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Mountain Glaciers – Indicators, Resources, Hazards

- Environmental challenges
- Remote sensing of parameters

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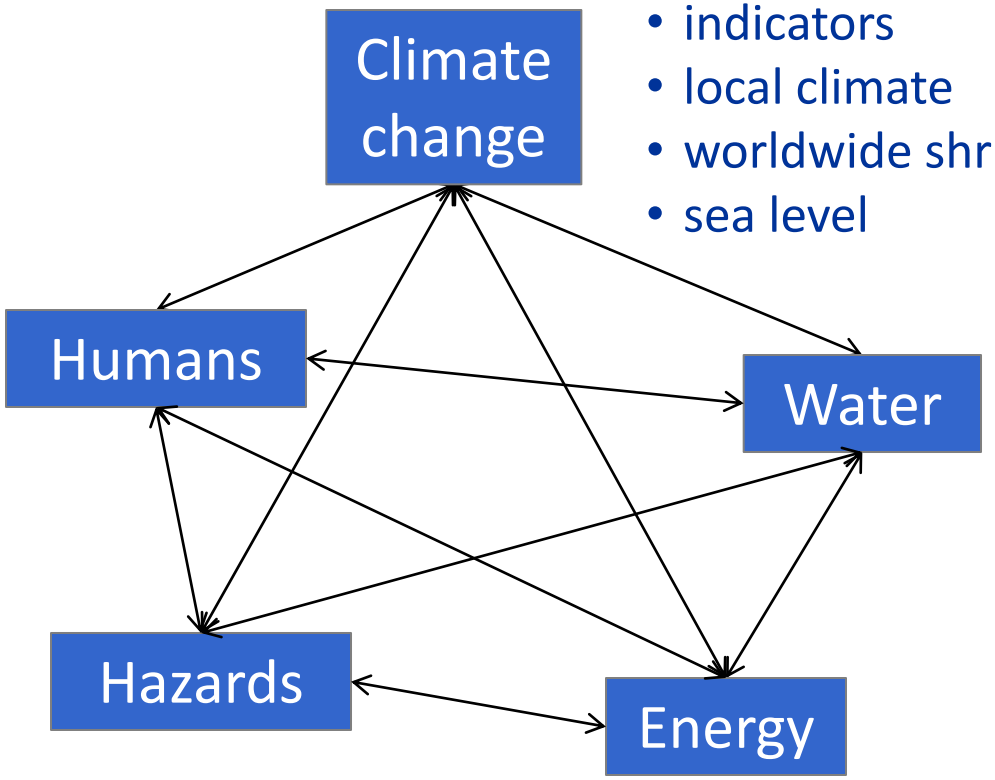
Mountain glaciers



- indicators
- local climate
- worldwide shrinkage
- sea level

- household, agriculture, industry
- runoff seasonality
- 2-phase response
- snow / climate regime!

- lake outbursts
- ice avalanches
- rock avalanches
- slope instabilities
- combinations/ chain reactions

- hydropower

Glacier lake outbursts

5 km

Tam Pokari, Nepal, 1998

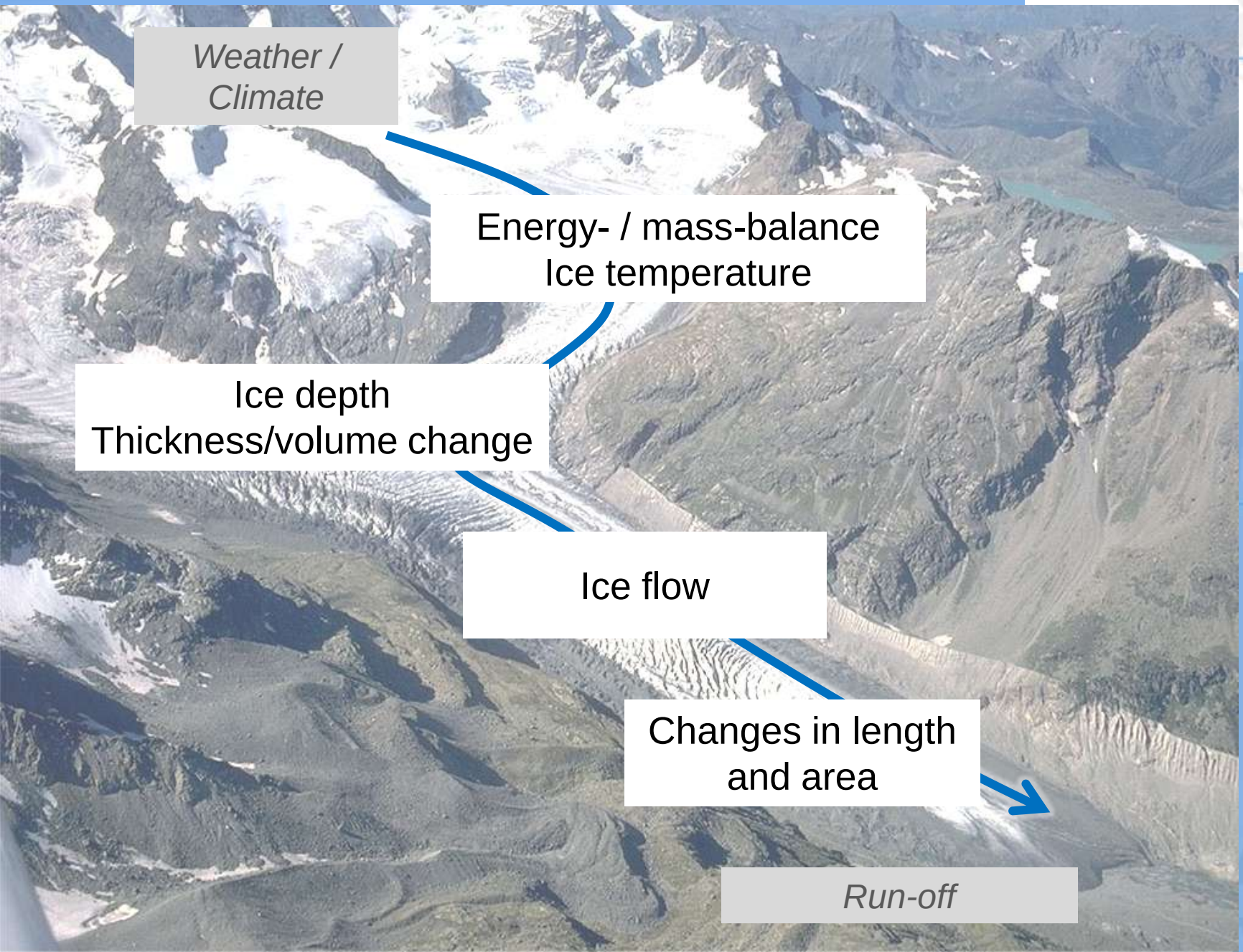
Challenge: temporary lakes

Macugnaga, Italy, 2002

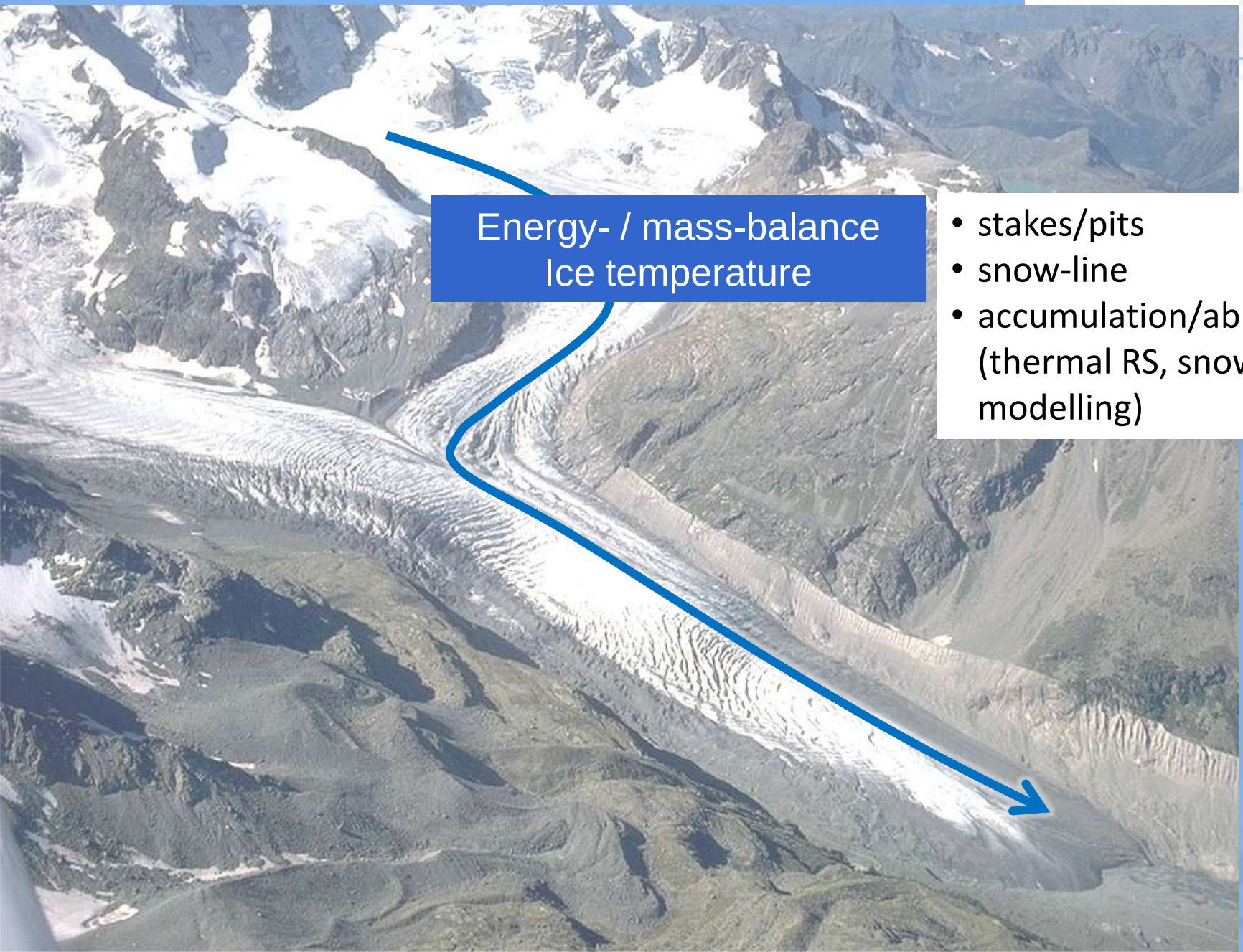
Ice/rock avalanches

Kolka/Karmadon, Caucasus, 2002 (I. Galushkin)

