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Sub Sea Permafrost Climate Modeling – The fate of the East Siberian Arctic Shelf

Christian Rodehacke (1), Martin Stendel (1), Sergey Marchenko (2), Dmitry Nicolsky (2), Jens Christensen (1), and Vladimir Romanovsky (2)

(1) Danish Meteorological Institute, Climate and Arctic, Copenhagen, Denmark (cr@dmi.dk), (2) Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK, USA

Recent observations indicate that the East Siberian Arctic Shelf (ESAS) releases methane, which stems from shallow hydrate seabed reservoirs. The total amount of carbon within the ESAS is so large that release of only a small fraction, for example via taliks, which are columns of unfrozen sediment within the permafrost, could impact distinctly the global climate. Therefore it is crucial to simulate the future fate of ESAS' sub sea permafrost with regard to changing atmospheric and oceanic conditions. However only very few attempts to address the vulnerability of sub sea permafrost have been made, instead most studies have focused on the evolution of permafrost since the Late Pleistocene ocean transgression, starting 14000 years ago.

In contrast to land permafrost modeling, any attempt to model the future fate of sub sea permafrost needs to consider several additional factors, in particular the dependence of freezing temperature on water depth and salt content and the differences in ground heat flux depending on the seabed properties. Also the amount of unfrozen water in the sediment needs to be taken into account. Using a system of coupled ocean, atmosphere and permafrost models will allow us to capture the complexity of the different parts of the system and evaluate the relative importance of different processes.

Here we present results of a novel approach by means of dedicated permafrost model simulations. By applying an ensemble approach, we will show how uncertainties in boundary conditions and applied forcing scenarios control the future fate of the sub sea permafrost. We explore the impacts of the atmospheric forcings and its variabilities, various plausible flooding histories, different oceanographic boundary conditions, geothermal regimes, for instance, on the results. Extended simulations into the future for the next millennia, offer a glimpse of a selection of future scenarios. Our simulations have been driven by conditions of the Laptev Sea region in East Siberia.