



The effects of post-condensation exchange on the isotopic composition of water in the atmosphere

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We conducted experiments with an atmospheric general circulation model to determine the effects of non-Rayleigh, post-condensation exchange (PCE) on the isotopic composition of water in the atmosphere. PCE was found to universally deplete vapor of heavy isotopes, but had differential effects on the isotopic composition of precipitation. At low latitudes, local PCE with fresh vapor at the surface enriches precipitation in heavy isotopes, particularly during light rainfall. When rainfall is heavy, PCE tends to deplete vapor and precipitation of heavy isotopes via atmospheric moisture recycling, supporting recent interpretations of vapor isotope measurements from satellites, particularly over the Asian Monsoon region. In the extratropics, PCE causes local enrichment of precipitation, which is often entirely offset by upstream PCE depletion of the source vapor, resulting in a net depletion in local precipitation. The transition from net enrichment to net depletion is controlled by the transition from rain to snow-dominated precipitation. Surprisingly, this transition was also found to influence the temperature effect. In regions with a strong seasonal mix of rain and snow, such as Europe, the temperature effect appears to be controlled by PCE rather than Rayleigh depletion.