Remote sensing of parameters

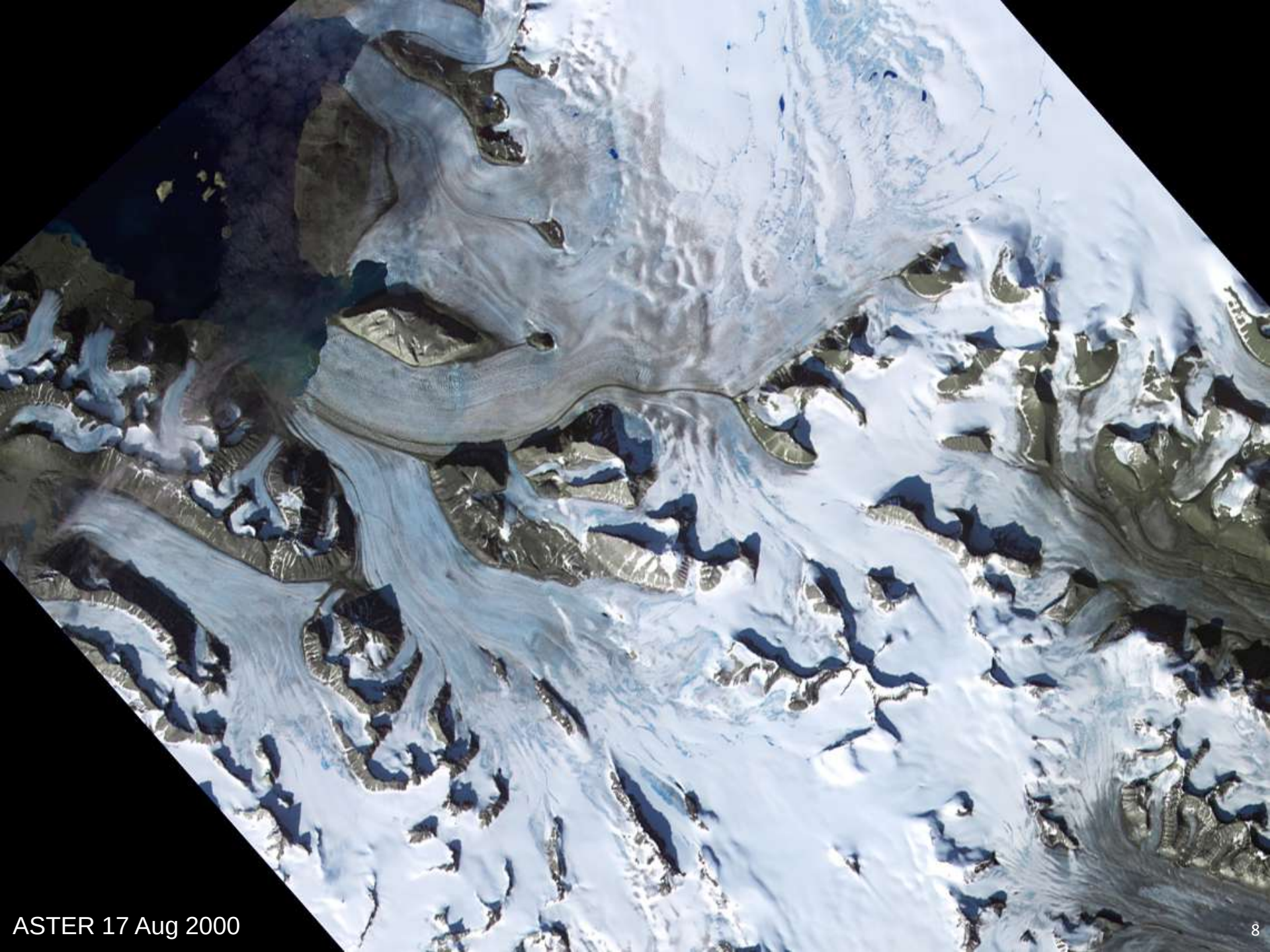


Remote sensing of parameters



Energy- / mass-balance
Ice temperature

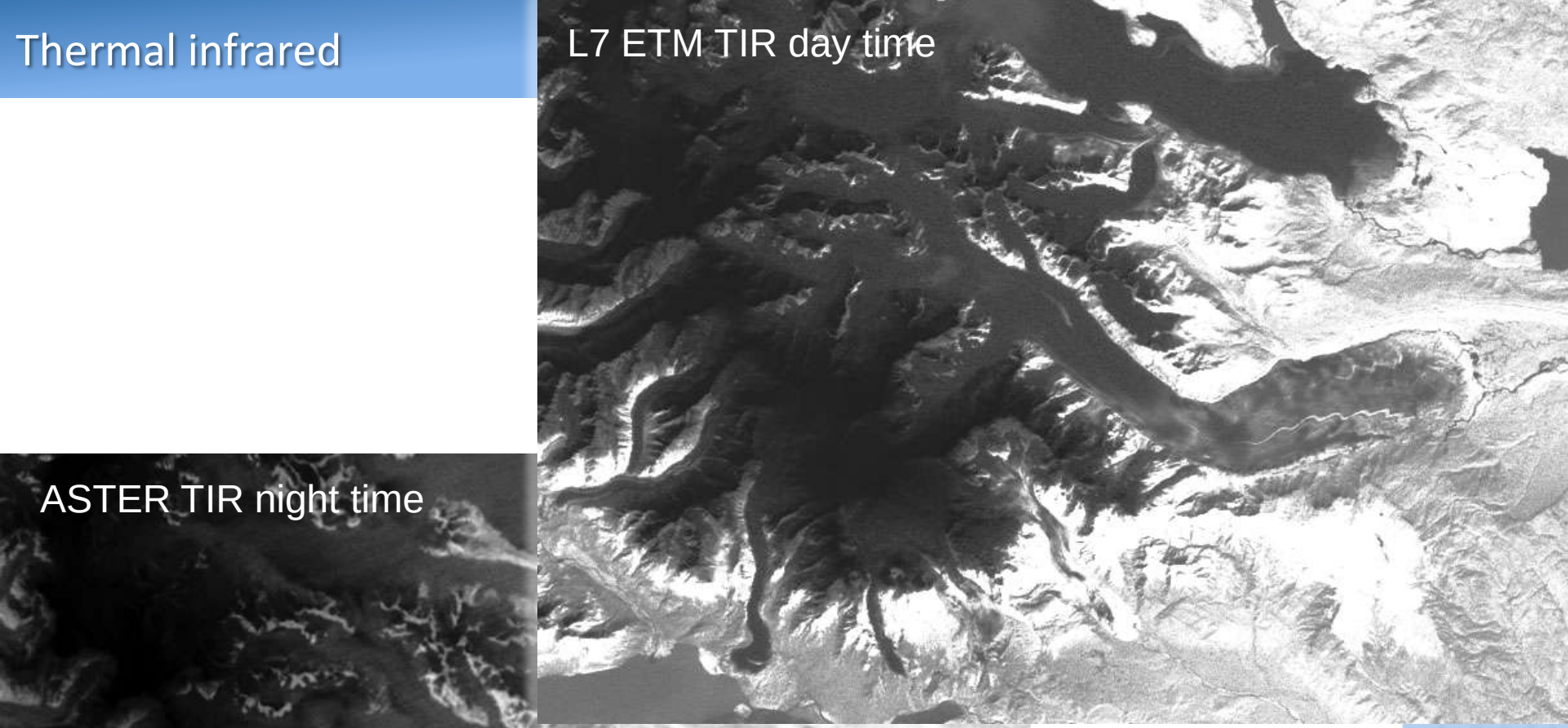
- stakes/pits
- snow-line
- accumulation/ablation ? (thermal RS, snow-fall, modelling)



ASTER 17 Aug 2000

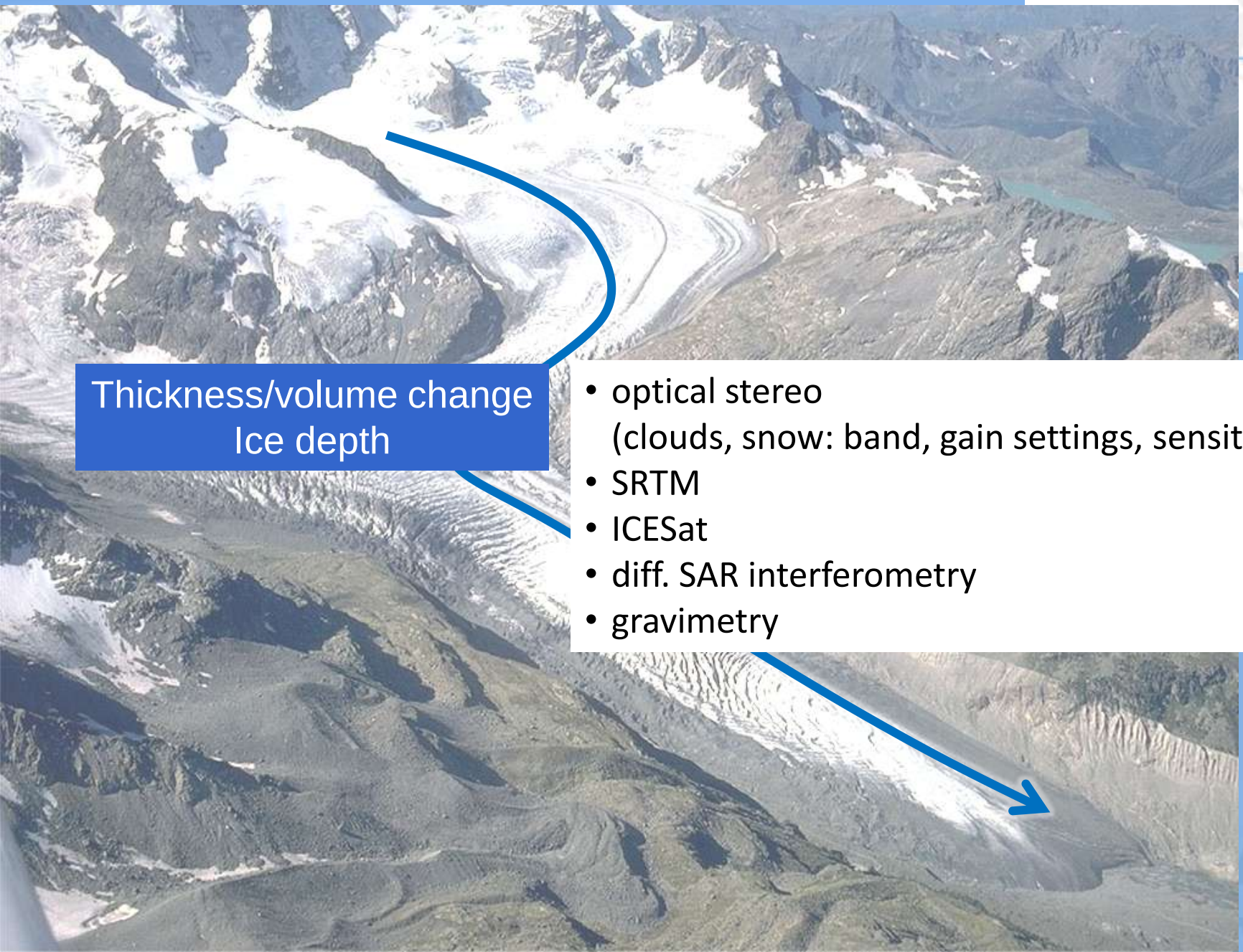
ALOS PALSAR HV-HH composite (HH: yellow, HV: blue)

Thermal infrared



Kääb (2005)

