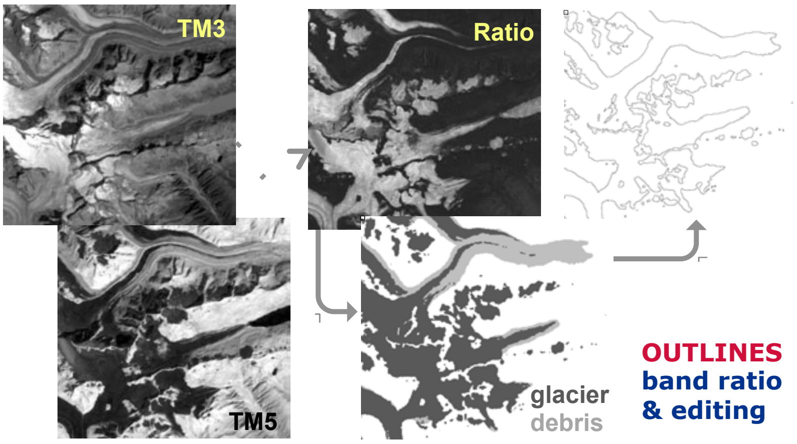
Glaciers_cci

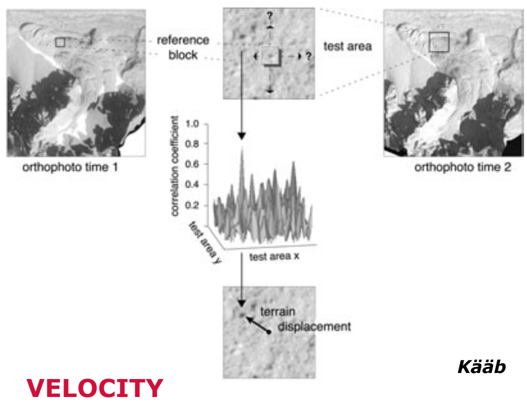
Science overview by SL

GIUZ

Glaciers_cci products: Methods



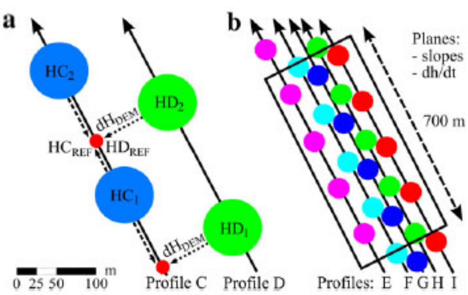
OUTLINES
band ratio & editing



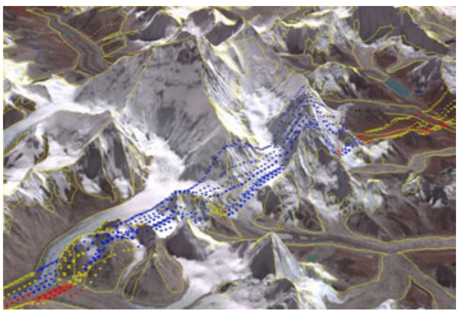
VELOCITY
cross-correlation & offset tracking

