

Dynamics of active layer depth and ground temperature in relation to fluctuation of climatic controls and human impact

Elena A. Babkina¹, Marina O. Leibman¹, Artem V. Khomutov¹,
Damir R. Mullanurov¹, Anatoly A. Gubarkov²

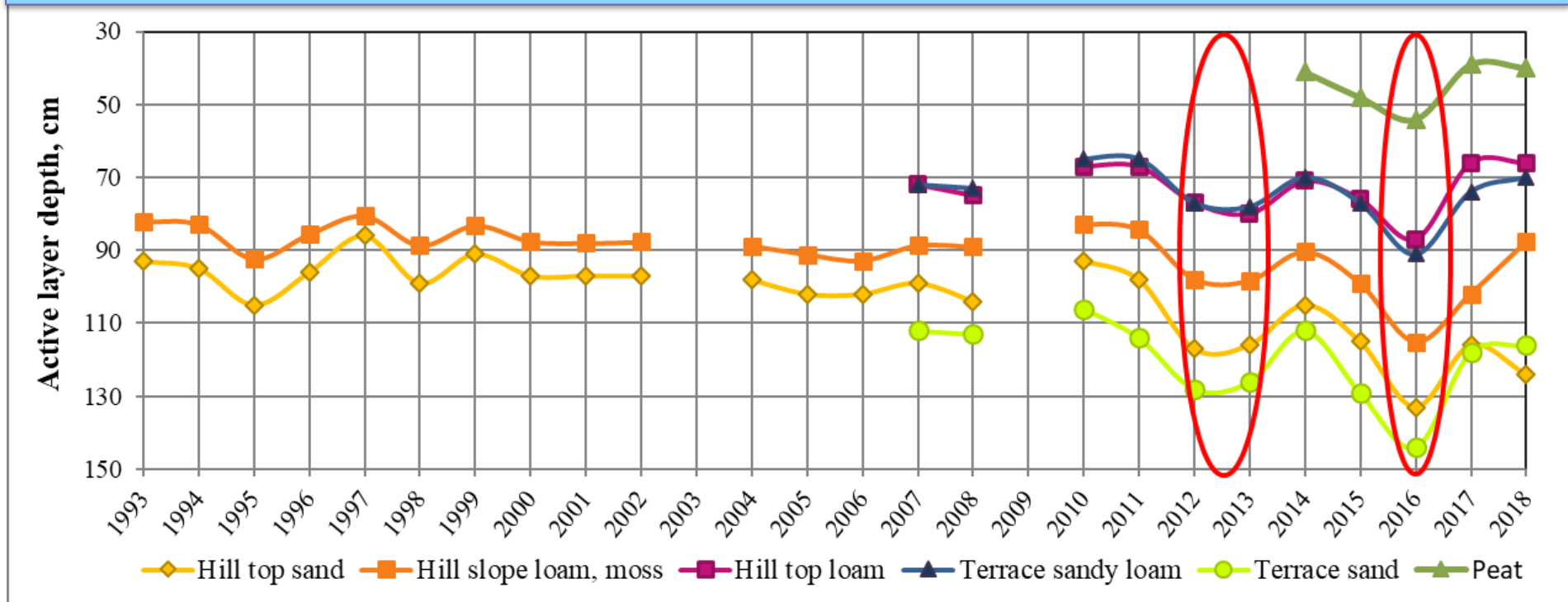
¹Earth Cryosphere Institute, Tyumen Scientific Centre SB RAS, Tyumen, Russia

²Tyumen Industrial University, Tyumen, Russia



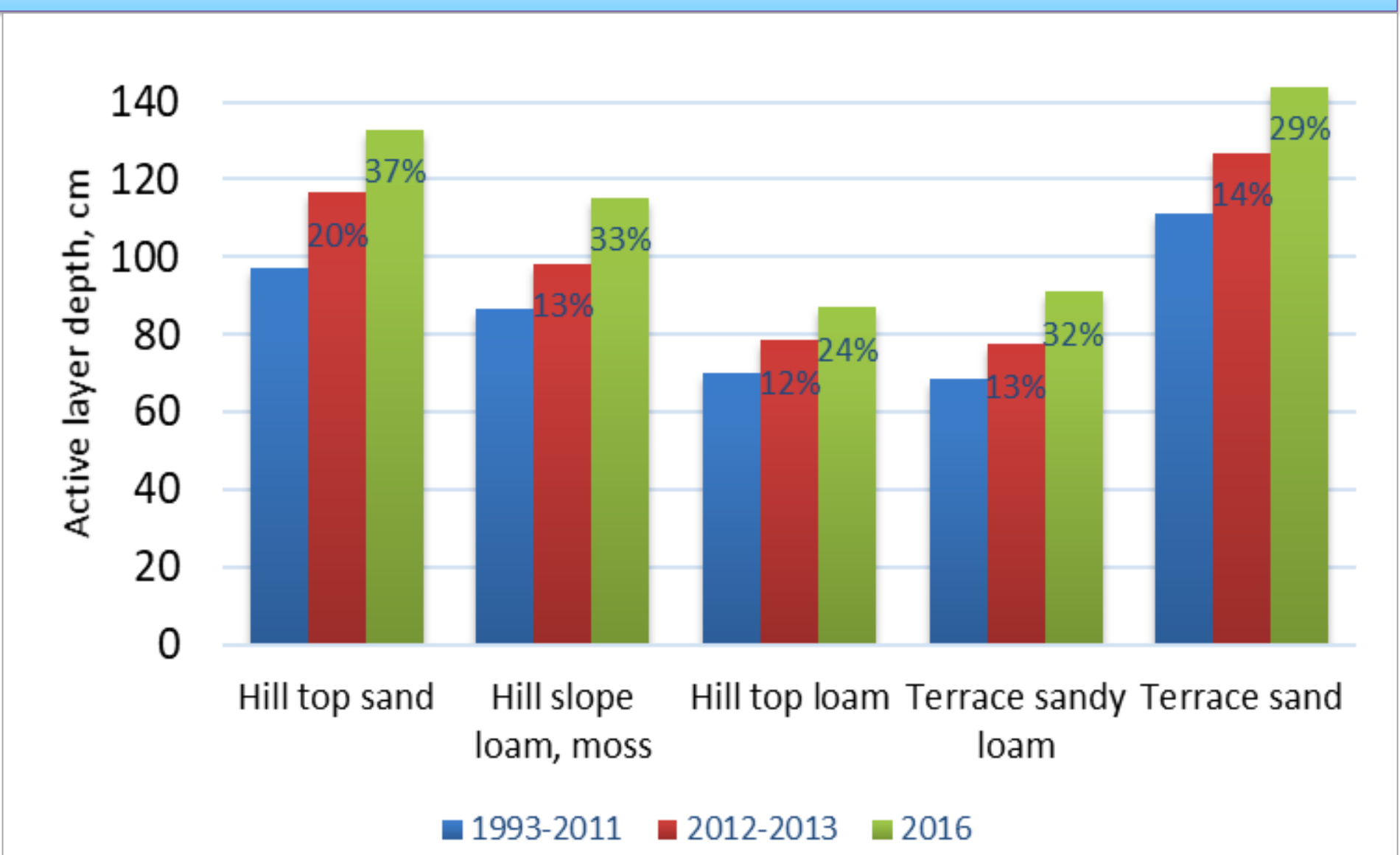
Mesaurements of the active layer depth (ALD) and ground temperature is carried on Central Yamal (since 1993), Gydan Peninsula and Pur-Taz interfluves (since 2016).