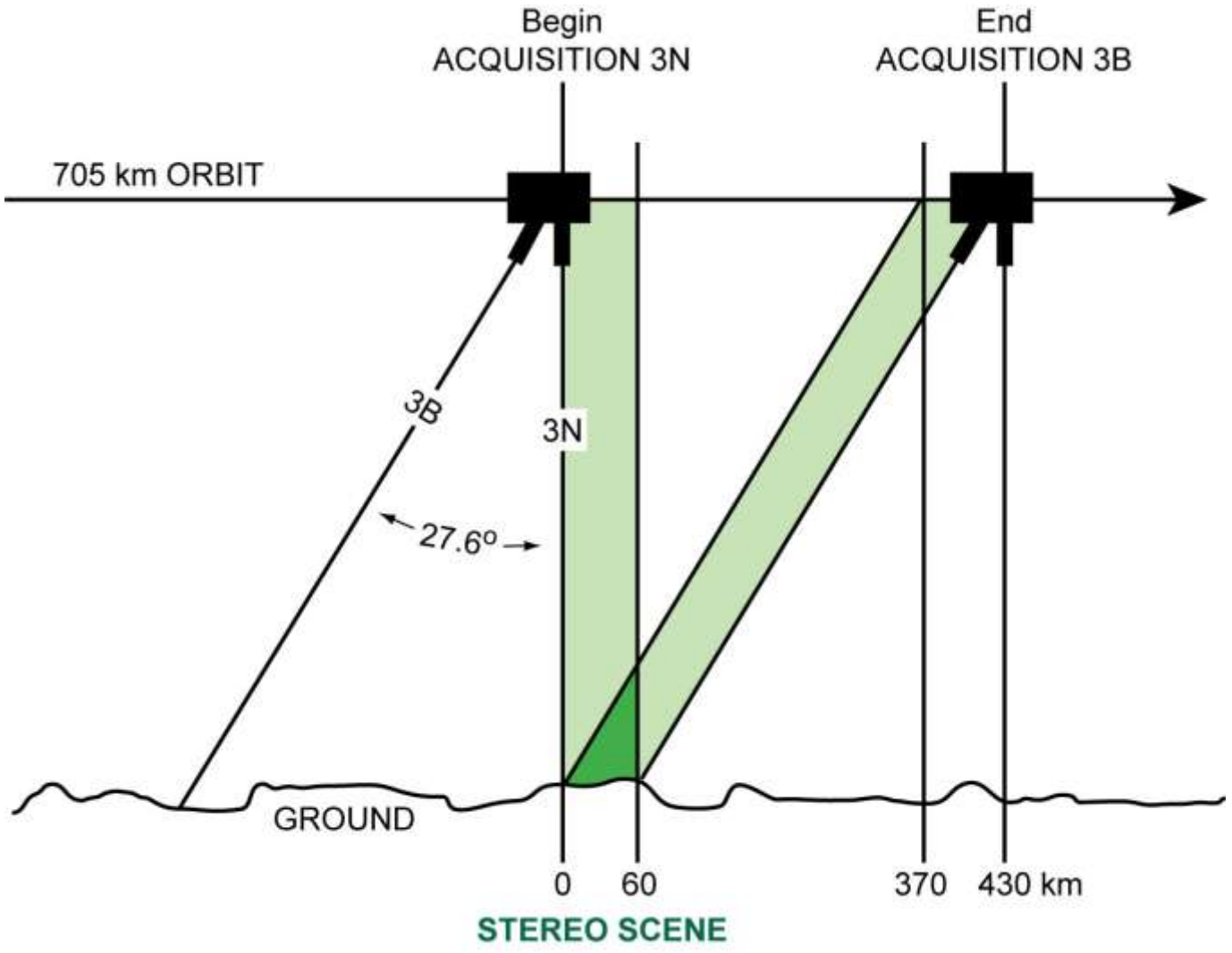
Remote sensing of parameters



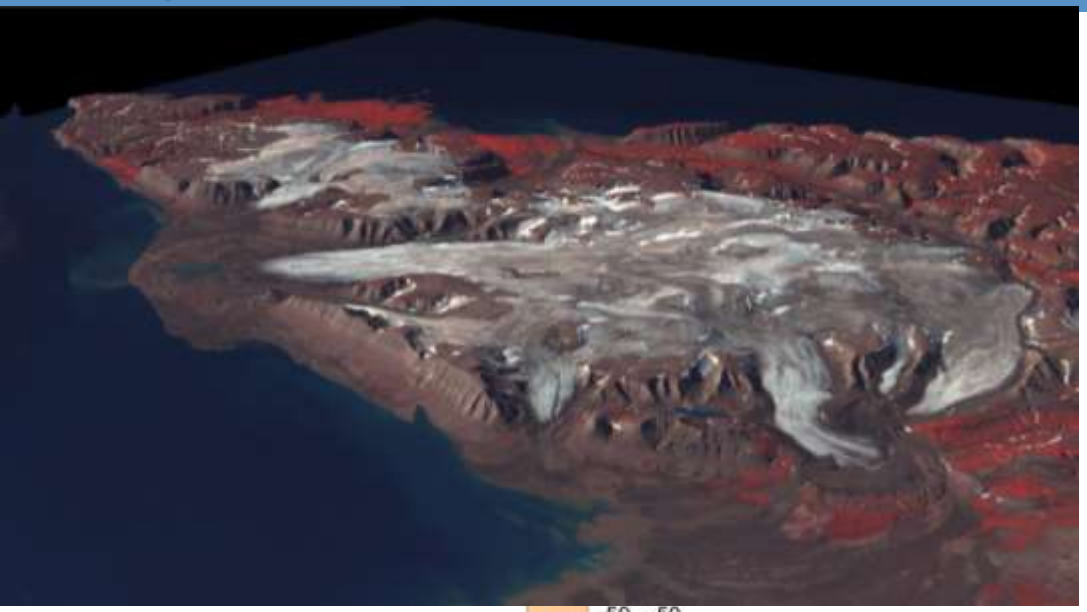
Thickness/volume change
Ice depth

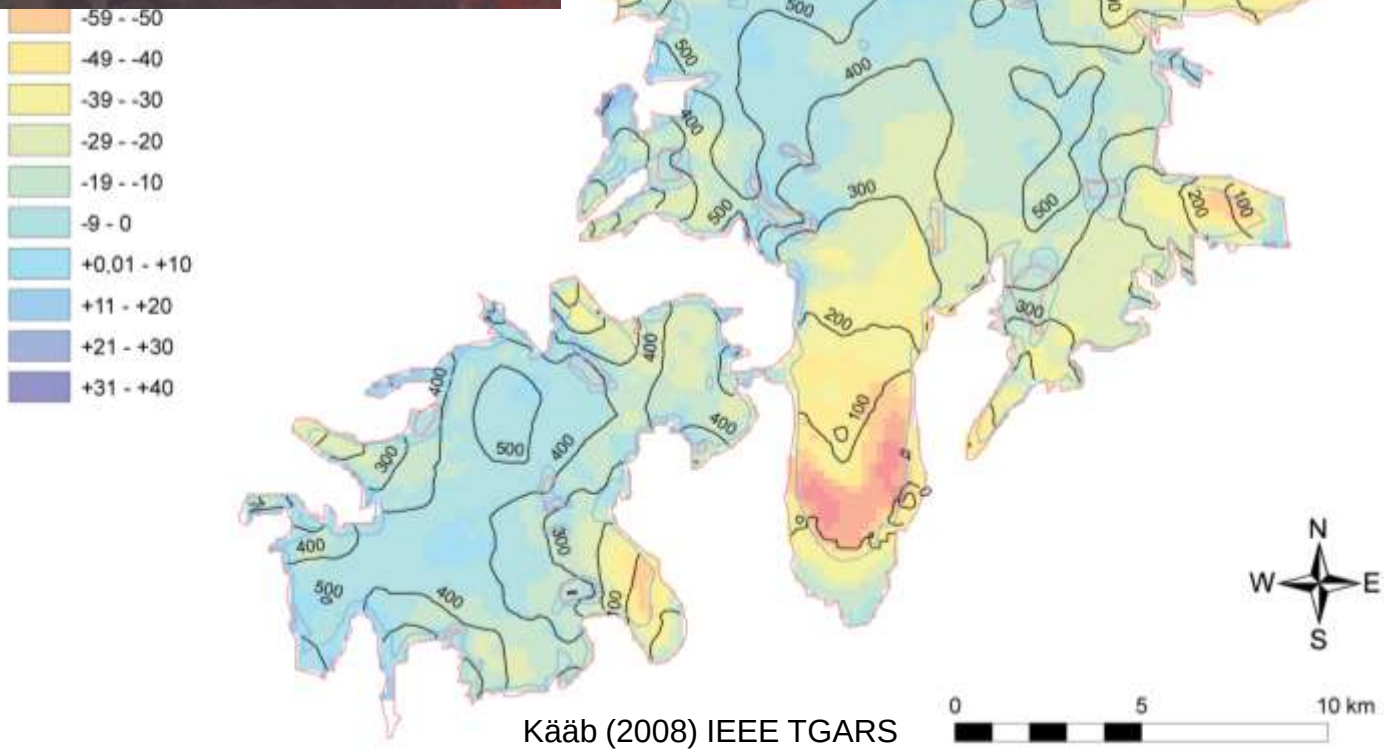
- optical stereo
  (clouds, snow: band, gain settings, sensitivity)
- SRTM
- ICESat
- diff. SAR interferometry
- gravimetry

ASTER along-track stereo



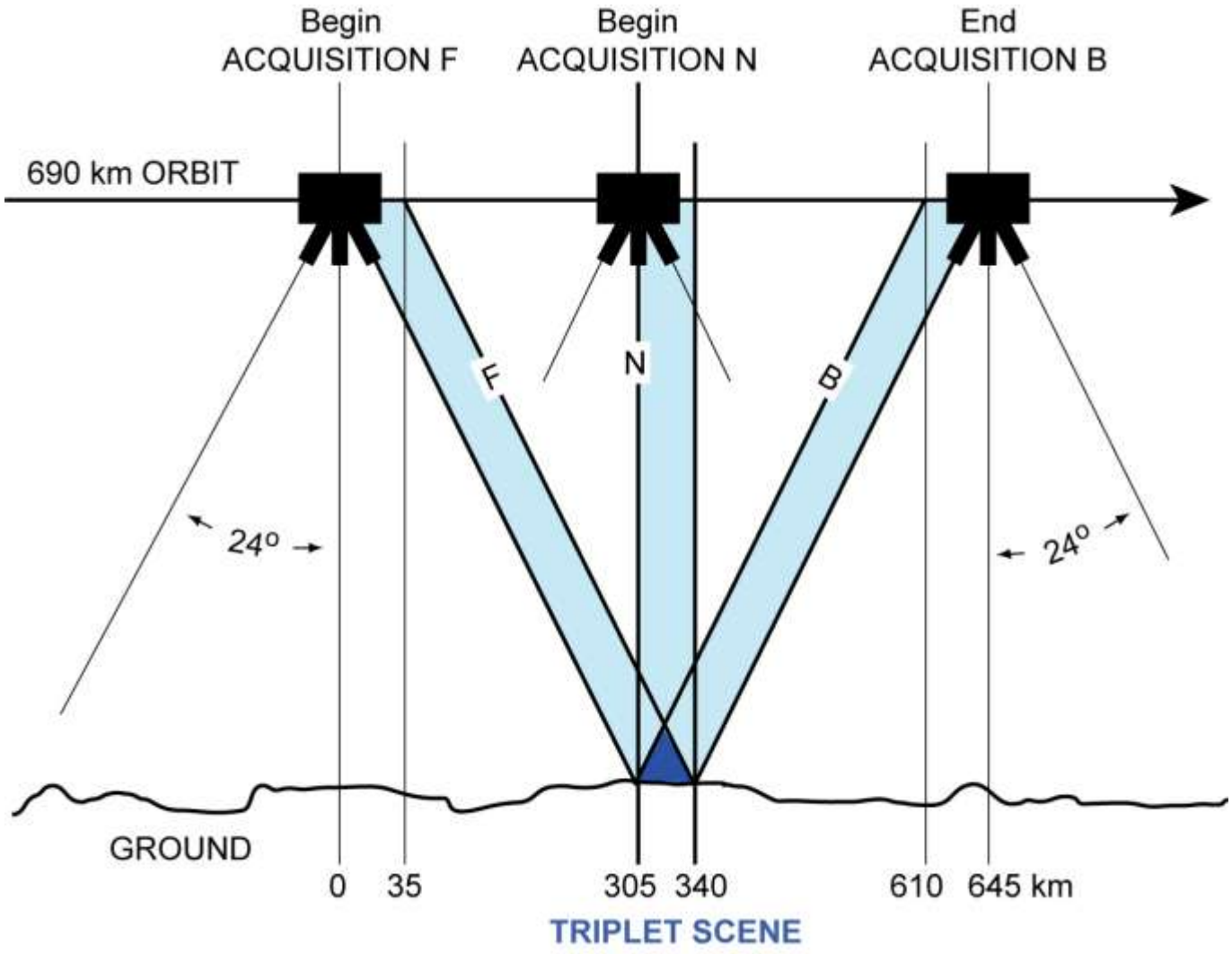
Interpolated elevation differences 1970 – 2002



