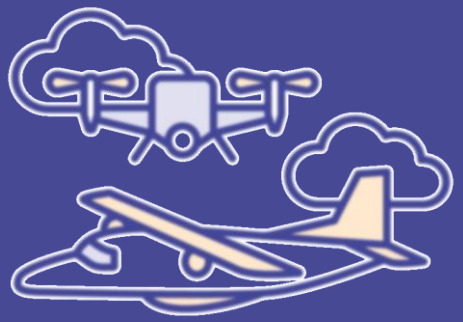
Potential of SIOS's airborne imaging sensors in Svalbard



Shridhar D. Jawak, Agnar Sivertsen, Trond Løke, Friederike Körting, Na Liu, Veijo Pohjola, Małgorzata Błaszczyk, Michał Laska, Achut Parajuli, Esther Mas Sanz, Joanna E. Szafraniec, Julian Podgorski, Marie Henriksen, Oliver Hasler, Sagar Wankhede, Shunan Feng, Riccardo Cerrato, Ximena A. Vega, Emiliana Valentini, William D. Harcourt, Dariusz Ignatiuk, Christiane Hübner, Inger Jennings, Ilkka Matero, Øystein Godøy and Heikki Lihavainen

EGU European Geosciences Union

SIOS SVALBARD INTEGRATED ARCTIC EARTH OBSERVING SYSTEM

SIOS – a Norwegian initiated international collaboration to create a regional observing system

The Observing System

- A cooperating international research infrastructure for improved knowledge of environmental and climate change in the Arctic
- Focus to answer Earth System Science questions
- Systematic long term observations – stable over time, yet dynamic as new questions from society arise
- Minimizing environmental footprint, optimizing measurements and resources, new technologies, remote sensing, integration of data
- Open, free and harmonized data
- **Improving research conditions** for scientists working in ESS

The regional scope

- The Norwegian archipelago Svalbard and surrounding waters

SIOS

ESS = Earth System Science

www.sios-svalbard.org

Remote Sensing Service

- **Single point of contact** for satellite information for Svalbard
- Information about **opportunities** and on **how to use** satellite data
- Streamlined **access to EC Copernicus** programme satellite data for Svalbard
- Working together with product users and providers **to improve the usability** of satellite data
- Providing **tools** for satelitte data users
- Prioritized **geospatial product** generation

Norway’s first passenger aircraft with high resolution remote sensing capabilities

Current payload

- Hyperspectral Imagery (VNIR-1800, Norwegian Electro-Optics)
  - Detection and classification of objects based on spectral signature; vegetation, oil on water, algae
    - 400 - 1000 nm, 3.26 nm spectral resolution
    - 570 meter wide strip from 1000 m height with 0.30 m resolution

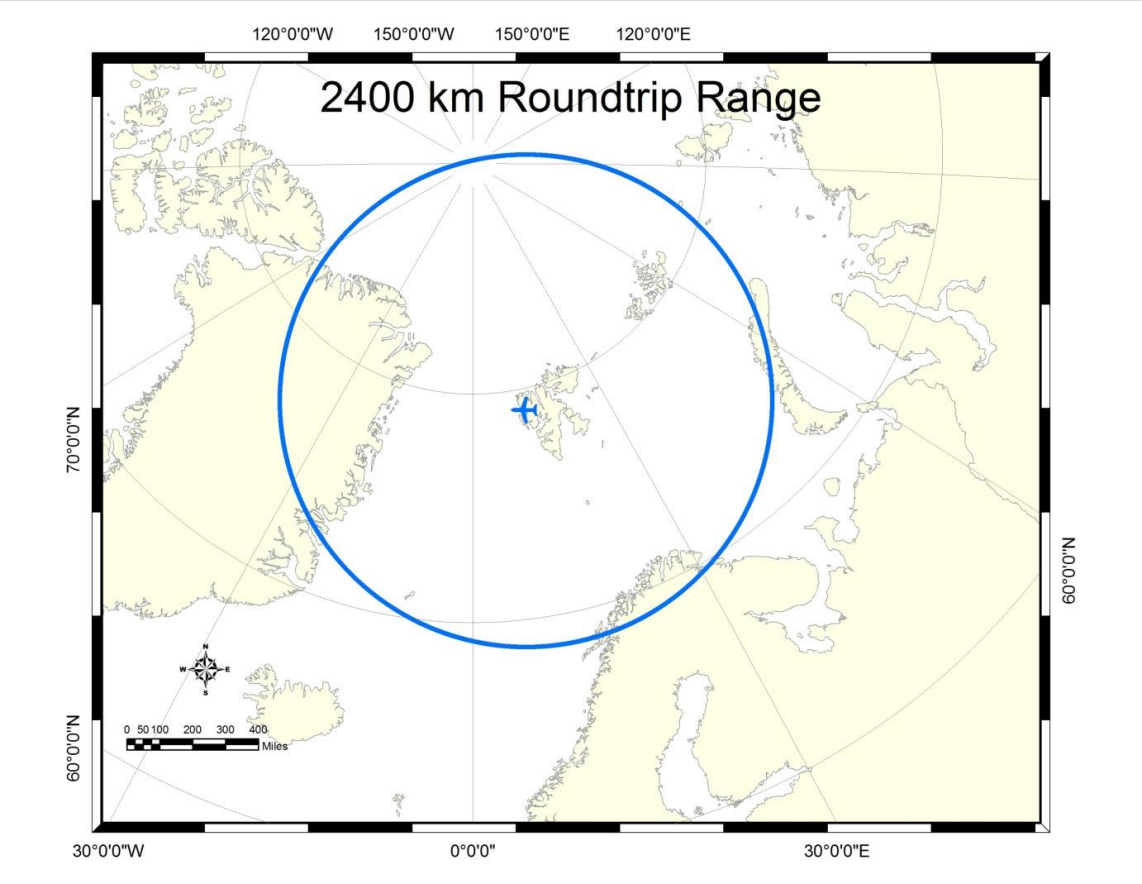
- Medium format camera (PhaseOne IXU-150, 50 Mpix)
  - High resolution images, 3D / Terrain model
    - 800 meter wide strip from 1000 m height with 0.1 m resolution

- Broadband Radio (Radionor)
  - Retrieve data from buoys, relays, data sharing, coordination and preparedness
    - 5.8Ghz, up to 15 Mbit / s and 200 km range

