Leibnitzkopf Rock Glacier (Austrian Alps): Detection of a Fast Moving Rock Glacier and Subsequent Measurement of its Flow Velocity

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1. Introduction

- Kinematics of rock glaciers
- Application of geobrowsers (Google Maps, Microsoft Bing) for detection and quantification of fast moving rock glaciers
- Test site: Schober Mountains (Hohe Tauern Range, Austria)

western part (120 km²)
of the Schober Mountains

2. Identifying fast moving rock glacier

- Visual method
- Measuring method

2.1 Visual method

Microsoft Bing Maps (access 26-05-2012)

http://maps.google.com/

http://www.bing.com/maps/

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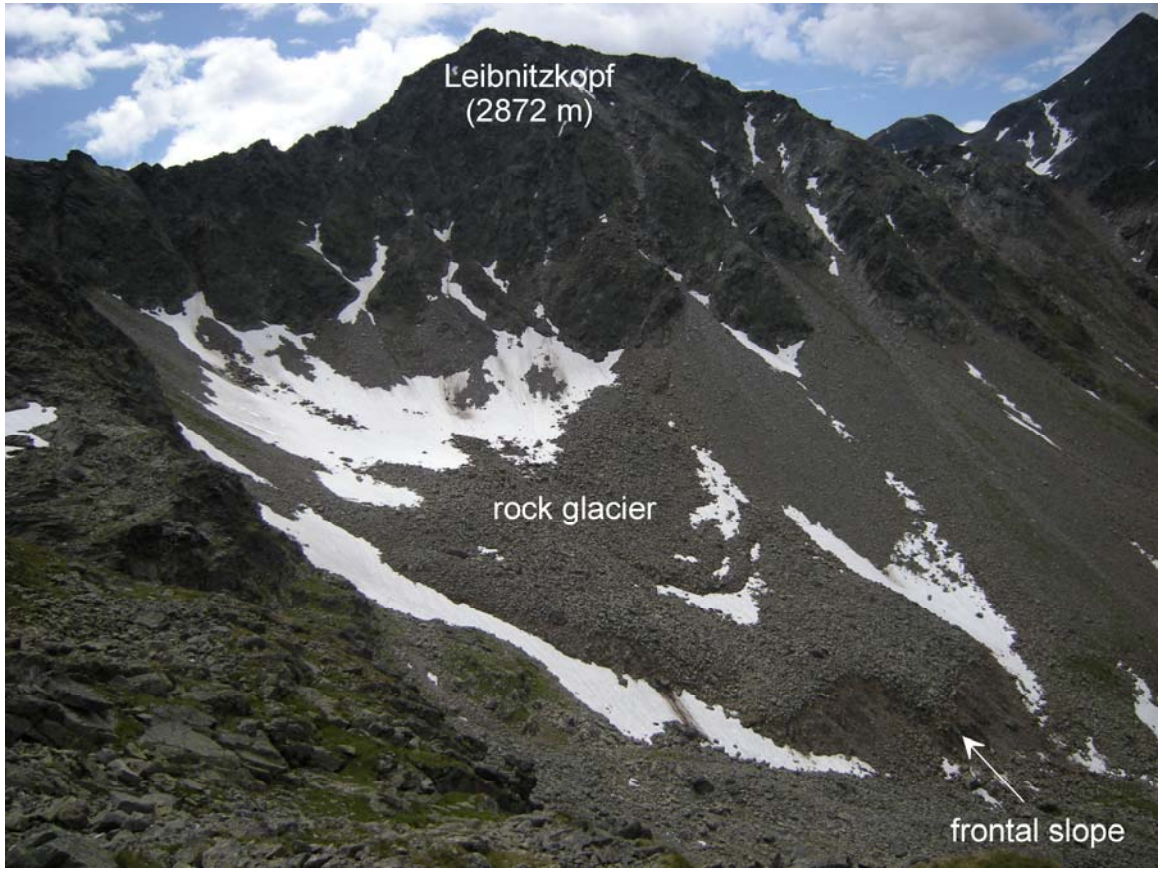

