living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

SHORELINE CHANGE ASSESSMENT IN SVALBARD ARCHIPELAGO

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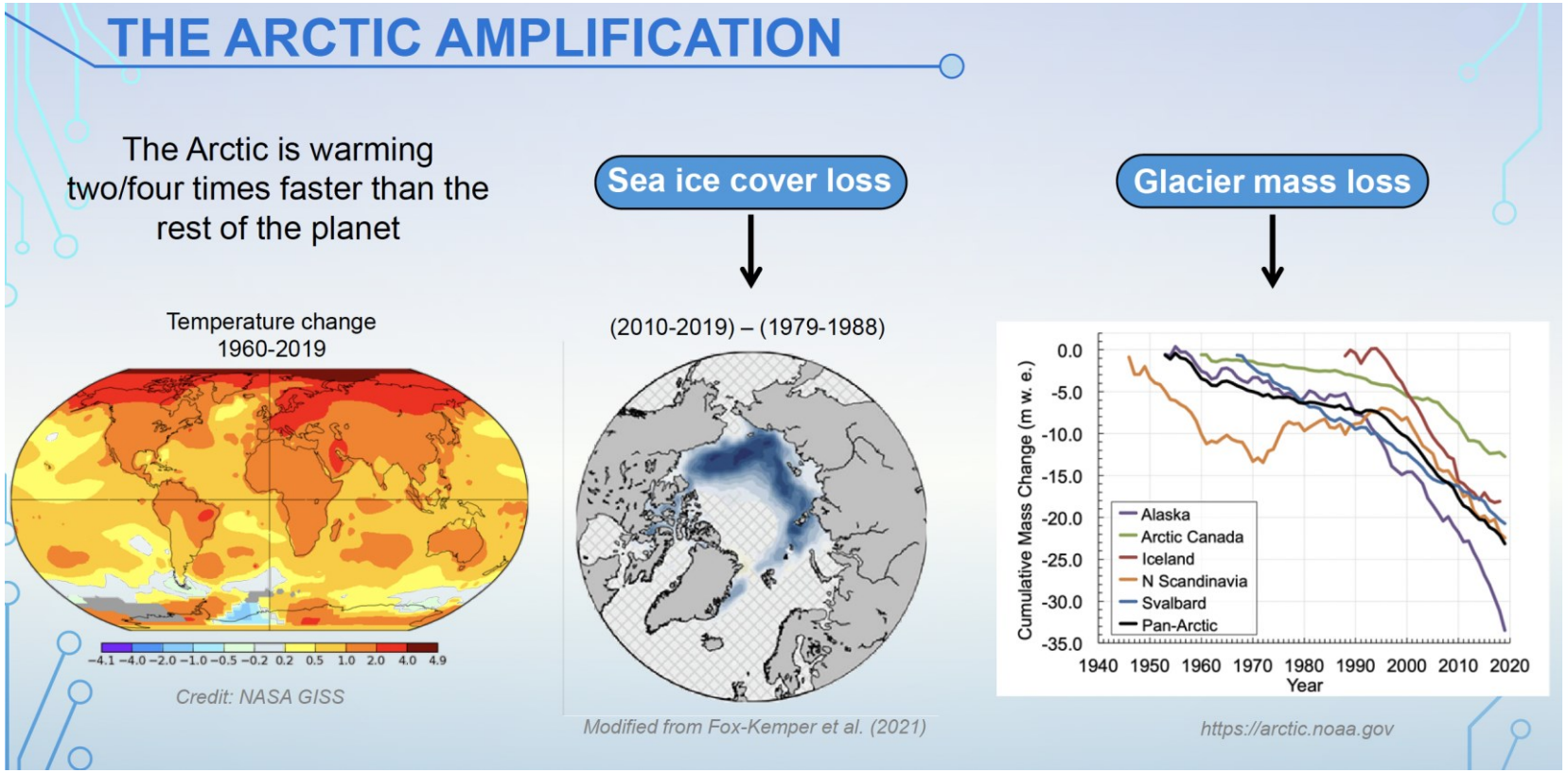
Introduction

