Climate Research Data Package (CRDP) - Technical Note

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Document status sheet

Version	Date	Changes	Approval
0.1	21.03.2024	Initial draft	
0.2	28.06.2024	Update for Phase 2	

The work described in this report was done under Contract Change Note 1 (CCN1) of ESA contract 4000127593/19/I-NB. Responsibility for the contents resides with the authors who prepared it.

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Related documents

Acronym	Title	Document reference	Version	Date
[RD1]	CRDP	Glaciers_cci_D3.2_CRDPv2	1.0	08.10.2021

Table of Contents

1. Purpose of this document

This is a technical document describing the contents of the Climate Research Data Package (CRDP) of the Glaciers_cci+ Phase 2project. It provides an overview of the datasets created for the different study sites: Global, Greenland, Svalbard, Karakoram. We do not list here details of the individual datasets used for processing (e.g. date, path/row), but give a generalized overview and describe their main characteristics. The database itself is accessible on a separate webpage (http://glaciers-cci.enveo.at/crdp2_ph2_internal) containing zip files of all datasets complemented with metadata sheets (see Section 2). For previously released products, we refer to the CRDP document of Phase 1 of the project [RD1].

2. Accessing the Climate Research Data Package

The generated output products of Glaciers_cci are stored in the Climate Research Data Package (CRDP) database, which can be accessed via http://glaciers-cci.enveo.at. The main landing page provides a brief introduction and links to a public and an internal database (Fig. 2.1). The latter is available for project partners only and is password protected.

Figure 2.1: CRDP access on the website http://glaciers-cci.enveo.at.

Accessing public products

There is a two-step procedure for accessing the public database, related to (i) viewing and selecting of products and (ii) downloading the products. The first step "Viewing and selecting" does not require any registration. In the second step "Downloading of the product" we ask for the approval of a data usage disclaimer by providing name, affiliation and email address, a password is not required (Fig. 2.2). The entered information is only used for tracking the use of the products, fully compliant with EU data policy standards. Entering the Glaciers_cci CRDP public database provides direct access to released products, which can be selected and downloaded. All datasets are provided in a table providing some basic description and the spatial and temporal coverage, type of data and downloadable metadata. The basic layout of these tables are the same as in the internal database and are further described in the next section. After internal approval products from the internal database will be transferred here.

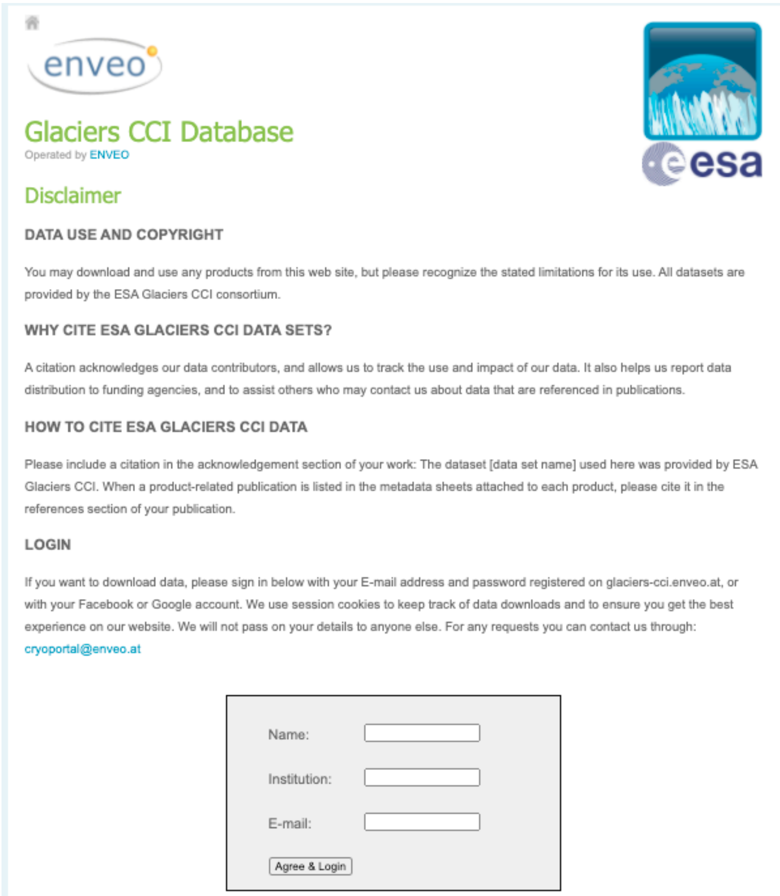

Fig. 2.2: Data disclaimer and login screen for accessing the public product database.

