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2.4. Transformation of The Arctic and Subarctic Landscapes under Climate Change and Human Impact

Methane content in the upper permafrost and active layer of Western Yamal, Russian Arctic

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Methane concentration in ground ice and frozen Quaternary sediments of the Kara Sea region has a substantial variability. Methane content in the active layer of different dominant landscapes of typical tundra is extremely variable too. High methane concentrations are found in marine clays with the presence of Massive Tabular Ground Ice (MTGI). The sands which freeze simultaneously with sedimentation have lower methane concentrations. High concentrations of methane in permafrost is attributed to migration and conservation of methane in ice bubbles under advancing freezing fronts, which is supported by the isotopic content of methane. The microbial origin of methane confirms that methane in permafrost is not related to seepage or migration of mantle methane through permafrost. It also confirms the non-atmospheric origin of massive tabular ground ice bodies widely present in the study area. The highest mean methane concentrations were found in wet polygonal tundra (8516 ppmV), bogs (4507 ppmV) and bottoms of the water tracks (3681 ppmV). These types of landscapes, which together compose almost 40% of typical landscapes of Western Yamal can be a significant source of methane emissions to the atmosphere. The landscape types that are characterized by good drainage, primarily sands and blowouts, have little methane available. Northwest Siberia has experienced one of the highest rates of climate change with increasing air temperatures, increased thaw depth and permafrost warming with these trends likely to continue in the future. The upper part of the coasts in the region is composed by ice-rich marine clays characterized by high methane content. Permafrost degradation due to climate change will be exacerbated along the coasts where declining sea ice is likely to result in accelerated rates of coastal erosion, especially in areas with presence of MTGI, further releasing the methane which is not yet accounted for in the models. Methane fluxes measured in typical tundra of Western Yamal are approximately 2 times lower than those measured in Alaska. The estimates of methane in various types of permafrost and ground ice are therefore an important contribution in regional assessments of the methane emissions from permafrost and as validation to the Earth System Models.

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