Carbon dynamics following permafrost thaw gradient in high latitude peatland environment

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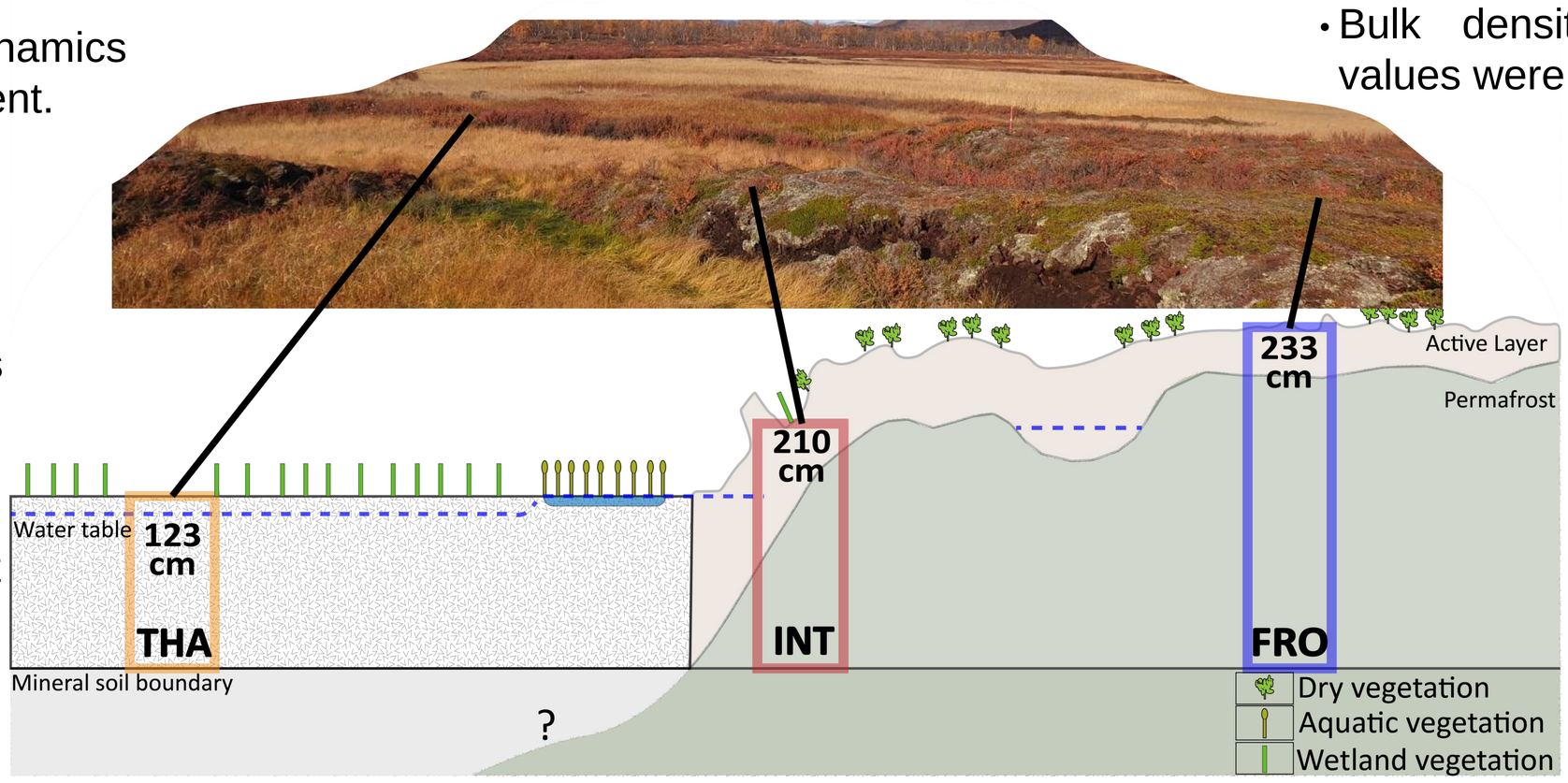
1. Aims

This study aims to:

- Quantify carbon dynamics along a thaw gradient.
- Link carbon dynamics to soil properties and site history.
- Compare to studies with similar environmental conditions but differing permafrost histories.

