Monitoring the snow cover on the slopes of a polar glacier using terrestrial laser scanning

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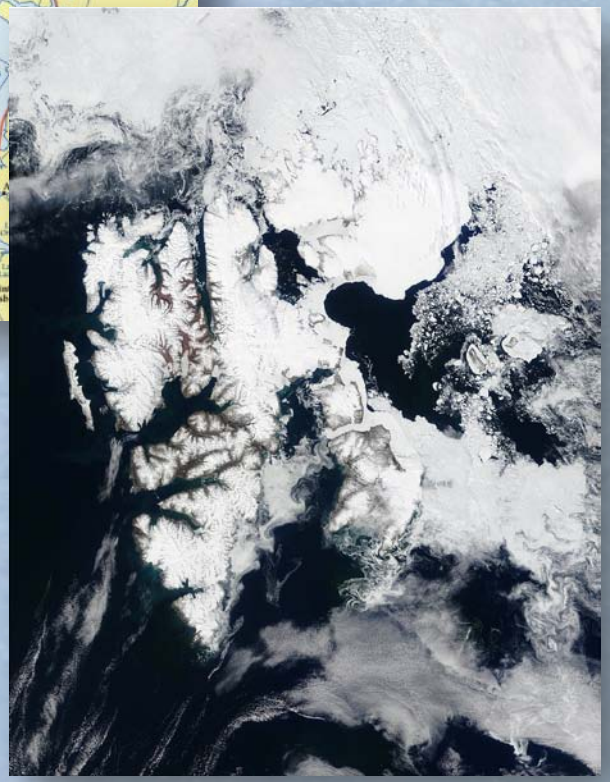
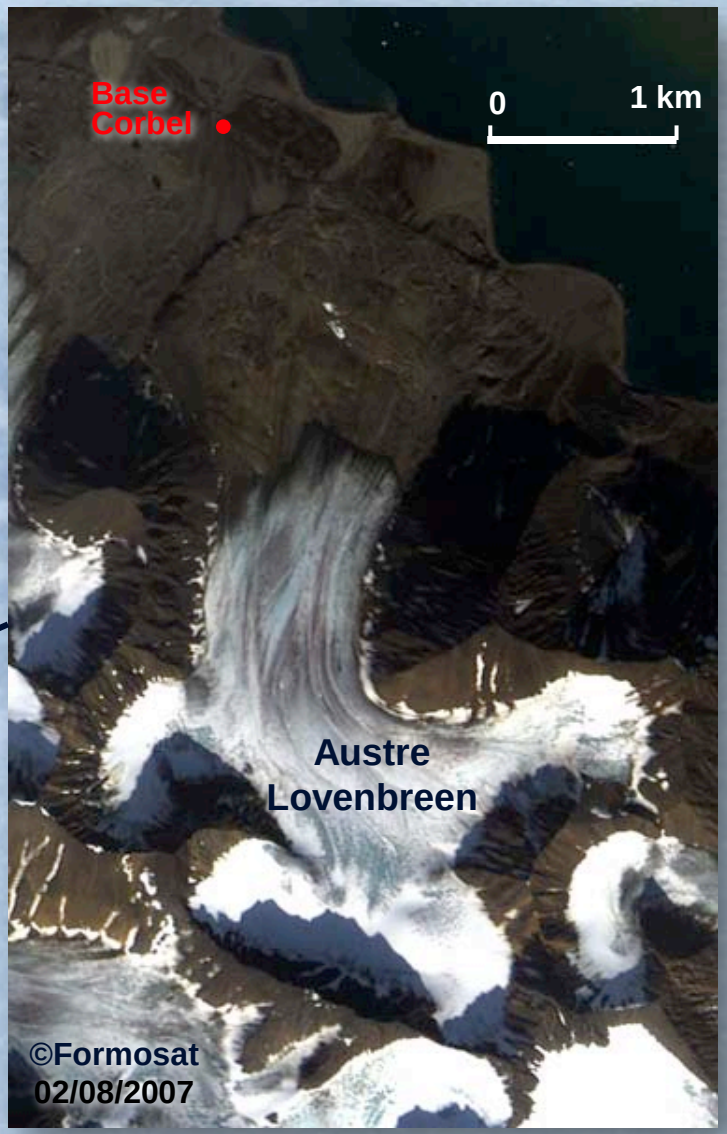
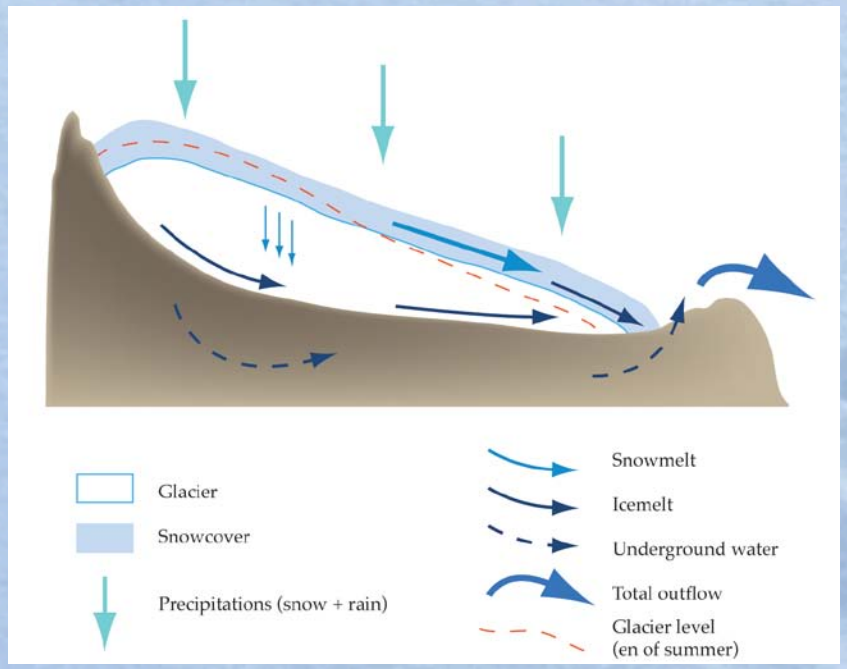


Fieldwork:
Northwestern Svalbard
78° N



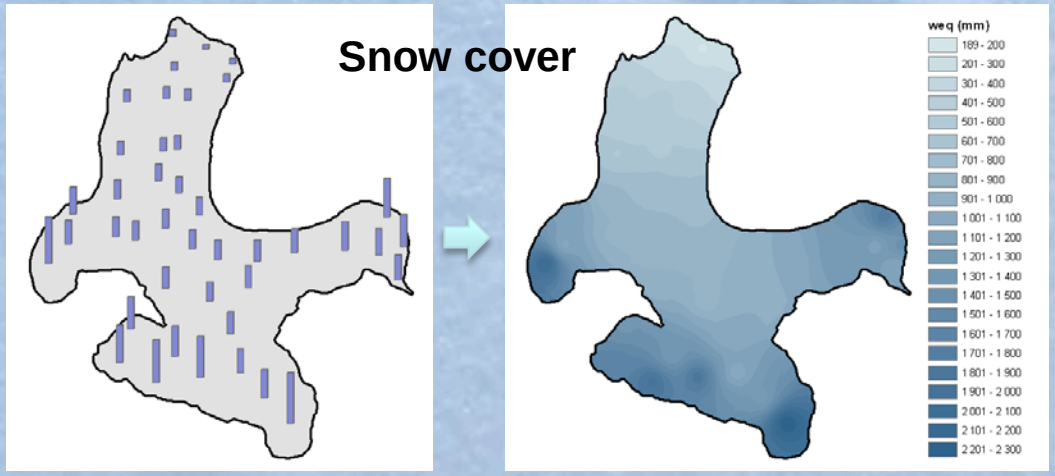
Austre Lovenbreen,
6 km east of Ny Alesund

