

# **Eta Model seasonal forecasts and climatology over South America**

Sin Chan Chou, Josiane F. Bustamante, Jorge L. Gomes

**Center for Weather Prediction and Climate Studies - CPTEC  
National Institute for Space Research - INPE  
Cachoeira Paulista, SP, 12630-000, Brazil**



- Need of seasonal forecasts for planning activities.
- Seasonal forecasts are expressed in terms of anomalies,
- Model climatology is necessary to extract the predicted anomaly from the seasonal forecasts.
- Systematic errors grow in seasonal integrations differently from short term integrations,

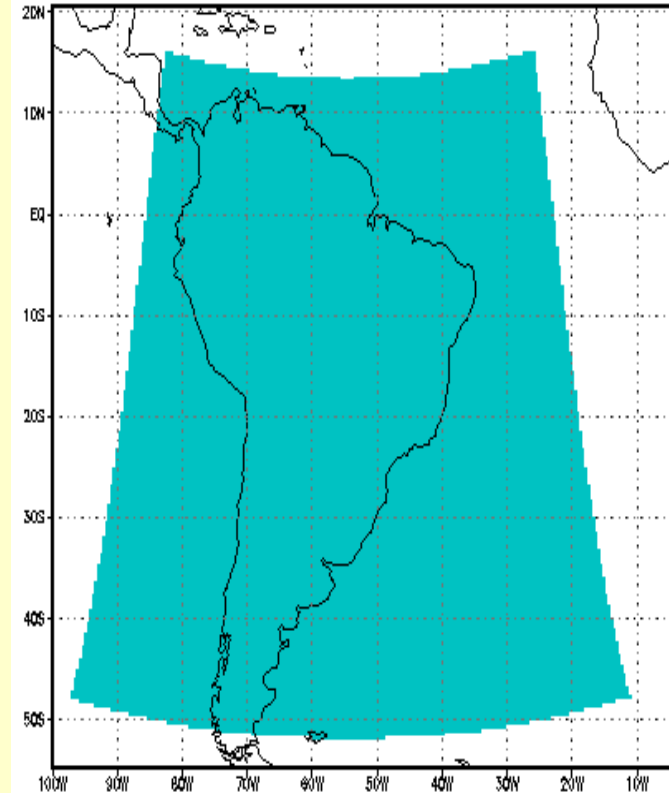
## Objectives

- To produce Eta Model seasonal climatology over South America;
- To identify systematic errors;
- To evaluate the Eta Model climatology in the rainy season (DJF) and the dry season (JJA) over South America;
- To evaluate model ability to capture interannual variability.
- Tests of ensemble seasonal forecasts

# Model configuration

*Domain* covers most part of South America

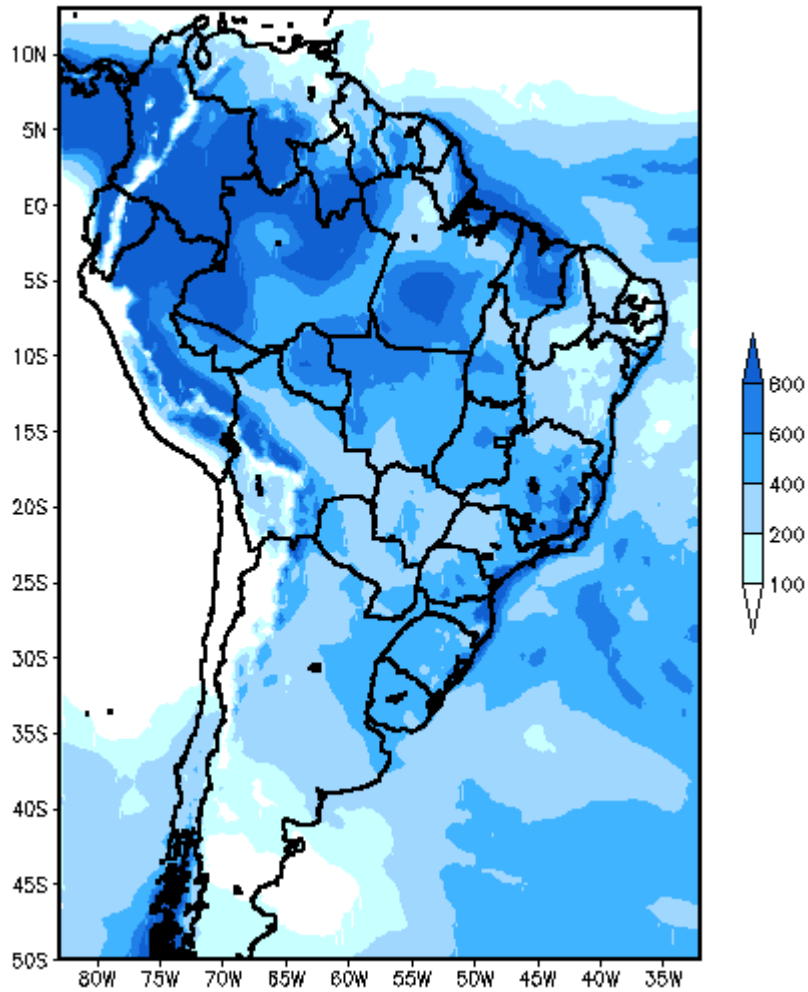
- **Resolution:** 40 km, 38 layers, dt = 96s
- Grid-point model (E-grid)
- Eta vertical coordinate (Mesinger, 1984),
- **Model top:** 25 hPa,
- **Integration length:** 4.5 months,
- **Prognostic variables:** T, q, u, v,  $p_s$ , TKE, cloud water/ice,
- **Convection:** Betts-Miller-Janjic scheme
- **Stratiform rain:** Zhao scheme
- **Turbulence:** Mellor Yamada 2.5; MO surface layer, Paulson functions
- **Radiation:** GFDL package, tendencies updated every hour,
- **Land surface scheme:** OSU scheme, 2 soil layers,
- .



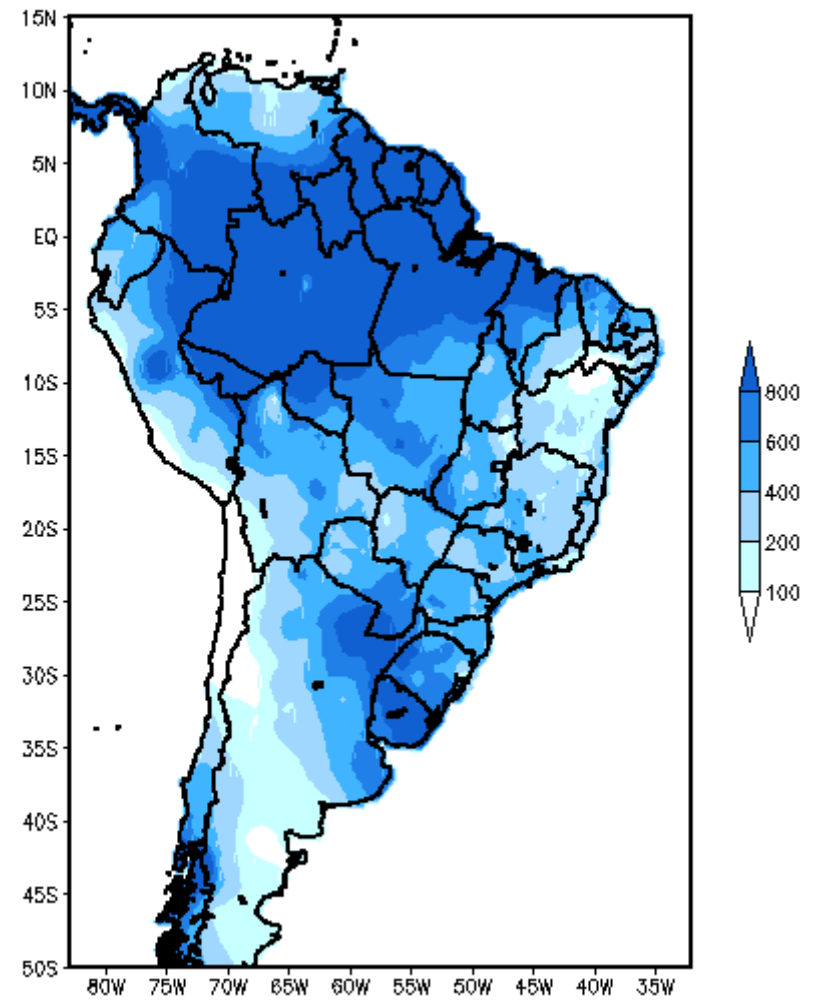
- **Lower boundary conditions:**
  - persisted SST anomaly, daily updated during integration
  - Climatological soil moisture
  - Seasonal albedo.

