SMALL SCALE (<10,000 km^2) ISOSCAPES REVEAL SPATIALLY VARIABLE WATER SOURCES FOR NORTHEASTERN OHIO PRECIPITATION, SURFACE WATER, AND GROUNDWATER

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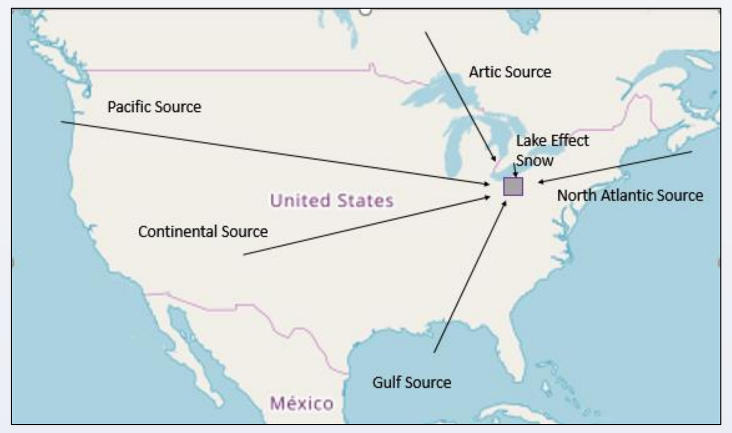
Introduction

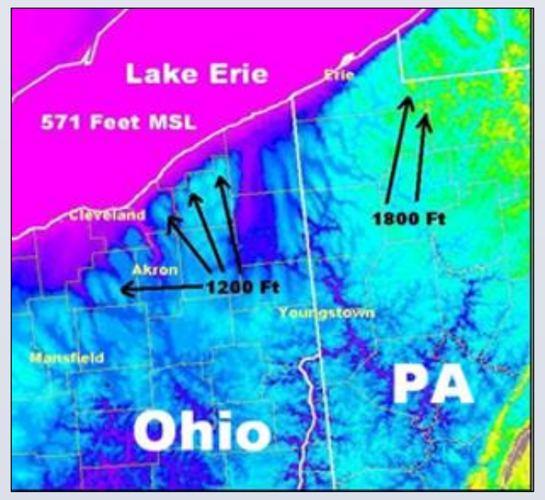
Isoscapes are an emerging tool to visualize and analyze the variation of water isotopes at large regional scales.

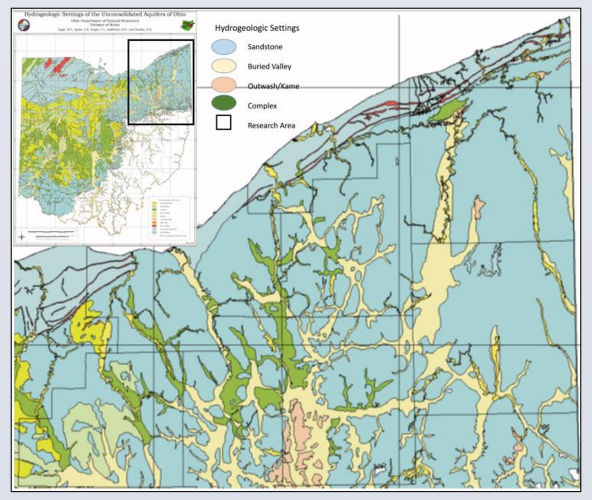


Here we hypothesize that varying influences of different air mass source areas, plus lake effects, have the potential to impart variation in groundwater isotopes at much smaller scales.

