Copernicus Global Land Service

-with a focus on water quantity products-

Land Monitoring

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On behalf of the Copernicus Global Land Service consortium

WaterForCE workshop 15/03/2021

Water scenarios for Copernicus Exploitation

Joint Research Centre JRC

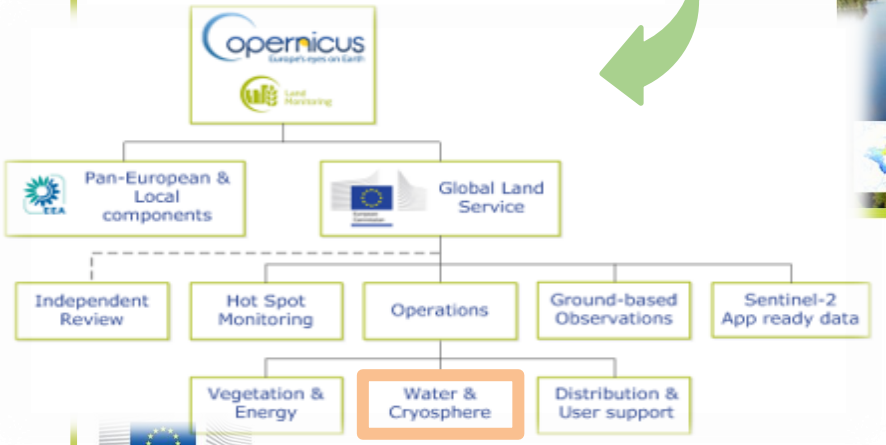
Copernicus Europe's eyes on Earth | European Commission | CLS | Finnish Meteorological Institute | vito | PML Plymouth Marine Laboratory | Brockmann Consult GmbH | SYKE | enveo | HYGEOS | IMDC | University of Reading | LEGOS | TU Wien | GEO

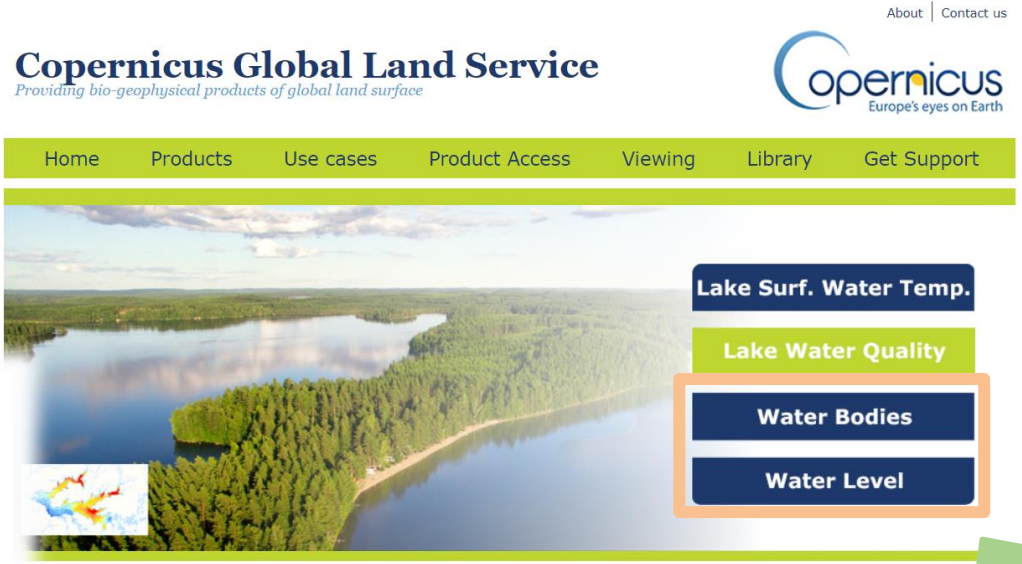
Global Land Operations

Copernicus
Europe's eyes on Earth

Copernicus Services

- Atmosphere Monitoring;
- Marine Environment Monitoring;
- Land Monitoring;
- Climate Change;
- Emergency Management;
- Security.





