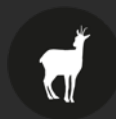


# State of Art and future developments on remote sensing for water quantity

In situ calibration and validation of satellite hydrology products

Water-ForCE Workshop, online, 18th May 2021

**isardSAT**<sup>®</sup>



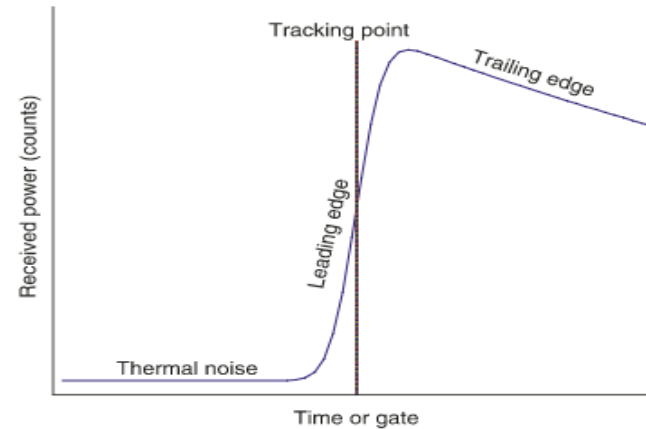
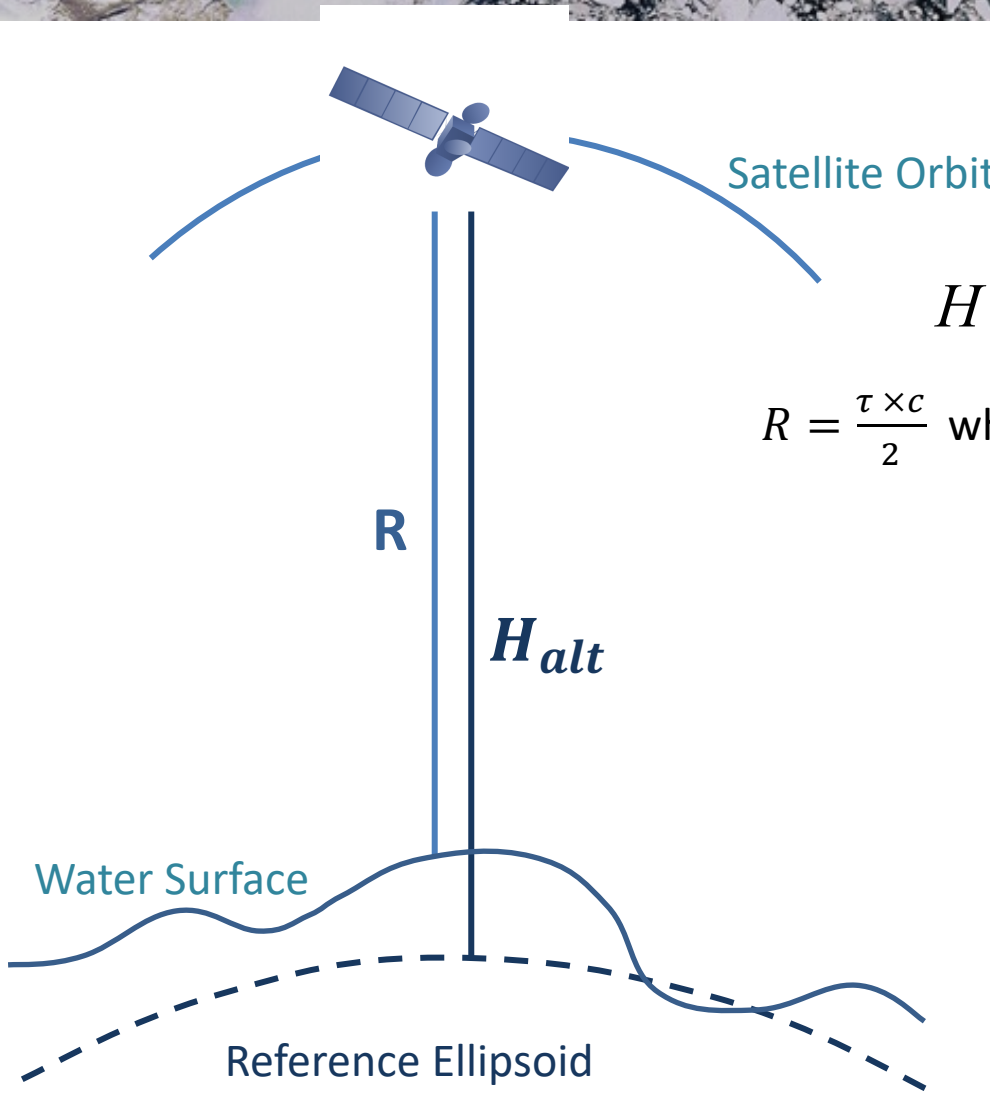
- Water Level estimation and validation
- Soil Moisture estimation and validation
- Conclusions

# Altimetry Principle

(EGM2008)

$$H_{waterlevel} = H_{alt} - (R + Corr) - C_{geoid}$$

$$R = \frac{\tau \times c}{2} \text{ where } \tau \text{ is echo delay, } c \text{ is the speed of light}$$



Waveform:  
The shape of the echo returned

$$Corr = C_{wet\_tropo} + C_{dry\_tropo} + C_{iono} + C_{solid\_earth\_tide} + C_{pole\_tide} + C_{ocean\_tide}$$

