Application of cosmic ray snow gauges to monitor the snow water equivalent on alpine glaciers

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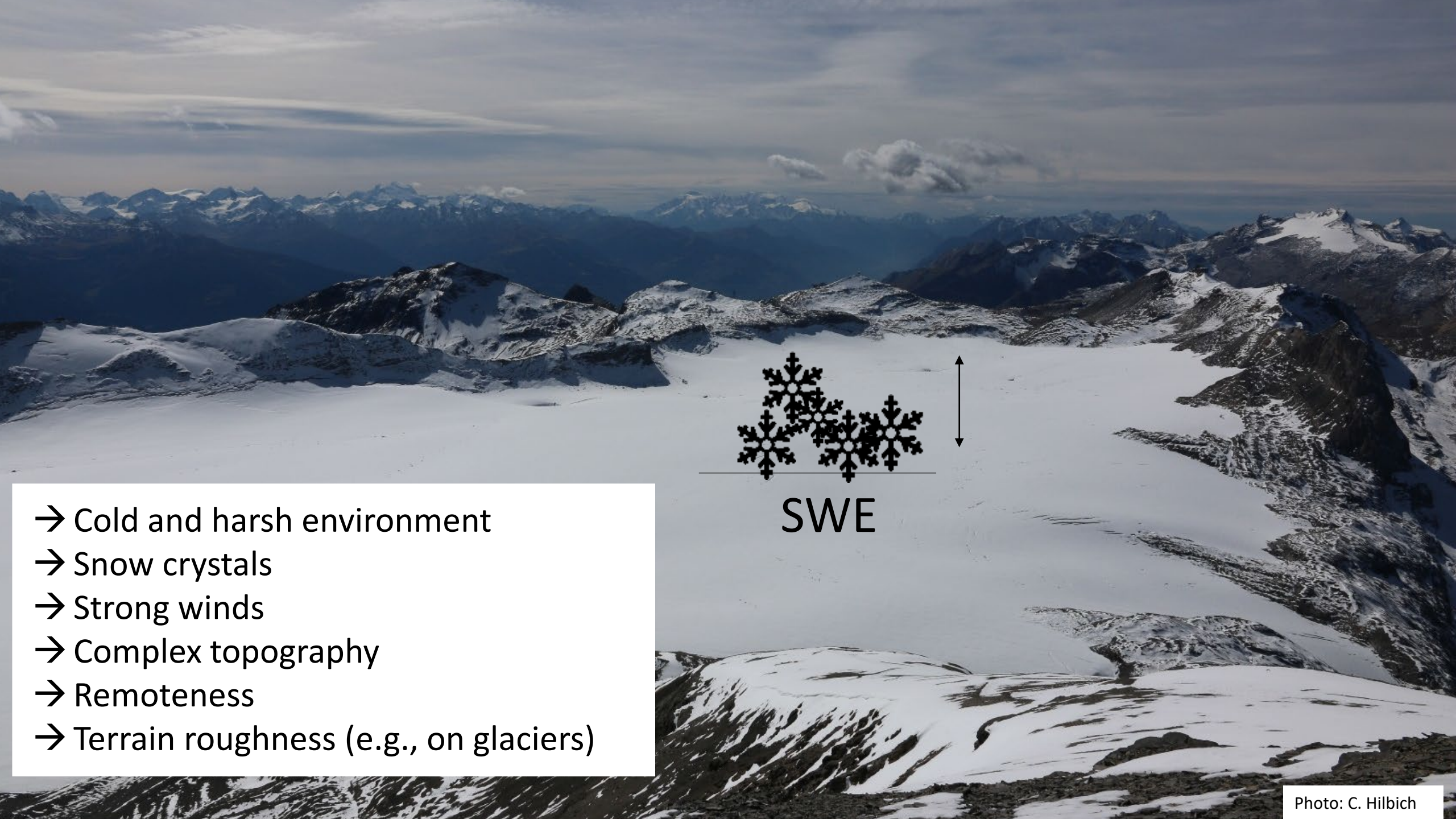
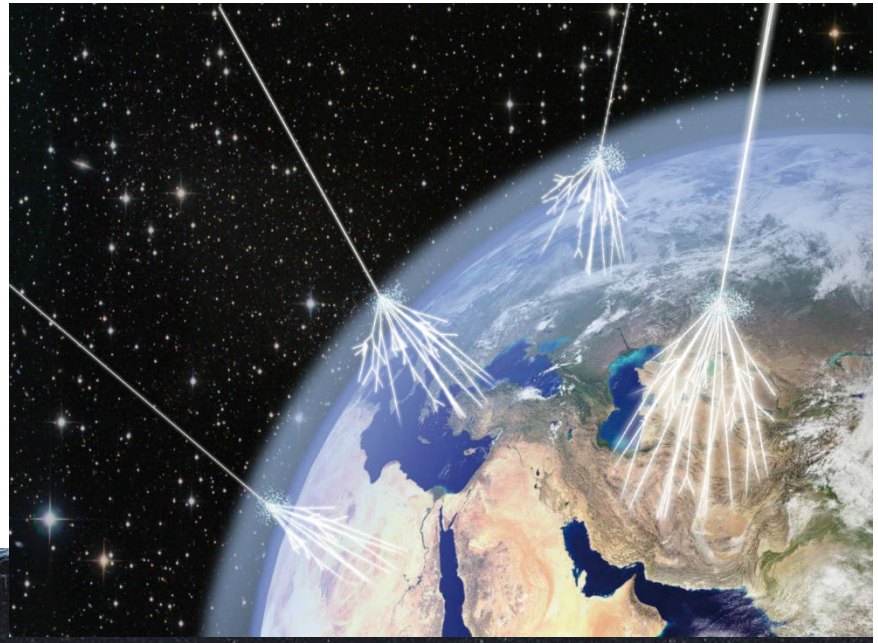
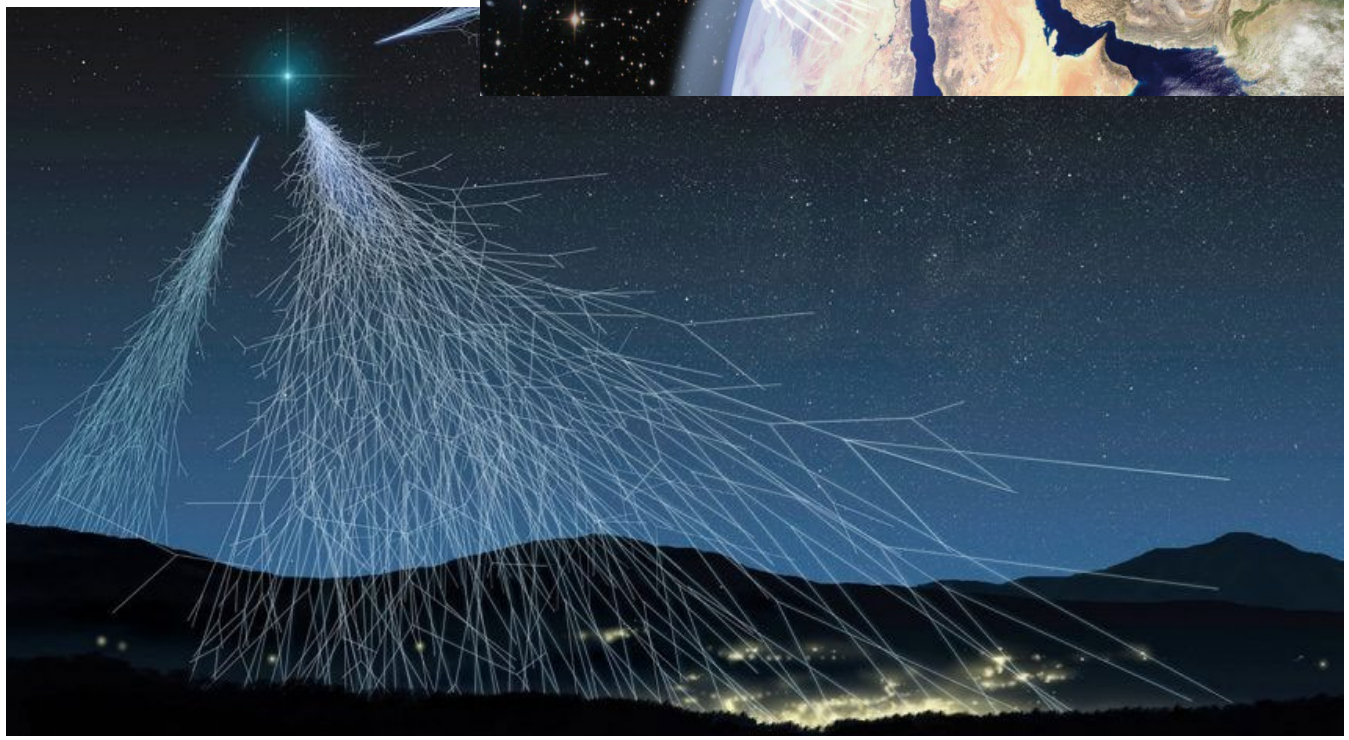


