ABSTRACT: Climate change will disproportionally affect higher-latitude ecosystems, and northern peatlands will be particularly susceptible. Decomposition in these high-carbon ecosystems is expected to increase in a warmer, carbon dioxide enriched future. Quantifying the dynamics of carbon and associated biogeochemical cycles under current and future climate scenarios is necessary to understand how climate change may alter these important ecosystem processes. During a large-scale ecosystem experiment in an 8.1-ha black spruce-<em>Sphagnum</em> bog at the Marcell Experimental Forest (Marcell, MN), temperature (ambient to +9 °C) and CO2 concentrations (ambient, +900 ppm) will be increased inside replicated, 12-m diameter, open-topped chambers. Prior to the onset of this experiment, we measured the spatial and temporal variation in peat pore water chemistry to develop a baseline for the design of the experiment and to better understand biogeochemical cycling under ambient conditions. We found the largest differences in chemistry by depth (0 to 3-m deep), and little variation in near-surface pore waters from bog, lagg (transitional zone between uplands and the bog), and outlet stream. Ammonium was low at the surface (0.1 mg/L) likely due to plant uptake, but was highest at depth (3.8 mg/L), potentially due to remineralization in the absence of nitrification. Nitrate was almost always undetectable, except in near-surface layers during snowmelt when the water table is high and nitrate bypasses plant and microbial uptake before being exported. Total organic carbon decreased from surface (60 mg/L) to deep (20 mg/L) peats, yet concentrations were at least an order of magnitude higher than in most well-studied upland ecosystems. Phosphorus in deeper peats was also high, but there was significant variation in space and time. Overall, there are two different pools of water within the peat: shallower waters originating from precipitation, and deeper waters originating from long residence times in the peat and exchange with the regional groundwater aquifer. If increased temperature results in greater evapotranspiration and drier conditions, these previously-isolated deep ammonium and phosphorus pools may become available, with cascading effects to plant and microbial communities.