

Modelado acoplado oceano-atmósfera. El papel de TSM en la modulación del clima tropical.

Paulo Nobre
INPE-CPTEC

Gilvan Sampaio
INPE-CCST

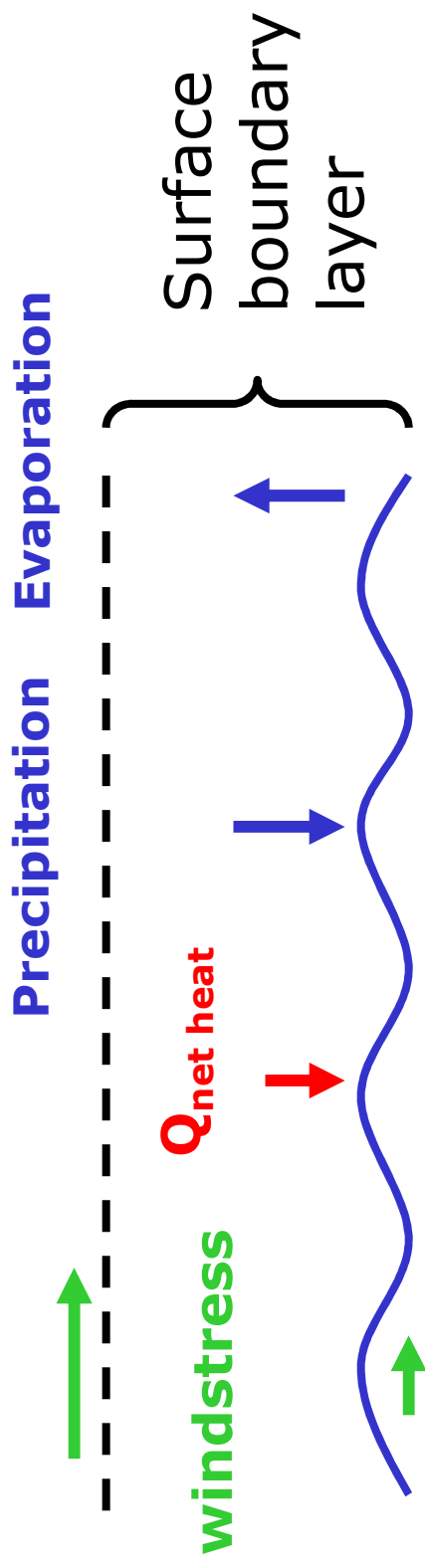


outline

- Global scale phenomena modulating South American climate
- Coupled O-A modes of variability
- Some deficiencies of CGCM modeling over the Atlantic

Ocean-Atmosphere Interaction

- The ocean and atmosphere interact continuously
- Fluxes of heat, fresh water and momentum (+ numerous chemical species)



Basic properties of the Ocean

- Density:
 - At SLP ocean is $\sim 1000x$ more dense than the atmosphere
- Heat capacity:
 - Specific heat capacity is $\sim 1200x$ atmosphere
 - 2.5m of ocean has same heat capacity as whole atmosphere

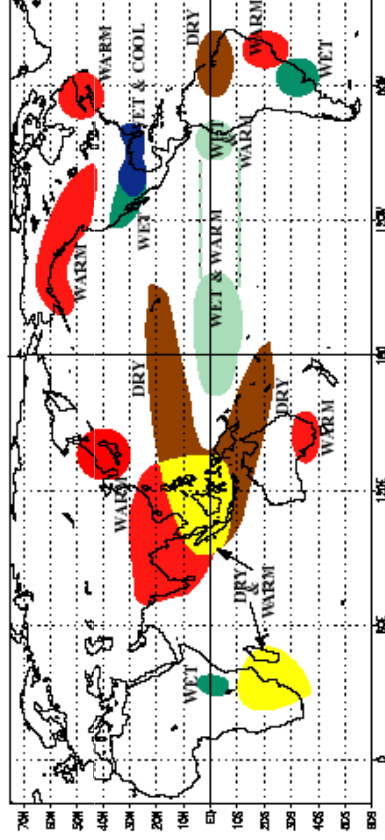
- Velocities:

Atmos.	Advective	mid-latitude internal Rossby waves
	~ 10 m/s	~ 10 m/s
Ocean	$\sim 1-10$ cm/s	~ 1 cm/s

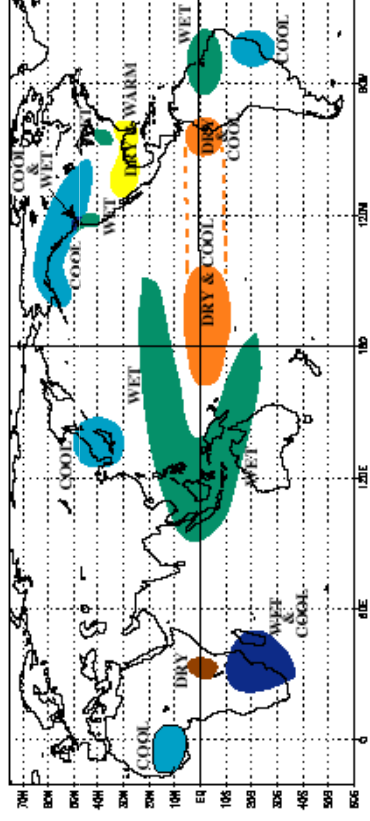
- **Ocean moves and adjusts $\sim 1000x$ more slowly than the atmosphere – a source of *memory* in the climate system**

