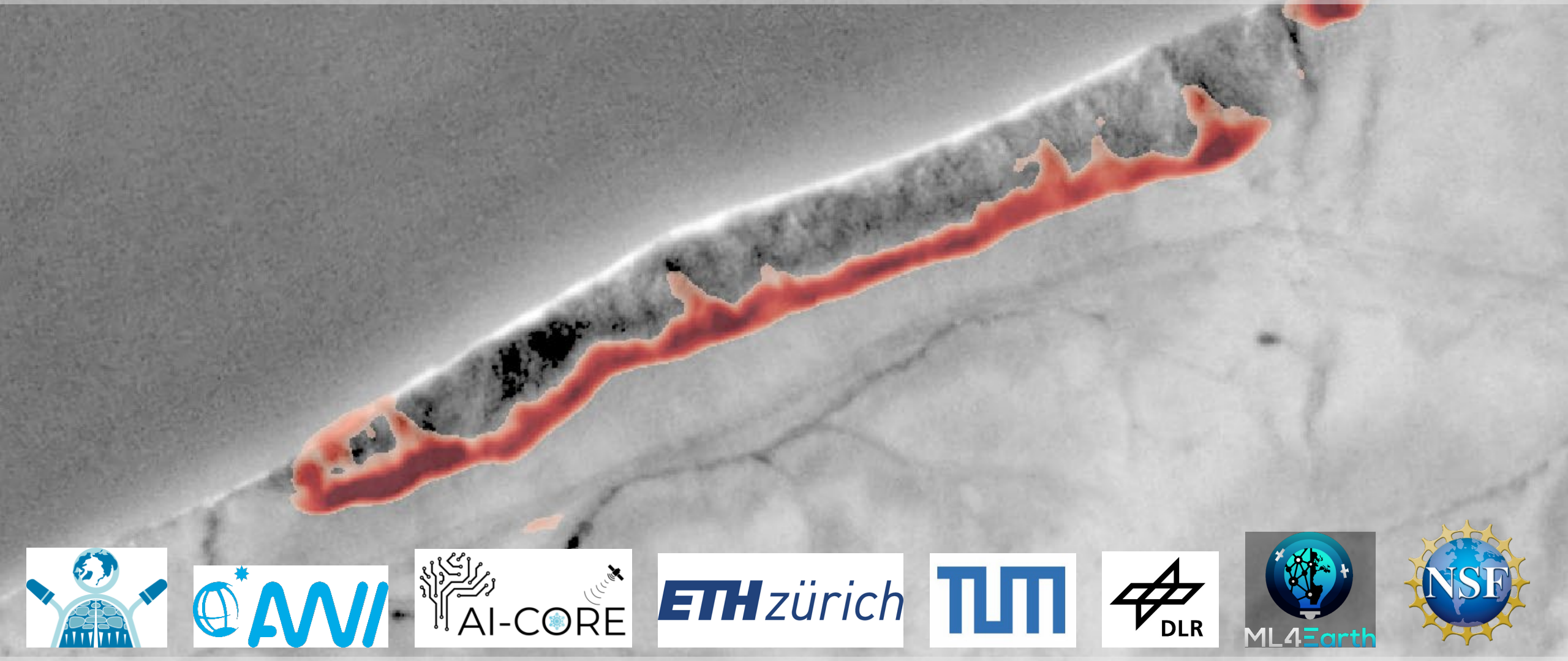
Towards a Deep-Learning based Inventory of Retrogressive Thaw Slumps across the Arctic



2022-12-16 – AGU Fall Meeting

Ingmar Nitze, K.Heidler, S.Barth, P.Bernhard, K.Maier, G.Grosse

Retrogressive Thaw Slumps

Retrogressive Thaw Slumps

Significance

- PF disturbance
- Influence on BG Cycles
- Geohazard
- Downstream Ecology
- Indicator of Change

Retrogressive Thaw Slumps

Significance
- PF disturbance
- Influence on BG Cycles
- Geohazard
- Downstream Ecology
- Indicator of Change

Key attributes
- Size & Shape
- Stratigraphy
- Vegetation
- Dynamics
- Definition not clear

Deep Learning for mapping RTS

New Data + Techniques available !

Global Data:
PlanetScope (3m)
VHR constellations
- Maxar, Skysat, Pleiades

DEM
- Arctic DEM

Methods:
- Deep Learning
- Machine-learning
- Computer Vision
- Image Augmentation
- …

Computational resources:
- GPU Processing (Deep-learning)
- High-performance computing
- Cloud Computing

…

Deep Learning for mapping RTS

New Data + Techniques available !