- State of the art

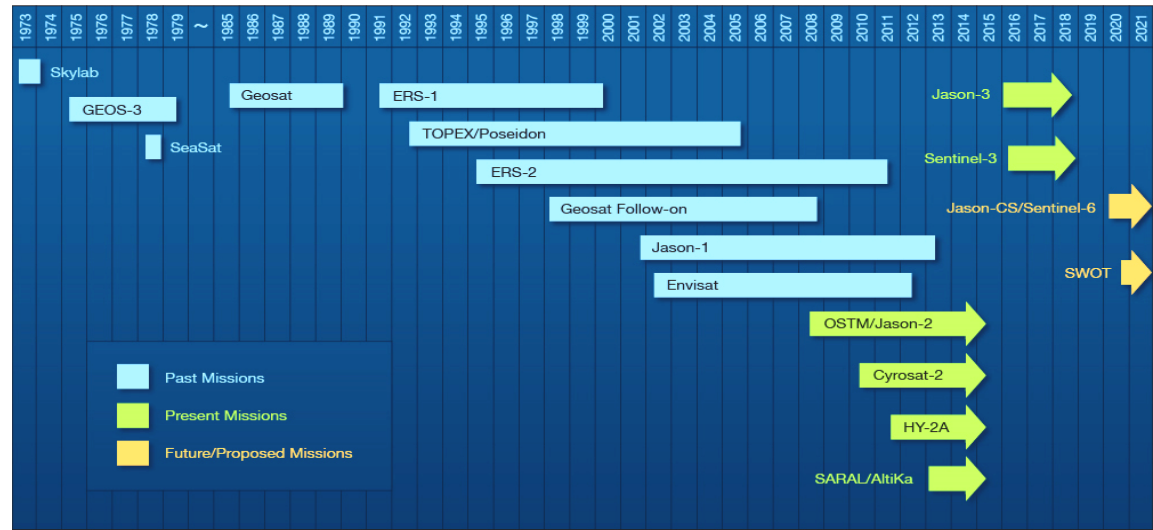
Ocean



Inland water bodies  
with a scale  
of several kilometers



Small water bodies  
width less than 2 km



**LRM altimeter**

(Low-resolution mode):  
Footprint ≈ 2 km

Individual echoes [1]:  
limitations

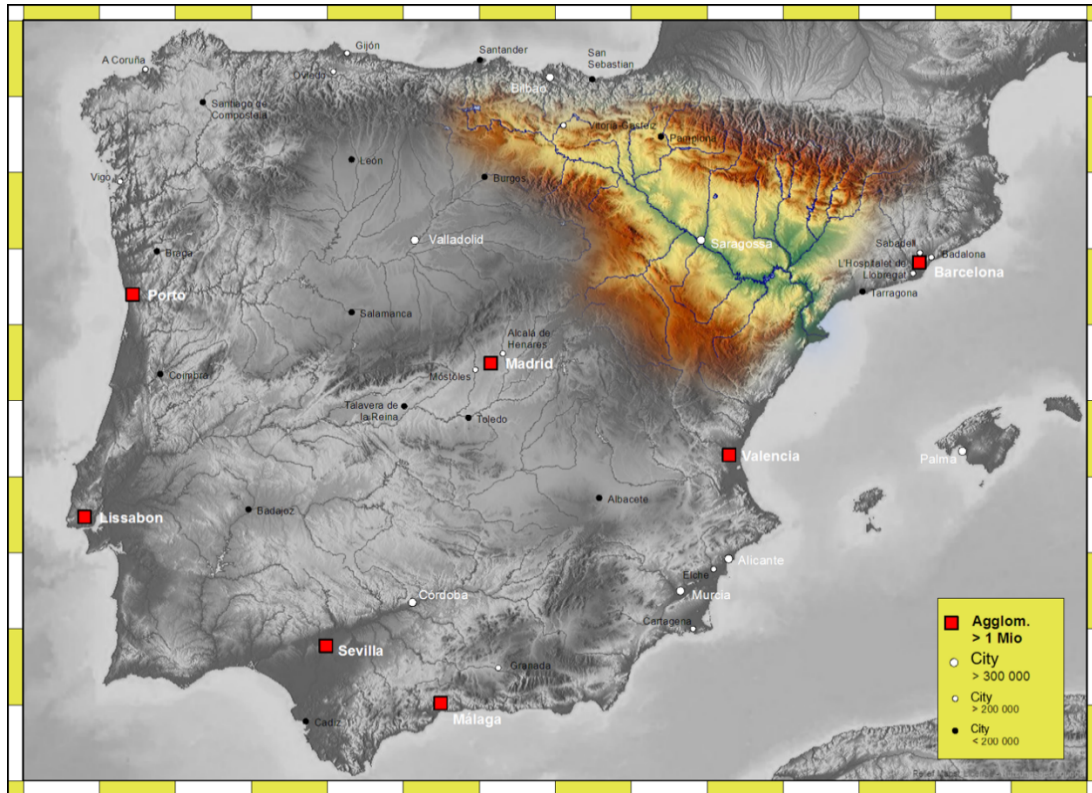
**SAR altimeter:**

Footprint ≈ 300 m

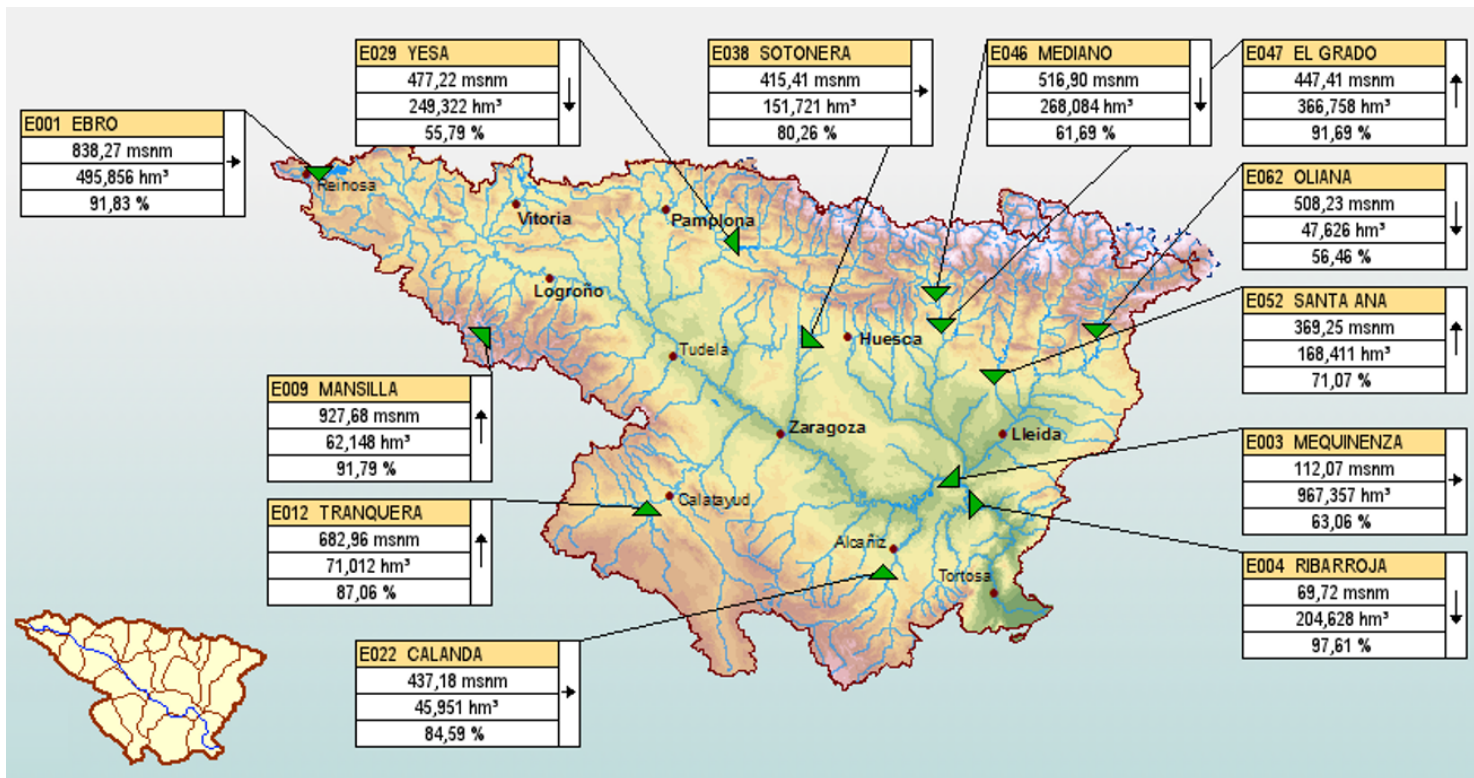
Fully Focused SAR :  
not yet fully operational

