

Rock glacier dynamics in marginal permafrost

Retezat Mountains, Southern Carpathians

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West University of Timișoara



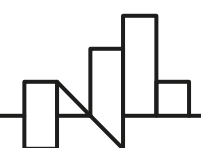
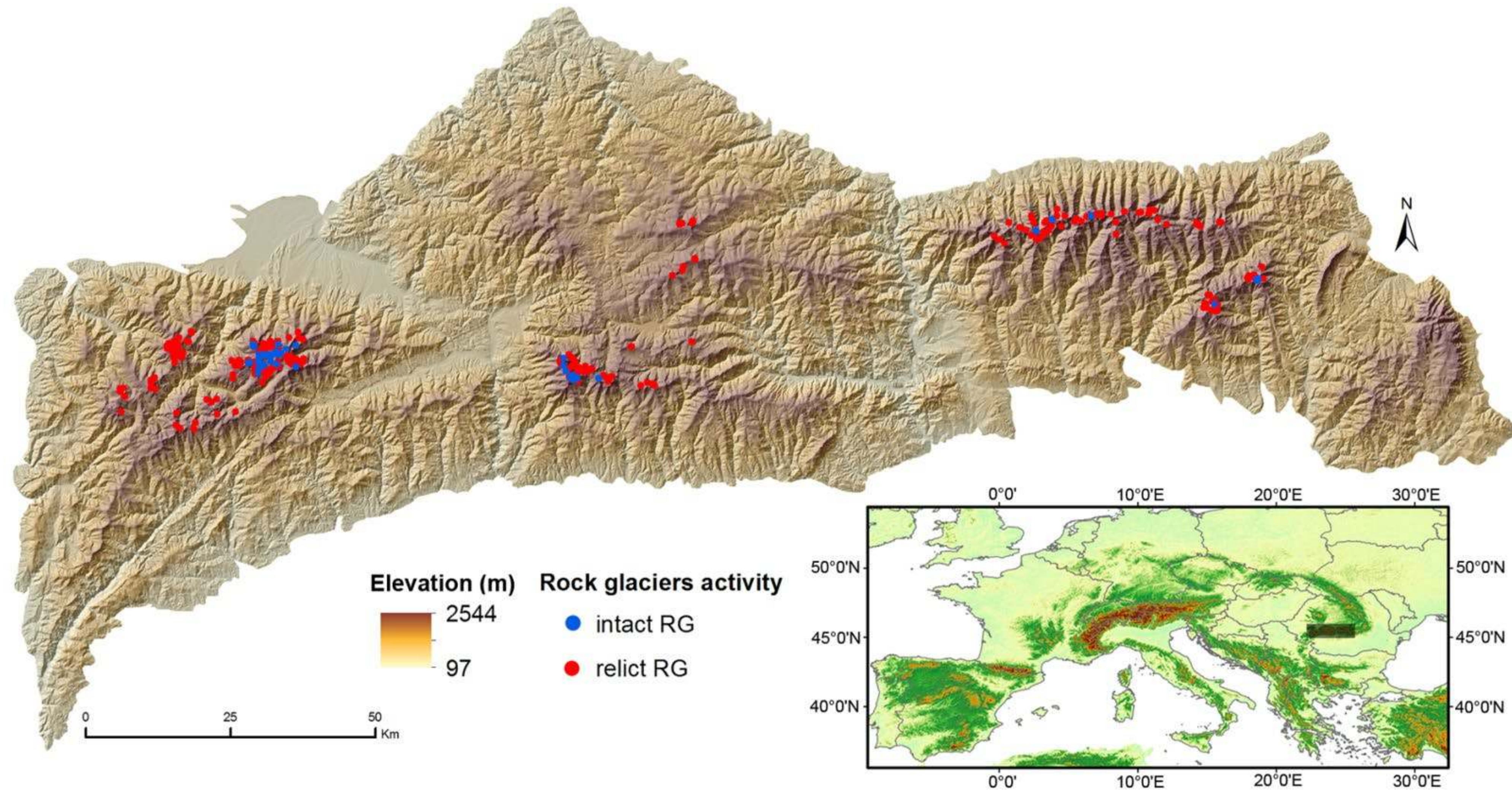
PermaCOST



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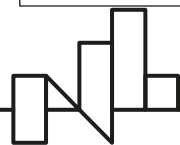
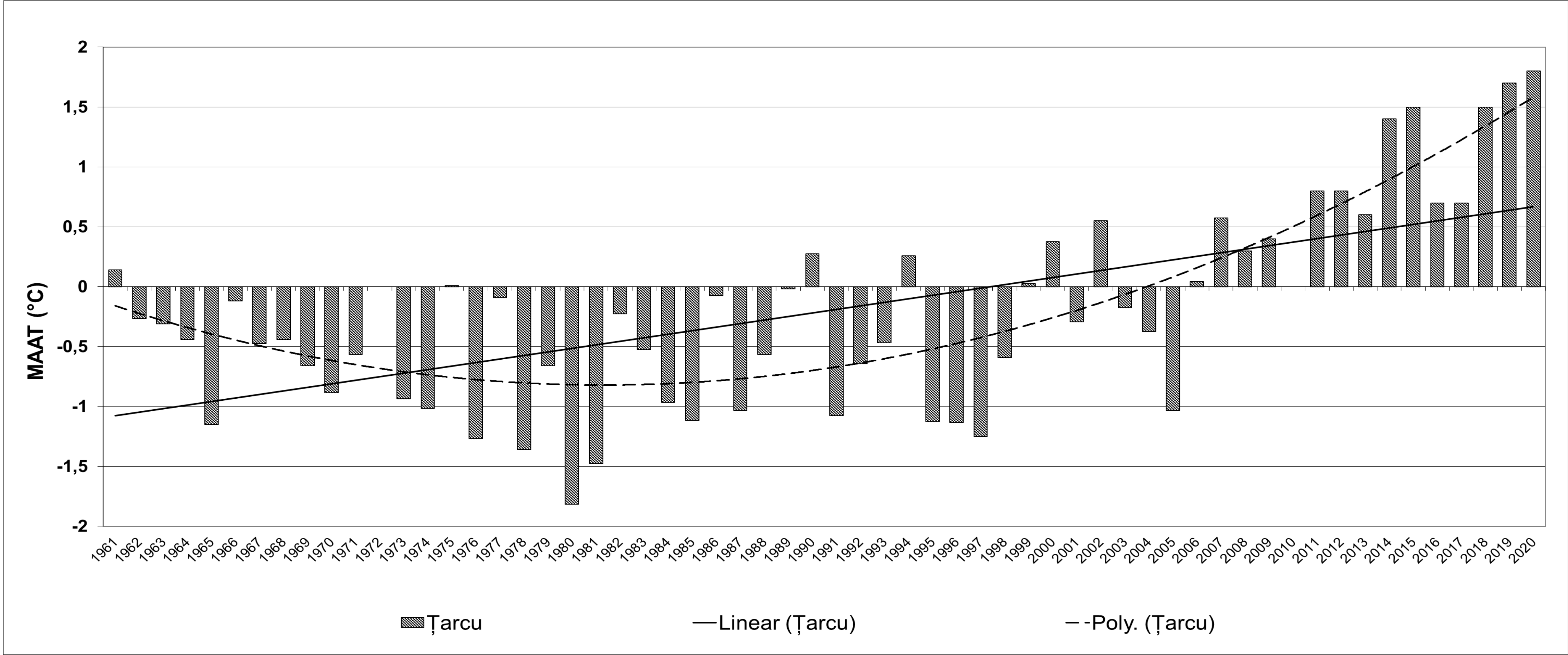
permacost.eu & cost.eu/actions/CA24157

Rock glaciers in the Southern Carpathians



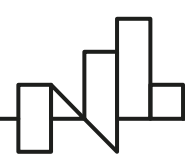
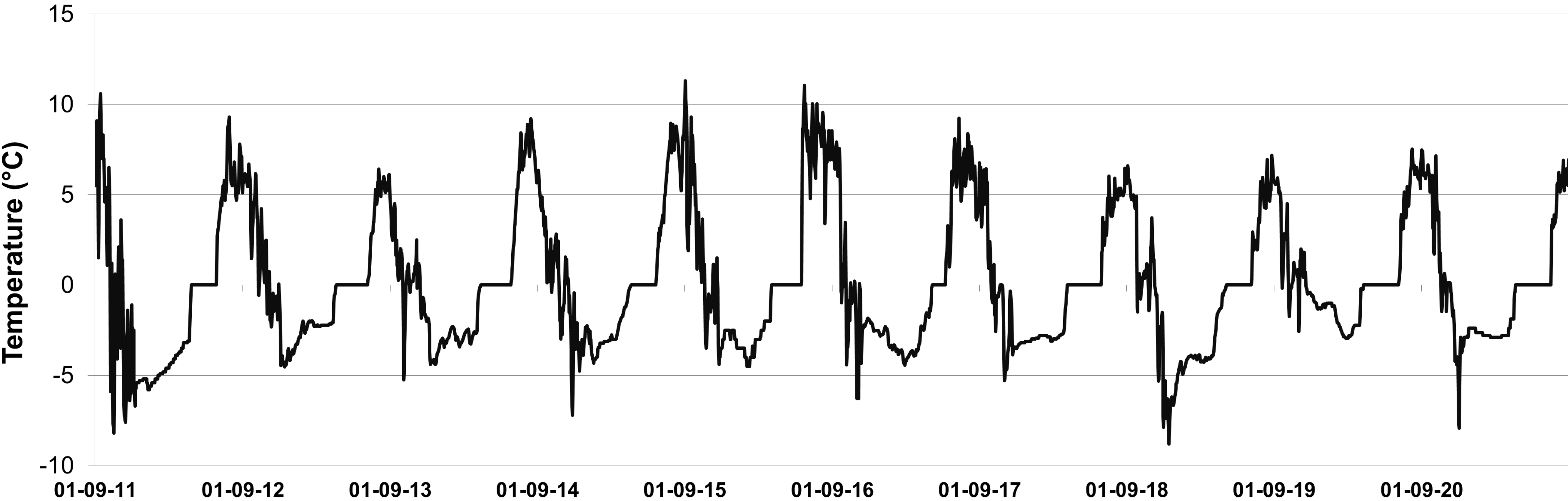
Mean annual air temperature over the last 6 decades

MAAT (1961-2020) – Vf. Țarcu (2180 m)

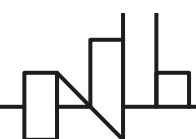
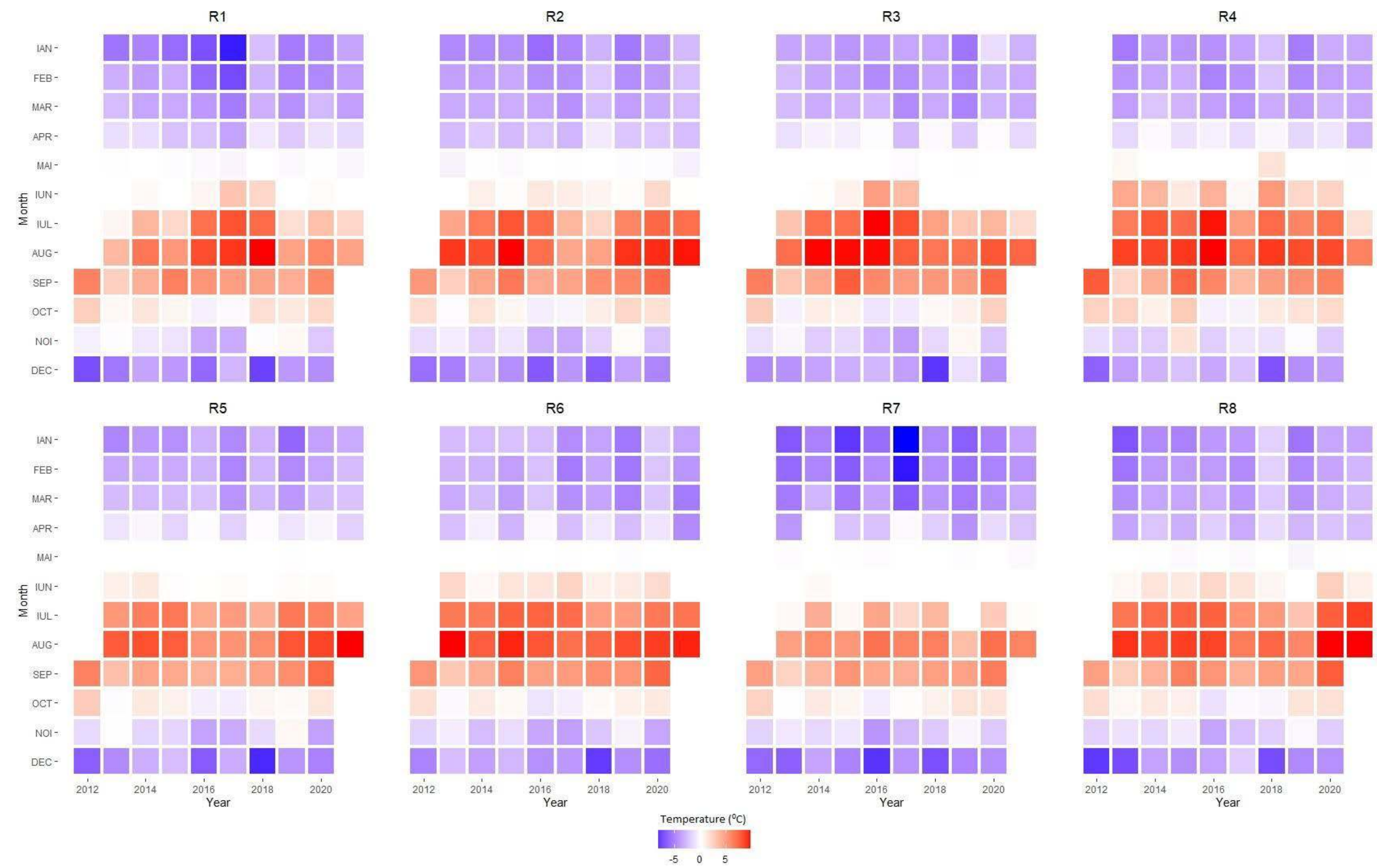


