

Permafrost and its effect on landscape processes in the Arctic

- 1) What is permafrost and why is it important ?
- 2) How is the permafrost changing in the Arctic and in Svalbard ?
- 3) How does permafrost respond to climatic changes – examples of geohazards controlled by permafrost

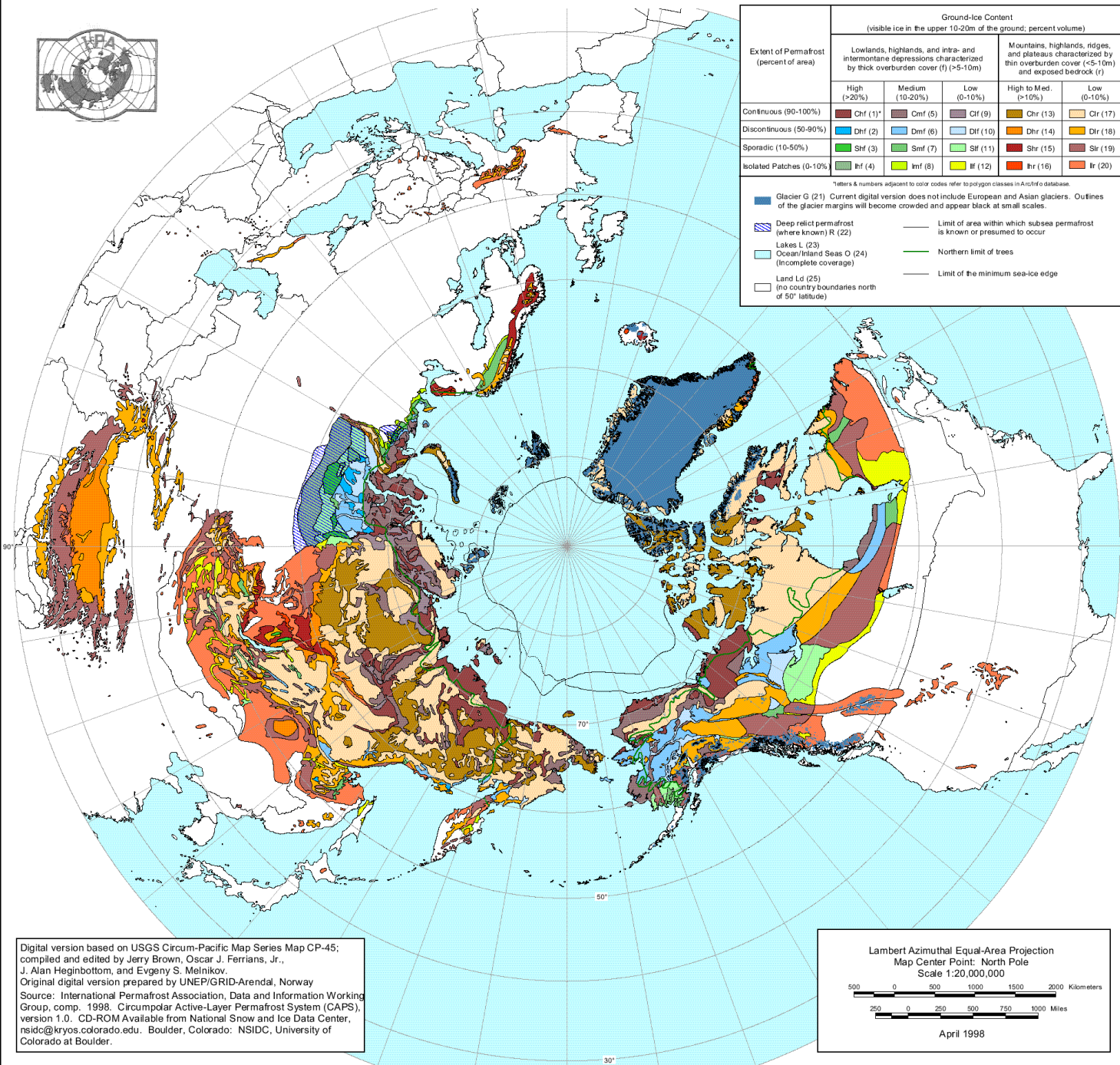


Hanne H. Christiansen, Dr. Prof.
Arctic Geology Department

President, International Permafrost Association



CIRCUM-ARCTIC MAP OF PERMAFROST AND GROUND-ICE CONDITIONS



What is permafrost ?