The ENSO effects

WARM EPISODE RELATIONSHIPS DECEMBER - FEBRUARY

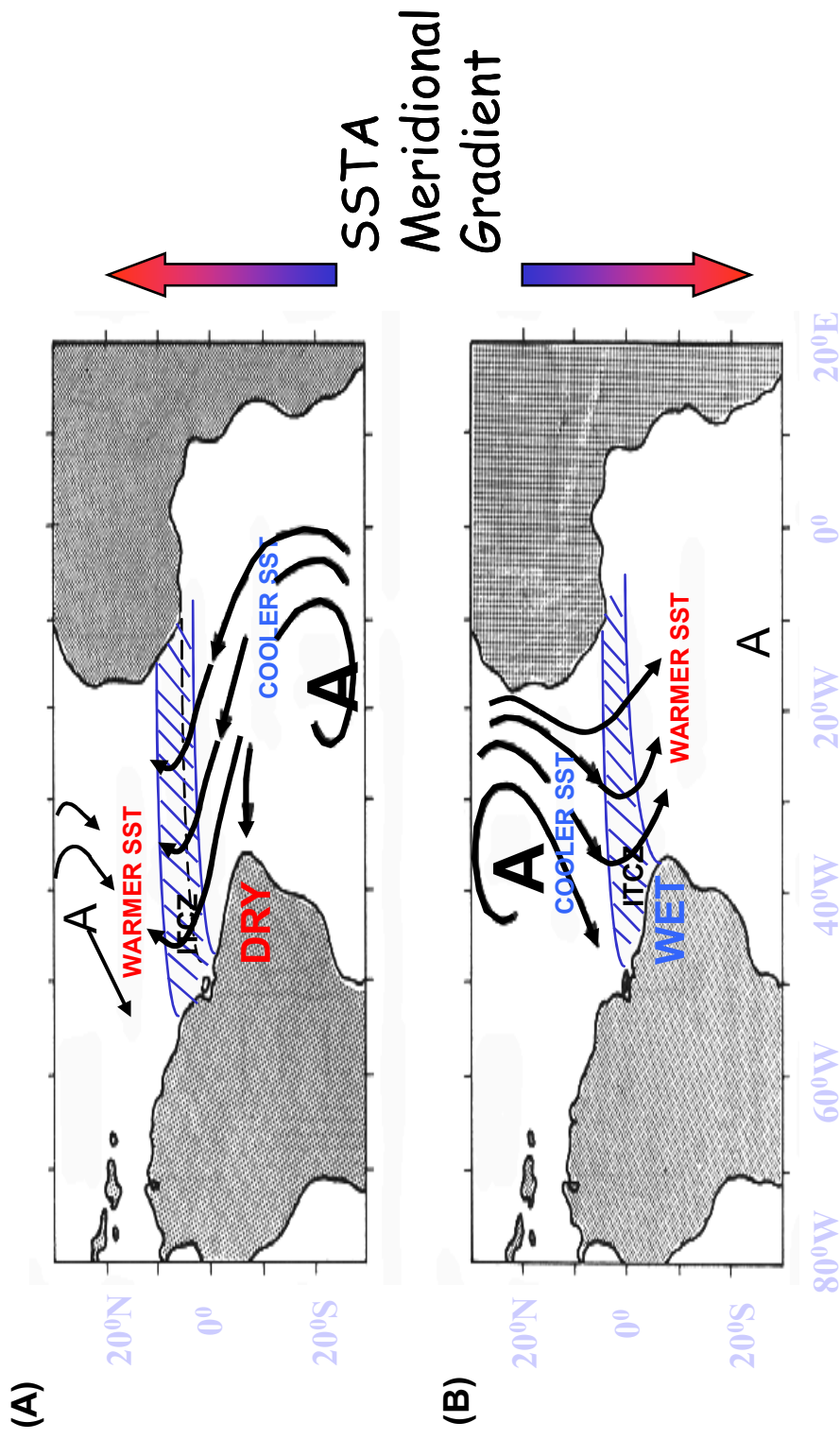


COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



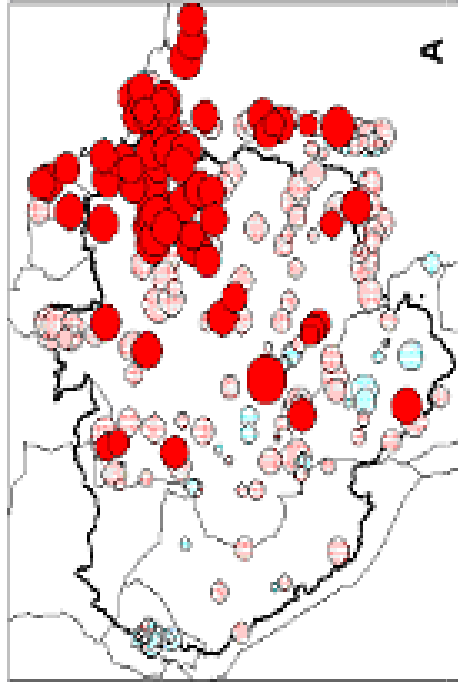
VPM11 Miami, 25-27 March 2008

The ITCZ Influence

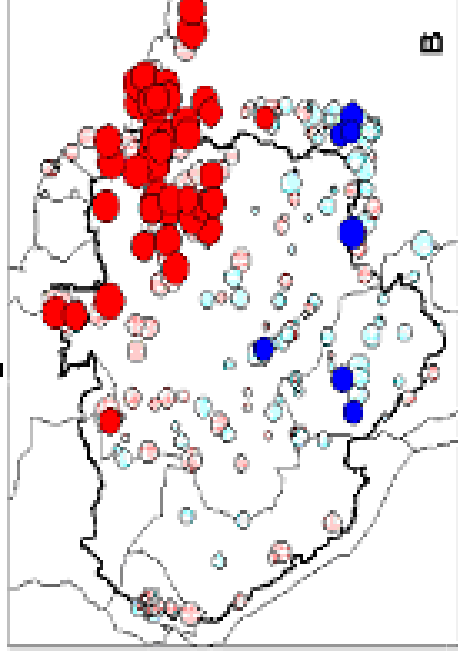


Variabilidade interanual do clima na Amazônia

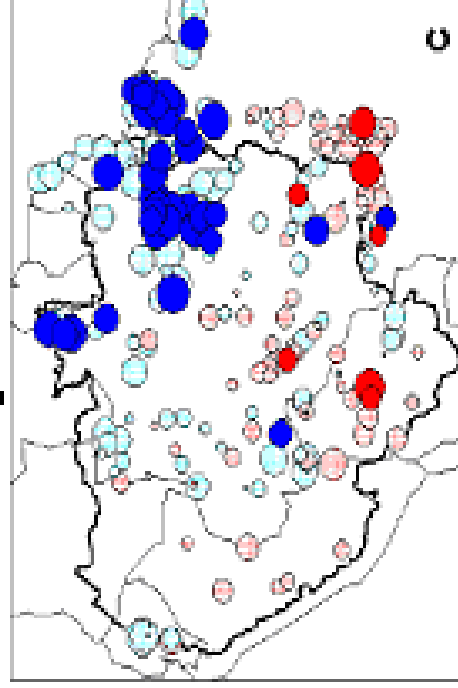
El Niño



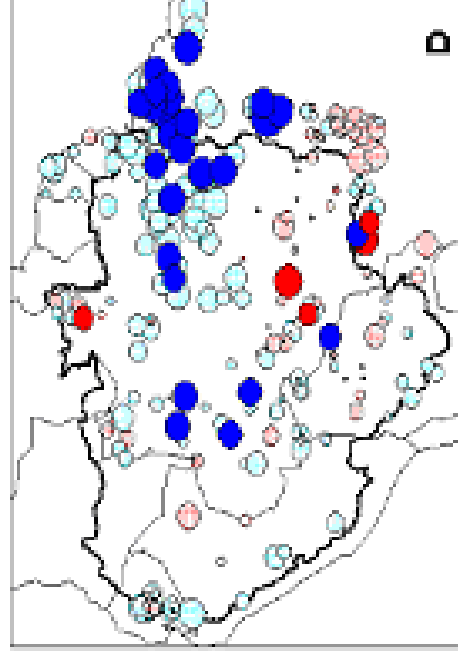
Atlântico Tropical Sul mais frio



Atlântico Tropical Norte mais frio

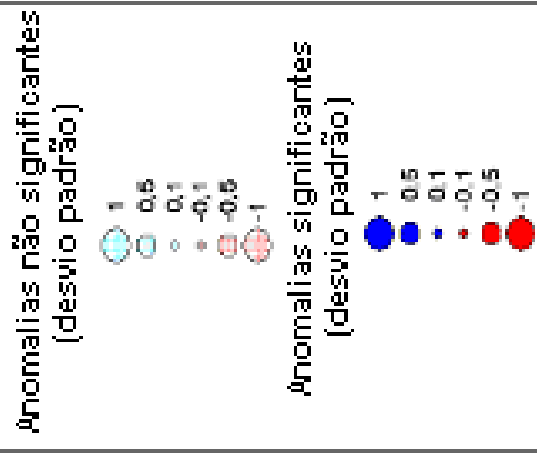


La Niña



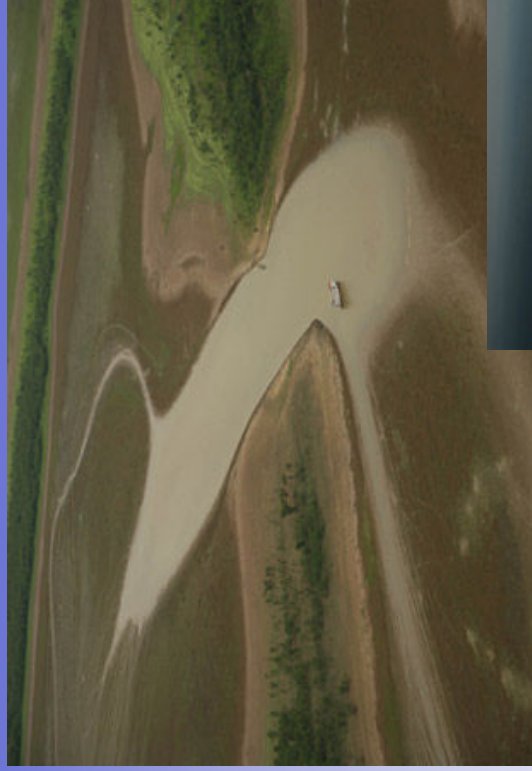
Variabilidade interanual de anomalias de chuva na Amazônia e Tocantins

(Ronchail et al., 2002)

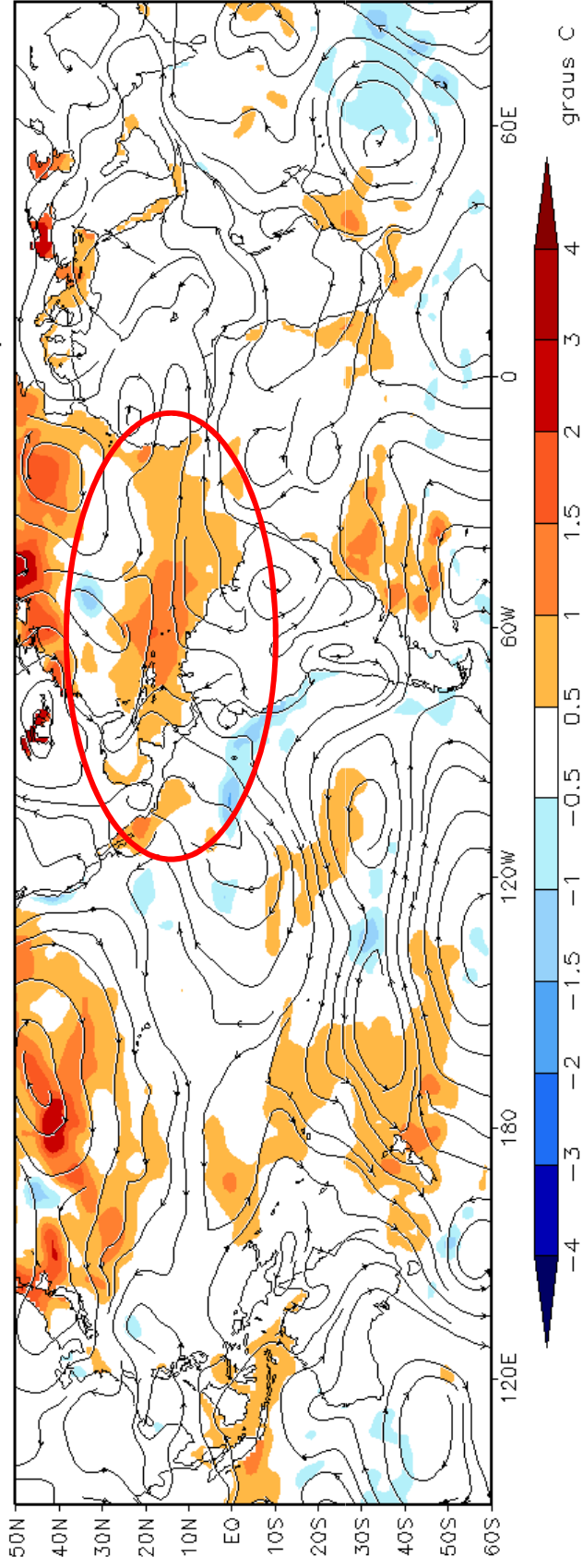


Estamos assistindo a mais extremos hidrológicos?

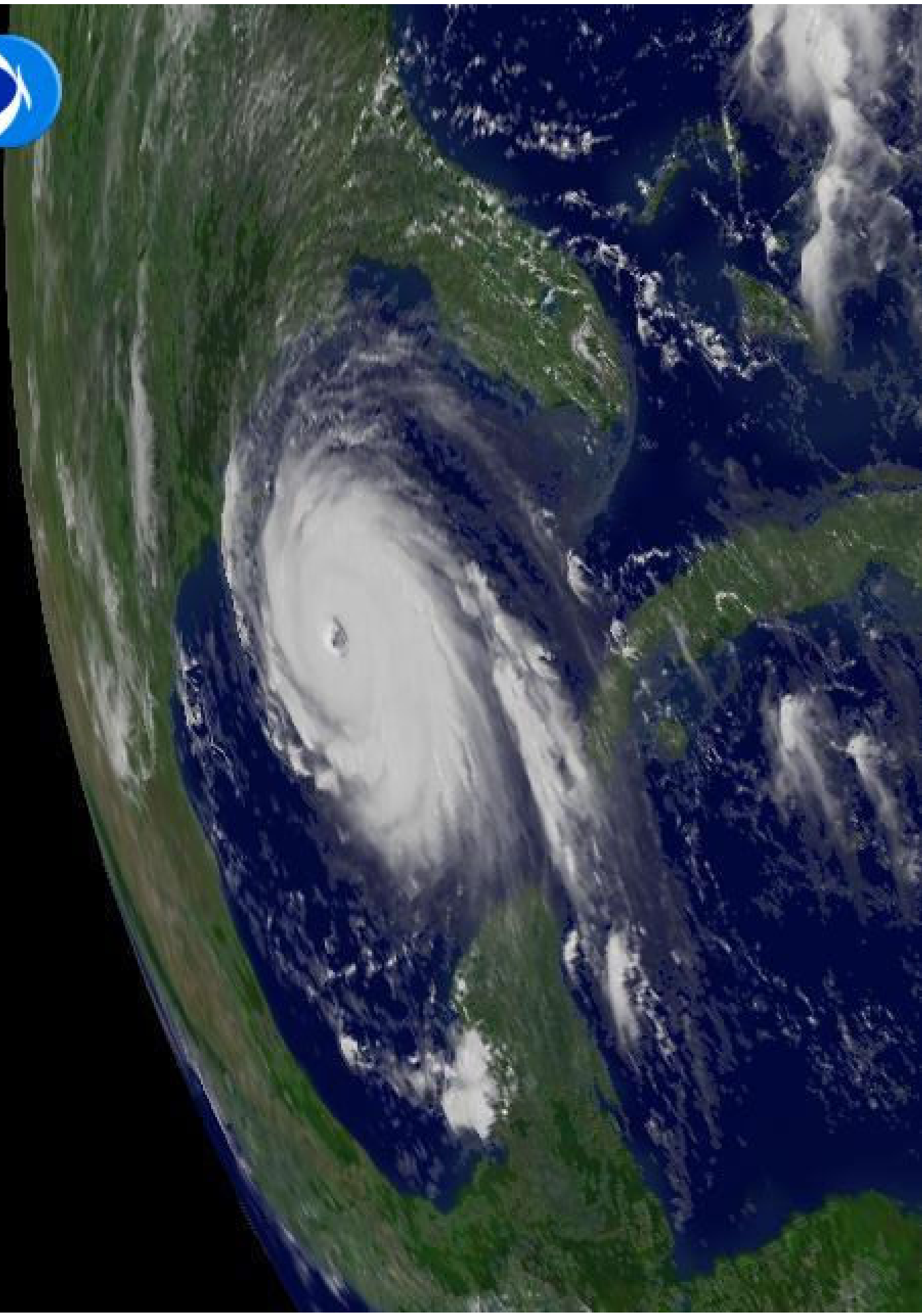
“A Seca da Amazônia em 2005 considerada uma das mais severas em 100 anos”



