climate change initiative

→ PERMAFROST

ESA CCI+ Phase 2: Mountain Permafrost component
Rock glacier inventory (RoGI): generation and status

GAMMA REMOTE SENSING · b·geos · University of Oslo · AWI · UNI FR Université de Fribourg Universität Freiburg · NORCE · Alma Mater Studiorum Università di Bologna · West University of Timisoara · TERRASIGNA

permafrost cci

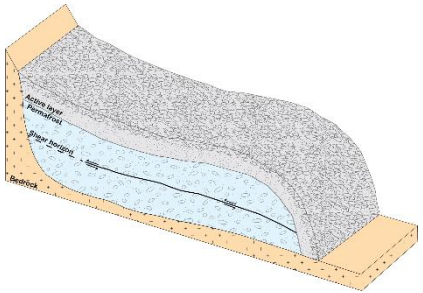
Mountain permafrost and rock glaciers

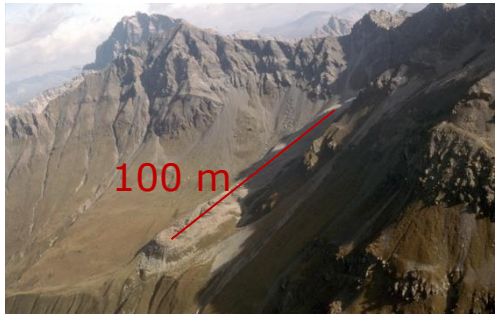
Permafrost ECV is traditionally documented by **Ground Temperature** and **Active Layer Thickness**.

However, **mountains** are characterized by large variability over short distances, with sparse in-situ measurements and difficulties for permafrost models to represent fine-scale variability.

- There is a **need for other proxies** to document permafrost changes.
- **Rock glaciers** are easily identifiable evidence of permafrost occurrence.

"Rock glaciers are **debris landforms** generated by the **former or current creep of frozen ground (permafrost)**, detectable in the landscape with the following morphologies: **front, lateral margins** and optionally ridge-and-furrow surface topography" (RGIK, 2023).





Mountain permafrost and rock glaciers

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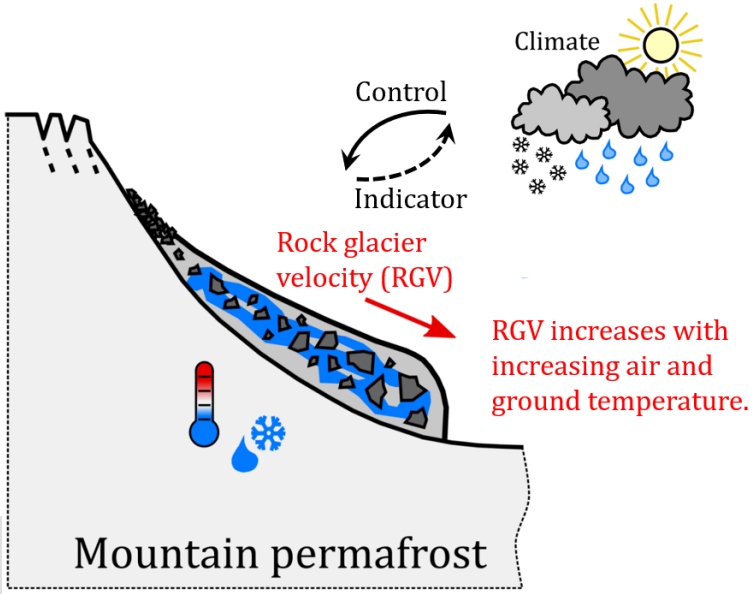
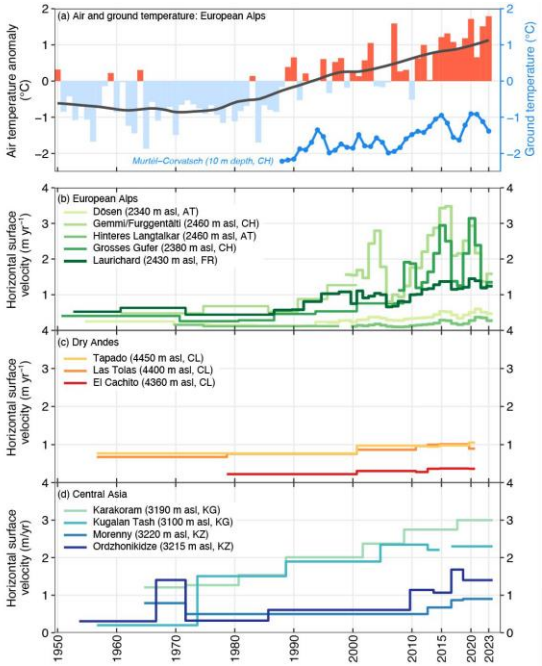
- There is a **need for other proxies** to document permafrost changes.
- **Rock glaciers** are easily identifiable evidence of permafrost occurrence.
- **Rock glacier velocity (RGV)** is influenced by changing climate

