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Elevated atmospheric temperatures through permafrost feedbacks

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The thawing of permafrost and the associated release of carbon constitutes a positive feedback in the climate system. Multiple uncertain factors hinder so far an exact quantification of this feedback, in particular because of uncertainties in the magnitude of high latitude amplification of global warming, regionally inhomogeneous soil properties and soil carbon content, the time needed for decomposing the organic material in the soils, as well as the uncertain fractions of soil carbon that might be released as carbon dioxide via aerobic decomposition or as methane via anaerobic decomposition. In this study, we provide an estimation of the potential effect of the permafrost feedback in a simplified framework. We base our simulations on prior distributions informed by the literature for the parameters of a new simplified permafrost module within the probabilistic carbon-cycle climate model MAGICC.
While permafrost feedbacks on future temperature increases are weak under the low RCP3-PD scenario, we estimate an extra warming for the high RCP8.5 scenario, steadily increasing with time up to 0.5°C for the median ($\sim$1.0°C for the upper 66% quantile) by 2300. Mean CO2 emission rates from permafrost carbon release can reach about 3 GtC/yr in the second half of the 22nd century (about 5 GtC for the upper 66% quantile). Permafrost methane emissions resulting from high warming levels (RCP8.5) can be comparable in magnitude (about 200 MtC/yr by 2200, 66% quantile) to anthropogenic emissions seen in the low emission scenario.