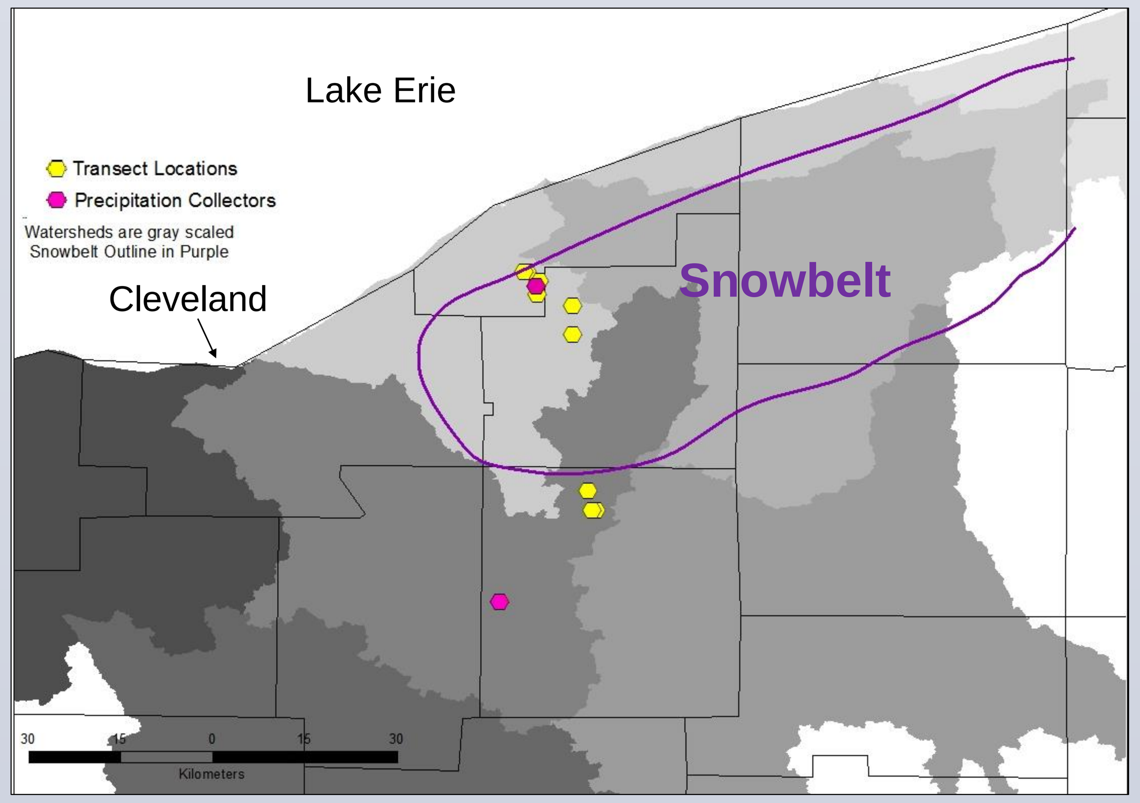
Study Area and Methods

Across a 10,000 km^2, low relief area in northeastern Ohio, mean annual precipitation ranges from 900-1100 mm and winter snowfall varies from 800 to 2500 mm. Relief in the study area is <200 m (left) Higher elevation areas near Lake Erie form a Snowbelt. The area is underlain by glacial materials, sandstones and shale. Aquifers shown at right.





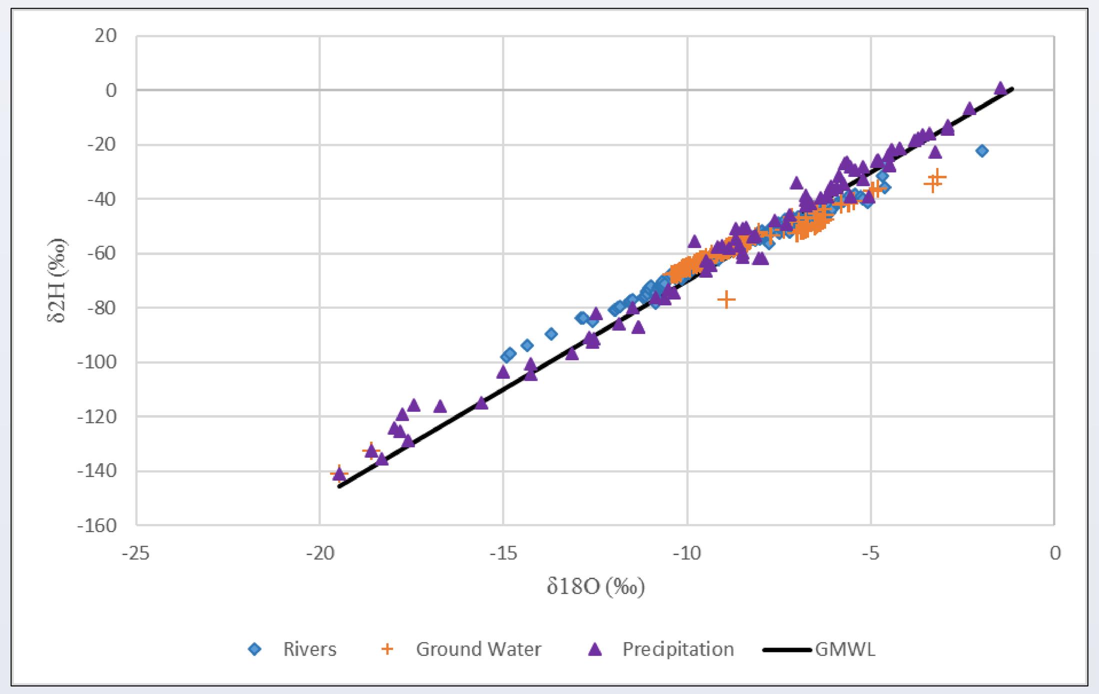
Lake, river, and groundwater samples were collected from 120 locations seasonally, and 12 locations sampled biweekly. Precipitation was collected at 2 locations 50 km apart. One is located in the Snowbelt; the other in Kent.



