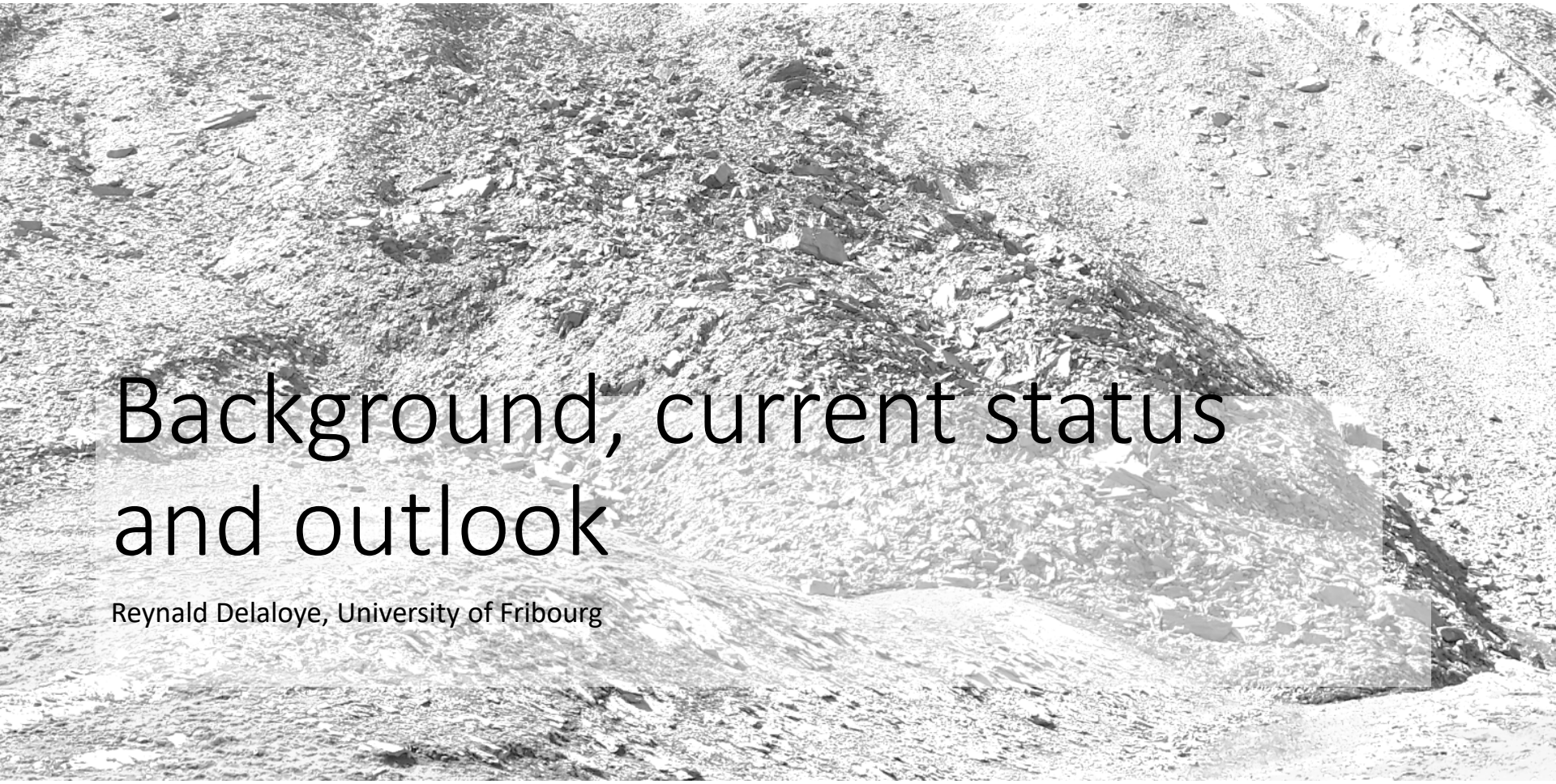
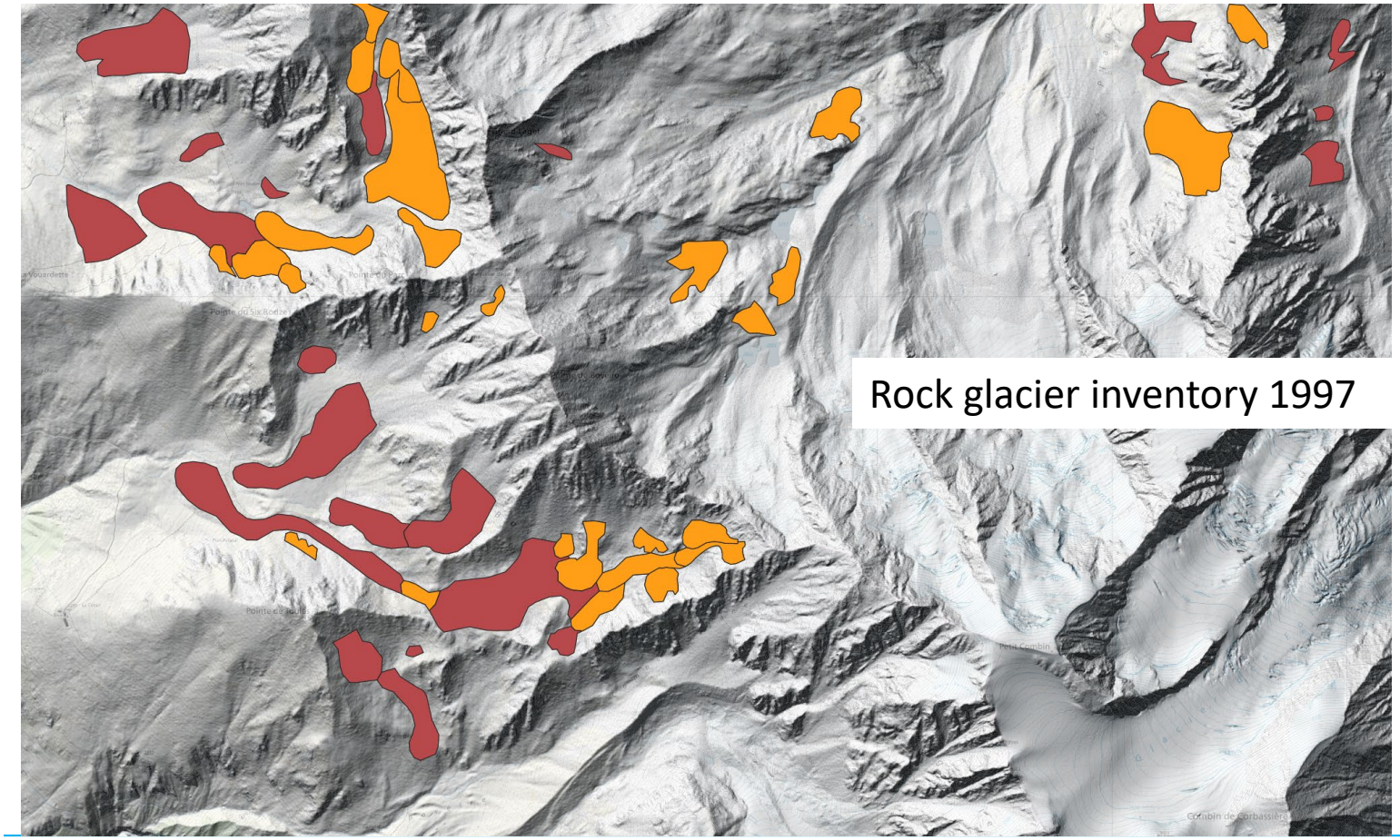