hydrological balance

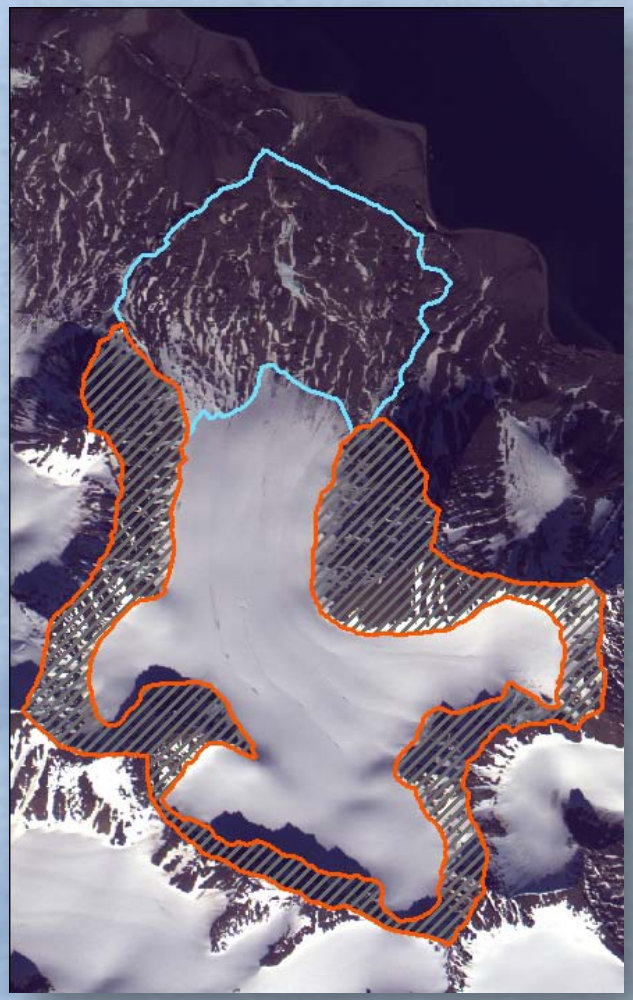


– hydrological probes on the two rivers

–> hourly discharges of the outlets



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

Snow cover dynamics

Snow is a key element to glacier behaviour

- It constitutes an important part of the hydrological budget
- Slopes = 35 % of glacier basin area

Fieldwork April 2012

Terrestrial Laser Scanner:

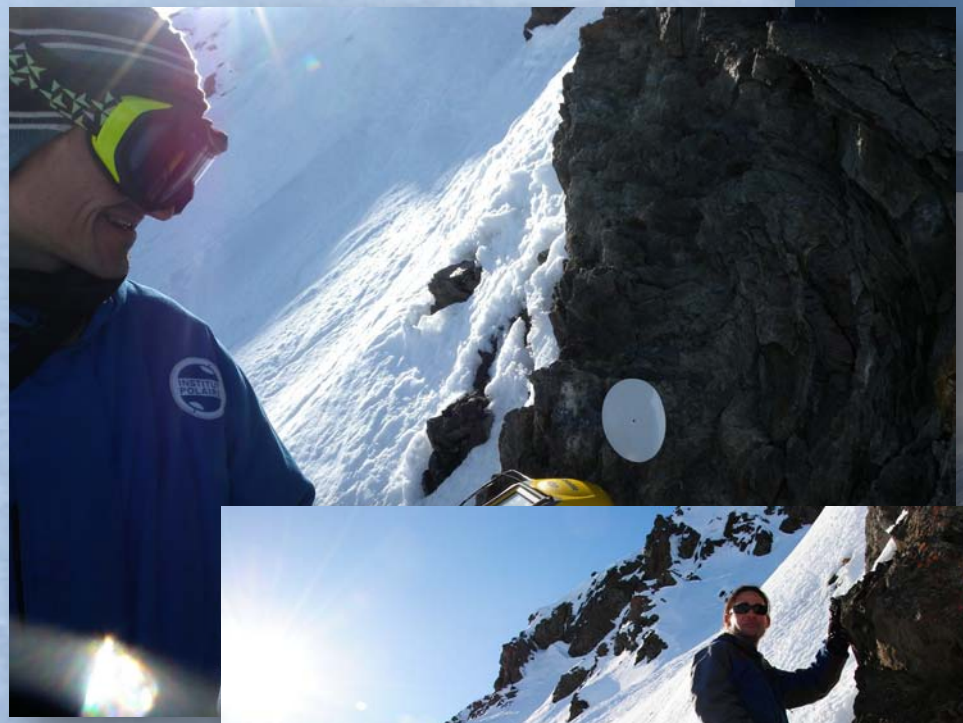
Advantages compared to airborne Lidar:
- **Easier to repeat measurements**
- **Fairly easy to operate for a small team**
- **Cheaper**

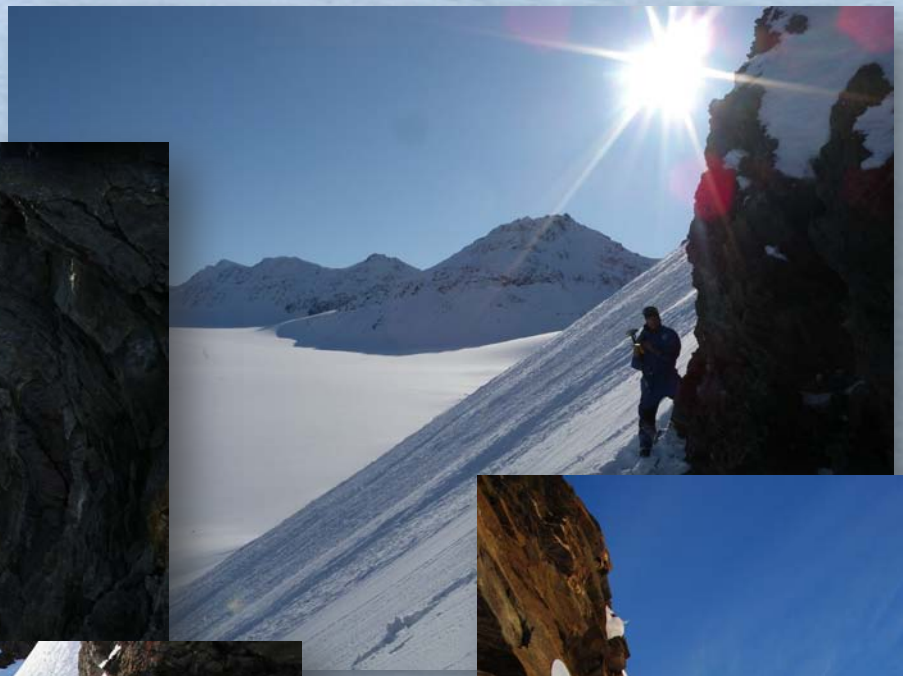
TLS equipment:

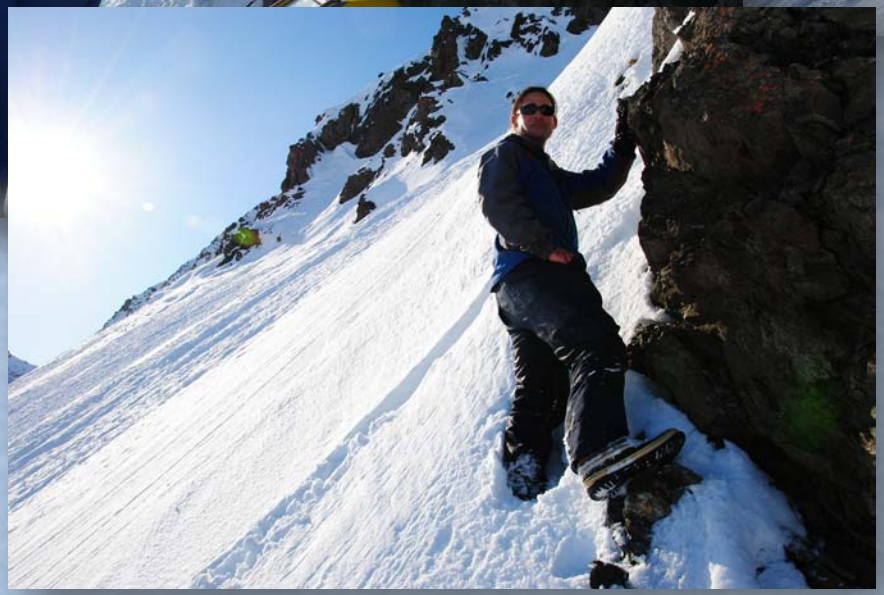
Riegl LPM 321

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

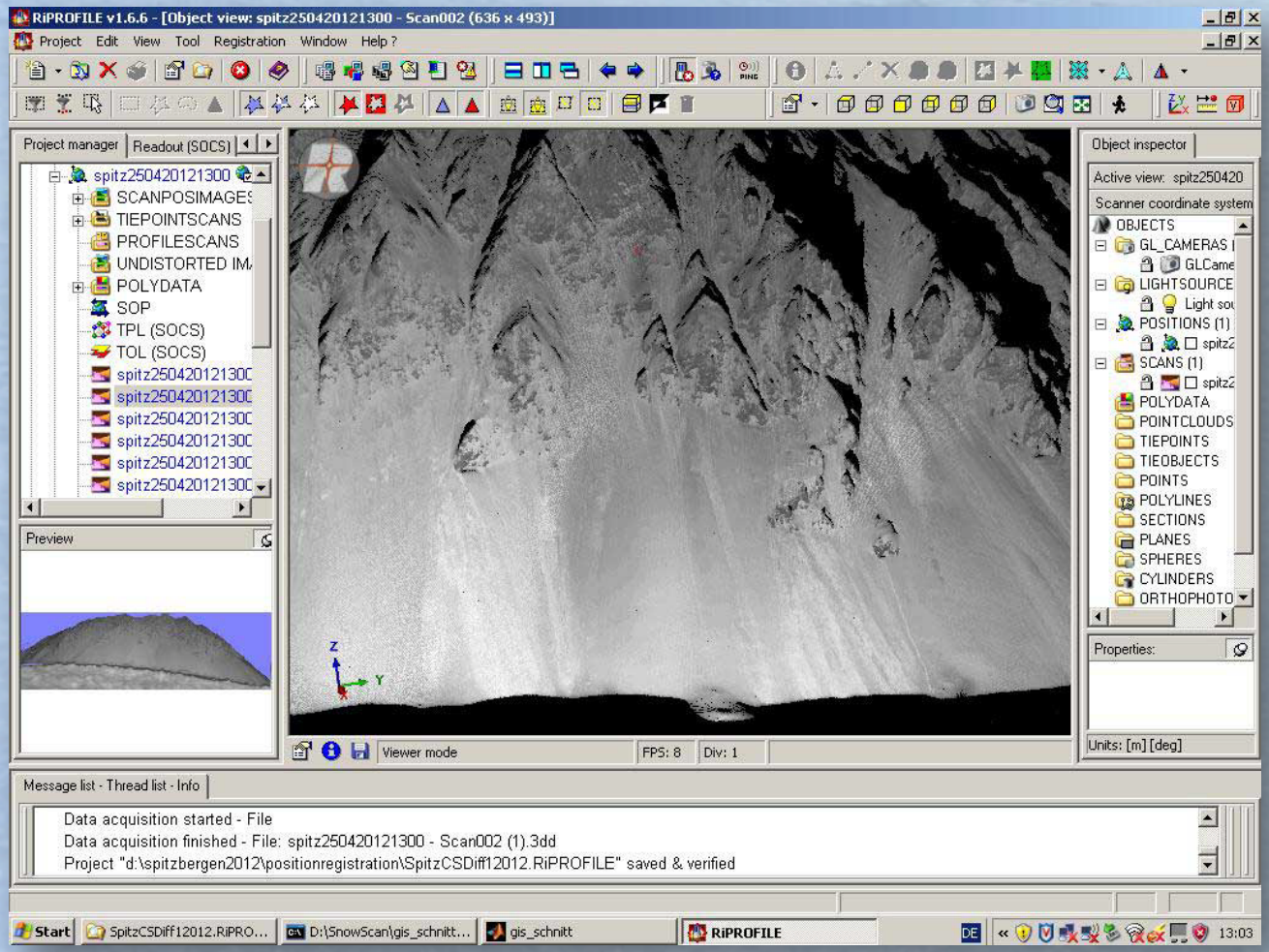
Field operation:
TLS + tripod + generator + computer





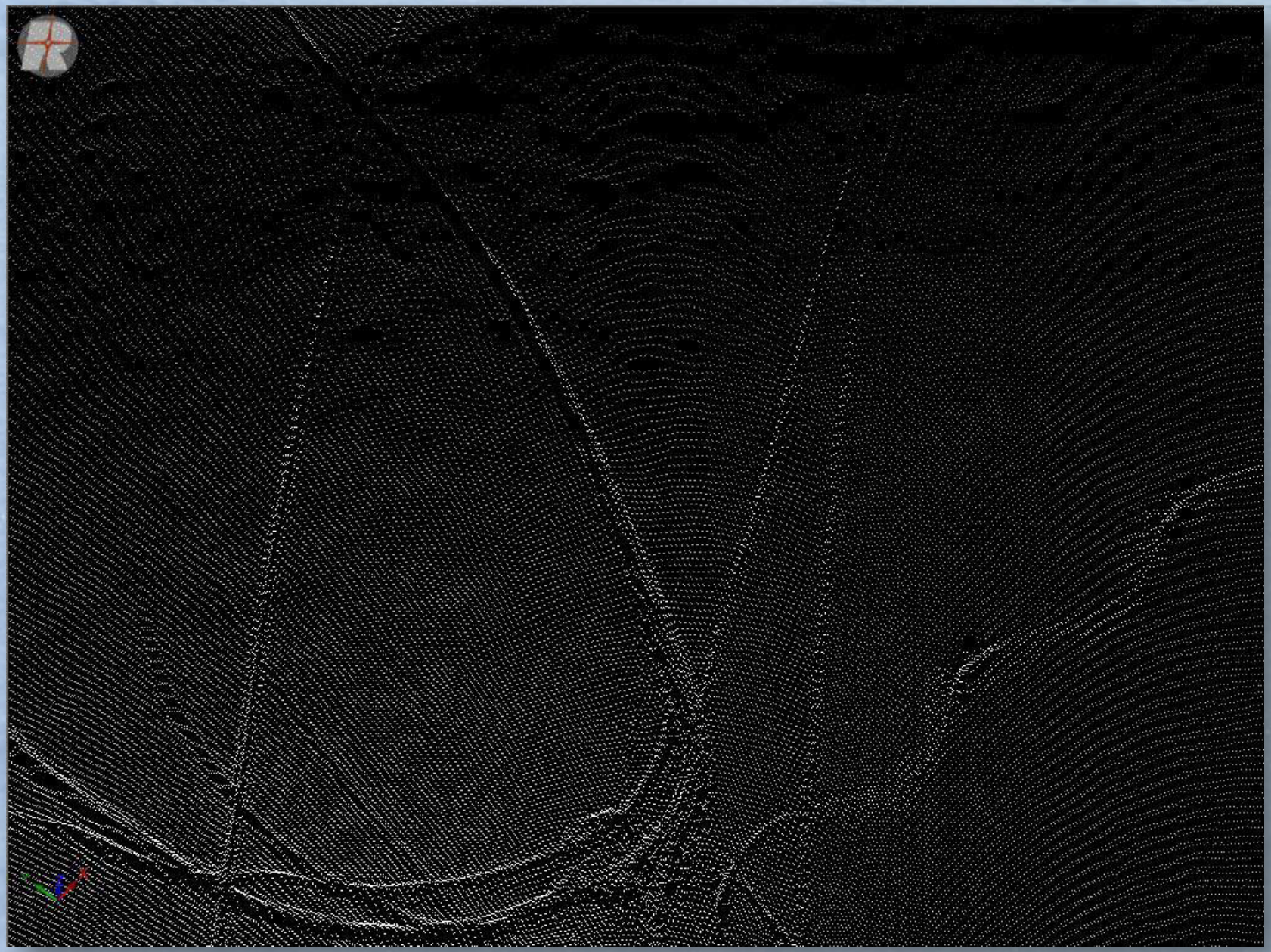


Reflectors set-up for scan registration
Can be troublesome in the steepest slopes