RGV has been included in the implementation plans of GCOS and GTN-P as **a new Quantity to document the ECV Permafrost**.



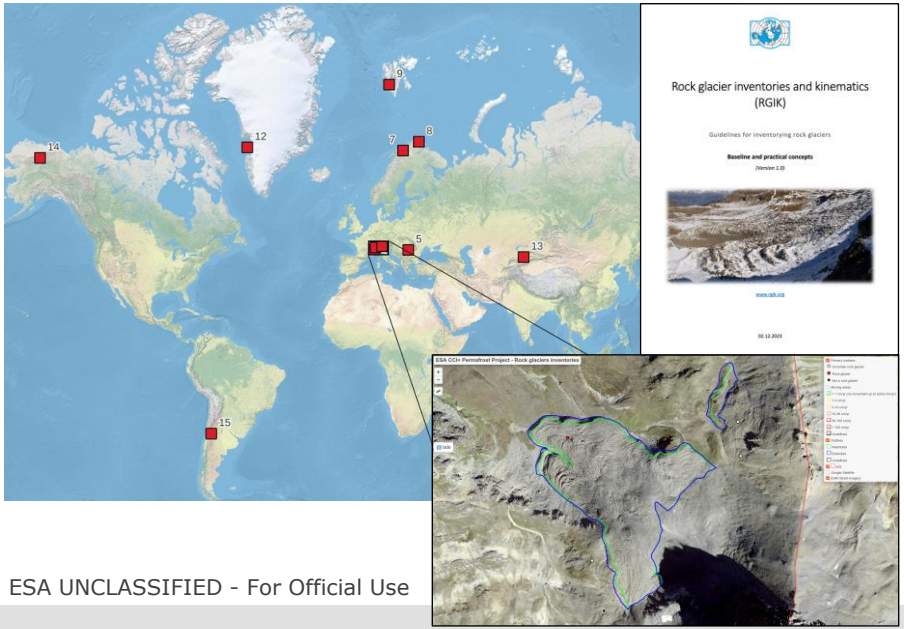
Pellet et al., 2024.



Remote sensing for Rock Glacier Products

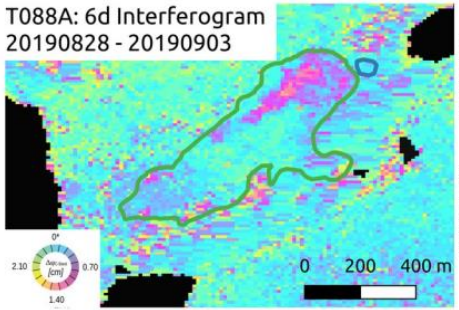
Rock Glacier Inventories (RoGI)

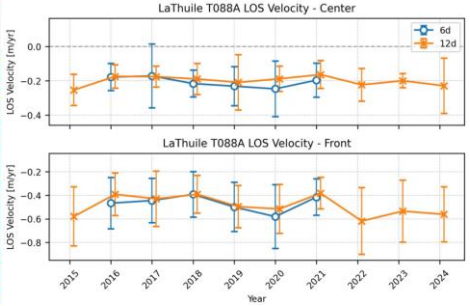
CCI is supporting the development of guidelines and GIS tools for worldwide production of standardized RoGI using remote sensing.



Rock Glacier Velocity (RGV)

CCI is making a significant contribution to develop RGV based on remote sensing, in particular InSAR. Production has started in the areas covered by RoGI.



