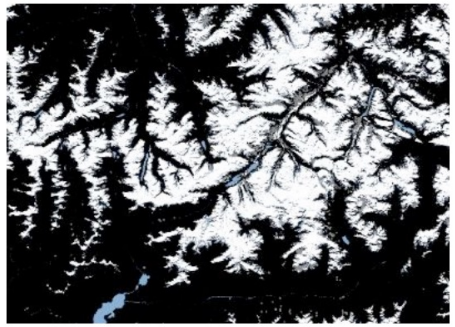
Fractional Snow Cover 2016-present (raster 20 m), Europe, daily

General info

Download



Provides at pan-European level according to Sentinel-2 revisit (5 days) and in near real time daily values of the snow fraction as the percentage at the top of canopy and on ground. The data are available at 20 m x 20 m spatial resolution with the temporal extent from 2016 to present. The concept and methodology used to generate this layer were updated and improved between 2024 and 2025. These changes have been fully implemented since January 2025. A complete reprocessing of the data back to 2016 is underway to homogenize the time series.

Validation status

Validated

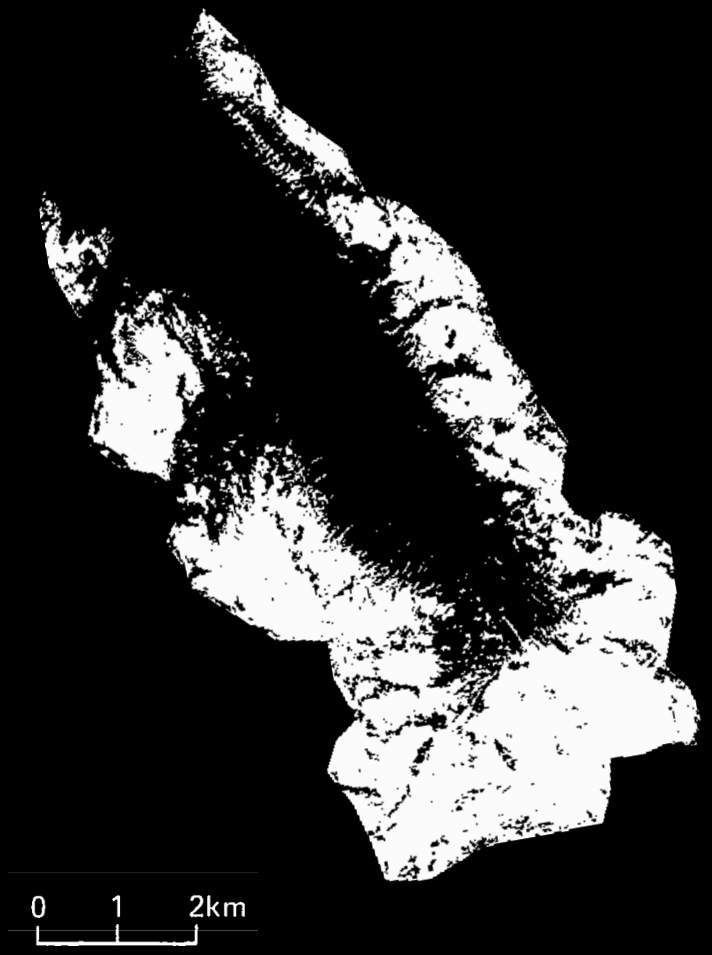
Dataset citation

- **DOI:** https://doi.org/10.2909/4a9529e9-4f5e-401f-bd72-dde7068848f6

You can find instructions on how to cite CLMS data in our Data policy section.

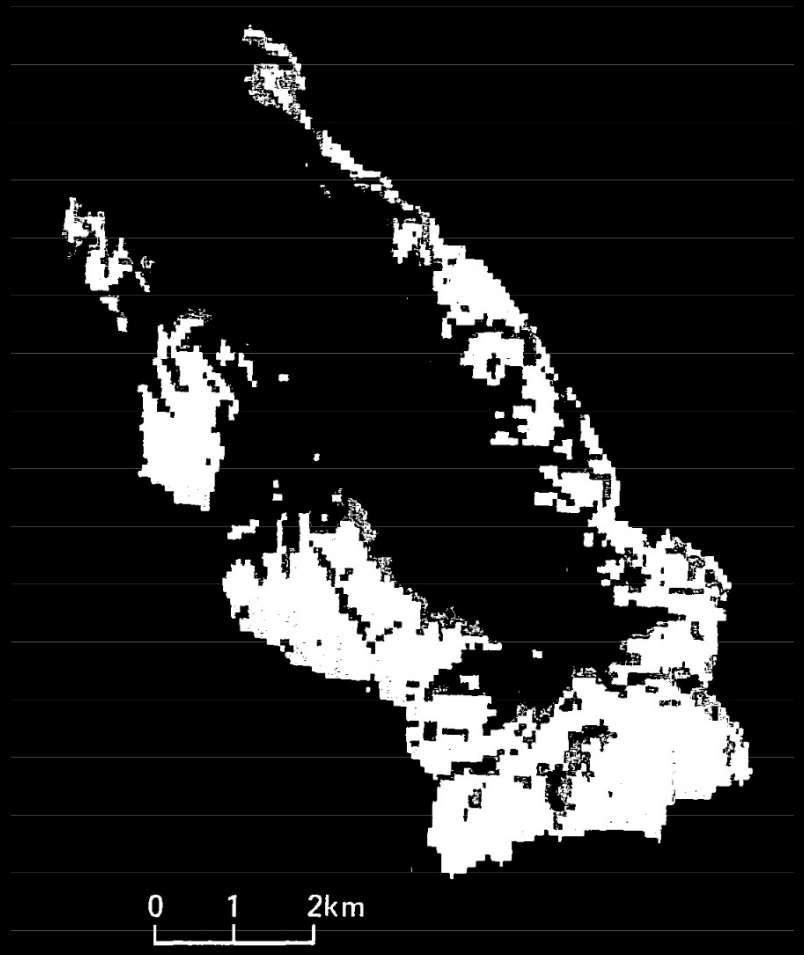
Characteristics

Dischma, 19 Jun 2024



Sentinel-2
(786km)

Dischma, 08 Jun 1976
Rango & Martinec (1979)



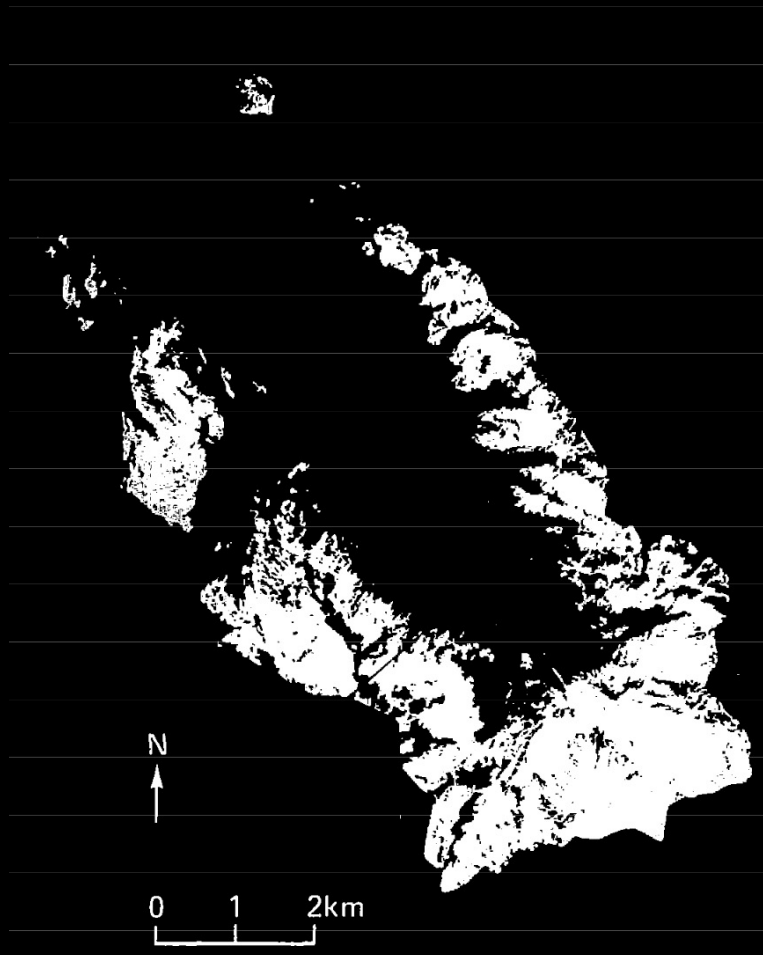
LANDSAT DIGITAL CLASSIFICATION
(920km)

Dischma, 19 Jun 2024
Gascoin (yesterday night)

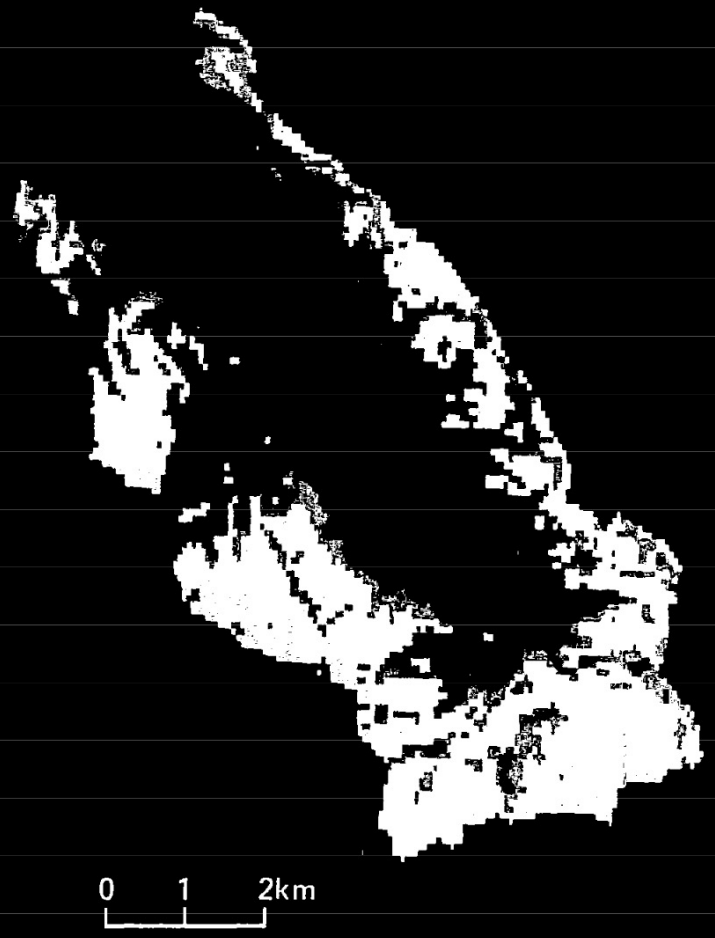
SENTINEL-2
(786km)

Dischma, Suisse, 08 juin 1976
Rango & Martinec (1979)

Dischma, Suisse, 19 juin 2024
Gascoin (hier soir)



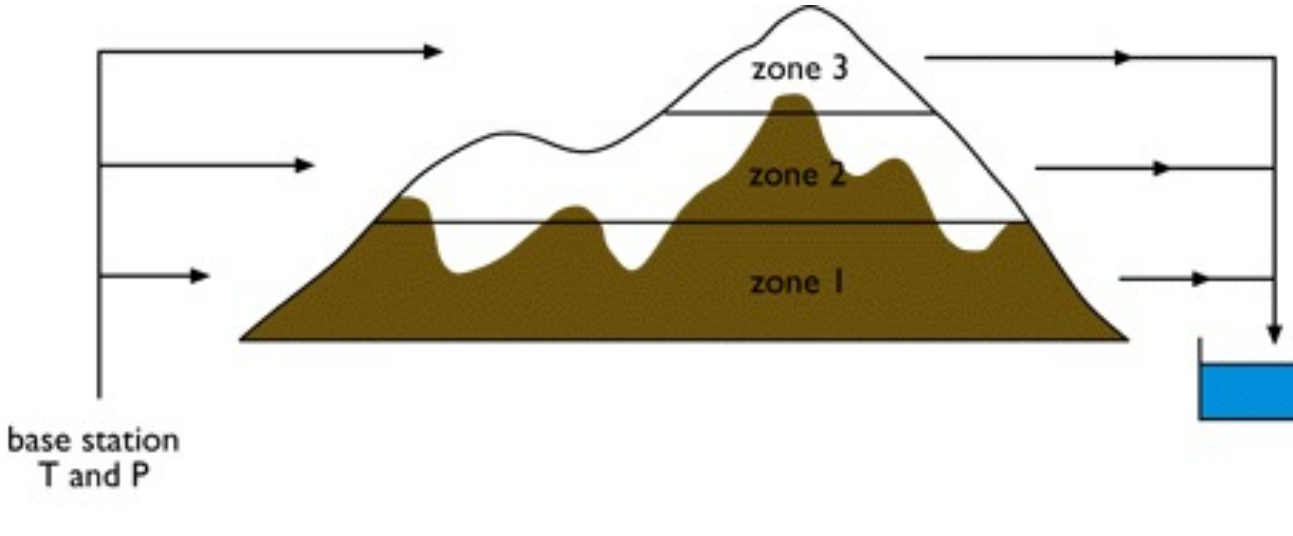
AIRCRAFT ORTHOPHOTO
(9.80km)