Photograph 2009

L: 350 m
W: 200 m

Leibnitzkopf rock glacier

2.1 Measuring method

Screen shot
1905 x 740

Google maps Österreich

Orthophoto:
GSD 35 cm
18.9.2002
Land Tirol (source)

Mercator projection

Screen shots of virtual globes

Screen shot
1871 x 691

bing Beta

Orthophoto:
GSD 35 cm
21.9.2006
BEV (source)

Mercator projection

Computation of displacement vectors and flow velocity

- Change detection
- Particle tracking, precise co-registration (NCC, back-matching)
- Matlab-based program

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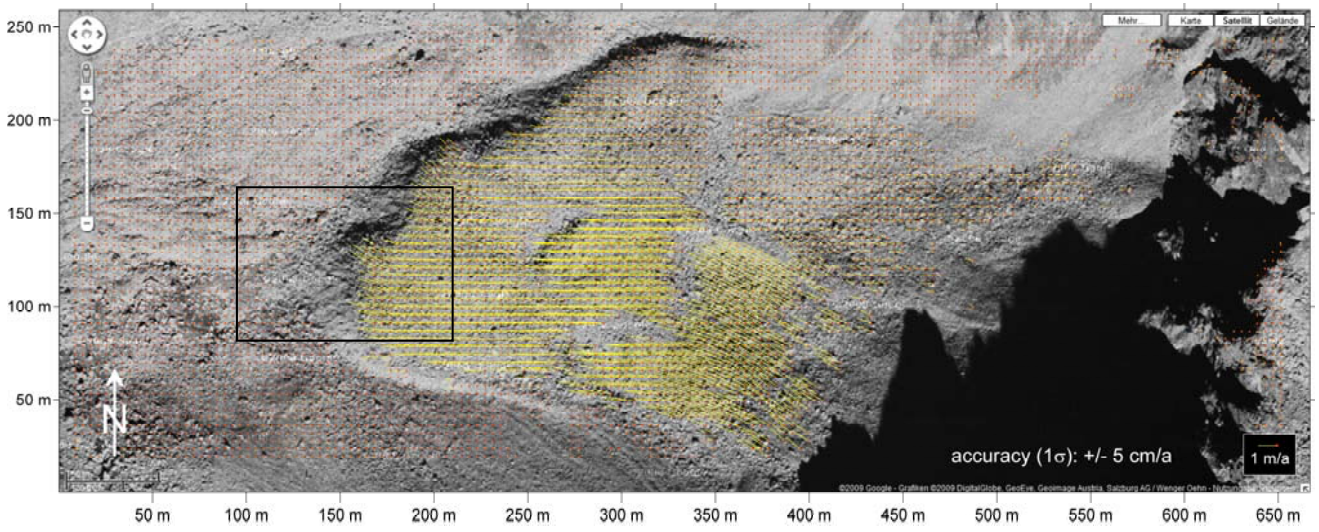
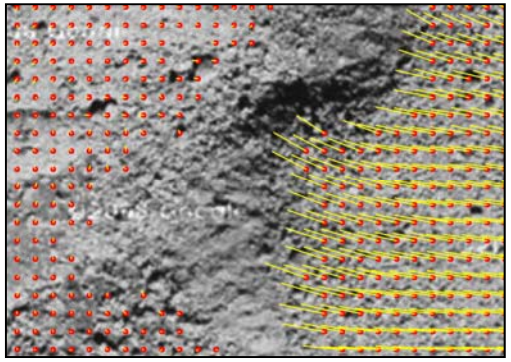
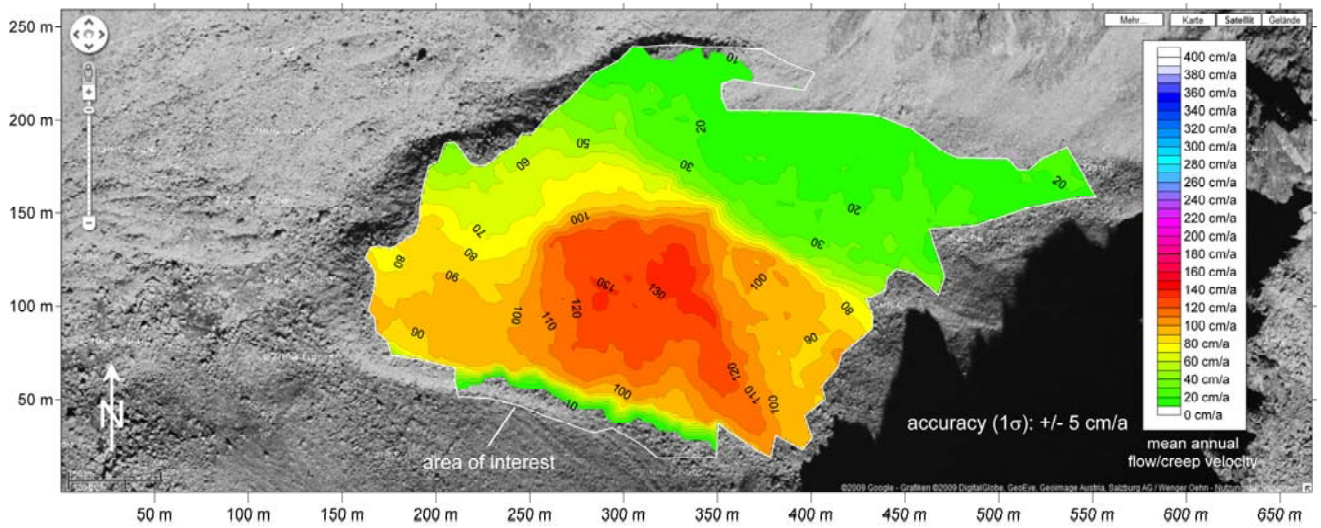


