An overview of Seasonal Forecast-related issues over the Pan-VAMOS domain

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Thanks to the contributions received from Matt Barlow, Hugo Berbery, Chris Castro, Iracema Cavalcanti, David Gochis, Dave Gutzler, José Marengo, Kingtse Mo and Paulo Nobre

Outline

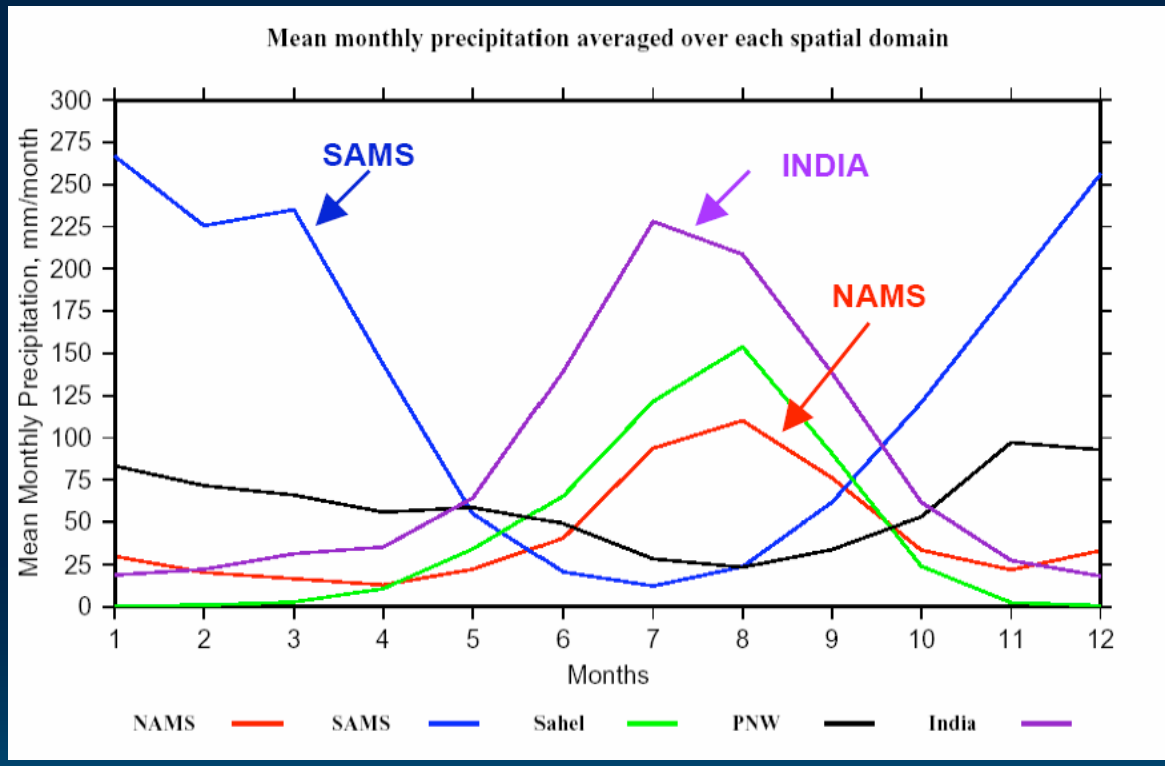
- Key features of the American Monsoon System
- The VAMOS modeling strategy
- Strengths and weaknesses of Seasonal Prediction over the Pan-VAMOS region
- Current and planned activities

What factors are limiting our ability to **improve** seasonal predictions for societal benefit?

What factors are limiting our ability to **use** seasonal predictions for societal benefit?

North and South America Monsoon Systems NAMS & SAMS

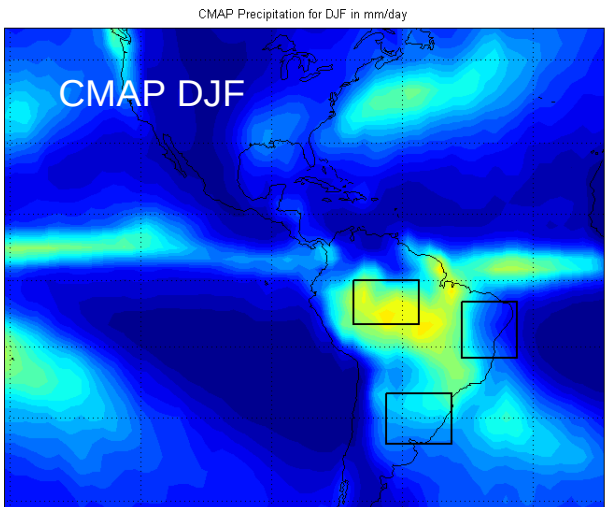
- NAMS and the SAMS receive more than 50% of total annual precipitation during the respective summer monsoons,
- The NAMS and SAMS can be interpreted as the two extremes of the same cycle

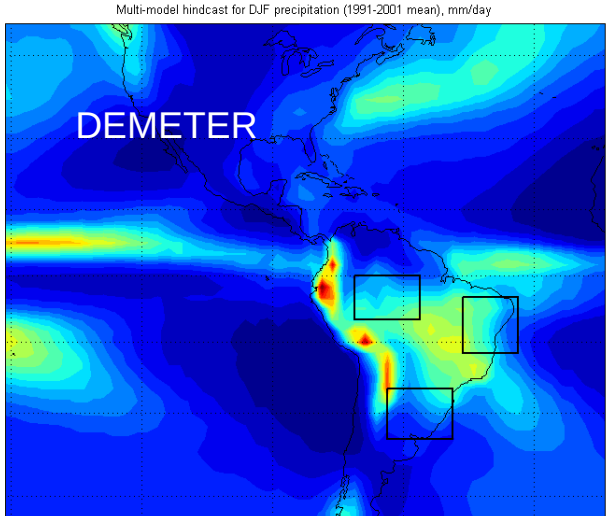


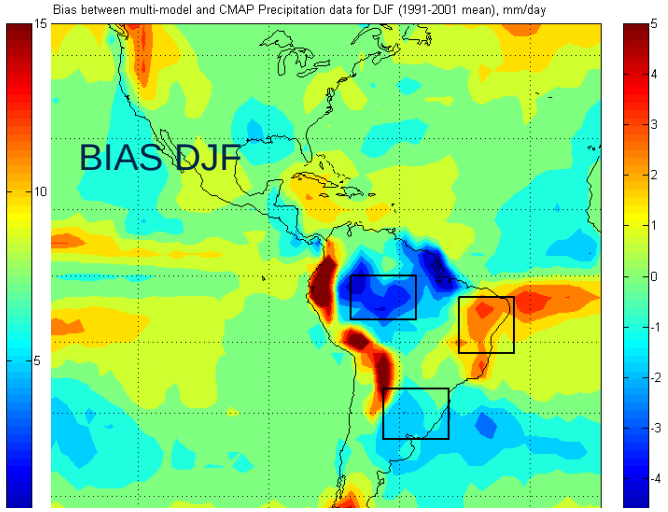
Vera et al., J of Clim. 2006

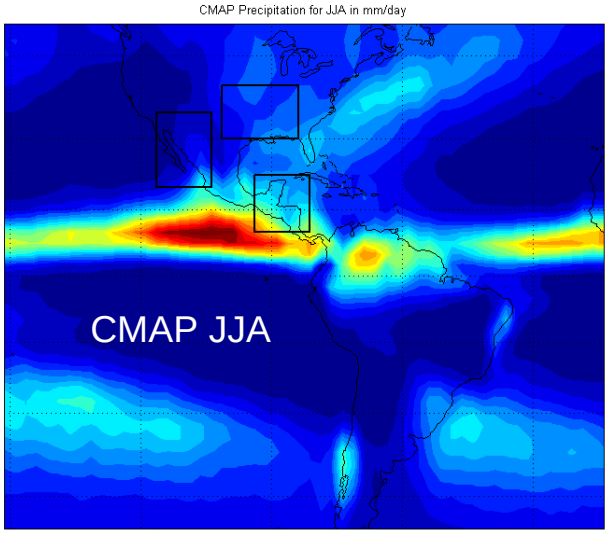
VAMOS modeling strategy

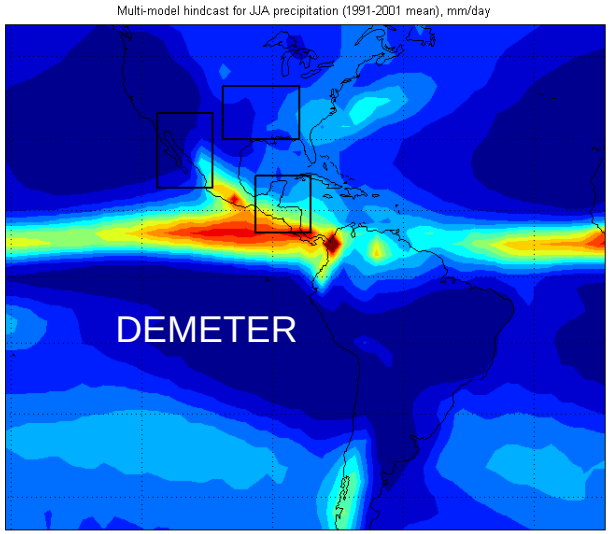
- Goal: *To improve the prediction of warm season precipitation over the Americas, for societal benefit, and to access the implications of climate change.*