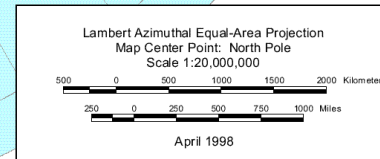
A negative thermal state in the ground

24 % of terrestrial parts of the Earth

**Asymmetrical distribution:
Climatic control**

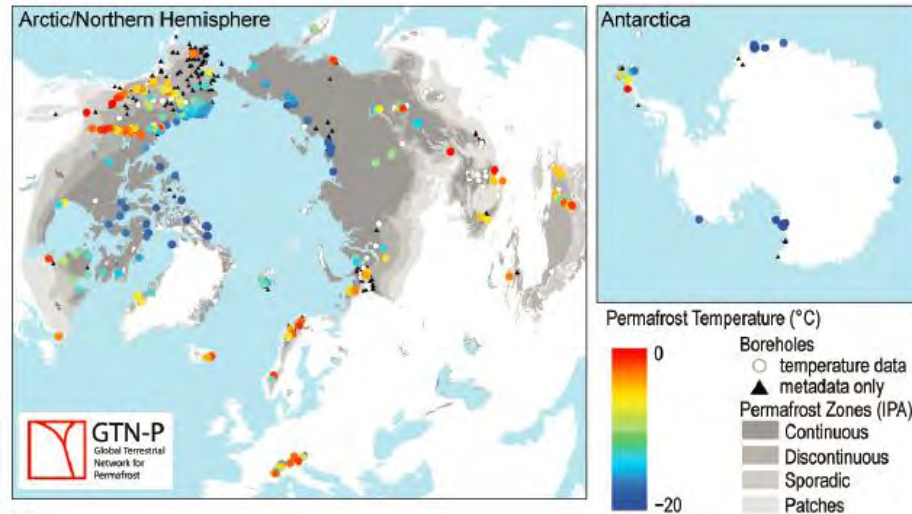


Digital version based on USGS Circum-Pacific Map Series Map CP-45; compiled and edited by Jerry Brown, Oscar J. Ferrians, Jr., J. Alan Heginbottom, and Evgeny S. Melnikov.
Original digital version prepared by UNEP/GRID-Arendal, Norway
Source: International Permafrost Association, Data and Information Working Group, comp. 1998. Circumpolar Active-Layer Permafrost System (CAPS), version 1.0. CD-ROM Available from National Snow and Ice Data Center, nsidc@kryos.colorado.edu. Boulder, Colorado: NSIDC, University of Colorado at Boulder.



The permafrost in Svalbard is the warmest this far north in the Arctic

(a)



(b)

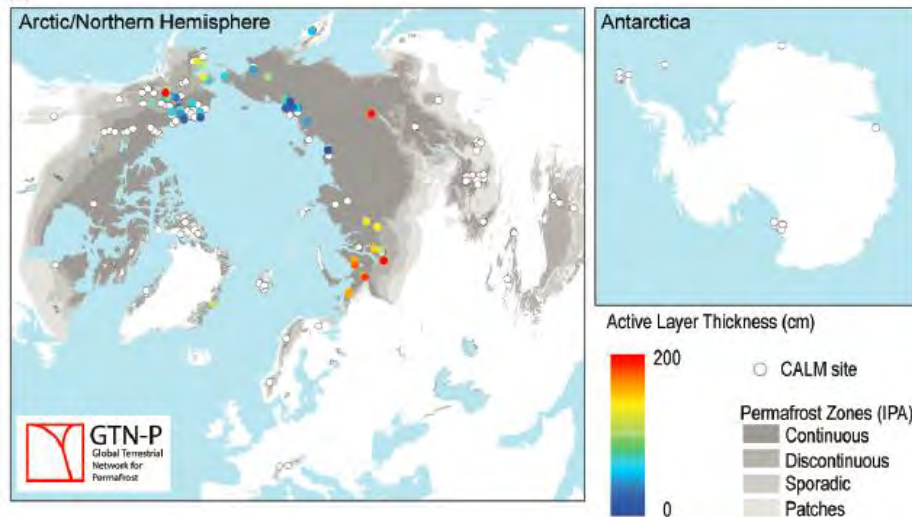


FIG. 2.10. (a) Permafrost monitoring boreholes showing permafrost temperature (°C) at zero annual amplitude depth in 2010–16 as reported by 314 sites. (b) Active layer thickness (cm) with data from 2016 as reported by 83 sites. (Source: Global Terrestrial Network for Permafrost.)

