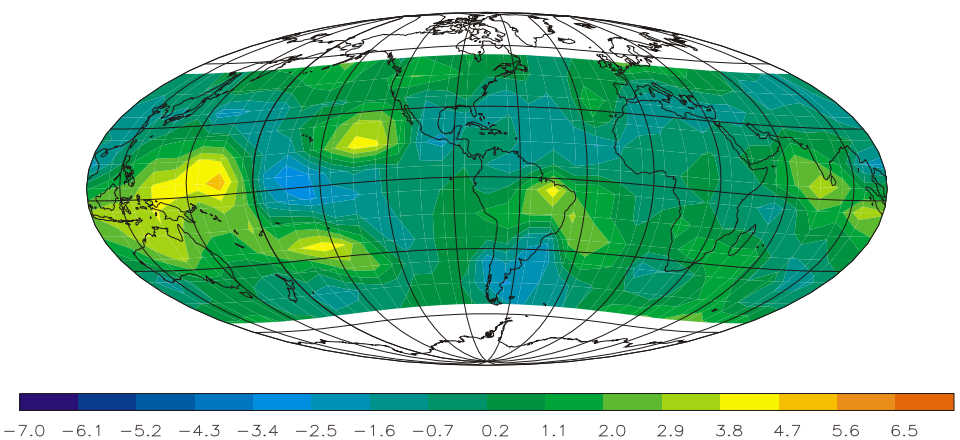
Composites of OLR anomalies by AAO

High



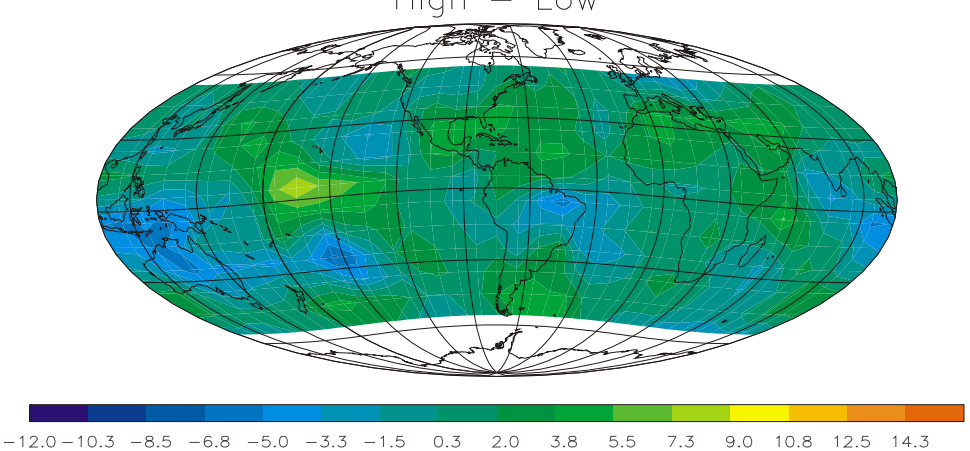
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

High − Low



−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

To test statistical confidence

- *Random AO Index & AAO Indexes are generated for the ERBS period.*
- *Composite the months with > 1-std.*

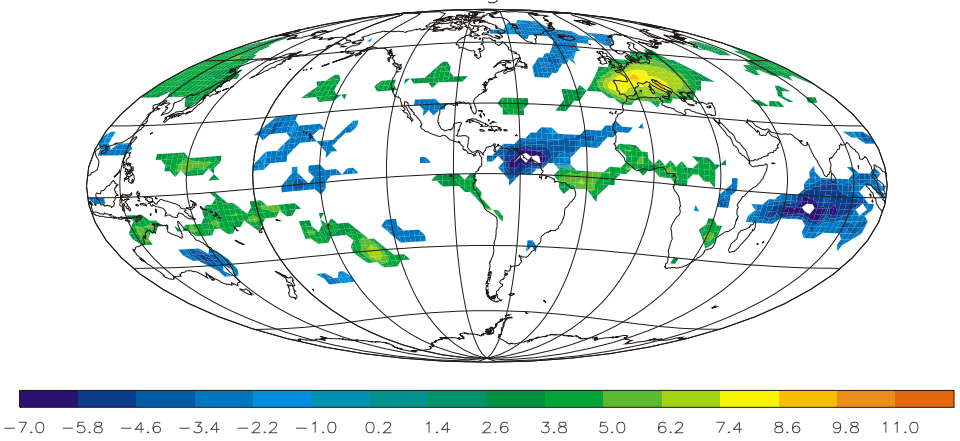
Sample size:

AO (H) 23	*AO (L) 19*
AAO (H) 25	*AAO (L) 25*

- *Spatial mean and std are calculated.*
- *Regions beyond 2- std (spatial) are re-plotted.—> 95% confidence level.*

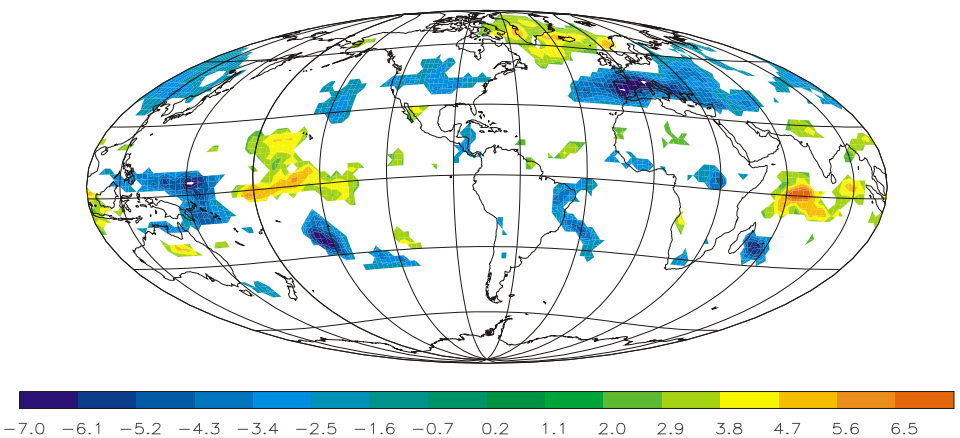
Composites of OLR anomalies by AO

High



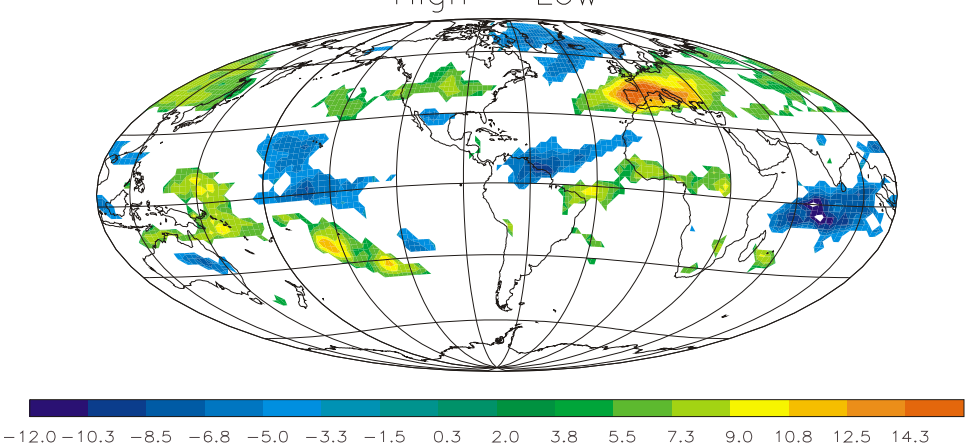
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

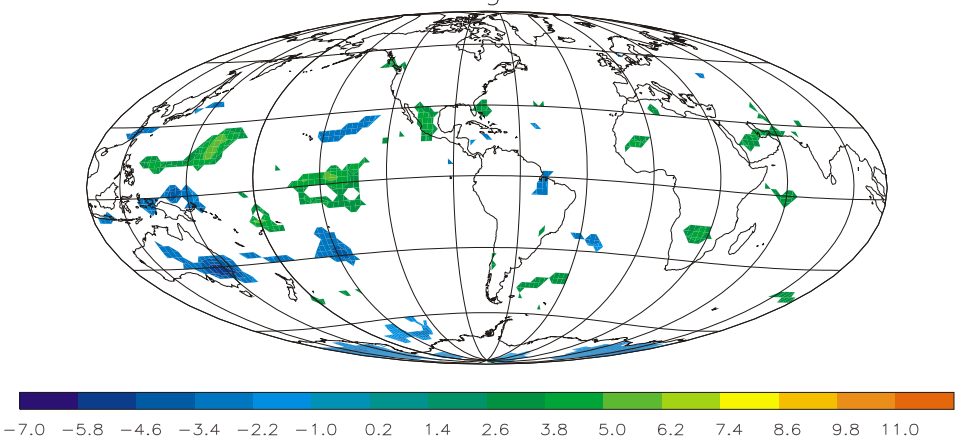
High − Low



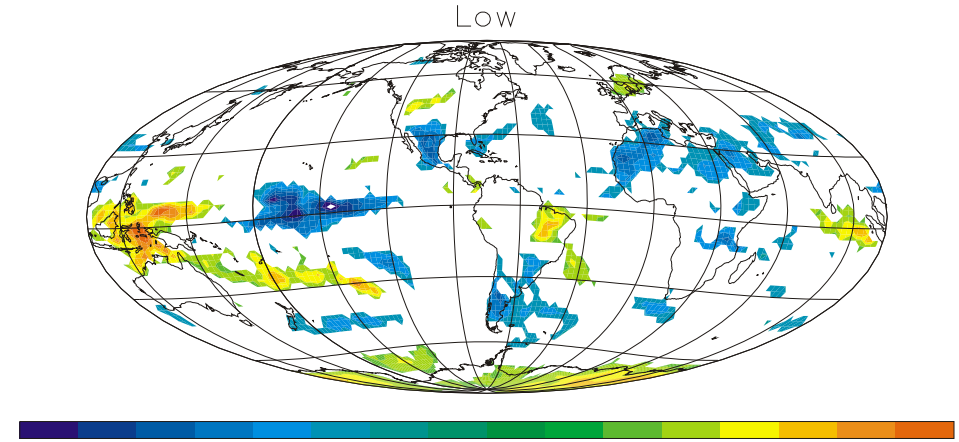
−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

