Land surface – atmosphere interaction in southeastern South America

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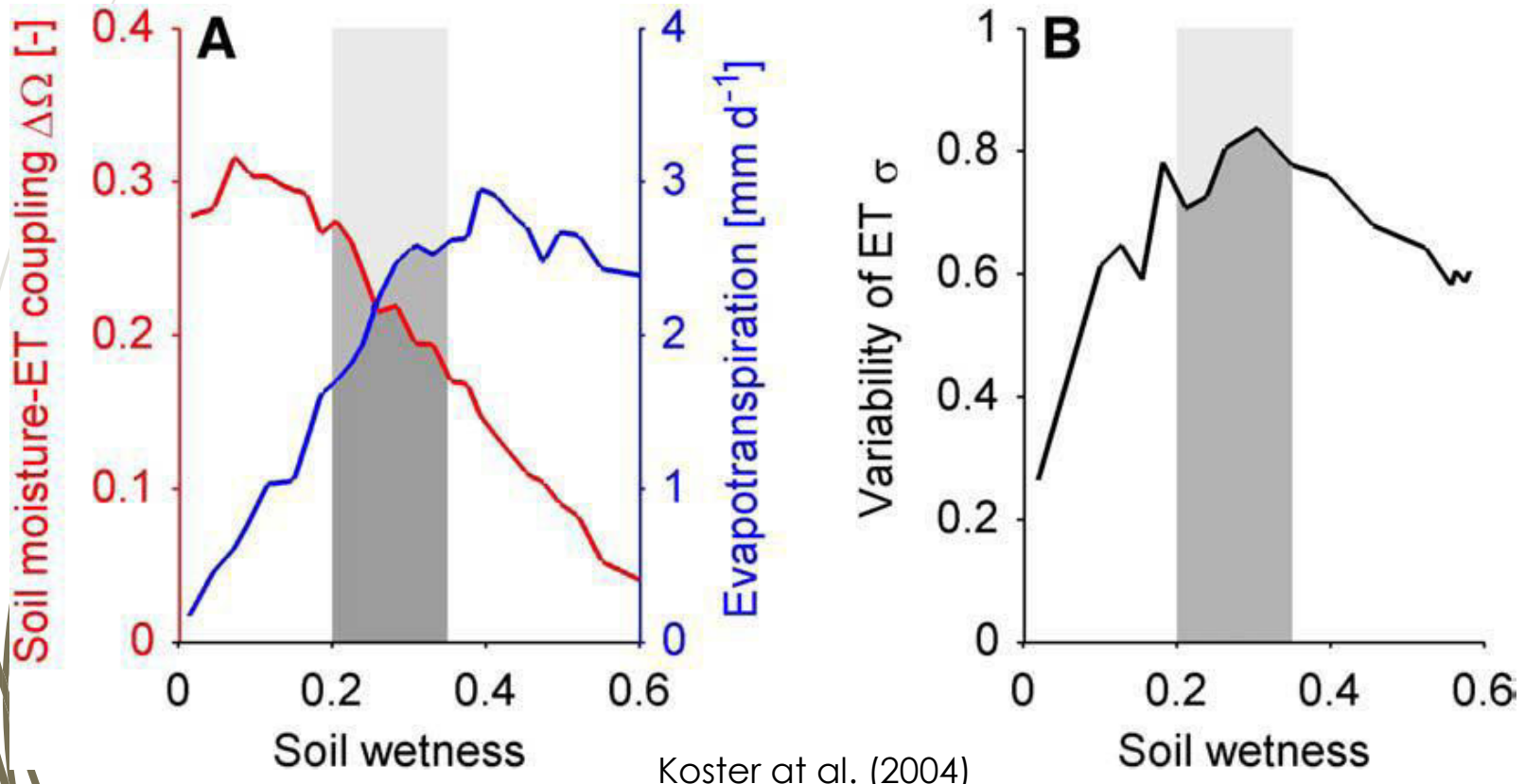
What? Why? What for?

- The land surface influences the atmosphere at multiple spatial and temporal scales especially in extra-tropical regions.
- Because the understanding of how land surface anomalies (e.g. soil moisture) lead to changes in atmospheric states and fluxes (e.g. rainfall, cloud cover, moisture convergence) is incomplete.
- To improve short term and seasonal forecasting, drought/flooding assessment and ecosystem management.