Climate change impacts

- Increasing temperature
- Sea ice cover and glacier losses

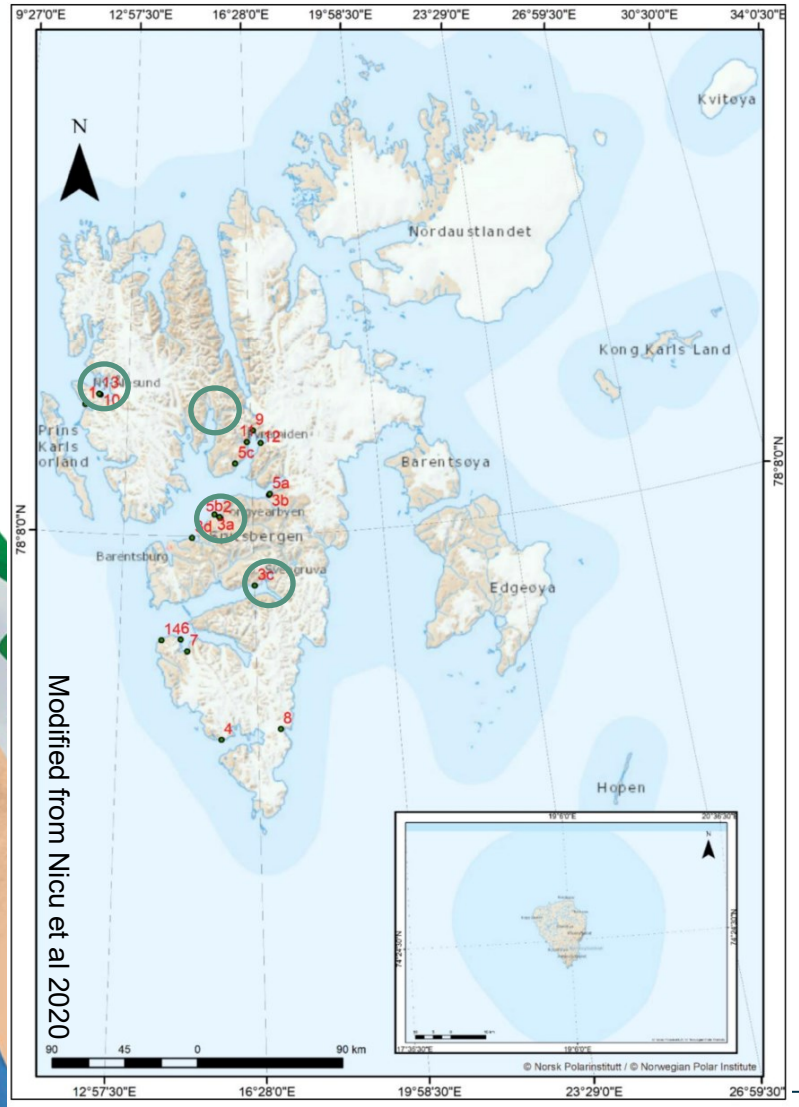
Studying Arctic coasts

- Lack of large scale shoreline mapping
- Improve knowledge of past trends to better address future changes



The Arctic is warming 3x times faster than the rest of the planet

Scientific background



Studies of coastal dynamics in Svalbard 2005-2021

Sites 1-14: Coastal erosion (Nicu et al 2020)

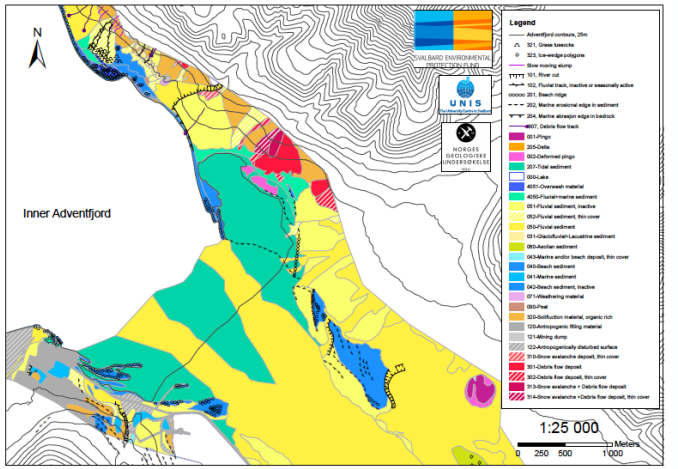
UNIS- studies
System understanding (cases) and long term monitoring:

- Adventfjorden
- Sassenfjorden
- Dicksonfjorden
- Hollendarbukta
- Gipsvika
- Van Mijenfjorden
- Prins Karls Forland