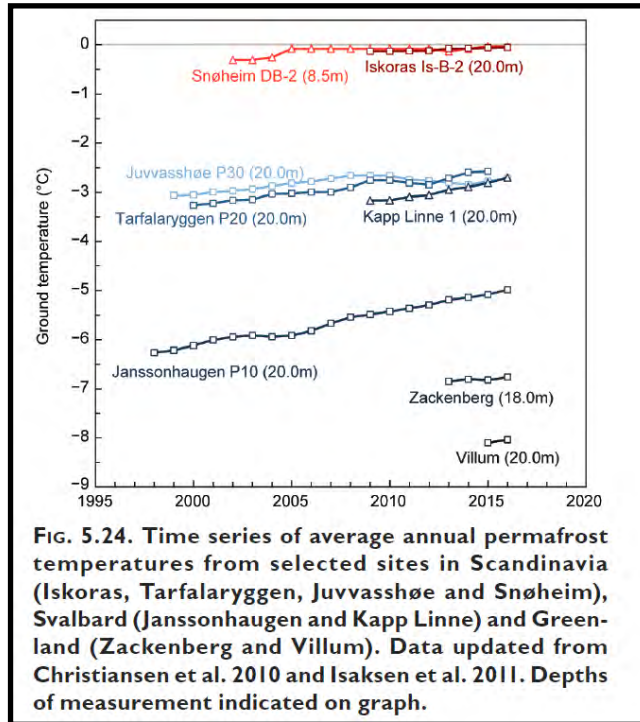
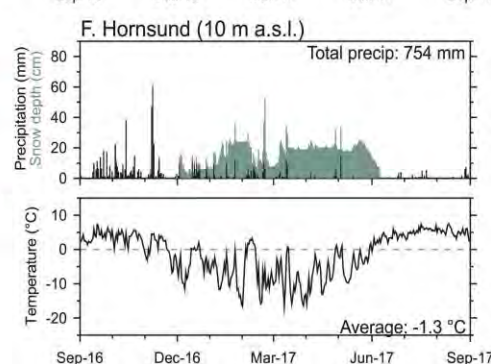
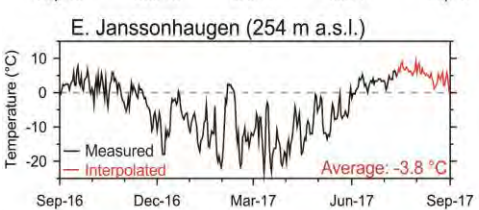
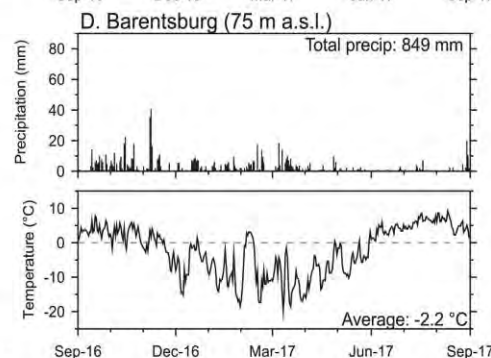
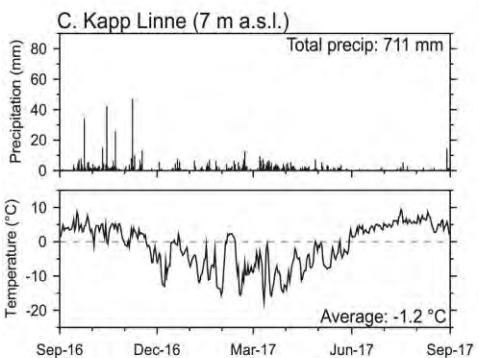
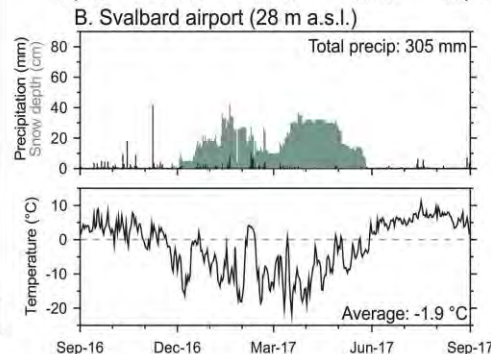
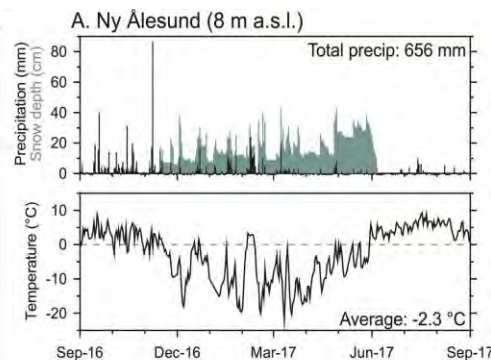
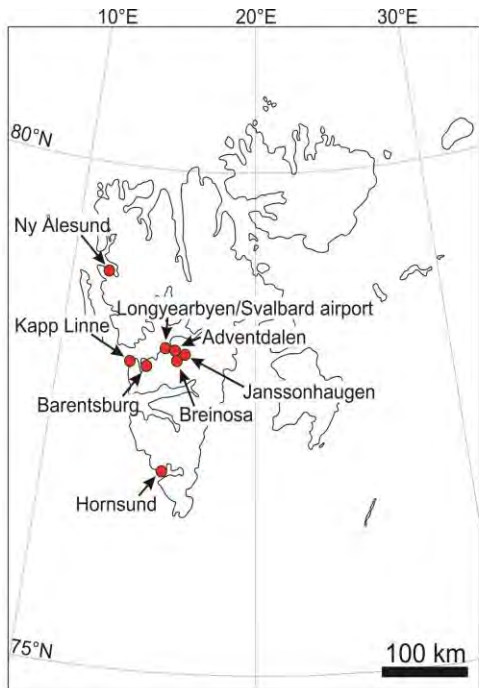


FIG. 5.24. Time series of average annual permafrost temperatures from selected sites in Scandinavia (Iskoras, Tarfalaryggen, Juvvasshøe and Snøheim), Svalbard (Janssonshaugen and Kapp Linne) and Greenland (Zackenberg and Villum). Data updated from Christiansen et al. 2010 and Isaksen et al. 2011. Depths of measurement indicated on graph.

