

climate change initiative

→ PERMAFROST

1st Permafrost CCI User Workshop  
Virtual Meeting, 27 September 2021

# Rock glacier kinematics as a new associated parameter of ECV permafrost



permafrost  
cci

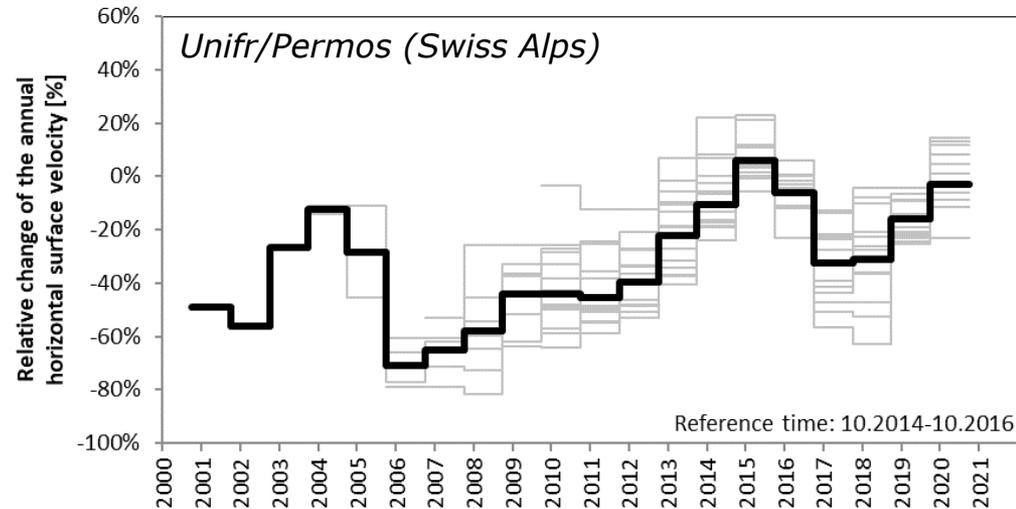
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# Why documenting rock glacier kinematics?



- Active rock glaciers are **mountain permafrost landforms** consisting of a mixture of ice and rocks. They are creeping down the slope at a variable rate of motion.
- Rock glacier creep rate depends on climatic conditions. They tend to **accelerate on an interannual basis under warmer conditions.**
- Rock glaciers display a **concomitant regional behaviour**, velocity change occur at same time and in same proportion in a given region.





Supported by the **International Permafrost Association (IPA)**, the network currently consists of approx. **160 people** from 25 countries.

## Objectives:

- Define **standard guidelines** for:
  - **Inventorying** rock glaciers in mountain permafrost regions, incl. indications on the **creep rate (kinematics)**.
  - Generating **rock glacier kinematics time series** in a climate-oriented perspective.
- Initiate the development of **a world-wide rock glacier database**, incl. kinematics.

## IPA Action Group : Rock glacier inventories and kinematics



The IPA Action Group (2018-2023) intends to sustain the first steps toward the organization and the management of a network dedicated to rock glacier mapping (inventorying) and to promote the integration of permafrost creep rate (rock glacier kinematics) as a new associated parameter to **Essential Climate Variable (ECV)** Permafrost within the **Global Climate Observing System (GCOS)** initiative supported by the World Meteorological Organization (WMO), characterizing the evolution of mountain permafrost on the global scale.

<https://www.unifr.ch/geo/geomorphology/en/research/ipa-action-group-rock-glacier/>



**Baseline concepts** and **practical guidelines** for inventorying rock glaciers, documenting their creep rates and generating standard time series.