In this presentation focus on Water bodies extent and Water level products

Joint Research Centre JRC

CLS

Finnish Meteorological Institute

vito

PML Plymouth Marine Laboratory

Brockmann Consult GmbH

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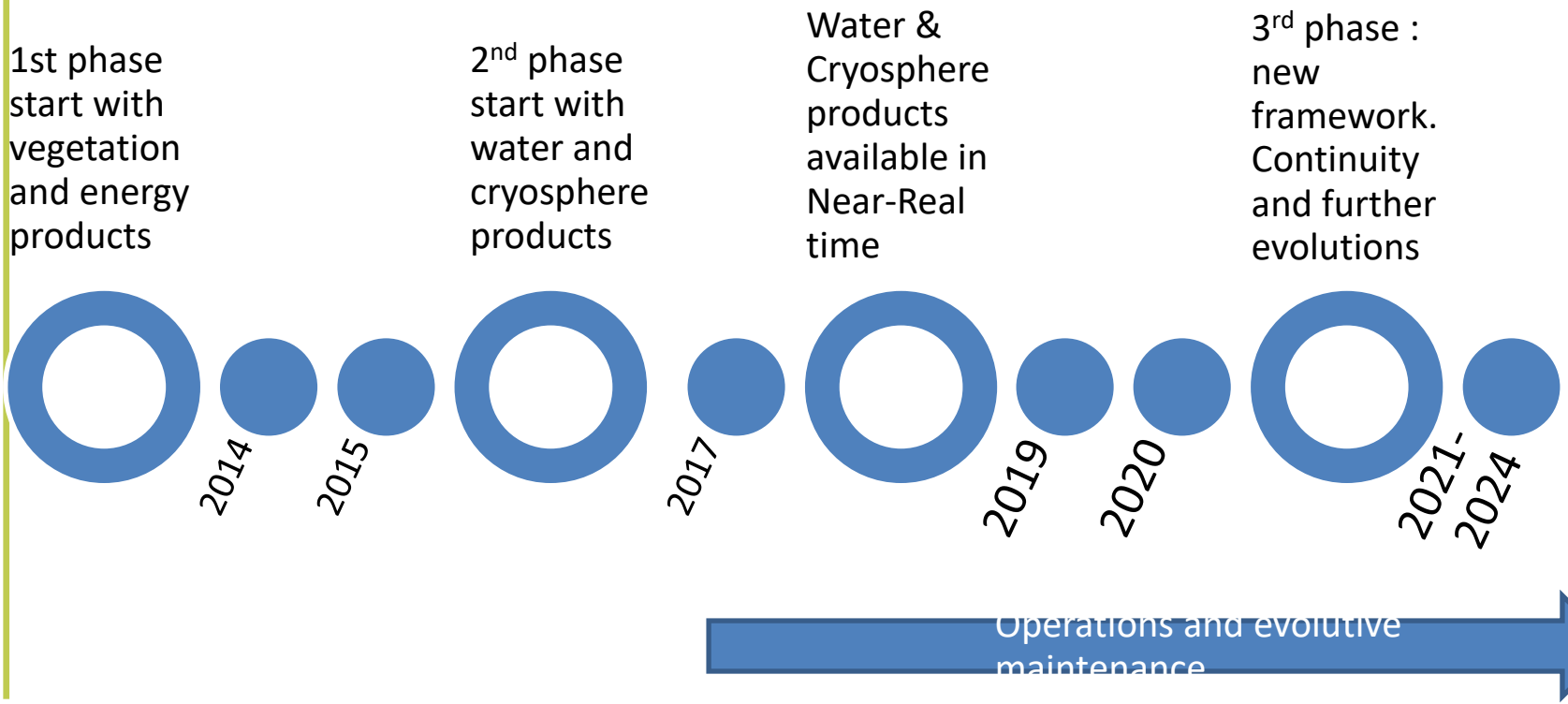
University of Reading

LEGOS

TU WIEN GEO

Global Land Operations

The cryopshere and water component: Copernicus Global Land Operational Service to answer societal challenges



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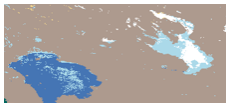
Copernicus Global Land Core Service

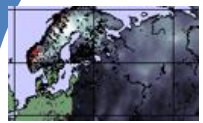
Downstream services

Space Data

In Situ



Lake Ice Extent

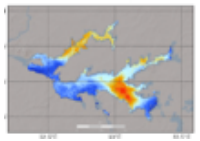


Snow Water Equivalent

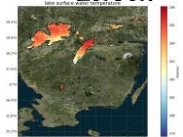
Snow Cover Extent

Areas of Water Bodies

Lakes, reservoirs and rivers Water Level



Lake Water Quality



Lake Surface Water Temperature

End users Applications

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A Service for multiple applications

High potential of downstream applications:

- Large variety of thematic areas
- Strong impact in the socio-economic sector
- Objective:
  - maximise the benefit of the Water services to applications and end users
  - Ensure that products and services are fit for purpose

Copernicus Global Land – Cryosphere and water Service

Global Land Operations

Cryopshere and water

	Current Status (March 2021)			Comments
	Resolution	**Cover**	**Sensors**	
Snow Water Equivalent	0.05° (~5km), daily	Northern hemis.	SSMI/S+ Synop SD obs	
Snow Cover Extent	500m, daily	Europe	MODIS	
	1km, daily	Northern hemis.	VIIRS	**Transitioning to Sentinel-3 SLSTR data**
Lake Ice Extent	250m, daily	Europe	MODIS	
Lake Water Quality	100m, 10 days	2000 Lakes	Sentinel-2 MSI	**Demonstration over 2019/ early 2020 over Europe and Africa → to return Global**
	300m, 10 days	Global, 4000 Lakes	Sentinel-3 OLCI	Not detailed in this presentation. See https://land.copernicus.eu/global/products/lwq
Lake Surface Water Temperature	1km, 10 days	Global	Sentinel-3 SLSTR	Not detailed in this presentation. See https://land.copernicus.eu/global/products/lswt

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Copernicus Global Land – Cryosphere and water Service

		Current Status (March 2021)			Comments
		Resolution	**Cover**	**Sensors**	
Vegetation and energy	**Soil Water Index**	1/112° (~1km)	Europe	Sentinel-1 C-band SAR + Metop ASCAT	
		0.1° (~12.5 km)	Global	Metop ASCAT	
	Surface Soil Moisture	1/112° (~1km)	Europe	Sentinel-1 C-band SAR	
Cryopshere and water	**Areas of Surface Water Bodies**	300m, monthly	Global	Sentinel-2 MSI	previously with Proba-V
		100m, monthly	Global	Sentinel-2 MSI	New resolution
	River Water Level	>300m wide rivers, 10 to 27 days	Global (+11300 stations over rievrs)	J3, Sentinel3A&B SRAL	
	Lake Water Level	>500km² lakes, 1-to-10 days	Global (156 lakes)	J3, Sentinel3A&B SRAL	

