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Circumpolar mapping of permafrost temperature and thaw depth in the ESA Permafrost CCI project

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Permafrost is an Essential Climate Variable (ECV) within the Global Climate Observing System (GCOS), which is characterized by subsurface temperatures and the depth of the seasonal thaw layer. Complementing ground-based monitoring networks, the Permafrost CCI project funded by the European Space Agency (ESA) 2018-2021 will establish Earth Observation (EO) based products for the permafrost ECV spanning the last two decades. Since ground temperature and thaw depth cannot be directly observed from space-borne sensors, we will ingest a variety of satellite and reanalysis data in a ground thermal model, which allows to quantitatively characterize the changing permafrost systems in Arctic and High-Mountain areas. As recently demonstrated for the Lena River Delta in Northern Siberia, the algorithm uses remotely sensed data sets of Land Surface Temperature (LST), Snow Water Equivalent (SWE) and landcover to drive the transient permafrost model CryoGrid 2, which yields ground temperature at various depths, in addition to thaw depth. For the circumpolar CCI product, we aim for a spatial resolution of 1km, and ensemble runs will be performed for each pixel to represent the subgrid variability of snow and land cover. The performance of the transient algorithm crucially depends on the correct representation of ground properties, in particular ice and organic contents. Therefore, the project will compile a new subsurface stratigraphy product which also holds great potential for improving Earth System Model results in permafrost environments.
We present simulation runs for various permafrost regions and characterize the accuracy and ability to reproduce trends against ground-based data. Finally, we evaluate the feasibility of future “permafrost reanalysis” products, exploiting the information content of various satellite products to deliver the best possible estimate for the permafrost thermal state over a range of spatial scales.