Status report on the La Plata Basin (LPB) - A CLIVAR/GEWEX Continental Scale Experiment

Hugo Berbery and Maria A. Silva Dias
(Co-chairs for CLIVAR/VAMOS and GEWEX/GHP)
with contributions of the LPB ISG

Outline

1. Motivations for LPB

2. LPB priority areas

3. Implementation of activities
    1. Data collection
    2. Monitoring
    3. Field Experiment
    4. Modeling activities

5. Future steps

La Plata Basin (LPB) Science plan:

www.atmos.umd.edu/~berbery/lpb

- What climatological and hydrological factors determine the frequency of occurrence and spatial extent of **floods and droughts**?

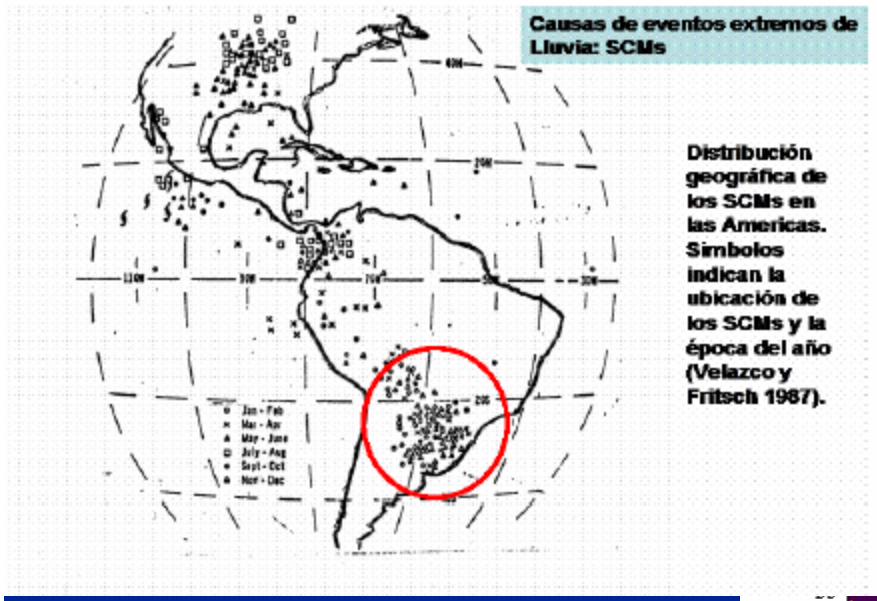
- How **predictable** is the regional weather and climate variability and its impact on hydrological, agricultural and social systems of the basin?

- What are the impacts of global **climate change and land use change** on regional weather, climate, hydrology and agriculture? Can their impacts be predicted, at least in part?

Scientific Motivations

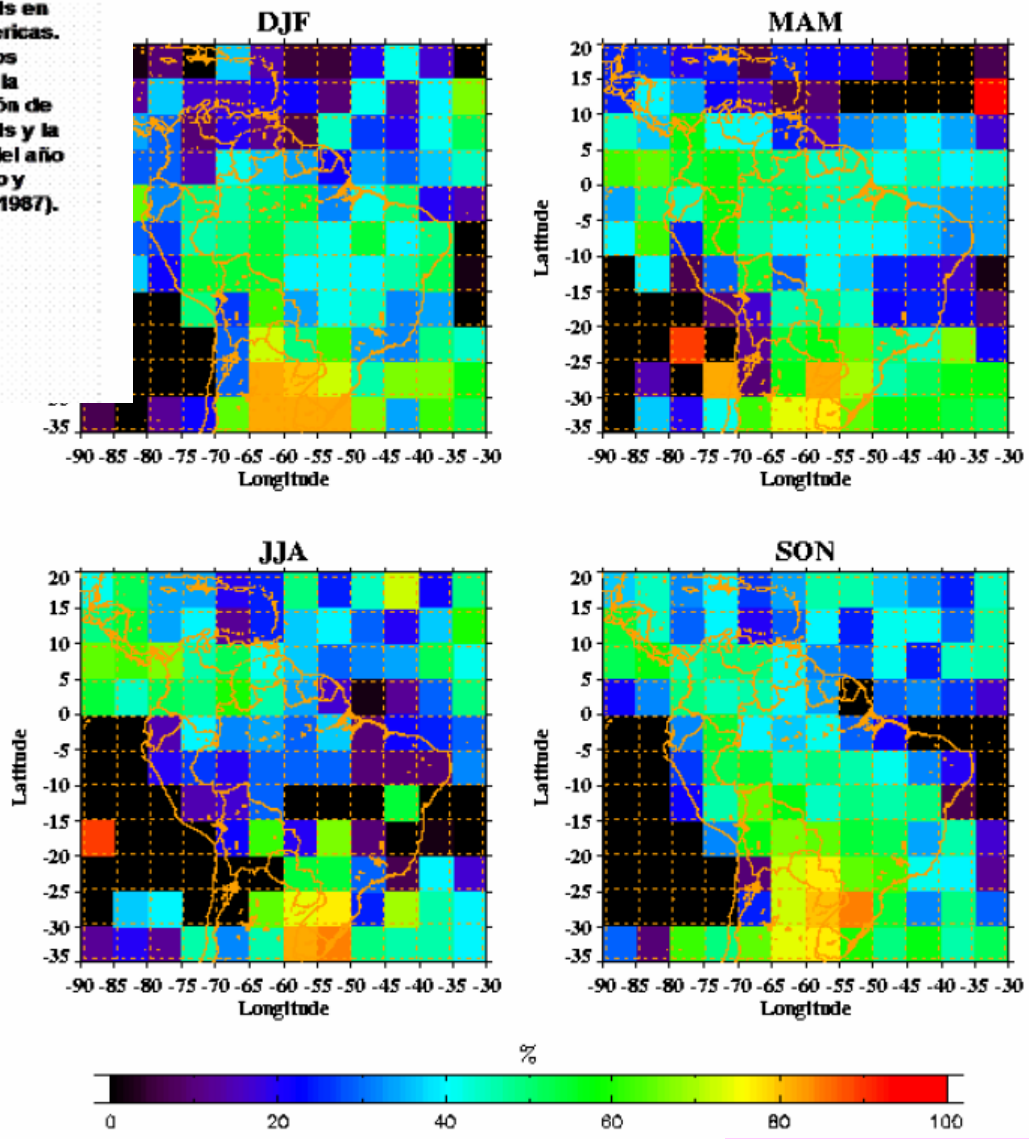
Extreme events

MCSs



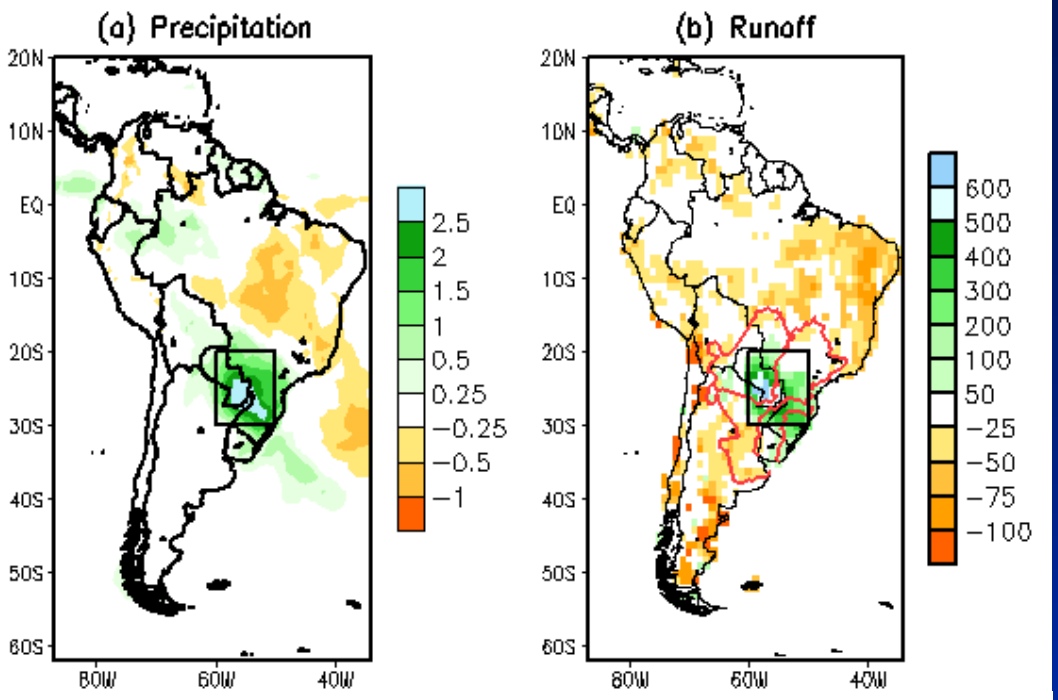
Distribución geográfica de los SCMs en las Americas. Simbolos indican la ubicación de los SCMs y la época del año (Velazco y Fritsch 1987).

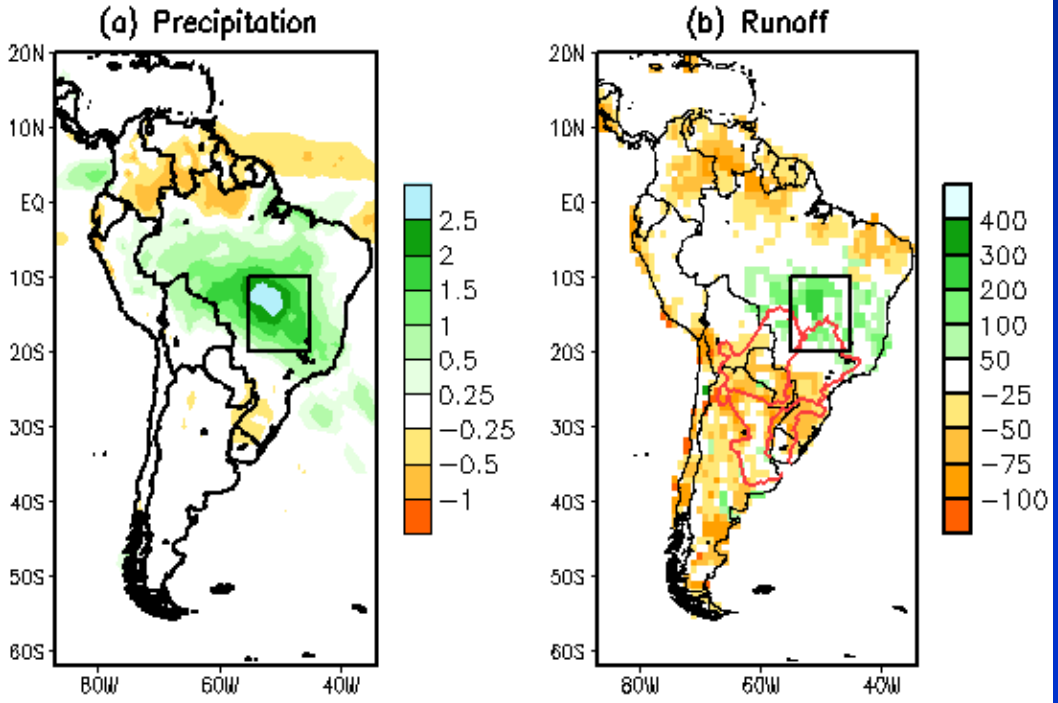
Velasco and Fritsch 1987



Courtesy of Zipser

FIGURA 2.15: Porcentaje de precipitación convectiva (Gentileza de E. Zipser)



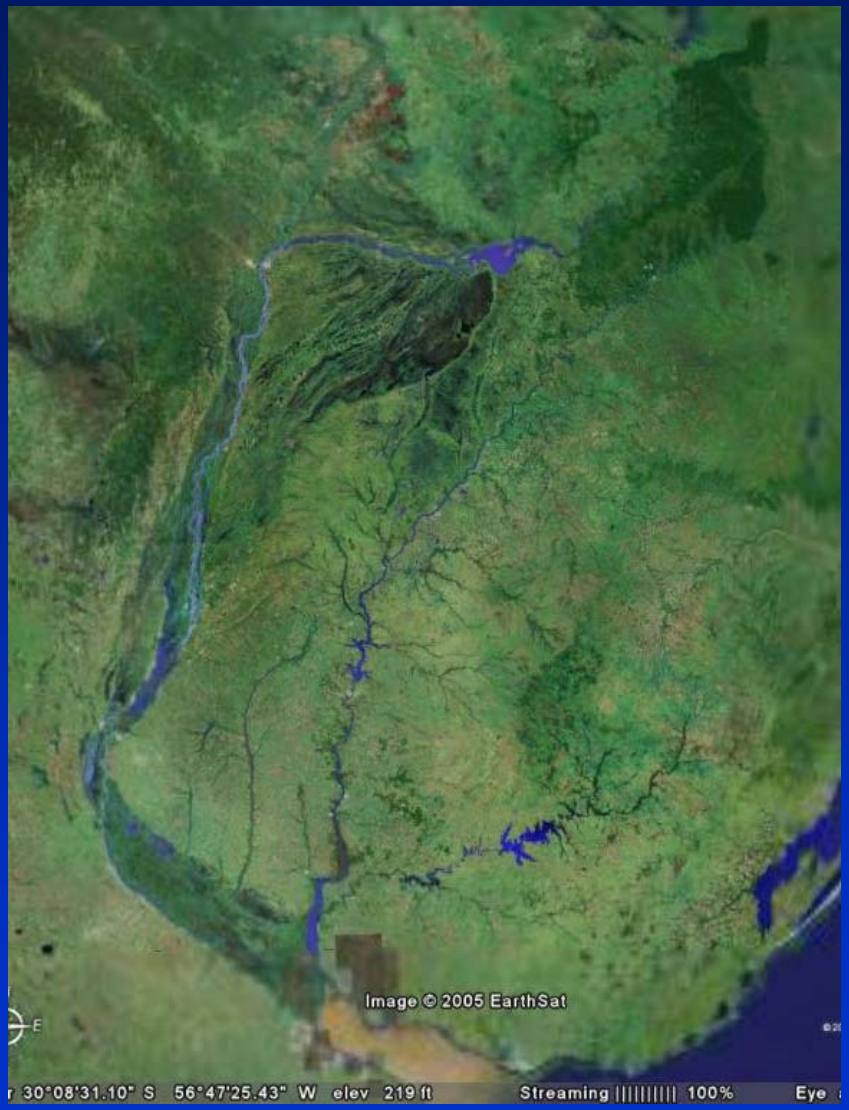


Intense precipitation events

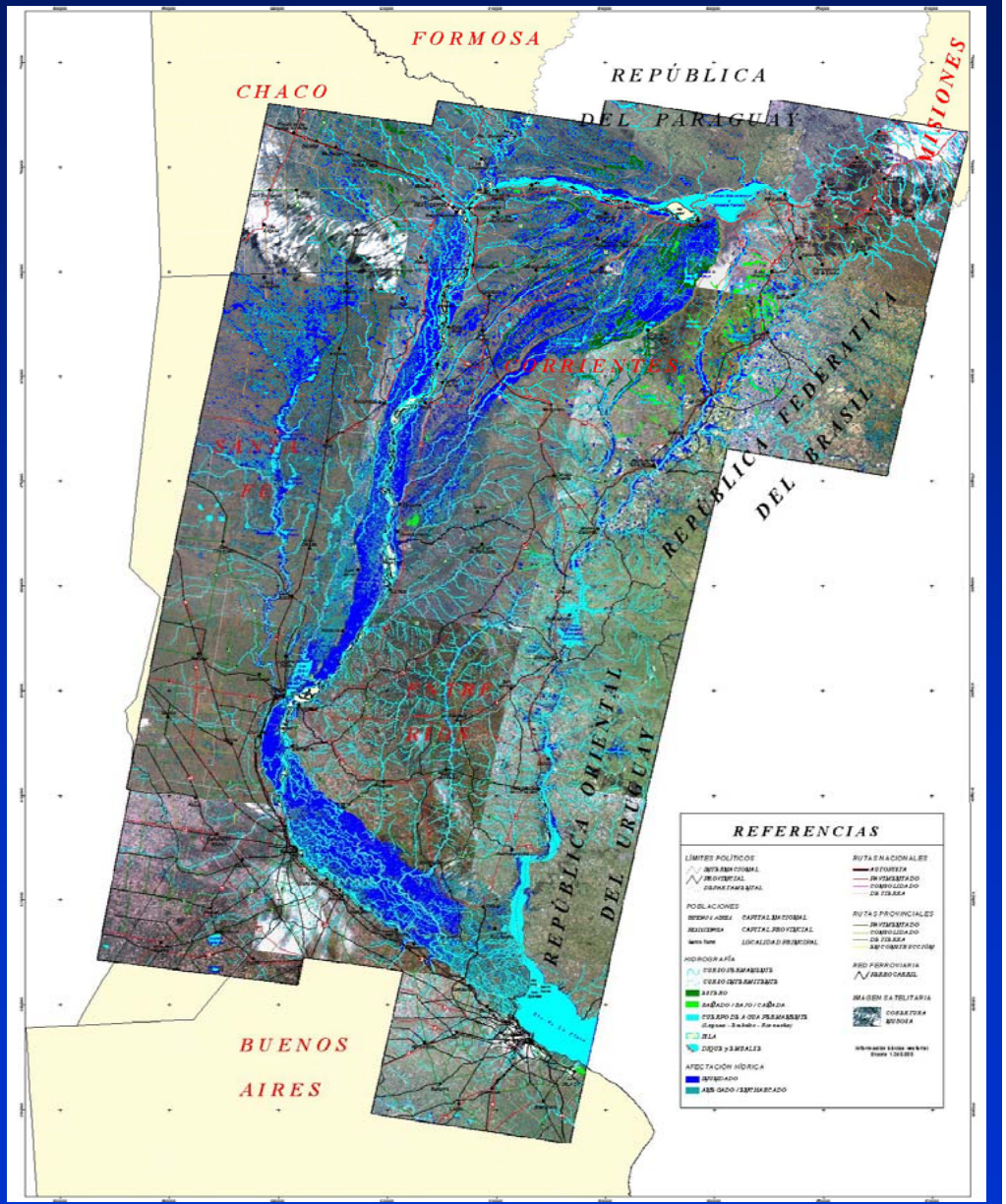
and their impact on model runoff

"The signal of precipitation events is amplified in the total runoff"