Perennial dynamics of ALD for various surfaces on Central Yamal

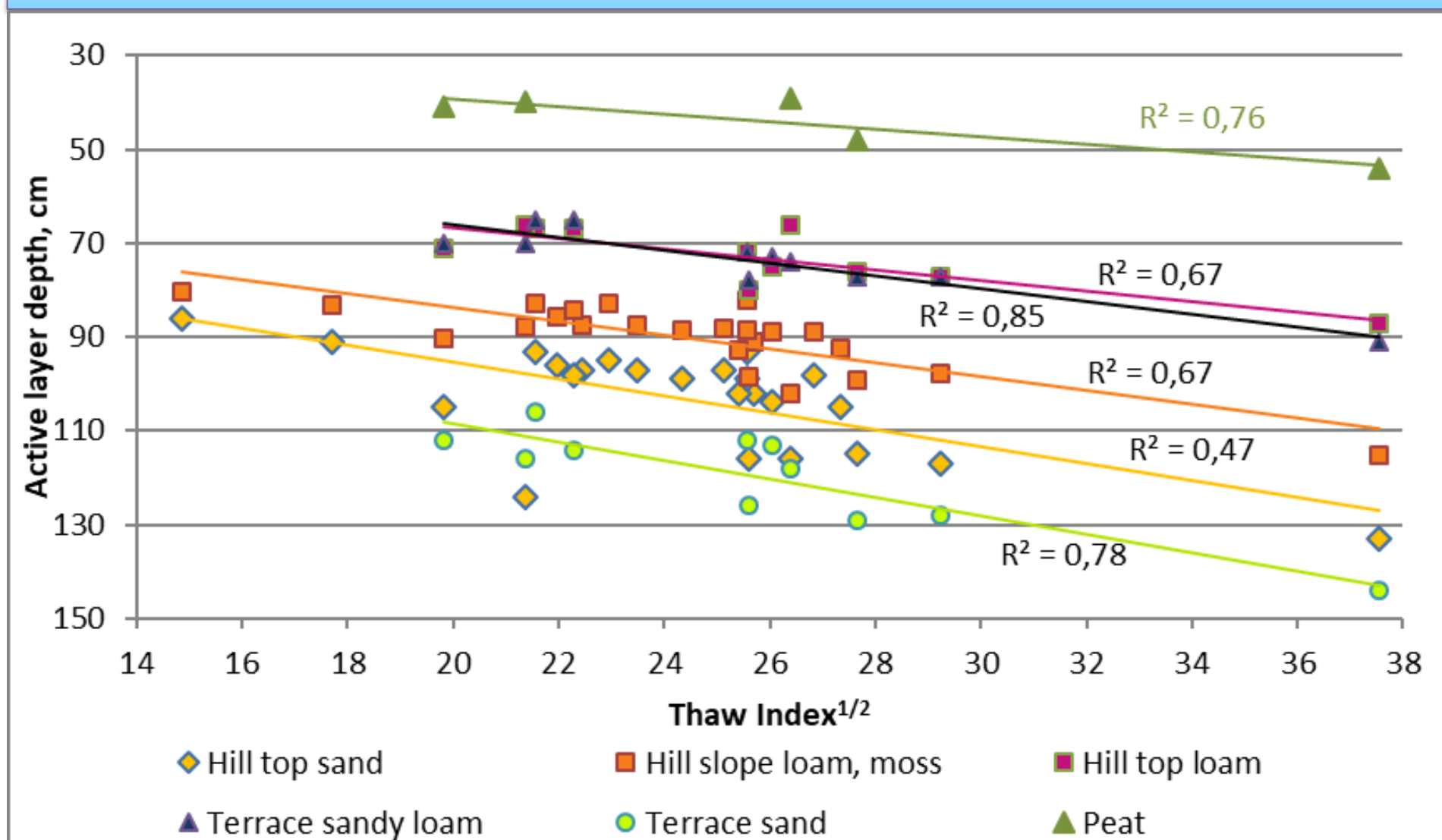


Air temperature rise in summer and the increase of summer total precipitation in 2012 and 2016 caused a significant active layer deepening in all types of surface as compared with the previous period of 1993-2011 (12-20% in 2012, 24-37% in 2016).

