

# Comparative analysis of regional simulations over South America: RegCM3 versus RegCM4

(and RegCM3 in the CLARIS-LPB Project)

International Conference on the Coordinated Regional Climate  
Downscaling Experiment – CORDEX-

**Rosmeri P. da Rocha**

Collaboration: S. V. Cuadra, L. F. Kruger, M. S. Reboita, M.  
Llopart and T. Ambrizzi

Department of Atmospheric Sciences



# Outline

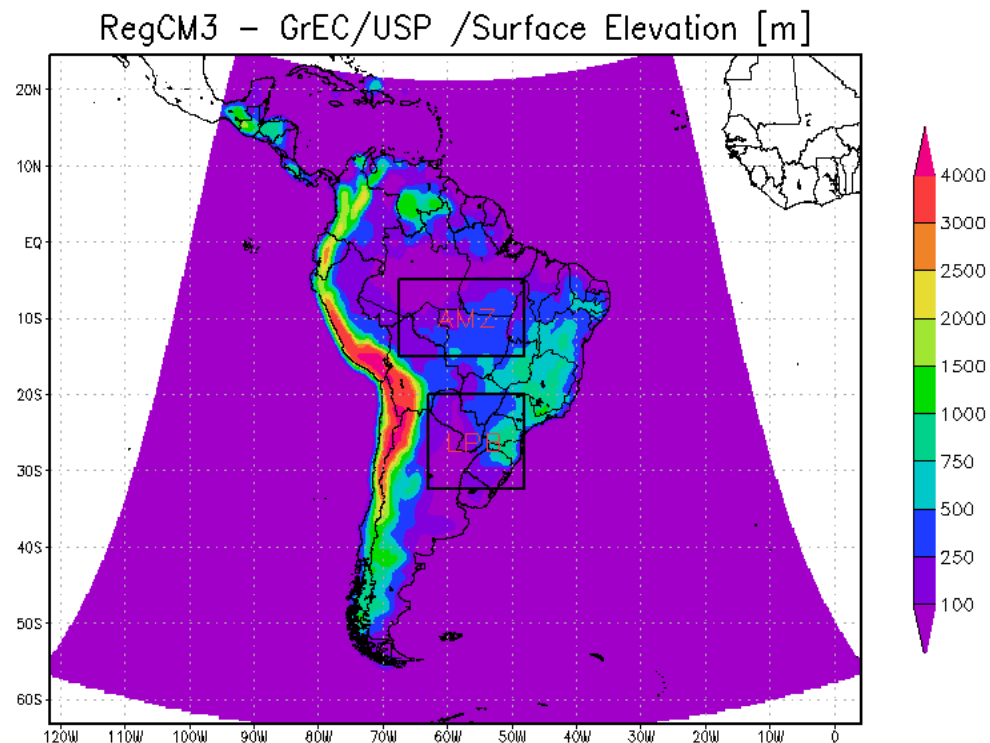
- CLARIS-LPB project has motivated optimizations in the RegCM3 model (da Rocha et al. 2011) to improve rainfall estimation over tropical and subtropical South America;
- May 2010 – RegCM4 is made available to be used in climatic simulations;

# Objective

- Comparison of RegCM3 and RegCM4 to simulate the climatology over South America;
- **To present contribution of RegCM3 to the CLARIS-LPB project (status of simulations)**
- **USP (R. P da Rocha and T. Ambrizzi):**
  - providing RegCM3 downscaling to CLARIS-LPB project
  - analyzing the relationship between extratropical/subtropical cyclogenesis in the extreme events over LPB.
- CLARIS-LPB PROJECT aims :  
*predicting the regional climate change impacts on La Plata Basin (LPB) in South America*  
*designing adaptation strategies for land-use, agriculture, rural development, hydropower production, river transportation, water resources and ecological systems in wetlands.*
- 7 regional models are involved in the regional climate downscaling (SMHI-RCA, USP-RegCM3, MPI-REMO, UCLM-PROMES and INPE-Eta).

# Simulation domain (CORDEX)

**Includes all South America continent and adjacent oceans**



## Common aspects of the simulations:

**Horizontal resolution = 50 km**

**Vertical levels = 18**

**Initial and boundary conditions:** ERA-Interim

**SST = weakly mean**

Radiation, Grell convective scheme, SUBEX, Zeng scheme for surface fluxes over the sea.

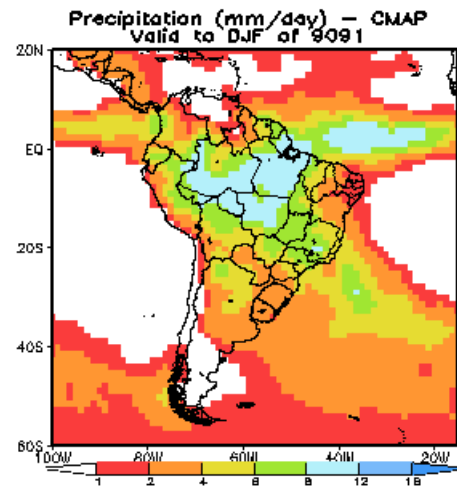
From January of 1989 to

|        | Simulation Period    |
|--------|----------------------|
| RegCM4 | Jan 1989 to Sep 1993 |
| RegCM3 | Jan 1989 to Jan 2007 |
|        |                      |