Normal conditions



1997/98 Flood of the Paraná River (Satellite images from CONAE)



Scientific Motivations

Predictability

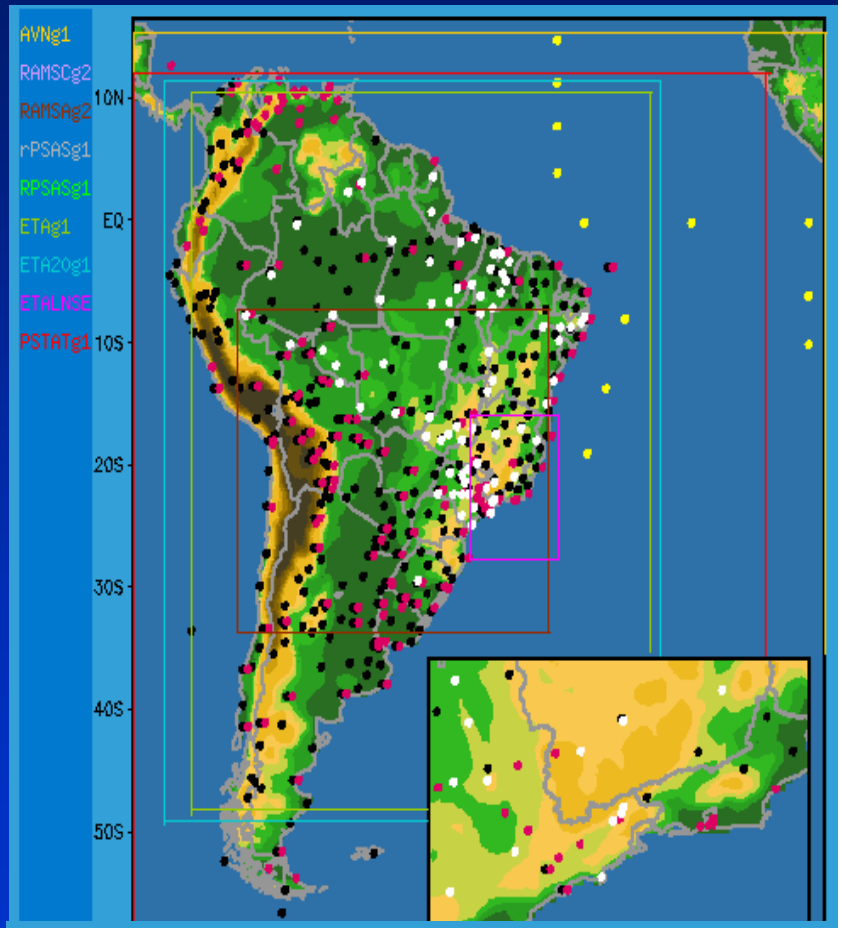
Model Intercomparison - Super Model Ensemble

* Available models :
  - Global models:
    CPTEC, NCEP, ECMWF, UKMO,...

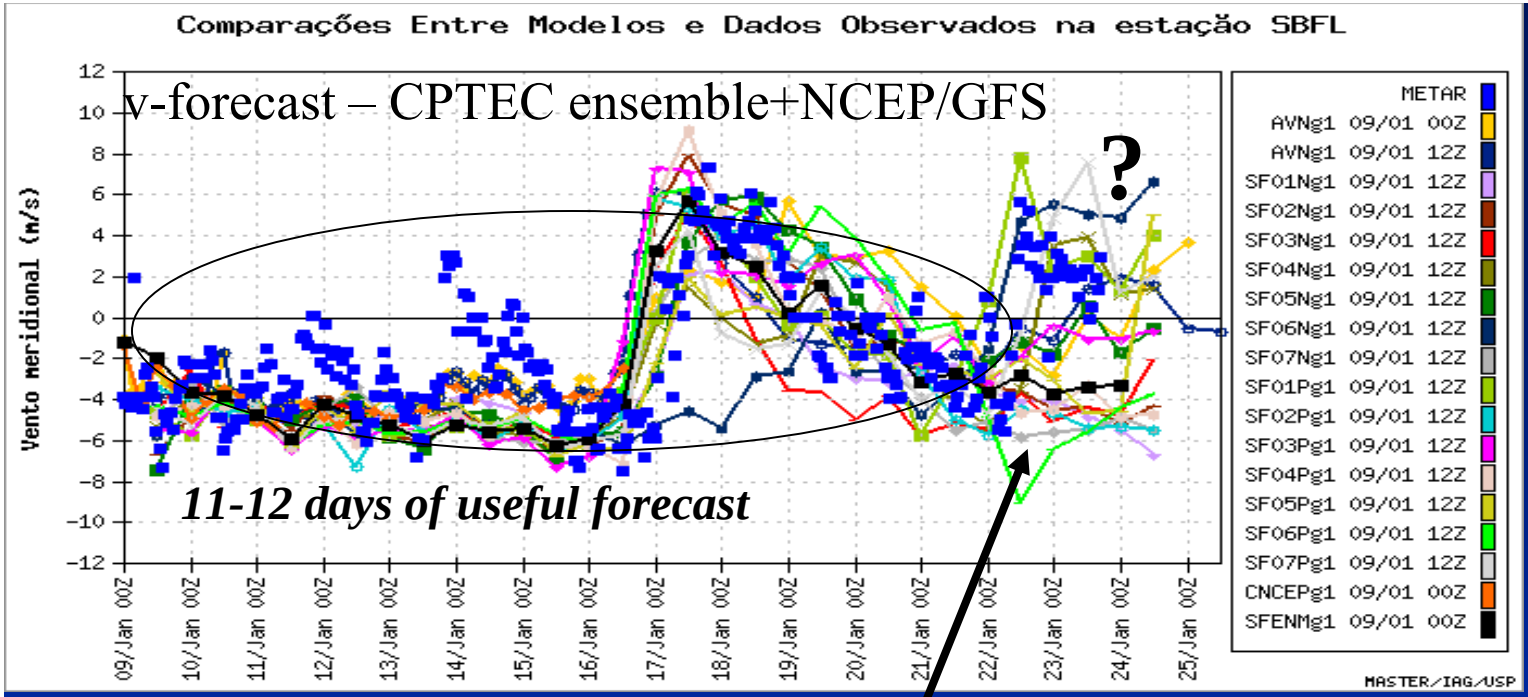
  - Regional models: ~14

* Collaborative work -> Model improvement

* Evaluation Metric: Fit to Surface Data: METAR, SYNOP, Autom. Stations and PIRATA buoys

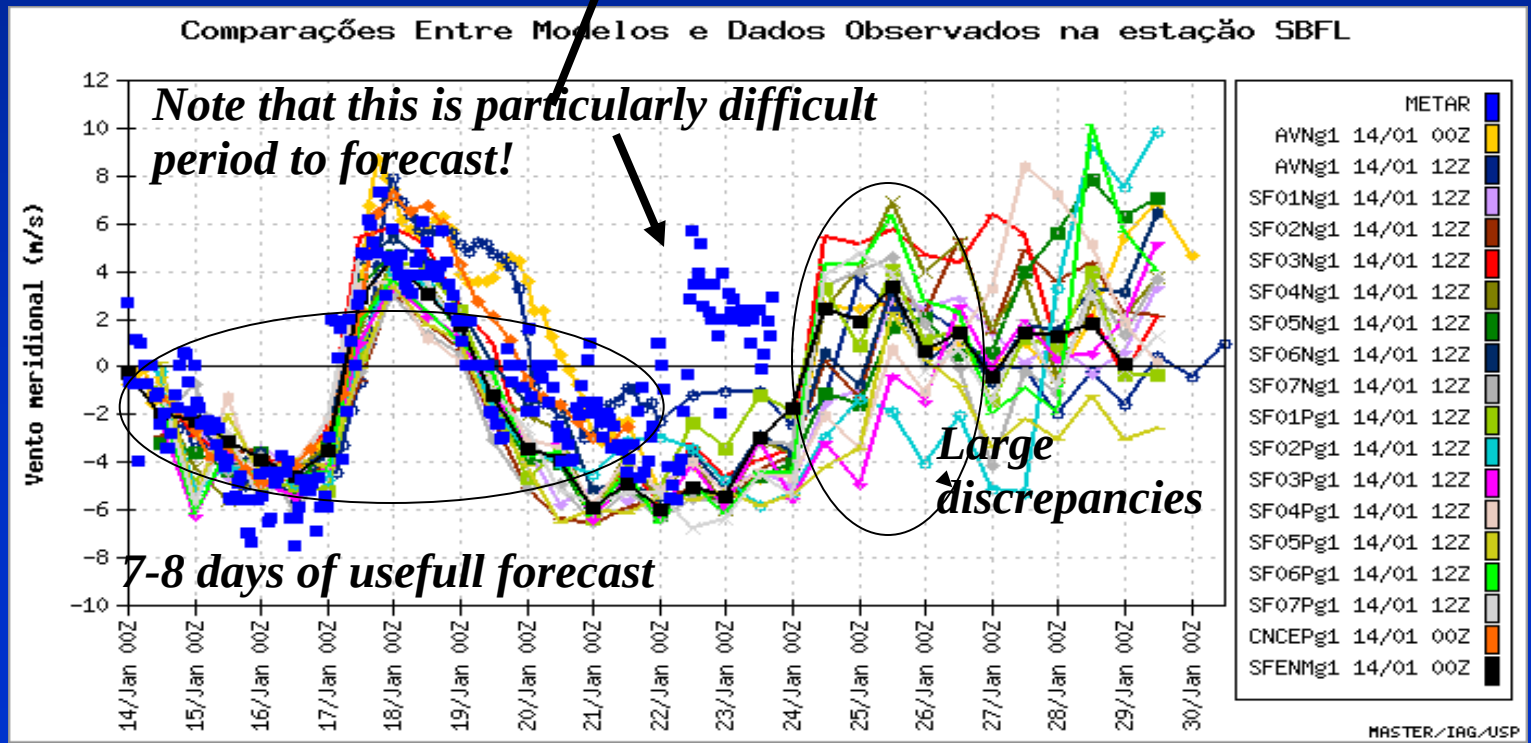


This work has been supporting regional activities of THORPEX/TIGGE - WMO.

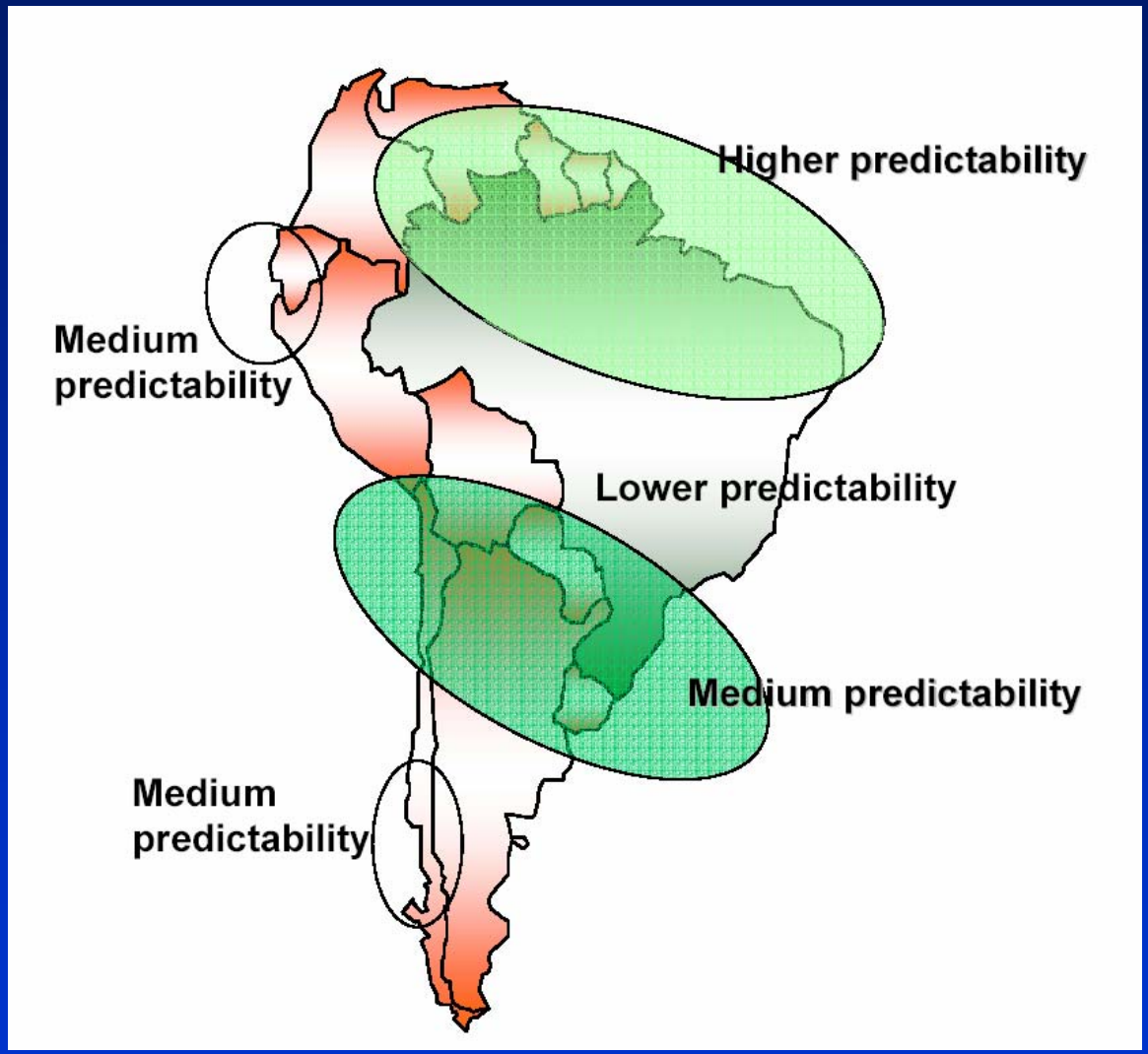


Example of meridional wind forecast comparison of CPTEC ensemble members and NCEP/GFS

Blue squares: Observations at the SBFL airport



Regions with lower, medium and higher predictability at seasonal and interannual time scales
(Source: J. Marengo, CPTEC/INPE).



