Active layer thickness database for the Lena Delta region (NE Siberia) and its analysis in relation with landscape parameters

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The active layer thickness (ALT) is one of currently two Essential Climate Variables (ECVs) related directly to permafrost regions as defined by the Global Climate Observing System at the World Meteorological Organization. Within the framework of the Circumpolar Active Layer Monitoring (CALM) program established in the 1990s, ALT is being monitored across the Arctic to better understand climate change impacts on landscape, permafrost, hydrology, vegetation, and soil biogeochemistry (Nelson et al. 2021). In addition to this standardized monitoring program at established sites, many ALT measurements are collected every year during other field work covering various research questions, field sites, and approaches. Usually, much of this ALT data remains unpublished. The Lena Delta region (NE Siberia) has been one of the Arctic focus regions of many Russian and international scientific teams for several decades. In a first step, we aimed to compile all available ALT measurements for the Lena Delta region, including both unpublished and published data collected during Russian and joint German-Russian expeditions since 1991, standardize them and make them accessible for further use. We adhere to the FAIR guiding principles for scientific data management and stewardship (Wilkinson et al. 2016) by publishing one comprehensive dataset in the PANGAEA Data Publisher for Earth & Environmental Science. In a second step, we will analyze this comprehensive dataset together with other data available for the region to reveal determining factors for spatial and temporal ALT variation.

Our Lena Delta ALT database contains ALT data collected by researchers during different tasks, such as sampling of exposures, drilling of boreholes, continuous measurements with soil temperature sensors and data loggers, soil and vegetation surveys, as well as for validation of remote sensing data. They include single measurements at individual locations as well as ALT transects across landforms and gridded measurements.

The ALT database contains about 6000 site measurements from different areas of the Lena Delta region with clustering in five research-intensive areas including Muostakh Island and Bykovsky Peninsula (Figure 1). 35 % of the ALT measurements were collected on Samoylov Island where the Samoylov Island Research Station has been operated since several decades (Hubberten et al. 2006), 22 % were measured on Kurungnakh Island, and 21 % on the Bykovsky Peninsula. Sobo-Sise Island and Muostakh Island represent 10 and 9 % of the number of ALT measurements, respectively. The remaining 3% were collected from other locations. ALT was measured mostly once per site, but some sites were measured 2-5 and more times in order to reveal microrelief and vegetation impact.
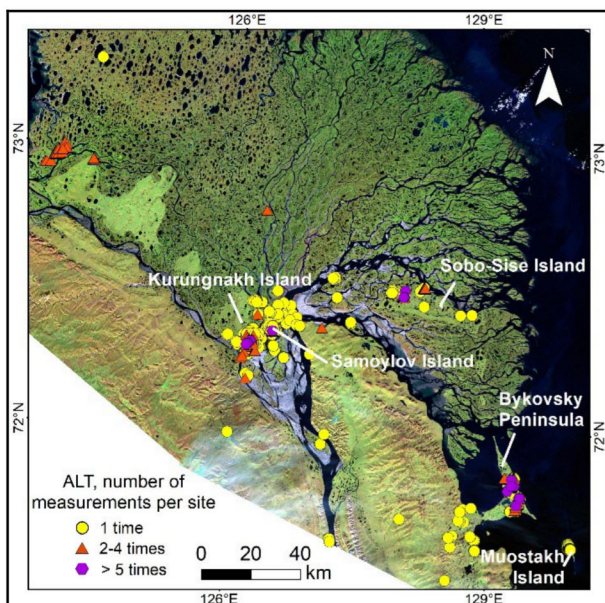

Figure 1. Distribution and quantity of ALT measurements in the Lena Delta region.

For several sites, repeated measurements of ALT profiles were conducted at the same locations in different years, e.g., on Samoylov Island from 2013 to 2022, on Sobo-Sise Island in 2015, 2016, and 2018, and on the Bykovsky Peninsula in 2015, 2016, and 2021. Repeated ALT measurements within one year were collected in 2010 and 2013 on Samoylov Island, in 2013 and 2014 on Kurungnakh Island and in 2017 on Bykovsky Peninsula.

The measurement sites represent various landscapes underlain by different types of deposits (Holocene Lena Delta terraces, remnants of Yedoma Ice Complex, slope deposits on the low-mountain relief, etc.), which are characterized by various relief positions, and different microtopography, soils, and vegetation cover.

Preliminary analyses indicate that the compiled ALT data show landscape unit-dependent variabilities, intraseasonal fluctuations, and long-term trends. Further in-depth spatial and temporal ALT analysis together with other existing datasets such as the ArcticDEM, a new habitat map for the Lena Delta (Lisovski et al. 2023), and climate parameters will be performed in order to reveal relationships with landscape characteristics and climate change.

Our new ALT database presents a valuable synthesis of permafrost and soil surface dynamics in the important Arctic region for the last decades in addition to established CALM sites and published literature data for other permafrost regions. The data may be useful for parametrization or validation of permafrost modeling results and remote sensing studies.

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