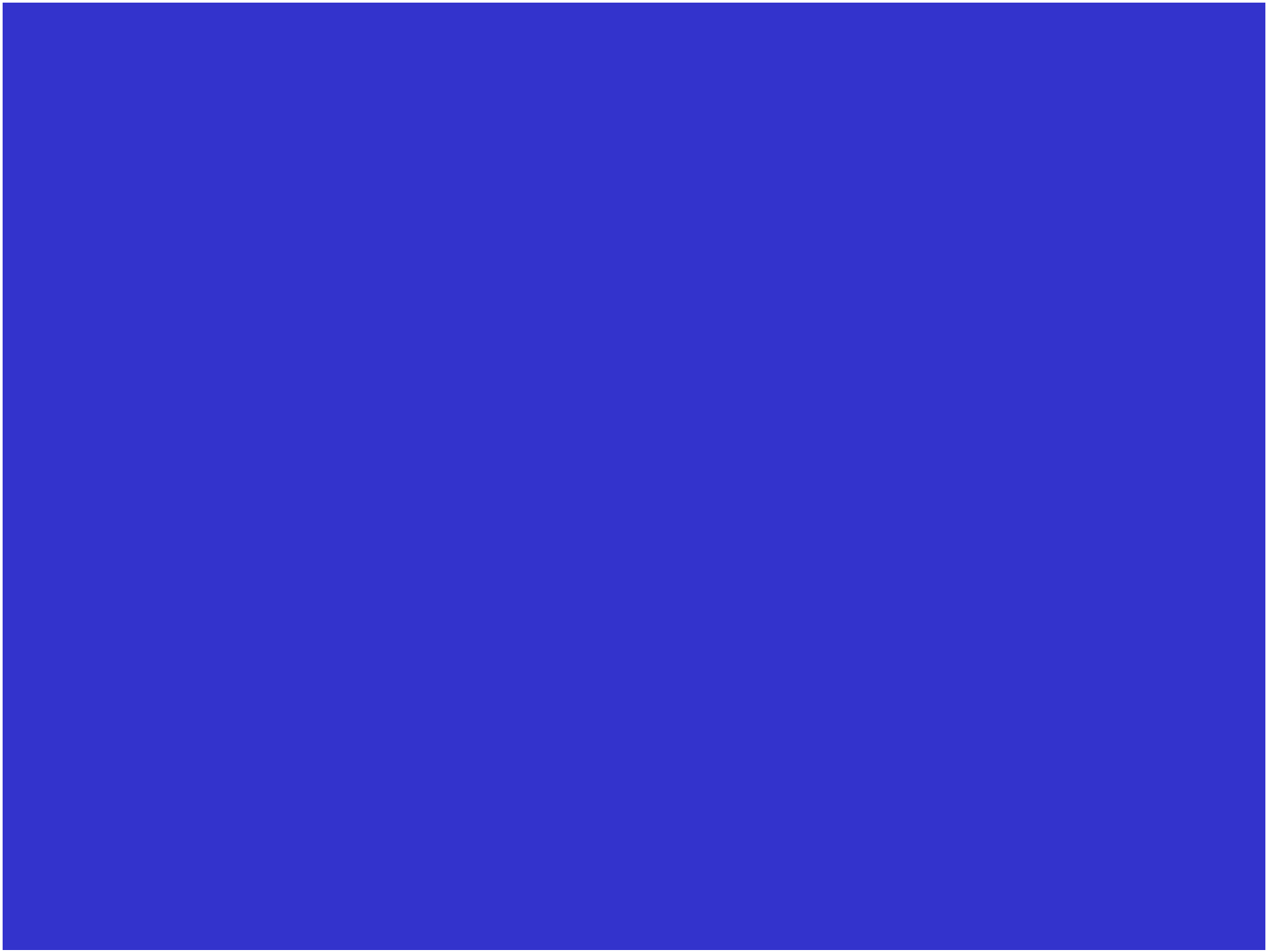


Quantitative assessment of the creep process of Weissenkar rock glacier (Central Alps, Austria)

V. Kaufmann [1], R. Ladstädter [1] and G.K. Lieb [2]

[1] Institute of Remote Sensing and Photogrammetry
Graz University of Technology

[2] Institute of Geography and Regional Sciences
University of Graz

TUG

UNI GRAZ

Outline

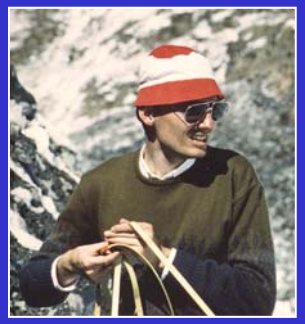
1. Introduction
2. Geographical setting
3. Geodetic surveys 1997-2004
4. Aerial surveys 1974, 1998, 2002
5. Analysis of geodetic measurements
6. Analysis of photogrammetric measurements
7. Comparative analysis and conclusions

1. Introduction

The Schober Mountains was chosen as a study area in order to investigate both glaciological and periglacial phenomena.

