Sentinel-3 Thematic Products for Inland Waters, Sea Ice and Land Ice

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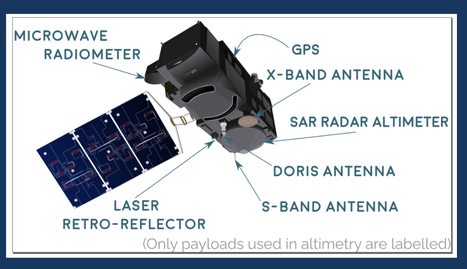
Sentinel-3 Surface Topography Mission and new Land Thematic Products

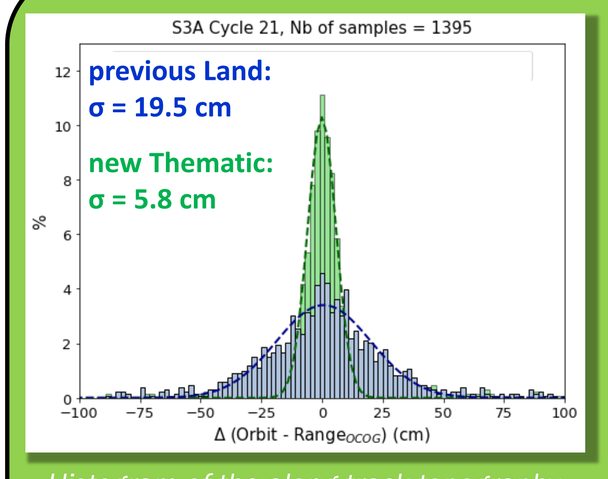
- **The current Sentinel-3 constellation includes Sentinel-3A and Sentinel-3B**, launched respectively on February 2016 and April 2018. **Sentinel-3C and Sentinel-3D will follow** (respectively planned for ~2025 and 2027). ESA and the MPC recently developed independent separated delay-Doppler and Level-2 processing chains for Inland Waters, Sea-Ice, and Land Ice measurements, to generate **the so-called Sentinel-3 STM LAND level-2 Thematic Products.**
- **For Hydrology and Sea Ice Thematic Products**, the delay-Doppler processing includes the zero-padding and Hamming processing. **For Land Ice Thematic Products**, the delay-Doppler includes the extended-window processing.
- **The Thematic Processors were deployed in operation by ESA in September 2023** (Baseline Collection 005). In Q2-Q3 2023, a **Full Mission Reprocessing** was performed with these new Thematic Processors, to provide homogeneous Sentinel-3 data set to the users over the 3 Thematic surfaces.



Orbit characteristics

Altitude: 814.5 km
Orbit cycle: 27 days
Inclination: 98.6°

Hydrology Thematic Products

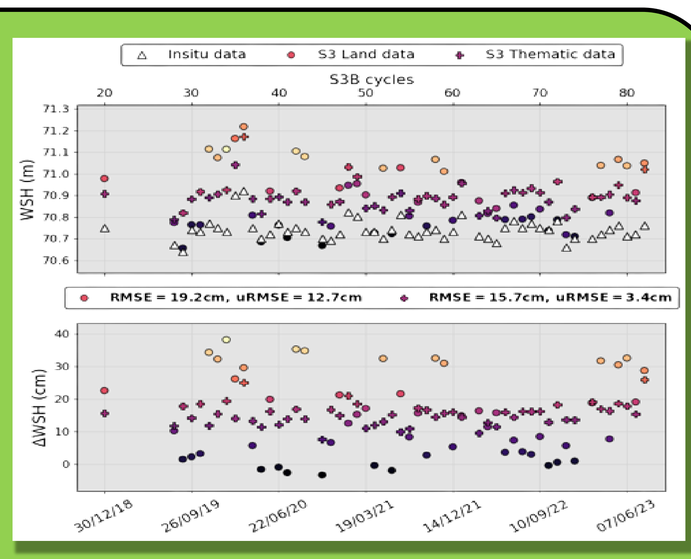


Histogram of the along-track topography variation at 20 Hz over lakes 1-5 km², with Land (blue) and Thematic (green) Products.

STD of the distribution provides the 20 Hz noise estimation.

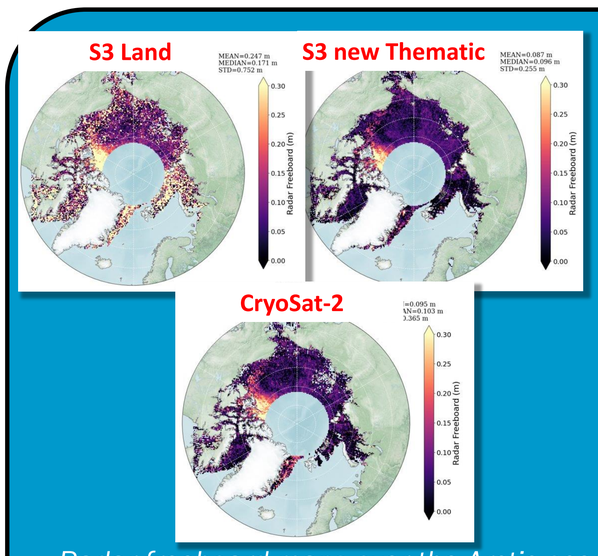
With the Hydrology Thematic Products, the precision in the elevation estimated over inland waters is significantly enhanced compared to previous Land products. The 20 Hz noise over small to moderate size lakes (1-5 km²) is improved by a factor 4 with Thematic products (left figure). The performances over flat rivers reaches better than 5 cm precision. These statistics have been computed over the whole reprocessed dataset.