## IPA Action Group Rock glacier inventories and kinematics

Towards standard guidelines for inventorying rock glaciers

**Baseline concepts**

(Version 4.2.1)



<https://www3.unifr.ch/gea/geomorphology/en/research/ipa-action-group-rock-glacier> (Action Group website)

### Inventories

01.08.2021



## IPA Action Group Rock glacier inventories and kinematics

Kinematics as an optional attribute in standardized rock glacier inventories

(Version 2.1)



<https://www3.unifr.ch/gea/geomorphology/en/research/ipa-action-group-rock-glacier> (Action Group website)

### Kinematics attribute

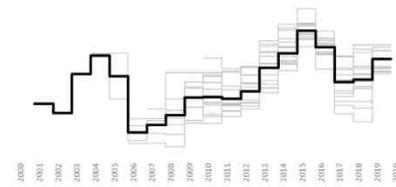
05.05.2020



## IPA Action Group Rock glacier inventories and kinematics

Rock Glacier Kinematics as an associated parameter of ECV Permafrost

(Version 2.1)



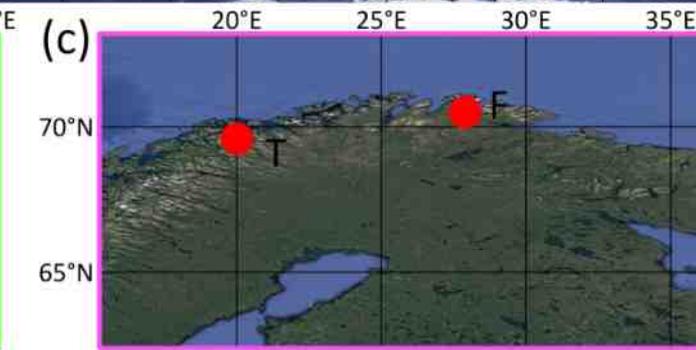
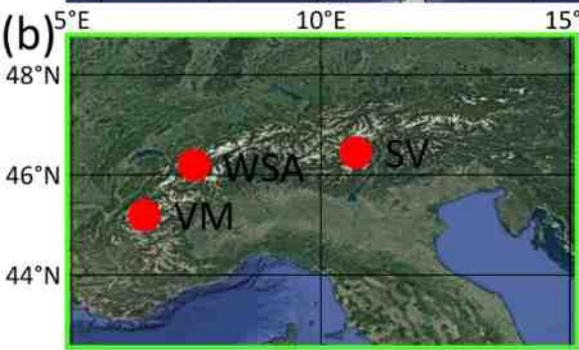
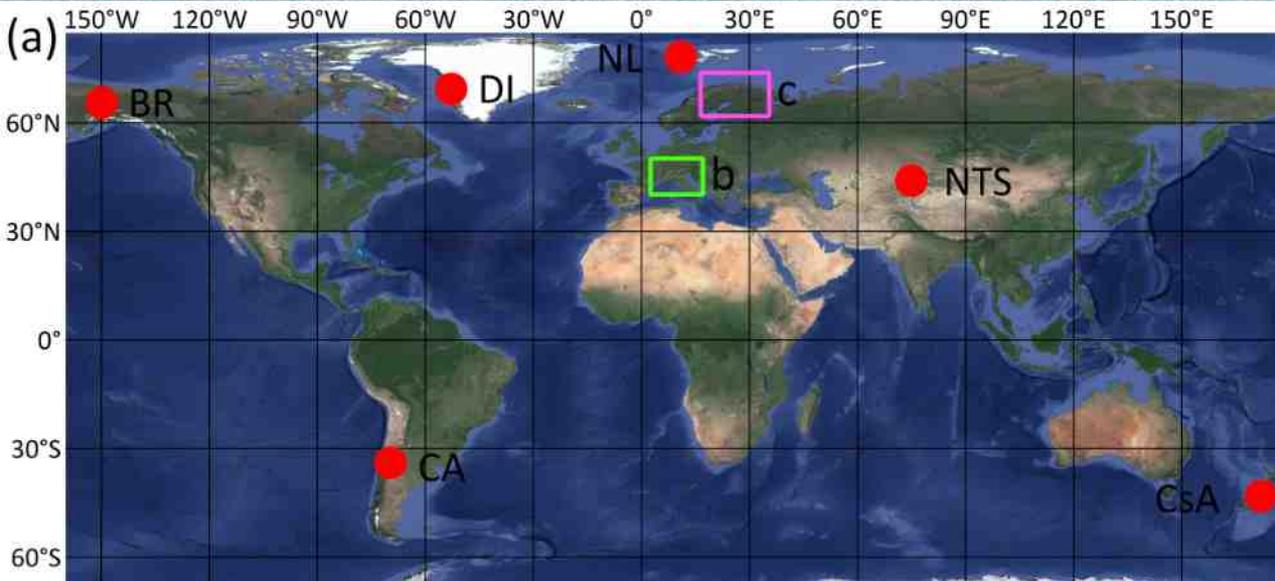
<https://www3.unifr.ch/gea/geomorphology/en/research/ipa-action-group-rock-glacier> (Action Group website)