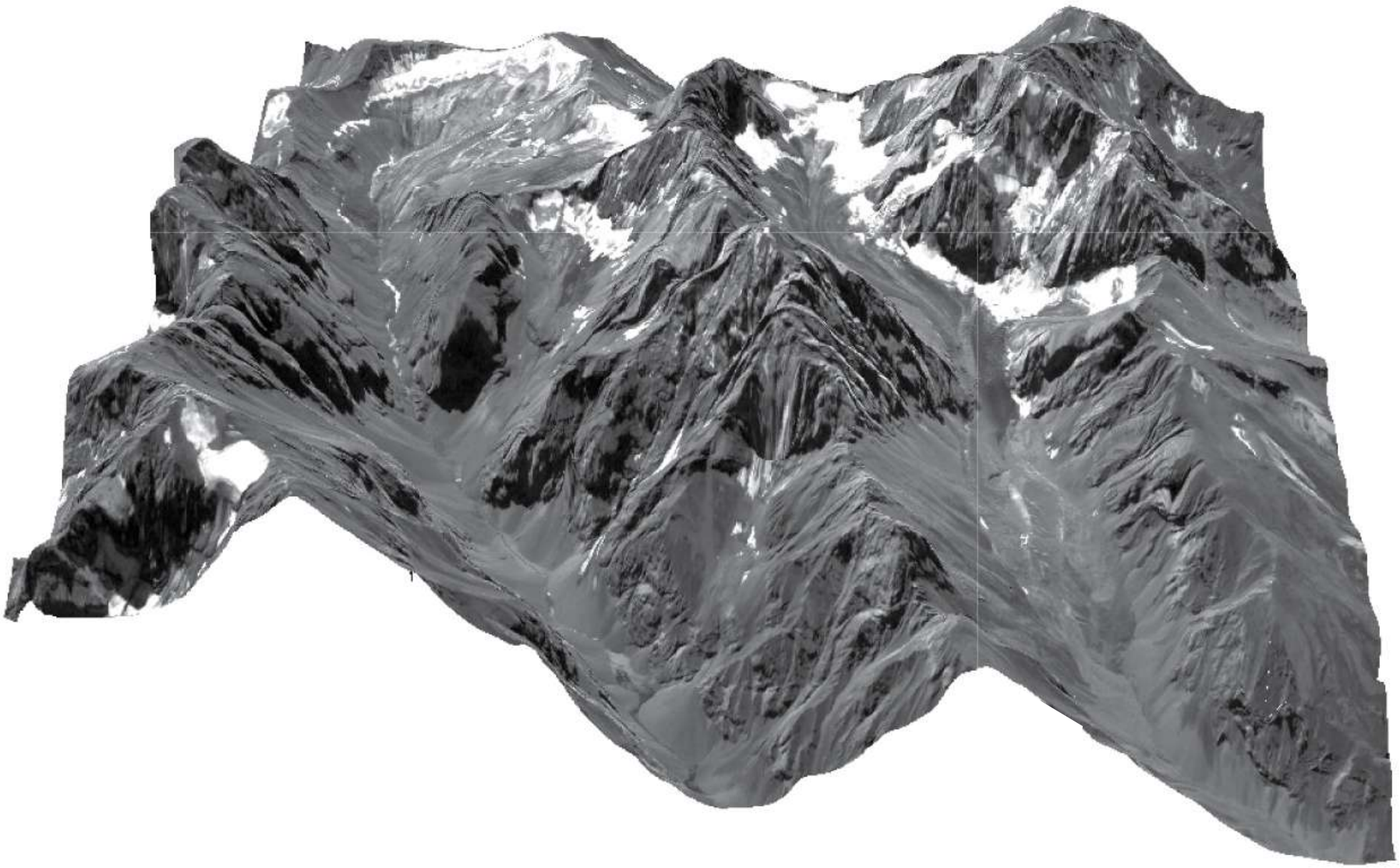


Kääb (2008) IEEE TGARS

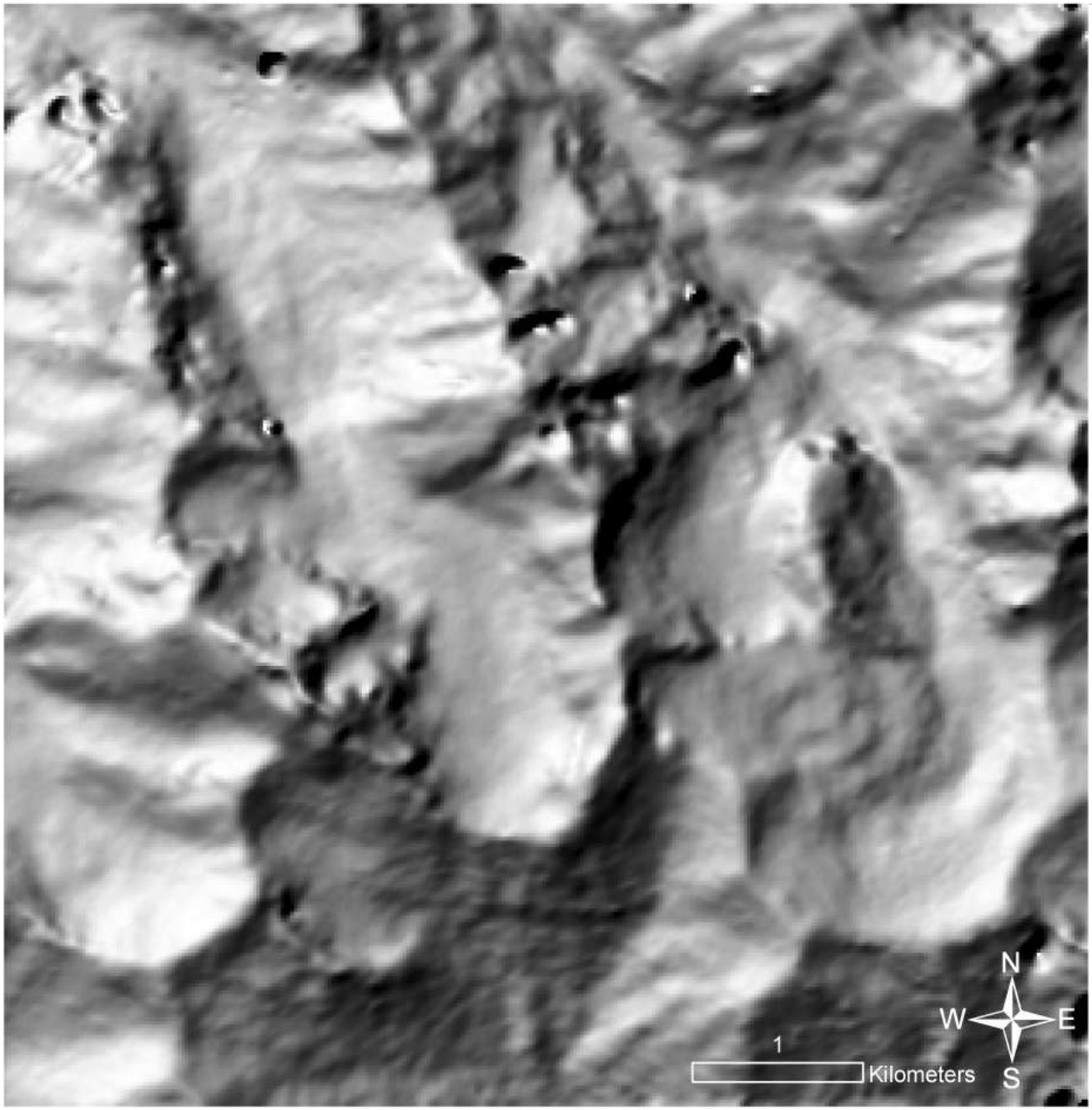
ALOS PRISM triplet stereo



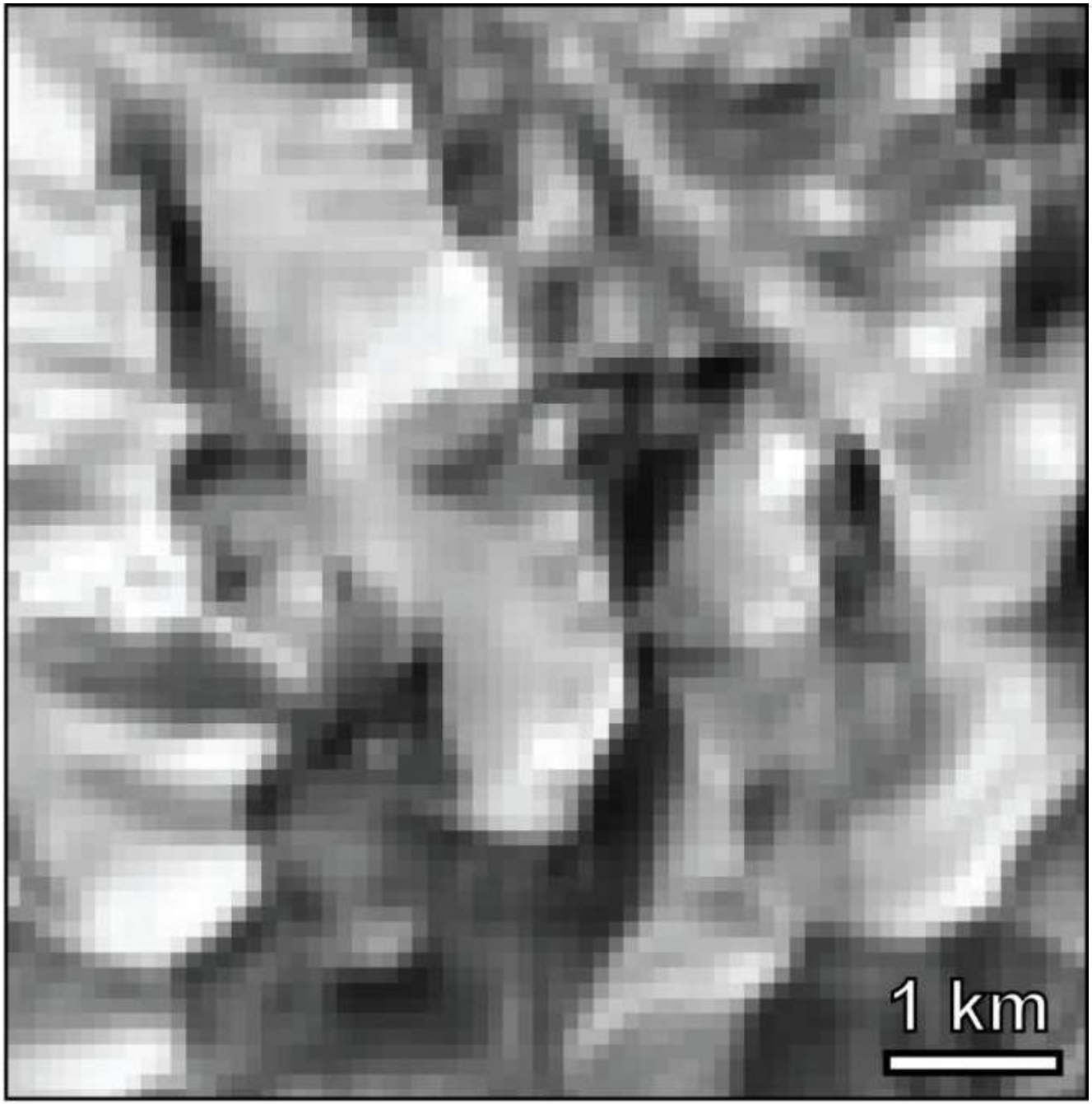
Tien Shan



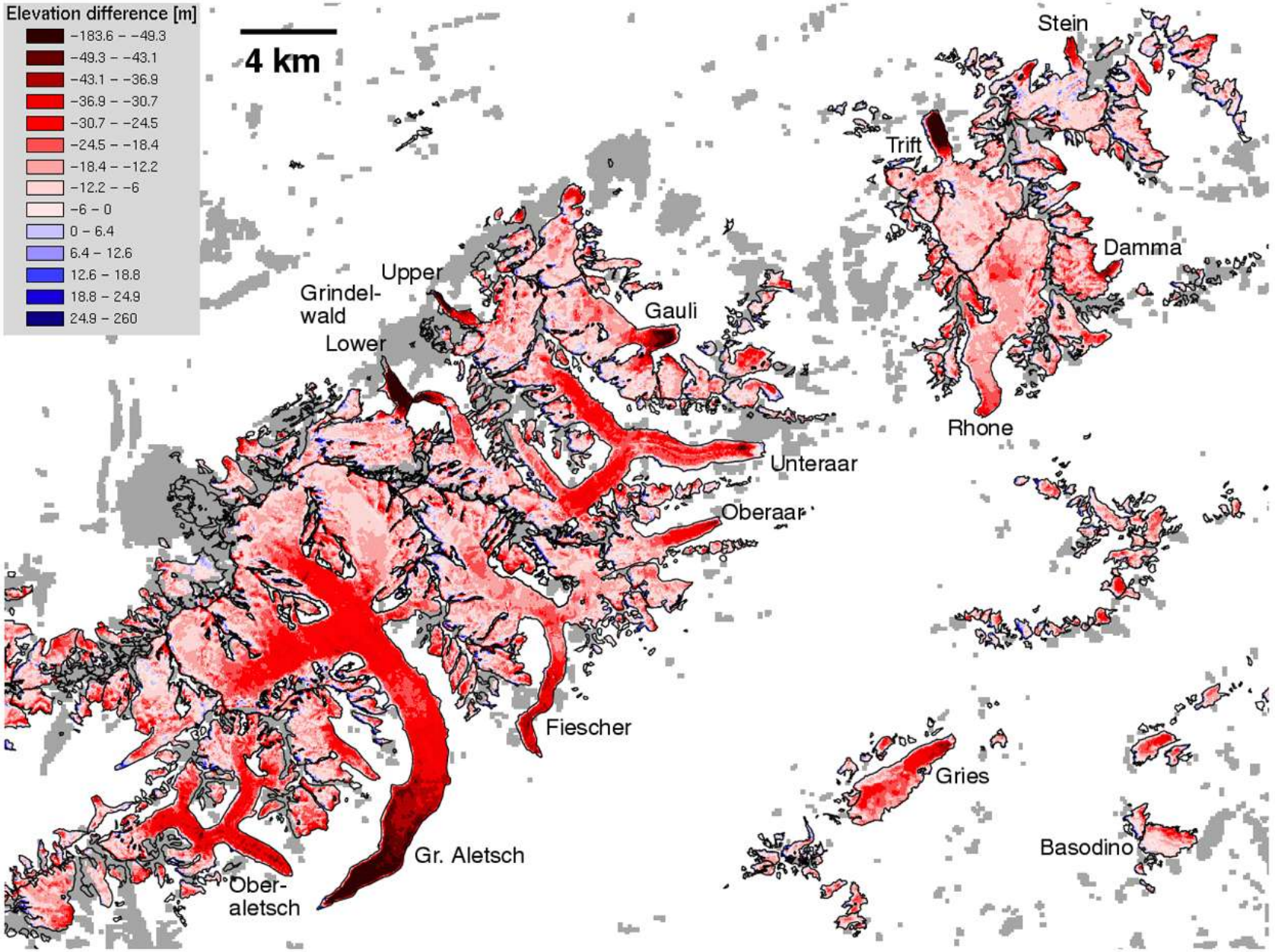
PRISM DEM Triplet



SRTM

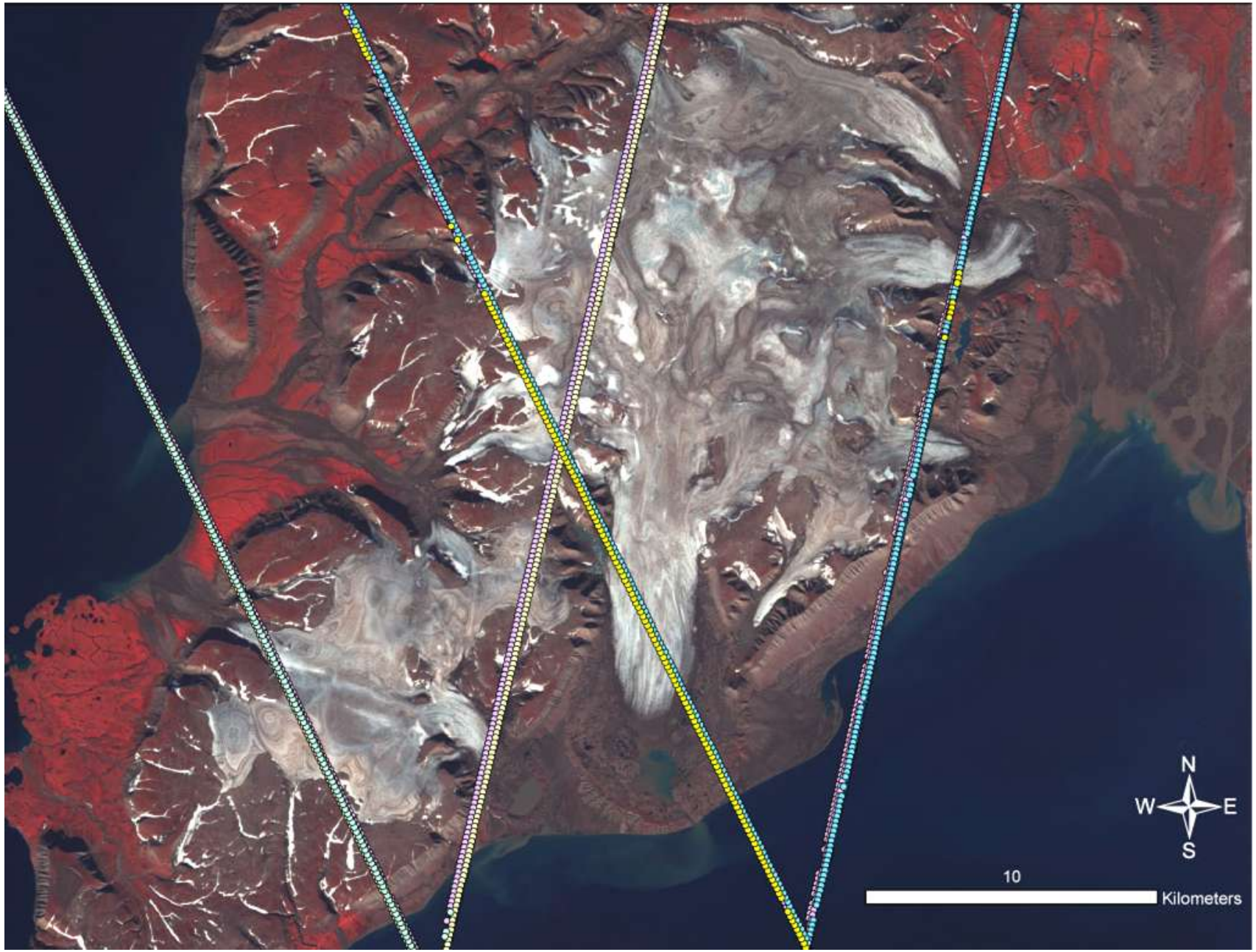


