Why do we need high quality in situ observations in remote mountain areas?

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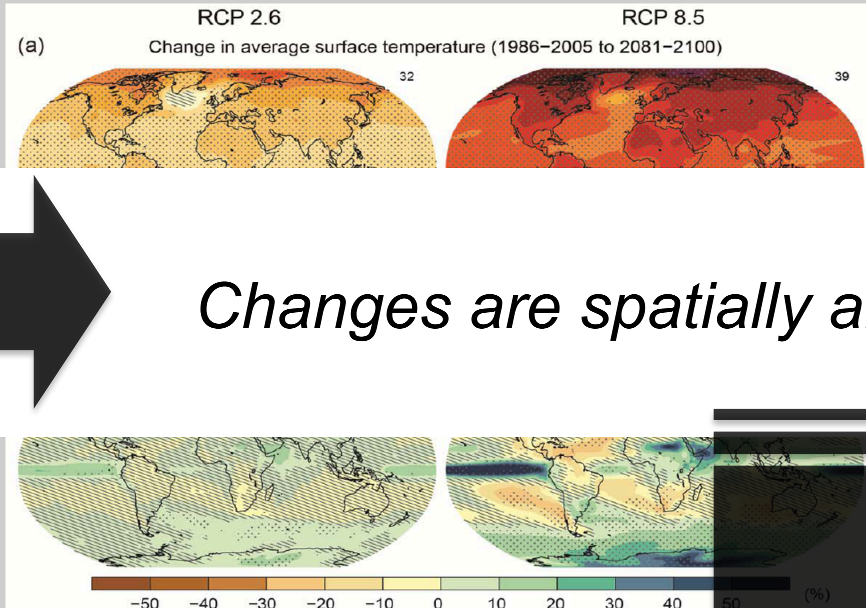
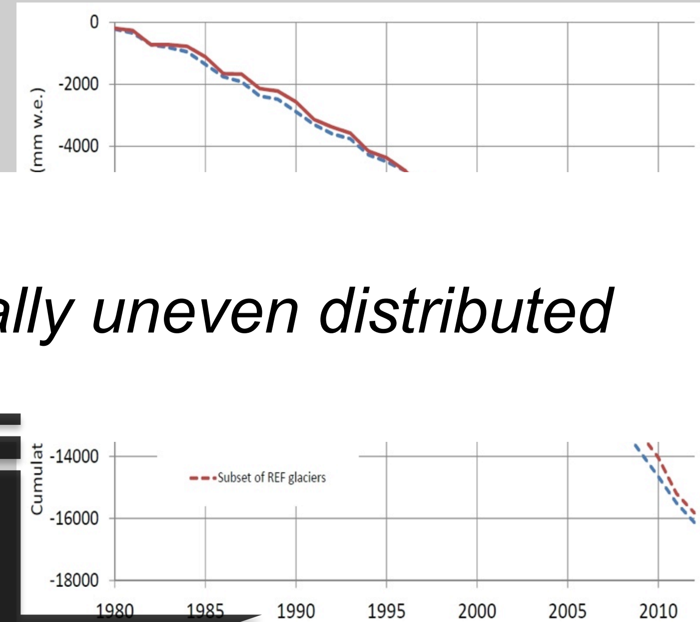
wgms

Global change – local impacts



IPCC 2013

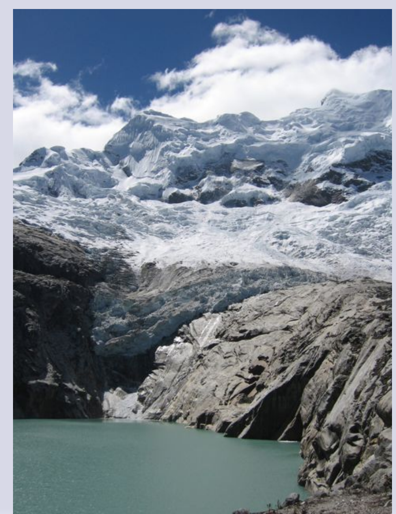


WGMS 2012

Changes are spatially and temporally uneven distributed

Effective impacts depend also on the local livelyhood

Water resources



Glacier risks

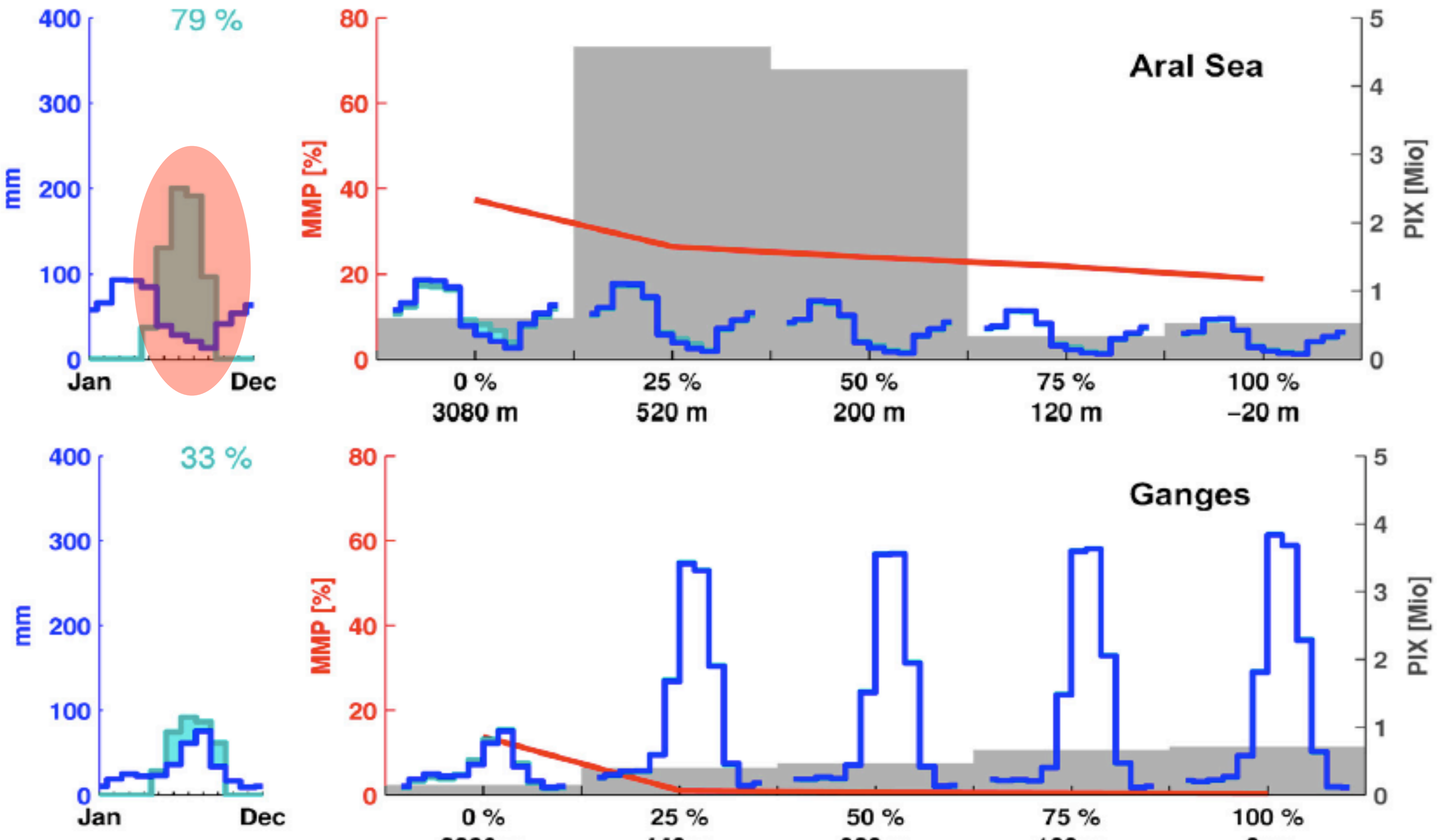
Water as a source of conflicts: example Central Asia

Varis 2014

Impact assessment

… seasonal availability of water?

