Ministério da Ciência e Tecnologia - MCT
Instituto Nacional de Pesquisas Espaciais - INPE
Centro de Previsão de Tempo e Estudos Climáticos - CPTEC

PREVISÕES SAZONAIS

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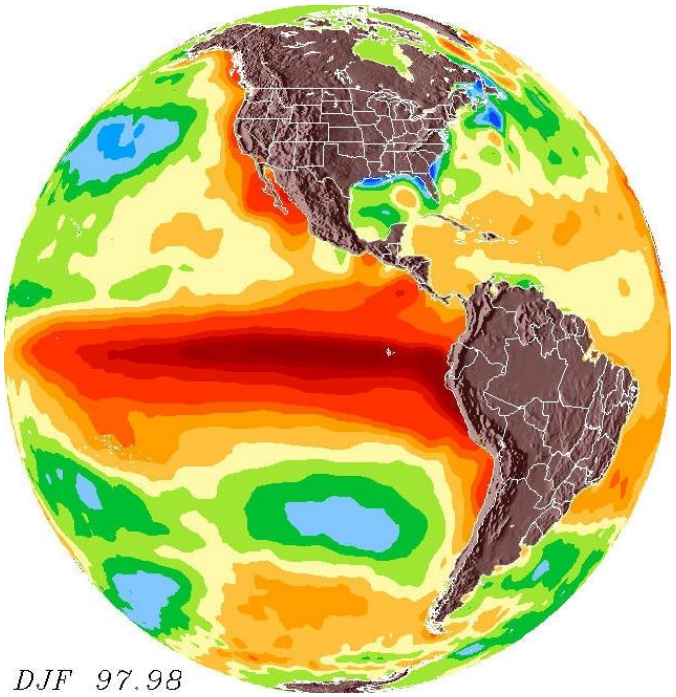
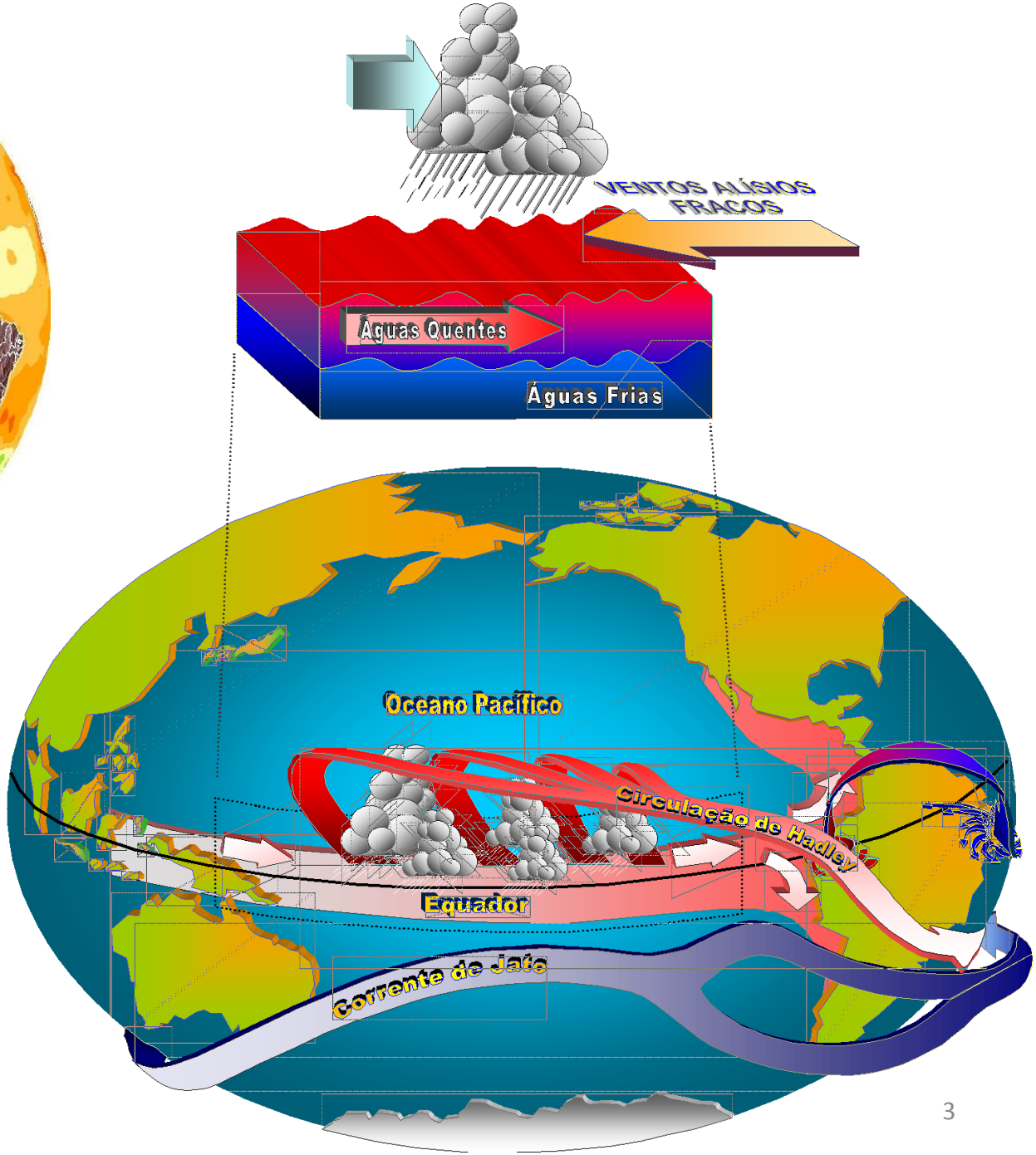
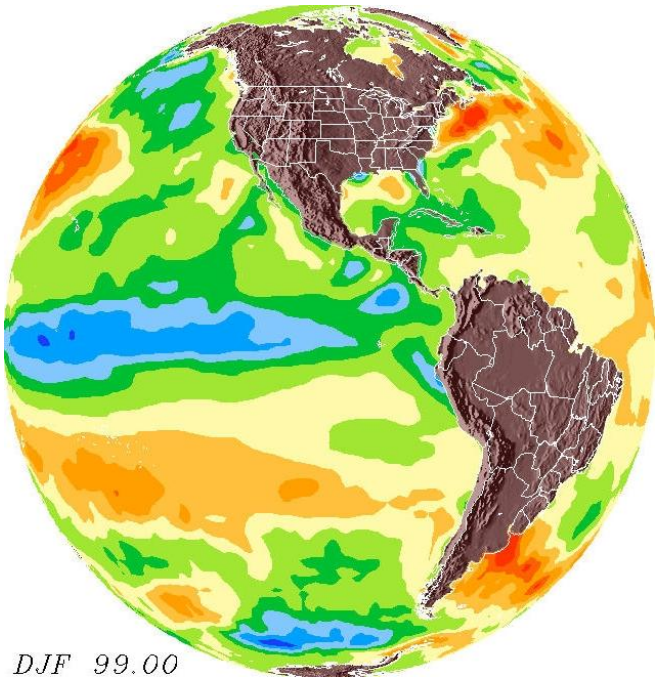
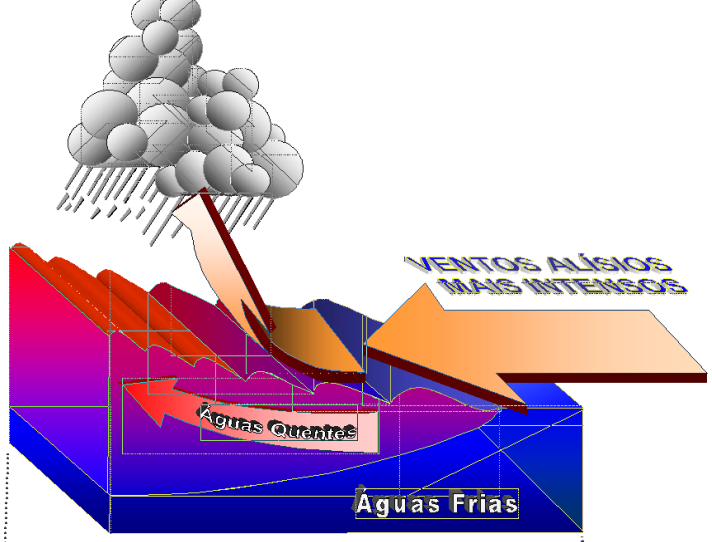
Fenômenos	ESCALA ESPACIAL	ESCALA TEMPORAL
1. El Niño/La Niña	Aprox 15000 km	3 – 6 anos
2. Osc. Madden Julian – MJO	Aprox 10000 km	30 – 60 dias
3. Zona Convg Atl Sul – ZCAS	Aprox 6000 km	5 – 10 dias
4.Ciclone extratropical	1000 – 6000 km	1 – 7 dias
5.Ciclone tropical (furacão)	500 – 1000 km	1 – 2 dias
6.Frentes Frias/Quentes	50 – 500 km	3 – 24 h
7.Complexos Convectivos -MCC	50 – 500 km	12 h – 30 h
8.Linhas de instabilidade	50 – 500 km	12 h – 30h
9.Fenômenos orográficos	10 – 200 km	< 24 h
10. Convecção profunda	1 – 50 km	< 3 h
11. Efeitos urbanos	1 – 20 km	< 3 h
12. Tornado	500 m – 1 km	< 30 min
13. Plumas de fumaça	< 500 m	< 30 min
14. Turbulência	< 50 m	< 3 min

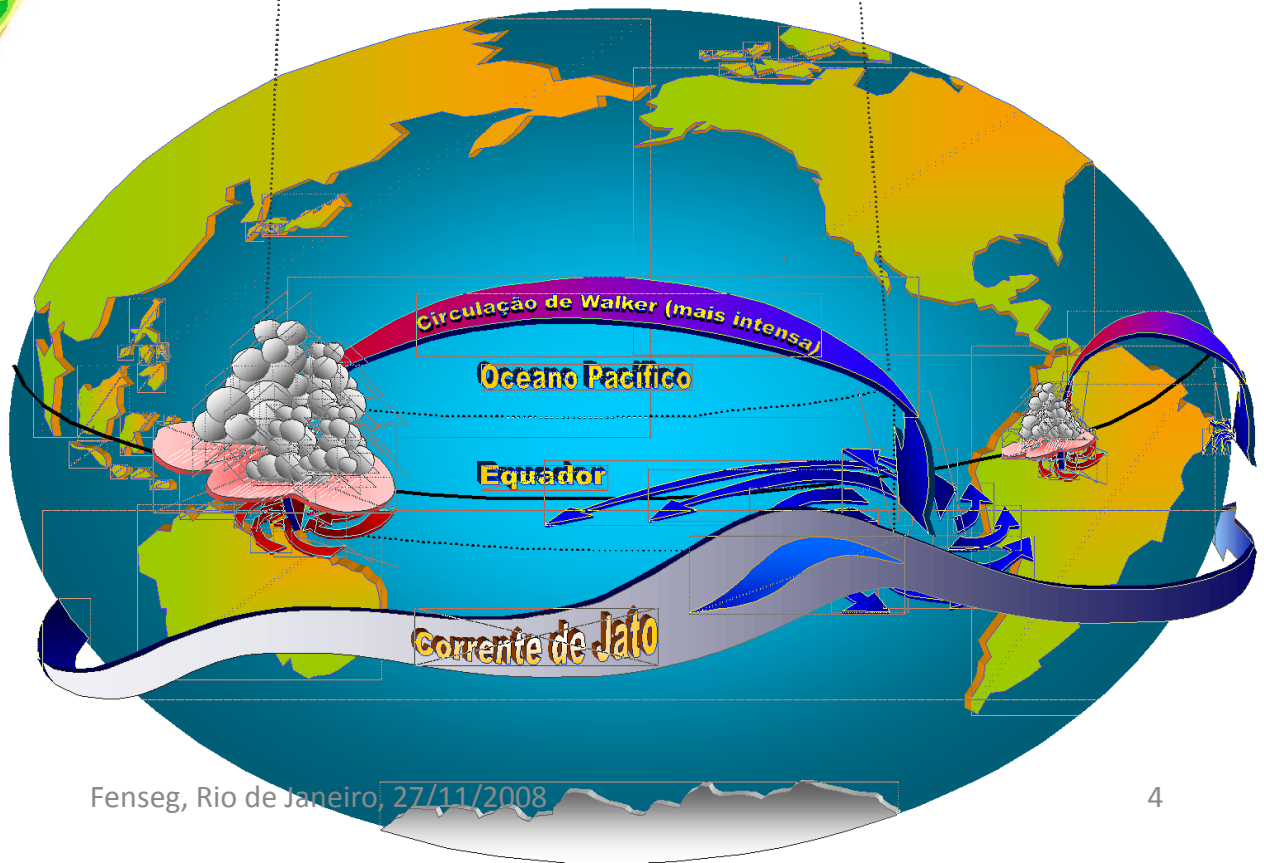

DJF 97.98

El Niño


VENTOS ALÍSIOS FRACOS
Águas Quentes
Águas Frias
Oceano Pacífico
Circulação de Hadley
Equador
Corrente de Jato


DJF 99.00

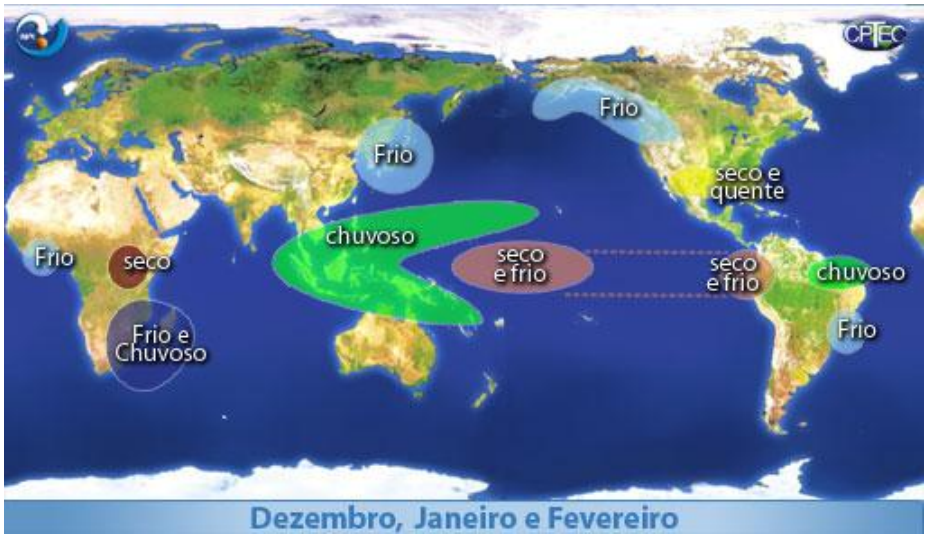

VENTOS ALÍSIOS
MAIS INTENSOS
Águas Quentes
Águas Frias

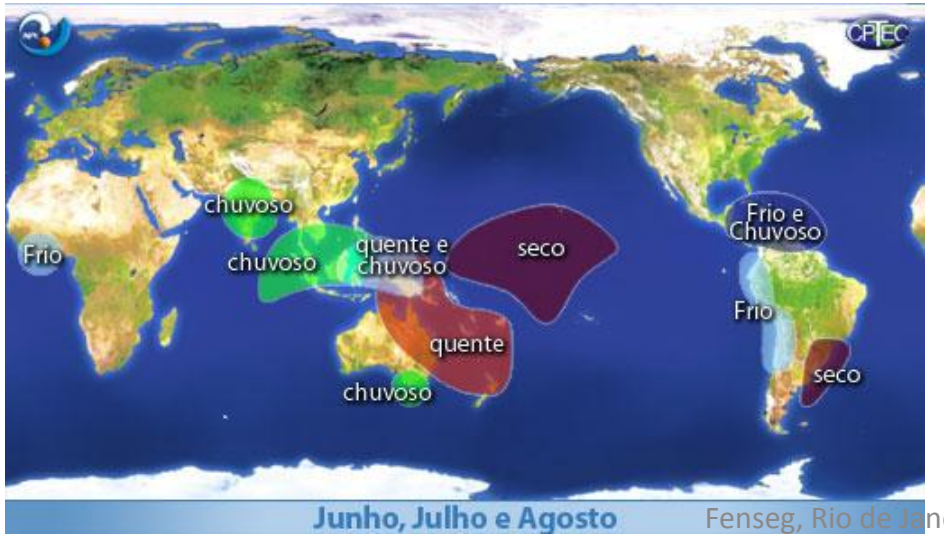

Circulação de Walker (mais intensa)
Oceano Pacífico
Equador
Corrente de Jato

La Niña

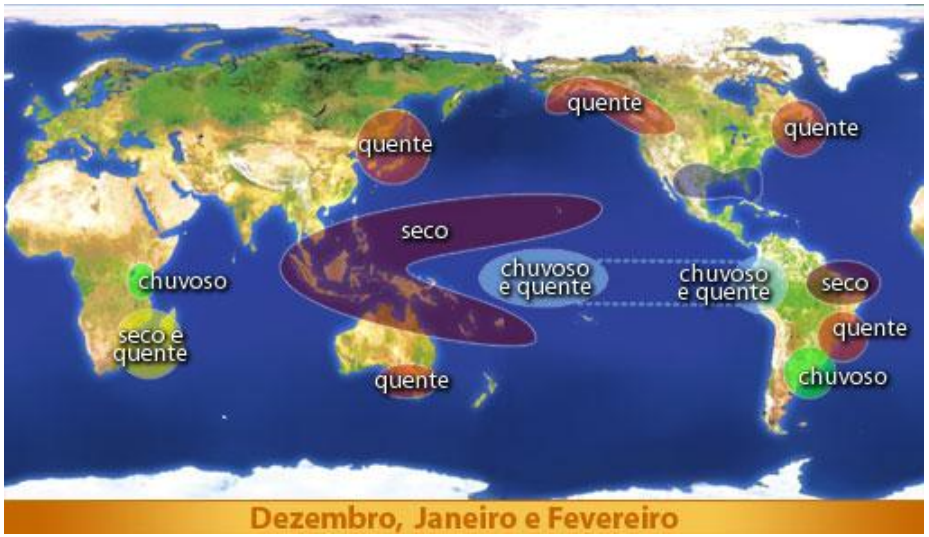
IMPACTOS

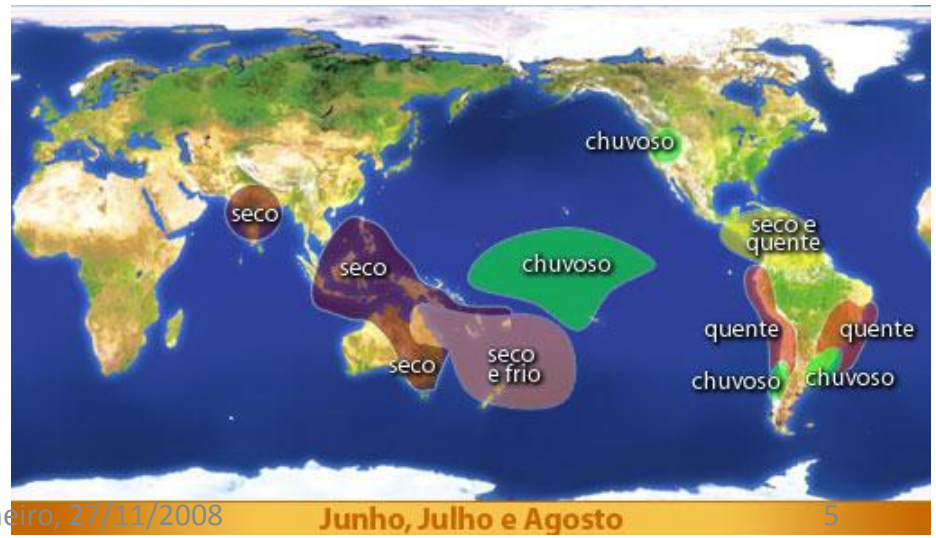
La Niña



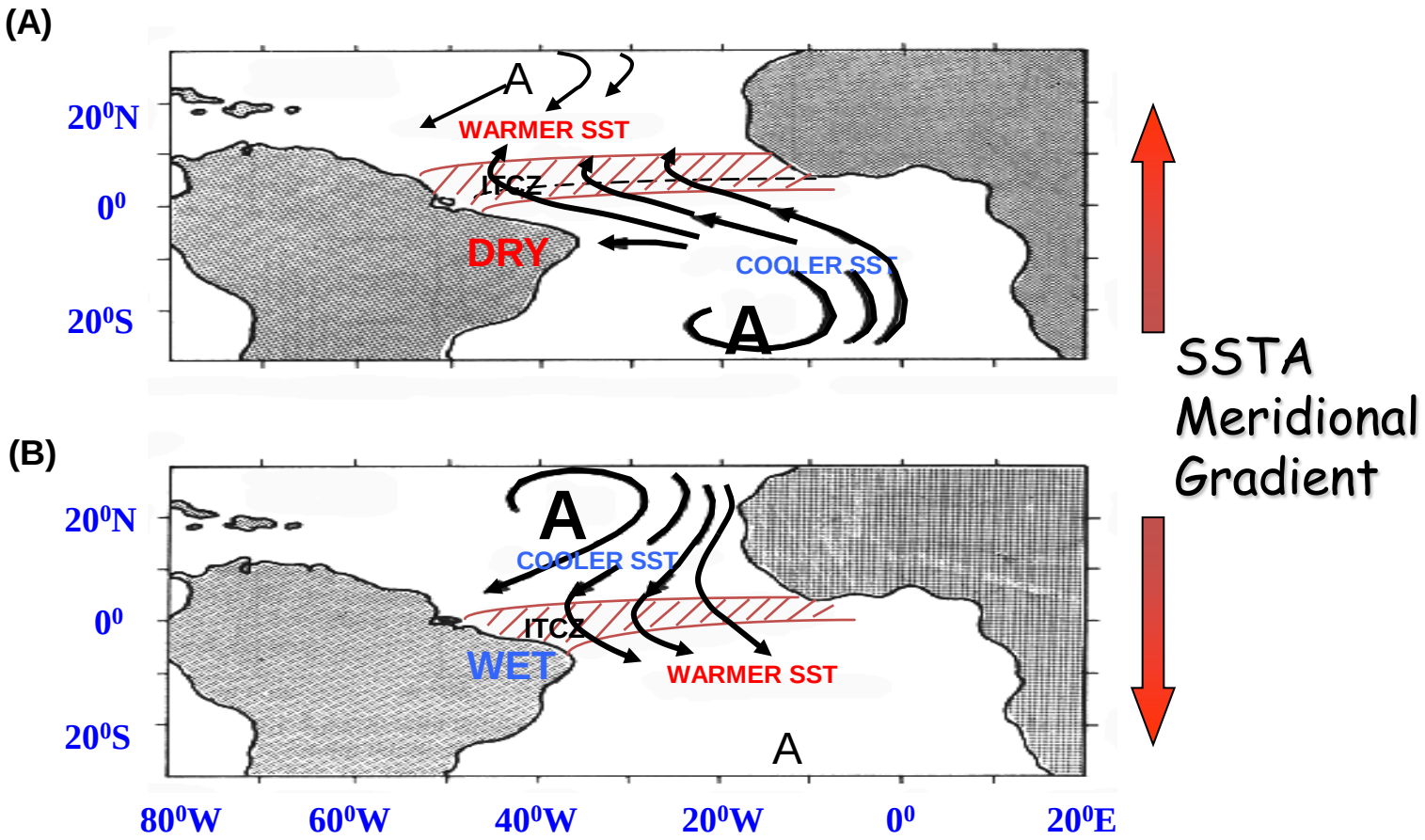


El Niño





The ITCZ Influence

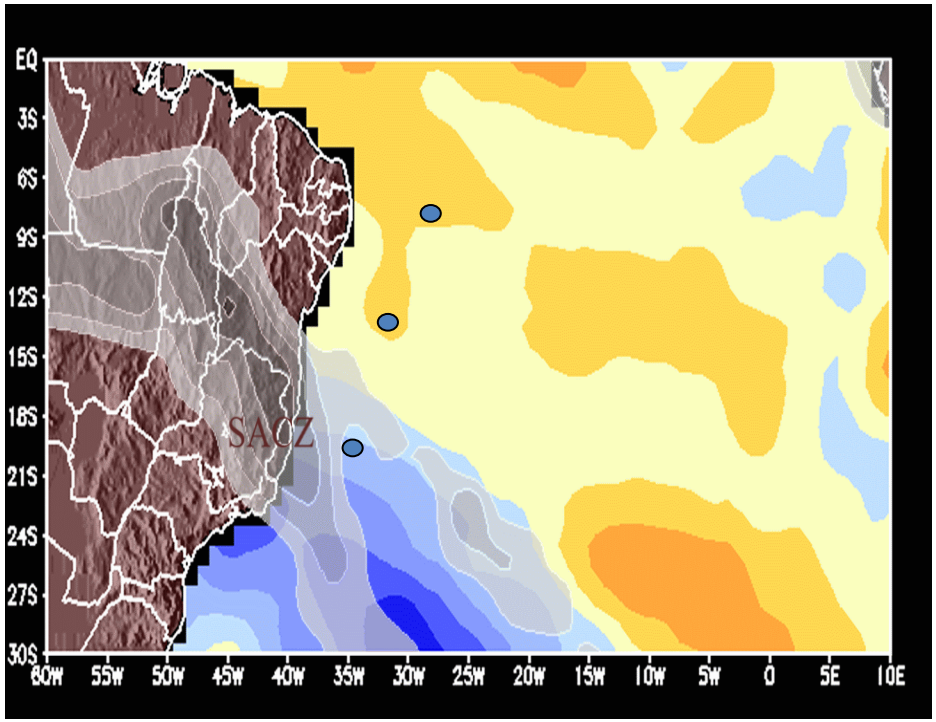


Adapted from: C. A. Nobre and L. C. B. Molion (1988)

SACZ

- South Atlantic Convergence Zone (SACZ) formation over cold waters => Atmospheric forcing over underlying SST?