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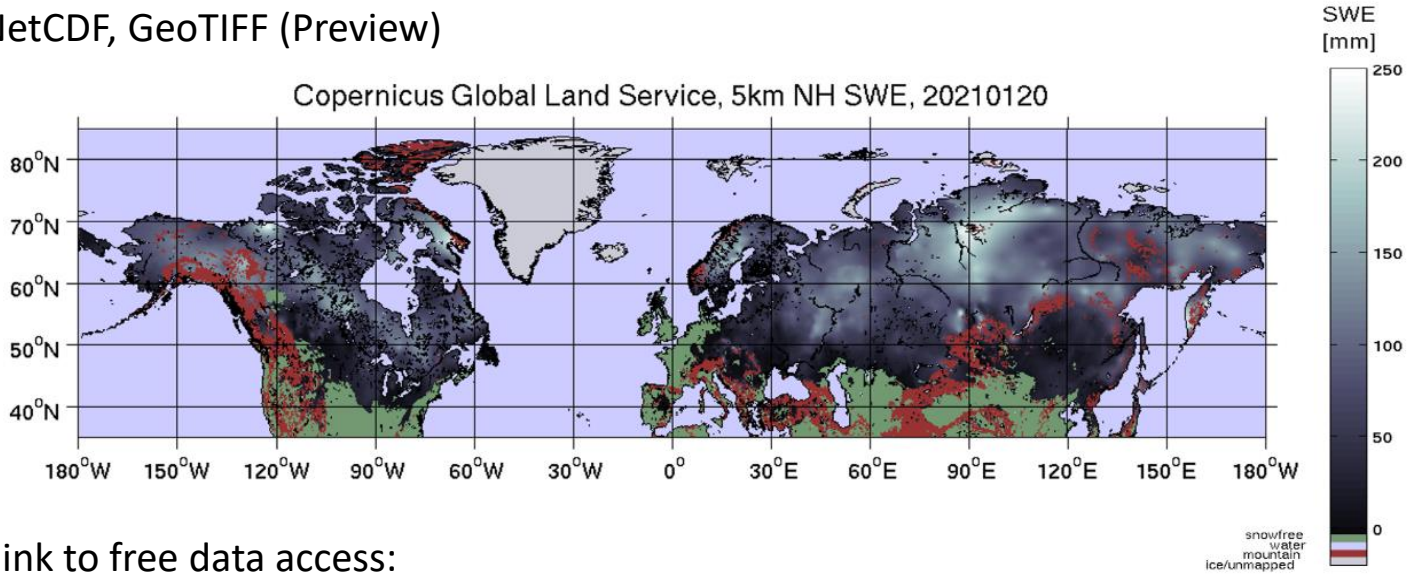
Snow Water Equivalent – Overview

Northern Hemisphere (excluding mountains) **5km**

- 0.05° (~5km) NH lat/lon grid, Passive MW radiometer + Synop SD obs.
- Daily product, available online ~40h after satellite data acquisition.
- SWE product time series available for 01.01.2006 –> present day
- Accuracy : ~30 mm (RMSE of SWE retrieval)
- Format : NetCDF, GeoTIFF (Preview)

Proposed Evolution roadmap :

- 1km resolution



Documentation + link to free data access:
https://land.copernicus.eu/global/products/swe

Snow Cover Extent – Overview

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Northern Hemisphere 1km

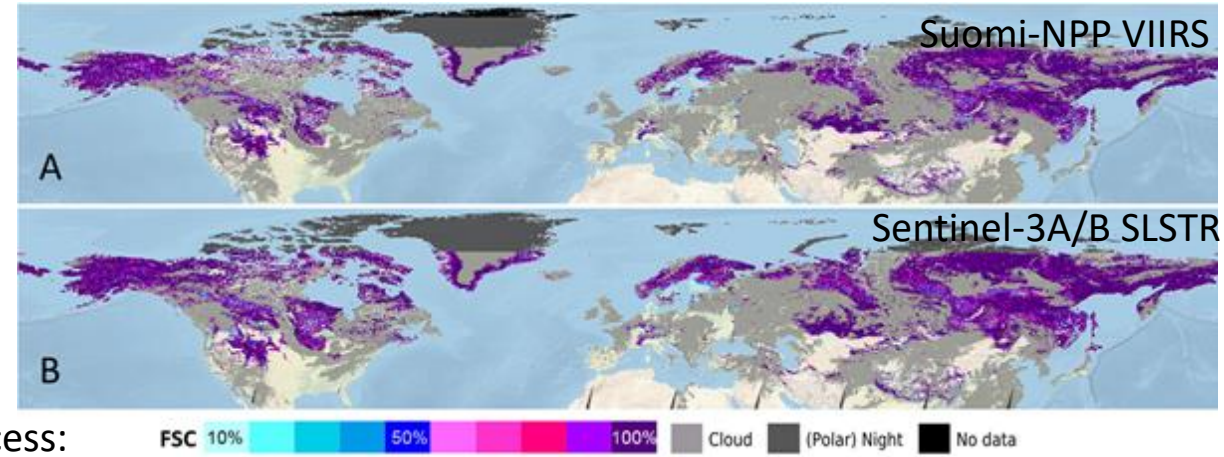
- 1km NH lat/lon grid, S-NPP VIIRS data
- Daily product.
- SCE product time series available from January 2018 –> present day
- resulting omission and commission errors are smaller than 10%, with an overall accuracy of >90%
- Format : NetCDF

Proposed Evolution roadmap :

- Use of S3 SLSTR data
- Provide uncertainty estimation
- Daily cloud product for the Northern Hemisphere
- Including South. Hemis.