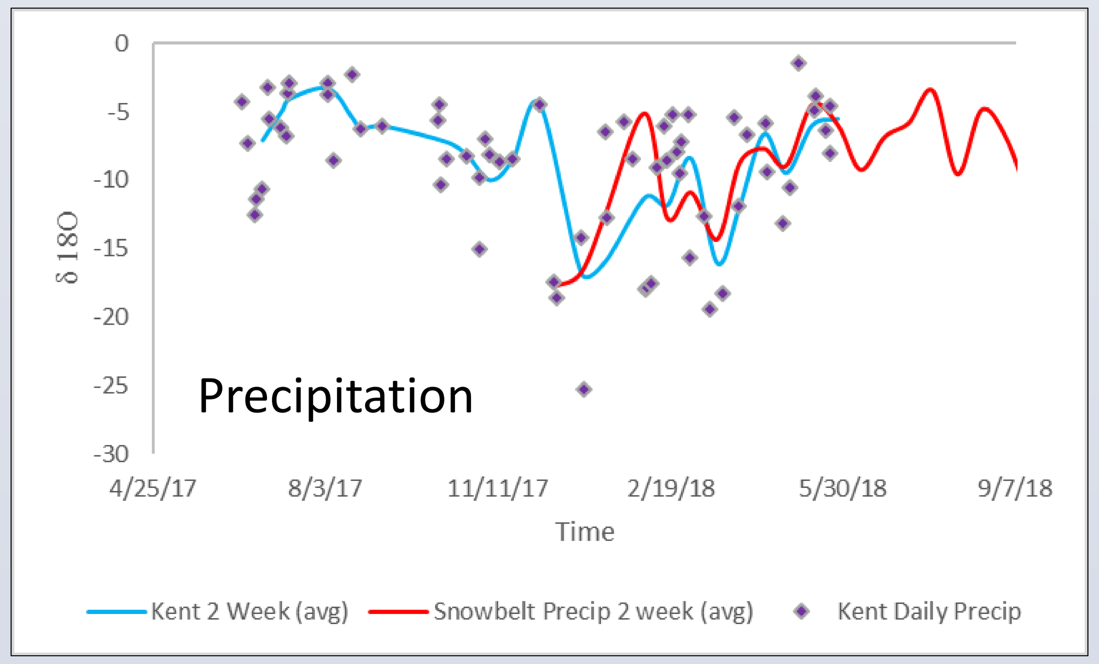
Water samples were analyzed with a Picarro L2130-i, and precipitation source areas were calculated using the NOAA HYSPLIT model using the NARR dataset.