Global Data:
PlanetScope (3m)
VHR constellations
- Maxar, Skysat, Pleiades

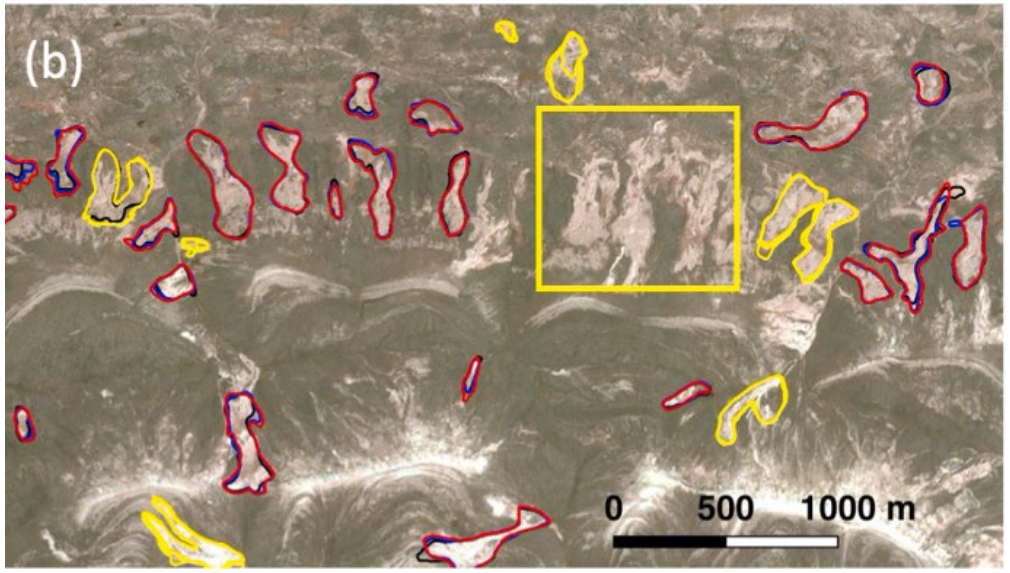
DEM
- Arctic DEM

Methods:
- Deep Learning
- Machine-learning
- Computer Vision
- Image Augmentation
- …

Computational resources:
- GPU Processing (Deep-learning)
- High-performance computing
- Cloud Computing