### Kinematics time series

08.07.2021



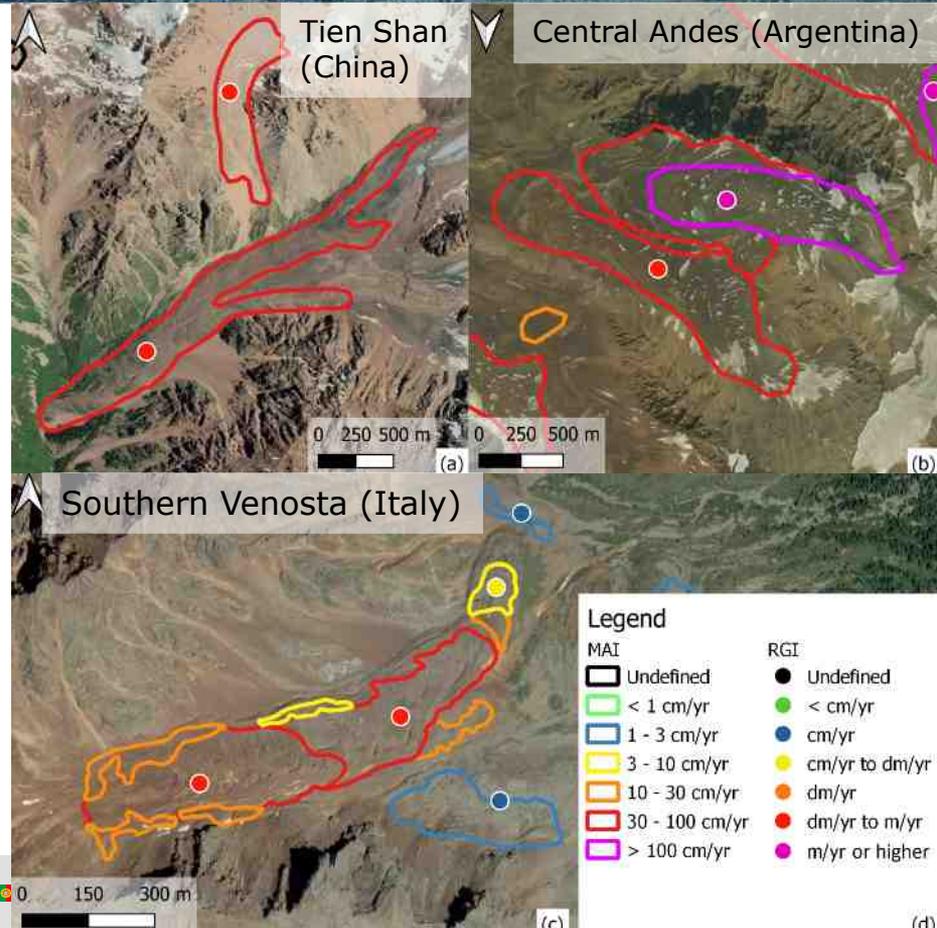
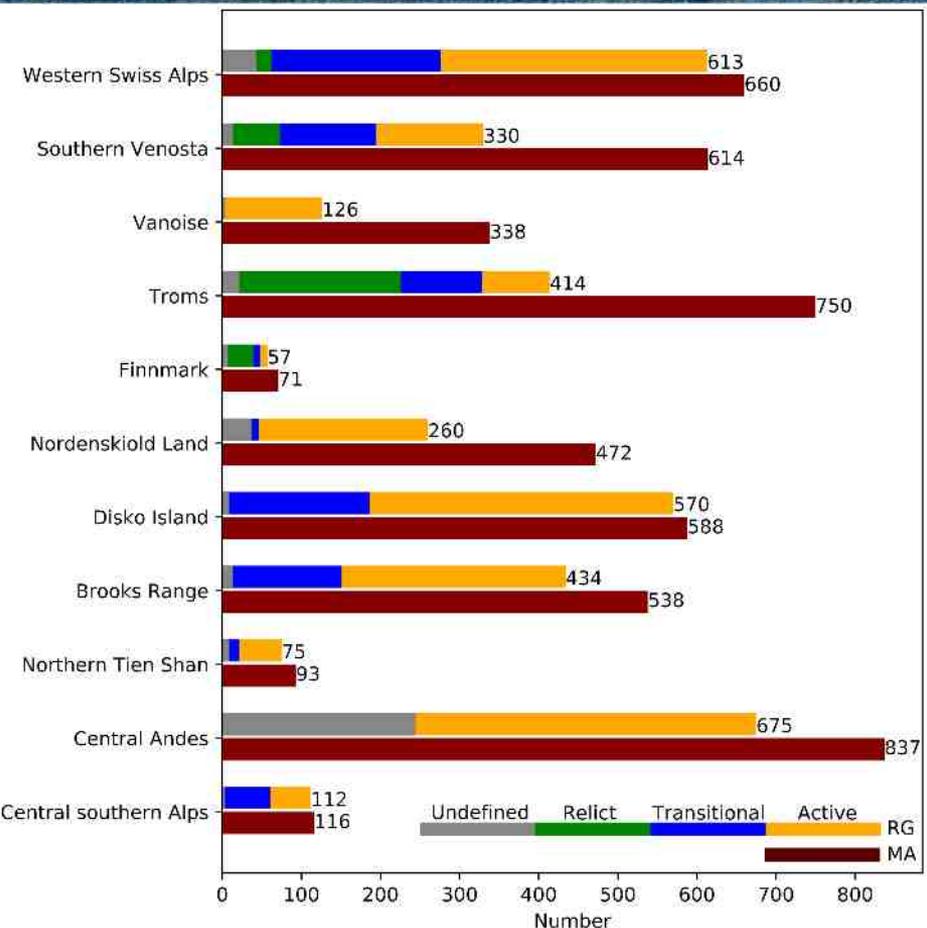
# Guidelines are applied on 11 regions to produce RGIs including kinematics



