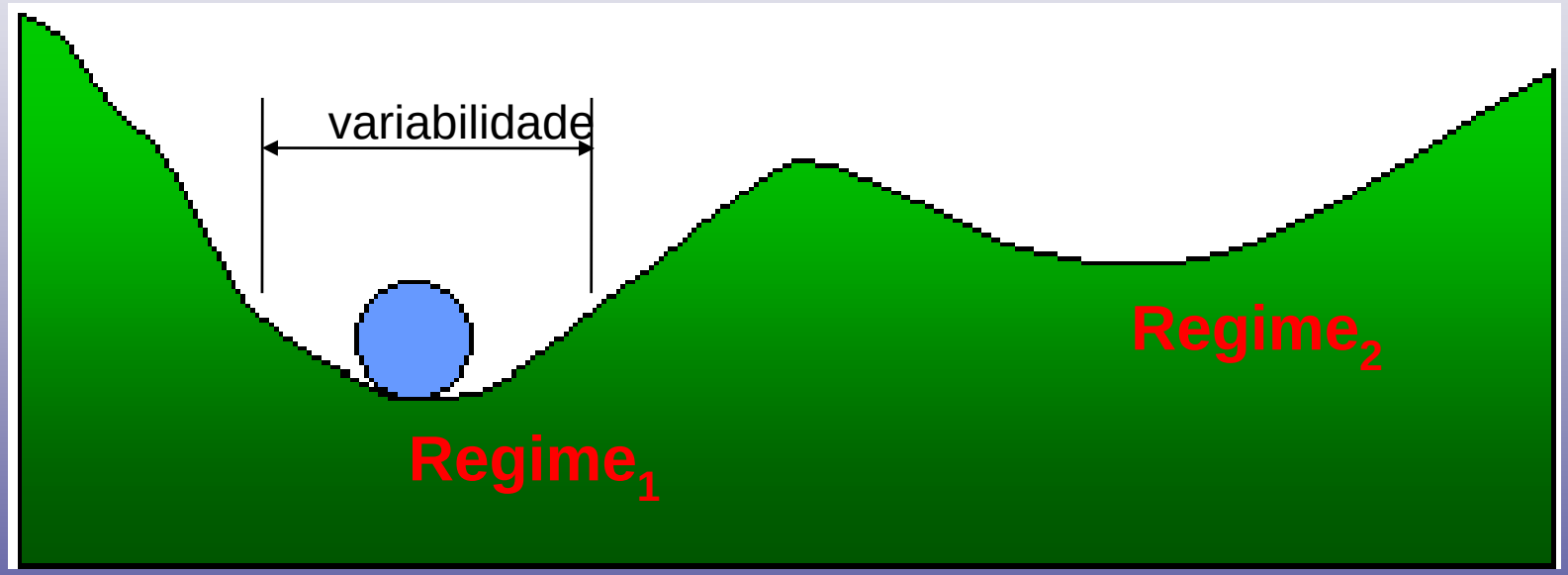
Modelo Brasileiro do Sistema Climático Global - MBSCG

