Symposium *Prix de Quervain* , Bern, 6. November 2013

Global Glacier Changes

in comparison with Switzerland

Michael Zemp

Director WGMS, PD Dr. sc. nat.

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Switzerland

wgms
World Glacier Monitoring Service

Universität Zürich[UZH]

Schweiz am Sonntag

Startseite Wirtschaft Geld Politik Nachrichten Sport Menschen Me

Die ersten Gletscher wachsen wieder

Von Fabienne Riklin

Samstag, 28. September 2013 23:30

Twittern 27 +1 3

Empfehlen 412 Personen empfehlen das. Registriere dich, um die Empfehlungen deiner Freunde sehen zu können.

«Es sieht so aus, dass der Findelgletscher an Masse gewonnen hat», sagt Glaziologe Matthias Huss. Foto: Keystone

Für die Schweizer Alpen war 2013 ein guter Sommer. Die Gletscher haben so wenig Masse verloren, wie seit zehn Jahren nicht mehr.

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NACHRICH

Gletschers elze verlan mt

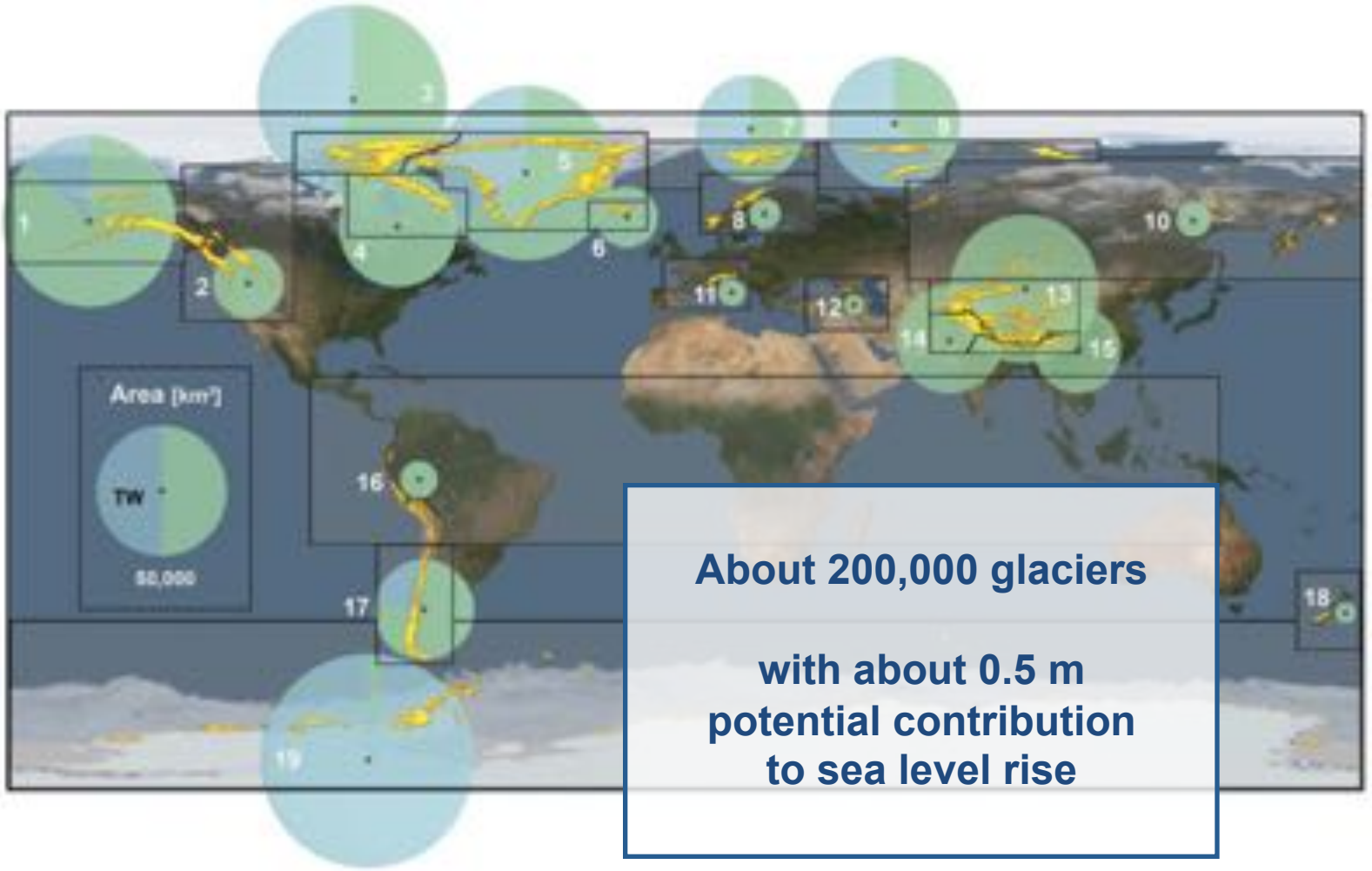
Neuste Messdaten zeig Nordtessin und Südwallis si gewachsen

50

Where to get sound information about climate change?

- Summary of the current state of knowledge
- > 9,200 scientific publications cited
- 259 Authors
- 1,089 Expert Reviewers with >50,000 comments
- Full report is online available

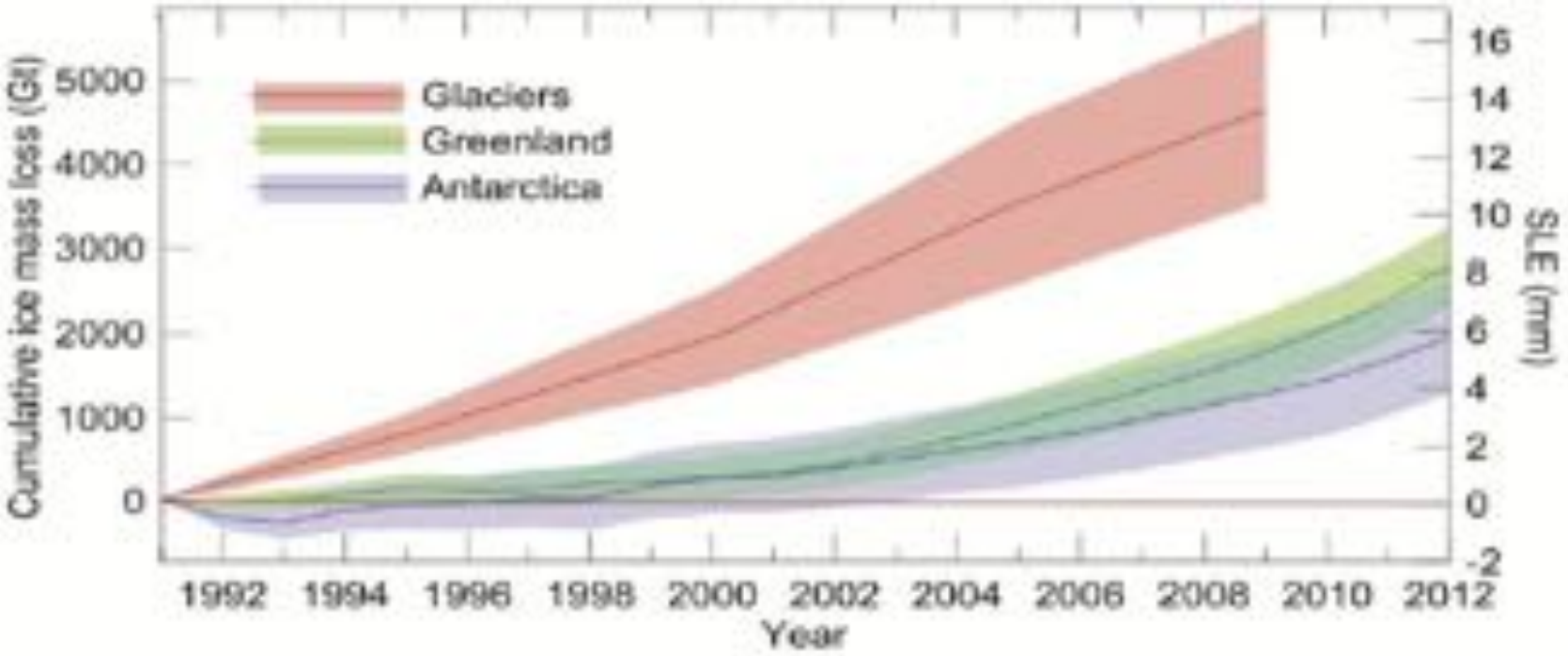
How much glacier ice is out there?



About 200,000 glaciers

with about 0.5 m potential contribution to sea level rise

Contribution of glaciers and ice sheets to sea level change



Cumulative ice mass loss from glacier and ice sheets (in sea level equivalent) is 1.0 to 1.4 mm/yr for 1993-2009 and 1.2 to 2.2 mm/yr for 2005-2009.

How (fast) are glaciers changing?

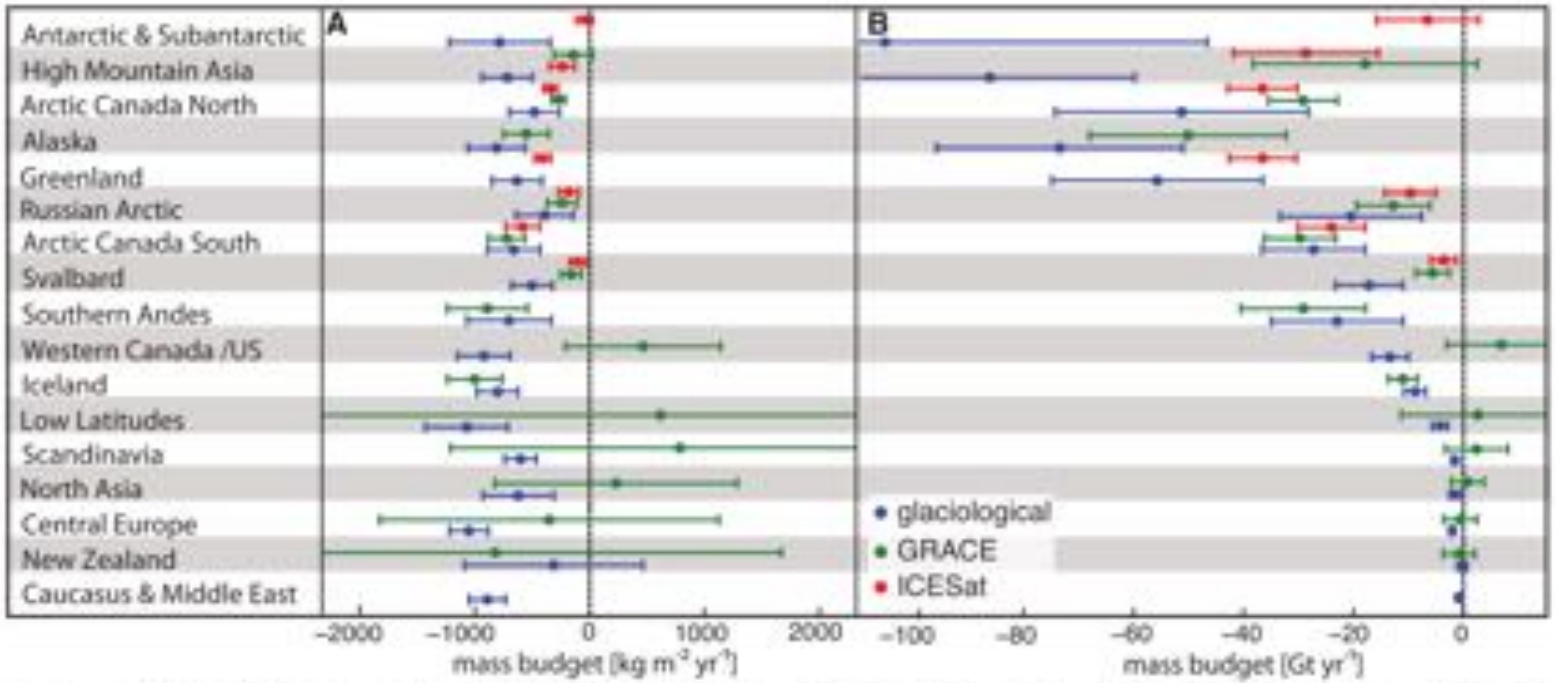


Fig. 3. Comparison of regional glacier mass-budget estimates. Regional estimates of glacier mass change for 2003–2009 in (**A**) kg m^{-2} year^{-1} and (**B**) Gt year^{-1}. Estimates are as assessed by ICESat (*8*, *13*, *14*) and GRACE [JW12 (*9*, *10*)] and from interpolation of glaciological records (*2*) with an updated measurement data set for 2003–2009 (glaciological). Regions are arranged from top to bottom by total glacierized area. Uncertainties give the 95% CI.

