Land Surface Feedbacks and Climate Change over South America as Projected by RegCM4

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1. Introduction

→ The hydroclimatic regime variability over the Amazon and La Plata Basin, the two main Basins of South America (SA), are affect by local climate feedbacks (da Rocha et al. 2012) and for climate patterns associated with SST anomalies (Grimm et al. 1998)

2. Objectives

→ In the context of CORDEX (Coordinated Regional Downscaling Experiment), the objective of this study is to evaluated the local and remote impacts of climate change over SA using the Regional Climate Model (RegCM4 – Giorgi et al. 2012) driven by three different global climate models (GCMs) during the rainy season .

3. Data and Methods

- *Forcing and Simulations Design*

→ RegCM4 simulations forced by GCMs (**Table 1**) for one scenario (rcp8.5). RegCM4 is integrated from 1970 until 2100, horizontal resolution of 50 km and 18 sigma-pressure levels. We focused in two time periods as show in **Table 1**.

Table 1. Names and periods of RegCM4 simulations

Experiments Acronyms	Drive Model (GCM)	Reference Period	Far Future Period
RegHad_BATS	Had_GCM	1975-2004	2070-2098
RegHad_CLM	Had_GCM	1975-2004	2070-2098
RegGFDL	GFDL_GCM	1975-2004	2070-2098
RegMPI	MPI_GCM	1975-2004	2070-2098

→ All simulations used CLM land surface scheme and Emanuel convective scheme, except for one simulation, driven by Had_GCM, that used BATS as a land surface scheme and a mixed convective scheme.

→ Simulation domain (**Fig.1**) was defined following CORDEX projec t (Giorgi et al. 2009). Also shown in **Fig.1** are the two different subregions representing the two main basin in AS – Amazon (AMZ) and La Plata Basin (LPB) – selected for more detailed analysis.

→ Reference period was compared to observation dataset of CRU (Climate Research Unit)

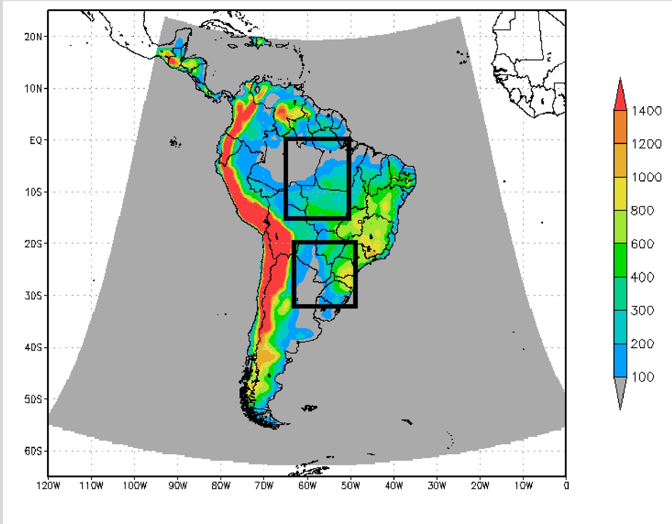

Figure 1. Domain and location of the AMZ and LPB

- *Statistical Approach*

→ The Parameter λ is used to investigate the strength of the coupling between soil moisture and precipitation (Orlowsky and Seneviratne, 2010; Mariotti et al. 2011; Notaro and Liu, 2008)

→ Using equation bellow we compute the feedback parameter λ between soil moisture and precipitation in the simulations:

$$\lambda = \frac{\mathrm{cov}(s(t-\tau), a(t))}{\mathrm{cov}(s(t-\tau), s(t))}$$

- S Is a slowvarying variable (soil moisture)
- a Is a fast varying atmospheric variable (precipitation)
- τ Is the time lag

→ In this analysis λ thus represents the fraction of precipitation change attributed to variations in monthly soil moisture.

