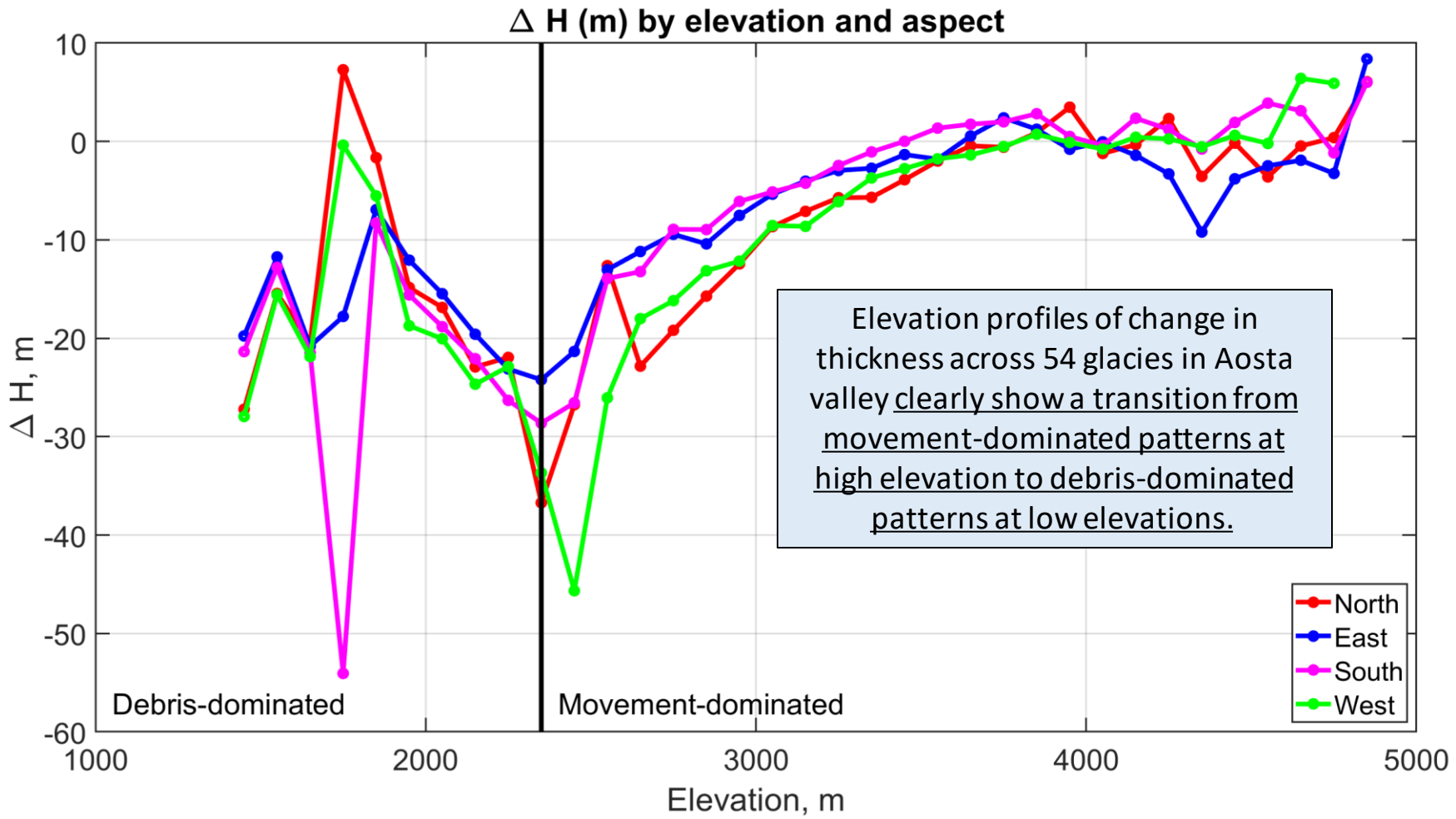
Coupling the **Δh parametrization** with melt beneath a supraglacial **debris** cover: an evaluation across **54 glaciers** in the **southern European Alps**

F. Avanzi, S. Gabellani, E. Cremonese, U. Morra di Cella, M. Huss

Glacier mass balance: **essential**, and yet **hard-to-model** component of the water budget (esp. for parsimonious models)

Additional complication for models in a warming climate: **debris & its impact on local melt**

Our goal: develop a parametrization of melt beneath supraglacial debris solely based on long-term DEM differentiation



Elevation profiles of change in thickness across 54 glacies in Aosta valley clearly show a transition from movement-dominated patterns at high elevation to debris-dominated patterns at low elevations.