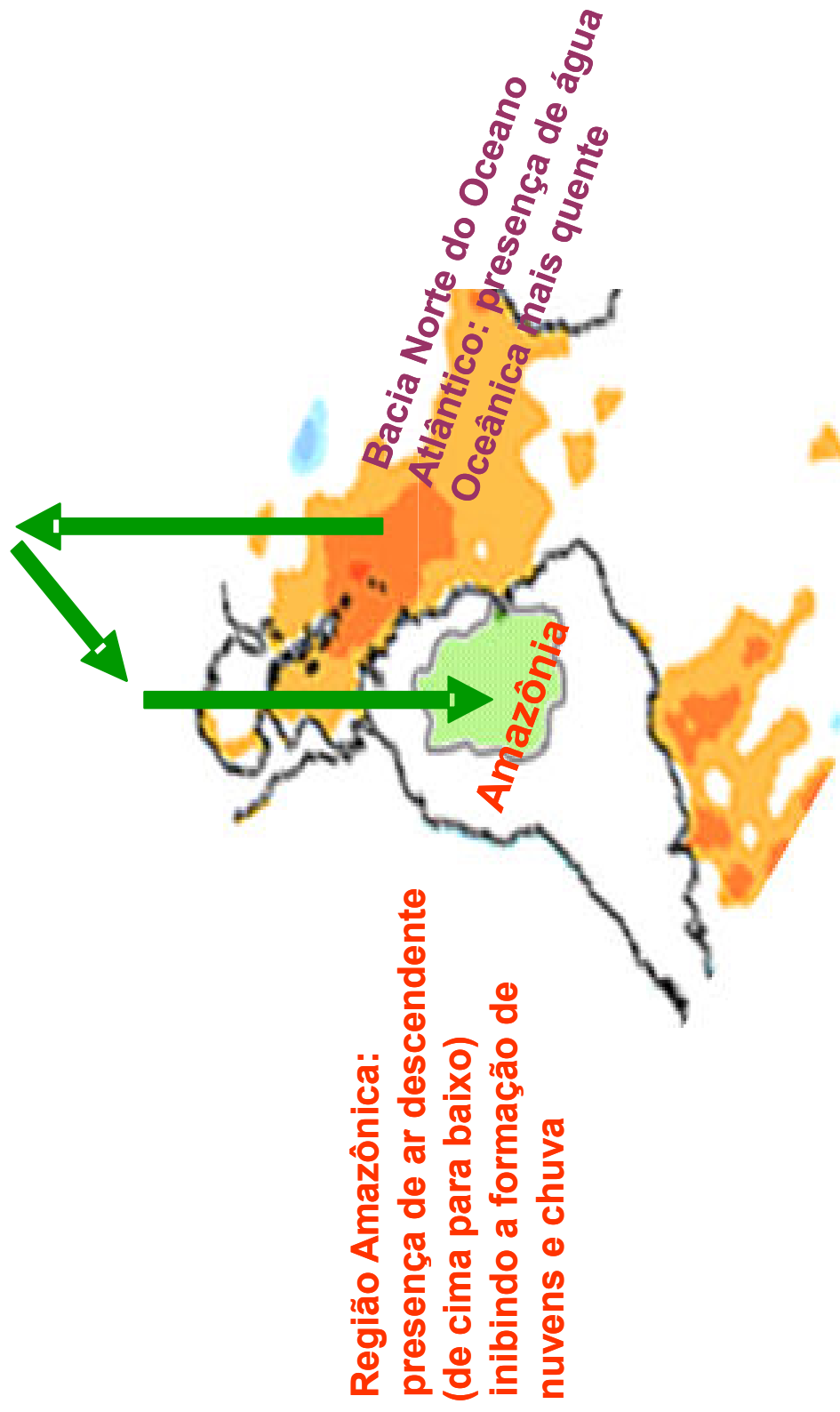
ATSM & Anomalia de Vento 850mb SET/2005



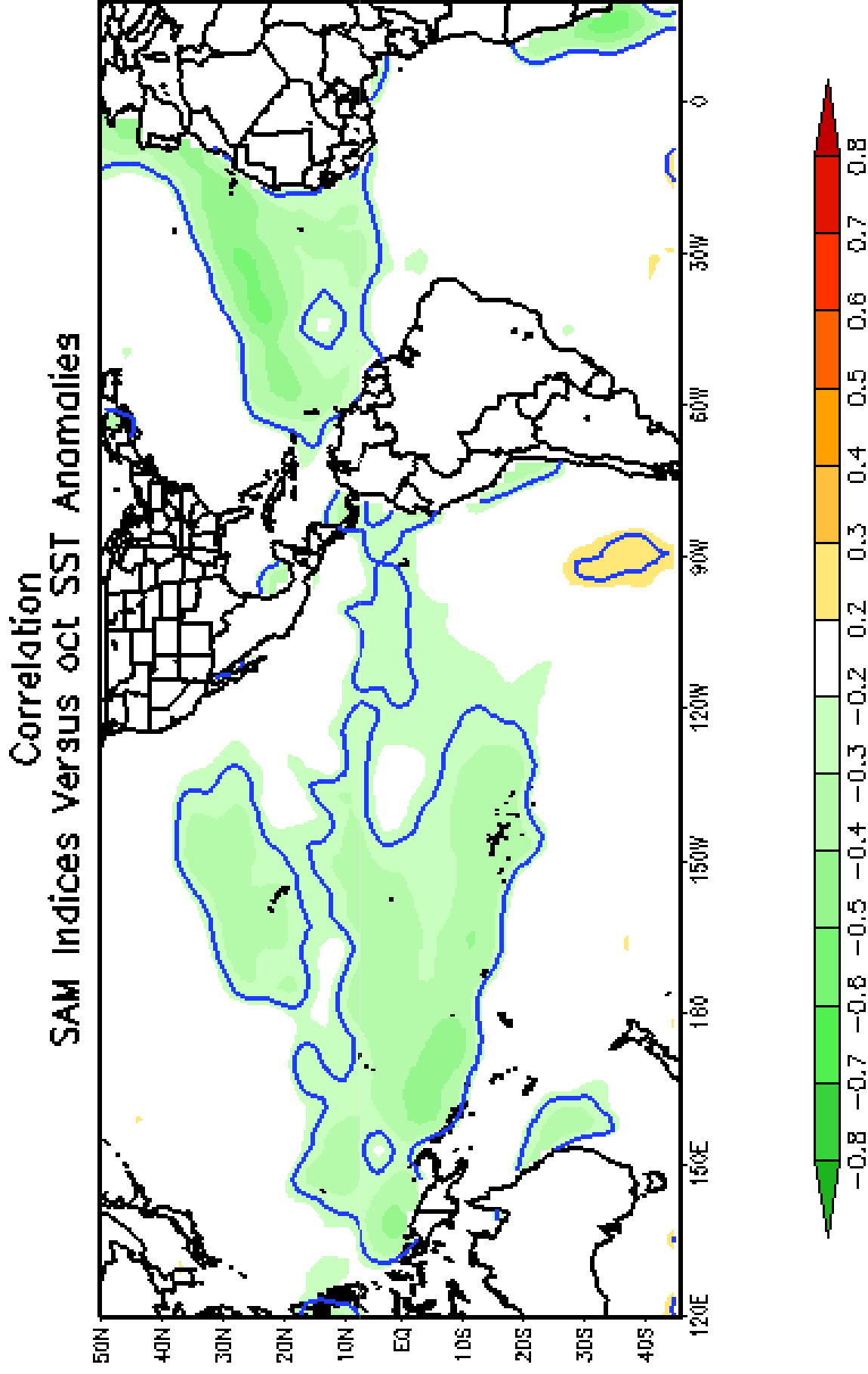
Furacão Katrina



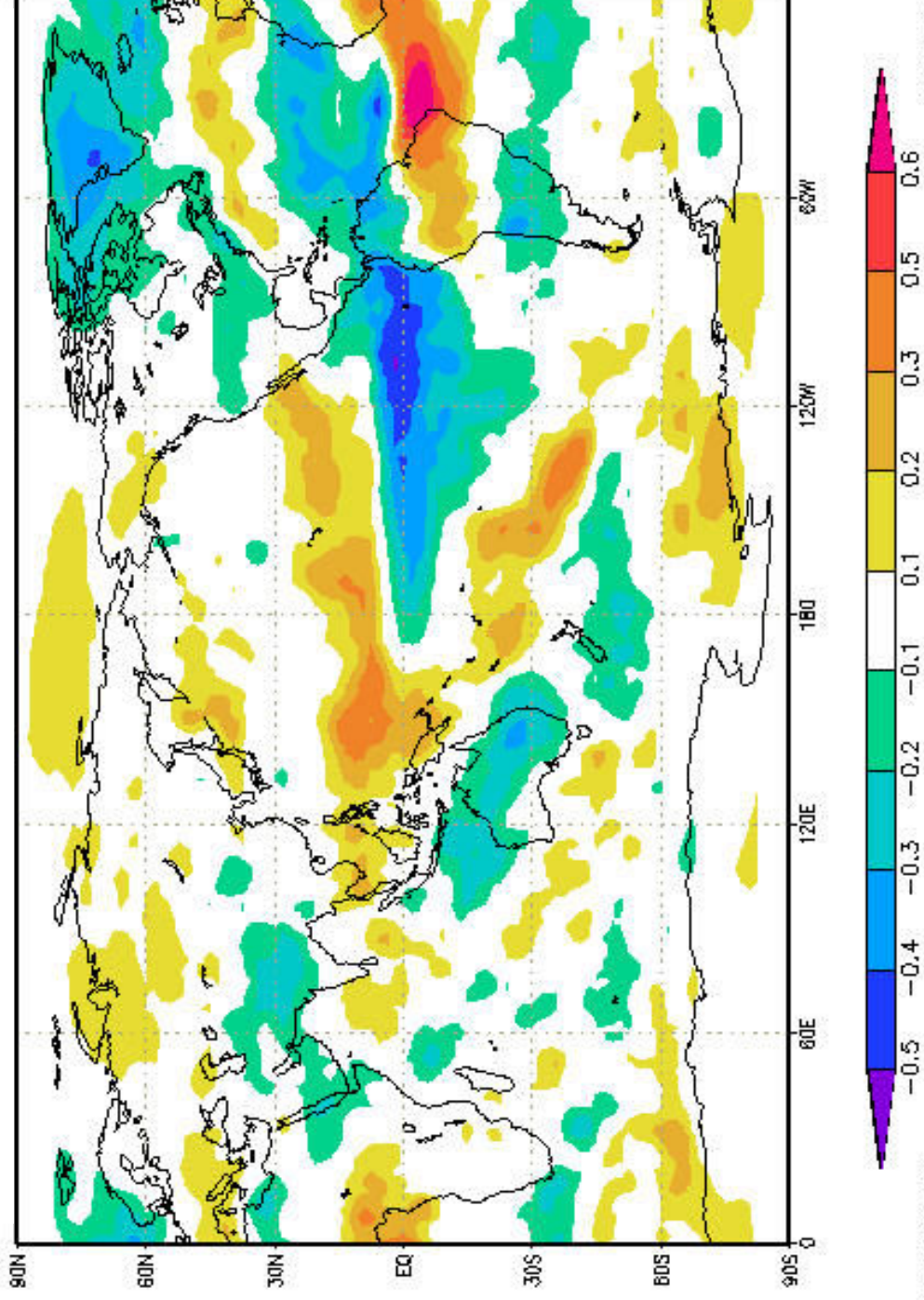
Padrão observado em Setembro 2005



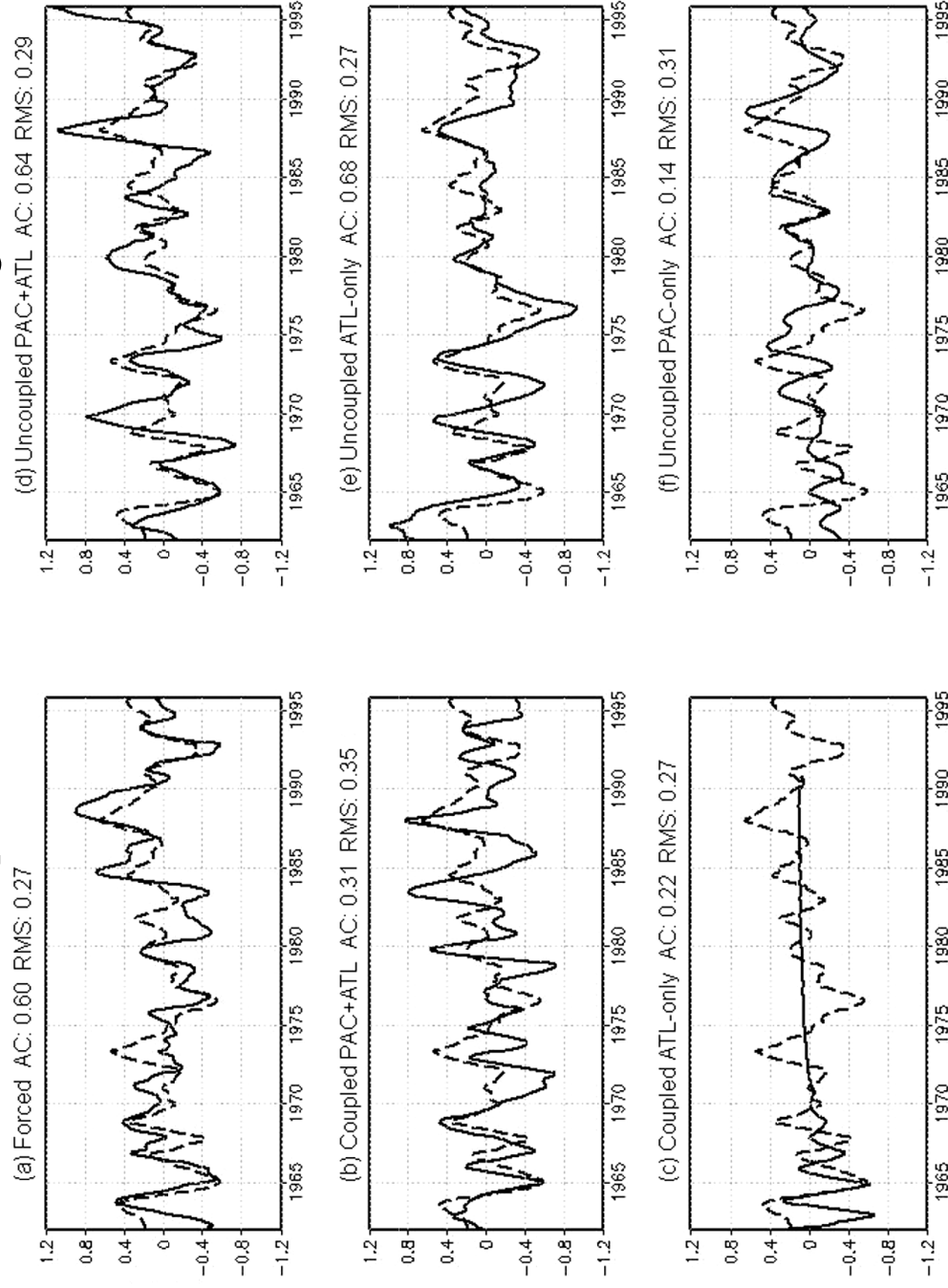
Correlation of Dec-March rainfall anomalies over Southern Amazonia (5-15°S – 50-75°W) and Global October SST anomalies



