Ecological and Climate Impacts of Greenlandic Glacial Outwash Plains (ECO-Plains)

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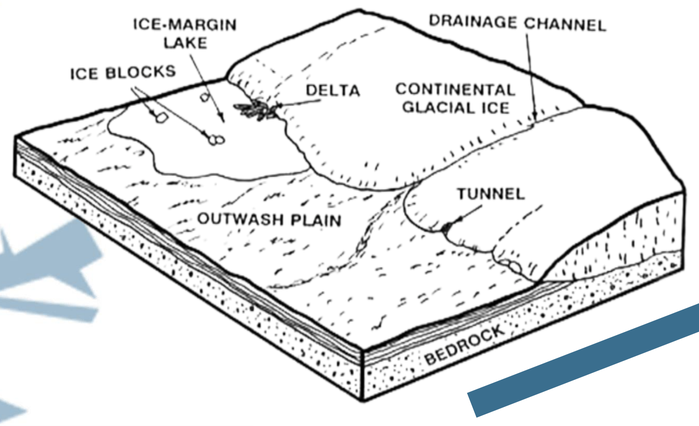
Exploring Glacial Outwash Plains

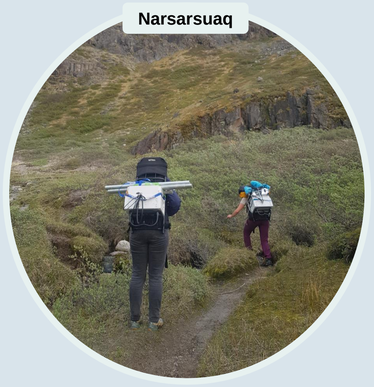
The Arctic warms **two to four times faster** than the global average[1]
→ **Glacial outwash plains** are developing fast!

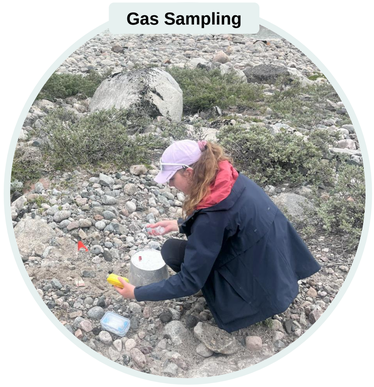
Outwash plains are sites of **greenhouse gas fluxes**[2]
Resulting aerosols impact **cloud formations** and **radiative transfer**[3]
These aerosols can intervene in **other ecosystems**
Neither the **spatial** nor the **temporal** evolution of outwash plains has been estimated

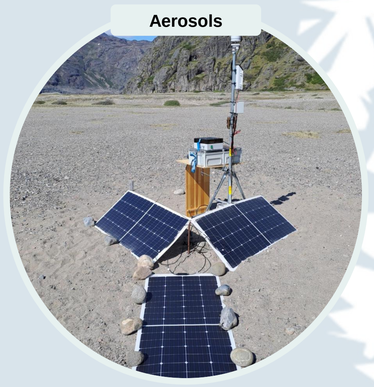
Aim: To explore the climate and ecosystem impacts of these rapidly developing environments in Greenland
Methodology: Fieldwork sample collection, in-situ analysis, laboratory analysis, bioinformatics, numerical simulations for impact estimation and machine learning on satellite imagery



Fieldwork







Satellite Image Analysis

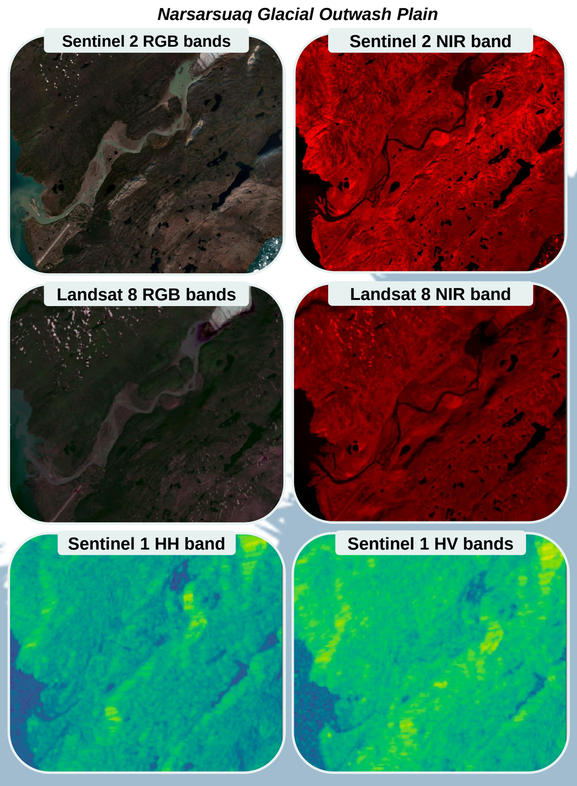
Understand natural phenomenon through remote sensing