Composites of OLR anomalies by AAO

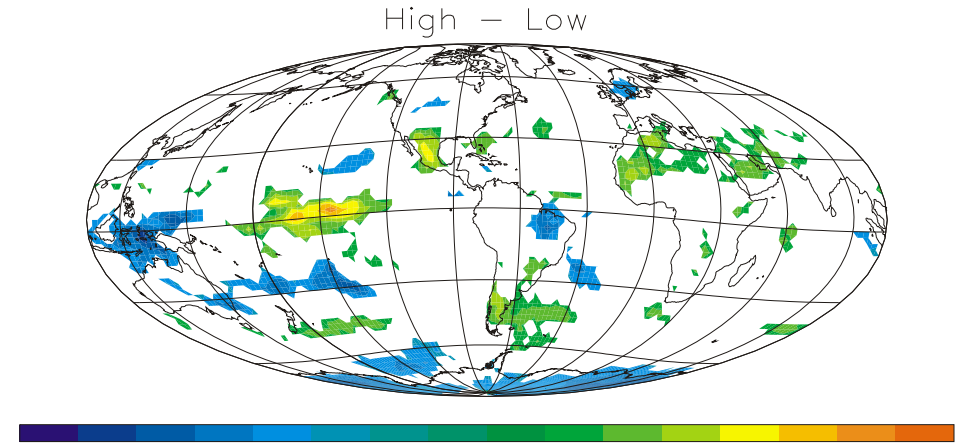
High



Low

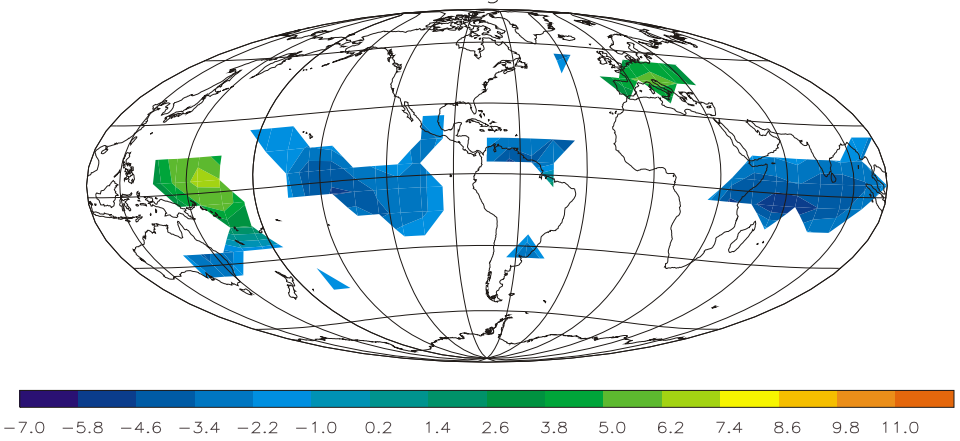


High − Low



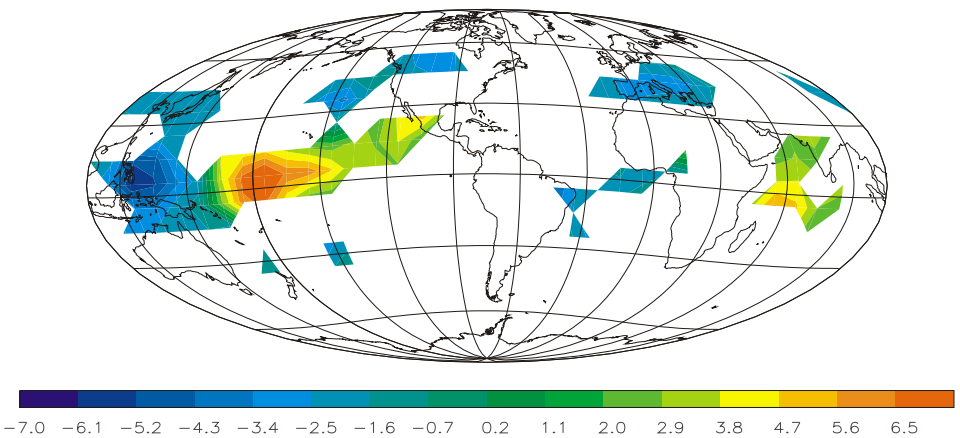
Composites of OLR anomalies by AO

High



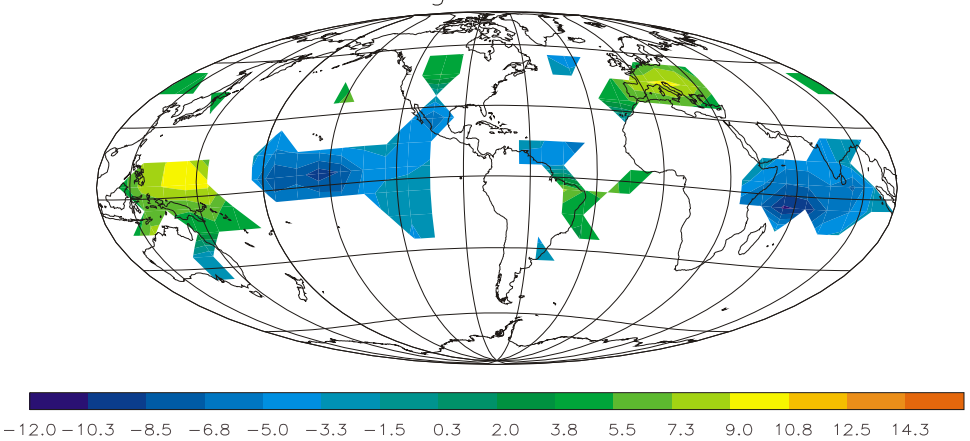
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

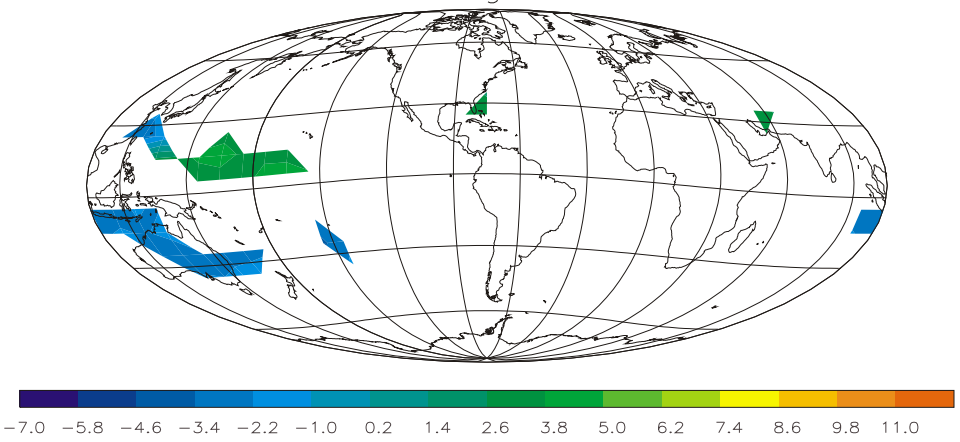
High − Low



−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

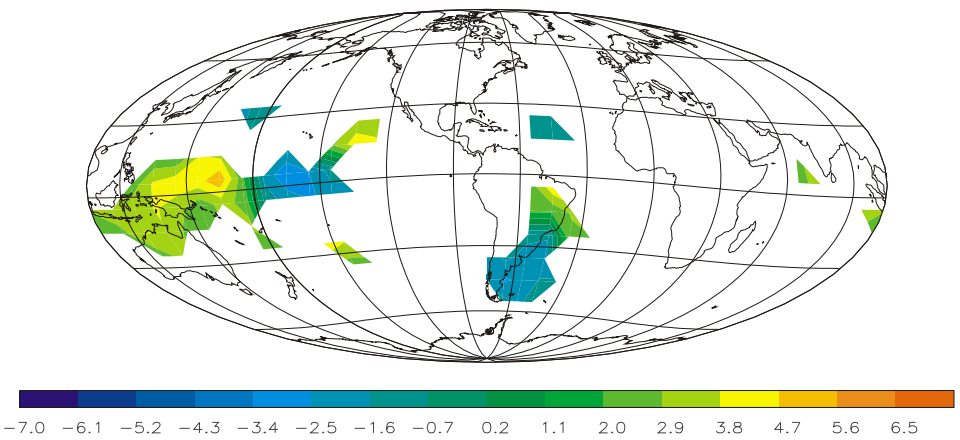
Composites of OLR anomalies by AAO

High



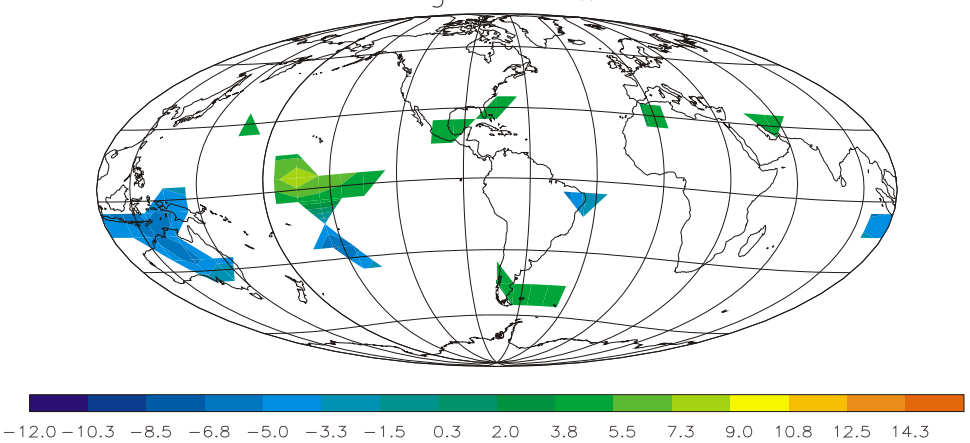
−7.0 −5.8 −4.6 −3.4 −2.2 −1.0 0.2 1.4 2.6 3.8 5.0 6.2 7.4 8.6 9.8 11.0

Low



−7.0 −6.1 −5.2 −4.3 −3.4 −2.5 −1.6 −0.7 0.2 1.1 2.0 2.9 3.8 4.7 5.6 6.5

High − Low



−12.0 −10.3 −8.5 −6.8 −5.0 −3.3 −1.5 0.3 2.0 3.8 5.5 7.3 9.0 10.8 12.5 14.3

Summary:

- **On 2-D analysis, ERBS OLR shows significant AO signals over the tropics and the subtropics. Similar features also appear on Reanlaysis.**
- **High AO and Low AO phases are anti-correlated over Spain and northern Indian Ocean.**
- **Tropical Pacific is AO phase dependent, but high and low phases are not correlated.**
- **AAO signal is less influential but over Western Pacific and Southeast part of South America.**

