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The Impacts of Inundating Australia on Australian Monsoon

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Large-scale perturbations in land surface characteristics have been found to induce disturbances in the overlying atmosphere via land-atmosphere coupling. The perturbations can lead to changes in hydroclimatic variables, such as precipitation and air temperature, or in atmospheric circulation patterns. However, the local and remote atmospheric responses to continental-scale changes in land surface water have not been well studied in Australia. In this study, using the Community Earth System Model 2 (CESM2) of the National Center for Atmospheric Research (NCAR), we investigate the changes in Australian monsoon, which primarily impacts the northern Australian climate, in response to an extreme surface condition: the whole Australia being treated as a shallow lake in model simulations. The simulation results show that a continental-scale lake would extend the Australian monsoon season via earlier onset and later end. We find that the most significant changes in the simulated precipitation occur during the pre-monsoon period (e.g., early October to mid November). Considering that the traditional scheme used to explain monsoonal rainfall by the theory of land-sea thermal contrasts is not consistent with the simulated precipitation patterns, this study analyzes the changes in moist static energy (MSE) budget, the simulation with a hypothetical lake features an atmospheric condition that favors the formation of precipitation: increased moisture convergence and dry static energy divergence, which might be associated with the increased net energetic forcing and export of MSE. We also confirm the dominant role of atmospheric circulation in determining the variability of precipitation over northern Australia in wet season via examining the regional moisture recycling. A relative impact computation upon components in the moisture budget shows that the dynamic component of the vertical advection of moisture contributes the most to the temporal evolution of precipitation over northern Australia in wet season.