Assessment of climate change in terrestrial water storage over the Magdalena-Cauca basin

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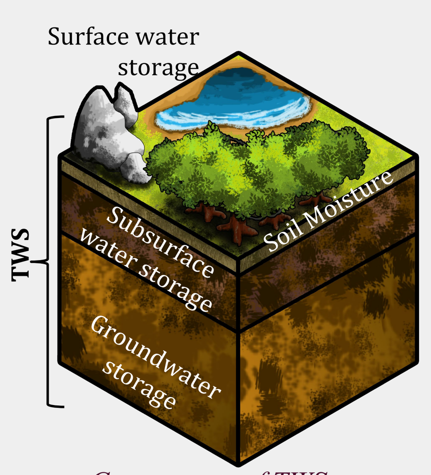
Introduction



Components of TWS.

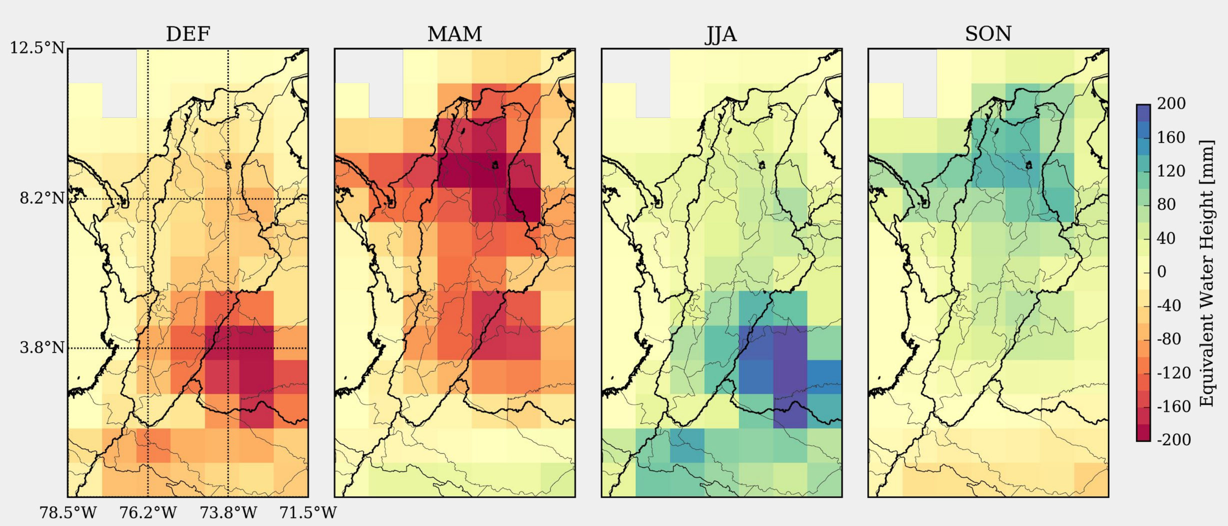
The study of terrestrial water storage (TWS) variability is important to understand local hydrological processes, changes in water availability, and, in general, the assessment of regional effects as a result changes in the global water cycle.

We assess the impacts of climate variability and change in TWS in Magdalena-Cauca basin (Colombia).

