Mid-year Project Review for Research Theme Area #5: Environment

Fate and transport and food web models of radionuclides in the Laurentian Great Lakes system: model development

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Fate and transport of tritium in the Laurentian Great Lakes system

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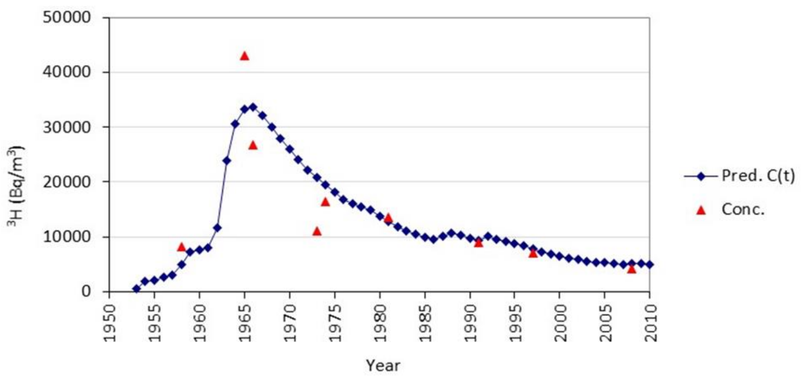
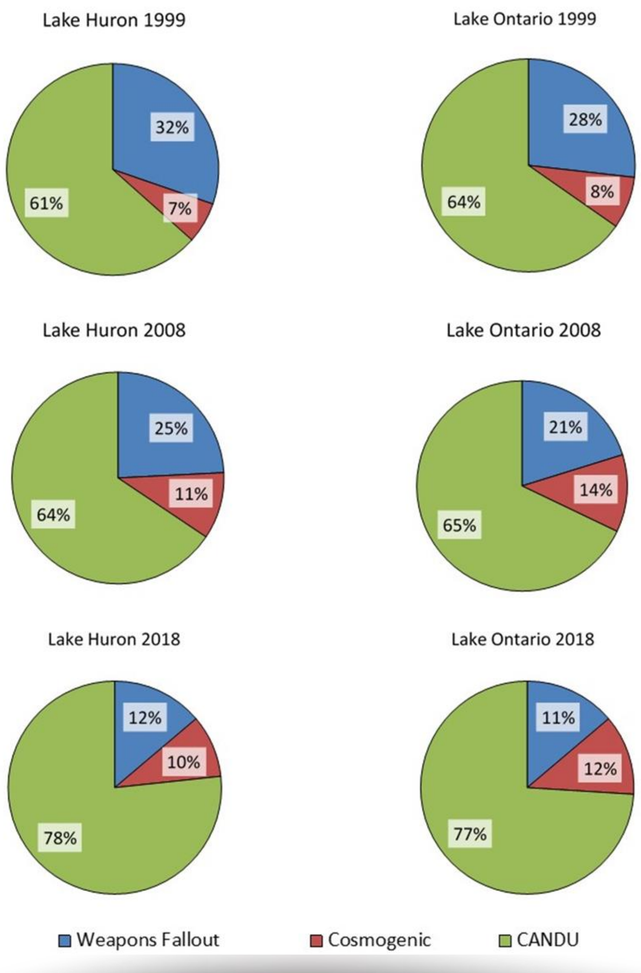
Abstract

The hydrological implications of the dispersion of tritium as a contaminant in Lake Ontario are analyzed, with a brief discussion on tritium in Lake Huron. A mass balance modelling approach is used to help understand the movement and impacts of tritium discharged from CANDU NGS into Lake Ontario and Huron. To provide estimates of future lake ^{3}H concentrations, a concentration-time model was developed and updated. Historical and projected tritium concentrations for both Lake Ontario and Huron are presented. The predicted results indicate the importance of dilution to the dispersion of tritium from either Bruce Power or Ontario Power Generation due to an accidental releases.

- Measured Lake Ontario tritium (red triangle) vs. model calculated Lake Ontario tritium to 2010.



