Documentation of the retreat of Gössnitzkees and Hornkees glaciers (Hohe Tauern range, Austria) for the time period 1997-2006 by means of aerial photogrammetry

V. Kaufmann and R. Ladstädter

Institute of Remote Sensing and Photogrammetry
Graz University of Technology
Austria

Outline

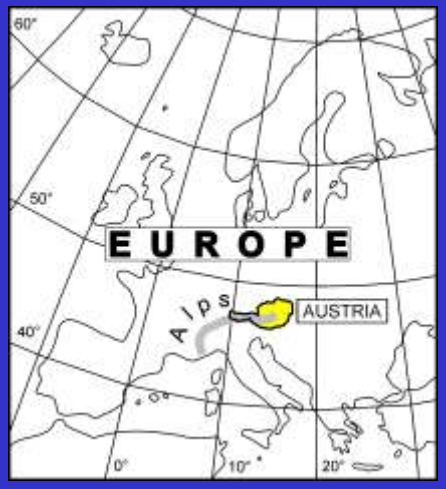
1. Introduction and geographical setting
2. Aerial photographs 1997, 2002 and 2006
3. Photogrammetric mapping
4. Quantification of glacier change
5. Conclusions

1. Introduction and geographical setting

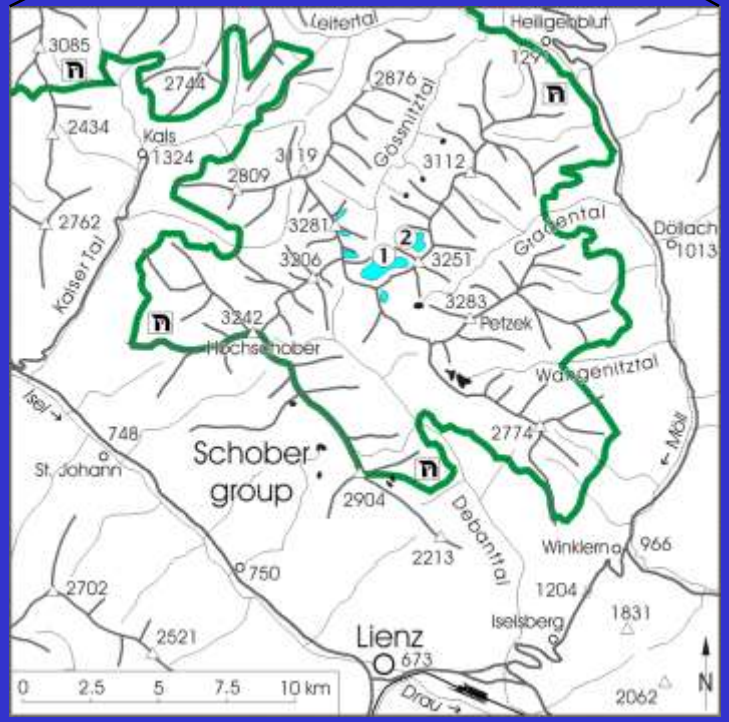
The glacier history of Gössnitzkees and Hornkees was reconstructed for the time period 1850-1997 within a research project carried out by the *Institute of Geography and Regional Science, University of Graz*, and the former *Institute of Geodesy, Graz University of Technology*, with financial support of the Hohe Tauern Park Service.

■ We intend to extend the observation period to the present.

▶ Atmospheric warming (climate change) → glacier retreat
▶ Austrian glacier inventories 1969 and 1998
▶ Longterm-monitoring: geodetic measurements, terrestrial photogrammetry, TLS
▶ Related project: ALPCHANGE



Location map



① Gössnitzkees

② Hornkees

Hohe Tauern National Park

SCHOBER GROUP

- 30 peaks higher than 3000 m
- 29 relatively small glaciers (mean area in 1987: 18 ha)
- continental climate

GÖSSNITZKEES

- largest glacier
- 58.9 ha (2006)

HORNKEES

- 30.6 ha (2006)