Paulo Nobre

Workshop MBSCG-Modelagem de Superfície

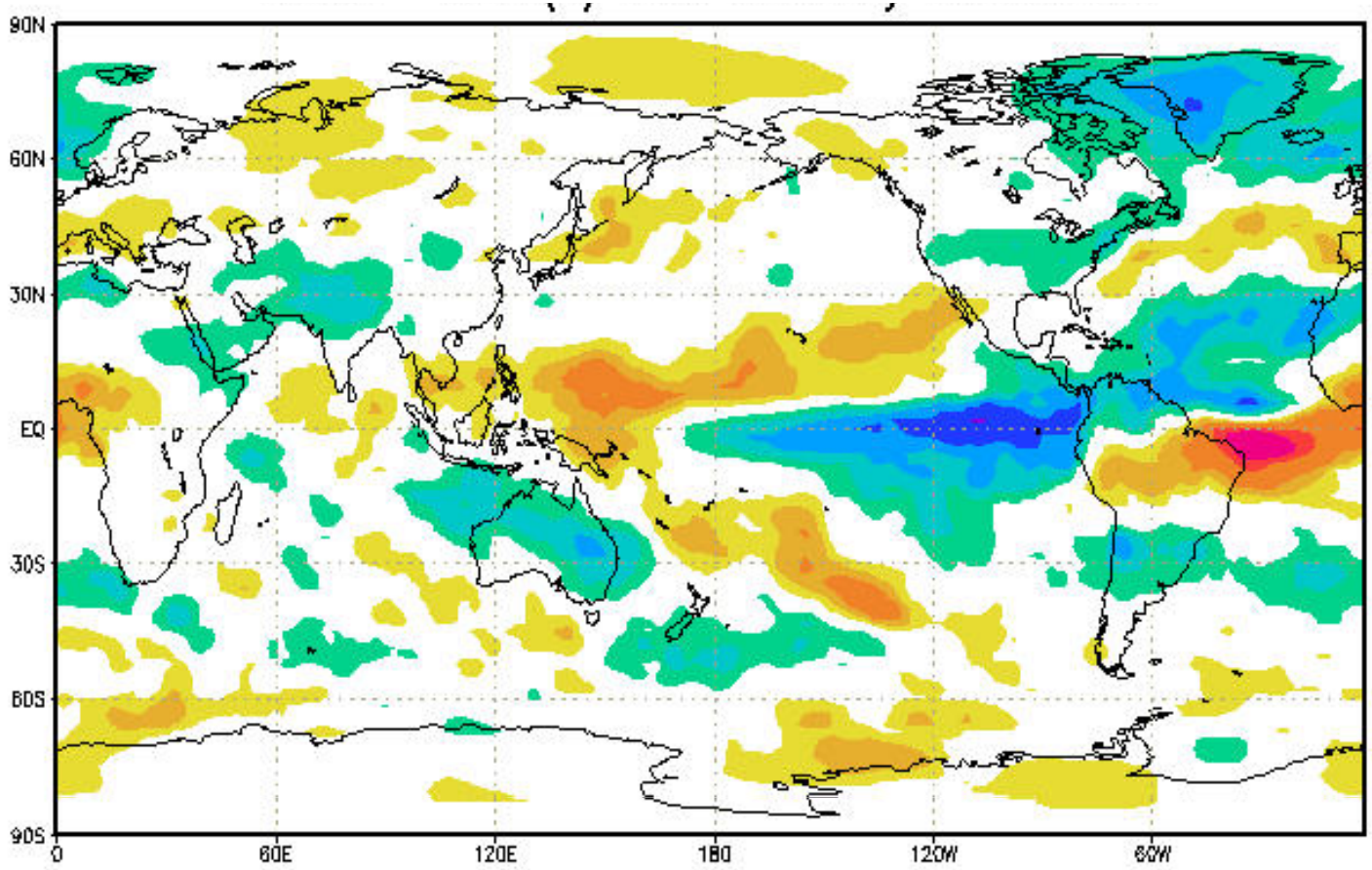
Cachoeira Paulista, 27 de julho de 2009

Variabilidade Climática
X
Mudança Climática



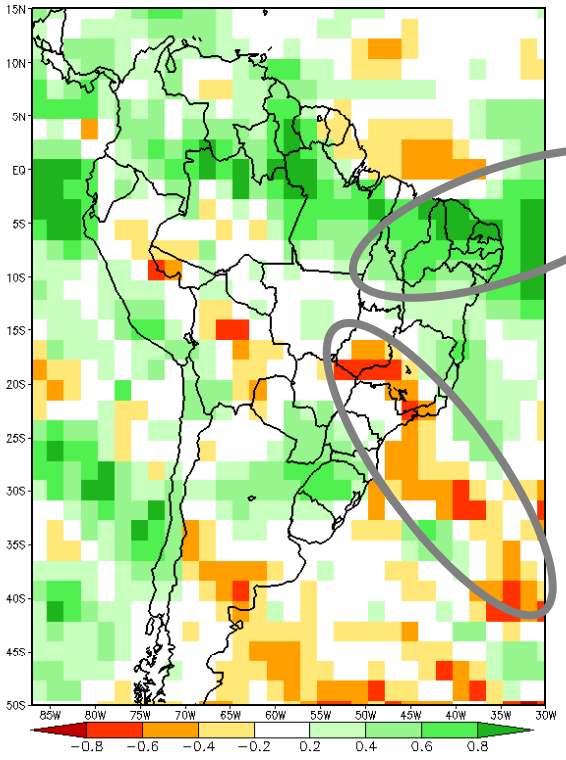
$T_1 < T_2$

ATLANTIC ITCZ POSITION AND OLR ANOMALY CORRELATION

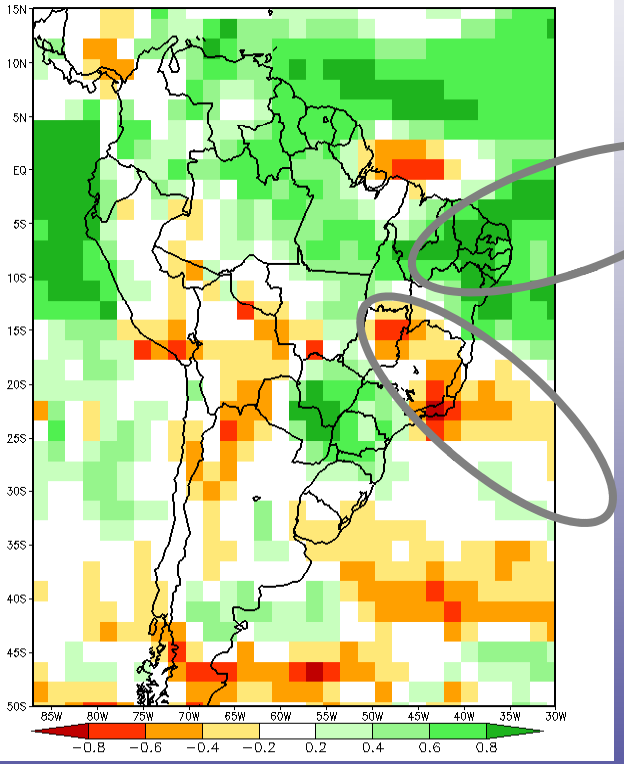


Scientific Challenge: SACZ 2-tier low predictability

DJF



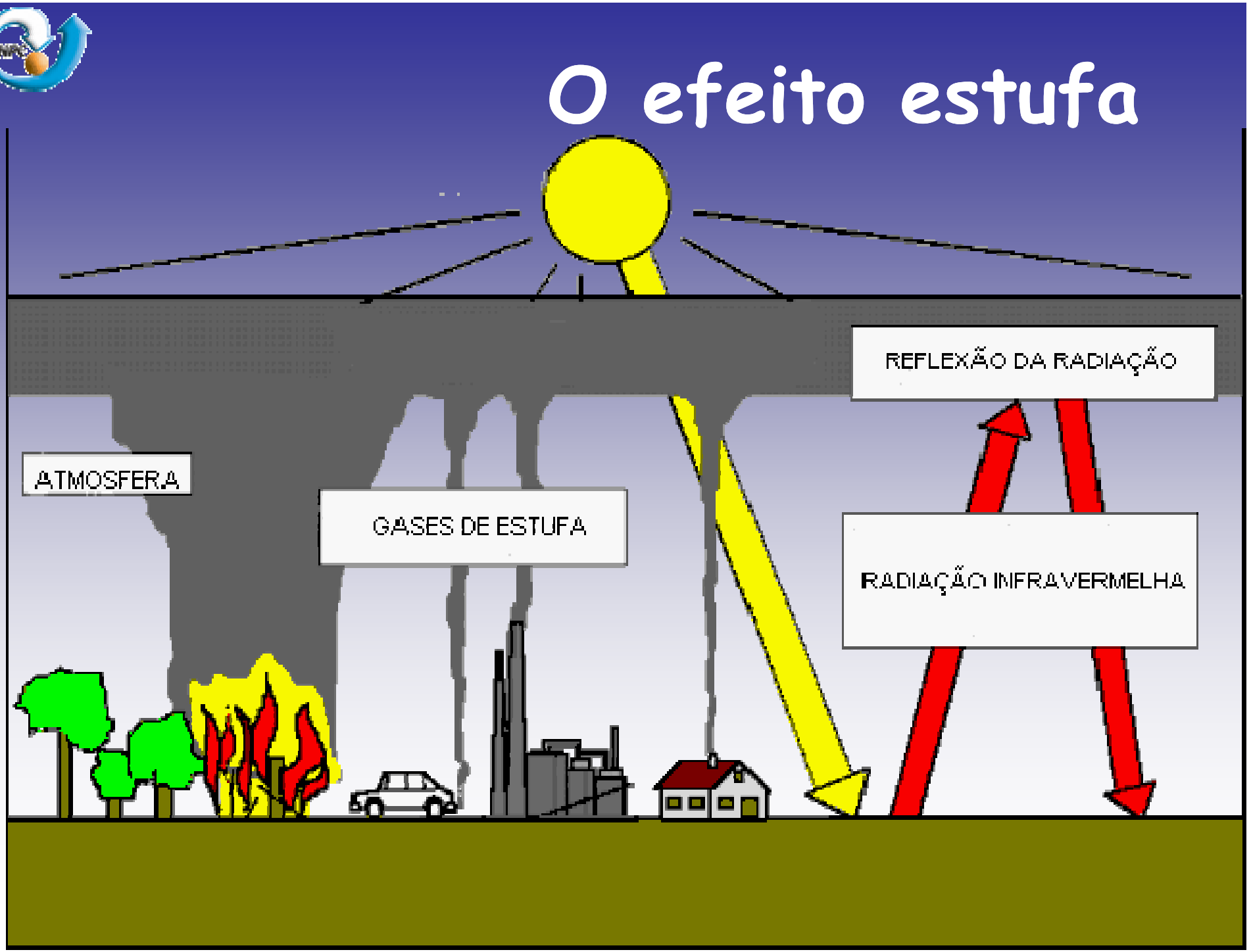
MAM



CPTEC AGCM, 50 years, 10 Member Ensemble, Kuo, T062L28, Obs SST

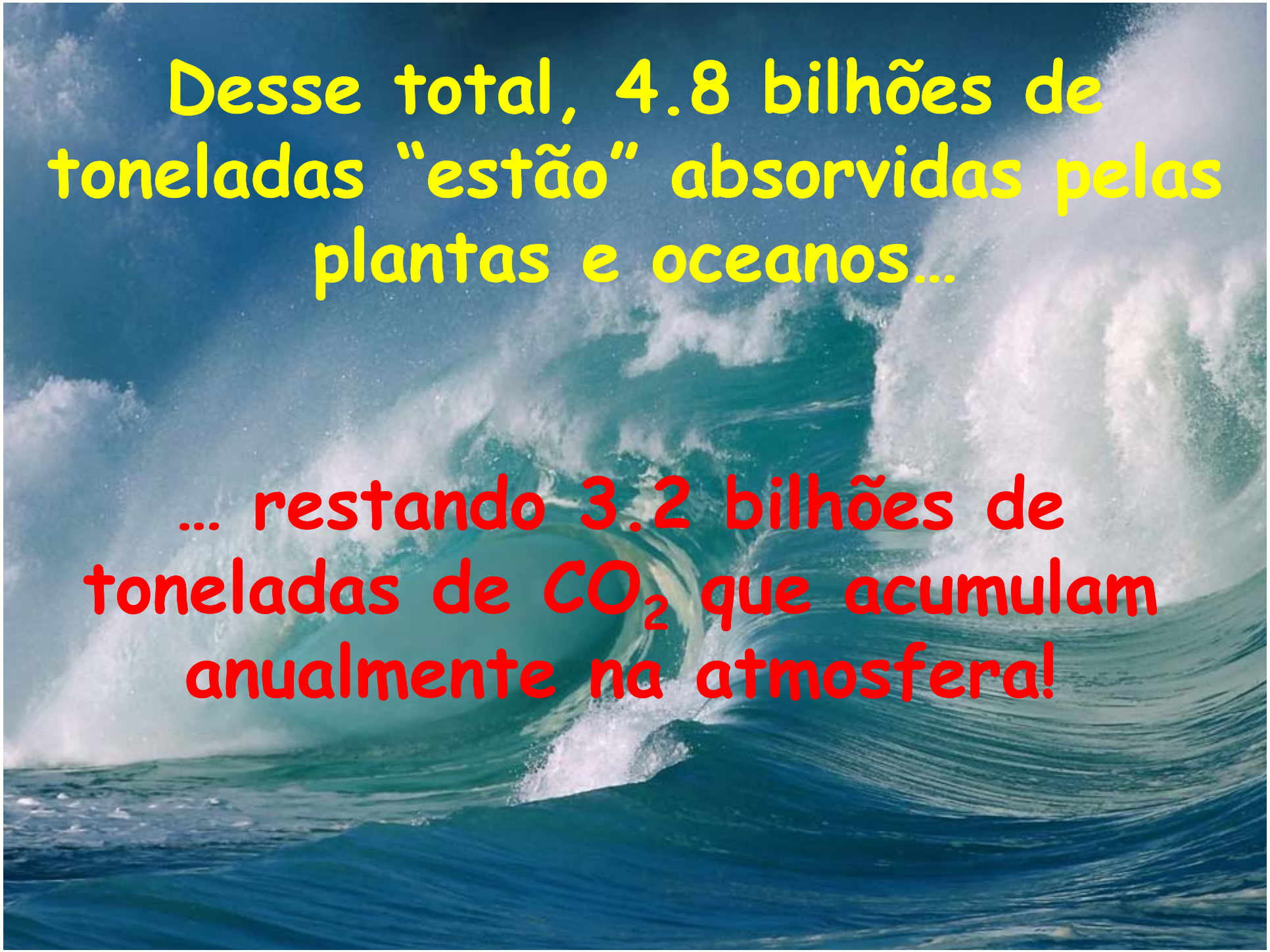
Marengo et al (2002)

O efeito estufa

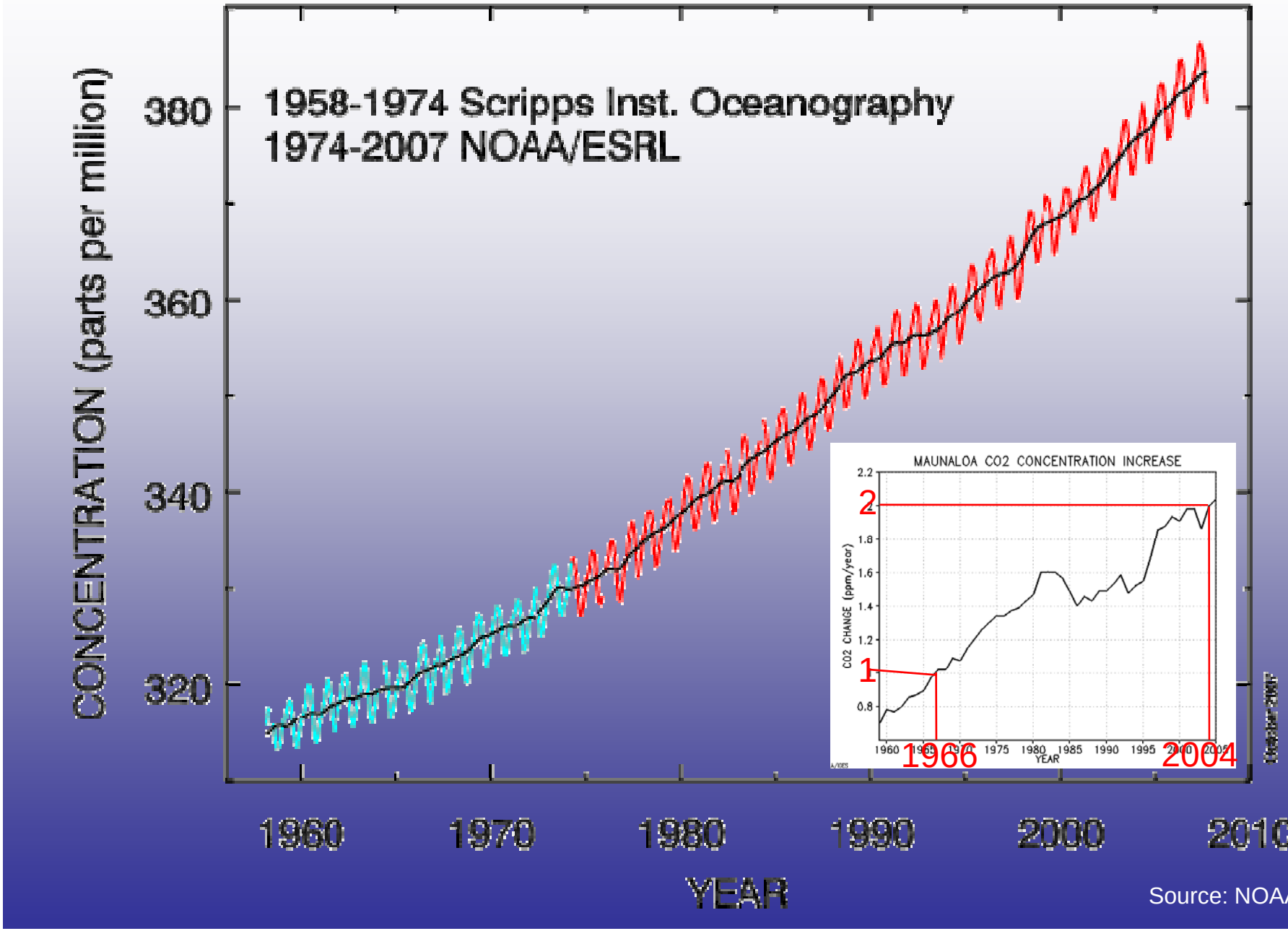


Anualmente adicionamos 8 bilhões de toneladas de CO_2 na atmosfera…

…resultado da queima de combustiveis fósseis, restos de plantações & florestas e derrubada de florestas.

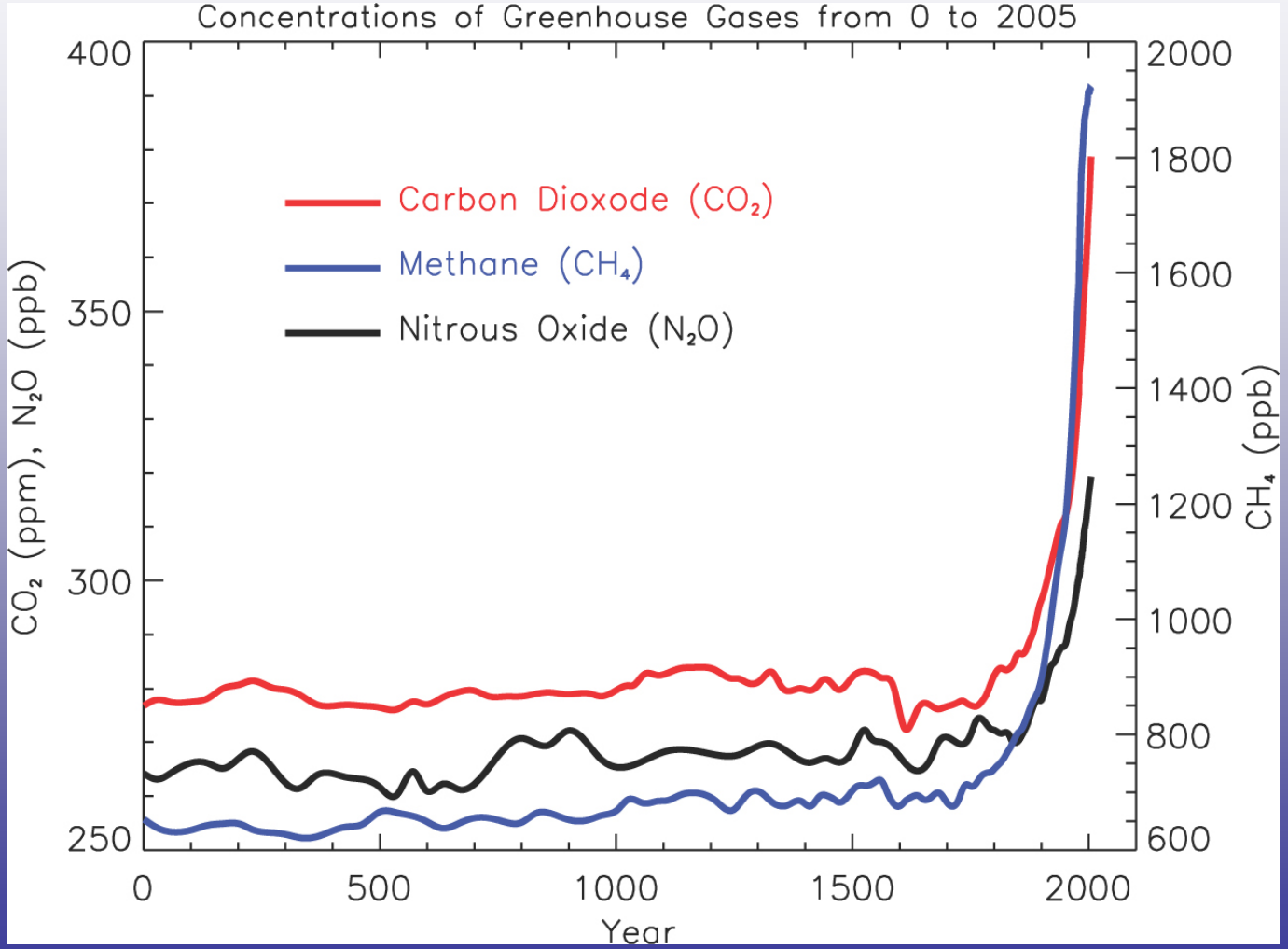

Desse total, 4.8 bilhões de toneladas "estão" absorvidas pelas plantas e oceanos...
... restando 3.2 bilhões de toneladas de CO_2 que acumulam anualmente na atmosfera!

Atmospheric CO_2 at Mauna Loa Observatory



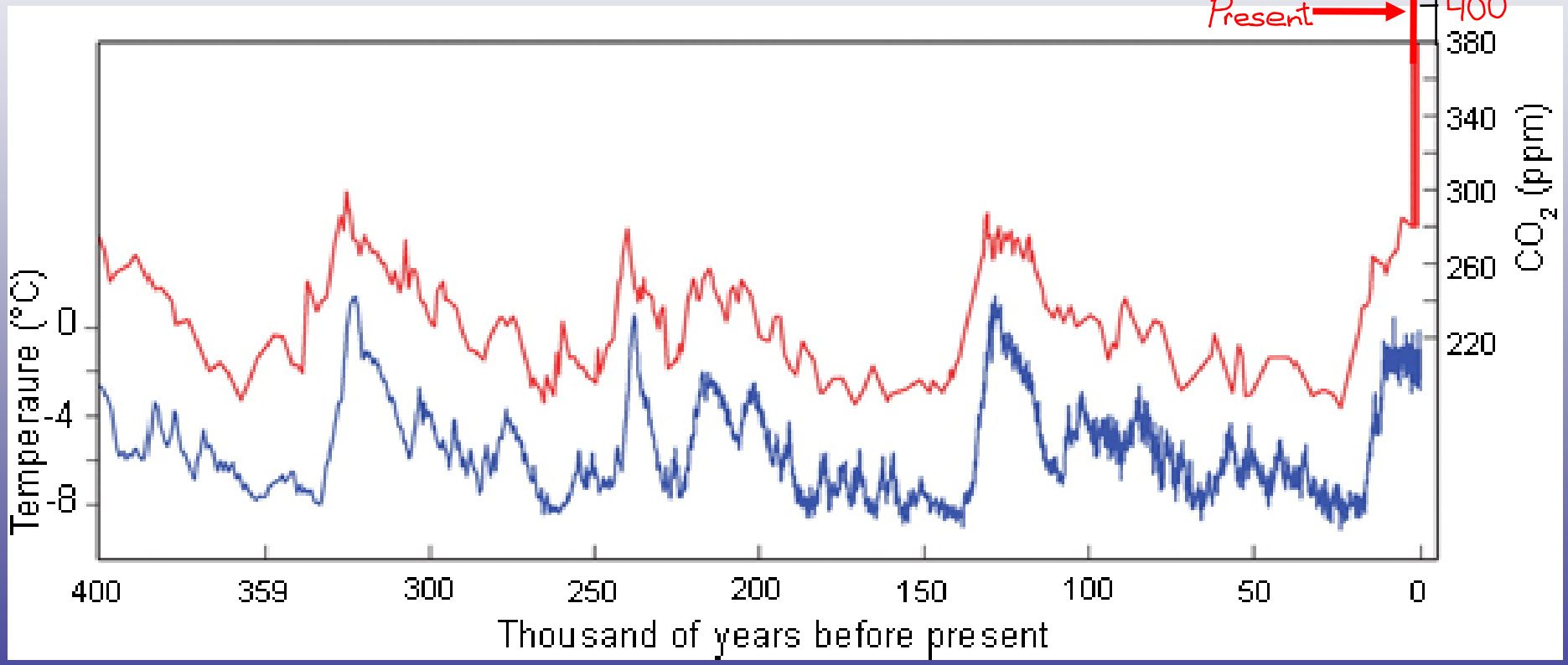
Source: NOAA.

