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Model-Based Analysis of the Effect of Long-term Atmospheric Nitrogen Deposition on Nitrogen and Carbon Dynamics in Northern Peatlands

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Peatlands, as a unique biological community that provides important ecological, economic and protective functions, are highly threatened by climate change and nitrogen deposition. To understand how nitrogen deposition and Climate change could affect peatlands, a process based model has been developing to simulate short term and long term changes in peatlands biogeochemistry and ecology. To simulate carbon and nitrogen dynamics in the peatland system, the model currently contains three main modules: Hydrothermal generates daily water table and soil temperature; Plant dynamics simulates the competition of peatland vegetation in natural nutrient poor condition as well as potential shift of plant composition and ecosystem function under high nutrient input and climate change; Soil organic matter (SOM) dynamics simulates the decomposition of SOM into inorganic carbon and nitrogen and their transformation and translocation within the peat. This model especially focuses on nitrogen dynamics both in plant and peat and the integration of nitrogen cycle with carbon cycle for peatland. Water table is modeled as a bucket model that calculates real time water storage from precipitation, evapotranspiration and runoff, then generates water table level and soil moisture along peat depth. Soil temperature along depth is calculated from soil thermal conductivity features and air temperature. Plant carbon and nitrogen dynamics are modeled for 3 plant functional types (moss, graminoids and shrubs) with different tolerant levels to temperate, moisture, light and nutrients. SOM decomposition is simulated in a layer structure with 5cm resolution. Within each layer one labile and one recalcitrant organic carbon and nitrogen pool are decomposed simultaneously on rates controlled by SOM quality, nitrogen availability, moisture and microbial efficiency. Preliminary simulation for water table, Temperature, plant dynamics, carbon budget and peat initiation for Mer Bleue bog (Ottawa Canada) shows good correlation with field data. SOM decomposition simulation reveals that the extremely low decomposition rate of SOM in saturated zone plays an important role in peatland formation process. Following work is to integrate all three modules at peatland ecosystem level for systematic and long term simulations. Main challenge is to model the massive system on a proper complexity level that is able to demonstrate quantitative and qualitative questions while provide alteration possibilities.