# FMAM - 2002

**Eta**

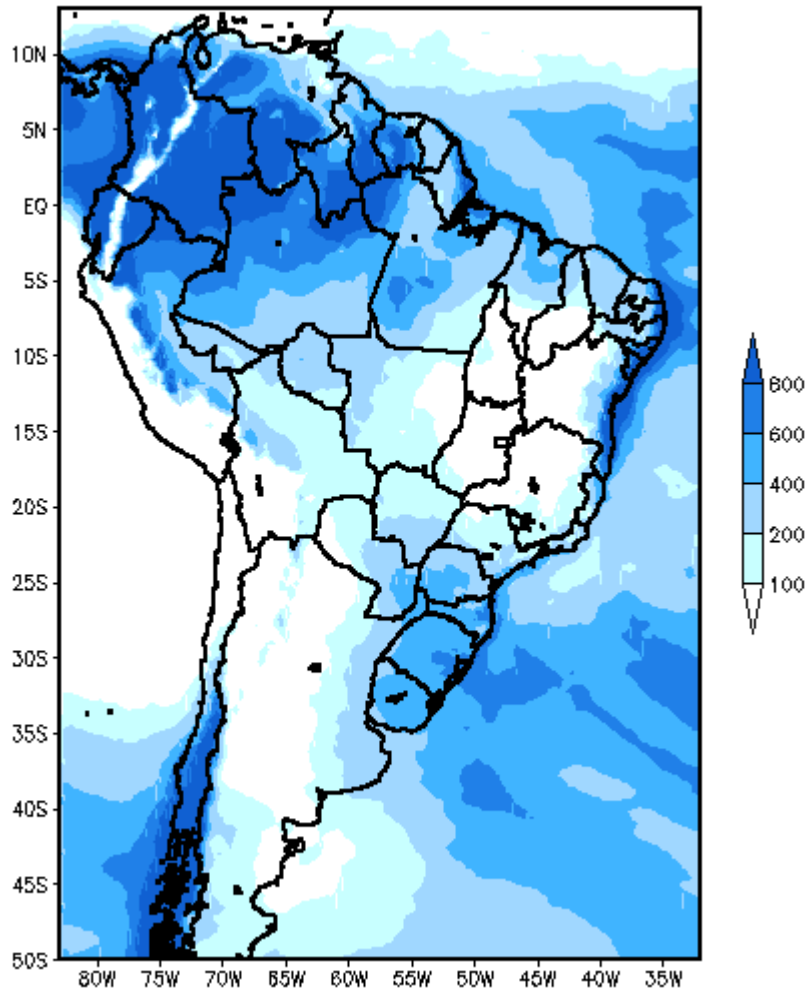


**Obs**

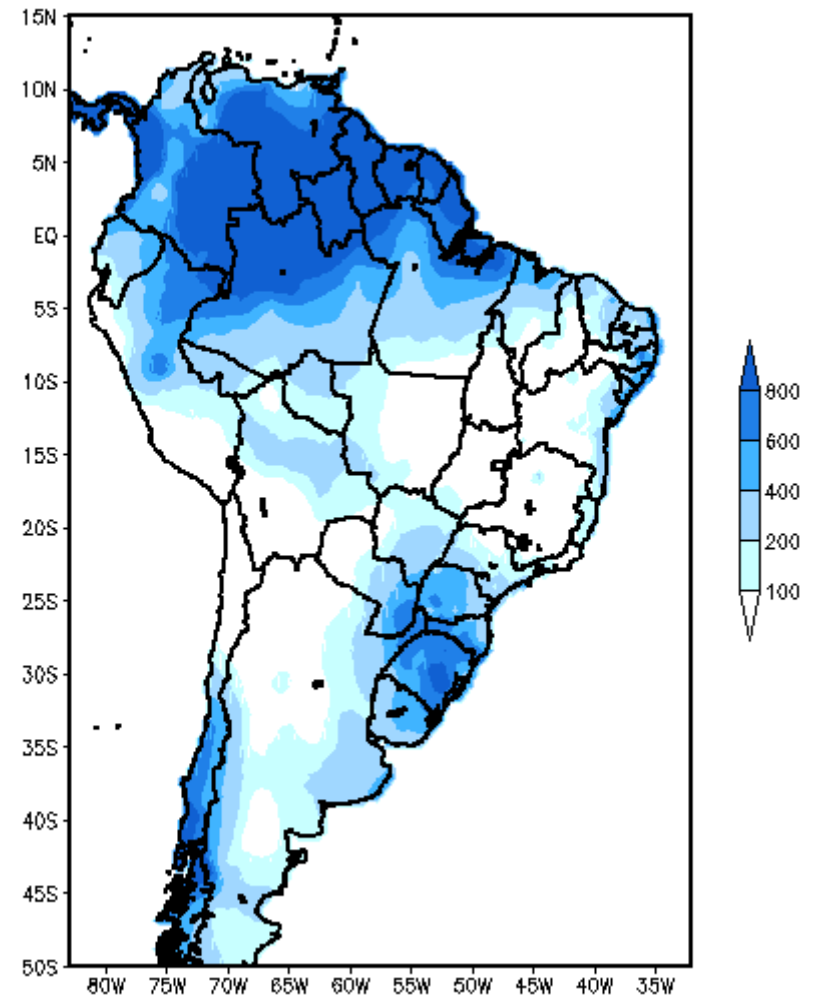


# MJJA - 2002

## Eta

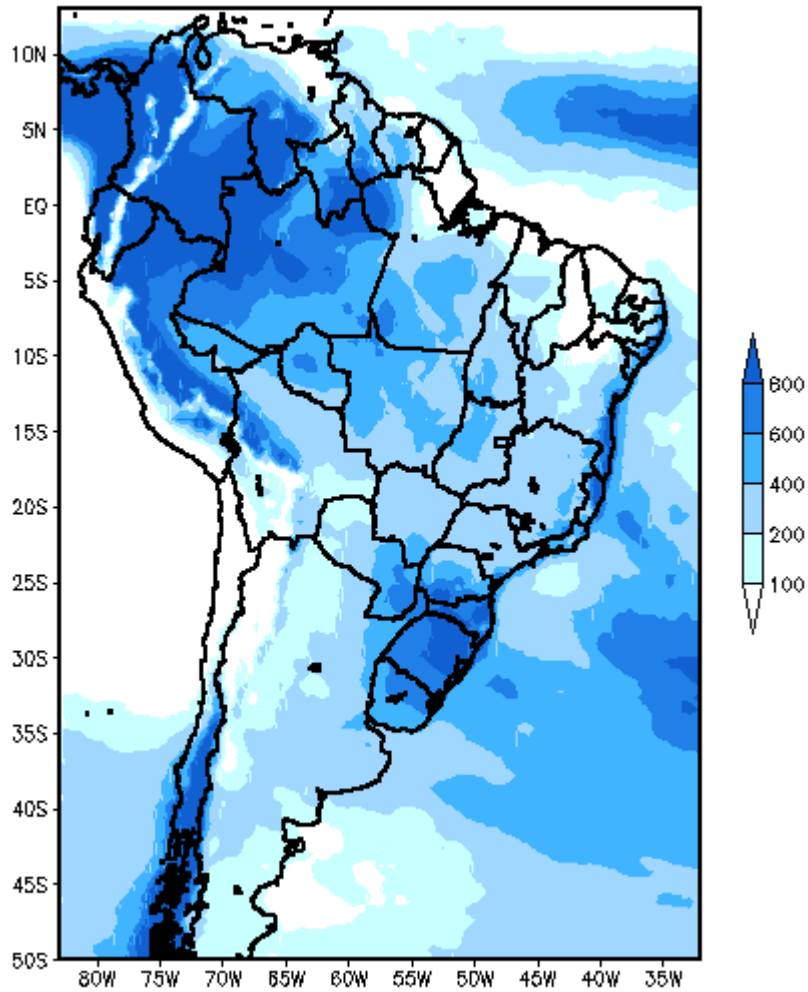


## Obs

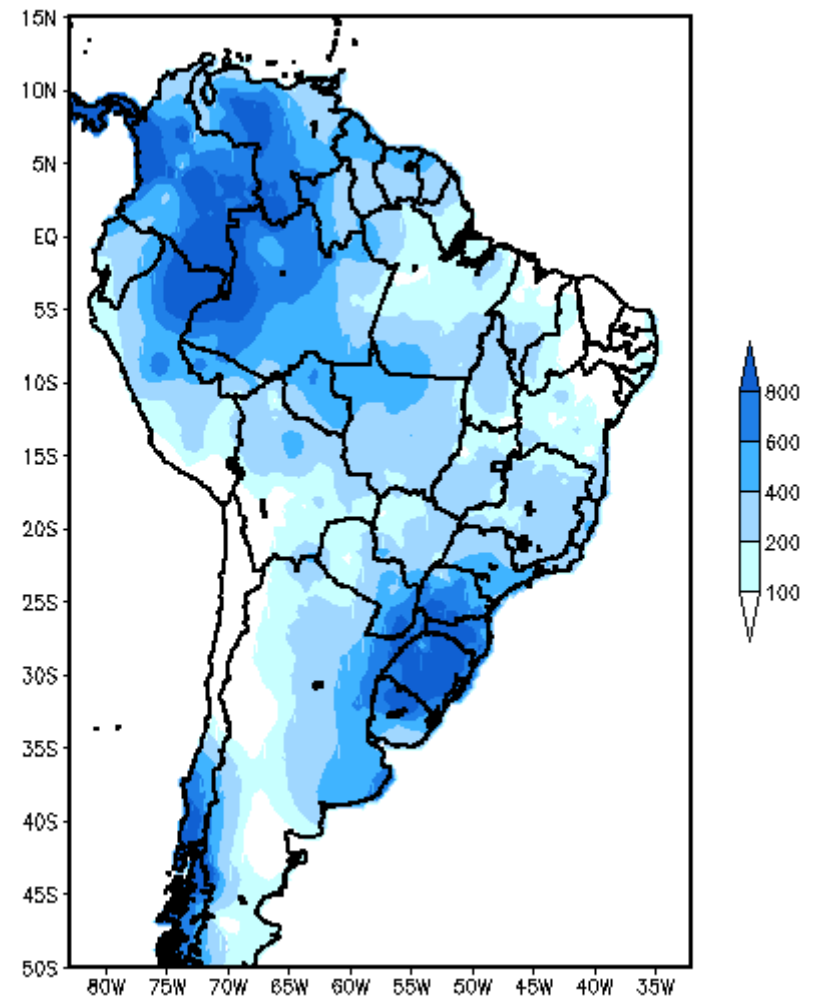


# ASON - 2002

**Eta**

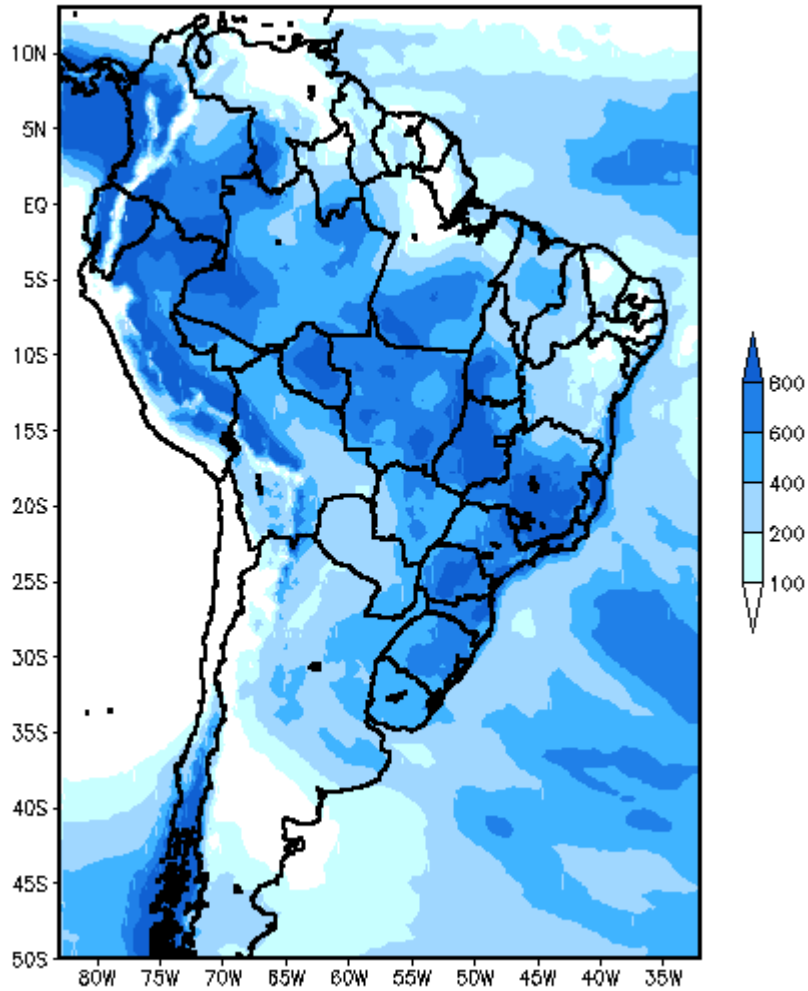


**Obs**

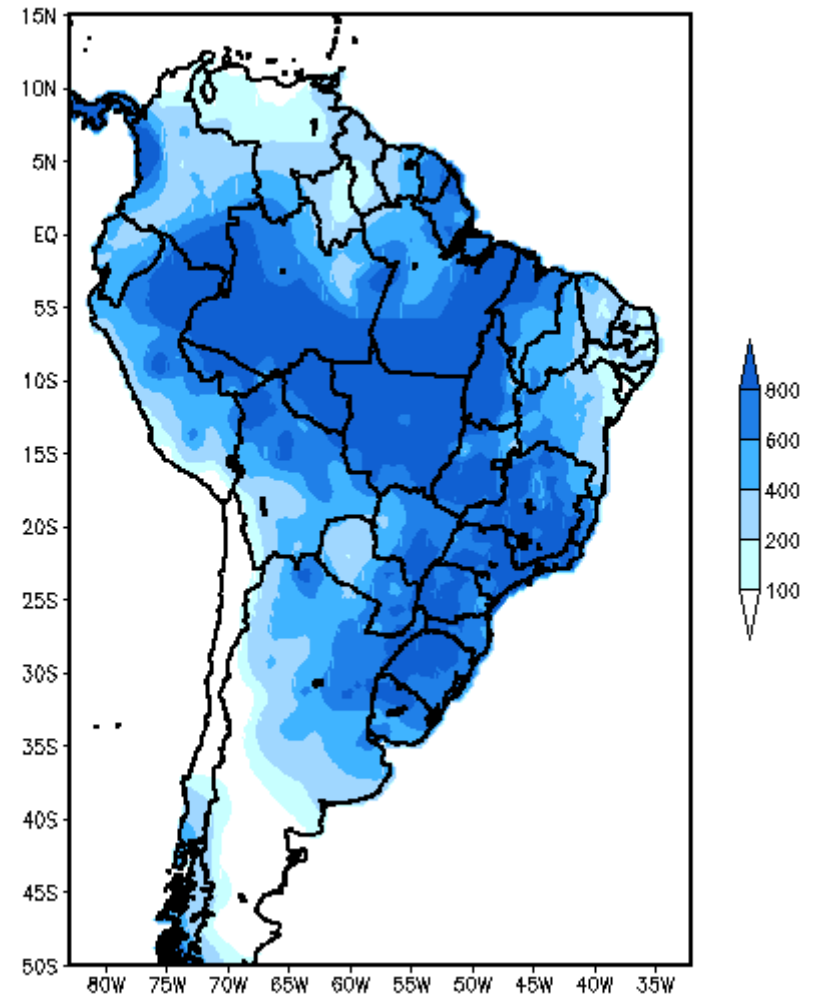


# NDJF - 2002

**Eta**



**Obs**





## Poor's man model climatology

5-year 4,5 month integrations:  
1996, 1997, 1998, 1999, 2000

Model seasonal climatology - seasonal forecasts = anomaly forecast

Assume: climatology and model systematic errors have been *removed*

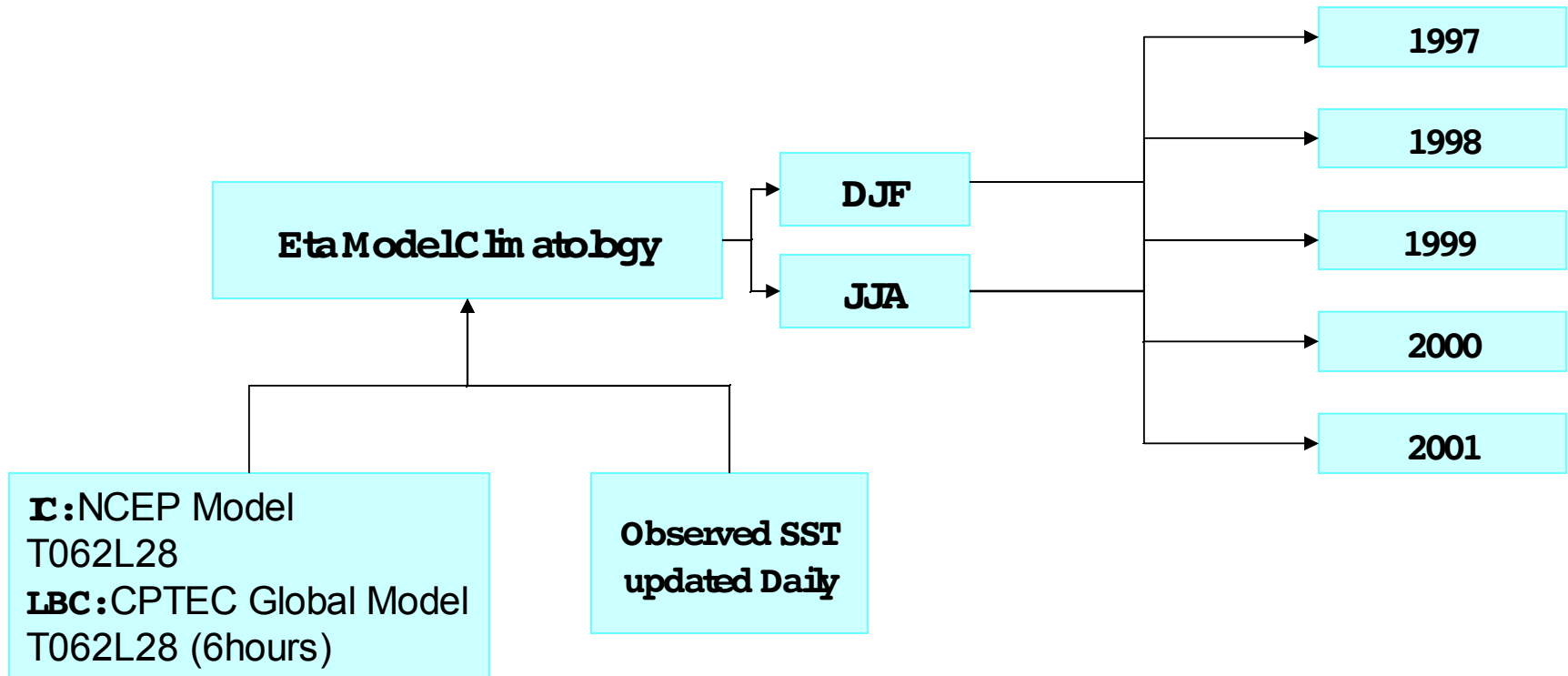
<b>SST:</b>	Observed monthly mean, 1o X 1o lat x lon, daily updated
<b>Initial Soil Moisture:</b>	Monthly mean data, 2 soil layers
<b>Albedo:</b>	Seasonal climatology