The precision is strongly improved over inland waters, in particular over small targets (factor 4). The topography estimated over rivers is also more accurate.



Water level time series generated with S3B Land (circles) and Thematic (diamonds) products, compared with in situ data (triangle) over Yonne River. uRMSE improves from 12.7 to 3.4 cm

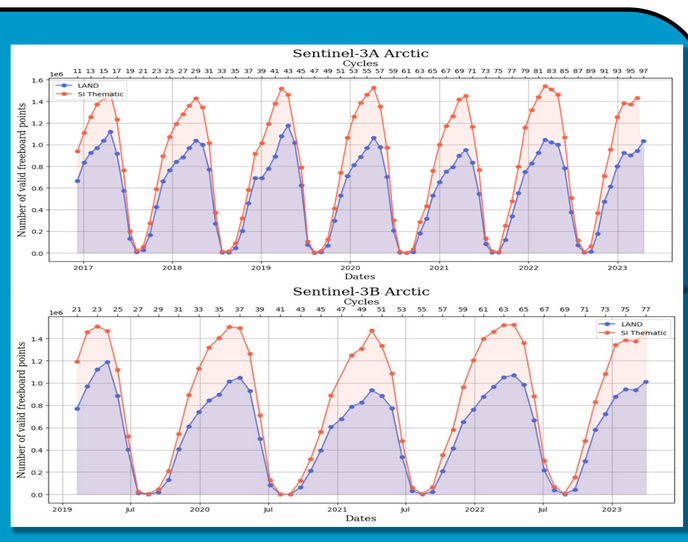
Sea Ice Thematic Products



Radar freeboard maps over the Arctic ocean, generated with Sentinel-3A previous Land (top left), new Thematic (top right) and CryoSat-2 (bottom)

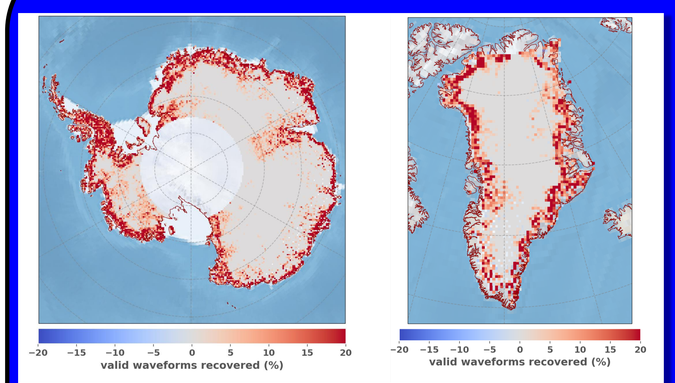
With the Sea Ice Thematic Products, the freeboard is estimated with an improved accuracy and precision thanks to Zero-Padding and Hamming processing. Sentinel-3 and CryoSat-2 now observe the same radar freeboard patterns (left maps). This agreement was observed over the full reprocessed time series. More valid freeboard estimations are also available in the Thematic Products (right figures).

The estimated freeboard is now in line with CroySat-2. There are 25 % more valid freeboard estimations compared to previous Land Products.



Number of valid 20 Hz freeboard records available in the previous Land (blue) and new Thematic (red) products over the Arctic, for S3A (top) and S3B (bottom)

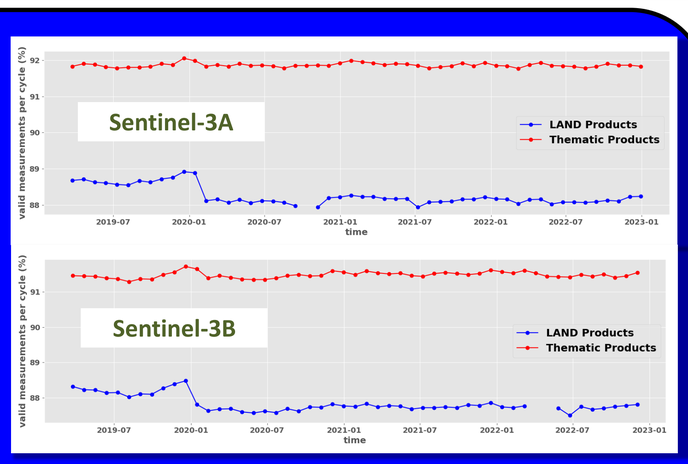
Land Ice Thematic Products



Comparison of the data coverage between previous Land and new Thematic products, in terms of valid waveforms. With Thematic Products the improvement reaches 20-30% over the margins.

With the Land Ice Thematic Products, the data coverage is significantly improved compared to previous Land Products (left maps). By comparing the estimated topography to an external DEM, there are on average ~3-4 % more valid elevations available in the Thematic Products compared to previous Land Products (right figures).

The data coverage improvement is substantial compared to previous Land Products. It achieves 20-30 % over the polar ice sheet margins.



Number of valid "ice sheet elevations" available at 20 Hz rate over the Antarctica ice sheet, after outlier removal (bias to DEM > 50 m), in the previous Land (blue) and new Thematic (red) Products

Conclusions

The complete Sentinel-3 reprocessing data set has been fully validated by the MPC experts. The data completeness is ~99.9%. The performances are significantly improved compared to previous product version.

With the Thematic Products, users have now access to a full homogeneous Sentinel-3 altimetry data set over land areas, with an optimised processing for their surface of interest.

data access