



# Brazilian Efforts toward an Earth System Model

Paulo Nobre

National Institute for Space Research – INPE

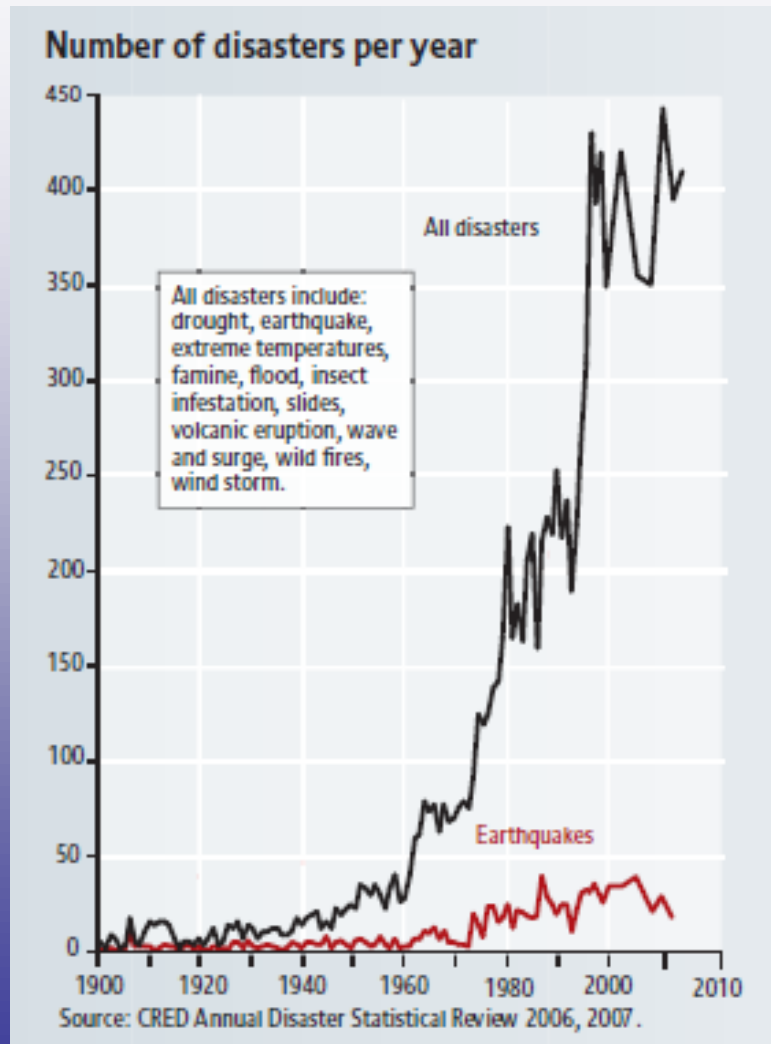
Center for Weather Prediction and Climate Studies – CPTEC

Center for Earth System Science – CCST

Viçosa, 24 de fevereiro de 2010



# What's Global Climate Change about...





# What can we contribute?

- Land surface
  - Vegetation dynamics
    - Forest fires, agriculture, reforestation...
  - Continental hydrology
    - Sediment, chemistry transport to oceans
- Atmosphere
  - Rainfall
  - Chemistry/Aerosol
- Ocean
  - Biogeochemistry
    - CO<sub>2</sub> fluxes

# Brazilian Model of the Global Climate System

Mid-1970s

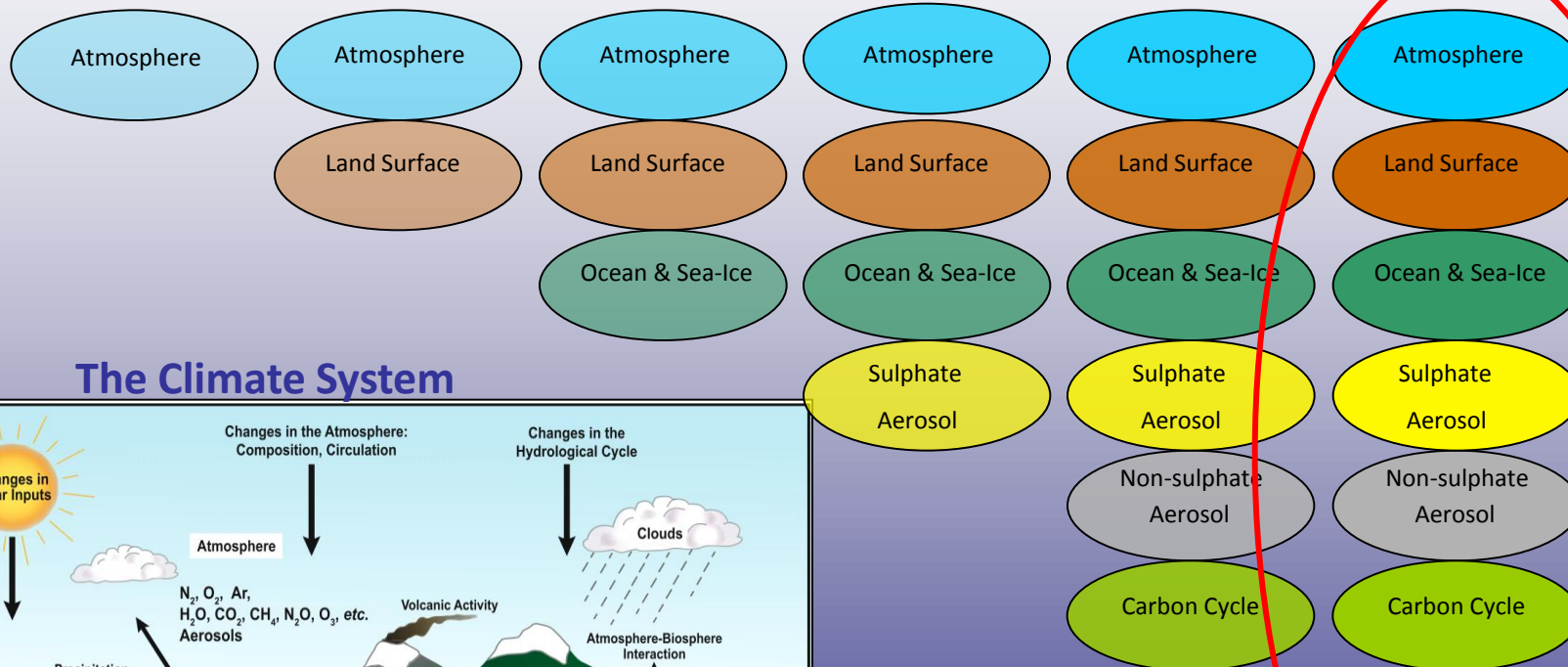
Mid-1980s

Early 1990s

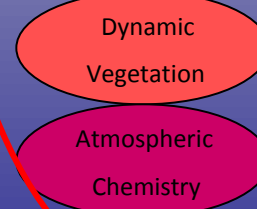
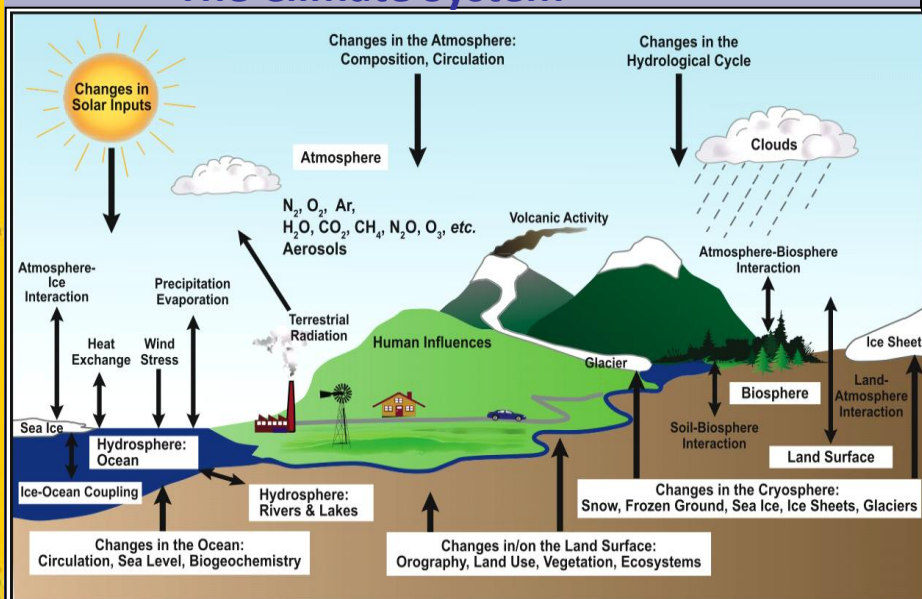
Late 1990s