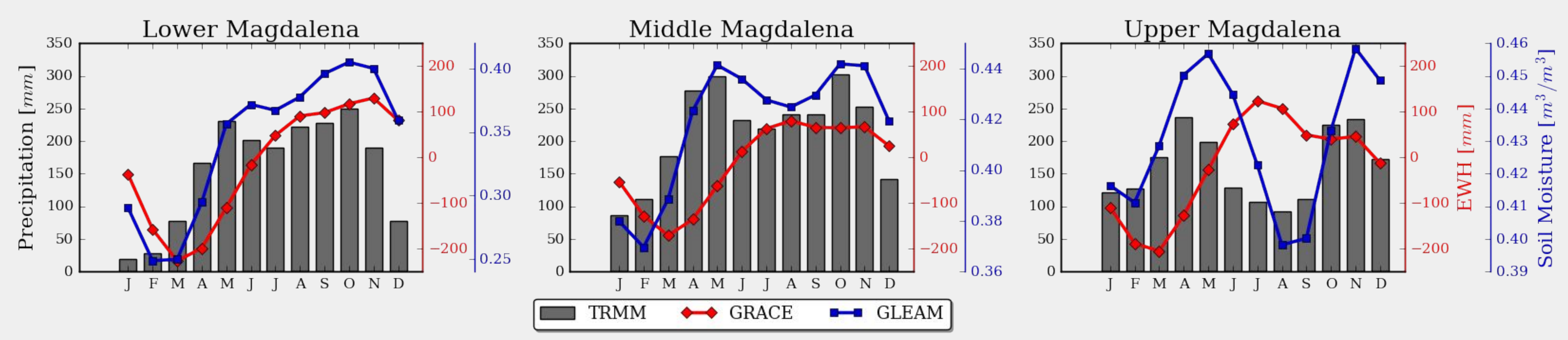
Localization of Magdalena-Cauca Basin

GRACE - Terrestrial Water Storage (TWS)

Seasonal Cycle



Seasonal cycle of mean changes in terrestrial water storage from GRACE observations from 2002 to 2015.

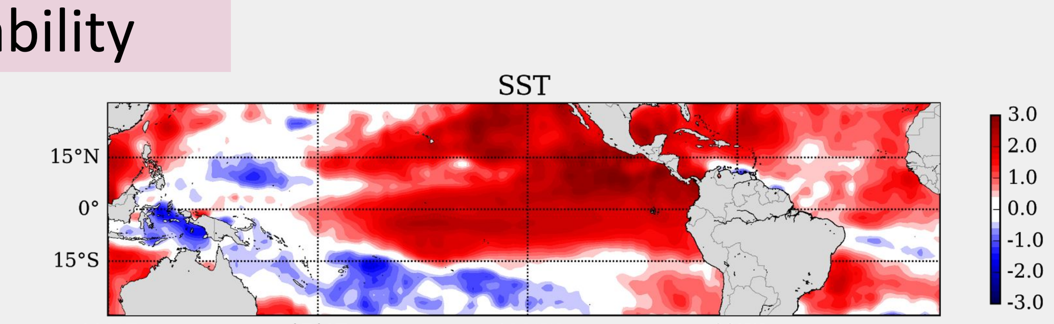


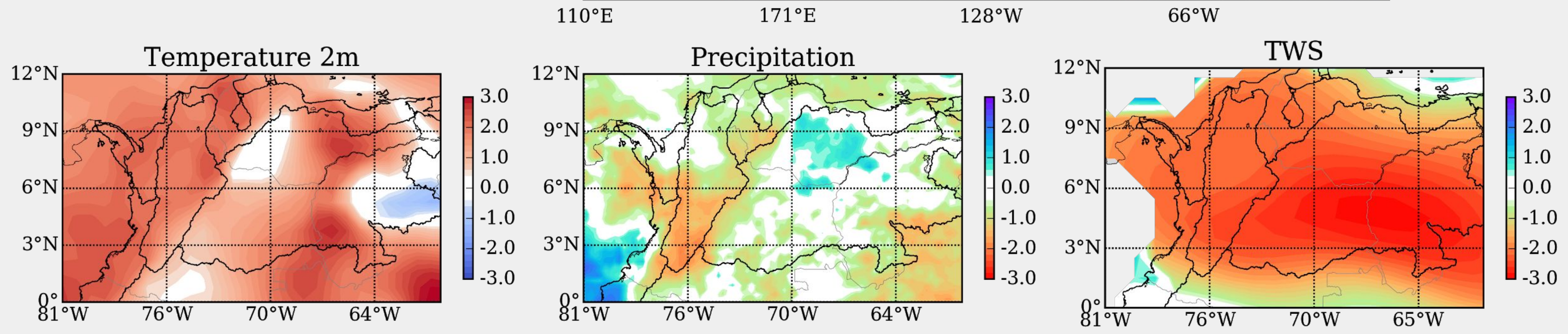
Annual cycle of precipitation (TRMM), terrestrial water storage (GRACE) and soil moisture (GLEAM).

Precipitation and TWS present differences in the seasonal variability, especially at the upper part of the basin. This is likely due to the role of local characteristics (soil depth, vegetation, and topography) modulating the precipitation-TWS relationship.

Inter-annual Variability

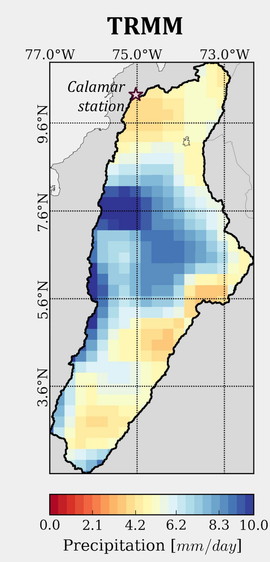
ENSO explains up to 70% of the inter-annual variability in TWS of the Northern South America.



