MONSOON EXPERIMENT IN SOUTH AMERICA (MESA)

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MESA SWG Chair

An internationally coordinated, joint CLIVAR – GEWEX program aimed at providing:

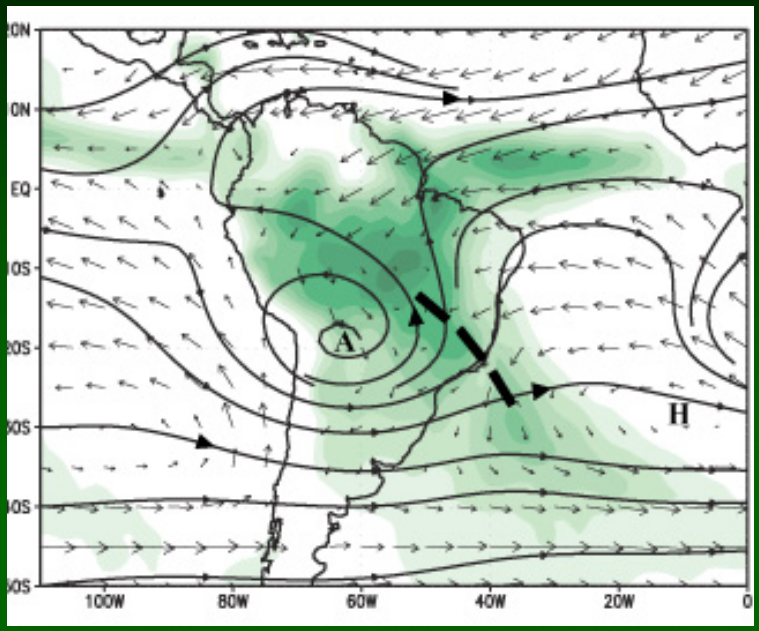
1.a better understanding of the South American monsoon system and its variability,

2.a better understanding of the role of that system in the global water cycle

3. improved observational data sets, and

4.improved simulation and prediction of the monsoon and regional water resources.

MONSOON EXPERIMENT SOUTH AMERICA (MESA)



HYPOTHESIS:

The SAMS provides a physical basis for determining the degree of predictability on short- and long timescales over the region.

MESA PRIORITY RESEARCH AREAS (PRA):

Better understanding and simulation of:

- **diurnal and mesoscale variability (PRA-I);**
- **intraseasonal variability (PRA-II)**
- **interannual and longer time variability (including ACC) (PRA-III)**
- **monsoon evolution and variability (PRAs-I, II, III)**

MONSOON EXPERIMENT SOUTH AMERICA (MESA)

OUTLINE

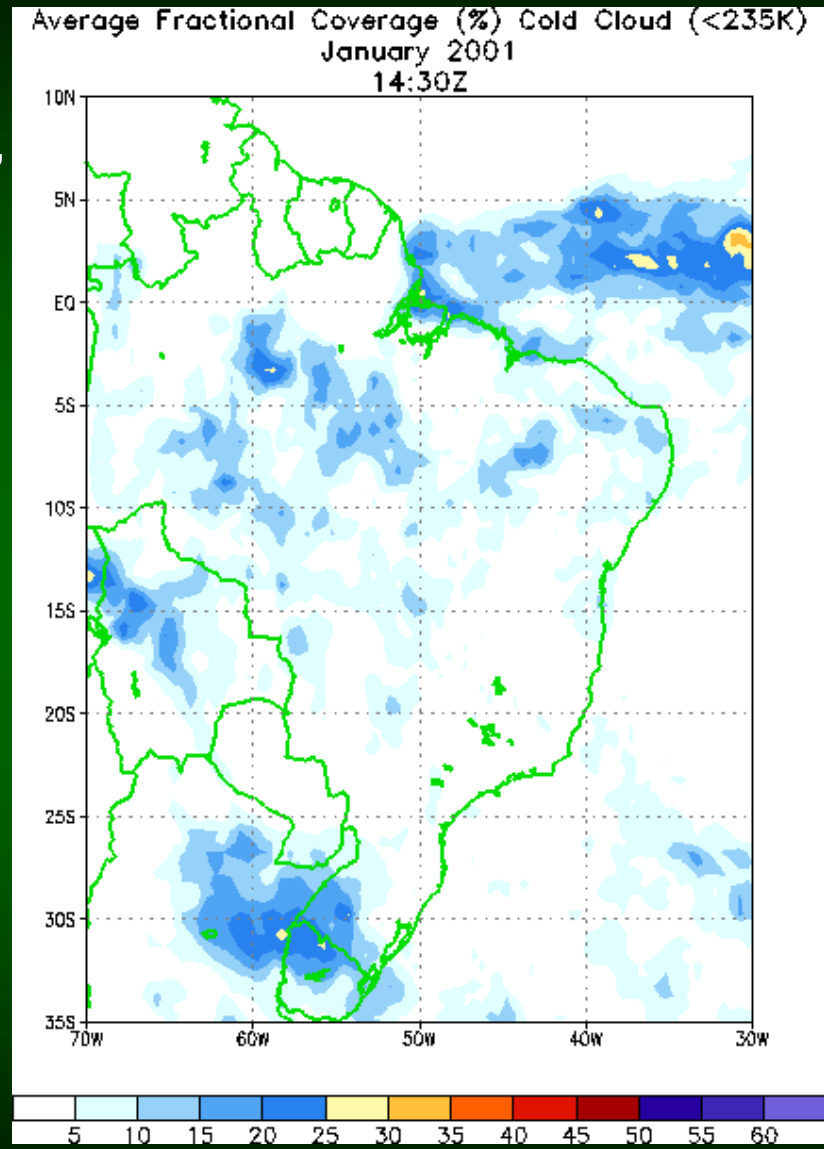
- PRA Scientific Questions
- Databases
- MESA Projects
- Climate Monitoring and Field Campaigns
- MESA Milestones

MESA PRA-1: Diurnal and mesoscale variability

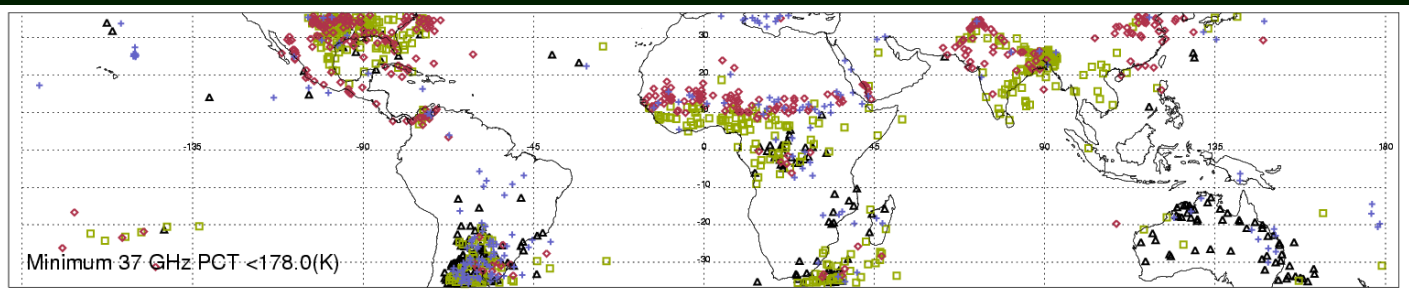
•The diurnal cycle is a dominant feature in South America as in every other monsoon system. However, there are a number of characteristics unique to the SAMS case. The very wide and wet continental land mass over the equatorial region sustains a diurnal regime of convection that is more like the oceanic counterpart and quite distinct to that over drier land.

