EGU2020-646
https://doi.org/10.5194/egusphere-egu2020-646
EGU General Assembly 2020

Simulating preferential flow in a two water worlds framework

Jesse Radolinski[1], Luke Pangle[2], Julian Klaus[3], Durelle Scott[4], and Ryan Stewart[5]
[1]University of Innsbruck, Institute of Ecology, Austria (jesse.radolinski@uibk.ac.at)
[2]Georgia State University, Geosciences Department, USA (lpangle@gsu.edu)
[3]Luxembourg Institute of Science and Technology, Environmental Research and Innovation, Luxemburg (julian.klaus@list.lu)
[4]Virginia Polytechnic Institute, Department of Biological Systems Engineering USA (dscott@vt.edu)
[5]Virginia Polytechnic Institute, School of Plant and Environmental Sciences, USA (rds@vt.edu)

Ecohydrological separation has been observed across climates and biomes, and at a fundamental level suggests that water in mobile versus immobile domains may resist mixing over varying periods of time; however little mechanistic evidence exists to explain this separation at a process scale. Non-equilibrium flow in the vadose zone may partially account for widespread perception of distinct hydrological domains yet no studies have weighed its contribution. Using a simple isotope mixing technique, we sought to determine the amount of preferential flow necessary to maintain a two water worlds scenario (i.e., physical separation between mobile and immobile water pools). We constructed 60 cm soil columns (20 cm-ID PVC) containing low soil structure (sieved soil material), subsoil structure (intact B horizon), and soil structure without matrix exchange (tubing reinforced macropores) to simulate multiple preferential flow scenarios. Columns were subjected to 3 rain storms of varying rainfall intensity (~2.5 cm h^{-1}, ~5 cm h^{-1}, and ~11 cm h^{-1}) whose stable isotope signatures oscillated around known baseline values. Isotopic analysis was performed on collected leachate and matrix water sampled via direct vapor equilibration. Preliminary estimates of matrix water indicate up to 100% mixing with infiltrating rain water under low rainfall intensity (2.5 cm h^{-1}) in subsoil structure columns, whereas high intensity rain (11 cm h^{-1}) produced clear separation between columns with intact or artificial soil structure and those controlled for structure (low structure treatment). This separation was confirmed by preferential flow estimates; however minimizing matrix exchange (via artificial macropores) reduced preferential flow by a factor of 4 compared to soil with intact structure. These data suggest that distinct domain separation may only be possible under extreme precipitation intensity; and that exchange with less mobile storage in the soil matrix produces more preferential flow. We intend to use these estimates of preferential flow as a benchmark to understand the prevalence, persistence, and plausibility of ecohydrological separation. As a next step, we will use this conceptual framework to define how recurrent drought, elevated CO_2, and warming may alter the partitioning of mobile and immobile water in mountain grasslands.