

## Copernicus Land High Resolution Snow & Ice products from Sentinel-2 and Sentinel-1 over Europe

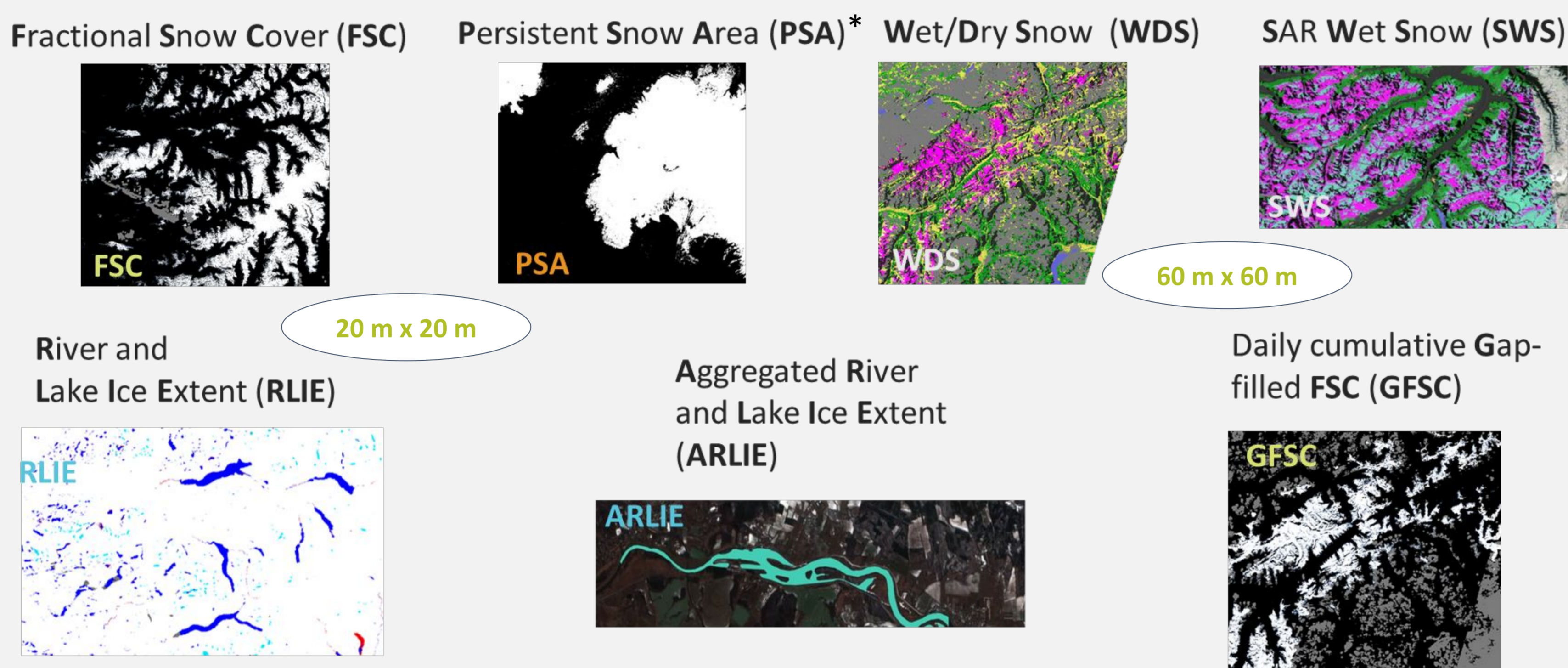


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Since July 2020, under European Environment Agency (EEA) delegation, the Copernicus Land Monitoring Service (CLMS) operationally produces and disseminates **Pan-European High-Resolution Snow & Ice products (HR-S&I) in near-real time**. This HR-S&I Service component has been developed and is currently operated by a consortium led by Magellium in partnership with CESBIO, ENVEO, FMI and Météo-France, and contracted by EEA as entrusted entity of DG-DEFIS (European Commission - Directorate General Defense Industry and Space) for this service.