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

- debris-covered glacier
- nourished by avalanches
- proglacial lake

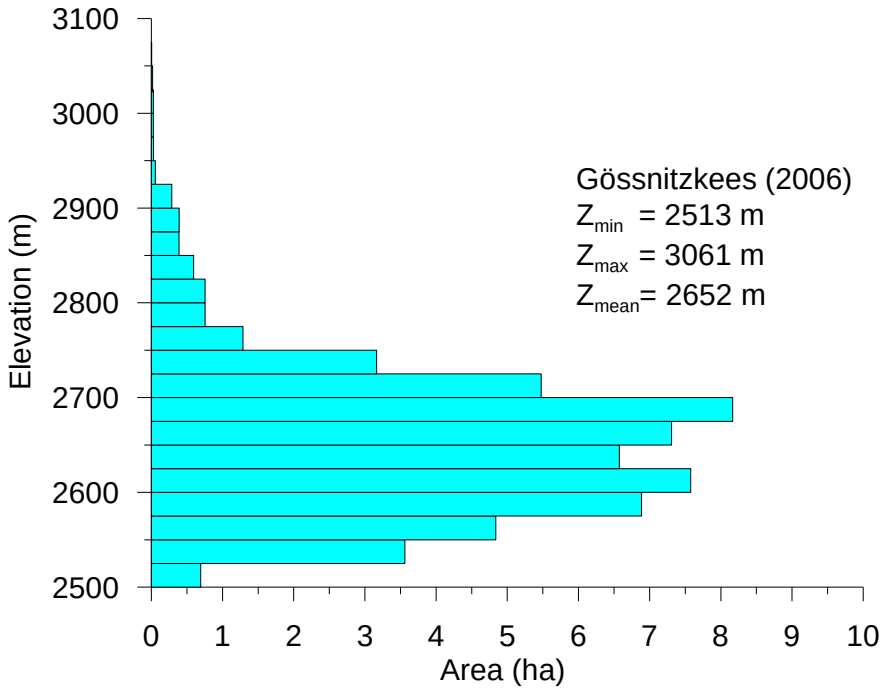
Gössnitzkees

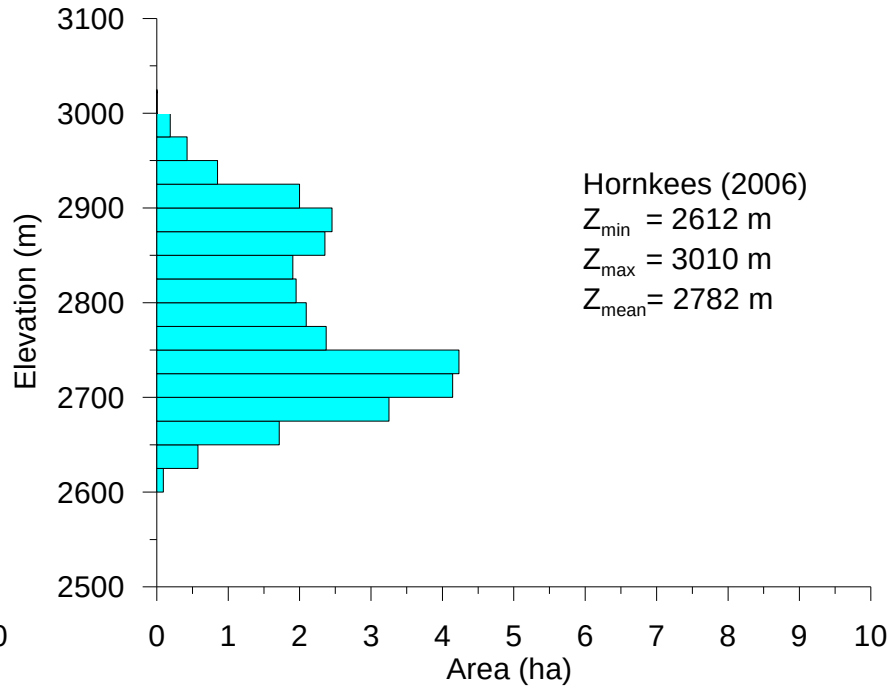
Terrestrial photographs (26 July, 2007)

