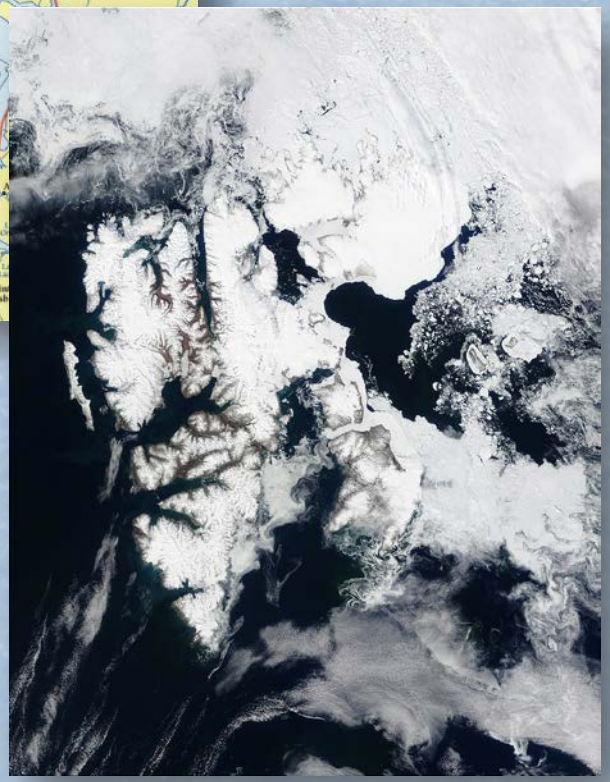
Repeat terrestrial laser scanning surveys to describe and quantify slope dynamics in an Arctic glacier basin. Austre Lovénbreen, Svalbard – 79° N)

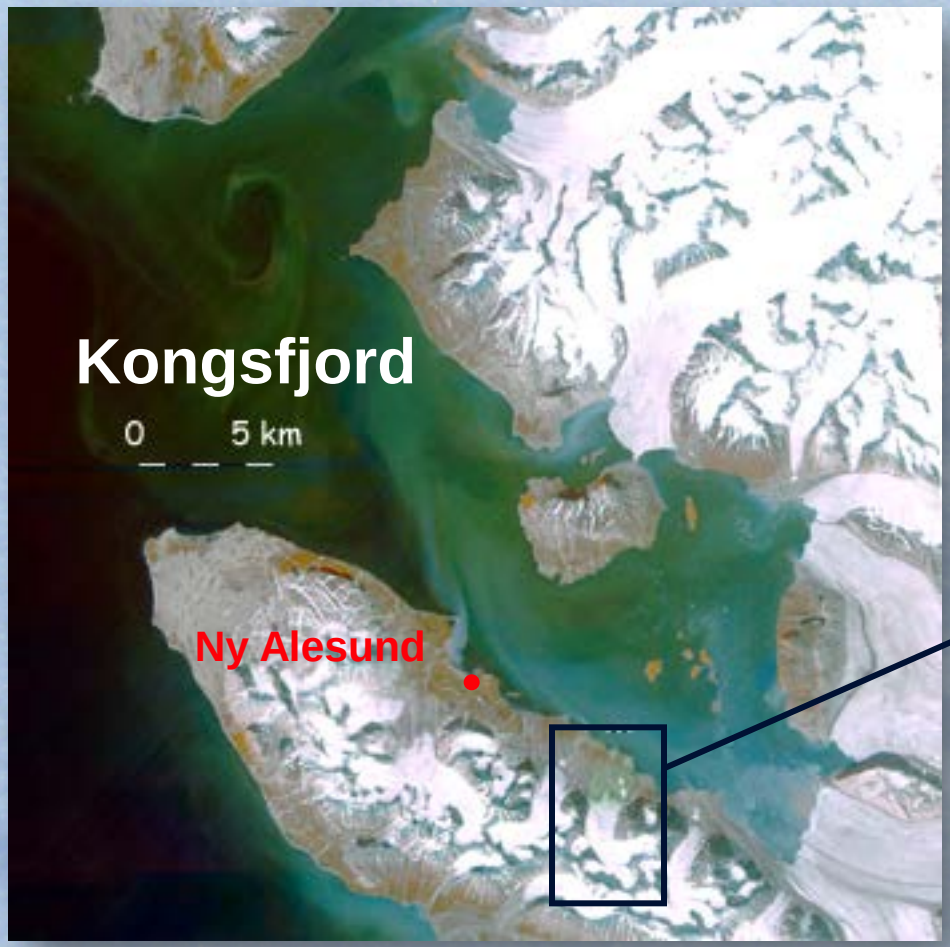
Florian TOLLE[1], Alexander PROKOP[2], Eric BERNARD[1], Jean-Michel FRIEDT[3], Madeleine GRISELIN[1]

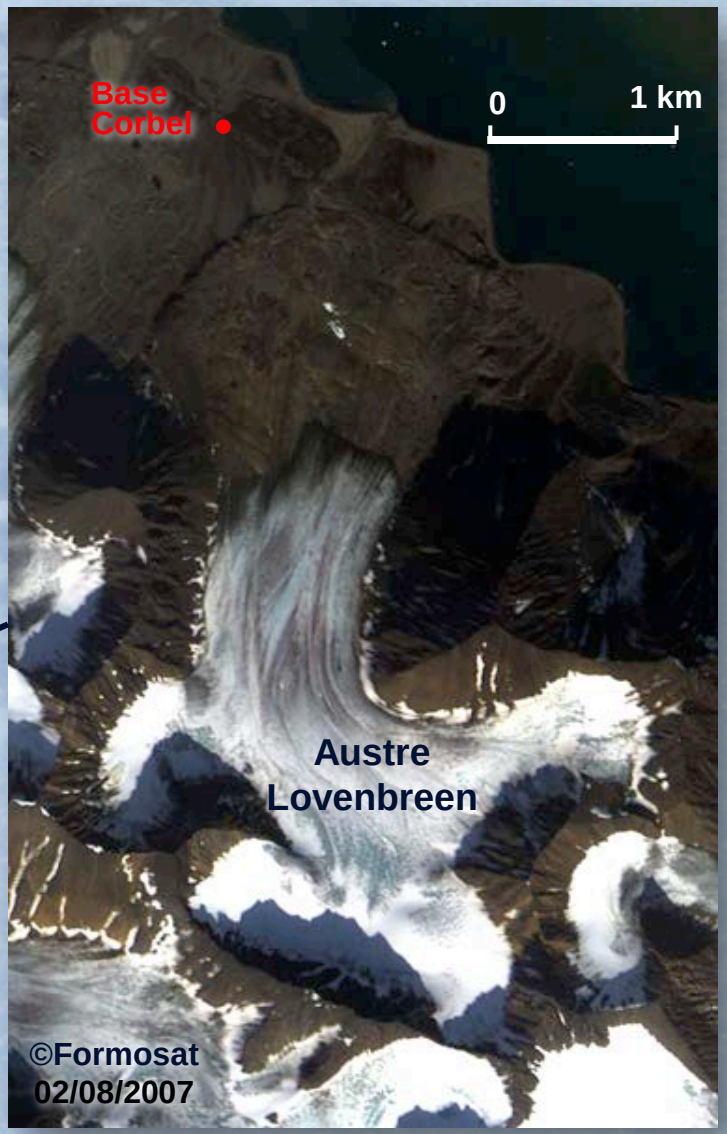
[1] ThéMA CNRS, Université de Franche-Comté, Besançon, France
[2] BOKU, University of natural resources and life sciences, Vienna, Austria
[3] FEMTO-ST CNRS, Université de Franche-Comté, Besançon, France

13th circumpolar remote sensing symposium – Reykjavik
8-12th September 2014



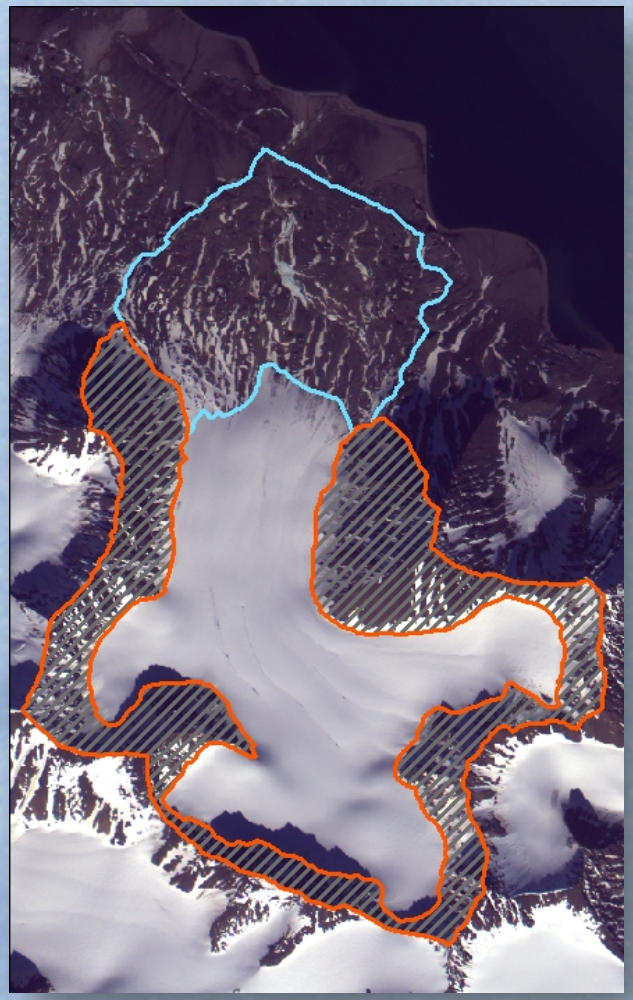
Fieldwork:
Northwestern Svalbard
78° N





Austre Lovénbreen,
6 km east of Ny Alesund

The slopes represent 35 % of the whole basin of the Austre lovénbreen



Slope related issues

- **snow dynamics**

- annual snow volume monitoring using TLS
- maximum in April-May
- minimum late August
–> part of the slopes in the total hydrological budget
–> avalanches, melt, snow quality evolution

- **rock and permafrost**

- rock fall monitoring (August)
- permafrost dynamics (rock slides, creeping, etc.)

