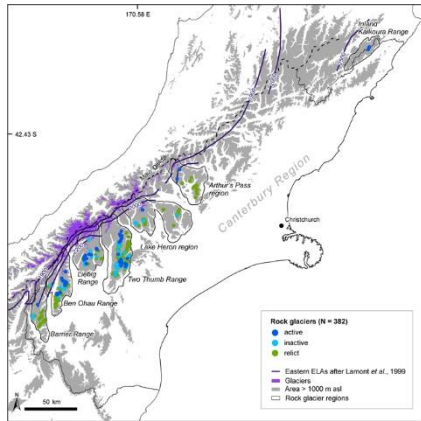


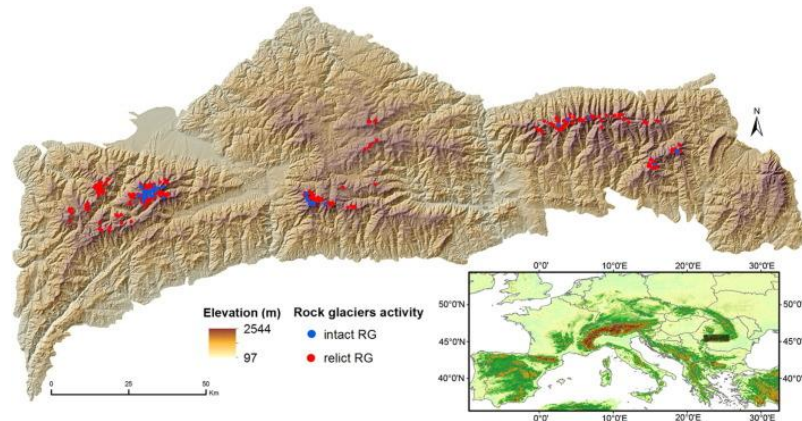
Rock glacier inventories and kinematics : *a new IPA Action Group* (2018-2020)

R. Delaloye, C. Barboux,
X. Bodin, A. Brenning, L. Hartl,
Y. Hu, A. Ikeda, V. Kaufmann,
A. Kellerer-Pirklbauer,
C. Lambiel, L. Liu, M. Marcer,
B. Rick, R. Scotti,
H. Takadema, D. Trombotto,
S. Vivero, M. Winterberger

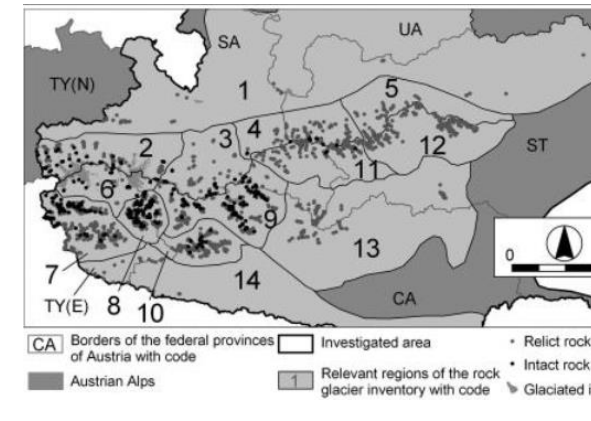
Rock glaciers inventories have been set up in many regions over the world for decades but without any real coordination.



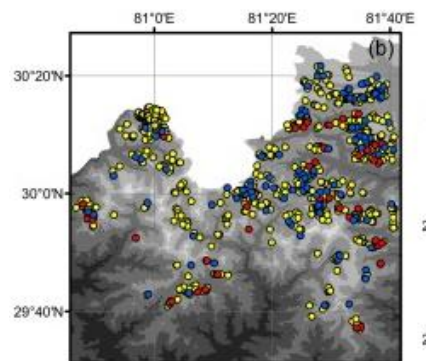
Canterbury Range, New Zealand
Sattler et al. (2016)
Front. Earth Sci.



