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GEOPHYSICS

Methane Anomalies in the Near-Water Atmospheric Layer above the Shelf of East Siberian Arctic Shelf

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Simultaneous measurements of methane in the near-water atmospheric layer and in the surface water layer were carried out for the first time in a shallow-water region of the East Siberian shelf. It follows from the data obtained that the regions of anomalously high values of methane concentration in the air (up to 8 ppm) spatially coincide with the patches of anomalously high concentrations of methane dissolved in water (up to $5 \cdot 10^2$ nM). The analysis of possible sources allowed us to formulate a hypothesis that the genesis of the distinguished anomalies can may be related to the deep sources of methane anomalies. Deep sources of methane include modern methane and/or ancient methane accumulated in the deposits of natural gas and methane gas hydrates.

During warm interglacial epochs, the high latitudes of the Northern Hemisphere deliver methane into the atmosphere maintaining methane concentrations in the Arctic atmosphere higher by 8–10% than that in the Antarctica atmosphere. During cold glacier epochs, this gradient decreases to practically insignificant levels [1]. Land ecosystems are considered the main sources of methane in the arctic region. A special role belongs to wetlands and thermal karst sink lakes underlining year-round by non-freezing talics regions. The total contribution of such ecosystems in the global methane cycle is estimated at 27–28% (140–145 Tg, where 1 Tg = 10^{12} g) [2]. It is known that the Barrow atmospheric monitoring station in Barrow (Alaska, United States) annually records increased concentrations of methane in the atmosphere. Their maximums are continue from the summer season to the autumnal–winter interseasonal period, when the production of land Arctic ecosystems decreases gradually and terminates [3]. Hence, the source maintaining high methane emission in the autumn–winter period should possess a potential related to the influence of the other factors that are endemic for the Arctic region.

Thus far, the role of marine Arctic ecosystems as methane sources has been considered insignificant. At the same time, data in [4, 5] indicate that the role of the Arctic Ocean (AO) is significantly underestimated. For example, the total flux contribution of methane into the atmosphere from the shallow-water part of the shelf only in the Russian seas of to the arctic region can reach the values comparable with the contribution of all continental seas the World Ocean [4]. In our opinion, the East Siberian Arctic shelf should be considered with special attention.

DESCRIPTION OF THE STUDY REGION

The study region includes the eastern sector of the shallow-water shelf of the Laptev Sea (including the estuary of the Lena River) and adjacent sector of the shelf of the East Siberian Sea (up to the estuary of the Indigirka River) (Fig. 1). A large part of this region is under the influence of the Lena River discharge. This region is characterized by a negligible slope of the seafloor bottom. Therefore, the coastline is rapidly displaced over large distances during the period of regressions (decrease in the sea level) and transgressions (increase in the sea level). These displacements result in

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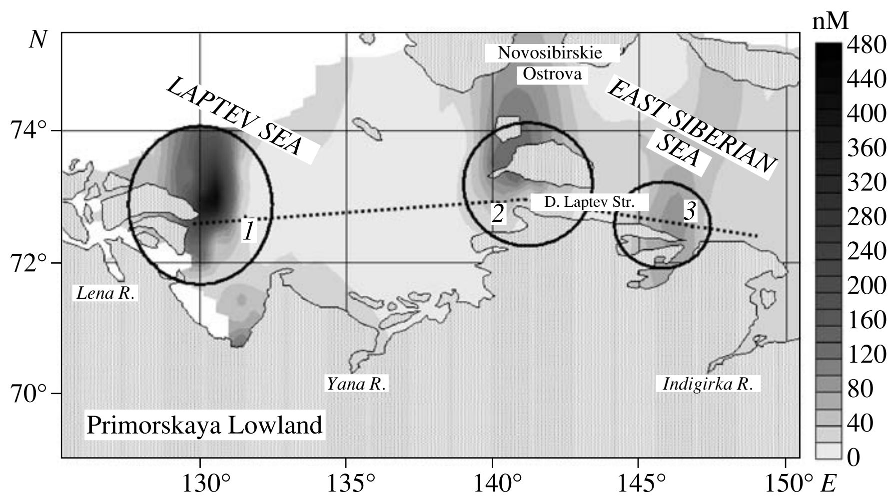

Fig. 1. Distribution of methane in the surface water layer in the study region (September 2005).

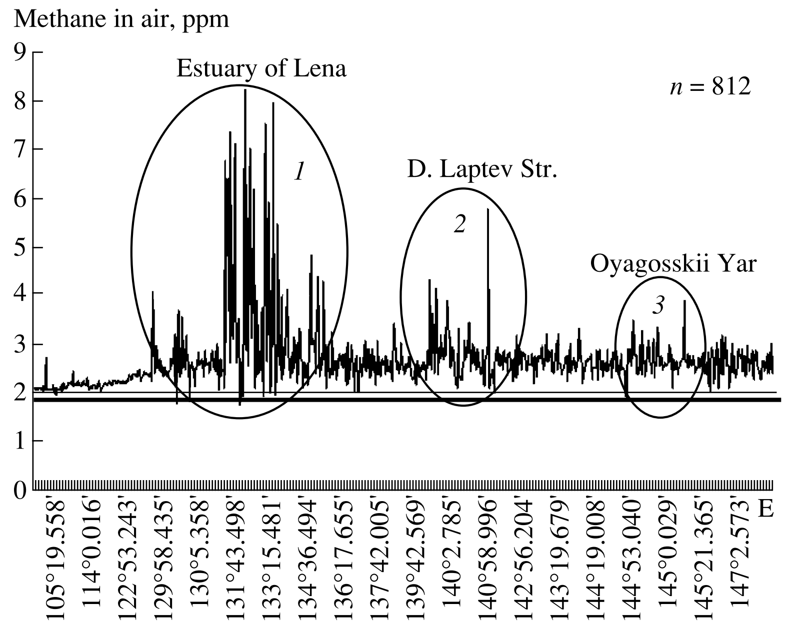

Fig. 2. Methane concentration in the near-water atmospheric layer along the route of the ship (location of the section is shown in Fig. 1 with a dashed line).

weak freezing of bottom sediments during the regression periods and their strong degradation during transgression periods [6]. According to [7], the thickness of perennial frozen rocks (hereafter, permafrost) in this region varies from a few meters to a few hundred meters [7]. The width of the shallow-water shelf reaches 500 km. Its relatively flat surface is underlain by paleovalleys of ancient rivers, which empty into the Laptev Sea 250–300 km north of the present coastline [8, 9]. The location of paleovalleys generally coincides with the location of tectonic faults (Fig. 3), the seismic activity of which persists to this day.

MATERIALS AND METHODS

Air sampling was carried out using a reinforced vinyl sampler fitted to an external meteorological mast installed at the bow of the ship. Continuous recording of wind speed, and direction, and other meteorological parameters was carried out along the route of the ship using a LiCor 1440 automatic meteostation. The mean height of air sampling was equal to 5 m above the sea level. The air from the near-water atmospheric layer was continuously pumped through a loop of the faucet of a SRI–8160C gas chromatograph equipped with a flame ionization detector. Inflow of air to the gas chromatographic channel (silicagel column) was performed