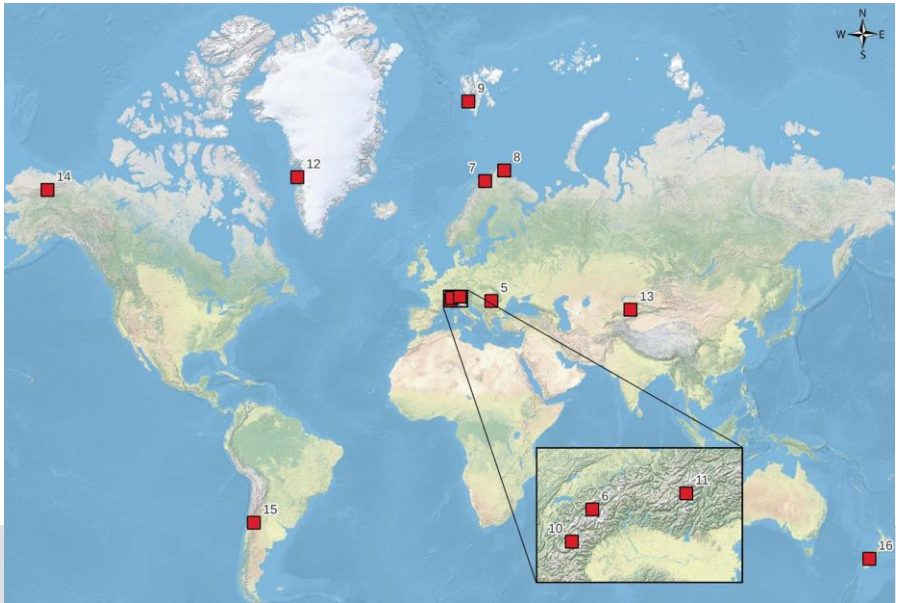


CCI Permafrost rock glacier inventories

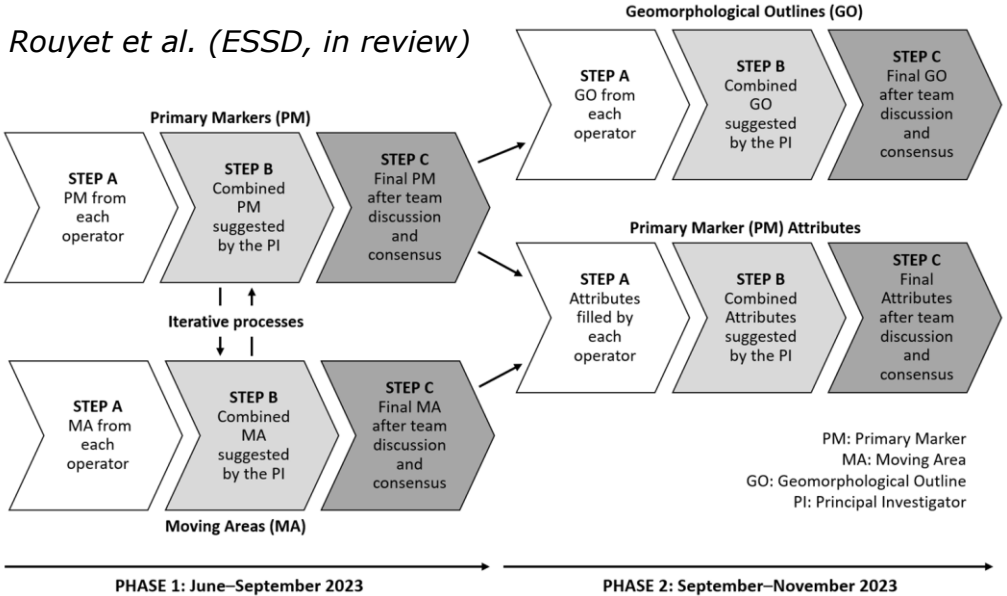
CCI Phase 1: Bertone et al. (2022) TC paper focusing on integration of InSAR-kinematics in RoGI

CCI Phase 2: Consolidation of the RoGI products with a multi-operator mapping exercise involving 41 operators following similar guidelines.

> Collaborative production and dissemination of 12 Rock Glacier Inventories around the World.



Rouyet et al. (ESSD, in review)



RoGI: available guidelines and tools

Home | About RGIK | Meet The Team! | Working Groups | Resources | Community

info@rgik.org

Join RGIK Today!

https://www.rgik.org/

RGIK Resources

Baseline Concepts and Guidelines

- Guidelines for Inventorying Rock Glaciers (RoGI)
- Guidelines for Rock Glacier Velocity (RGV)
- Requirements for RGV as an ECV Quantity for Permafrost

QGIS Tools

- RoGI QGIS Template
- RoGI Exercise in the Goms Valley, Switzerland
- RoGI Dirru-Steintälli Exercise in the Matter Valley, Switzerland