- **glacier / slope interface**

- characterizing slope bottom dynamics

- **glacier dynamics**

Fieldwork

Terrestrial Laser Scanner:

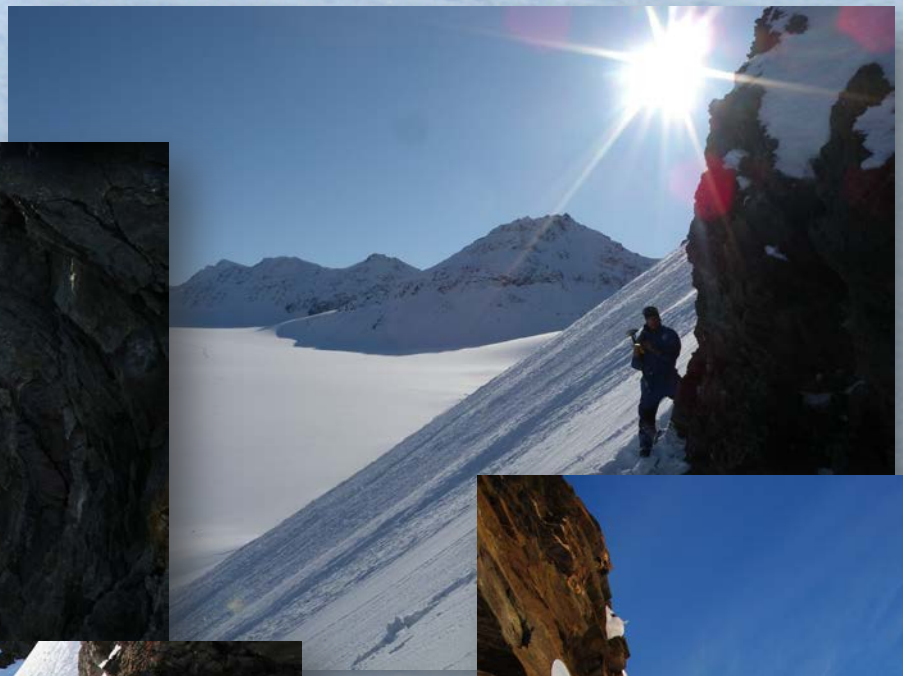
Advantages compared to airborne Lidar:
- **Easier to repeat measurements**
- **Fairly easy to operate for a small team**
- **Cheaper**

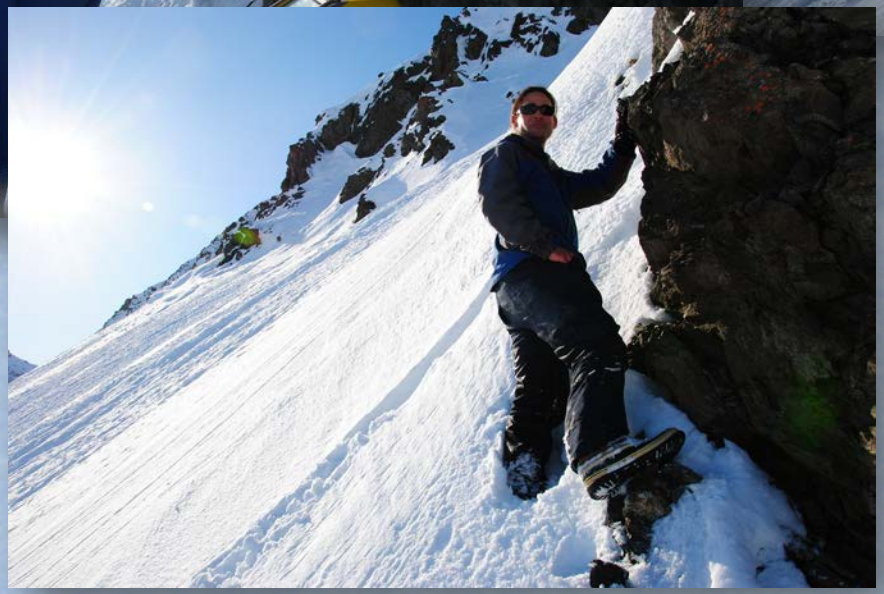
TLS equipment:

Riegl LPM 321

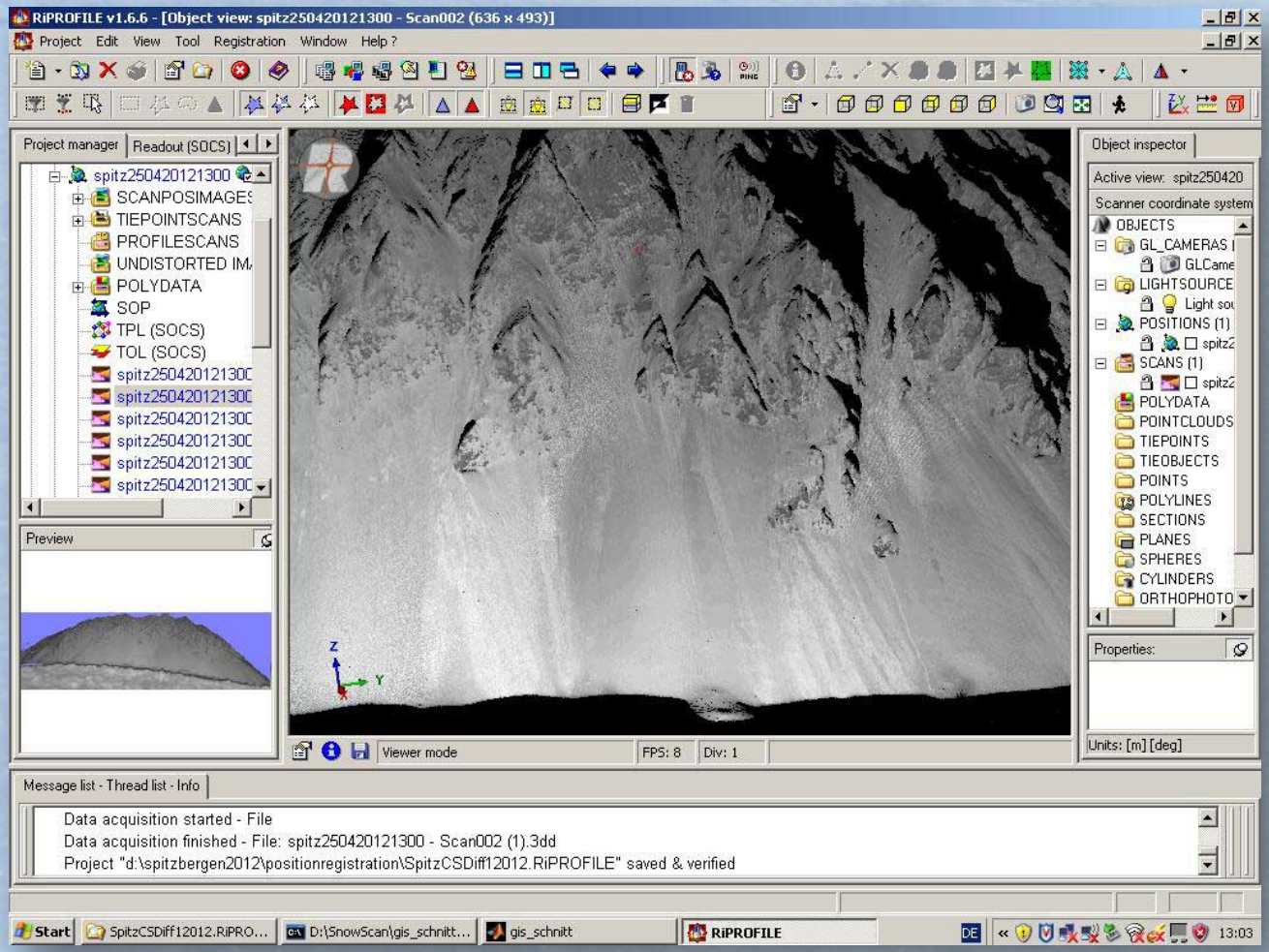
Wavelength: 905 nm (most suited for snow scanning)
Maximal range: 6000 m
Beam size: 50 cm at 500m

Field operation:
TLS + tripod + generator + computer



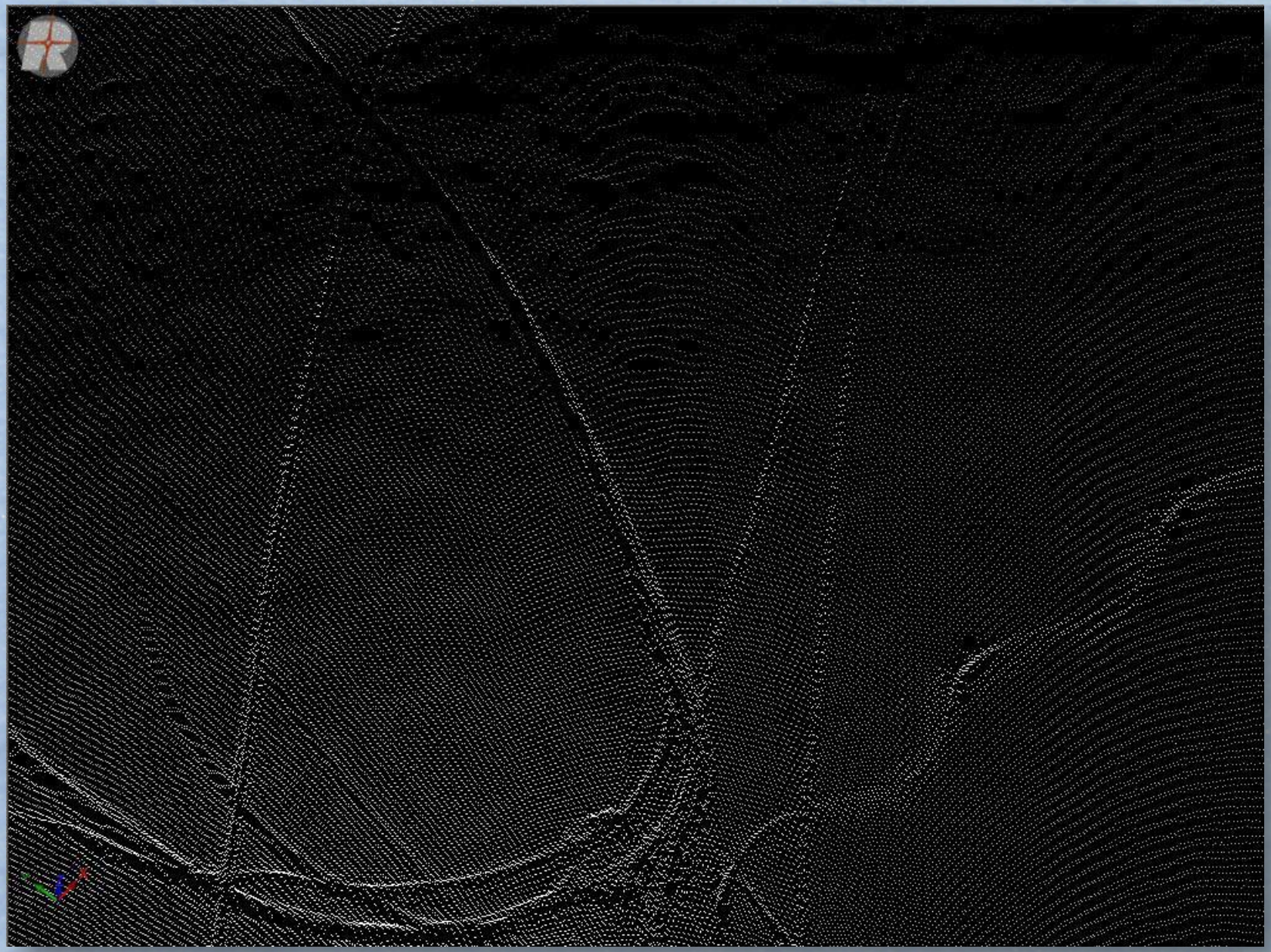


Reflectors set-up for scan registration
Can be troublesome in the steepest slopes

