Towards deciphering the contribution of permafrost and active layer to summer runoff in a small alpine catchment

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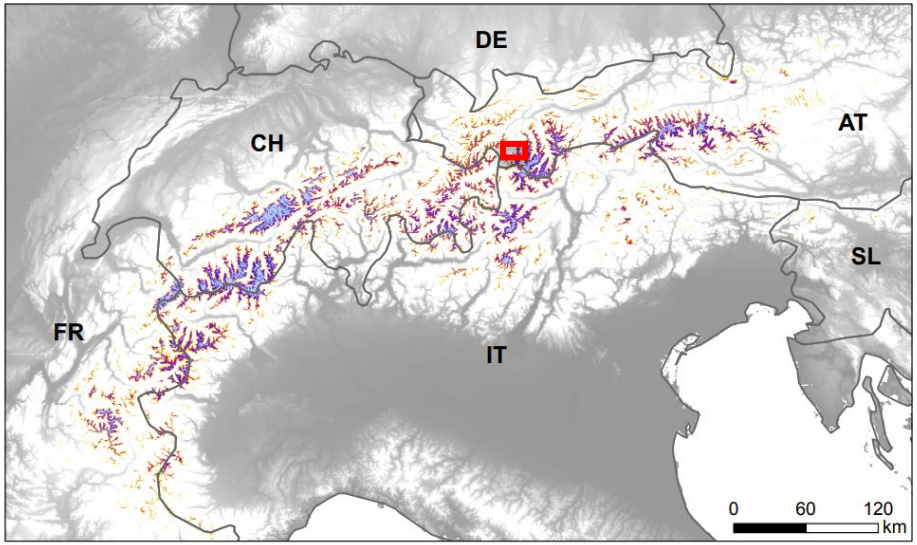
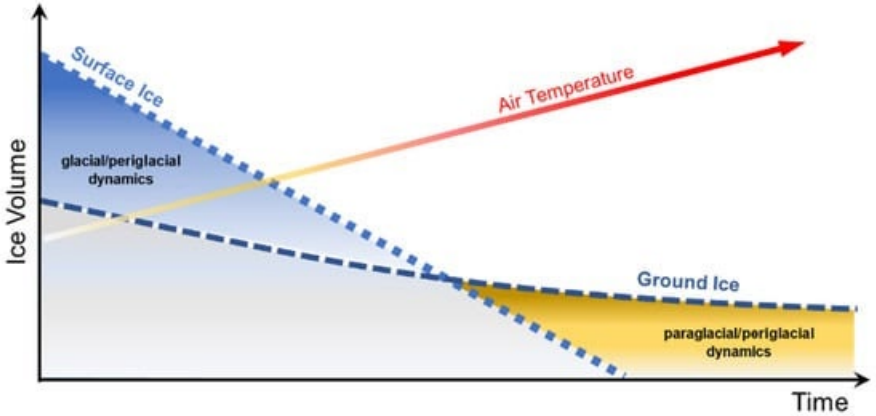
Background and Relevance

Alpine permafrost presence is currently estimated to range around **3000 km²**. Corresponding to ~25 km³ ice in the underground.



Alpine Permafrost Index Map (APIM, Boeckli et al. 2012)



Future change in ice volumes in moutain regions (Arenson et al. 2022, Haeberli et al. 2017)

→ When will we reach the point where mainly underground ice is contributing to the discharge in a small Alpine valley?

↳ How much is it currently contributing to the late summer discharge?