<b>Initial Conditions:</b>	NCEP analyses at T62L28, on Day-15
<b>L. B. Conditions:</b>	CPTEC GCM simulations at T62L28, updt 6/6 h

### **5-year seasonal climatology**

1997,  
1998,  
1999,  
2000, and  
2001.

### **Period evaluated**

3 last months of the integration  
Dry (JJA) season  
Rainy (DJF) season



**Seasonal climatology** were produced on a **monthly basis**, however, only the results of **DJF** season (a rainy season) and **JJA** season (a dry season) are shown here.

# Daily Mean Precipitation

DJF

Obs

Eta

5-yr climatology

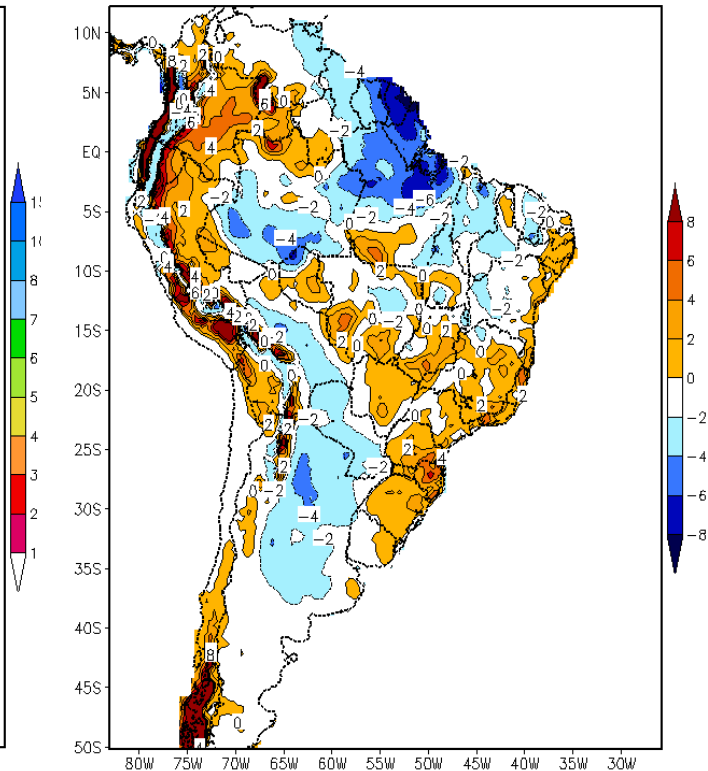
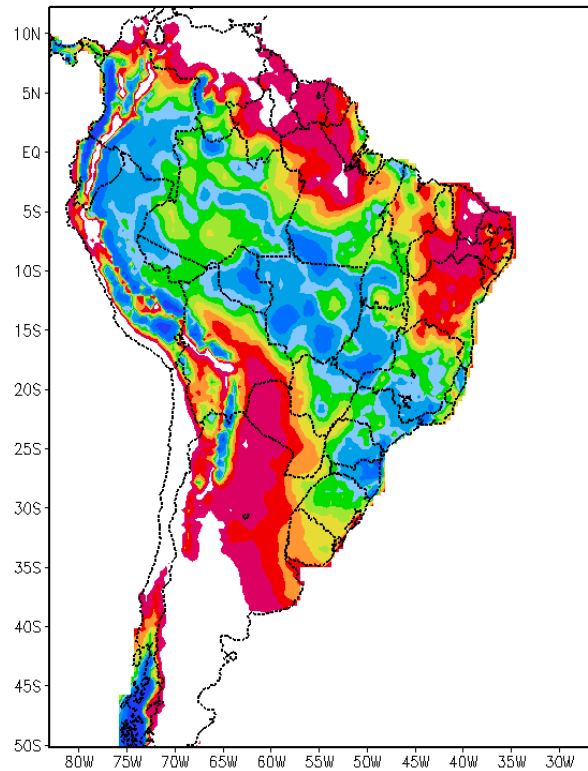
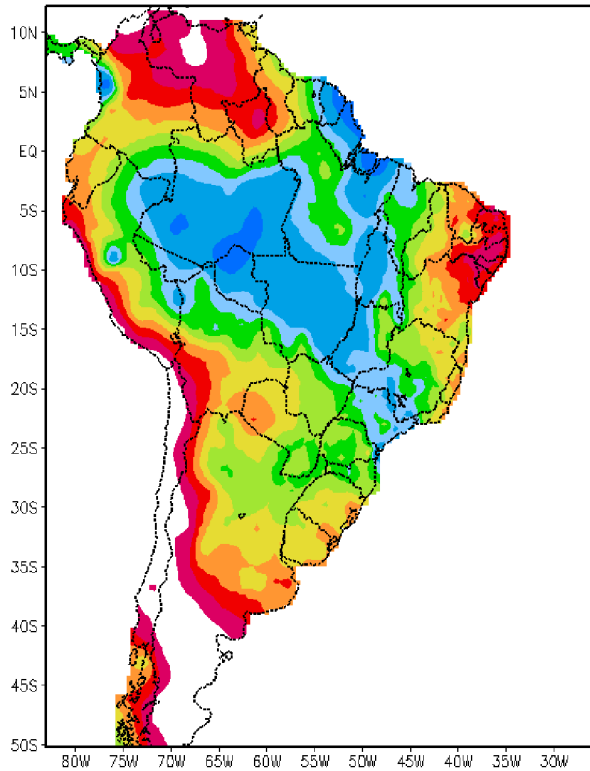
5-yr climatology

Eta mean error

Obs Mean Precip  
(mm/day) 5-yr - DJF

Eta 40km Mean Precip  
(mm/day) 5-yr - DJF

FCT-OBS DJF (mm/day)