Ground surface temperature over the last decade

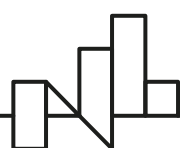
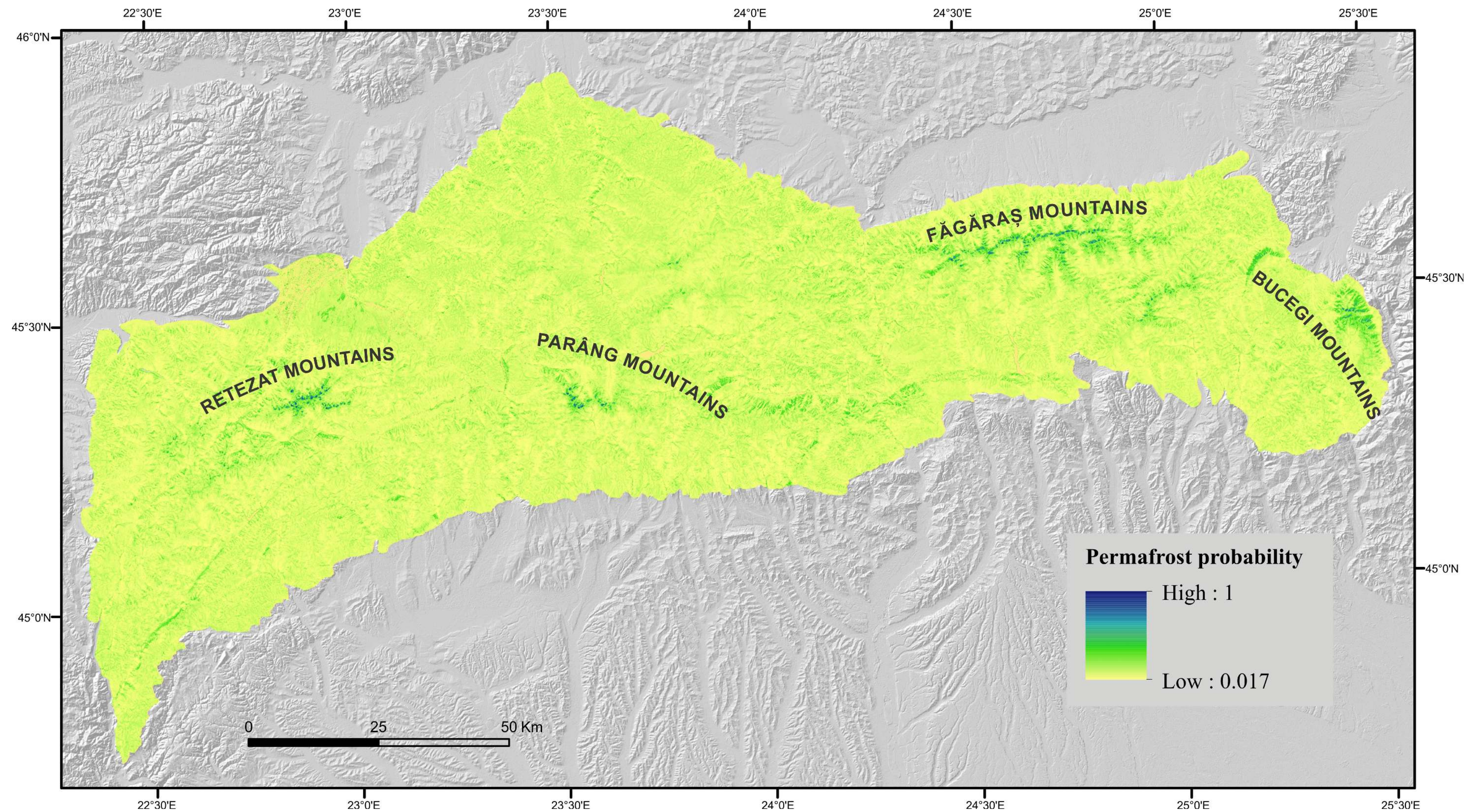
GST (2011-2021) – Valea Rea RG (2100 m)



Ground surface temperature of rock glaciers

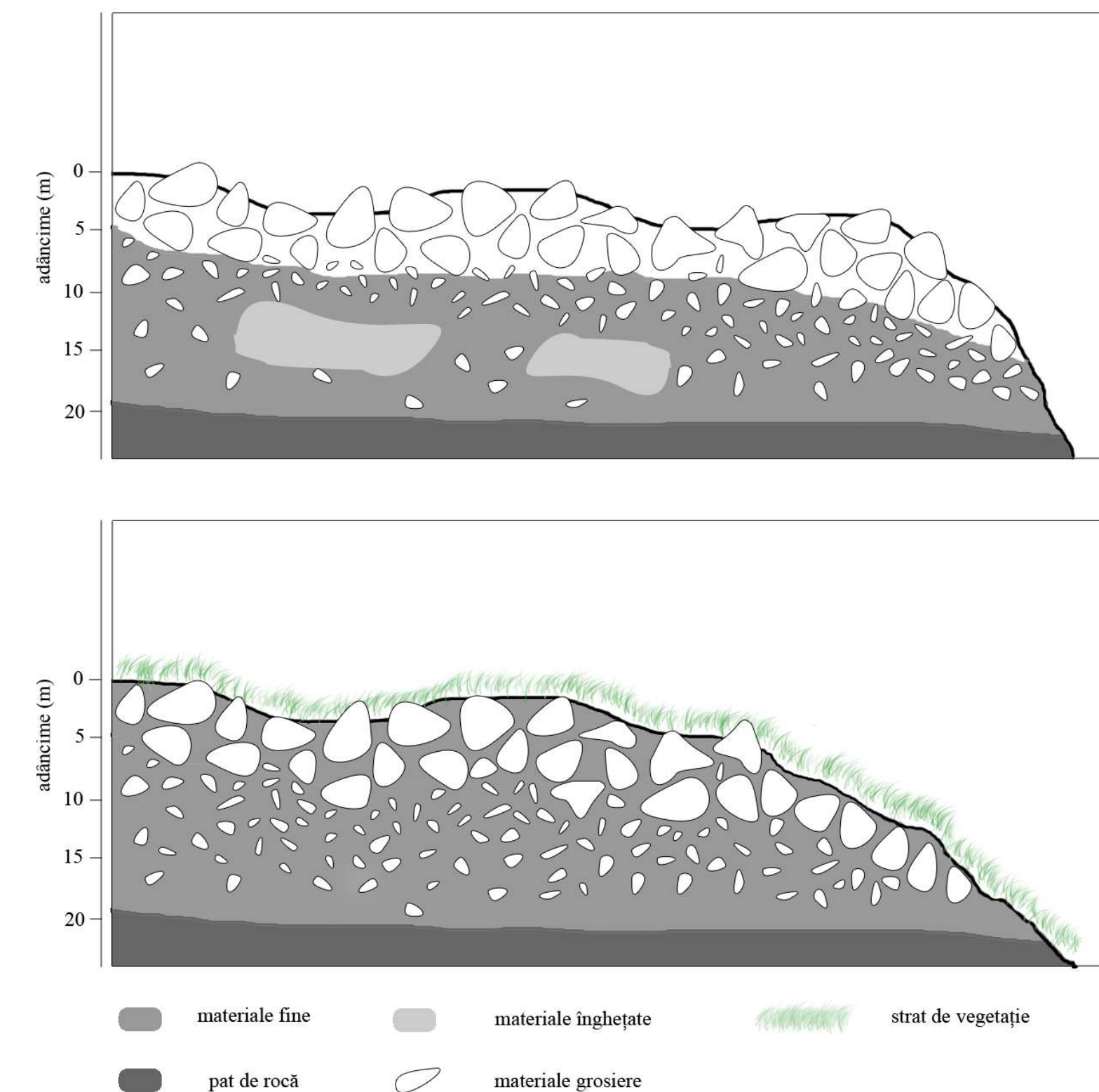


Southern Carpathians permafrost probability map

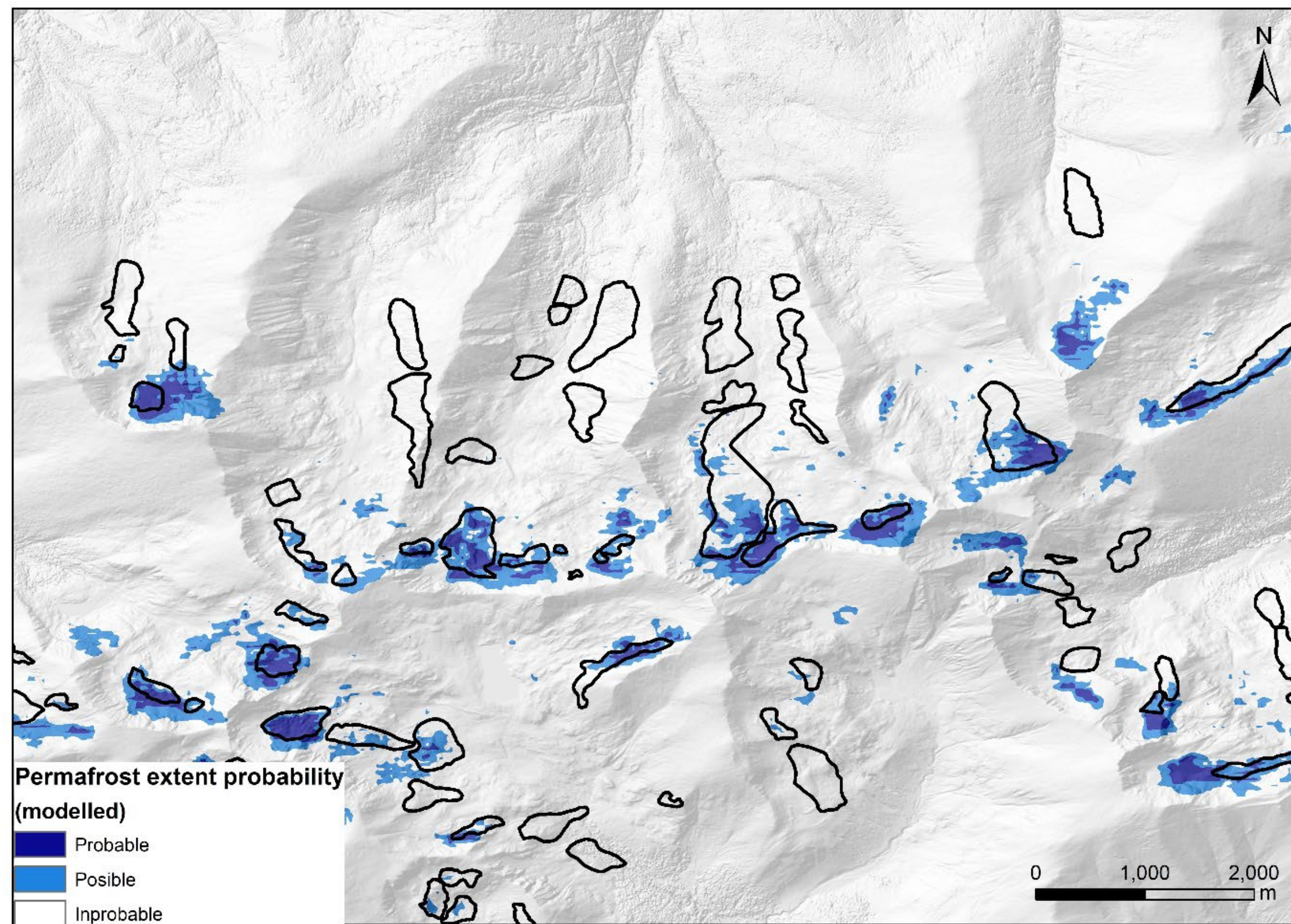


Characteristics of the RGs and marginal permafrost

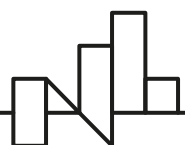
- Small displacement rates (few cm/yr) are determined by **patchy distribution of permafrost and thin permafrost**;
- Permafrost existence is limited to those sites above 2100 m where boulders occur (high porosity), the income of solar radiation is reduced;
- Snow cover disappears only in the second half of July or August, preventing the heating of the active layer;
- Permafrost appears likely where a strong cooling occurs in the early winter (convection, advection);
- **Thick active layer** (around 5 m);



