GLACIOCLIM DMP

Plan de gestion de données créé à l'aide de DMP OPIDoR, basé sur le modèle "ANR - DMP template (english)" fourni par Agence nationale de la recherche (ANR).

Plan Details

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Project Details

Project title GLACIOCLIM

Acronym GLACIOCLIM

Abstract

The SNO (Service National d'Observation) GLACIOCLIM is a National Observation Service aimed at standardizing and sustaining a network of measurements on a set of glaciers worldwide and snow observatories to document the impact of climate change in four regions with highly contrasting climates (temperate, tropical, and polar zones). The objective of this National Observation Service is to provide long-term data to the scientific community on one of the most relevant indicators of climate change: glaciers. In addition, the snow sites contribute to the understanding of critical glaciological processes and enable a fruitfull methodological and instrumental cooperation. The observations conducted by GLACIOCLIM, integrated into global glacier and snow monitoring networks, contribute to improving estimates of water resources and sea level rise potential associated with variations in glacier extent worldwide.

GLACIOCLIM's observation strategy (including monitored variables, instrumented sites, protocols, etc.) is aligned with internationally defined strategies such as the Global Terrestrial Network for Glaciers, Global Cryosphere Watch, and World Glacier Monitoring Service. The labeled in-situ observations pertain to glaciological, meteorological and snow variables. They are carried out on 5 glaciers and 2 snow sites in the French Alps, 2 glaciers in the Andes (Bolivia and Ecuador), 1 glacier in Himalaya (Nepal) and 2 sites in Antarctica (coastal and continental plateau). The GLACIOCLIM data series are among the longest series in the world.
The GLACICOCLIM data serve as relevant climate indicators in high-latitude, mid-altitude and high-altitude areas. Annual observations are considered as *Essential Climate Variables* by the World Meteorological Organization (WMO), that means variables or a group of linked variables that critically contributes to the characterization of Earth's climate.

Funding

- Institut National des Sciences de l'Univers (INSU) :
- Observatoire des Sciences de l'Univers de Grenoble (OSUG) :
- Institut polaire français Paul-Émile-Victor (IPEV) :
- Institut de Recherche pour le Développement (IRD) :
- Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE) :
- French national meteorological service (Météo-France) :
- Private and Institutional partners :

Start date 2004-01-01

Partners

- Parc National des Ecrins
- International Centre for Integrated Mountain Development
- Tribhuvan University
- Universidad Major de San Andrés
- Instituto Nacional de Meteorologia y Hidrologia

Research outputs :

1. Default research output

Contributors

Name	Affiliation	Roles
Arroyo Daniel		
Gouttevin Isabelle - https://orcid.org/0000-0002-1801-684X	Météo-France - https://ror.org/0233st365	• DMP manager
Six Delphine - https://orcid.org/0000-0001-7699-9568	Observatoire des Sciences de l'Univers de Grenoble (OSUG) - https://ror.org/03vte9x46	• Project coordinator

GLACIOCLIM DMP

1. Data description and collection or re-use of existing data

1a. How will new data be collected or produced and/or how will existing data be re-used?

Data collection

GLACIOCLIM combines the reuse of historical data with ongoing collection efforts, using in situ measurements, aerial/satellite surveys, and meteorological observations. Data integration and extrapolation contribute to a comprehensive understanding of glacier changes and their relationship with climate in addition to snow and glacier processes. Existing data, both historical and ongoing, are integrated and extrapolated over time and space to provide a comprehensive view of glacier evolution, while for snow sites reference snow and/or meteorological data are targetted. Ongoing efforts involve combining various data sources, including glaciological, geodetic, and meteorological data, to document spatial and temporal variability.

Glacier Snout Position

Existing data on the position of glacier snout, dating back to the 19th century, is available for approximately 2000 glaciers worldwide. Ongoing monitoring of glacier snout positions provides essential data, and historical records contribute to understanding regional representativity. The snout position data is crucial for simulations and understanding climate-glacier relationships.

In Situ Mass Balance Measurements

Annual in situ mass balance measurements involve point-by-point assessments of winter and summer mass changes, combining direct measurements and modeling to estimate glacier-wide balances. Long-term in situ mass balance measurements for specific glaciers, such as Sarennes, Saint-Sorlin, and Argentière in the French Alps, have been ongoing since the mid-20th century.