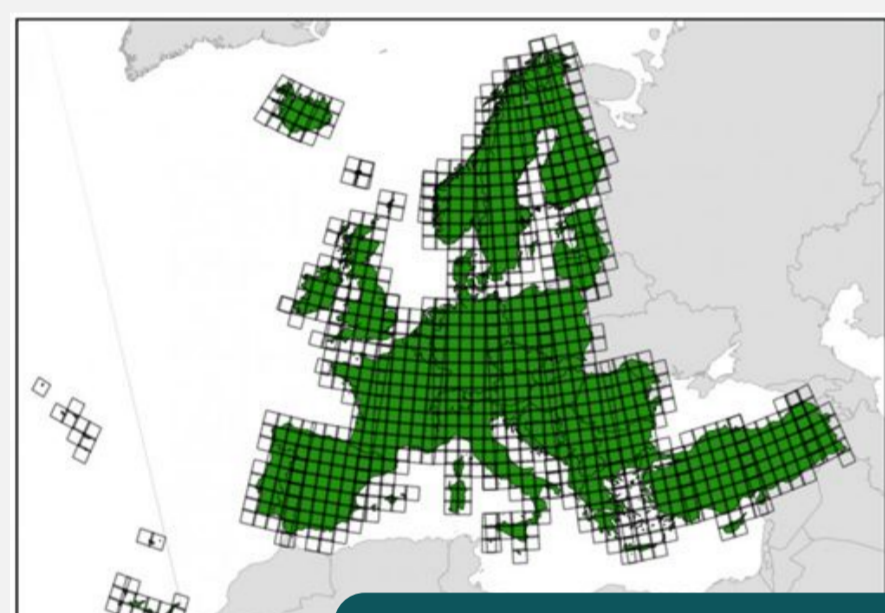
### Near-real time production



2016 2017 2018 2019 2020 2021 2022 2023

HR-S&I products are available from September 2016.

Every day ~ 2700 HR-S&I products processed from  
~ 550 Sentinel-2 products  
~ 230 Sentinel-1 products  
within a maximum of 3 hours after the L1C Sentinel-2/GRD Sentinel-1 data are available on the WEKEO DIAS European cloud infrastructure.



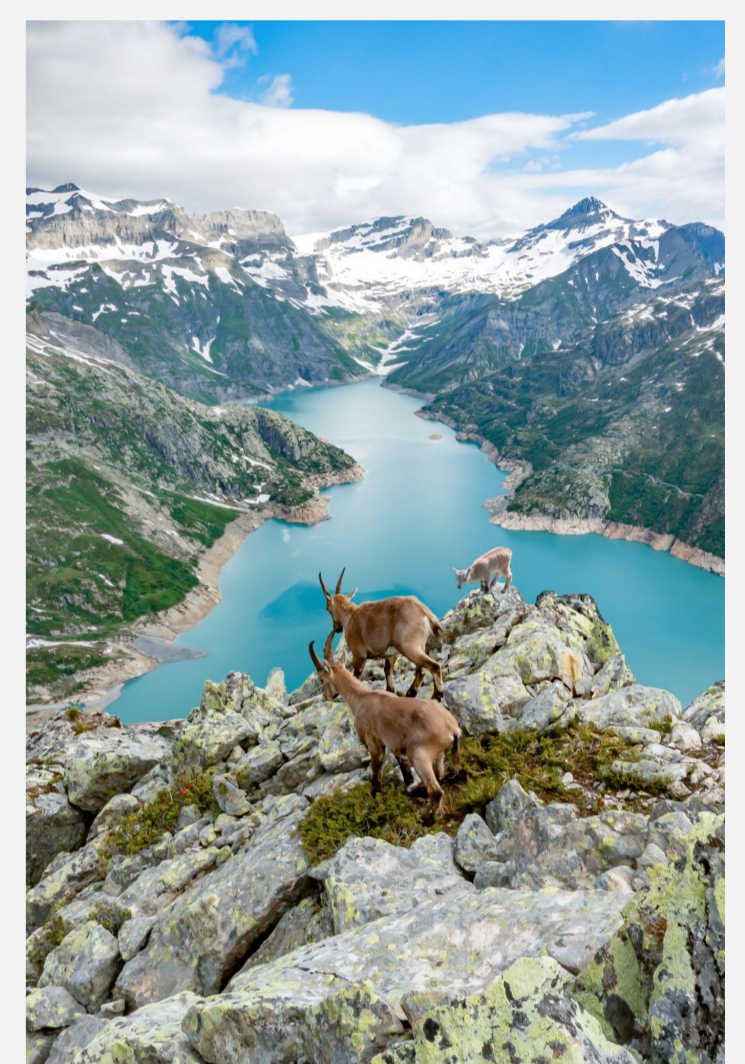
Area of availability EEA38+ UK  
~ 1000 Sentinel-2 tiles (110 km x 110 km)

