Glaciers_cci: Monitoring and change assesment of glaciers using satellite data

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R. McNabb, C. Nuth, K. Langley, A. Kääb (Uni Oslo)
A. Shepherd, K. Briggs, L. Gilbert (Uni Leeds)
T. Strozzi, A. Wiesmann (Gamma)
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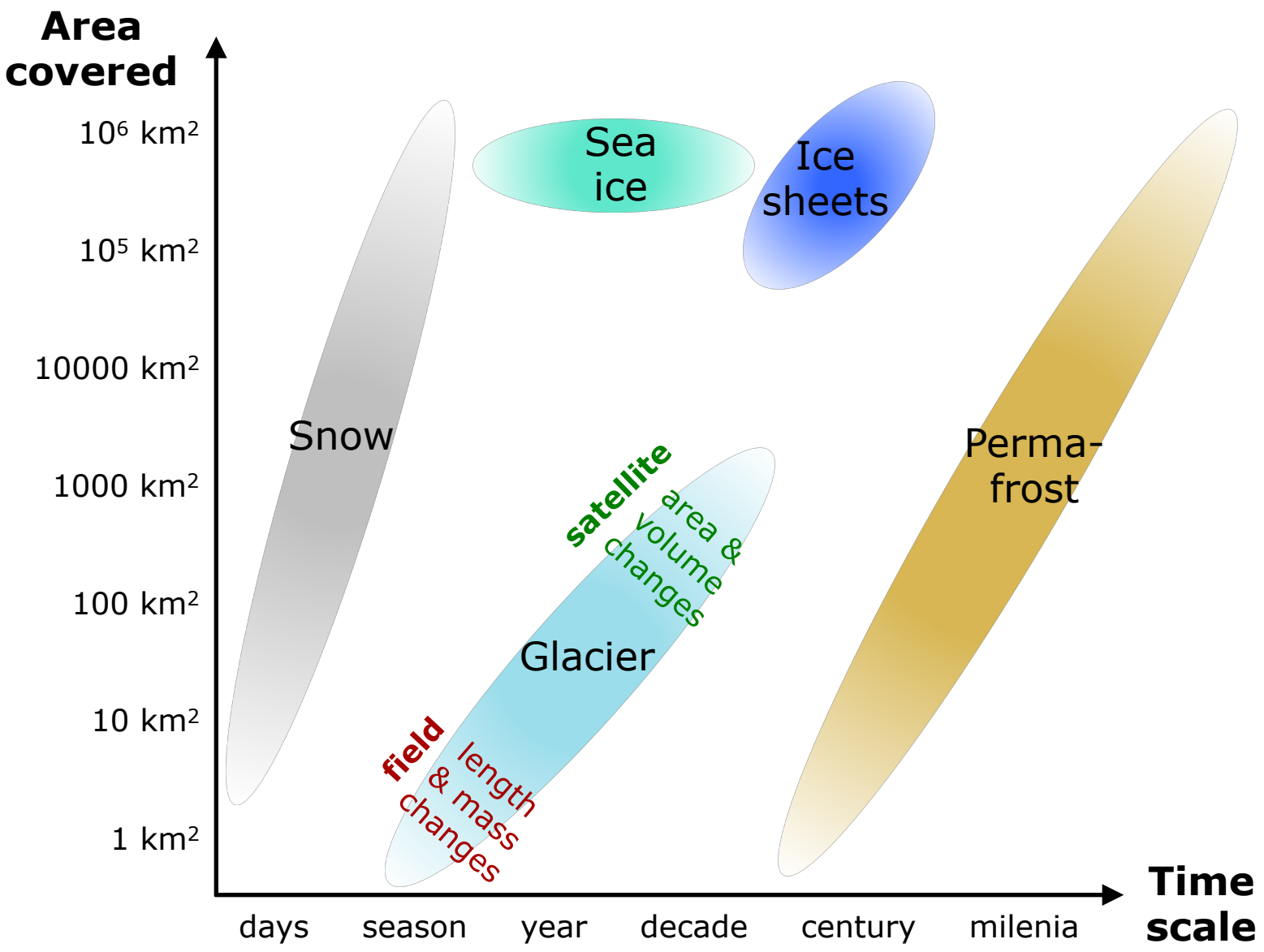
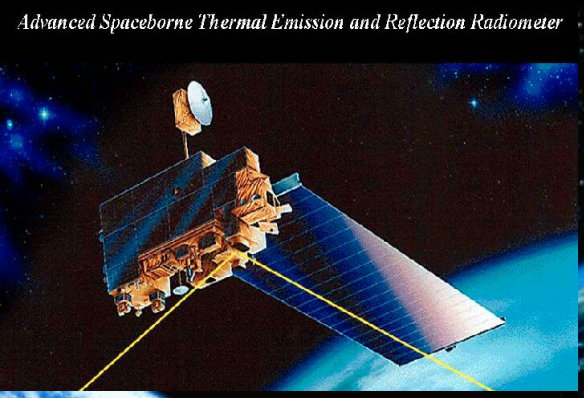
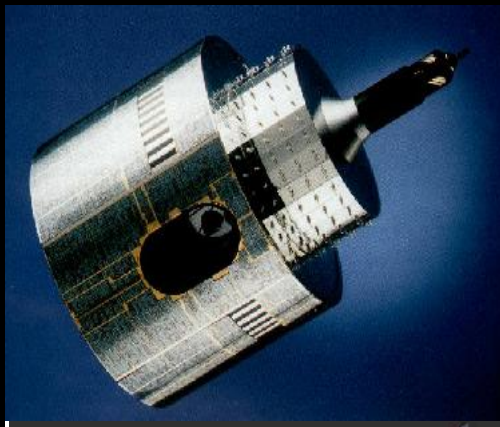
Typical cryosphere temporal / spatial scales

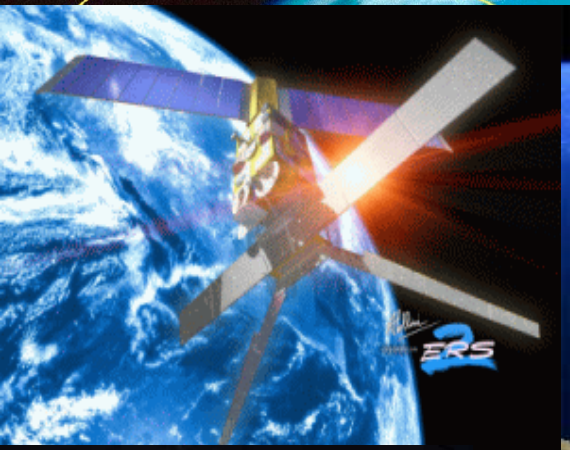


F. Paul

Satellites







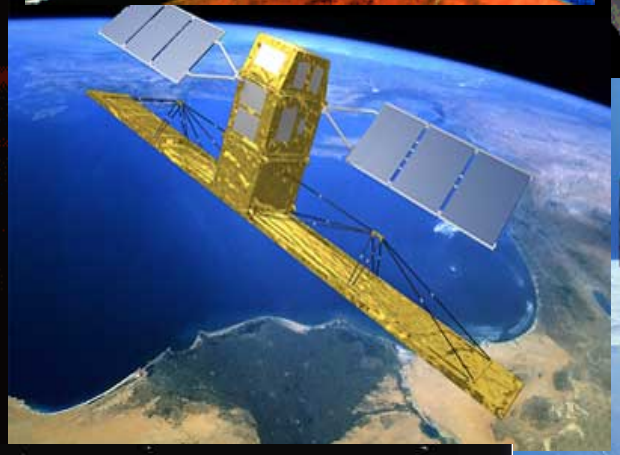
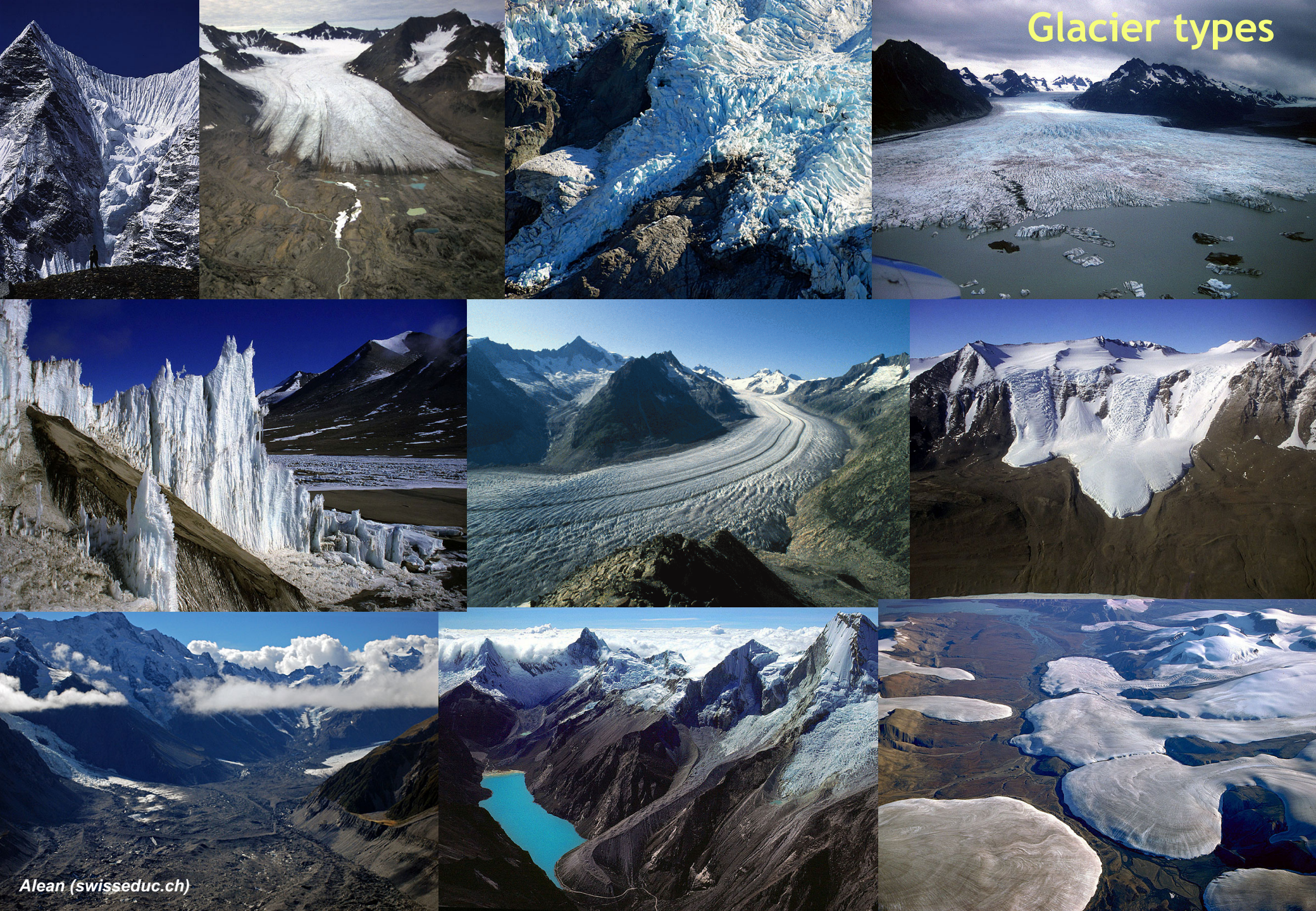