4. Results and Discussion

→ For the present day climate (**Fig. 2**), the regional simulations reproduce reasonably well the precipitation annual cycle over AMZ and LPB. In particular the RegCM4 runs driven by MPI and GFDL are quite good over the AMZ and RegCM4 runs driven by HadGEM for LPB.

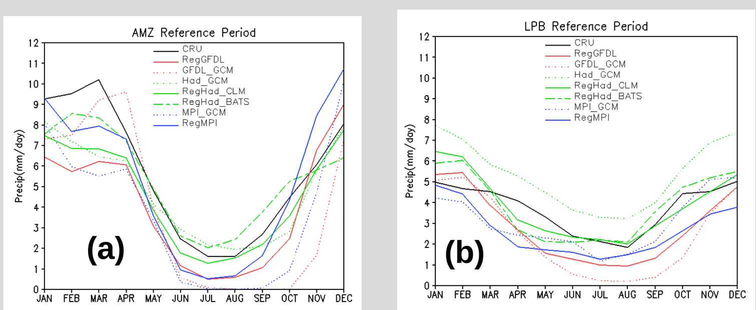

Figure 2. Annual Cycle of precipitation for reference period **(a)** over AMZ **(b)** over LPB

→ For the future climate projections (**Fig. 3**), all global models show a precipitation decrease over the central Amazon Basin, northeast Brazil, and northern of SA (ranging from -5 to -25%), except the GFDL. Over LPB, mainly over northern Argentina and western AMZ regional simulations indicate na increase of precipitation (ranging from 25 to 50%). These patterns are intensified in the RegCM4-CLM simulations.