\*annual product

### Applications

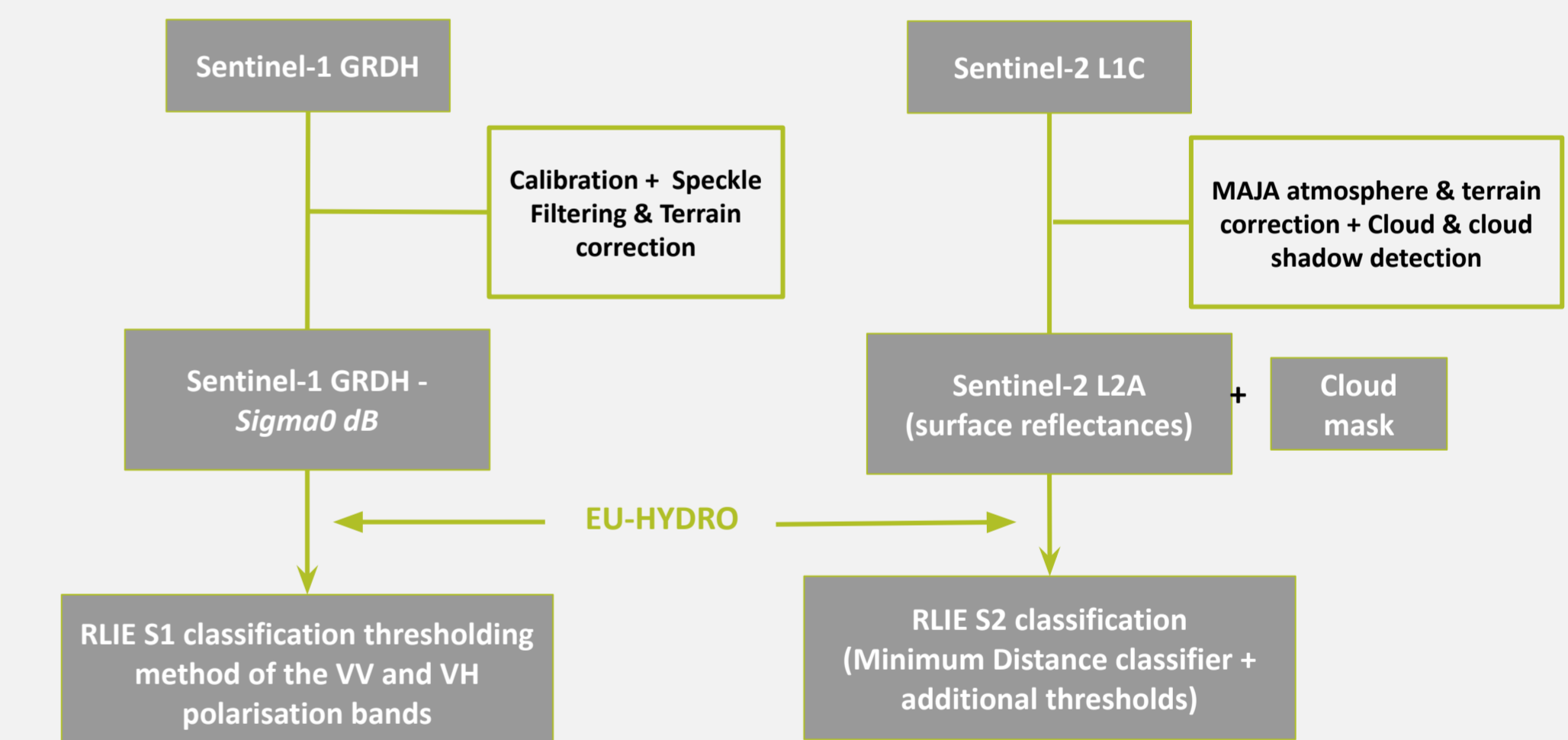
- Water management,
- Energy,
- Biodiversity,
- People and infrastructure safety,
- Navigation,
- Support to climate studies,...