Three main sites:
❶ Goessnitzkees (= glacier)
❷ Hinteres Langtalkar rock glacier
❸ Weissenkar rock glacier

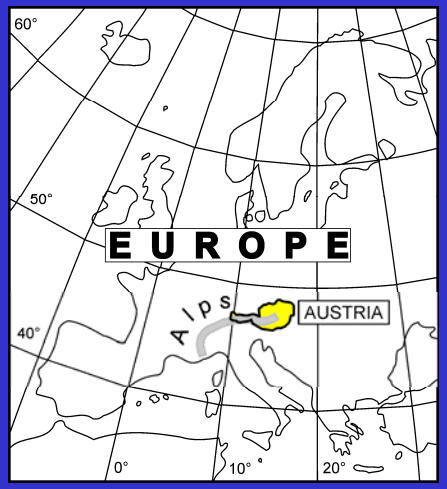
Geomorphological mapping and monitoring of glacier retreat started as early as the 1980s:



The long-term monitoring programs at these three sites are intended to

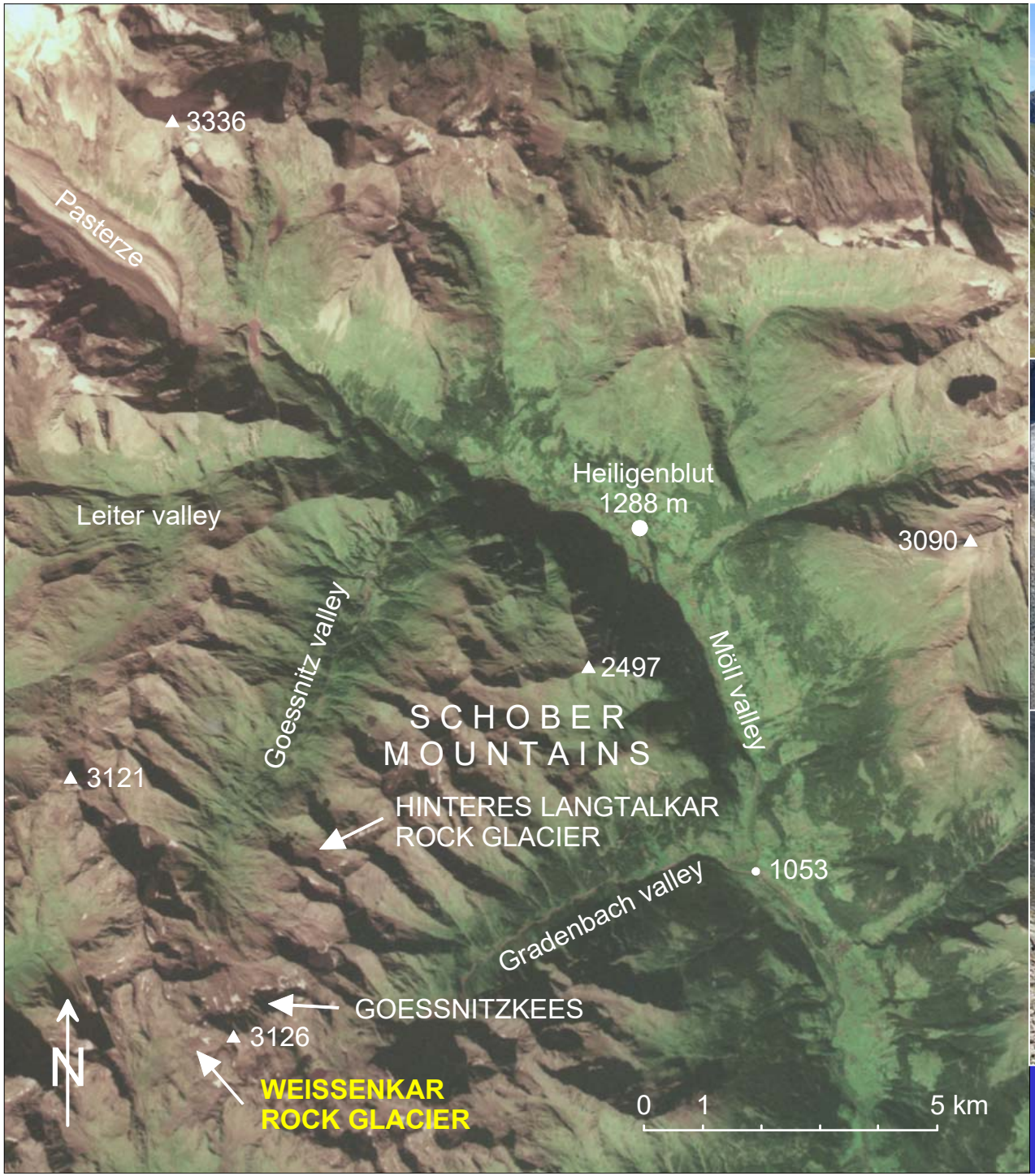
(1) better understand mass transport systems, with special regard to rock glacier dynamics and genesis,
(2) facilitate comparative analysis of glacial and permafrost areas, and
(3) contribute to climate change studies in high-mountain areas.