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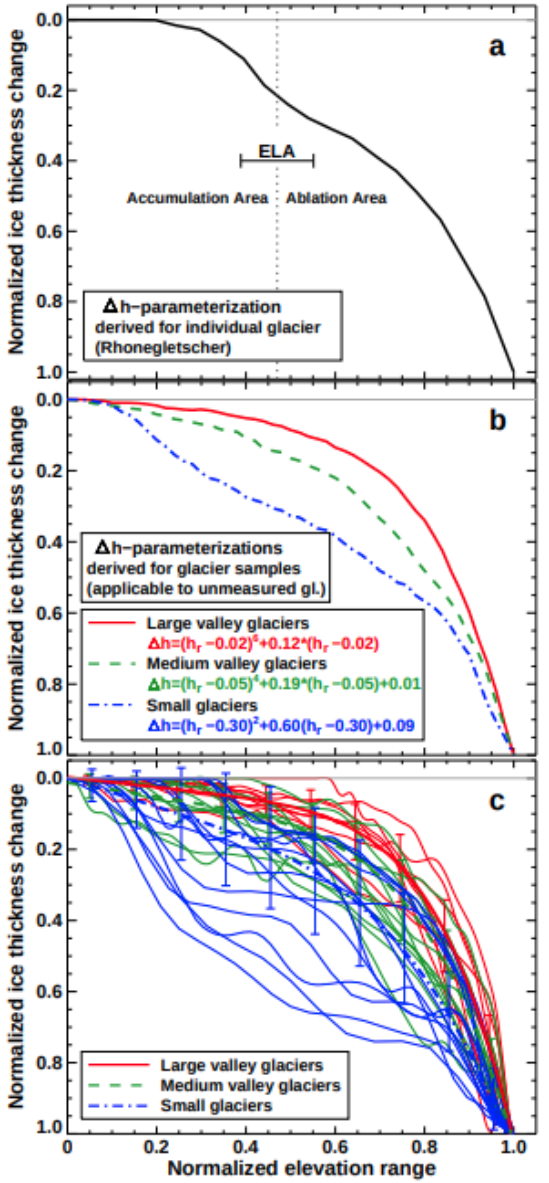
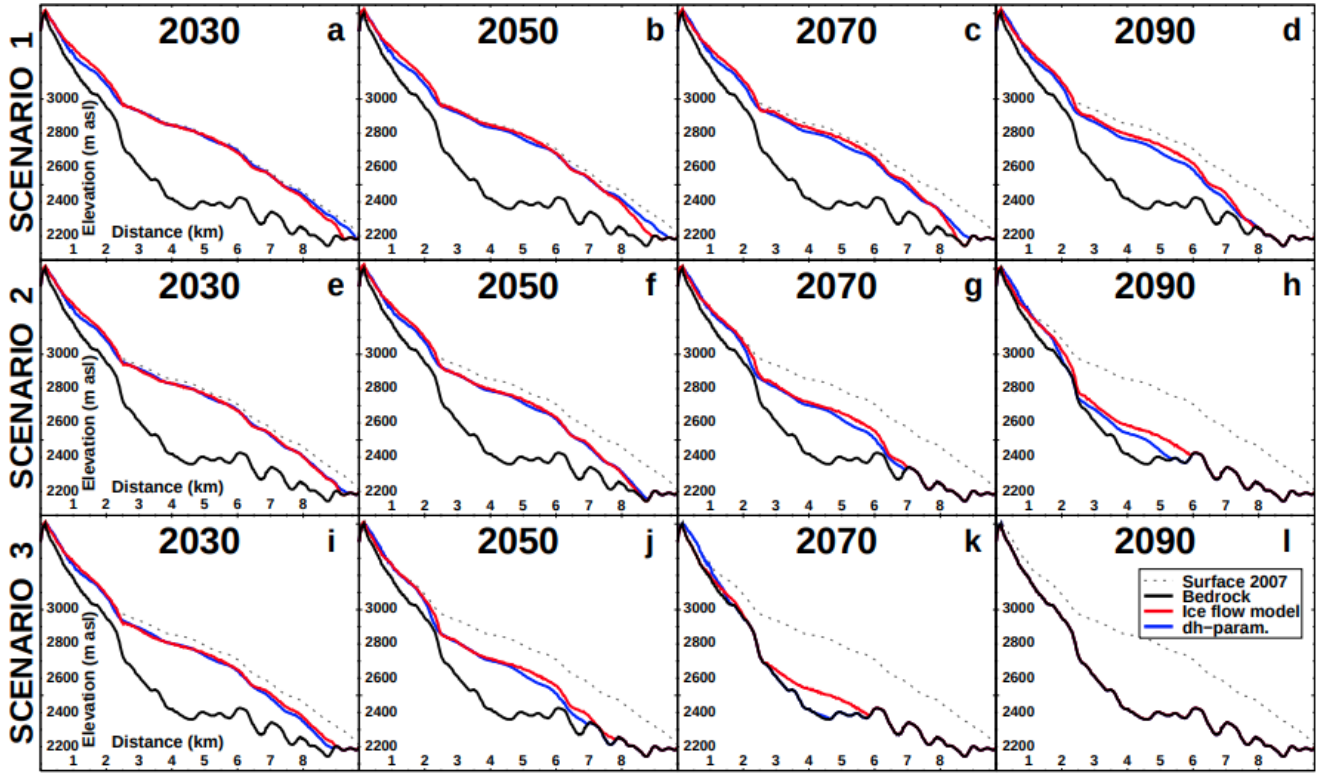
Intro: the "Δh profile"

Huss et al. 2010, https://doi.org/10.5194/hess-14-815-2010

What is it? *"The Δh-parameterization describes the spatial distribution of the glacier surface elevation change in response to a change in mass balance."*

How it works: parametrize long-term changes in ice thickness & scale them based on annual mass balance