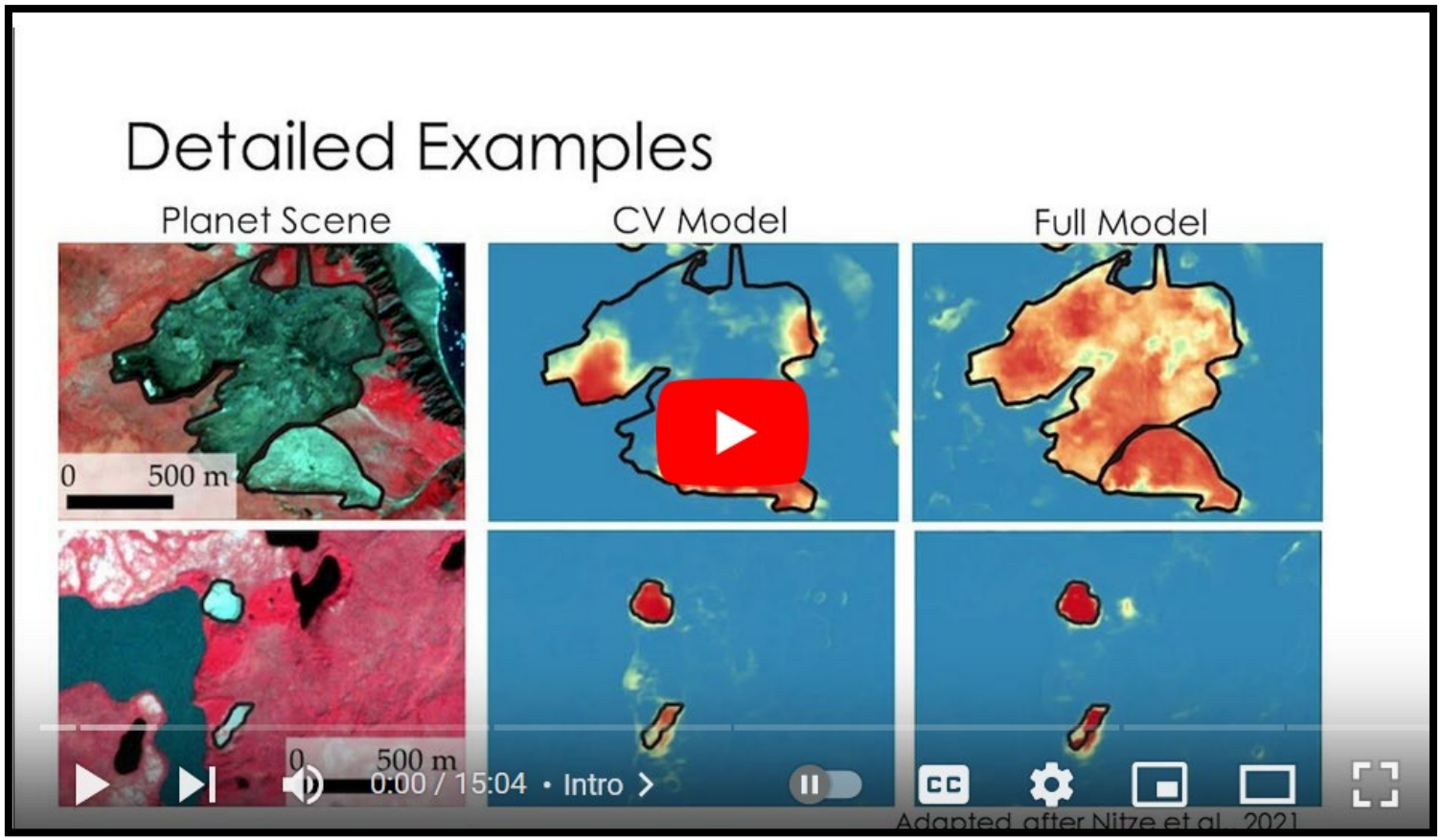
…

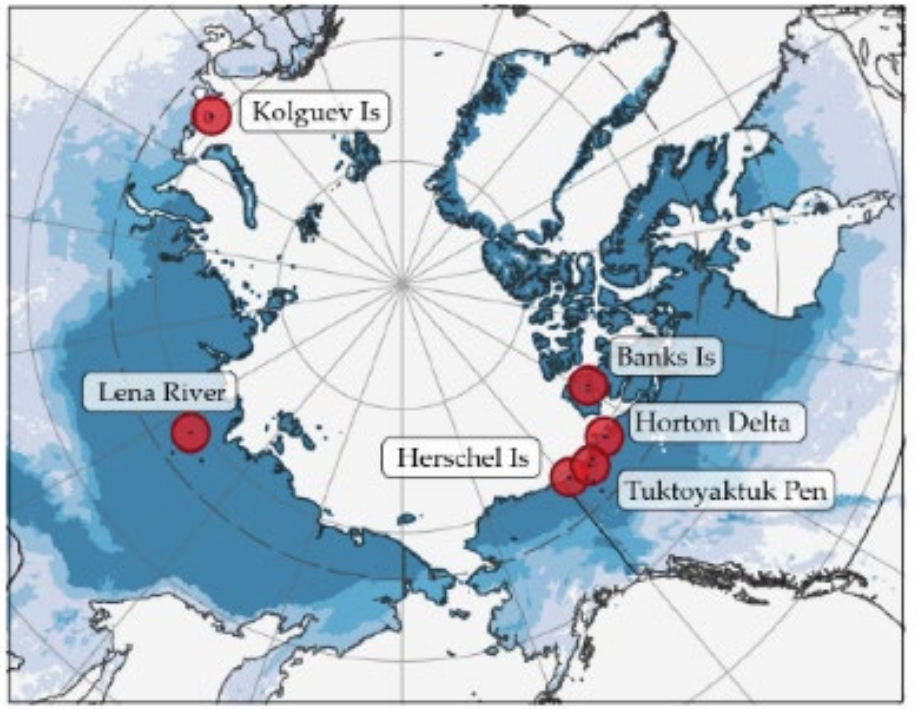
Only few permafrost DL studies
-> even fewer for Thaw Slumps



Huang et al., 2021

AGU21 Nitze et al.
https://youtu.be/Cuva8OebyrA





Adapted after Nitze et al., 2021
(Remote Sensing)

6 Sites
Setup of Methodology
Performance tests

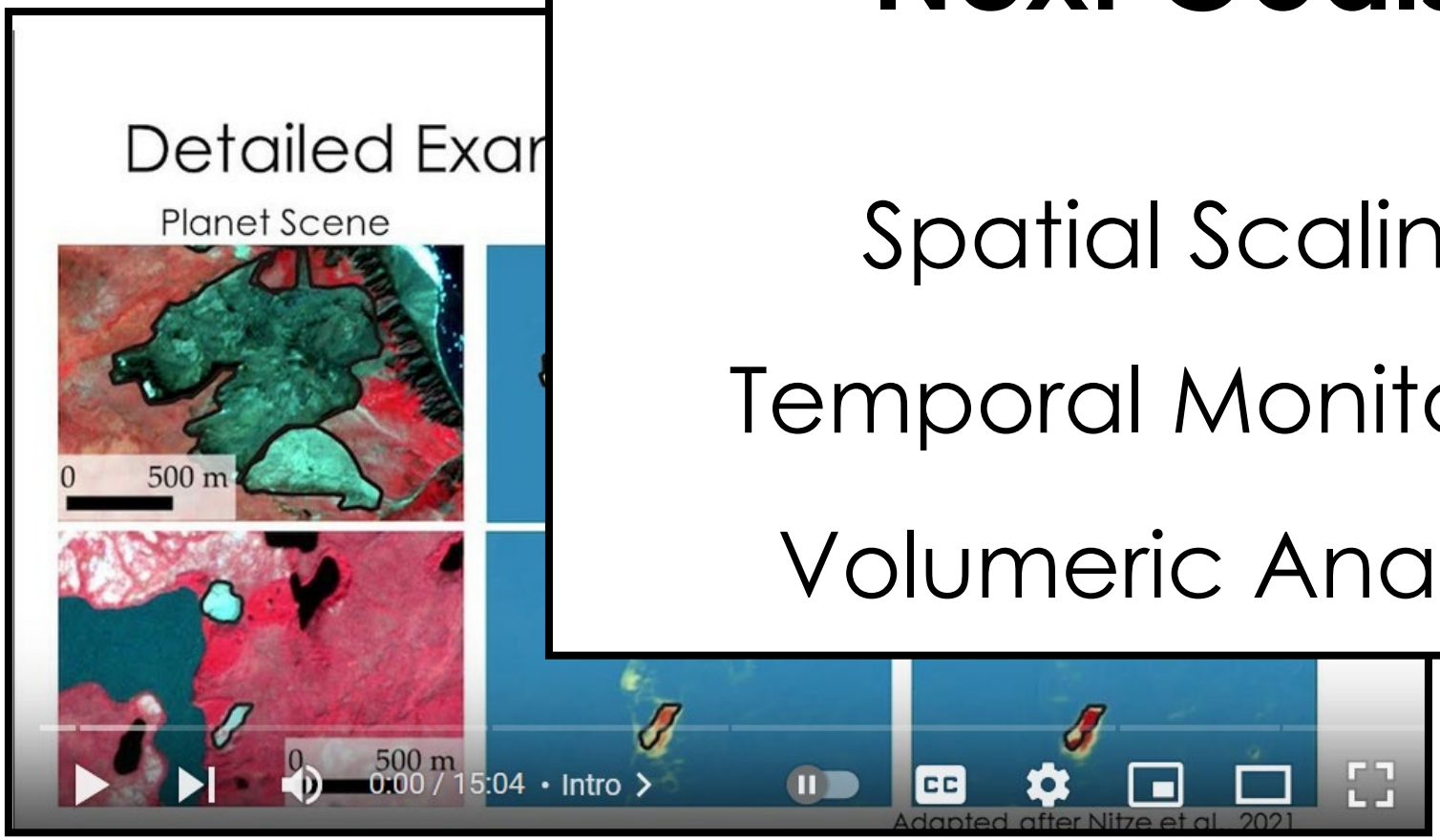
AGU21 Nitze et al.
https://youtu.be/Cuva8OebyrA