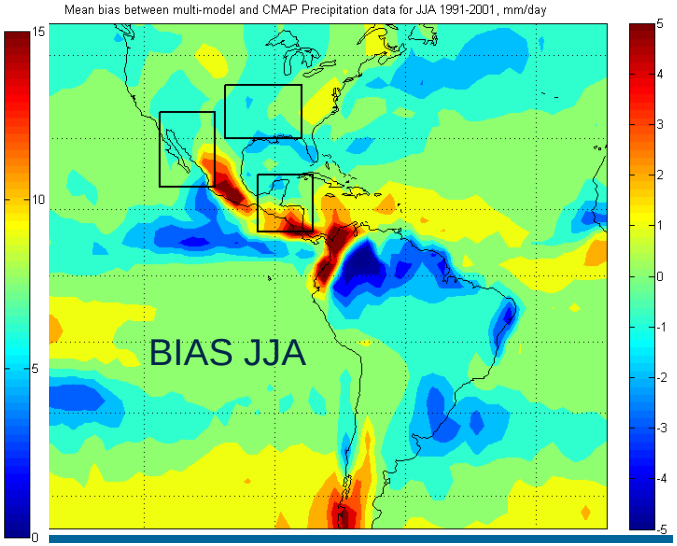












Sources of summer precipitation variability

- Influence of ENSO on monsoon rainfall;
- Relative roles of SSTs (both tropical and extratropical SSTs) and soil moisture on monsoon rainfall;
- Why the rainfall patterns favour the dipole structure (e.g. the dipole between rainfall over the Great Plains and the Southwest ; and the SACZ and subtropical plains in South America)?
- Climate and weather link: Intraseasonal variability
- The limit of predictability
- Diurnal cycle associated and mesoscale variability with monsoon rainfall

*This complexity in terms of spatial and temporal scales and climate system interactions (i.e., land-atmosphere or ocean-atmosphere) necessitates an **integrated multi-tiered** modeling and data analysis and assimilation strategy.*

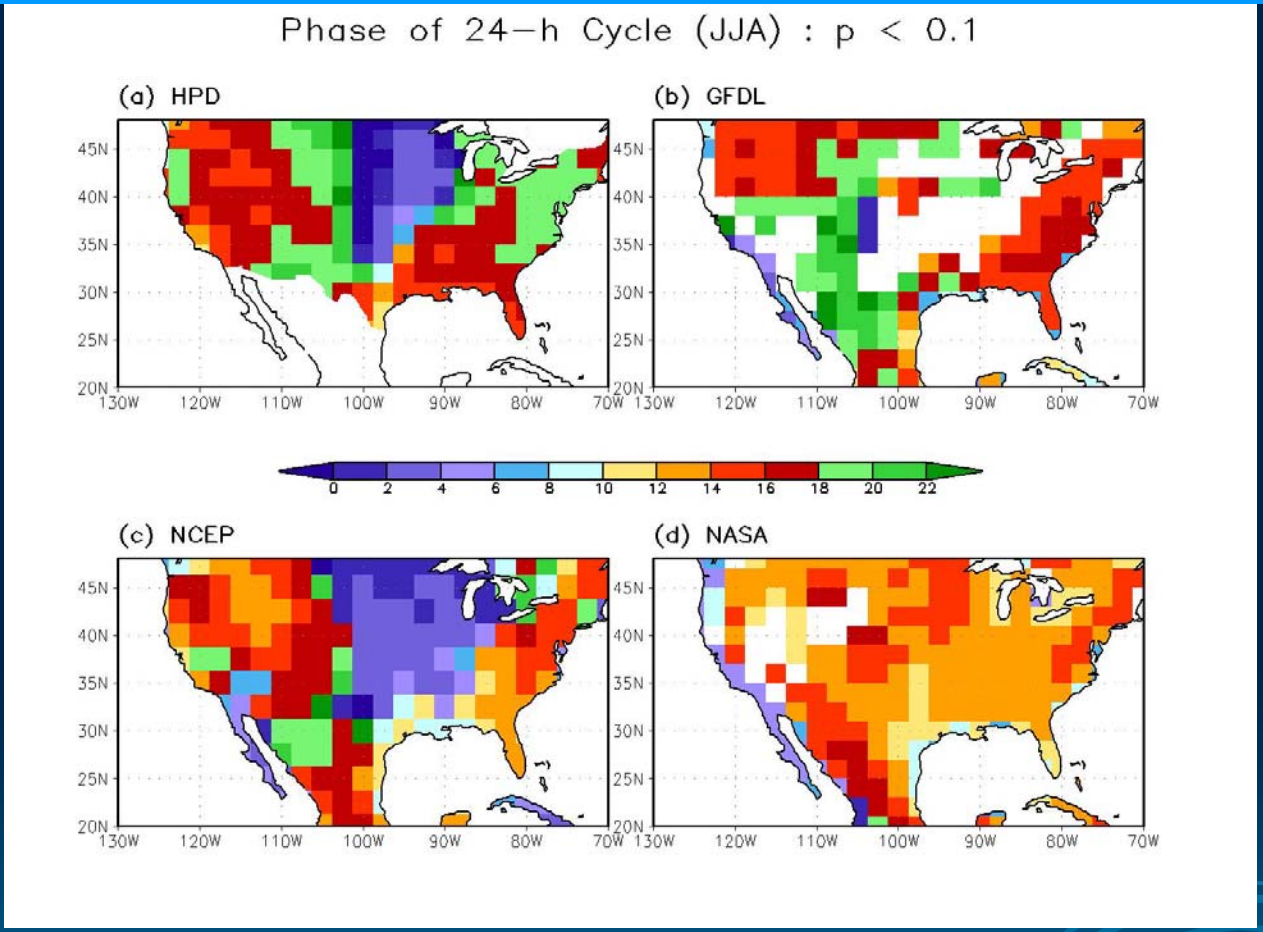
Coordinated activities mostly related to SALLJEX and NAME04 greatly aided in the identification of critical issues

- Diurnal cycle of moisture fluxes, land-sea breezes and precipitation were identified early on as key features of the monsoon climatology (Berbery, 2000; Salio et al., 2002, Marengo et al., 2004)
- Early monsoon studies identified key uncertainties in NAM/SAM regional climate(/case study) simulations related to convective parameterization (Gochis et al., 2002, 2003, P. Silva Dias, pc 2003, Rozante and Cavalcanti, 2006, Ruiz and Saulo, 2006)
- NAME Model Assessment Project Phase-I (NAMAP-I) identified key deficiencies in monsoon onset and diurnal cycle of precipitation and land surface fluxes (Gutzler et al., 2006)
- Due to sparcity of observing network global and regional reanalyses generally possess significant error in representing regional patterns of moisture convergence in the core NAM region
- Lack of observations over Central South America affects the representation of the LLJ and moisture convergence (Herdies et al., 2007)

Examples

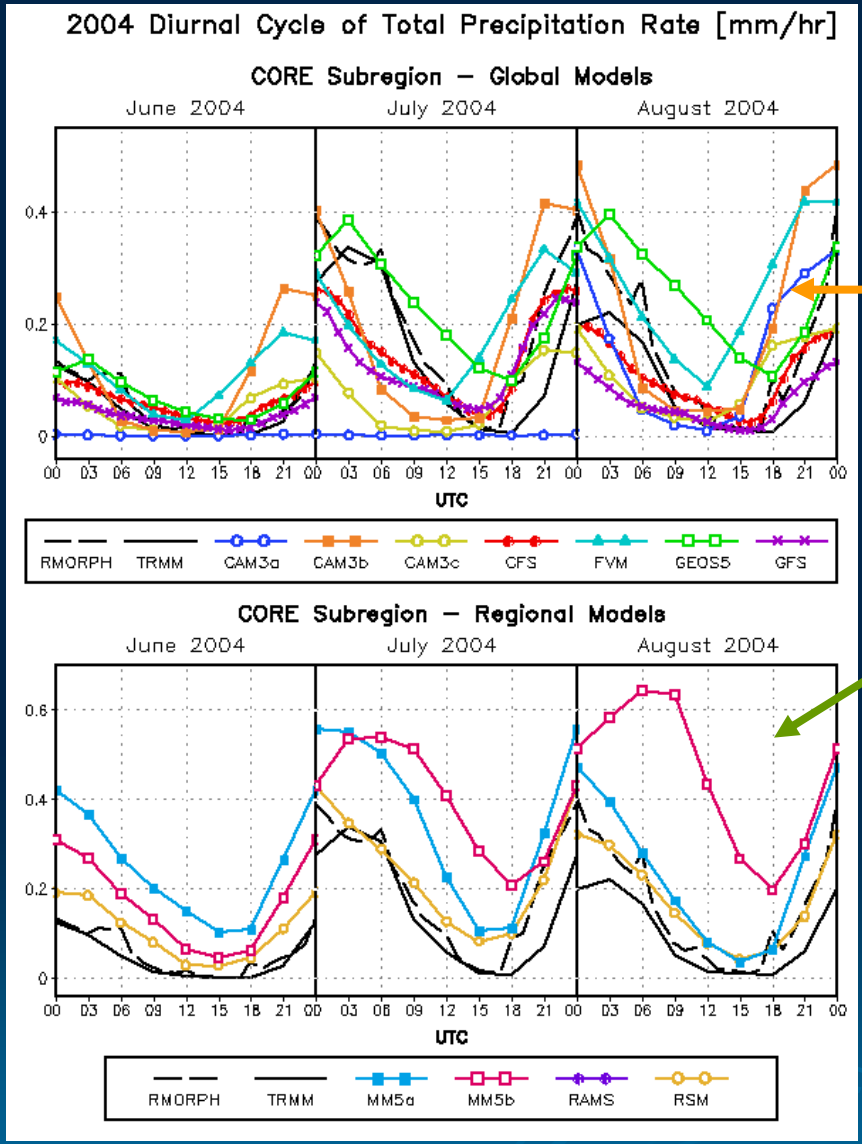
Diurnal cycle

Phase (local time) of Maximum Precipitation (24-hour cycle)



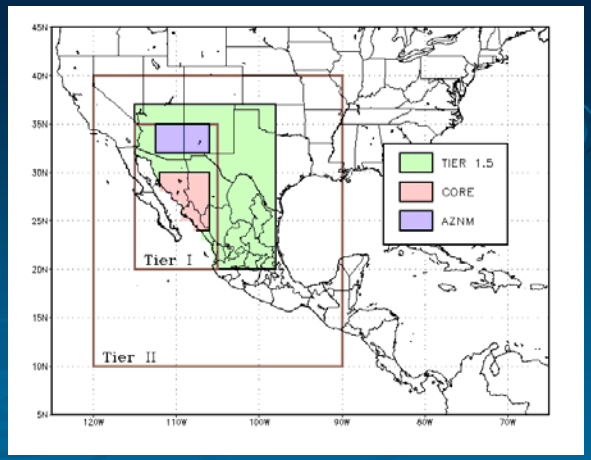
From “Warm Season Diurnal Cycle Simulation – Issues in Global Modeling”, Schubert and collaborators. NAME SWG meeting, Mexico, march 2005

Diurnal cycle



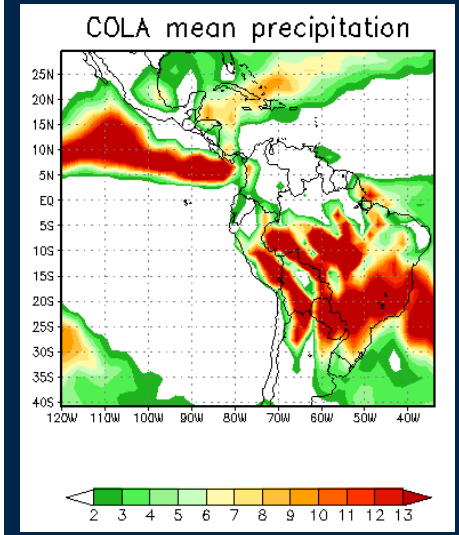
Most **global** models (top panel) simulate reasonably well the diurnal cycle of total precipitation in the CORE subregion compared to RMORPH or TRMM estimates ...

