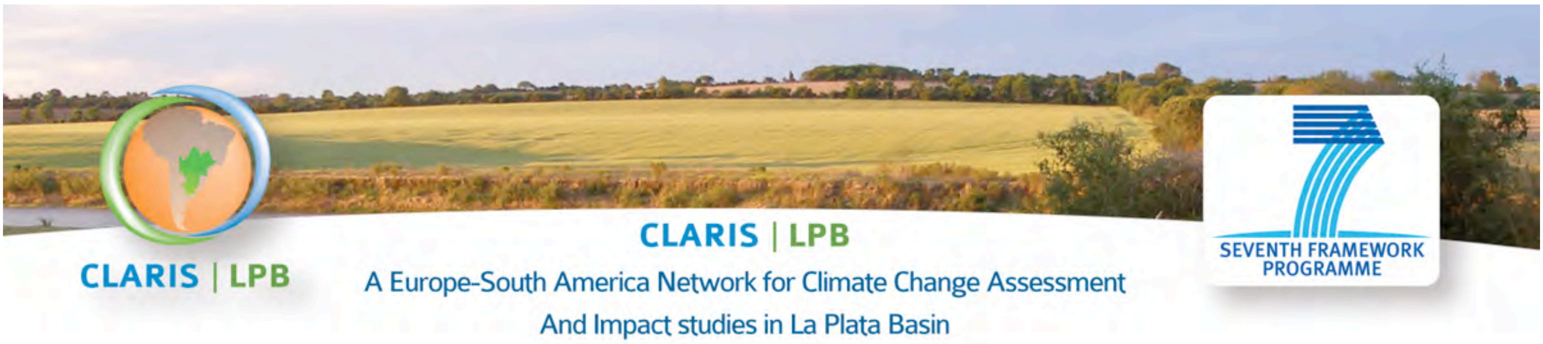


CLARIS | LPB

CLARIS | LPB
A Europe-South America Network for Climate Change Assessment
And Impact studies in La Plata Basin
www.claris-eu.org
Deliverables

SEVENTH FRAMEWORK PROGRAMME

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

D 5.4: Datasets best representing land-use and soil moisture fields will be identified for use in simulations of land surface effects

Due date of deliverable: Month 24

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

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

Deliverable No	Deliverable title	WP	Lead beneficiary	Estimated indicative person-months (permanent staff)	Nature	Dissemination level	Delivery date
D5.4	Datasets best representing land-use and soil moisture fields will be identified for use in simulations of land surface effects	5			R	PU	24

Deliverable Framework

This deliverable has been included in order to generate reliable information necessary to address the following issues:

- To study the land-atmosphere feedbacks to identify the regions of larger interaction and to analyze the role of soil moisture conditions and land use on the development of precipitation
- To examine the regional effects of climate change and variability on the La Plata basin hydrologic cycle, with emphasis in land surface-atmosphere feedbacks and their impact on extreme events.

Actions

The following actions have been undertaken:

a) Generation of surface and sub-surface variables climatology using GLDAS 1 and GLDAS-2 datasets