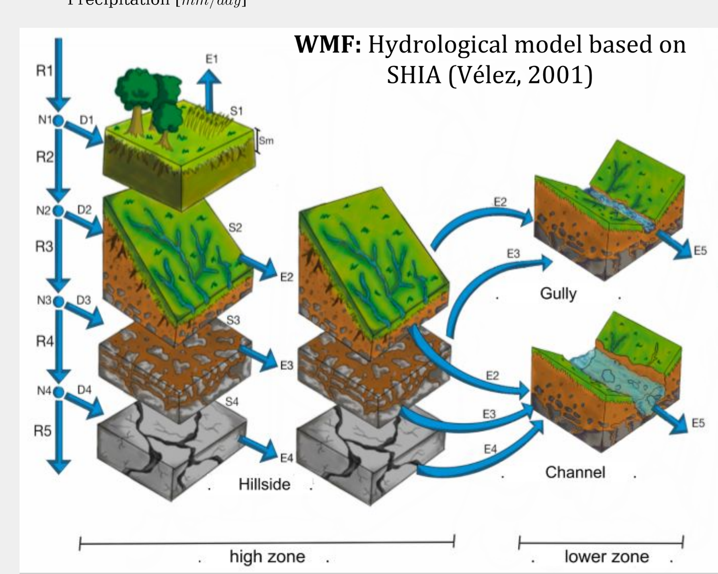


Oceanic, atmospheric and superficial mean anomalies between September and November 2015. 2015-16 El Niño event.

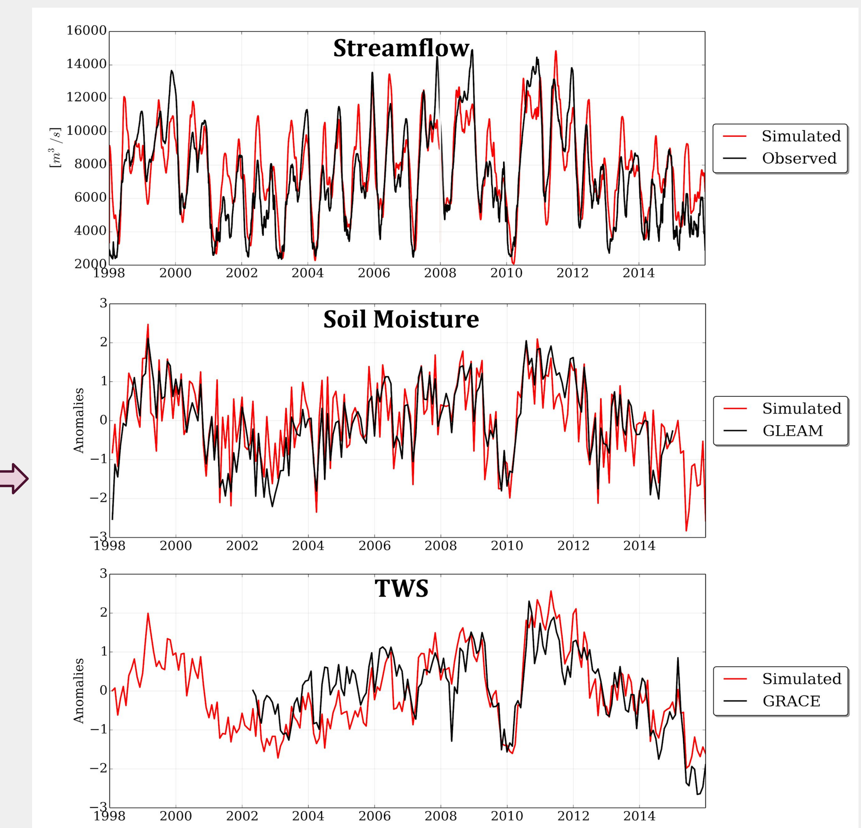
Hydrologic Simulation Experiment



For the simulation, we used the *Watershed modeling framework* (WMF), calibrated and validated using daily precipitation from TRMM and daily streamflow in Calamar station.