Background

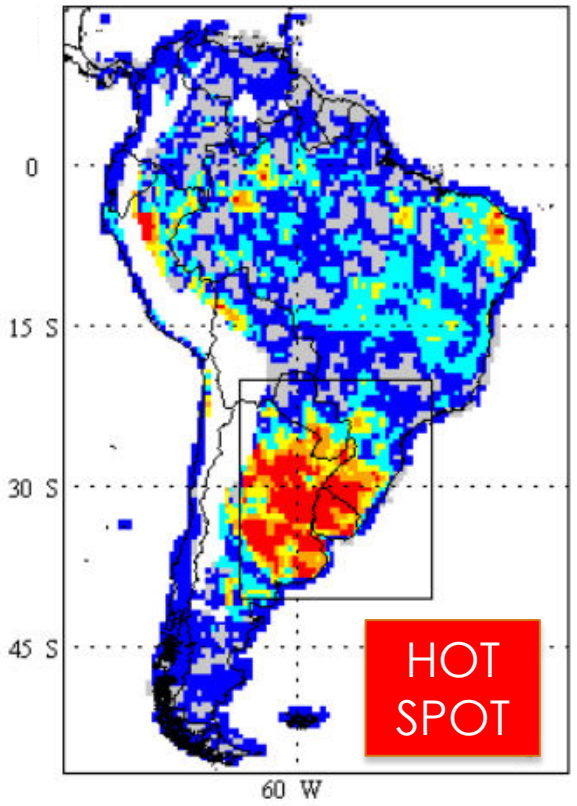
Transition regions between dry and wet climates show that evaporation is strongly regulated by soil moisture availability. As a result, these regions are very sensitive to L-AI affecting their weather and climate.



Koster at al. (2004)

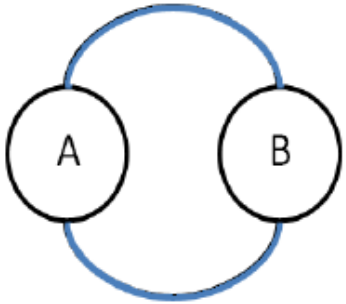
In southeastern South America

- Land atmosphere **interaction/coupling** is high in **summer** and specially in the terrestrial segment of the hydrological cycle, i.e **soil moisture – evapotranspiration** (Sörensson and Menéndez, 2011; Spennemann and Saulo, 2015)



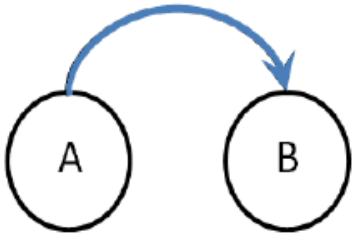
Data

INTERACTION



- Gauge observations,
- Satellite products
- Reanalysis
- Land surface models
- RCMs, GCMs

COUPLING

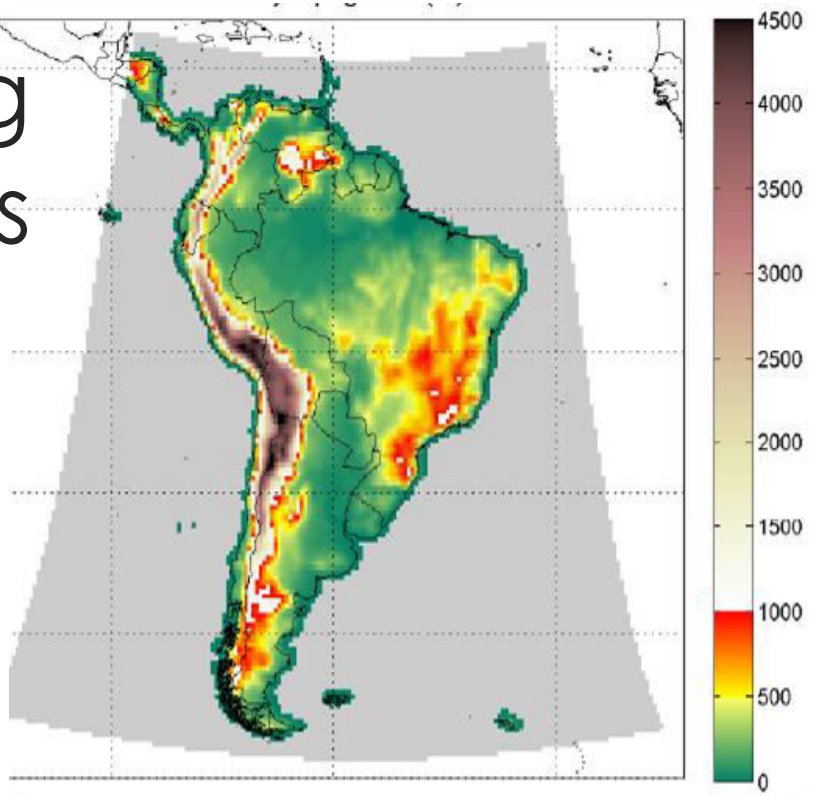


- Climate models

Through controlled experiments (soil moisture prescribed)

