A Report on the Balzan Excursions in Oberengadin
Guided by Hans Oerlemans
2022 Balzan Prizewinner for Glaciation and Ice Sheet Dynamics

---

Participants:

Hans Oerlemans	Balzan Prizewinner
Sierd Cloetingh	Balzan General Prize Committee member
Laura Laera	Balzan Foundation Board member
Marco Cameroni and Christina Leutwyler	Balzan Foundation board member and his wife
Suzanne Werder	Balzan Secretary General
Federica Andreoli	Balzan staff
Paolo Corona	Balzan staff
Valeria Sforzini	Reporter with one of Italy's daily newspapers *Corriere della Sera*
Sandro Orlando	Reporter with the weekly magazine *Oggi*
Tommaso Scanziani	Balzan press office staff

PROGRAMME:

Thursday 21 September 2023:
The group arrived in the afternoon at the Sporthotel Pontresina, and was treated to a welcome dinner at the Sporthotel's Sportstübli.

Friday 22 September 2023:
Due to the inclement weather conditions (constant heavy rain for the whole day), the original programme (which foresaw the ascent to Diavolezza) was changed by reversing the Friday and Saturday excursions. It was therefore decided to hike in the rain with appropriate clothing to the snout of the Morteratsch glacier. It was not possible to enjoy the expected views, but there was some medium- and short-distance visibility to let the participants admire the features of the glacial and periglacial landscape.

After taking the train to the Morteratsch station, the group hiked to the snout of the Morteratsch glacier.
Along the trail, it was possible to see the successive stages of plant colonisation of grounds once covered by the retreating glaciers. Many erosional features on the way showed how glaciers shape the landscape.

Once back at the hotel, the group dined at the Sporthotel's Sporthütta. After dinner, an evening lecture was delivered by Hans Oerlemans and Felix Keller on the history of the Oberengadin glaciers and the MortAlive project.

Saturday 23 September 2023:
Although weather conditions were still not ideal, there was almost no precipitation. The temperature, which had dropped in the night and early morning, brought the snow level down to 2,400-2,500 meters. at At almost 3,000 meters, the landscape in Diavolezza was therefore already winter-like, with a layer of snow about 15 centimeters thick. Views of the surrounding peaks were partially compromised, but a few fleeting openings allowed views of Piz Palü. It was still possible to enjoy a good view towards the Vedretta Pers.

After returning to the valley by cable car, participants visited the VR Glacier Experience exhibition, then returned to Pontresina.

Sunday 24 September 2023:
Due to an overnight improvement, the weather conditions were finally very good. The sunny day, with a clear sky and very good visibility, allowed the hike to run smoothly.

After arriving at Muragl by bus, the group took the cable train to Muottas Muragl with its incredible view on the Engadin lakes. The hike started with a stop at the Muragl rock glacier and an explanation about this type of formation. The hike continued to Pontresina, where they could observe dams built to protect the village from landslides. The dams represent an example of fine integration of protective structures into the landscape.


Muragl rock glacier (photo I. Gärtner-Roer)