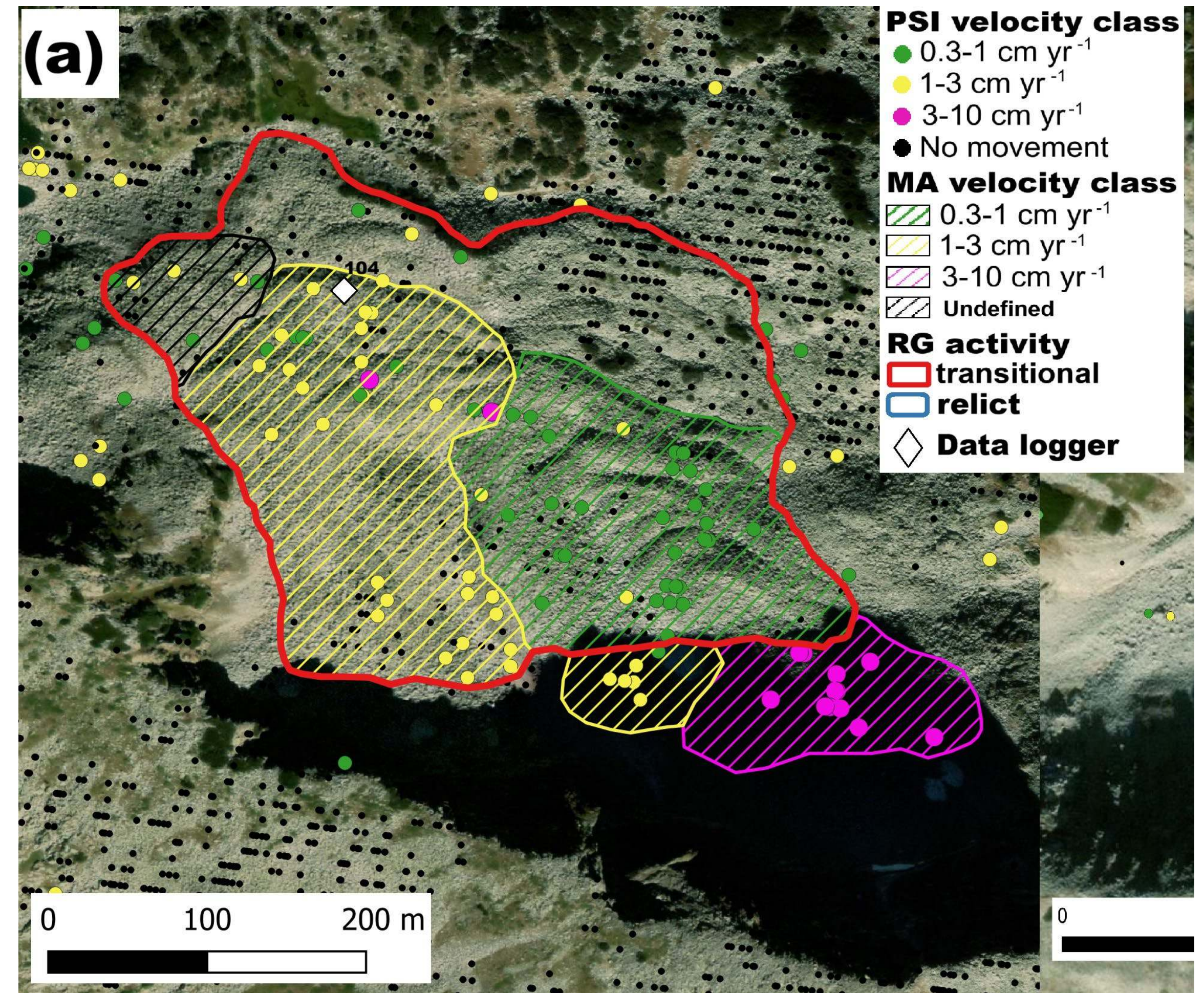
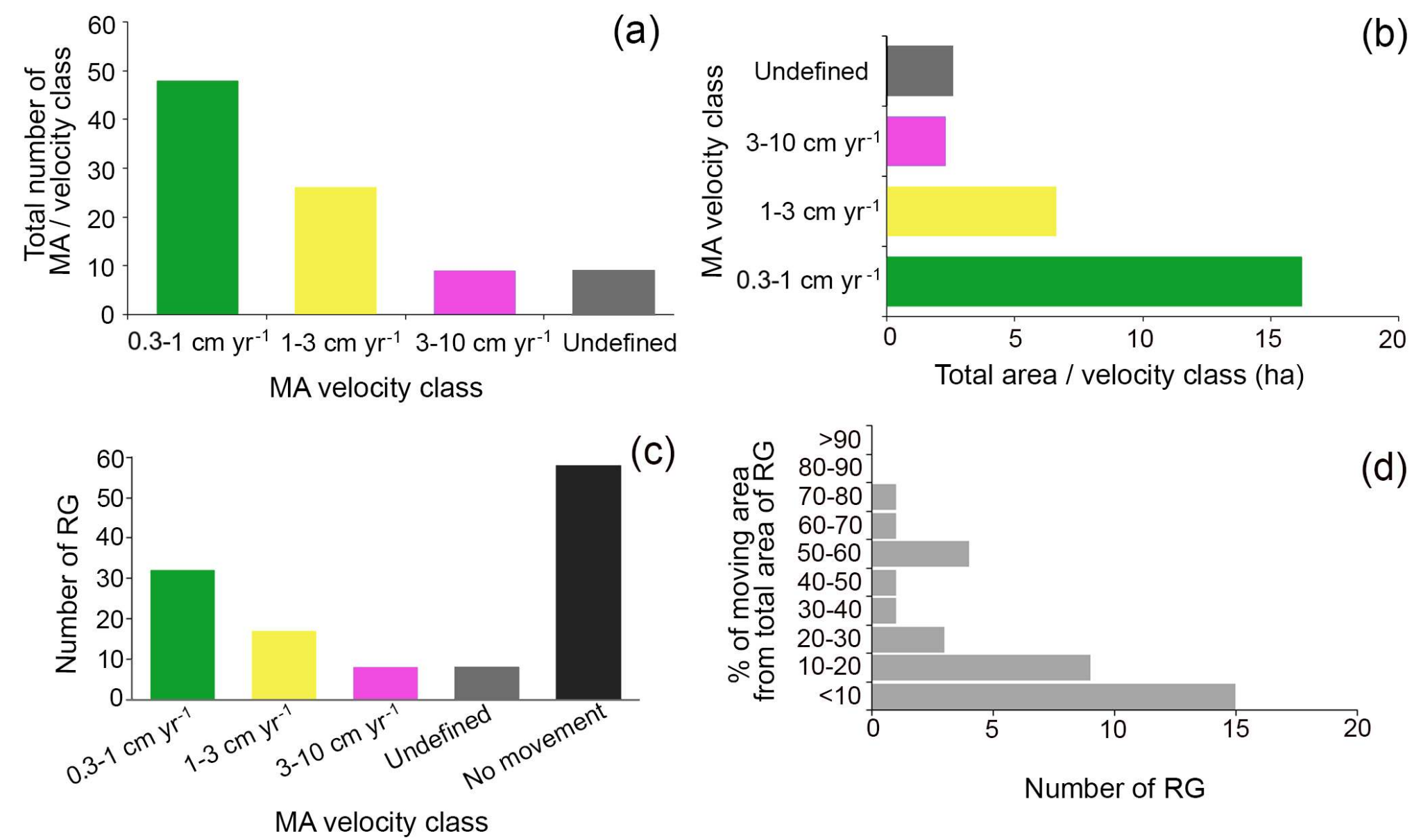
RGs in Retezat Mountains



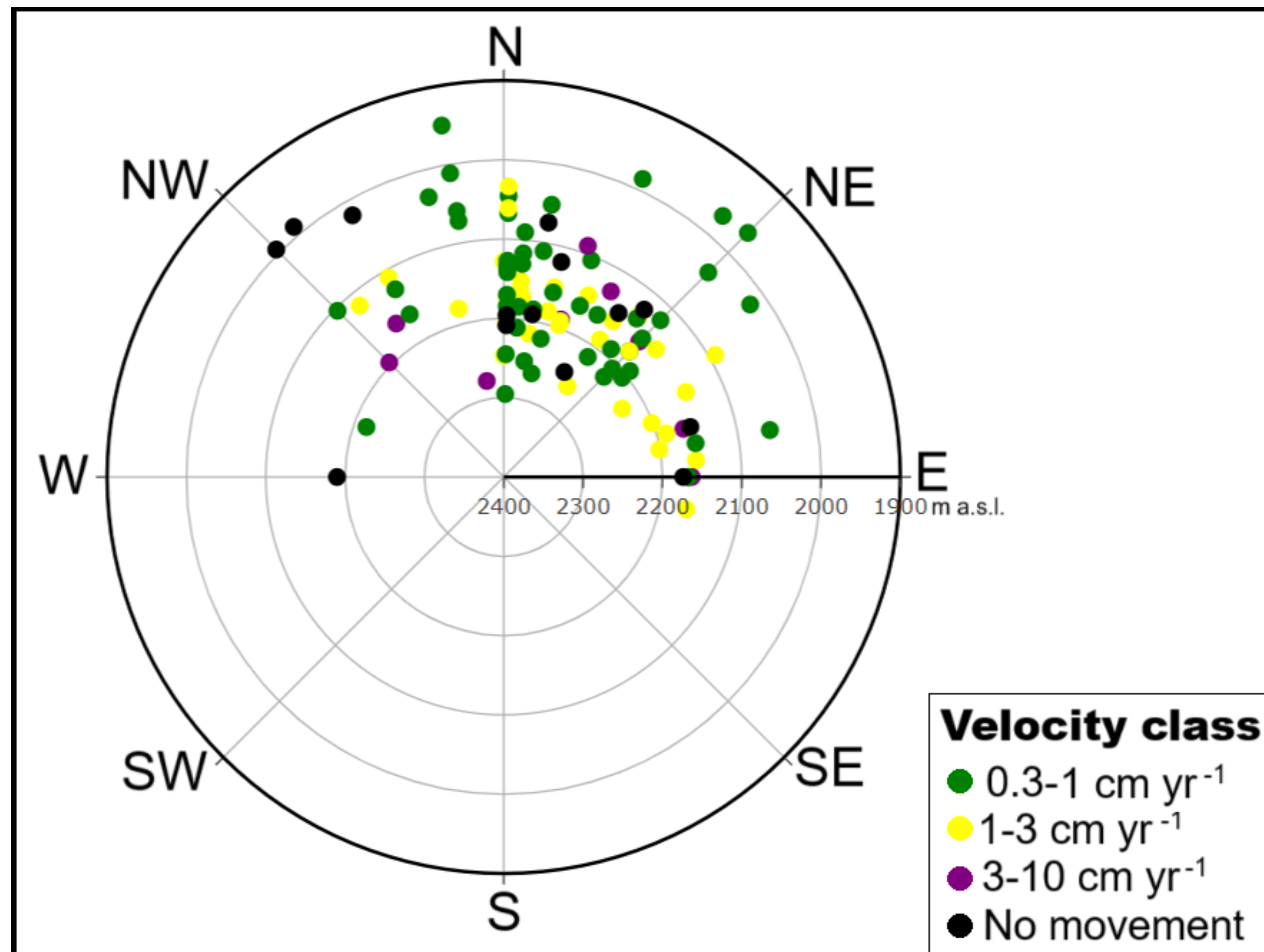
- Temperate climate
- Altitude up to 2519
- 96 mapped rock glaciers
- Isolated patches of permafrost



Moving Areas in Rock Glaciers



Moving areas – slope aspect

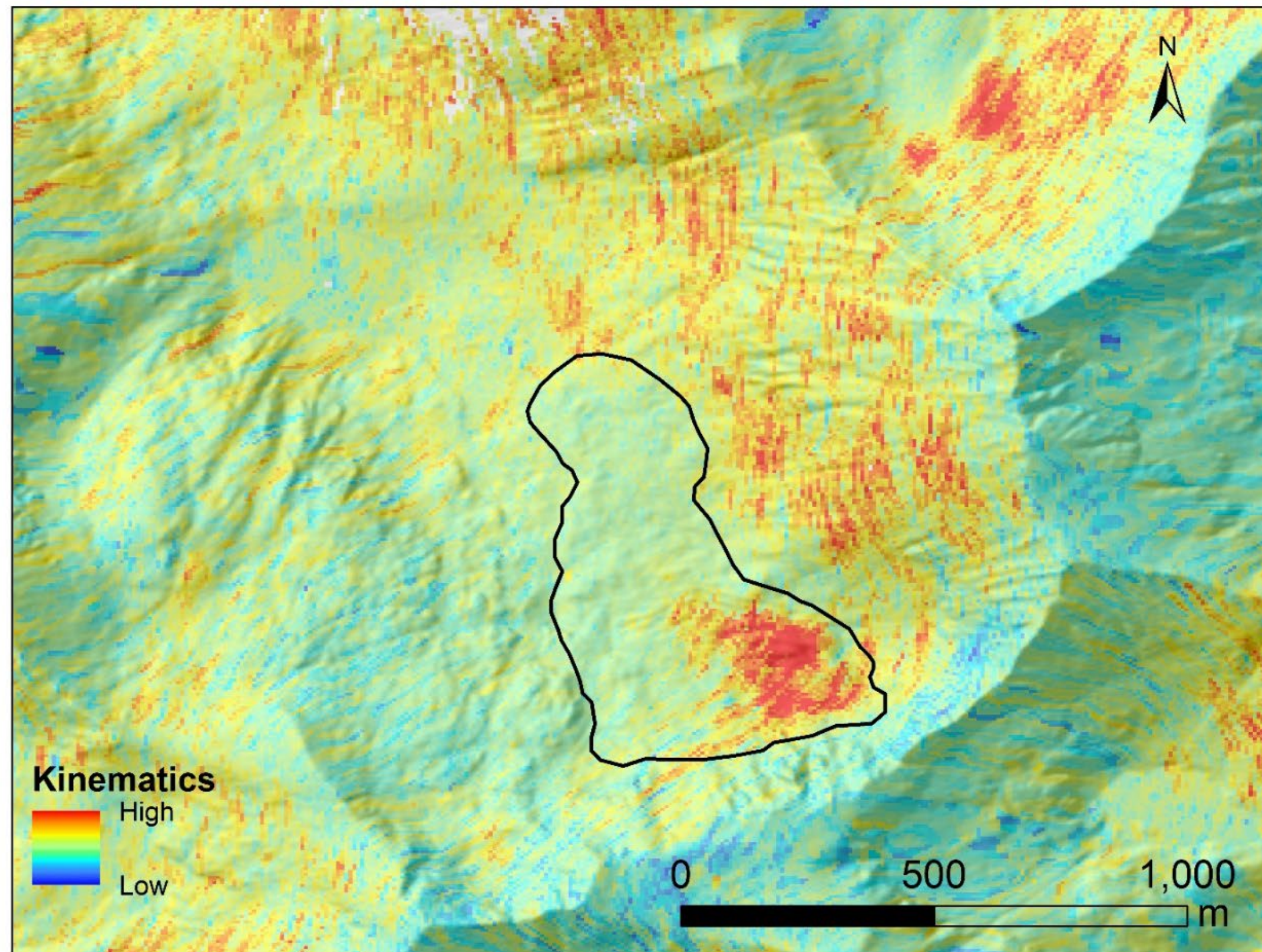


- Most Moving Areas occur on north-facing slopes.
 - Not ideal for radar remote sensing
- Use different methods
 - InSAR
 - PSI
 - Ground measurements (dGPS)