Contribution potential of glaciers to water availability in different climate regimes



Kaser et al. 2010

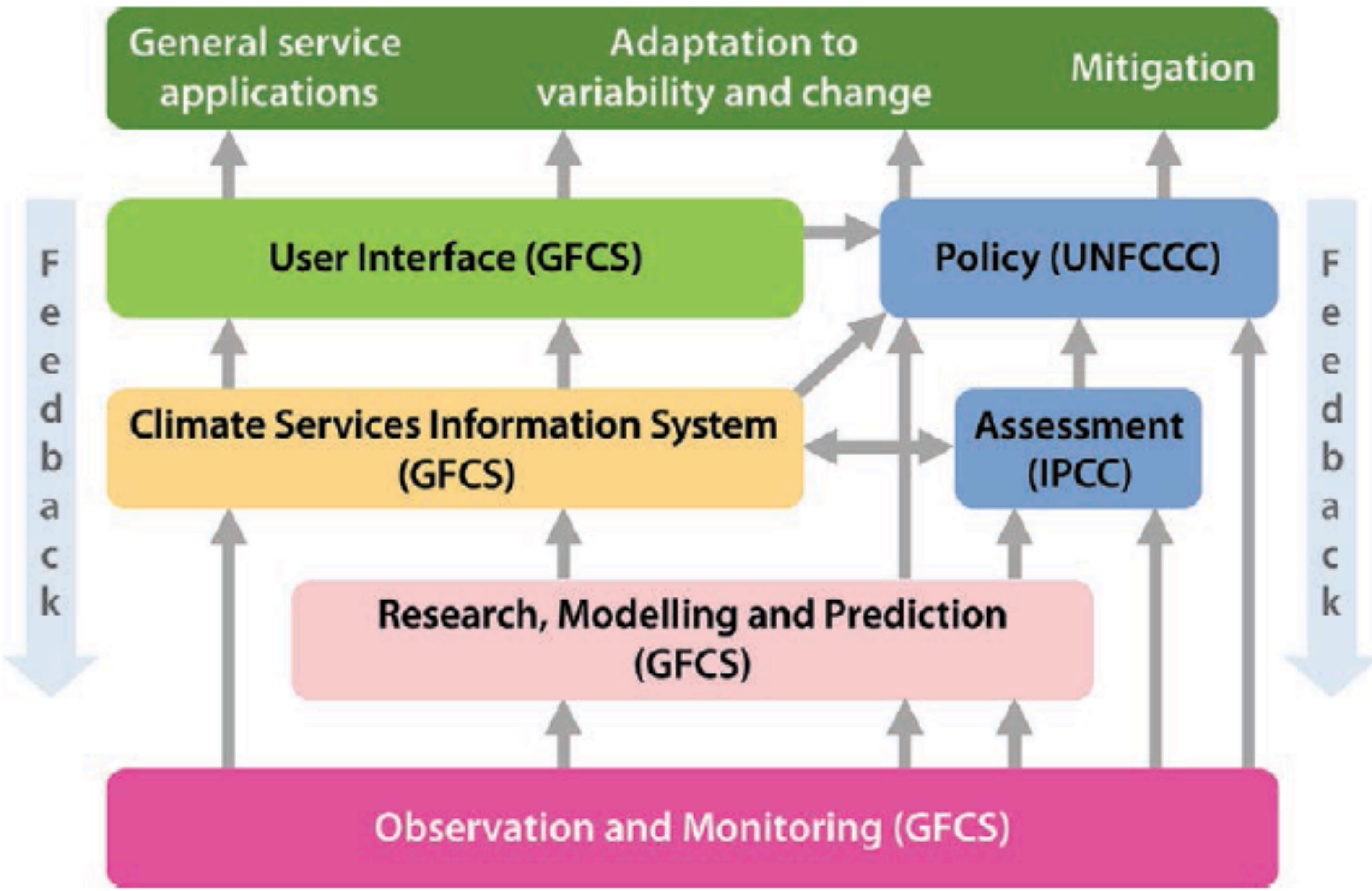
Systematic Observations

Systematic observations play a key role for IPCC in detecting and attributing climate change, to get an estimation of the global, regional and local impacts and vulnerability.

Decision makers on different levels then rely on such sound knowledge-based climate services to take their decisions.

GCOS 2015

Global Framework of Climate Services



Bojinski et al. 2014

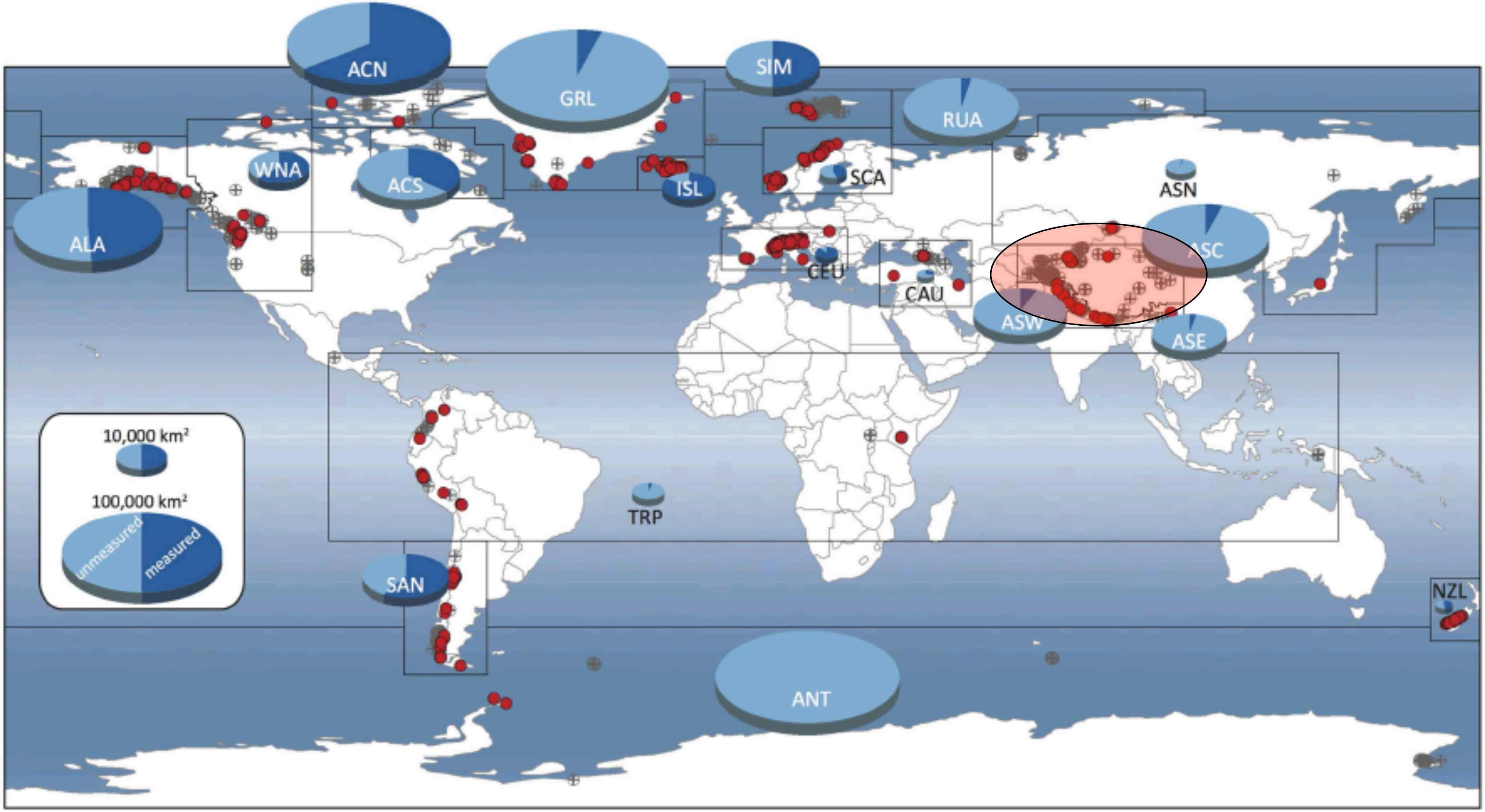
Essential Climate Variables (ECVs)

ECVs are identified based on the following criteria:

- Relevance: The variable is critical for characterizing the climate system and its changes.
- Feasibility: Observing or deriving the variable on a global scale is technically feasible using proven, scientifically understood methods.
- Cost effectiveness: Generating and archiving data on the variable is affordable, mainly relying on coordinated observing systems using proven technology, taking advantage where possible of historical datasets.