Contributions to the precipitation variance

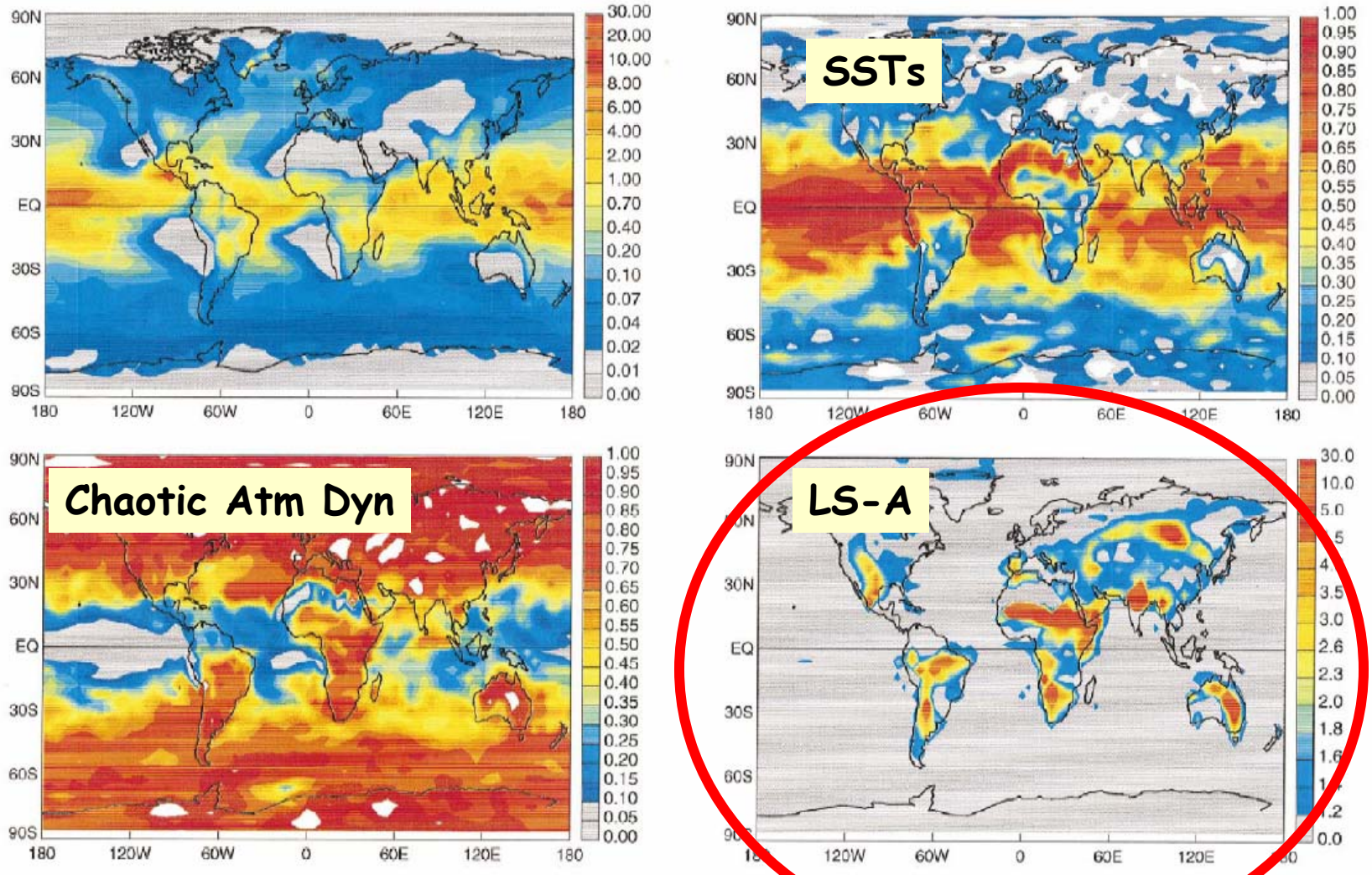


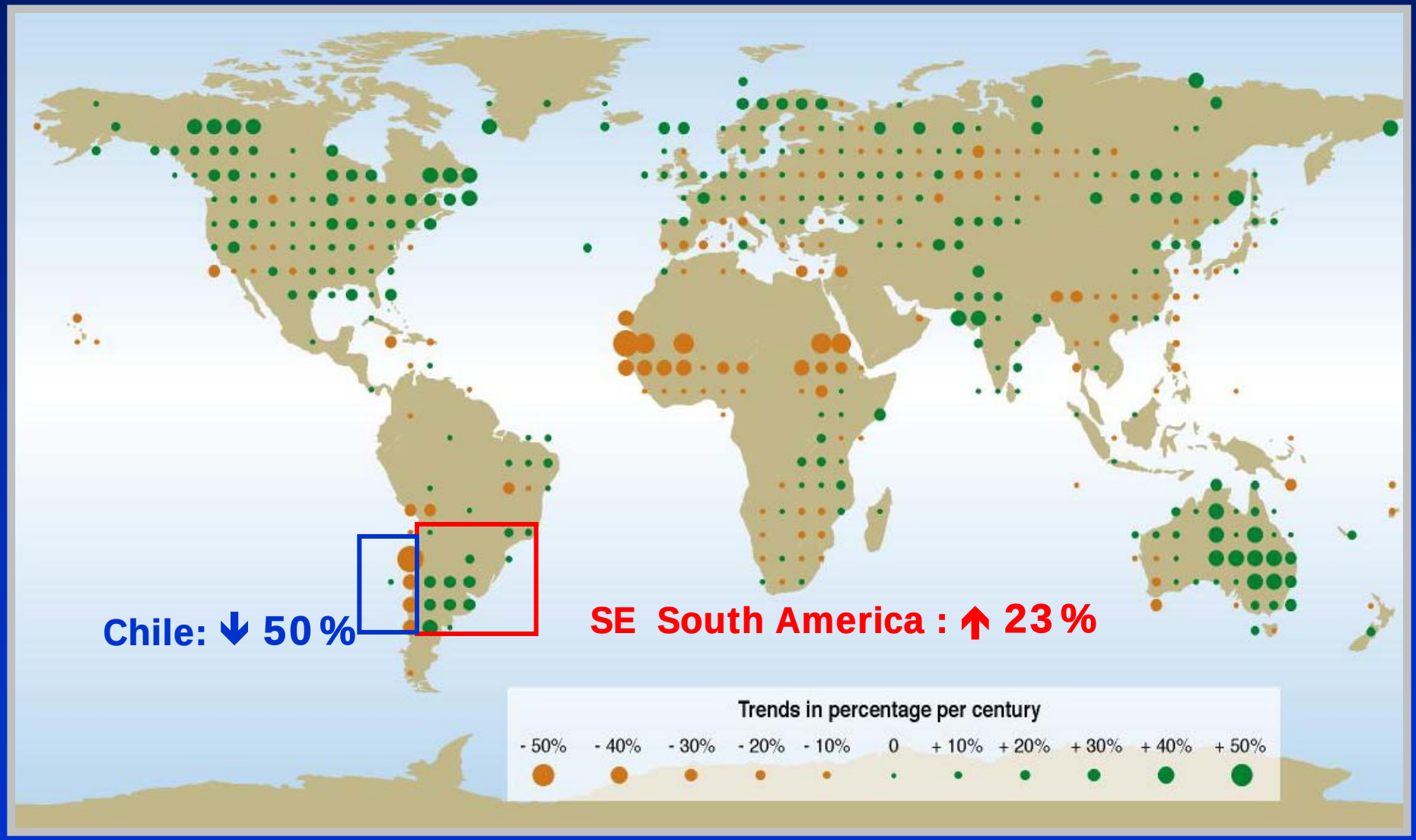
FIG. 9. Breakdown of the contributions of oceanic, atmospheric, and land surface processes to precipitation variance, assuming a linear framework. Top left: precipitation variance in the absence of land–atmosphere feedback (σ^2_{AO}). Top right: The fraction of the precipitation variance induced by variable SSTs [X_O from (3)]. Bottom left: The fraction of the precipitation variance induced by chaotic atmospheric dynamics ($1 - X_O$). Bottom right: Amplification of variance due to land–atmosphere feedback ($\sigma^2_{ALO}/\sigma^2_{AO}$).

Koster et al. (2000)

Scientific Motivations

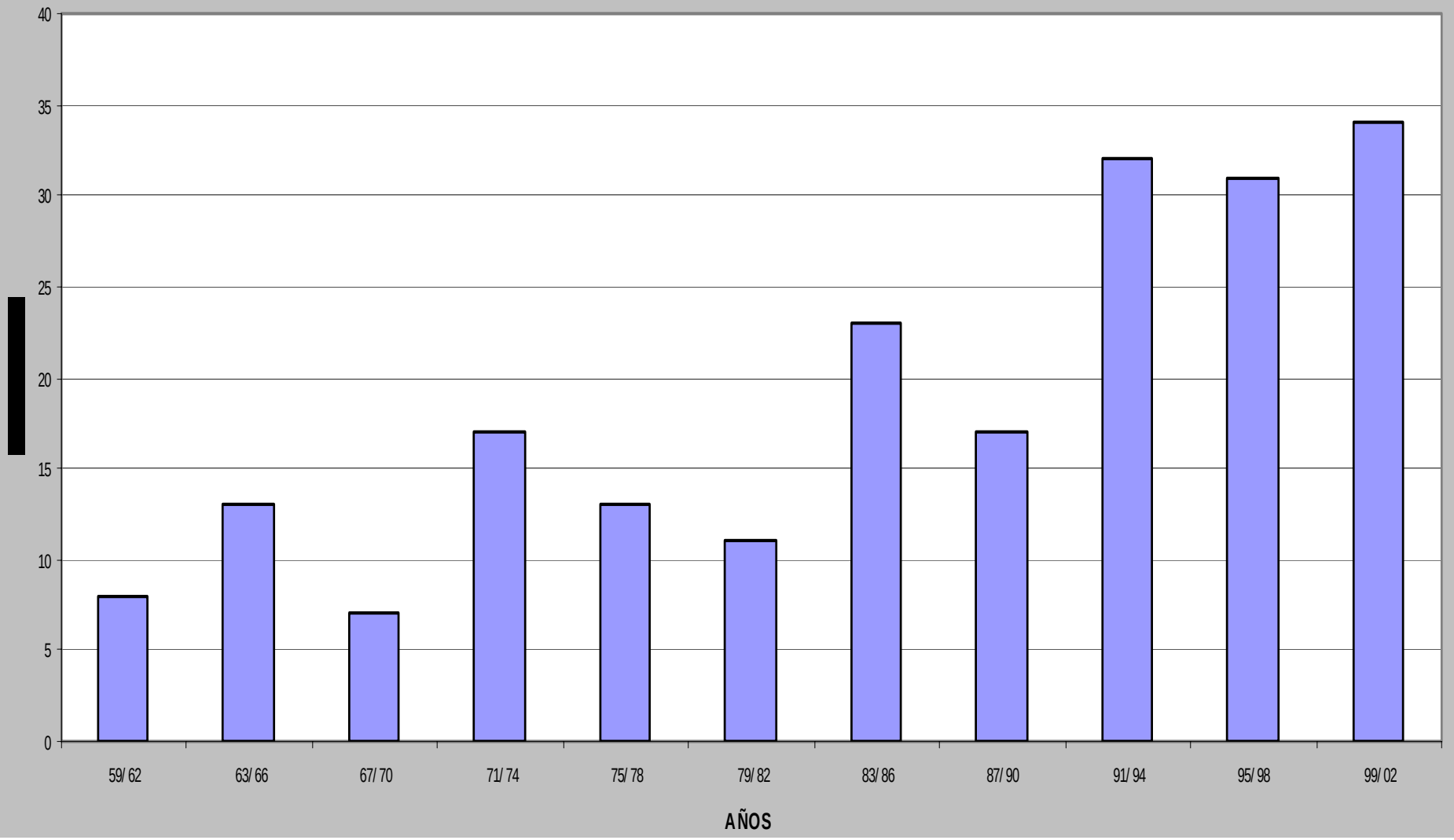
Trends

Trends in annual precipitation 1900-2000

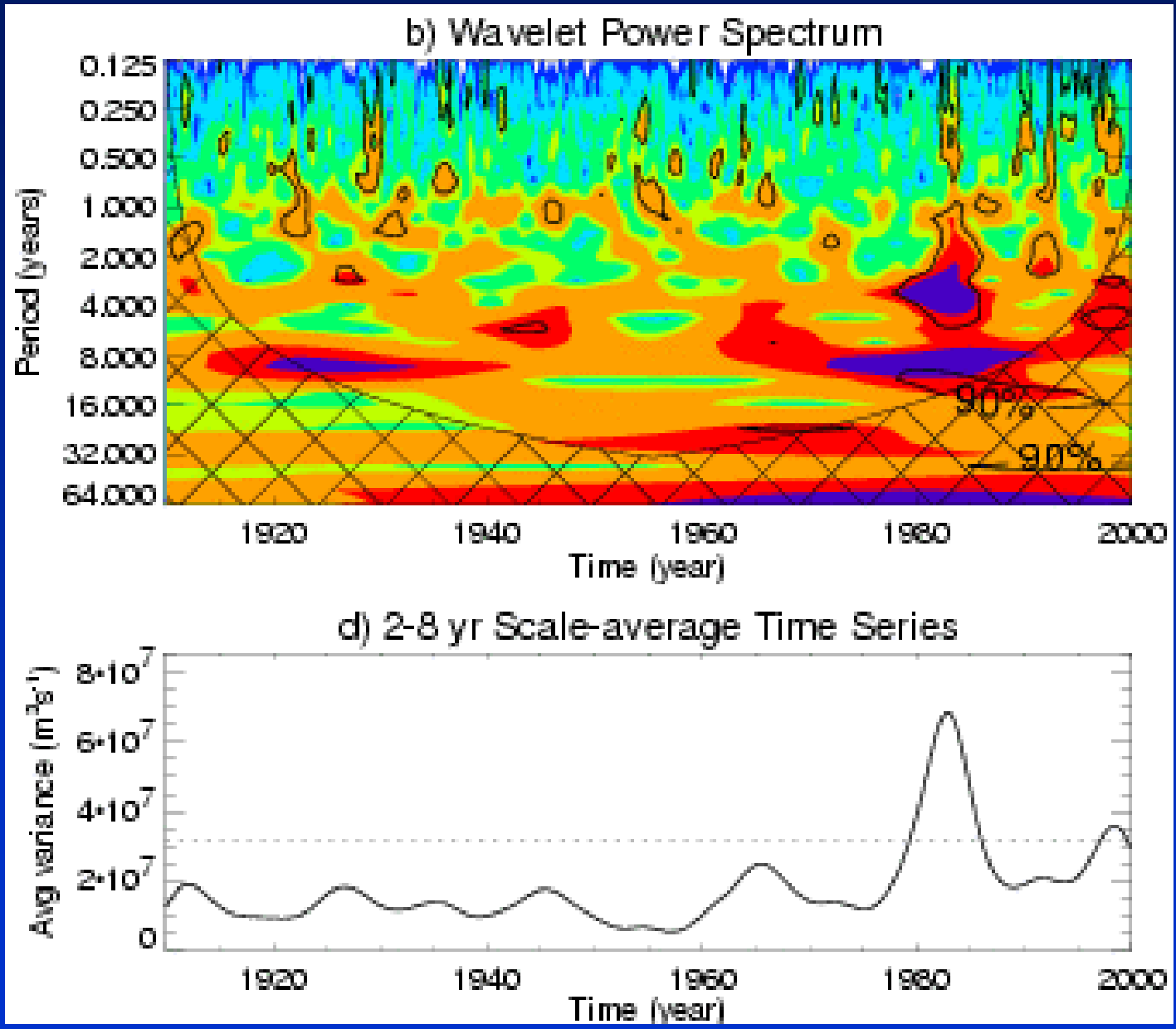


IPCC (2001)

Number of cases with P> 100 mm/(2 days) for 16 gauging stations over central and northeastern Argentina



