Global Land Ice Measurements from Space (GLIMS) Glacier Database, Version 1

USER GUIDE

How to Cite These Data

Please refer to Section 7 in this User Guide for detailed information on how to correctly cite these data. If you refer to the global GLIMS data set, please cite:

GLIMS and NSIDC (2005, updated 2020): Global Land Ice Measurements from Space glacier database. Compiled and made available by the international GLIMS community and the National Snow and Ice Data Center, Boulder CO, USA. https://doi.org/10.7265/N5V98602. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0272

National Snow and Ice Data Center

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1 DATA DESCRIPTION

The Global Land Ice Measurements from Space (GLIMS) is an international initiative with the goal of repeatedly surveying the world's estimated 200,000 glaciers. GLIMS uses data collected by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument aboard the Terra satellite and the LANDSAT series of satellites, along with historical observations. The GLIMS initiative has created a unique glacier inventory, storing information about the extent and rates of change of all the world's mountain glaciers and ice caps.

Note: A GLIMS Glacier Viewer was developed to provide the public with easy access to the GLIMS Glacier Database. **A detailed description on how to use this web application and the text-based search option is given in Section 3 Software and Tools.**

1.1 Parameters

The following table gives a list of important GLIMS parameters. A more comprehensive list of parameters can be found on the GLIMS Description of fields web page.

Table 1. List of GLIMS Parameter

Parameter	Description
line_type	Type of entity: glac_bound = glacier boundary (polygon) snowline = end-of-season snow line centerline = center line along middle of glacier debris_cov = debris cover (polygon) pro_lake = proglacial lake (polygon) supra_lake = supraglacial lake (polygon)
anlys_id	unique ID for this outline
glac_id	GLIMS glacier ID (e.g. G254228E40365N). Format is GxxxxxxEyyyyyH where: G is a literal (stands for "glacier") xxxxxx is the east longitude of the chosen representative point of the glacier E is a literal (denotes east longitude) yyyyy is the latitude of the chosen representative point of the glacier H can be "N" or "S", denoting northern or southern hemisphere, respectively
area	glacier area given by provider, km^2
db_area	glacier area calculated by NSIDC at ingest, km^2
min_elev	Minimum elevation, in meters above sea level
mean_elev	Mean elevation, in meters above sea level
max_elev	Maximum elevation, in meters above sea level
src_date	Effective date for the glacier outlines

Parameter	Description
glac_name	Name of glacier, if available
wgms_id	ID from the World Glacier Monitoring Service
glac_stat	Glacier status: "exists" or "gone"
subm_id	Submission ID (can be used to tie together outlines from the same provider
proc_desc	Processing description
rc_id	Regional Center ID
geog_area	General geographic area
chief_affl	Institution of Regional Center chief
loc_unc_x	Positional uncertainty of each vertex of polygons in x, m
loc_unc_y	Positional uncertainty of each vertex of polygons in y, m
glob_unc_x	Positional uncertainty of polygon itself in x, m
glob_unc_y	Positional uncertainty of polygon itself in y, m
submitters	List of people who submitted the data
analysts	List of people who created the data

1.2 File Information

1.2.1 Format

GLIMS Data are available in several file formats:

- ESRI Shapefile
- MapInfo Table Format
- GML (Geography Markup Language)
- KML (Keyhole Markup Language for viewing in Google Earth)
- GMT (Generic Mapping Tools)

Where and how to select the data format and model selection is described in detail in Section 3.4 Tour of GLIMS Data Download. Details of what files will be present depending on the data format choice is given in Table 2.

Table 2. Download Package Content Depending on Selected Download Option

Download option	Download package content
ESRI Shapefile	• glims_*.dbf: Attribute data and object IDs for the features • glims_*.prj: Definition of the map projection • glims_*.shp: Geometry information for the features • glims_*.shx: Geometry index to speed searching

Mapinfo Table	• glims_* directory, containing:
	  ○ layer.dat: Attribute data for the features
	  ○ layer.id: Info linking graphic data to the database
	  ○ layer.map: Graphic and geographic information for each feature
	  ○ layer.tab: ASCII file linking other files, holds information about the type of data set file

GML	• glims_*.gml: The main data file containing information on the features • glims_*.xsd: A schema file to describe the GML format.
KML	• glims_*.kml: The main data file containing information on the features
GMT	• glims_*.gmt: The geometry, attribute, geographic extent, and projection data in a simple ASCII format defined by the GMT group
Note: glims_* refers to all file options available such as "glims_images", "glims_lines", "glims_points" and "glims_polygons". They are described in more detail in Table 3*.*	

1.2.2 Naming Convention

Each GLIMS download package can be ordered as a .zip or .tar option and all downloaded compressed folders will have the following file naming convention:

`glims_download_XXXXX.<ext>` where `XXXXX` is a 5-digit random order number and the extension is dependent on the zip or tar selection of the download order. An example file name is `glims_download_08054.zip`.