Background, current status and outlook

Reynald Delaloye, University of Fribourg

Motivation - I



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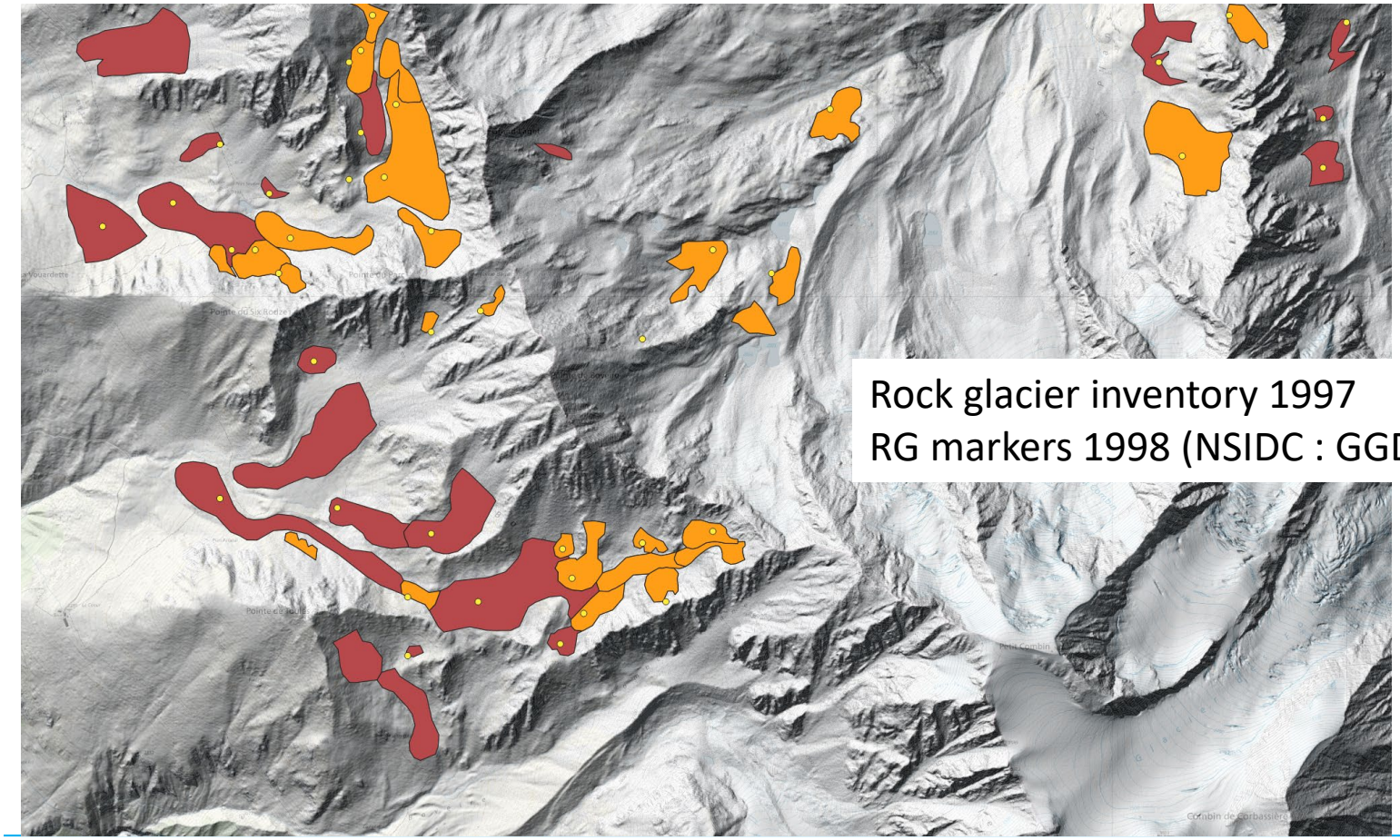
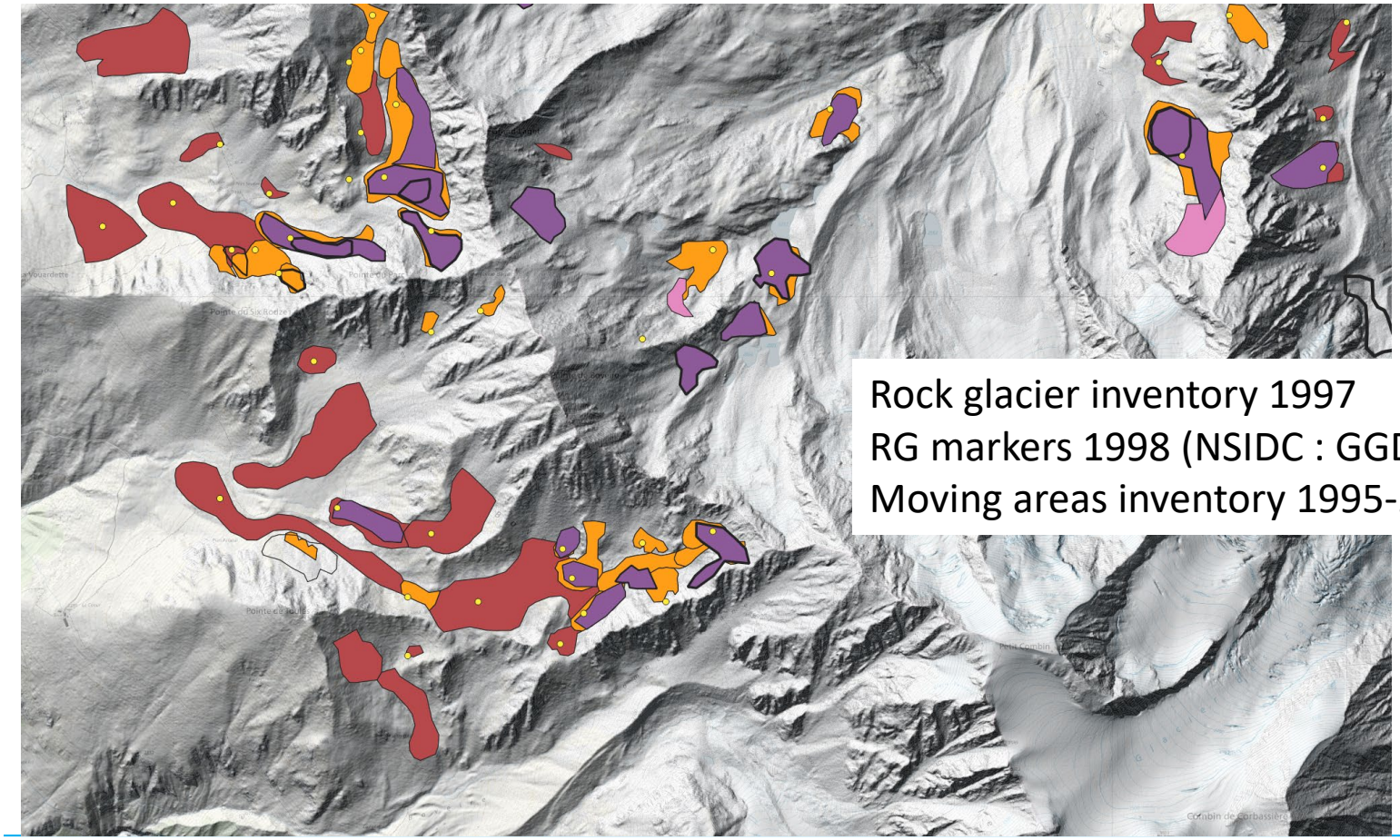


Rock glacier inventory 1997
RG markers 1998 (NSIDC : GGD290)