ATLANTIC ITCZ POSITION AND OLR ANOMALY CORRELATION

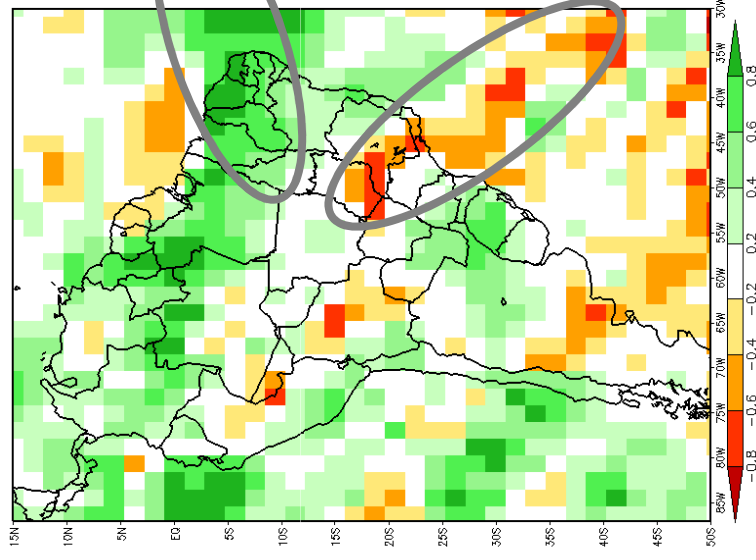


Tropical Atlantic SST coupled variability

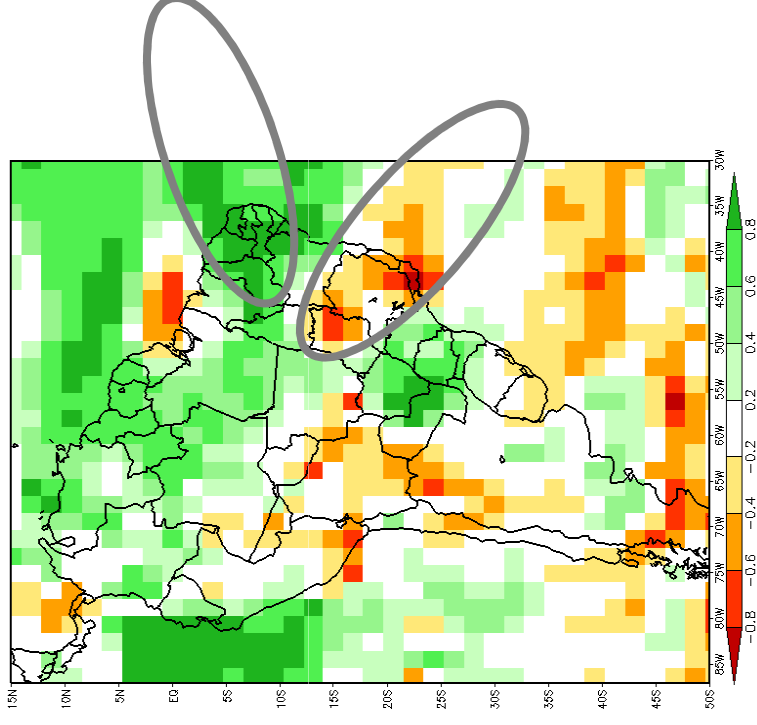


Scientific Challenge: SACZ 2-tier low predictability

DJF



MAM



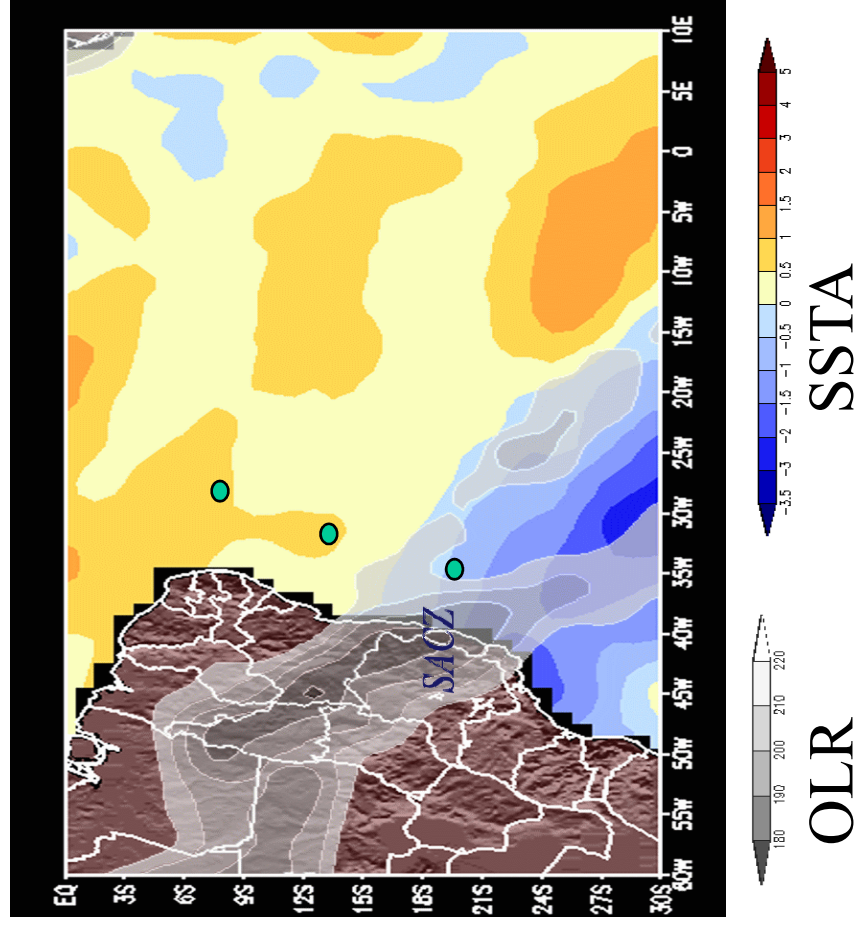
Marengo et al. (2002)

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



The South Atlantic Convergence Zone (SACZ)

