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Influence of vegetation canopies on precipitation partitioning and isotope fractionation in northern upland catchments

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Climate change is predicted to have far reaching implications for northern high latitude regions including changing precipitation regimes and increasing temperatures in the coming decades. In many areas this will promote increased forest cover as a result of vegetation succession or mitigation measures. For example, in the Scottish Highlands, forest cover is increasing as a result of adaptive management and increased biofuel production. In the wet, windy Scottish hydroclimate this has the potential to significantly increase interception losses, reduce net precipitation and affect the spatial and temporal distribution of soil moisture. Recent studies have also shown that such processes may also change the isotopic signature of net rainfall in throughfall and stemflow with implications for using isotopes as hydrological tracers. Such effects may be exacerbated by projected higher temperatures and reduced summer precipitation. The main focus of this study was to quantify the effects of forest and non-forest vegetation canopies on the spatio-temporal variability of throughfall and stemflow in the Bruntland Burn, a 3.2 km2 montane experimental catchment in the Scottish Highlands. We investigated differences in both the quantity and isotopic composition of throughfall and stemflow under Scots Pine (Pinus sylvestris) forest and heather (Calluna vulgaris) moorland growing on podzolic soils. Altogether, 75 throughfall and 10 stemflow collectors were placed in four plots with different topographic positions and vegetation characteristics (two different aged Scots pine plantations and two heather sites) and canopy coverage was determined using digital photography. Over a 5 month sampling period, weekly throughfall samples were taken. We also analysed more than 1100 samples for stable isotopes δ18O and δD. Interception losses were 38% under moorland and up to 47% for the plantation sides. Both throughfall and stemflow amounts were found to be highly variable and were mostly dependent on gross rainfall, canopy coverage and wind speed. Throughfall was the dominant canopy pathway with stemflow accounting for <1% of inputs. The variation in the isotopic signal was found to be mainly driven by the isotopic signature of the incoming precipitation and little variability between the sites and between throughfall and stemflow was detected. Fractionation in the canopy was small and limited to low precipitation amounts (<5mm) in the warmest summer periods.