RoGI: available data package

zenodo Search records... Communities My dashboard

Published May 19, 2025 | Version v2

Dataset Open

Rock Glacier Inventories (RoGI) in 12 areas worldwide using a multi-operator consensus-based procedure

Rouyet, Line (Contact person)[1, 2] ; Bolch, Tobias (Producer)[3, 4] ; Brardinoni, Francesco (Producer)[5] ;
Caduff, Rafael (Producer)[6] ; Cusicanqui, Diego (Producer)[7] ; Darrow, Margaret (Producer)[8] ; Delaloye, Reynald (Producer)[1] ;
Echelard, Thomas (Producer)[1, 5] ; Lambiel, Christophe (Producer)[9] ; Pellet, Cécile (Producer)[1] ; Ruiz, Lucas (Producer)[10] ;
Schmid, Lea (Producer)[1] ; Sirbu, Flavius (Producer)[11] ; Strozzi, Tazio (Project manager)[6]
Show affiliations

The Rock Glacier Inventories and Kinematics community (RGIK) has defined standards for generating Rock Glacier Inventories (RoGI). In the framework of the European Space Agency Climate Change Initiative for Permafrost (ESA CCI Permafrost), we set up a multi-operator mapping exercise in 12 areas around the World. Each RoGI team was composed of five to ten operators, involving 41 persons in total. Each operator performed similar steps following the RGIK guidelines and using a similar QGIS tool. The individual results were compared and combined after common meetings to agree on the final consensus-based solutions. In total, 337 "certain" rock glaciers have been identified and characterised, and 222 additional landforms have been identified as "uncertain" rock glaciers.
The dataset consists of three GeoPackage files for each area: 1) the Primary Markers (PM) locating and characterising the identified Rock Glacier Units (RGU), 2) the Moving Areas (MA) delineating areas with surface movement associated with the rock glacier creep, based on spaceborne Interferometric Synthetic Aperture Radar (InSAR), and 3) the Geomorphological Outlines (GO) delineating the restricted and extended RGU boundaries. Here we describe the content, structure, and naming convention of the final PM/MA/GO dataset. The RoGI guidelines, the GeoPackage (gpkg) templates for performing similar RoGI in other areas, and exercises based on the QGIS tool are available on the RGIK website. The data can be viewed in a dedicated WebGIS tool.

Associated ESSD paper: Rouyet, L. et al. 2025. Rock Glacier Inventories (RoGI) in 12 areas worldwide using a multi-operator consensus-based procedure, Earth Syst. Sci. Data. https://doi.org/10.5194/essd-2024-598.

Funding: The initiative is funded by the European Space Agency Permafrost Climate Change Initiative (ESA CCI Permafrost, contract 4000123681/18/I-NB). The work of the Rock Glacier Inventories and Kinematics (RGIK) community has been supported by the International Permafrost Association (IPA), GCOS Switzerland, and SwissUniversities.

Files

Rouyet-et-al_RoGI_Zenodo_v2.0.zip

Rouyet-et-al_RoGI_Zenodo_v2.0.zip

Rouyet-et-al_RoGI_Zenodo_v2.0

- AAA_README_FIRST.pdf
- ESACCI-PERMAFROST_ROGI_ALL-AREAS_AOI-PM-MA-GO_2025-fv02.0.gpkg
- ESACCI-PERMAFROST_ROGI_SINGLE-AREA

AREA_05-1_Carpathians_Romania
AREA_06-1_WesternAlps_Switzerland
AREA_07-1_Troms_Norway
AREA_08-1_Finnmark_Norway
AREA_09-1_NordenskioldLand_Norway
AREA_10-1_VanoiseMassif_France
AREA_11-1_SouthernVenosta_Italy
AREA_12-1_DiskoIsland_Greenland
AREA_13-1_NorthernTienShan_Kazakhstan
AREA_14-1_BrooksRange_USA
AREA_15-1_CentralAndes_Argentina
AREA_16-1_SouthernAlps_NewZealand

