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A satellite remote-sensing based analysis of soil moisture drought

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Soil moisture-temperature and soil moisture-precipitation feedbacks directly affect the water, energy and biogeochemical cycles, manifesting in a relationship between soil moisture conditions and the occurrence and persistence of extreme weather and weather related events in many regions of the world. While various studies have investigated the impacts of droughts on various climate and ecosystem variables, they are often not global or they do not make use of direct soil moisture observations. Here we use the satellite derived global soil moisture observations from the merged remotely sensed soil moisture dataset developed in the framework of the ESA Climate Change Initiative (CCI) program on the global monitoring of Essential Climate Variables to assess how temperature, precipitation, evapotranspiration and vegetation behave during extremely dry soil moisture conditions at the peak of the growing season using drought event composite analysis.

For many regions longer-term precipitation deficits build up to cause large negative soil moisture anomalies. At the peak of the dry period significant negative anomalies are found for evapotranspiration and vegetation, while temperature exhibits a significant positive anomaly. Vegetation shows a delayed response, with generally larger anomalies over grassland than over forest. Both differences could be due to the limited information contained on the deeper root zone in the remotely sensed soil moisture signal. In addition, the contrasting responses between forest and grasslands could be due to physiological differences, with forest being better able to save water during dry conditions. An analysis of ERA-Interim/Land soil moisture shows that for many regions deeper soil layers exhibit a lesser anomaly, indicating that soil moisture is still available at these deeper depths. Overall our results illustrate the usefulness of remotely sensed soil moisture for studying land-vegetation-atmosphere dynamics at the global scale.