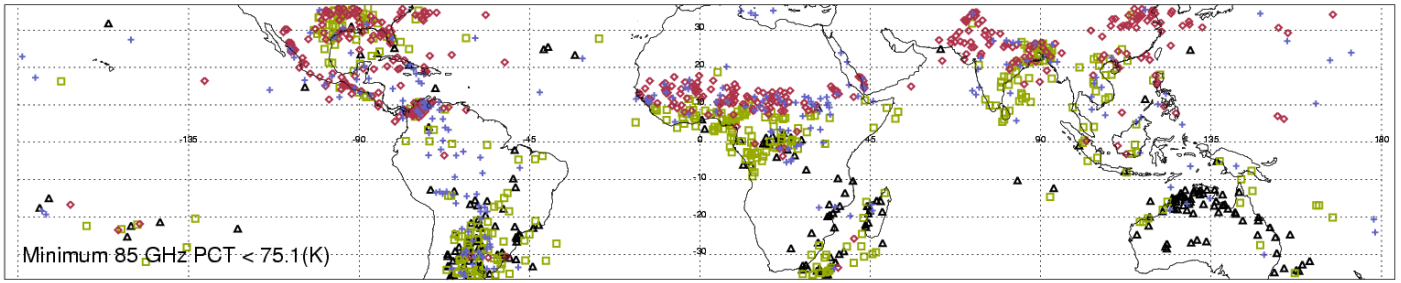
•There are clear features that drive most of the diurnal oscillations over SAMS region: the LLJ, the orographic effect and land-sea breezes, which in conjunction with the solar cycle are responsible for the observed diurnal cycle of convection. The interaction between these features and precipitation are enormous challenges to the understanding and, consequently, the prediction, of the SAMS.

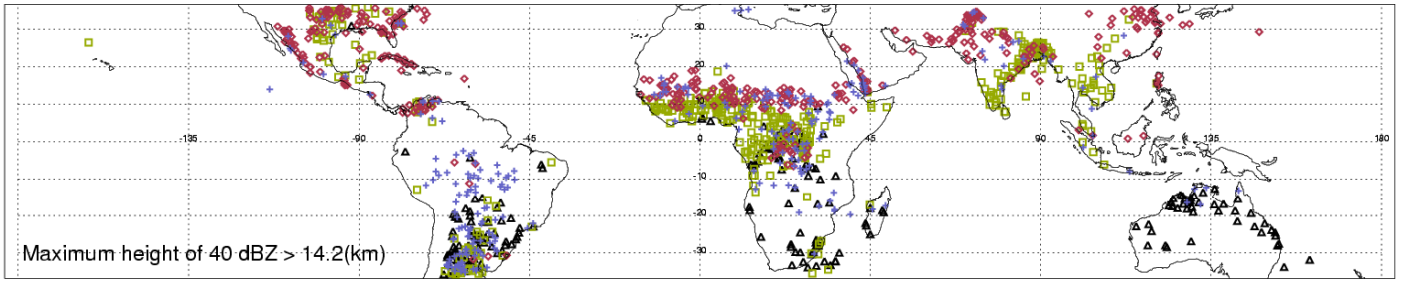
•Numerical analysis and modeling of rainfall variability in the SAMS are limited by the capability of the models to simulate the physics of the rain-producing weather systems.

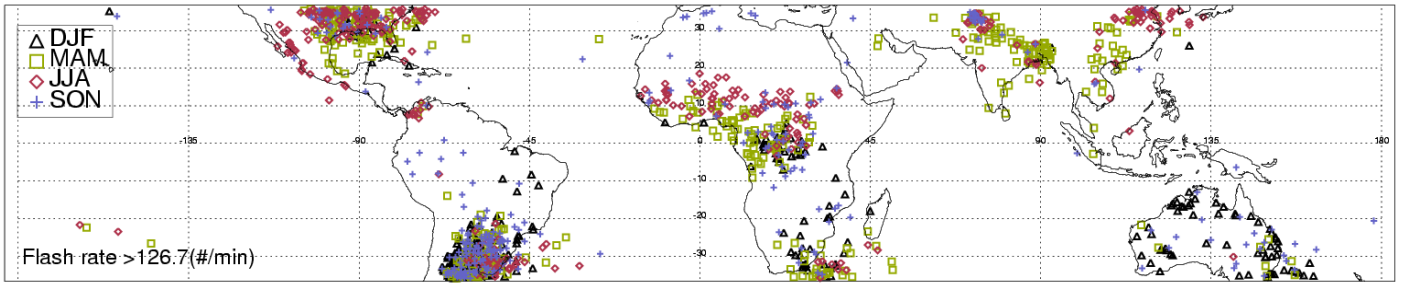


MESA PRA-1: Diurnal and mesoscale variability









MESA PRA-1: Diurnal and mesoscale variability

Scientific Questions

•Can the diurnal cycle of precipitation associated with the main precipitation regimes documented over SAMS be precisely identified? (i.e., MCS-regime, tropical-convection regime, altiplano-regime)

•Which are the main processes underlying the identified diurnal cycles?

•Which is the physics of rainfall processes in different portions of the SAMS?

•To what extent/Through which mechanisms does soil hydrology affect the diurnal cycle?

MESA PRA-1: Diurnal and mesoscale variability

Actions

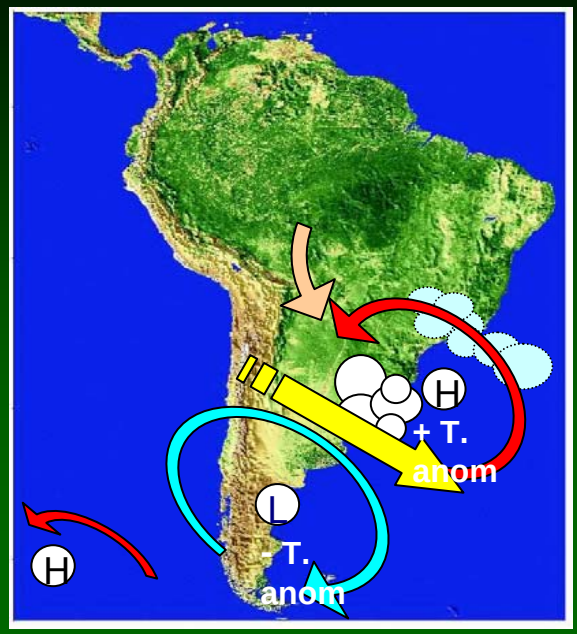
•High resolution (both spatial and temporal) precipitation and convection data sets are needed. Available derived-precipitation data (proxies for precipitation) need to be validated.

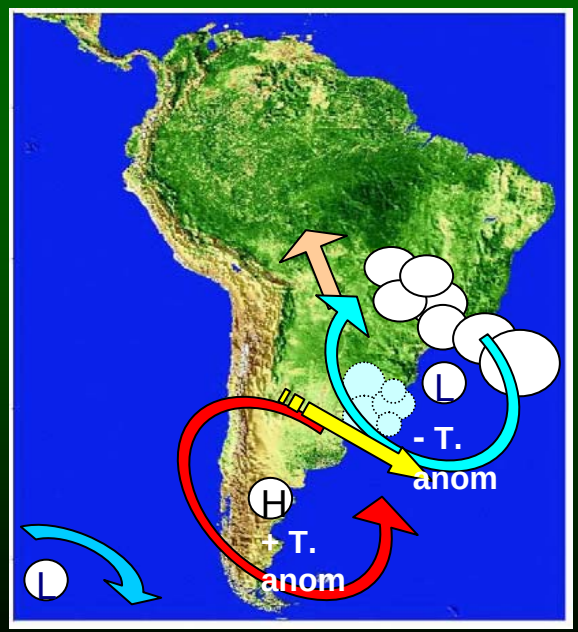
•Models resolution is crucial for the ability to simulate MCSs. Very high resolution (i.e., 3 km grid size or smaller) experiments are needed to get a better picture of the organizational characteristics of MCS.

• *The diurnal cycle is a basic climatic feature* in the consideration of all other scales. The current status of the diurnal cycle in existing models should be documented (Small diagnostic project, with runs already available, and then perform new runs, WGSIP?).

