



Biosphere-Atmosphere-Ocean interactions and climate change: the case of Amazon deforestation

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Amazon Savannization

- The result of global warming over Brazil shall be the progressive substitution of tropical rainforest for a kind of vegetation less rich and stable than the Savanna, the lowgrowing vegetation of Africa, and similar to the Cerrado.

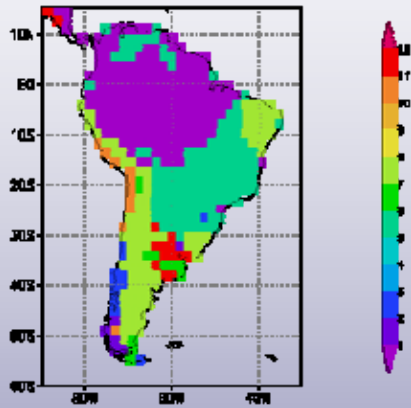


What is the role of Amazon deforestation on the global oceans?

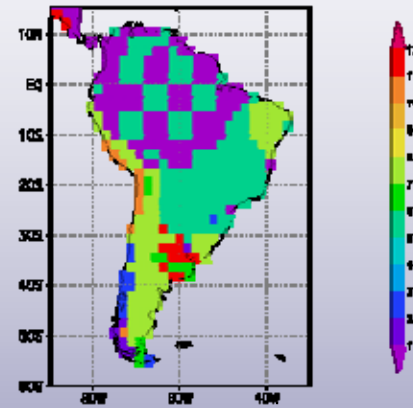