Around 2000

Mid 2000s



## The Climate System





CPTEC.2.0 mpi, T213L64

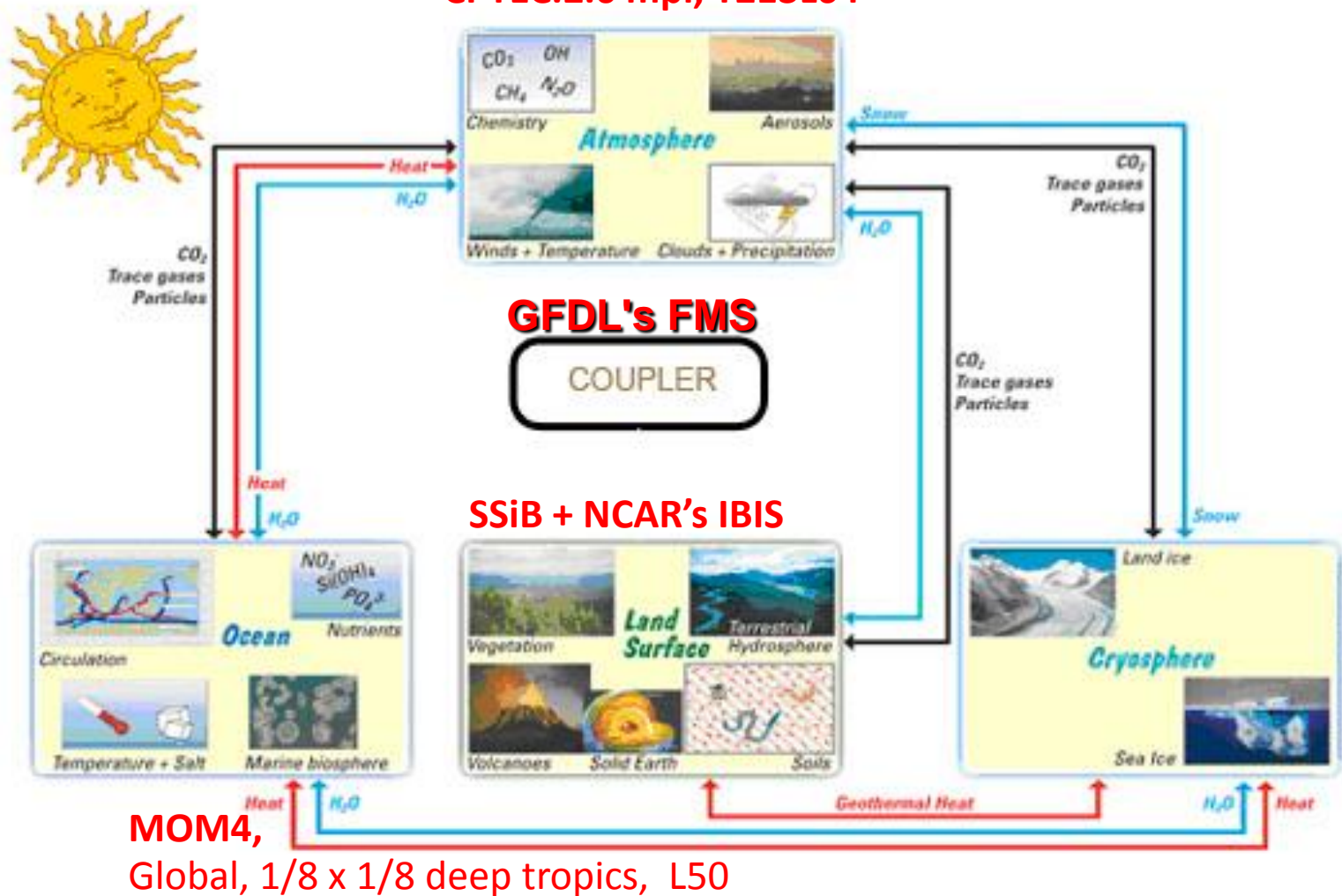
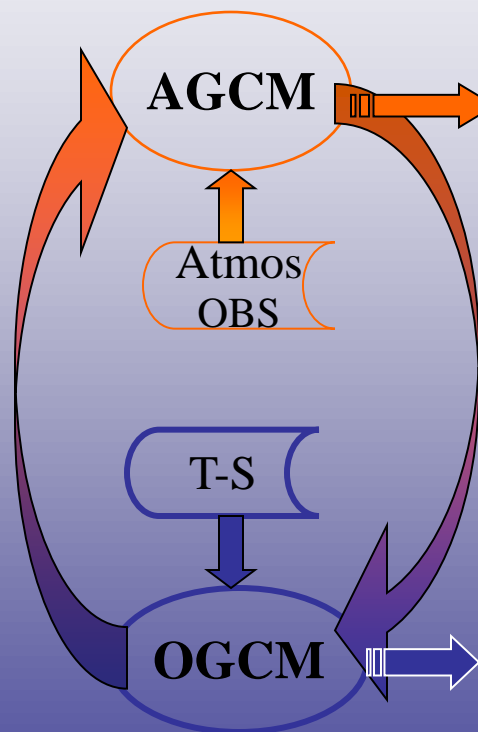


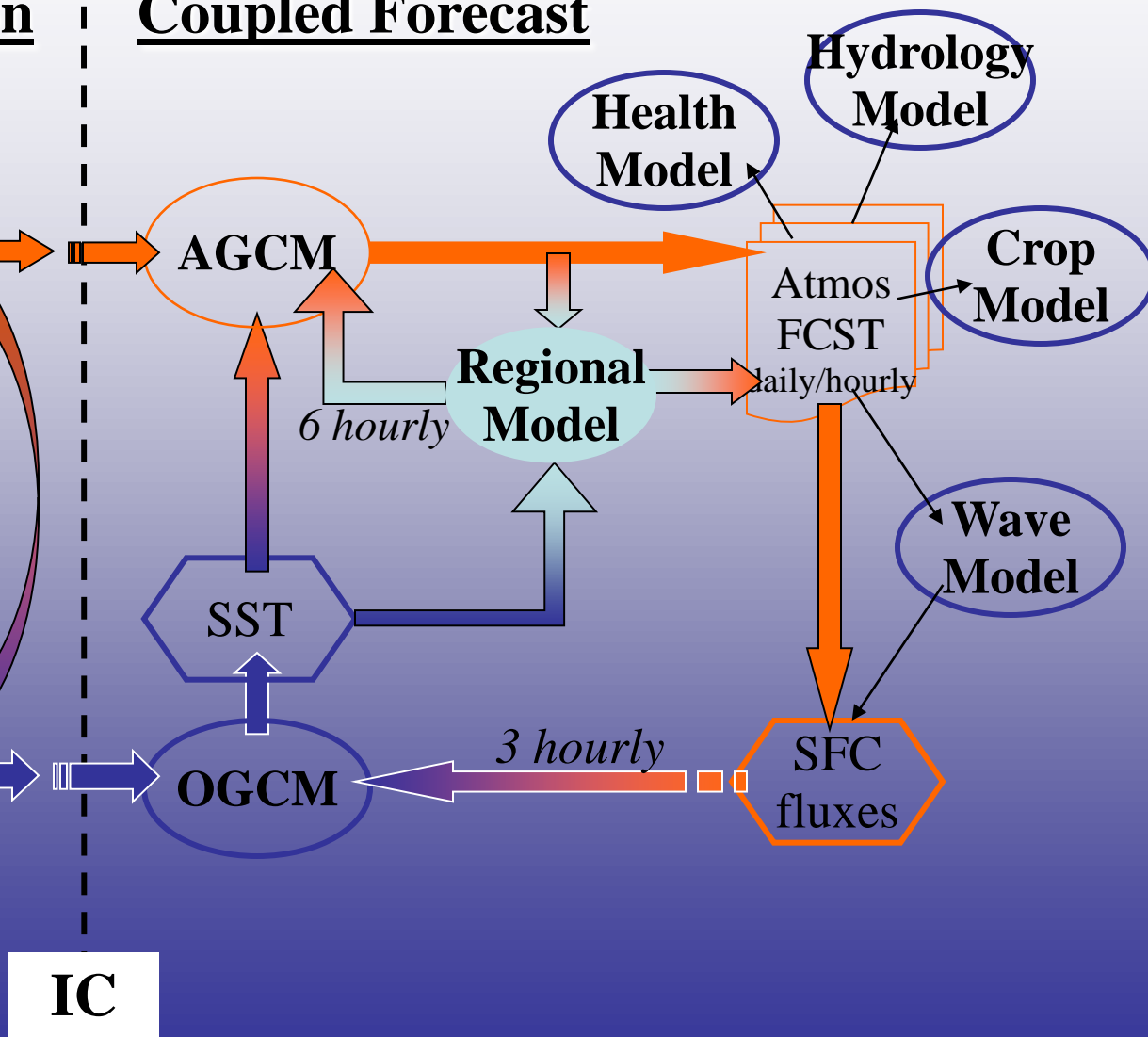
Figure 1 - The Global Climate System. A modified "Bretherton Diagram" highlighting linkages between biogeochemical and physical climate systems. (Guy P. Brasseur, NCAR)