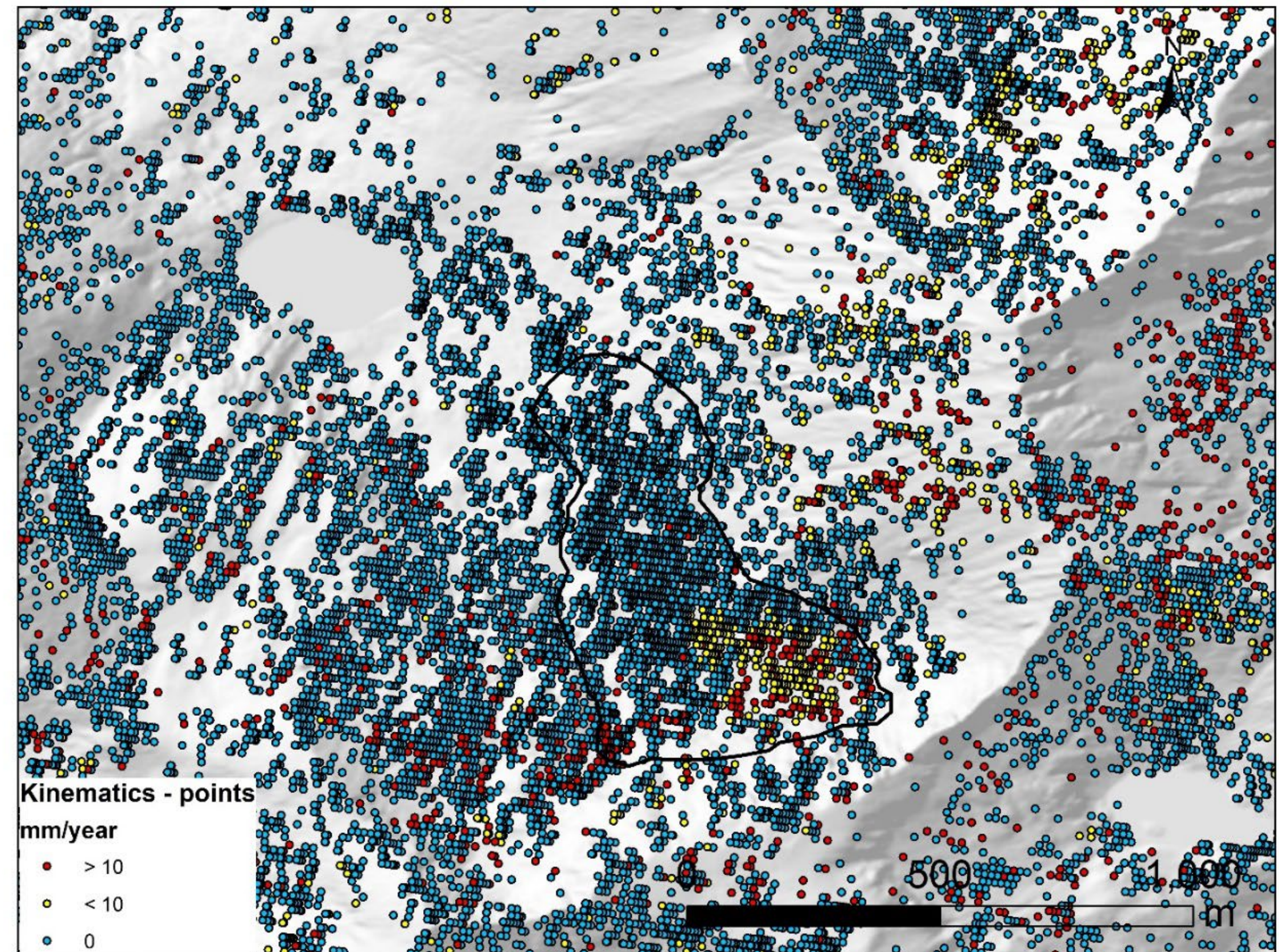


Galesul RG - kinematics

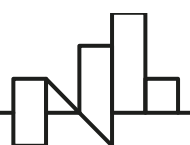
Based on Sentinel 1 between 2016 - 2021



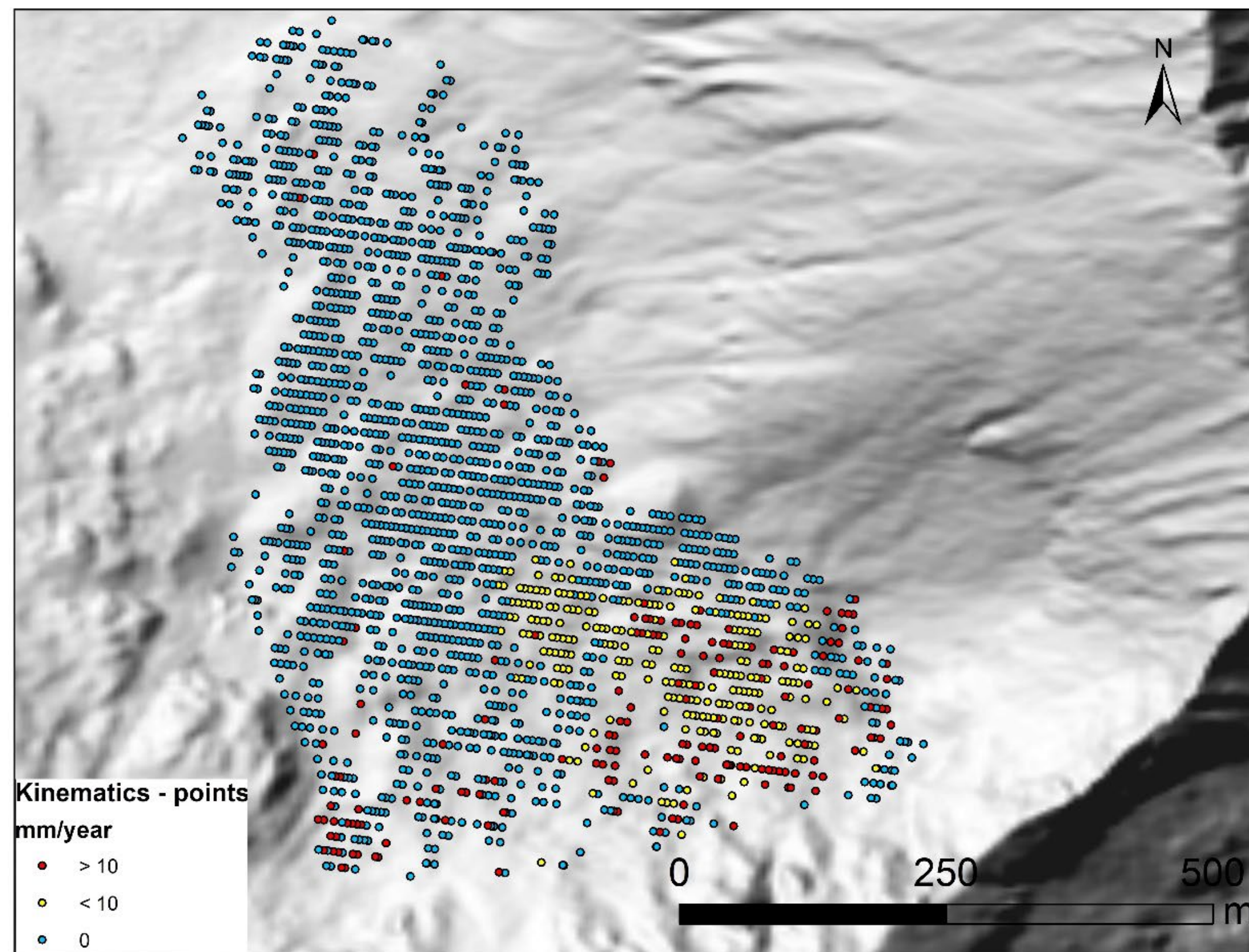
InSAR



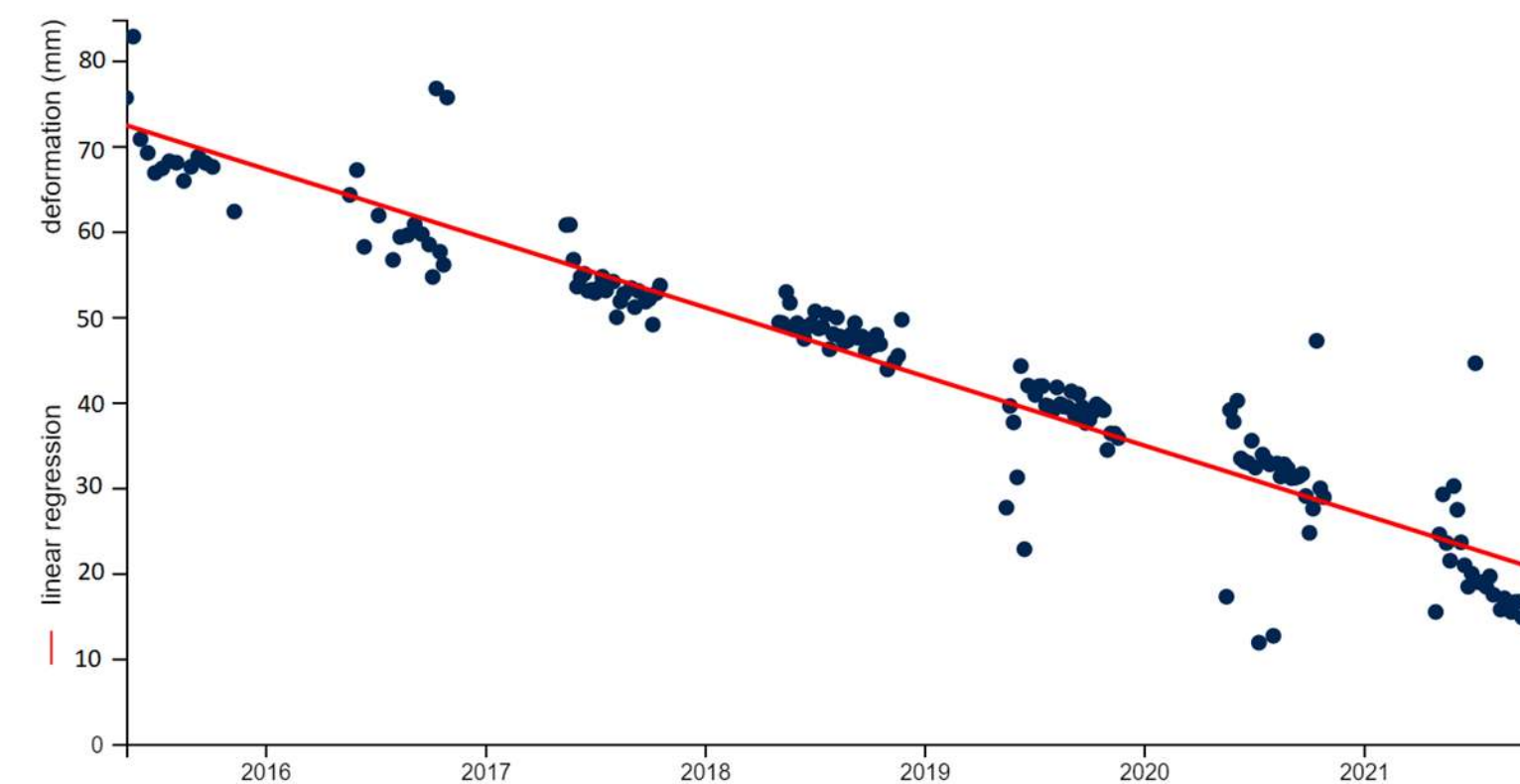
Persistent Scattered Interferometry (PSI)

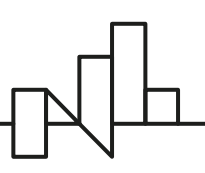
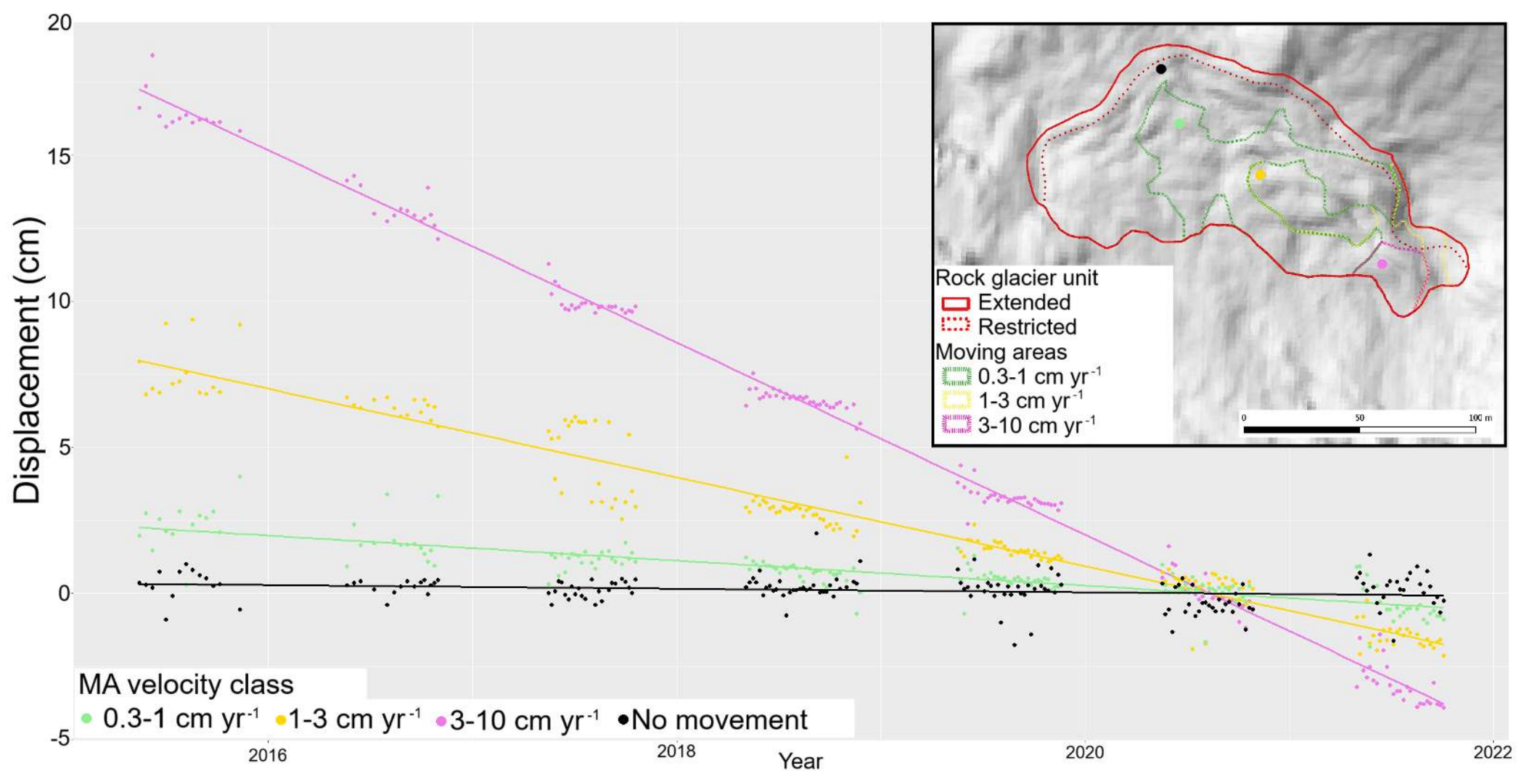
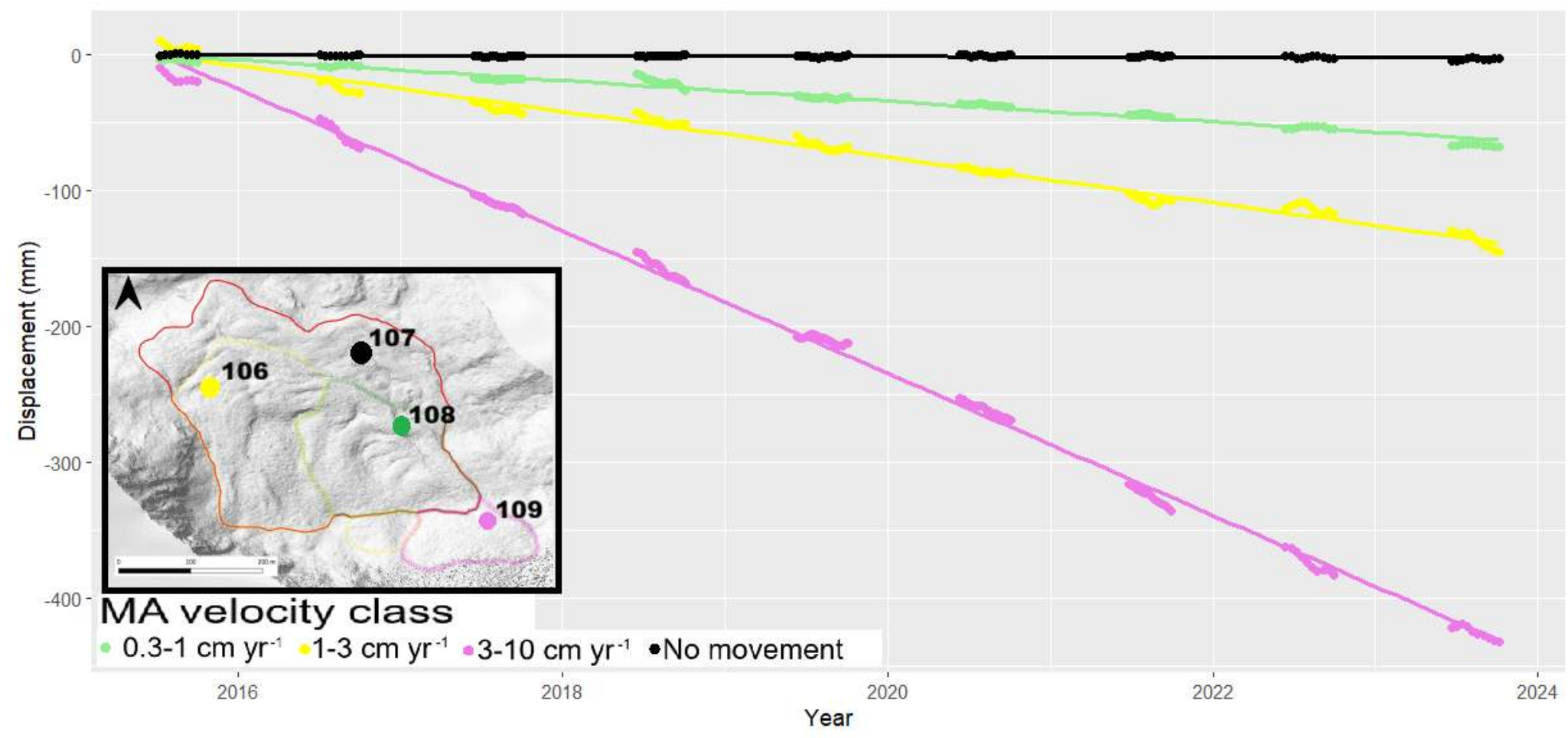