Although the model was not calibrated for water storage, the simulations of monthly mean anomalies of TWS show consistency with GRACE observations, and soil moisture variability is consistent with GLEAM data.



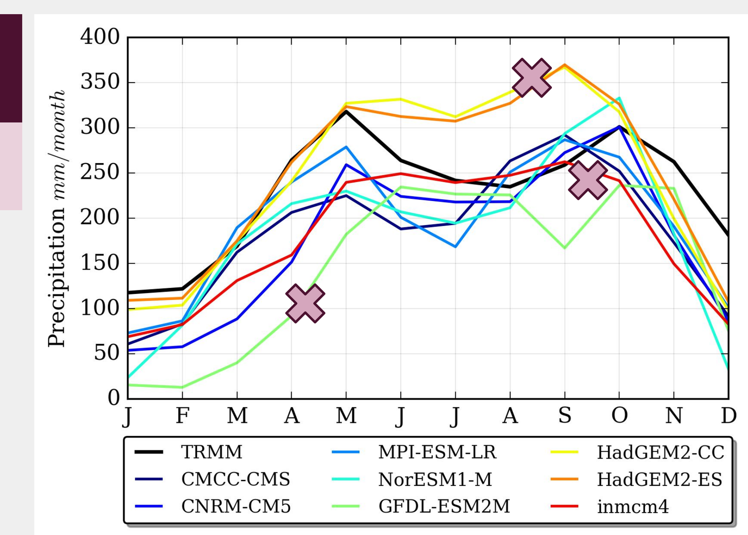
Methodology and results of hydrologic simulation.

Climate Change

General circulation models

Four GCMs were selected based on their representation of spatio-temporal variability of precipitation in the Colombian Andean region.

GCM data was statistically downscaled to a spatial resolution of 0.25 by 0.25 degrees using a quantile mapping method.



Selection of GCMs. Annual cycle of precipitation.

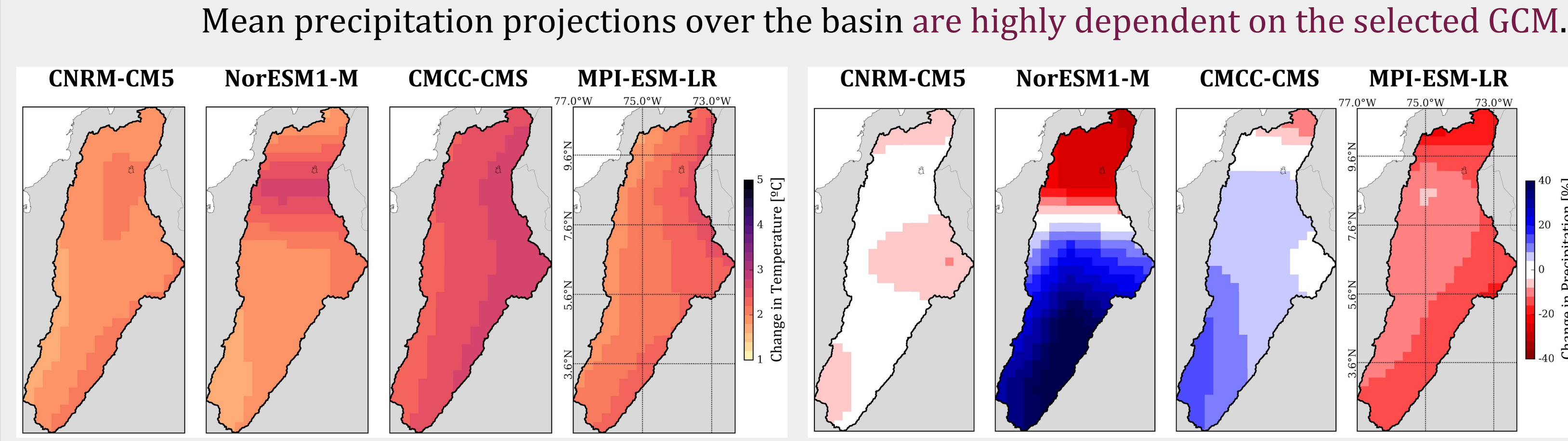
GCMs used for the analysis.