Motivation - I



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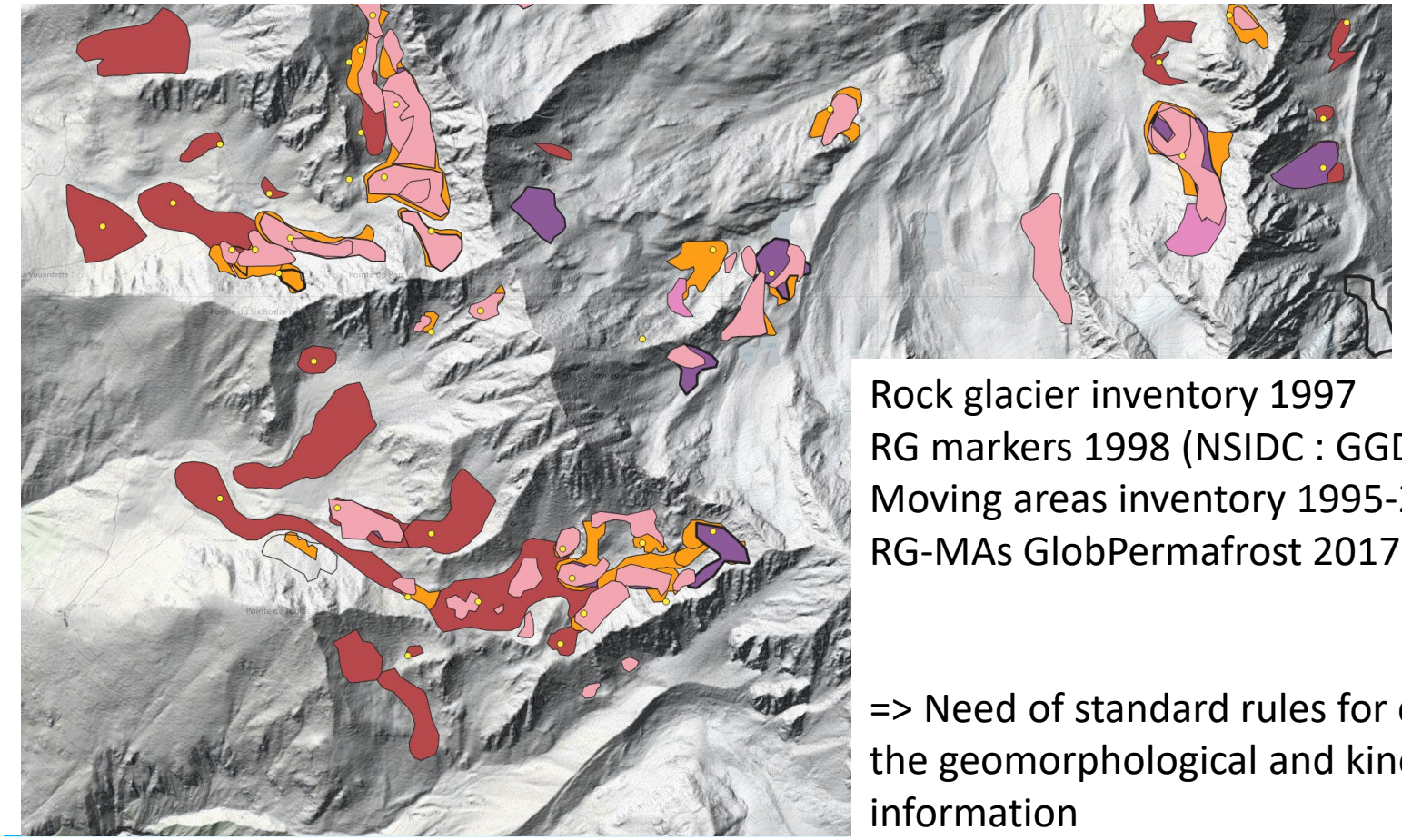
Moving areas inventory 1995-2003

