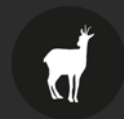


Water Elevation and Water Extent Measurements With Sentinel-6 Fully-Focussed SAR

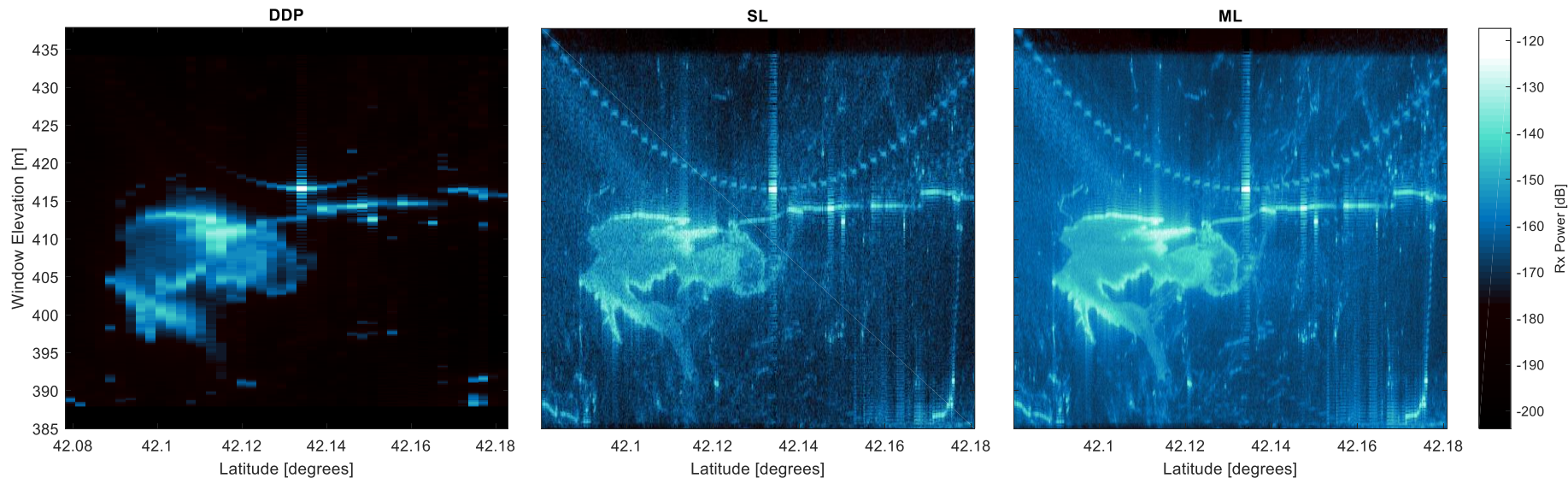
OSTST 2022 – Venice, Italy

Ferran Gibert, Adrià Gómez-Olivé, Charlie McKeown,
Robert Molina, Albert Garcia-Mondéjar

isardSAT[®]

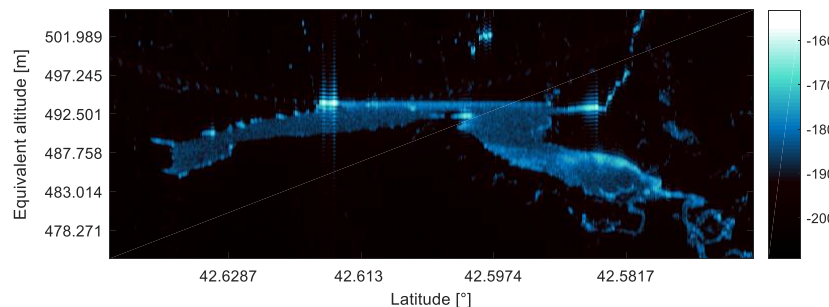
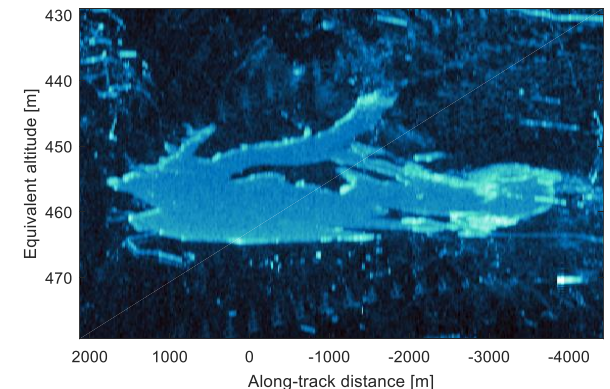


- **Sentinel-6A** data processed with **Fully-Focussed SAR (FF-SAR)** is expected to provide increased performance due to its increased along-track resolution and reduced along-track replicas.
- **In-land waters** monitoring benefits from such improvement.