Tool for coupling studies

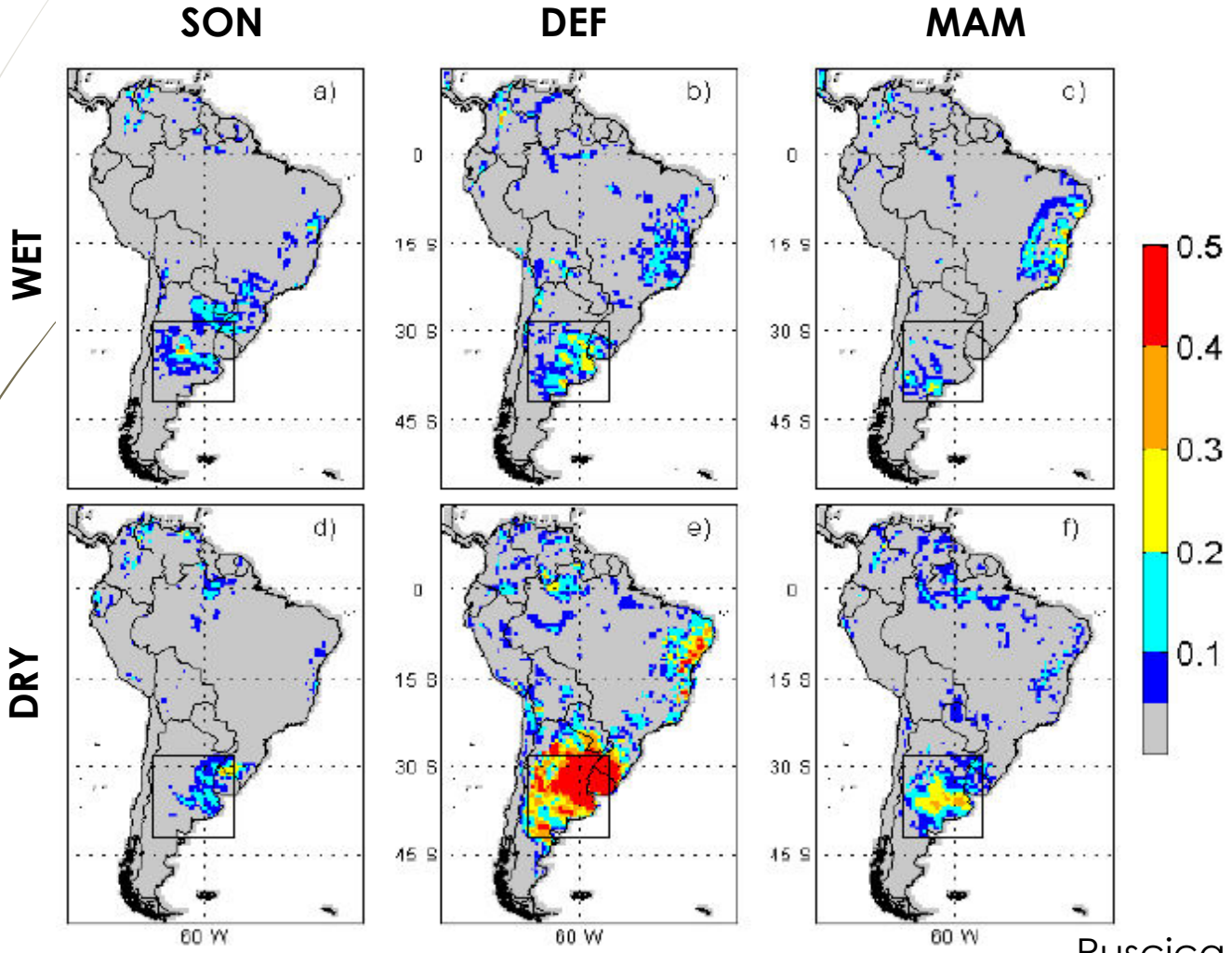
- Atmospheric and hydrostatic Regional Climate Model **RCA4**
- Version used for CORDEX-CMIP5
- 40 vertical levels. ERA-Interim (0.75°, 6hs)
- Controlled experiments
- Statistical coupling index from Koster et al. (2004)



Version first time executed over South America for land – atmosphere climate studies

Coupling results

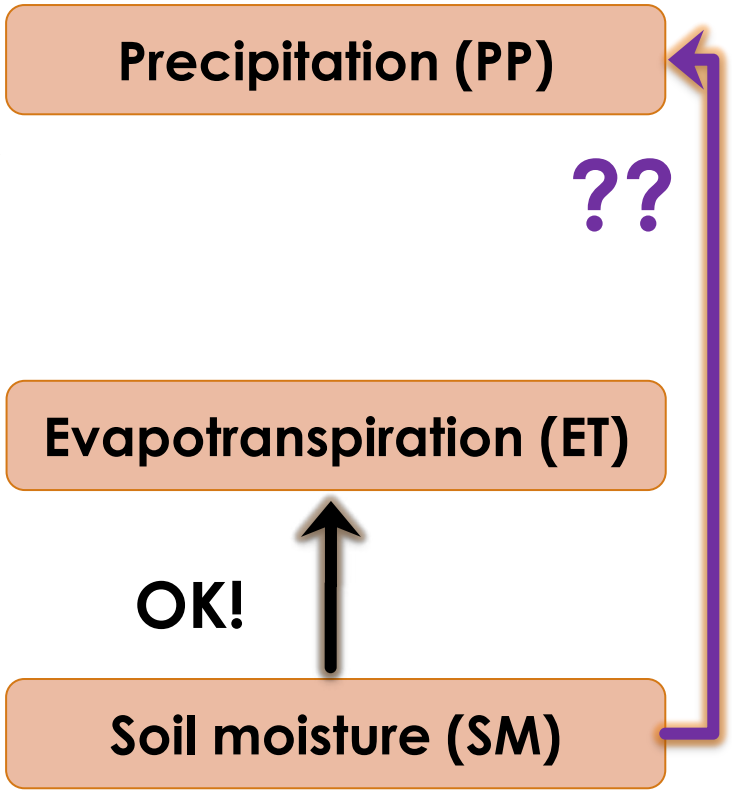
TERRESTRIAL SEGMENT COUPLING reaches its maximum intensity during **summer** preferentially with **dry** soil moisture anomalies