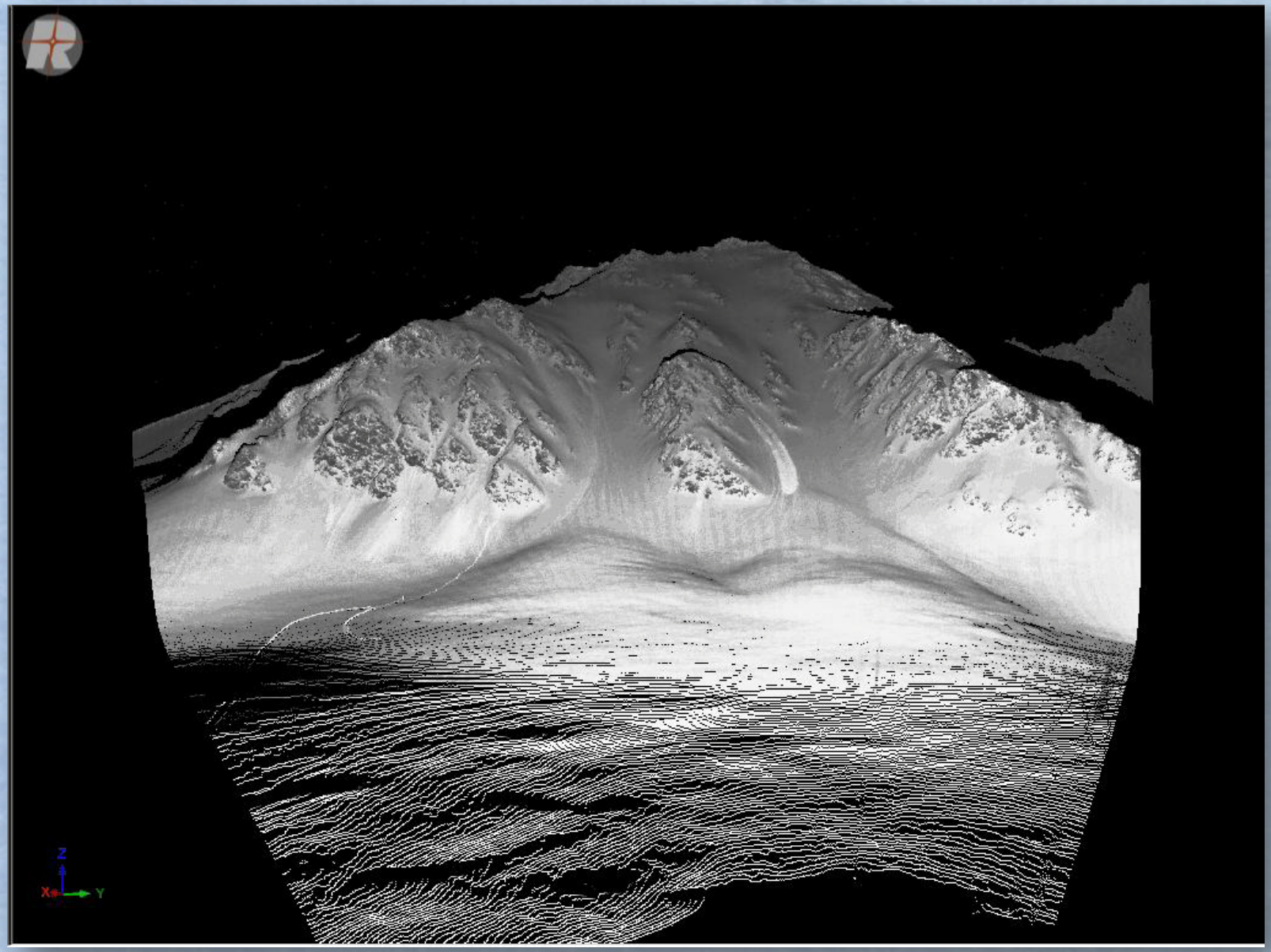


Acquired data: Point cloud with reflectance values
Reflectance values vary according to:
- Ground surface
- Incident angle

