Instrument: **SP1 Cooperation**

Thematic Priority: **Priority Area 1.1.6.3 "Global Change and Ecosystems"**

FP7 Collaborative Project – Grant Agreement 212492

CLARIS LPB
A Europe-South America Network for Climate Change Assessment and Impact Studies in La Plata Basin

DELIVERABLES

D4.2: Progress report on the statistical characterization of the variability patterns, trends and shifts detections in time- series of precipitation (instrumental and proxy), streamflows and temperature observations.

Due date of deliverable: Month 6

Start date of project: **01/10/2008** Duration: 4 **years**

Organisation name of lead contractor for this deliverable: P1-IRD

Deliverable No	Deliverable title	WP	Lead beneficiary	Estimated indicative person-months (permanent staff)	Nature	Dissemination level	Delivery date
D4.1	Progress report on the statistical characterization of the variability patterns, trends and shifts detections in time-series of precipitation (instrumental and proxy), streamflows and temperature observations.	WP4	P1-IRD	11,50	R	U	6

WP4 - Hydro climate low-frequency variability trends and shifts in the LPB: Characteristics and Large-scale mechanisms

WP Leaders: Myriam Khodri (IRD), Marcelo Barreiro (UR), Leila de Carvalho (USP)

Progress Report on the statistical characterization of the variability patterns, trends and shifts detections in time- series of precipitation (instrumental and proxy), streamflows and temperature observations (6 months)

The WP4 has three mains objectives:

I. To characterize the regional interdecadal variability over South America and to advance our understanding on the key processes that govern the climate natural low-frequency variability and trends over the past 150 years in the La Plata Basin using observations (input from WP3) and global models.

II. Evaluate the uncertainties involved with the IPCC AR4 (A1B SRES scenario) projected hydroclimate changes on two time horizons: 2010-2040 and 2070-2100.

III. Produce a set of scenarios to assess the uncertainties of future projections due to decadal variability for WP5, WP8 and WP9.

Due to the delay in funding and consequences in the hiring process, the tasks planned for the first 6 months of the project were only partially initiated. This document provides therefore an update to the KOM meeting report, giving the progress status only for those tasks that have already started and groups that were able to initiate the work without funding.
For a reminder, during the **first 6 months** we've planned to start addressing the **Objective I.** and explore the following scientific questions:

- What are the characteristics of the **observed low-frequency** hydroclimate variability and trends in the LPB region and their **teleconnections** to global modes of variability?
- What are the characteristics of the **observed hydroclimate "shifts"** during the 20th century, i.e. rapid and persistent transition between two stable climatic "equilibriums" or simply a change of phase within a decadal signal?
- What are the roles of large-scale variability in determining the **observed precipitation and temperature** variability and trends in the LPB?

Task 4.1*: Statistical characterization of the variability, trends and "shift" during the 20th century, at the record's local-scale using a set of observations and proxy over the SESA, Andean, Patagonian and Amazonian regions.*

Item 4.1.1*. Work on long instrumental records for a few specific stations that cover at least 60 years. Collaborations within WP4*

In the first stage of the project since the La Plata Basin Database is not yet available, few groups have started the investigation using already available data. This report there

- **CONICET** (Carolina Vera, Gabriel Silvestri) initiated the planned work on a few individual instrumental times-series for precipitation (gauge based).

Vera and Silvestri are currently working on the analysis of the low-frequency variability of precipitation at the different sub-regions of LPB. A dataset that includes temporal series of precipitation monthly data of around 100 years for a small group of stations was organized. Variability bands on interannual, inter-decadal and multi-decadal time scales were isolated from the precipitation time series using Fourier analysis. Similar analyses were performed also to ENSO and SAM indexes. Current work is concentrated on understanding the main features that characterize the precipitation variability on those bands, to distinguish the differences in the variability at both tropical and subtropical regions and to understand how they are related to the variability associated with the large-scale forcing. A paper is currently being in preparation that will be tentatively submitted for publications in a few months.

