Using Ecosystem Functional Types as Lower Boundary Conditions in Simulations of Droughts in Southern South America

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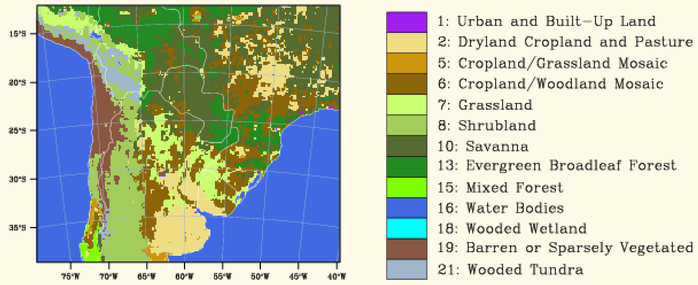
Introduction

Land surface processes occur across a range of timescales from rapid energy and water exchange with the atmosphere on short timescales to changes in soil moisture, vegetation structure and phenology on longer timescales. However, many land-atmosphere coupled models, represent vegetation with land cover types fixed in time.

In this work we examine the advantages of using Ecosystem Functional Types as a replacement of conventional land cover types in WRF/Noah. EFTs are defined on a yearly basis, therefore, they can reproduce vegetation changes resulting from either land use or natural changes.

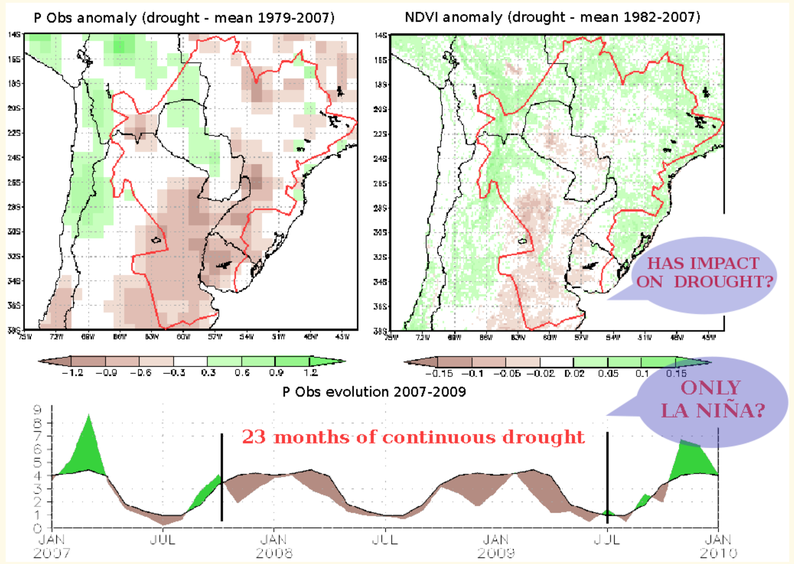
Conventional representation of vegetation

USGS Land Use Dominant Category (1993) $\Longrightarrow$ **fixed in time**



- The categories were determined by information from 1992/1993. If this period was highly anomalous, it would downgrade simulations under different conditions.
- The drought effect on vegetation and the land use changes in last decades in South America are not represented!

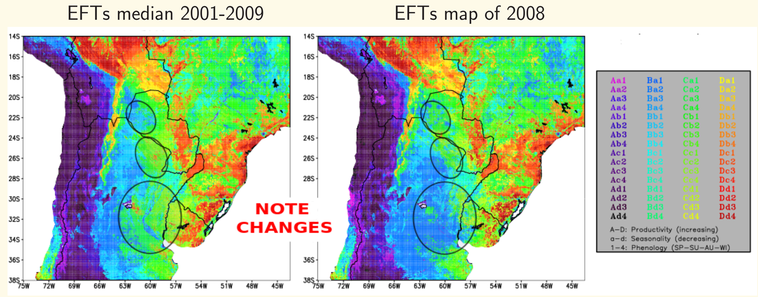
Drought of 2008



Hypothesis: Land use changes and vegetation variability modify biophysical properties (GVF, LAI, Z0...) that may affect heat fluxes, and therefore, may act as a secondary forcing over the overlying atmospheric states.

Can a realistic representation of vegetation help reduce biases and improve the simulation of interannual variability?

A New Approach: Ecosystem Functional Types



EFTs are groups of ecosystems with homogeneous exchanges of matter and energy with the atmosphere.

- 65 categories **time-varying** (a specific map for each year).
- Changes in physical properties are defined in a consistent manner.
- Interannual variability of the land processes is represented.

Experiments

Long-term **simulations** with **different vegetation maps** as lower boundary conditions were carried out using the regional coupled model WRF/Noah.