2. Geographical setting



Location map

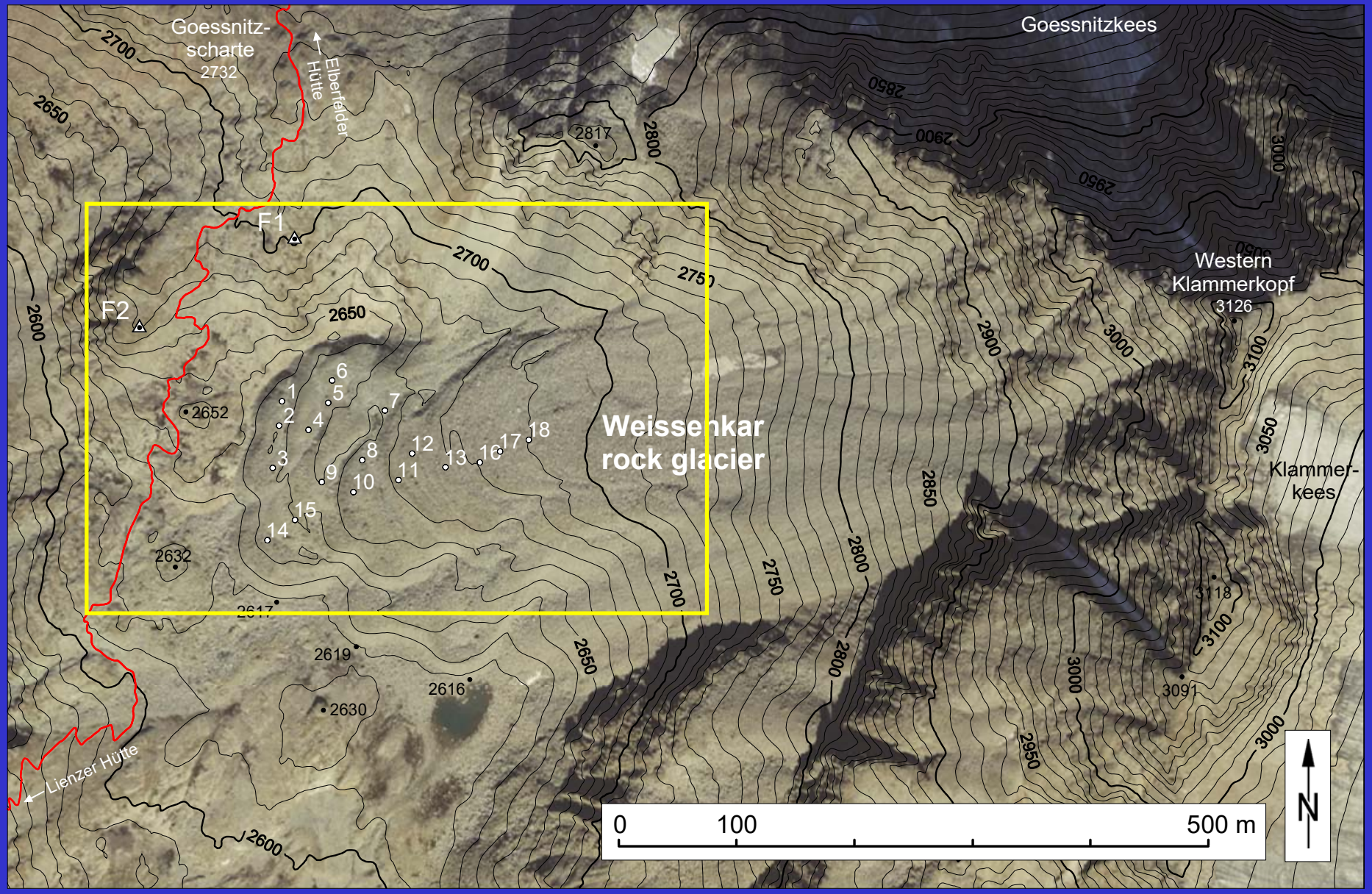
Panoramic view of Weissenkar rock glacier



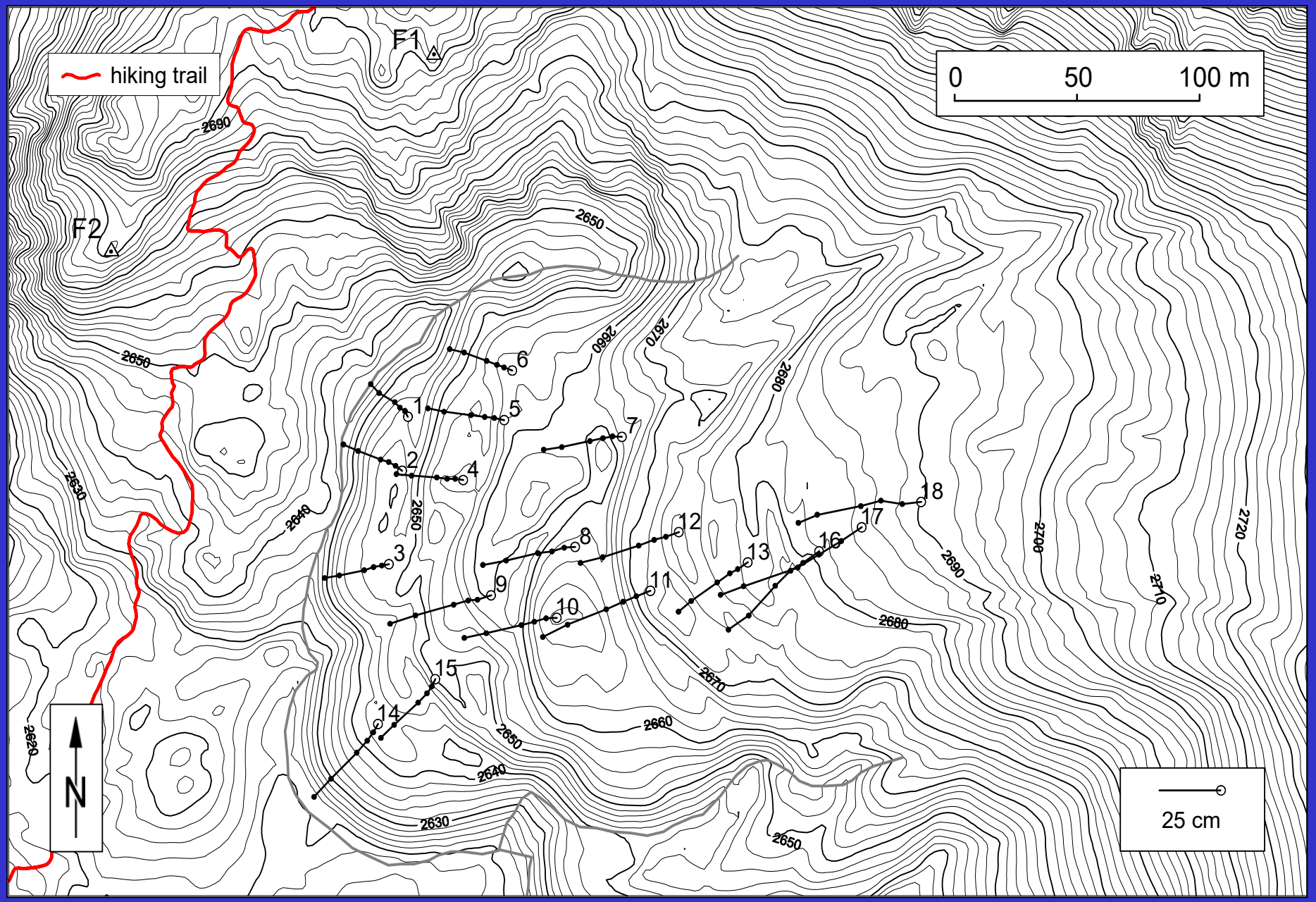
Russian KFA-1000 space image
(25 September 1991,
AUSTROMIR project)