ELEVATION CHANGE

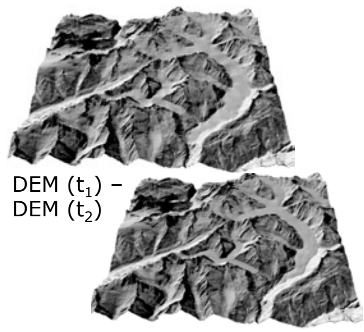
Repeat Altimetry



Altimetry-DEM

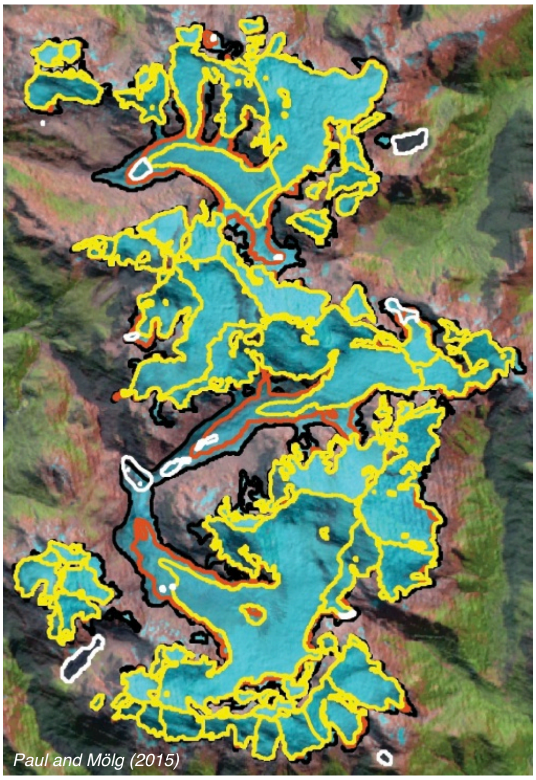


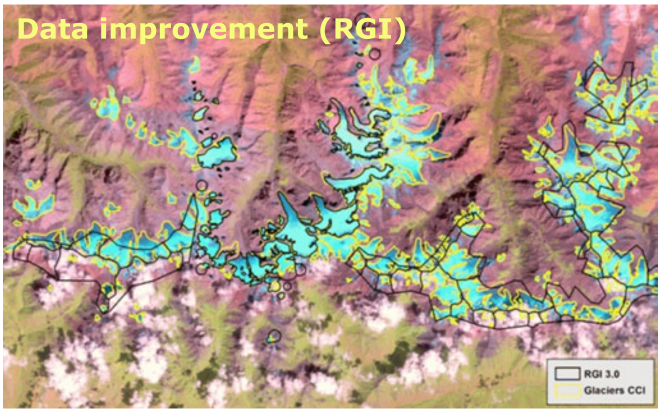
DEM differencing

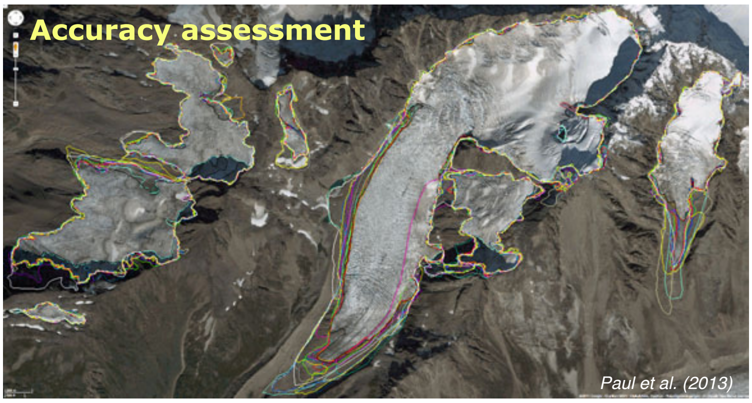


Glaciers_cci products: Area

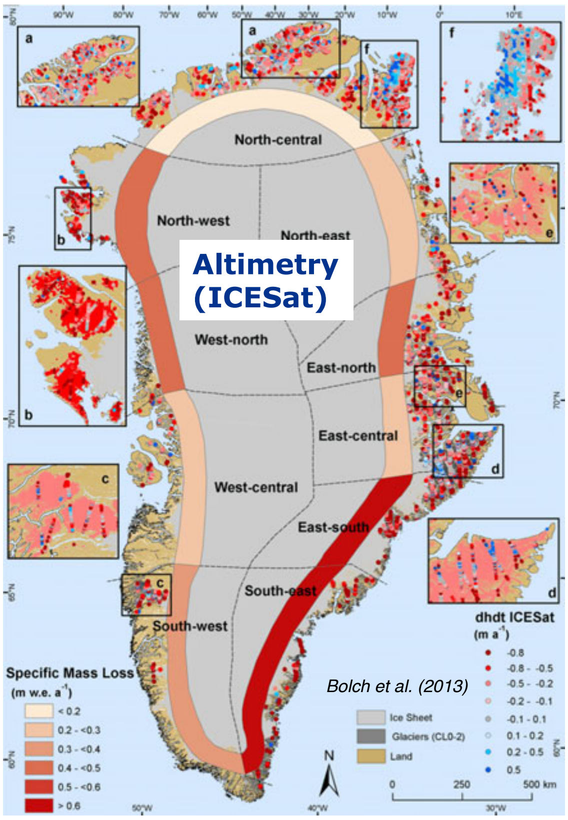
Change assessment

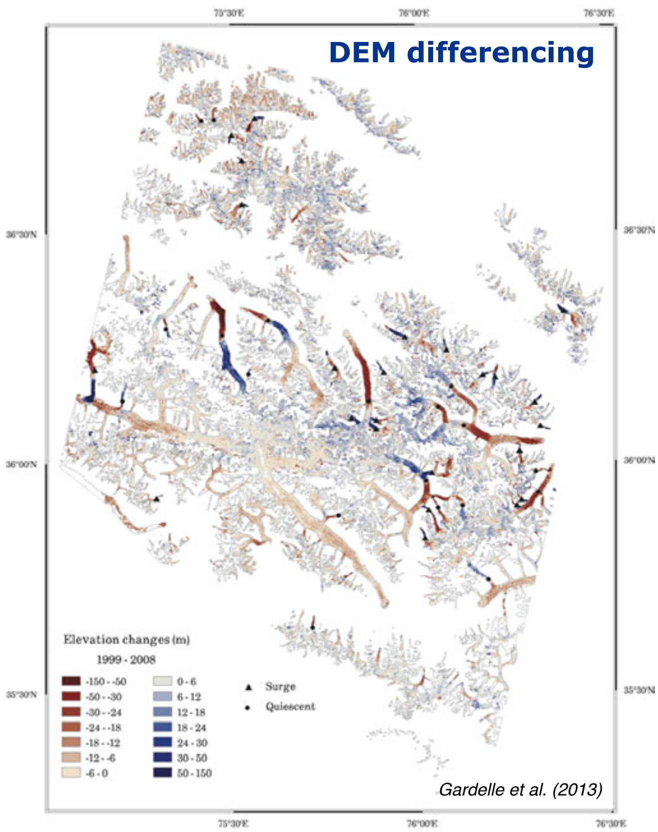






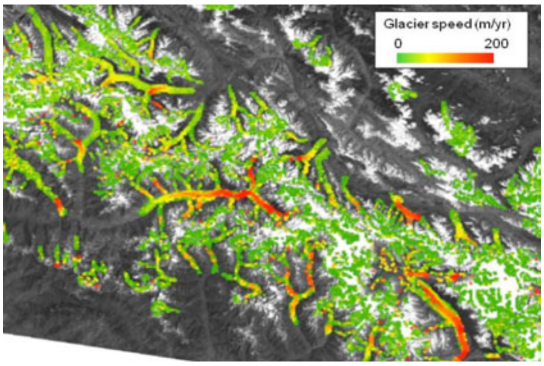
Glaciers_cci products: Elevation change



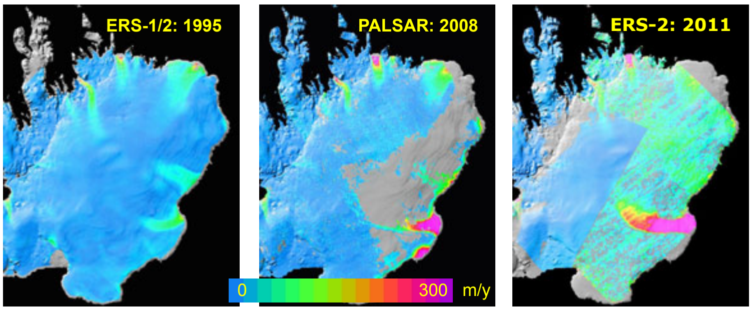


Glaciers_cci products: Velocity

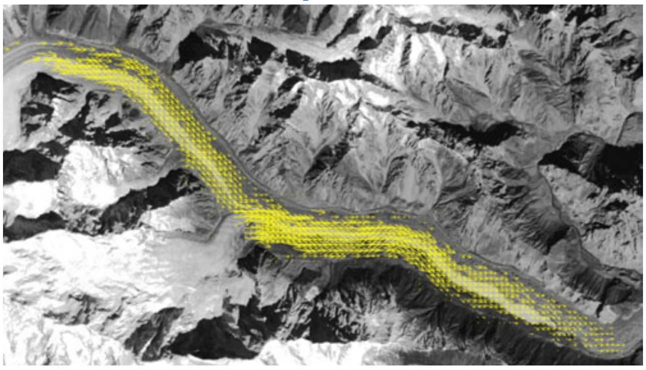
Velocity fields



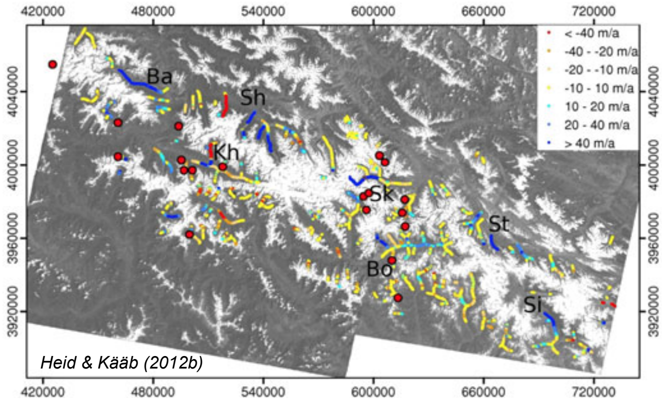
Velocity: time series



Velocity vectors



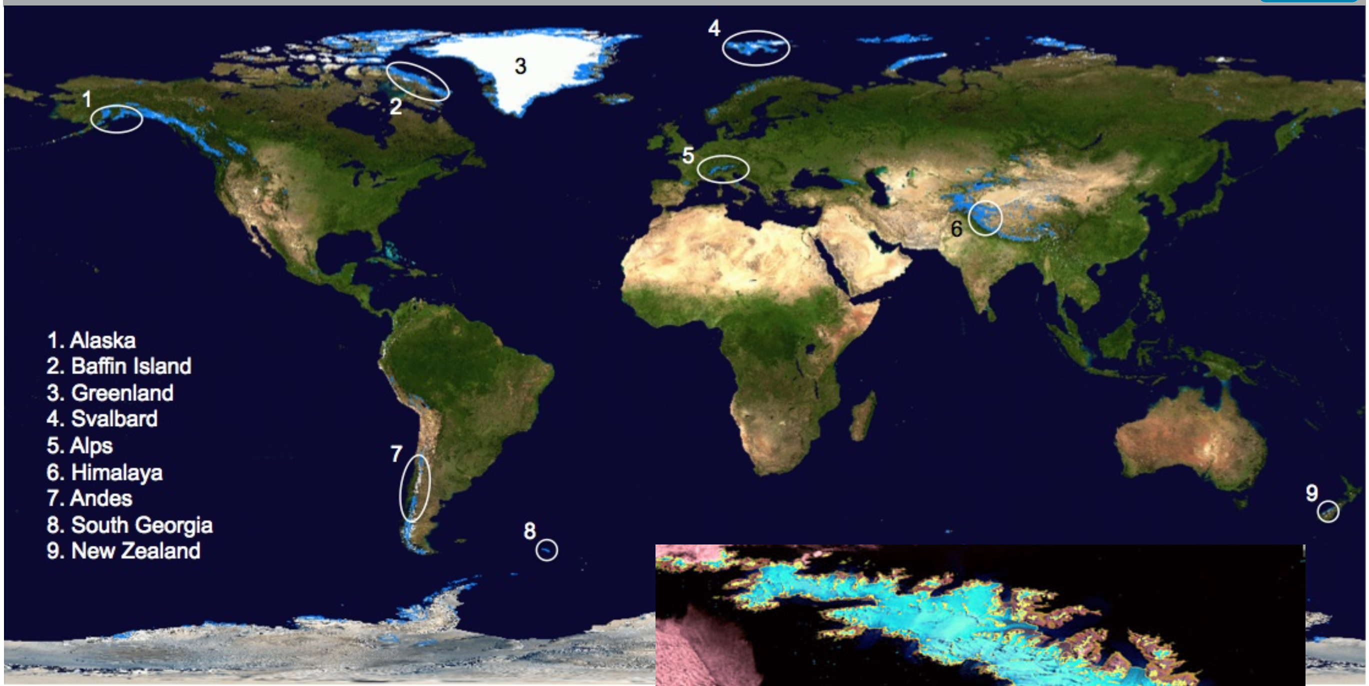
Velocity: decadal trends