LANDSAT DIGITAL CLASSIFICATION
(920km)

SENTINEL-2
(786km)

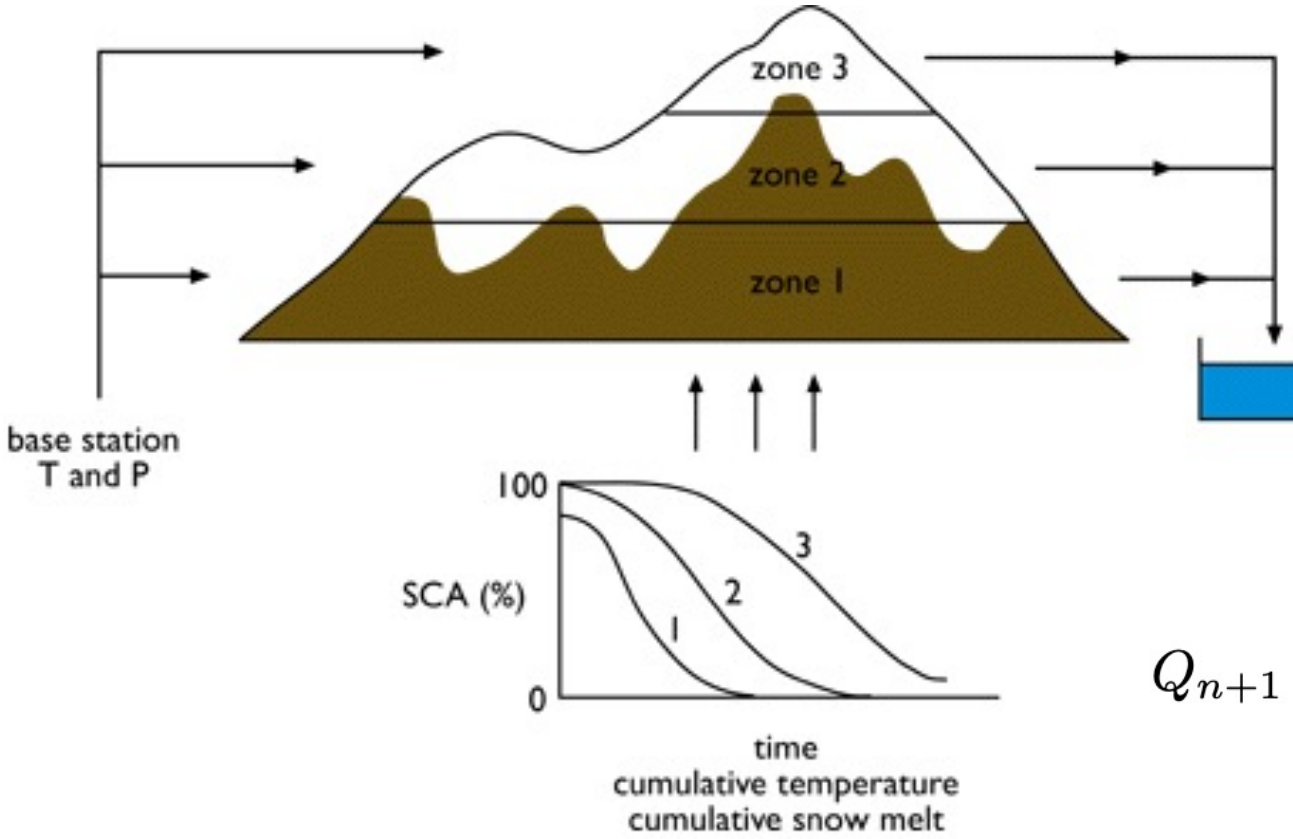
Snowmelt runoff model (1983)



$$Q_{n+1} = k_r Q_n + (1 - k_r)(K_d T_a S + P_l)$$

DeWalle & Rango (2008)

Snowmelt runoff model (1983)



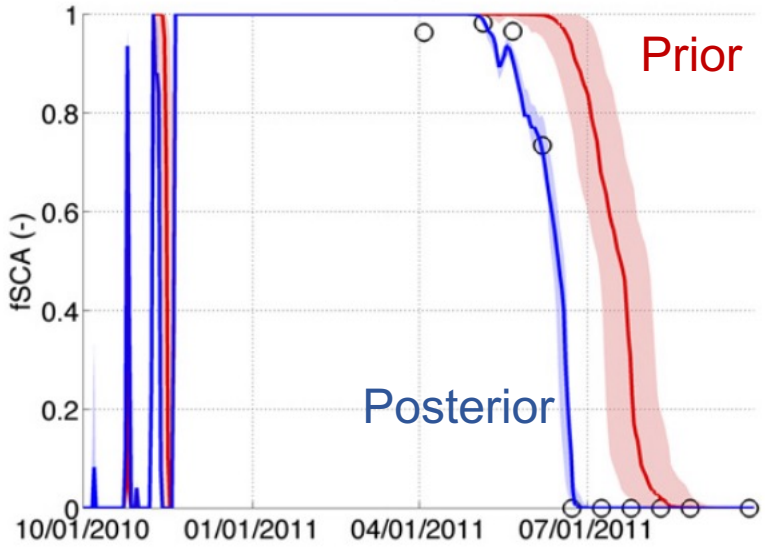
$$Q_{n+1} = k_r Q_n + (1 - k_r)(K_d T_a S + P_l)$$

$$Q_{n+1} = K_r Q_n + (1 - K_r) \sum_i (K_{d,i} T_{a,i} S_i + P_{l,i})$$

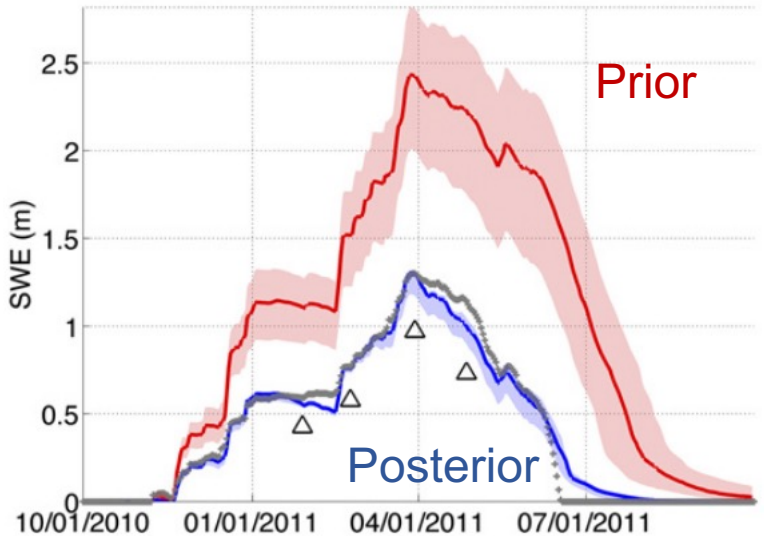
DeWalle & Rango (2008)

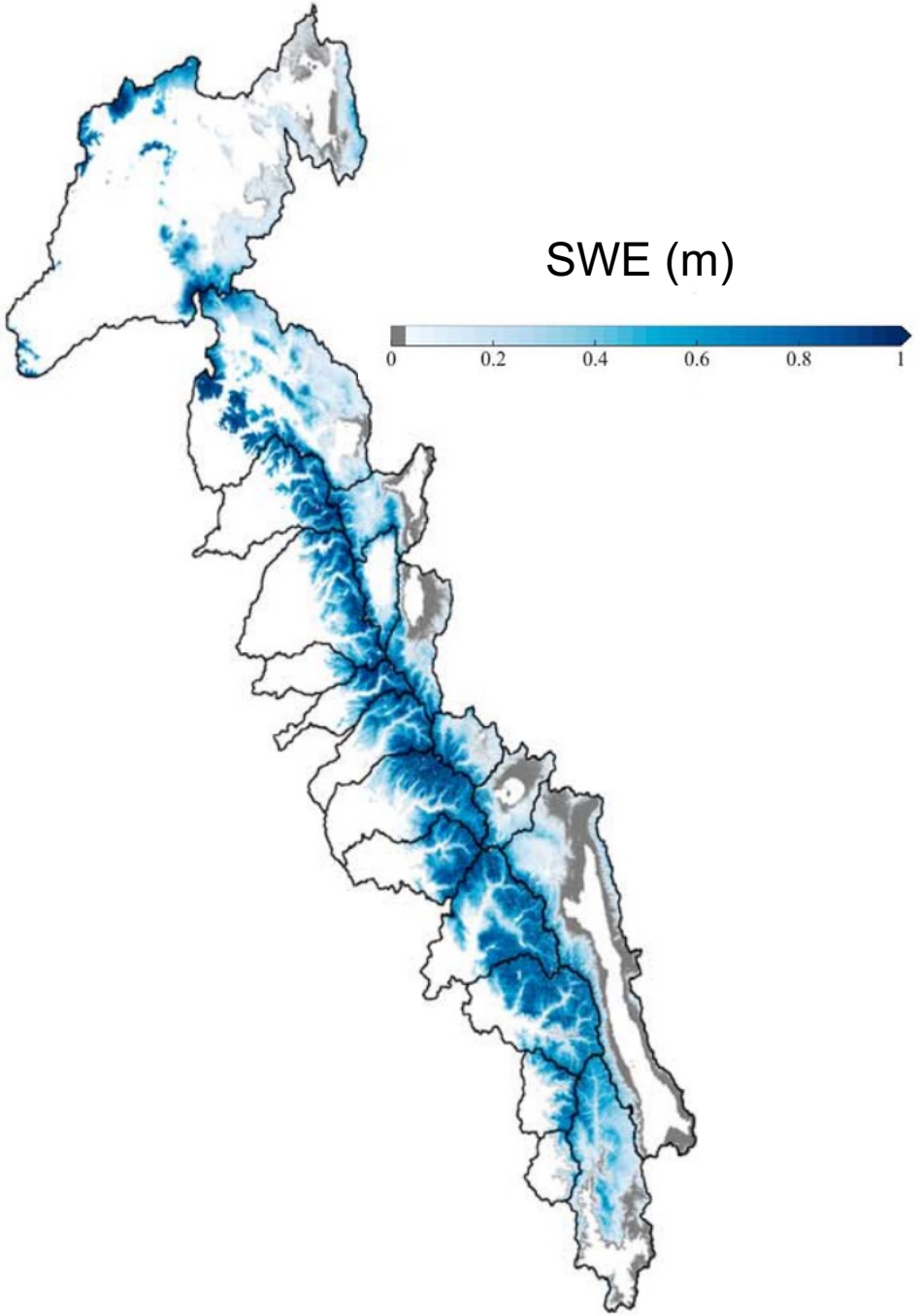
Particle Batch Smoother (1983)

Fractional snow cover area



SWE





Margulis et al. (2015, 2016)

The Cryosphere, 9, 1191–1202, 2015
www.the-cryosphere.net/9/1191/2015/
doi:10.5194/tc-9-1191-2015

The Cryosphere Open Access

User requirements for the snow and land ice services – CryoLand

E. Malnes[1], A. Buanes[1], T. Nagler[2], G. Bippus[2], D. Gustafsson[3], C. Schiller[4], S. Metsämäki[5], J. Pulliainen[6], K. Luojus[6], H. E. Larsen[7], R. Solberg[8], A. Diamandi[9], and A. Wiesmann[10]

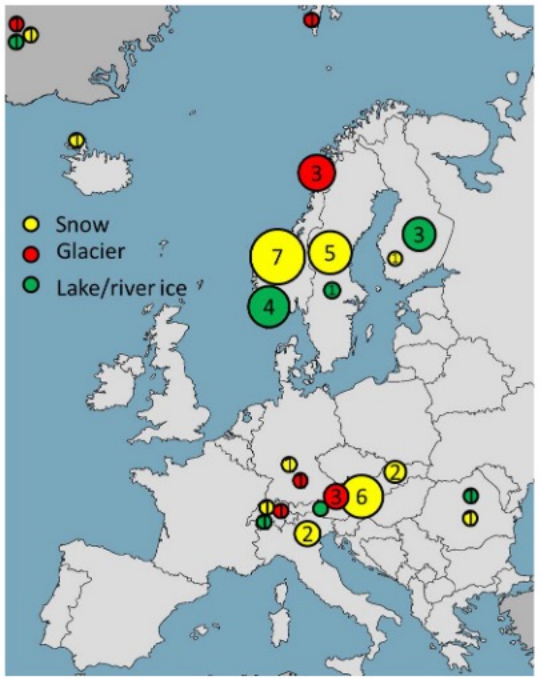
[1]Norut, Tromsø, Norway
[2]ENVEO, Innsbruck, Austria
[3]Swedish Meteorological and Hydrological Institute, Norrkjöping, Sweden
[4]EOX, Vienna, Austria
[5]Finish Environmental Institute, Helsinki, Finland
[6]Finish Meteorological Institute, Helsinki, Finland
[7]Kongsberg Satellite Services, Tromsø, Norway
[8]Norwegian Computing Centre, Oslo, Norway
[9]Administratia Nationala de Meteorologie, Bucharest, Romania
[10]Gamma Remote Sensing, Bern, Switzerland