Internal database

The internal database for Glaciers_cci+ contains, apart from the tabs from the previous phases of the project, four additional tabs for phase 2 of the Glaciers CCI+ project: Surges, SEC, Length, GSC (glacier surface classification). As for the public part, the tabs list all datasets in a table, providing some basic information, including an ID number, a description, the region and period covered, data category and format/type as well as a quicklook/coverage figure and download links for the dataset and associated metadata sheet. The ID number is a unique alphanumeric number used for internal identification of a dataset.

The metadata description provides information on the content of the file, product version, generation date, institute and author, satellite data used as input, geographical coverage, etc. It is provided as both a .docx and .pdf document. Additionally, there is a column which indicates whether a dataset is released and publicly available or not. Once a dataset is fit for release it will be moved to the public part of the database and this is indicated in this column. Figure 2.3 shows as example a screenshot of the new SEC panel in the CRDP database listing the surface elevation change datasets for the Greenland peripheral glaciers derived from various sensors. New datasets will be added during the project as they become available. An overview on the produced and/or foreseen datasets is provided in the following chapters. Figure 2.4 shows as example the standardised metadata sheet for the “Global glacier surge inventory 2017- 2022”

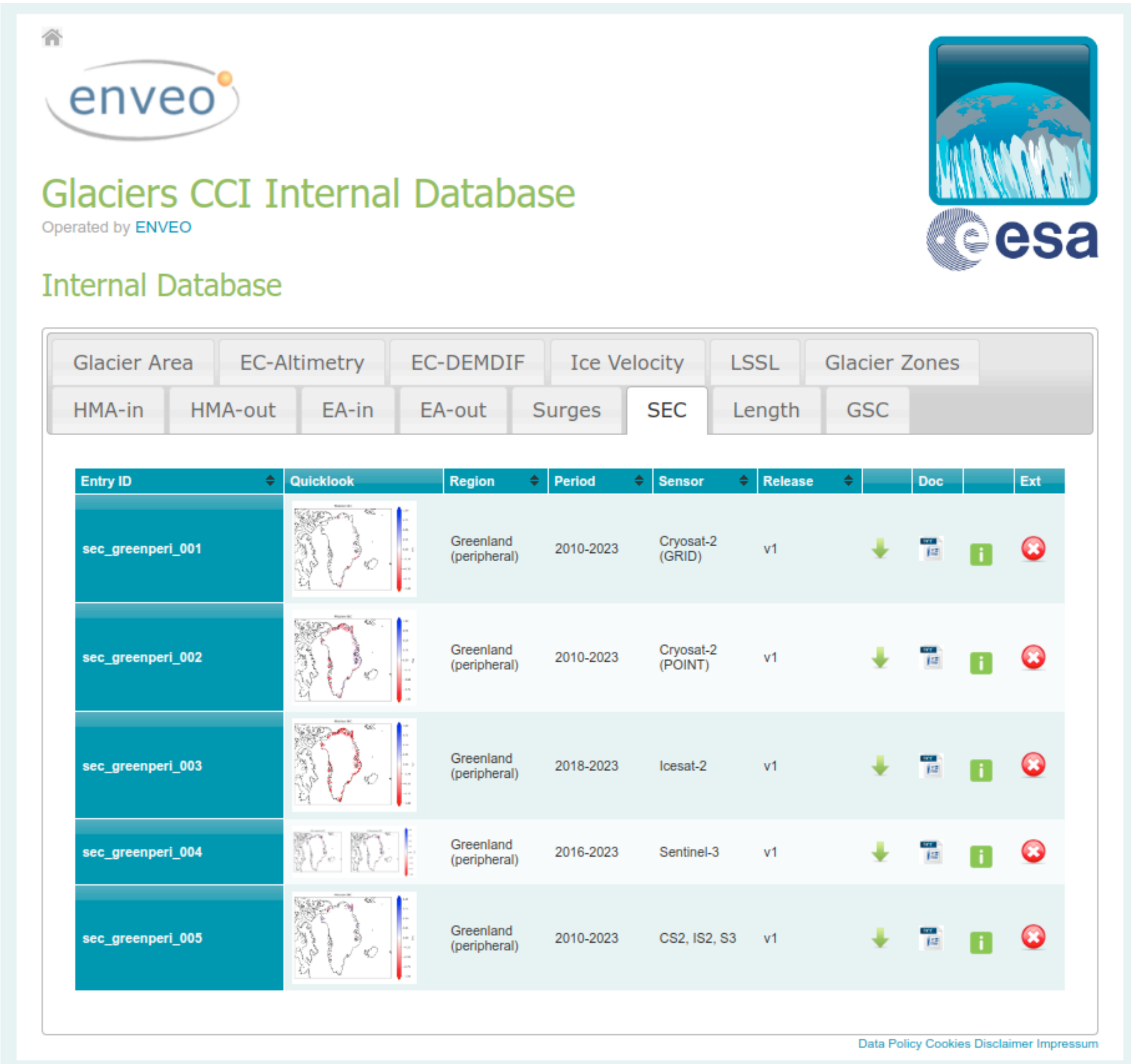

Figure 2.3: Screenshots of the SEC panel of the internal CRDP database.

Metadata Information Sheet

1. Identification

LongName	**glacier_cci_surges_2017_2022_v1.txt**		
ShortName	Global glacier surge inventory 2017-2022	**Type**	vector (polygon), shapefile
Creators	Andreas Kääb and co-authors	**Institution**	Dept. of Geosciences, University of Oslo
Created at	29.06.2023 (release v1.0)	**Funding**	ESA Glacier_cci
Entry ID	gs_global_001	**Remarks**	submitted to RGI

2. Description

Description	Using global Sentinel-1 radar backscatter data, the locations of glaciers with surge-type activity during 2017–22 are systematically mapped. Patterns of pronounced increases or decreases in the strongest backscatter between two winter seasons often indicate large changes in glacier crevassing, which are treated here as a sign of surge-type activity. Validations against velocity time series, terminus advances and crevassing found in optical satellite images confirm the robustness of this approach. The dataset contains 116 surge-type events globally between 2017 and 2022, around 100 of which on glaciers already