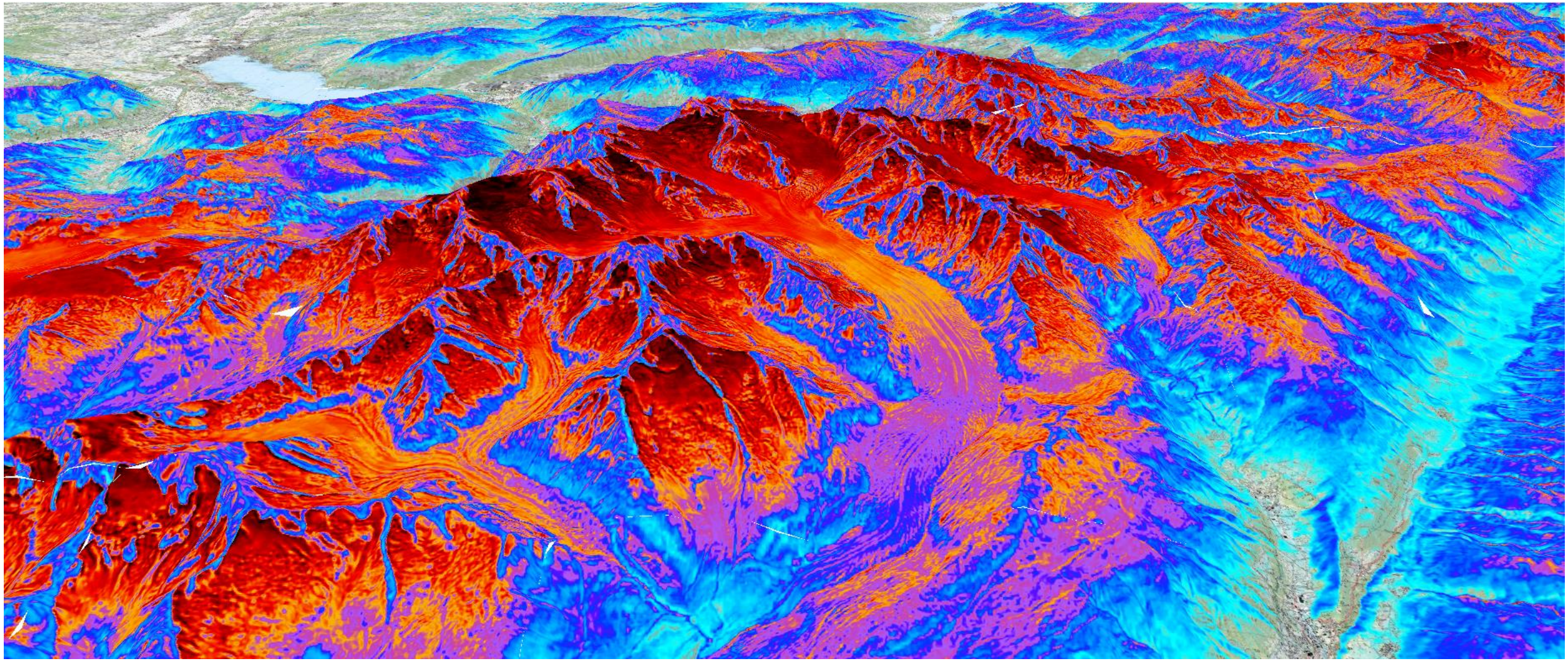
ExoLabs

Next-Generation Snow Products

hendrik.wulf@exolabs.ch

Mapped or Modelled?



Snow depth

ExoLabs' snow department

Satellite data stream

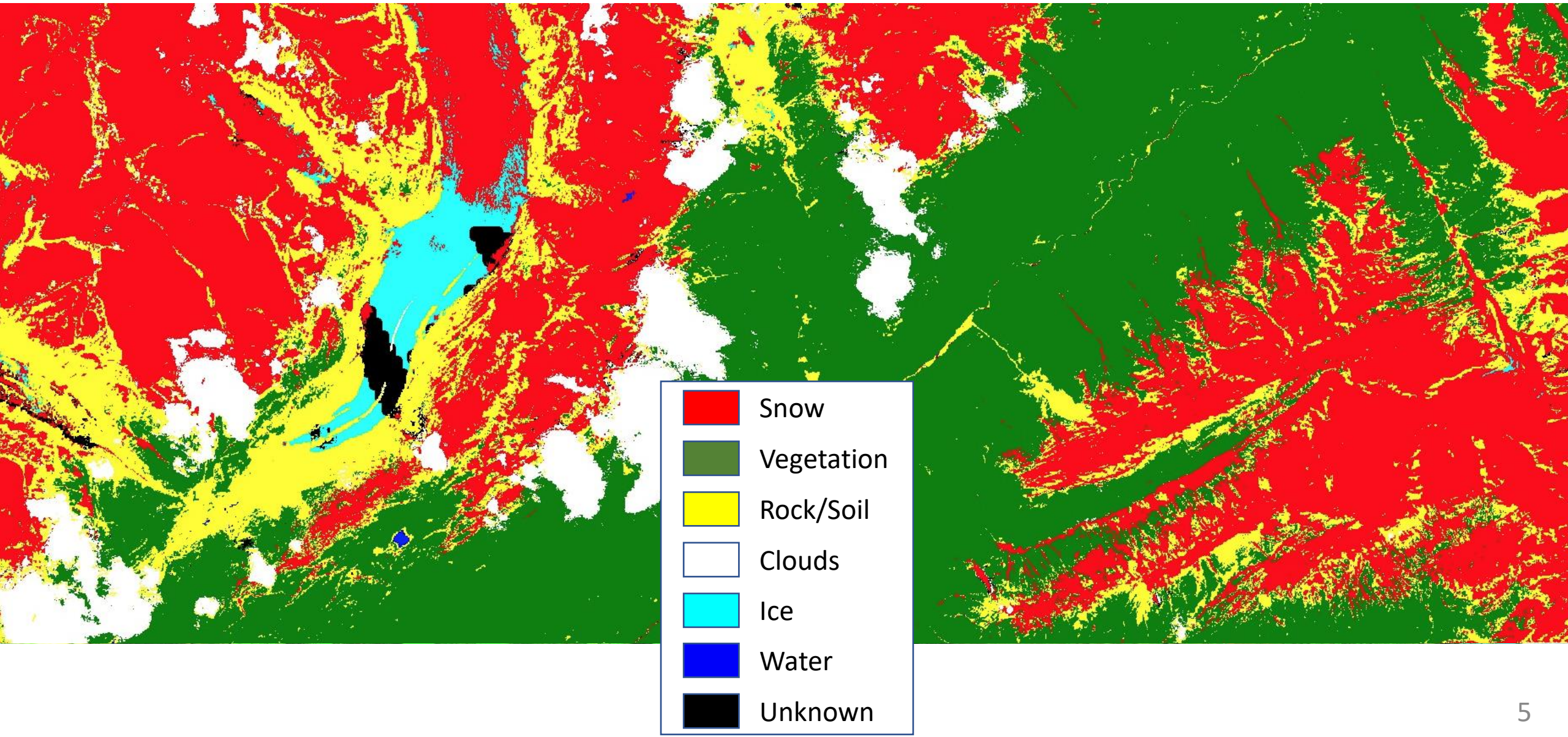
Optical high-resolution (4 Satellites)

- *Sentinel-2 A/B*
- *Landsat 8/9*

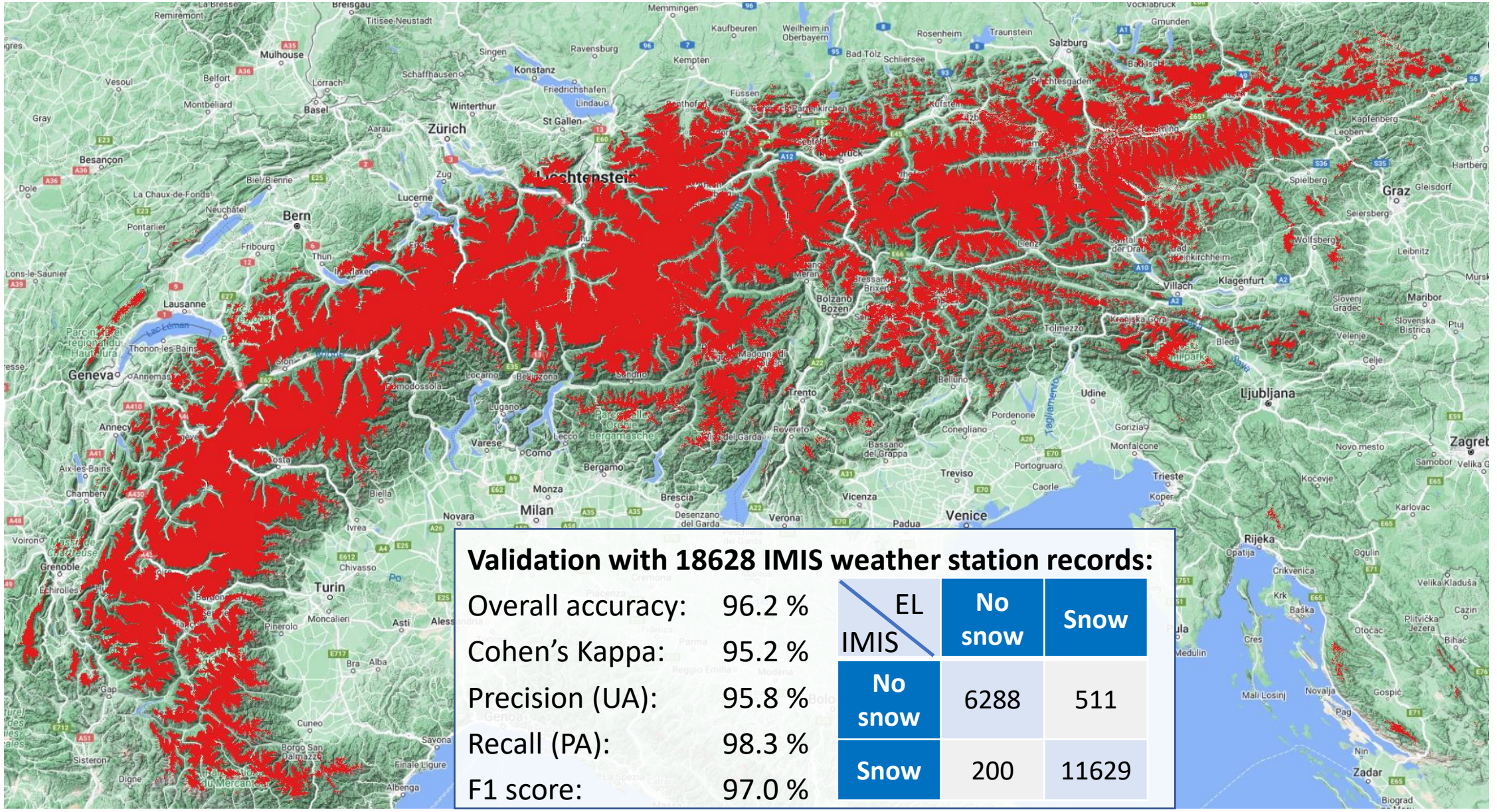
Optical medium-res. (6 Satellites)