Galesul RG - kinematics



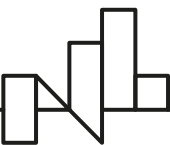
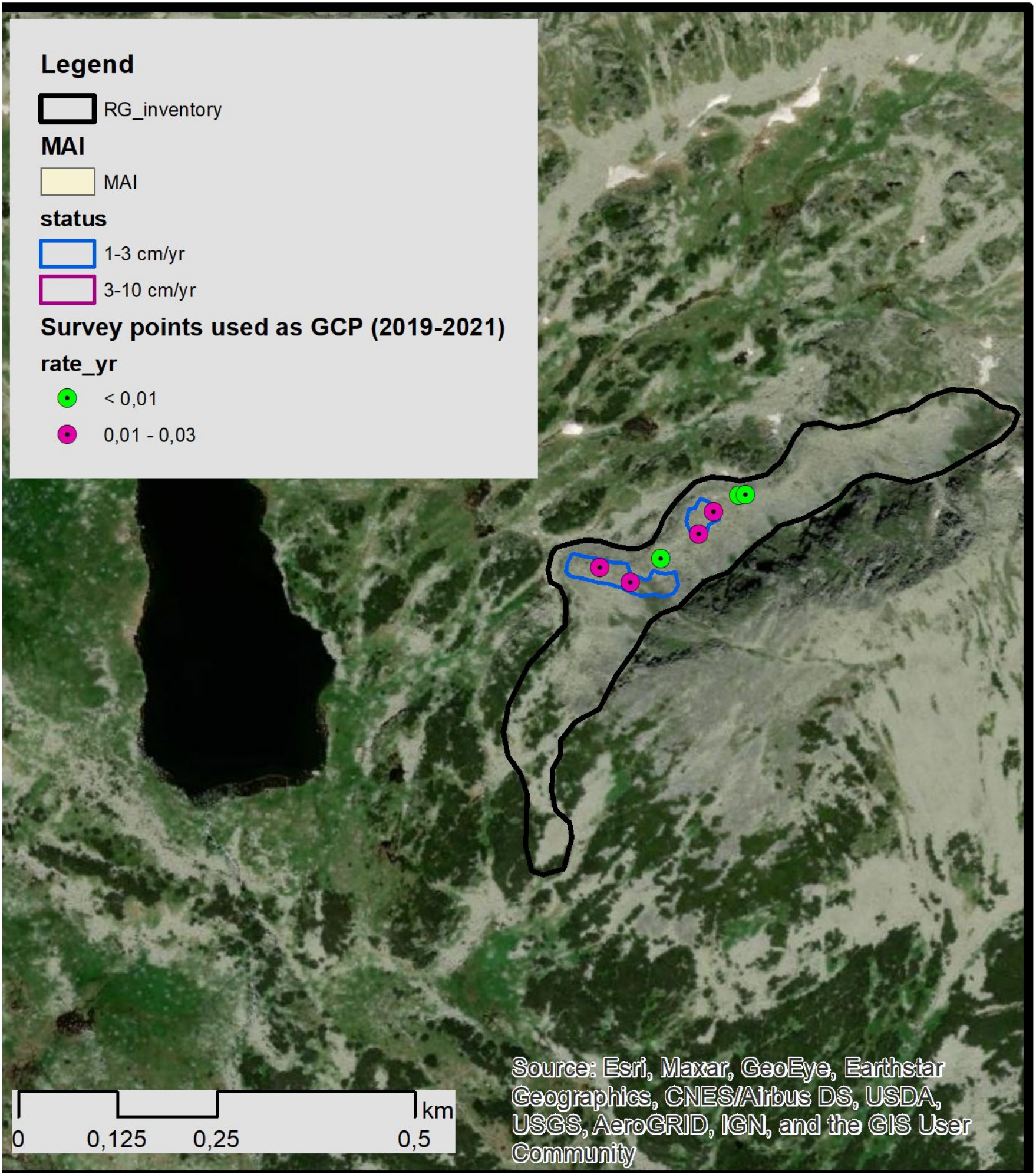
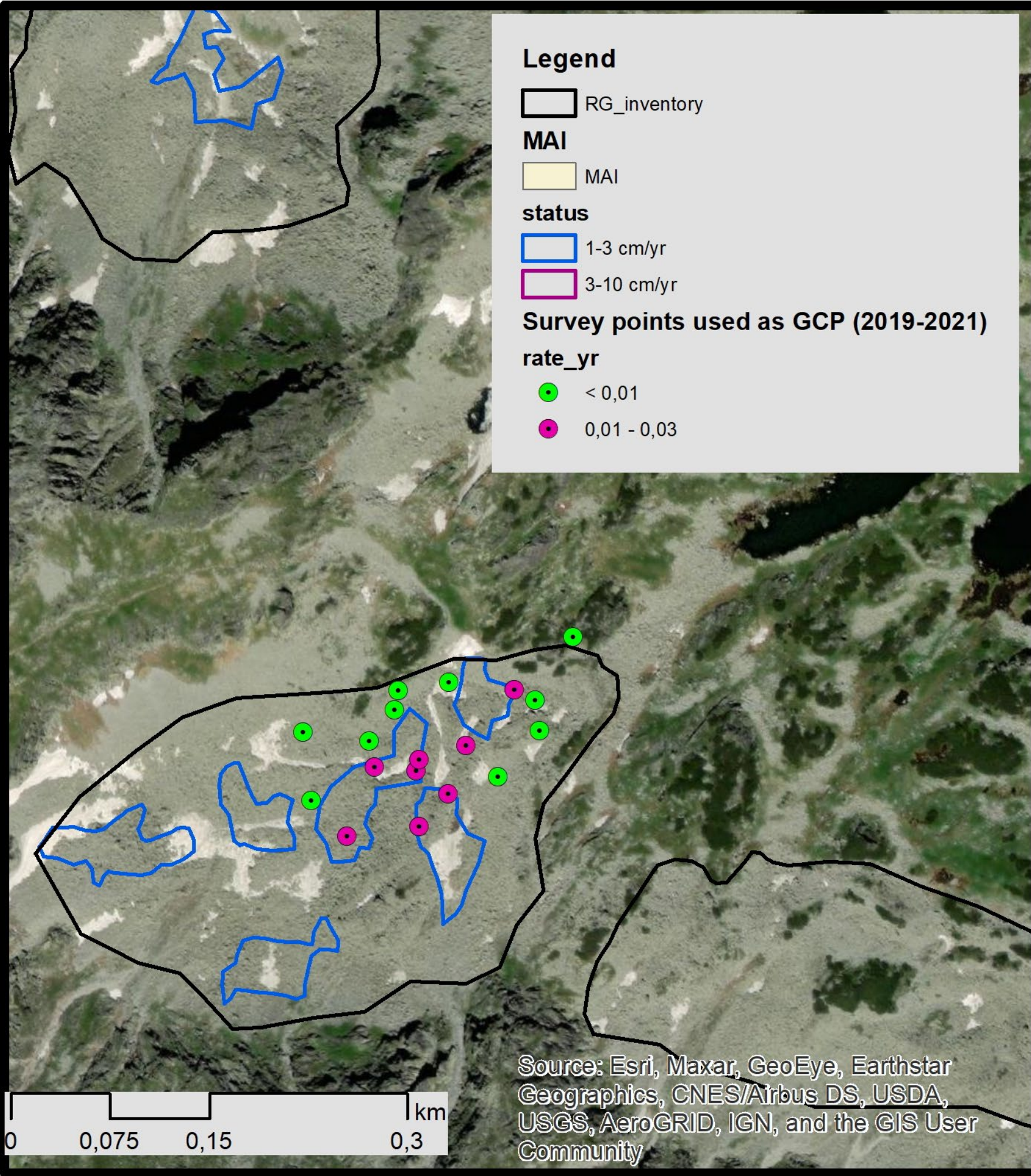
- Galesul RG
- Altitude 2200
- Surface area 21.7ha
- Persistent Scattered Interferometry (PSI)