DynaCoast: Dynamic Svalbard Coastline

- First dataset for the Svalbard coastline
- Geomorphological mapping of the coastal zone

https://svalcoast.com



Forskningsrådet

SVALBARDS MILJØVERNFOND

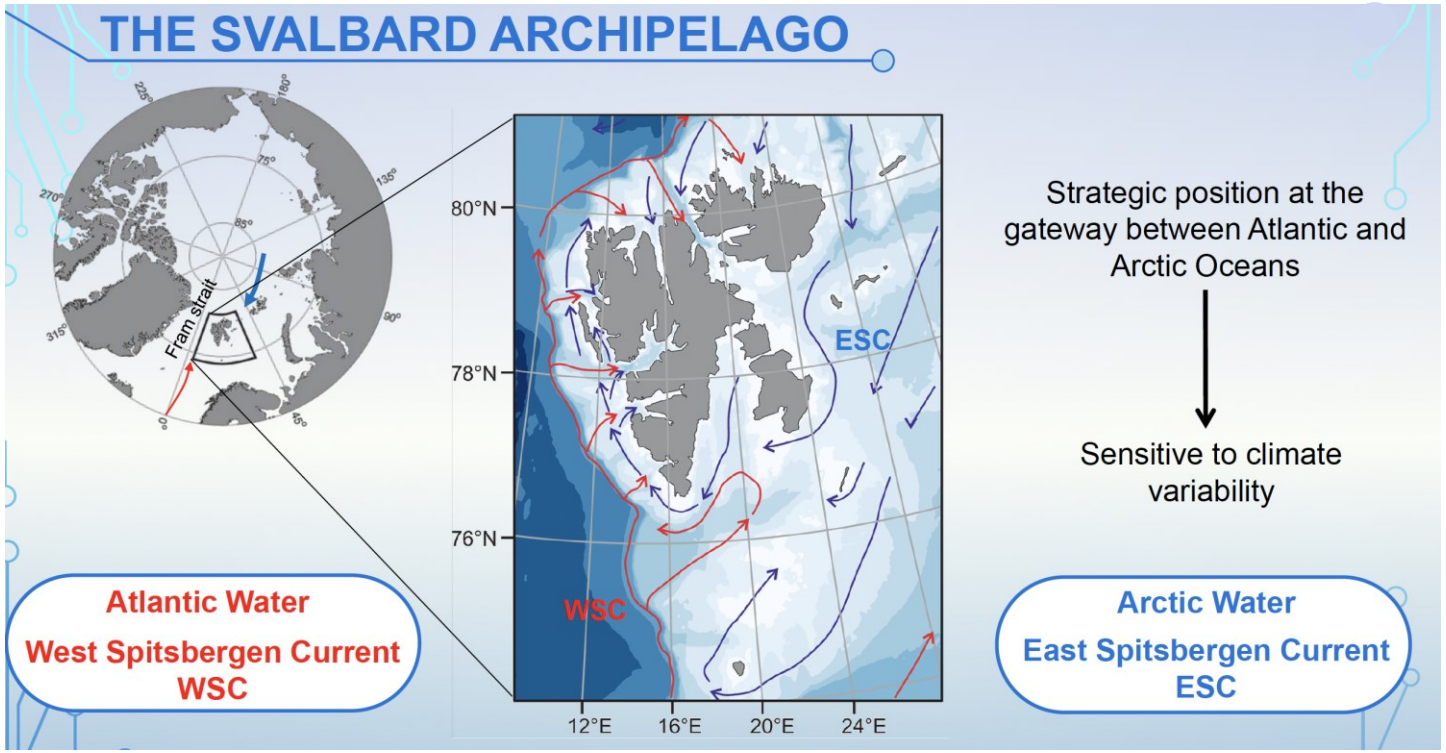
UNIS The University Centre in Svalbard

And international partners

Study Area

Northernmost study area of the Space for Shore project

- **Arctic coasts**
  - Some of **the most rapidly changing** coasts on Earth (Irrgang et al., 2022)
- **Real need for shoreline mapping**
  - **Fjords** are poorly covered (Rubensdotter and Jensen, 2020)
  - **Limited availability** of observational, oceanographic and environmental data (Irrgang et al., 2022)
- **Five study areas in Spitsbergen**
  - Rocky shores alternating with sand and gravel beaches and glaciers
- **Challenge**
  - Assessing the relevance of our tools to new coasts



