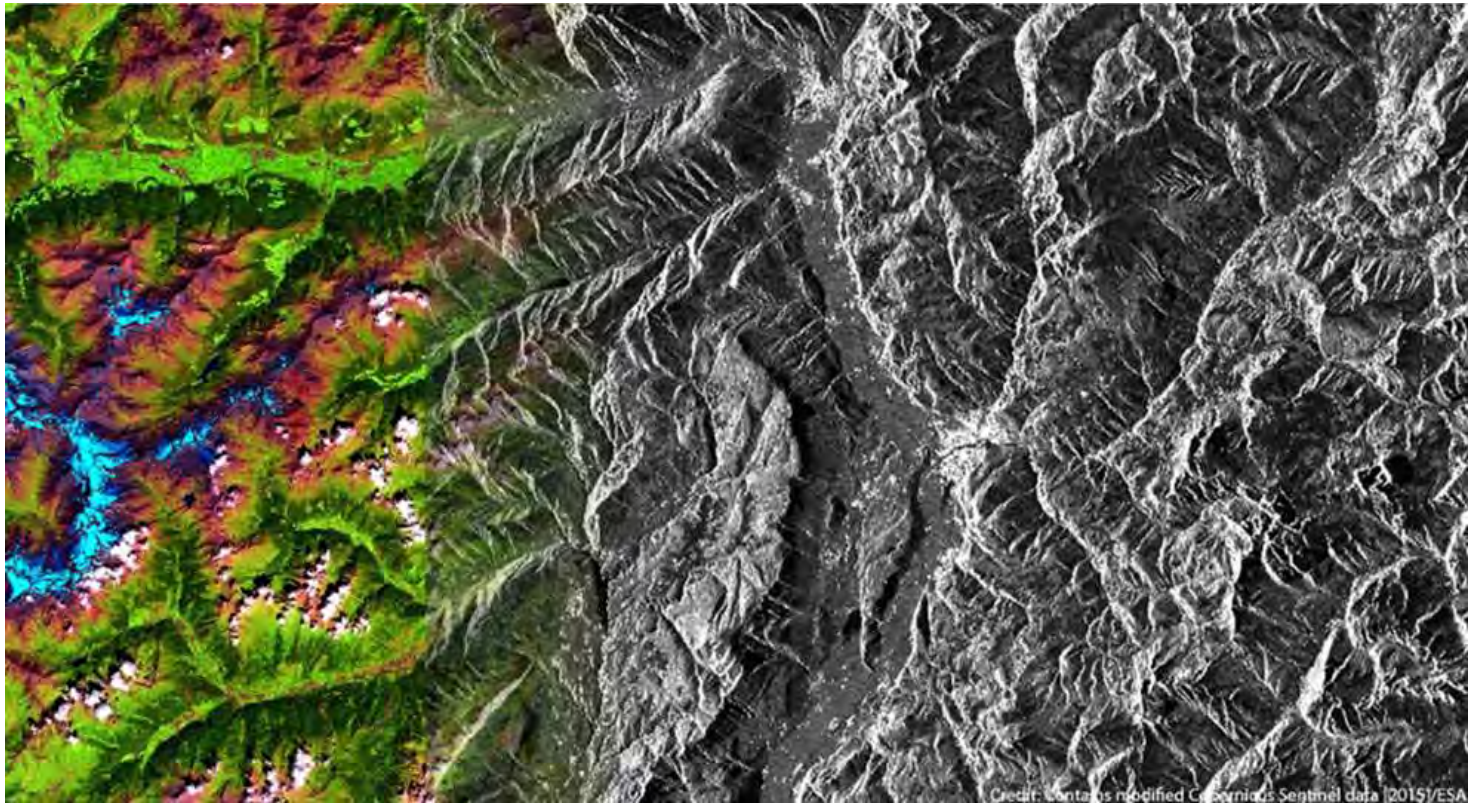
This project is funded by the European Union

eurac research

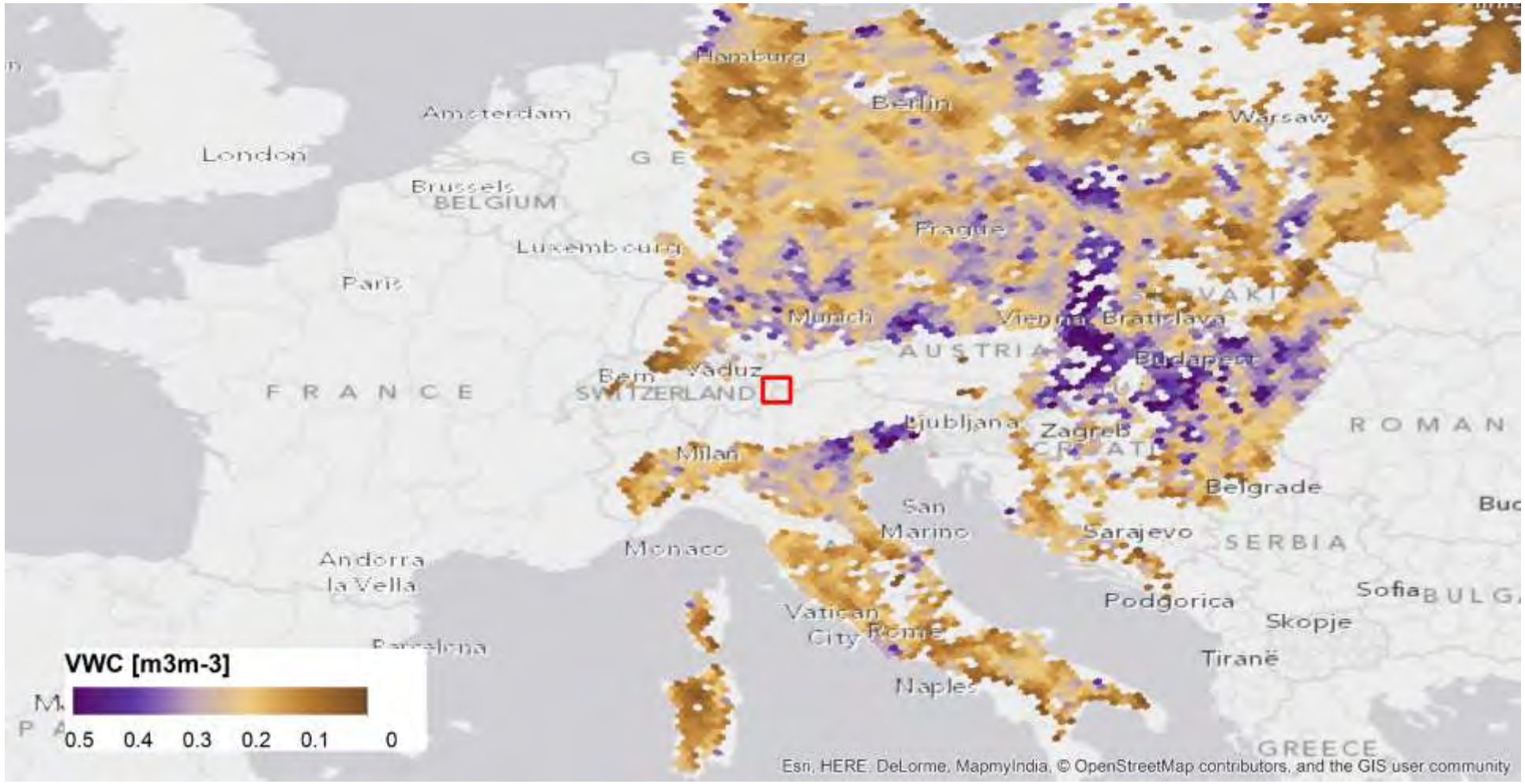


Sentinel 1&2 @ Bolzano/Bozen

Challenges in observing mountain ecosystems

C. Notarnicola, M. Callegari, F. Greifeneder, A. Jacob, C. Marin, M. Zebisch

A focus on mountain area



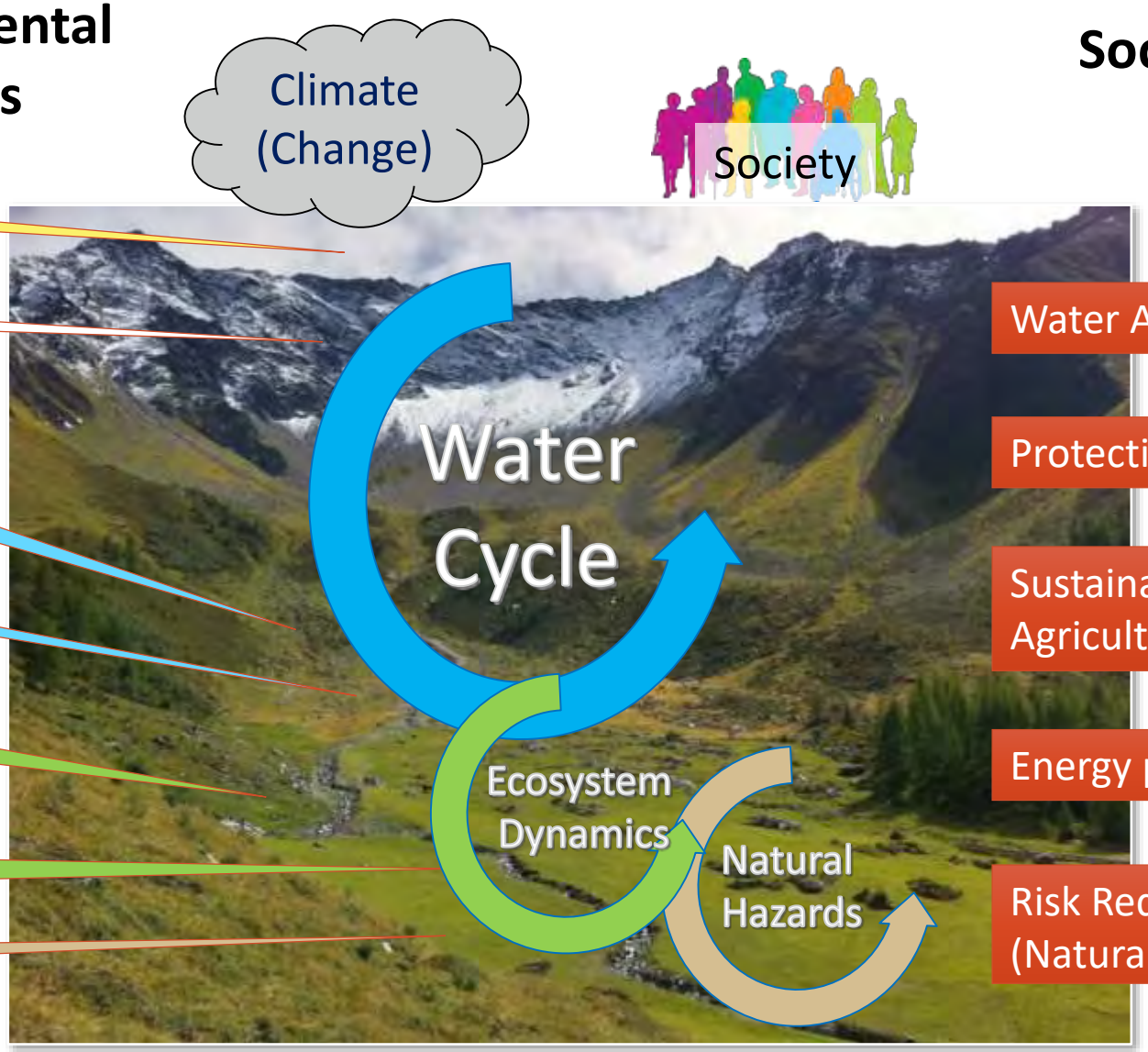
VWC: Volumetric Water Content

TU Wien ASCAT product

Earth Observation in Mountains

From EO: Key Environmental Parameter and dynamics

- Solar Radiation
- Snow Cover
- Evapo-transpiration
- Soil Moisture
- Land Cover + Ecosytems
- Vegetation Parameters
- Terrain Movement