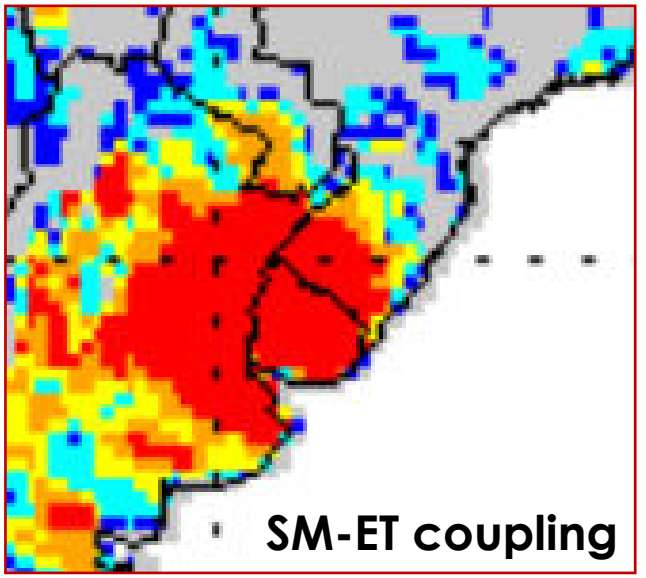


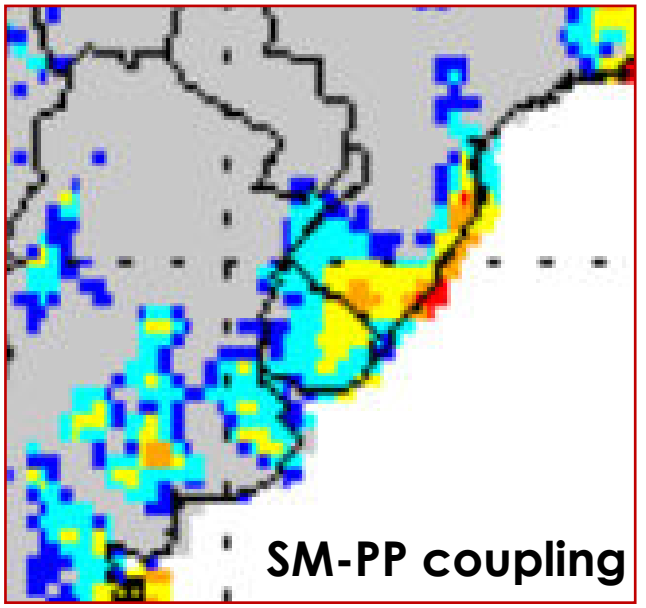
Ruscica et al., 2015

Ruscica et al., 2015

SESA during this dry summer ..



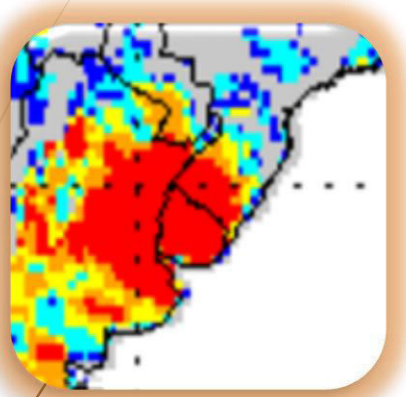




Ruscica et al., 2015

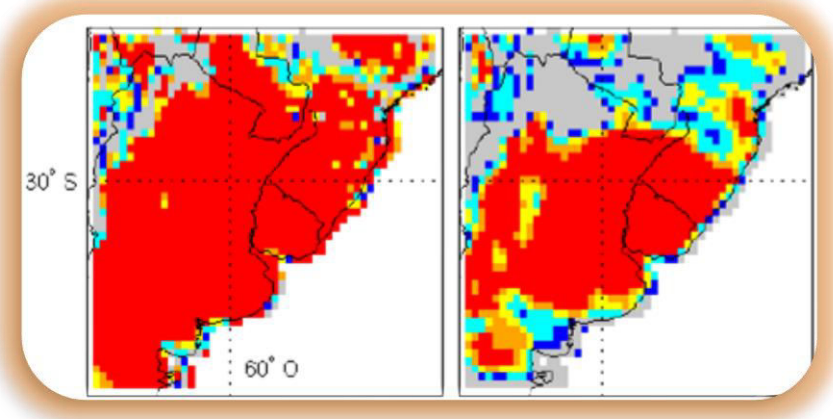
SM coupled with ..