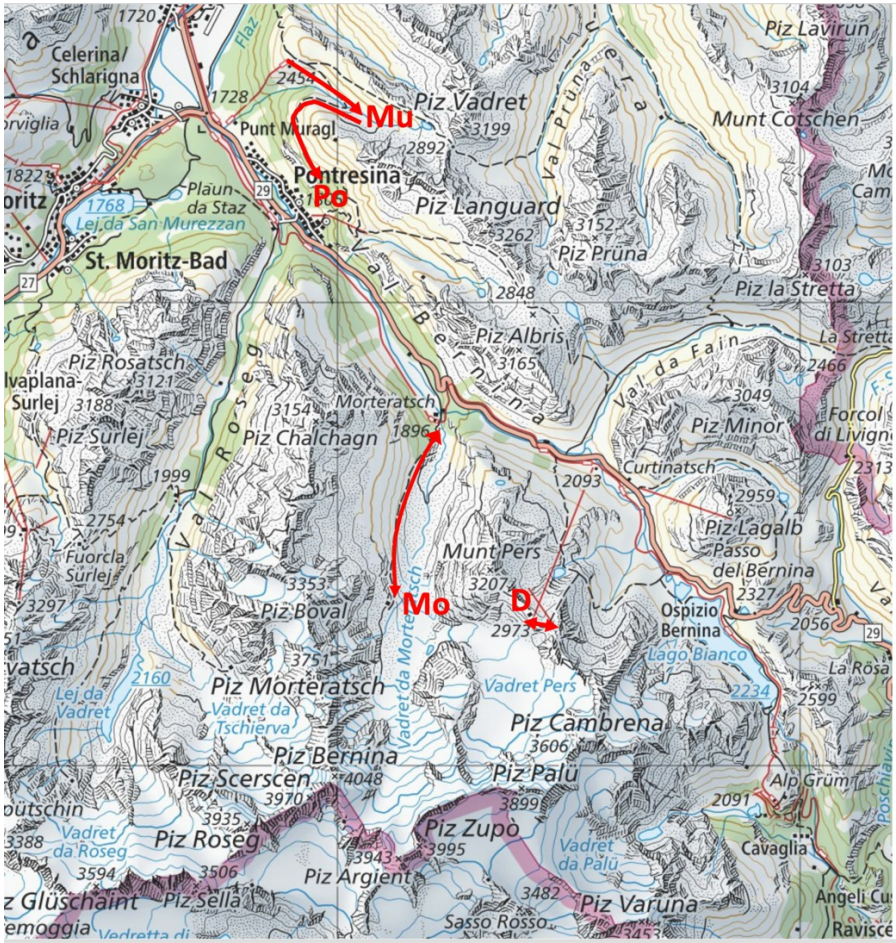
Background

The landscape of the Oberengadin has to a large extent been shaped by the action of glaciers and peri- glacial features. Glaciers, rock glaciers, glacial deposits, moraines, scratched surfaces, and erratics are found everywhere. Permafrost is particularly widespread due to relatively dry conditions (limited snow cover in winter as compared to many other parts of the Alps).

At the peak of the last glacial period (LGM: Last Glacial Maximum), the Alps were covered by a huge ice cap, from which large glaciers flew out to the plains surrounding the Alps. Deep U-shaped valleys were carved out, partly filled afterwards with sediment and water. All the spectacular lakes in the Alps are due to the carving action of glaciers (Bodensee, Lac Léman, Vierwaldstättersee, Lago Maggiore, Lago di Garda and many others). At the LGM, about 20 000 years ago, only the highest peaks of the Alps protruded through the ice cap.

After the melting of the LGM ice cap, glaciers remained in the highest part of the Alps, including the Bernina mountains (highest peak: Piz Bernina, 4049 m). Here the Vadret da Morteratsch is the largest glacier. Like other glaciers in the Alps, it fluctuated in extent through time, with minimum glacier stands in Roman times, the late Medieval Period and the present time.

Rock glaciers, existing of a mixture of rock and ice, are abundant in the Oberangadin. They flow slowly (typically between 1 and 100 cm per year), which is enough to prevent the development of significant vegetation.

