Climate and environmental changes during the last 4000 years on Barentsøya (E-Svalbard)

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During the SEES.nl expedition in August 2015, a multi-disciplinary team of scientists had the opportunity to collect a range of samples and study a.o. climate, flora, fauna, and human behaviour in E-Svalbard. We present here the first results from the lake cores we took on Barentsøya, in combination with recent *Salix polaris* leaf material collected during landings, which allows for plant physiological climate reconstructions on fossil leaf material.

In W-Spitsbergen several lake cores have been studied before (* Birks et al., 2004). On Edgeøya and Barentsøya, no lake sediments have been investigated until now. Several proxies will be used for palaeo-environmental and palaeo-climatological reconstructions, providing a unique record of climate change over the last 4000 years. Chronology is based on ^{210}Pb dating, AMS-^{14}C dating on *Salix* leaf fragments in combination with tephrochronology.

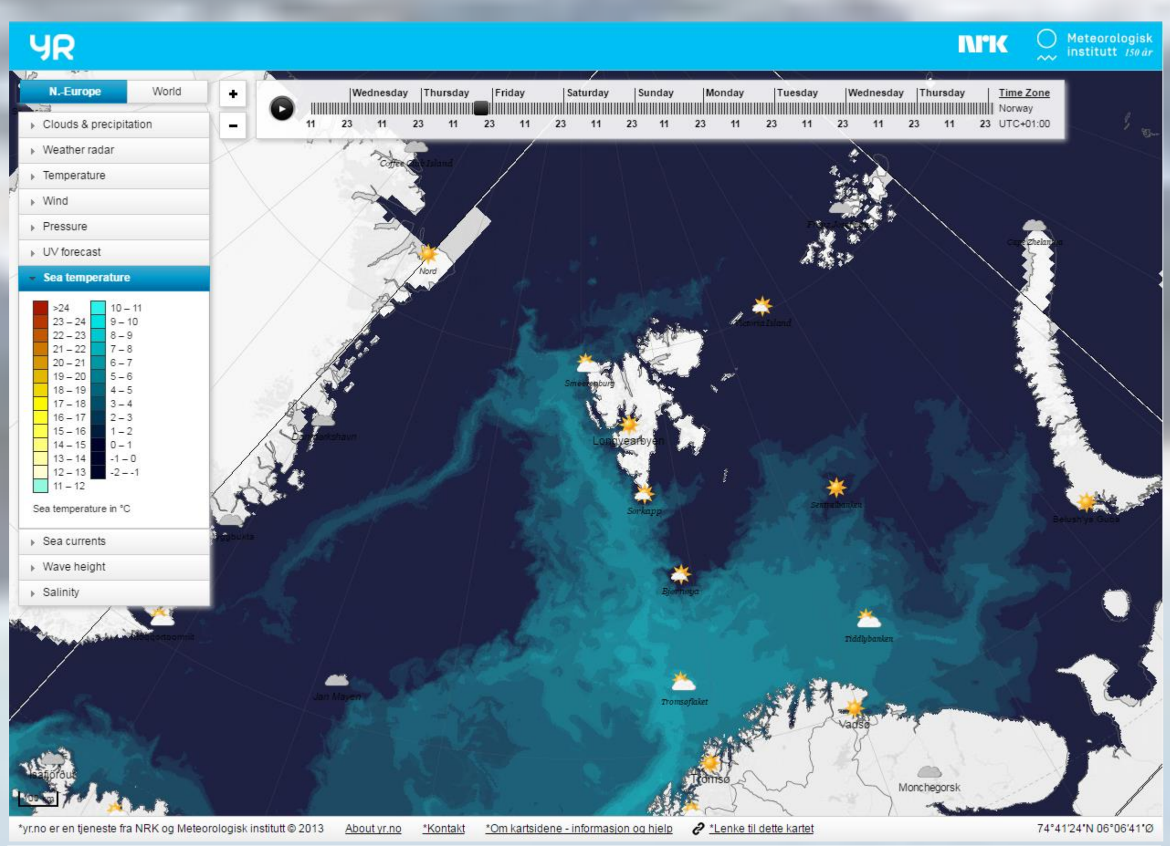


Fig. 1: The Spitsbergen Current forms the Polar limb of the N-Atlantic circulation. The relative warm water results in a strong W-E temperature gradient over Svalbard, with average temperature differences over 5°C between Hornsund and N-Edgeøya (A & B in Fig. 2 & 3). This area is particularly vulnerable for past and future climate and environmental change.