Material and Method

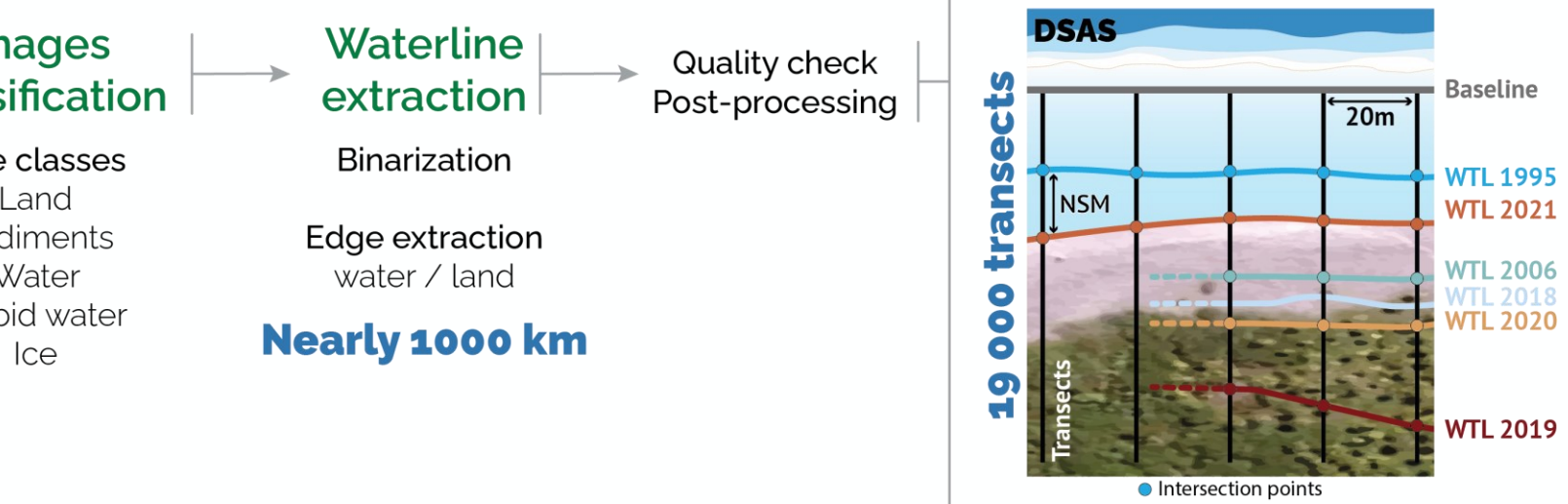
Shoreline change assessment

Images acquisition → **Images classification** → **Waterline extraction** → Quality check Post-processing

- Images acquisition: Sentinel 2, Landsat 5
- Images classification: Five classes — Land, Sediments, Water, Turbid water, Ice
- Waterline extraction: Binarization; Edge extraction water / land

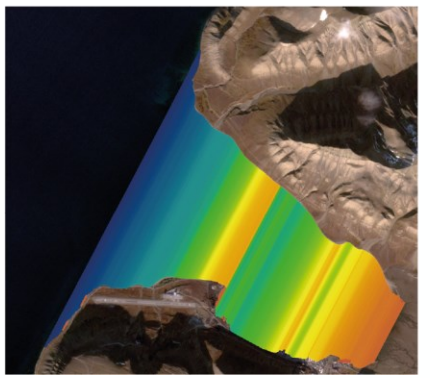
Nearly 1000 km

Shoreline change assessment → Mapping coastal changes



370 km

Width of fjords



Several challenges to be addressed

- Spreading our tools to new types of coastlines
- Remote areas
- Specific climatic and geomorphologic context
- Limited or no validation data

Uncertainty

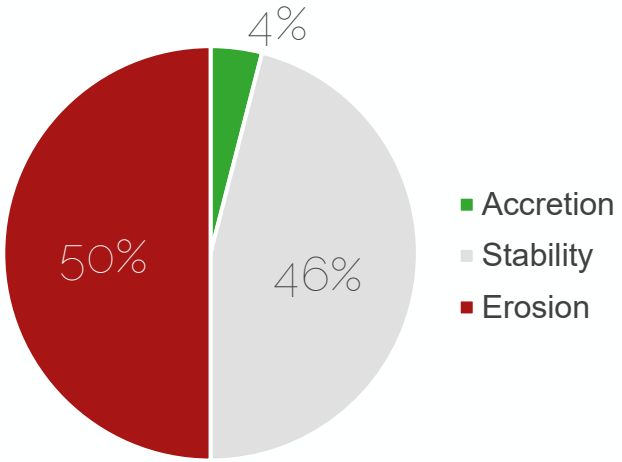
- **20m** (pixel size, rectification, tide…)