# Daily Mean Precipitation

JJA

Obs

Eta

5-yr climatology

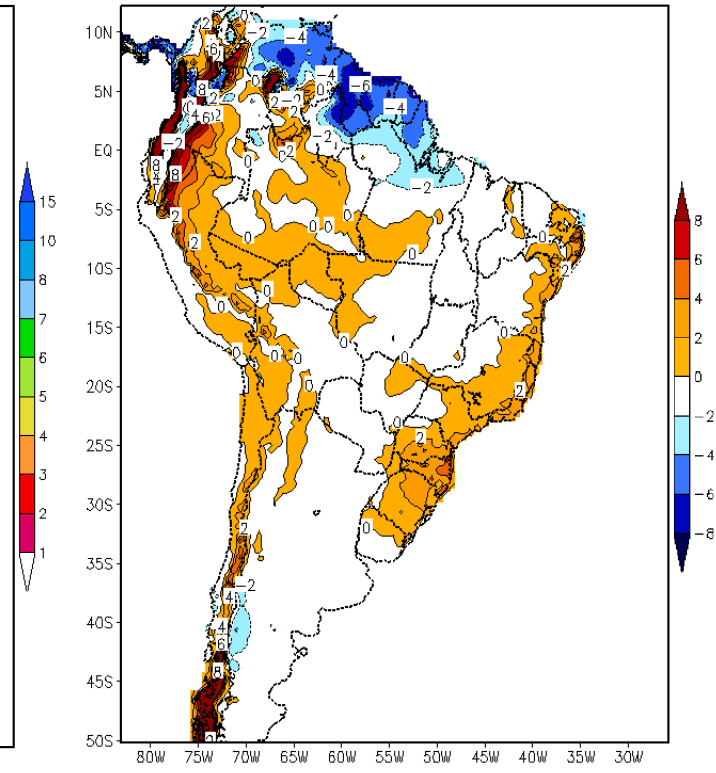
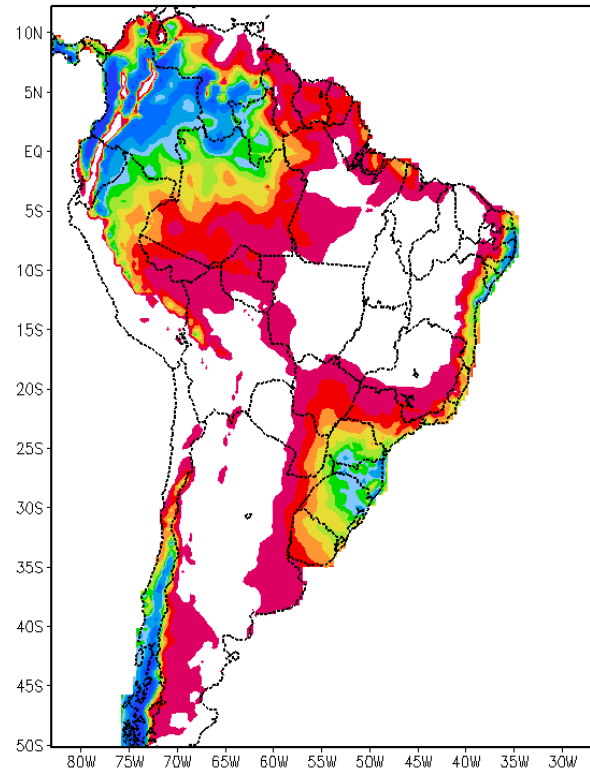
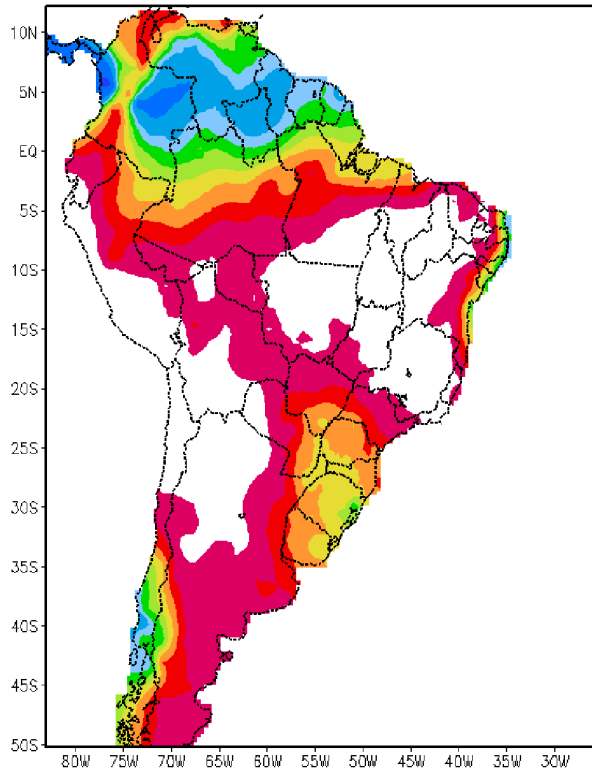
5-yr climatology

Eta mean error

Obs Mean Precip  
(mm/day) 5-yr - JJA

Eta 40km Mean Precip  
(mm/day) 5-yr - JJA

FCT-OBS JJA (mm/day)



# Mean Sea Level Pressure - DJF

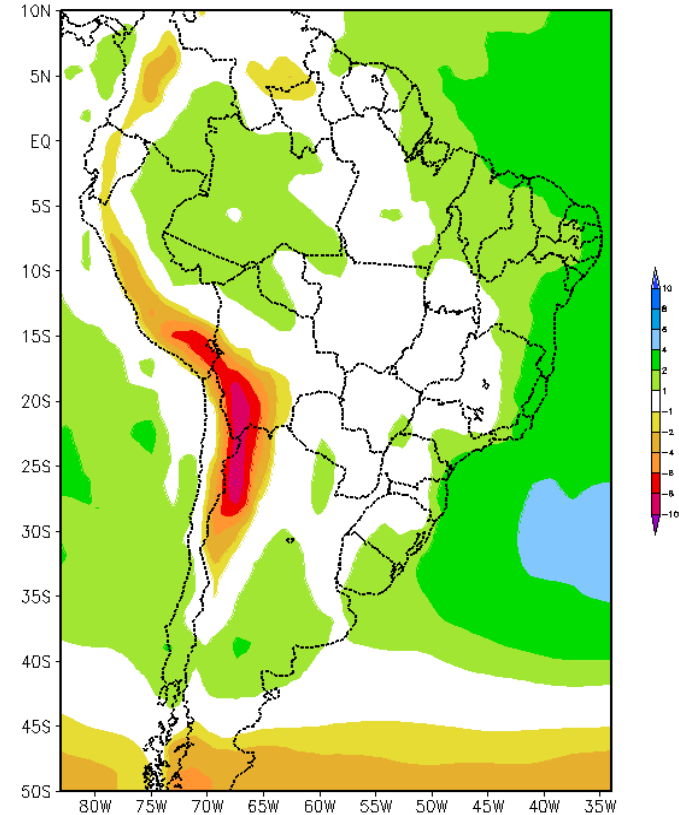
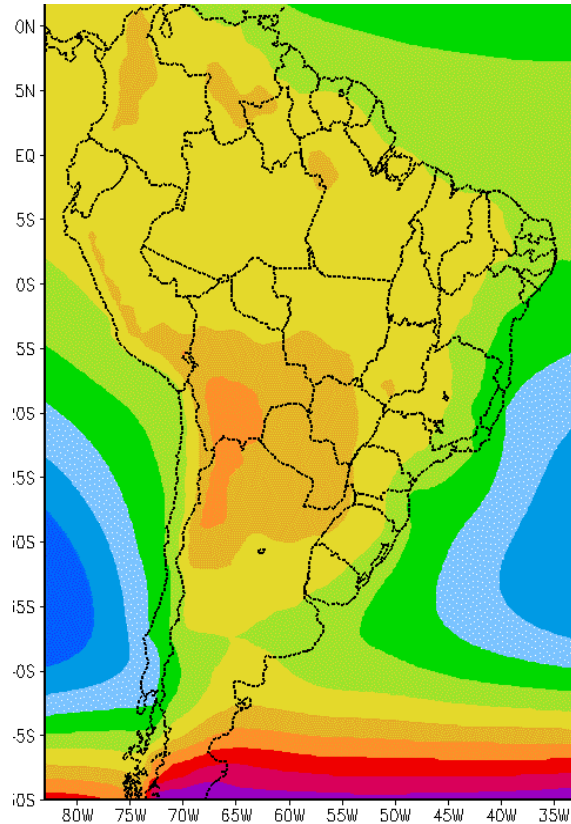
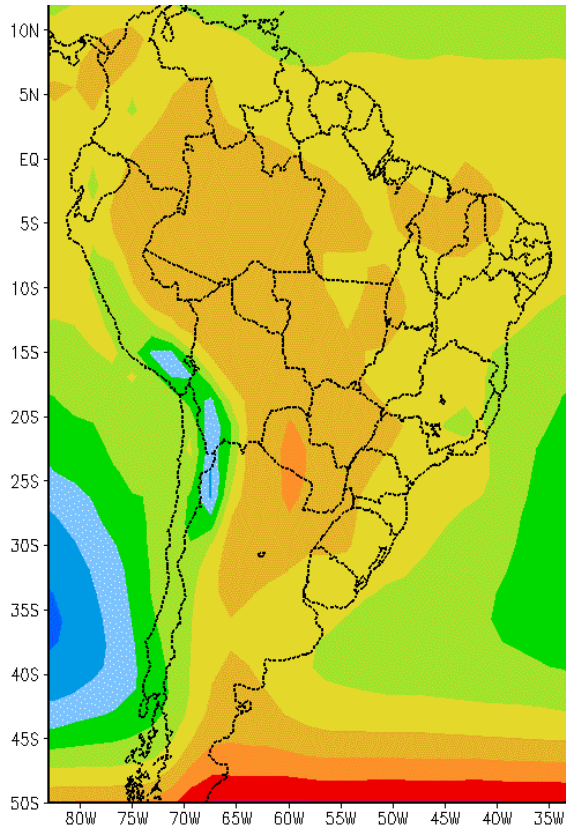
NCEP Analyses