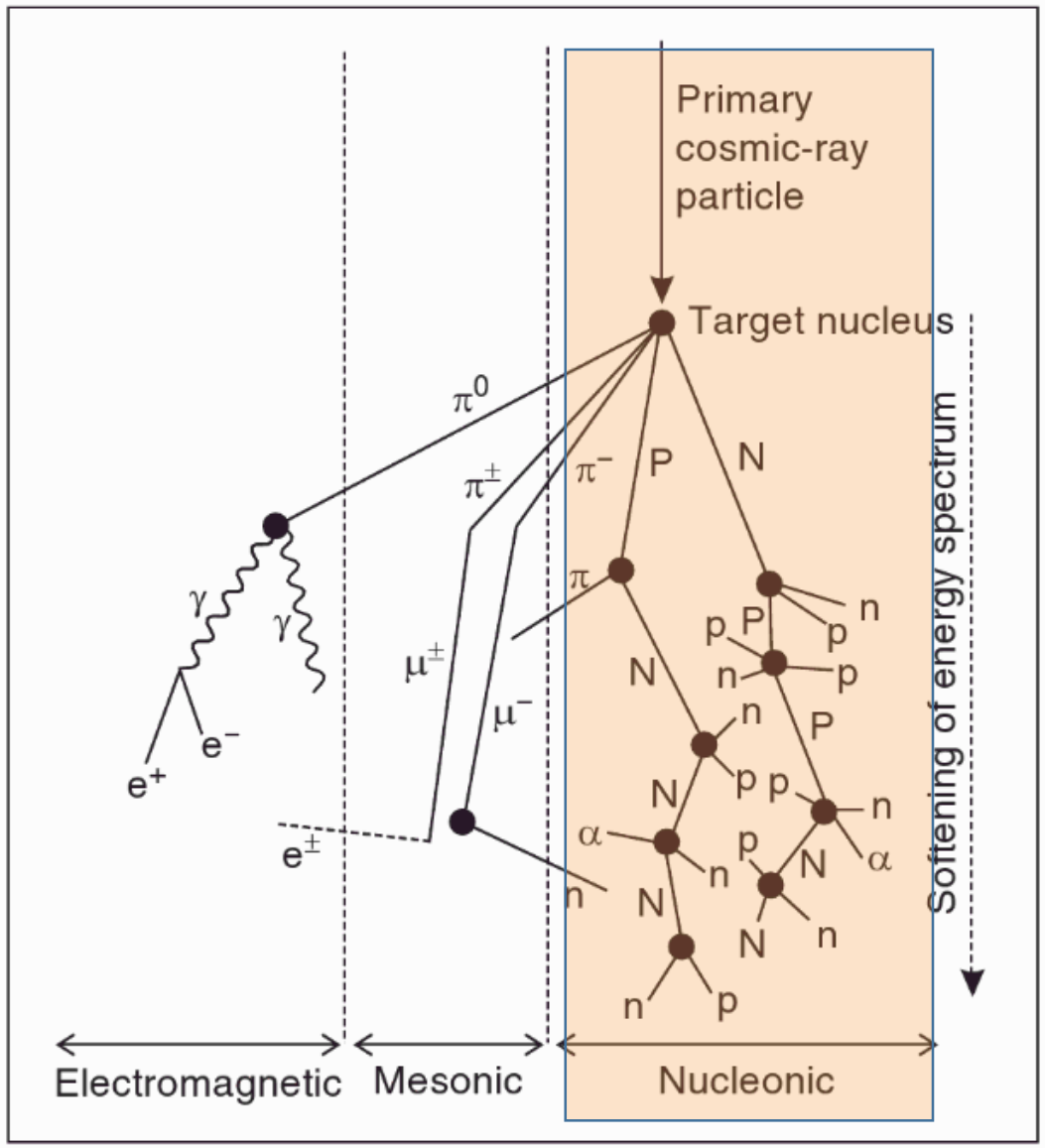
→ Cold and harsh environment
→ Snow crystals
→ Strong winds
→ Complex topography
→ Remoteness
→ Terrain roughness (e.g., on glaciers)

Photo: C. Hilbich

Cosmic rays







Sources: Fig.1 https://cds.cern.ch/record/1345733; Fig.2 https://www.foronuclear.org/en/nuclear-power/questions-and-answers/on-nuclear-physics/where-do-cosmic-rays-come-from/

