High potential for future tipping point in Arctic land surface conditions

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Geomorphic sensitivity of the Arctic region: geohazards and infrastructure (INFRAHAZARD)

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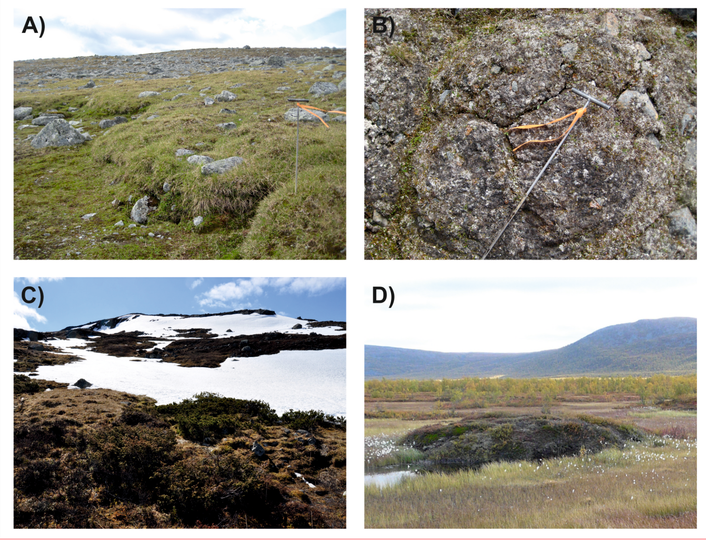
Periglacial realm is a major part of the cryosphere, covering ~ 25 % of Earth's land surface. It consitutes of active cryogenic land surface processes (**LSP**), for example: **A)** solifluction, **B)** cryoturbation, **C)** nivation (local snow accumulation site), and **D)** permafrost mounding



- **Topoclimatic surfaces at 50 m resolution were created based on ~ 950 weather stations and environmental layers over Fennoscandia (Fig1; Aalto et al., 2017a)**
- **These data enabled the first fine-scale assessment of the current and future periglacial realm**

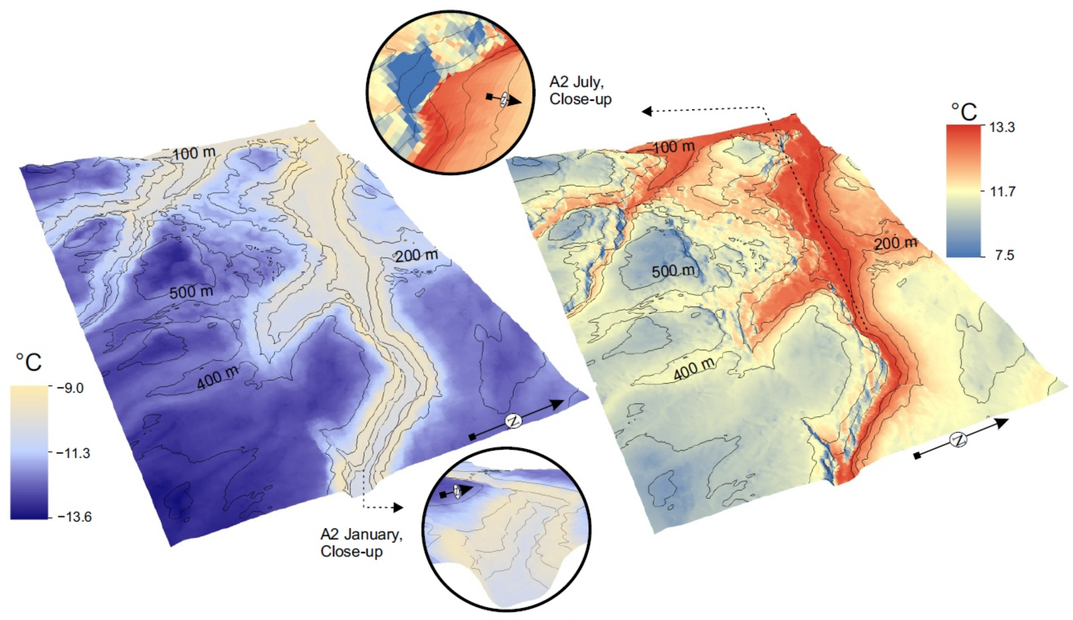


Figure 1. 3-D visualizations of the modelled January and July average temperatures (1981-2010) from the northernmost Fennoscandia.