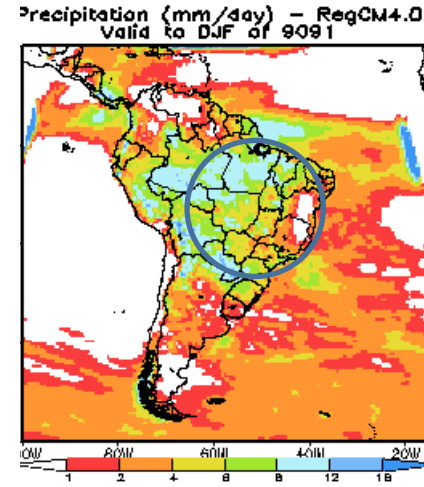
## Summer: DJF 90-91 and 91-92

90-91: RegCM4  
is wetter than  
RegCM3 over  
tropics and  
subtropics

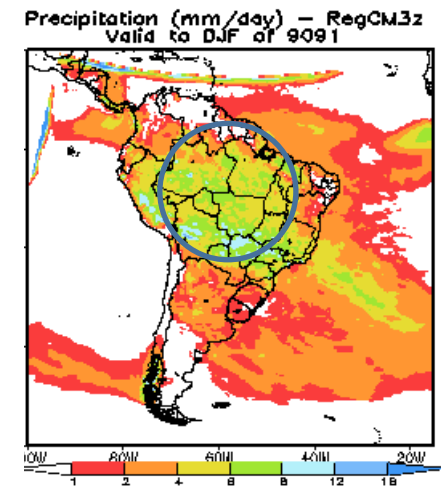
CMAP



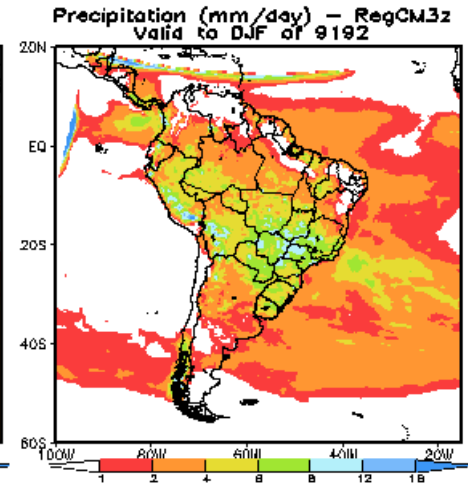
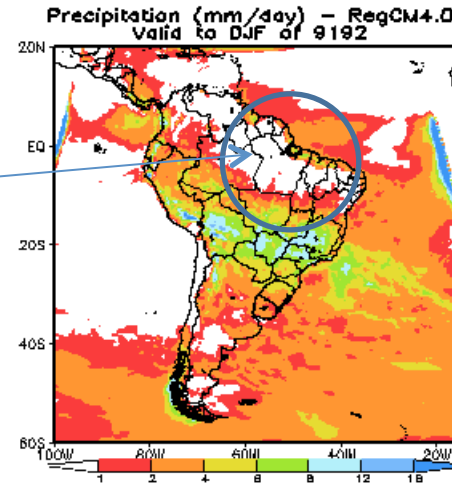
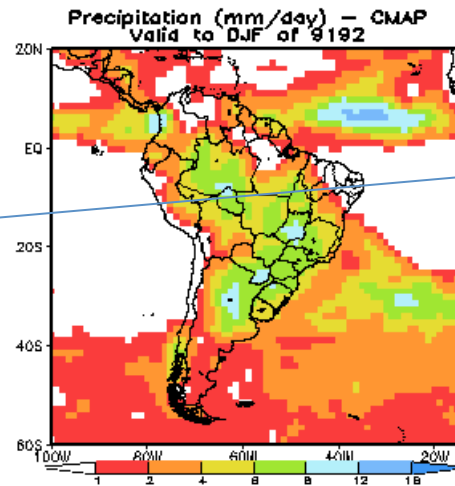
RegCM4



RegCM3



9192: RegCM4  
simulates a  
excessive drying  
in northern  
Amazon

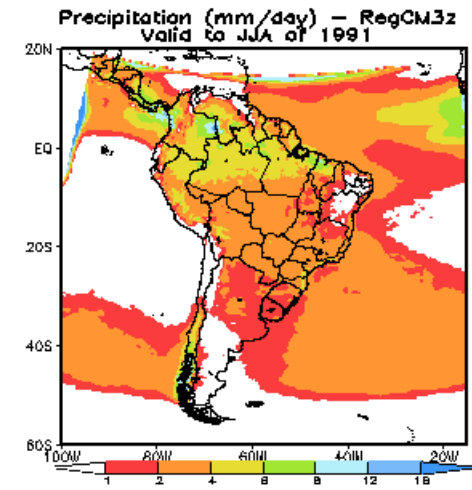
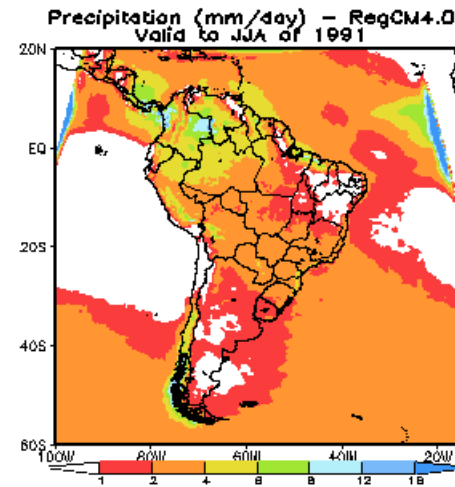
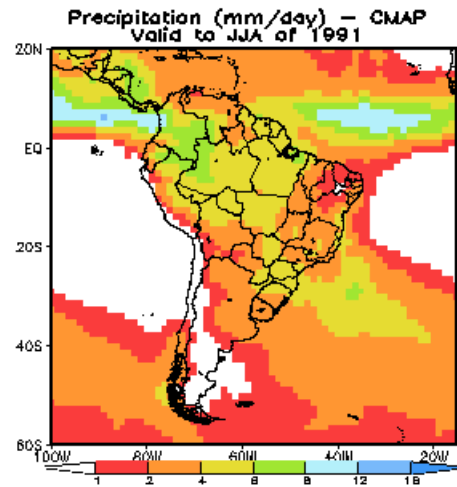