Background and Relevance

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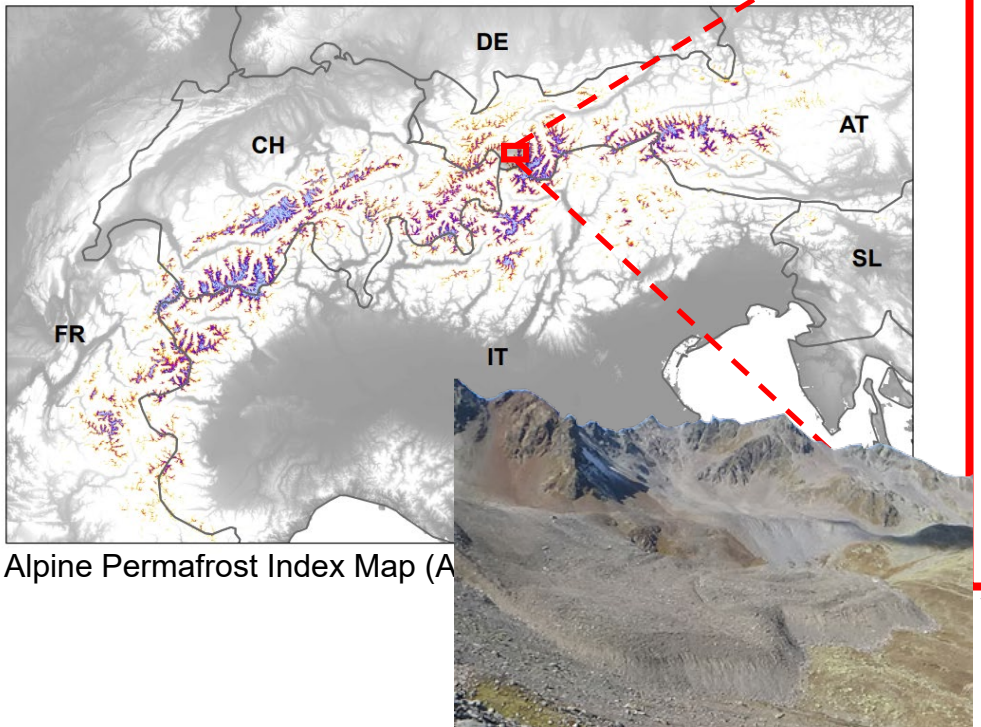
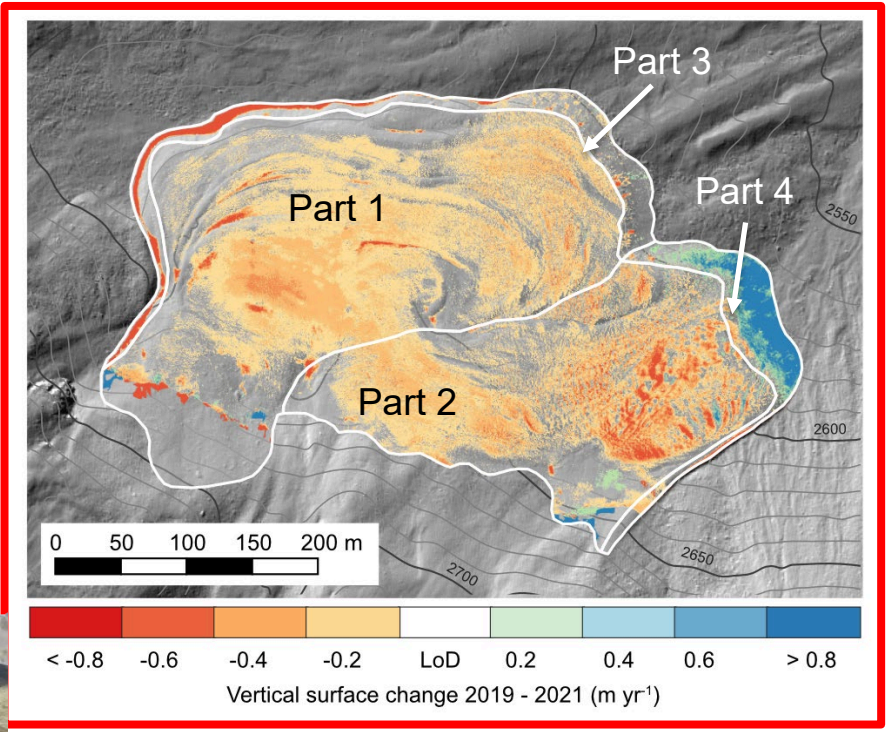
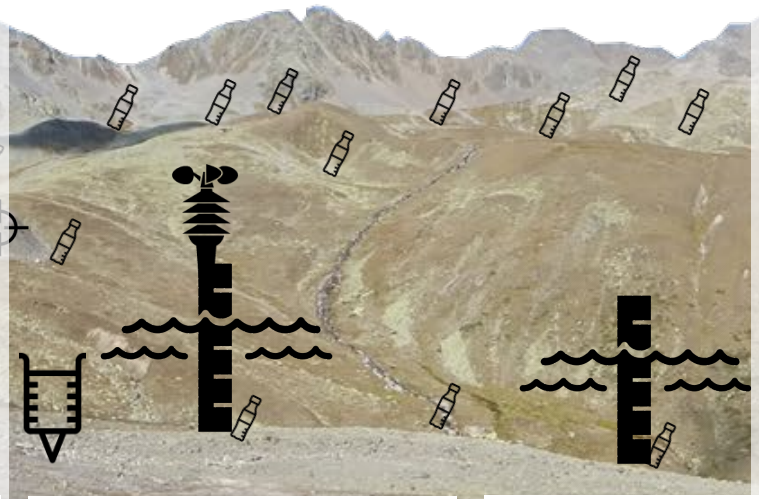