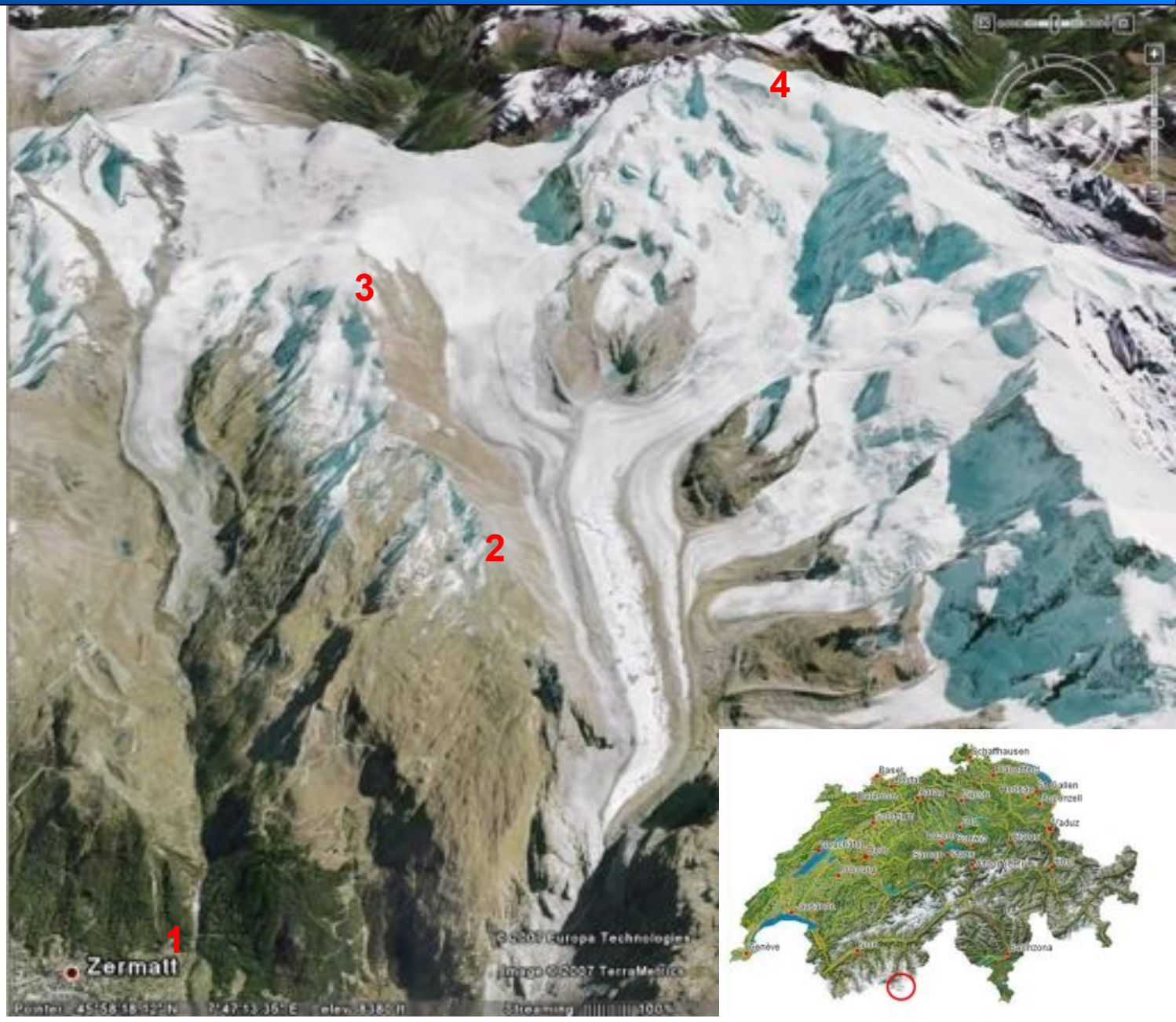
Gardner et al. (2013)