Bojinski et al. 2014

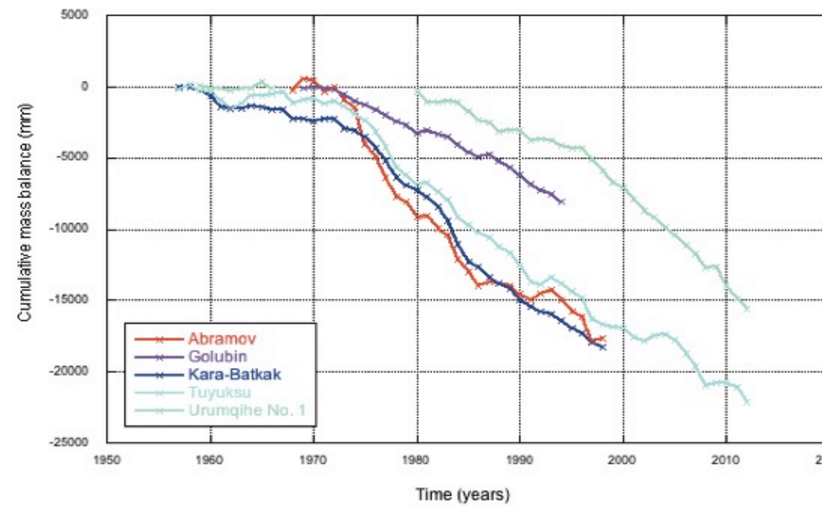
Example ECV: glaciers



Zemp et al. 2015

Interrupted long-term measurements

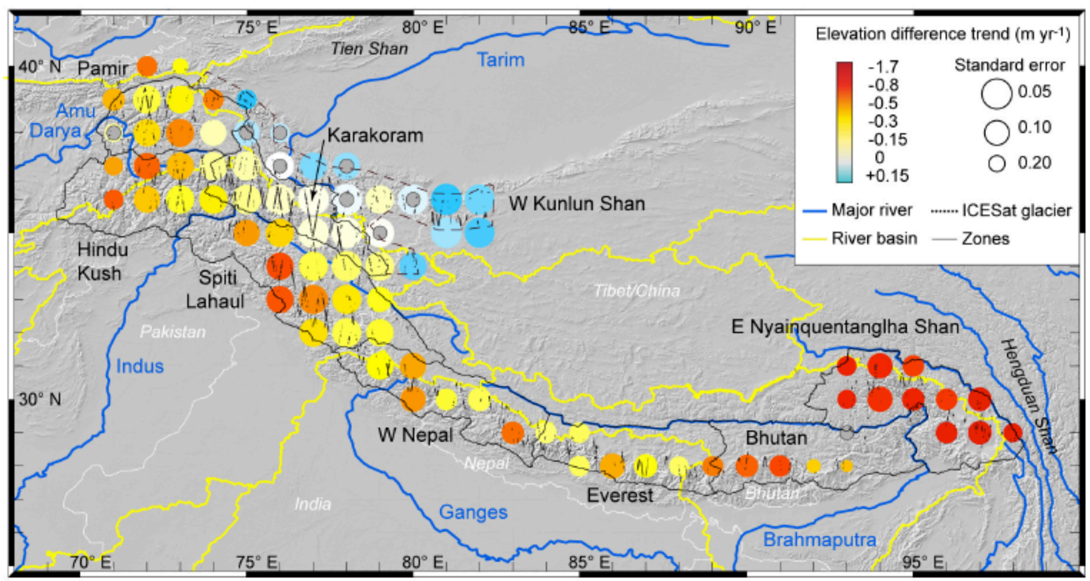
Some selected long-term mass balance time series in Central Asia



Data Source: WGMS

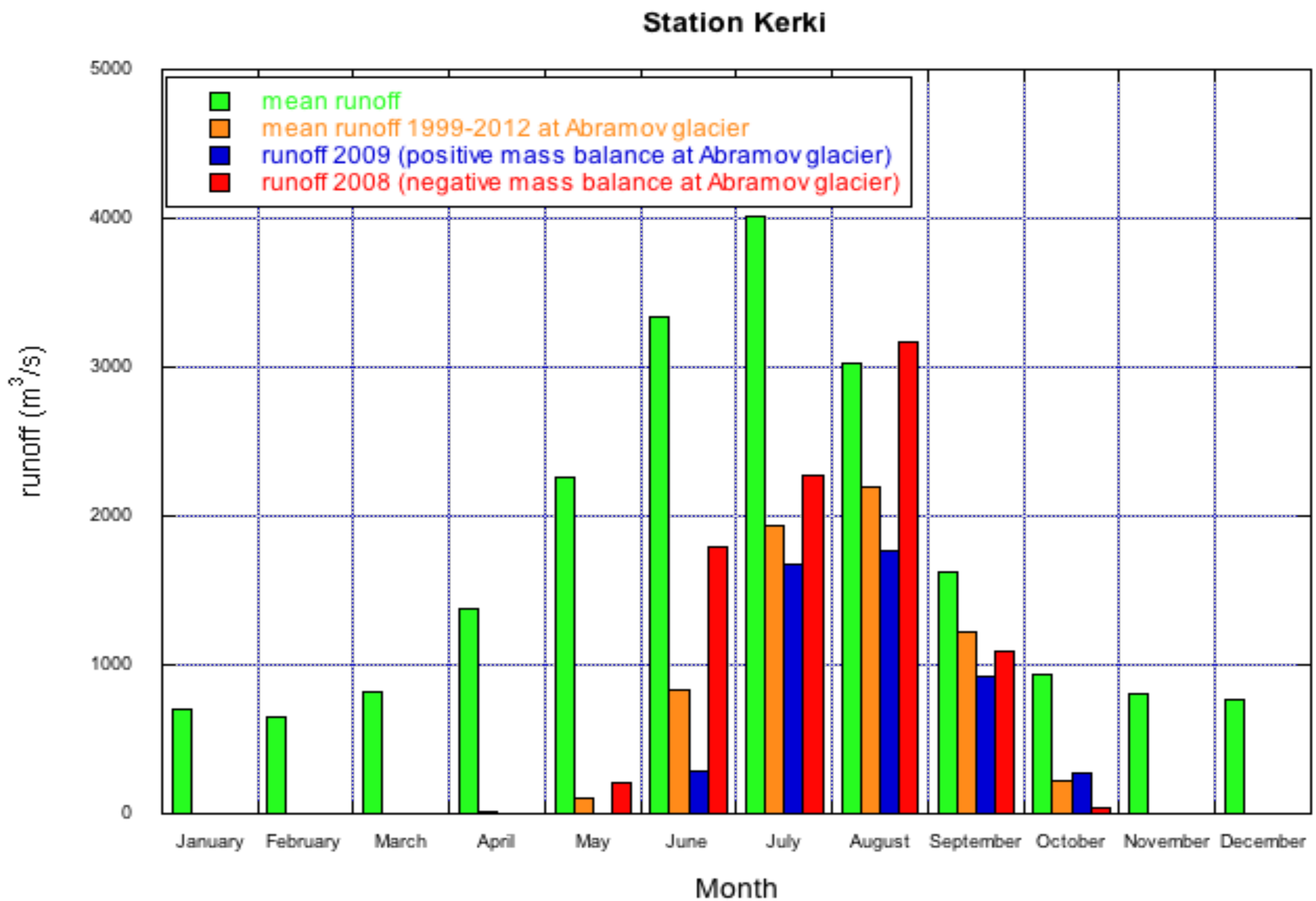
Contrasting results of different studies about glacier mass changes

