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The interaction of climate and glacial landforms on subsurface and surface hydrology and chemistry across a heterogeneous boreal plain landscape

Kelly Hokanson (1), Jaime Carrera-Hernández (2), Kevin Devito (1), and Carl Mendoza (1)

(1) University of Alberta, Canada (hokanson@ualberta.ca), (2) Centro de Geociencias, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico

The Boreal Plains (BP) region of Canada is experiencing high levels of anthropogenic activity and may be susceptible to climate change to various degrees. The BP is characterized by heterogeneous glacial landforms, with large contrasts in storage and transmissivity, which when coupled with wet-dry climate cycles, results in complex groundwater-surface water interactions. Predicting the impacts of land use change, climate change, and the future performance of constructed and reclaimed landscapes is currently not possible due to our limited knowledge regarding the natural variability of water table fluctuations, geochemistry, and salinity across the various glacial landforms in the BP. We compare isotopes, EC, chemistry (DOC, Ca, Mg, SO4) and water table position between a drought (2003) and a wet (2013) year to examine the interactions between climate, landform, and geology on the variation in landscape connectivity and overall salinity distribution. Data were collected from surface waters to a depth of 40 m, along a 50 km transect encompassing pond-wetland-forestland sequences across the major glacial depositional types typical of the BP (coarse textured glaciofluvial outwash, fine textured stagnant ice moraine, and lacustrine clay plain). Within each landform, sites range from isolated local flow systems to large intermediate scale flow systems. High spatial variability of water table fluctuations and salinity illustrate the strong regional controls that climate and geology exerts over scales of groundwater flow between landforms and surface water bodies across the BP, reinforcing the need to link surface water and groundwater processes when developing conceptual models. Additionally, when coupled with a strong, physical hydrogeologic conceptual model, synoptic chemical and isotopic surveys can be used to confirm scales and directions of flow; however, without an understanding of the climatic and geologic influence of the region, such data cannot be used as a diagnostic tool on their own. Improvement of our understanding of effects of climate and geology on intermediate and local scale flow systems, and the natural variability of salinity and chemistry, can help develop diagnostic tools to aid in the evaluation of reclaimed and constructed landscapes in the Boreal Plain.