- AIS (Kongsberg Seatex)
  - Collection and sharing of AIS data. Better real-time coverage around Svalbard.
  - Seatex's first airborne AIS developed in the project

- GNSS (APLANIX POSAV V6 410)
  - Accurate and direct georeferencing of images and single pixels (0.5 pixel accuracy)

Capability Lufttransport Dornier



Airborne Remote Sensing Campaigns

Sensors

- RGB camera and hyperspectral imager installed on Dornier aircraft stationed in Longyearbyen
- High resolution georeferenced images

Opportunities

- First call in 2020 resulted in 25 flight hours for 10 projects
- Second call in 2021 resulted in 25 flight hours for 11 projects

Data will be available eventually through SIOS Data Access Point

Airborne Remote Sensing Campaigns in Svalbard

Campaigns 2020

10 projects, 25 flight hours

Campaigns 2021

11 projects, 25 flight hours

SIOS Hyperspectral Remote Sensing Training Course -2021

15 teachers
80 applications
35 selected participants

- **17 PhD Students**
- **04 Masters/Bachelors Students**
- **06 Researchers**
- **06 Postdocs**
- **01 Educator**
- **01 Industry**

25 institutions from 11 nations

292 lecture series participants

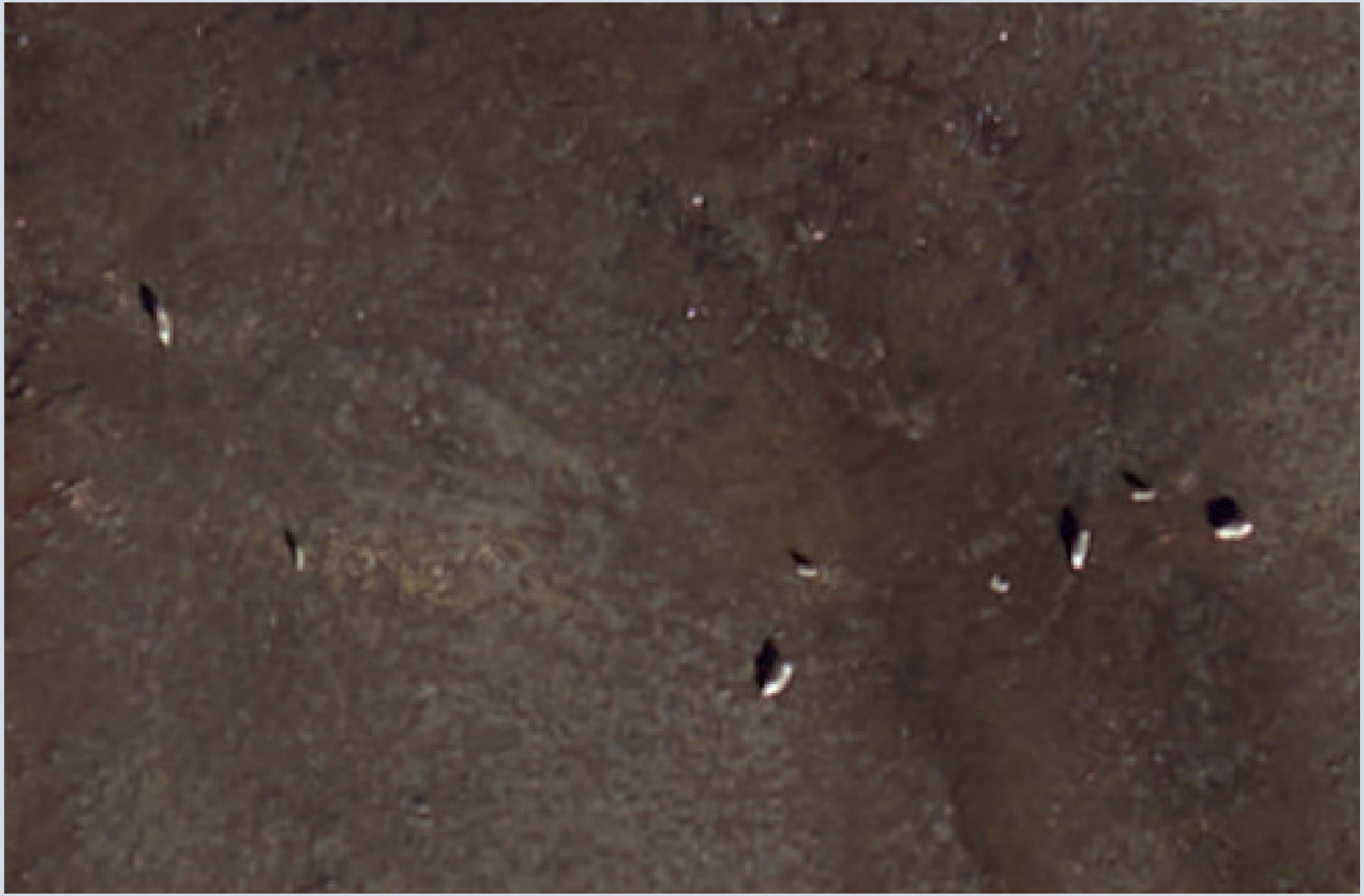
10 mini projects

Manuscript: Potential of hyperspectral sensors in Svalbard (under prep)