La Plata river discharge

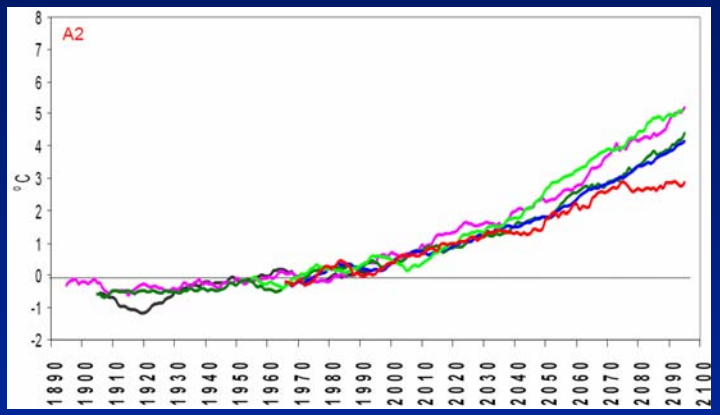


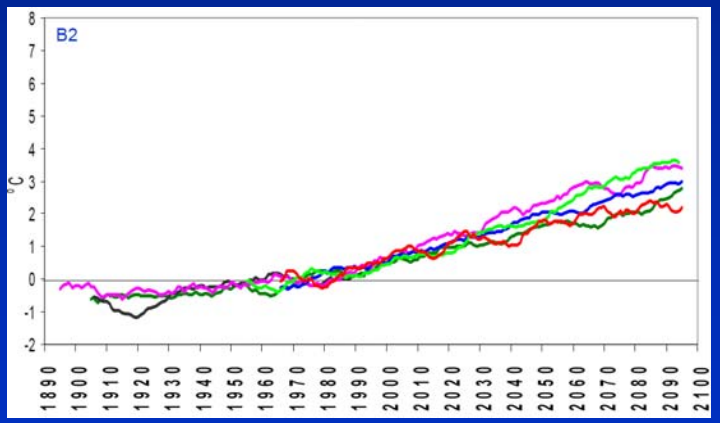
Scientific Motivations

Climate Change Scenarios

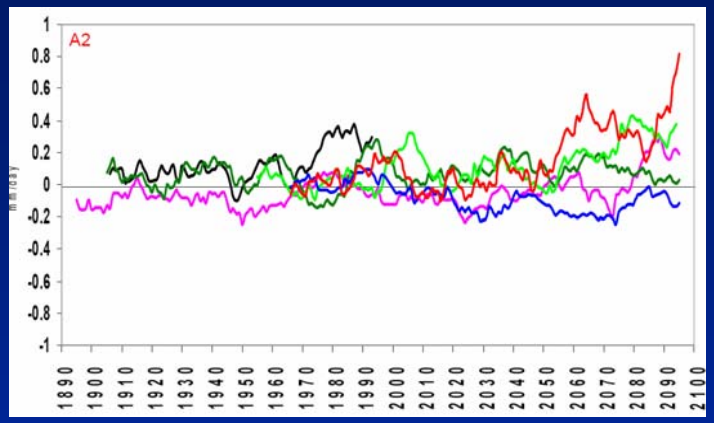
LPB temperature and precipitation scenarios for 2050-2080

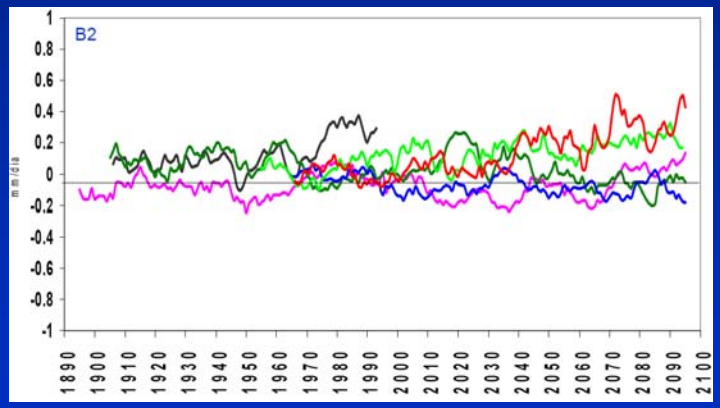
Temperature





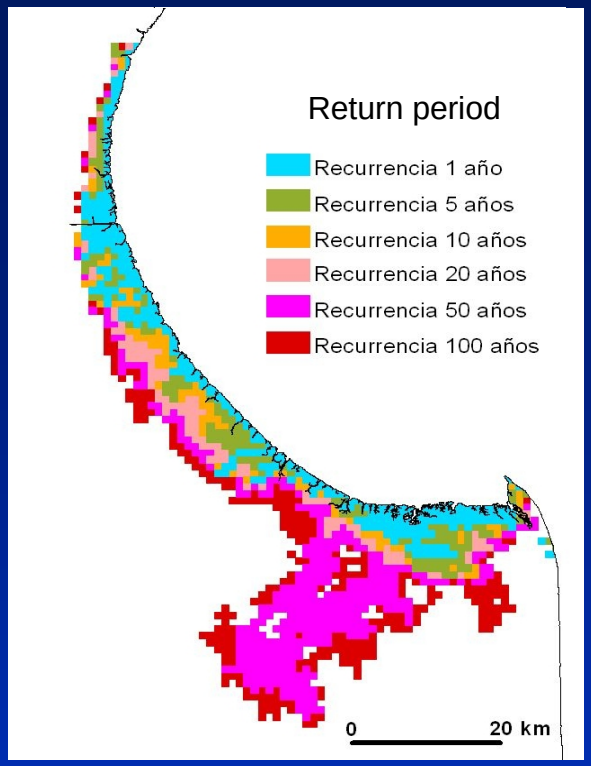
Precipitation



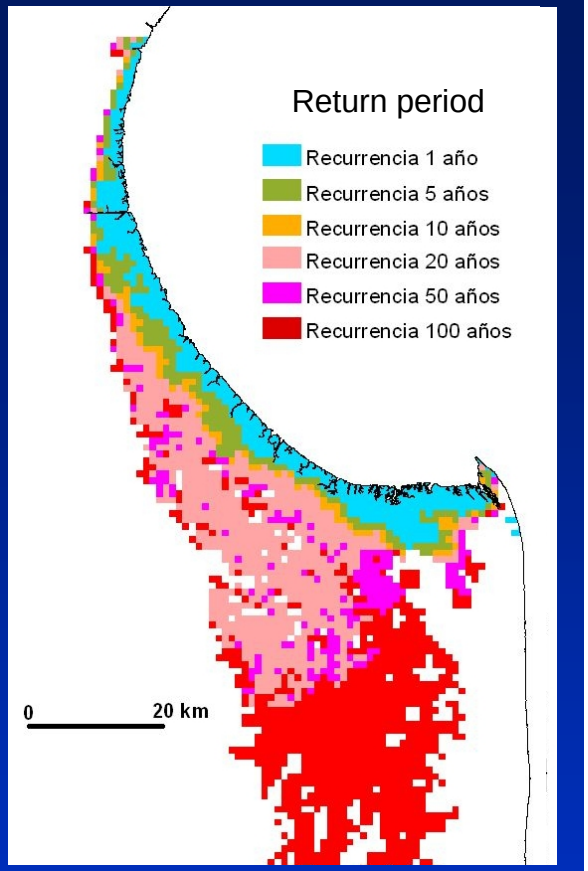


"In the La Plata Basin, temperatures will be higher and rainfall will tend to be above normal as projected by all IPCC models, especially for the time slices between 2050 and 2080." Courtesy of Marengo

RISK MAPS 2030



RISK MAPS 2070



"Floods will be more frequent over larger (populated) areas near the mouth of the La Plata River"

Re, Luduena & Menendez

Implementation Plan

↑↓

GEF

Implementation Plan

PART A: The International Program on the La Plata Basin (LPB)

1. La Plata Basin
2. Scientific background

PART B: Current status of research and applications

3. Survey of observational datasets
4. Modeling capabilities

PART C: Implementation of LPB CSE

5. Data rescue efforts
6. Hydro-climatic monitoring activities
7. Field Experiment (PLATEX)
8. Data management
9. Modeling activities
10. Predictability and climate change assessments
11. LPB Timeline (2005-2015)
12. LPB Legacy

PART B: Current status of research and applications

3. Survey of observational datasets

3.1 Surface datasets
3.2 In-situ measurements
3.3 Hydrologic Observations
3.4 Remote sensing
3.5 Radars
3.6 Soil moisture measurements and estimates
3.7 Flux towers

4. Modeling capabilities

4.1 Atmospheric Models
4.2 Distributed Hydrological Models
4.3 Regional Institutions

PART C: Implementation of LPB CSE (1)

5. Data rescue efforts

6. Hydro-climatic monitoring activities

6.1 A supersite
6.2 Digital raingauges
6.3 In-situ soil moisture measurements
6.4 Flux Towers
6.5 Wind profiler

7. Field Experiment (PLATEX)

7.1 Doppler radar measurements
7.2 Aircraft soil moisture measurements
7.3 Flux towers
7.4 Upper air observations
7.5 Operations Center

PART C: Implementation of LPB CSE (2)

9. Modeling activities

9.1 Development of hydrologic distributed models
9.2 Coupled models development
9.3 Data Assimilation Effort
9.4 Ensemble forecasting
9.5 Coordination among forecasting institutions

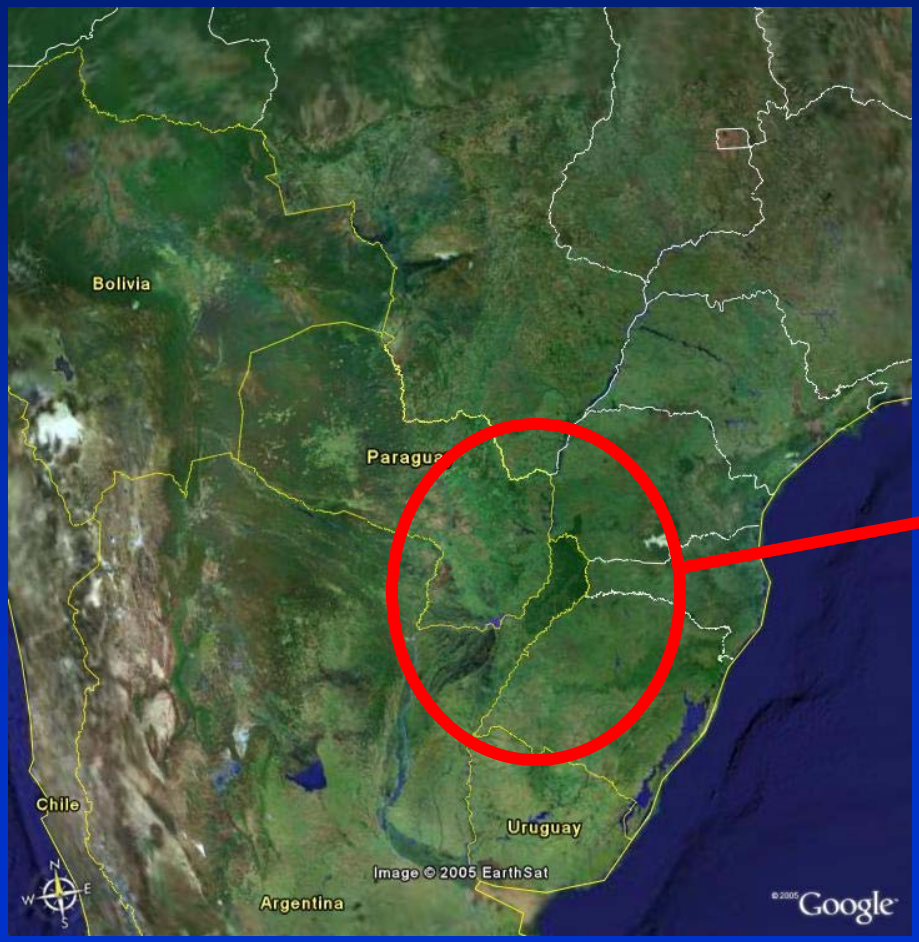
10. *Predictability and climate change assessments*

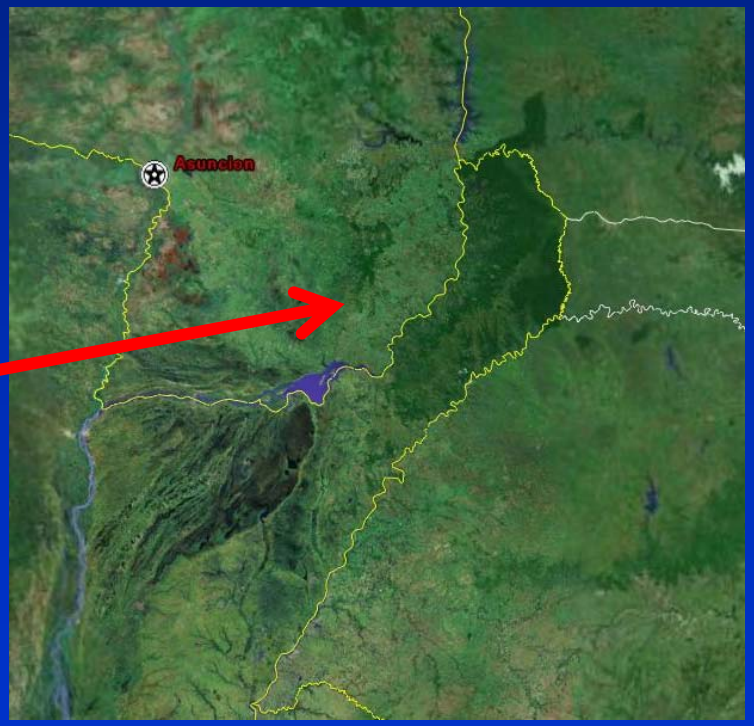
10.1 Land cover/Land use
10.2 Climate change scenarios and regional downscaling

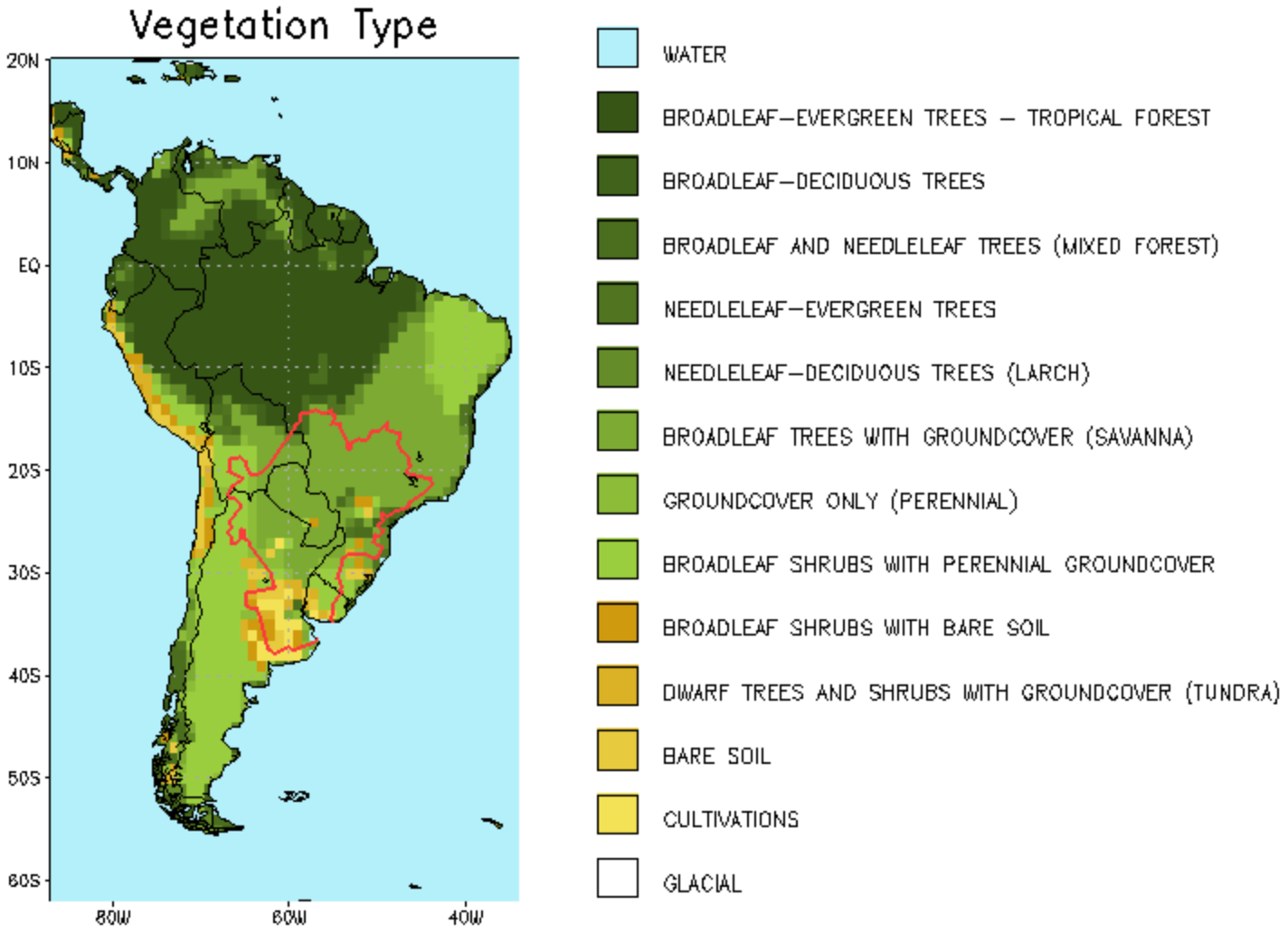
Planned activities

Land surface effects

Land cover / Land use






Vegetation Type
20N
10N
EQ
10S
20S
30S
40S
50S
60S
80W
60W
40W
WATER
BROADLEAF—EVERGREEN TREES — TROPICAL FOREST
BROADLEAF—DECIDUOUS TREES
BROADLEAF AND NEEDLELEAF TREES (MIXED FOREST)
NEEDLELEAF—EVERGREEN TREES
NEEDLELEAF—DECIDUOUS TREES (LARCH)
BROADLEAF TREES WITH GROUNDCOVER (SAVANNA)
GROUNDCOVER ONLY (PERENNIAL)
BROADLEAF SHRUBS WITH PERENNIAL GROUNDCOVER
BROADLEAF SHRUBS WITH BARE SOIL
DWARF TREES AND SHRUBS WITH GROUNDCOVER (TUNDRA)
BARE SOIL
CULTIVATIONS
GLACIAL

