Sensitivity Experiments for Multiple Equilibria of the Water Cycle Analyzed by a Soil-Atmosphere Model

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In the middle latitude, atmospheric blocking is one of the most impactful weather patterns in causing floods, droughts and unusually high or low temperatures. For example, in 2010, Russia was characterized by anomalously high temperatures due to a blocking high.

Soil moisture bimodality has been found from in-situ observation during the warmer season, possibly linked to the existence of a positive feedback between soil moisture and precipitation at the midlatitudes. D'Andrea summarized the relationship between atmosphere and soil. The physical mechanism for the existence of this bimodality was proposed by a coupled soil-atmosphere model, that could predict the existence of multiple equilibria in the water balance of the atmospheric boundary layer and the upper soil layer.

In the present study, to further investigate the relationship between atmospheric blocking and soil bimodality, we make use of an analytical soil-atmosphere model. We evaluate the sensitivity of the multiple equilibria to variations in key parameters and check the robustness of this phenomenon under various conditions to identify possible ways of improving the representation of physical land-atmosphere interactions in models. We introduce modifications from parametrizations to the definition of initial conditions, including adoption of different soil types, evapotranspiration rates, moisture convergence, irrigation and perturbations on radiation.