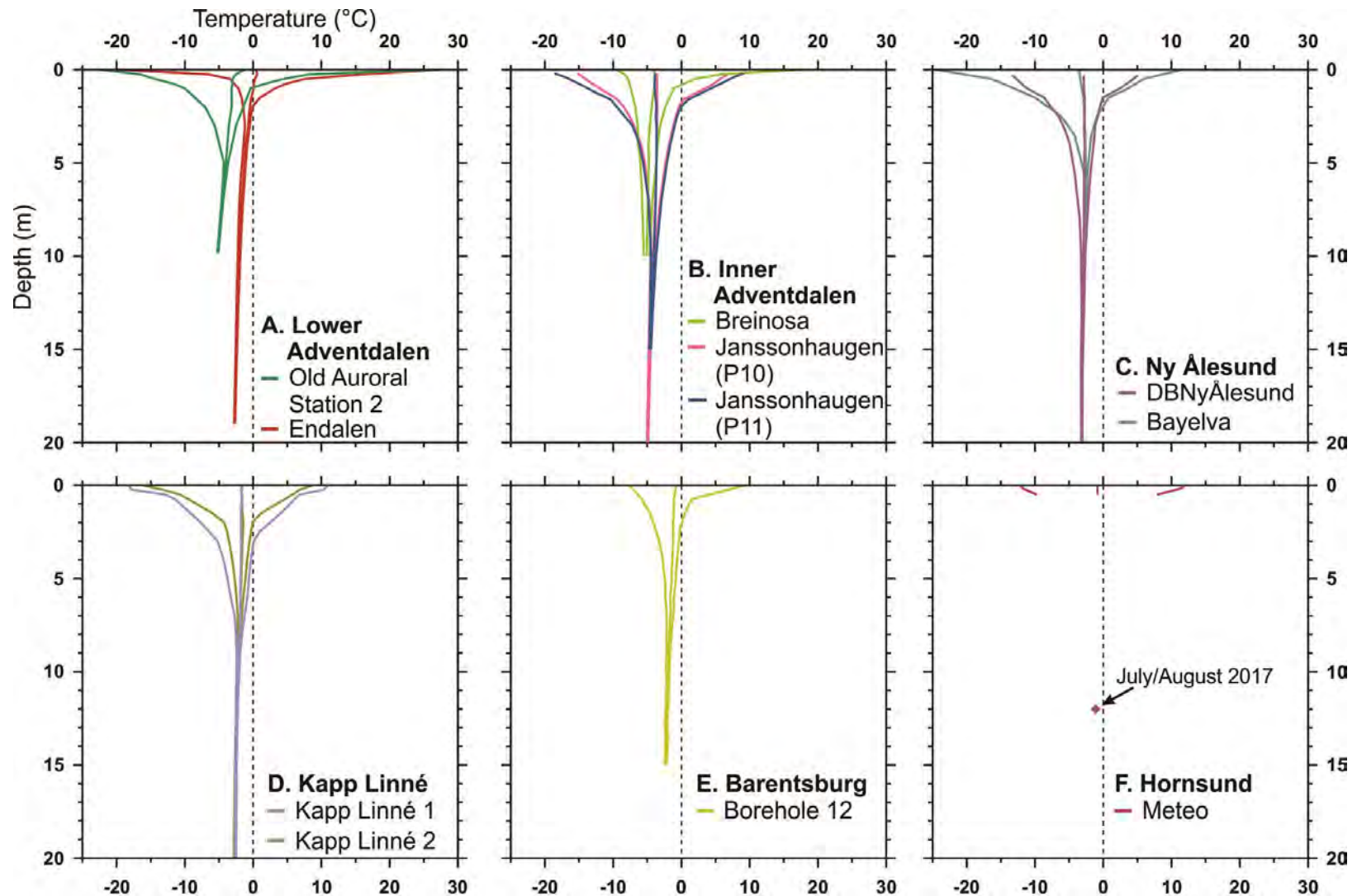
The permafrost
 Essential Climate Variables:
 Permafrost temperature
 and active layer thickness
 from (BAMS State of
 Climate, 2016).



Permafrost observation infrastructure in Svalbard from 1998: Norwegian-German-Russian-Italien-Polish SIOS collaboration 2016-2017