## Winter JJA 1991

CMAP

RegCM4

RegCM3



1991 was a wet winter in South America and both RegCM3 and RegCM4 capture this characteristics, although both underestimate rainfall intensity in the:

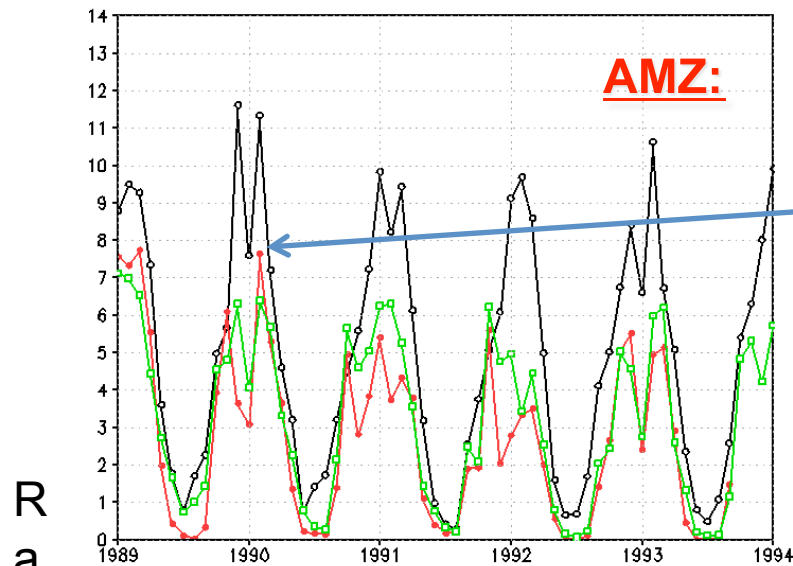
- ITCZ
- subtropics (Southeastern of South America) → rainfall associated to the transient systems

## Rainfall (mm/day) time series (monthly values)

BLACK – CMAP

GREEN – RegCM3

RED – RegCM4

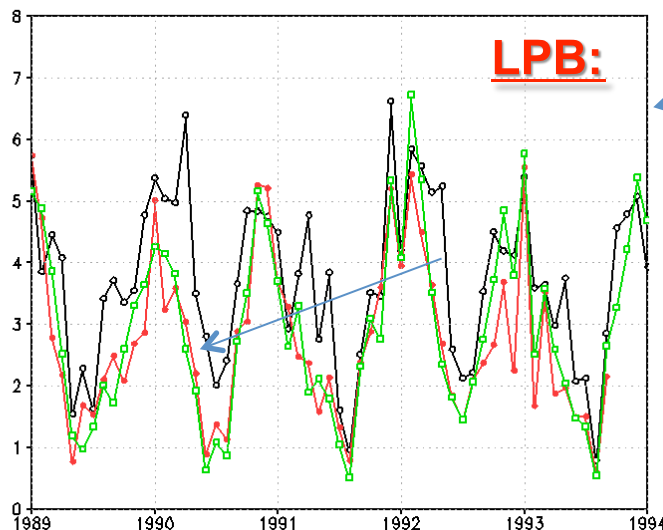


**AMZ:** RegCM3 and RegCM4 underestimate rainfall intensity during rainy season

-Difference of ~ 4-5 mm/day at every rainy season

-RegCM4 is similar/dryer than RegCM3

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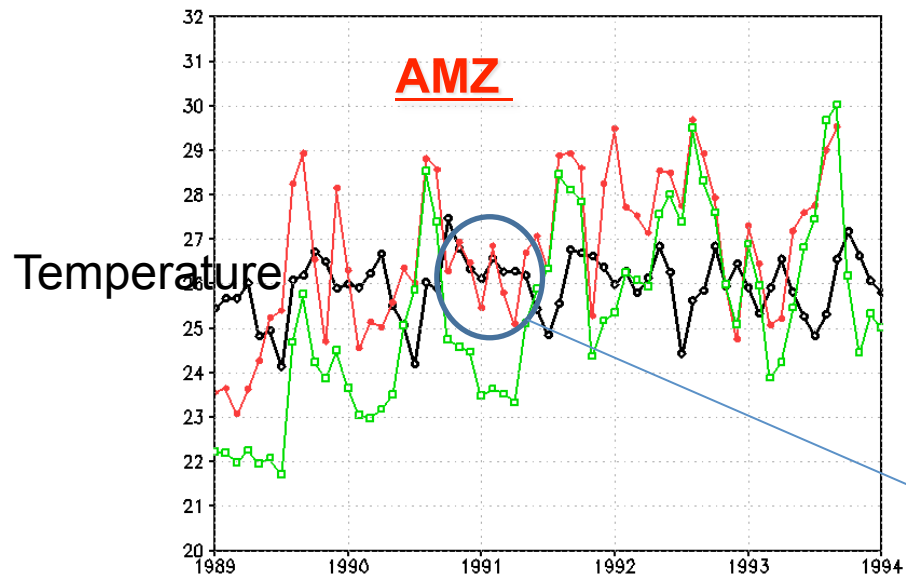