Probably a **smaller real error**

Previous validation (Y1&2 of S4S project) : **5-10m error**

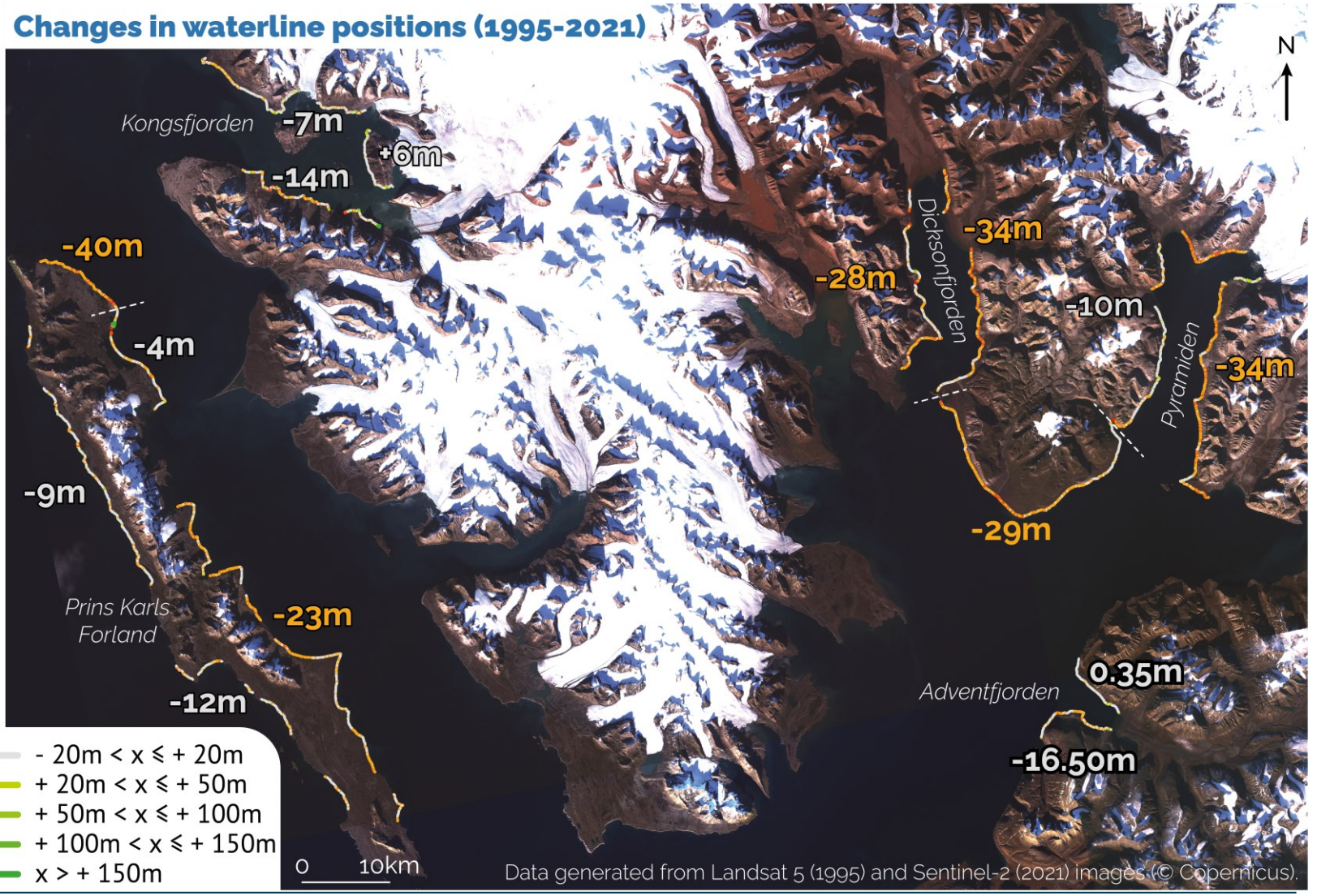
Results - Shoreline change

Shoreline retreat = main pattern of change