Alpine Permafrost Index Map (A



Vertical surface change on the Kaiserberg rock glacier

Methods July-September 2018-2019



UAV volume loss detection and feature tracking

I-buttons temperature measurements

ERT measurements once a year

15min discharge measurements of two Hydro stations + monthly evaporation free rain sample

Monthly sampling of diverse springs, glacier samples, and precipitation(n ≈ 40), Temp. and EC on site

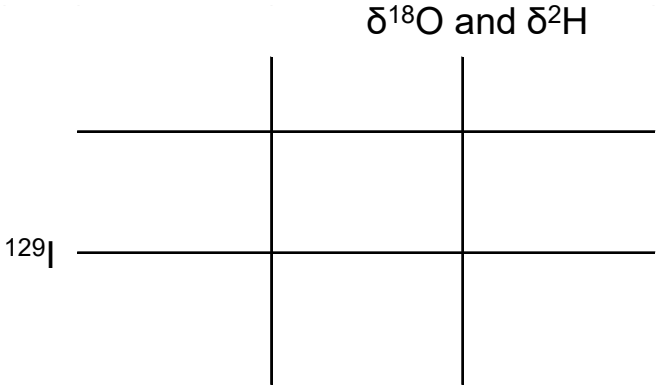
Methods

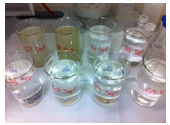




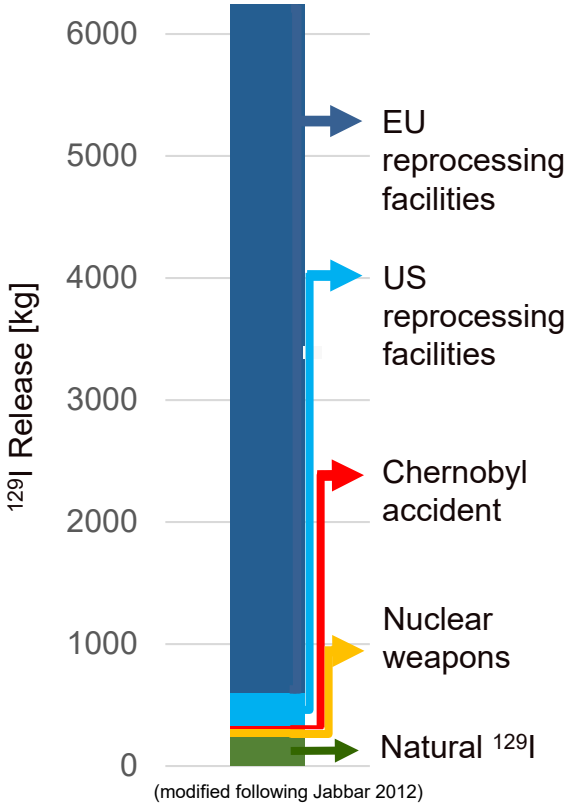
Waters of different origin have different stable isotope signatures using $\delta^{18}O$ and $\delta^{2}H$ (Dansgaard 1954, Friedmann et al. 1964)

^{129}I concentrations world wide enriched by several orders of magnitude mainly due to reprocessing facilities

