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Rising Temperatures Increase Importance of Oceanic Evaporation as a Source for Continental Precipitation

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Understanding vulnerabilities of continental precipitation to changing climatic conditions is of critical importance to society at large. Terrestrial precipitation is fed by moisture originating as evaporation from oceans and from recycling of water evaporated from continental sources. In this study, continental precipitation and evaporation recycling processes in the Earth system model GFDL-ESM2G are shown to be consistent with estimates from two different reanalysis products. The GFDL-ESM2G simulations of historical and future climate also show that values of continental moisture recycling ratios were systematically higher in the past and will be lower in the future.

Global mean recycling ratios decrease 2%–3% with each degree of temperature increase, indicating the increased importance of oceanic evaporation for continental precipitation. Theoretical arguments for recycling changes stem from increasing atmospheric temperatures and evaporative demand that drive increases in evaporation over oceans that are more rapid than those over land as a result of terrestrial soil moisture limitations. Simulated recycling changes are demonstrated to be consistent with these theoretical arguments. A simple prototype describing this theory effectively captures the zonal mean behavior of GFDL-ESM2G.

Key sources of terrestrial evaporation, notably the interior of the Amazon basin and parts of the Ganges-Brahmaputra and Indus River basins, may experience reductions in moisture recycling. This has implications for key sink regions of terrestrial recycled precipitation, especially in rain-fed agricultural regions where crop yields will become increasingly soil moisture limited, such as the La Plata River basin, the corn producing regions of North America, southern Africa and the Sahel.

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