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Limited impacts of a permanent inland lake in central Australia on local-to-regional precipitation

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Abstract: This research was inspired by a potential geo-engineering project, commonly referred to as the Bradfield Scheme, proposed decades ago aiming at irrigating semi-arid regions of central Australia for agriculture and gradually changing the rainfall regime over the region. The initial conceptual appeal of the proposal was to introduce a large water expanse into the middle of an arid region lacking water resources, which was suggested would induce hydroclimatic changes favourable toward increased agricultural productivity. However, there is a lack of research into the impact of newly established inland water bodies on local-to-regional hydroclimate and detailed land-atmosphere interactions involved in the potential changes. We will present the impact of a permanent inland lake in central Australia on local-to-regional precipitation based on a numerical experiment using a coupled land-atmosphere model with numerical water tracers (WVTs).

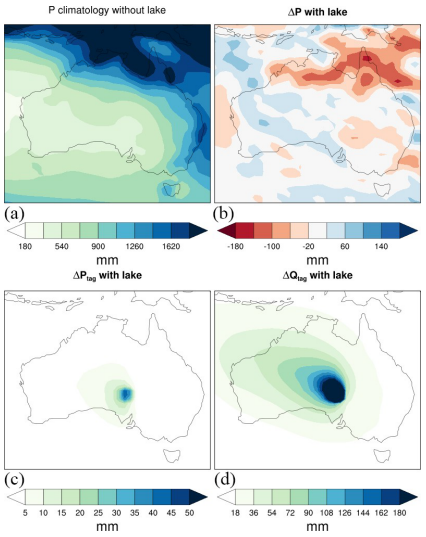

Figure 1. 1975–2004 annual average for (a) simulated precipitation climatology, (b) difference in simulated precipitation caused by the lake, (c) difference in simulated lake-originated precipitation, (d) difference in simulated lake-originated water vapor

Kati Thanda–Lake Eyre is an ephemeral saline lake in central Australia and when full, is the largest inland water expanse in Australia. By emulating an idealised permanent Kati Thanda in the community earth system model (CESM) coupling land and atmosphere, we investigated how precipitation responded to that land surface perturbation from local to regional scales. At the local scale, the permanent lake strengthened the rainfall recycling process but failed to cause significant changes in total precipitation. The permanent lake was found to influence the local thermodynamics and dynamics. Specifically, the lake increased the latent heat flux through changes in the surfaceenergy budget, which corresponded to a significantly enhanced moisture flux into the overlying atmosphere. However, it also led to significant evaporative cooling, creating strong divergence in the lower atmosphere and suppressing precipitation formation. At the regional scale, the impacts of the permanent lake were negligible as well even though additional moisture originating from the lake spread over the continent as shown by the built-in WVTs of CESM. To compensate for a relatively small sample size, instead of simply depending on significant tests, our study employed an isotope-enabled version of CESM with internal WVTs and showed that the precipitation of water vapor originating from the lake region trivially contributed to total precipitation. Based on the results, we conclude that a large permanent lake in the Kati Thanda–Lake Eyre region in central Australia may have limited impacts on local-to-regional precipitation. For a better understanding of the underlying mechanisms of land-atmosphere interactions, our study also shows that coupled climate models together with moisture-tracking tools have important potentials in the assessment and mitigation of extremes (e.g., floods) or perturbed land surface (driven by either natural or anthropogenic factors). Future works will continue to investigate the variability of local and regional hydroclimates responding to permanent inland lakes of different sizes.

Keywords: *Land-atmosphere coupling, numerical model simulation, moisture tracking*