Supplement of Earth Syst. Dynam., 17, 1135–1150, 2026
https://doi.org/10.5194/esd-17-1135-2026-supplement

Earth System Dynamics
Open Access
EGU

Supplement of

Hysteresis and irreversibility in permafrost physical response to increase and decrease of CO_2 emissions

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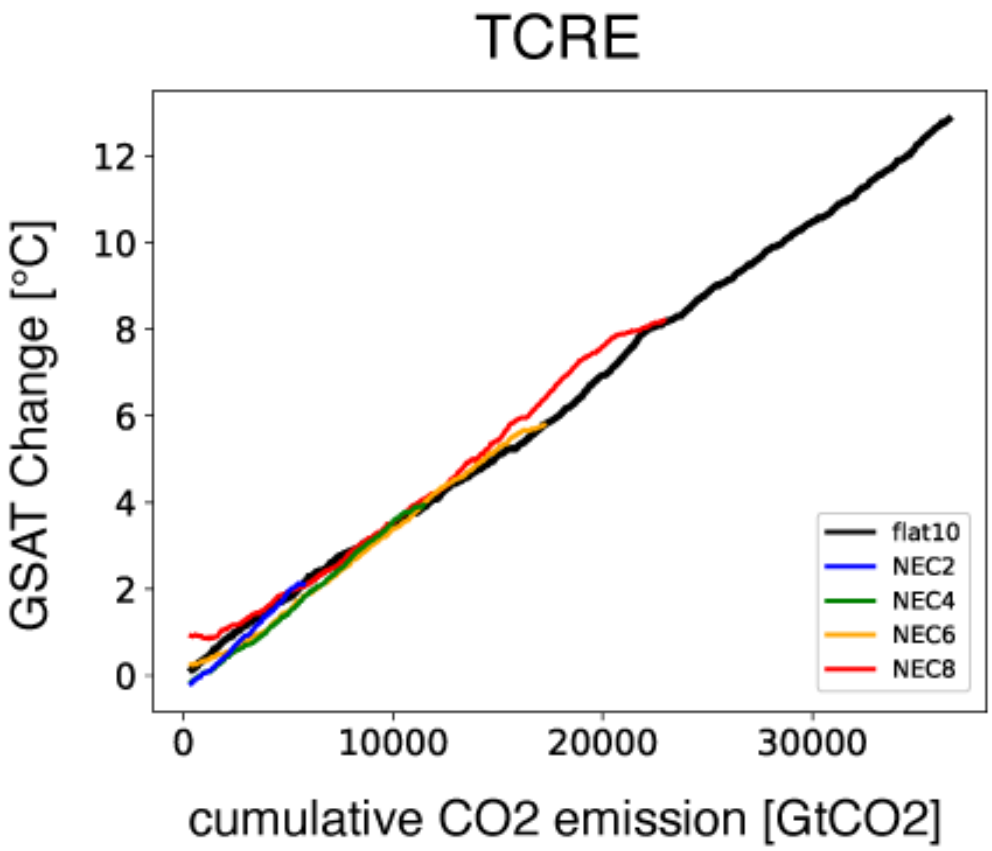

Figure S1: Transient Climate Response to cumulative carbon Emissions (TCRE). Color convention follows in Fig. 1.

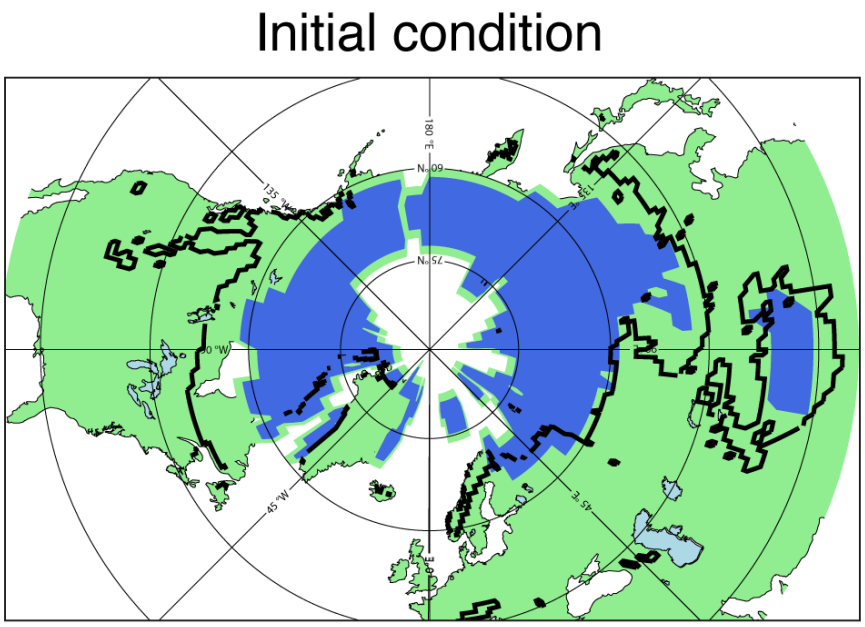

Figure S2: Permafrost areas (blue) at initial state. The black line indicates the observed boundary of permafrost (Brown et al., 2002).