Image source: Internet


Glacier types
Alean (swisseduc.ch)

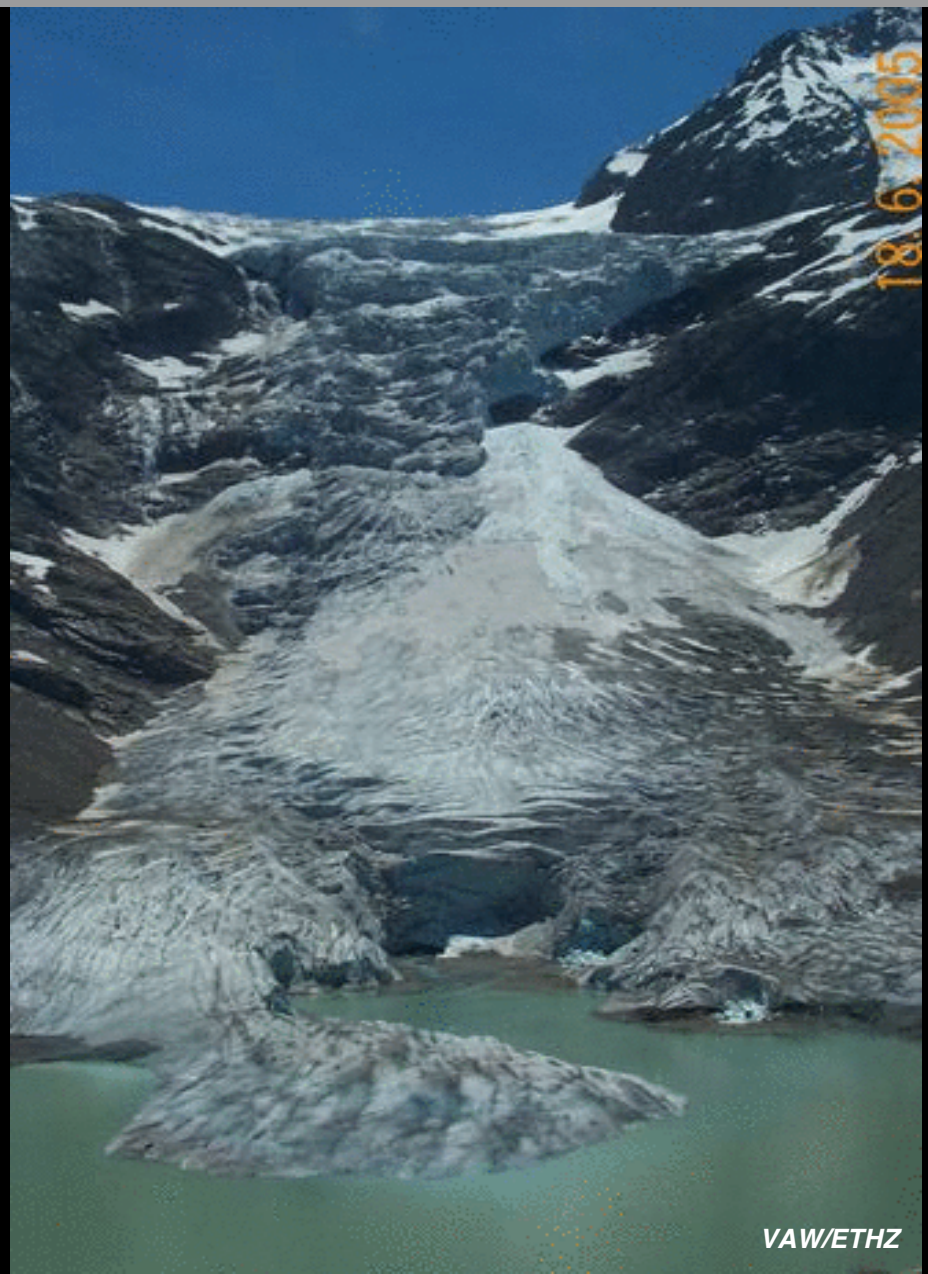
Climate change indicators: Pasterze 2009

Alean

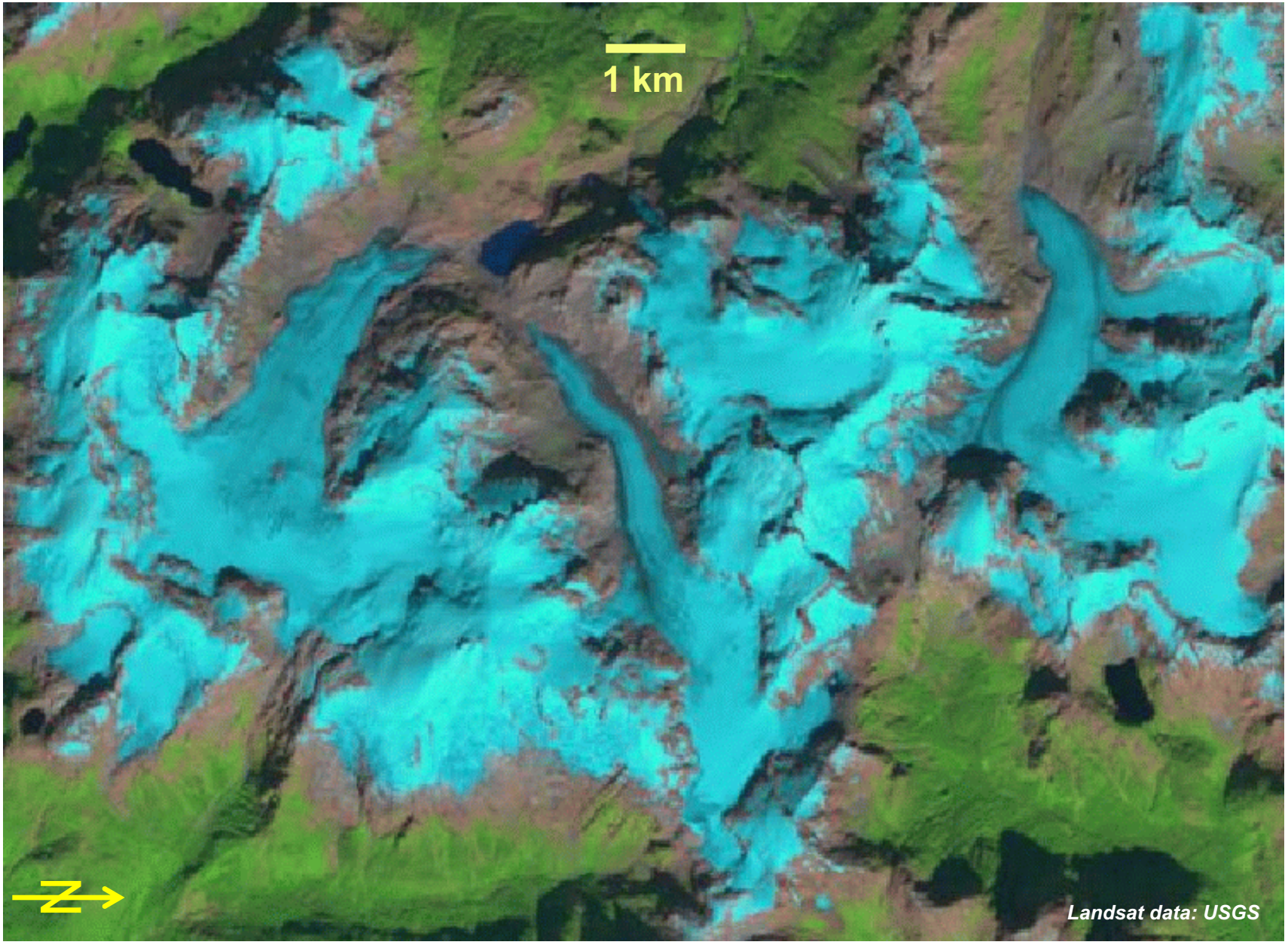
Climate change indicators: Pasterze 2018

rudipo.blogspot.com

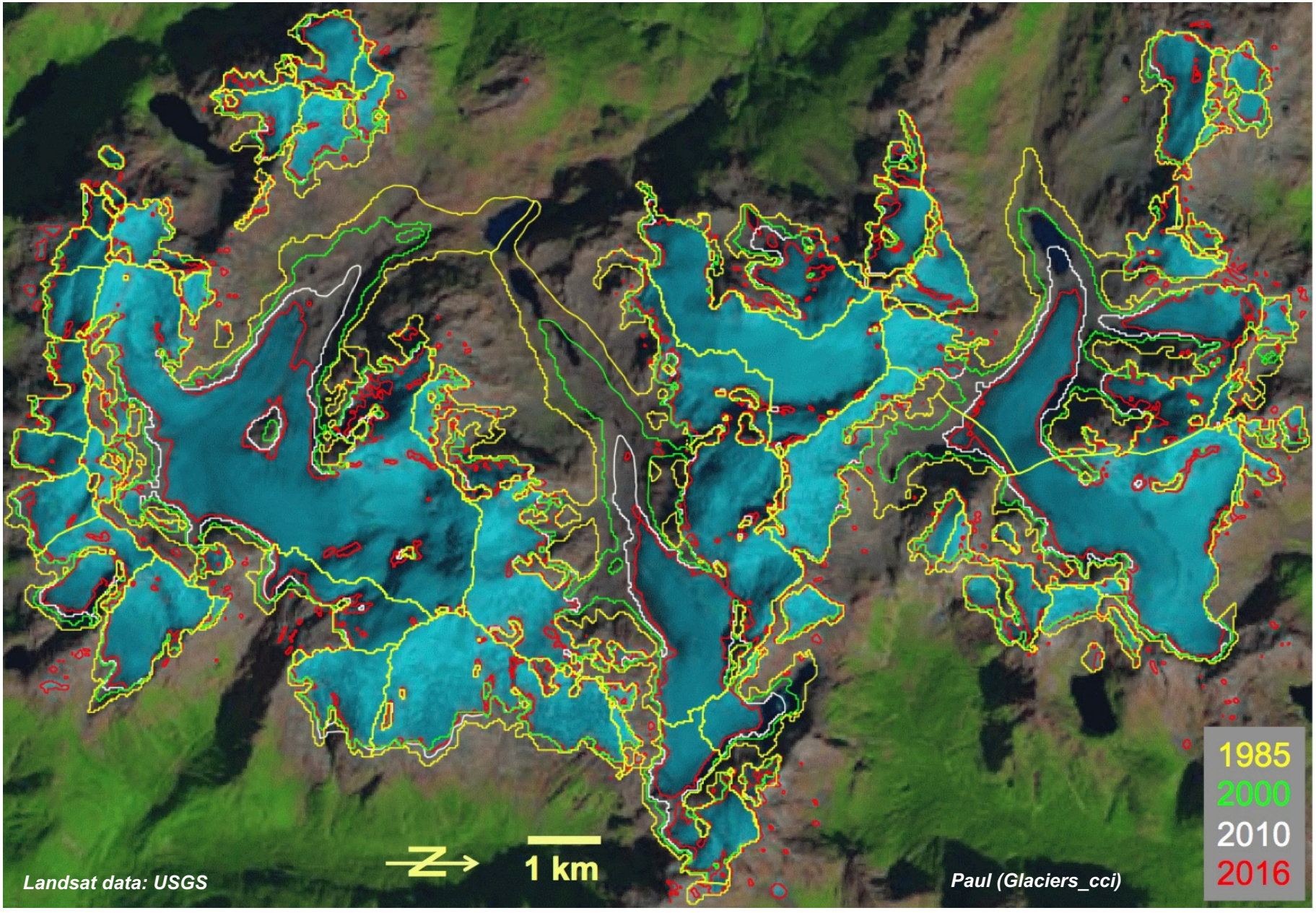
Retreat, thinning and flow of Triftglacier