Experiment Design: Vegetation Scenarios

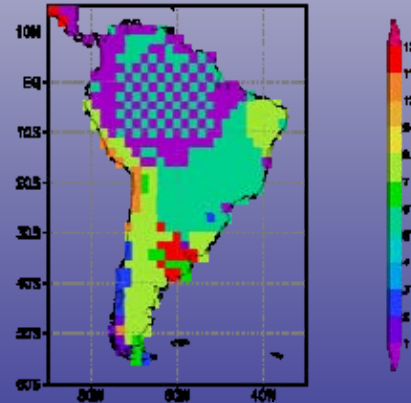
CTRL



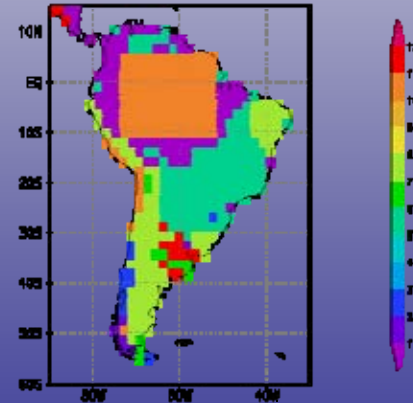
50% SAVANNA LM



50% SAVANNA SM



100% BARE SOIL





Atmospheric GCM

ATMOSPHERIC MODEL



SST

PRESCRIBED



Coupled Ocean-Atmos GCM

ATMOSPHERIC MODEL

Momentum,
heat &
Fresh Water

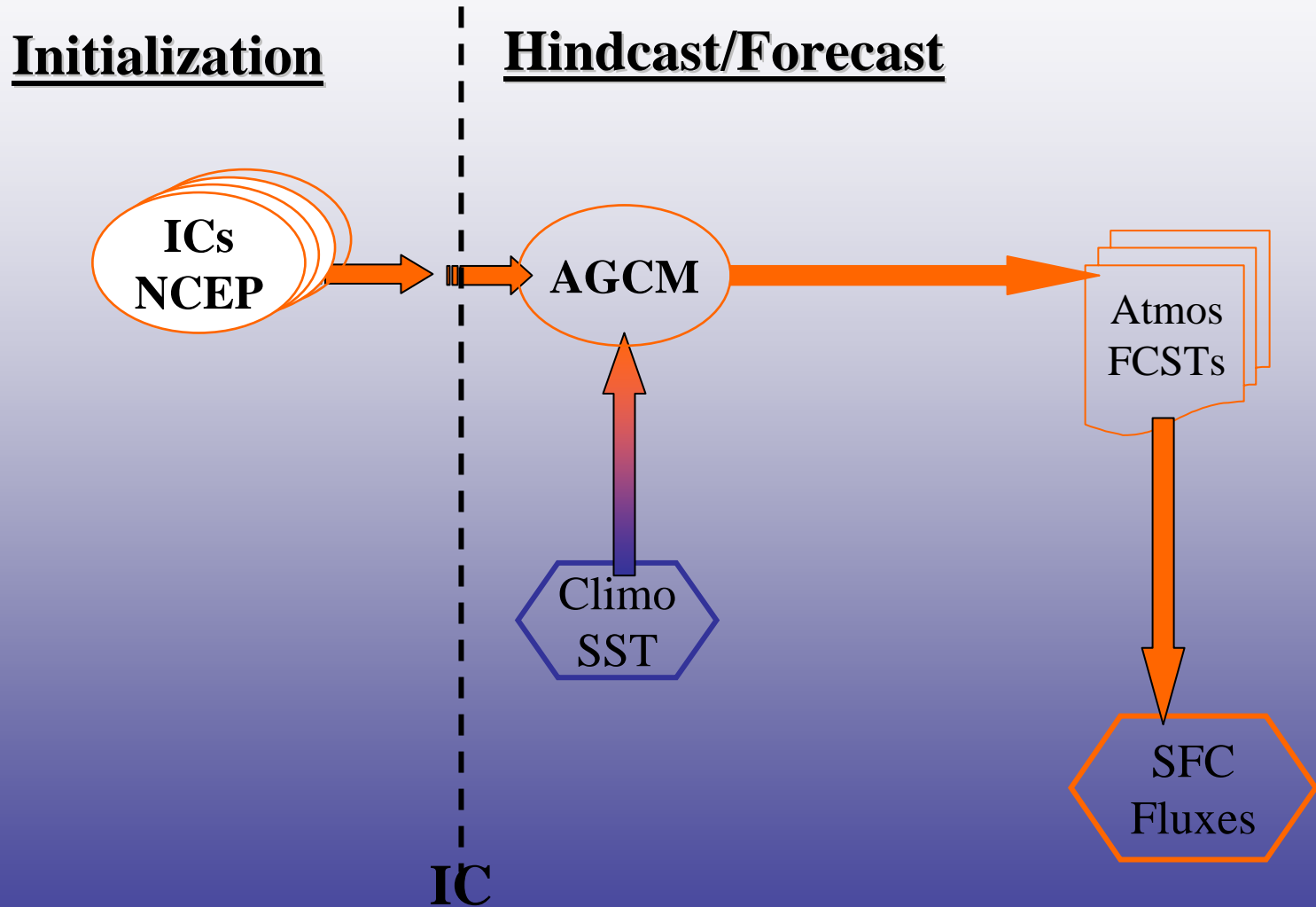
Daily Flux
Exchanges

SST

OCEAN MODEL



SST forced AGCM experiments

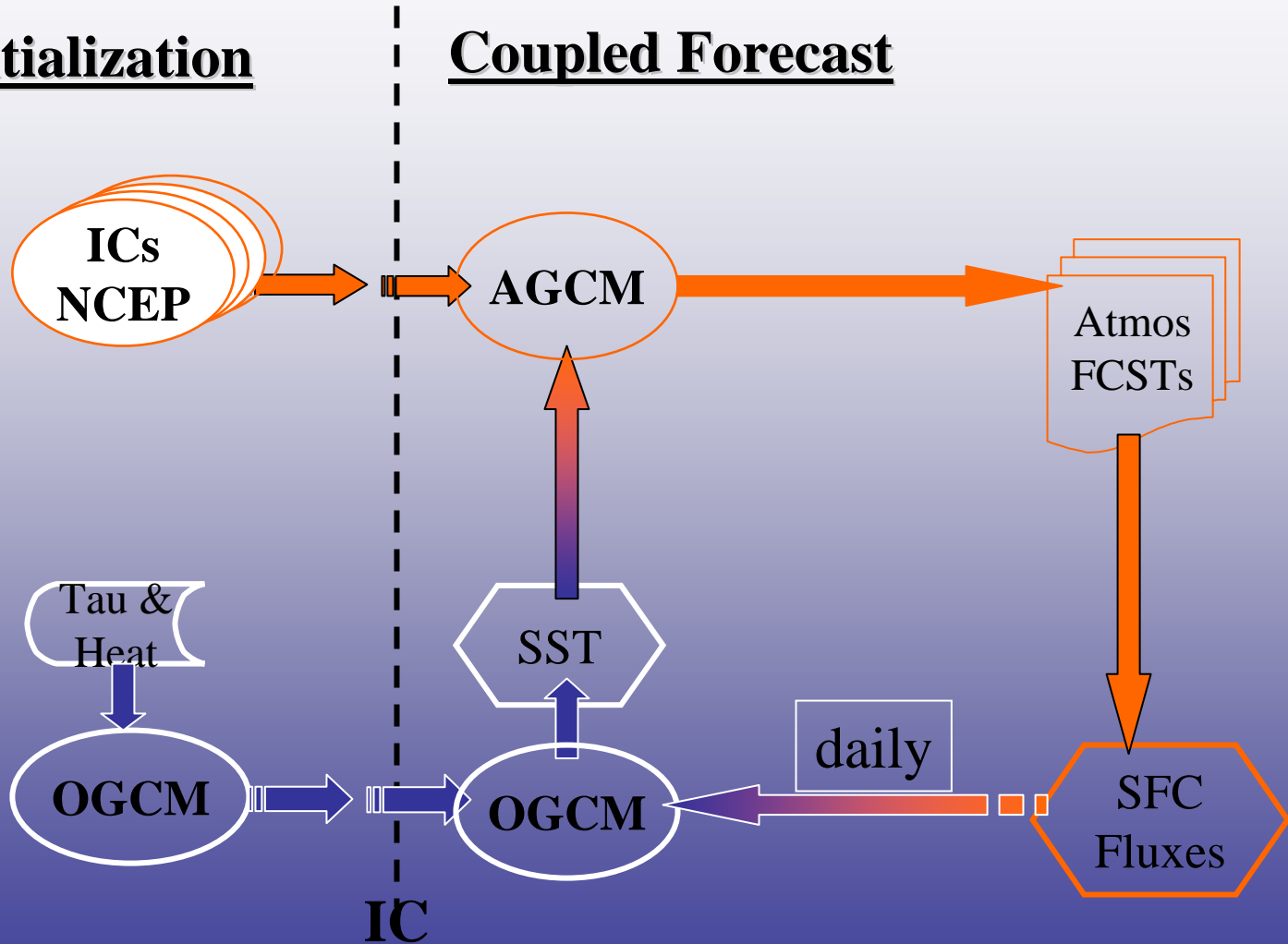




Coupled Ocean-Atmos experiments

Initialization

Coupled Forecast