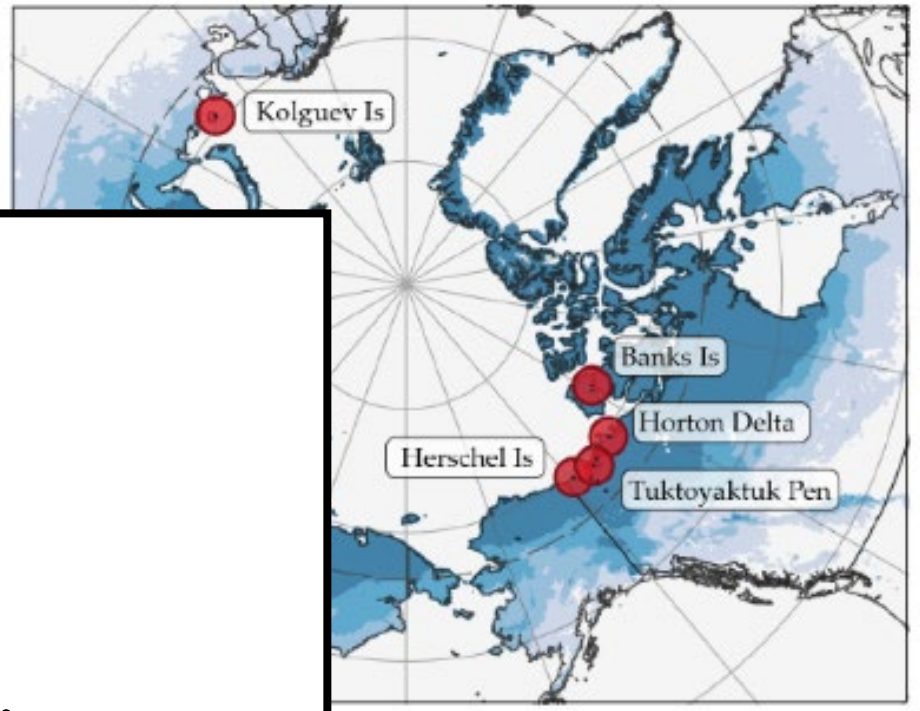
Next Goals!