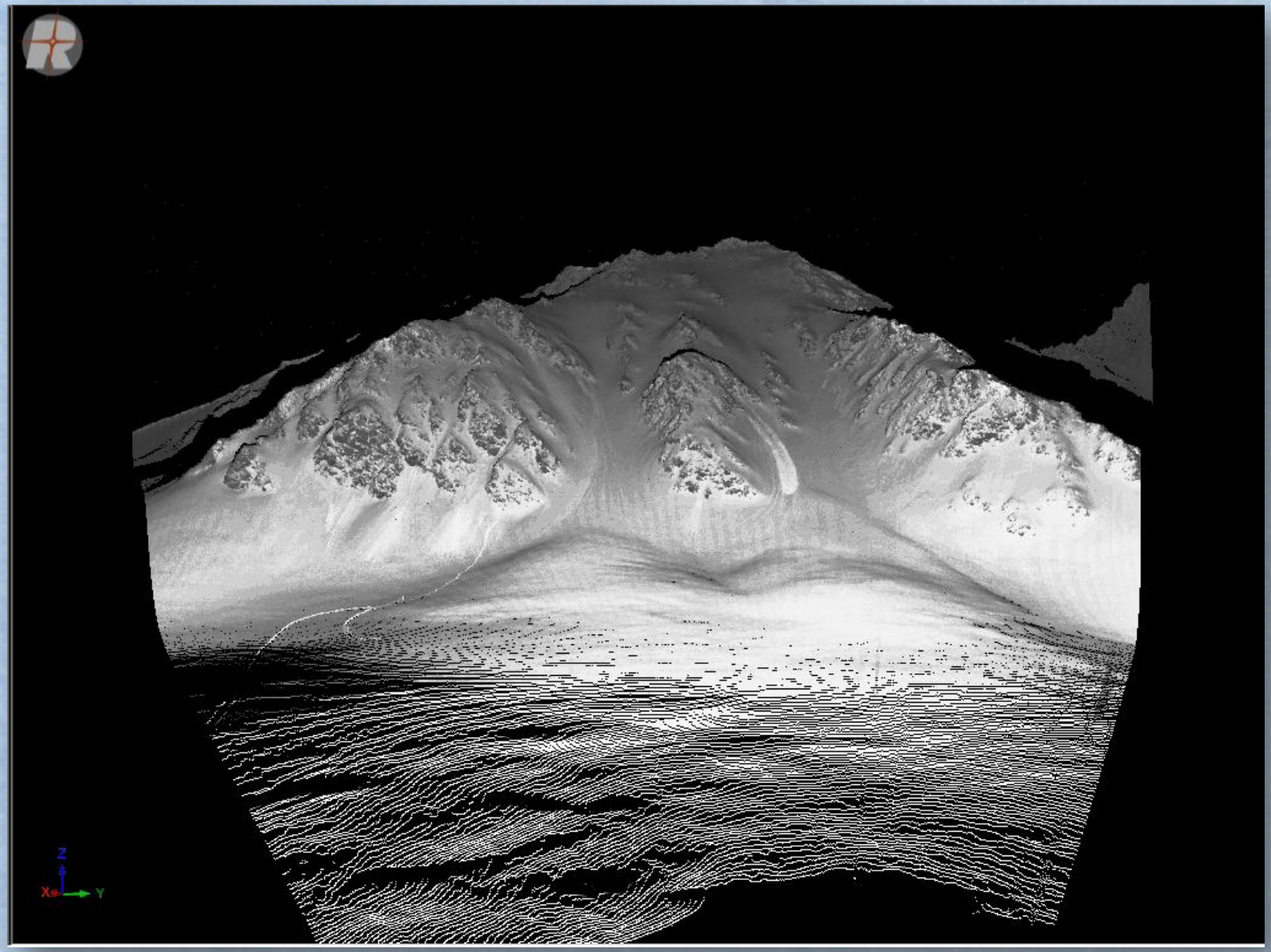


Acquired data: Point cloud with reflectance values
Reflectance values vary according to:
- Ground surface
- Incident angle