Motivation - I



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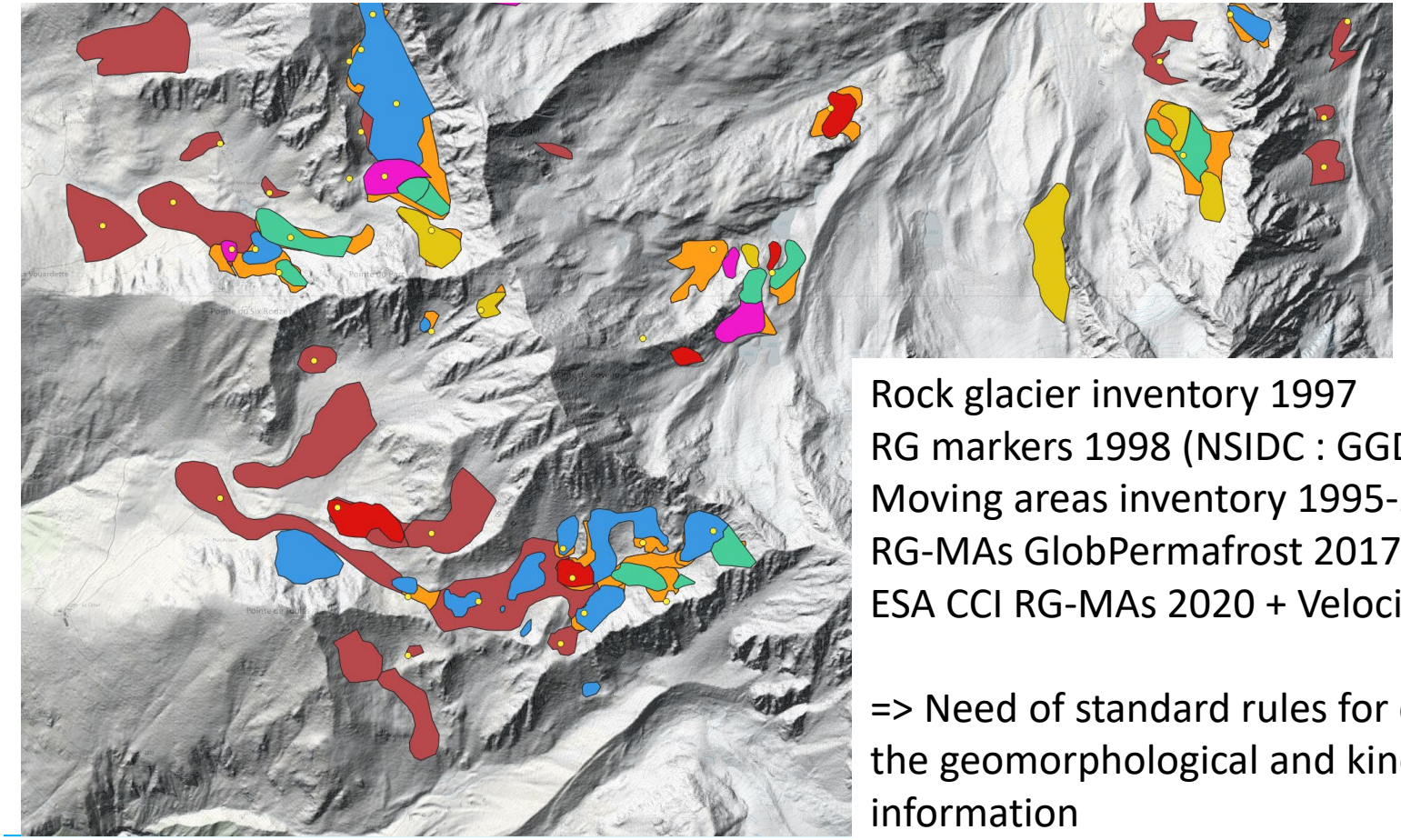
RG-MAs GlobPermafrost 2017

