COASTAL RETREAT AND METHANE EMISSION IN THE WESTERN YAMAL

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Summary
This study proves that permafrost degradation of coastal and marine sediments of the Arctic Seas can result in large amount of methane emitted to the atmosphere. The quantitative assessment of such emissions requires data on methane content in permafrost sediments and ground ice. The samples were analyzed to determine composition, salinity, and organic carbon content. Gas was present in pores of sediments and in bubbles within the ice. The methane content is characterized by high variability. The value of methane emissions in the destruction of frozen sea shore with underground ice is high enough and comparable to the emission of methane from wetland ecosystems.

Introduction
Methane is emitted in the atmosphere during the permafrost degradation on the Arctic shelf, the continent and the melting of the subsurface ice. Methane is the second greenhouse gas after the carbon dioxide, its increase in the atmosphere has a significant impact on the climate as a whole. Since the second half of the XX century, the concentration of methane in the atmosphere has been increasing annually by 1%.

Methodology and Results
Long-term regular observations near the polar station Marre-Sale, Western Yamal ($69^0$43'N/$66^0$49'E) of the sea coast retreat since 1978 showed a speed of about 1.7 meters per year. The profile of the coastal cliff near the station is a complex of quaternary deposits that contains an uneven-aged syngenetic ice wedges and two types of tabular massive ground ice. Methane contained in the air bubbles in the underground ice and permafrost sediments. More than 400 samples of gas from permafrost and ice were selected. CH_4 concentration was measured by headspace-equilibration, using KhPM-4 (Russia) gas chromatograph with flame ionization detector and hydrogen used as a carrier gas (Pushchino, Russia). It was found out that there is abnormally high value of methane concentration in tabular massive ground ice. The methane content in it reaches 21.5 ml kg^{-1} . Methane is practically absent in the Holocene sands with syngenetic ice-wedges. Epigenetic types of freezing explain high levels of methane in marine sediments. Syngenetic freezing does not contribute to the accumulation of methane while the epigenetic freezing is favorable for its conservation (Vasiliev et al., 2015). Theamount of methane released from permafrost due to erosion was estimated for 100 m of the coast and for the full length of 4.5 km long coastal section was estimated. It was found, that each year the destruction of 100 m of the sea coast in the research area causes 10300 g of methane to be released into the atmosphere and around 463500 g is released around a 4.5 km-long coastline. The amount of methane released into the atmosphere every year by the destruction of a 100 meter and 4.5 km long coast was calculated. It was found, that each year the destruction of 100 m of the sea coast in the research area causes 10.3 kg of methane to be released into the atmosphere and around 463.5 kg is released around a 4.5 km-long coastline. Marine clay and loam contribute most of all to methane emission that happens due to the destruction of the sea coast near the polar station Marre-Sale contribute (Fig.).

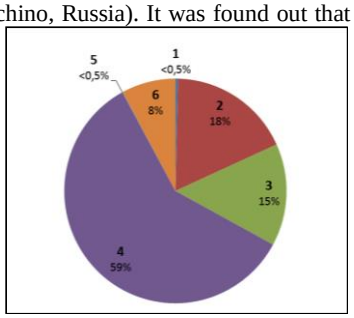

Fig. The contribution of methane from sediments and ice in the total emission of methane in the destruction of a 100 m coast segment in one year. 1 – alluvial sand; 2 – lacustrine silt and sand; 3 – lacustrine silt and sand; 4 – marine clay and loam; 5 – ice wedges; 6 – tabular massive ground ice.

Conclusions
The comparison between the amount of methane released into the atmosphere from the surface of tundra wetland ecosystems of the north of Western Siberia and the amount of methane released into the atmosphere as a result of the destruction of the sea coast near the polar station Marre-Sale showed, that the amount of methane coming from the 100 m^2 section of the coast amounted to 0.501 kg / year. On average tundra wetland ecosystems emit 0.117 kg / year of methane from a 100 m^2 segment (Kazantsev, 2013). The value of methane emissions in the destruction of frozen sea shore with underground ice is high enough and comparable to the emission of methane from wetland ecosystems.

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