1: Zermatt,
1,600 m asl

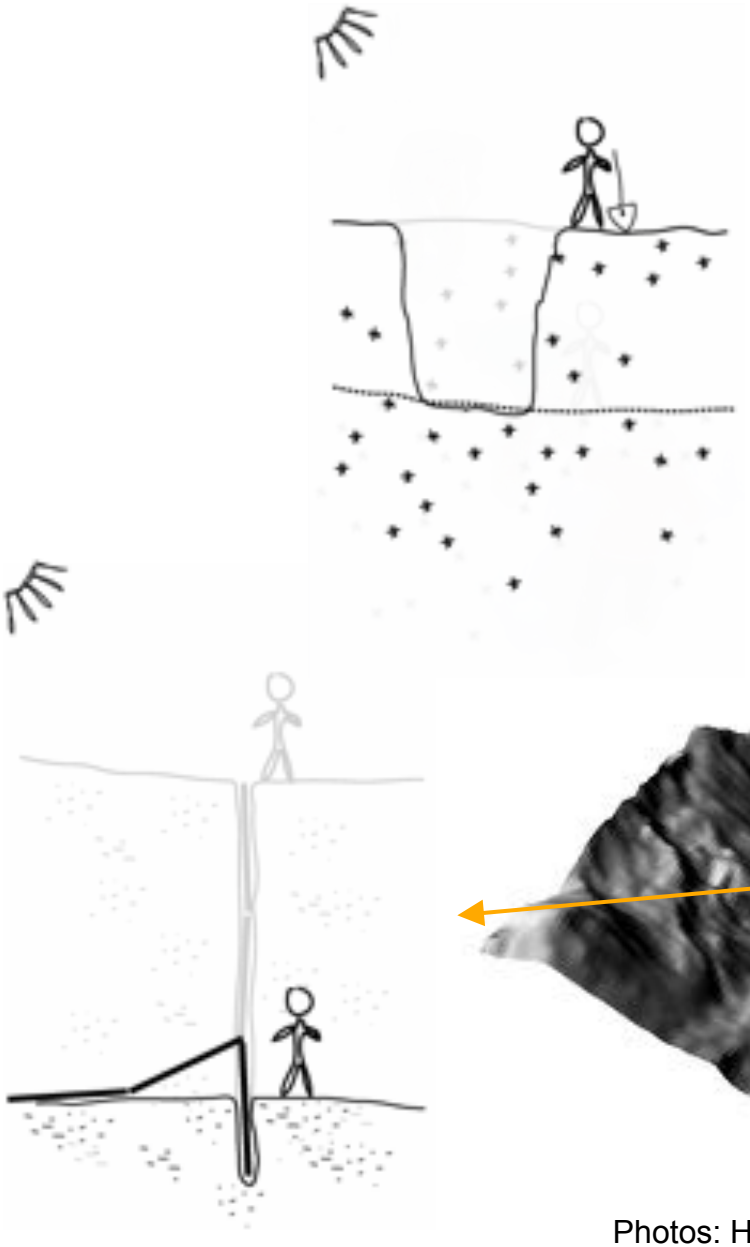
2: Rotenboden,
2,800 m asl

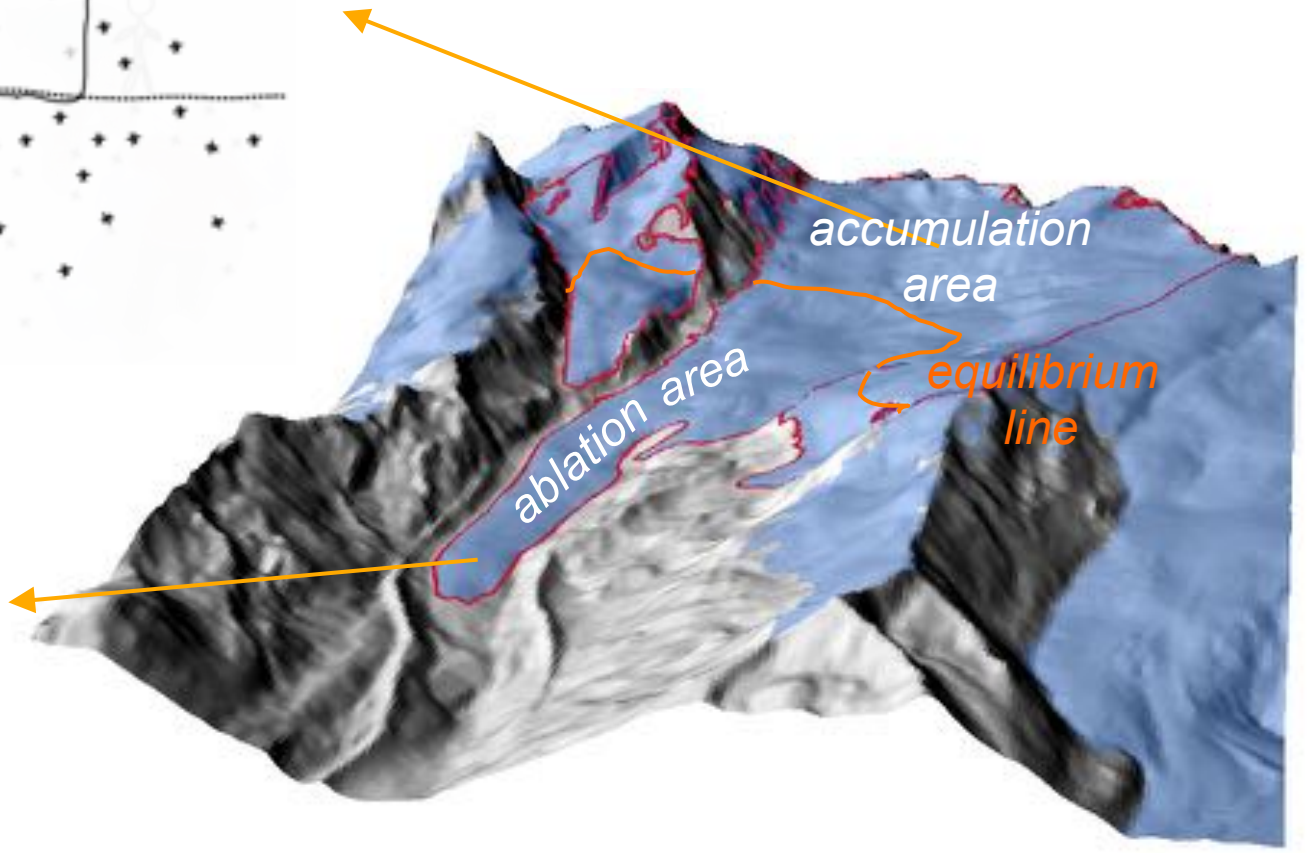
3: Stockhorn Stat.,
3,400 m asl

4: Colle Gnifetti,
4,450 m asl
Capna Margarita,
4,554 m asl



The direct glaciological method





Photos: H. Machguth

Photo: N. Salzmann

Photo: S. Bircher

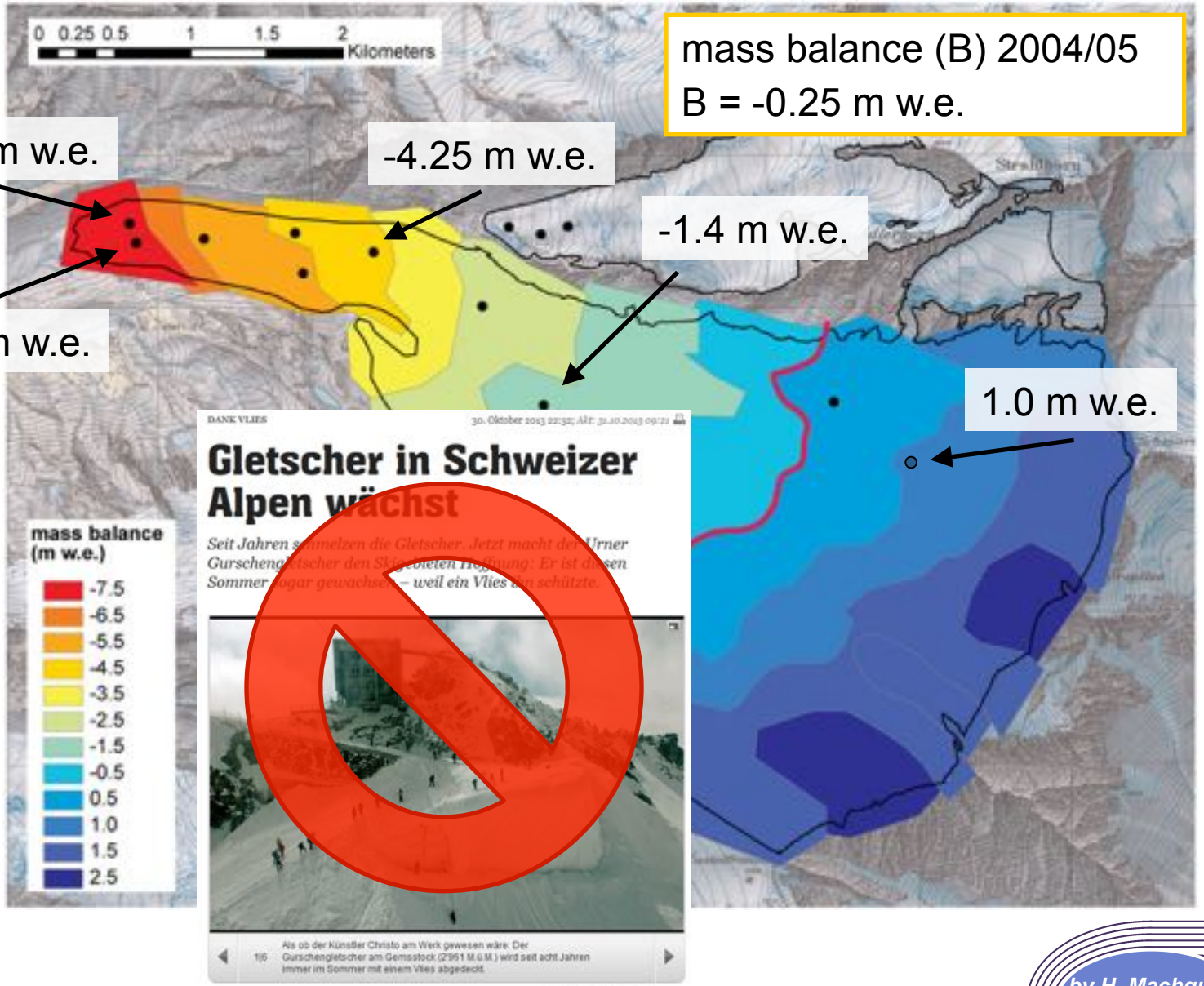
Stake drilling / Stake readings

Photo: H. Machguth

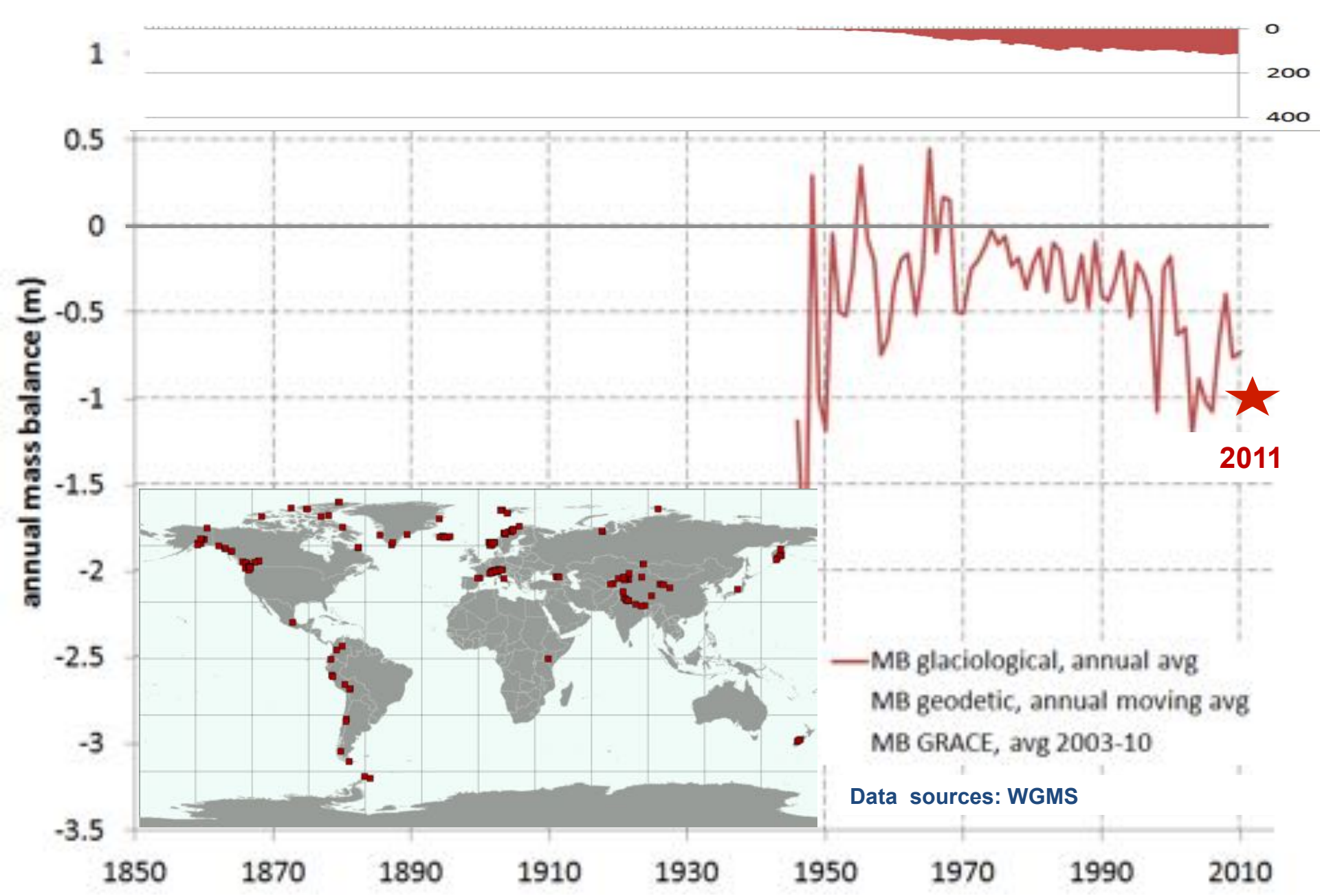