ALD increase

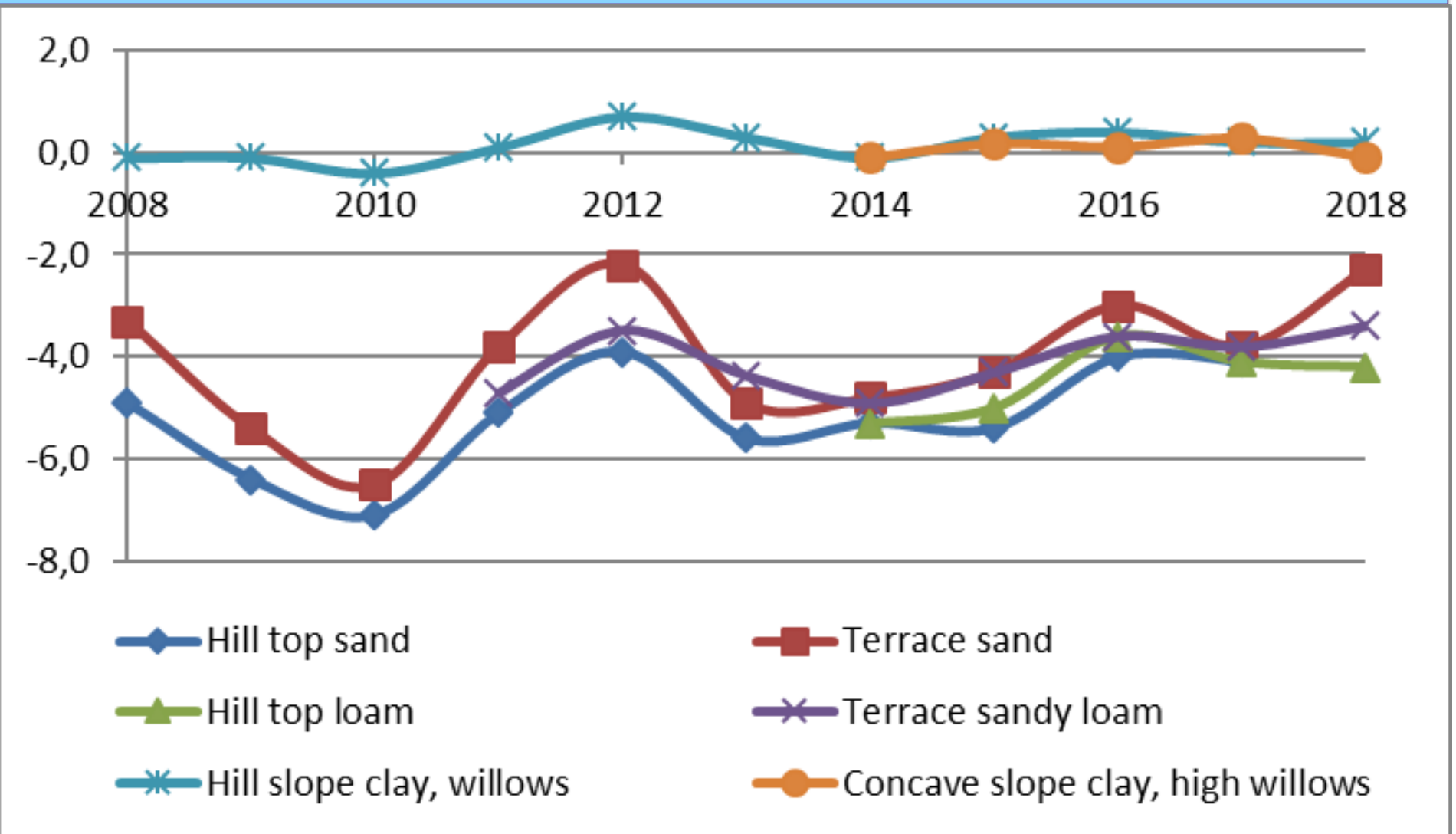


Relation ALD and Thaw Index^{1/2}



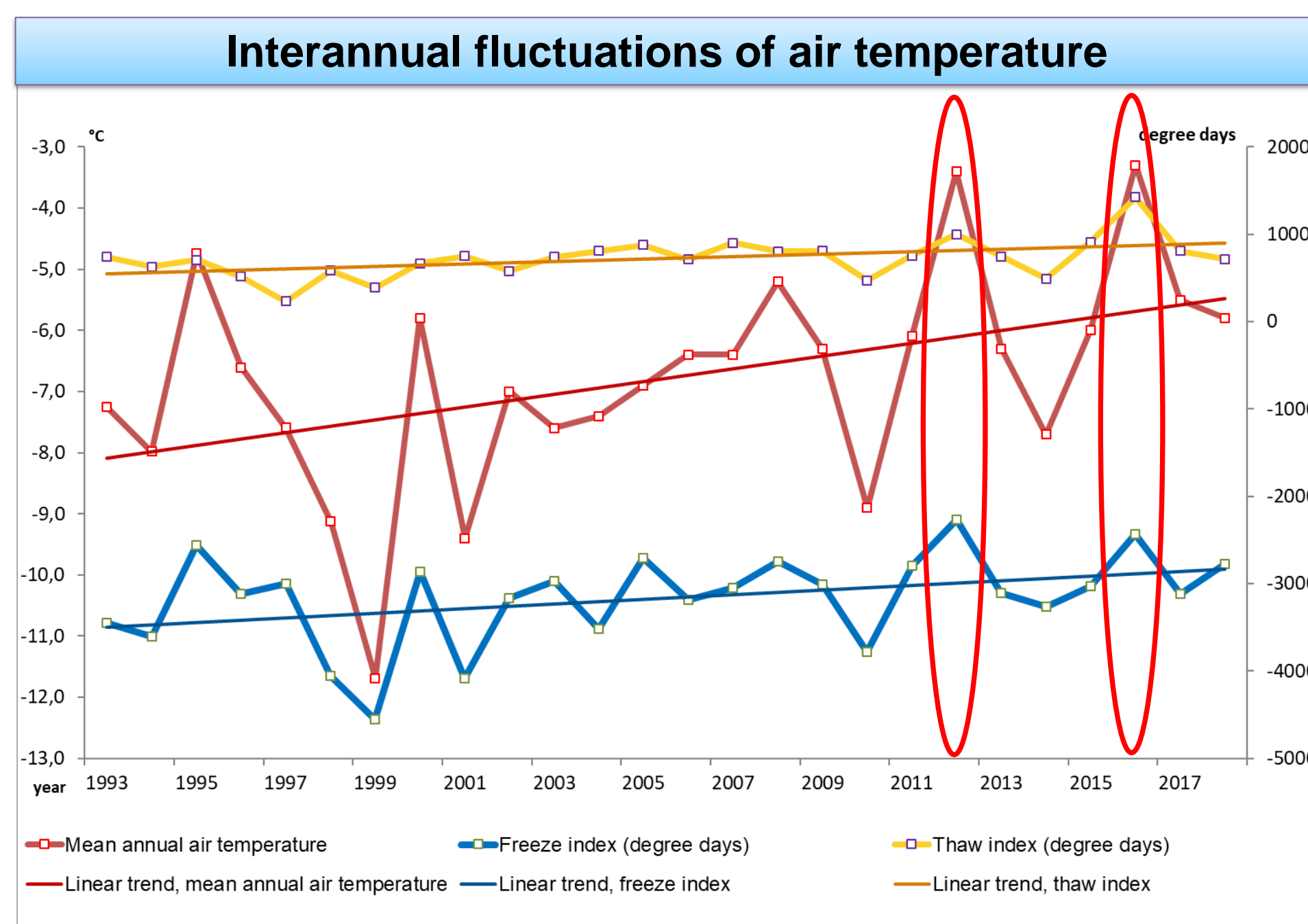
The active layer depth at all grids of this site correlates well with Thaw Index^{1/2} from the Marre-Sale weather station records.