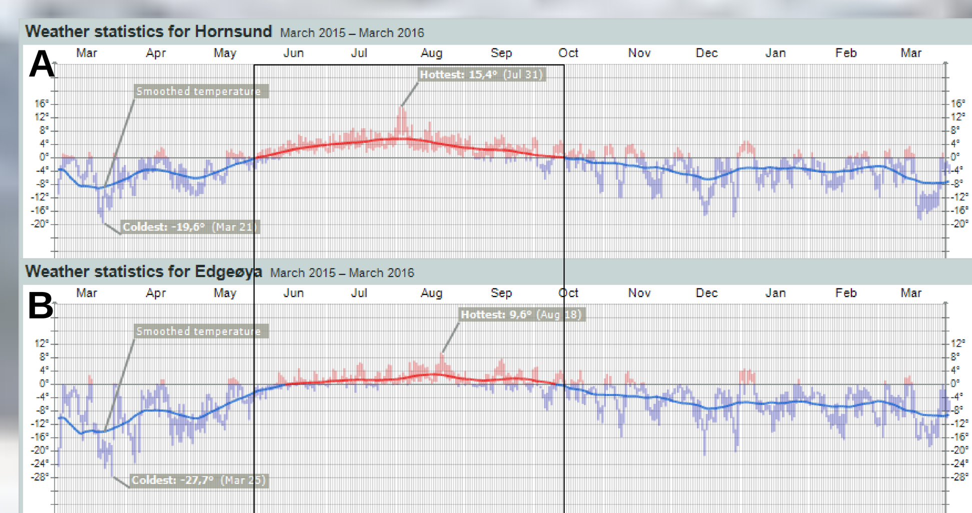


Fig. 2: Temperature records over March 2015 - March 2016 from the meteorological stations Hornsund (A) and N-Edgeøya (B). Note that not only the average values, but also T_{max} and T_{min} differ with several degrees, leading to a considerably shorter growing season on Edgeøya. *Source: www.yr.no/place/Norway/Svalbard/*