SRTM – national mapping agency DEM

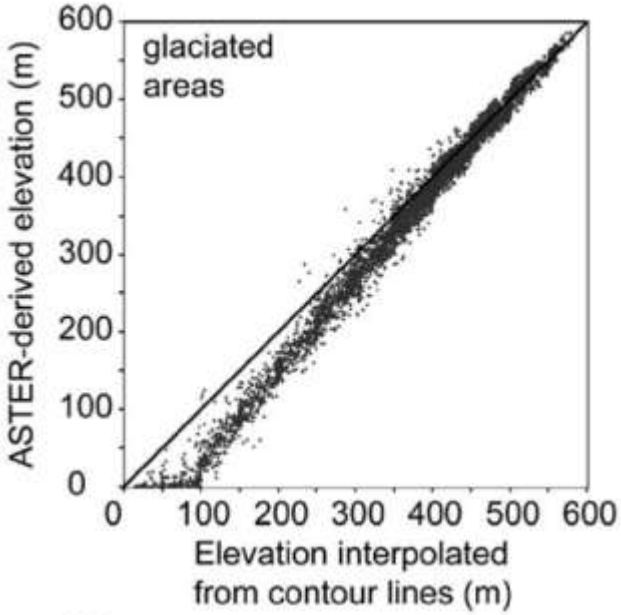


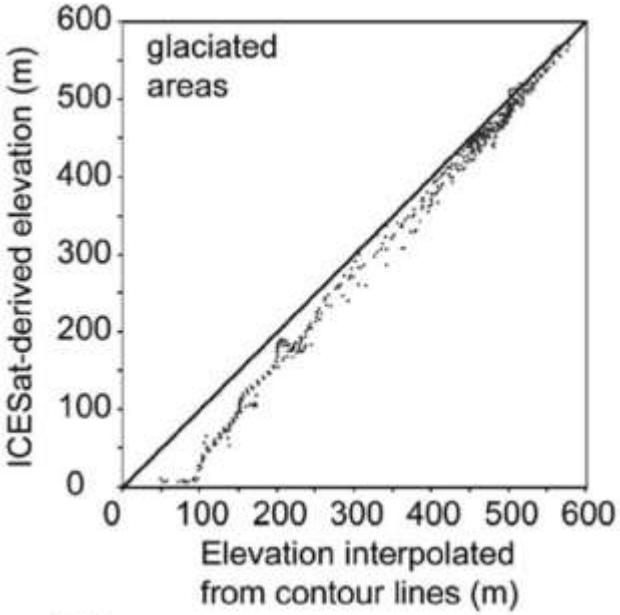
Paul & Haeberli (2008) GRL

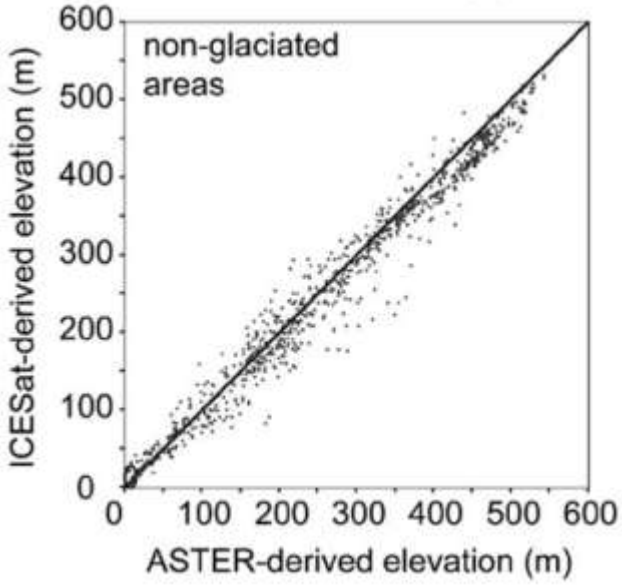
IceSat GLAS

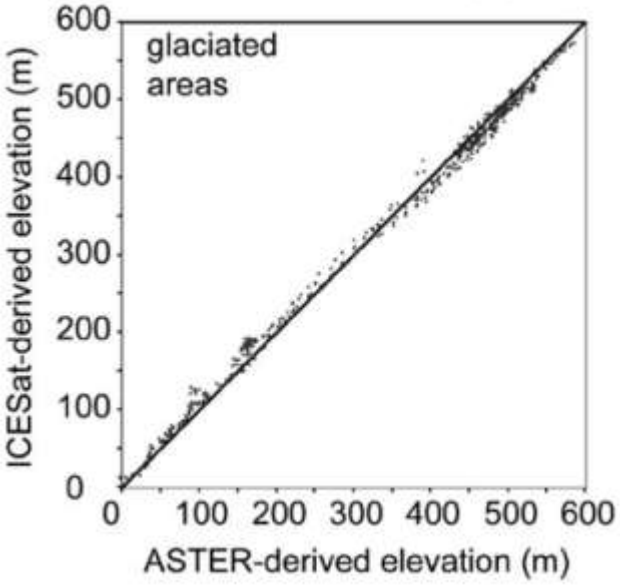


Elevation differences 1970 – 2002 – 2006