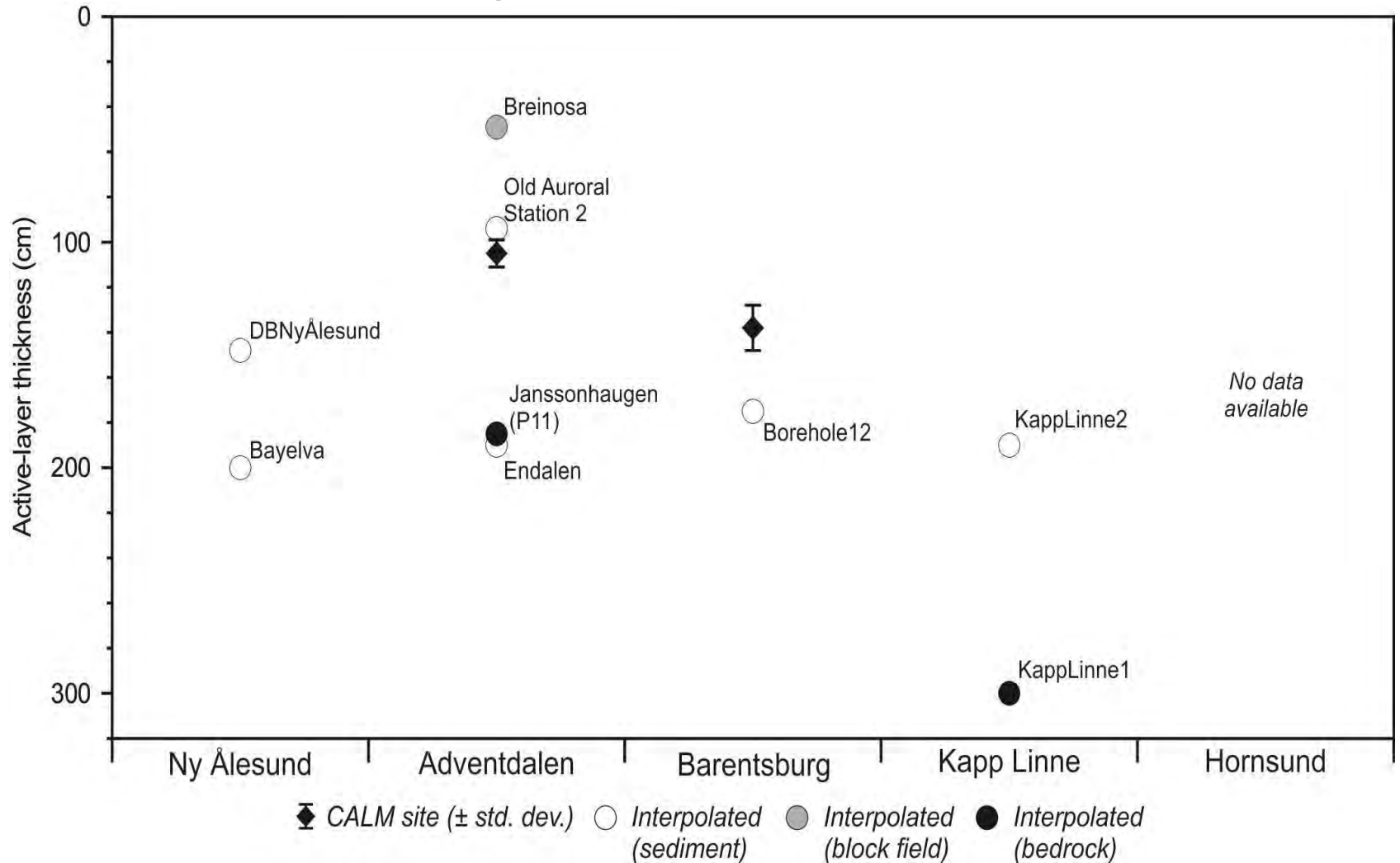


Permafrost temperatures in Svalbard



Ground thermal snapshot (minimum, mean, and maximum temperatures) as measured in the upper 10 to 20 m of the permafrost observation boreholes in Svalbard during the 2016/2017 hydrological year. Christiansen et al., 'Permafrost thermal snapshot and active-layer thickness in Svalbard 2016-2017', from State of Environmental Science in Svalbard. To be published January 2019.