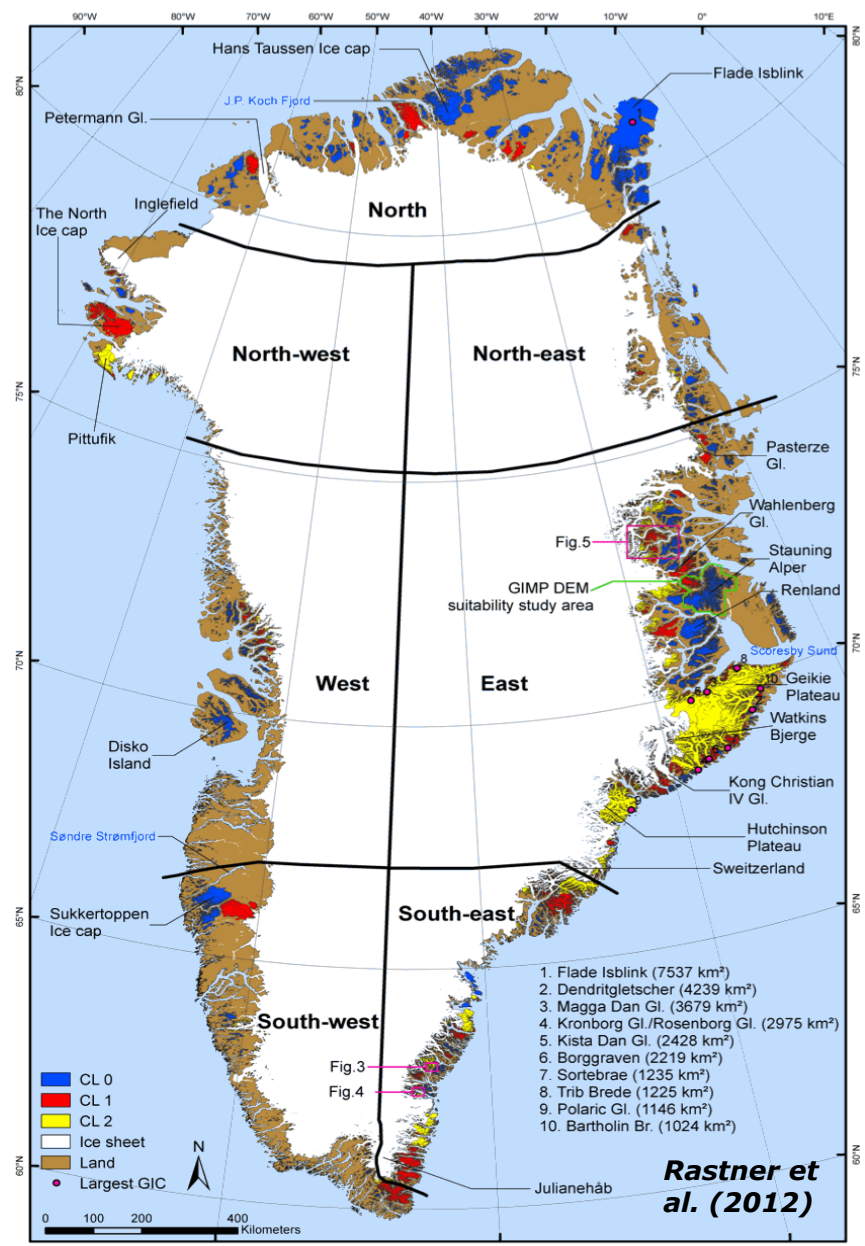
Glacier shrinkage in Patagonia: 1998-2014



Time series of area changes Patagonia



Glacier outlines from Glaciers_cci

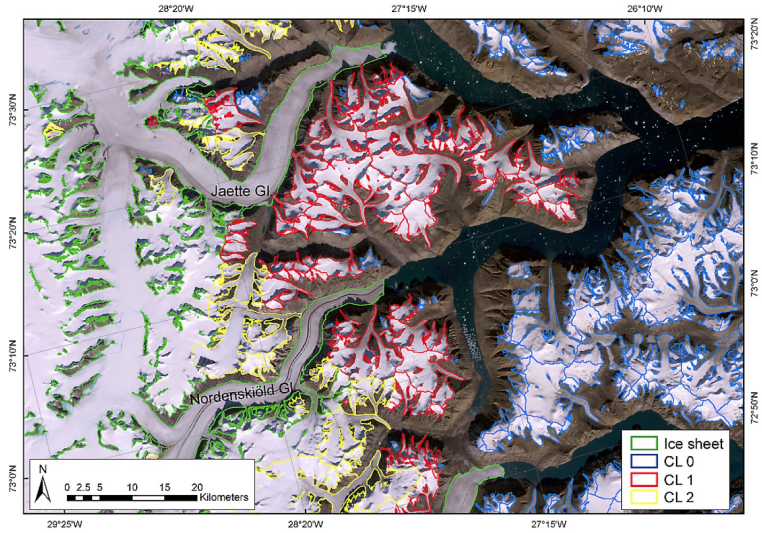


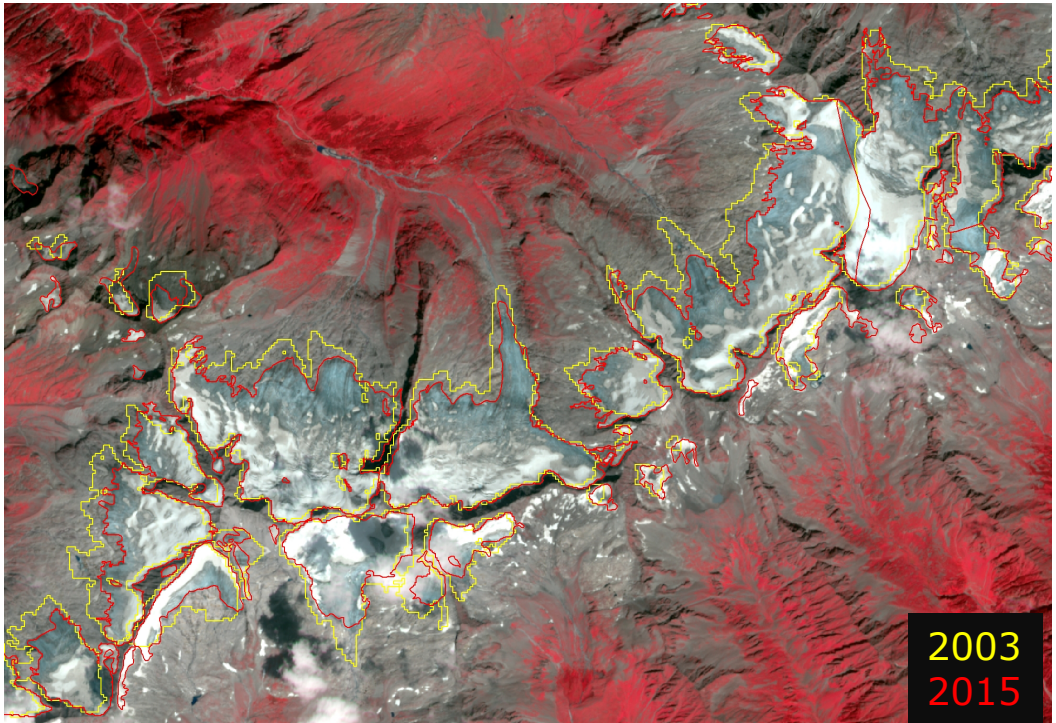
Connectivity levels :

