# Projecting future greenhouse gas release by an Earth system model with explicit permafrost dynamics

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Permafrost is distributed widely over the Arctic. The region is sensitive to climate change owing to the feedback processes related and ice and snow. Increase in permafrost temperature and thickening of active layer of frozen ground (upper layer of permafrost where frozen ground thaws in summer and freezes again in winter) are already observed. In addition, dynamic and irreversible thawing of ice-rich permafrost called "Yedoma" and consequential ground subsidence are also reported in various places. Permafrost stores large amounts of organic carbon that has not been decomposed since earlier Holocene or the Late Pleistocene, and thus thawing of permafrost may cause increase in the atmospheric greenhouse gases, possibly contributing to positive feedback to global warming. However, considerable uncertainty remains in the possible effects of permafrost thawing on future climate change because global distribution of permafrost and details in the processes of GHG release from the thawing permafrost are not known well. In the three-year project "Assessing and projecting greenhouse gas release from dynamic permafrost degradation" (2-1605, Environment Research and Technology Development Fund of the Ministry of the Environment, Japan: 2016-2018), we aim to assess and project the impacts of greenhouse gas release through dynamic permafrost degradation using in-situ and remote sensing (e.g., satellite and airborne) observations, lab analysis of sampled ice and soil cores, and numerical modeling, by demonstrating the vulnerability distribution and relative impacts between large-scale degradation and such dynamic degradation. In this presentation, we report the status of the numerical modeling. We use a state-of-the-art Earth system model (MIROC-ESM, Hajima et al., in preparation), where a global physical land surface model MATSIRO (Takata et al. 2003, Nitta et al. 2014) and a global land vegetation model VISIT (Ito et al. 2012) is included. We improved the physical processes related to permafrost thawing (e.g., increasing in numbers in vertical layers; consideration of changes in thermal conductivity of frozen/unfrozen soil water, and insulating effect by soil organic layer) in MATSIRO and found that it led to improvement in distributions of permafrost. We also try to implement the carbon dioxide and methane release due to permafrost thawing in VISIT to estimate the future greenhouse gas emission.

Keywords: Permafrost, Greenhouse gas, Climate change

 