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Modeling regional groundwater flow in a peat bog complex in Ontario, Canada

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Peatlands are important ecohydrological systems and contribute significantly to the global carbon cycle. They function as carbon sinks through CO_2-sequestration but also emit methane depending i.a. on the prevailing hydrological structures. Knowledge of their hydrology including exchange between the groundwater and surface water domain is thus necessary to understand wetland environments and to determine their vulnerability to climate changes. The impact of proposed wetter conditions on wetland hydrological homeostastis in northern bogs is uncertain to this date. Elevated water tables due to changing hydrological flow patterns may affect the characteristics of wetlands as a carbon reservoir. Modeling approaches allow quantifying and qualifying of these flow patterns on a longer time scale. Luther Bog is located in Southern Ontario. The ombotrophic bog to poor fen is partially bordered by Luther Lake which inundates the area since its creation in 1952. In this study the interaction between the wetland and the adjacent lake is modeled using the fully-integrated HydroGeoSphere model. A transient three-dimensional groundwater mode is set up for a small catchment with the lake level implemented as a constant-head boundary condition. Hydraulic properties of the peat were estimated executing bail tests on multilevel piezometers at different sites within the wetland. The first hypothesis is that the wet conditions in the runoff network keep the water table in the wetland high over a specific transition zone. The Second is that there may be a reversal of flow directions over the hydrological year, due to varying boundary conditions, e.g. evapotranspiration and precipitation. First results indicate that exchange rates may be very slow. This is supported by manual measurements of little hydraulic gradients and little topographic gradients. The results also show a seasonal effect in flow directions in both, the groundwater and the surface water domain. The model will be tested upon its sensitivity to variations in the anisotropy of hydraulic conductivities as this is difficult to determine in the field using known approaches, e.g. bail tests. A transport simulation will be conducted to determine the exact amount of exchange water and the extent of the exchange zone.