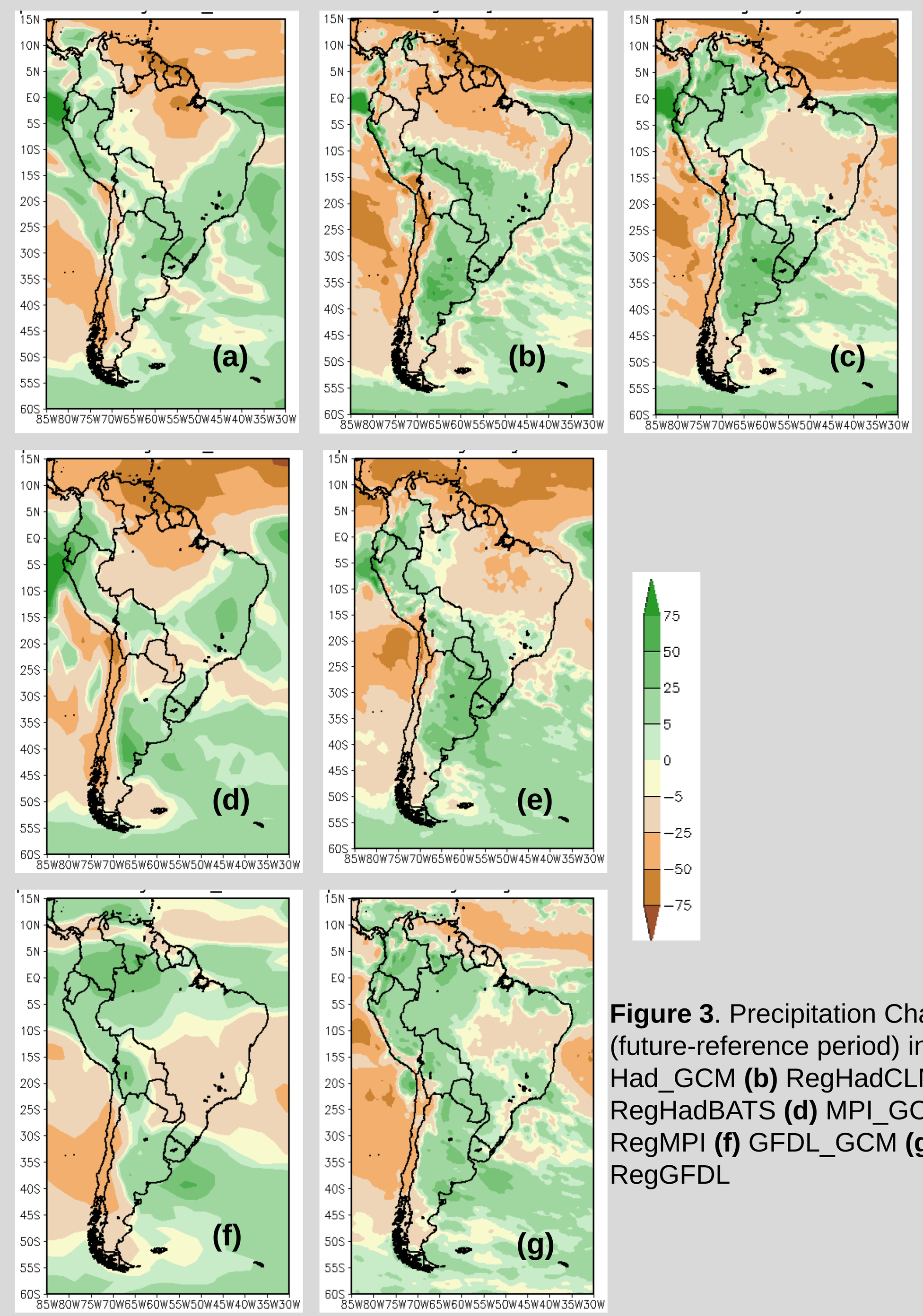

Figure 3. Precipitation Change (future-reference period) in % **(a)** Had_GCM **(b)** RegHadCLM **(c)** RegHadBATS **(d)** MPI_GCM **(e)** RegMPI **(f)** GFDL_GCM **(g)** RegGFDL

→ Over LPB all models presented a positive coupling between sea surface temperature (SST) in Niño 3.4 region and precipitation for far future period (**Fig.4**). This positive feedback was also observed during the reference period (Ropelewski and Halpert, 1987;1989).

→ A strong negative SST/precipitation regression is projected by all models (regional and global) over southeastern AMZ. RegCM4-CLM simulations indicates a positive signal over most of the northwestern AMZ. For present day climate, many studies have shown that El Niño (EN) years are related with drier periods in AMZ (Grimm and Ambrizzi, 2009).

→ The anomalies of the λ (**Fig.4**) show a decrease between soil moisture and precipitation coupling over AMZ. This decoupling is more discernible for the simulations using CLM land surface scheme.RegHadBATS simulation presents in general high λ anomaly values.

→ The RegCM-CLM simulations have a common feature and they show a similar behavior, a decrease in anomalies of λ over AMZ and an increase over LPB, except for RegGFDL. The RegCM-BATS shows a different soil moisture feedback picture – that identifies different hot-spot zones of soil moisture and precipitation. This distinction may be explained by the differences in the two land-surface schemes and in the precipitation change signal.

→ ***From the results presented here, it is clear that the differences between present and future climate are no completely well understood. RegCM4 simulations driven by different GCMs show divergent patterns in simulate precipitation and also for the coupled between precipitation and soil moisture. A more detail analysis is encouraged.***