- **UFPR** (A. Grimm) is well advanced in the task of characterizing inter decadal variability of precipitation over South America.

This work is being carried out through the ACP analysis of 50 years series of observed data over extensive areas of the continent. The analysis is being complemented by work on fewer longer series over a more limited area. Also the connection of the modes of precipitation variability with global SST variability is being investigated. A paper on interdecadal variability was presented at the 9th International Conference on Southern Hemisphere Meteorology and Oceanography, held in Melbourne, Australia, on February 2009. The reference is: Grimm, A. M., J. P. J. Saboia, J. W. Y. Bernardo, A. L. Frigo, 2009: INTERDECADAL OSCILLATIONS OF THE SOUTH AMERICAN MONSOON AND ITS EXTREME PRECIPITATION EVENTS. Preprints of the 9th International Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne, Australia, American Meteorological Society. Available at http://www.bom.gov.au/events/9icshmo/manuscripts/W0845_Grimm.pdf

Item 4.1.2. **Integrating longer-term proxy with instrumental records to help in characterizing the low frequency variability of the 20th century. Collaborations between WP4 and the Paleo-group of WP3**

This task hasn't started yet since the approach will strongly depend on the results obtained within Item 4.1.1. However a workshop has been scheduled for the beginning of September 2009 regrouping **IRD** (M. Khodri, F. Vimeux, F. Sylvestre), **CIGES-CONICET** (E. Piovano), University of Geneva (Daniel Ariztegui)**, USP** (L. Carvalho) and **CONICET** (C. Vera) to work on characterising the low frequency variability of the isotopic proxy data (for the last 150 years) from Andean and Patagonian ice cores and SESA lakes cores and compare to instrumental records to see if this is consistent. The workshop will be hosted by IRD (M. Khodri) in Paris.

Task 4.2: *Statistical characterization of the patterns of interdecadal variability of precipitation over South America and its relationship with global modes of low-frequency variations during the 20th century, with emphasis on regions with strong components of interdecadal variability*

Item 4.2.1. **Relating Amazonian and LPB precipitation anomalies to weather regimes**

IRD (Jhan Carlo Espinoza, María Laura Bettolli, Josyane Ronchail, Mathieu Lengaigne, Jean Philippe Boulanger, Ariel D'Onofrio.) have applied Neuronal networks as self-organizing maps (SOM or Kohonen maps –Kc-, Kohonen 1984, Leloup 2007), and an ascendant hierarchical classification in order to

identify the synoptic conditions that characterise the atmospheric circulations at large-scale in the tropical South America (Weather Types –WT-).

In previous studies Espinoza (2009) and Espinoza et al. (in preparation), have identified WTs in Amazon basin using low-level winds (U and V at 850 hPa) on a region included between 50-80W and 10N-30S. In the current work, the same methodology has been applied for a region including the whole Amazon Basin (AB) and La Plata Basin (LPB) (between 50-80W and 10N-40S). ERA-40 data has been employed for the regional description of winds circulation and for the atmospheric variability analysis, on a 2.5x2.5˚ grid, from the 1 September 1957 to the 31 August 2002. Observed rainfall data has been selected in the Norwest and the South of the AB. For the first step of this work, two stations are also taken into account in LPB (Las Lomitas and Rosario in the North and South of the LPB, respectively). The preliminary results show that WTs definitions are strongly related to extra-tropical wave alternation (South Pacific anticyclone, Chaco depression, South Atlantic anticyclone), which produce perturbations toward low latitudes, also due to the meridional extension of the Andes Cordillera (Garreaud 2000). These results are very similar to those found by Espinoza (2009). Rainfall and WTs relationship has been analysed for the northwest and South of the AB, while work is currently being carried out for two stations in LPB (Las Lomitas and Rosario, Figure 1). The first results show that the methodology applied permit to recognise the atmospheric patterns related to strong rainfalls in AB and LPB.