Mean annual ground temperature at the active-layer base

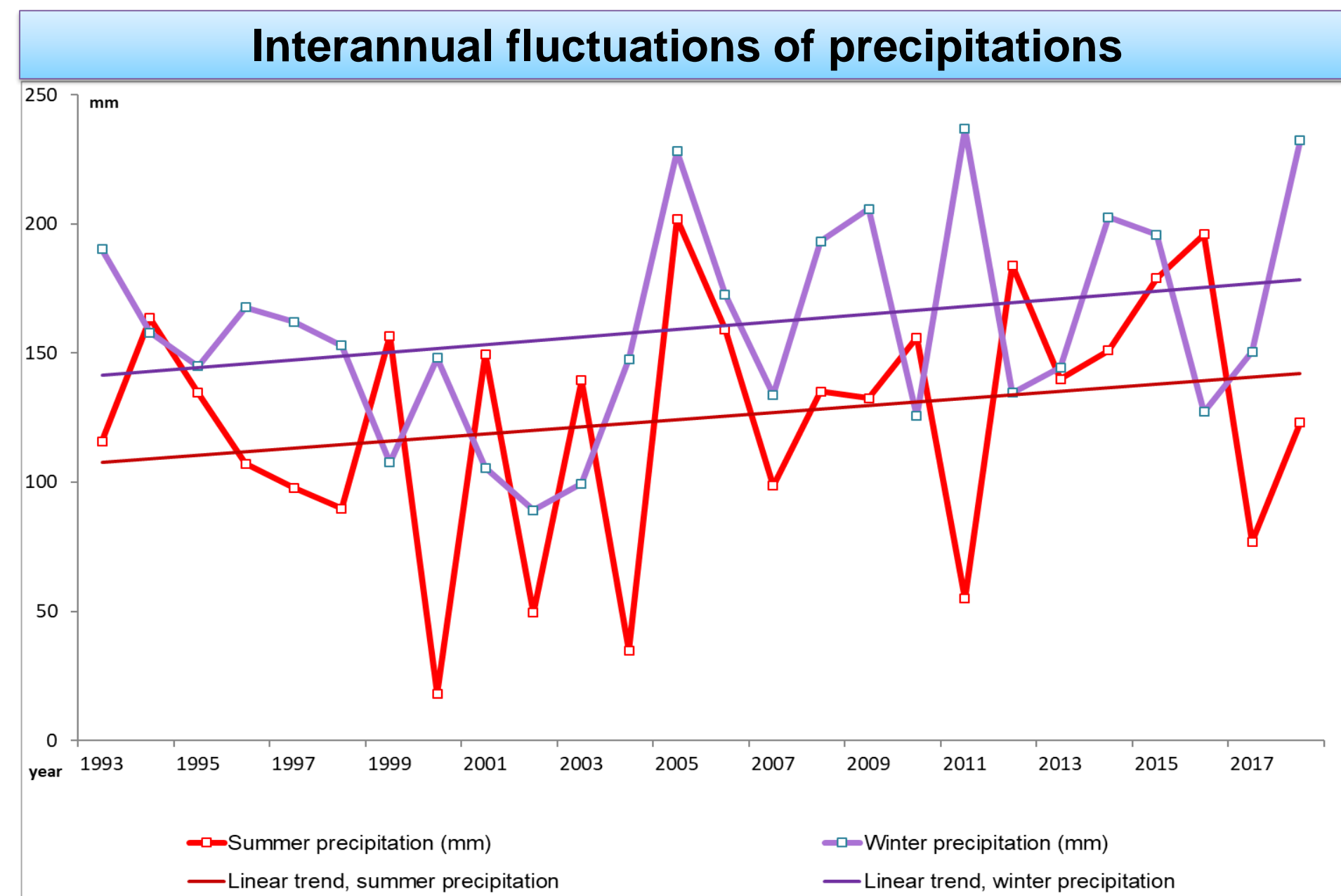


The ground temperature rise also observed through entire of all the surface types of the active layer during the warmest 2012 and 2016.

There is a significant increase of the ground temperature at 10 m depth, starting from the moment the borehole was established (the growth over 6 years is 0.7°C).



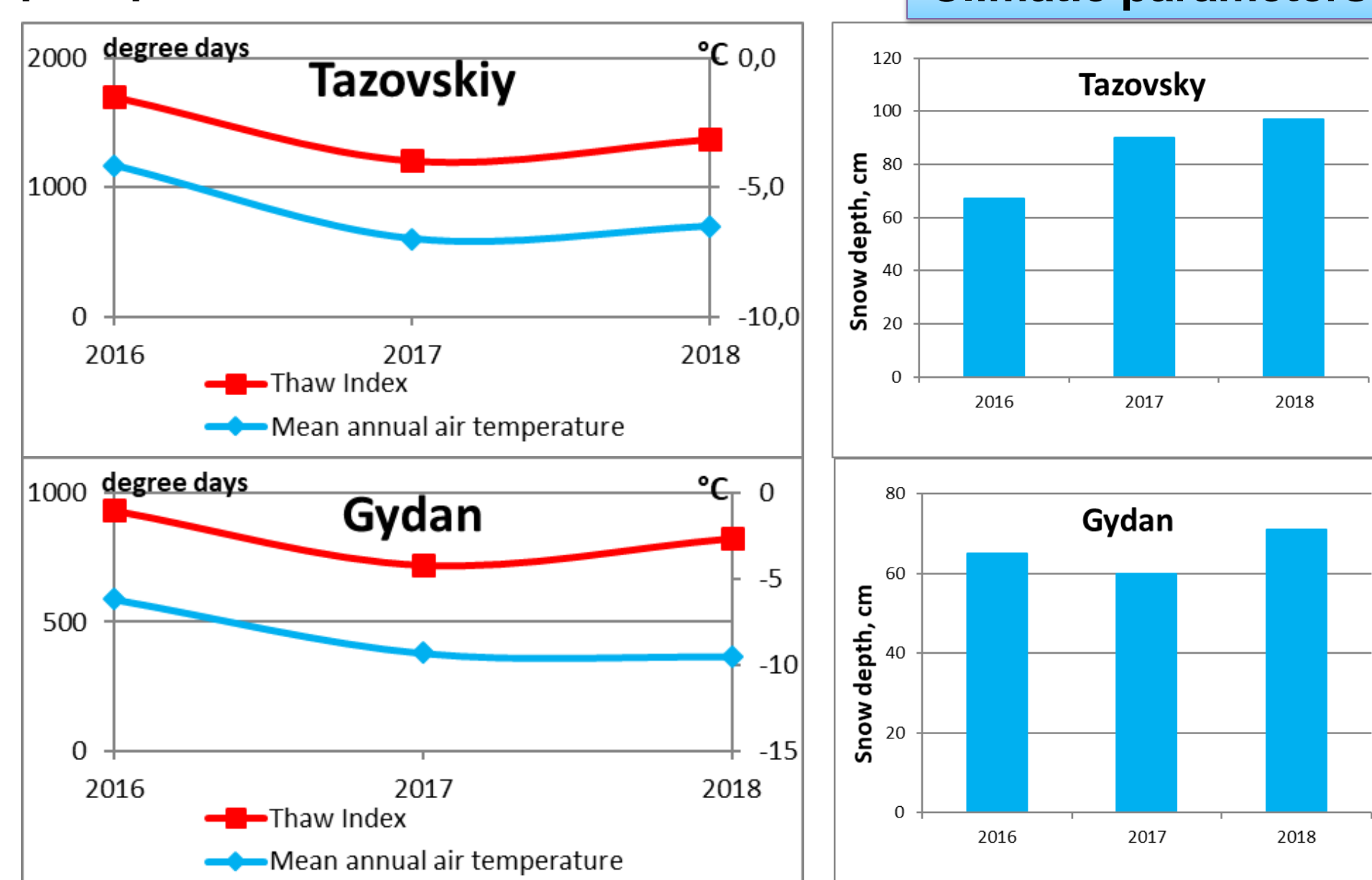
We use the records of the weather station Marre-Sale closest to the key area «Vaskiny Dachi».