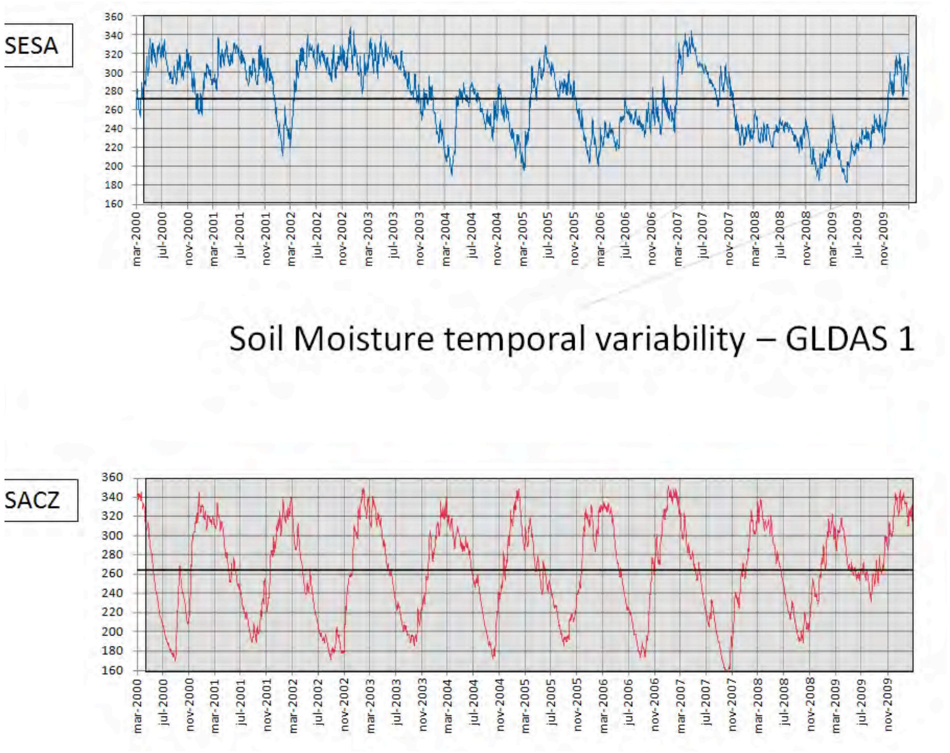
GLDAS stands for Global Land Data Assimilation System (Rodell et al 2004) and is a land surface modeling system that integrates data from advanced observing systems to support improved forecast model initialization and hydrometeorological investigations. Within this system it is possible to select different land surface models and different atmospheric forcings to obtain the land surface state. In our case, the NOAH version 2.7.1 forced with the GDAS analysis and CMAP precipitation data was chosen for the period 2001 to 2008, when relatively minor changes affected the forcing fields (i.e. the GDAS and the CMAP). GLDAS 1 was the first version of this data set available. The horizontal grid spacing of this data set is 0.25° x 0.25° degrees and the temporal resolution is 3 hourly, with 4 soil layers at 0-10 cm, 10-40 cm, 40-100 cm y 100-200 cm depths. Only 12 UTC data have been archived for Claris LPB project.

The variables that we have archived include:
Surface pressure Pa
Near surface air temperature K
Near surface wind magnitude m/s
Near surface specific humidity kg/kg
Total evapotranspiration kg/m^2
Snow water equivalent kg/m^2
Total canopy water storage kg/m^2
Average layer soil temperature K (at 4 soil depths)
Average layer soil moisture kg/m^2 (at 4 soil depths)
Snowmelt kg/m^2/s
Net shortwave radiation W/m^2
Net longwave radiation W/m^2
Latent heat flux W/m^2
Sensible heat flux W/m^2
Snowfall rate kg/m^2/s
Rainfall rate kg/m^2/s
Average surface temperature K
Ground heat flux W/m^2
Surface incident shortwave radiation W/m^2
Surface incident longwave radiation W/m^2
Subsurface runoff kg/m^2
Surface runoff kg/m^2

However, as pointed out by Sheffield et al. 2006, first-order errors in the land surface simulations carried out over North America, were due to inaccurate specification of the forcings and especially in precipitation. In order to provide optimum and frozen in time forcing fields, Sheffield et al., 2006 produced a global dataset of near-surface meteorology that can be used to force models of the land surface water and energy budgets. This data set has been used to generate GLDAS 2, which is based on the same NOAH model version as the GLDAS 1, but covers a longer period, from 1948 to 2010, at a lower resolution (1° x1°), with the same sub-surface layers, and 3 hourly. In our case, a sub- set of this data set, from 1979 to 2010 has been compiled for Claris LPB project. Our data base includes the same variables as before, and we have daily values as well as monthly means.

b) Analysis of soil moisture climatology as derived from GLDAS-1 and GLDAS-2 datasets

A preliminary analysis of the first meter depth soil moisture (root zone SM) mean and variability has been done, covering the complete period using the first data set available GLDAS 1, that was afterwards repeated with GLDAS-2. The first objective was to document the relative importance of root SM variability at interanual, seasonal and subseasonal scales. Part of this analysis focused on two sub-regions of LPB: Southeastern South America –SESA- and the continental portion of the South Atlantic Convergence Zone –SACZ-.