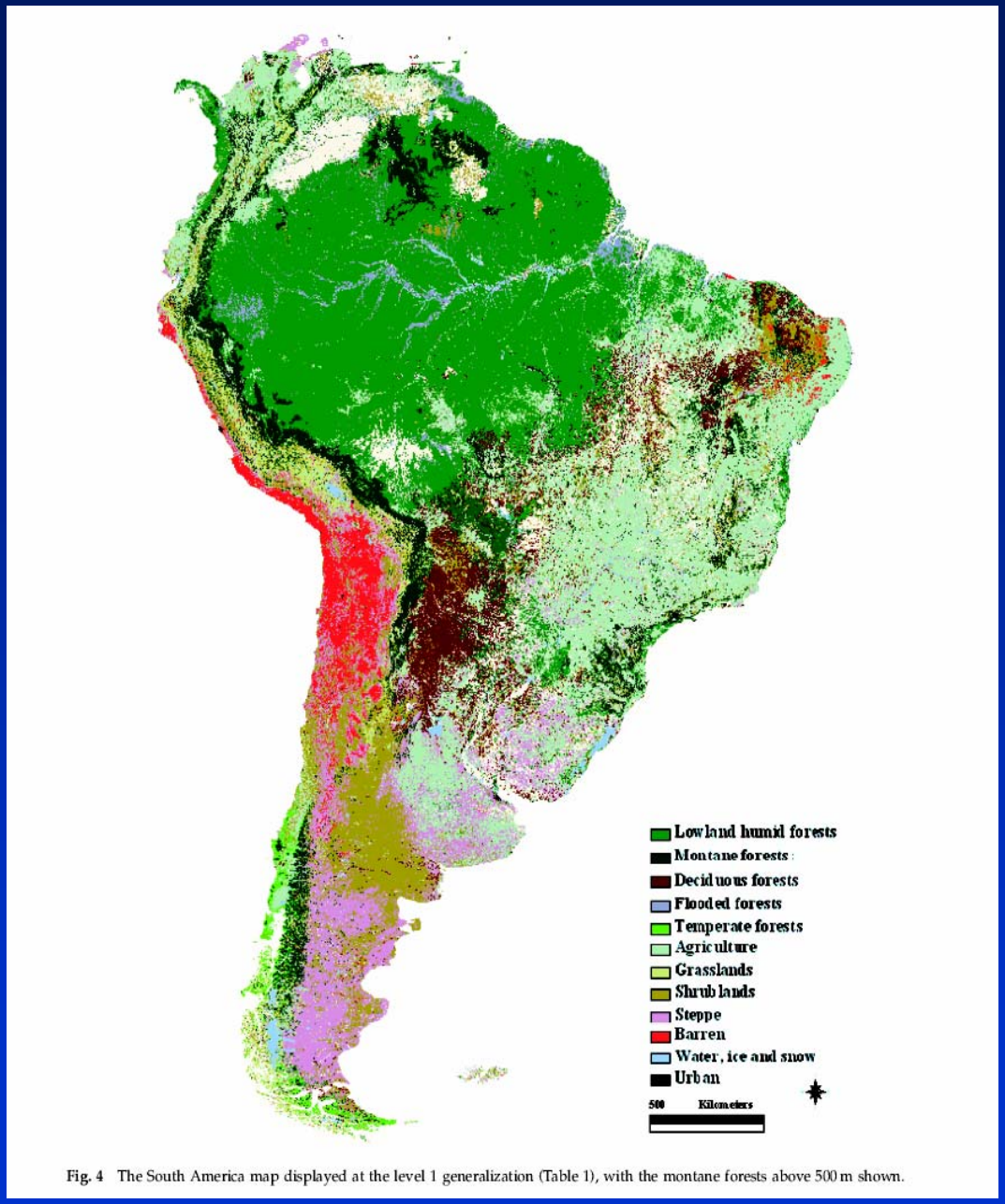


Fig. 4 The South America map displayed at the level 1 generalization (Table 1), with the montane forests above 500 m shown.

Vegetation types
at 1 km resolution

Eva et al (2004)

South American Land Data Assimilation System

NASA/GSFC, CPTEC/INPE/Brazil and the University of Arizona are implementing SALDAS, using retrospectively and near real-time atmospheric forcing from numerical prediction models and remote sensing measurements.

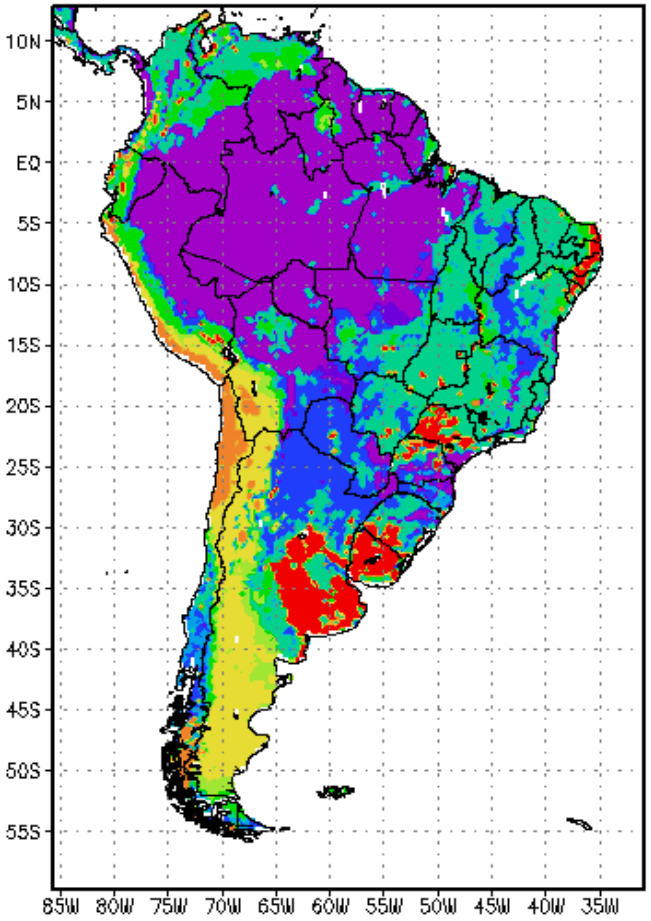
Model parameters will be derived from the existing high-resolution vegetation and soil types.

Water and energy balances will be validated with various in-situ observations over South America

The results, will be used to further validate and constrain the SALDAS predictions using data assimilation techniques and the land surface conditions used for NWP initialization.

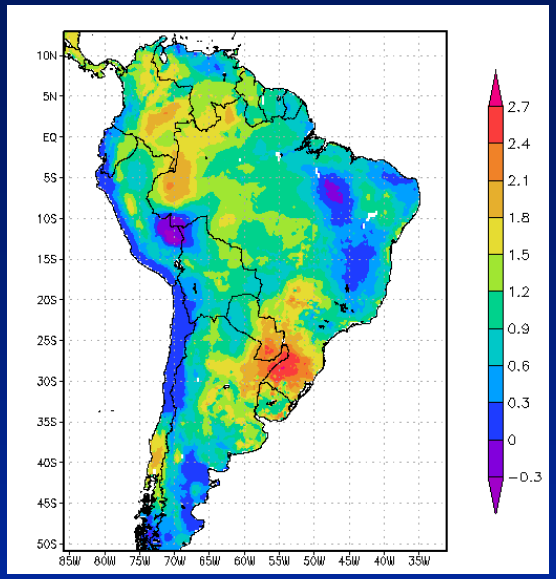
La Plata Basin: high spatial and temporal resolution runs help to improve the understanding of the hydrological and meteorological processes over the region. Under the LIS framework, SALDAS can be set to run at up to 1Km spatial resolution with hourly output.

UMD vegetation classification

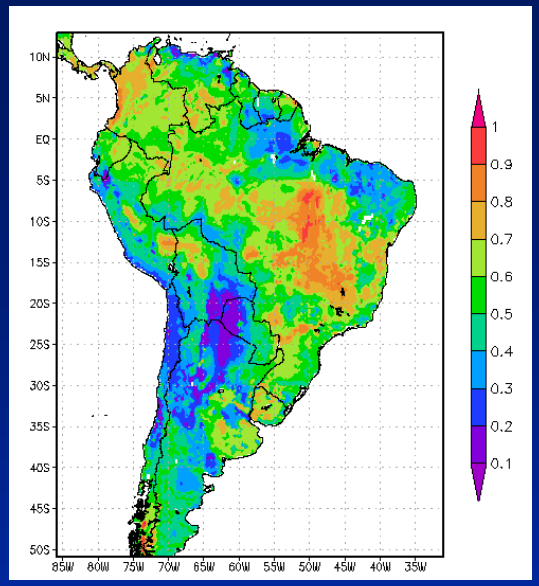


12 tropical rainforest
11 broadleaf deciduous trees
10 broadleaf and needleleaf trees
9 needleleaf evergreen trees
8 needleleaf deciduous trees
7 broadleaf trees with ground cover
6 grassland
5 broadleaf shrubs with ground cover
4 broadleaf shrubs with bare soil
3 dwarf trees with ground cover
2 desert
1 crops

South American Land Data Assimilation System

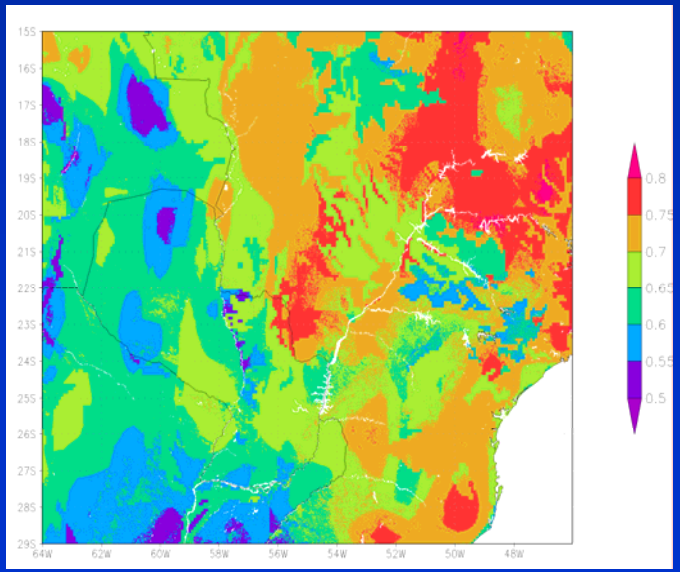


Evaporation in Kg/m2 on December 1989 using ECMWF bias corrected atmospheric forcing *(Berg et al., 2005, Int. J. Clim., 25 (13), 1697-1714)*



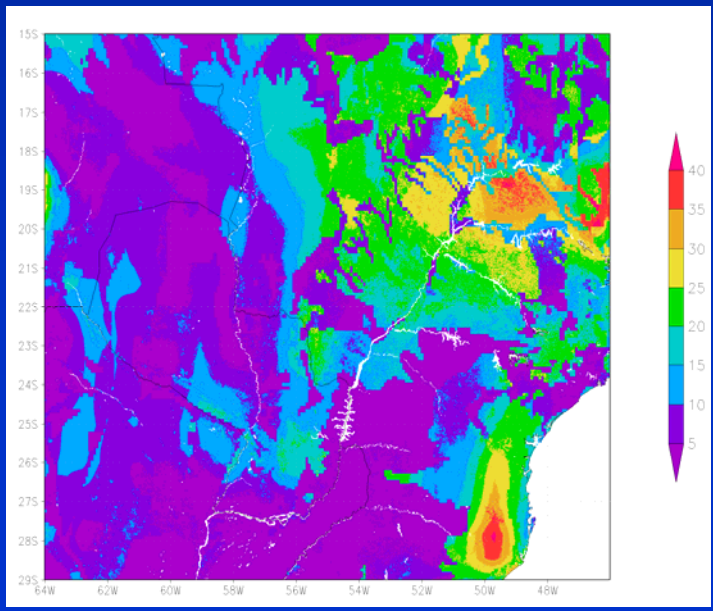
Volumetric soil moisture on December 1989 using ECMWF bias corrected atmospheric forcing *(Berg et al., 2005, Int. J. Clim., 25 (13), 1697-1714)*

Volumetric soil moisture



1Km resolution - January 2000

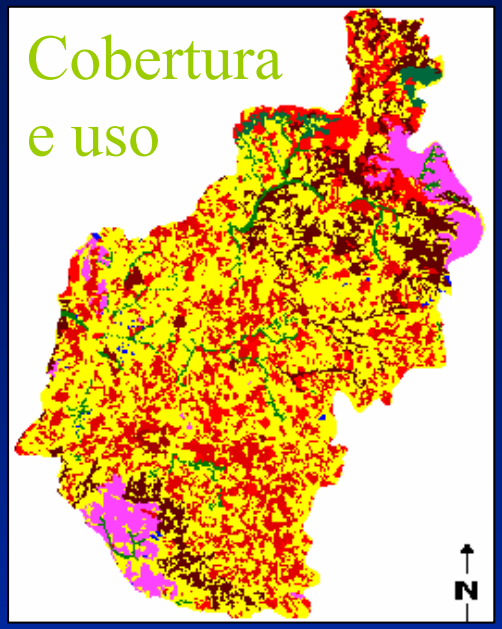
Total runoff (Kg/m²)

