Influence of vegetation on water isotope partitioning across different northern headwater catchments

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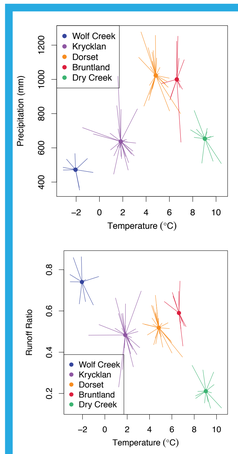
Introduction and Objectives

The use and redistribution of water by vegetation has a large impact on hydrologic cycling in northern catchments. This work is part of the VeWa project (vegetation effects on water flow and mixing in high-latitude ecosystems) which aims to improve our understanding of the role of vegetation in the partitioning of water along a cross-regional gradient. Five high latitude catchments were chosen in North America and Europe with a range of vegetation ecosystems and precipitation patterns. As an initial comparison between the sites, precipitation and stream isotope data was plotted to identify how isotope patterns vary between the catchments.

* How do stable isotope dynamics vary between cross-regional northern sites?
* How does the seasonality of stable istope dynamics vary with the vegetation and hydrometric dynamics found in norther sites?

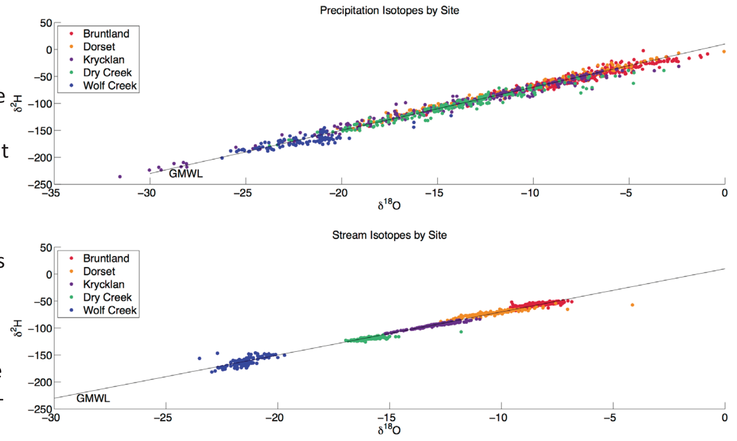


Study Catchments

The five study sites range from cold and dry with a high runoff ratio to warm with a low runoff ratio. The sites in Scotland and Ontario are the most similar in precipitation, temperature and runoff, but still vary significantly in type of vegetation and amount of snowfall.

Isotope Comparison

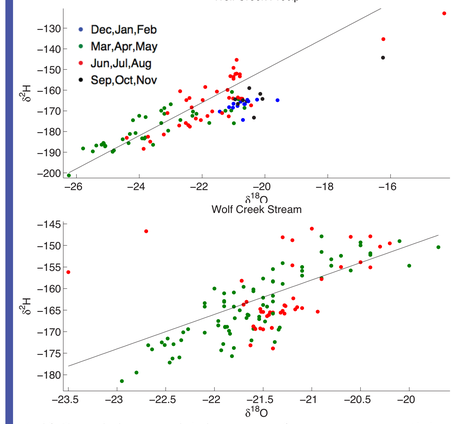
Precipitation and stream flow at each site occupies spaces on the meteoric water line that broadly reflects latitude. The northern-most sites have more depleted isotopes while Dry Creek shows depletion due to the Rocky Mountains. Krycklan demonstrates the largest range of precipitation isotopes.



Wolf Creek

(Yukon Territory, Canada)
60°7' N
58% Shrub/sub-alpine
40% Alpine tundra
<5% Wetlands


Wolf Creek Precip

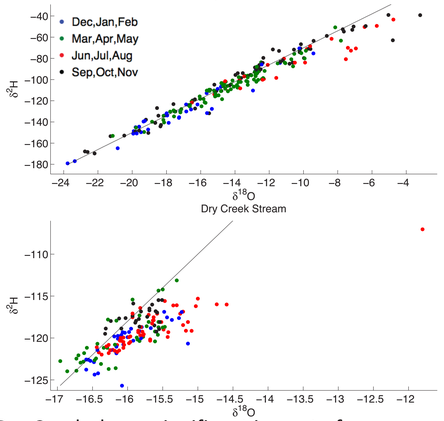


Wolf Creek has a thick permafrost and conditions prevent year-round sampling for seasonality, but depletion is greatest during snowmelt

Dry Creek

(Idaho, US)
43°7' N
Mostly grassland
Conifers at high elevation
Riparian hardwoods