1. **How much has the area of glacial outwash plains increased?**
2. **Have the proportions of vegetated areas changed?**
3. **How to characterize floods happening in summer?**

Datacube:
Multiple satellite data sources (e.g. Sentinel 1 & 2, Landsat 4-9)
Numerical weather prediction products (ERA5)

Methodologies:
Deep learning models for *spatial* and *temporal* characterization
Multimodal models
Unsupervised change detection

Narsarsuaq Glacial Outwash Plain



Role of Microbial Communities

Receding glaciers uncover new habitats of nutrient poor soil

Microbes are capable of colonising this oligotrophic environment, creating nitrogen and carbon pools that are essential for the establishment of plants[4]

Microbial interactions with greenhouse gas fluxes during this development remains largely unknown

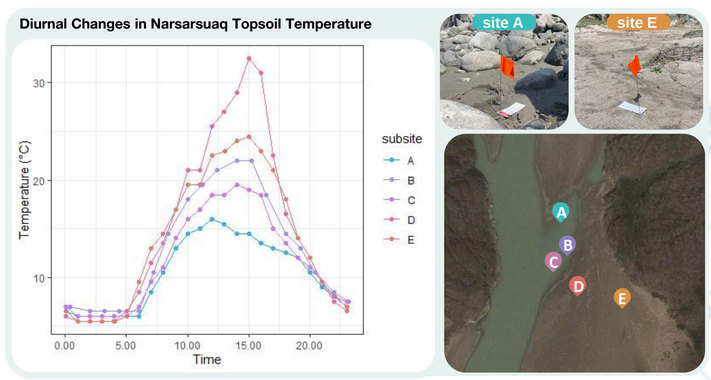
What is the role of microbial communities in greenhouse gas exchange and soil development of glacial outwash plains in Greenland?

Approach

Metagenomics and metatranscriptomics of soil microbiomes to characterise community structure, functional potential and active taxa involved in greenhouse gas fluxes

Greenhouse gas flux measurements via gas chromatography of CO_2, CH_4 and N_2O

Physicochemical analysis of soil TOC, TC, TN, NH_4, NO_2, NO_3, temperature, pH and particle size



Preliminary Results

➔ Diversity of vegetated and non-vegetated sites
➔ Varying sediment types
➔ Diurnal temperature shifts in topsoil

High-Latitude Dust

Fine glacial dust from outwash plains can become airborne with high wind speed

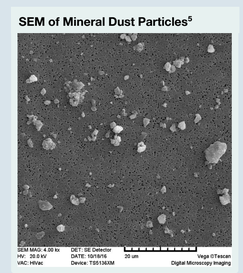
Dust aerosol can directly influence radiative transfer, alter cloud properties by acting as ice-nucleating particle (INP) and transport nutrients to other ecosystems[3]

How do INP-activity, bioaerosols, optical properties and nutrient content of glacial dust change over the chronosequence in southern Greenland?

Approach

Measurements of aerosol size distributions, meteorology, soil moisture, airborne INP in Narsarsuaq glacial outwash plain

Analysis of dust samples along chronosequence on INP-activity, bioaerosol, nutrient content (particularly Fe) and optical properties



Conclusion

Intersection of three fields of work

➔ Soil microbial genetics
➔ Ice nucleating activity of dust and bioaerosols
➔ Satellite imagery for large scale understanding

Expected outcomes

Characterise biogeochemical processes and future trajectories of ecosystem function of glacial outwash plains in Greenland
Understand the significance of these developing environments in relation to climate change

References

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