<b>European Alpine sites</b>	
Western Swiss Alps (WSA)	University of Fribourg, Switzerland
Italy, southern Venosta (SV)	University of Bologna, Italy
France, Vanoise (VM)	EDYTEM - CNRS, France
<b>European subarctic/arctic sites</b>	
Norway, Troms (T)	Norce/Unis/UiO, Norway
Norway, Finnmark (F)	Norce/Unis/UiO, Norway
Svalbard, Land Nordenskiöld (NL)	Norce/Unis/UiO, Norway
<b>Extra-European sites</b>	
Alaska, Brooks Range (BR)	University of Alaska Fairbanks, US
Argentina, Central Andes (CA)	IANIGLA, Mendoza, Argentina
China, northern Tien Shan (NTS)	University of St Andrews, UK
Greenland, Disko Island (DI)	Gamma Remote Sensing, Switzerland
New Zealand, Southern central Alps (CsA)	University of Lausanne, Switzerland



# Inventoried moving areas and rock glaciers

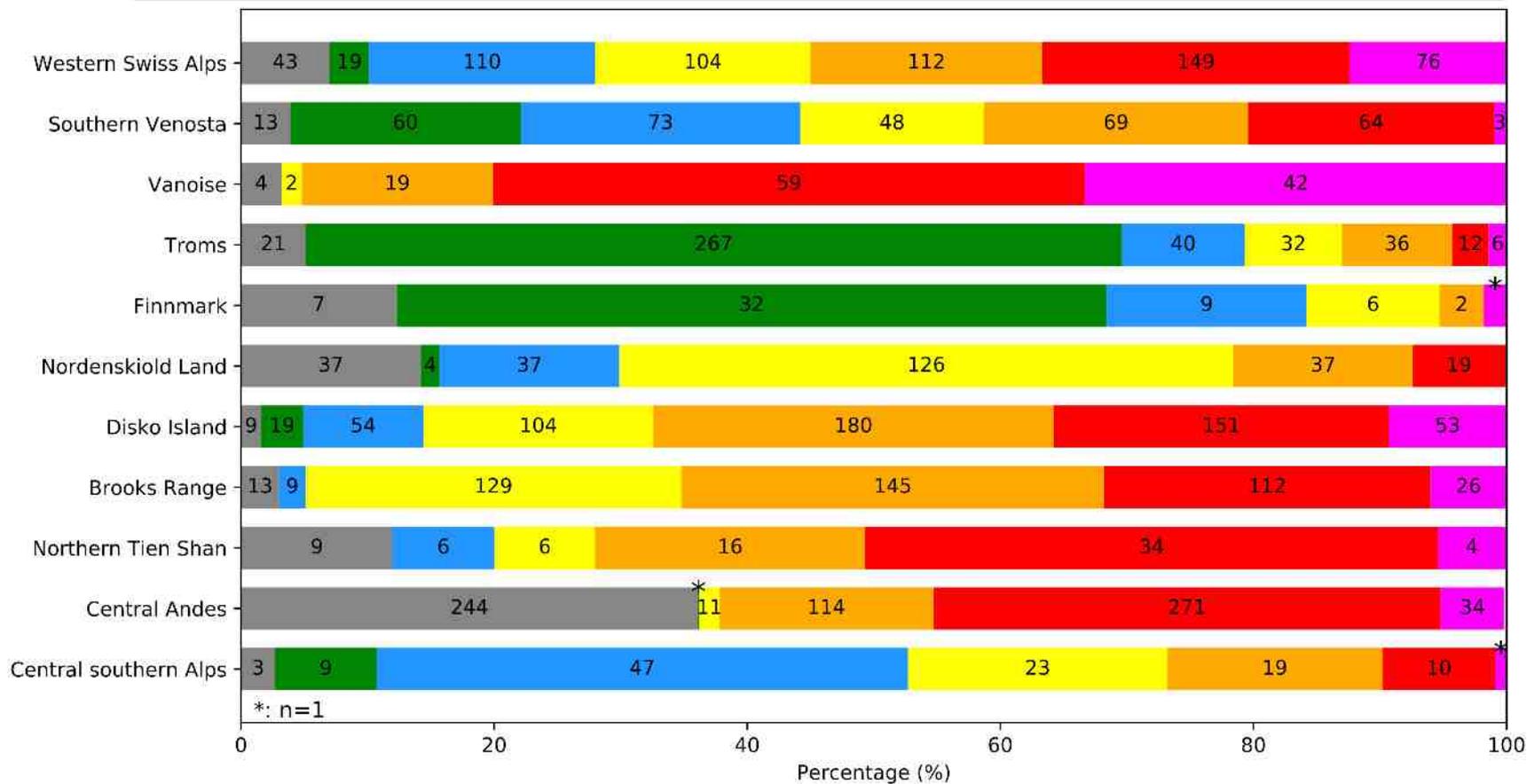




# Inventoried rock glaciers: percentage of kinematic classes



Legend: Undefined (grey), < cm/yr (green), cm/yr (blue), cm/yr to dm/yr (yellow), dm/yr (orange), dm/yr to m/yr (red), m/yr or higher (magenta)

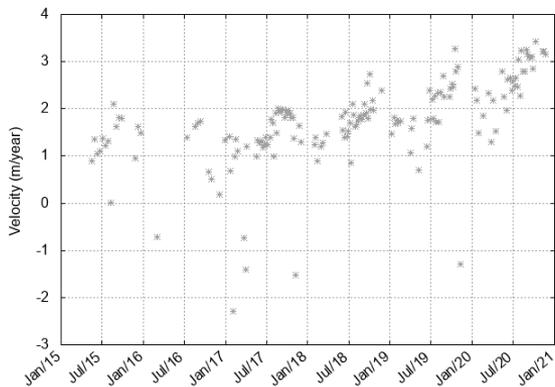
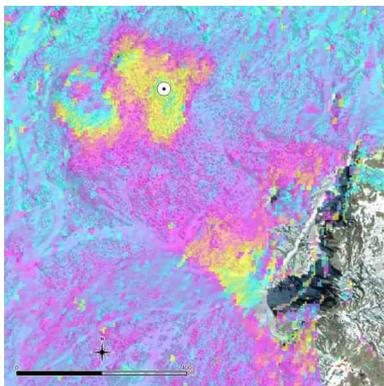