2. Study Area



3. Methods

Carbon stock:

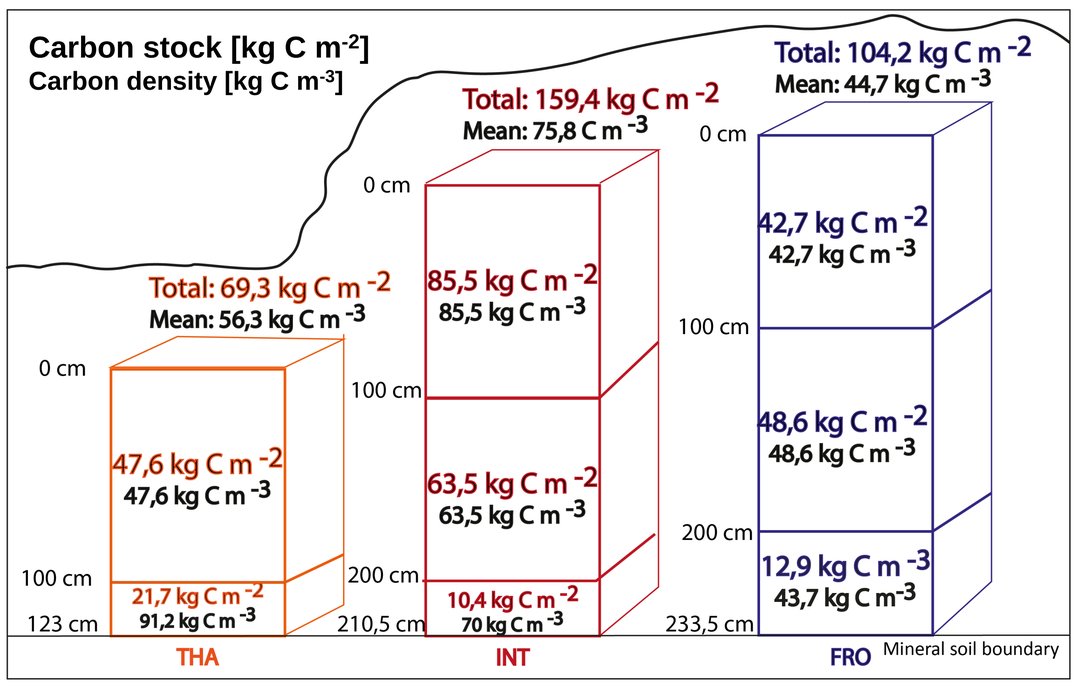
- Bulk density (BD) and TOC values were determined.