Societal functions + Challenges

- Water Availability
- Protection of Biodiversity
- Sustainable Agriculture + Forestry
- Energy production
- Risk Reduction (Natural Hazards, Climate)

Earth Observation in Mountains

Challenges for EO in Mountains

Often Cloudy

Heterogeneous Land Cover with many transitions

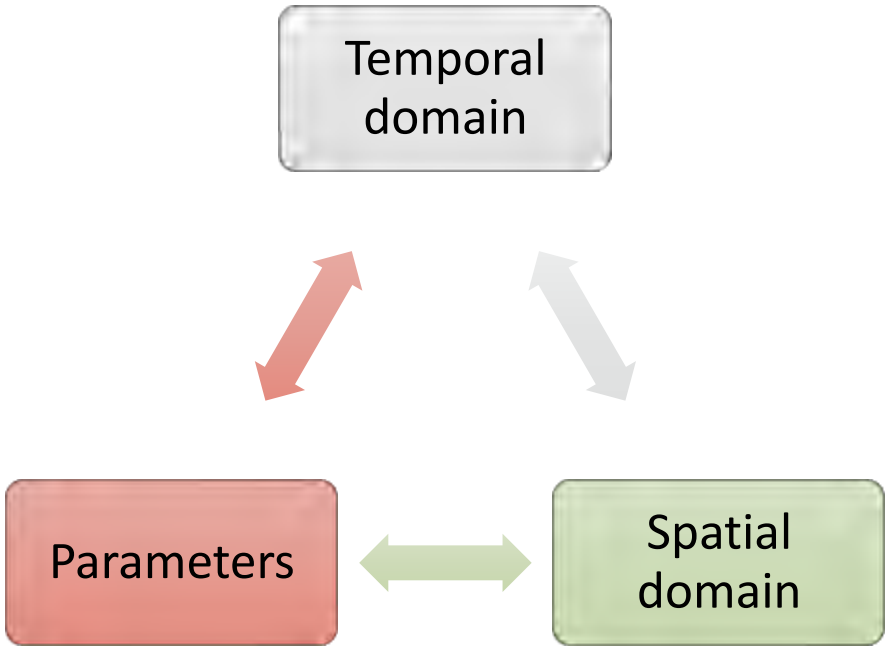
Steep Terrain

Missing In-Situ Data

The challenge: EO Observable Parameters

Many data exists for observing alpine cryosphere changes: **ground** and **satellite**

Ground data		Satellite data	
Point measurements or small areas	−	Cover wide areas (also in hardly accessible places)	+
Low revisit time (for manual measurements)	−	High revisit time	+
High accuracy	+	Low accuracy	−

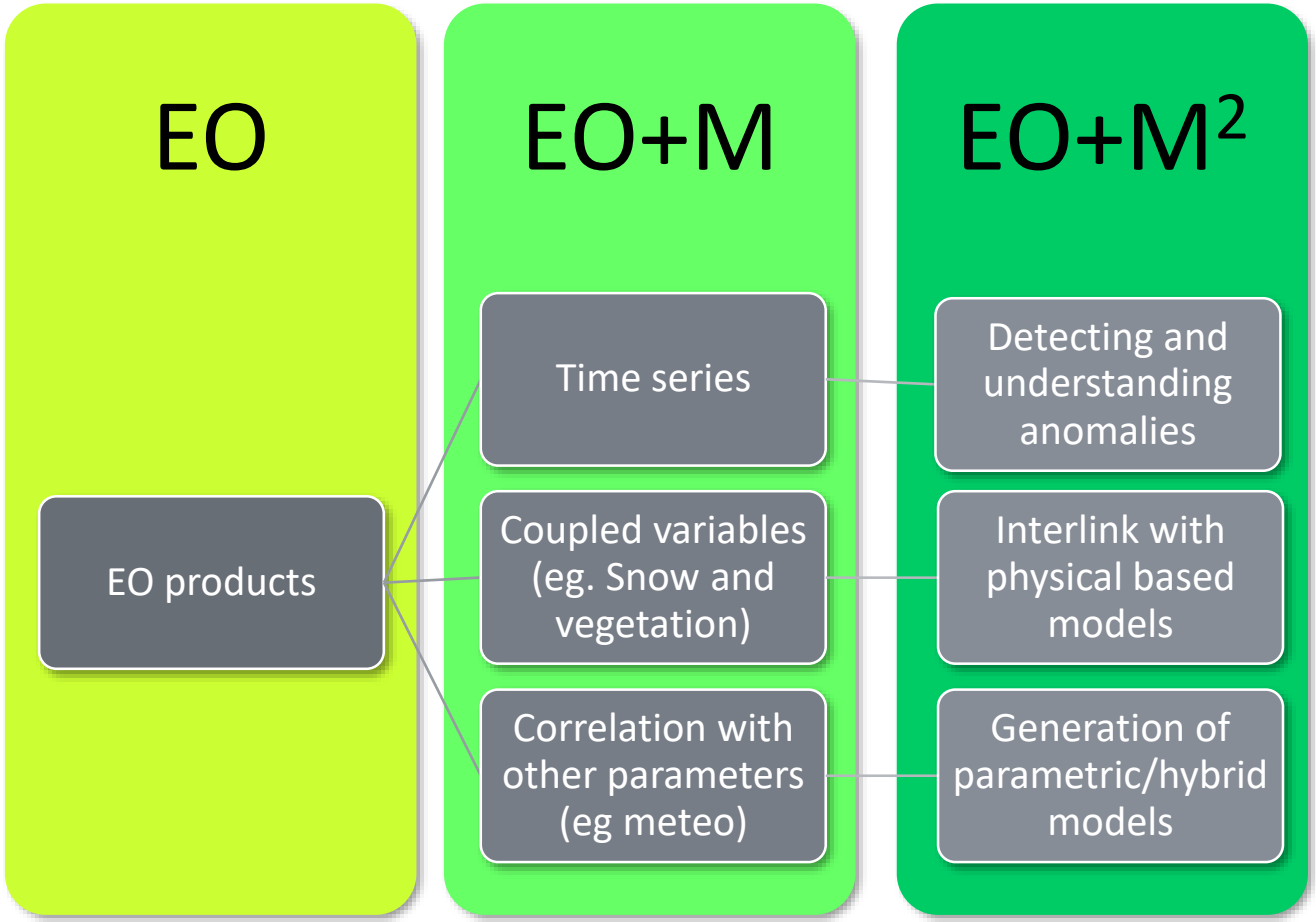


Overview of User requirements

Variables	Data Requirements			Data Specifications				
	Context	Problems	Users	Spatial Resolution	Time Resolution	Accuracy	Lead Time	Scale
Soil moisture	Agriculture	Irrigation	Consortium	Variable	Weekly			Macro
		Hydrographic services	Hydrographic office	250 m	daily			
				20 m				
Evapotraspiration	Agriculture	Irrigation		Variable				
		Vertical profiling		1km				
Snow cover	Civil Protection (e.g. avalanche forecast)	Resolution	Civil Protection	250 m	weekly			
	Tourism	Exposure	Consortium		daily			
					monthly			
Snow water equivalent	Civil Protection	Hydrographic services	SKITOUR	250 m	weekly			
	Idroelectric productivity	Wind						
Infiltration	Agriculture	Irrigation		Variable				
		Humidity						
Run-off	Civil Protection	Outlier detection			Daily			Basin
					Weekly			
River discharge	Civil Protection	variability of monthly discharge with altitude	Water resources					Basin
		48h forecasting	Idroelectric Company					
		Outlier detection						
Precipitation	Tourism	irrigation	management	250 m				
	Agriculture	measuring errors	Hydroelectric Company					
	Civil Protection	Gridded data						