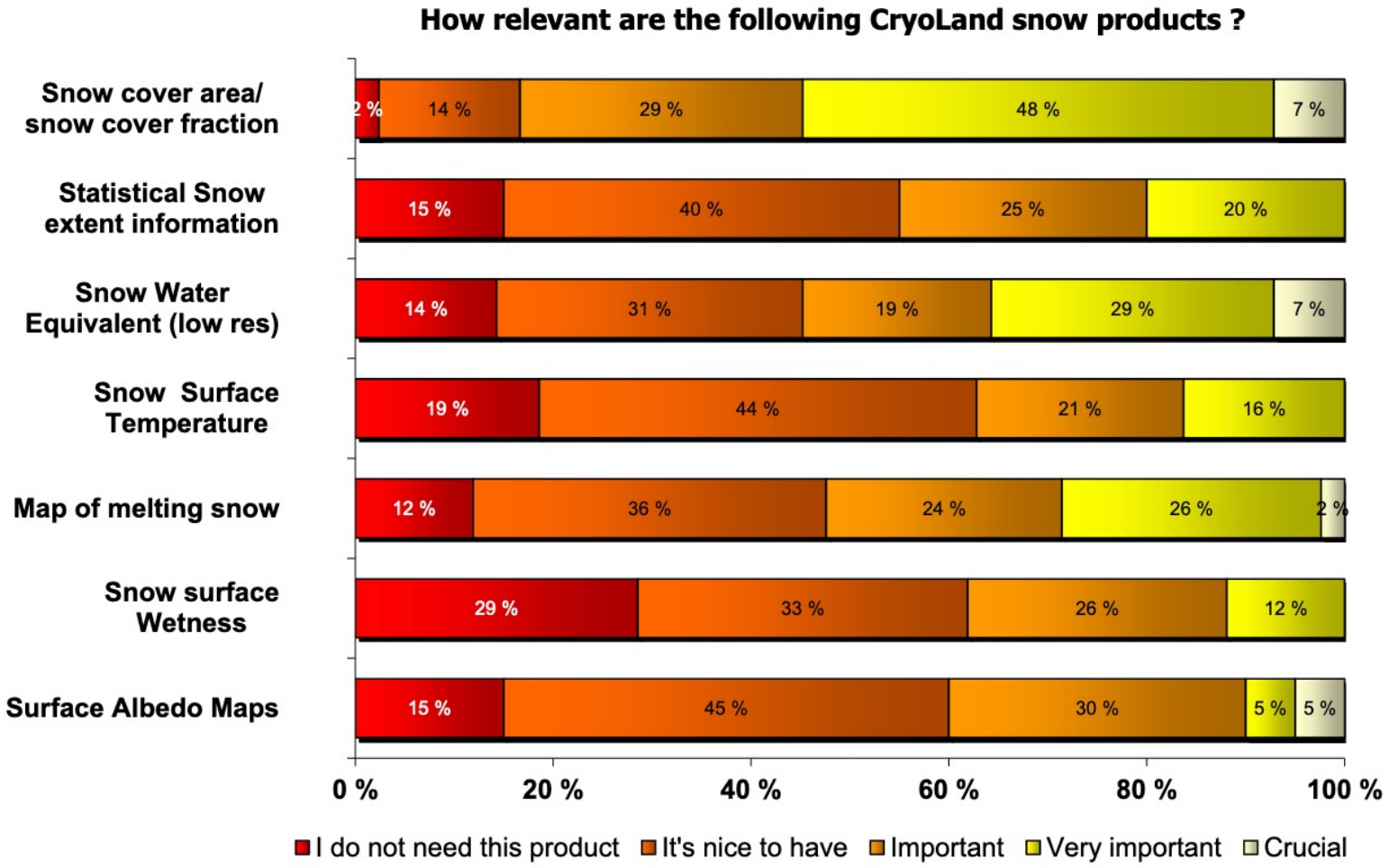
The Cryosphere, 9, 1191–1202, 2015
www.the-cryosphere.net/9/1191/2015/
doi:10.5194/tc-9-1191-2015

The Cryosphere
Open Access

User requirements for the snow and land ice services – CryoLand

	Total	
Type of organization	Percentage	Number
Private company	16 %	19
National authority*	25 %	30
Regional authority*	15 %	18
Scientific*	19 %	23
Consulting	11 %	13
Other	13 %	16
Total	100 %	119





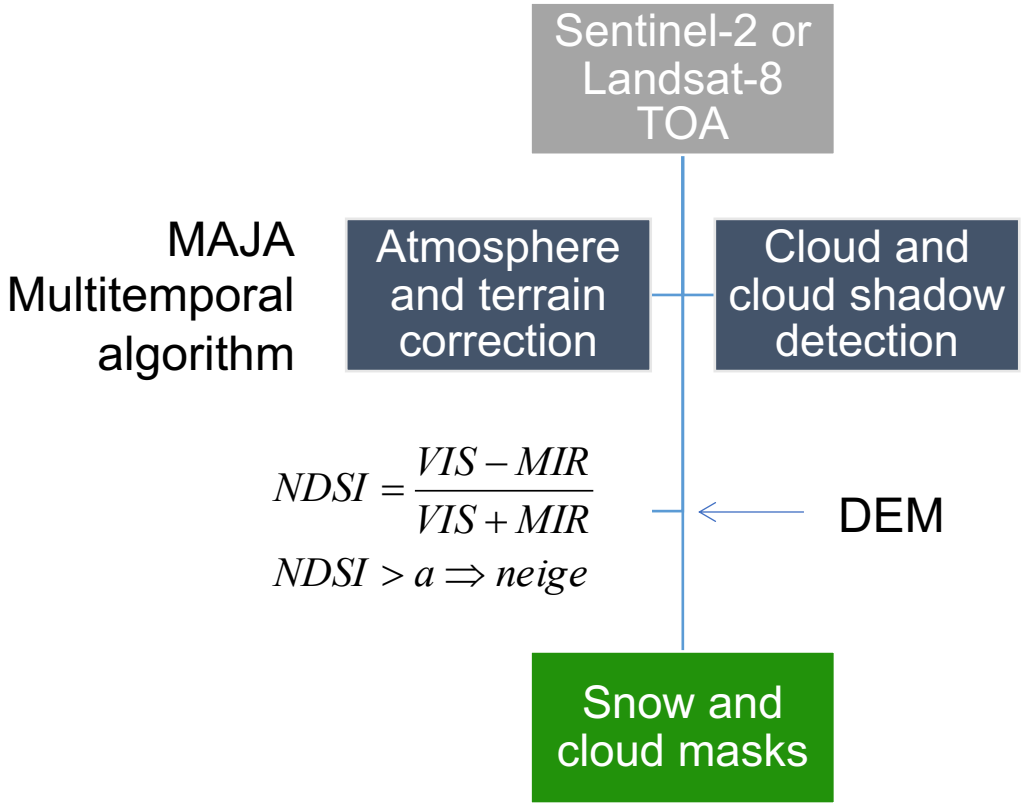
+ Near-real time
+ High resolution
+ Daily revisit

Malnes et al. (2015)

“ The Copernicus sensors Sentinel-1, -2 and -3 will be well suited for addressing most of the prioritized products when they become operational from 2015. A particular point that was highlighted during the user requirement survey was the need for Pan-European services for snow water equivalent and snow cover fraction. These services, in addition to the need for highly accurate regional services, were prioritized the highest and, hence, were also rapidly implemented by the CryoLand consortium. A continuation of the CryoLand snow and land ice services has been suggested as a Copernicus land monitoring core service. This service will need to focus on broadening the number of countries/users involved.”

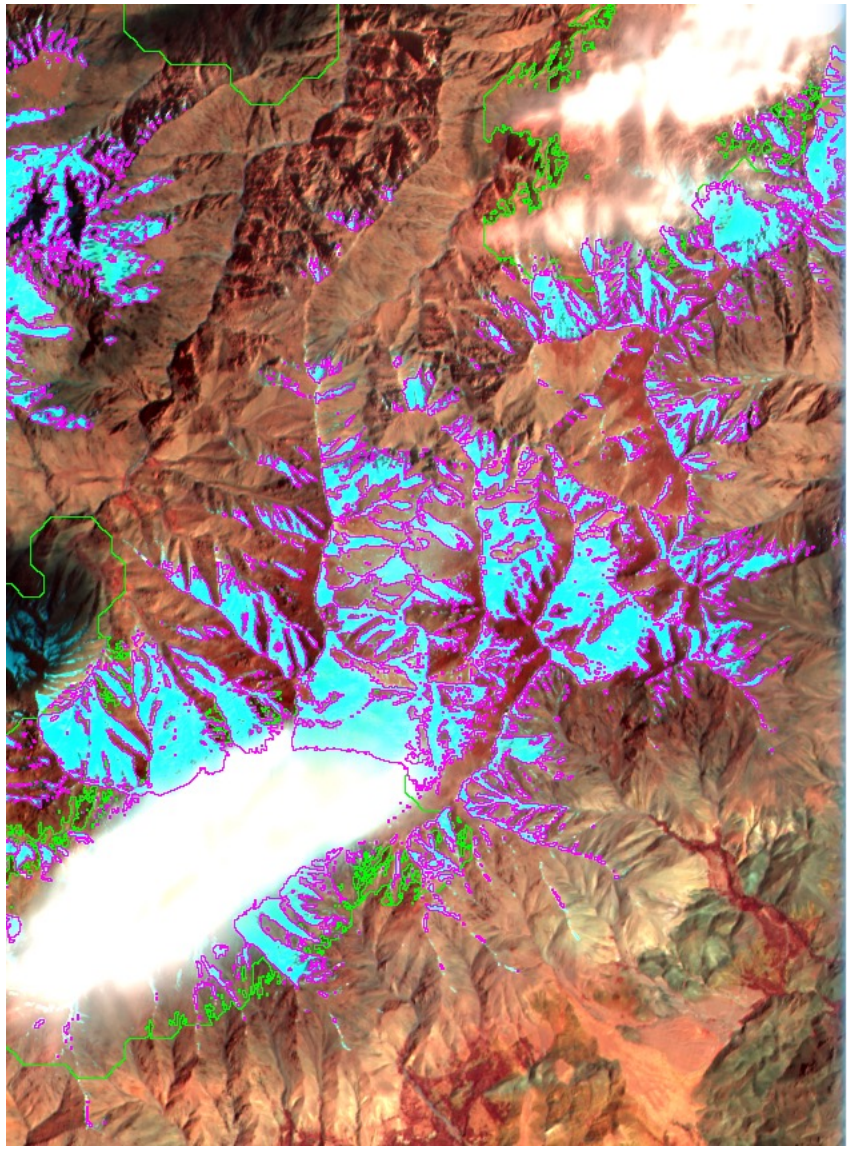
Malnes et al. (2015)