1.2.3 ZIP/TAR File Contents

All compressed files contain a README.txt and a CITATIONS.txt file as well as a number of different data files depending on the selected data format (See Table 2). All potential file contents are described in Table 3.

Table 3. File Content Information

File Name	File Content Information
README.txt	General Information on content of the downloaded compressed folder.
CITATIONS.txt	Information on sources for the data, as well as how to cite the data in your own works.
glims_hypsometry_*.csv	Hypsometry (area-elevation histogram) data for the various glaciers/analyses in the search. The data are provided in histogram form, with a different file for each bin size present in the database. The CSV file has columns for the glacier ID and analysis ID, as well as a column for each elevation bin. The column header for each bin shows the center elevation of that bin. The bins represent meters of elevation, and the data represent the glacier area (in square kilometers) in that elevation bin. If there are no files present, there are no hypsometry data for any of the glaciers selected.
glims_images.*	The files contain information on the images that are linked to the glaciers selected. Attributes include the glacier ID, analysis ID, instrument short name, original ID, acquisition time, and a flag called "est_loc". If this flag is 0, it means the coordinates listed are what are stored in the database. If the flag is 1, it means no coordinates were given, so the coordinates listed were estimated as an average of the other image coordinates in the package. If this file is not present, there were no images corresponding to the glaciers selected.
glims_lines.*	The data represent line features associated with the glaciers selected. These line features will either be "snow lines" or "center lines" for the glacier. If this file is not present, there are no line data for the glaciers selected.
glims_points.*	The data are representative points for the glaciers selected.
glims_polygons.*	The data represent polygon features, typically glacier outlines, but also including regions of glacial lakes, debris cover, rocks within the glacier (nunataks), and other polygonal features.
*Note: * refers to the different file extension options depending on what file format was selected. See* Table 2 *for more details.*	

1.3 Spatial Information

1.3.1 Coverage

GLIMS data is global but spatial coverage for individual download orders can be customized, for example, by zooming into a certain region in the map interface (See Section 3.1 Guide to using the GLIMS Glacier Viewer (map interface)).

1.3.2 Resolution

Polygons are created from satellite imagery with resolution (pixel size) in the 5-30 m range. The polygons are vector data and the positional uncertainty and their vertices are given in `loc_unc_x, loc_unc_y, glob_unc_x` and `glob_unc_y`. For more details on these parameters see Table 1.

1.3.3 Geolocation

All data are in the latitude/longitude coordinate system on the WGS-84 datum.

1.4 Temporal Information

1.4.1 Coverage

Most data come from satellite imagery and are therefore post-1980, but some data come from mapping moraines. The general temporal coverage is currently 1850 – 2018.

1.4.2 Resolution

Time coverage is irregular and data entry dependent.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

GLIMS is an international initiative with the goal of repeatedly surveying the world's estimated 200,000 glaciers. GLIMS uses data collected by the ASTER instrument aboard the Terra satellite and the LANDSAT series of satellites, along with historical observations.

The GLIMS initiative has created a unique glacier inventory, storing information about the extent and rates of change of all the world's mountain glaciers and ice caps. The GLIMS project at NSIDC has implemented a database of glacier outlines from around the world and other information about glaciers that also includes metadata on how those outlines were derived. The GLIMS Glacier

Database was created from data contributions from many glaciological institutions, which are managed by Regional Coordinators, who coordinate the production of glacier mapping results for their particular region. The GLIMS Glacier Database provides students, educators, scientists, and the public with reliable glacier data from these analyses. New glacier data are continually being added to the database.

Closely related to GLIMS, and in the future converging with GLIMS, is the Randolph Glacier Inventory (RGI 6.0), a global inventory of glacier outlines. While GLIMS is a multi-temporal database with an extensive set of attributes, the RGI is intended to be a snapshot of the world's glaciers as they were near the beginning of the 21st century. The content of the RGI has mostly been integrated into the GLIMS database with the exception of a couple of regions. However, work remains to be done to make the RGI a downloadable subset of GLIMS, offering complete one-time coverage, version control and a standard set of attributes. Production of the RGI was motivated by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). Future updates will be made to the RGI and the GLIMS Glacier Database in parallel during a transition period. As all these data are incorporated into the GLIMS Glacier Database and as download tools are developed to obtain GLIMS data in the RGI data format, the RGI will evolve into a downloadable subset of GLIMS, offering complete one-time coverage, version control, and a standard set of attributes.

2.2 Acquisition

Most data are retrieved from satellite optical imagery. Some data come from old geographical maps and some from mapping moraines with satellite imagery.

2.3 Processing

The processing is variable. Most processing involves image classification with the band ratio method and polygons are typically edited to correct small errors and to include debris cover when the satellite imagery is converted from raster to vector. Some data are the result of manual digitization.