Concentrations of GHG

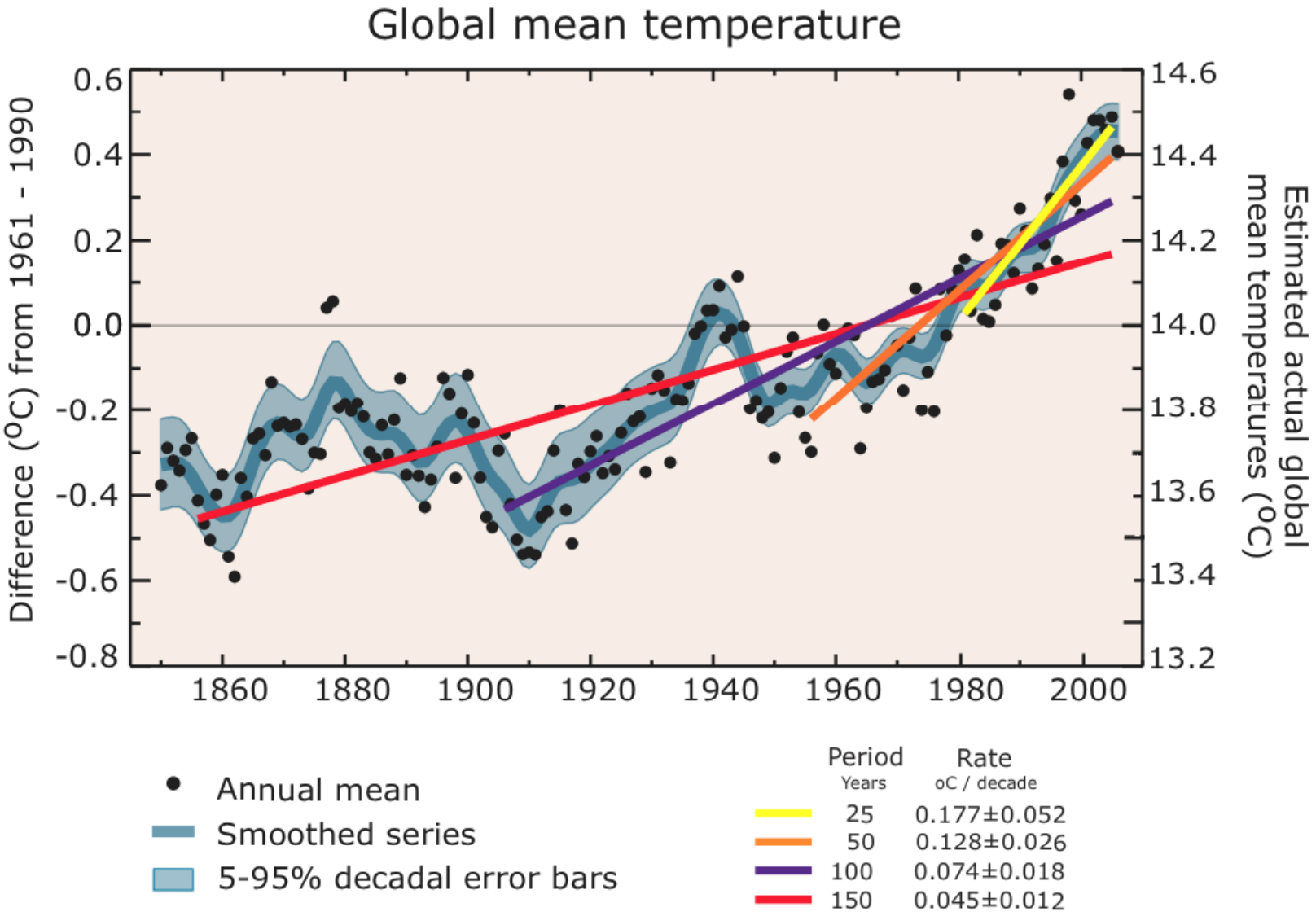


Source: Intergovernmental Panel on Climate Change (IPCC) AR4.

Concentração de CO_2
Temperatura do ar
ao longo de 400,000 anos



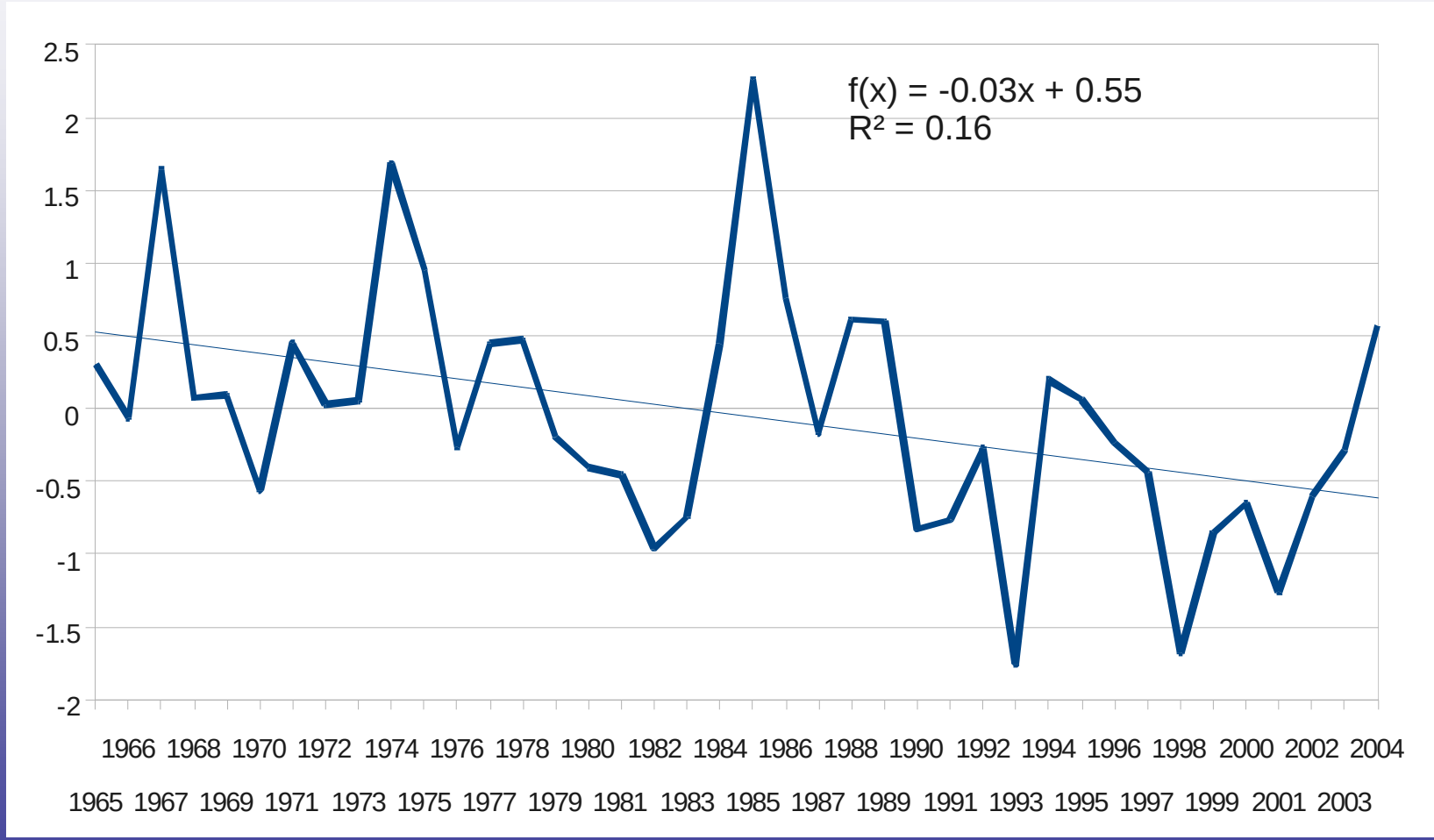
Aquecimento global está acelerando



Source: Intergovernmental Panel on Climate Change (IPCC) AR4.