The Use of CERES/ERBE data at NCEP/CPC

** MRF and CERES*

Cloud Prediction Scheme

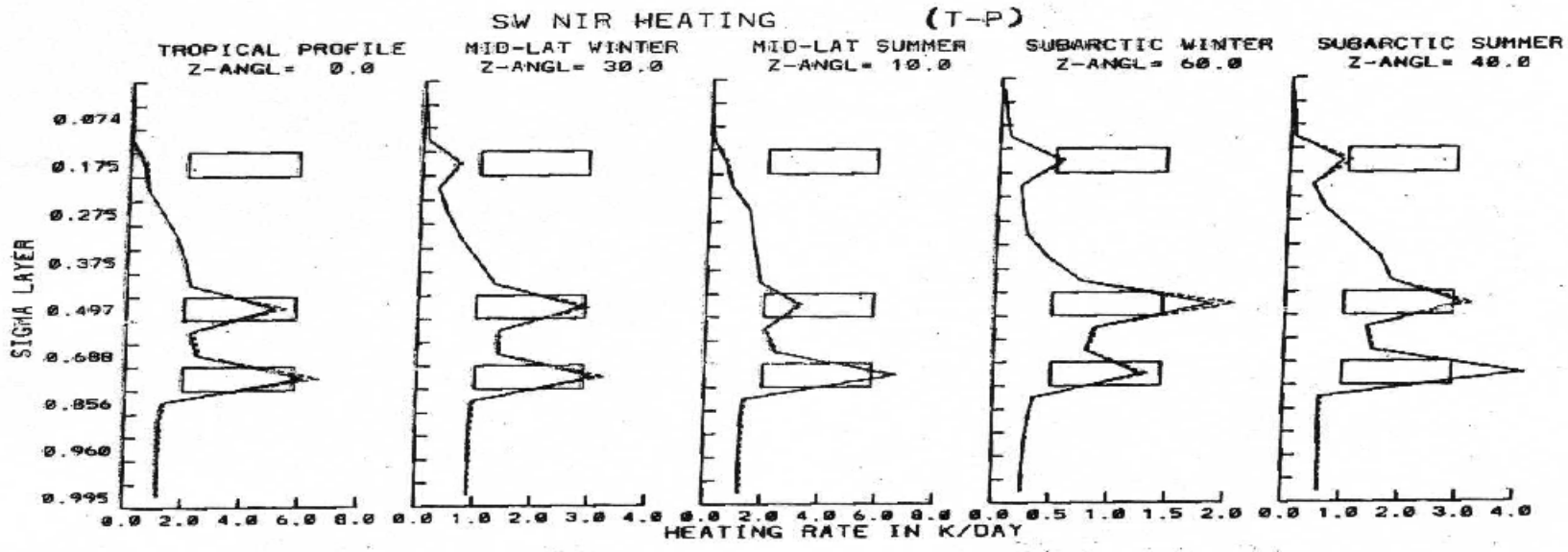
Previous Model	Current Model
- Diagnostic cloud scheme: no model carried cloud Prognostic variable.	- Prognostic cloud scheme: cloud condensate q_c as model caried variable: $\frac{\partial q_c}{\partial t} = -v \cdot \nabla q_c - \sigma \frac{\partial q_c}{\partial \sigma} + S_c + S_g - P - E + F_{q_c}$ Zhao & Carr (1997); Sundqvist et al. (1989)
- Slingo type convective cloud RTNEPH tuned stratiform cloud Campana et al. (1994); Slingo (1987) Mitchell & Hahn (1989)	- One type cloud cover: $C = f(RH, q_c, q^*)$ Xu & Randall (1996)

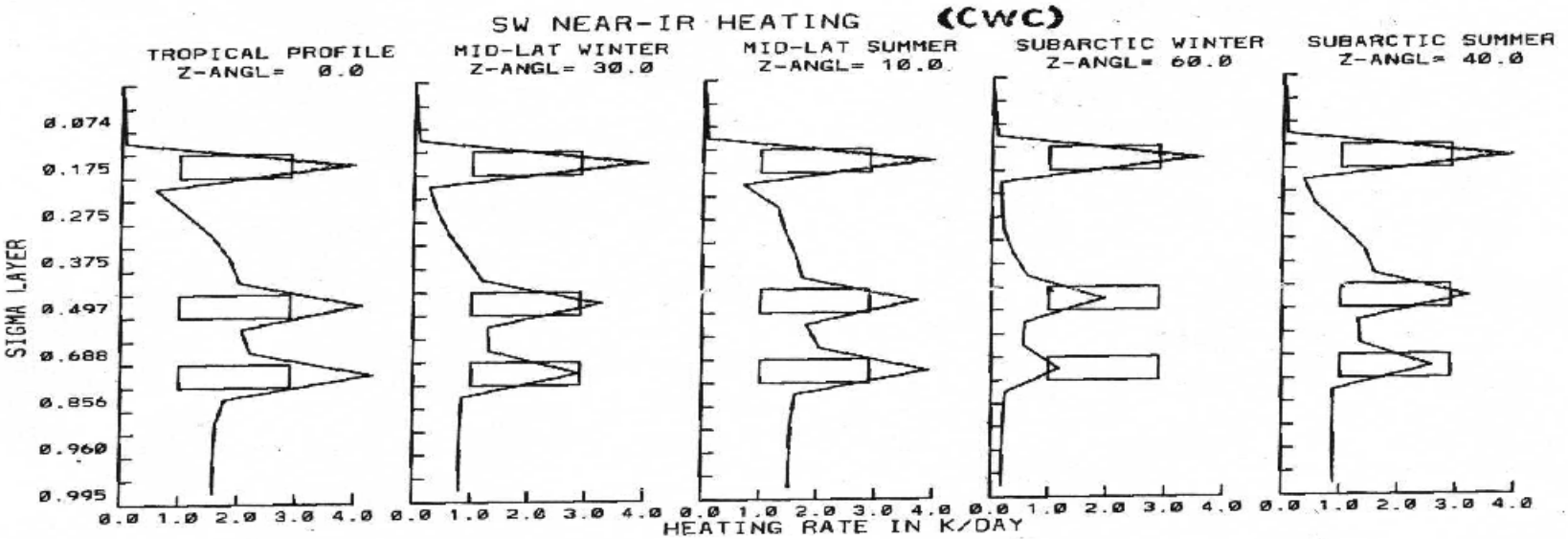
Radiation Calculation Scheme

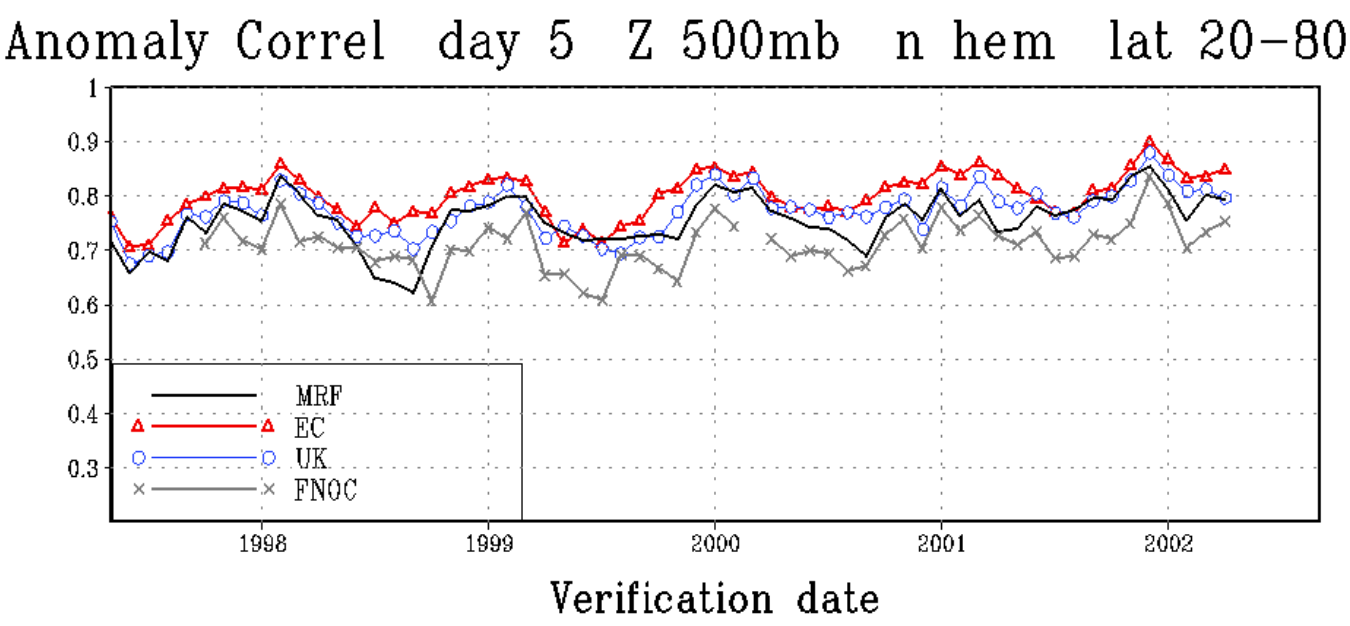
Previous Model	Current Model
- LW: GFDL model (H_2O, CO_2, O_3)	- Same GFDL model
Schwarzkophf & Fels (1991, 1985)	* upgrade to AER's RRTM in progress
	Mlawer et al. (1997
- SW: Chou's model (H_2O, CO_2, O_3, O_2)	- Same but updated
4 - uv and visible bands	8 - uv and visible bands
1 or 3 near-ir bands	1 or 3 near-ir bands
Chou (1992, 1990), Chou & Lee (1996)	Chou & Suarez (1999)
Hou et al. (1996)	Hou at al. (2002)
- Aerosols: No aerosols effect	- OPAC global climatology
	Hess et al. (1998)
- Surface Albedo: Global climatology	- Same model
Based on surface vegetation types	
Briegleb et al. (1986), Briegleb (1992), Hou at al. (2002)	

