Modelling the Influence of Subsurface Geology on Northern Peatland Hydrology

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Peatlands are complex wetlands that play an important role in global carbon cycling as both carbon sinks and sources they contain over one third of all global soil carbon but cover <3% of all land surfaces. The hydrology of a peatland exerts a significant control on overall carbon cycling as the position of the water table directly impacts carbon sequestration and emission while circulation within the peat basin will influence nutrient availability. Hydro-geophysical studies of northern peatlands over the last two decades have identified the presence of eskers buried beneath some peat deposits in Maine. These studies have hypothesized that eskers drive vertical groundwater flow within these systems and may act as hotspots for methane emissions. However, only conceptual hydrologic models have been developed to support this claim. Using the results of these studies along with new hydrologic and geophysical datasets, a USGS MODFLOW 6, finite-difference groundwater flow model was developed for Caribou Bog near Bangor, ME. Caribou Bog is a multi-unit, ombrotrophic, domed bog with a patterned pool system. Groundwater flow simulations were run at regional and local scales by inserting a fine-scale model encompassing a single peat unit into a coarser-grid, watershed area. The PEST parameter estimation package was used to calibrate the model and MODPATH 7 was used to identify flow paths within the model. Simulation results will be used to show that these esker deposits enhance vertical flow through the peat and potentially connect the peatland to the regional aquifer system. These results challenge the traditional viewpoint that ombrotrophic peat systems in boreal regions are relatively disconnected from groundwater flow. Furthermore, they may provide insights into the spatial variability of carbon cycling within peatlands, particularly to assess hydrologic response caused by changing precipitation patterns and warming temperatures expected due to climate change.