2.4 Quality, Errors, and Limitations

For details on Quality, Errors, and Limitations refer to "Chapter 7 | Quality in the GLIMS Glacier Database" in Kargel et al. (2014). The uncertainty parameters in the data are `loc_unc_x`, `loc_unc_y`, `glob_unc_x` and `glob_unc_y`. For more details on these parameters see Table 1.

2.5 Instrumentation

Data are retrieved from TERRA/ASTER and LANDSAT-7 satellites as well as from ground-based observations.

3 SOFTWARE AND TOOLS

This section describes:

- How to explore the GLIMS database using the GLIMS data viewer, a map interface. (see Section 3.1)
- How to explore the GLIMS database using a text-based interface searching for glaciers based on name, classification, area, ect. (see Section 3.2)
- A tour of the xml based quick look on the data (see Section 3.3)
- What data download options are available for GLIMS (see Section 3.4)

3.1 Guide to using the GLIMS Glacier Viewer (map interface)

The GLIMS Glacier Viewer was developed to provide the public with easy access to the GLIMS Glacier Database. This Web application allows users to view and query several thematic layers, including glacier outlines, Regional Coordinator institution locations, the World Glacier Inventory, and more. GLIMS data can be downloaded into a number of GIS-compatible formats, including ESRI Shapefiles, MapInfo tables, GML, and KML suitable for viewing in Google Earth.

The GLIMS Glacier Viewer can be accessed here: http://glims.colorado.edu/glacierdata/ by clicking “GLIMS Glacier Viewer”. Figure 1 shows the Access Page for the GLIMS Glacier Viewer.

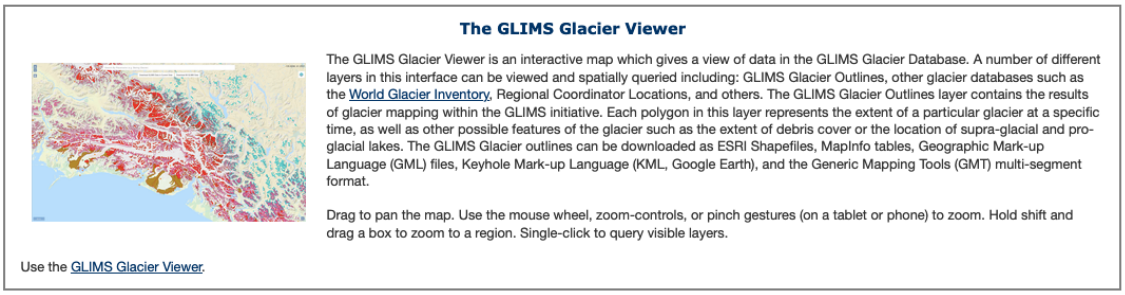


Figure 1. Access Page for GLIMS Glacier Viewer

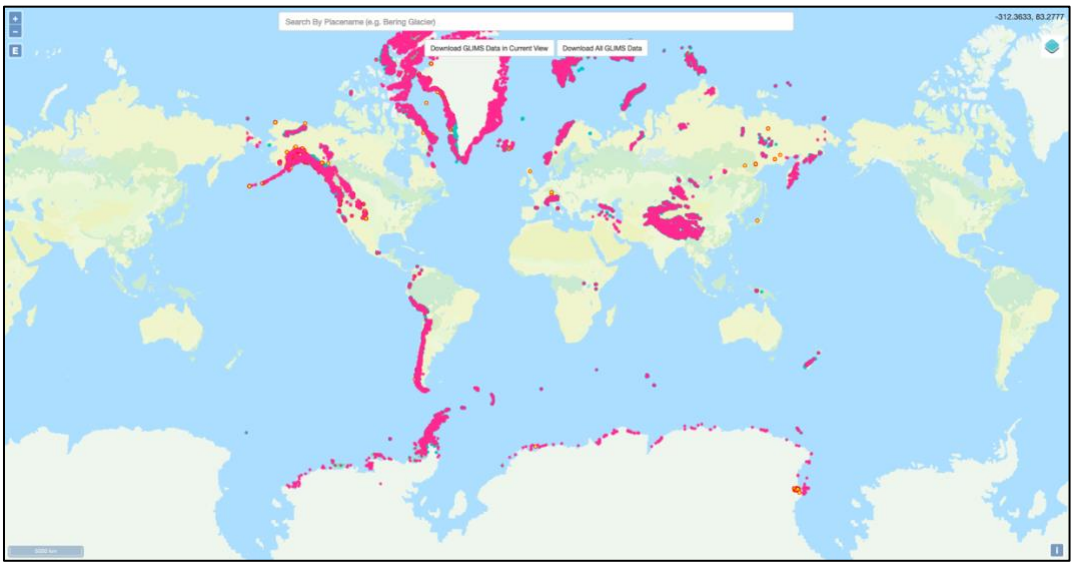


Figure 2. Screenshot of the Interactive GLIMS Glacier Viewer Map

This will open a map view; an example is shown in Figure 2. The following features are available in this interactive map:

- Use the mouse wheel, zoom-controls in the upper left, or pinch gestures (on a tablet or phone) to zoom
- Hold SHIFT and the left mouse button to draw a box to zoom into the map.
- Click on the ‘E’ in the upper left corner to show the entire world map
- Drag by holding the left mouse button to pan the map
- Hovering over the layer symbol on the upper right displays the map legend (See Figure 3), allows to show or hide different glacier databases and to choose the underlying base map.
- The search bar on the center top allows users to search glaciers by name.
- Right under the search bar are buttons to “download all GLIMS Data in Current View” or to “download all GLIMS data”.
- To customize the area of interest both, zoom and reshaping the browser window can be used to select a region (e.g. tall and skinny versus short and wide)
- A single click on an element displays a window with the available data for the selected item including Glacier Name, Glacier ID, Analysis ID, Area, AS-of Date, Source and an option to select more info. (see Figure 4)

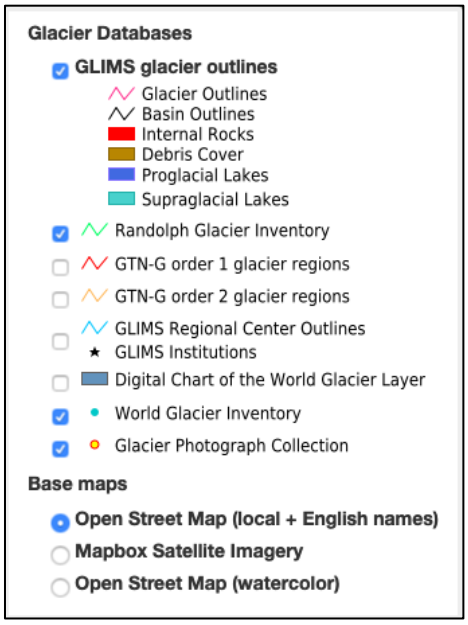


Figure 3. GLIMS Glacier Viewer Legend

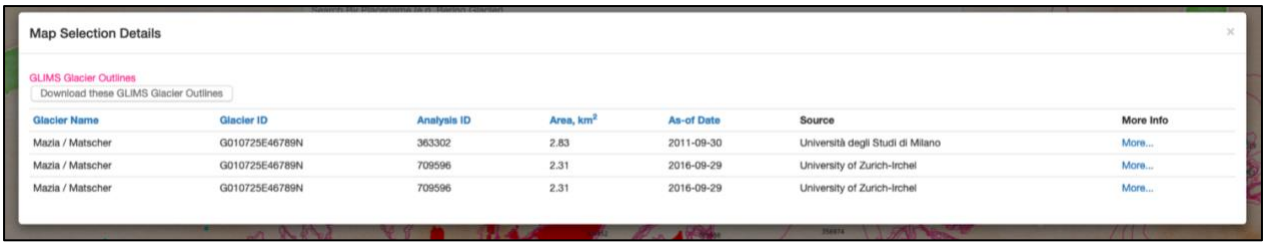


Figure 4. Map Selection Details

3.2 Guide to using the GLIMS Text-search function

A different option to search the GLIMS database is via the text-search based function. It can be accessed on the same webpage (http://glims.colorado.edu/glacierdata/) by clicking “Use the GLIMS Text Search”, see Figure 5.

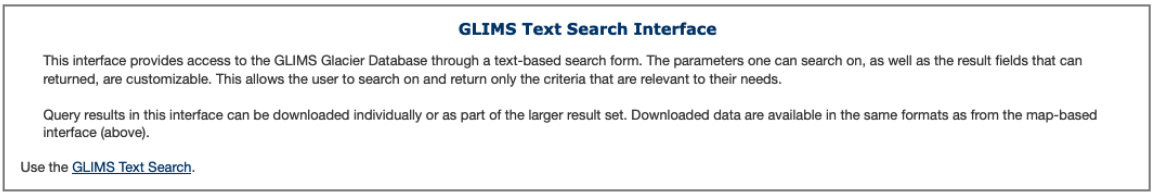


Figure 5. Access Page for GLIMS Text Search

This opens a parameter-based search interface shown in Figure 6. This allows for the search of glaciers by name, ID, country or other text-based information as well as to filter the database by glacier area, elevation, length, width, WGMS classification, etc. Another option is to search for data provided by a specific data center, data submitter, or data analyst. The search button will search the database by the given parameters and the reset button will reset the search form.