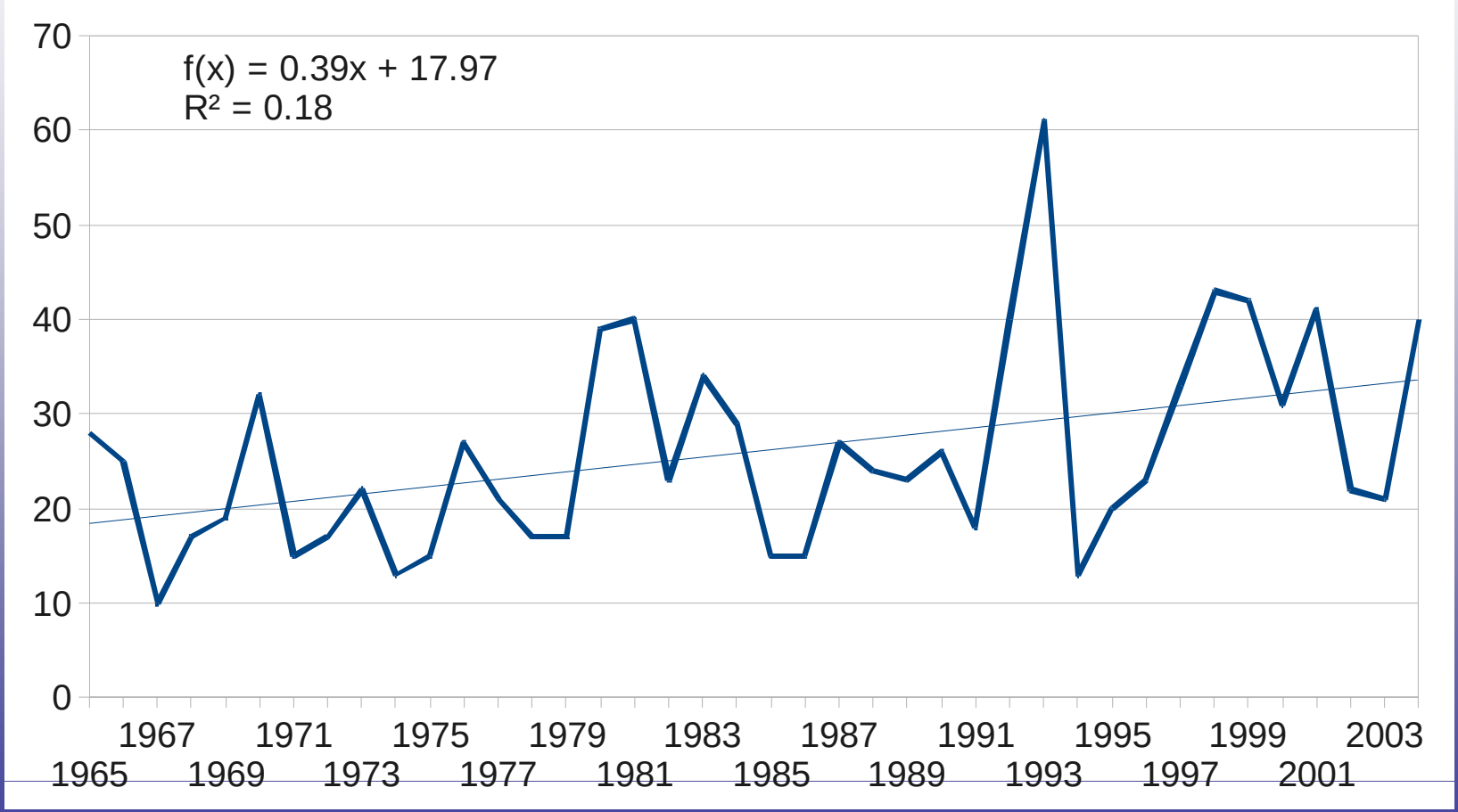
Precipitação Total fev-mai

Bacia do Pajeú – anomalia normalizada



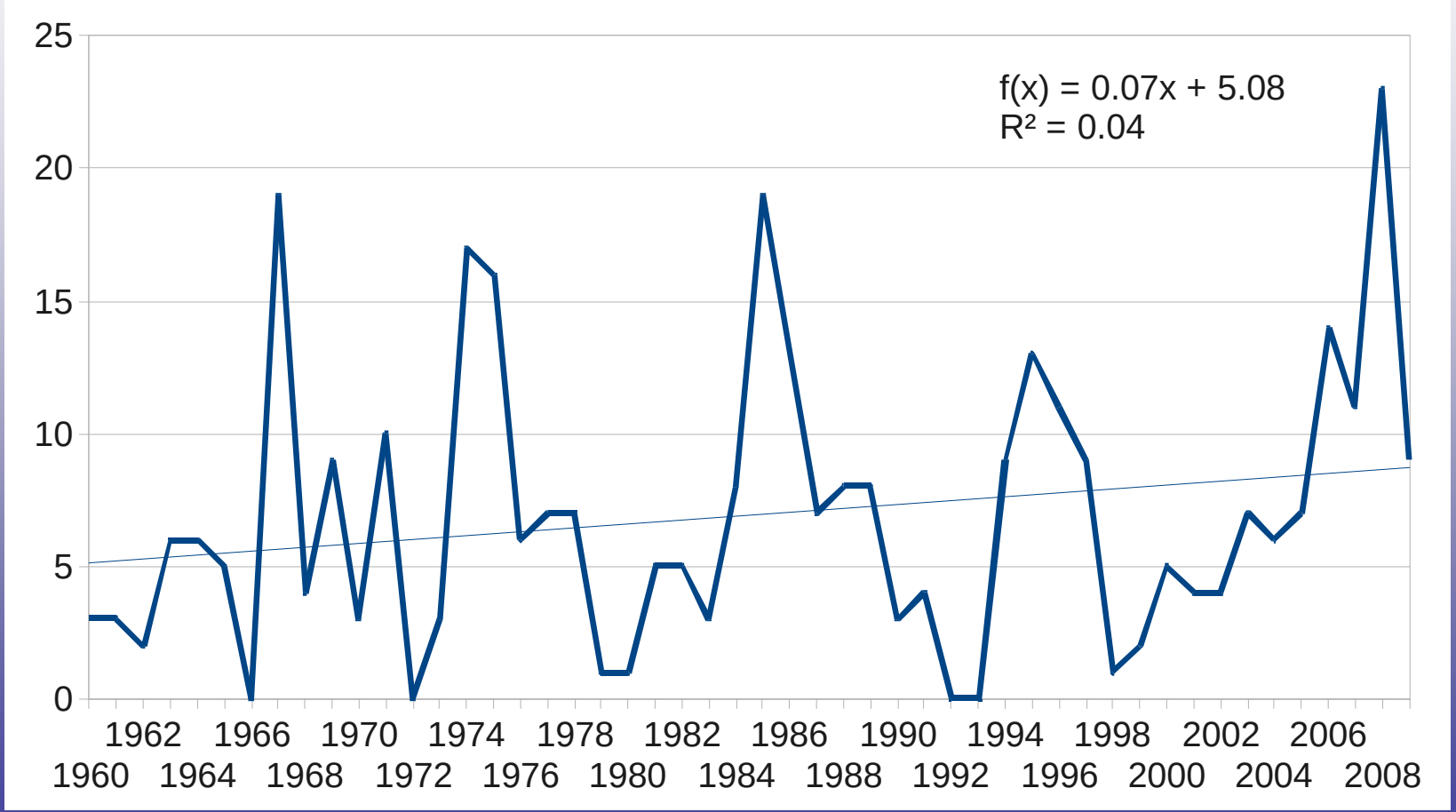
Veranicos Máxima Duração

Bacia do Pajeú

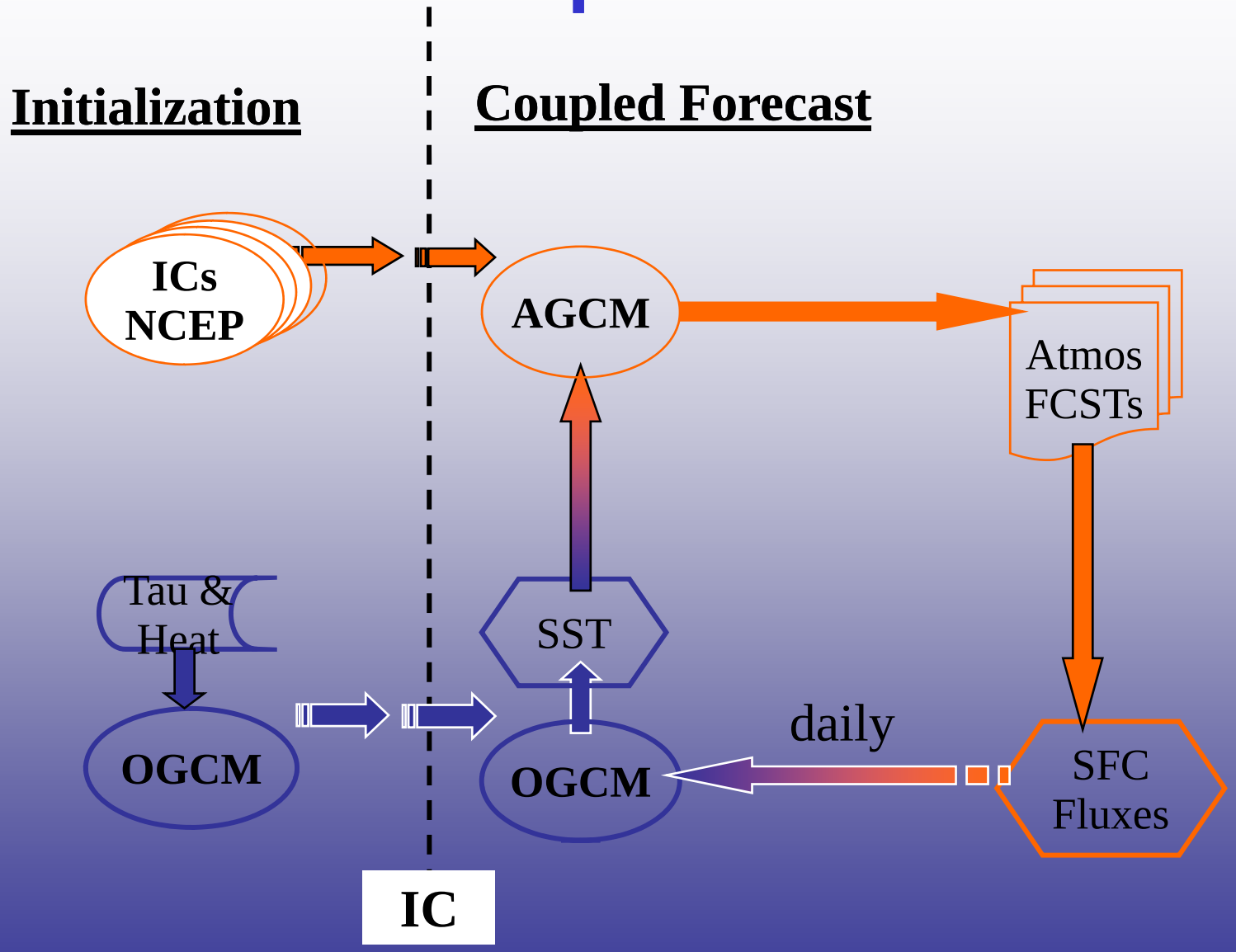


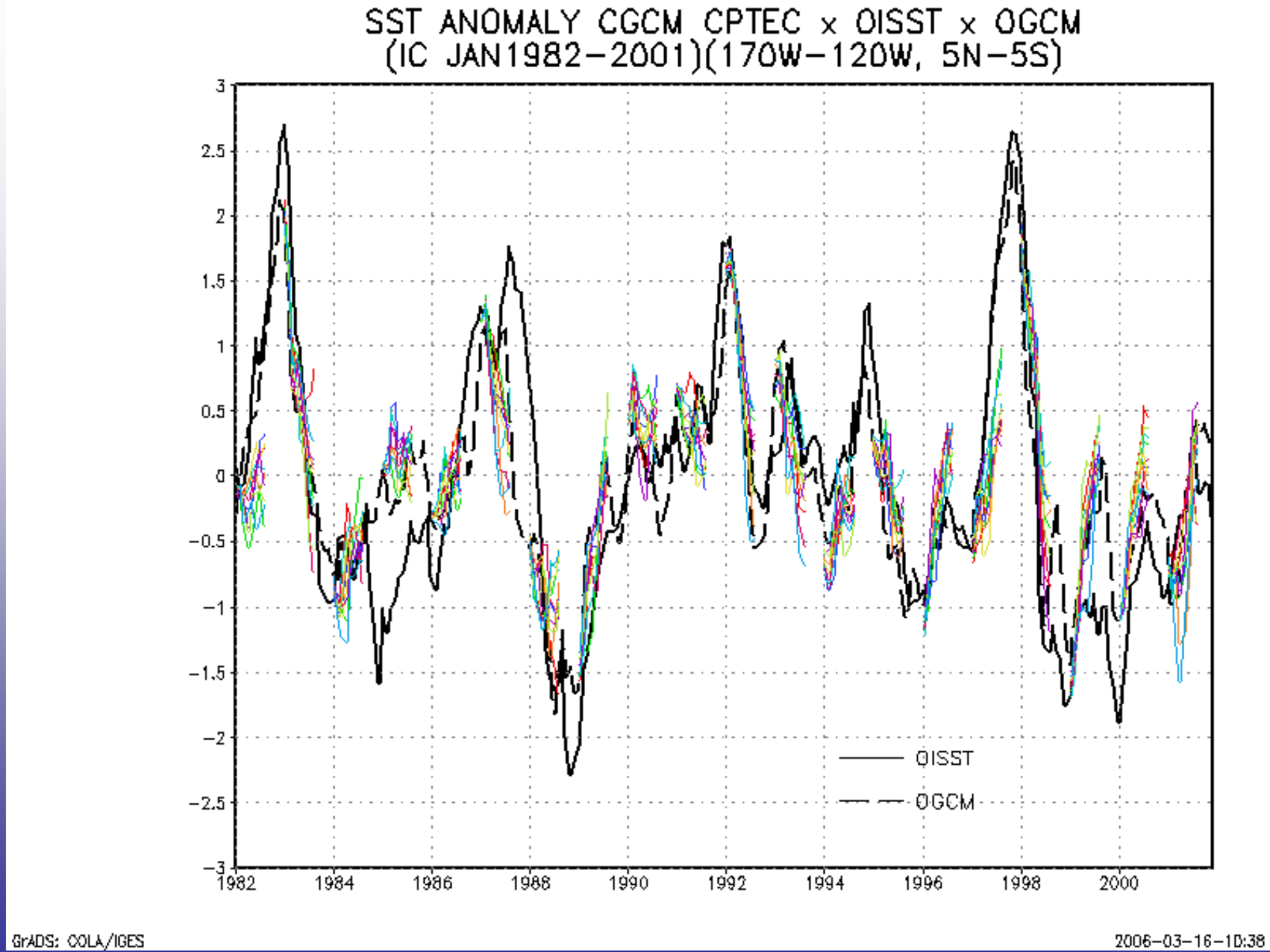
Frequência Precipitação Intensa

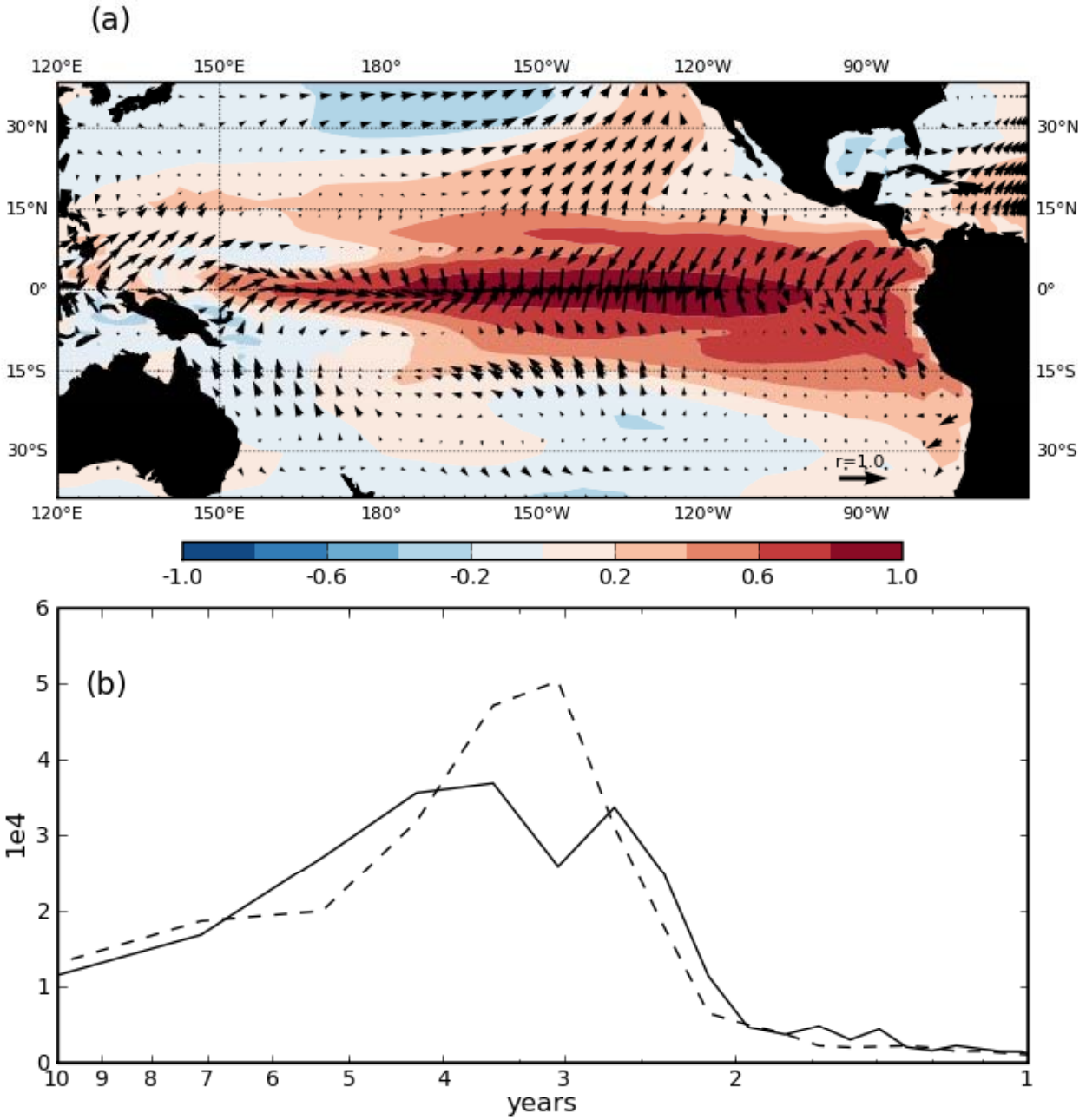
Bacia do Pajeú, > 50 mm/dia



CPTEC's Coupled GCM V.1.0




SST ANOMALY CGCM CPTEC x OISST x OGCM
(IC JAN1982-2001)(170W-120W, 5N-5S)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
OISST
OGCM
GrADS: COLA/IGES
2006-03-16-10:38


(a)
120°E
150°E
180°
150°W
120°W
90°W
30°N
15°N
0°
15°S
30°S
r=1.0
-1.0
-0.6
-0.2
0.2
0.6
1.0
(b)
1e4
0
1
2
3
4
5
6
10
9
8
7
6
5
4
3
2
1
years

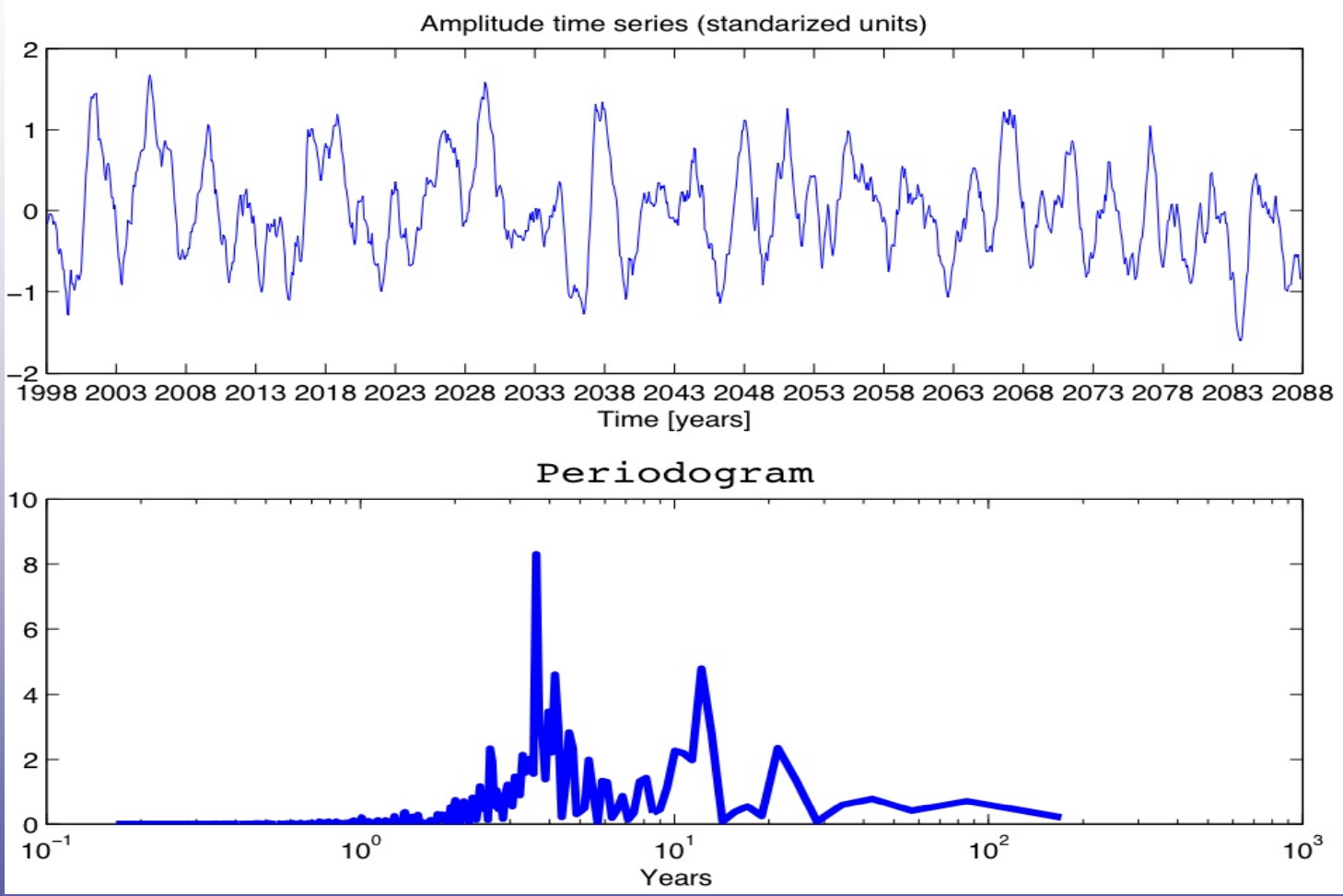
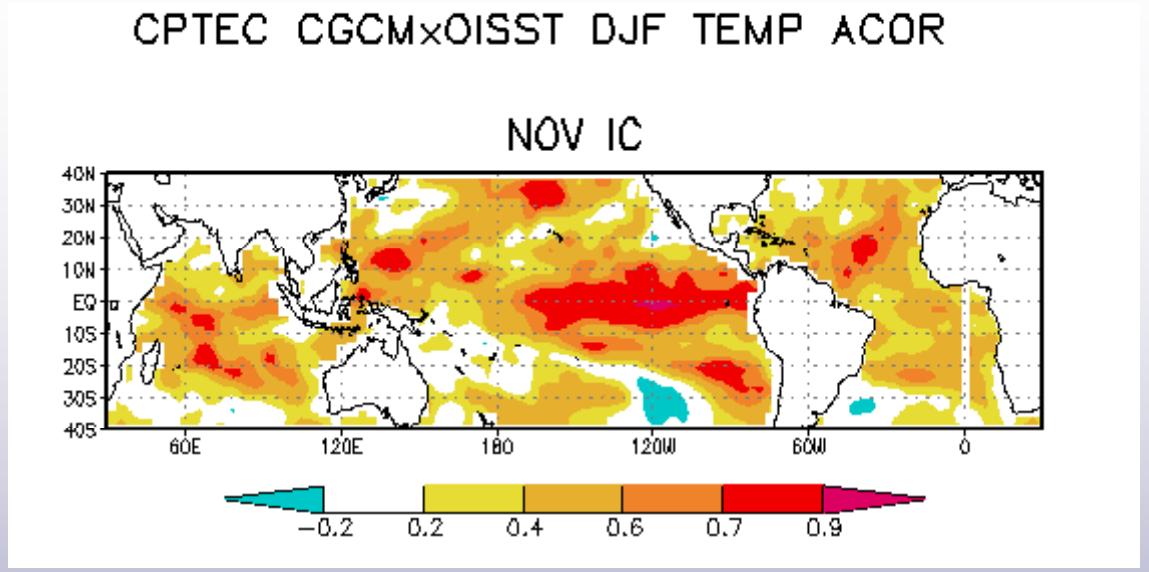
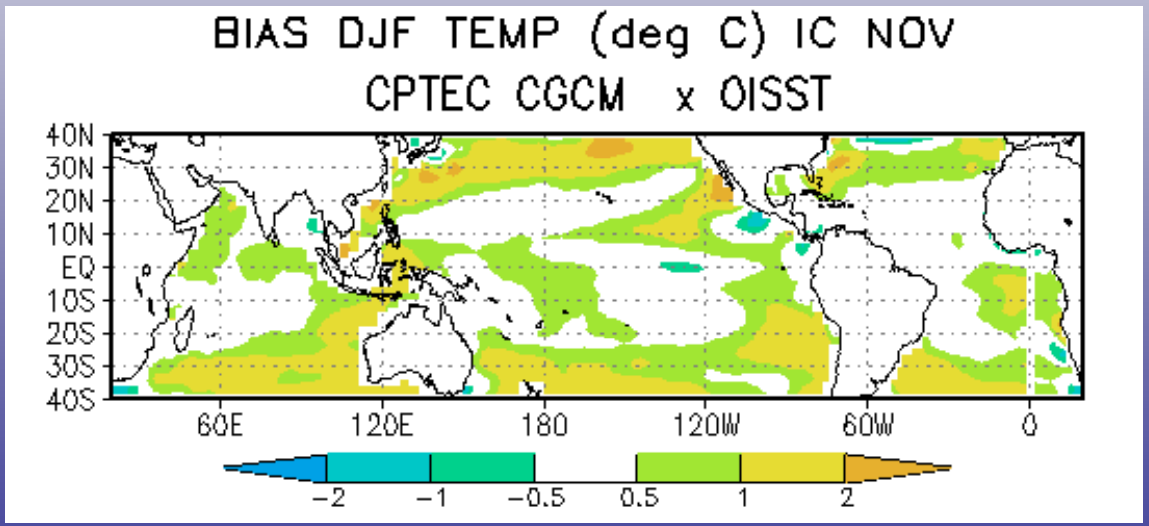