Evapotranspiration

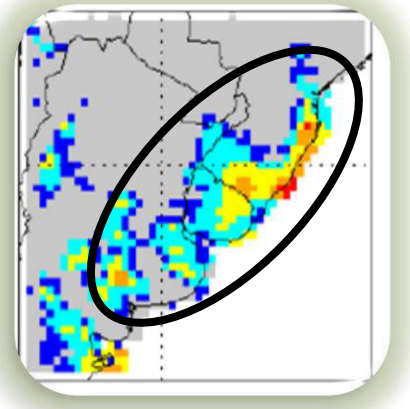


Bowen Ratio

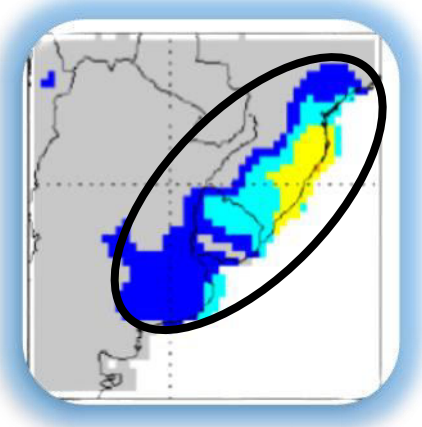
Boundary Layer Depth



Precipitation



Moist Static Energy

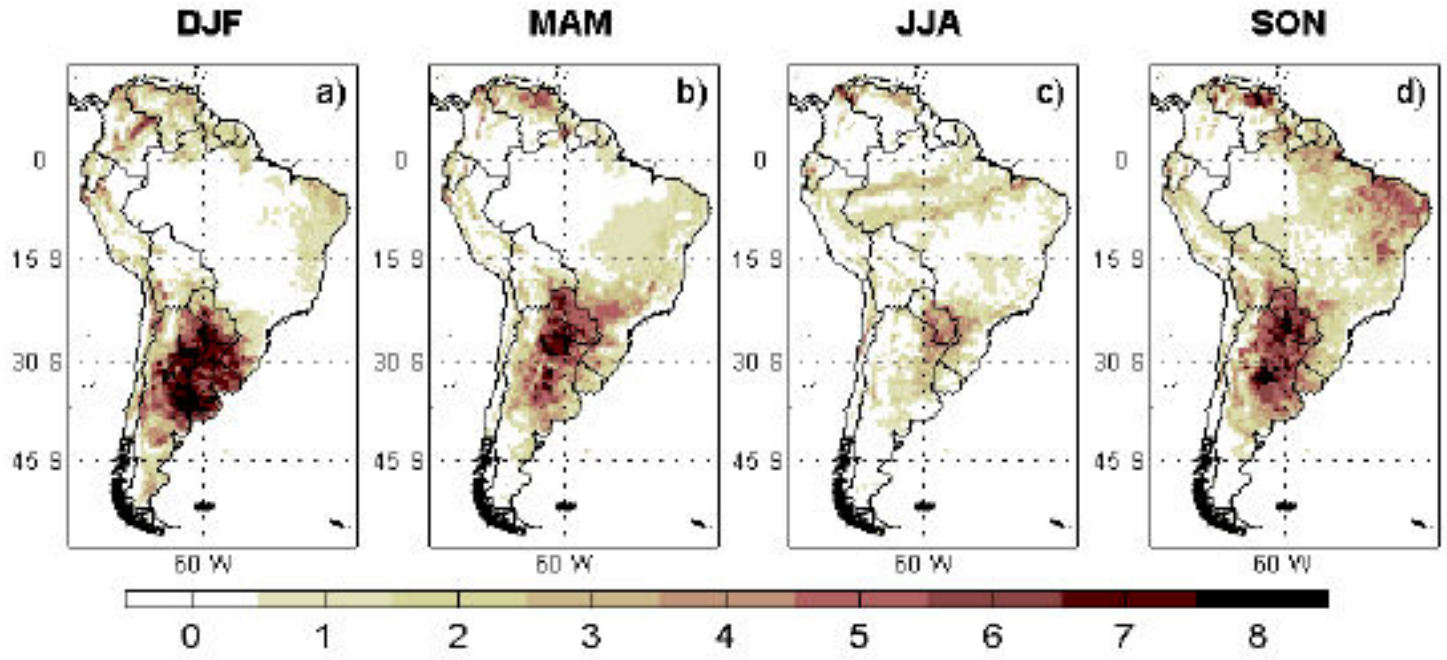


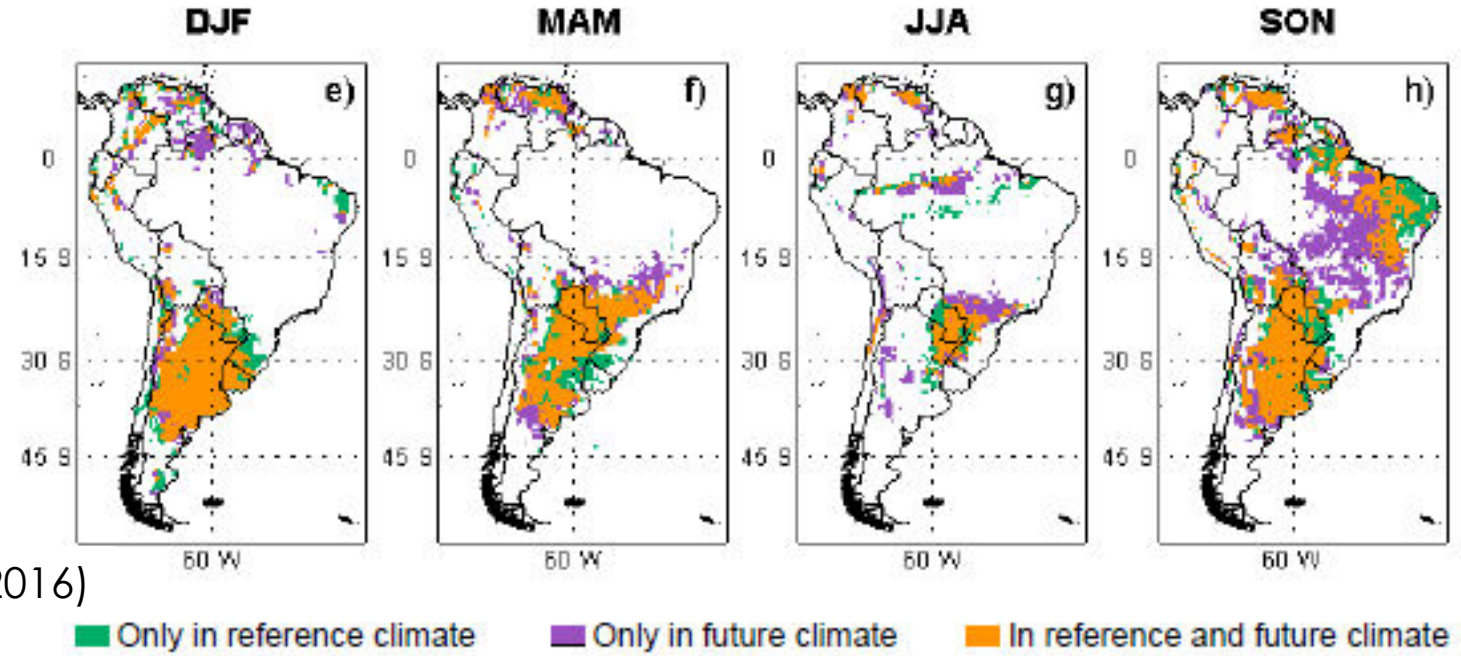
For L-A interaction studies

- 2 periods of 30 years:
  - reference climate (1961–1990) and
  - future climate (2071–2100)
- 8 ensemble members based on the combinations of four RCMs forced by three GCMs (CLARIS-LPB)