→ *Explore water level and water extent measurement capabilities over a subset of inland water targets processed with S6A FF-SAR*

- Water extent and water level measurements
 - Water **level** measurements require **nadir** targets
 - Water **extent** measurements require **off-nadir** targets
 - Target height data knowledge & unambiguous scenario

Yesa reservoir*La Sotonera reservoir*

- **Water level**

- Three reservoirs selected:
 - Yesa ~1.8-2.5 km
 - Itoiz ~130 m
 - Mequinensa ~0.6-2 km
- Processed with 2.9 s integration time
 - Along-track resolution ~0.6 m
 - Multi-looked to 20 m.



Yesa reservoir



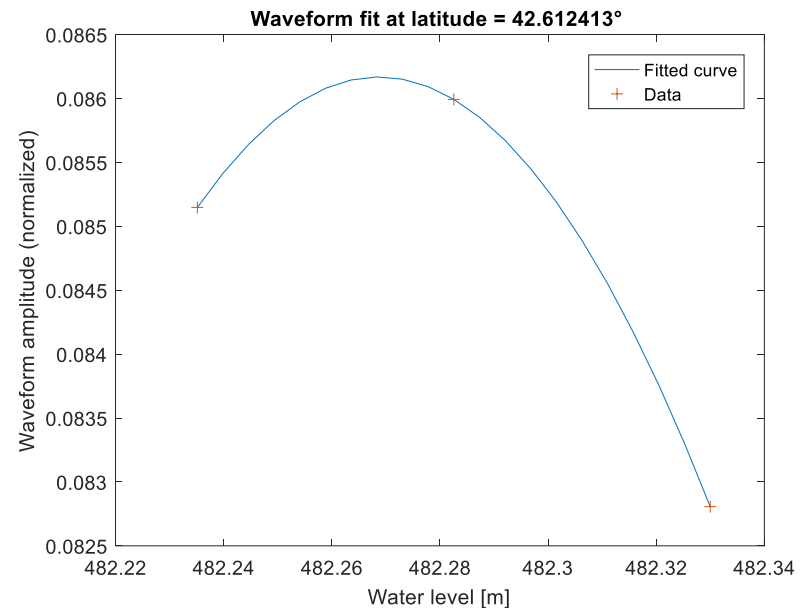
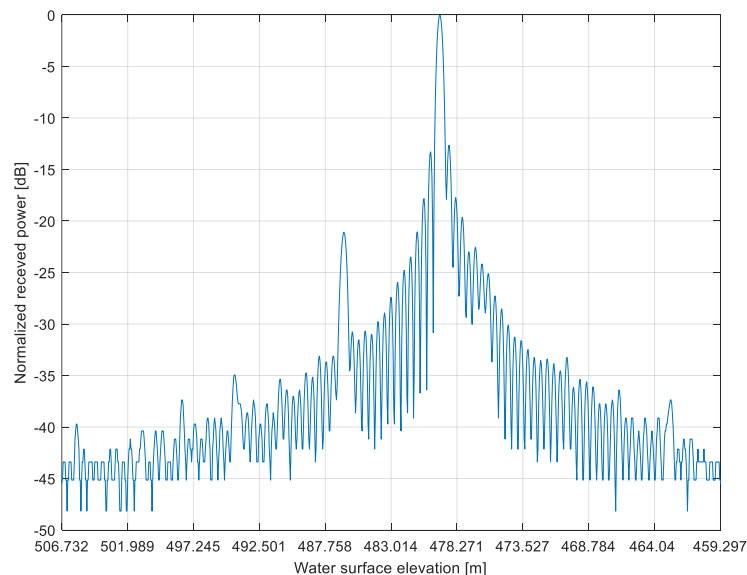
Itoiz reservoir