Name	Institute	Resolution
CMCC-CMS	Centro Euro-Mediterraneo per I Cambiamenti Climatici	2.8 x 2.8
CNRM-CM5	Centre National de Recherches Meteorologiques	1.4 x 1.4
MPI-ESM-LR	Max Planck Institute for Meteorology (MPI-M)	1.87 x 1.87
NorESM1-M	Norwegian Climate Centre	2.5 x 1.9

Climate change scenarios.

RCP	Period	ID
4.5	Mid-21st century (2021-2050)	M1
8.5	Mid-21st century (2021-2050)	M2
4.5	End of the 21st century (2071-2100)	F1
8.5	End of the 21st century (2071-2100)	F2

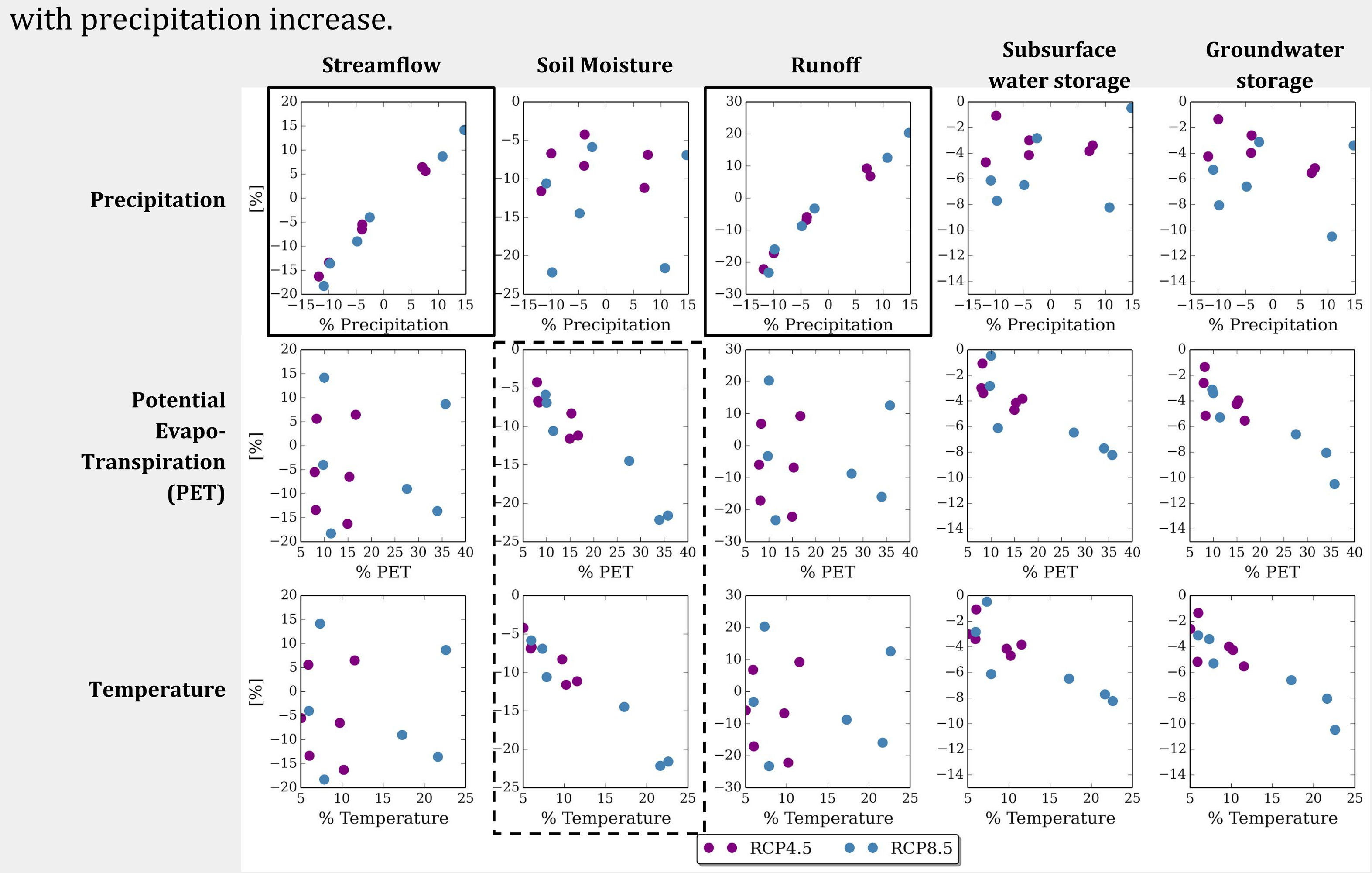
Mean precipitation projections over the basin are highly dependent on the selected GCM.