2D displacement vectors 2002-2006



Zoom



Isotachs 2002-2006

V_{max} = 136 cm/a

Mean annual horizontal movement 2002-2006

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Google Maps | Bing Maps | Anaglyph

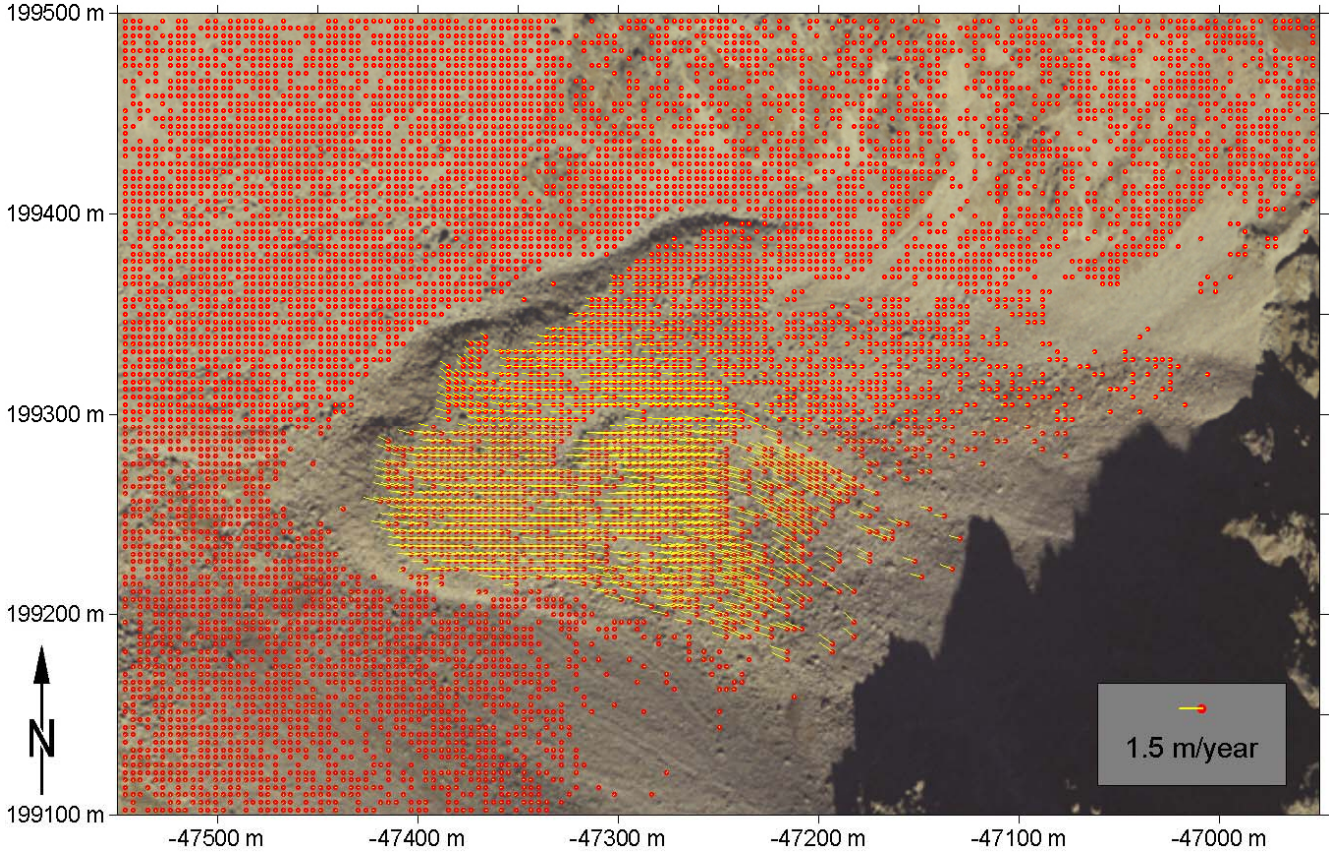
Horizontal flow/creep 2002-2006

150 m

3. Other measurements

- Photogrammetric change detection
  using original aerial photographs (2002 – 2006 – 2009)
- Low-cost GPS-based measurements (2010 – 2011)