The challenge: from EO products to ecosystem understanding

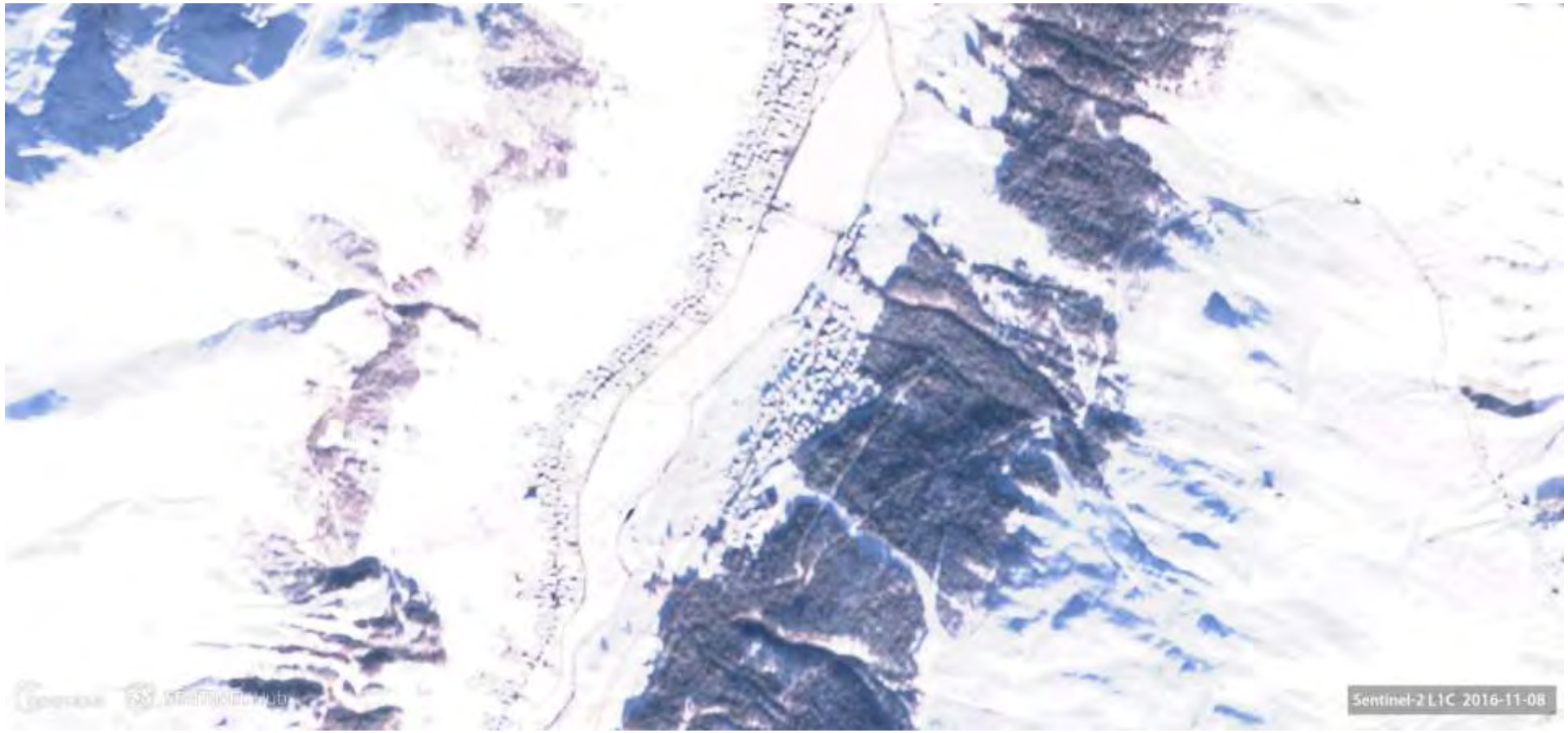
Three main semantic levels



Copernicus Sentinels – a new Era of EO

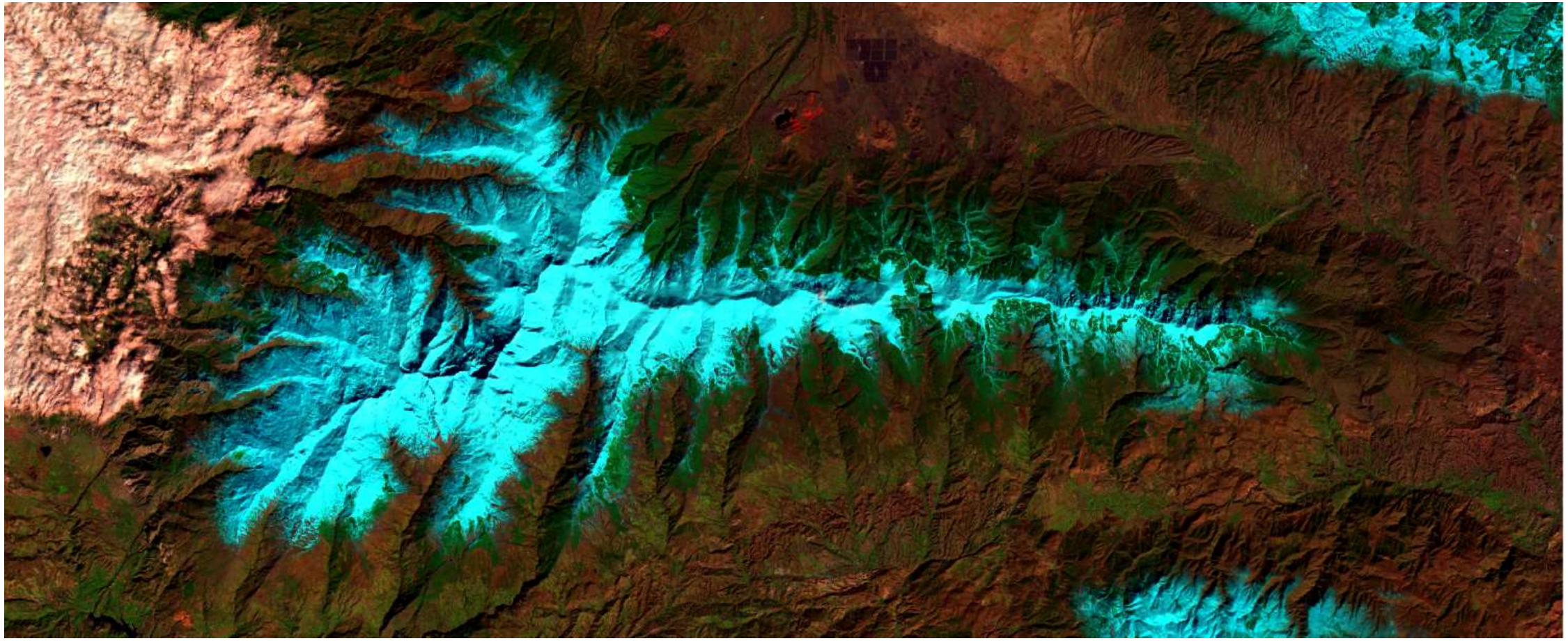
	Name	Main payload for SAO	Spatial Resolution	Temporal Resolution	Description
	Sentinel 1	C-Band SAR	20 m	6 days	• Monitoring of cryosphere, Soil Moisture, monitoring of terrain deformation
	Sentinel 2	Multispectral 13 (VIS – SWIR)	10/20 m	5 days	• Monitoring of Cryosphere and Vegetation, information for emergency services
	Sentinel 3	Multispectral 21 bands (VIS – SWIR)	300 m	1 day	• monitoring cryosphere, vegetation condition and health
	Sentinel 4	Meteosat third generation	8 km	Hour	• monitor key air quality trace gases and aerosols over Europe at high spatial resolution with a fast (hourly) revisit time
	Sentinel 5	Hyper-spectral soundings	<8 Km for λ>300nm; <50 Km for λ<300nm	1 day	• monitoring of trace gas concentrations for atmospheric chemistry and climate applications
	Sentinel 6	/	/	/	• high precision ocean altimetry measurements

Snow Monitoring: Copernicus Sentinels



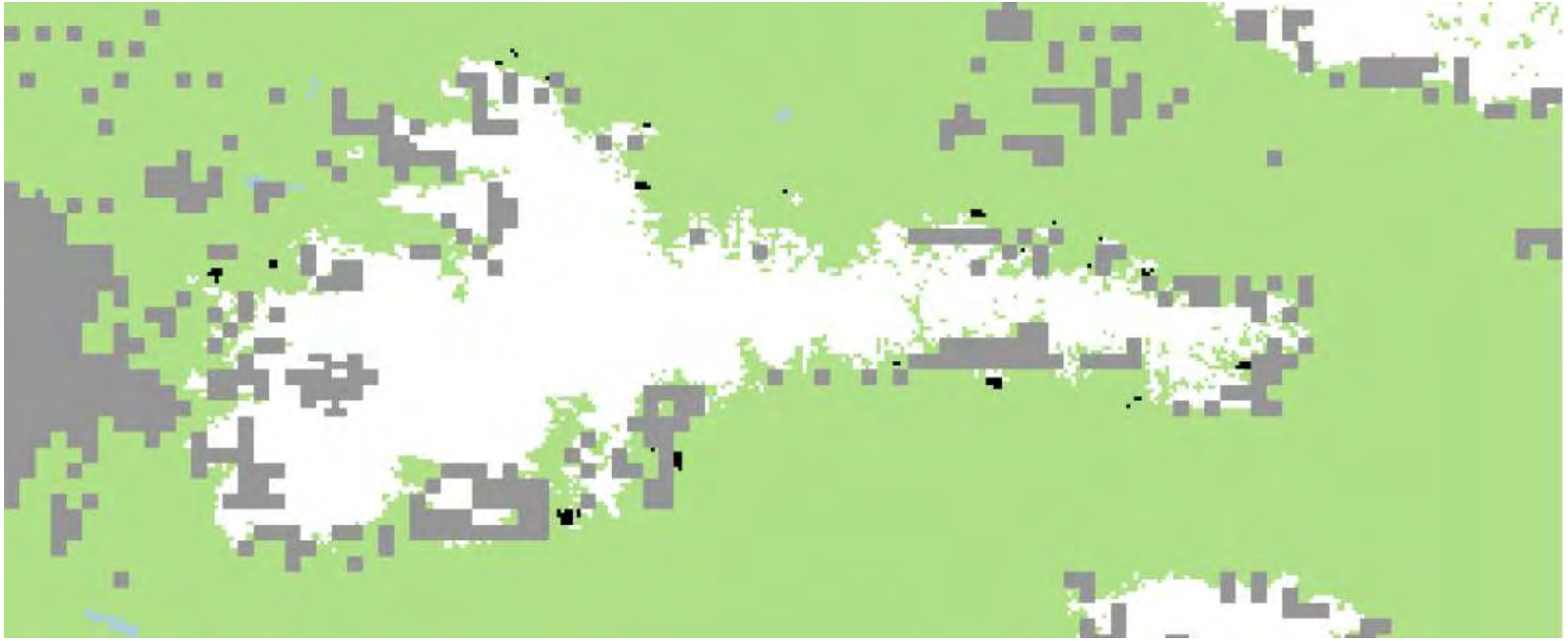
->Snow

22-Feb-2015, Sierra Nevada



Landsat-8 - R: SWIR (B7), G: NIR (B5), B: Green (B3)

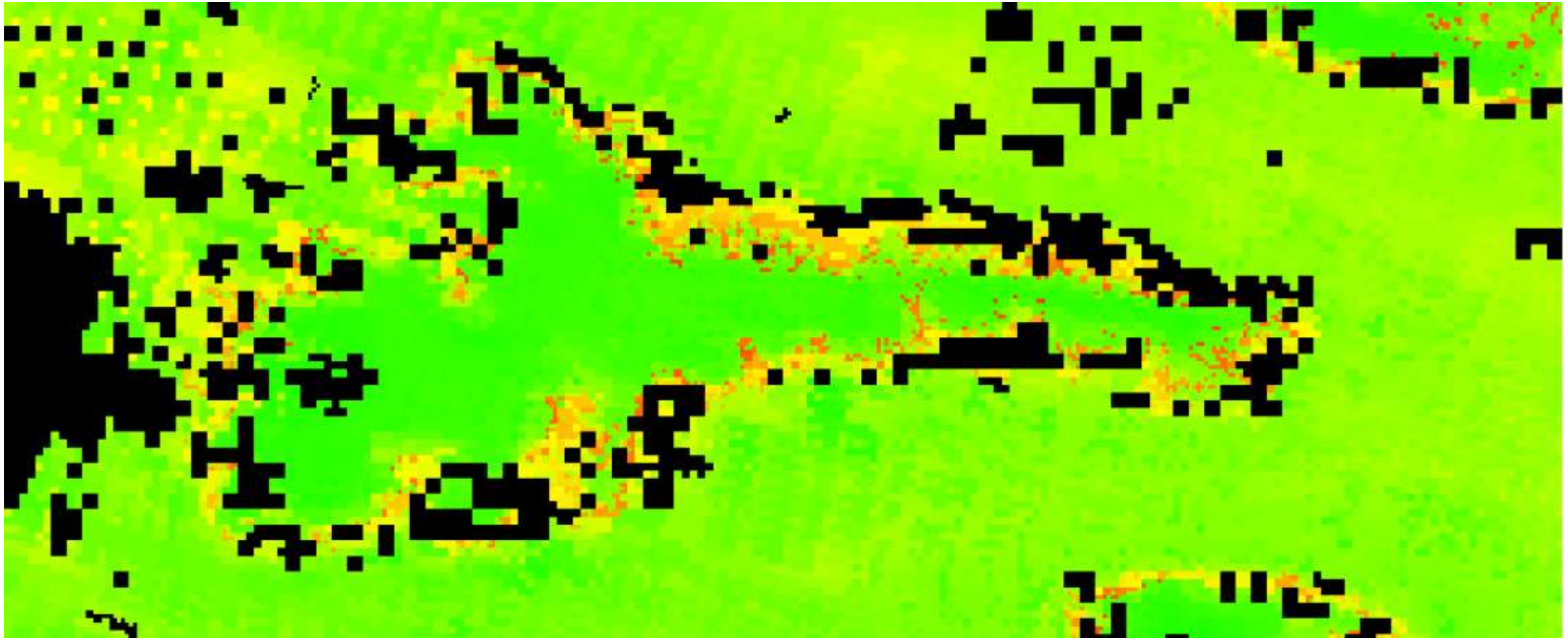
22-Feb-2015, Sierra Nevada



Snow map EURAC, 250 m resolution

(Notarnicola et al., 2013)