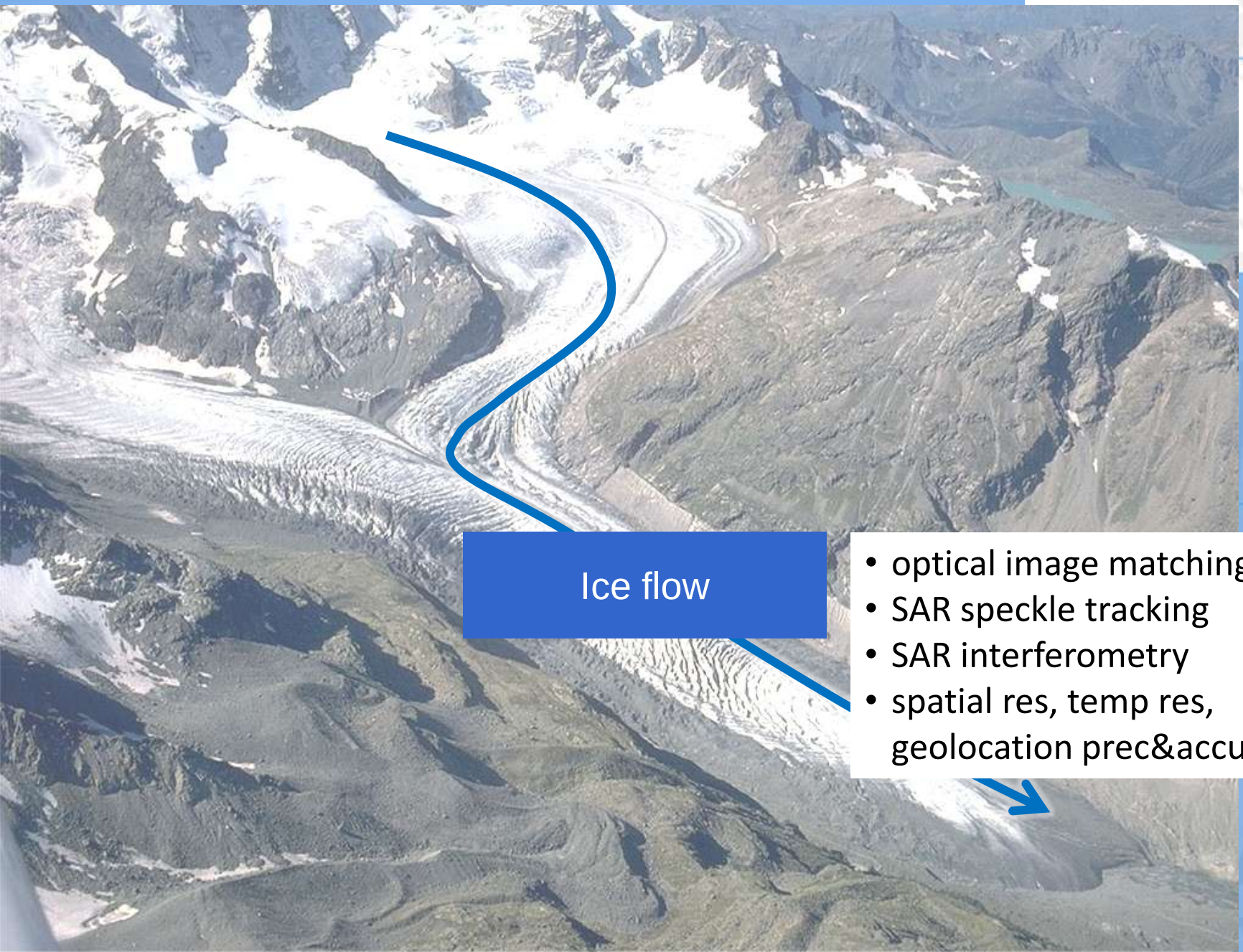




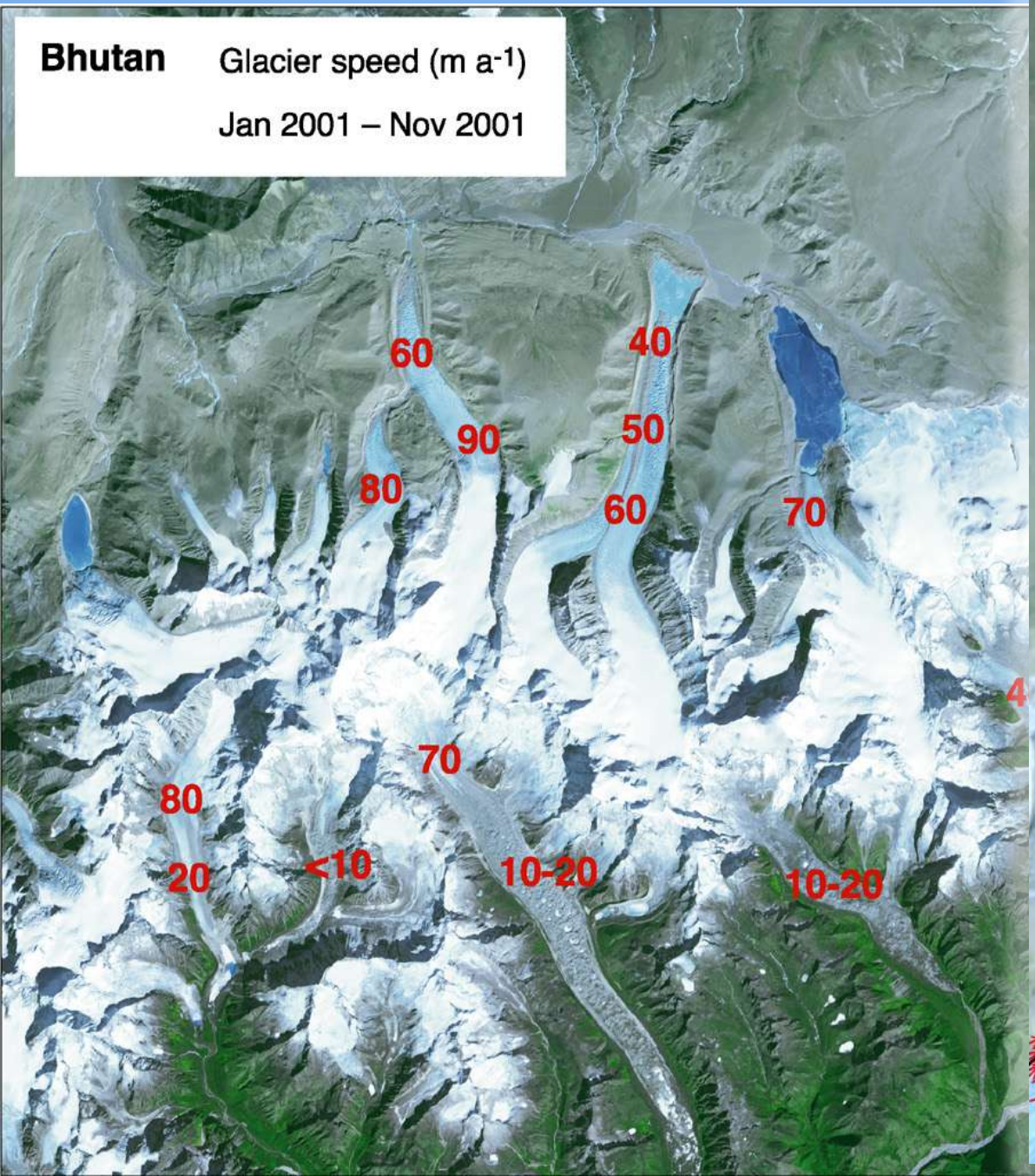


Kääb (2008) IEEE TGARS

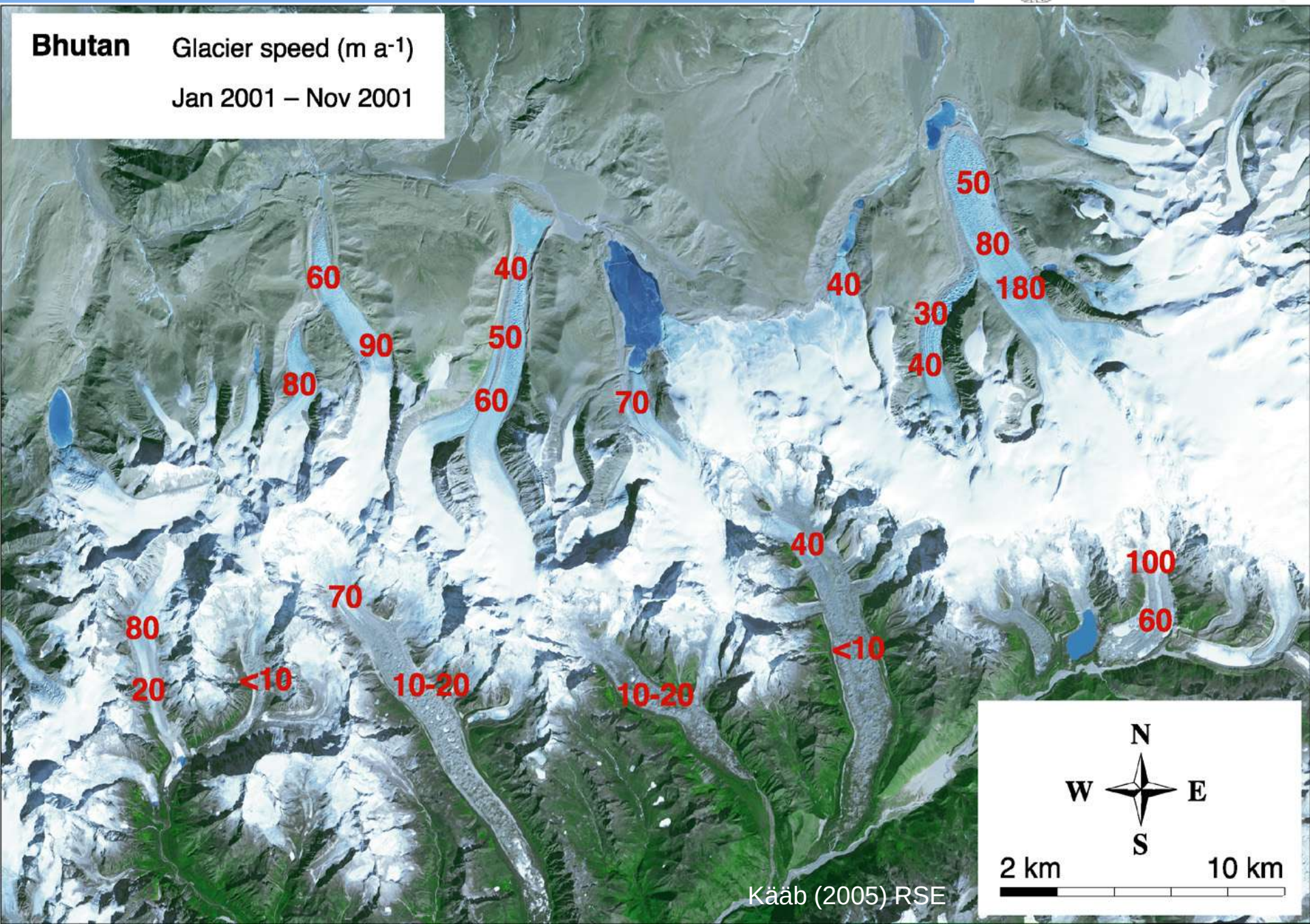
Remote sensing of parameters



Optical image matching



Optical image matching

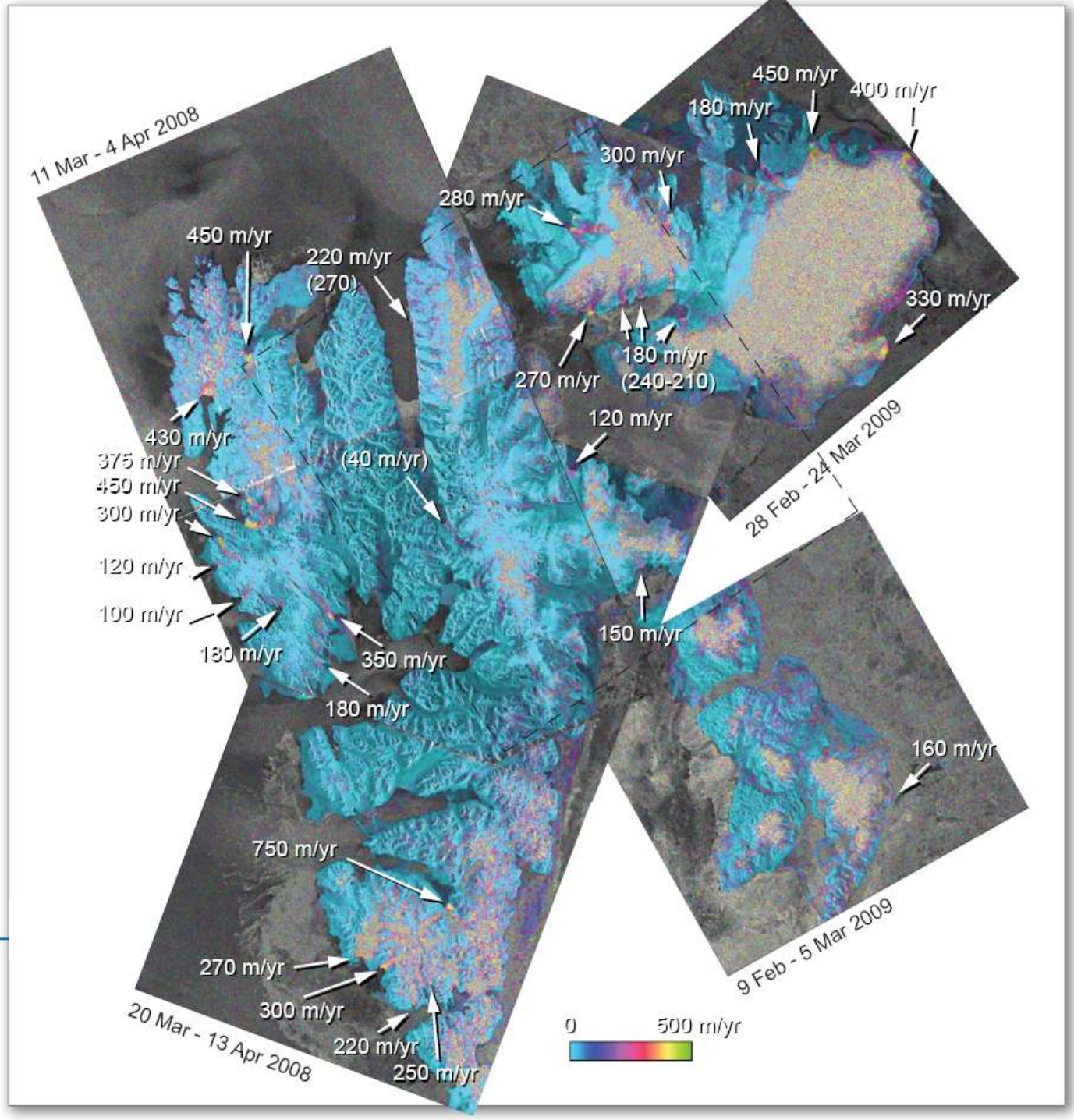