Photos: N. Salzmann

Snow pits

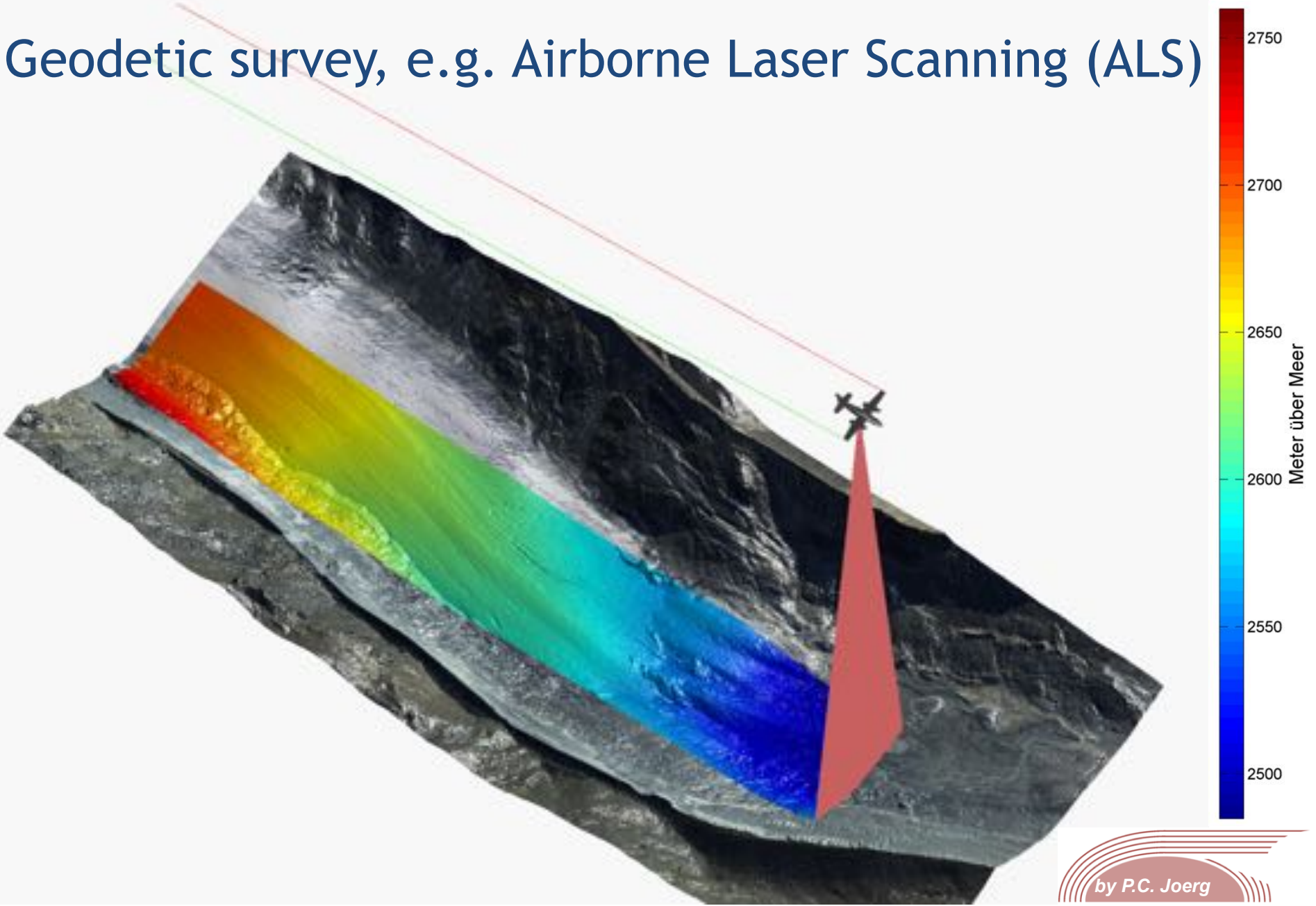
by H. Machguth



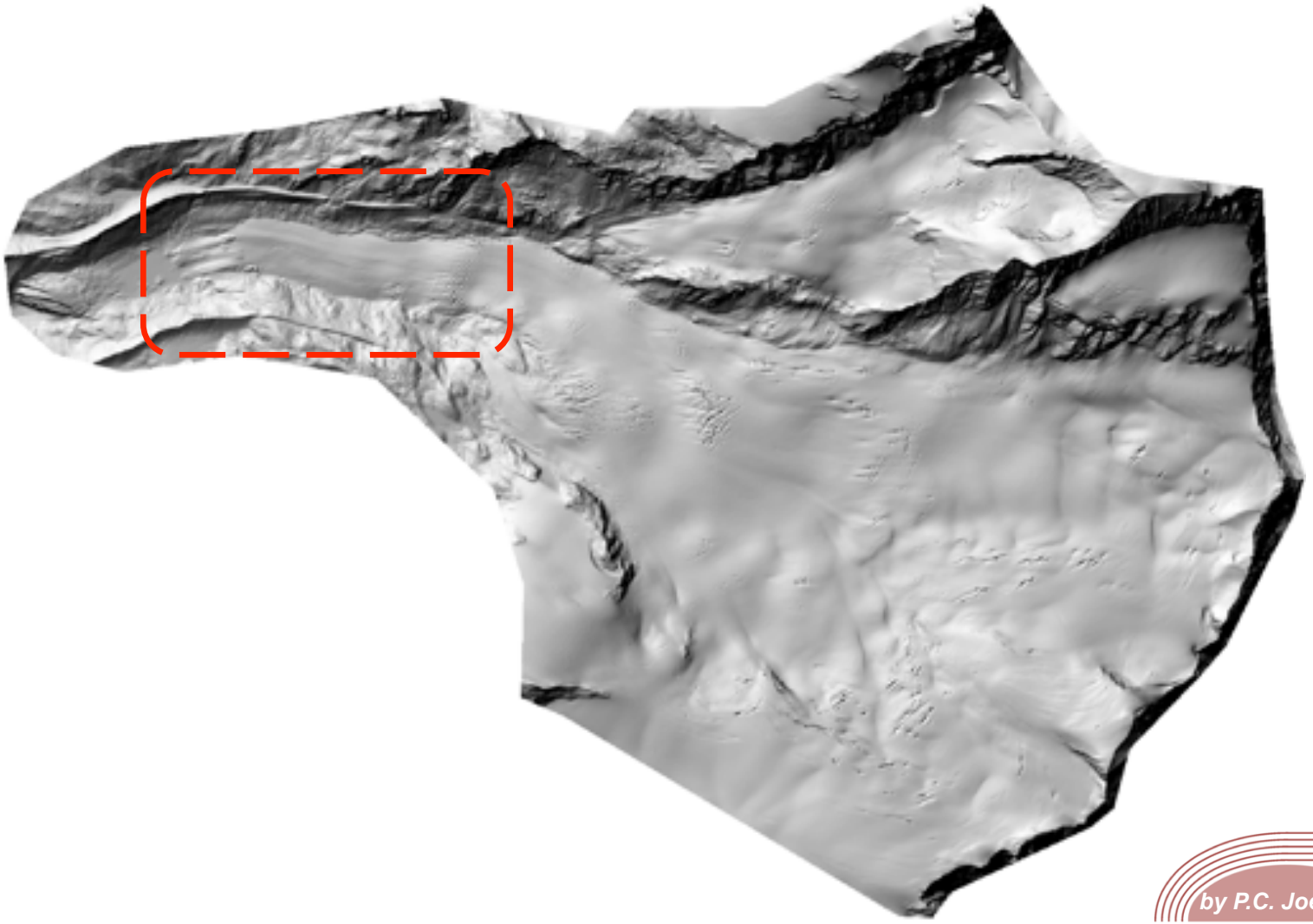
by H. Machguth


annual mass balance (m)
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
1850
1870
1890
1910
1930
1950
1970
1990
2010
0
200
400
2011
MB glaciological, annual avg
MB geodetic, annual moving avg
MB GRACE, avg 2003-10
Data sources: WGMS

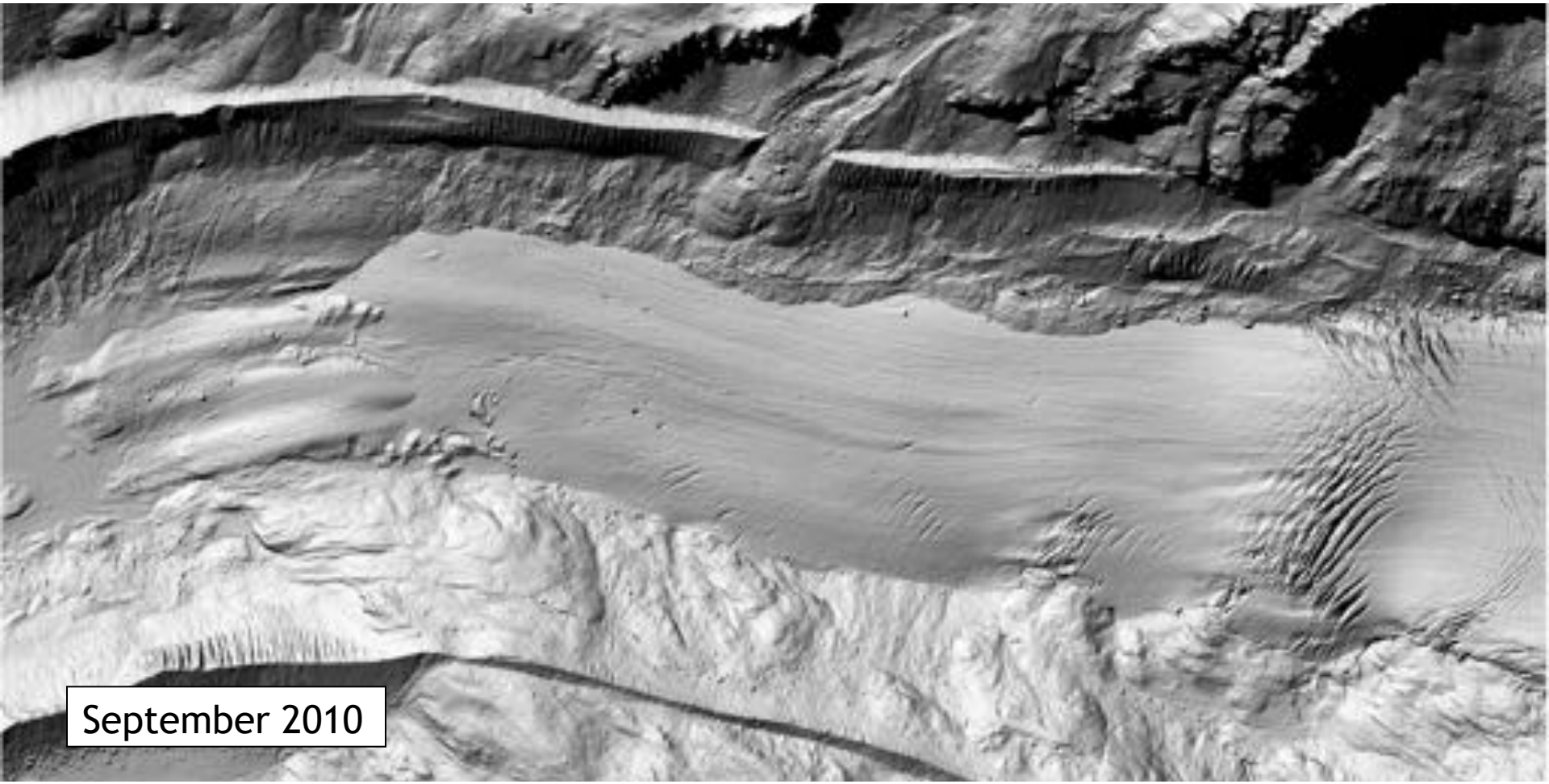
Geodetic survey, e.g. Airborne Laser Scanning (ALS)