- Robertson and Mechoso (2002)
- Chaves and Nobre (2004)



OBS: 17-25 NOVEMBER 1999

SST control over tropical climate

Predictability of the second kind

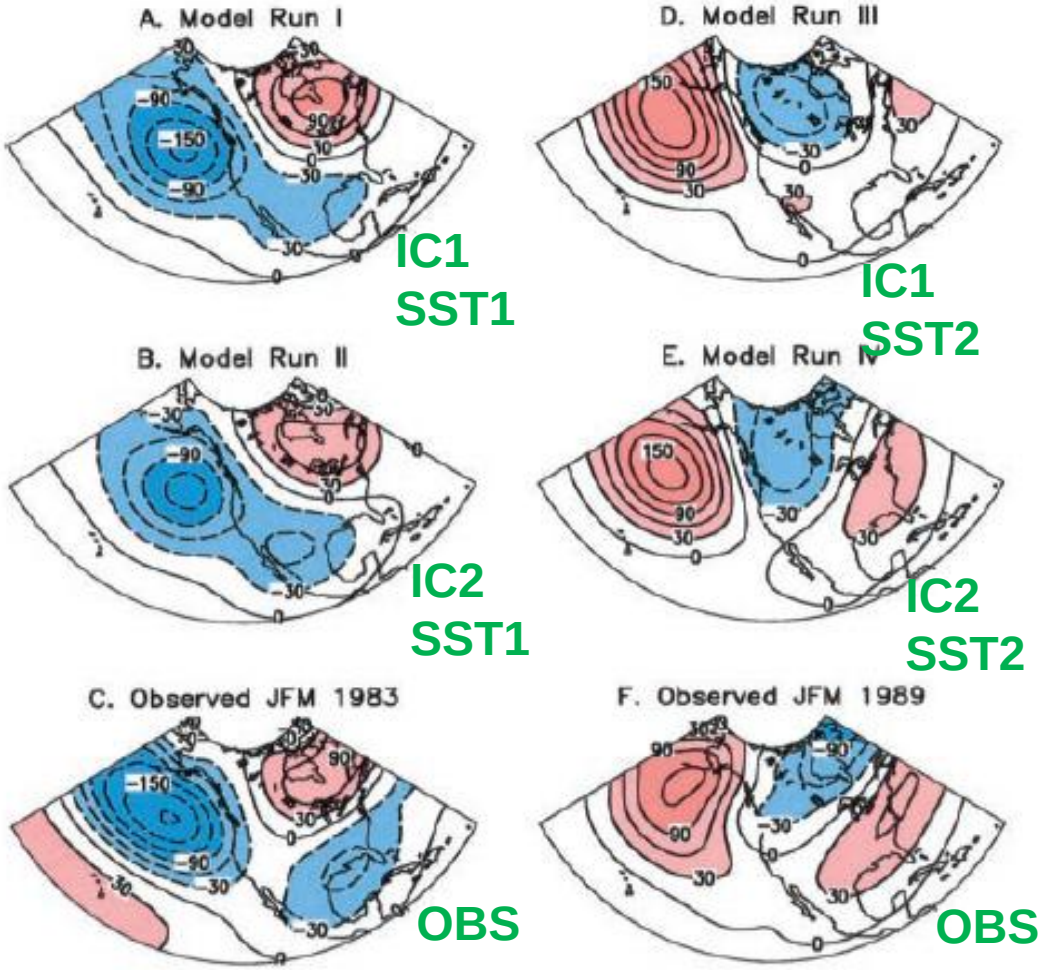


Fig A & D; B & E use:

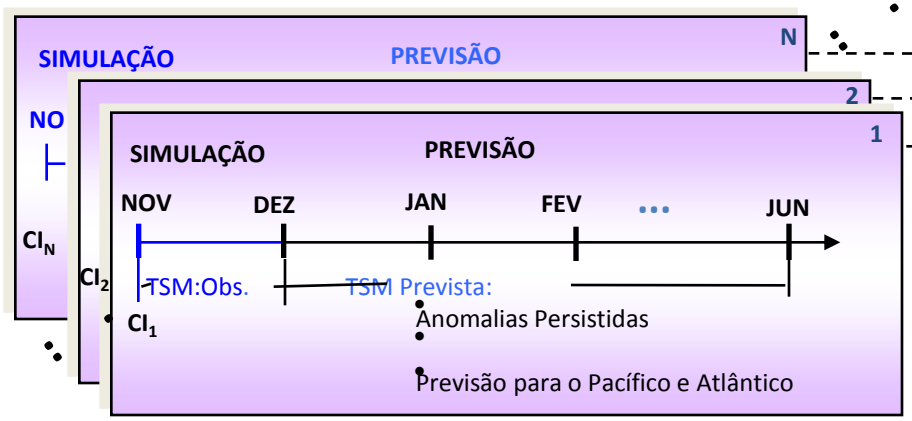
same ICs and different SSTs ->

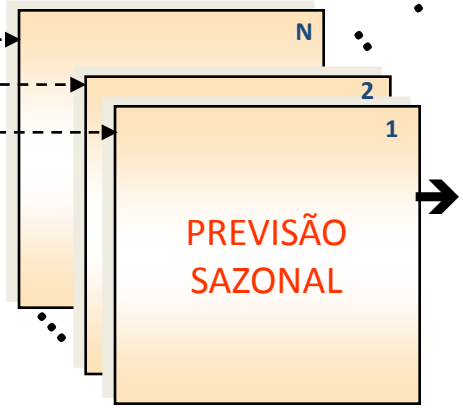
Different atmospheric patterns

Predictability in the Midst of Chaos: A Scientific Basis for Climate Forecasting (Shukla et al, 1998)

"Therefore, it should be possible to predict the large-scale tropical circulation and rainfall for as long as the ocean temperature can be predicted."

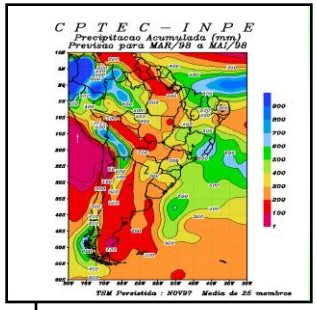
CPTEC/INPE Seasonal Forecast Suite



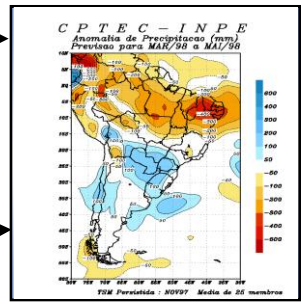


CONJUNTO

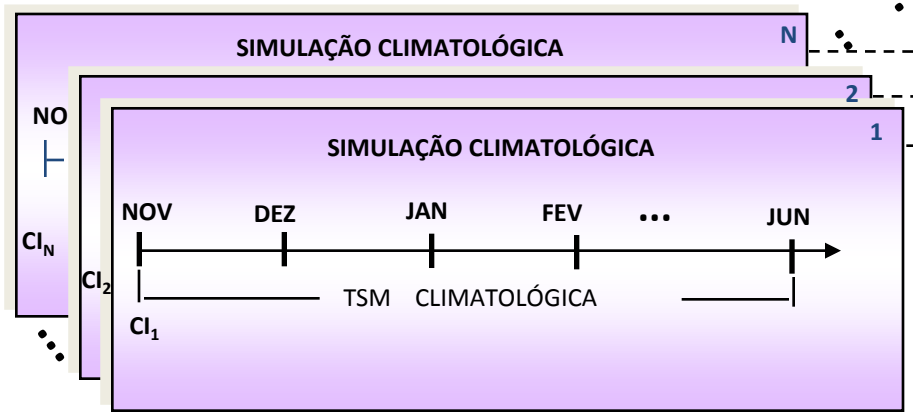
PREVISÃO MÉDIA DO CONJUNTO

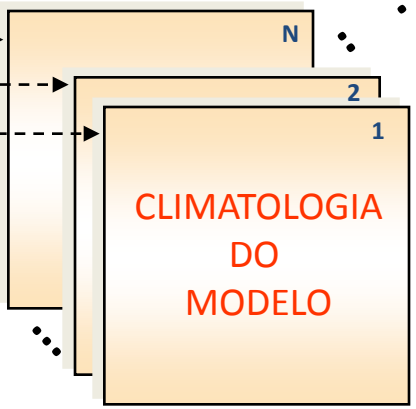


PREVISÃO DA ANOMALIA

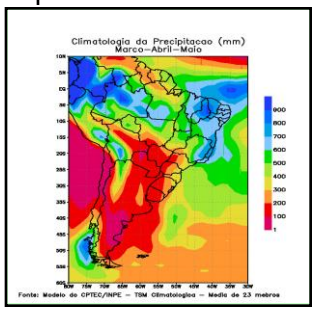


SUBTRAÇÃO





CONJUNTO



CLIMATOLOGIA DO MODELO
MÉDIA DO CONJUNTO

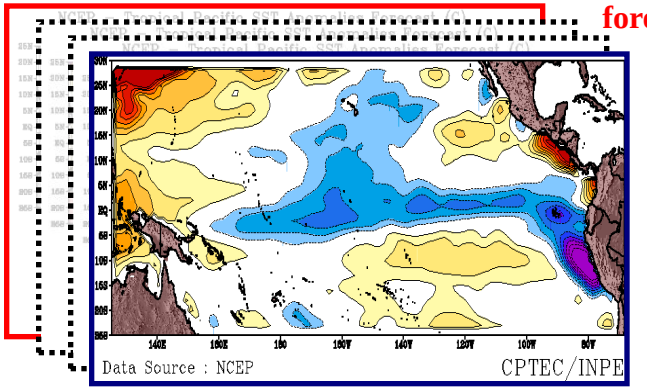
bcs for CPTEC´s AGCM

Tropical Pacific SSTa

NCEP coupled model forecast

Last month forecast

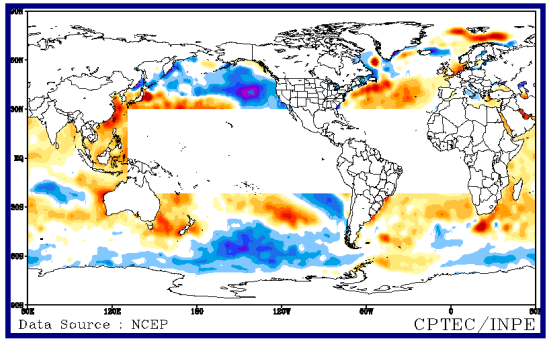
plus



first month of forecast

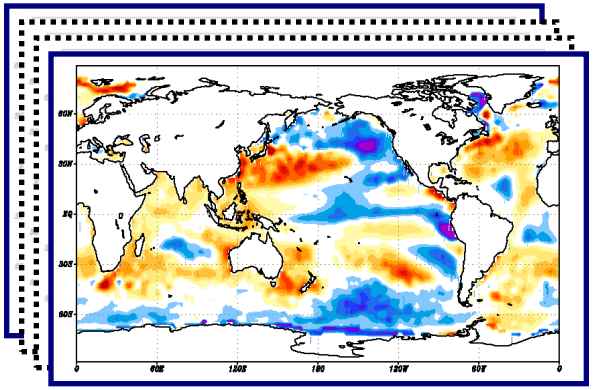
global sst anomalies

NCEP



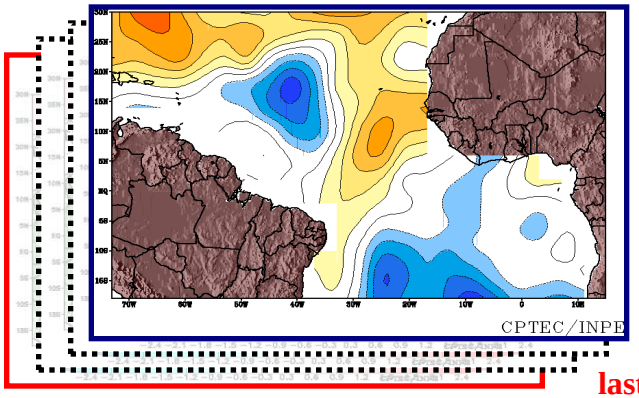
all over the oceans: Persisted SSTa

SST anomalies



Atlantic SST anomalies

SSTa forecast over Atlantic - SIMOC/CPTEC

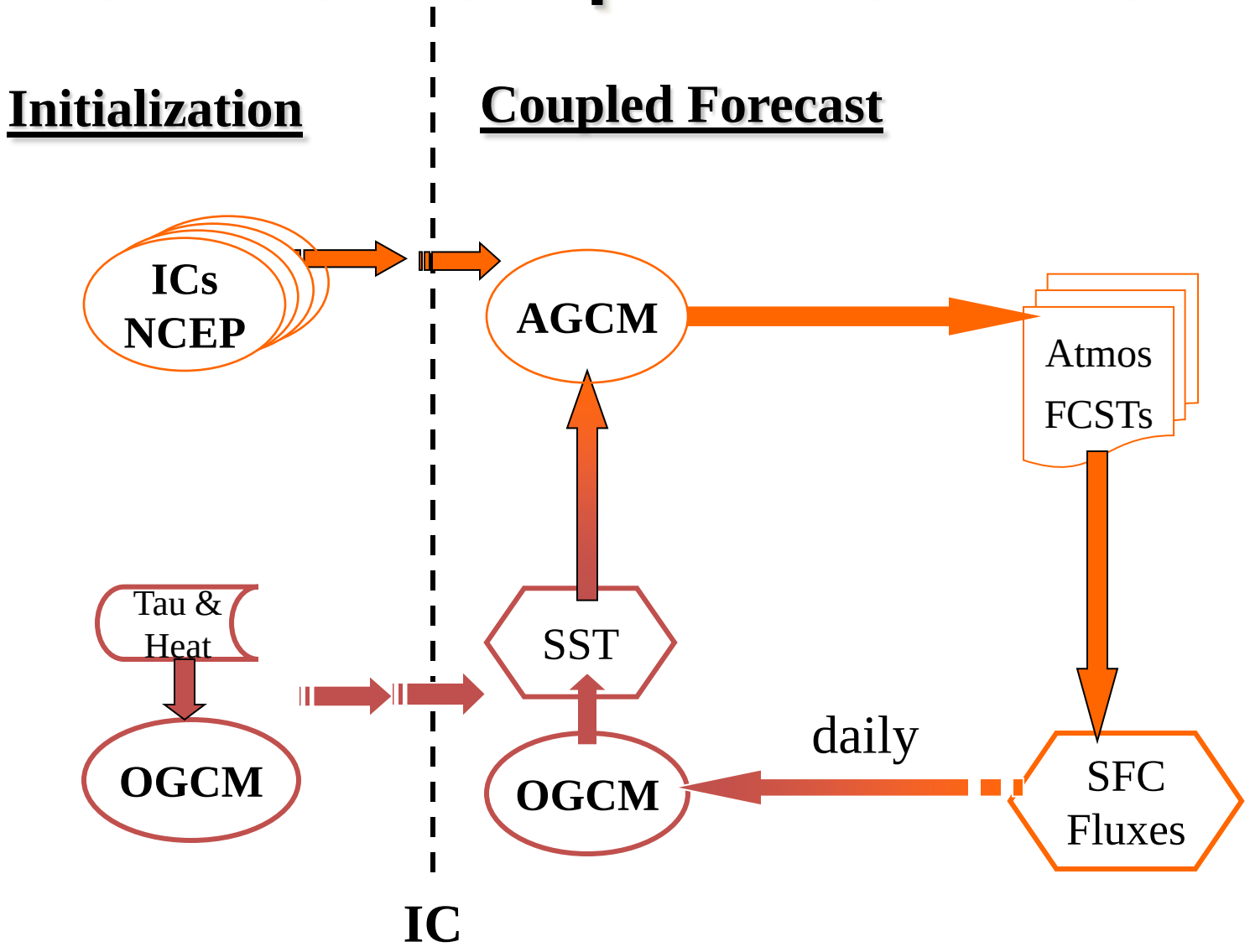


plus

first month of forecast

last month of forecast

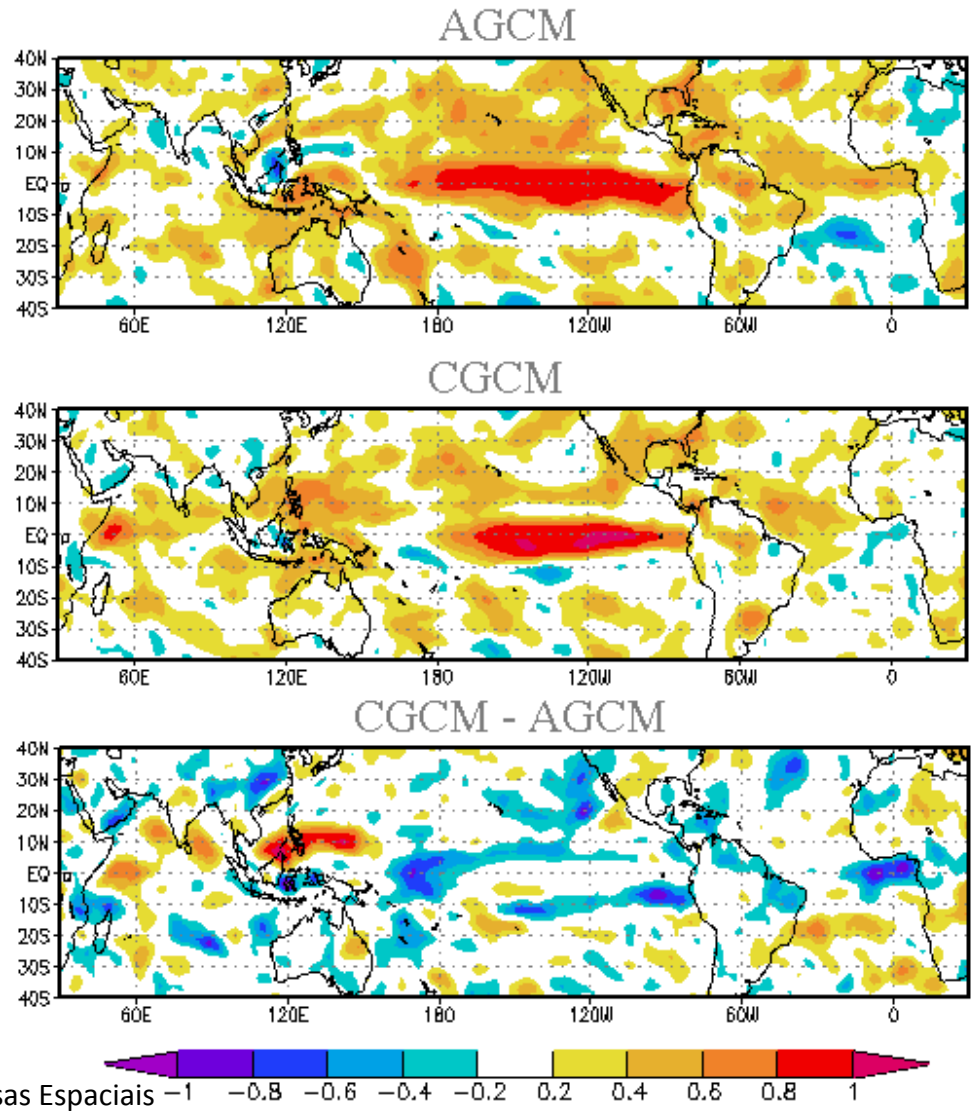
CPTEC's Coupled GCM V.1.0



Scientific Motivation:

Coupled Ocean-Atmosphere processes at play?

