What Water Tracers Tell Us About Hydrologic Cycle Change in a Warmer World

H.A. Singh, C.M. Bitz, A. Bailey, J. Nusbaumer, A. Donohoe, D.C. Noone

Numerical water tracers, which track atmospheric moisture from where it evaporates to where it precipitates, are a powerful tool for understanding how the hydrologic cycle changes in a warmer world. Water tracer experiments performed with a state-of-the-art global climate model, the CESM1, reveal that atmospheric moisture transport changes significantly as the globe warms, and that most of these changes are attributable to an increase in the residence time of water in the atmosphere. As the residence time of water increases, precipitation at a given locale tends to become less dependent on locally-sourced moisture and more dependent on remotely-sourced moisture, i.e. the global moisture transport length scale increases. Such length scale increases are manifested in a number of ways, including increased moisture export from the subtropical Atlantic to the Pacific, which salinizes the Atlantic and freshens the Pacific; and more subtropical moisture entering the Arctic in spring and summer. On the other hand, processes peculiar to the polar regions, particularly sea ice loss and increased local evaporation, complicate the hydrologic cycle response over the poles in the fall and winter seasons. Overall, such significant changes in moisture transport in a warmer world are expected to alter the isotopic composition of water, though how these changes manifest remains an area of active research.