- ✓ Specific common rules containing a detailed standardized method were developed and applied on different regions of the world
- ✓ People from different institutes produced new rock glacier inventories or updated existing ones according to these standards
- ✓ Despite limitations, this work has demonstrated the large potential and feasibility of producing homogeneous inventories of moving areas and kinematics-based rock glacier inventories on a global scale
- ✓ This approach can be applied to other regions of the world
- ✓ The kinematics-based rock glacier inventories are online at <https://www.unifr.ch/geo/geomorphology/en/research/cci-permafrost.html>

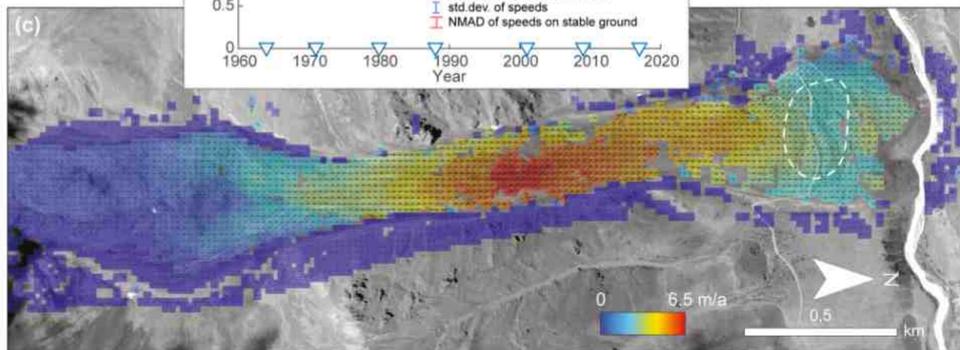
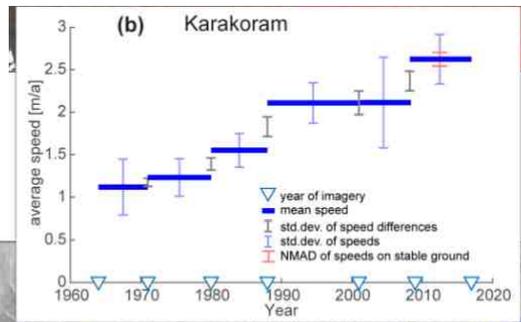