3.1 Photogrammetric change detection 2002-2006

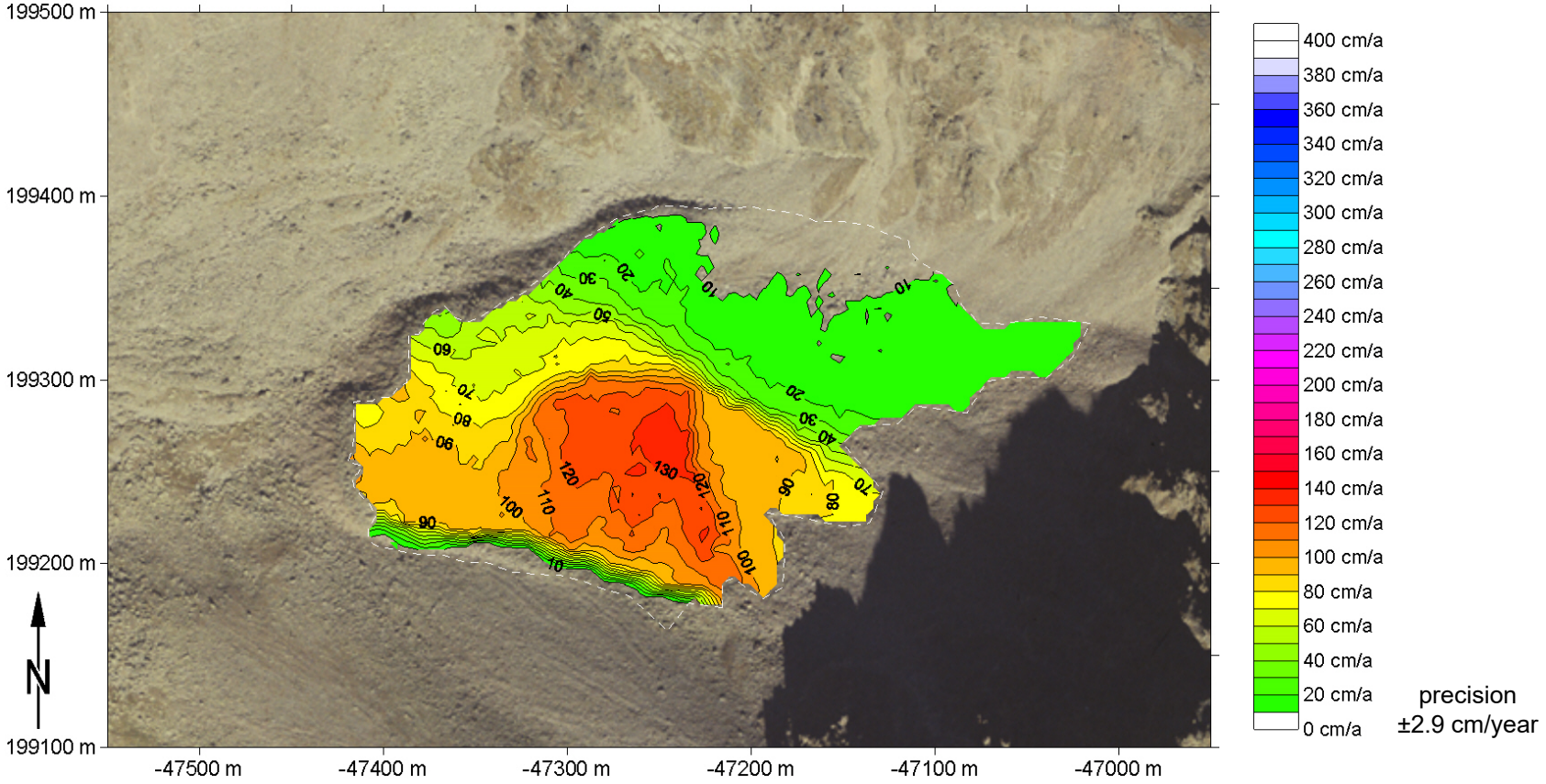


Aerial photos
© TIRIS, Innsbruck
© BEV, Vienna

precision
±2.9 cm/year