3. Geodetic surveys 1997-2004

2 stable reference points: F1 & F2
18 object points
surveys: (1997), 1998, 1999, 2000, 2001, 2003, 2004
accuracy: 0.5 – 1 cm in planimetry and height

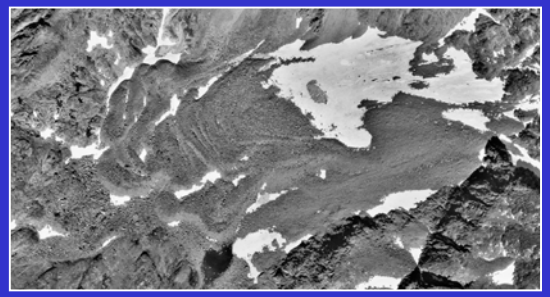


Orthophoto map showing Weissenkar rock glacier. Aerial photograph: 18 September 2002.

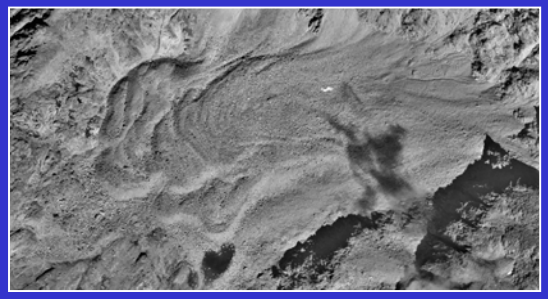


Horizontal movement of Weissenkar rock glacier for the time period 1998-2004.

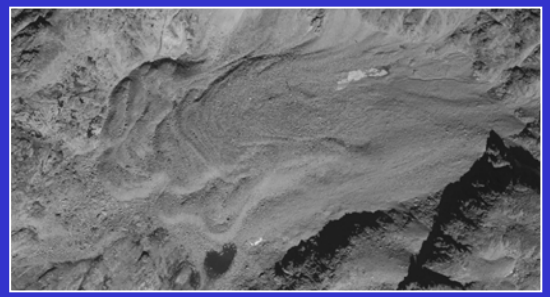
4. Aerial surveys 1974, 1998, 2002



1974



1998



2002

date	photos	image scale	focal length	type of film
5.9.1974	3	1:10,000	210 mm	B & W
26.8.1998	2	1:10,500	152 mm	B & W
18.9.2002	2	1:14,000	305 mm	color pos.