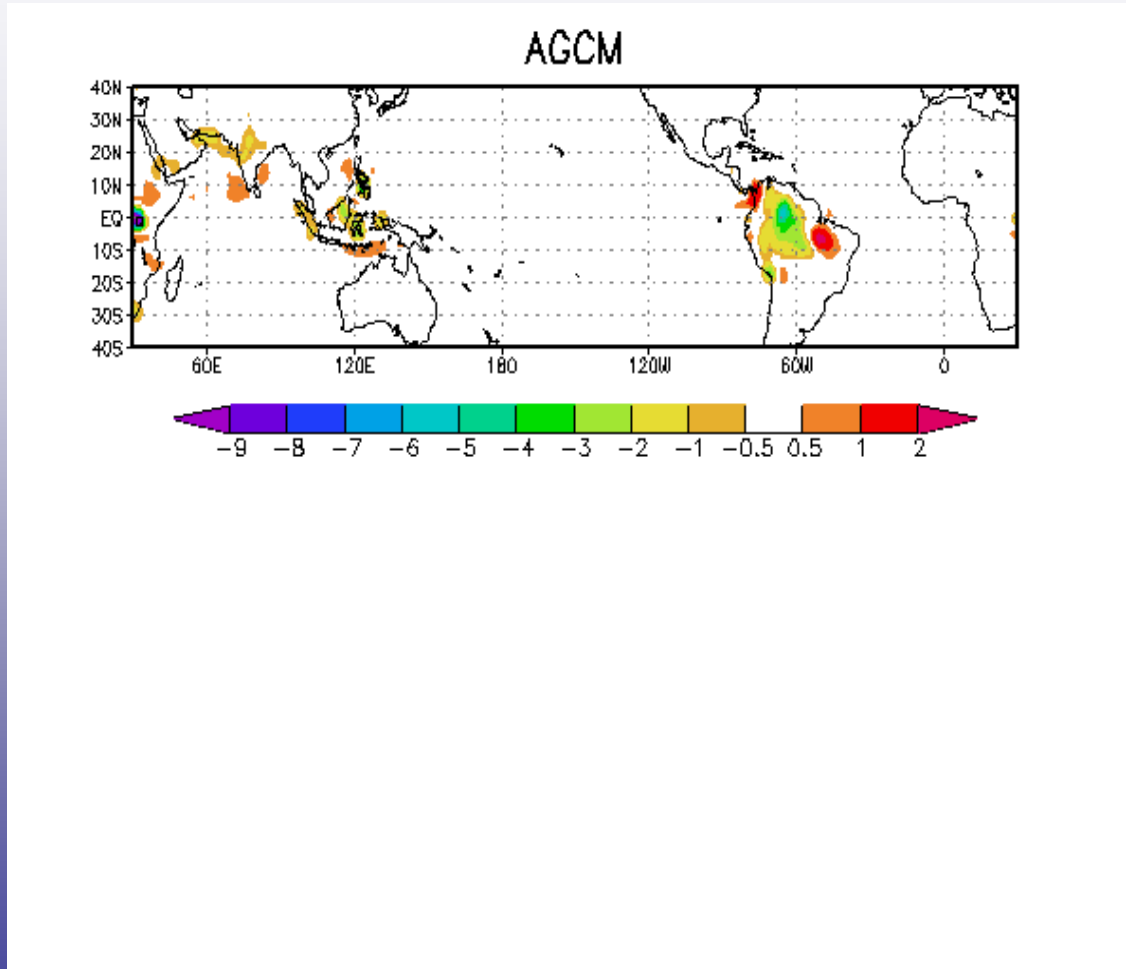


Model/Experiment Description

- **Atmospheric Global Model**
 - CPTEC's AGCM T062 L28
 - SSIB land-vegetation scheme
 - RAS convection scheme
- **Oceanic Global Model**
 - GFDL's OGCM (MOM_3) Global Tropics
 - $\frac{1}{4} \times \frac{1}{4}$ lat-lon deep tropics, 40S-40N
- **Coupling Strategy**
 - Fully coupled (Momentum, Total Heat, E-P)
 - Daily coupling interval
- 10 member ensembles,
- 20 years-long each run,
- 4 Amazon vegetation scenarios.



Ensemble Precip. Departures (Deforest - Ctrl)