- SACZ formation over cold waters => Atmospheric forcing of underlying SST?
- Robertson and Mechoso (2002)
- Chaves and Nobre (2004)
- De Almeida et al (2007)
- Nobre et al (2008, in prep)

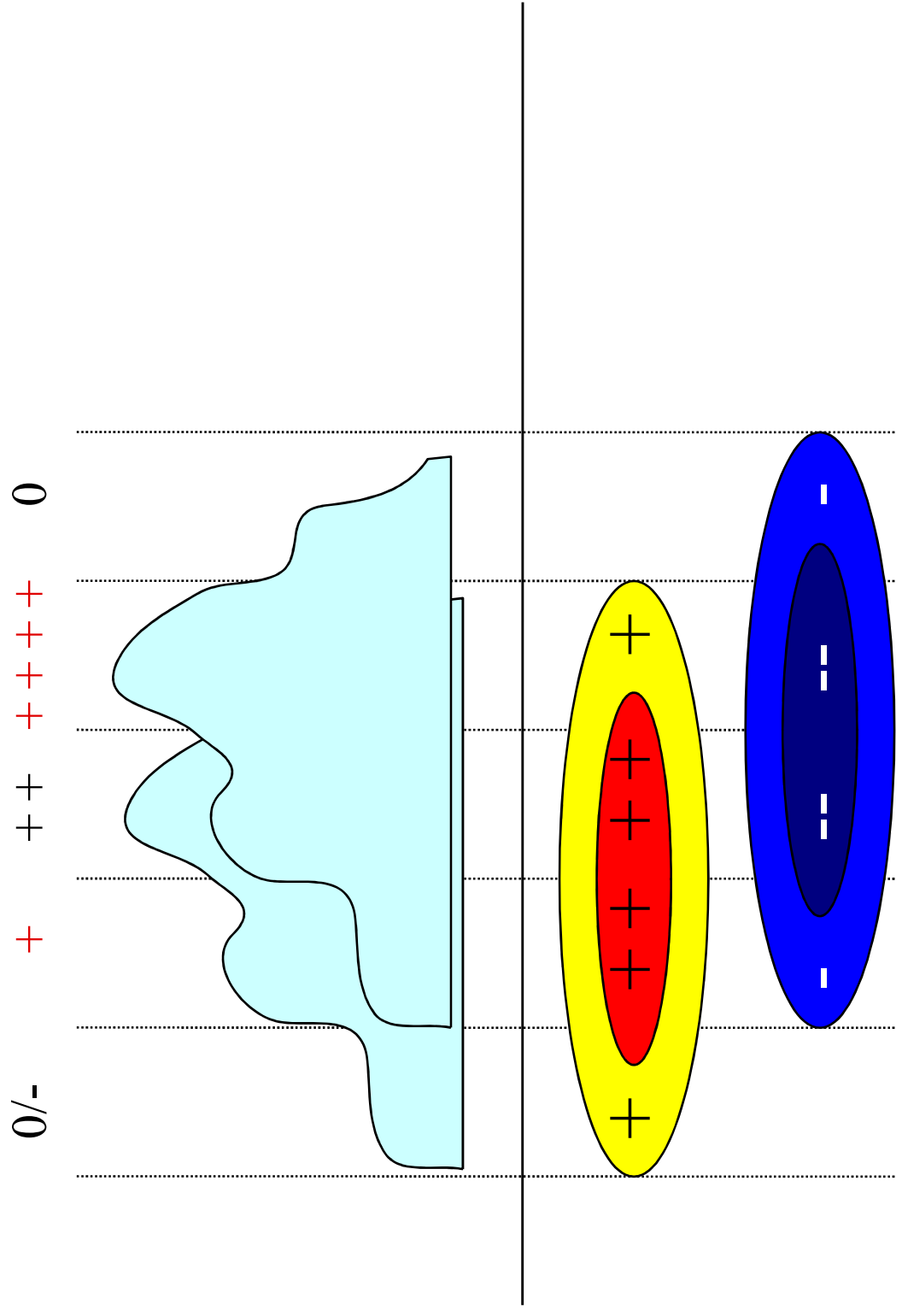


OBS: 17-25 NOVEMBER 1999

The SACZ

- Convective system active during the austral summer
- Interannual variability ~ climatology
- Negative feedback with SST (Chaves & Nobre, 2004)
- +SST -> +SACZ -> -SST
- Confirmed with NCEP data (De Almeida & al. 2007)

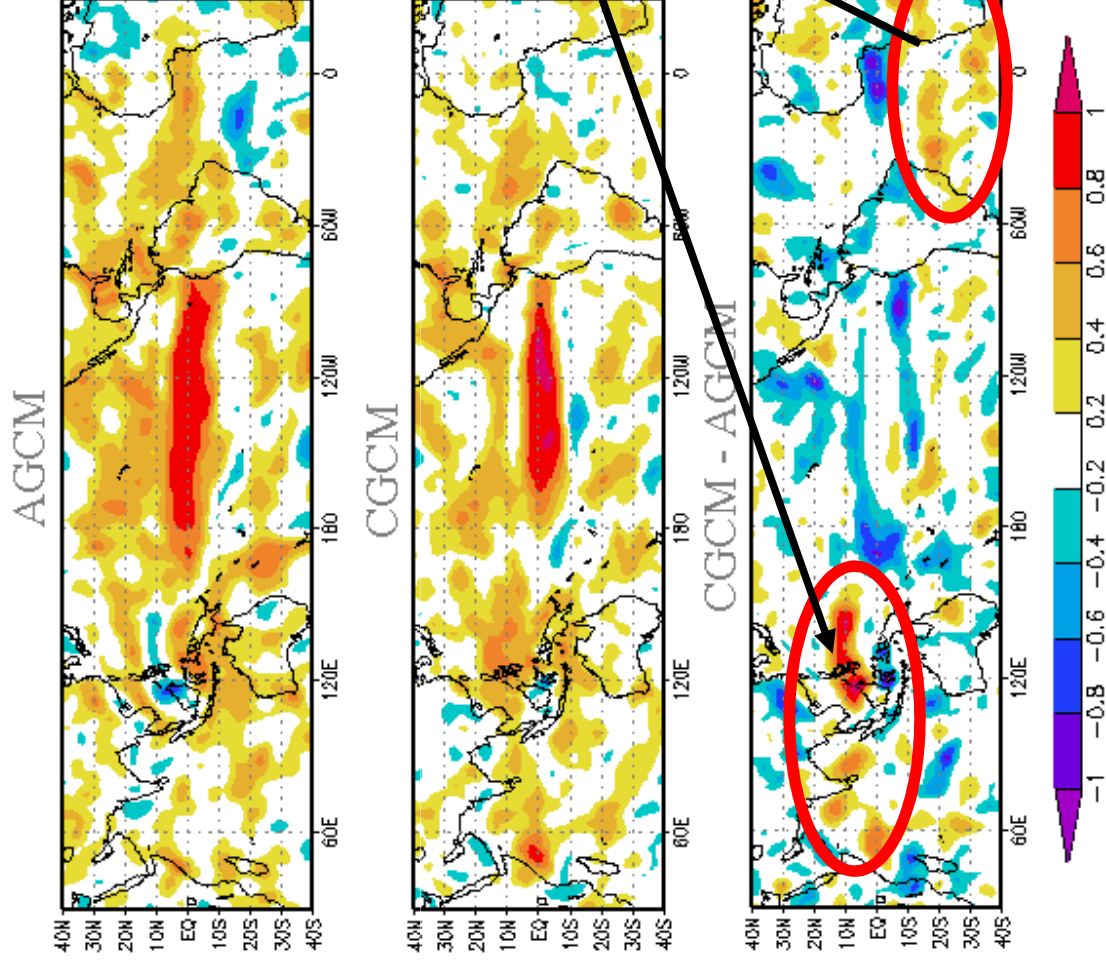




VPM11 Miami, 25-27 March 2008

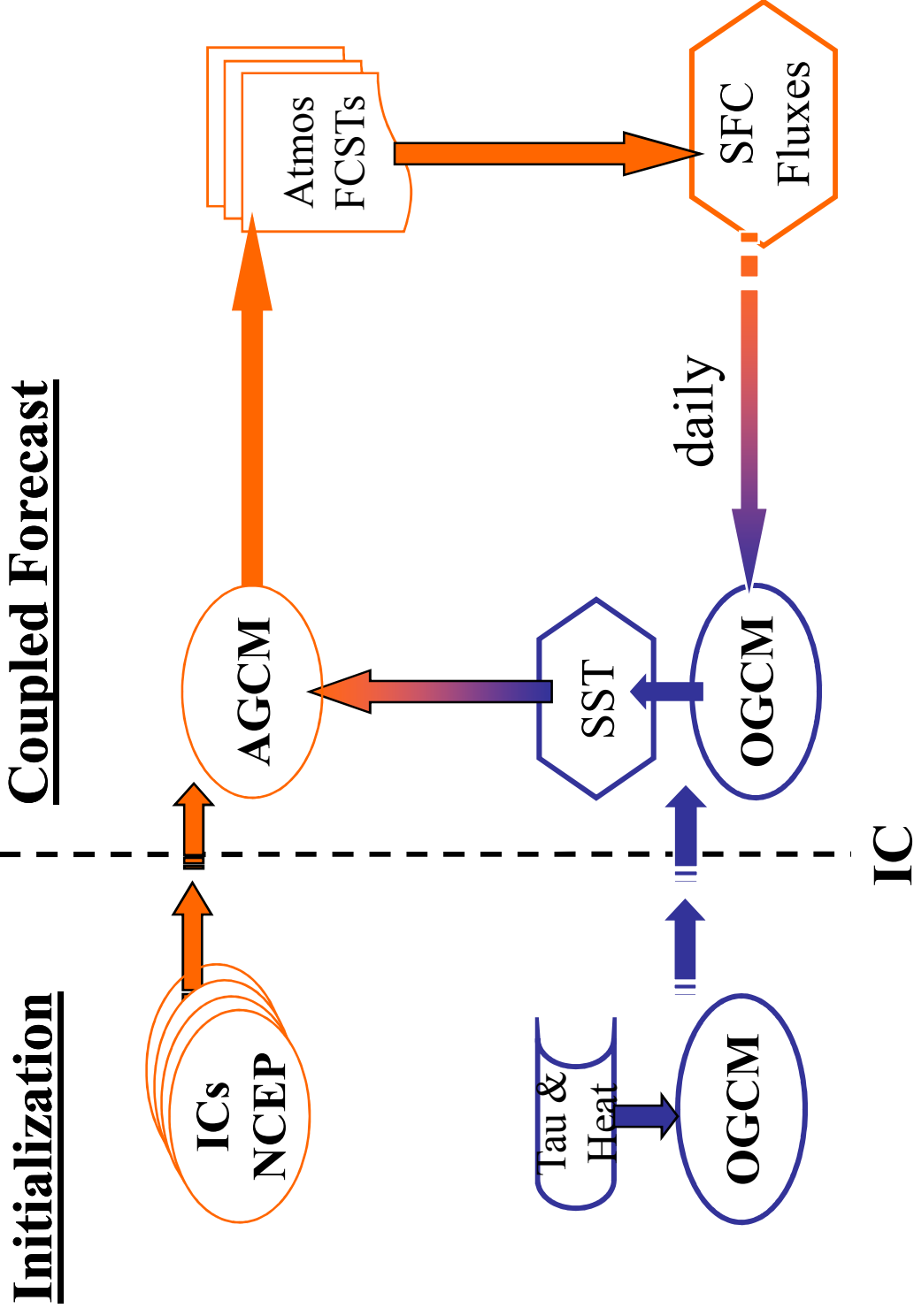
Coupled Ocean-Atmosphere processes at play

