Poster Presentation
Theme 3.1: Biogeochemical Processes - Processes Understanding and Human Impacts
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Sub-sea permafrost modelling: 1D vertical extent, sediment reaction-transport scheme and in situ GHG formation

Puglini, Matteo* (1,2); Brovkin, Victor (1); Arndt, Sandra (2)
1: Max-Planck Institute for Meteorology, Hamburg, Germany; 2: Université Libre de Bruxelles, Brussels, Belgium

The role that submarine permafrost may play within global carbon cycle and its possible feedback effects on climate system in the frame of ongoing climatic change represent a challenge for the current research of the field. Subsea permafrost is in fact thought to store a large amount of carbon (~ 1400 PgC) in form of frozen sediments and to determine the physical conditions (temperature and pressure) for the formation and the preservation of gas hydrates as well as to act as a cap preventing upward seepage of gas coming from beneath. Due to the paucity of measurements very little is known about subsea permafrost (extent, physical and biogeochemical features, related processes) but because of the drastic soil warming in the aftermath of sea transgression and because of salt intrusion, it is thought to be rather weak and susceptible to changes. In light of how ongoing global warming may affect its thermal regime in the future, an evaluation of its properties as well as of the amount of GHG (CO_2 and CH_4) that may be produced and released is needed.
For this purpose we have modified the permafrost module already present in the land-surface model JSBACH (within MPI-ESM) and originally designed to simulate land permafrost. We developed a 1D vertical scheme (with an increased number of soil layers) for a coastal grid point, ran an offline spin-up phase using MPI-ESM climatology for pre-industrial state (randomly picking up years out of an ensemble of 40 years to account for interannual variability) and in the following we simulated the submergence imposing the uppermost boundary conditions (temperature and salinity) taken from output of MPI-OM. We ran then this setup for a centennial time scale to check for permafrost thermal degradation. To account for carbon soil accumulation in subaerial condition an existing Yedoma model will be then employed in coupling with a bioenergetic reaction-transport model to take into account the period after sea transgression. This model is going to be specifically taylored for high-latitude shelf environment, methane formation and aerobic and anaerobic methane oxidation within the sediments. It is expected to be sensitive to the influx of reactive iron into the sediments and is also suitable for further refinements to consider carbon (gas, DIC and DOC) exchange with overlaying water column. We will investigate the prominent role of the first phases after sea transgression (characterized by a higher thawing rate) in determining subsea permafrost thermal degradation (as expected according to the rough scaling typical of Stefan's problem and as recently confirmed). In particular we will focus on submergence details and time sequence in order to get plausible model outcomes. First results will be presented.

Poster Session (see poster session schedule)