**LPB:** Larger similarities between RegCM3 and RegCM4 during summer;

**Autumn and winter:** larger underestimations of both model versions

## Air temperature (oC) time series (monthly values)

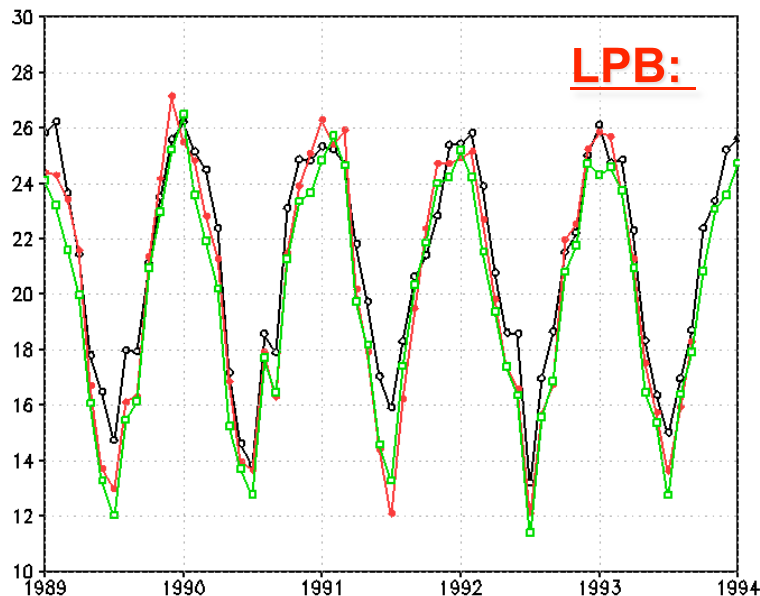
BLACK – CMAP  
GREEN – RegCM3  
RED – RegCM4



**AMZ:** in the tropics RegCM3 and RegCM4 present larger monthly variability than CRU analysis:

-Warmer dry season

-RegCM4 reduces RegCM3 cold biases during rainy season, but has large month-to-month variability.



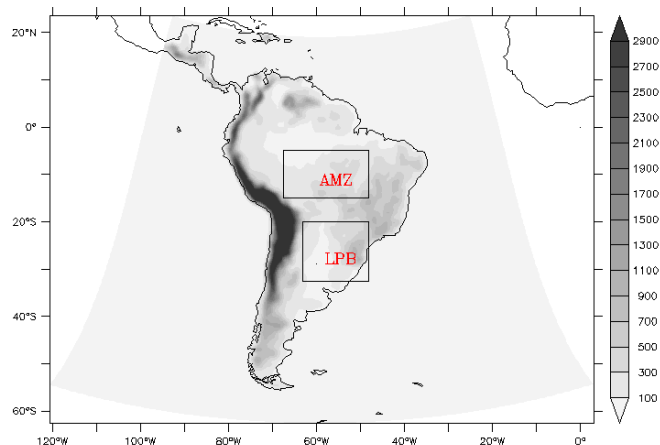
**LPB:**

RegCM4 presents a small reduction of RegCM3 cold bias during cold season

# RegCM3 simulations to the CLARIS-LPB

We are using an optimized version of RegCM3 (RegCLARIS)

| INITIAL AND<br>BOUNDARY<br>CONDITIONS<br>-----<br>PERIODS | ERA-Interim | HAdCMQ0<br>A1B | ECHAM5 |
|-----------------------------------------------------------|-------------|----------------|--------|
| 1960-1990                                                 |             | X              | X      |
| 1989-2008                                                 | X           |                |        |
| 2010-2040                                                 |             | X              | X      |
| 2070-2100                                                 |             | X              | X      |

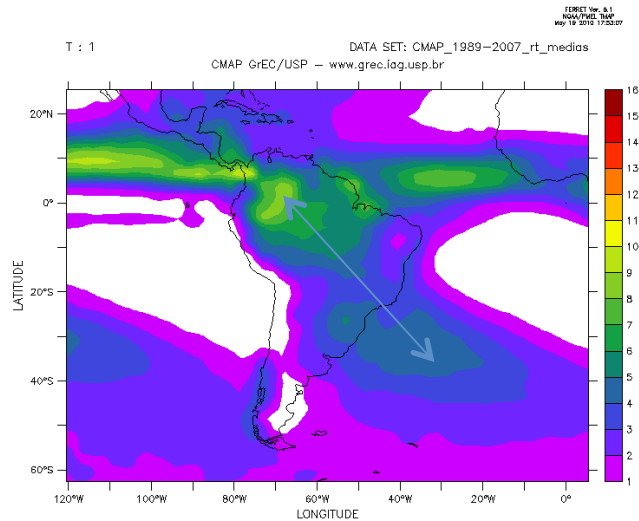


We finished 6 of the 7 simulations (except the red one) and we are finishing post-processing to send the data to the CLARIS-LPB data base until end Mach-2011 (we are 1 month late).