Zone	Glacier area (km^2)	This study ($m\,yr^{-1}$, ± at 1σ-level)	Gardner et al. (2013; $m\,yr^{-1}$, ± at 2σ-level)	Neckel et al. (2014; $m\,yr^{-1}$, ± at 1σ-level)	Gardelle et al. (2013; $m\,yr^{-1}$, ± at 1σ-level)
Eastern Nyainqêntanglha[a]	6000	−1.34 ± 0.29	−0.30 ± 0.13 −0.40 ± 0.41[b]	−0.81 ± 0.32	−0.39 ± 0.16
Bhutan	3500	−0.89 ± 0.16	−0.89 ± 0.18	−0.78 ± 0.27	−0.26 ± 0.15
Everest	8500	−0.37 ± 0.10	−0.44 ± 0.20		−0.30 ± 0.16
West Nepal	7500	−0.43 ± 0.09		−0.44 ± 0.26	−0.38 ± 0.16
Spiti–Lahaul	9500	−0.49 ± 0.12	−0.53 ± 0.13		−0.53 ± 0.16
Karakoram	21 000	−0.10 ± 0.06	−0.12 ± 0.15		+0.12 ± 0.19
Hindu Kush	5500	−0.49 ± 0.10			−0.14 ± 0.19
Pamir	6500	−0.48 ± 0.14	−0.13 ± 0.22		+0.16 ± 0.15
Western Kunlun Shan–Tarim	12 500	+0.05 ± 0.07	+0.17 ± 0.15	+0.04 ± 0.29	
Area-weighted mean	80 500	−0.37 ± 0.10			

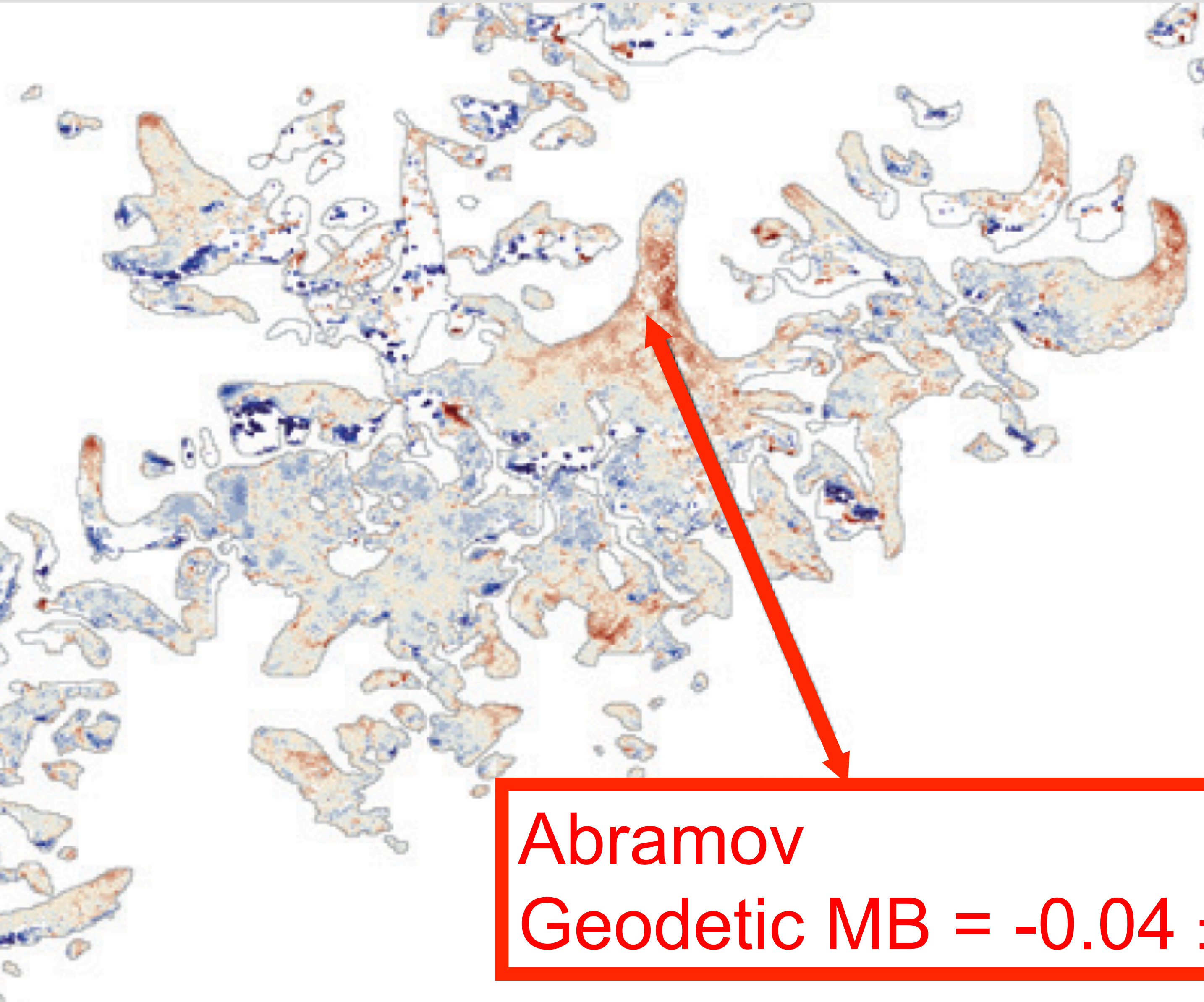


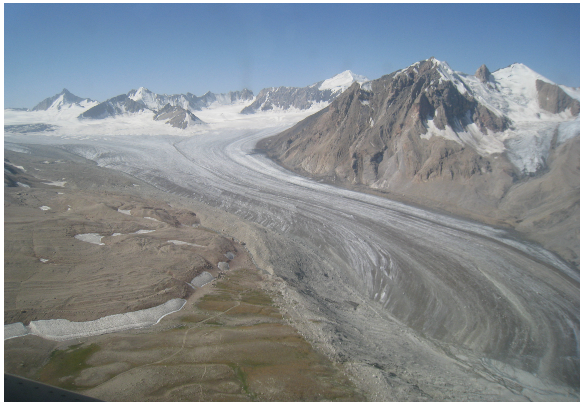
Kääb et al. 2015

Monthly glacier runoff at Kerki station estimated based on melt reconstructions of Abramov glacier