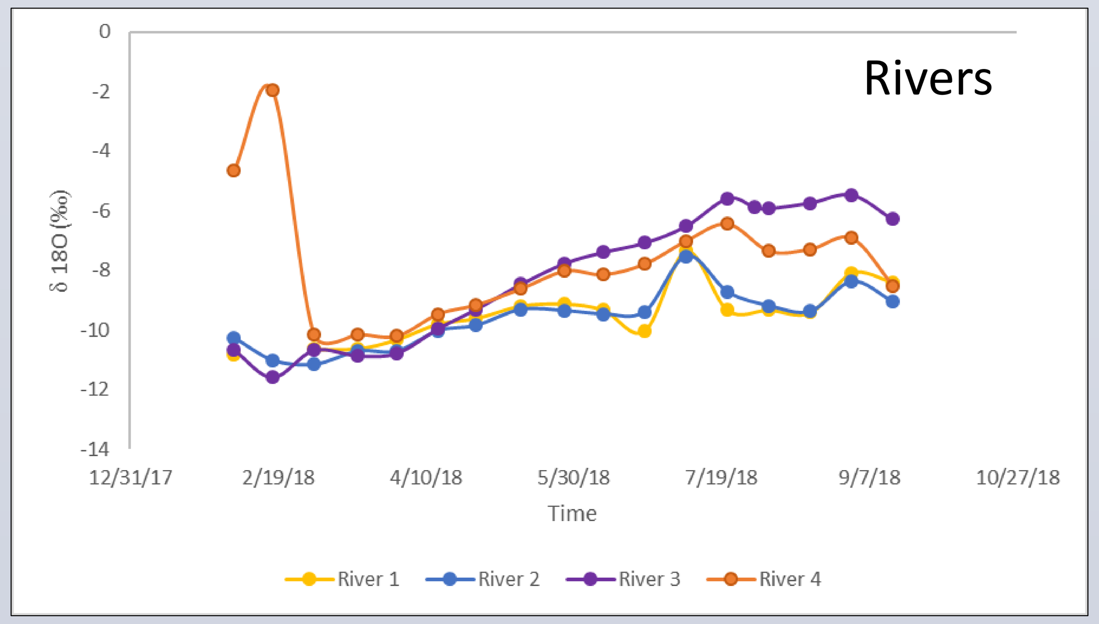
Spatial and Temporal Variation

Precipitation, groundwater, and river samples cluster along the Global Meteoric Water Line ($\delta^2H = 8*\delta^{18}O + 10$). Groundwater shows >6‰ variation in $\delta^{18}O$ across the study area.



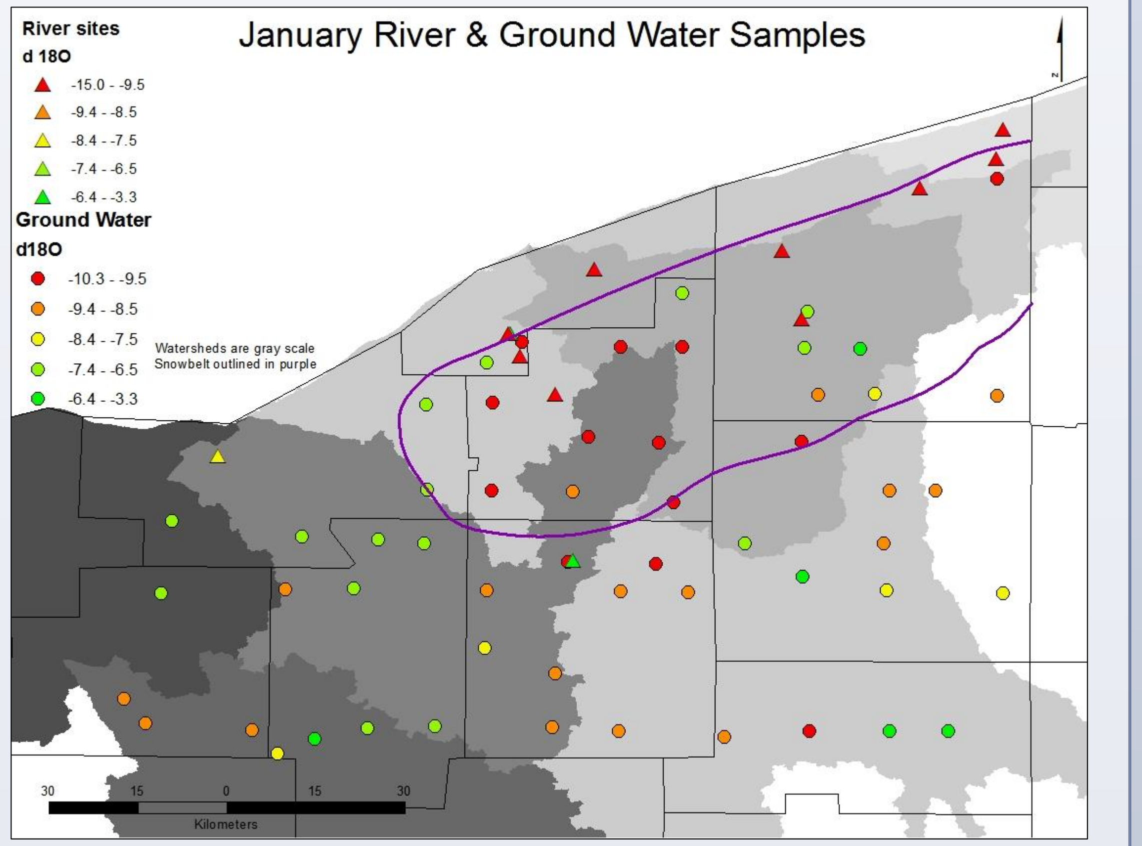
Precipitation has marked inter-storm variability, particularly in the winter. Two-week weighted averages reflect this variability, somewhat masking the typical sinusoidal seasonal signal. Precipitation within and south of the Snowbelt are similar, but during the winter there is clear indication of storms reaching one area but not both.

