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US Corn Belt enhances regional precipitation recycling

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Precipitation recycling, characterized by the contribution of local evapotranspiration (ET) to local precipitation, is a critical component of the
regional water cycle. In the US Corn Belt, vast croplands and irrigation applications have markedly modified surface energy and water balance, which in
turn modulates precipitation recycling. However, previous studies often neglected the complex hydrological and crop physiological processes at land surface with an oversimplified assumption. In this study, we aim to understand the precipitation recycling in the US Corn Belt with explicit shallow groundwater dynamics, crop growth, and irrigation processes in the WRF model, with the water vapor tracer (WVT) capability to track ET directly from croplands. We found that the croplands exhibit a strong cooling effect on air temperatures and increasing summer precipitation. The increase in precipitation can be attributed to enhanced precipitation recycling, ranging from 11 to 22%, and much stronger seasonality during summer growing seasons. Such cooling effect and contribution to precipitation recycling is more significant in a drought year compared to normal and wet years, depending on both large-scale moisture advection and local moisture source. Our results have important implications to modeling ecohydrology and agricultural management in the Earth system, understanding precipitation recycling in the entire water cycle and designing sustainable water resource governance.