The Tropospheric Humidity Trends of NCEP/NCAR Reanalysis before the Satellite Era

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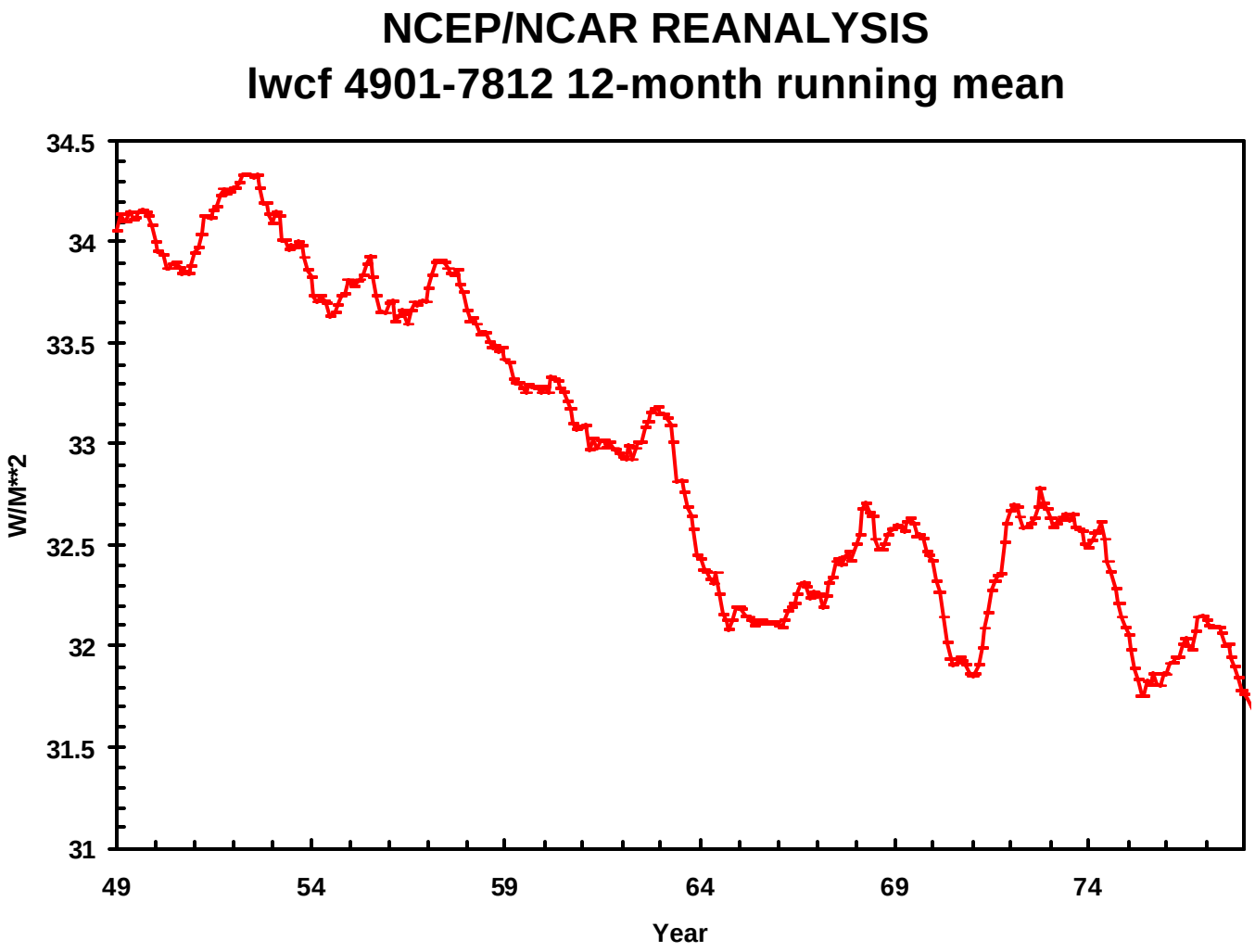
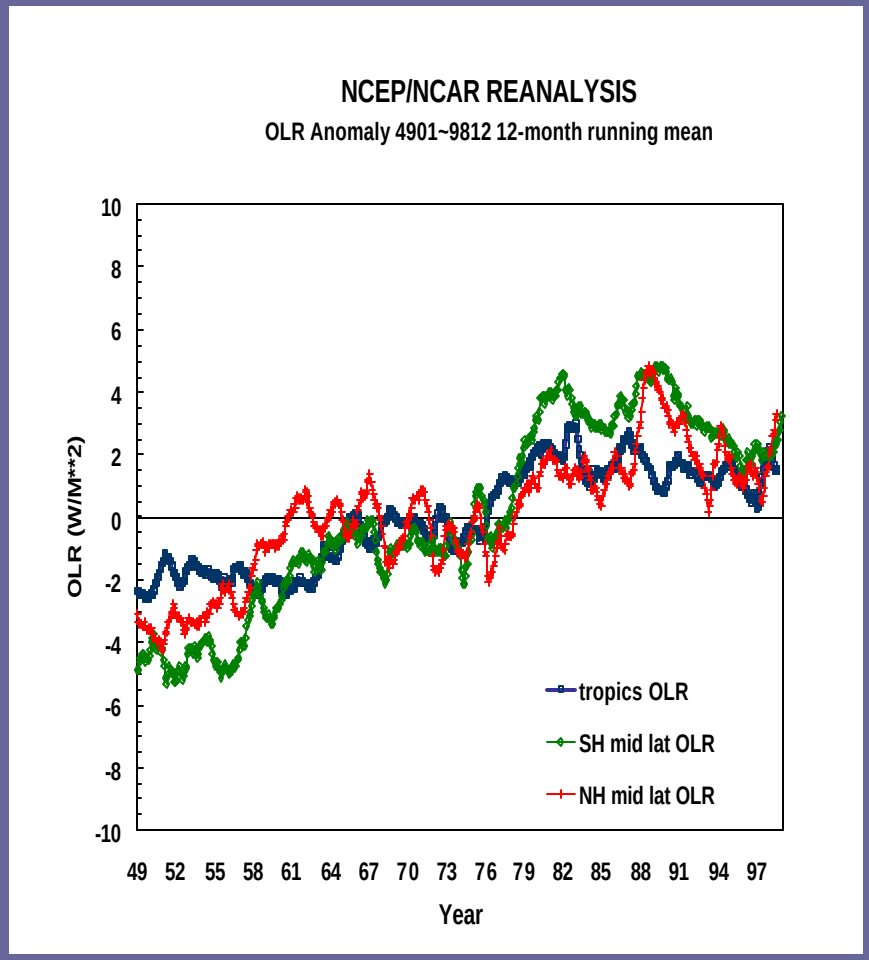
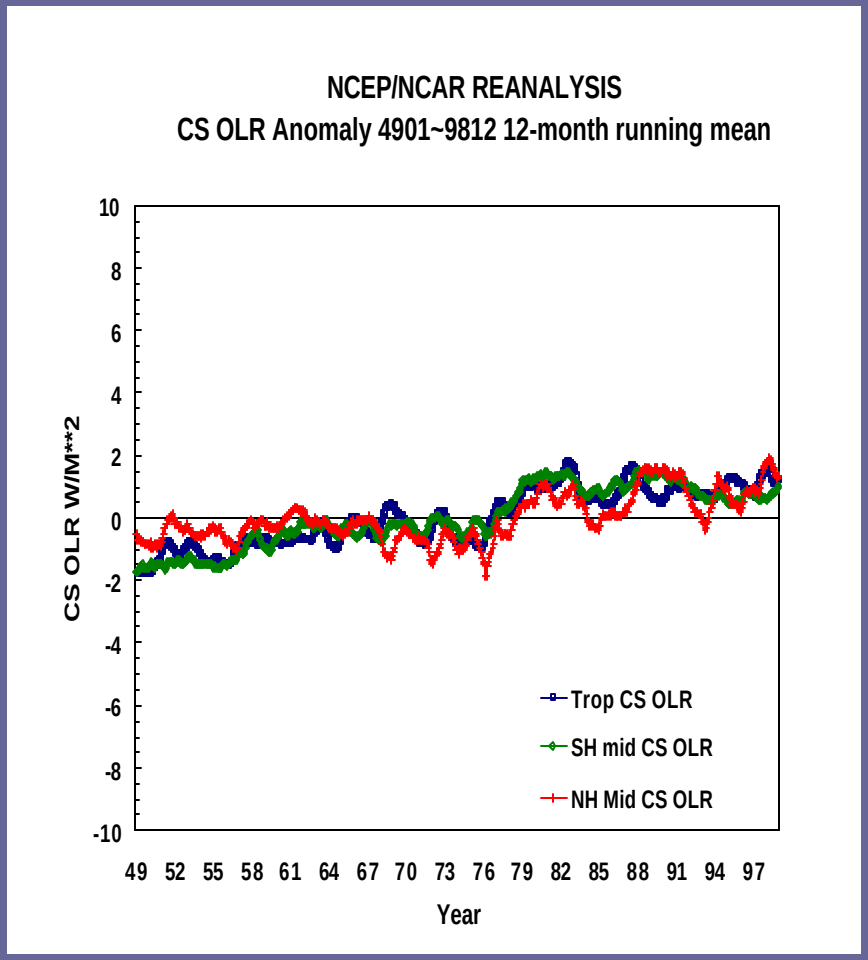
Acknowlegement: Roger Lin, Shuntai Zhou, Mel Gilman, etc.


NCEP/NCAR REANALYSIS
lwcf 4901-7812 12-month running mean
34.5
34
33.5
33
32.5
32
31.5
31
W/M**2
49
54
59
64
69
74
Year

