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Study Of the Development of Extreme Events over Permafrost areas - SODEEP

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In the frame of the ERA-NET project SODEEP, we examine the impact of climate change on the permafrost degradation and related biophysical feedbacks over various spatial and temporal scales. Our aim is to assess the role of land-atmosphere interactions on the severity and frequency of extreme events over circum-Arctic land areas. Our focus regions are major bio-climatic zones of the Russian Arctic and sub-Arctic, which are not only extremely vulnerable habitats to the permafrost degradation due to climate change, but also exhibit a threat for the global climate due to frozen soil-bounded carbon. The data from long-term in situ observations and field studies as well as medium and high-resolution satellite-borne and aerial observations are combined with a state of the art hierarchy of climate models to identify missing or misrepresented permafrost-relevant key processes in numerical models. The rate of the permafrost temperature rise is different in different climatic zones. The maximum growth rate is observed in the southern tundra, the minimum in the southern forest-tundra and northern taiga, where the permafrost temperature is close to 0°C. The ground temperature rise reduce the bearing capacity. The layers of the "zero curtain" with a thickness of several meters occur at temperatures close to 0°C. Its presence inhibits the degradation of permafrost.

Here, we present the project and first results. The latter comprise preliminary results from field campaign and development of a permafrost temperature dynamics and active layer thickness database, processing of optical satellite images (spatio-temporal changes related to lake extent and trend of several multi-spectral indices, i.e. NDVI, NDMI, Tasseled Cap indices based on Landsat and Sentinel-2 images selected from archives and acquired between 1987-2018), as well as the progress in understanding and implementation of permafrost related processes into the regional climate model REMO and simulations with Geophysical Institute Permafrost Laboratory (GIPL) model to reproduce historic permafrost distribution 1960-2009 on the pan-Arctic at 0.5° spatial resolution. Thermal and hydrologic properties of the ground material and snowpack are parameterized using vegetation cover, surface geology and extensive empirical observations. This model will be augmented later in the project with advances in techniques as geographic object-based image analysis for interpretation of remote sensing imagery through automated identification of landscape changes and used to update permafrost scheme in climate models. The approach using empirical regional trends detected from long records was applied for mapping of current and future (2050 and 2100) permafrost temperature. Trends are identified by taking into account the current changes in climate and permafrost characteristics.

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