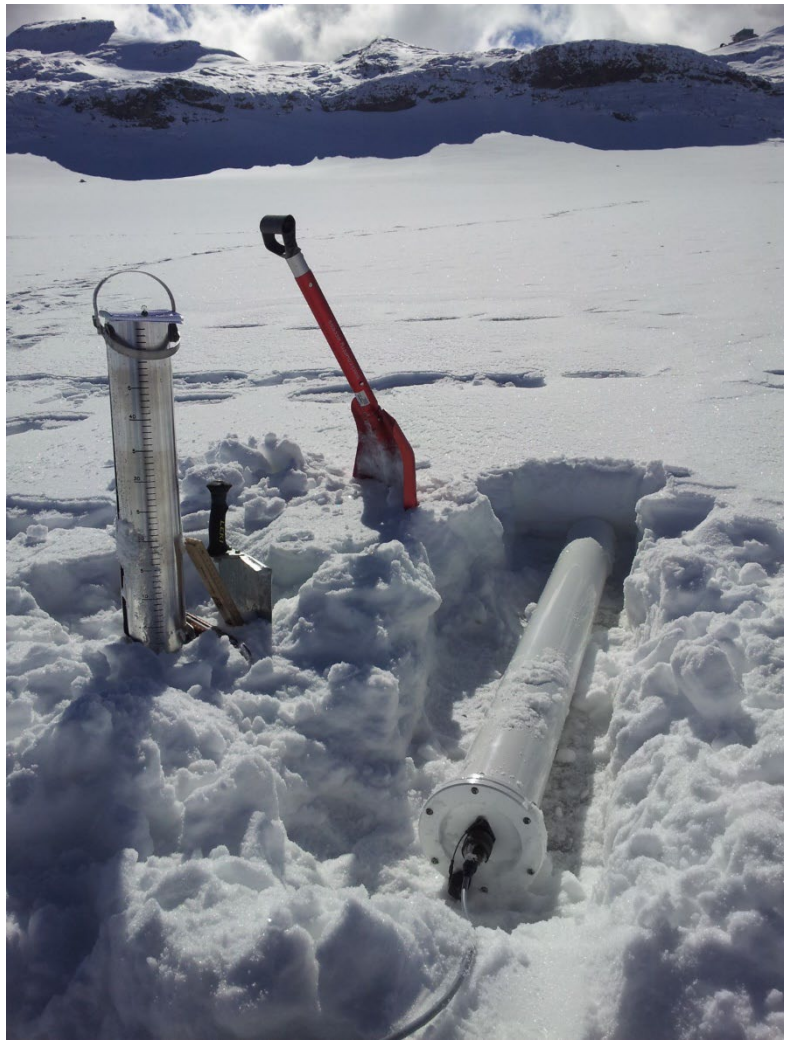
Dunai (2010)