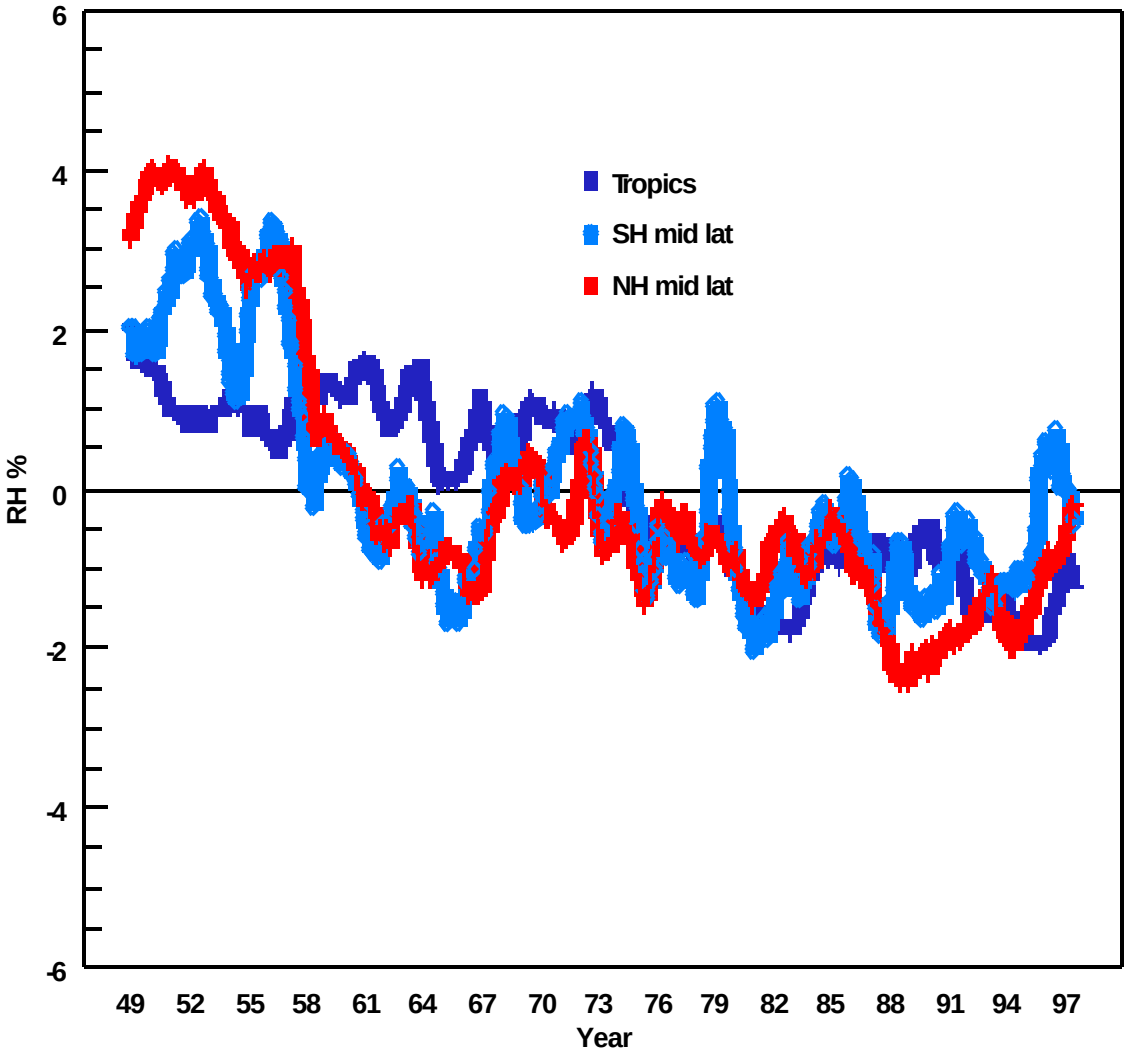
LWCF = CSOLR-OLR





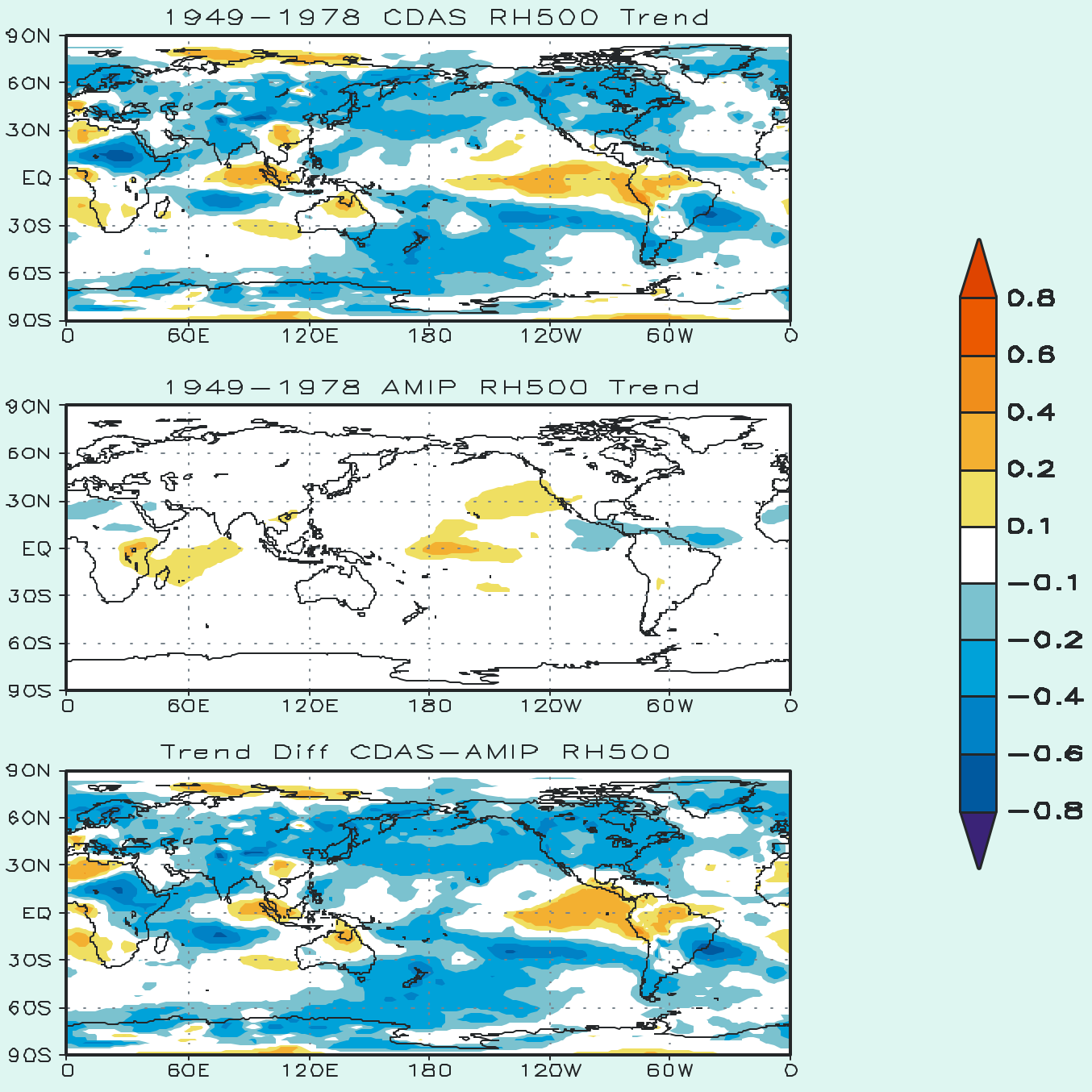
NCEP/NCAR REANALYSIS

500mb RH Anomaly 4901~9712 12-month running mean

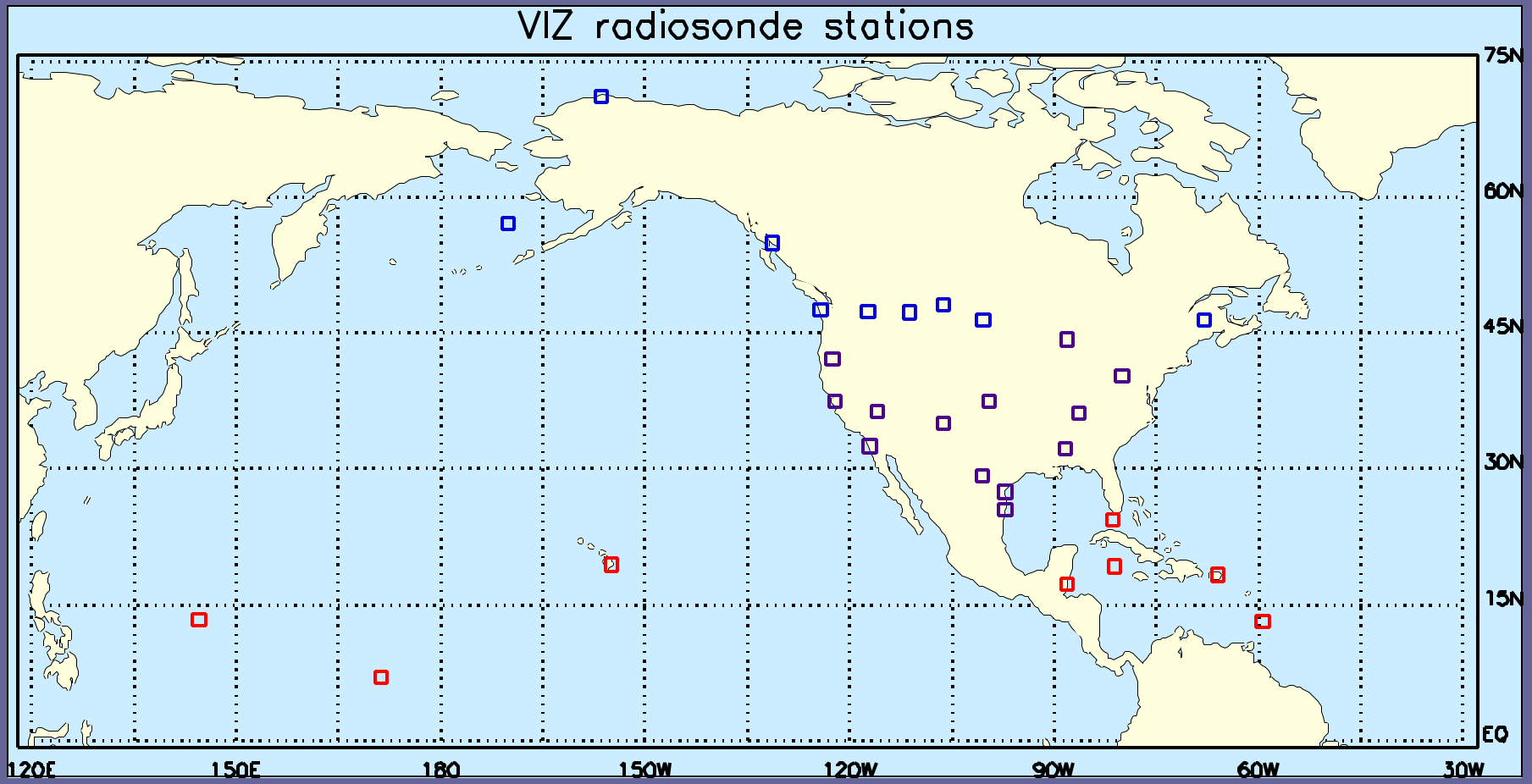


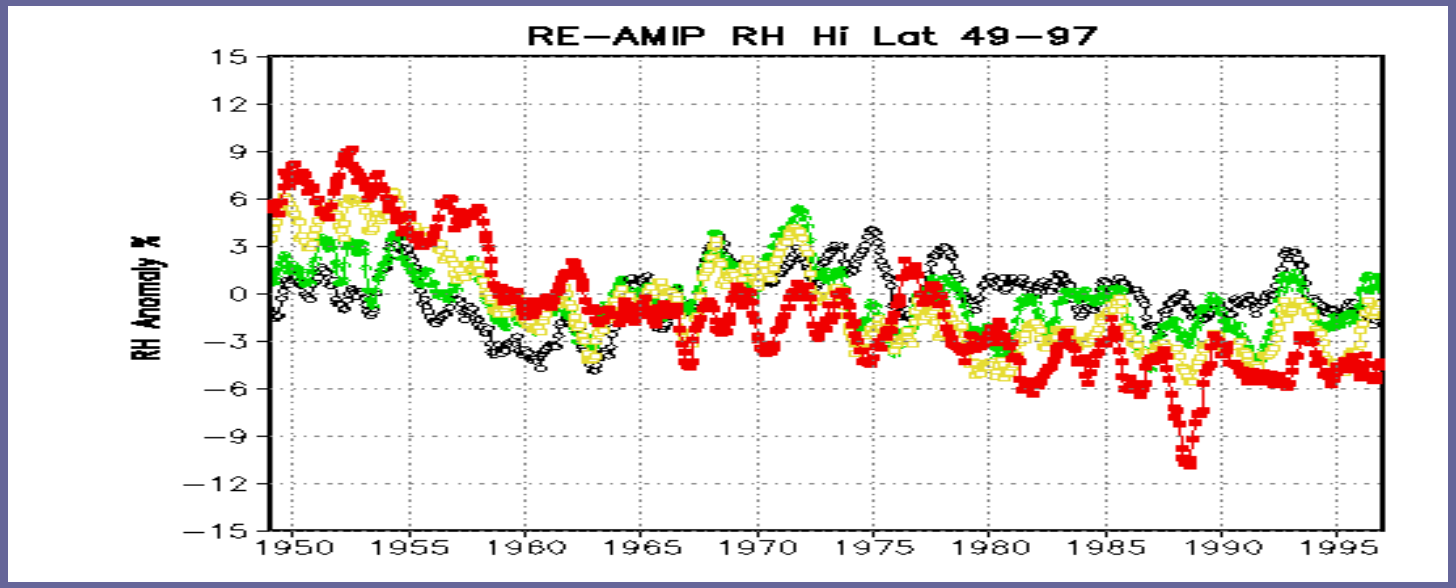
The Attributes of Reanalysis GDAS and the Model used for AMIP runs

