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INTERNATIONAL CONFERENCE ON
MOUNTAINS AND CLIMATE CHANGE

CRYOSPHERE
Some considerations from recent footprints of the cryospheric sciences to the forthcoming steps

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What is cryosphere?
ice in all its forms:
glaciers and ice sheets, snow, ground ice, sea ice, river ice, cave ice and - why not - the ice cubes to cool a whisky glass.

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Cryosphere: the collective term for the components of the Earth system that contain a substantial fraction of water in the frozen state

Cryospheric science: the science studying all the ice in the Solar System or, zooming on the Earth's ice, the science of ice in the environment.

Cryosphere: a natural integrator of climate variability, that provides some of the most visible signatures of climate change

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Sometime the term *glaciology* is considered being a synonymous of *cryospheric sciences*, but in the common perception *glaciology* is used in a quite narrow way to cover the study of glaciers

Glaciology is a relatively modern discipline (less than two centuries of history)

First landmark: the idea that glaciers fluctuate over time (1840 Louis Agassiz' Glacial Theory)

Second landmark: the 1952 Glen's experiments on the deformation of ice

The landmark of the current scientist generation?

Glacier change as a key of global change and as the highest-confidence temperature indicator in the climate system

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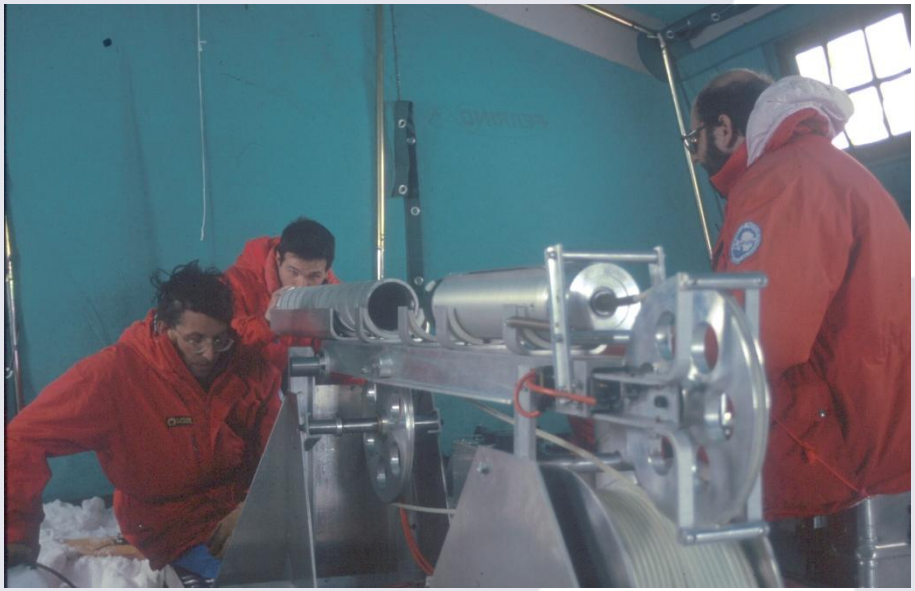

Two kinds of evolutions in history of cryospheric sciences :

1) The technology-based evolution; their gallop is mainly based on computer power, ice-drilling, remote sensing, geophysical technique development.

2) The paradigmatic evolution brought about the leading idea of interaction between cryosphere and other components of the global environmental system, such as climate or sea level

“A report card on the progress of glacial studies over the past 40 years might read encouraging progress, but surprisingly large gaps in knowledge remain” (Sugden, 2006)

“A large number of big unanswered questions and unsolved problems that go to the heart of the discipline” (Knight, 2011)

“Glaciologists are inspired by the knowledge they have gained, but they are challenged by what remains to be understood” (Clarke, 2005)