Geodetic mass balance 1999-2011

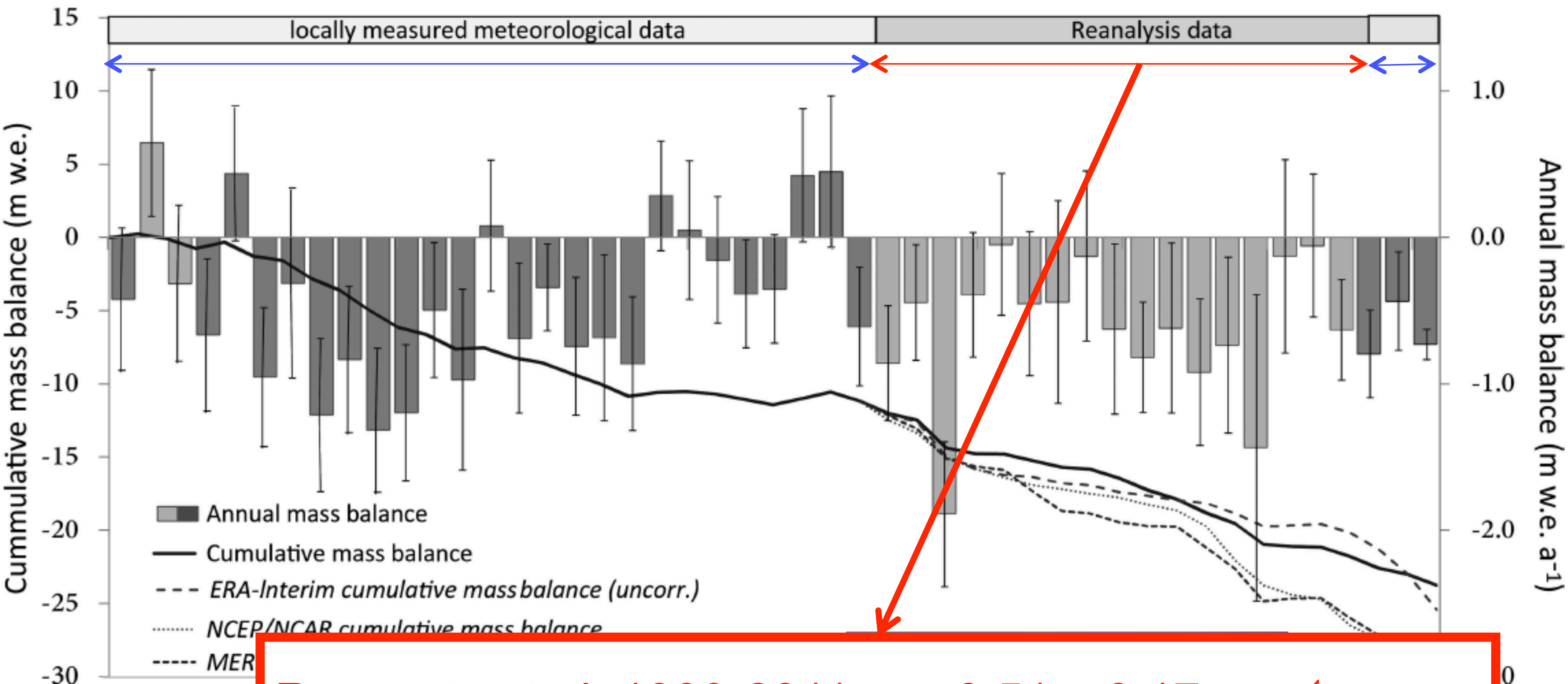




Abramov
Geodetic MB = -0.04 ±0.10 m a^{-1}

Gardelle et al. 2013

Mass balance 1969-2014 of Abramov glacier



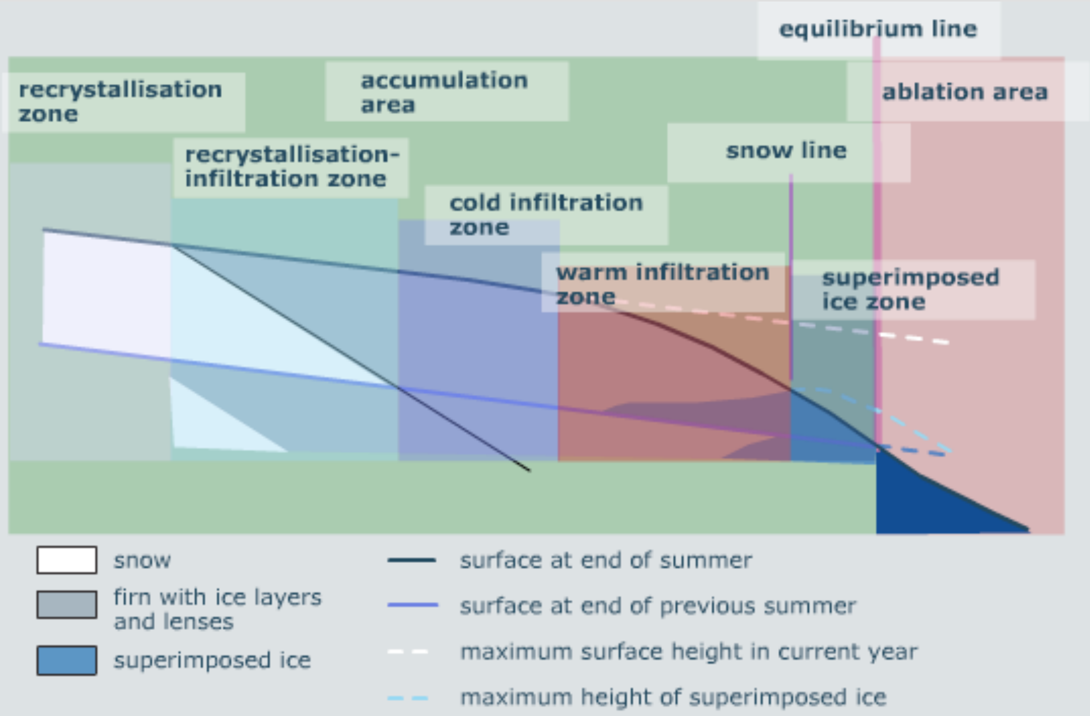
Reconstructed: 1999-2011 --> -0.51 ± 0.17 m a^{-1} w.e.

Barandun et al. 2015

Selected Challenges occurring at different glacier monitoring sites

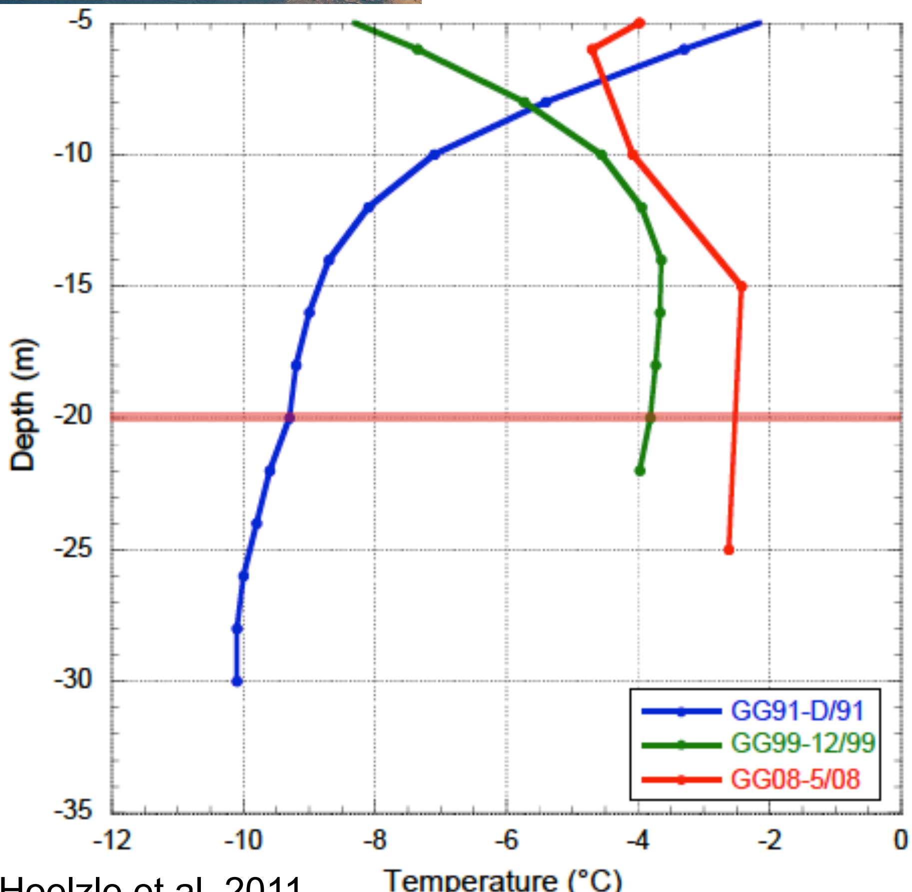
- Accumulation area:
  - ➢ Thermal state of accumulation area influencing facies zones
  - ➢ Accumulation distribution
- Ablation area:
  - ➢ Albedo change
  - ➢ Debris cover