DJF Precipitation Forecasts anomaly correlations

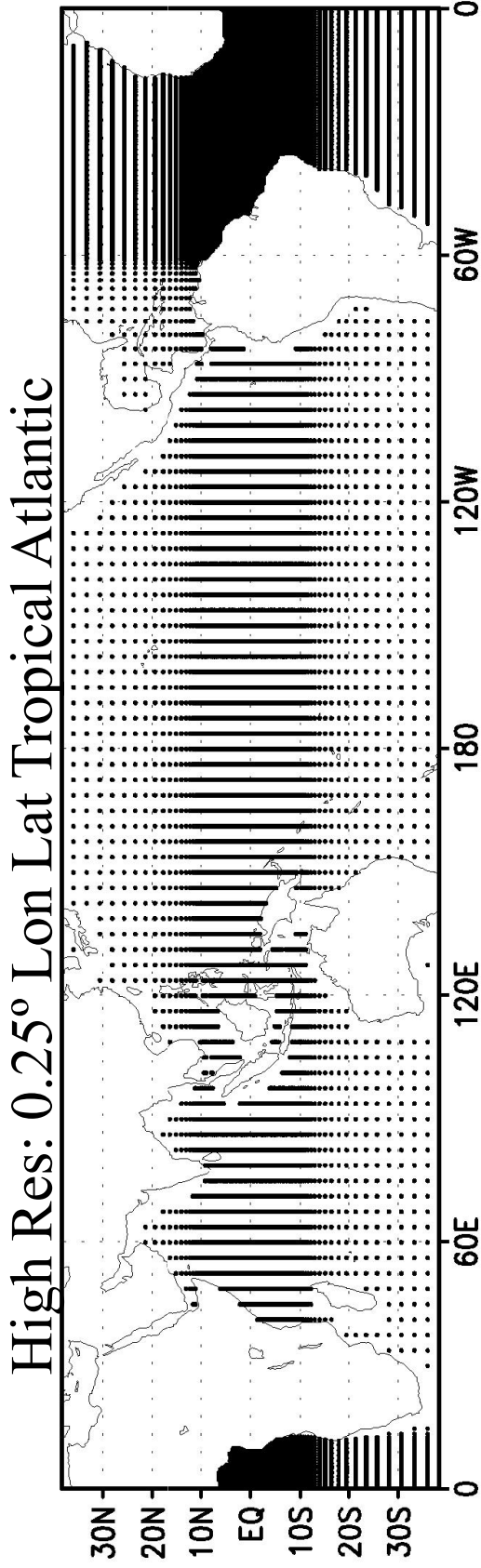


Nobre et al. (2008, in prep)