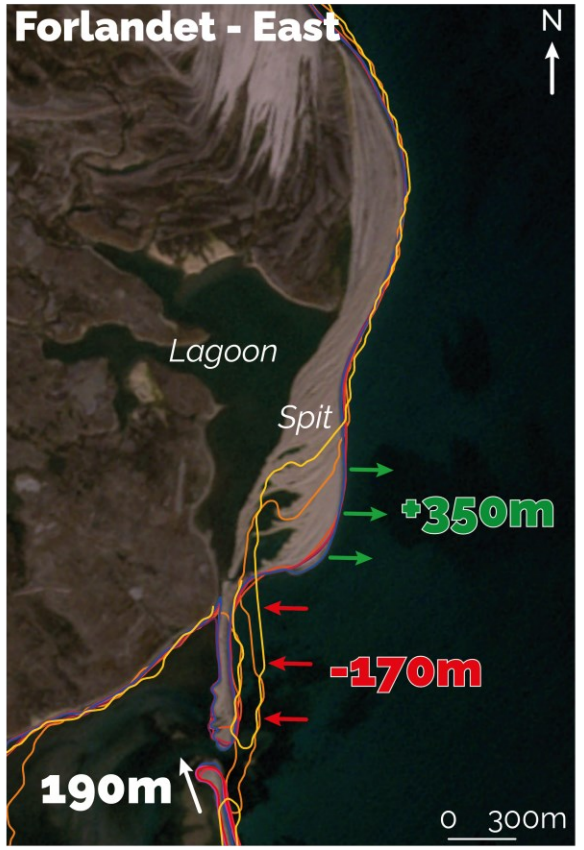


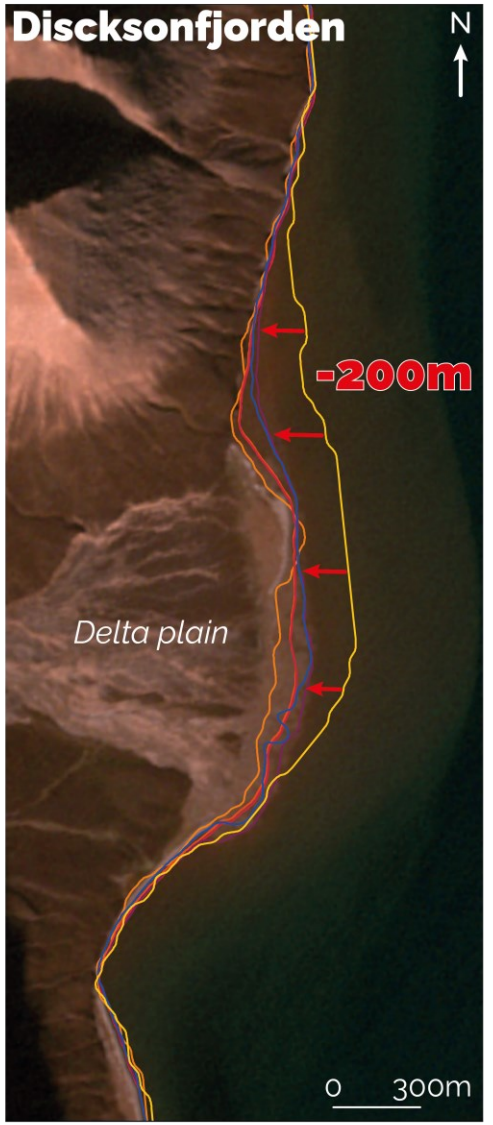
Extreme values :

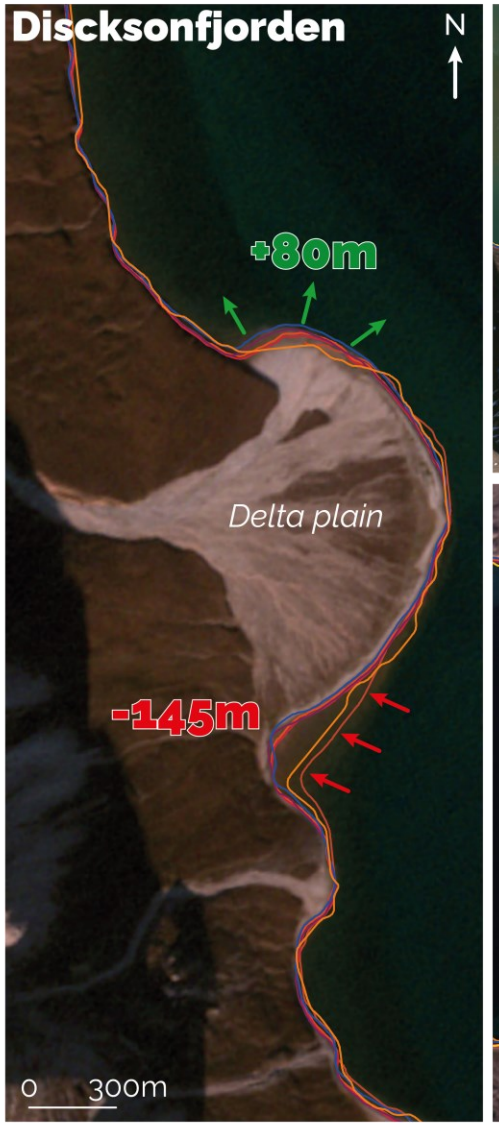
- **-200m** (Dicksonfjorden)
- **+350m** (Prins Karls Forland)

