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Accounting for seasonal isotopic patterns of forest canopy intercepted precipitation in streamflow modeling

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It is well known that forest canopy interception alters the isotopic signal of precipitation leading to significant isotopic differences between open precipitation (OP) and throughfall (TF). This can have important consequences for the modeling of water transit times using isotopic tracer data. Since TF data is rarely available for hydrological modeling studies, some studies used a simple static correction by uniformly increasing OP values to infer TF estimates. Here, we used a three year time series of isotope tracers in a 38.5 ha temperate, spruce forested headwater catchment to develop a more adequate method to better account for time variable throughfall isotope effects on the OP time series. Isotopic changes, defined as the difference TF-OP, varied seasonally with higher values during winter and lower values during summer. We used this pattern for calculating the fraction of young water (Fyw), which is the percentage of streamflow younger than a specific age. Fyw was calculated for OP, TF (reference case) and two different OP correction methods: one corrected by adding a time-invariable factor (OPconst) as was done in previous studies, while the other was corrected with a seasonally variable signal (OPseas). We found that Fyw derived from OPseas came closest to TF with 10.7-11.0% of streamflow younger than 44 days compared to the reference of TF with 12.5-12.6% of streamflow younger than 39 days, respectively. Compared to this, Fyw derived from OP and OPconst were far off from the reference case (only 8.5-8.8% of streamflow being younger than 46 days for both inputs). This finding suggests that in temperate regions seasonal isotopic enrichment patterns in throughfall of forest stands occur that need to be accounted for in the estimation of Fyw.