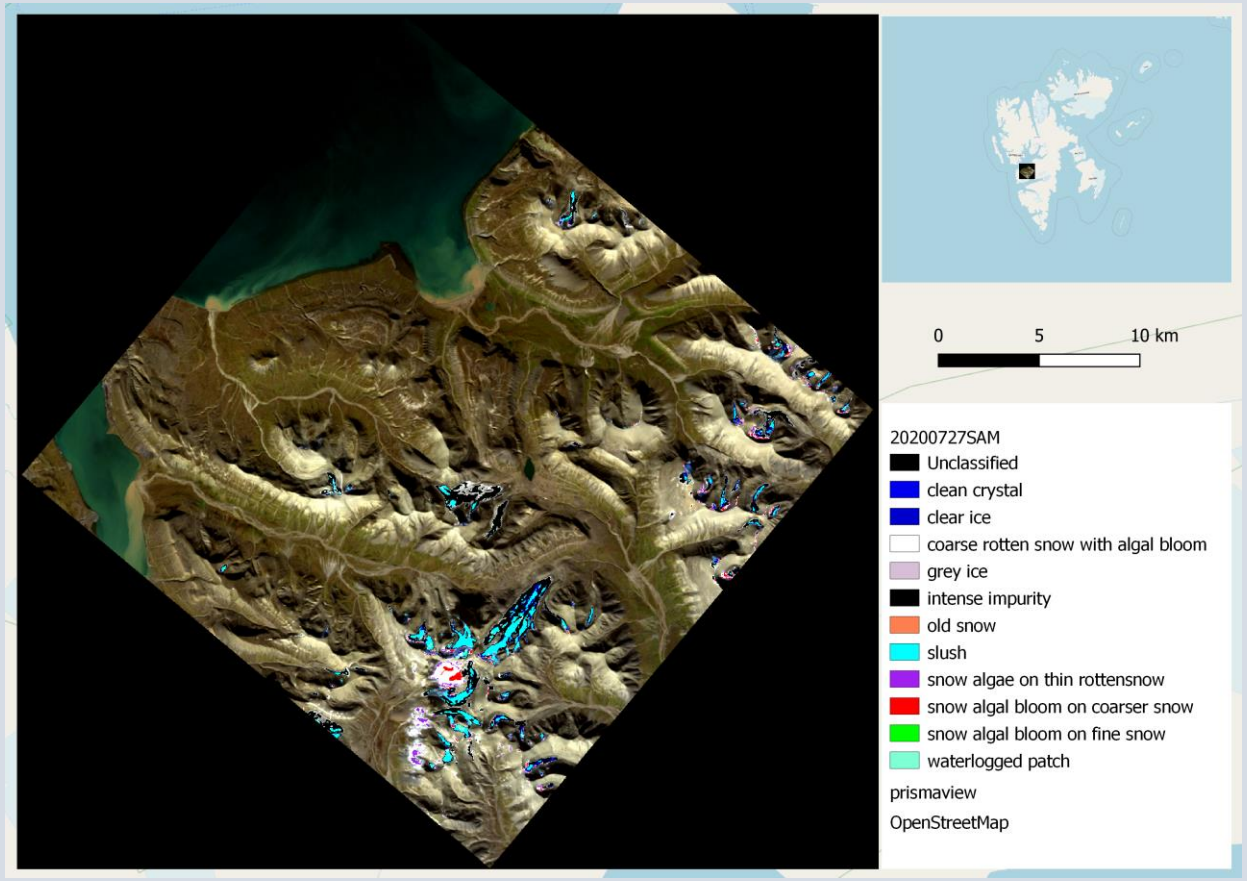
Dornier images for crevasse identification

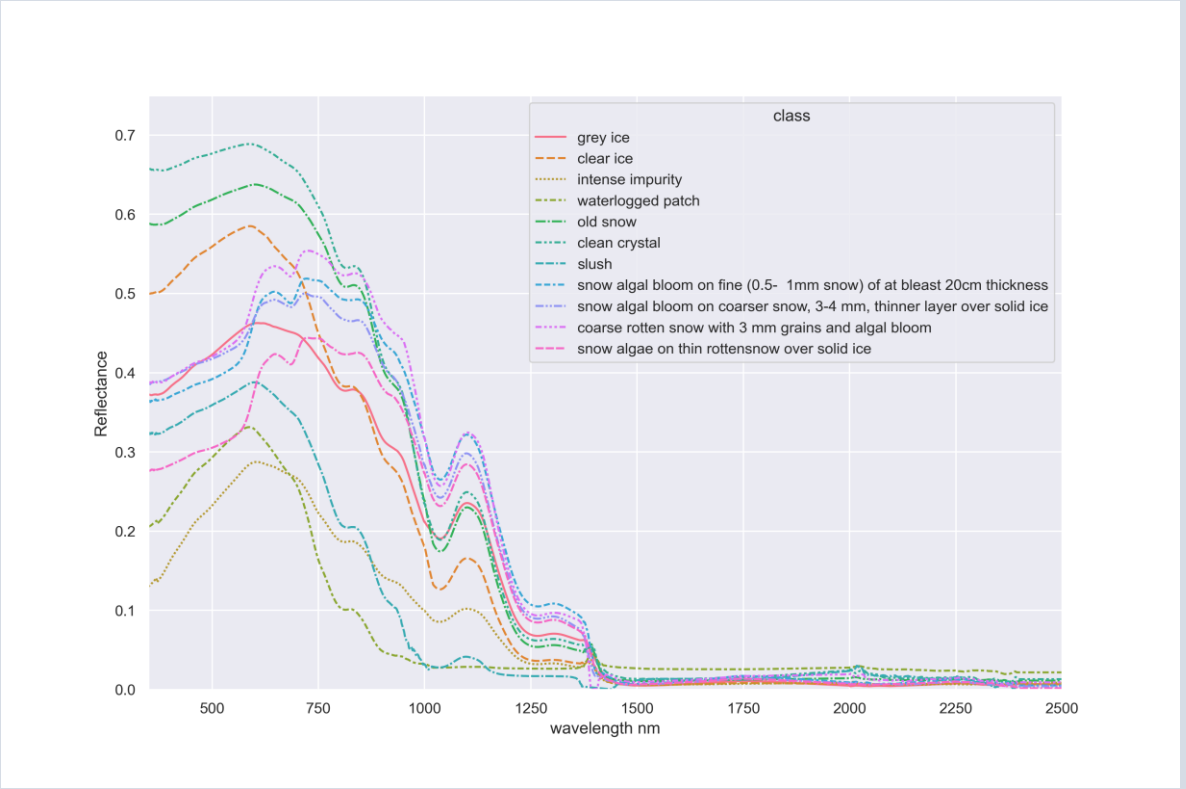
Dornier images for crevasse identification

