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

D5.5: Identification of the regions that are most likely to exhibit land-atmosphere interactions

Due date of deliverable: Month 24

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Organisation name of lead contractor for this deliverable: P13-CONICET

Deliverable No	Deliverable title	WP	Lead beneficiary	Estimated indicative person-months (permanent staff)	Nature	Dissemi nation level	Deliv ery date
D5.5	Identification of the regions that are most likely to exhibit land-atmosphere interactions	WP5			R	PU	24

1. Achievements

Sörensson et al. (2010) and Sörensson and Menéndez (2011) calculate the coupling strength between soil moisture, evapotranspiration and precipitation for the austral summer by analyzing ensembles of simulations performed with a RCM. The Rossby Centre Atmospheric regional model RCA3-E (Samuelsson et al., 2011) was employed. The model domain covers the South American continent, and is based on a rotated grid system with a horizontal resolution of 0.5º and 24 unevenly spaced sigma levels in the vertical with the five lowest levels below 900 hPa.

The methodology has been adapted to regional modelling following Koster et al. (2006). Two ensembles of ten members each were created (called W and S), starting from different initial dates. Each member extends over a period of 120 d from November 1, 1992 to March 31, 1993:

Ensemble W: Model with a full land surface–atmosphere interaction.

Ensemble S: The ensemble members are forced, at each time step, to maintain the same space–time varying series of top and deep soil moisture.

Since the initial dates and the lateral boundary forcings as well as the SST are the same for the two ensembles (all initial and boundary conditions are from ERA-40), the only difference between ensemble W and S is that in W there is full interaction between soil moisture and the atmosphere, while in S the soil moisture is a boundary condition.

The study isolates the aspects related to the locally forced component of evapotranspiration and precipitation (that is, climate variability arising from the interactions with the continental surface) and constitutes a partial contribution towards process-based understanding of features driving the climate system at the regional scale.

The geographical distribution of precipitation coupling strength for South America reveals large regions with relatively weak or non-uniform random values while some main hotspots—regions with high coupling strength —could be identified. The main hotspot of strong coupling between land and both evapotranspiration and precipitation is located near the Rio de la Plata in South Eastern South America. The breakdown of the coupling mechanism into two segments—the link between soil moisture and evapotranspiration and the link between evapotranspiration and precipitation—helps to identify some of the reasons for the geographical distribution of the hotspots. Evapotranspiration rates are sensitive to soil moisture in dry climates but not in wet climates where it is partially controlled by atmospheric demand. However, a strong coupling with precipitation benefits from high atmospheric moisture variability as found in wet climates but not in dry climates. In consequence, in transition zones between wet and dry conditions (like in parts of La Plata Basin), where evapotranspiration variations are suitably high but are still sensitive to soil moisture, the land states tend to have relatively strong impacts on precipitation.

2. Interaction with WP6

As a contribution to "T6.1: Exploring on the large scale conditions in which the extremes are embedded and on the processes controlling/interacting with the extremes", it was explored the relationship between extremes and land surface conditions in La Plata Basin.

Sörensson and Menéndez (2011) found out that strong rainfall in Southern LPB may be partly related to land–atmosphere coupling. The regional spatial patterns of extreme precipitation (defined as the fraction of the total seasonal precipitation that is due to the 95th percentile of daily precipitation) are well correlated with the regions of strong coupling between soil moisture and evapotranspiration over large areas of South Eastern South America. In addition, results suggest that extreme precipitation seems enhanced over regions of high soil moisture-precipitation coupling if the model includes a complete land surface-atmosphere interaction (in comparison with simulations in which the link between precipitation and soil moisture is cut through using prescribed soil moisture).

Over the region, rainfall extremes are associated with convective storms. Ruscica et al. (2011) speculate that the surface soil moisture heterogeneities would favor the development of strong precipitation events. In their experiment they find that, on days before the extreme precipitation events, the spatial heterogeneity of soil moisture tends to be enhanced relative to that in the mean field ensemble, suggesting that convection could be enhanced by mesoscale circulations associated with horizontal contrasts in the surface properties.

3. Future work

We must caution against generalizing the results of Sörensson and Menéndez (2011) as the experiments have been restricted to one single regional model (RCA3-E) and one single season (austral summer 1992-1993). In order to address the realism of the results concerning the coupling strength between soil conditions, evapotranspiration and precipitation, two additional activities are planned:
i) To repeat the experiment under different seasons using a new version of the regional model (RCA4);
ii) To repeat the experiments with other RCMs participating in CLARIS LPB.

4. Other comments

The present investigation has been part of the PhD thesis work of Anna Sörensson (thesis defended in March 2010) and of the ongoing work of the PhD student Romina Ruscica, both at the Universidad de Buenos Aires.

This research has been conducted within the framework of collaboration between CIMA/CONICET-UBA (Argentina) and Rossby Centre/SMHI (Sweden).

5. Publications

Ruscica R.C., A.A. Sörensson, C.G. Menéndez, 2011: Investigating the role of soil moisture gradients on extreme precipitation over Southeastern South America. 2011 WGNE Blue Book "Research Activities in Atmospheric and Oceanic Modelling" (A. Zadra, Editor), WGNE/WCRP-WMO, http://collaboration.cmc.ec.gc.ca/science/wgne/.

Sörensson, A.A., 2010: Analysis of Land Surface-Atmospheric Feedbacks in South America using a New Regional Climate Model. PhD thesis, Universidad de Buenos Aires.

Sörensson A.A., C.G. Menéndez, P. Samuelsson, U. Willén, U. Hansson, 2010: Soil-precipitation feedbacks during the South American Monsoon as simulated by a regional climate model. Climatic Change, 98, 429-447, DOI 10.1007/s10584-009-9740-x.

Sörensson, A.A. and C.G. Menéndez**,** 2011: Summer soil-precipitation coupling in South America. Tellus 63A, 56–68.

6. Other references

Koster, R.D., and coauthors, 2006: GLACE: the global land–atmosphere coupling experiment. Part I: overview. J. Hydrometeror. **7**, 590–610.

Samuelsson, P., and coauthors, 2011: The Rossby Centre Regional Climate Model RCA3: model description and performance. Tellus 63A, 4–23.