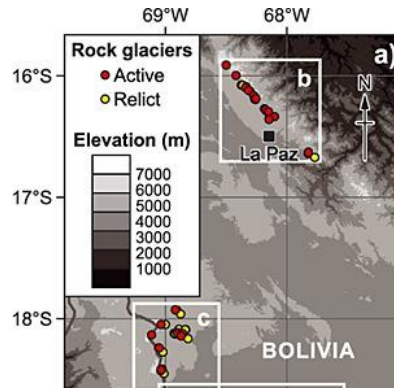
Southern Carpathian rock glaciers
Onaca et al. (2017)
Geomorphology



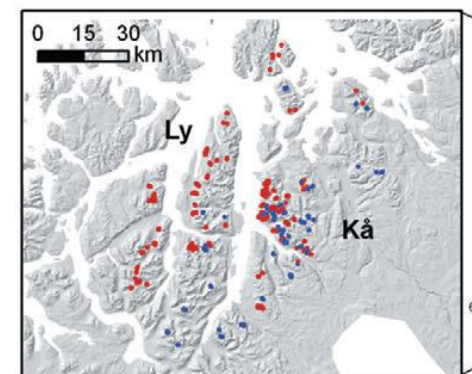
Central and eastern Austria
Kellerer-Pirklbauer et al. (2012)
Austrian Journal of Earth Sciences



Nepalese Himalaya
Jones et al. (2018)
Global and Planetary Change

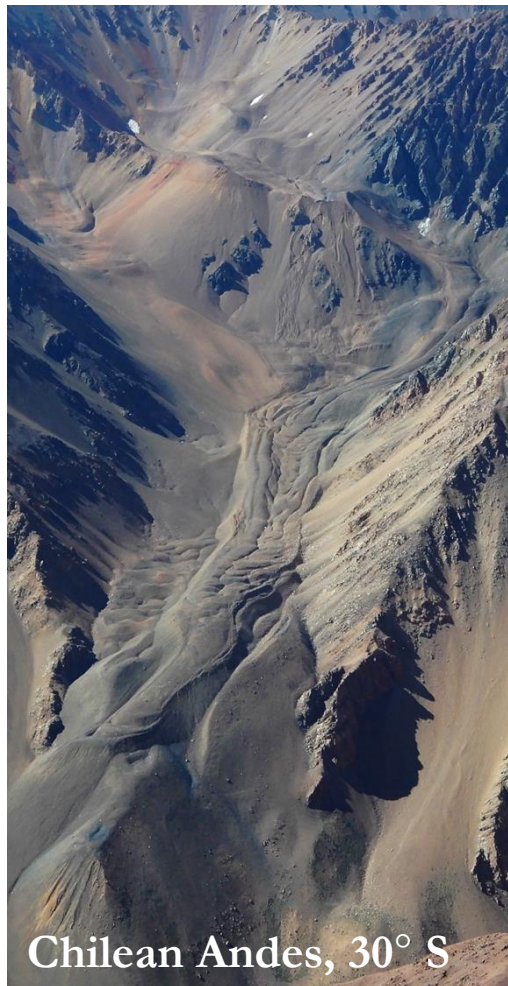


Bolivian Andes
Rangercroft et al. (2014)
PPP



Norway
Lilleøren and Etzel Müller (2011)
Geografiska Annaler

On the periglacial slopes of many mountain ranges over the Earth, considerable volumes of **frozen** fine- and coarse-grained debris are involved in building up **rock glaciers** as a typical morphological sediment-transferring feature.



Rock glaciers have often been distinguished between intact (active/inactive) and relict landforms on morphological indices only, as for instance observable on aerial photography.