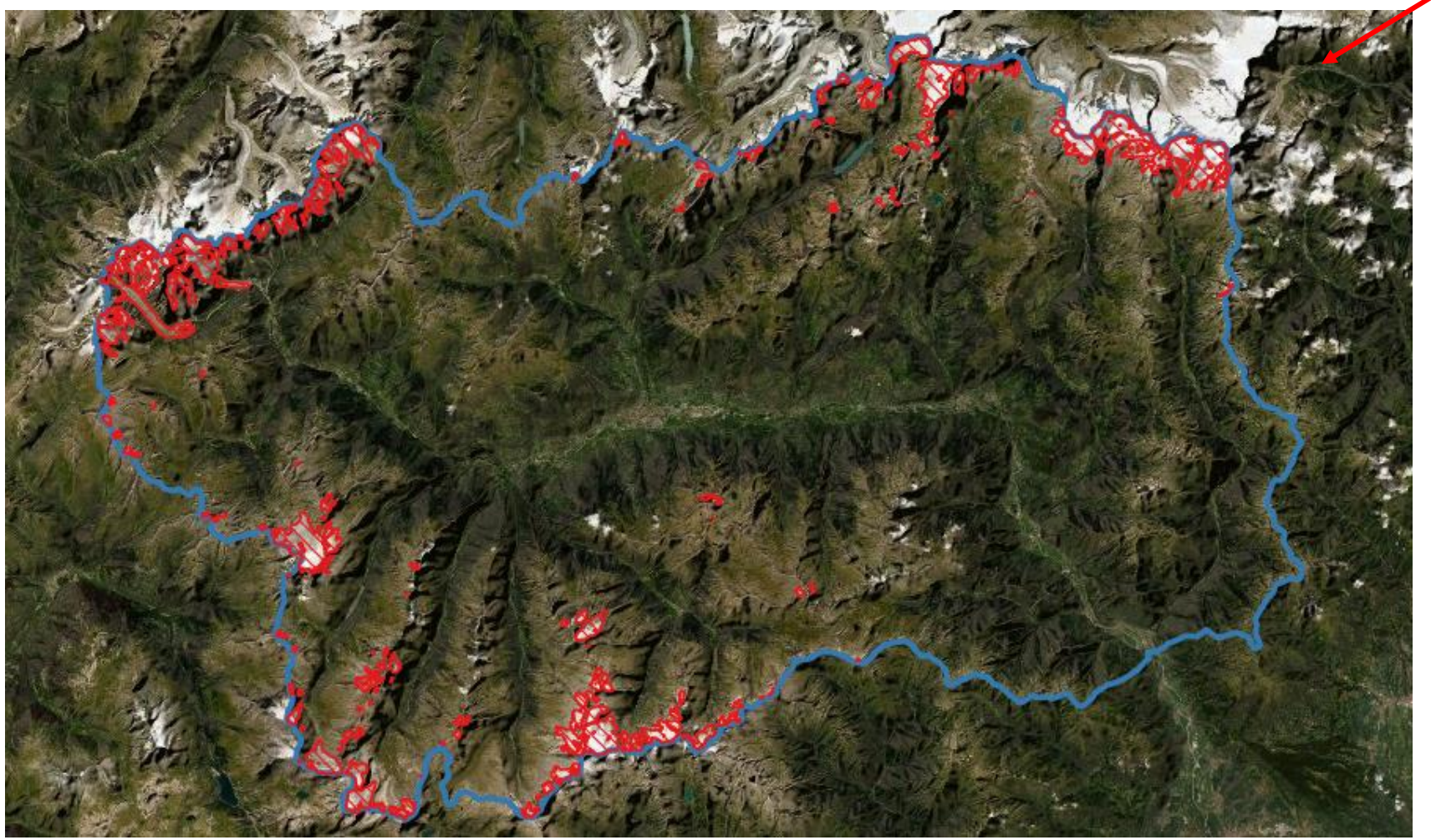


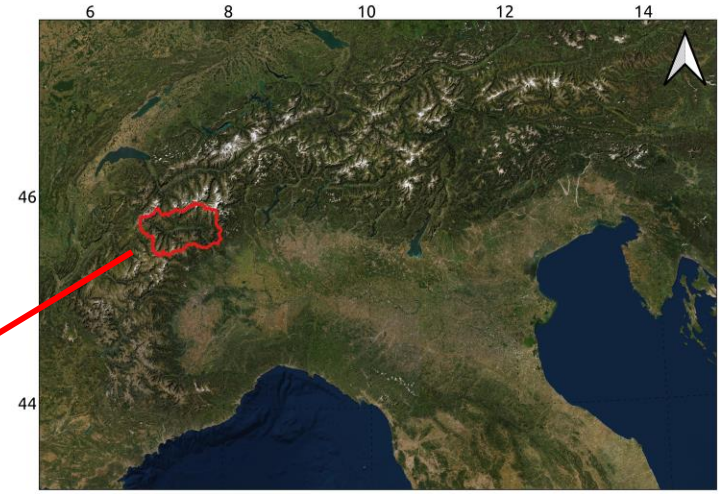


Has it been applied before? Yes, benchmarked against long-term scenarios of glacier retreat using an ice-flow model

Data & Methods

About 4% of Aosta valley is covered by glaciers (134 km^2), some of which are characterized by thick debris and develop for several kilometers



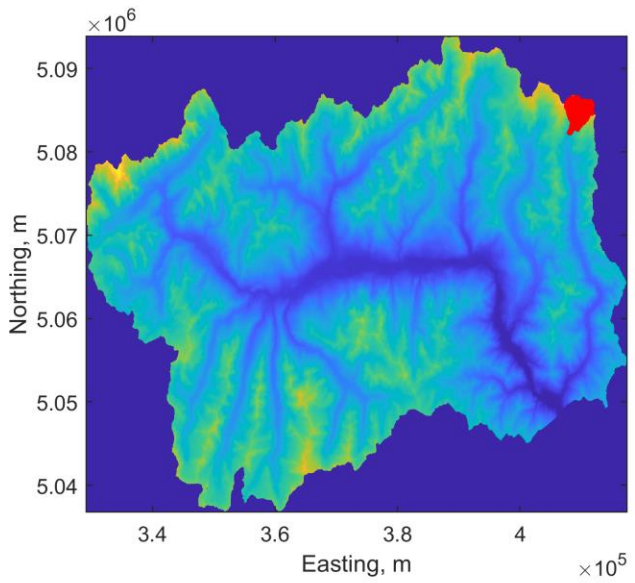


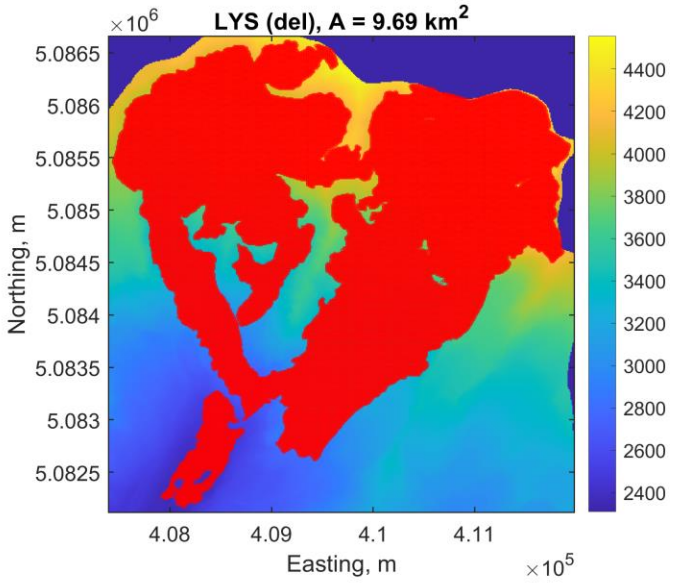
We derived elevation profiles for all glaciers in Aosta valley with area > 0.4 km^2, and so glacier-specific Δh – profiles, using DEM differentiation (2008 – 1991)