FSC products support snow water equivalent estimation for the Emosson lake catchment for hydropower production, Switzerland (picture S. Mauroux)

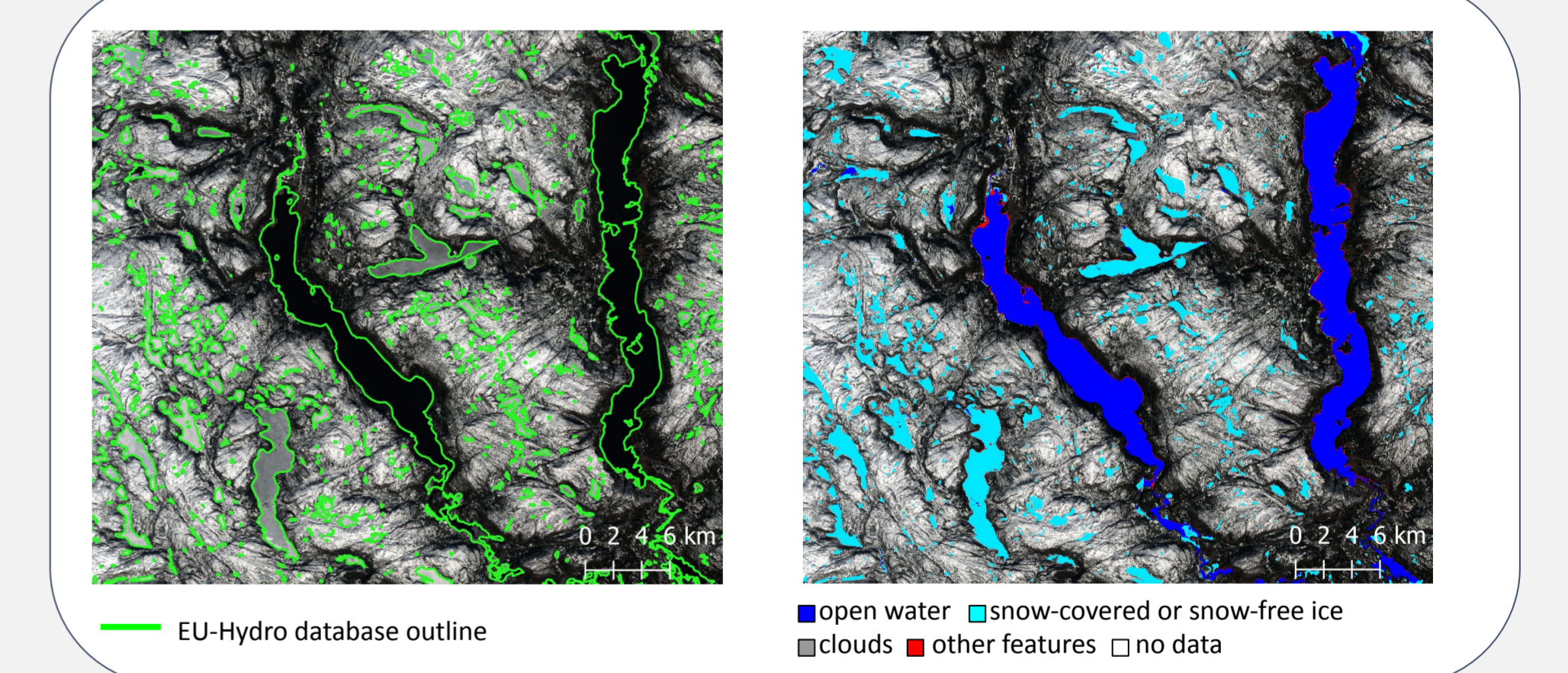


### Ice products

RLIE is detected from both Sentinel-1 and Sentinel-2.