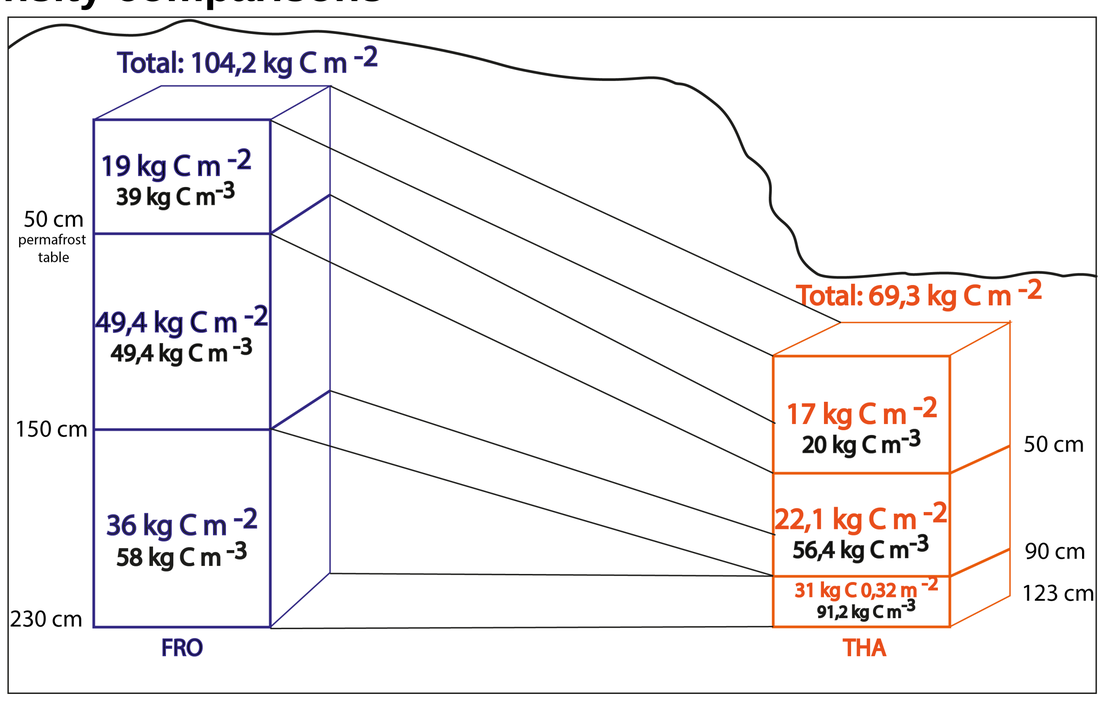
Site history:

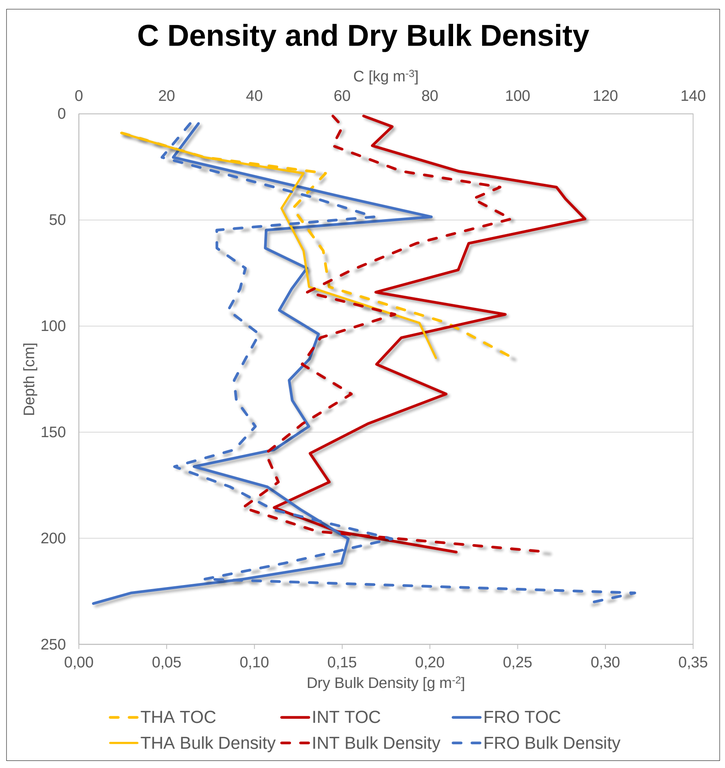
- Visual description, comparing of historical drone images,13C, radiocarbon dating, macrofossil analyses, C:N ratio.