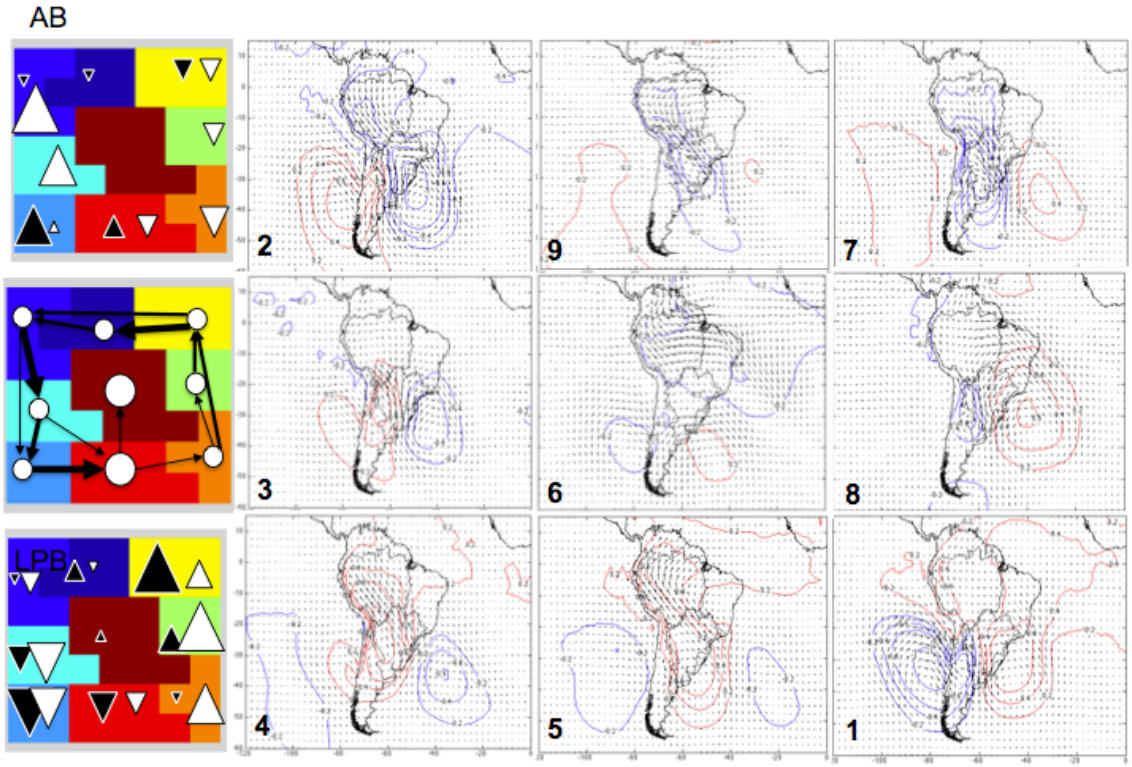


Figure 1: Winds anomalies and geopotential anomalies at 850hPa for each WT, during SON season (1974-2002). In the top and left, each WT is characterized by a rainfall index for North of the AB (black triangles) and South of the AB (white triangle), which explain a deficit or surplus of the rainfall (triangles pointing down or up, respectively). In down and left, the same rainfalls index for LPB, Las Lomitas station (black triangle, North of the LPB) and Rosario station (white triangle, South of the LPB). In the centre and left the WTs persistence (size of circle) and WTs transitions (arrows thickness) are indicated.

Item 4.2.2. **Relating low frequency LPB precipitation anomalies to global modes of variability**

- **CONICET (**Carolina Vera, Gabriel Silvestri**)**

A paper entitled "Non-stationary impacts of the Southern Annular Mode on Southern Hemisphere climate", by G. Silvestri and C. Vera has been accepted pending by revisions in J. Climate. In this paper, the temporal stability of the Southern Annular Mode (SAM) impacts on Southern Hemisphere climate during austral spring is analyzed. Results show significant changes in the typical hemispheric circulation pattern associated with SAM, particularly over South America and Australia, between 1960s-1970s and 1980s-1990s. In the first decades, SAM positive phase is associated to an anomalous anticyclonic circulation developed in the southwestern subtropical Atlantic that enhances moisture advection and promotes precipitation increase over the la Plata Basin (LPB). On the other hand, during the last decades the anticyclonic anomaly induced by SAM positive phase, covers most of southern South America and the adjacent Atlantic producing weakened moisture convergence and decreased precipitation over LPB as well as positive temperature anomaly advection over southern South America.