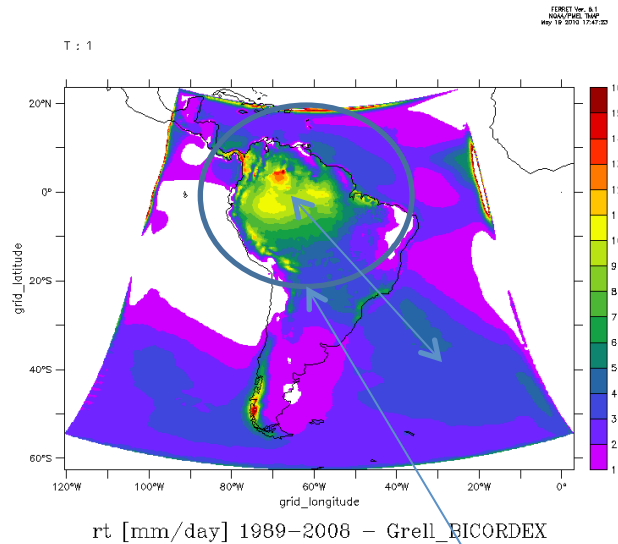
# RegCLARIS nested in ERA-Interim

## Climatology (1989-2008): annual rainfall (mm/day)

### CMAP



### RegCLARIS

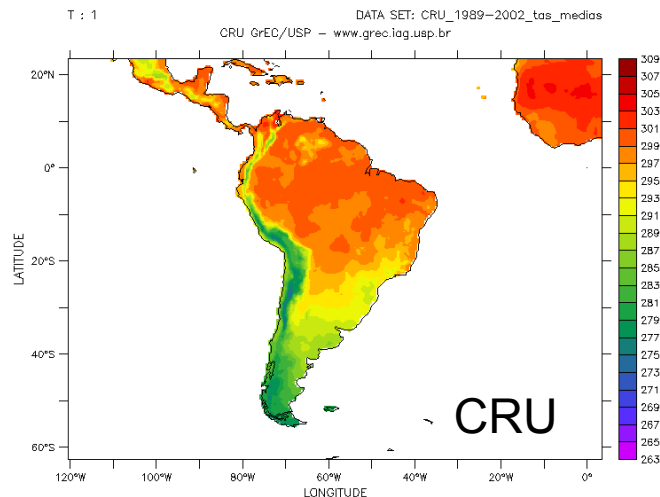


Over continental South America RegCLARIS simulates the main observed precipitation bands:

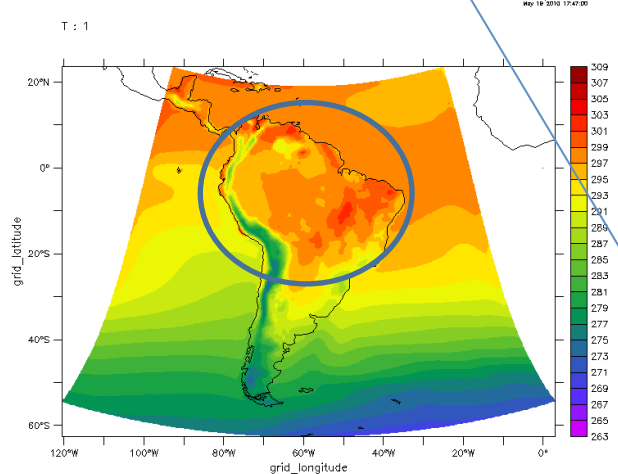
- maximum in northwestern that is NW-SE oriented and decrease of intensity in SOA

- Minimum in the center Argentina and Northeast Brazil

Simulation is wetter/colder than analysis in the northwestern part of continent

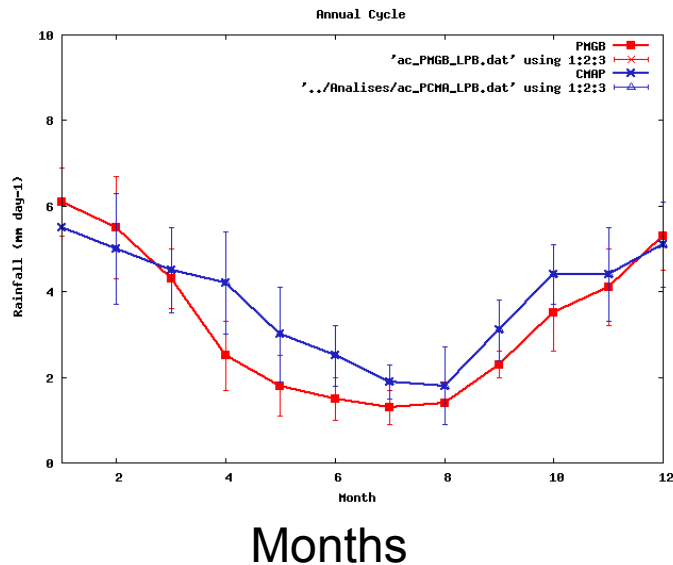
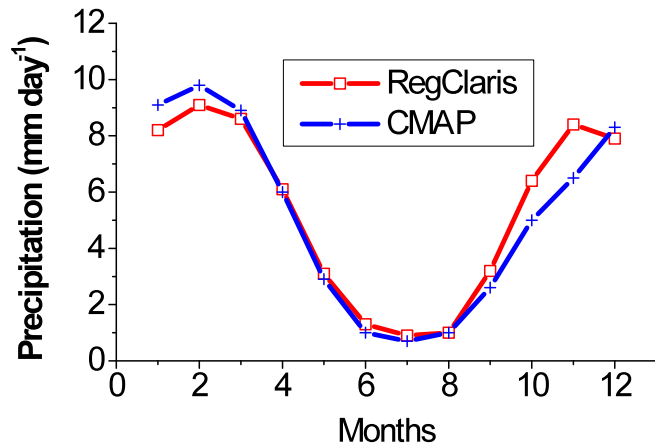