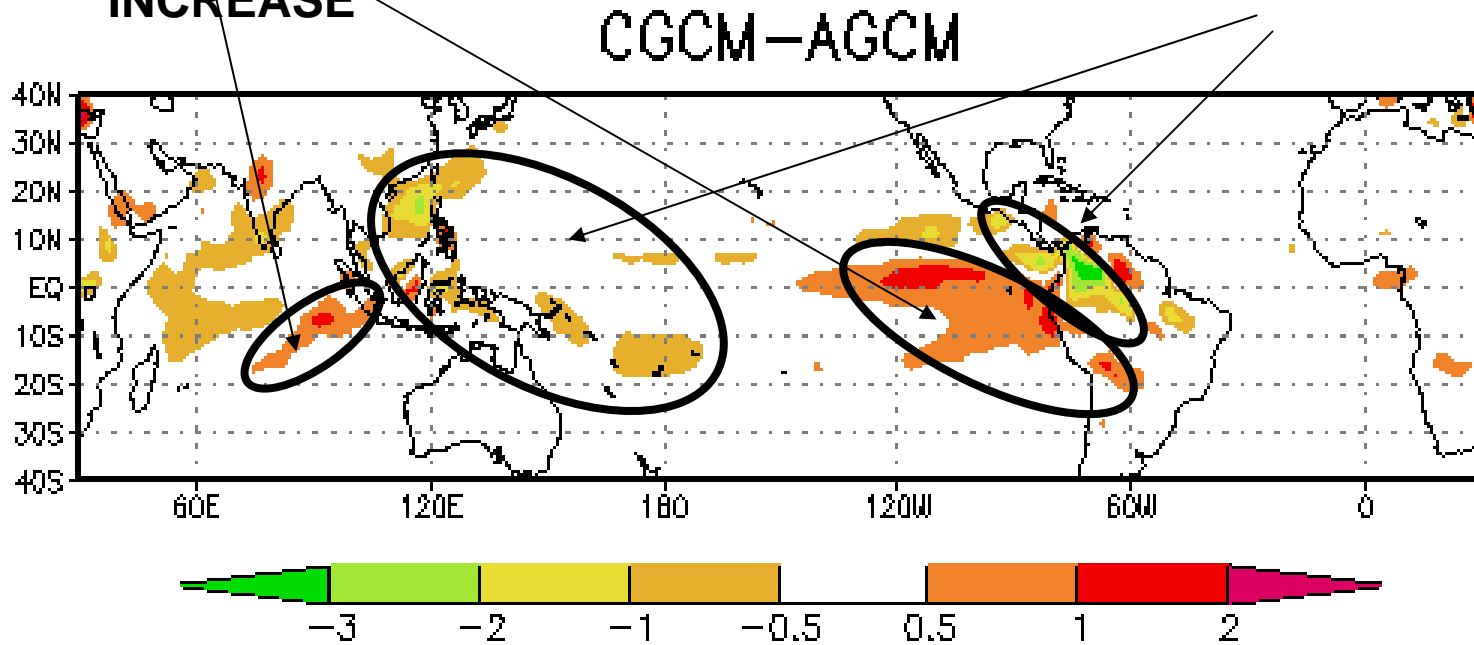




CGCM minus AGCM Precipitation Departures

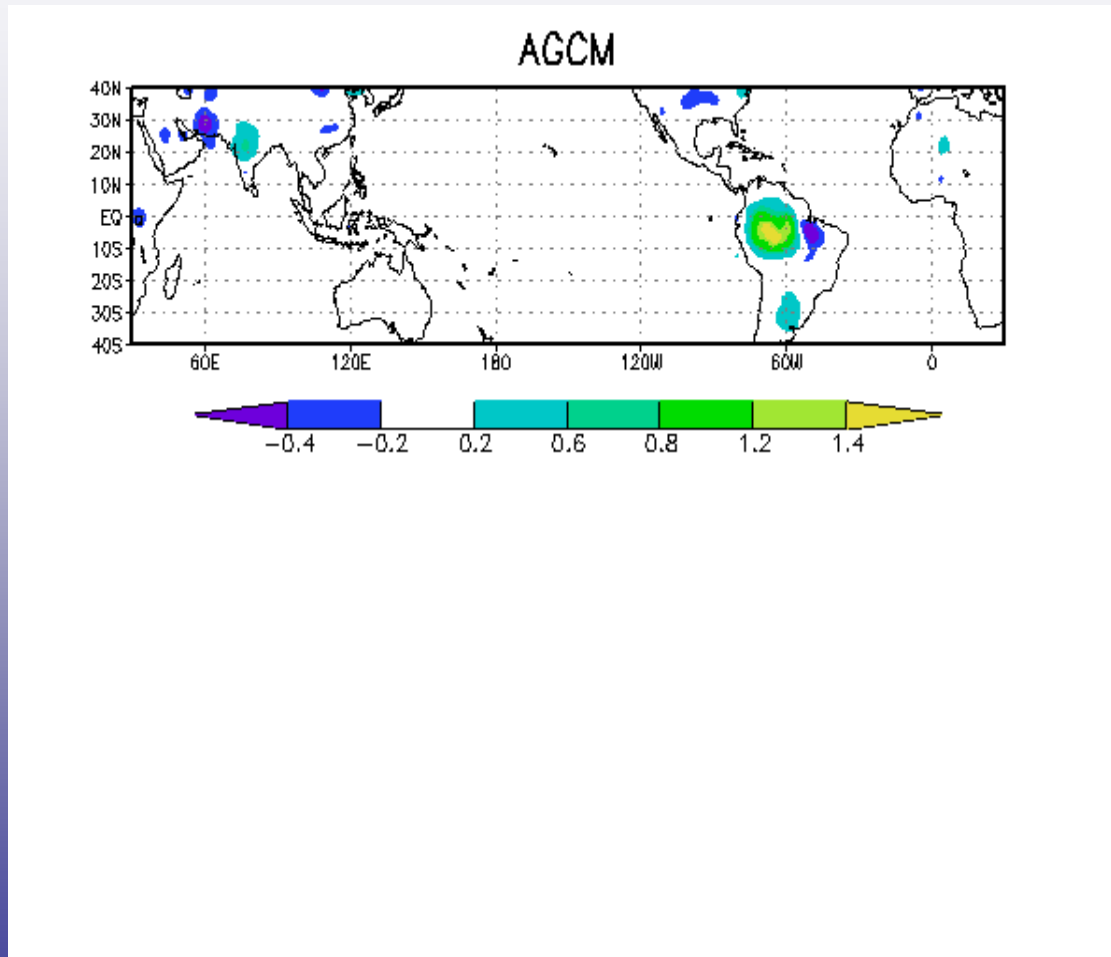
PRECIPITATION
INCREASE

PRECIPITATION
REDUCTION





Ensemble Air Temp Departures (Deforest - Ctrl)