Snow cover area from Sentinel-2



SPOT 4 Take 5

Snow cover area from ~~Sentinel-2~~



Snow

Cloud

MAJA Multitemporal algorithm

Sentinel-2 or Landsat-8 TOA

Atmosphere and terrain correction

Cloud and cloud shadow detection

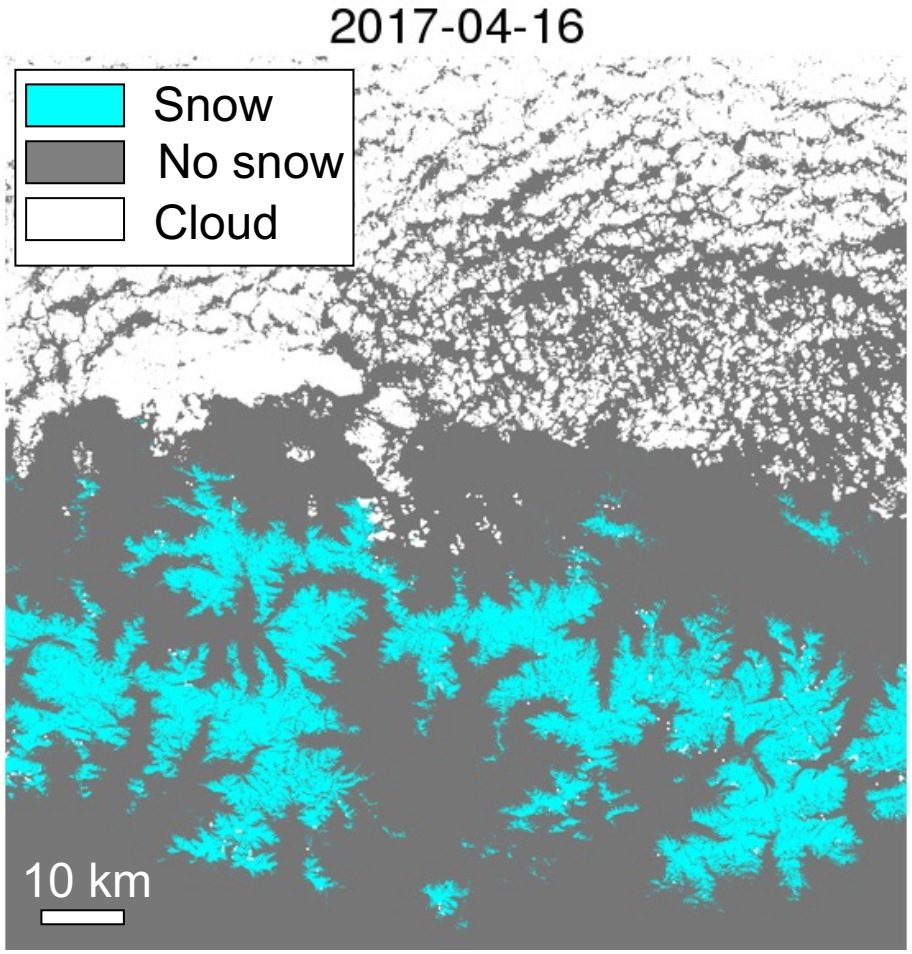
$$NDSI = \frac{VIS - MIR}{VIS + MIR}$$

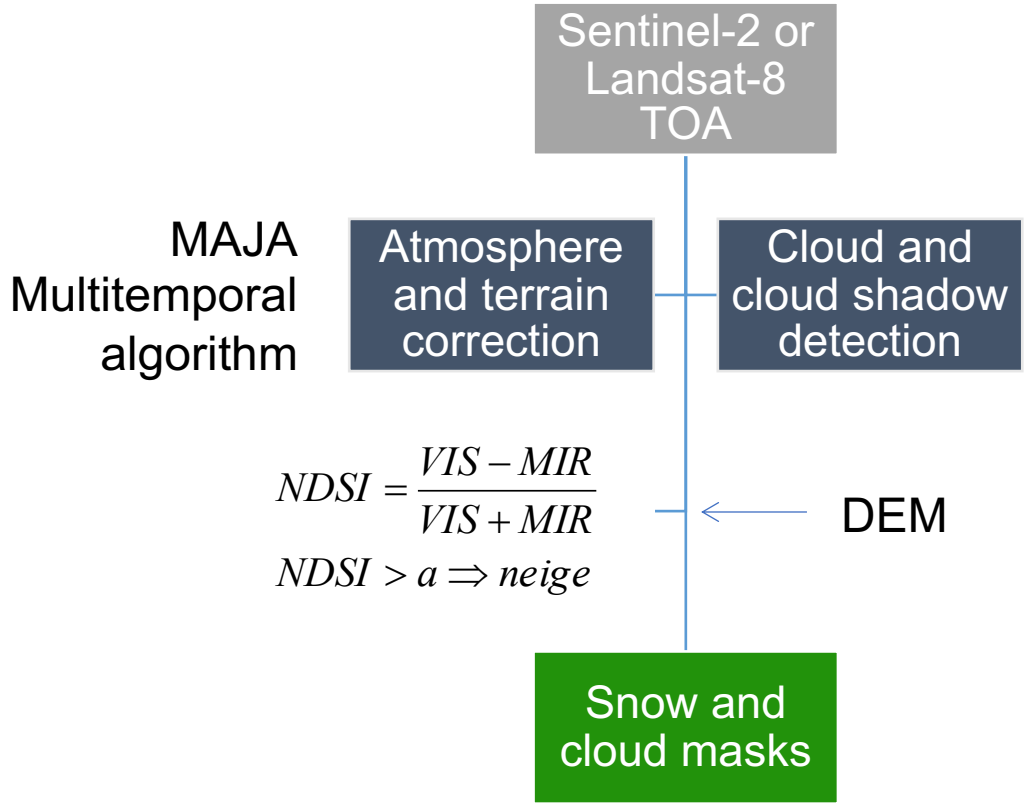
$$NDSI > a \Rightarrow neige$$

DEM

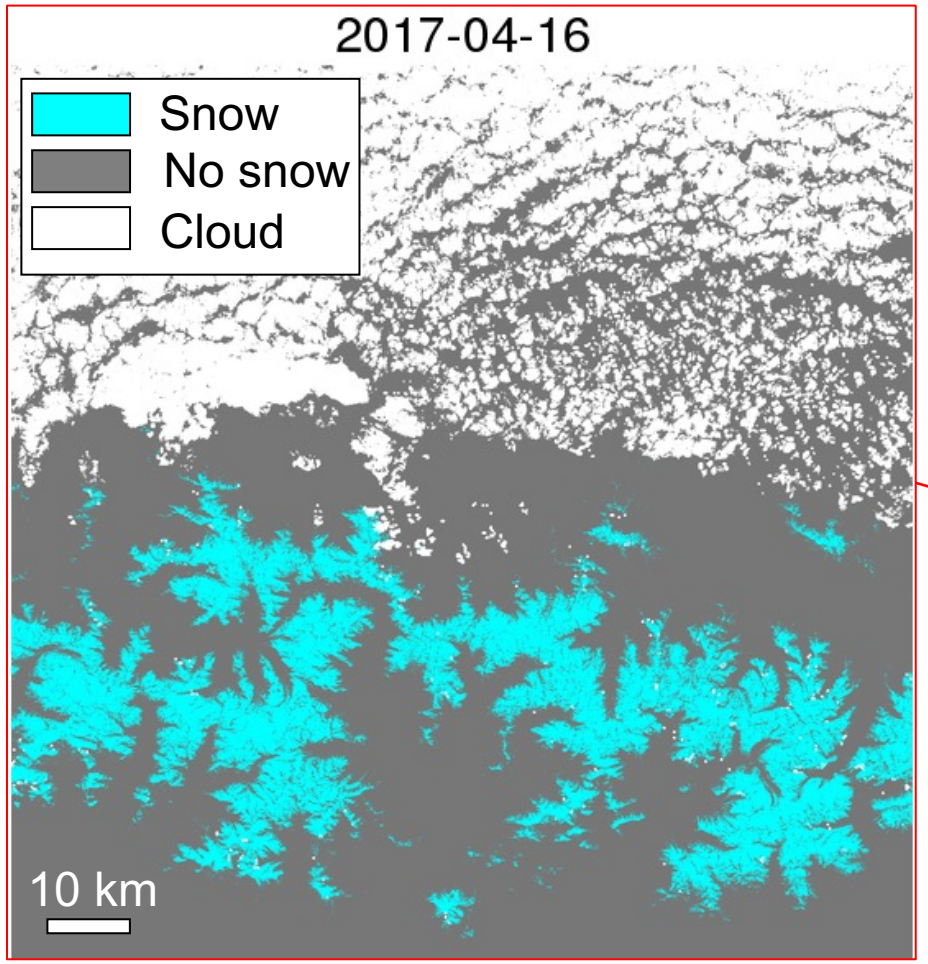
Snow and cloud masks

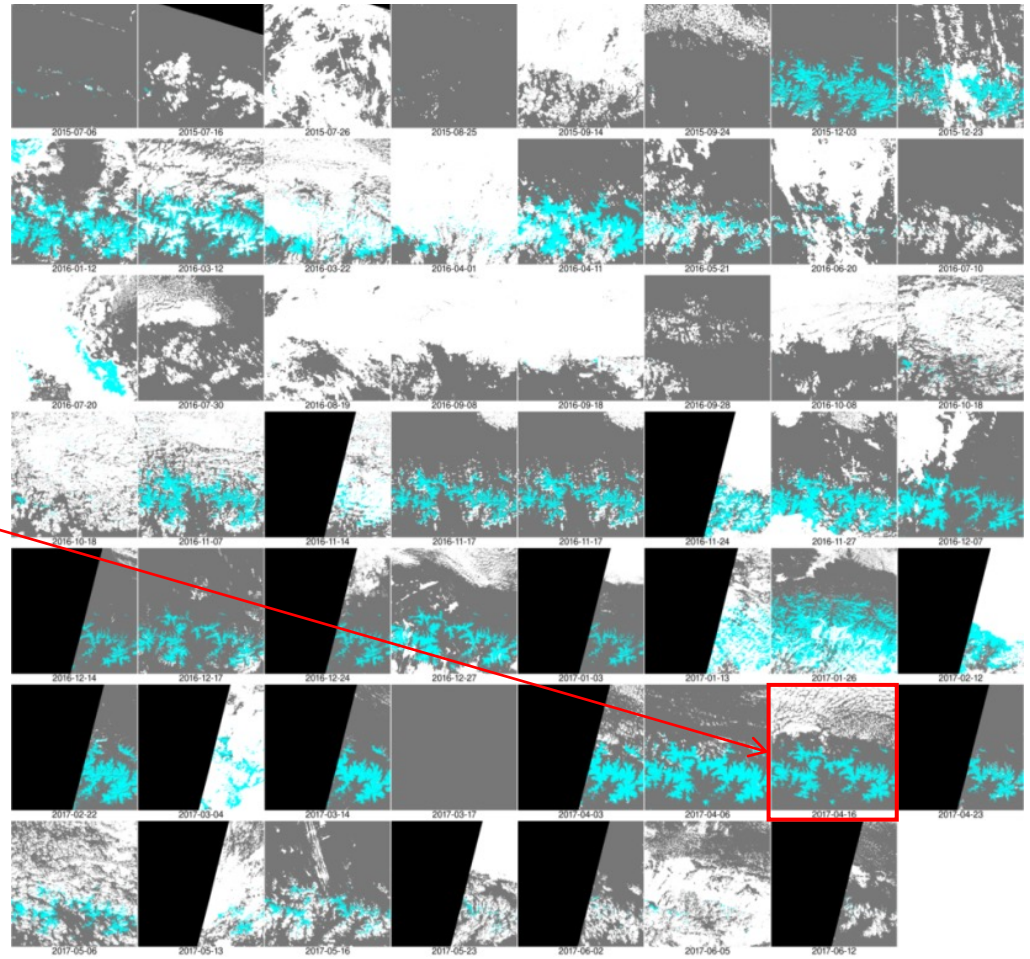
Snow cover area from Sentinel-2



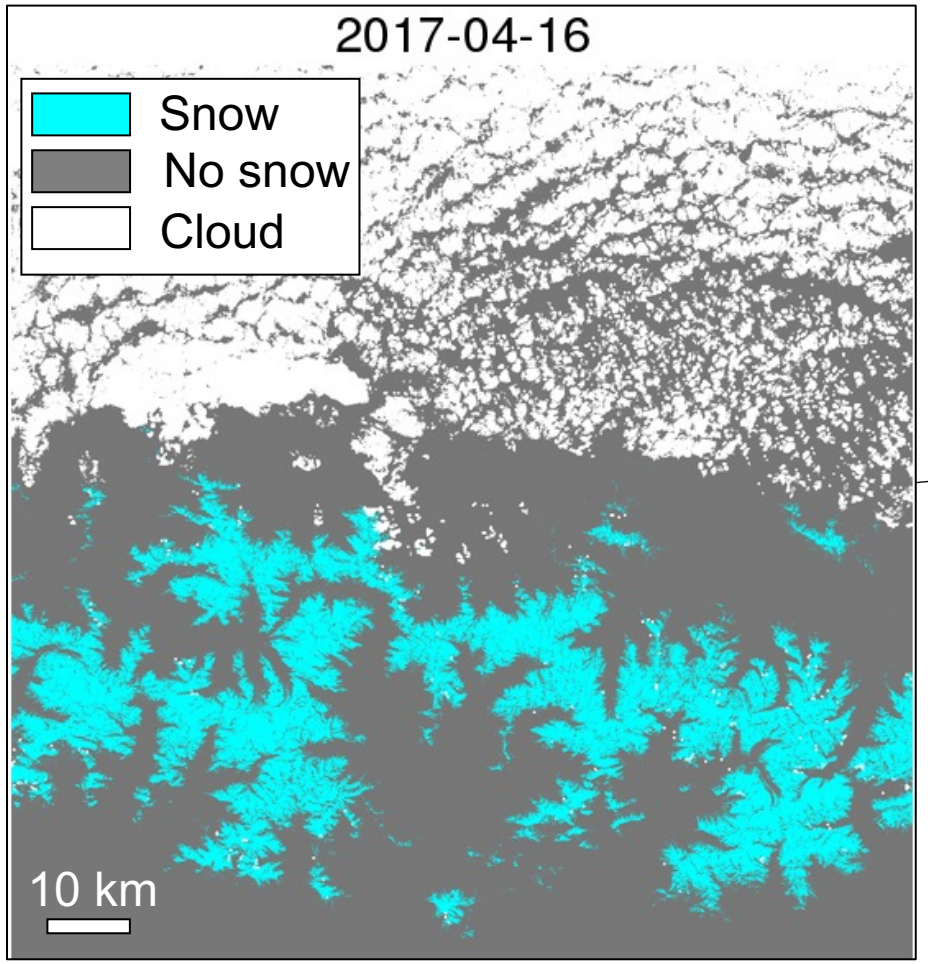


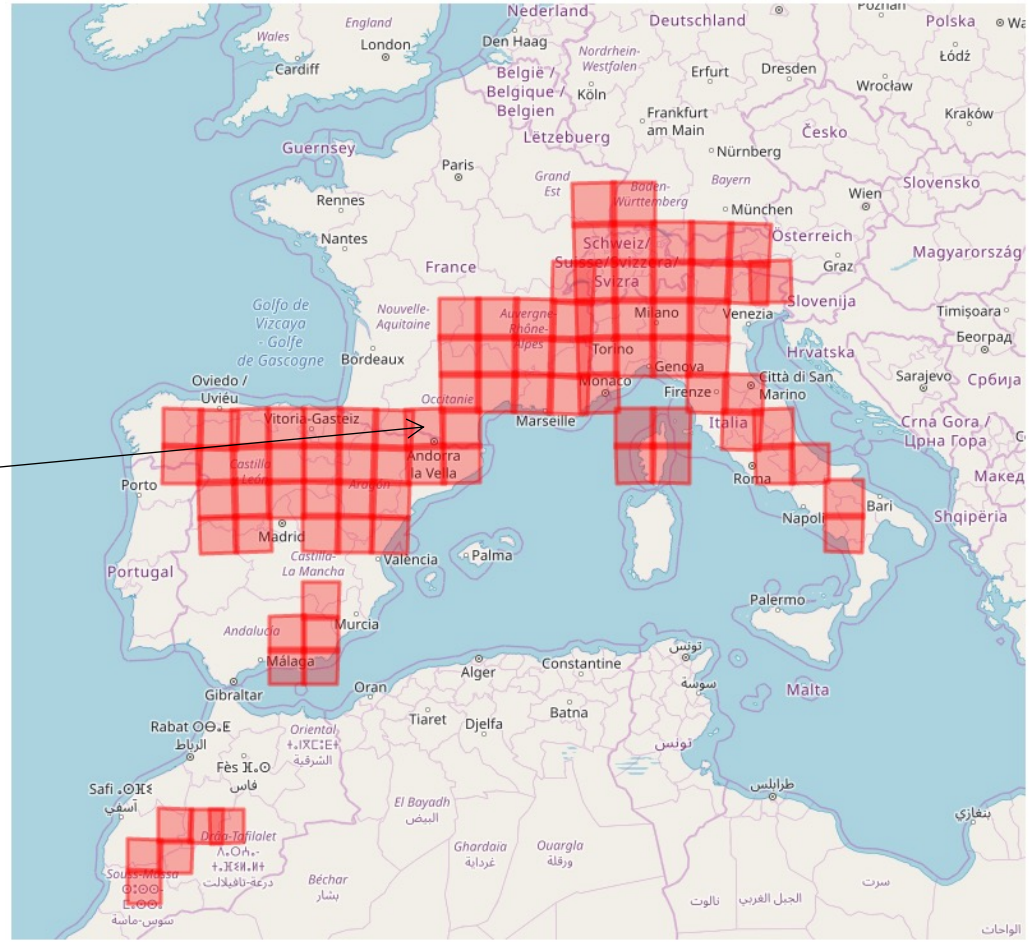