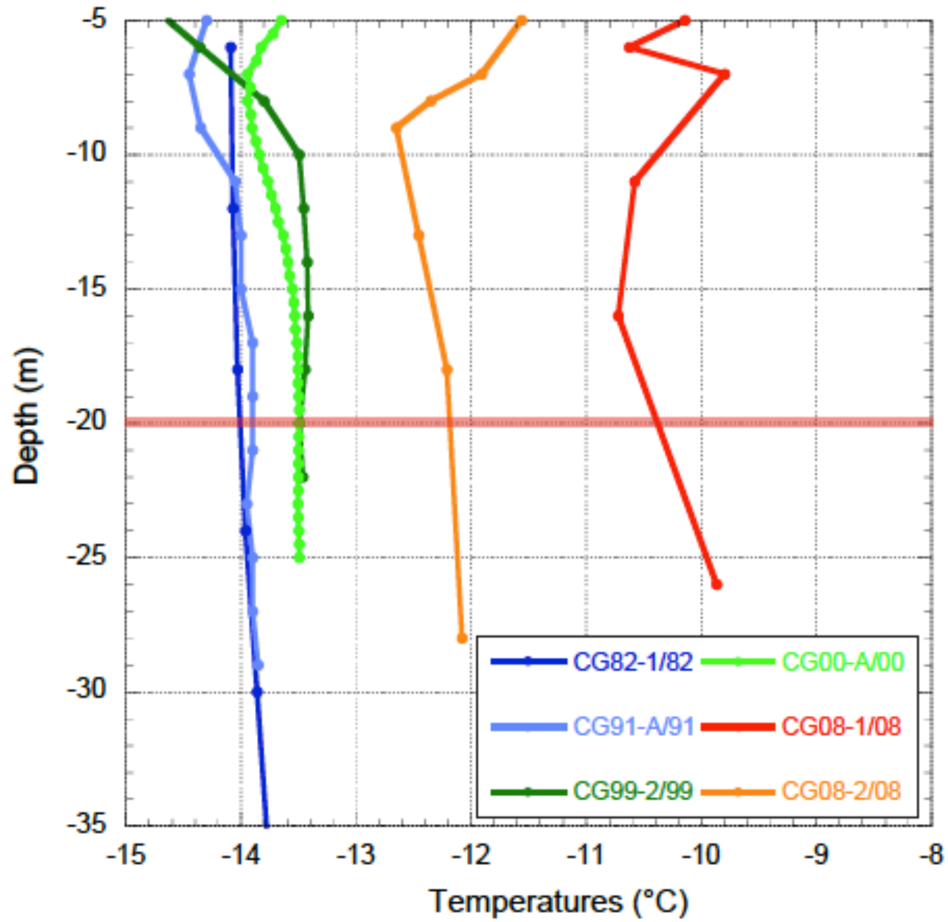
Impacts of changes in firn facies zones



- Change in accumulation processes warm vs cold solid precipitation
- Ice crust building at the surface
- Internal ice lenses influence on water transport
- Penetration depth of Radar signals (SRTM)