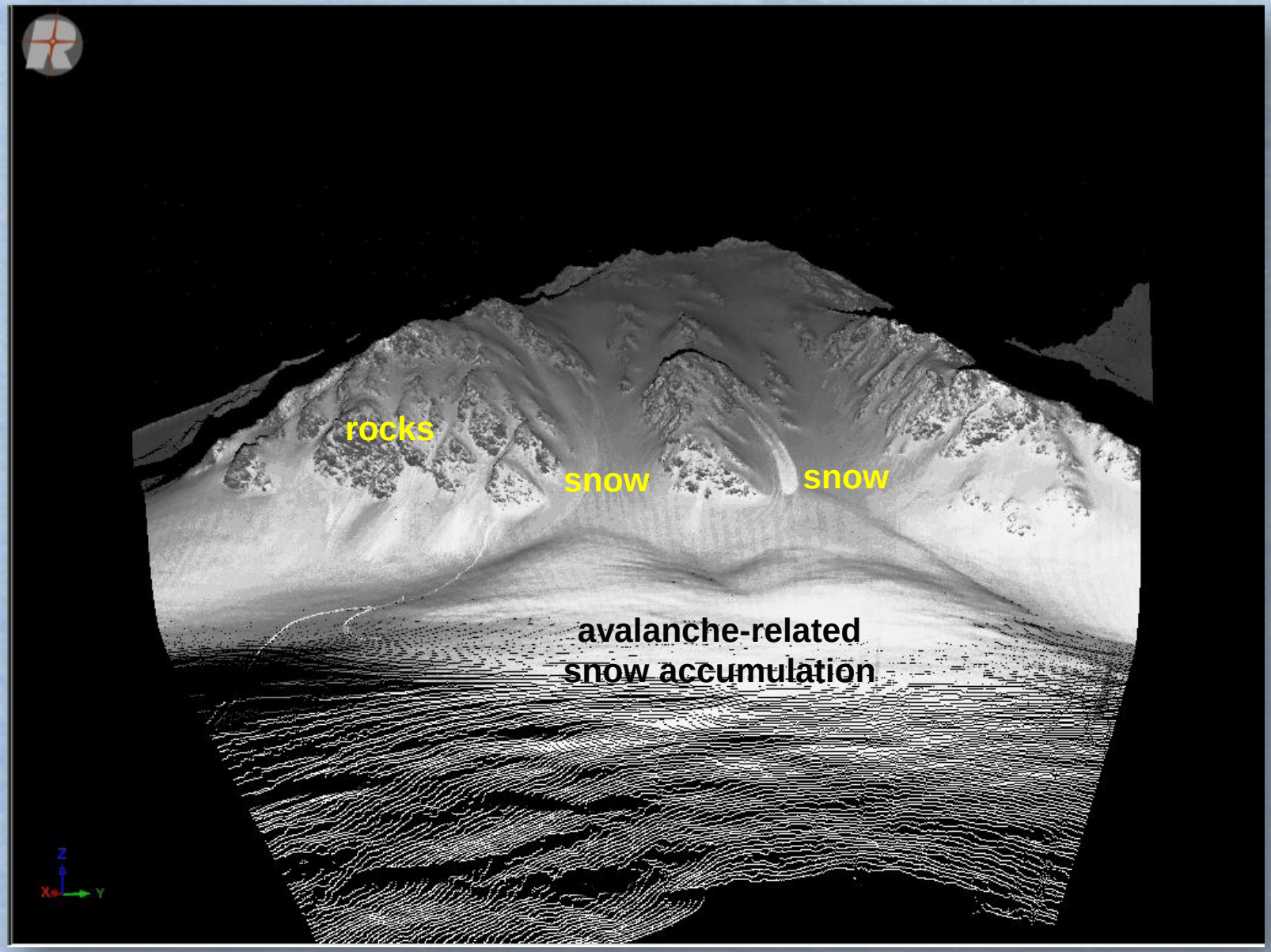
Shadow areas



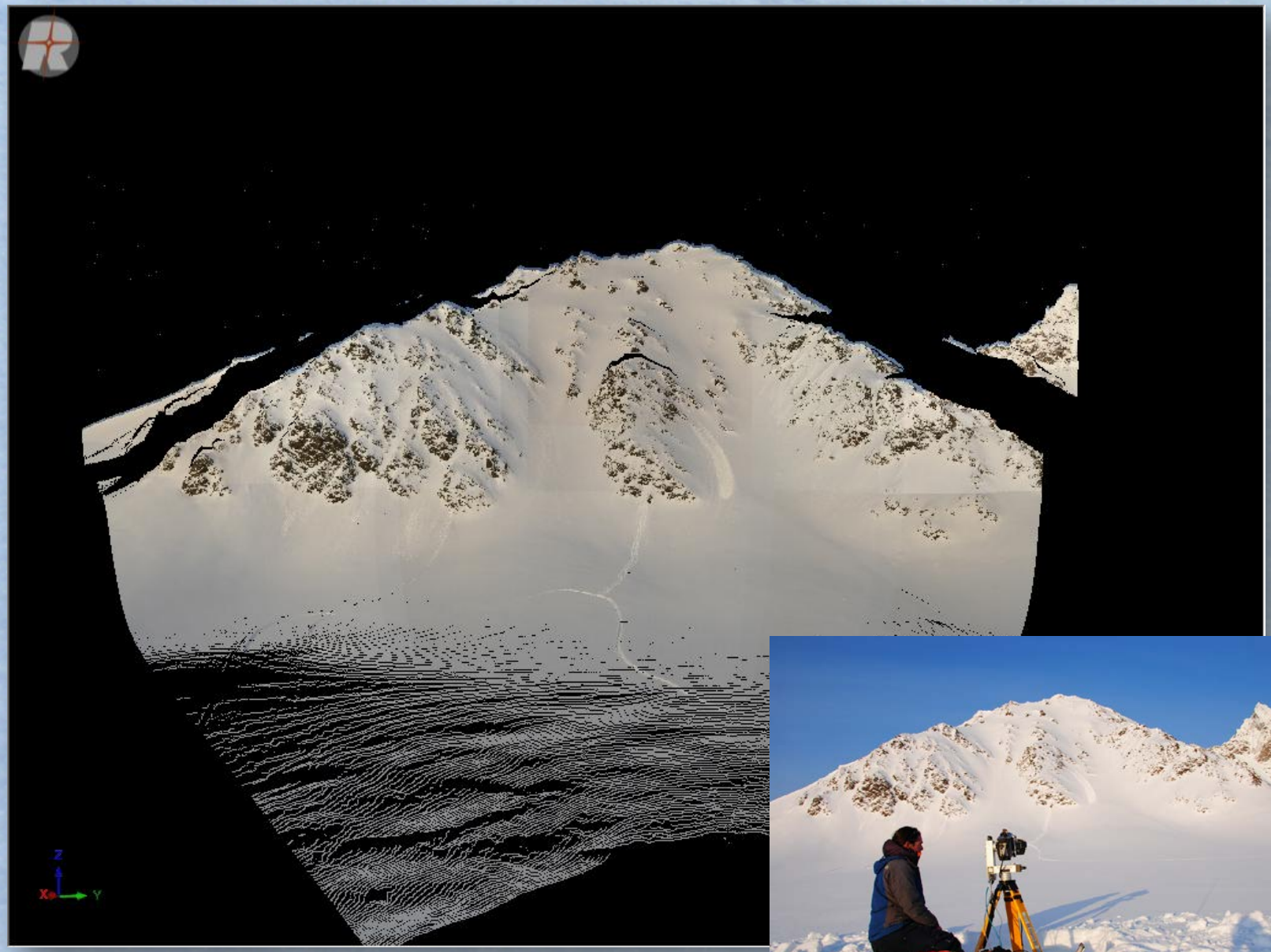
Point cloud



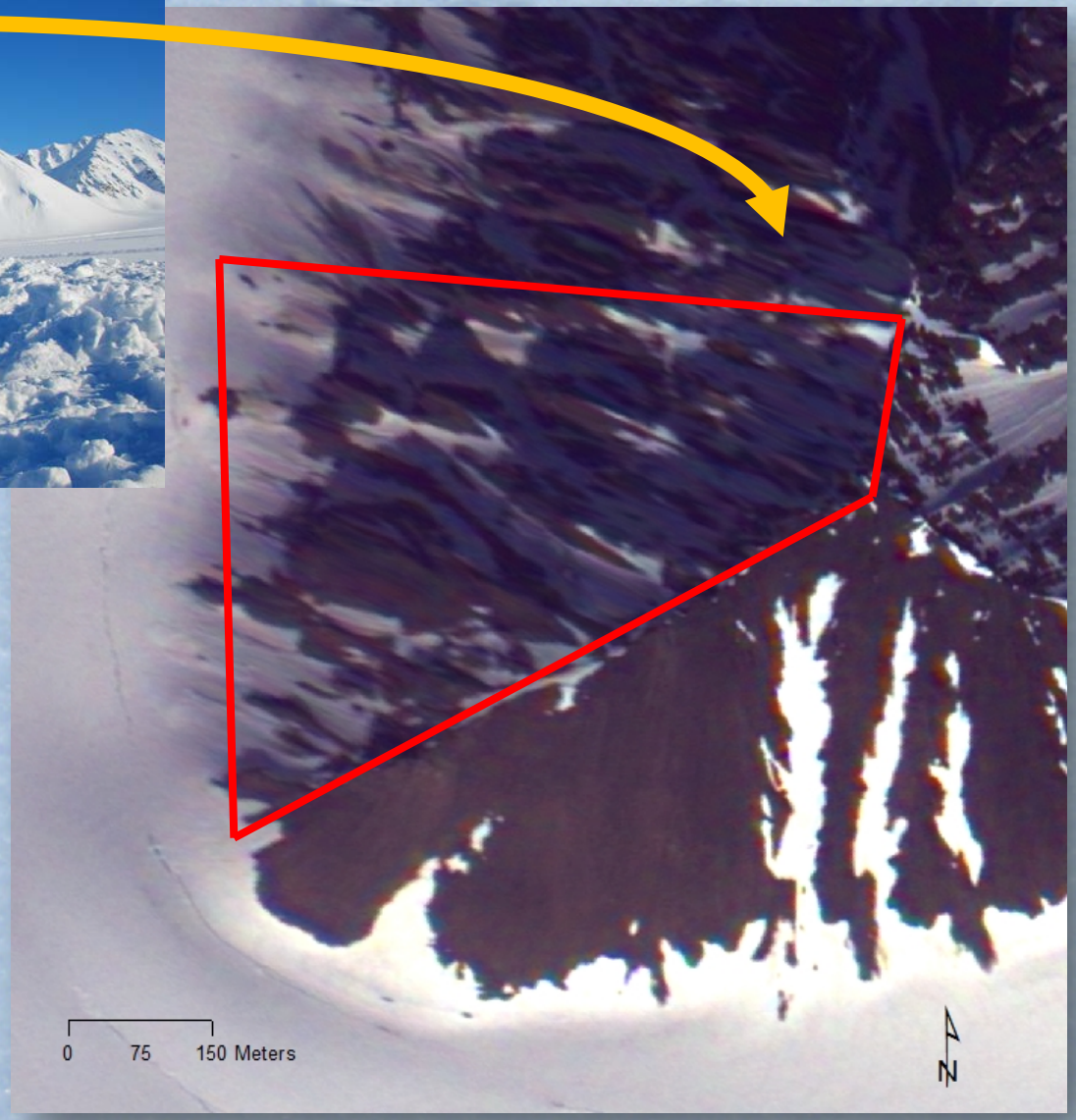
Data seen from TLS data acquisition location