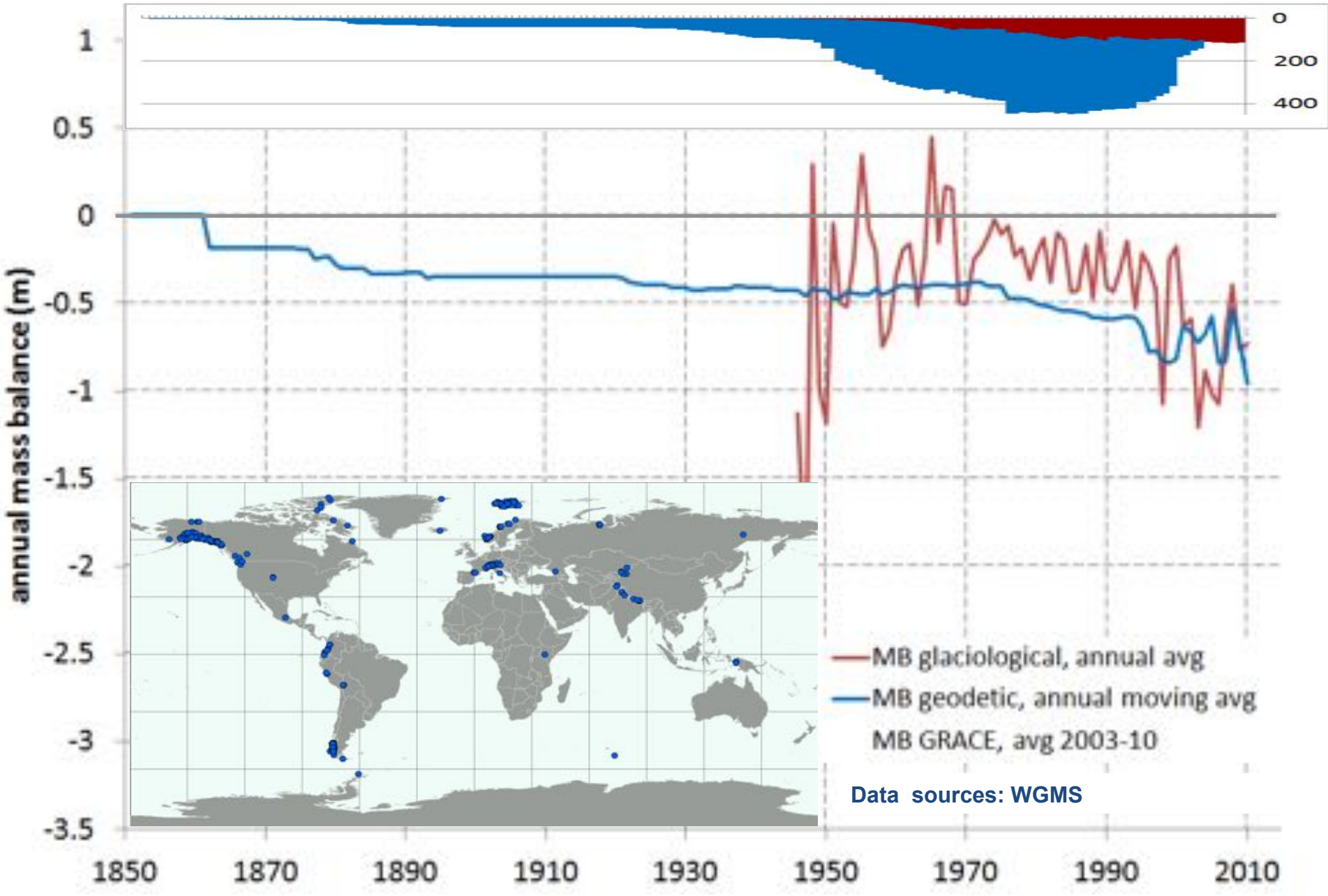


Hillshaded DEM OKT 2009



Hillshaded DEM of glacier tongue area

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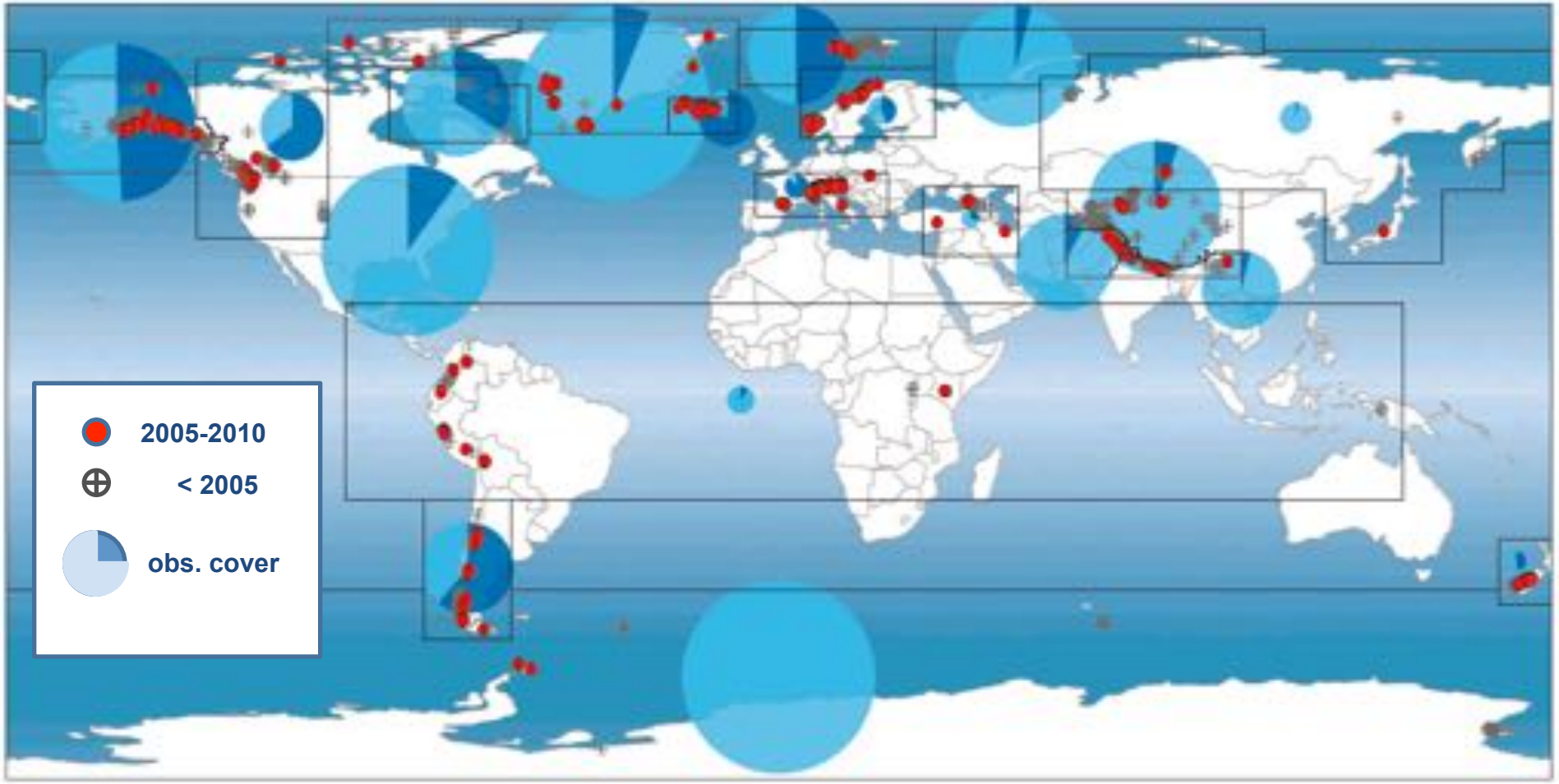
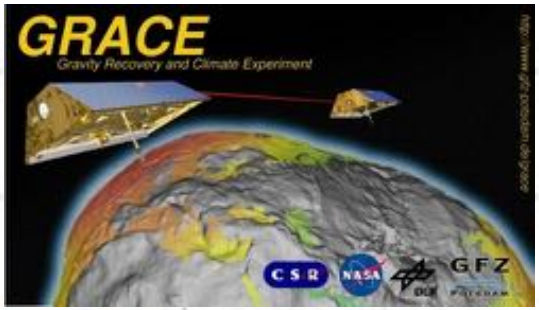
MB GRACE, avg 2003-10
Data sources: WGMS

Glacier fluctuations



front variation observations and reconstructions, **glaciological and geodetic balances**

Zemp et al. (in prep)



annual mass balance (m)

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-0.5
-1
-1.5
-2
-2.5
-3
-3.5

1850 1870 1890 1910 1930 1950 1970 1990 2010

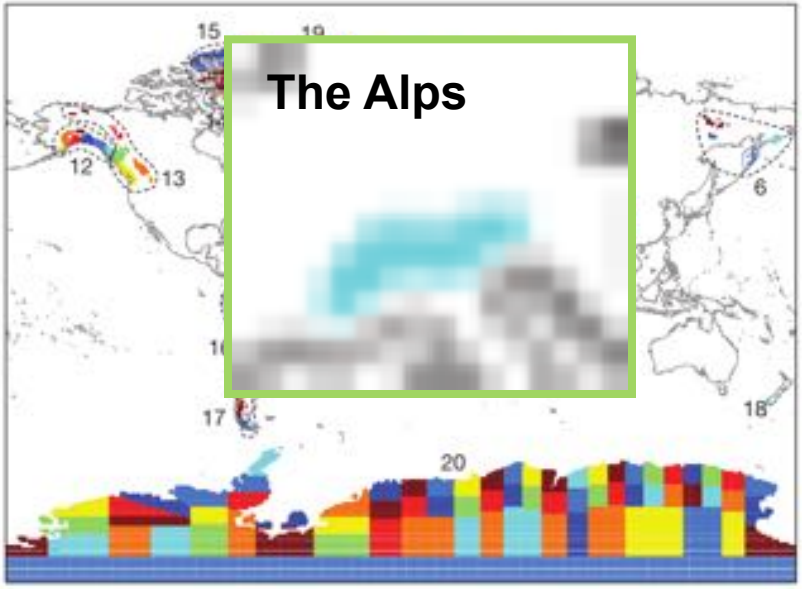


Figure 1 | Mascons for the ice-covered regions considered here. Each coloured region represents a single mascon. Numbers correspond to regions shown in Table 1. Regions containing more than one mascon are outlined with a dashed line.

MB glaciological, annual avg
MB geodetic, annual moving avg
MB GRACE, avg 2003-10

Data sources: WGMS, Jacob et al. 2012

Elevation changes from ICESat

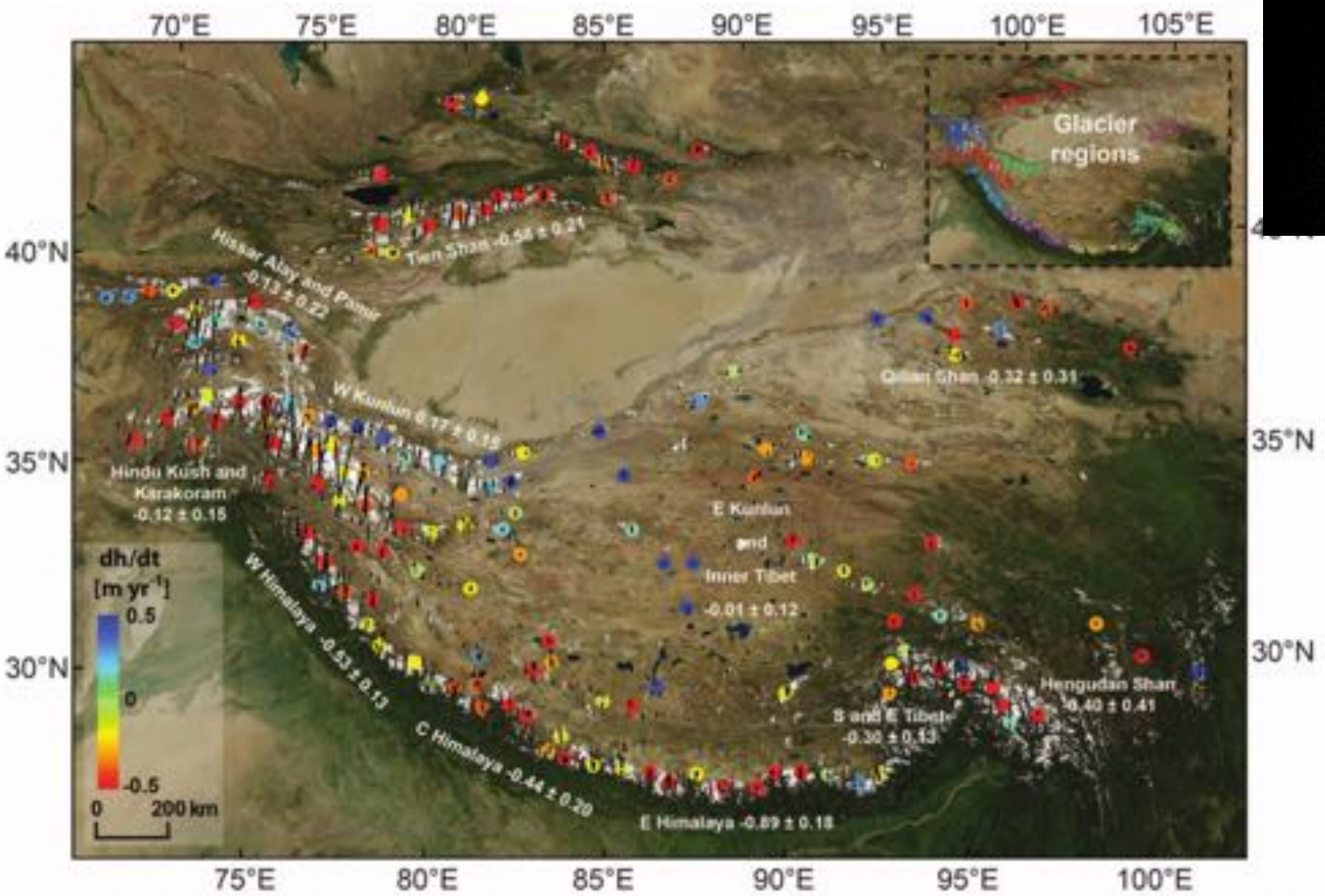
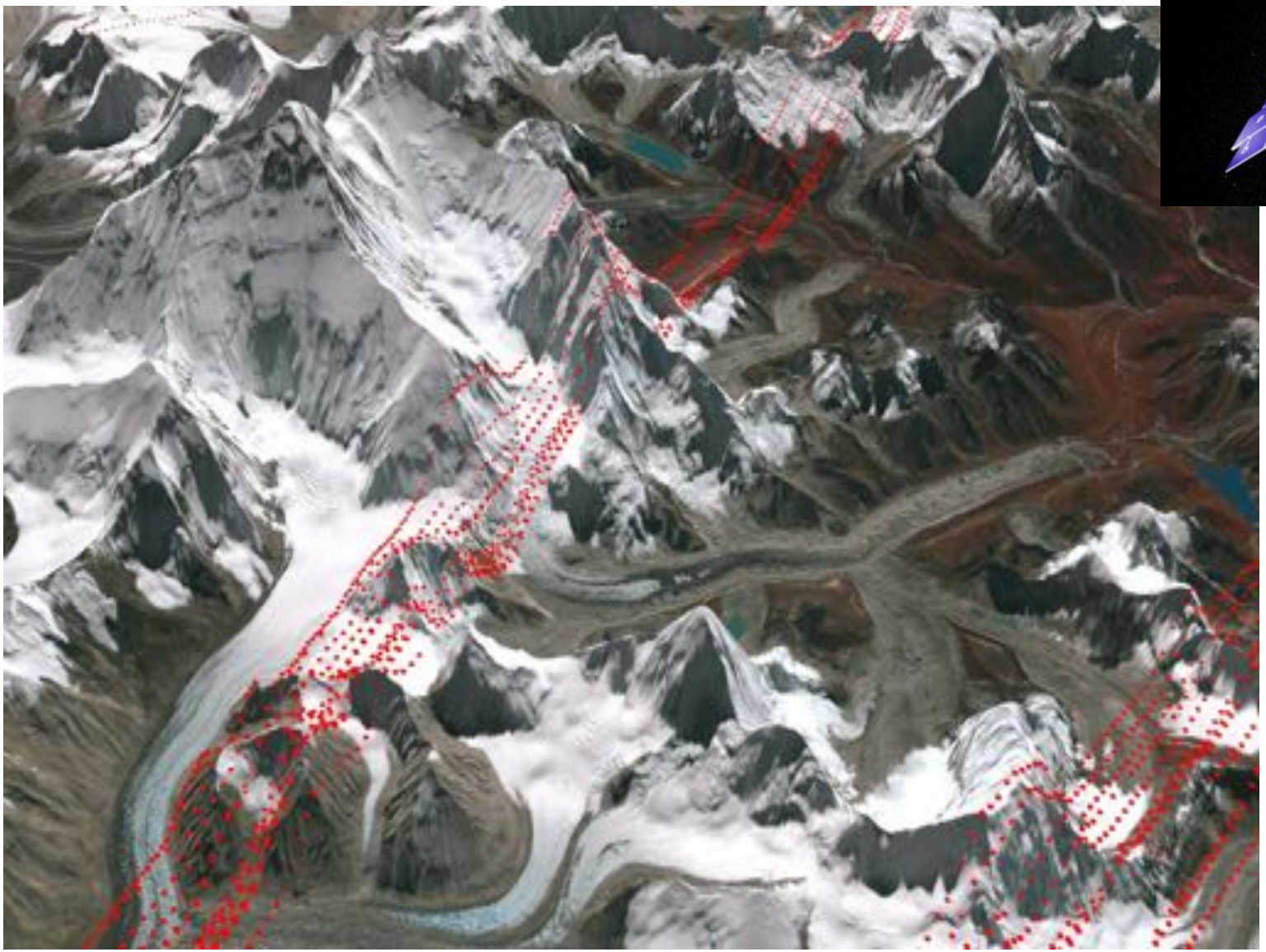


Fig. 4. Elevation changes for high-mountain Asia glaciers. Averaged elevation change rates (*dh/dt*) between October 2003 and October 2009 for high-mountain Asia. Each colored dot represents an independent spatial average of a minimum of 50 *dh/dt* observations within a radius of 50 km. ICESat ground tracks over glaciers are shown with thin black lines. The inset image and text labels define a set of subregions for which we have estimated area-averaged elevation changes (shown here in m year^{-1} together with their uncertainties) and mass budgets (table S5). Uncertainties give the 95% CI.