know as surge-type. The data reveal a pronounced spatial clustering in three regions, (i) Karakoram, Pamirs and Western Kunlun Shan (~50 surges), (ii) Svalbard (~25) and (iii) Yukon/Alaska (~9), with only a few other scattered surges elsewhere. This spatial clustering is significantly more pronounced than the overall global clustering of known surge-type glaciers. The 2017–22 clustering may point to climatic forcing of surge initiation.
Methods	Manual detection and interpretation of SAR backscatter anomalies based on winter stacks of Sentinel-1 data.
Dataset	116 surge-type glacier activities.
Uncertainty	Not quantified, but qualitative comparison to regional surge inventories
References	https://doi.org/10.1017/jog.2023.35
Citation	Kääb A, Bazilova V, Leclercq PW, Mannerfelt ES, Strozzi T. Global clustering of recent glacier surges from radar backscatter data, 2017–2022. Journal of Glaciology. 2023;69(277):1515-1523. doi:10.1017/jog.2023.35

3. Source data

Source	Sentinel scihub; Google Earth Engine	**Date (range)**	2017-2022
Satellites	Sentinel-1	**Years total**	6
Sensors	Sentinel-1 SAR	**Remarks**	-
Path / row range	global		
№ of scenes	global		

4. Geographic coverage

Country	global
Region	global
RGI Region	global
Longitude	global
Latitude	global
Projection	Lon / Lat
Datum	WGS84
Sampling	Individual points

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Metadata Information Sheet

5. Data files

Name*	glacier_cci_surges_2017_2022_v1.txt		
Size	10 KB	**Upload**: 17.01. 2024	
File 1	datafile		
File 2	This Metadata Information Sheet		

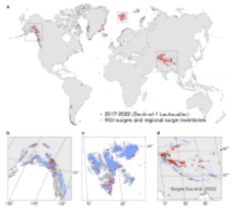
Data colums:

No :	running number
GLIMS_ID:	GLIMS ID of glacier
RGI_ID:	RGI6.0 ID of Glacier
Lon:	Longitude (degree WGS 1984)
Lat:	Latitude (degree WGS 1984)
Surge_start:	approx. year of first visibility of surge as backscatter anomaly 1000: surge start before 2017
Surge_end:	approx. year of last visibility of surge as backscatter anomaly 3000: surge end after 2022
Name_or_comment:	Glacier name and/or other comments

Field separator: ;
Decimal separator: ,
No data: -

Sample rows:

```
22 ; G017096E77164N ; RGI60-07.00250 ; 17,239 ; 77,148 ; 1000 ; 2019 ; Markhambreen
23 ; G017138E77876N ; RGI60-07.00266 ; 17,114 ; 77,865 ; 2021 ; 3000 ; Vallakrabreen
24 ; G018098E77802N ; RGI60-07.00276 ; 18,213 ; 77,843 ; 2017 ; 2021 ; Arnesenbreen(two surge phases)
```



Maps of Sentinel-1 backscatter-derived glacier surges over 2017–22. (a) Global distribution of 2017–22 surges (red dots), and glaciers with RGI v.6 surge-type flag and additional regional inventories (white circles). (b–d) Details of the main map, including RGI v.6 glacier areas. Map projection is van der Grinten as compromise between equal-area and conformal projection.