Active layer thickness in Svalbard

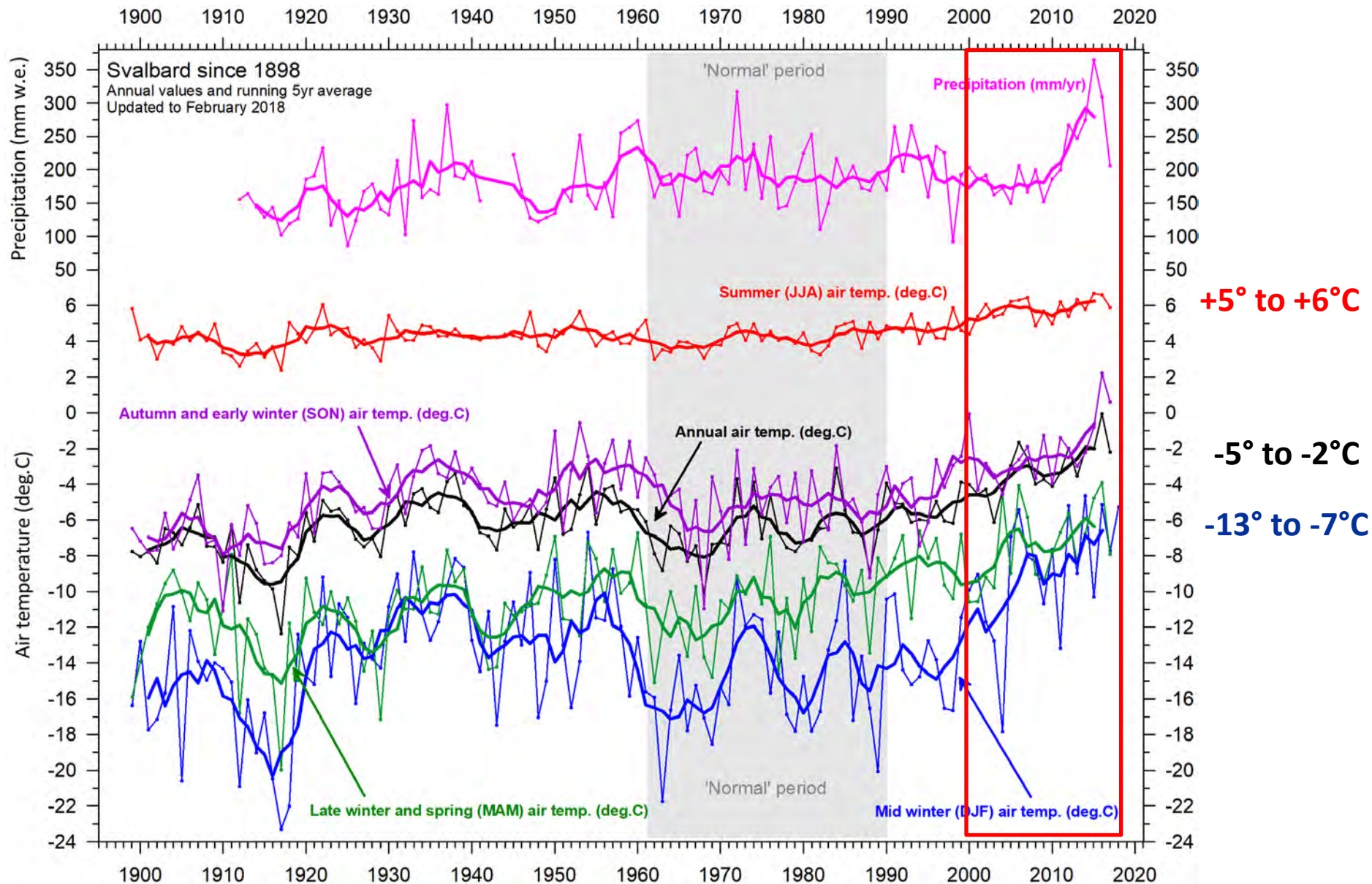


Active-layer thicknesses recorded at the end of August, 2017 from CALM grids and interpolated from the reported boreholes. The active-layer at the Bayelva site in Ny Ålesund was estimated using the Stephan equation. Note shading denotes substrate type. Christiansen et al., 'Permafrost thermal snapshot and active-layer thickness in Svalbard 2016-2017', from State of Environmental Science in Svalbard. To be published January 2019.

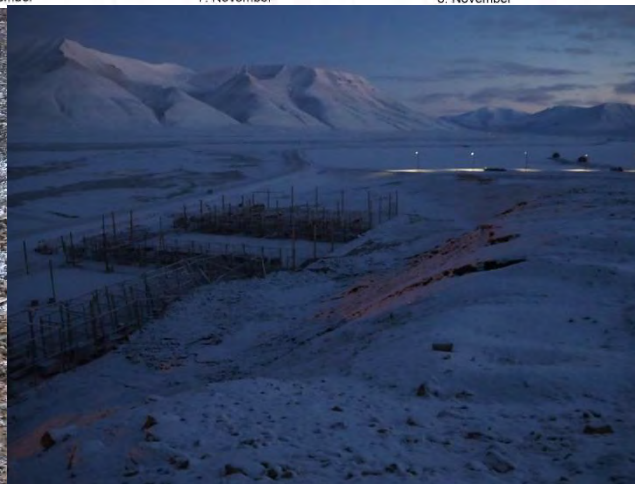
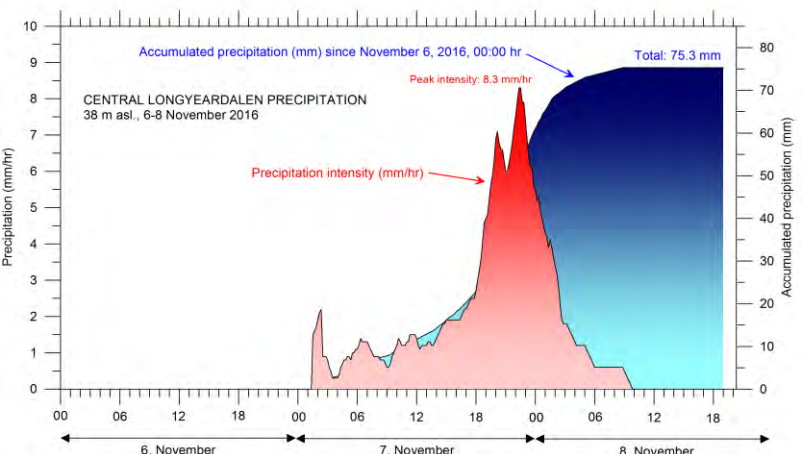
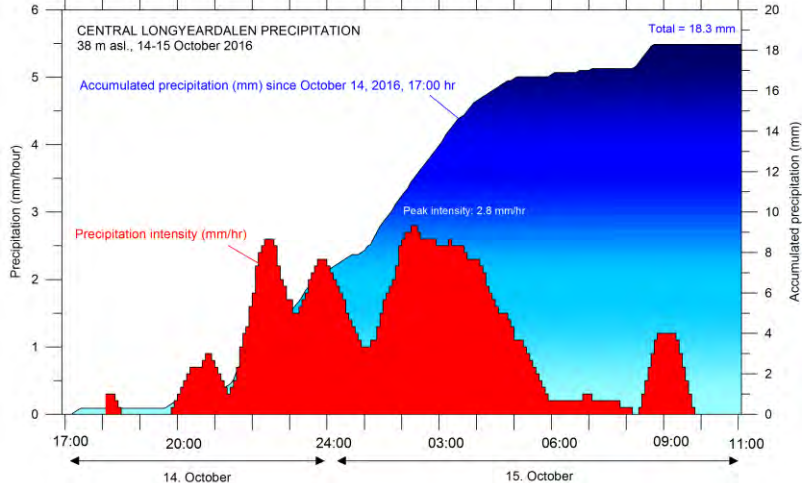
The present 2016-2017 landscape scale variability:
Permafrost MAGT at 10 m depth vary from -5.2°C to -1.9°C
Active layer thickness vary from 3.2 m to 1.1 m