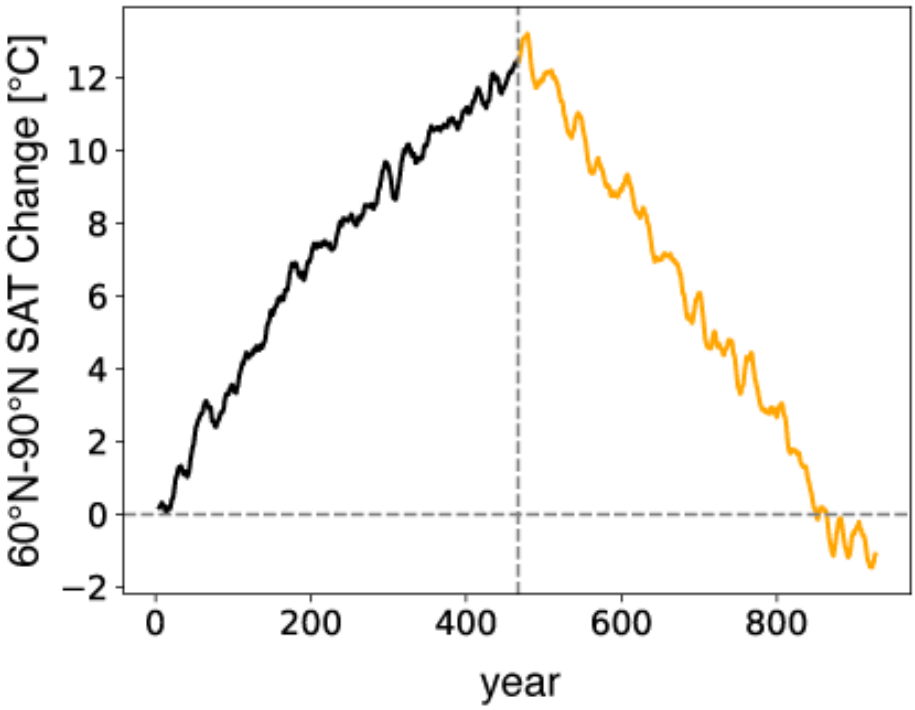

Figure S3: Time evolution of surface air temperature change in the region from 60° N to 90° N. The vertical dashed line indicates the year when the flat10 run is switched to NEC6.

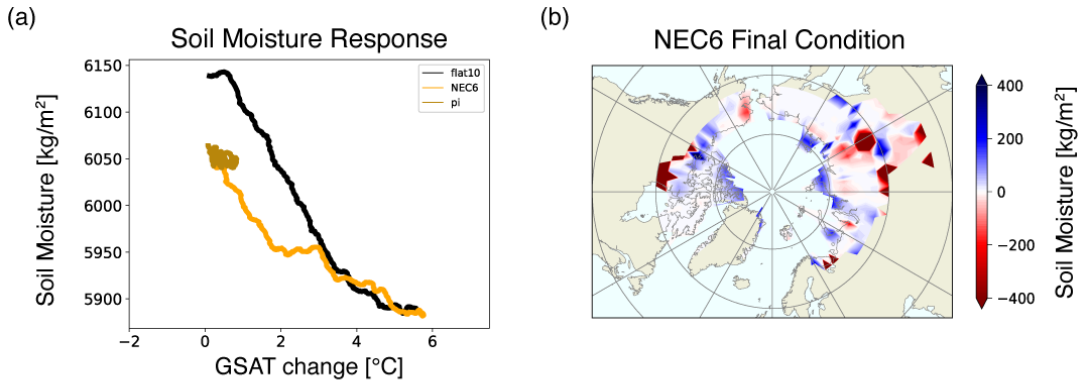

Figure S4: (a) Response of the average soil moisture in the permafrost region (0-14m) in flat10 (black), NEC6 (yellow) and following piControl experiment (dark orange). (b) Difference of the 10year-mean soil moisture (0-14m) from piControl in the end of NEC6.

