Distribution patterns of vegetation in Midtre Lovénbreen foreland, Spitsbergen (79°N)

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Introduction

Climate change accelerates the rate of glacier retreat and expands the foreland. In the newly exposed land, black crusts and pioneering plants are colonized first, and the plant composition changes to mature vegetation types. The glacier forelands which were exposed in different times represent different ages of the soil. Therefore, forelands of receding glaciers are good field sites to study soil development processes and vegetation succession through a space for time substitution approach. Thus, we were aiming for revealing the plant distribution pattern along the chronosequence from the recent glacier front (the present) to the end of place indicating the maximum glacial advance (historical glacial front). Furthermore, we tried to understand the relationship between plant species and local environmental factors such as microtopography, microclimate, etc.

Previous studies in Midtre Lovenbreen

Supraglacial ecosystem

- Cryoconite
  - Microbes (Anesio *et al.*, 2010)
  - CO_2 fluxes (Hodson *et al.*, 2007)
- Retreat of glacier
- Mass balance of glacier (NPI measurement since 1967)
- Energy balance of the surface of glacier (Arnold *et al.*, 2006)

Midtre Lovenbreen

Subglacial ecosystem (ice-bed interface)

- Glacier-bed characteristics by radar (King *et al.*, 2008)

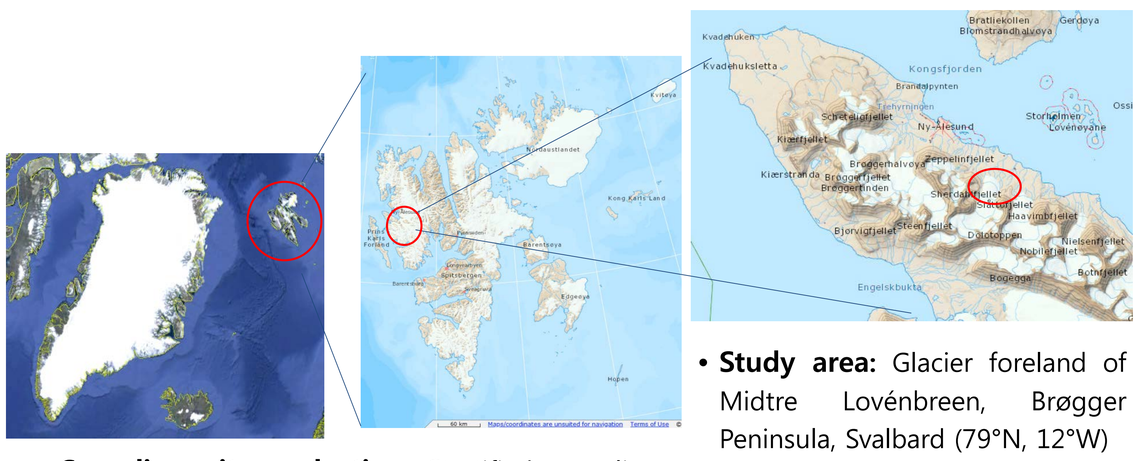
Proglacial ecosystem (glacier foreland)

- Glacier river system-nitrogen (Hodson *et al.*, 2010)
- Plant succession: Laffly/Brossard/ Nilsen
- Plant and soil succession (Hodkinson *et al.*, 2003)
- Characteristics of SOC by pyrolysis GC-MS (White *et al.*, 2007)
- Microbial community structure (Schuette *et al.*, 2009, 2010)
- Weathering of rocks by pioneer microbes (Borin *et al.*, 2010)

Research gaps on successional studies:

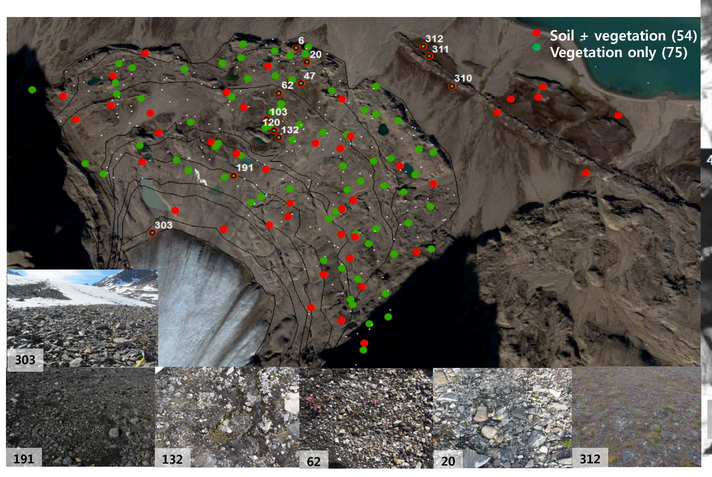
- Most influencing factors: glacier retreat periods, ignored disturbances by melting water runoff
- Linear transect studies: all areas containing have not been covered