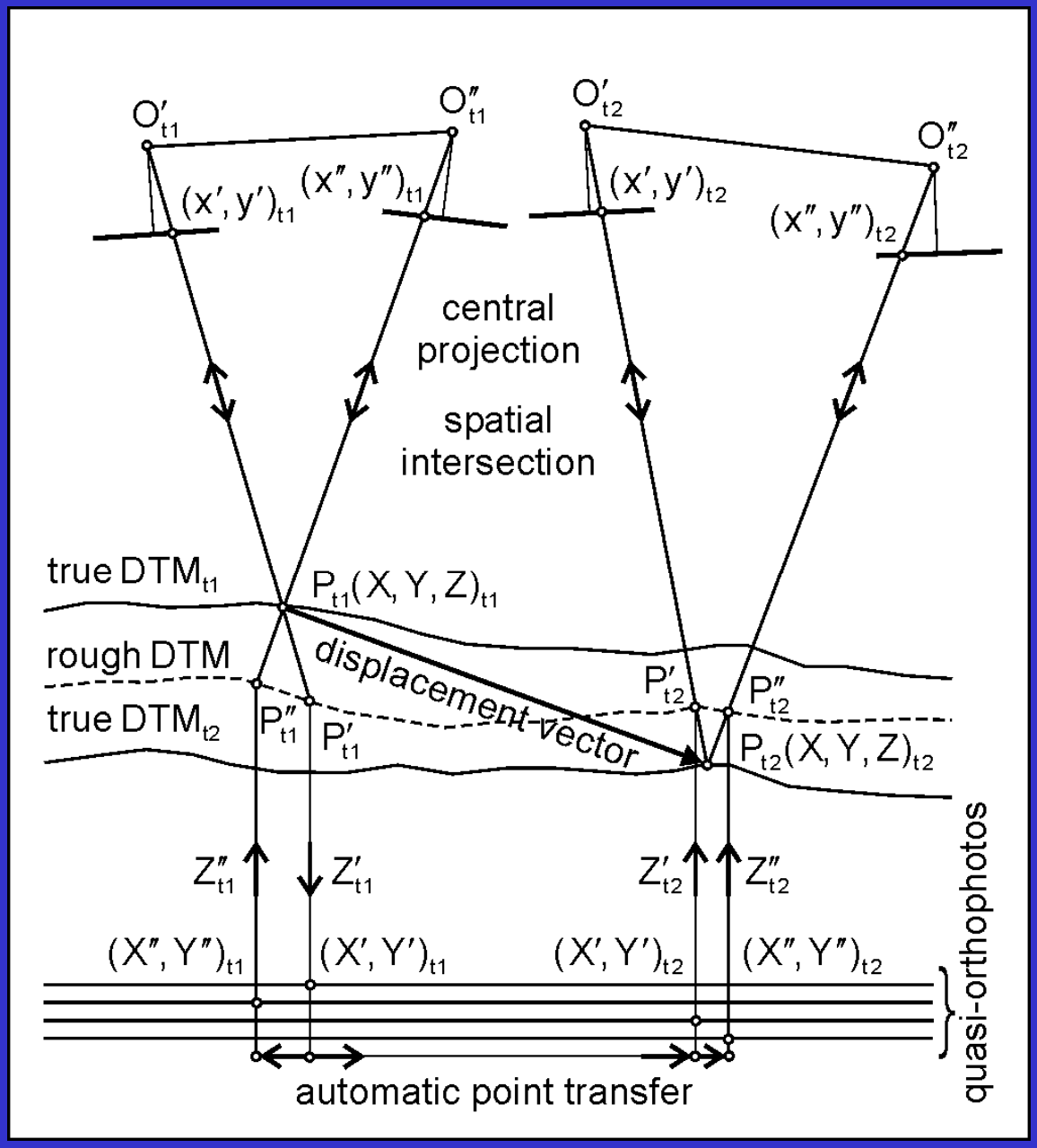
Scanning of photographs using the UltraScan 5000 scanner of Vexcel Imaging Austria
Photogrammetric orientation of 4 stereomodels (ISSK of Z/I Imaging)
Photogrammetric feature collection (➔ DTM of 2002)
Multi-photo constrained image matching using ADVM software
➔ 3D displacement vector for the time intervals 1974-1998 and 1998-2002