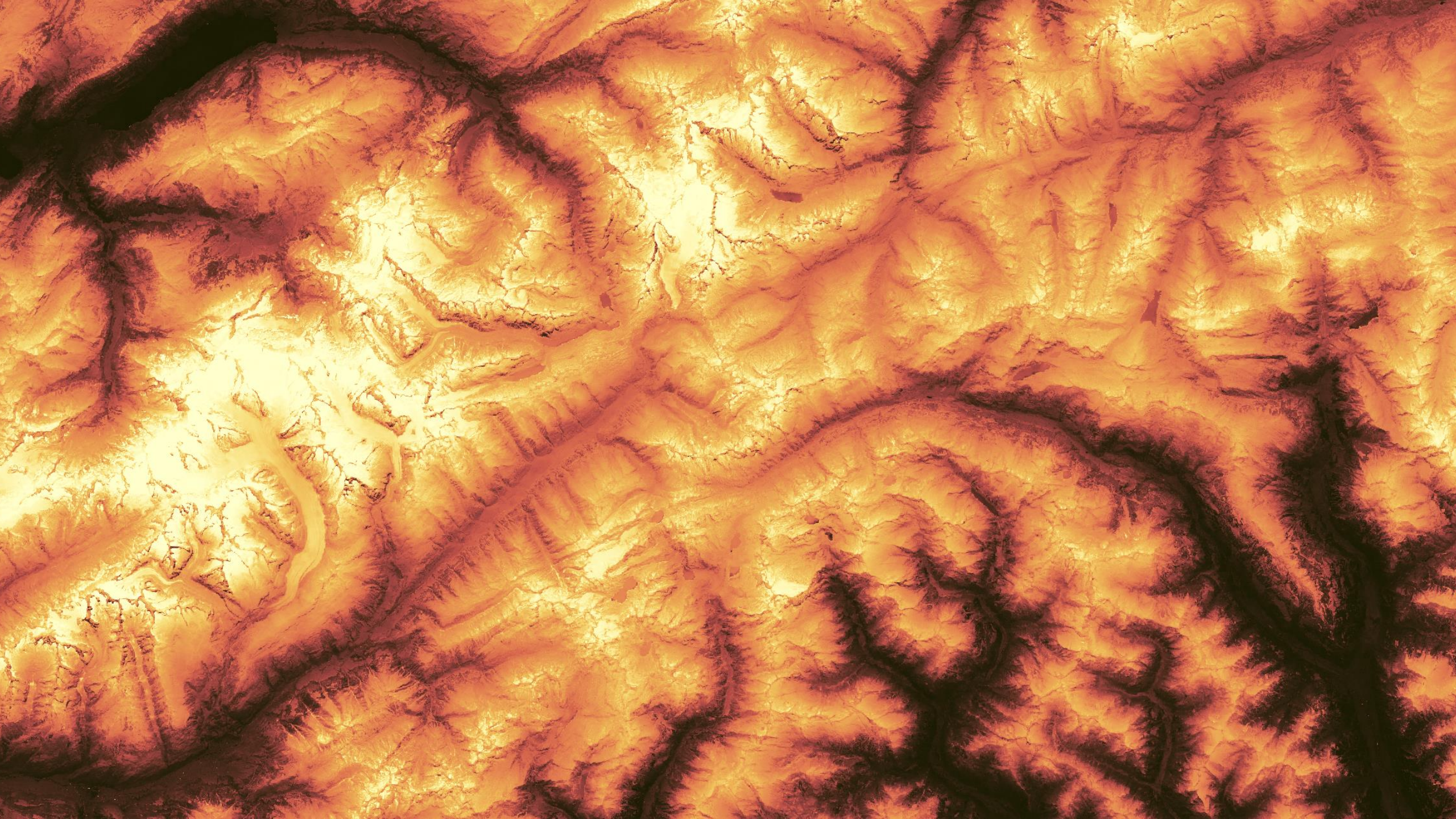
- Sentinel-3 A/B (OLCI + SLSTR)
- *MODIS (Aqua/Terra)*
- VIIRS (SNPP/NOAA20)

Snow Cover - Satellite Image



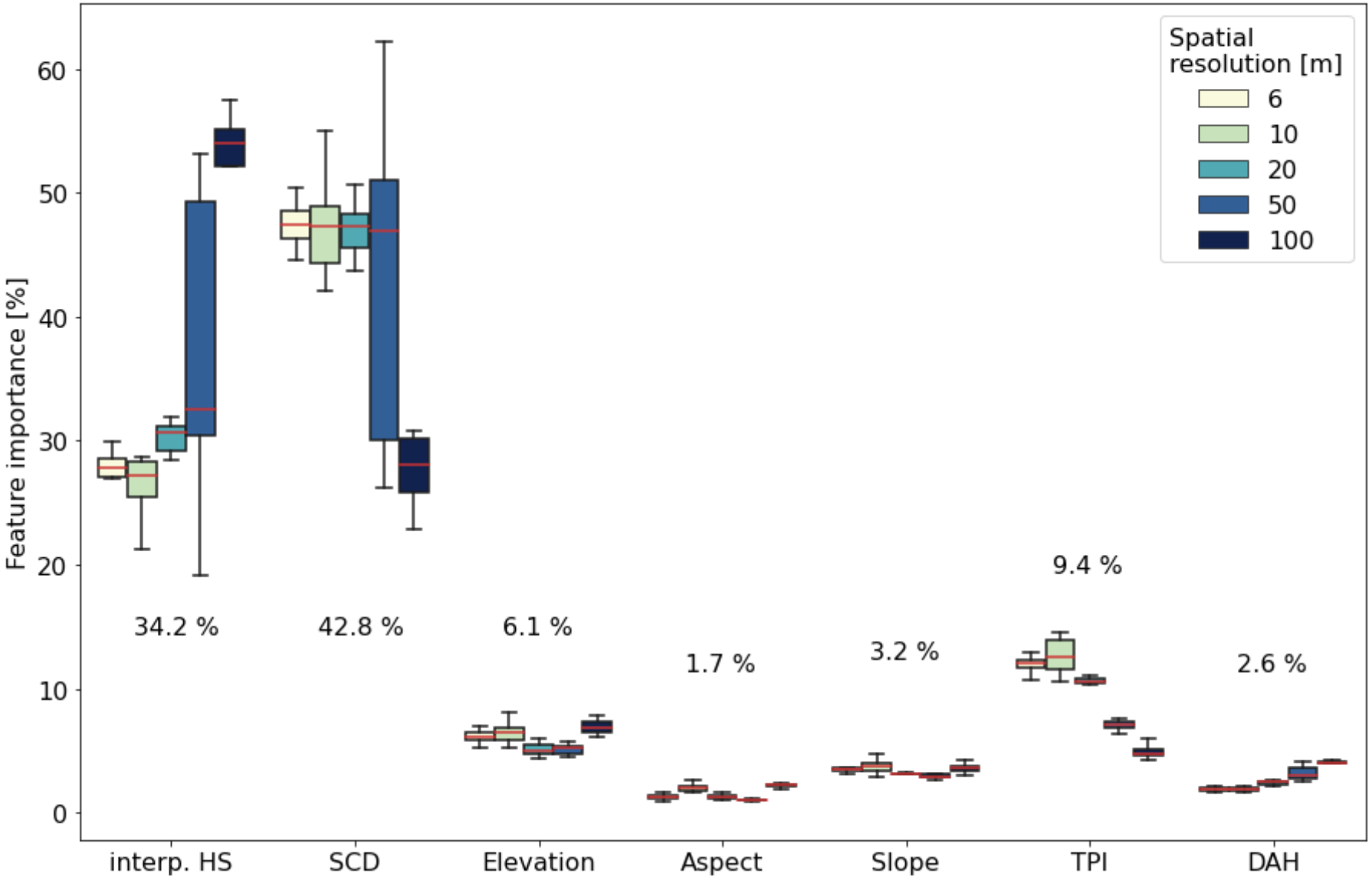
Snow Cover – Product & Validation





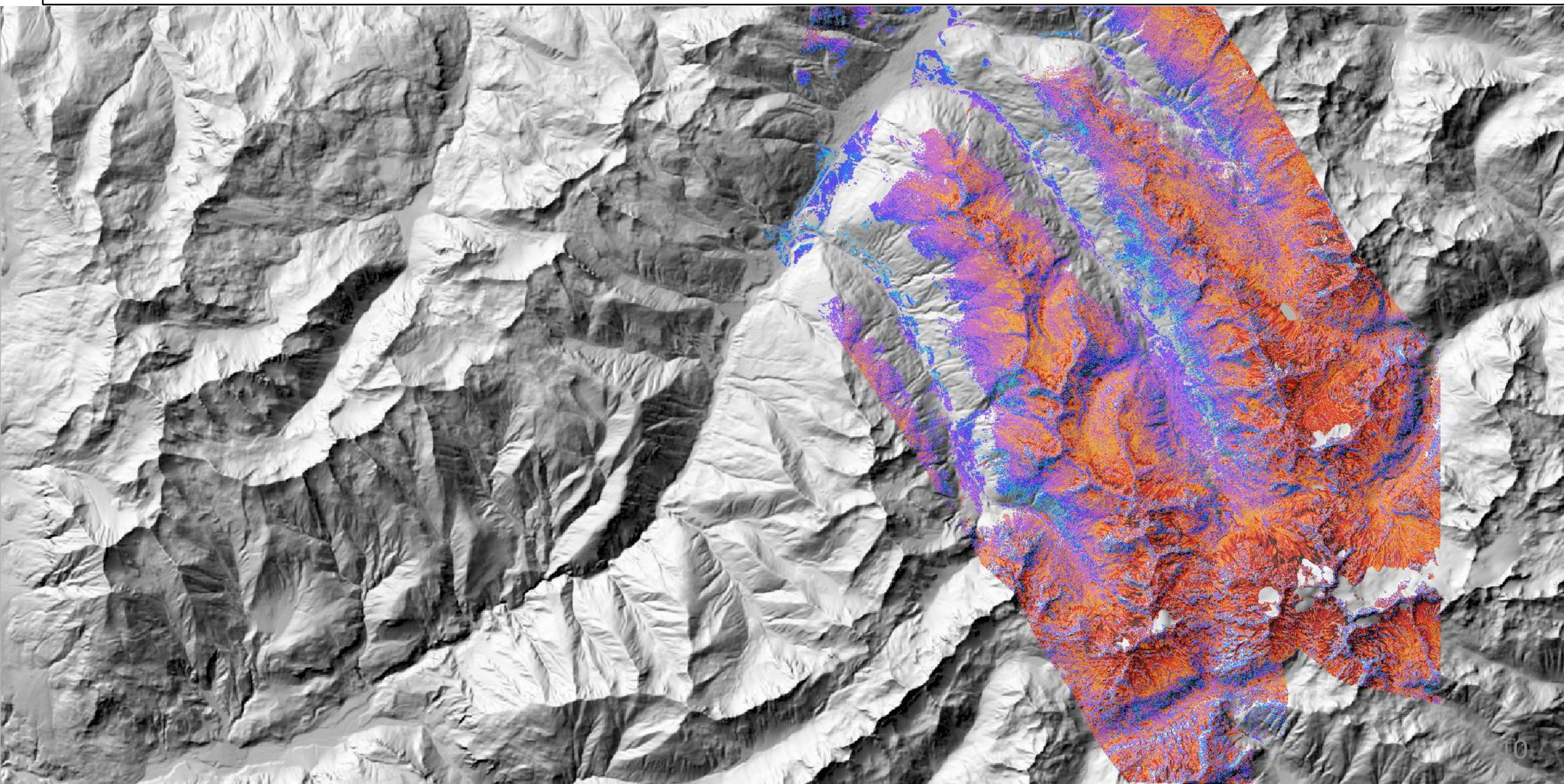
Günter (Guru)

Snow Cover Duration (SCD)



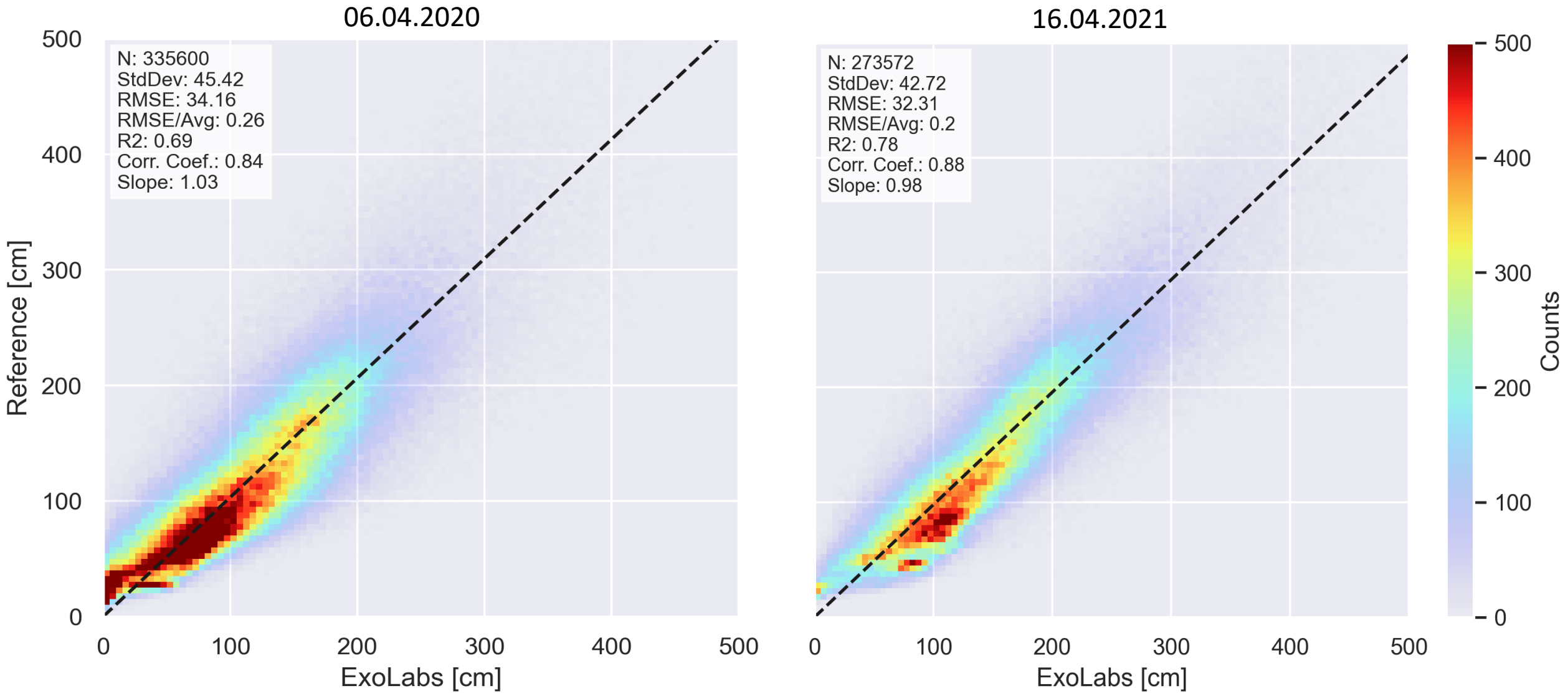
Elena (UZH)