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Figure 2.4: Example metadata sheet for the global glacier surge inventory derived from Sentinel-1 SAR data acquired from 2017- 2022 (Kääb et al., 2023).

3. Inventory of glacier surges (global)

To generate a global surge inventory for the period 2017-2022, backscatter anomalies in the global Sentinel-1 radar data archive were systematically mapped. All data used are publicly available (Table 3.1) and are therefore not duplicated on the server. Other data was only used for validation, all of which are either publicly available (Table 3.2) or shown in Kääb et al (2023). The inventory dataset (Table 3.3) is a table and contains 116 surge-type events globally between 2017 and 2022 (Fig. 3.1), around 100 of which on glaciers already known as surge-type. Details and interpretation of the detected temporal/spatial surge clusters with regard to potential changes in climatic forcing are provided in Kääb et al. (2023).

Citation: Kääb, A., Bazilova, V., Leclercq, P.W., Mannerfelt, E.S., Strozzi, T. (2023). Global clustering of recent glacier surges from radar backscatter data, 2017–2022. *Journal of Glaciology*, 69 (277), 1515-1523; doi.org/10.1017/jog.2023.35

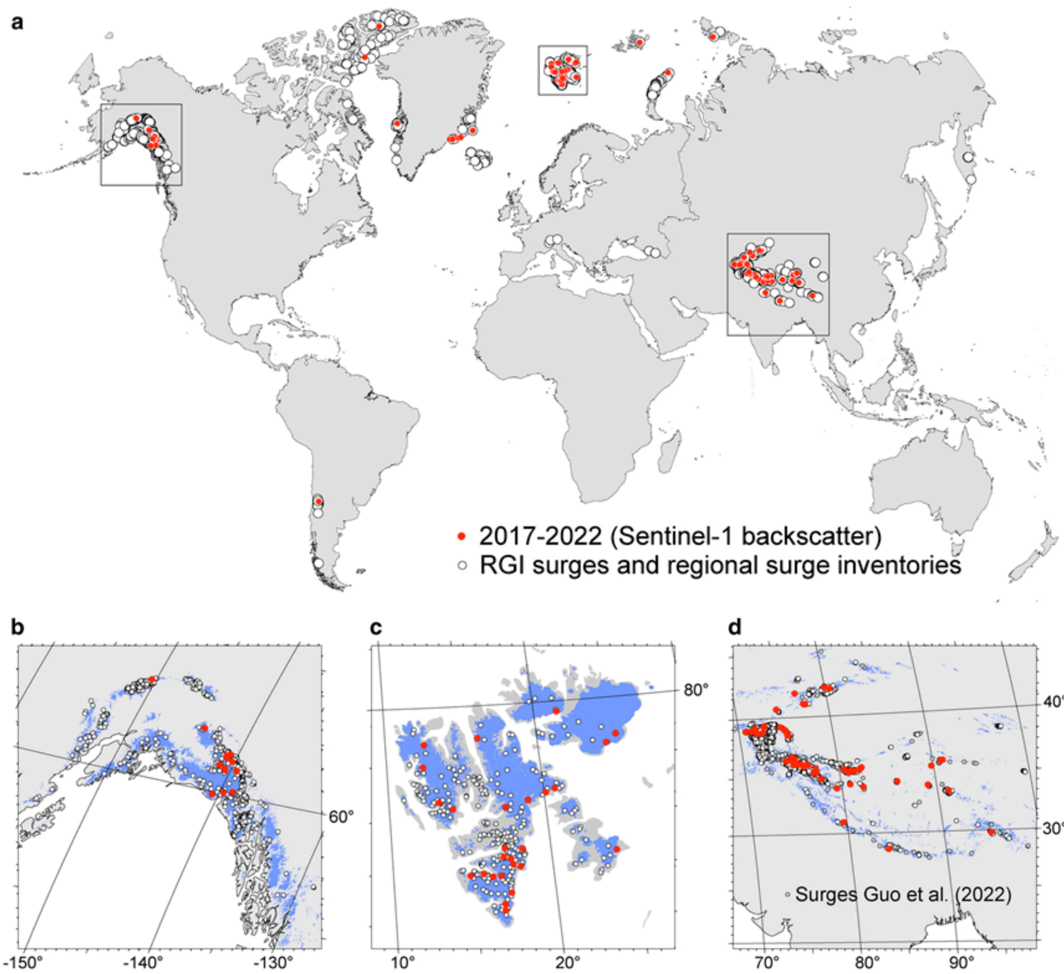

Fig. 3.1: Maps of Sentinel-1 backscatter-derived glacier surges over 2017–22. (a) Global distribution of 2017–22 surges (red dots), and glaciers with RGI v.6 surge-type flag and additional regional inventories (white circles). (b–d) Details of the main map, including RGI v6.0 glacier areas in blue. Map projection is van der Grinten as a compromise between equal-area and conformal projection.

Table 3.1: EO datasets used as input for the inventory of glacier surges.

Nr.	Sensor	Period	Product	Coverage	Processing details	Source
1	Sentinel-1	2017-2022	SAR back-scatter	global	Detection of regions with glacier anomalies through analysis of stacks of Sentinel-1 SAR backscatter data from the entire period	Link 1
2	Sentinel-1	2017-2022 winter data	SAR back-scatter	global	Detailed manual detection and interpretation of SAR backscatter anomalies based on winter stacks of Sentinel-1 data.	Link 1

Link for the source in Table 3.1:
Link 1: https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S1_GRD

Table 3.2: Auxiliary datasets used for validation of the inventory of glacier surges.