Snow cover area from Sentinel-2 time series





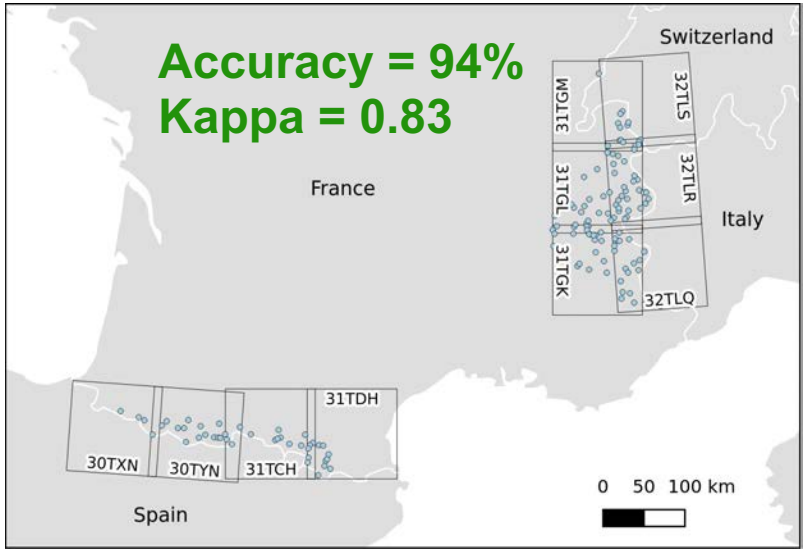
Snow cover area from Sentinel-2 time series



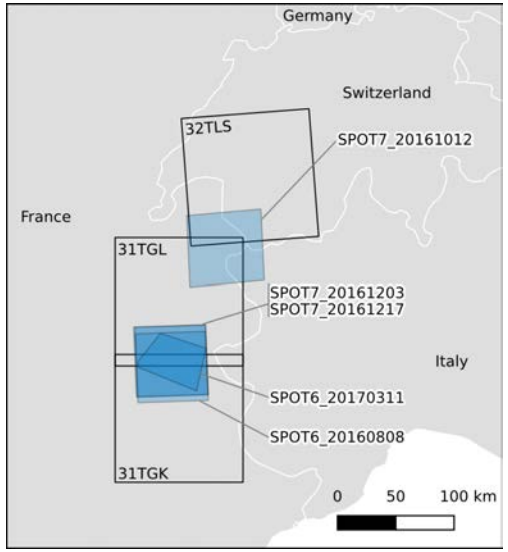


Evaluation

Comparison with 1414 ground truth observations (120 stations)



Comparison with 5 very high resolution images (SPOT-6/7)



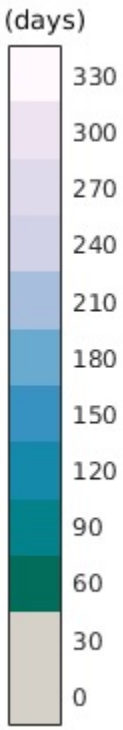
Accuracy = 89% - 99%
Kappa = 0.62 - 0.90

Gascoin, S., Grizonnet, M., Bouchet, M., Salgues, G., and Hagolle, O.: Theia Snow collection: high resolution operational snow cover maps from Sentinel-2 and Landsat-8 data, *Earth Syst. Sci. Data*, 2019.

Communication (blog, papers, end-users, conferences…)