Spatial Scaling

Temporal Monitoring

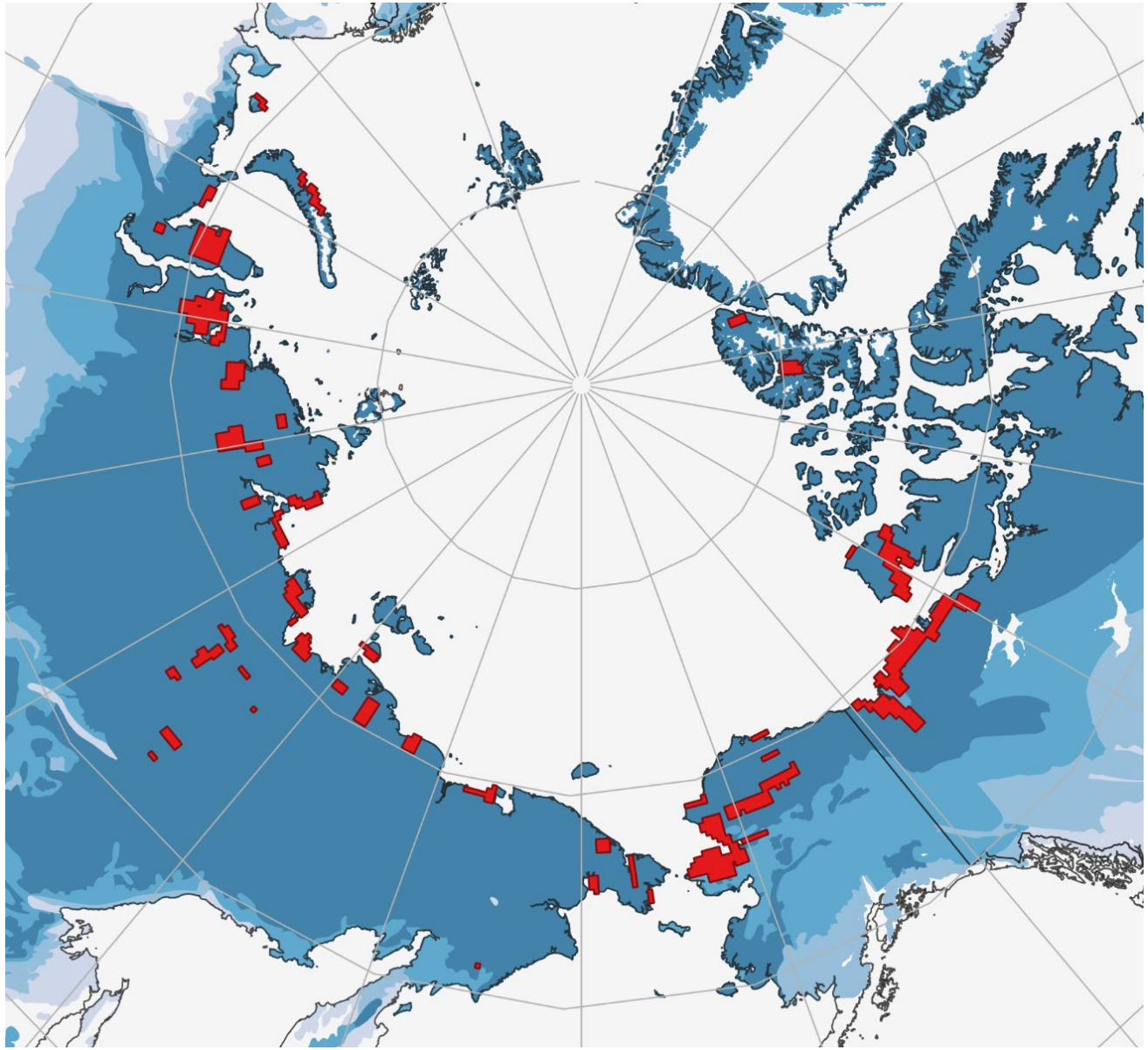
Volumeric Analysis





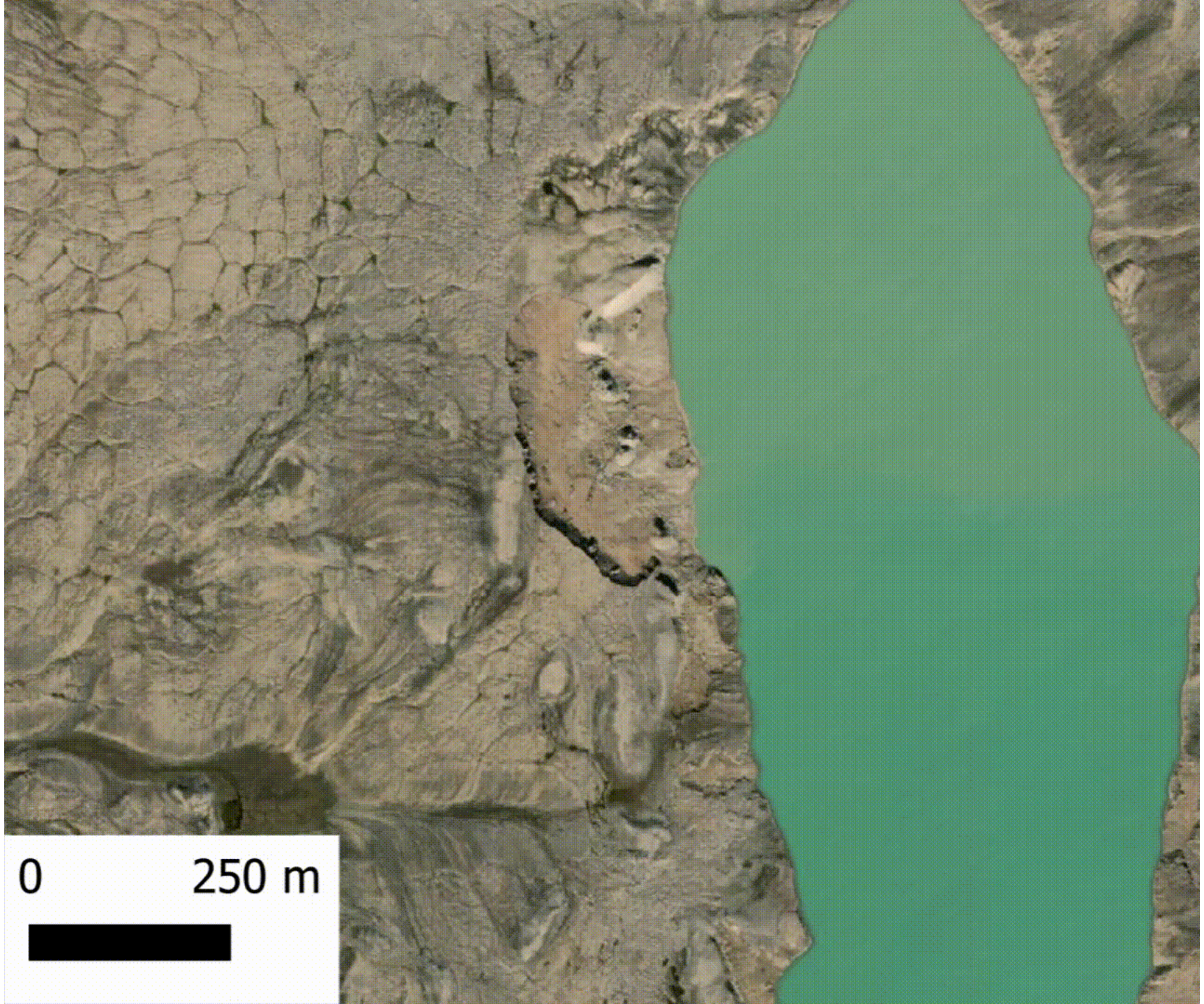
tze et al., 2021

Setup of Methodology
Performance tests



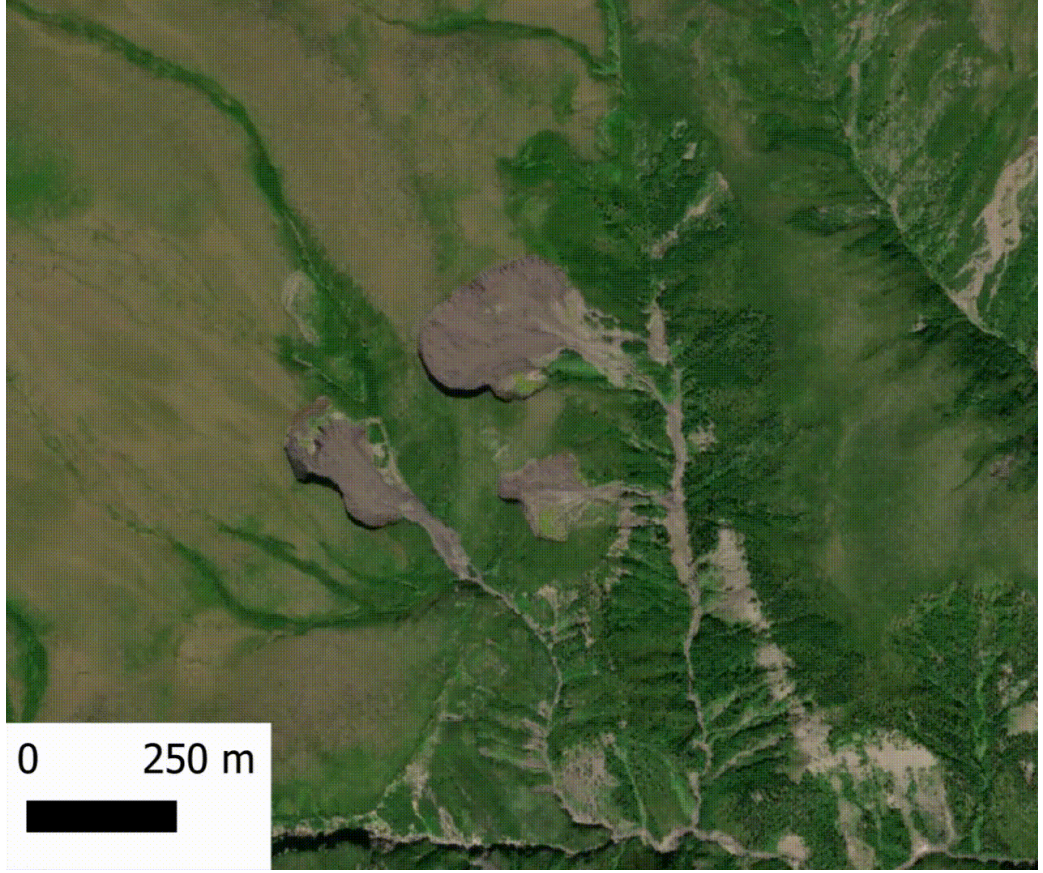
Current data footprint (Dec 2022)

- Total data area 1 Mkm² of PlanetScope (limited Quota)
- ~3000 Planet images (Scenes + Orthotiles)
- 849 unique tiles (118 multi-temporal)
  - 2018/19 - 2022