3	Auxiliary / ASTER	2000-2020	Glacier elevation changes	global	Validation against global glacier elevation changes by Hugonnet et al. (2021)	Link 3
4	Sentinel-2	2017-2022	optical bands	global	Validation against terminus advances and crevassing found in optical satellite imagery	Link 4/5
5	Sentinel-1	2017-2022	SAR	Sval-bard	Validation against time series of glacier velocities using standard offset tracking procedures	Link 4/5
6	Auxiliary / various optical sensors	2027-2022	optical bands	Schee le-breen	Validation against time series of glacier velocities from repeat Sentinel-2, Landsat 8 and ICEYE data	Official data providers
7	Auxiliary	-	GLIMS	global	Assignment of GLIMS_ID to identified glaciers	Link 7
8	Auxiliary	-	RGI6.0 surge code	global	Comparison with existing surge inventory. Surge codes in RGI 6.0 are from Sevestre and Benn (2015)	Link 8
9	Auxiliary	2000-2018	HMA_STG inventory	HMA	Comparison with existing surge inventory for HMA by Guillet et al. (2022)	Link 9
10	Auxiliary	2008–2012	Svalbard surge inventory	Sval-bard	Comparison with existing surge inventory for Svalbard by Farnsworth et al (2016)	Link 10
	Auxiliary	-	RGI-extended	global	Combined global surge inventory compiled for this study: RGI 6.0, Sevestre and Benn (2015), Guillet et al. (2022), Farnsworth et al. (2016), Jiskoot et al (2003), Sevestre and Benn (2015), Bhambri et al (2017), Goerlich et al (2020), Guan et al (2022), Guo et al (2022)	literature, see reference list below

Links for the sources in Table 3.2:
Link 3: https://doi.org/10.6096/13, Link 4/5: https://scihub.copernicus.eu/,
Link 7: https://www.glims.org/, Link 8: https://www.glims.org/RGI/,
Link 9: https://zenodo.org/records/5524861,
Link 10: https://doi.org/10.1016/j.geomorph.2016.03.025

Table 3.3: Details of the inventory of glacier surges.

Nr.	Name	Format	Resolution	Coverage	Projection	Comments
1	Glaciers_ CCI Surges 2017-2022 v1	txt	Position of individual glaciers	global	WGS 1984	Data columns: GLIMS_ID, RGI_ID, lon and lat, Surge start/end (year), glacier name and comments

Cited literature

Bhambri, R, Hewitt, K, Kawishwar, P and Pratap, B (2017) Surge-type and surge-modified glaciers in the Karakoram. Scientific Reports 7(1), 15391. doi: 10.1038/s41598-017-15473-8

Farnsworth, WR, Ingolfsson, O, Retelle, M and Schomacker, A (2016) Over 400 previously undocumented Svalbard surge-type glaciers identified. Geomorphology 264, 52–60. doi: 10.1016/j.geomorph.2016.03.025