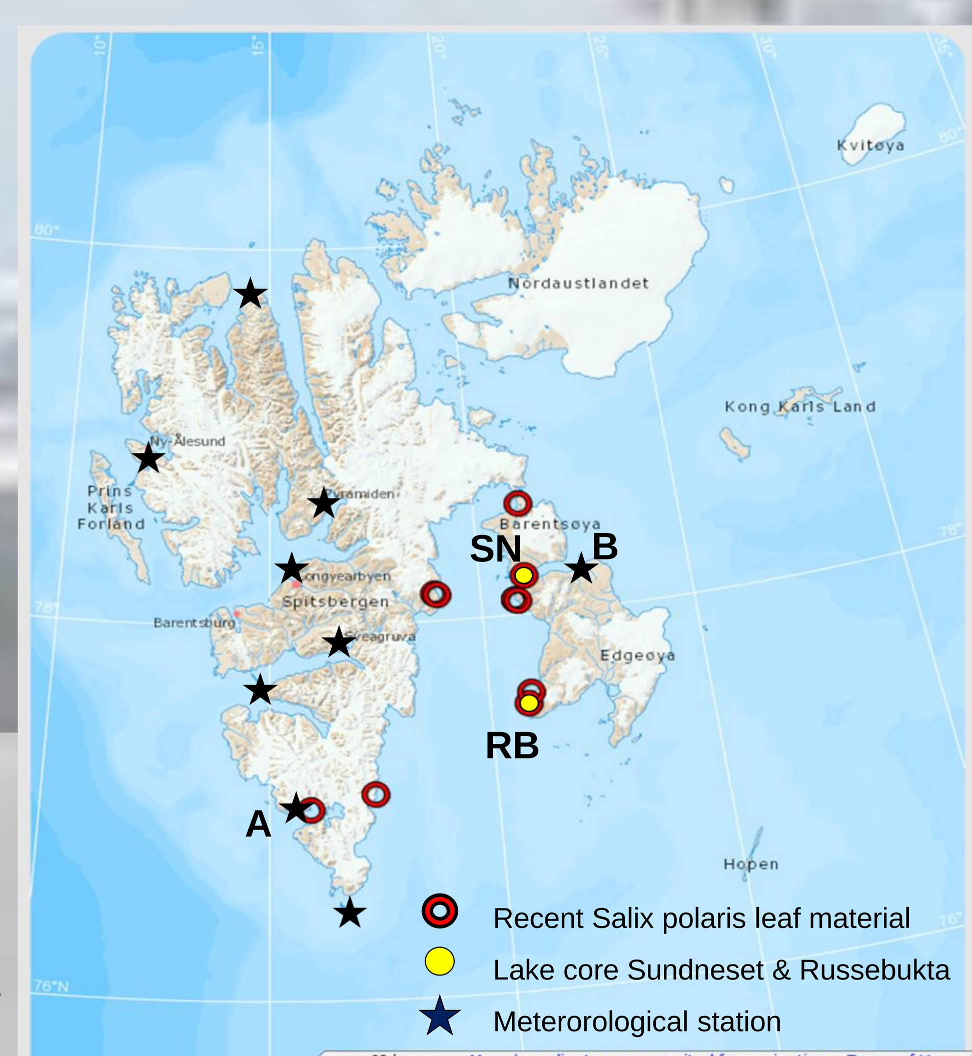


Fig. 3: the Svalbard Archipelago with meteorological stations, lake core locations, and landing spots of the SEES expedition where recent *Salix polaris* leaf material has been collected. The recent leaf material, in combination with the meteorological data will be used to build a calibration dataset for growing season changes.