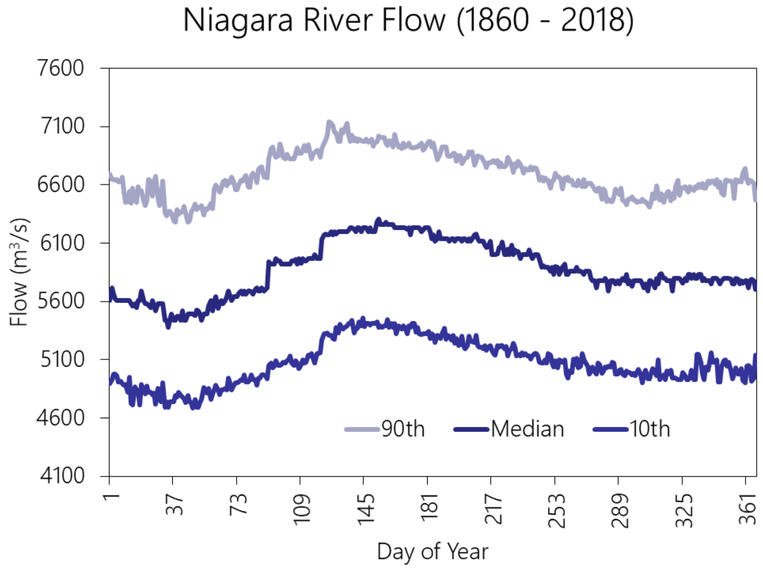
- Pie charts showing relative contributions of cosmogenic (red), weapons fallout (blue) and CANDU (green) inputs to Lake Ontario and Lake Huron tritium inventories



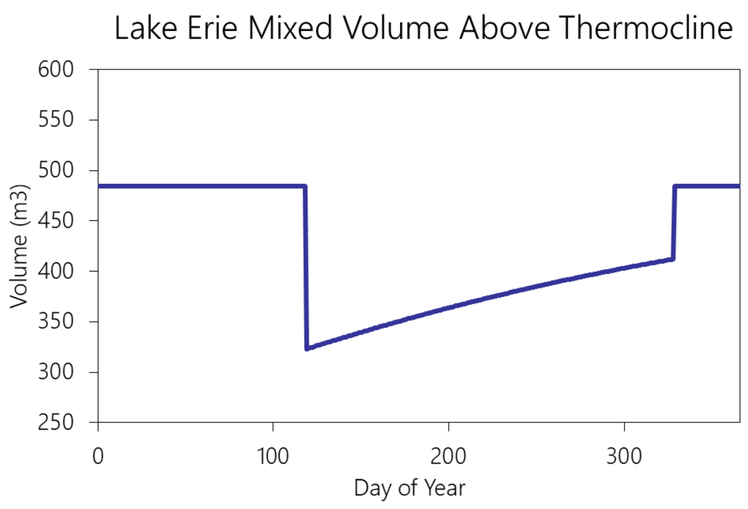
Multi-basin, stratified box for the Laurentian Great Lakes System

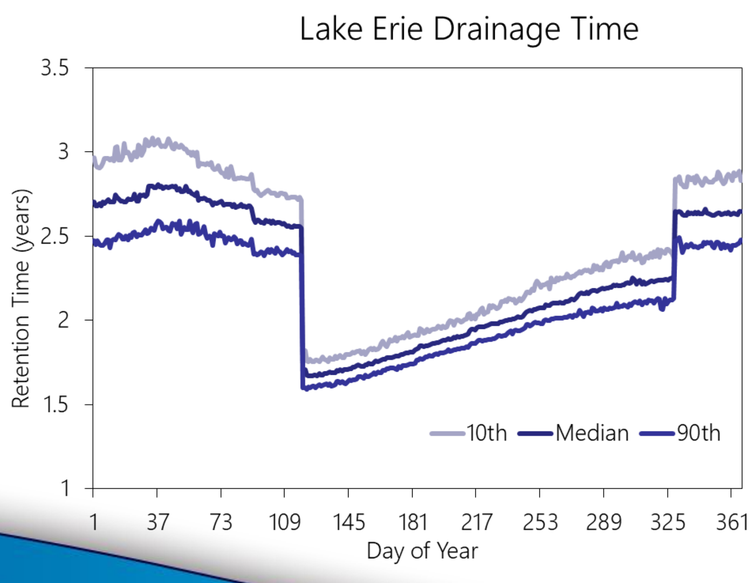
We built on the models of Sharp et al. (in press) by accounting for the development of stratification and its effect on the retention time and dilution of radionuclides released during the summer and fall. This also improves on previous modelling efforts during the 1980's that considered the lakes as single compartments.

