OUTLINE PART II

- Satellite Flux Estimates
  - wind stress
  - radiation
  - precipitation
- A Merged Flux Climatology
  - corrections
  - mean balances
- Variability of Ocean Surface Fluxes
  - annual cycle
  - interannual to decadal

Satellite Wind Stress

Passive microwave : wind speed (direction ??)

Active radars -- Altimeters : wind speed

-- Scatterometer : vector wind

Empirically relate backscatter σ_o to buoy U_N
(-.3m/s bias ; 1.3 m/s rms difference)
wind direction either very good or very bad
("ambiguity" errors)

Scatterometer wind, U_S, to stress

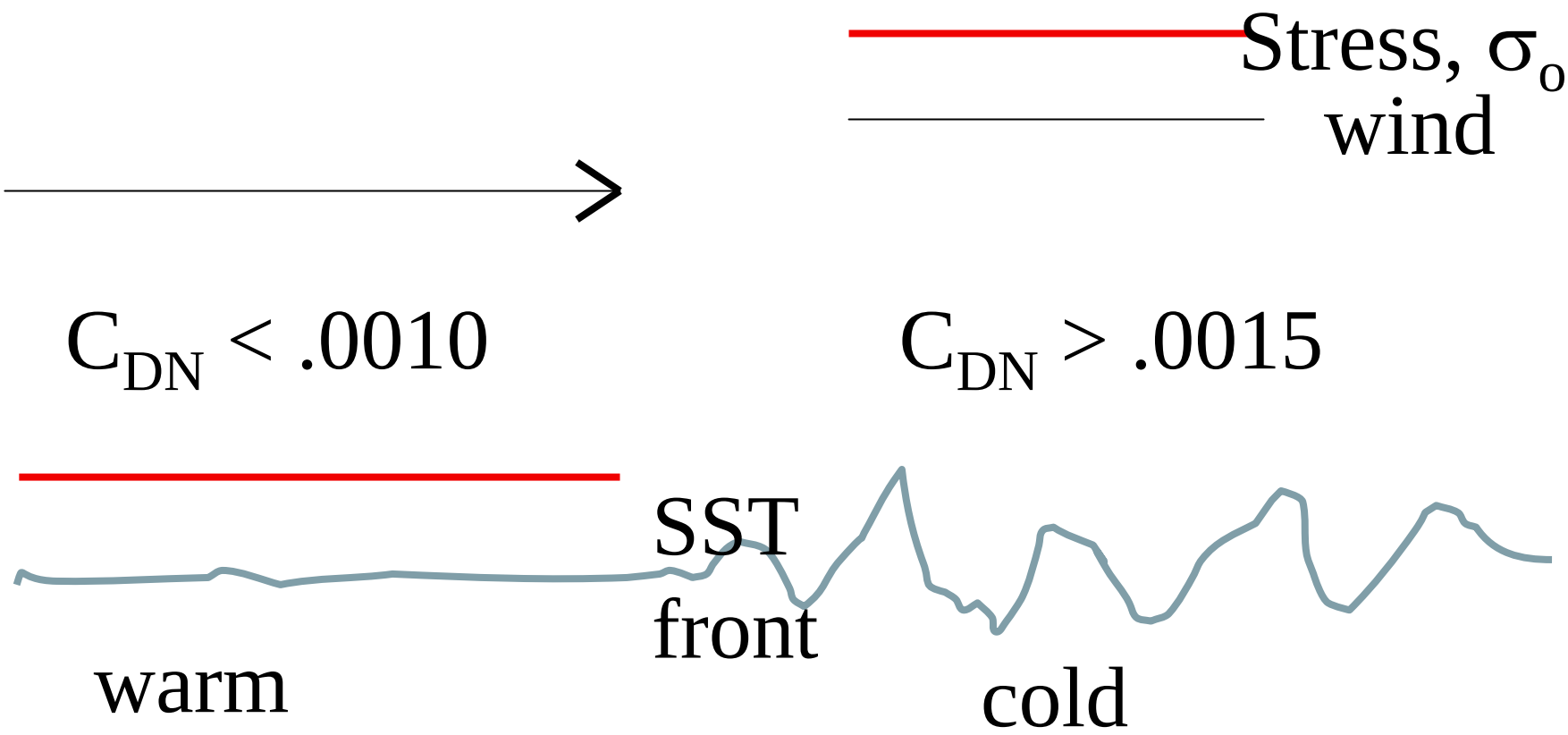
A: $u^{*2} = C_{DN}(U_S) \quad U_S^2$

B: $u^{*2} = C_{DN}(U_S, \text{waves}) \quad U_S^2$

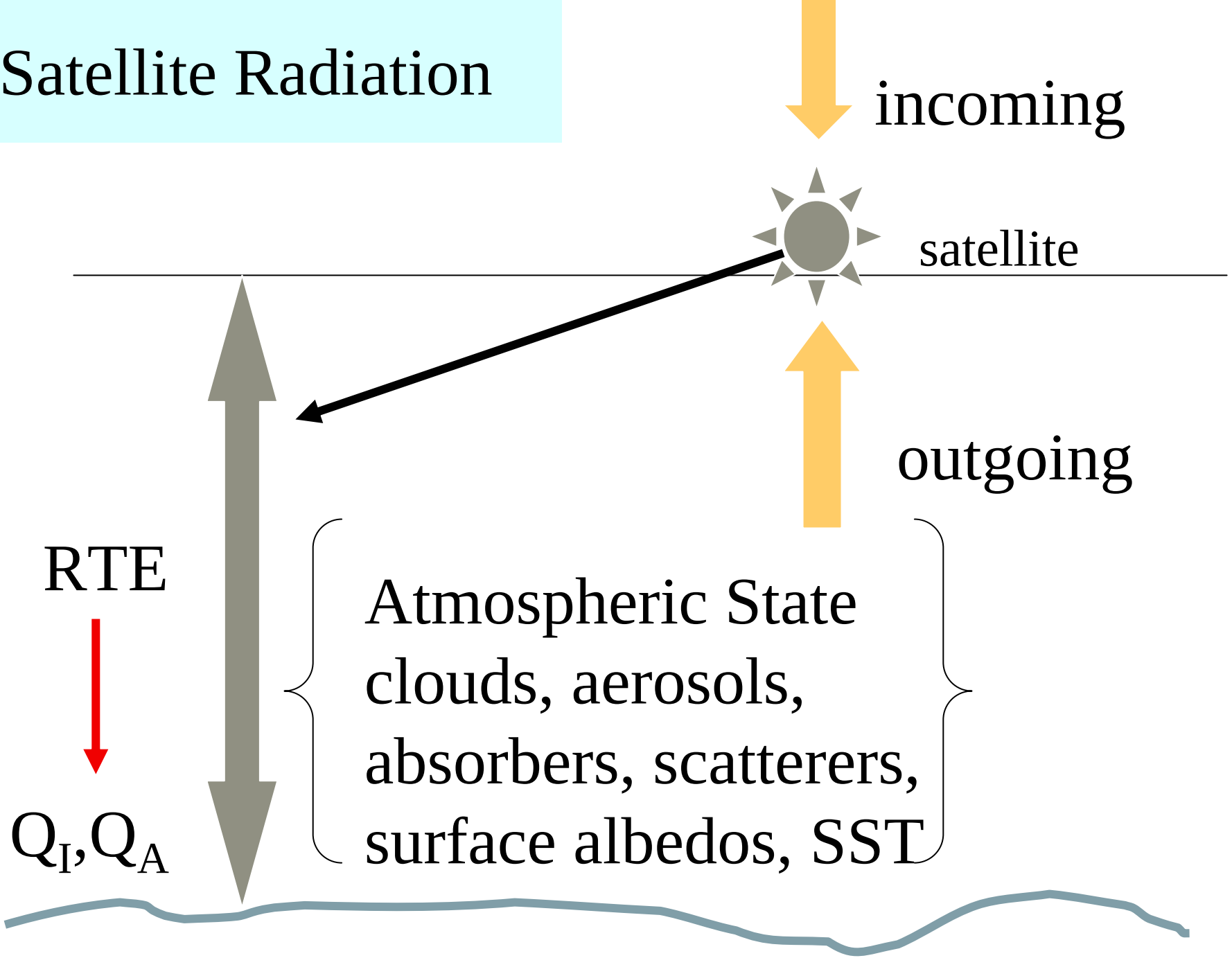
Scatterometer wind, U_S, to stress

A: $u^{*2} = C_{DN}(U_S) \quad U_S^2$

because σ_o varies with wind stress more than wind speed.

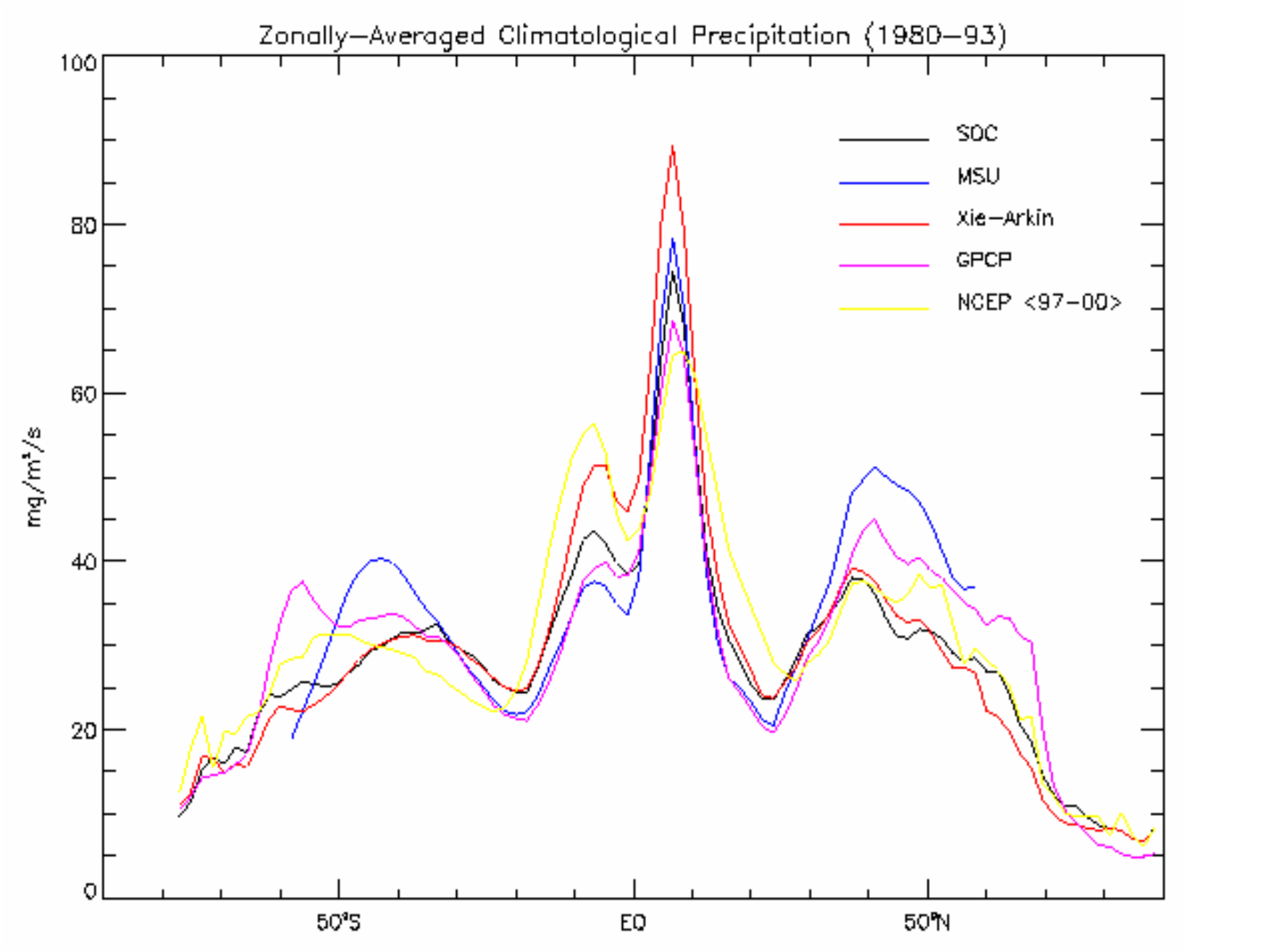


Satellite Radiation



Satellite Precipitation (Rain)