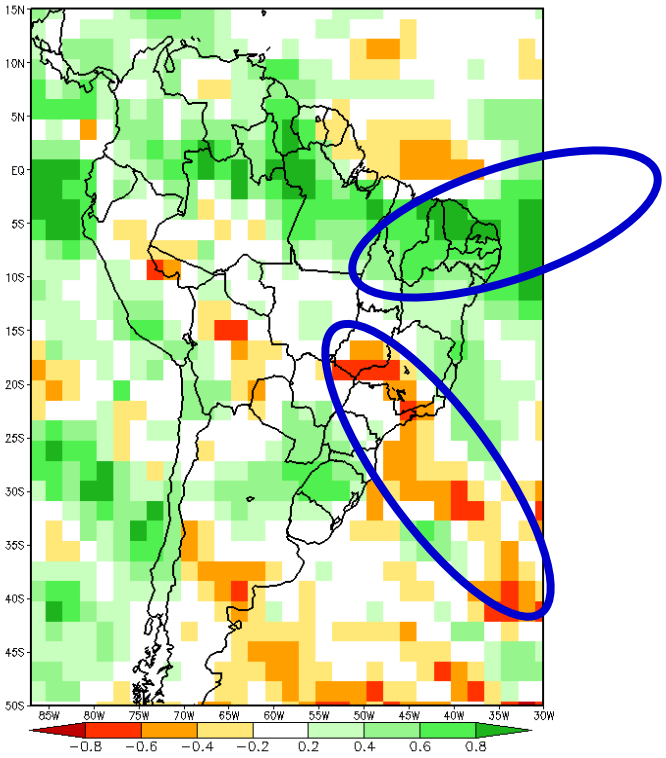
DJF Precipitation Forecasts anomaly correlations



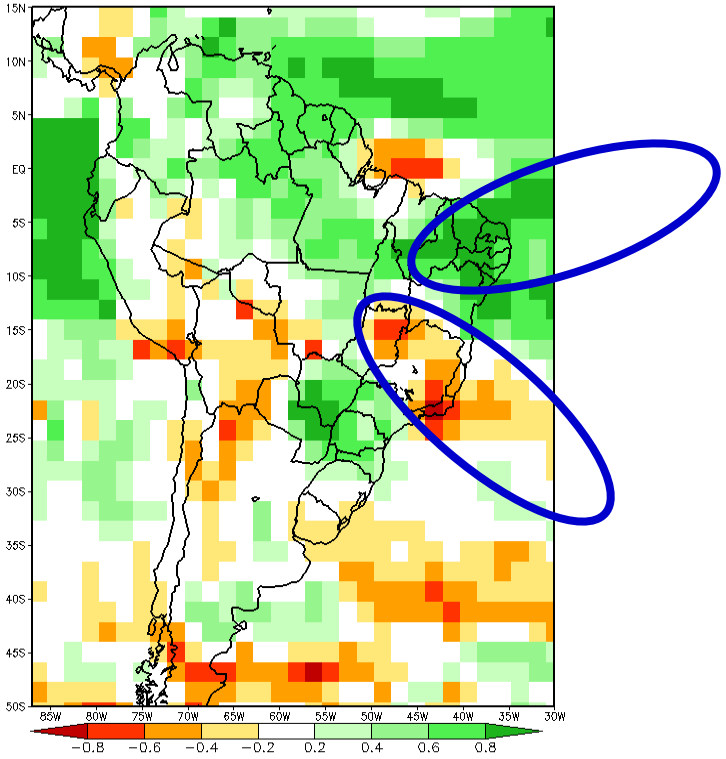
Nobre et al. (2009)

Scientific Challenge: SACZ low predictability

DJF



MAM



CPTEC AGCM, 50 years, 10 Member Ensemble, Kuo, T062L28, Obs SST

Marengo et al. (2002)

CPTEC GCM

Origin:

- NMC, 1988 (NCEP)
- COLA (Center for Ocean-Land-Atmosphere Studies)
- Rhomboidal Version 1.7 Fortran 77 from COLA

Current Version:

- Triangular 2.0 CPTEC/COLA (COLA Version 1.12 + CPTEC)
- Fortran 90 Syntax, Optimizations for NEC-SX machines, OpenMP
- Sigma at Vertical and Spherical at Horizontal Coordinates
- Full Quadratic Gaussian Grid

Dynamics: Spectral

Initial Boundary Conditions:

- Climatological Zonal Mean Ozone
- Fixed Atmospheric CO_2 Amount
- Initial Climatological Fields: Soil Moisture, Snow
- Weekly Mean Sea Surface Temperature

CPTEC GCM Physics

Land Surface : SSiB (Xue, 1990, SiB - Sellers et al, 1986)

Planetary Boundary Layer:

- Vertical Turbulent Diffusion 2.0 (Mellor and Yamada, 1982)
- Gravity Wave Drag (NCEP, 1988)

Radiation (GFDL):

- Short Wave Every Hour (Lacis and Hanson, 1974)
- Long Wave Every Three Hours (Harshvardhan et al, 1974)
- Cloud Radiation Interactions (Slingo, 1987)

Convective precip:

- Deep: KUO (Kuo, 1965; Anthes, 1977) or
  RAS (Moorthi & Suarez, 1992)
- Shallow (Tiedke, 1983)

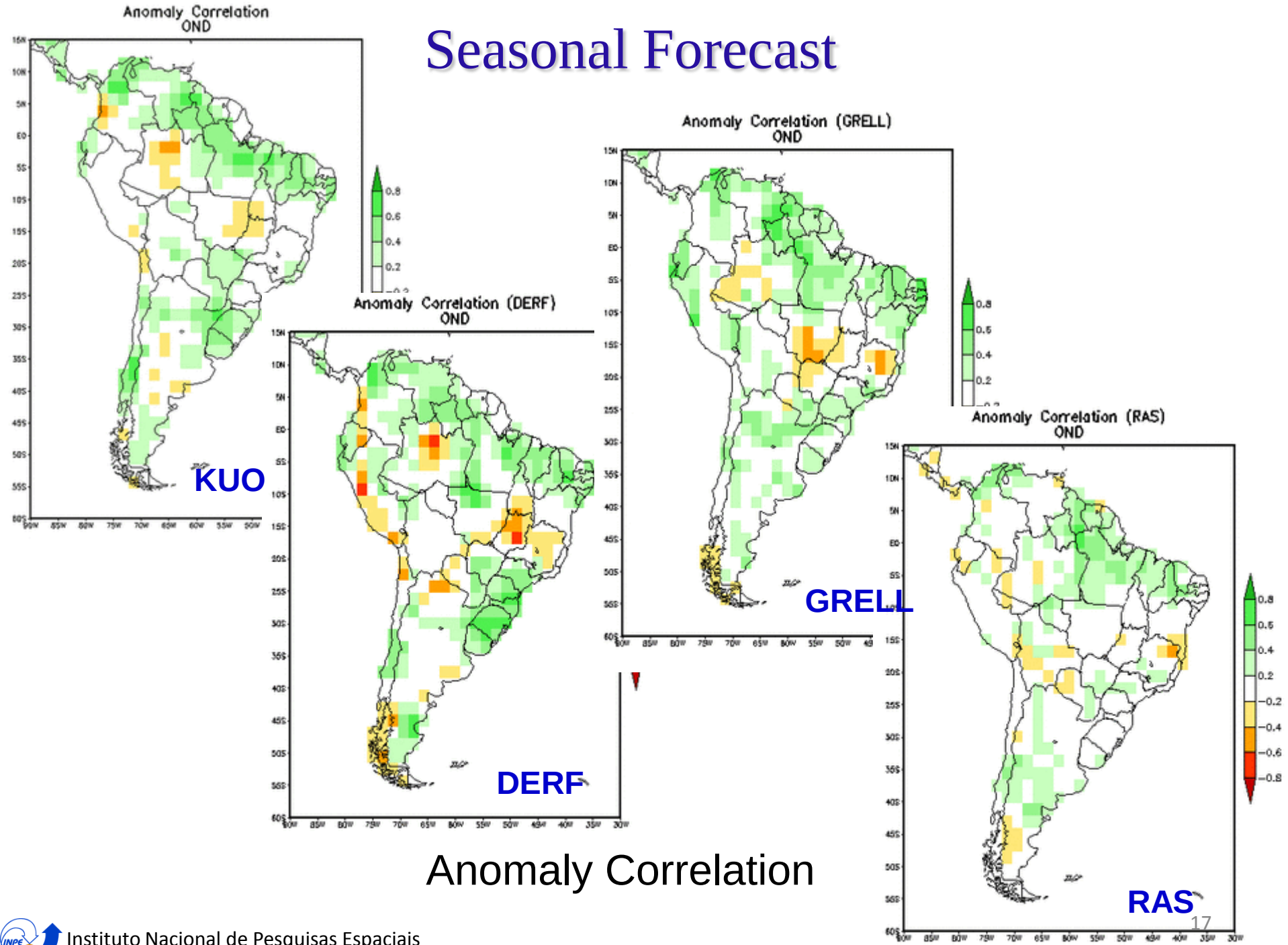
Stratiform precip:

Large Scale Condensation (NCEP, 1988)

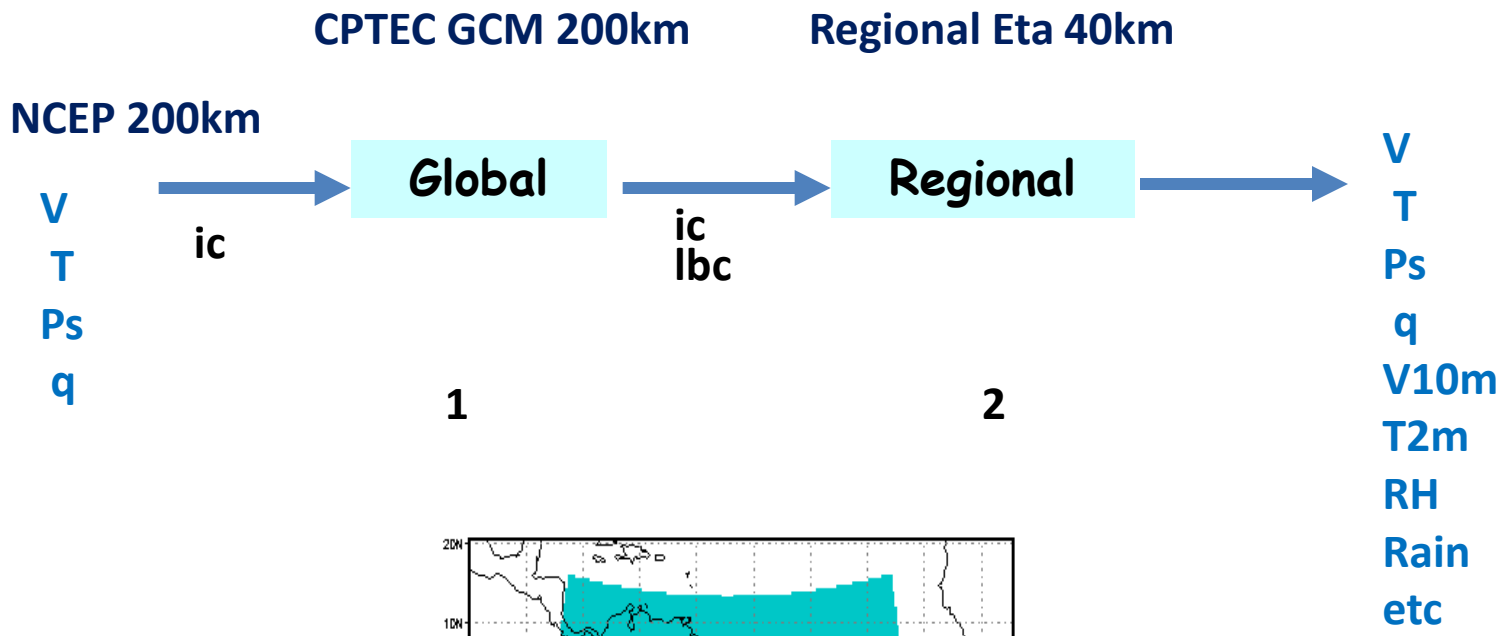
CPTEC seasonal prediction operational runs

- **AGCM 1.7**
  - **KUO, RAS, GRELL, DERF**
  - **FCST SSTA, PRESCRIBED SSTA**
  - **15 Members each: 120 total**
  - **4-month forecasts**
- **CGCM 1.0**
  - **T062L28, RAS CPTEC AGCM**
  - **¼ degree deep tropics, L20 MOM3 OGCM**
  - **10 Members per month**
  - **7-month forecasts**
- **Eta**
  - **40 km grid L38**
  - **LBC AGCM T062L28, Kuo**
  - **5 members, iC**
  - **4-month forecasts**

Seasonal Forecast

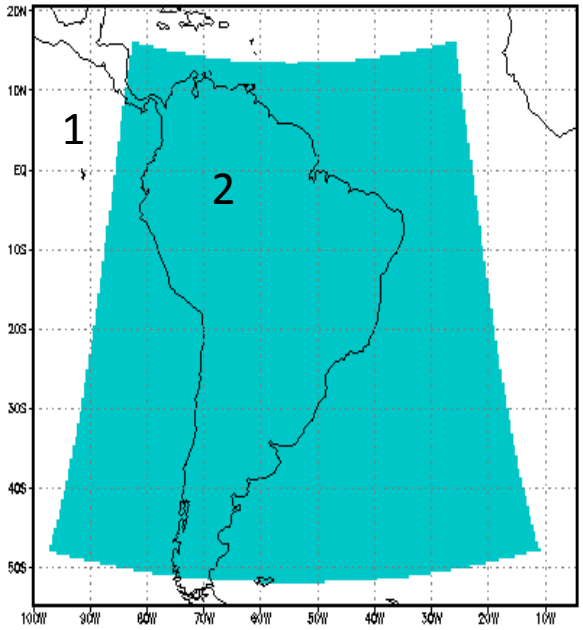


Anomaly Correlation



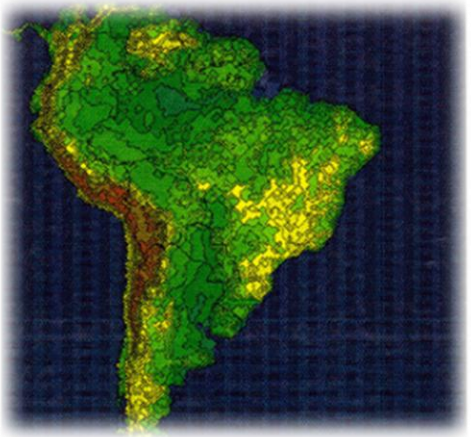
IC: 13,14,15,16,17

1200 UTC cycle,
Run continuous 4,5 month integrations



Eta Model at INPE operational since 1997,

Seasonal climate runs since 2003



Model characteristics

- ***Domain***
  - Most part of South America
  - Southeast Brazil
  - Northeast Brazil
- ***Resolution***: 40 km/38 layers;
  - 20km/38 layers;
  - 10km/38 layers;
  - 5km/50 layers NH
- ***Grid-point model***
  - Arakawa E grid and Lorenz grid
- ***Eta vertical coordinate*** (Mesinger, 1984)
- ***Prognostic variables:***

T, q, u, v, p_s, TKE, cloud water/ice, hydrometeors

- ***Time integration:***
  - 2 level, split-explicit
  - **Adjustmet**: forward-backward
  - **Advection**: first forward and then centered
- ***Convection***:
  1. Betts-Miller-Janjic scheme,
  2. Kain-Fritsch scheme
- **Stratiform rain**:
  1. Zhao scheme
  2. Ferrier scheme
- ***Turbulence***:
  - Mellor Yamada 2.5, MO surface layer, Paulson functions
- ***Radiation***:
  - GFDL package
- ***Land surface scheme***:
  - NOAH scheme, 4 soil layers,
- ***Initial conditions***
  - NCEP T126L28 analyses,
- ***L.B.C.***
  - CPTEC T126L28 GCM, uptd 6/6 h,
- *Initial soil moisture*: 12h Global model forecast or climatology
- ***Initial albedo:*** seasonal climatology

- **Condições iniciais**: NCEP T062L28

  13, 14, 15, 16, 17 /06/2008, as 1200 UTC

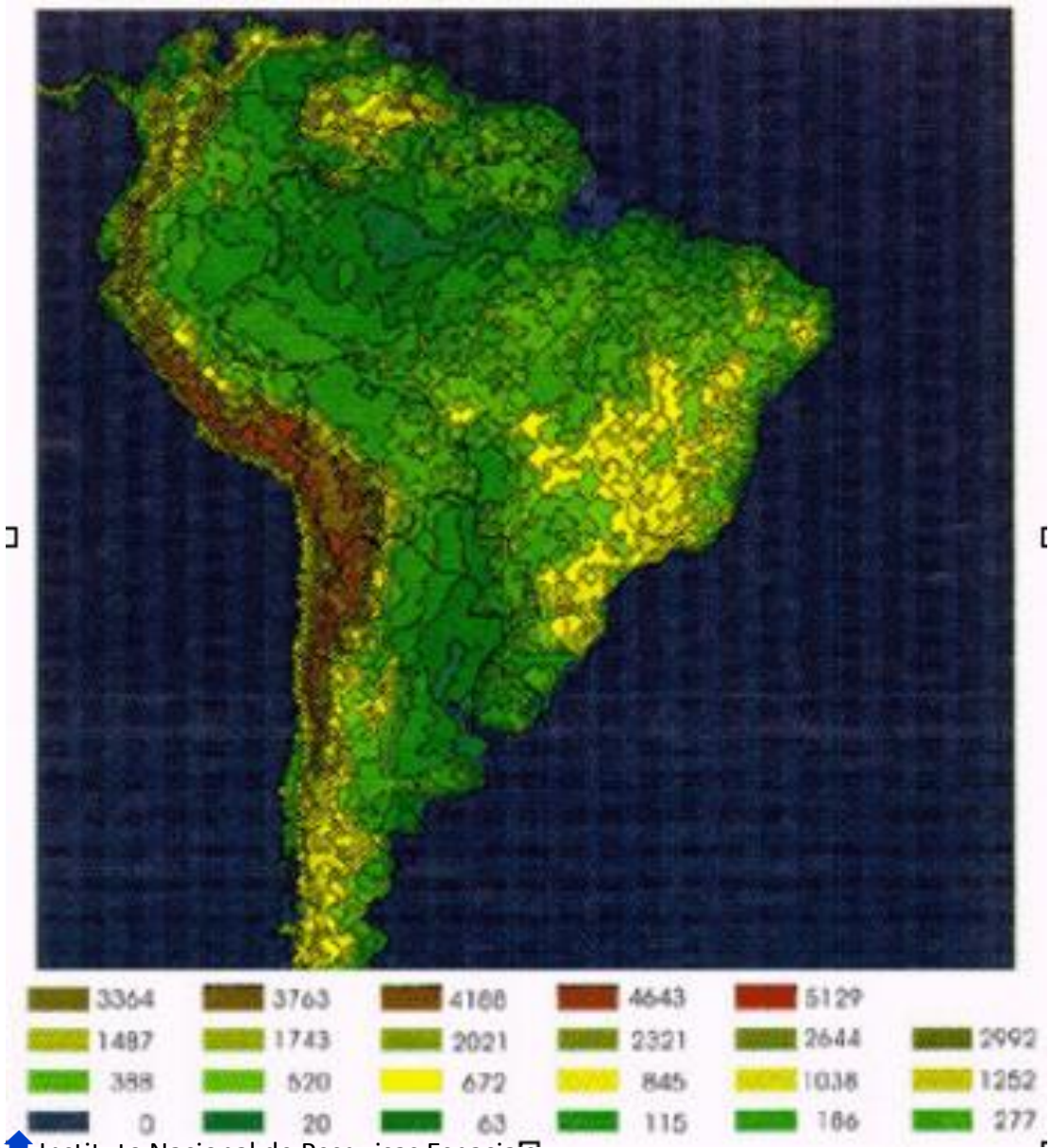
- **Condições de contorno lateral**: Modelo Global do CPTEC T062L28, 6/6h

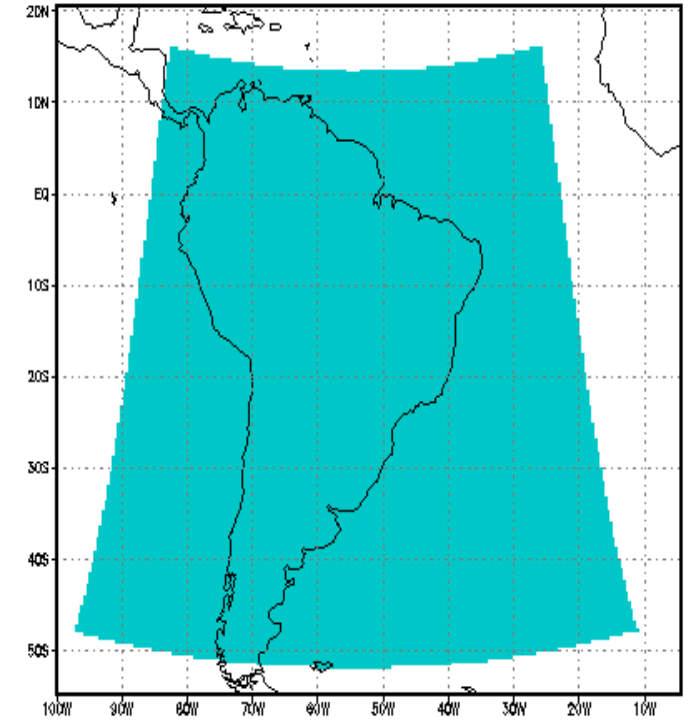
- **Condição de contorno inferior:**

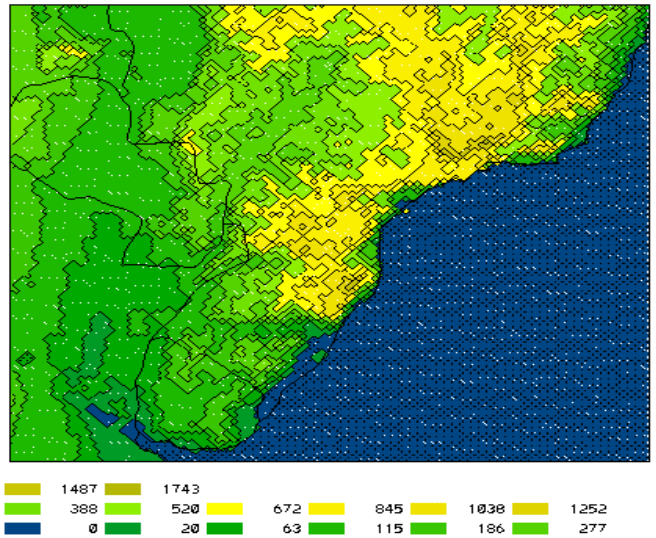
  - Anomalia de *SST persistida*, atualizada diariamente durante a integração
  - Umidade do solo climatológica
  - Albedo sazonal. .

