Recommendations to Enhance Hydrological Models for Improved Estimates of Climate Impacts on Northern Waters

ROBIN THORNE[1], PHILIP MARSH[1], DAVID RUDOLPH[2], CHRISTOPHER SPENCE[3], OLIVER SONNENTAG[4], JEFFREY MCKENZIE[5], AND AARON BERG[6]

ABSTRACT

The rapidly changing Arctic climate is impacting the interactions between surface water, supra-permafrost water, snow, vegetation, lakes, and streamflow, particularly as ongoing climate warming continues to thaw the permafrost. Across the Northern Water Futures (NWF) study domain, which is a Northwest Territories-focused consortium, spatial and temporal variability in active layer thickness, the occurrence of taliks, soil infiltration, subsidence, and the contribution of groundwater flow to streamflow, are all expected to be enhanced. A key challenge for Arctic models is dealing with freeze/thaw conditions and the high spatial variability in terrain and vegetation. Hydrologic models are being developed in NWF and other research groups around the globe, but there are many difficulties and approaches in developing such models.

Integrated surface and subsurface hydrological models are critical tools to investigate the impacts of warming on Arctic hydrology over the coming decades and centuries. First, we will review a suite of available hydrological models for this purpose, with a focus on interactions between permafrost, groundwater, and streamflow. We will consider potential limitations due to the lack of sophisticated 3D permafrost/groundwater model components and limitations in modeling at the high spatial resolution required. Second, we will use a case example in changes to the development of Arctic models using examples from the Trail Valley Creek (TVC) research watershed, north of Inuvik, NWT. Finally, we will make recommendations to enhance model development as needed, such as the inclusion of components from cryohydrogeological and lake process models, to address changes in Arctic hydrology at the scales required to address societal needs.

[1] Department of Geography and Environmental Studies, Wilfred Laurier University, Waterloo, ON, Canada
[2] Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, ON, Canada
[3] Environment and Climate Change Canada, Saskatoon, SK, Canada
[4] Département de géographie, Université de Montréal, Montréal, QC, Canada
[5] Department of Earth and Planetary Sciences, McGill University, Montréal, ON, Canada
[6] Department of Geography, Environment and Geomatics, University of Guelph, Guelph, ON, Canada