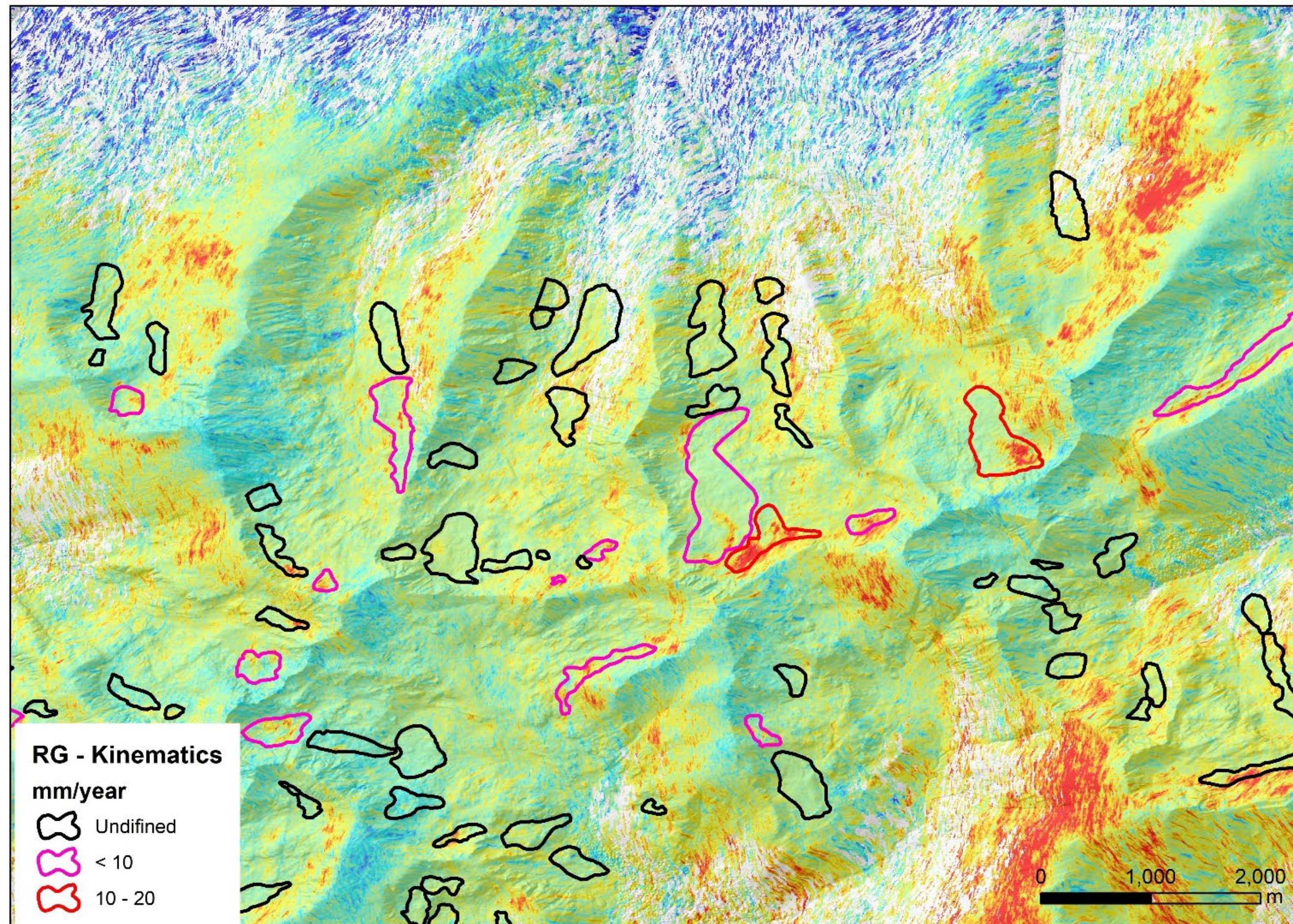


RG kinematics validation

Using terrestrial DGPS measurements

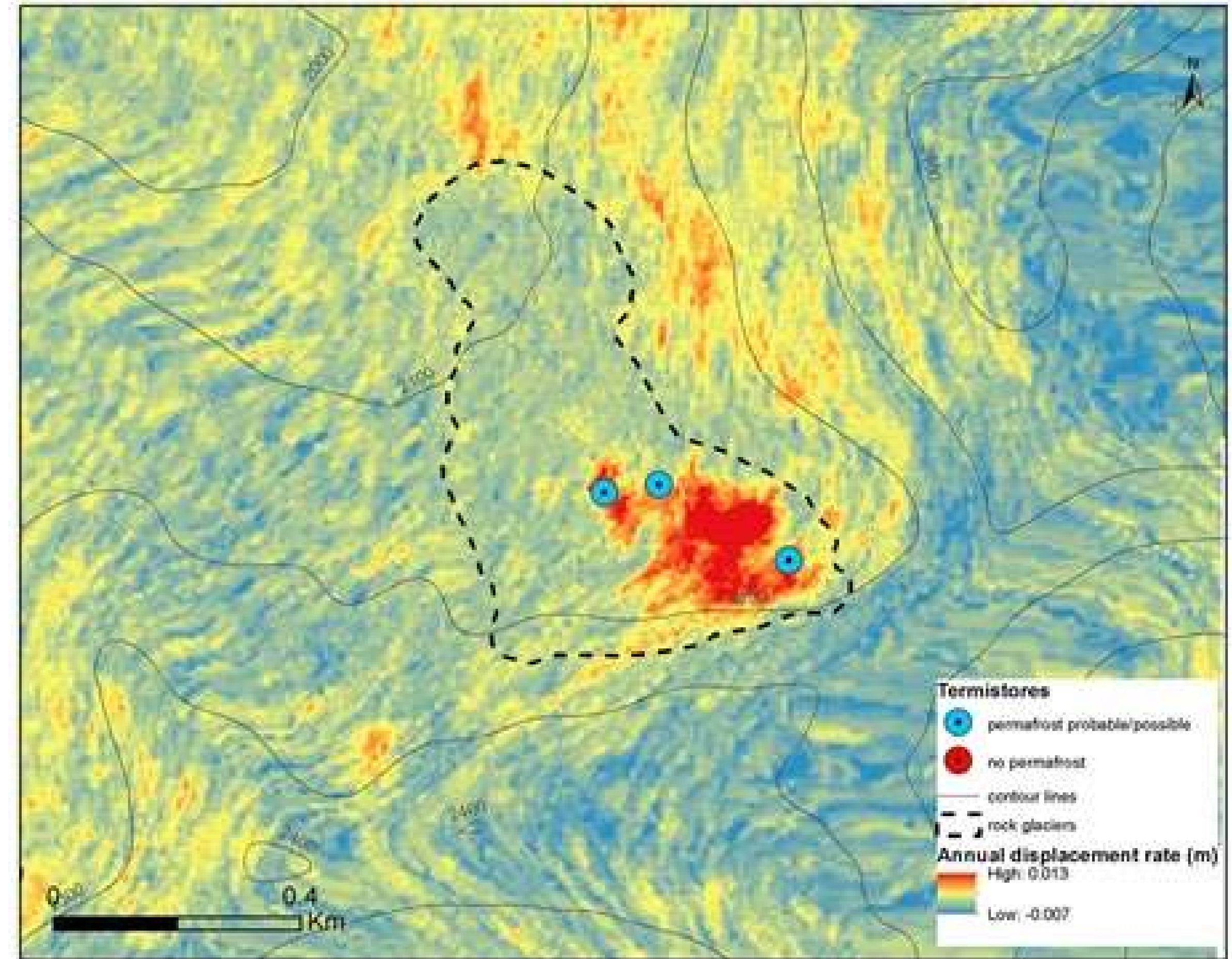
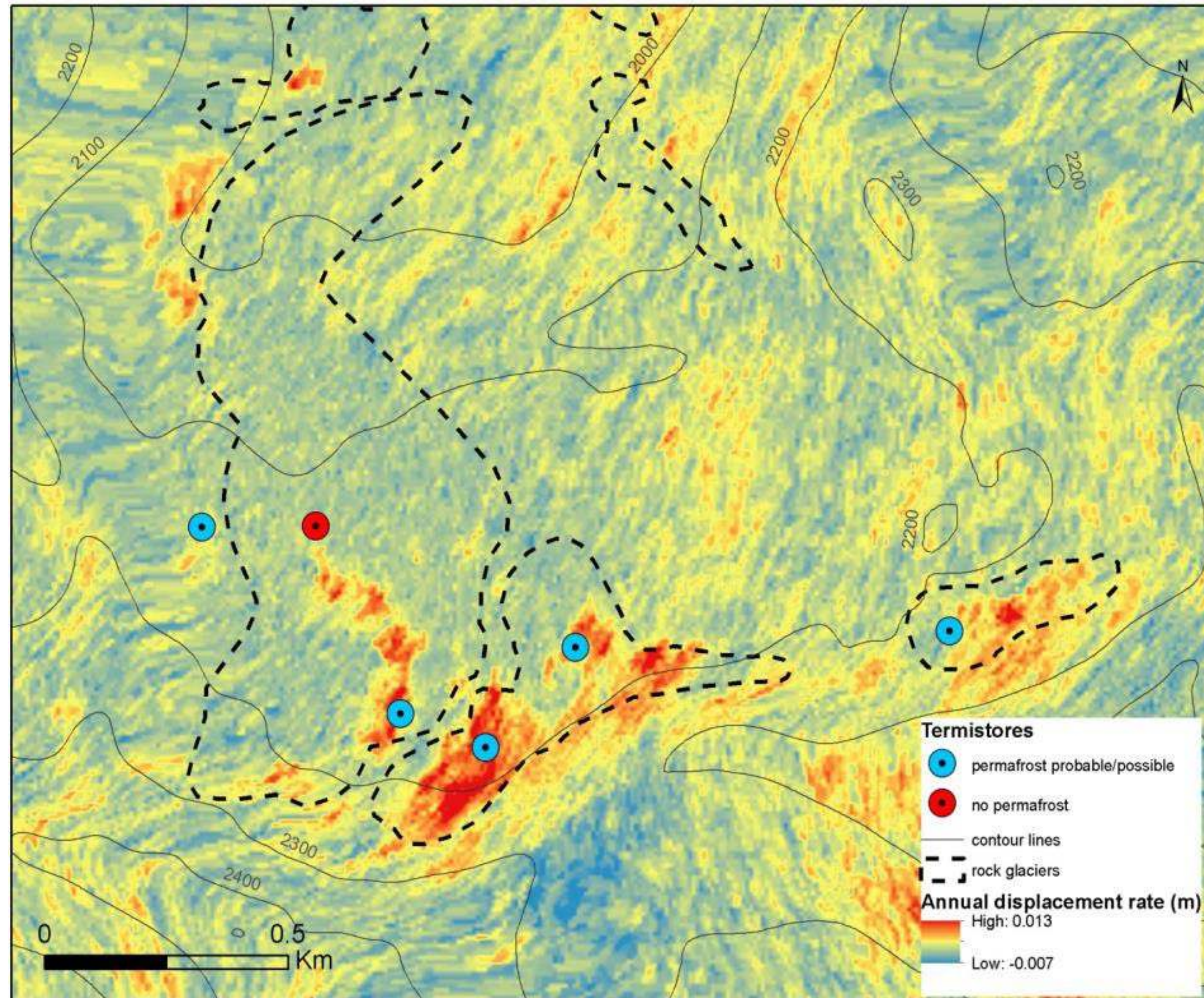


RGs kinematics in Retezat Mountains



- 96 rock glaciers
- 80 no kinematics
- 14 under 3 cm/year
- 2 between 3 – 10 cm/year

RG kinematics – GST measurements (examples)

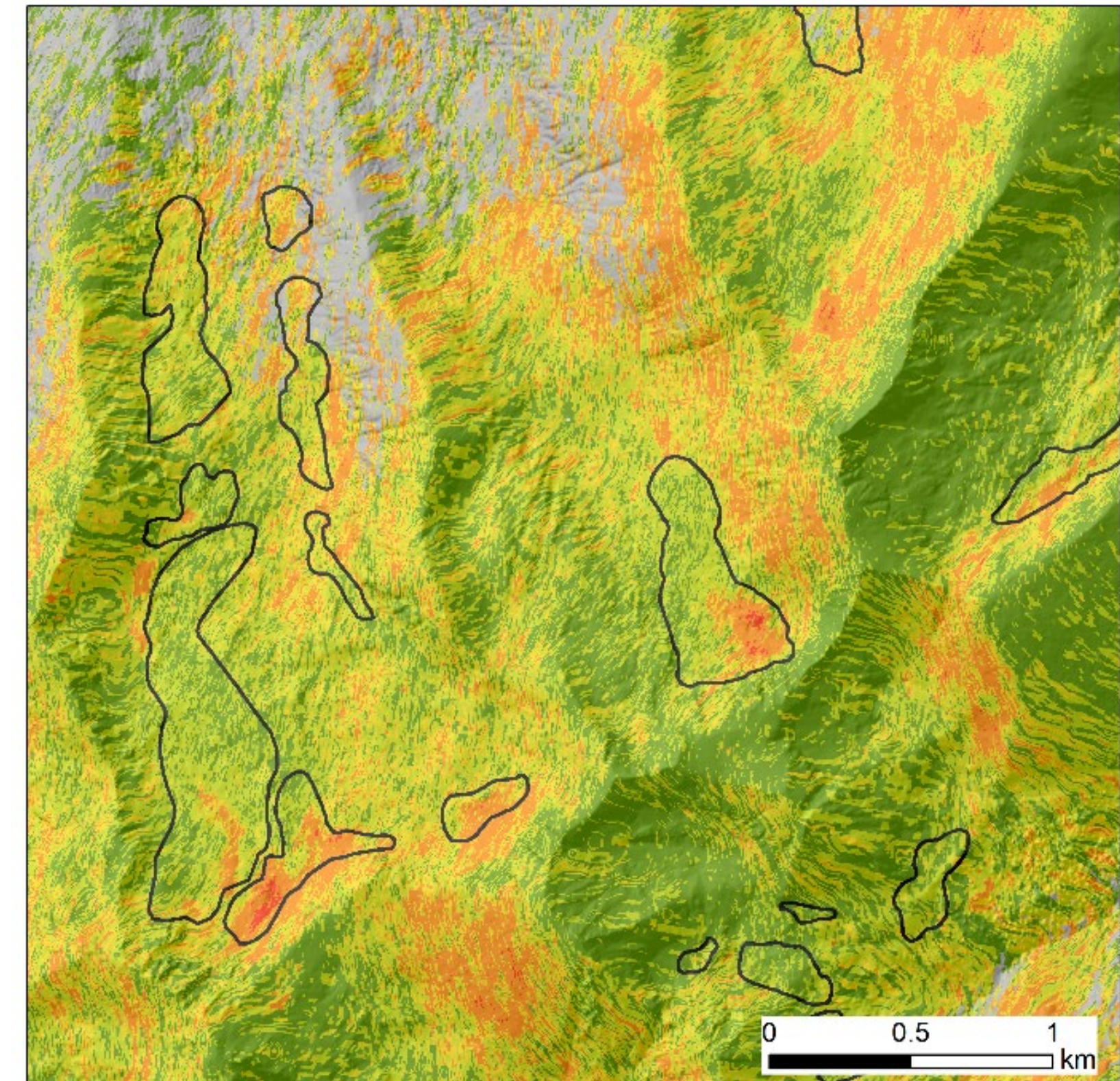
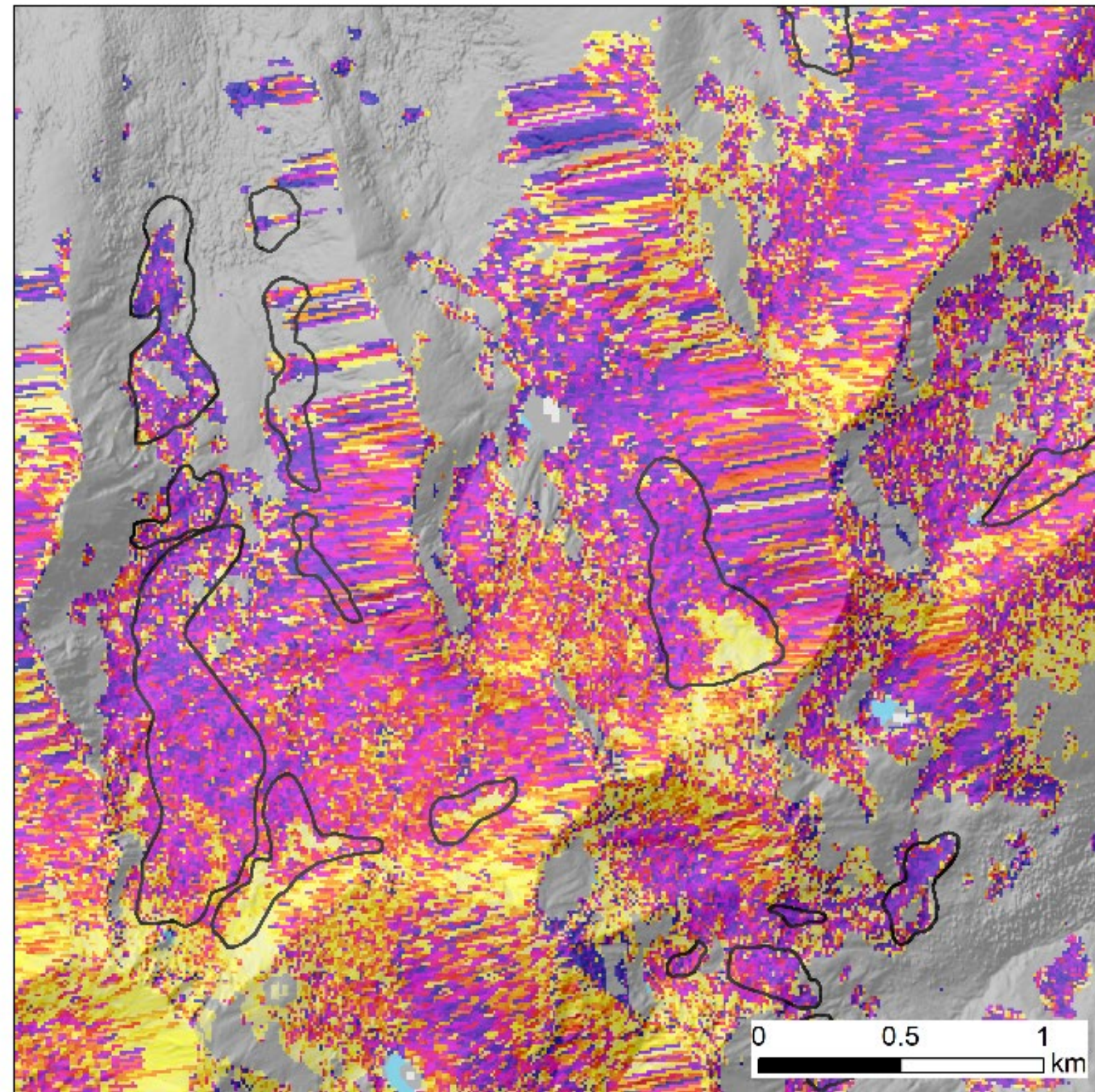
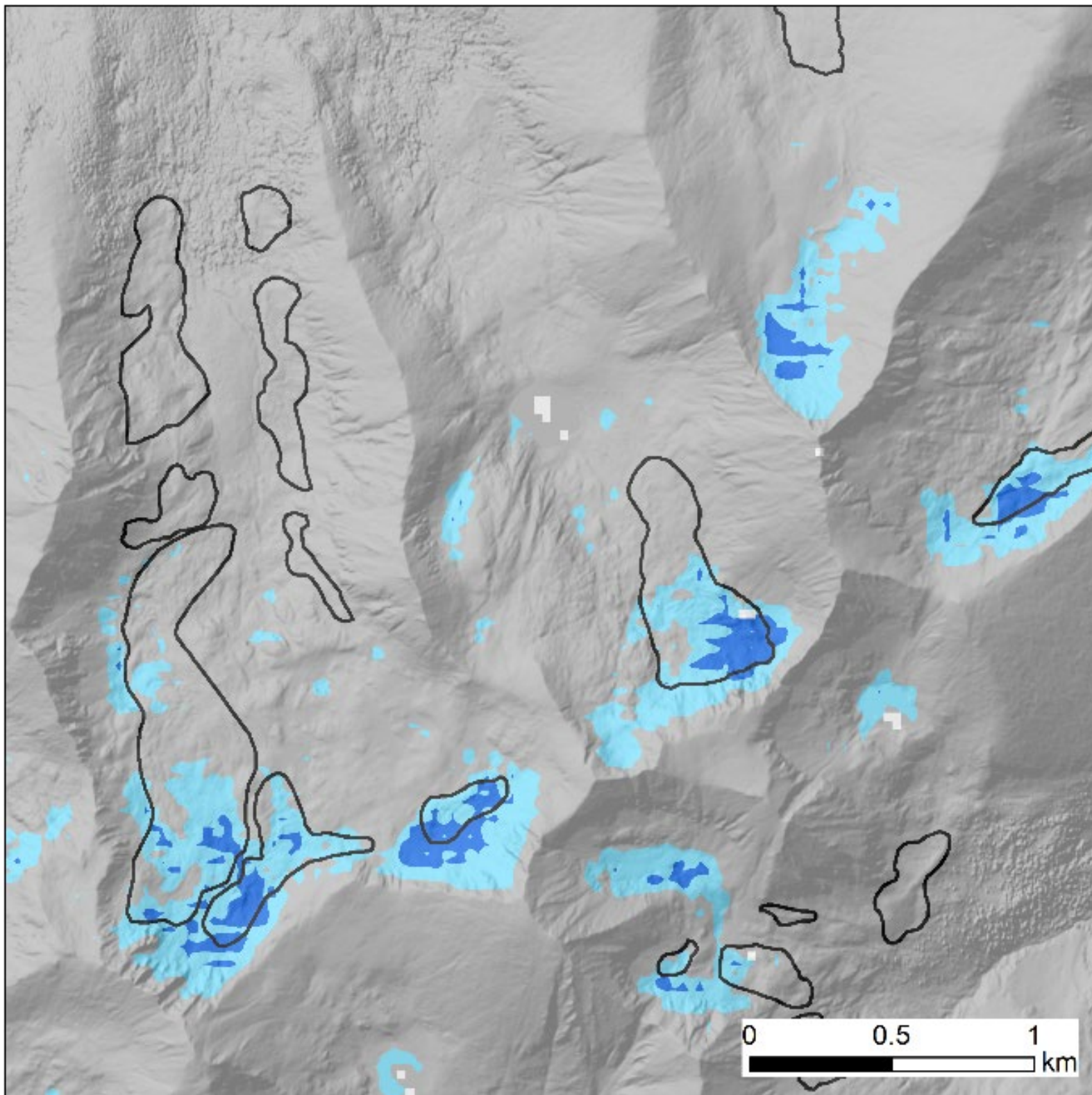