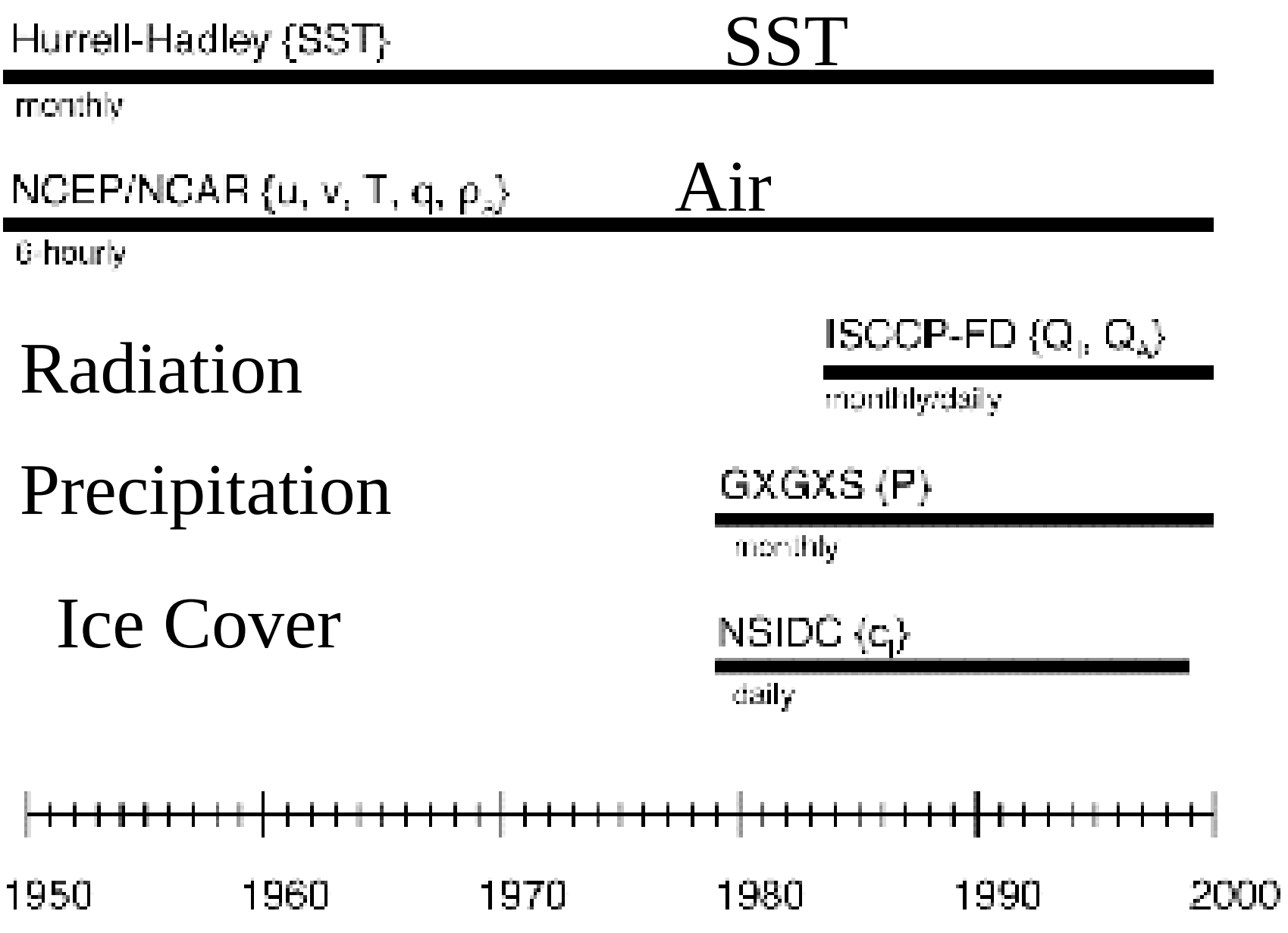
- CMAP ; Xie and Arkin (1996)
- GPCP : Global Precipitation Climatology Project
- MSU : Microwave Sounding Unit
- TRMM : Tropical Rainfall Measuring Mission


Zonally–Averaged Climatological Precipitation (1980–93)
100
80
60
40
20
0
mg/m²/s
50°S
EQ
50°N
SOC
MSU
Xie–Arkin
GPCP
NCEP <97–00>

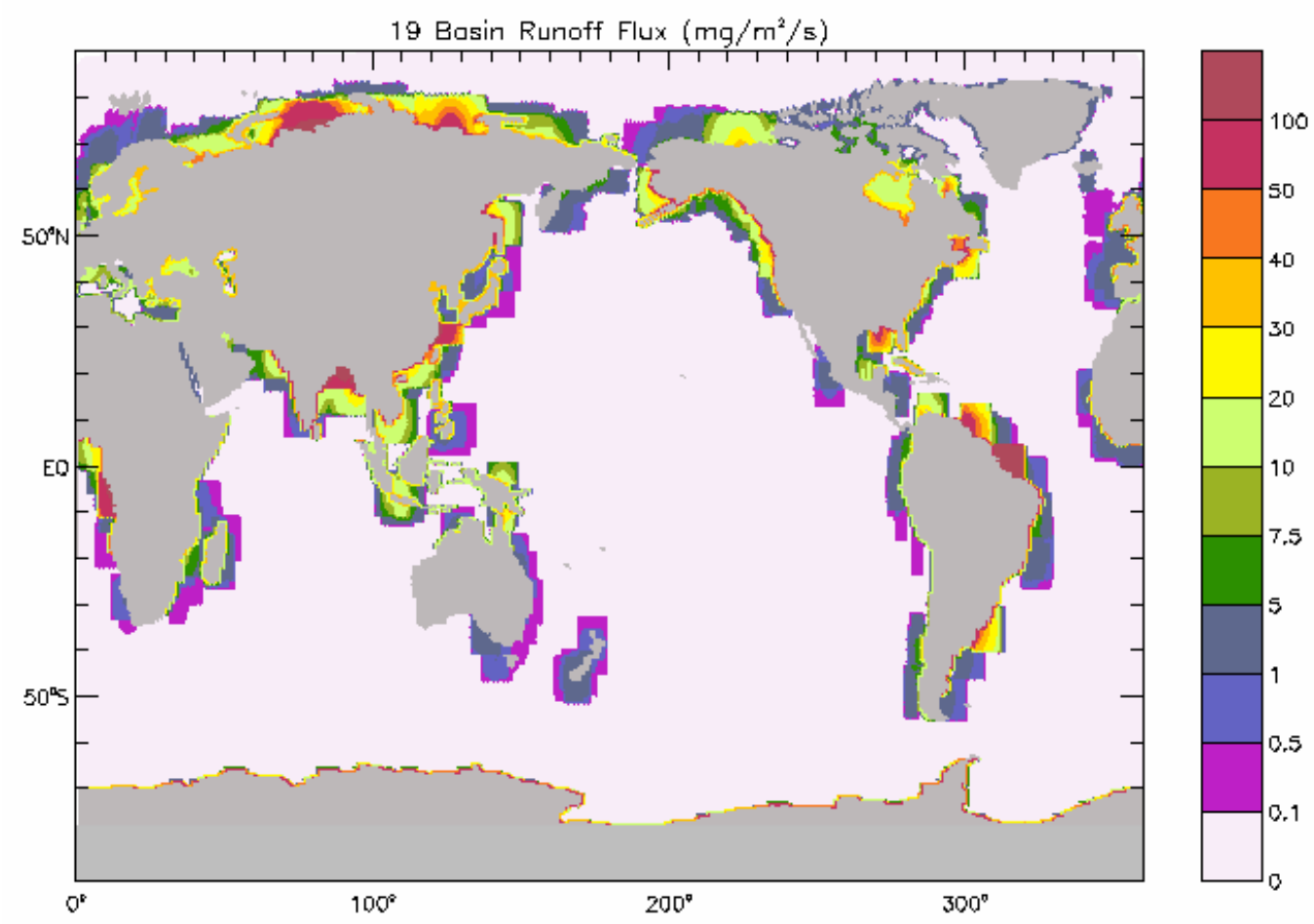
6. Merged Flux Climatology

" …. There is presently no one flux climatology which does not exhibit significant errors in one region or another in each of the various flux components." (WGASF, 2000)

Large, W.G. and S.G. Yeager, 2004: Diurnal to Decadal Forcing for Ocean and Sea-Ice Models: The Data Sets and Flux Climatologies, NCAR Tech. Note, NCAR/TN-460+STR, 105 pp.

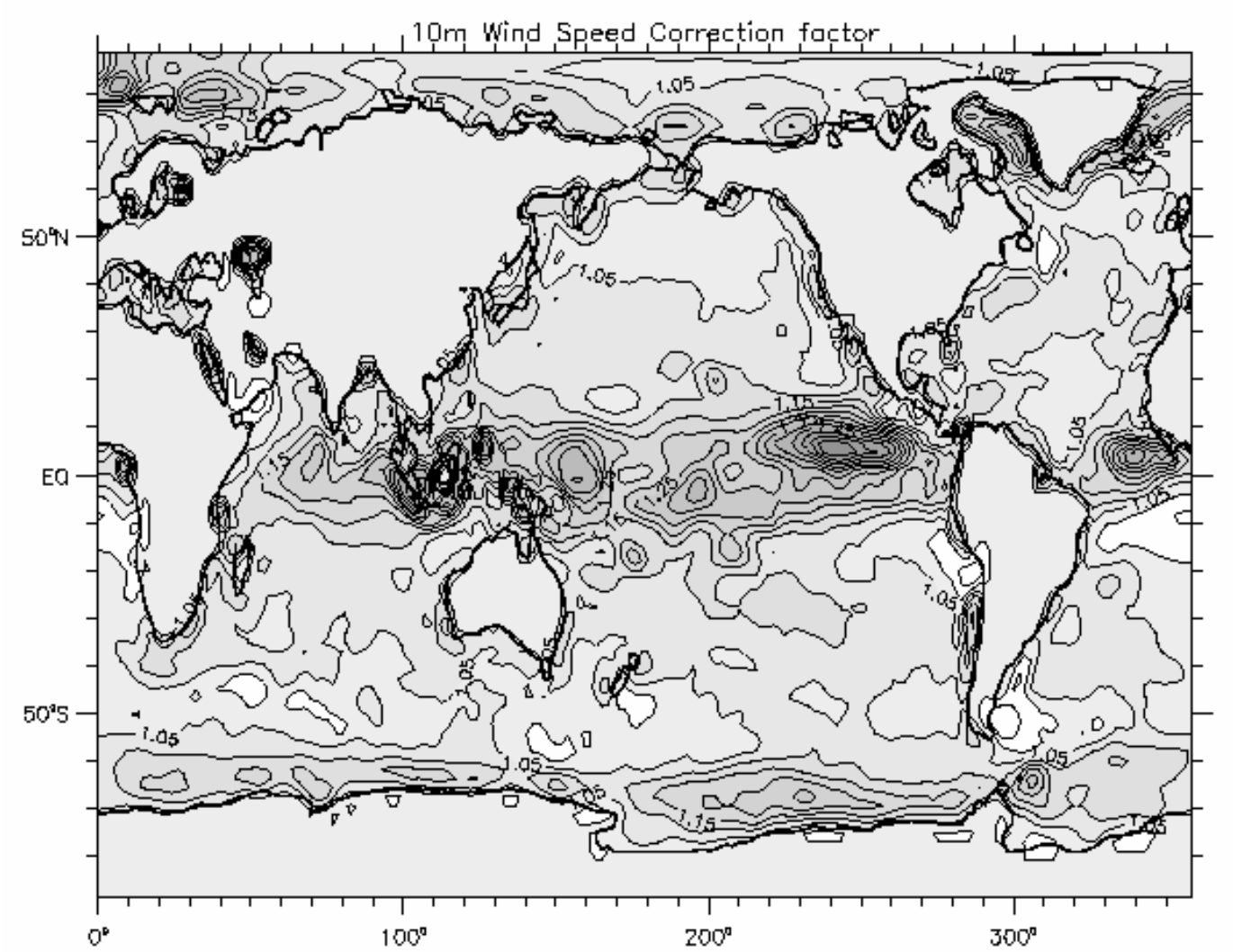

Hurrell-Hadley {SST}
SST
monthly
NCEP/NCAR {u, v, T, q, p_s}
Air
6 hourly
Radiation
ISCCP-FD {Q_l, Q_s}
monthly/daily
Precipitation
GXGXS {P}
monthly
Ice Cover
NSIDC {c_l}
daily
1950
1960
1970
1980
1990
2000

R


19 Basin Runoff Flux (mg/m²/s)
50°N
EQ
50°S
0°
100°
200°
300°
100
50
40
30
20
10
7.5
5
1
0.5
0.1
0

Corrections

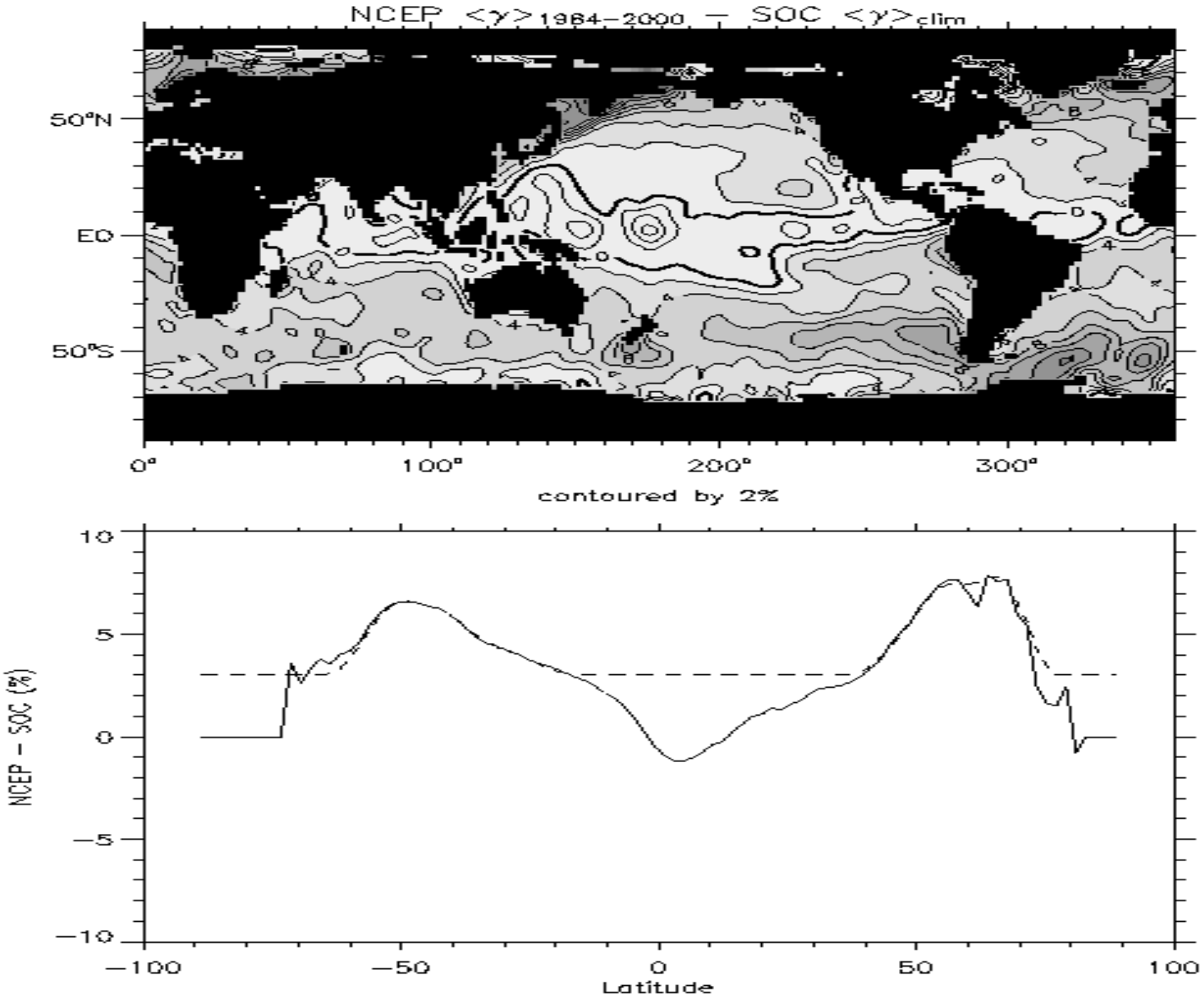
	none	wind	humidity	All
Q_S	173			
Q_L	-52			
Q_E	-76			
Q_H	-13			
Q_{as}	31			
E	-30.5			
P	30.4			
R	3.5			
F_{as}	3.4			