Hornkees

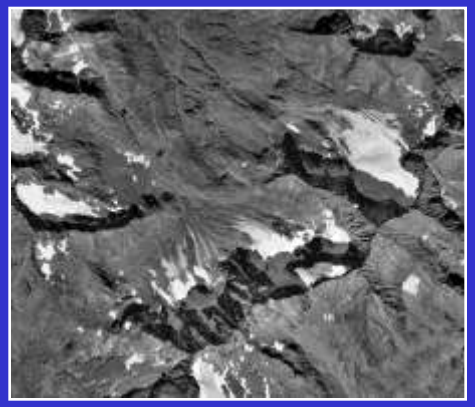
Photographs by M. Avian

Area-elevation distribution of Gössnitzkees and Hornkees for 2006





2. Aerial photographs of 1997, 2002 and 2006



1997

2002

2006

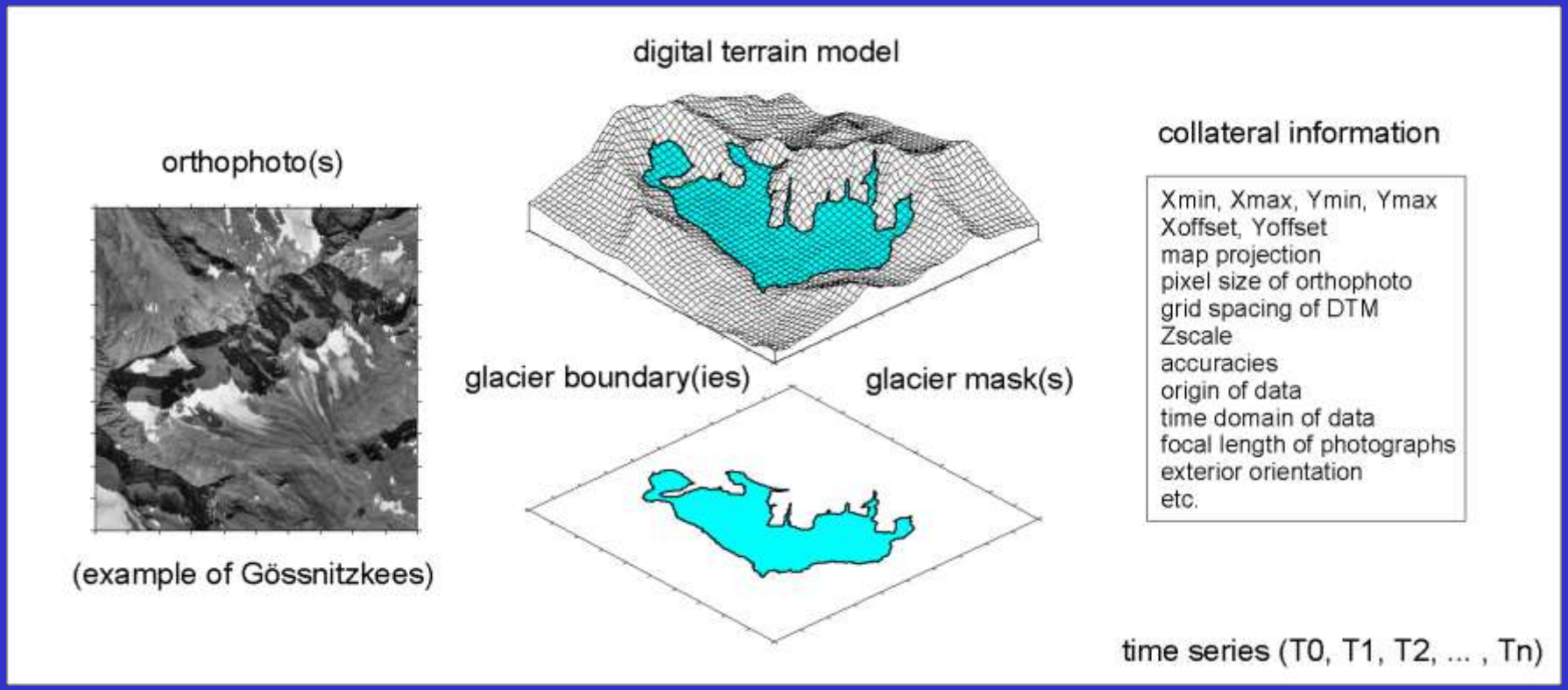
Year	photos	Image scale	Focal length	Film type
1997*	2	1:30,000	150 mm	B & W
2002	8	1:14,000	300 mm	color positive
2006	8	1:15,900	300 mm	color positive

* previous project

Digital photogrammetric workflow.

➔ DTMs, glacier boundaries, and orthophotos.

3. Photogrammetric mapping



Layer structure of the digital database for glacier studies

Workflow:

3.1 Photogrammetric orientation

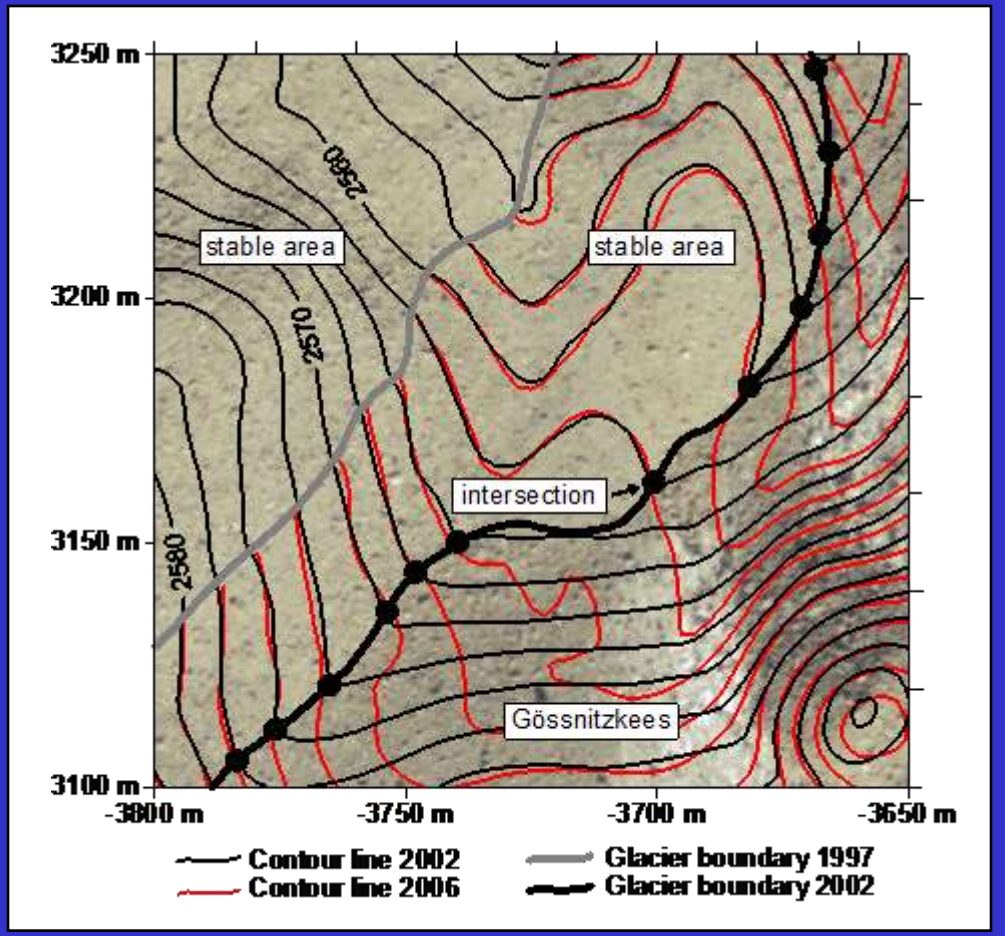
❶ Reference model: stereo model of 1997 → A set of stable ground control points was available.
❷ Elements of exterior orientation of all photographs were provided.
❸ Systematic offsets in height were detected.

3.2 Feature extraction

❶ Contour lines, ridge lines, drainage lines, spot heights
❷ Computation of DEMs (TIN and raster-based)
❸ Delimitation of the glacier boundaries