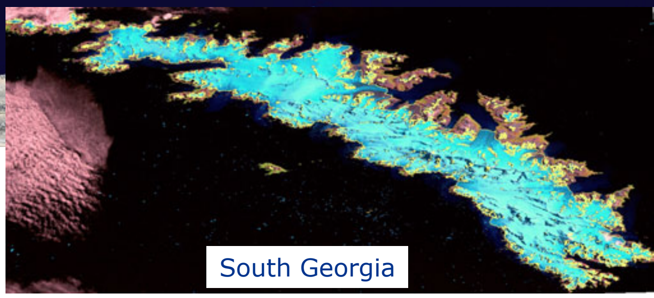


Glaciers_cci product specifications

Product	Area	Elev. change (ALT)	Elev. change (DEM)	Velocity
Sensor	Optical	Altimeter (opt./radar)	Optical / Radar	Optical / Radar
Format	Shape file (vector)	Shapefile (csv)	Geotiff (raster)	Shapefile (csv)
Sources	CRDP, GLIMS/RGI	CRDP	CRDP (WGMS)	CRDP (GLIMS)
Validation method	Manual editing (visual)	Filtering (slope, outlier)	co-registration, stable ground differences	stable ground, in-situ
Validation datasets	High-resolution data (Google Earth), coherence images	IceBridge / Cryovex	ICESat, LIDAR & national DEMs	Automatic GNSS
Challenges	Global consistency, debris, snow, clouds, shadow, water	clouds / footprint size, interpolation, short time series	Co-registration, data