=> Need of standard rules for combining the geomorphological and kinematic information

Motivation - I



Rock glacier inventory 1997
RG markers 1998 (NSIDC : GGD290)
Moving areas inventory 1995-2003
RG-MAs GlobPermafrost 2017
ESA CCI RG-MAs 2020 + Velocity class

=> Need of standard rules for combining the geomorphological and kinematic information

Motivation - I

- Lack of homogeneity between all existing inventories
- Emergence of kinematics-based rock glacier inventories
- Global exploitation of non-homogeneous and non-exhaustive rock glacier inventories (e.g. Jones et al. 2018)
- New tools… (remote sensing, AI)

=> Need of defining standard guidelines (recommendations) for inventorying rock glaciers

Motivation - II

PACE 21 workshop – Svalbard – September 2004

=> First observation of common regional behavior of rock glacier movement (after the heat wave of summer 2003 over Europe)

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PACE 21 workshop – Svalbard – September 2004

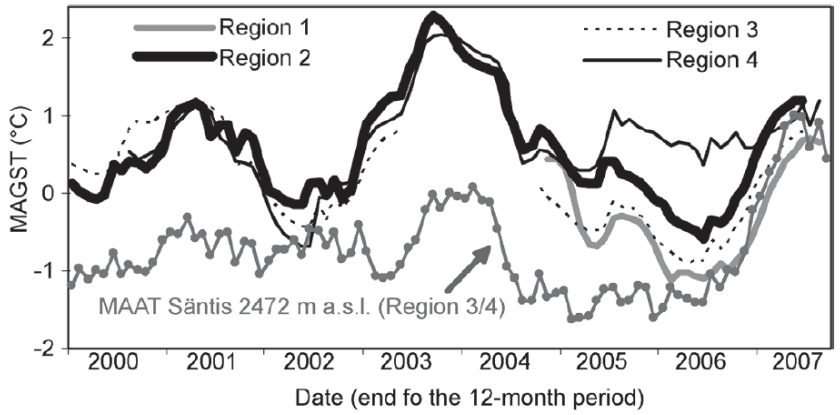
=> First observation of common regional behavior of rock glacier movement (after the heat wave of summer 2003 over Europe)

8ICOP – Fairbanks – June 2008

=> First observation of common behavior of rock glacier movement variations over the European Alps

Motivation - II

8ICOP – Fairbanks – June 2008



Recent Interannual Variations of Rock Glacier Creep in the European Alps

Reynald Delaloye, Eric Perruchoud
Department of Geosciences, Geography, University of Fribourg, Switzerland
Michael Avian, Viktor Kaufmann
Institute of Remote Sensing and Photogrammetry, Graz University of Technology, Austria
Xavier Bodin
Institute of Alpine Geography, Joseph Fourier University, Grenoble, France
Helmut Hausmann
Institute of Geodesy and Geophysics, Vienna University of Technology, Austria
Atsushi Ikeda
Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan
Andreas Kääb
Department of Geosciences, University of Oslo, Norway
Andreas Kellerer-Pirklbauer
Institute of Geography and Regional Science, University of Graz, Austria
Karl Krainer
Institute of Geology and Paleontology, University of Innsbruck, Austria
Christophe Lambiel
Institute of Geography, University of Lausanne, Switzerland
Dragan Mihajlovic, Benno Staub
Institute of Geography, University of Bern, Switzerland
Isabelle Roer
Department of Geography, University of Zurich, Switzerland
Emmanuel Thibert
Cemagref, Grenoble, France

