Project: **1142**

Project title: **Nunataryuk WP8**

Principal investigator: **Victor Brovkin**

Report period: **2020-01-01 to 2020-12-31**

Experiments performed in project bm1142

During the first 8 Months of 2021, the main focus of the work of the main project investigator was to fine tune the results from the previous reporting period, mainly by performing experiments to test the validity and influence of various model assumptions on the thawing of sub-sea permafrost (SSPF).

Furthermore efforts were make to improve the soil hydrology of the land model JSBACH with special focus on the Arctic permafrost regions and to understand the large spread of results within the CMIP6 models in the Arctic regions. These experiments were performed using the MPI-ESM1.2. Runs were made to compare runs with parameters leading to a dry or wet Arctic respectively. This work was made jointly together with CLICCS project bm1219.

During the remaining part of the year plan is to implement salinity diffusion which in several studies (e.g. Angelopoulos et al., 2019) has been demonstrated to significantly impact the thawing of SSPF ice, into the SSPF version of JSBACH and test this new approach as well technically as scientifically.

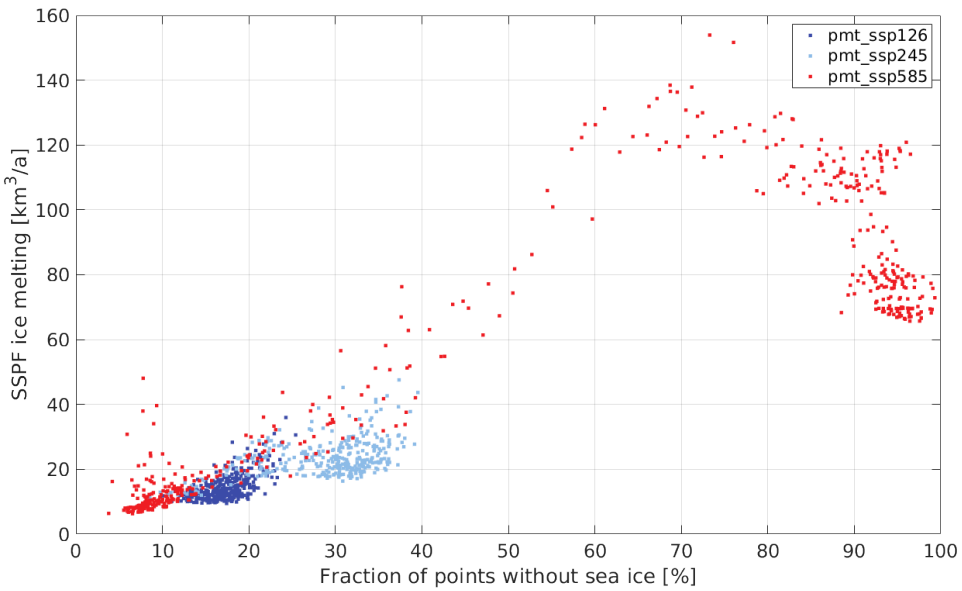

Fig. 1: Relation between melting of SSPF and loss of sea ice based on montly average values of loss of SSPF ice and sea ice cover for points containing SSPF in year 1850. Data covers the period 1850-3000. From Wilkenskjeld et al., 2021)

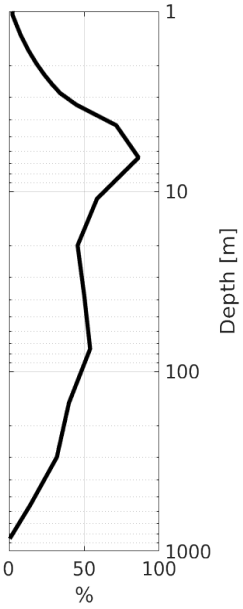

Fig. 2: Initial (1850) SSPF ice concentration with depth (From Wilkenskjeld et al. 2021)

Scientific results

The melting of SSPF – which is very hard to observe - has been demonstrated to have a strong relation to the disappearance of the easy observable local sea ice (Fig. 1.). The length of the local open water season ice extend is suggested as a possible proxy for the rate of degradation of SSPF. For very low sea ice covers (appearing in the distant future in experiment pmt_ssp585), all near surface (in the upper ~100m of sediments) SSPF has disapeared. Both decreasing SSPF ice concentration with depth (Fig. 2) as well as longer delay caused by thermal inerty lowers the

melting rates.

It was demonstrated that by making the MPI-ESM Artic dry or wet causes differences comparable to the spread in the CMIP6 model ensemble. Thus it is very likely that differences in soil hydrology parameterizations is a significant source of uncertainty in the Arctic regions for the CMIP6 models and improvements in understanding and implementation could therefore enhance confidence in the ESMs.

Effect of Covid-19

Since EU, the funder of the project, are aware that the Covid-19 situation through various paths has caused delays in the work, the project has been extended by another year. One of these paths was the close down of the Hamburg kindergardens from the beginning of the year to mid May. This caused the main project investigator (Stiig Wilkenskjeld) to be caught in home-office with two kindergarden kids which could not be externally supervised. This has resulted in a delay in the project of 2-3 Month, since the supervising situation did not allow for efficient work.

The work done within the project focused on analysing and writing up model results achieved in the previous reporting period. These effects are of course also reflected in the Node-hour consumption.

References

Angelopoulos, M., Westermann, S., Overduin, P., Faguet, A., Olenchenko, V., Grosse, G., and Grigoriev, M. N.: Heat and Salt Flow in Subsea Permafrost Modeled with CryoGRID2, JOURNAL OF GEOPHYSICAL RESEARCH-EARTH SURFACE, 124, 920–93, https://doi.org/10.1029/2018JF004823, 2019.

Wilkenskjeld, S., Miesner, F., Overduin, P.P, Puglini, M. and Brovkin, V.: Strong Increase of Thawing of Subsea Permafrost in the 22nd Century Caused by Anthropogenic Climate Change, Submitted to “*The Cryosphere*”.