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Monitoring of Thermokarst Lake Changes and Coastal Dynamics in Permafrost Landscapes of the East-Siberian Sea Region Using High Resolution Imagery and DEM Data

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The coastal region bordering the East-Siberian Sea is covered by ice-rich Yedoma deposits, which are extremely vulnerable to thaw in the course of climate warming in the high latitudes. Widespread permafrost degradation throughout the Arctic resulted in relief changes on ground-ice-cored Yedoma uplands. In order to track dynamics of these processes in the Kolyma lowland tundra at Cape Maly Chukochy (N 72.08°, E 159.9°), we used a set of very high resolution remote sensing imagery (GeoEye and historical airphotos) which were compared with DEM data (TanDEM-X and derived from WorldView-2). Analysis of meteorological data have put observed changes into the context of warming and wetting trends.

Yedoma uplands represent flat bogged areas featuring a high number of thermokarst ponds with an average size of 5-10 m in diameter. Our image dataset revealed a doubling in the number and areal coverage of ponds from 1972 to 2009 and a further twofold increase until 2013, while thermokarst lakes that formed within Yedoma deposits increased by 7-10 %, being partially in agreement with studies conducted elsewhere in the Arctic. Coastal erosion rates from 1972 until 2013 were high and 1,5 m per year on average. We used the areal extend of thermokarst mounds (baydzherakhs) on Yedoma slopes as indicator for ground ice melt and our estimates show a baydzherakhs coverage increase of 20 % by 2013.

All these changes highlight the activation and acceleration of permafrost degradation on Yedoma uplands in response to increasing air temperatures and precipitation in the East-Siberian Sea coastal region.