voids, penetration, cell size, projection, sensor biases (jitter)	orthorectification of input data (DEM accuracy), lack of contrast (optical)
Archived datasets	Corona, Hexagon Landsat MSS / TM	ICESat GLAS EnviSat RA-2	SRTM, GDEM2, RAMP NED / CDED, GIMP, SPOT-SPIRIT	ERS-1/2, ALOS PALSAR Envisat ASAR, Landsat TM / ETM+ (SLC on)
Ongoing missions	Landsat ETM+ / OLI Terra ASTER, SPOT	Cryosat 2	ASTER14 DMO, TanDEM-X	ALOS PALSAR 2, ASTER TerraSAR-X, Landsat OLI Cosmo-Skymed
Forthcoming datasets	Sentinel 2	Sentinel 3, ICESat 2	World-DEM	Sentinel 1 and 2

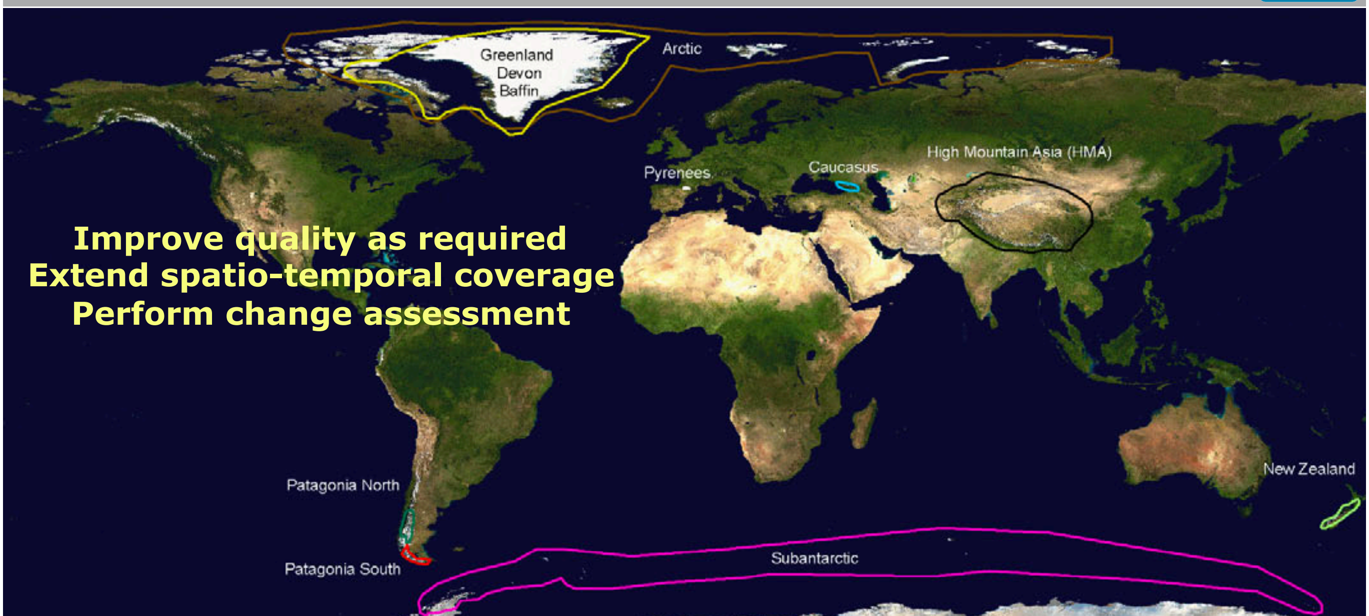
Glaciers_cci products: Key regions Ph. 1





Randolph Glacier Inventory (RGI) is merged from GLIMS, DCW, WGI data and numerous new contributions