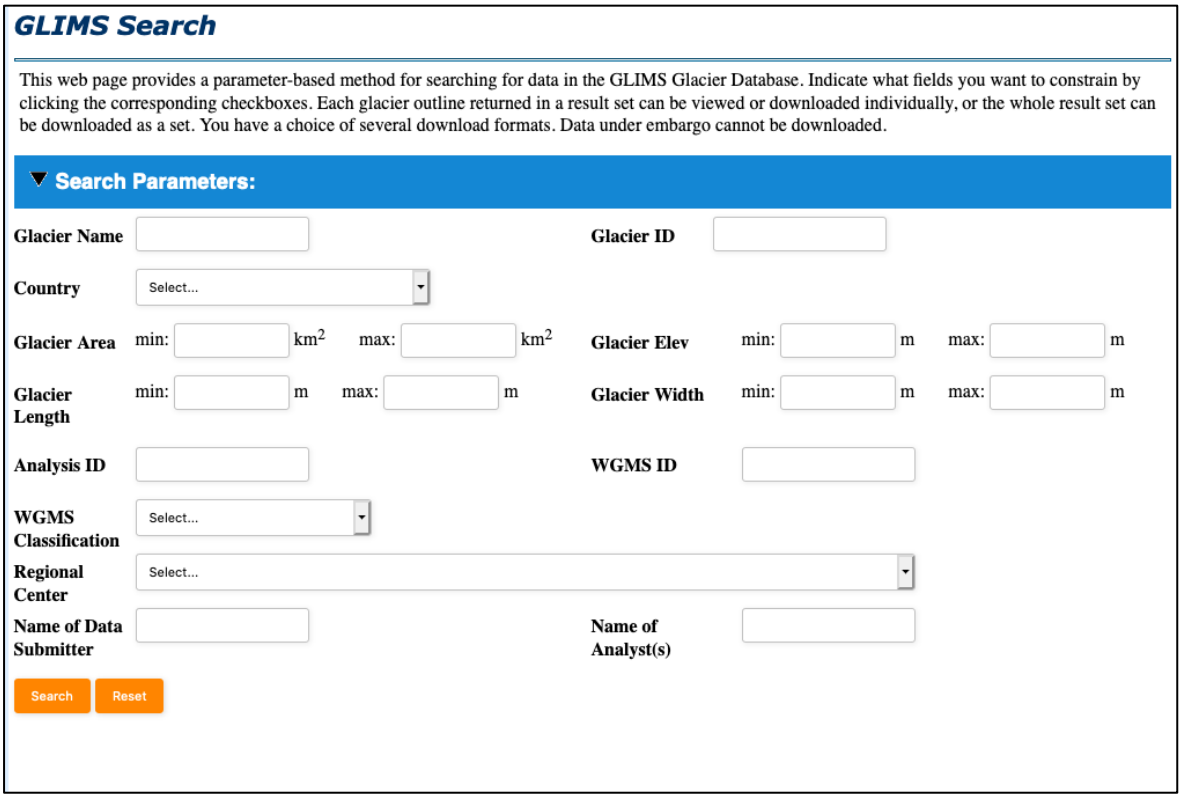
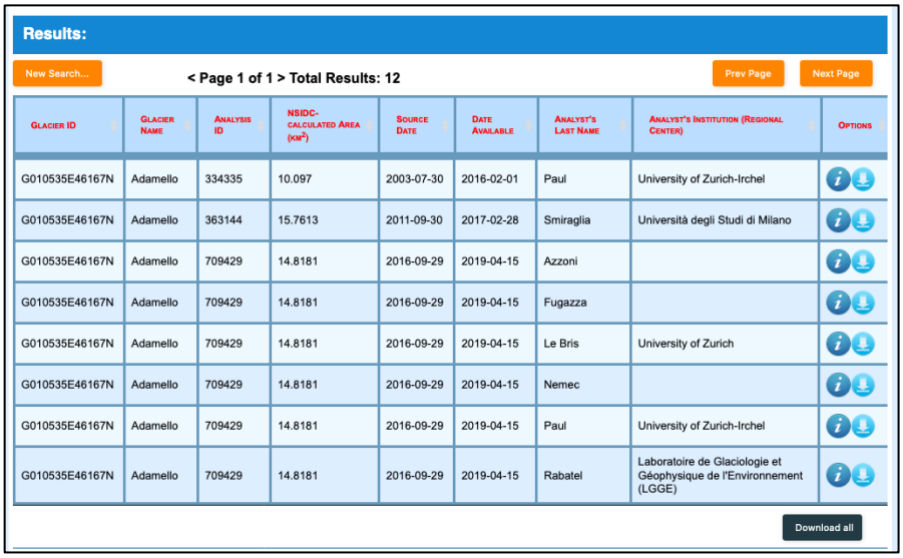


Figure 6. GLIMS Parameter-Based Search Interface

An example result list of glaciers is shown in Figure 7. This is the output when entering *Adamello* (a glacier in Italy) in the glacier name field. The results list displays glacier ID, glacier name, analyst ID, NSIDC- calculated area, source date, date available, analyst's last name, and analyst's institution. At this point, the user has the option to click the "download all" button or click on the "information icon" or "download icon" to the right of each listed data set.