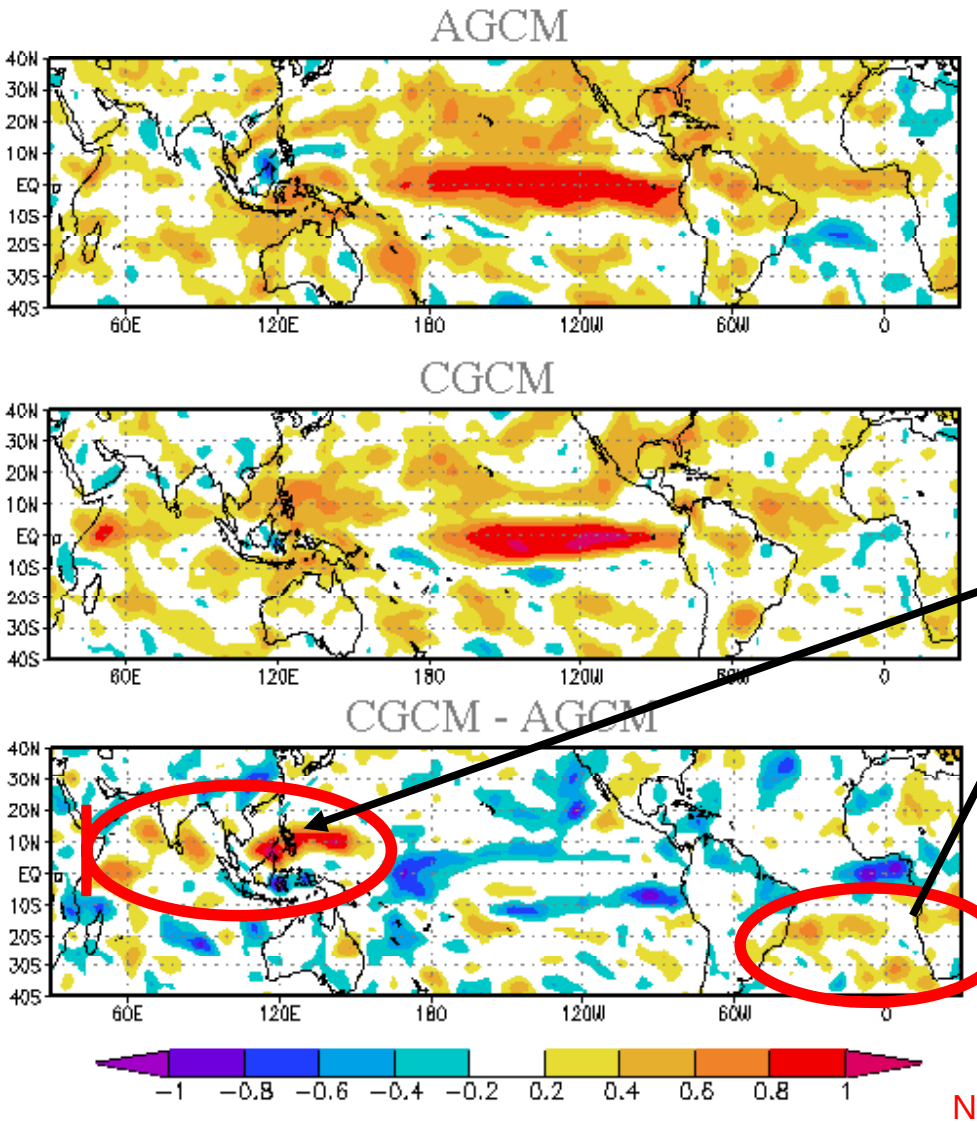
Figure 3 - Principal component time series (upper pannel) of the first eigenvector of SST anomaly for the global tropics (figure not shown) and its power spectra (lower pannel).


CPTEC CGCMxOISST DJF TEMP ACOR
NOV IC
40N
30N
20N
10N
EQ
10S
20S
30S
40S
60E
120E
180
120W
60W
0
−0.2
0.2
0.4
0.6
0.7
0.9


BIAS DJF TEMP (deg C) IC NOV
CPTEC CGCM x OISST
40N
30N
20N
10N
EQ
10S
20S
30S
40S
60E
120E
180
120W
60W
0
−2
−1
−0.5
0.5
1
2

Coupled Ocean-Atmosphere processes at play

DJF Precipitation Forecasts anomaly correlations

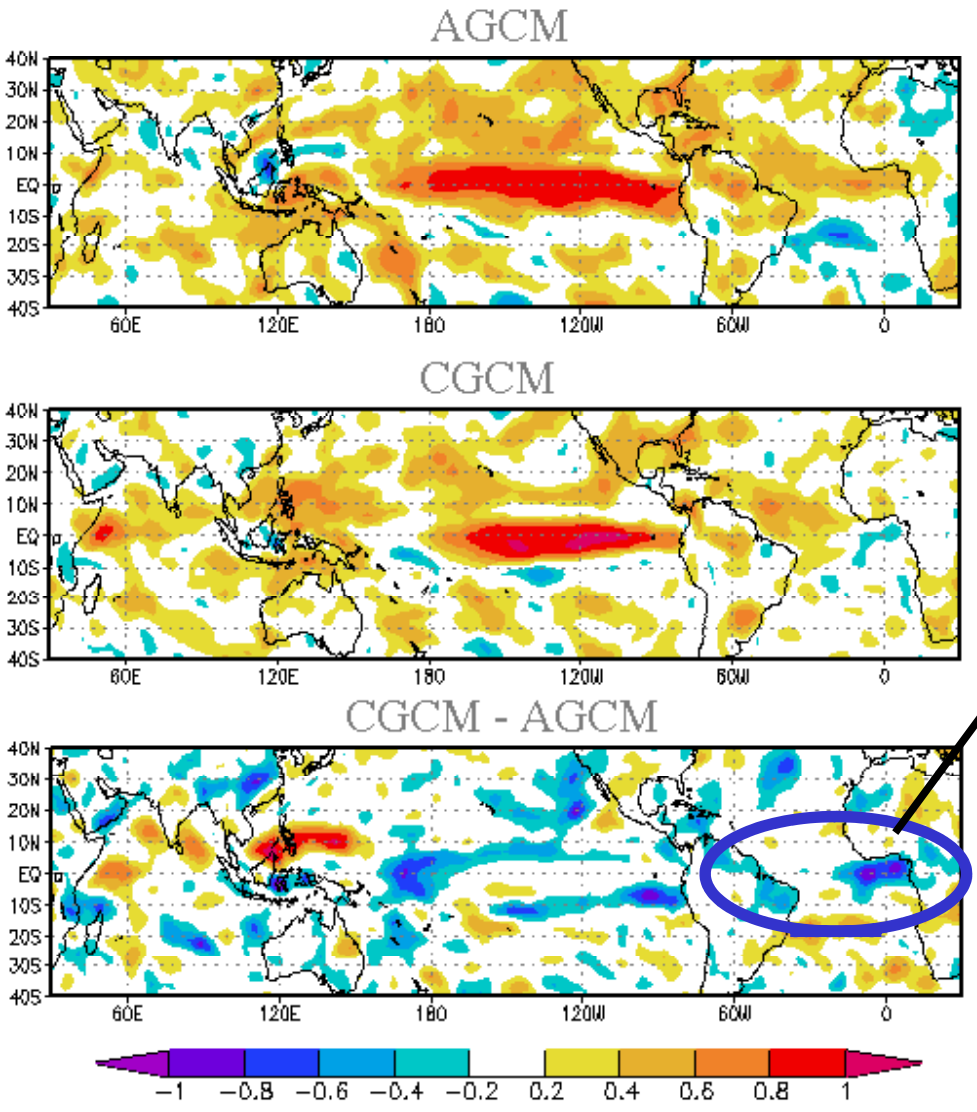


Increased Coupled Model Forecast Skill

Nobre et al. (2008, in prep)

Coupled Ocean-Atmosphere processes at play

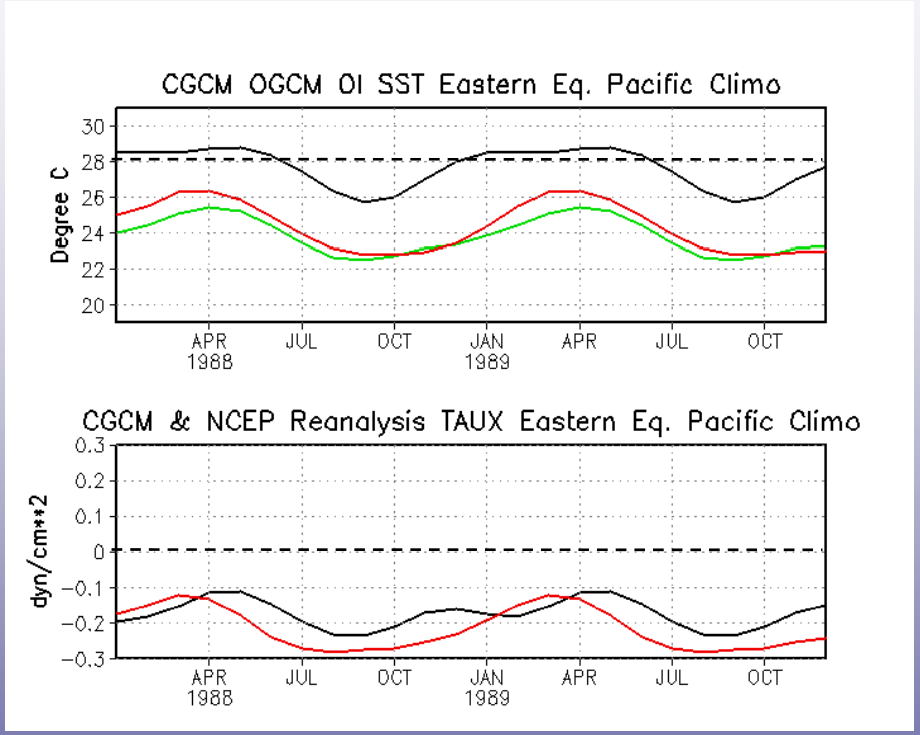
DJF Precipitation Forecasts anomaly correlations

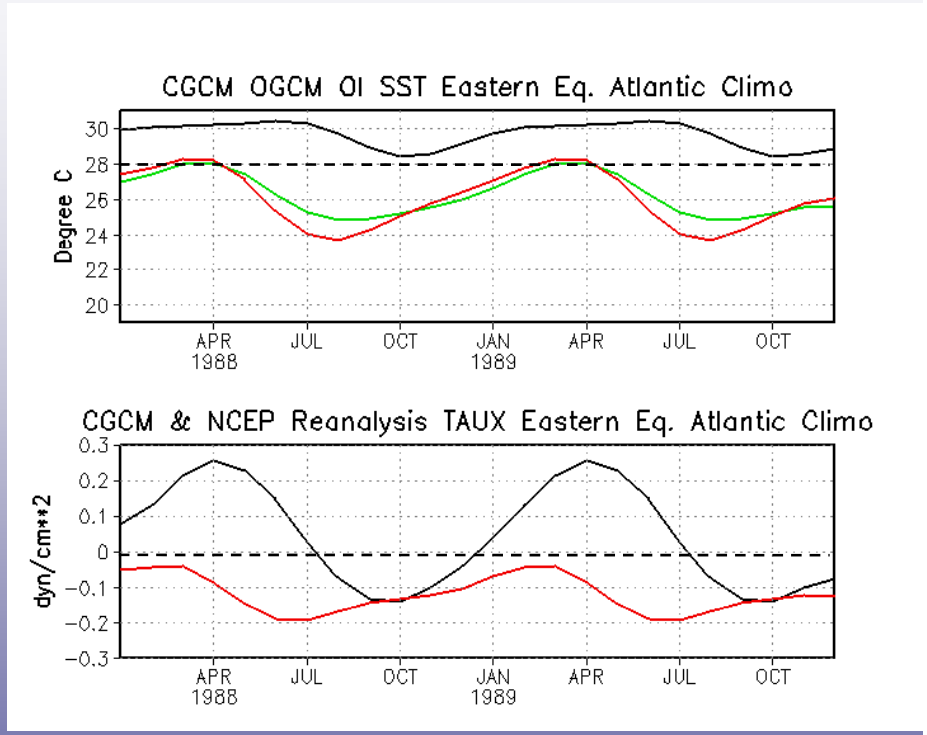


Decreased Coupled Model Forecast Skill

Nobre et al. (2008, in prep)