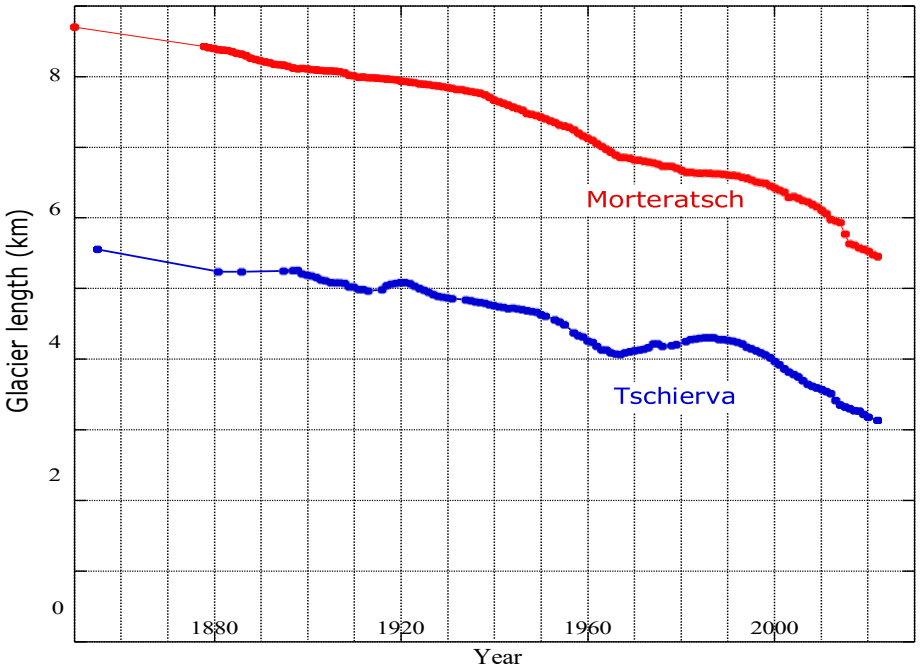


Geographical information

D: Diavolezza
Mo: Morteratsch glacier
Mu: Muragl rock glacier
Po: land slide protection dam

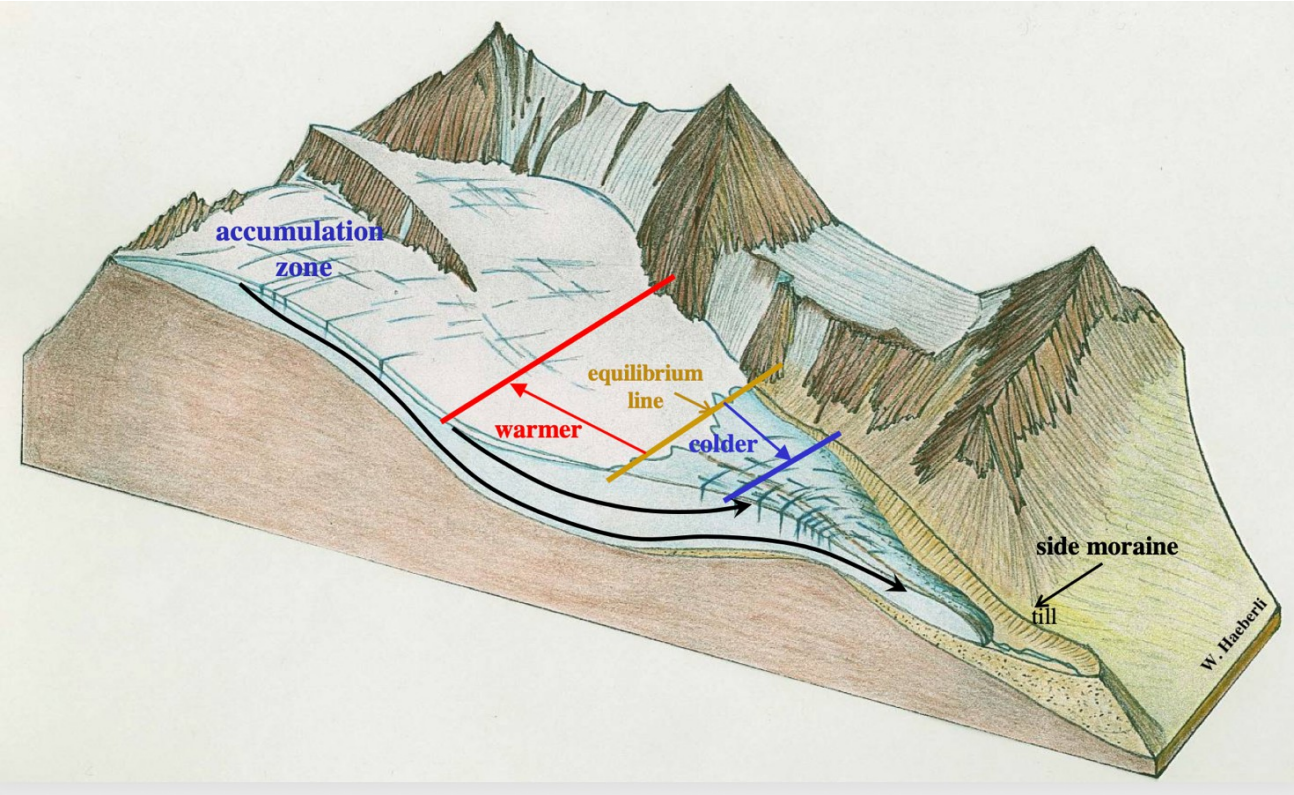
hikes in red

Length record of the Vadret da Morteratsch and Vadret da Tschierva (data GLAMOS)



Vadret da Morteratsch and Vadret Pers, photographed from a glider (Christine Levy, 1.8 2017)

How does a glacier work?