Data seen from TLS data acquisition location



Color info added to the data



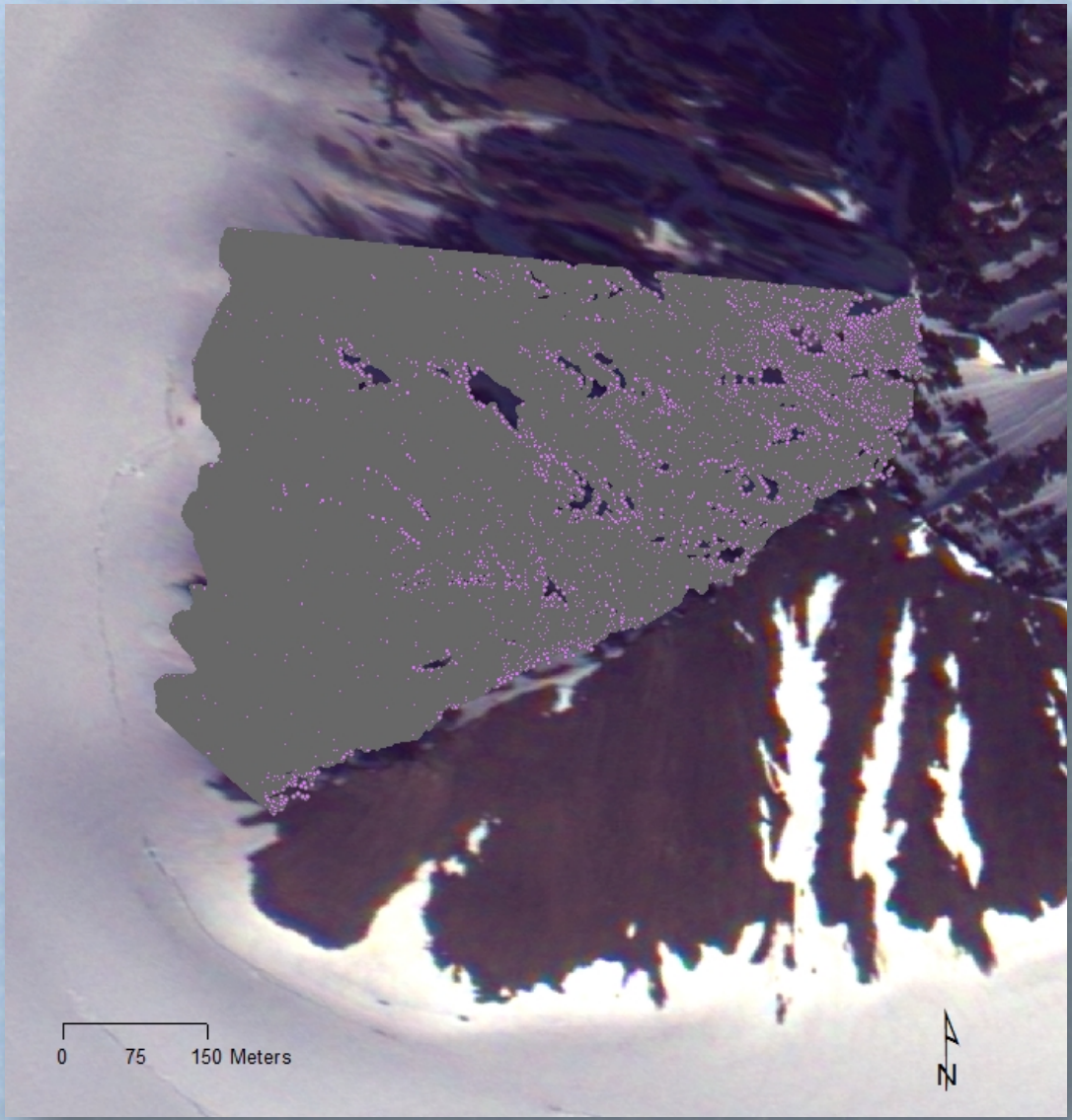
Example of scan processing

TLS acquired data

More than 700 000 points

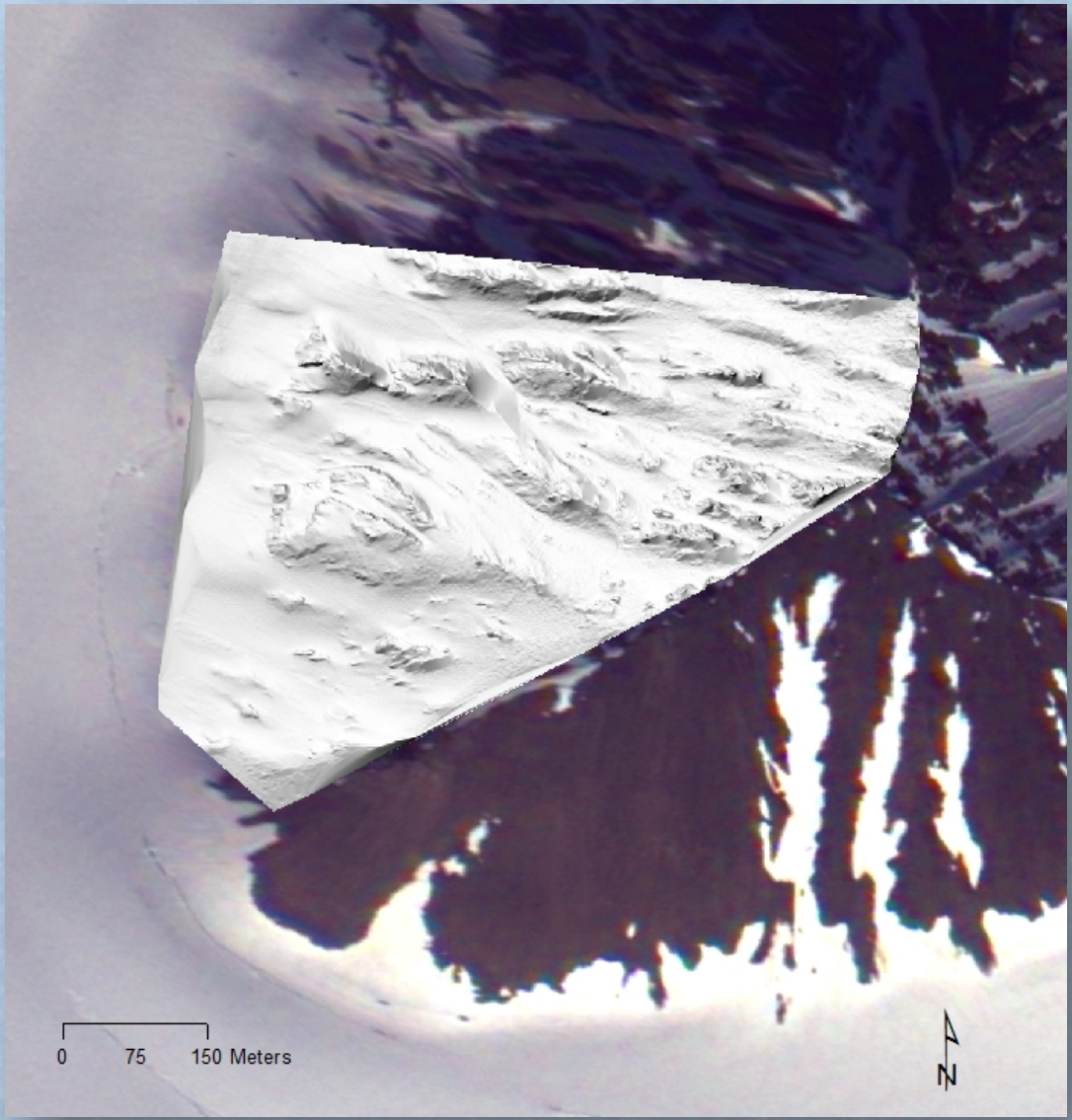
X – Y – Z data

Shadow areas



TLS acquired data

Point data is interpolated to a surface model



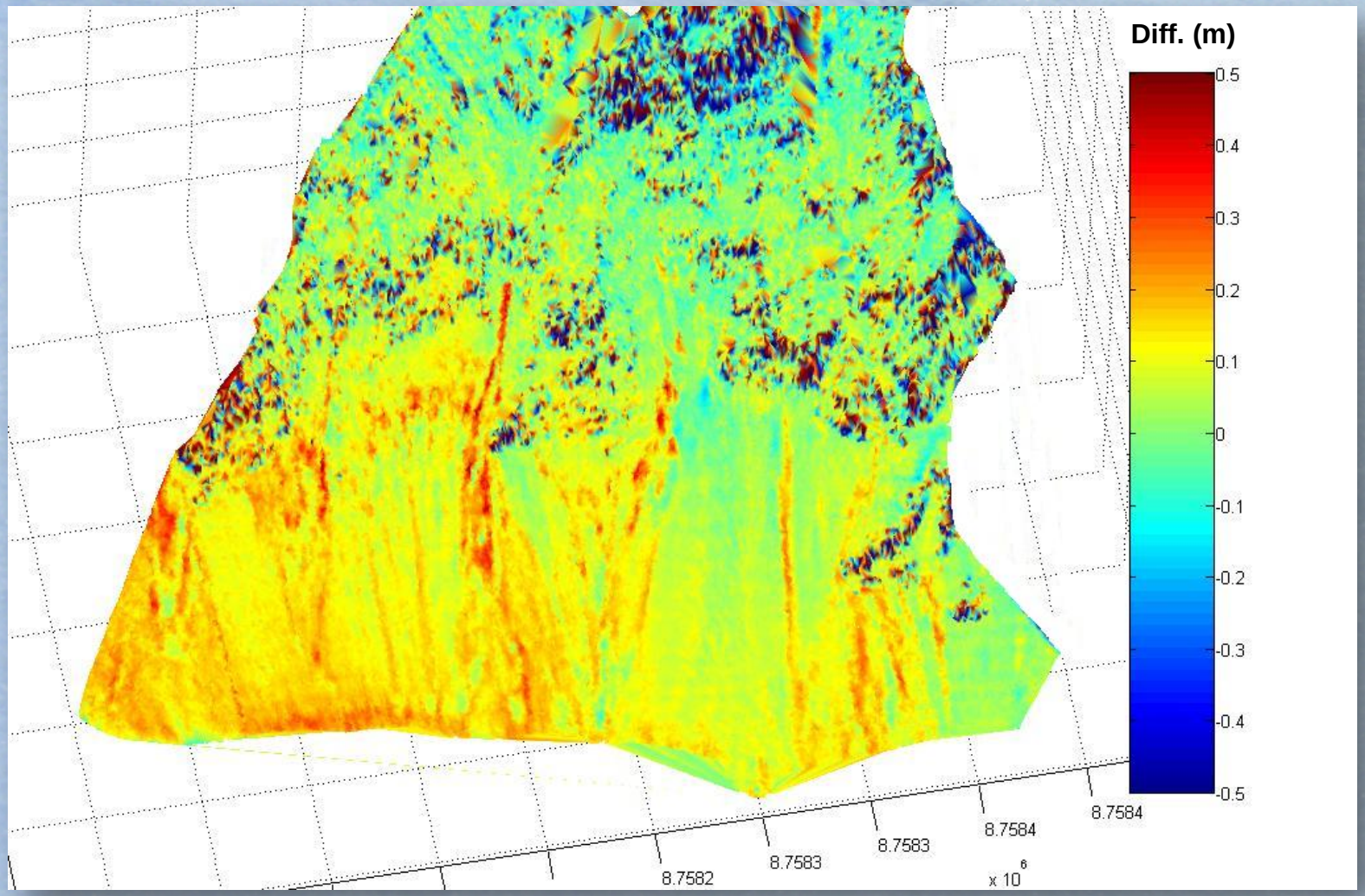
Surface model at snow maximum

Surface model at snow minimum

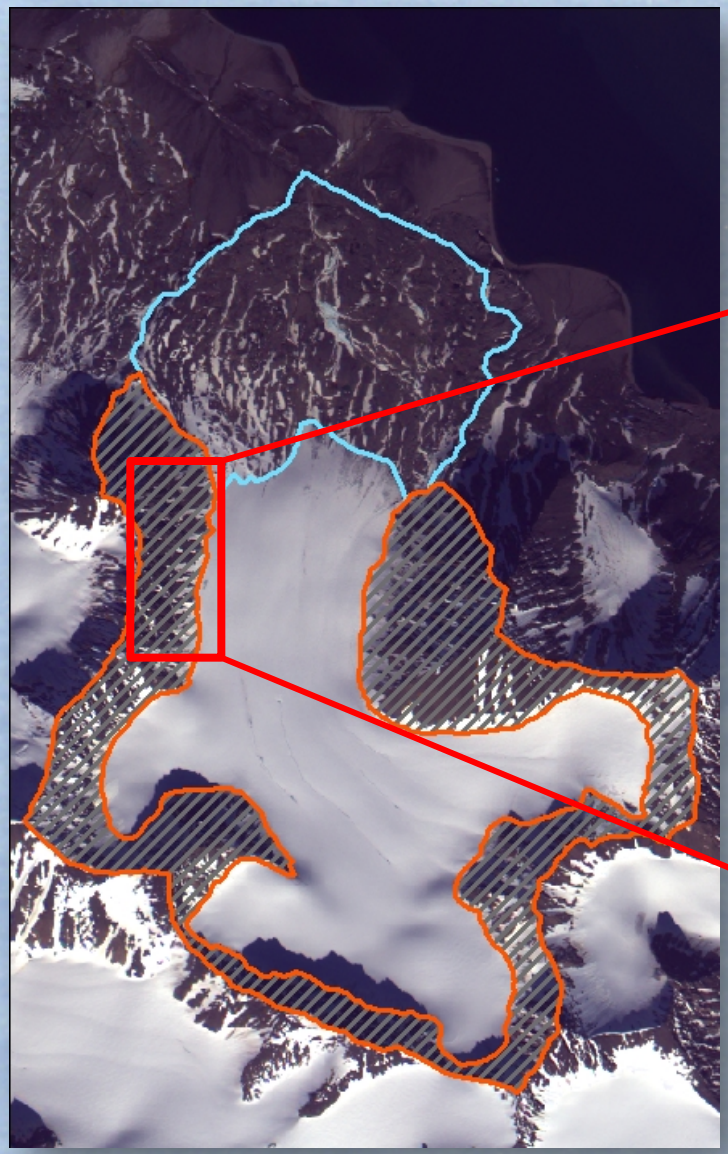
Snow volume on slopes

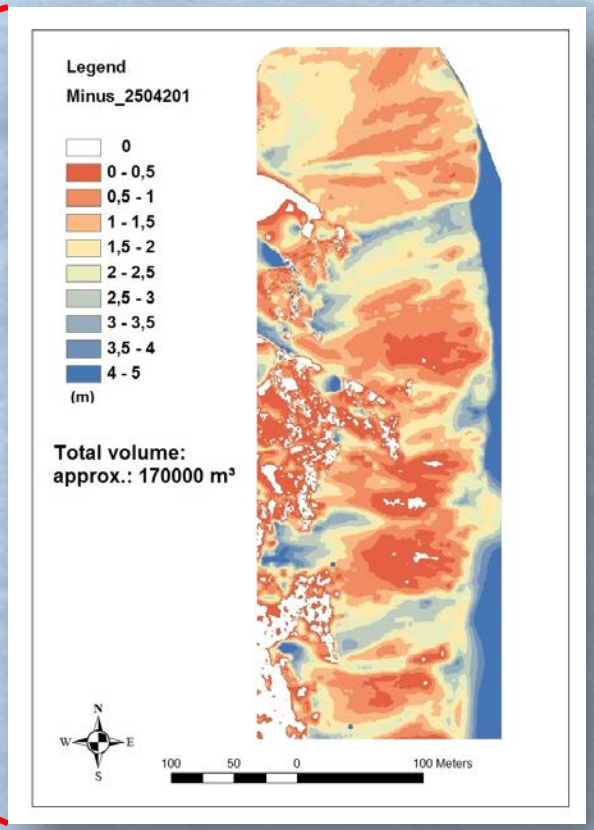
Remaining snow

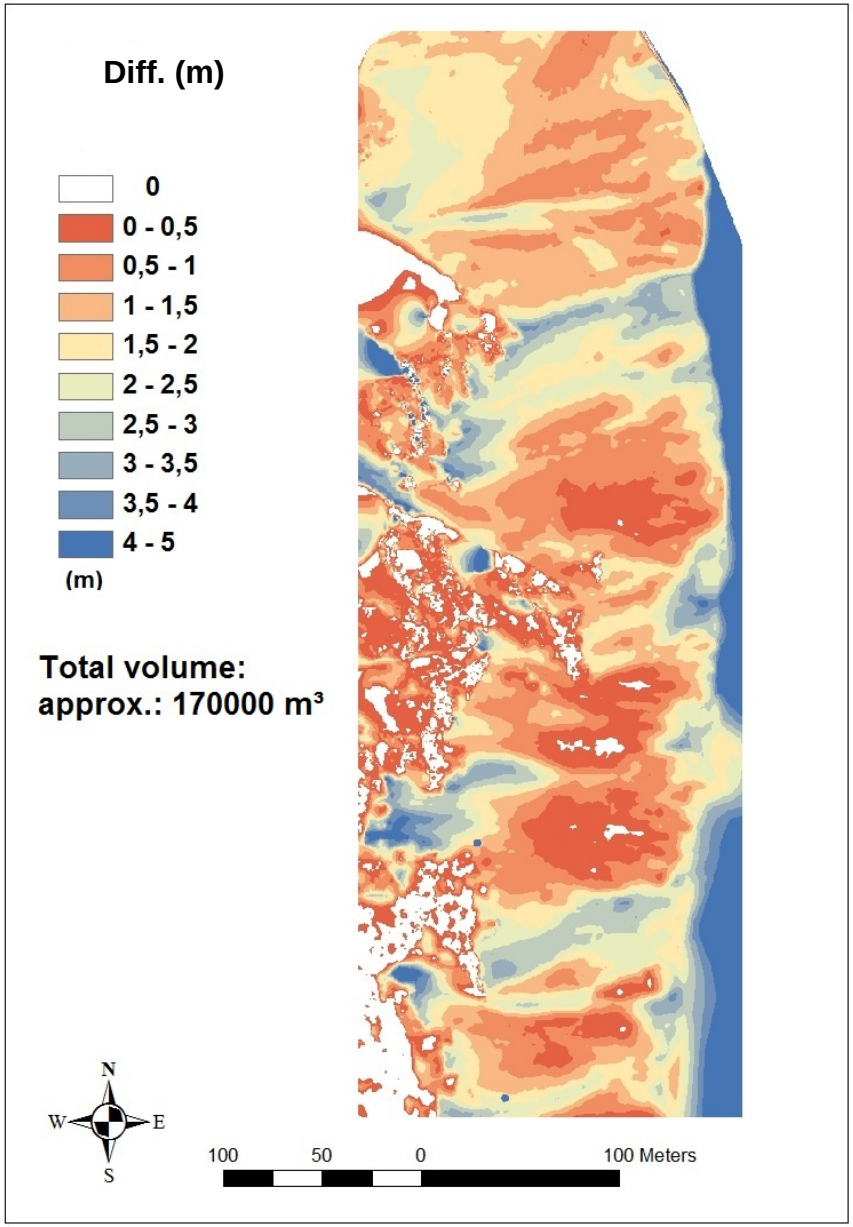
Example on one slope
Western part of the glacier basin