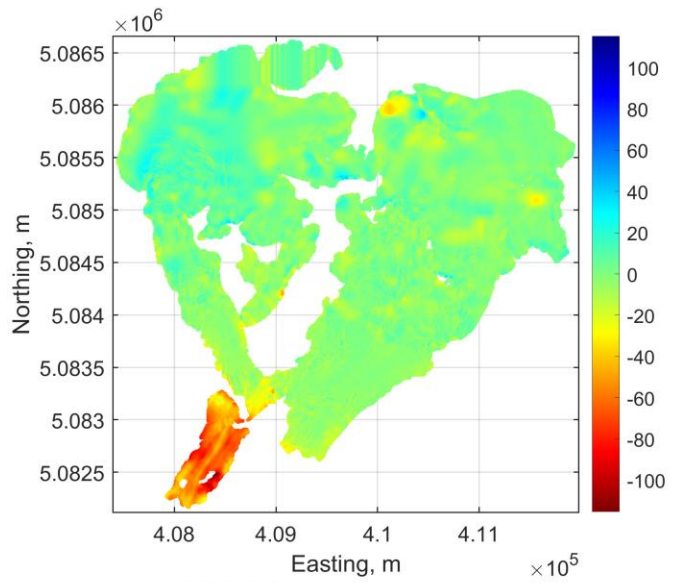
Debris-free, Δh profiles in Aosta valley

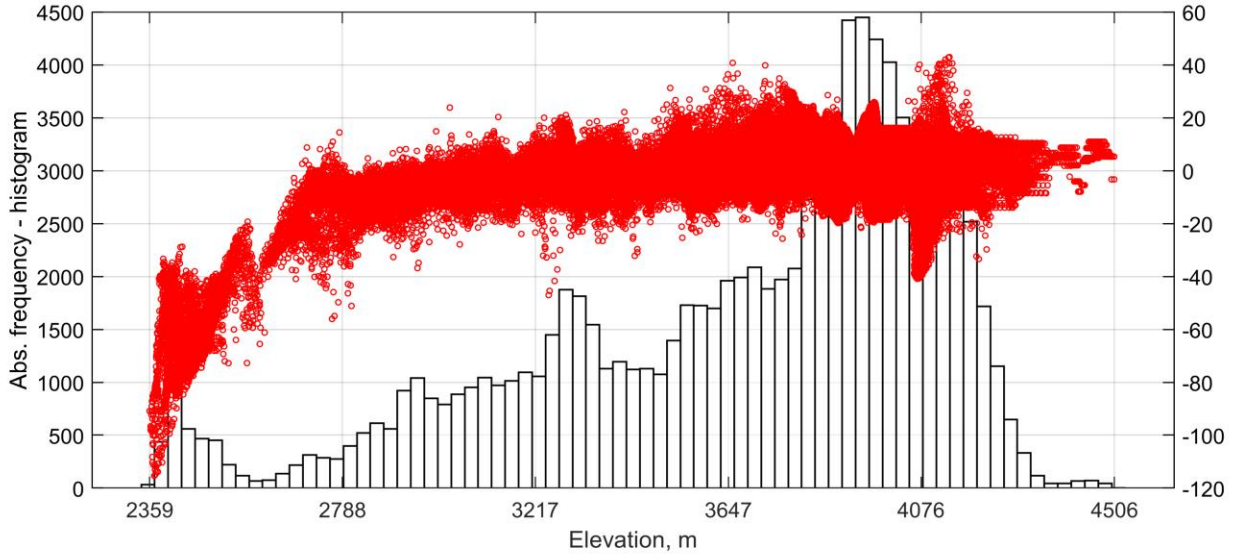
The Δh profile show a monotonous, "smooth" trend with elevation for debris-free glaciers