- Second generation land surface schemes, where stomatal control on ET is parameterized
- All models are hydrostatic and with 0.5∘ × 0.5∘ spatial resolution
- Series of seasonal values of ET and PP
- Statistical index from Zeng et al. (2010)

Ensemble consensus of L-A interaction (reference climate)

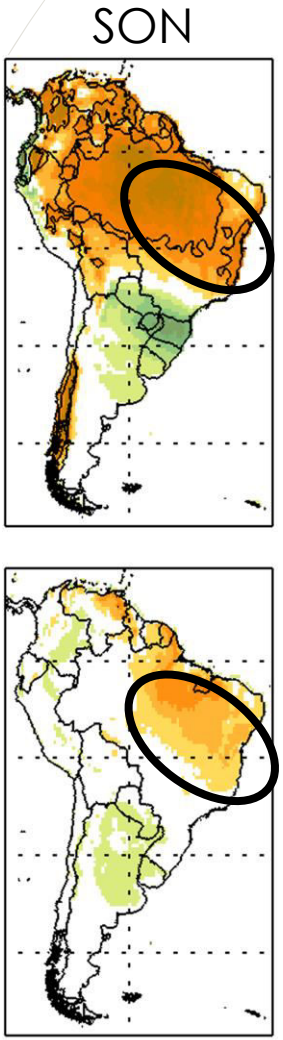
Response of L-A interaction to Climate Change