Results:

New Search... < Page 1 of 1 > Total Results: 12 Prev Page Next Page

Glacier ID	Glacier Name	Analysis ID	NSIDC-calculated Area (km²)	Source Date	Date Available	Analyst's Last Name	Analyst's Institution (Regional Center)	Options
G010535E46167N	Adamello	334335	10.097	2003-07-30	2016-02-01	Paul	University of Zurich-Irchel	
G010535E46167N	Adamello	363144	15.7613	2011-09-30	2017-02-28	Smiraglia	Università degli Studi di Milano	
G010535E46167N	Adamello	709429	14.8181	2016-09-29	2019-04-15	Azzoni		
G010535E46167N	Adamello	709429	14.8181	2016-09-29	2019-04-15	Fugazza		
G010535E46167N	Adamello	709429	14.8181	2016-09-29	2019-04-15	Le Bris	University of Zurich	
G010535E46167N	Adamello	709429	14.8181	2016-09-29	2019-04-15	Nemec		
G010535E46167N	Adamello	709429	14.8181	2016-09-29	2019-04-15	Paul	University of Zurich-Irchel	
G010535E46167N	Adamello	709429	14.8181	2016-09-29	2019-04-15	Rabatel	Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE)	

Download all

Figure 7. Example Results List

3.3 Tour of GLIMS Data Info

Section 3.1 and 3.2 described how to filter GLIMS data via the map interface or the text search option, respectively. Both searches result in a list of results that have a “more info” option. Via the map, you click on the “more…” link on the right side of the results list (Figure 4); and for the text search, you click on the info icon under the “Options” column. Both results in display of the information with various tabs such as “Glacier Info”, “Submission Info”, “Analyst Info”, “Image Info”, “Map Info”, “Glacier Map”, “Hypsometry” and “Download”. An example display is shown in Figure 8. Each tab can be explored for more information on a particular GLIMS record. The “Download” tab with its options is explained in more detail in the next section.

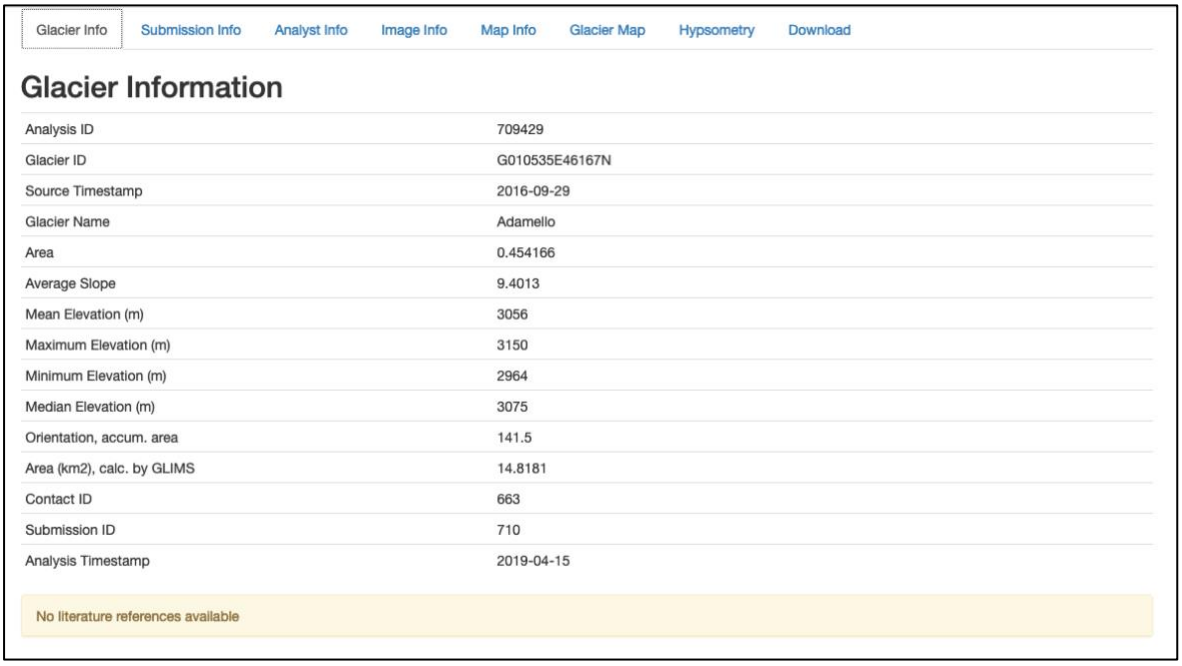


Figure 8. Example Information for Analysis ID 709429

3.4 Tour of GLIMS Data Download

There are several options to get to a download interface and GLIMS records can be downloaded individually or as aggregates. The following are some of the ways to download GLIMS data:

- After selecting an individual GLIMS record on the list provided by the text search (Figure 7) and clicking the “Info” icon, the download option will be on the top right tab (Figure 8) and link to the download interface.
- After selecting an individual GLIMS record on the list provided by the text search (Figure 7), the “Download” icon on the right side of the record will lead directly to a download interface.
- The “Download all” button at the right lower corner of the list provided by the text search (Figure 7) will lead to the download interface.