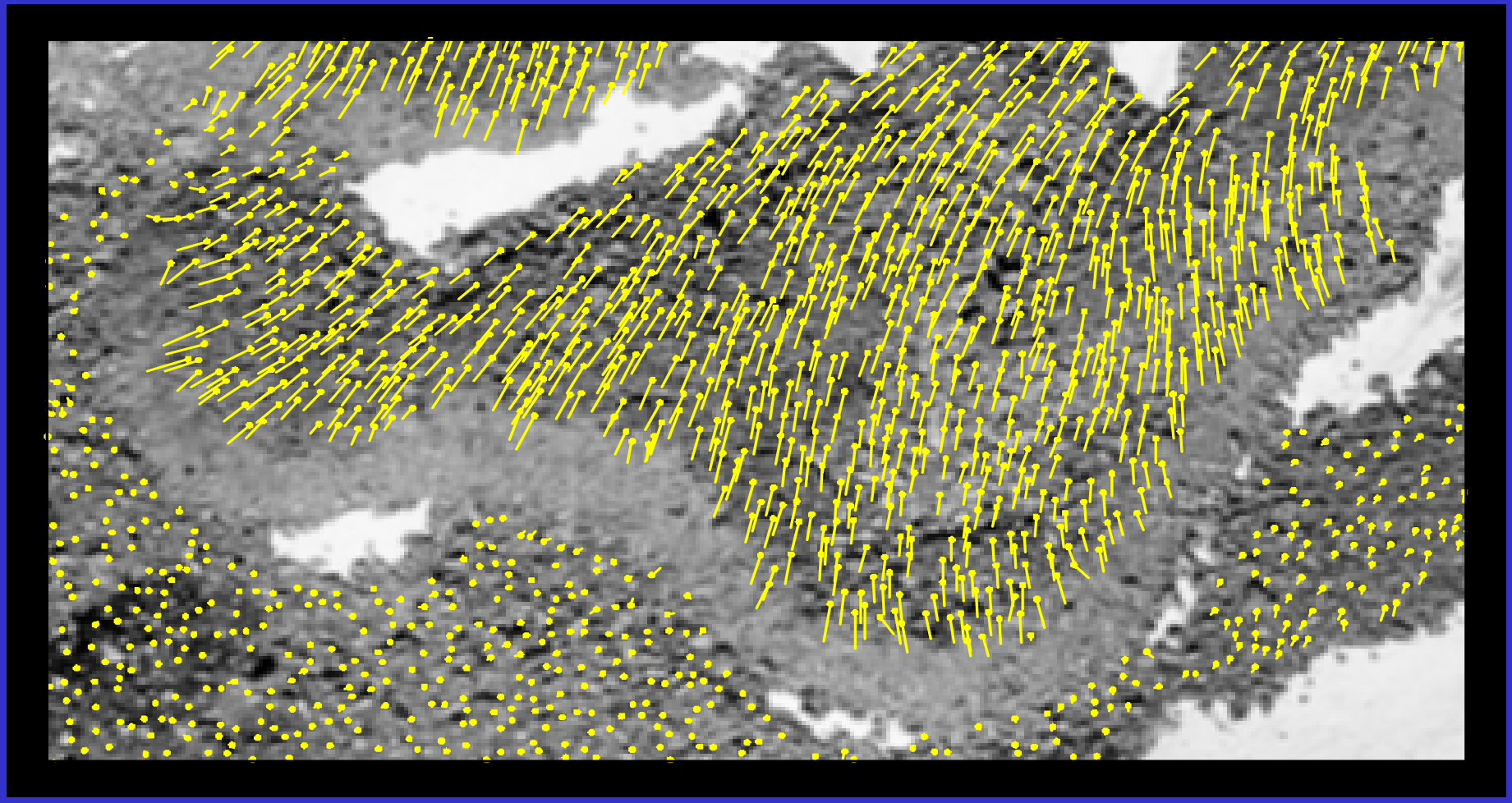
Software ADVM

Basic concept

Automatic measurement of displacement vectors in time series of aerial photographs

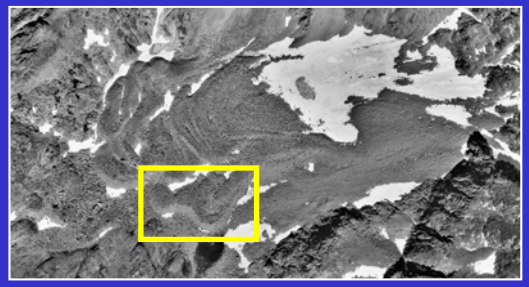
(HMRSC VII)





Horizontal displacement vectors derived from aerial photographs 1974 and 1998.

5 cm a^{-1}



5. Analysis of geodetic measurements

Mean annual horizontal movement (cm a^{-1})

1998/1999	1999/2000	2000/2001	2001/2003	2003/2004	1998/2004	1974/1998	1998/2002
4.9	4.6	5.9	6.8	8.2	6.2	3.2	5.3

