Geophysical Research Abstracts
Vol. 15, EGU2013-4009-1, 2013
EGU General Assembly 2013


# Numerical simulation of vertical transport and oxidation of methane in Arctic Ocean

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The high abundance of methane in shelf of East Siberian Arctic Seas (ESAS) has been a subject of a number of field studies (e.g. Shakhova et al., 2010). This experimental evidence provoked discussions on probable origins of that methane and possible feedbacks to modern climate change. For instance, the hypothesis of methane hydrates degradation under current ocean warming was tested recently in several modeling studies none of which supported this degradation to be significant feedback for climate change. Regardless the origin of methane the knowledge of its budget in the water column is important to link its bottom flux with emission to the atmosphere (and vice versa). It is frequently assumed that all methane released from a seabed of ESAS shelf reaches the atmosphere. When using ocean circulation models (Biastoch et al., 2011) this simplification is cancelled out but the vertical resolution of 3D models at the shelf (that is several tens meters deep) is not enough to accurately resolve turbulent transport of methane and other gases. Moreover, up the knowledge of authors none of the ocean models includes explicitly bubble transport of gases. These constrains motivate this study.

In this study a high-resolution 1D single column ocean model is constructed to explicitly simulate the methane transport, oxidation and emission to the atmosphere. The model accounts for both vertical turbulent transport (using k-$\varepsilon$ closure) and bubble transport of gases. The ground under the seabed is represented by multilayer heat and moisture transfer model, including methane hydrate evolution. It is forced by time series of atmospheric variables from NCEP reanalysis and horizontal advection terms taken from FEMAO-1 3D ocean model. The baseline simulation is performed for the period 1948-2011. The model is validated using temperature profiles measured at research vessels in ESAS. The annual cycle and multiyear variability of methane profiles in water are studied and compared to available in situ measurements. The components of methane budget in water column are calculated, and the ratio of bubble flux to turbulent one inter alia. A number of additional experiments are performed to assess the sensitivity of methane budget components to variation of uncertain parameters of the model (such as initial bubble radius).

References

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