Title: High temperature sensitivity of peat decomposition due to physical-biogeochemical feedback

Abstract:
Historically, northern peatlands have functioned as a carbon sink by sequestering a large amount of soil organic carbon (SOC) mainly due to low decomposition rates in cold, largely waterlogged soils. Water table, an essential determinant of SOC dynamics, interacts and coevolves with peat SOC; due to the high water holding capacity and the low hydraulic conductivity of peat, accumulation of SOC results in a higher water table that further lowers SOC decomposition rates (positive feedback). Although this 2-way interaction between hydrology and biogeochemistry has been noticed in several observational and analytical studies, the complex behavior of peat dynamics was not reproduced in process-based simulation of soil hydrology and biogeochemistry. By continuously updating peat depths in a coupled soil physical-biogeochemical model, we found that the feedback between water table and peat depth increases temperature sensitivity of peat decomposition and intensifies SOC loss under climate change. Our model successfully reproduces both fast-timescale dynamics of water table and soil temperature and long-term SOC equilibria of shallow and deep peatlands in northern Manitoba, Canada. In long-term simulation, an experimental warming of 4 °C caused 40 % SOC loss from the shallow peat, and 86 % from the deep peat. Peatlands will quickly respond to the expected warming in this century by losing labile SOC in dry periods.

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Takeshi Ise
Research Scientist
Frontier Research Center for Global Change
Japan Agency for Marine-Earth Science and Technology
3173-25 Showa-machi, Kanazawa-ku
Yokohama 236-0001 Japan
+81-45-778-5595
ise@jamstec.go.jp