10m Wind Speed Correction factor
50°N
EQ
50°S
0°
100°
200°
300°
1.05
1.15

Corrections

	none	wind	humidity	All
Q_S	173			
Q_L	-52			
Q_E	-76	-84		
Q_H	-13			
Q_{as}	31	23		
E	-30.5	-33.4		
P	30.4			
R	3.5			
F_{as}	3.4	0.5		

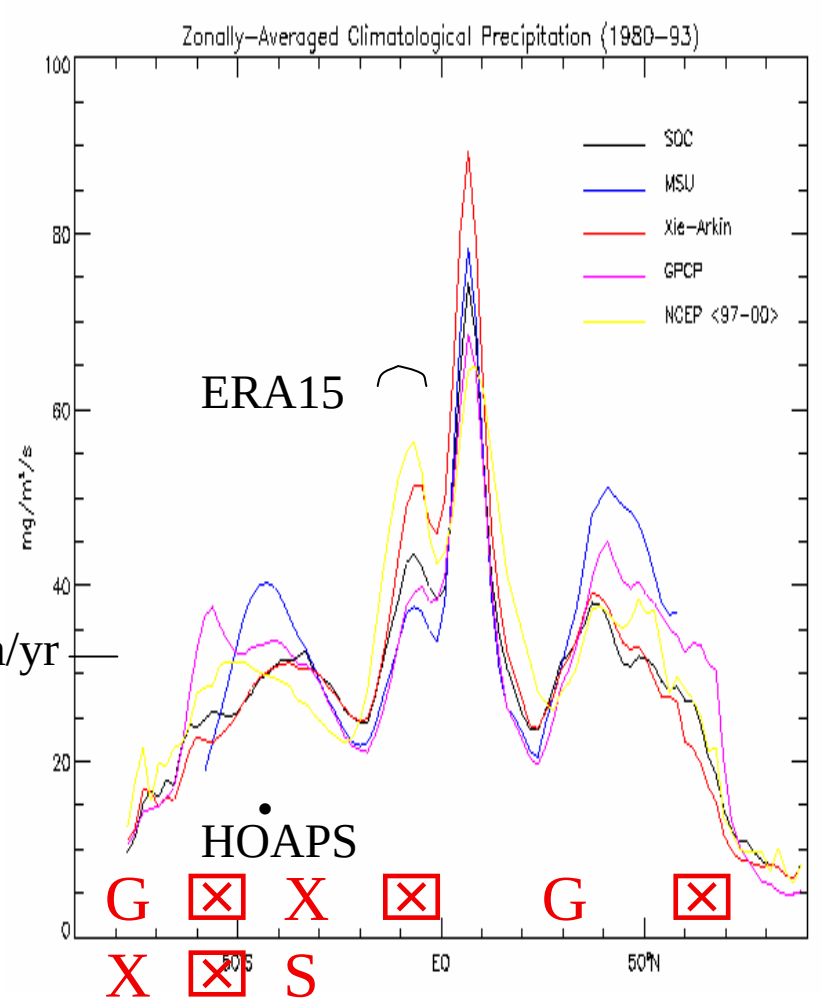
γNCEP - γSOC

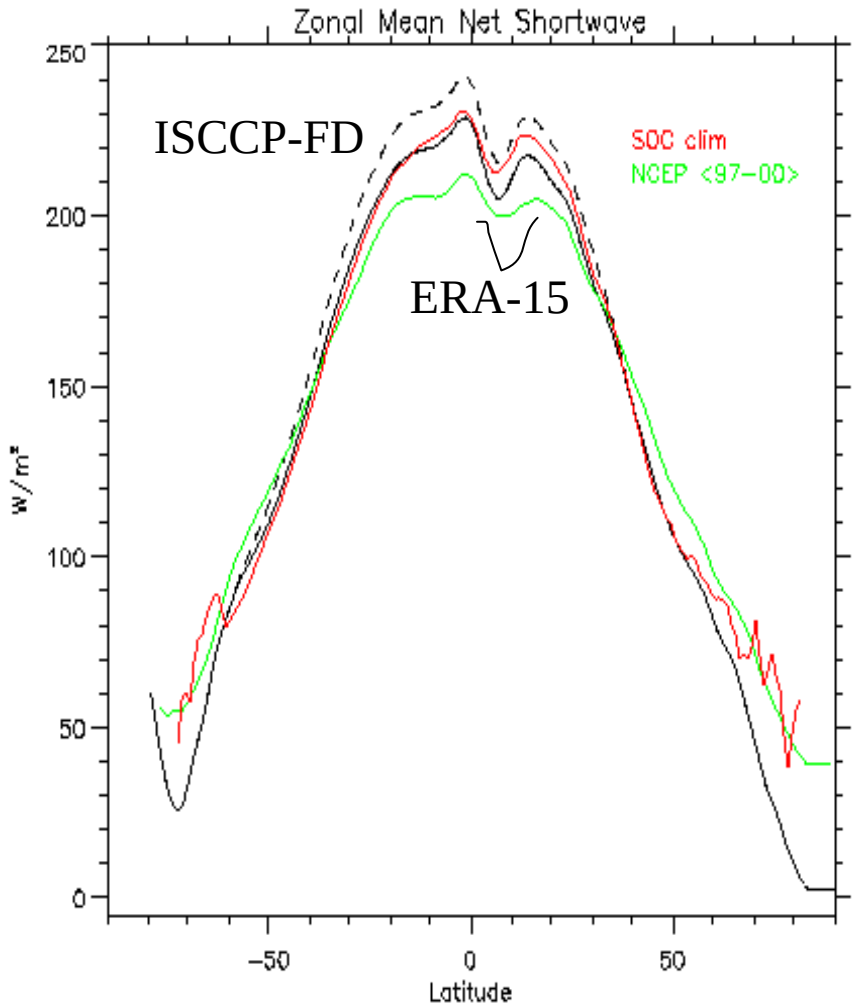

NCEP <γ>1984–2000 − SOC <γ>clim
50°N
EQ
50°S
0°
100°
200°
300°
contoured by 2%
10
5
0
−5
−10
NCEP − SOC (%)
−100
−50
0
50
100
Latitude

Corrections

	none	wind	humidity	All
Q_S	173			
Q_L	-52			
Q_E	-76	-84	-89	
Q_H	-13			
Q_{as}	31	23	18	
E	-30.5	-33.4	-35.6	
P	30.4			
R	3.5			
F_{as}	3.4	0.5	-1.7	

NWP Radiation and Precipitation



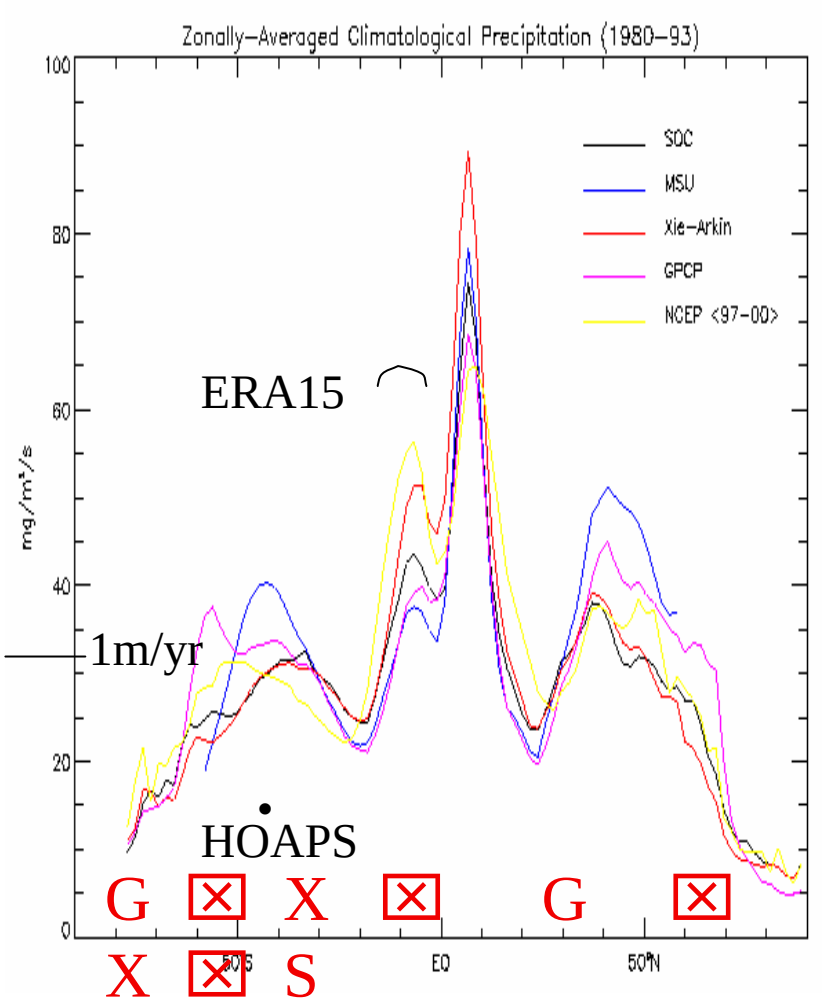


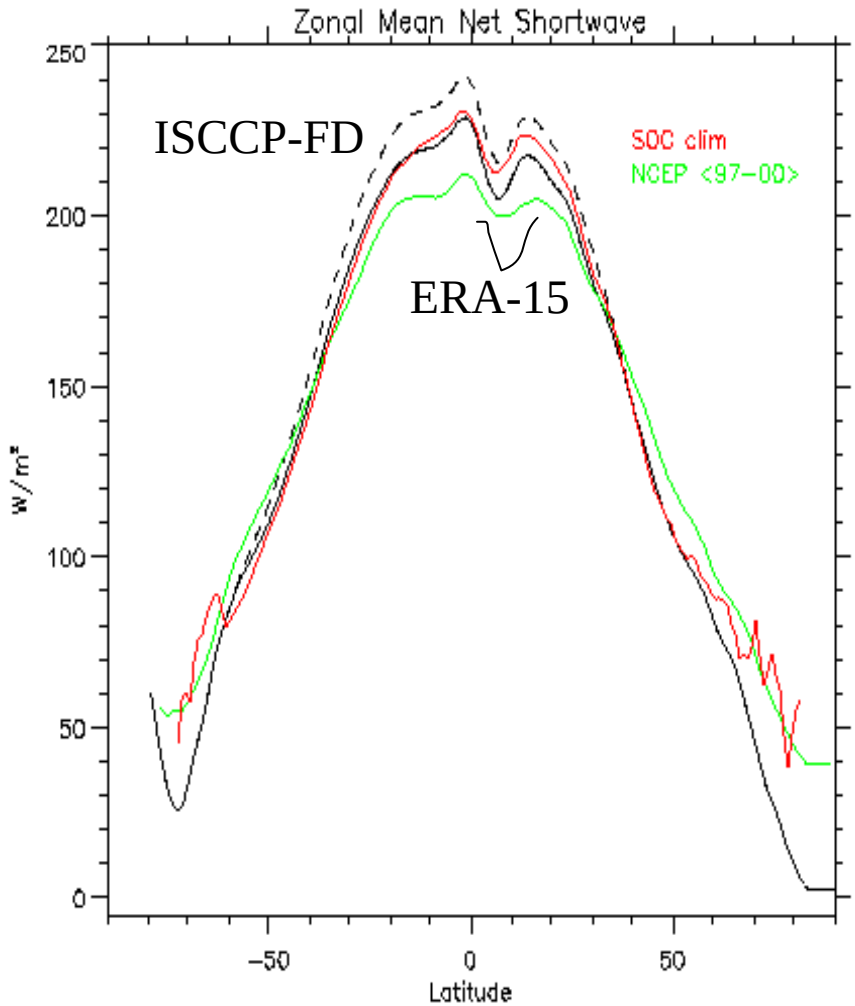
Refs: Beranger et al. 1999 ; WGASF (2000)

Corrections

	none	wind	humidity	All
Q_S	173			165
Q_L	-52			-52
Q_E	-76	-84	-89	-97
Q_H	-13			-14
Q_{as}	31	23	18	1
E	-30.5	-33.4	-35.6	
P	30.4			
R	3.5			
F_{as}	3.4	0.5	-1.7	