Increase of englacial temperatures and corresponding change of firn facies zone

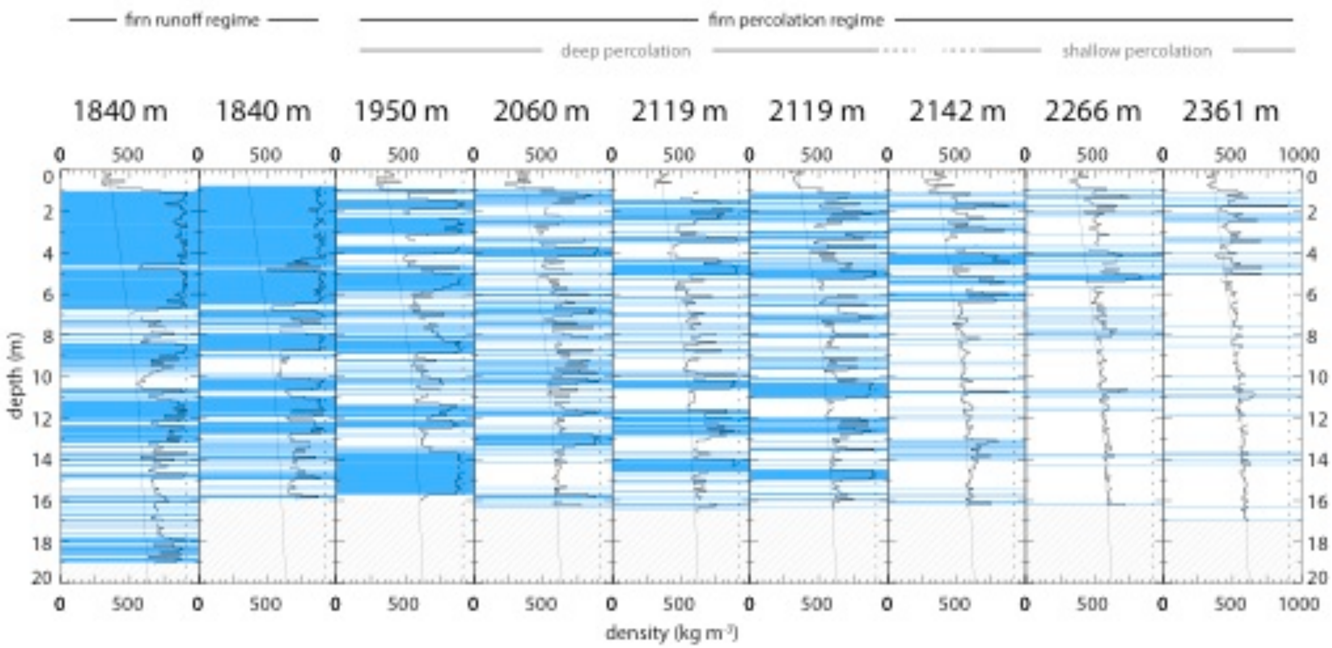




Hoelzle et al. 2011

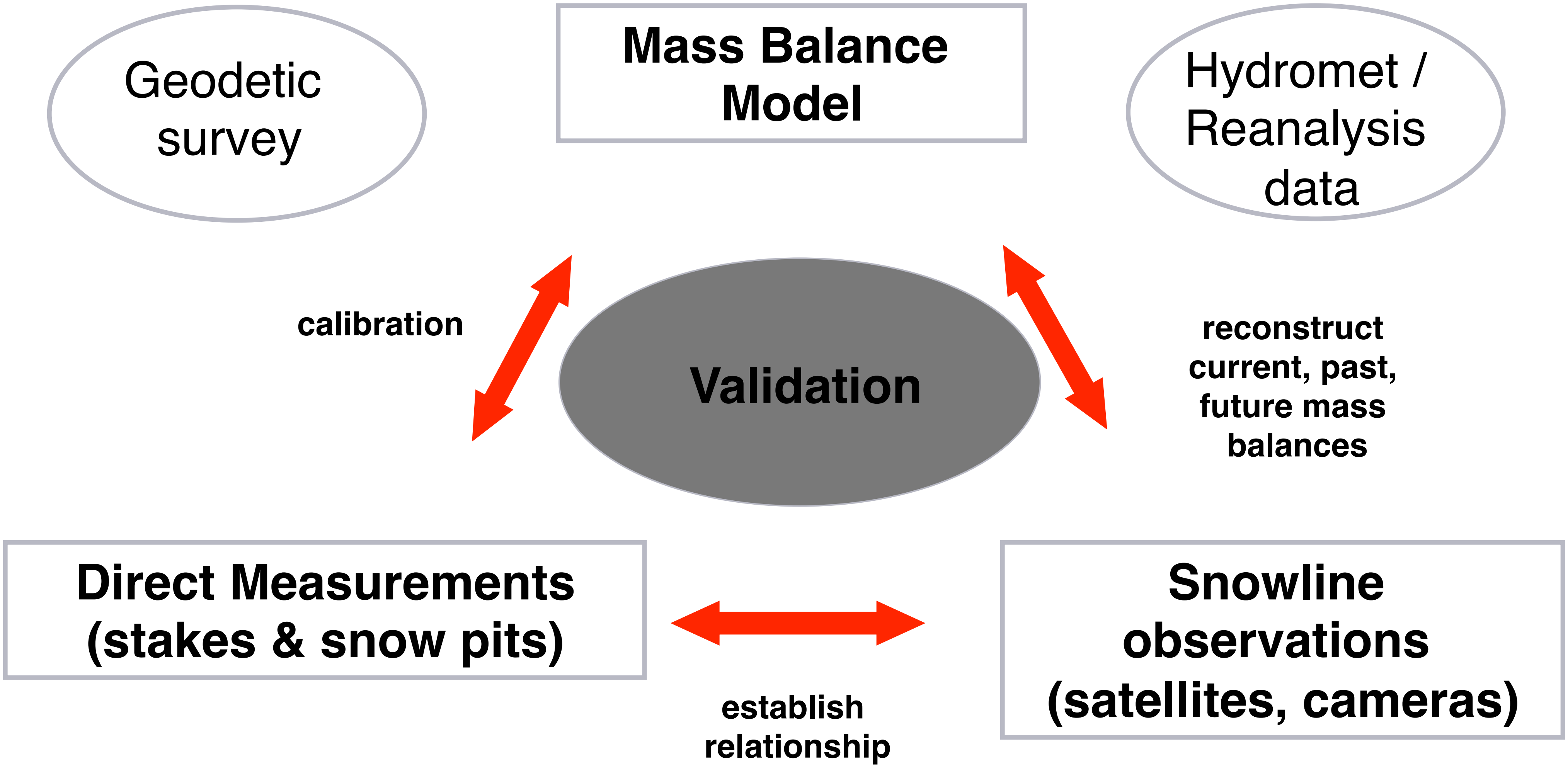
Increase of ice layers influences runoff patterns

- increase of number of ice lenses (transient process)
- ice layer act like a lid on the firn, preventing the percolation of meltwater and forcing meltwater to runoff the surface
- the surface ice layer blocks the access to the firn below, preventing further meltwater storage in the still free available pores