Snow surface variations tested (April 2012)
8 days time interval – One snowstorm (15 cm mean accumulation in flat areas)
Altitude difference between two consecutive scans




Legend
Minus_2504201
0
0 - 0,5
0,5 - 1
1 - 1,5
1,5 - 2
2 - 2,5
2,5 - 3
3 - 3,5
3,5 - 4
4 - 5
(m)
Total volume:
approx.: 170000 m³
N
W
E
S
100
50
0
100 Meters

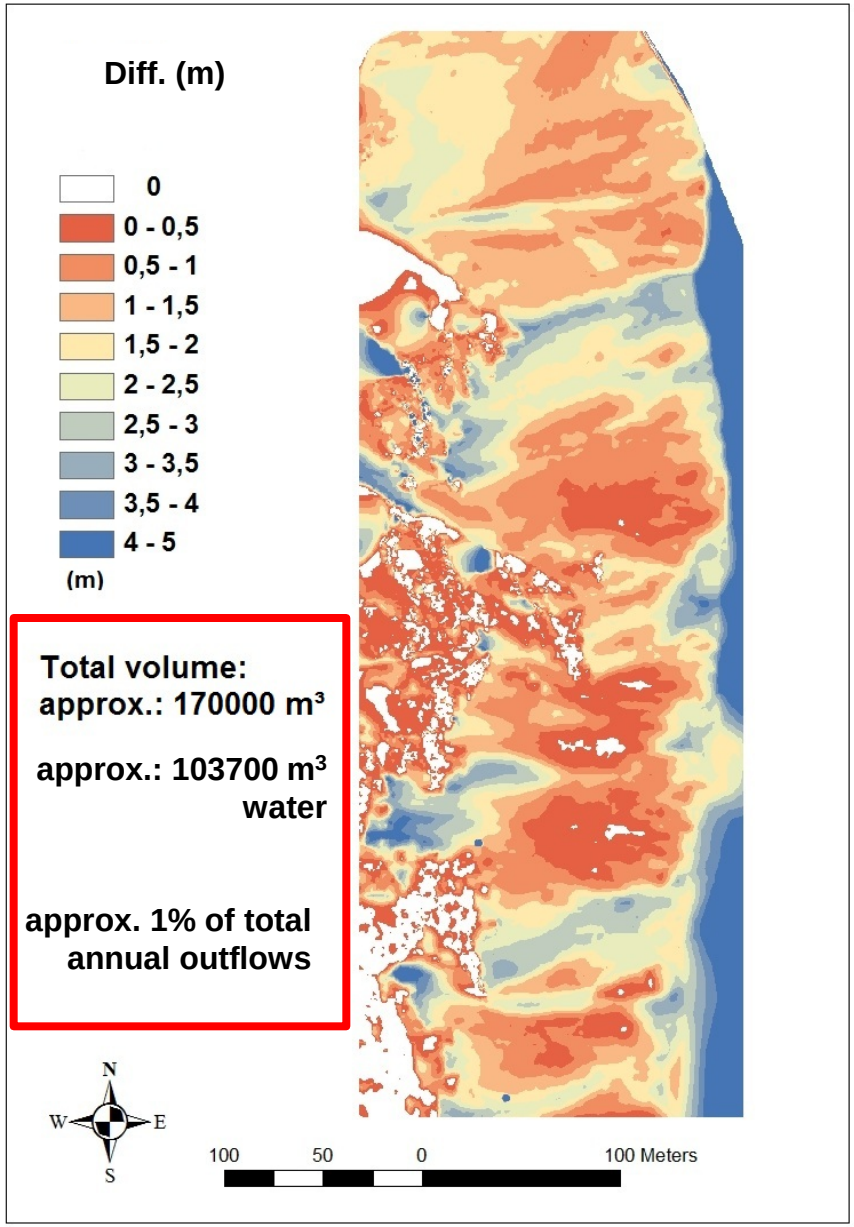


Snow surface variations tested (April to August 2012)

4 months interval

Altitude difference between two consecutive scans

Snow drilling in the slopes for future reference



Total volume:
approx.: 170000 m³

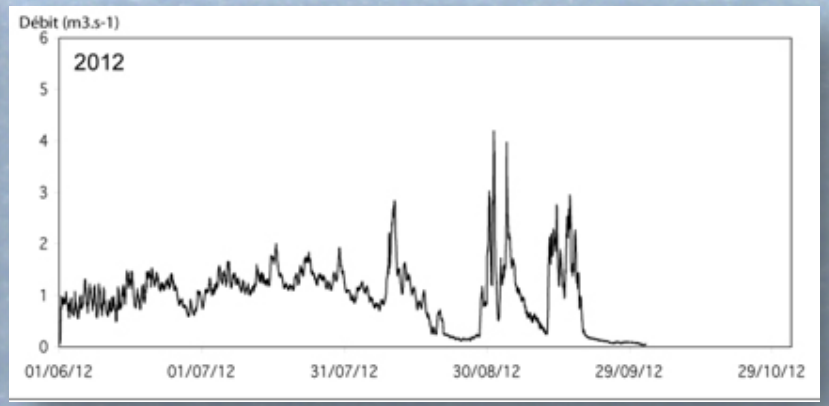
approx.: 103700 m³ water

approx. 1% of total annual outflows

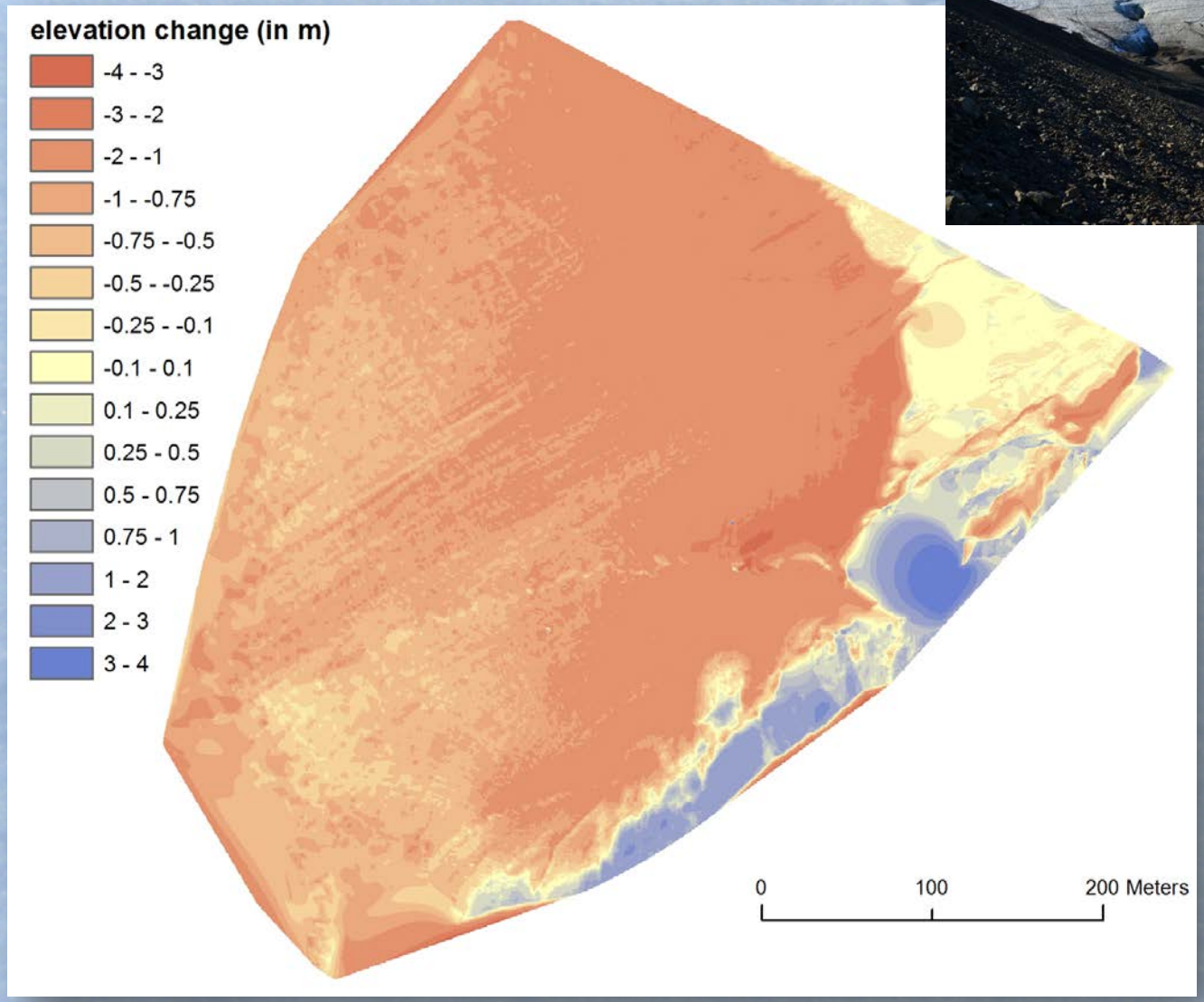
Snow surface variations tested (April to August 2012)