Dornier images for reindeer counting

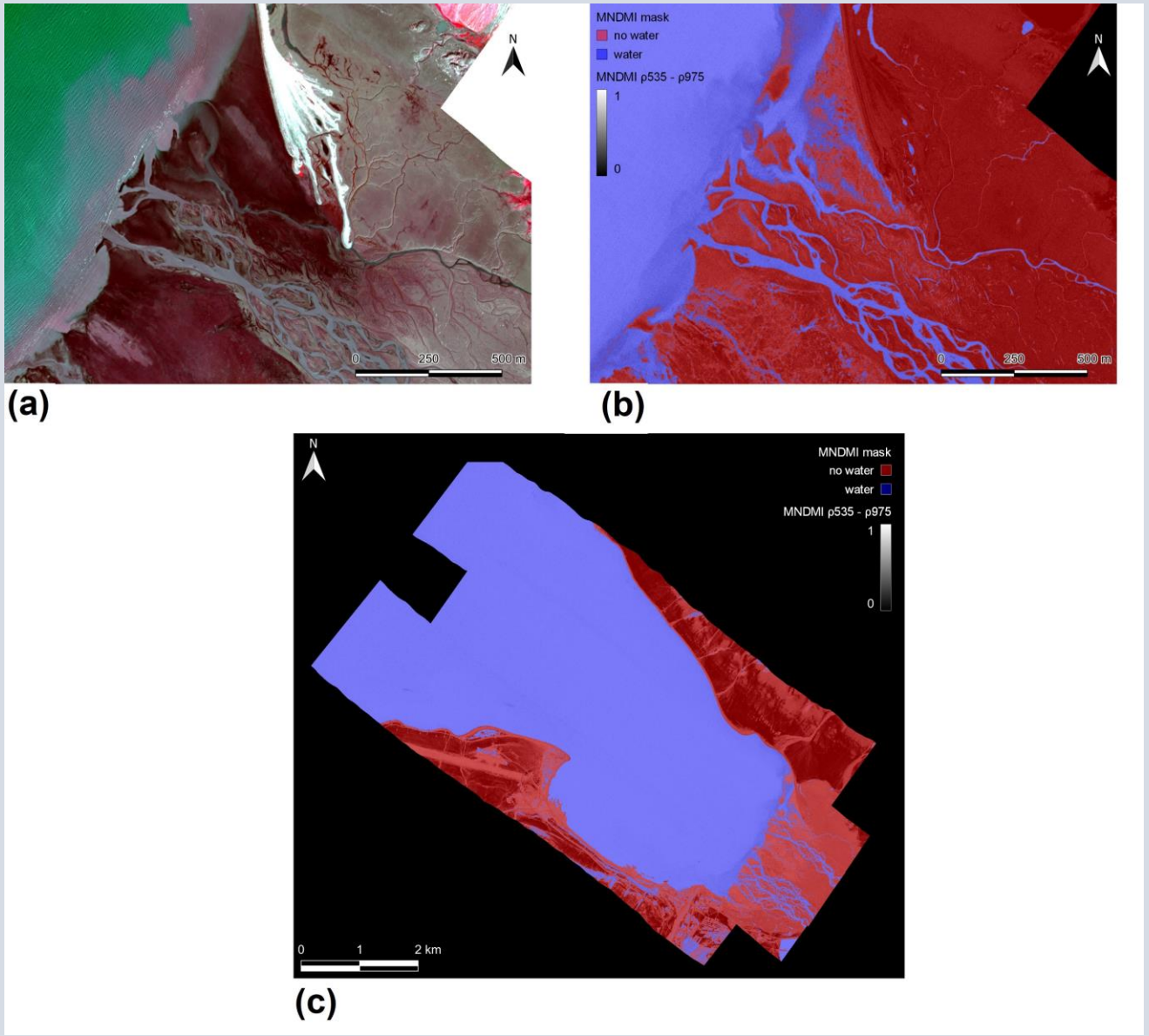


Glacier classification using SAM

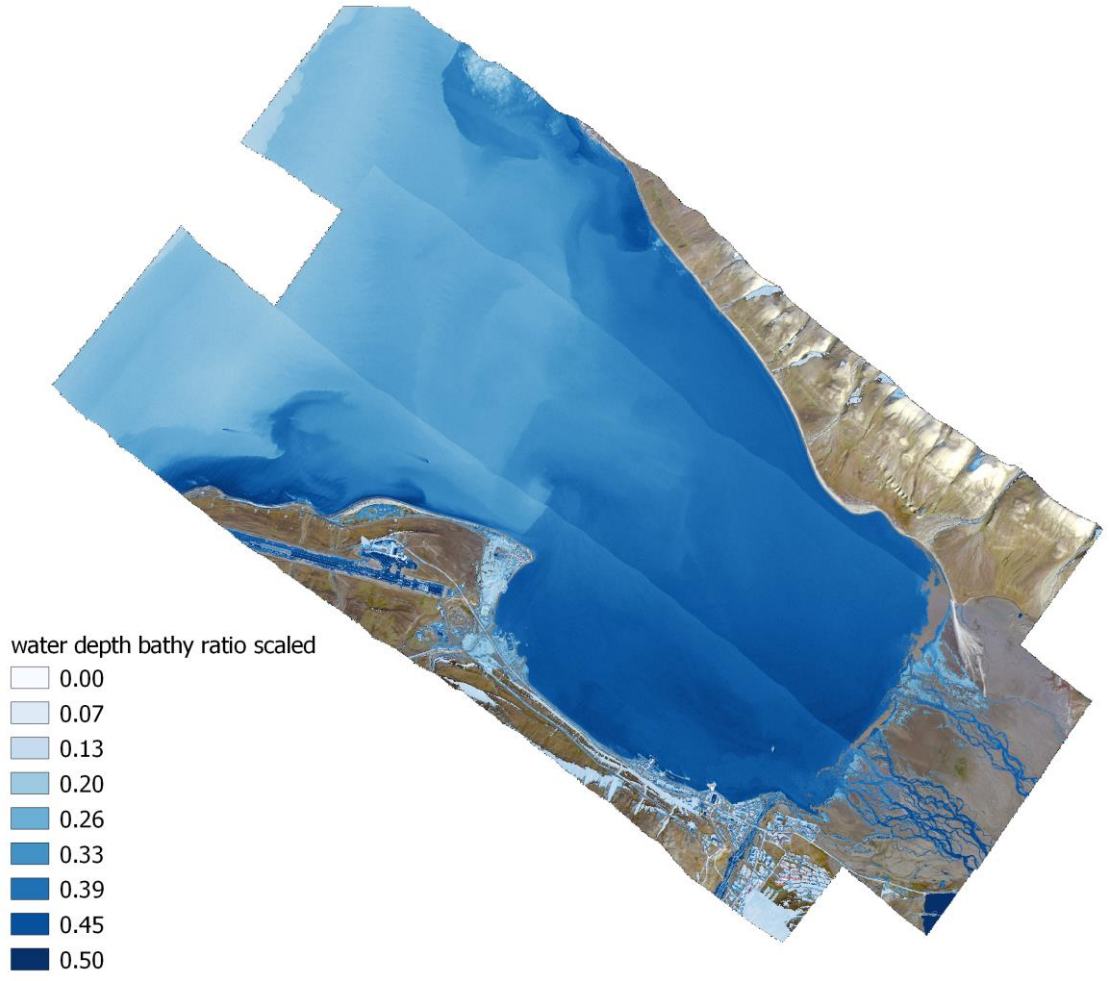




Waterbody mapping

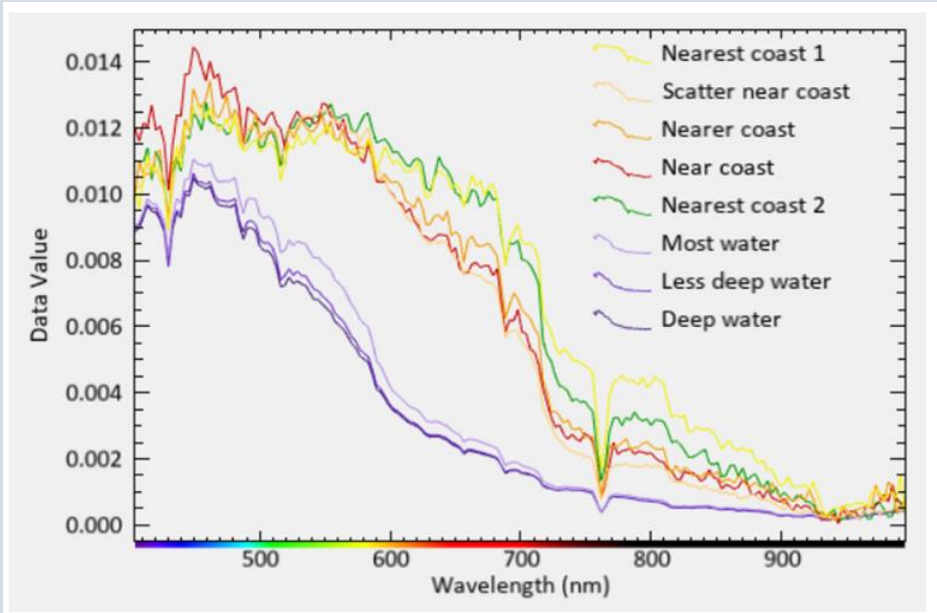


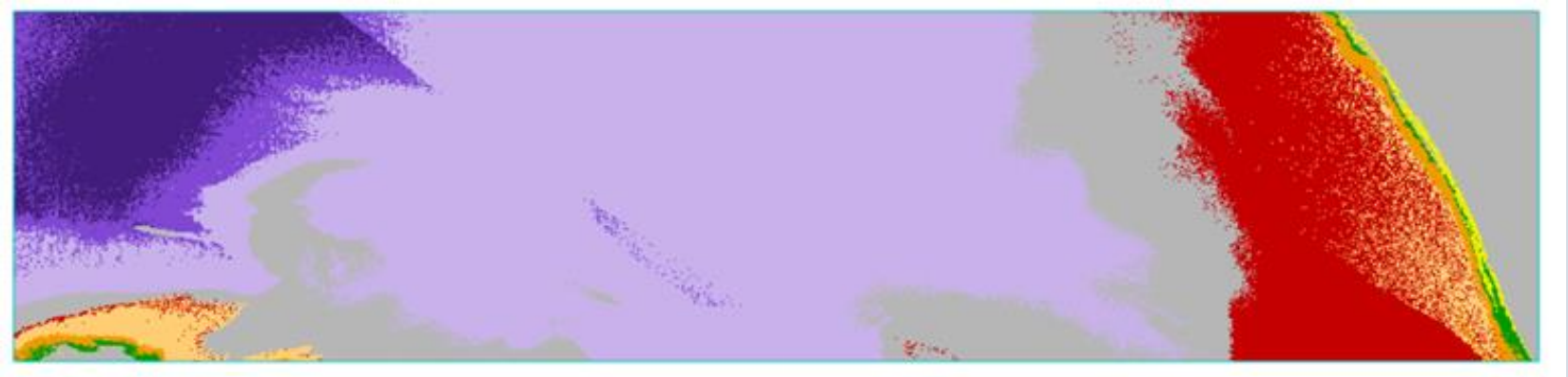
Relative water depth using ratio model



Water classification using SAM

- Visually inspected each endmember
- Tried to label them and group them into colors
- Can see two main areas
  - Coastal water
  - More open water