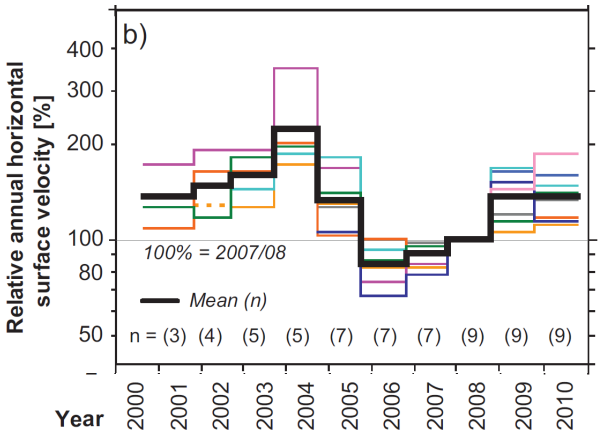
«Interannual variations of rock glacier dynamics appear so far – with probably a few exceptions – to be primarily related to external climatic factors rather than to the internal characteristics of the rock glaciers. They are mostly well related to shifts in mean annual ground surface temperature with a few months of time lag reflecting the delay in propagation of corresponding anomalies deeper into permafrost.»

Follow-up : Kellerer-Pirklbauer et al (in prep.). *Environmental Research Letters*

Motivation - II

Integration in PERMOS (Permafrost Monitoring in Switzerland) – 2008

http://www.permos.ch/downloads/permos08-10.pdf (PERMOS 2013)



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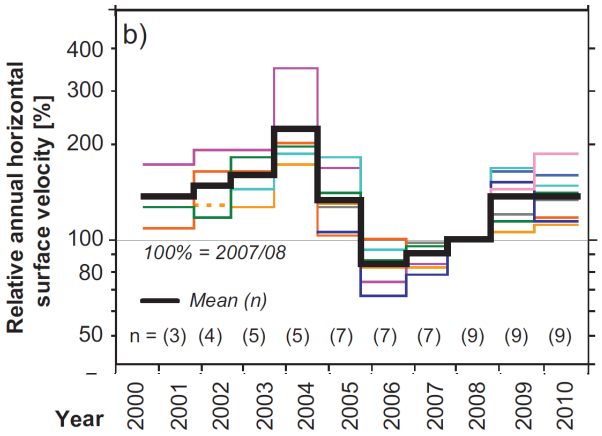
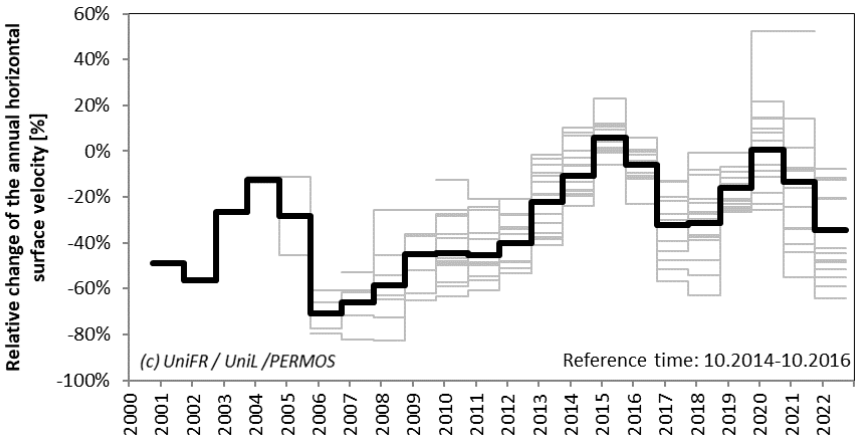


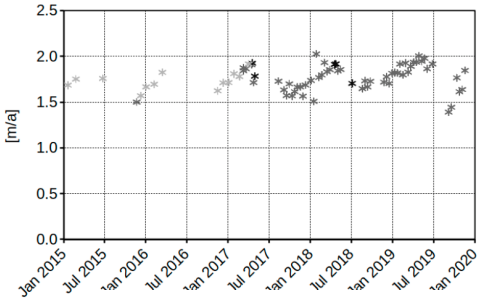
12 years later…



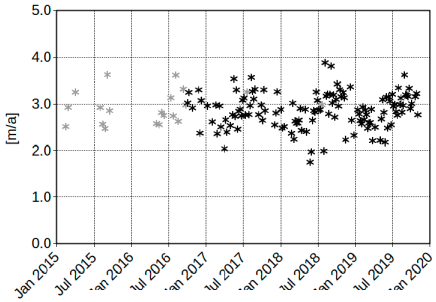
Motivation - II

Sentinel-1 – open access SAR data – 2014

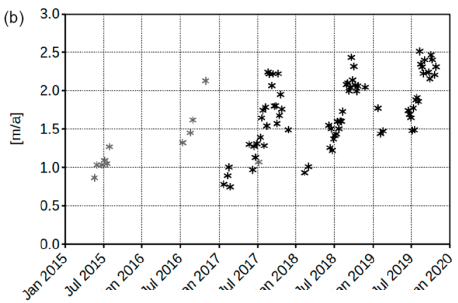
=> opens the way to the “real-time” monitoring of rock glaciers in many regions on Earth (e.g. Strozzi et al. 2020)



Dos Lenguas, Argentina



Manissuarsuk, Greenland



Distelhorn, Swizterland

Motivation - II

- Overall absence of permafrost temperature long-term measurements in mountain regions
- Changes in rock glacier velocities are providing indirect information on permafrost temperature (and related water content) changes

⇒Exploiting the multitude of rock glaciers globally…

… using remote sensing data

to get information about the ongoing changes in permafrost temperature in mountain regions (=> integration to ECV Permafrost)