Glaciers_cci products: Key regions Ph. 2

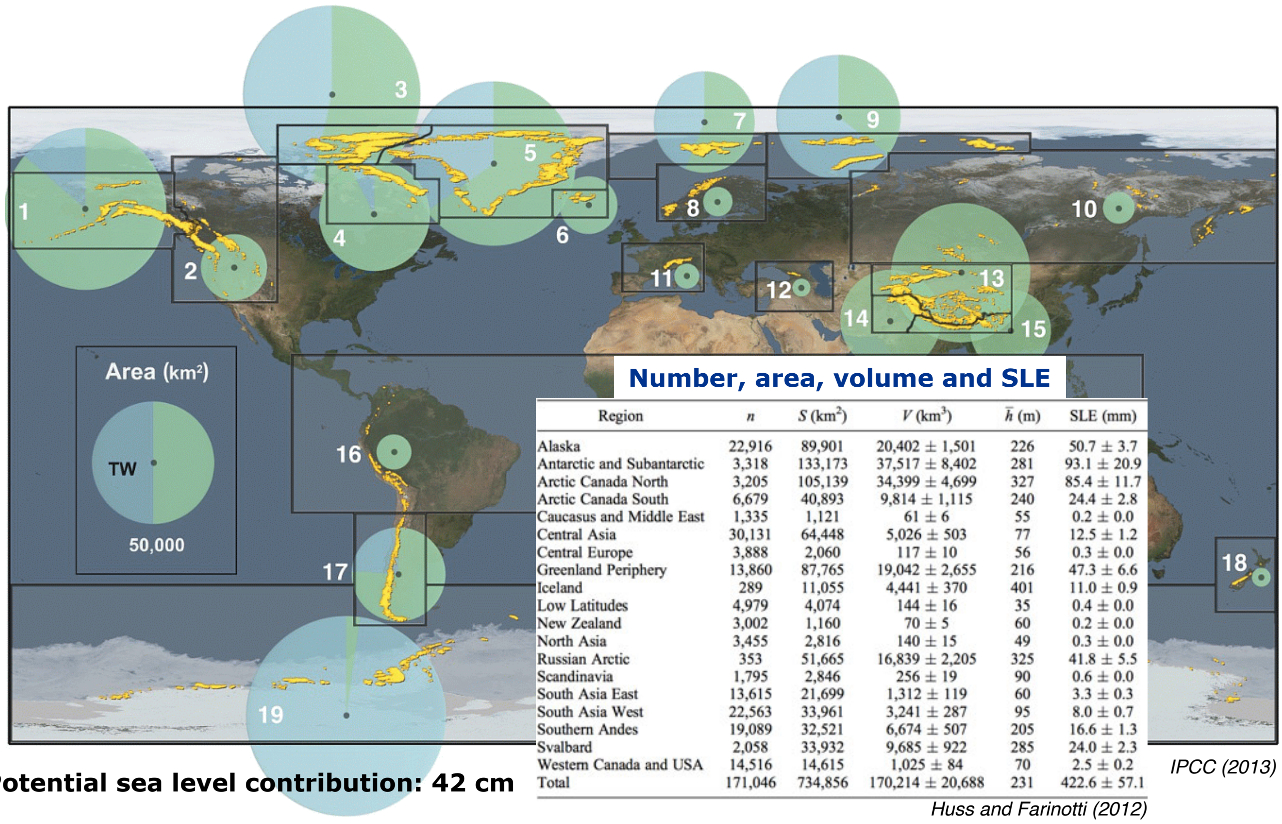


Id	Name	Products	AREA	ALT_ALT	ALT_DEM	DEM_DEM	IV_OPT	IV_MW	RGI_region
1	Arctic	ALT-ALT, IV-MW	0	1	0	0	0	1	3,4,5,6,7,9
2	Subantarctic	ALT-ALT, IV-MW	0	1	0	0	0	1	19
3	High Mountain Asia (HMA)	AREA, ALT-DEM, DEM-DEM, IV-OPT, IV-MW	1	0	1	1	1	1	13,14,15
4	Caucasus	DEM-DEM, IV-OPT	0	0	0	1	1	0	12
5	Pyrenees	AREA	1	0	0	0	0	0	11
6	Baffin Devon Greenland (BDG)	AREA, ALT-ALT, IV-OPT; IV-MW	1	1	0	0	1	1	3,4,5
7	Patagonia North	AREA, DEM-DEM, IV-OPT	1	0	0	1	1	0	17
8	Patagonia South	AREA, ALT-DEM, DEM-DEM, IV-OPT, IV-MW	1	0	1	1	1	1	17
9	New Zealand	AREA, DEM-DEM, IV-OPT	1	0	0	1	1	0	18

Current applications: Overview

- **The datasets produced are used by glaciologists, hydrologists and climate change related assessments (e.g. IPCC) for further calculations from global to regional scales**
- **Key applications of the RGI are determination of total glacier volume, past changes in volume, future glacier evolution and impacts of changing glaciers on hydrology/run-off**
- **The RGI is used as a mask to determine values for glaciers only**
- **Elevation/mass changes inform all of the above of changes in water resources, run-off and sea level rise**
- **Data are used directly or for spatial interpolation / up-scaling**
- **Flow velocities and their changes inform directly on dynamic instabilities (surges) and mass fluxes but also on total volume**
- **Data are assimilated in models or interpreted visually**

Current applications: RGI



Potential sea level contribution: 42 cm

IPCC (2013)

