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Metrics to Characterize Land Controls in the Dynamical Evolution of Clouds

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The spatial patterns (e.g. orographic precipitation, hydroecological gradients) and temporal rhythms of water cycle processes (e.g. diurnal cycle, seasonality, active and break phases of convective activity) studied through exploratory data analysis of remote sensing and model data show the emergence of coherent, complex order from the interplay between large-scale forcing and local landform constraints. Although there is a large body of evidence from observations and model studies linking precipitation occurrence to land-surface conditions, the space-time dynamics by which land-atmosphere feedback mechanisms control, and are reflected in the dynamics of moist processes in the mid and upper troposphere are not well understood. A basic research question is to establish measurable cause-effect relationships between convective instabilities generated by land-atmosphere interactions within limited areas (as described by differential surface water and energy flux patterns) and the dynamical evolution of moist processes in the mid and lower troposphere regionally (as manifest by cloud and precipitation patterns): in other words, the challenge is to isolate the contribution of land controls to the predictability of clouds. Here, we rely on the framework of nonlinear dynamical systems to establish suitable metrics of spatial complexity in the coupled land-atmosphere system. Results from diagnostic data analysis of model simulations, reanalysis products, and ground-based and remote-sensing observations of cloud, precipitation patterns, and land surface characteristics such as orography, soils, and vegetation from initial efforts focused on the Indian subcontinent during he monsoon season will be presented.