Motivation - II

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⇒Exploiting the multitude of rock glaciers globally…

… using remote sensing data

to get information about the ongoing changes in permafrost temperature in mountain regions (=> integration to ECV Permafrost)

⇒But, we have first to agree on what rock glaciers are

⇒Development of standard guidelines for rock glacier mapping + categorization (in particular, connection to upslope unit)

- Action Group application to IPA – November 2017

CHAMONIX Mont-Blanc 23 June - 1st July 2018 EUCOP5

Rock glacier inventories and kinematics: a new IPA Action Group

Reynald Delaloye[1], Chloé Barboux[1], Xavier Bodin[2], Alexander Brenning[3], Lea Hartl[4], Yan Hu[5], Atsushi Ikeda[6], Viktor Kaufmann[7], Andreas Kellerer-Pirklbauer[8], Christophe Lambiel[9], Lin Liu[5], Marco Marcer[10], Brianna Rick[11], Riccardo Scotti[12], Hideyuki Takadema[13], Dario Trombotto Liaudat[14], Sebastián Vivero[9], Maria Winterberger[1]

Abstract

A new IPA Action Group (2018-2020) is intending to promote the integration of permafrost creep rates (rock glacier kinematics) as a new associated parameter to the 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. The main scopes of this group are to sustain the first steps toward the organization and the management of a network dedicated to rock glacier mapping (inventorying) and monitoring all around the world and the definition of the necessary standards.

Objectives and scope of the Action Group (KO meeting Chamonix)

Task 1: *definition of a rock glacier*

1. Integrate a working definition of a rock glacier. This definition should guide the observations made when working on an inventory.
2. Define widely accepted standard guidelines for inventorying rock glaciers (what do we observe exactly? Is it an outline, a point on a map?).
3. Set up practical guidelines which will be based according to the first two points, allowing a standard procedure for inventorying rock glaciers (how to do it).

Task 2: *fulfil the ECV requirements – preparation of the products*

Promoting the use of satellite imagery: monitoring rock glacier dynamics at a regional scale…. Integration of in situ data….

To be developed according to achievement of Task 1

Task 3: operational development a database

TBD in a next step

- **Phase I – June 2018-June 2020**
  - Kick-off meeting – EUCOP5, Chamonix (F), June 2018
  - Workshop I – Evolène (CH), September 2019
    - Dedicated to RoGI

      => Committee RoGI
  - Workshop II – Fribourg (CH), February 2020
    - Dedicated to :
      - Kinematic attribute in RoGI
      - RGV

      => Committee RGV

- **Phase II – June 2020-June 2023**
  - Committees workshop – Fribourg (CH), November 2022
  - Workshop III – EUCOP – Puigcerdà (E) – June 2023

- Support provided by :
  - Alpine Geomorphology Research Group, Univ. Fribourg
  - ESA CCI Permafrost – Phase I (2019-2020 – 1.5 yr)
  - GCOS Switzerland – (2021-2023 – 2 yr)
  - ESA CCI Permafrost – Phase II (2022-2025 – 3 yr)
  - BiGeA, Univ. Bologna (2023-2024)
  - RoDynAlpS, Univ. Fribourg/Lausanne/Zurich, SLF Davos (2023-2027)
  - …

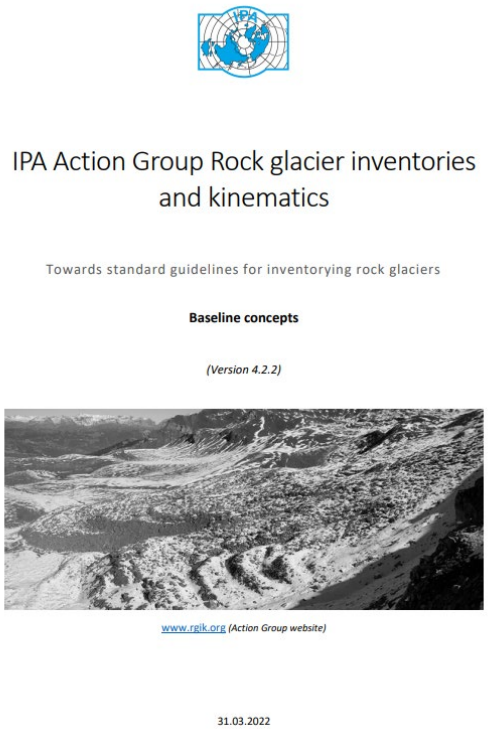
⇒Part-time enrolment, for diverse periods :

- Chloé Barboux, Aldo Bertone, Alessandro Cicoira, Thomas Echelard, Nina Jones, Cécile Pellet, Sebastiàn Vivero

+ active participation by committees members

(and other members of the IPA Action Group)

RoGI achievements (-> next presentation)



Standard guidelines for inventorying rock glaciers
- Baseline concepts (v4.2.2) (RGI_BCv4.2.2) (31.03.2022)
- Practical concepts (v2.0) (RGI_PCv2.0) (11.04.2022)

Kinematics as an optional attribute in standardized rock glacier inventories
- Baseline concepts (v3.0) (RGI_KAv3.0) (11.05.2022)
- Practical guidelines: rock glacier inventory using InSAR (kinematic approach) (v3.0.2) (11.06.2020)

Training tool/area

RoGI – main open issues / what next ?