- A single click in the map interface results in a pop-up window, clicking on “More…” will show one record like in Figure 8 and the download tab will again lead to the download interface.
- A single click in the map interface results in a pop-up window, and clicking on “Download these GLIMS Glacier Outlines” on the top left will lead to the download interface.
- In the map interface, there are also the options “Download GLIMS Data in Current View” and “Download All GLIMS Data” on the center top (Figure 2) that both lead to the download interface.

An example view of the download interface is shown in Figure 9:

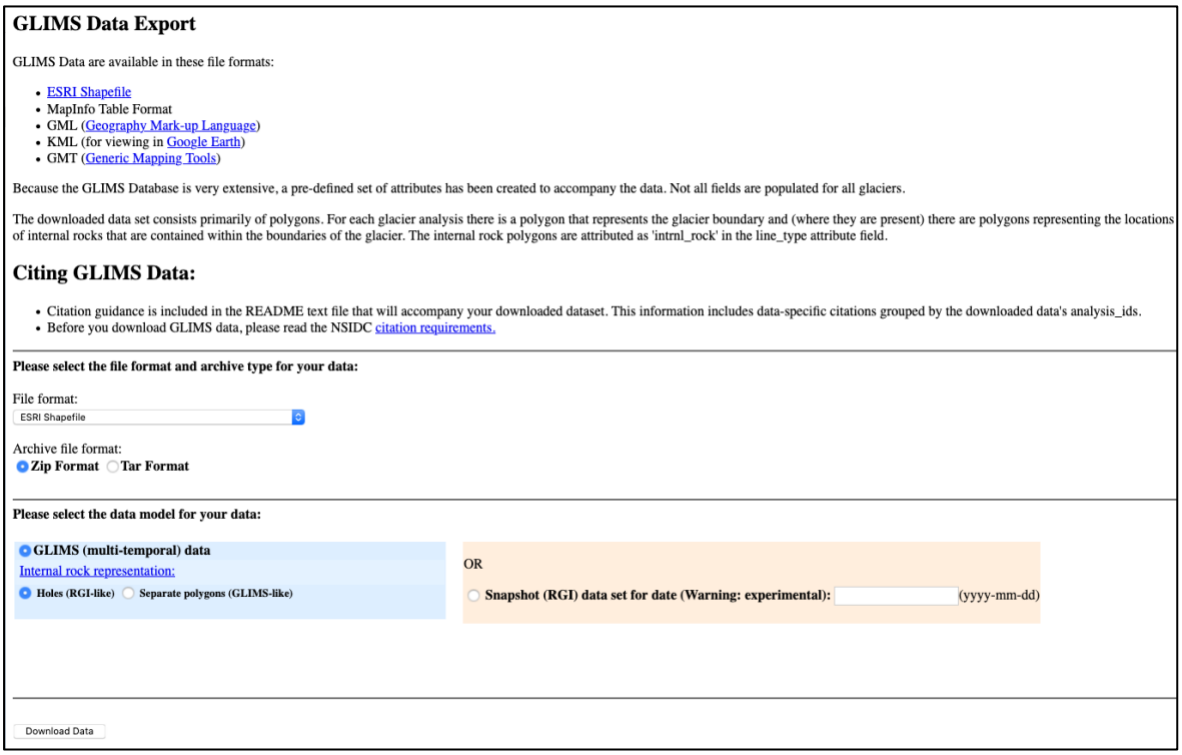


Figure 9. GLIMS Download Interface

The first section in the GLIMS Download Interface describes the available file formats as well as citation guidelines. Click on “citation requirements” in the center of the screen for more information on NSIDC’s data citation policies or find the information directly on NSIDC’s Use and Copyright web page. Each data download will include a CITATIONS.txt file with citation guidelines. See more detailed information on how to cite these data in Section 7 Citing GLIMS Data.

3.4.1 Data Format Selection

GLIMS Data are available in several file formats:

- ESRI Shapefile
- MapInfo Table Format
- GML
- KML (for viewing in Google Earth)
- GMT

For each download order, you can select one of the above file formats. An archive file format (Zip or Tar) also has to be selected. Zip is the default selection.