Permafrost probability and RG kinematics

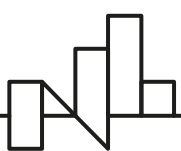
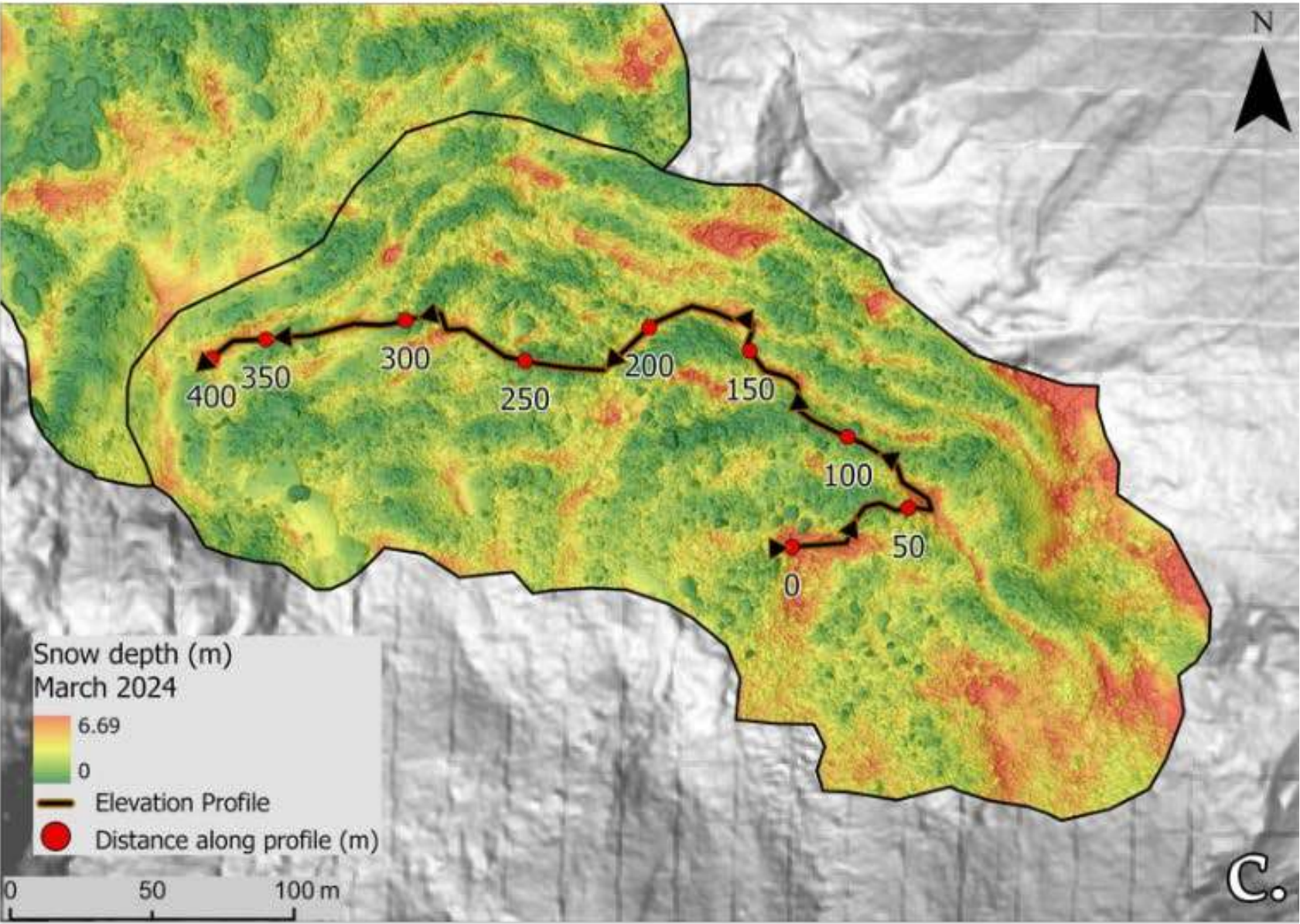
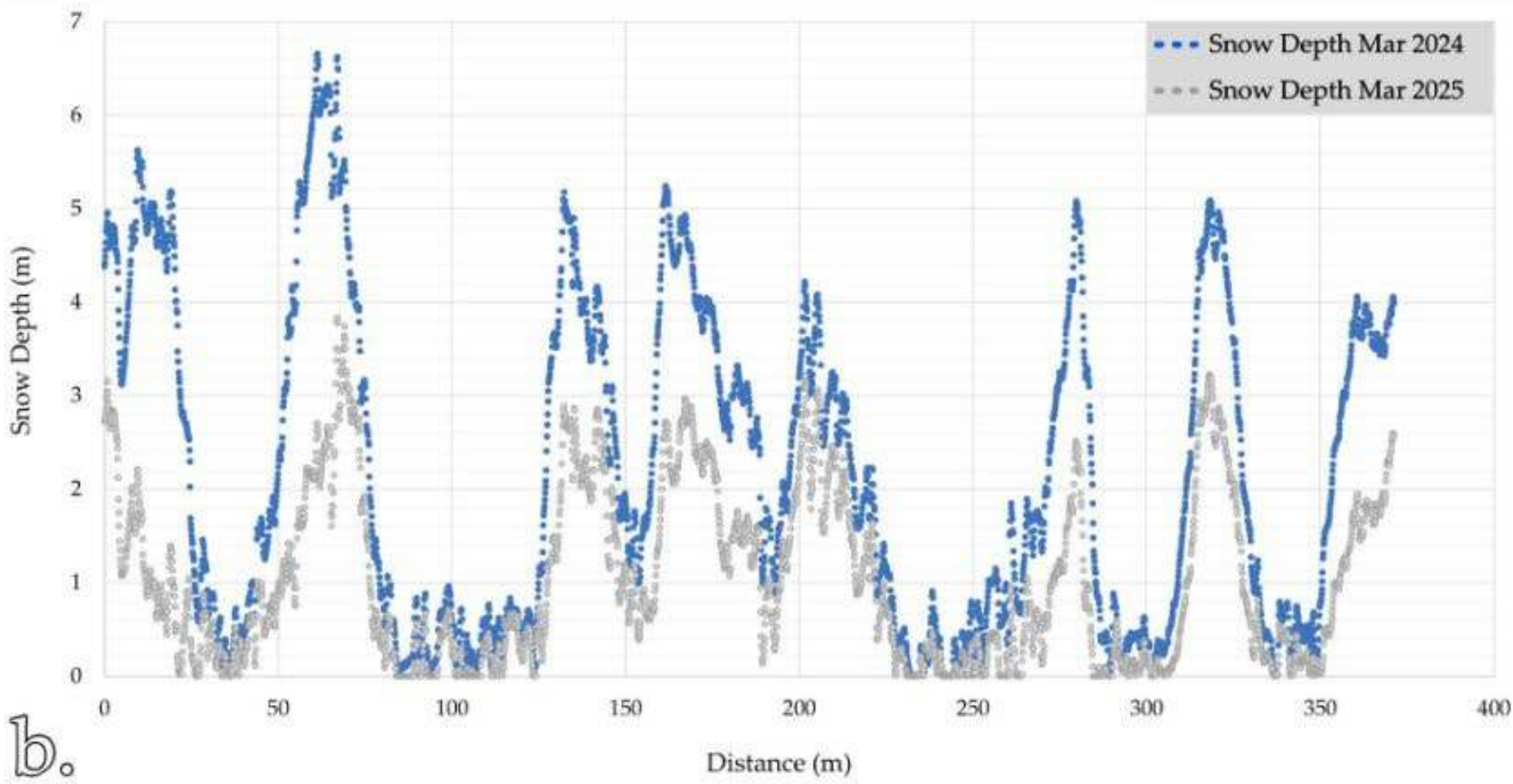
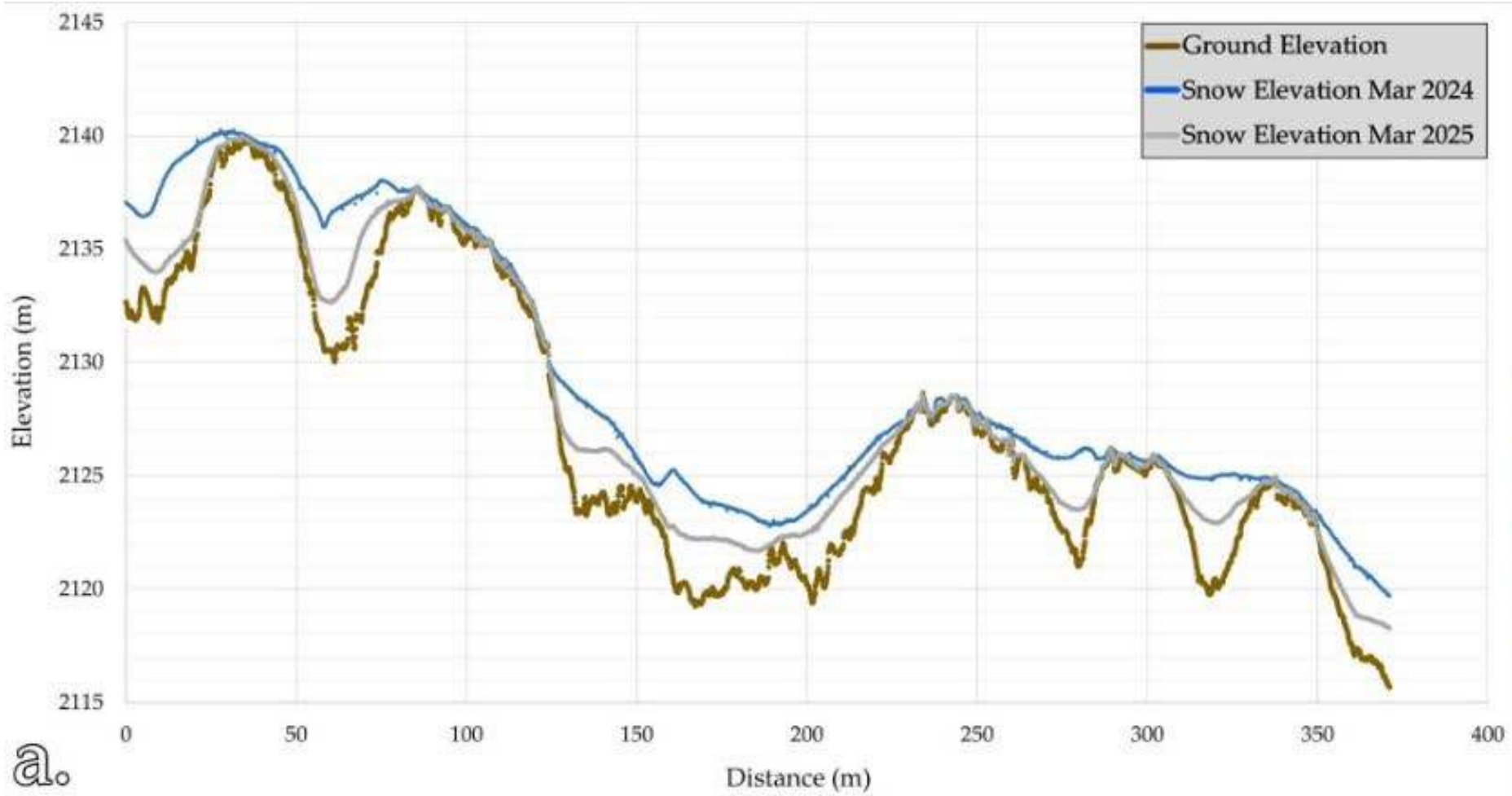
Permafrost model