# INPE's Climate Forecast Coupled Suite Goal

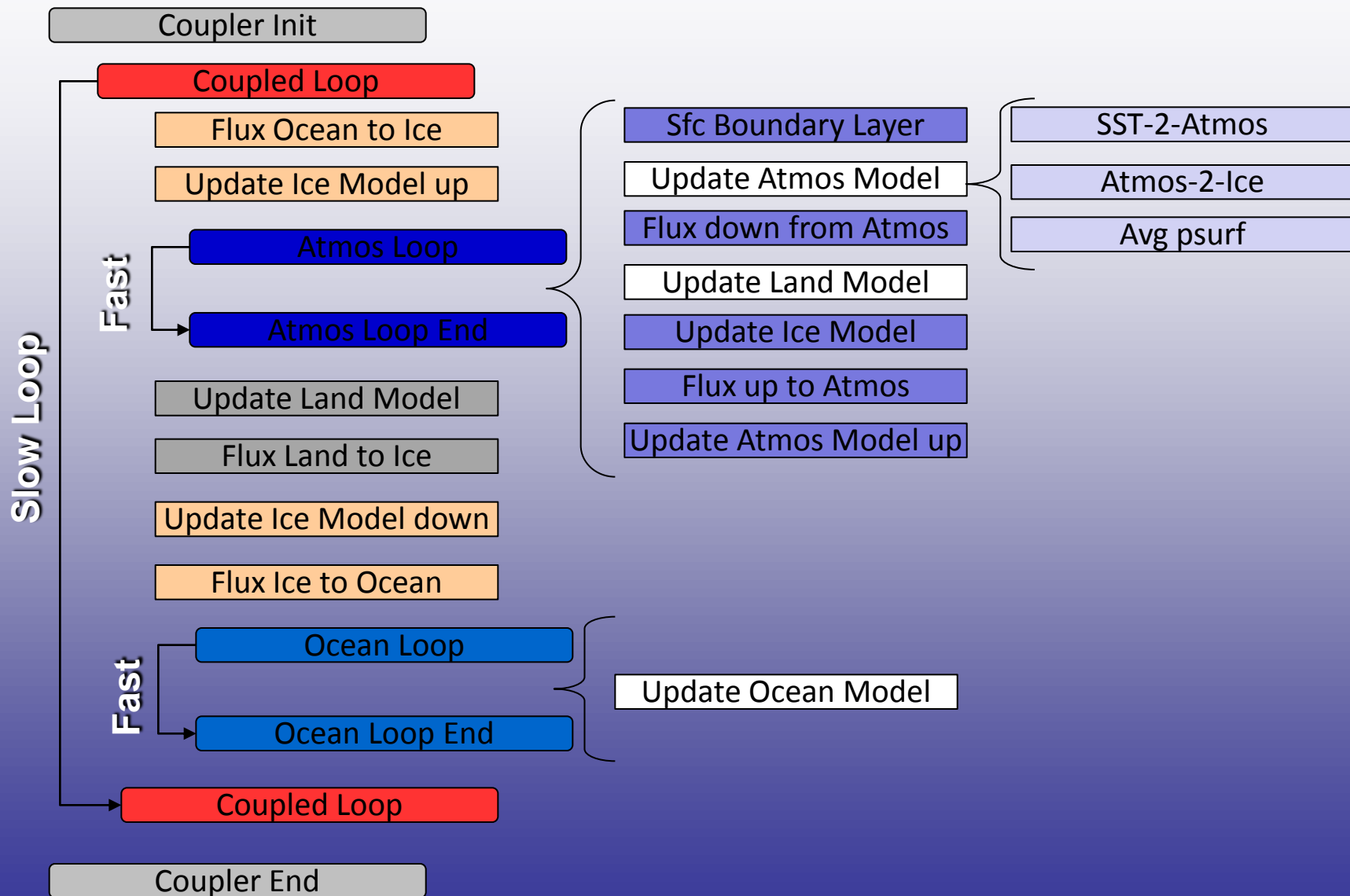
## Data Assimilation



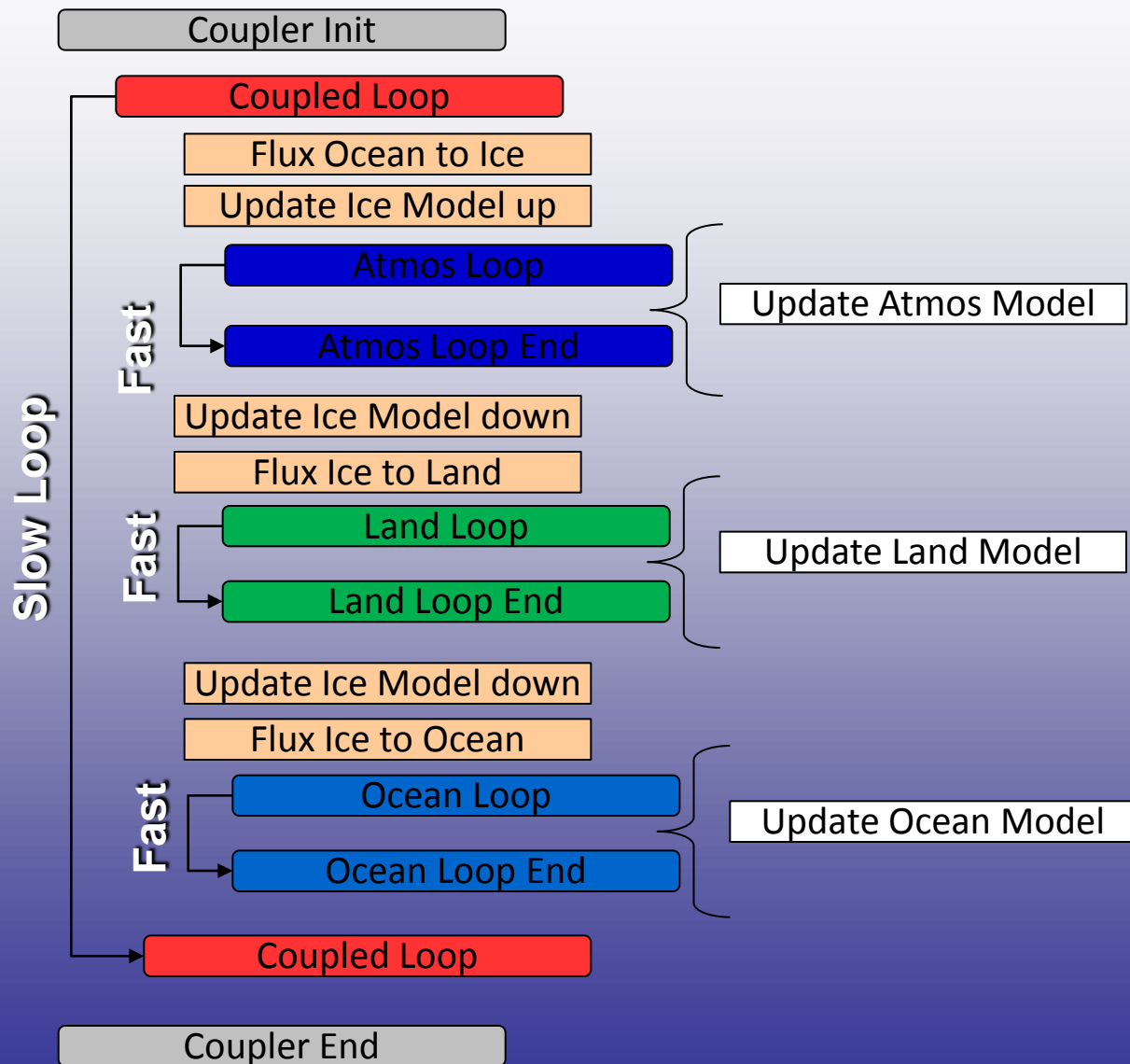
## Coupled Forecast



# INPE's CGCM FMS implementation



# INPE's CGCM FMS implementation







# Component models...

- Atmos GCM:
  - CPTec.2.0 mpi/open\_mp,
  - Semi-Lagrangian,
  - Resolution T62L64; T126L64; T213L64
    - Increased PBL and Stratosphere vertical resolution
  - RAS/Grell deep cumulus convection
    - Improved stratus parameterization scheme
  - atmospheric chemistry & aerosols
- Land Surface Model: IBIS/INLAND
  - Dynamic vegetation
  - Carbon Cycle
  - Fire Model
  - Improved hires land surface hidrology