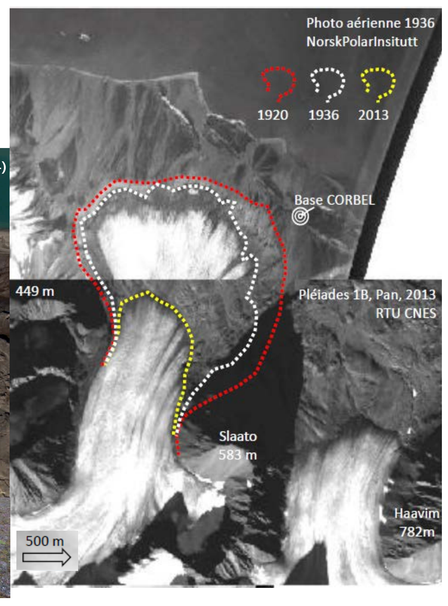
Study area & methods



- **Study area:** Glacier foreland of Midtre Lovénbreen, Brøgger Peninsula, Svalbard (79°N, 12°W)

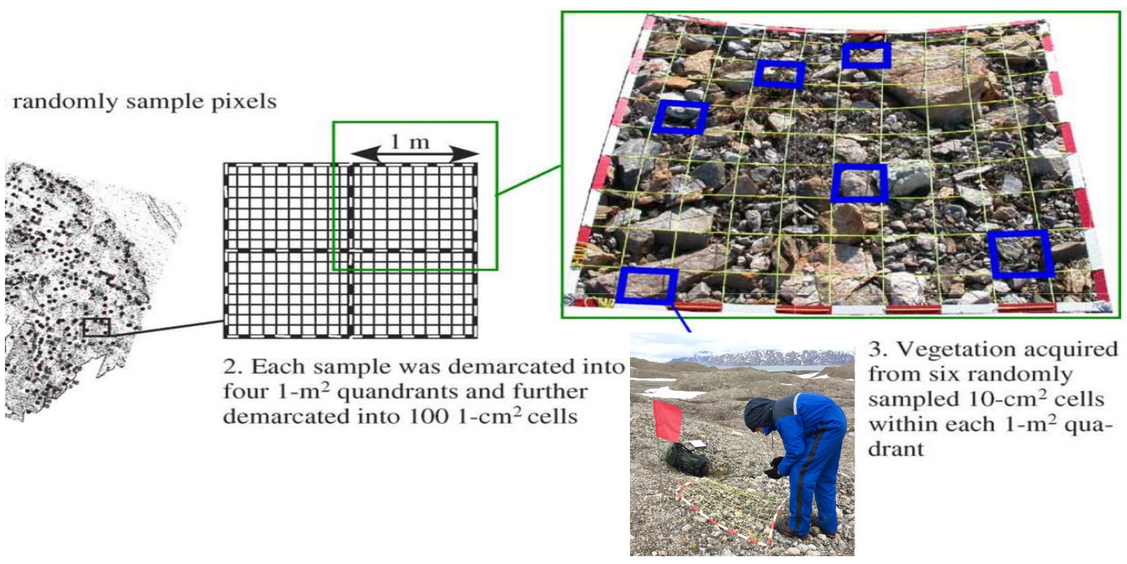
- **Sampling sites selection**: Stratified sampling with a consideration of X, Y coordinates, runoff, age, slope, and wind from 300 sites of Moreau (2005)





Methods

- We chose 102 study plots from 300 plots by previous research conducted in 2003 through the stratified sampling method and recorded the frequency of each plant species and the coverage of vascular plants, lichen, moss, and black crust.



- Raw plants data was divided into qualitative data and quantitative data.
- Quantitative data is black crust, Lichens, Bryophytes, Vas_pla (Vascular plants), Sal_pol (*Salix polaris*), Sax_opp (*Saxifraga oppositifolia*). For correspondence analysis (CA), we changed quantitative data to qualitative data to understand the grouping patterns of plants by categorizing "1" for 0~25%, "2" for 25~50%, "3" for 50~75%, and "4" for 75~100% of coverage.
- In the CA, we removed some outliers which were too far from the others in the plots.