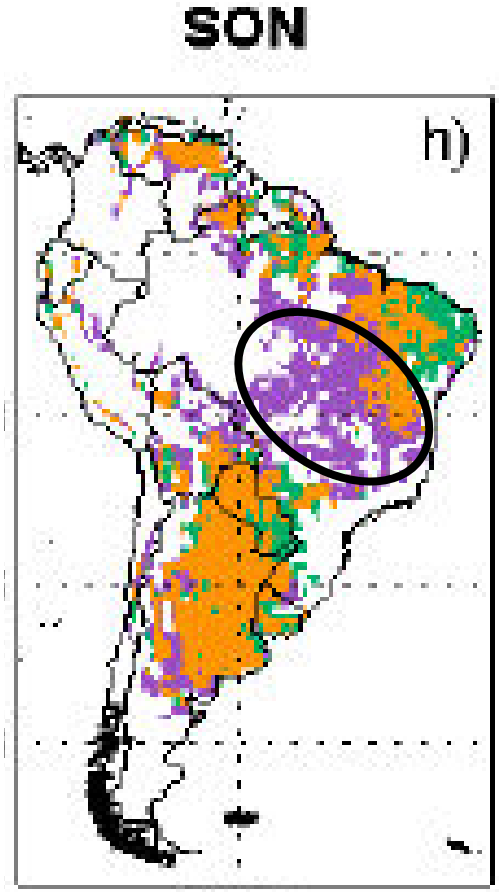


Ruscica et al. (2016)

Future climate transition zones



strong negative response of PP and ET to CC, that convert the energy-limited region to a SM-limited region, and consequently to a hotspot of L-A interaction