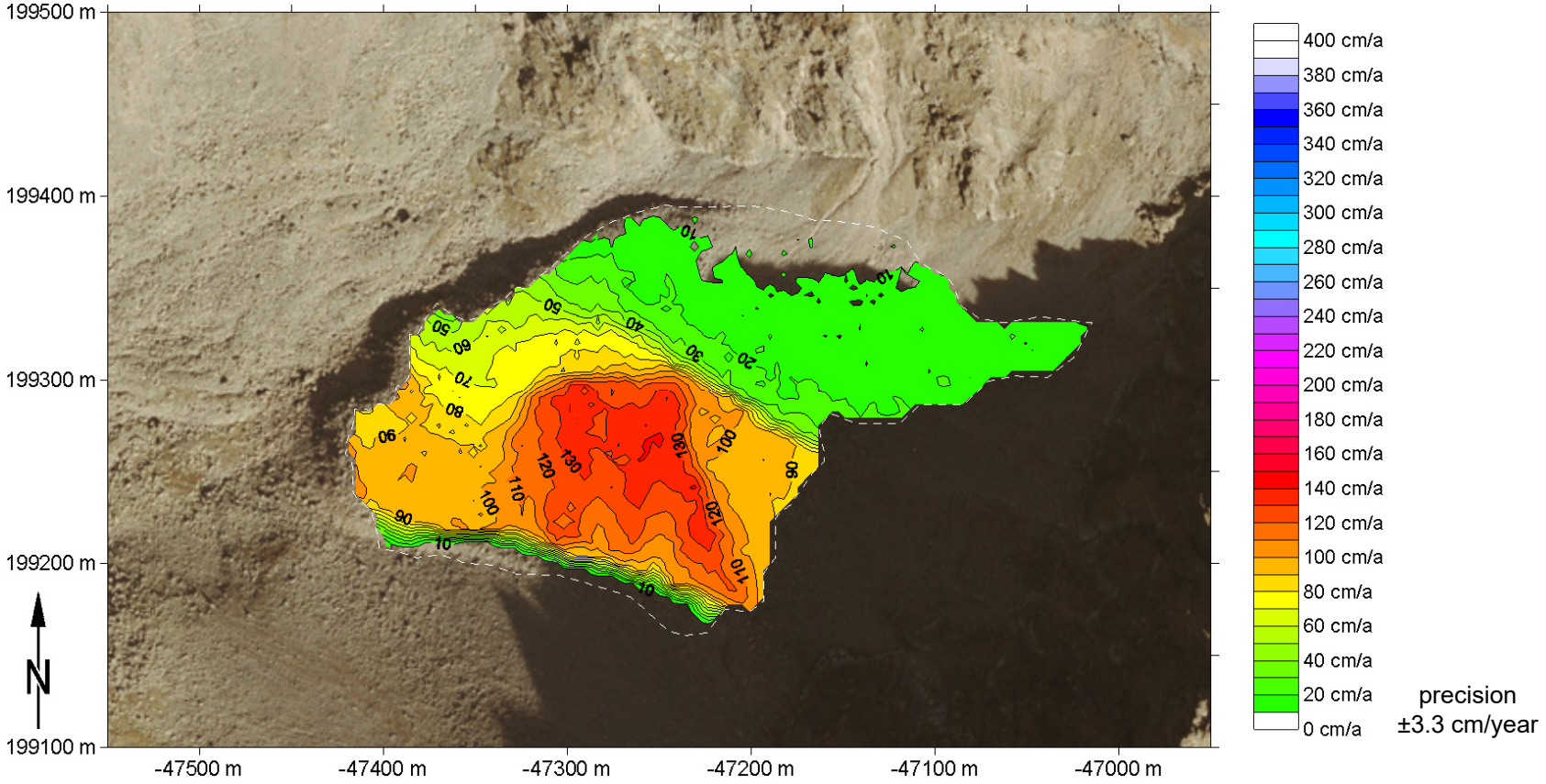
Displacement vectors derived by means of image matching
GSD 25cm, NCC [0.6], grid spacing & template size 15 x 15