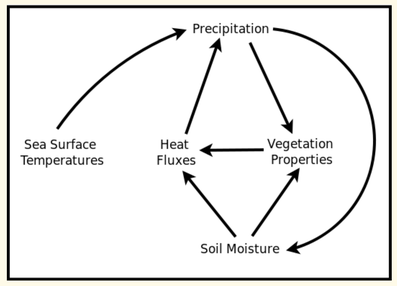
- Period: September 2007 - July 2009. (23 months with precipitation deficit)
- Domain: A region in SA covering La Plata Basin. Resolution: 18 km.
- Two ensembles are compared:
  - ▷ USGS: Esemble of 4 members using conventional land cover maps.
  - ▷ EFTs: Ensemble of 4 members using EFTs map of 2008.

Results: Ensembles differences

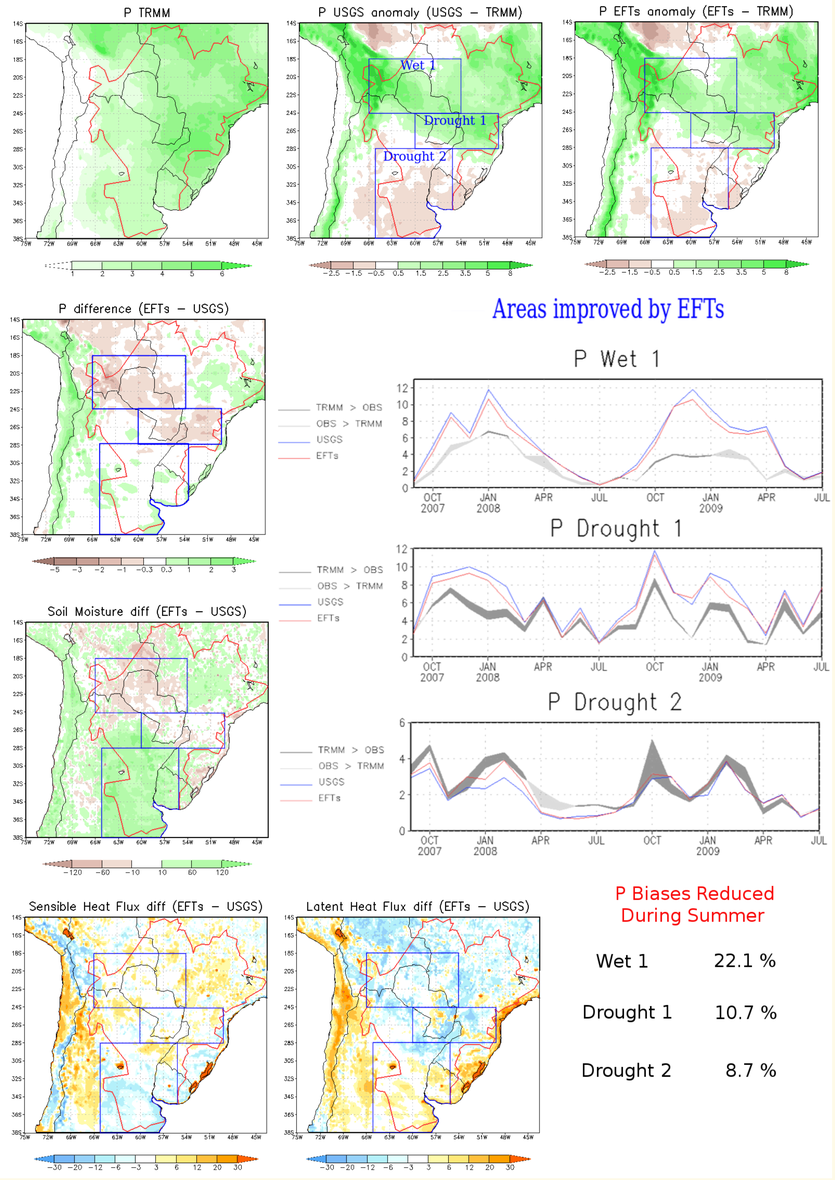
The use of EFTs modifies vegetation properties maps, which changes the spatial distribution of soil moisture respect to USGS simulations.

In areas where soil moisture is decreased, evapotranspiration reduces while sensible heat flux raises, which results in lower precipitation.

Conversely, regions where EFTS add moisture to soil, sensible heat flux diminishes while latent heat flux increases favoring wet conditions and more rainfall.



Results: Precipitation



P Biases Reduced During Summer

Wet 1	22.1 %
Drought 1	10.7 %
Drought 2	8.7 %

Conclusions

- The model is sensitive to land cover changes and vegetation variability.
- Use of EFTs as a replacement for land cover types:
  - ▷ represents better the heat fluxes and the land-atmosphere interactions,
  - ▷ improves the forecast of the drought and reduces the biases in regions of high P,
  - ▷ downgrades T over west LPB, but improves the simulation to the east.(not shown)