https://doi.org/10.5281/zenodo.14501398

RoGI: available WebGIS

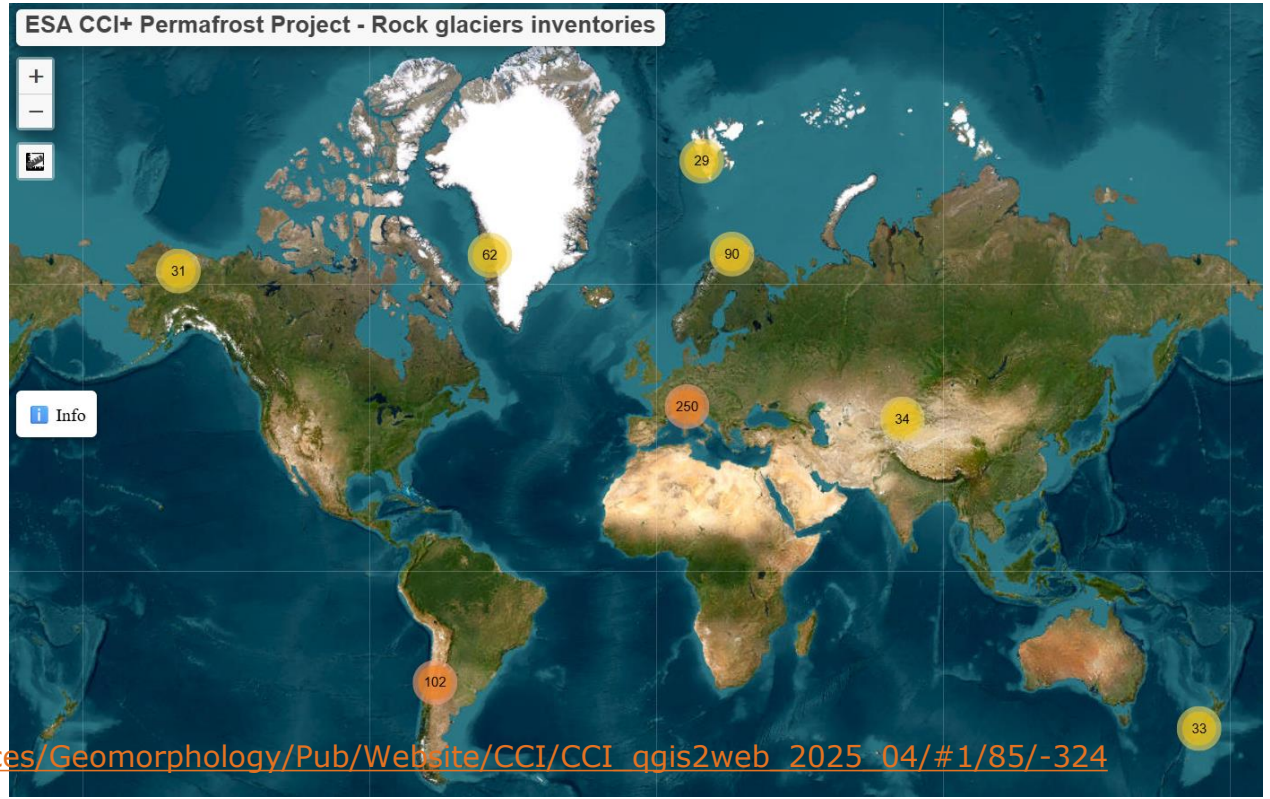
ESA CCI+ Permafrost Project – Rock Glacier Inventories

This WebGIS presents the rock glacier inventories compiled in the framework of the ESA CCI+ Permafrost project. The dataset covers 12 areas worldwide.

Attribute values:

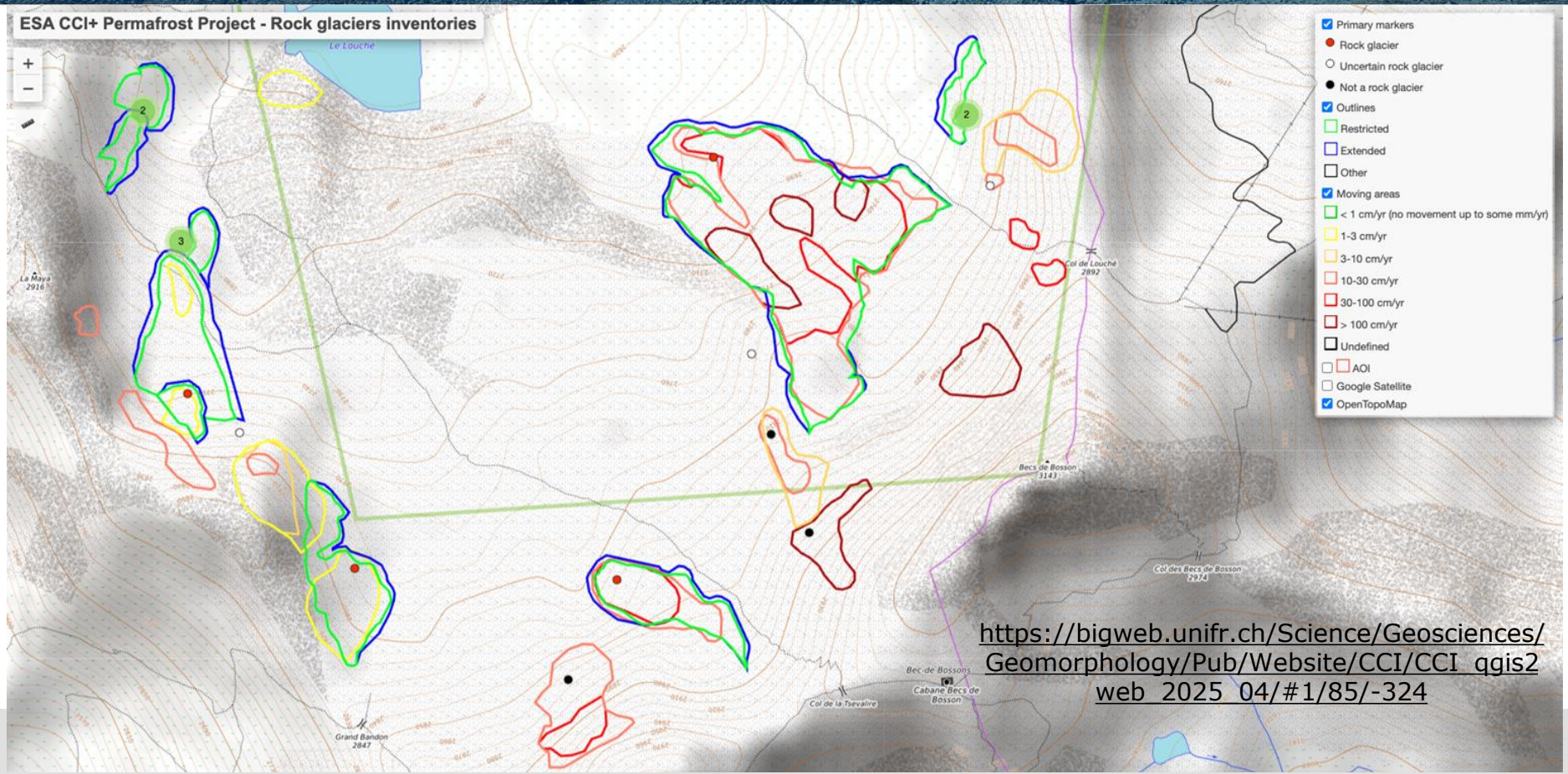
- **Lat**: Latitude
- **Long**: Longitude
- **AssocRGS**: Associated Rock Glacier System (RGS)
  - Mono-unit RGS
  - Multi-unit RGS
- **UpslCon**: Upslope Connection
  - 1 – Talus-connected
  - 2 – Glacier forefield-connected
  - 3 – Glacier-connected
  - 4 – Debris-mantled slope-connected
  - 5 – Landslide-connected
  - 6 – Poly-connected
  - 7 – Other
  - 8 – Uncertain
  - 9 – Unknown
- **KinAtt**: Kinematic Attribute
  - 0 – Undefined
  - 1 – < cm/a
  - 2 – cm/a
  - 3 – cm/a to dm/a
  - 4 – dm/a
  - 5 – dm/a to m/a
  - 6 – m/a
  - 7 – > m/a
- **Morpho**: Morphology
  - Complex
  - Simple
- **ActCl**: Activity Class
  - 1 – Active
  - 2 – Active uncertain
  - 3 – Transitional
  - 4 – Relict uncertain
  - 5 – Relict
  - 6 – Uncertain

For more information, see:
– The RGIK RoGI guidelines
– The RoGI Zenodo dataset
– The ESSD data description paper



Data viewer:
https://bigweb.unifr.ch/Science/Geosciences/Geomorphology/Pub/Website/CCI/CCI_qgis2web_2025_04/#1/85/-324

RoGI: available WebGIS



https://bigweb.unifr.ch/Science/Geosciences/Geomorphology/Pub/Website/CCI/CCI_qgis2web_2025_04/#1/85/-324

RoGI: available paper

Preprints / Preprint essd-2024-598

Search

https://doi.org/10.5194/essd-2024-598

Abstract | Assets | Discussion | Metrics

14 Jan 2025

Status: a revised version of this preprint is currently under review for the journal ESSD.