Eta Forecast

Fcst - Anl

LBC: CPTEC GCM

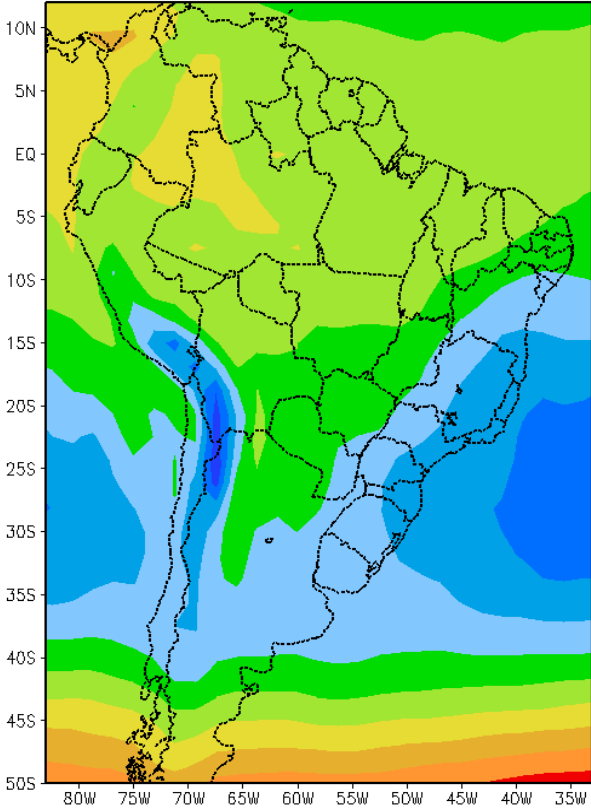
Eta mean error



# Mean Sea Level Pressure - JJA

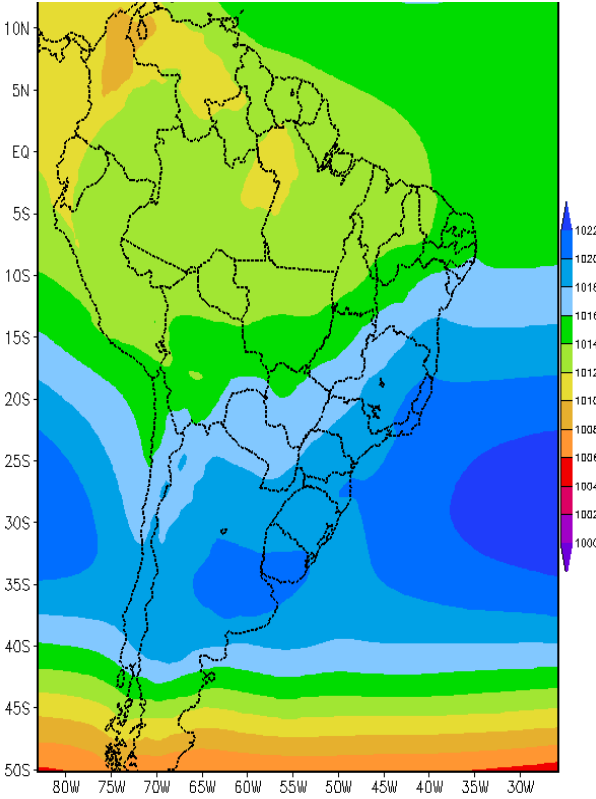
NCEP Analyses

(hPa) 5-yr - JJA



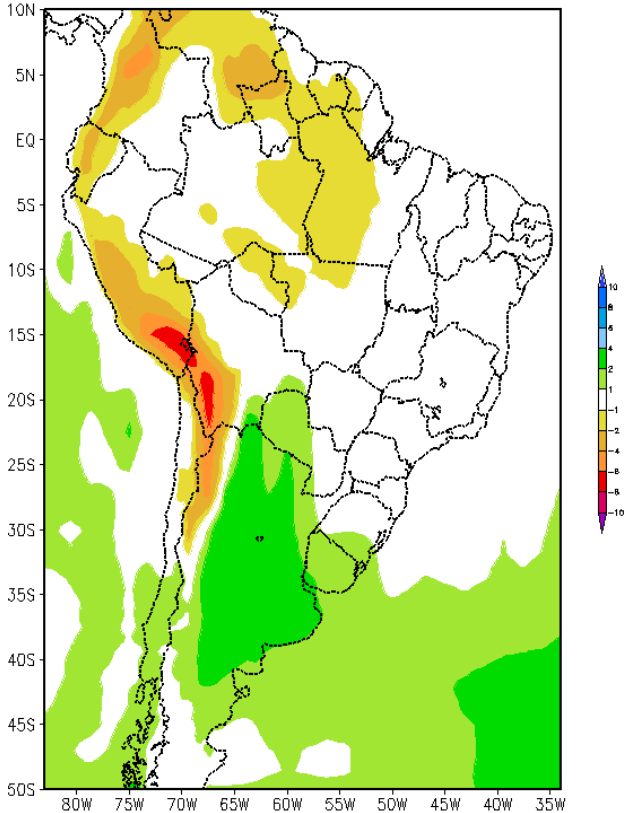
Eta Forecast

LBC: CPTEC GCM



Eta mean error

Mean Sea level Pressure



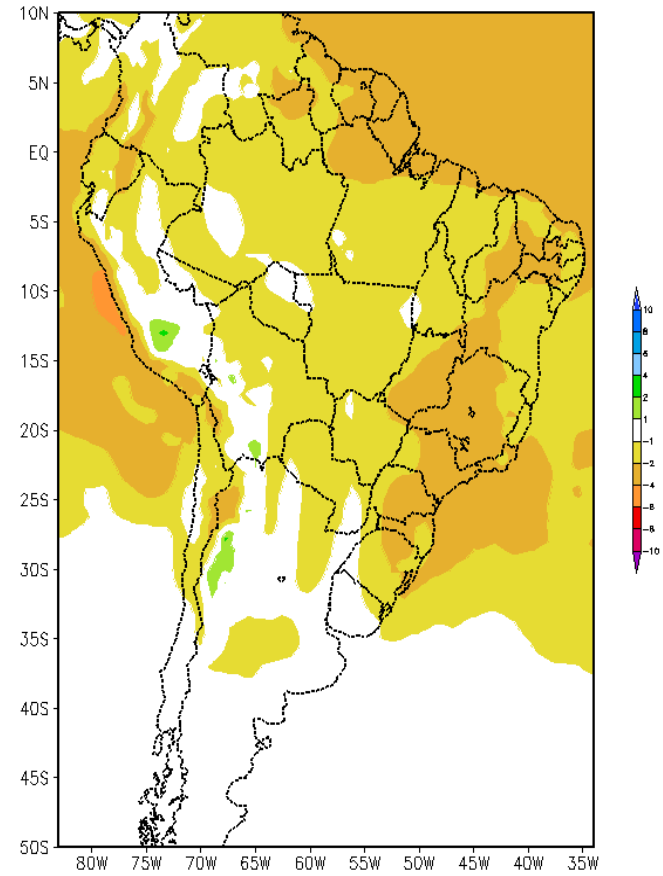
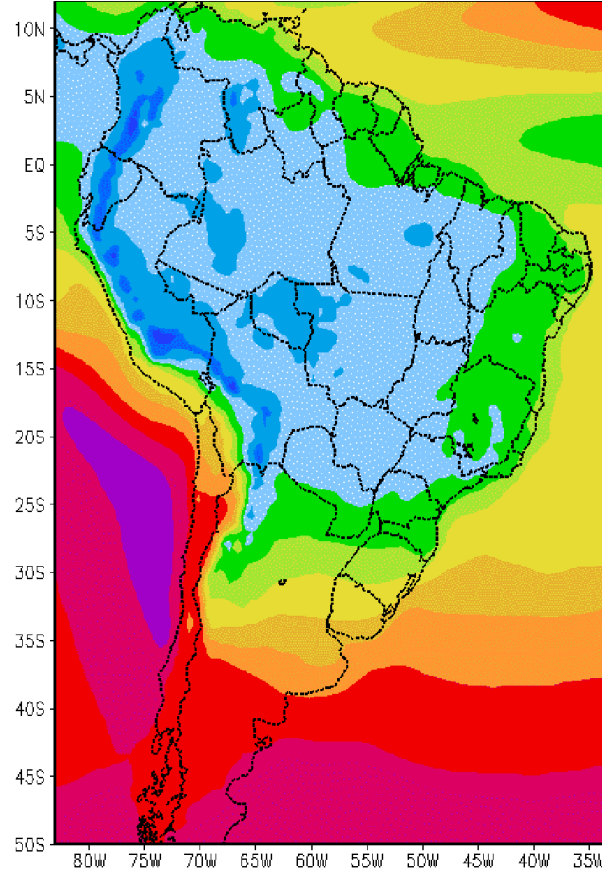
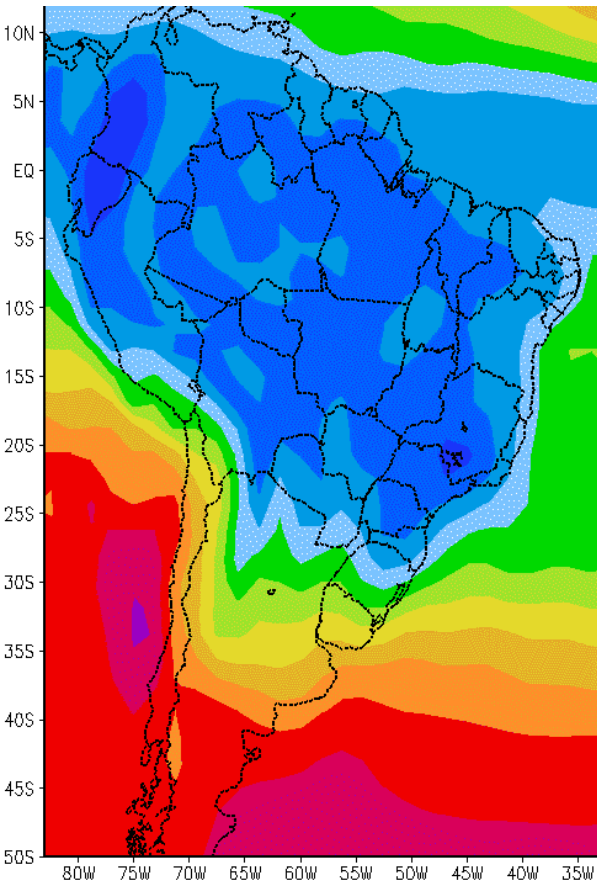
# 850-hPa Specific Humidity - DJF