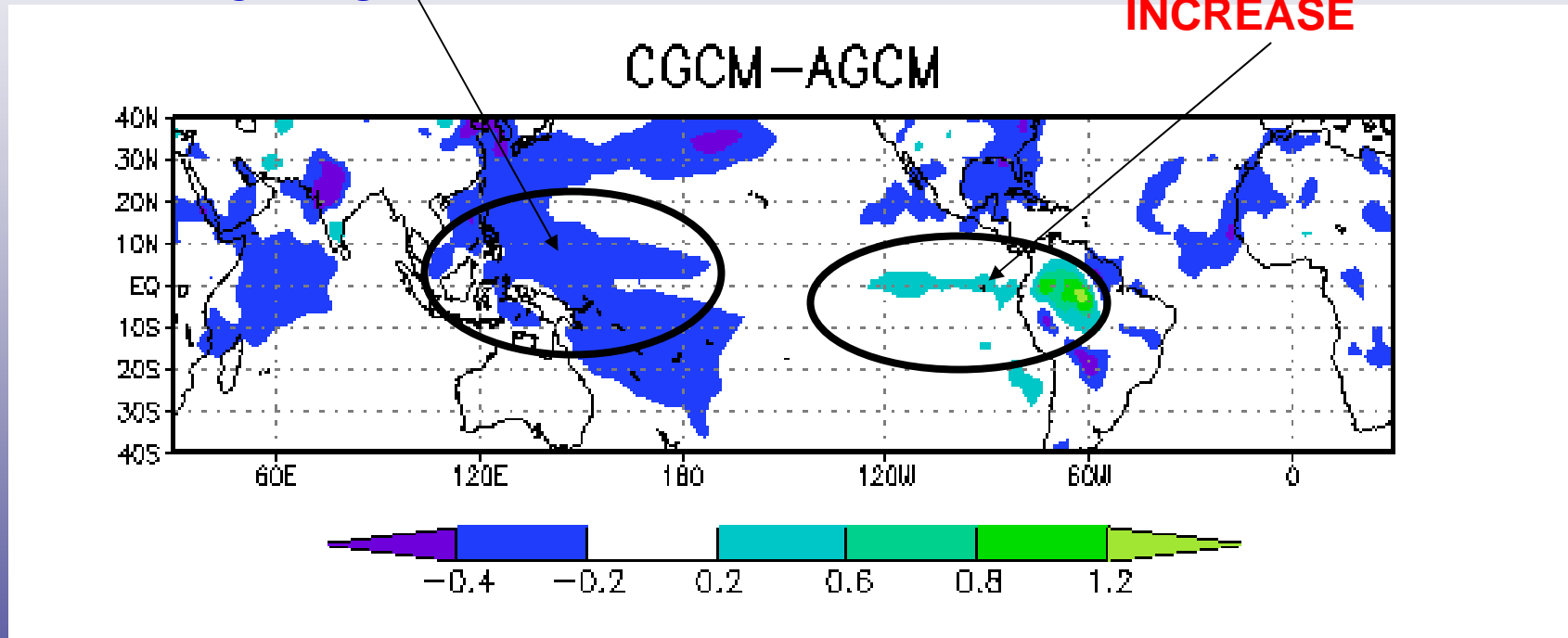


CGCM minus AGCM

Air Temperature Departures

TEMPERATURE
DECREASE

TEMPERATURE
INCREASE



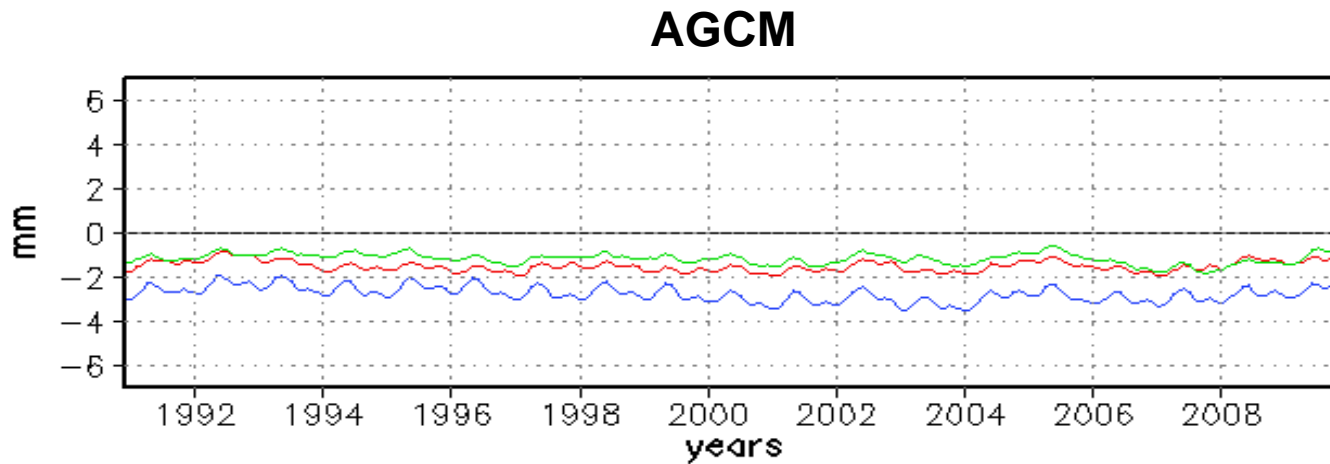


Atmospheric patterns changes in the coupled model results due to Amazon deforestation resemble those of warm ENSO conditions.