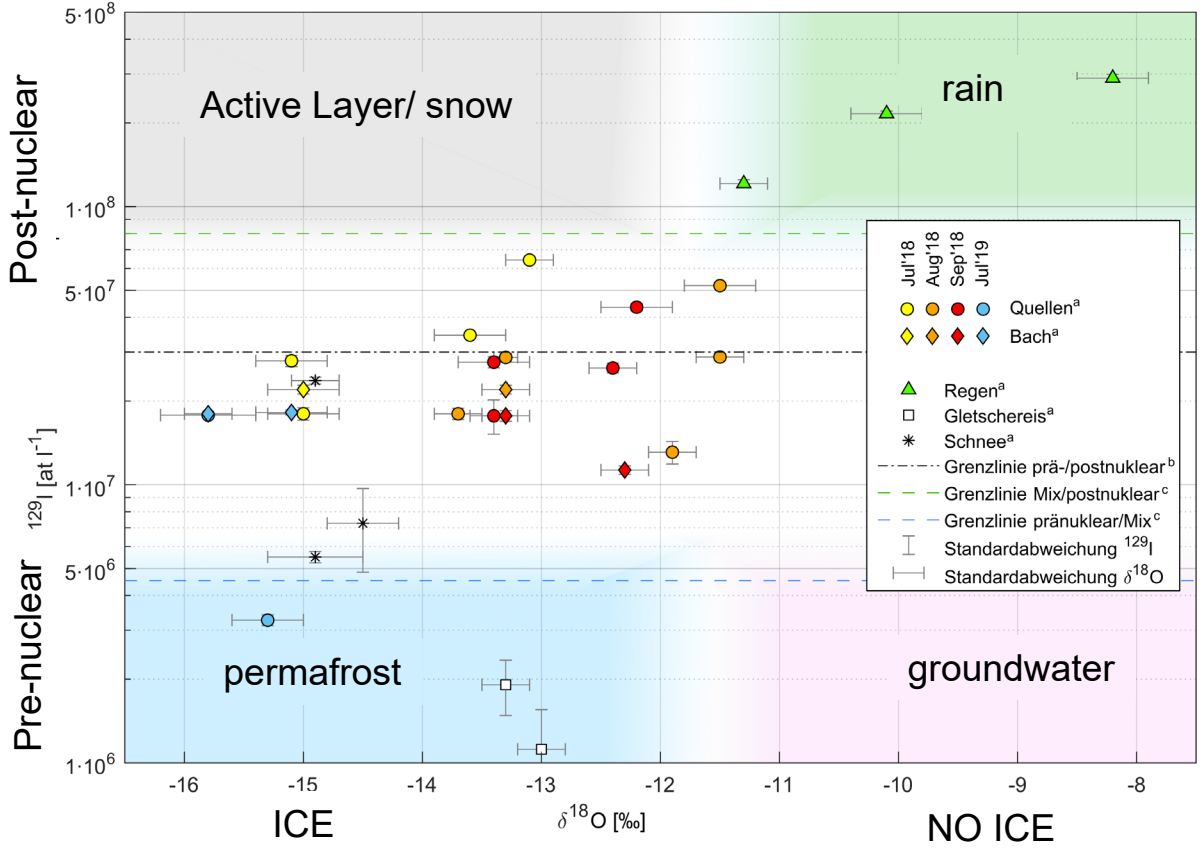






Results

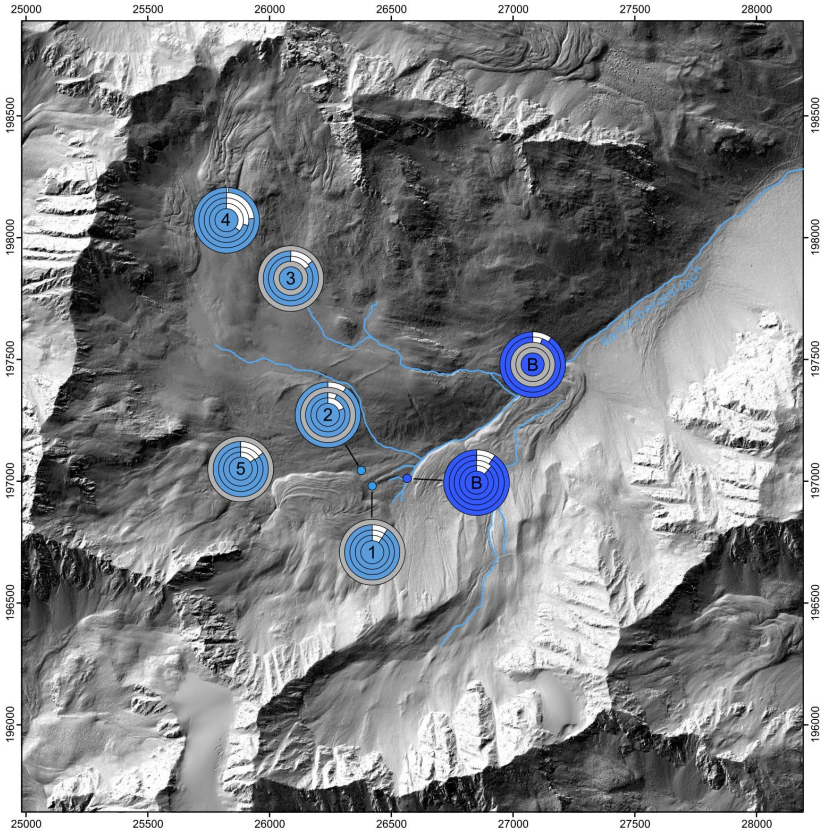


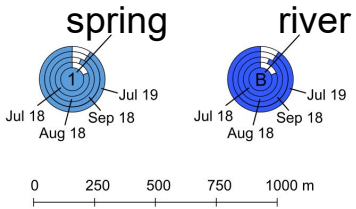
The majority of the springs show a mixed signal of pre- and post-nuclear melting water.

64-99% ± 25% pre-nuclear melting water (~permafrost)

Permafrost contribution to the discharge for selected samples (Moser 2020)

Discussion





Permafrost contribution to the discharge for selected samples (Moser 2020)

Over the summer months 2018-2019 the contribution of degraded permafrost to the discharge stays high, ranging around ~80%± 25% in average.

Results of volume loss and discharge estimations are not directly comparable because:

- Subsurface discharge of rock glacier is not known