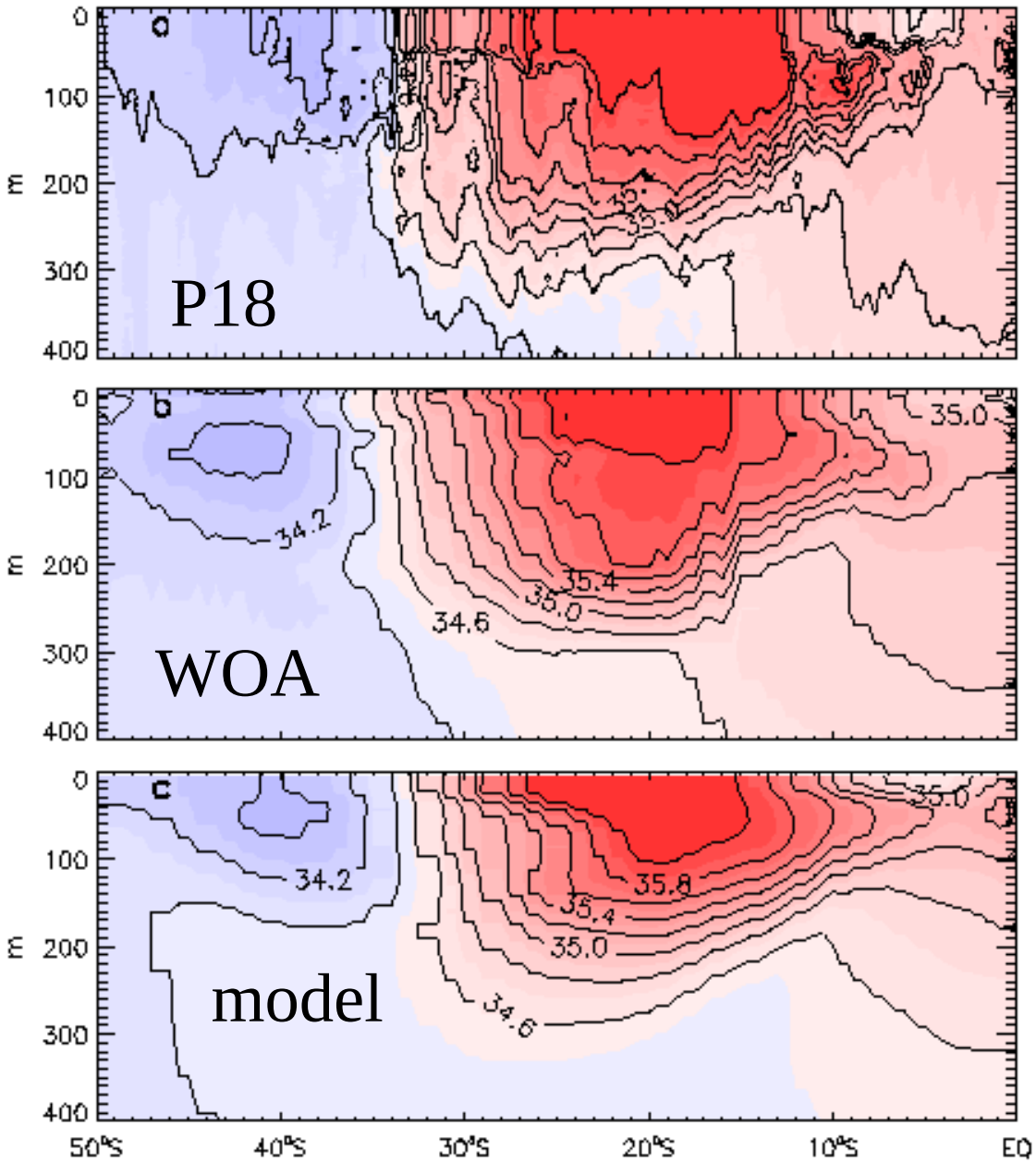
NWP Radiation and Precipitation





Refs: Beranger et al. 1999 ; WGASF (2000)

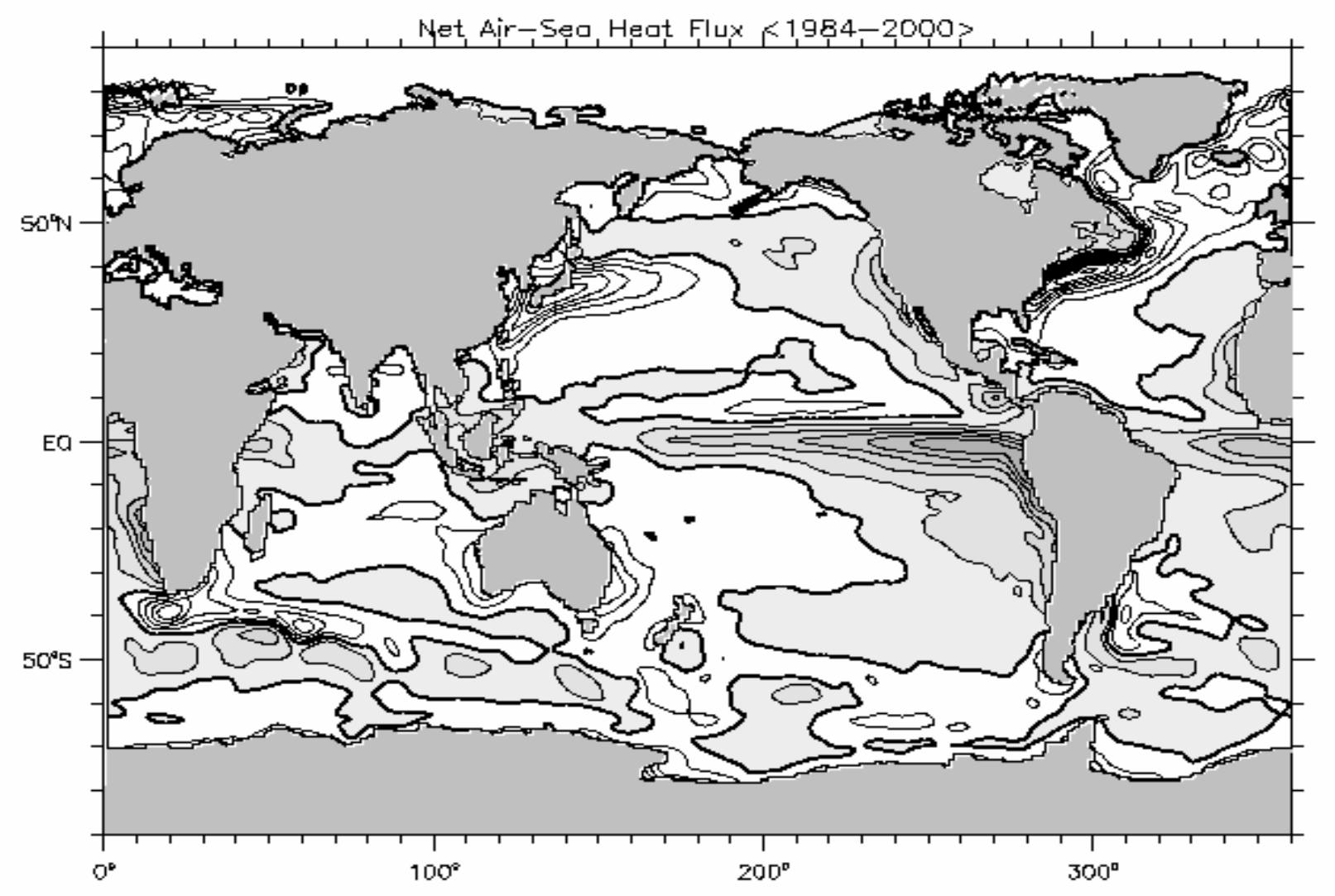
CMAP P gives March model salinity comparable to WOCE (P18) and WOA98



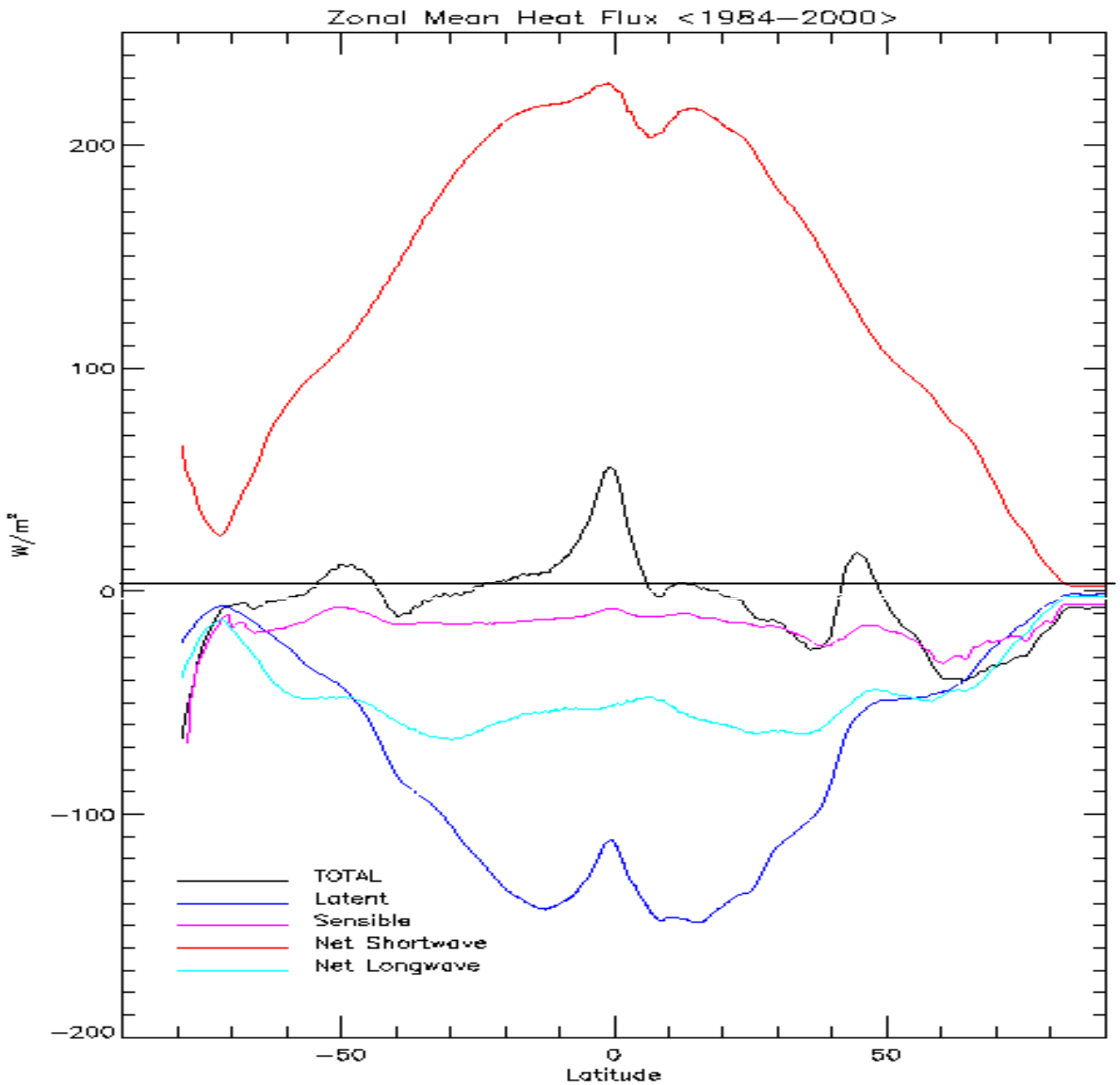
Corrections

	none	wind	humidity	All
Q_S	173			165
Q_L	-52			-52
Q_E	-76	-84	-89	-97
Q_H	-13			-14
Q_{as}	31	23	18	1
E	-30.5	-33.4	-35.6	-39.0
P	30.4			35.4
R	3.5			3.5
F_{as}	3.4	0.5	-1.7	-0.1