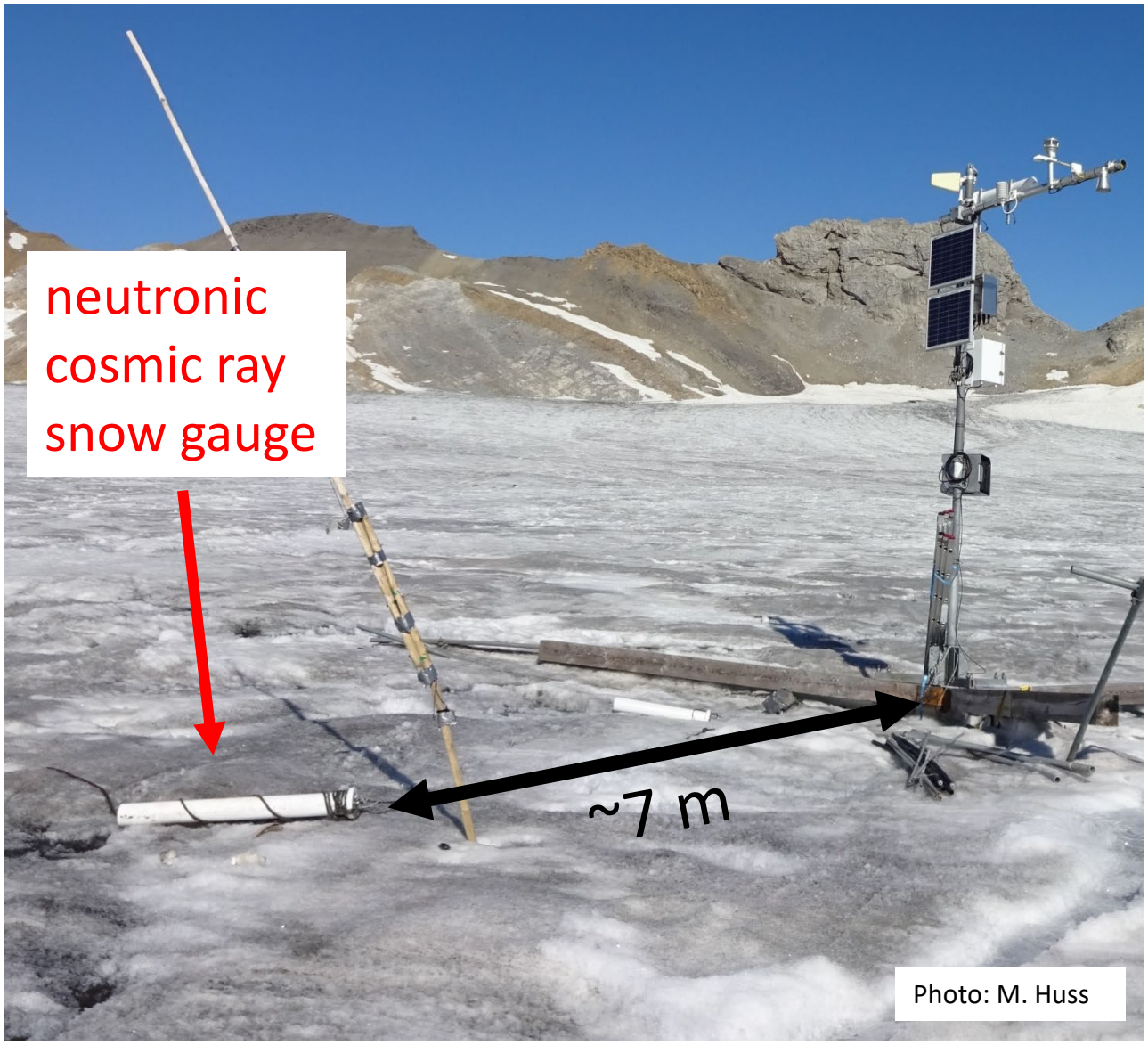
Study site


Glacier de la Plaine Morte
Photo: C. Hilbich

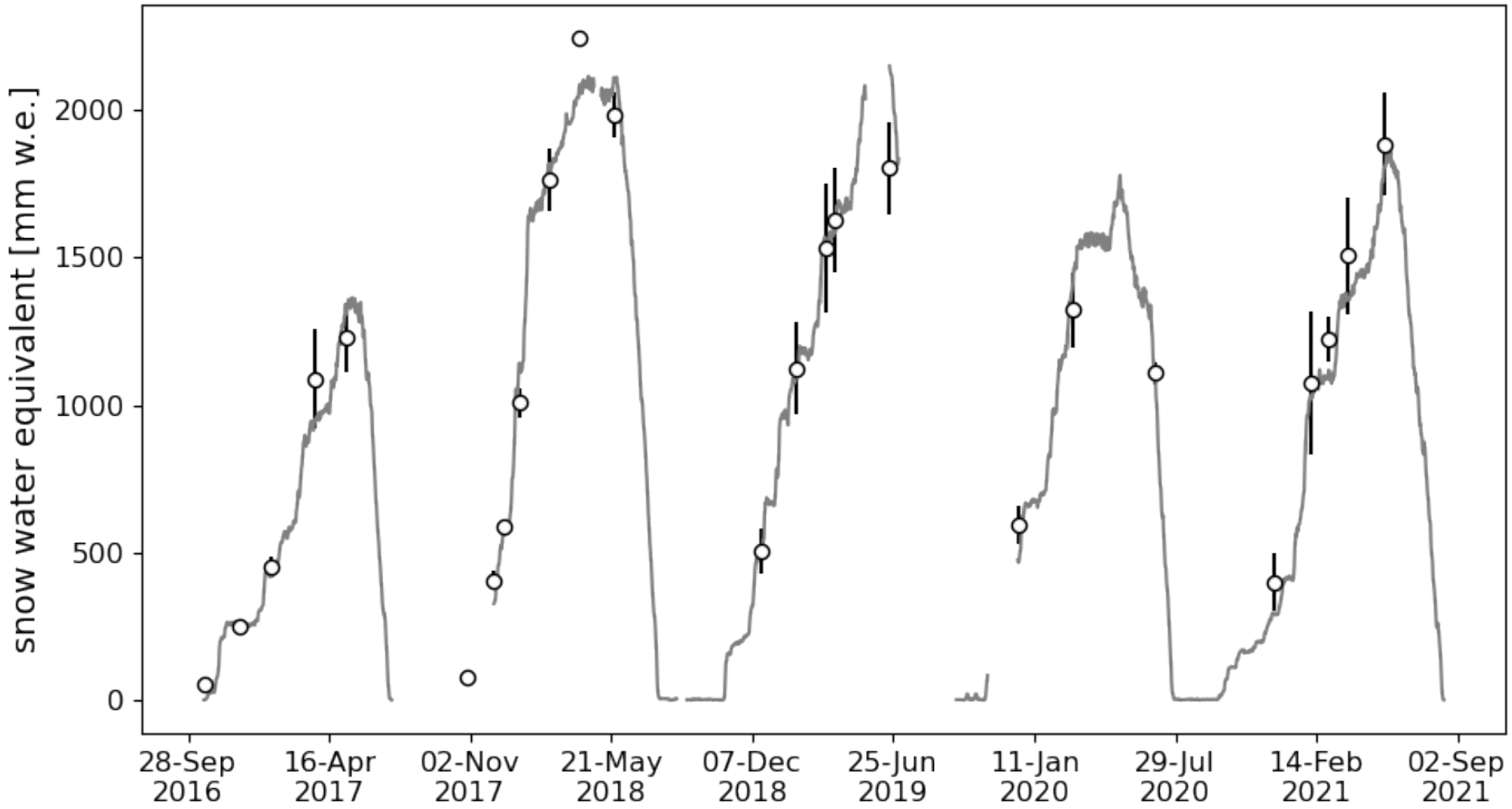

Zurich
Bern
Fribourg
Geneva

Measurement setup