(Chou et al, Nonlinear Processes in Geophysics, 2005)

Step mountains







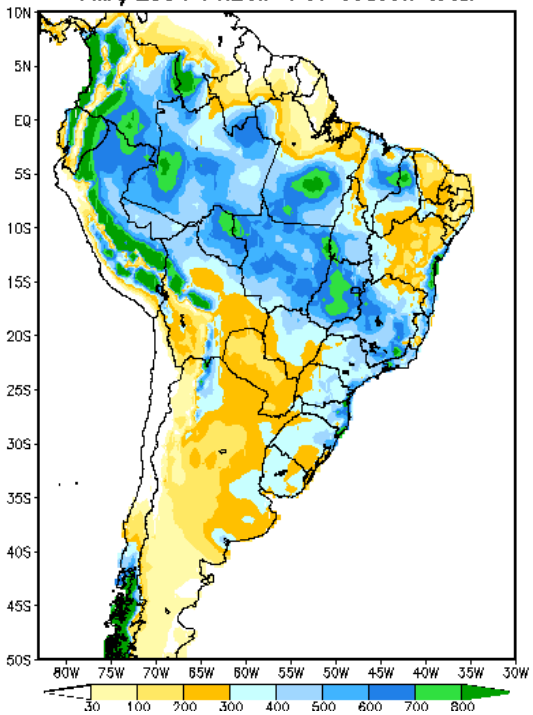
Seasonal Forecasts

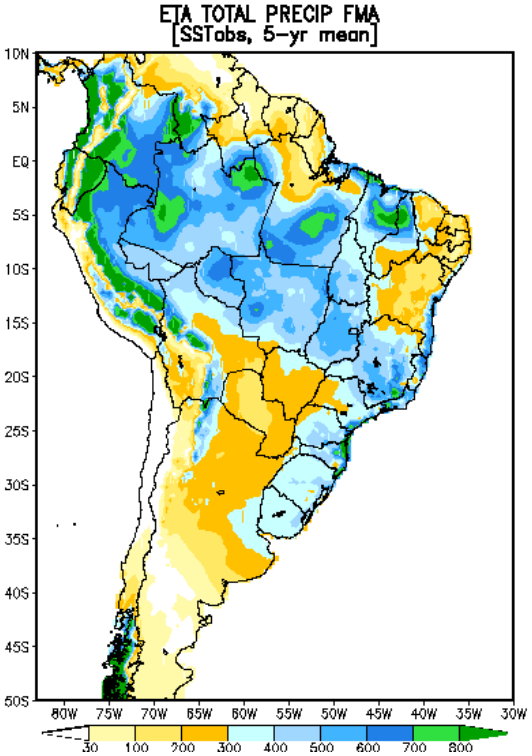
(Chou et al, 2005)

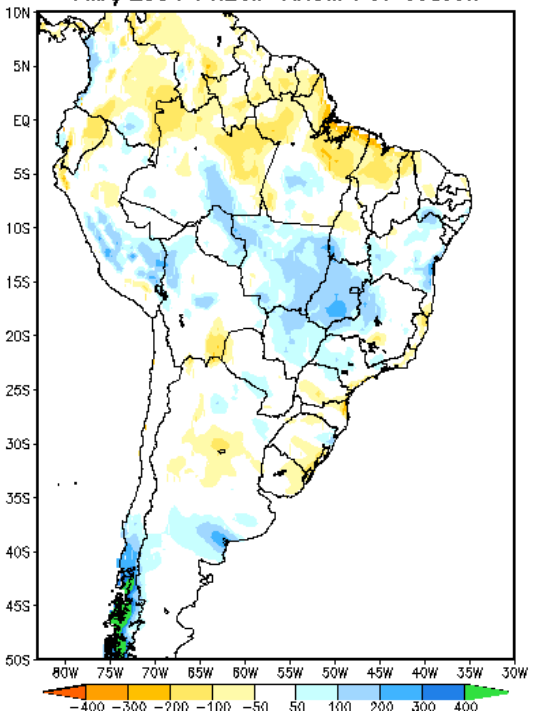
Poor's man model climatology

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

seasonal forecasts − Model seasonal climatology = anomaly forecast





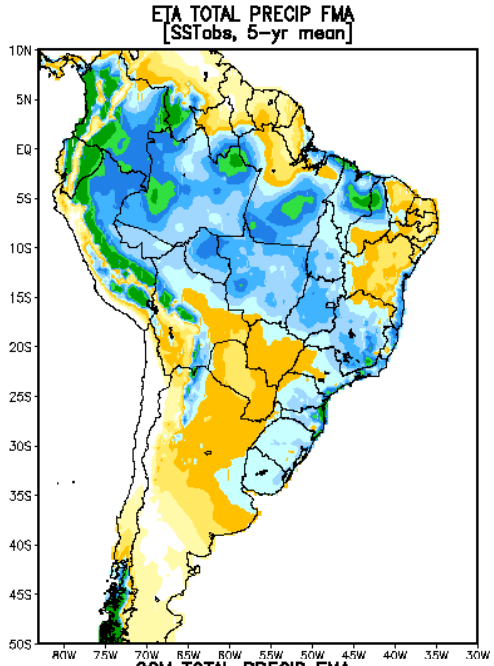


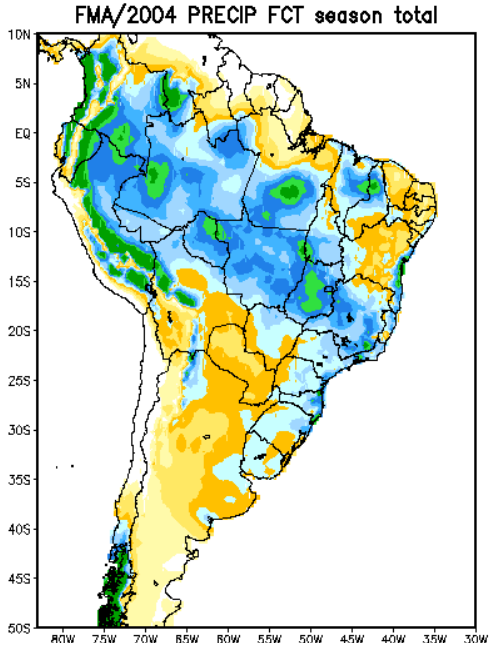
FMA 2004

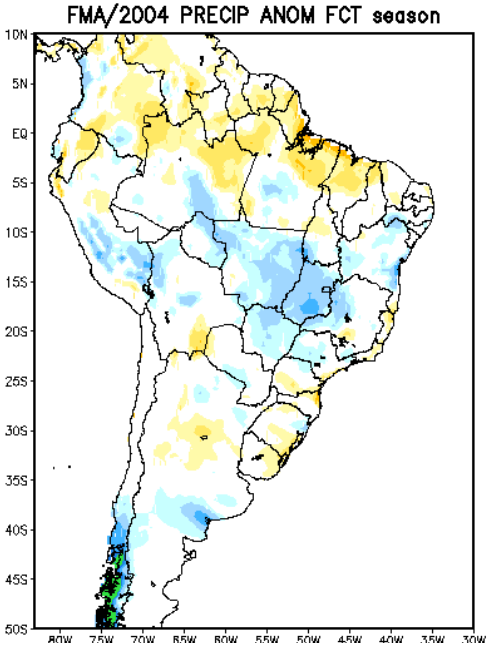
Assume: climatology and model systematic errors have been ***removed***

FMA 2004

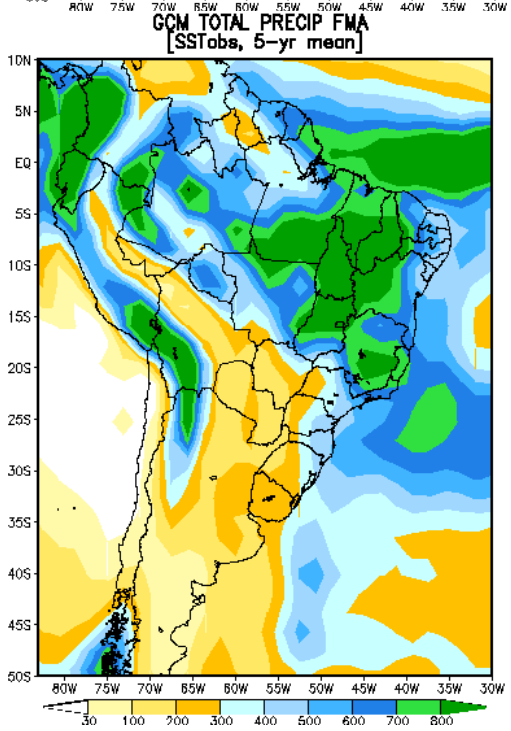
Eta

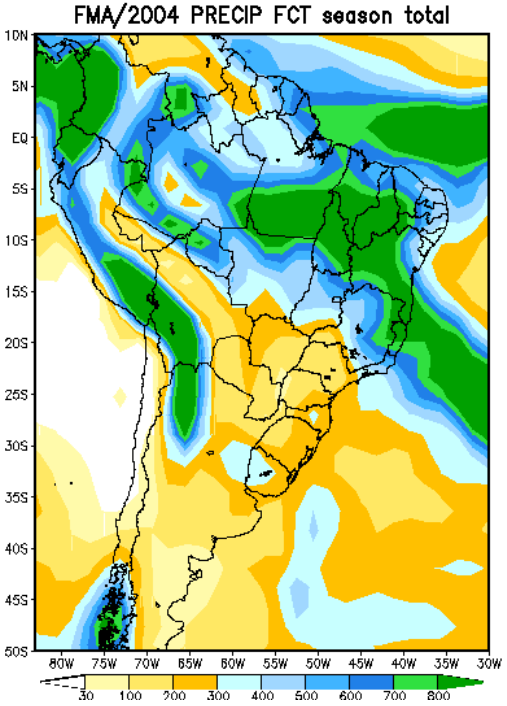


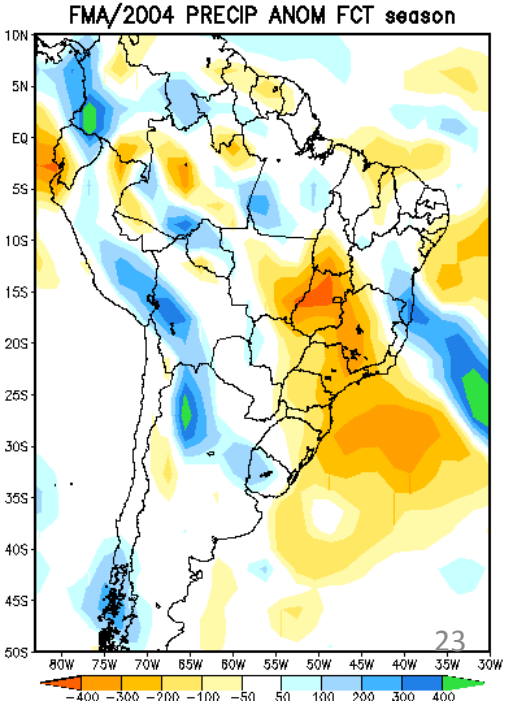




GCM

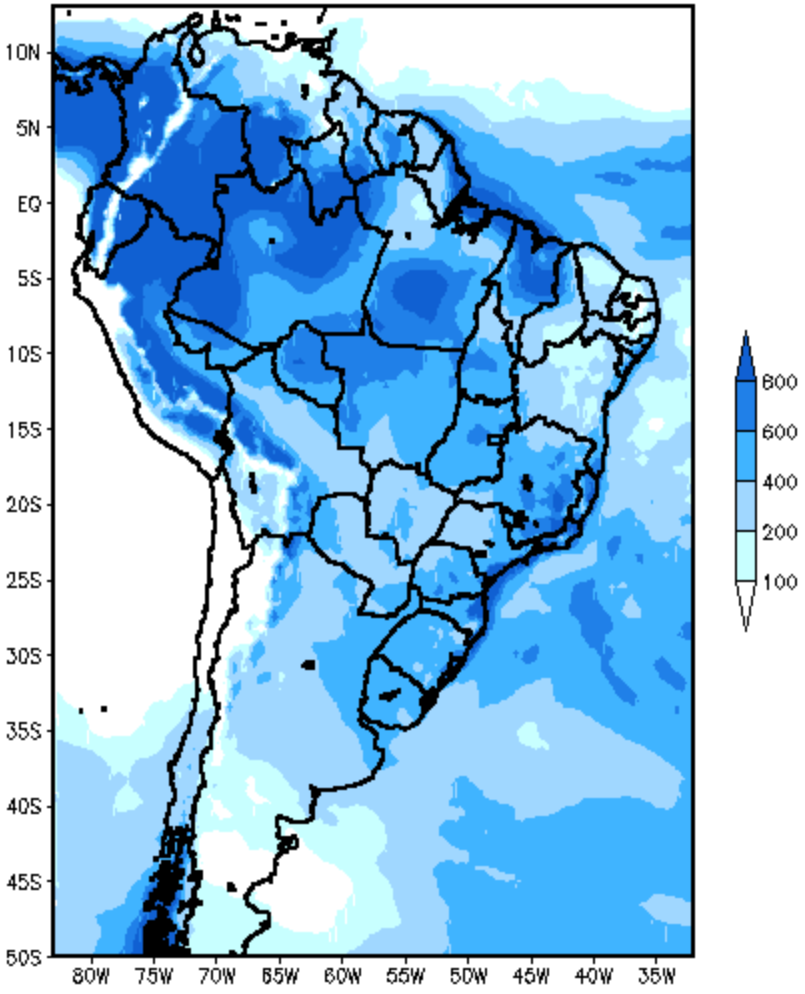






FMAM - 2002

Eta



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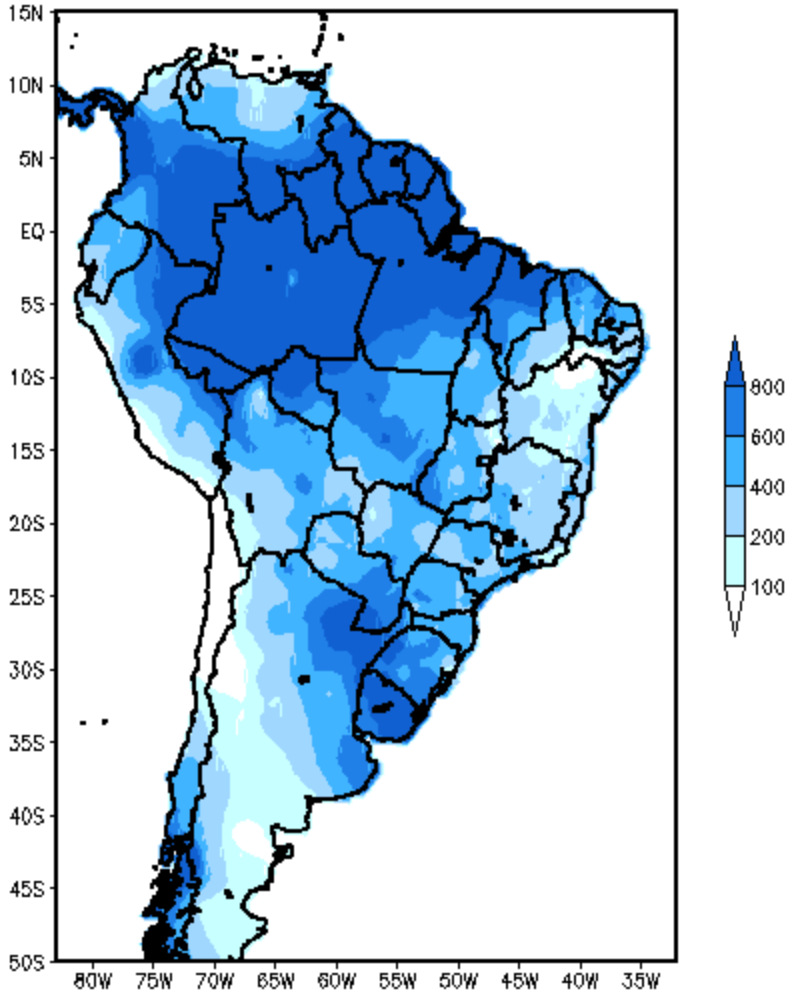
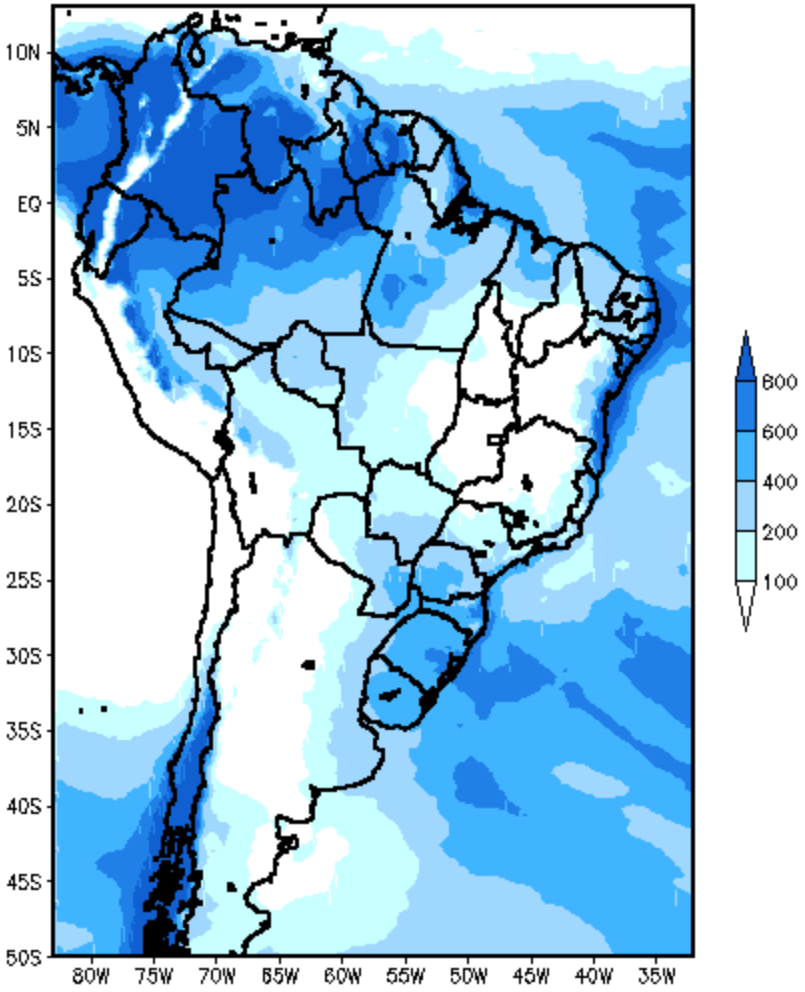
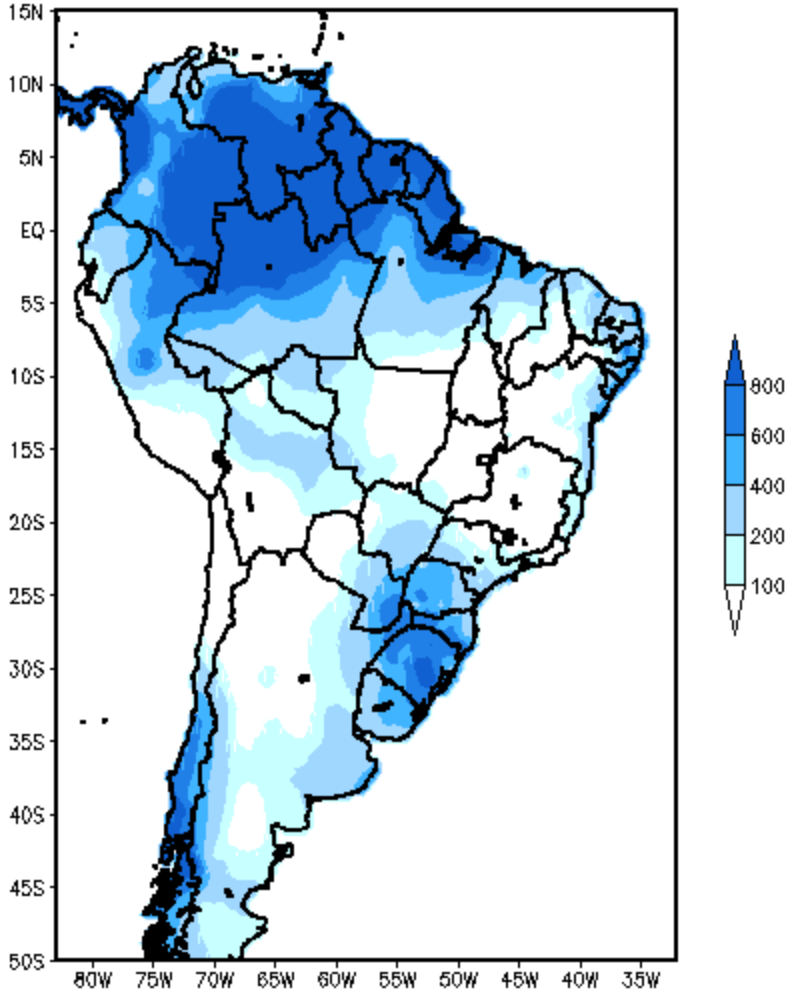