Soil Moisture temporal variability – GLDAS 1

The root zone SM temporal evolution shown in the previous figure, denotes rather distinct character of this variable over these two subregions:

- Interannual variability is the main source of variability over SESA (even larger than seasonal variability)
- The seasonal cycle modulates most of the variability over SACZ
- Sub-seasonal variability seems to be more important over SESA than over SACZ (not shown in this figure)

Other statistics were calculated for this data set, including EOFs and wavelet analysis, in order to study the main modes of variability. However, given that a more comprehensive data set became available (GLDAS-2), we preferred to focus the analysis in the latter. It should be noted, however, that differences between the data sets are not negligible, as evident in Figure 1. This figure shows the mean value and the standard deviation of the root zone SM as shown by GLDAS-1 as well as the difference between these fields as derived from GLDAS 2 and GLDAS-1 (compared over the same 2001-2008 period).

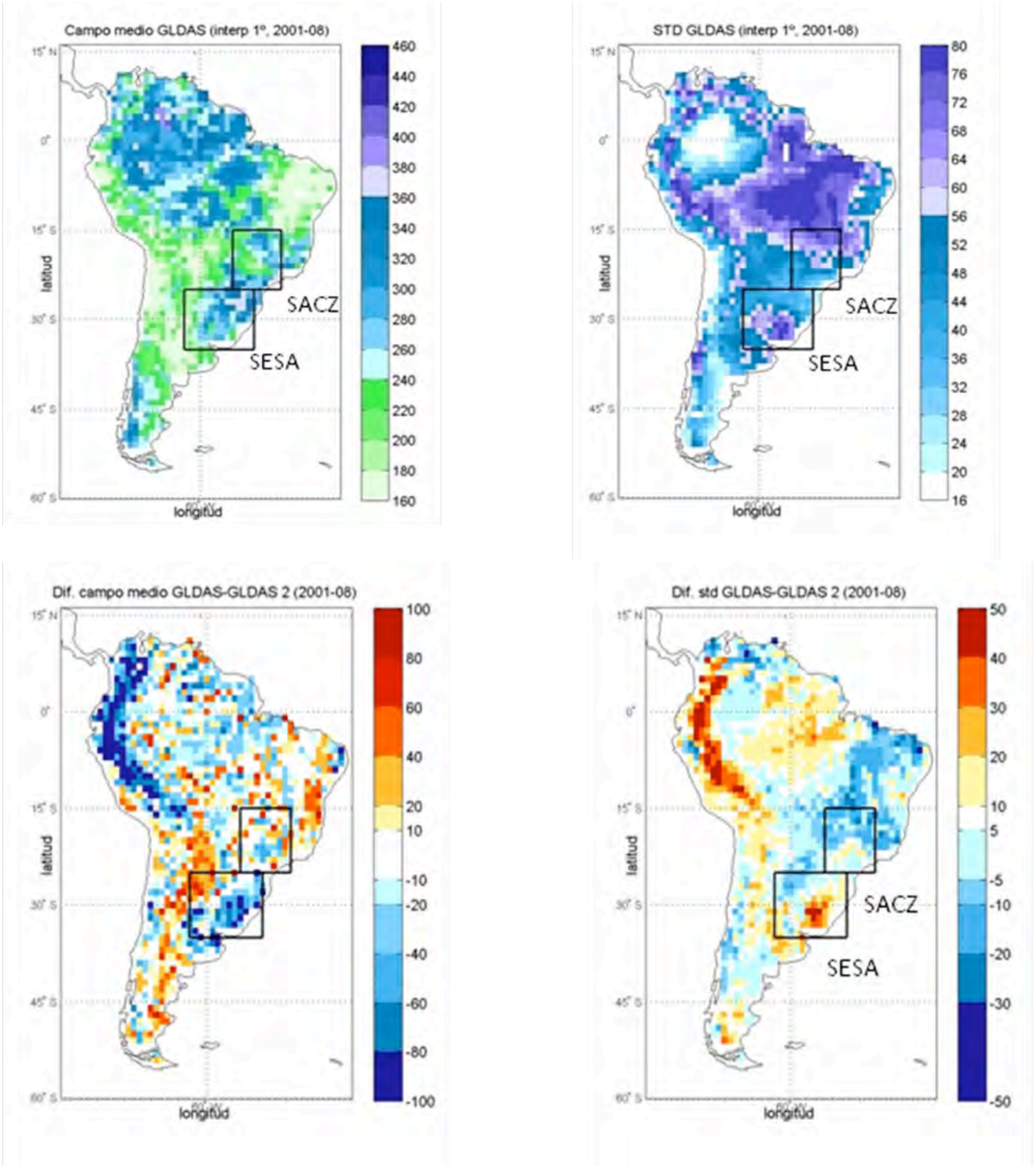


Figure 1: Upper left: mean soil moisture corresponding to 2001-2008 period (GLDAS-1). Upper right: soil moisture standard deviation for the same dataset and period. Lower panels: differences (GLDAS-1-GLDAS 2). In all cases, values are in mm and correspond to the first meter.

We consider that the differences among these data sets deserve further analysis, which is being carried out now.