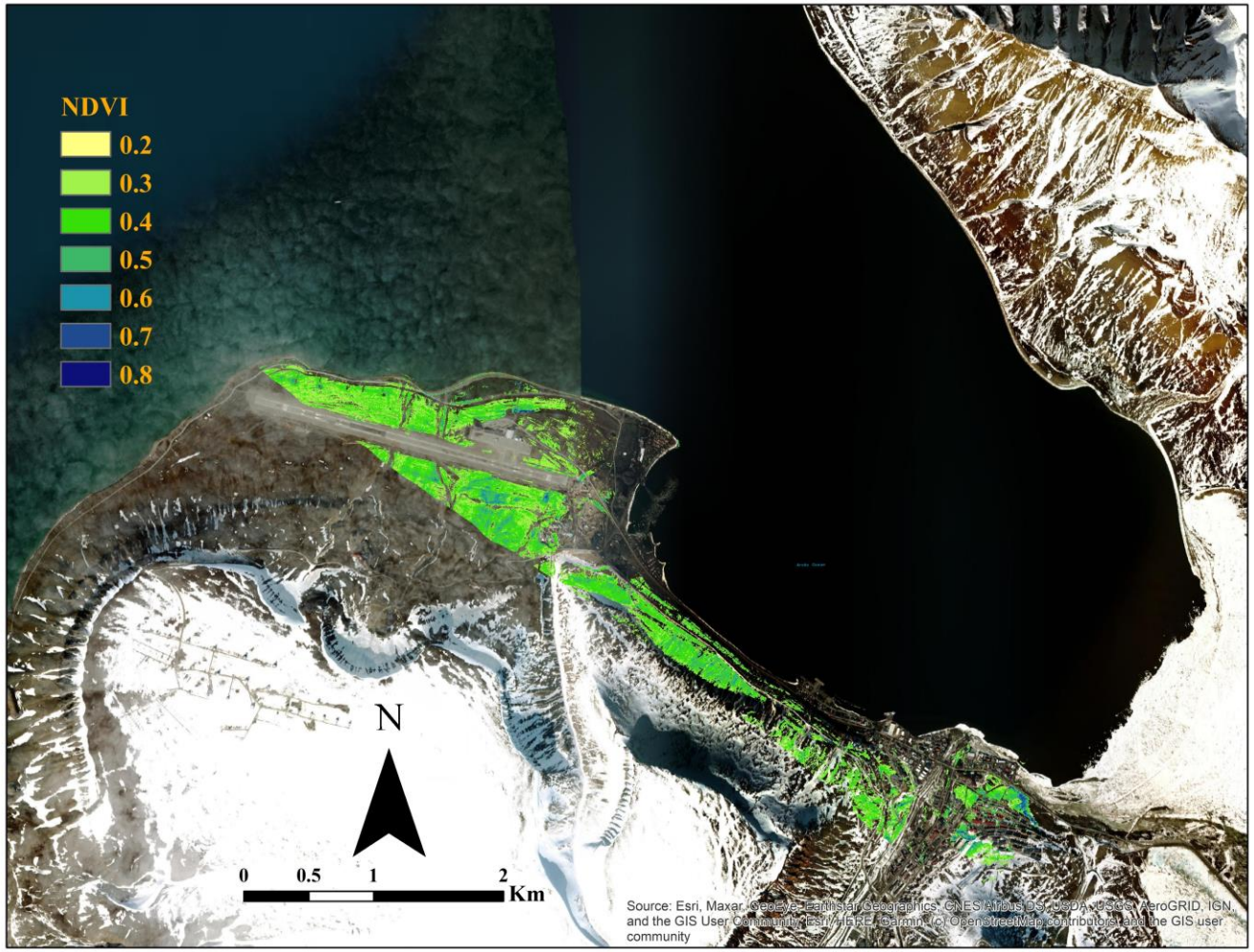


Vegetation mapping using NDVI

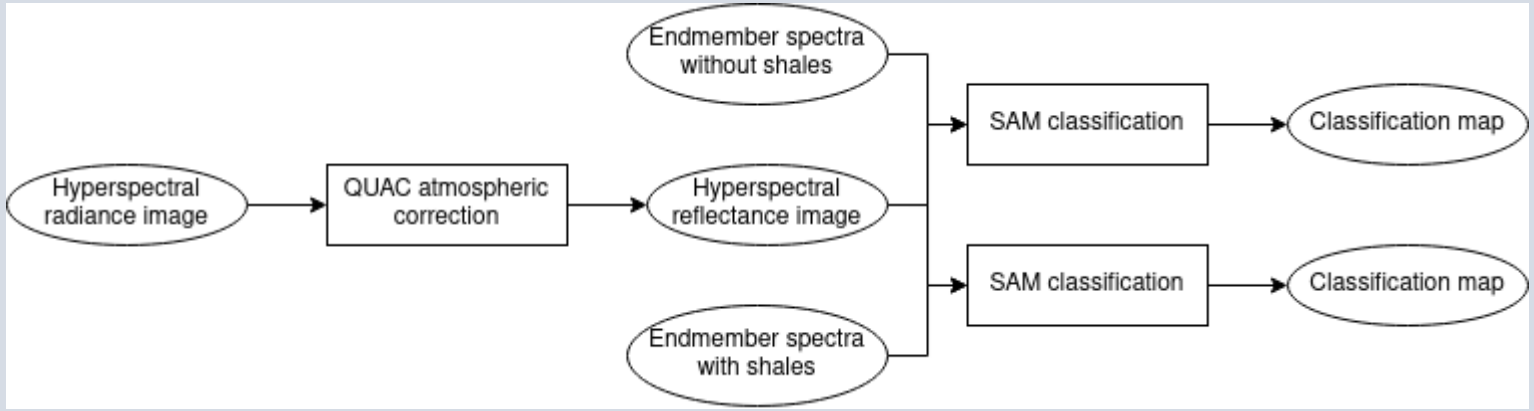
NDVI = (NIR – Red)/(NIR + Red)