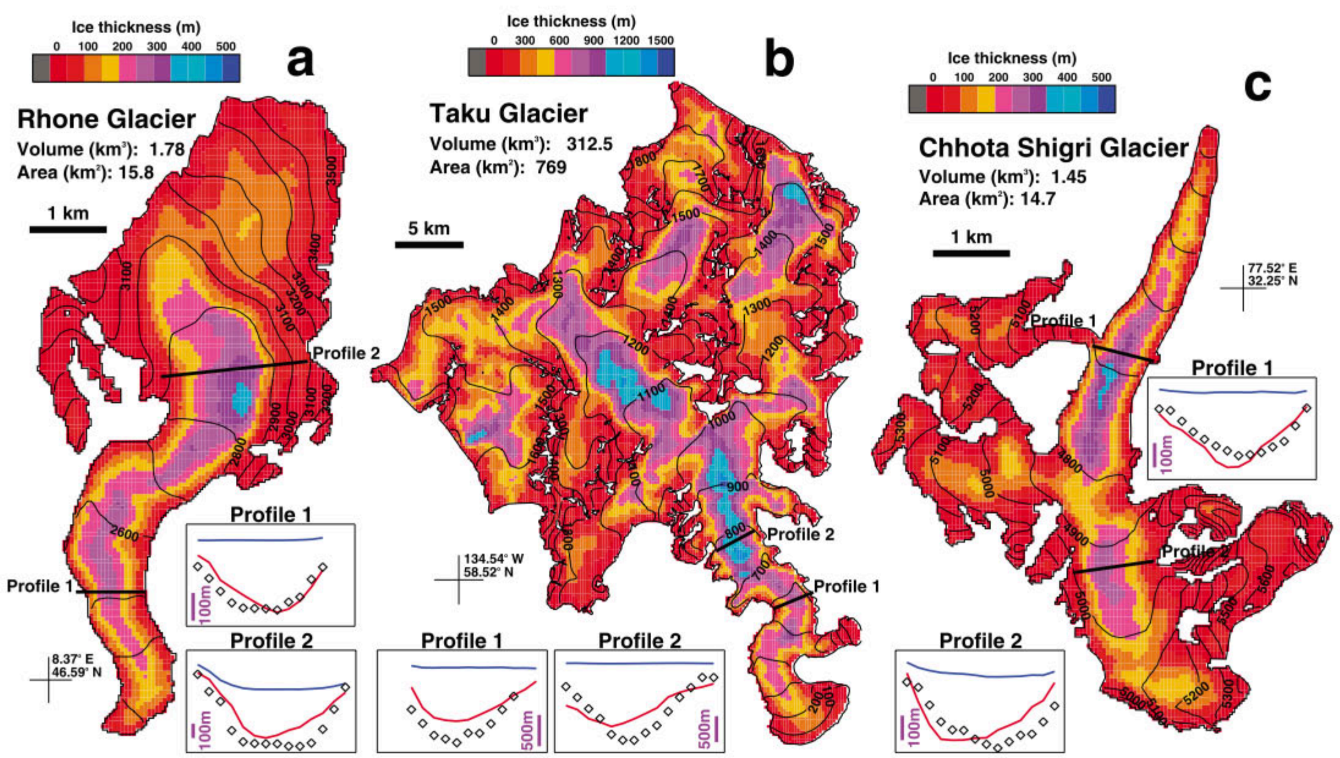
Number, area, volume and SLE

Region	n	S (km^2)	V (km^3)	$\bar{h}$ (m)	SLE (mm)
Alaska	22,916	89,901	20,402 ± 1,501	226	50.7 ± 3.7
Antarctic and Subantarctic	3,318	133,173	37,517 ± 8,402	281	93.1 ± 20.9
Arctic Canada North	3,205	105,139	34,399 ± 4,699	327	85.4 ± 11.7
Arctic Canada South	6,679	40,893	9,814 ± 1,115	240	24.4 ± 2.8
Caucasus and Middle East	1,335	1,121	61 ± 6	55	0.2 ± 0.0
Central Asia	30,131	64,448	5,026 ± 503	77	12.5 ± 1.2
Central Europe	3,888	2,060	117 ± 10	56	0.3 ± 0.0
Greenland Periphery	13,860	87,765	19,042 ± 2,655	216	47.3 ± 6.6
Iceland	289	11,055	4,441 ± 370	401	11.0 ± 0.9
Low Latitudes	4,979	4,074	144 ± 16	35	0.4 ± 0.0
New Zealand	3,002	1,160	70 ± 5	60	0.2 ± 0.0
North Asia	3,455	2,816	140 ± 15	49	0.3 ± 0.0
Russian Arctic	353	51,665	16,839 ± 2,205	325	41.8 ± 5.5
Scandinavia	1,795	2,846	256 ± 19	90	0.6 ± 0.0
South Asia East	13,615	21,699	1,312 ± 119	60	3.3 ± 0.3
South Asia West	22,563	33,961	3,241 ± 287	95	8.0 ± 0.7
Southern Andes	19,089	32,521	6,674 ± 507	205	16.6 ± 1.3
Svalbard	2,058	33,932	9,685 ± 922	285	24.0 ± 2.3
Western Canada and USA	14,516	14,615	1,025 ± 84	70	2.5 ± 0.2
Total	171,046	734,856	170,214 ± 20,688	231	422.6 ± 57.1

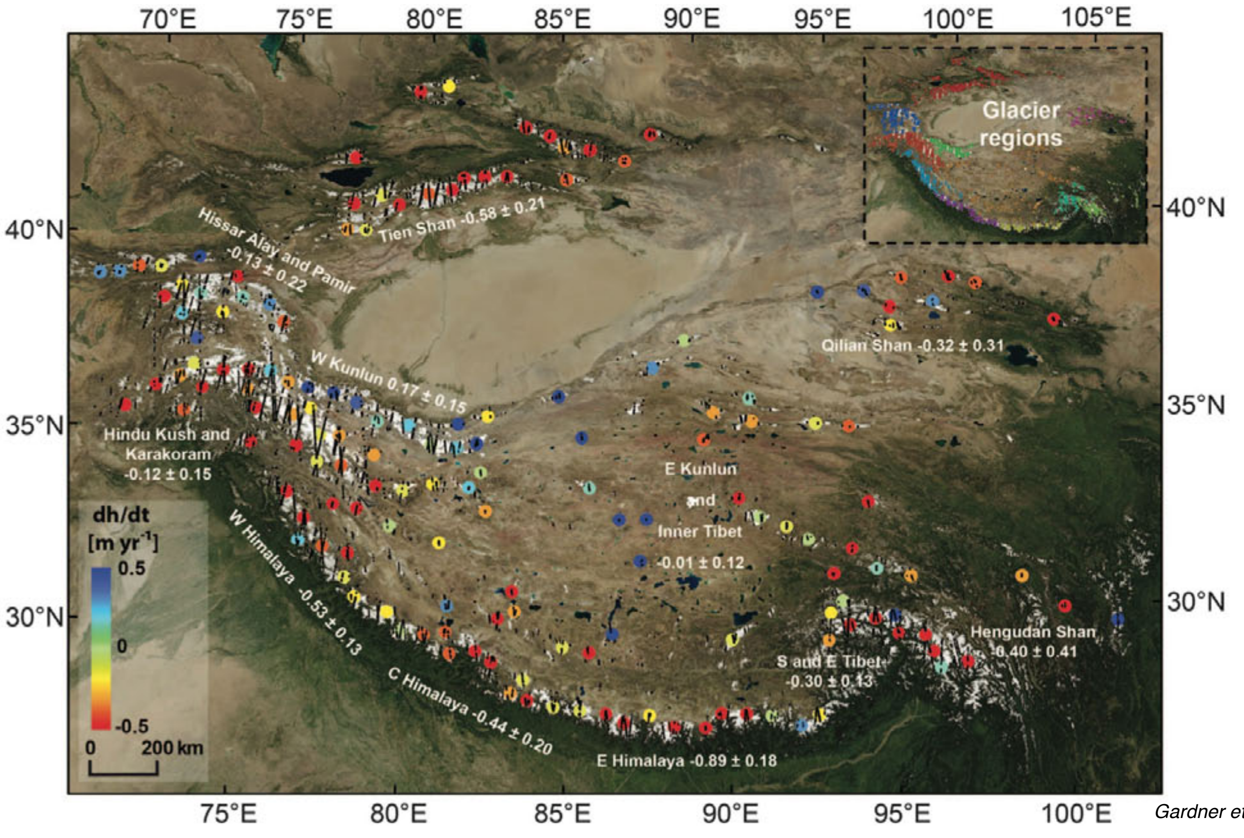
Huss and Farinotti (2012)