c) Comparison of GLDAS-1, GDAS and WRF soil moisture with observational data obtained over Buenos Aires Province

The aim of the study carried out by Ferreira et al 2011, is to document how soil moisture variability is represented by global analyses and regional atmospheric models compared with a unique dataset of sparse measurements over an agricultural productive area of Argentina.
Given that soil moisture is a Land Surface Model (LSM)-derived variable and it is acknowledged that it is a physical quantity that cannot be compared directly with on-site measurements we normalized this variable using corresponding dynamic range extremes. The results show large differences between LSM and field campaign values, not evident when absolute values are compared. Model-derived values were systematically below the observed ones, as seen in the following figure:

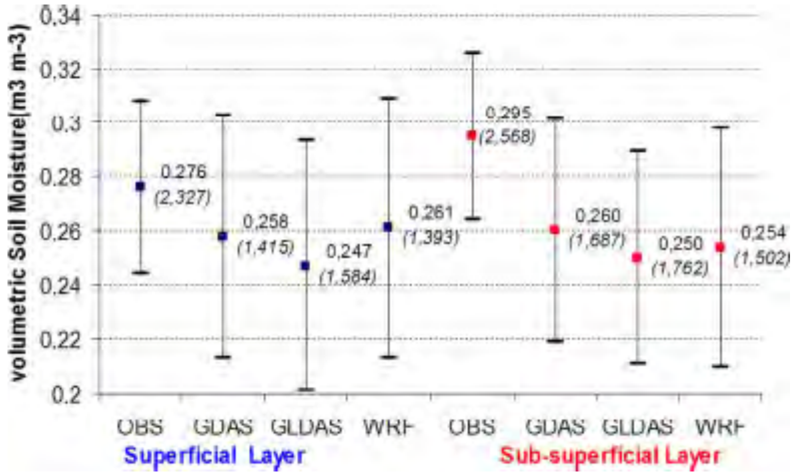


Figure 2: Mean soil moisture (m3m−3) observed and estimated by GDAS, GLDAS andWRF, with their standard deviation. Blue boxes correspond to the superficial layer and red boxes to the subsuperficial one. Normalized values are in parentheses.

Temporal variability is not well reproduced by any of the derived soil moisture data sets (see Fig. 3), and this problem does not seem to be explained by a failure in the representation of precipitation, which in general denotes reasonable agreement between observations and forcing data used to run soil models (at least this is the case for GLDAS).