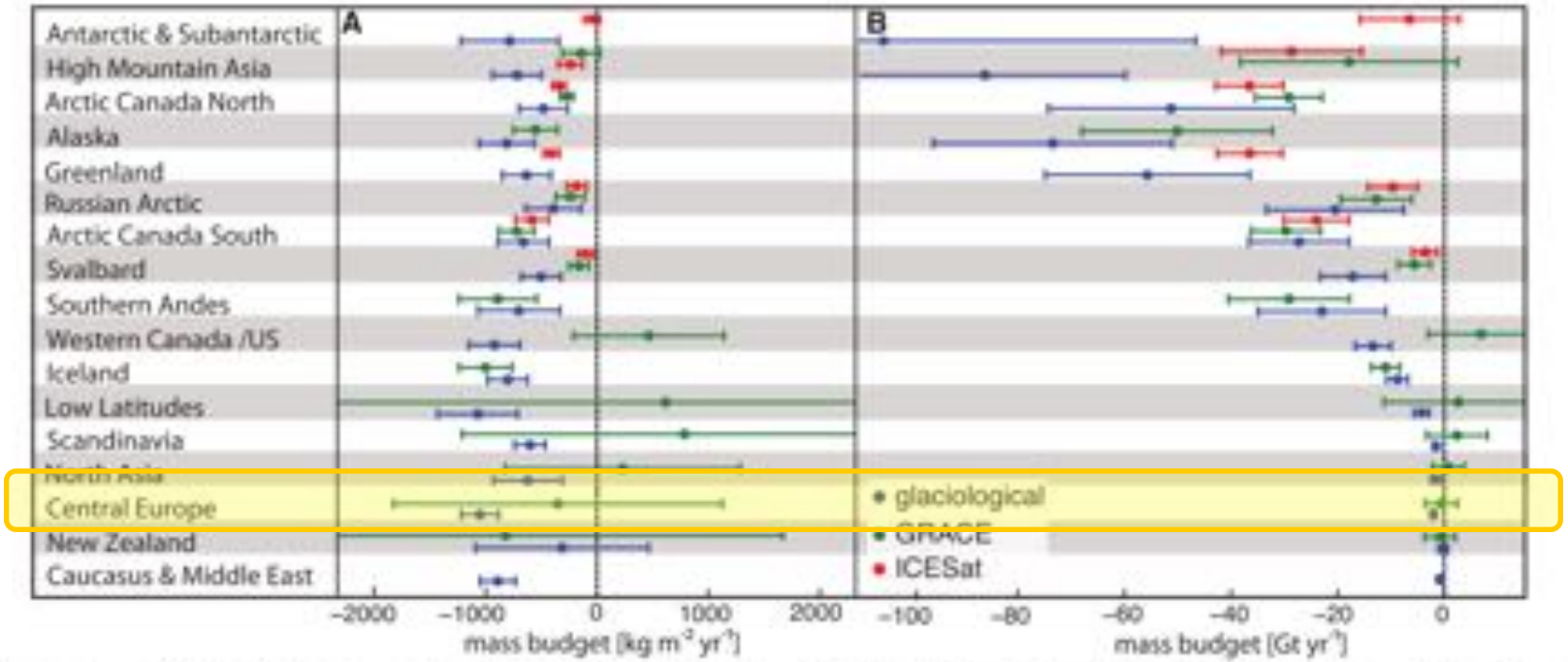
Gardner et al. (2013)

Elevation changes from ICESat



Kääb et al. (2013)

How (fast) are glaciers changing in the Alps?



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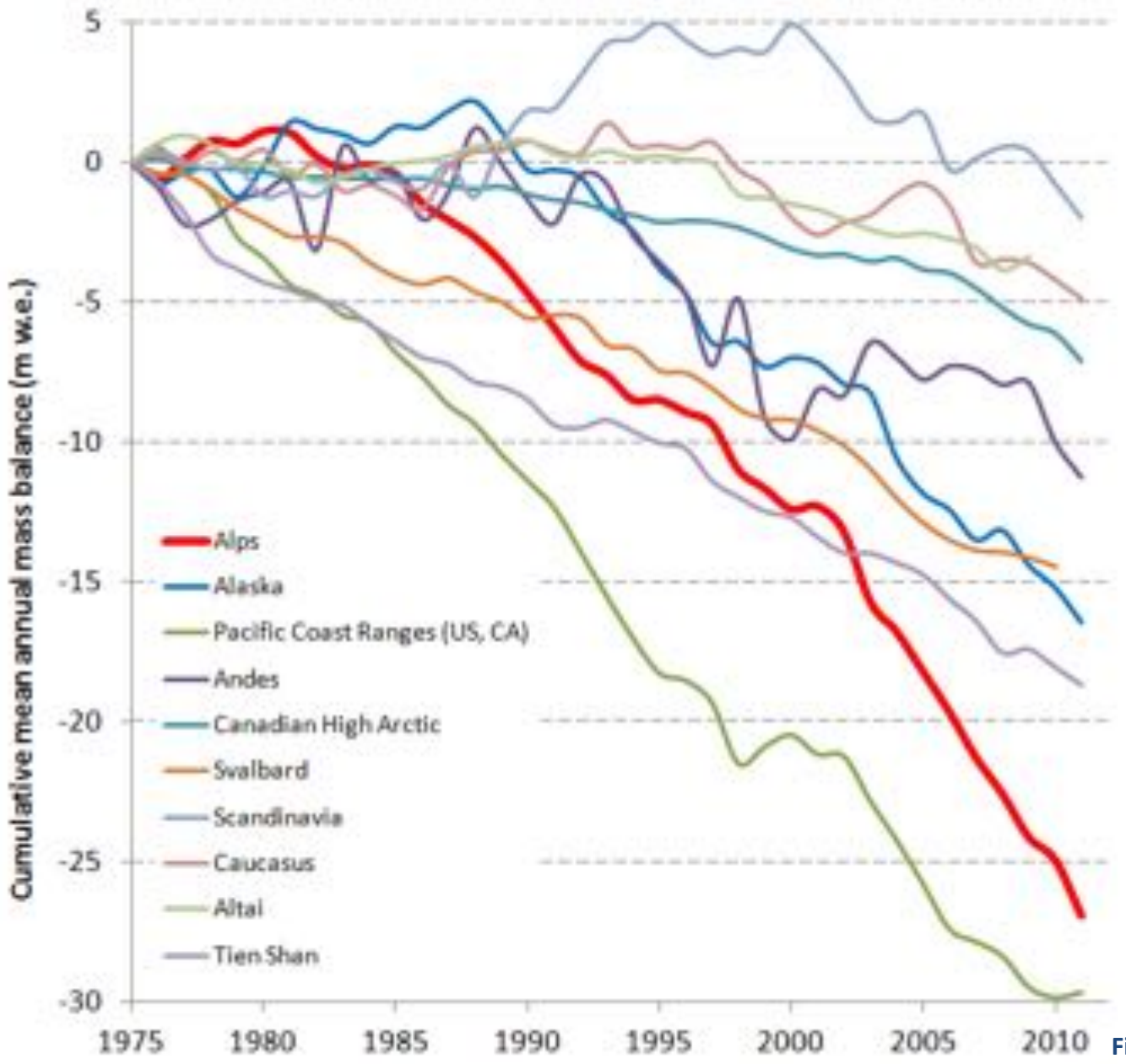

Figure based on data from WGMS (2013)

Schweiz am Sonntag

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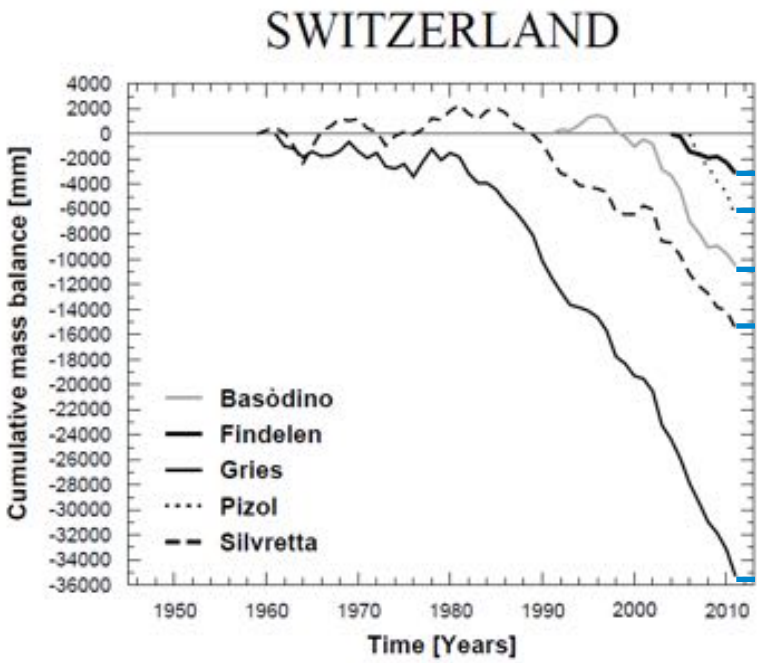
In 2012/13, **some** Alpine glaciers showed a

- **minor mass gain** but **continued frontal retreat**
- mainly due to a **long and partially snowy winter**
- supported by some **summer snow fall events**.