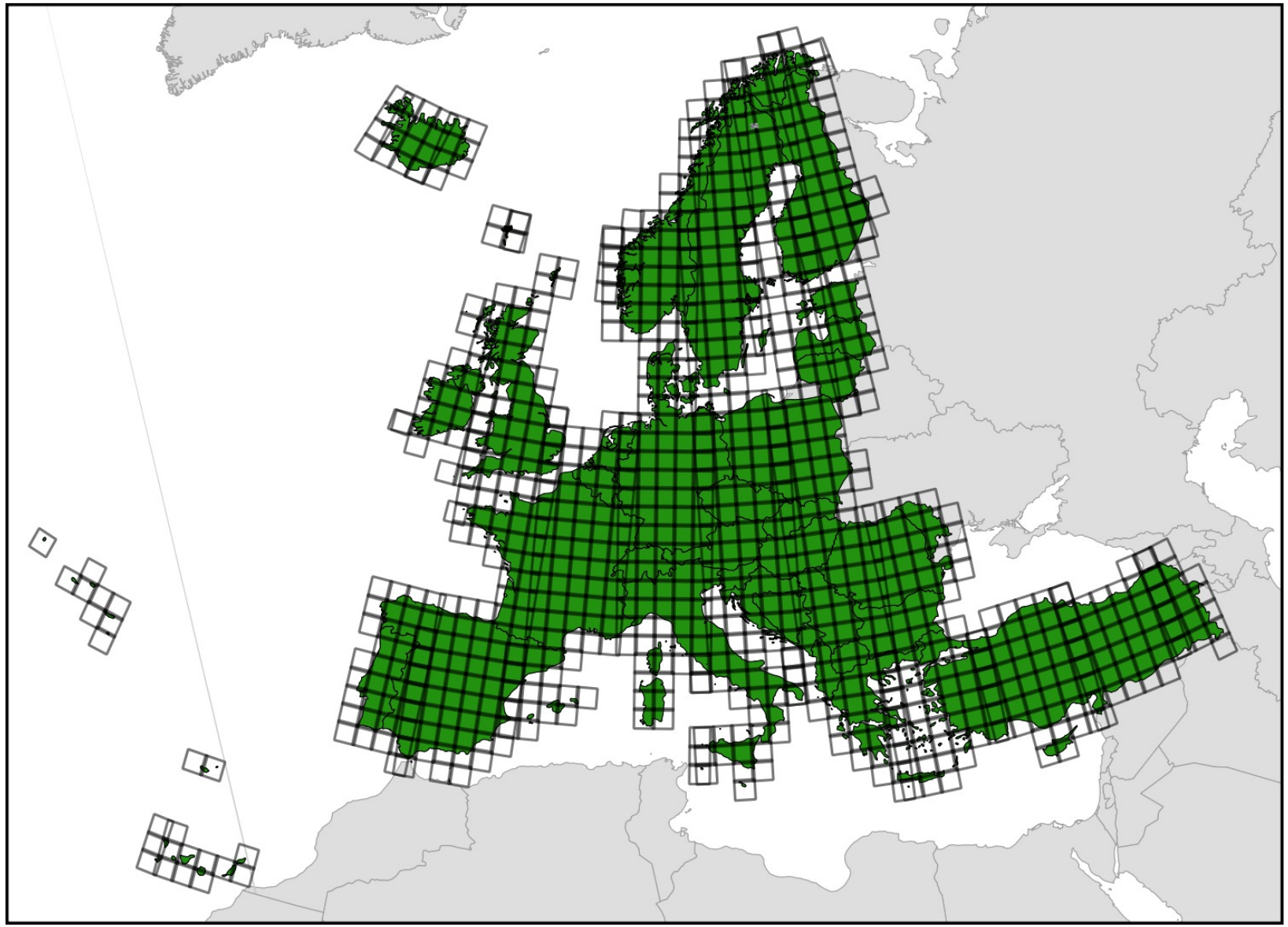
Water year 2016-2017

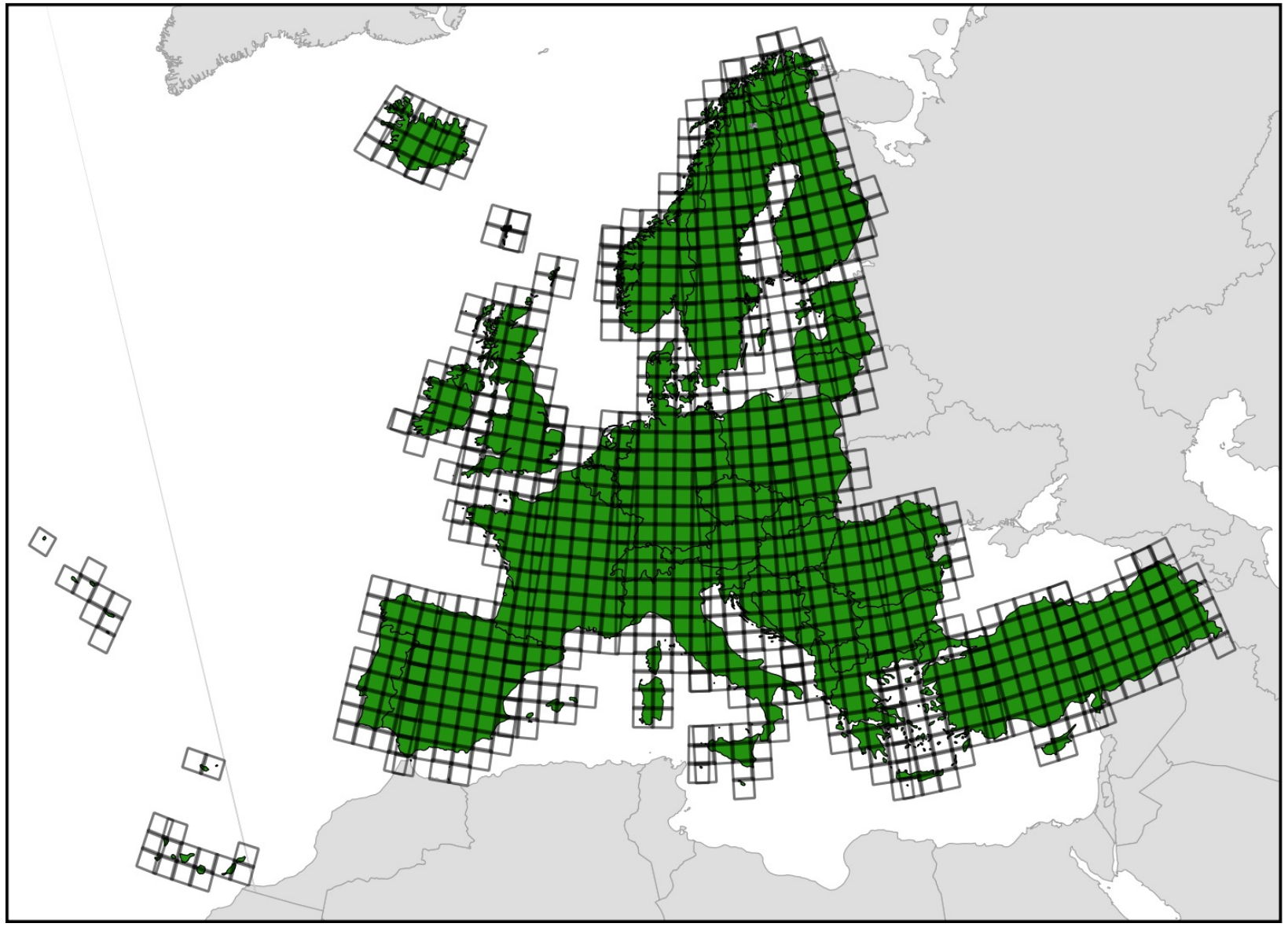
Water year 2017-2018



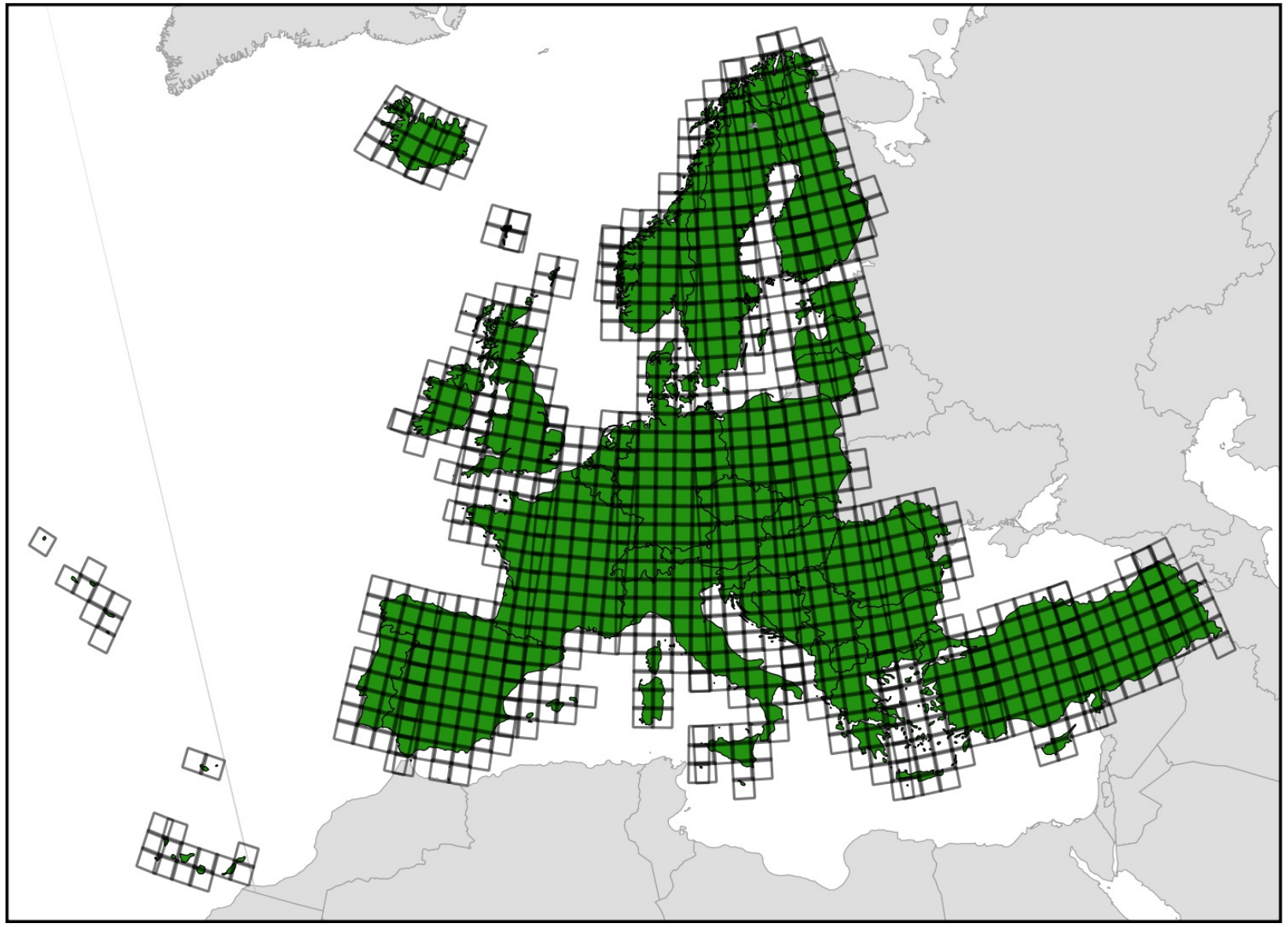
Copernicus

European Environment Agency





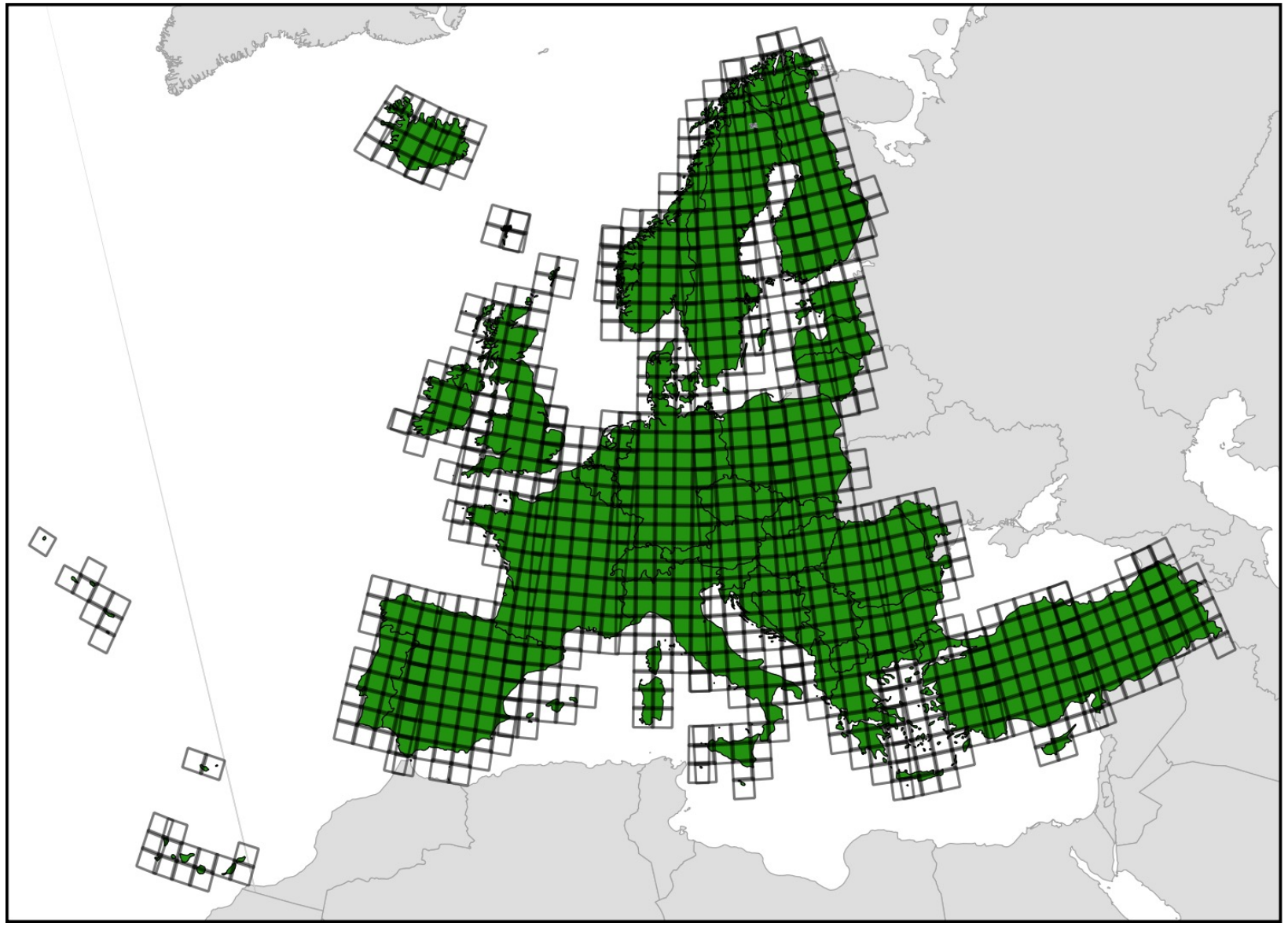
1) S2: 1.1M€ - Magellium (CESBIO sous-traitant), Astri Polska - dont 70% pour Magellium/CESBIO. Juin 2019-Juin 2024



1) S2: 1.1M€ - Magellium (CESBIO sous-traitant), Astri Polska - dont 70% pour Magellium/CESBIO. Juin 2019-Juin 2024

2) S1: 1.2M€ - Magellium, ENVEO, FMI, Astri Polska, MFR/CEN, 38% Magellium. Octobre 2020 - Juin 2024

3) S1 et S2 - 4.6M€ - Magellium (CESBIO sous-traitant), ENVEO, FMI, Geoville, 45% Magellium + CESBIO – Sep. 2023- Juin 2027



70 workers in total for the near-real time processing, and 220 for archive processing.

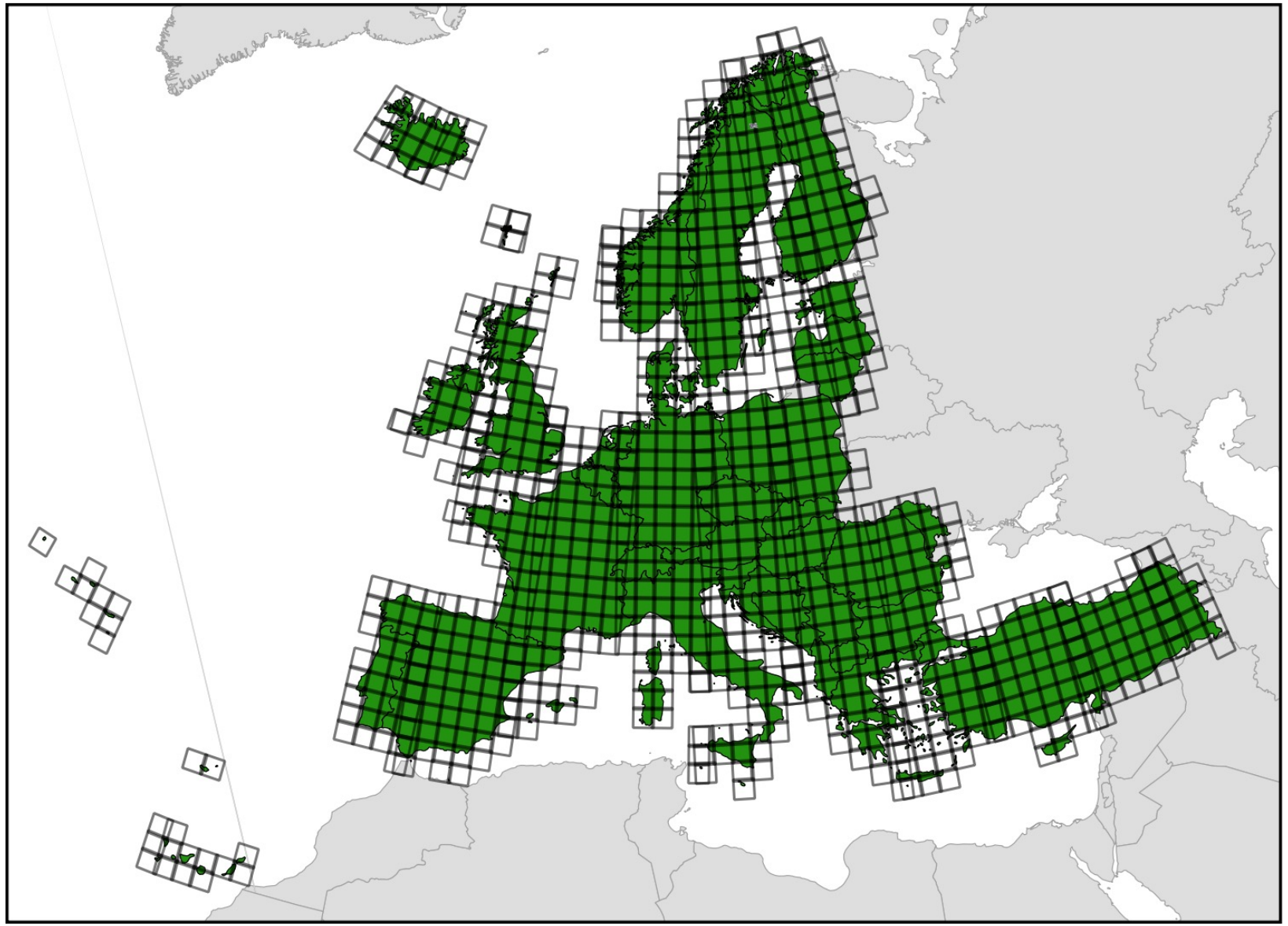
1 worker: 4 cores, 8 Gb RAM, 32 Gb SSD

Catalog ~17 TB (2016–2027).