(-> “Next steps” session)

- Development of the operational phase
- Final product(s) / Publications
- Further training tools/areas ? (CCI Permafrost Phase II)

RGV achievements

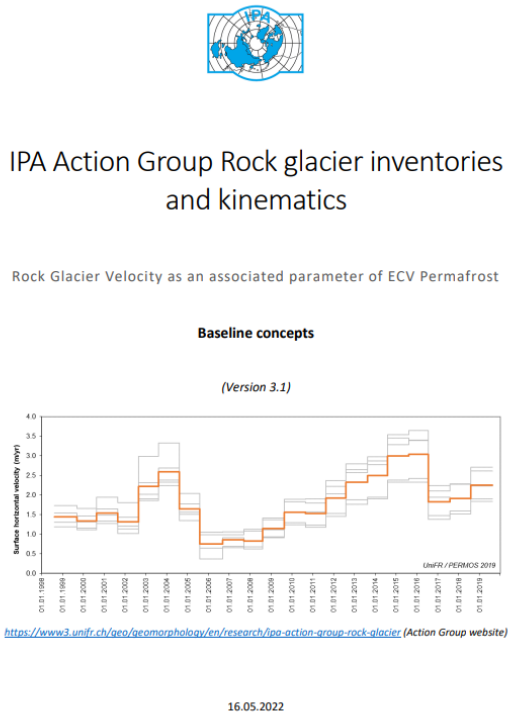
- GTN-P Strategy and Implementation Plan 2021-2024 (pdf)
- GCOS ECV Implementation Plan 2022

The latest plan focussed on enhance observation systems and long-term data to understand and address climate change was adopted by the UNFCCC's scientific and technological advisory body at COP27 [12 November, 2022].

The 2022 Global Climate Observing System implementation plan (GCOS-244) outlines the practical actions needed – and gaps to be addressed – **over the coming decade** to provide the actionable climate information for mitigation, early warning systems to help tackle the climate crisis, as well as information provide information relating to the risks and attribution of extreme events.

See : ESA Climate Office - GCOS plan adopted at COP27 (esa.int)

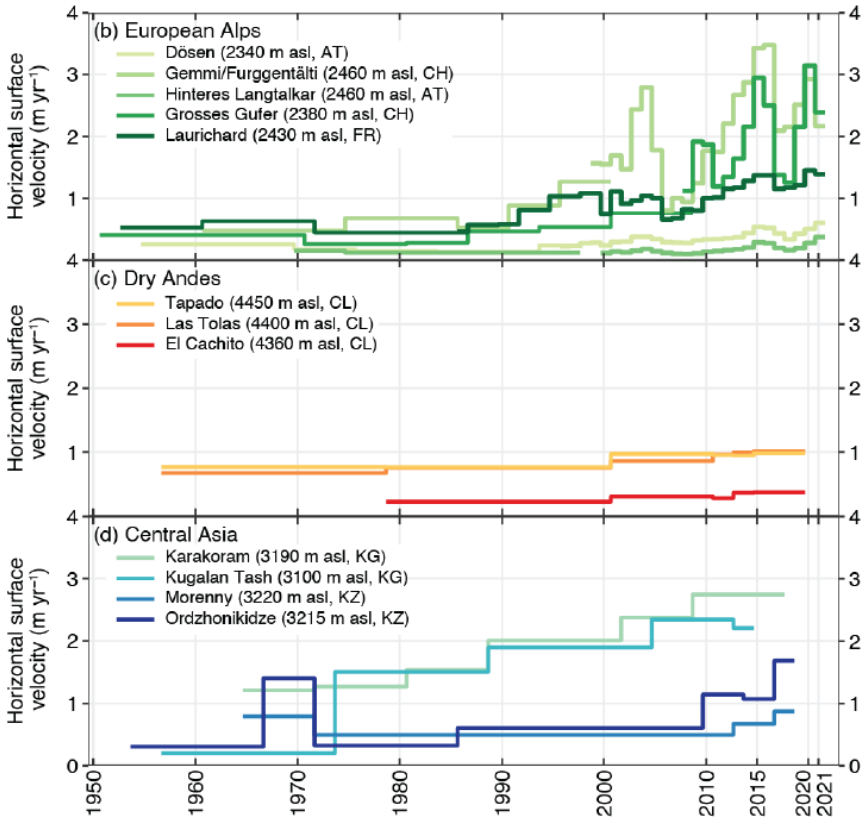
RGV achievements (-> next presentation)



Rock glacier velocity as an associated parameter of ECV Permafrost

- Baseline concepts (v3.1) (RGV_BCv3.1) (16.05.2022)

RGV achievements



[State of the Climate - American Meteorological Society (ametsoc.org)]

State of the Climate in 2021

ROCK GLACIER VELOCITY
C. Pellet et al.
S43-44

RGV – open issues / what next ?

(-> “Next steps” session)

- Development of the practical guidelines (ongoing)
- RGV extraction from velocity time series (guidelines needed)
- Final documentation product(s) / Publications
- Development of the operational phase

RGIK – open issues / what next ?

(-> “Next steps” session)

- What next after closing workshop (EUCOP6 – June 2023)?
  - Long-term strategy ?
  - Governance ?
  - Development of a RGIK service ?
  - Database and web platform ?
- IPA Standing Committee ?
  - Proposal submitted to IPA EC in May 2023
  - Will be discussed by the IPA Council Meeting on Wednesday
  - But first make the structure working (-> 6 years)
- Puigcerdà Commitment
  - Defines objectives and governance structure of RGIK