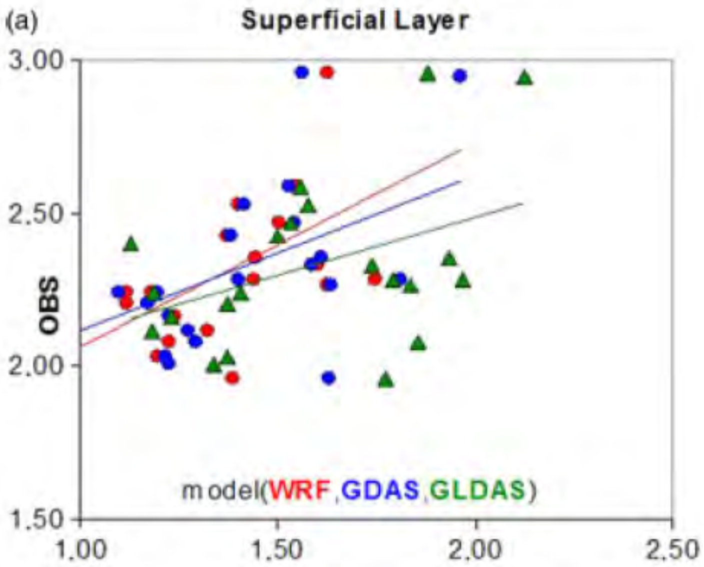


Figure 3: Comparison of normalized soil moisture at the superficial soil layer: observed *versus* GLDAS (green), GDAS (blue) and WRF (red) models

Our results suggest that important efforts should be carried out in order to better represent regional soil moisture variability including the analysis of remote sensing information.

d) Generation of surface and sub-surface variables climatology using HRLDAS 3.2 .

Motivation: Understanding the variability of the terrestrial hydrologic cycle is central to determining the potential for extreme events and susceptibility to future change. In the absence of long-term, large-scale observations of the components of the hydrologic cycle, modeling can provide consistent fields of land surface fluxes and states.

This deliverable discusses the water and surface energy budgets over the La Plata basin and subbasins using the uncoupled NOAH (National Centers for Environmental Prediction/Oregon State University/Air Force/Hydrologic Research Lab Model) (Chen et al. 1996; Koren et al. 1999) Land surface Model forecasts forced by the “50-Year High-Resolution Global Dataset of Meteorological Forcings for Land Surface Modeling” (Sheffield et al, 2005).
It also discusses the relation between surface states (soil moisture) and other variables that affect the surface energy balance, potentially interacting with precipitation processes. After that we proposed the study of meteorological, hydrologic and agronomic drought computing drought indexes as SPI (standardized precipitation index), SRI (standardized runoff index), SMI (standardized moisture index).

Model used: The community NOAH LSM was developed beginning in 1993 through a collaboration of investigators from public and private institutions, spearheaded by the National Centers for Environmental Prediction (Chen et al. 1996; Koren et al. 1999). NOAH is a stand-alone, 1-D column model which can be executed in either coupled or uncoupled mode. The model applies finite-difference spatial discretization methods and a Crank-Nicholson time-integration scheme to numerically integrate the governing equations of the physical processes of the soil-vegetation-snowpack medium. NOAH has been used operationally in NCEP models since 1996, and it continues to benefit from a steady progression of improvements (Betts et al. 1997; Ek et al. 2003).

In our case we have used the offline 2D driver code: High-Resolution Land Data Assimilation System (HRLDAS) v3.2 – 2010.

Description of the experiment:

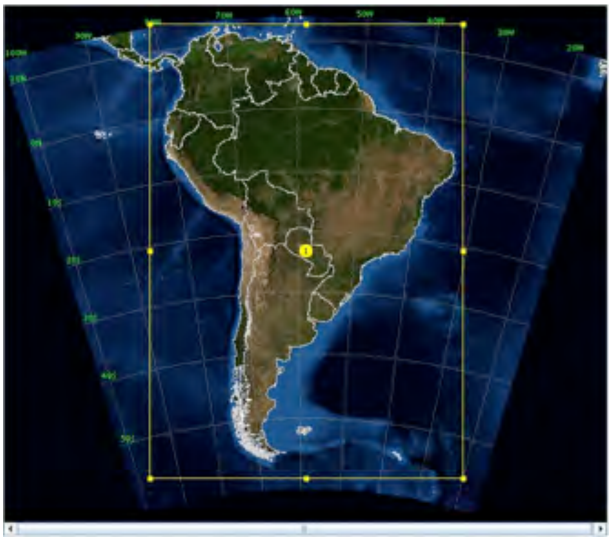
The experiment covered all South America at a resolution of 1 degree. Using the fields computed by the model HRLDAS-NOAH forced by the “50-Year High-Resolution Global Dataset of Meteorological Forcings for Land Surface Modeling” (Sheffield et al, 2005).