Snow depth - ExoLabs



Snow depth - Validation

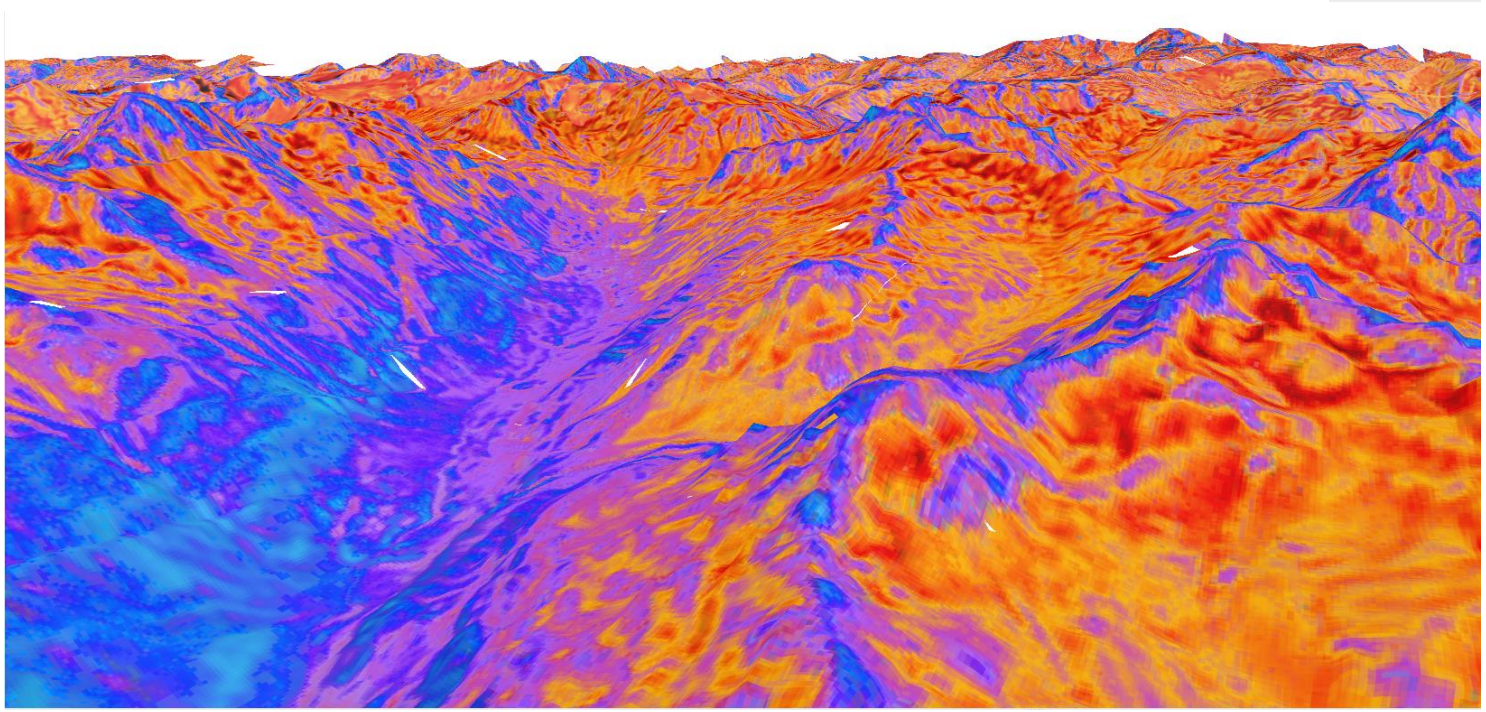
Validation on a 20 m spatial resolution scale!



DeepSnow Project

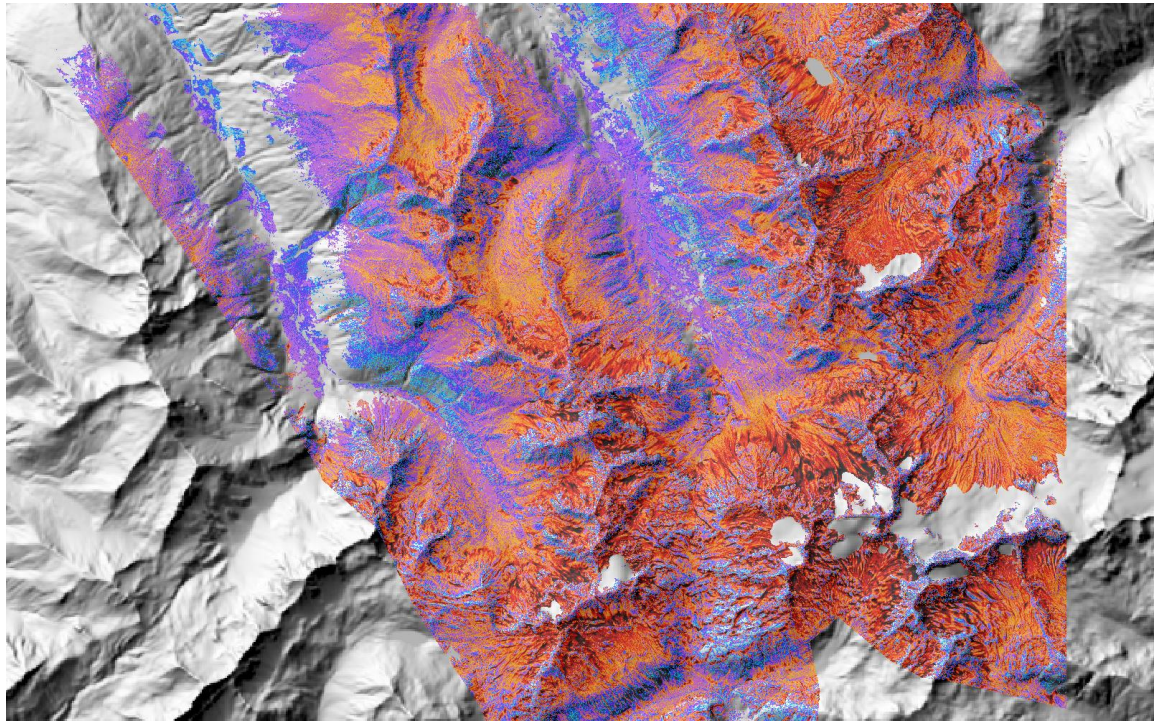
Snow depth estimation at country-scale with high spatial and temporal resolution

Rodrigo Caye Daudt [a], Hendrik Wulf [b], Elisabeth D. Hafner [a, c, d], Yves Bühler [c, d], Konrad Schindler [a], Jan Dirk Wegner [a, e]

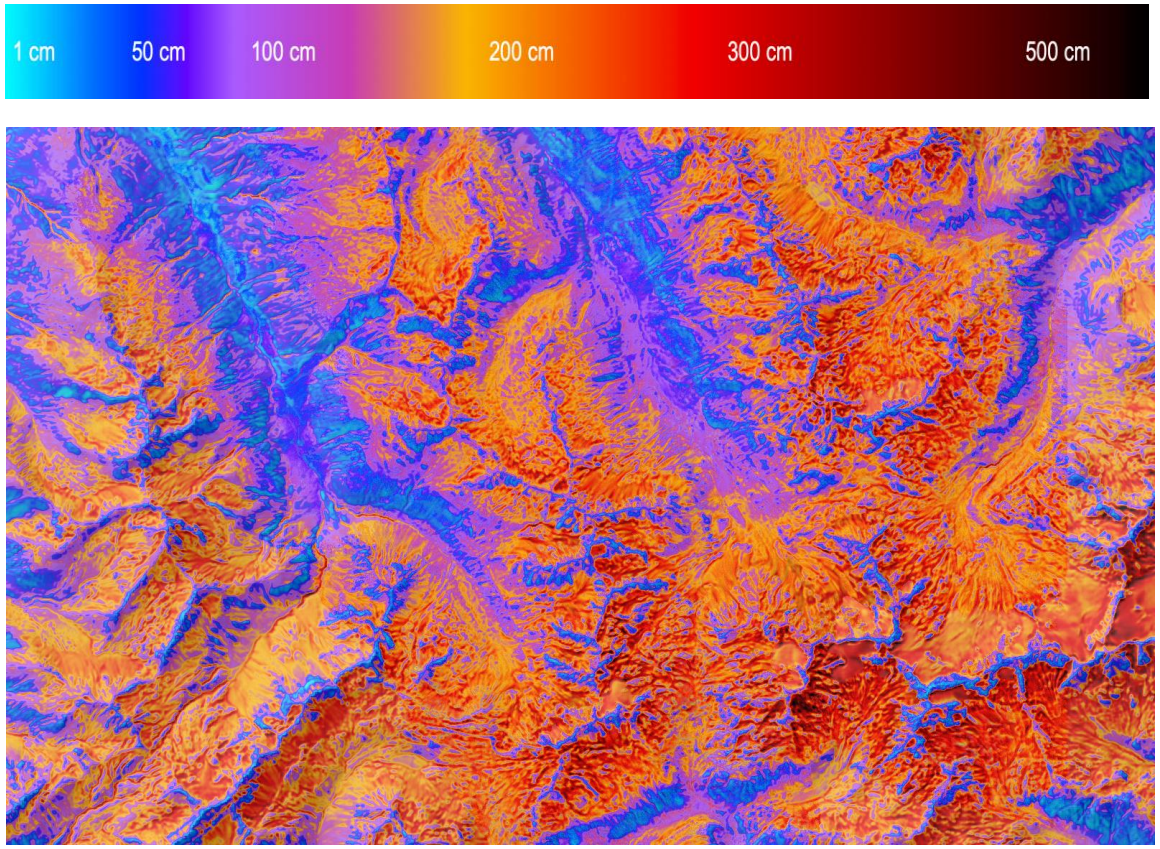


Rodrigo (ETHZ)

