Measuring sea level in coastal lagoons using Sentinel-3 satellite radar altimetry

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Sea level change is an issue at the boundary line with land. It represents a potential threat to infrastructures and population living in low-elevation coastal areas. A slow rise of the sea level of few cm would make a difference to the land-sea interface, as present regional sea level trends associated to climate change are positive almost everywhere around the world: the sea would not retreat from land, making the land permanently lost. The satellite radar altimetry is the only measuring system capable of observing sea level changes independent of land. Unfortunately, using the classical open ocean altimetry sea level products, the number of valid data strongly decrease within 10–15 km from the coast, making those products not usable at land-sea interface. However, in the last years, there has been growing interest in improving the quality of altimeter data close to the coast. Considerable research has been carried out into overcoming to uncertainties in corrections and complexity of radar return and extending the capabilities of radar altimeters to measure sea level changes as close as possible to the coast. Modern altimetry is now bringing new opportunities to extend the coverage to sheltered coastal regions, e.g. coastal lagoons. The availability of individual echoes stimulated the implementation of new processors (e.g., Delay-Doppler, PISA, Fully-Focused SAR, etc.). The burst?repetition frequency of Sentinel-3 enhances along track data at 80 Hz (i.e. every 89 m). In this study we use those high-resolution radar ranges that are estimated with two methods: 1) the Precise Inland Surface Altimetry (PISA) algorithm (Abileah and Vignudelli, 2021) and 2) the ESA GPOD/Earth Console® Altimetry service, using the default “Inland Water High product Resolution”. We propose a new approach to identify bursts in sheltered coastal regions (e.g., coastal lagoons). This approach is based on Radar Cross Section (RCS) classification in specular, quasi-specular and non-specular behaviour. The idea is that specular surfaces have much higher signal-to-noise ratio than Brownian surfaces, therefore, retrieving more precise ranges. We use independent observations from the ICESat-2 lidar and from tide gauges to support the interpretation of the results. The study area is the Grado-Marano Lagoon (Northern Adriatic Sea, Italy), which is an interesting laboratory where the continuum from sea to inland can be analysed, also in virtue of the favourable location of two Sentinel-3 altimeter tracks. Motivation for this work is that sheltered coastal regions are shallow transition zones characterized by slow water flow, low waves and intertidal marshes protecting confined portions of the water surface from wind. For example, around 32,000 lagoons (Carter et al., 1996) are identified along 13% of the world's coastline (Barnes, 1980). Because of sparse in situ measurements, especially in developing countries, the usage of satellite data is currently the only option to monitor sea level changes, besides the fact that in-situ observations are expensive and need continuous efforts for monitoring and maintenance operations Moreover, satellite altimetry in such environment gives continuity of observations from open ocean through the coast and inland.

References

Abileah, R. and Vignudelli, S., doi:10.1016/j.rse.2021.112580

Barns S. K., Coastal lagoons, doi:10.1017/S0025315400047135.

Carter, R.W.G., et al.. doi:10.1017/CBO9780511564420

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