22-Feb-2015, Sierra Nevada

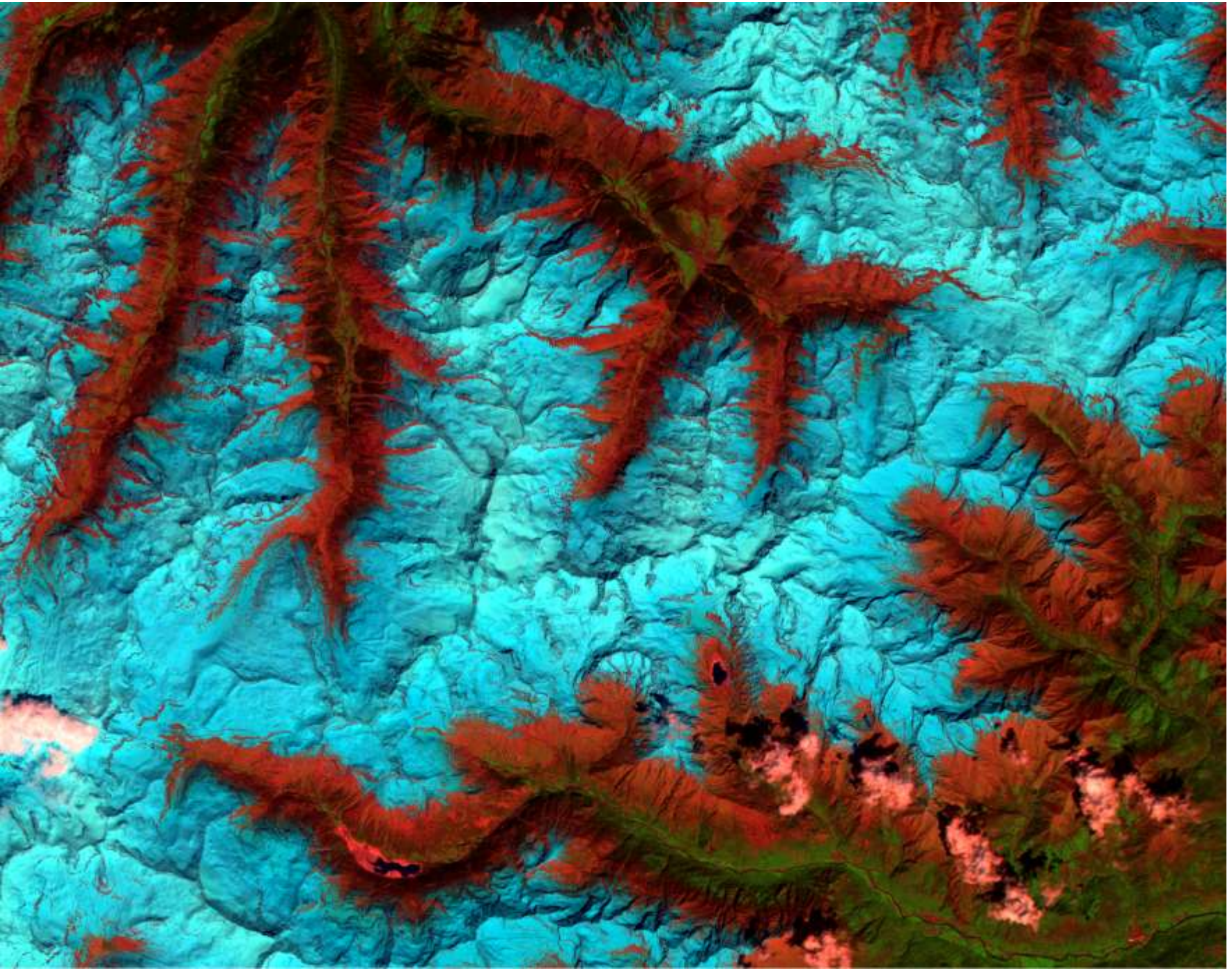


Snow map EURAC, 250 m resolution
Confidence layer

low confidence → high confidence

no data

eurac research



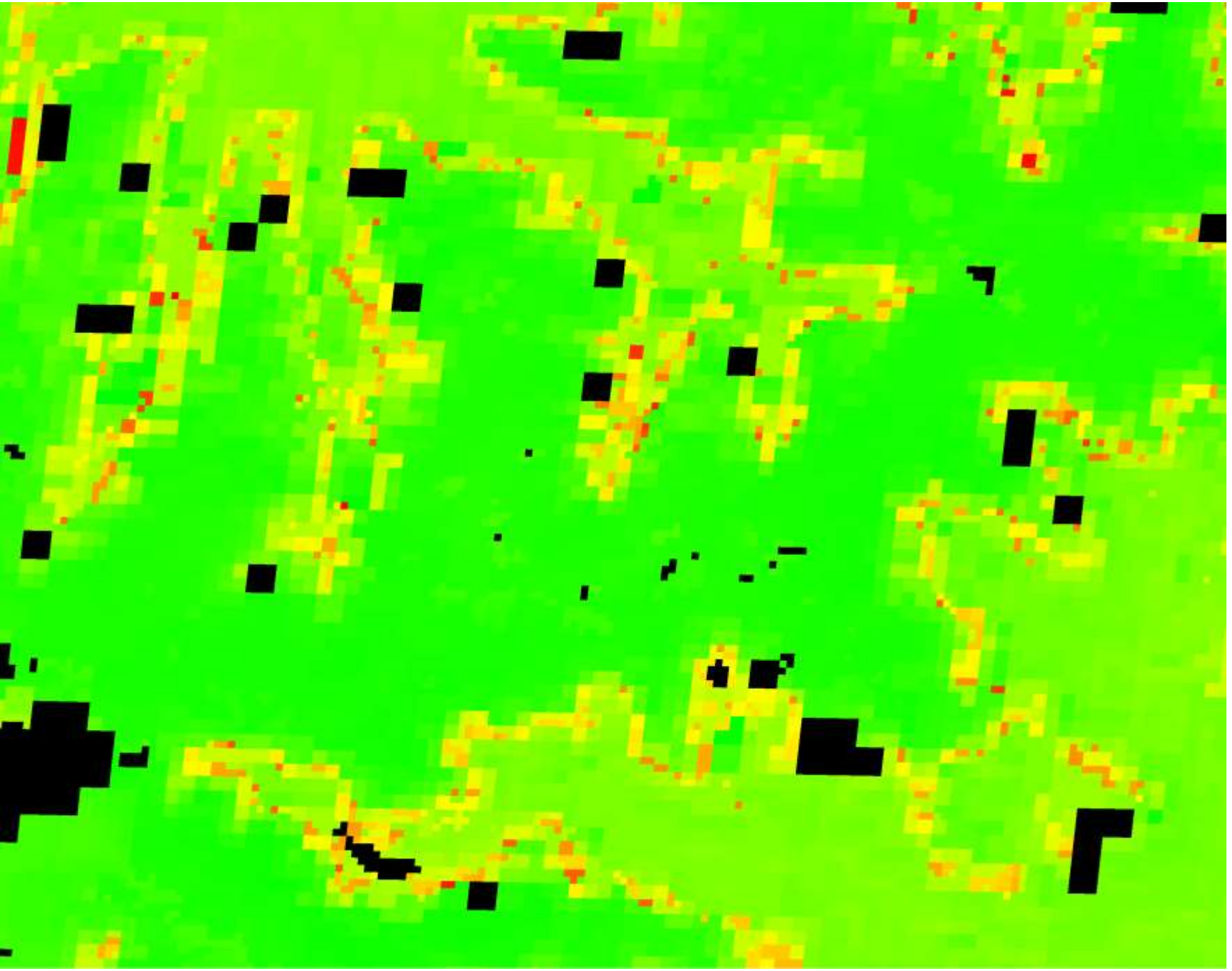
15-May-2016
Gran Paradiso

Sentinel-2
R: SWIR (B12)
G: NIR (B8)
B: Green (B3)