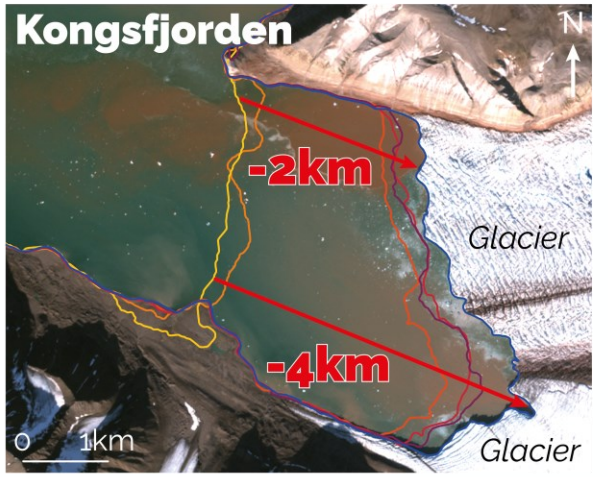


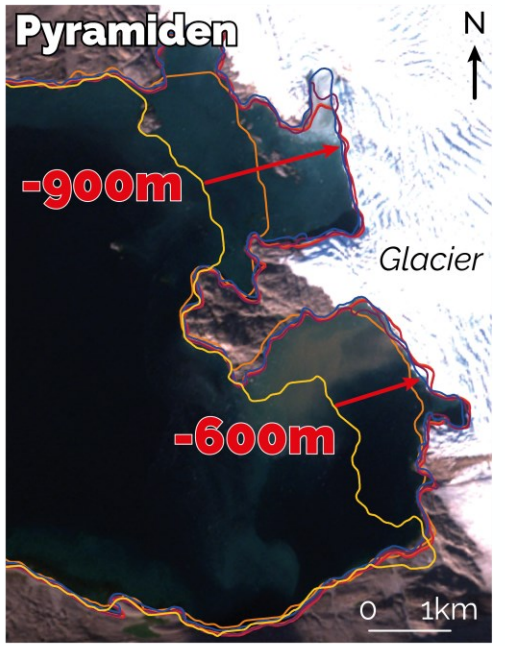
Results - Shoreline change











Waterline positions

- 1995
- 2006
- 2018
- 2019
- 2020
- 2021

Data generated from Landsat 5 (1995, 2006) and Sentinel-2 (2018, 2019, 2020, 2021) images (© Copernicus).

What next? - Bathymetry

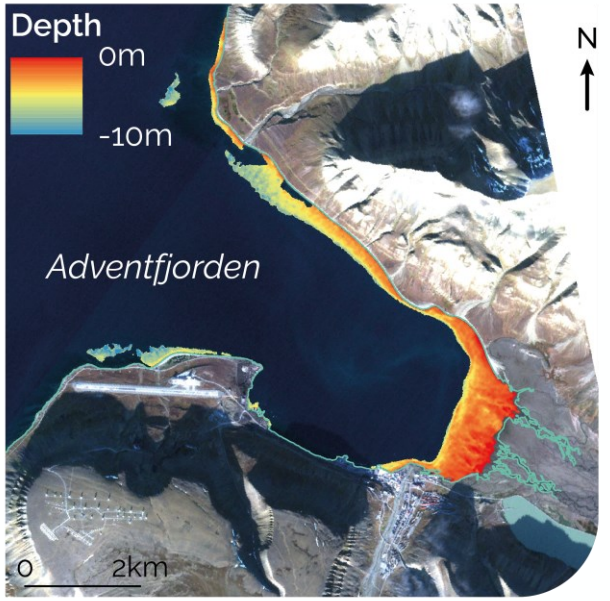
Satellite-derived bathymetry

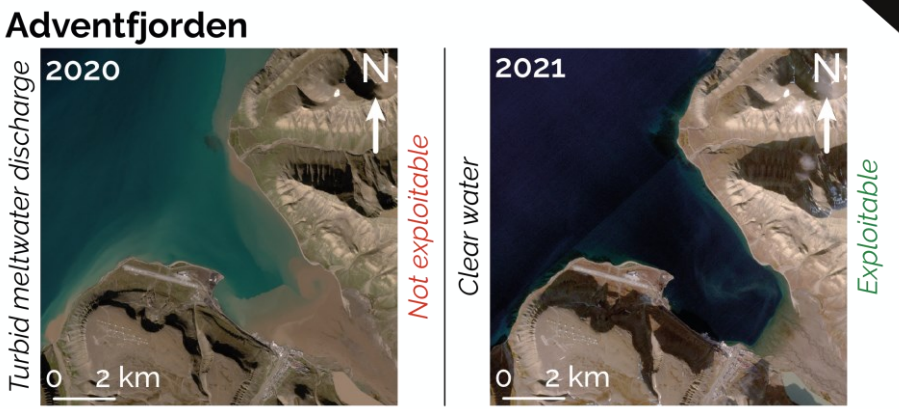
- Shallow water mapping (0 / -10m)
- Complements field data (start below -10m)
- Mapping changes in the foreshore