Task 4.3: *Statistical assessment of the existing IPCC AR4 OAGCMs skills in reproducing the 20th century LPB mean climate, trends, low frequency variability and teleconnections against the diagnostics of Tasks 4.1 and 4.2.*
Item 4.3.1 *Statistical analyses of the IPCC AR4 models skills in reproducing global and regional modes of variability for the 20th century.*

- **CONICET (**Carolina Vera, Gabriel Silvestri**)**

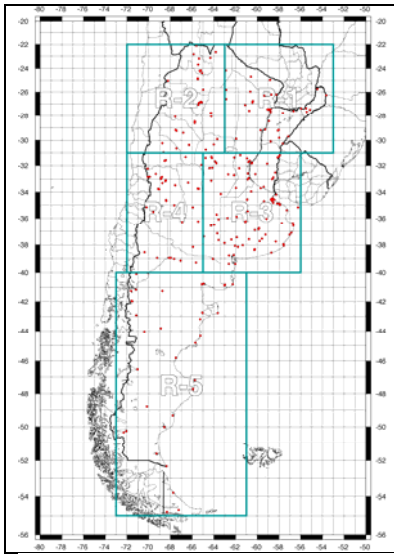
The following papers were presented at the 9th International Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne, Australia, February 9-13, 2009.
Vera, C. S., P. Gonzalez, G. Silvestri, 2009: About uncertainties in WCRP/CMIP3 climate simulations over South America. An assessment of the ability of 20th-century simulations from the WCRP/CMIP3 models in reproducing the seasonal and year-to-year climate variations in South America is presented. Climate change projections and the associated uncertainty issues are also discussed. The analysis of the climate conditions represented by the models during the summer season shows in general cold biases over tropical South America and warm biases at the subtropics. Moreover, models are able to reproduce in some extent the basic features of the precipitation seasonal cycle over South America; although the precipitation amounts in the SACZ, monsoon core, and La Plata Basin regions are not well quantified. There is a large agreement among models in projecting for the second half of 21C mainly an increase of precipitation over southeastern subtropical South America and a reduction along the southern Andes. Furthermore, projected temperature changes are positive over the whole continent and larger at the tropical and equatorial regions. The analysis of the uncertainties associated with the climate projections essentially shows that temperature changes are significantly larger than the inter-model variability. However, our results indicate that precipitation changes in most of the continental regions are smaller than the inter-model variability. To reduce model biases and uncertainties for the projection, weighted ensemble mean (WEM) is utilized to estimate climate conditions in present as well as in the future. However it was found that the WEM performance was not significantly different from that of the standard mean.

Gonzalez, P. L. M., C. S. Vera, 2009: Intraseasonal variability over South America in WCRP/CMIP3 simulations. The analysis of the characteristics of the leading pattern of convection variability in South America on intraseasonal time scales, SASS, reveals that WCRP/CMIP3 models are able to represent it. Nevertheless, the band of significant activity between 40 and 60 days evident in the observed SASS is not present in the models. This seems to be related to the fact that they are not able to reproduce the activity of the MJO, as could be seen by the lack of propagation in the convection anomalies along the tropical Indian and western Pacific Ocean. Nevertheless, other relevant features of the variability such as the large-scale environment and the wave structures are represented acceptably. The analysis of the variability observed for the 21st Century reveals that the dispersion among models is larger than the

changes observed, and thus no certain prediction can be made. Currently, the work continues in extending it to a larger ensemble of WCRP/CMIP3 models.