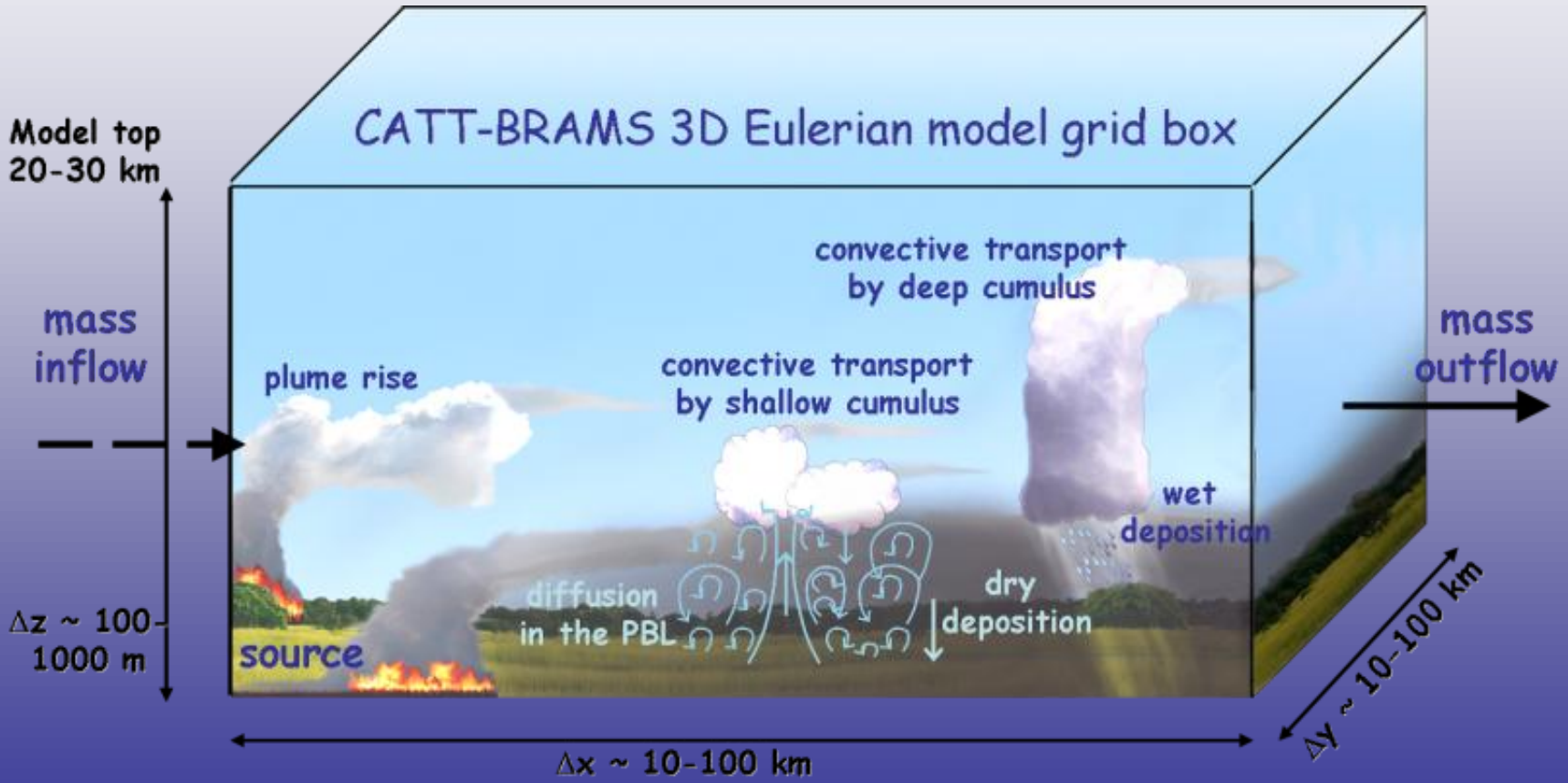
# Component models...

- OGCM:
  - MOM4,
  - 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 (Topaz, Bling)
- GFDLs FSM coupler
  - Up to 3-hourly coupling interval (lim. atmos radiation)

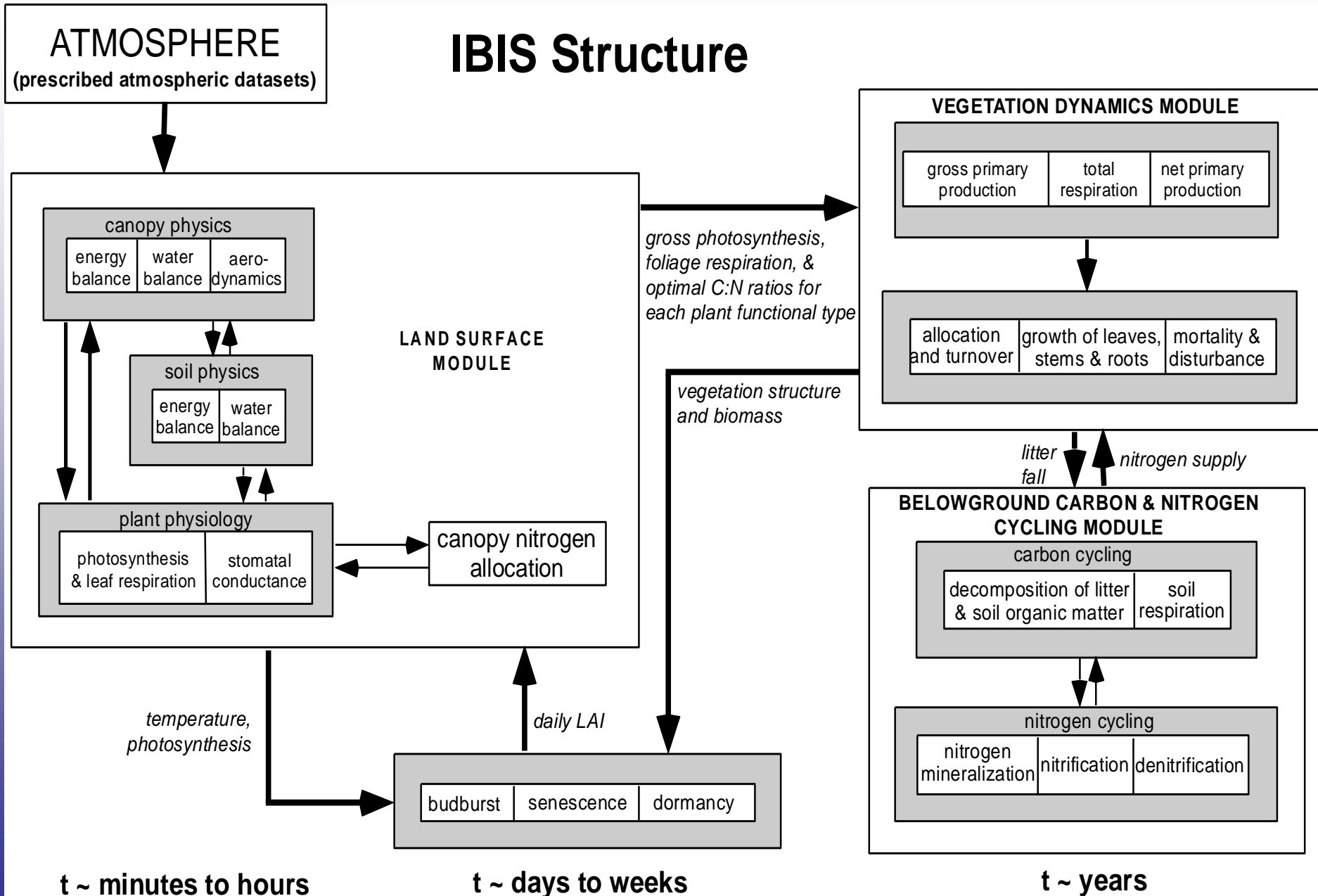
# INPE developments on the atmospheric chemistry modeling