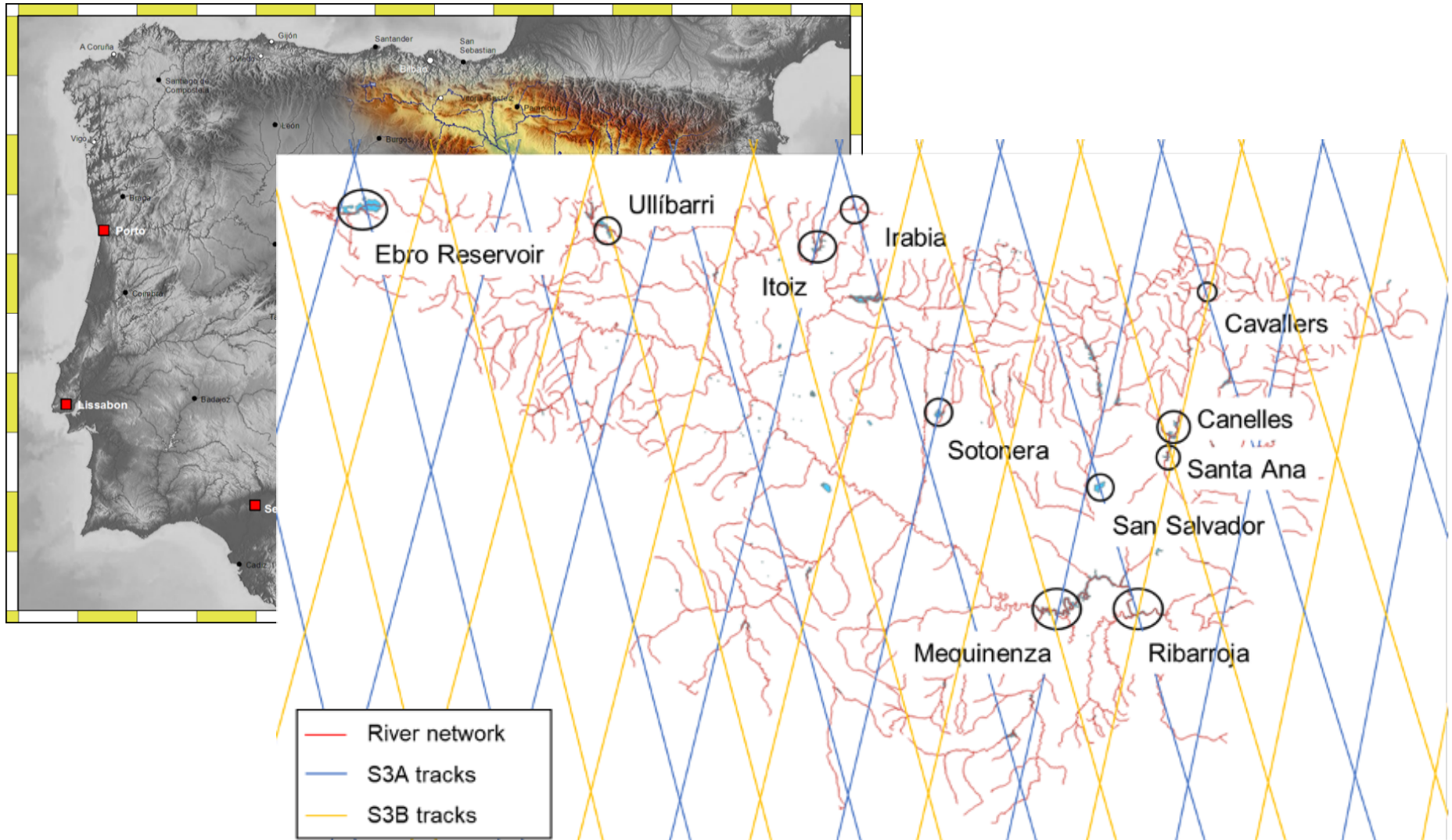


**sentinel-3**



SAIH Ebro:  
water levels, river  
flows, reservoir  
volumes

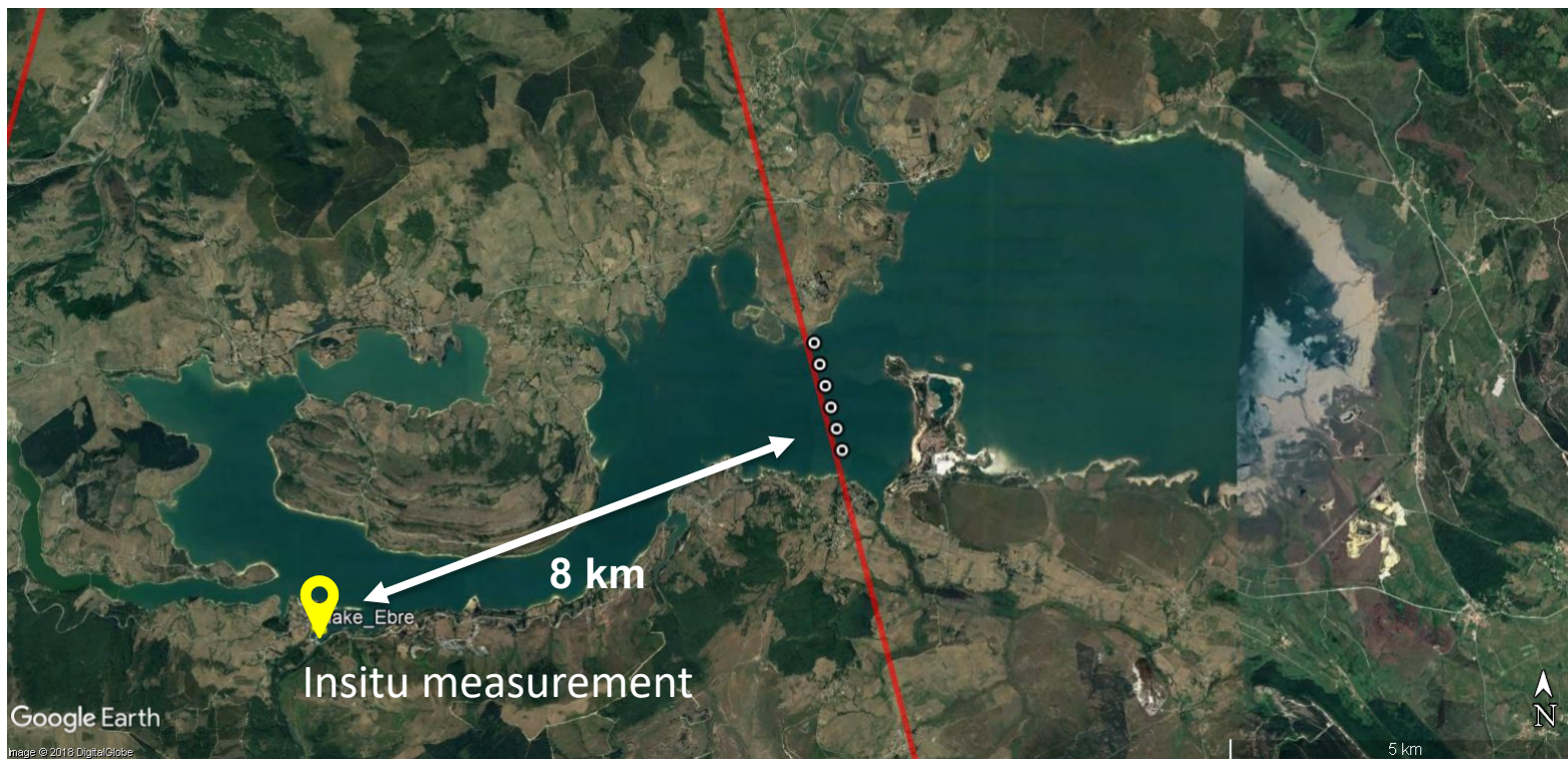




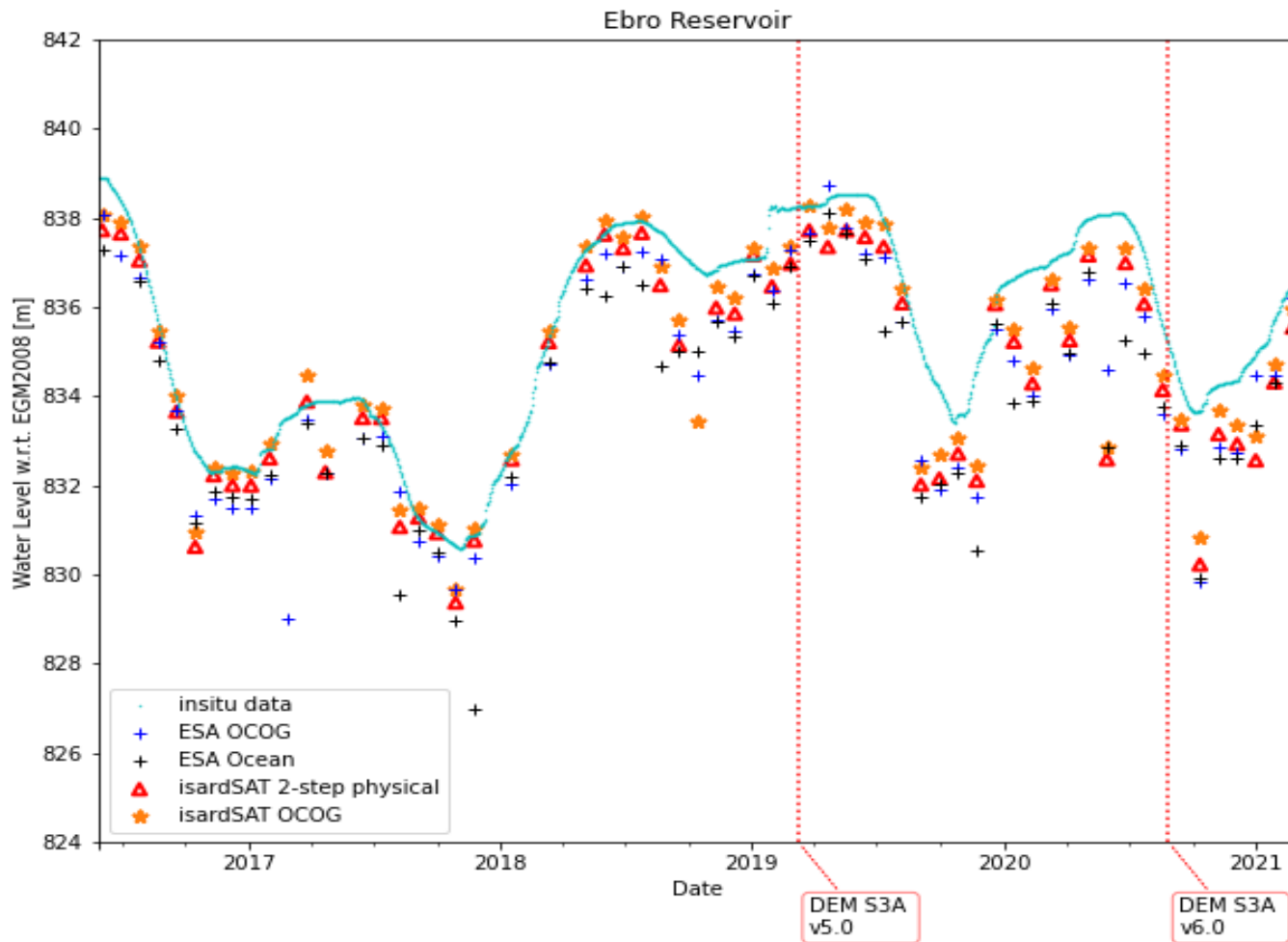