01 April 2019. Norwegian Lakes, RLIE S2 product



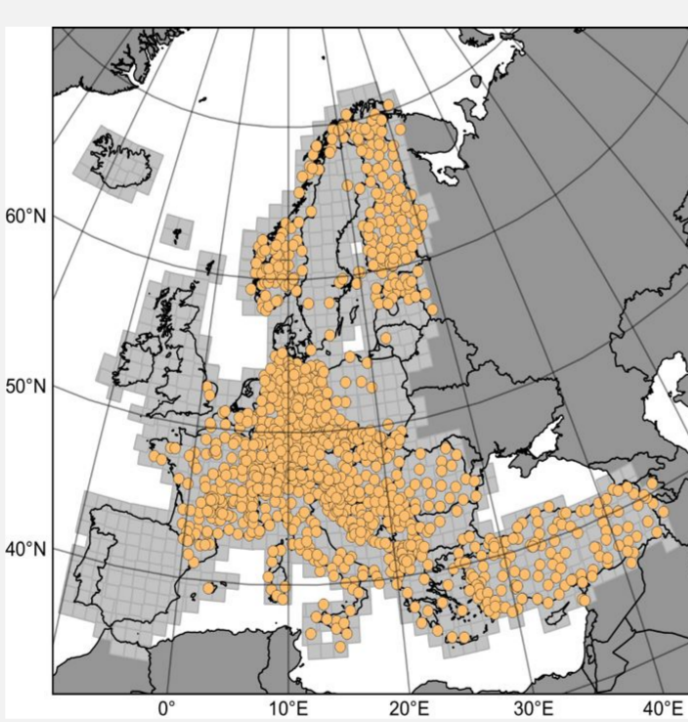
RLIE products were validated by comparison with in situ measurements from Czech Republic, Finland, Hungary and Serbia. Moreover, the evaluation of the algorithms was done against six manually interpreted SPOT 6/7, Pléiades 1A/1B images and MAJA Sentinel-2 L2A images. Remaining challenges to tackle with confusion on ice types (thin, dark, snow-covered, frazil) and depending on surfaces (lakes, rivers, banks).

### Snow products

#### Snow cover

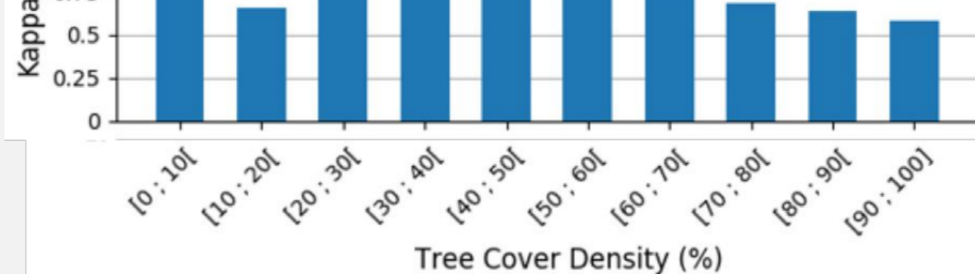
FSC product from S2 MAJA Level-2A images (Gascoin et al., 2018)

- snow detection based on the Normalised Difference Snow Index (NDSI) with the Let-It-Snow processor
- snow fraction on snowy pixels is estimated from the NDSI, on top-of-canopy and under the canopy