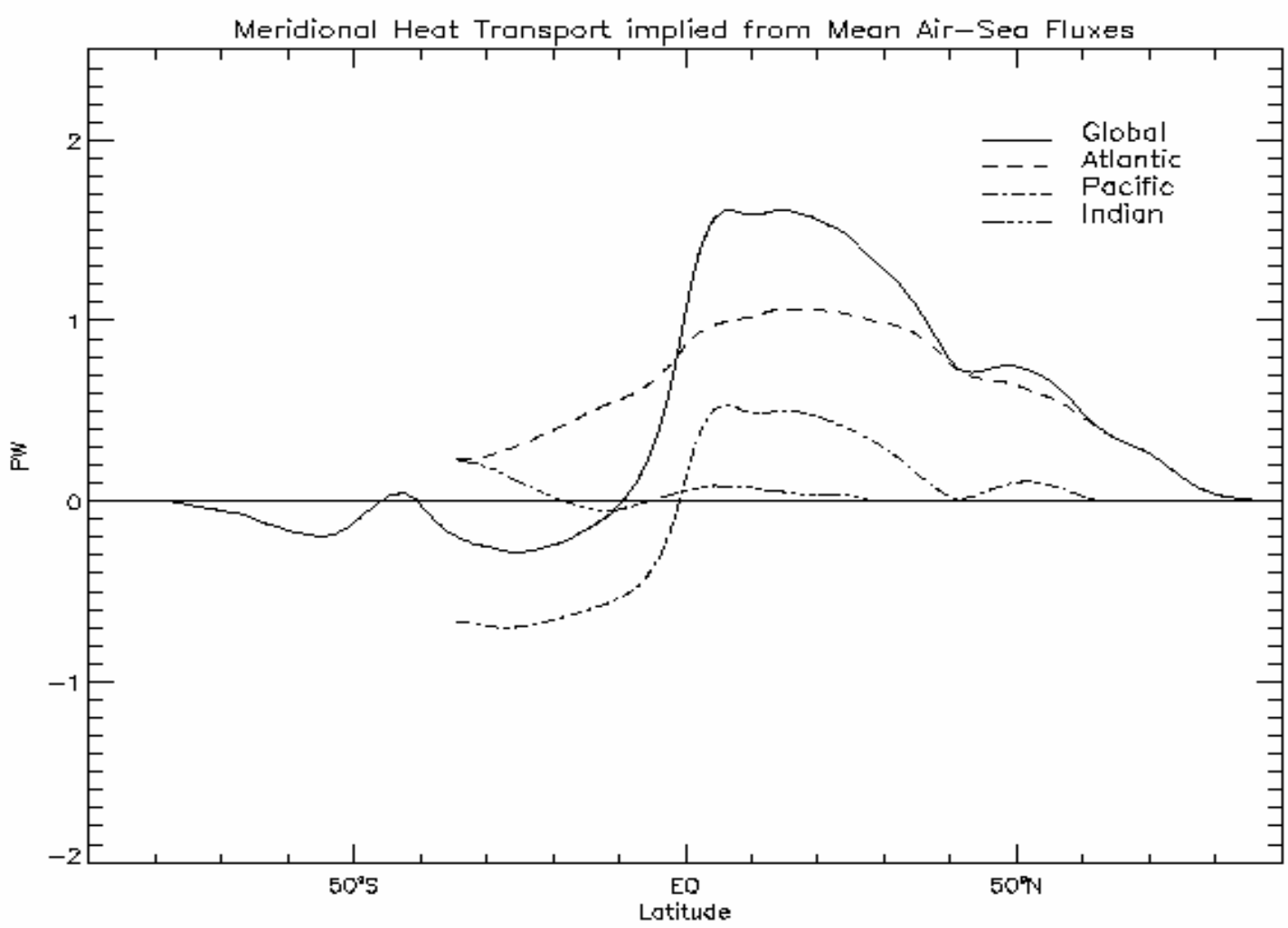
Q_{as}: ci = 25 W/m2



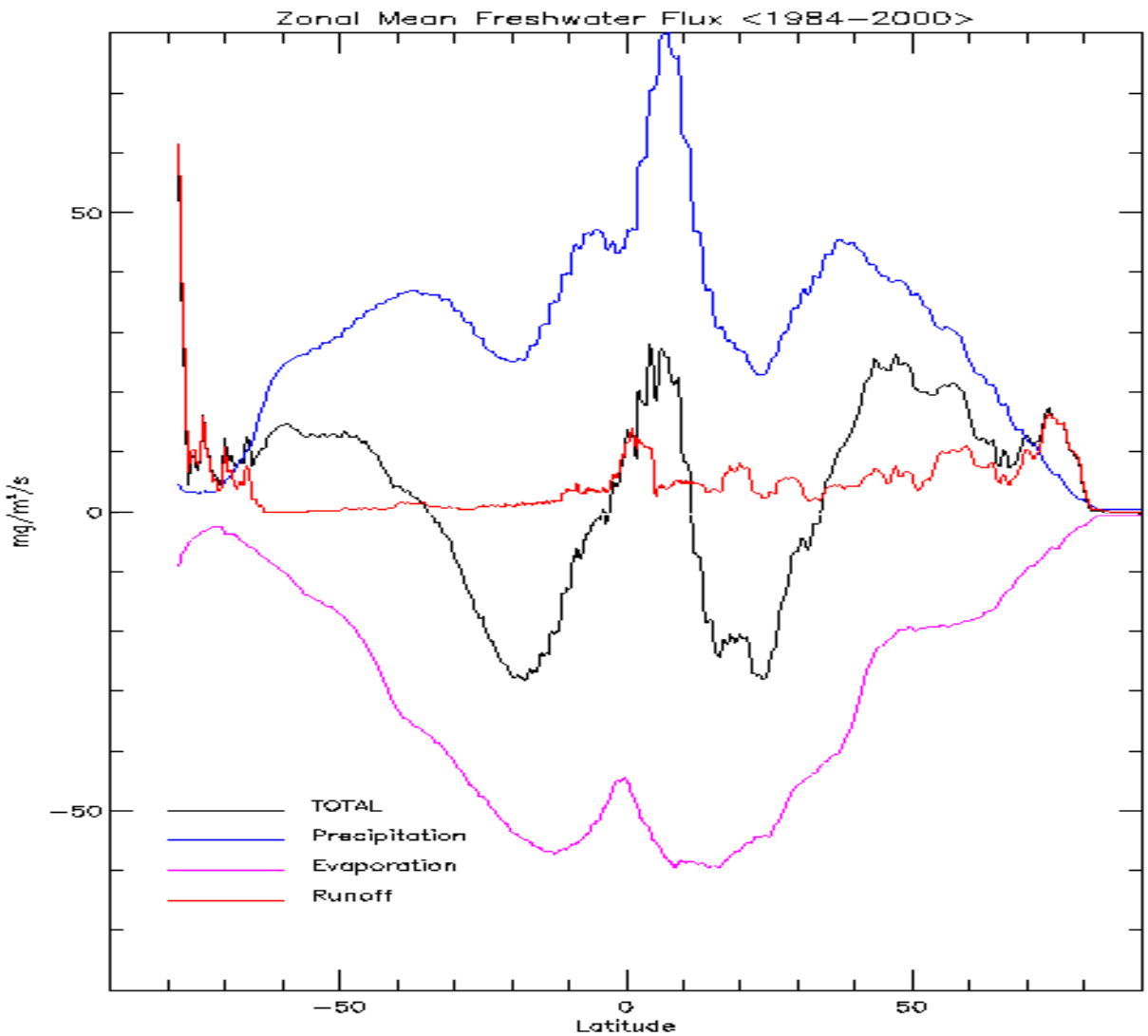
Q_{as}


Zonal Mean Heat Flux <1984—2000>
200
100
0
−100
−200
W/m²
−50
0
50
Latitude
TOTAL
Latent
Sensible
Net Shortwave
Net Longwave

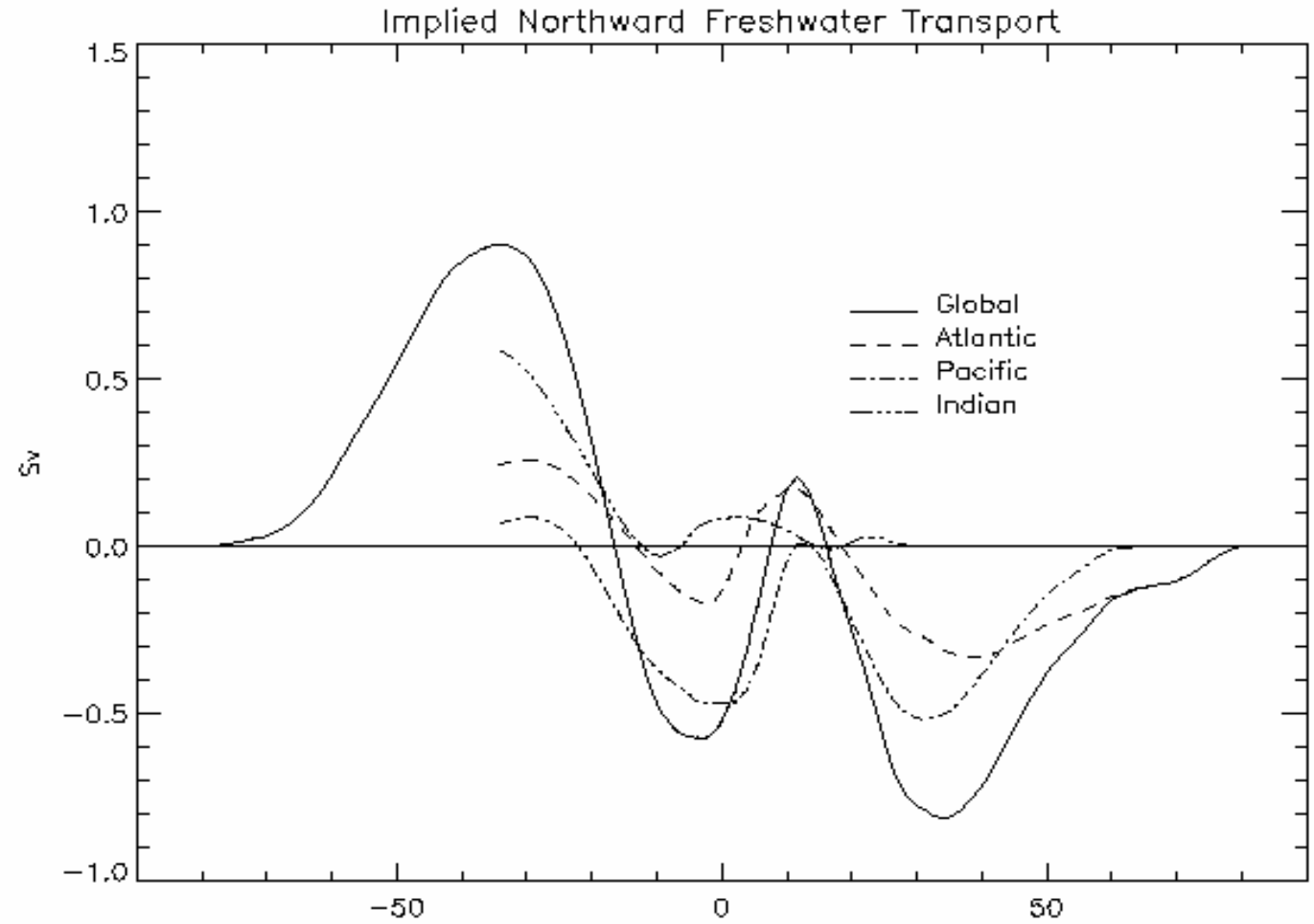
Northward Heat Transport (PW)



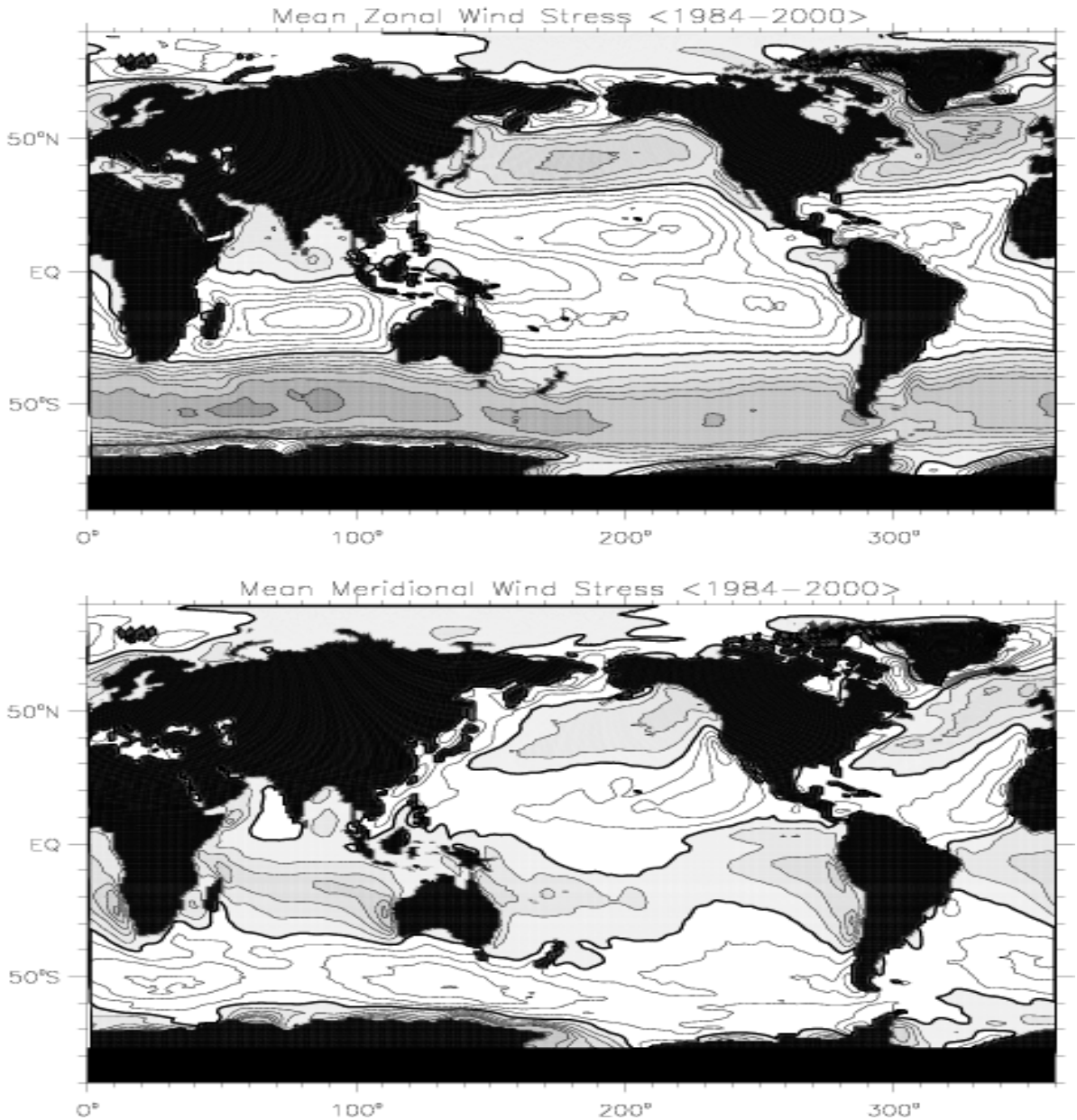
F


Zonal Mean Freshwater Flux <1984–2000>
50
0
−50
mg/m²/s
−50
0
50
Latitude
TOTAL
Precipitation
Evaporation
Runoff