Glacier flow / speckle tracking

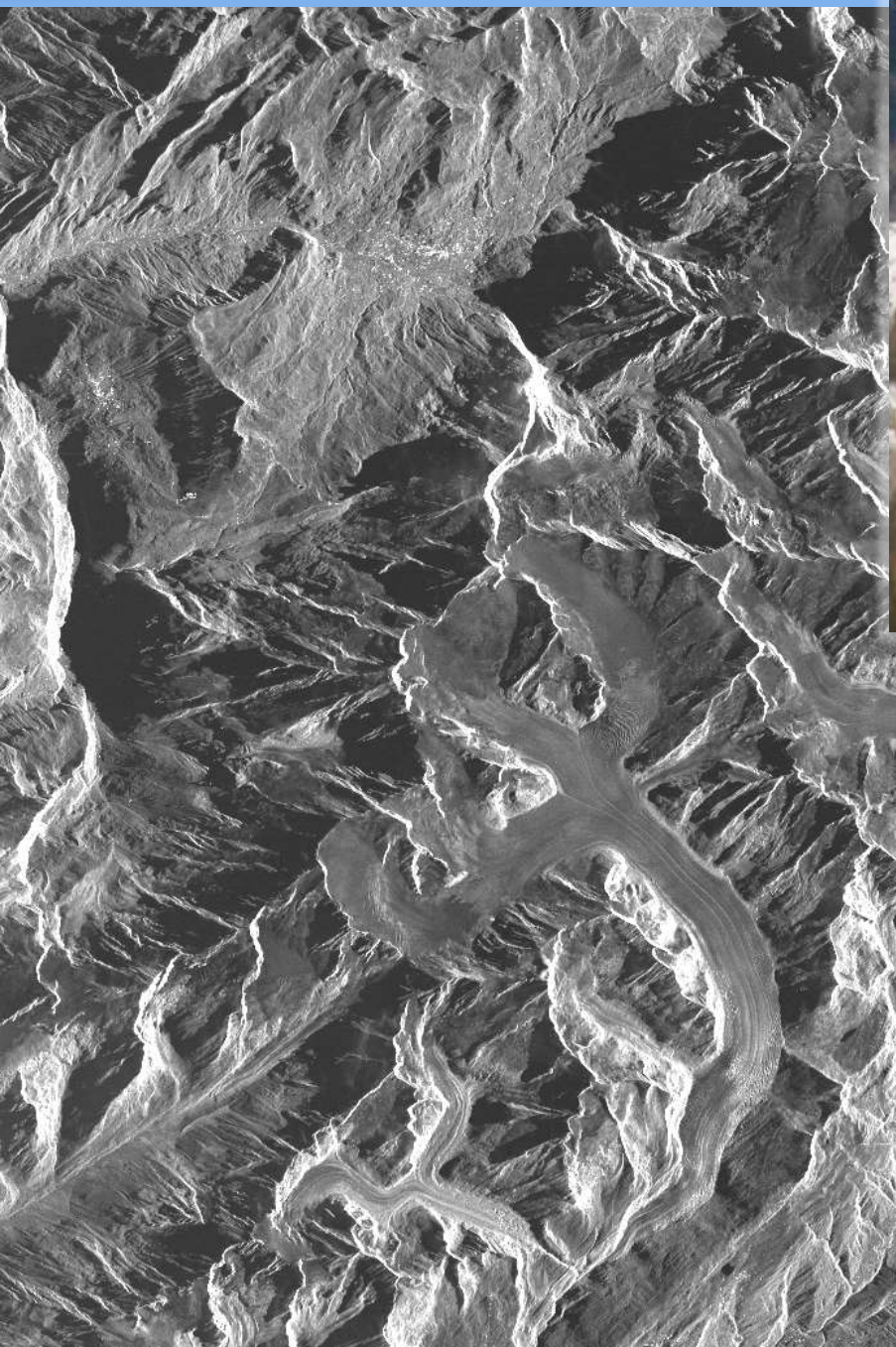
Radarsat data:

Norsk Romsenter
NORWEGIAN SPACE CENTRE

KONGSBERG

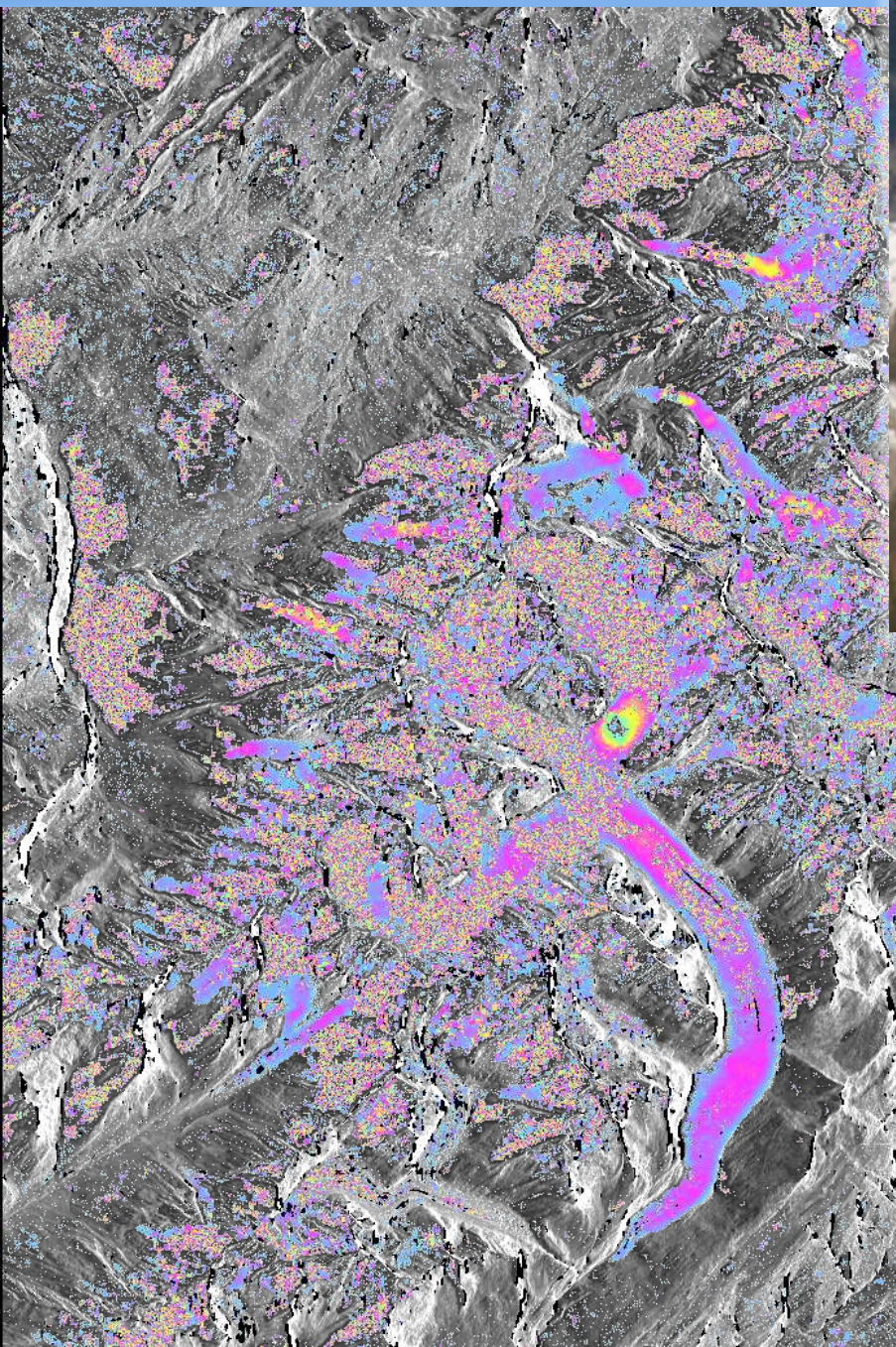


SAR speckle tracking (TSX)

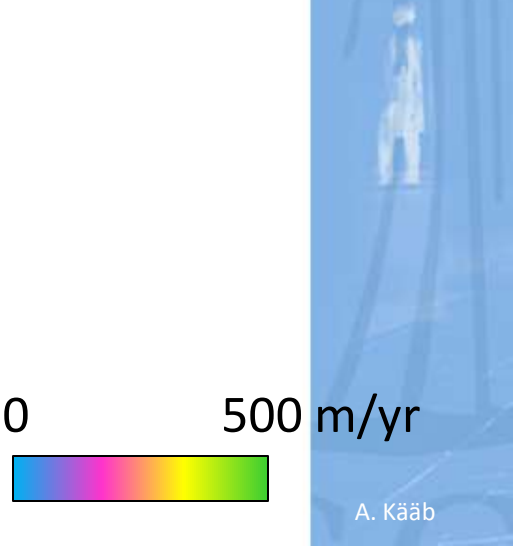


A. Kääb

SAR speckle tracking (TSX)