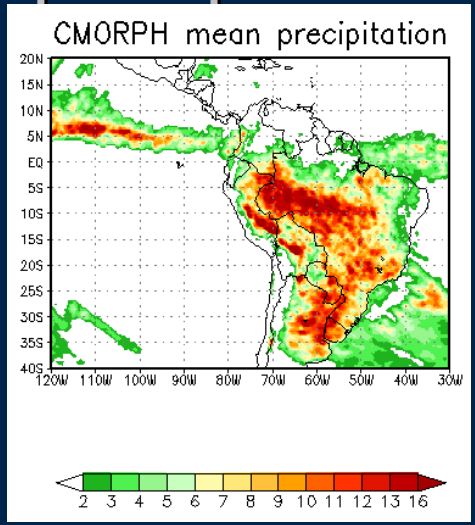
regional models (bottom) seem to exhibit much less consistency.



courtesy D. Gutzler

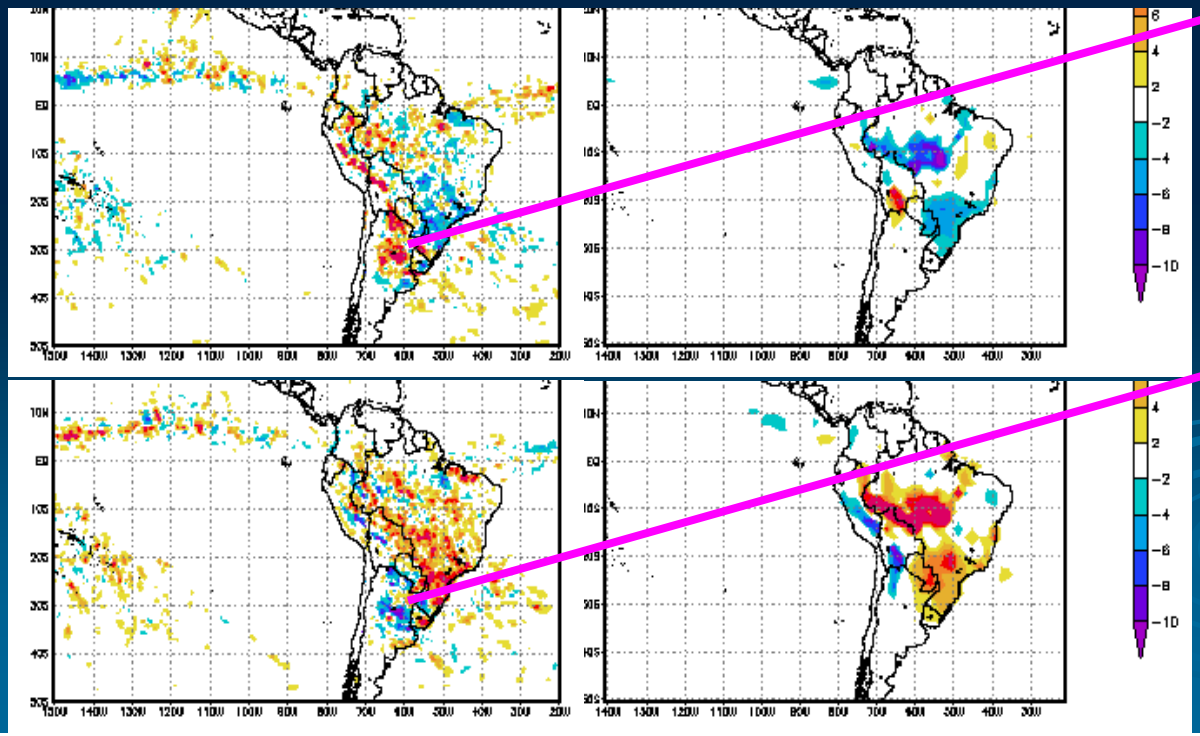
Summer precipitation over SAMS (2002-2003)





CMORPH

COLA



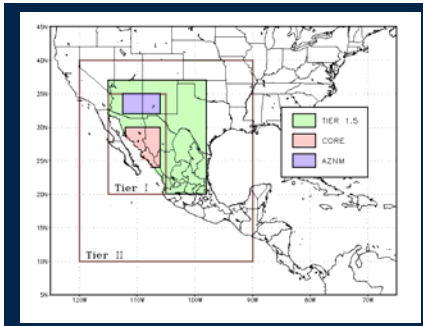
06 UTC ~ 03 LST

18 UTC ~ 15 LST

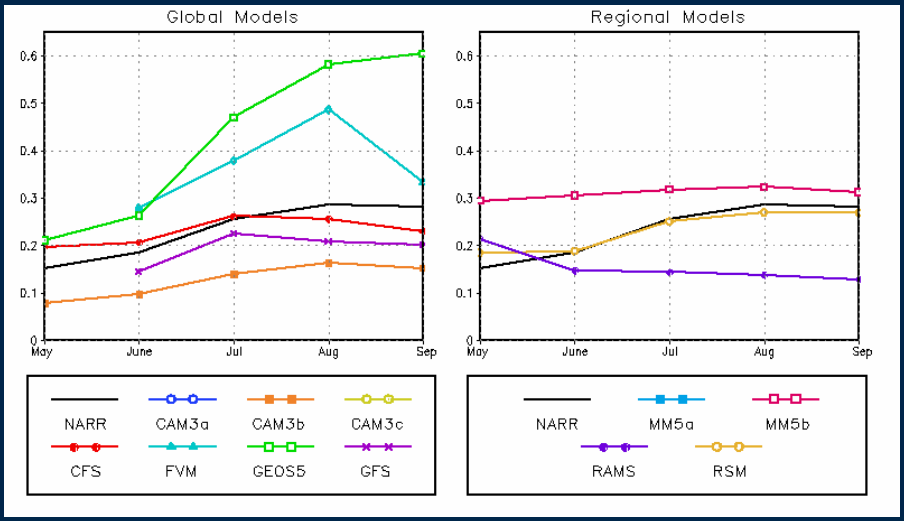
- From Saulo and Nogués-Paegle, VPM8, 2005

Land-surface interaction

Surface Fluxes and Soil Moisture

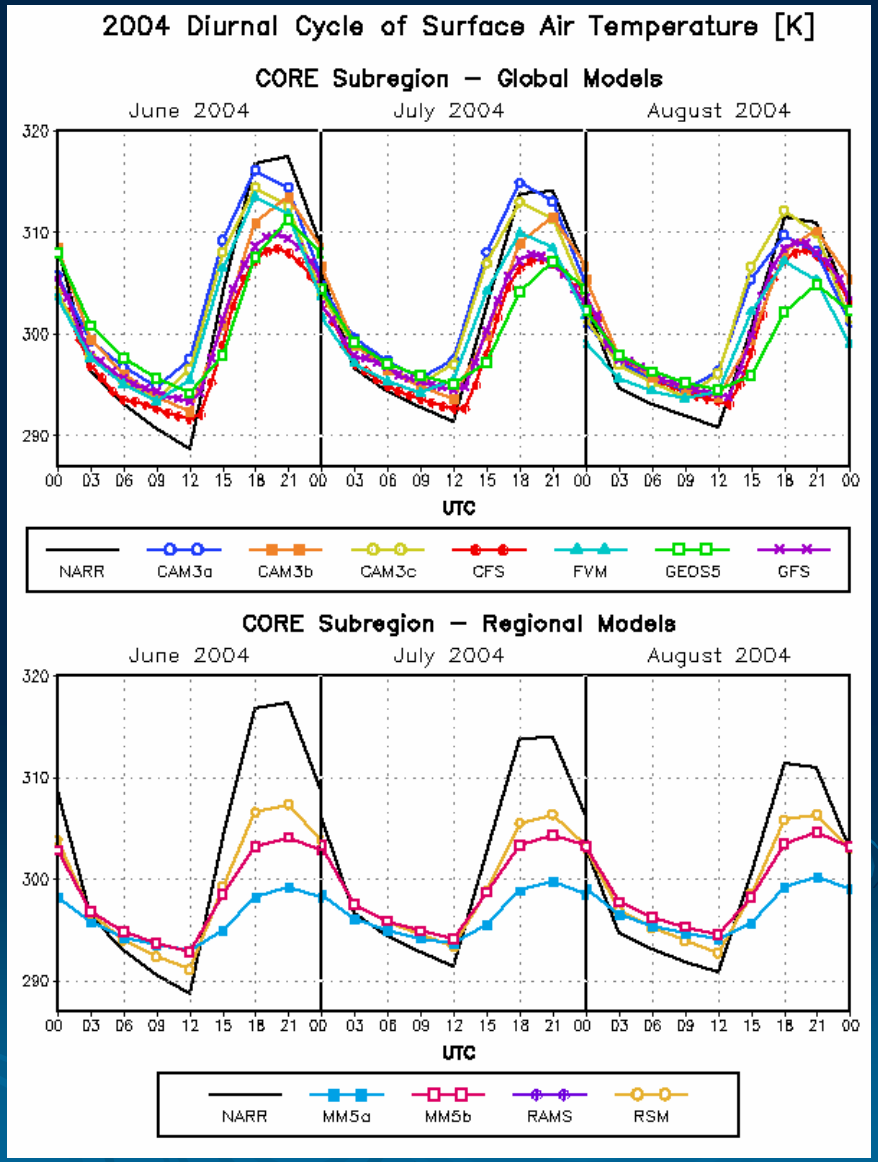


Surface Layer Soil Moisture



Soil moisture across the CORE region in most simulations does not vary much from month to month.