TAS [K] 1989-2002 - CRU



# RegCLARIS: climatology (1989-2008) of rainfall annual cycle and extremes

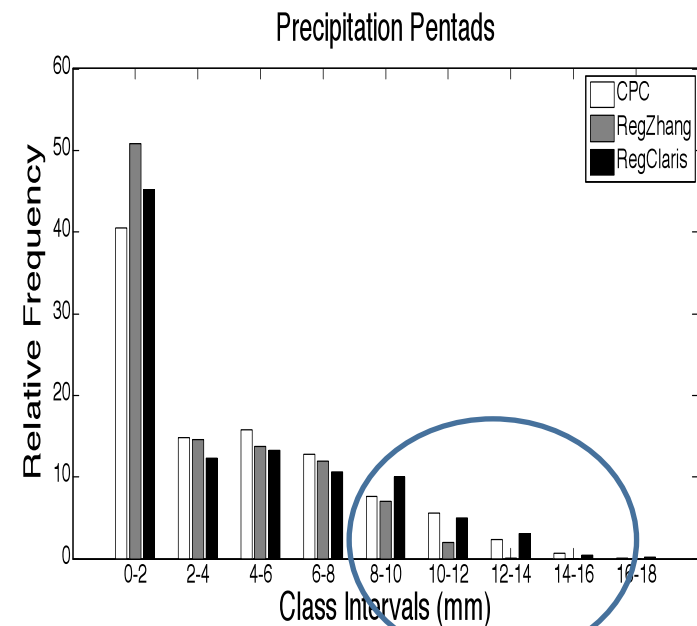
Blue: CMAP and Red: RegCLARIS



**AMZ:** simulated rainfall annual cycle similar to the observed (small overestimation during onset of wet season).

**LPB:** underestimation is larger in autumn

## Precipitation pentads over South America monsoon region



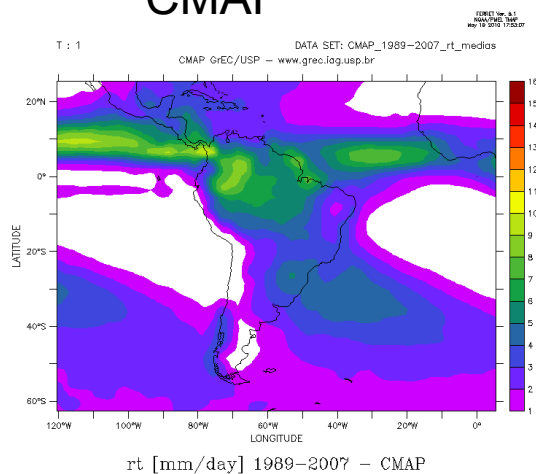
RegCLARIS: reduction of weaker rain and increase the frequency of intense events (> 8 mm/day)

Time correlation: 0.80

# RegCM3 nested in the HadCM3 – A1B

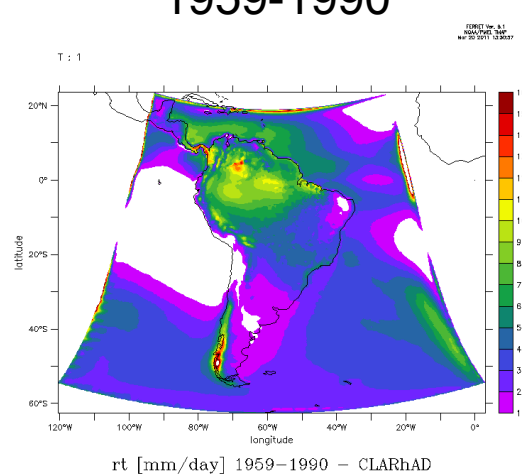
## Climatology of annual rainfall (mm/day)