MJJA - 2002

Eta

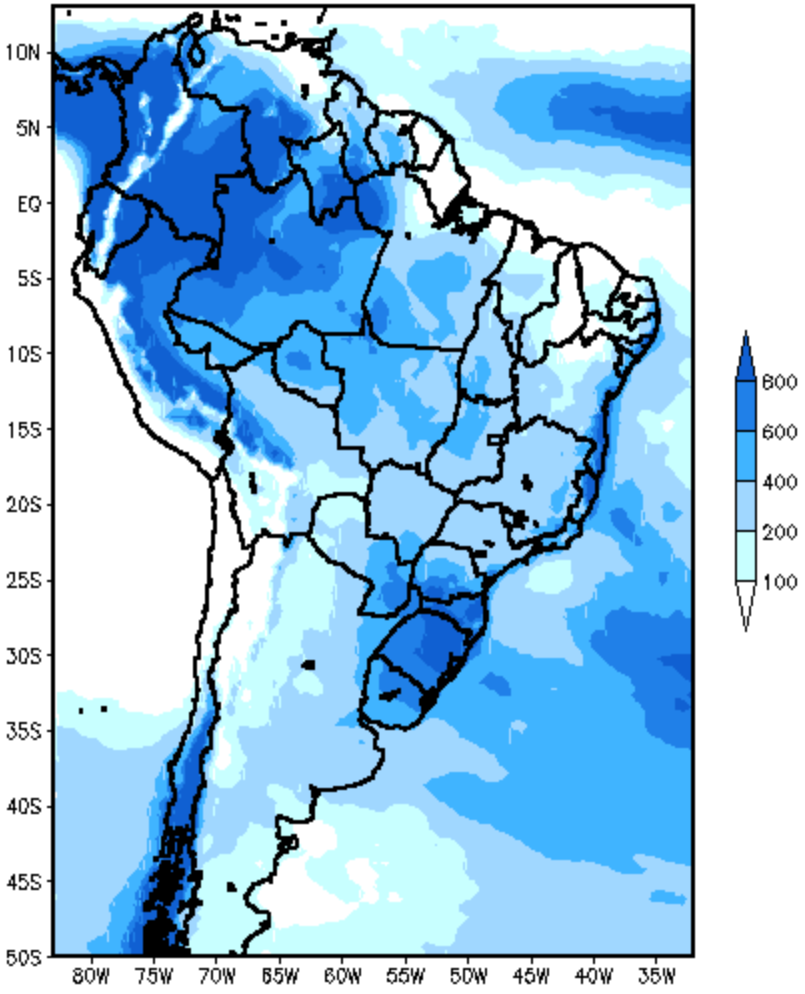


Obs

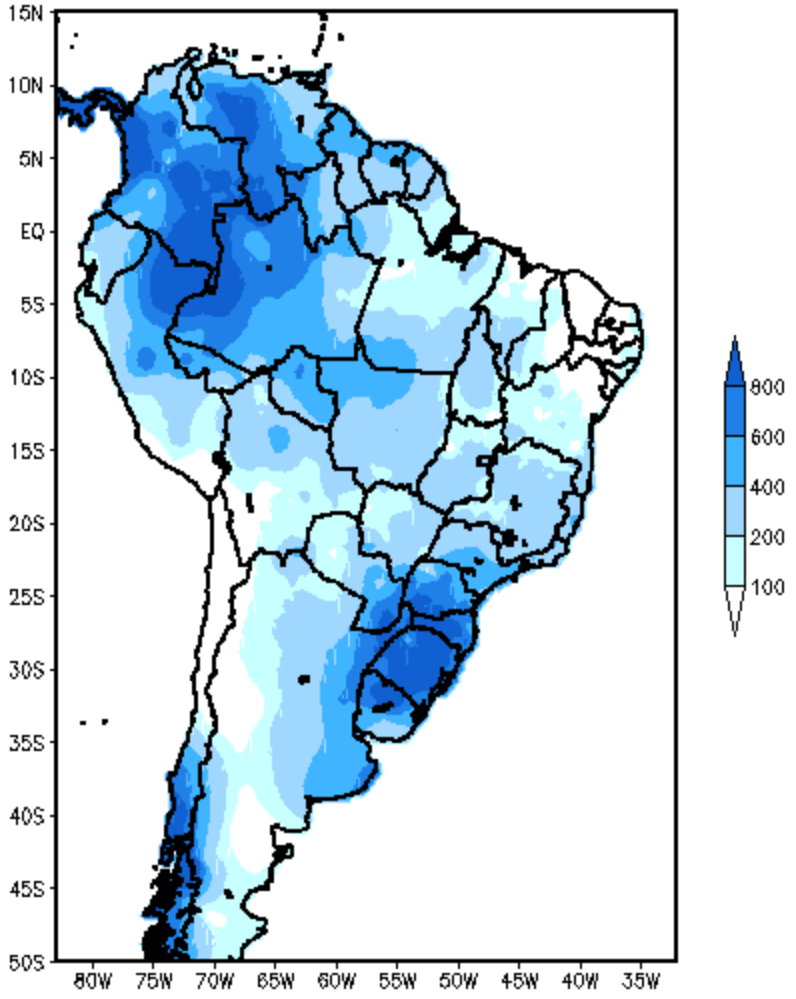


ASON - 2002

Eta

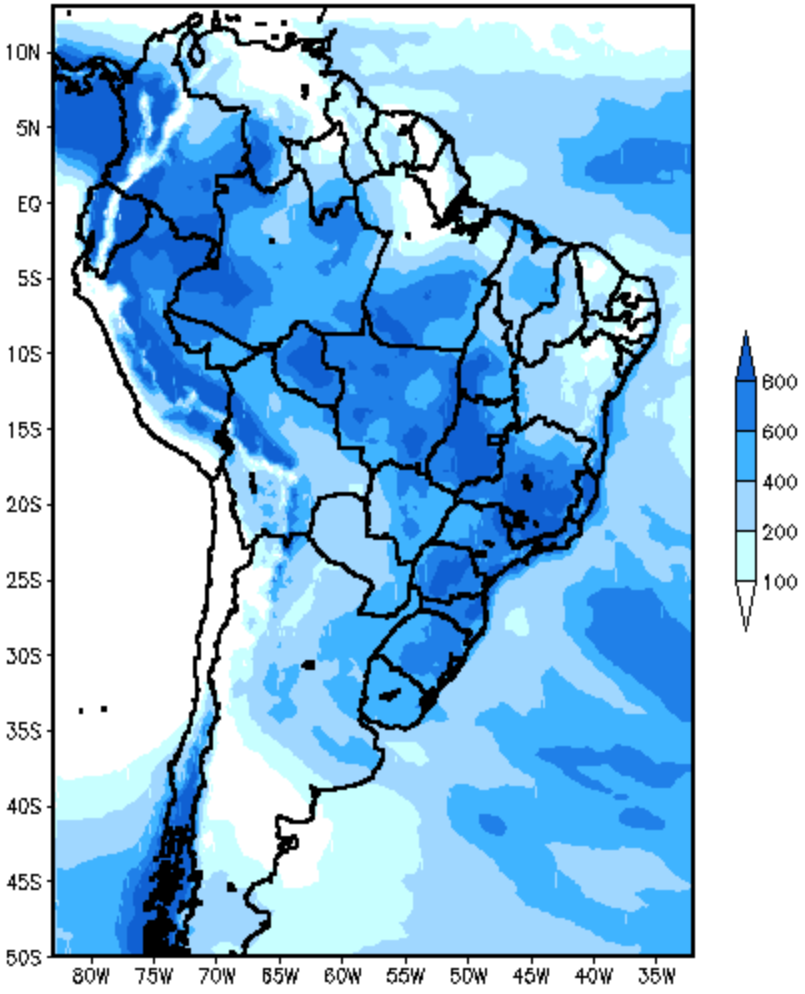


Obs



NDJF - 2002

Eta



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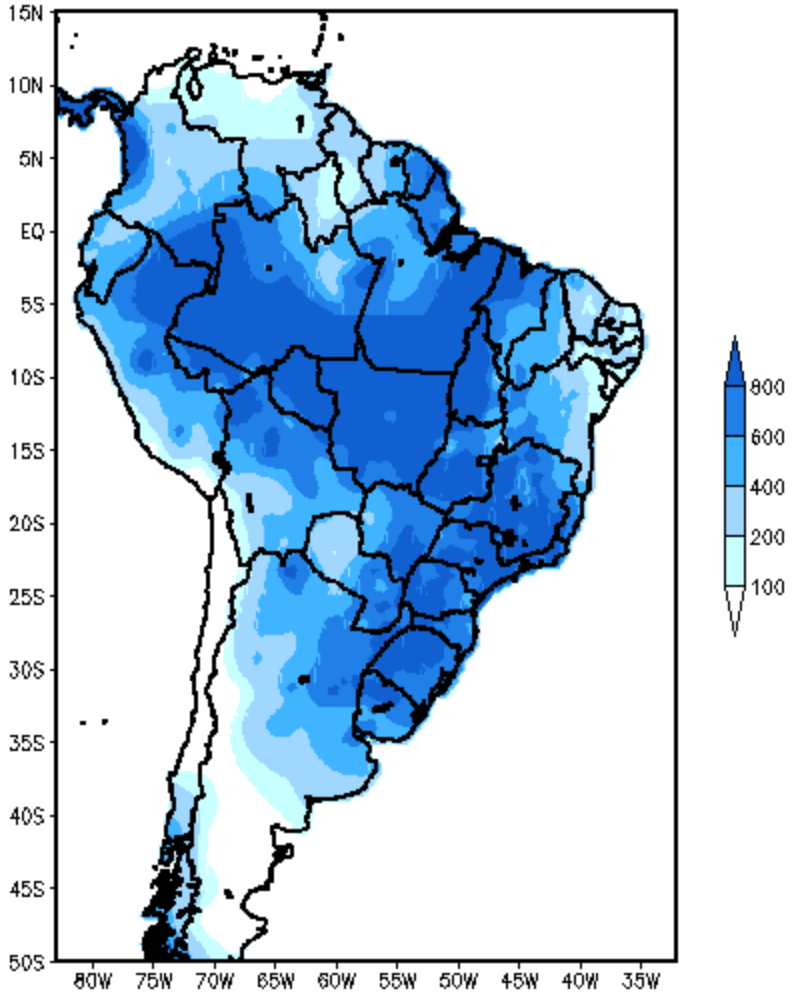


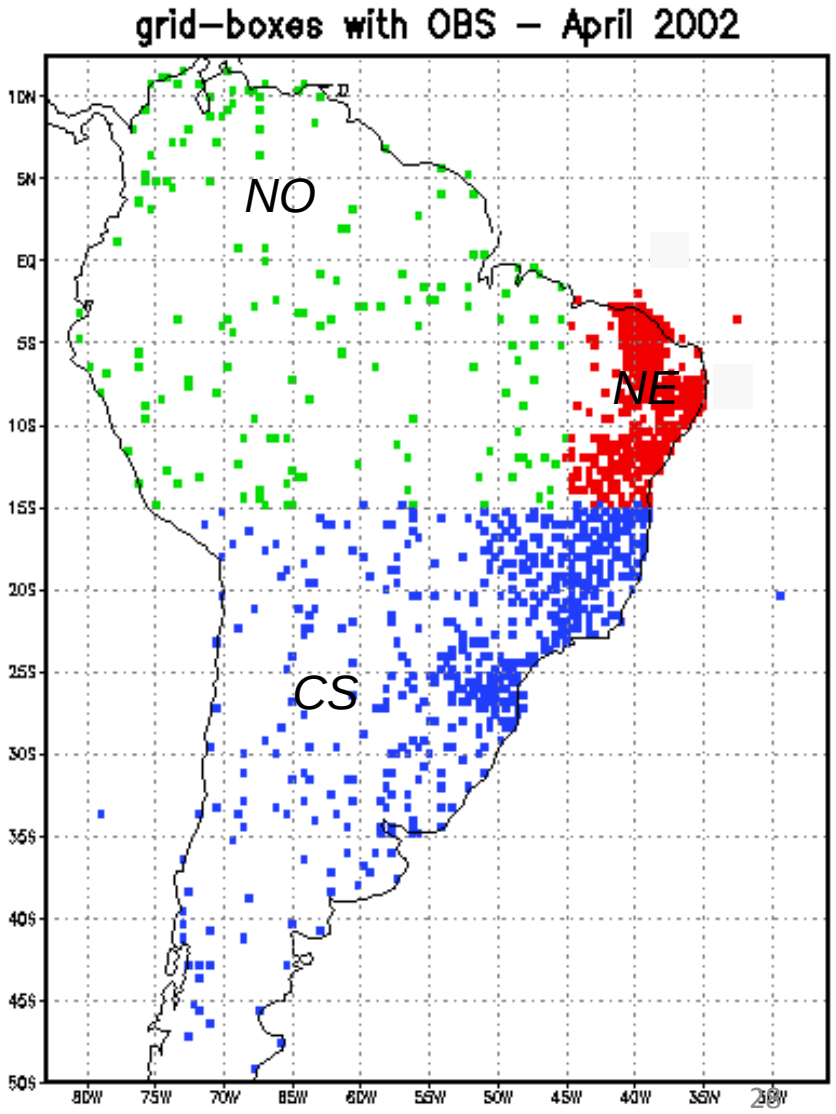
Equitable Threat Score

Two indices are calculated for precipitation evaluation.

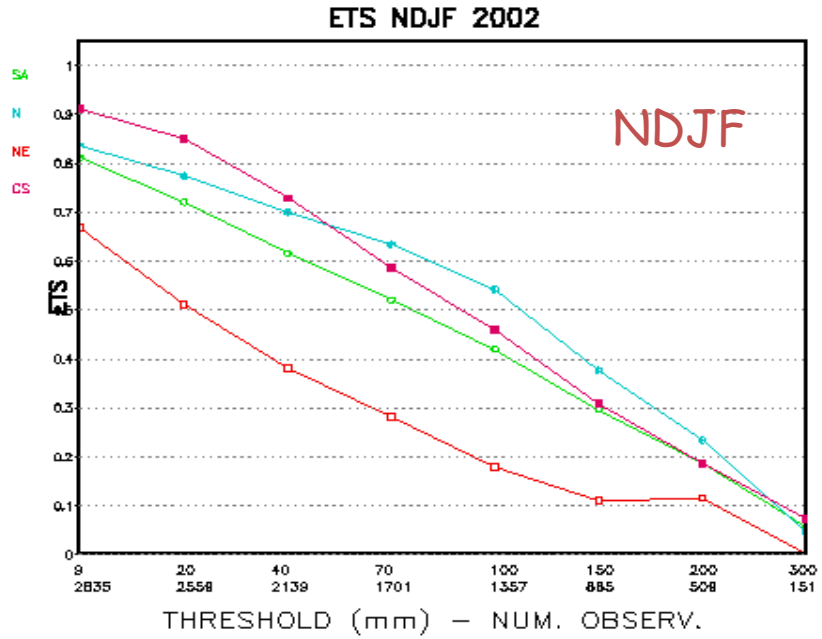
$$ETS = \frac{H - CH}{F + O - H - CH}$$

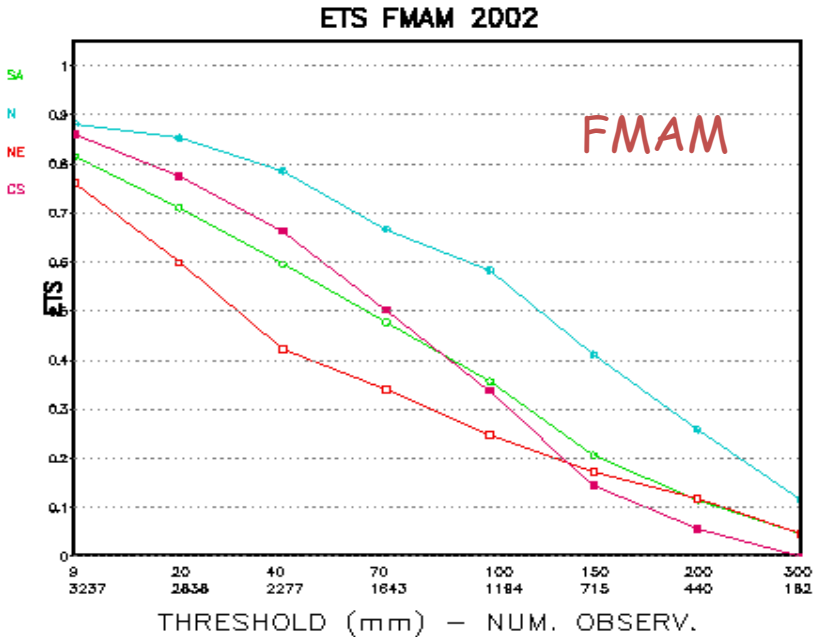
$$BIAS = \frac{F}{O} \qquad CH = \frac{F \times O}{N}$$

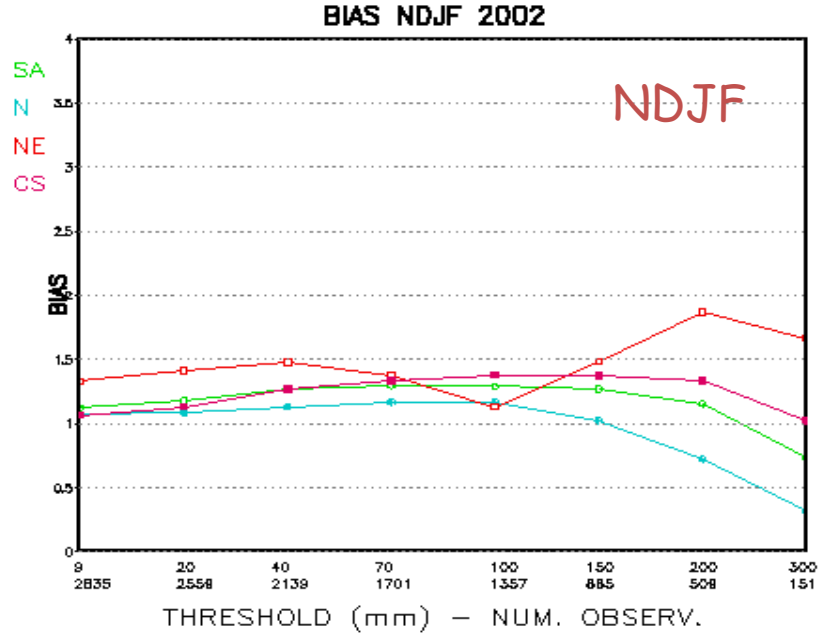
F = No. of forecast pts above a threshold
O = No. of observations pts above a threshold
H= No. of hits
CH = No. of points of random hits