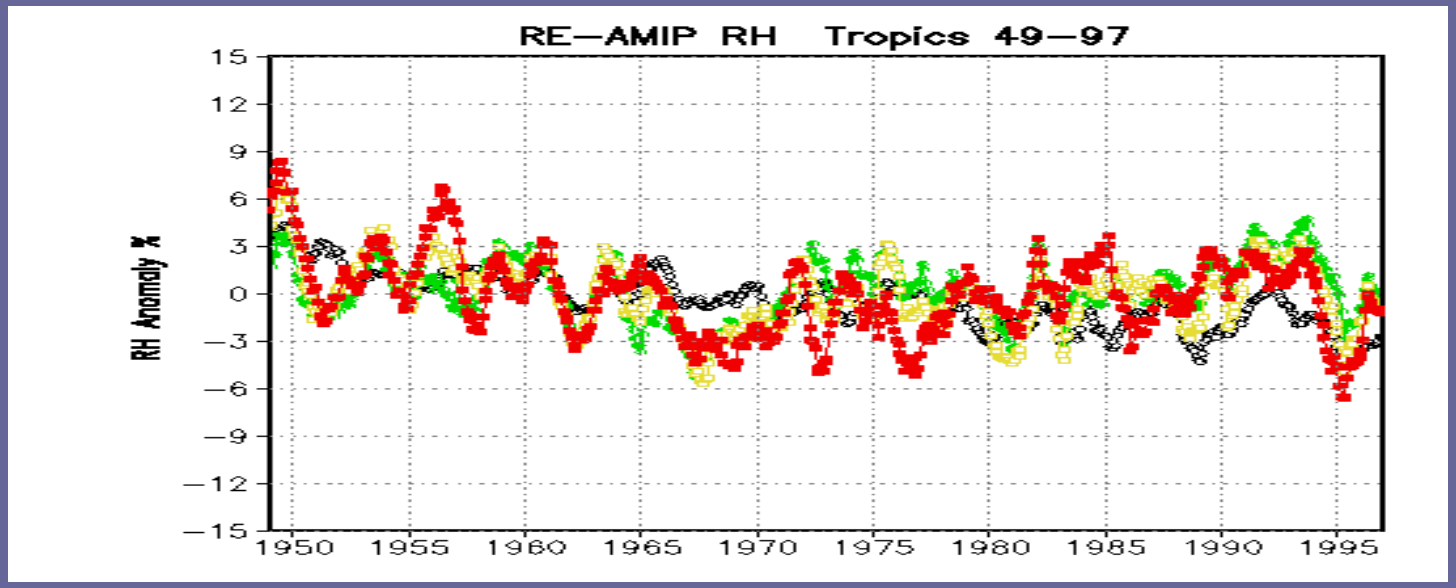
	Reanalysis	AMIP-ensemble10
• Convection Scheme	SAS	RAS
• SW Radiation	Lacis & Hansen (1974)	Chou et al (1992, 96)
• Boundary Layer	Local Diff	Non-Local
• Orography	Mean	Smooth Enhanced
• Resolution	T62L28	T42L24
• Soil Moisture	w/ nudging	interactive
• Snow	Obs (fixed on ‘72)	Climatology
• Radiation Resolution	124 (3-hr)	128 (3-hr)


1949–1978 CDAS RH500 Trend
1949–1978 AMIP RH500 Trend
Trend Diff CDAS–AMIP RH500
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0.8
0.6
0.4
0.2
0.1
–0.1
–0.2
–0.4
–0.6
–0.8