Snow Depth - DeepSnow



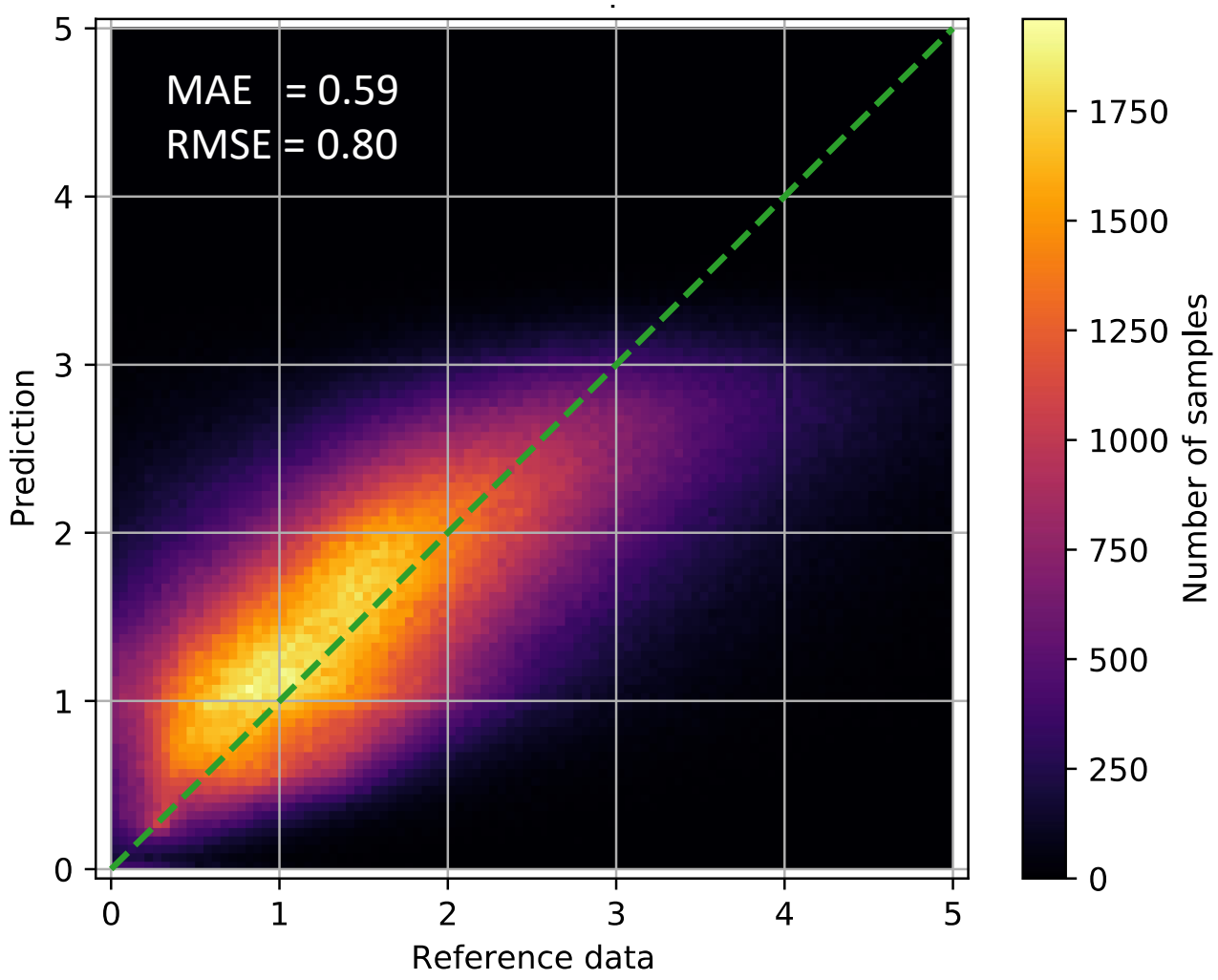
Airborne Reference Data, ©SLF (16.04.2021)

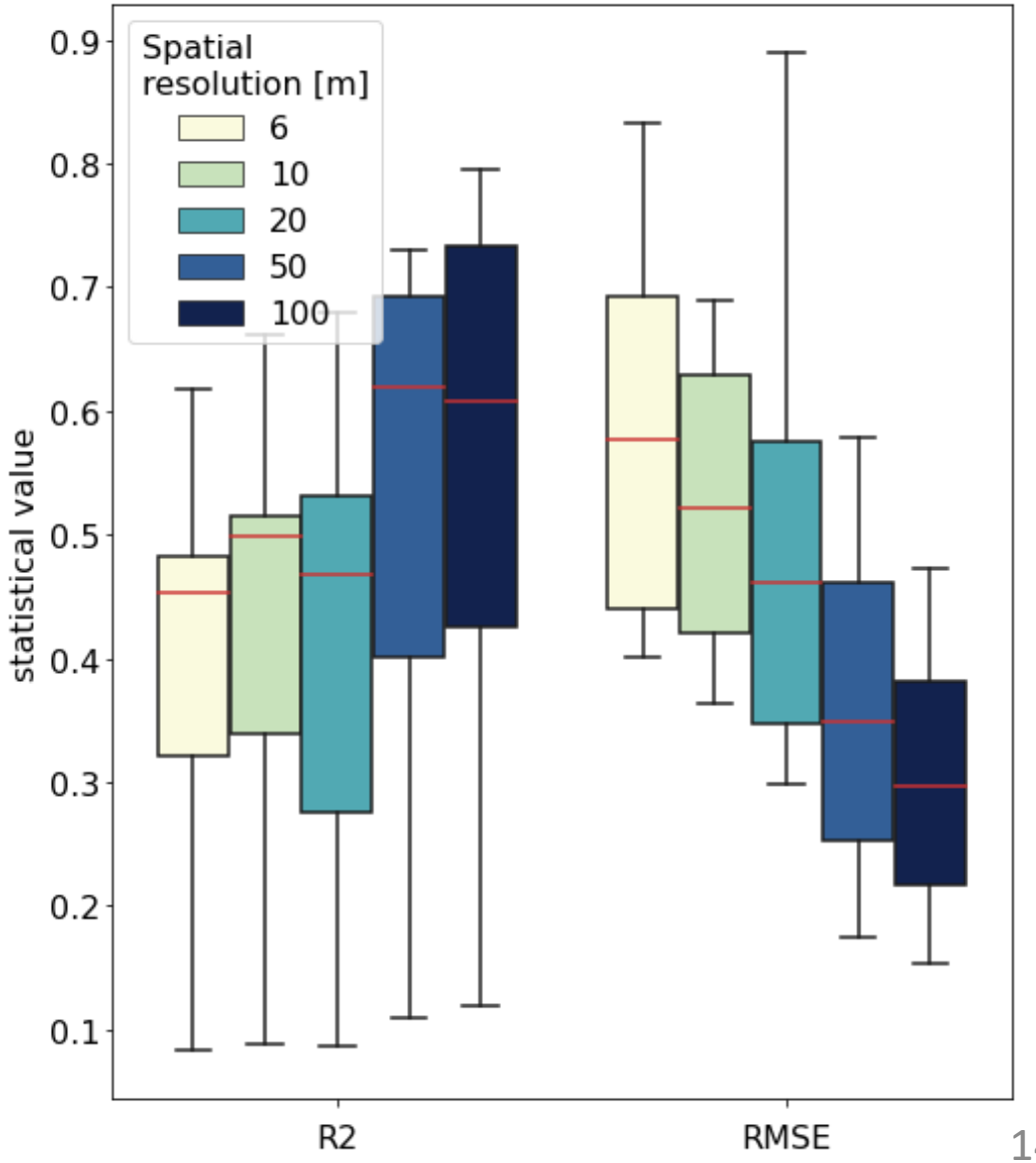


Rodrigo's Snow Depth product (16.04.2021)

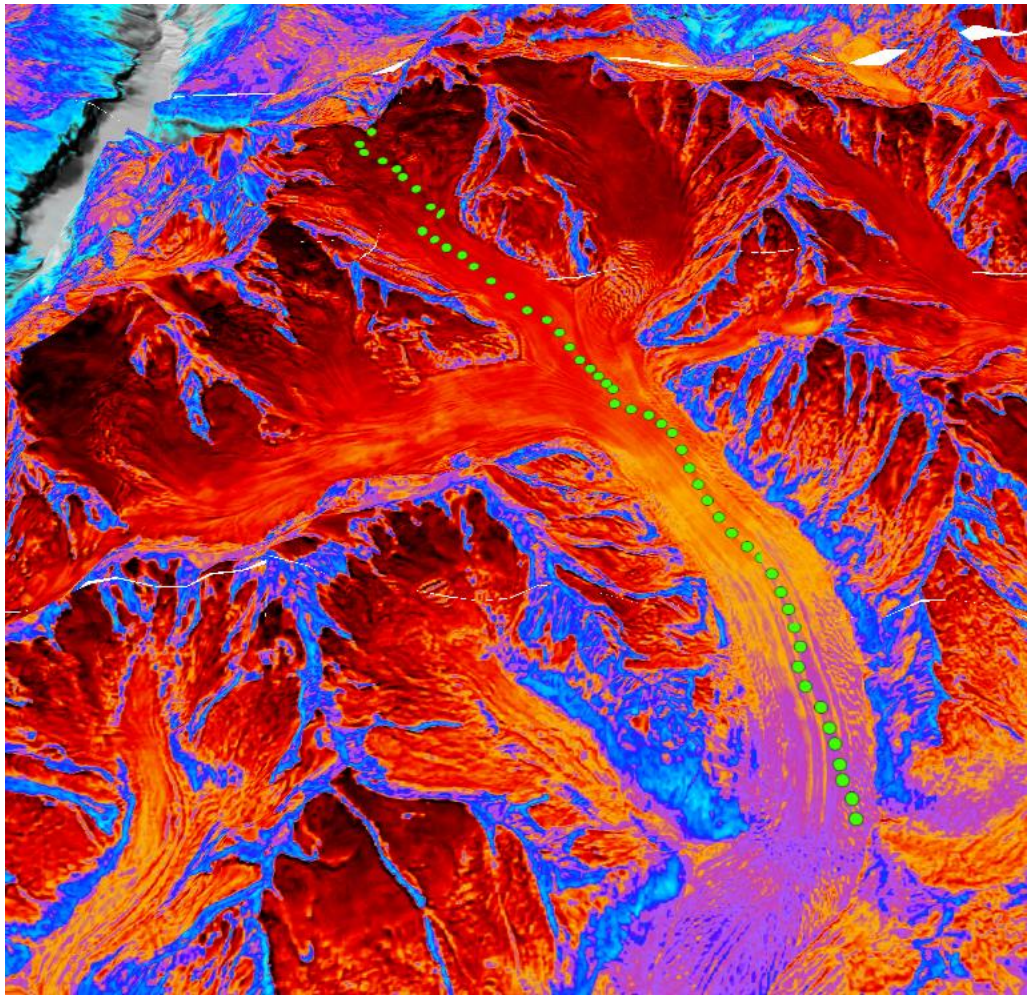
Snow depth – Validation 2

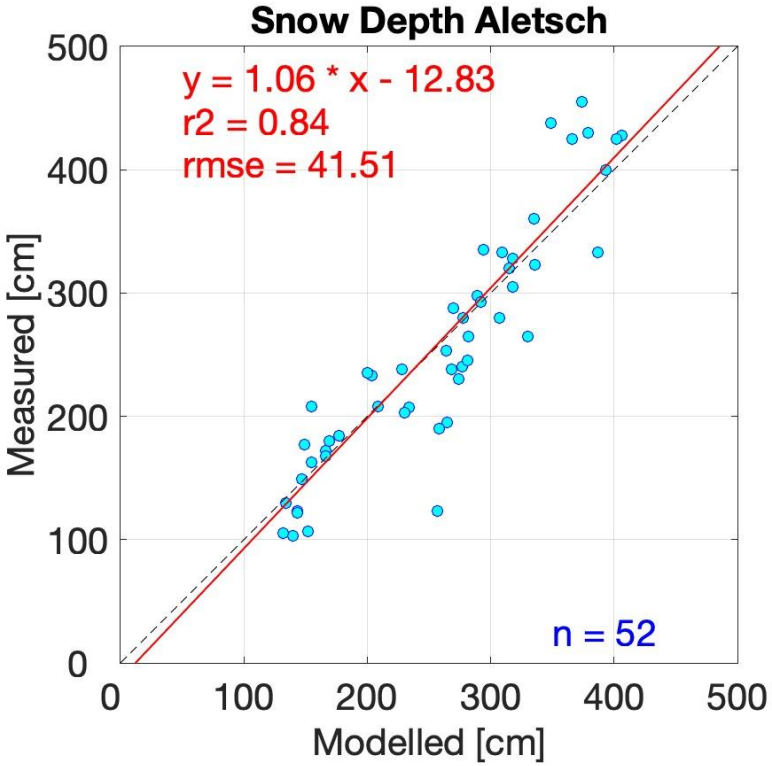
Validation on a 10 m spatial resolution scale!