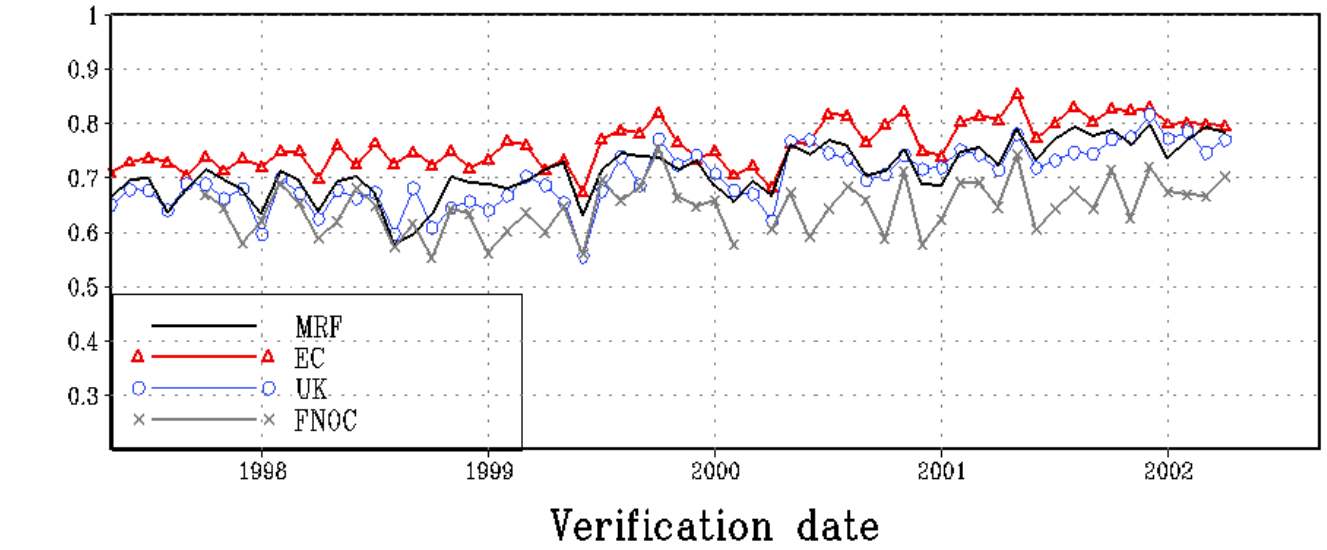
Cloud Optical Properties

Previous Model	Current Model
- SW:	
$\tau = f(T_c, \Delta p_c)$	$\tau_v = f(CWP, r_e, v)$
ω_v = *prescribed values*	$\omega_v = f(r_e, v)$
g_v = *prescribed values*	$g_v = f(r_e, v)$
	$r_e = f(CWP, T_c, q)$
Harshvardhan et al. (1989)	Slingo (1989); Chou et al. (1998) Heymsfield & McFarquhar (1996)
- LW:	
$\varepsilon = 1 - e^{-a\tau}$	$\varepsilon = 1 - e^{-b\tau}$
	$\tau = f(CWP, r_e)$
Harshvardhan et al. (1989)	Kiehl et al. (1998)


SW NIR HEATING (T-P)
TROPICAL PROFILE
Z-ANGL= 0.0
MID-LAT WINTER
Z-ANGL= 30.0
MID-LAT SUMMER
Z-ANGL= 10.0
SUBARCTIC WINTER
Z-ANGL= 60.0
SUBARCTIC SUMMER
Z-ANGL= 40.0
SIGMA LAYER
0.074
0.175
0.275
0.375
0.497
0.688
0.856
0.960
0.995
0.0 2.0 4.0 6.0 8.0
0.0 1.0 2.0 3.0 4.0
0.0 2.0 4.0 6.0 8.0
0.0 0.5 1.0 1.5 2.0
0.0 1.0 2.0 3.0 4.0
HEATING RATE IN K/DAY

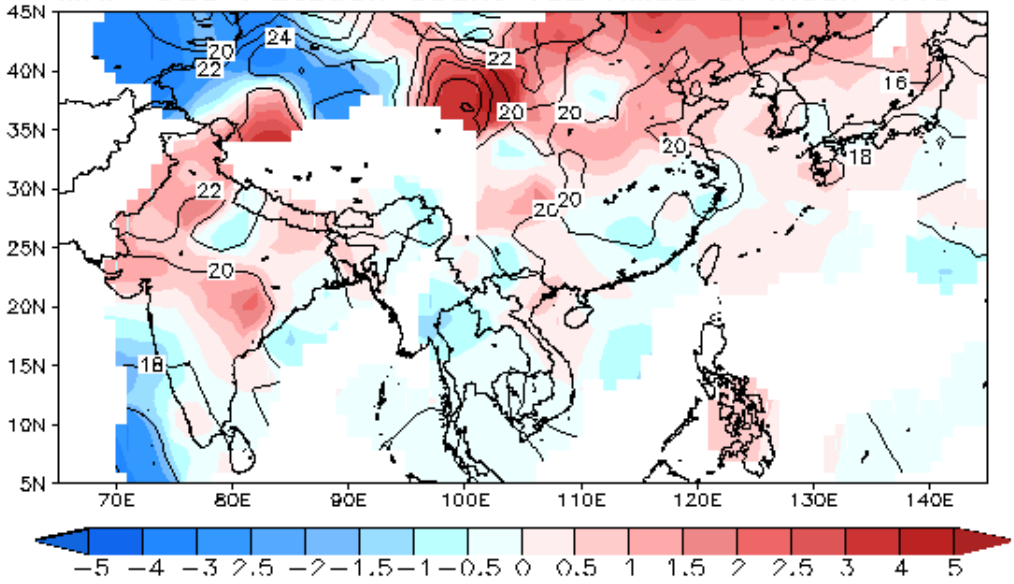

SW NEAR-IR HEATING (CWC)
TROPICAL PROFILE
Z-ANGL= 0.0
MID-LAT WINTER
Z-ANGL= 30.0
MID-LAT SUMMER
Z-ANGL= 10.0
SUBARCTIC WINTER
Z-ANGL= 60.0
SUBARCTIC SUMMER
Z-ANGL= 40.0
SIGMA LAYER
0.074
0.175
0.275
0.375
0.497
0.688
0.856
0.960
0.995
0.0 1.0 2.0 3.0 4.0
0.0 1.0 2.0 3.0 4.0
0.0 1.0 2.0 3.0 4.0
0.0 1.0 2.0 3.0 4.0
0.0 1.0 2.0 3.0 4.0
HEATING RATE IN K/DAY


Anomaly Correl day 5 Z 500mb n hem lat 20-80
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
MRF
EC
UK
FNOC
1998
1999
2000
2001
2002
Verification date


Anomaly Correl day 5 Z 500mb s hem lat 20-80
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
MRF
EC
UK
FNOC
1998
1999
2000
2001
2002
Verification date

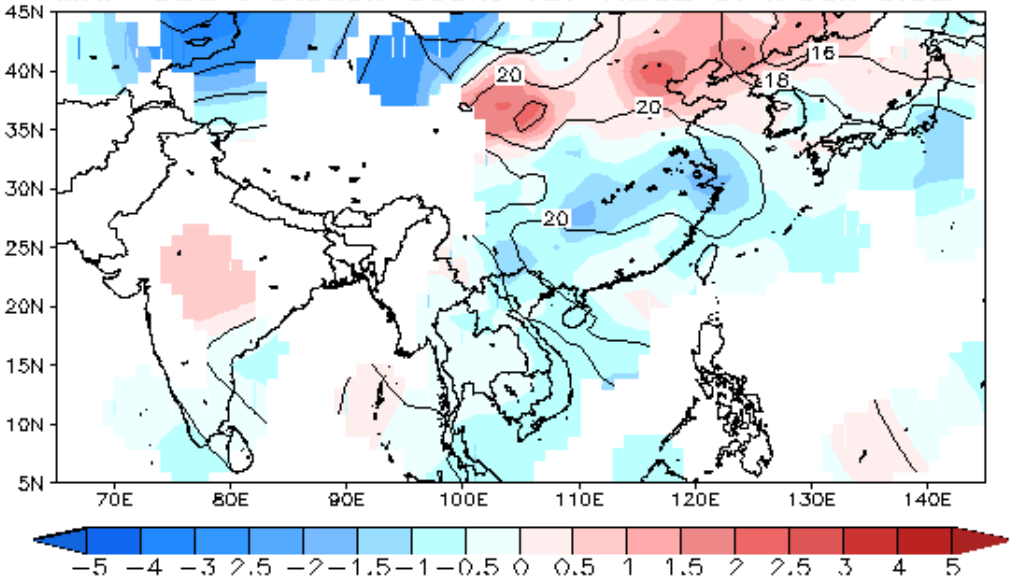
Temp 850 mb 48-HR BIAS in Celsius
from 00z01jul2000-00z31jul2000

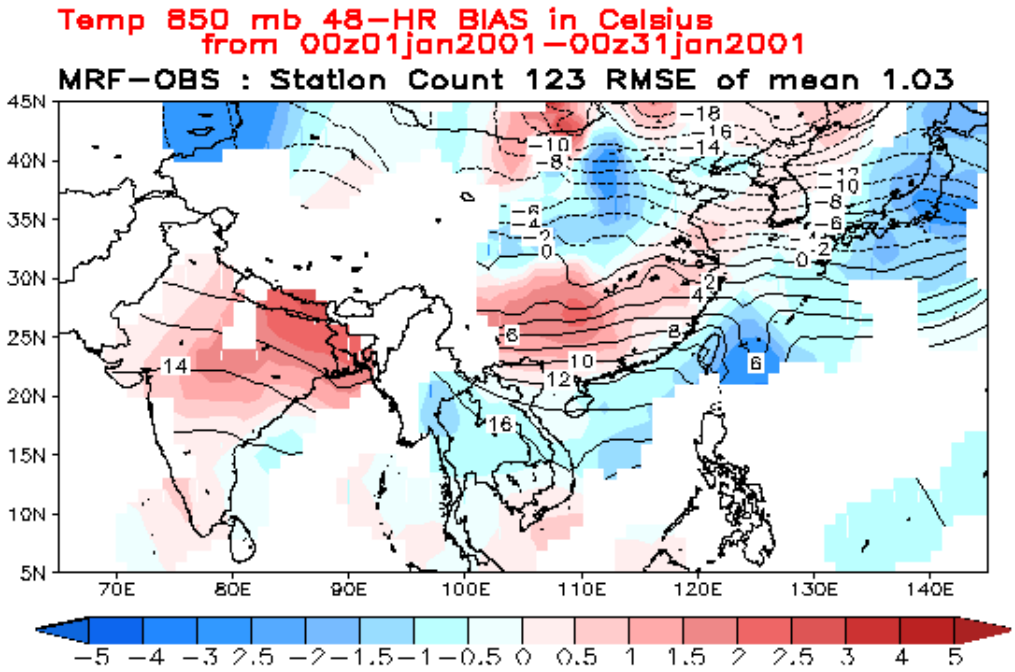
MRF-OBS : Station Count 162 RMSE of mean 1.19