- 4336 training samples (hand digitized)
  - iterative approach
  - digitize - train – analyze - repeat



Location:
Banks Island

Background layer:
ESRI Satellite



Location:
Peel Plateau (NW Canada)

Background layer:
ESRI Satellite

Location:
Novaya Zemlya (NW Russia)

Background layer:
ESRI Satellite

Good performance in well known regions

Temporal evolution detected

Well defined headwall

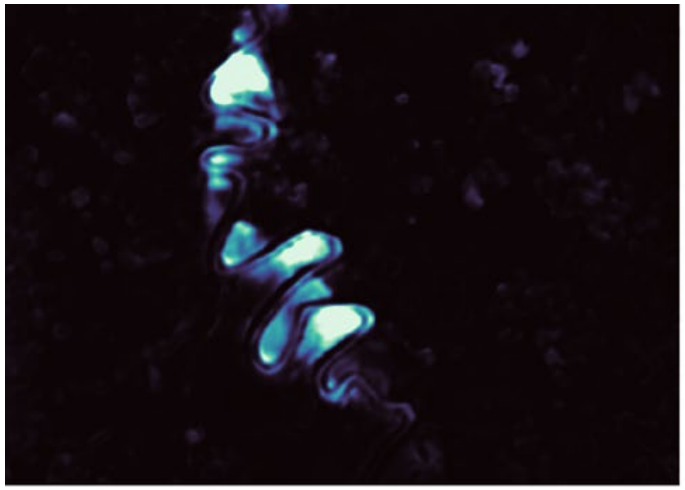
Scaling to the Arctic?