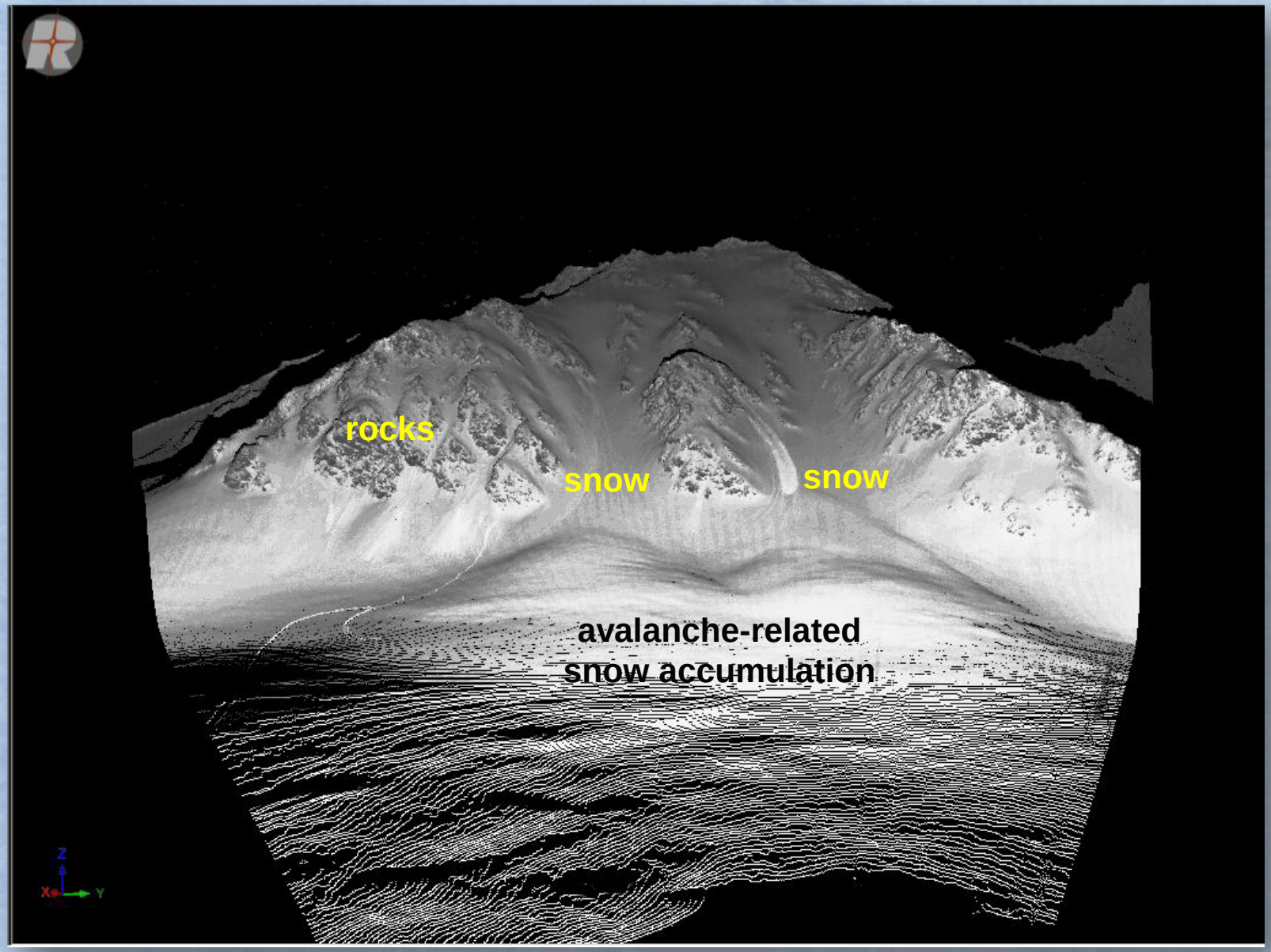
Shadow areas



Point cloud



Data seen from TLS data acquisition location



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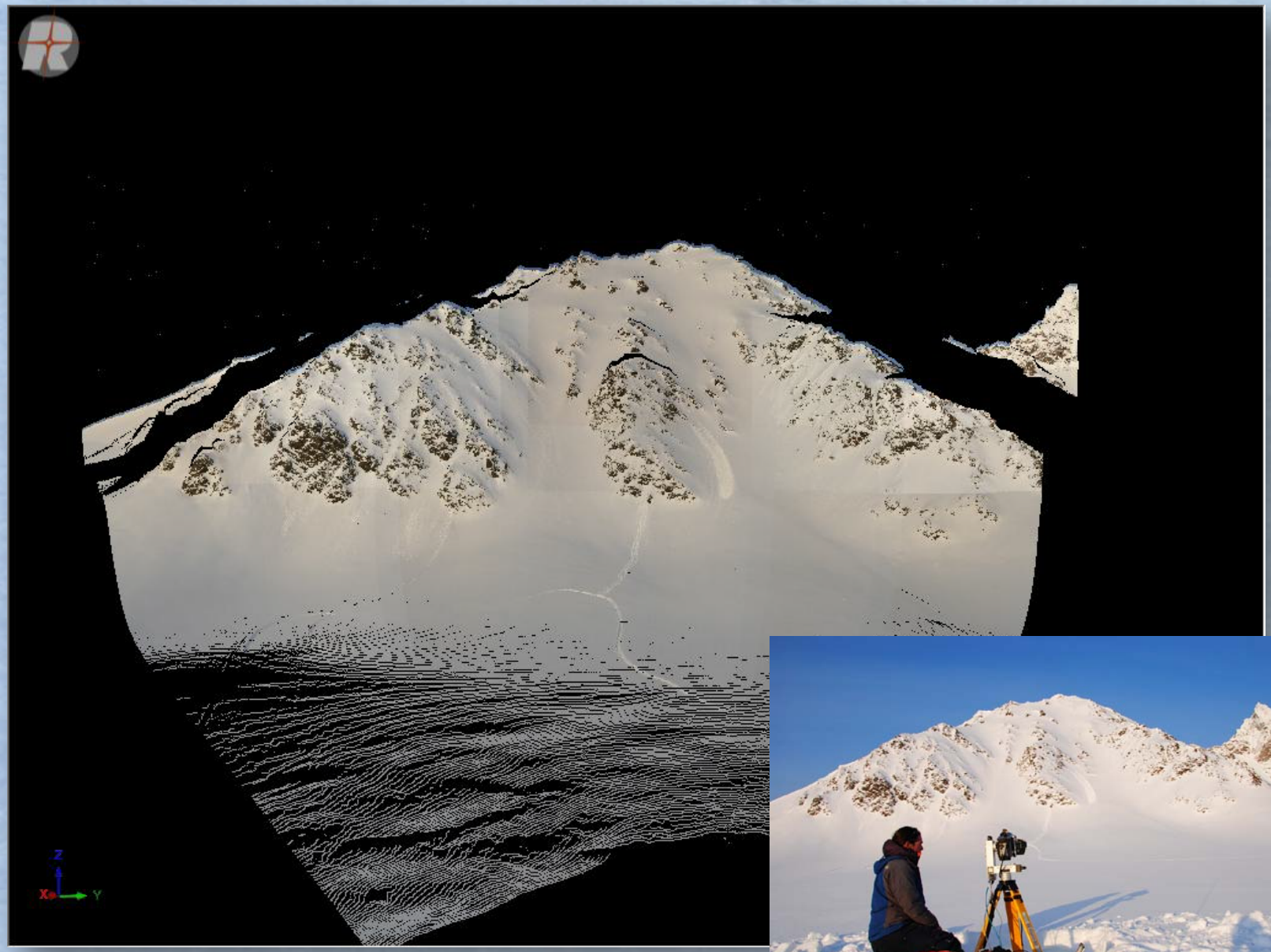
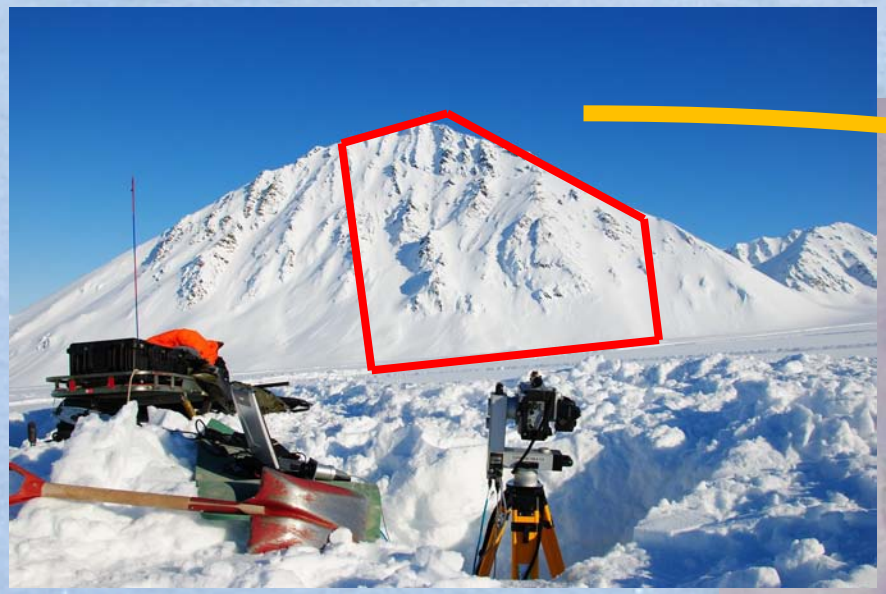
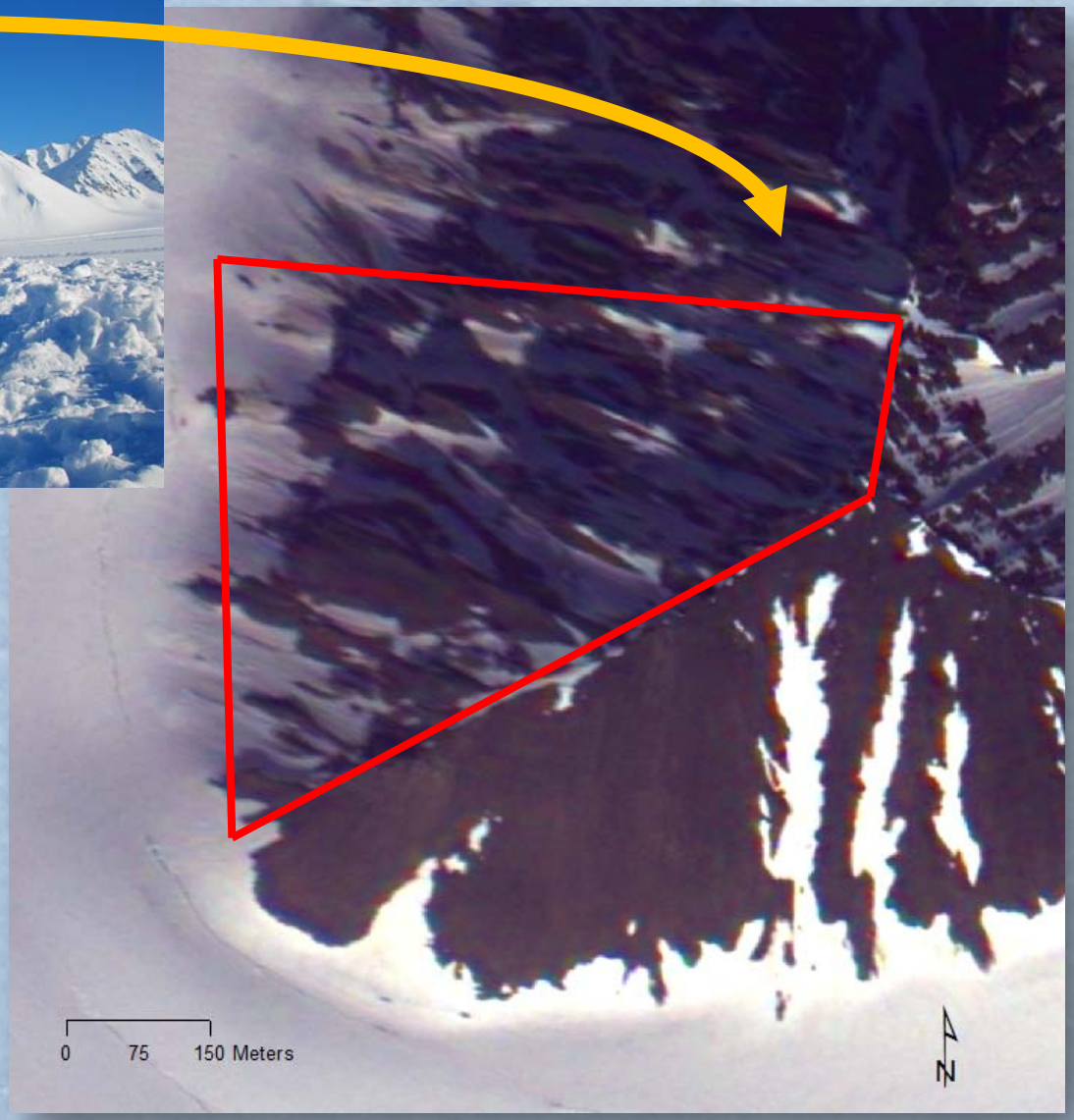