European 500m

- 500m grid, MODIS data
- Daily product.
- SCE product time series available from March 2017 –> present day
- Format : NetCDF



Documentation + link to free data access:
https://land.copernicus.eu/global/products/sce

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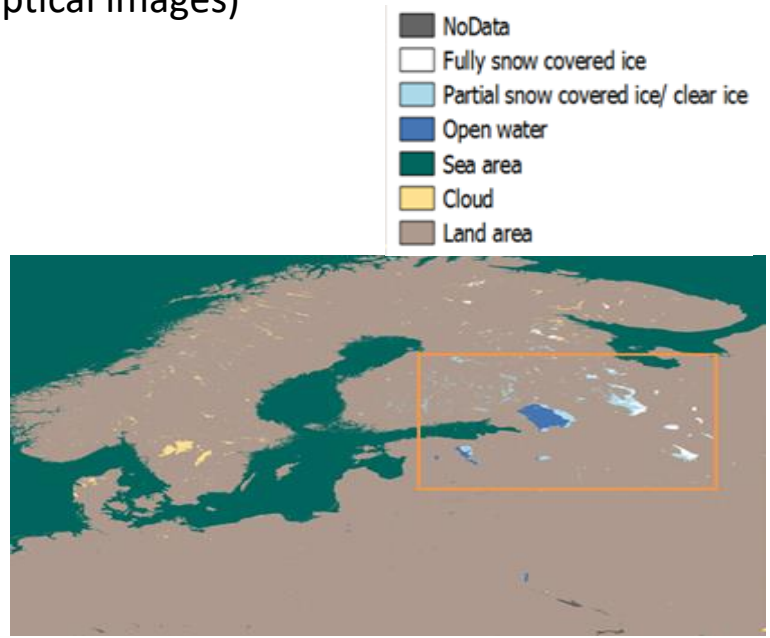
Lake Ice Extent – Overview

Like Ice Extent (Northern) 250m

- 0.0025° (~250m), MODIS data
- Daily product, available online ~4h after last overpass
- LIE product time series available for March 2017 –> present day
- Accuracy : 96% (comparison with high res 20m optical images)
- Format : NetCDF

Proposed Evolution roadmap :

- 500m Global product with S3-SLSTR data
- Extending the Northern Europe Lake Ice Extent (LIE-NE) service to Pan-European area
- exploiting Sentinel-3 SLSTR/OLCI L1C synergy data



Documentation + link to free data access:
https://land.copernicus.eu/global/products/lie

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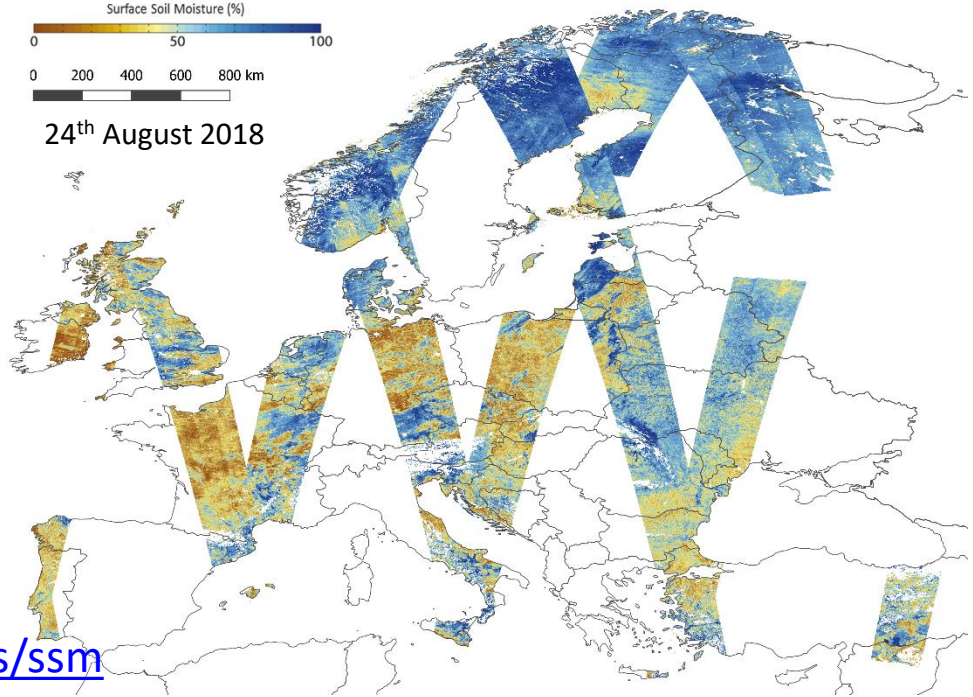
Surface Soil Moisture (SSM) - overview

- Input sensor: Sentinel-1 C-band SAR
- Method: change detection model applied to model long term dry and wet conditions
- Variables:
  - relative SSM, in % saturation
  - Noise on SSM
  - Flags (water, low sensitivity, topography)
- Resolution: 1/112° (~1km)
- Coverage: Europe
- Period: from 2015 to NRT