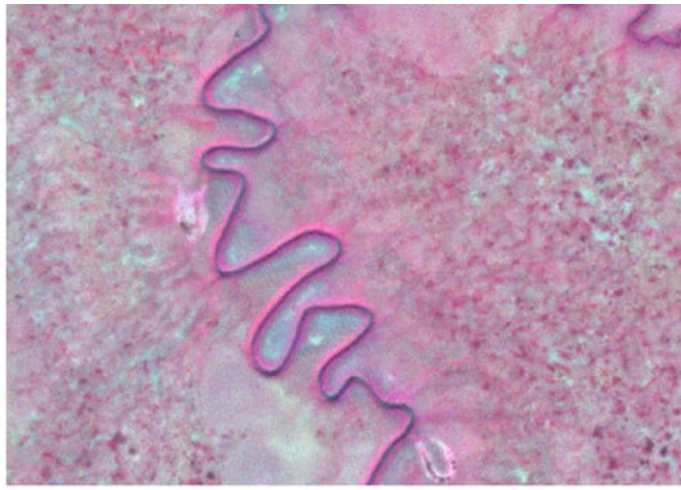
Positives

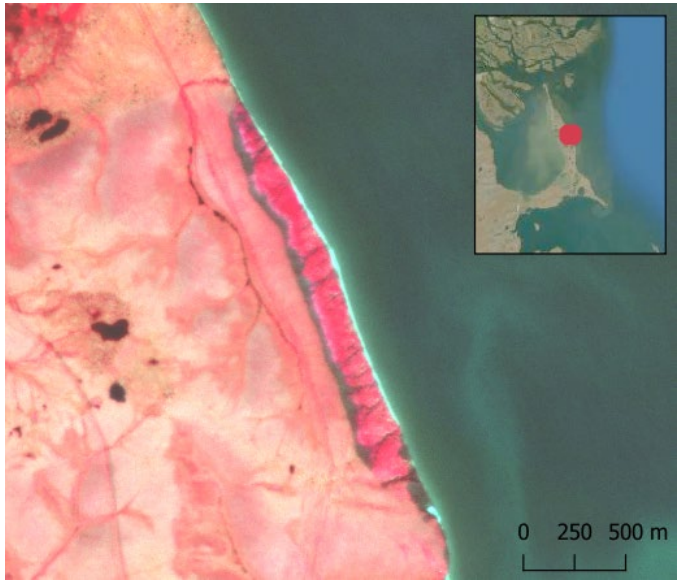
- Good performance in trained areas
- Fast and established processing pipeline

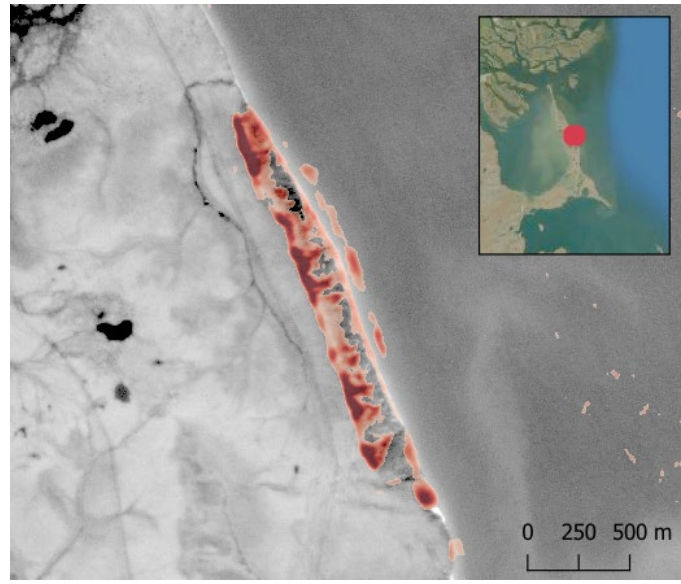
Challenges:

- Many False positives
  - Spatial diversity
- Semantics: What is an RTS?
- Data access (commercial data)