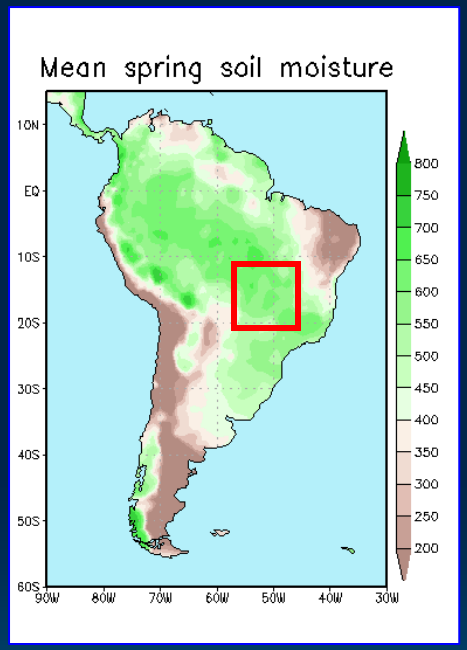
Models with the most summer soil moisture have the most variability, highest precipitation rates and low surface temperature.

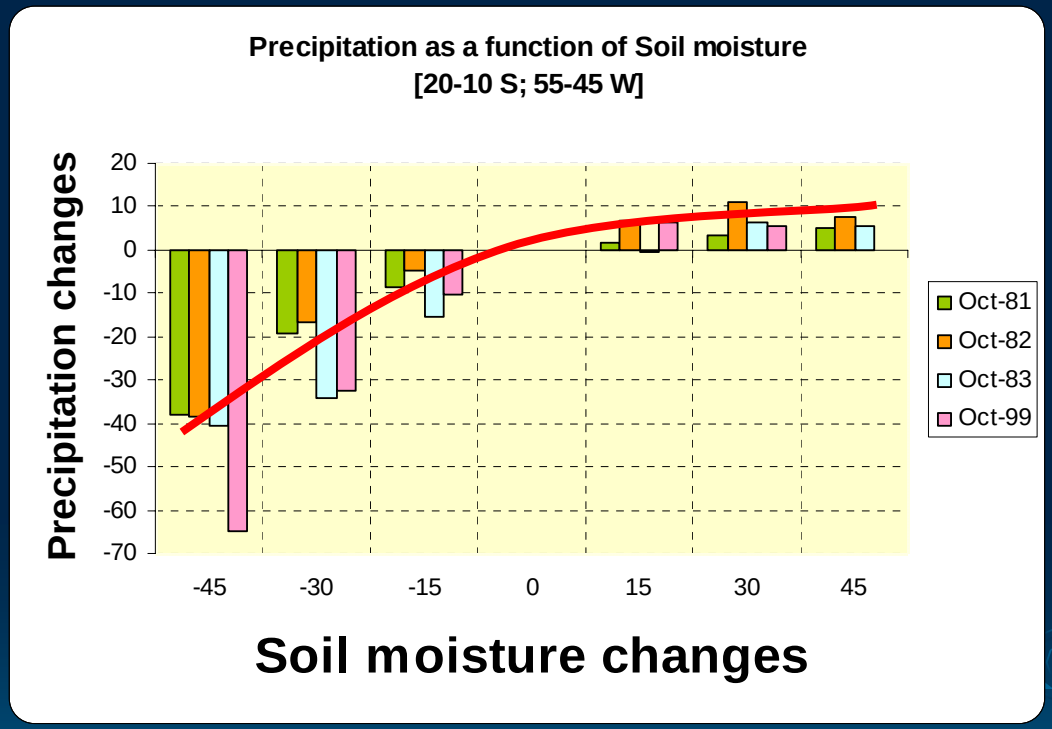


(slide courtesy D. Gutzler)

How does Soil Moisture Influence the early stages of the South American Monsoon?

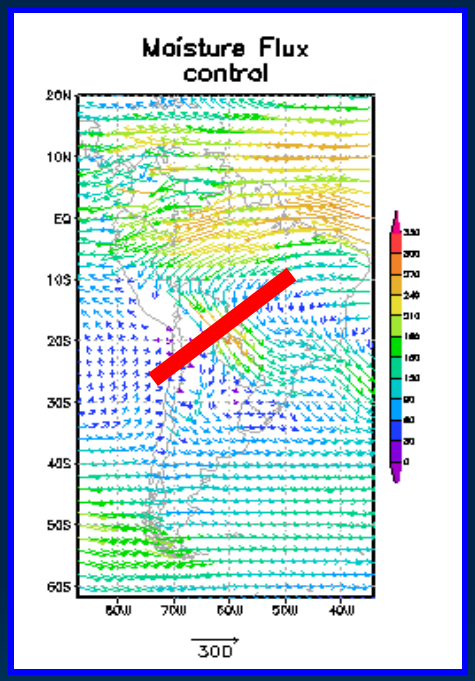
Collini et al 2007, JCLI in press

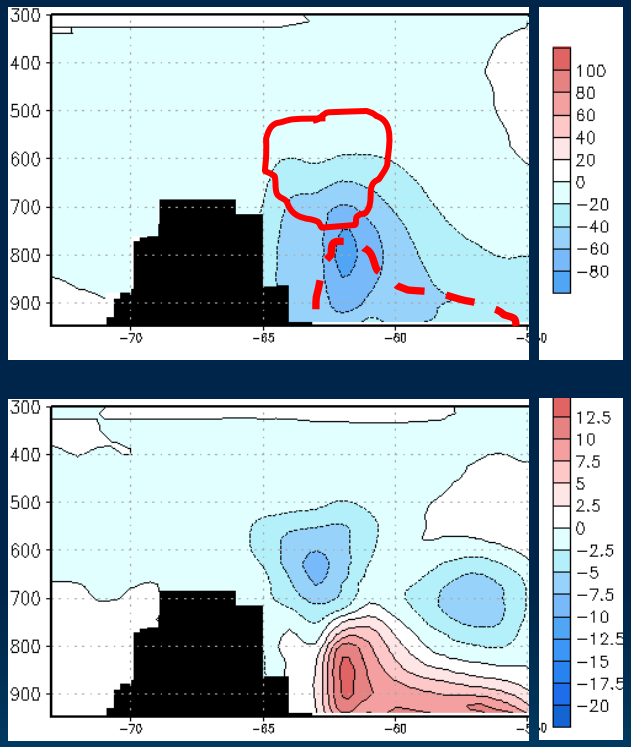




There is more sensitivity to reductions of soil moisture than to increases (closer to saturation)

Cross section of the Moisture Flux





Control Run

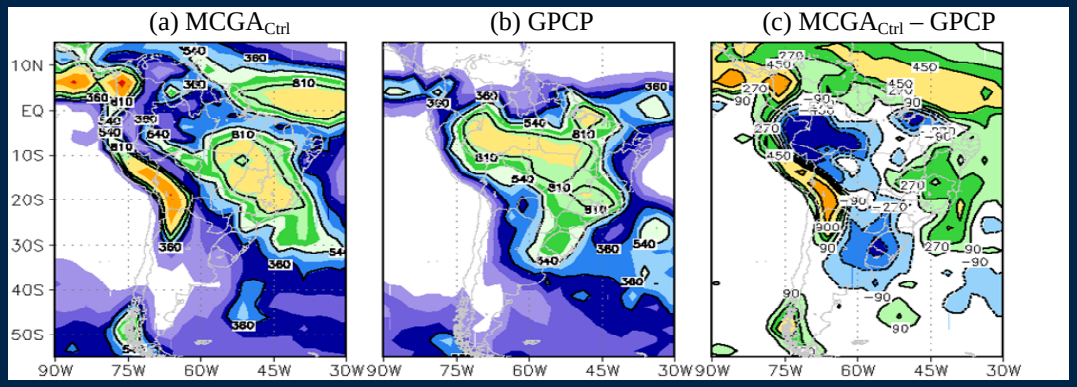
Mean Moisture Flux

Reduced SM Experiment

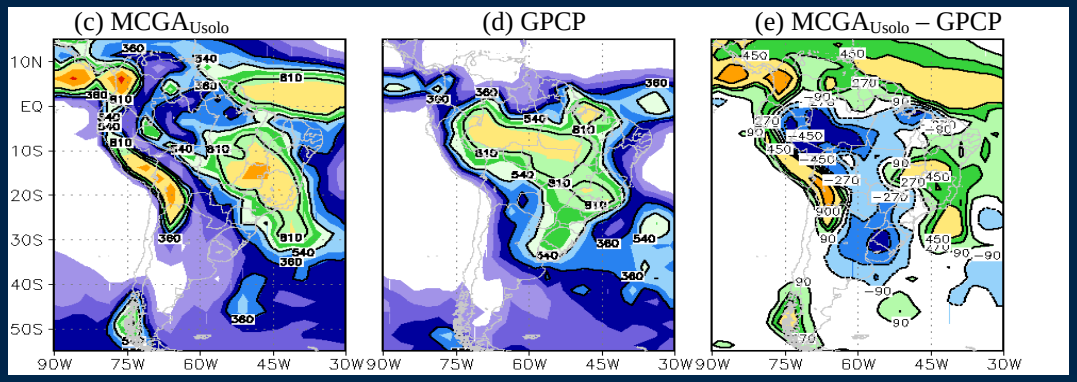
Anomalies with respect to control

A deeper boundary layer (higher top) that in turn has associated a higher LLJ; together with the reduction in atmospheric moisture content, a reduction of the convergence of moisture flux is observed.