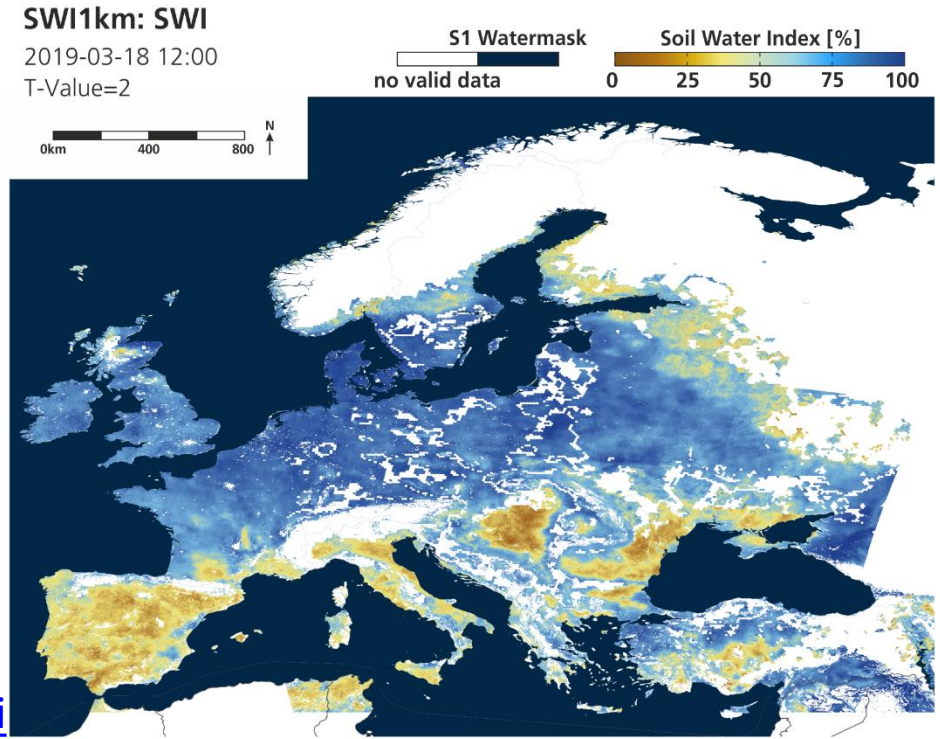


Quality Assessment Reports available on
https://land.copernicus.eu/global/products/ssm

Global Land Operations

Soil Water Index (SWI 1km) - overview

- Input sensors: Sentinel-1 C-band SAR + Metop ASCAT
- Method: two-layer water model, adapted to use a recursive formulation and not accounting for soil texture
- Variables:
  - SWI for 8 T values (T=2, 5, 10, 20, 40, 60, 100)
  - Surface State Flag (frozen, unfrozen, melting/water on the surface)
  - Flags (water, low sensitivity,
- Resolution: 1/112° (~1km)
- Coverage: Europe
- Period: from 2015 to NRT

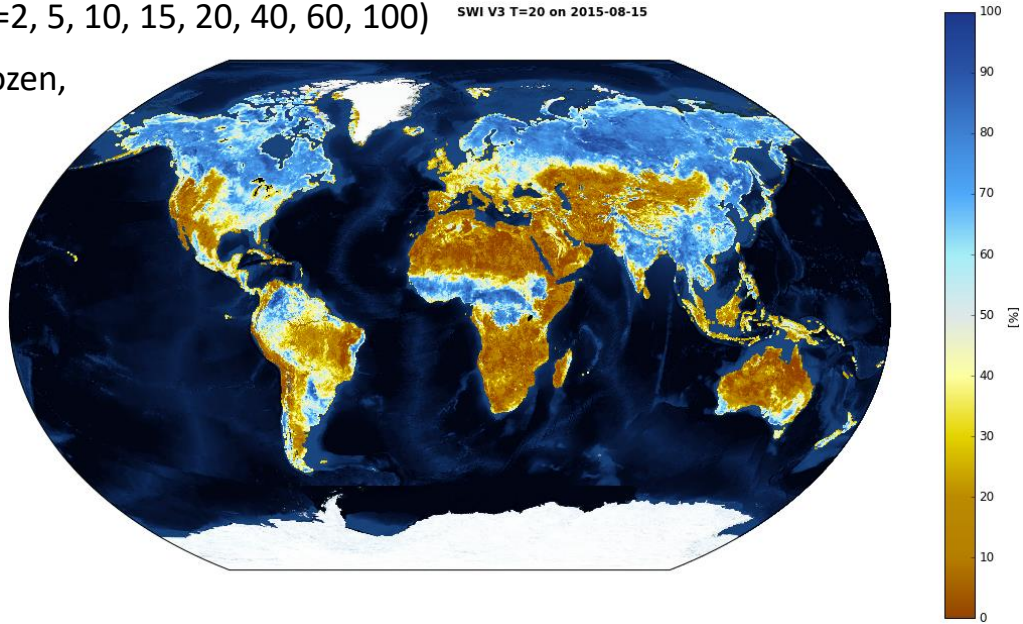


Quality Assessment Reports available on https://land.copernicus.eu/global/products/swi

Global Land Operations

Soil Water Index (SWI 0.1°) - overview

- Input sensors: Metop ASCAT
- Method: two-layer water model, adapted to use a recursive formulation and not accounting for soil texture
- Variables:
  - SWI for 8 soil depths (T values =2, 5, 10, 15, 20, 40, 60, 100)
  - Surface State Flag (frozen, unfrozen, melting/water on the surface)
  - Static layers (water fraction, topography, tropical forest)
  - SWI10: Average of SWI over a 10 days period, calculated for each soil depth
- Resolution: 0.1° (~12.5 km)
- Coverage: Globe
- Period: from 2007 to NRT