Rock Glacier Inventories (RoGI) in 12 areas worldwide using a multi-operator consensus-based procedure

Line Rouyet, Tobias Bolch, Francesco Brardinoni, Rafael Caduff, Diego Cusicanqui, Margaret Darrow, Reynald Delaloye, Thomas Echelard, Christophe Lambiel, Lucas Ruiz, Lea Schmid, Flavius Sirbu, and Tazio Strozzi

Abstract. The Rock Glacier Inventories and Kinematics community (RGIK) has defined standards for generating Rock Glacier Inventories (RoGI). In the framework of the European Space Agency Climate Change Initiative for Permafrost (ESA CCI Permafrost), we set up a multi-operator mapping exercise in 12 areas around the world. Each RoGI team was composed of five to ten operators, involving 41 persons in total. Each operator performed similar steps following the RGIK guidelines (RGIK, 2023a) and using a similar QGIS tool. The individual results were compared and combined after common meetings to agree on the final consensus-based solutions. In total, 337 "certain" rock glaciers have been identified and characterised, and 222 additional landforms have been identified as "uncertain" rock glaciers.

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How to cite. Rouyet, L., Bolch, T., Brardinoni, F., Caduff, R., Cusicanqui, D., Darrow, M., Delaloye, R., Echelard, T., Lambiel, C., Ruiz, L., Schmid, L., Sirbu, F., and Strozzi, T.: Rock Glacier Inventories (RoGI) in 12 areas worldwide using a multi-operator consensus-based procedure, Earth Syst. Sci. Data Discuss. [preprint], https://doi.org/10.5194/essd-2024-598, in review, 2025.

ESSD paper - data description:

- Presentation of methodology
- Data format and attributes
- Examples of results
- Discussion of limitations
- Suggestions of applications
- Prospects

https://doi.org/10.5194/essd-2024-598

RoGI production in new regions: ongoing

New RoGI regions:

Led by CCI partners

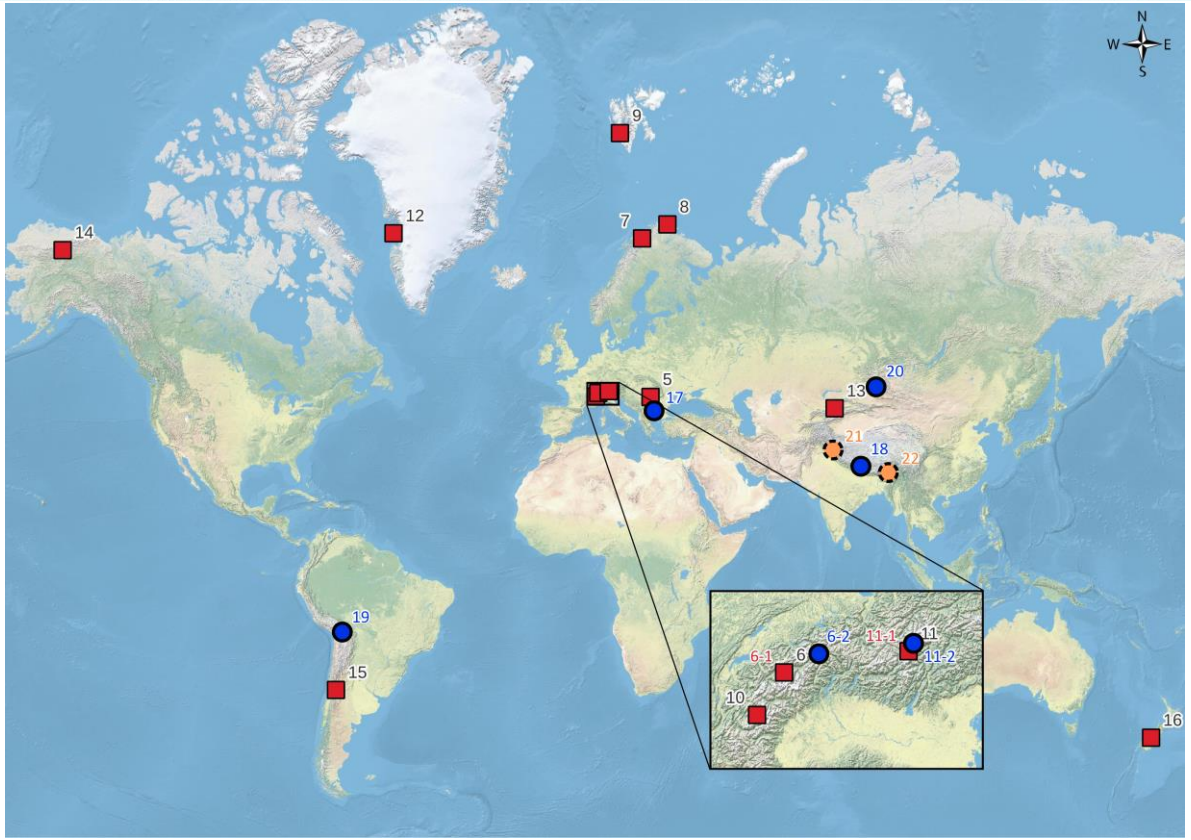
- **Goms-Binntal**, Switzerland (PI Unifr)
- **Northern Venosta**, Italy (PI UniBo)
- **Rila and Pirin**, Bulgaria (PI WUT)