IMPACT OF ESTIMATED vs CLIMATOL. SOIL MOISTURE

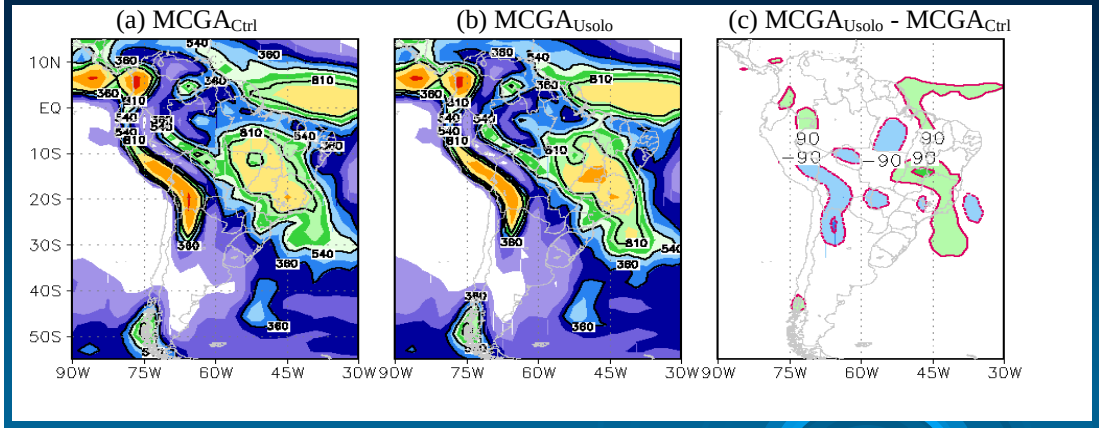


Climat. Soil moisture



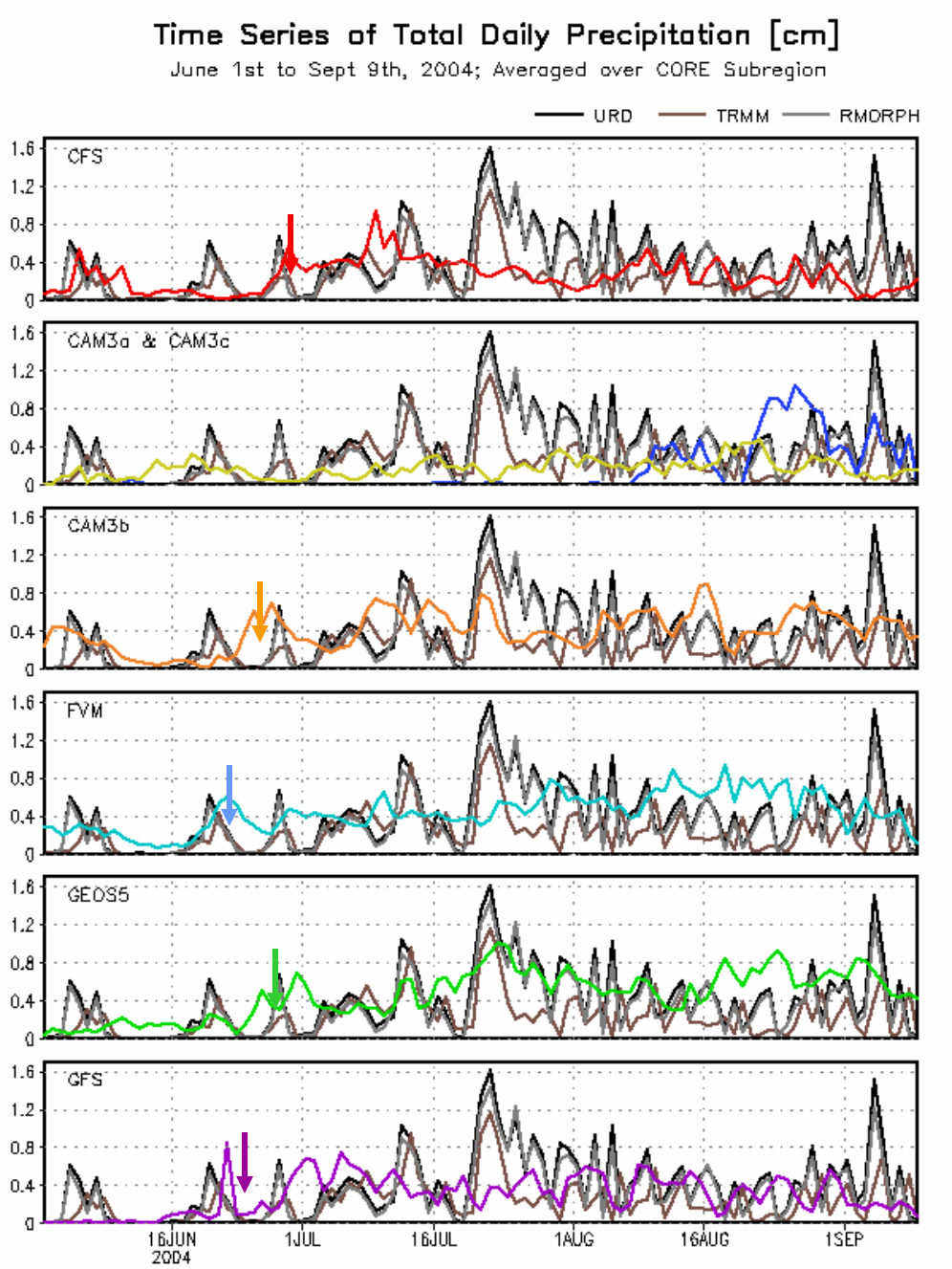
Estimated soil moisture

The systematic errors persist and are increased in the SACZ and eastern Amazonia



Difference of the 2 runs

Souza and Cavalcanti, 2007



Monsoon Onset
CORE Subregion

Previous NAMAP results indicated that global models tend to delay monsoon onset unrealistically.

Most global models in NAMAP2 exhibit a pronounced increase in precipitation across the CORE subregion in late June, reasonably consistent with observations.

This onset followed a widespread but short-lived rainy period in early June that was also captured by most models.

(slide courtesy D. Gutzler)

Need of more observations

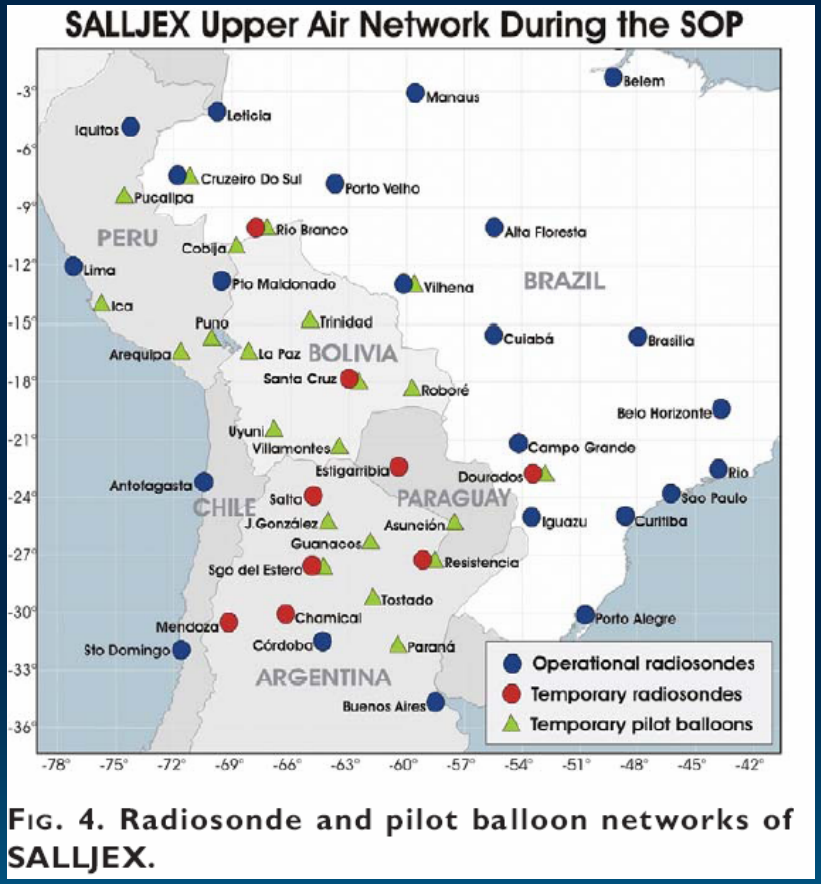
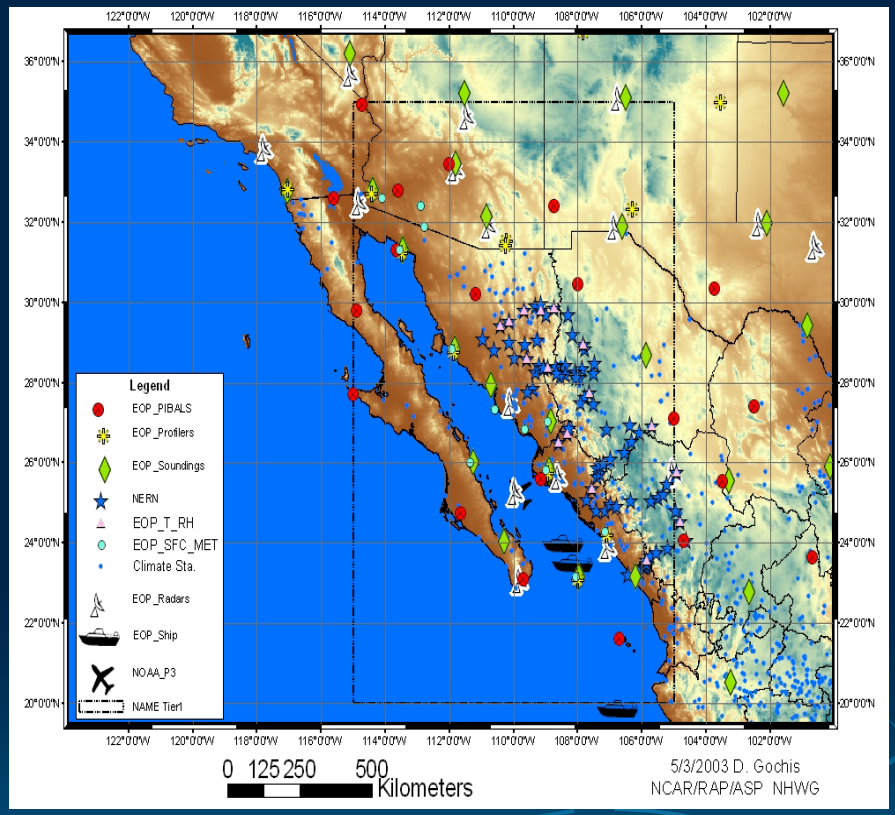