CPTEC's Coupled GCM V.1.0

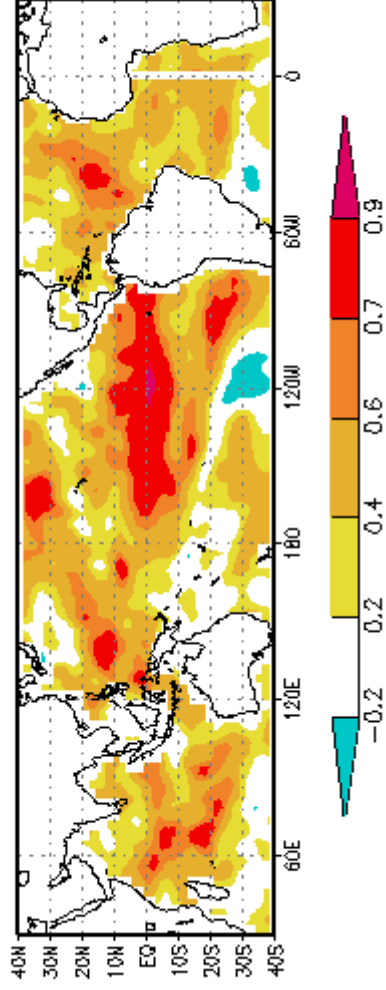


OGCM Grid

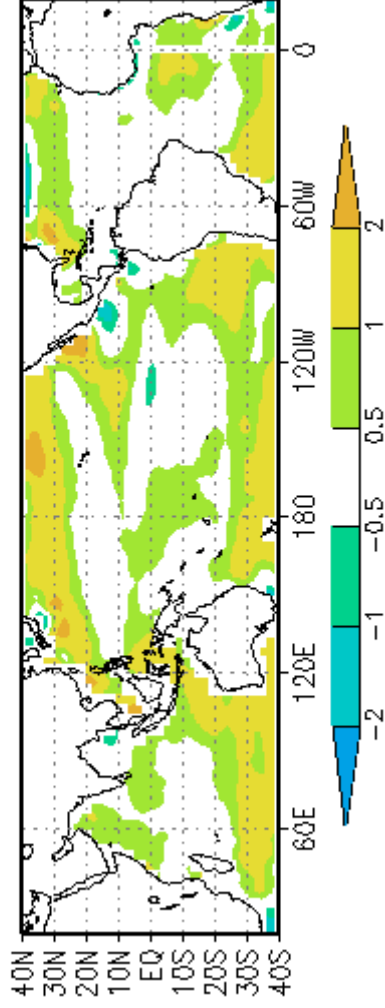


CPTEC CGCMxOISST DJF TEMP ACOR

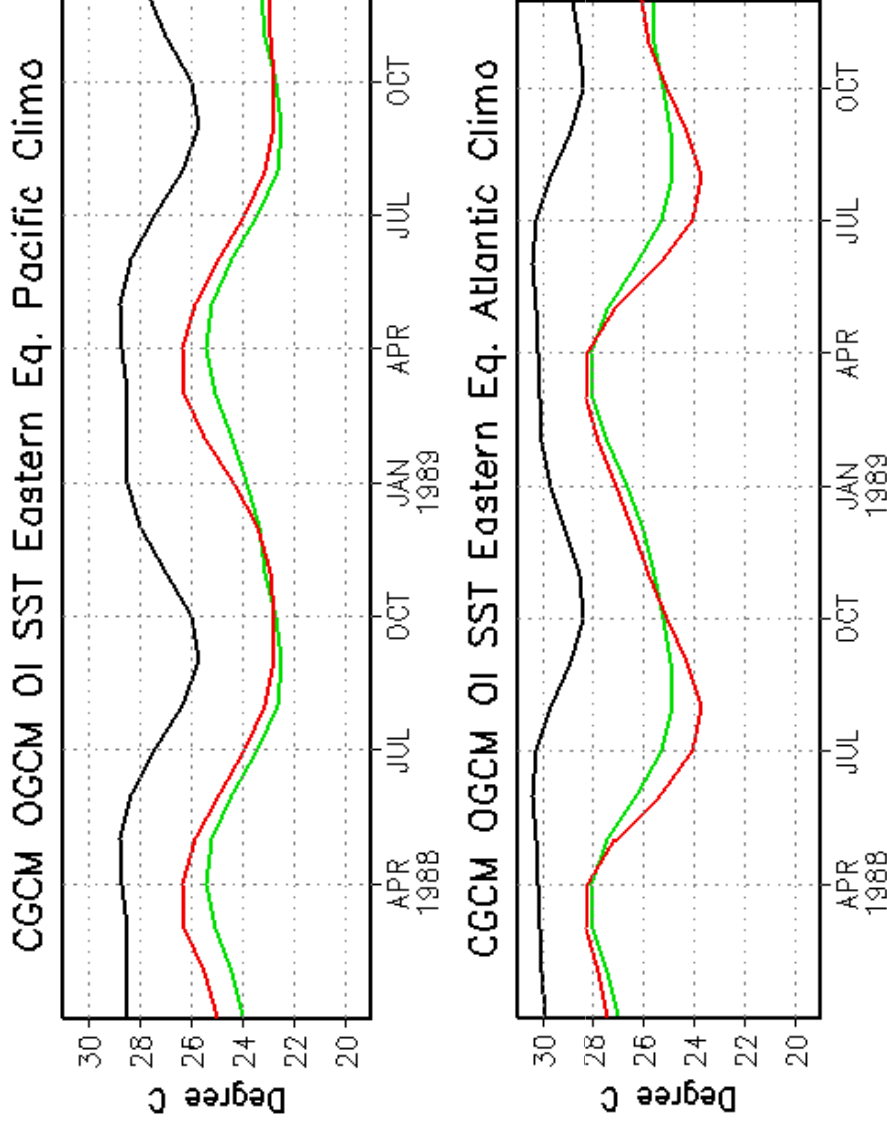
NOV IC



BIAS DJF TEMP (deg C) IC NOV CPTEC CGCM x OISST



Eastern Oceans' Coupled O-A Interactions



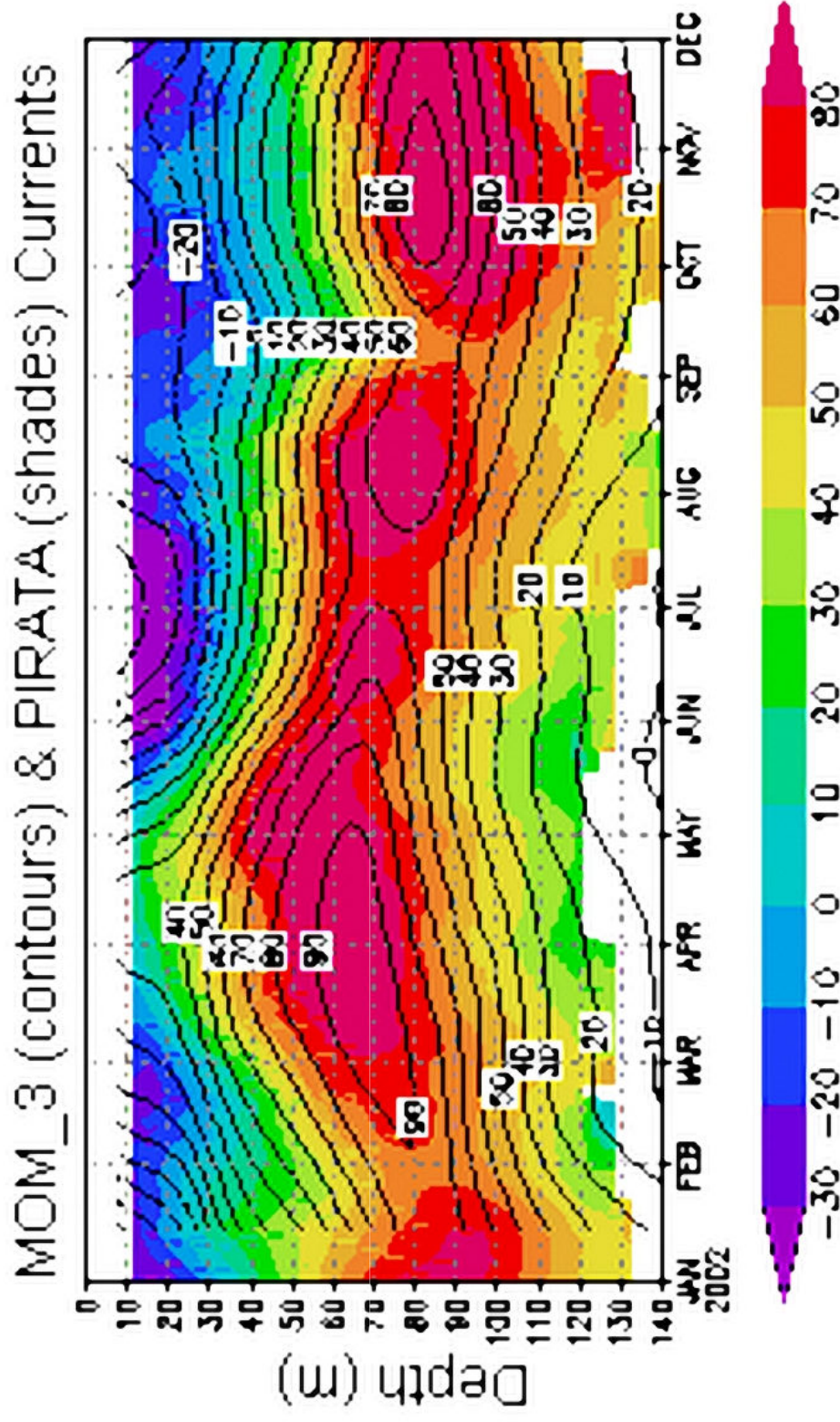
— CGCM Climatology

— OGCM Climatology

— OI-SST / NCEP Reanalysis



Atlantic EUC Obs & Simulation at 23W

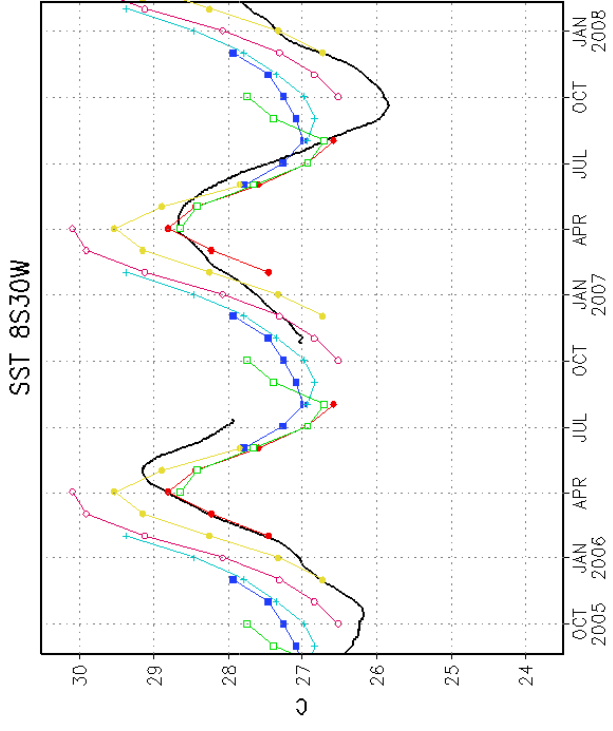
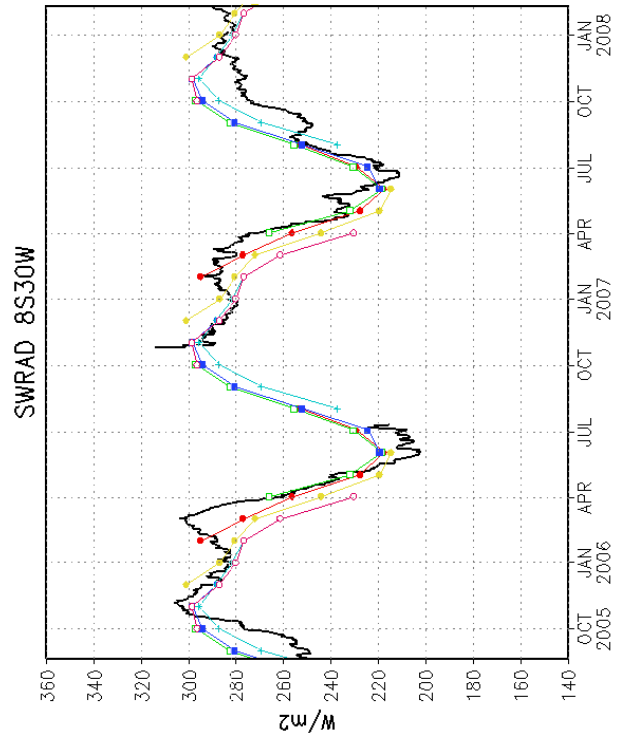


Model Configuration

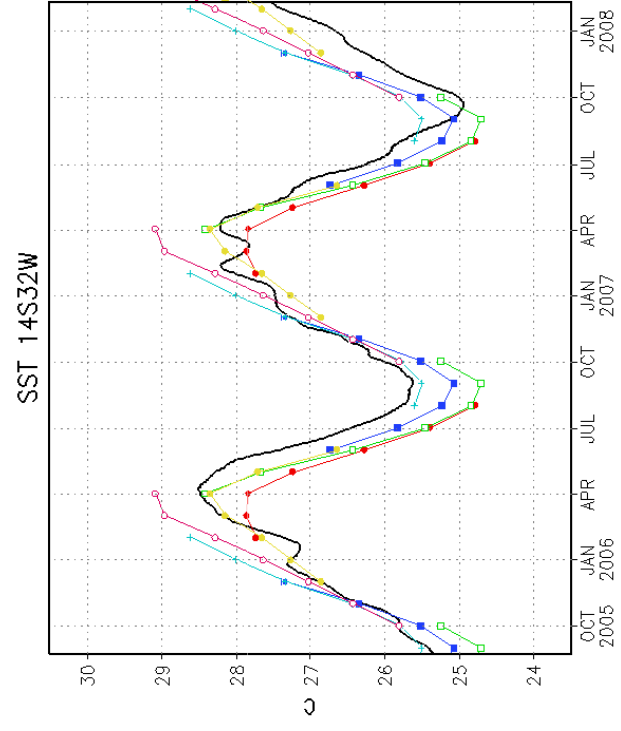
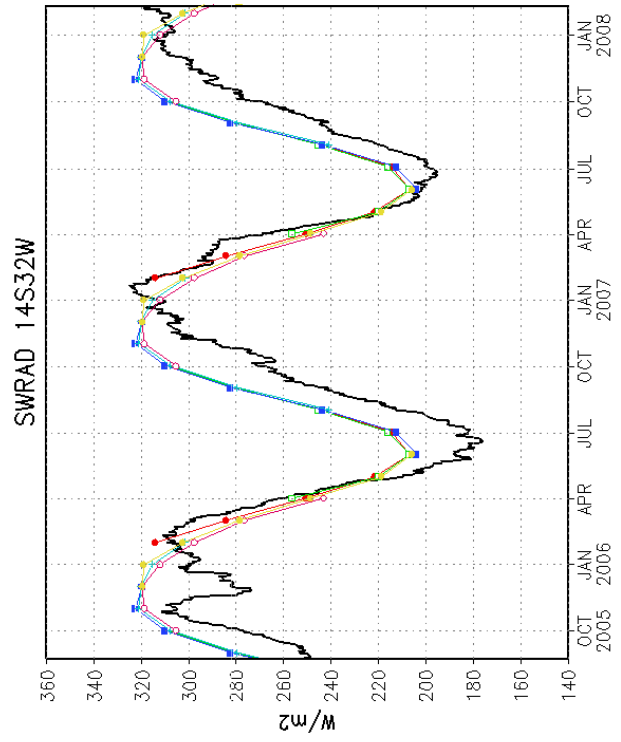
- Modular Ocean Model (MOM) version 3
- Global Tropics – 1/4 x 1/4 degree between 10° S – 10° N and 60° W – 12° E
- Pacanowski and Philander vertical mixing
- CGCM: (daily, fully coupled) to CPTEC AGCM, T062L28, RAS, SSiB.
- Atmos IC: NCEP
- Ocean IC: MOM3 forced runs, no ODA
- 10 members, 20 years of 8 month forecast runs



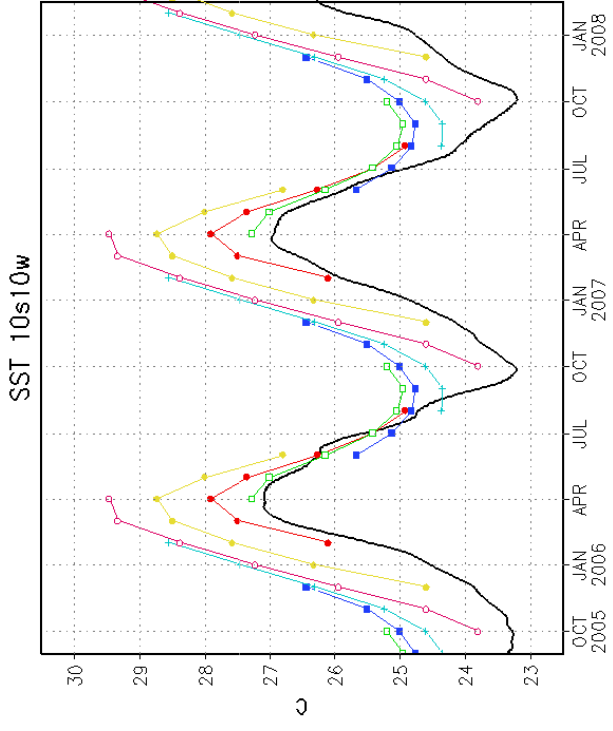
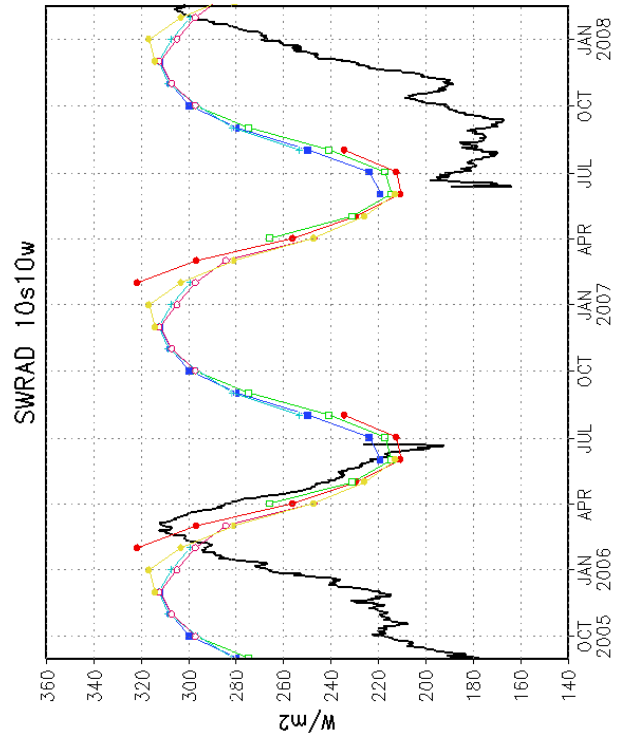
8S 30W