Ice Thickness and Elevation Changes

Ice thickness variations are measured every year on each glacier along profiles spread at different altitudes. Surface elevation changes are measured using aerial or satellite surveys every 5 to 10 years. Annual in situ measurements complement satellite surveys, helping to quantify uncertainties in aerial/satellite-derived elevation models.

Surface Velocity and Topographic Measurements

In situ topographic measurements, including surface ice velocity, provide insights into glacier flow dynamics. Surface ice velocity is measured in situ to understand dynamic glacier responses to climate changes. These measurements are essential for understanding glacier response to annual mass balance.

Meteorological Observations

Continuous meteorological observations, including wind speed, solar radiation, atmospheric and surface temperatures, are recorded at various sites. High-altitude and high-latitude meteorological observations complement conventional networks, providing insights into the ice-climate relationship. Precipitation estimates are made using rain gauges.

Snow depth

Snow depth data are continuously acquired by automatic sensors at the 2 snow observation sites. Manual reference measurements are also carried out weekly at the Col de Porte site during the winter season and are used in the development of expert data for this site.

Snow flux

Blowing snow flux is estimated at one meter, and as an integrate over 20cm-1.2m height, based on automatic measurements performed by Snow Particle Counters. This estimation relies on an expert methodology and ancilary data (height of the sensors, snow depth, wind speed) described in the following article describing the Col du Lac Blanc data:

Guyomarc'h, G., Bellot, H., Vionnet, V., Naaim-Bouvet, F., Déliot, Y., Fontaine, F., Puglièse, P., Nishimura, K., Durand, Y., and Naaim, M.: A meteorological and blowing snow data set (2000–2016) from a high-elevation alpine site (Col du Lac Blanc, France, 2720 m a.s.l.), Earth Syst. Sci. Data, 11, 57-69, https://doi.org/10.5194/essd-11-57-2019, 2019.

1b. What data (for example the kind, formats, and volumes), will be collected or produced?

The observations of glaciers and weather are carried out in the French Alps, the Tropical Andes (Bolivia, Ecuador), Antarctica (Dome C area, Adélie land area), and the Himalayas (Nepal). Snow observations are conducted in the French Alps.

Time span column

The start of measurements for each variable varies depending on each site or glacier. For instance, the oldest measurement dates back to 1890, specifically for the snout position variable at the Mer de Glace observation site. This table presents an average date of measurements grouped by regions. For more detailed information on the dates associated with each measurement site, it is necessary to refer to the GLACIOCLIM website.

Variable type	Measured variables	Data kind	Data format	Data volume	Locations	Time span	Data contact
Glacier	Snout position	Numeric time series	CSV	50 MB	Alps: Argentière, Mer de Glace, Gébroulaz, Saint-Sorlin, Glacier Blanc. Himalaya: Mera. Andes: Zongo, Antizana.	Alps: 1975-ongoing Himalaya: 2007-ongoing Andes:1995 - ongoing	Principal investigator: Delphine Six (UGA-IGE)
	Mass balance	Numeric time series	CSV	100 MB	Alps: Argentière, Mer de Glace, Gébroulaz, Saint-Sorlin, Glacier Blanc. Himalaya: Mera. Andes: Zongo, Antizana. Antarctica: Dome C, Terre Adélie.	Alps: 1975-ongoing Himalaya: 2007-ongoing Andes:1995 - ongoing Antarctica: 2003 - ongoing	Principal investigator: Delphine Six (UGA-IGE)
	Ice thickness and elevation change	Numeric time series	CSV	200 MB	Alps: Argentière, Mer de Glace, Gébroulaz, Saint-Sorlin, Glacier Blanc. Himalaya: Mera. Andes: Zongo, Antizana.	Alps: 1975-ongoing Himalaya: 2007-ongoing Andes:1995 - ongoing	Principal investigator: Delphine Six (UGA-IGE)
	Surface velocity and topography	Numeric time series	CSV	200 MB	Alps: Argentière, Mer de Glace, Gébroulaz, Saint-Sorlin, Glacier Blanc. Himalaya: Mera. Andes: Zongo, Antizana. Antarctica: Glacier de l'Astrolabe.	Alps: 1975-ongoing Himalaya: 2007-ongoing Andes:1995 - ongoing	Principal investigator: Delphine Six (UGA-IGE)
Snow	Snow depth	Numeric time series	CSV, NetCDF (version-4)	50 MB	Alps: Col du Lac Blanc, Col de Porte.	Col du Lac Blanc: 01/12/2000 - ongoing Col de Porte: 01/08/1960 - ongoing	Principal investigator: Isabelle Gouttevin (Meteo France-CEN) Data manager: Hugo Merzisen (Meteo France-CEN), Yves Lejeune (Meteo France-CEN), Hervé Bellot (INREA-IGE) Data collector : Yannick Deliot (Meteo France CEN), Anne Dufour (Meteo-France CEN), Yves Lejeune (Meteo France CEN) and Hervé Bellot (INRAE-IGE) Project member : Marie Dumont, Jean-Michel Panel, Florence Naaim, Mathieu Fructus, Erwan