Current applications: Volume

F04010 HUSS AND FARINOTTI: GLOBAL GLACIER ICE THICKNESS AND VOLUME F04010



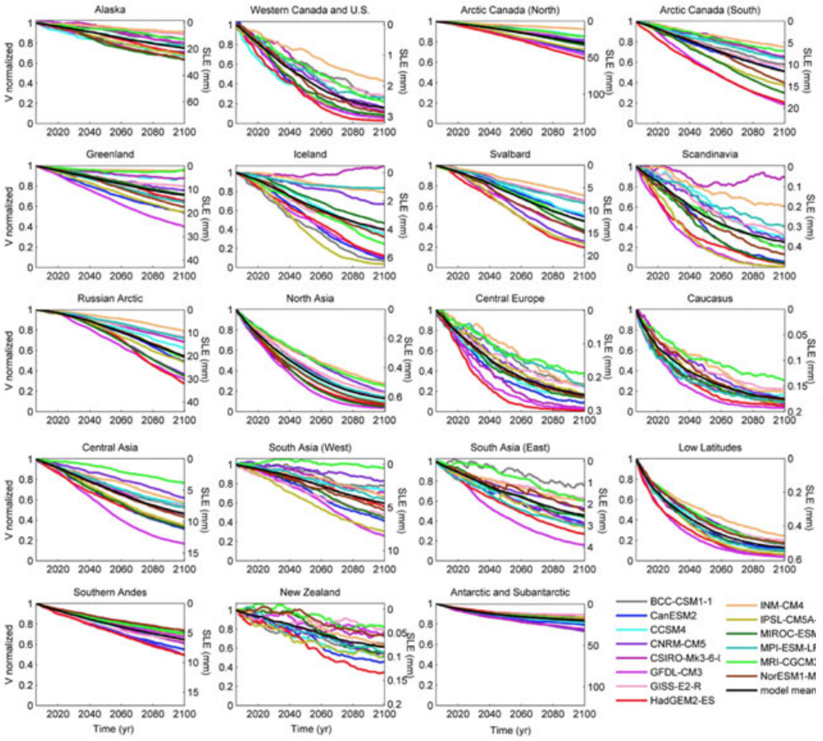
Current applications: Mass change HMA



Gardner et al. (2013)

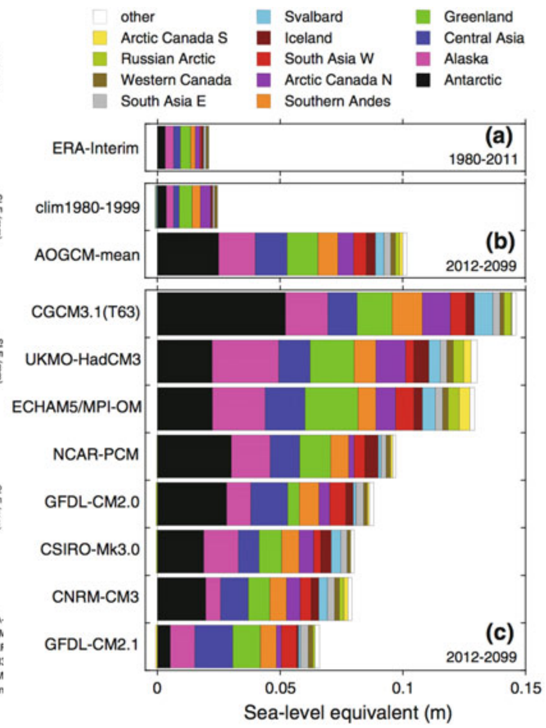
Current applications: Future glacier volume

Transient evolution of global glacier volumes



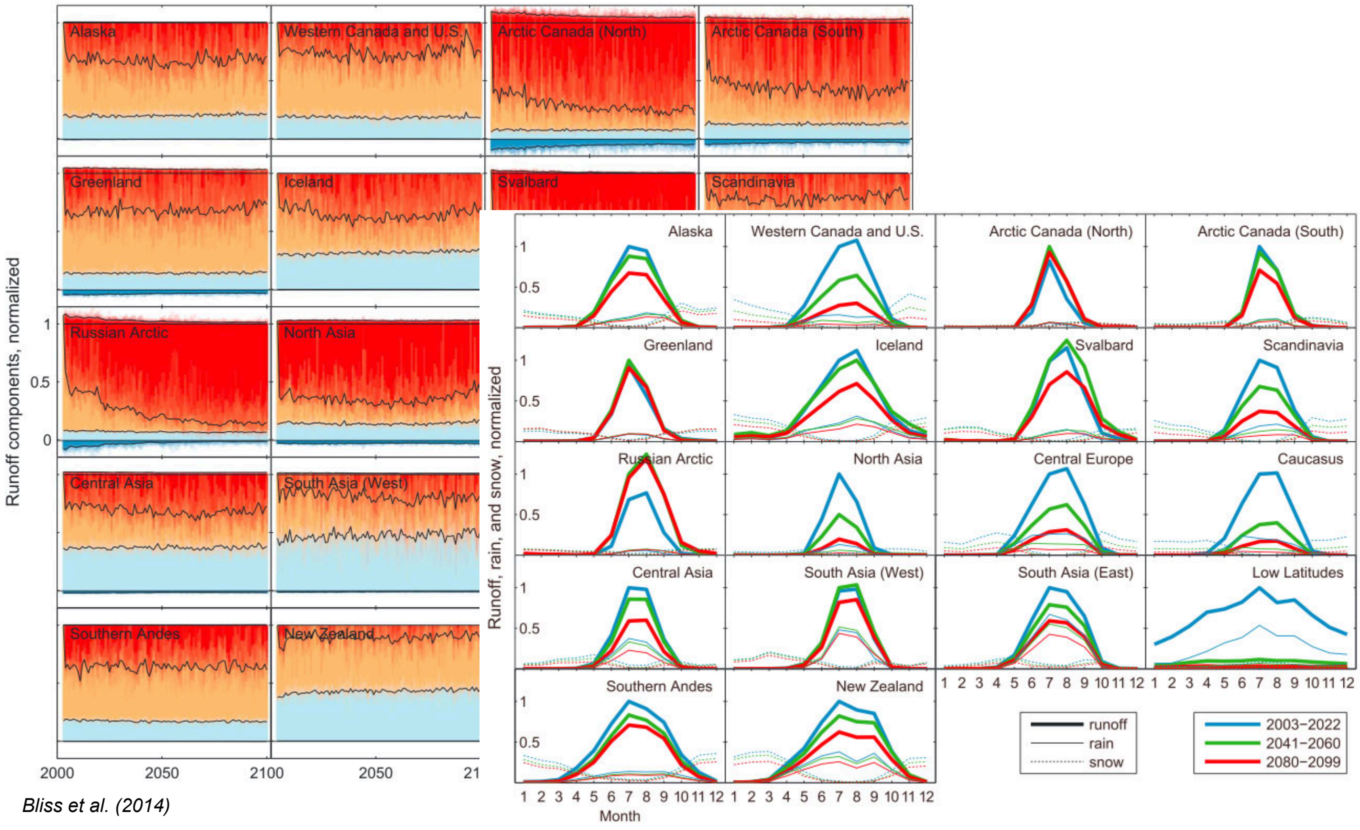
Radic et al. (2013)