The following actions have been undertaken:

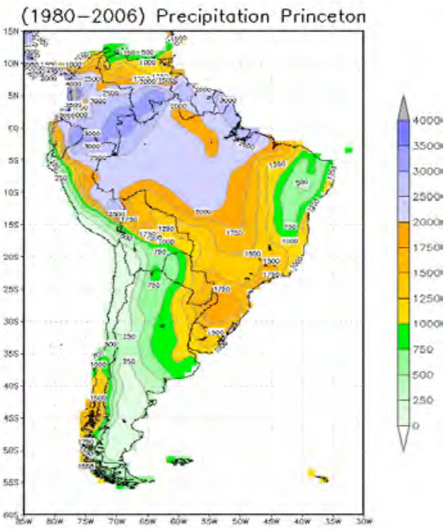
- Calculation of an energy balance
- Calculation of soil moisture balance

Those actions were undertaken to assess the correct operation of the uncoupled model HRLDAS-NOAH, which was acceptable.

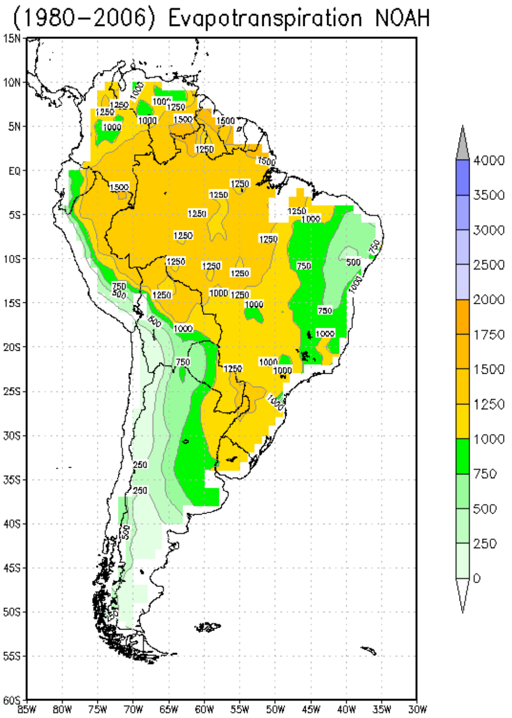
Some results: Model Outputs



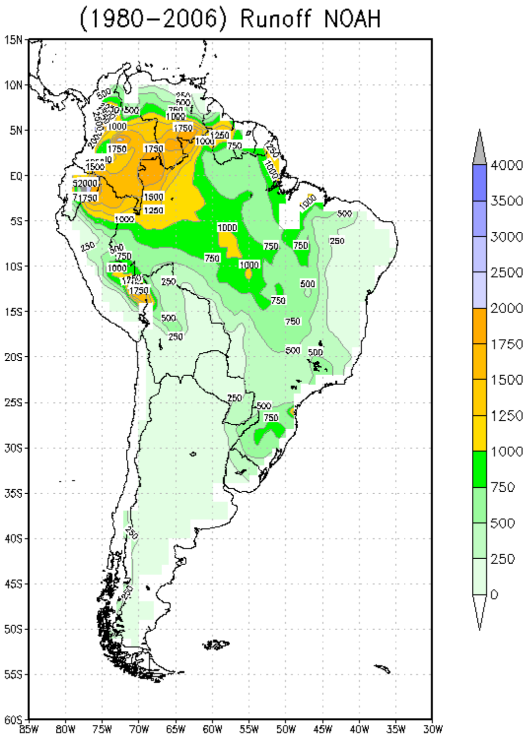
Model domain (resolution 1X1 degree)