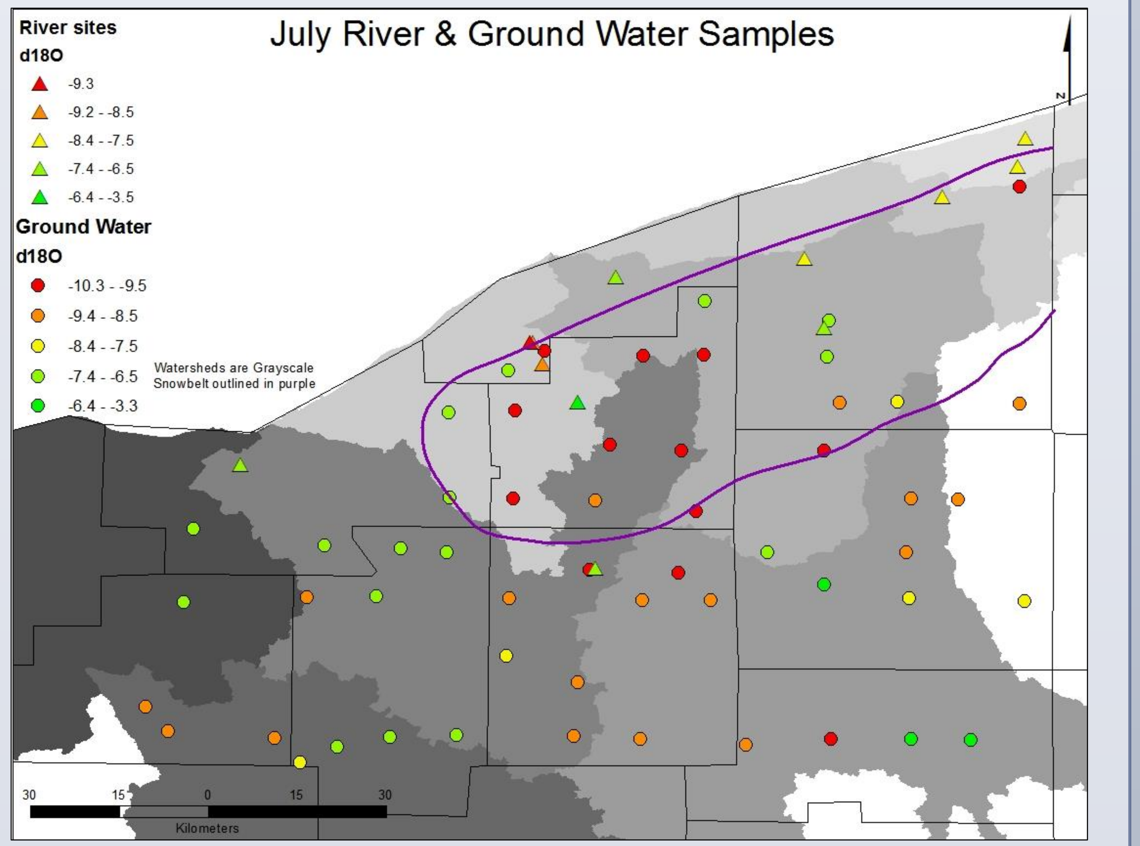




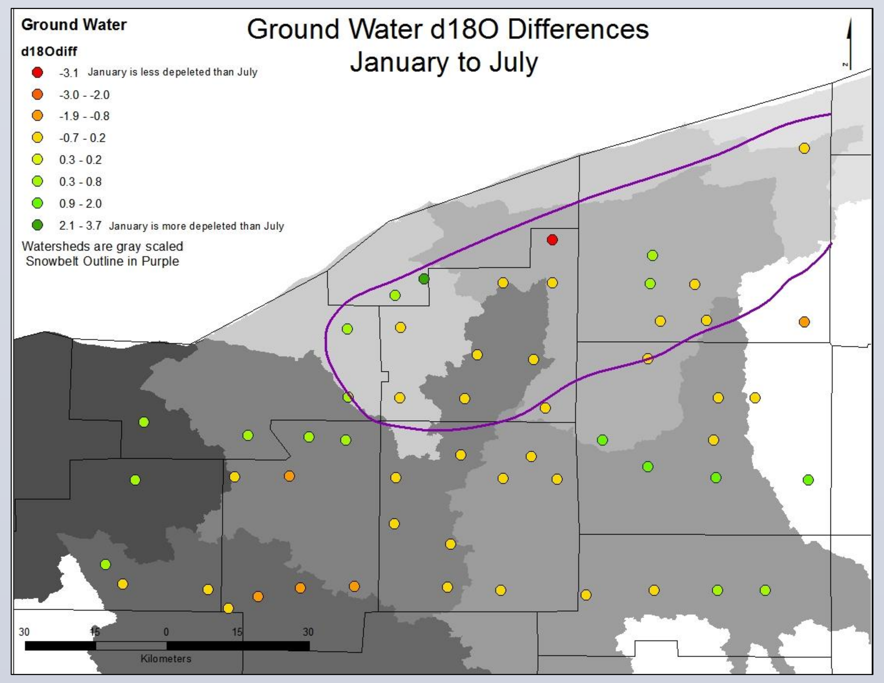
Rivers with small watersheds (1,2) in the Snowbelt have little seasonal isotopic variation compared to a larger northward (3) and southward (4) flowing rivers. The most southern river is influenced by rain-events during January and February that did not affect the more northern rivers.

Groundwater Isoscape