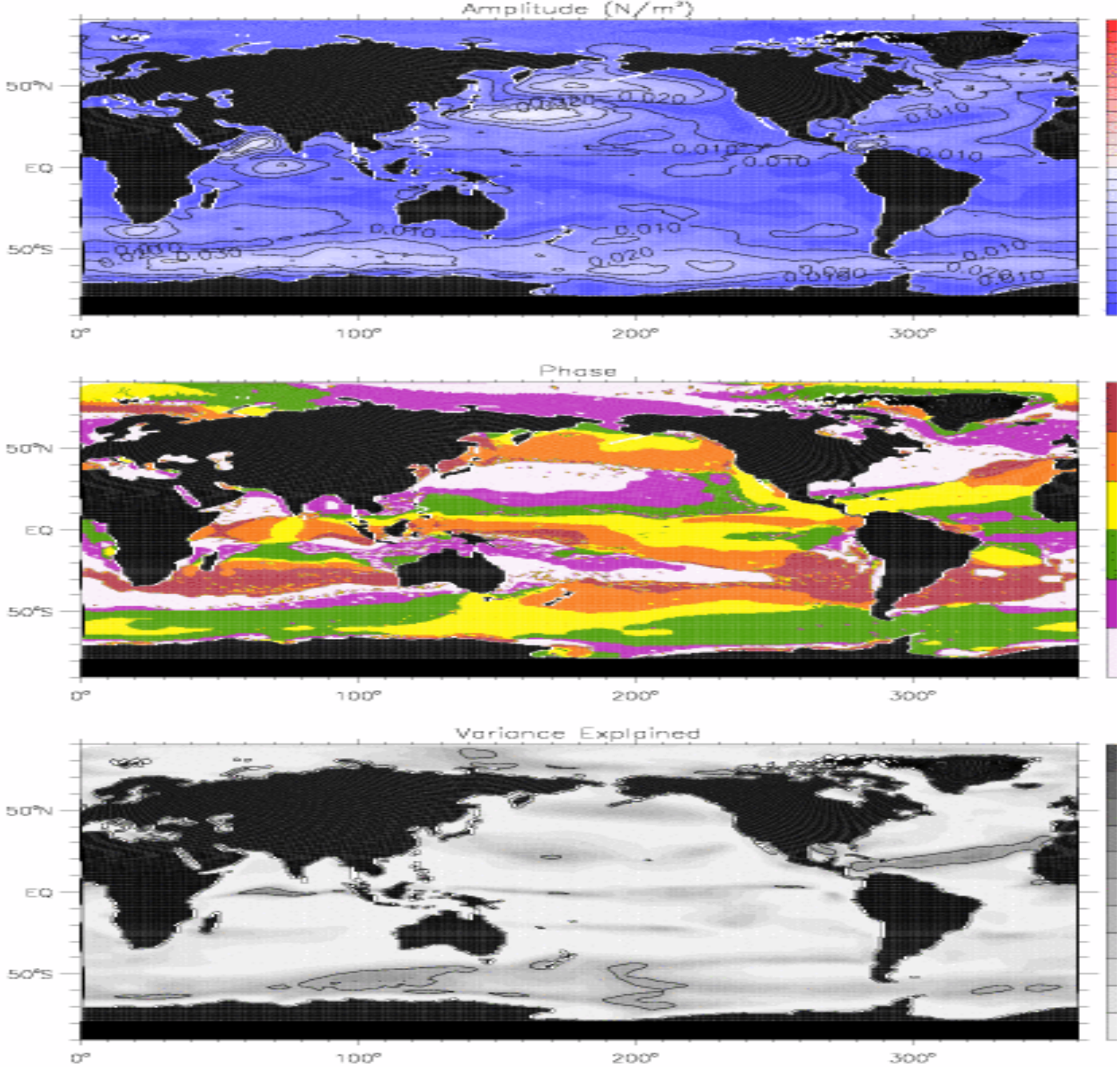
Northward Freshwater Flux (Sv)



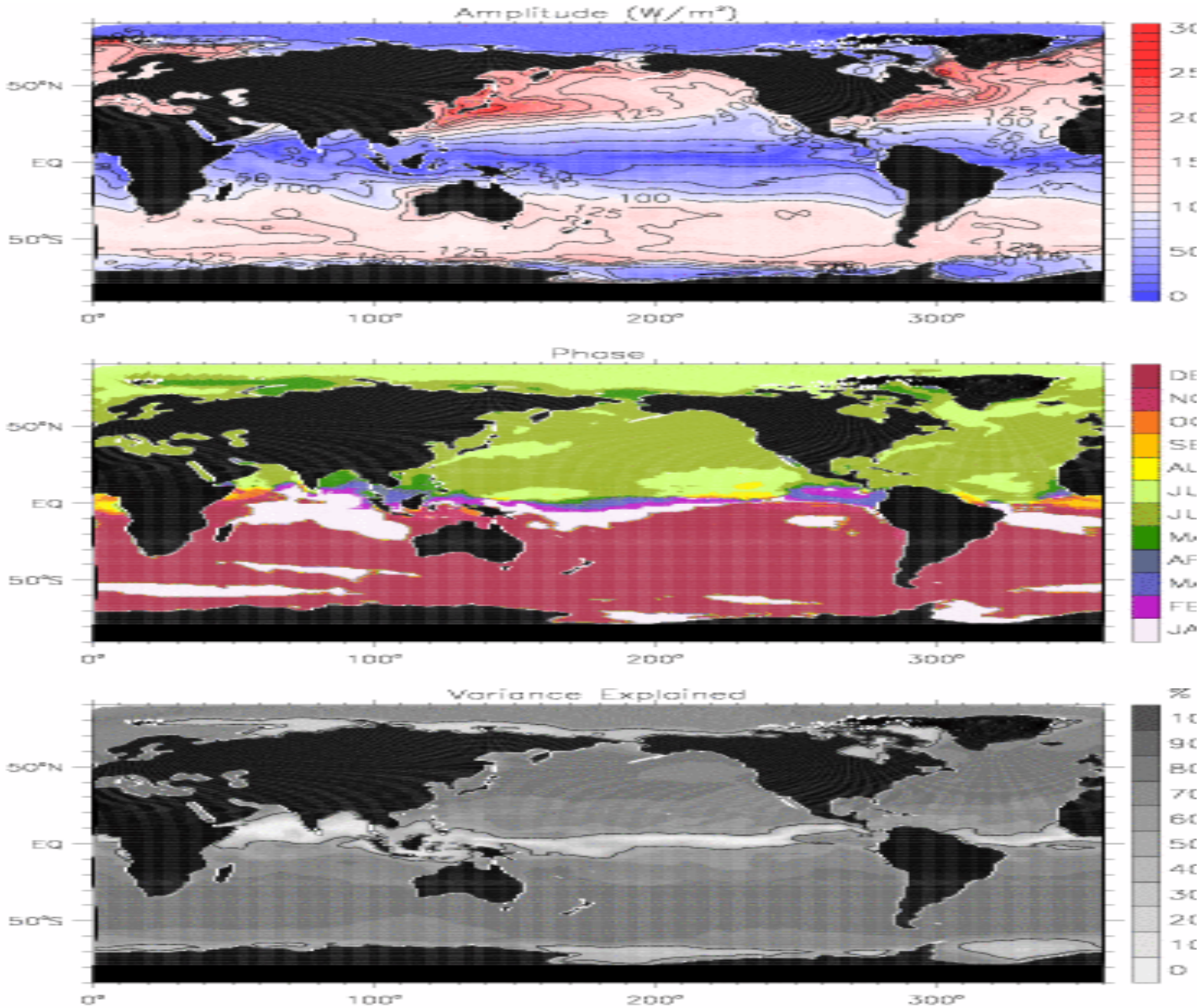
Stress


Mean Zonal Wind Stress <1984–2000>
50°N
EQ
50°S
0°
100°
200°
300°
Mean Meridional Wind Stress <1984–2000>
50°N
EQ
50°S
0°
100°
200°
300°

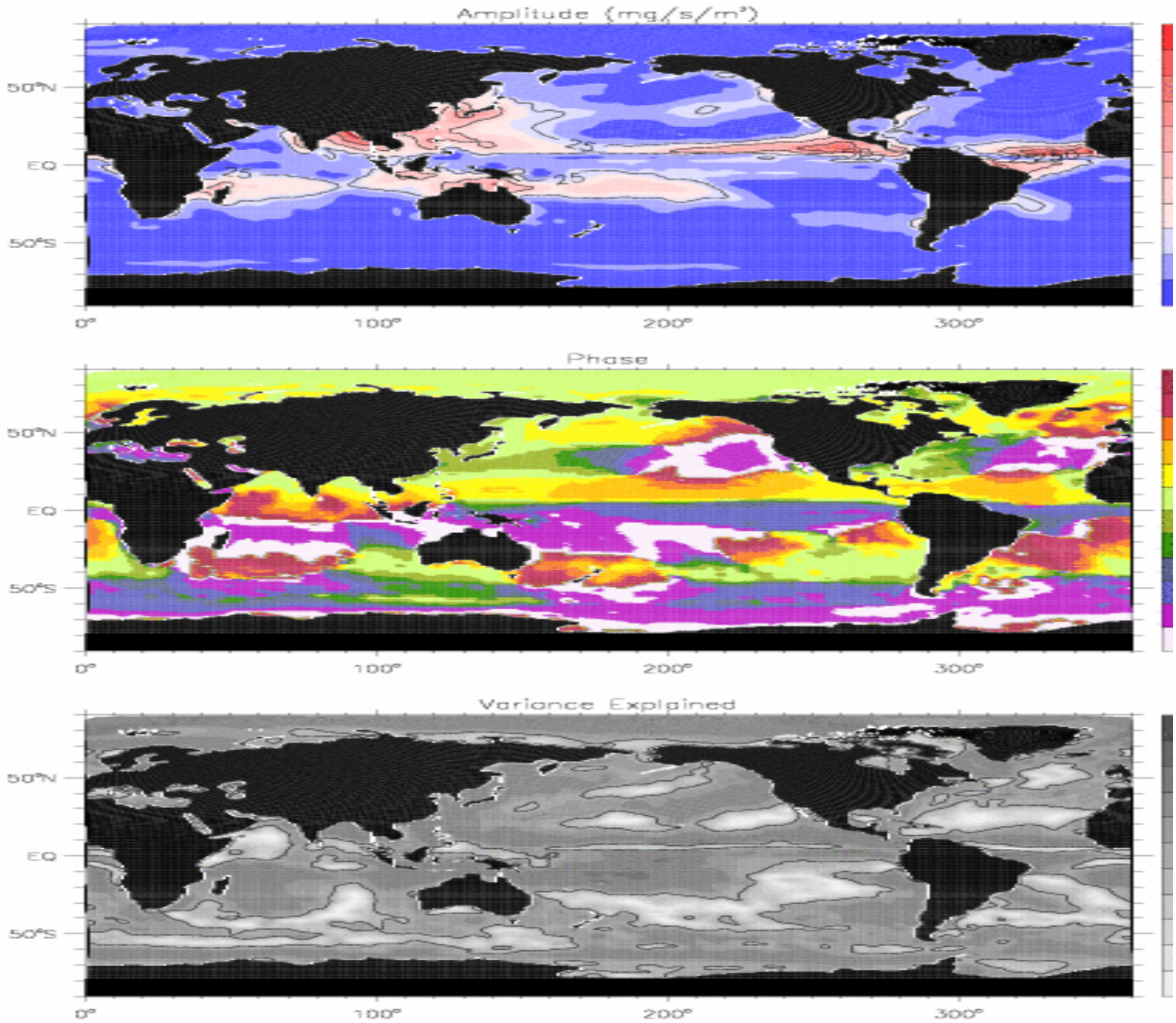
Stress


Amplitude (N/m²)
50°N
EQ
50°S
0°
100°
200°
300°
0.020
0.010
0.030
Phase
50°N
EQ
50°S
0°
100°
200°
300°
Variance Explained
50°N
EQ
50°S
0°
100°
200°
300°