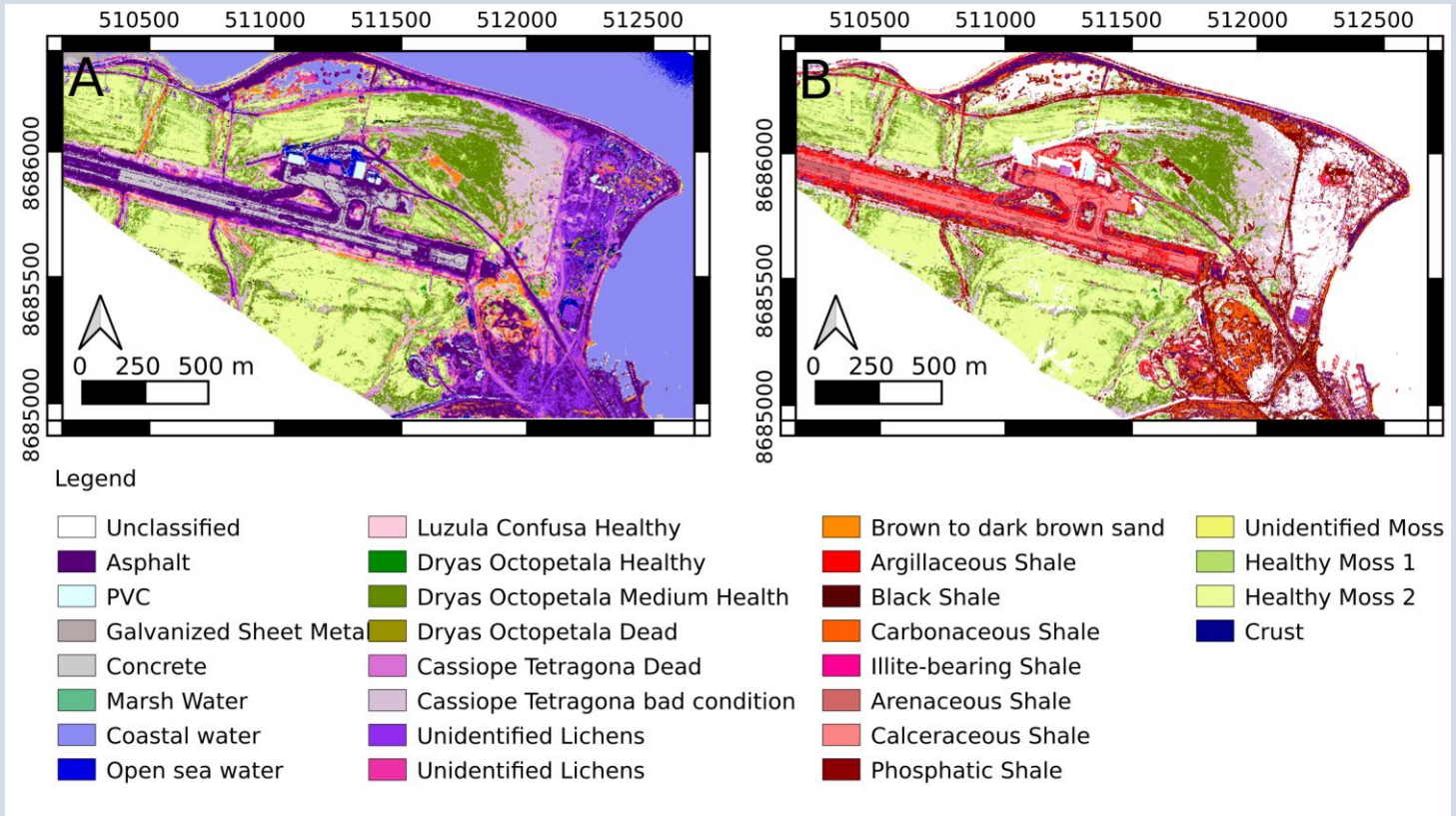
NIR- 799 (nm)

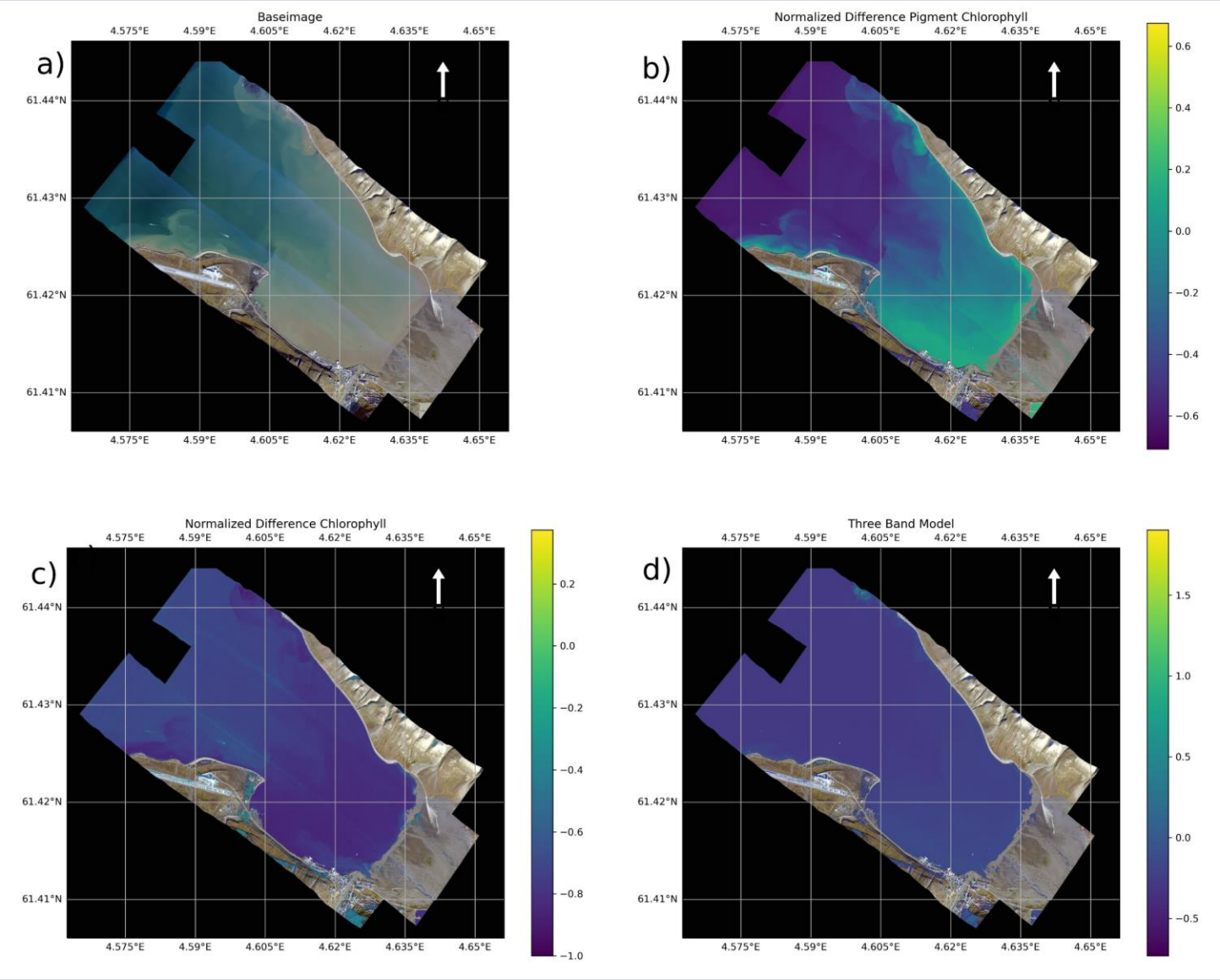
Red- 681 (nm)