Validation - glacier measurements

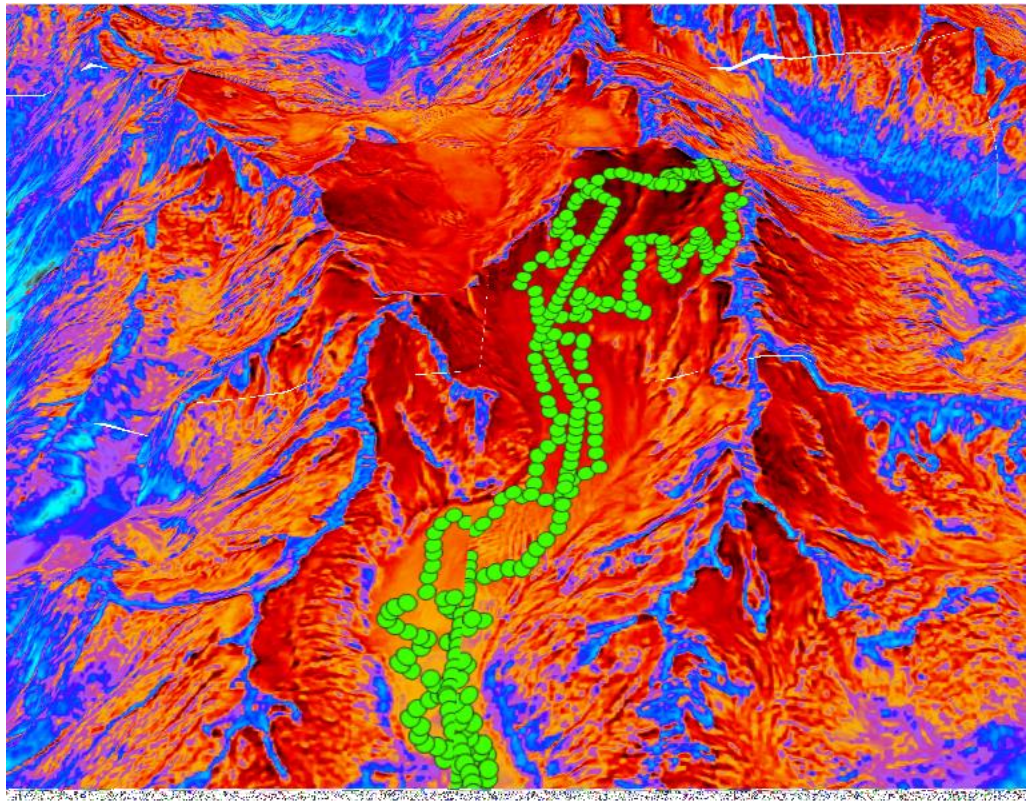


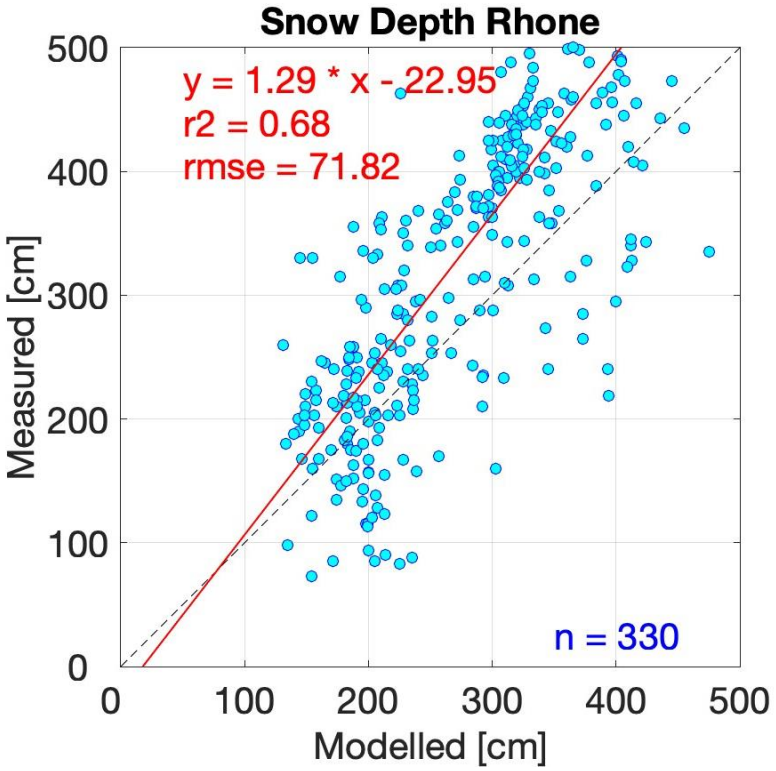


Mauro (UniBe)

GLAMOS (2022). Swiss Glacier Mass Balance, release 2021, Glacier Monitoring Switzerland, doi:10.18750/massbalance.2021.r2021.

Validation - glacier measurements

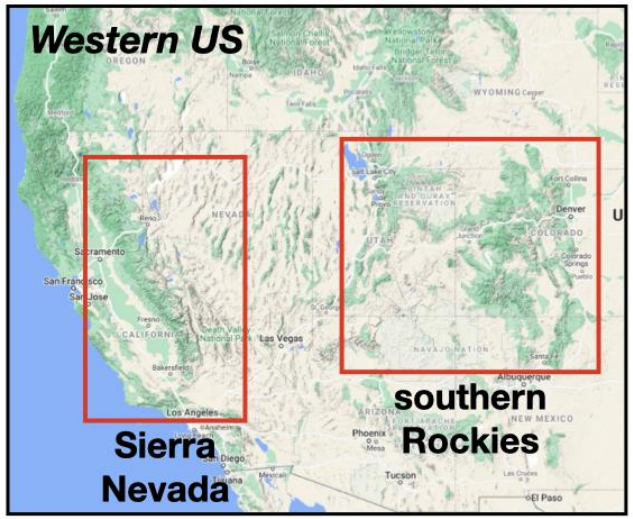


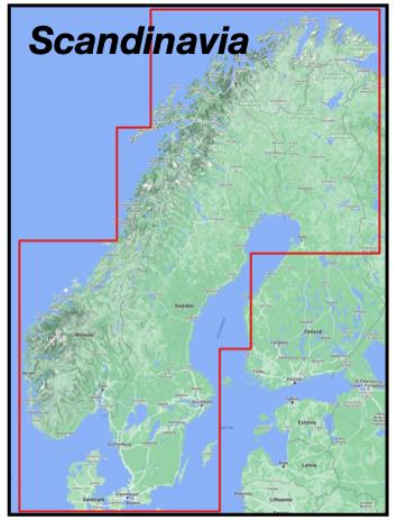


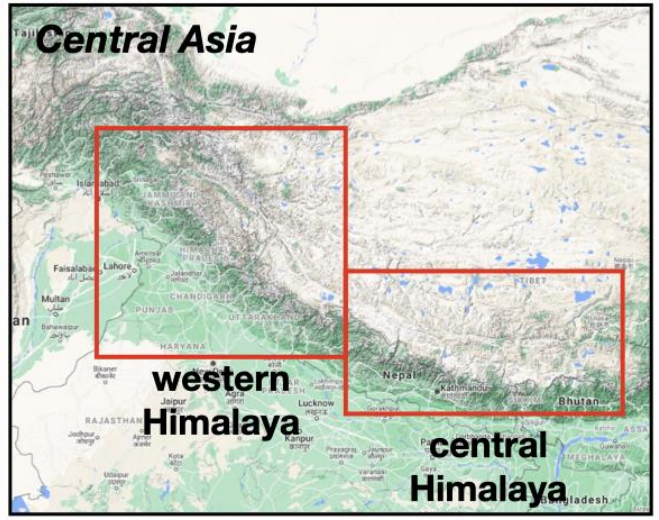
Mauro (UniBe)

GLAMOS (2022). Swiss Glacier Mass Balance, release 2021, Glacier Monitoring Switzerland, doi:10.18750/massbalance.2021.r2021.

Service coverage







We are operating in a scalable cloud-based environment.

We can transfer our snow services also to your area of interest.

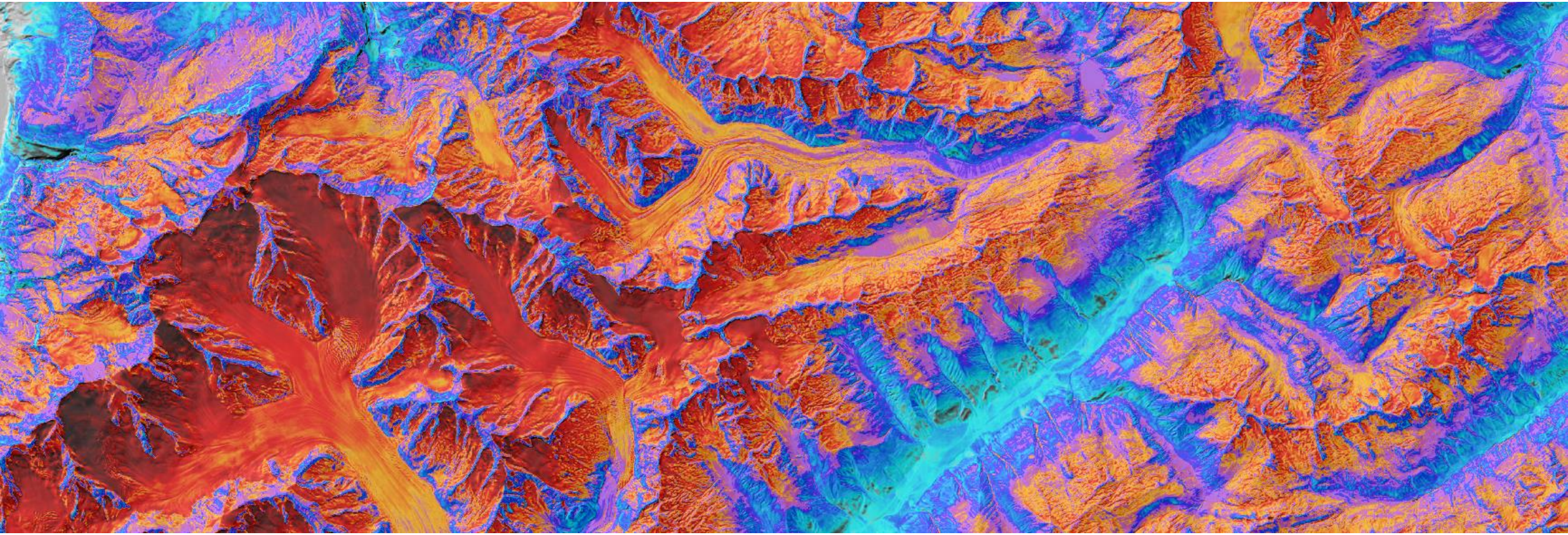
Open to collaboration

- **Innovative** snow products from a spin-off of the University of Zurich
- **Experienced** in research collaboration with renowned research institutions (e.g. SLF, ETH, ESA)
- **Trusted and integrated** by outdoor experts

  (e.g. Swiss Alpine Club, SwissTopo, Outdooractive, FATMAP, Skitourenguru, Gipfelbuch)

ExoLabs

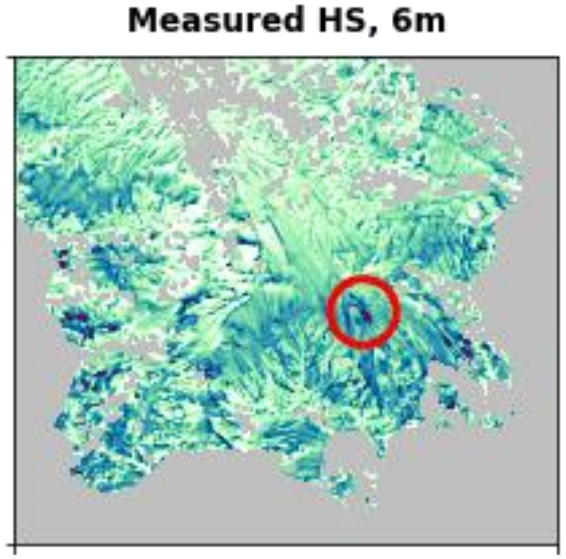
Thank you for your attention!