ALOS-2 PALSAR-2

Sentinel 1

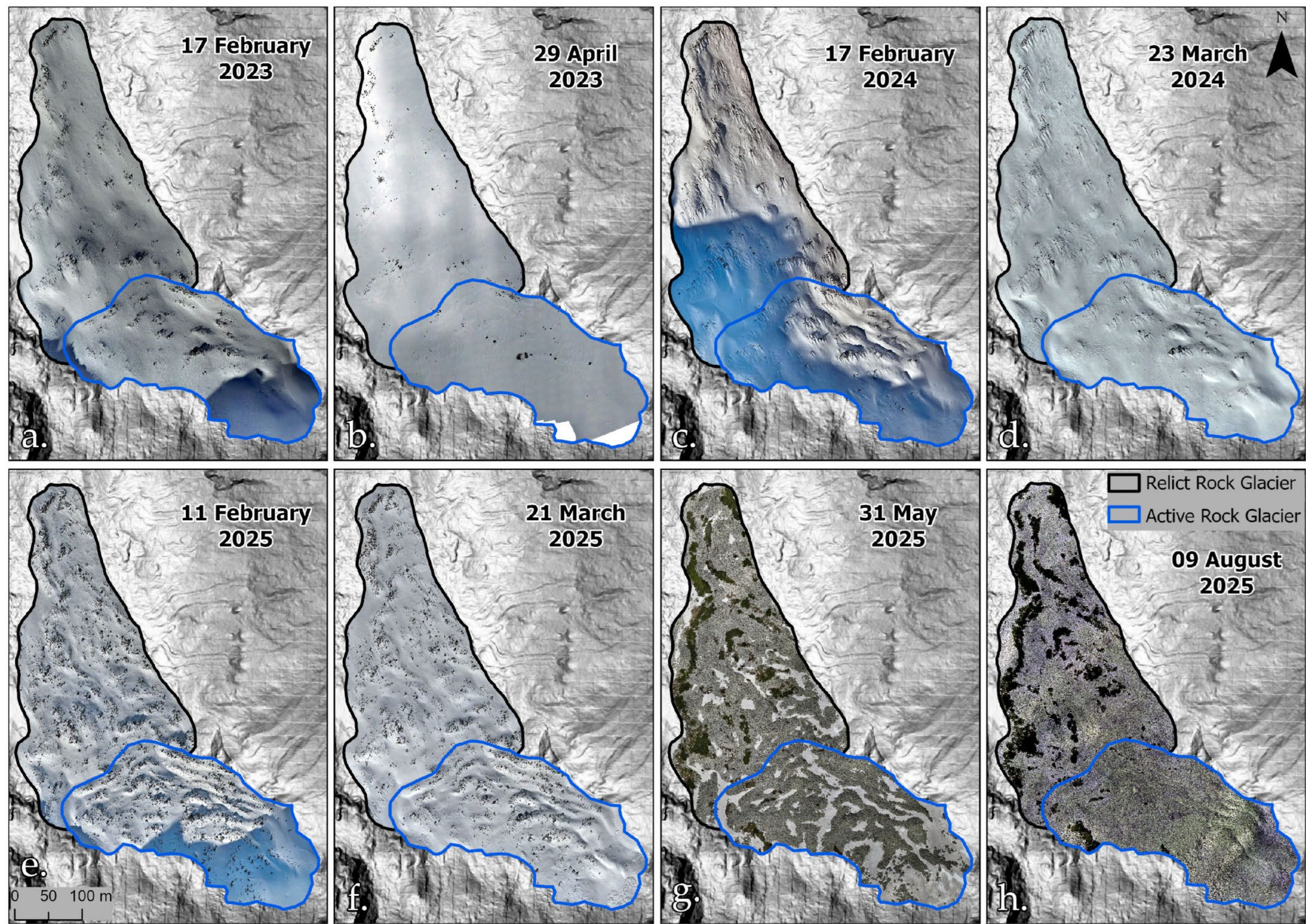


Snow distribution on Rock Glaciers

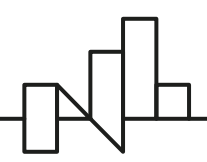


* Ionita, A. et al, 2026. UAV-Derived Snow Depth Patterns on the Galeșu Rock Glacier, Retezat Mountains: Multi-Winter Evidence of Microtopographic Control, Water 18(14), 1760; <https://doi.org/10.3390/w18141760>

Snow distribution on Galesu Rock Glacier

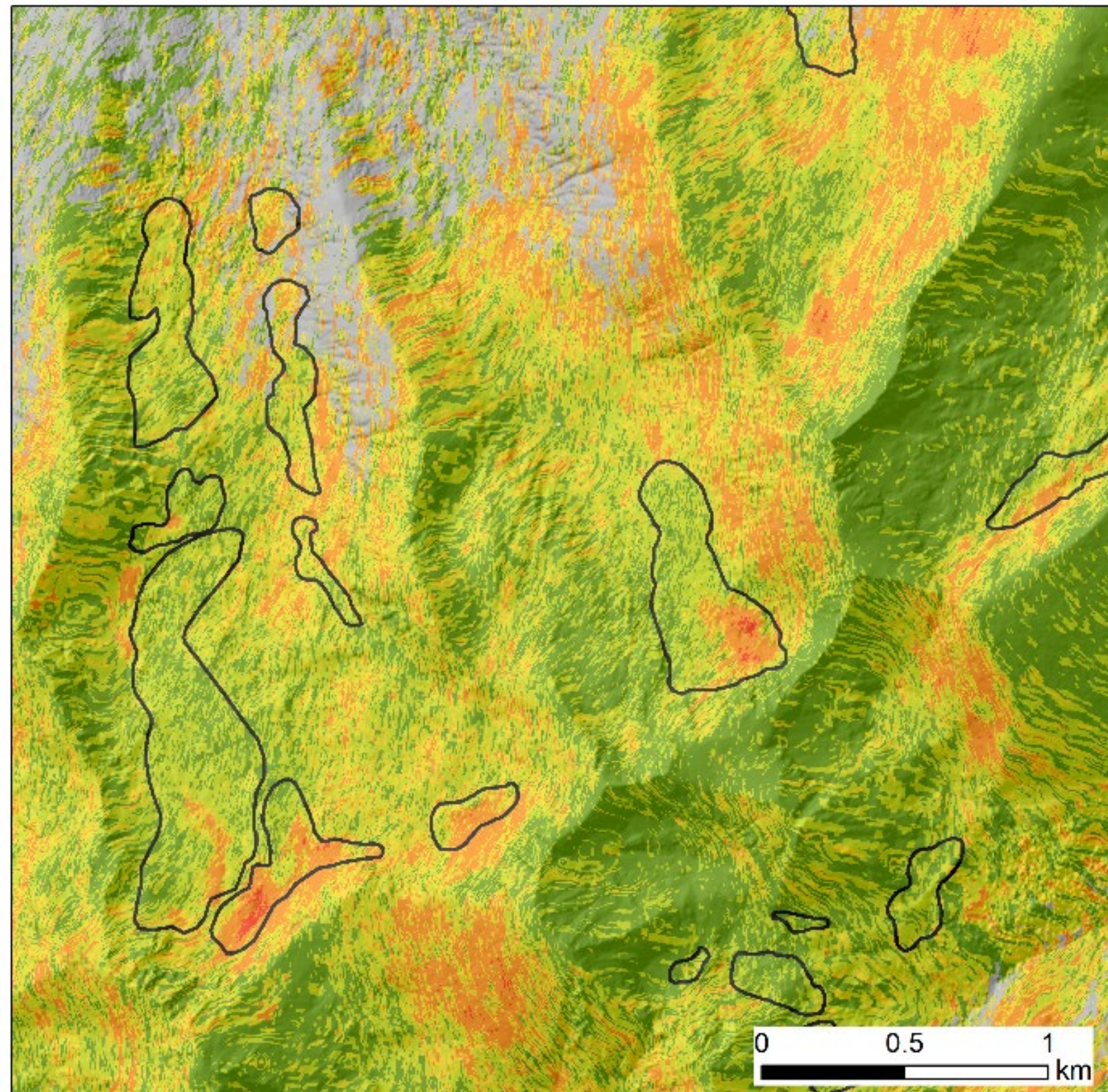


GST profile

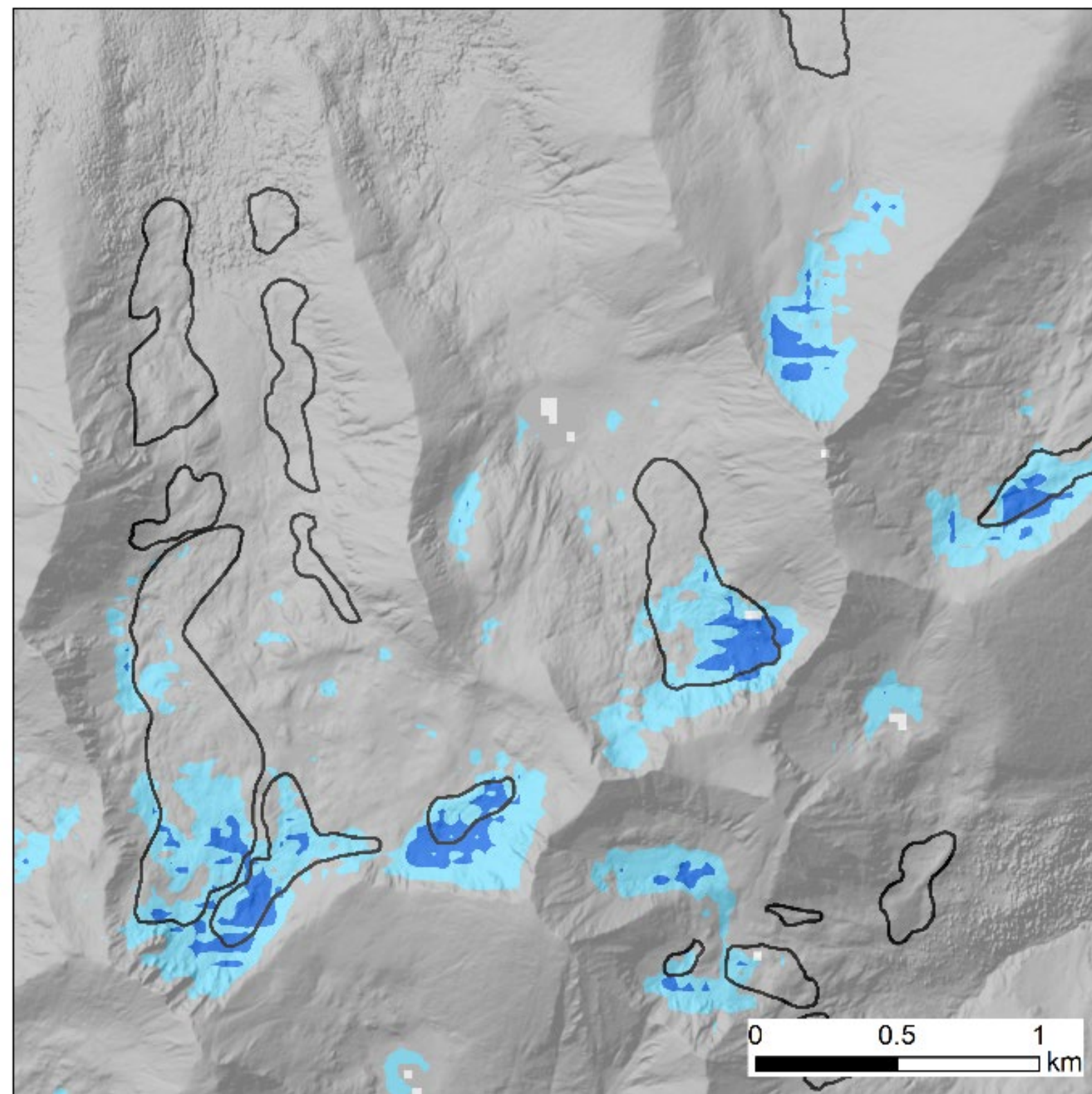


Discussion and Conclusion

RG kinematics



Permafrost (modelled)



- There is a good agreement between the areas with high kinematics and the areas with permafrost
- PSI works good for slow moving RG (mm/year - cm/year)
- Multiple data



Thank you