30 Stations Suggested by J. Christy







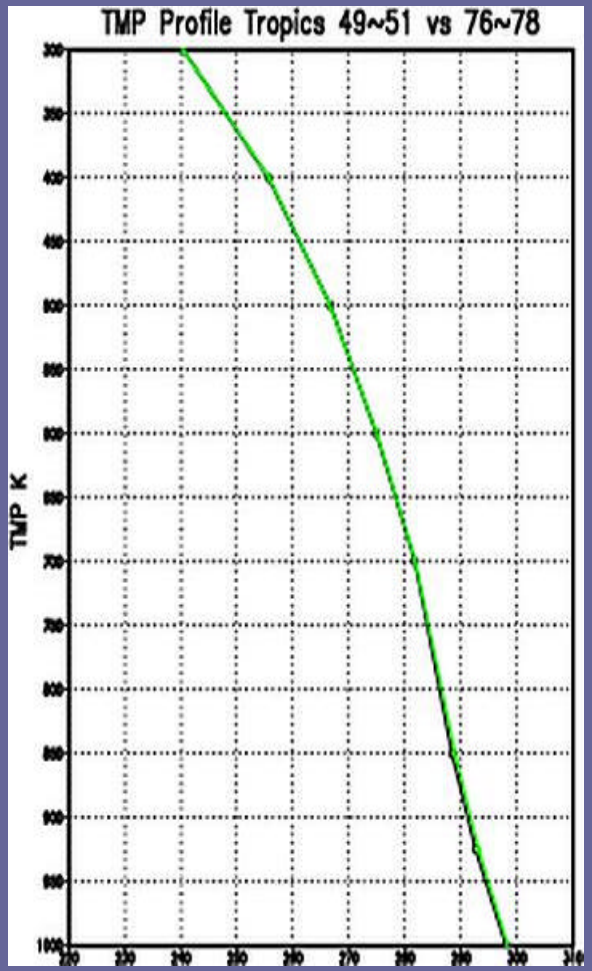
Red – **300 hPa**

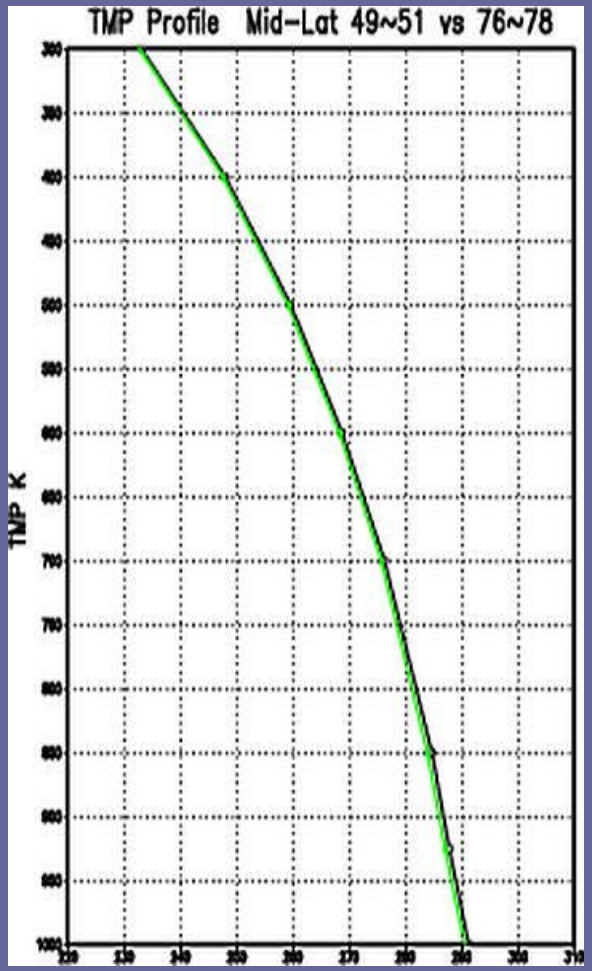
Yellow – **500 hPa**

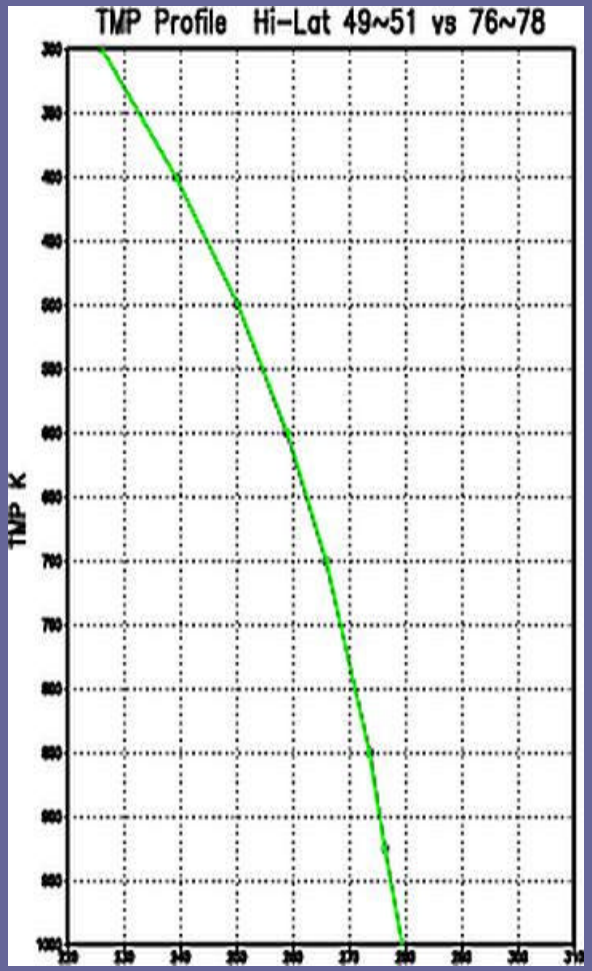
Green – **700 hPa**

Black – **850 hPa**

T Profiles from 36-month means



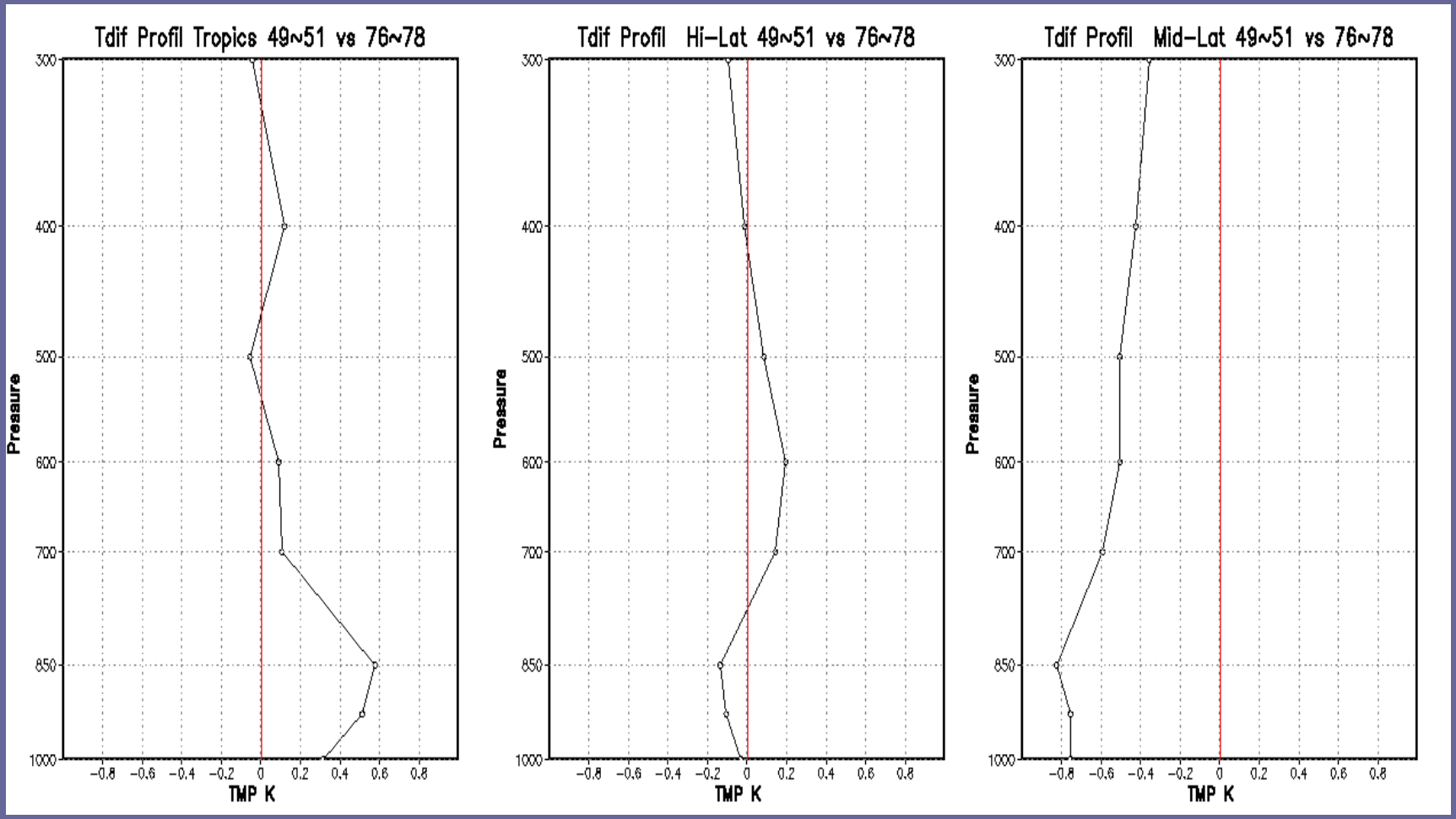




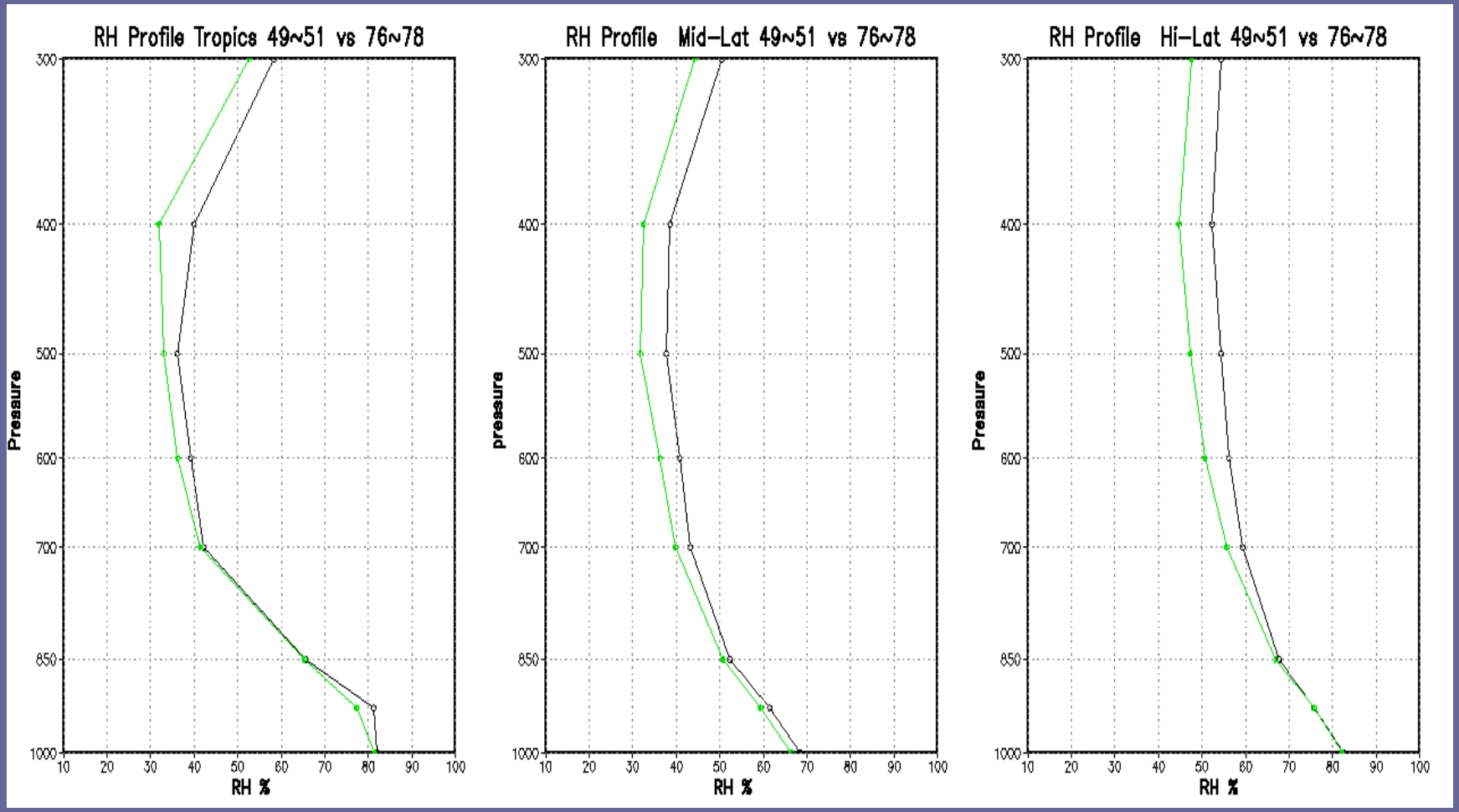
Green – **76~78**

Black – **49~51**

T-dif Profiles from 36-month means



RH Profiles from 36-month means



Green – **76~78**

Black – **49~51**

Hygristor Time constants

- ***Carbon hygristor*** ***1~2 sec at sfc***
- ***Thin Film*** ***1~2 sec at sfc***
- ***Goldbeater, Hair*** ***>10 sec at sfc, 5min 300 hPa***

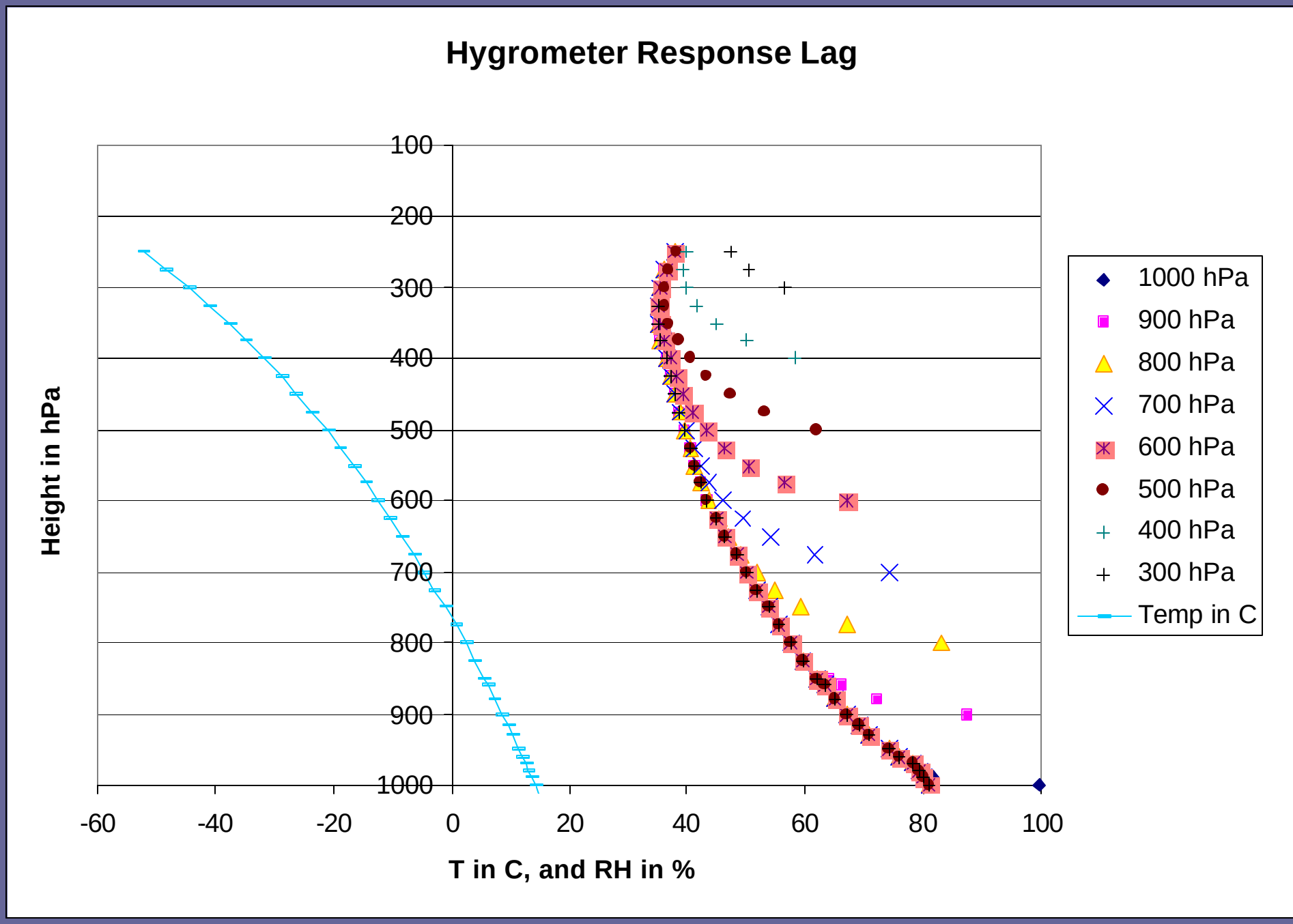
Hygrometer simulator

an educational toy

$$l\ (T) = 3 + 5(15-T),\ T \leq 15\ C$$

Time-lag constant of a hygristor is a function of temperature.
Based on Nash and Schmidlin, 1987, we determine that the rate of increase to be 5 sec/ °K, so that the time-lag constant can reach 5 minutes at 300 hPa, where the temperature is lower than -40°C. Balloons ascend at 15 f/s.

$$RH(i) = RHe + (RH\ (i-1) - RHe\ ) \exp\ (-t/\ l\ (T))$$


Hygrometer Response Lag
Height in hPa
100
200
300
400
500
600
700
800
900
1000
-60
-40
-20
0
20
40
60
80
100
T in C, and RH in %
1000 hPa
900 hPa
800 hPa
700 hPa
600 hPa
500 hPa
400 hPa
300 hPa
Temp in C

Conclusion

- *The trend of upper air humidity within NCEP/NCAR Reanalysis appears to be an artifact, caused by long time-lag constant in the older hygrometers, and other factors.*
- *Implies that similar problems, in general, in the time-series radiosonde time-series before the satellite era.*
- *Significant implication on the earth energy balance and cloud fields of the Reanalysis.*
- *No humidity climatology yet!*
- *Suggestions: future Reanalyses includes a special fixed observation system sub-analysis using only the limited well-known, high quality, well calibrated, fixed number stations for GDAS, such that a baseline reference analysis for the full analysis can be established .*