Rock glaciers (N = 382)

- active
- inactive
- relict

Rock glaciers

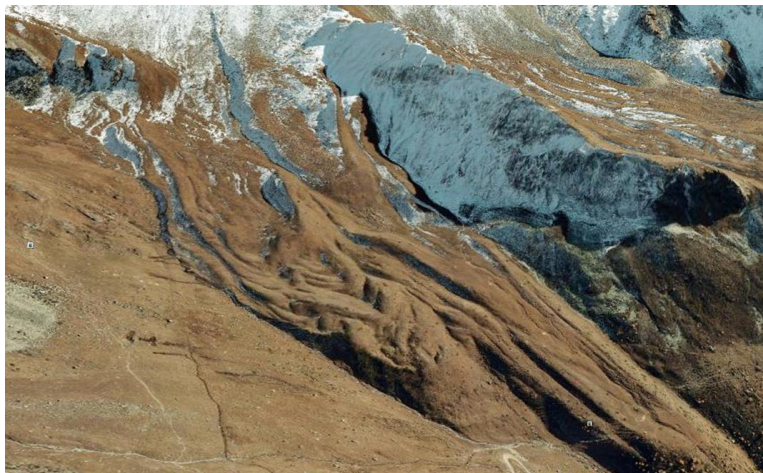
- Active
- Relict

Rock glaciers activity

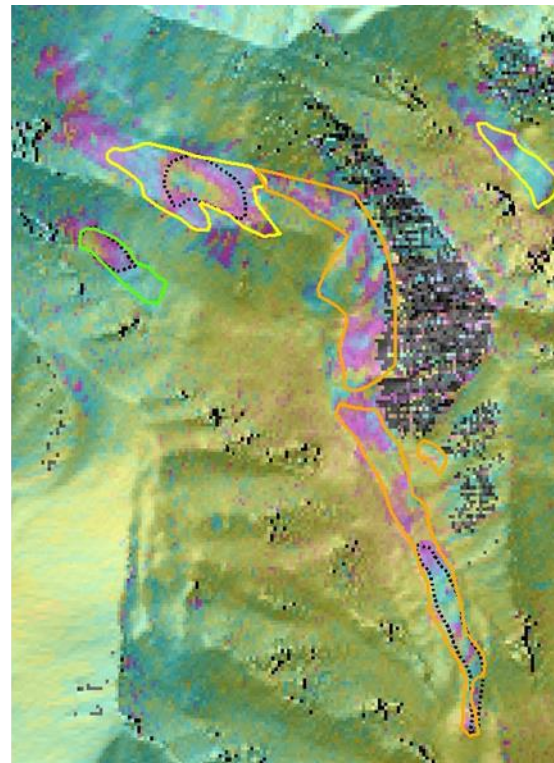
- intact RG
- relict RG

Activity Status

- I-DLs
- DDAs
- Unclassified



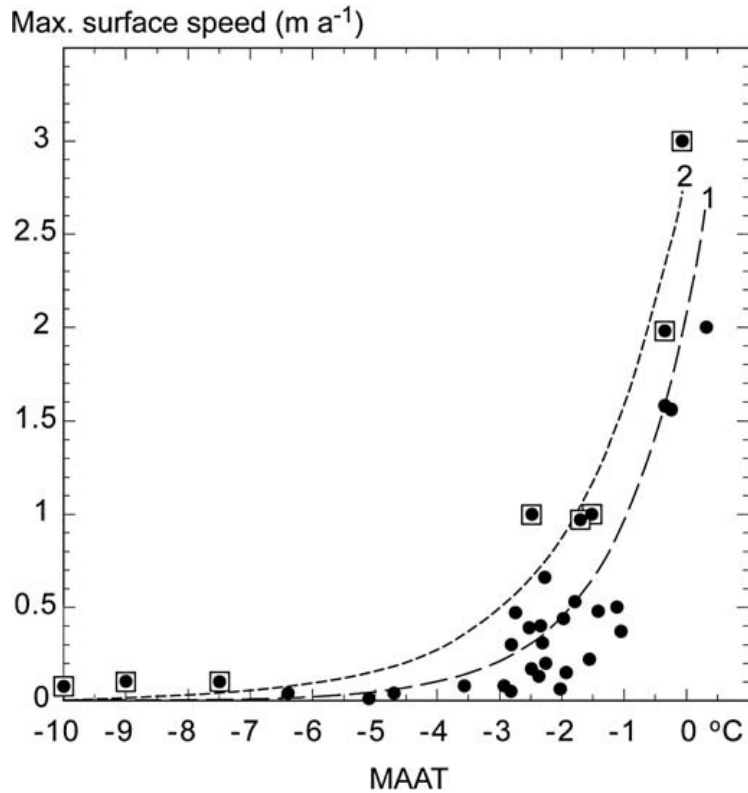
Development in remote sensing technologies in particular, e.g. **InSAR** or **photogrammetry**, and the **greater availability of appropriate satellite imagery**, has recently permitted to include more detailed kinematic information within rock glacier inventories.