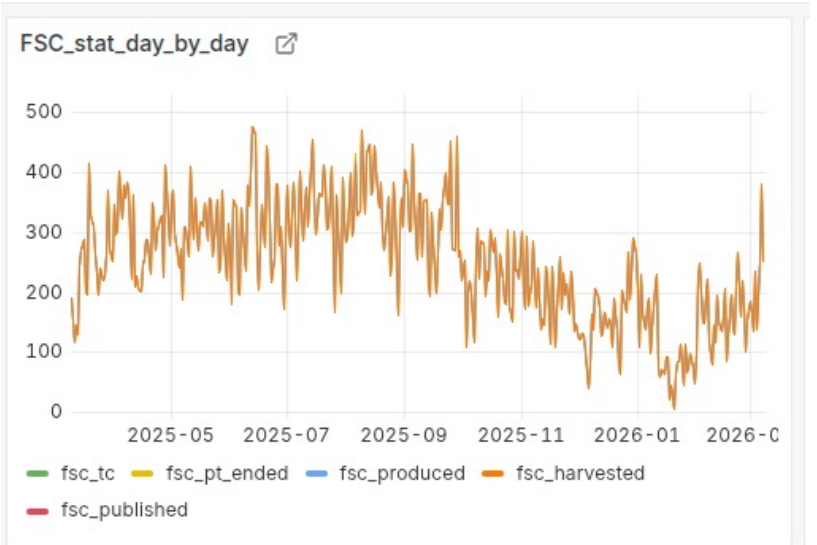
Copernicus

European Environment Agency

magellium



Products per day



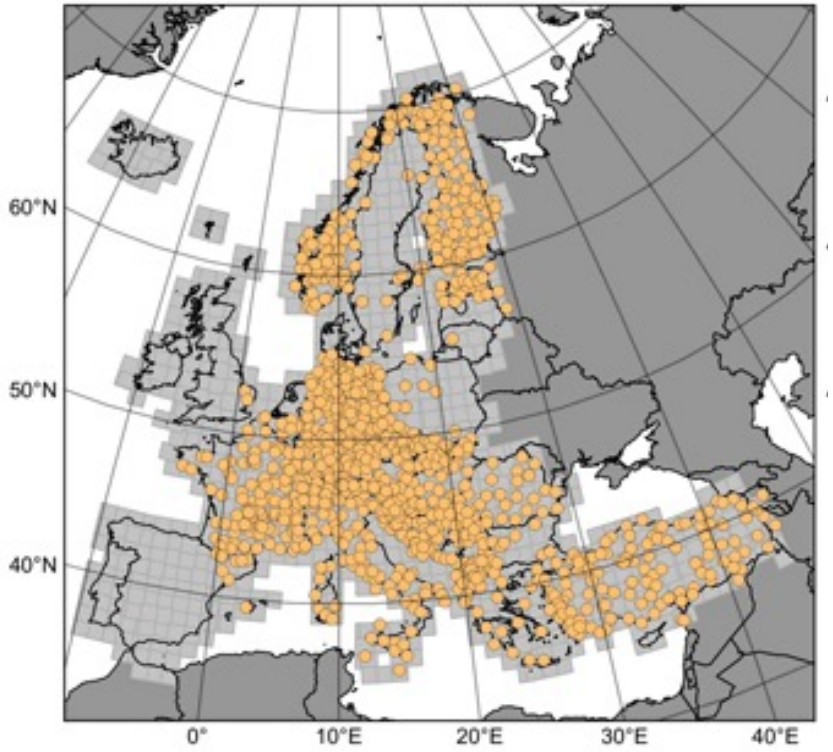
Impact

- Création d’emploi

Impact

- Création d’emploi
- Poursuivre l’évaluation

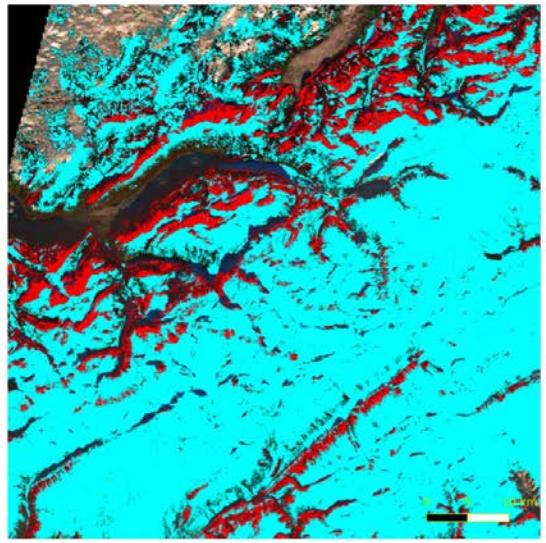
Barrou Dumont et al. 2021



Impact

- Création d’emploi
- Poursuivre l’évaluation
- Avoir des retours utilisateurs

17 Dec. 2020 Alpes Suisses



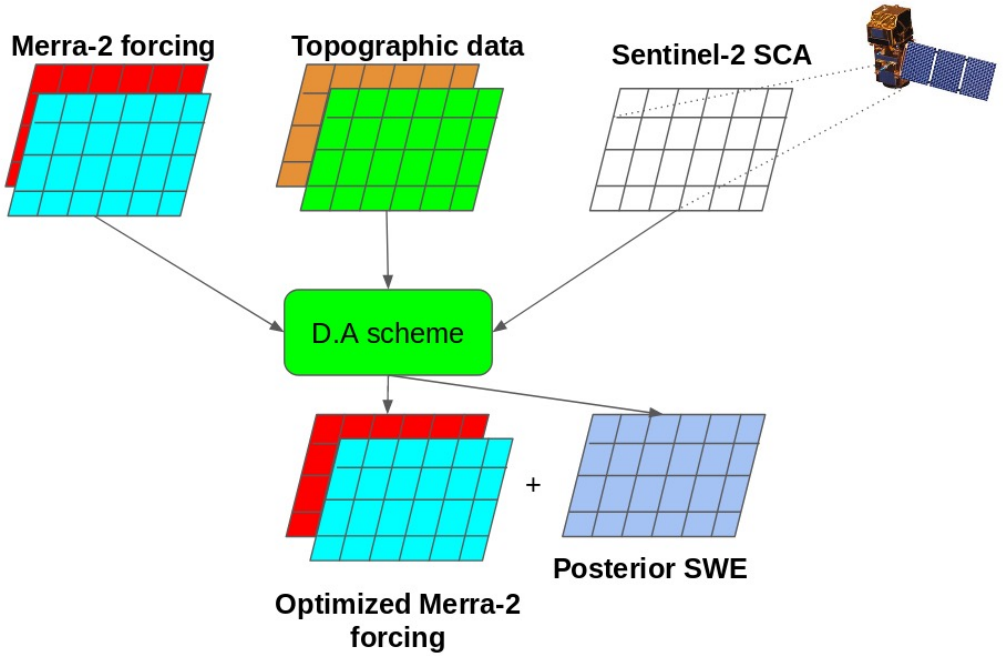
https://gitlab.orfeo-toolbox.org/remote_modules/let-it-snow/-/issues/21

Impact

- Création d’emploi
- Poursuivre l’évaluation
- Avoir des retours utilisateurs
- Applications !

“Assimilation of Sentinel-2 Data into a Snowpack Model in the High Atlas of Morocco”

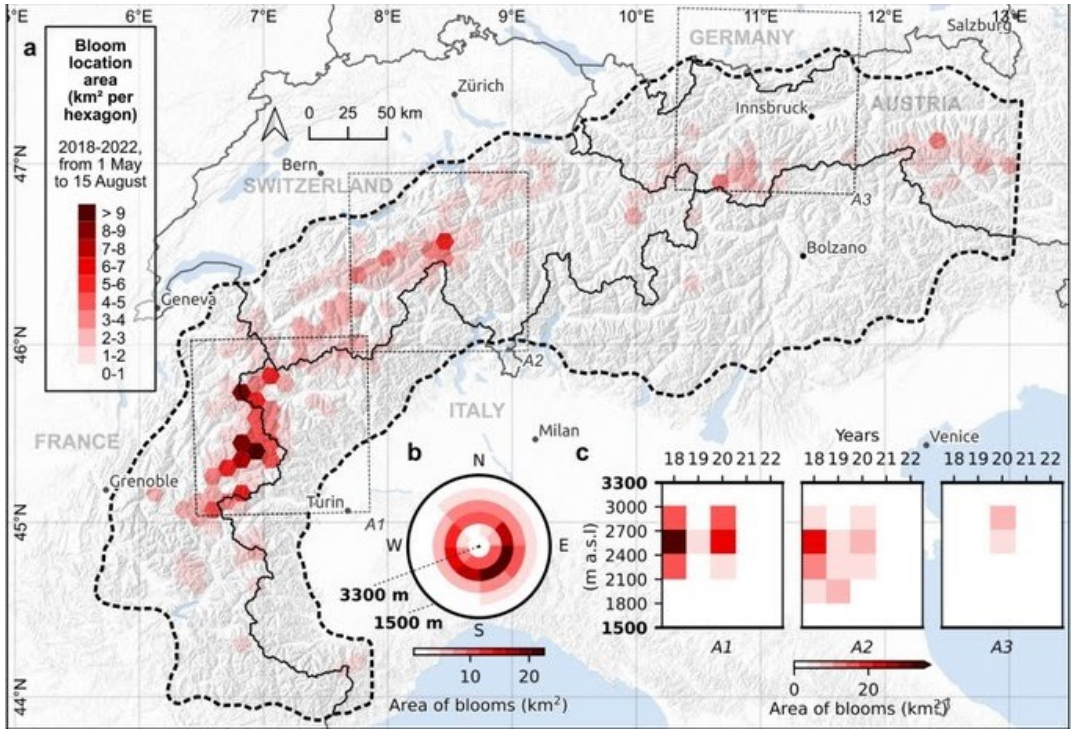
Baba et al. (2018)



Impact

- Création d’emploi
- Poursuivre l’évaluation
- Avoir des retours utilisateurs
- Applications !

Roussel et al. (2024)



Conclusion (1/2)

Ingrédients qui ont favorisé ce succès

- Une analyse des besoins (CryoLand, etc.)
- Une base scientifique (articles MAJA et LIS)
- Un démonstrateur (Theia)
- Un soutien institutionnel (CNES, Météo-France)
- Des ingénieur.e.s au top (CNES, Magellium)

Conclusion (2/2)

Avantages

- Evaluations plus poussées
- Applications plus ambitieuses
- Interactions stimulantes (ingénieurs, gestionnaires)

Conclusion (2/2)

Avantages

- Evaluations plus poussées
- Applications plus ambitieuses
- Interactions stimulantes (ingénieurs, gestionnaires)

Inconvénients

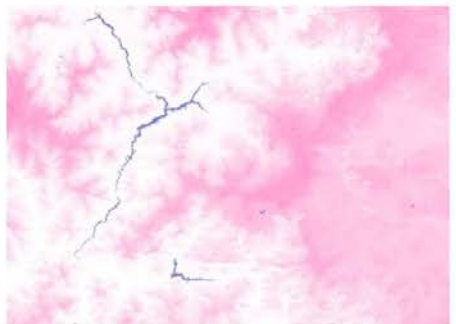
- Evolutions sont limitées
- Demande du temps (QC)
- Parfois un peu rébarbatif
- Expose à la critique

Snow Phenology 2016-present (raster 20 m, 60 m and 100 m), Europe, yearly

General info

Download

Provides the annual variation of the snow cover: the number of days with snow cover, the first day and the last day of the longest observed snow period over the year. The data are available from 2016 to present on annual base, from Sentinel-2 imagery only and from a combination of Sentinel-1 and Sentinel-2. Snow Phenology is the evolution of the Persistent Snow Area product.