Glaciers form when elevated terrain, a plateau or mountain peaks, is above the so-called equilibrium line. The equilibrium line (yellow in the figure) separates the accumulation zone (where the amount of snowfall in winter exceeds melt in summer) from the ablation zone (where all winter snow disappears in summer). Due to thermodynamic and pressure effects, the snow in the accumulation zone turns into ice. When pressure is high, ice behaves as a viscous material and starts to flow down (black lines). For a glacier in equilibrium with the prevailing climate, the total mass gained in the accumulation zone is equal to the mass lost in the ablation zone. The flow of ice takes care of the necessary mass transfer down-glacier.

When climate warms, the equilibrium line will go up, typically by 100 m per degree K temperature increase (e.g. *Oerlemans, 2010*). There will be more melt and a smaller portion of the precipitation will fall as snow. The ablation zone expands, and the accumulation zone shrinks. The net mass budget thus becomes negative. Mass equilibrium can only be restored when the ablation zone is reduced by retreat of the glacier snout. For a cooling climate the opposite takes place, and the glacier will expand. Note that for a glacier with a small surface slope, the effect of a rising equilibrium line will be larger - such a glacier is more sensitive to climate change.

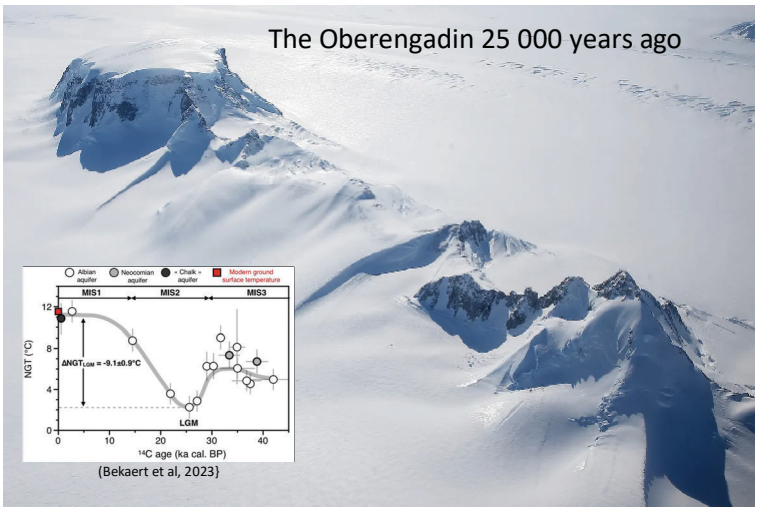
Most glaciers are currently out of balance with the prevailing climate, i.e. they are 'too large' for present-day temperatures. At the end of the summer, the size of the accumulation area can be observed by visual inspection. In recent years, many smaller glaciers in the Alps had no accumulation zones anymore because of a very high equilibrium line. Depending on their size, these glaciers will disappear within a few decades (e.g. Zekollari et al., 2019)

Oerlemans J (2010): *The Microclimate of Valley Glaciers*. Igitur, Utrecht University, 138 pp. ISBN 987- 90-393-5303-5

Zekollari H, Huss M and Farinotti D (2019) Modelling the future evolution of glaciers in the European Alps under the EURO-CORDEX RCM ensemble, *Cryosphere*, **13**, 1125–1146 (doi.org/10.5194/tc-13- 1125-2019)

Glacier fluctuations

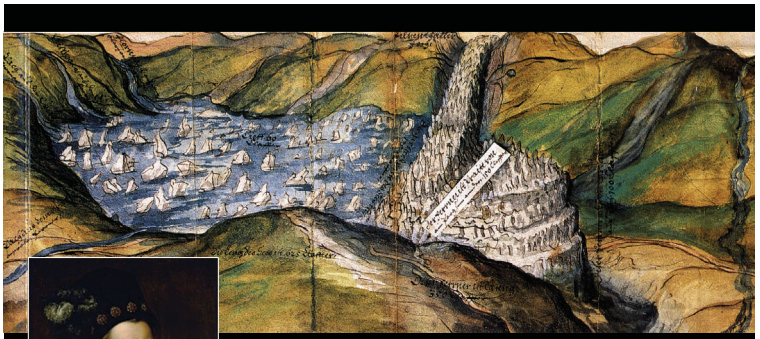
J. Oerlemans (Utrecht University & Glaciervision)



(Bekaert et al, 2023)

Why are we interested in glaciers ?