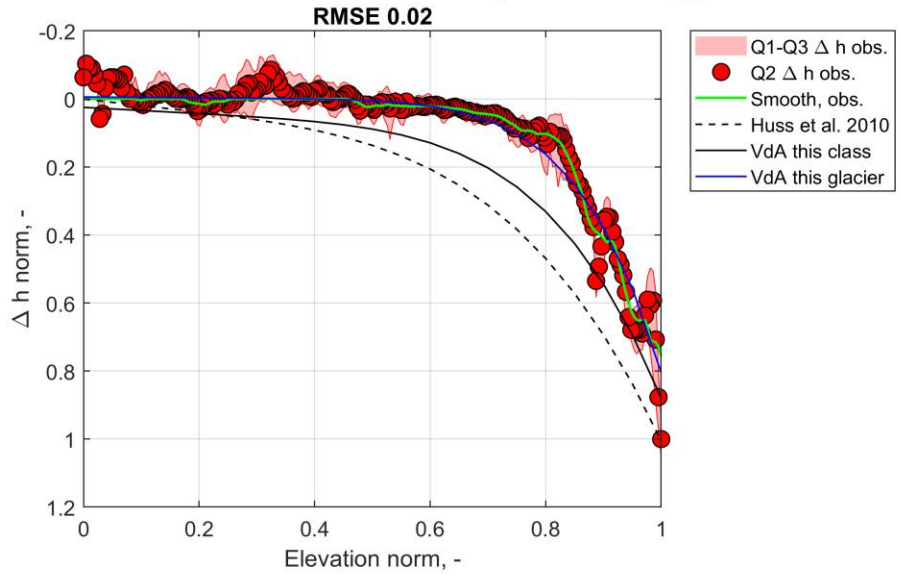
Lys glacier











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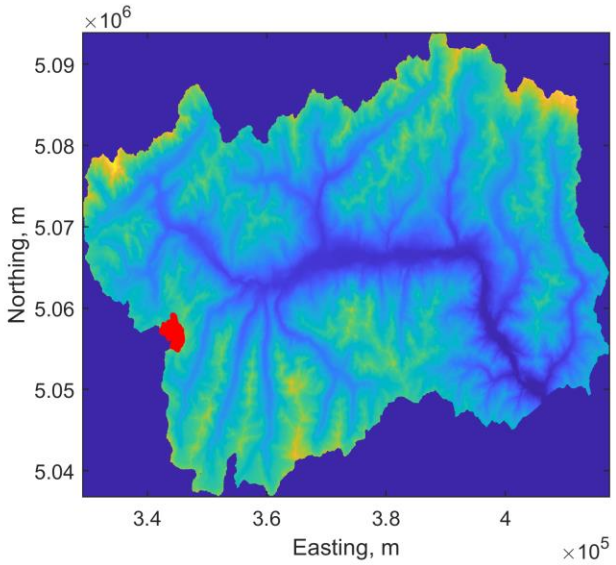
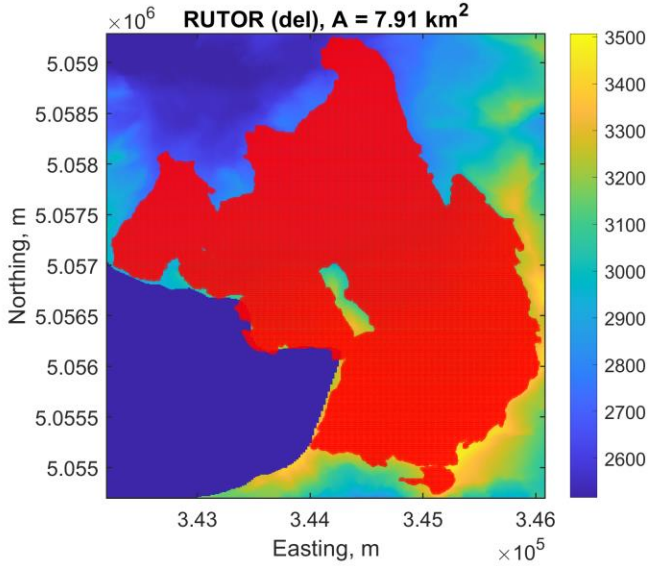
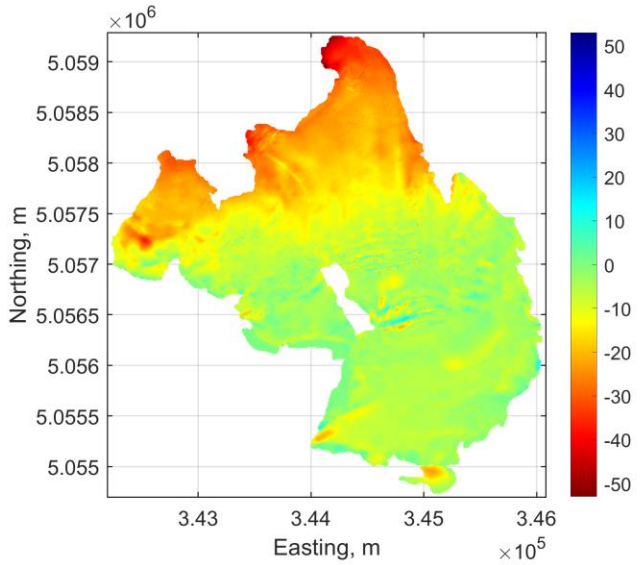
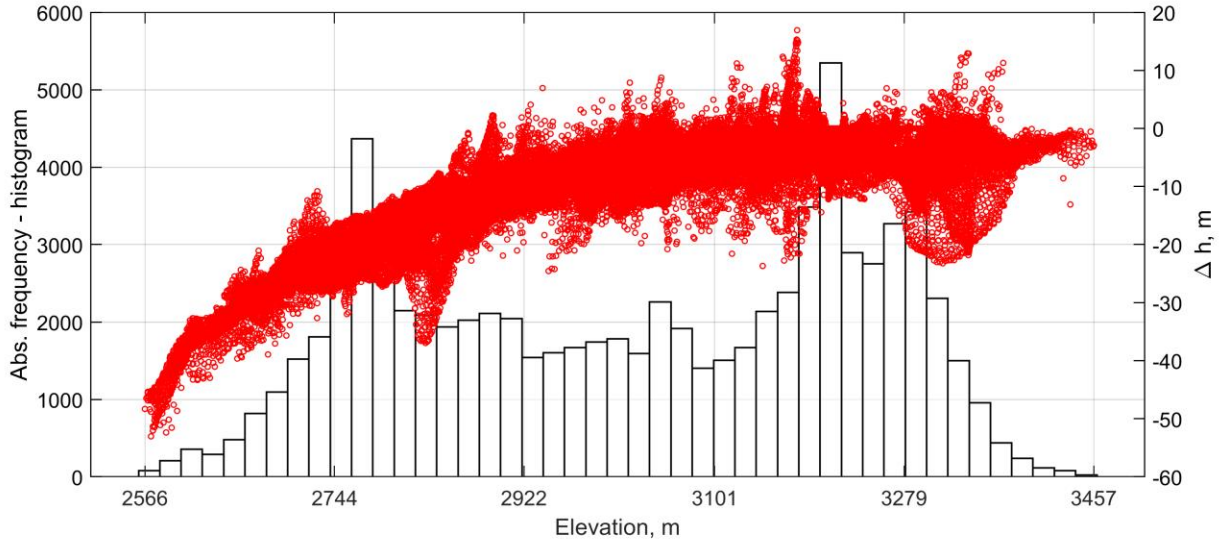
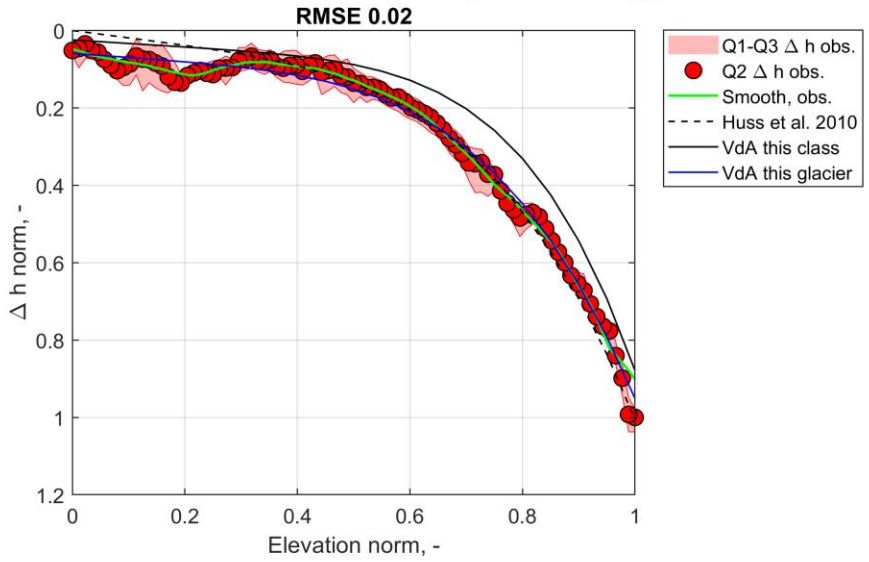
Rutor glacier







