# Evaluating the assumption of equilibrium between precipitation and vapor during evaporation using data and models

Rich Fiorella[1], Scott Allen[1], Jessica Guo[1], Bill Anderegg[1], Stephen Good[2], David Noone[2], Chris Still[2], Jason B. West[3], and Gabe Bowen[1]

1: University of Utah
2: Oregon State University
3: Texas A&M University

Stable water isotopes are common tracers of environmental processes in various natural archives such as leaves, soils, and lakes. Partial evaporation of these pools causes an increase in the abundance of heavy isotopologues that is proportional to the gradients in humidity and isotope ratio of the evaporating water and the surrounding atmosphere. Until recently, measurements of the isotope ratio of atmospheric water vapor were difficult to obtain and remain scarce. As a result, it has been frequently assumed that the isotope ratio of the atmosphere is in equilibrium with local precipitation. We evaluate this assumption using two distinct approaches. First, we compiled an 8-member ensemble of general circulation models including calculations of isotope ratios in precipitation and vapor. We find that equilibrium between vapor and precipitation is relatively rare on annual and monthly timescales, largely a result of atmospheric transport and mixing processes. Second, we test these results by compiling a set of paired vapor and precipitation ratios and leveraging the new set of paired measurements provided by the National Ecological Observatory Network (NEON). Calibration approaches to NEON water isotope data will also be briefly discussed. Vapor isotope ratios, and their variation with respect to precipitation isotope ratios, help improve our understanding of source, sink, and transport of water in the atmosphere and improve efforts to model isotope ratios in evaporative systems.