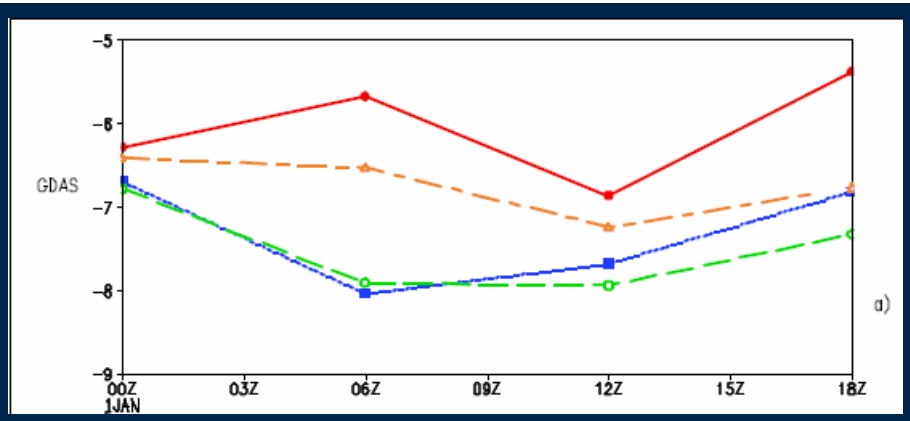
FIG. 4. Radiosonde and pilot balloon networks of SALLJEX.



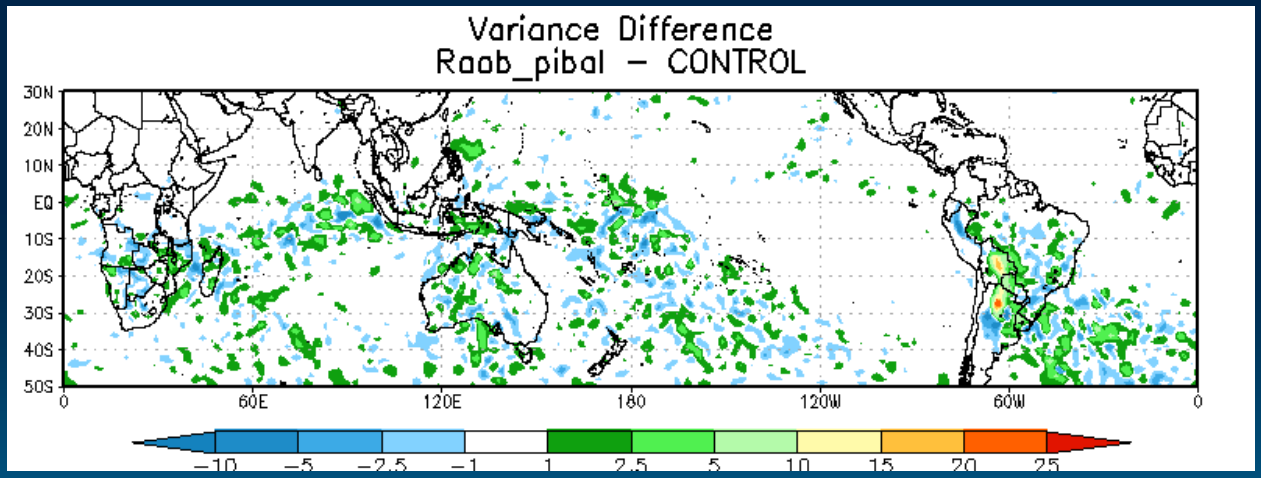
- SALLJEX 2002-2003
- NAME 04

The reanalysis using SALLJEX data.

Herdies et al, J. Clim 2007



Mean low level wind at Santa Cruz



850 hPa wind variance difference (with – without SALLJEX data)

- From Nogués Paegle and Saulo, AGU meeting 2006

Modeling Issues of the North American Monsoon: need for a robust regional observing system

Difference in CDAS moisture flux and precipitation w/ and w/out soundings and precip. data

Modeling Issues of the North American Monsoon: Progress and current issues

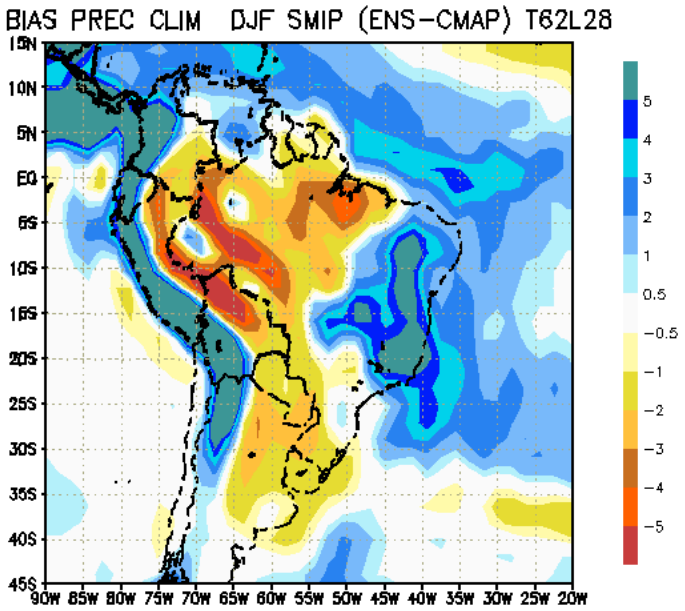
- NAMAP-II results from 2004 showing improvements in model simulation of onset
- Significant problems with diurnal cycle and regional moisture transport (LLJ) in global models remain
- Regional modeling studies producing reasonable diurnal cycles of precipitation and intra-seasonal variability
- Lingering uncertainties in timing and magnitude of land-atmosphere and ocean-atmosphere fluxes which vary widely in models. 2004 NAME data is helping with model validation
- Dependence of NAM rainfall on seasonal transient behavior highlights need for robust regional observing system

What is being done

SMIP STUDIES
SEASONAL PREDICTION

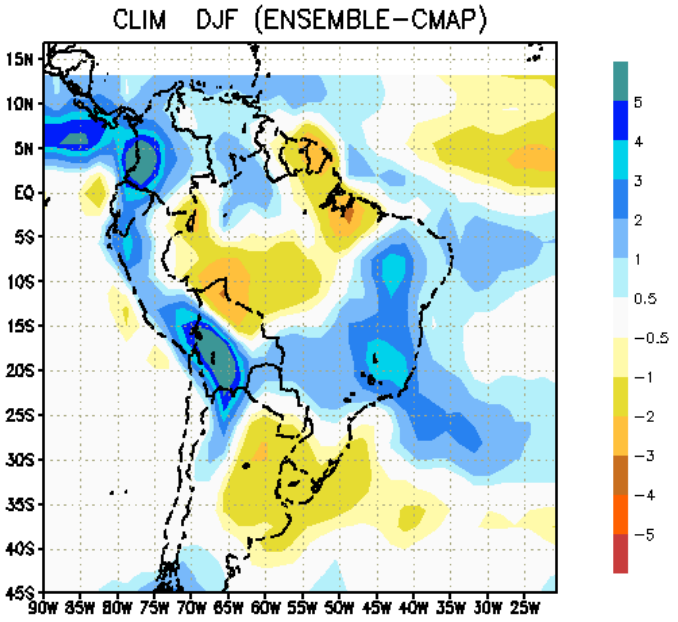
- **Investigation of improvements in seasonal prediction considering a multi-model ensemble**
- **CPTEC, SCRIPPS, IAP, KMA, MGO**

CPTEC



Reduction of bias

Multi-Model



Cavalcanti et al 2007 (see POSTER and Lincoln´s presentation)

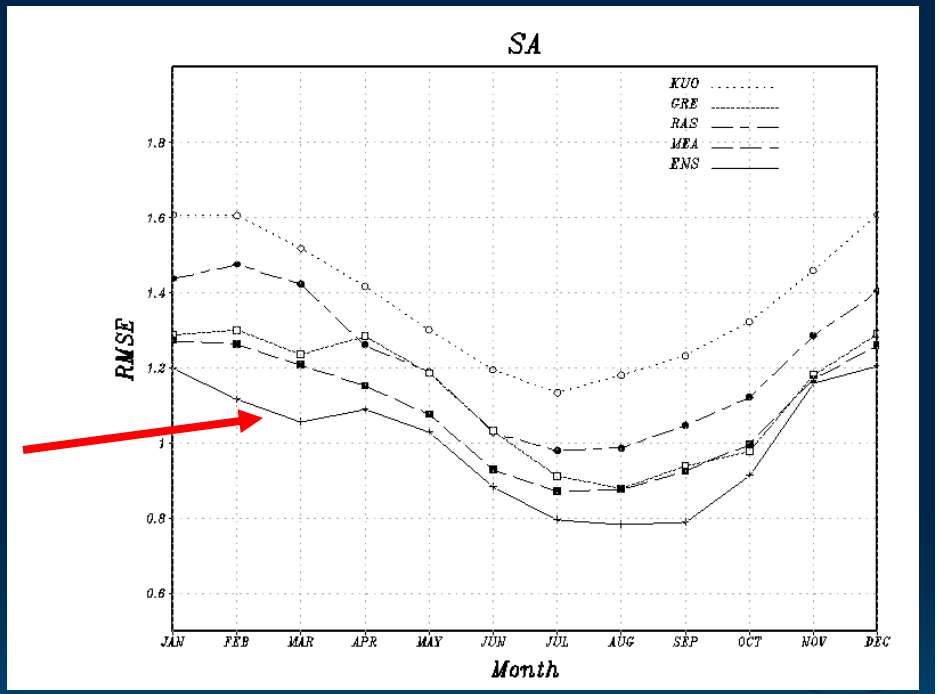
Statistical method for multi-model error correction