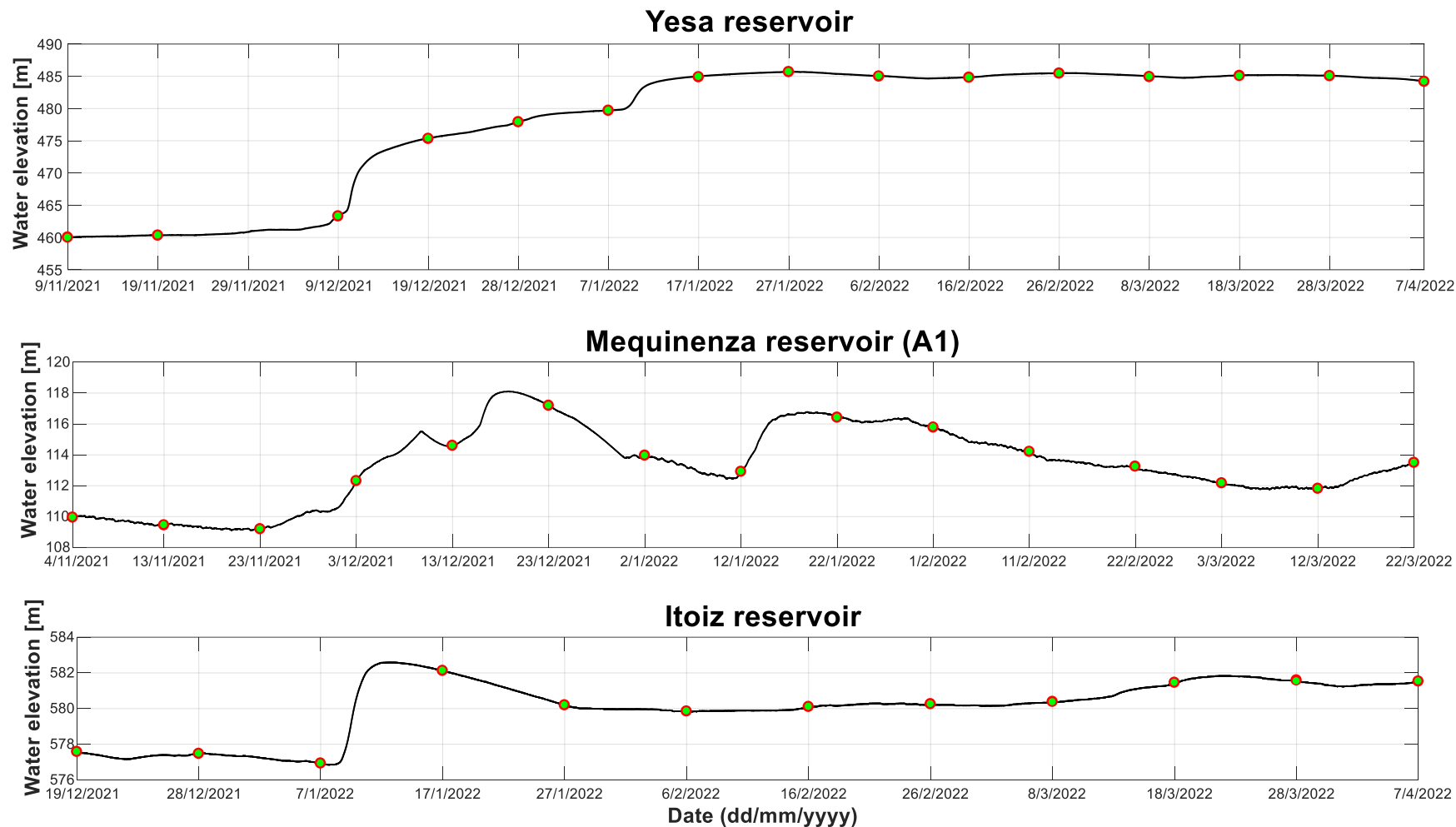
Mequinensa reservoir



- Waveform processing
 - Nadir reflections almost *pure* sinc functions
 - Retracker based on Gaussian fit over main lobe with a limited number of points
 - Post-processing applied to discard waveforms with high-power peaks away from the expected target elevation.
 - Geophysical corrections extracted from L2 files.