							Le Gac
	Snow flux	Numeric time series	NetCDF (version-4)	30 MB	Alps: Col du Lac Blanc.	Col du Lac Blanc: 01/01/2011 - ongoing	Principal investigator: Florence Naaim (INRA-IGE) Data manager: Hervé Bellot (INRAE-IGE), Data collector : Hervé Bellot (INRAE-IGE)
Meteorological	Meteorological observations	Numeric time series	CSV, NetCDF (version-4)	800 MB	Alps: Col du Lac Blanc, Col de Porte, Argentière, Saint-Sorlin. Himalaya: Mera. Andes: Zongo, Antizana. Antarctica: Terre Adélie, Dome C.	Alps: 1975-ongoing Himalaya: 2007-ongoing Andes:1995 - ongoing Antarctica: 2007 - ongoing	Principal investigator: Delphine Six (UGA-IGE), and Isabelle Gouttevin-Meteo (France-CEN) and Florence Naaim (INRAE-IGE) for snow sites Data manager: Yannick Deliot (Meteo France CEN), Anne Dufour (Meteo-France CEN), Yves Lejeune (Meteo France CEN) and Hervé Bellot (INRAE-IGE) for snow sites Project member : Marie Dumont, Jean-Michel Panel, Erwan Le Gac, Mathieu Fructus, Yannick Deliot, Florence Naaim

2. Documentation and data quality

2a. What metadata and documentation (for example the methodology of data collection and way of organising data) will accompany the data?

Metadata and documentation for raw data

Glacier data

Collected raw data:

Metadata for raw data is meticulously documented in a notebook, accessible to all researchers within the lab. The recorded information encompasses date and time collection (in UTC format) and location. It also includes records of anomalies during data collection, such as measurement-related issues or problems with sensors. Additionally, any actions taken during data collection, such as cleanings or specific operations, are documented.

Teletransmitted raw data:

There is a file called "SAV" that is teletransmitted daily. It includes information about sensor programs, the temperature of the location, and details about the battery status. It also contains diagnostic variables, data transmission issues or information about sensors that need to be emptied or cleaned.

Metadata and documentation for processed data

Current state

Glacier, snow and meteorological data is available on GLACIOCLIM's website, organized by regions (Alpes, Andes, Antarctica, Himalaya), type of data, sites, and is presented in separate files for each year, alongside information about measured variables, time span, and locations.

A comprehensive metadata catalog is available too: This catalog provides detailed descriptions of available datasets, employing standardized domain keywords and referencing WGMS (World Glacier Monitoring Service) and GCOS (Global Climate Oserving System).

Specifically meteorological and snow datasets from Col de Porte and Col du Lac Blanc are referenced by a DOI, incorporating metadata aligned with the DataCite standards. This metadata includes information on creators, dataset title, publisher, year of publication, dataset abstract, data access and use constraints, keywords, geolocations, dates, contributors, funding references, primary language, related identifiers, and data formats. Data can be obtained in ZIP files.