- **Inter-WP work (WP3-WP4-WP6):** Jean-Philippe Boulanger, A. Rolla, H. Berbery, S. Perkins (University of South Wales)

Our work was presented in the 9th International Conference on the Southern Hemisphere Conference organized by the American Meteorological Society in Melbourne in February 2009. It aims at evaluating IPCC AR4 simulations of daily variables such as precipitation, minimum and maximum temperatures. In this first stage of the project when the La Plata Basin Database is not yet available, we initiated the investigation using the the data from the Argentinean National Weather Service.



First, we divided Argentina in 5 regions, which dimensions are a compromise between the climate coherency of each region, the IPCC AR4 model resolutions and the density of the NWS station network.
In each region, following the method suggested by Perkins et al. (2007), we computed a daily PDF (Probability Distribution Function) for each variable (P, Tmin, Tmax) considering all stations or all the model gridpoints belonging to that region. We considered the period 1961-1990 as a reference for the 20th century.
Then we computed the common area between the observed and modelled PDFs, which represent a skill index for each model in reproducing the daily PDF of the observations (see Fig. 2).

Left panel : NWS daily station network and the five Argentinean regions.

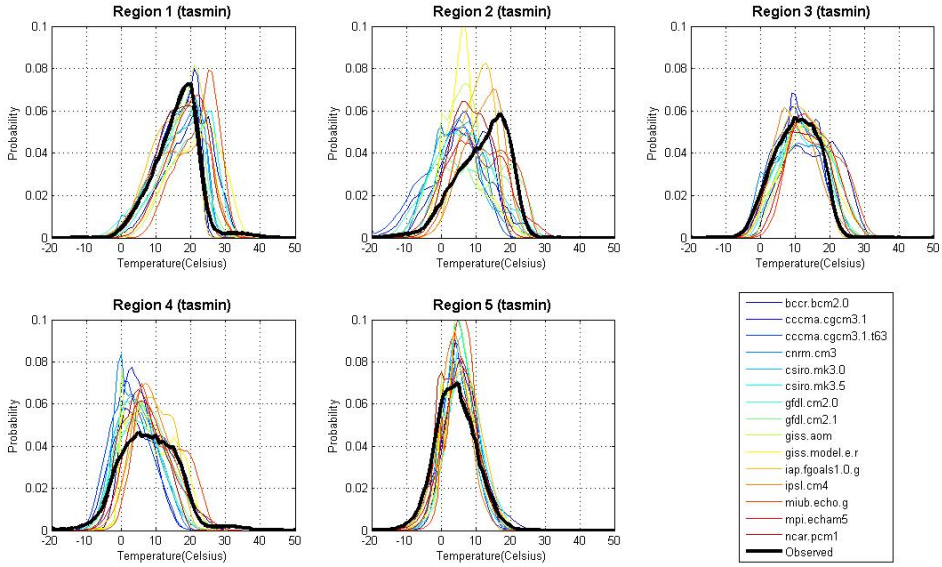


Fig2 : Representation of the observed and modelled PDFs in each region of Argentina.

Applying the same method to minimum and maximum temperature, we identified five models as skilfull in simulating the daily PDFs of the three variables in the three regions: MPI_ECHAM5, GFDL_CM2.1, GFDL_CM2.0, CSIRO_MK3.5 and CSIRO_MK3.0.

Future progress (next 6 months):
The final objective of this work is to identify the best models for the region in order to project possible future scenarios useful for extreme event and impact studies.
Our analysis led us to conclude that the index suggested by Perkins et al (2007) capture the model skill in representing the center of the PDF, but is not appropriate to quantify the model skills in simulating the left- or right- tails of the PDFs. Therefore, we are currently developing extreme event index based on the PDFs to complete the skill index. We will then be able to rank the models according to such a skill index for the selected Argentinean regions. We will also evaluate the model skills in simulating extreme events (WP6). Finally, we will use the best models to study possible changes under climate change conditions in order to provide different scenarios for extreme event and impact studies.
Our results will also be discussed inside WP4 to understand the model skills in representing the regional climate physical processes.
Last, once the LPB database will be ready, we will apply the same technique to La Plata Basin.