An AMIP simulation Using the Current NCEP Operational Global Forecast Model

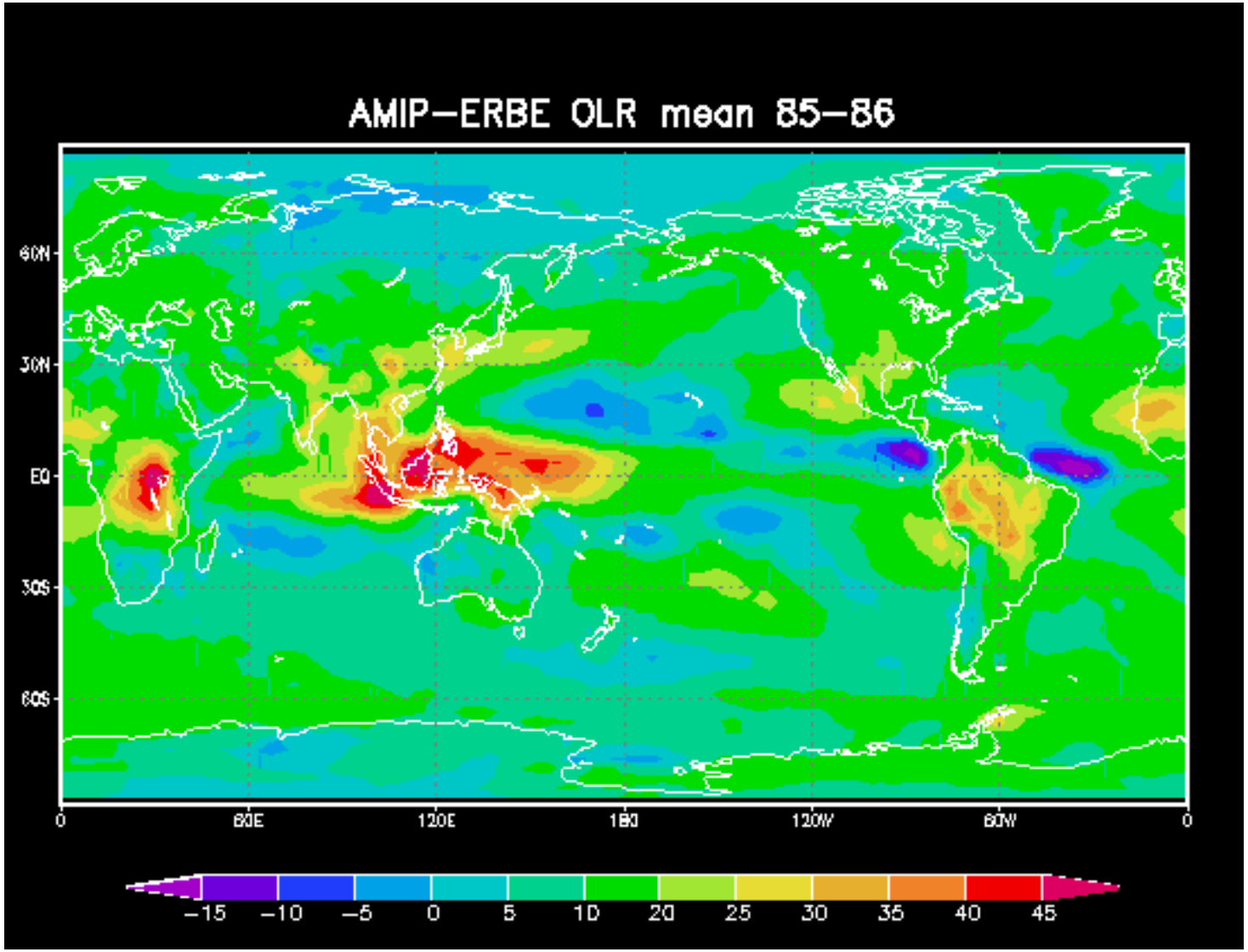
S-K Yang
Alvin J. Miller
28th CERES Science Team Meeting
5/6-8/03, Norfolk, VA

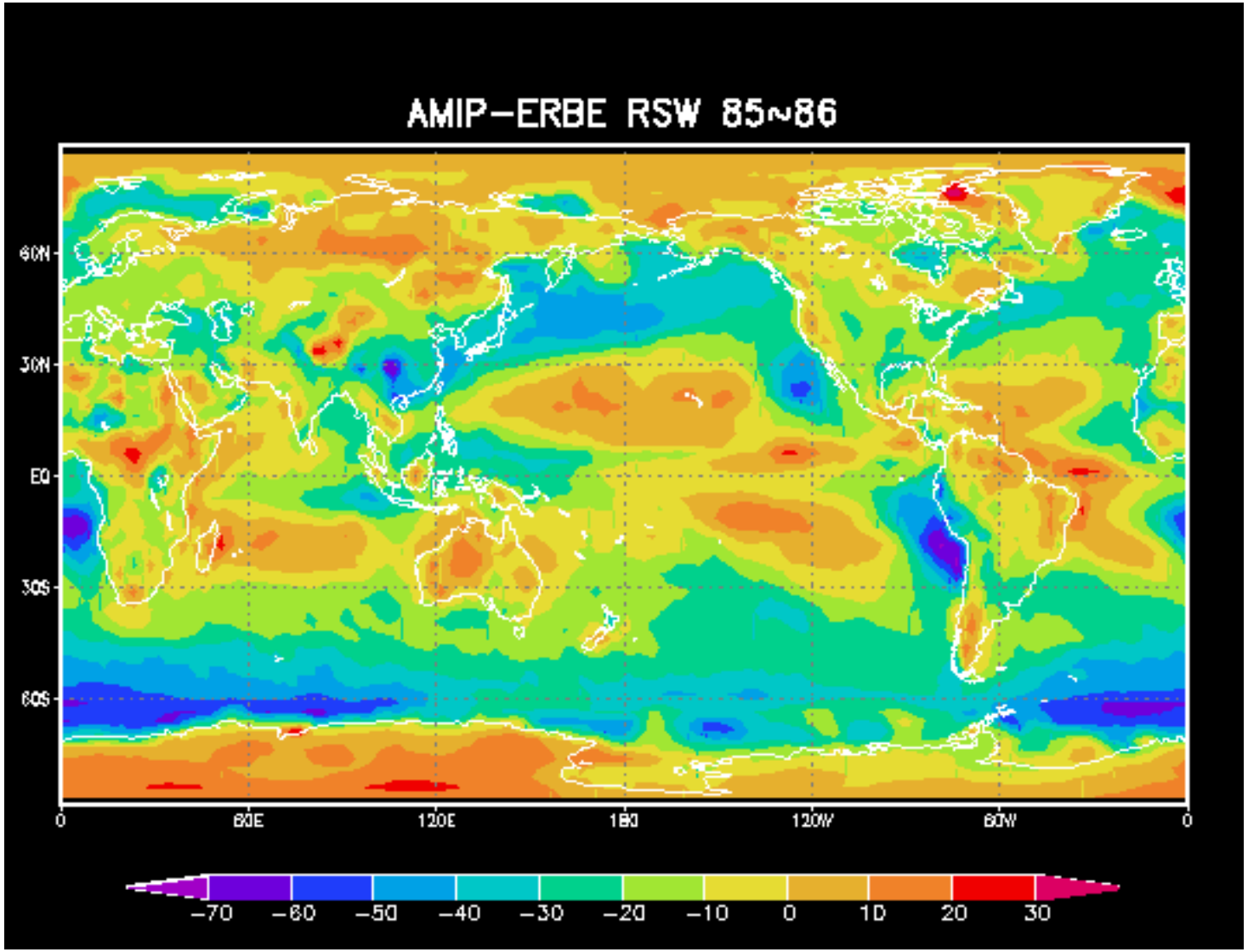
Attributes of GFS AMIP Model 1949~2001

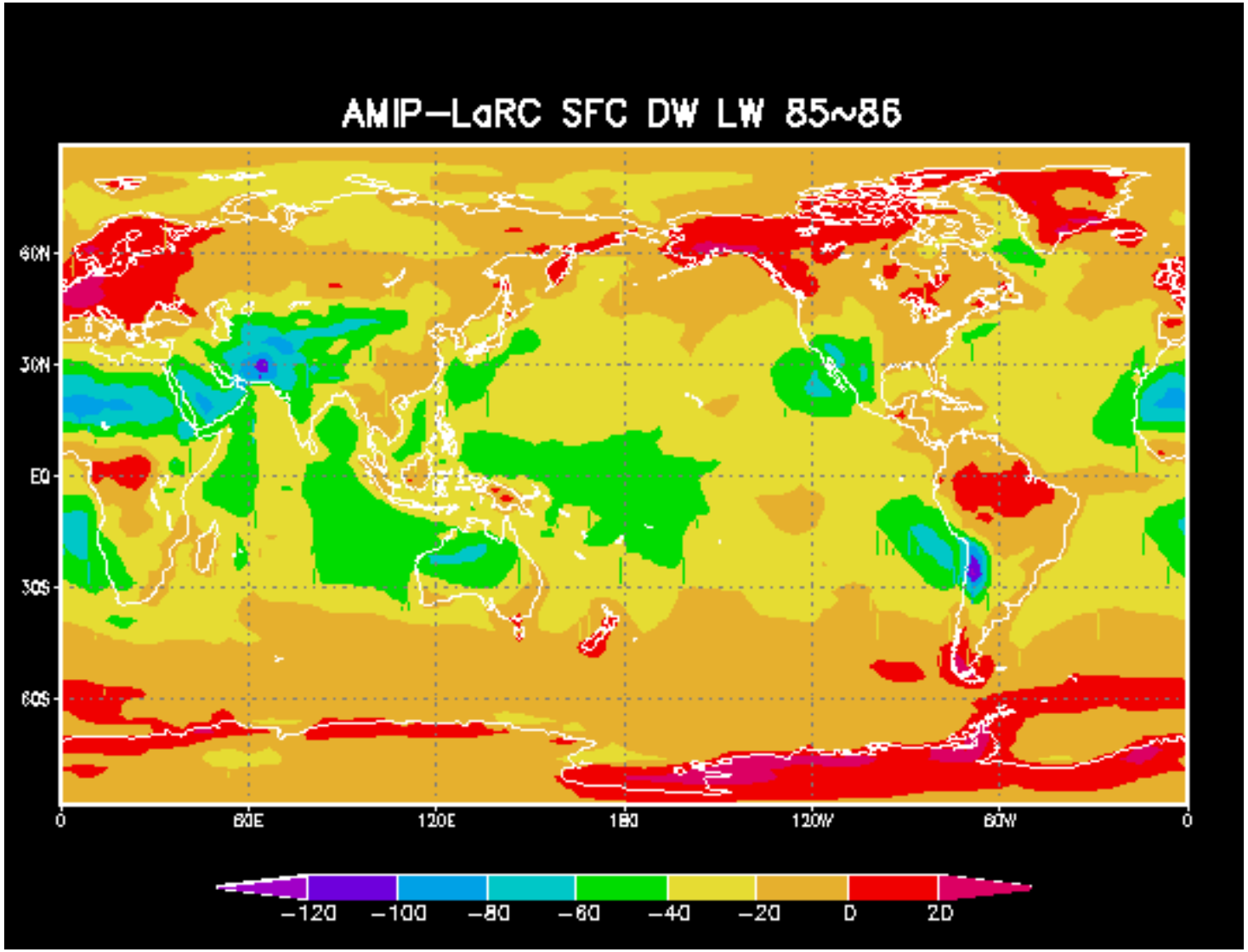
	AMIP
• Convection Scheme	SAS
• SW Radiation	Chou et al (1992, 96)
• Boundary Layer	Non-Local
• Orography	Mean
• Resolution	T62L64
• Soil Moisture	Climatology
• Snow	Climatology
• Radiation Resolution	as dynamics 194 Gaussian Grid (3-hr)