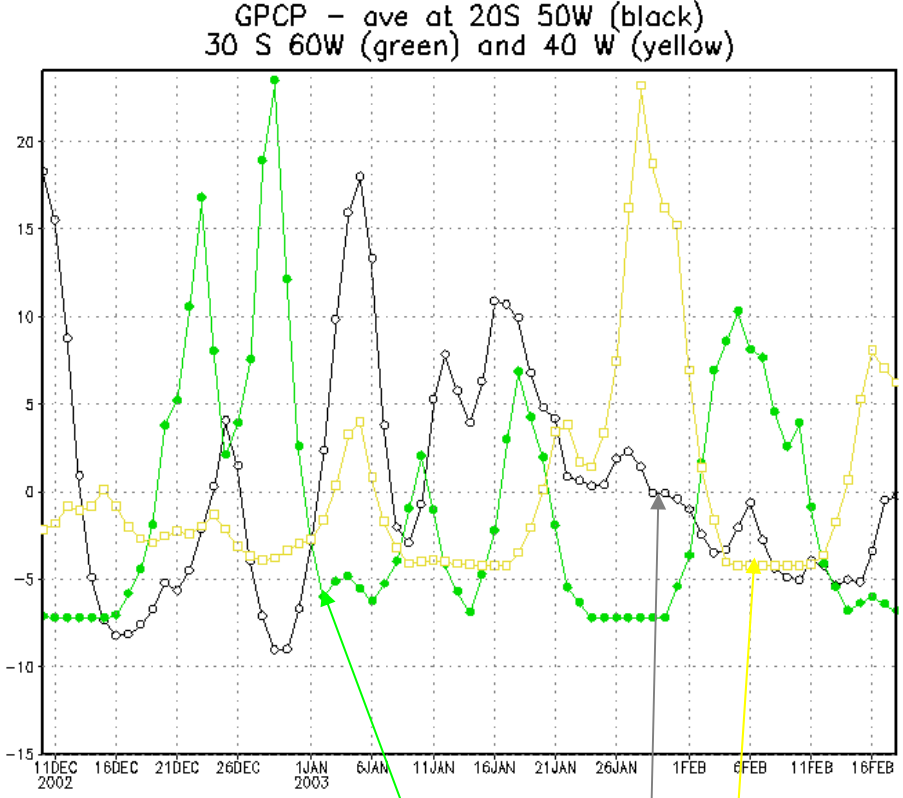
•The simulation of MCS require an understanding of the close interaction between parameterized convective fluxes, and mesoscale circulations that are explicitly resolved by the model's dynamics. Basic research is also needed to determine the resolution required to successfully simulate the relevant dynamics. Observational studies to improve our understanding of MCSs and to provide the observational and reanalyses datasets required to guide the modeling work are still needed.

MESA PRA-2: Intraseasonal variability





Typical circulation features of the SAMS accompany wet and dry conditions over Southeastern South America (e.g. Diaz and Aceituno 2003)


GPCP – ave at 20S 50W (black)
30 S 60W (green) and 40 W (yellow)
11DEC 2002
16DEC
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1JAN 2003
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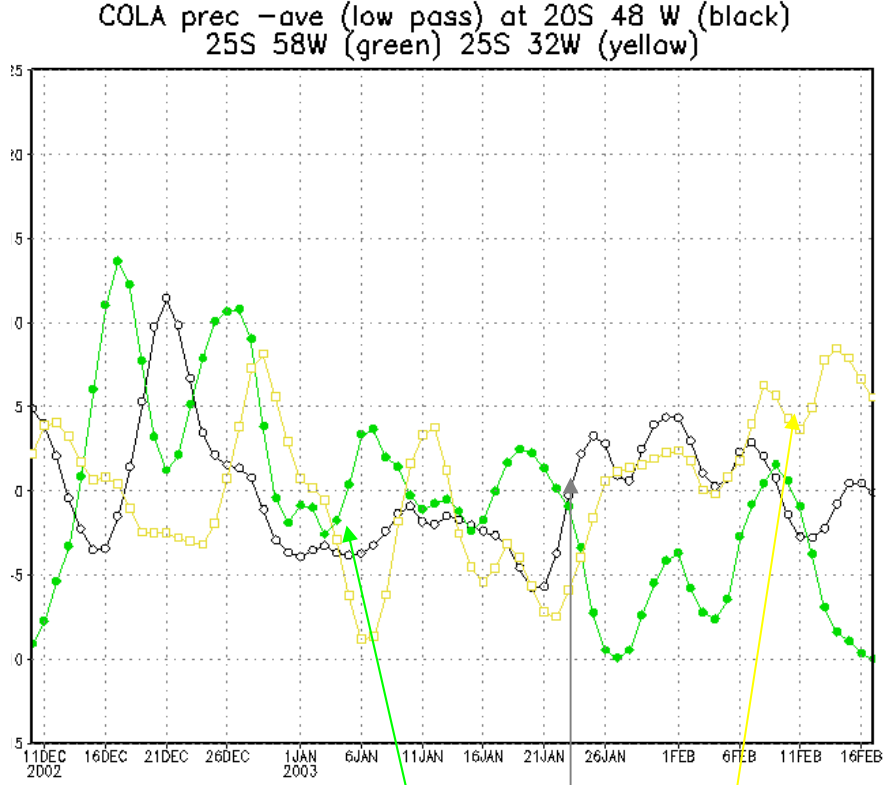
COLA prec –ave (low pass) at 20S 48 W (black)
25S 58W (green) 25S 32W (yellow)
11DEC 2002
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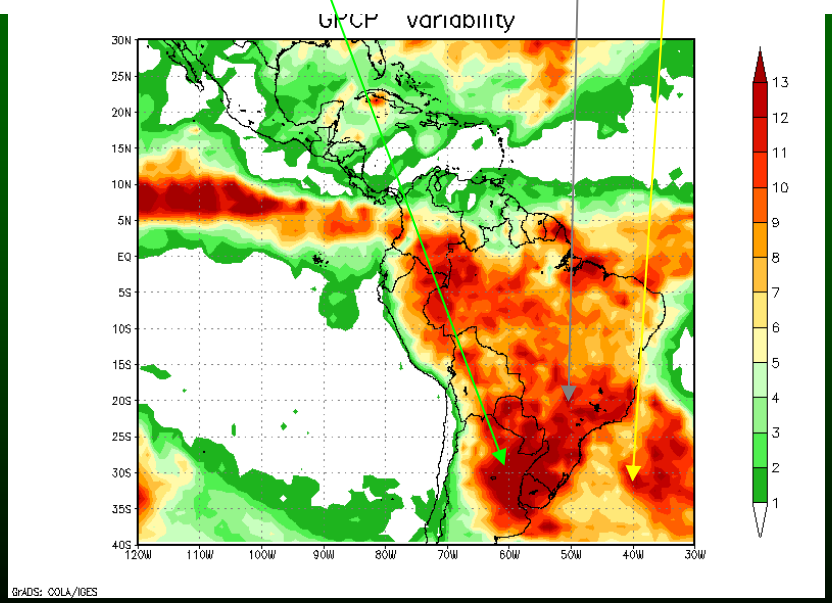
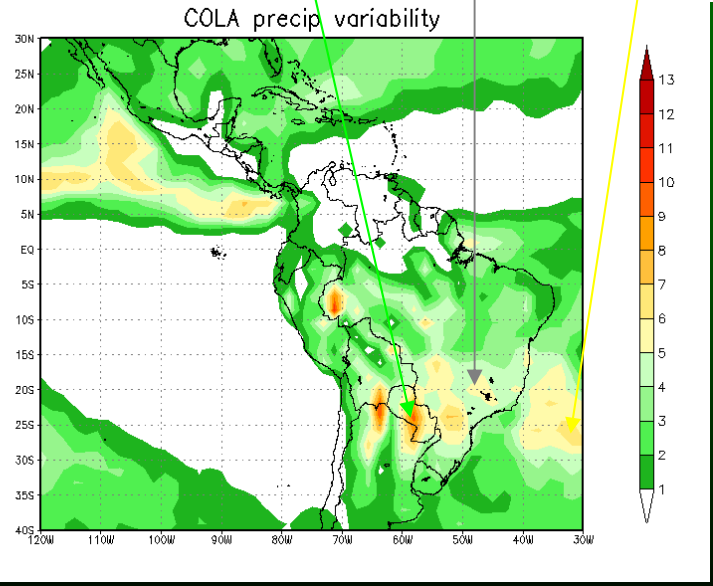

GPCP variability
GrADS: COLA/IGES


COLA precip variability

MESA PRA-2: Intraseasonal variability

Scientific questions:

•Are current descriptions of the ISO over South America accurate? What is the evidence for inter-annual and longer modulations of the ISO over South-America?

•Is the skill of seasonal forecasts over South America dependent on the strength of the ISO?

•How well are local and remote forcings known and specified in model simulations? How important is to reproduce the diurnal cycle in SA for simulations of the ISO?

•Is the predictability and signal of the ISO dependent on initial conditions?

•What are the relationships between ISO and extreme weather events in South America? Do local and remote forcings play different roles on the frequency of extreme events? How predictable is the influence of ISO on the occurrence of extreme weather events?