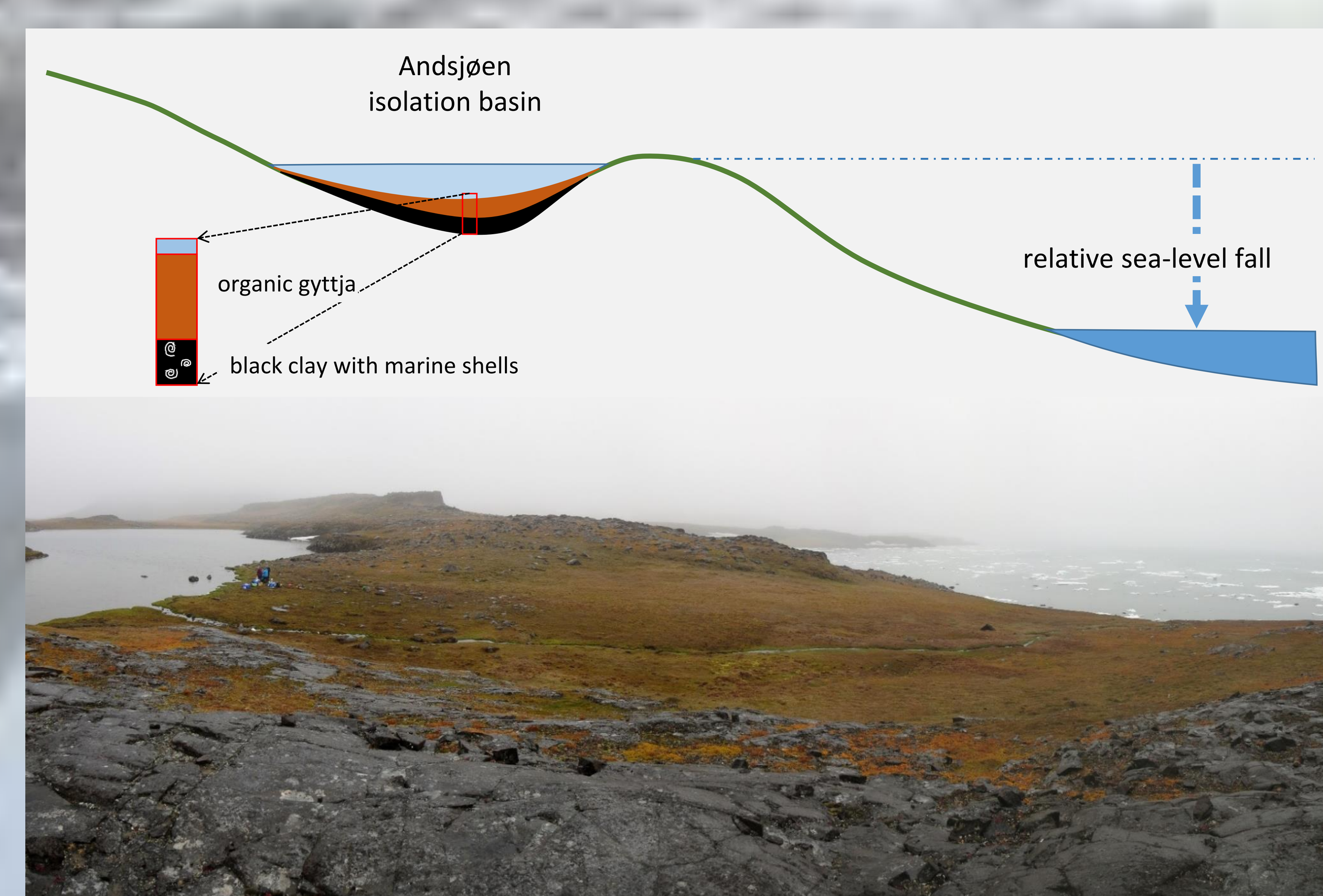
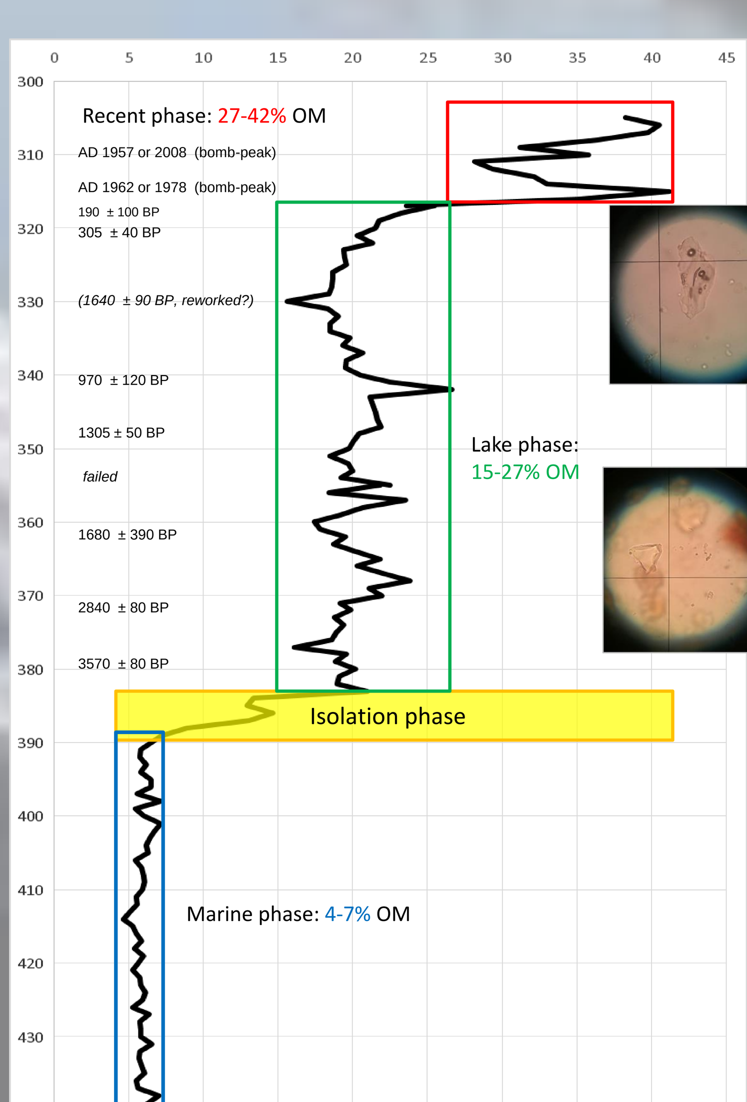


Fig. 4: Lake Andsjøen at Sundneset (S-Barentsøya) at +15m asl has been formed in intrusive dolorites and became disconnected from the sea due to isostatic uplift since deglaciation. Based on a relative sea-level reconstruction using ^{14}C-dated driftwood in coastal terraces in this region (* Bondevik et al., 1995), we estimated that the isolation took place 2500-3000 yrs ago.