15-May-2016
Gran Paradiso

Snow map EURAC
250 m resolution

snow
cloud
snow free
no data

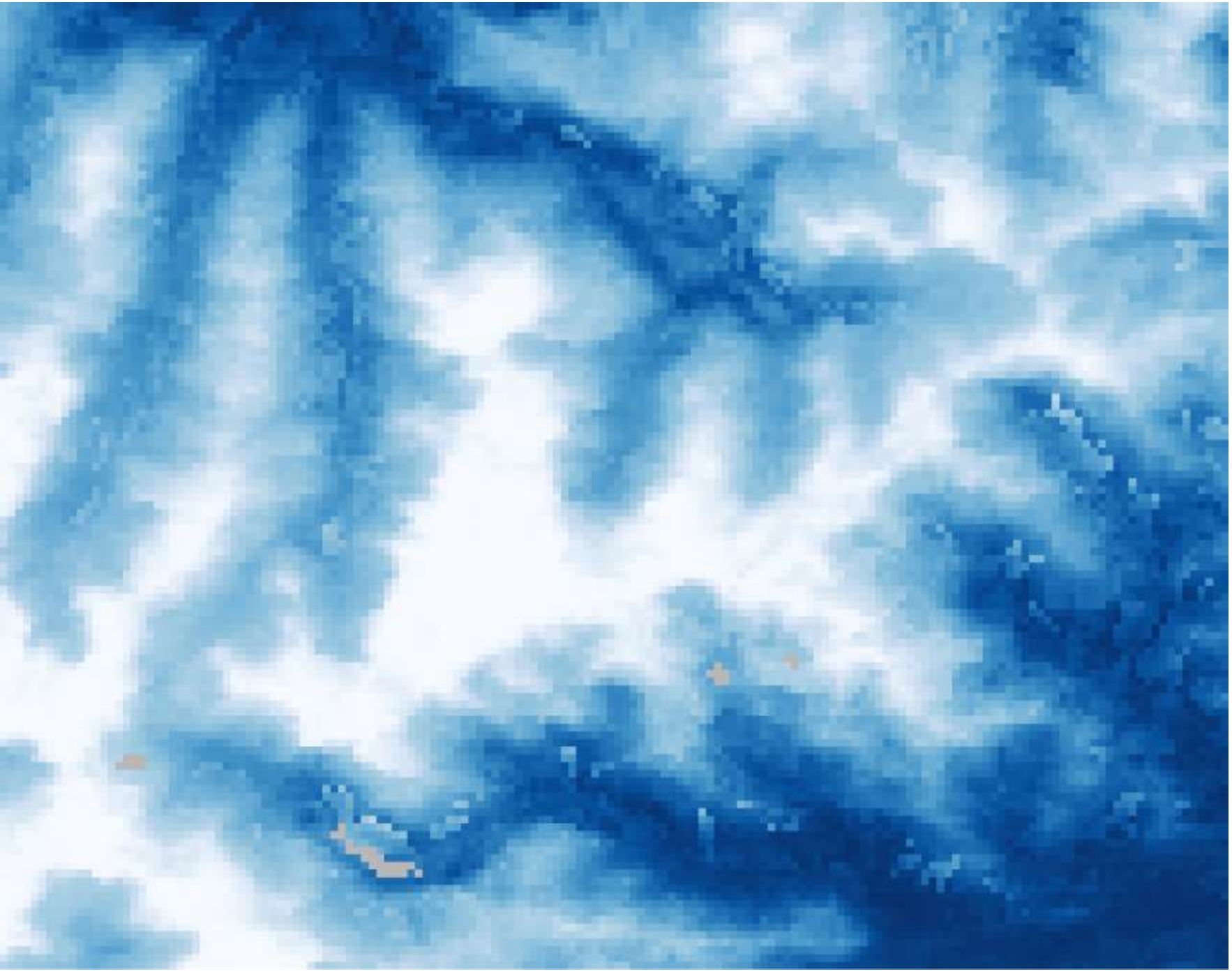


15-May-2016
Gran Paradiso

Snow map EURAC
250 m resolution
confidence layer

low confidence → high confidence

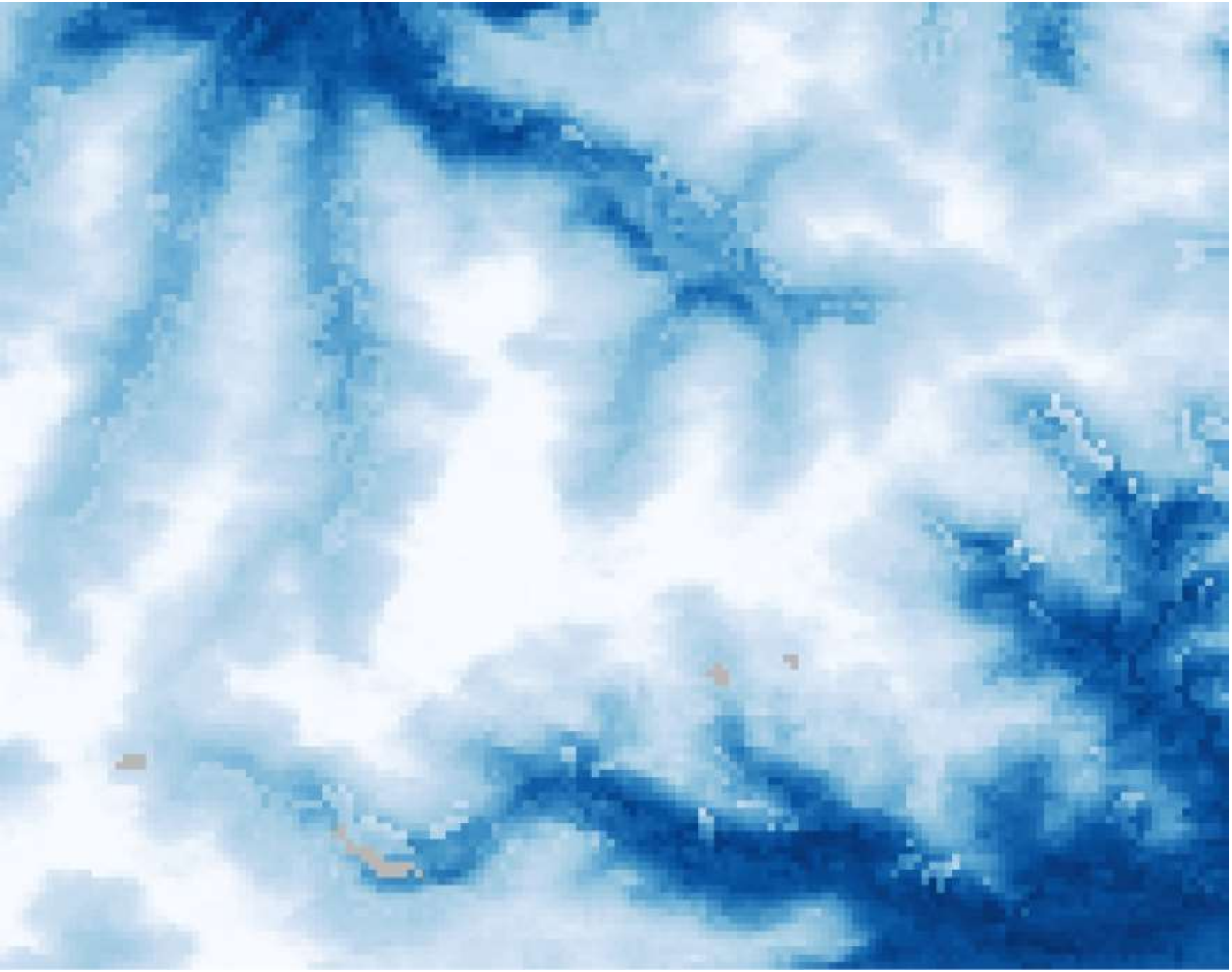
no data



Snow cover duration
Gran Paradiso
1-Oct-2006 – 30-Sep-2007

0 365 days

no data



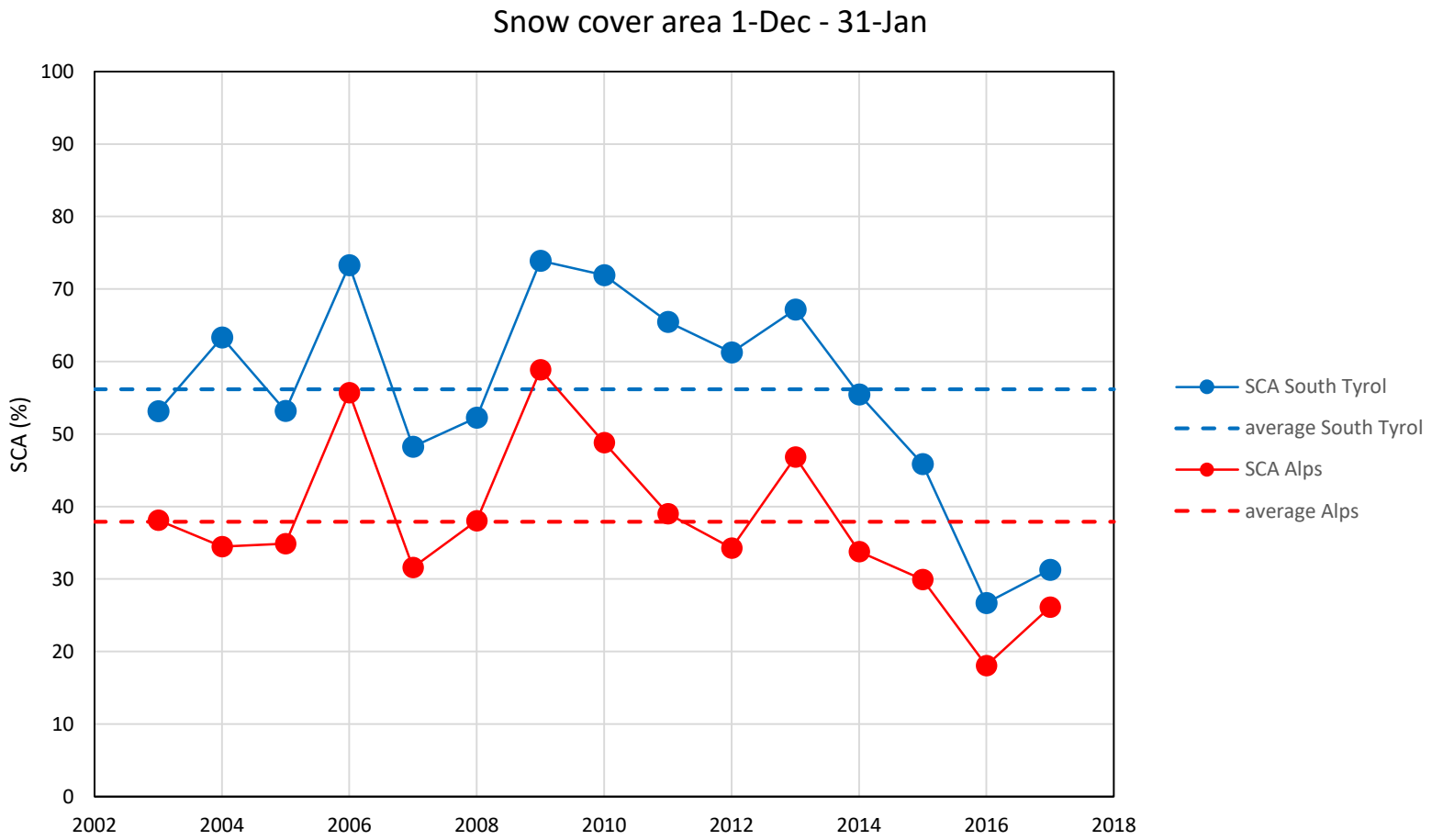
Snow cover duration
Gran Paradiso
1-Oct-2012 – 30-Sep-2013

