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Streamwater transit time estimates affected by isotope transformations within the forest canopy

Michael Stockinger (1), Heye Bogena (1), Andreas Lücke (1), Bernd Diekkrüger (2), Jeffrey McDonnell (3), and Harry Vereecken (1)

(1) Forschungszentrum Jülich, IBG-3: Agrosphere, Jülich, Germany (m.stockinger@fz-juelich.de), (2) University of Bonn, Department of Geography, Meckenheimer Allee 172, 53115 Bonn, Germany, (3) Global Institute for Water Security, University of Saskatchewan, Saskatoon, Canada; School of Geosciences, University of Aberdeen

Stable isotopes of water are often used as tracers of water movement at the catchment scale. Previous studies have mainly used tracer information of open precipitation (OP) to derive the Transit Time Distribution (TTD) models of streamflow emanating from forested catchments. However, rainfall passage through the forest canopy may alter the precipitation water tracer information due to evaporation, possibly leading to erroneous TTD estimates. Here we compare the effects of different precipitation tracer inputs for TTD modeling for a 0.39 km^2 forested headwater catchment in the Eifel region of Germany: throughfall (TF) measured for 19 months, OP and OP corrected by a constant factor to account for canopy influence (OPcorr). We used the 1.5 year long time series of weekly precipitation and stream isotope data to evaluate changes in stream isotope simulation and TTD results using the TRANSEP model. Stream isotope simulation results were improved with a maximum increase in Nash-Sutcliffe Efficiency of 0.23 (0.44 to 0.67) when TF was used instead of OP. We found that TF influences on OP isotope composition had a significant effect on TTDs, with transit times decreasing by up to 27%. These results show the importance of accounting for canopy-induced isotope tracer changes in estimating streamwater transit time.