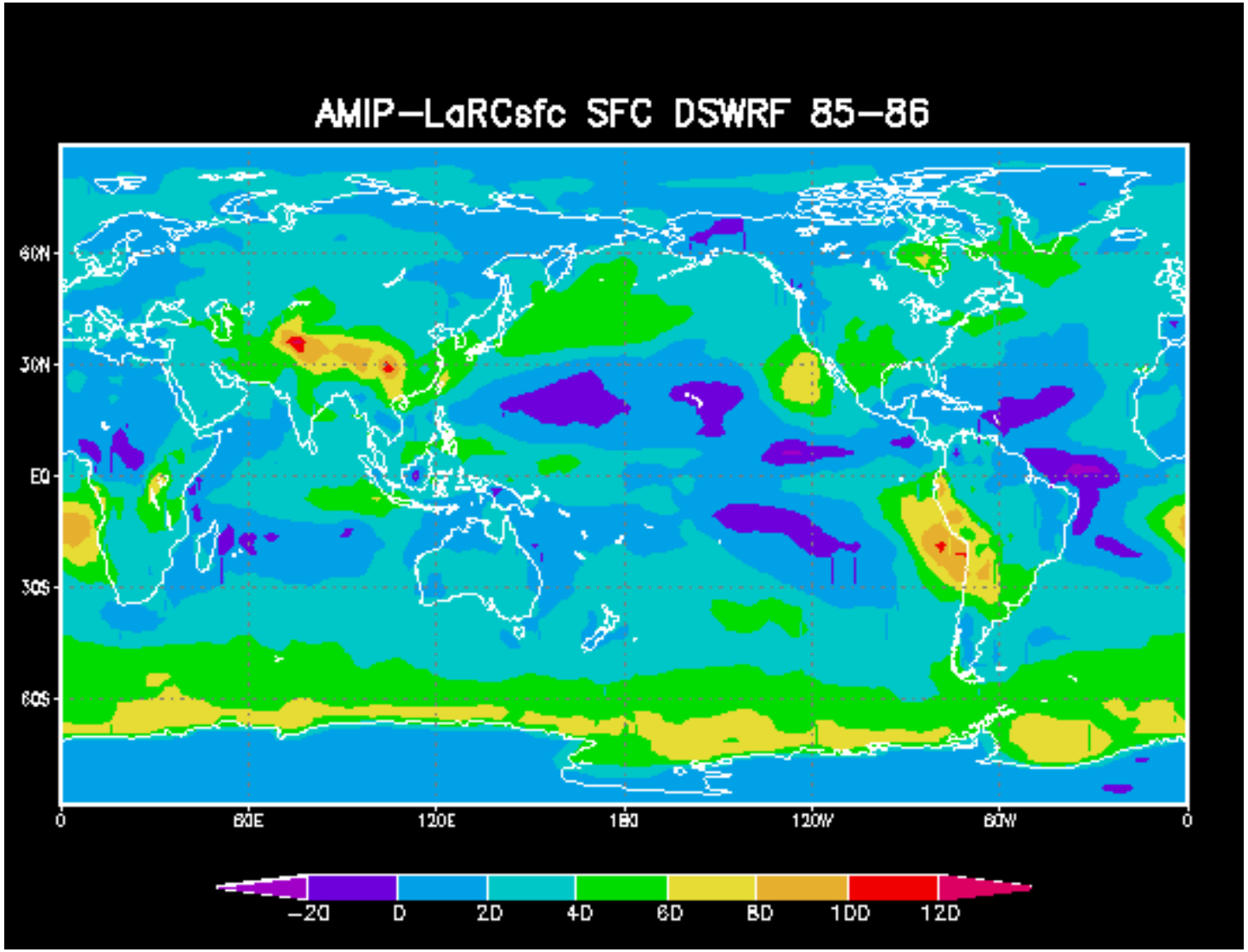
Comparison of 1985~1989 4-year global means to ERBE/LaRC-Surface Radiation Budget Dataset, W/M^2

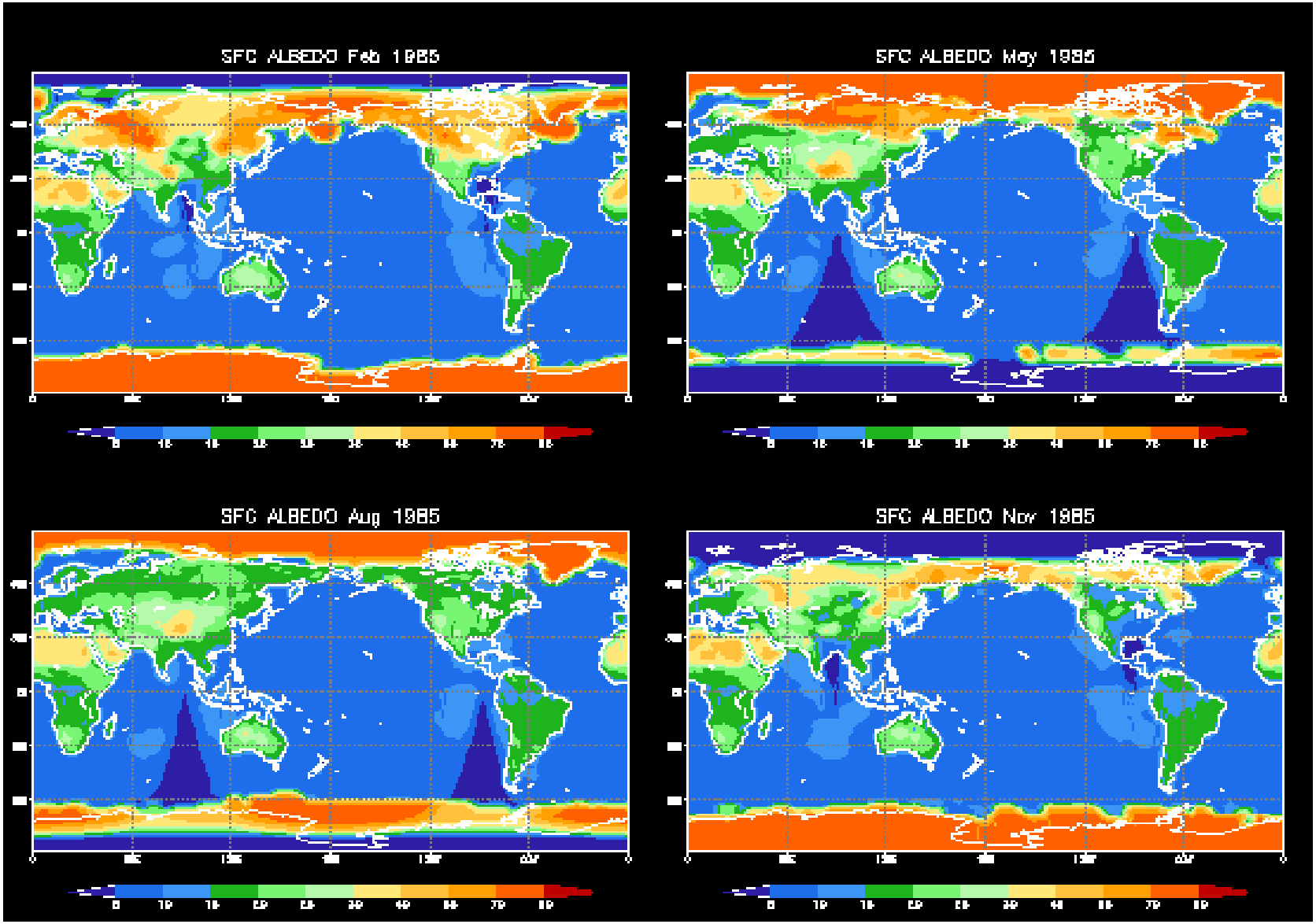
	TOA OLR	*TOA RSW*	*Sfc dn Lw*	*Sfc Dn SW*
CDAS R-1	237.3	115.6	333.2	207.0
AMIP	245.5	87.4	325.5	211.2
ERBE/ LaRC sfc	235.3	102.7	348.3	184.3
Diff	10.2	-15.3	-22.8	26.8

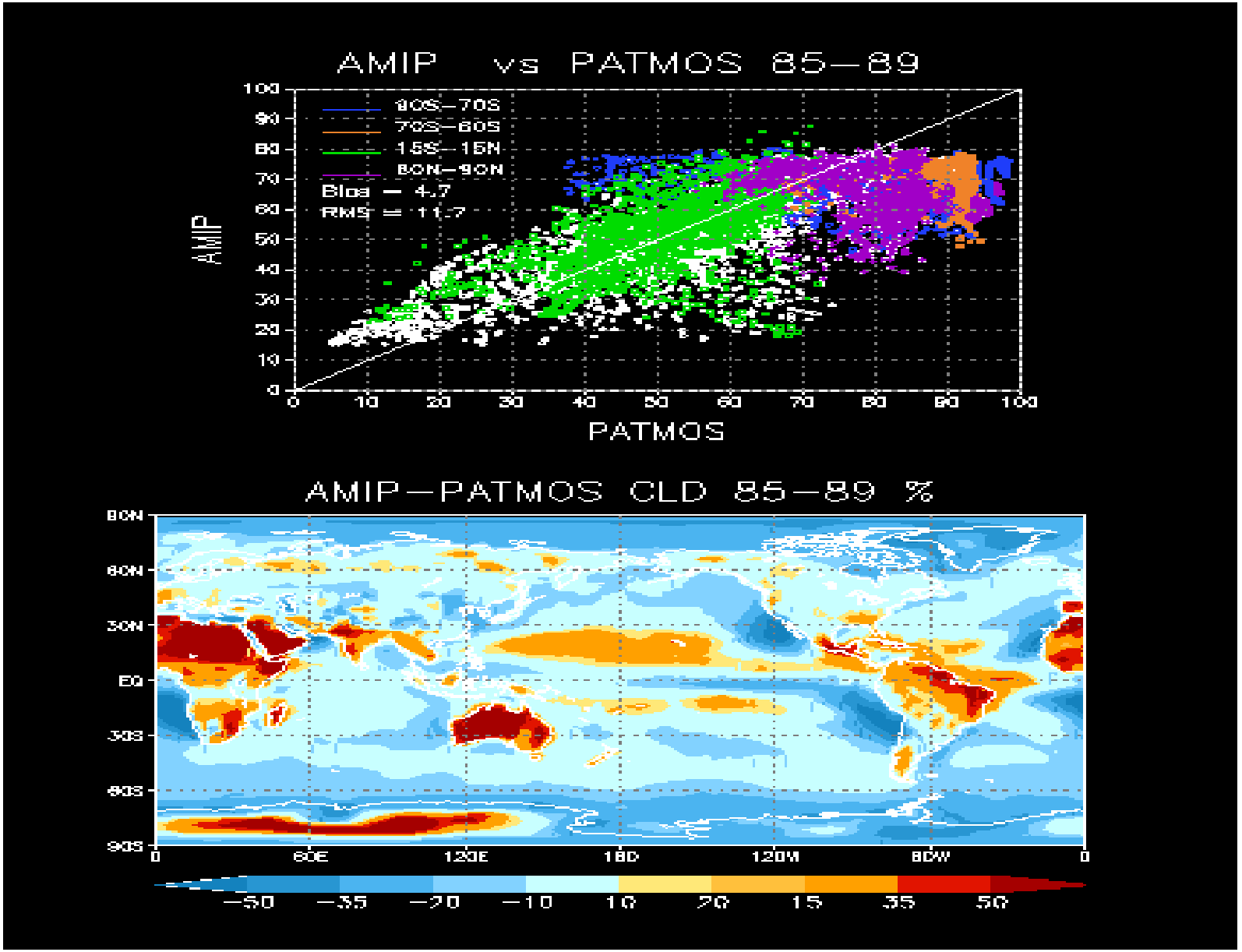

AMIP–ERBE OLR mean 85–86
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
−15
−10
−5
0
5
10
20
25
30
35
40
45