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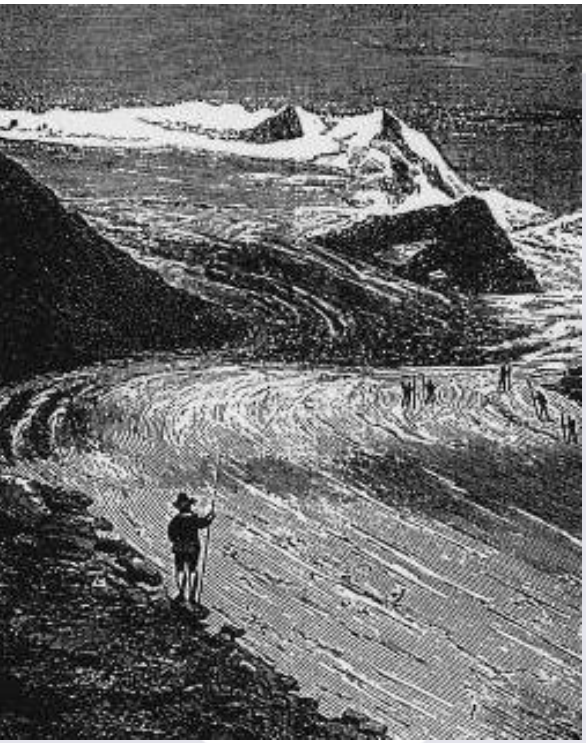


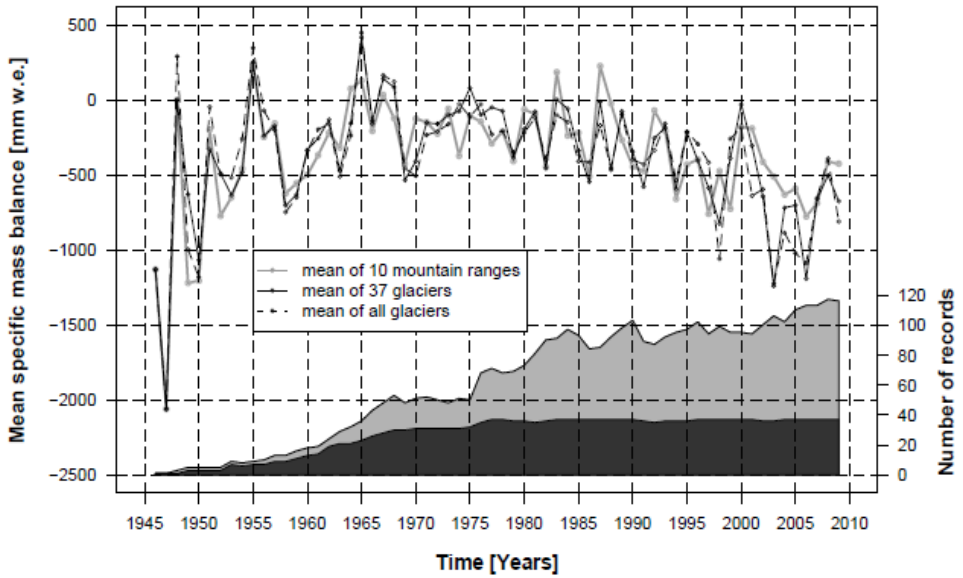
(da Stoppani, 1876)

1939 (Archivio P. Casati)

Glaciers: over the past 100 years, and particularly since the 1980s, there has been worldwide and dramatic shrinkage of glaciers. Increases in global air temperatures may lead to the extinction of glaciers from many mountain regions over the coming decades