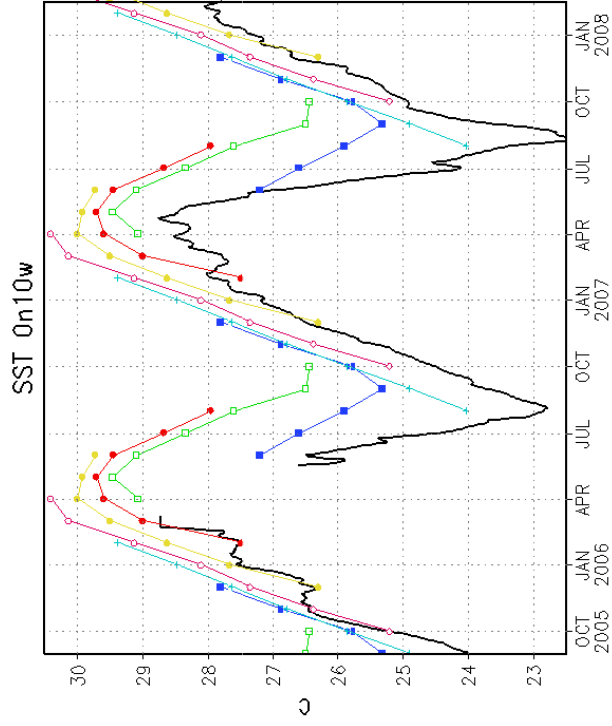
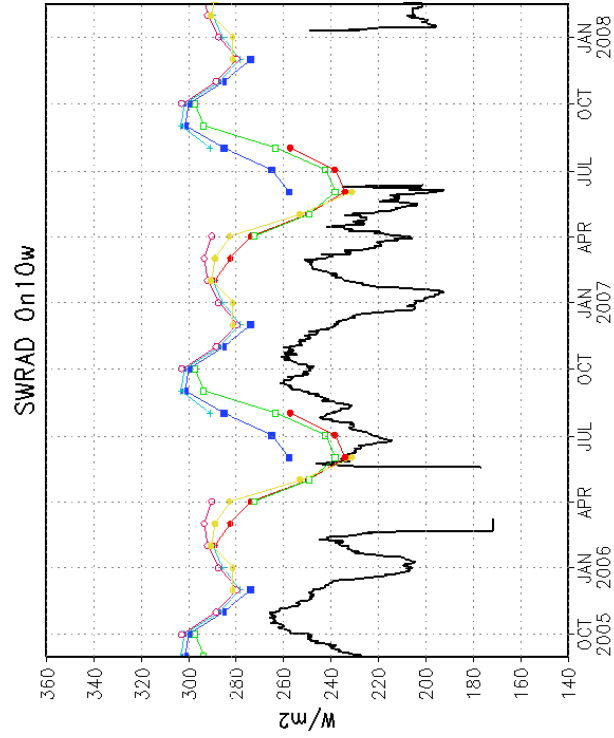
14S 32W



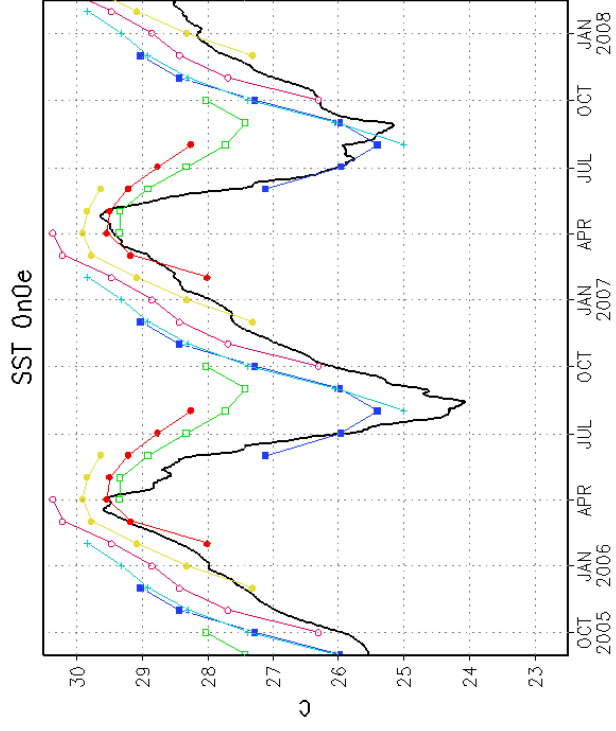
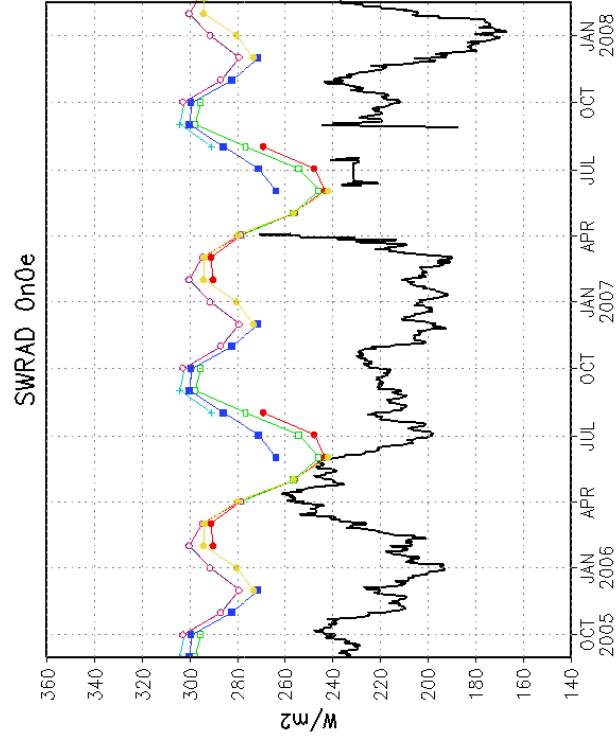
10S 10W



ON 10W

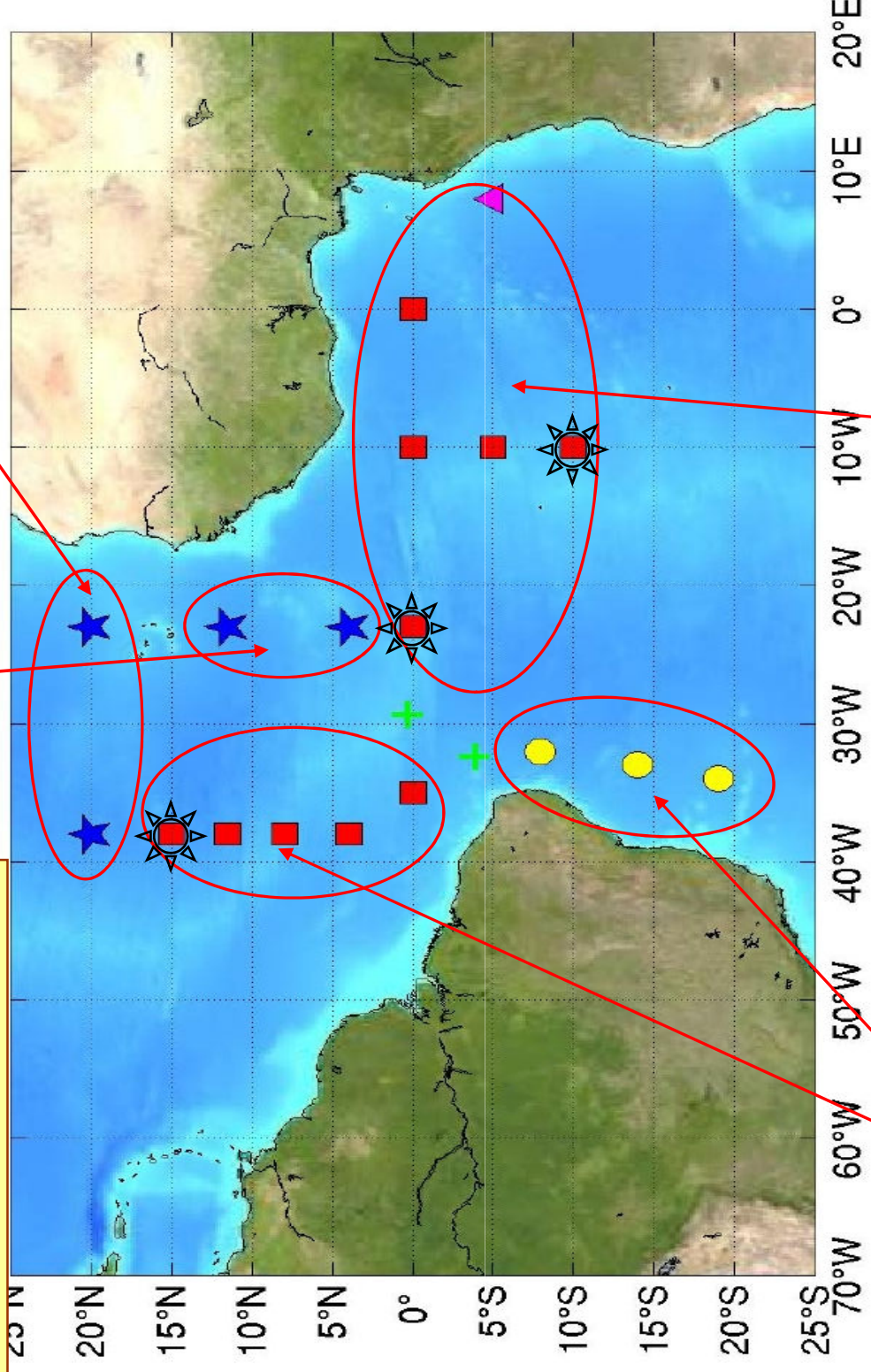


ON OE



PIRATA network status:

Maintained by USA : 4 Atlas buoys : 2 deployed in 2006, at 4N & 11N/23W, 2 at 20N/23W & 38W deployed in 2007



Maintained by France : 6 Atlas buoys + At 23°W-Equator : surface ADCP mooring since 2001

Maintained by Brazil: 8 Atlas buoys



☀ Ocean Sites reference flux (swr, lwr, rh, air T, SLP).

Concluding Remarks

- Tropical Atlantic is an important asset to predict South American climate variations
 - Thermally direct driven circulations (e.g. ITCZ)
 - Coupled modes (e.g. SACZ)
- Tropical Atlantic Variability (TAV) is likely to be a damped mode which depends on remote forcings (e.g. ENSO)
- Fully Coupled O-A models necessary to predict TAV (yet, long way to go).
 - Stratus clouds and zonal currents still a challenge