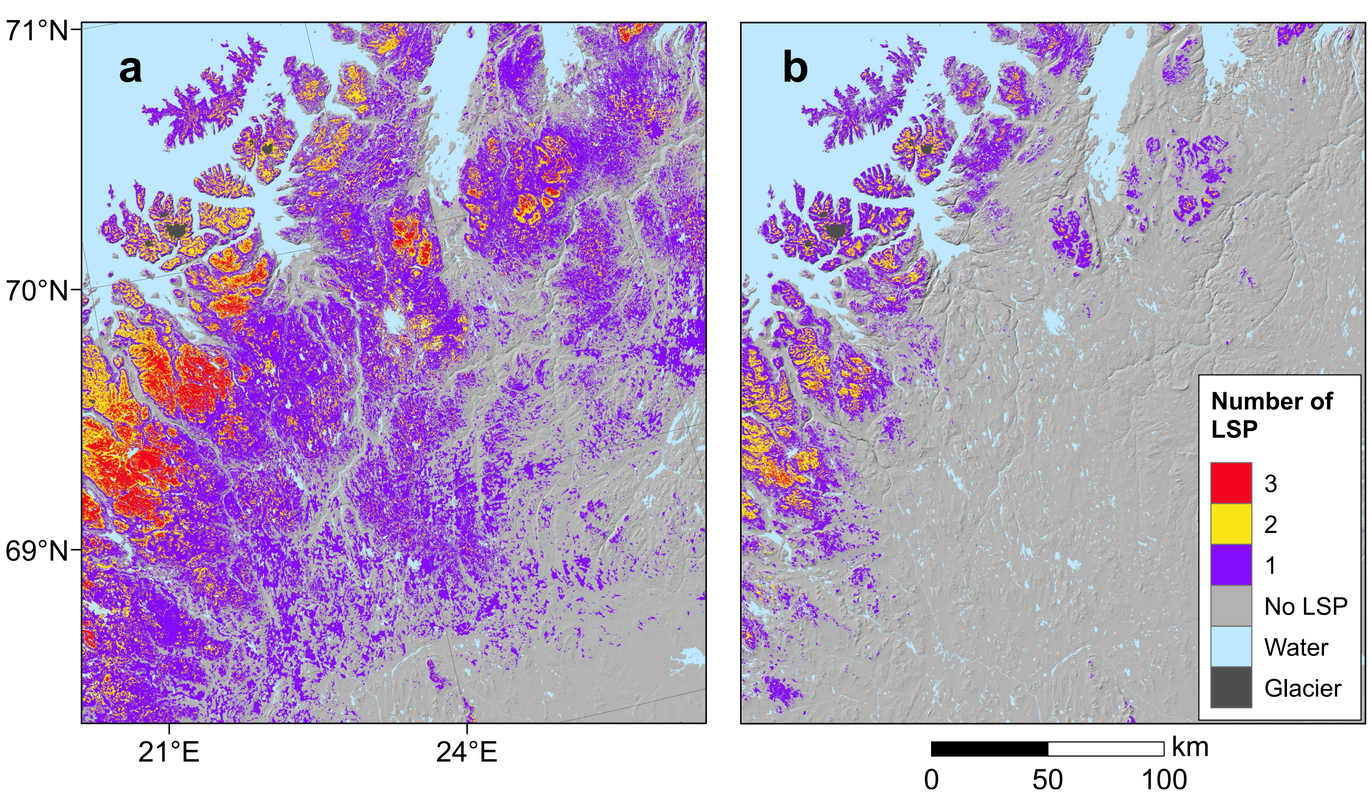


Figure 2. The suitable overlapping conditions for the cryogenic land surface processes (LSP) under **a)** baseline and **b)** future climate (2040-2069 RCP4.5).