Goerlich, F, Bolch, T and Paul, F (2020) More dynamic than expected: an updated survey of surging glaciers in the Pamir. Earth System Science Data 12(4), 3161–3176. doi: 10.5194/essd-12-3161-2020

Guan, WJ and 7 others (2022) Updated surge-type glacier inventory in the West Kunlun mountains, Tibetan Plateau, and implications for glacier change. Journal of Geophysical Research-Earth Surface 127(1), Artn e2021JF006369. doi: 10.1029/2021JF006369

Guillet, G and 6 others (2022) A regionally resolved inventory of High Mountain Asia surge-type glaciers, derived from a multi-factor remote sensing approach. Cryosphere 16(2), 603–623. doi: 10.5194/tc-16-603-2022

Hugonnet, R and 10 others (2021) Accelerated global glacier mass loss in the early twenty-first century. Nature 592(7856), 726–731. doi: 10.1038/s41586-021-03436-z

Jiskoot, H, Murray, T and Luckman, A (2003) Surge potential and drainage-basin characteristics in East Greenland. Annals of Glaciology 36, 142–148. doi: 10.3189/172756403781816220

Sevestre, H., and D.I. Benn, 2015, Climatic and geometric controls on the global distribution of surge-type glaciers: implications for a unifying model of surging, Journal of Glaciology, 61(226), 646-662.

4. Elevation changes of peripheral glaciers (Greenland)

The surface elevation change products contain surface elevation time-series and their associated change rates from radar and laser altimetry products. They cover the Greenland peripheral glaciers region as defined by the Randolph Glacier Inventory v7.0. All input data is publicly available, from the links given in Table 4.1 below, so it is not repeated on the server.

Table 4.1: EO and auxiliary datasets used as input for the elevation change product.

Nr.	Sensor	Period	Product	Coverage	Processing details	Source
1	Sentinel 3A SRAL	December 2016 to February 2023	LAND thematic	Greenland	Input elevations	Link 1
2	Sentinel 3B SRAL	January 2019 to February 2023	LAND thematic	Greenland	Input elevations	Link 1
3	CryoSat-2 SIRAL	July 2010 to February 2023	Swath thematic point and gridded products	Greenland periphery	Input elevations and uncertainties	Link 2
4	ICESat-2 ATLAS	October 2018 to March 2023	ATL14 and ATL 15	Greenland	Input elevations and uncertainties	Link 3
5	RGI 7.0	Present	Glacier product	Greenland periphery	Input glacier outlines	Link 4
6	Arctic DEM	2007-2022 (summers)	500 m DEM	Arctic land domain	Elevations used to filter inputs and guide interpolation. Surface slope derived from local elevations	Link 5
7	Sentinel 3 A / B and Operation IceBridge	Summer 2021	Accuracy calibration	North-west Greenland	Calibration by slope table used to derive uncertainties	Link 6

Source links and citations for Table 4.1 are given below.

Link 1: https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-altimetry/products-and-algorithms/baseline-collection-005-processing-status

Jettou, G. (2022) Sentinel-3 SRAL/MWR Land User Handbook S3MPC-STM_RP_0038 – Issue 1.1 – 05/12/2022

Link 2: https://cryotempo-eolis.org

Jakob, L., and Gourmelen, N., (2023). Glacier Mass Loss Between 2010 and 2020 Dominated by Atmospheric Forcing. Geophysical Research Letters 50(8), 1–10. doi.org/10.1029/2023GL102954

Link 3: https://nsidc.org/data/atl14/versions/3

Smith, B., T. Sutterley, S. Dickinson, B. P. Jelley, D. Felikson, T. A. Neumann, H. A. Fricker, A. Gardner, L. Padman, T. Markus, N. Kurtz, S. Bhardwaj, D. Hancock, and J. Lee. (2023). ATLAS/ICESat-2 L3B Gridded Antarctic and Arctic Land Ice Height, Version 3 [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/ATLAS/ATL14.003, [accessed 2023].