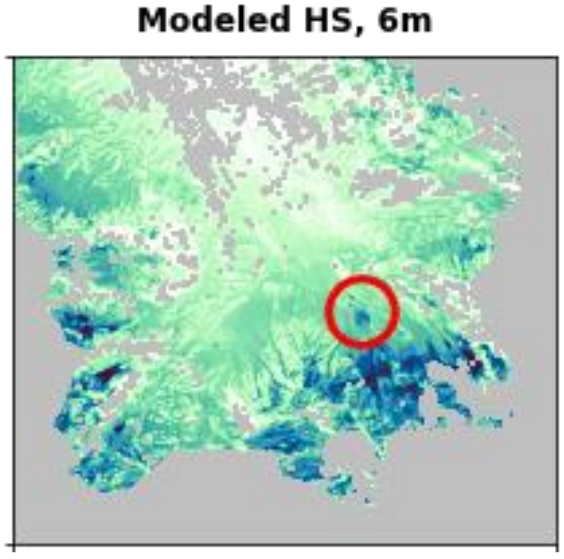


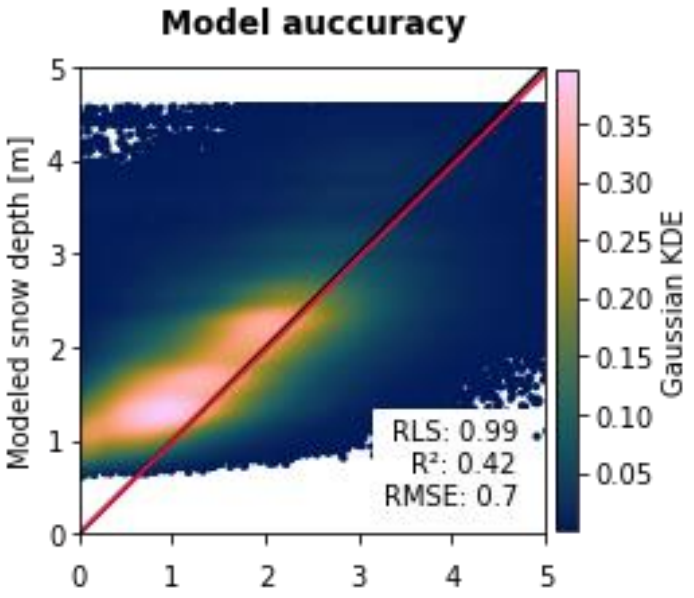
We would love to collaborate with you!

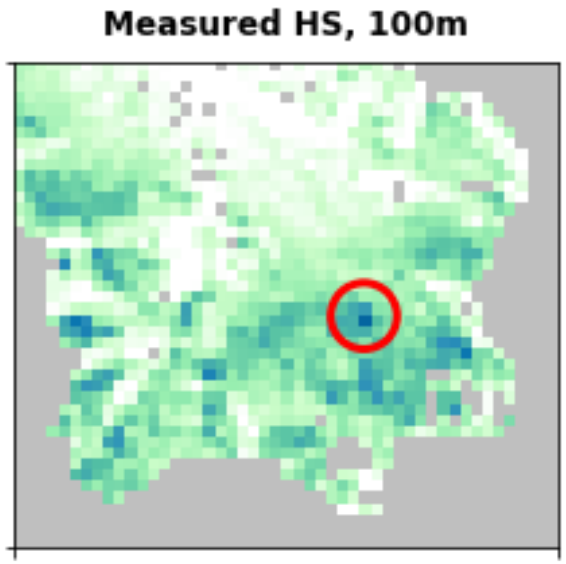
ExoLabs

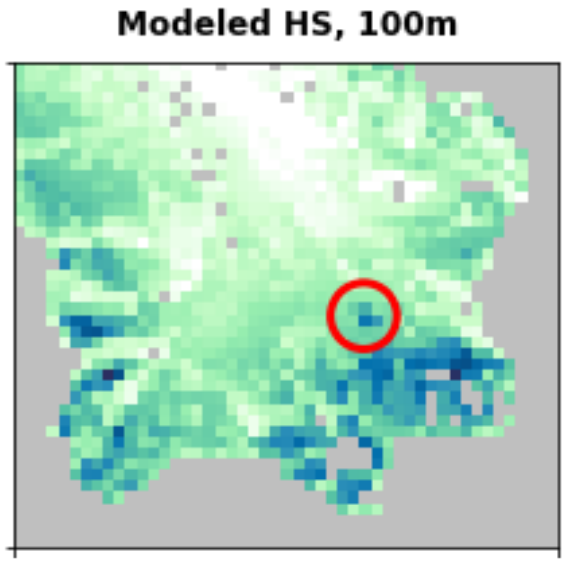
Resolution matters!