**NCEP Analyses**

**Eta Forecast**

**LBC: CPTEC GCM**

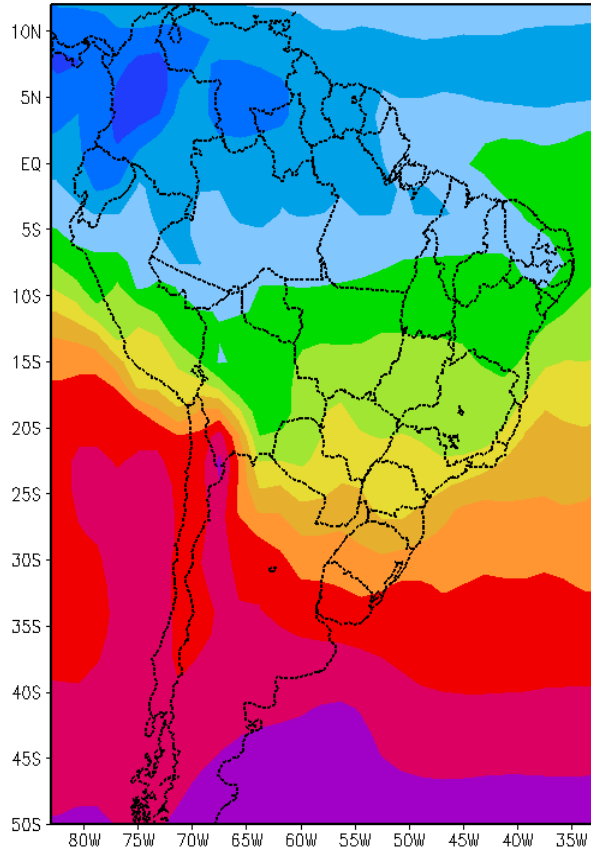
**Eta mean error**





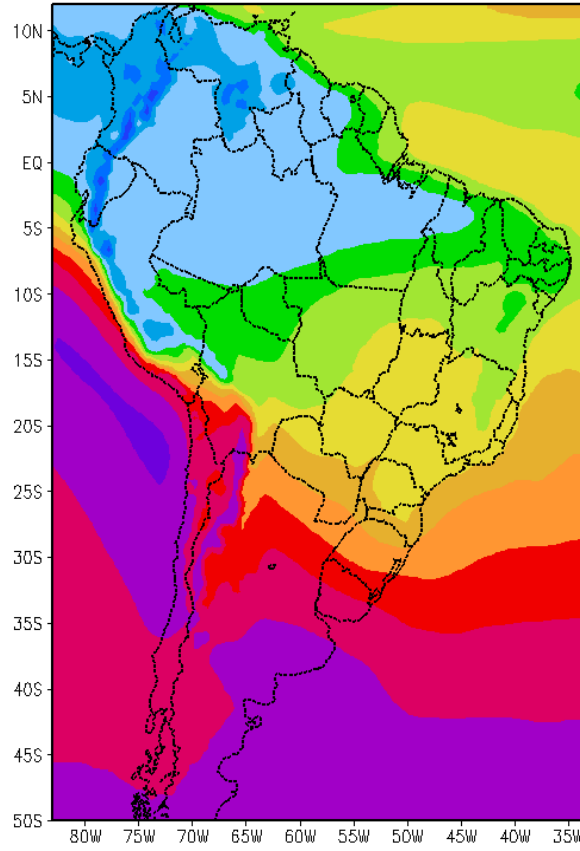
# 850-hPa Specific Humidity - JJA

## NCEP Analyses

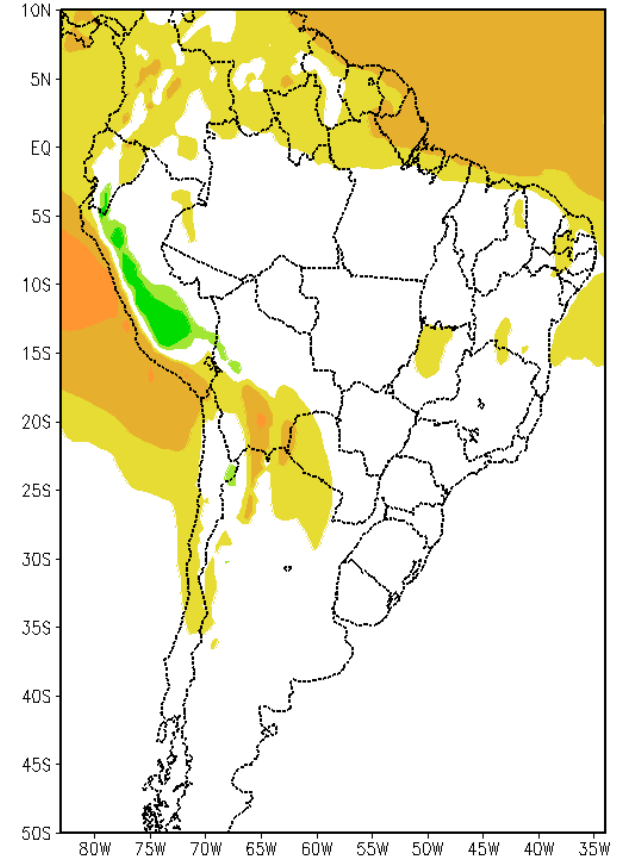


## Eta Forecast

LBC: CPTEC GCM

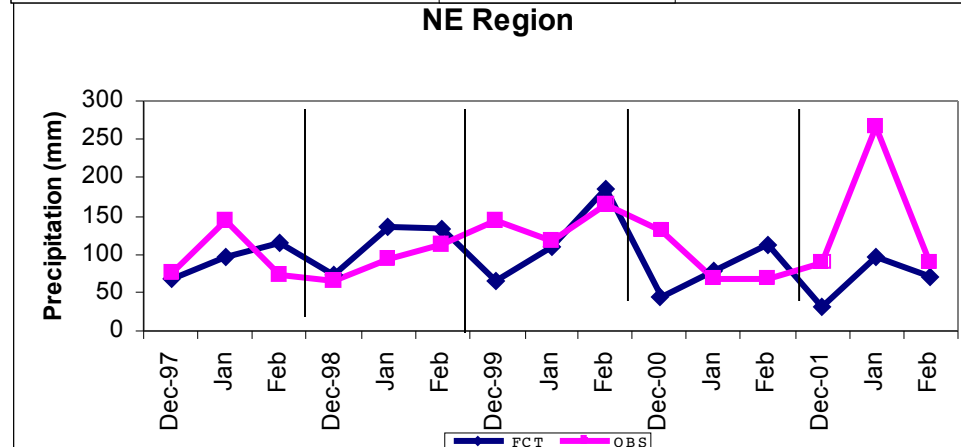
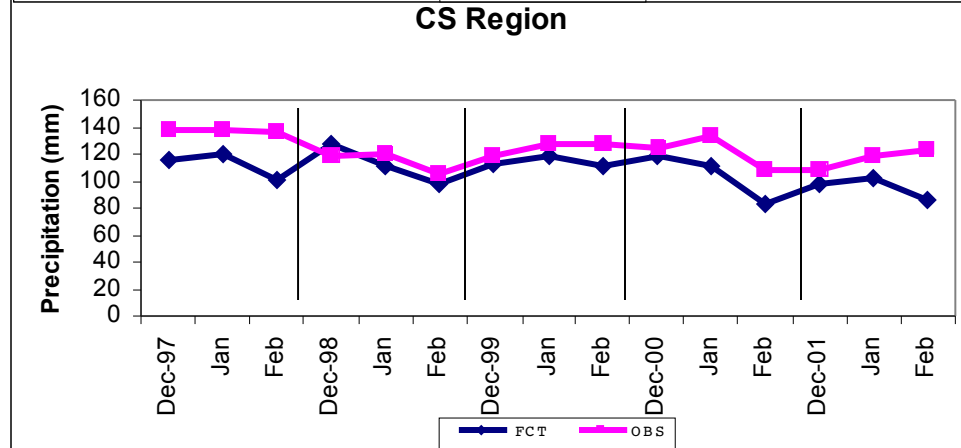
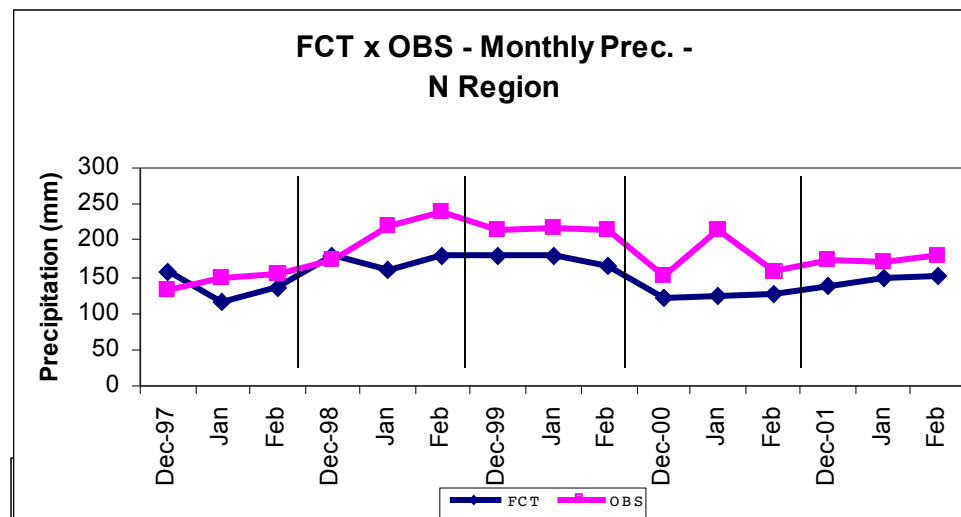
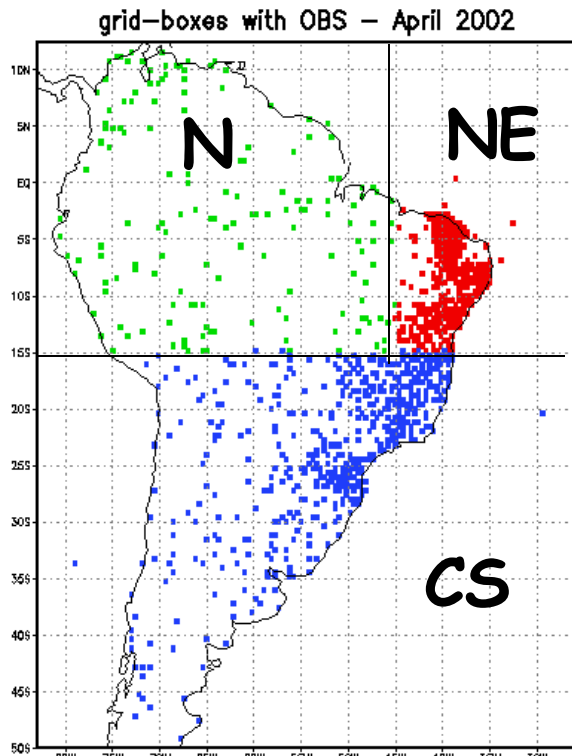