- hydrology / meltwater in summer (irrigation, reservoirs)
- touristic attraction
- hazards:
  - ice avalanches
  - lake outbursts
- palaeoclimate reconstruction
- contribution to sea-level change



Kaiser Rudolf II

Vernagtferner, Austria 1601

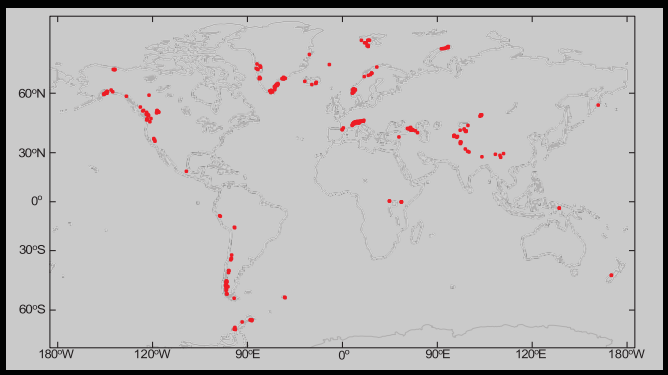
Nicolussie (1990)

Hornkees, Waxeggkees (Austria, Zillertal, Berliner Hütte)

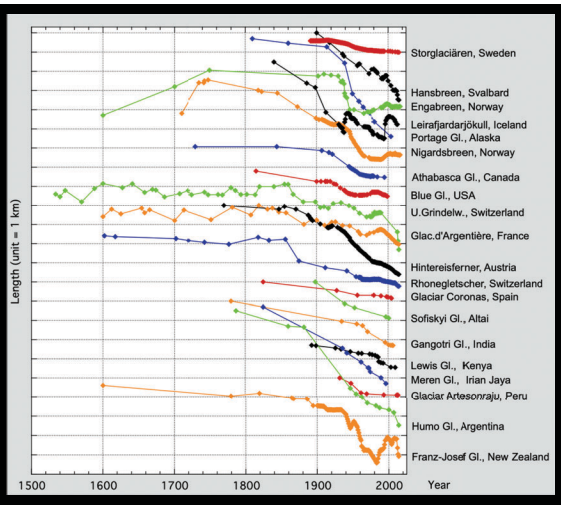
1905 **2003**

Gesellschaft für ökologische Forschung (München) / W. Zängl

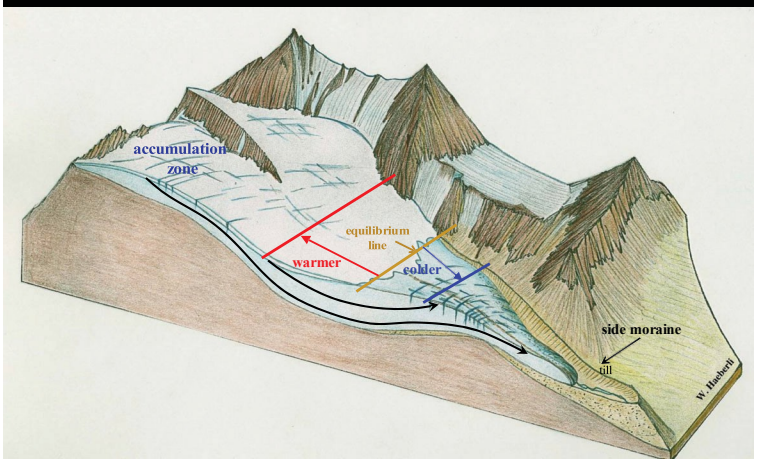
Glaciers are (still) everywhere !