MESA PRA-2: Intraseasonal variability

Actions:

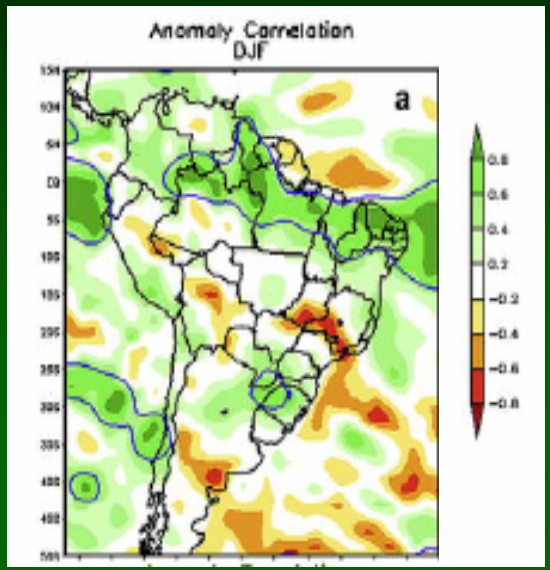
•Simulation of the ISO over SA might require:

- coupled modeling to properly simulate the ocean-air interaction in the SACZ,
- •sophisticated regional models with adequate land-air interactions to downscale the signal over the highly complex surface conditions of SA,
- •and a modeling approach that allows for local processes to feedback in the large scale circulation.

•Extended numerical integrations (from CPTEC and four different model runs) are available and should be used to examine the veracity of ISO simulations.

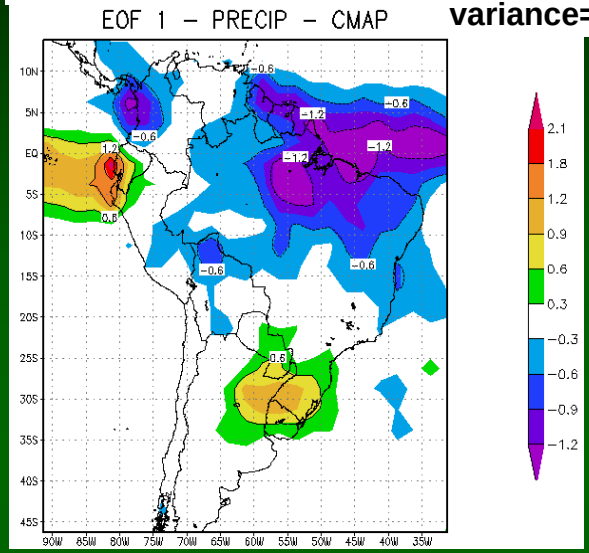
•Assessment of the intraseasonal variability in South America in IPCC AR-4 runs.

Prediction and Predictability

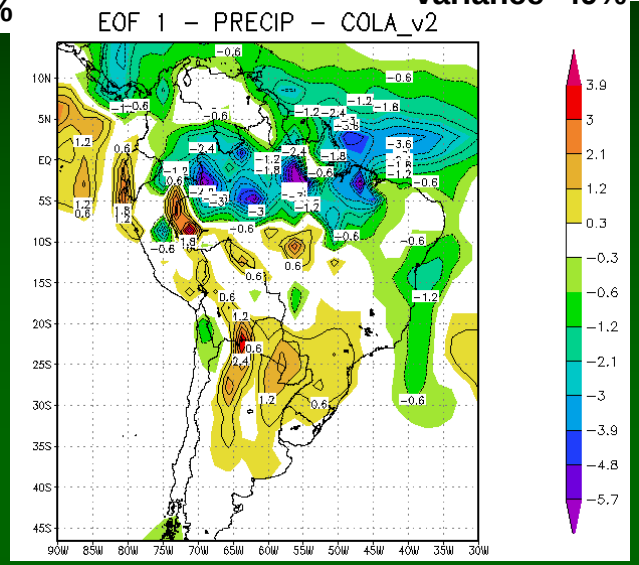


1st leading EOF of precipitation seasonal interannual variability

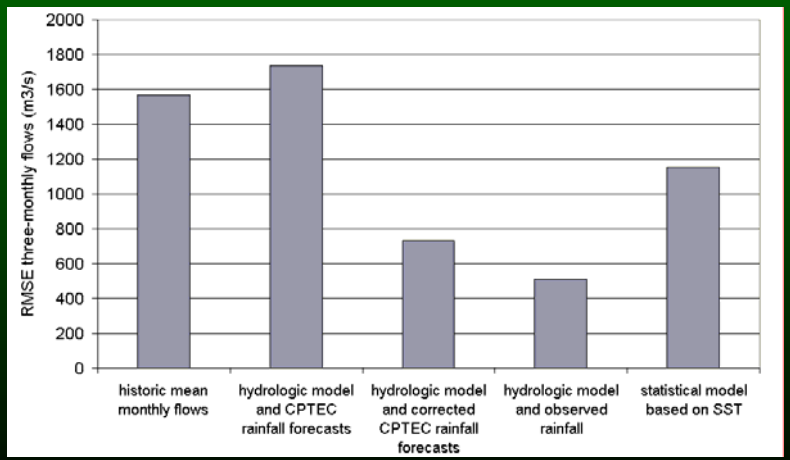
%of explained variance=22%



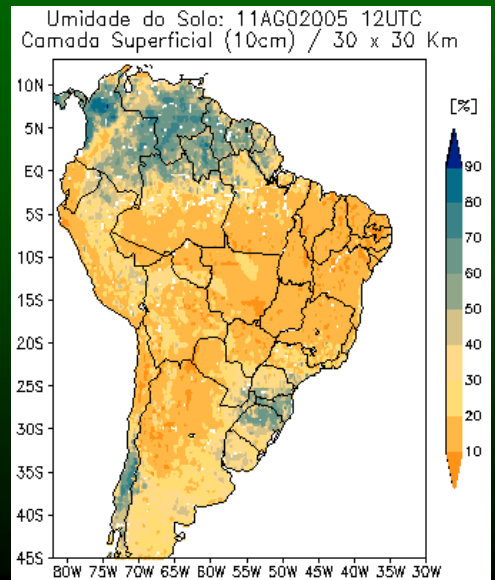
%of explained variance=49%



Applications



Nowcasts: Soil moisture monitoring (a possible climate index?)



MESA PRA-3: Interannual and longer timescale variability

Scientific Questions:

•How do land surface processes affect variability? How is variability affected by biomass burning?

•Are there prognostic relationships between the western subtropical South Atlantic SST variability and the precipitation variability in central-east Brazil or SACZ? Coupled (ocean-atmosphere) processes in the maintenance and variability of the SACZ

•Does the NAO play any role on the South America monsoon variability? How?

•How does the interannual to decadal variability influence the onset and ending of the rainy season?