3.3 Orthorectification/Mosaiking

3.4 Final map production

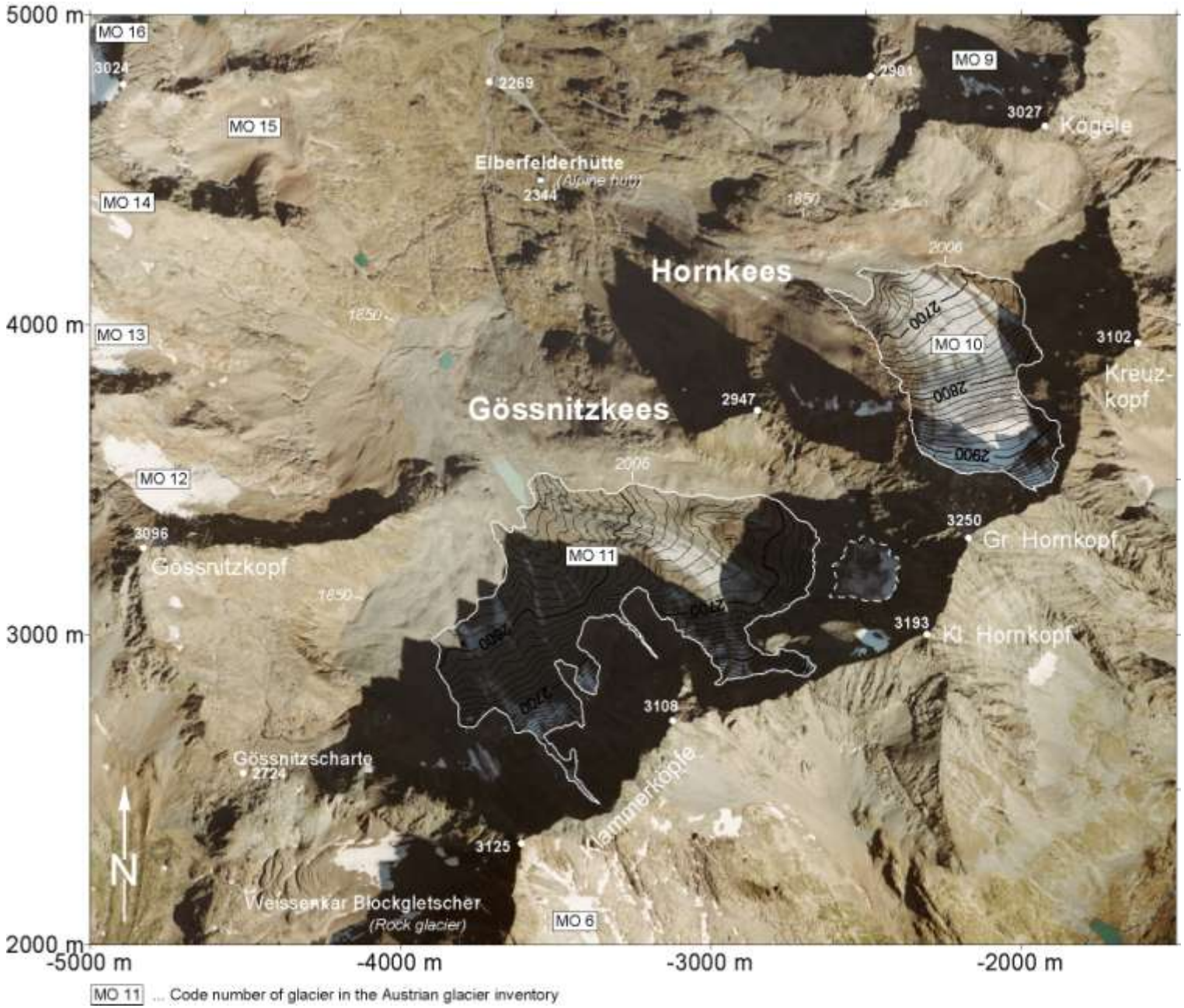


4. Quantification of glacier change

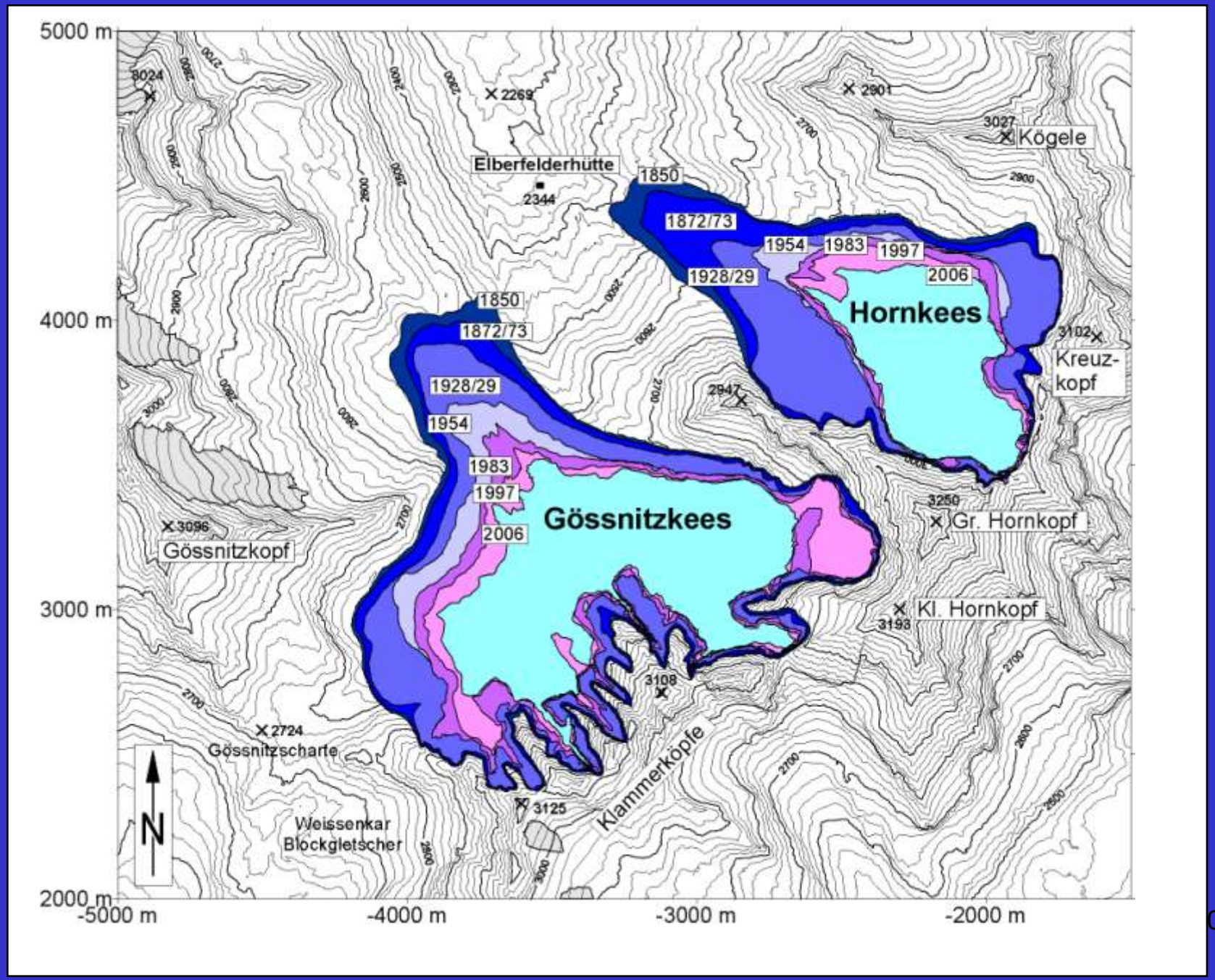
4.1 Glacier change in area

Period	Gössnitzkees		Hornkees	
	Change in area (ha)	Change in area (ha a^{-1})	Change in area (ha)	Change in area (ha a^{-1})
1850/1873	-9.45	-0.41	-7.21	-0.31
1873/1929	-13.82	-0.25	-13.92	-0.25
1929/1954	-35.01	-1.40	-26.58	-1.06
1954/1969	-4.01	-0.27	-1.70	-0.11
1969/1974	-3.35	-0.67	-0.51	-0.10
1974/1983	+0.24	+0.03	-0.45	-0.05
1983/1992	-11.87	-1.32	.	.
1992/1997	-2.61	-0.52	-5.20 (1983/97)	-0.37 (1983/97)
1997/2002	-12.32	-2.46	-3.10	-0.62
2002/2006	-4.48	-1.12	-2.38	-0.60
1850/2006	-96.68 (-62.2 %)	-0.62	-61.03 (-66.6 %)	-0.39