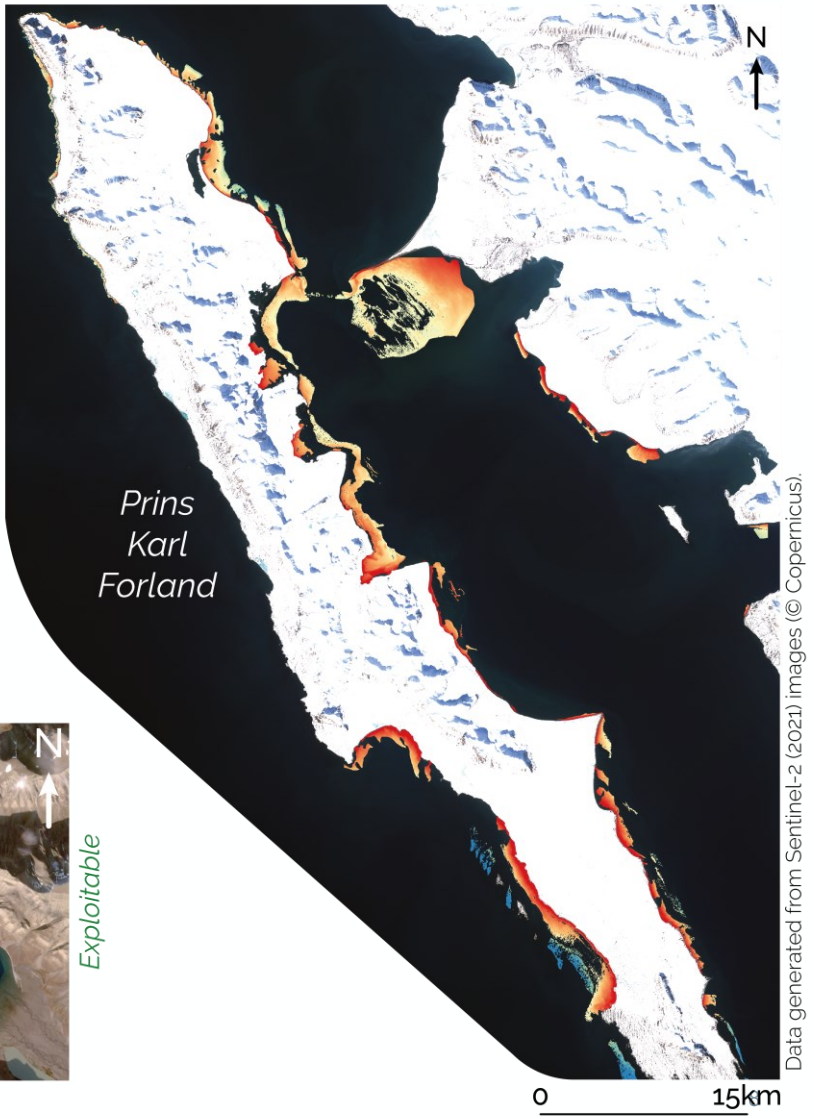
Some limitations

- **Context-specific** (Fjords)
  - step fore beach slopes
- **Not context-specific**:
  - Turbidity
  - Cloud
  - Ice

} **Few usable images**







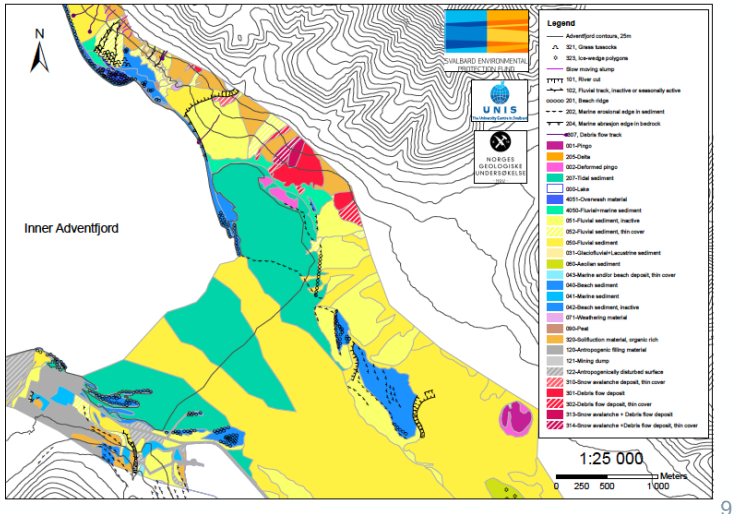
Conclusion

Extraction of coastal dynamics indicators from satellite images: a key data source for remote areas

- Assess coastal dynamics in areas where no historical data exists
- An interesting cost-benefit ratio, especially for remote and hard-to-reach areas
- Possibility of studying a territory in its entirety and of detecting changes on a local scale
- Ability to monitor all types of coasts

Work with local experts to move from detecting coastal dynamics to attributing observed changes

- Collaboration with **local experts** is needed to validate the results
- **DynaCoast**: mapping of the coastal features could help to attribute the detected changes and to identify the key processes (help for the coastal zones management, especially in high latitudes)



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THANK YOU FOR YOUR ATTENTION

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