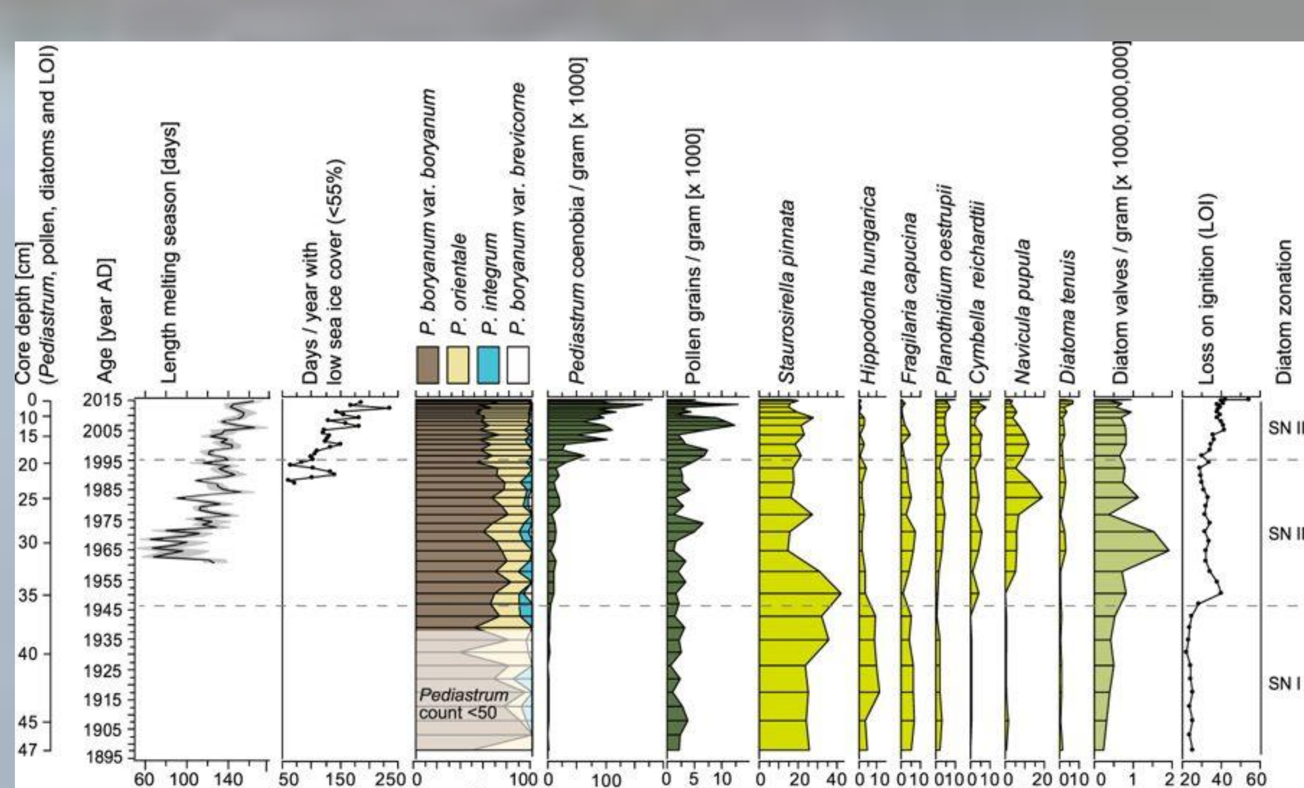


Fig. 6: The top part of the core from Sundneset, which has been ^{210}Pb dated, shows an unprecedented increase in organic matter, mainly produced by Pediastrum algae. This is supposedly related to a strong decrease in seasonal sea ice cover linked to recent climate change (* Woelders et al., 2018).

Fig. 5: Loss on ignition record from the core at Sundneset. The core had been taken in the deepest part of the lake with a water depth of 300 cm. The upper part of the organic lake deposits shows higher values of organic matter, related to an increase of *Pediastrum* algae as evidenced by the first palynological analyses. Abundant *Salix polaris* leaf material allowed for ^{14}C dating the record and estimation of the isolation phase to ca. 3500 BP. Lower values of LOI point to lower productivity rates during Littla Ice Age. The presence of tephra in the LOI residues opens up the potential to further tephochronological research.