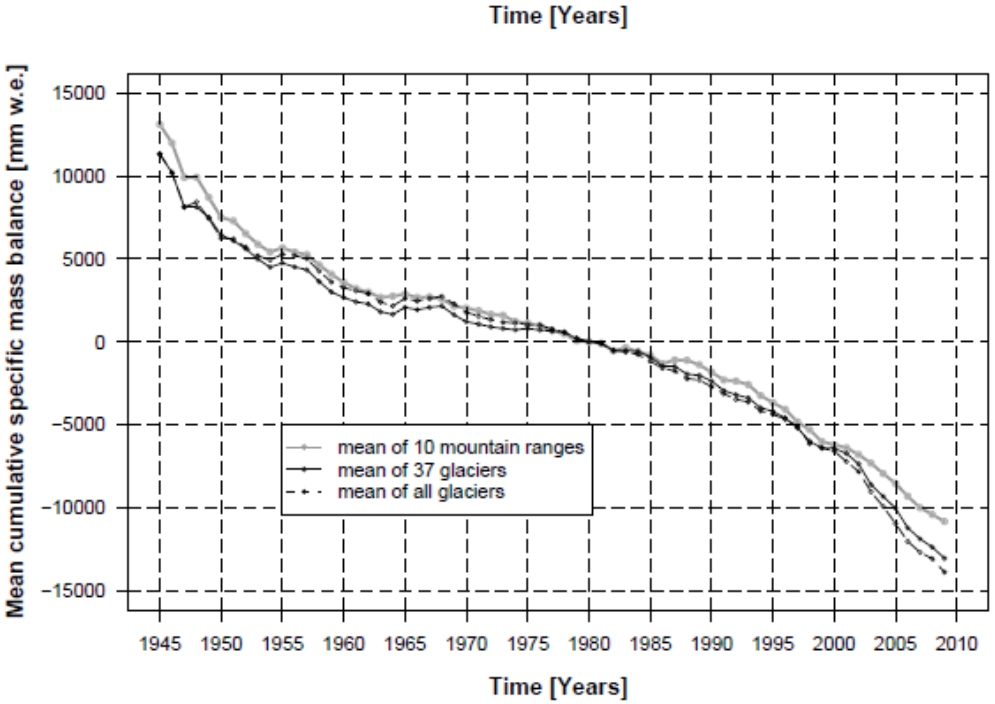
Forni Glacier, Italian Alps

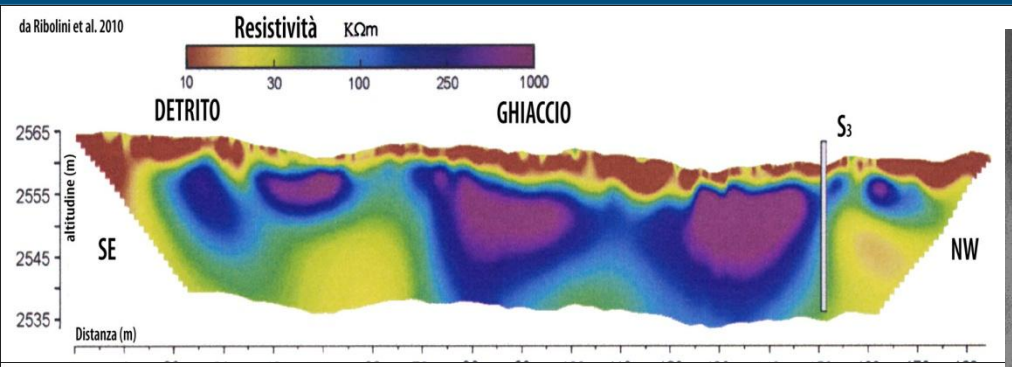
2013

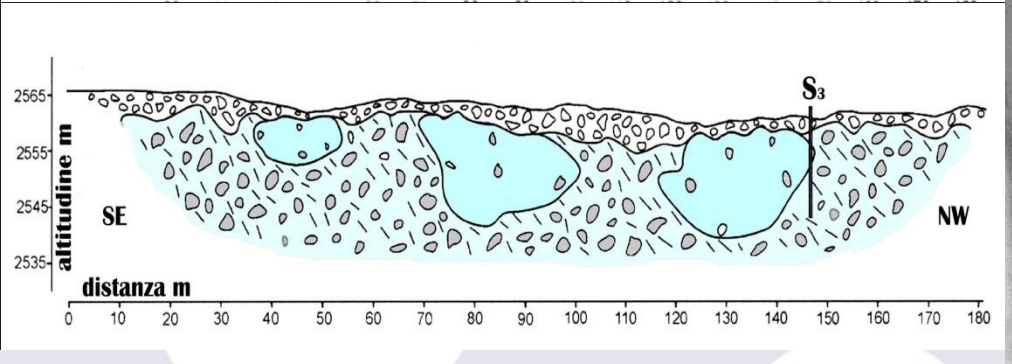


Mean specific mass balance (left) and mean cumulative specific mass balance (down) since 1945/46 (WGMS, 2011)

The average rate of ice loss from glaciers around the world was more than 226 Gt yr−1 over the period 1971−2009 and 275 Gt yr−1 over the period 1993−2009 (IPCC, 2013).
The melt rate and cumulative loss in glacier thickness continues to be extraordinary (WGMS, 2011).