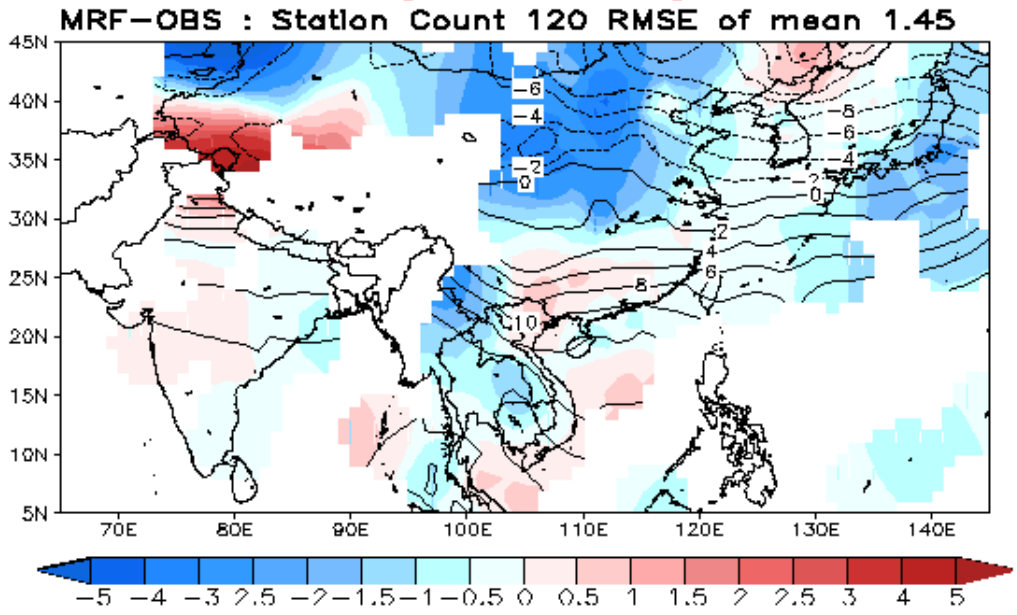


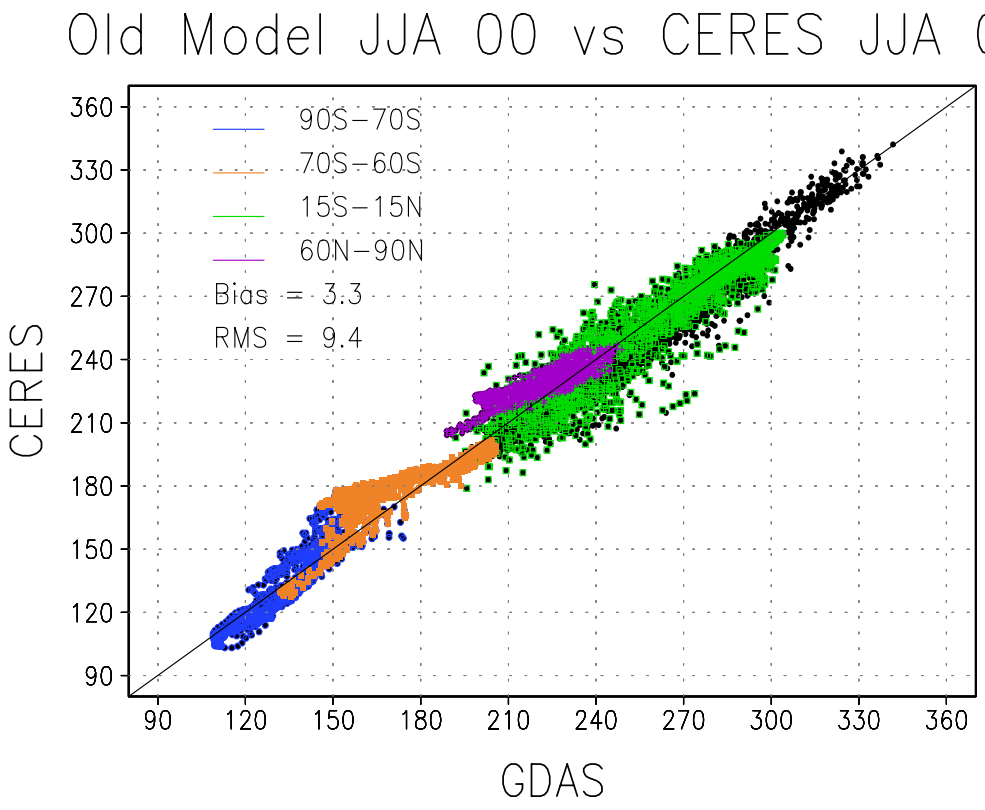
Temp 850 mb 48-HR BIAS in Celsius
from 00z01jul2001-00z31jul2001

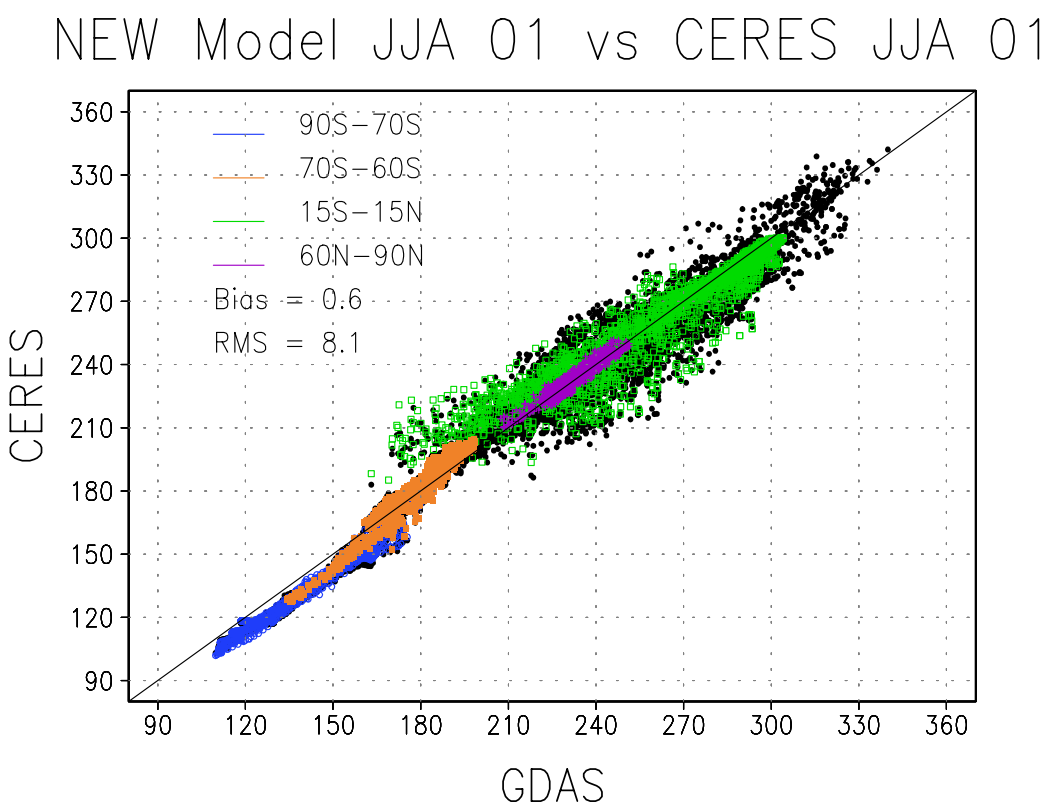
MRF-OBS : Station Count 107 RMSE of mean 0.92



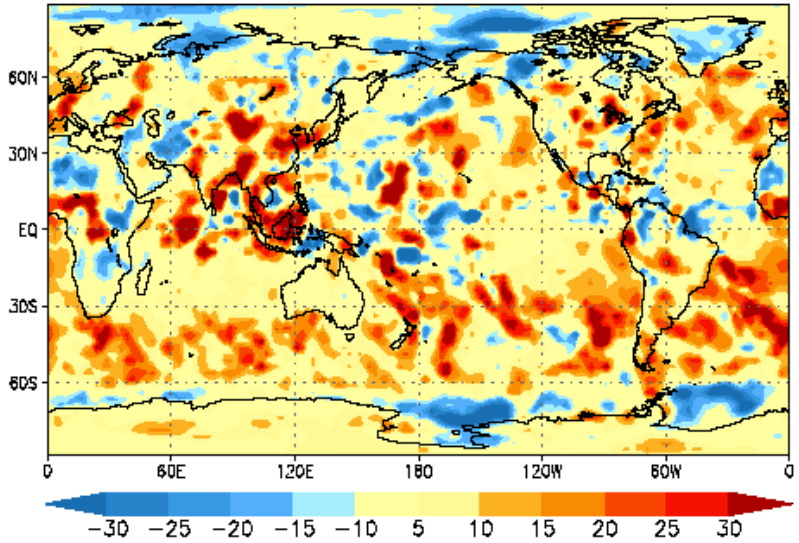

Temp 850 mb 48-HR BIAS in Celsius
from 00z01jan2001-00z31jan2001
MRF-OBS : Station Count 123 RMSE of mean 1.03
45N
40N
35N
30N
25N
20N
15N
10N
5N
70E
80E
90E
100E
110E
120E
130E
140E
-5 -4 -3 2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 4 5


Temp 850 mb 48-HR BIAS in Celsius
from 00z01jan2002-00z31jan2002
MRF-OBS : Station Count 120 RMSE of mean 1.45
45N
40N
35N
30N
25N
20N
15N
10N
5N
70E
80E
90E
100E
110E
120E
130E
140E
-5 -4 -3 2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 4 5

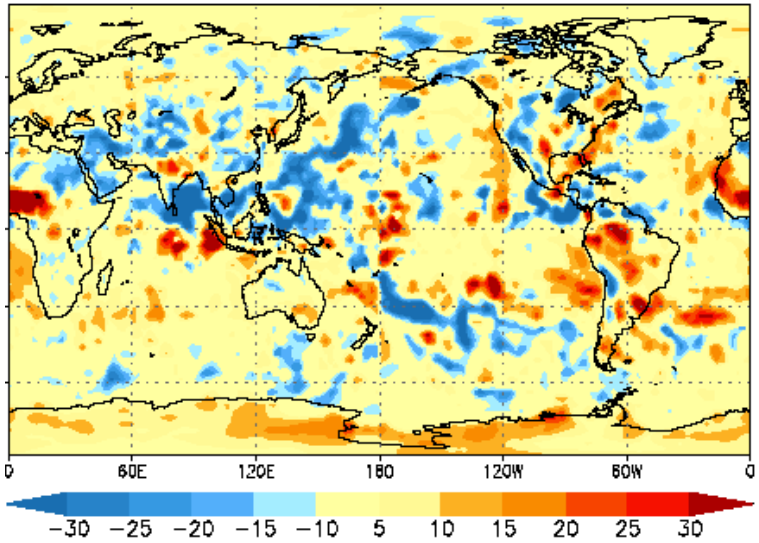

Old Model JJA 00 vs CERES JJA 00
90S-70S
70S-60S
15S-15N
60N-90N
Bias = 3.3
RMS = 9.4
CERES
GDAS
90
120
150
180
210
240
270
300
330
360