# Ebro Reservoir

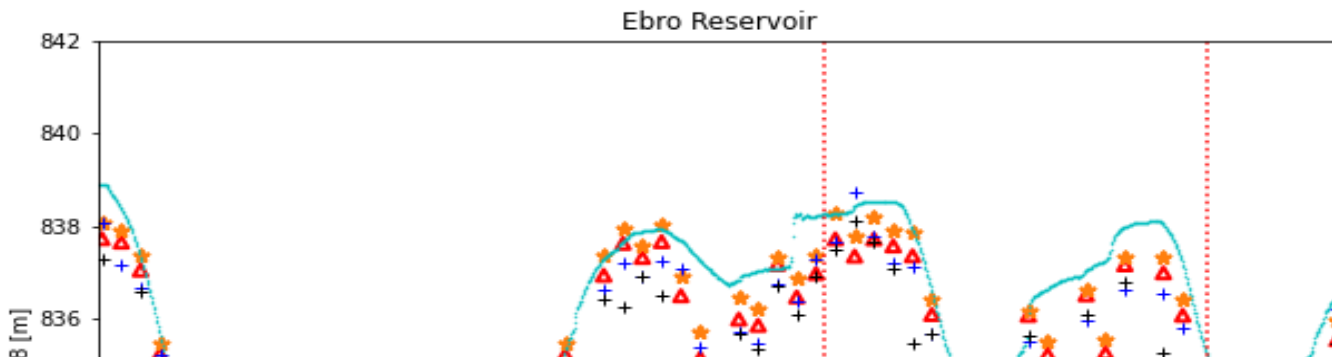
Width  $\approx$  1.8km

**Average Slope (5 km): 4%**



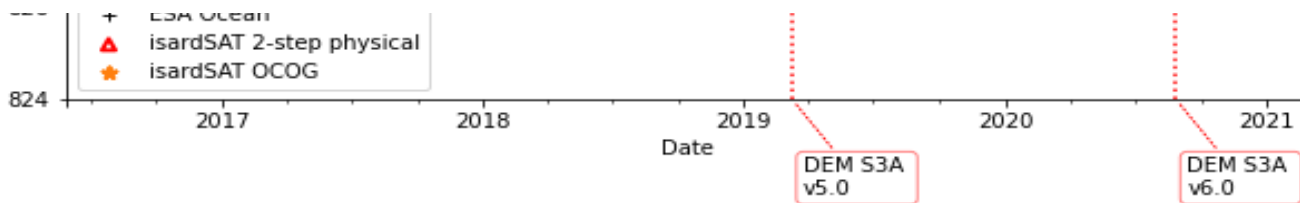






RMSE / Bias / MAD [m]

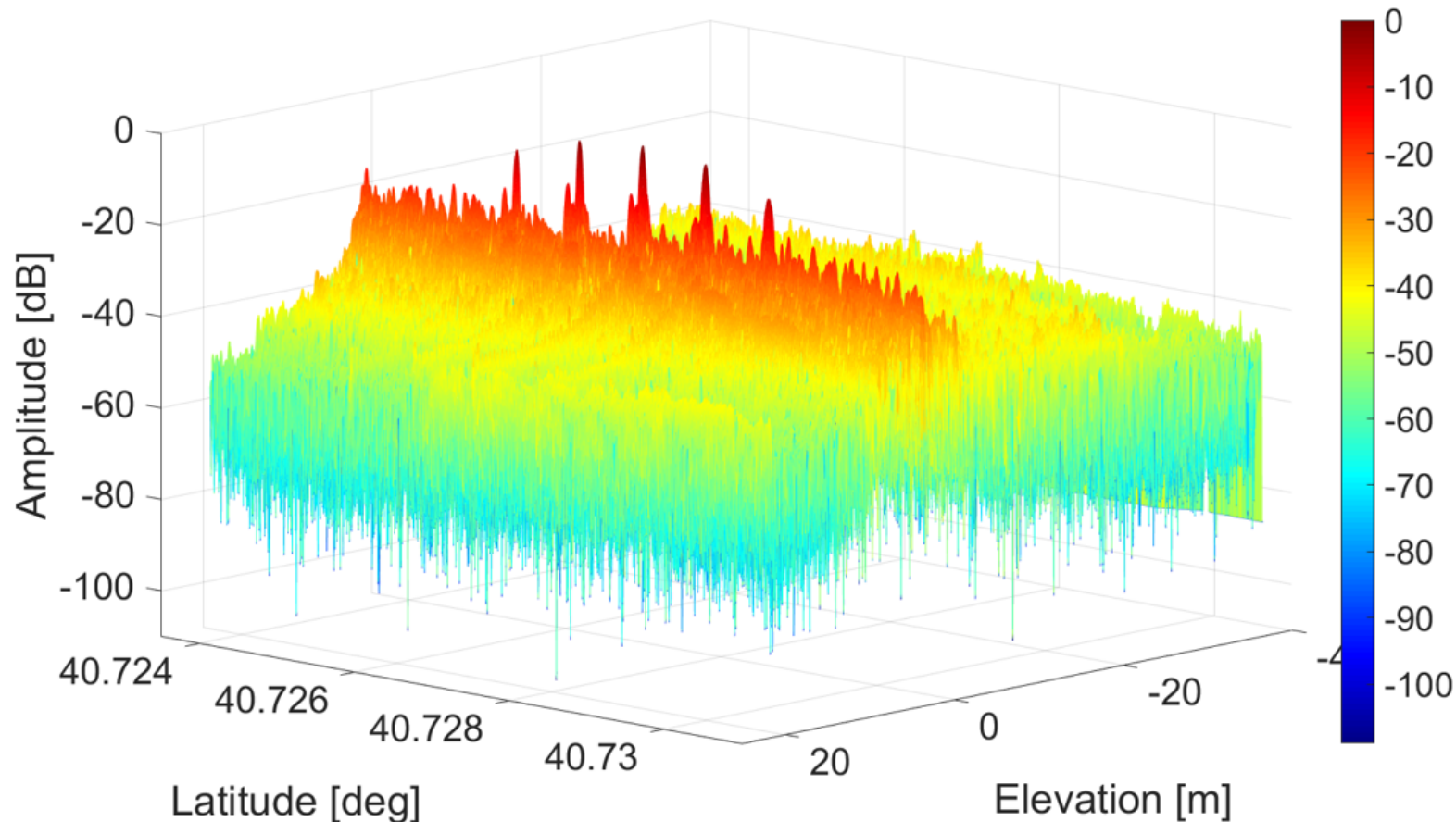
Reservoir	Width	Track	RMSE / Bias / MAD [m]			
			L2 ocean	L2 OCOG	isardSAT 2-step physical	isardSAT OCOG
Ebro	1.8 km	S3A 014	1.89 / -1.57 / 0.71	2.09 / -1.02 / 0.44	1.44 / -1.03 / 0.56	1.26 / -0.74 / 0.55