Eastern Oceans' Coupled O-A Interactions





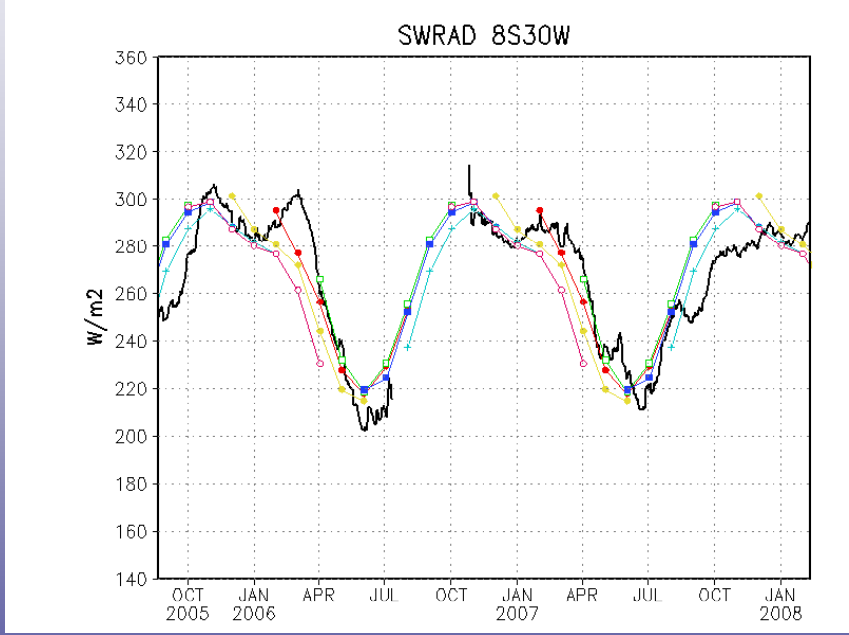
CGCM Climatology

OGCM Climatology

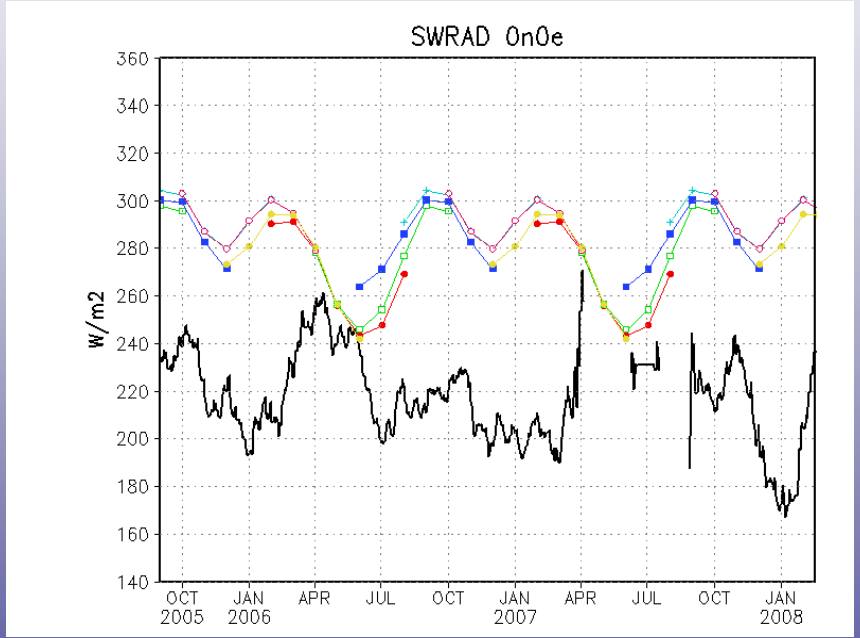
OI-SST / NCEP Reanalysis

CGCM SWRad systematic errors

8S 30W



0N 0E



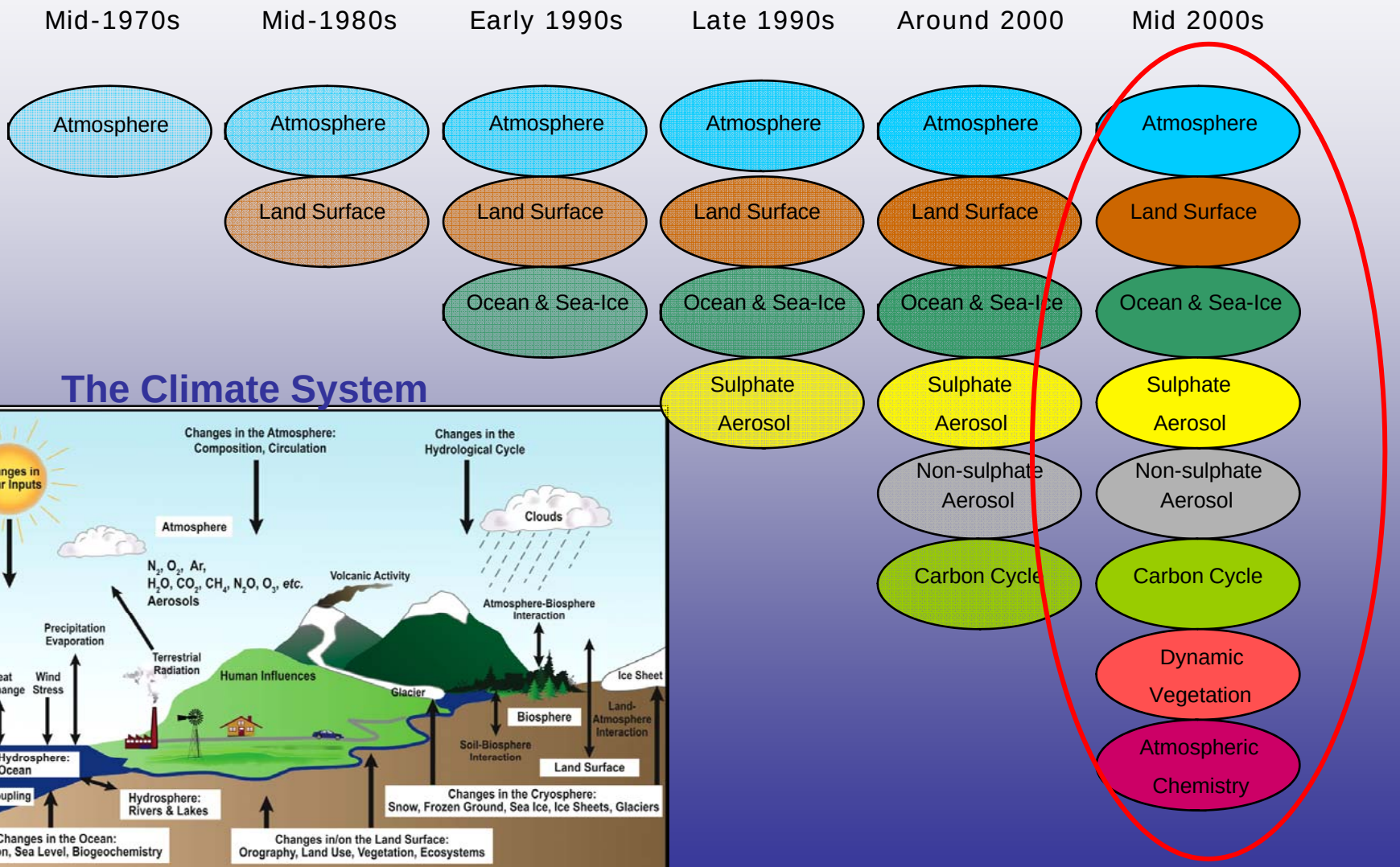
INPE's CGCM Evolution

- Version 1.1:
  - COLA AGCM, RAS, SIB, T042L18,
  - anomaly coupling to MOM2 at 1/3 degree deep global tropics, 40S-40N, L20, rigid lid.
- Version 1.2:
  - CPTEC/COLA AGCM, RAS, SSiB, T062L28,
  - fully coupled to MOM3, daily coupling, at ¼ degree deep global tropics, 40S-40N, L20, rigid lid.
- Version 2.0:
  - CPTEC AGCM 2.0, Kuo/RAS/Grell, SsiB/IBIS, T213L64
  - fully coupled to MOM4 , 3 hourly coupling, at 1/8 degree deep tropics, global, L50, free surface, sea ice & biogeochemistry
  - GFDL's FMS coupler

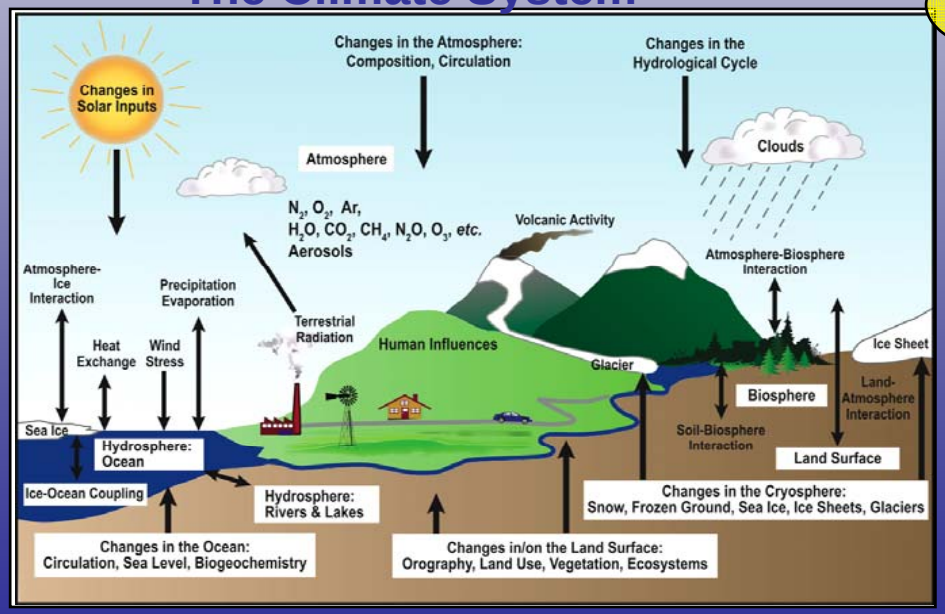
Rede CLIMA

Sub-Rede Modelagem Climática:

Modelo Brasileiro do Sistema Climático Global



The Climate System



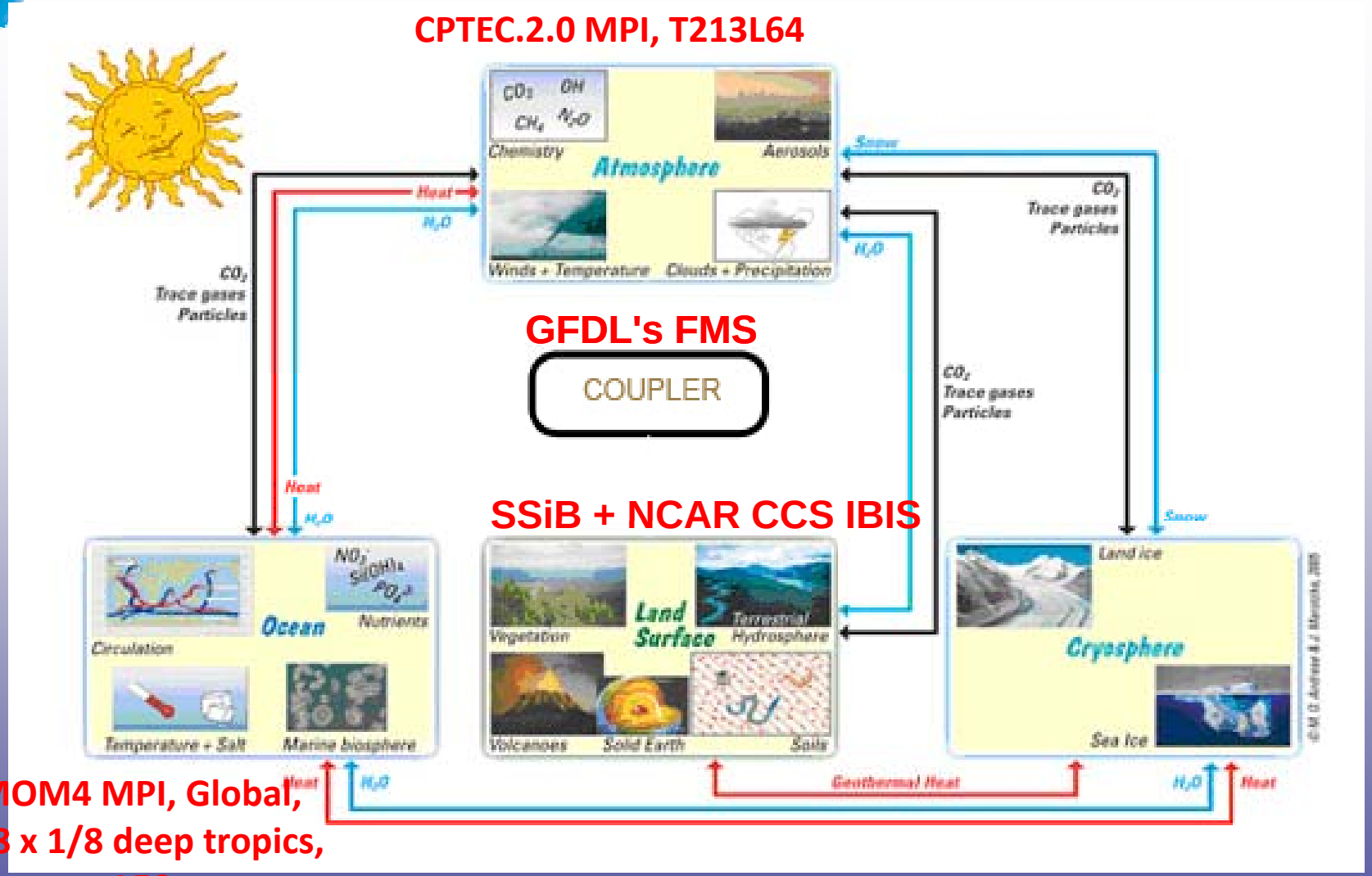


Figure 1 - The Global Climate System. A modified "Bretherton Diagram" highlighting linkages between biogechemical and physical climate systems. (Guy P. Brasseur, NCAR)