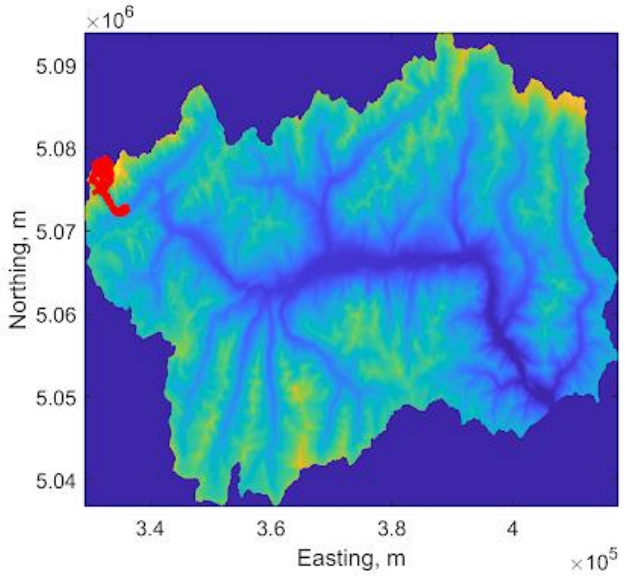


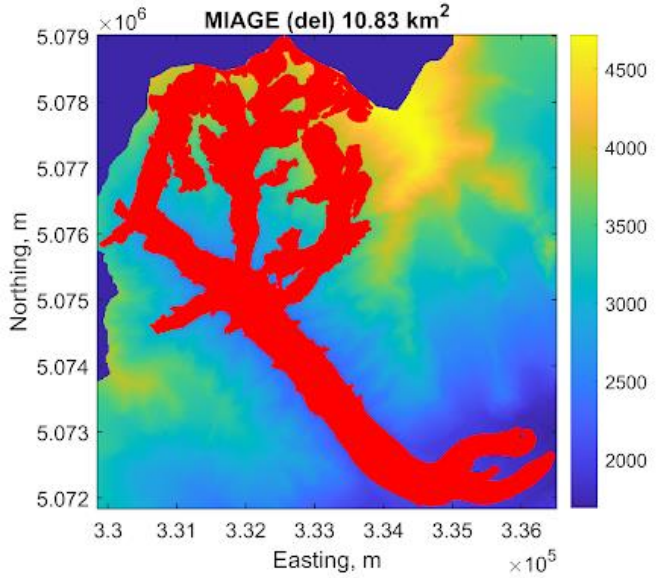


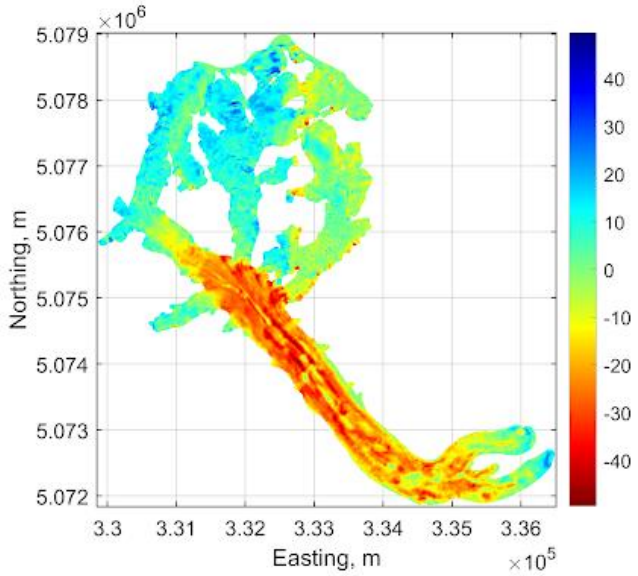
Debris-covered, Δh profiles in Aosta valley