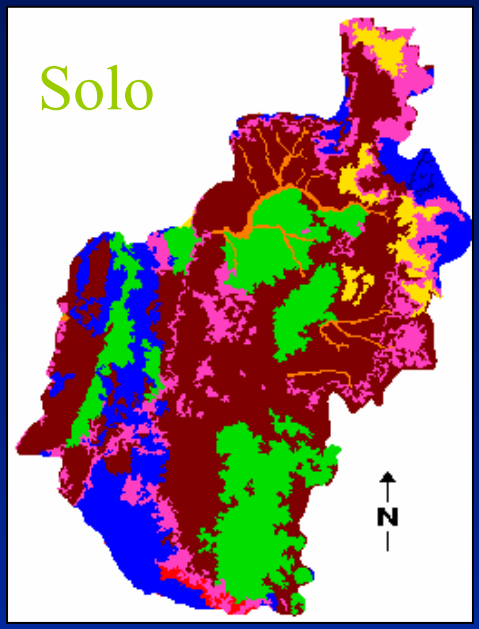


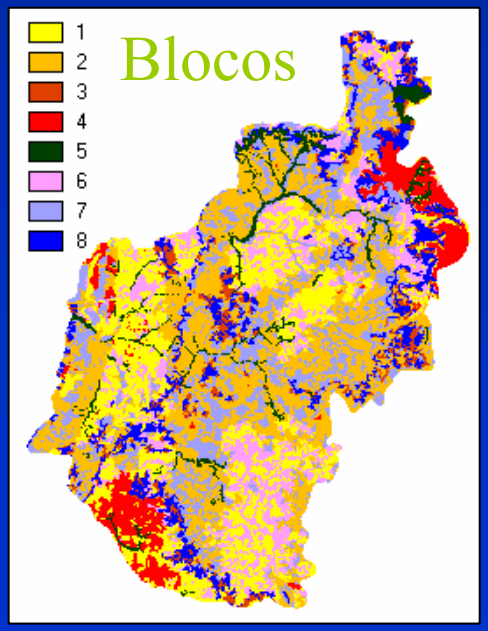
Planned activities

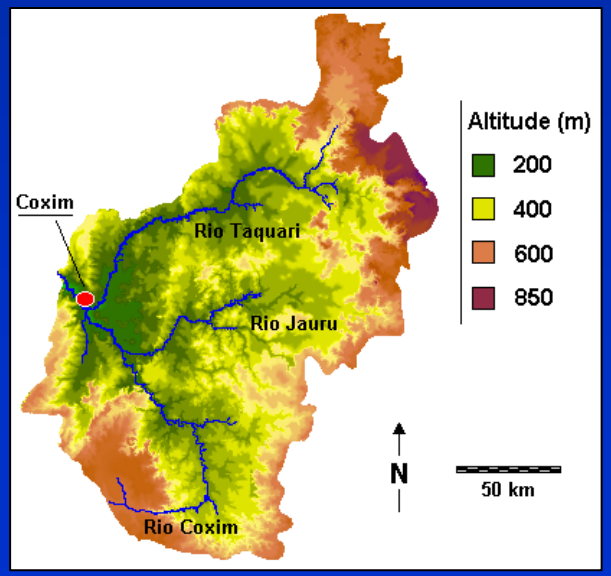
Hydrologic modeling

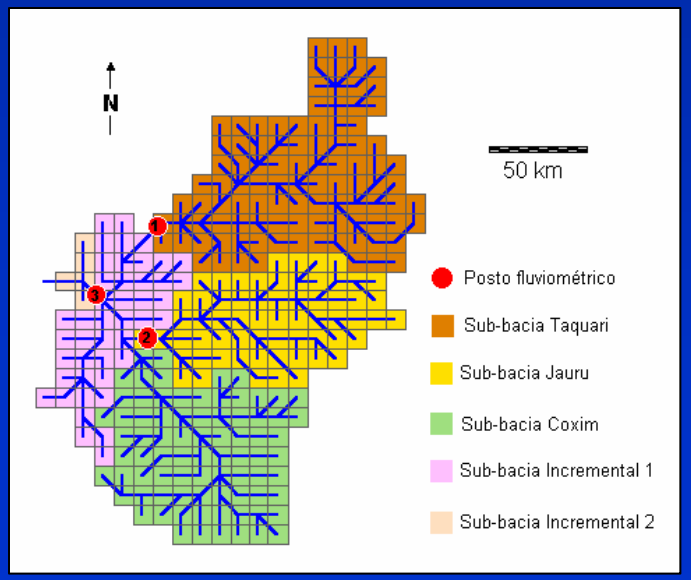

BRASIL
40° W
00° S
Rio Paraguai
Rio Taquari
Bacia do rio
Taquari, MS
30° S
70° W
30° S
40° W


Cobertura
e uso
N

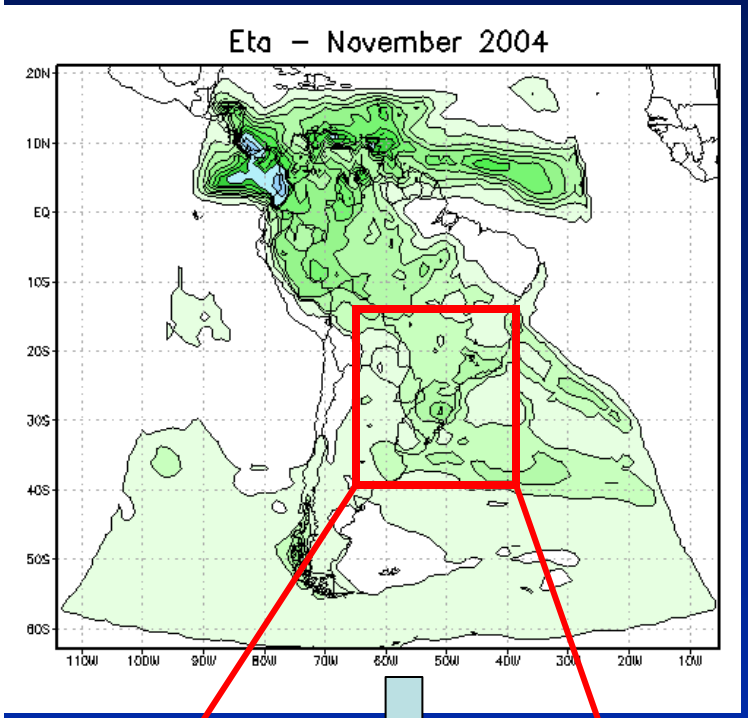

Solo
N

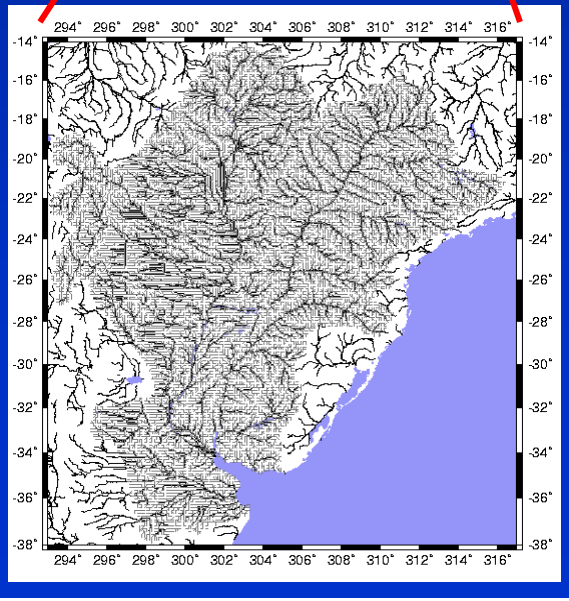

1
2
3
4
5
6
7
8
Blocos

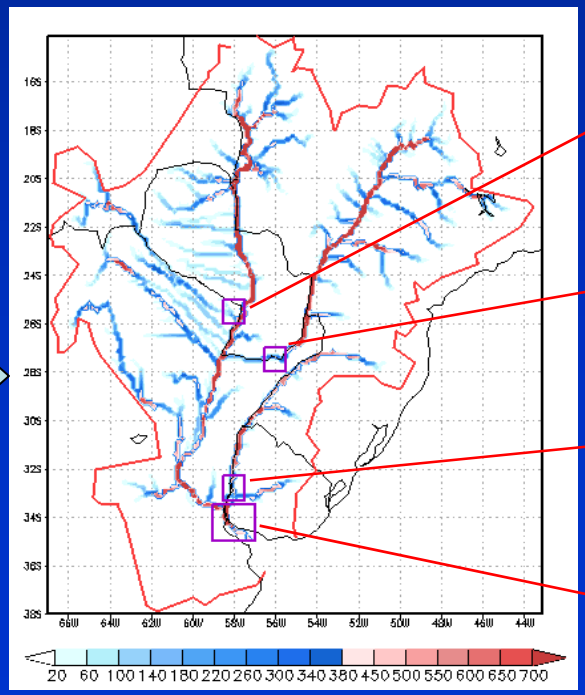

Coxim
Rio Taquari
Rio Jauru
Rio Coxim
Altitude (m)
200
400
600
850
N
50 km

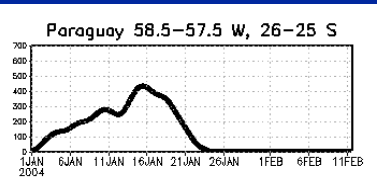

N
50 km
1
2
3
Posto fluviométrico
Sub-bacia Taquari
Sub-bacia Jauru
Sub-bacia Coxim
Sub-bacia Incremental 1
Sub-bacia Incremental 2

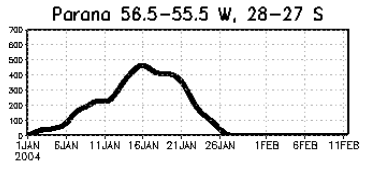
Brazilian basins where a Distributed hydrologic model is being applied (UFRGS)

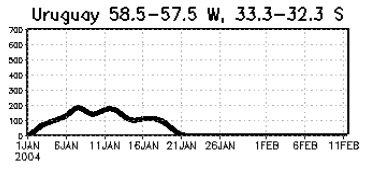


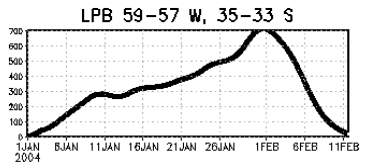










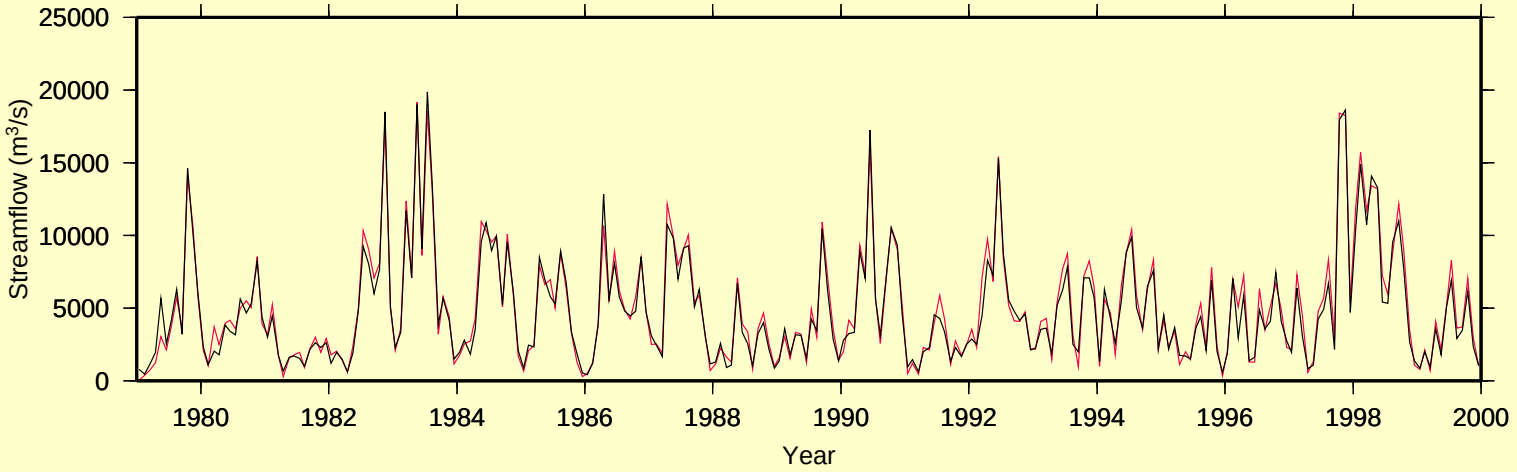


Model configuration

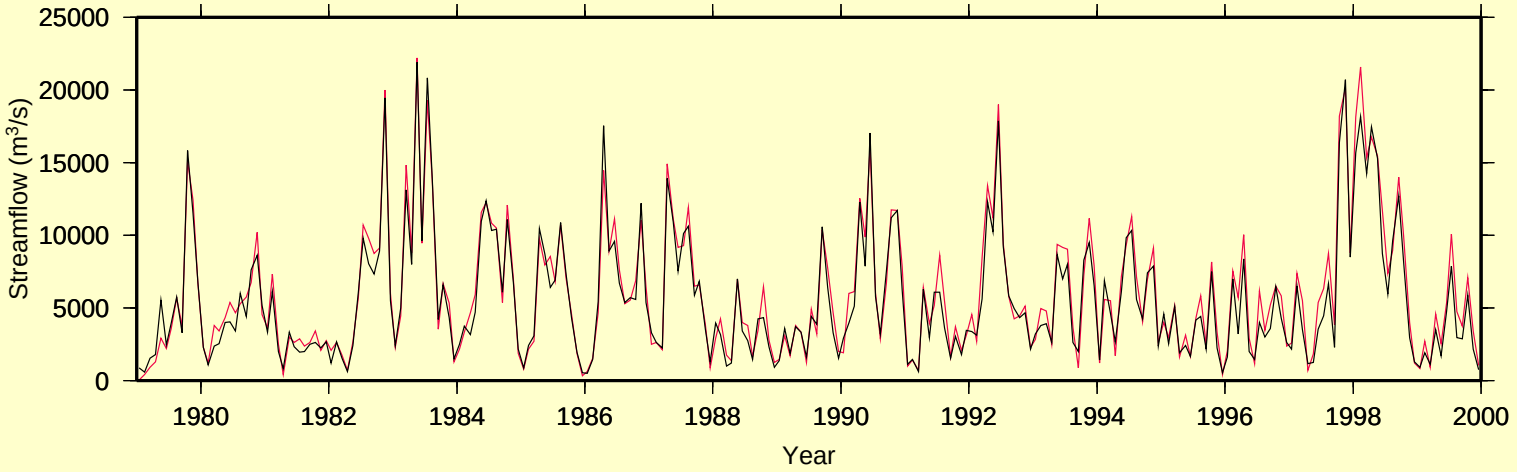
Uruguay

Monthly time series of streamflow (1979-1999)

Uruguay at Paso de los Libres (Area: 189,300km^2)



Uruguay at Concordia (Area: 240,000km^2)



Simulated **Observed**

Planned activities

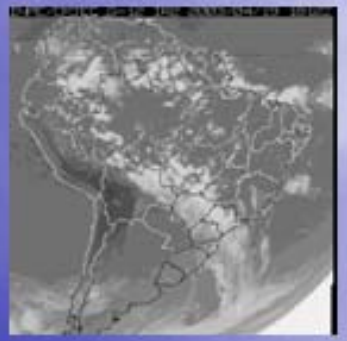
Datasets

Remote sensing products

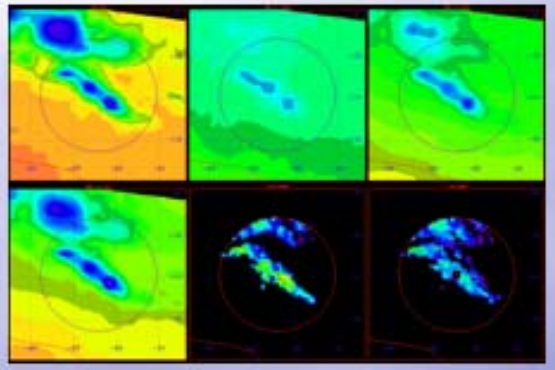
LPB
La Plata Basin Program

Integração de Dados => Estimativa de Precipitação

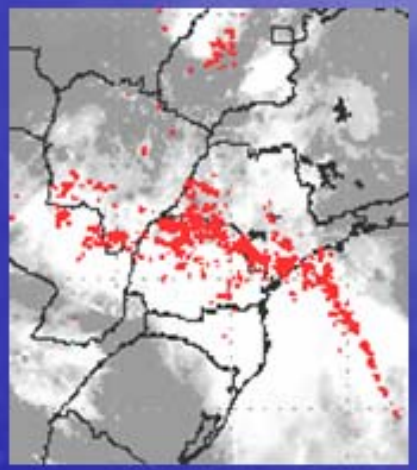
Satélite Geoestacionário



MICROONDAS – NOAA e AQUA

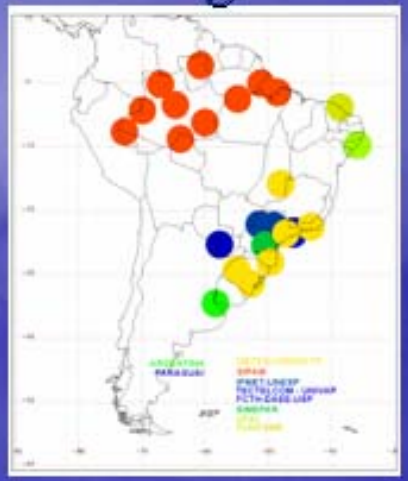


Relâmpagos



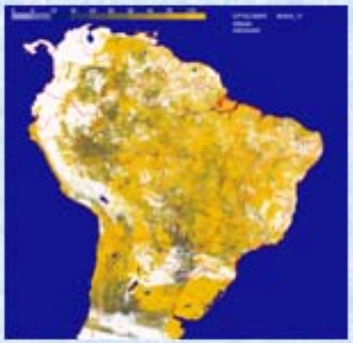
Plataforma de Coleta de Dados

Radares Meteorológicos



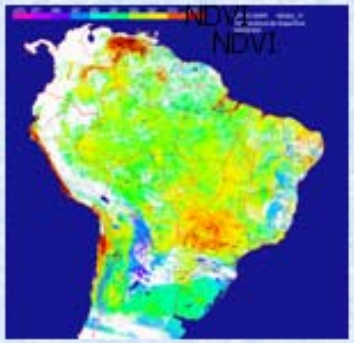
Produtos de Superfície (NOAA, GOES, AQUA)