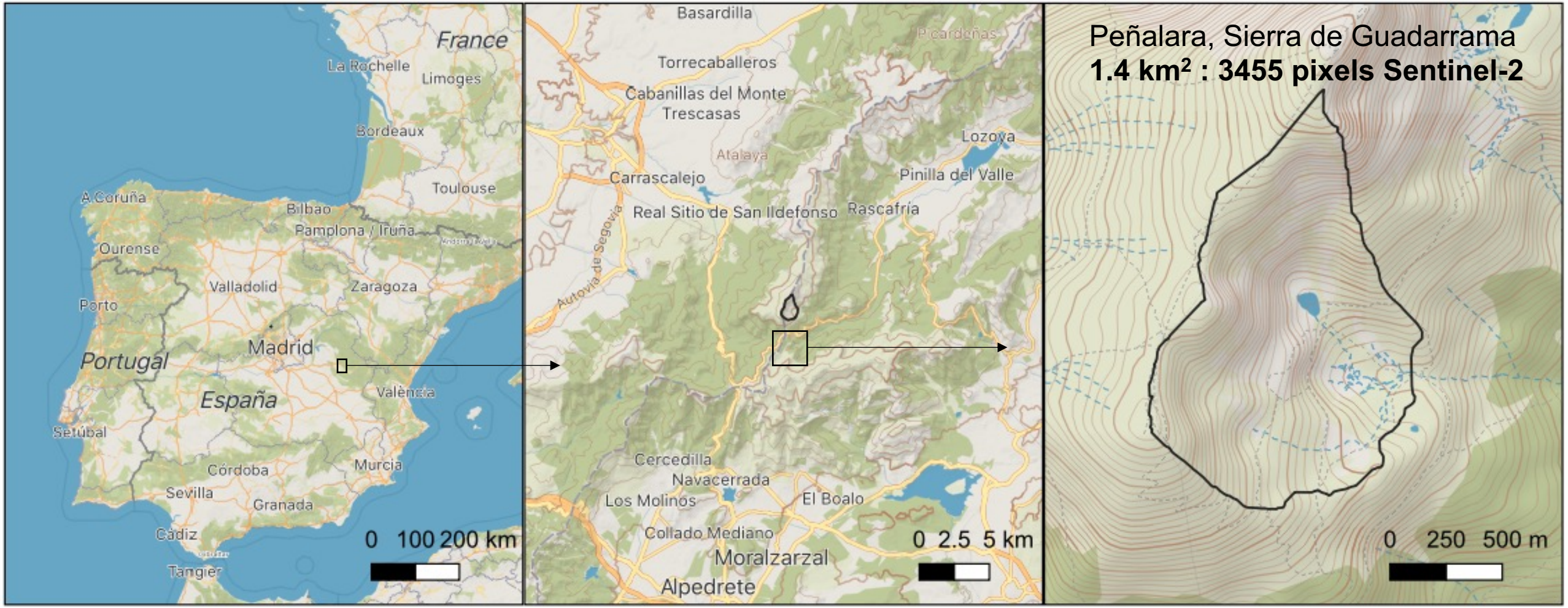


Validation status

Not validated

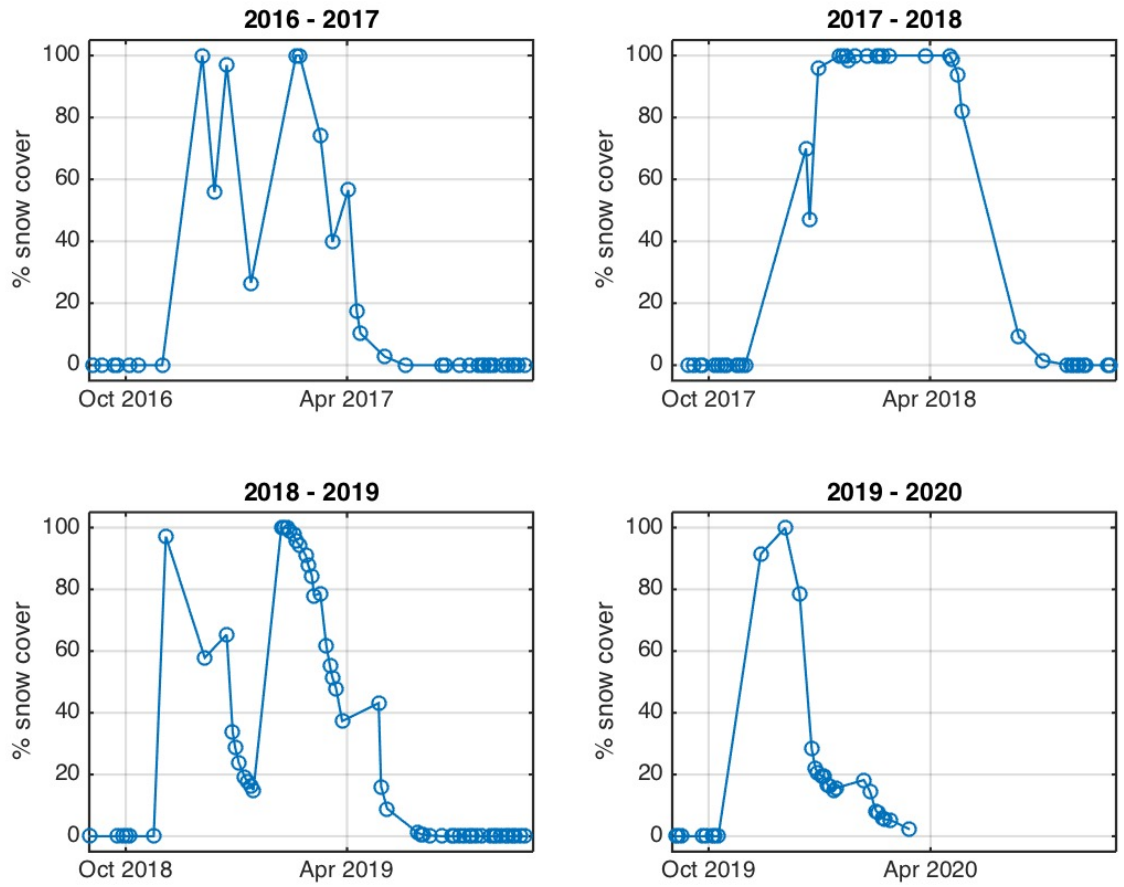
Dataset citation

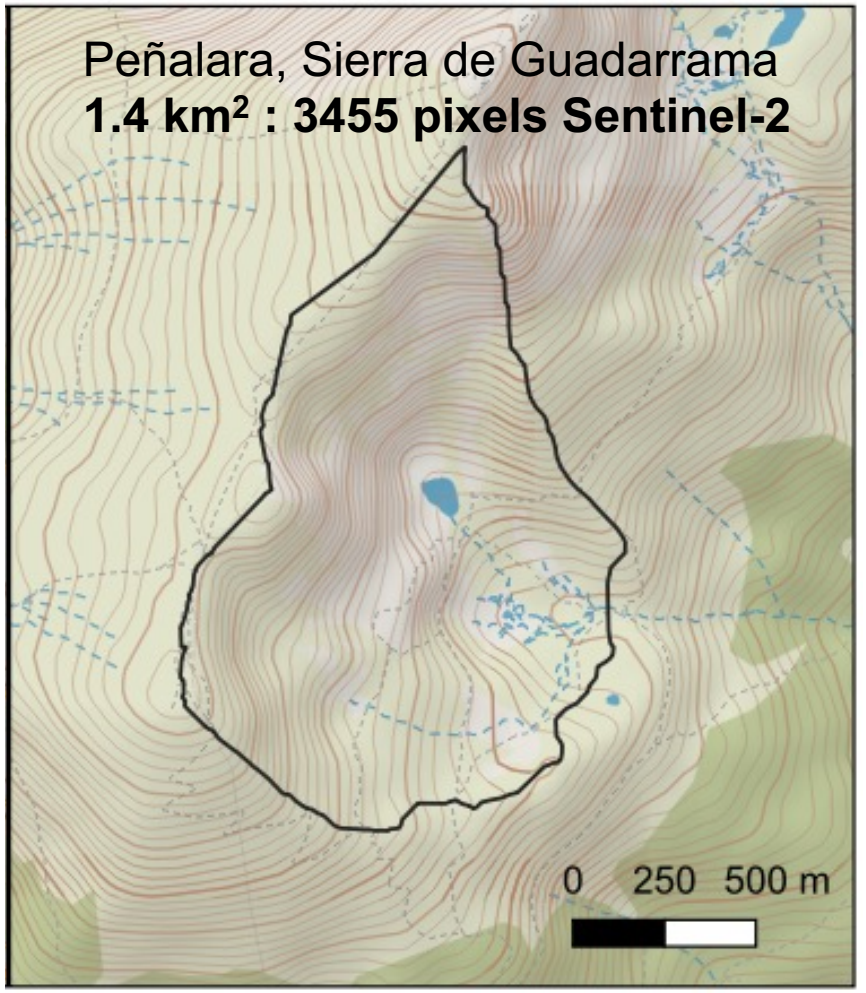
- **DOI (Sentinel-2 based, raster 20 m):** https://doi.org/10.2909/d3e5340d-5325-4196-8c98-cb4e397746ea
- **DOI (Sentinel-2 based, raster 100 m):** https://doi.org/10.2909/4187eaf1-69f8-40ba-afff-c13b2433dd53
- **DOI (Sentinel-1&2 based, raster 60 m):** https://doi.org/10.2909/5c6763f3-834c-4b9a-ba3a-bc3c14f85875
- **DOI (Sentinel-1&2 based, raster 100 m):** https://doi.org/10.2909/3893c1e6-eea1-46bc-9321-d11f0e39a044

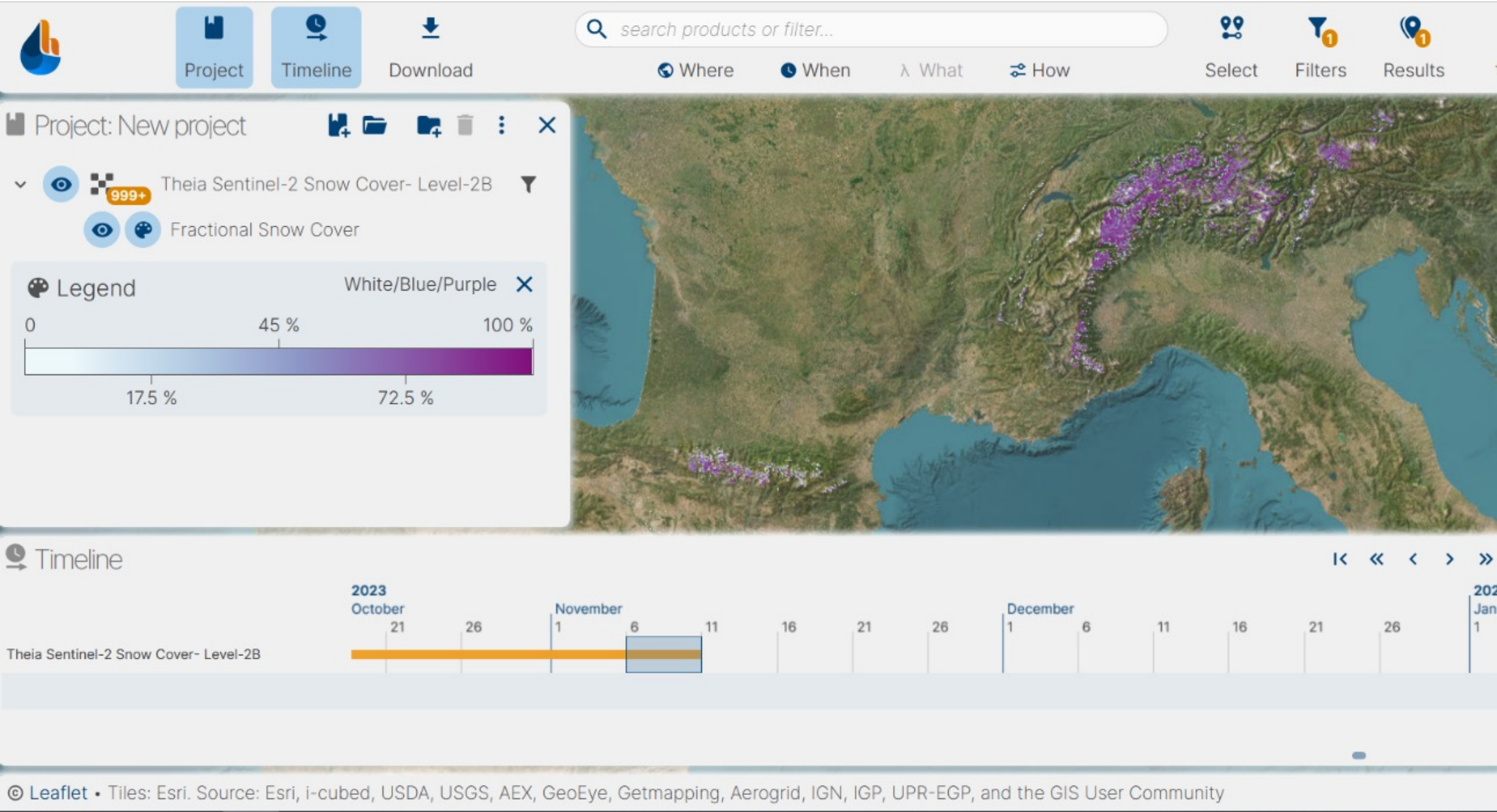

France
La Rochelle
Limoges
Bordeaux
Toulouse
A Coruña
Bilbao
Pamplona / Iruña
Ourense
Valladolid
Zaragoza
Porto
Madrid
Portugal
España
València
Setúbal
Córdoba
Murcia
Sevilla
Granada
Cádiz
Tangier
0 100 200 km
Basardilla
Torrecaballeros
Cabanillas del Monte
Trescasas
Atalaya
Lozoya
Carrascalejo
Pinilla del Valle
Real Sitio de San Ildefonso
Rascafría
Autovía de Segovia
Cercedilla
Navacerrada
Los Molinos
El Boalo
Collado Mediano
Moralzarzal
Alpedrete
0 2.5 5 km
Peñalara, Sierra de Guadarrama
1.4 km² : 3455 pixels Sentinel-2
0 250 500 m

Suivi de la surface enneigée d'un tout petit bassin versant

Surface enneigée (nuages < 10%)






Project
Timeline
Download
search products or filter...
Where
When
What
How
Select
Filters
Results
Project: New project
999+
Theia Sentinel-2 Snow Cover- Level-2B
Fractional Snow Cover
Legend
White/Blue/Purple
0
45 %
100 %
17.5 %
72.5 %
Timeline
2023
October
November
December
21
26
1
6
11
16
21
26
1
6
11
16
21
26
1
Theia Sentinel-2 Snow Cover- Level-2B
© Leaflet • Tiles: Esri. Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community