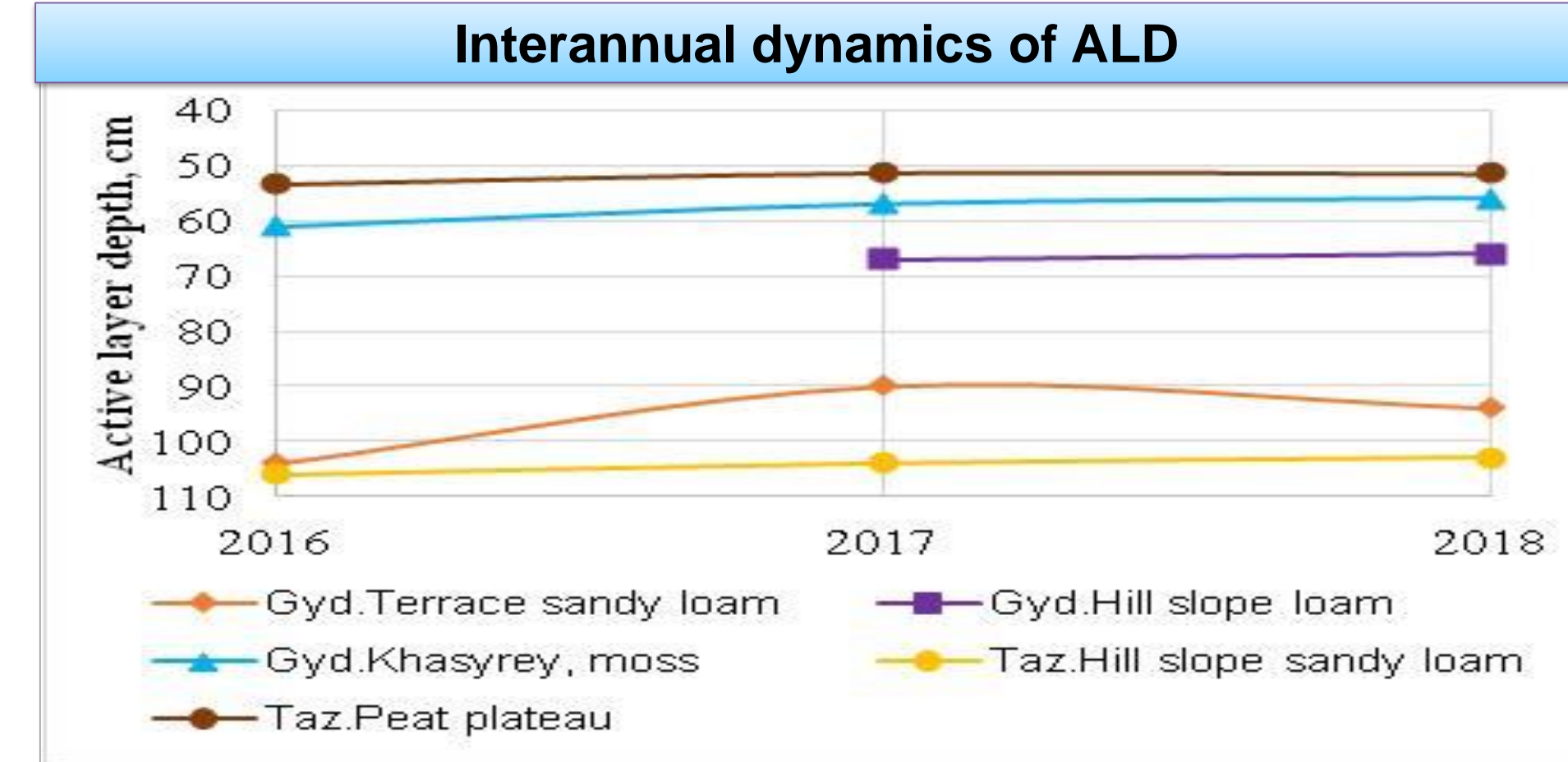
Analysis of climatic parameters showed that there is a warming trend over the period from 1993.

From 1993 there is increasing trend of the mean annual air temperature till 2018 with the highest value in 2012 and 2016.