4 months interval

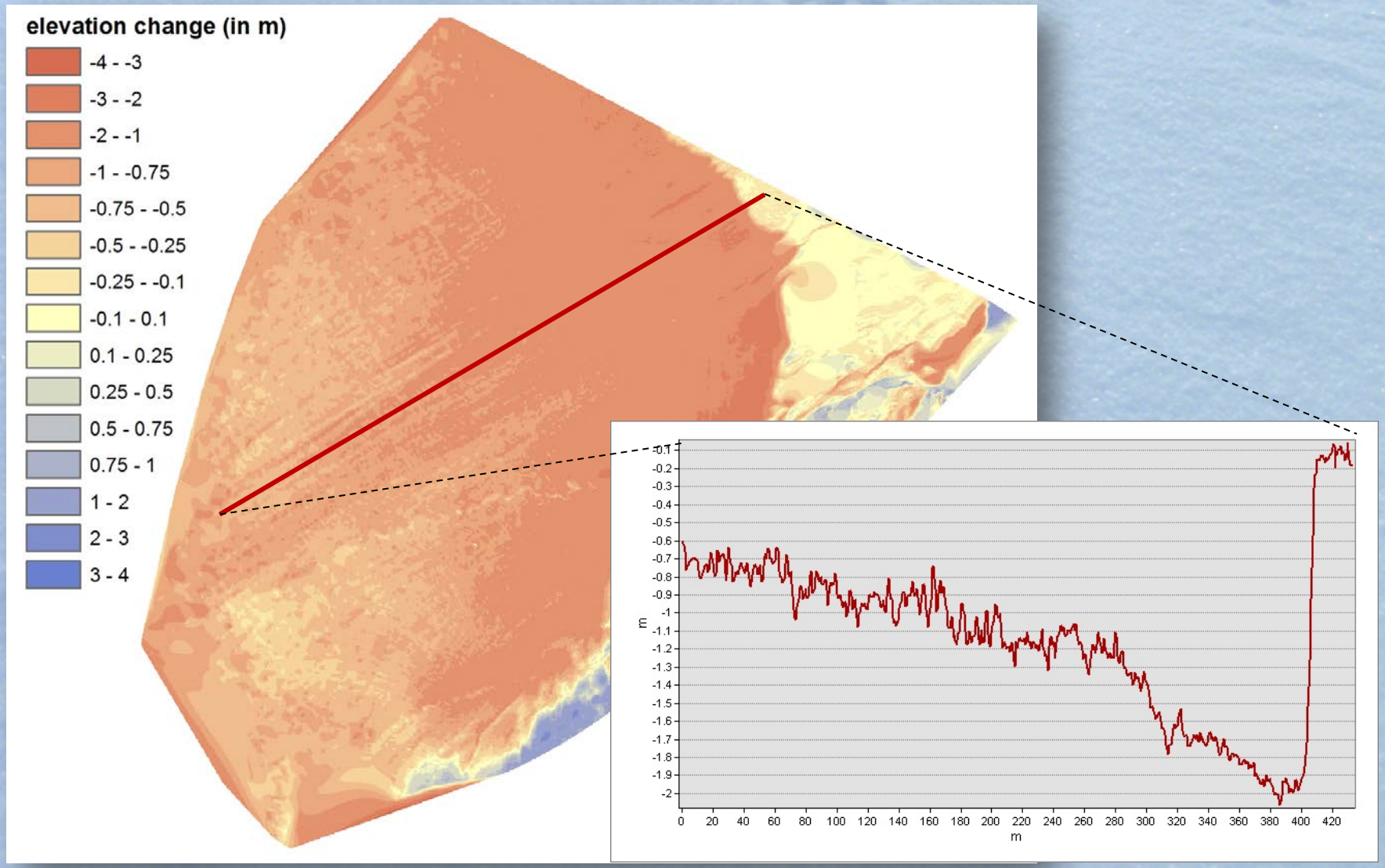
Altitude difference between two consecutive scans



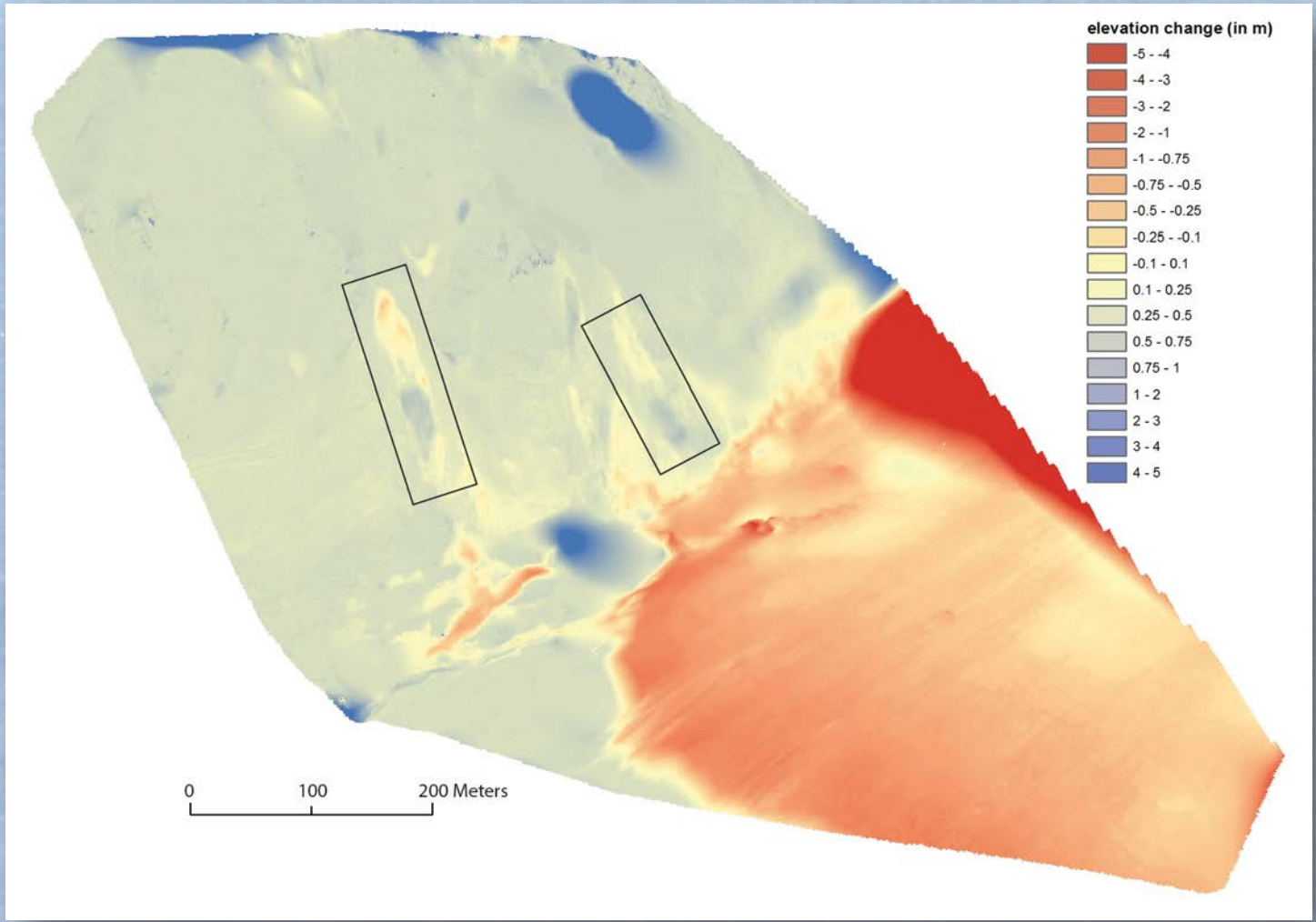
Summer to summer differential map (2013 to 2014) at the glacier snout

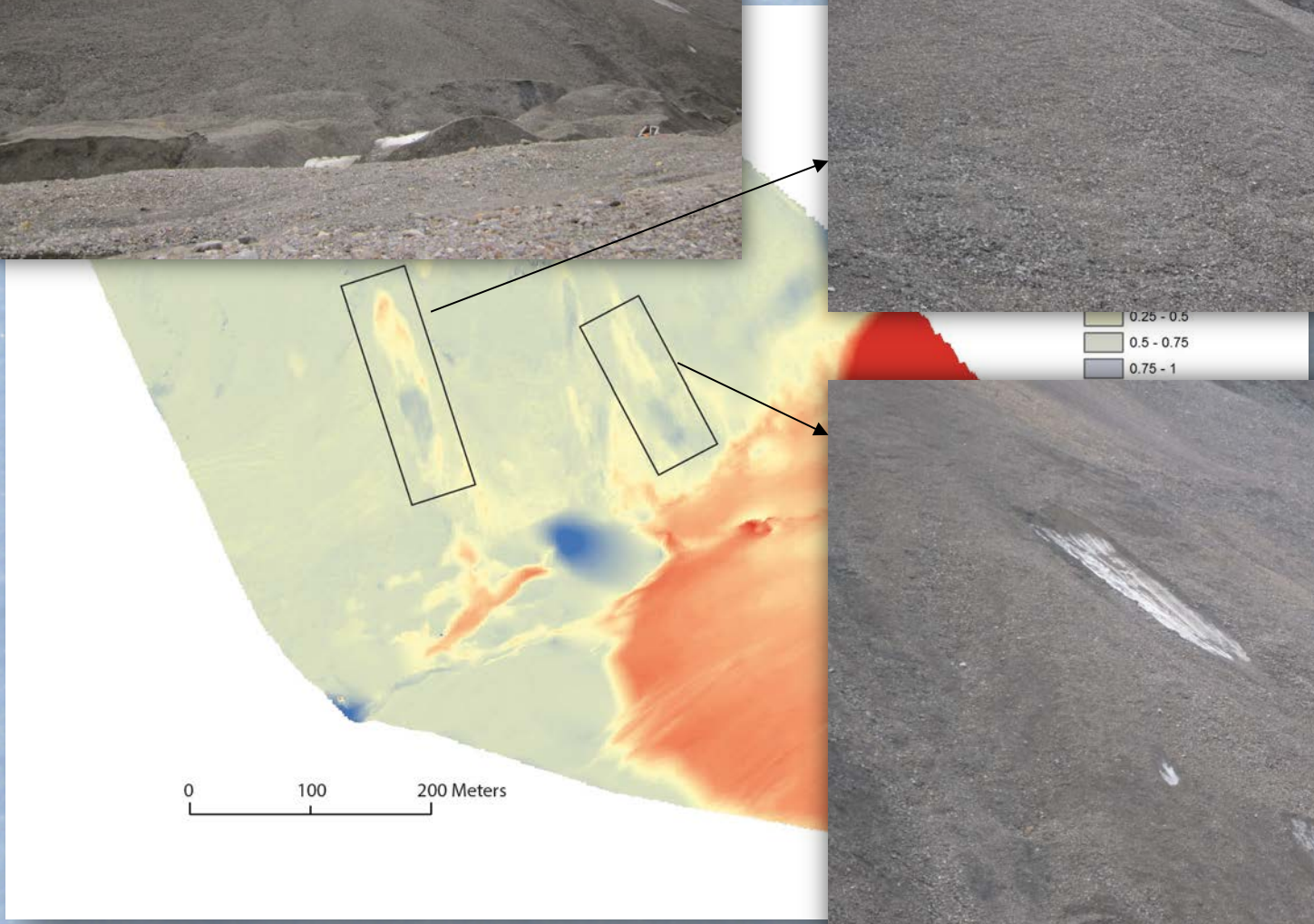


Summer to summer differential map (2013 to 2014)