NEW Model JJA 01 vs CERES JJA 01
90S-70S
70S-60S
15S-15N
60N-90N
Bias = 0.6
RMS = 8.1
CERES
GDAS
90
120
150
180
210
240
270
300
330
360

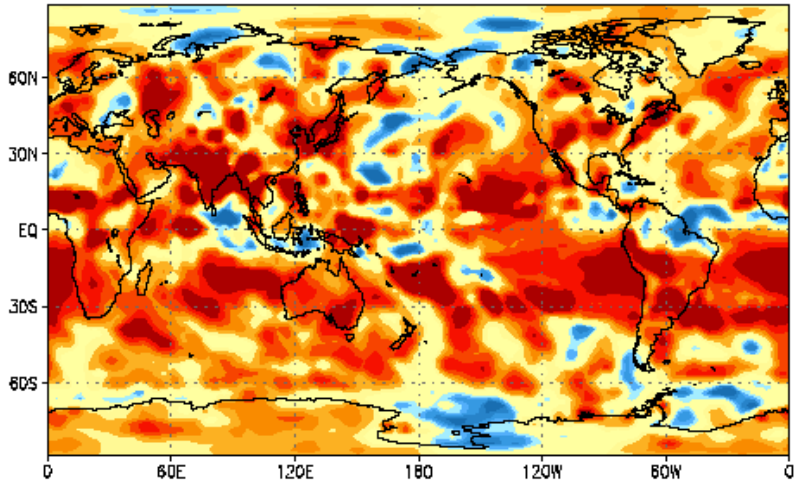
NCEP Model OLR – CERES JJA '00



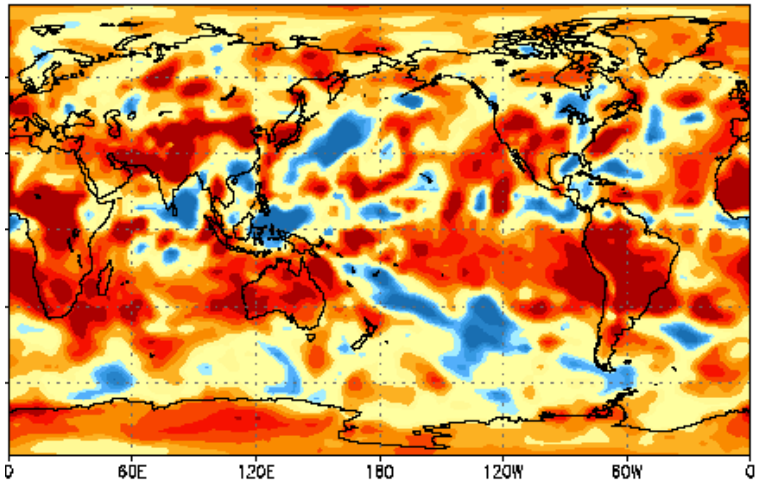
NCEP Model OLR – CERES JJA '01

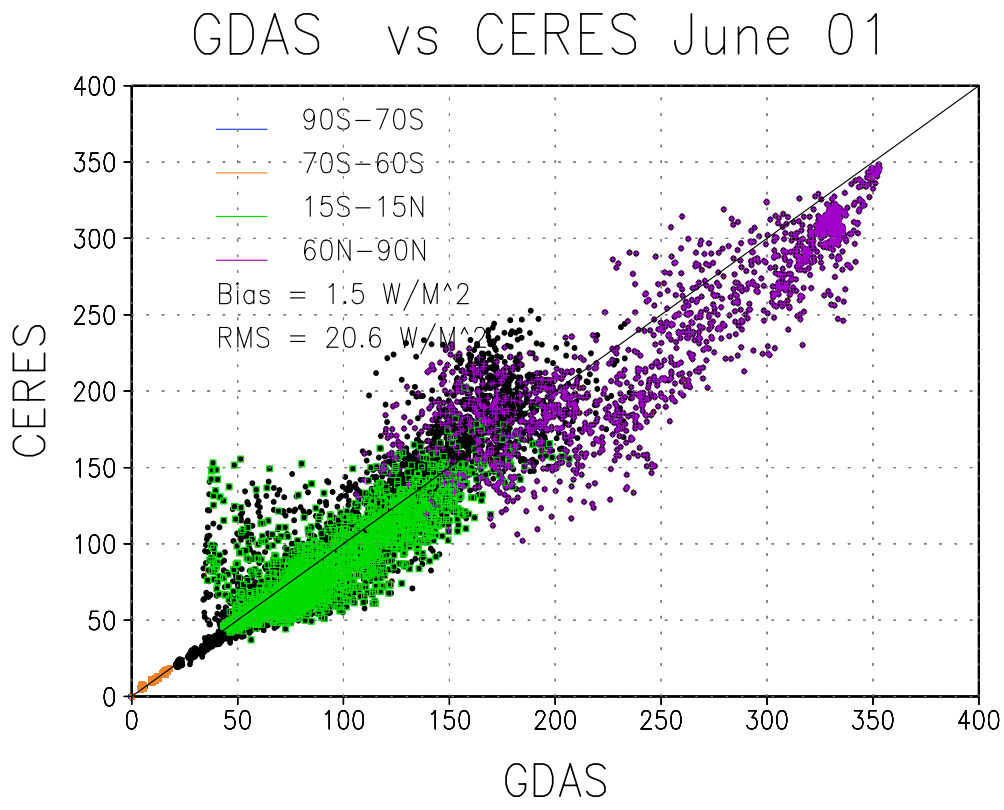


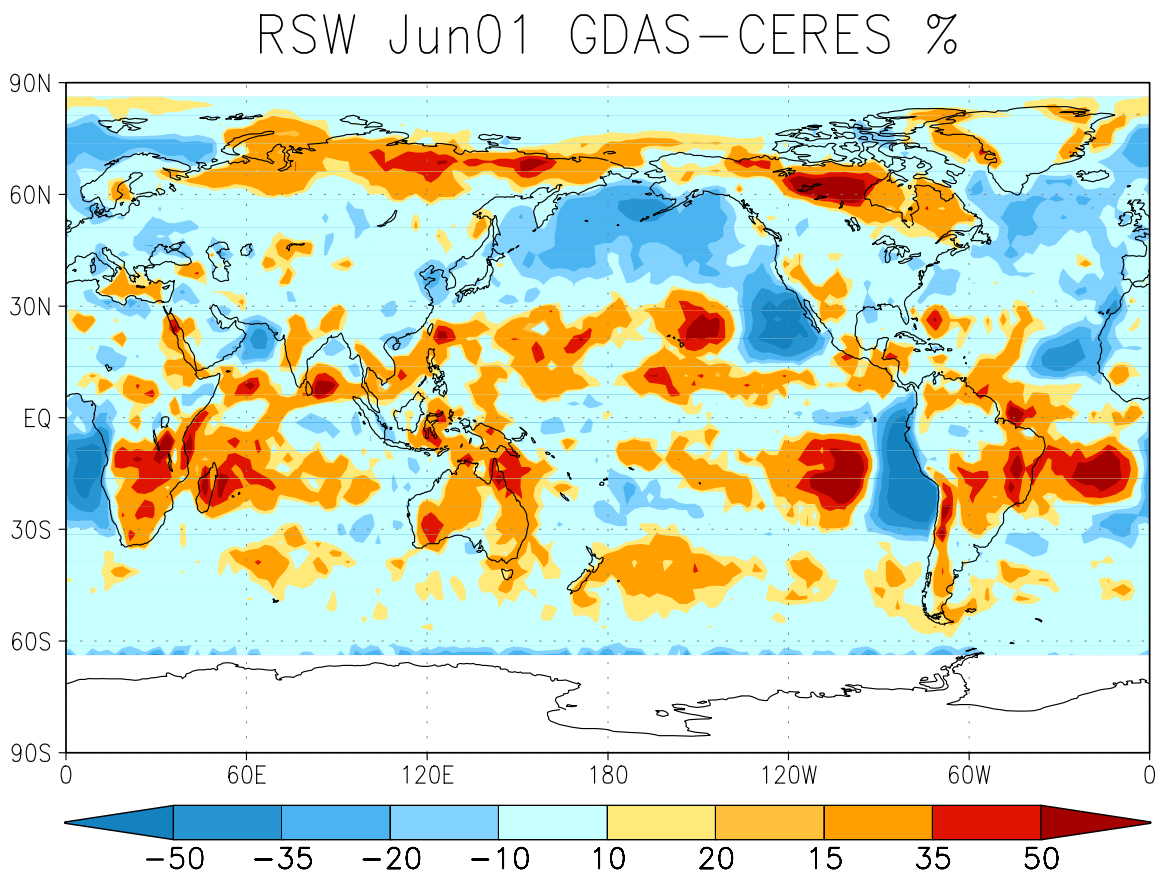
NCEP Model OLR – AVHRR JJA '00

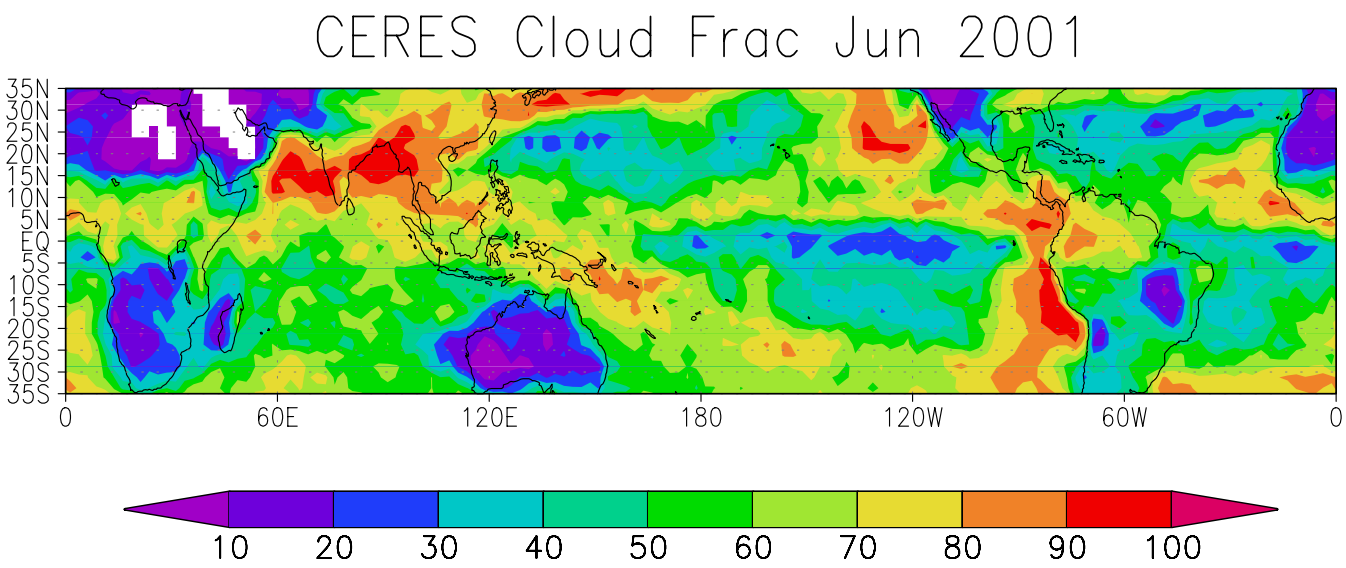


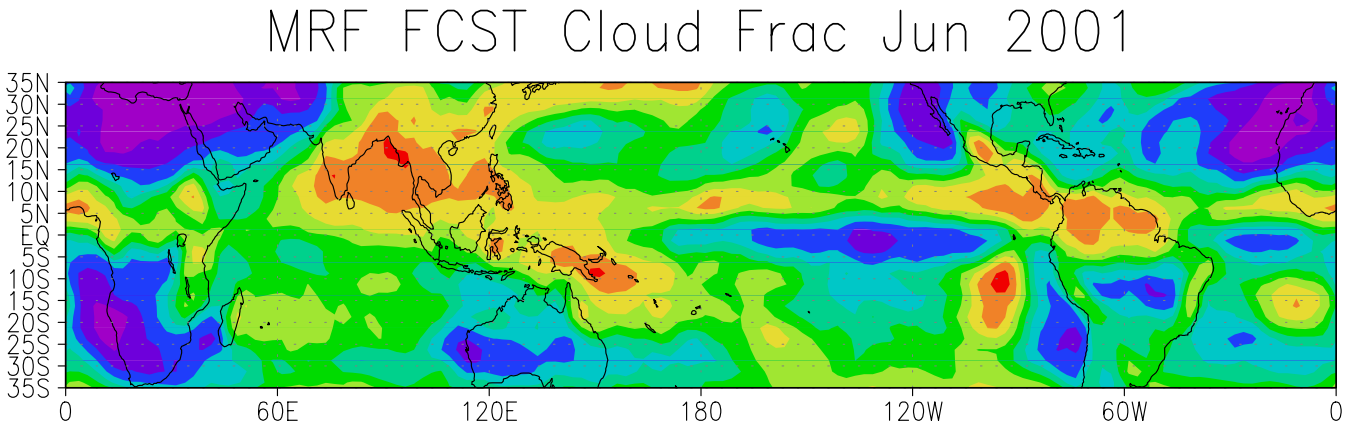
NCEP Model OLR – AVHRR JJA '01

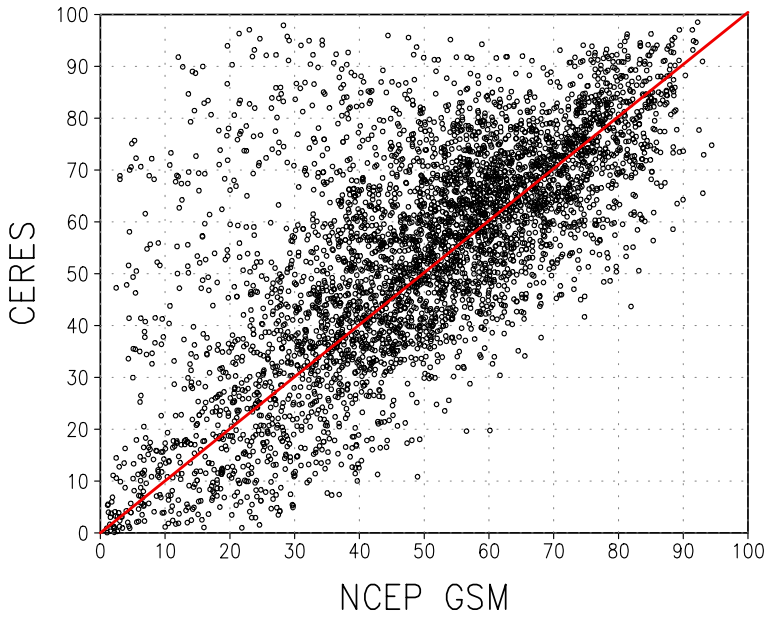