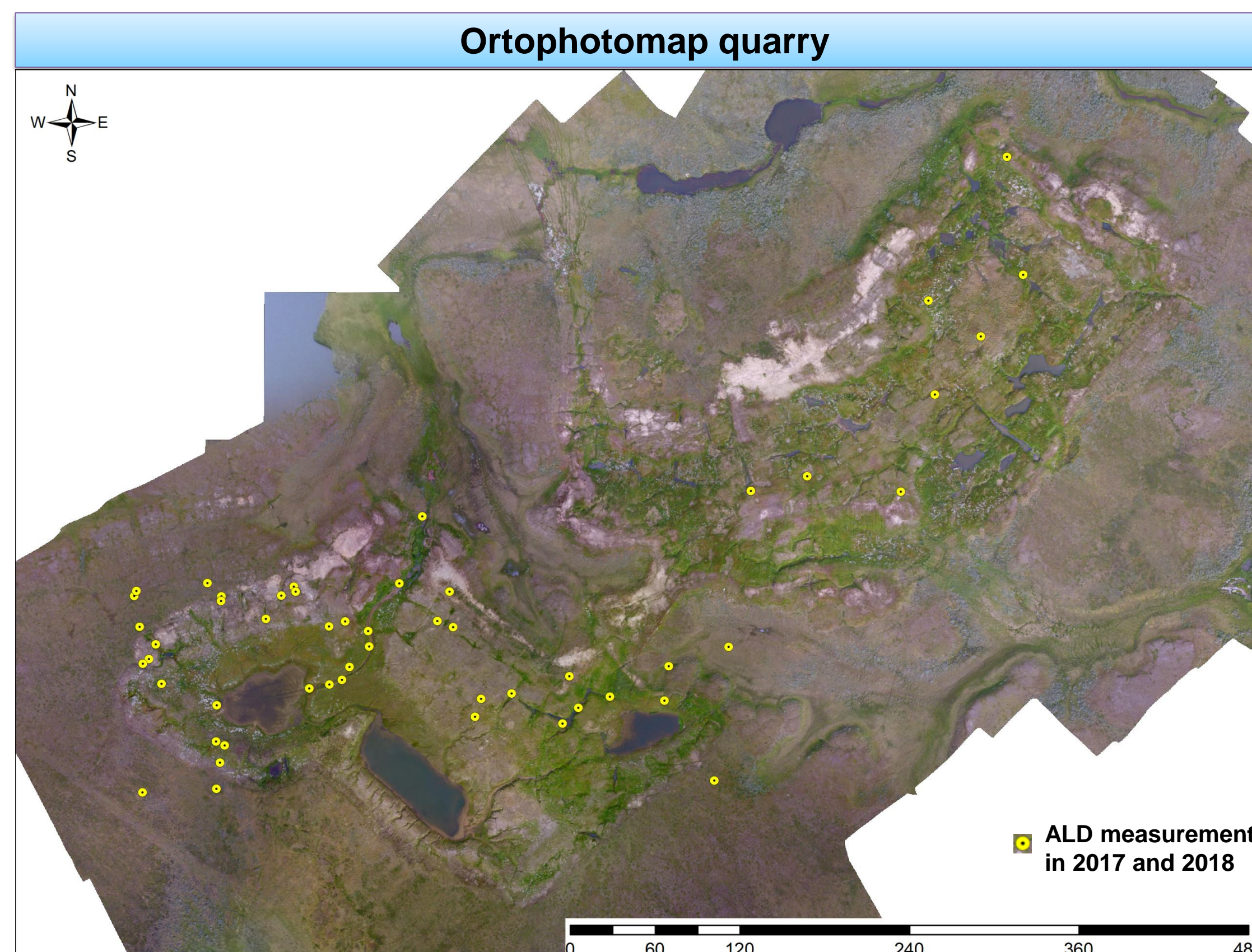
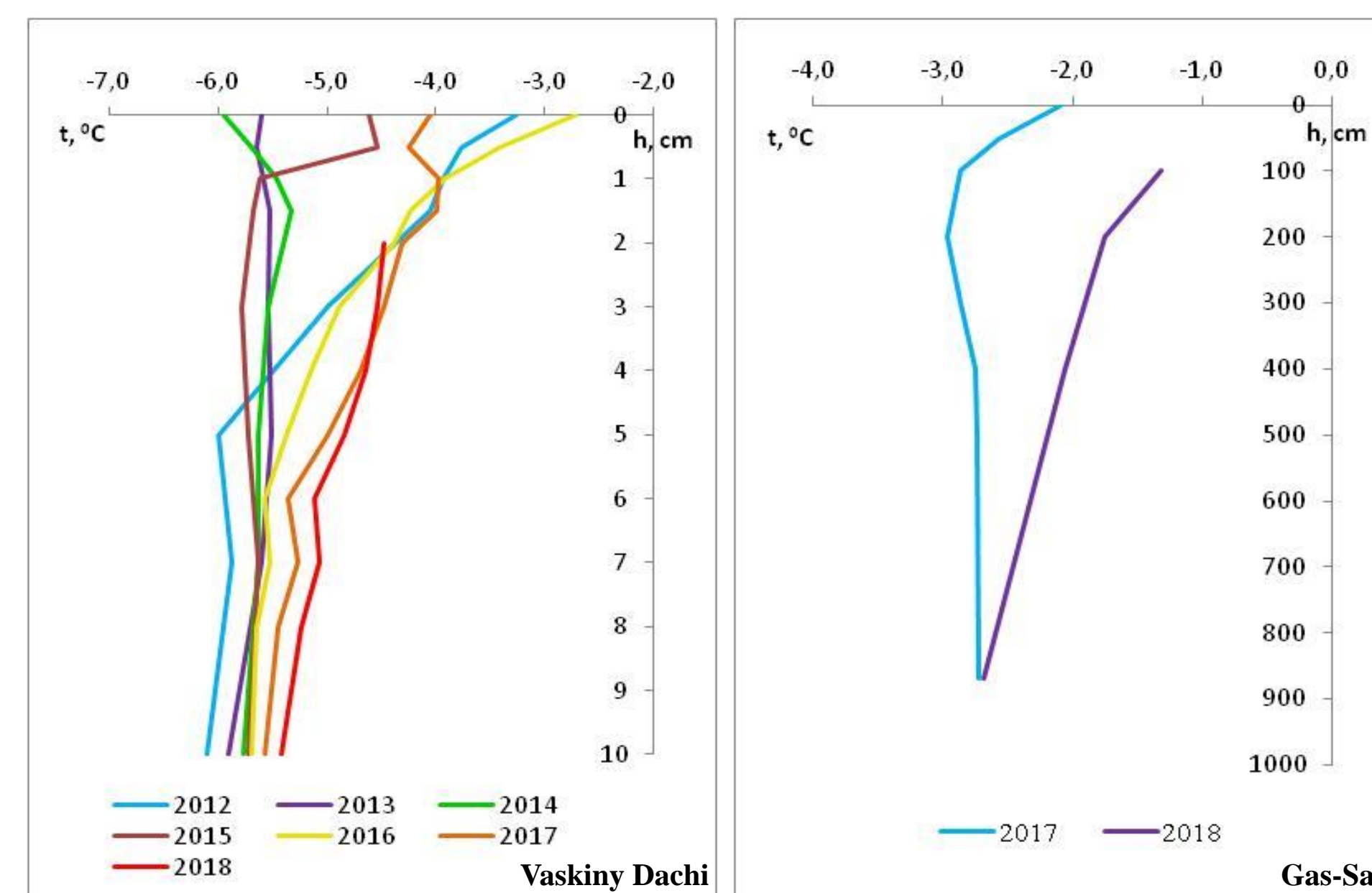
Years of 2012 and 2016 are characterized by the highest thaw index and freeze index, the largest sum of summer precipitation.



We use the records of the weather station Tazovsky and Sopochnaya Karga closest to the key areas «Gas-Sale» and «Gyda».



The observations series on the north of Gydan Peninsula and the Pur-Taz interfluvium are short (since 2016). Ground temperature in 2018 was higher compared to 2017 in both Gyda and Gaz-Sale key areas, most likely due to thicker snow cover as follows from weather station records.