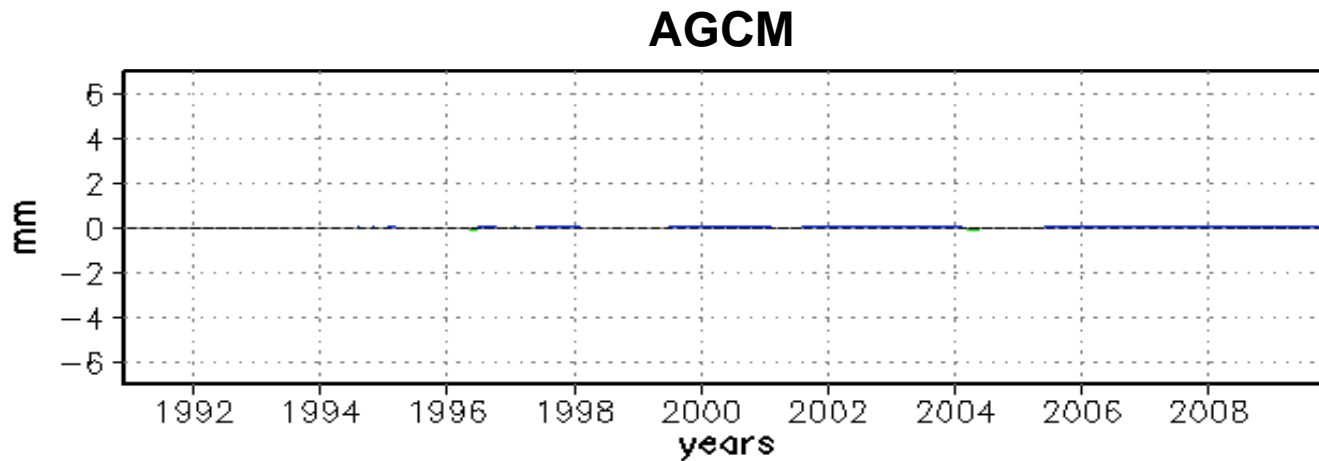
Amazon

Precipitation Departures



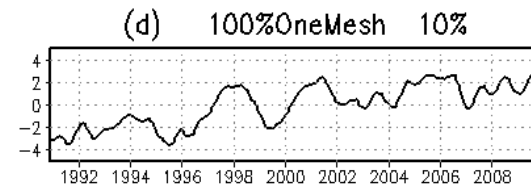
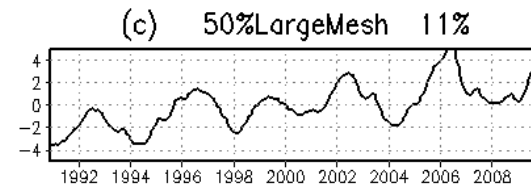
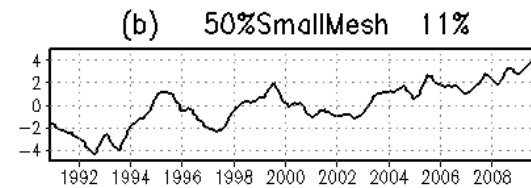
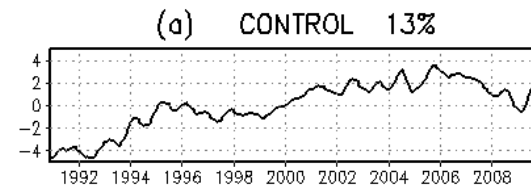
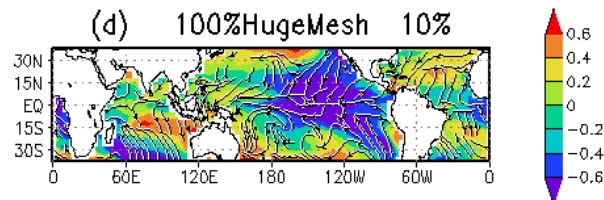
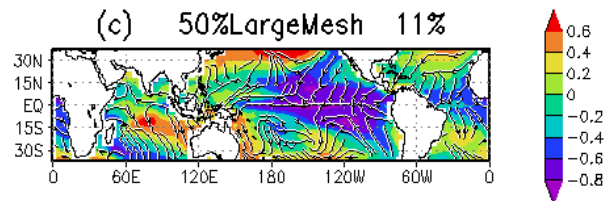
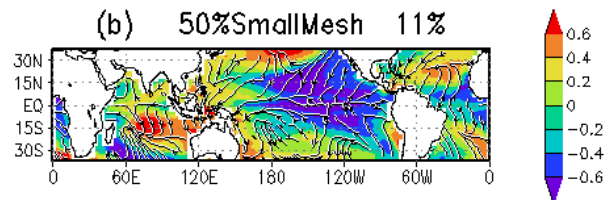
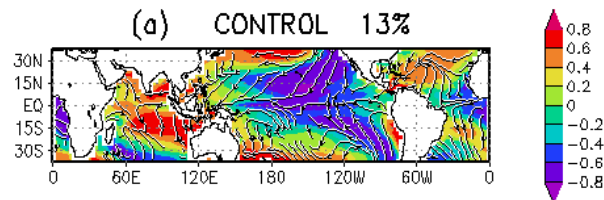