Snow data:

The raw data and processed data metadata for the snow sites is currently documented in two datapapers.

Lejeune, Y., Dumont, M., Panel, J.-M., Lafaysse, M., Lapalus, P., Le Gac, E., Lesaffre, B., & Morin, S. (2019). 57 years (1960–2017) of snow and meteorological observations from a mid-altitude mountain site (col de porte, France, 1325 m of altitude). Earth System Science Data, 11(1), 71–88. https://doi.org/10.5194/essd-11-71-2019

Guyomarc'h, G., Bellot, H., Vionnet, V., Naaim-Bouvet, F., Déliot, Y., Fontaine, F., Puglièse, P., Nishimura, K., Durand, Y., & Naaim, M. (2019). A meteorological and Blowing snow data set (2000–2016) from a high-elevation alpine site (Col du Lac Blanc, France, 2720 m a.s.l.). Earth System Science Data, 11(1), 57–69. https://doi.org/10.5194/essd-11-57-2019.

Next state

Metadata will adhere to the Theia/OZCAR metadata model, commonly known as the Theia/OZCAR pivot format, while observed variables will be named in accordance with the Theia/OZCAR thesaurus.

The pivot format comprises three integral components: Observatory description (adhering to the Dublin Core standard), Dataset description (conforming to the ISO 19115/Inspire standard), and Observation description (following the Observation & Measurement standard).

Pivot format section	Components
Observatory description	1. Identification: Name, Title and Description 2. Fundings 3. Contacts
Dataset description	1. Identification : Dataset title, Description, 2. Thematic: GEMET Inspire Theme,Topic Category (ISO 19115) 3. Keywords 4. Spatial Extent 5. Temporal Extent 6. Access and use constraints 7. Contacts
Observation description	1. Sampling feature of interest : Station name, Location 2. Variable: name, unit and description 3. Acquisition Procedure: Processing information, Sensor Information 4. Observation: Temporal extent 5. Result: Time series data

For more in-depth information about the metadata pivot format, kindly refer to the following link: https://theia-ozcar.gricad-pages.univ-grenoble-alpes.fr/doc-producer/producer-documentation.html#modele-de-donnees-pivot

For more in-depth information about the Thesaurus of THEIA/OZCAR, kindly refer to the following link: https://theia-ozcar.gricad-pages.univ-grenoble-alpes.fr/doc-producer/producer-documentation.html#thesaurus-theia-ozcar-categories-et-noms-de-variables

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2b. What data quality control measures will be used?

The GLACIOCLIM data are mostly collected in harsh environments where wind, snow and cold conditions are prone to wear the sensors rapidly and alter their measurements. Therefore emphasis is put on the calibration and routine checks of the sensors. Overall, the GLACIOCLIM approach involves a combination of diverse measurements, rigorous quality controls, and thorough data validation to ensure the reliability of results in extreme environmental conditions.

Calibration of Measurement Instruments

Calibration Protocols

Before deployment in the field, each instrument undergoes an initial calibration in the laboratory or in specialized centers. Sensors, such as those used to measure ice thickness (GPR), thickness variations (d-GNSS) and ice flow velocities (d-GNSS), are calibrated to ensure their accuracy. Geodetic and meteorological instruments, like photogrammetry systems or humidity sensors, undergo regular calibrations to guarantee precise results. For instance the Snow Particle Counters undergo annual revisions. Sensors exposed to extreme conditions (cold, wind, humidity) may require periodic adjustments to maintain accuracy.

Routine Checks

Routine checks are conducted during measurement campaigns to detect any drift or anomaly in the instruments over the course of the long-term measurements. Continuous measurement instruments, such as meteorological sensors, are regularly verified and adjusted if necessary based on punctual in-situ measurements or independant observations. For instance, wind sensors are also regularly checked at null wind-speed while snow depth sensor are checked based on a ruler measure.

Preventive Maintenance

In addition to calibration, preventive measures are taken to ensure the proper functioning of the instruments.
This may include the regular replacement of wear-prone components, sensor cleaning, and other technical adjustments.

Adaptations to Environmental Conditions

Extreme environmental conditions, such as intense cold in Antarctica, often require specific adaptations to ensure the proper functioning of instruments. Technologies used in these challenging environments, such as the use of rugged PCs and batteries adapted to the cold, are key elements of adaptation.