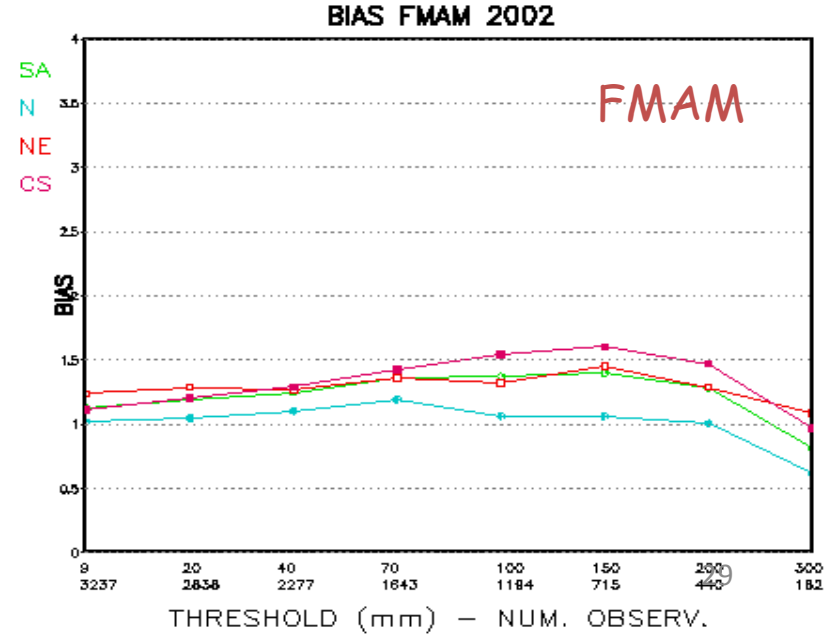


AVALIAÇÃO de PRECIPITAÇÃO - REGIOES

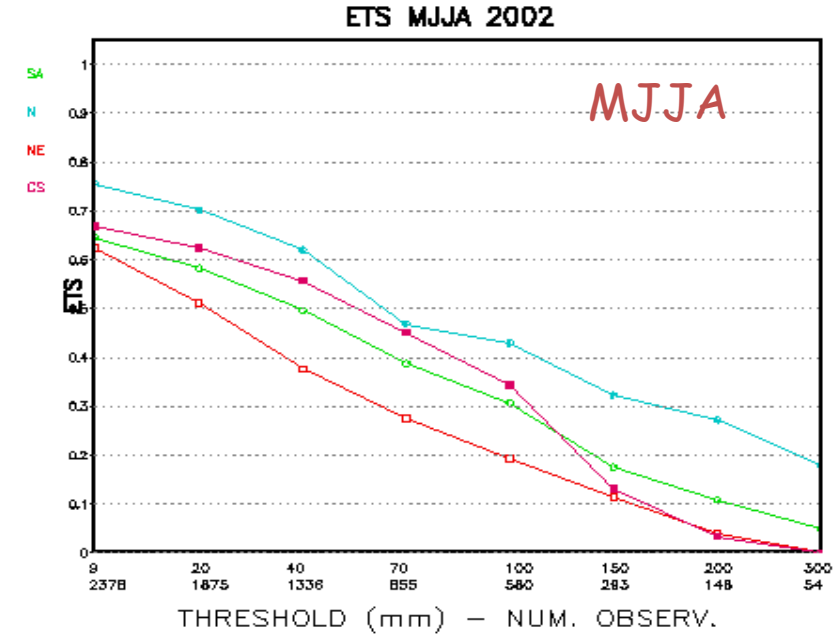


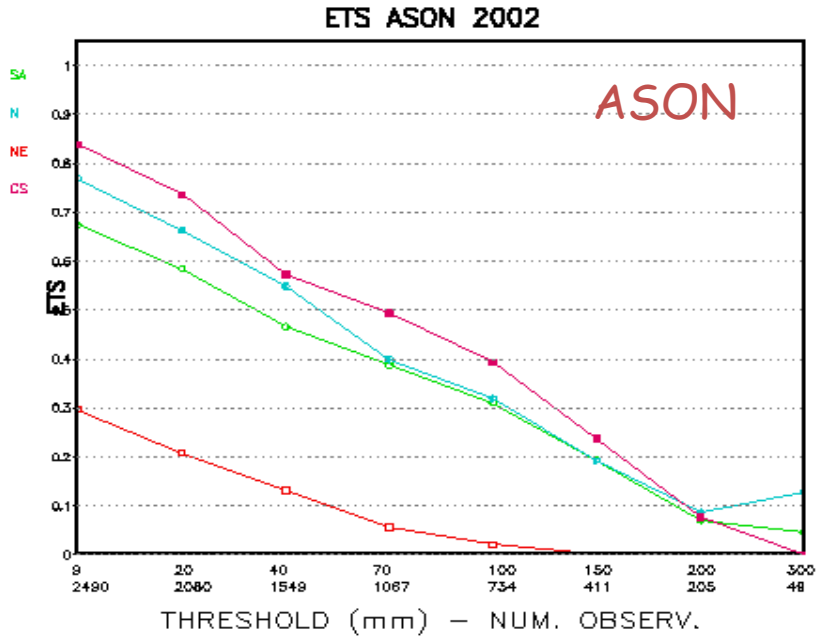


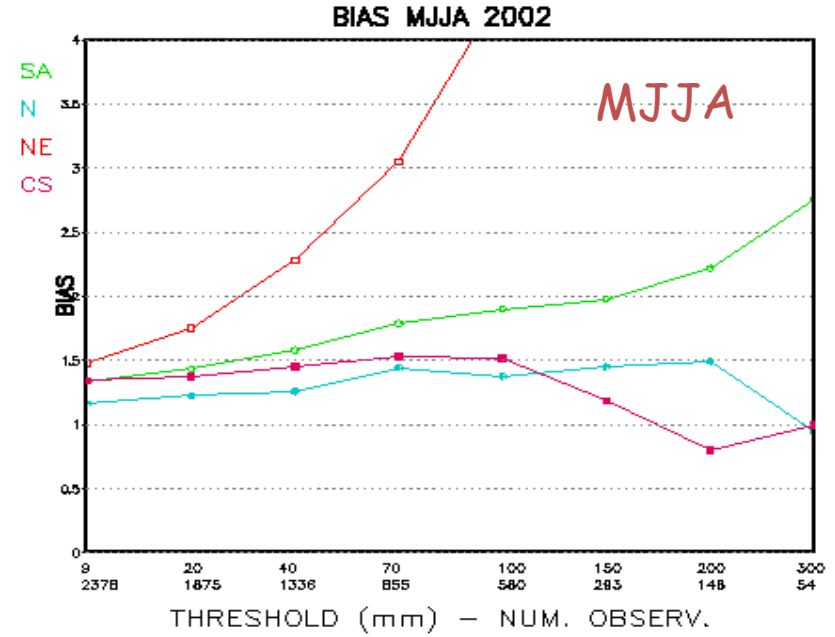


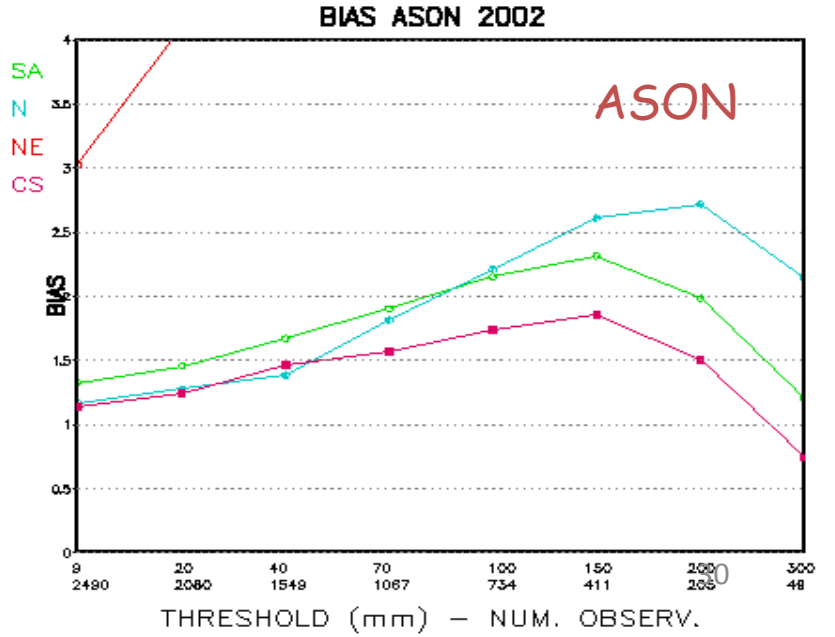


AVALIAÇÃO de PRECIPITAÇÃO - REGIOES



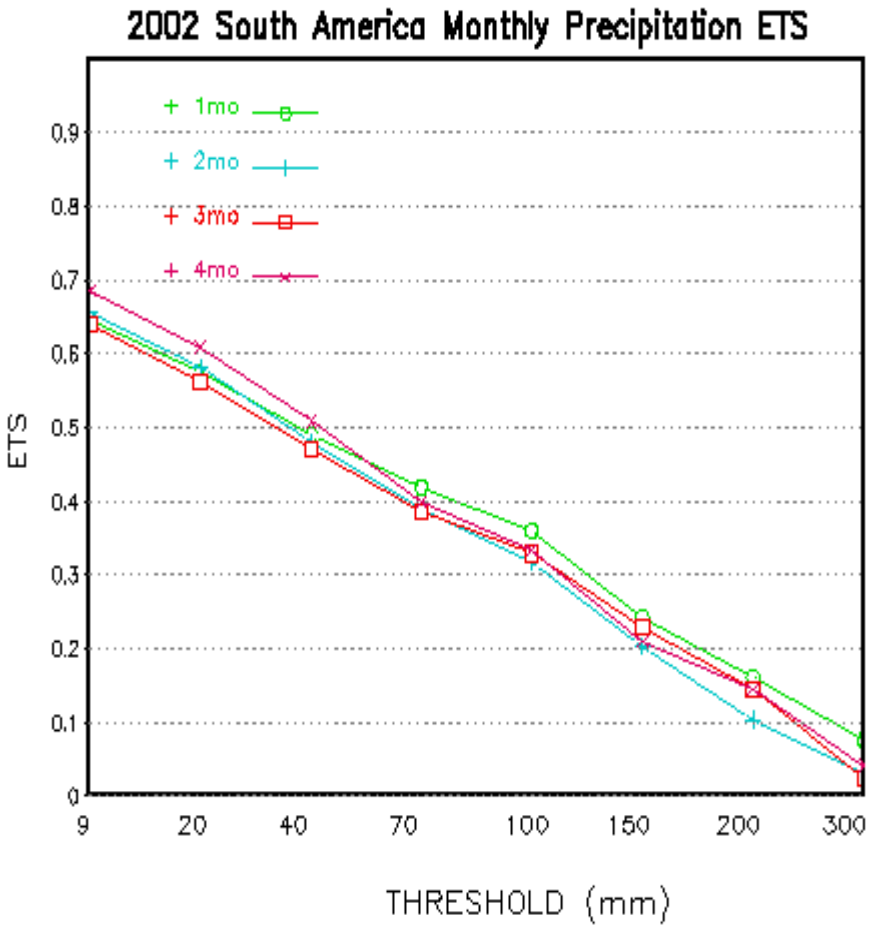




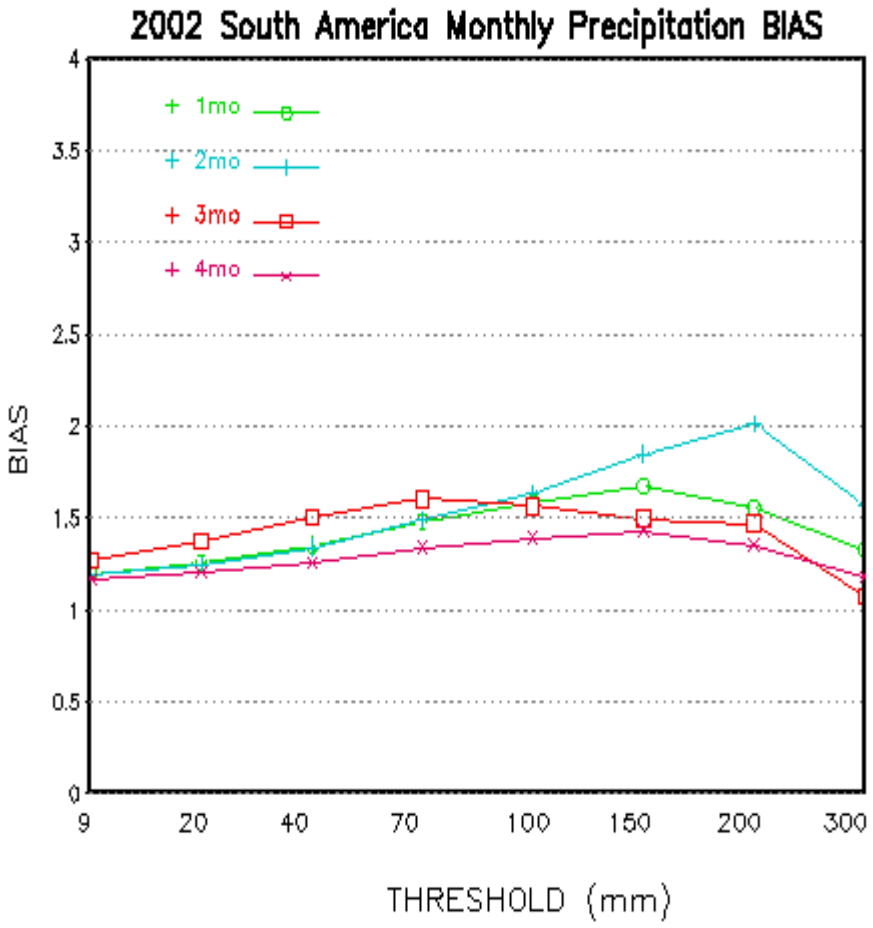


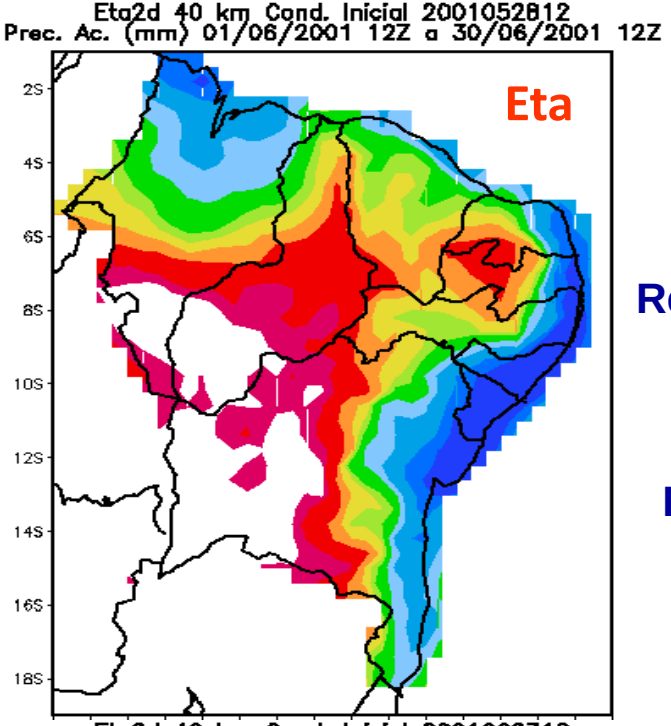
AVALIAÇÃO de PRECIPITACAO - PRAZOS

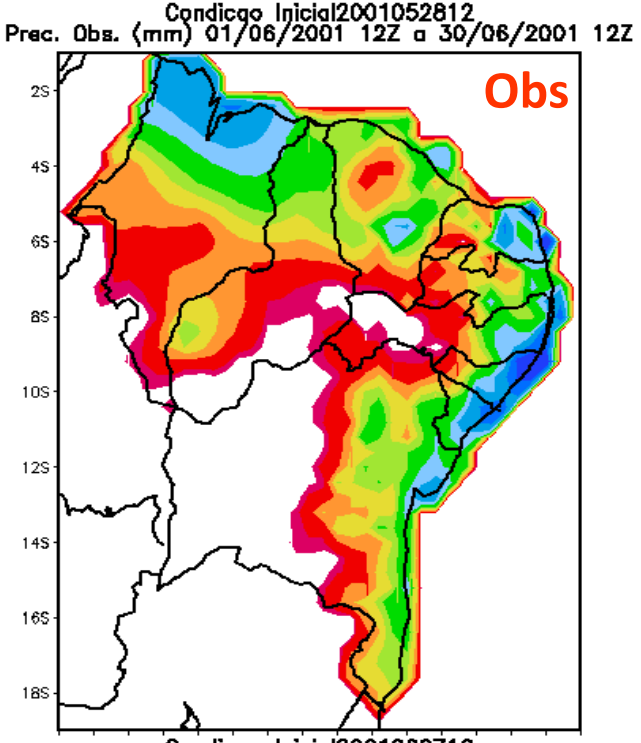
ETS



BIAS







Seasonal forecast

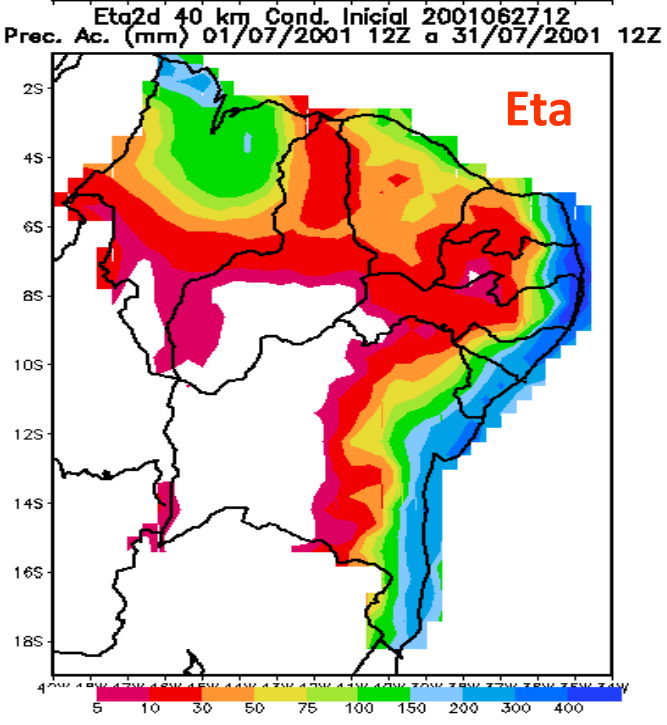
Regional Eta/CPTEC Model

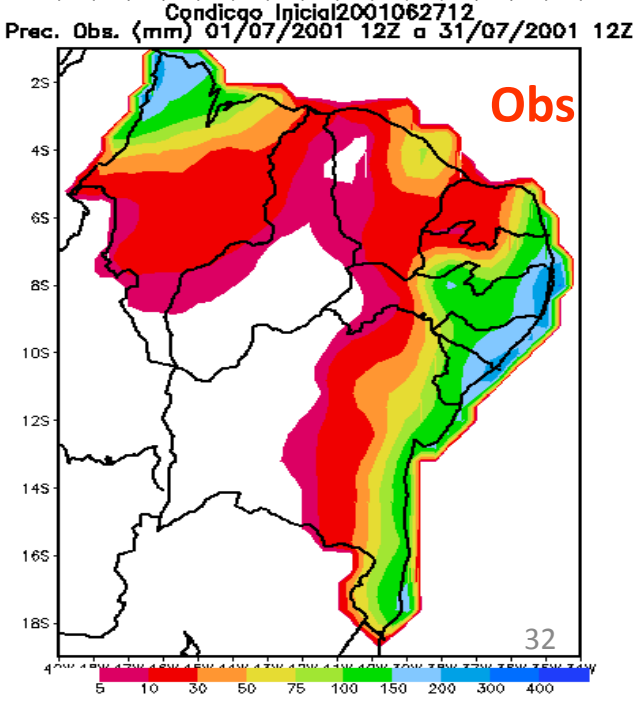
40 km, 38 layers

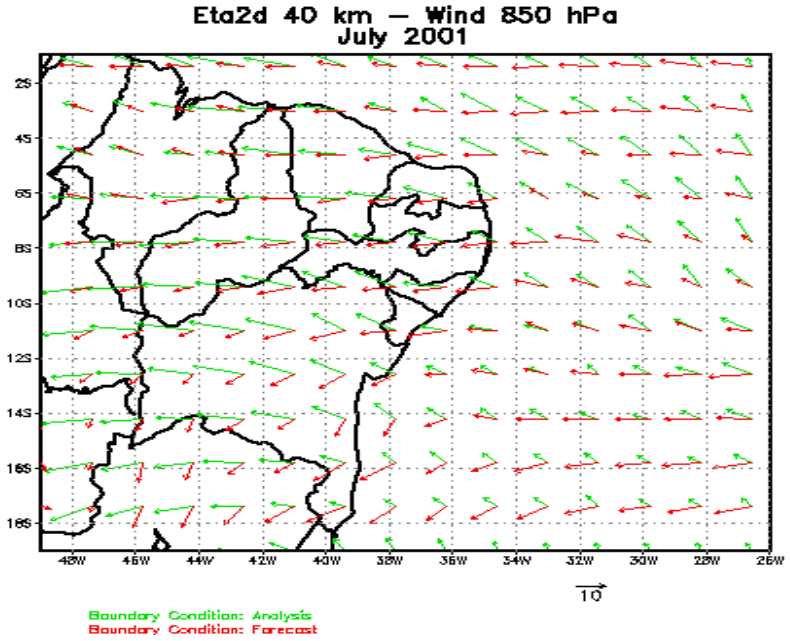
Forecast vs Observation

