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Response of terrestrial hydrology to climate and permafrost change for the 21st century as simulated by JSBACH offline experiments

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Permafrost (PF) or perennially frozen ground is an important part of the terrestrial cryosphere; roughly one quarter of Earth's land surface is underlain by permafrost.
As it is a thermal phenomenon, its characteristics are highly dependent on climatic factors. The impact of the currently observed warming, which is projected to persist during the coming decades due to anthropogenic CO_2 input, certainly has effects for the vast permafrost areas of the high northern latitudes. The quantification of these effects, however, is scientifically still an open question. This is partly due to the complexity of the system, where several feedbacks are interacting between land and atmosphere, sometimes counterbalancing each other. In terms of hydrology, changes in permafrost characteristics may lead to contradicting effects. E.g., observations show that the deepening of the Active Layer (AL) can both decrease and increase soil moisture, depending on the specific conditions. For the investigation of hydrological changes in response to climatic and thus PF change, it is therefore necessary to use a model.
To address this response of the terrestrial hydrology to projected changes for the 21st century, the global land surface model of the Max-Planck-Institute for Meteorology, JSBACH, was used to simulate several future climate scenarios. JSBACH recently has been equipped with important physical PF processes, such as the effects of freezing and thawing of soil water for both energy and water cycles, thermal properties depending on soil water and ice contents, and soil moisture movement being influenced by the presence of soil ice.
In order to identify hydrological impacts originating solely in the physical forcing, experiments were conducted in an offline mode and with fixed vegetation cover. Feedback mechanisms, e.g. via the carbon cycle, were thus excluded.
The uncertainty range arising through different Representative Concentration Pathways (RCPs) as well as through different GCMs was addressed through the use of combinations of two RCPs and two GCMs as driving data. Analysis will focus on hydrological variables and related quantities.