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Regions of strong coupling between soil moisture and precipitation - as viewed from space

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The landmark paper by Koster et al. ("Regions of strong coupling between precipitation and soil moisture", Science, 2004) identified "hotspots" across the world where soil moisture feedbacks are important for rainfall, based on an ensemble of climate models. Their global map showed that over the North American Great Plains, the Sahel, Equatorial Africa and India, knowledge of soil moisture state increased 6-day rainfall predictability. Whilst most models broadly agreed on the location of the hotspots, there was large disagreement between models on the strength of the surface-atmosphere coupling. This implies considerable uncertainty in the depiction of soil moisture feedbacks in climate models.

In this study, we use satellite datasets of soil moisture and precipitation to produce a similar observation-based map for each season of the year. Retrievals of soil moisture have been produced from a number of passive and active microwave sensors dating back 3 decades, and a merged long term satellite soil moisture dataset suitable for coupling analyses is now available. Similarly, several multi-annual global precipitation products at high spatial (0.25°) and temporal (3 hours) have been produced which merge microwave and thermal infra-red data. We have performed statistical analyses on mesoscale features within these datasets to identify where in the world daily precipitation patterns are sensitive to antecedent soil moisture.

The observations agree well with the model-based study in some, but not all, hotspot regions for boreal summer. They also illustrate the importance of soil moisture feedbacks across parts of South America, Southern Africa and Australia at other times of year. The sign, as well as the strength, of the soil moisture feedback differs from region to region. For example, in West Africa, we find afternoon storms are strongly favoured over dry soils, consistent with previous studies (Taylor and Ellis, GRL 2006). Possible reasons for differences between the observation and model-based maps will be discussed, highlighting processes which may be important in determining the nature of the feedback.