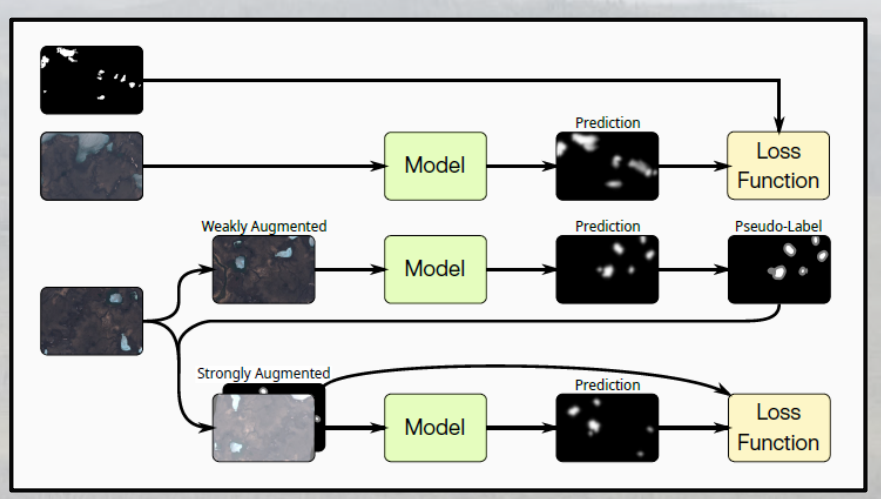




Outlook

Self supervised learning

- Less training data required



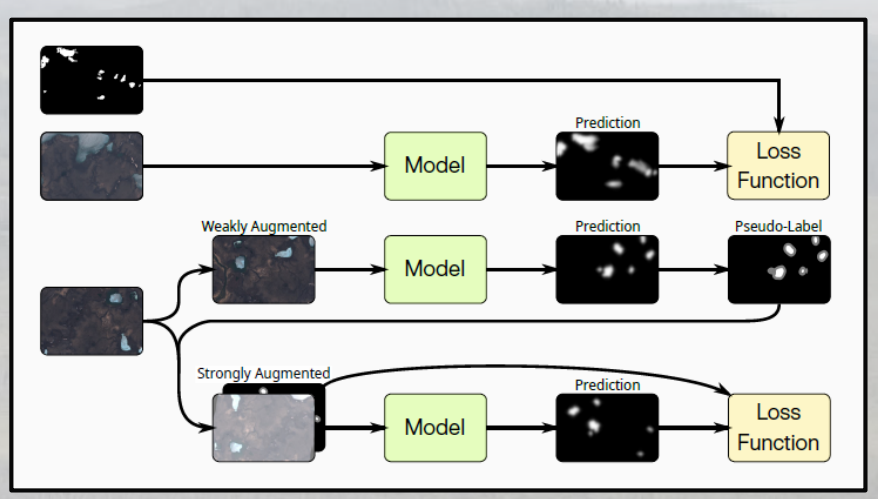
Outlook

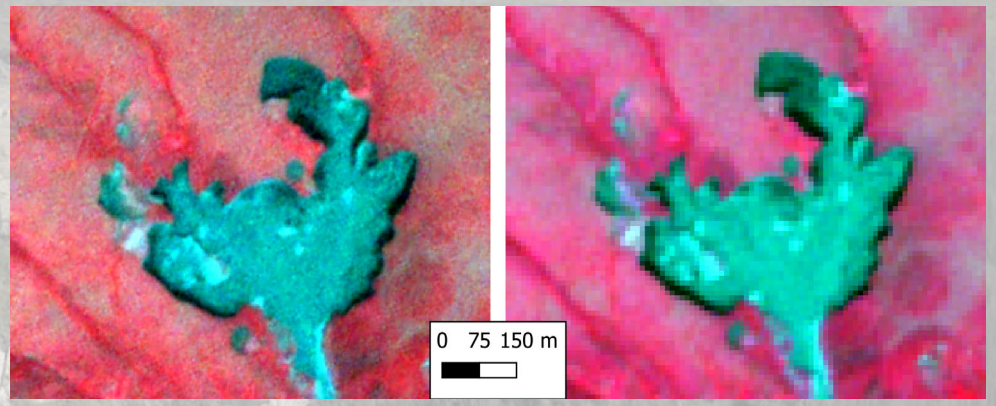
Self supervised learning

- Less training data required

Additional Data Sources

- Sentinel-2 → free data
- Panarctic extent
- Monitoring

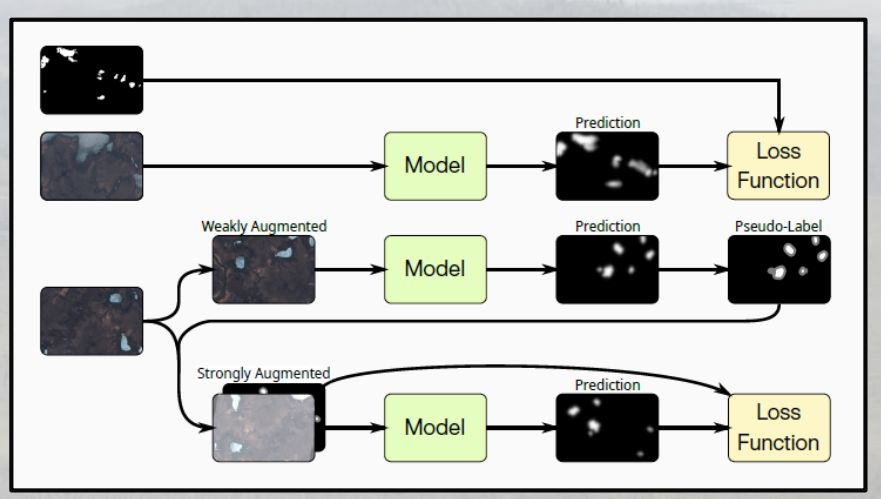




Outlook

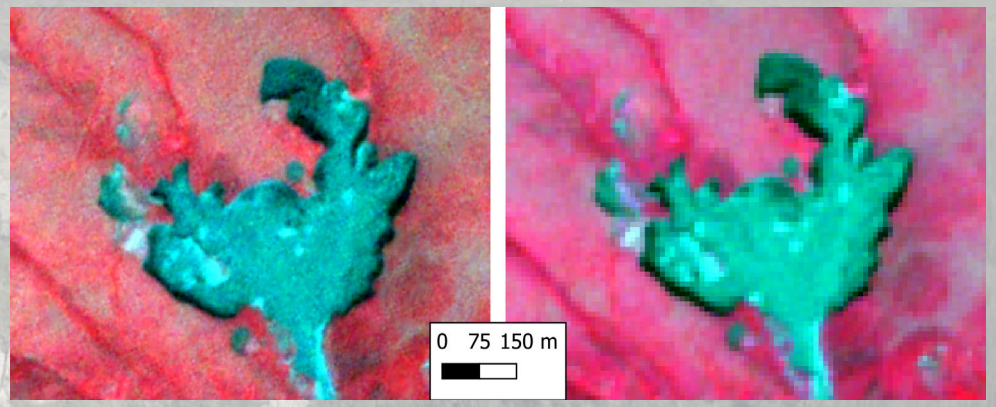
Self supervised learning

- Less training data required



Additional Data Sources

- Sentinel-2 → free data
- Panarctic extent
- Monitoring



Volumetric Changes

- RTS are 3D features !!!

Thank You

Contact: ingmar.nitze@awi.de

Twitter: @i_nitze **Mastodon:** @i_nitze@mapstodon.space **Github:** https://github.com/initze/

Code: https://github.com/initze/thaw-slump-segmentation

Training Labels: https://github.com/initze/ML_training_labels

References:

Nitze, I., Heidler, K., Barth, S., & Grosse, G. (2021). Developing and Testing a Deep Learning Approach for Mapping Retrogressive Thaw Slumps. Remote Sensing, 13(21). https://doi.org/10.3390/rs13214294

Huang, L., Liu, L., Luo, J., Lin, Z., & Niu, F. (2021). Automatically quantifying evolution of retrogressive thaw slumps in Beiluhe (Tibetan Plateau) from multi-temporal CubeSat images. International Journal of Applied Earth Observation and Geoinformation, 102, 102399. https://doi.org/10.1016/j.jag.2021.102399

Thanks to all people involved, special thanks to Mark Lara + PDG Team + RTSInTrain team, and many more