Sub-sea permafrost modelling based on idealised laboratory experiment

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Submarine relic permafrost is gaining more and more interest in recent time due to the large amount of organic carbon that is thought to be stored in there (~1400 PgC) and consequently to the role it may play in the global climate system if that carbon were released. Subsea permafrost is also important since can stabilise clathrates.

In this work we aim at modelling thermochemical properties of submarine permafrost. To do so we carry out idealised laboratory experiments whose results are used to modify the permafrost model implemented into the land-surface model JSBACH (within MPI-ESM) [Ekici et al., 2014]. So far, JSBACH only accounts for terrestrial permafrost soil, and does not include any physics related to salt presence. We use the climate forcing from the last glacial cycle as simulated by the CLIMBER-2 model [Ganopolski and Calov, 2011] to spin up a permafrost soil which is later flooded and degraded, taking into account the change in bathymetry due to ice-complex disintegration [Nicolsky et al., 2012]. In order to test the model, we will limit it to a 1-D vertical setup with the stratigraphy prescribed from individual field measurements.

Because of the rare and sparse in situ measurements, the study of submarine permafrost has been mainly based on modeling whose results cannot be well evaluated due to missing data. In order to assess our model, simplified experimental setups in controlled environments have been performed and in this poster comparative results of a thawing permafrost/melting ice model in comparison to measurements are reported.

In the experimental setup, we first overlayed a freshwater ice sample with salty water and examined if the temperature and salinity evolution agree with model results. After this ancillary comparison, a setup was shaped to reproduce more faithfully a flooded ice-bonded soil. For this purpose, beads of different sizes have been used to simulate soil as a porous medium. They have been submerged with freshwater, then frozen and salty water at a temperature comparable with the one measured at the seabottom (-1.5 °C) has then been poured on top. Comparisons between salinity and temperature profile have been drawn, too.

References

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