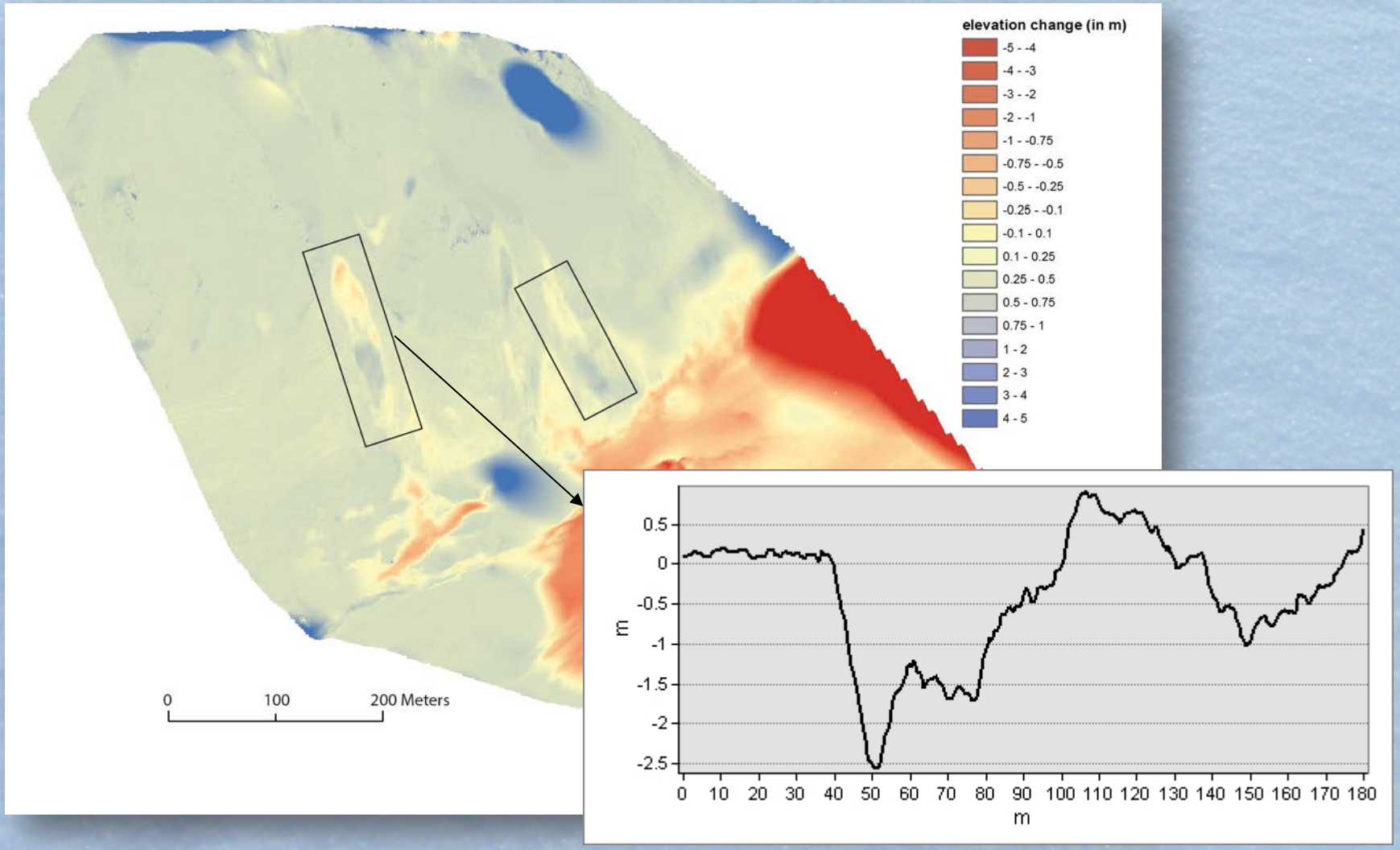


Summer to summer differential map (2013 to 2014) with rock slides

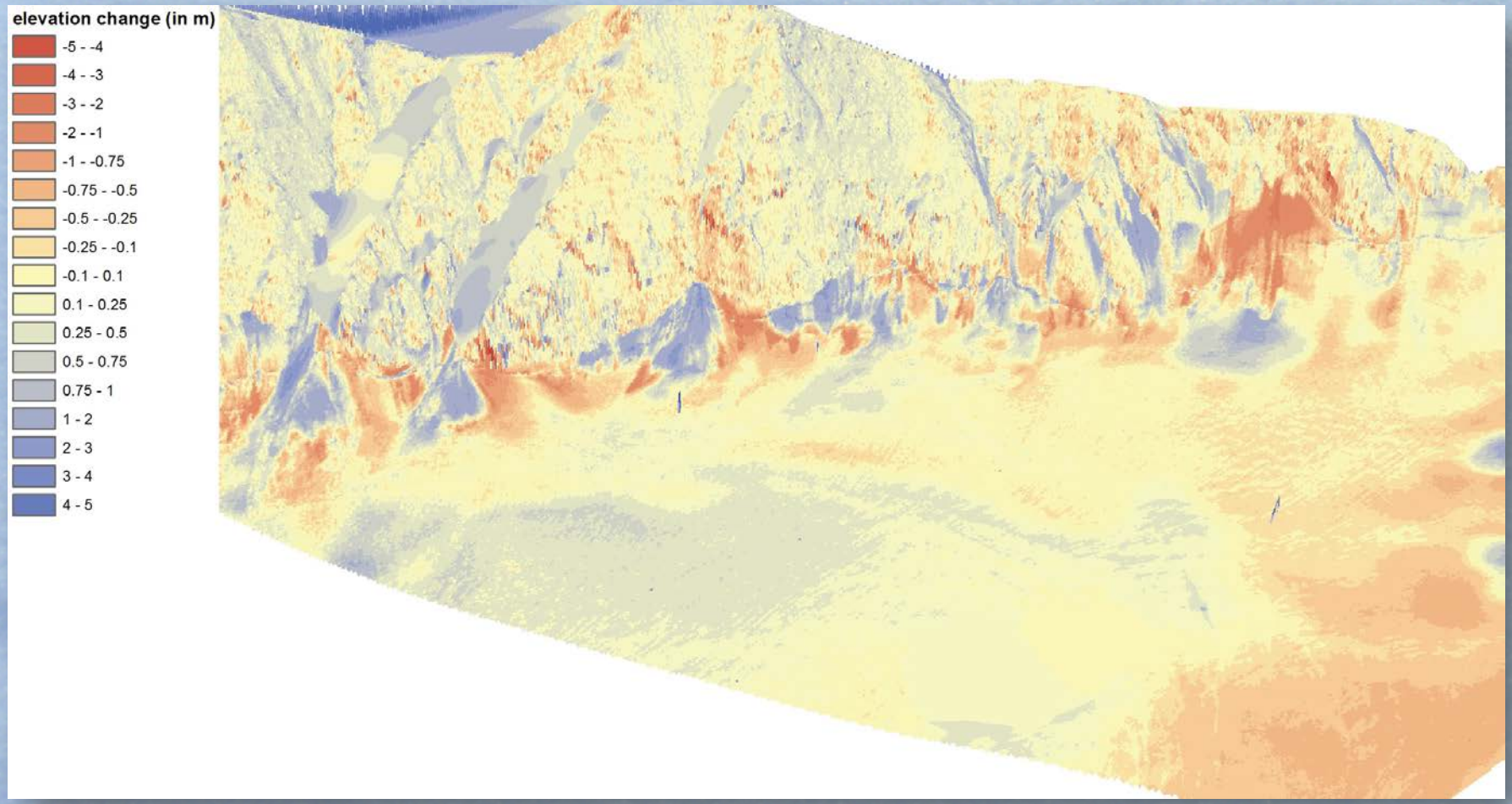



0.25 - 0.5
0.5 - 0.75
0.75 - 1
0
100
200 Meters

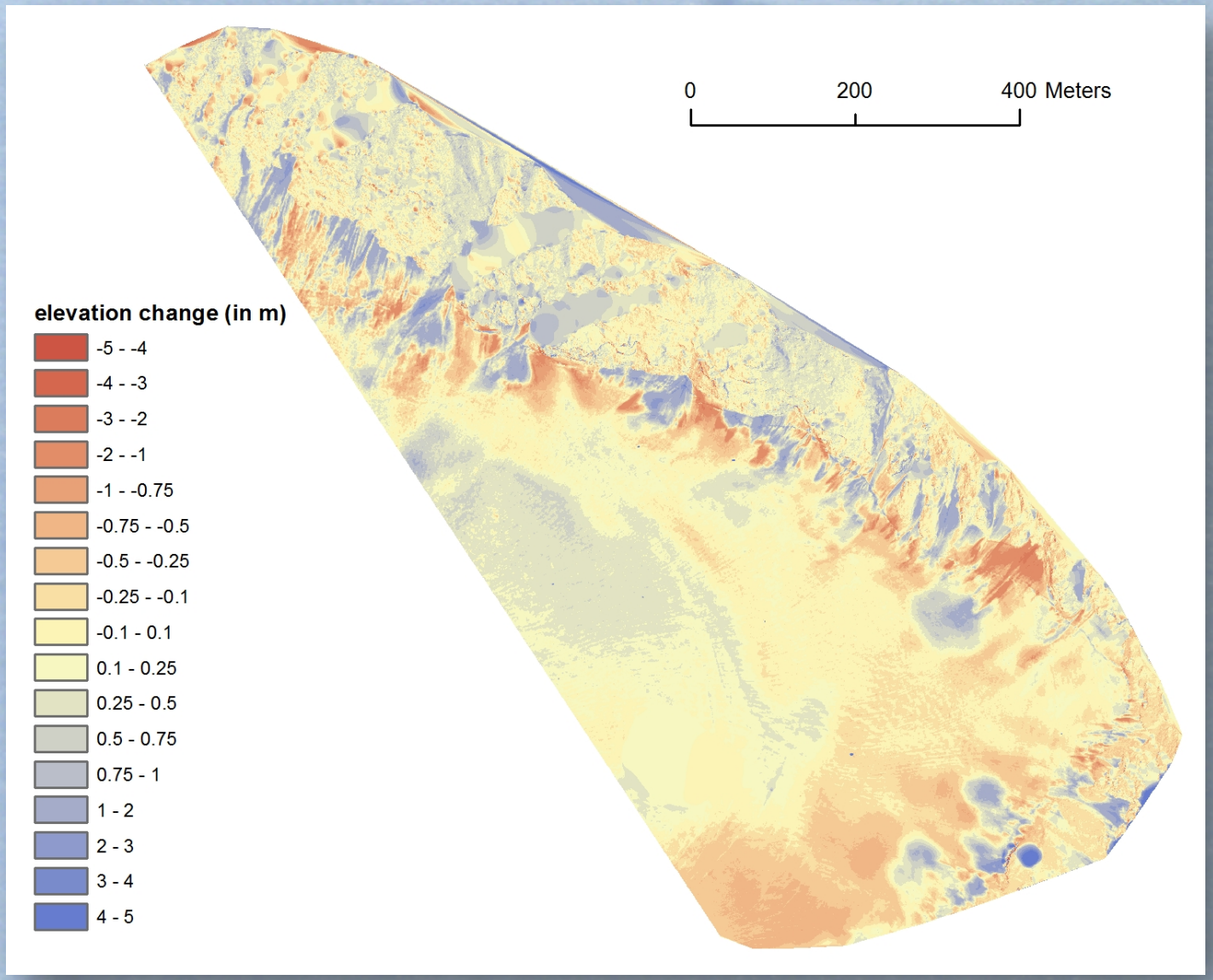
Summer to summer differential map (2013 to 2014) with rock slides



Summer to summer differential map (2013 to 2014) in the accumulation area



Summer to summer differential map (2013 to 2014) in the accumulation area



Summary

- **snow dynamics**
  - **- annual snow volume monitoring using TLS**
    - **- maximum in May**
    - **- minimum late August**
  - **–> part of the slopes in the total hydrological budget**
  - **–> avalanches, melt, snow quality evolution**

- **rock and permafrost**
  - **- with TLS evaluate the rock fall monitoring (August)**
  - **- permafrost dynamics (rock slides, creeping, etc.)**

- **ice and glacier / slope interface**
  - **- characterizing slope bottom dynamics**

- **monitoring ice volume**

Thanks for your attention

Repeat terrestrial laser scanning surveys to describe and quantify slope dynamics in an Arctic glacier basin. Austre Lovénbreen, Svalbard – 79° N)

Florian TOLLE[1], Alexander PROKOP[2], Eric BERNARD[1], Jean-Michel FRIEDT[3], Madeleine GRISELIN[1]

[1] ThéMA CNRS, Université de Franche-Comté, Besançon, France
[2] BOKU, University of natural resources and life sciences, Vienna, Austria
[3] FEMTO-ST CNRS, Université de Franche-Comté, Besançon, France

13th circumpolar remote sensing symposium – Reykjavik
8-12th September 2014