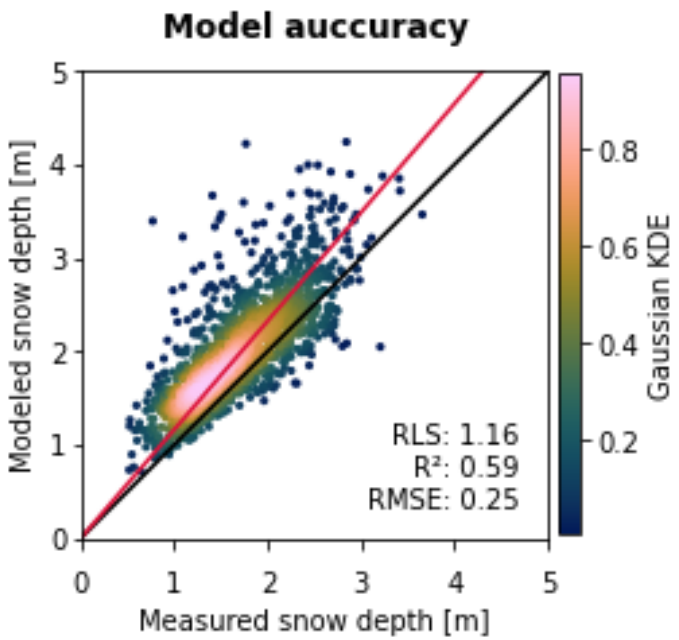




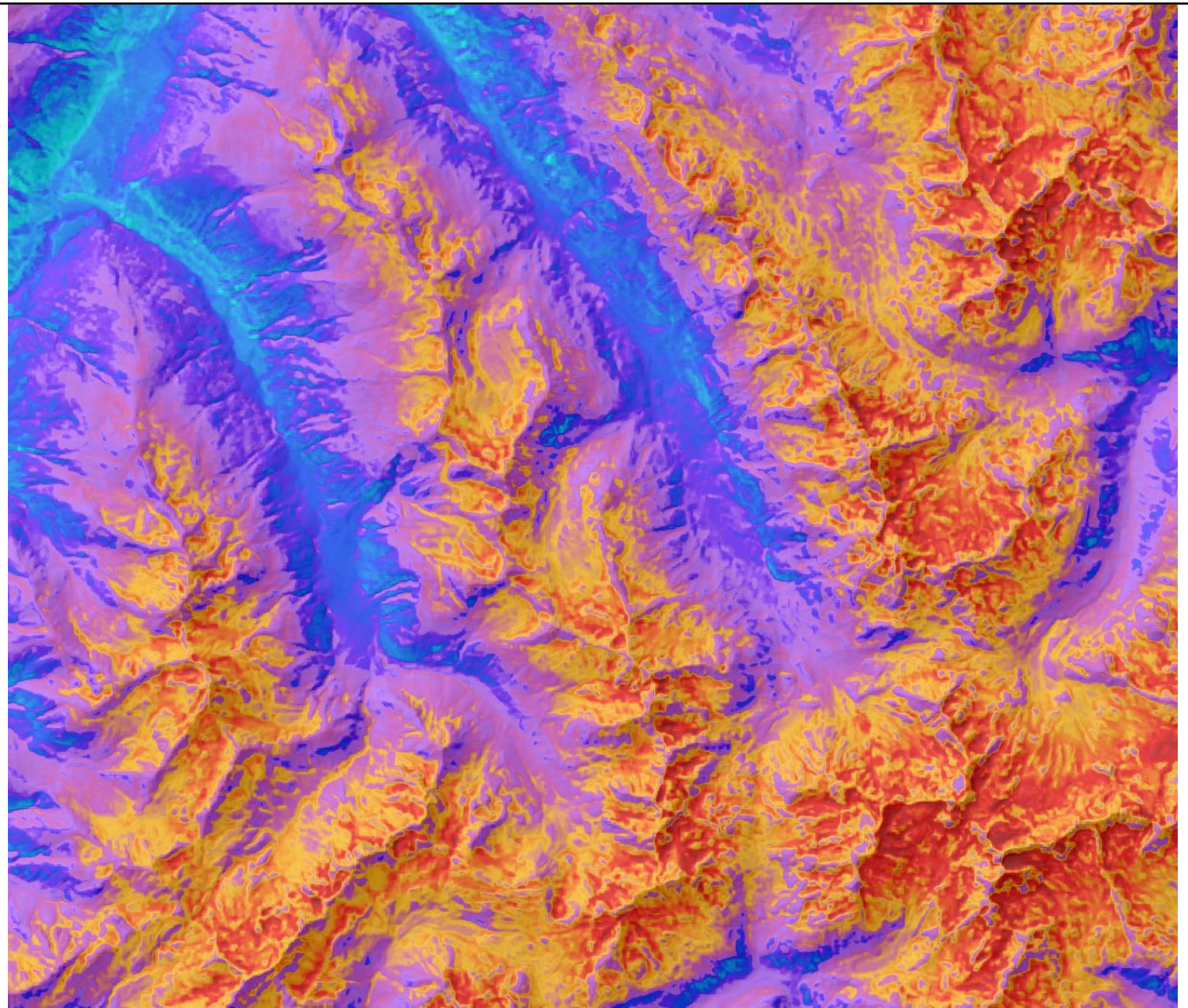




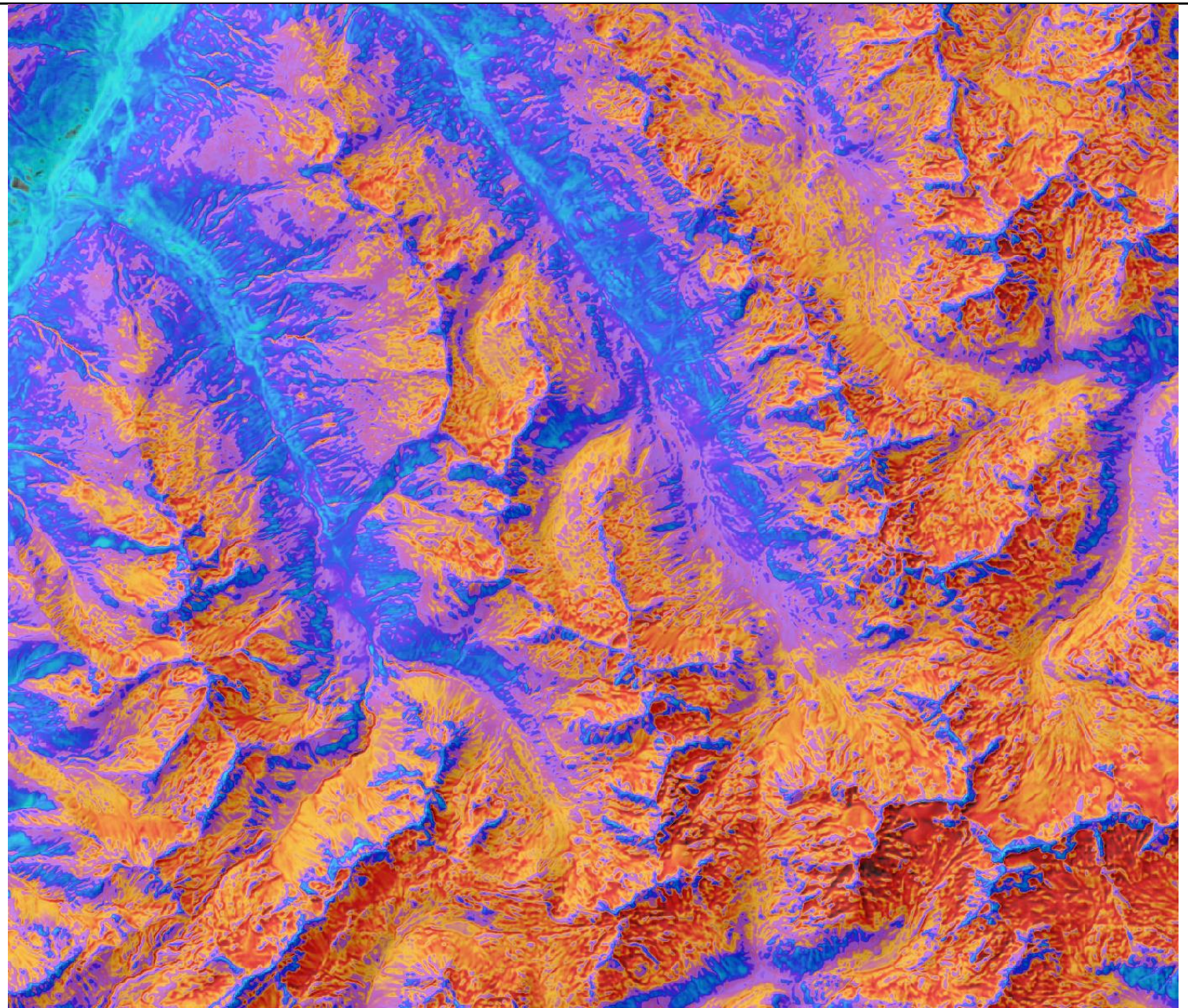




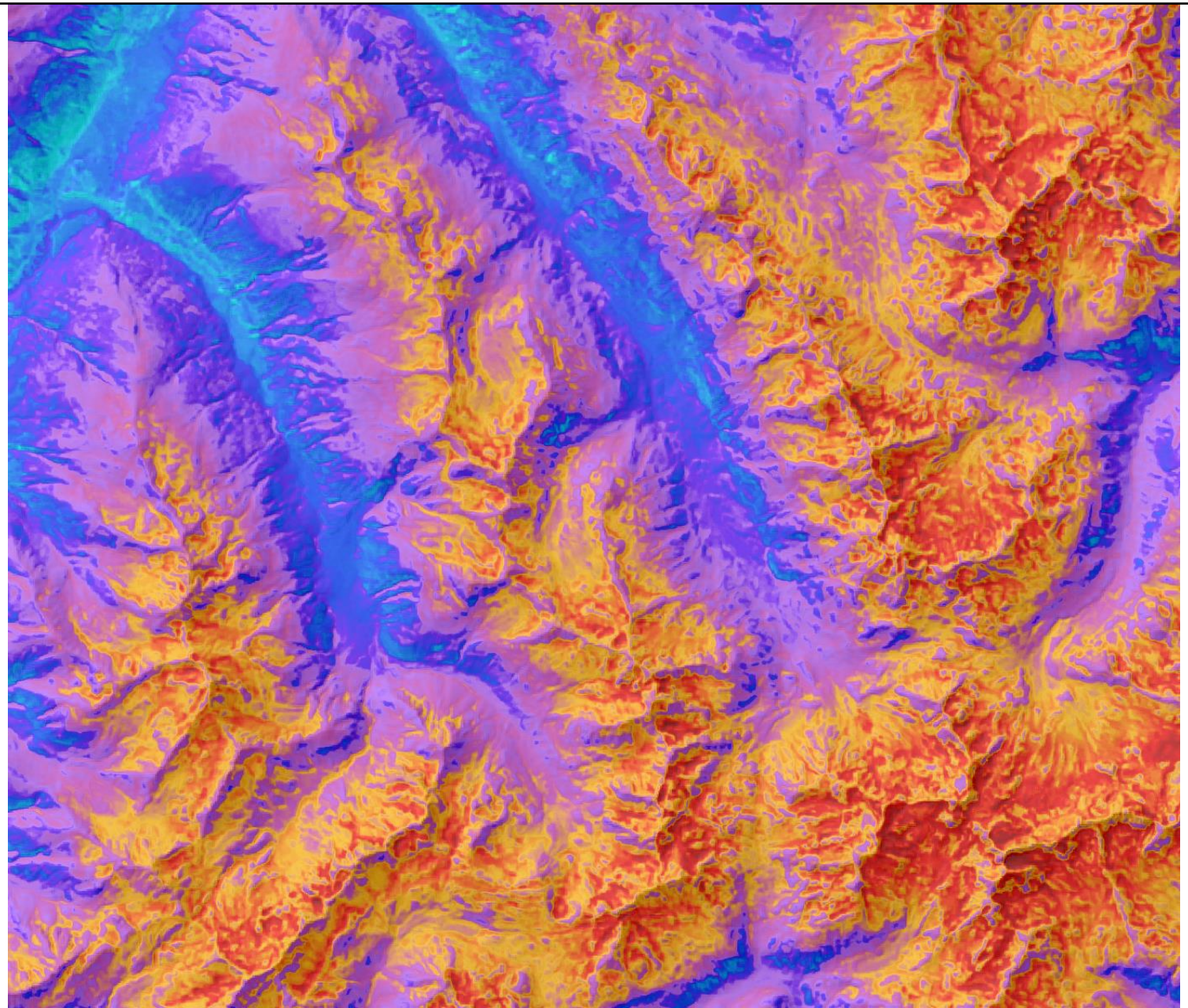
Ultracam vs. ExoLabs



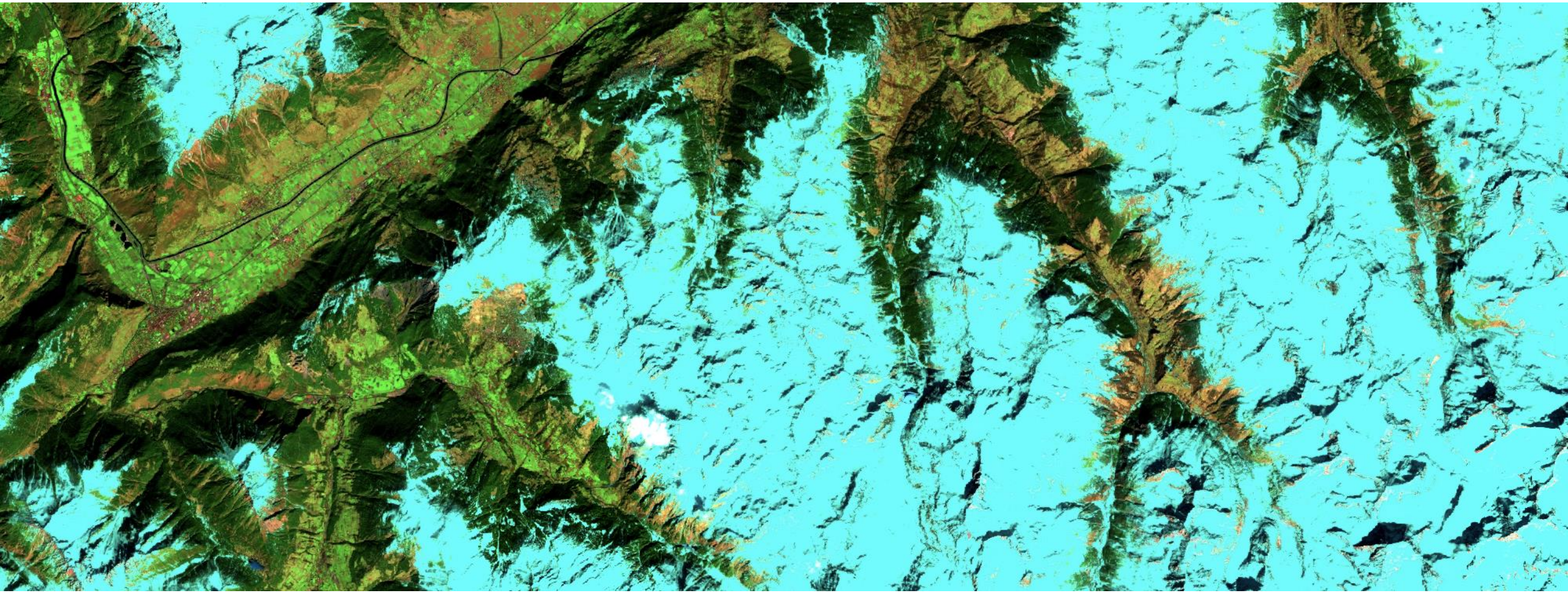
Ultracam vs. DeepSnow



DeepSnow vs. ExoLabs

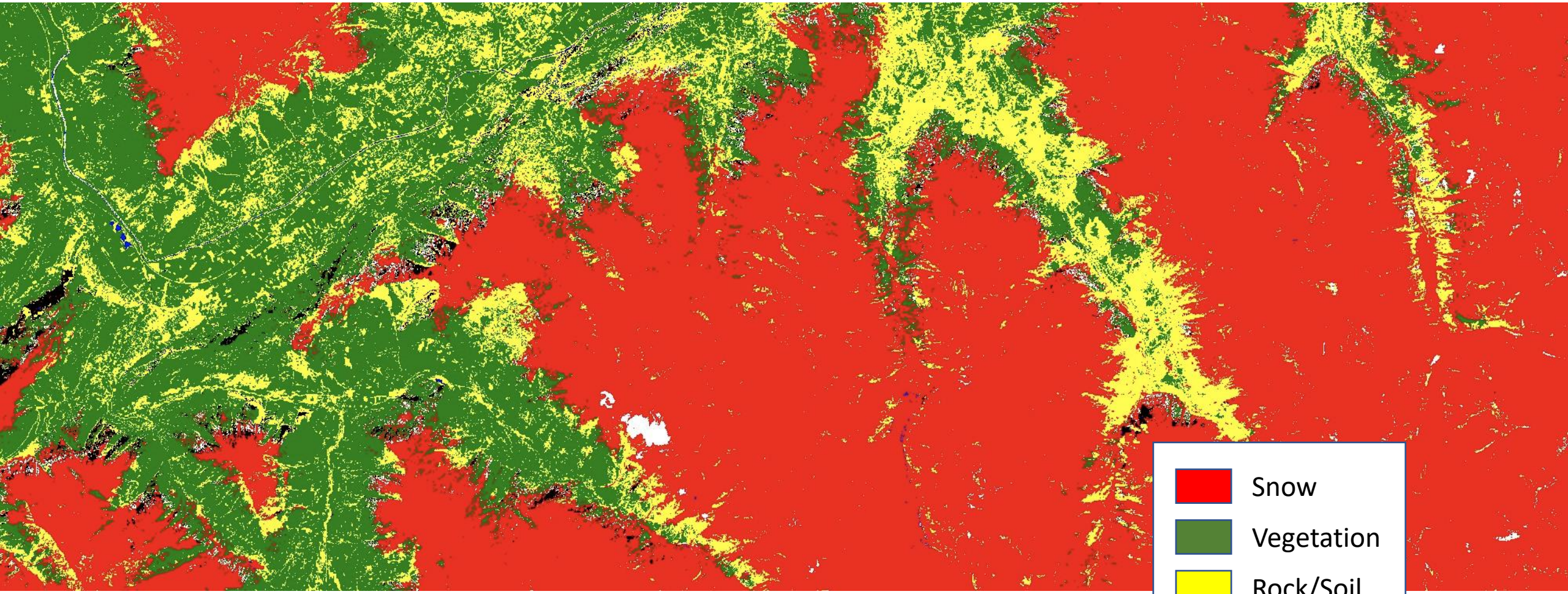


Snow Cover Extent – Satellite Image



Sentinel-2 false color composite (SWIR2, NIR, red) from 04.04.2021. Snow appears in turquoise colors.

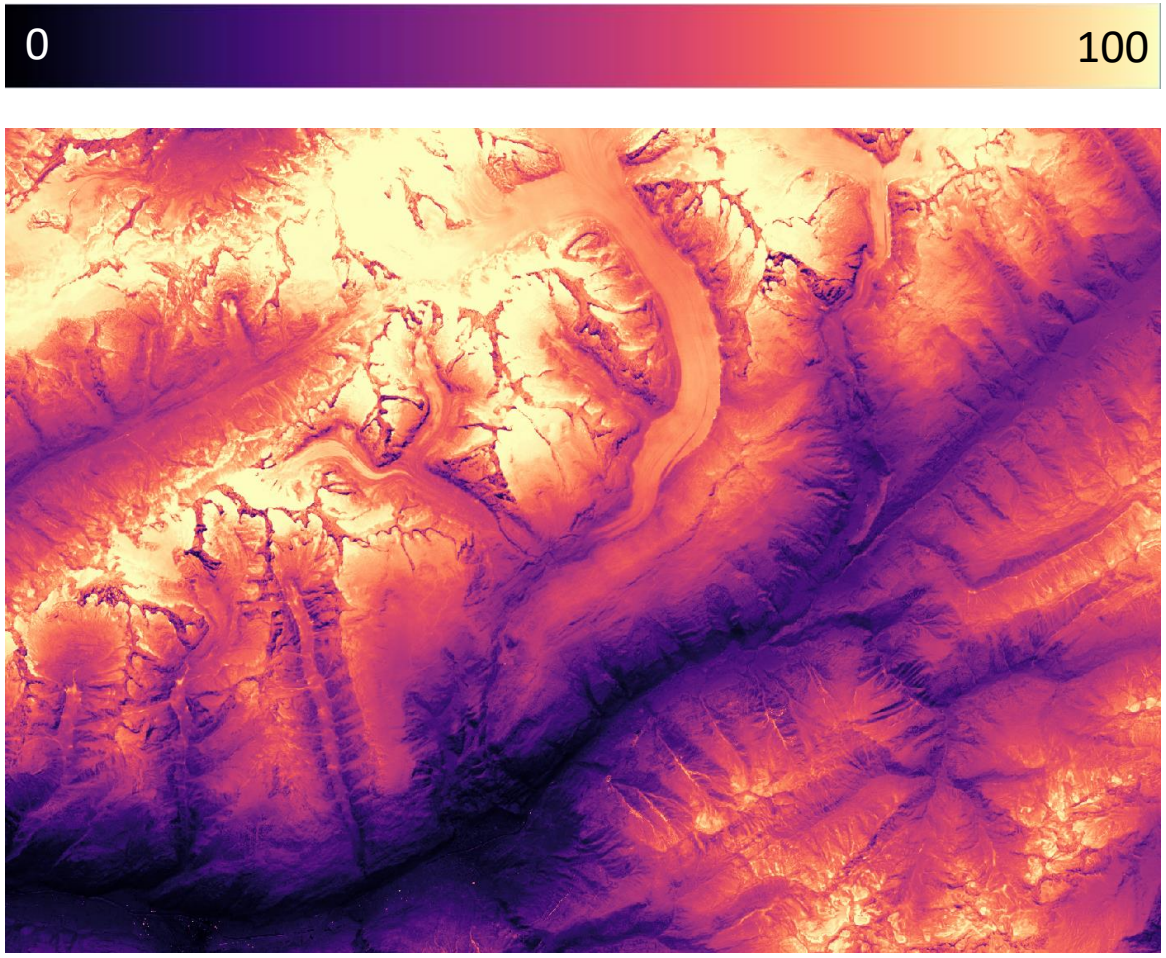
Snow Cover Extent - Classification



Snow cover extent classification. Snow in forests and shaded areas is very well captured.

