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Where and why soil moisture – precipitation feedback is negative: observational perspective over the African Sahel

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Soil moisture affects initiation of convective rain storms and related precipitation variability. Yet, the physical mechanisms, strength and even the sign of the soil moisture – precipitation coupling remains uncertain, owning largely to a lack of extensive long-term observational products.
Recent studies, built on global remote sensing data and probability statistics at 5° grid resolution, suggest the co-existence of a positive temporal (rain over temporally wetter soils) and a negative spatial (rain over spatially drier soils) coupling. However, the physical interpretation of the obtained statistical relationships remains subtle.

Our present study revisits the physical nature of the observed spatial and temporal soil moisture – precipitation coupling (SMPC) at 1° grid resolution over the Sahelian domain (5-20°N, 20°W-40°E). Analysis of a 10-yr (2002-2011) satellite remote sensing data set of daily AMSR-E soil moisture and 3-hourly TMPA precipitation reveals a dipole pattern in the spatial SMPC over the region. In the S-W of the domain (Ghana, Benin), rainfall events indicate higher probability to occur over spatially drier soils, while they happen preferably over spatially wetter soils in the East (South Sudan). The dominant spatially negative coupling in the Sahel shows coherence with a negative temporal feedback. The latter contrasts with previous global findings and gives rise to additional questions on the atmospheric moisture origin in the event locations.

The identified land surface factors contributing to the negative SMPC on the S-W include the presence of statistical extremes and higher relative to the rest of the domain drying rates of the upper surface layer prior events. In contrast, seasonal flooding of the territories in the East and an overall moister land surface and boundary layer characterize the locations of positive coupling in the South Sudan region.
The contribution of atmospheric factors to the observed coupling relationships and related mechanisms will be investigated.