Orthophoto (2006) of the study area



Change in area of Gössnitzkees and Hornkees since 1850

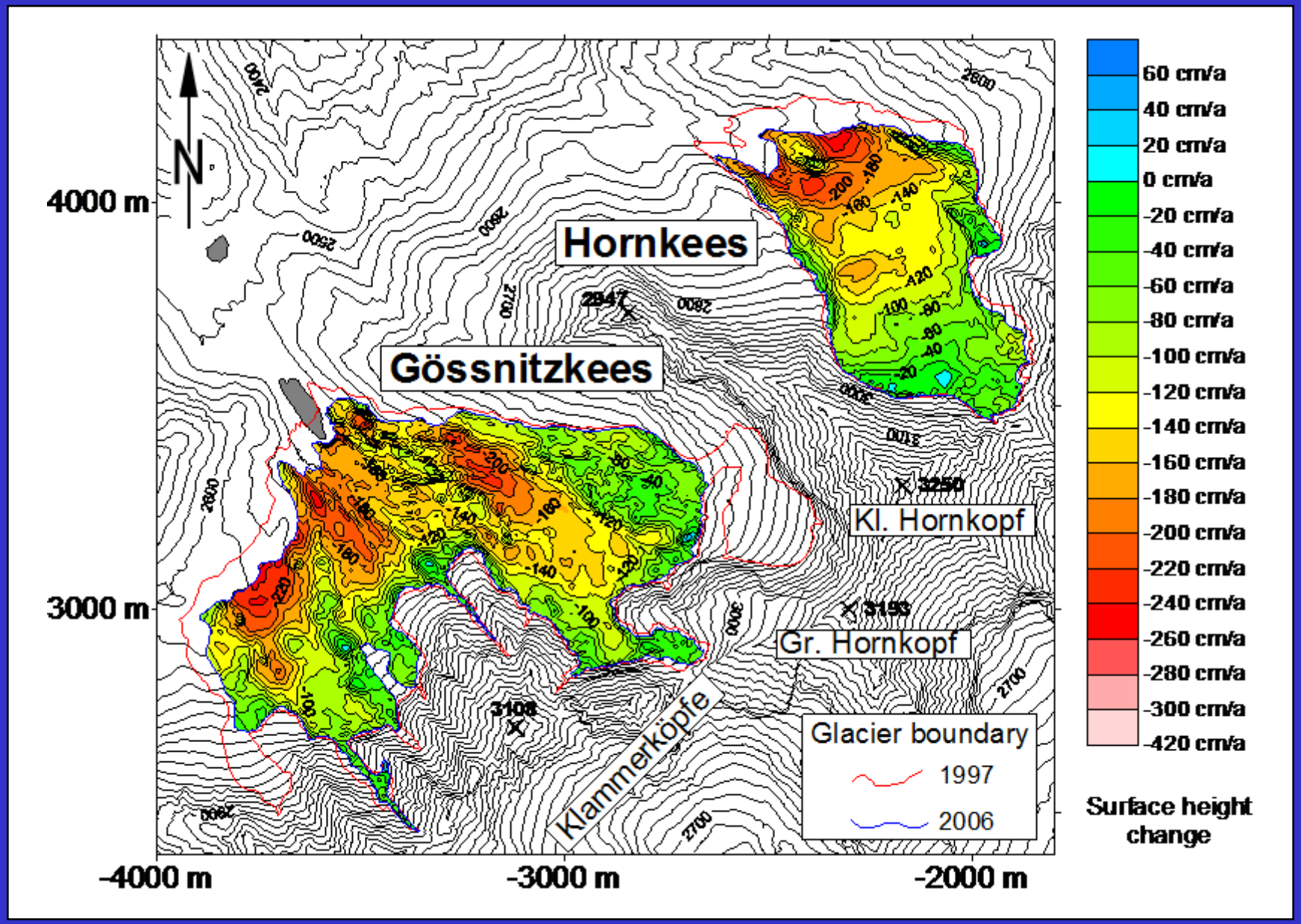


4.2 Glacier change in volume

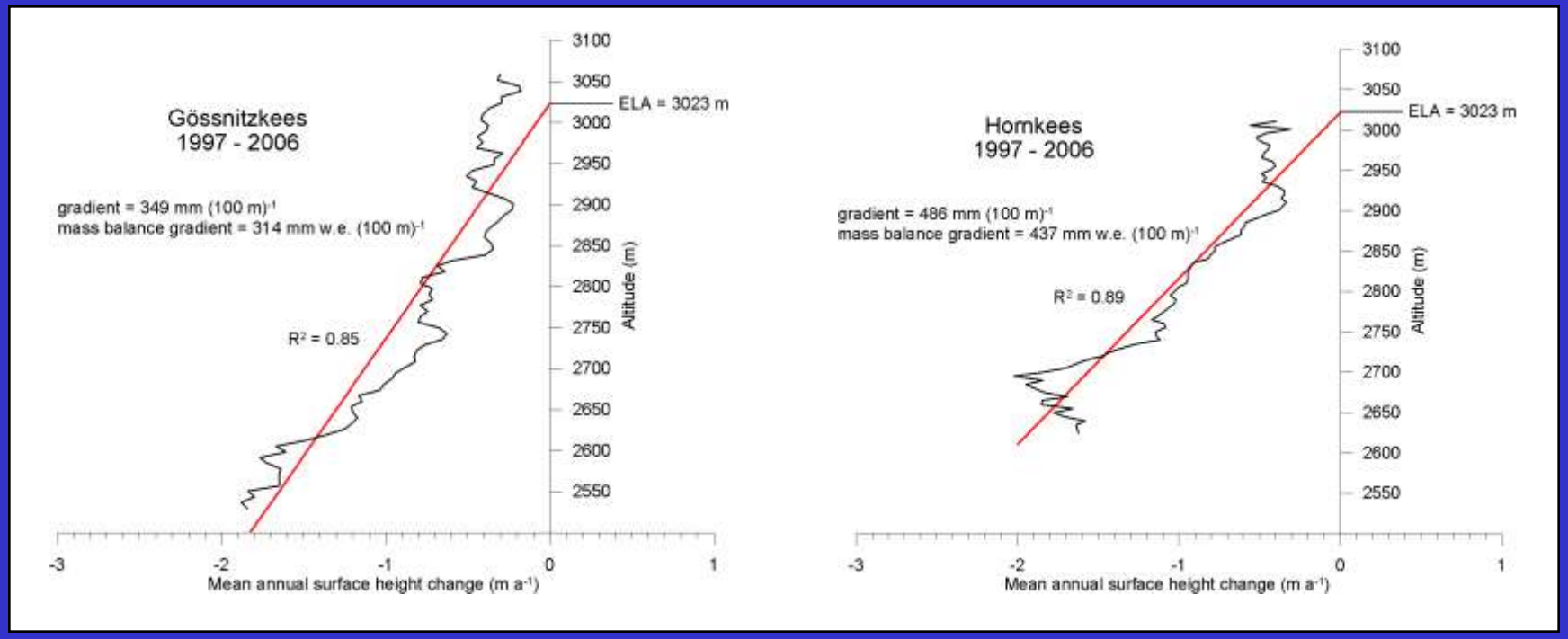
Period	Gössnitzkees		Hornkees	
	Volumetric change (10^6 m^3)	Volumetric change (10^6 m^3 a^{-1})	Volumetric change (10^6 m^3)	Volumetric change (10^6 m^3 a^{-1})
1850/1873	-11.98	-0.52	-7.80	-0.34
1873/1929	-17.08	-0.31	-12.63	-0.23
1929/1954	-30.65	-1.23	-12.49	-0.50
1954/1969	-3.09	-0.21	-0.40	-0.03
1969/1974	-2.49	-0.50	-0.36	-0.07
1974/1983	+0.55	+0.06	+0.87	+0.10
1983/1992	-8.83	-0.98	.	.
1992/1997	-3.93	-0.79	-5.35 (1983/97)	-0.38 (1983/97)
1997/2002	-3.83	-0.77	-1.87	-0.37
2002/2006	-3.11	-0.78	-1.55	-0.39
1850/2006	-84.52	-0.54	-41.61	-0.27

