Relationship Between Isotope Ratios in Precipitation and Surface Water Across Watersheds of the National Ecological Observation Network

Zachariah Butler[1], Stephen P. Good[1], Marja Haagsma[2], Catalina Segura[1], and Huancui Hu[3]

[1]Oregon State University Graduate School
[2]Oregon State University
[3]Pacific Northwest National Laboratory

July 23, 2023

Abstract

The timescales associated with precipitation moving through watersheds reveal processes that are critical to understanding many hydrologic systems. Measurements of environmental stable water isotope ratios (δ ^{2}H and δ ^{18}O) have been used as tracers to study hydrologic timescales by examining how long it takes for incoming precipitation tracers become stream discharge, yet limited measurements both spatially and temporally have bounded macroscale evaluations so far. In this observation driven study across North American biomes within the National Ecological Observation Network (NEON), we examined δ ^{18}O and δ ^{2}H stable water isotope in precipitation (δP) and surface water (δQ) at 26 co-located sites. With an average 54 precipitation samples and 139 surface water samples per site, assessment of local meteoric water lines (LMWL) and local surface water line (LSWL) showed geographic variation across North America. Taking the ratio of estimated seasonal amplitudes of δP and δQ to calculate young water fractions (F_{yw}), showed a F_{yw} range from 1% to 93% with most sites having F_{yw} below 20%. Calculated mean transit times (MTT) based on a gamma convolution model showed a range from 0.10 to 13.2 years, with half of the sites having MTT estimates lower than 2 years. Significant correlations (r) were found only between the F_{yw} and watershed area, longest flow length, and the longest flow length/slope, whereas the only significant correlation observed for MTT was with site latitude. The estimated F_{yw} and MTT provide information describing hydrologic processes at NEON sites, however limited correlations of F_{yw} and MTT with the environmental characteristics we analyzed demonstrate that these quantities are primarily driven by site or area specific factors. The analysis of isotope data presented here provides important constraints on isotope variation in North American biomes and the timescales of water movement through NEON study sites.

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