Q

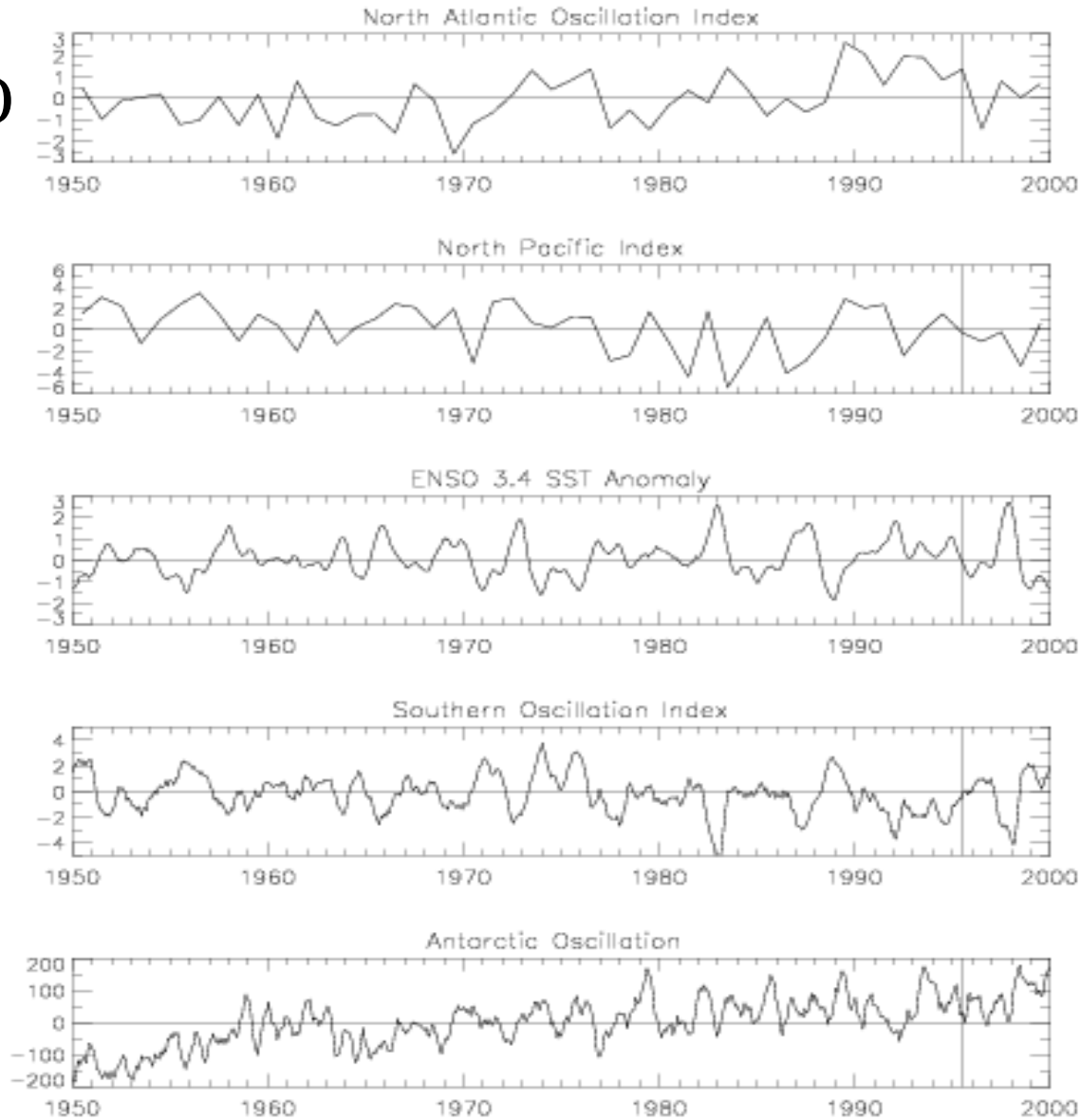

Amplitude (W/m²)
50°N
EQ
50°S
0°
100°
200°
300°
Phase
Variance Explained
%

F

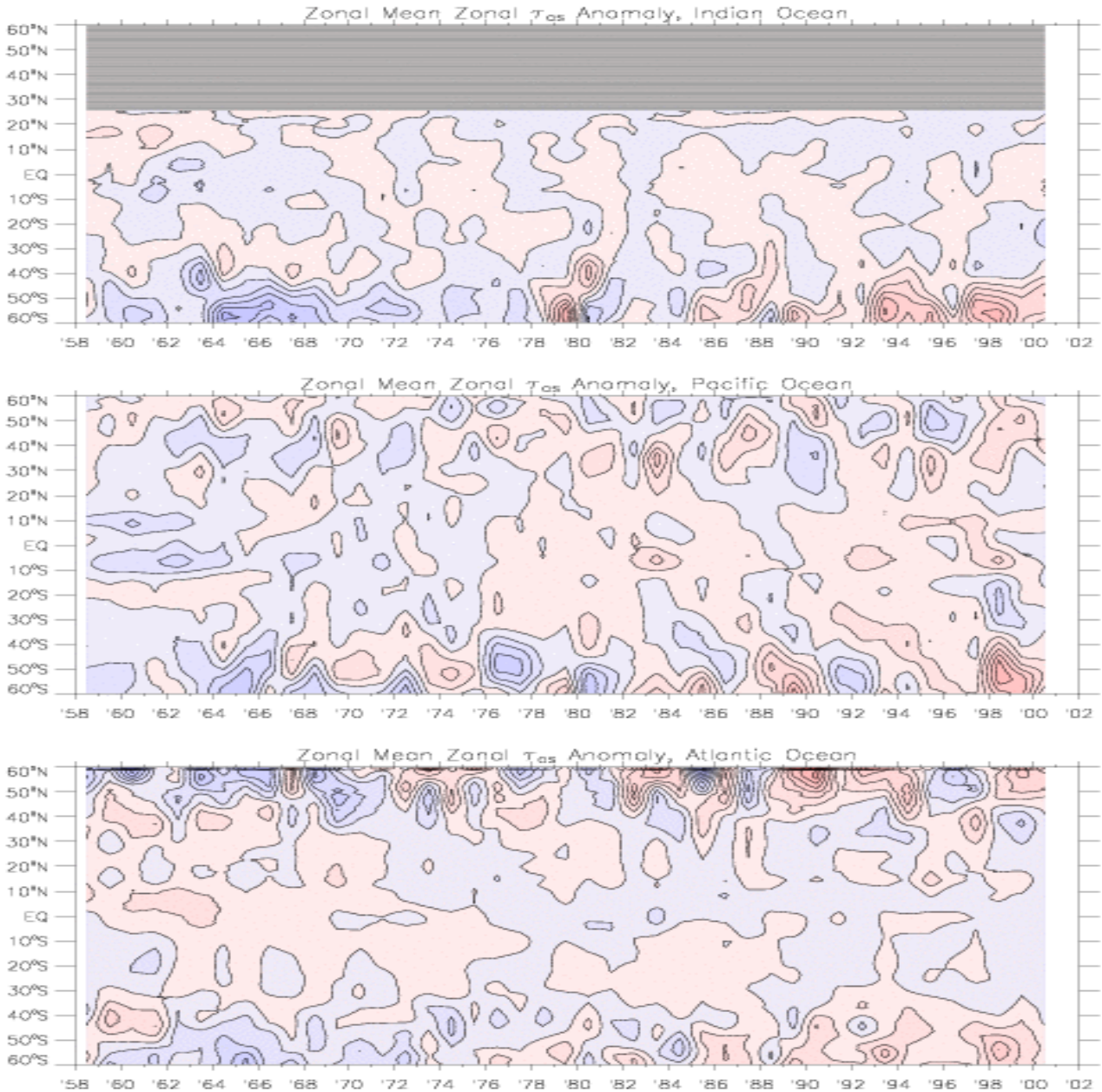

Amplitude (mg/s/m³)
50°N
EQ
50°S
0°
100°
200°
300°
25
Phase
50°N
EQ
50°S
0°
100°
200°
300°
Variance Explained
50°N
EQ
50°S
0°
100°
200°
300°

Indices

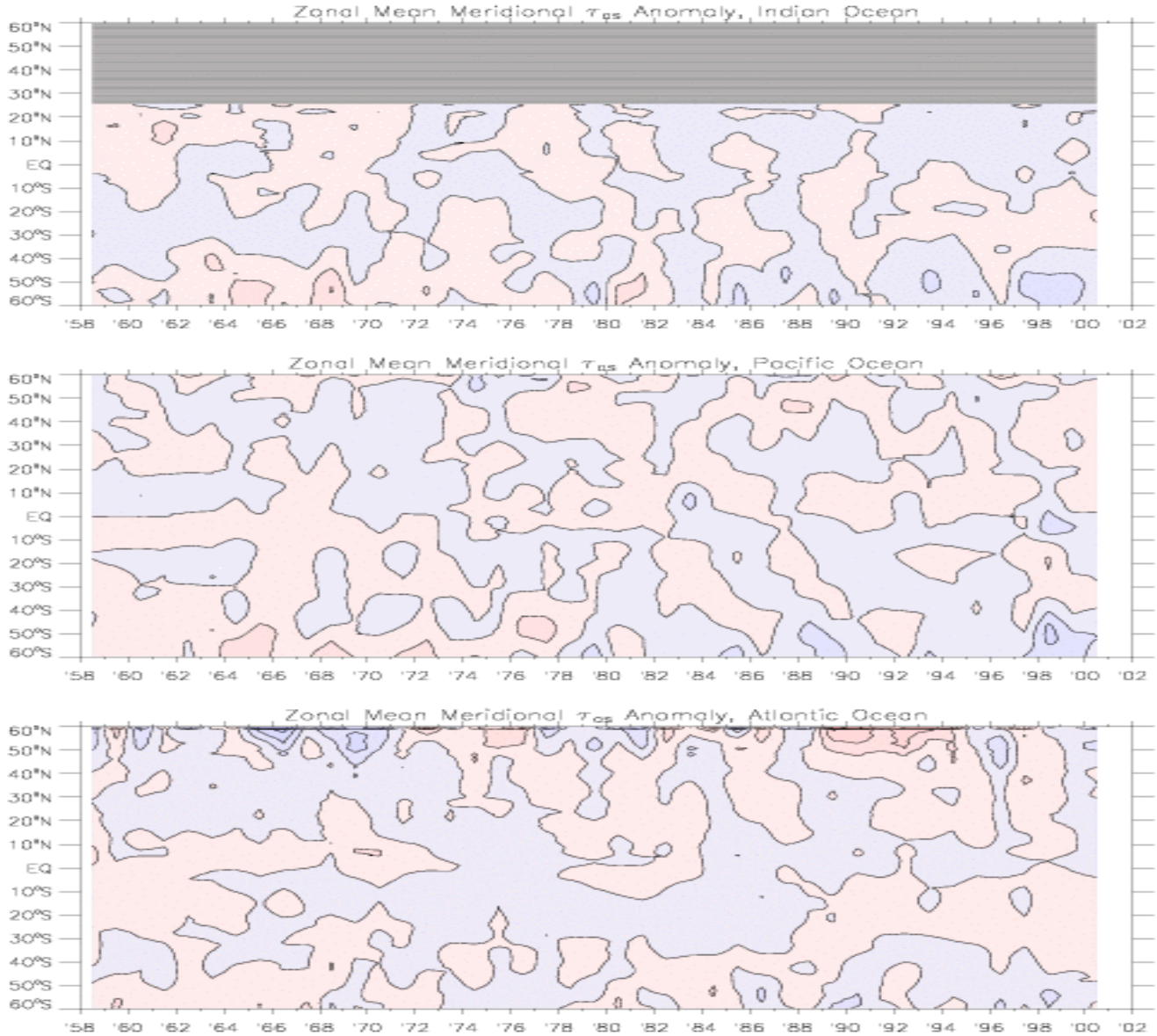
NAO


North Atlantic Oscillation Index
North Pacific Index
ENSO 3.4 SST Anomaly
Southern Oscillation Index
Antarctic Oscillation
1950
1960
1970
1980
1990
2000

τ_λ

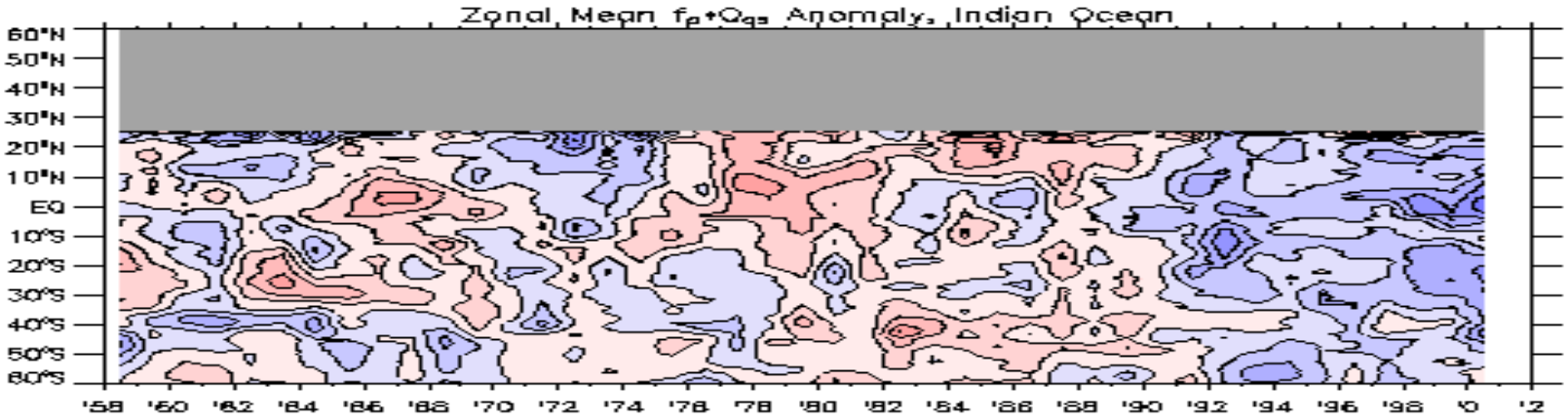

Zonal Mean Zonal τ_{os} Anomaly, Indian Ocean
Zonal Mean Zonal τ_{os} Anomaly, Pacific Ocean
Zonal Mean Zonal τ_{os} Anomaly, Atlantic Ocean
60°N
50°N
40°N
30°N
20°N
10°N
EQ
10°S
20°S
30°S
40°S
50°S
60°S
'58 '60 '62 '64 '66 '68 '70 '72 '74 '76 '78 '80 '82 '84 '86 '88 '90 '92 '94 '96 '98 '00 '02

τ_ϕ

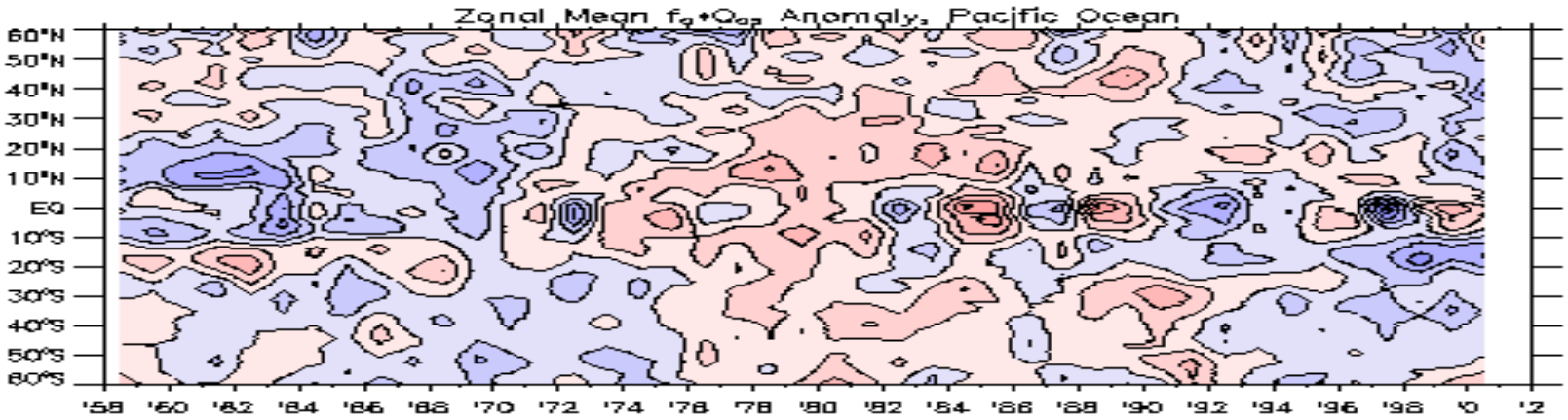

Zonal Mean Meridional $\tau_{\phi s}$ Anomaly, Indian Ocean
Zonal Mean Meridional $\tau_{\phi s}$ Anomaly, Pacific Ocean
Zonal Mean Meridional $\tau_{\phi s}$ Anomaly, Atlantic Ocean
60°N
50°N
40°N
30°N
20°N
10°N
EQ
10°S
20°S
30°S
40°S
50°S
60°S
'58 '60 '62 '64 '66 '68 '70 '72 '74 '76 '78 '80 '82 '84 '86 '88 '90 '92 '94 '96 '98 '00 '02