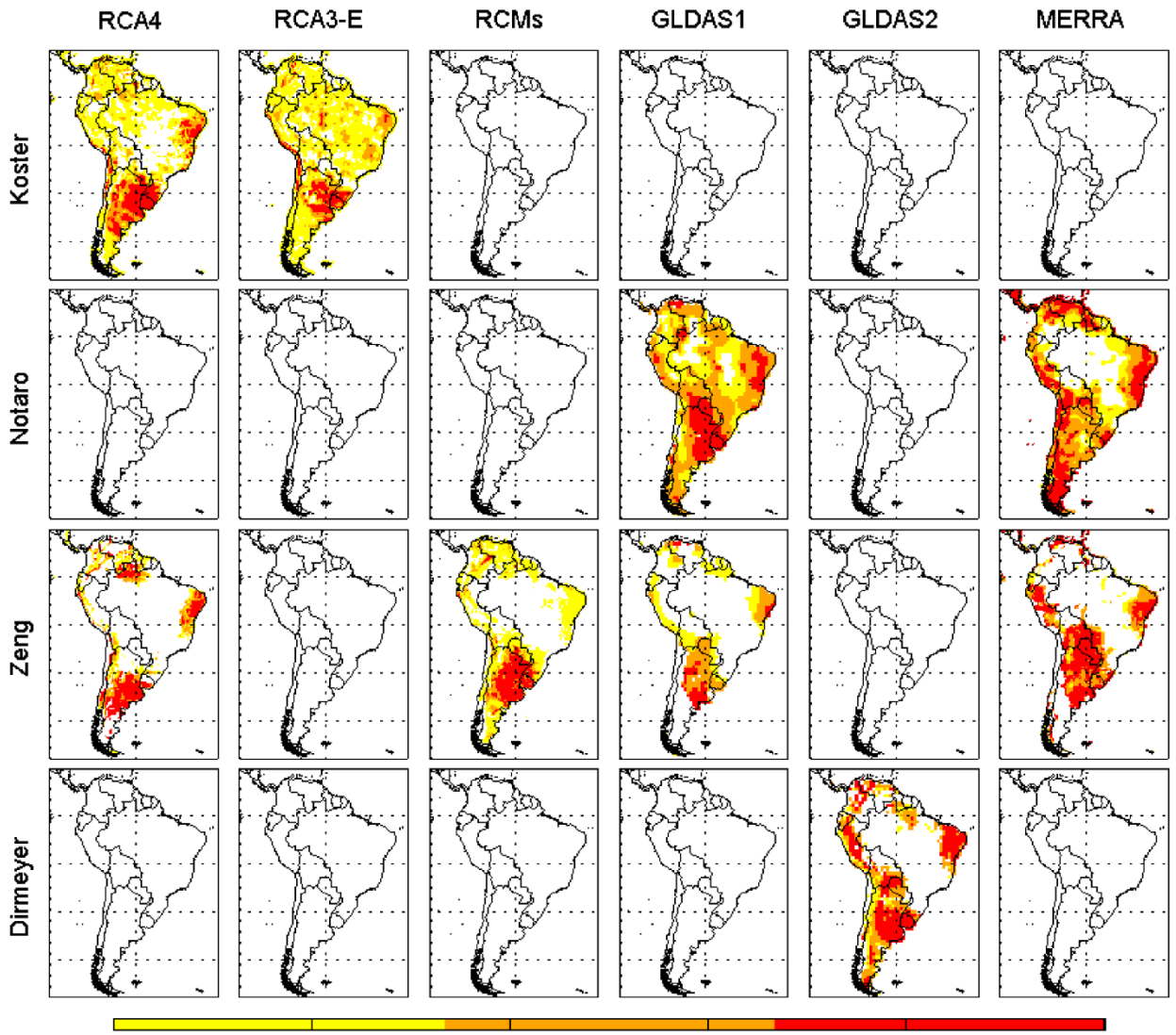


Ruscica et al. (2016)

More data.. More methodologies..

Southeastern SA is a region of soil moisture – atmosphere interaction for different input data and indices used, independently of the studied period, spatial and temporal scale.

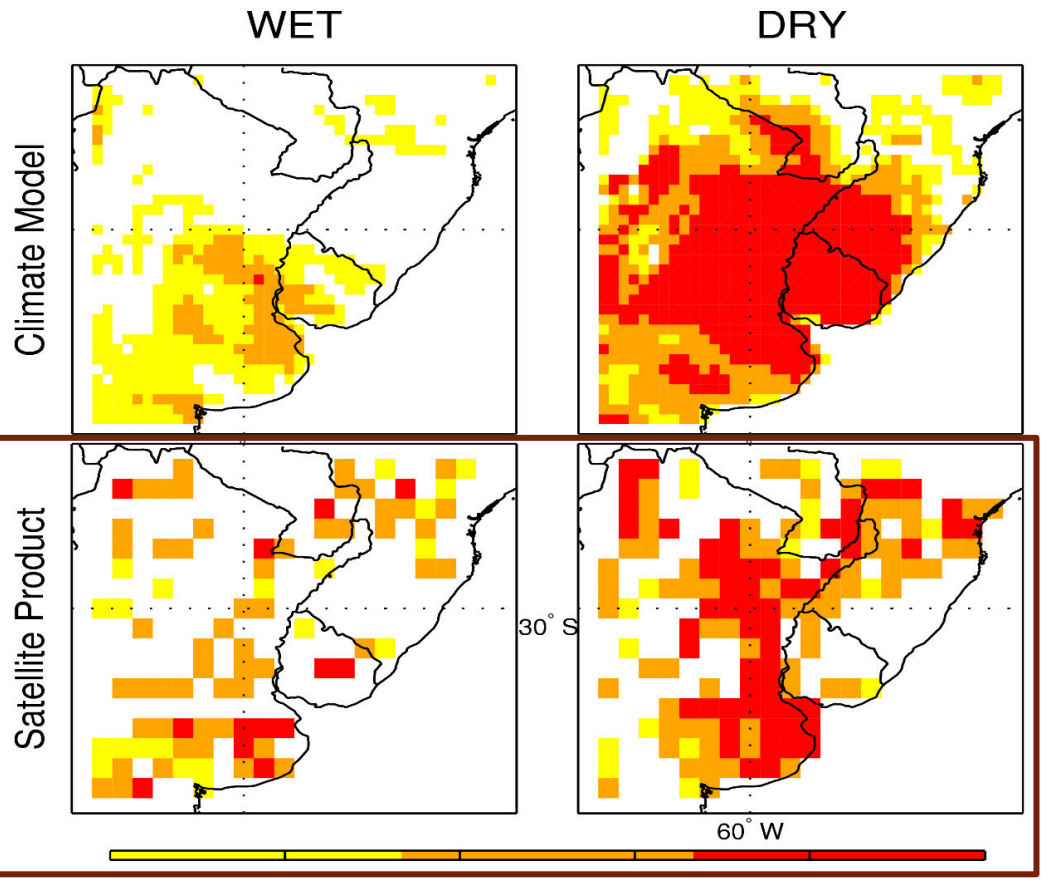
Nevertheless these studies have several limitations related to model assumptions and parameterizations



Work in progress: Adding satellite products

The L-A interaction with **remote sensing data agrees with climate results**. The interaction is higher during dry than during wet summers, although with higher spatial variability in the structure of the hot spots

MODIS LST (Land Surface Temperature) product MOD11A2 and SOIL MOISTURE DATA (AMSRE-LPRM)



Summary

- The most robust hotspot in SA is found in southeastern South America (SESA) for different periods, spatial-temporal scales, methodologies and datasets (RCMS, reanalysis and satellite products) and specially during dry summers
- Soil moisture couples precipitation in SESA during a dry summer through its influence on moist static energy
- In future climate, SESA maintains its status as a hotspot, and eastern Brazil becomes a new one during austral spring
- SESA has poor observational networks for soil moisture and evapotranspiration, therefore satellite products is used to validate model results of coupling

Thank you

References

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