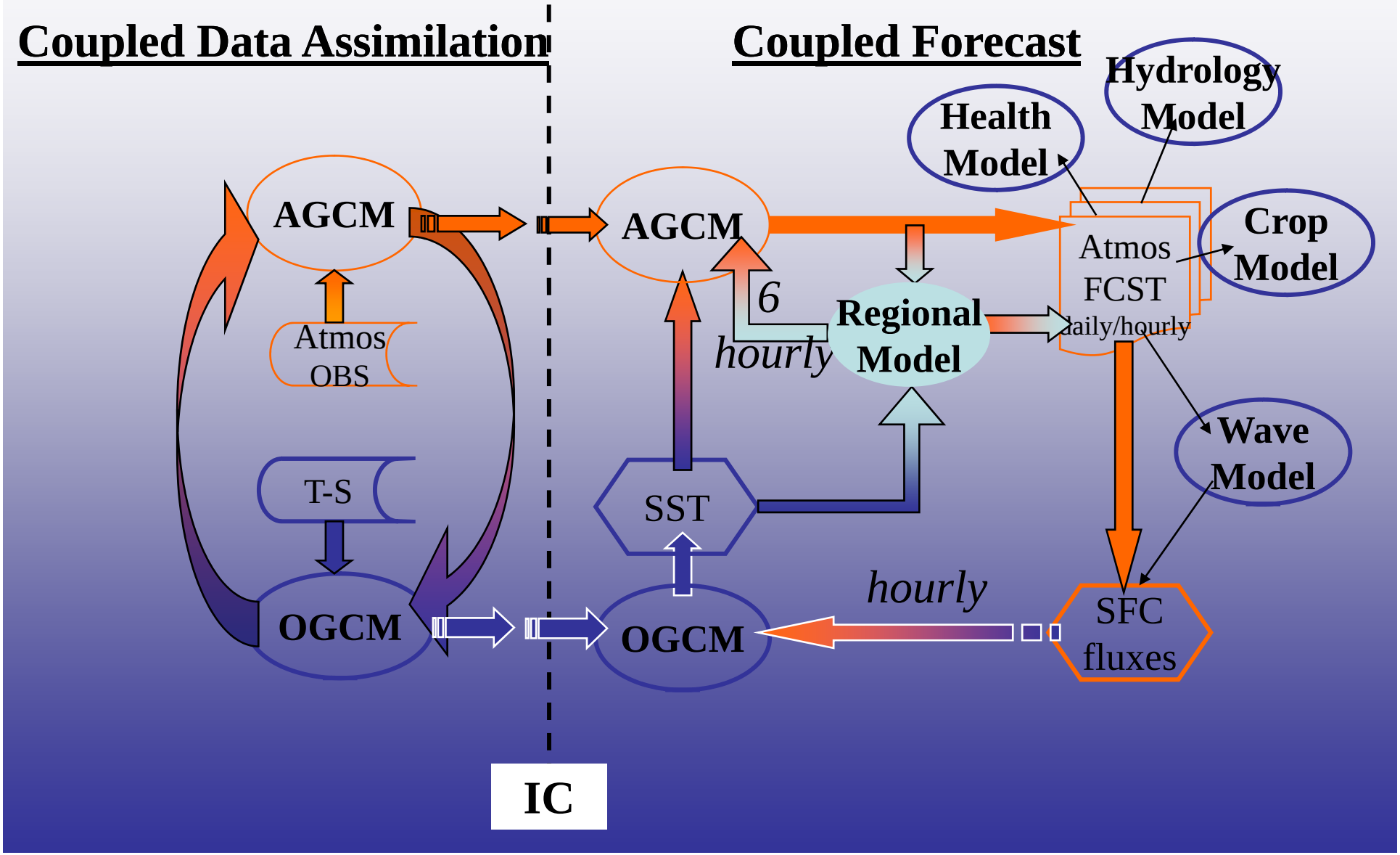
Structure of INPE's Coupled Model

- Atmos GCM:
  - CPTEC.2.0 MPI,
  - Semi-Lagrangian,
  - Resolution T62L64; T126L64; T213L64
    - Increased PBL and Strosphere vertical resolution
  - Kuo/RAS/Grell deep cumulus convection
  - atmospheric chemistry & aerosols (t.b.i.)
- Land Surface Model: IBIS–(t.b.i.)
  - Dynamic vegetation
  - Carbon Cycle
  - Fire Model
  - Improved hires land surface hidrology

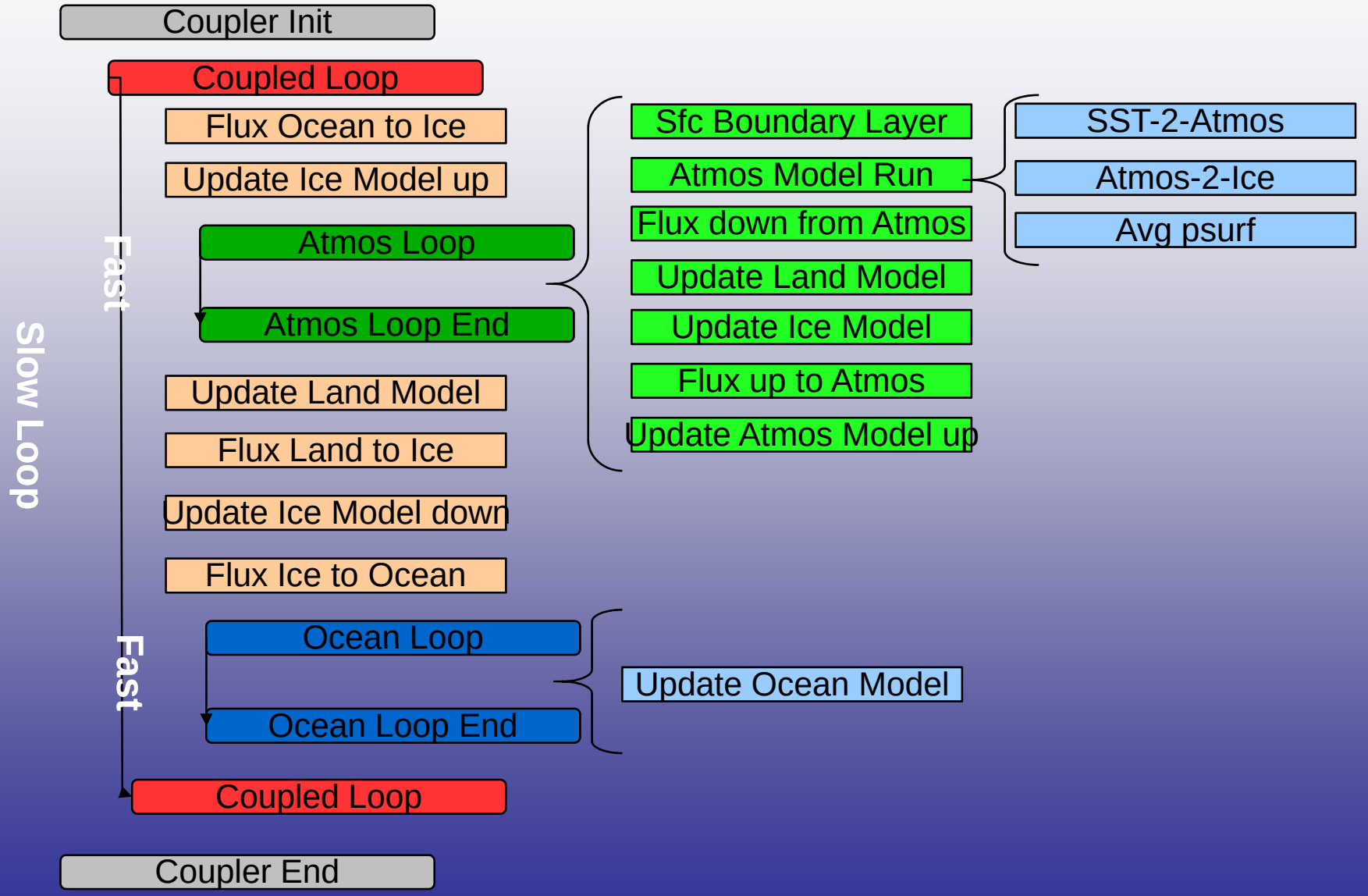
Structure of INPE's Coupled Model

- OGCM:
  - MOM4 MPI,
  - Global, 1/4 x 1/4 deep tropics,
  - L50, 10m spacing upper 250 m,
  - Philander and Pakanowski vertical mixing
  - free surface,
  - fresh water flux,
  - river inflow;
  - Dynamical ice model (SIS)
  - Biogeochemistry model
- MOM4's FSM coupler
  - hourly coupling interval