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Water Bodies extent– Overview

- Products up to september 2020 :

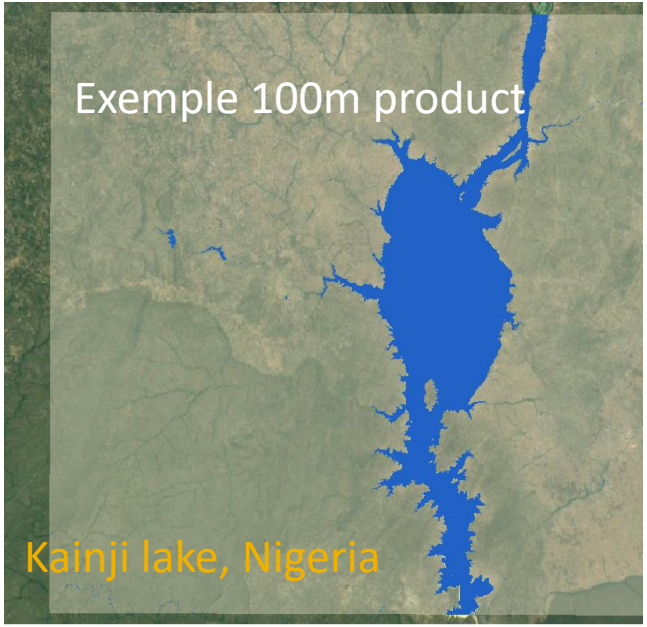
-Decadal Global product, 300m resolution using Proba-V (Janvier 2014 to July 2020)

- Decadal Europe product, 300m resolution using Proba-V (July 2020 to September 2020 : mission switched from operationnal to research mode)

- Products since october 2020 :

- Monthly Global product, 300m resolution using Sentinel-2A&B (since October 2020)

- Monthly Global product, 100m resolution using Sentinel-2A&B (since October 2020)



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Water Bodies extent– 100m and 300m monthly products based on S2 data

- **Global, monthly product**
- Method : Modified Normalized Difference Water Index (MNDWI): Green (B3, 10m) and (B11, 20m) bands **Sentinel2-MSI**. Only processed in GSWE maximum extent pixels
- **Available in less than 5 days** after the end of the month
- Quality assessment report being finalised by the producers, omission and commission errors soon available.
- Format : netcdf

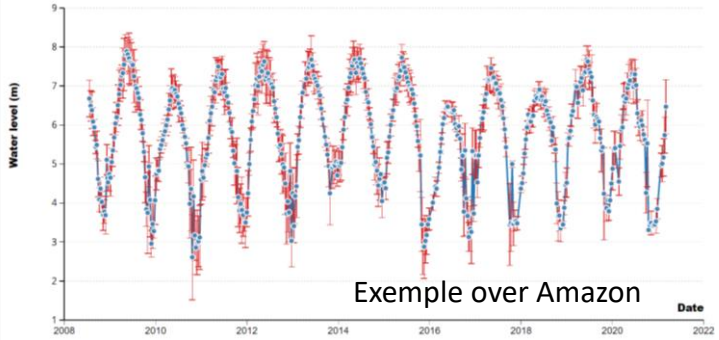
2 Variables in dataset :
- Xater bodies detection layer (WB). Differentiate sea and continental waters
- The quality layer (QUAL). Details the water occurrence during the month or the reason why there is no data (clouds, no input data …)

Documentation + link to free data access:
https://land.copernicus.eu/global/products/wb

Proposed Evolution roadmap :
- Integration of updated GSWE map
- Connexion with Surfwater project (CNES) : S2 as well as S1 SAR data.

Lakes and Rivers Water Level– Overview

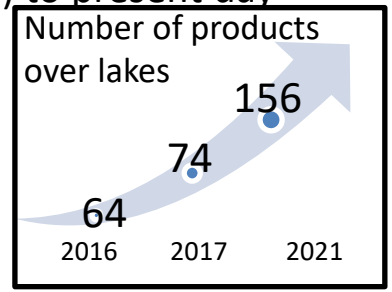
Global Land Operations

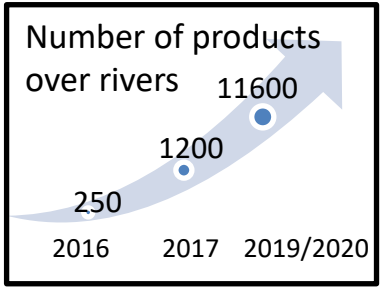


Lake (+ réservoirs) and Rivers Water Level Global

- **Water Level Time series + associated uncertainty**.
- Method : altimetry data
- One file per station / lake Jason2&3, Sentinel-3A&B data
- **Daily production**. Updated each time a satellite passes over target **within ~1.5 days**
- time series over rivers :
  - Jason stations : available from January 2008 –> present day
  - Sentinel3A stations : available from 2016 -> present day
  - Sentinel3B stations : available from 2019 -> present day
- time series over lakes : as far as 1992 (Topex Poseidon) to present day
- **Accuracy : 10cm over lakes, 15cm over rivers**
- Format : Geojson

Documentation + link to free data access:
https://land.copernicus.eu/global/products/wl