## Eta mean error

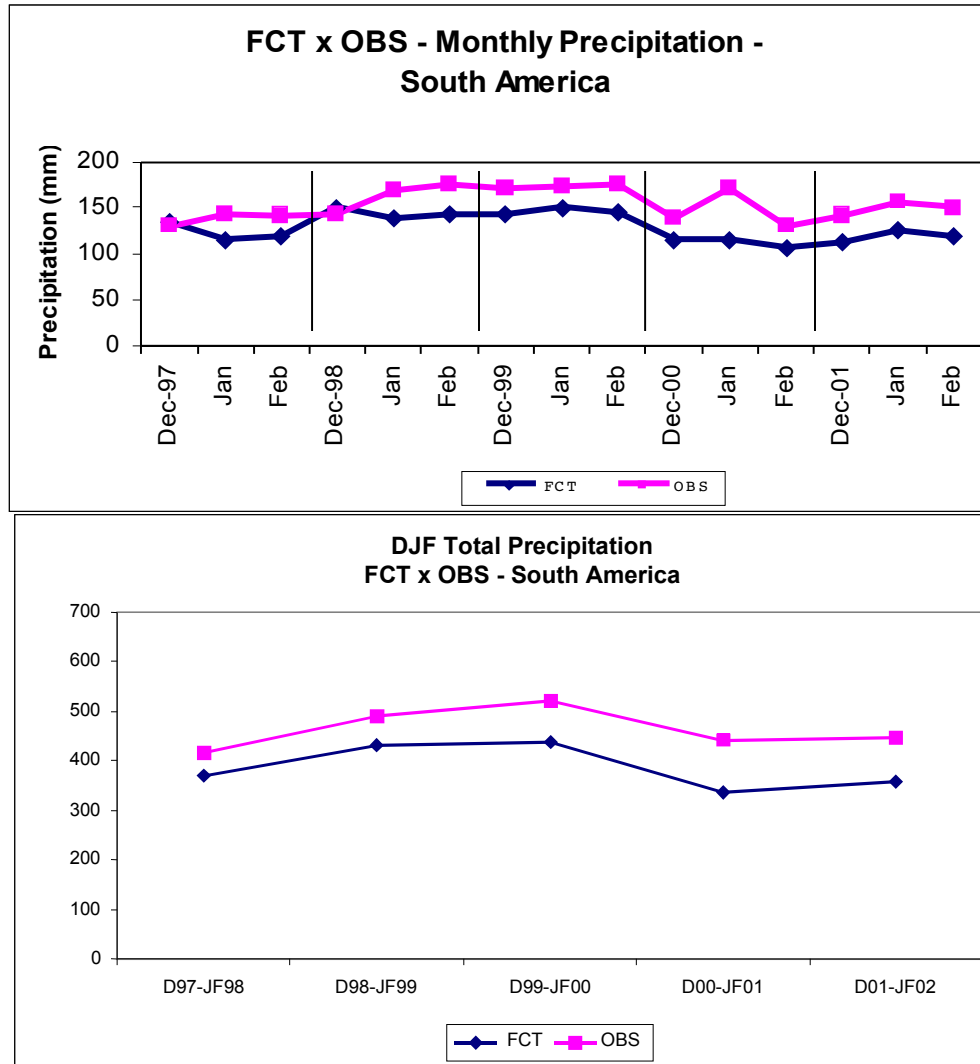


Inter-annual  
variability

Area mean  
precipitation



# Inter-annual variability

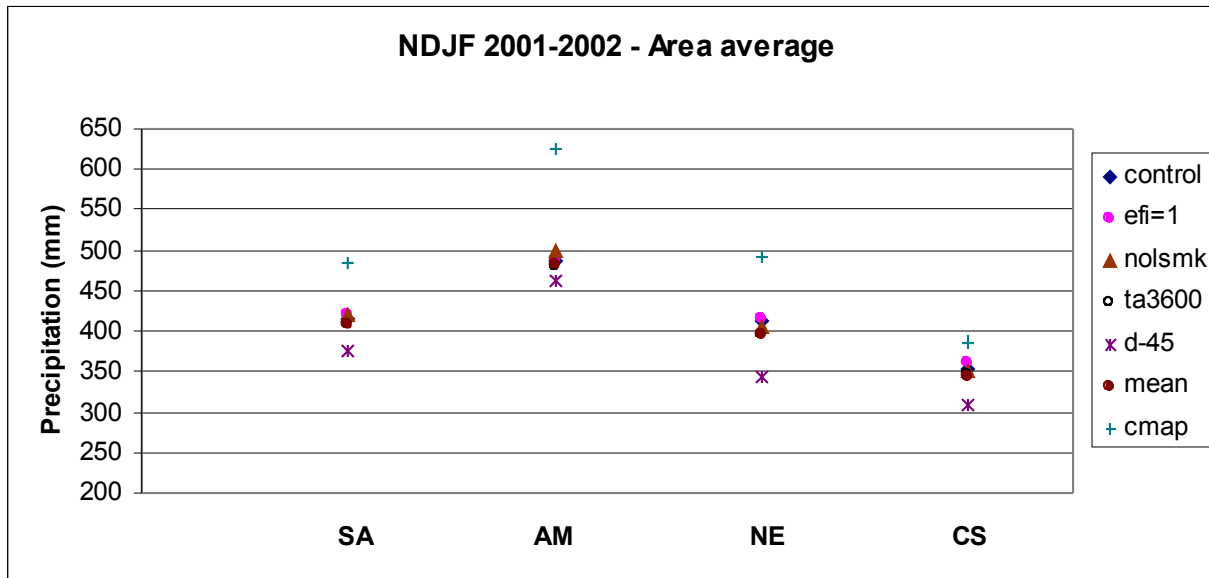
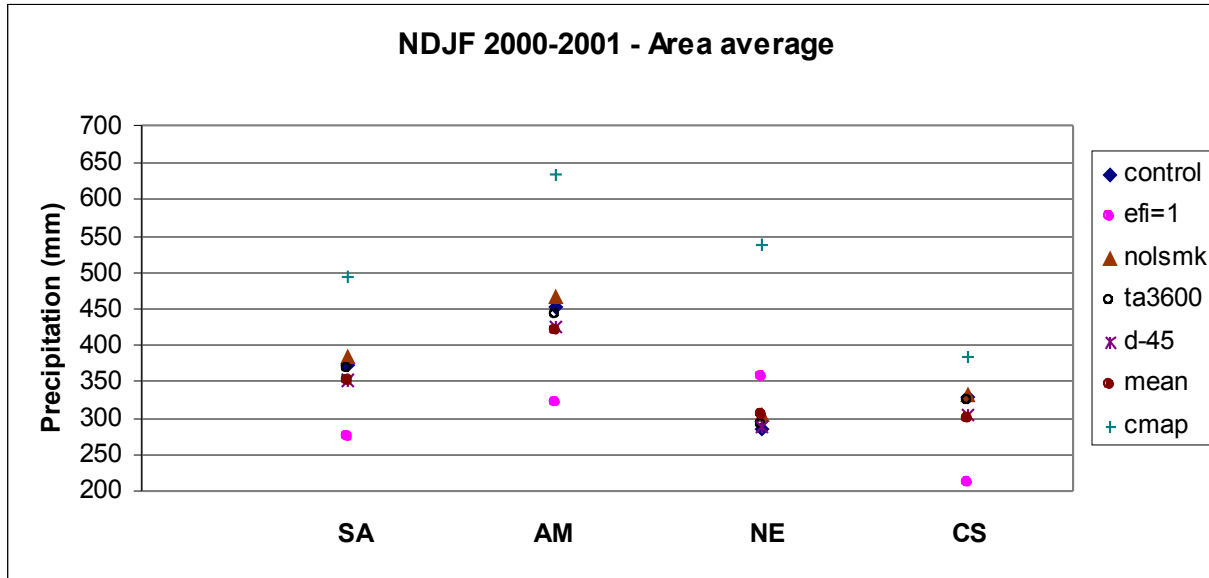


The interannual variability of the continental rains is reasonably captured by the model in the rainy season.

## Combination of **ensemble** generated by perturbation in the initial conditions and model physics

<b>Members</b>	<b>Description</b>
1 Control	Initial conditions: DAY – 15
2	Increase convective rain through cloud efficiency
3	Continental convective activity equal to sea convective activity
4	Extend convective cloud life cycle
5	Earlier initial condition: DAY – 45
6	Initial conditions: DAY – 17
7	Initial conditions: DAY – 13
8	Initial conditions: DAY – 13

Each physics perturbed member show comparable forecast skill one to the other.



## Meses chuvosos de 5 anos:

1998  
1999  
2000  
2001  
2002

Rodada	Período de Integração
OND	Out-Nov-Dez-Jan-Fev-Mar-Abr
NDJ	Nov-Dez-Jan-Fev-Mar-Abr
DJF	Dez-Jan-Fev-Mar-Abr
JFM	Jan-Fev-Mar-Abr
FMA	Fev-Mar-Abr

## Membros

## Construção do membro

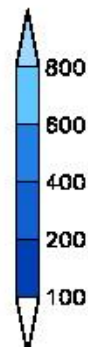
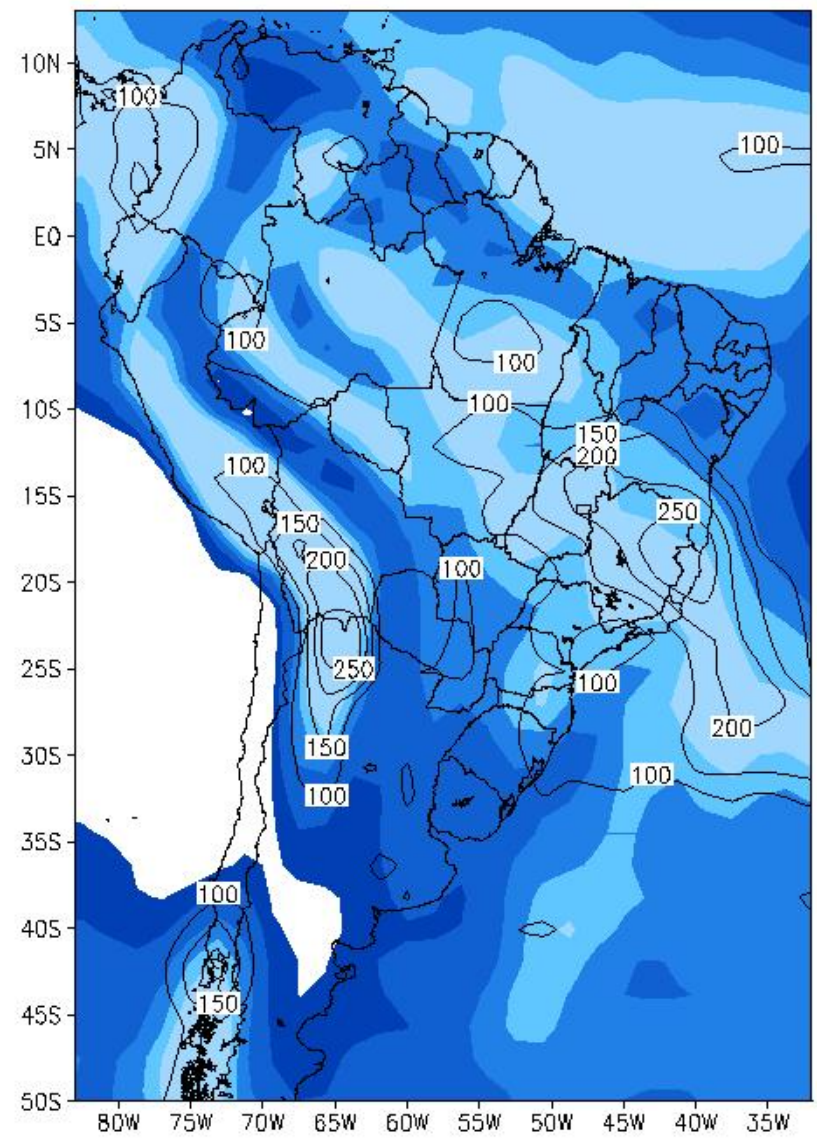
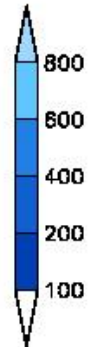
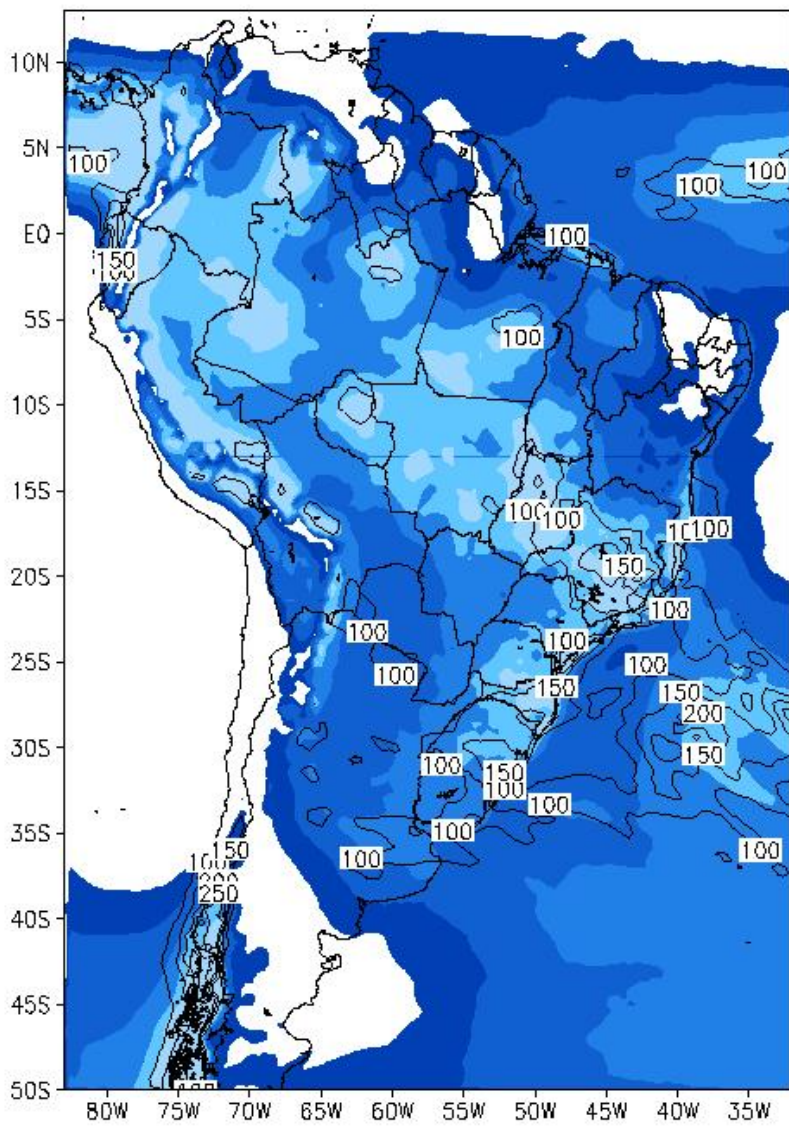
- 1 Controle
- 2 Condição Inicial: dia -15
- 3 Aumento da chuva convectiva por eficiência total da nuvem
- 4 Atividade convectiva continental igual à oceânica
- 5 Aumento do ciclo de vida da nuvem convectiva
- 6 Condição Inicial: dia -45
- 7 Condição Inicial: dia -17 ou -13

> Combinação de previsão por ensemble de condição inicial e de física

- ENSEMBLE Mean NDJF 2002-2003 total precipitation - shaded
- Spread of precipitation (4 months, mm) - lines
- 5 members