Critical Analysis and Data Validation

Quality Control

Raw data undergoes quality control. For weather measurements, visual checks and comparisons with pre-established models or interannual references are performed. For glaciological measurements, mass balance calculations are verified site by site, also comparing from one site to another on the glacier.

Data Validation

Validated data is then submitted to external partners (for glaciers in Bolivia and Ecuador) or specific staff. Raw and processed data undergo a validation process that may vary depending on the nature of the measurements. The inter-variable consistency can also be examined to assist in qualifying or correcting the data.

For snow depth and weather measurements, gap-filling can be performed with the help of redundant measurements.

Some of the GLACIOCLIM data are post-processed data (e.g., snow transport fluxes), with post-processing only occurring after a consistency check of the core variables. These consistency checks rely on estimations of the uncertainty in the measurements of the core variables and can be found in the following GLACIOCLIM datapaper:

Guyomarc’h, G., Bellot, H., Vionnet, V., Naaim-Bouvet, F., Déliot, Y., Fontaine, F., Puglièse, P., Nishimura, K., Durand, Y., & Naaim, M. (2019). A meteorological and Blowing snow data set (2000–2016) from a high-elevation alpine site (Col du Lac Blanc, France, 2720 m a.s.l.). Earth System Science Data, 11(1), 57–69. https://doi.org/10.5194/essd-11-57-2019.

Uncertainty

Uncertainty in mass balance calculations is quantified, taking into account systematic and random errors in in-situ observations and their processing. Previous work has established standardized methodologies for quantifying uncertainties.

Uncertainty in snow depth data at the snow sites is charaterized with the help of the spatial variabilty and knowledge of the sensors' accuracy. Uncertainty in meteorological observations is derived from instruments' uncertainty and can be refined through specific campaigns.

Processing Time

The entire process, from data extraction to report writing, requires approximately 10 days of 1 FTE (full-time equivalent) per site. The snow site Col de Porte is an exception to that rule, as the production of expert data requires approximately 1 month FTE.

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3. Storage and backup during the research process

3a. How will data and metadata be stored and backed up during the research?

Glacier data

Raw data and metadata

Raw data is obtained through teletransmission or direct collection. Teletransmitted data is transmitted multiple times daily via Loggernet (teletransmission software) to an IGE server for storage (using SUMMER storage solution). Raw data directly collected is stored on researchers' local machines and external hard disks. However, there is an ongoing effort to implement the use of a team-shared directory (using SUMMER storage solution).

Metadata for collected raw data is recorded in the notebook mentioned in section 2a. Additionally, this information is digitized and stored on researchers' local machines and external hard disks. However there is also an ongoing effort to implement the use of the team-shared directory.

Metadata for teletransmitted raw data (SAV file) is directly stored in the IGE server.

Processed data and metadata

Additionally, investigators retrieve raw data from the IGE server onto their local machines at least once per year for analysis and quality control procedures. Processed data and metadata are stored on their local machines and external hard disks. Here, there is also an ongoing effort to implement the use of the team-shared directory.

Snow and meteorological data

Raw data is transmitted to a server at CNRM and, for the data that are acquired by INRAE, to an INRAE server. An initial correction, based on the accuracy of the acquisition dates, is performed by a technician. Following this, engineers and/or review the data and make adjustments, including gap filling and expert data qualification and validation. However, due to resource constraints, this process is not applied to all data. Simultaneously, both raw and validated data are stored at CNRM and INRAE.

Storage and backup solutions

GLACIOCLIM leverages storage and backup solutions provided by UGA, INRAE and CNRM infrastructures. These systems are designed to guarantee elevated data security and availability:

1. SUMMER Storage: Provided by UGA University, SUMMER offers backup on a remote site with a 30-day history and synchronous replication, providing redundancy for data on two geographically distant sites. This robust architecture is based on Netapp@ servers.