CMAP



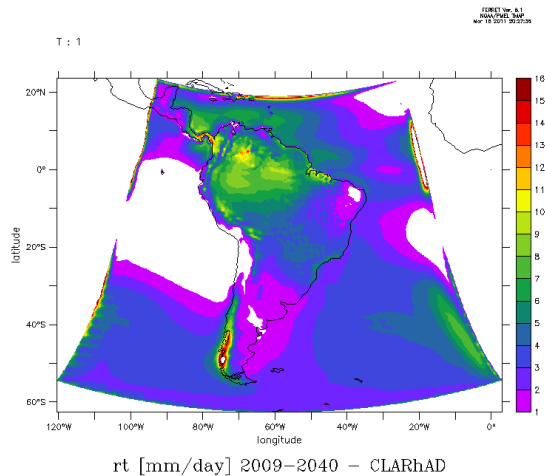
rt [mm/day] 1989–2007 – CMAP

1959–1990



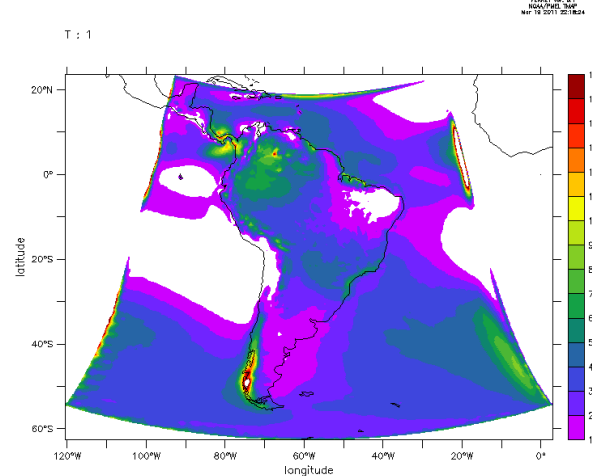
rt [mm/day] 1959–1990 – CLARHAD

2009–2040



rt [mm/day] 2009–2040 – CLARHAD

2069–2097



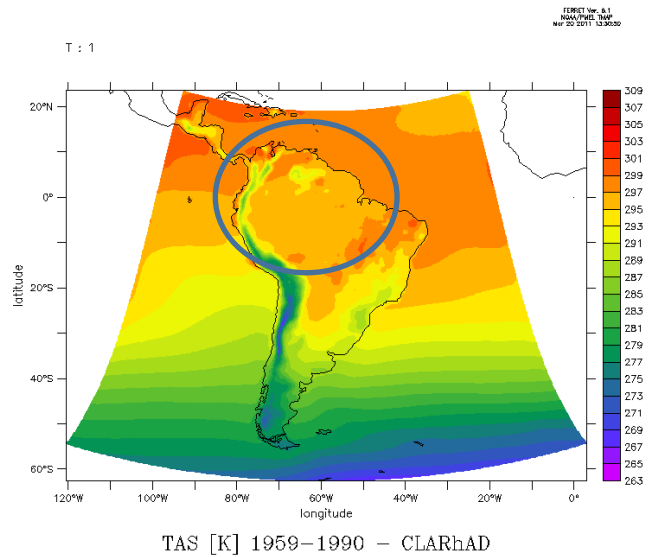
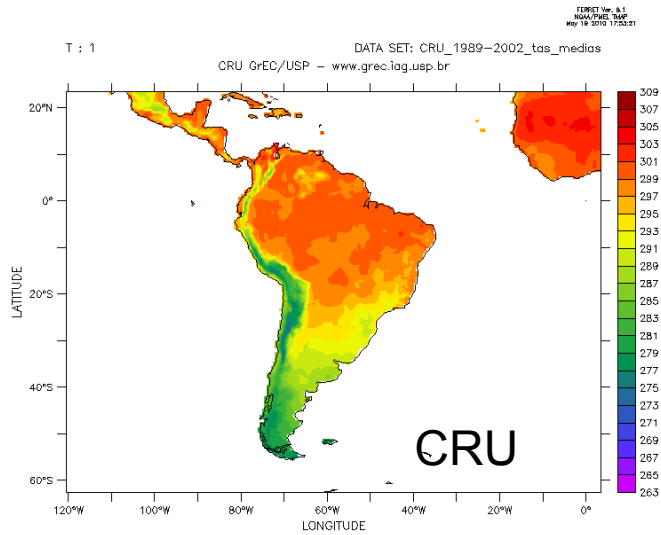
rt [mm/day] 2069–2097 – HADAM

Present day climate obtained from RegCLARIS-HadCM3 is similar to that of RegCLARIS-ERA-Interim, except for the weaker SACZ in the South Atlantic Ocean

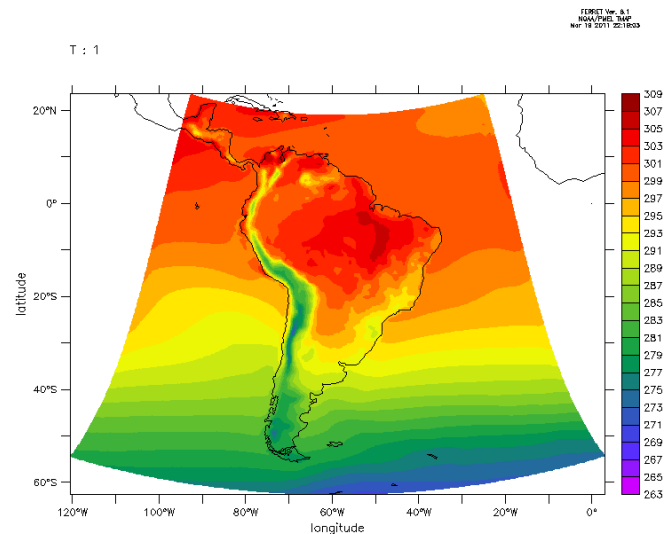
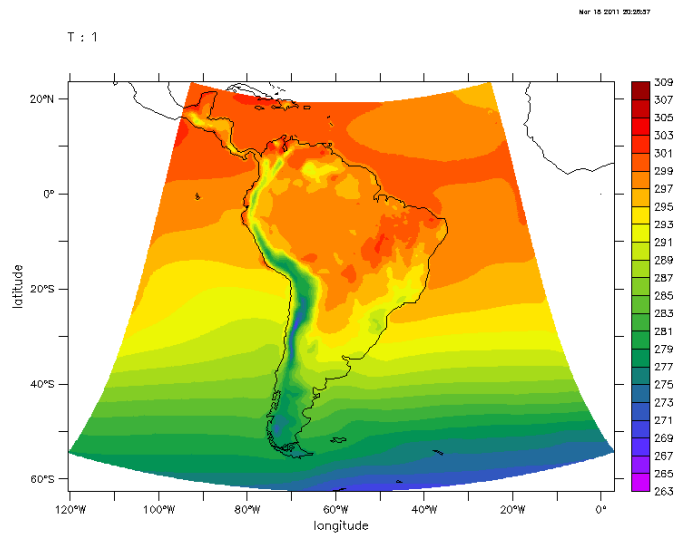
RegCM3 is showing reduction in rainfall over tropical South America (the same signal of HadCM3 driving simulation)