CL0: none

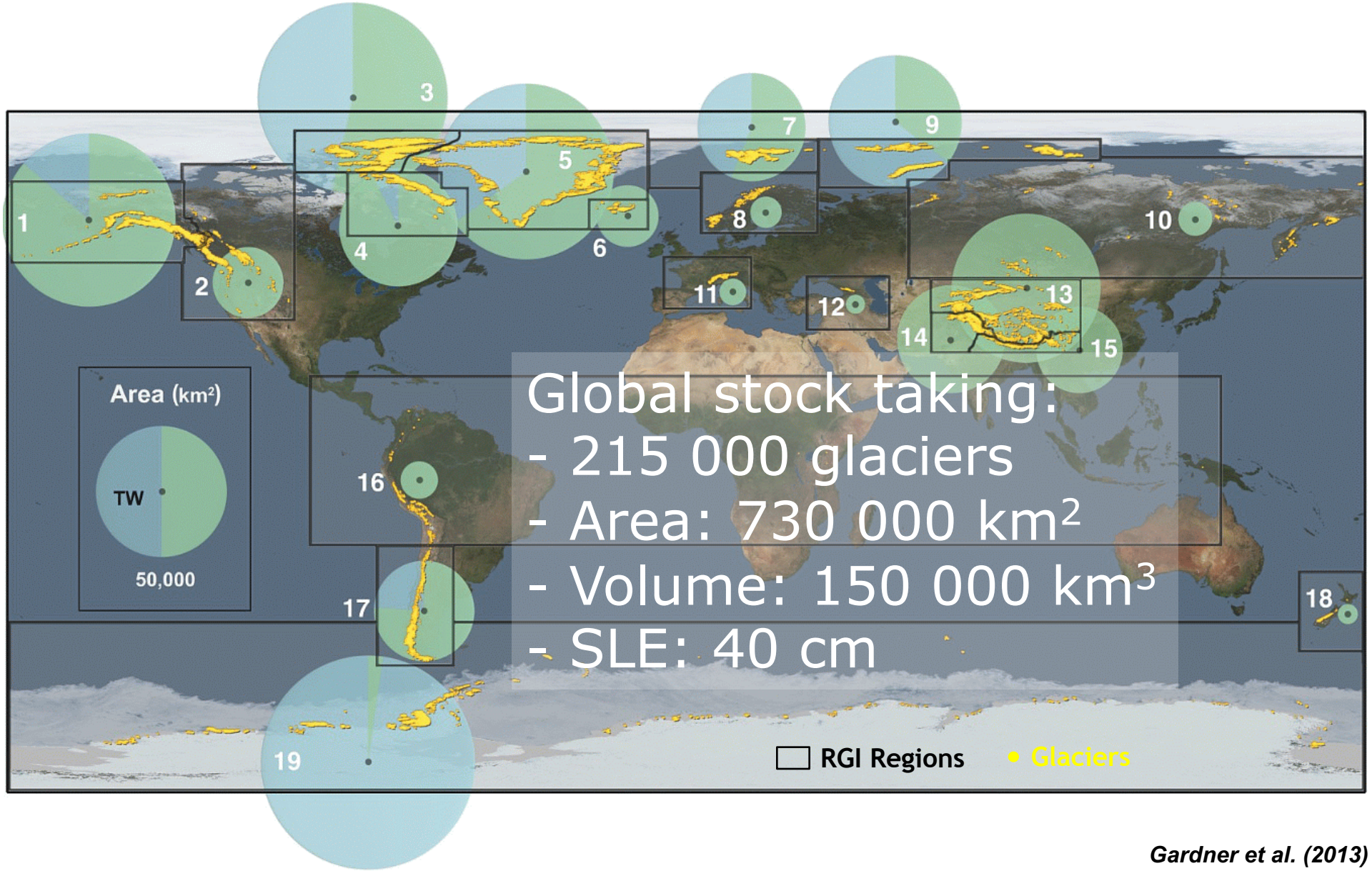
CL1: weak

CL2: strong



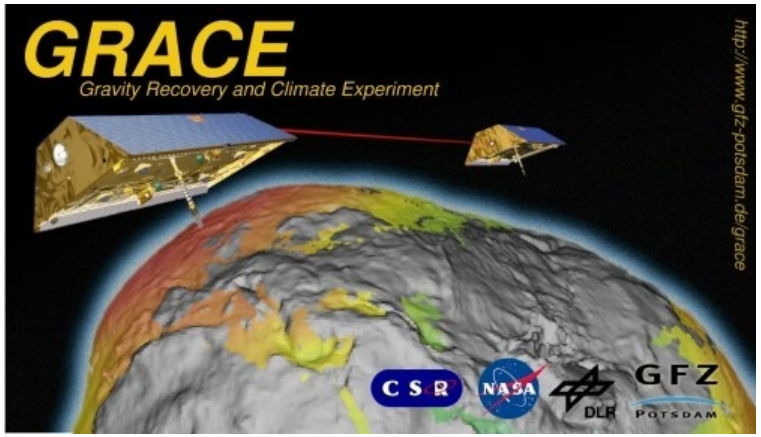


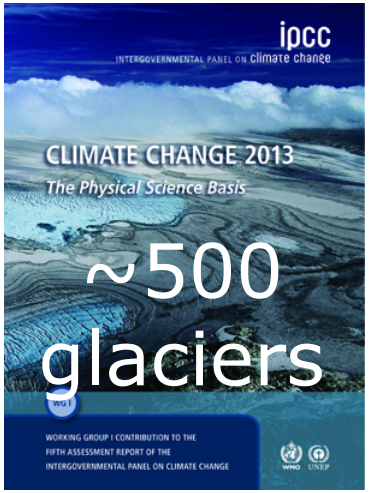
The Randolph Glacier Inventory (RGIv3.2)

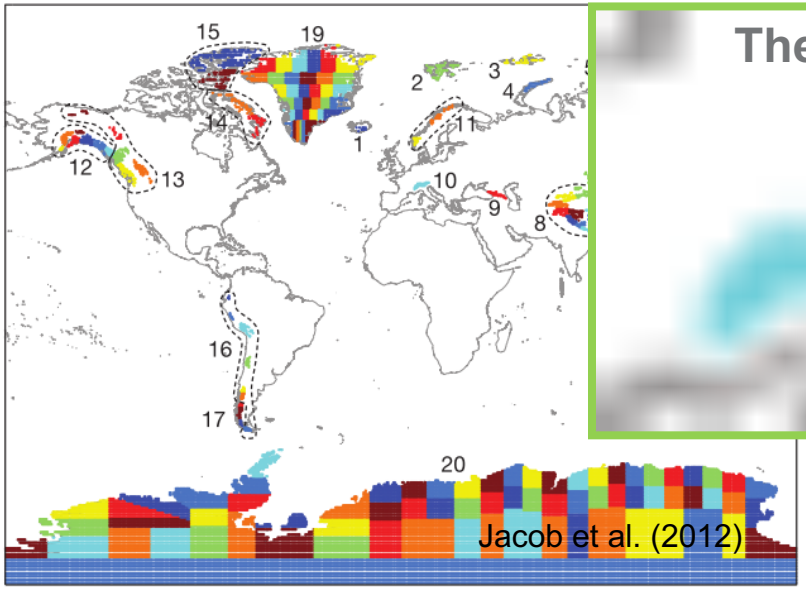


Gardner et al. (2013)

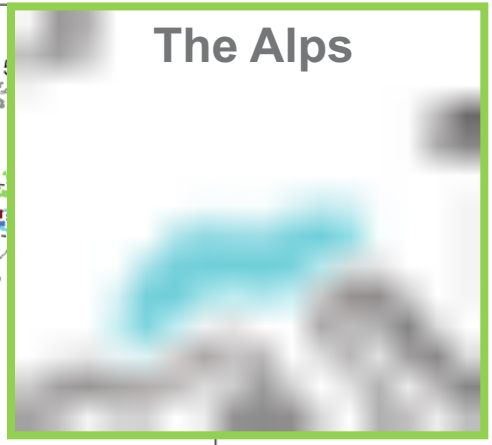
Glacier mass balance for IPCC AR5

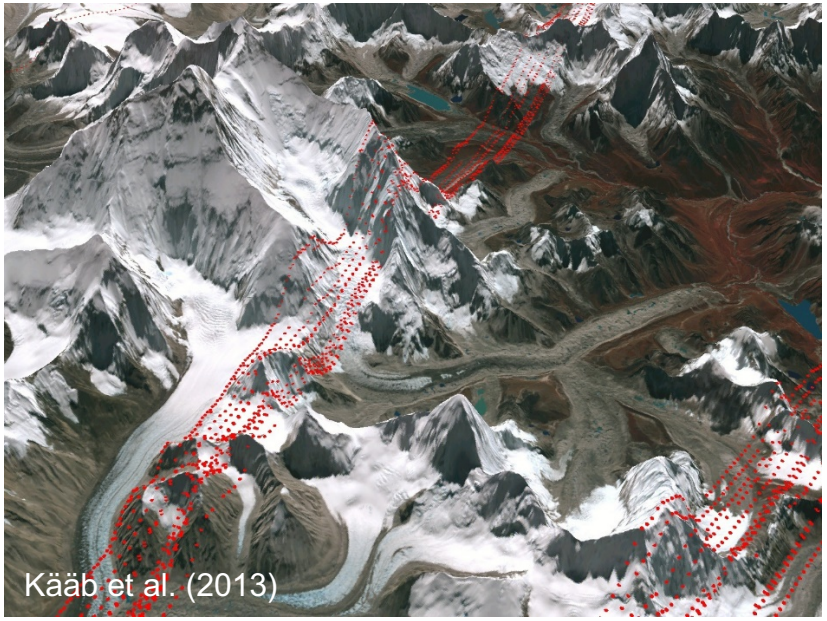






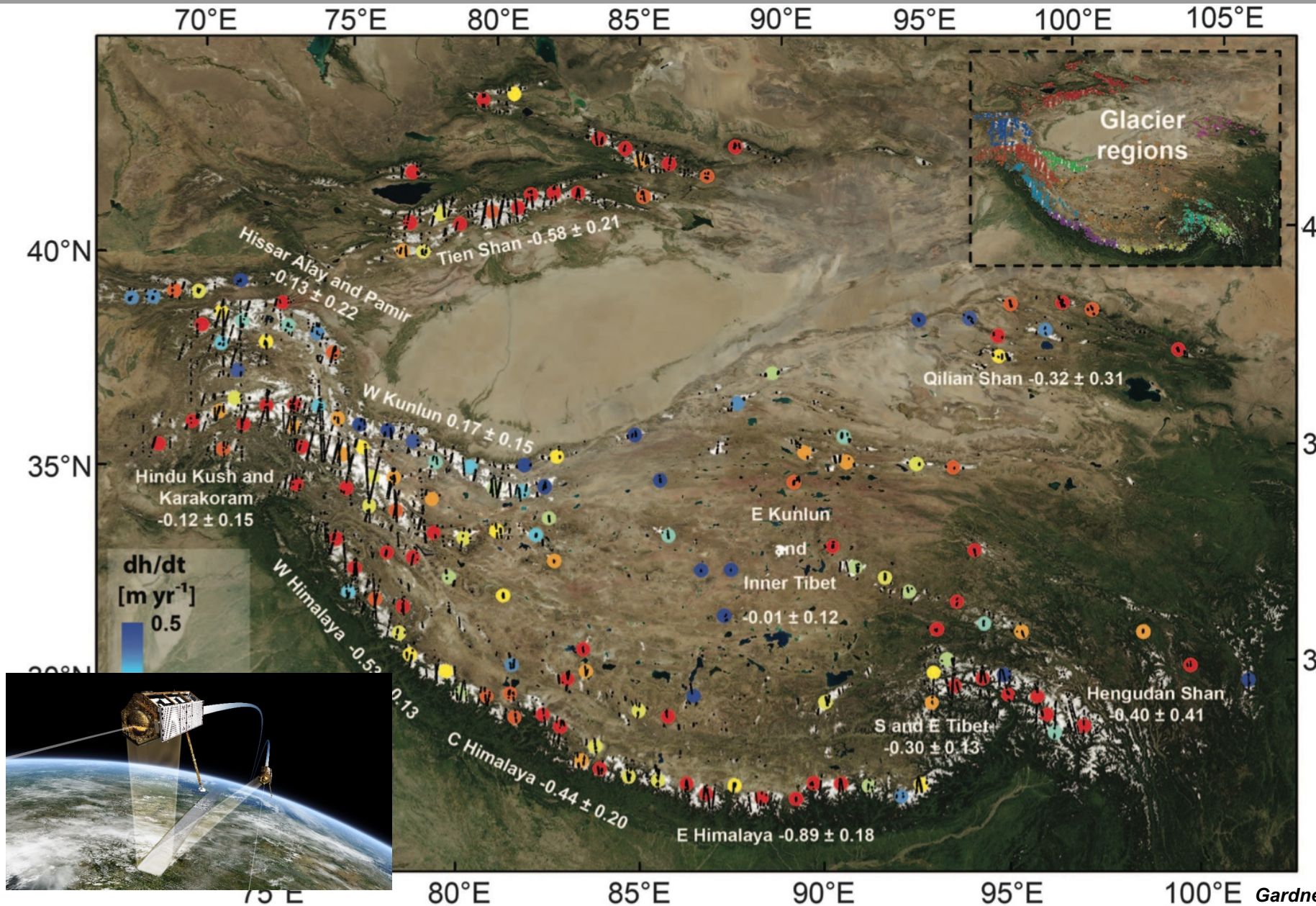
Jacob et al. (2012)