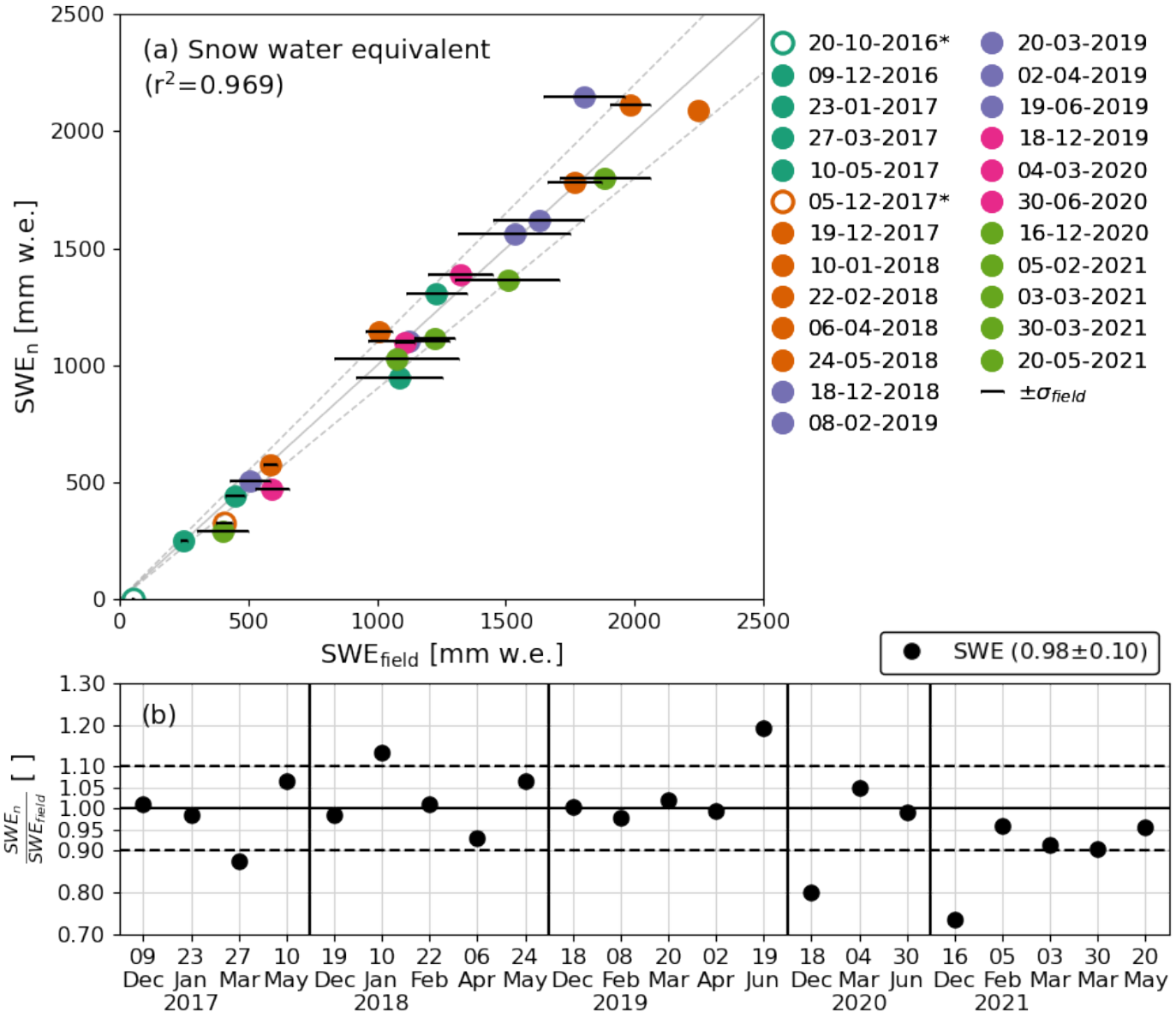


Neutronic cosmic ray snow gauge

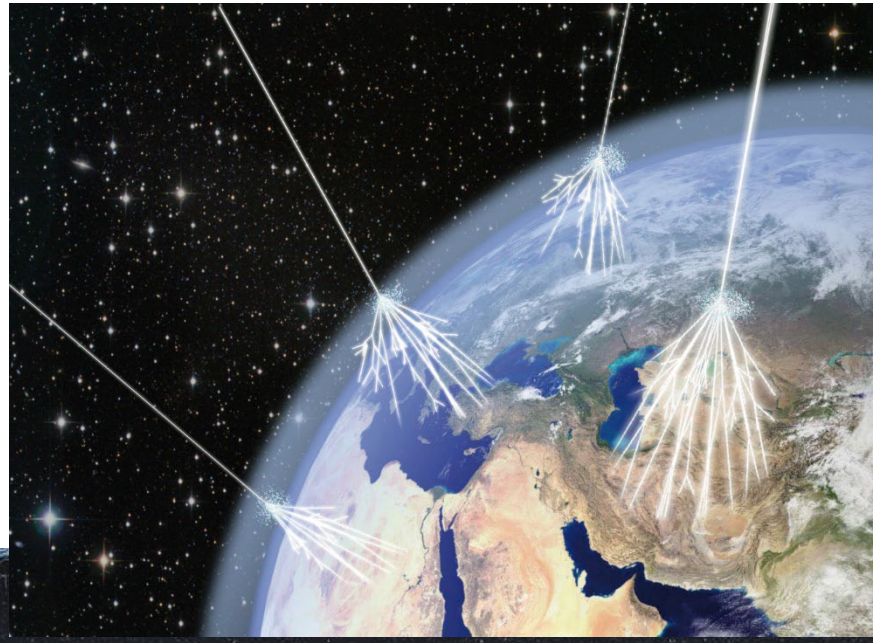


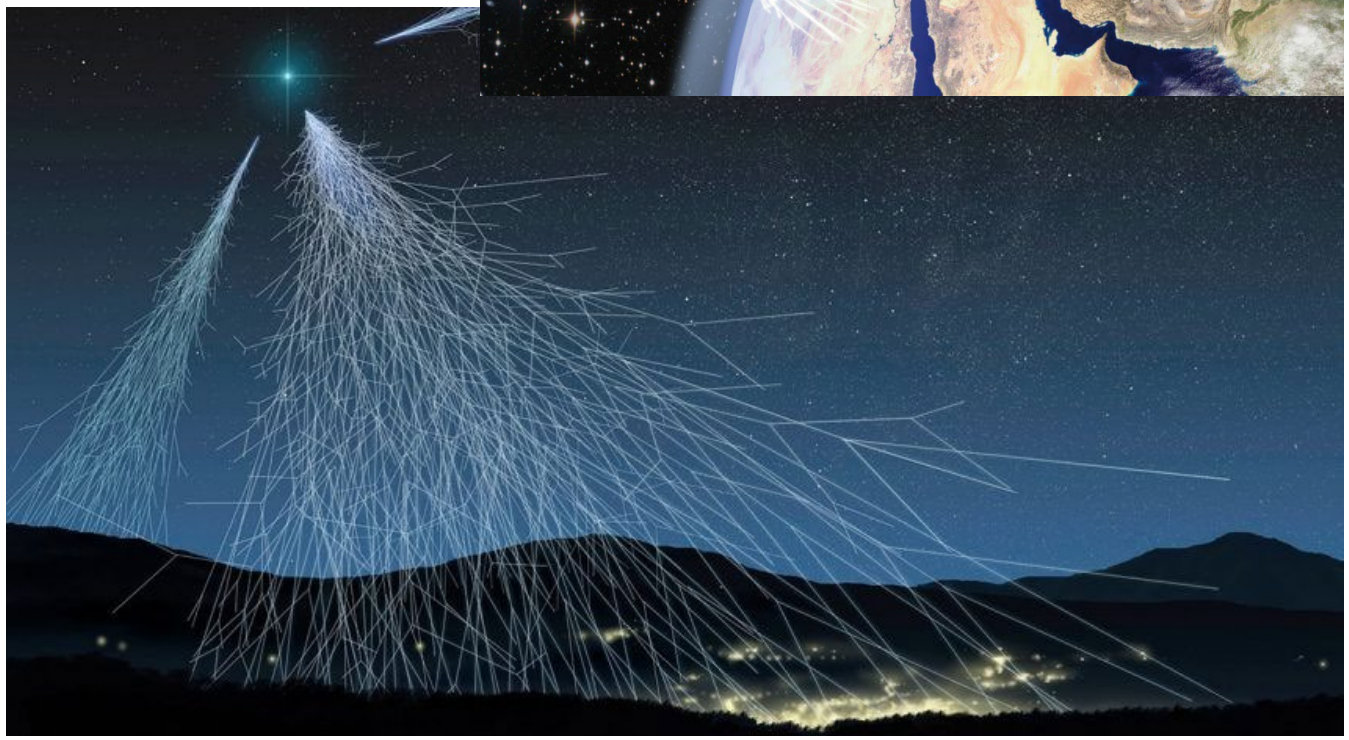
Validation of the neutronic cosmic ray snow gauge