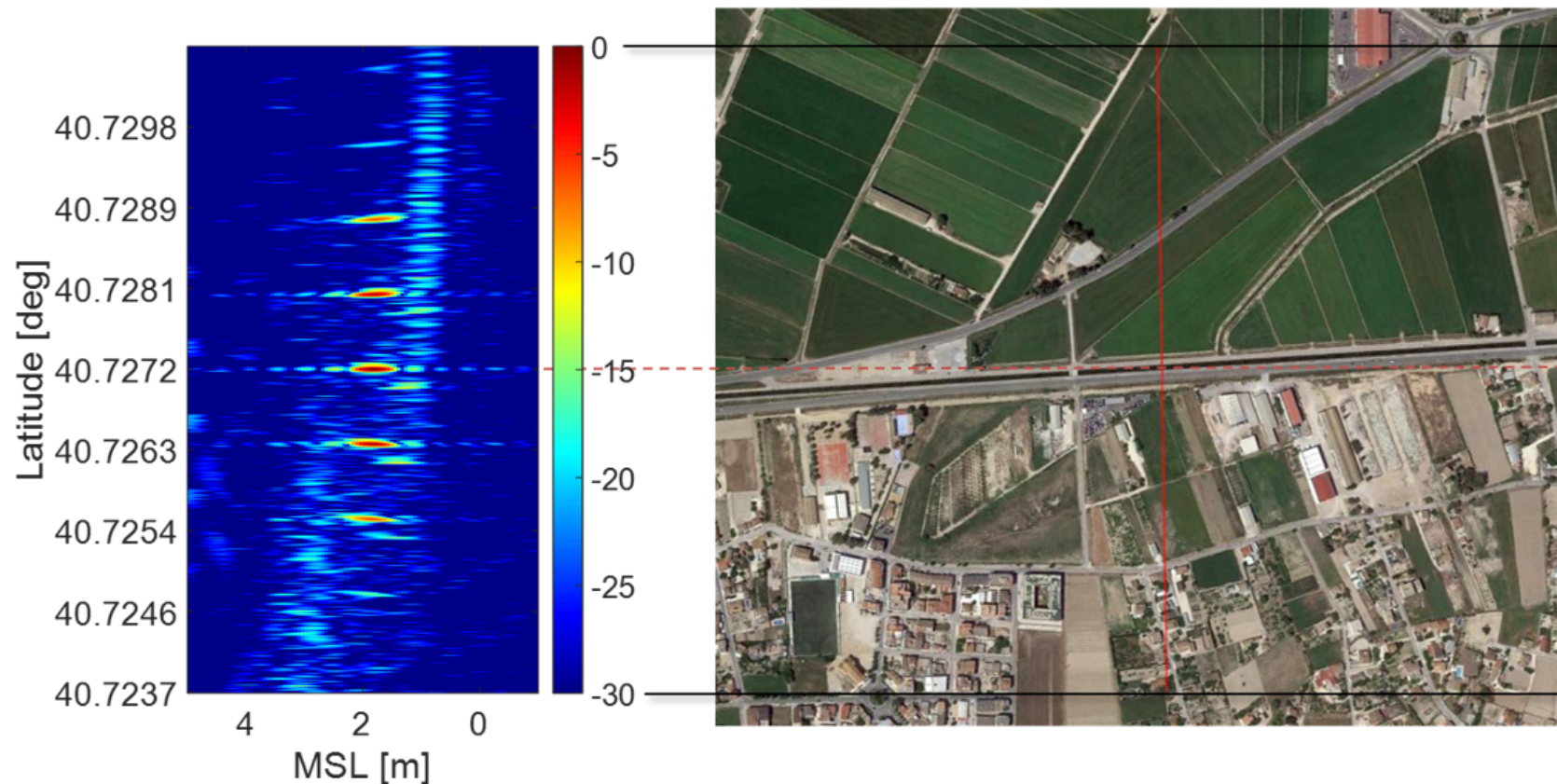
Reservoir	Width	Track	MAD [m]			
			L2 ocean	L2 OCOG	isardSAT 2-step physical	isardSAT OCOG
Ribarroja	400 m	S3A 242	0.17	0.16	0.18	0.20
		S3B 336	0.20	0.19	0.15	0.18
Mequinenza	600 m	S3A 279	0.47	0.10	0.12	0.11
		S3B 242	0.12	0.09	0.14	0.12

Quartly, Graham D., et al. "The roles of the S3MPC: Monitoring, validation and evolution of Sentinel-3 altimetry observations." *Remote Sensing* 12.11 (2020): 1763.