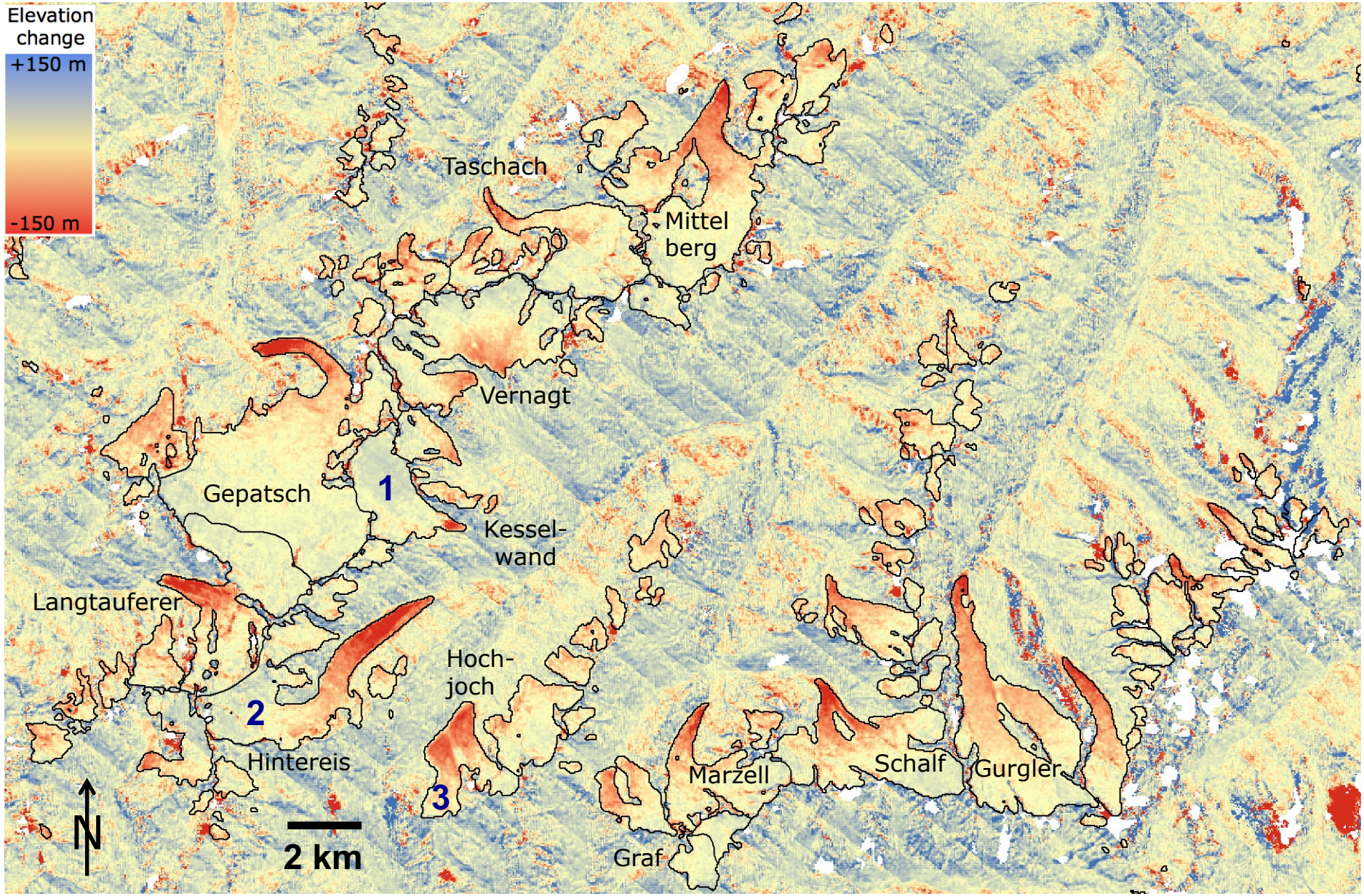
Kääb et al. (2013)

Elevation changes in High Mountain Asia

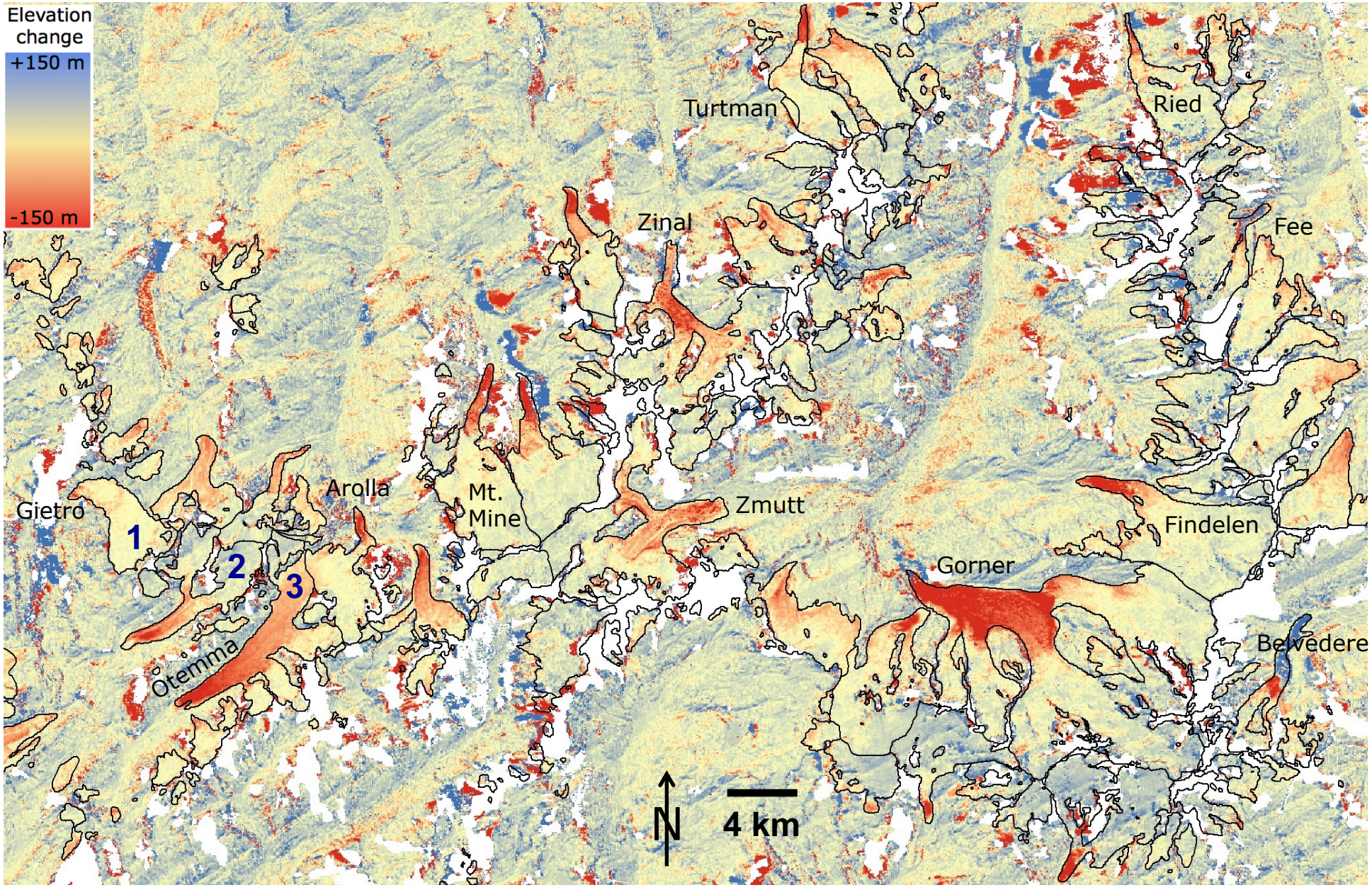


Gardner et al. (2013)

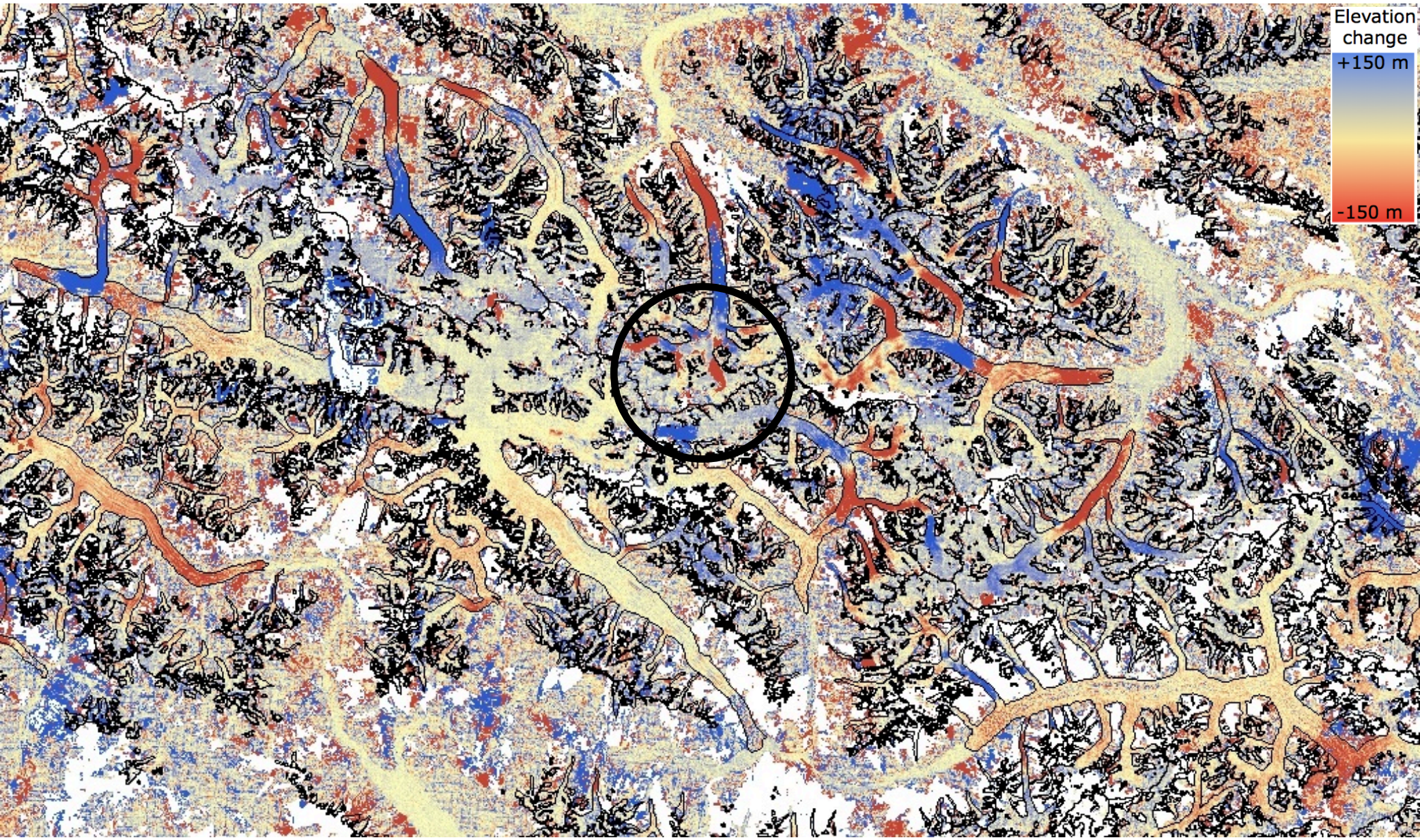
Elevation change pattern Ötztal (TDX-SRTM)



