Assessment of methane release from hydrates in oceanic sediments due to possible climate changes in the 21st century.

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Methane hydrates, ice-like compounds in which methane is held in crystalline cages formed by water molecules, are widespread in areas of permafrost and along continental margins (i.e, at intermediate water depths, from 250 m to several thousand meters water depth), where they are stabilized by in situ pressure and temperature fields. The widely used "consensus" global estimate of hydrate-bound methane carbon is ~ 10000 GtC (~ $20*10^{15}$ m^3 of methane) [1]. For comparison, the global inventory of fossil fuels including coal is estimated to be around 5000 GtC [2], which is in the same order of magnitude.

Massive releases of methane from hydrates have been mentioned to be responsible for rapid climate changes in the past. The Paleocene/Eocene thermal maximum is an example of a transient period with drastic climate change most likely caused by a release of 1500-2000 Gt of methane carbon within a several thousand years [3].

There is some concern, that the expected global warming may lead to hydrate instability in future and thus to an enhanced emission of methane. Accordingly, it is important to quantify the possible methane release and its impact on climate system.

In present work we tried to assess possible methane release from hydrates in the 21st century. Methane hydrate formation assumed to occur upon appropriate temperature and hydrostatic pressure conditions which are set correspondingly to [4]. Temperature profile of sediments is simulated using the model of heat and moisture transport in soil [5] adapted for oceanic conditions. Ocean bottom temperature simulations from the GFDL and INM climate models under SRES-A2 anthropogenic scenario for the 21st century are used as an upper boundary conditions. Geothermal flux of 50 mW/m^2 is set on the lower boundary. Hydrates are supposed to saturate 5% of pore space in hydrate stability zone (HSZ) [6].

Estimated total methane release in 21st century (Fig. 1) equals to ~ $10.2*10^{13}$ m^3 (~ 60 GtC) for GFDL climate model forcing and ~ $6.2*10^{13}$ m^3 (~ 35 GtC) for INM model. It corresponds to average emissions of 600 MtC/yr and 350 MtC/yr on the ocean bottom accordingly. Simulated hydrate dissociation occurs mostly in high latitudes. These estimates are close to total anthropogenic and natural emissions of methane to atmosphere of ~ 500 MtC/yr [7] but the bulk of this methane is oxidized by microbes in the water column [8].

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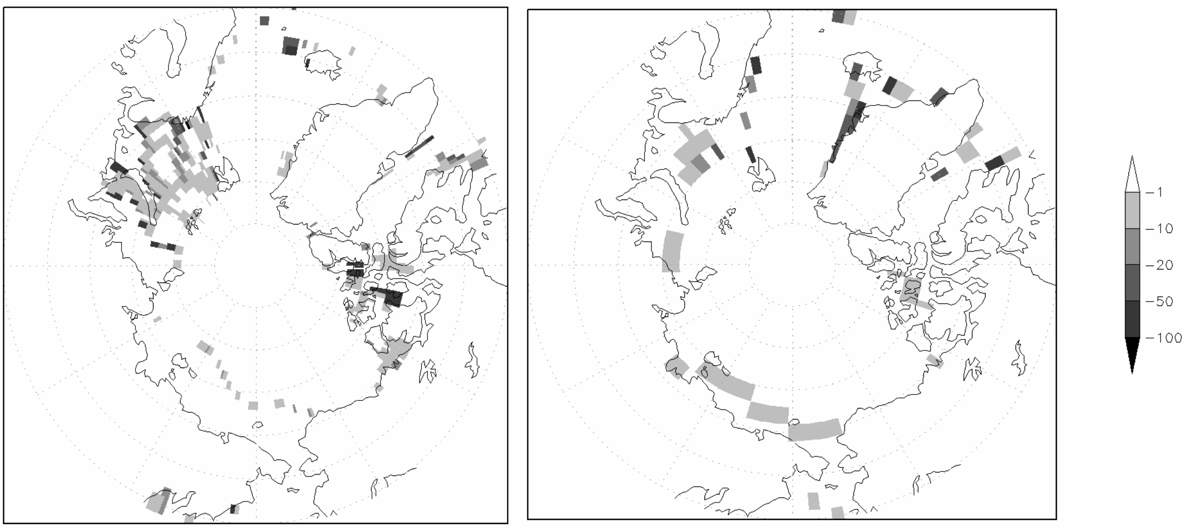

Fig 1. Changes in HSZ thickness (m) in the 21st century with GFDL (left) and INM (right) climate model forcing.