3.1 Photogrammetric change detection 2002-2006



Mean annual horizontal flow velocity
max. v = 139 cm/year

3.1 Photogrammetric change detection 2006-2009



Mean annual horizontal flow velocity
max. v = 143 cm/year

3.2 Low-cost GPS-based measurements

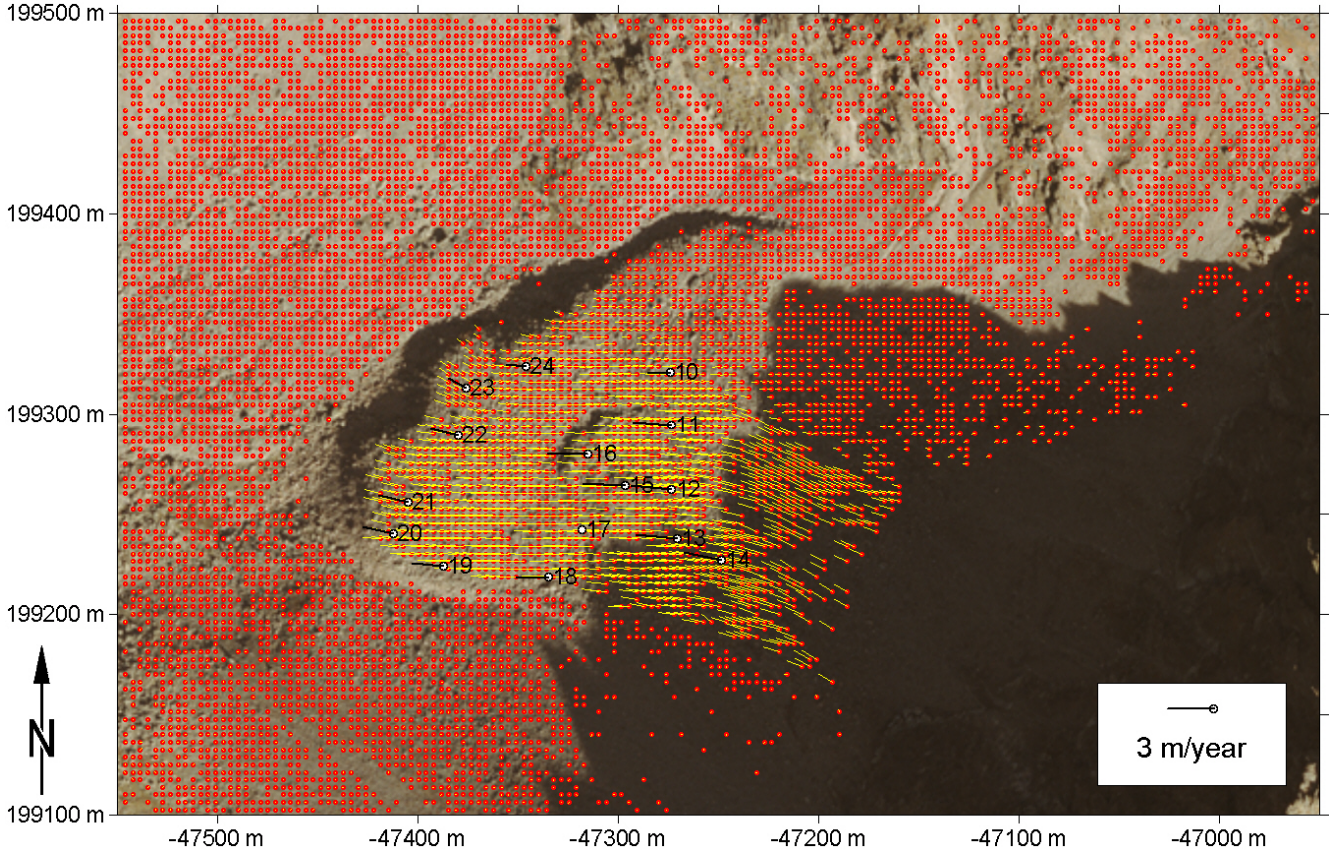
- A GPS-based observation network consisting of 19 stabilized points (4 of which are stable) was installed in 2010.
- Measurement equipment (GPS module ASHTECH AC-12, data logger, Leica AS05 geodetic antenna, adapter) is low cost and also lightweight.
- A Virtual Reference Station (VRS) was used.
- Planimetric accuracy is ±1-2 cm.
- Height accuracy is lower, i.e. ±7 cm.

3.2 Low-cost GPS-based measurements

Marking of observation points

Adapter with GPS antenna

3.2 Low-cost GPS-based measurements



max. v = 257 cm/year

yellow: displacement vectors (2006-2009) by photogrammetric measurements
black: displacement vectors (2010-2011) by geodetic measurements (dGPS)

4. Conclusions

- Change detection and high-precision measurement of flow velocities of active rock glaciers using screen shots of geobrowsers (virtual globes) is possible.
- Obvious drawbacks:

  - Limited availability of high-resolution image data in high mountain areas
  - Limited availability of multi-temporal image data
  - Lack of information about exact acquisition dates or source of image data
  - Lack of information about the accuracy of the image data (orthophotos)
  - Potential legal obstacles to using the image data as shown in this presentation

4. Conclusions

- *Leibnitzkopf rock glacier*

  Mean annual horizontal flow velocity (at 14 GPS points):

  - 2002-2006: 98.2 cm/year
  - 2006-2009: 103.8 cm/year (+ 6%)
  - 2010-2011: 197.6 cm/year (+ 90%)

- Annual GPS measurements will be continued.

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