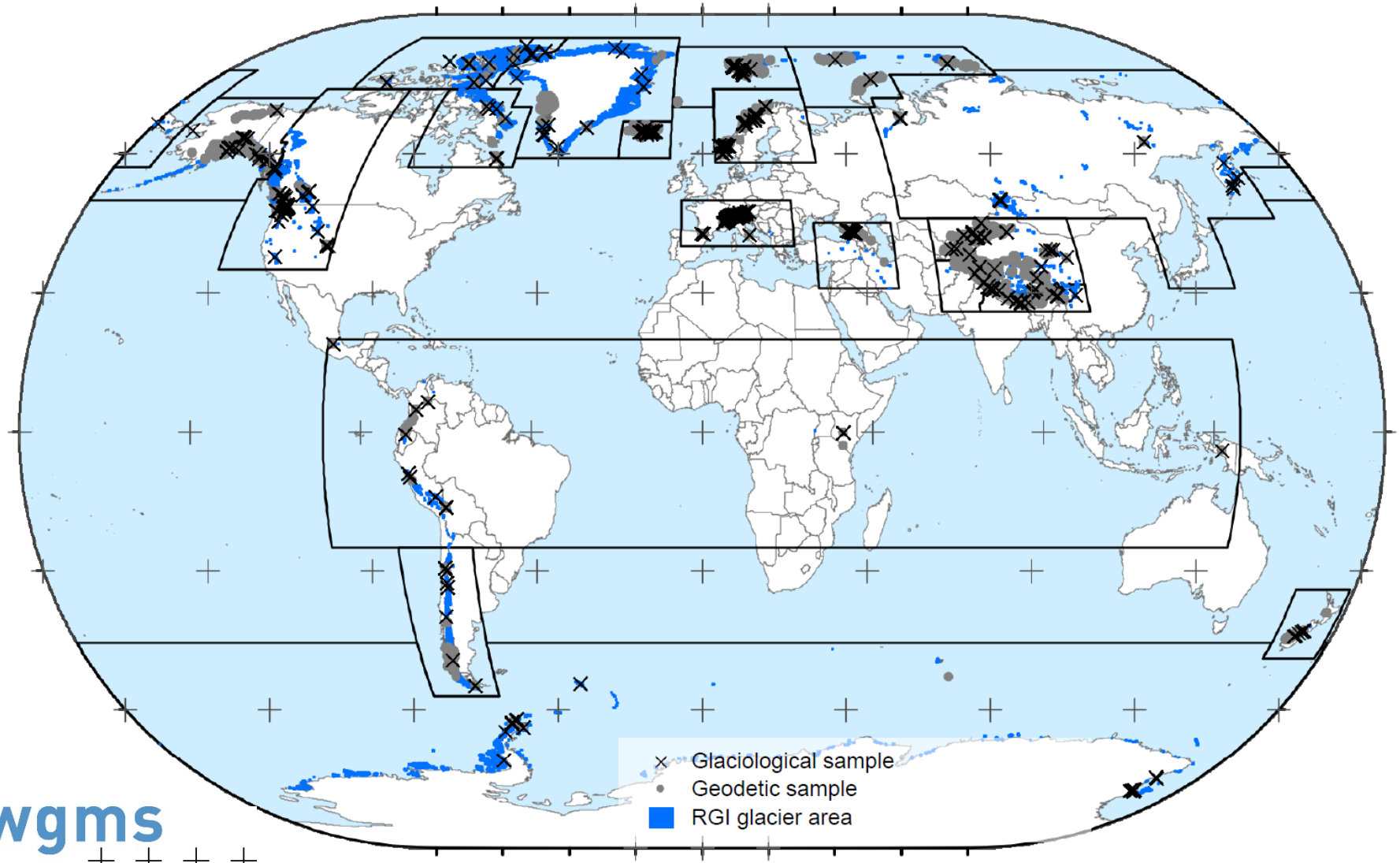
Elevation change pattern Valais (TDX-SRTM)



Elevation changes Karakoram (TDX-SRTM)



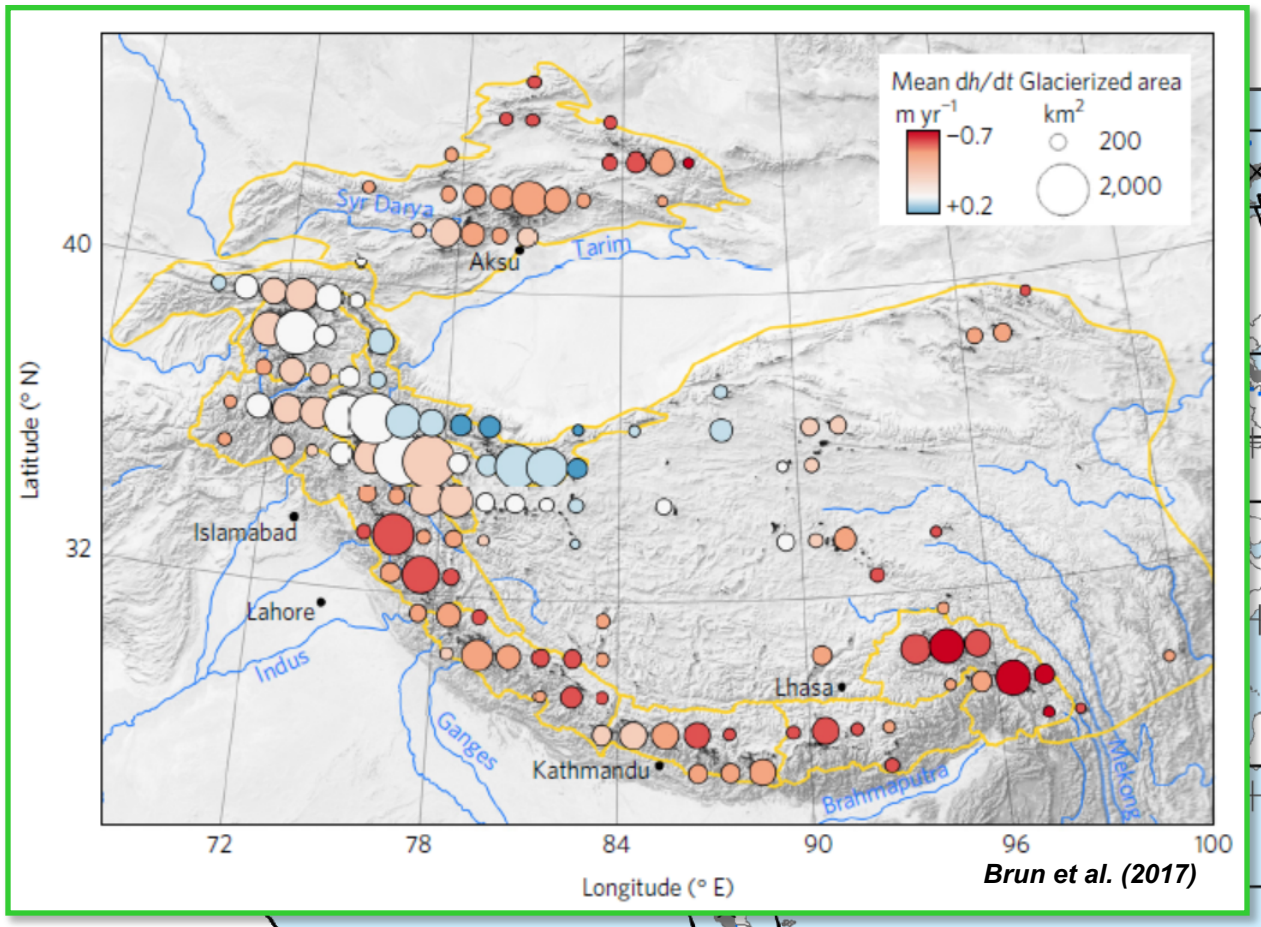
Worldwide glacier datasets



wgms

Zemp et al. (in press)

Worldwide glacier datasets

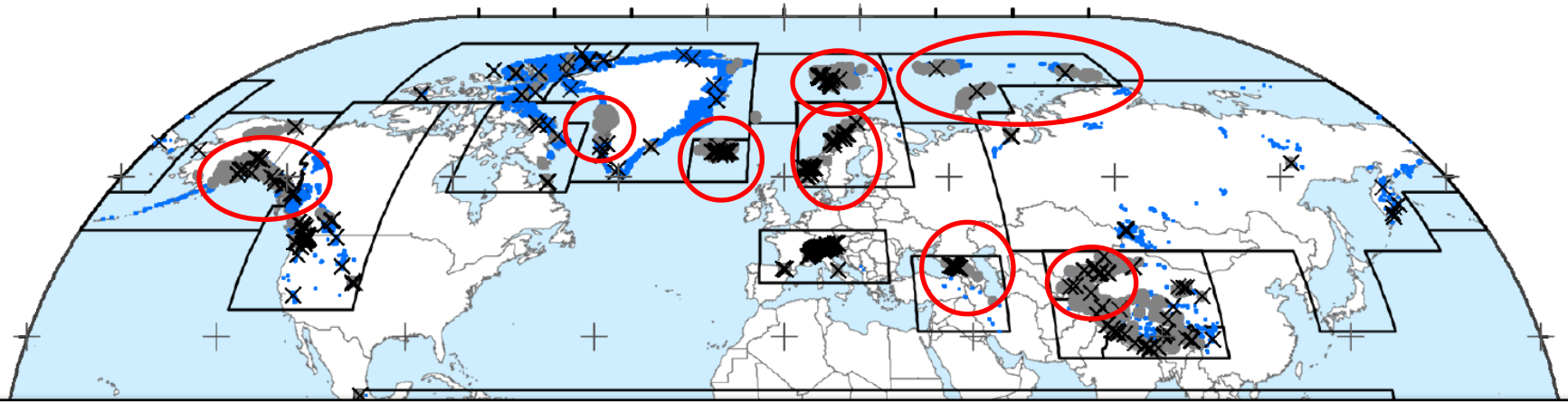


Brun et al. (2017)

Zemp et al. (in press)