Eastern Pacific Precipitation Departures





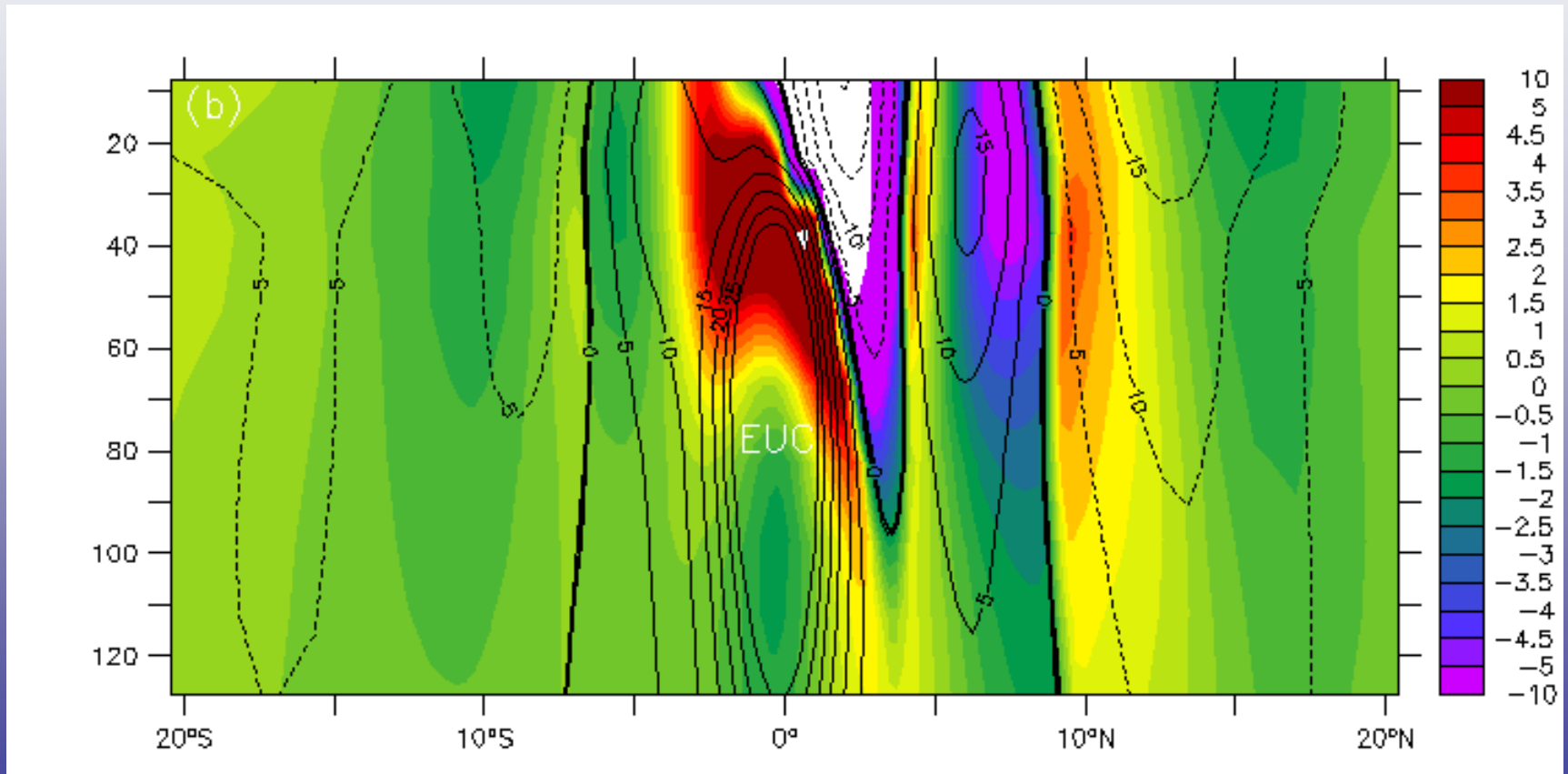
Joint SST-Tauxy EOFs





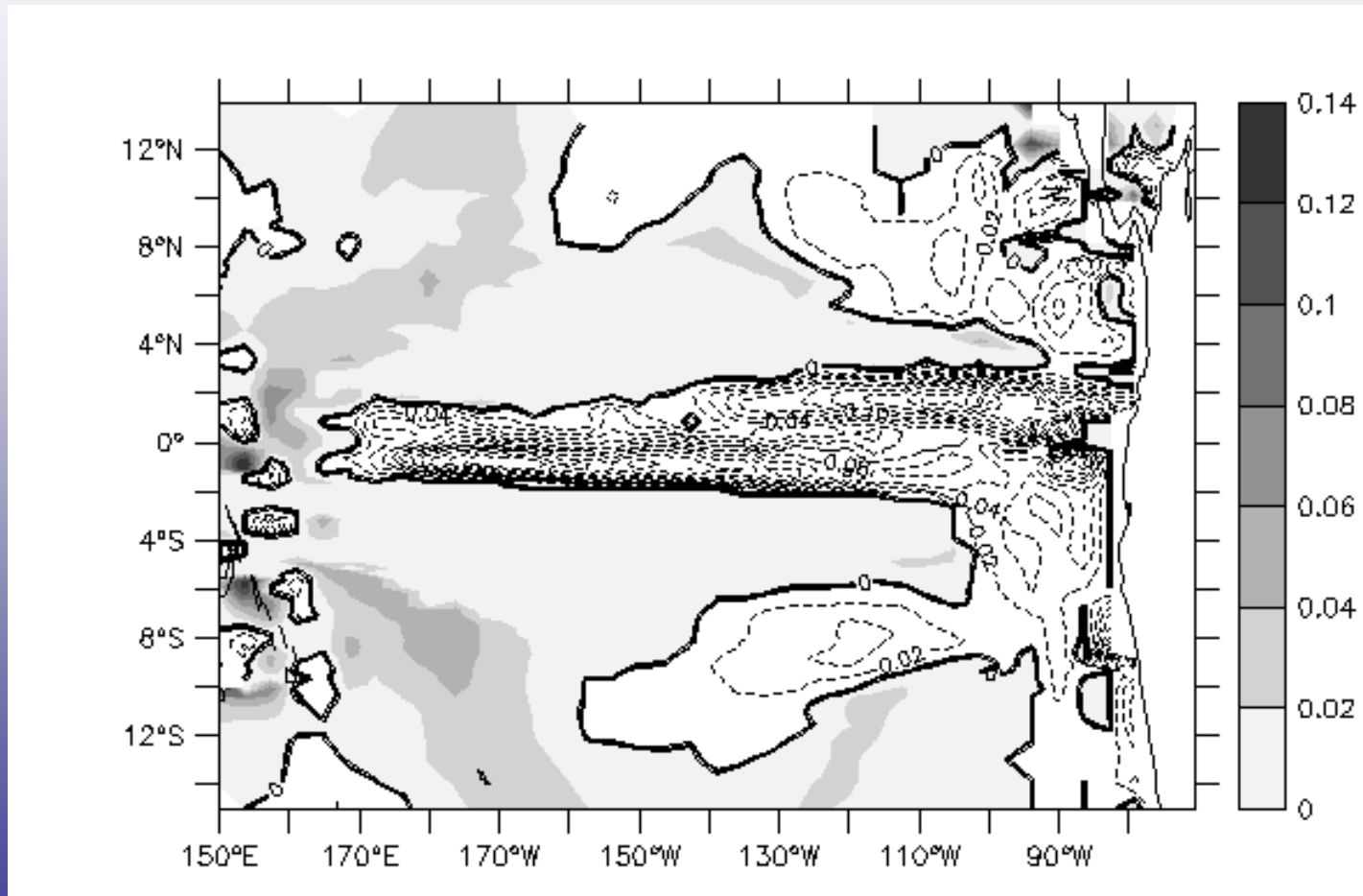
Zonal Velocities over the Pacific

Ctrl (contours); Deforest - Ctrl (shades)





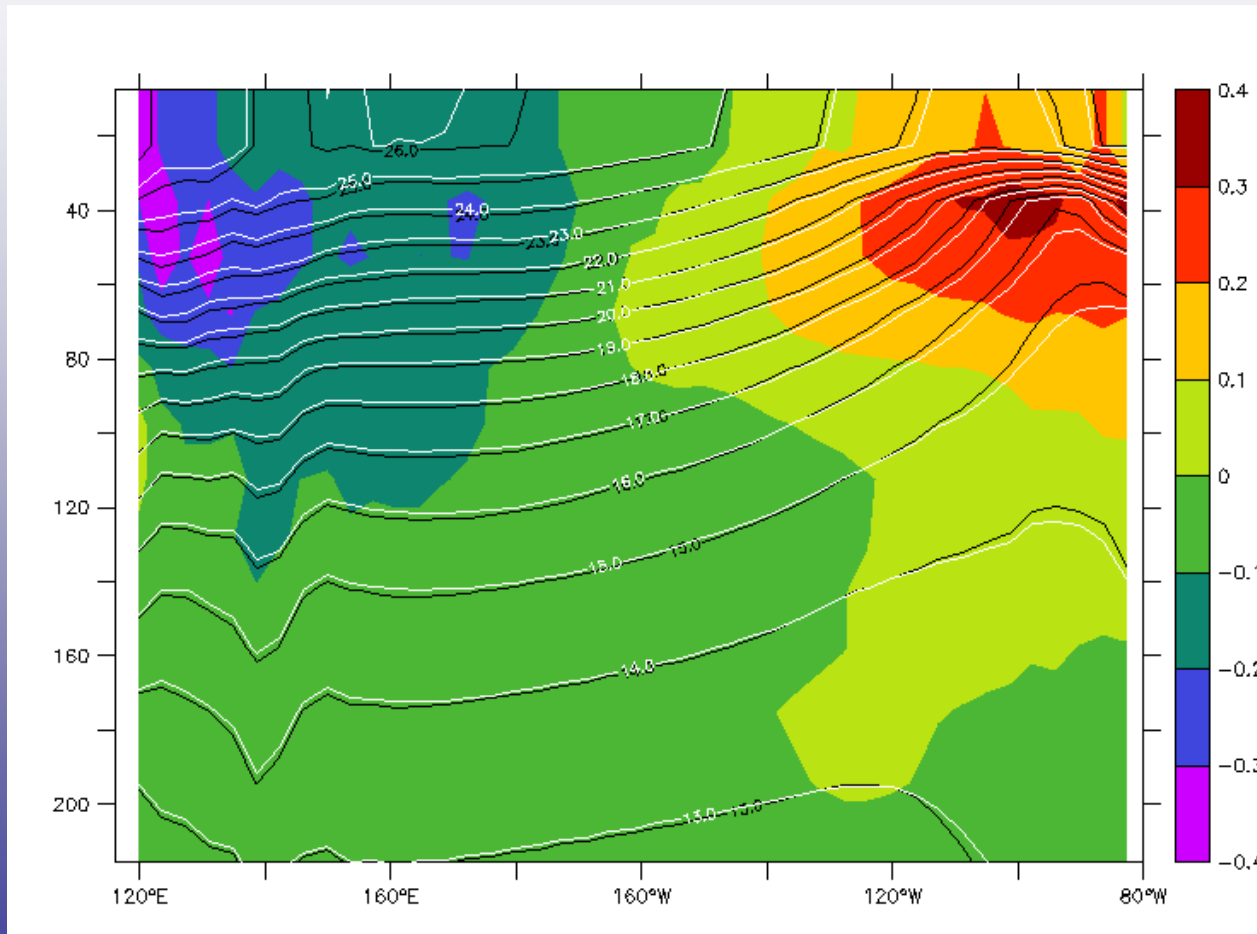
Vertical Velocity Departures (Deforest - Ctrl)





Pacific Thermocline Depth

Deforest - Ctrl (shades)





Summary

- Amazon deforestation induces global rainfall, atmospheric, and oceanic circulation pattern changes which resemble ENSO-like states;
- There seems to exist a positive feedback between Amazon rainfall reduction associated with tropical rainforest clearing and ENSO conditions in the coupled model results;
- Fully coupled ocean-atmosphere modeling is central to produce the global-scale rainfall and circulation pattern changes due to tropical deforestation.