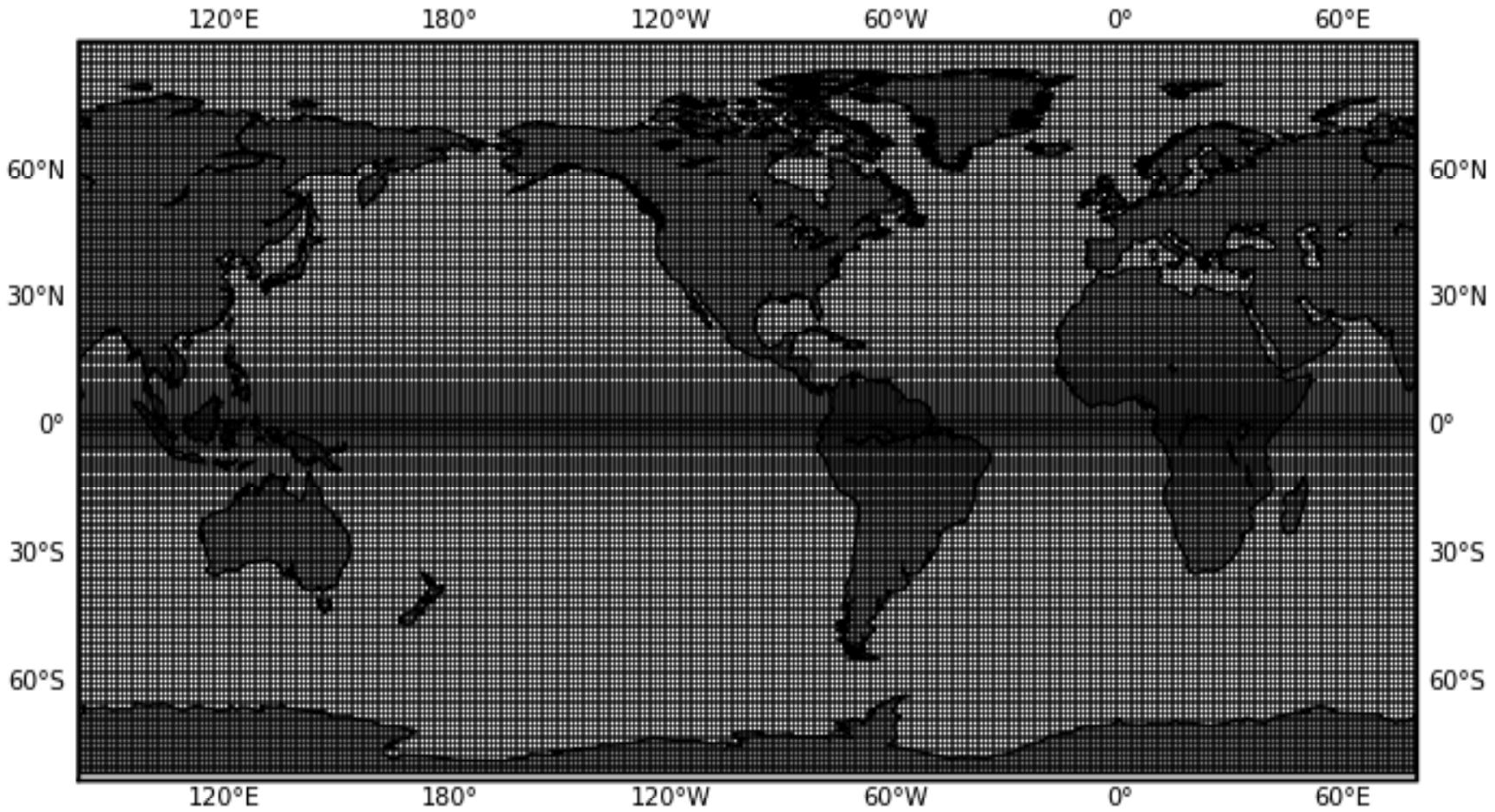
INPE's Global Climate Goal



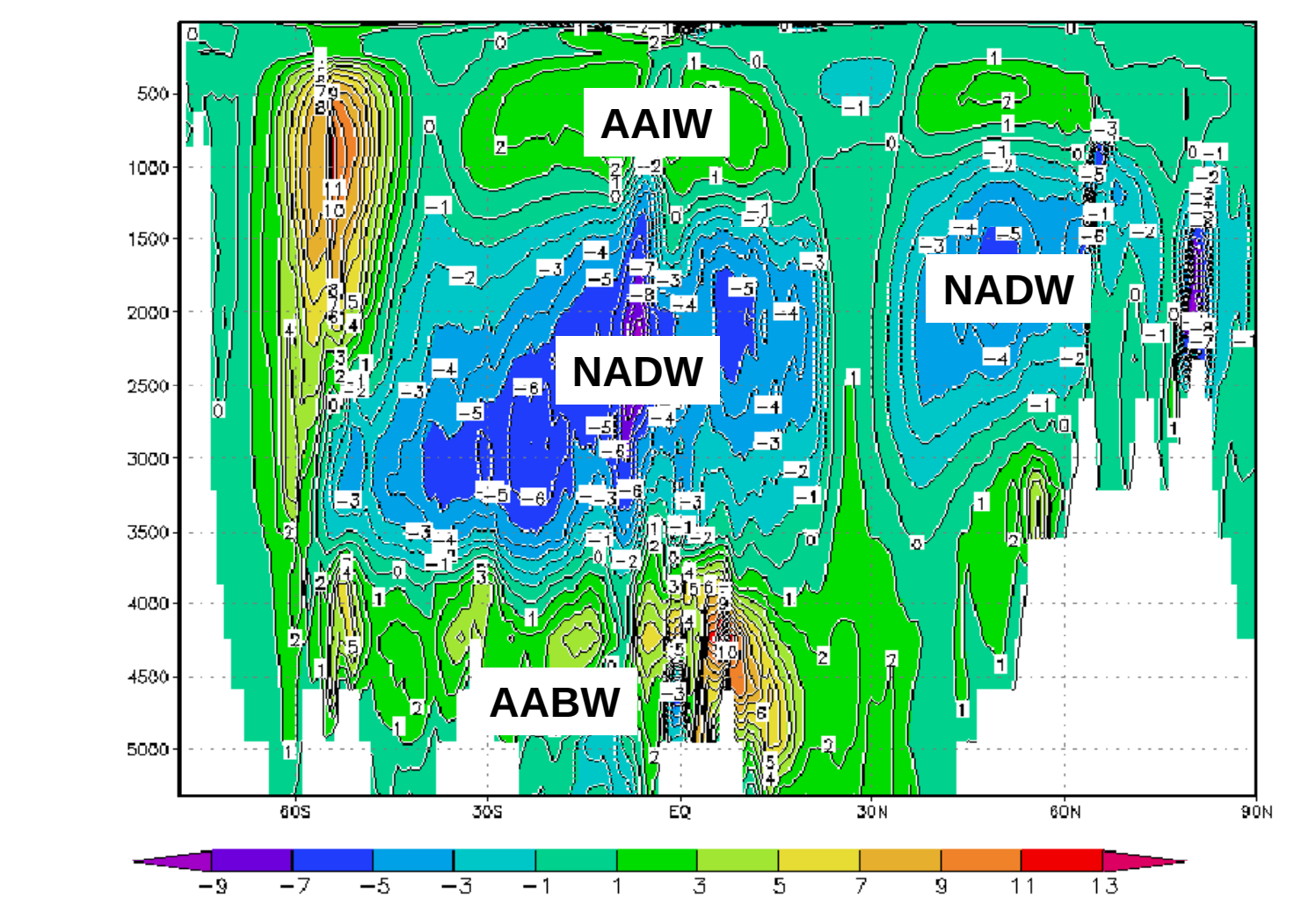
MOM 4's FMS COUPLER



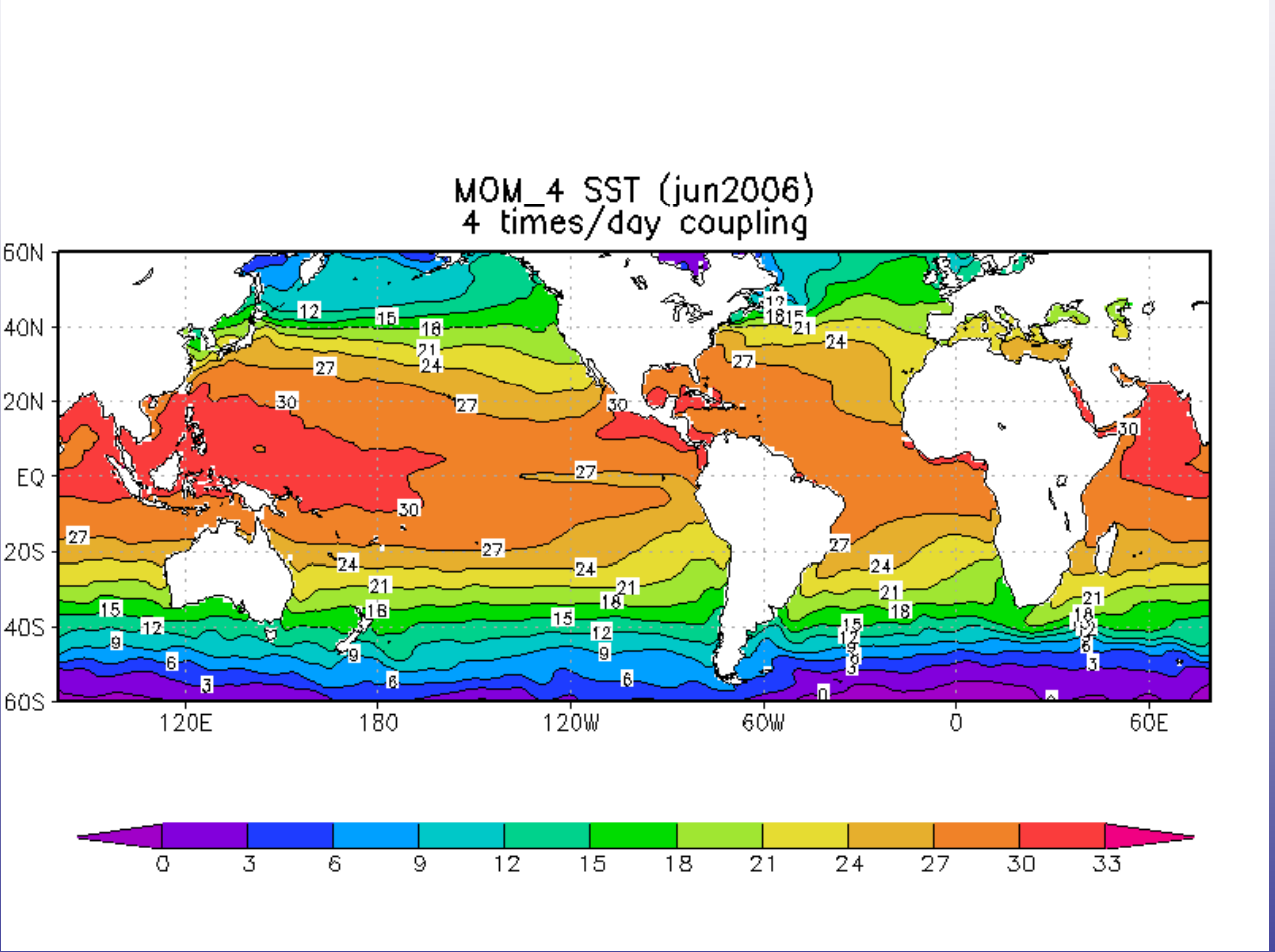
OGCM Grid



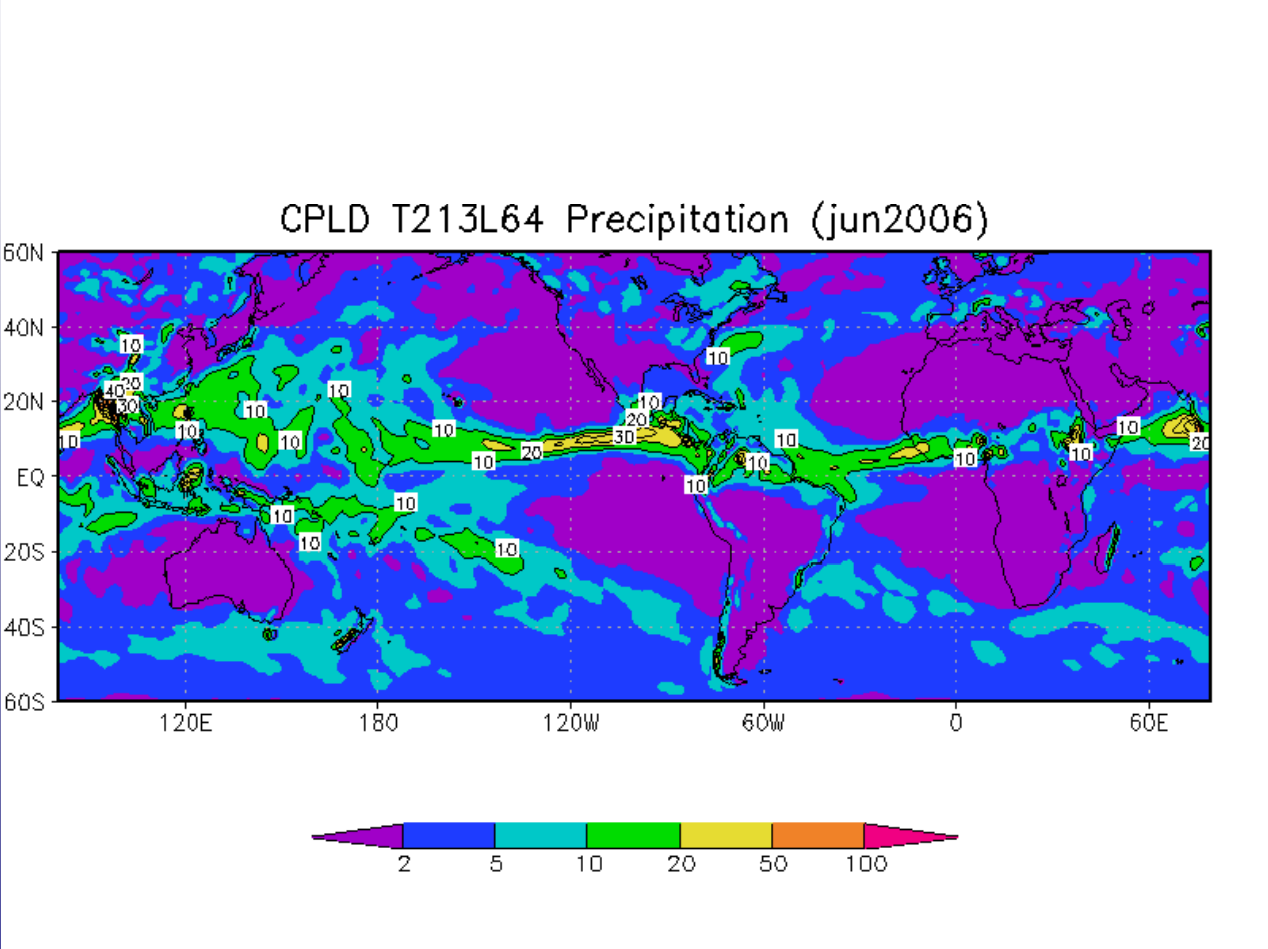
MOM4 Atlantic Meridional Transport (Sv)



INPE-CPTEC CGCM V.2.0
T213 L64, 6 hourly coupling
30 days avrg spinup SST

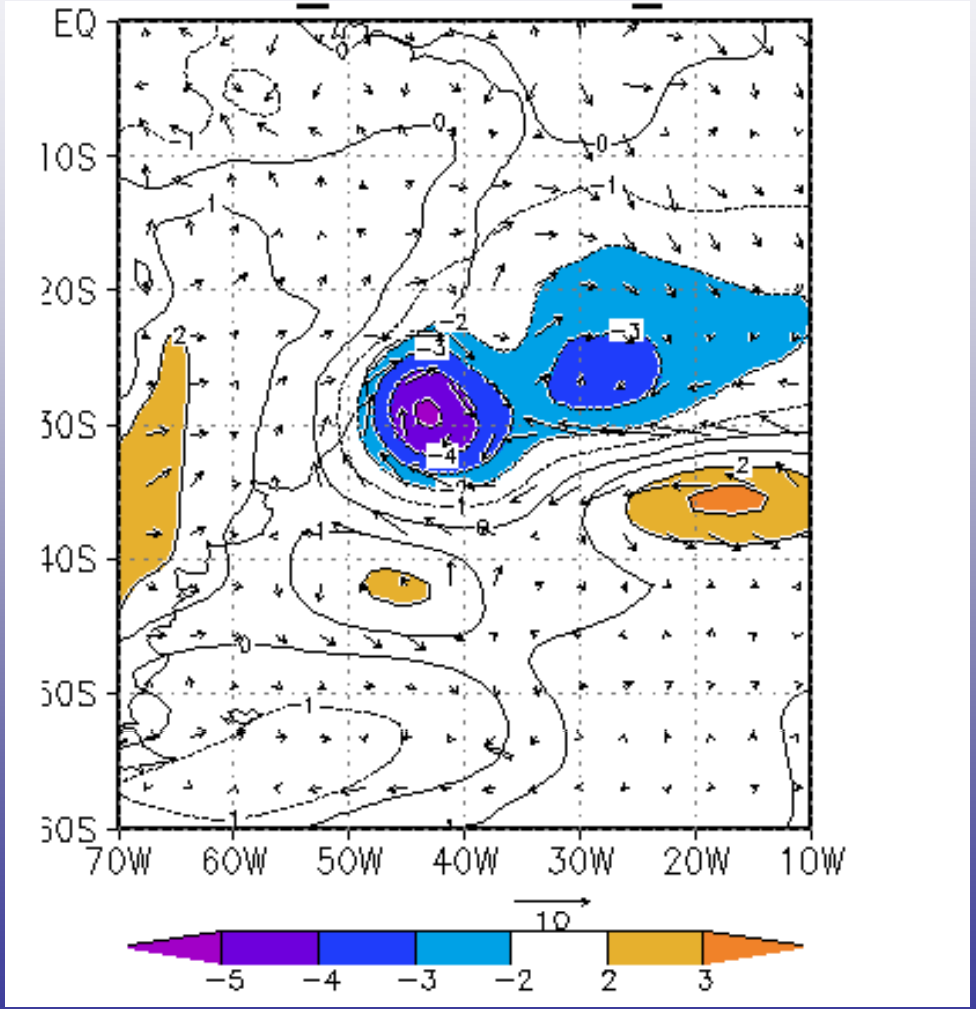


INPE-CPTEC CGCM V.2.0
T213 L64, 6 hourly coupling
30 days avrg spinup Precip



Catarina Tropical Storm Hits Brazil
26 March 2004

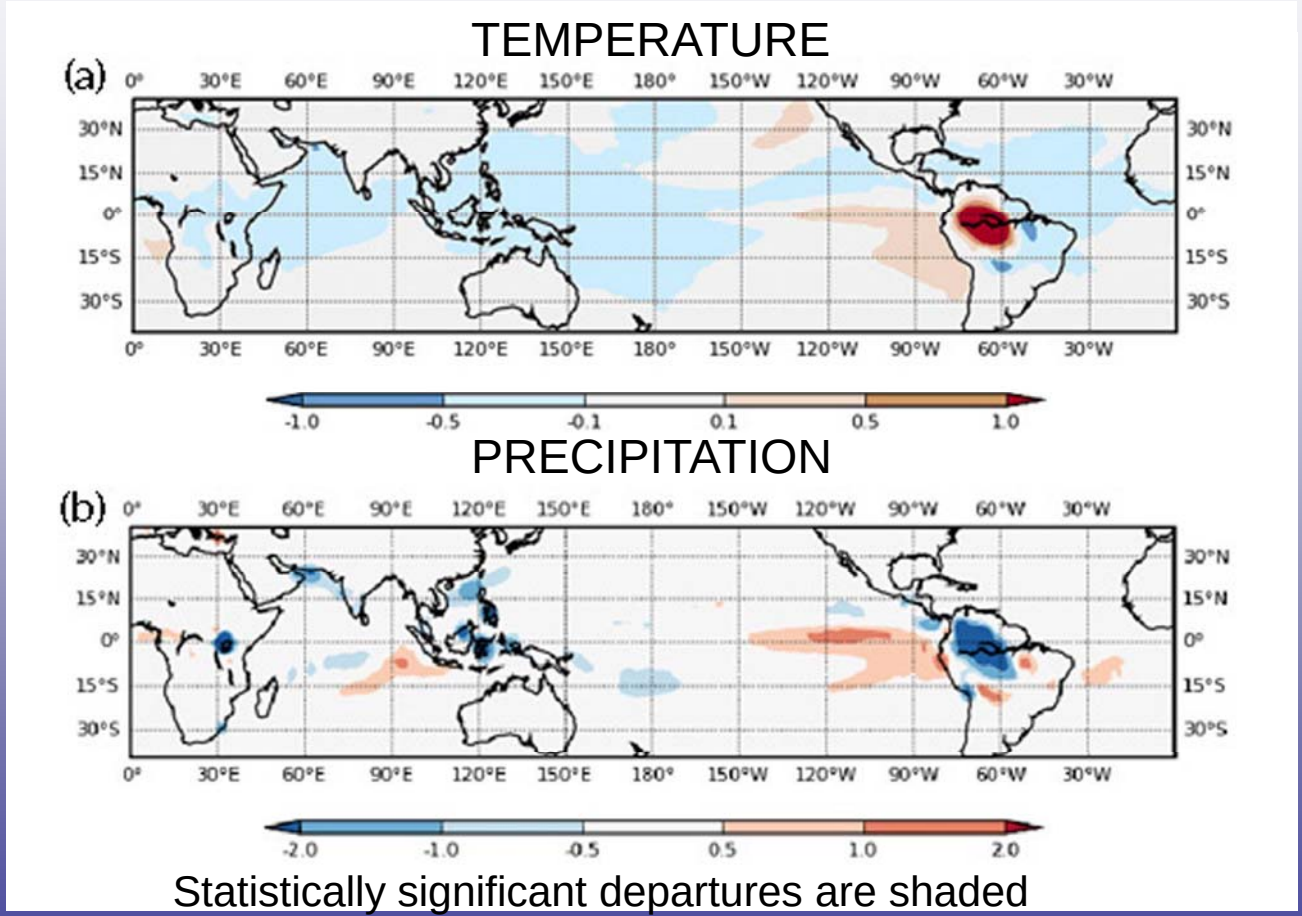
72 hours CATARINA FCST
CGCM-AGCM (T62L28) SLP
ci: 12Z24MAR2004 FCST: 12Z27MAR2004



Nobre and Malagutti, (pers. comm)

Amazon deforestation experiment

rainfall and temperature departures



Statistically significant departures are shaded

Nobre et al. (2008) accepted