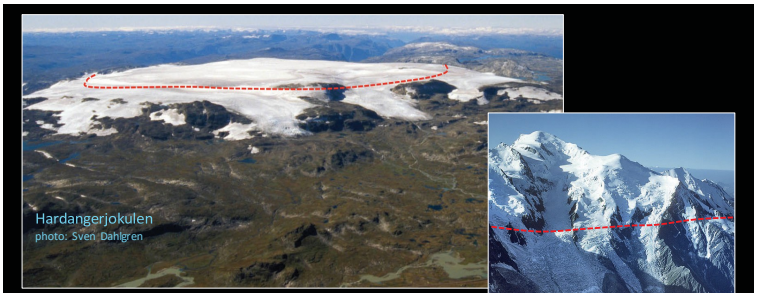


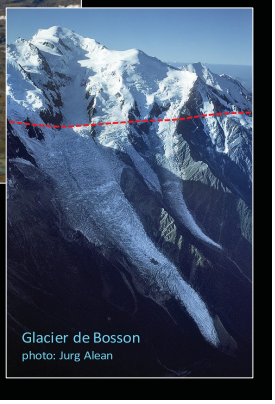
~ 500 length series, starting before 1950



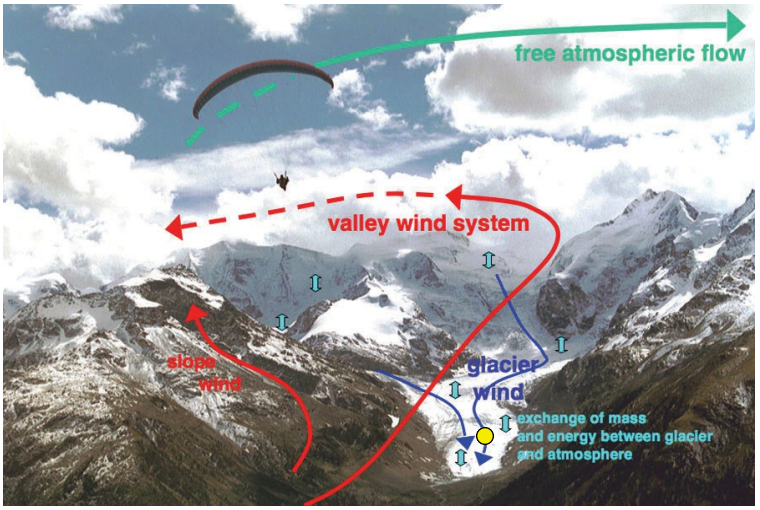
How does a glacier work ?

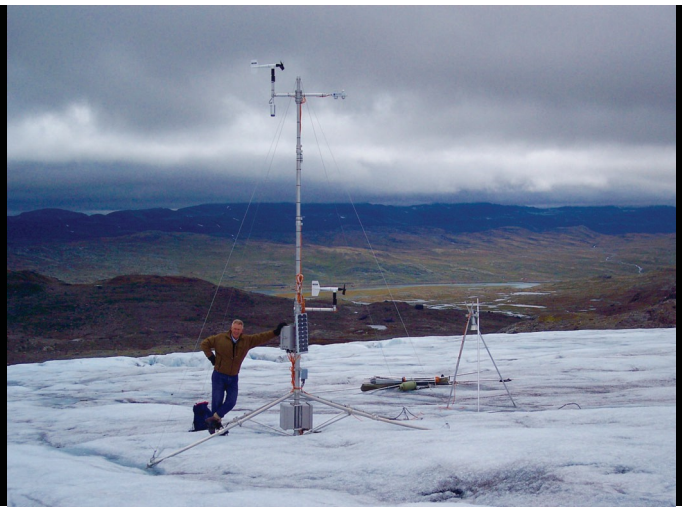






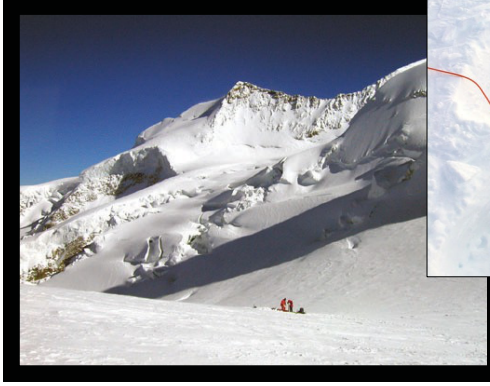
Climate sensitivity: **slope** is an important factor



