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Impacts of permafrost thaw on carbon sequestration of wetlands in cold region of Northeast China

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Permafrost in northern high latitudes was a huge soil carbon sink. About 16%-30% of the terrestrial surface soil carbon was stored in northern permafrost region, which was quite sensitive to the global change. During the 21 century, 25%-30% of the soil organic carbon of the permafrost region will be decomposed. The high latitude permafrost in northeast China is within the southern margin of the permafrost region on the Eurasian continent. More than 48% of the marsh wetlands in China inhabit in the northeast region and they are huge soil carbon sink. There were four main frozen soil types in northeast China, which was continuous permafrost, discontinuous permafrost, isolated permafrost and seasonal freezing soil, respectively. The active layer depths of the permafrost have been increasing since 1970s. During 1970-2009, annual temperature of permafrost region in northeast China increased by 0.9-2.2 ℃and there was obvious northward movement for the southern boundary of permafrost region. In our research, the impacts of permafrost thaw on soil organic carbon variations and greenhouse gas emissions were investigated in northeast China. Our results demonstrated that air temperature and solar radiation were the main environmental factors affecting the net primary production of plants in the permafrost region of northeast China. The soil organic carbon (SOC) content, soil N content and C/N of different wetland soils increased following the sequence from seasonal freezing soil, discontinuous permafrost and continuous permafrost. The permafrost regions had greater organic carbon content than the regions with seasonally frozen ground. The light fraction organic carbon accounted for 5%-83% of the SOC and was particularly enriched in the permafrost region; however, their activities were low due to the cold temperature. Under global warming, the labile carbon pool may be mobilized and contribute to the greenhouse effect. Compared with the CH4 concentration in the active layer, the concentration in the permafrost layer was 10-40 times higher with higher temperature sensitivity. CH4 emissions of the wetlands in the seasonal freezing region showed a synchronized change with the variation of air temperature while those in the permafrost region showed synchronized change with the variation of active layer depth. The results of intensive field campaign on the estimation of CH4 emission in the spring freeze-thaw transition period showed that the spring thaw could cause a large CH4 emission with the maximum hourly emission rate three orders higher than the regularly observed CH4 emission rate in the growing season. Vascular plants play an important role in wetland CH4 emission during the spring freeze-thaw transition period. Net ecosystem CO2 exchange of wetlands in different permafrost region correlated significantly with temperature. Using eddy covariance technique, we found that wetlands in permafrost region and seasonal freezing region both functioned as carbon sink of the atmosphere under current climate conditions with carbon sequestration rates of 47.6 and 138.6 gCm-2yr-1, respectively.

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