2. CNRM server: The Col du Lac Blanc database is stored on a dedicated server, "cenobshuez", located in the CEN Grenoble building and equipped with RAID back-up solution. These data include the raw data, webcam images and corrected and validated data. Raw data land are retrieved by the server on a daily basis, and the data then fill-in the dedicated postgresql database where corrections/validation are made later. A dump of this sql database is realized every day at 23h15 and this dump file is stored on another CEN server (cenfic3) backed-up by a TSM solution at the CNRM Meteopole center in Toulouse. The Col de Porte data are retrieved hourly on a dedicated server, "cenexp2", located in the CEN building in Grenoble and equipped with RAID back-up solution. This server then automatically fills-in the current year data table in the relational BDNiv database containing all Col de Porte data, and where data corrections/validation are performed later. A dump of this relational database is realized every day at 23h30 in different format to enable an easy restoration of data and metadata and database structure. These dump files are stored on another CEN server (cenfic3) server backed-up by a TSM solution at the CNRM Meteopole center in Toulouse.

3. INRAE server: The INRAE srorage solution relies on VSAN with backup once a week. The server is installed at the INRAE building. The data will be relocated in the UGA infrastructure and SUMMER solution in Spring 2024.

Service	**Contact**
SUMMER	Patrice Navarro (IGE) Rémi Cailletaud (OSUG)
INRAE server	Florent Barbault (INRAE)
CNRM server	Col du Lac Blanc : Hugo Merzisen (Meteo France) Yannick Deliot (Meteo France) Col de Porte : Romain Besombes (Meteo-France)
GLACIOCLIM's website	Delphine Six (Editorial director) OSUG communication service: Marion Papanian, Pierre Jacquet

3b. How will data security and protection of sensitive data be taken care during the research

Contact information

The contact point information of contributors in this DMP is considered as personal data. Therefore, we will seek their consent, providing them with the opportunity to refuse, modify, or request the deletion of their information.

4. Legal and ethical requirements, code of conduct

4a. If personal data are processed, how will compliance with legislation on personal data and on security be ensured?

In order to comply with the General Data Protection Regulation (GDPR), we are going to implement the following:

- Obtain consent from individuals regarding the use of their personal contact information.
- An email will be sent once per year reminding them of the possibility to modify or delete their personal information.

4b. How will other legal issues, such as intellectual property rights and ownership, be managed? What legislation is applicable?

Intellectual property

As the data produced by GLACIOCLIM is funded by public funders, in accordance with the Law for a French Digital Republic (LOI n° 2016-1321 du 7 octobre 2016 pour une République numérique), they are obligated to be open and accessible, and they are made available as soon as the processing is done (usually on an annual basis). Data is freely reusable, with the condition of acknowledging its authors according to the sentences indicated here below:

"Les auteurs remercient le Service National d'Observation GLACIOCLIM (programme du CNRS-INSU, OSUG, IRD, INRAE, Météo France, IPEV) pour les données fournies."

"The authors thank the GLACIOCLIM National Observation Service (CNRS-INSU program, OSUG, IRD, INRAE, Météo France, IPEV) for providing the data."

Licenses

Glacier data licence: CC-BY-NC
Snow data licence: CC-BY
Meteorological data at snow sites: CC-BY

4c. What ethical issues and codes of conduct are there, and how will they be taken into account?

The primary ethical consideration is ensuring the appropriate handling of personal information related to contributors. The treatment of such data is outlined in detail in response to questions 3b and 4a.

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5. Data sharing and long-term preservation

5a. How and when will data be shared? Are there possible restrictions to data sharing or embargo reasons?

Current state

There are no restrictions to data sharing nor embargo.

How and when data will be shared

For glaciological data, field reports are produced annually for each site, and is currently shared with the community through the GLACIOCLIM website and access to data files is available through the Nextcloud platform of OSUG. Part of the data is also sent annually to the World Glacier Monitoring Service, with verifications performed by national correspondents. Mass balance (Terre Adelie) data, is integrated into the QGIS Quantarctica distribution, an Geographical Information System (GIS) visualization software.

