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Satellite Altimetry In Coastal Lagoons: The Case Of The Marano-Grado And Venice Lagoons In The Northern Adriatic Sea

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In the Northern Adriatic Sea, the Marano-Grado and Venice coastal lagoons lay at the edge of a coastal plain of 2.400 km2 of low-lying areas along 300 km of coast (Bondesan et al., 1995). Defined as geographically distinct water bodies, coastal lagoons are shallow, enclosed by barriers, intermittently connected to the ocean through restricted inlets, and typically aligned parallel to the shore (Tagliapietra et al., 2009). Such sheltered coastal regions are characterized by slow water flow, low waves and intertidal marshes partially protecting the surface from wind. However, they face dual threats of storm surges and rising sea level, which shape their geomorphological evolution.

Satellite radar altimetry emerges as an indispensable tool for studying these environments, as traditional tide gauges are insufficient for discerning sea level changes independent of land shifts. Unlike classical open ocean altimetry, which loses accuracy within 10–15 km of the coast, modern coastal altimetry, bolstered by advancements like Delay-Doppler processors and high burst-repetition frequencies (e.g., 80 Hz), extends reliable coverage to sheltered coastal areas. Recent enhancements, such as the implementation of SAR and SARin processing algorithms developed by the HYDROCOASTAL project team, further strengthen the capabilities of coastal altimetry (https://eo4society.esa.int/projects/hydrocoastal/) and are implemented in the ESA GPOD/Earth Console® Altimetry Virtual Lab service. Notably, the PISA algorithm, specializing in conditions like specular reflection, leverages Radar Cross Section (RCS) classification to distinguish between specular, quasi-specular, and non-specular behavior (Abileah and Vignudelli, 2021). This algorithm capitalizes on the superior signal-to-noise ratio of specular surfaces, enabling precise range retrieval in challenging scenarios.

In this study, high-resolution radar data are employed in the examination of the Venice and Marano-Grado coastal lagoons. The Marano-Grado Lagoon serves as a validation platform, with a comparative analysis of data in two Sentinel-3 tracks. Subsequently, the utility of these data, encompassing wind speed and significant wave height, is evaluated within the coastal zone of the Venice Lagoon. These two coastal zones are chosen not only for their geographical significance but also due to the availability of in-situ observations from various instruments, including tide gauges, wave recorders, and wind instruments: this multi-instrumental approach offers distinct

advantages for comprehensive comparison and interpretation purposes.

The motivation driving this study is rooted in the recognition of approximately 32,000 lagoons, spanning 13% of the world's coastline (Carter et al., 1996; Barnes, 1980). Limited in-situ measurements, particularly in developing nations, propel the reliance on satellite data as the most viable option for monitoring sea level changes. The cost and logistical challenges associated with in-situ observations further underscore the importance of satellite altimetry in providing a seamless observational continuum across open oceans, coastal regions, and inland waters.

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