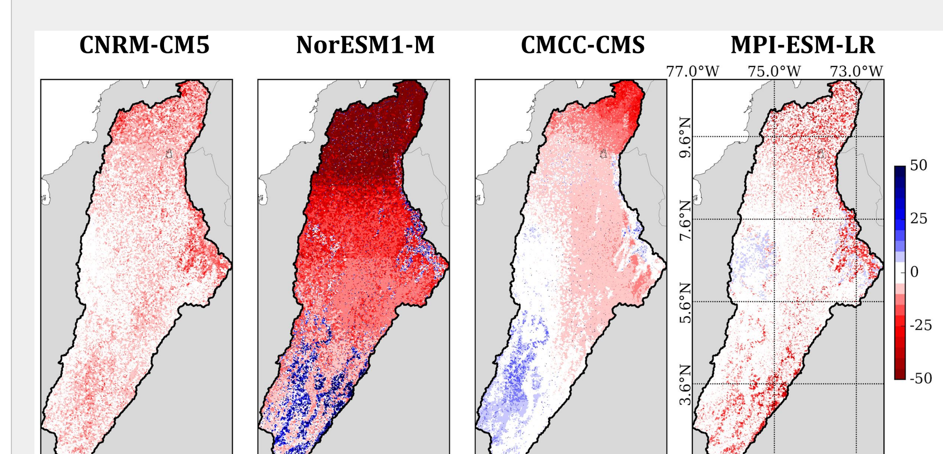
*Changes in mean temperature and mean annual precipitation projected by GCMs (Scenario **F1**).*

Impacts on water storage

Changes in precipitation, as expected, exhibit a direct impact on runoff and streamflow. On the other hand, temperature and evapotranspiration have considerable impact on soil moisture: positive trends in atmospheric temperature result in negative changes in soil moisture, even in scenarios with precipitation increase.



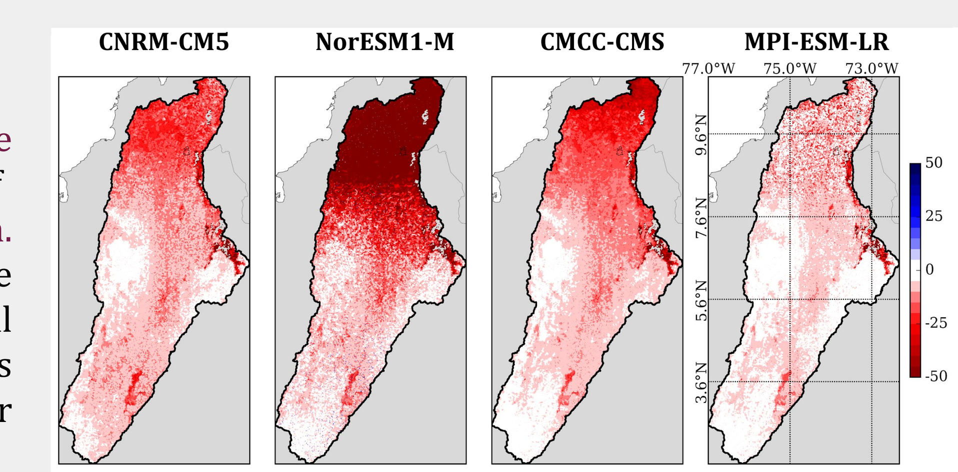
Mean changes in water storage components and streamflow vs mean changes in precipitation, PET and temperature.



*Changes in mean groundwater storage. (Scenario **F1**).*

Precipitation, along with soil properties and topographic characteristics condition the patterns and magnitude of changes in subsurface and groundwater storage.

Results show mean soil moisture decrease, in all climate change scenarios, due to the influence of temperature and evapotranspiration. This could lead to changes in the soil-atmosphere interaction, and local energy balance, with potential impacts for ecosystems and water supply for human consumption and agriculture.



*Changes in mean soil moisture. (Scenario **F1**).*

Acknowledgements

This work was supported by COLCIENCIAS and Universidad Nacional de Colombia within the project Jóvenes Investigadores 2015. Luz Adriana Gómez was partly funded by Universidad Nacional de Colombia under the Facultad de Minas graduate scholarship program. The authors would also like to acknowledge the use of free software including Python.