Snow Cover Extent - Validation

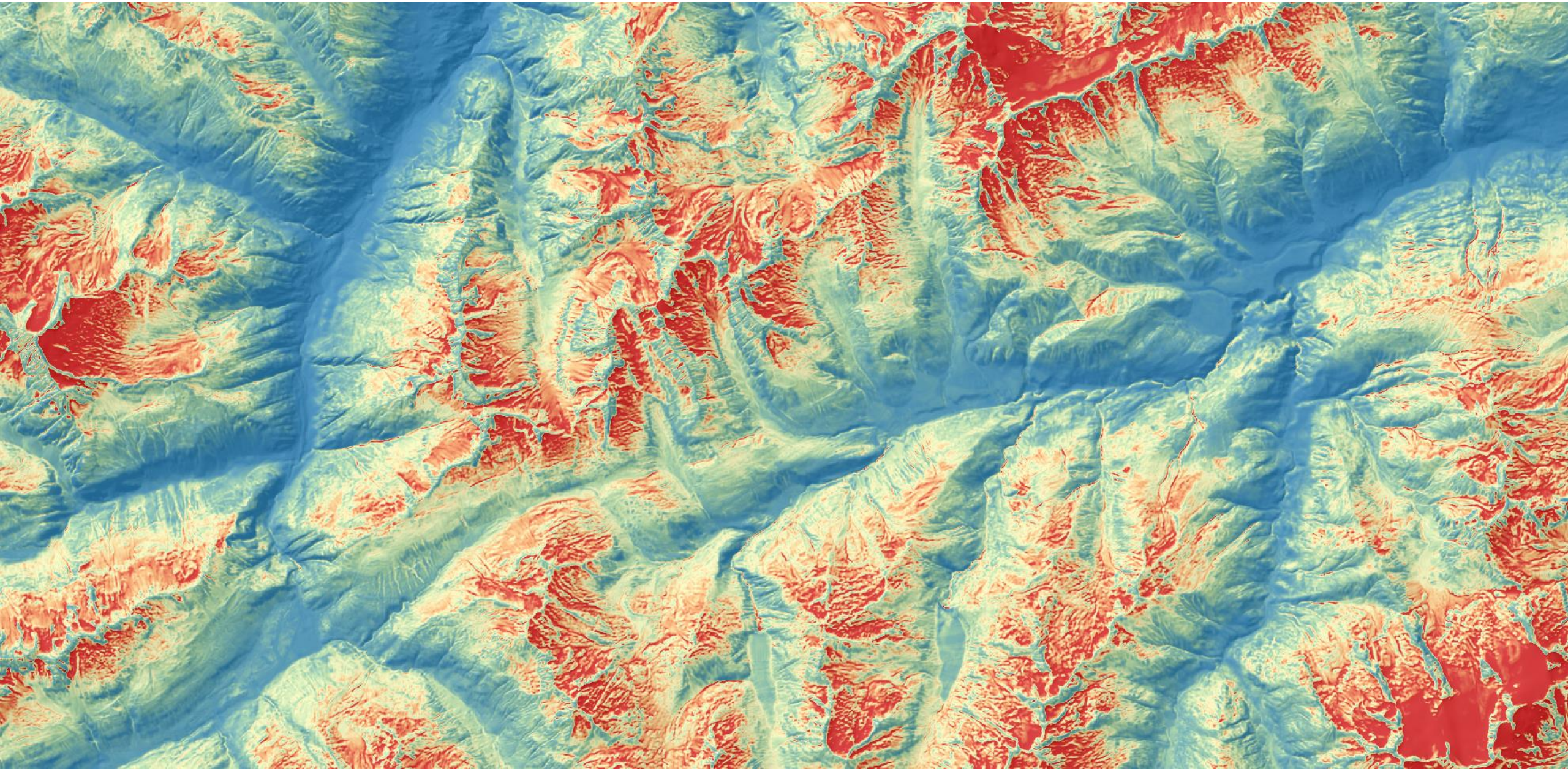
Aerial Image



Snow Cover Duration (Sentinel-2, 2016-22)

Snow Water Equivalent

1 kg/m^2 — 800 kg/m^2



Snow products

Snow product specifications:

We provide our core products in **real time** with **daily updates** in a **20 m** spatial resolution across global **mountain ranges**.

Core Snow products:

- Snow Cover Extent (SCE)
- Snow Depth (HS)
- Snow Water Equivalent (SWE)

Further snow products

- SCE / HS / SWE **forecasts**
- Snow surface **temperature**
- Snow **albedo**
- Snow cover **trends**

Approach

1) Snow products

- *Holistic* – Combining all relevant space and ground measurements
- *Innovative* – Applying machine learning methods & geostatistical models
- *Scalable* – Providing best-quality snow products for any area of interest

2) Snow services

- *Reliable* – Exploiting AWS Cloud computing for secure snow services
- *User friendly* – Easy and documented data uptake via API

Additional data streams

In-situ measurements (>2000 in Europe)

Meteorological forecasts

Climatology data

Land cover

Elevation

ExoLabs

Earth Observation service provider

Spin-Off from the University of Zurich

Near real-time environmental monitoring

Partners and References

esa business applications

WSL SLF

UBIMET WEATHER MATTERS

SPACE INNOVATION

outdooractive

ETH zürich

Universität Zürich[UZH]

Swiss Re

THINK OUTSIDE

Schweizer Alpen-Club SAC
Club Alpin Suisse
Club Alpino Svizzero
Club Alpin Svizzer

data service

Swiss Alliance for Data-Intensive Services

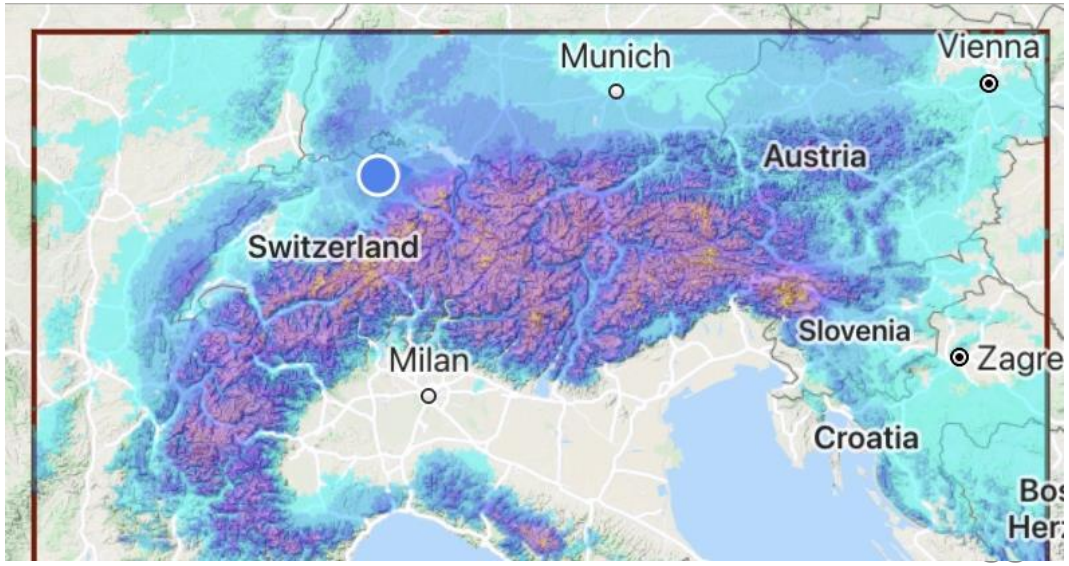
Snow Monitoring Innovations

Snow products

- Snow cover, snow depth, snow water (SWE)
- High spatial (20 m) & temporal (daily) resolution
- Large spatial extent (e.g. Alps) without data gaps
- Full value chain (observations, models, forecasts)
- Transferable to any area of interest (global)

Snow service

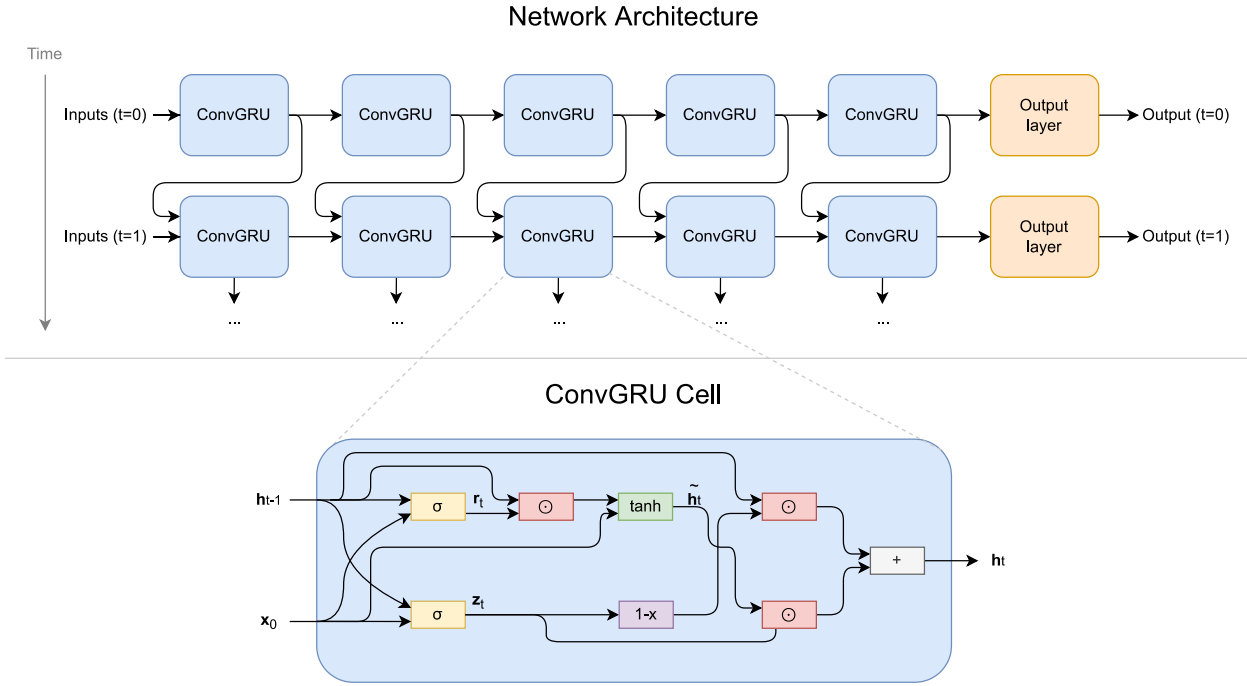
- Fully operational on AWS (reliable & secure)
- Documented data services via API (user-friendly)



ExoLabs

Snow Depth Estimation at Country-Scale with High Spatial and Temporal Resolution

Rodrigo Caye Daudt[a,*], Hendrik Wulf[b], Elisabeth D. Hafner[a,c,d], Yves Bühler[c,d], Konrad Schindler[a], Jan Dirk Wegner[a,e]



Rodrigo (ETHZ)

Innosuisse - Swiss Innovation Agency

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Confédération suisse
Confederazione Svizzera
Confederaziun svizra