Precipitation 1980-2006


(1980–2006) Evapotranspiration NOAH

Evapotranspiration 1980-2006


(1980–2006) Runoff NOAH

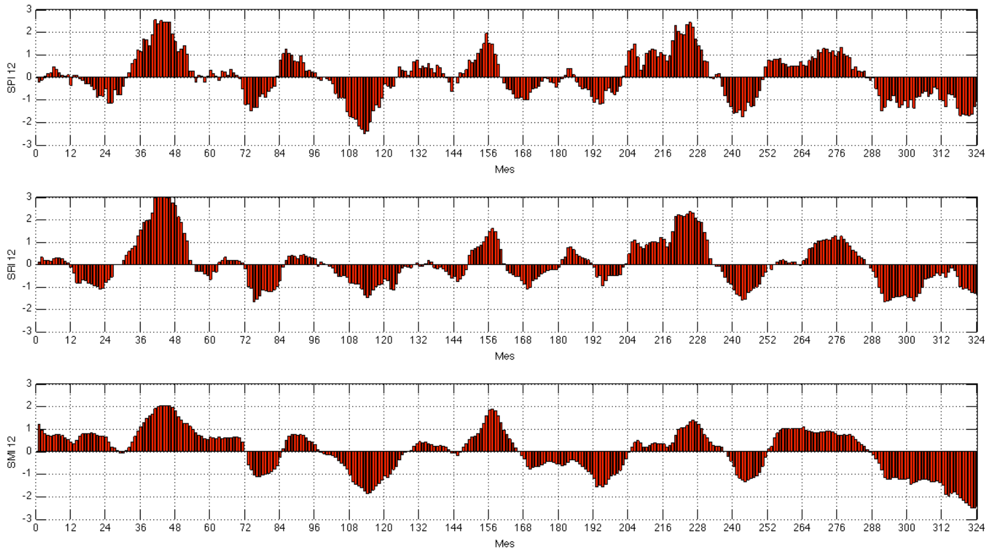
Runoff 1980-2006

Water Balance

WATER BALANCE	UP	PY	LP	UY	**LPB**
precipitation	129,33	86,44	75,56	131,97	102,87
evapotranspiration	91,77	74,94	71,38	94,33	81,72
runoff	37,71	11,75	4,37	37,79	21,35
dSM/dt	-0,06	-0,18	-0,15	-0,05	-0,12
Res=pp-evt-rnoff-(dSM/dt)	-0,09	-0,07	-0,04	-0,11	**-0,08**

Energy Balance

ENERGY BALANCE	HRLDAS 3.2				
	UP	PY	LP	UY	**LPB**
sw (short wave)	195,56	199,30	193,10	184,78	195,15
lw (long wave)	380,33	380,07	351,15	358,80	371,82
hfx (latent heat flux)	18,23	31,07	26,99	5,88	23,27
qfx (sensible heat flux)	87,33	71,33	67,90	89,76	77,77
grdflx (soil heat flux)	-0,34	-0,48	-0,36	-0,37	-0,40
fdown (radiation forcing)	520,16	514,37	488,26	490,93	508,07
skintemp (skin temperature)	296,25	296,84	291,93	292,54	295,16
albedx (Albedo)	0,28	0,33	0,29	0,28	0,30
embrd (emiss)	0,95	0,93	0,95	0,95	0,94
fdown=sw*(1-albed)+lw	520,16	514,37	488,26	490,93	508,07
solnet=SW*(1.-ALBEDX)	139,824	134,298	137,108	132,129	136,249
v1:5.67051E-08*embrd*skintemp^4	413,42	410,00	391,01	393,80	405,23
NOAHRES=(solnet + lwdn) - sheat + ssoil - eta - (emissi * STBOLT * (t1x**4)) - flx1 - flx2 - flx3	**-0,20**	**-0,27**	**-0,21**	**-0,14**	**-0,22**



Applications: Drought Indexes Period 1980-2006. Meteorological spi (top), hydrological sri (center) and agricultural drought smi (bottom).

The dataset generated and controlled, will be available in six months time from now, in order to give surface boundary conditions for Regional Atmospheric Models.

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