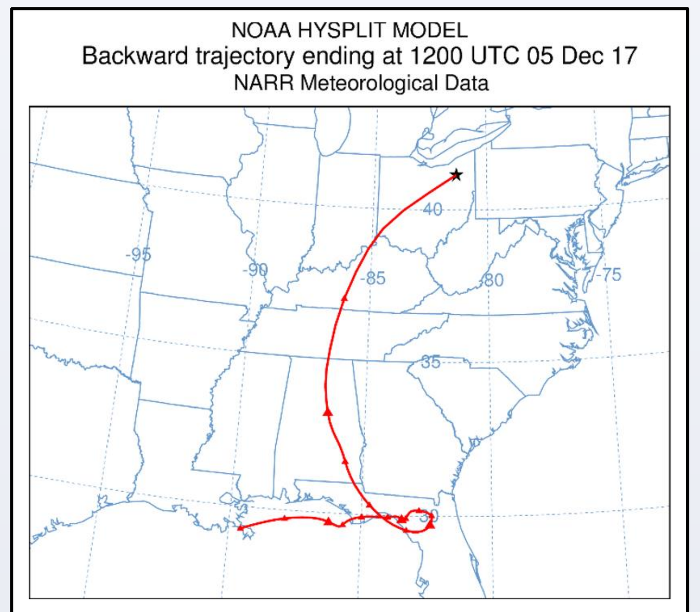


Groundwater within the Snowbelt has a more depleted $\delta^{18}O$ isotopic signature than the sample locations outside of the Snowbelt. In January, rivers were highly depleted, as sampling occurred during a snowmelt event. July data shows rivers exhibiting spatial variation broadly consistent with groundwater in their watersheds.