- 8-month time series compared to in-situ data



- Water level results
 - Performance evaluated in terms of bias and standard deviation of residual errors
 - Bias below 6 cm for all targets.
 - Standard deviation between 2 and 4 cm for all targets
 - Equivalent Delay-Doppler performance evaluated for comparison.

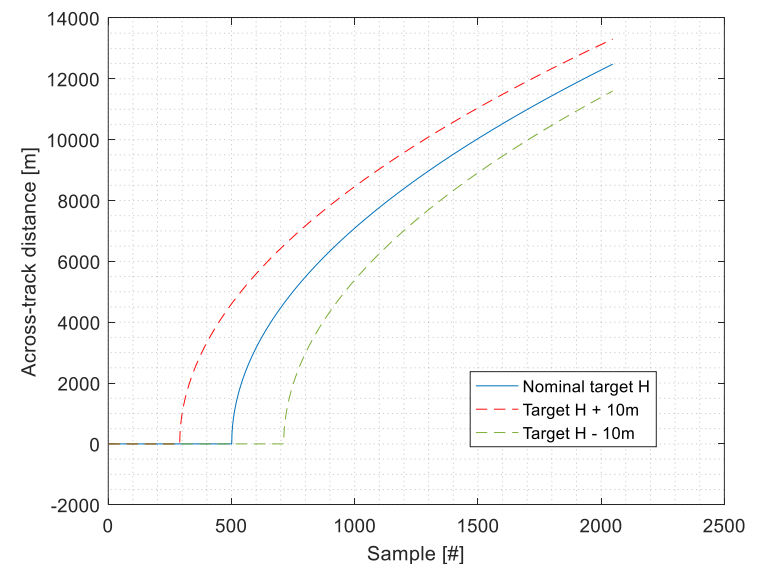
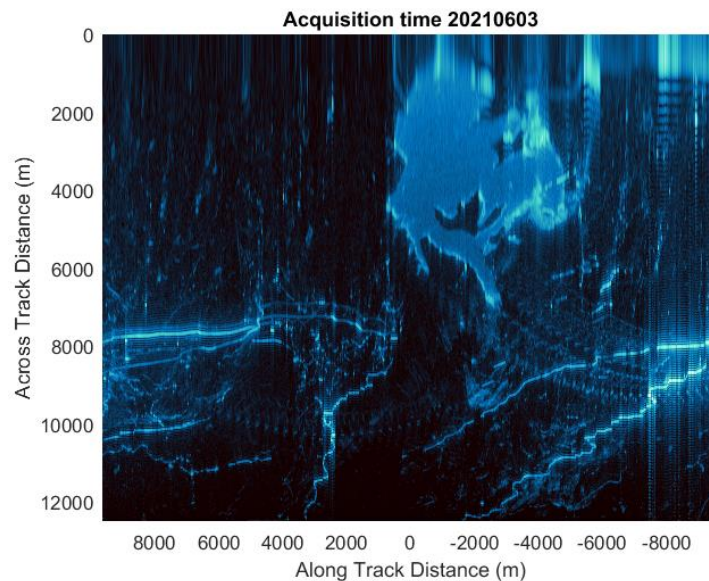
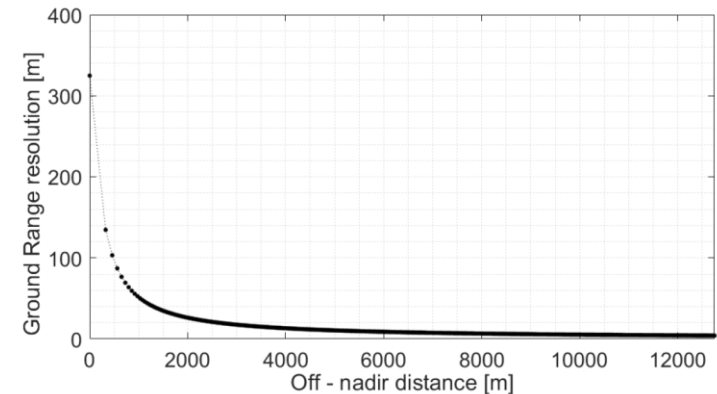
Yesa reservoir		
	FF-SAR	Delay-Doppler
Bias [cm]	3.0	-9.9
Std [cm]	3.9	10.9