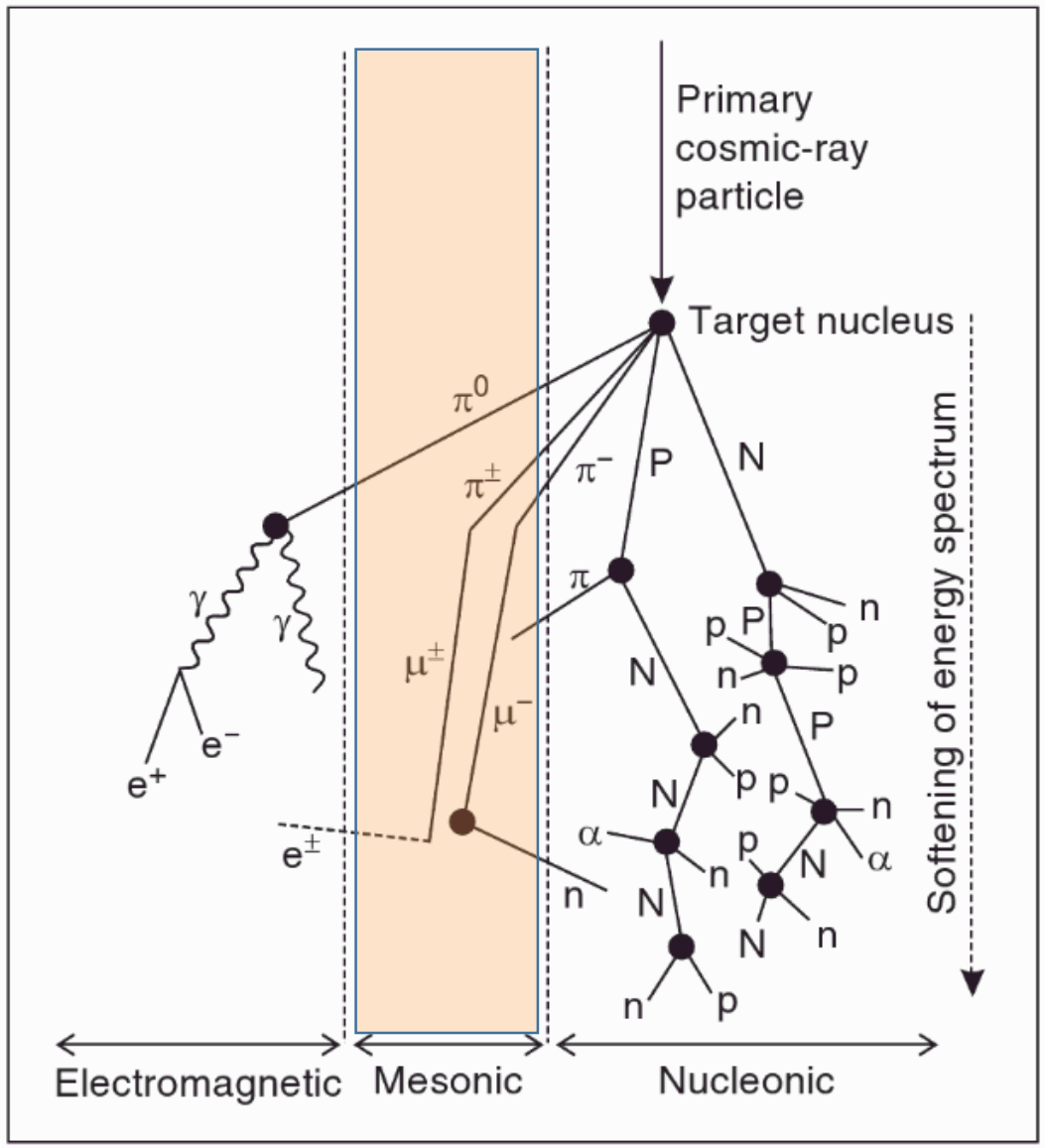
Photos: N. Clerx



Cosmic rays







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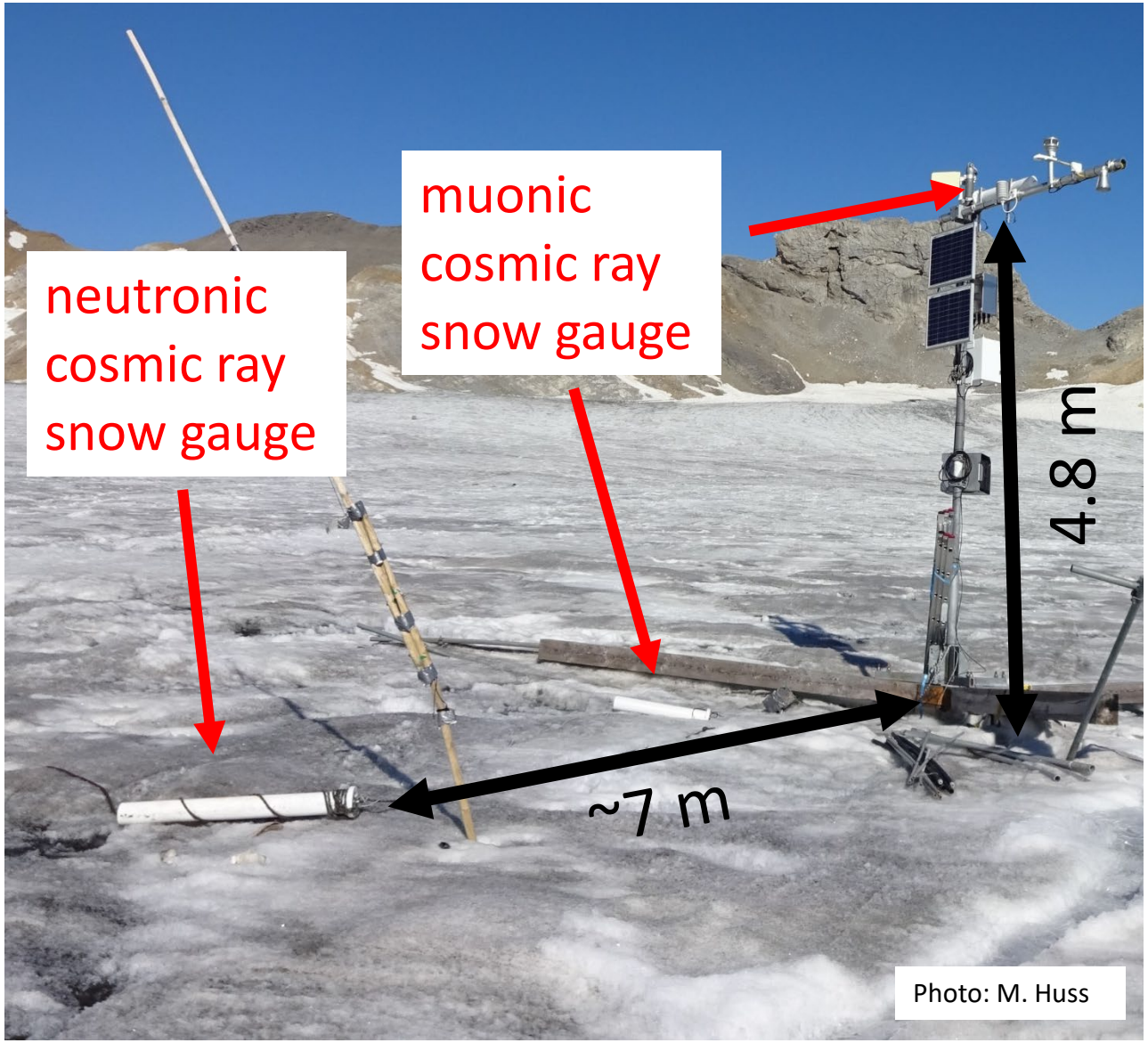
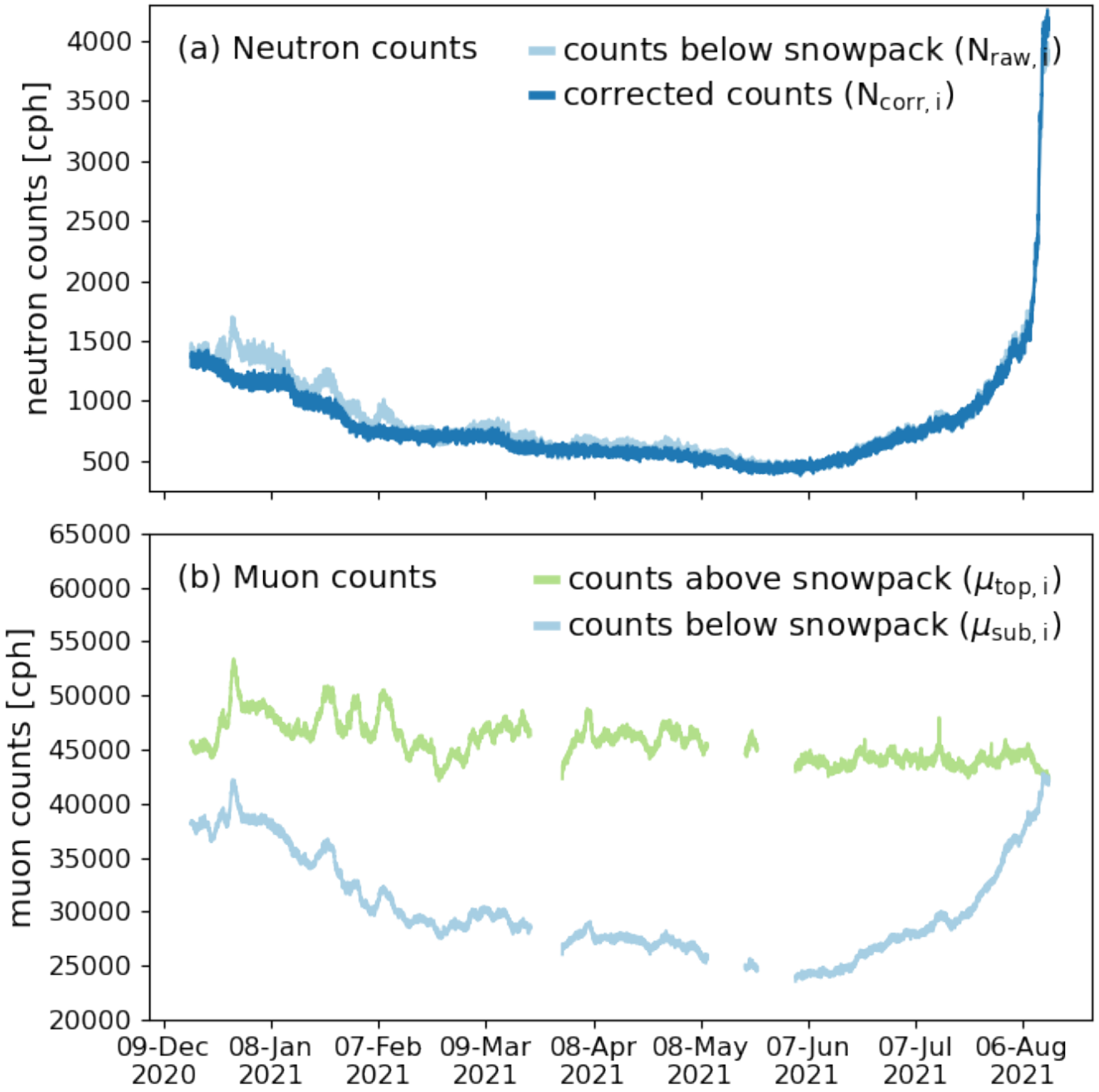
Dunai (2010)