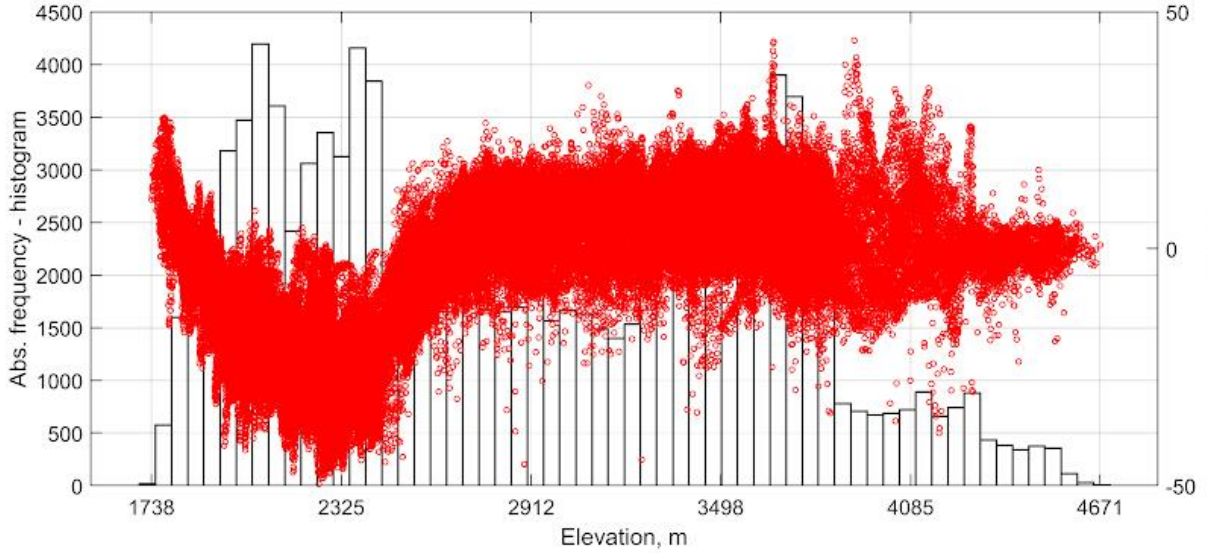
The Δh profile for partially debris-covered glaciers is much more complex!