Itoiz reservoir		
	FF-SAR	Delay-Doppler
Bias [cm]	2.7	--
Std [cm]	2.0	--

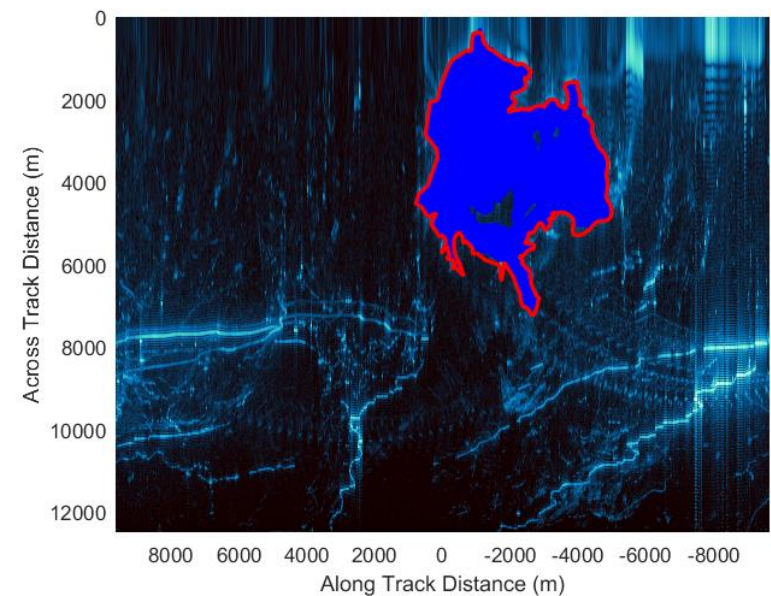
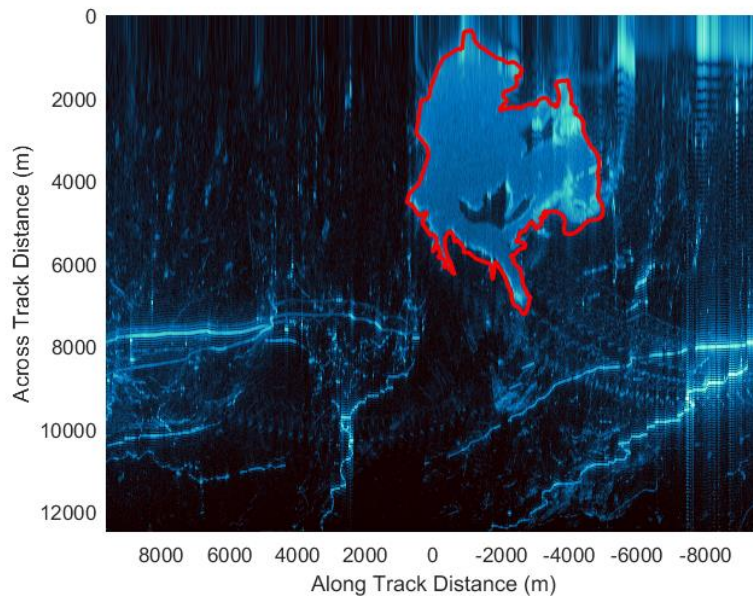
Mequinensa reservoir	A1		A2		D1	
	FF-SAR	Delay-Doppler	FF-SAR	Delay-Doppler	FF-SAR	Delay-Doppler
Bias [cm]	2.3	-10.4	-0.4	-14.1	5.5	-11.6
Std [cm]	3.8	4.4	3.5	4.2	3.9	5.6

Water extent

- Geolocation:
 - Ground resolution increasing with off-track distance.
 - Radargram projection to ground grid requires knowledge of target height.