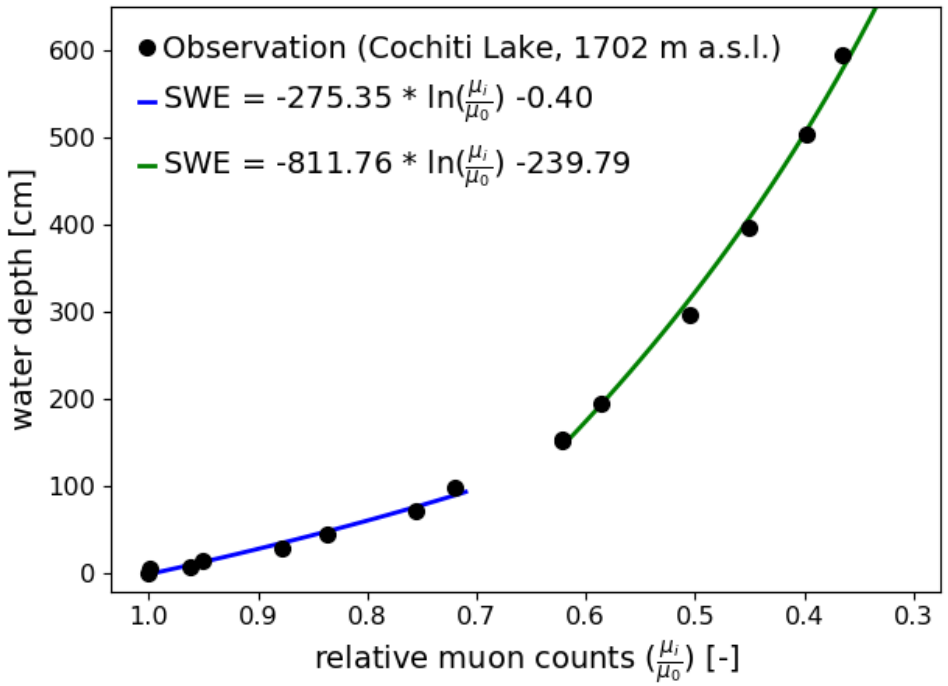
Measurement setup



Neutron and muon count rates – evolution over the winter season

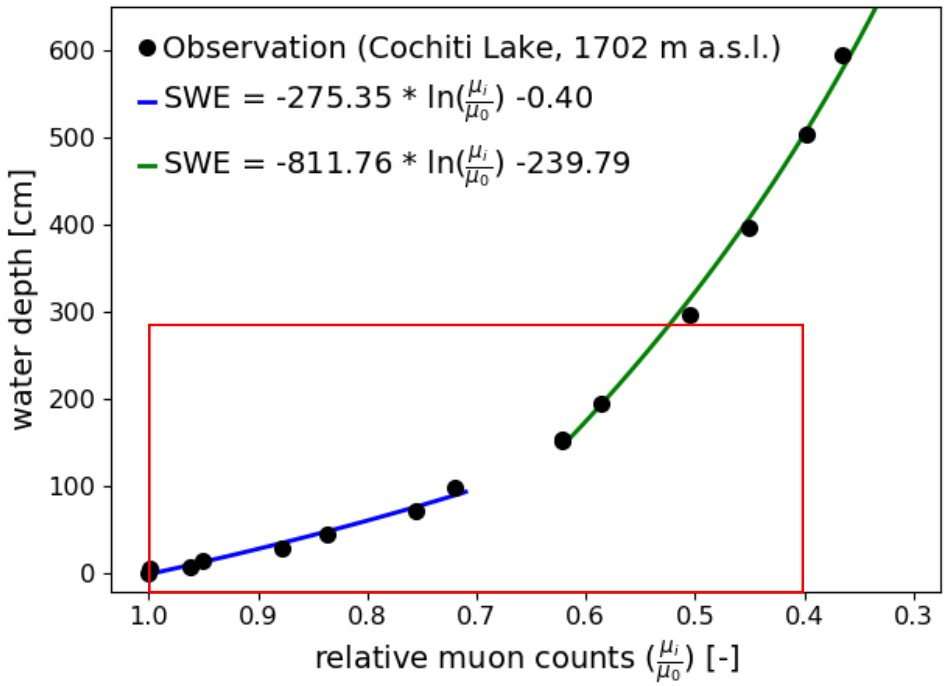


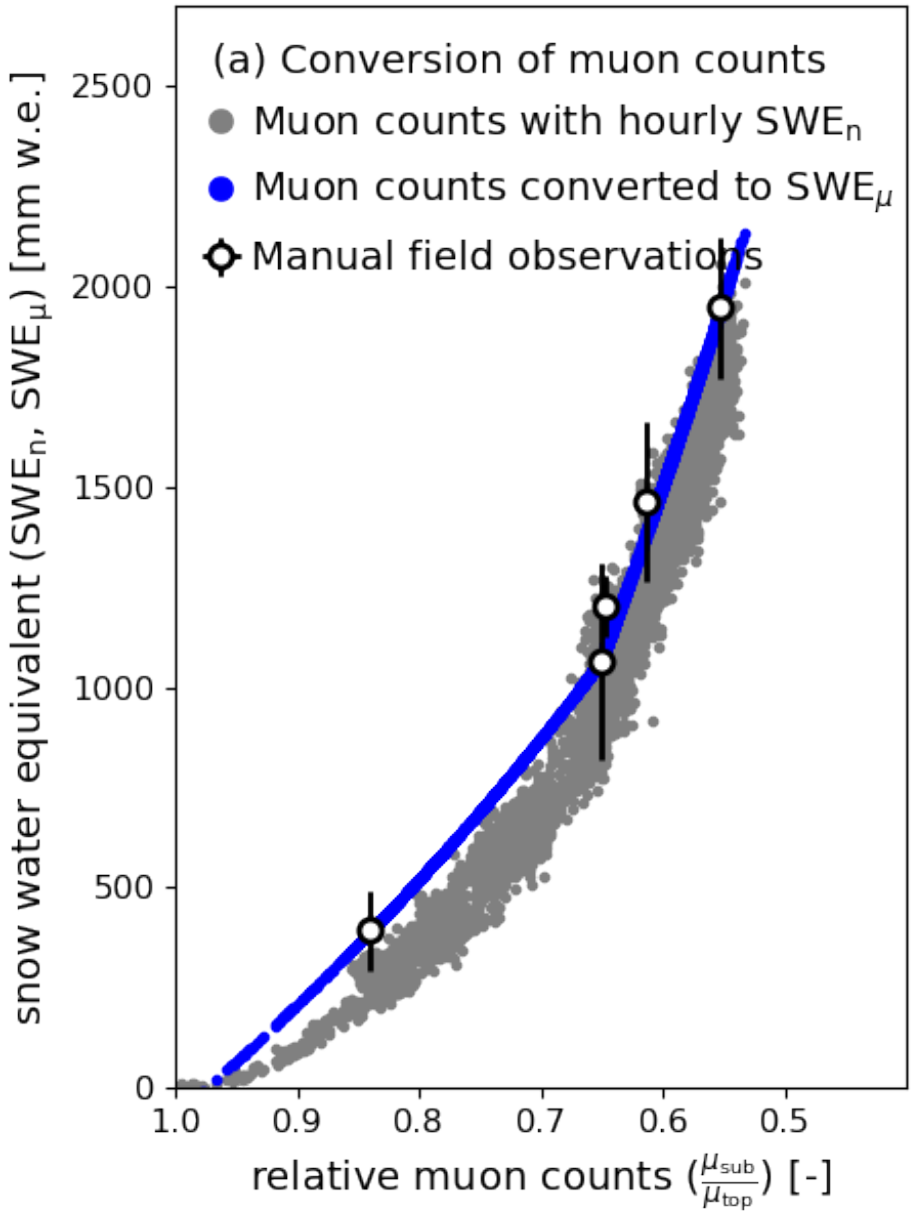
From muon counts to SWE – lake experiment



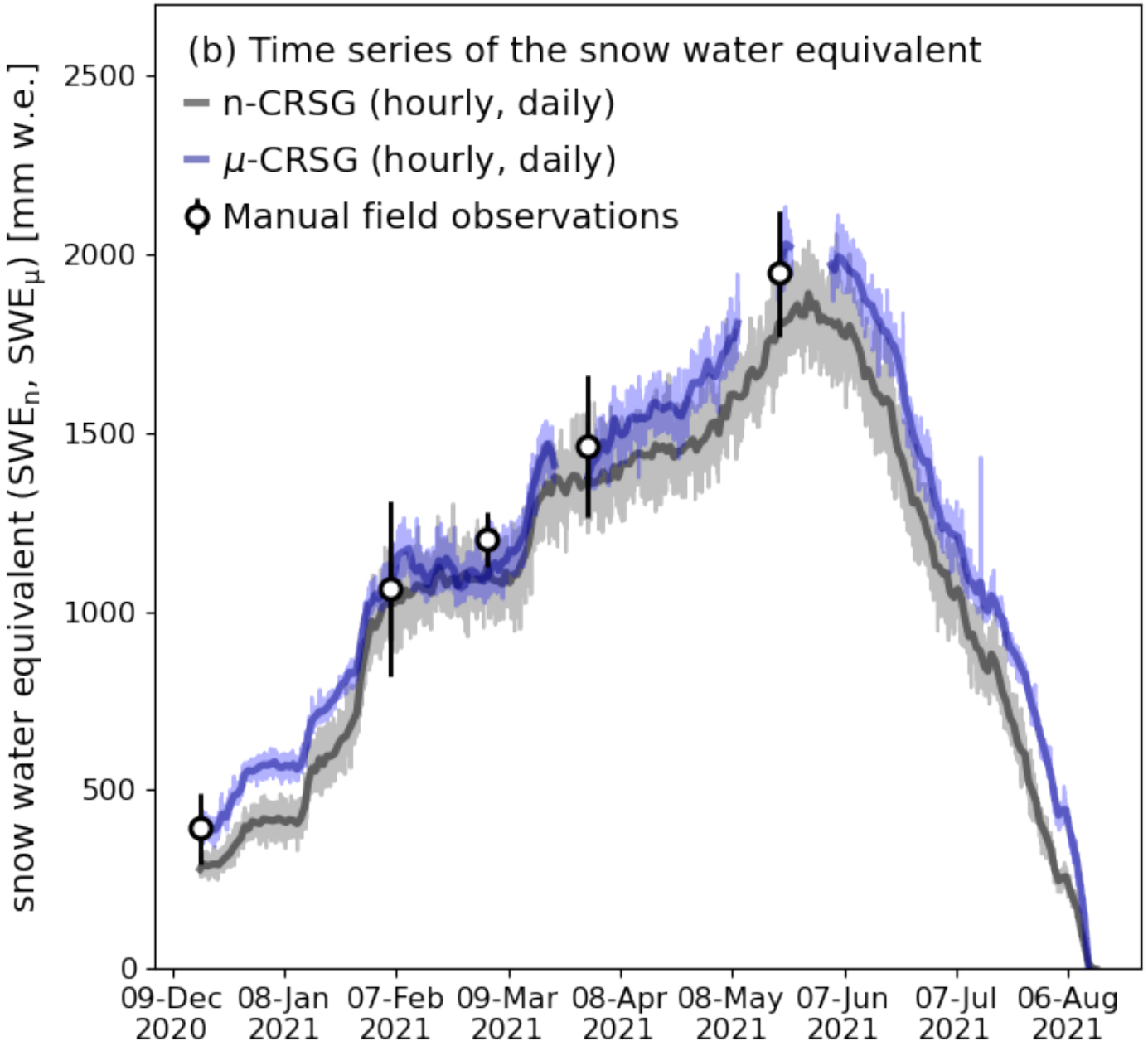
lake experiment

From muon counts to SWE





Time series of SWE



Conclusions

Cosmic ray snow gauges are promising devices for monitoring the snow water equivalent on alpine glaciers.

	neutronic CRSG		muonic CRSG
Performance	☺		?
Noise (sub-daily)	😐		☺
Noise (daily)	☺		?
Weight	☺	<	☺
Price	☺	<	☺

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Conclusions

Cosmic ray snow gauges are promising devices for monitoring the snow water equivalent on alpine glaciers.

- The neutronic cosmic ray snow gauge has been thoroughly evaluated for a glacierized high mountain site and shows a good performance.

- The muonic cosmic ray snow gauge shows promising results, but more research is necessary to answer open questions.

References

Gugerli, R., Desilets, D., and Salzmann, N.: Brief communication: Application of a muonic cosmic ray snow gauge to monitor the snow water equivalent on alpine glaciers, The Cryosphere, 16, 799–806, https://doi.org/10.5194/tc-16-799-2022, 2022.

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Thank you!

Photo: A. Nestler