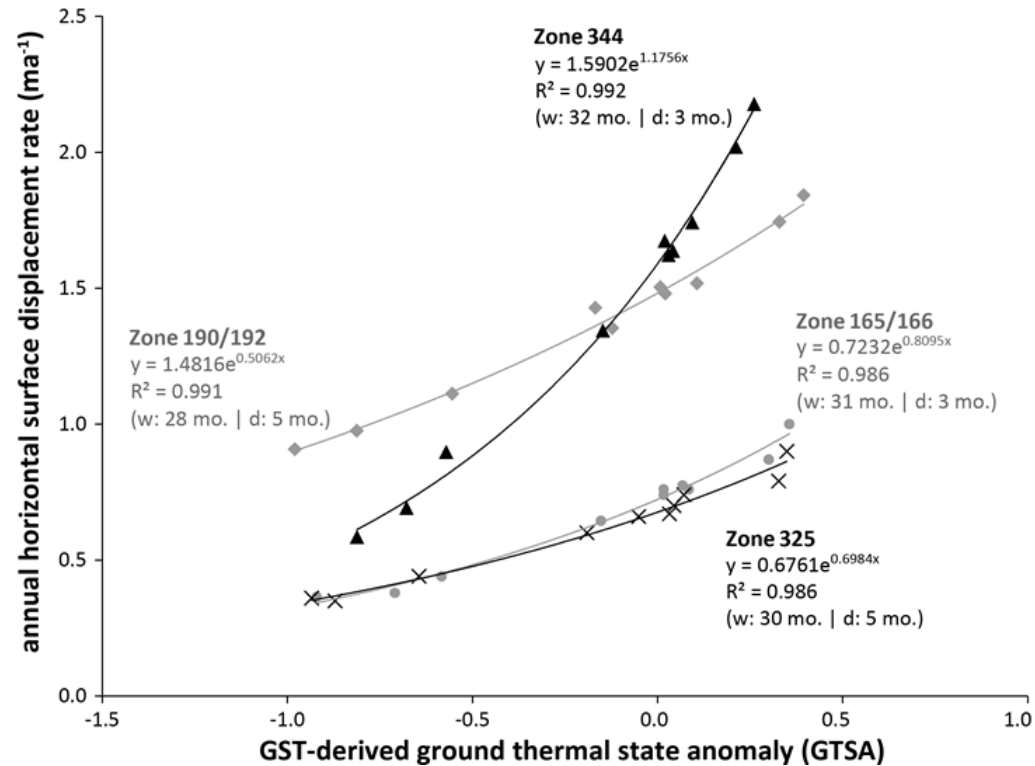
SENT1 Asc. .20150222_20150318 (24d)

ESA Projects :
GlobPermafrost, CCI+

Warmer permafrost conducts to higher motion rate of rock glaciers (pcf), especially when the temperature is rising close to 0°C.