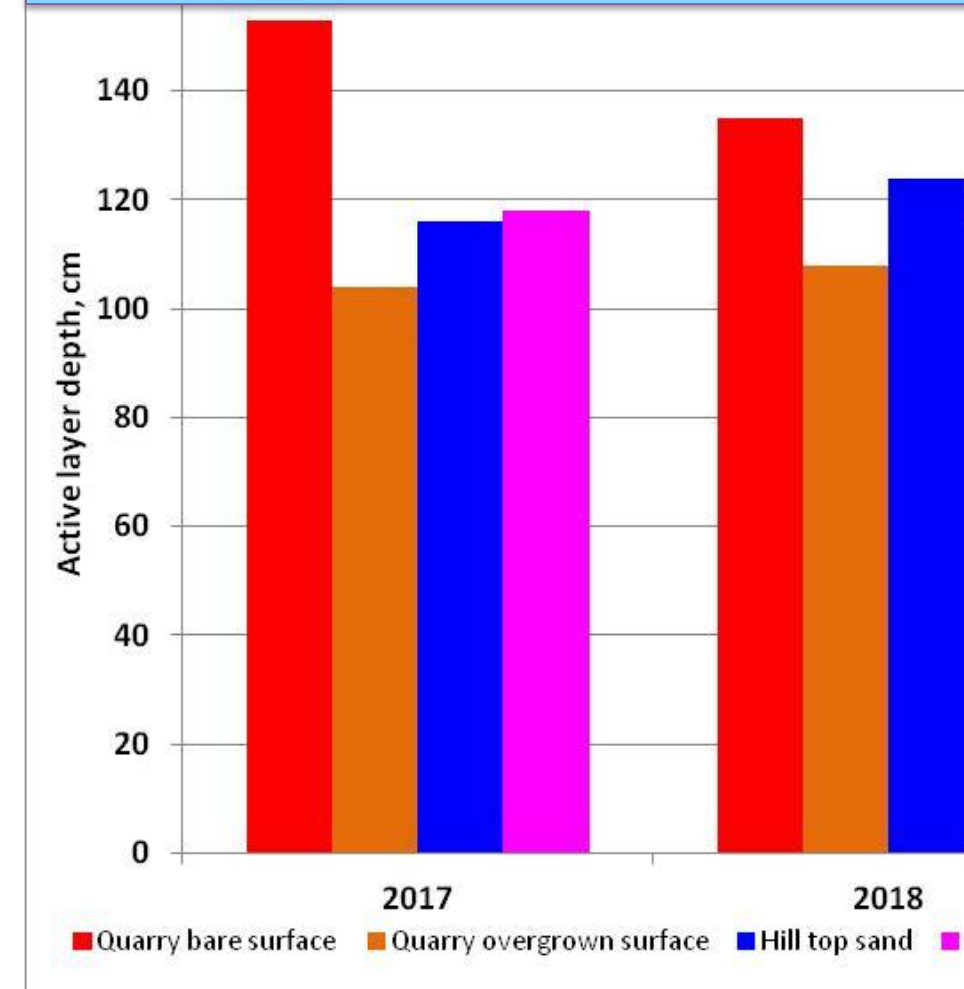
Surfaces of the quarry



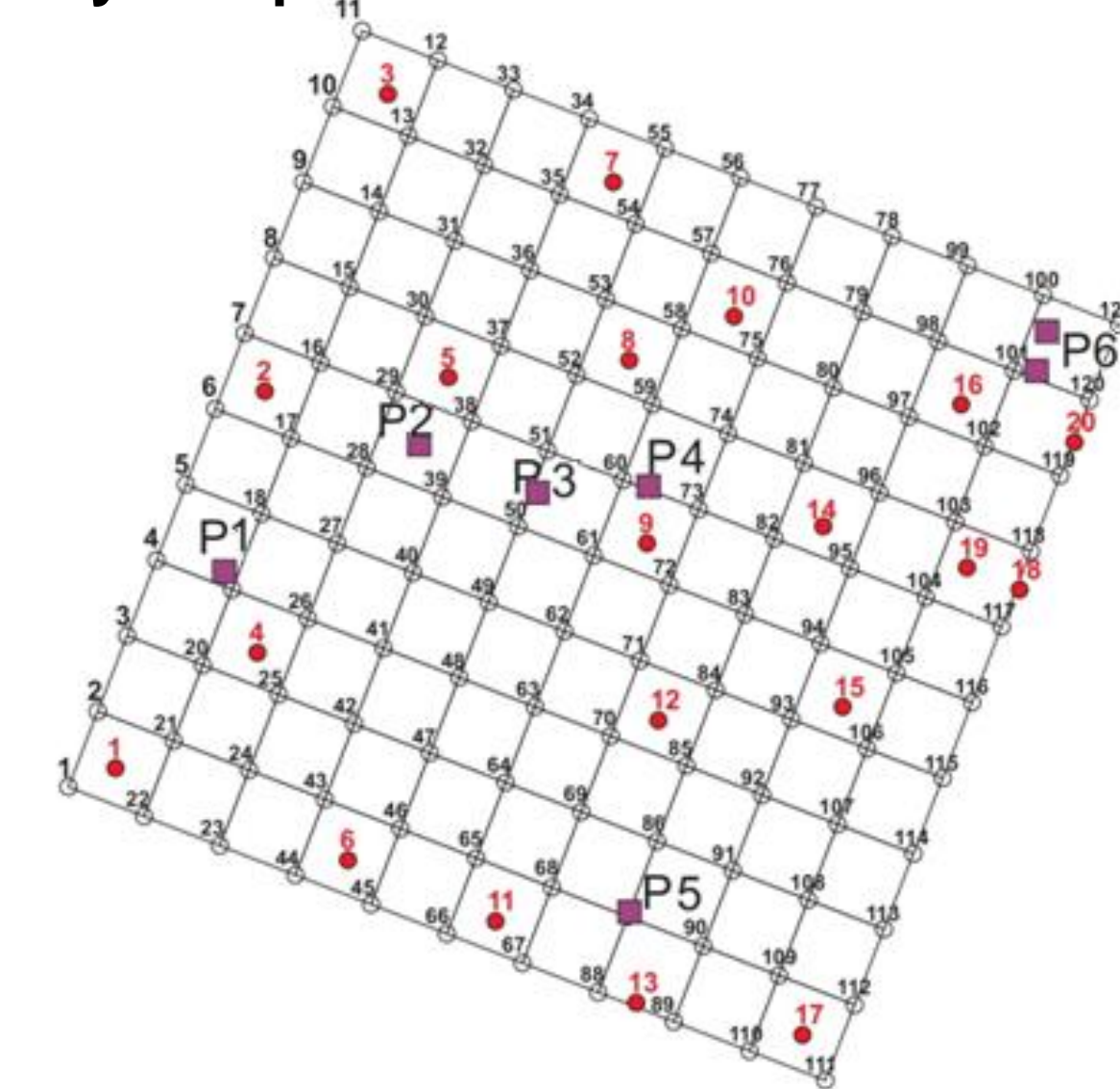
ALD measurements across vehicle track



ALD for quarry surfaces

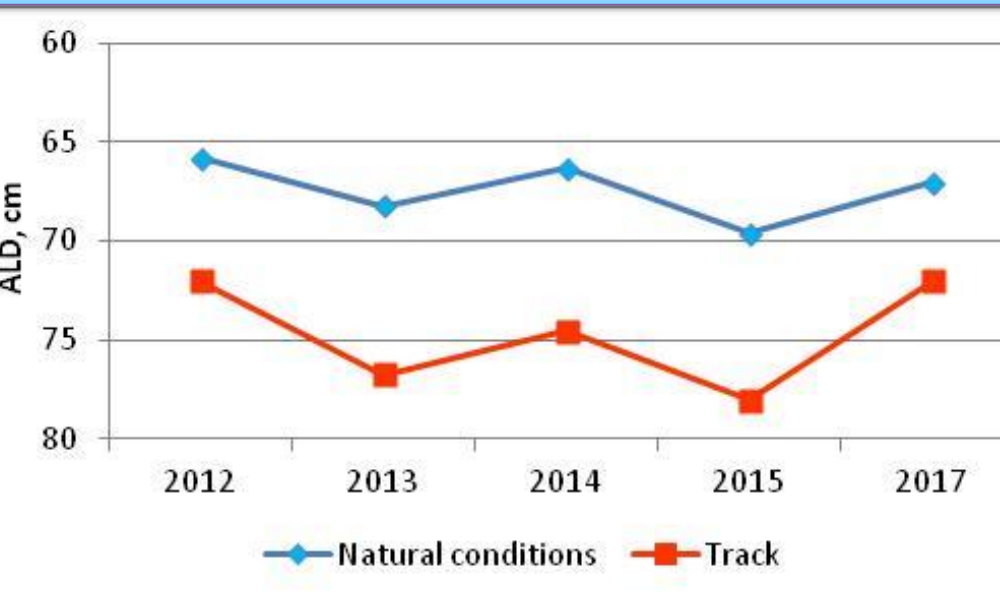


On the disturbed surface of the quarry the melting of the ice wedges continues. Portions of quarry where vegetation cover restores active layer depths tend to values characteristic of natural conditions.



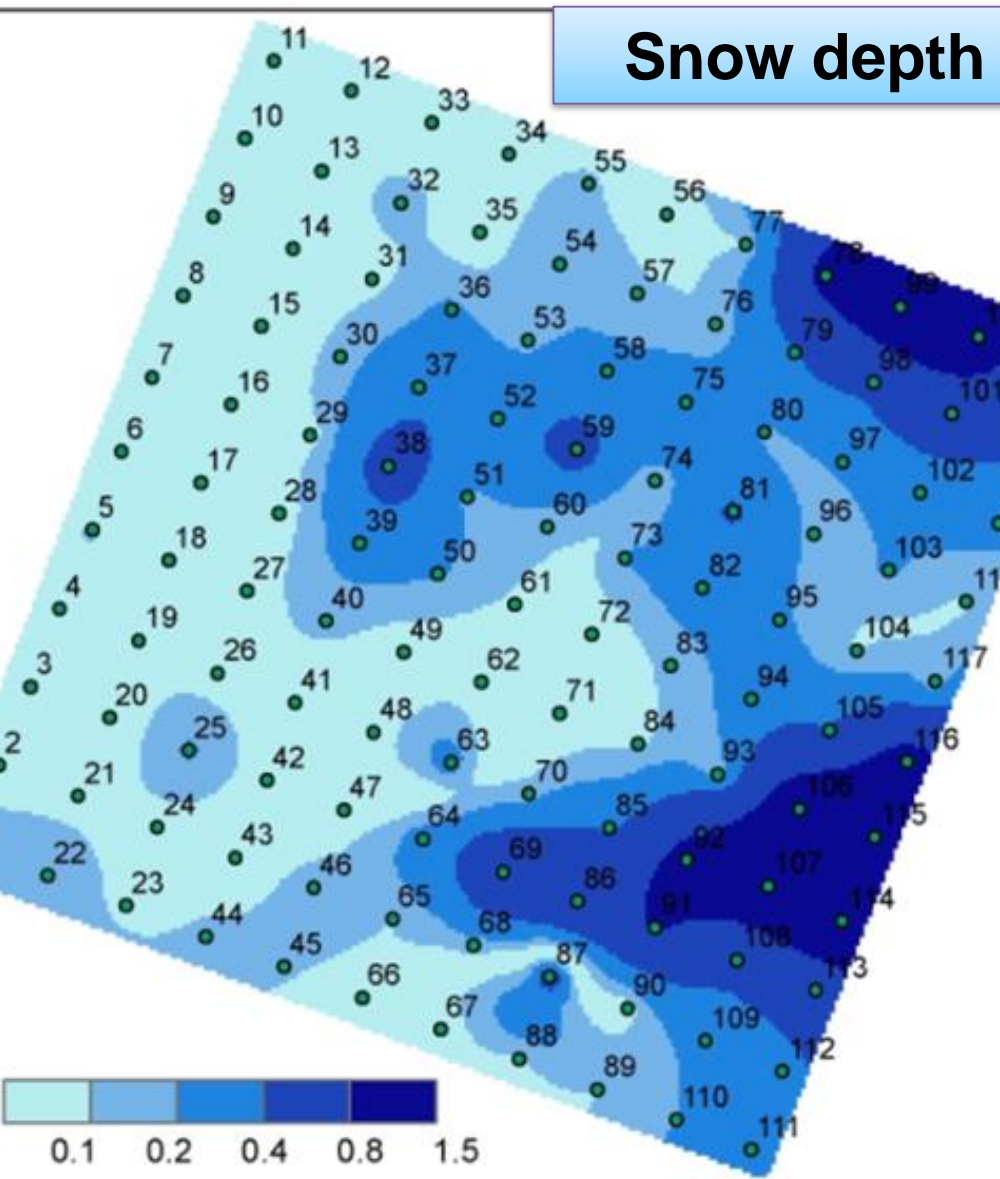
More moisture and more snow show maximum subsidence. Saline soils show subsidence 50% less than non-saline. Moisture content and snow cover provide moisture for active-layer ice lenses in winter, at the same time, determining slower freezing in winter and more intensive frost-heaving. More heaving in cold season, deeper subsidence in warm season.

ALD for surfaces across track



An increase of active layer depth within the areas with technogenic impact in comparison with natural conditions was revealed to be 10-20%.

Observations in Central Yamal also include measurements of seasonal subsidence (since 2007). Subsidence at Vaskiny Dachi CALM grid ranges between 0 and 70 mm depending on soil moisture, snow thickness and soil salinity.



Frost heave devices