Link 4: https://www.glims.org/RGI/

RGI 7.0 Consortium (2023). Randolph Glacier Inventory - A Dataset of Global Glacier Outlines, Version 7.0. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi:10.5067/f6jmovy5navz.

link 5: https://www.pgc.umn.edu/data/arcticdem/

Porter, C. et al. (2023), "ArcticDEM, Version 4.1", https://doi.org/10.7910/DVN/3VDC4W, Harvard Dataverse, V1, [accessed 2023].

link 6:
https://sentinels.copernicus.eu/web/sentinel/user-guides/sentinel-3-altimetry/document-library/-/asset_publisher/ZO9eh5qR8wB9/content/sentinel-3-stm-annual-performance-report-2021

STM ESL's and Jettou, G. (2021). S3MPC STM Annual Performance Report - Year 2021, S3MPC.CLS.APR.010 - Issue 1.0 - 08/12/2021

The products contain time-series at varying spatial resolution depending on input mission - along track, gridded and per-glacier - and derived elevation change rates. The peripheral glacier region forms a rim around Greenland, so any imposed grid would be mainly empty. To save space, only individual grid cells containing data are included, along with their locations so that the full grid can be reconstructed.

Table 4.2: Details of the elevation change products for the Greenland's peripheral glaciers. All datasets are of type vector and provided in netCDF format. The projection is northern polar stereographic, EPSG 3413. Comments: Nr 1: Both Sentinel 3A and 3B. Windowed SEC only available for 3A, as 3B launched less than 5 years ago. Nr.5: Mission too short so far to make 5 year windowed SEC.

Nr.	Name	Resolution
1	Sentinel 3 Greenland peripheral glaciers radar altimetry SEC product	Along track 300 m, cells 500 m by 500 m, and per-glacier. Monthly time-series. Full mission and 5 year windowed SEC.
2	CryoSat-2 Greenland peripheral glaciers point swath radar altimetry SEC product	Cells 500 m by 500 m, and per-glacier. Monthly time-series. Full mission and 5-year windowed SEC.
3	CryoSat-2 Greenland peripheral glaciers gridded swath radar altimetry SEC product	Cells 2 km by 2 km, monthly time-series. Full mission and 5 year windowed SEC.
4	Sentinel 3 and CryoSat-2 Greenland peripheral glaciers joint radar altimetry SEC product	Cells 500 m by 500 m, and per-glacier. Monthly time-series. Full mission and 5-year windowed SEC.
5	ICESat-2 Greenland peripheral glaciers laser altimetry SEC product	Cells 1 km by 1 km, and per-glacier. 3-monthly time-series. Full mission and 4 year windowed SEC.

Validation is mainly done by intercomparison of the different products. One extra validation dataset is used, which combines data from ICESat and ICESat-2 to make a long-term gridded elevation change record. The citation (dataset link on webpage) is:

Khan, S. A., Colgan, W., Neumann, T. A., van den Broeke, M. R., Brunt, K. M., Noël, B., Bamber, J. L., Hassan, J., & Bjørk, A. A. (2022). Accelerating ice loss from peripheral glaciers in north Greenland. Geophysical Research Letters, 49(12). https://doi.org/10.1029/2022GL098915

5. Glacier facies (Karakoram)

The glacier surface classification (GSC) products provide information on the snow covered glacier surfaces, the snow free glacier ice, and snow free debris covered glacier areas and their associated uncertainty indicated by quality flags. Products cover the largest part of the Karakoram region at selected dates between April and October every year from 2016 to 2023, and for selected dates and years between 1993 and 2015. All input data are publicly available, from the links given in Table 6.1 below, so it is not repeated on the server.

Table 6.1: EO and auxiliary datasets used as input for the glacier surface classification product in the Karakoram. CAMS = Copernicus Atmosphere Monitoring Service.

Nr.	Sensor	Period	Product	Processing details	Source
1	Sentinel 2A MSI	May 2016 to Oct 2023	L1C	Input spectral reflectances	Link 1
2	Sentinel 2B MSI	May 2017 to Oct 2023	L1C	Input spectral reflectance	Link 1
3	Landsat 5 TM	Apr 1994 to Oct 2013	L1TP	Input spectral reflectance, cloud mask	Link 2
4	Landsat 7 ETM+	Apr 1999 to Oct 2002	L1TP	Input spectral reflectance, cloud mask	Link 2
5	Landsat 8 OLI / TIRS	Apr 2013 to Oct 2016	L1TP	Input spectral reflectance, cloud mask	Link 2
5	RGI 7.0	Present	Glacier product	Input glacier outlines	Link 3
6	Copernicus DEM	Variable	GLO-30	Orthometric heights used for topographic & atmospheric correction	Link 4
7	CAMS, Global reanalysis (EAC4)	2003 - 2023	AOD550, TCWV, GTCO3	Input atmospheric parameters	Link 5