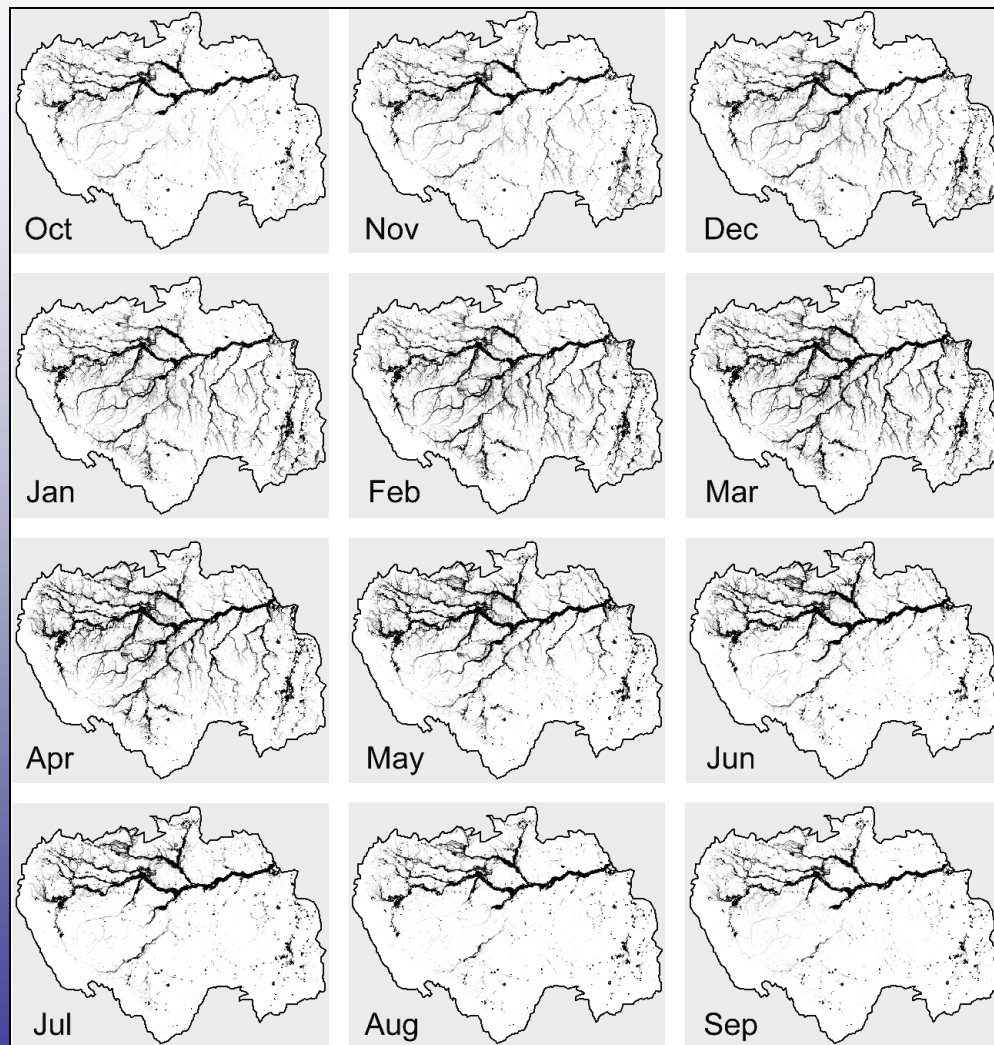
## Coupled Chemistry-Aerosol-Tracer Transport model to the Brazilian developments on the RAMS



## IBIS Structure

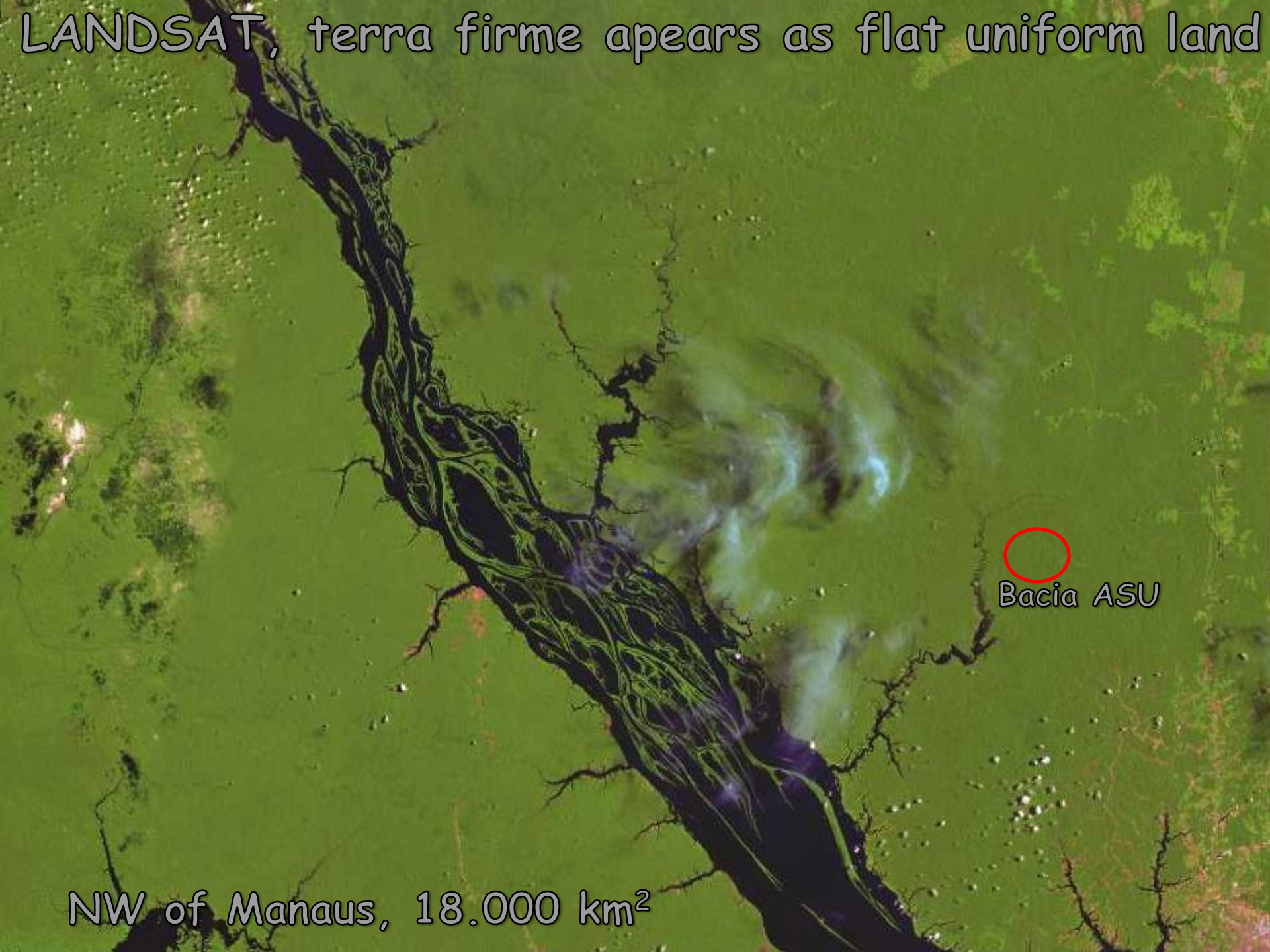


- Applications over:
  - Amazônia
  - Pantanal
  - Araguaia
- Implications:
  - Flux exchanges between sfc and atmos
  - Hydrology
  - Carbon cycle



