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On the gas hydtrate methane emissions and possible hypoxia in the East Siberian Arctic Seas

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Recent field companies showed the high concentrations of dissolved methane in the region of East Siberian Arctic Seas (ESAS). These high concentrations were attributed to the degradation of the underwater permafrost which corked the methane from the shallow gas-hydrates deposits (Shakhova, et. al., 2010). Some aspects of the problem of the methane evolution, released at ESAS, were investigated in (Malakhova amd Golubeva, 2013), where the estimated methane emission to the atmosphere was two order lower than the estimates by Shakhova, et.al., 2010.

In this study the version of the regional 3D coupled ice-ocean model FEMAO-1 was applied to the problem of the methane transport, oxidation and emission to the atmosphere. Model was driven by the AOMIP-FAMOS forcing 1948-2011, and showed the steady rise of mean bottom temperature at ESAS after 1990 till now. This temperature rise assumed to be sufficient to destabilize undersea permafrost and provoke the additional methane release from gas-hydrates.

A set of numerical experiments were carried out to simulate various scenarios of the methane evolution:

1. The quasi-equilibrium state of the dissolved methane distribution forced by the sources at the continental slope and river runoff transport for the period of 1948-1990. This set of experiments was aimed to reproduce the observed methane concentrations and to tune the model parameterizations.

2. The scenario of ESAS abrupt methane release during 1990-2011 with various fractions of dissolved methane and bubbles. The fractions of the dissolved methane and bubbles were previously estimated in (Stepanenko and Iakovlev, 2013). This set of experiments was aimed to reproduce the observed vertical methane distribution with maximum at the ocean surface.

3. The ESAS abrupt methane release with limitation of oxidation in areas of hypoxia. This set of experiments was aimed to evaluate the possibility of hypoxia at the ESAS shelf and beyond, and to estimate the required methane flux to switch off the oxidation.

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