Spatio-temporal analysis of the coupling between soil moisture and surface climate in the La Plata Basin: combining results from regional climate models and satellites

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New collaboration between remote sensing group and RCM group at the University of Buenos Aires

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- Regional Climate Models
- Interaction between land surface and atmosphere

- Active/passive microwaves
- Soil moisture, evapotranspiration, flood monitoring
• Annual mean of precipitation: 300mm in the west and 1200mm in the east, but the interannual variability is very high.

Annual precipitation Puán 1960-2010, values between 300 and 900 mm.

• The Argentine Pampas is an extremely flat region that extends over 600,000 km².
• Mostly covered by annual crops and ranching.
Coupling between soil moisture and atmosphere

- The memory of the soil moisture is longer than the memory of the atmosphere.
- Soil moisture influences on the atmosphere through the partitioning of energy into latent and sensible heat flux.
- Soil moisture could therefore be a low frequency modulator of the atmosphere in some regions.
- This can improve predictions on weekly-seasonal scales.
How to measure the coupling: Example

\[ I_{Temp} = \text{STD}_{\text{SM}} \cdot \beta_{\text{Temp, SM}} \]

Variability of soil moisture

Sensitivity of temperature to soil moisture.

In regions with coupling, the soil moisture anomalies are anticorrelated with the surface temperature anomalies. (+SM → +ET → -T)

\( \beta < 0 \) is a necessary conditions for a casual influence of soil moisture on temperature.
Coupling between soil moisture and evapotranspiration for austral summer

Indices

\[ \Delta \Omega_x = \Omega_x(S) - \Omega_x(W) \]

Koster et al., 2004

\[ \lambda_{ET} = \frac{\text{Cov}(SM(t-\tau), ET(t))}{\text{Cov}(SM(t-\tau), SM(t))} \]

Notaro, 2008

Multiple sources, indices temporal scales show robust signal of coupling for the Pampas region.

Nevertheless these studies have several limitations related to model assumptions and vegetation parameterizations, as well as the lack of observational data for the evaluation of models performance.

Can satellite data be used to validate the results?
Meanwhile we got a visit from IAFE...

Soil moisture products from different satellite systems report different patterns over la Pampa.

These products discrepancy was also observed for other areas around the world.

All products claim some form of validation (in situ validation in some densely instrumented sites – not available in our region).

Therefore, since:
(1) product quality in the area cannot be guaranteed by global validation and
(2) direct in situ validation is not possible,

Alternative validation schemes become relevant.

Can soil moisture – atmosphere coupling be used to calibrate satellite product over the Pampa?
Soil moisture – surface fluxes coupling: starting point of the interaction between the IAFE and CIMA REMOTE SENSING GROUP

1. COUPLING

REMOTE SENSING GROUP

Evaluation of soil moisture product

2. ?

MODELLING GROUP

Evaluation of coupling

3. ??
Satellite data to calculate coupling

- **Infrared derived Temperature**
  - MODIS level-3 (MOD11A2)
  - 8-days-means
  - 1km

- **Microwave derived Soil Moisture product**
  - AMSRE / LPRM
  - Daily
  - 0.25° (25km)

**June 2002 – October 2011 (AMSR-E)**

Interpolated to a 1 degree grid, temporal resolution 8 days
Coupling between soil moisture and evapotranspiration for austral summer

Satellite products give similar signal of coupling in the Pampas region.

I_{Temp} = STD_{HS} \cdot \beta_{Temp.HS}
Coupling during extreme conditions

Second step:

Does the coupling change under extremely dry / wet conditions?

Does the model and the satellite give the same results?

(different periods)
Coupling during wet and dry summers

Both sources show stronger coupling for dry conditions.
Future Plans

Analyze coupling with complementary satellite products.

Integrate available information about biogeophysical variables.

Can we constrain satellite products with model dynamics?

Is it possible to integrate soil moisture satellite products in the regional climate models?
Tack så mycket!


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