MESA PRA-3: Interannual and longer timescale variability

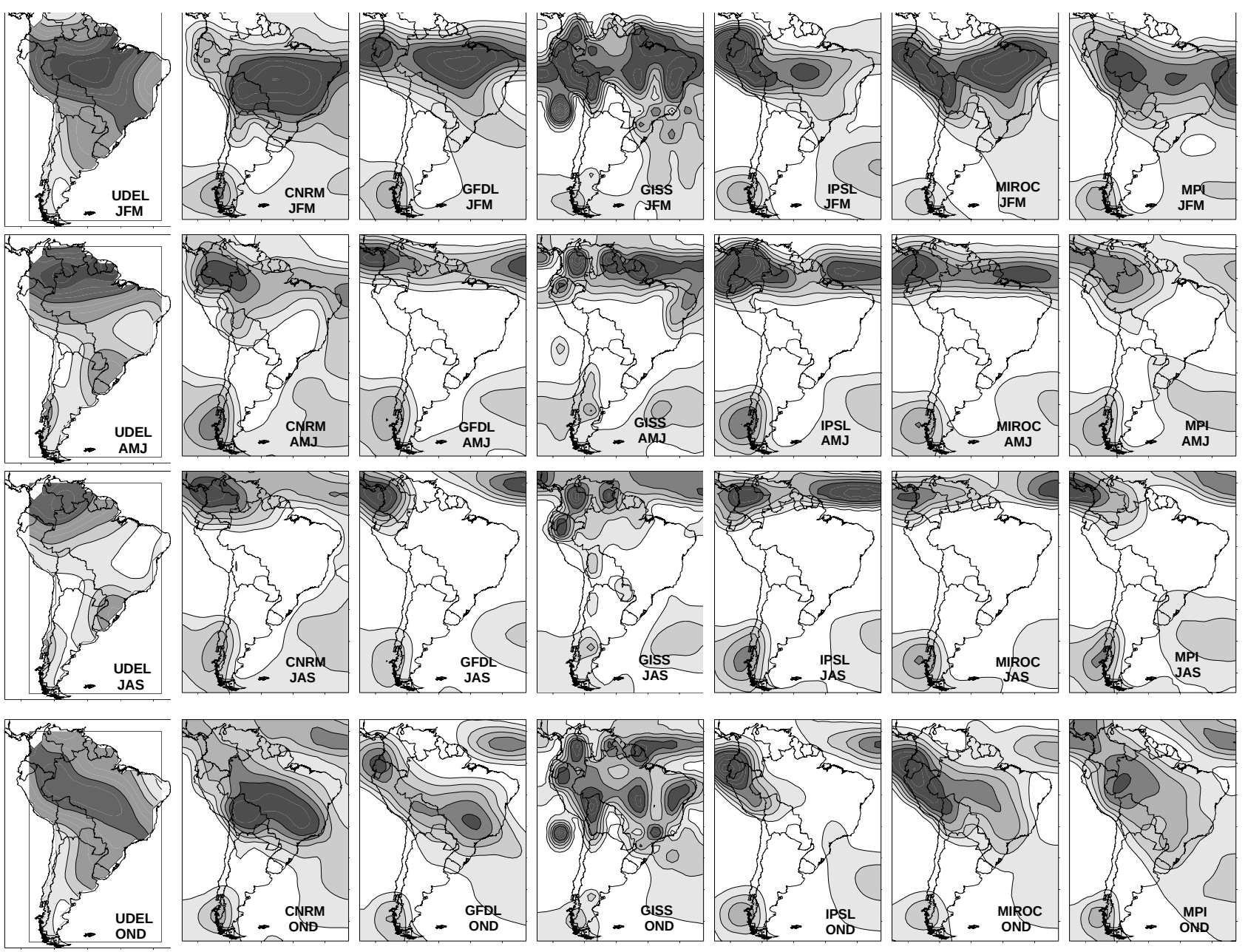
Actions:

- Improve access to historical precipitation and temperature records.
- Develop soil moisture data sets, aerosol-loading indices.
- Determine Climate indexes

- Seasonal simulation assessment of WGSIP models
- IPCC AR-4 model simulation assessment
- Predictability studies for SALLJEX
- Produce improved well-calibrated real-time probabilistic seasonal forecasts

- O-A coupled simulations in the SW-Atlantic. Enhanced observations in western subtropical South Atlantic are needed

Climatological seasonal mean precipitation(1970-1999)



Vera et al. (2006, GRL submitted)

MESA PRA-3: Climate Change assessment in South America

Scientific Questions:

•What are the patterns and magnitude of SST increase in the oceans surrounding the South American continent under climate change scenarios?

•To what extent does the seasonal cycle of SAMS will change under climate change scenarios?

•Will the observed positive trends in SALLJ events and rainfall over the Amazon and LPB persist on future climate change?

•How will SAMS seasonal climate predictability change in future climate scenarios? To what extent will the ENSO and AAO signatures in SAMS and LPB change? Will the observed soil moisture forcing on SAMS persist or change?

•How will rainfall and temperature extremes (frequency and intensity) in the SAMS-LPB region behave under future climate change scenarios? How will hydrological extremes in the SAMS-LPB region change**?**

MESA DATABASES

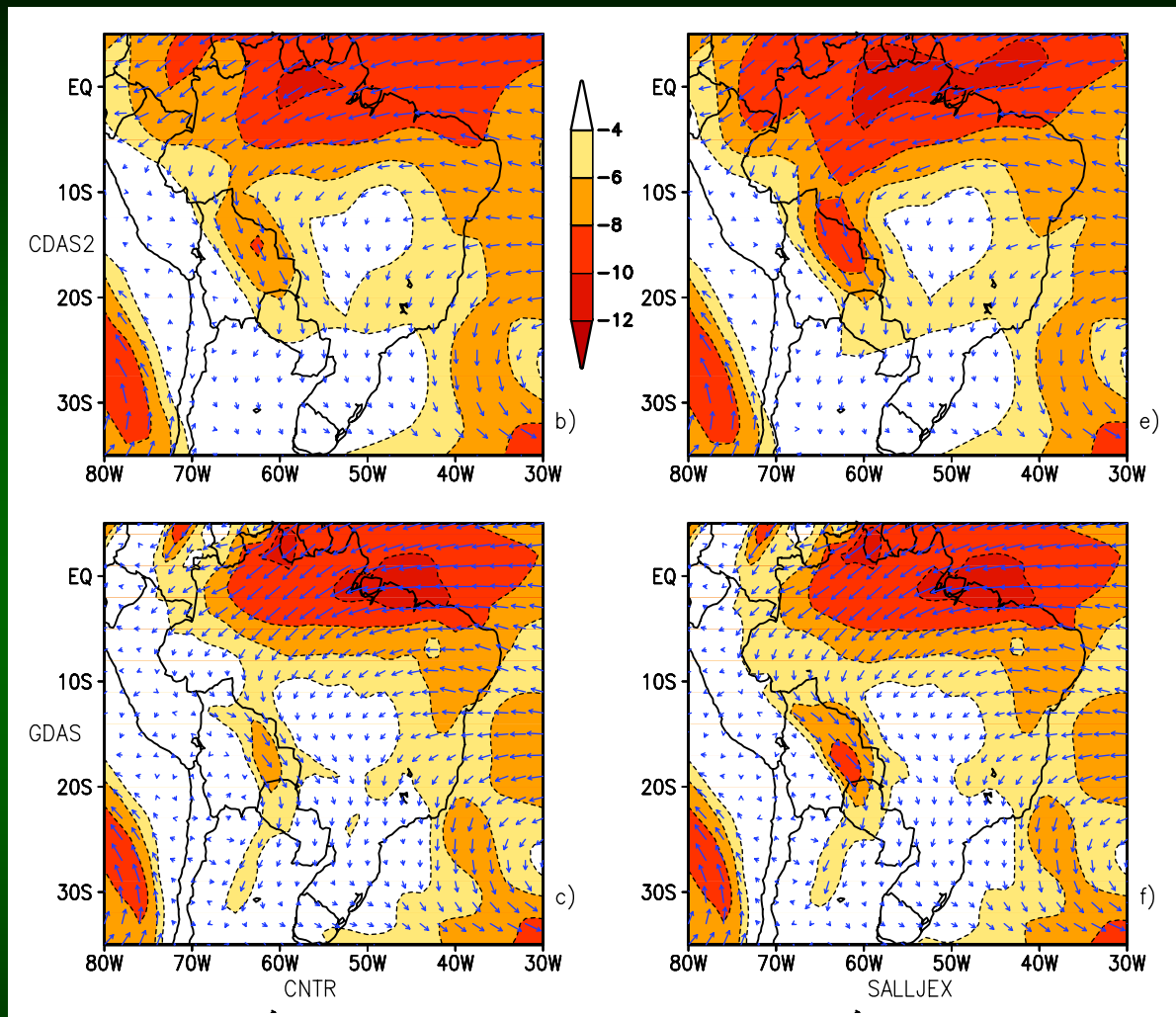
SALLJEX DATA ON NCEP GLOBAL ANALYSES

The strength of the low-level flow east of the Andes mountains varies by up to 40% in the analyses, with CDAS2 having the strongest jet and GDAS, the operational data assimilation system, having the weakest jet

The influence of SALLJEX data is concentrated over the region where the rawinsonde and pilot balloon observations were made and the global influence is close to zero outside of the region

The strength and location of the core of the low-level jet analyzed in the two systems with SALLJEX data are in better agreement than in the control runs