- The model accounts for daily variation in tributary input and outflow as well as precipitation and evaporation on the lake surface as demonstrated for the Niagara River.



- Stratification reduces the volume of a lake into which radioactive effluent is mixed, increasing concentration of radionuclides in surface water, and reducing water residence time.

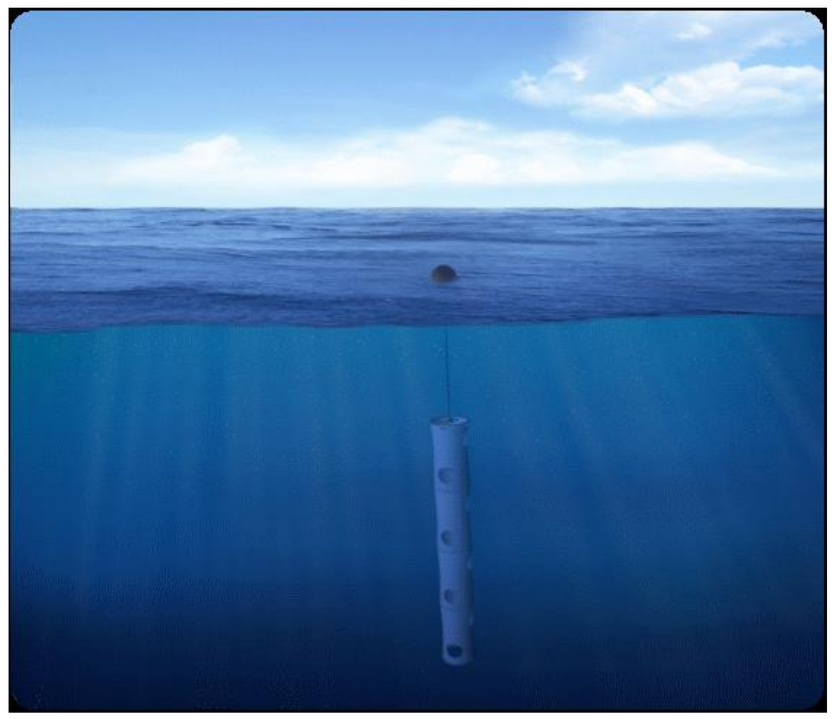




Use of GPS drifters to directly measure dispersion for fate and transport models

In a novel application of drifter technology, we will use GPS drifters to assess contaminant fate and transport in the Laurentian Great Lakes. These drifters are equipped with wind sensors to determine direction and velocity as well as temperature sensors at depths from the surface to 15 m. When deployed at CANDU NGSs, HTO in surface water can be used as an independent measure of dispersion to confirm the utility of drifters for this use.

- Drifters that measures currents at 1, 5, 10 and 15 m will be deployed at Bruce NGS and Darlington NGS with as many as 14 deployed simultaneously. This provides a large of pairs for new dispersion statistical methods.



- The drifters stream data to satellites every few minutes, generating plots of their movement with currents at different depths. Our deployment would be considered "micro-scale", tracking the fate of transport of contaminants over a few km rather than the more common oceanographic use for mapping large-scale ocean currents and circulation.