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Modelling of the 21st century submarine clathrates global response to climate change

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Potential changes in thickness of methane clathrates stability zone (MCSZ) during the 21st century are estimated based on the model for thermophysics of oceanic sediments developed at the A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences (Denisov et al., 2011). This model is forced by the output of two global climate models one of which was developed at the Institute of Numerical Mathematics, Russian Academy of Sciences (INM CM–3.0) and the other at the Geophysical Fluid Dynamics Laboratory (GFDL CM–2.1). Both global climate models were forced by the SRES A2 scenario. Methane clathrates stock was calculated assuming that organic pool is always sufficient for clathrates formation. As the initial conditions, the temperature gradient in bottom part of the sediments corresponded to their equilibrium state at the near bottom temperature in the beginning of the 21st century. The depth of the computational domain in the oceanic sediments was 830 m.

Assuming that clathrates occupy 5% of sediment pore space, the total simulated present day clathrate stock is $(10.0 - 14.5) \times 10^{14}\ m^3$ at standard temperature and pressure (STP) which corresponds to $600 - 870\ PgC$. These values are broadly consistent with available empirical estimates. In the 21st century, climate warming results in MCZS contraction with typical values about $10\ m$. The most marked signal is found in the Barents Sea sector of the Arctic. This releases $3.9 \times 10^{11}\ m^3$ STP or $35\ PgC$ ($3.9 \times 10^{11}\ m^3$ STP, $60\ PgC$) of methane from sediments to the water in the simulations forced by the INM CM–3.0 (GFDL CM–2.1) outputs or $350\ TgC/yr$ ($600\ TgC/yr$) on average. Destabilization of oceanic clathrates occur mainly in the high latitudes of the Northern Hemisphere.

Denisov, S.N., M.M. Arzhanov, A.V. Eliseev, and I.I. Mokhov, 2011: Assessment of the response of subaqueous methane hydrate deposits to possible climate change in the twenty first century, Doklady Earth Sci., **441**(2), 1706–1709, doi: 10.1134/S1028334X11120129.