wgms

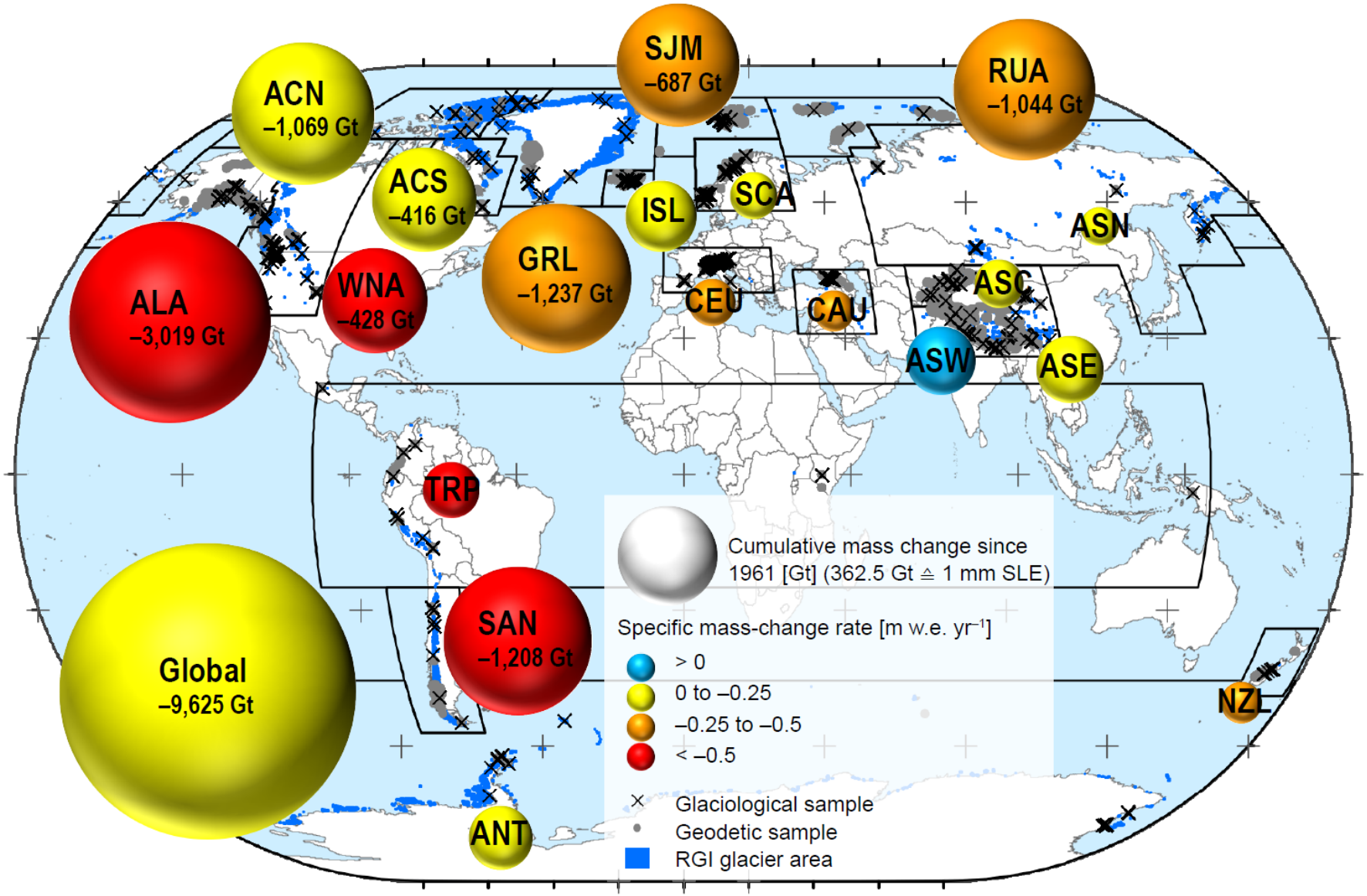
New worldwide glacier datasets



Region	DEMs used	Survey period	Glaciers	Observations
Alaska	ASTER, ArcticDEM, IPY-Spirit	2000–2017	122	485
Greenland	TanDEM-X, AeroDEM	1985–2012	1,202	1,202
Iceland	ASTER, ArcticDEM, IPY-Spirit	2000–2017	254	2,463
Svalbard	ASTER, ArcticDEM, IPY-Spirit	2000–2017	1,072	8,334
Scandinavia	ASTER, ArcticDEM	2000–2017	1,036	11,925
Russian Arctic	ASTER, ArcticDEM, IPY-Spirit	2000–2017	372	3,679
Caucasus	ASTER	2000–2017	360	3,576
Africa	ASTER	2000–2017	1,683	7,174
Central Asia	ASTER, HMA DEMs	2000–2017	11	182
New Zealand	ASTER	2000–2018	439	31,853
Total			6,551	70,873

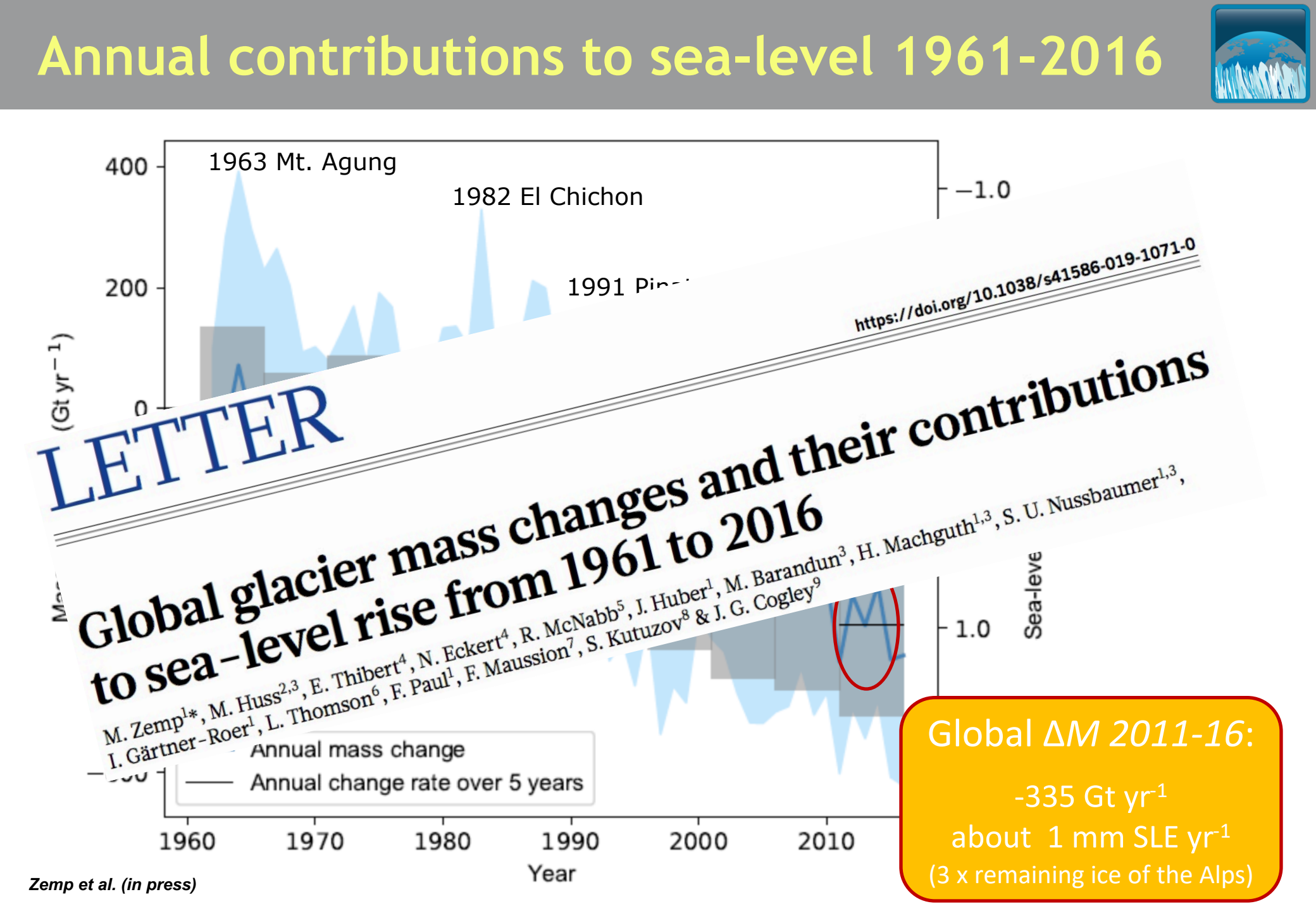
Zemp et al. (in press)

Cumulative glacier mass changes 1961-2016



Zemp et al. (in press)

Annual contributions to sea-level 1961-2016



https://doi.org/10.1038/s41586-019-1071-0

LETTER

Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016

M. Zemp[1]*, M. Huss[2,3], E. Thibert[4], N. Eckert[4], R. McNabb[5], J. Huber[1], M. Barandun[3], H. Machguth[1,3], S. U. Nussbaumer[1,3], I. Gärtner-Roer[1], L. Thomson[6], F. Paul[1], F. Maussion[7], S. Kutuzov[8] & J. G. Cogley[9]

Global Δ*M 2011-16*:

-335 Gt yr^{-1}

about 1 mm SLE yr^{-1}

(3 x remaining ice of the Alps)

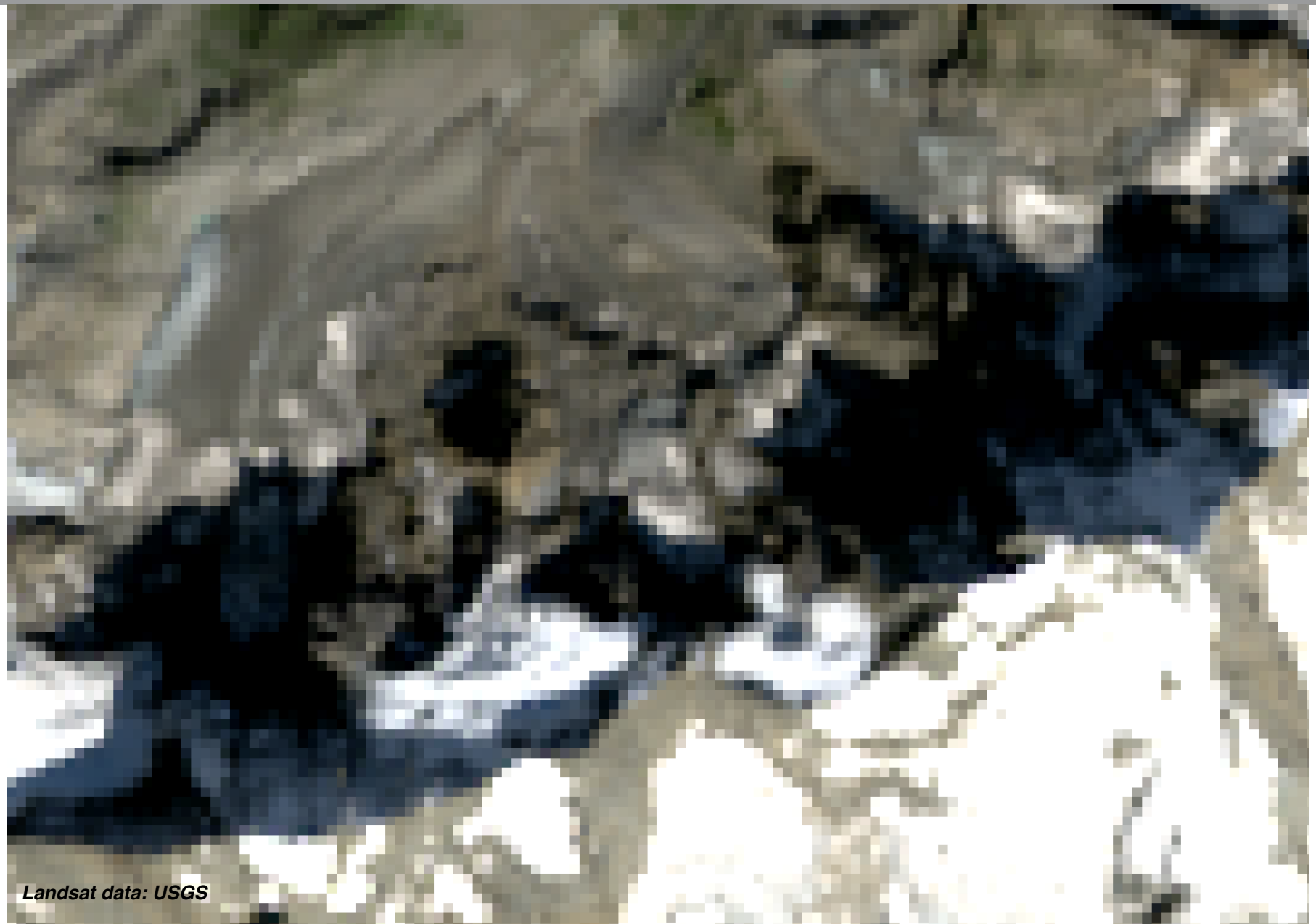
Zemp et al. (in press)