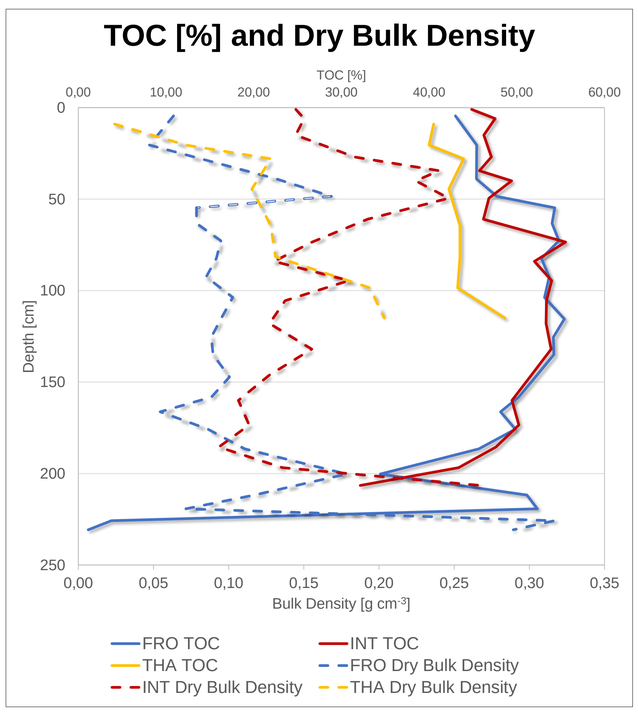
4. Results

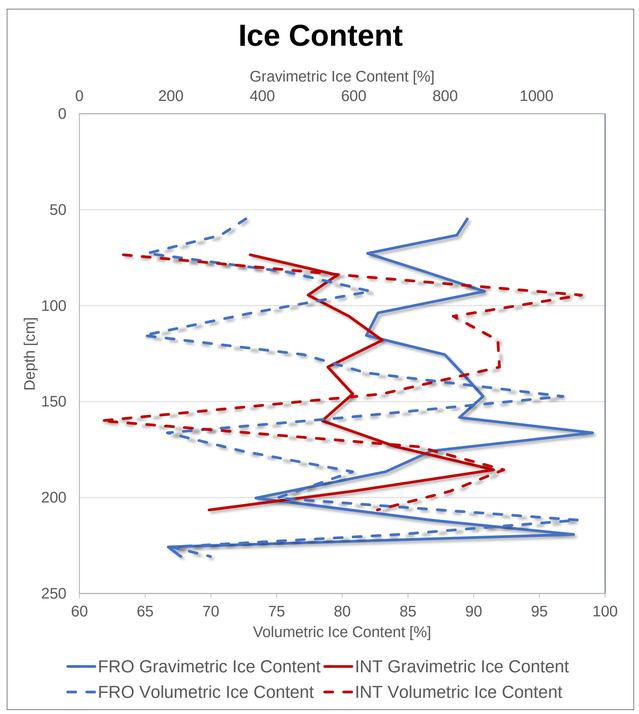
Two different carbon stock/ density comparisons











5. Discussion

Key findings:

- Large carbon mass loss following thaw, highest in the middle of the core.[1,2]
- Higher C density in thawed site than most intact palsa site.

Peat properties, ice content and site evolution

- Subsidence of about 1 m after permafrost thawing.
- High ice content.
- Increasing decomposition and BD with depth at THA.

Stability of carbon after thaw

- High TOC [%] values across all cores (mean: 47,2 %; SD: 10,3).
- Highest values in INT site, particularly in AL.
- Apparent carbon accumulation rates (ACAR) from similar environments estimate carbon accumulation upon thaw + 20 years:
  - → gain of 1,9 kg C m^{-2} at palsa (95 g C m^{-2} y^{-1}; SD = 45)[6]
  - → gain of 2,9 kg C m^{-2} in wetland (147 g C m^{-2} y^{-1}; SD = 40)[6]

Interpretation and next steps

- Various possible pathways for C, like CO_2/CH_4, TOC, erosion → C:N ration, ^{13}C.
- Mixing and relocation upon thaw may lead to spatial heterogeneity → ^{14}C.

References:
[1]Jones, M.C. et al. (2016) Available at: https://doi.org/10.1111/gcb.13403.
[2]Heffernan, L. et al. (2020) Available at: https://doi.org/10.1029/2019jg005501.
[3]Holmes, M.E. et al. (2022) Available at: https://doi.org/10.1029/2021gb007113.