NDVI

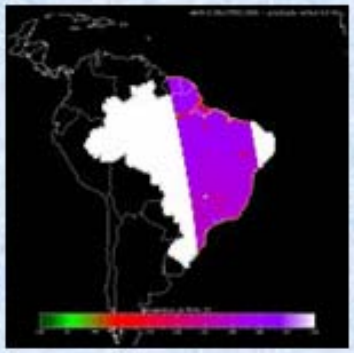


Albedo da superfície

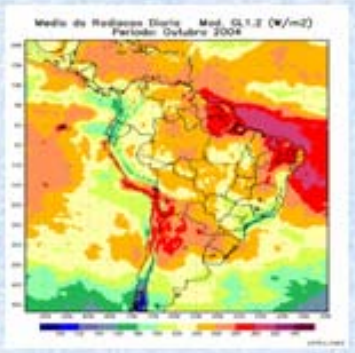
Emissividade



Temperatura da superfície



Umidade de solos - em desenvolvimento



Radiação Solar na superfície

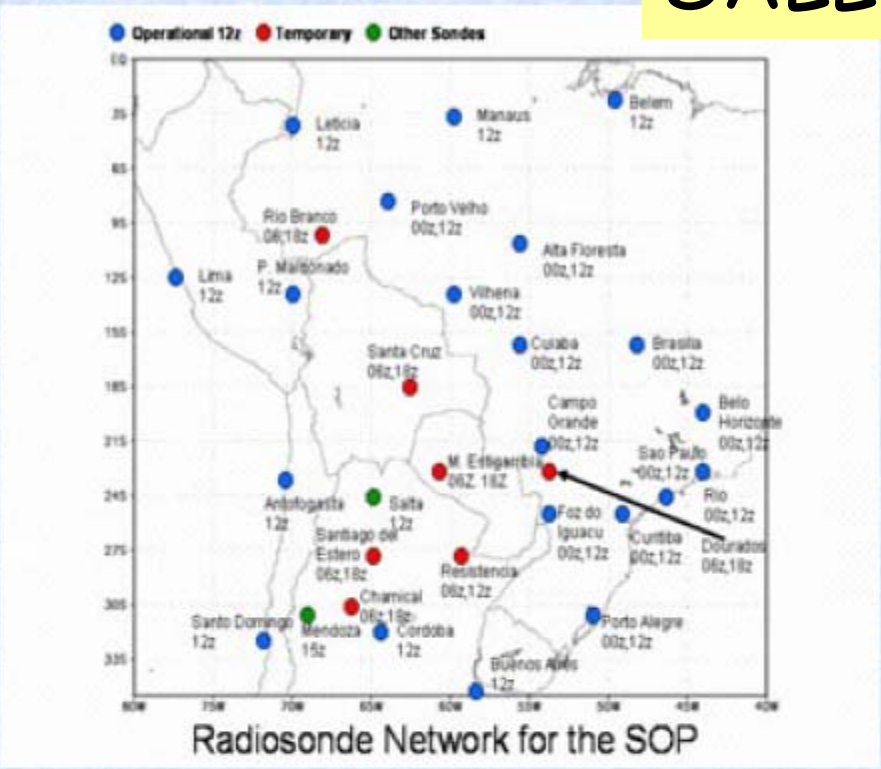
Monitoramento bioclimático da superfície continental por satélite

Planned activities

Datasets

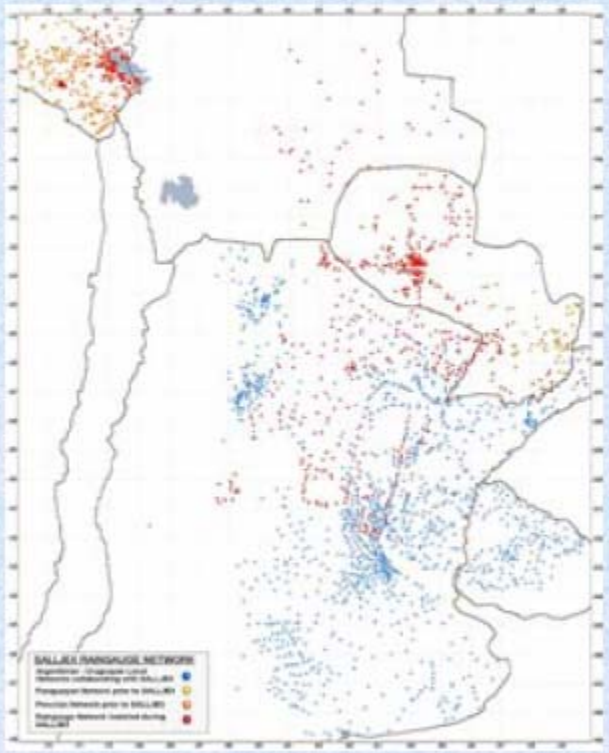
Field experiment
&
Enhanced monitoring

SALLJEX



Radiosonde Network for the SOP

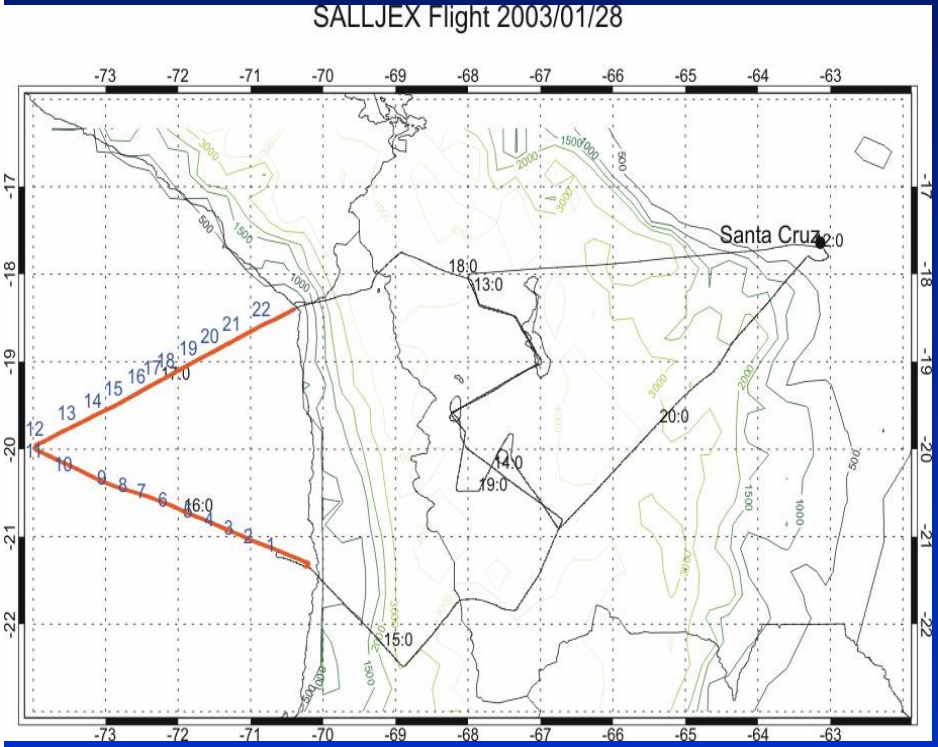
SALLJEX DATA NETWOKS



- Raingauges installed during SALLJEX

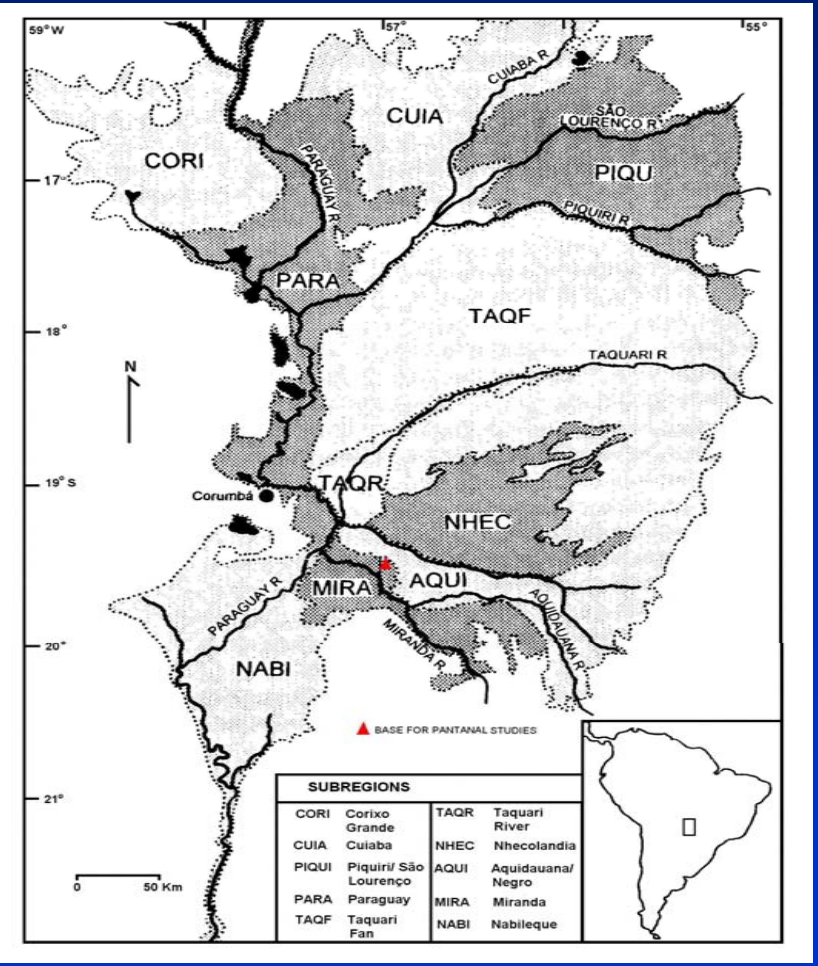
Pibal Network

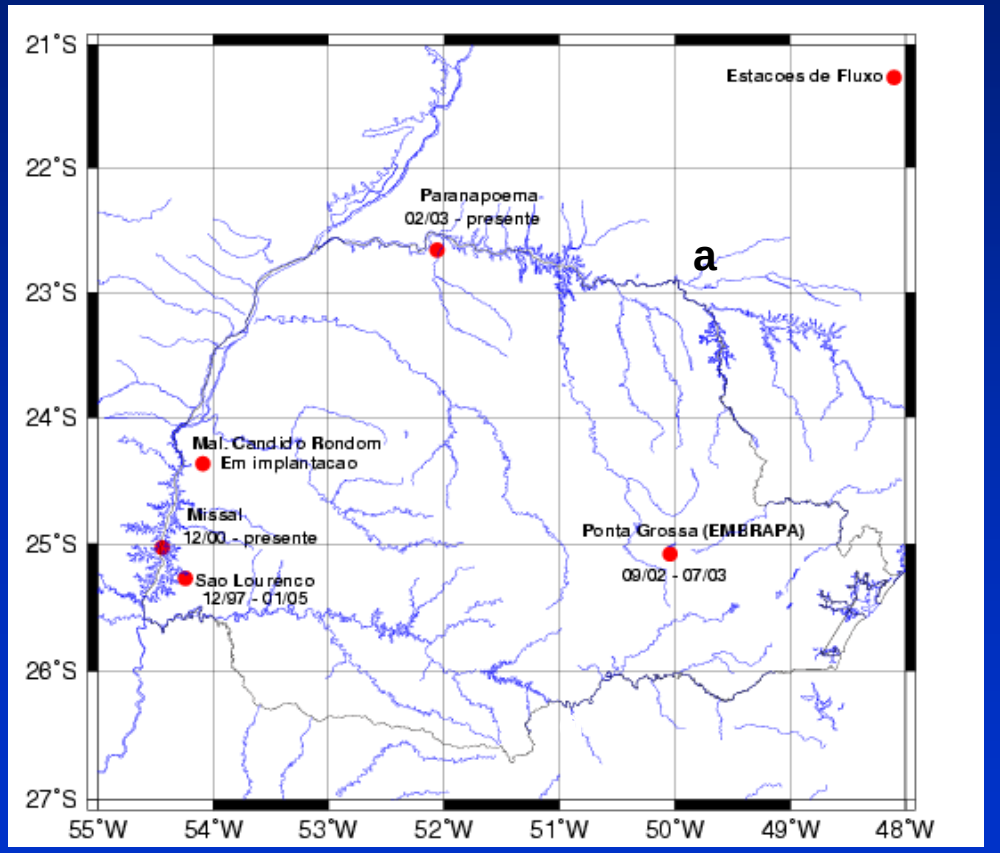
VAMOS/SALLJEX



NOAA/P-3 Missions

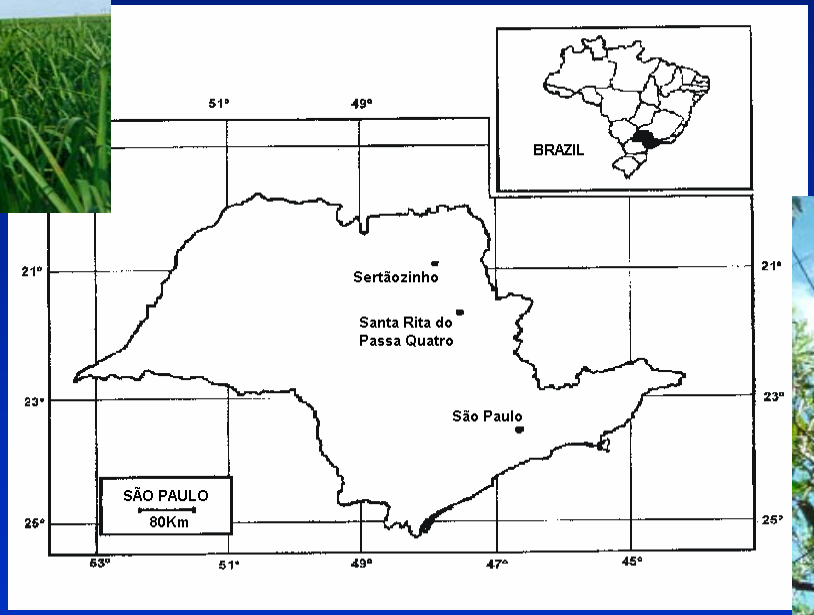
Flux towers in Pantanal and Parana State





Flux towers in Sao Paulo State

Project funded by FAPESP (Dr. Humberto Rocha)



Agronomic Institute of Campinas and UNICAMP experience on crop physiology will also be needed