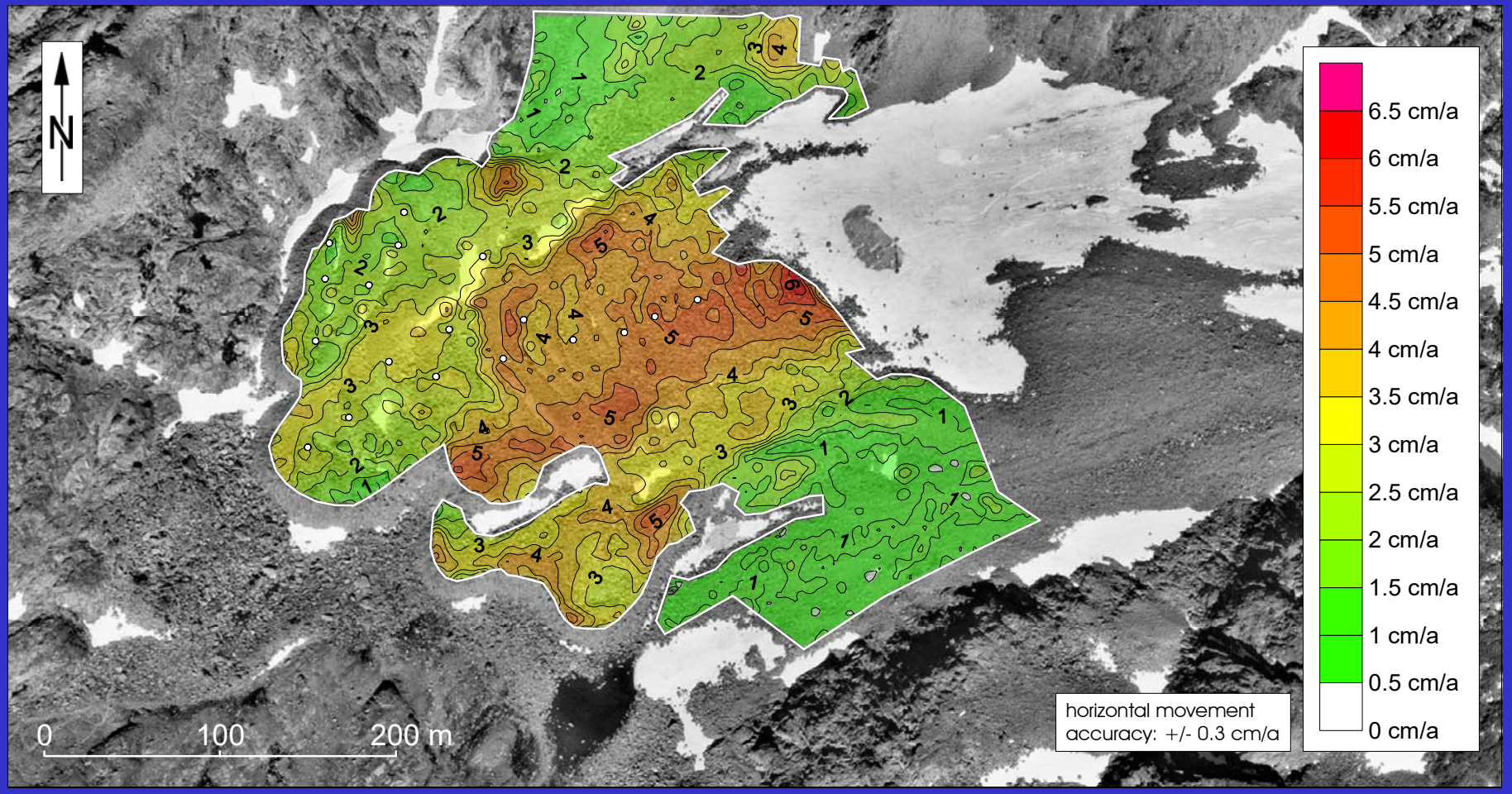
Change of mean annual creep velocity

from – to	change of mean value	relative change	significance level
1998/1999 – 1999/2000	- 0.3 cm a^{-1}	-4 %	non-significant
1999/2000 – 2000/2001	+1.3 cm a^{-1}	+ 28 %	significant
2000/2001 – 2001/2003	+0.9 cm a^{-1}	+ 14 %	significant
2001/2003 – 2003/2004	+1.4 cm a^{-1}	+ 21 %	significant
1998/1999 – 2003/2004	+3.3 cm a^{-1}	+ 68 %	significant

Points of the upper lobe: Marked surface lowering in the order of 2-7 cm a^{-1} is taking place.

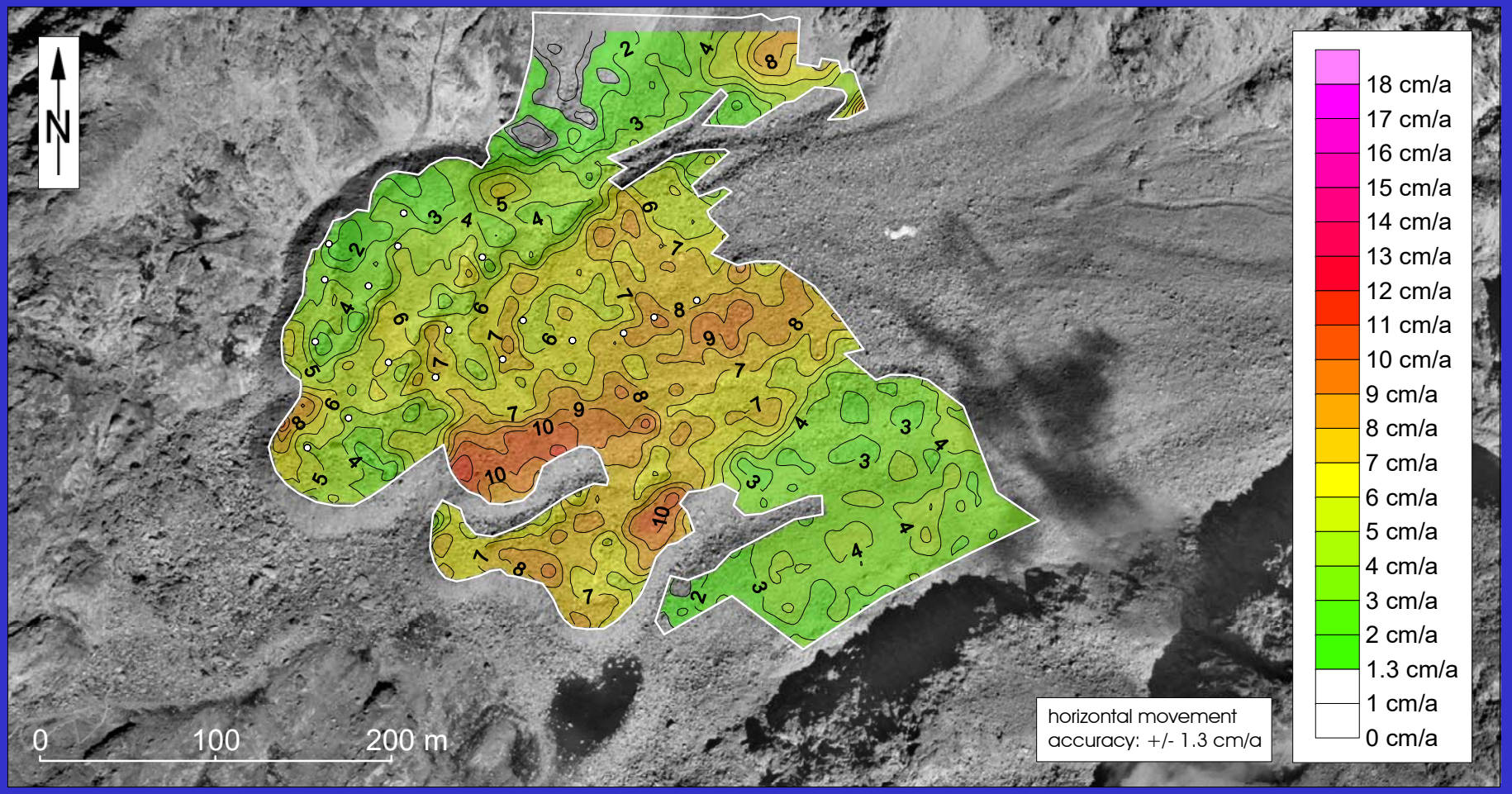
Points 1, 2 & 3: These points show a small uplift due to longitudinal compression.