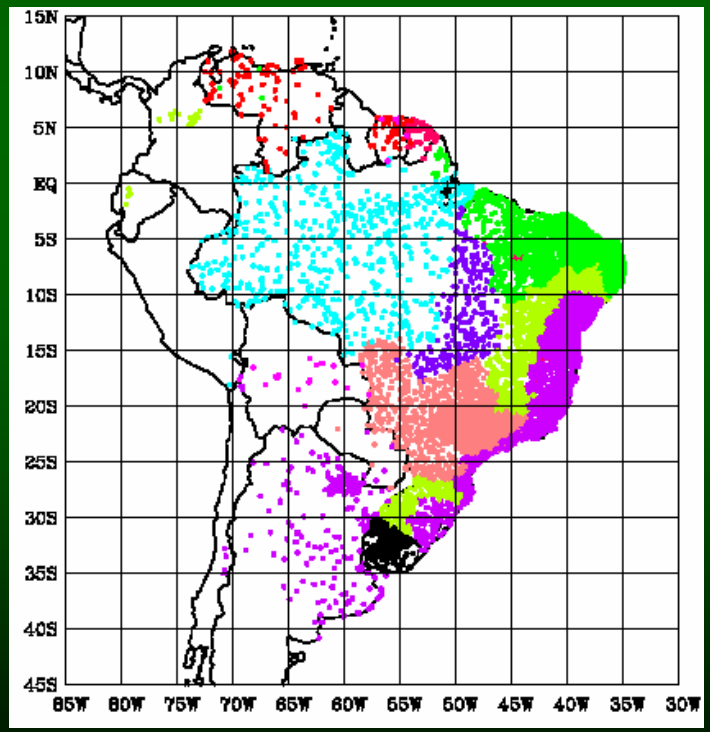
Herdies et al (2006)

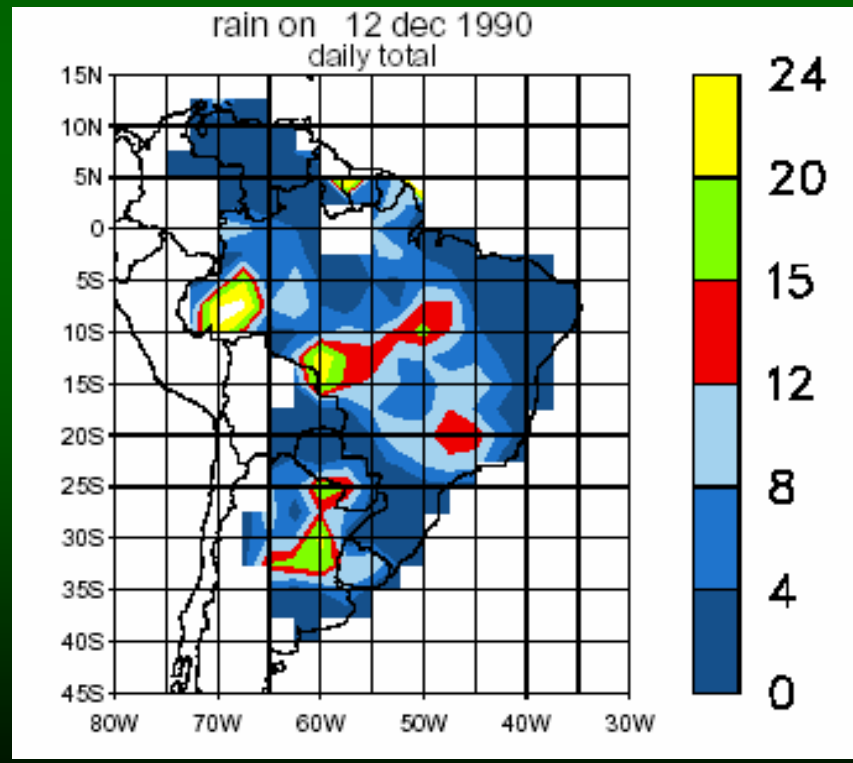


Mean low-level wind (vector) and wind speed magnitude (shaded) at 850 hPa for january 15 to February 15, 2003. (Left) CDAS2, and GDAS, (Right) Idem, including SALLJEX data. Values are in m/s.

Daily Precipitation Grids for South America

- Daily observations of precipitation from stations in South America have been combined into daily gridded fields
- Temporal coverage: 1 Jan 1940 to 22 June 2005 (currently)

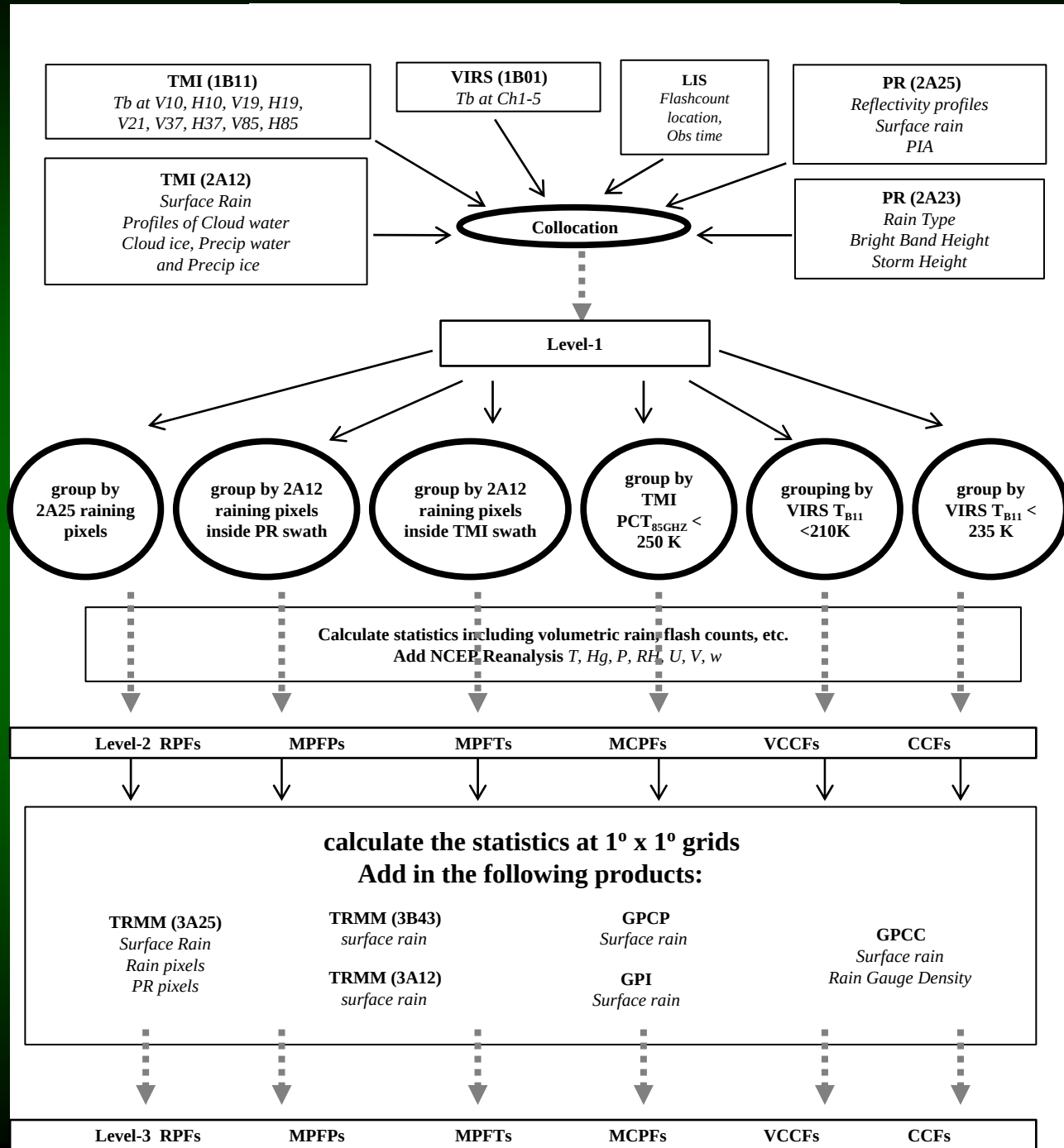




Liebmann & Allured (2005, BAMS)

Precipitation feature (PF) database

Univ. of Utah
(Zipser et al)



MESA RELATED PROJECTS

“A Europe-South America Network for Climate Change Assessment and Impact Studies”
CLARIS

- The project addresses three strategic objectives:
- to set up and favour the technical transfer and expertise in Earth System and Regional Climate Modelling between Europe and South America together with the providing of a list of climate data (observed and simulated) required for model validations.
- to create a South American high-quality climate database for studies in extreme events and long-term climate trends.
- to strengthen the communication between climate researchers and stakeholders, and to demonstrate the feasibility of using climate information in the decision-making process.