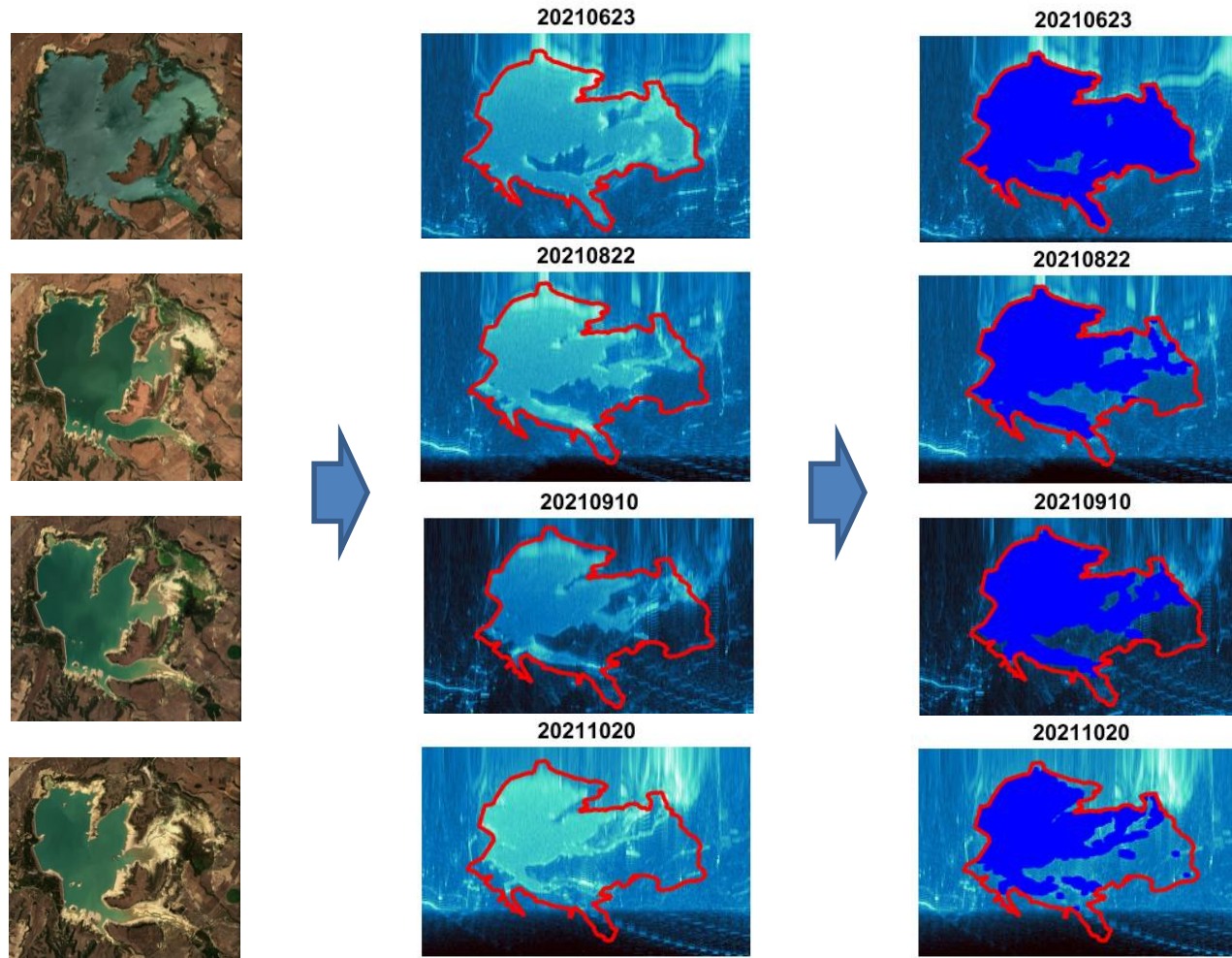
- Mapping
 - Methodology based on pixel intensity threshold evaluation
 - Image processing techniques required to optimise binarisation