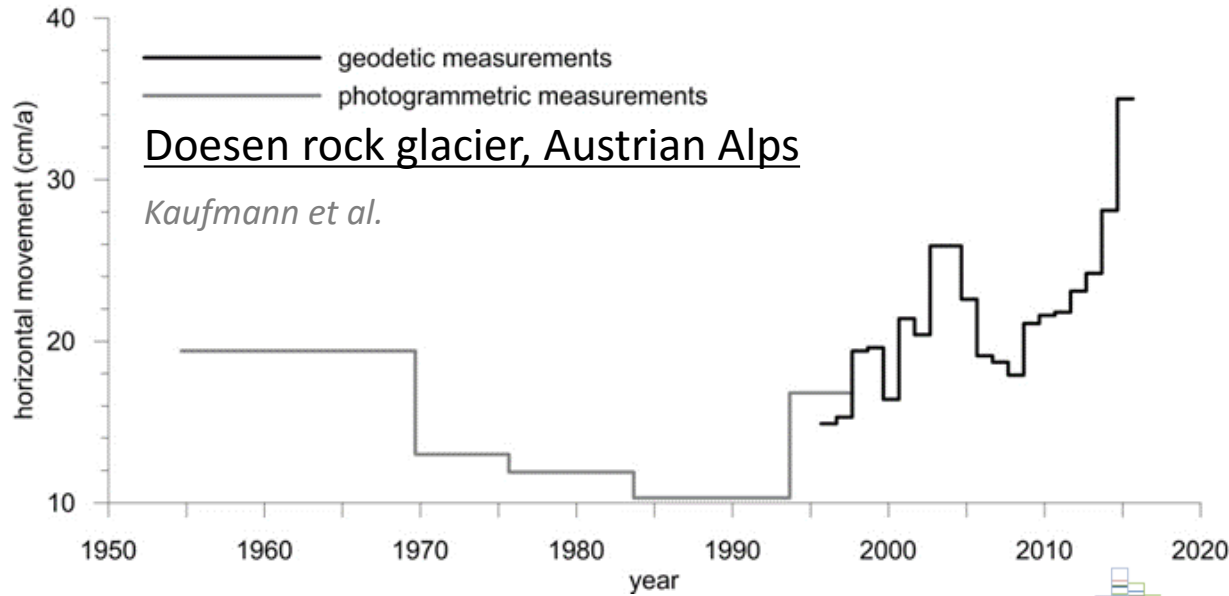


Frauenfelder et al. 2003 ICOP



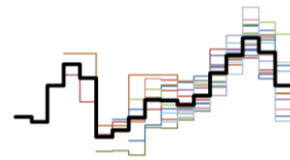
Staub et al. 2016 ICOP

Concomittant regional behavior !



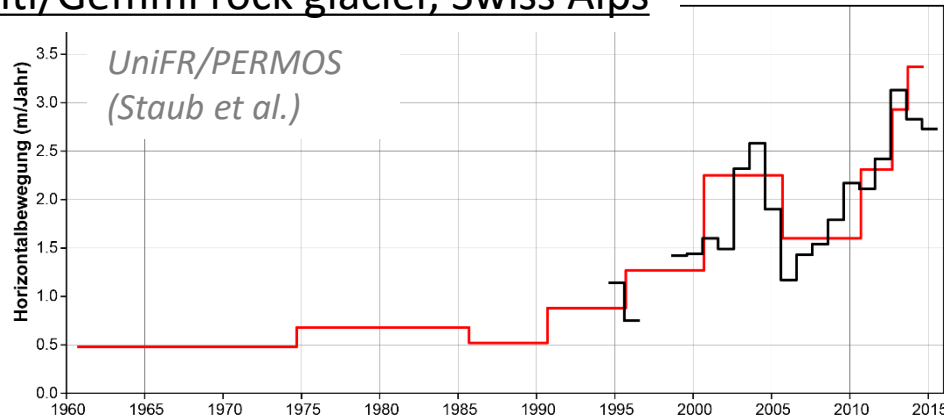
See also :