Period : January 1982 to December 2001

Model: AGCM CPTEC and Different convection schemes

Kuo (KUO); Arakawa e Schubert (RAS) and Grell (GRELL)

ENS



Pezzi et al 2006

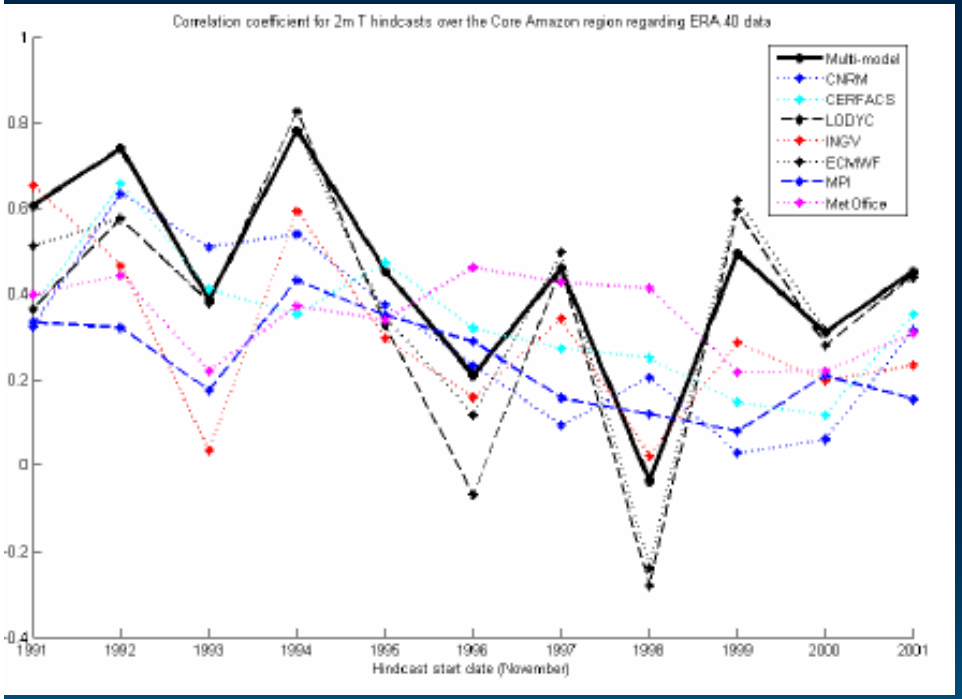
Demeter products: Correlation Coefficients

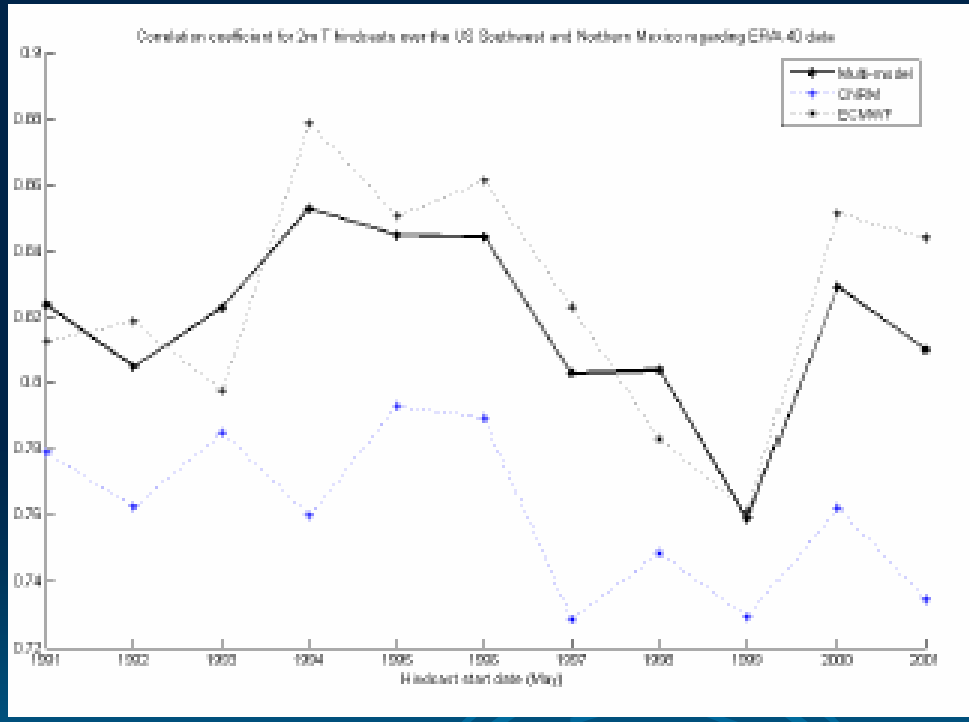
Core Amazon Region – Dec.