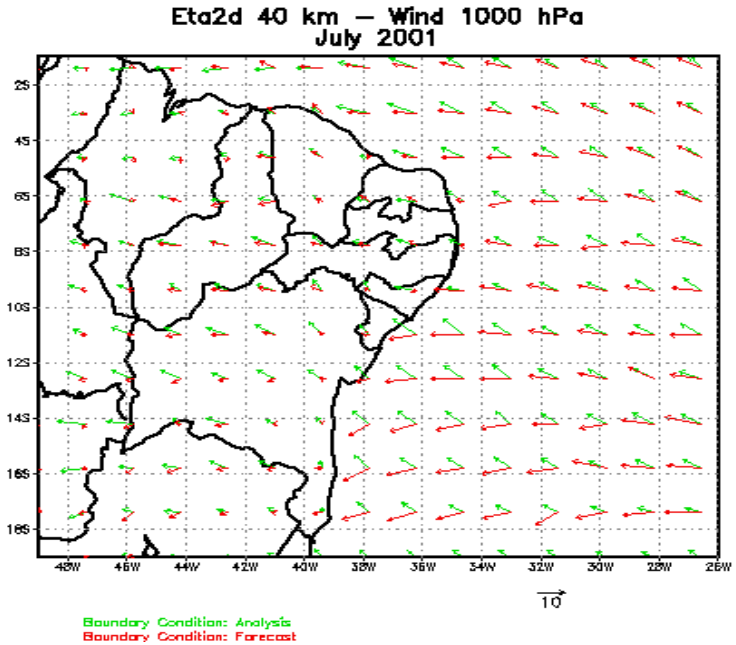
June 2001

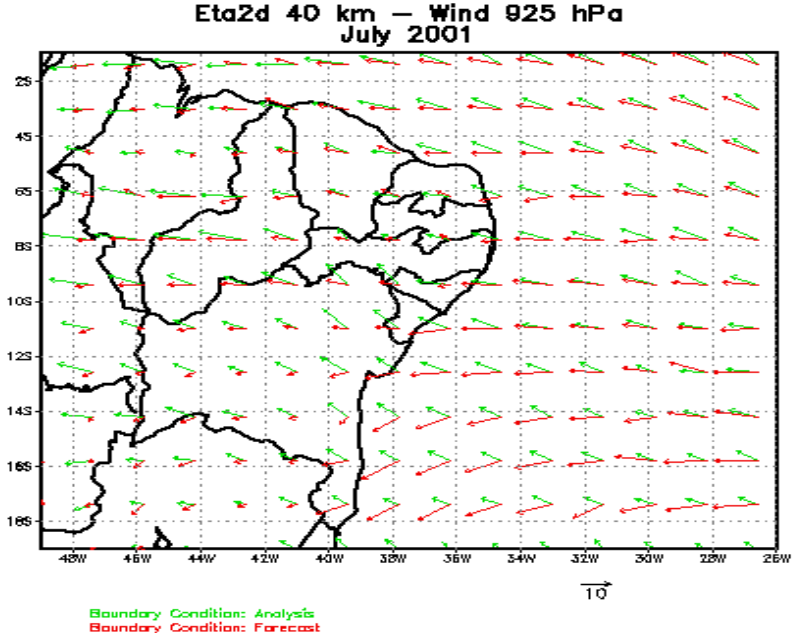
July 2001









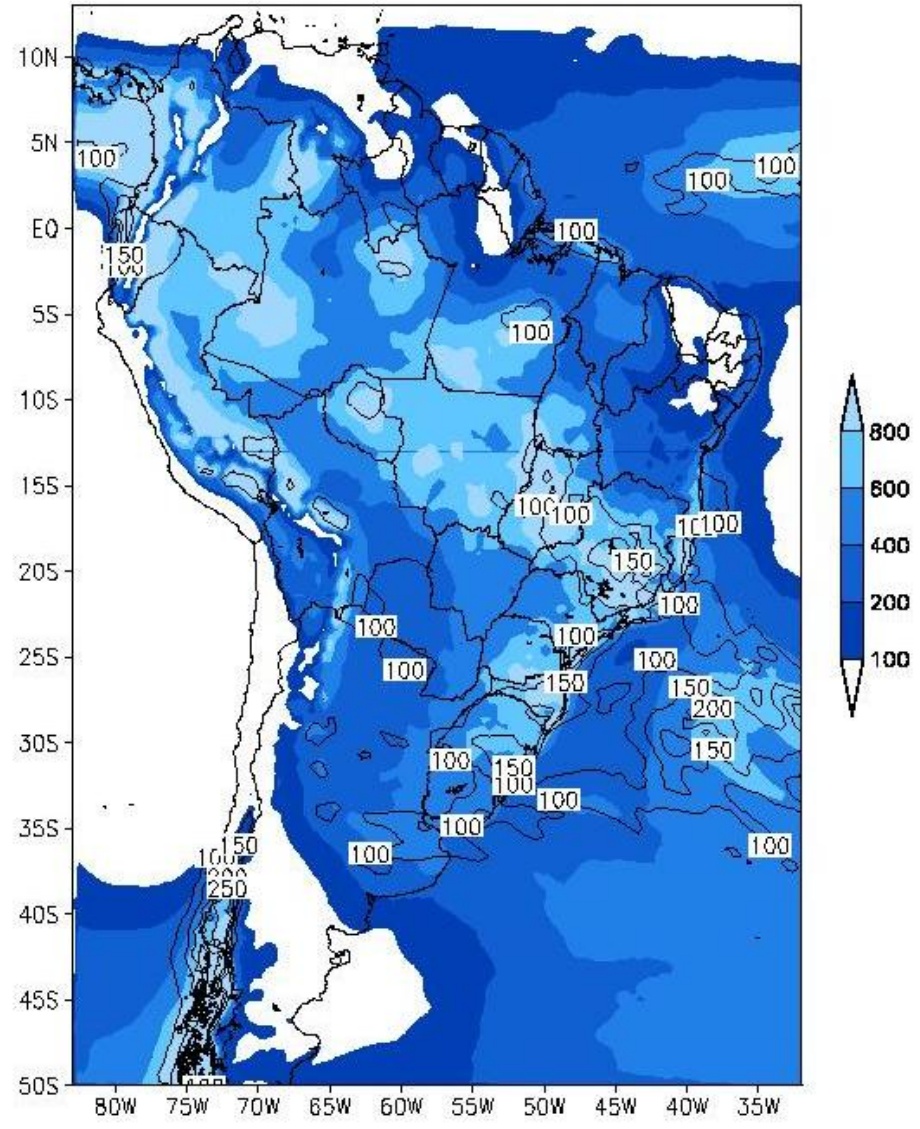


Analysis vs Forecast

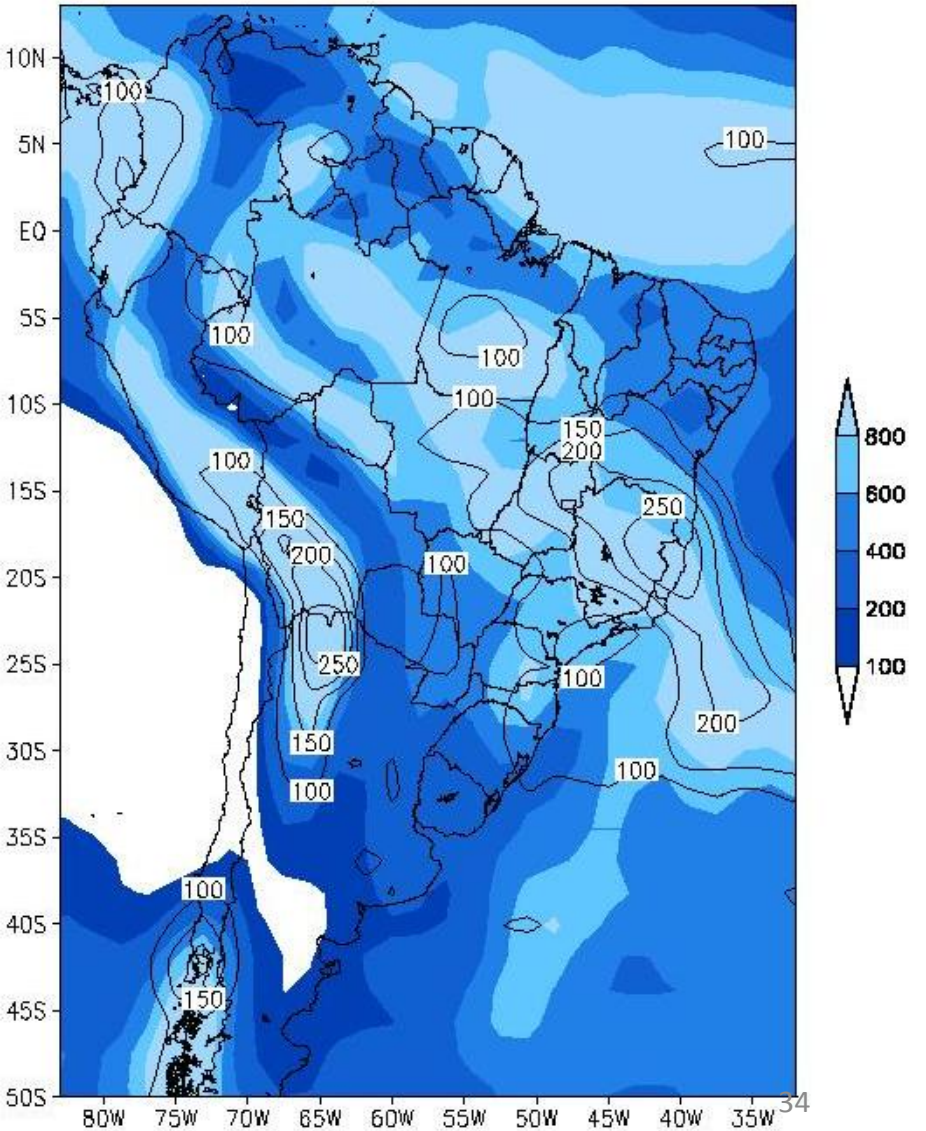
Wind Vetor

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

Eta

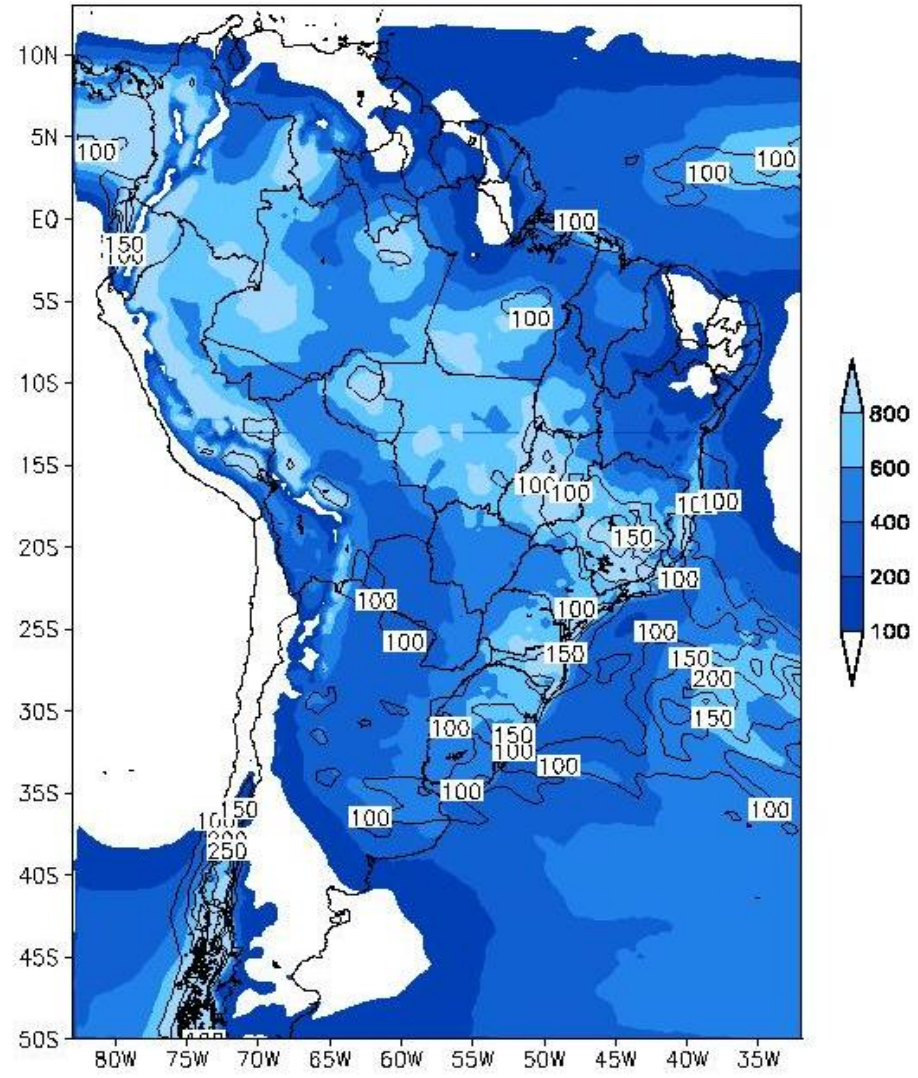


GCM



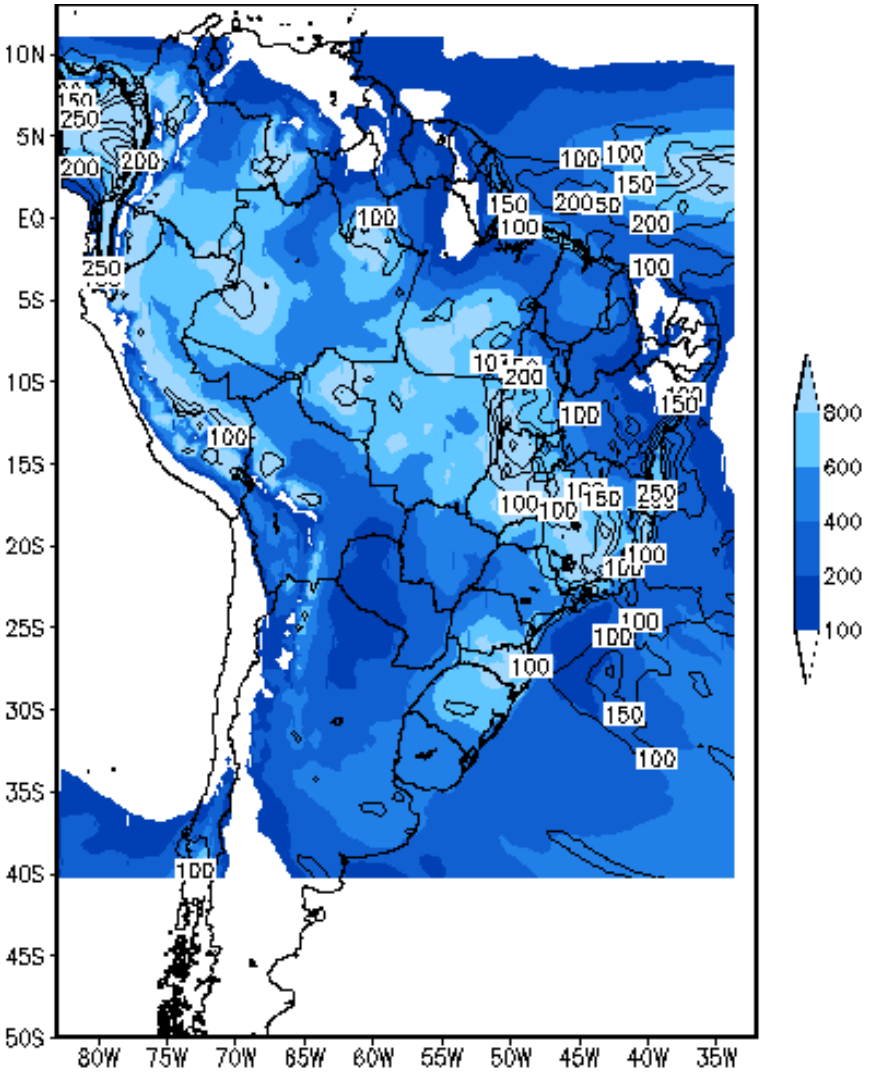
2002-2003 NDJF precip total & Spread

Initial Conditions



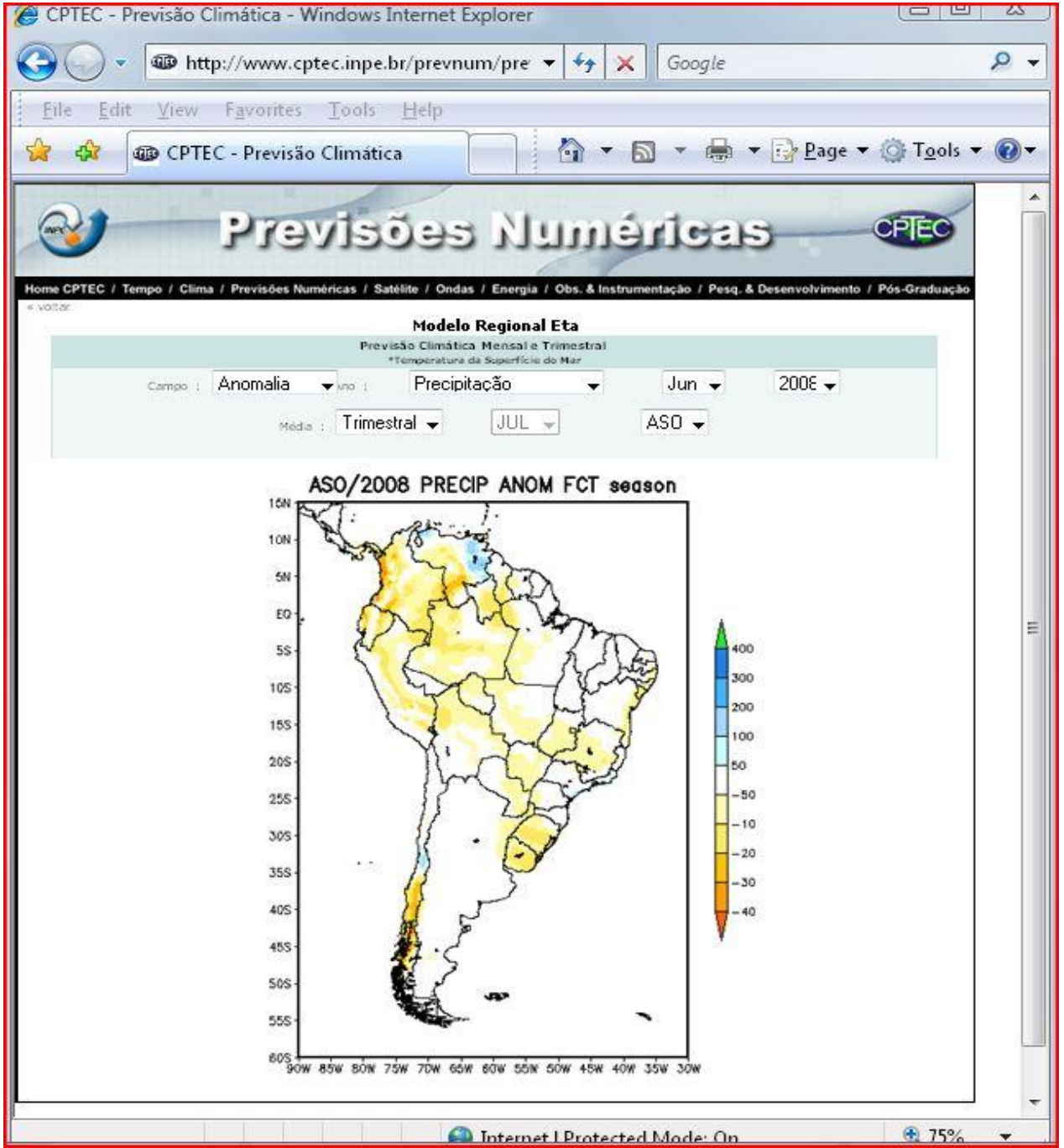
•Some spread due to frontal passage

Physics

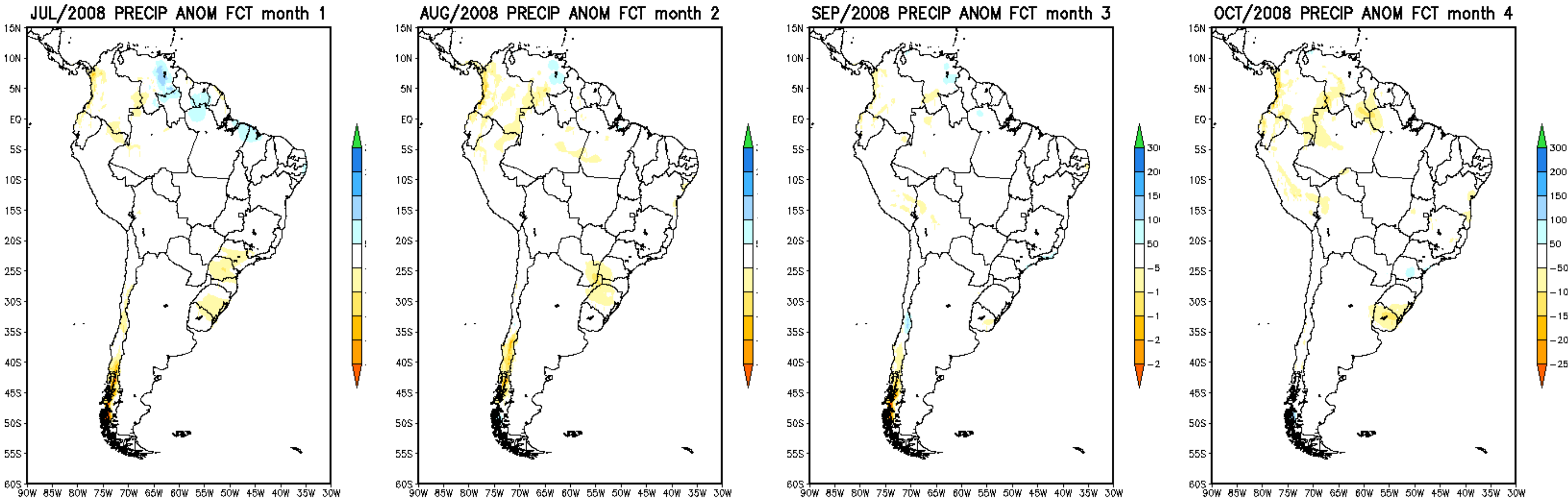


•More spread in lower latitudes

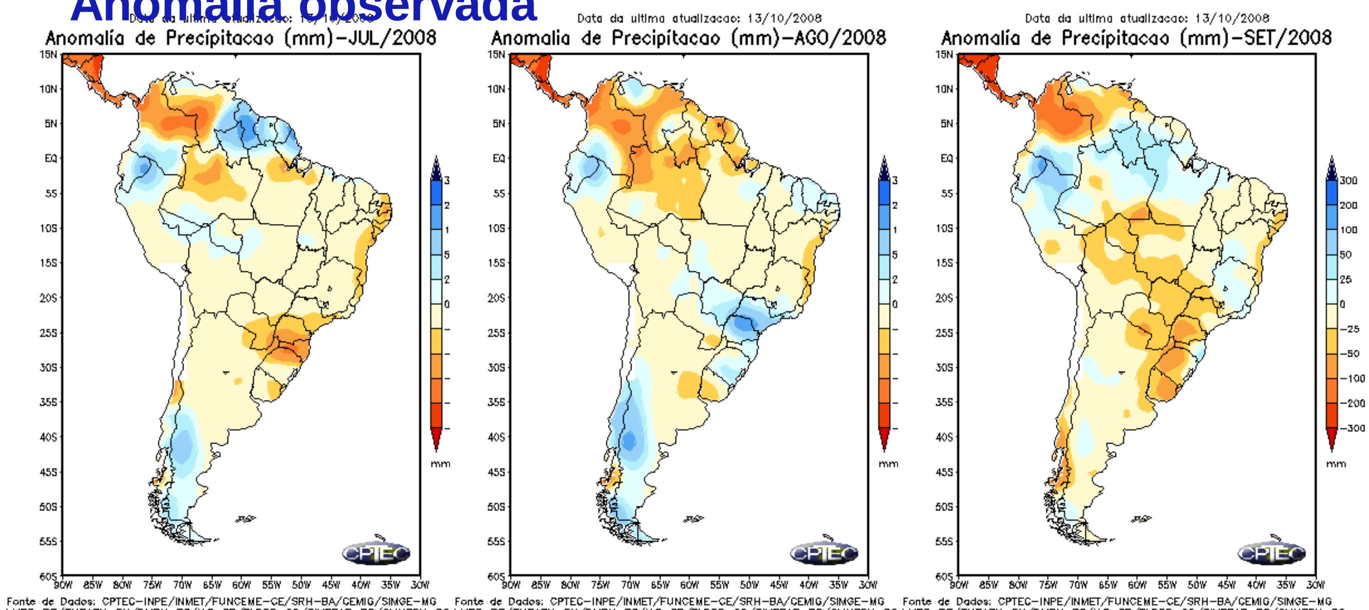
http://www.cptec.inpe.br/prevnum/prev_clima/reg_eta_clima.shtml