Led by external partners:

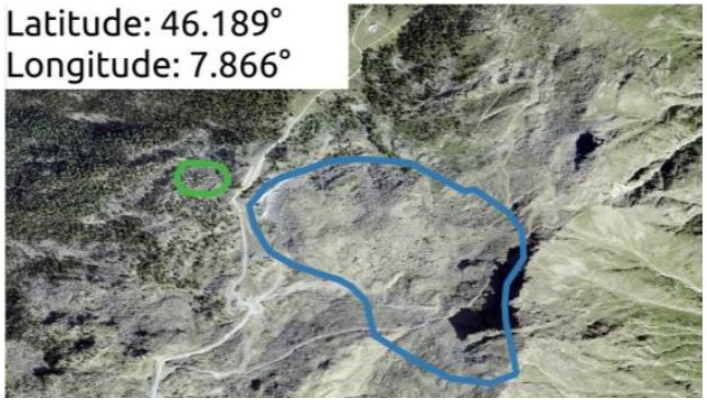
- **Thsengel Khairkahan, Mongolia**
  (PI Mongolian Academy of Science)
- **Manalsu, Nepal**
  (PI Univ. Grenoble Alpes and CHUK)
- **Sajama, Bolivia-Chile**
  (PI Univ. Grenoble Alpes, with local partners)

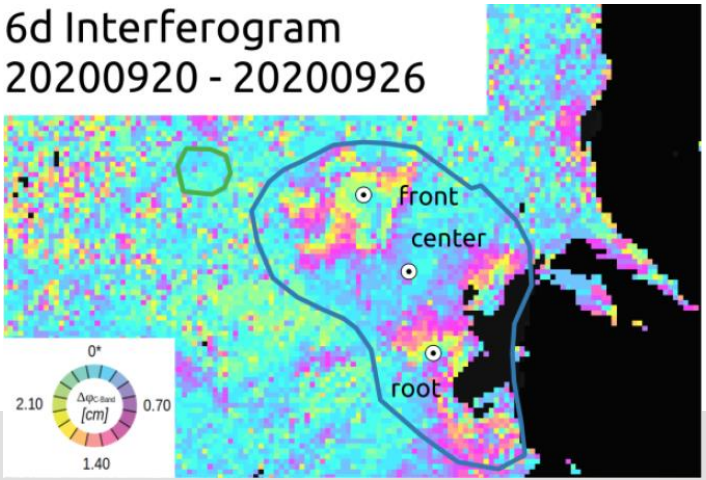
+ Baralacha La, India
(PI UniBo, collaboration with local partners)

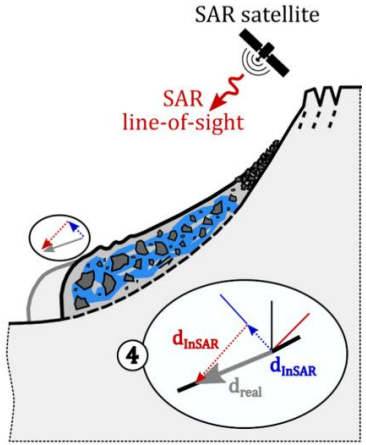
+ Thana, Bhutan
(PI Unifr, collaboration with local partners)



RGV products for selected landforms: ongoing







Development of robust methodology for the widespread monitoring of rock glacier velocity time series using SAR remote sensing

> Systematic documentation and dissemination of InSAR-RGV products