Summary and Conclusions

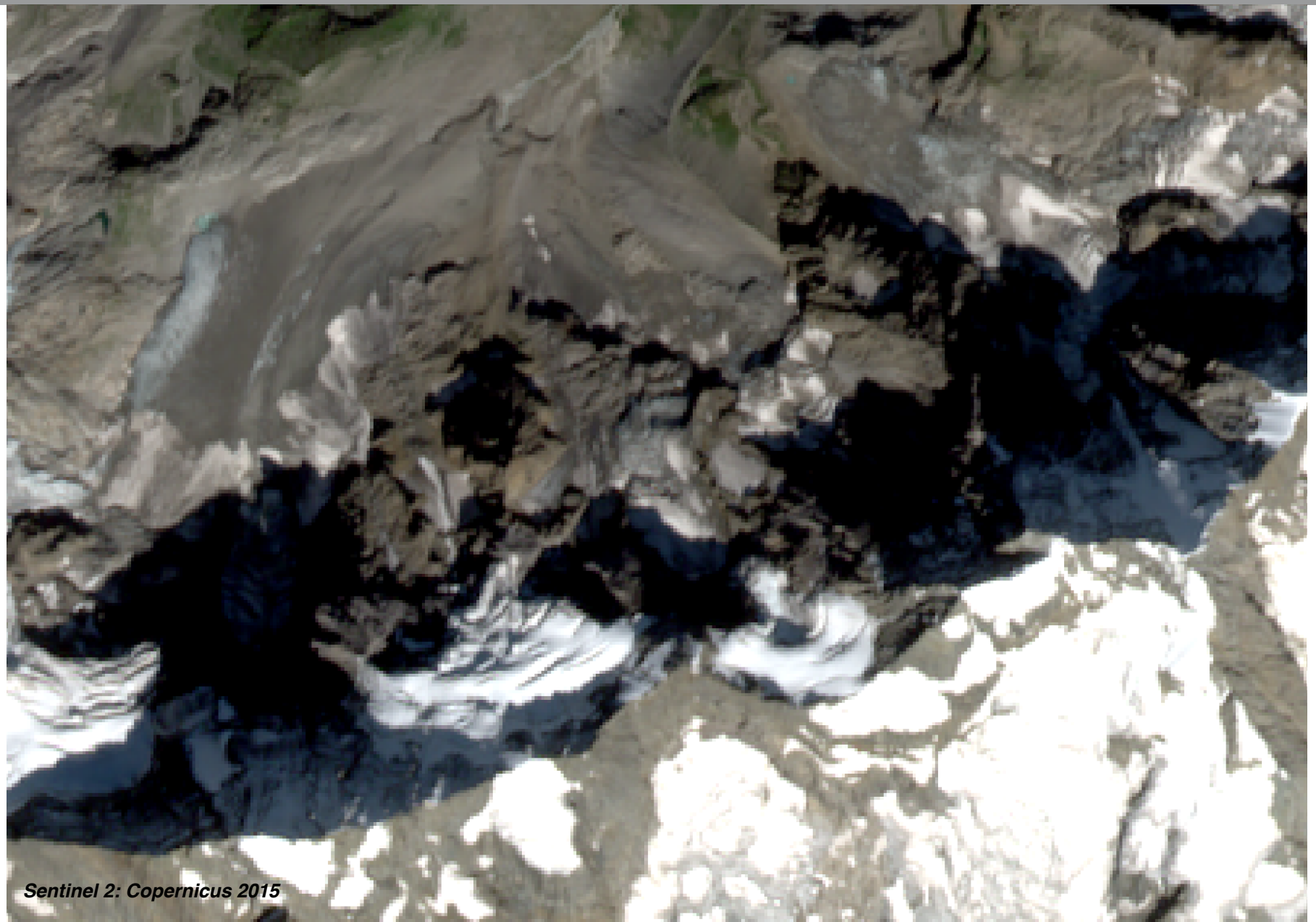
- Glaciers are shrinking globally at still increasing rates apart from Karakoram / Pamir / Kunlun Shan surge cluster
- RS provides data for inaccessible regions and largely enhance knowledge on CC impacts & process understanding
- Outlines are key to derive further information & changes
  - glacier-specific topographic parameters, constrain mass balance/velocity, errors
- There is regionally and locally strong variability that is not always easy to explain (e.g. with elevation / hypsometry)
  - animations from image quicklooks are a helpful tool to analyse glacier dynamics
- Free availability of satellite data resulted in huge progress in CC impact assessment => increase with Sentinel 2 (10m / 5d)

THANK YOU!

Landsat 8 (30 m)

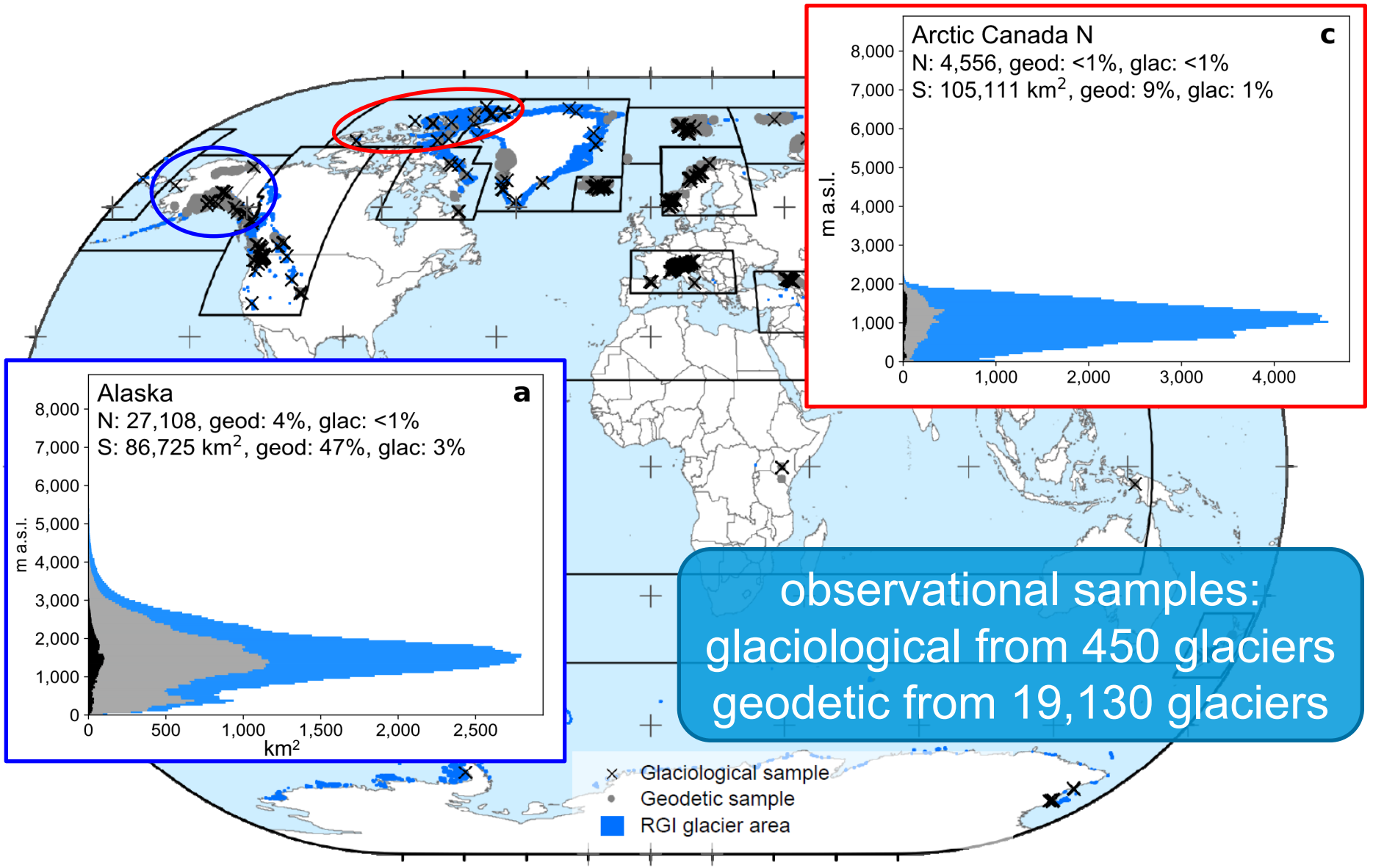


Sentinel 2 (10 m)

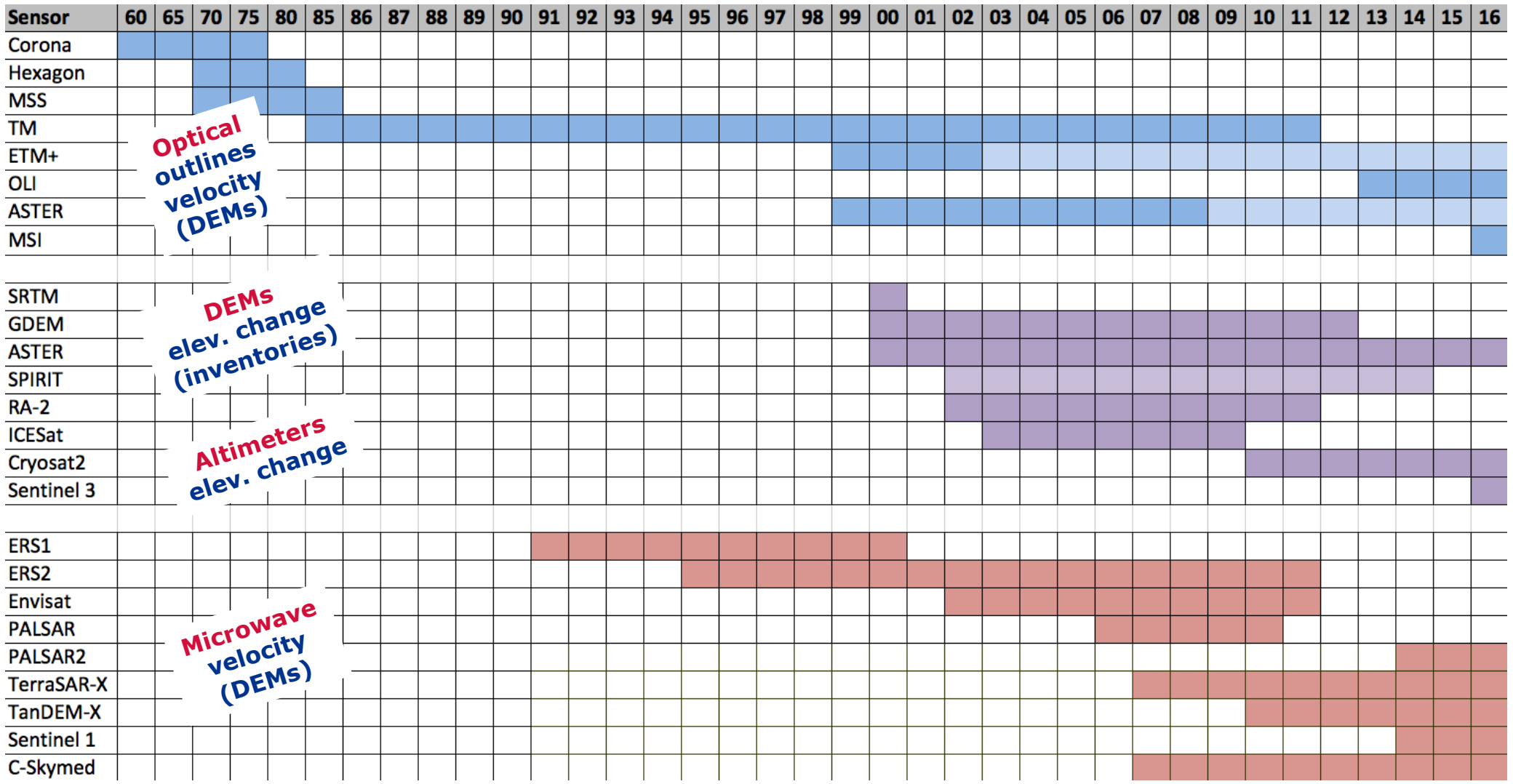


Sentinel 2: Copernicus 2015

Representativeness of geodetic mass balance



Sensors: timelines and applications



Paul (Glaciers_cci)