Delaloye et al. 2008 ICOP
Kellerer-Pirklbauer et al.
2018 EUCOP
PERMOS

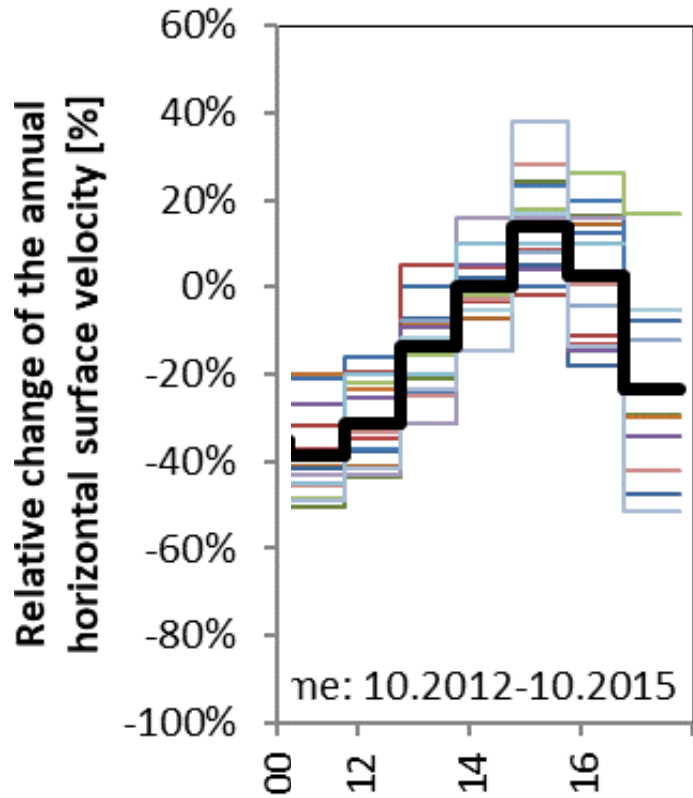


PERMOS “Ensemble”
(relative velocity change)

Furggentälti/Gemmi rock glacier, Swiss Alps

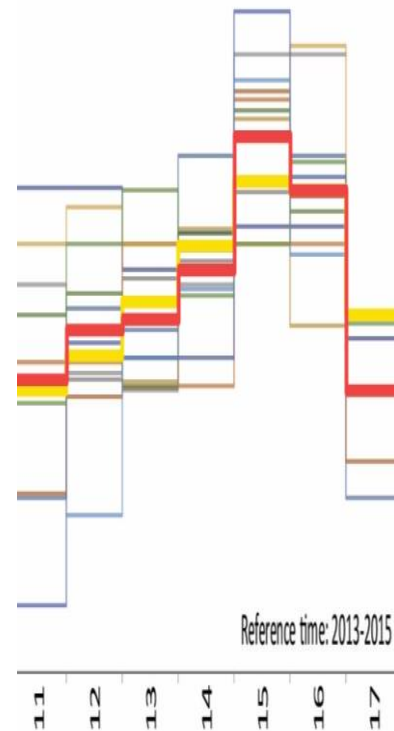


Observing or deriving a **rock glacier kinematic variable** on a global scale appears to be technically feasible using in particular satellite **SAR interferometry**, but also in combination with terrestrial geodetic surveys and photogrammetry analyses.



Annual mean

Geodetic measurements



Summer velocities

InSAR-derived data series

Barboux (GlobPermafrost Workshop)

Monitoring of **rock glacier kinematics** provides :

- clue information on the transfer rate of sediments along mountain slopes (-> e.g. large-scale to local scale risk management perspective)
- on the **impact of climate** change on the stability of frozen debris-covered mountain slopes



Objectives and scope of the Action Group (2018-2020)

(1/2) The Action Group intends to sustain the **first steps** toward **the organization and the management** of a **network** (open-access database) dedicated to rock glacier mapping (inventorying) and monitoring (kinematics) in all relevant mountain regions on Earth including definition of the necessary standards.

Objectives and scope of the Action Group (2018-2020)

(2/2) The Action Group expects that in the long run **rock glacier kinematics** could be recognized by the permafrost community (e.g. GTN-P) and later by the WMO as a **new associated parameter to the ECVs of Permafrost**.

Rock glacier kinematics could be integrated in the monitoring strategy of international programs in addition to the observation of *permafrost thermal state* and *active layer* trends.

Timeline

The Action Group will be active over a two-year period, from mid-2018 to mid-2020.

Kick-off Meeting – Thursday 28 June 15.45 – 17.00 - Bourrit

Two Action Group **Workshops** are foreseen in 2018/19 and 2019/20, with field trips in rock glacier prone regions.