Gao, Q., Makhoul, E., Escorihuela, M. J., Zribi, M., Quintana Seguí, P., García, P., & Roca, M. (2019). Analysis of retracker's performances and water level retrieval over the ebro river basin using sentinel-3. *Remote Sensing*, 11(6), 718.

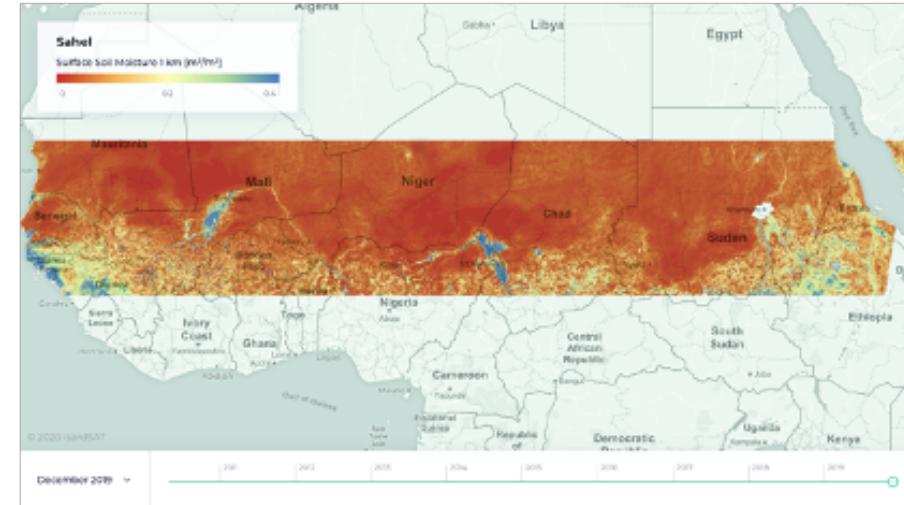


**Figure 3.** Fully-Focused SAR Power waveforms obtained from a S3A pass over a water channel in Ebre Delta. On-ground surface spacing is set to 0.5m . The central peak corresponds to the channel location and the other four are the replicas located every +/-92m in the along-track direction.



**Figure 4.** Geolocation of the S3A pass shown in Figure 3. The central peak observed on the *left* plot with latitude  $40.7272^{\circ}$  corresponds to the subsatellite track crossing point with the irrigation channel, as shown in *right* plot. The replicas in the along-track direction can be also appreciated.

<b>Data</b>	<b>From surface to root-zone soil moisture derived from L-band MW</b>
<b>Temporal coverage</b>	since 2010
<b>Spatial coverage</b>	Global
<b>Temporal resolution</b>	every 1/2 days
<b>Spatial resolution</b>	1 km
<b>Delivery</b>	WMS, FTP, direct download



High resolution soil moisture, disaggregation with SMOS/SMAP in combination with thermal/optical data S3/MODIS (Merlin et al. 2013, Stefan et al. 2021)

<https://accwa.isardsat.space/eo-products/>  
<https://locust-hub-hqfao.hub.arcgis.com/>



SM

L-band Passive MW SMOS/SMAP/CIMR

- accuracy 0.04 m<sup>3</sup>/m<sup>3</sup>
- low spatial resolution 40 km
- high temporal 2/3

+

O/T Medium Resolution S3/MODIS (1 km, 1 d)

or

O/T High Resolution LandSat (100 m, 16 d)



SM (1 km, 2/3 d)

SM (100 m, 16 d)

L-band Passive MW SMOS/SMAP/CIMR

+

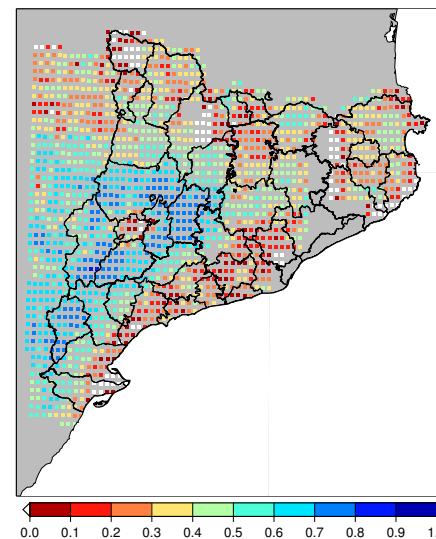
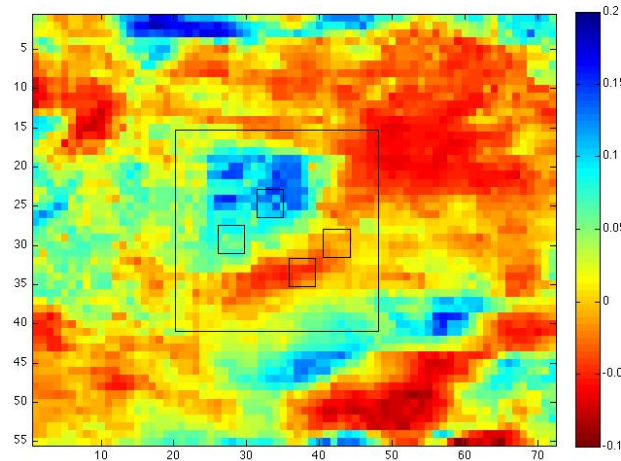
O/T Medium Resolution S3/MODIS (1 km, 1 d)

O/T High Resolution LandSat (100 m, 16 d)



SM (1 km, 2/3 d)

SM (100 m, 16 d)





## Continuous measurements

+ 2 demonstrative farms (3 soil moisture profiles: surface, root, infiltration)

