Effects of Global Warming and Elevated CO_2 on Peatland Ecosystem Productivity and Greenhouse Gas Emissions: A Modeling Study

Peatlands is an important ecosystem storing more than 20% of the global soil carbon. But the impacts of global warming and elevated atmospheric carbon dioxide (CO_2) concentration on peatland ecosystem productivity and soil greenhouse gas (GHG, such as CO_2, methane CH_4 and nitrous oxide N_2O) remain unclear. In this study, we simulated the dynamics and controls of peatland soil CO_2, CH_4 and N_2O emissions using a process-based model (Forest DeNitrification-DeComposition, Forest-DNDC) under different temperature and CO_2 conditions. The simulations were based on the long-term DOE SPRUCE (Spruce and Peatland Response Under Changing Environments) experimental study where spruce peatland ecosystems were exposed under five temperature levels (i.e., +0, +2.25, +4.5, +6.75, +9°C) and CO_2 conditions (+0, +500 ppm). Data measured at the experimental plots from 2015 to 2021 were used to drive and parameterize the DNDC model. Our preliminary results showed that there were strong seasonal and interannual variations of net ecosystem exchange of CO_2 (NEE) and greenhouse gas emissions, especially soil CO_2 and CH_4. Both CO_2 and CH_4 emissions increased with temperature increase. With global warming, NEE shifted from carbon sink to source. Elevated CO_2 had limited impacts on NEE and GHGs emissions. Results of this study could improve our understanding of the magnitudes and controls of peatland productivity and soil GHG emissions.