Estimated volume of Gössnitzkess (2006: 19.9 10^6 m^3) and Hornkees (2006: 8.2 10^6 m^3)

Mean annual surface height change for the period 1997-2006



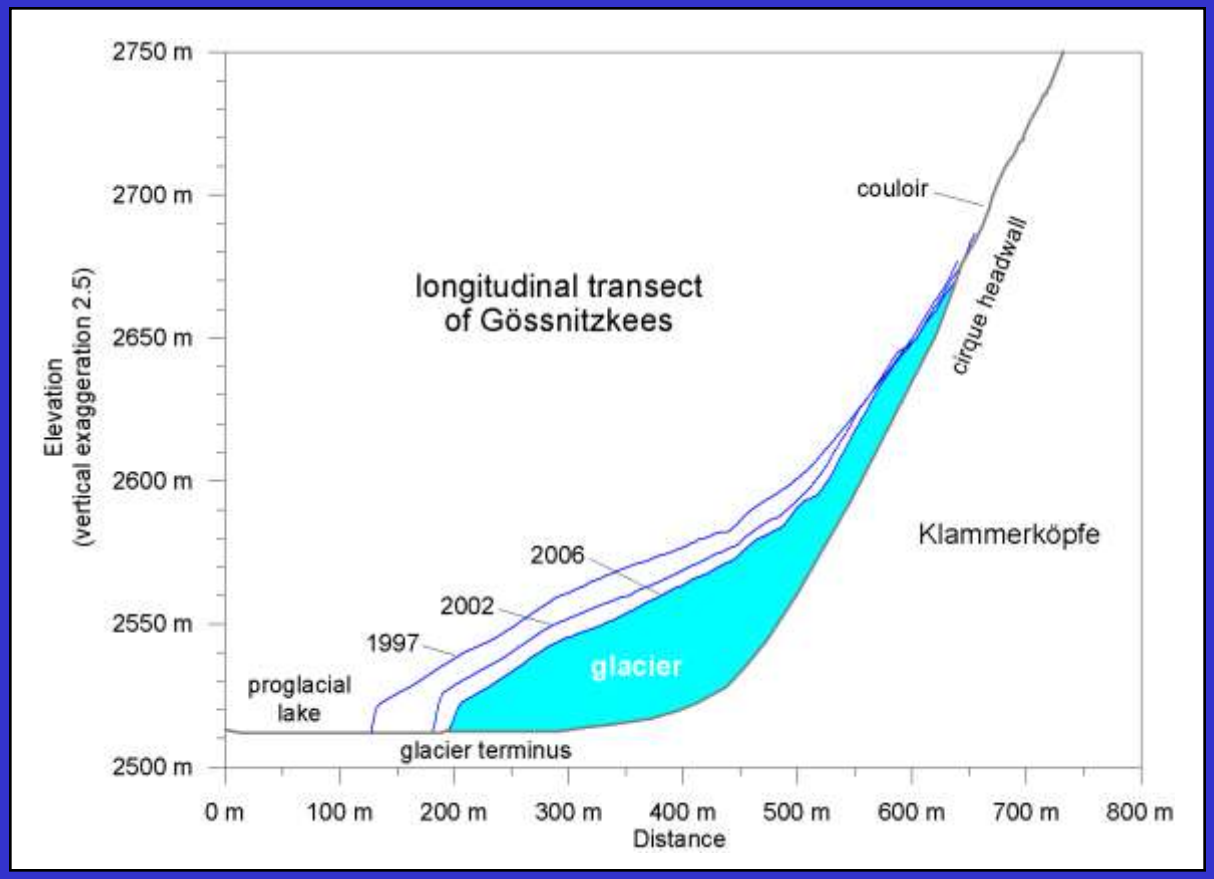
Estimation of the equilibrium line altitude (ELA) for the period 1997-2006



The two glaciers are completely out of balance.

5. Conclusions

Ongoing glacier retreat suggests that both glaciers will vanish around 2030. This implies that all other glaciers of the Schober group will share the same fate, sooner or later.



For further information please contact

Viktor Kaufmann and Richard Ladstädter

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/