0 — 365 days

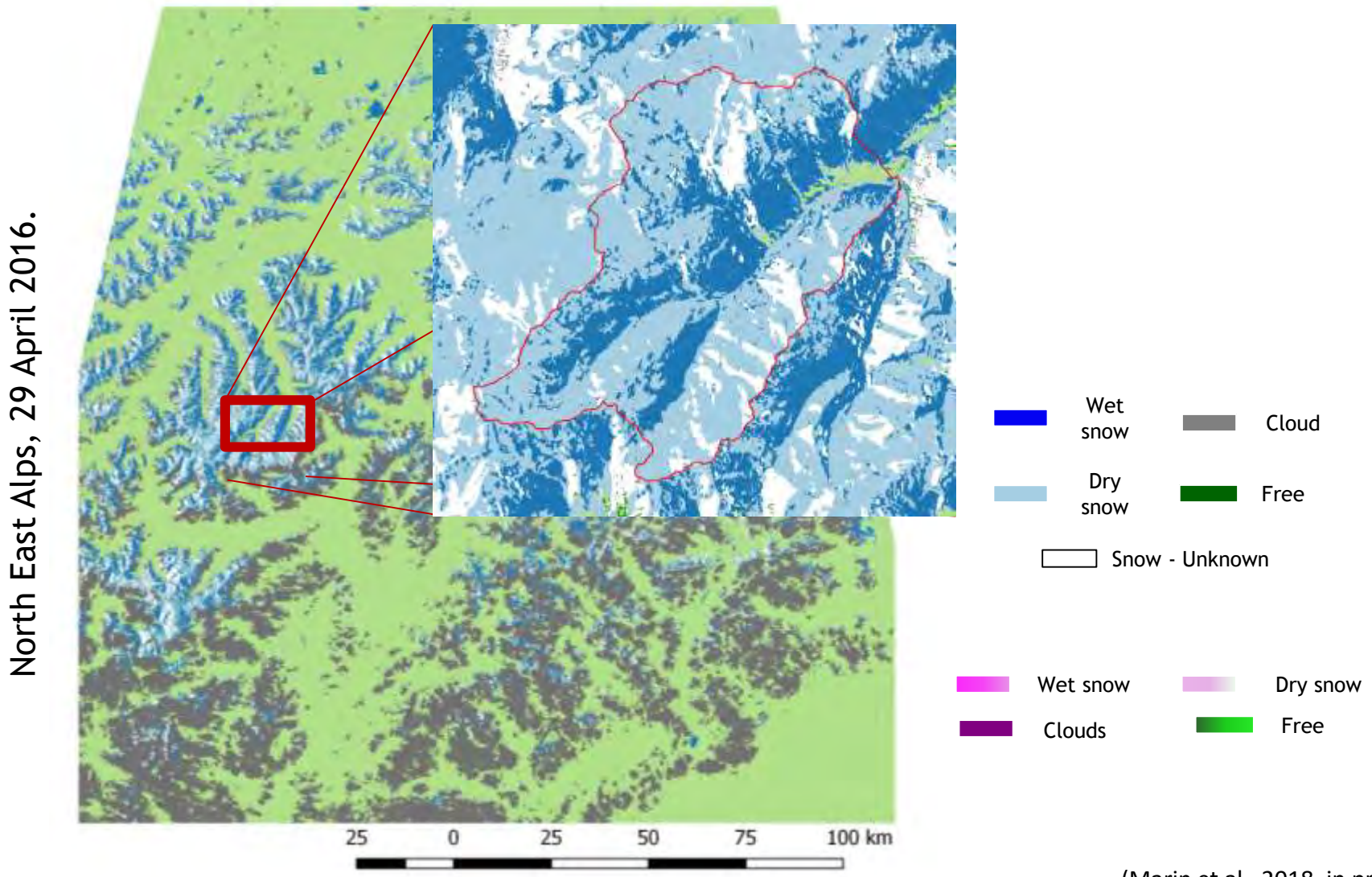
no data

(Xie et al, 2017)

How does snow cover change in the last years?



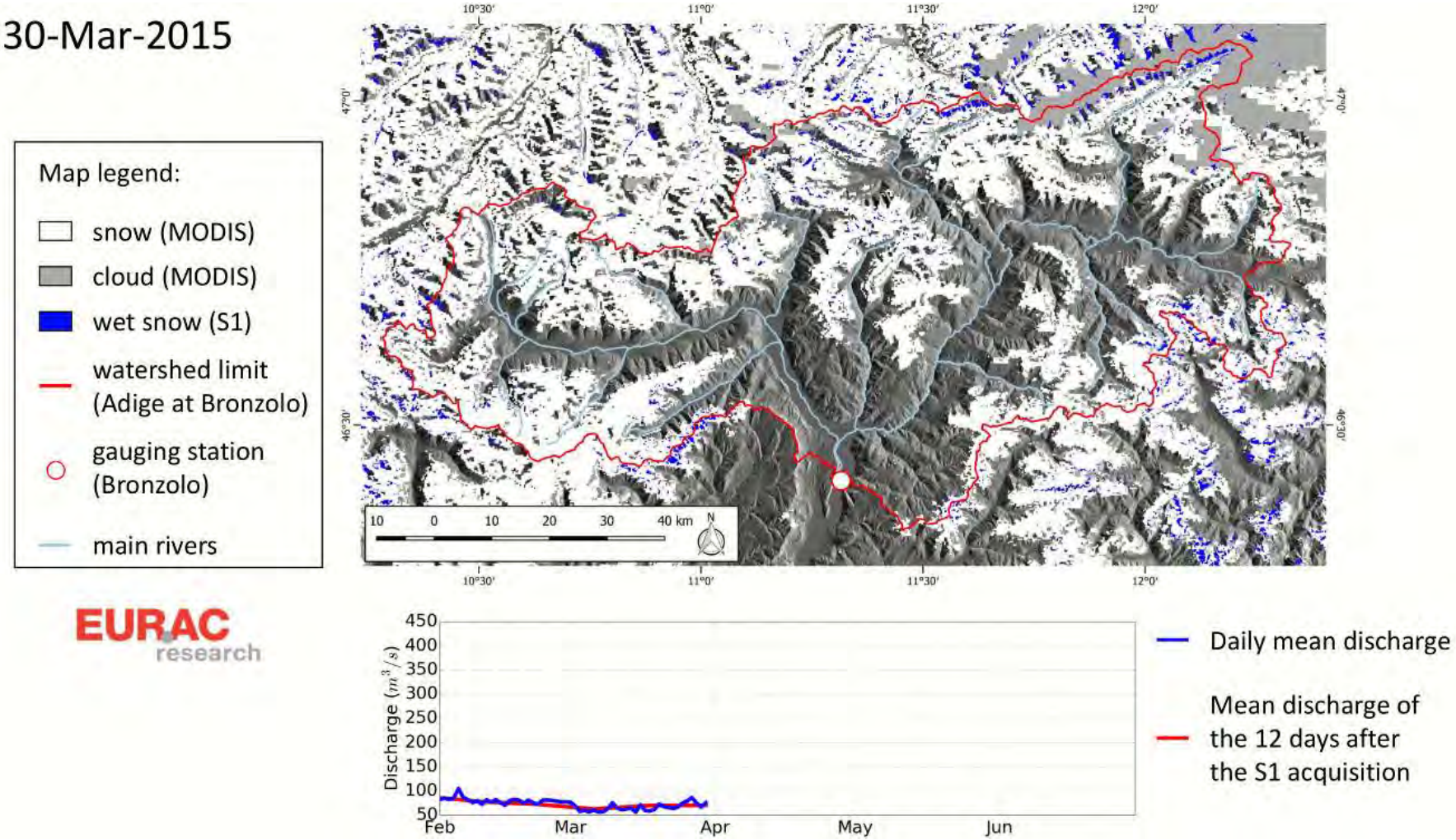
Synergy of optical and radar data: Sentinel 1 & 2

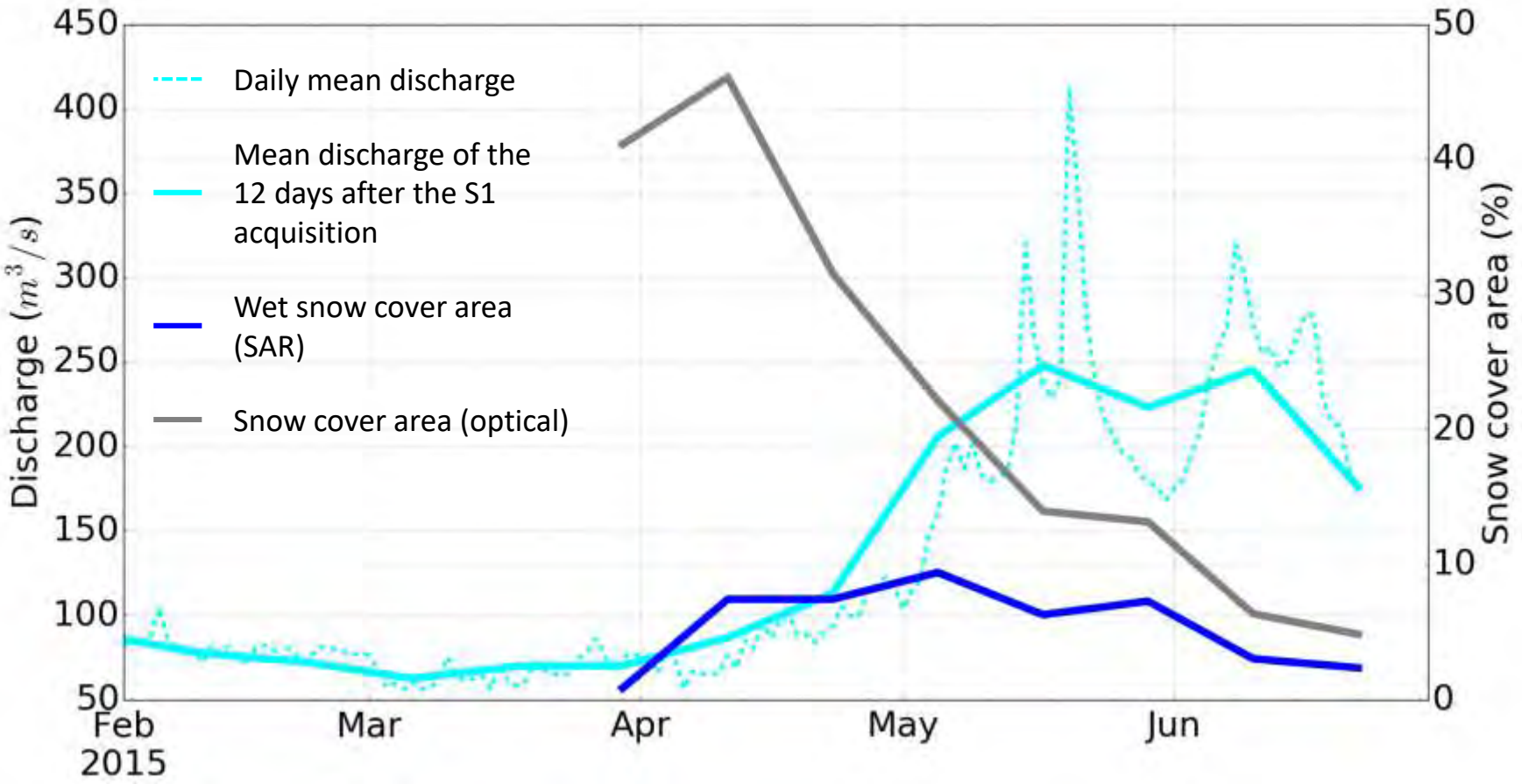


(Marin et al., 2018, in prep)