Eta

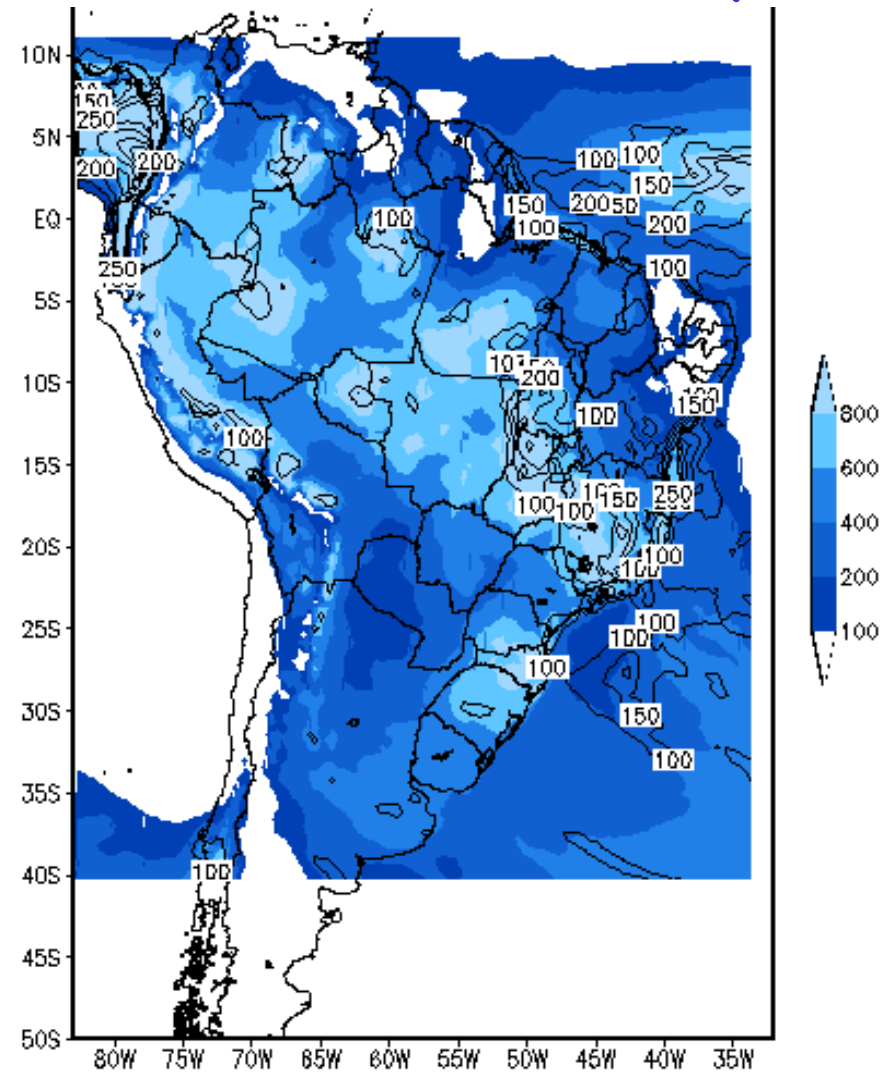
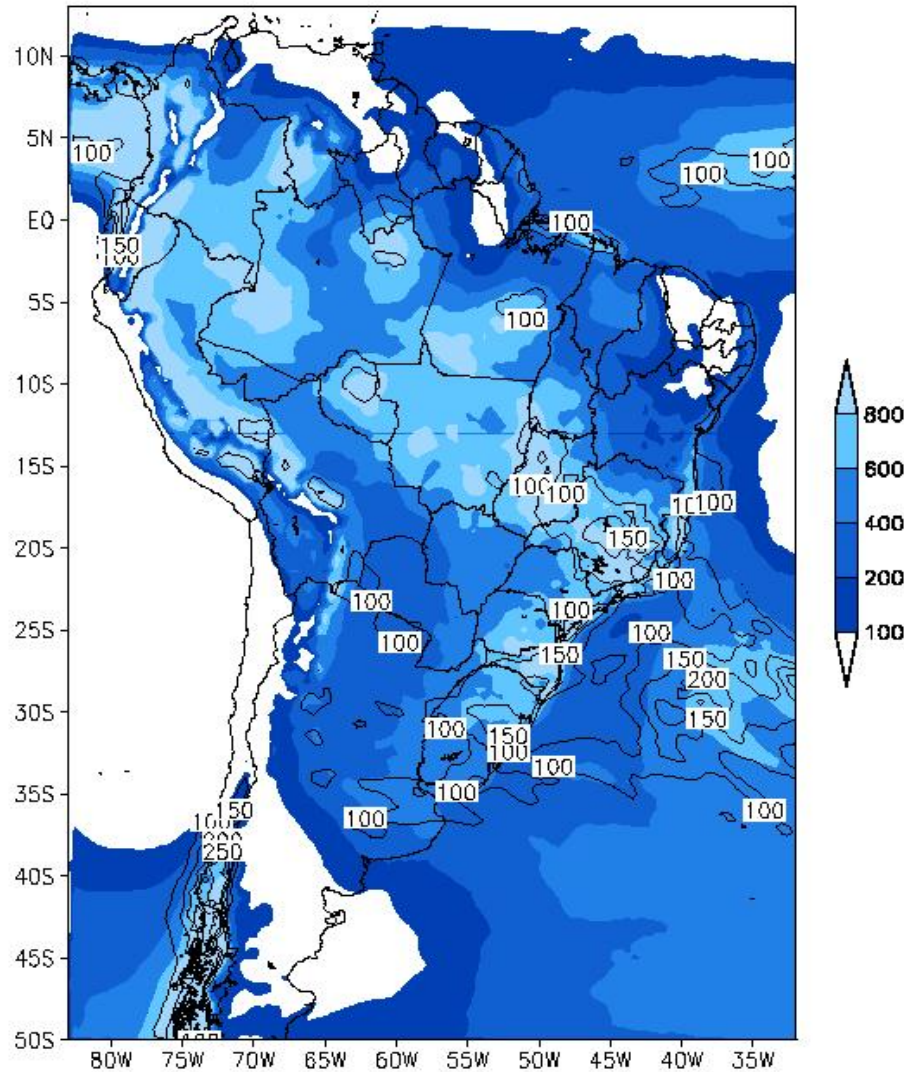
GCM



# 2002-2003 NDJF precip total & Spread

Initial Conditions

Physics



•Some spread due to frontal passage

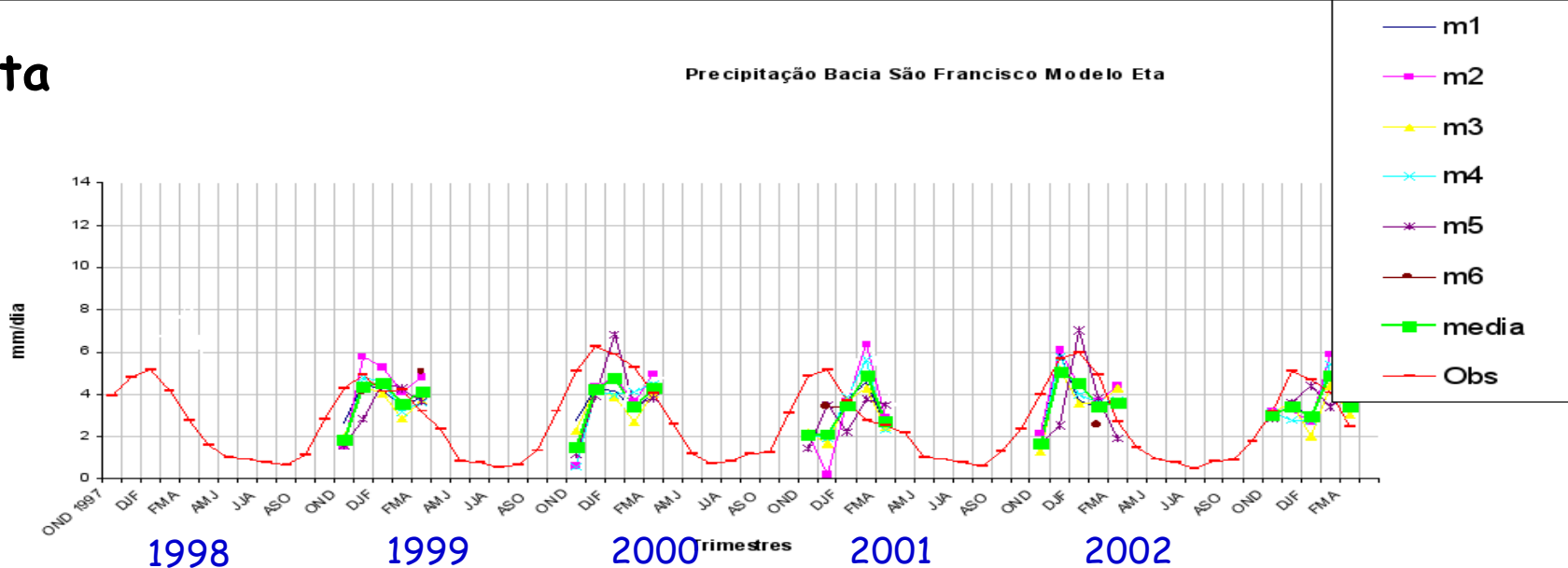
•More spread in lower latitudes



# 3-month total precipitation forecast over São Francisco Basin, Brazil

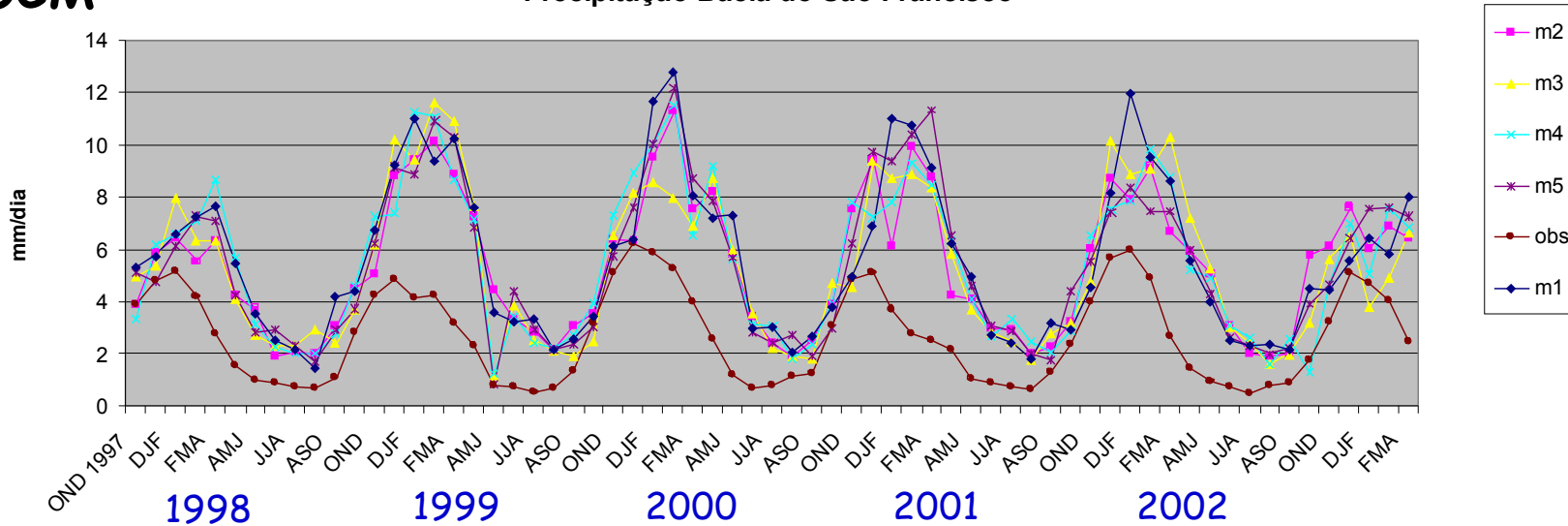
Eta

Precipitação Bacia São Francisco Modelo Eta



GCM

Precipitação Bacia do São Francisco



# Preliminary Conclusions

A *poor's man* 5-year model climatology of seasonal Eta Model forecasts over South America was produced and evaluated against NCEP analyses.

- The model in general captured the precipitation patterns in the rainy and dry seasons. Some larger errors occurred on three areas: south Chile, north Amazonia and eastern Brazil,
- The interannual variability of the continental rains seems to be reasonably captured by the model.

## Next steps

- Further investigation is necessary to identify the source of model errors.
- Evaluate anomaly extracted from this climatology.
- Include ensemble to the seasonal climatology,
- Test increase of domain,
- Test role of adjacent oceans.
- ...