Model Intercomparison – Super Model Ensemble

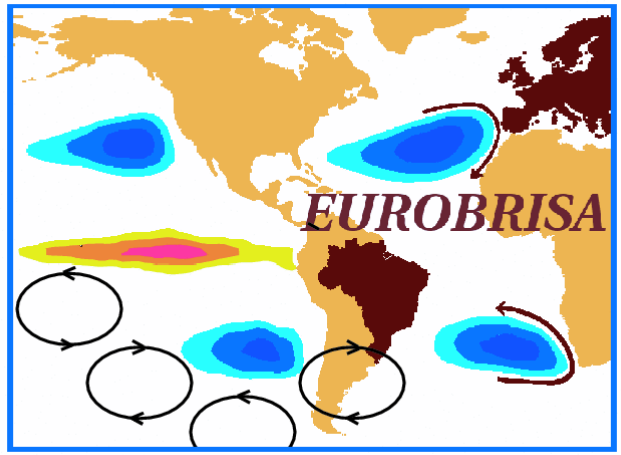
Participants:

- Center for Weather Prediction and Climate Studies (CPTEC/INPE) – Cachoeira Paulista/Brazil
- Brazilian National Meteorological Institute – INMET - Brasilia/Brazil
- Laboratory of Meteorology Applied to Regional Weather Systems (MASTER) – Univ. of São Paulo, São Paulo- Brazil
- CIMA/Univ. of Buenos Aires, Buenos Aires, Argentina
- Laboratory of Mesoscale Forecasting (LPM/Federal Univ. of Rio de Janeiro), Rio de Janeiro
- Center of Land-Ocean-Atmosphere of LNCC (CATO/LNCC) _ Petrópolis/Brazil
- Department of Meteorology of University of Maryland - Washington USA
- Brazilian Marine Meteorological Service (SMM/CHM) - Niteroi, Brazil
- Center of Environmental Resources Information and Hydrometeorology (CIRAN/EPAGRI) Florianópolis, Brazil
- Unversity of Rio Grande (FURGS) – Rio Grande, Brazil
- Public available information from NCEP and other instituitions
- New participants: **UK Metoffice, ECMWF**

This is work has been supporting regional activities on the THORPEX/TIGGE - WMO.

The EUROBRISA Project

Lead Investigator: Caio A.S. Coelho



Key Idea:

To improve seasonal forecasts in S. America: a region where there is seasonal forecast skill and useful value.

http://www.met.rdg.ac.uk/~swr01cac/EUROBRISA

Aims

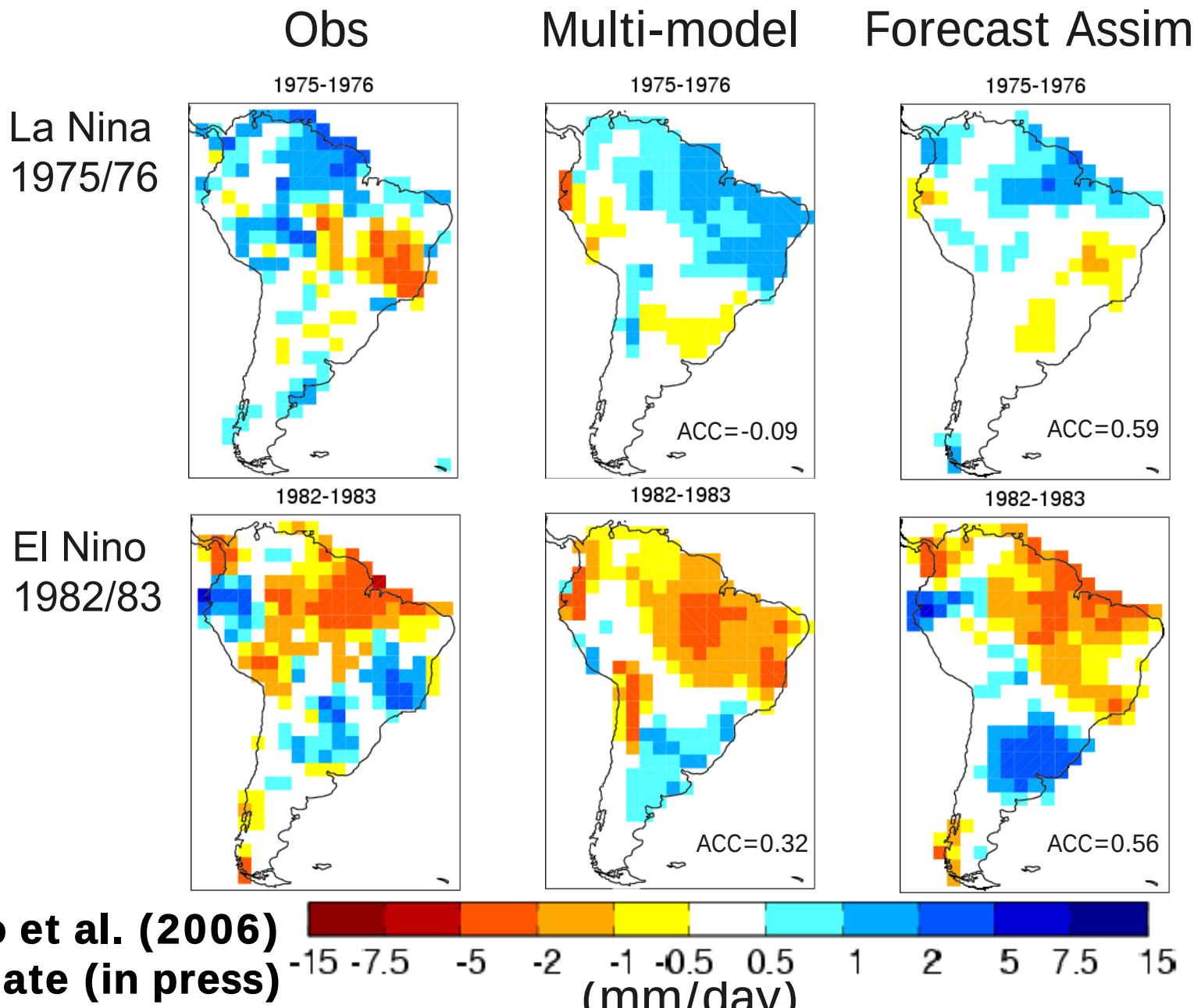
- Strengthen collaboration and promote exchange of expertise and information between European and S. American seasonal forecasters

- Produce improved well-calibrated real-time probabilistic seasonal forecasts for South America

- Develop real-time forecast products for non-profitable governmental use (e.g. reservoir management, hydropower production, and agriculture)

Institutions	Country	Partners
CPTEC	Brazil	Coelho, Cavalcanti, Silva Dias, Pezzi
ECMWF	EU	Anderson, Balmaseda, Doblas-Reyes, Stockdale
INMET	Brazil	Moura, Silveira
Met Office	UK	Graham, Davey, Colman
Météo France	France	Déqué
UFPR/SIMEPAR	Brazil	Guetter
Uni. of Reading	UK	Stephenson
Uni. of Sao Paulo	Brazil	Ambrizzi, Silva Dias
CIIFEN	Ecuador	Camacho, Santos
IRI	USA	Baethgen