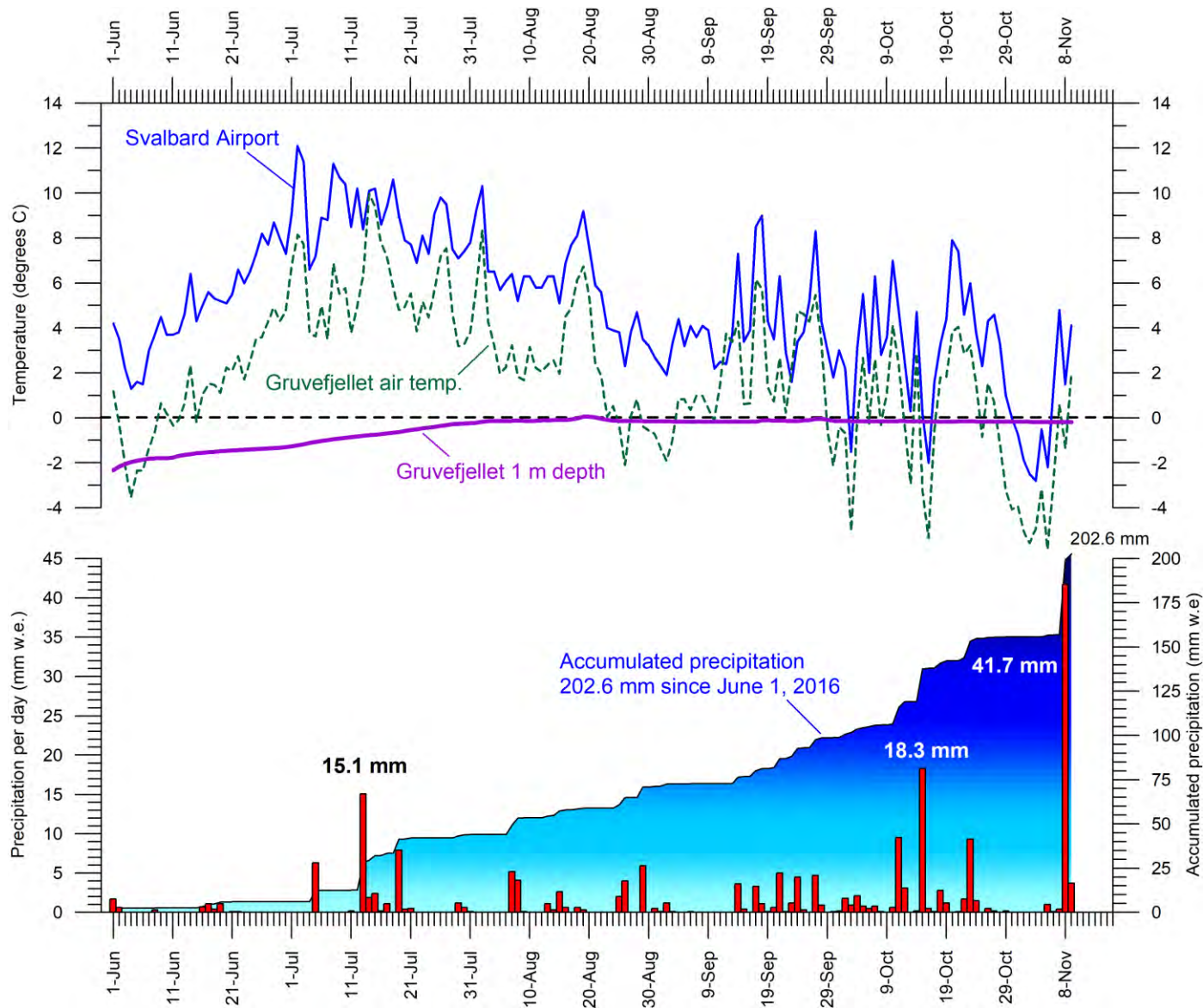
Meteorology in maritime Svalbard



The active layer in action autumn 2016



Warm and wet autumn 2016 – warmer shoulder season

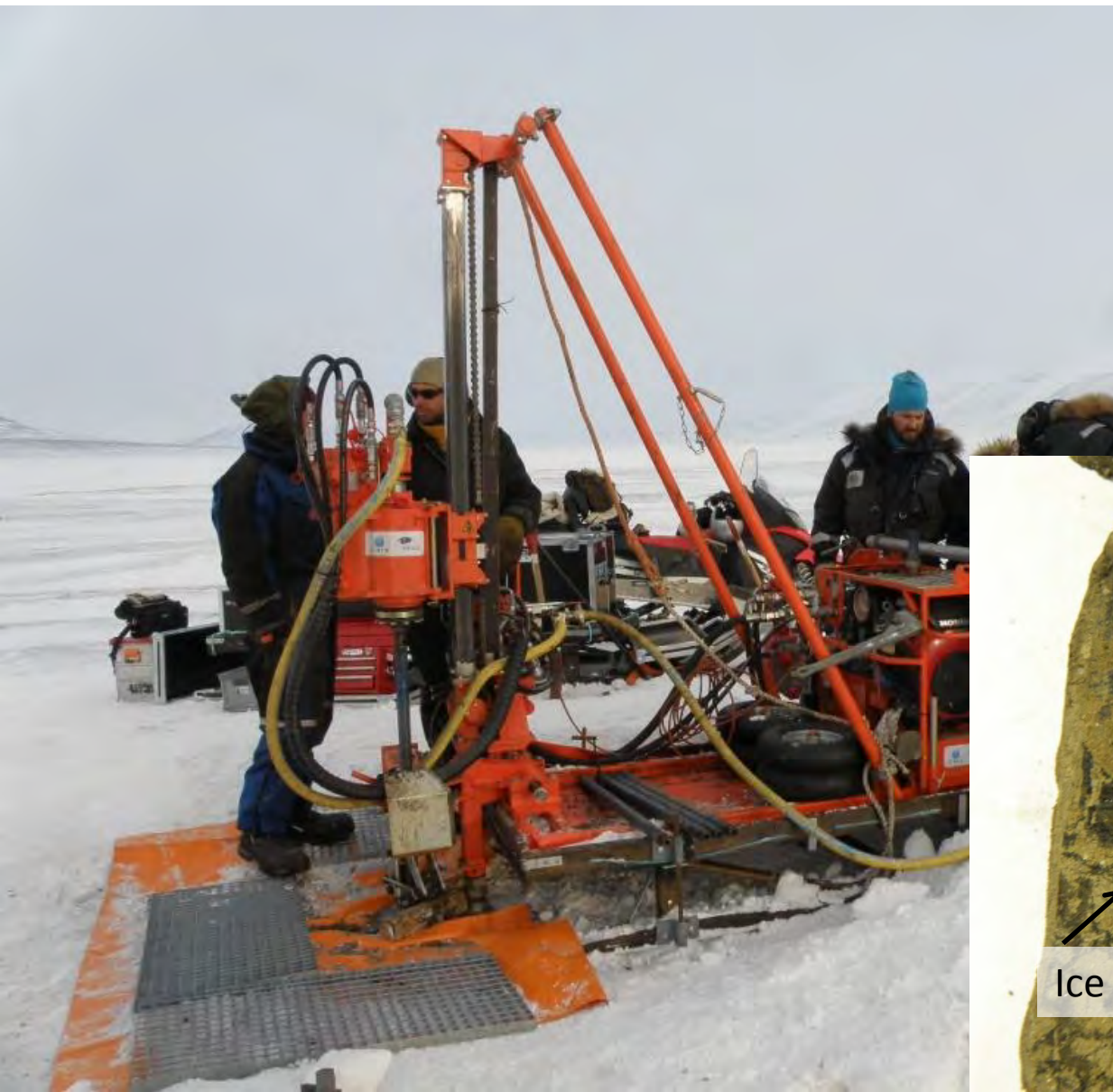


Future preparedness

**Online meteorological
and ground temp.
Observations**

**Just as for snow
observations.**

We core permafrost to know the ground ice content and reconstruct landscape development



Permafrost core with high ice content from Adventdalen



Ice lenses

Much ice close to the permafrost top – Ice-wedge polygons Adventdalen, Svalbard



Pingos in Reindalen – water moves into the permafrost



**Climate change and management
can influence infrastructure
on permafrost**