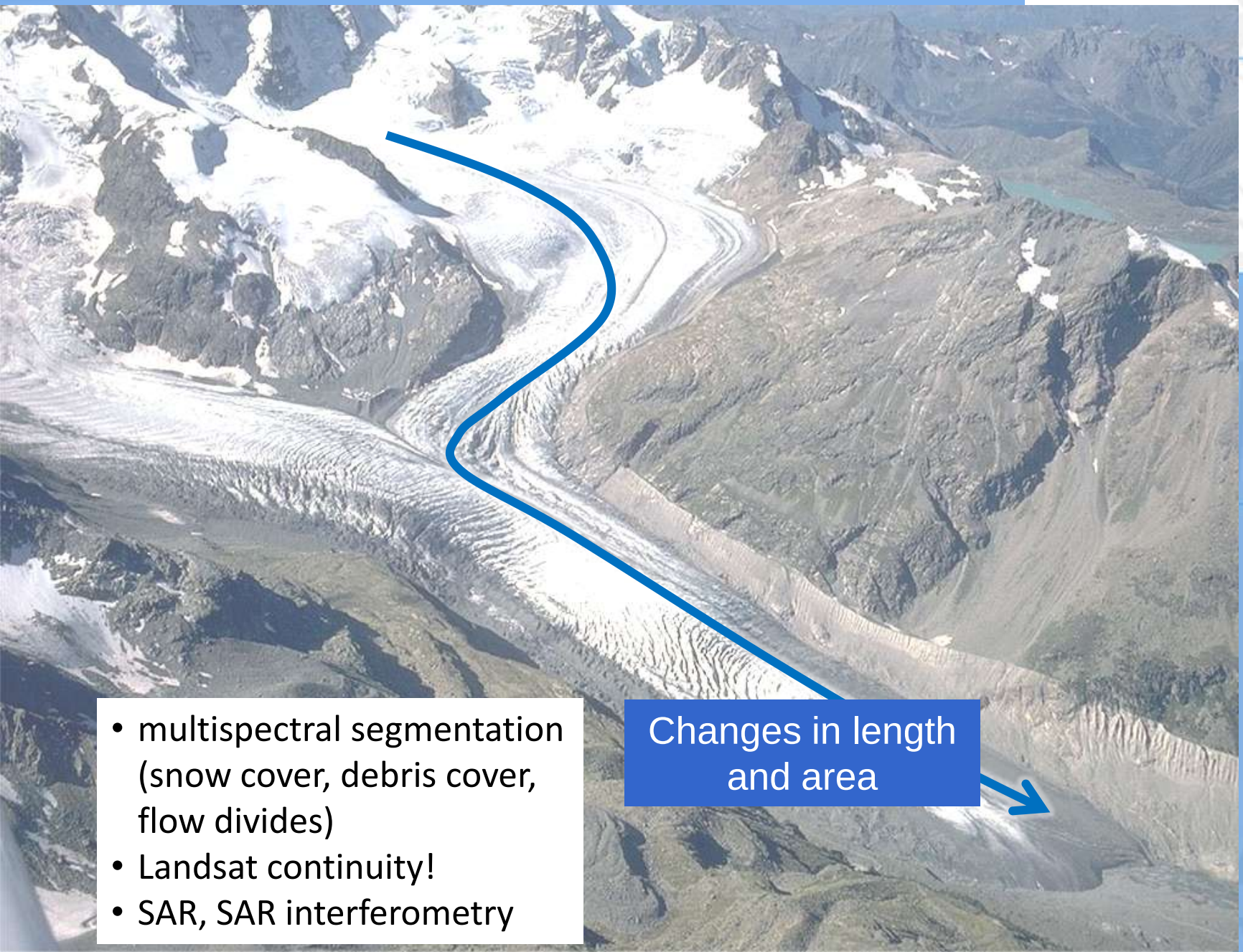


0 500 m/yr



A. Kääb

Remote sensing of parameters

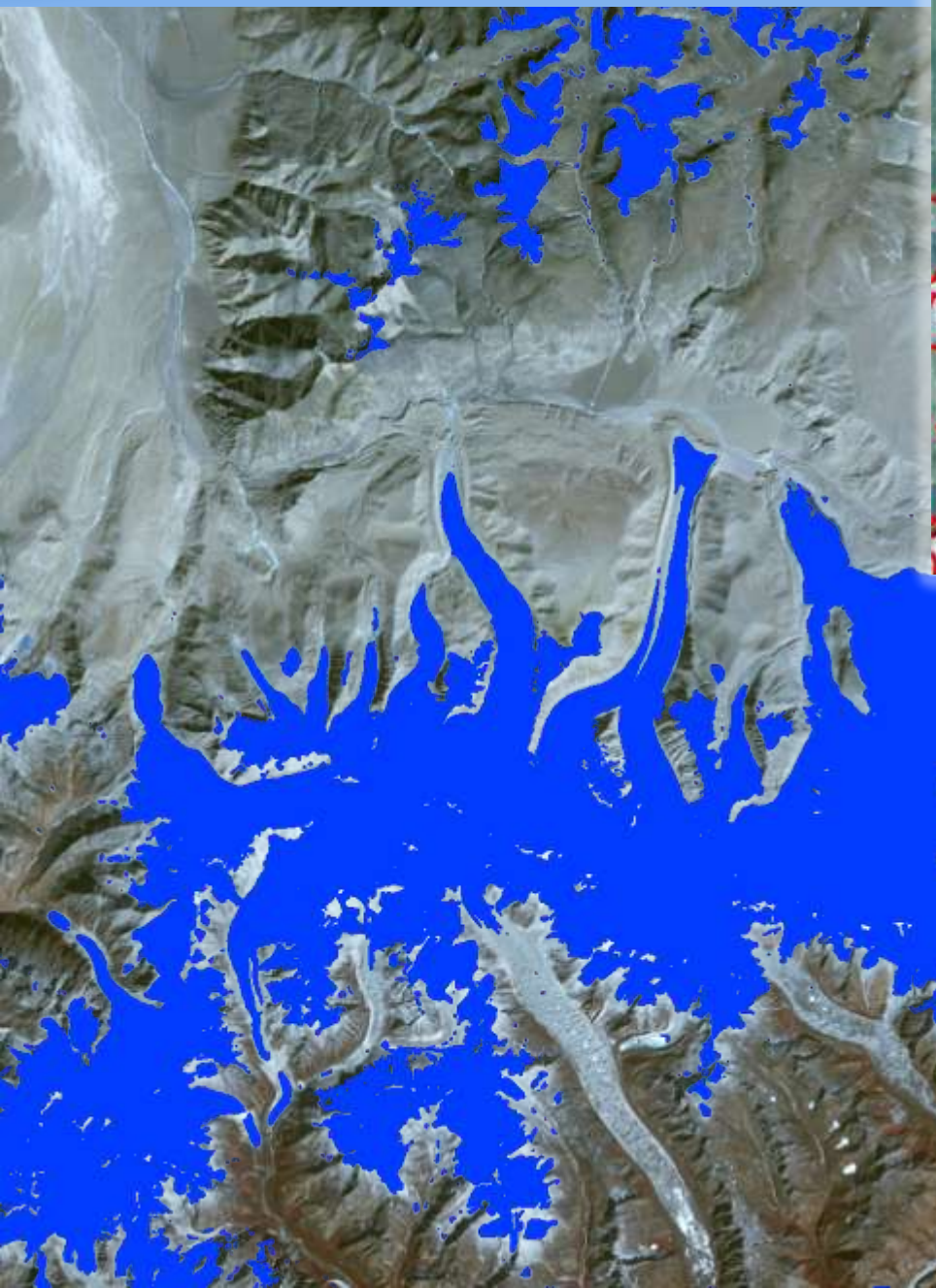


- multispectral segmentation (snow cover, debris cover, flow divides)
- Landsat continuity!
- SAR, SAR interferometry

Automatic segmentation

Automatic segmentation

Automatic segmentation



SAR-based multitemporal glacier mapping

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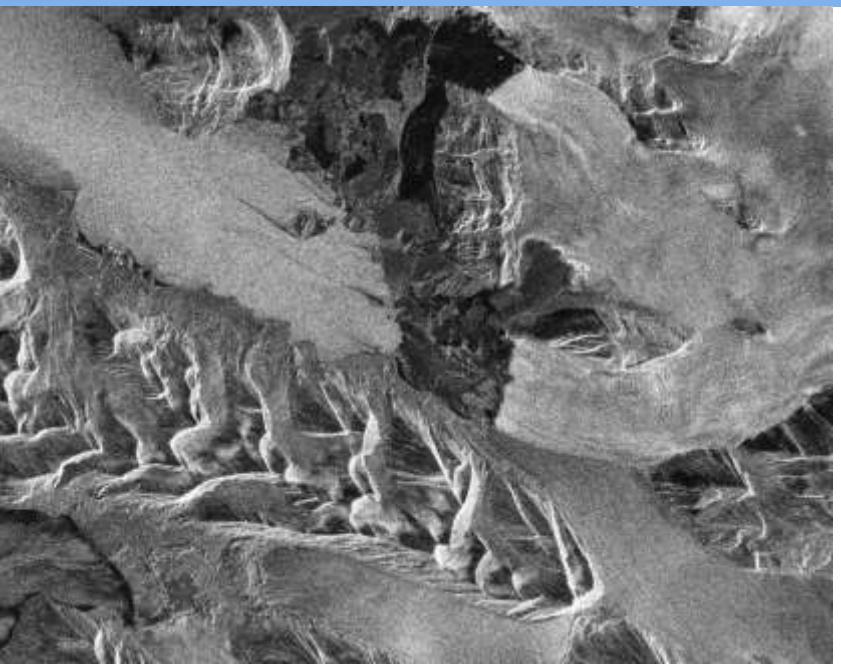

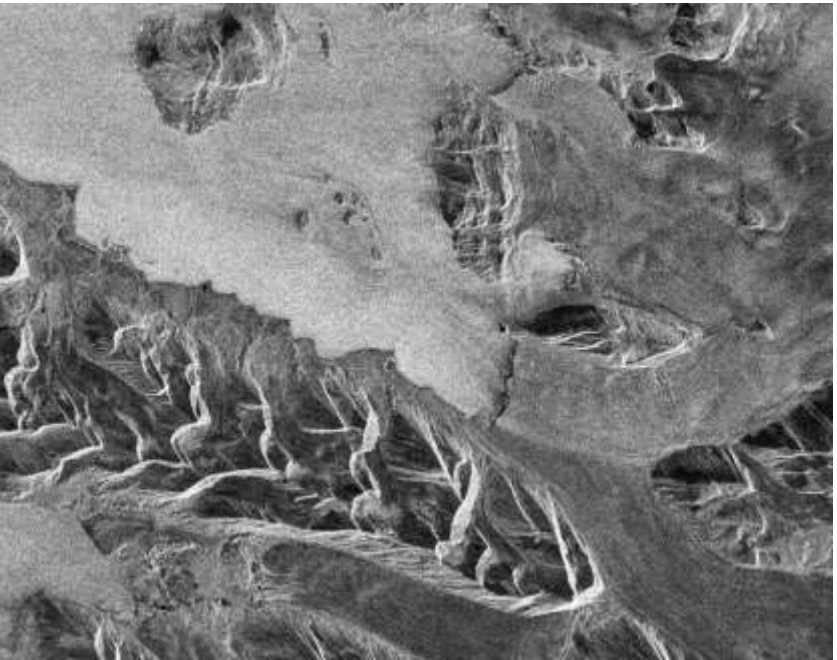

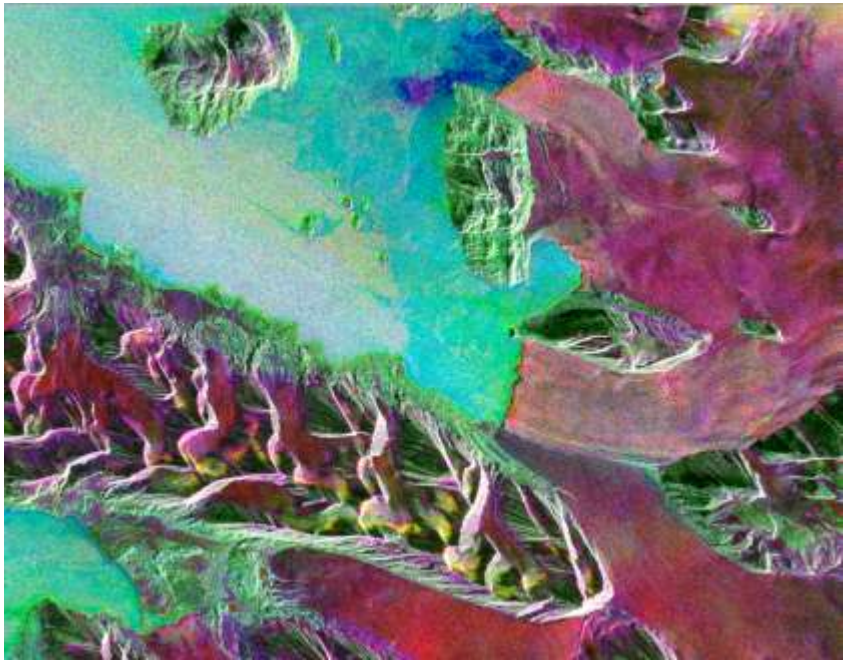

Summary / wish list

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- Increasing need for global information about glacier changes with
  - higher spatial and temporal
  - resolution and coverage
- improve SAR-based detection of mass balance
- Lidar and interferometric altimetry
- sensitivity/gain settings of optical sensors
- “global SRTM” every 5-10 years
- increase spatio-temporal resolution/coverage for ice flow
- improve geolocation precision and accuracy
- improve methods for automatic glacier inventorying
- ensure Landsat7-type continuity (GLIMS, GlobGlacier)
- RS + modelling / assimilation