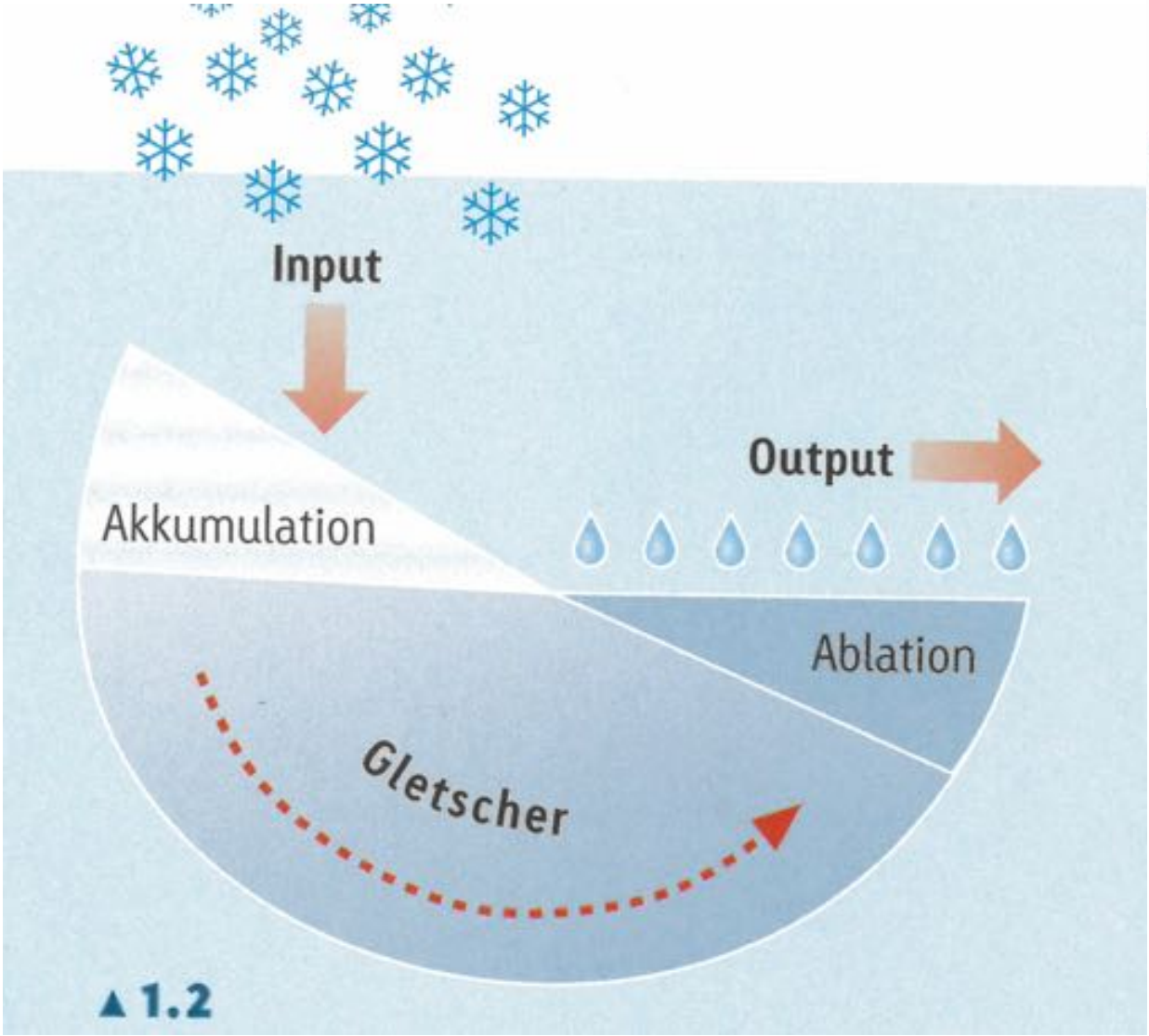


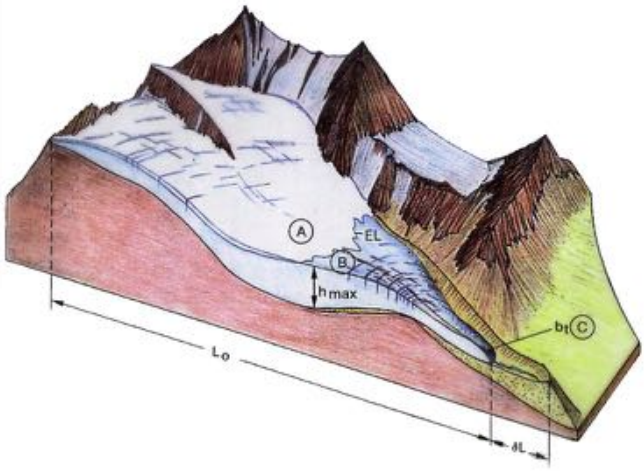
2013

WGMS (2013)

- On a century scale, **glacier shrinking is global, fast and accelerating**
- On a decadal scale, glaciers in various mountain ranges have shown periods of **intermittent re-advances**, as recently in Scandinavia and New Zealand
- Regions with strongest glacier mass loss include the European Alps, Alaska, and the US-Canadian Pacific Coast Ranges.
- **Do not believe everything written in newspapers.**
- **Even less believe the headlines.**
- **Better double-check with reliable (because verifiable) sources, e.g. IPCC AR5.**

Glacier crash course: glacier system

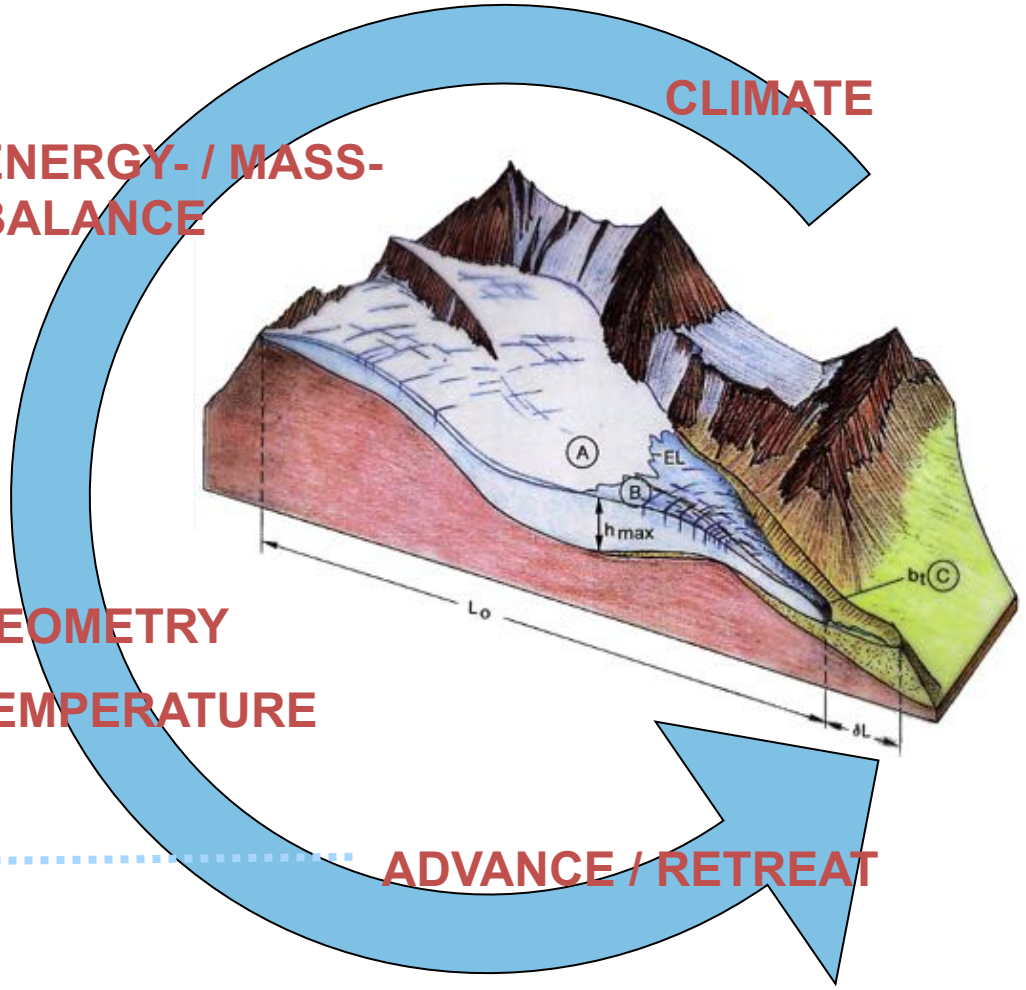




Haeberli (1998)

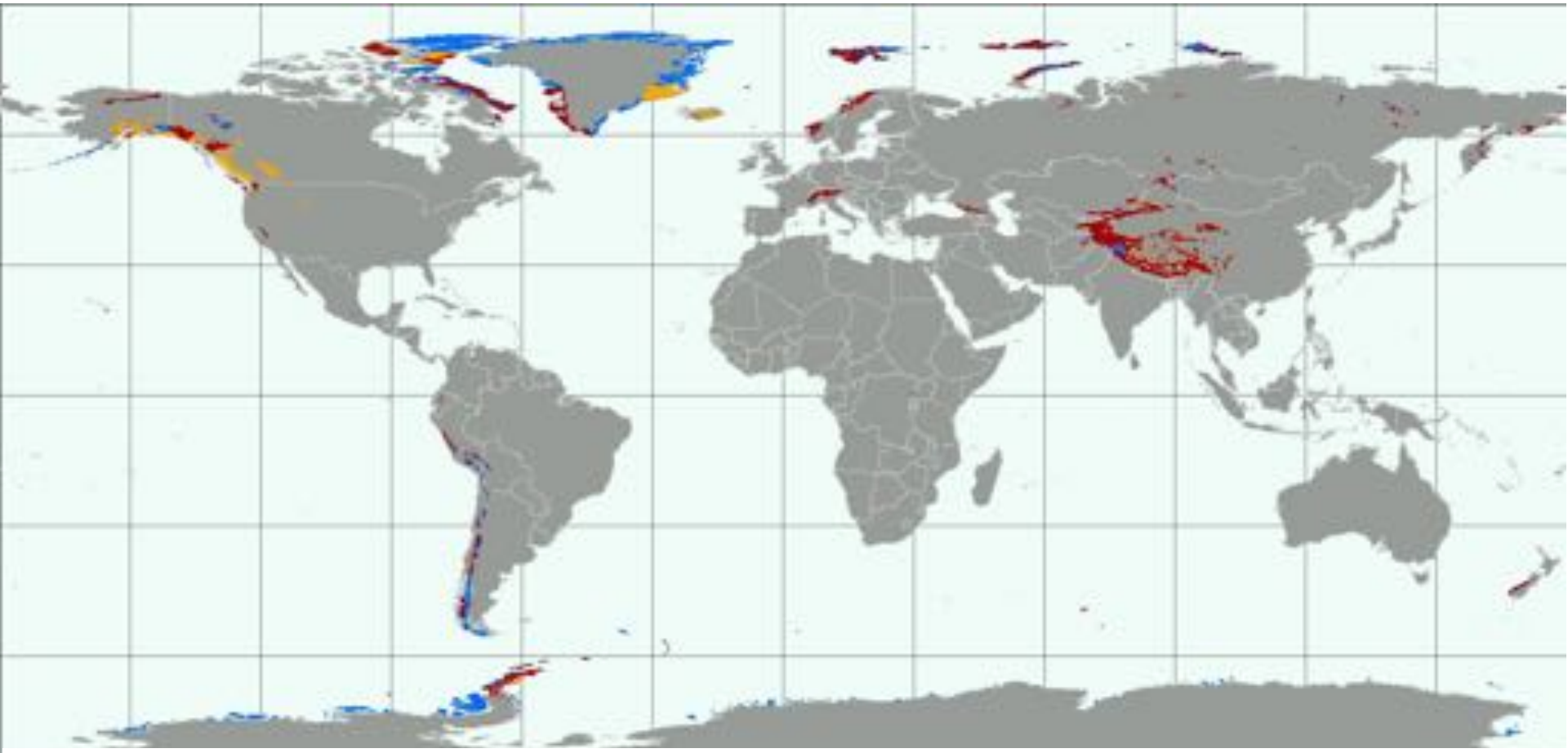
Winkler (2008)

Glacier crash course: climate-glacier process chain



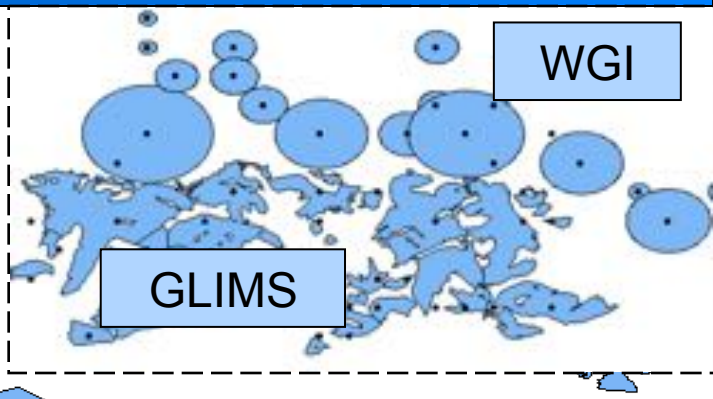
Haeberli (1998)

World Glacier Inventory



- **World Glacier Inventory:** mainly aerial photographs and maps around 1970s
- **GLIMS Inventory:** mainly satellite images after 2000
- **Randolph Glacier Map:** rough glacier outlines, rough time stamp, no attributes