Costa et al., in press

LANDSAT, terra firme appears as flat uniform land



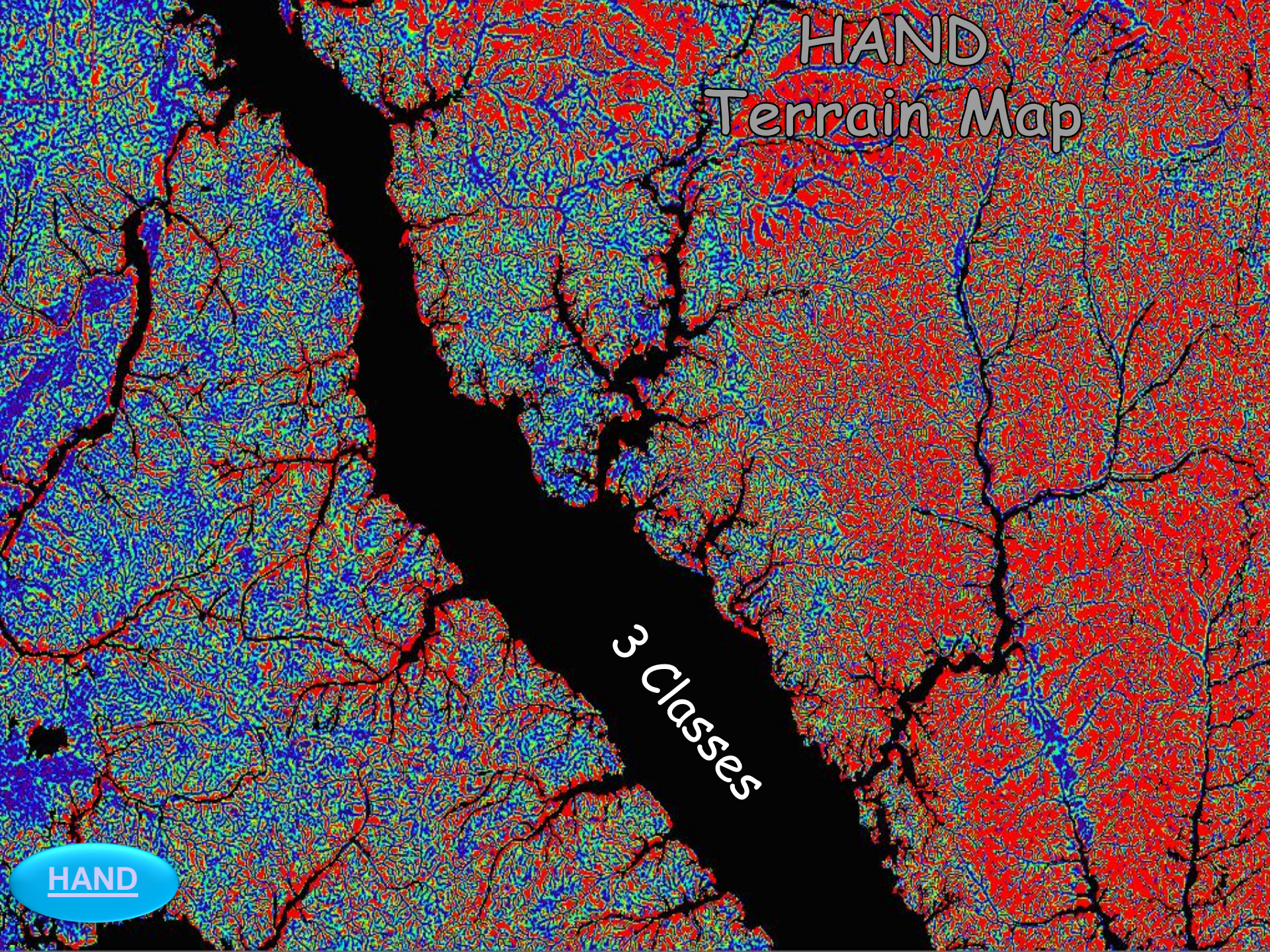
Bacia ASU

NW of Manaus, 18.000 km<sup>2</sup>

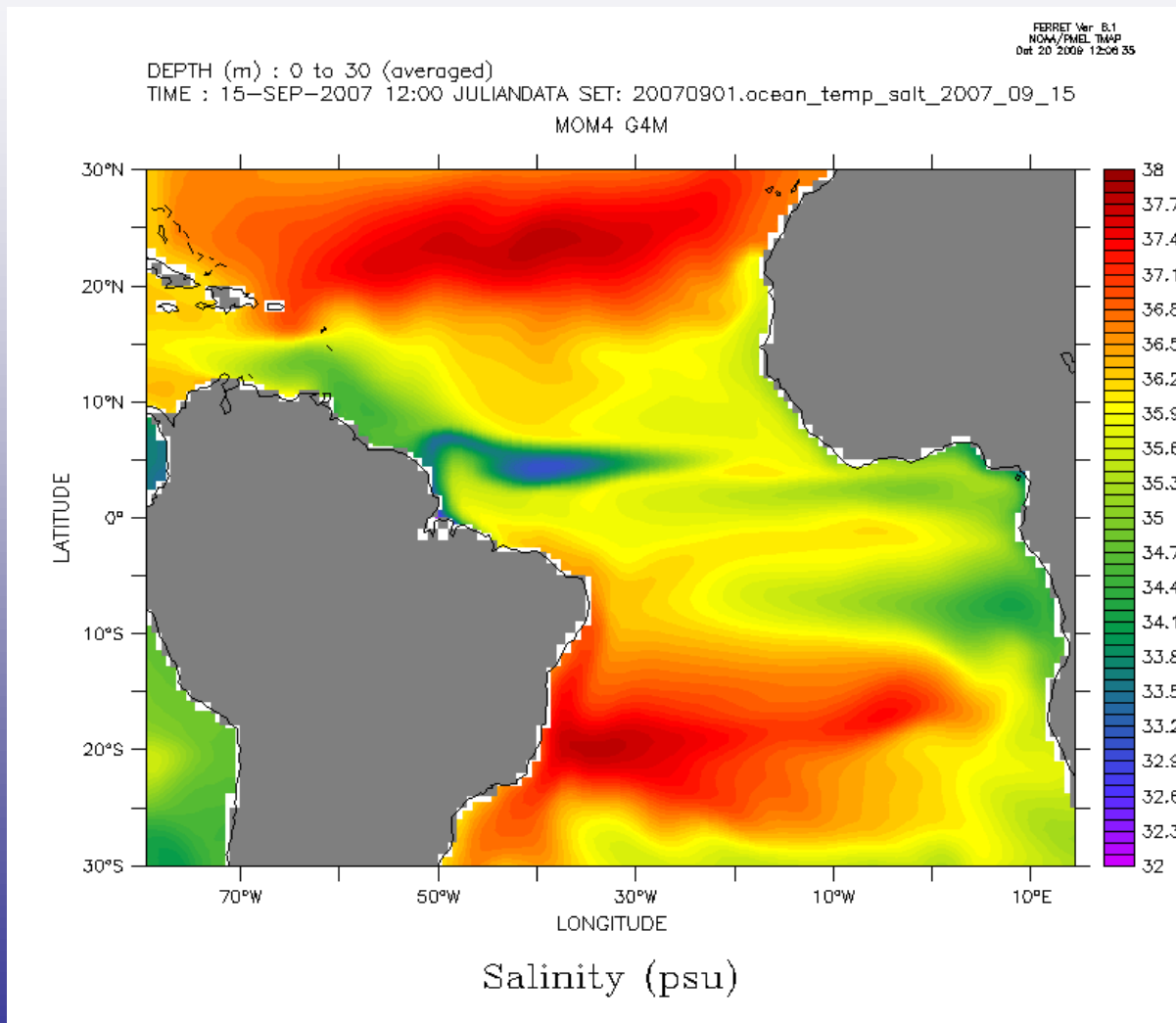
# HAND Terrain Map

3 Classes

HAND



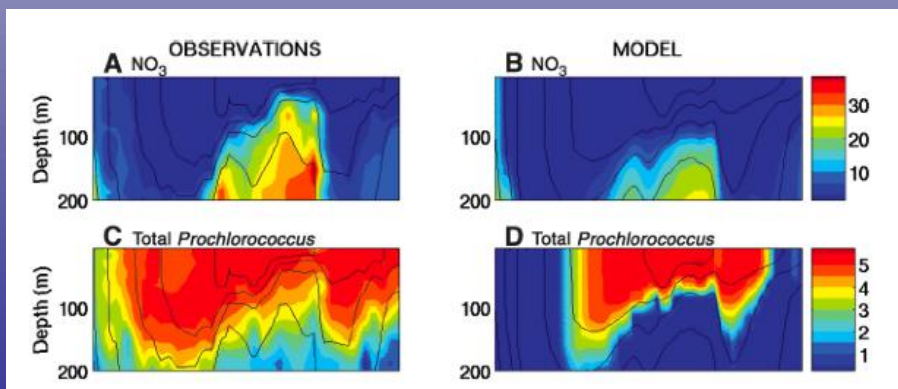
# Processes Resolved: River inflow effects on salinity





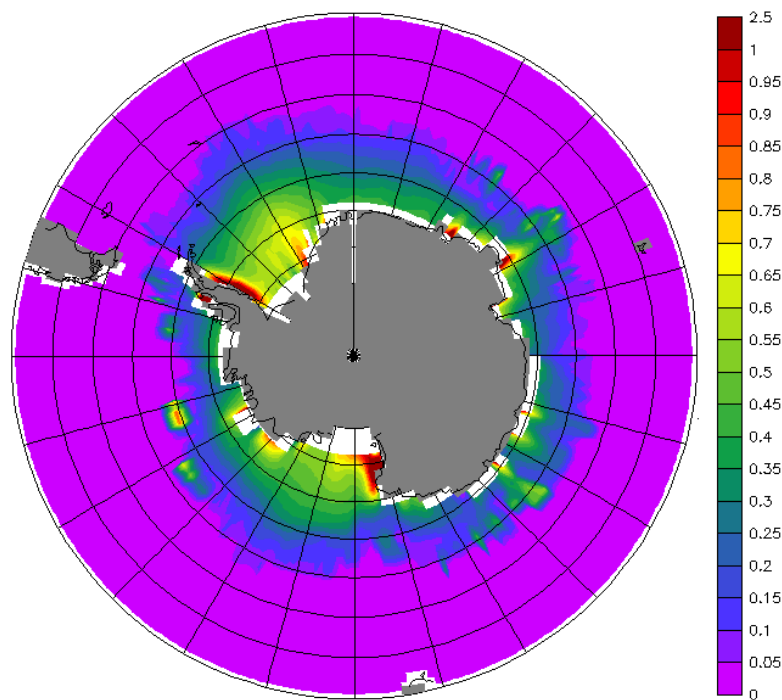
# Ocean biogeochemistry

- **MOM4p1**: OCMIP-2 (diagnostic) + 3 functional groups prognostic
- Challenges:
  - *Dynamic Green Ocean Models* (Le Quéré & al. 2005): **10 functional groups**
  - *Emergent Biogeography* (Follows & al. 2007): emerging functional groups



