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A model study of soil moisture feedbacks on hydroclimatic variability

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Land-atmosphere interactions are a major component of the physical climate system. One of the key variables involved in these interactions is soil moisture, which partly controls radiative and turbulent heat fluxes to the atmosphere. Through these processes, soil moisture variability has the potential to feed back on near-surface hydroclimate (precipitation, temperature).
This study investigates simulations performed at GFDL in the frame of the GLACE-CMIP5 project to investigate soil moisture feedbacks : a coupled land-atmosphere model was run over 1950-2100 with transient forcings, prescribed SSTs (derived from the corresponding historical and future coupled CMIP5 simulations) and with either interactive soil moisture, or soil moisture prescribed to its 1971-2000 climatology. Here we compare in particular the two simulations over 1971-2000, isolating the effect of soil moisture dynamics (since soil moisture climatology is identical) on the simulated climate. We place the emphasis on near-surface hydroclimatic variability. We show that soil moisture dynamics strongly enhance temperature variability over apparent 'hotspots', at different time scales over different regions. Analysis of the daily distribution of the different variables involved (soil moisture, surface fluxes, temperature, precipitation) sheds light on the higher-order moments of variability that emerge as a result of soil moisture dynamics: bi-modality, asymmetry. In particular, soil moisture dynamics disproportionately impact the high side of the temperature distribution. These results have implications for the analysis (attribution, projections) of extreme events (e.g., droughts, heat waves).