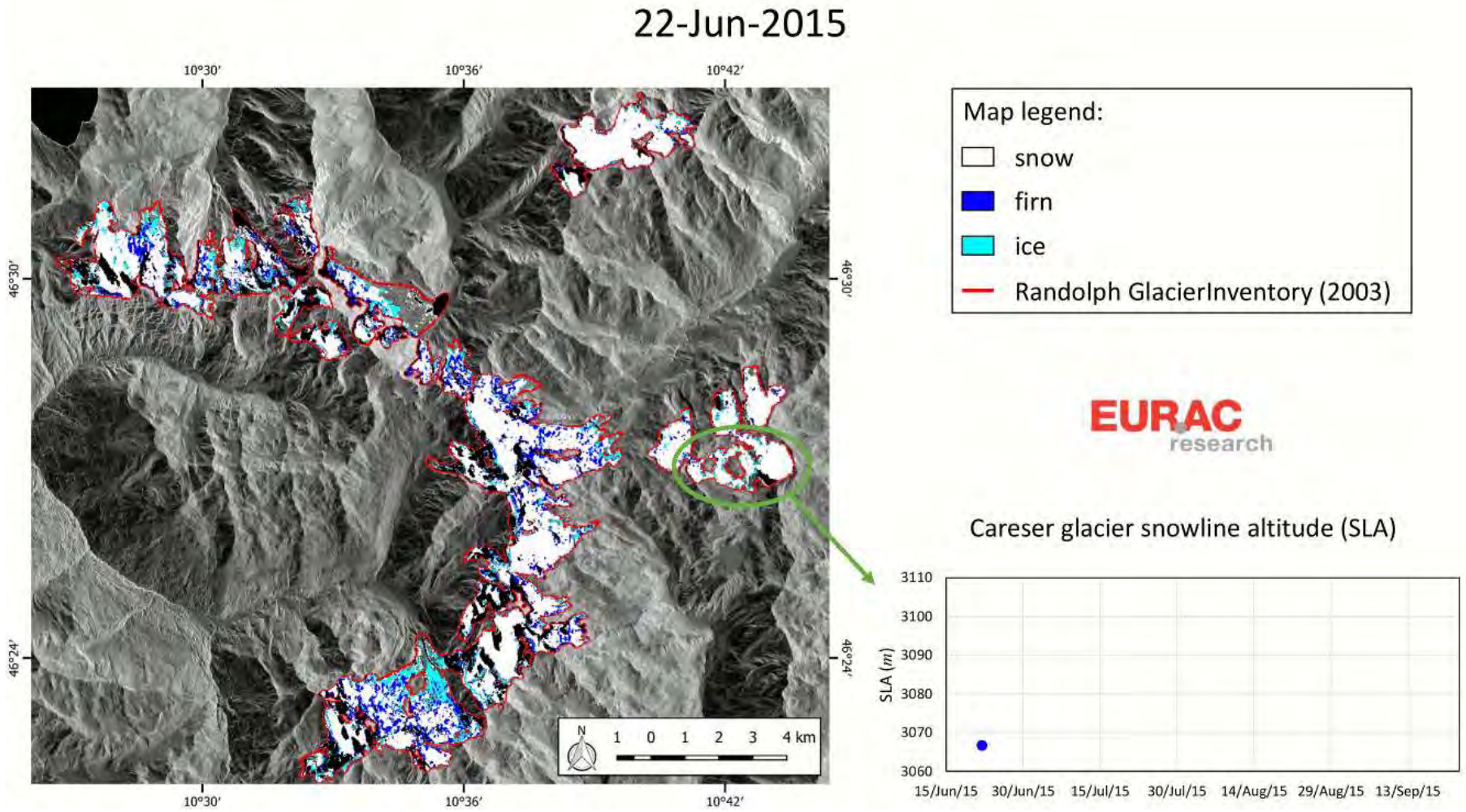
How can snow contribute to river discharge?

30-Mar-2015




Daily mean discharge
Mean discharge of the 12 days after the S1 acquisition
Wet snow cover area (SAR)
Snow cover area (optical)
Discharge (m^3/s)
Snow cover area (%)
450
400
350
300
250
200
150
100
50
50
40
30
20
10
0
Feb
2015
Mar
Apr
May
Jun

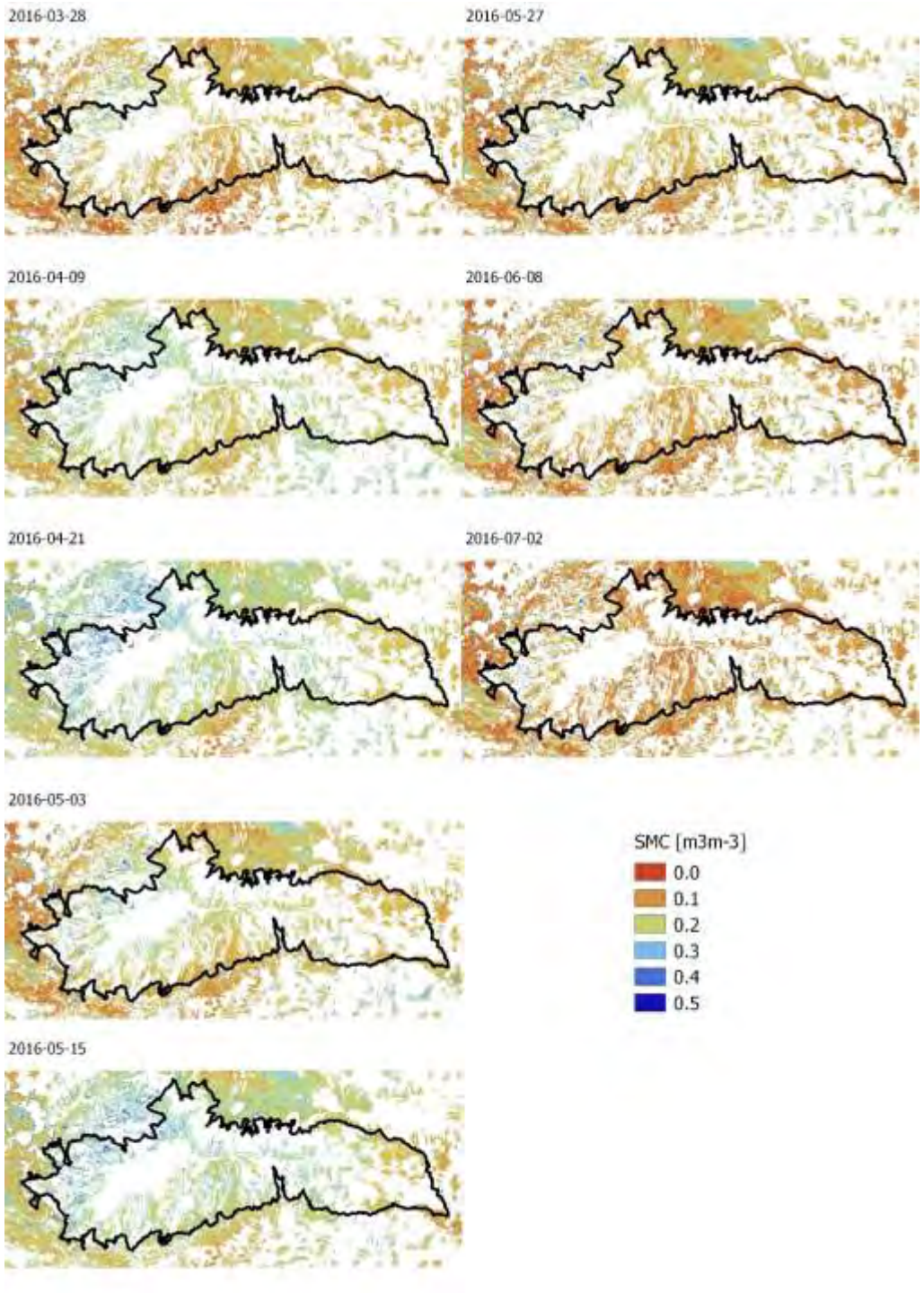
How do glaciers change in a season?



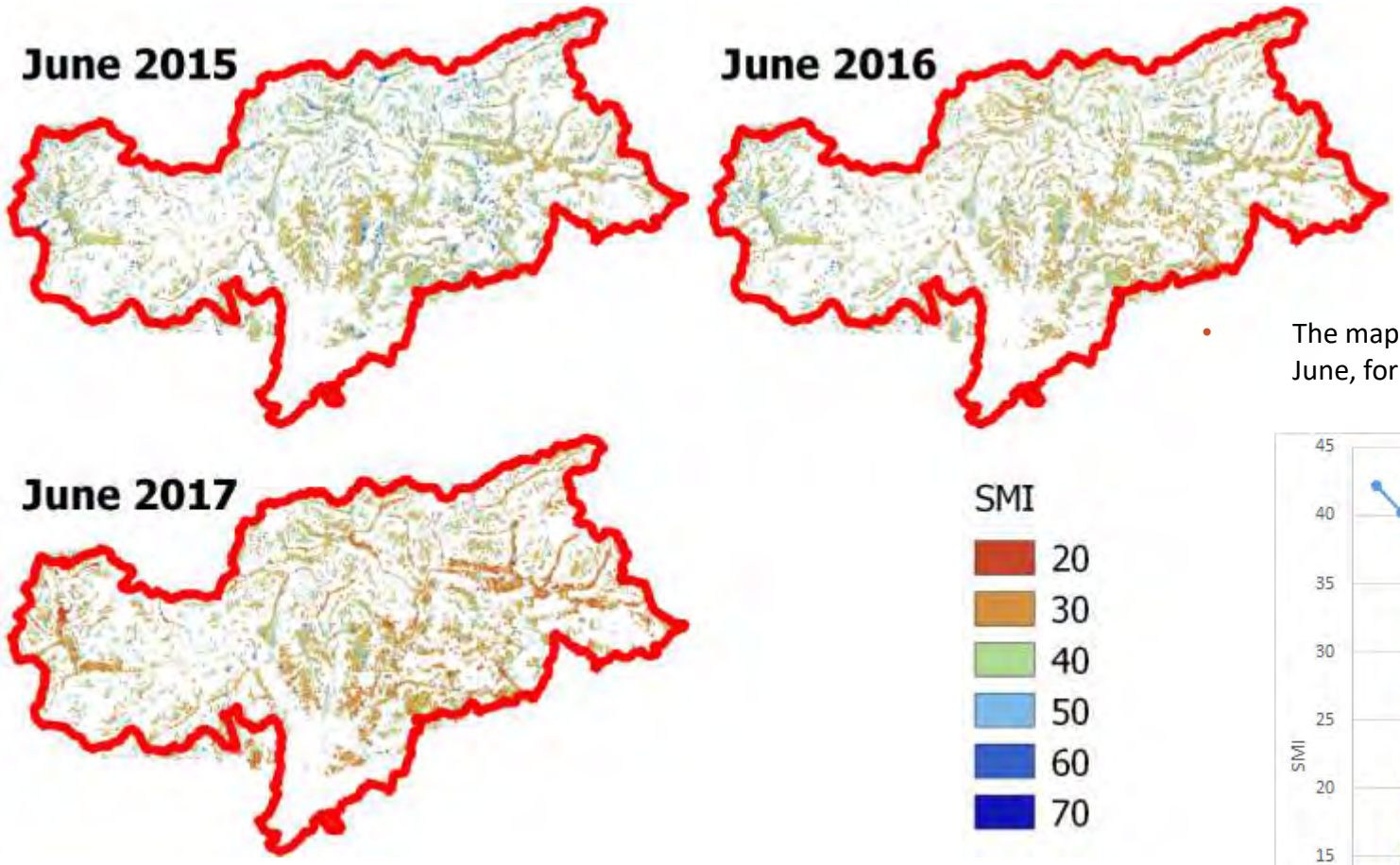
(Callegari et al, 2018, in prep)