The Action Group will be closed at **ICOP 2020** in Lanzhou. It expects :

- to set up the generally **accepted guidelines for inventorying rock glaciers including kinematics information**
- and to design and establish a dedicated (pioneer) web platform allowing an open access to rock glacier inventorying and monitoring data

Objectives and scope of the Action Group (2018-2020)

tbd

Task I

Definition of widely accepted **standard guidelines for inventorying (mapping) rock glaciers** in mountain permafrost regions, including indications on the activity rate

- Agreement of a **“working” definition** of rock glaciers (what do we want/need to inventory ?)
- Standards of inventorying (definition of key attributes), e.g. point location, outlining, etc... -> ***Inventorying strategy***
- **Practical guidelines** for inventorying rock glaciers (e.g. also including the use of InSAR)

Task II

Preparation of **“products”** which could serve for monitoring rock glacier **kinematics** as an associated parameter of the ECV (Essential Climate Variable) Permafrost

Task III

Operational development of a database / web platform

Objectives and scope of the Action Group (2018-2020)

tbd

Task I – *which is the most important and urgent one*

Definition of widely accepted **standard guidelines for inventorying (mapping) rock glaciers** in mountain permafrost regions, including indications on the activity rate

- a) Agreement of a **“working” definition** of rock glaciers (what do we want/need to inventory ?)
- b) Standards of inventorying (definition of key attributes), e.g. point location, outlining, etc... -> **Inventorying strategy**
- c) **Practical guidelines** for inventorying rock glaciers (e.g. also including the use of InSAR)

-> dedicated **Working Groups** for conducting/preparing the three sub-tasks (a-c), with the goal of finalizing them during a dedicated **workshop** early 2019 (January-February).

Objectives and scope of the Action Group (2018-2020)

tbd

Task I – *which is the most important and urgent one*

Questions to anyone interested:

- Leaders of the working groups ?
 - a.
 - b.
 - c.

- Members of the working groups ?
 - a.
 - b.
 - c.

- Any candidate for hosting workshop I ?

Objectives and scope of the Action Group (2018-2020) tbd

Task II

Preparation of “products” which could serve for monitoring rock glacier kinematics as an associated parameter of the ECV (Essential Climate Variable) Permafrost

1. Promoting the **use of satellite SAR interferometry**, e.g. Sentinel-1A data, but more generally remote sensing data, for monitoring the rock glacier activity at a regional scale and define appropriate standards and guidelines

Option on mountain permafrost submitted to the ESA CCI+ project, which could eventually be launched by the end of 2019 (?).

2. **Integrate** as far as possible local-scale monitoring data based on aerial and terrestrial geodetic surveys

e.g. collective work led by A. Kellerer-Pirklbauer et al, that provides an updated overview of what is monitored and where in the European Alps.

3. Setting up of **standard guidelines** for selecting an appropriate number of rock glaciers per region that can be then used to assess temporal trends with decadal to intra-decadal time steps (**product for ECV Permafrost**)

Same CCI+ Option as for 1.

Objectives and scope of the Action Group (2018-2020) tbd

Task II

Preparation of “products” which could serve for monitoring rock glacier kinematics as an associated parameter of the ECV (Essential Climate Variable) Permafrost

1. Promoting the **use of satellite SAR interferometry**, e.g. Sentinel-1A data, but more generally remote sensing data, for monitoring the rock glacier activity at a regional scale and define appropriate standards and guidelines
2. **Integrate** as far as possible local-scale monitoring data based on aerial and terrestrial geodetic surveys
3. Setting up of **standard guidelines** for selecting an appropriate number of rock glaciers per region that can be then used to assess temporal trends with decadal to intra-decadal time steps (**product for ECV Permafrost**)

Task II = focus of the second phase of the Action

Decision about organizing a **workshop II** dedicated to task II to be taken after workshop I.

Objectives and scope of the Action Group (2018-2020)

tbd

Task III

Operational development of a database / web platform

- Initiating the development of a **world-wide rock glacier database**, including kinematics,
- Build up and manage a **web platform** for visualization and **open data access**.

We do not have so far the necessary resources for launching task III, but of course any initiative in this sense is definitely welcome!

e.g. Barboux/Delaloye/Lambiel submission to a call of the Swiss Polar Institute in January 2018, but still waiting for an answer...