Micrometeorological observations in the Pantanal Area-Central Brazil

Fazenda São Bento– MS

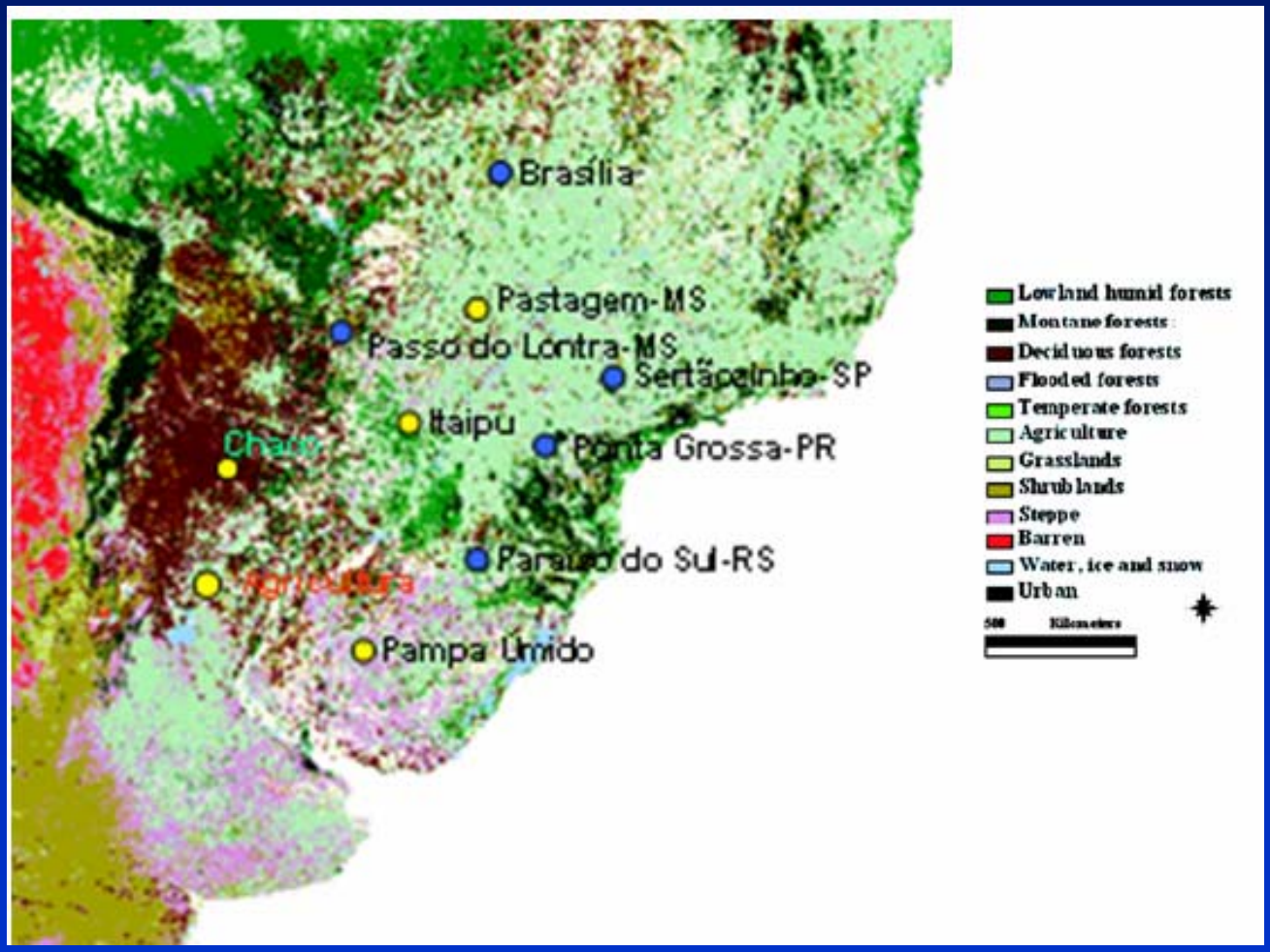
(19^{o} 33’ S; 57^{o} 54’ W)

-Objectives: Meteorological campaigns in the Pantanal area during wet and dry season to study boundary layer process and influences on weather and climate in the region

-Sensors at instrument tower (21 meters high)
Air temperature profile (5 levels)
H2O concentration profile (5 levels)
op canopy temperature (Infra-red sensor)
Wind velocity profile 5 levels)
Wind direction
Air pressure
Precipitation
Incoming and outgoing solar radiation (short wave radiation)
Incoming and outgoing terrestrial radiation (long wave radiation)
Incoming photosynthetically active radiation (PAR)
Turbulence measurements above forest canopy
High frequency (10.4 Hz) three wind components, air temperature, H2O and CO2 Concentration (Sensible and latent heat flux and CO2 flux)
Soil measurements
Soil heat flux (2 plates at depth of 1 cm and 10 cm, respectively)
2 five-level profiles of soil humidity, electric conductivity and temperature (sensors at depths of 1, 5, 10, 20, and 40 cm)
Methane concentration

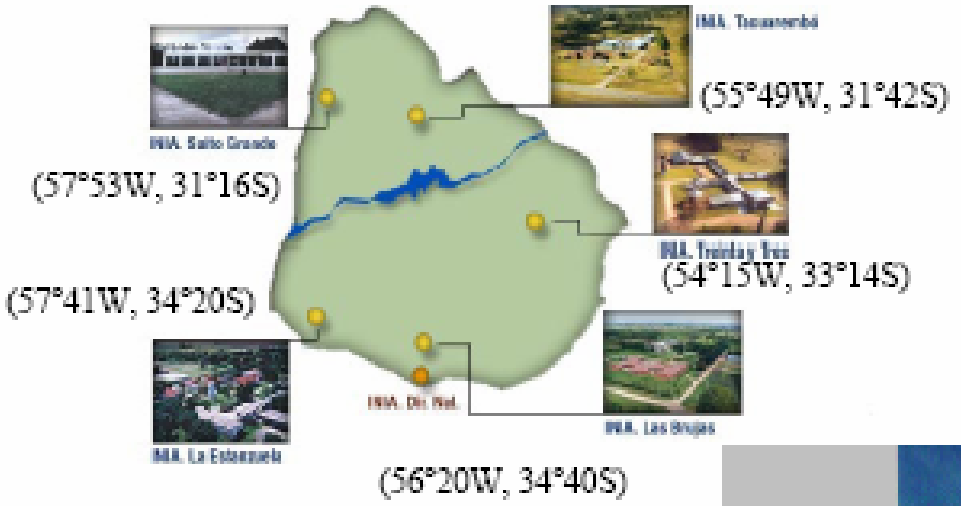
-Additional instrumentation:
Radiosonde station
Tethered balloon

Planned campaign in wet season of 2002


Brasília
Pastagem-MS
Passo do Lontra-MS
Sertãozinho-SP
Itaipu
Ponta Grossa-PR
Chaco
Pampa Úmido
Lowland humid forests
Montane forests
Deciduous forests
Flooded forests
Temperate forests
Agriculture
Grasslands
Shrublands
Steppe
Barren
Water, ice and snow
Urban
500
Kilometers

INIA — Uruguay

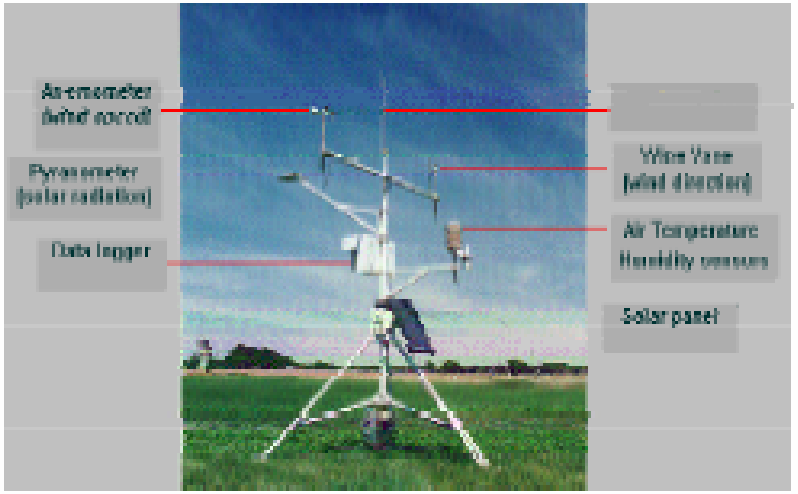
Instituto Nacional de Investigaciones Agropecuarias



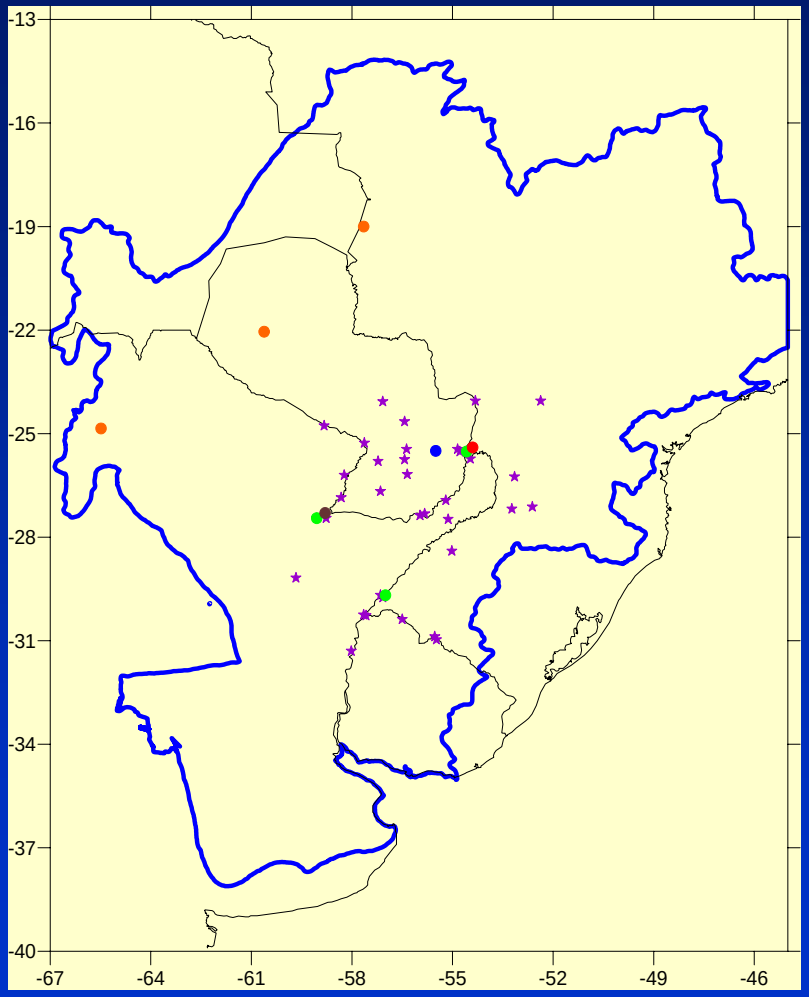
INIA's five surface monitoring stations have been providing data since 1965.

Data: Daily and monthly-mean air temp., rel. humidity, precip., evap., wind, hours of insolation and potential evap.

www.inia.org.uy



Working on establishing a supersite

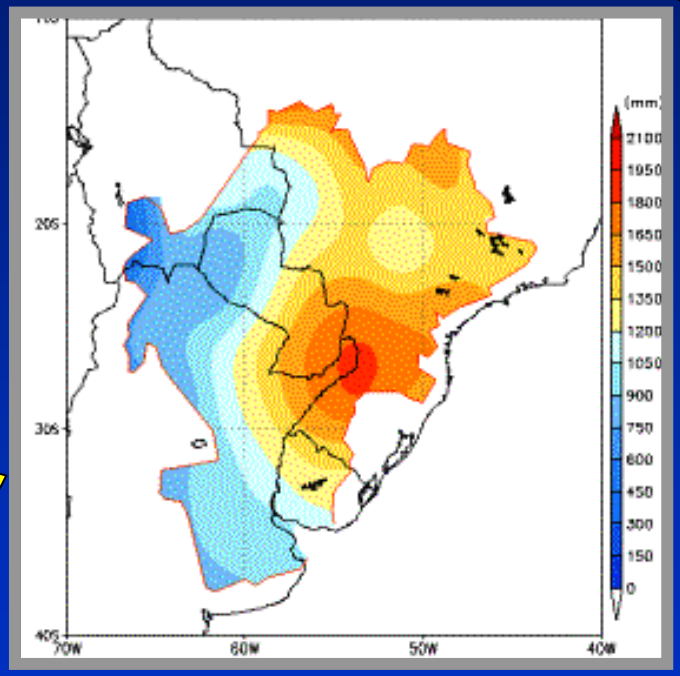


Raingauge Meso-network
Soil moisture measurements
Radar
Flux Tower
Aerosols
Rawindsonde
Wind profiler

La Plata Basin Priority areas

Land surface effects

Extreme events



Variability and trends

SST Anomalies (Atl & Pac)

Climate change scenarios

Hydro-climate Prediction

Main research areas

Improvement of models' representation of land surface-atmosphere interactions

Land surface contributions to predictability

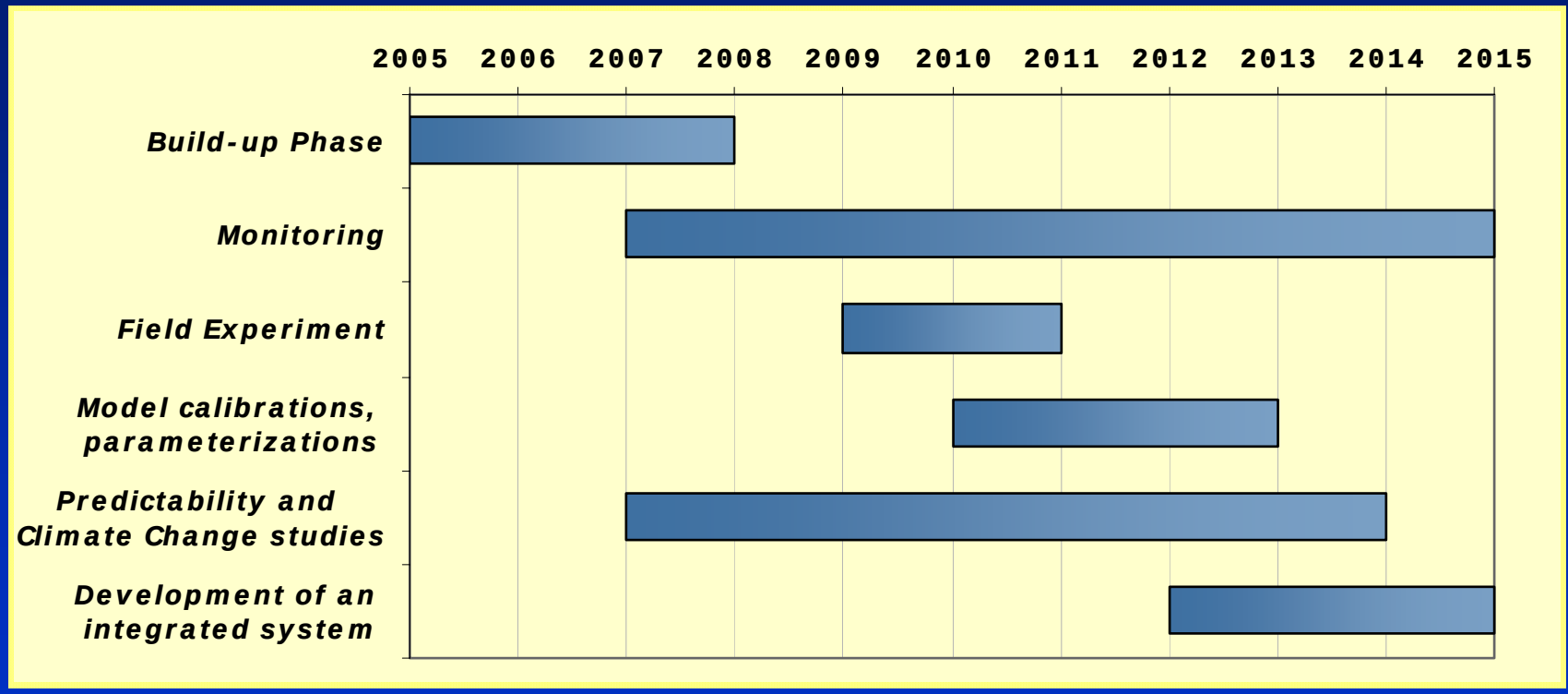
Develop coupled models at adequate resolutions for hydrologic purposes

Better estimates of MCS precipitation

Climate change scenarios

Impacts on the system's hydrology

LPB Timeline (2005-2015)



Still working on:

- Soil moisture measurements
- Aerosols
- Identification and establishment of a supersite
- Dates for the field experiment
- Data management and availability issues
- A SAm regional reanalysis project

- Field Experiment Manager
- Links to water management

A group meeting is needed to further advance our Implementation Plan: Can we do it by September '06?