->Soil Moisture

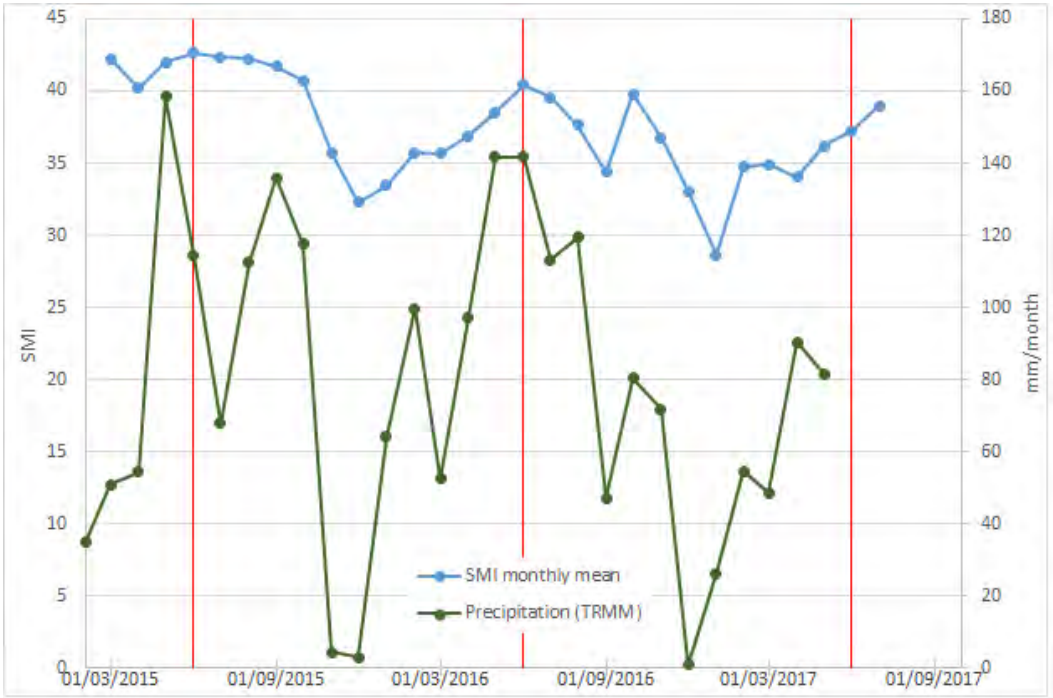
Sentinel-1 Soil Moisture: Sierra Nevada



Anomaly Detection



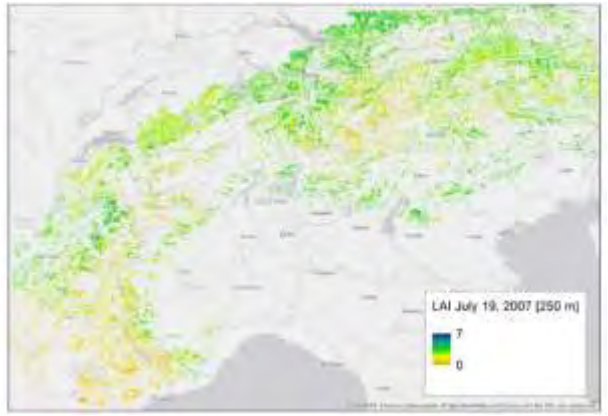
- The maps show the average (Sentinel-1) soil moisture index for the month of June, for the years 2015, 2016, and 2017



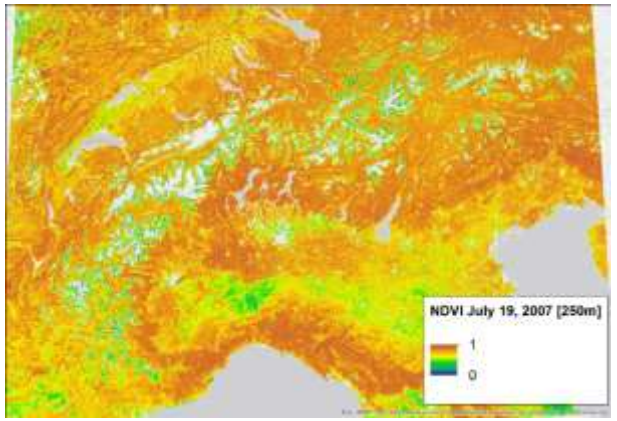
- The graph shows the monthly soil moisture index (blue line) between 2015 and 2017
- The green line precipitation estimates from TRIMM
- The red line indicates the month of June

How does snow cover duration influence vegetation development?

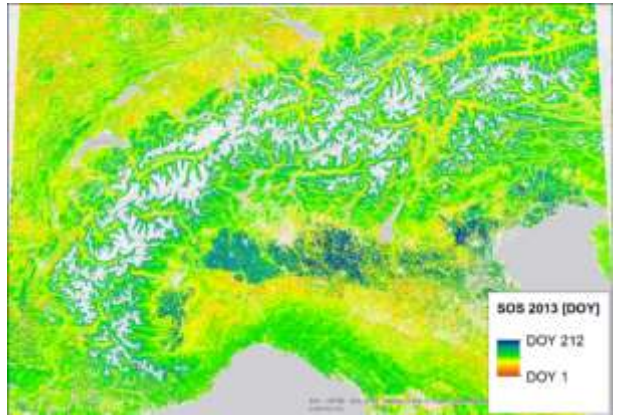
LAI

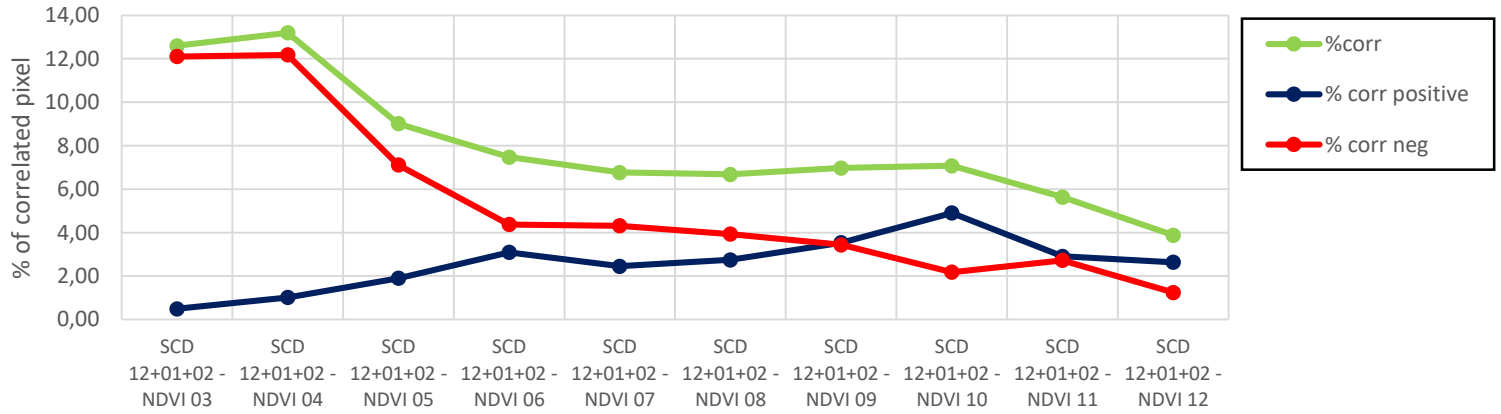


NDVI



Start of Season





(Asam et al., 2018, in prep)

Conclusions

- Generate tailored EO products to improve the detection of ecosystem in mountain areas to cope with topography and heterogenity
- Requirements for mountain regions: high spatial and temporal resolution monitoring
- ESA Sentinels: High temporal and spatial resolution environmental monitoring possible: every 5 days, 10-20 m resolution
- Big Data: new developments will be available thanks to Big Data technology
- Full exploitation of multisensor and multitemporal capability and interlink with modeling approaches
- Improve knowledge on the uncertainties in EO products
- Increase the availability of the ground information in mountain areas

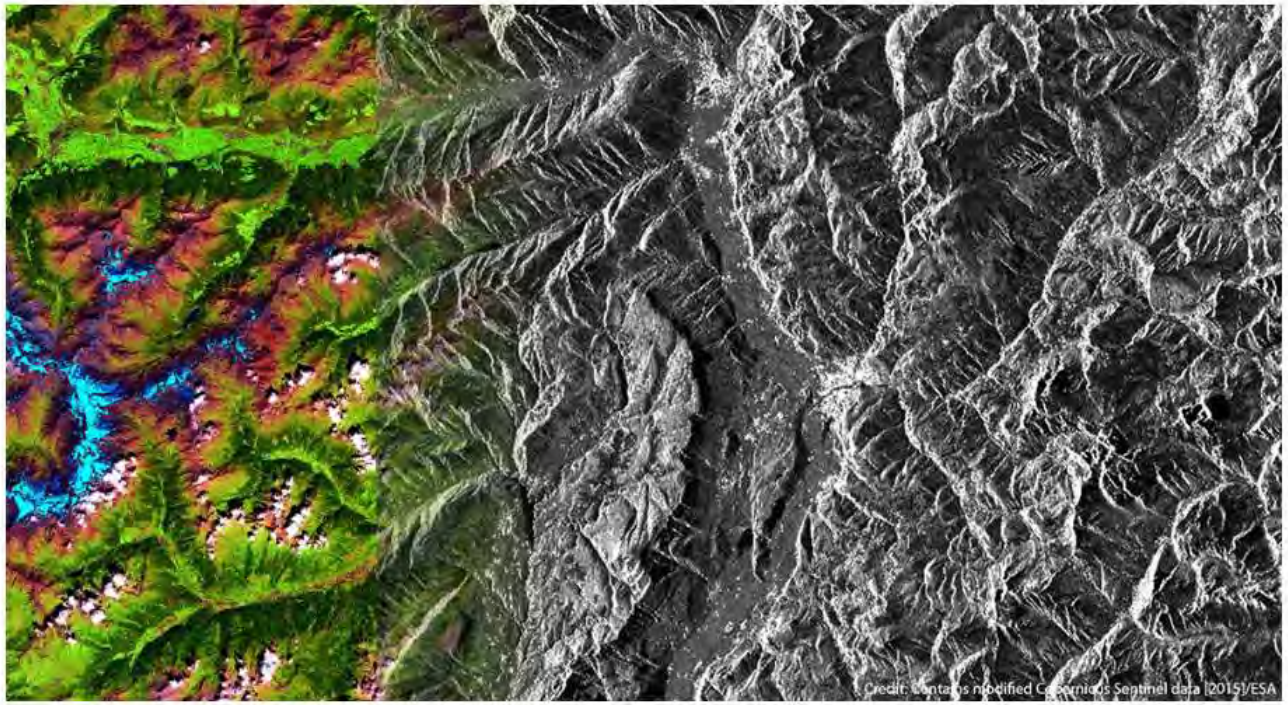
eurac research | Sentinel Alpine Observatory

SAO Sentinel Alpine Observatory

The **Sentinel Alpine Observatory** (SAO) is an initiative of the Institute for Earth Observation at Eurac Research. The aim is the development and provision of **satellite products and services**. They are mainly based on data from the **Copernicus Sentinel program** (EC/ESA) for monitoring key environmental variables in South Tyrol and the **European Alps**.

http://sao.eurac.edu/

Latest from the Blog



Welcome to the Sentinel Alpine Observatory