Local and remote Southern Hemisphere extratropical circulation responses to soil moisture anomalies in Australia

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Hemisphere-wide remote Rossby wave responses of the upper-level flow to soil moisture anomalies have been reported for the Northern Hemisphere. Model experiments varying soil moisture over North America point to the involvement of both linear and non-linear wave dynamics. Here three sets of model experiments are performed with the Community Earth System Model to study the role of soil moisture anomalies as a boundary forcing for the formation of extra-tropical upper-level Rossby wave patterns during Southern Hemisphere summer.

In the model experiments, soil moisture over Australia is set to +1STD (wet) and to -1STD (dry) of the ERA-Interim reanalysis climatology for the years 2009 to 2016. With this set-up 50 ensemble members are run and the wet and dry simulations compared. The local response to the soil moisture forcing is a positive heating anomaly in the dry simulations that results in a thermal low-like circulation anomaly with an anomalous surface low and an anomalous upper-level anticyclone.

A circum-hemispheric flow response is identified both in the extra-tropical upper-level flow and in the surface storm tracks that overall resembles a positive Southern Annular Mode-like flow anomaly in the dry simulations. The structure of this atmospheric response strongly depends on the background flow. During two El Niño summers the response is strongly influenced by nonlinear Rossby wave forcing, while during two La Niña summers the flow response resembles a circum-hemispheric wave train reflecting linear wave propagation.