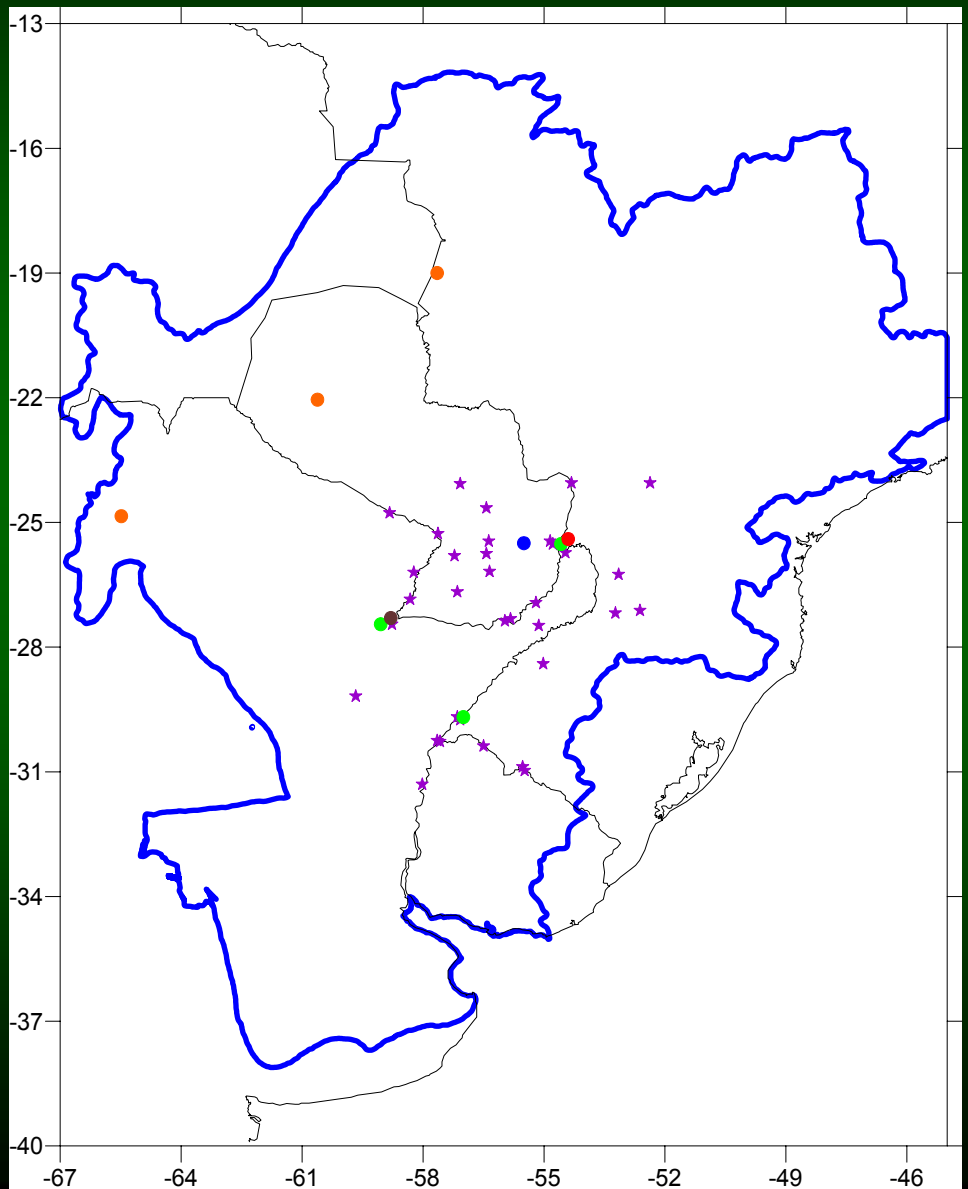
DJF rainfall anomalies for 1975/76 and 1982/83



Coelho et al. (2006)
J. Climate (in press)

Plans for future Field Campaigns

LPB CSE Field Campaign



Observing Platforms for the la Plata Basin:

(purple) high raingauge network, (blue) flux towers, (green and orange) radiosondes, (brown) wind profiler, (light blue) Doppler radar.

Monitoring: Soil moisture, surface fluxes, high-resolution precipitation, wind profiler

Field experimen (Oct-Jan)t: Enhanced radiosonde network (4timesxday), Doppler radar

WAVEs

southWestern tropical Atlantic climate Variability Experiment

A proposal outline for a new CLIVAR research program for the SW Atlantic Basin

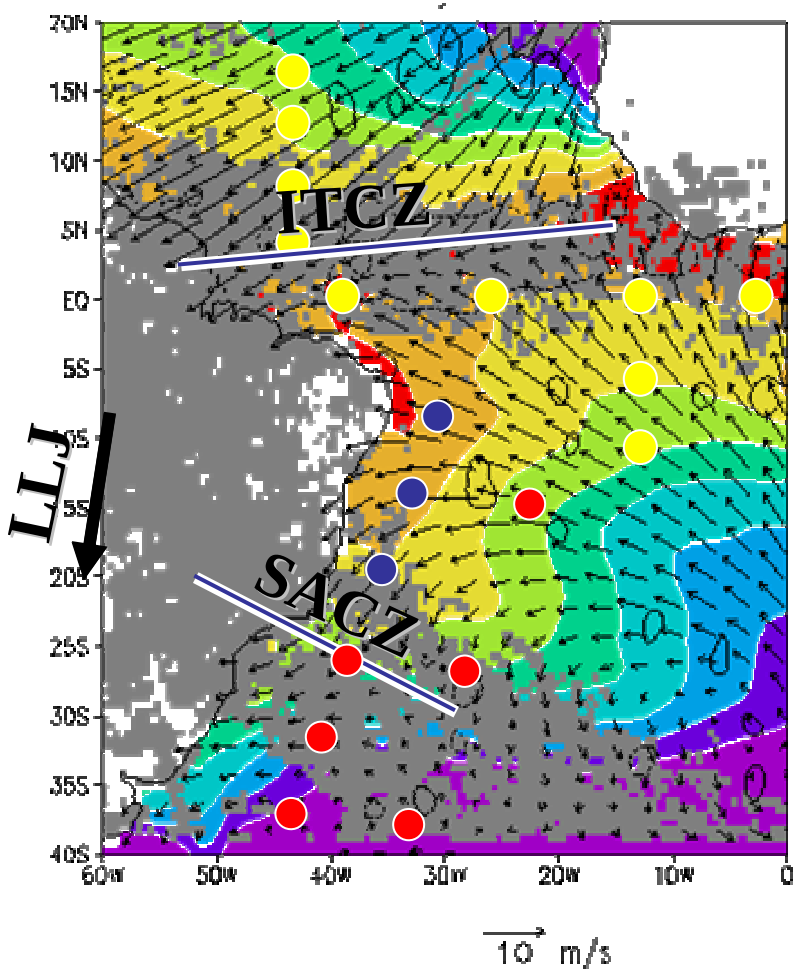
Paulo Nobre – CPTEC/INPE

To be presented during the ICSHMO, 2006

WAVEs Statement

- Field experiment and coupled modeling research program to study ocean-atmosphere-land phenomena leading to South Western tropical Atlantic-South American climate variability and change;
- To be submitted to CLIVAR's Atlantic Implementation Panel and VAMOS;
- Project time span is 2007-2012;

SACZ: an integration target of opportunity?



WAVEs Topics

- Coupled o-a variability associated to SACZ:
  - SST-Solar Radiation-Rainfall feedback processes
  - Barrier layers due to SACZ rainfall over the ocean and river discharges
  - Amazon soil moisture-rainfall memory: ITCZ-SACZ-LLJ interactions?
  - Teleconnections from the SPCZ

MESA MILESTONES

- ✓ FY04:
  - ✓ Quantitative information of the model errors in SALLJEX
  - ✓ Evaluation of impact of SALLJEX data on analysis and forecasts
  - ✓ Confirmation about the ability of the models to reproduce some of the elements of the low-level circulation of the SAMS
  - ✓ Preparation of GEF-PLATIN survey reports
- FY05:
  - ✓ SALLJEX Data Assimilation.
  - ✓ Planning of LPB CSE monitoring activities.
  - ✓ Assessment of the IPCC-AR4 simulations in the SAM region.
- FY06:
  - Assessment of Seasonal prediction simulations in the SAMS region.
  - Development of MESA climate indices
  - Seasonal simulation of SALLJEX season.
  - LPB CSE monitoring implementation.
  - Predictability of the SAM associated with Atlantic SST simulations.
  - Regional downscaling of IPCC-AR4 simulations.
- FY07:
  - LPB CSE experiment implementation, data collection, and integration.
  - Assessment of extreme event frequency changes in the regional climate change scenarios for South America and their impact on agricultural activities.
- FY08:
  - Evaluate the impact of soil moisture in simulations and predictions.
  - Hydrological studies of PLATEX data
- …Ultimate goal: Integrated view of the American Monsoon Systems, related interhemispheric connection, monsoon predictability and prediction

MESA DELIVERABLES

- More comprehensive understanding of South American climate variability and predictability;
- Strengthened multinational scientific collaboration across South America;
- Observing system design for monitoring and predicting the South American monsoon system;
- Measurably improved climate models that predict South American monsoon variability