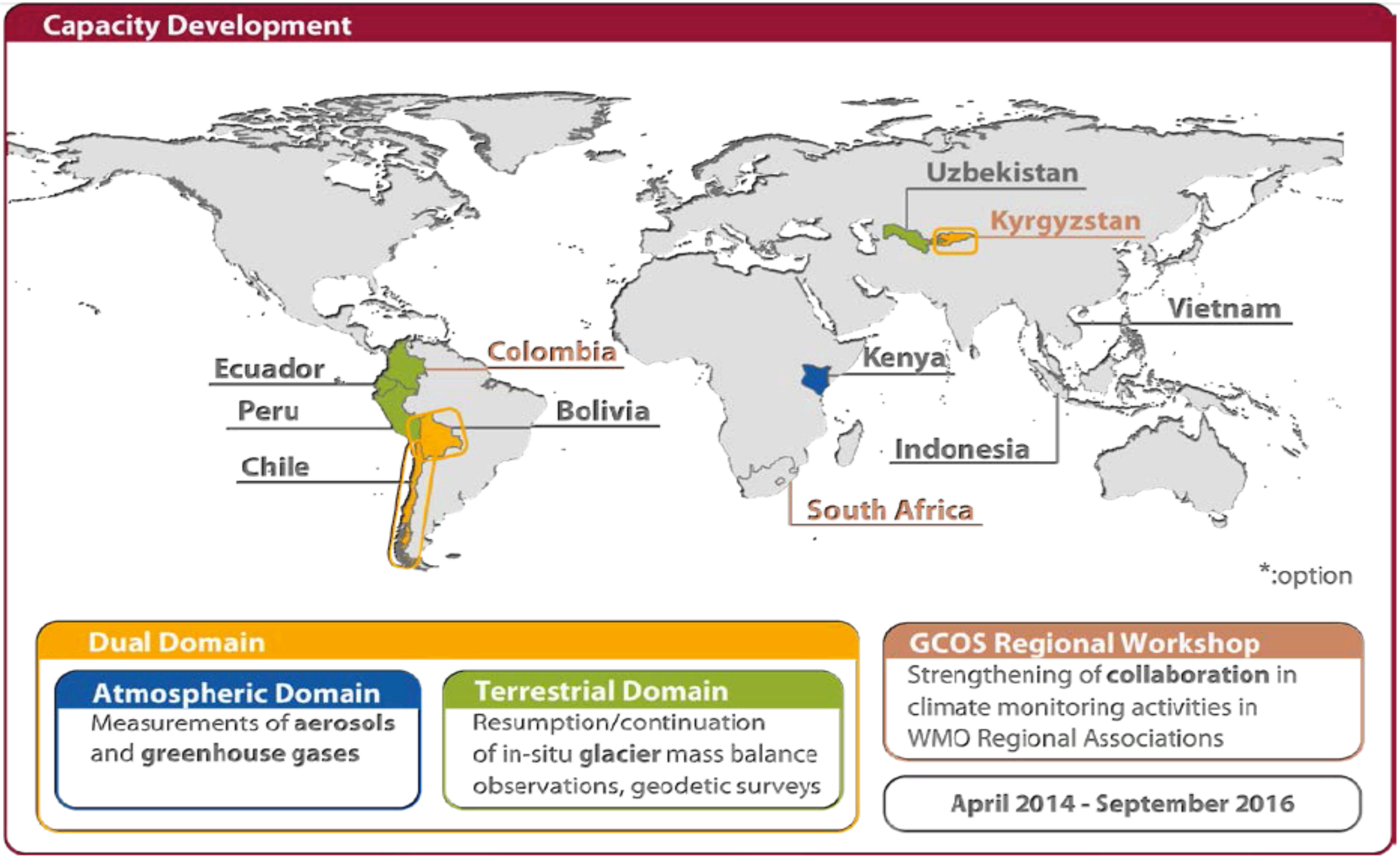
Machguth et al. 2016

Monitoring of mass balance



Current activities: eg CATCOS project

CATCOS
Capacity Building and Twinning for Climate Observing Systems



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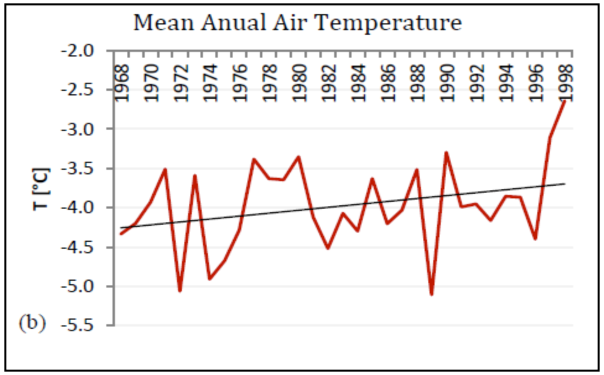
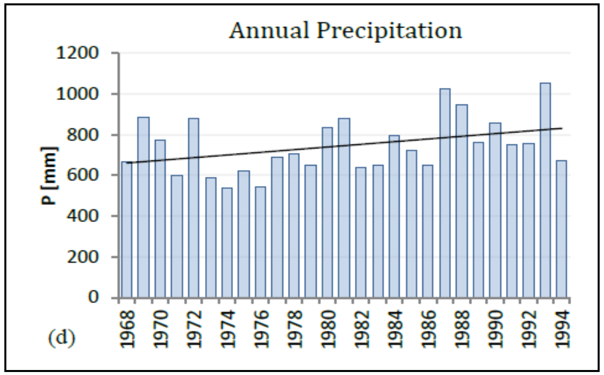
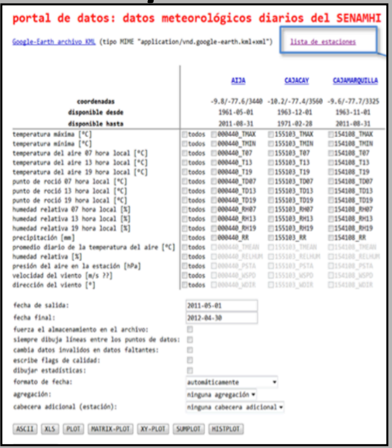
Baseline data

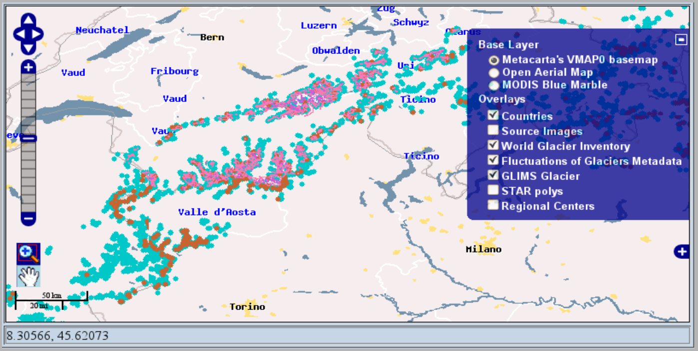
Local meteo measurements





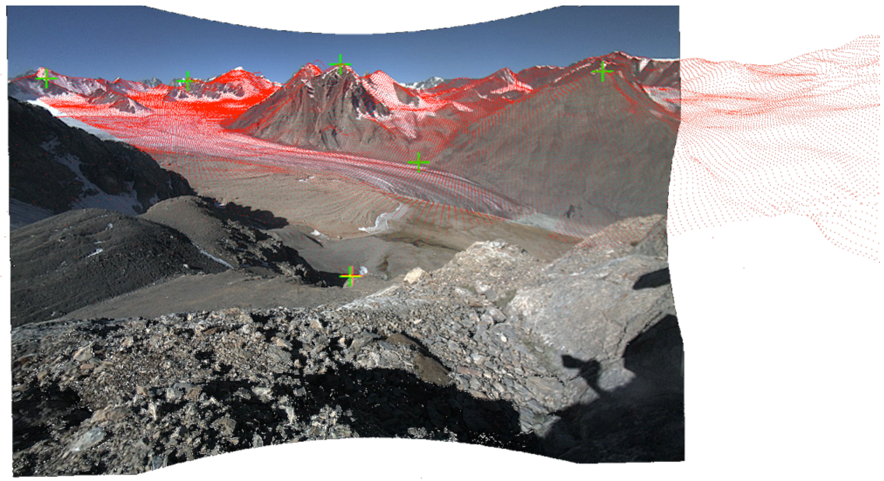
Data portal



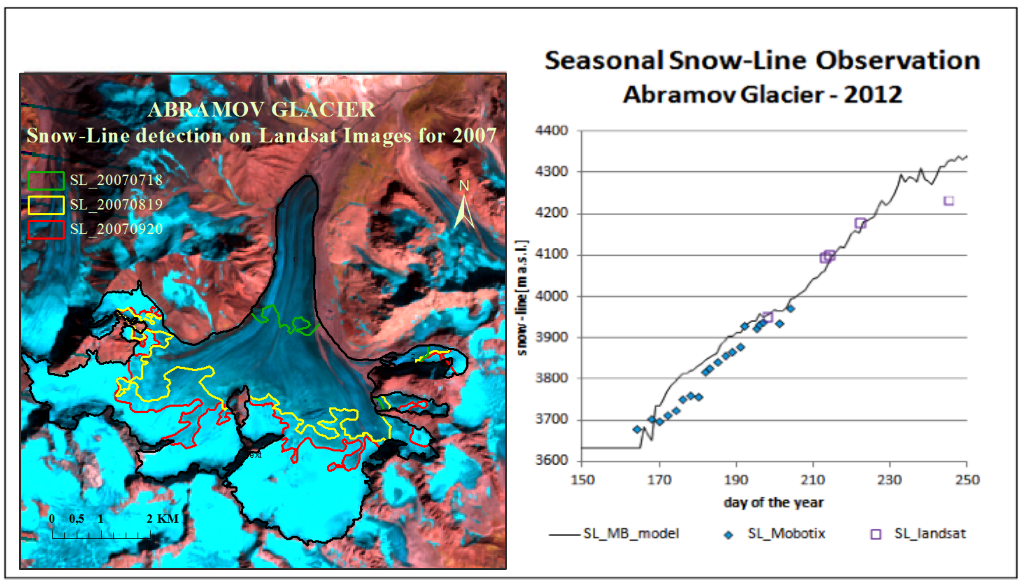


Glacier measurements

Abramov glacier, Pamir-Alay, Kyrgyzstan



Upper camera at Abramov

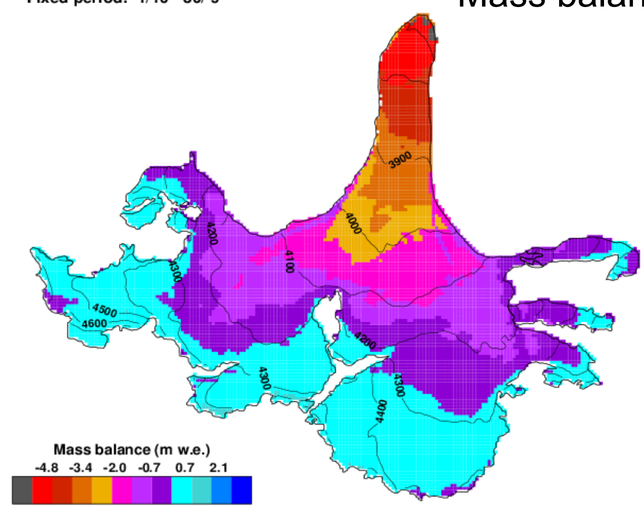


2011/2012

b_n (m w.e.)= -0.751

Fixed period: 1/10 - 30/ 9

Mass balance 2011/2012



Barandun et al. 2015

Conclusions

- Glacier mass balance results today based on different studies with different methods show strong differences with large uncertainties in important and large mountain ranges
- There is a need for a glacier monitoring combining traditional measurements with new technologies by using an integrated and multi-level strategy to improve estimates of glacier related variables such as mass balance or runoff

What do we need to answer the question about future evolution of the ECV: glacier

- good in-situ measurements to reduce existing uncertainties
- good coverage of remote sensing data
- good models (if possible in transient mode) relying on a sound process understanding
- good downscaling approaches for climate models
- combined analysis of in-situ observations, remotely sensed data and numerical models

THANKS FOR YOUR ATTENTION

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