- **Models predicted a near-complete decay of periglacial climate from Northern Europe and a significant elevational shift of cryogenic ground processes (Fig 2; Aalto et al., 2017b)**
- **These impacts are projected to be especially severe in high-latitude interiors**

- **Arctic vegetation patterns are strongly constrained by climate and land surface processes (Fig 3; Riihimäki et al., 2017)**
- **The loss of LSP due to climate change can cause an accelerated re-distribution of Arctic vegetation**
- **Cryogenic component is needed in future ecosystem and land surface models (Niittynen and Luoto, 2017)**

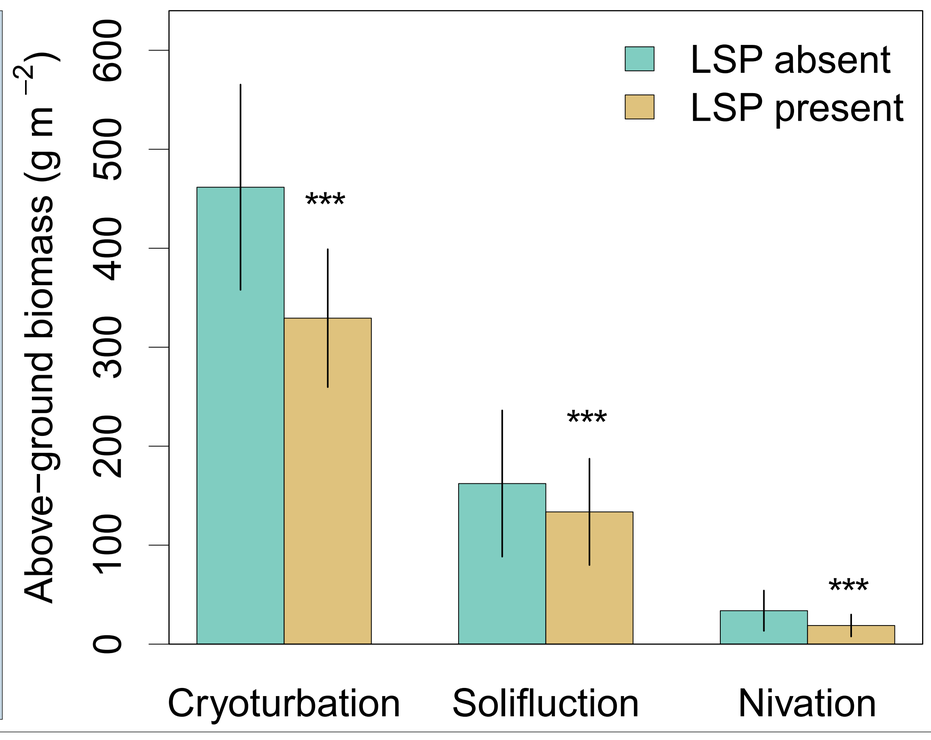


Figure 3. The effect of cryogenic land surface processes (LSP) on above-ground biomass, after controlling for the effects of climate, topography and soil characteristics. The asterisk (***) indicate statistically significant difference ($p < 0.001$) between sites with LSP absent and LSP present.

References
Aalto et al., 2017a. Revealing topoclimatic heterogeneity using meteorological station data. *International Journal of Climatology*.
Aalto J, Harrison S, Luoto M. 2017b. Statistical modelling predicts almost complete loss of major periglacial processes in Northern Europe by 2100. *Nature Communications*.
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Riihimäki H, Heiskanen J, Luoto M. 2017. The effect of topography on arctic-alpine aboveground biomass and NDVI patters. *International Journal of Applied Earth Observation and Geoinformation.*