Randolph (Global Glacier Map) 1.0



GLIMS

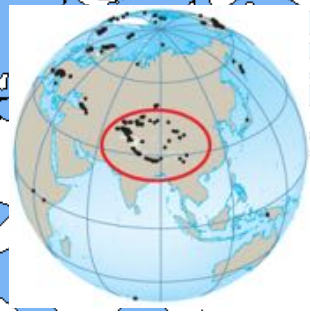
Compiled to serve IPCC AR5

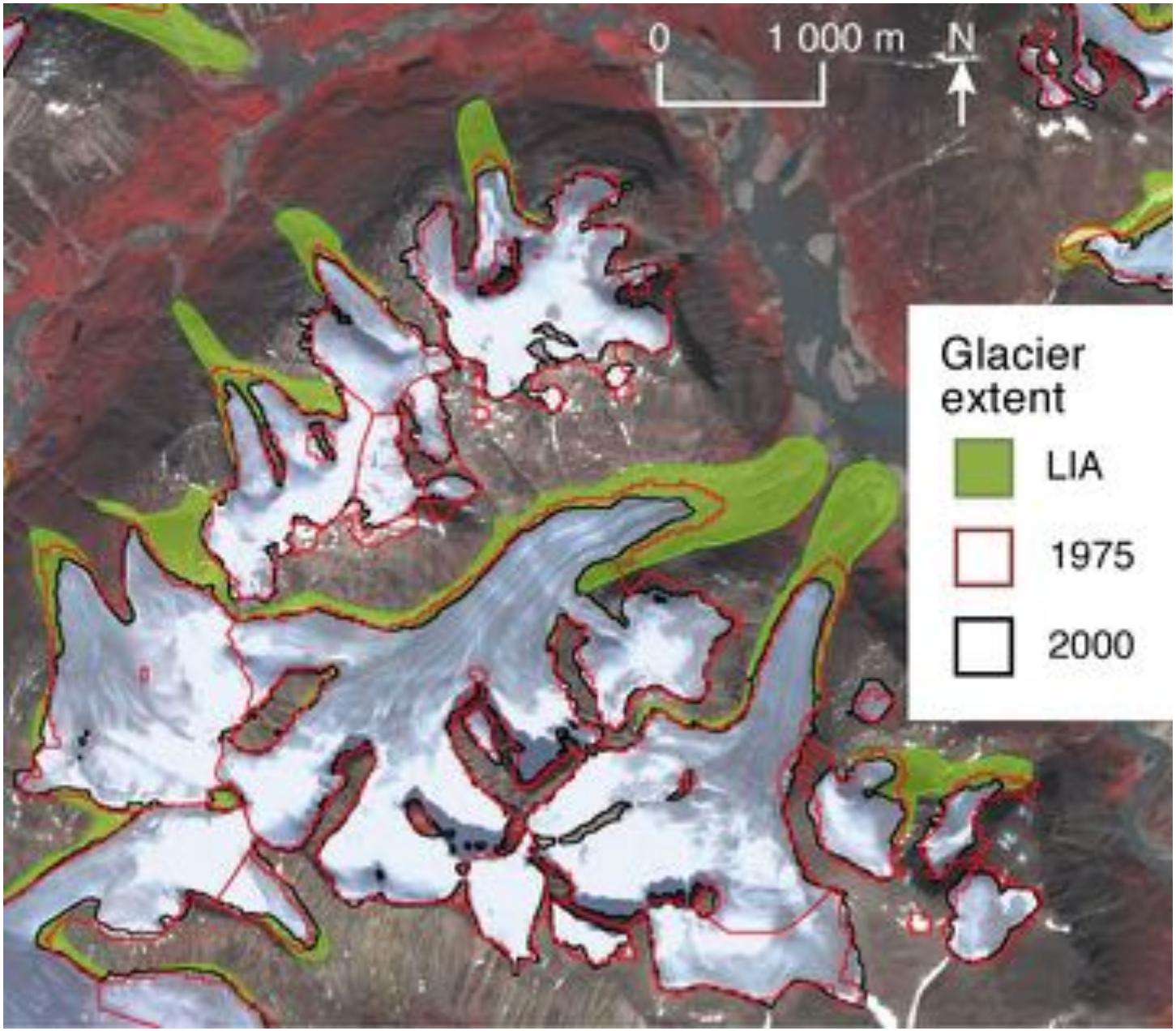
- main purpose: global SLR modelling
- by A. Arendt et al. from different source; mainly GLIMS, DCW, and WGI
- no attributes, no time stamp (1950-2010)
- final version available from GLIMS website
- additional high-quality outlines to be incorporated into GLIMS database

=> how to manage this task with the available resources?!

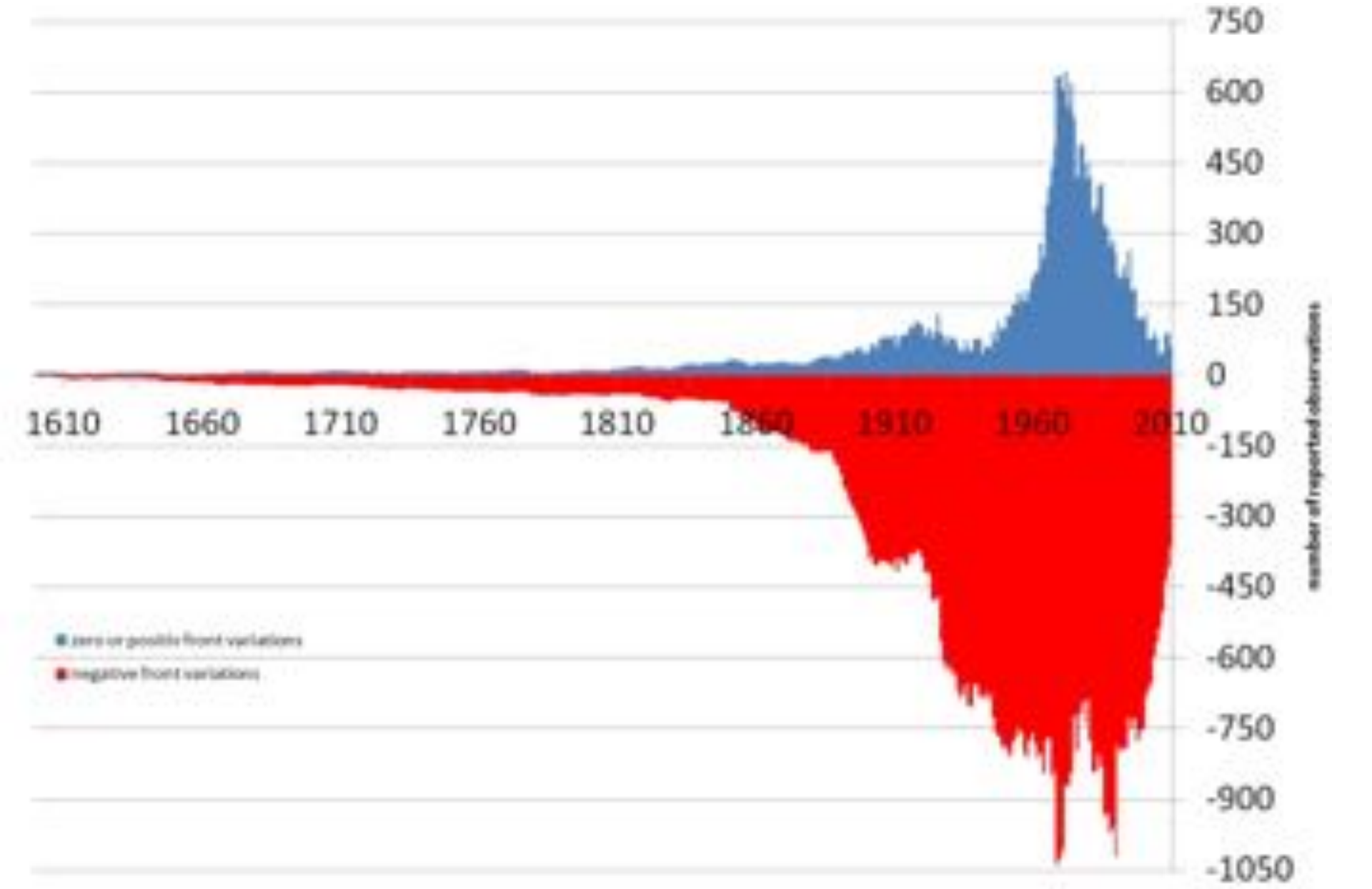
Fedtschenko

DCW





UNEP (2007)



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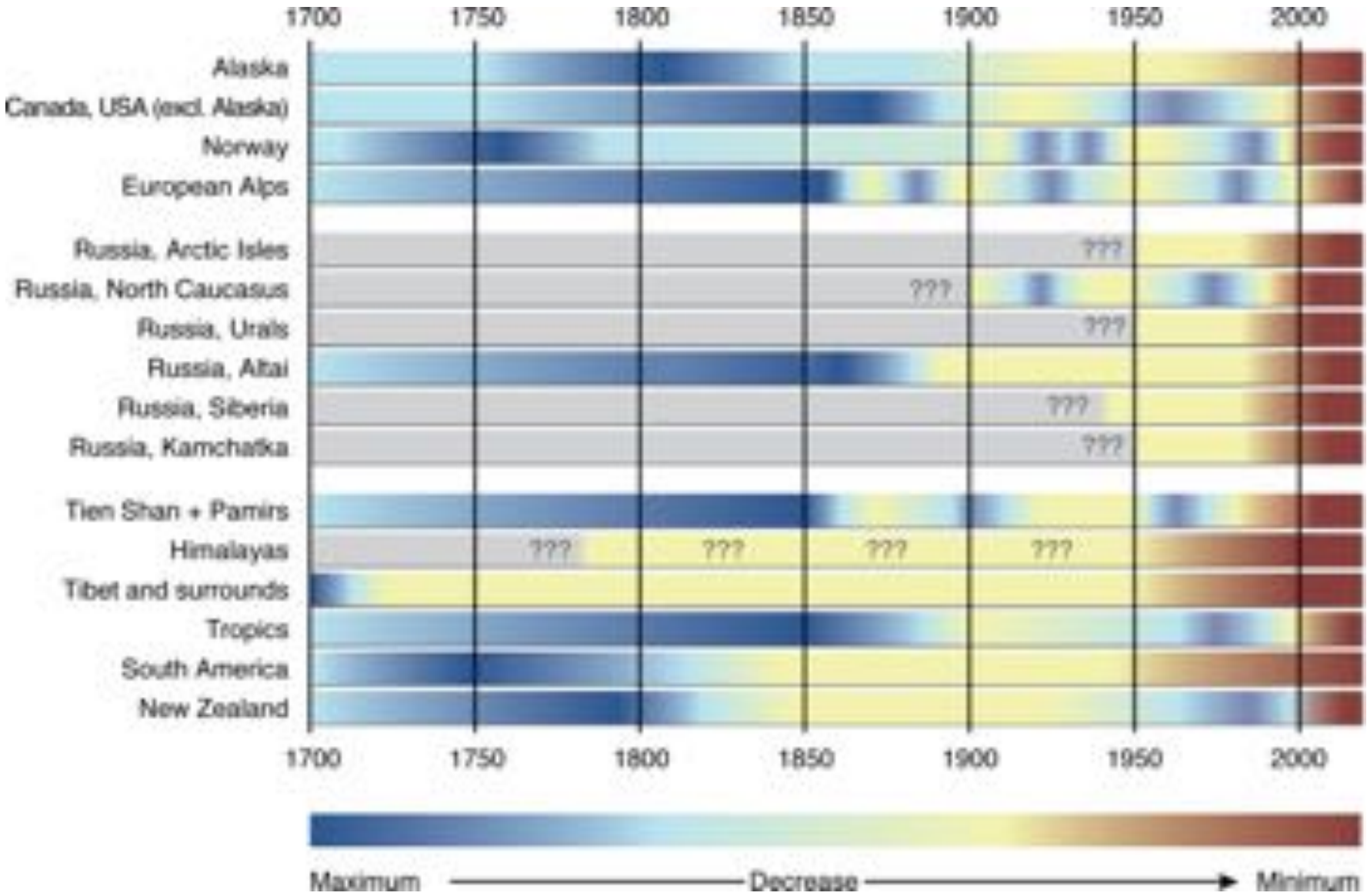

Zemp et al. in UNEP (2007)