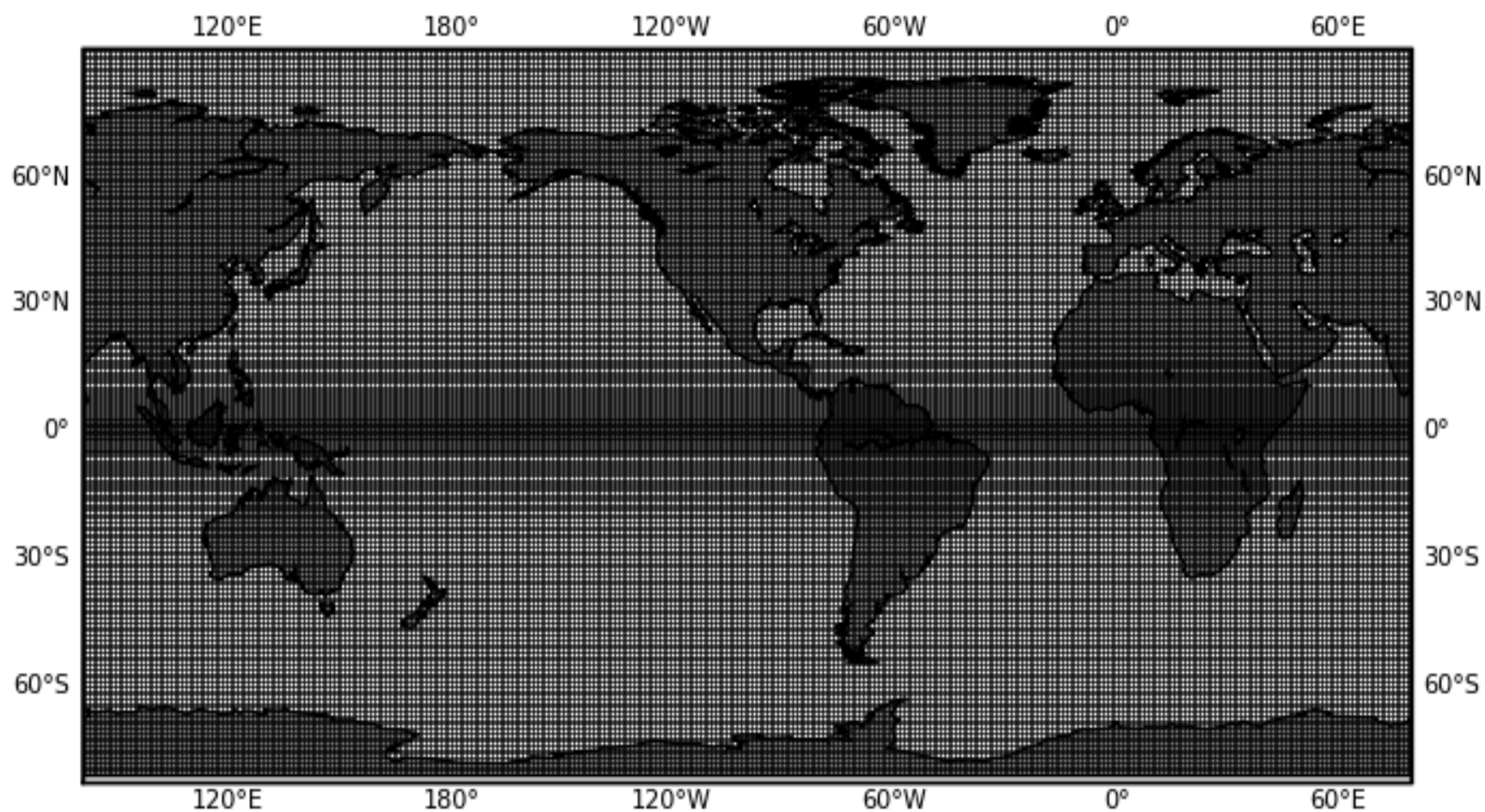
# Ice Cover Simulation

## INPE COUPLED O-A GCM



Ice Thickness (m) - MOM4p0/SX6  
26-JUN-2007 (2Mo A-O coupled)