At the snow sites, validated data are produced once a year, leading to an update of the distributed files under the dois, and can be downloaded at:

- Col de Porte: https://doi.org/10.17178/CRYOBSCLIM.CDP.2018
- Col du Lac Blanc: https://doi.org/10.17178/CRYOBSCLIM.CLB.all

Next state

Data will be accessible on the Theia/OZCAR web portal: https://in-situ.theia-land.fr/

The data download service will be available in the near future. Users will have the option to download data in CSV and NetCDF formats. Data downloading will require user authentication through Data Terra Single Sign-On authentication, ensuring adherence to embargoes and access restrictions for certain data. Authentication will also grant access to authenticated data producers for statistics on data downloads.

The data will also be indexed in a Geonetwork metadata catalog, allowing for automatic harvesting of the data catalog through the CSW webservice.

5b. How will data for preservation be selected, and where data will be preserved long-term (for example a data repository or archive)?

Data preservation

Due to the climatic purposes of GLACIOCLIM, all data must be stored for the long term. These data serves as relevant climate indicators in high-latitude, mid-altitude and high-altitude areas. All observations are considered as *Essential Climate Variables* by international organizations such as World Meteorological Organization, that means variables or a group of linked variables that critically contributes to the characterization of Earth's climate. The preservation of data is planned on platforms such as OSUG data center, INREA servers and CNRM servers, which serve as data repository.

At the current time, there is no long-term preservation solution. However, all necessary technological guarantees and measures are in place to ensure at least medium-term storage.

5c. What methods or software tools are needed to access and use data?

CSV format

- Any programming langages that can do data management
- Spreadsheet Software

XLS and XLSLX formats

- Spreadsheet Software.

Netcdf format

- NetCDF files require tools and librairies compatible with the NetCDF format (NetCDF format version 4): https://www.unidata.ucar.edu/software/netcdf/

5d. How will the application of a unique and persistent identifier (such as a Digital Object Identifier (DOI)) to each data set be ensured?

Current state

Only the snow datasets have a DOI provided by the DOI service of the OSUG data center.

Next state

Glacier data producers work to produce a DOI and a datapaper related to glaciological data.

Assigning a DOI through the workflow of data imported into Theia/OZCAR is not yet available, but it may be considered in the long term. If a dataset already has a DOI, this DOI will be mentioned in the metadata record on the Theia/OZCAR portal.

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6. Data management responsibilities and resources

6a. Who (for example role, position, and institution) will be responsible for data management (i.e. the data steward)?

Projet Leader:

Delphine Six (UGA-IGE), director of the Glacioclim Observatory.

Each geographic or thematic component manager is responsible for his or her own datasets:

- Andes: Antoine Rabatel (UGA-IGE)
- Antarctica: Vincent Favier (UGA-IGE)
- Himalayas: Patrick Wagnon (IRD-IGE)
- Alpine glaciers : Delphine Six (UGA-IGE)
- Alpine Snow: Isabelle Gouttevin (Météo France-CEN)

Hugo Mersizen (Météo France-CNRM), Yannick Deliot (Météo France-CNMR), Marie Dumont (Météo France-CNRM),Yves Lejeune (Météo France-CNMR), Anne Dufour (Météo France-CNMR), Mathieu Fructus (Météo France-CNMR), Hervé Bellot (INRAE-IGE), Florence Naaim (INRAE-IGE), Olivier Laarman (CNRS-IGE), with the support of the OSUG Data Center and eventually laboratories' IT services, are in charge of the following aspects:

- Data collection and pre-processing

- Data storage and backup
- Data archiving

The scientists and technical staff of GLACIOCLIM are responsible for:

- Data production and dissemination
- Data quality control
- Data storage

The Data Management Plan is jointly written by the Data Curator and GLACIOCLIM data manager.

6b. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

GLACIOCLIM data managers, with the technical support of OSUG data center, facilitate the creation of DOIs, ensure data security, and develop platforms/websites and cloud services.

With funding from Labex OSUG 2023-2024, we benefit from a 16-month Data Curator contract.

The technical services of the laboratories are involved in field data collection and data pre-processing.

The laboratories' IT services help for data storage and access.

Theia/OZCAR provides training and workshops on relevant topics.

The scientists and technical staff of GLACIOCLIM dedicate a portion of their time to collect, analyse, document and share the data.

OSUG and INRAE are in charge of providing necessary storage and backup ressources.