3.4.2 Data Model Selection

For the GLIMS multi-temporal data, there are two different options for internal rock representation. The “Holes” option represents internal rock outcrops (nunataks) as holes in the glacier boundary polygon similar to the RGI data. The “Separate polygons” option represents nunataks with separate polygons. Figure 10 details the two model options. A third option is available for snapshots in time where a date in yyyy-mm-dd format has to be entered.

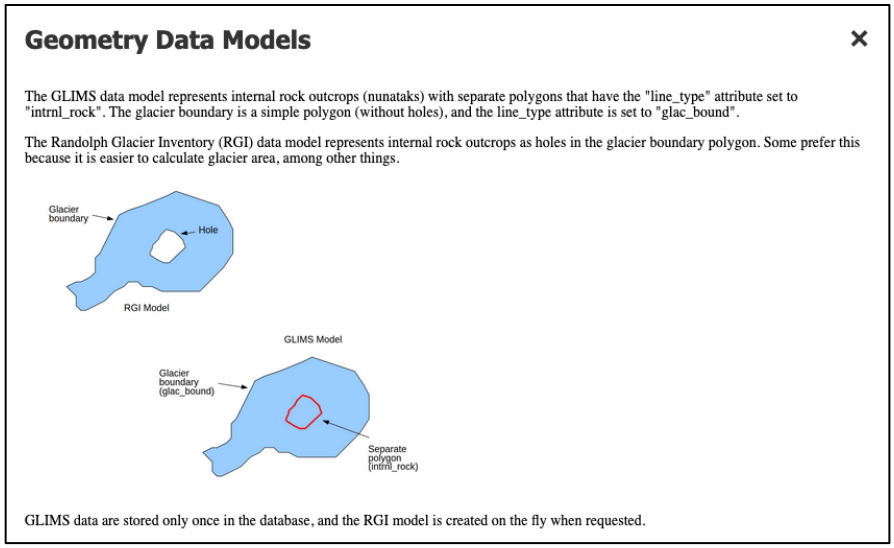


Figure 10. Geometry Data Model Options for GLIMS multi-temporal data

4 VERSION HISTORY

GLIMS data is updated continuously within Version 1.

5 RELATED DATA SETS

Randoph Glacier Inventory 6.0

6 RELATED WEBSITES

GLIMS | Overview
GLIMS | Data Access
GLIMS at NSIDC

7 CITING GLIMS DATA

When citing GLIMS data, please be sure to include all the information in the examples below, including the analyst's name.

When referring to the GLIMS Initiative in general, please cite:

Raup, B.H.; A. Racoviteanu; S.J.S. Khalsa; C. Helm; R. Armstrong; Y. Arnaud (2007). "The GLIMS Geospatial Glacier Database: a New Tool for Studying Glacier Change". Global and Planetary Change 56:101--110. (doi:10.1016/j.gloplacha.2006.07.018)

When referring to the complete set of GLIMS glacier data (e.g. for a global study of glaciers), please cite:

GLIMS and NSIDC (2005, updated 2020): Global Land Ice Measurements from Space glacier database. Compiled and made available by the international GLIMS community and the National Snow and Ice Data Center, Boulder CO, U.S.A. DOI:10.7265/N5V98602

When referring to Analysis_IDs in the range 328449--335984, please cite:

Paul, Frank (submitter); Paul, Frank (analyst(s)), 2010. GLIMS Glacier Database. Boulder, CO. National Snow and Ice Data Center. http://dx.doi.org/10.7265/N5V98602

When referring to Analysis_IDs in the range 362642--363545, please cite:

Smiraglia, Claudio (submitter); Smiraglia, Claudio (analyst(s)), 2015. GLIMS Glacier Database. Boulder, CO. National Snow and Ice Data Center. http://dx.doi.org/10.7265/N5V98602

When referring to Analysis_IDs in the range 706804--710644, please cite:

Paul, Frank (submitter); Azzoni, R.S.; Fugazza, D.; Le Bris, Raymond; Nemec, J.; Paul, Frank; Rabatel, Antoine; Ramusovic, M.; Rastner, Philipp; Schaub, Yvonne; Schwaizer (nee Bippus), Gabriele (analyst(s)), 2019. GLIMS Glacier Database. Boulder, CO. National Snow and Ice Data Center. http://dx.doi.org/10.7265/N5V98602

8 CONTACTS AND ACKNOWLEDGMENTS

A large consortium of scientists is collaborating in this project. The overall effort is guided by the GLIMS Core Team

9 REFERENCES

Kargel, J.S., G.J. Leonard, M.P. Bishop, A. Kaab, B. Raup (Eds), 2014, Global Land Ice Measurements from Space (Springer-Praxis). 33 chapters, 876 pages. ISBN: 978-3-540-79817-0.

A list of GLIMS publications sorted by year can be found here: https://www.glims.org/Publications/.

10 DOCUMENT INFORMATION

10.1 Publication Date

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10.2 Date Last Updated

15 December 2020