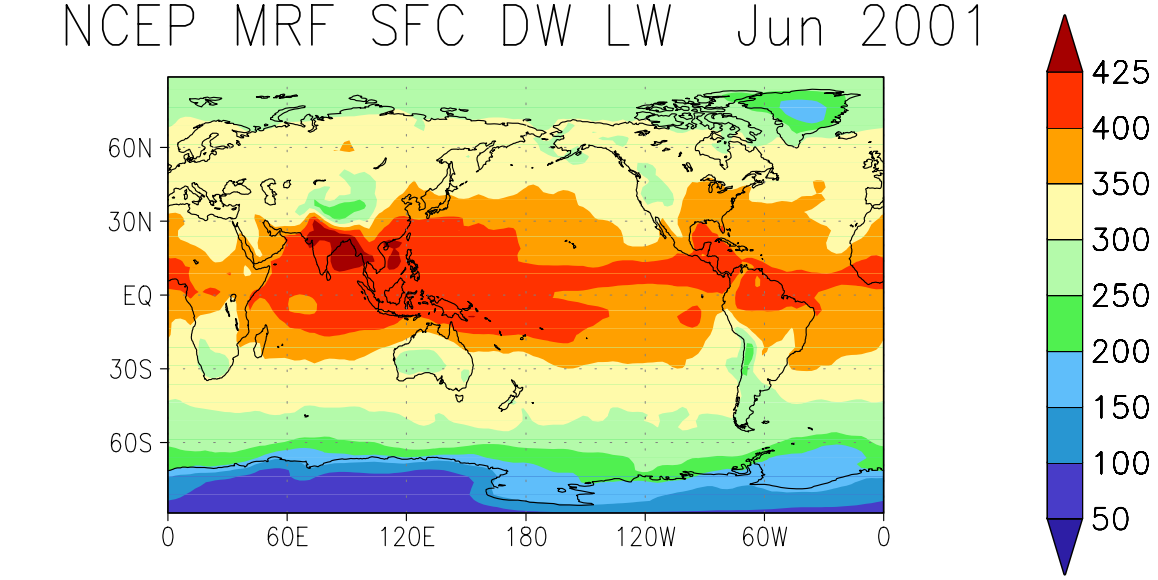

GDAS vs CERES June 01
90S-70S
70S-60S
15S-15N
60N-90N
Bias = 1.5 W/M^2
RMS = 20.6 W/M^2
CERES
GDAS
0
50
100
150
200
250
300
350
400

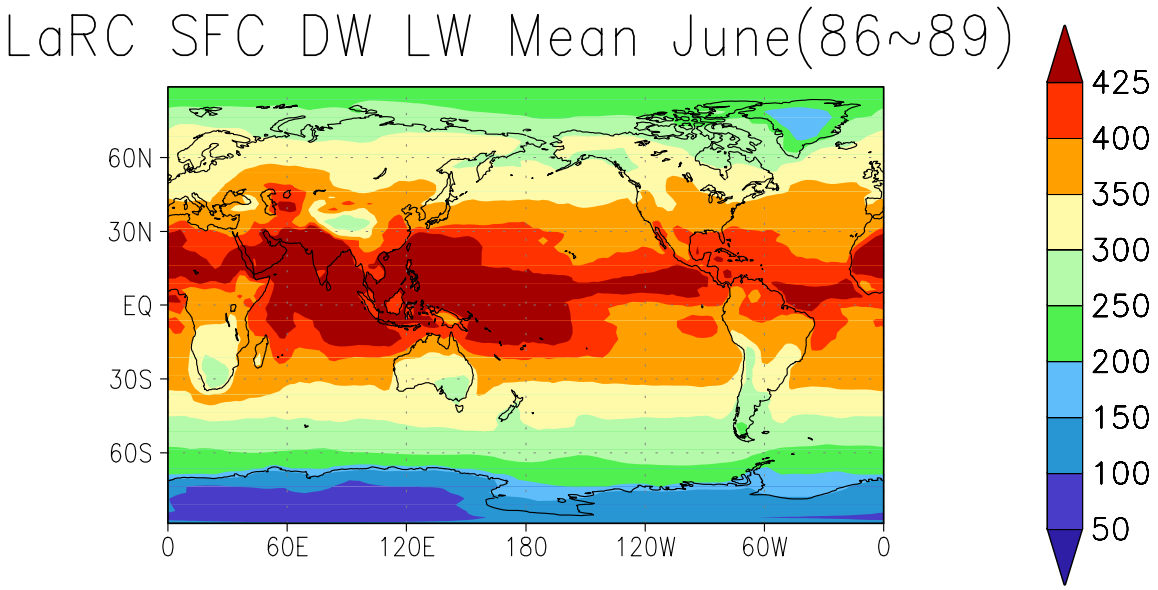

RSW Jun01 GDAS-CERES %
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
-50
-35
-20
-10
10
20
15
35
50

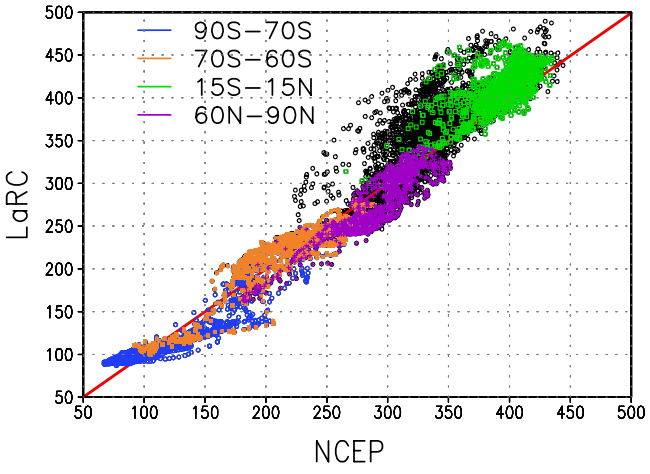

CERES Cloud Frac Jun 2001
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
15S
20S
25S
30S
35S
0
60E
120E
180
120W
60W
0
10
20
30
40
50
60
70
80
90
100