## Campaign

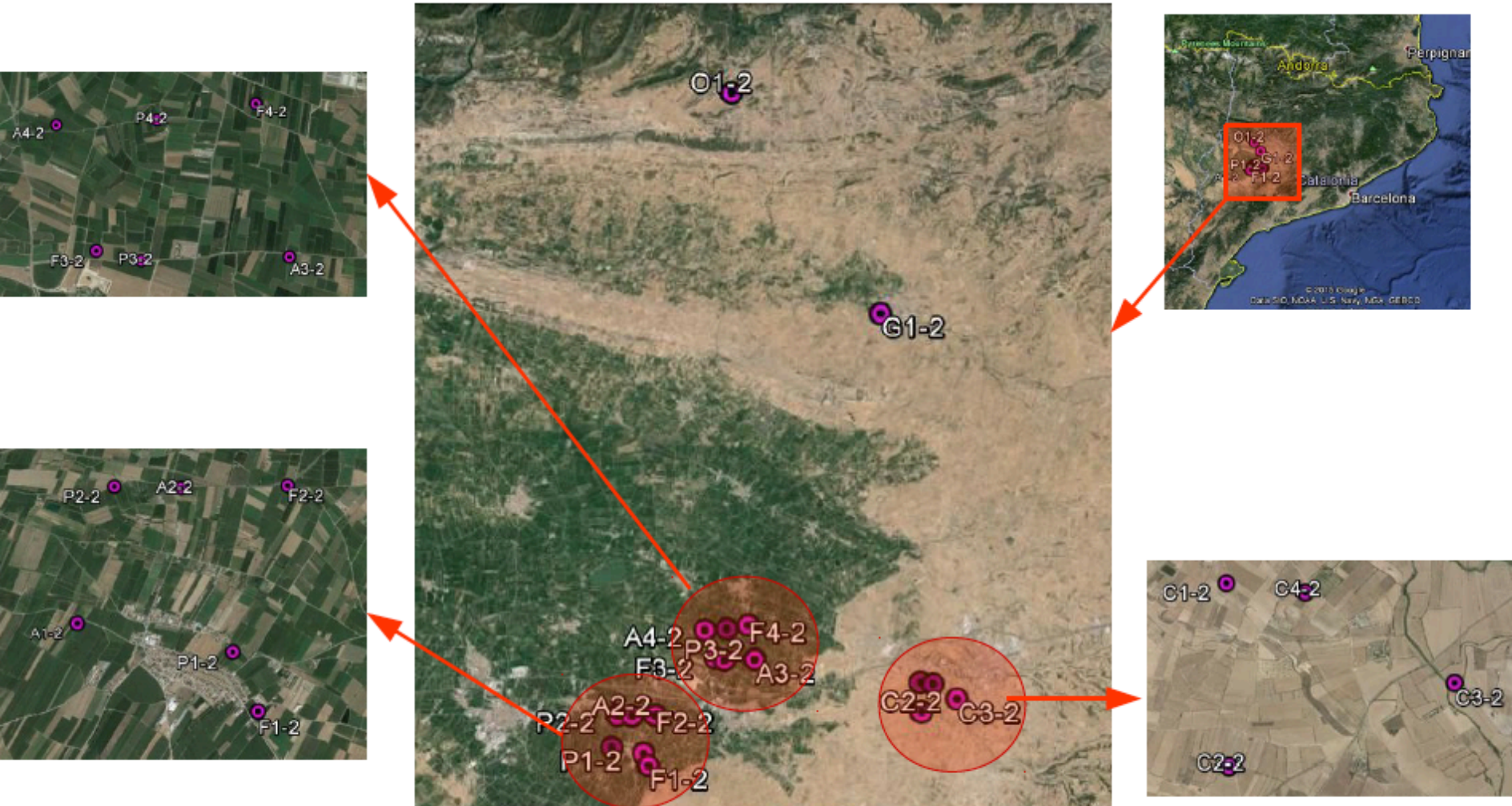
Once a month 2015 SSM (0 – 5 cm) measurements:

**Irrigated** : 4 corn, 4 alfalfa, 4 fruit trees

**Dryland**: 4 cereal fields

- soil texture, stone percentage, wilting point and field capacity
- Roughness measurements





L-band Passive MW SMOS/SMAP/WCOM

+

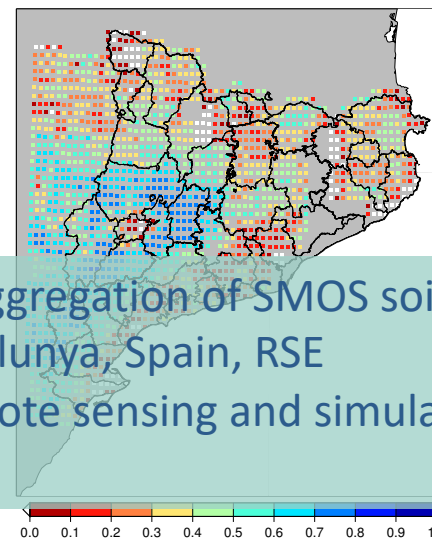
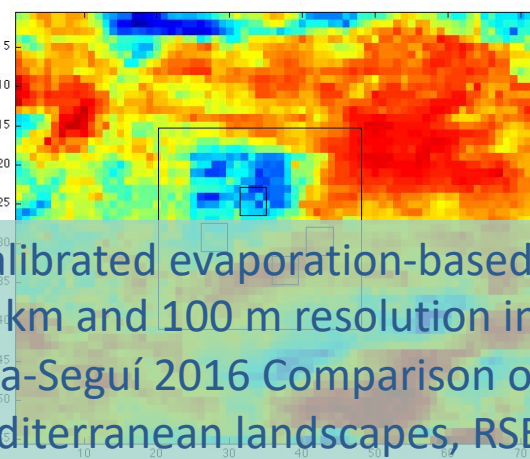
O/T Medium Resolution MODIS (1 km, 1 d)

O/T High Resolution LandSat (100 m, 16 d)



NSSM (1 km, 2/3 d)

NSSM (100 m, 16 d)



Merlin et al. 2013 Self-calibrated evaporation-based disaggregation of SMOS soil moisture: An evaluation study at 3 km and 100 m resolution in Catalunya, Spain, RSE  
Escorihuela and Quintana-Seguí 2016 Comparison of remote sensing and simulated soil moisture datasets in Mediterranean landscapes, RSE



Welcome to the Data Hosting Facility of the

# International Soil Moisture Network

select data from certain networks

- Africa
- Asia
- Australia
- Europe
- North America
- Oceania
- South America

In a certain time interval

from 2020/05/18 to 2021/05/18

1950  2021

Hide Stations that have no data in time interval.

In a certain area

Latitude Longitude

south-west -90 -180

north-east 90 180

Select from input

Clear

To select an area on the map press **SHIFT** and drag a rectangle.

and log in to download the selected data

Reset all

