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第四紀後期の永久凍土動態　全球気候モデル地表面気温からの推定
Paleo-permafrost Dynamics in the late Quaternary -Thermally-conditioned reconstruction from Global Climate Modeling-

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Change in the distribution and variations of permafrost in time and space is an important issue in understanding the attribution and consequence of Quaternary climate change, and projection of the future environment. The subsurface hydrothermal regime offers physical foundation and conditions to the various terrestrial processes and activities, ranging from pure physical to ecological to societal aspects. Through several physical and biogeochemical pathways, however, subsurface changes in land are significantly connected to the atmosphere and to the Oceans. Large-scale numerical climate modeling with improved freeze/thaw dynamics is a strong tool for investigation on the impacts and the attribution of changes in the regime. As a preliminary step, we analyzed the surface air temperature outputs from the Paleoclimate Model Intercomparison Project 2 (PMIP2) to examine the thermal conditions to ground freezing under different climate environment for Pre-industrial or 0 thousand years before present (ka), Holocene Optimum or 6ka, and Last Glacial Maximum (LGM) or 21ka. The variables, together with other meteorological variables, will constitute a basis of the forcing data in our successive integration studies.

A classification of frozen ground (FG) by freeze index (FI) and thaw index (TI) was constructed based on the occurrence frequency of the permafrost, seasonal freezing or no freezing under the present-day distribution. FI and TI are cumulative temperature values below and above the freezing point, respectively, and are derived from the station-based monthly surface air temperature. The present-day ground freezing distribution is taken from the map compiled by International Permafrost Association map (IPA map). Advantage of this classification method is simplicity and intuitiveness, but it also has limitation resulting from negligence of other important factors that control the sub-surface thermal regimes, such as snow cover, vegetation, soil characteristics and micro-topography.

The method was applied to the PMIP2 output to reconstruct the modeled "thermaly-conditioned" FG distribution for 0ka, 6ka and 21ka. The 0ka result shows reasonable consistency with the present-day result. The LGM case reconstructed the largest permafrost areas. 0ka and 6ka show similar size of distribution except for the regional differences as compared with observation-based reconstruction maps. For LGM, however, a reconstructed atlas shows presence of continuous permafrost south of 50^{o}N, including north of Alps, which this method failed to successfully represent. This discrepancy indicates either the insufficiency of the method or warmer tendency in the simulations for the region, or both. Beringia was not commonly specified for the LGM among the interations, which may hinder from plausible reproductions in the area of our interest (Alaska and east Siberia) for the period, and from direct comparison with the paleo-records of the region. Substantial elaboration will be needed to prepare for the next-step forcing data.

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