# Kinematic time series from remote sensing

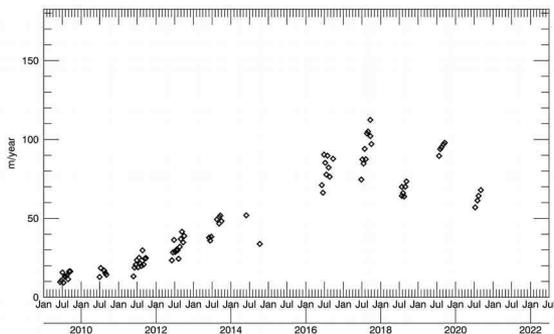


Distelhorn (Switzerland) Sentinel-1 DInSAR

Karakoram (Tien Shan)  
Matching of optical images



Trossingen (Germany)  
TerraSAR-X offset tracking

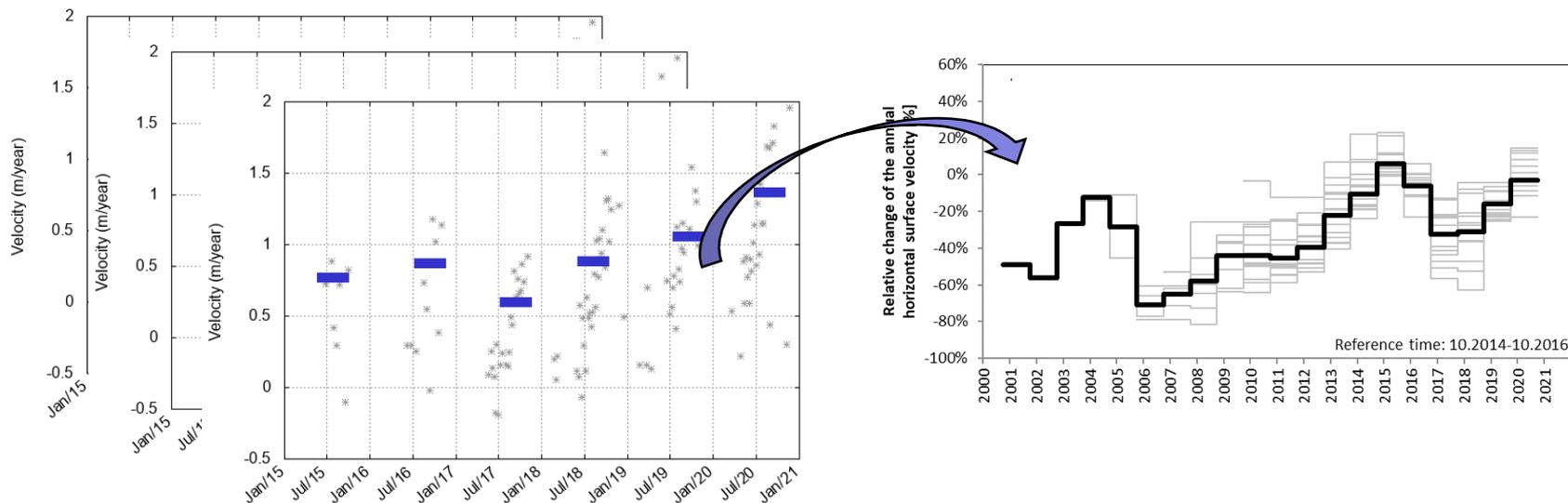




# Towards regional climatic indexes



The results processed so far with DInSAR, SAR offset-tracking and matching of optical images should be expanded to a larger number of rock glaciers to provide a sufficient geographical sampling necessary to represent a defined regional context and be able to express regional climatic indexes





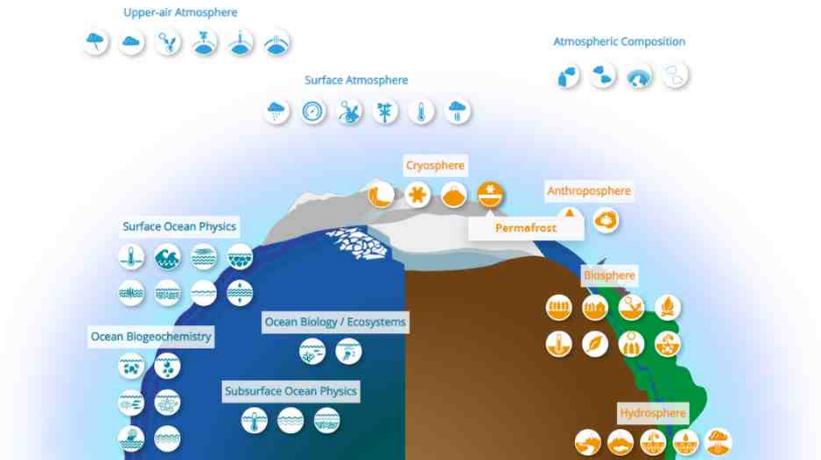
GCOS WMO IOC International Science Council UN environment KEEPING WATCH OVER OUR CLIMATE The Global Climate Observing System

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## Essential Climate Variables

[For table version click here](#)  
[What are Essential Climate Variables \(ECVs\)?](#)



- In 2020, Rock Glacier Kinematics has been proposed as a new **associated parameter to the variable ECV Permafrost** for the new GCOS implementation plan.
- In 2021, GCOS Switzerland has decided to support a **Service dedicated to Rock Glacier Inventories and Kinematics (RGIK)**.