Q

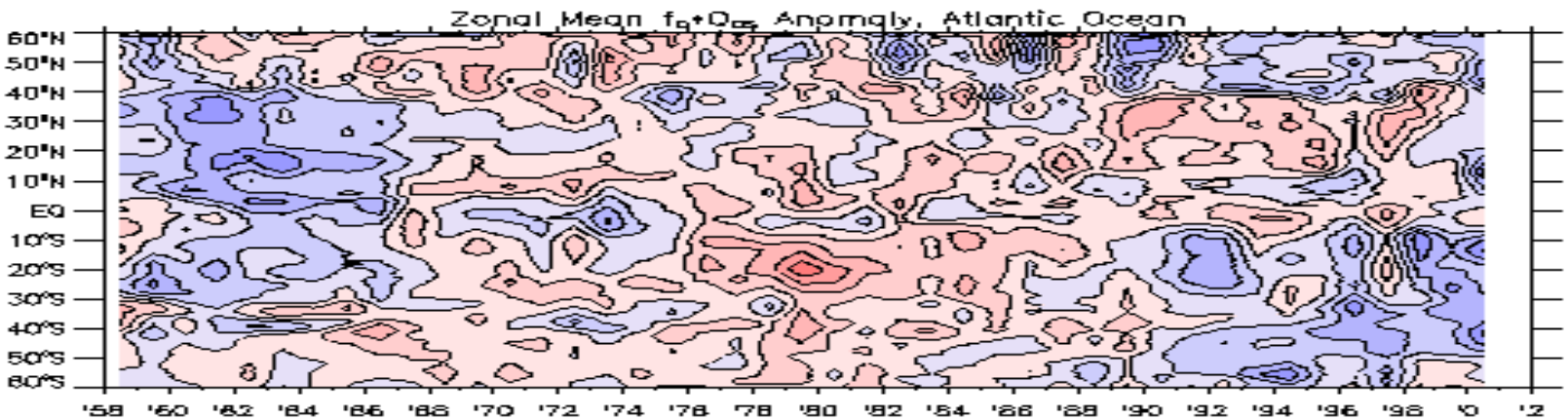
Indian



Pacific

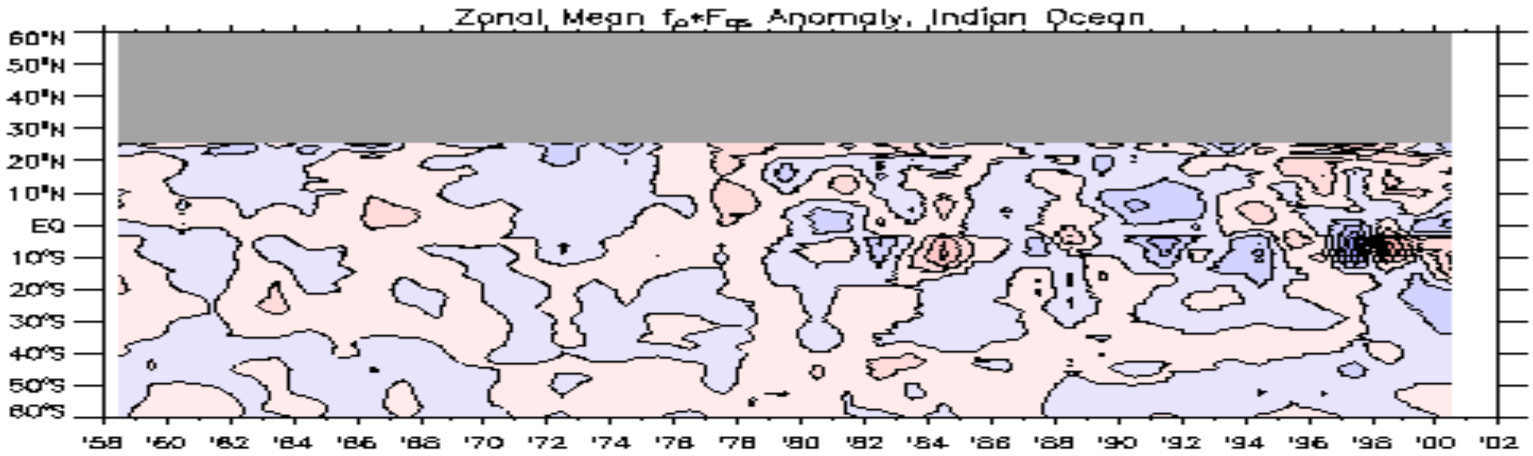


Atlantic

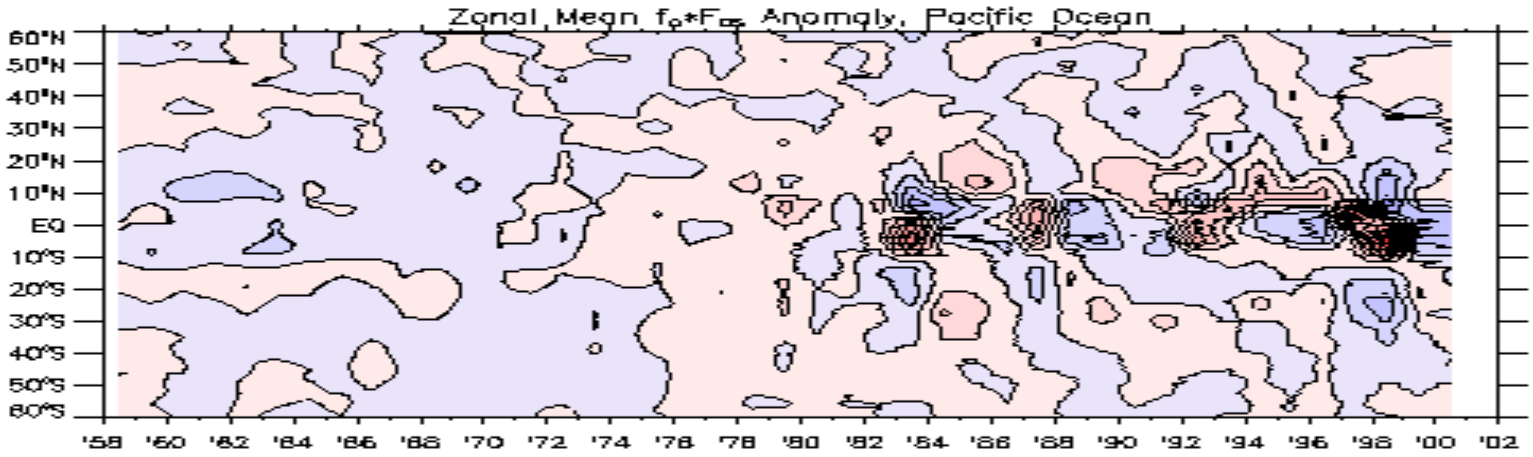


F

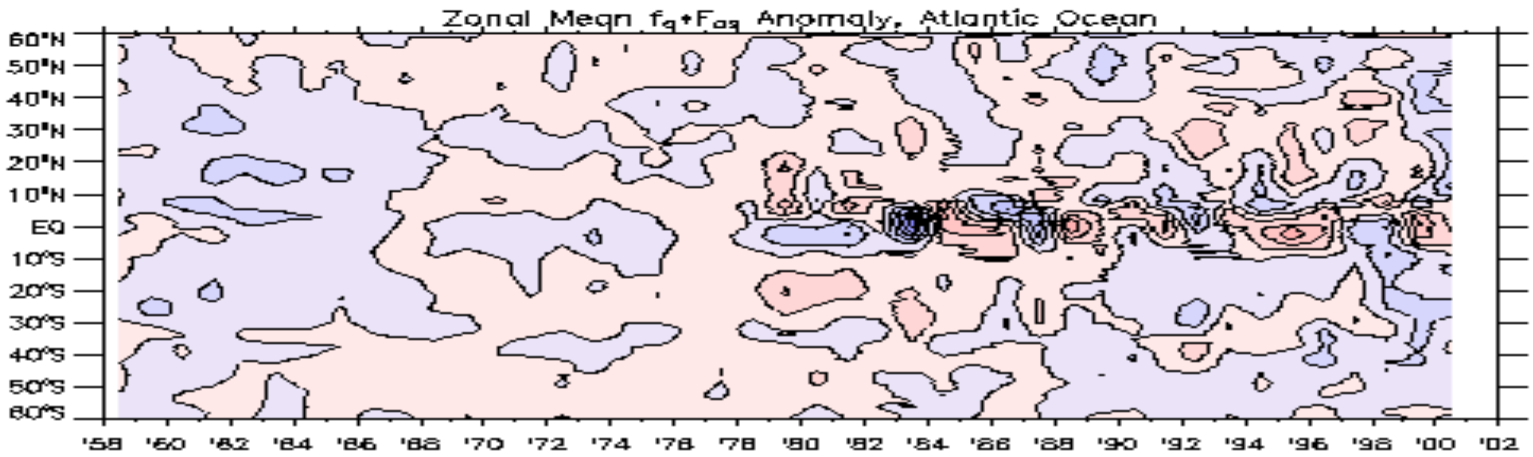
Indian



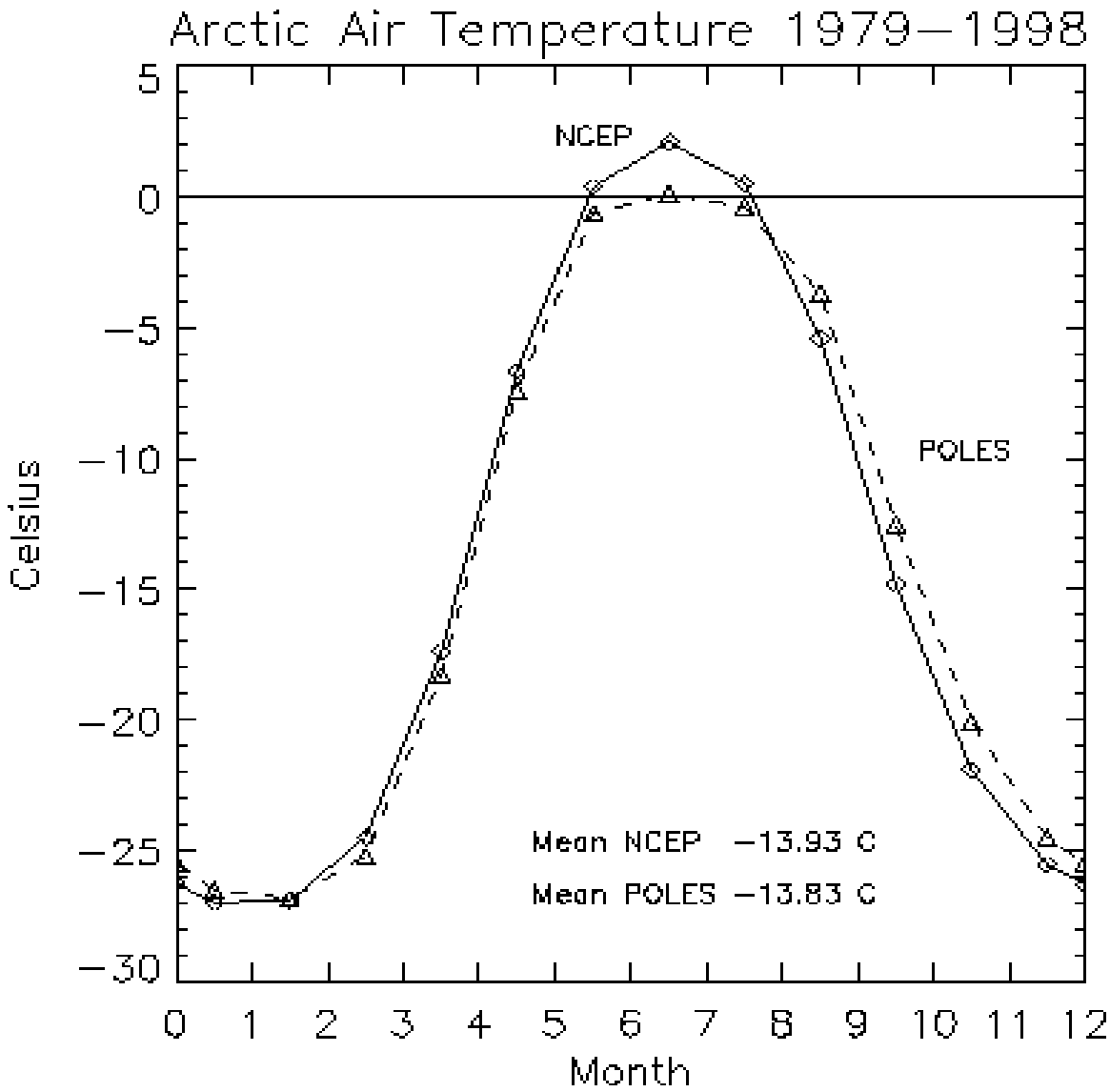
Pacific



Atlantic



Tair


Arctic Air Temperature 1979–1998
NCEP
POLES
Mean NCEP −13.93 C
Mean POLES −13.83 C
Celsius
Month
5
0
−5
−10
−15
−20
−25
−30
0 1 2 3 4 5 6 7 8 9 10 11 12