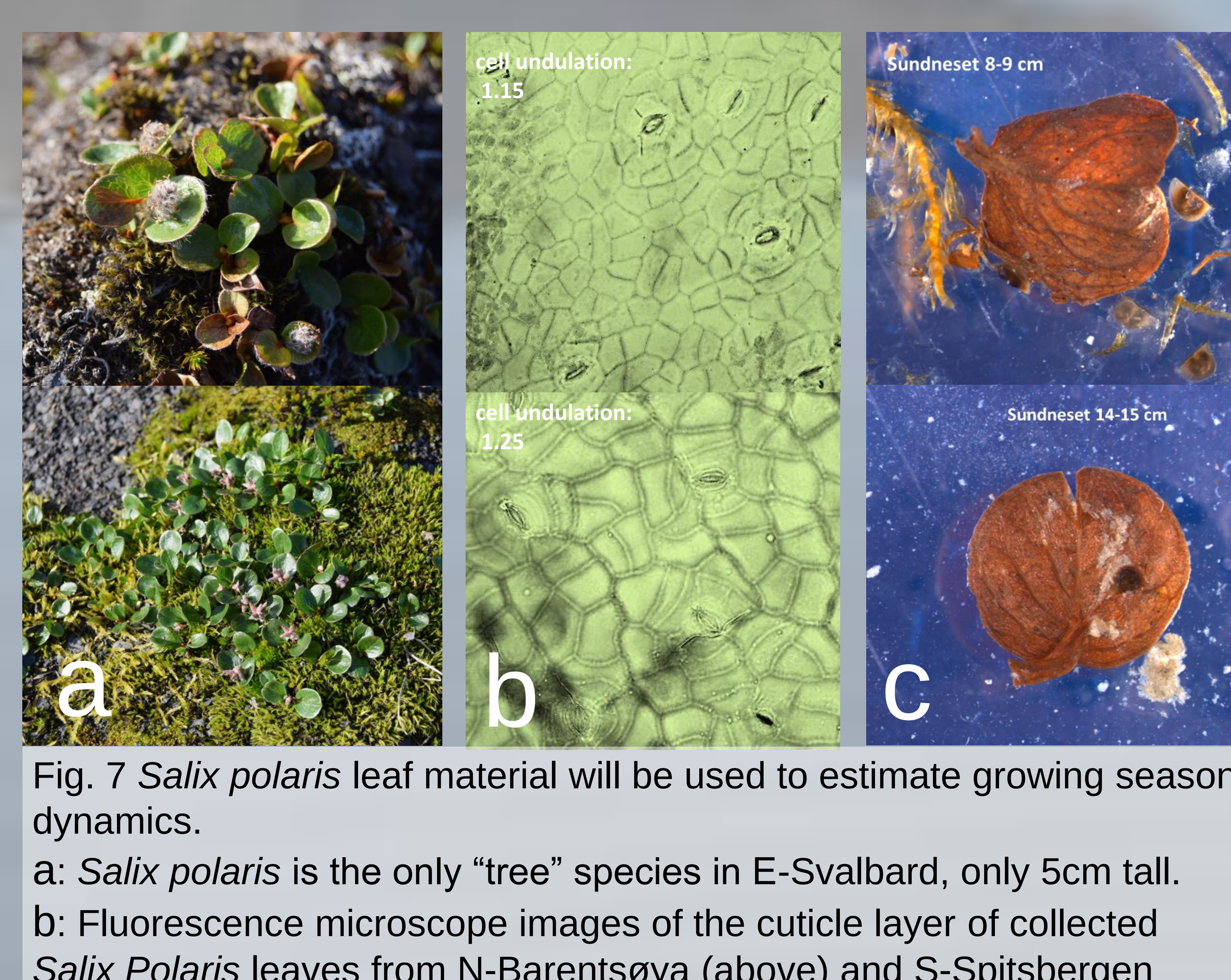


Fig. 7 *Salix polaris* leaf material will be used to estimate growing season dynamics.
a: *Salix polaris* is the only "tree" species in E-Svalbard, only 5cm tall.
b: Fluorescence microscope images of the cuticle layer of collected *Salix Polaris* leaves from N-Barentsøya (above) and S-Spitsbergen (below), showing a clear difference in cell undulation, most likely linked to a difference in growing season.
c: fossil leaf material, which is abundantly present throughout the lake sediment core from Sundneset, can be used for both dating and growing season reconstructions.

* Birks *et al*. 2004: Recent environmental change and atmospheric contamination on Svalbard as recorded in lake sediments – synthesis and general conclusions. *Journal of Paleolimnology 31*, 531-546.
* Bondevik *et al*. 1995: Postglacial sea-level history of Edgeøya and Barentsøya, eastern Svalbard. *Polar Research 14-2*, 153-180.
* Woelders et al. 2018: Recent climate warming drives ecological change in a remote high-Arctic lake. *Scientific Reports 8-6858*, https://www.nature.com/articles/s41598-018-25148-7