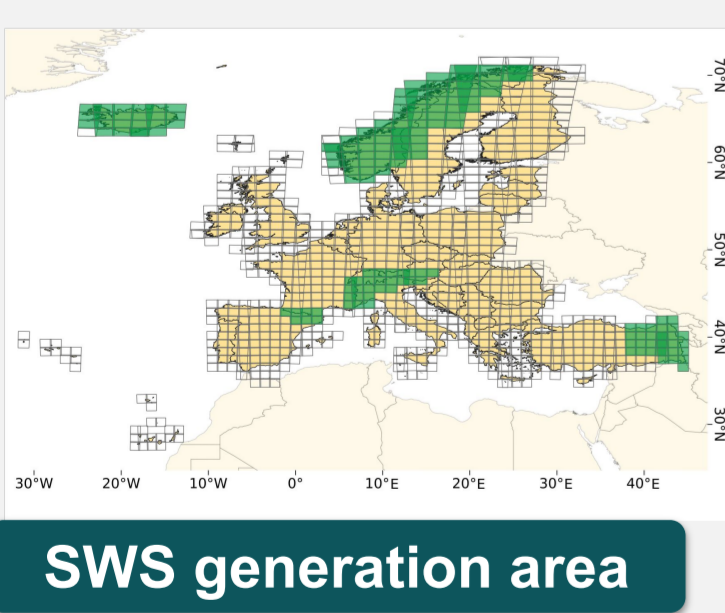
Data  
• 1700 stations  
• 26'933 matchups (hydrol. year 2016-2017)

Results  
• Good agreement (kappa = 0.8)  
• Lower performance in forest regions



Validation over Europe of the FSC against in situ observations. (Barrou-Dumont et al., 2021)

#### Wet snow extent



SWS from S1 GRD products to describe wet snow extent on mountain ranges (based on Nagler and Rott, 2000)

- change detection based on the ratio of the reduced backscatter coefficient of wet snow versus the conditions when the surfaces are snow-free or covered by dry snow.
- WDS combines snow cover map from S2 and wet snow detection from S1 to describe the snow state conditions
- Validation against Landsat-8 snow extent during melting period (approach described in ESA SnowPex project)
- Comparison against snowpack reanalysis from CROCUS model (Karbou et al., 2022)

### Access Snow & Ice data

Wekeo platform >> [wekeo.eu](http://wekeo.eu)  
Cryo portal >> [cryo.land.copernicus.eu/finder/](http://cryo.land.copernicus.eu/finder/)  
APIs for automated download



Free usage - registration required for download

Visit the pan-European [land.copernicus.eu](http://land.copernicus.eu) portal for more details!

### References

Find the documentation (product user manual, algorithm description, quality assessment reports..) on the pan-European [land.copernicus.eu](http://land.copernicus.eu) portal (> Biophysical parameters > Snow & Ice)

- Barrou Dumont, Z., Gascoin, S., Hagolle, O., Ablain, M., Jugier, R., Salgues, G., Marti, F., Dupuis, A., Dumont, M., and Morin, S.: Brief communication: Evaluation of the snow cover detection in the Copernicus High Resolution Snow & Ice Monitoring Service, The Cryosphere, 15, 4975–4980, <https://doi.org/10.5194/tc-15-4975-2021>, 2021.
- Karbou Karbou, F.; James, G.; Fructus, M.; Marti, F.: On the Evaluation of the SAR-Based Copernicus Snow Products in the French Alps. Geosciences 2022, 12, 420. <https://doi.org/10.3390/geosciences12110420>
- Gascoin, S., Grizonnet, M., Bouchet, M., Salgues, G., and Hagolle, O. (2018) Theia Snow collection: high resolution operational snow cover maps from Sentinel-2 and Landsat-8 data, Earth Syst. Sci. Data, <https://doi.org/10.5194/essd-11-493-2019>.
- Nagler T. and H. Rott. 2000. Retrieval of wet snow by means of multitemporal SAR data. IEEE Transactions on Geoscience Remote Sensing. vol. 38, no. 2, pp. 754–765, Mar. 2000.
- ESA QA4EO SnowPex snow product intercomparison and evaluation protocols and methods: <http://snowpex.enveo.at/documents.html>