MRF FCST Cloud Frac Jun 2001
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
15S
20S
25S
30S
35S
0
60E
120E
180
120W
60W
0


CERES
NCEP GSM
0
10
20
30
40
50
60
70
80
90
100

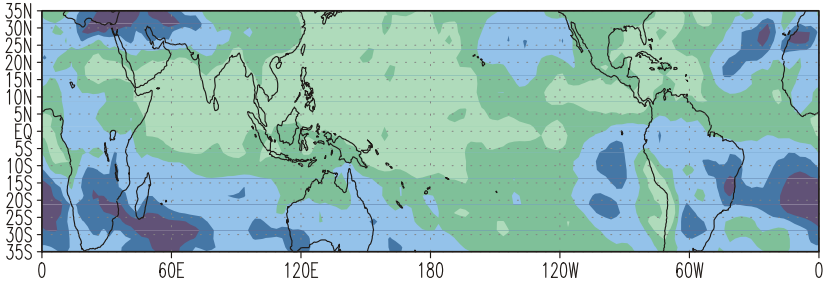

NCEP MRF SFC DW LW Jun 2001
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
425
400
350
300
250
200
150
100
50


LaRC SFC DW LW Mean June(86~89)
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
425
400
350
300
250
200
150
100
50

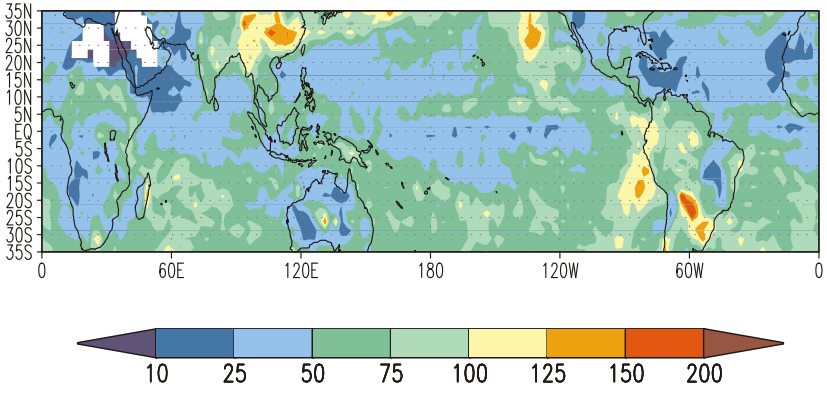

90S-70S
70S-60S
15S-15N
60N-90N
LaRC
NCEP
500
450
400
350
300
250
200
150
100
50

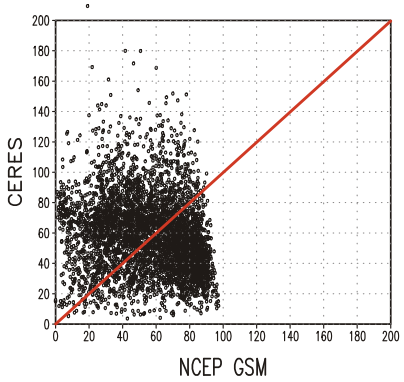
Normalized by Cloud

GDAS Cloud Water Jun 2001



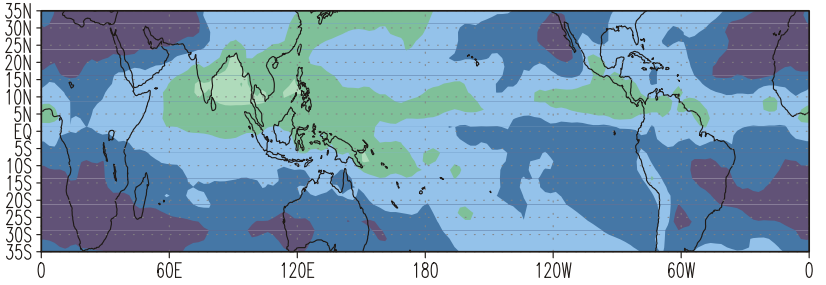
CERES Cloud Water Jun 2001



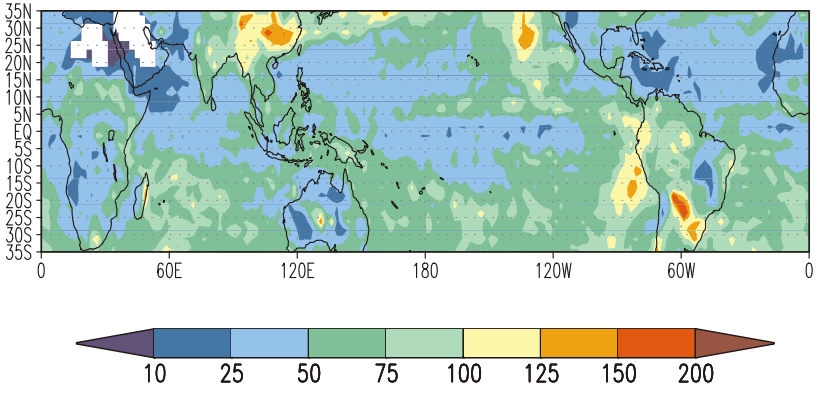


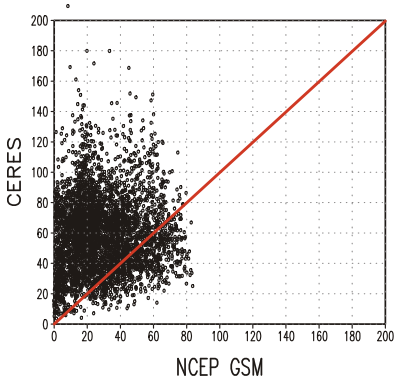
Not Normalized by cloud

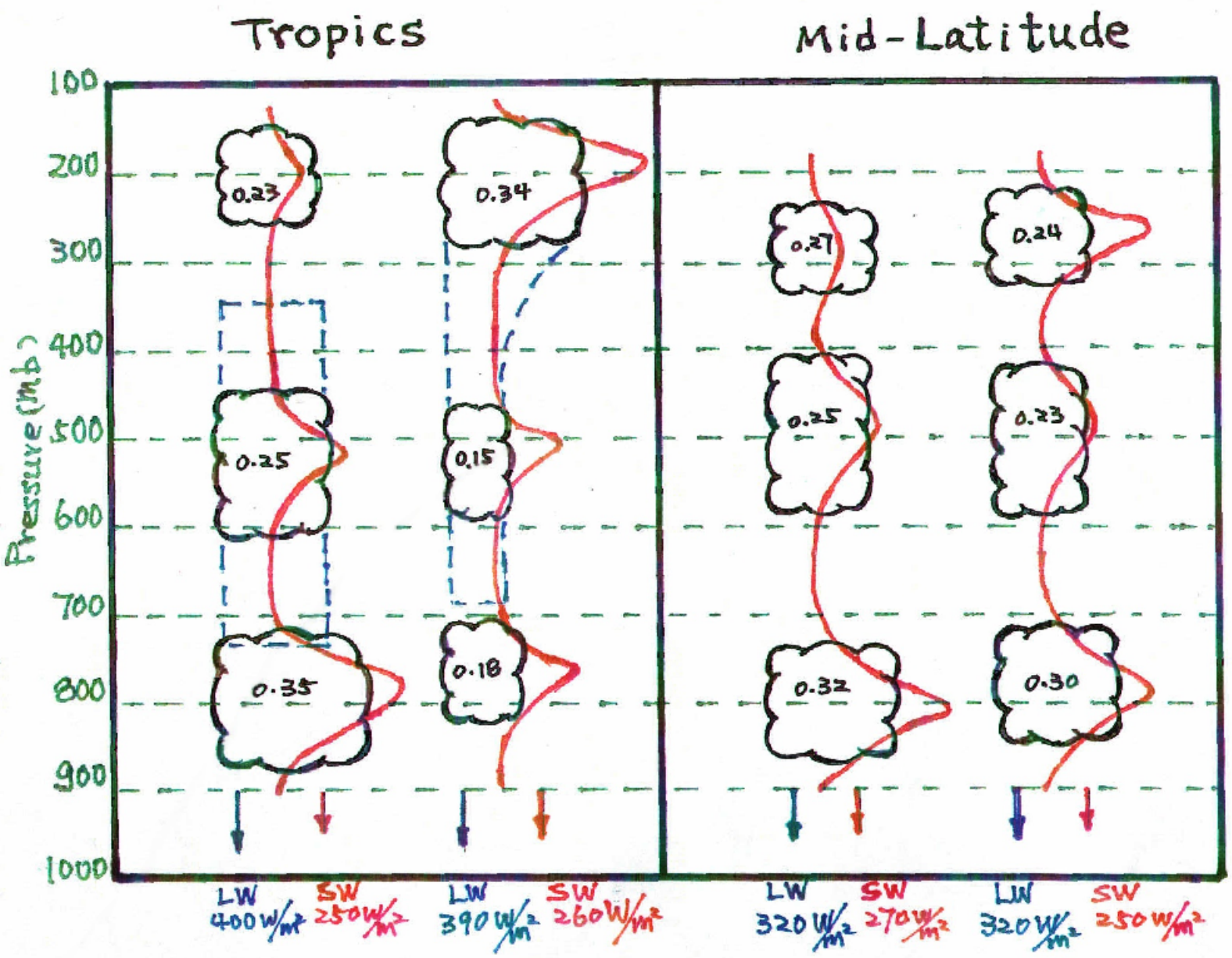
GDAS Cloud Water Jun 2001



CERES Cloud Water Jun 2001






Tropics
Mid-Latitude
Pressure (mb)
100
200
300
400
500
600
700
800
900
1000
0.23
0.25
0.35
0.34
0.15
0.18
0.27
0.25
0.32
0.24
0.23
0.30
LW 400 W/m²
SW 250 W/m²
LW 390 W/m²
SW 260 W/m²
LW 320 W/m²
SW 270 W/m²
LW 320 W/m²
SW 250 W/m²

Summary:

1. **New model physics in cloud/radiation parameterizations results in better model performance (forecast skill, Storm tracking, etc.), but tipped lower level temperature bias in the winter.**

- **Overall model radiative fluxes are improved: At TOA, model fluxes are within or close to the uncertainties of the observations. At SFC are close to the uncertainties of the retrieval algorithms (regional differences still large).**

- **Model cloud properties are still ambiguous. To improve the tropical cloud prediction, and cloud radiative properties, EMC need to save more model diagnostic parameters for the comparisons against ever increasing observations.**