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Absolute Baltic Sea Level Trends in the Satellite Altimetry Era: A Revisit

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For sea level studies, coastal adaptation, and planning for future sea level scenarios, regional responses require regionally-tailored sea level information. Global sea level products from satellite altimeter missions are now available through the European Space Agency's (ESA) Climate Change Initiative Sea Level Project (SL_cci). However, these global datasets are not entirely appropriate for supporting regional actions. Particularly for the Baltic Sea region, complications such as coastal complexity and sea-ice restrain our ability to exploit radar altimetry data.

This presentation highlights the benefits and opportunities offered by such regionalised advances, through an examination by the ESA-funded Baltic SEAL project (http://balticseal.eu/). We present the challenges faced, and solutions implemented, to develop new dedicated along-track and gridded sea level datasets for Baltic Sea stakeholders, spanning the years 1995-2019. Advances in waveform classification and altimetry echo-fitting, expansion of echo-fitting to a wide range of altimetry missions (including Delay-Doppler altimeters), and Baltic-focused multi-mission cross calibration, enable all altimetry missions' data to be integrated into a final gridded product.

This gridded product, and a range of altimetry datasets, offer new insights into the Baltic Sea's mean sea level and its variability during 1995-2019. Here, we focus on the analysis of sea level trends in the region using both tide gauge and altimetry data. The Baltic SEAL absolute sea level trend at the coast better aligns with information from the in-situ stations, when compared to current global products. The rise in sea level is statistically significant in the region of study and higher in winter than in summer. A gradient of over 3 mm/yr in sea level rise is observed, with sea levels in the north and east of the basin rising more than in the south-west. Part of this gradient (about 1 mm/yr) is directly explained by a regression analysis of the wind contribution on the sea level time series. A sub-basin analysis comparing the northernmost part (Bay of Bothnia) with the south-west reveals that the differences in winter sea level anomalies are related to different phases of the North-Atlantic Oscillation (0.71 correlation coefficient). Sea level anomalies are higher in the Bay of Bothnia when winter wind forcing pushes waters through Ekman transport from the south-west towards east and north.

The study also demonstrates the maturity of enhanced satellite altimetry products to support local sea level studies in areas characterised by complex coastlines or sea-ice coverage. The processing

chain used in this study can be exported to other regions, in particular to test the applicability in regions affected by larger ocean tides. We promote further exploitation and identification of further synergies with other efforts focused on relevant oceanic variables for societal applications.

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