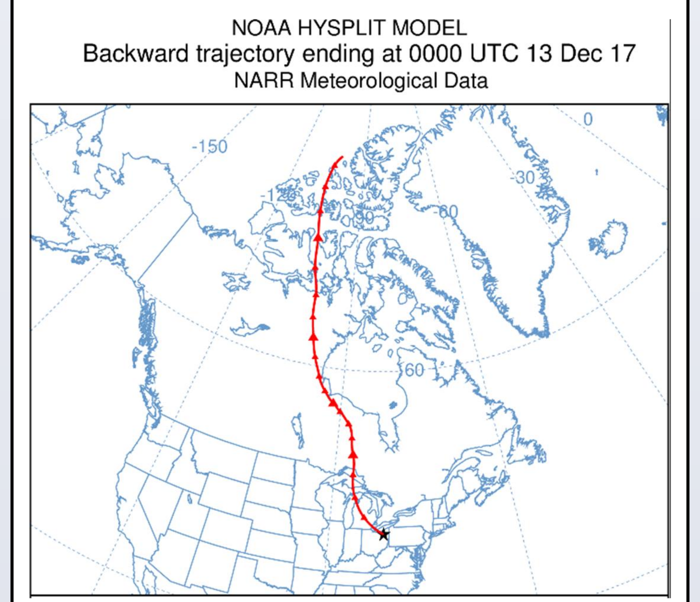


Most groundwater has nearly-constant $\delta^{18}O$ across seasons. Wells with greater variation will be further investigated using the ODNR well database.

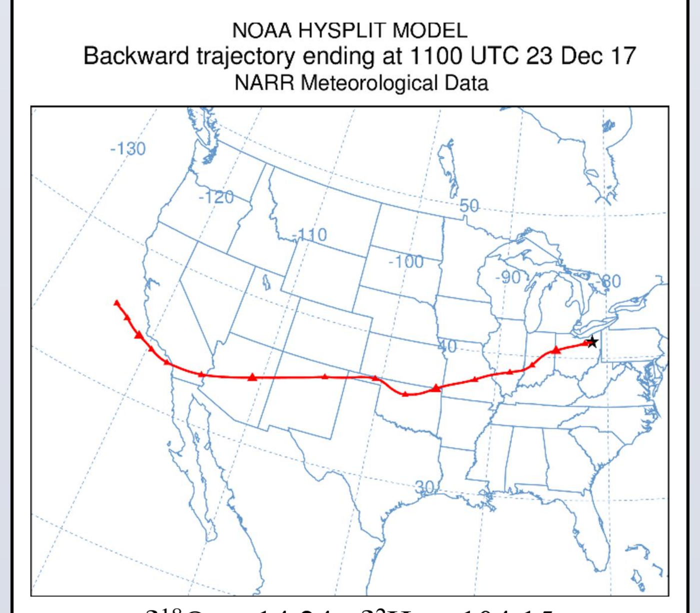
Precipitation Source Areas



$\delta^{18}O = -4.49$ $\delta^2H = -27.77$



$\delta^{18}O = -17.44$ $\delta^2H = -115.58$



$\delta^{18}O = -14.24$ $\delta^2H = -104.15$

Backward trajectory modeling for selected December 2017 storms shows that divergent isotopic signatures of event precipitation are associated with different source areas.

Next steps include refining the HYSPLIT modeling using higher resolution input data and develop regression models between isotopes and HYSPLIT outputs.

If we can identify different frequencies of particular precipitation sources across the study area, we can examine how those compare to the observed groundwater and river isoscapes.

Conclusions

Groundwater $\delta^{18}O$ varies by more than 6‰ in this 10,000 km^2 low relief area, with the most depleted ground waters occurring in the Snowbelt. River isotopes broadly reflect the groundwater isoscape, but show greater seasonal variation. Influence of moisture source areas is pronounced in the precipitation $\delta^{18}O$ and likely translates to the groundwater isoscape.

Acknowledgements

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