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Thermal regime of soil active layer at the Bolshevik Island (Archipelago Severnaya Zemlya) during 2016 – 2020 years

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Investigations of active soil layer on the Research station “Ice Base Cape Baranova” had been started in February 2016 after installation on the meteorological site sensors of Finnish Meteorological Institute: thermochain with IKES PT00 temperature sensors at depths of 20, 40, 60, 80 and 100 cm, soil heat flux sensor HFP, and two ThetaProbe type ML3 soil moisture sensors. Based on the results of measurements annual cycle of soil temperature changes was revealed with amplitudes 10 - 15 ° C less than the amplitudes of surface air layer temperature (Ta) and especially the temperature of the soil upper surface (Tsrad), in great degree determined by short-wave radiation heating and long-wave radiation cooling. Approximation by linear fittings shows average rates of increase Ta - 0.4°C/year, Tsrad - 0.3°C/year, and temperatures of active soil layer - 0.2°C/year.

The data on thermal regime of active soil layer and characteristics of energy exchange in atmospheric surface layer make it possible to draw the conclusion about the reason for the abnormally warm state of the upper meter soil layer in summer 2020, despite in March during the whole period under study active soil layer was the warmest in 2017. Comparison in temperatures of the underlying surface and characteristics of surface heat balance during period under study showed that in 2020 the temperature of the soil surface at the end of May for a short time reached the temperature of snow melting. It is happened 25 days earlier than in 2017 as well as other years and led to radical decrease in surface albedo, sharp increase of heat flux to the underlying surface, and increased duration of active soil layer heating.

Additionally, permafrost thawing studies using a manual contact method were carried out on the special site, organized according to CALM standards. These studies showed significant variety of soil active layer thicknesses in the relatively small area (~0.12 km^2), which indicates significant spatial variability of microrelief, structure and thermophysical properties of soil, as well as vegetation, typical for Arctic desert. Calculations carried out with version of the well-known thermodynamic Leibenzon model for various parameterizations of vegetation and soil properties partly described peculiarities of spatial variability of observed thawing depths.