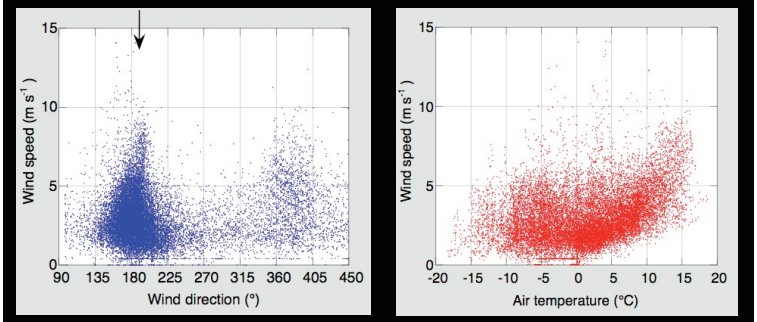


Measuring the energy budget of a glacier surface

accumulation zone

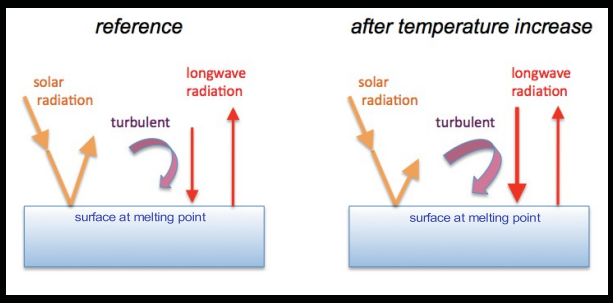


Vadret da Morteratsch, Switzerland



The large sensitivity of glaciers to temperature change is due to:

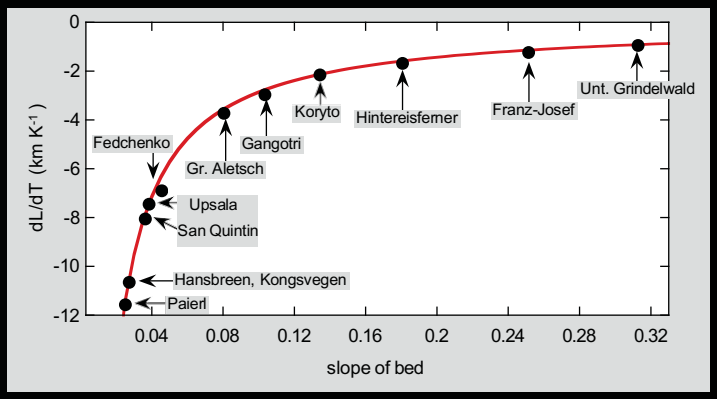
- albedo feedback
- longwave emission cut-off