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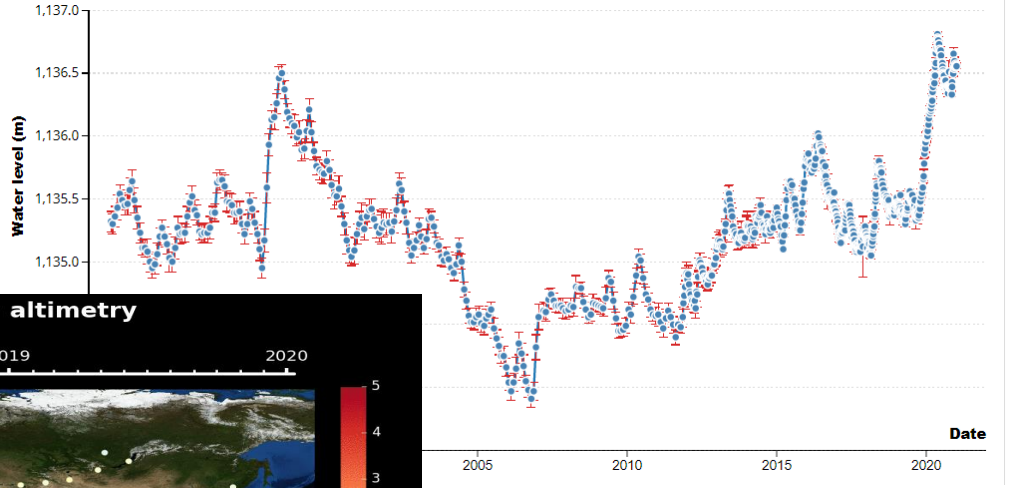
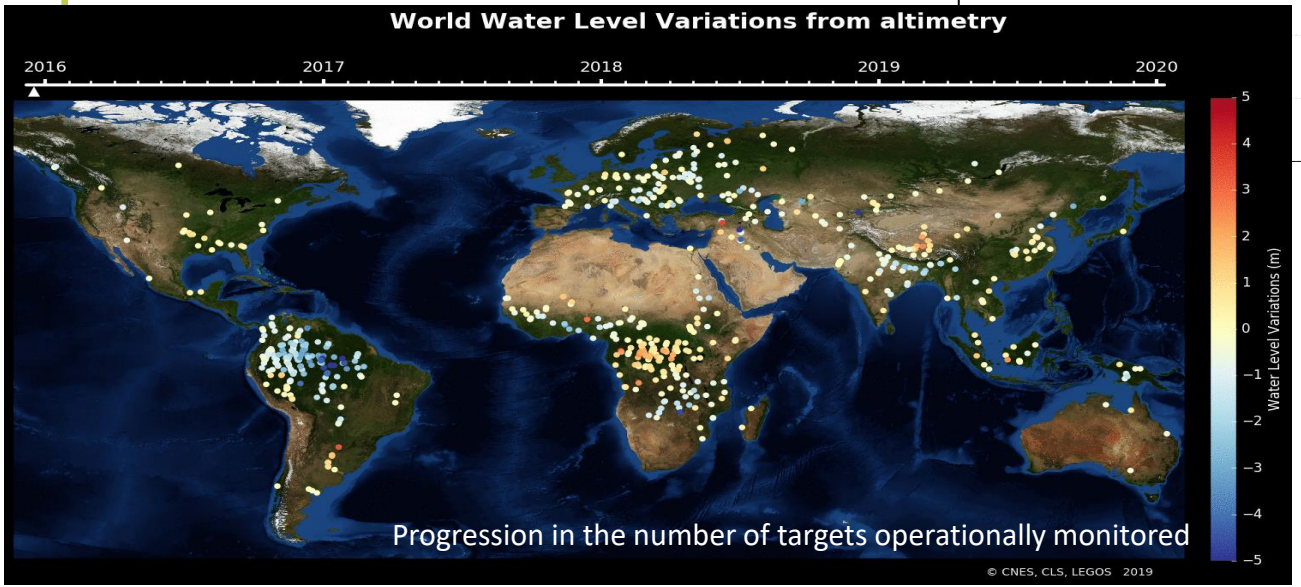
Lakes and Rivers Water Level– Overview

- Exemple of water level timeseries and associated uncertainties over Victoria Lake.
- Time sampling over lakes improved over the 4 last years with the inclusion of the Sentinel-3A&B measurements





- Coverage evolution over
- Colors represent water level anomaly (w.r.t mean)