1 month hindcasts

US SW and N Mexico – July

1 month hindcasts

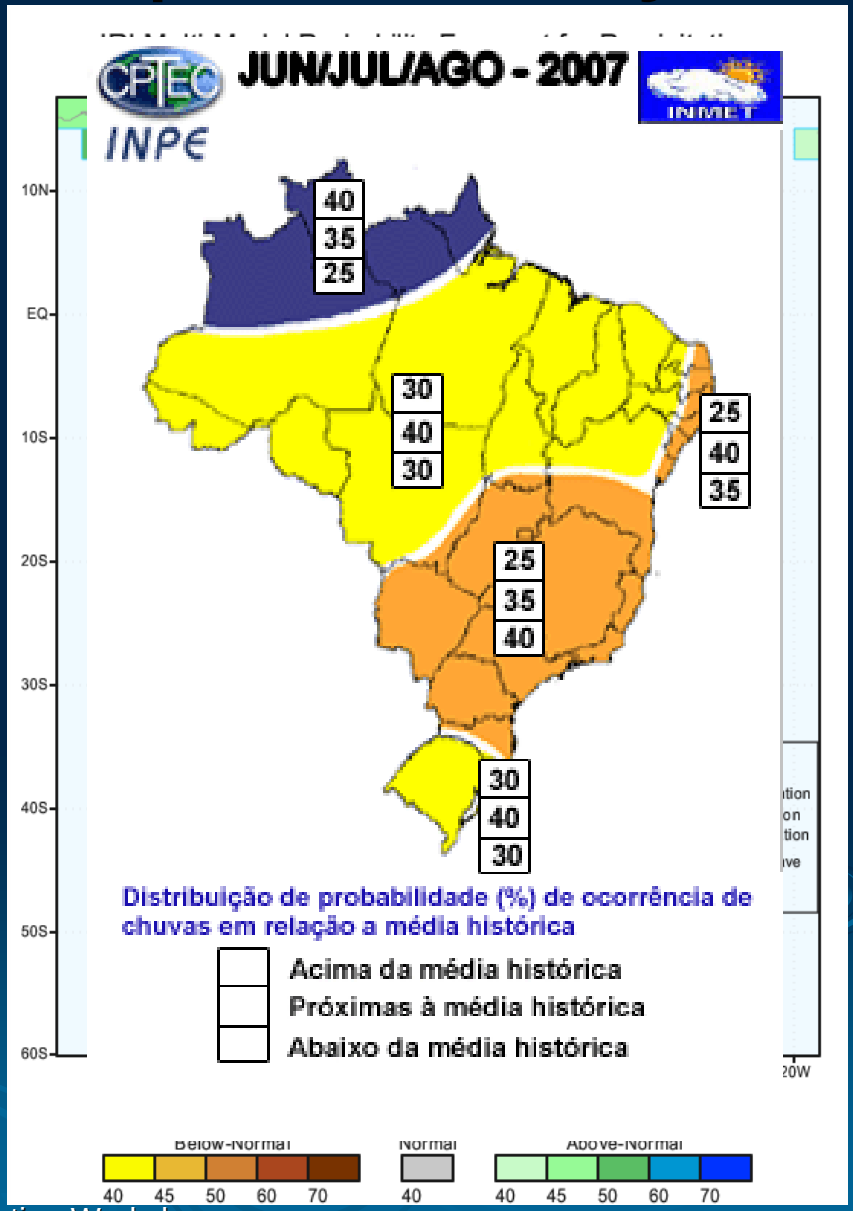




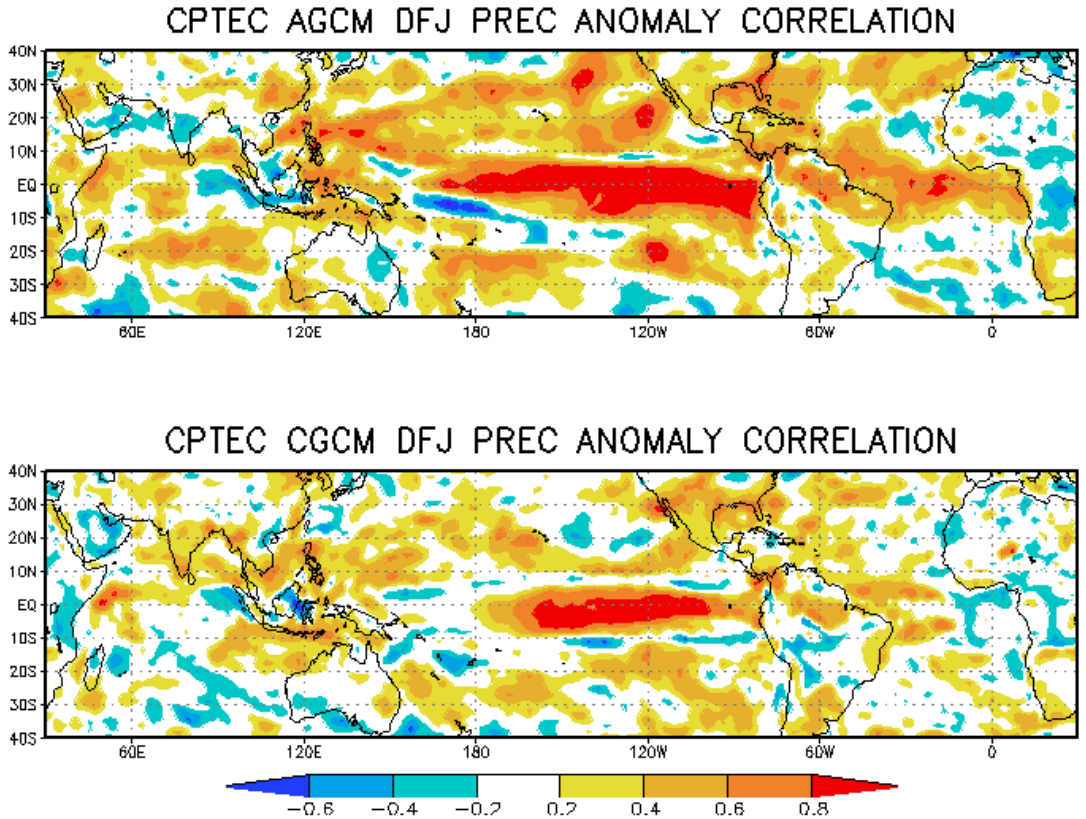
Saulo and Saunier, 2007

What is being done operationally?

- NCEP – Canada
  - Seasonal outlooks
- IRI
  - Different Regions worldwide
- CPTEC
  - Most concentrated in Brazil
- Climate Outlook Fora (COF) for southeastern South America (SESA)
- Centro Internacional de Investigaciones sobre el Fenómeno El Niño (CIIFEN) in Ecuador, coordinates COF activities in the countries on the west coast of South America,



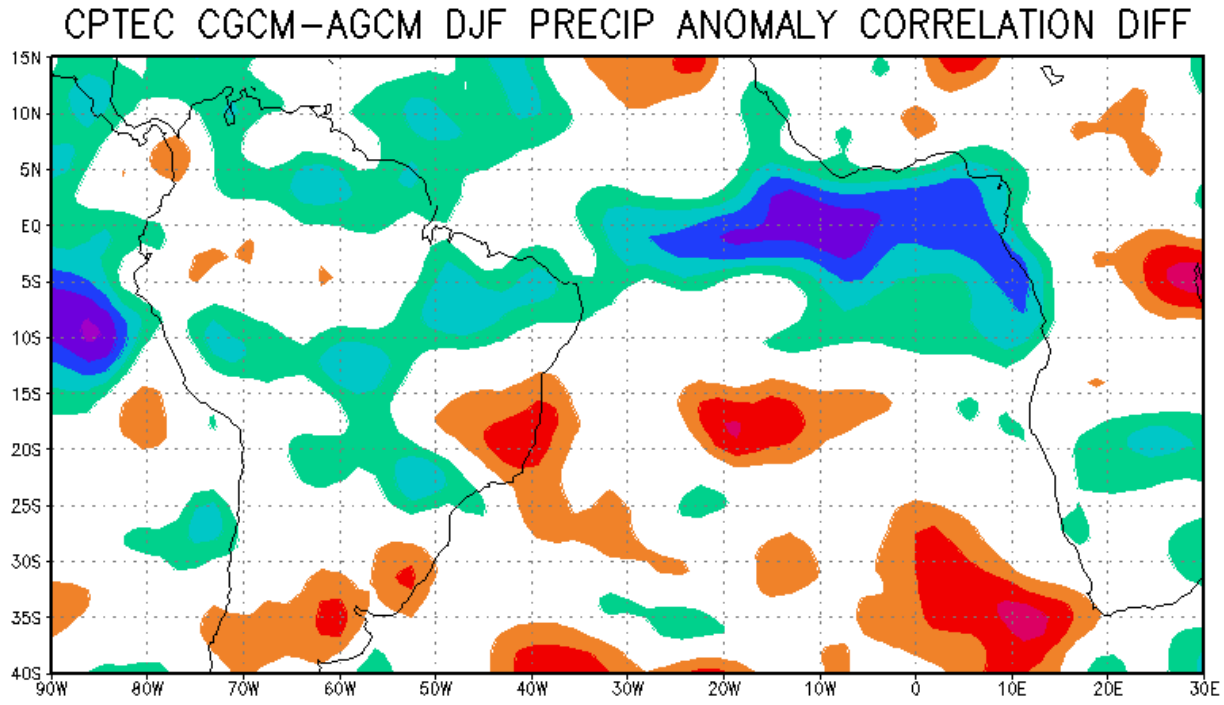
CPTEC's AGCM & CGCM DJF PRECIP FORECAST ACC



20 years, 10 member ensembles

Courtesy of P. Nobre

CPTEC's CGCM-AGCM DJF PRECIP FORECAST ACC

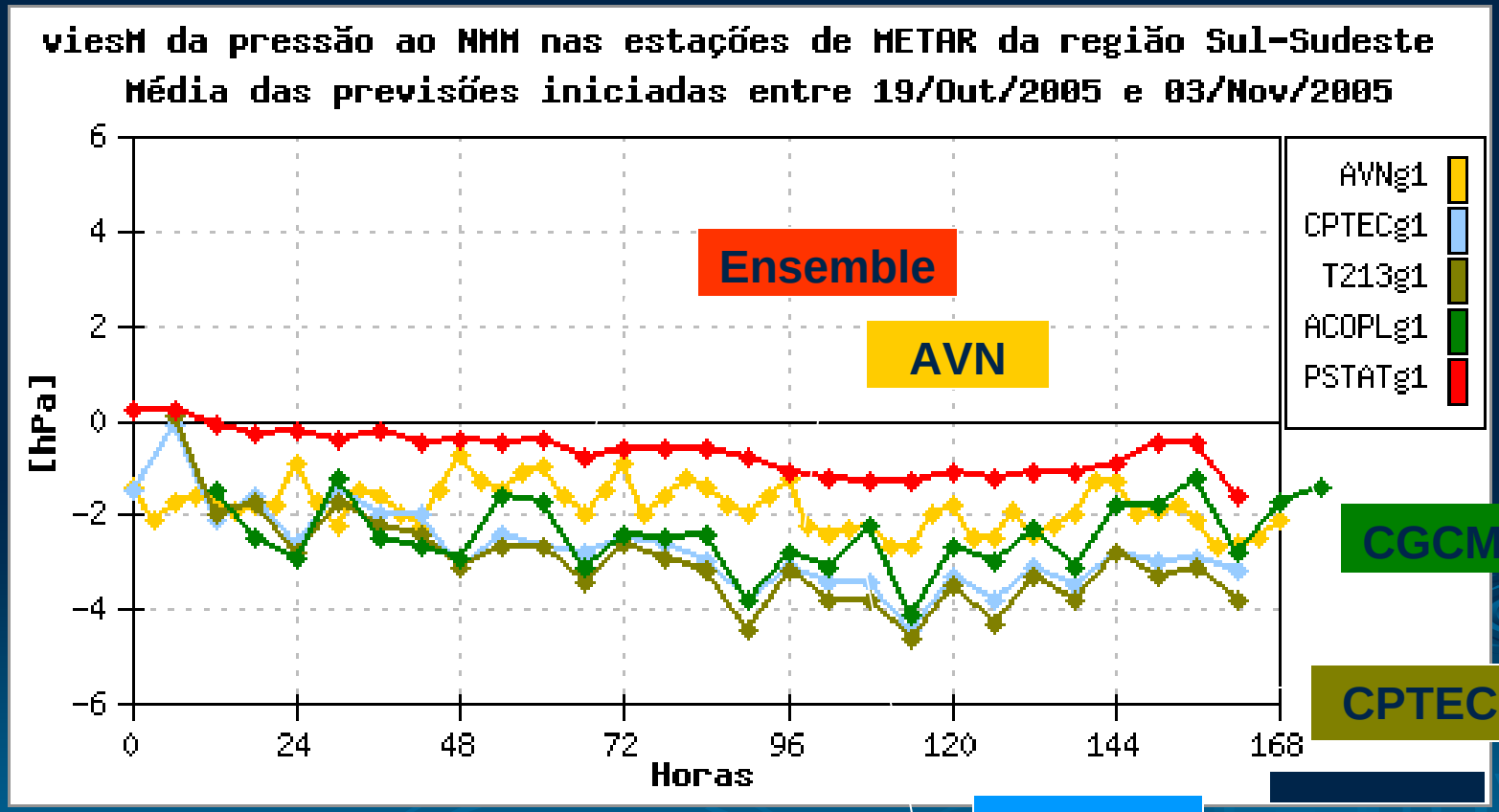


20 years, 10 member ensembles, October IC

Courtesy of P. Nobre

SLP FCST BIAS

OVER SE BRAZIL



Courtesy of P. Nobre

The NAME Forecast Forum: Tracking skill in N. American warm season precipitation forecasts

Purpose:

To provide an accessible, online forum, for the posting, distribution, monitoring and synthesis of intra-seasonal and seasonal forecasts of the North American Monsoon.

Principal Activities:

- Define and monitor key indices of monsoon behavior
- Monitor forecast skill of intra-seasonal to seasonal predictions of the North American Monsoon
- Disseminate to the community a range of NAM intra-seasonal and seasonal forecast products
- Synthesize NAM forecast products into periodic consolidated NAM outlooks
- Link NAM monitoring activities with other monsoon monitoring activities such as that currently under development by NOAA/CPC and other institutions