Landcover mapping using hyperspectral data





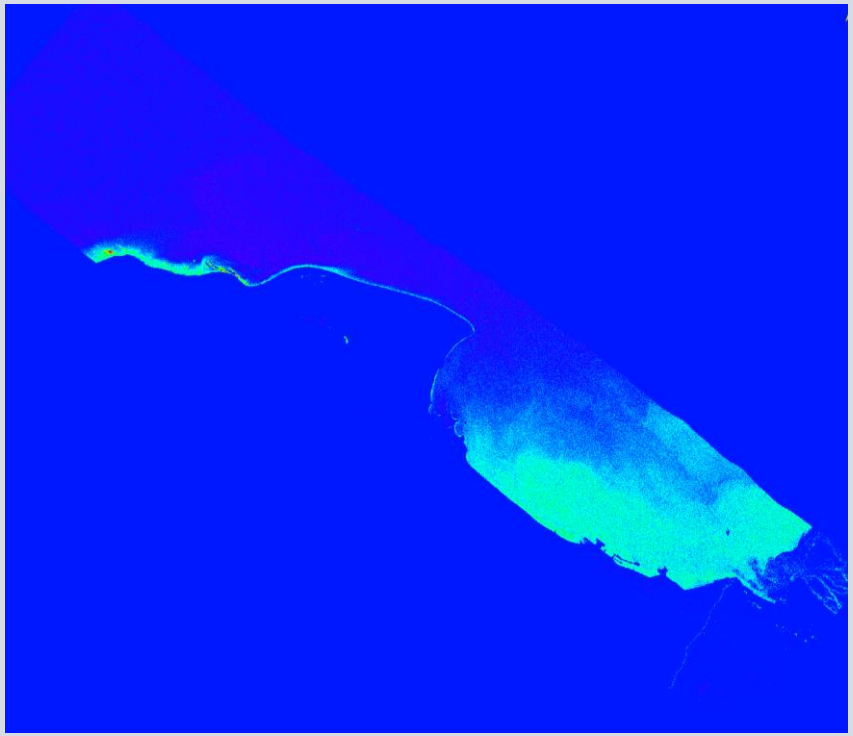


Relative Chl-a Concentration

- Spatial pattern seems reasonable.
- Chl-a = α(Relative Chl-a) + β
- Ground truth data to calibrate fitting curve
- Spatial resolution of satellite product is too coarse.

Chlorophyll mapping using hyperspectral data

MCI (Maximum Chlorophyll Index)

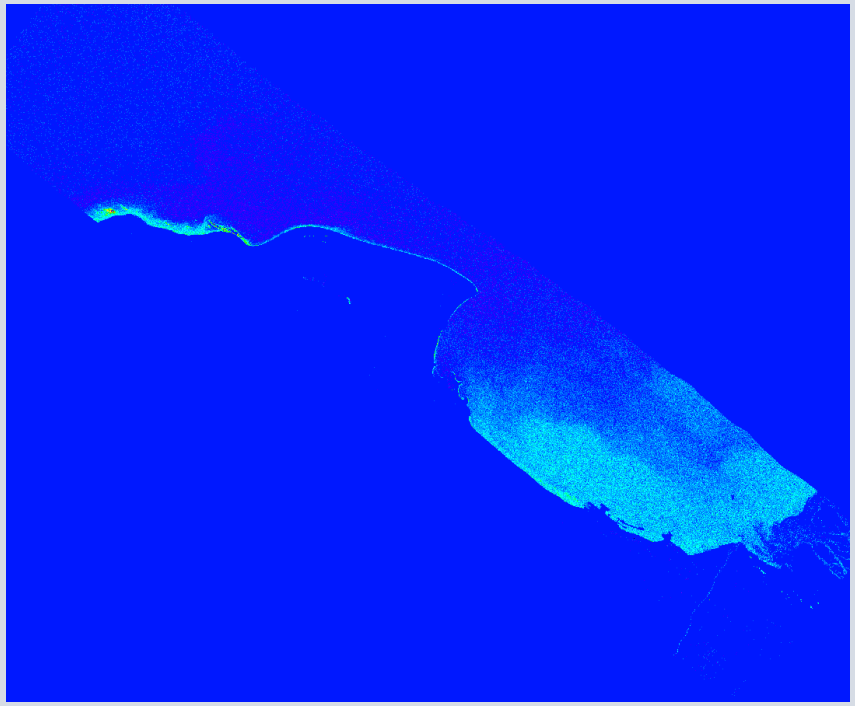


Color	MCI range	
	-0.00071	-0.00042
	-0.00042	-0.00012
	-0.00012	0.000172
	0.000173	0.000465
	0.000467	0.000758
	0.000761	0.001051
	0.001055	0.001344
	0.001349	0.001637
	0.001643	0.00193
	0.001937	0.002223
	0.002231	0.002516
	0.002525	0.002809
	0.002819	0.003102
	0.003113	0.003395
	0.003407	0.003688
	0.003701	0.003981

$$MCI = R_{\lambda 2} - \left[R_{\lambda 1} + (R_{\lambda 3} - R_{\lambda 1}) \cdot \frac{\lambda_2 - \lambda_1}{\lambda_3 - \lambda_1} \right]$$

λ_1 = 666.0177 nm Band 83
λ_2 = 710.6452 nm Band 97
λ_3 = 755.2728 nm Band 111

MERIS MCI (MERIS Maximum Chlorophyll Index)



Color	MERIS MCI range	
	-0.00089	-0.00059
	-0.00059	-0.00028
	-0.00028	0.000018
	0.000018	0.00032
	0.00032	0.000622
	0.000622	0.000924
	0.000924	0.001226
	0.001226	0.001528
	0.001528	0.00183
	0.00183	0.002132
	0.002132	0.002434
	0.002434	0.002736
	0.002736	0.003038
	0.003038	0.00334
	0.00334	0.003642
	0.003642	0.003944

$$MERIS\ MCI = \lambda_{709} - \lambda_{681} - \left[\frac{(710.64 - 681.95)}{(752.09 - 681.95)} \cdot (\lambda_{753} - \lambda_{681}) \right]$$

λ_{753}: Band 110 = 752.0851 nm
λ_{709}: Band 97 = 710.6452 nm
λ_{681}: Band 88 = 681.9561 nm

SIOS
SVALBARD INTEGRATED ARCTIC EARTH OBSERVING SYSTEM

An international partnership of researchers studying the environment and climate in and around Svalbard to

- Develop an efficient observing system
- Share technology, experience and data
- Close knowledge gaps
- Decrease the environmental footprint of science

www.sios-svalbard.org