Links and citations for Table 6.1 are given below.
Link 1: Copernicus Data Space Ecosystem | Europe's eyes on Earth
Link 2: EarthExplorer (usgs.gov)
Link 3: https://www.glims.org/RGI/
RGI 7.0 Consortium (2023). Randolph Glacier Inventory - A Dataset of Global Glacier Outlines, Version 7.0. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi:10.5067/f6jmovy5navz.
link 4: Copernicus Digital Elevation Model - Copernicus Contributing Missions Online; https://doi.org/10.5270/ESA-c5d3d65
link 5: CAMS global reanalysis (EAC4) (copernicus.eu)

The products are available for selected dates between April and October (during the ablation season), providing the following glacier surface classes observed per date: snow cover on glaciers, snow free glacier ice and snow free debris-covered glacier areas. Clouds over glaciers and non-glacierized regions are masked.

Table 6.2: Details of the glacier surface classification products.

Nr.	Name	Type	Format	Resolution	Coverage	Projection	Comments
1	Karakoram glaciers GSC product	raster	netCDF	Pixel spacing: 0.0002° x 0.0002°, temporal resolution variable	Kara-koram	Geographic coordinates, EPSG 4326	Products are based on Sentinel-2 A/B, Landsat 5 TM, Landsat 7 ETM+, or Landsat 8 OLI/TIRS

Validation is done by intercomparison of products from different sensors using acquisitions with maximum two days delay.

6. Length changes (Karakoram)

The glacier length change products are derived from time series of glacier outlines that were digitally intersected with the centreline of each selected glacier. The multi-temporal glacier outlines from around the 1990s, 2000s, 2010s and 2020s were derived from Landsat images which were processed in Google Earth Engine (GEE) and provided by Xie et al. (2023). Initial glacier mapping (clean ice) used the normalized difference snow index (NDSI) with manually selected thresholds and manual editing of outlines (e.g. to correct for wrongly mapped regions in shadow or water and to add debris-cover). We note that outlines by Xie et al. were not further corrected by us although we detected in a cross-check differences to our own interpretation for several glaciers.

Outlines for 1965 are derived by manual digitizing from a mosaic of orthorectified Corona KH-4 images that were created by Glaciers_cci using the ASTER G-DEM as a base for terrain elevation. As a note, the mountains and glaciers are already covered by the first winter snow, making the identification of glacier termini difficult. We thus focused on a selection of glaciers (surge-type and not surging) for this year. Table 6.1 is listing further details. The full list of Landsat images used to create the outlines is provided in the supplemental material (Table S1) of Xie et al. (2023). The input datasets are freely available (i.e. not on the server).

Table 6.1: EO input datasets used to create the glacier length dataset. All datasets are available from earthexplorer.usgs.gov or GEE. They are not provided on the server.

Nr.	Sensor	Date / Period (scene count)	Coverage (ID or Path / Row range)
1	Corona KH-4	08.10.1965 (11)	DS1025-1039 DF003 to DF013
2	Landsat 5 TM	1990 (5), 1991 (7), 1993 (1), 1994 (1)	Path 146-151, Row 34-37
3	Landsat 7 ETM+	2000 (23), 2001 (16)	Path 145-150, Row 34-37
4	Landsat 5 TM	2009 (36), 2010 (23)	Path 145-150, Row 34-37
5	Landsat 8 OLI	2018 (25), 2019 (28), 2020 (29)	Path 145-150, Row 34-37

For each selected glacier the largest extent was calculated and used to derive the longest possible centreline with the tools available for the Open Global Glacier Model (OGGM) by Maussion et al. (2019). The output dataset is a point shape file that is listing in its attribute table (.dbf format) for each glacier its ID, coordinates and length for the five points in time. This table also includes a flag indicating if the glacier is of surge type (1) or not (0). The two datasets listed in Table 6.2 are merged into one final dataset.

Table 6.2: Characteristic of the main output dataset. Details are provided in the PSD.

Nr.	Sensor	Date or Period	Coverage	Processing details
1	Landsat	1990-2020	Entire Karakoram	all glaciers >1km^2
2	Corona KH4	1965	Only NW Karakoram	Selected surge-type and usual glaciers

Cited literature:

Maussion, F. and 14 others (2019): The Open Global Glacier Model (OGGM) v1.1. Geosci. Model Dev. 12, 909–931; doi.org/10.5194/gmd-12-909-2019

Xie, F. and 26 others. (2023): Interdecadal glacier inventories in the Karakoram since the 1990s, Earth Syst. Sci. Data, 15, 847–867; doi.org/10.5194/essd-15-847-2023