Permafrost: mountain permafrost temperatures have increased in most regions since the early 1980s; active layer thickness has reduced

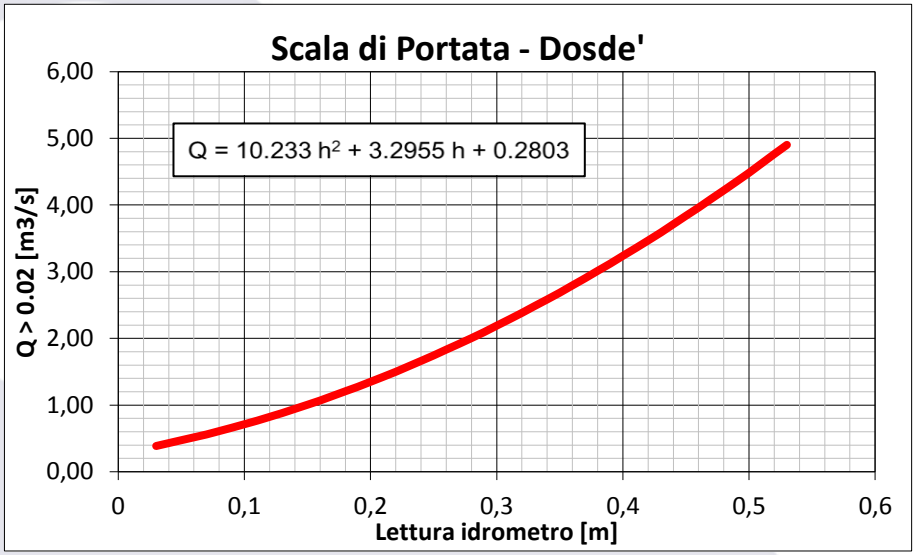
(da M. Guglielmin)

Snow: satellite records indicate that over the last 40 years mean monthly snow-cover extent in the Northern Hemisphere has declined

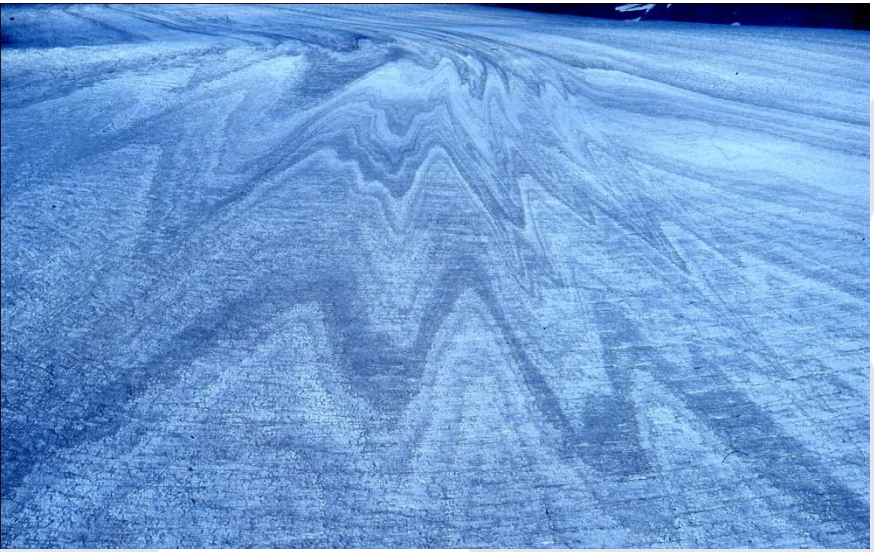
We need a more accurate quantitative knowledge of the different cryospheric components and of their present evolution

We need a more accurate knowledge of cryospheric hazards

We need a more accurate quantitative knowledge of the water resources stored in the cryosphere



(D. Bocchiola)



Malaspina Glacier, Alaska

Thanks for your attention

Calderone Glacier, Italy