Color info added to the data

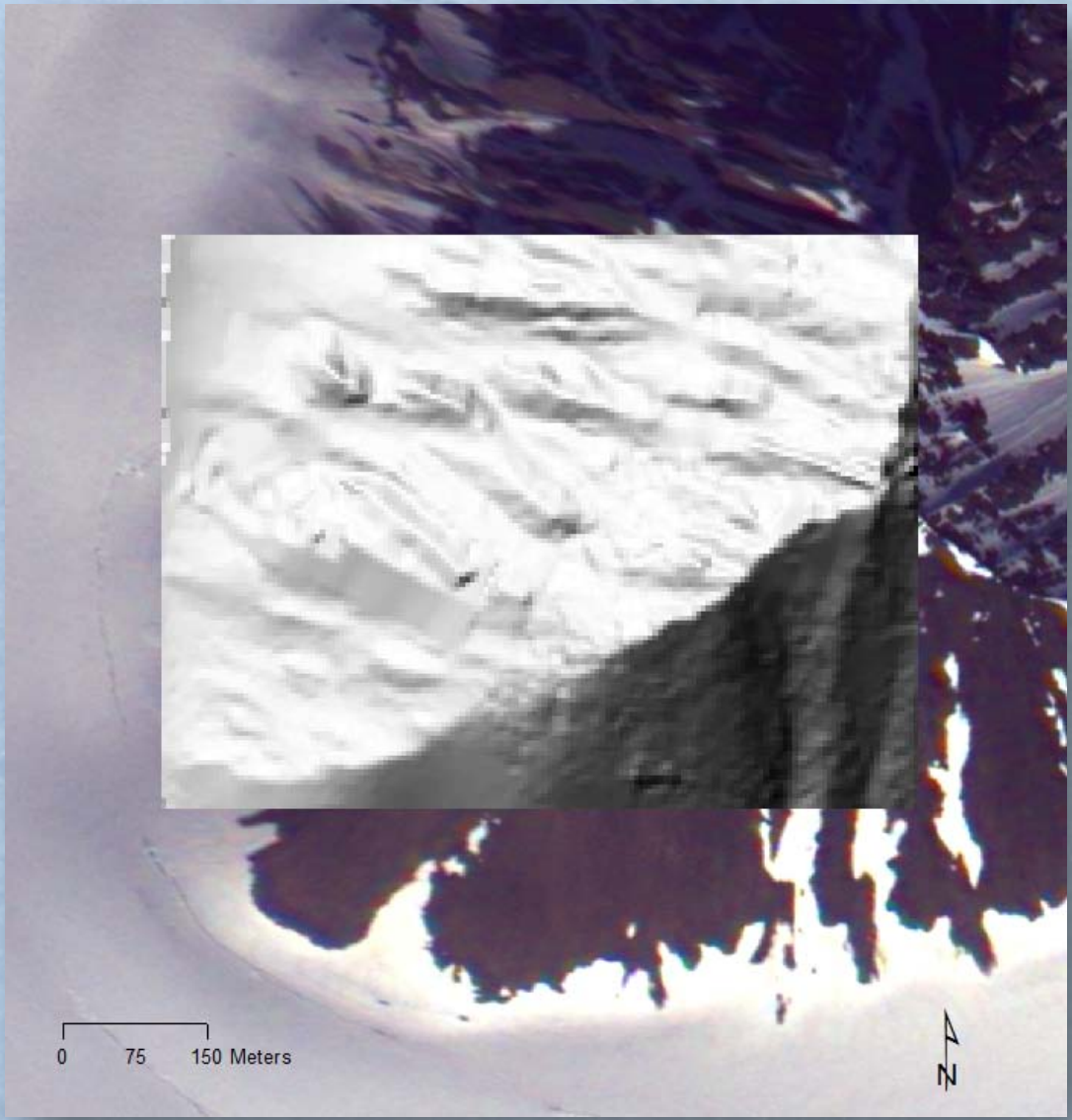




Example of scan processing

Reference digital elevation model

Norsk Polar Institutt (1995)