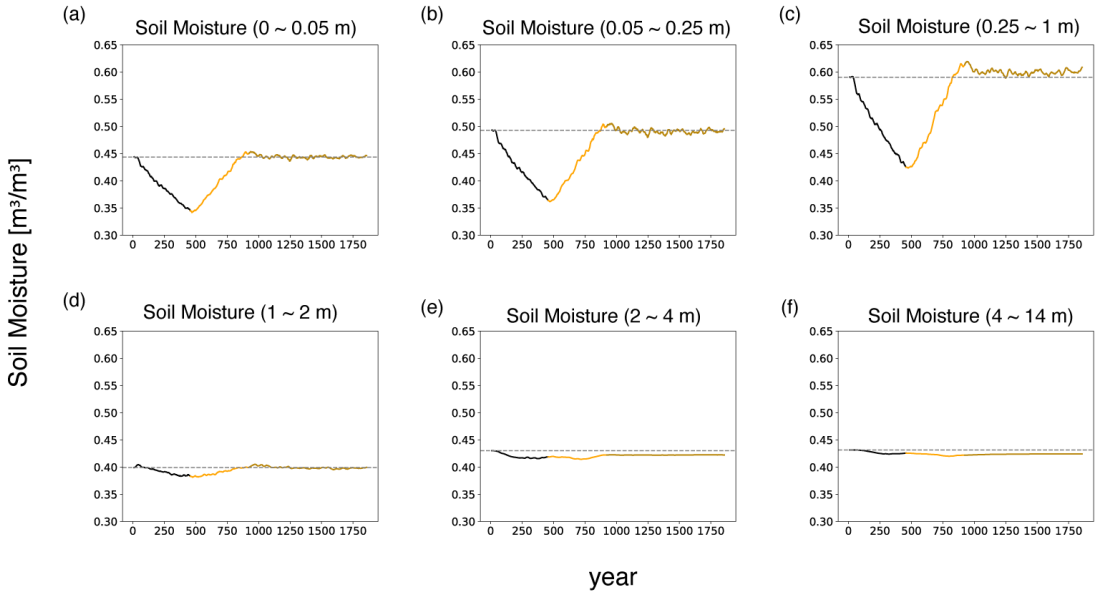

Figure S5: Time evolution of the average soil moisture in the permafrost region in first layer (0-0.05m), second layer (0.05-0.25m), 3-th layer (0.25-1m), 4-th layer (1-2m), 5-th layer (2-4m) and bottom layer (4-14m) in flat10 (black), NEC6 (orange) and following piControl experiment (dark orange).

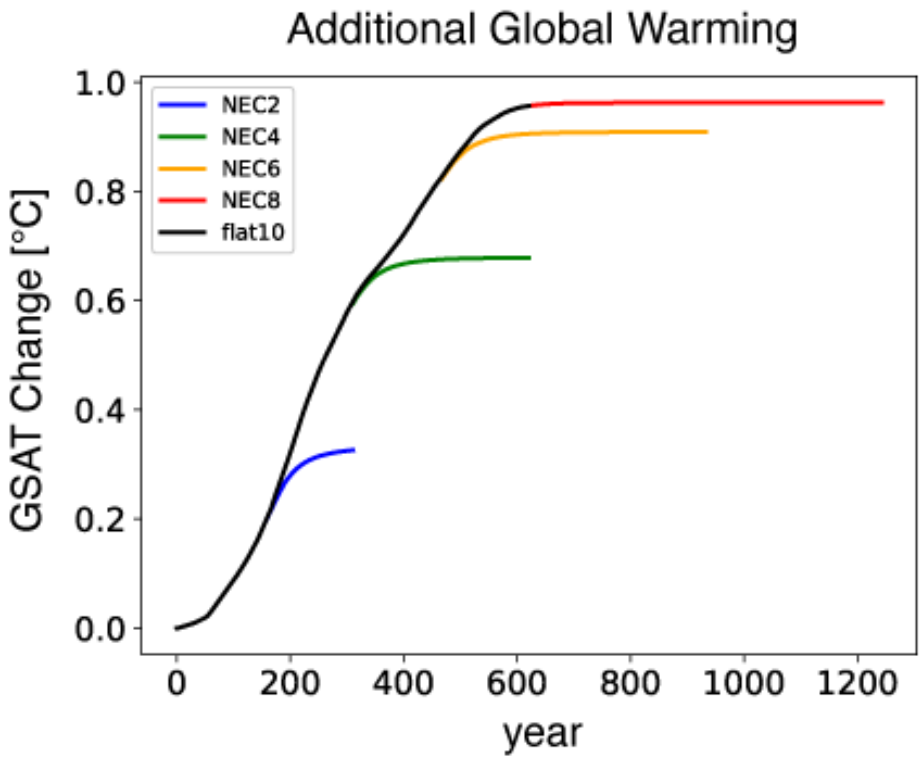

Figure S6: Time evolution of predicted additional global warming by CO_2 and CH_4 emission from permafrost thaw. The values were calculated using the cumulative CO_2 and CH_4 emissions from thawed permafrost simulated by PDGEM, along with the TCRE derived from the flat10 experiment. Methane was assumed to have a global warming potential 30 times greater than that of CO_2. Color convention follows Fig. 1.

References

Brown, J., Ferrians, O., Heginbottom, J. A., and Melnikov, E.: Circum-arctic map of permafrost and ground-ice conditions, Version 2 (GGD318), National Snow and Ice Data Center, https://doi.org/10.7265/skbg-kf16, 2002.