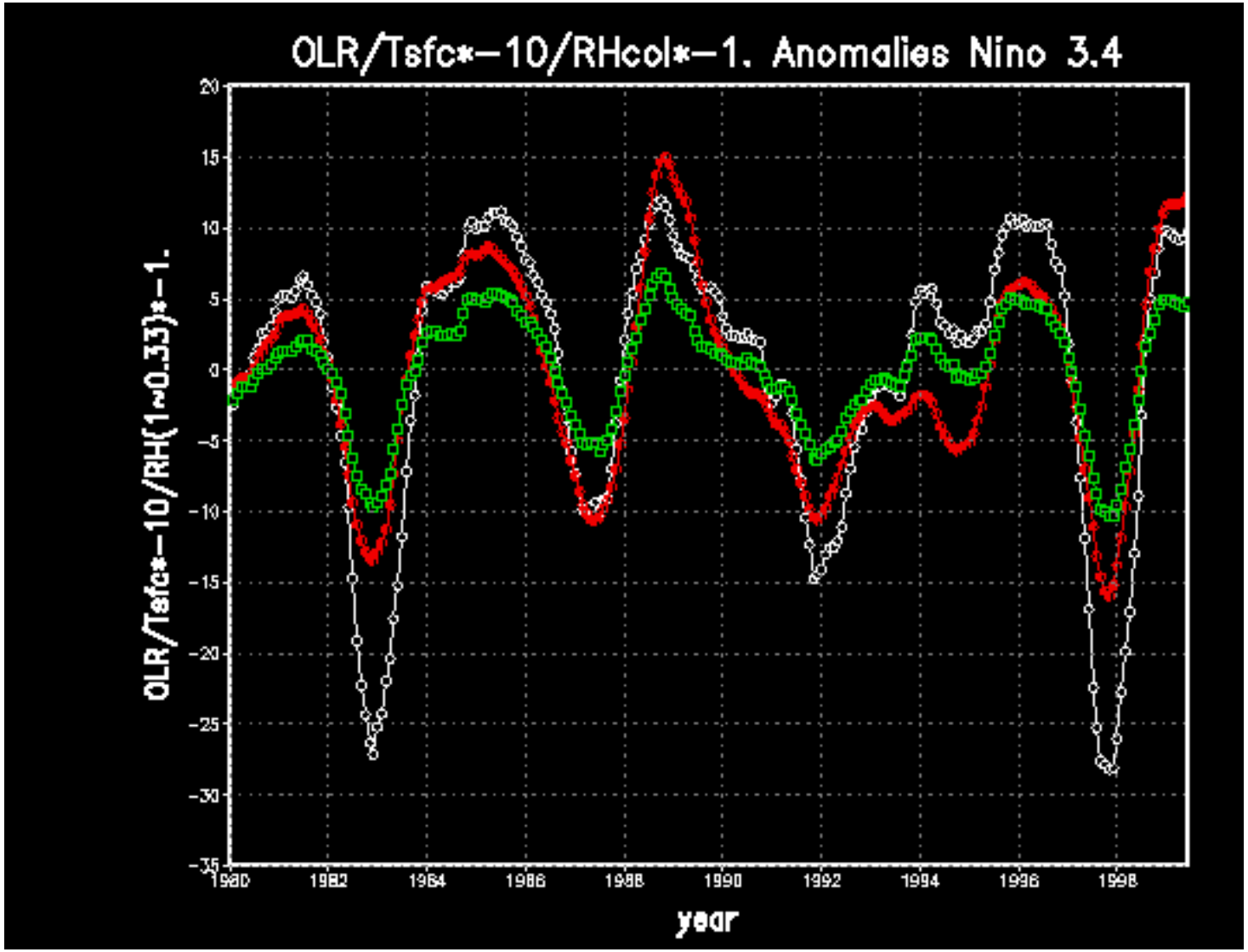

AMIP-ERBE RSW 85~86
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
-70
-60
-50
-40
-30
-20
-10
0
10
20
30


AMIP–LaRC SFC DW LW 85~86
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
−120
−100
−80
−60
−40
−20
0
20


AMIP–LaRCsfc SFC DSWRF 85–86
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
–20
0
20
40
60
80
100
120

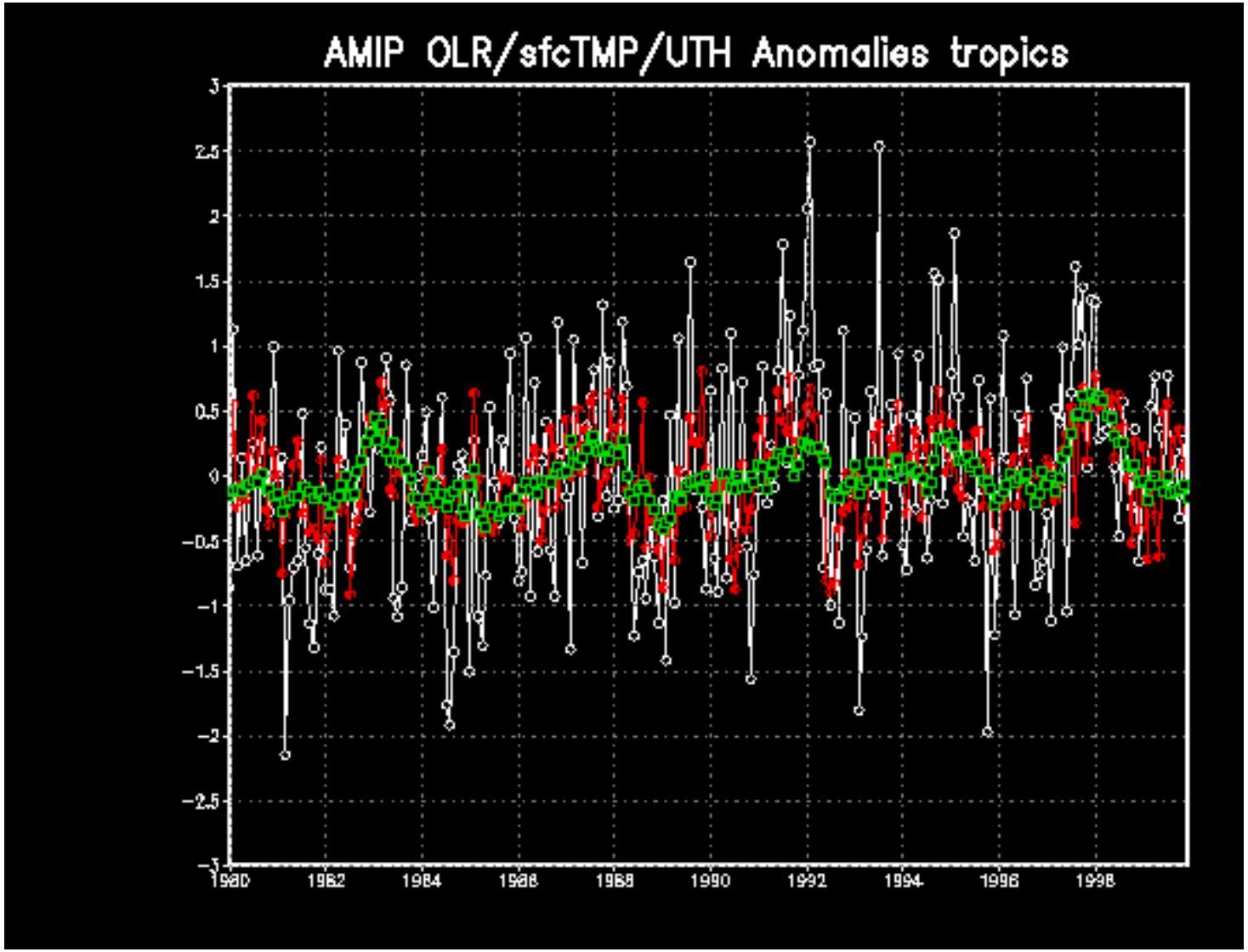

SFC ALBEDO Feb 1985
SFC ALBEDO May 1985
SFC ALBEDO Aug 1985
SFC ALBEDO Nov 1985


AMIP vs PATMOS 85-89
90S-70S
70S-60S
15S-15N
90N-90N
Bias = 4.7
RMS = 11.7
AMIP
PATMOS
AMIP-PATMOS CLD 85-89 %
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
-50
-35
-20
-10
10
20
35
50



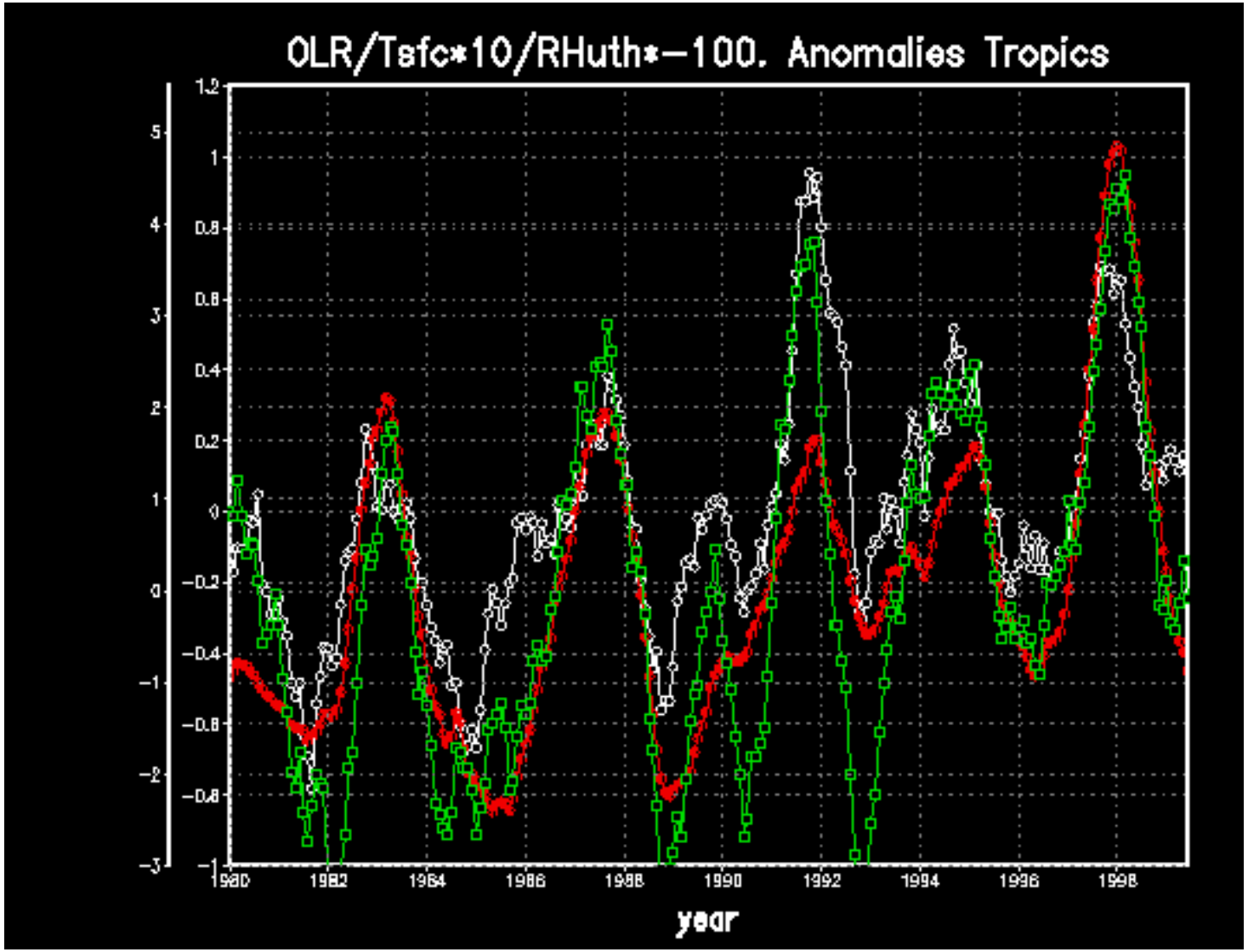
OLR- White; Tsfc*(-10.)-Red; RH(sigma 1-0.33)*(-1.)-Green