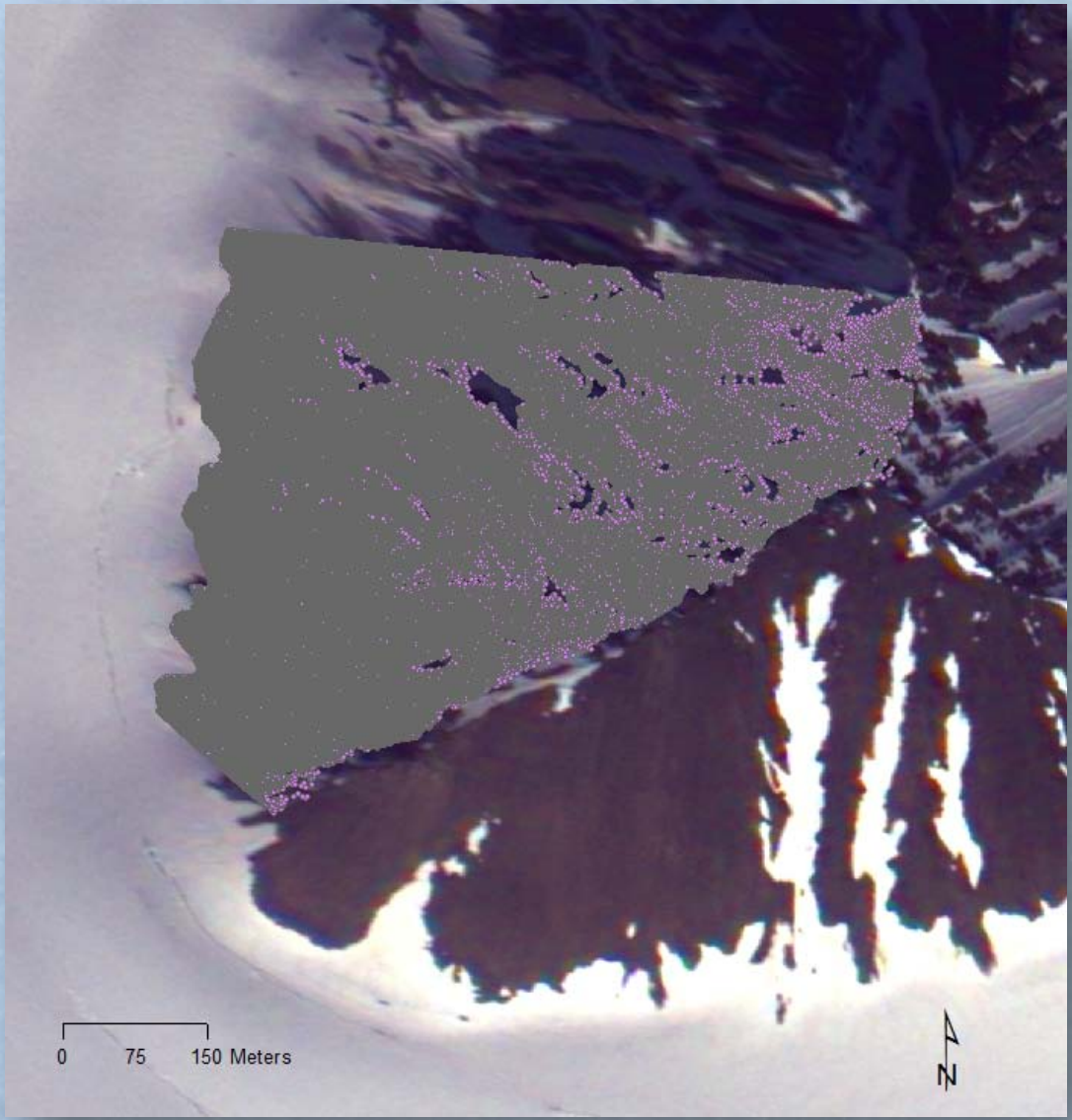


TLS acquired data

More than 700 000 points

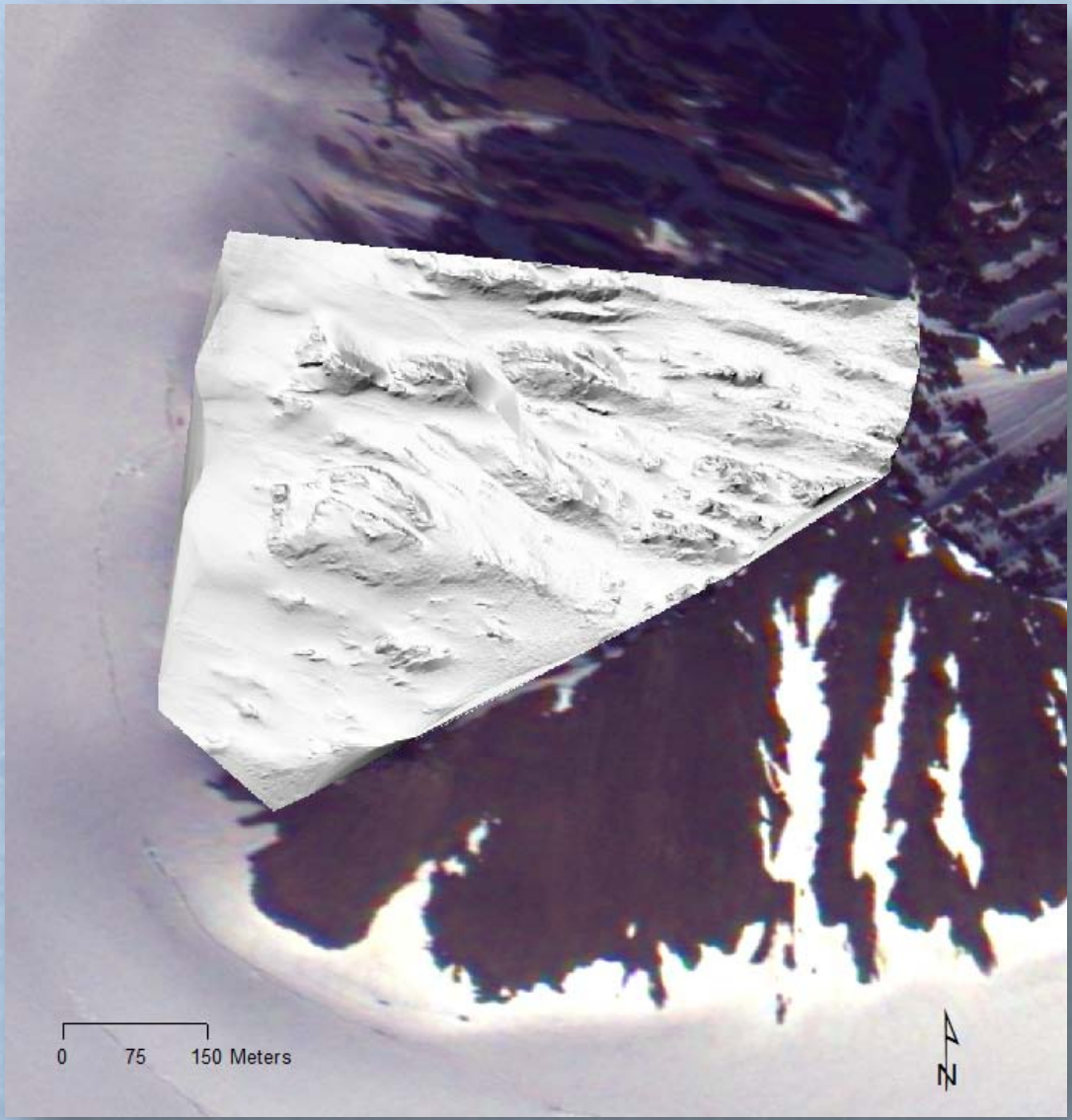
X – Y – Z data

Shadow areas

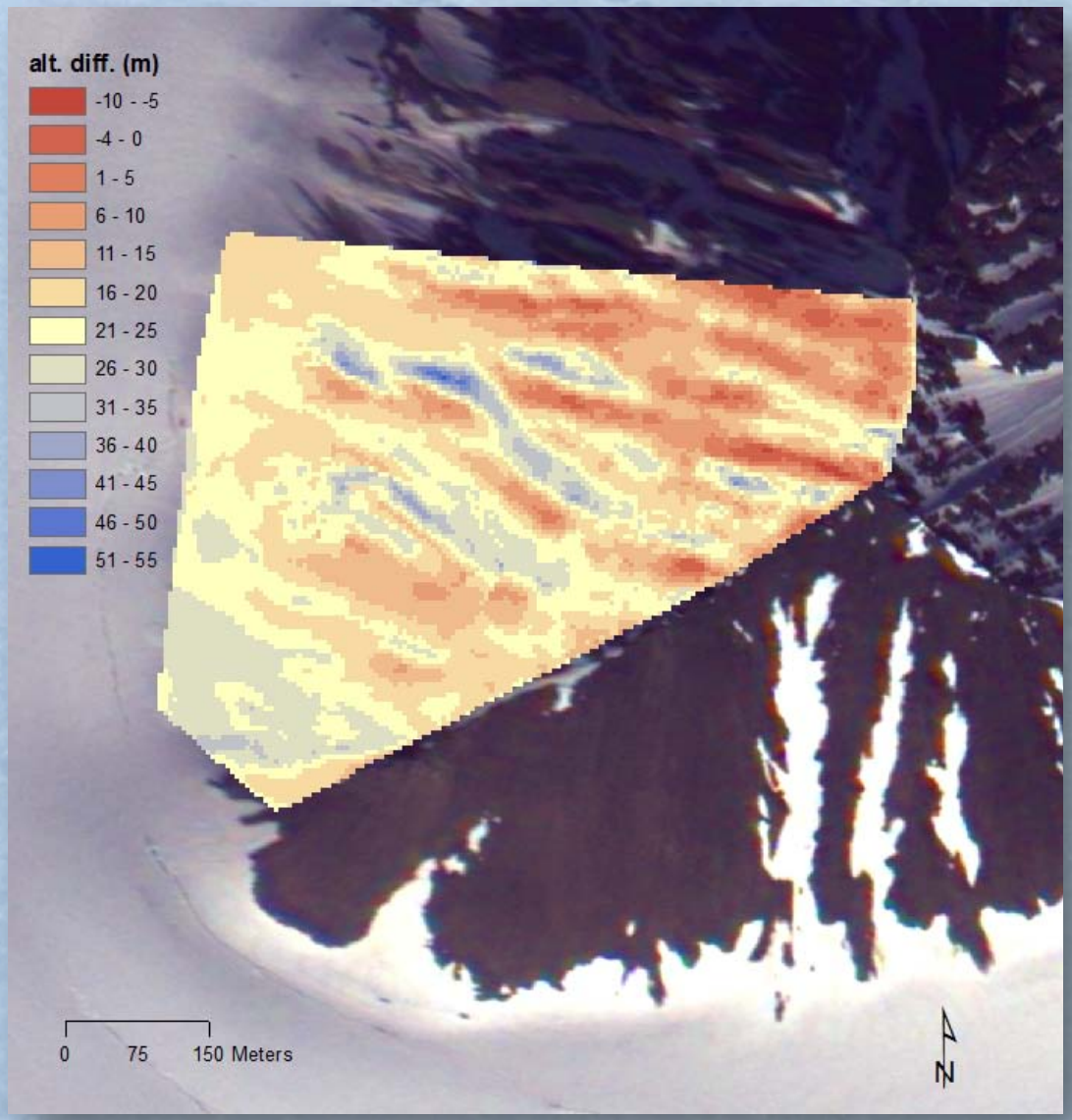


TLS acquired data

Point data is interpolated to a surface model



Altitude difference between reference DEM and TLS-derived DEM

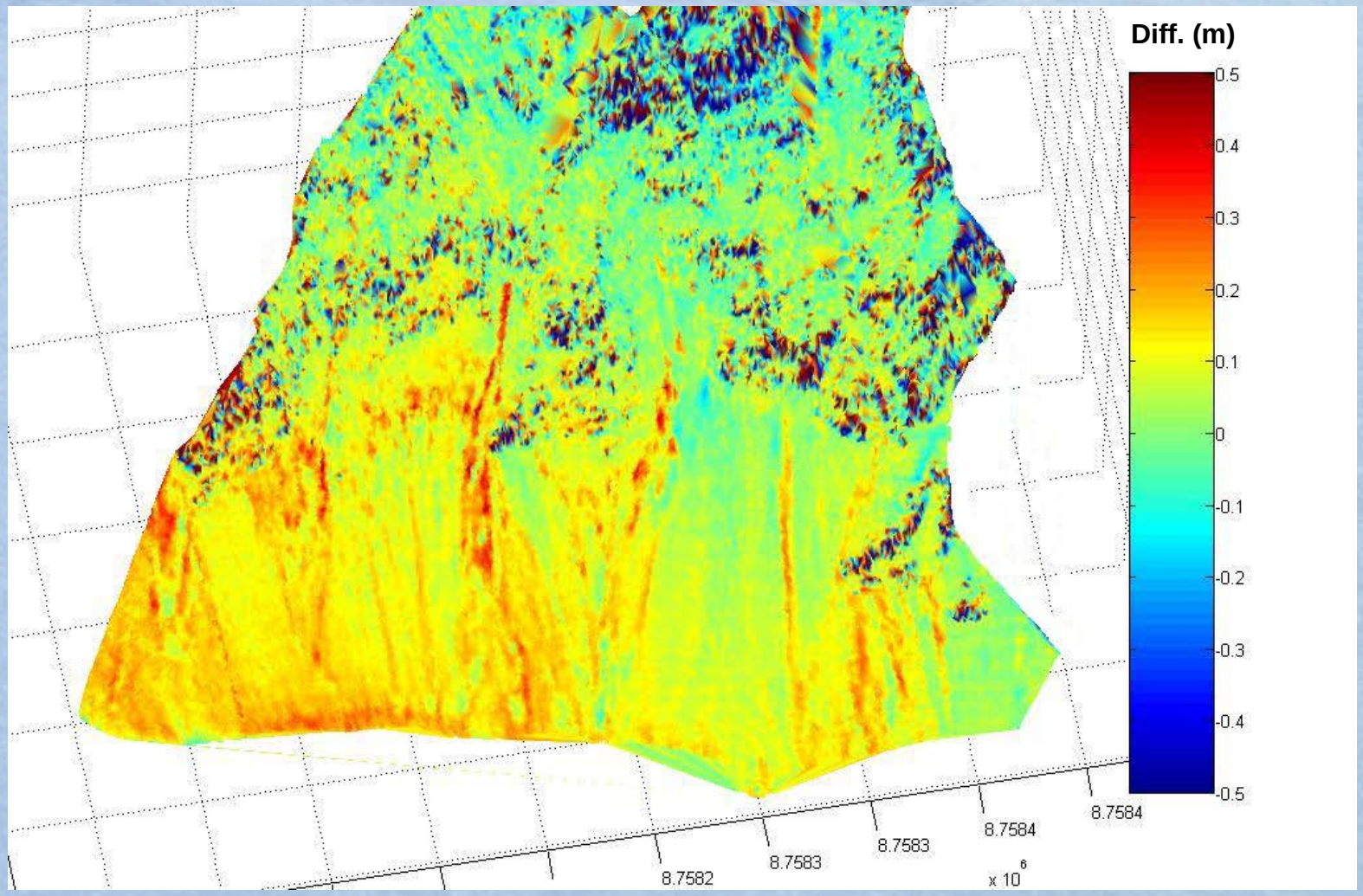


Surface model at snow maximum

Surface model at snow minimum

Snow volume on slopes

Remaining snow

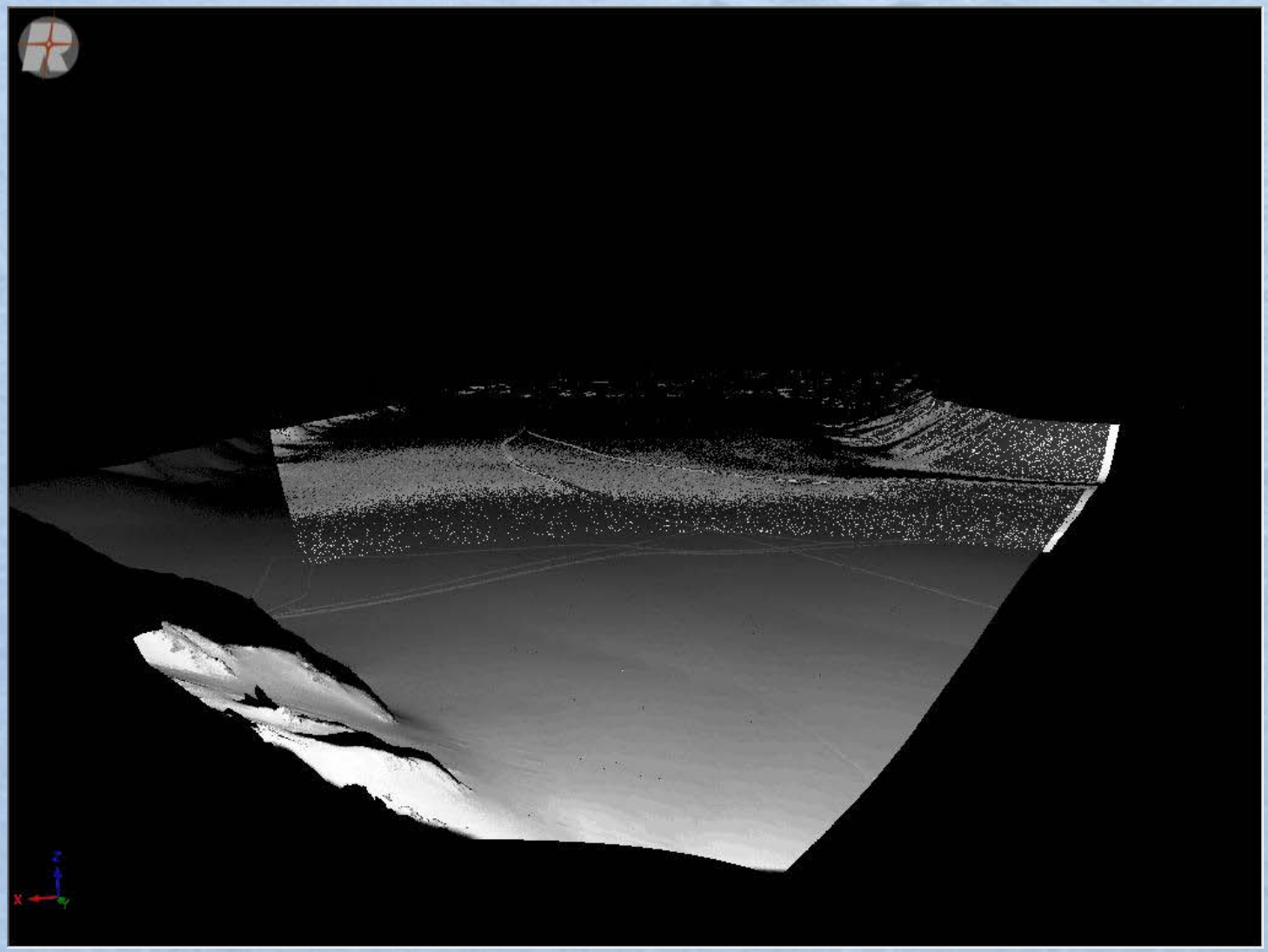


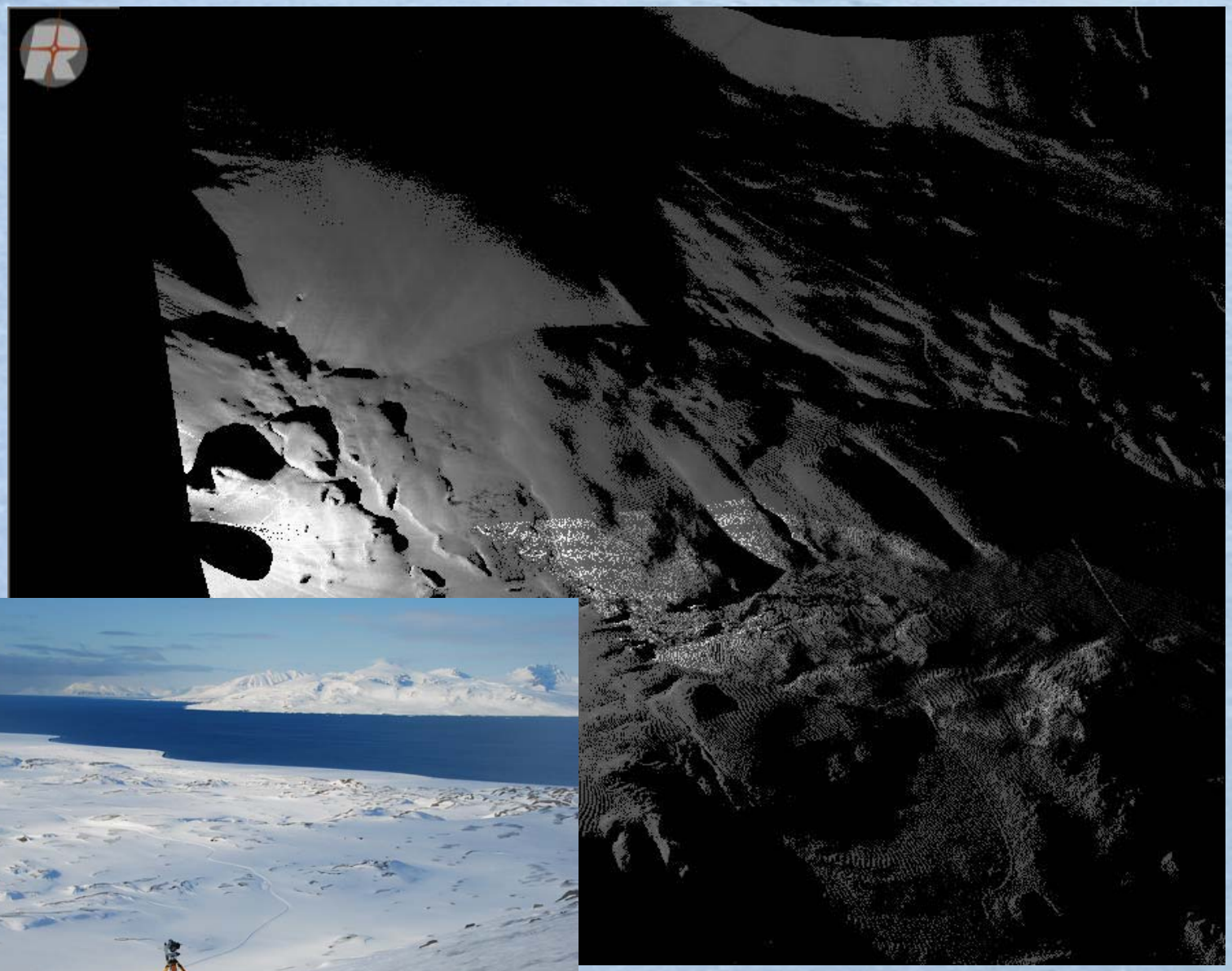
Snow surface variations tested (April 2011)
8 days time interval – One snowstorm (15 cm mean accumulation in flat areas)
Altitude difference between two consecutive scans

Snow drilling in the slopes for future reference

Glacier surface monitoring

Glacier surface monitoring





Glacier front and moraine monitoring

Glacier front monitoring fast changing area

Moraine and icings monitoring

Perspectives

- **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

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