6. Analysis of photogrammetric measurements



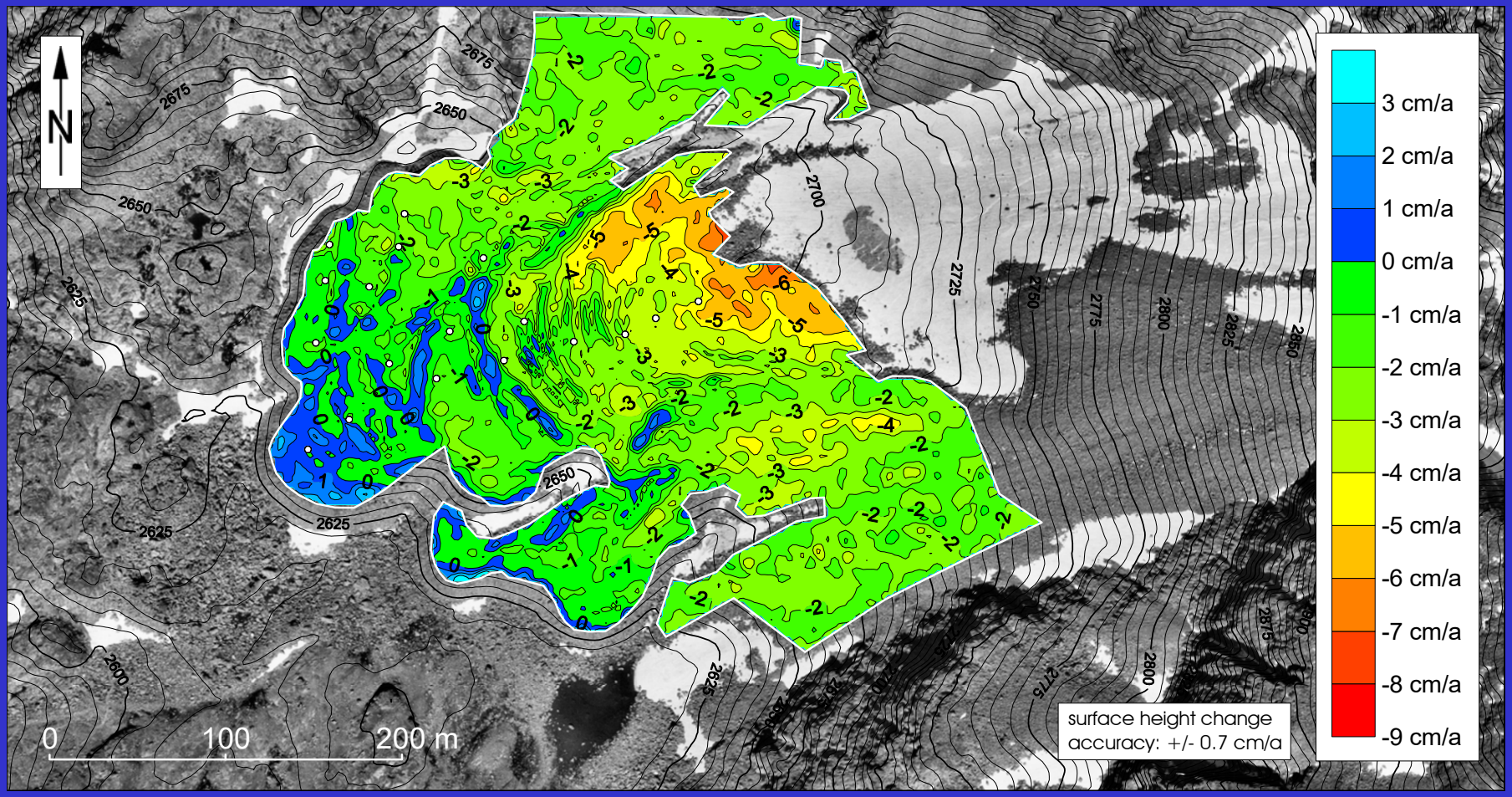
Mean annual horizontal flow/creep velocity for the time interval 1974-1998.

6. Analysis of photogrammetric measurements



Mean annual horizontal flow/creep velocity for the time interval 1998-2002.

6. Analysis of photogrammetric measurements



Mean annual surface height change for the time interval 1974-1998.

6. Analysis of photogrammetric measurements

Mean annual horizontal flow velocity at the 18 object points interpolated from the photogrammetrically determined displacements:

➔ significant increase in flow velocity of about 68 %
(An area-based analysis shows an increase of 93 %.)

1974-1998: The overall average of surface height change was calculated at -2 cm a^{-1}.

The upper-most lobe generally displays the highest rates of surface lowering.

7. Comparative analysis and conclusions

The geodetically measured horizontal creep velocities at the 18 object points are in very good agreement with the photogrammetrically derived values.

It can be concluded that the flow velocity of Weissenkar rock glacier has increased significantly throughout all time periods for which measurements are available, i.e., from 3.2 cm a^{-1} (1974-1998) to 8.2 cm a^{-1} (2003-2004).

Overall surface lowering suggests permafrost degradation of -2 cm a^{-1}.
Permafrost degradation is currently a matter of general discussion.

The recent increase in surface velocity also remains to be explained.

For further information please contact

Viktor Kaufmann

Institute of Remote Sensing and Photogrammetry
Graz University of Technology
Steyrergasse 30, A-8010 Graz

Tel.: +43 316 873-6336
Fax: +43 316 873-6337
E-mail: viktor.kaufmann@tugraz.at
http://www.geoimaging.tugraz.at/viktor.kaufmann/