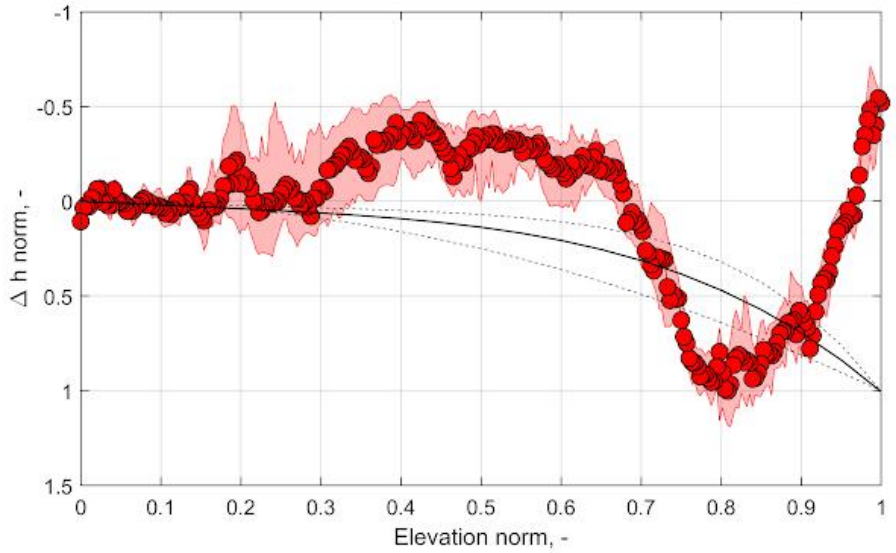
Miage glacier





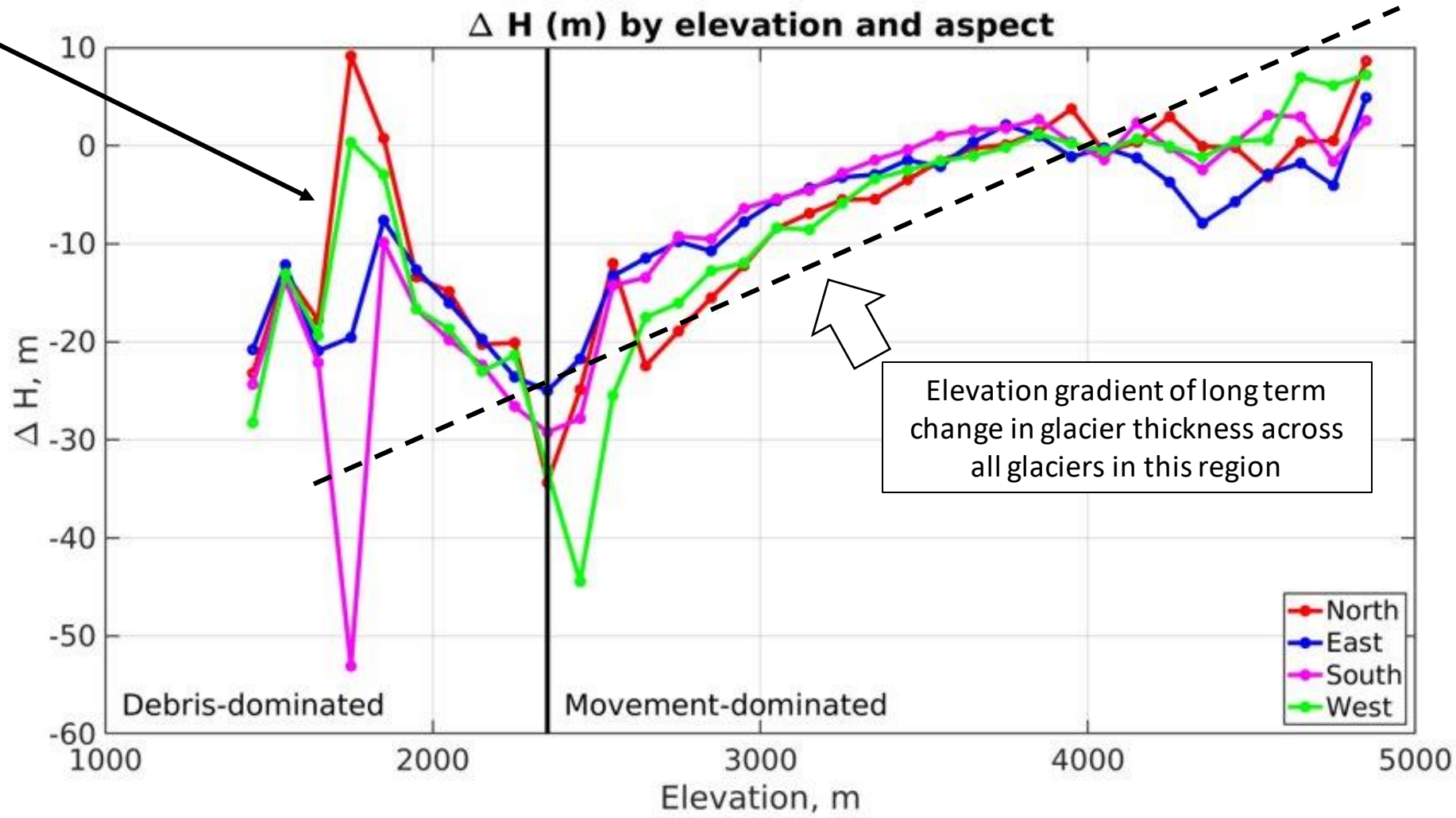






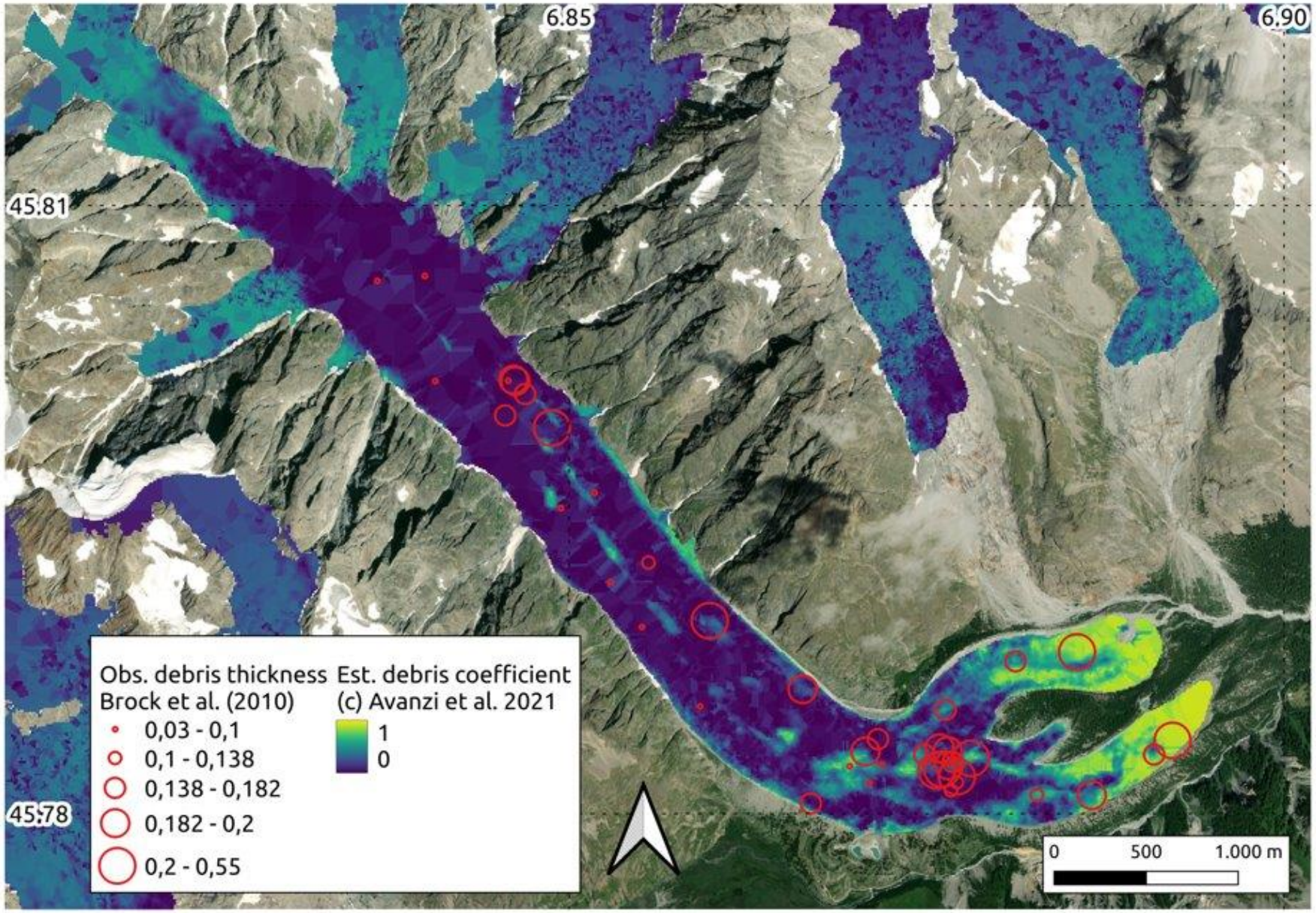
Can we leverage this spatial complexity?

Maybe yes! We are mapping **deviations** from locally observed change in elevation (using the same long-term DEM) and those expected by a regional, linear elevation gradient



Can we leverage this spatial complexity?

A comparison between these deviations and debris thickness measurements by Brock et al. 2010 (10.1029/2009JD013224) show some qualitative agreement, especially in terms of (1) high deviation values at the debris-covered terminus, and (2) low deviation values across the western side of the glacier where debris is shallow.



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I am particularly interested in discussing with attendees (you reading):

- Availability of debris-thickness measurements on Alpine glaciers
- Existing, parsimonious approaches to estimate MELT beneath debris
- Opportunities for collaborations on this or other projects related to water supply from cryosphere-dominated regions
- How beautiful the Alpine landscape is :)

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