Global Tropical (20S-20N) Monthly Means



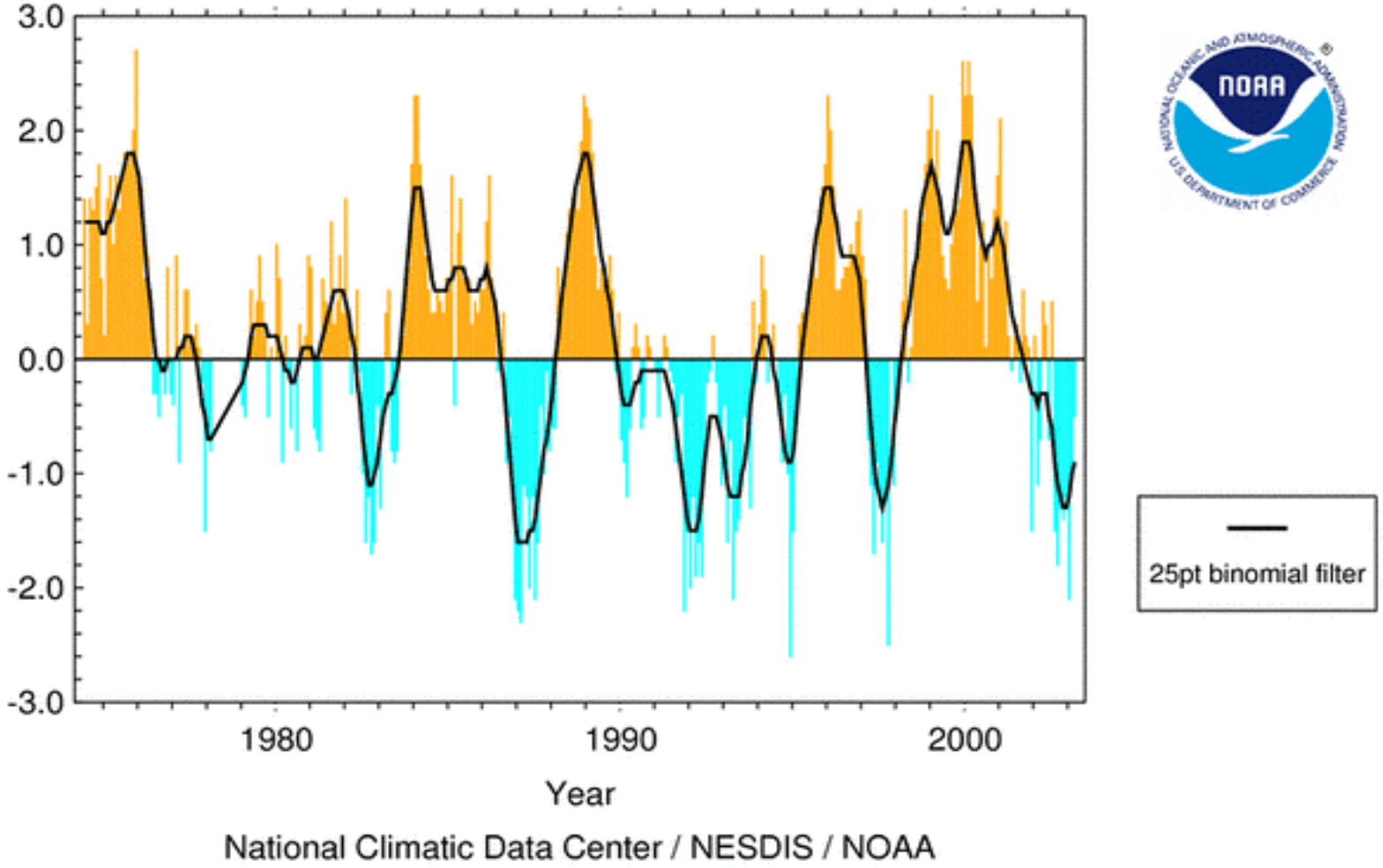
OLR- White; Tsfc-Red; RH(sigma 0.33-0.44)*(-10)-Green

Global Tropical (20S-20N) 12-month Running Means



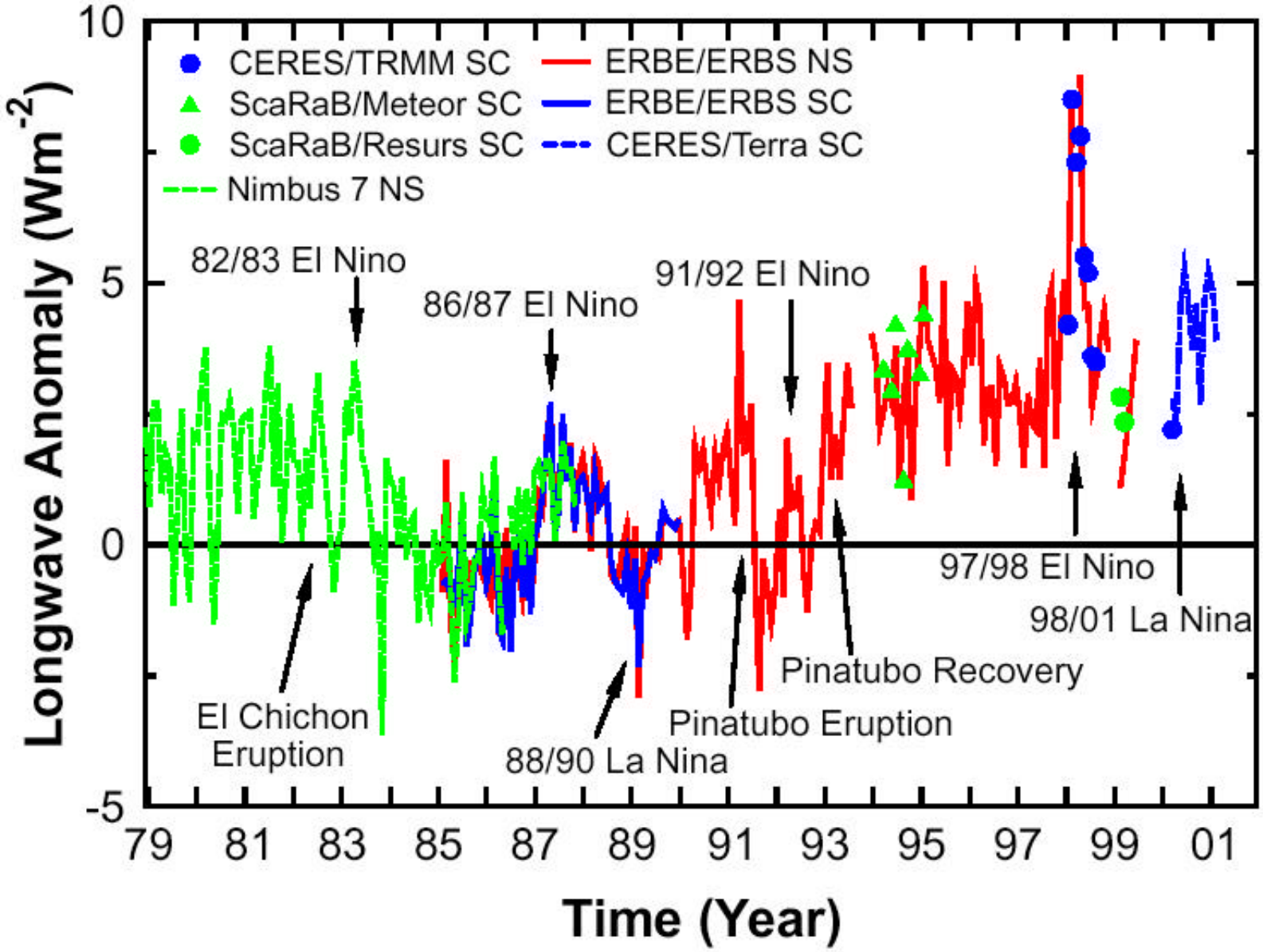
OLR- White; Tsfc*10-Red; RH(sigma 0.33-0.44)*(-100)-Green

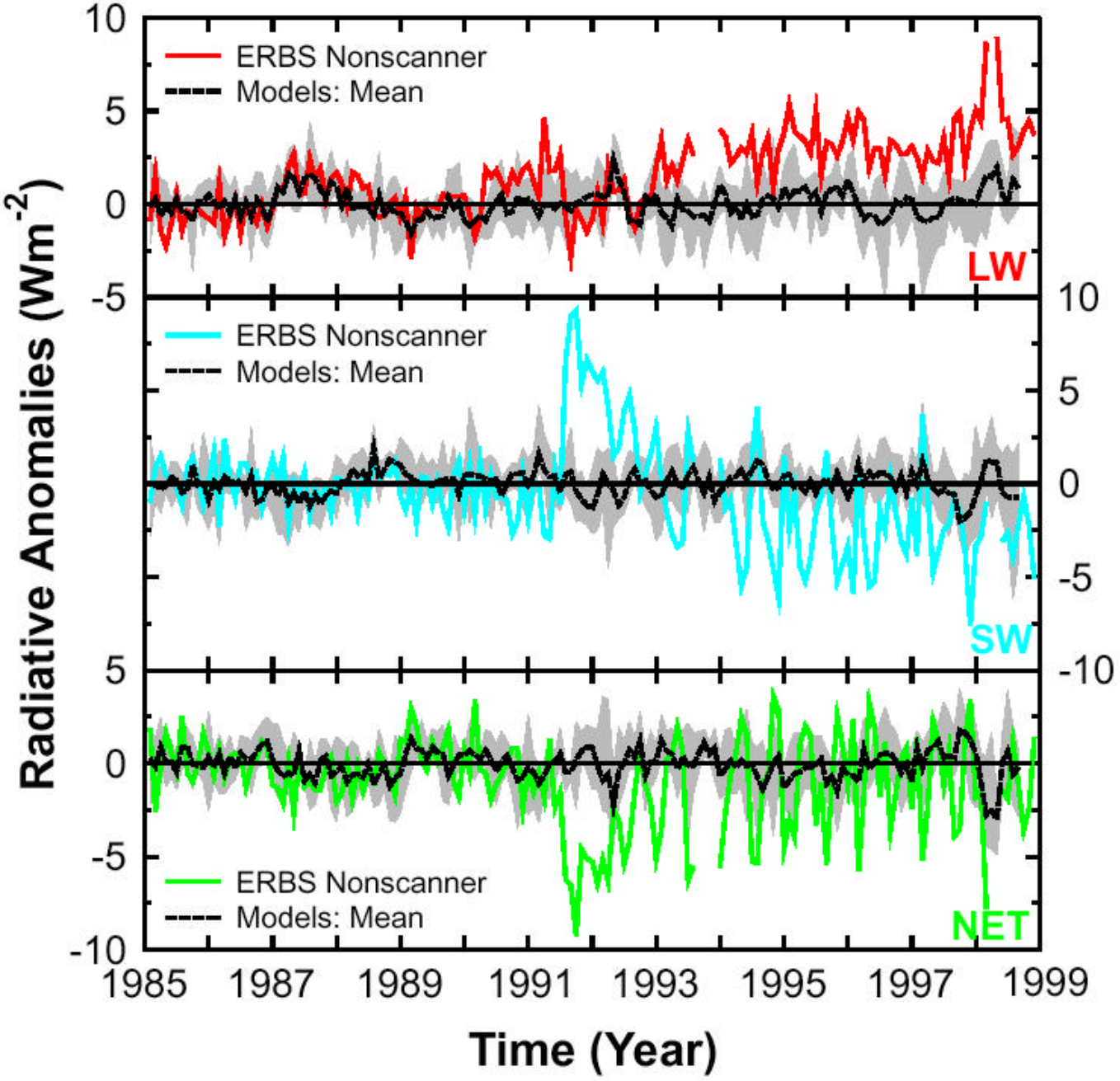
Standardized Outgoing Longwave Radiation (OLR) Anomalies



National Climatic Data Center / NESDIS / NOAA

Why we care about small calibration drifts: 1% = 2.5W/m^2 LW flux





5 current climate models all miss this decadal variation in the tropics: apparent strengthening of Hadley and Walker Circulation in the Tropics (20S-20N) from the 1980s to the 1990s. 1% to 3% signals, but as large or larger than century scale greenhouse gas forcing: climate may not change smoothly. (Science, Feb, 2002)

summary

- NCEP GFS AMIP is a
  Darker and Warmer Planet at TOA;
  Brigher and Colder at the surface.
- In the Nino 3.4 (120~170W, 5S~5N)
  OLR 🗐 –Tsfc; OLR 🗐 –Rhcol
- In the global tropics (20S-20N),
  OLR 🗐 Tsfc; OLR 🗐 out of phase with UTH
- Judging from the sensitivity to SST, the Model can’t simulate ERBE/ScaRab/CERES obserations