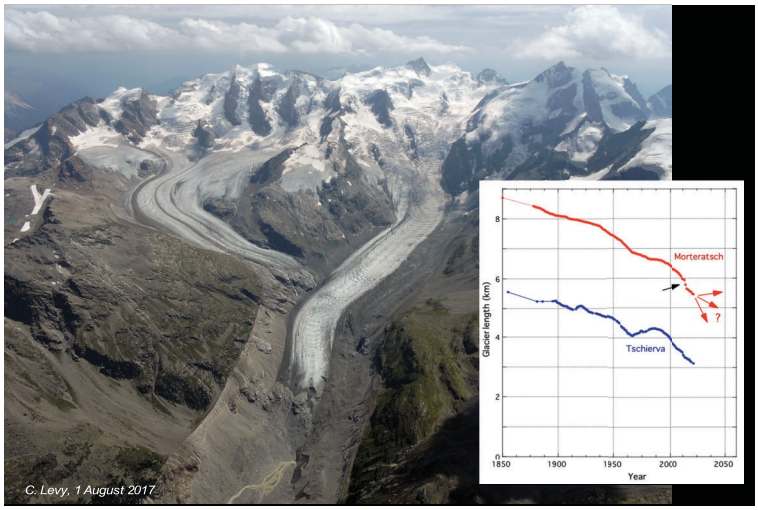


Reaction of the Equilibrium Line Altitude (ELA) to climate change

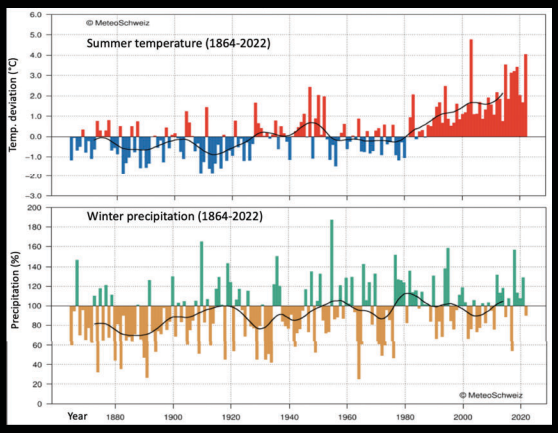
Temperature + 1 C ⇨ ELA: +100 m

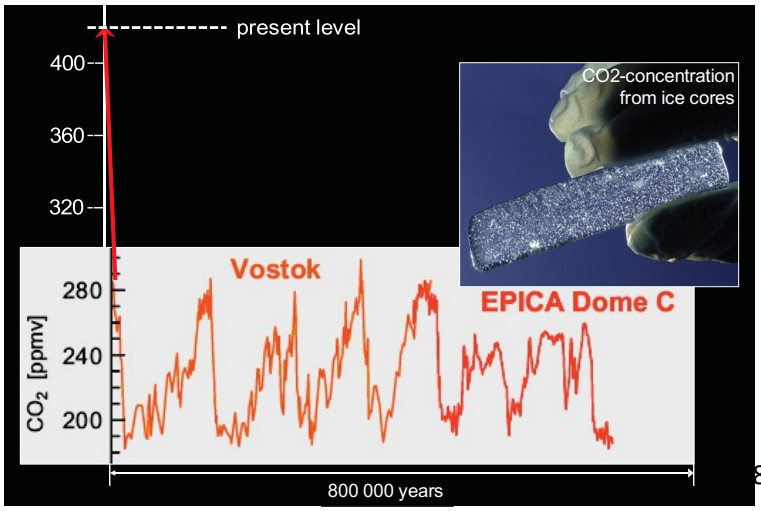
Precipitation + 10 % ⇨ ELA: - 25 m





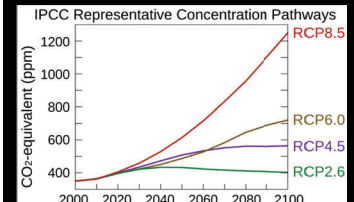
Temperature and precipitation in Switzerland - observations

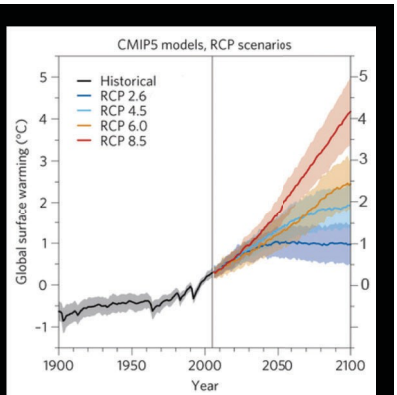




Source:

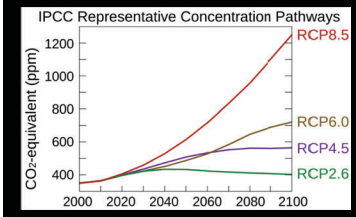
IPCC Assessment Report (2013), with updates

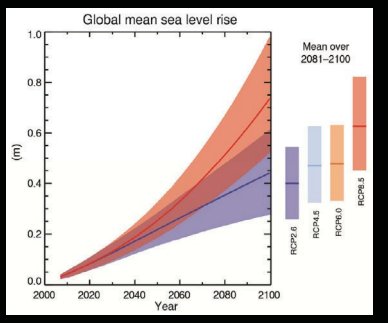




Source:

IPCC Asessment Report (2013), with updates





What can we do about it ?

- reduce greenhouse gas emissions
- work on local solutions (-> Felix Keller)