- Uncertainties in regard to small snow fields that exist throughout the summer
- Sampling only takes plase during “best weather days”

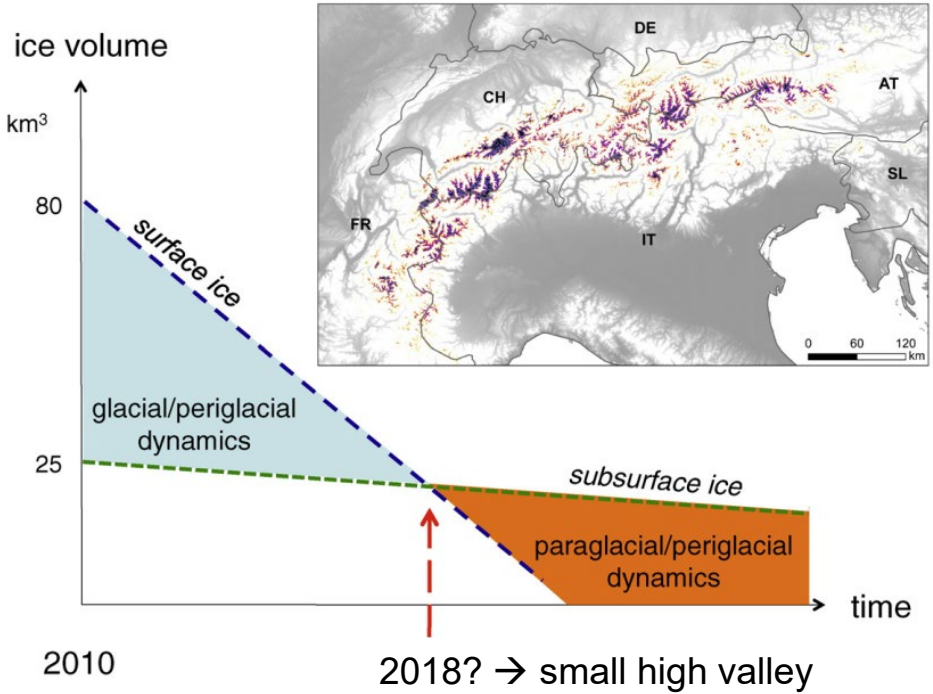
Conclusion

In the extreme cases of the summer months 2018-2019 the discharge of the small mountainous catchments shows a permafrost contribution of 64-99 ± 25%.

The volume loss of the Kaiserberg rock glacier sums up to ~6000 m^3 per year (2018-2021)

The combination of the two methods using direct and indirect measurements hints the dominace of permafrost in the late summerly discharge.

Haeberli et al. 2017



2018? → small high valley

Thank you for your attention and questions

YouTube: Check out our project video (in German)