Lakes and Rivers Water Level– Quality Assessment

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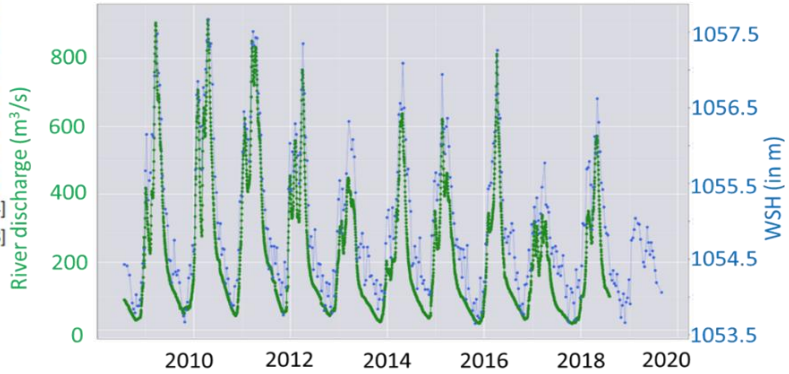
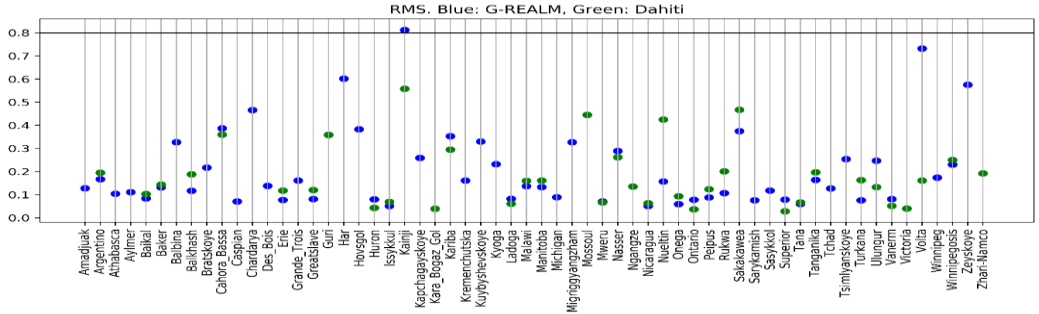
- computing the R^2 correlation coefficient between the operational stations situated on a same river

- Comparison to InSitu datasets





- Comparison to external datasets

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Lakes and Rivers Water Level– Proposed Evolution Roadmap

- Addition of Sentinel-6A : ensure the continuation of measurements on the Jason ground track. S6 uses SAR mode (similarly to S3A&B) : improved accuracy expected w.r.t J3

- Continue expanding the number of virtual stations and lakes : Given the OLTC updates for Jason-3, Sentinel-3A and Sentinel-3B that were performed in 2020 about 3000 new products are expected.

- Addition of Sentinel-3C

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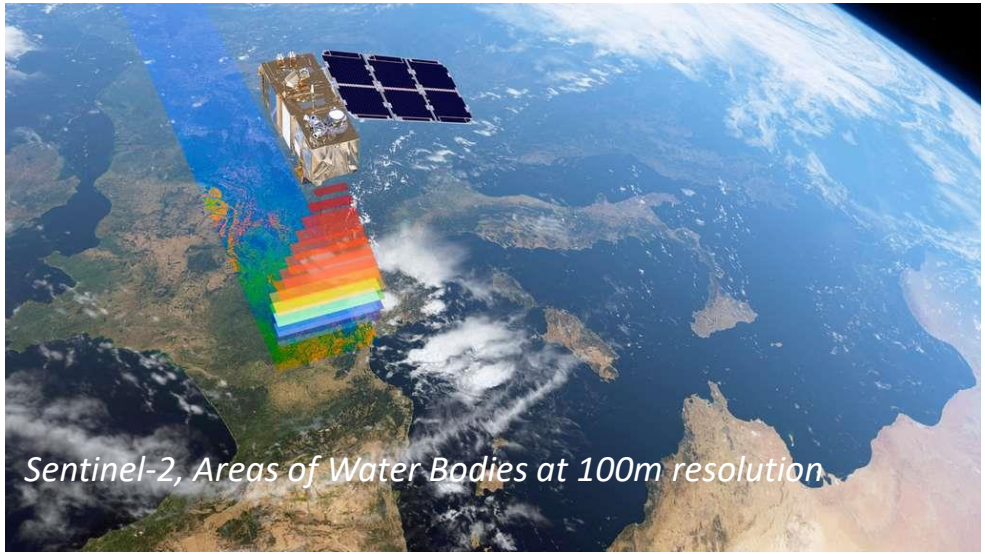
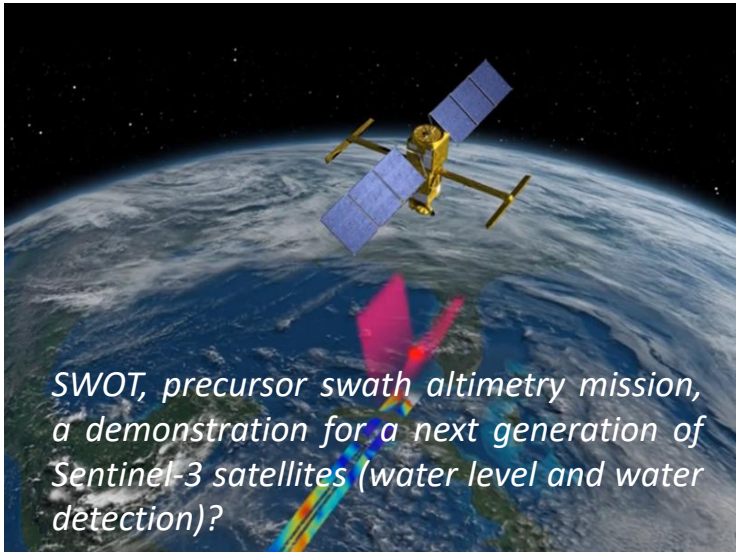
Conclusions:
An open access service to monitor water resources in Near-real time
Constant evolutions of the products to meet users needs

- **Users detailed needs are welcome (accuracy, resolution, coverage, availability…)**

The Copernicus Constellation and contributing missions promise many improvements and technological/scientific challenges ahead to improve the service towards higher space/time resolutions and meet user requirements



Sentinel-2, Areas of Water Bodies at 100m resolution



SWOT, precursor swath altimetry mission, a demonstration for a next generation of Sentinel-3 satellites (water level and water detection)?