Results & Discussion

Fig. 1a **Symmetric column plot (axes F1 and F2: 18.61 %)**

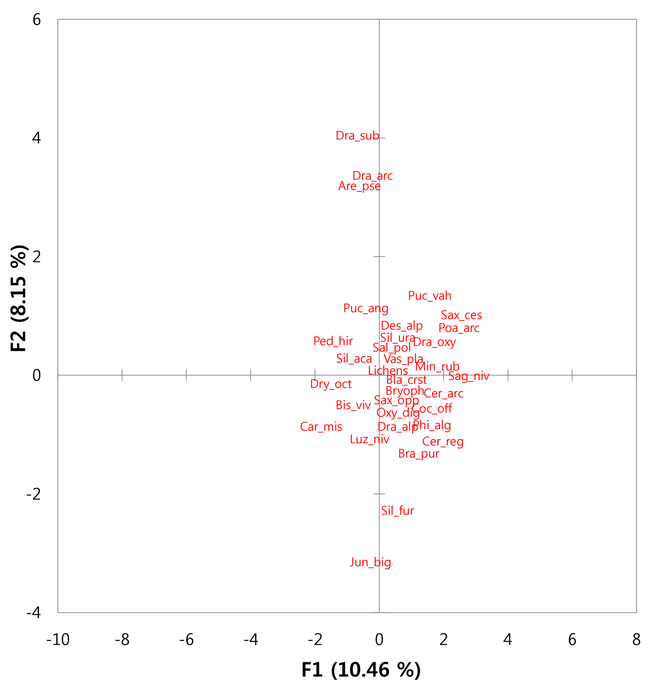


Fig. 1b **Symmetric column plot (axes F1 and F3: 17.72 %)**

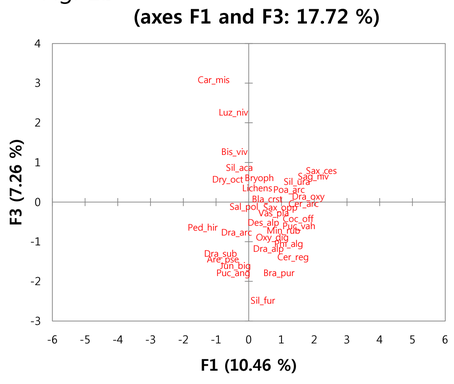
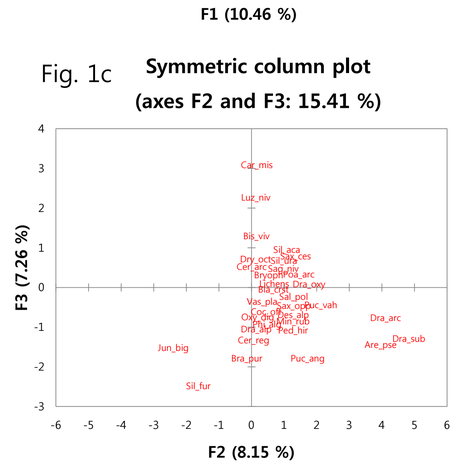


Fig. 1c **Symmetric column plot (axes F2 and F3: 15.41 %)**



- The correspondence analysis showed that the plants in the mature stage such as *Carex* and *Luzula* were positioned in the top of F3 (Fig. 1b, 1c).
- The species which were far from the center of F2 were not simultaneously observed with other species in the study plot.
- We could not find a distinct plant distribution pattern of plant colonization along the chronosequence in the glacier foreland. This finding was different from the results from Moreau et al. (2009). This may be resulted from the late sprouting of plants due to the late snow melting in 2014.

Further study

We are currently acquiring environmental data such as 1) snow free days from FORMOSAT, 2) slope, altitude, orientation, radiation, etc. from DEM and 3) the age of surface and runoff activity from aerial photographs. Although stages of plant colonization would be changed as soil developed, other environmental factors could have an impact on the vegetation distribution patterns too. Therefore, we are aiming to understand different plant community distribution patterns and trends that occur on this relatively new environment with a link of environmental parameters through detail analysis with environmental variables.

Acknowledgements

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