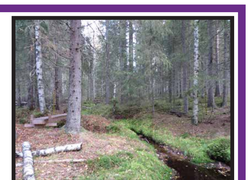

Dry Creek Precip

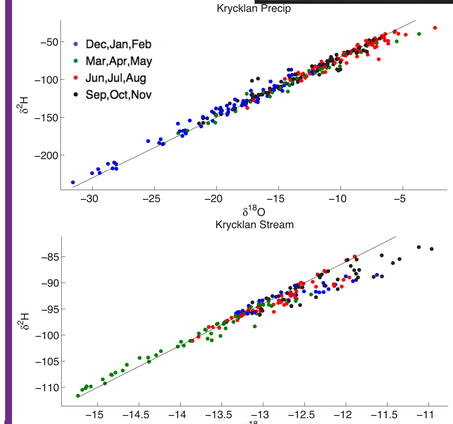


Dry Creek shows significant impact of evaporation, particularly in summer, but no strong seasonality impact on isotope depletion

Krycklan (Site 7)

(Northern Sweden)
64°12' N
85% Forest (conifer)
15% Wetland


Krycklan Precip

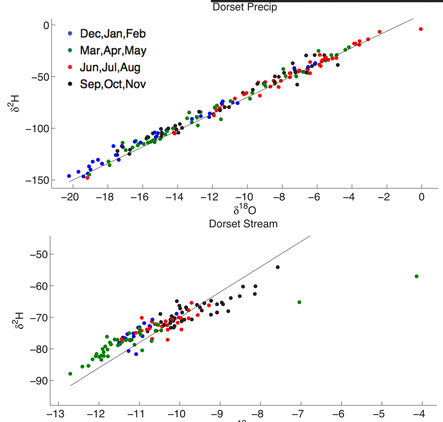


Krycklan shows a strong isotopic depletion during spring snowmelt and a groundwater influence in that depletes the summer rainfall.

Dorset (Harp 4)

(Ontario, Canada)
45°4' N
92% forest (deciduous / conifer)
8% Wetland


Dorset Precip

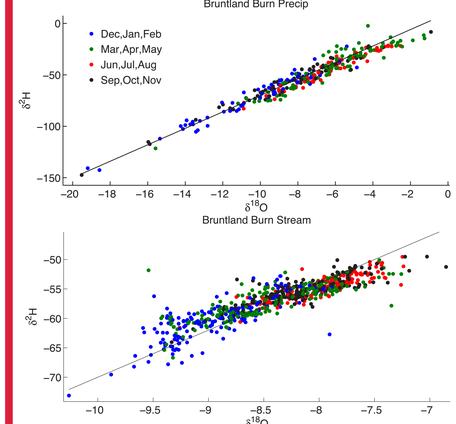


The stream shows a strong seasonal impact on fractionation, with the greatest depletion during spring snwomelt and least depletion in the fall.

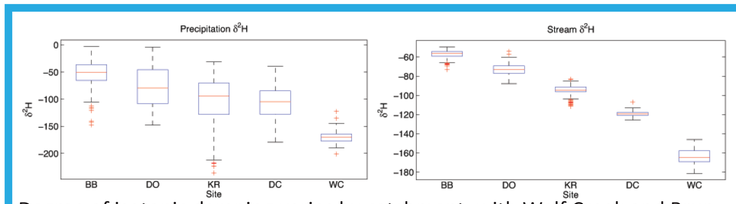
Bruntland Burn

(Northeast Scotland)
57°2' N
63% Heather Moorland
18% Wetlands
8% Forest (conifer)
5% Grassland


Bruntland Burn Precip



Isotopes are most depleted in winter and spring and summer shows the greatest impact of ET on isotope fractionation.



Degree of isotopic damping varies by catchment, with Wolf Creek and Bruntland Burn demonstrating the least amount of damping and Dry Creek and Krycklan the most significant.

Results

* Dry Creek, with the lowest runoff ratio, has isotopes which show strong deviation from the global meteoric water line in summer, suggesting a large influence of evapotranspiration and groundwater.
* Bruntland Burn, the least snowy system, has more isotopic depletion in the winter months than the other catchments.
*Krycklan, Dorset, and Dry Creek all have the greates isotopic depletion in spring melts, suggesting a strong snowmelt influence in these catchments.
* Krycklan and Dorset are the only catchments with significant forest cover and the only catchments that show a marked decrease in isotope depletion in the fall. This could be due to a change in the vegetation usage of groundwater as the plants shift to less productive winter months.

Future Work

* We are installing sapflow sensors to compare how vegetation water usage relates to isotope composition and how vegetation responds to water deficits
* Because the majority of plant roots are near the soil surface, we plan to sample the water isotopes in the top 10 cm of soil to see how the water used by plants compares to the water available to them
* Ultimately, we'd like to know what are the dominant processes and controls of water partitioning in different landscape units and at different northern sites across a cross-regional transect

http://www.abdn.ac.uk/geosciences/departments/geography-environment/vewa-908.php

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