Assessing and projecting greenhouse gas release due to abrupt permafrost degradation
永久凍土大規模融解による温室効果ガス放出量の現状評価と将来予測

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Permafrost is distributed widely over polar region. Polar region is sensitive to climate change owing to the feedback processes related to ice and snow. Increase in permafrost temperature and thickening of active layer—upper layer of permafrost where frozen ground thaws in summer and freezes again during the autumn—have already been observed (slow degradation). In addition, dynamic and irreversible melting of ground ice in “ice-rich permafrost” called *Yedoma* and consequential ground subsidence is also reported recently in various places. Permafrost contains large amounts of organic carbon that has not been decomposed since last ice age, and thus thawing of permafrost can lead to increase in atmospheric greenhouse gases (GHGs) concentrations, and possibly enhance global warming through positive feedback. However, considerable uncertainty remains in the possible effects of permafrost thawing on future climate change because global distribution of ice-rich permafrost as well as details in the processes of GHG release from thawed permafrost are not well known. In a three-year project “Assessing and projecting greenhouse gas release from dynamic permafrost degradation” (2-1605, Environment Research and Technology Development Fund of the Environmental Restoration and Conservation Agency, Japan: 2016-2018), we aim to assess and project the GHG release through dynamic permafrost degradation by means of in-situ and remote (e.g., satellite and air-born) observations, lab analysis of sampled ice and soil cores, and numerical modeling. We also demonstrate the vulnerability distribution, and estimate relative impacts between slow and dynamic degradation. In this presentation, we report the progress and results of the numerical modeling. We use a global physical land surface model MATSIRO (Nitta et al. 2014), which is a component of global climate model MIROC (Watanabe et al. 2010). In addition, a global land vegetation model VISIT (Ito et al. 2012) is coupled to MATSIRO and exchange variables such as soil moisture, temperature, and leaf area index with each other. We improved the physical processes related to permafrost dynamics (e.g., considering of changes in thermal conductivity of frozen/unfrozen soil water, and shielding effect by soil organic layer) in MATSIRO and found that permafrost distribution and active layer tend to be improved. We also try to implement the carbon dioxide and methane release due to permafrost thawing in VISIT to estimate the future greenhouse gas emission.

References

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