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Seasonal trends in stable water isotopes and estimation of mean transit times for mesoscale catchments with mixed landuse in northeastern Ontario, Canada

Krys Chutko (1), April James (1), Chris McConnell (2), Huaxia Yao (1,2)

(1) Nipissing University, Geography, North Bay, Canada, (2) Dorset Environmental Science Centre, Ontario Ministry of Environment and Climate Change, Canada

Northern Ontario Precambrian shield basins include considerable surface water (large lakes, wetlands), moderate relief (e.g. 400 m), variation in surficial geology (clay belt soils, glacial tills), and increasingly, the influence of human landuse impact (e.g. urban, agriculture) that are characteristic of northern Ontario, Quebec and parts of Scandinavia. In northeastern Ontario, Lake Nipissing and the French River are part of an important headwater tributary that flows into Georgian Bay, Lake Huron. Lake Nipissing and its 13,000 km^2 watershed is the source of water to local municipalities and First Nation communities, home to a First Nations fishery and 5% of Ontario's recreational angling, and contributes an estimated $100 million/year to Ontario's economy. In 2012, in response to increasing concerns over water quality and its implications for ecological and economic systems, and limited study of water quality and quantity in the Sturgeon River-Lake Nipissing-French River (SNF) basin, we initiated a stable water isotope (SWI) study to examine how landscape characteristics influence streamflow generation at scales where both natural landscape variation (e.g. surface reservoirs, clay belt soils, forested headwaters) and anthropogenic stressors (urbanization, agriculture) are anticipated to influence water quantity and quality.

Bi-weekly to monthly monitoring of SWI in precipitation and streamflow began in January 2013. Catchments range in size from 35 to 6,875 km^2, with a median size of 197 km^2 and median gradients from 1 to 8%. Landcover includes considerable agricultural (0-18%) and/or urban (0-47%) area. Lakes and wetlands together cover 10-25% of catchment area, with large individual lakes (e.g. Lake Temagami) acting as important reservoir storage for hydropower generation. The existing SWI dataset includes 2 years of streamflow data for 5 of the larger catchments, > 1 year for an additional 2 catchments, and 2 years of seasonal ice-off data for the remaining 9 catchments that freeze completely in winter. In this presentation we evaluate the seasonal trends in precipitation and streamflow from select catchments. Strong seasonal variation in precipitation (annual mean δ^{18}O = -13.10 ‰ is observed, with δ^{18}O of bulk samples ranging from -2.84‰ for summer rainfall to -29.85‰ for winter snow. Comparative analysis of precipitation, including meltwater collected using snowmelt lysimeters, is reported for samples collected on campus at Nipissing University and the Dorset Environmental Science Centre, a long term research station run by the Ontario Ministry of Environment and Climate Change, located approximately $\sim$ 126 km to the south. Streamflow in SNF catchments show the classic dampening of SWI signatures, with δ^{18}O ranging from -13.66‰ to -8.22‰ with seasonal variations of up to 4.45‰. Periodic regression analysis (the sine-wave approach) is used to estimate mean transit times (MTT) and assess the length of record required for most accurate estimates. This presentation will provide the first SWI assessment of the SNF catchments and evaluate the ability of our 1-2 year dataset and the sine-wave approach to provide useful estimates of MTT, a metric increasingly of interest in the study of catchment similarity.