# RegCM3 nested in the HadCM3 – A1B

## Climatology of air temperature (oC)



Simulation in the tropics is colder than in CRU analysis → positive feedback between rainfall and lower air temperature



Scenarios are indicating strong warming

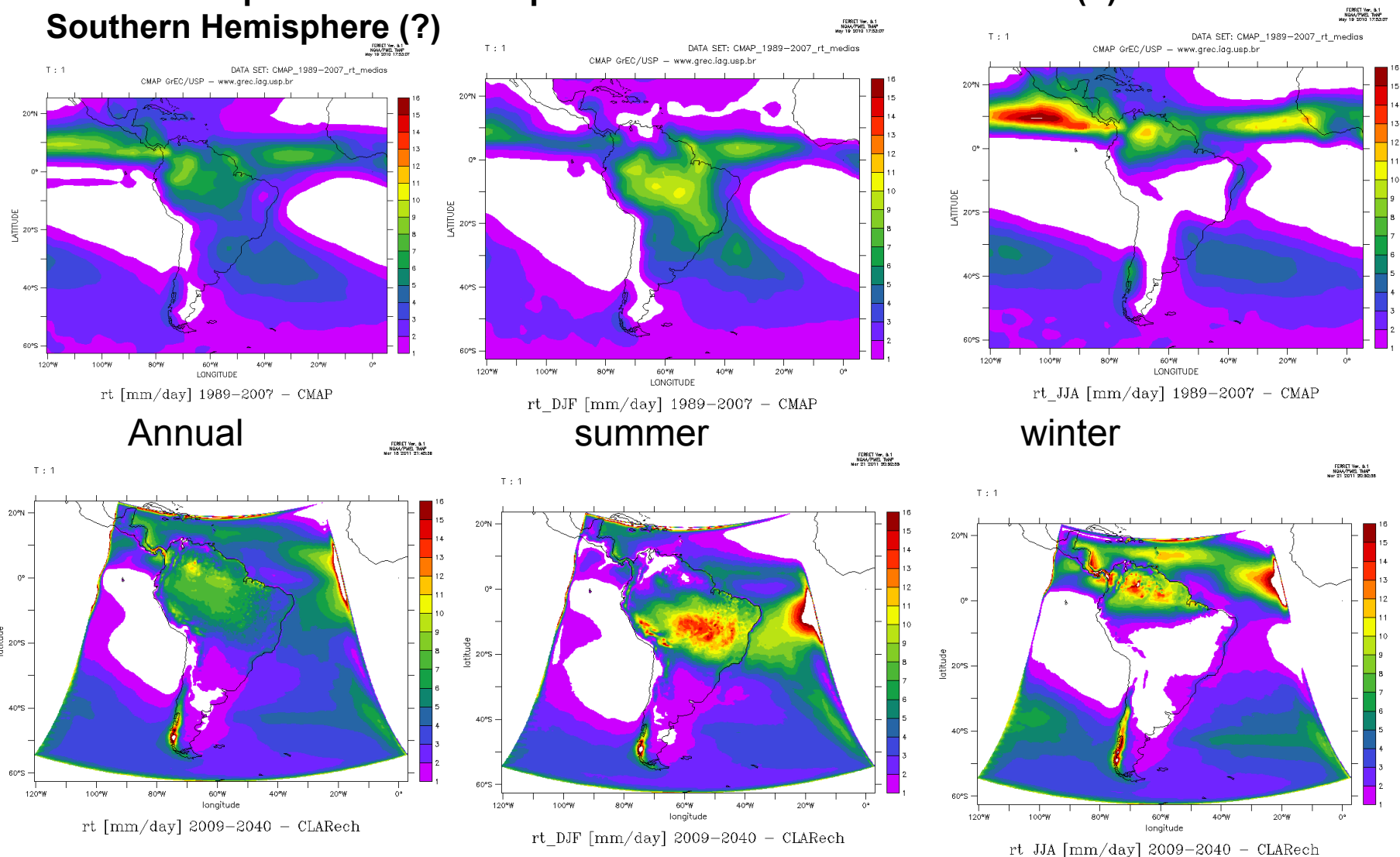
# RegCM3 nested in the ECHAM5 – A1B

## 2009-2040

**Annual scale: could apparently be useful.**

**But at seasonal scales the main large/ synoptic systems are wrongly positioned (ITCZ) or absent (SACZ) of simulation**

**Summer: tropical rainfall is displaced eastward and Atlantic ITCZ (?) is in the Southern Hemisphere (?)**



# Summary and conclusions

- RegCM3 x RegCM4
  - there are small differences in the annual cycle and monthly variability of rainfall over LPB and AMZ;
  - differences are larger for air temperature in the tropics (larger month-to-month variability in RegCM4 than RegCM3). RegCM4 reduces a little the cold bias in the tropics.

# RegCM3 – CLARIS-LPB

- RegCM3- simulations will be available in the CLARIS-LPB data base soon and
- they will be used together other models (MM5, RCM1, PROMES, REMO, WRF, ...) → making a multi-model ensemble to study-understand climate change in the subtropical South-America

Thank you!!