Future sea-level rise contribution



Giesen and Oerlemans (2013)

Current applications: Future runoff



Bliss et al. (2014)

Selected publications using the RGI

1. Bliss, A., R. Hock, and V. Radić (2014): Global response of glacier runoff to twenty-first century climate change. J. *Geophys. Res. Earth Surf.*, 119, 717–730. =>2
2. Dehecq, A., N. Gourmelen and E. Trouve (2015): Deriving large-scale glacier velocities from a complete satellite archive : Application to the Pamir-Karakoram-Himalaya. *Remote Sensing of the Environment*, 162, 55-66. =>0
3. Gardelle, J., E. Berthier, Y. Arnaud, and **A. Kääb** (2013): Region-wide glacier mass balances over the Pamir-Karakoram-Himalaya during 1999–2011. *The Cryosphere*, 7, 1263–1286. =>39
4. Gardner, A.S., G. Moholdt, J.G. Cogley, B. Wouters, A.A. Arendt, J. Wahr, E. Berthier, R. Hock, W.T. Pfeffer, G. Kaser, S.R.M. Ligtenberg, **T. Bolch**, M.J. Sharp, J.O. Hagen, M.R. van den Broecke and **F. Paul** (2013): A consensus estimate of glacier contributions to sea level rise: 2003 to 2009. *Science*, 340 (6134), 852-857. **=>110**
5. Giesen, R.H. and J. Oerlemans (2013): Climate-model induced differences in the 21st century global and regional glacier contributions to sea-level rise. *Climate Dynamics*, 41, 3283-3400. =>14
6. Grinsted, A. (2013): An estimate of global glacier volume. The Cryosphere, 7, 141-151. =>24
7. Huss, M. (2011): Present and future contribution of glacier storage change to runoff from macroscale drainage basins in Europe. *Water Resour. Res.*, 47, W07511. =>40
8. Huss, M. and D. Farinotti (2012): Distributed ice thickness and volume of 180,000 glaciers around the globe. *Journal of Geophysical Research*, 117, F04010. =>52
9. Jacob, T., J. Wahr, W. T. Pfeffer, and S. Swenson (2012): Recent contributions of glaciers and ice caps to sea level rise. *Nature*, 482, 514-518. **=>221**
10. Machguth, H. and M. Huss (2014): The length of the world's glaciers - a new approach for the global calculation of center lines. The Cryosphere, 8 (5) 1741-1755. =>2
11. Marzeion, B., A. H. Jarosch, and M. Hofer (2012): Past and future sea-level change from the surface mass balance of glaciers. *The Cryos*phere, 6, 1295-1322. =>48
12. Marzeion, B.. J.G. Cogley, K. Richter and D. Parkes (2014): Attribution of global glacier mass loss to anthropogenic and natural causes. *Science*, 345 (6199), 919-921. =>4
13. Mernild, S.H., W.H. Lipscomb, D.B. Bahr, V. Radić and M. Zemp (2013): Global glacier changes: a revised assessment of committed mass losses and samling uncertainties. *The Cryosphere*, 7, 1565-1577. =>8
14. Pfeffer, W.T., A.A. Arendt, A. Bliss, **T. Bolch**, J.G. Cogley, A.S. Gardner, J.-O. Hagen, R. Hock, G. Kaser, C. Kienholz, E.S. Miles, G. Moholdt, **N. Mölg**, **F. Paul**, V. Radic, **P. Rastner**, B.H. Raup, J. Rich, M.J. Sharp and the Randolph Consortium (2014): The Randolph Glacier Inventory: a globally complete inventory of glaciers. *Journal of Glaciology*, 60 (221), 537-552. =>22
15. Radić, V., and R. Hock (2013): Glaciers in the *Earth's hydrological cycle: Assessments of glacier mass and runoff changes on global and regional scales.* Surv. Geophys., 35 (3), 813-837. =>5
16. Radić, V., A. Bliss, A. C. Beedlow, R. Hock, E. Miles, and J.G. Cogley (2014): Regional and global projections of the 21st century glacier mass changes in response to climate scenarios from GCMs. *Climate Dynamics*, 42, 37-58. =>19

Total citations: 2+39+110+14+24+40+52+2+48+4+8+22+5+19=**389** or 28 for 14 (+221=**610** or 41 for 15) + IPCC

Future plans and products

- **Improve quality and consistency of RGI outlines**
- **Extend spatio-temporal coverage of products**
  - **Assess geodetic volume changes globally (using TanDEM-X, hold back @ DLR)**
  - **Determine representativeness of mass balance glaciers for improved extrapolation of sparse field data**
  - **Calibrate field measurements with geodetic methods**
- **Improve determination of ice thickness distribution (Option)**
- **Identify special glaciers (calving, surging, ice cap) in RGI**
- **Map and model the glaciers on the Antarctic Peninsula (API)**
- **Inform sea level, ice sheet and land cover CCIs**
- **Use animations to visualize glacier change for a wide public**