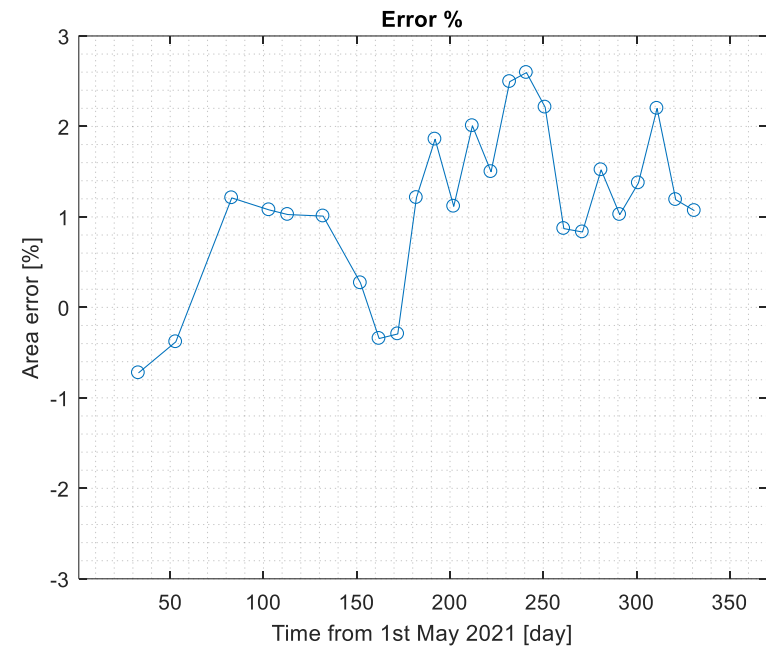
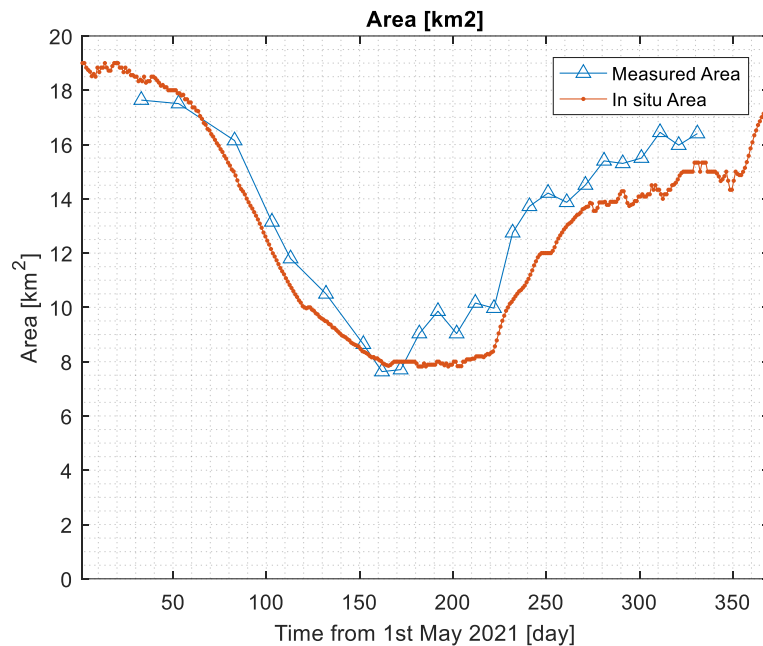
- Test case: La Sotonera lake, Aragon.
 - Lake with high seasonal area variability (irrigation usage)

Period June-October 2021





- Water extent validation
 - Comparison with area estimated from in-situ measurements of height and volume



Error bias $\sim 1.1 \text{ km}^2$

Error std $\sim 0.9 \text{ km}^2$

Conclusions & future work

- S6A performance over inland targets processed with FF-SAR has been explored through two analyses:
 1. Water level measurements over inland targets.
 - Std of errors wrt in-situ data between 2 and 4 cm.
 - Error biases < 6 cm.
 2. A water extent estimate case.
 - Area errors below 3% over a complex target with high area variability.
- Future work:
 - For both cases, enhance the analysis to include more targets and expand the time series.
 - For the water level case, test alternative retrackers.
 - For the water extent case, improve post-processing binarisation techniques.

Thank you for your attention!