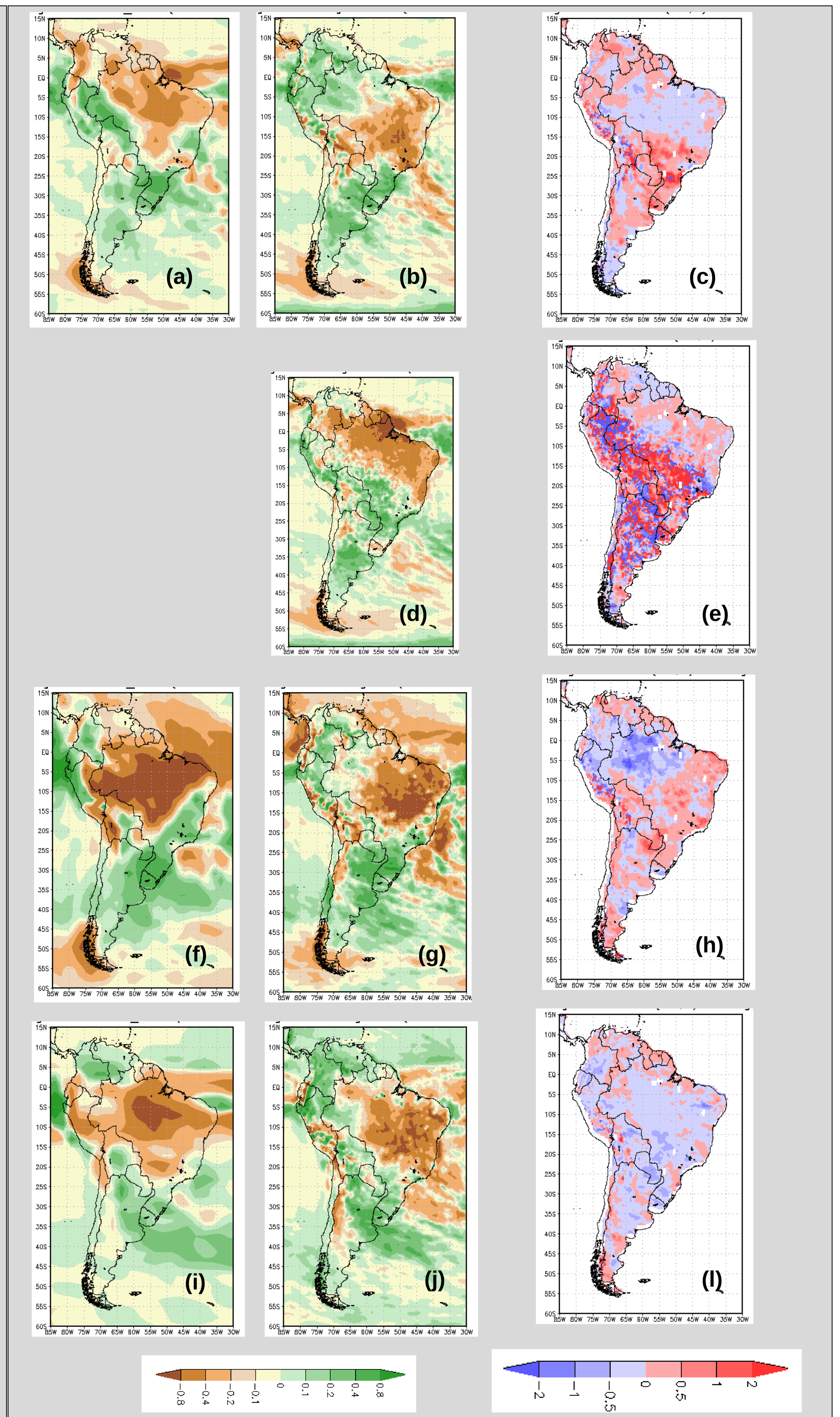

Figure 4. Regression between SSTxPrecip and λ change **(a)** Regression Had_GCM **(b)** Regression RegHadCLM **(c)** λ Change RegHadCLM **(d)** Regression RegHadBATS **(e)** λ Change RegHadBATS **(f)** Regression MPI_GCM **(g)** Regression RegMPI **(h)** λ Change RegMPI **(i)** Regression GFDL_GCM **(j)** Regression RegGFDL **(l)** λ Change RegGFDL. The SST anomaly index is defined as the SST anomaly mean over the box: 1700W-1200W and 50N-50S (Niño 3.4)

5. Acknowledgments

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