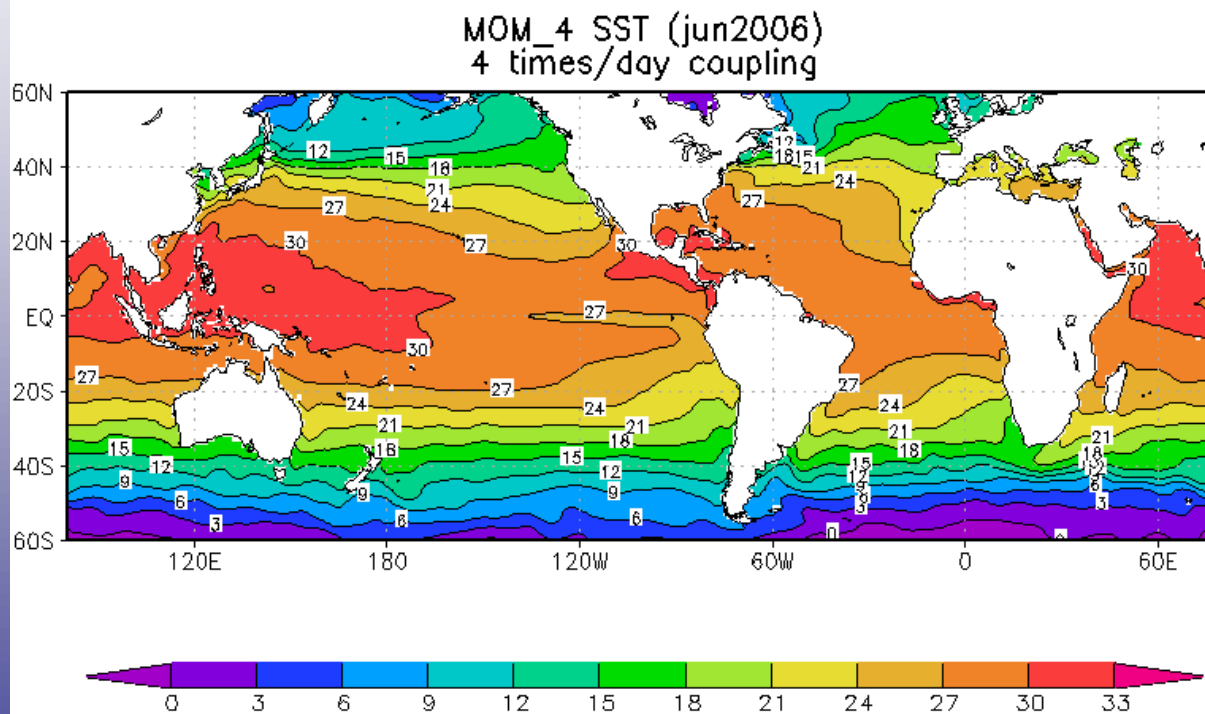
# OGCM Grid



# INPE-CPTEC CGCM V.2.0

## T213 L64, Kuo, 4 x daily coupling

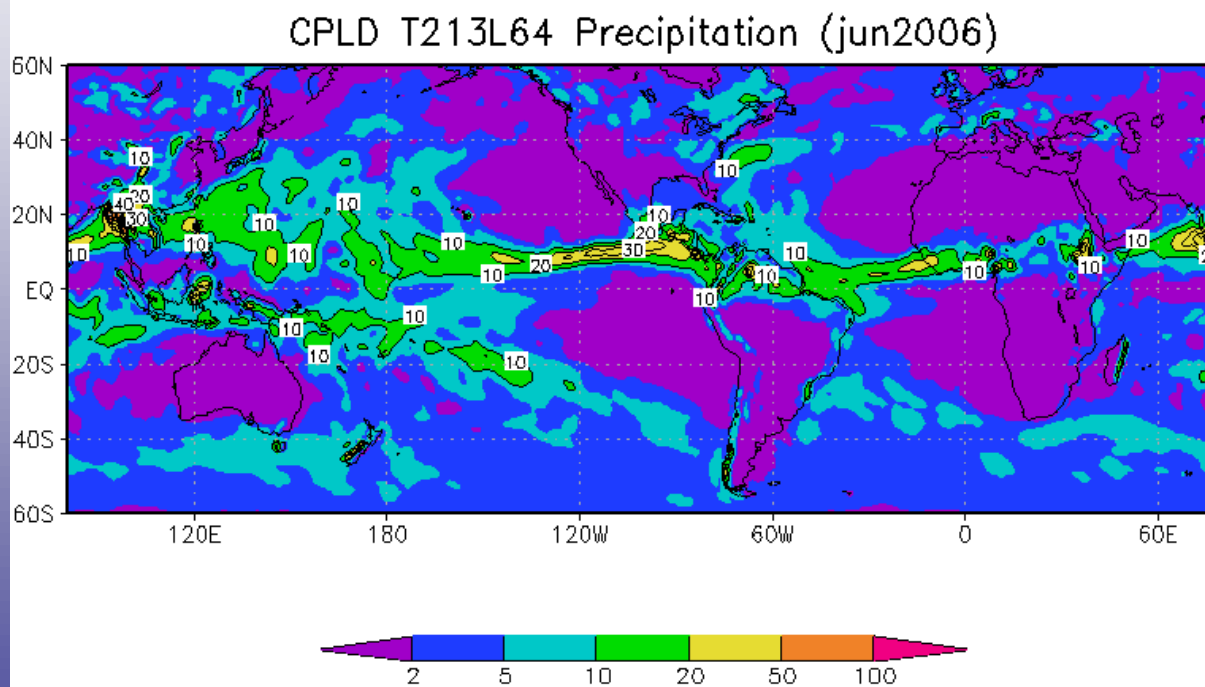
### 30 days avrg spinup SST



# INPE-CPTEC CGCM V.2.0

## T213 L64, Kuo, 4 x daily coupling

### 30 days avrg spinup Precip

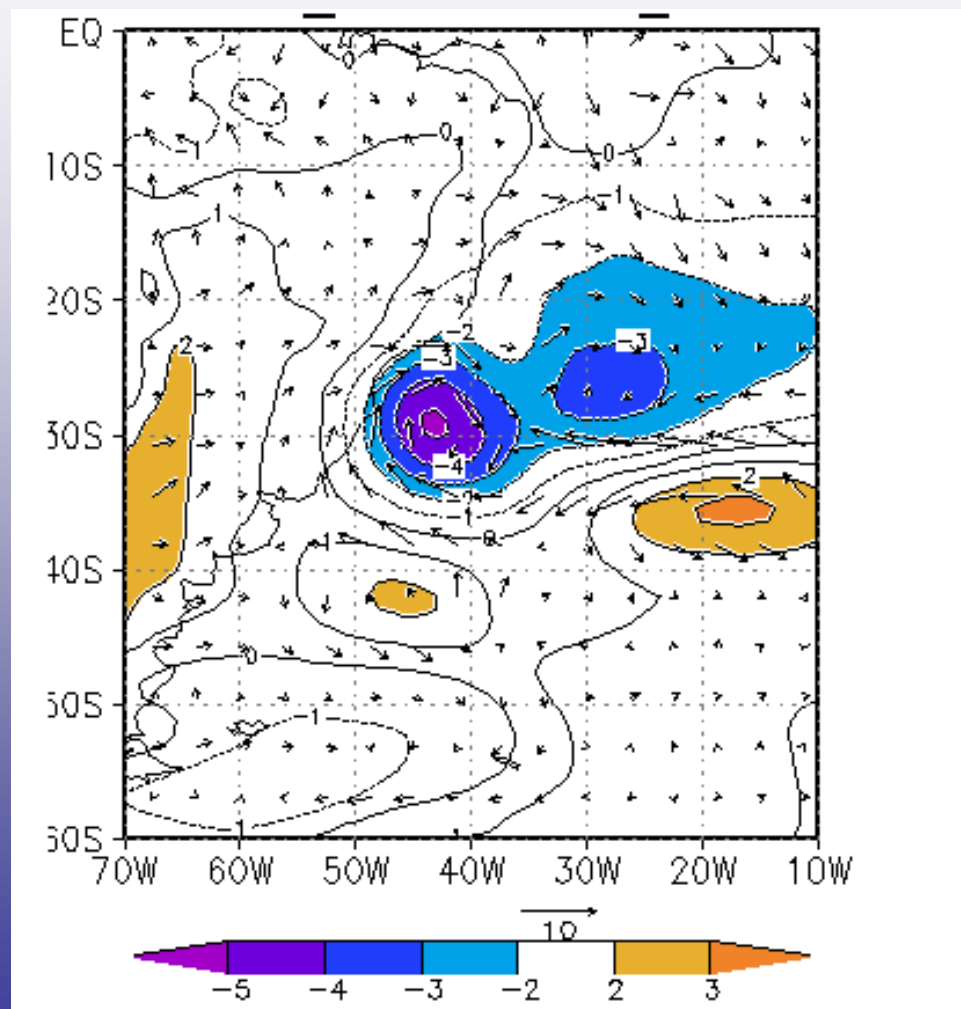


# Catarina Tropical Storm Hits Brazil 26 March 2004

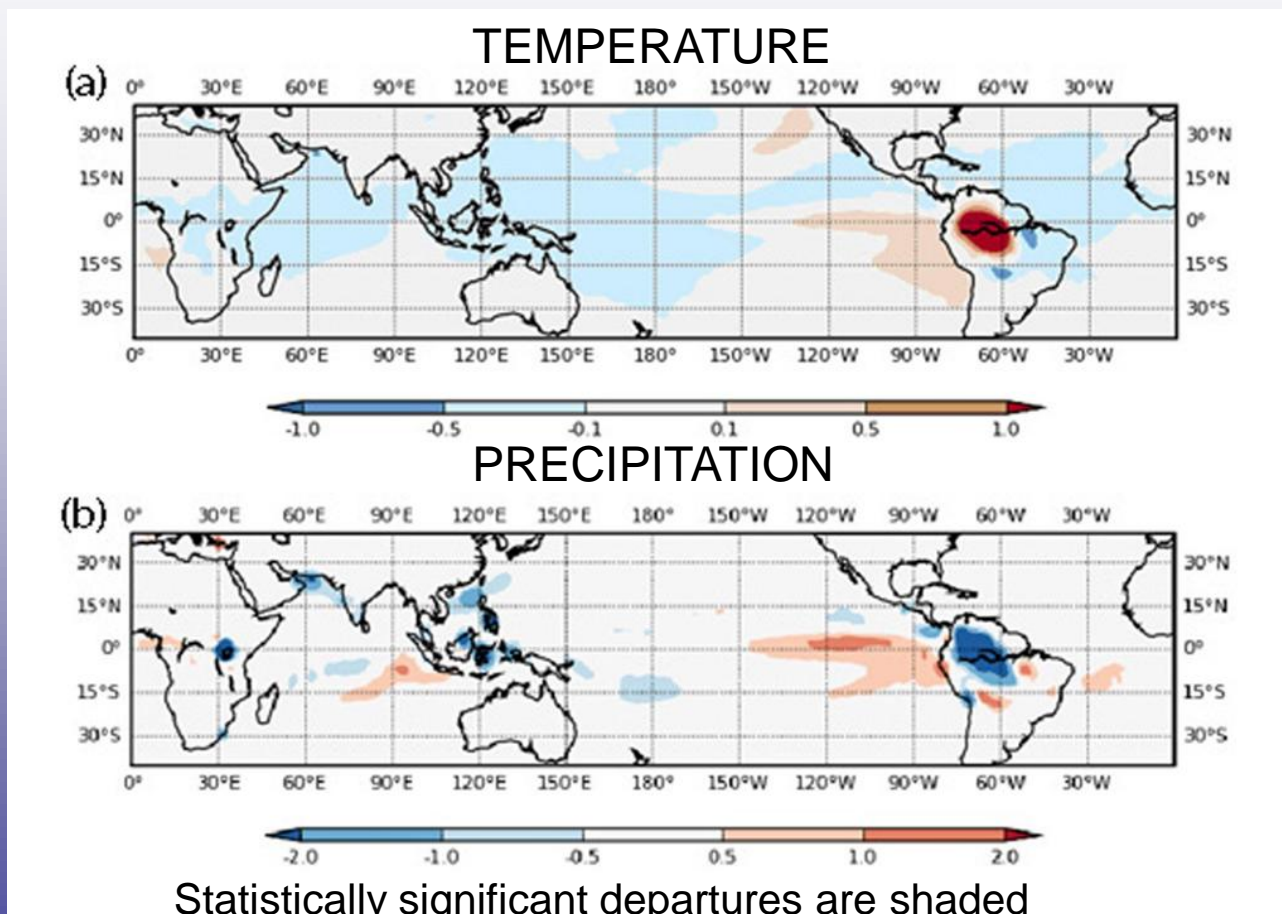


# 72 hours CATARINA FCST CGCM-AGCM (T62L28) SLP

ci: 12Z24MAR2004 FCST: 12Z27MAR2004



# Amazon Deforestation Experiment: Increased El Niño Conditions







In danger lies opportunity

Thank You.