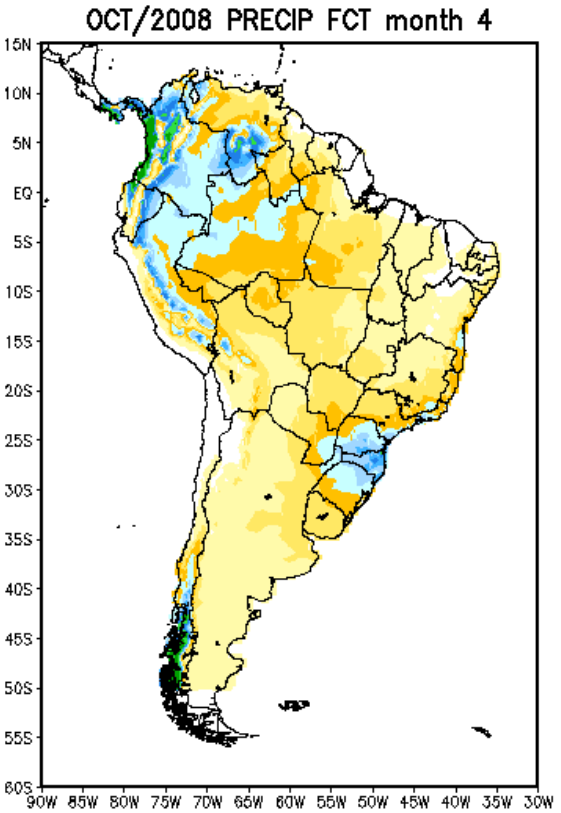
Anomalia prevista



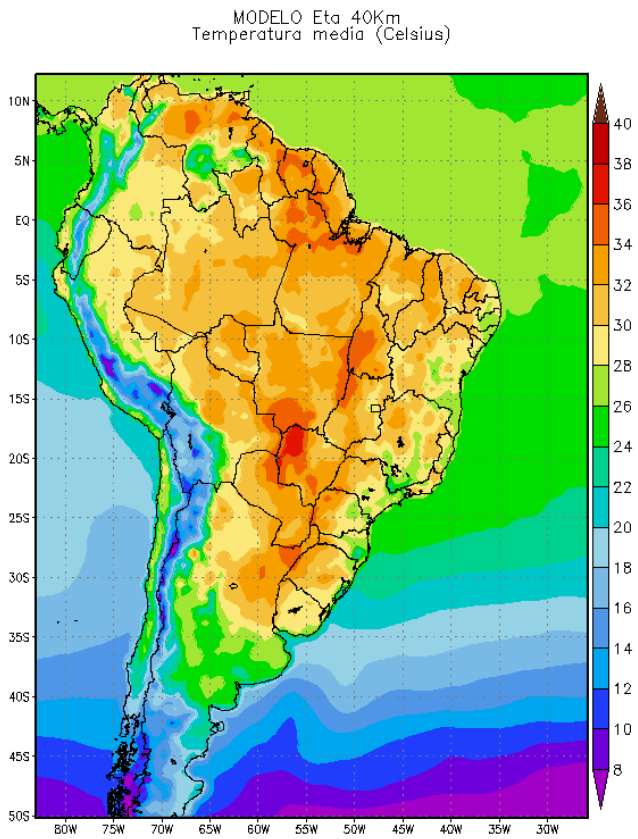
Anomalia observada



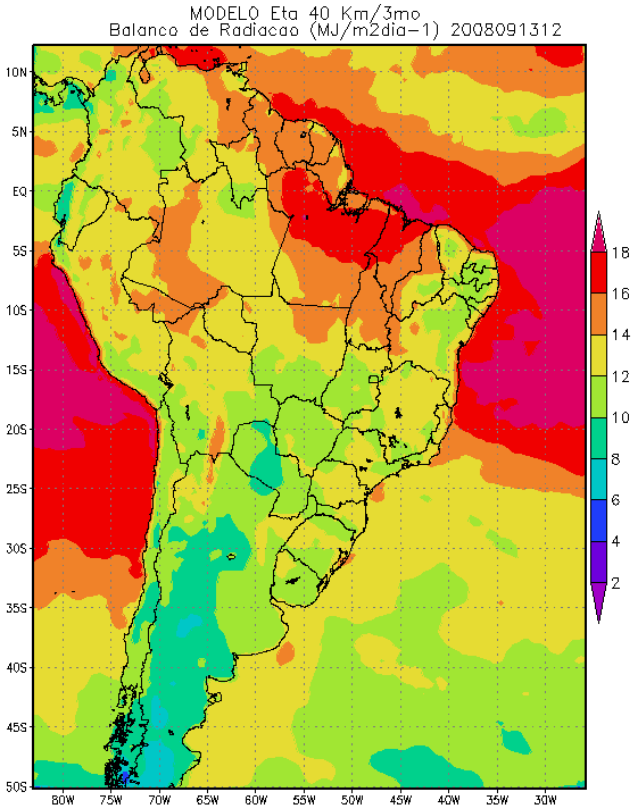
Eta-40km seasonal Forecasts



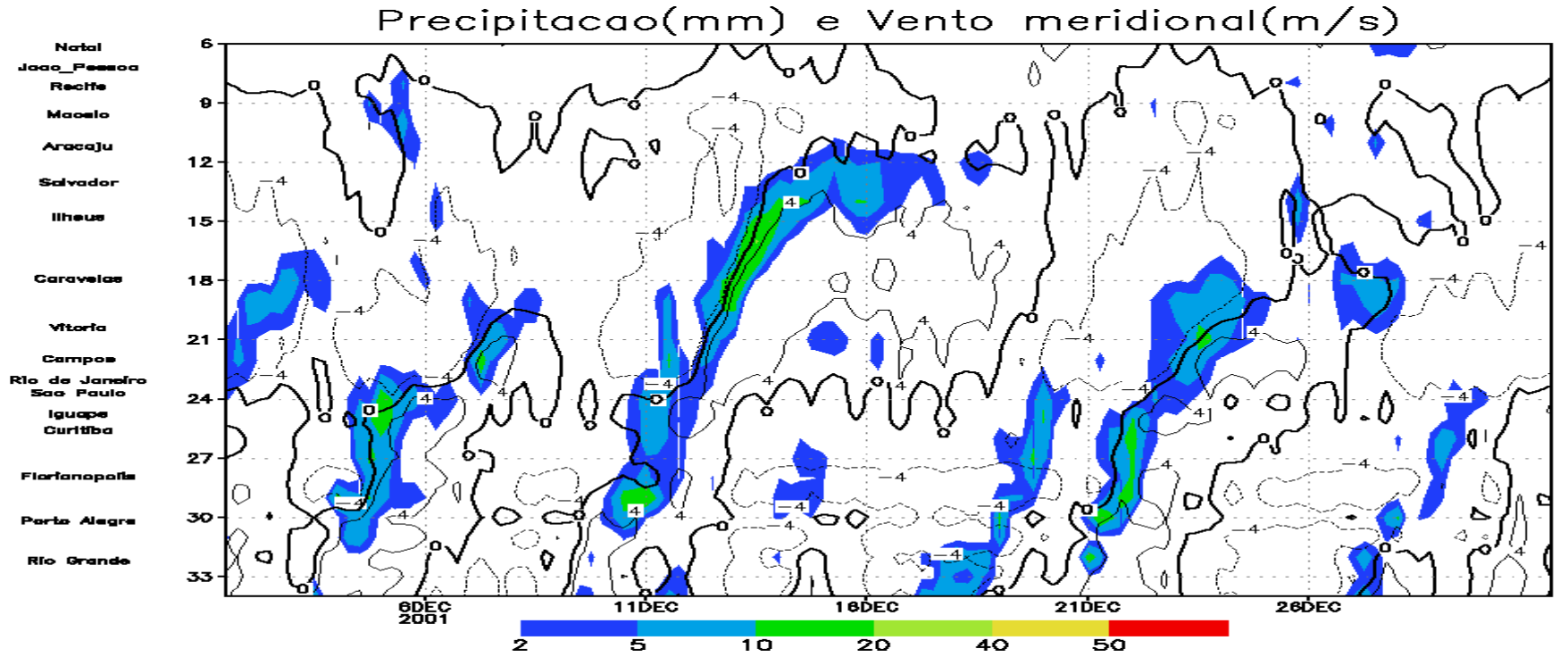
OCT 2008 Precipitation
T+4mo forecast

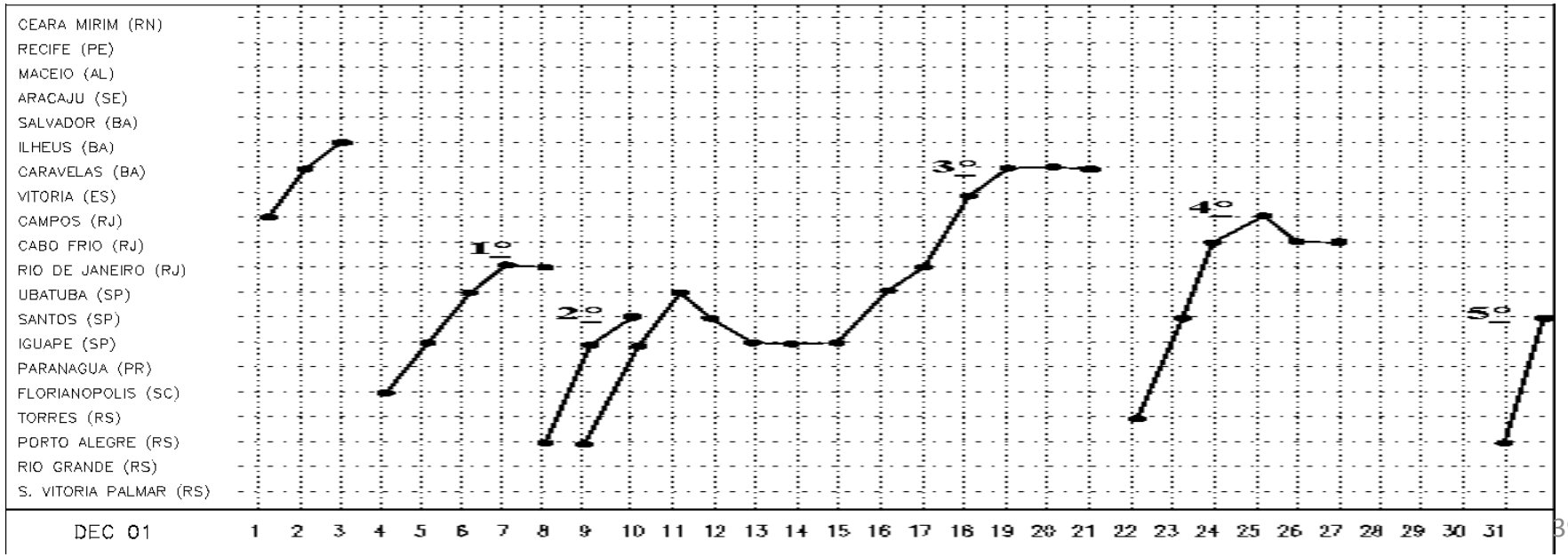


18z 2-m temperature
for NOV 2008
T+2mo forecast
Approx Tmax



Net Radiation forecast
for DEC 2008
(T+3mo forecast)


Precipitacao(mm) e Vento meridional(m/s)
Natal
Joao_Pessoa
Recife
Maceio
Aracaju
Salvador
Ilheus
Caravelas
Vitoria
Campos
Rio de Janeiro
Sao Paulo
Iguape
Curitiba
Florianopolis
Porto Alegre
Rio Grande
6
9
12
15
18
21
24
27
30
33
6DEC
2001
11DEC
16DEC
21DEC
26DEC
2
5
10
20
40
50


CEARA MIRIM (RN)
RECIFE (PE)
MACEIO (AL)
ARACAJU (SE)
SALVADOR (BA)
ILHEUS (BA)
CARAVELAS (BA)
VITORIA (ES)
CAMPOS (RJ)
CABO FRIO (RJ)
RIO DE JANEIRO (RJ)
UBATUBA (SP)
SANTOS (SP)
IGUAPE (SP)
PARANAGUA (PR)
FLORIANOPOLIS (SC)
TORRES (RS)
PORTO ALEGRE (RS)
RIO GRANDE (RS)
S. VITORIA PALMAR (RS)
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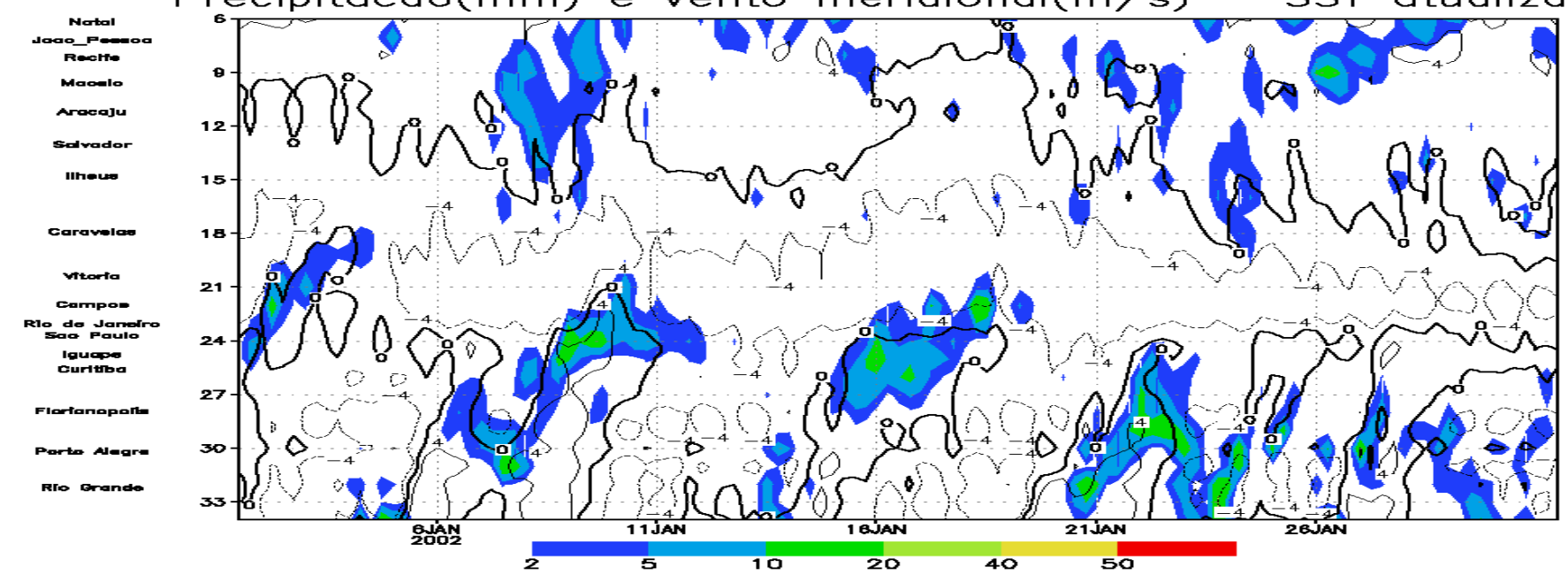
Precipitacao(mm) e Vento meridional(m/s) — SST atualizada
Natal
Joao_Pessoa
Recife
Maceio
Aracaju
Salvador
Ilheus
Caravelas
Vitoria
Campos
Rio de Janeiro
Sao Paulo
Iguape
Curitiba
Florianopolis
Porto Alegre
Rio Grande
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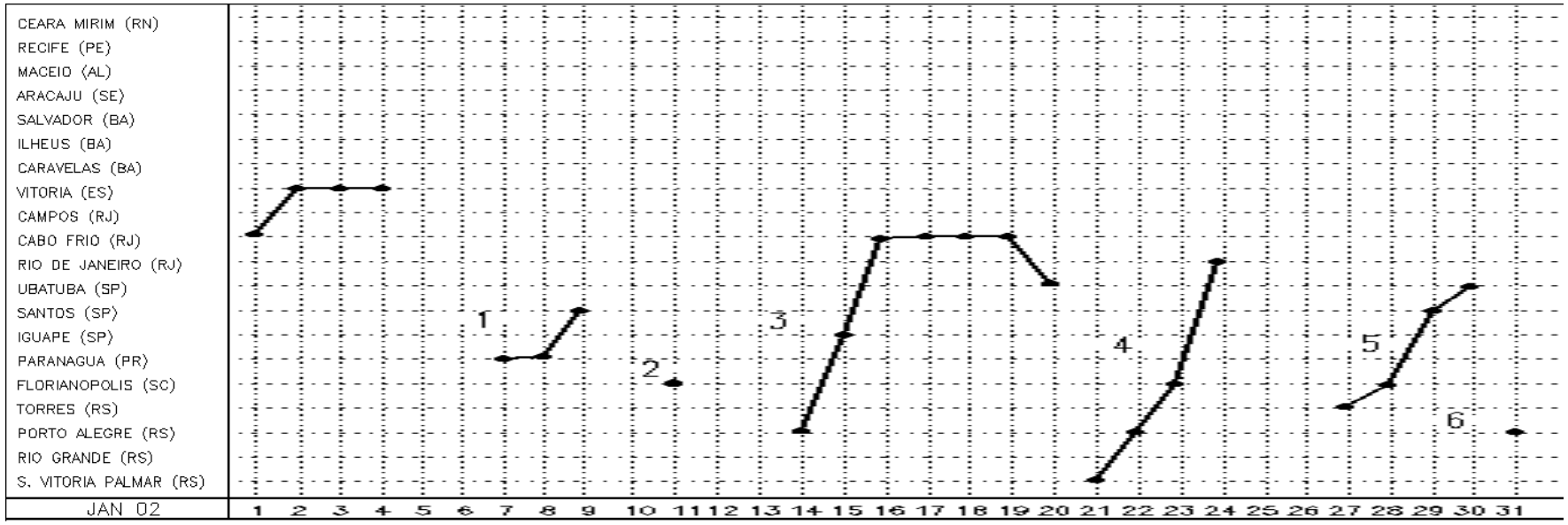
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S. VITORIA PALMAR (RS)
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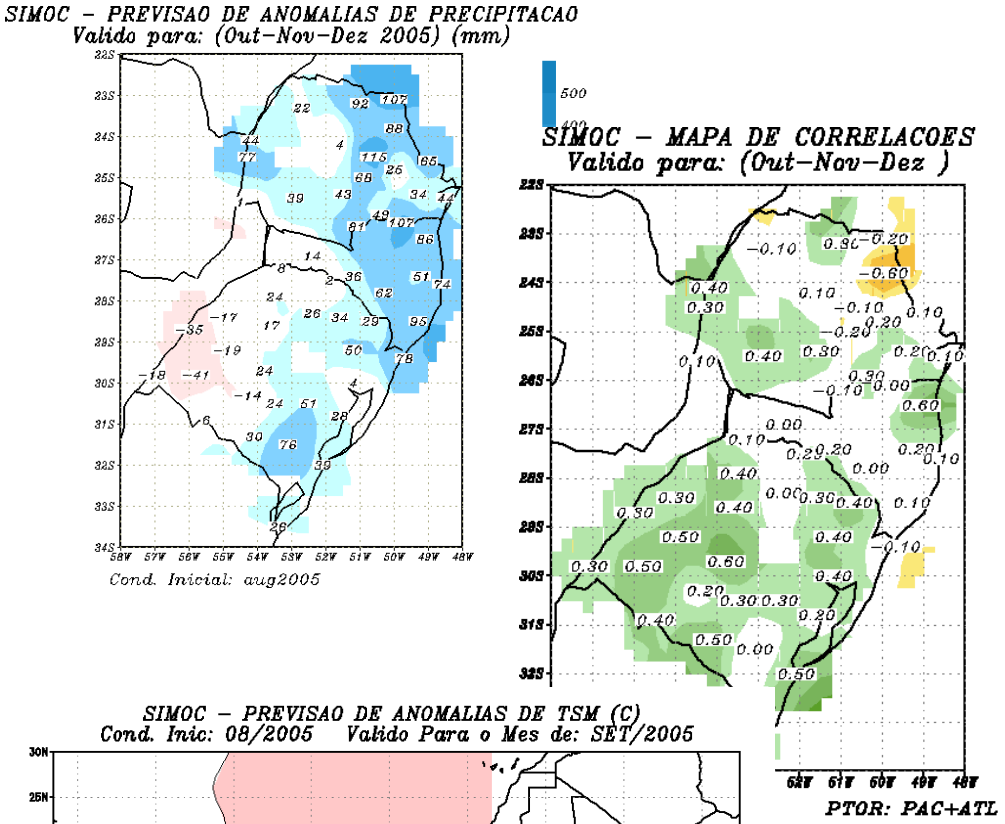
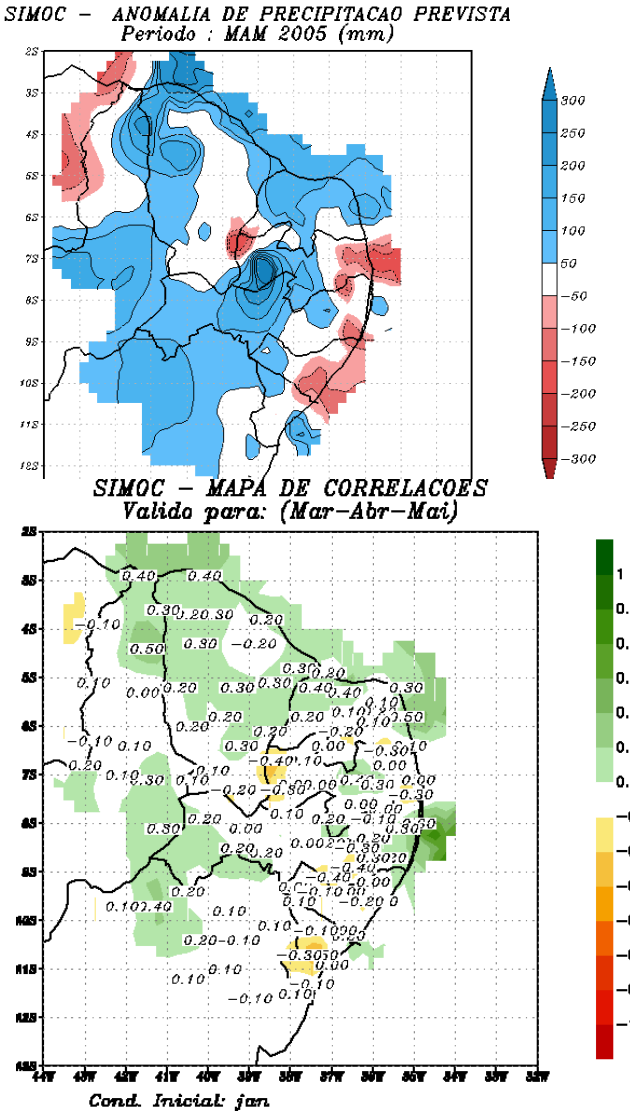
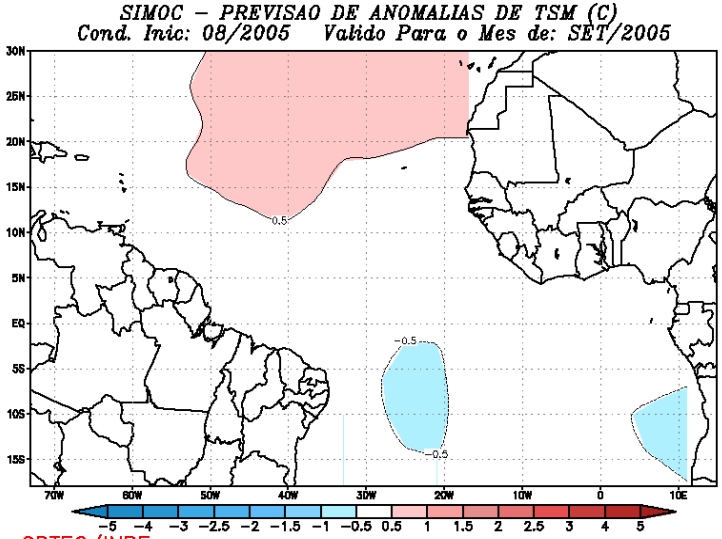
Seasonal Statistical Forecasts



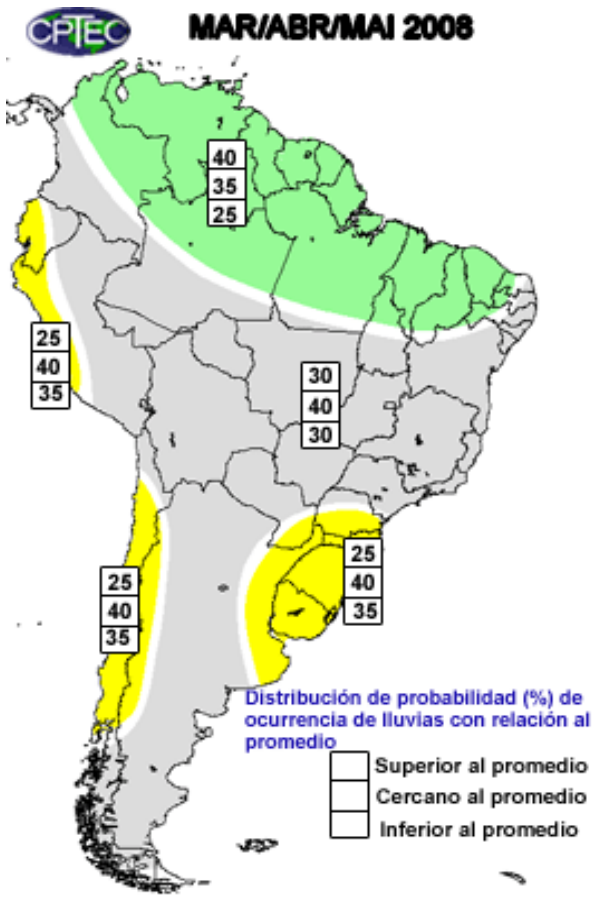




CPTEC/INPE

Seasonal Climate Prediction at INPE-CPTEC

- Real-time monthly meetings encompassing several institutions from South America
- Ensemble of AGCM and CGCM runs done at CPTEC as well as those done at IRI
- Dynamical downscaling using RCMs nested at CPTEC AGCM outputs
- Consensus precipitation forecast in terciles: Above, Normal, Below
- Consensus temperature forecast Above/Below



March-April-May 2008
Consensus Precipitation Forecast

To follow INPE-CPTEC real time monthly seasonal climate prediction Forum discussions can be accessed over the internet

(Demo)

http://visitview.cptec.inpe.br/clima/0108/poia.html

Research activities

LBC error correction

Model climatology

Coupling ocean-regional atmospheric model

Improve vegetation and soil maps

Statistical downscaling (correction)

Final remarks

CPTEC Seasonal climate forecasts are available at different horizontal resolutions. Data are available at request.

Quality of these forecasts are low, but there is some advantage over climatology information

Need of combination of dynamical forecasts with statistical model/tools

Need to explore more the use of seasonal forecast in different economic sectors: agriculture, energy, etc.

Are current systems and users prepared to take in model outputs, seasonal forecasts, probability forecasts?