Baltic SEAL: new insights into the mean and variability of the sea level in the Satellite Altimetry era

Marcello Passaro[1], Felix L. Müller[1], Adili Abulaitijiang[2], Ole B. Andersen[2], Emma Chalençon[5], Denise Dettmering[1], Jacob L. Høyer[3], Milla Johansson[4], Julius Oelsmann[1], Laura Rautiainen[4], Ida M. Ringgaard[3], Eero Rinne[4], Jani Särkkä[4], Rory Scarrott[5], Christian Schwatke[1], Florian Seitz[1], Kristine Skovgaard Madsen[3], Laura Tuomi[4], Americo Ambrozio[6*], Marco Restano[6**], Jérôme Benveniste[6]

1 Deutsches Geodätisches Forschungsinstitut, Technische Universität München (DGFI-TUM), Germany
2 SPACE National Space Institute, Technical University of Denmark, (DTU), Denmark
3 Danish Meteorological Institute (DMI), Denmark
4 Finnish Meteorological Institute (FMI), Finland
5 MaREI Centre, Department of Geography, Environmental Research Institute, University College Cork (UCC), Ireland
6* DEIMOS, c/o ESA-ESRIN, Italy 6** SERCO, c/o ESA-ESRIN, Italy 6 ESA-ESRIN, Italy

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 altimeters are now available through the European Space Agency's (ESA) Climate Change Initiative. 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 altimetry data opportunities.

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, enabled all mission data to be integrated into a final gridded product.

This gridded product, and range of altimetry datasets, enabled new insights into the Baltic Sea's mean sea level and its variability to be gathered. A new Mean Sea Surface dataset was developed, in addition to an 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. A pronounced sea level trend gradient which increases towards the North-East was found. Furthermore there is a strong observed correspondence between season-specific sea level trends and a decreasing trend in westerly wind forcing. The spatial and temporal density of the data also allows for a robust comparison between the sea level time series and relevant climate indices such as the North Atlantic Oscillation, with implications for regionalising global climate change impacts.

These initial investigations highlight the potential of regionalised products for the Baltic Sea region, and beyond. The availability of multi-mission along-track data, gridded monthly data, and an experimental high-rate temporal grid, offers a wide range of opportunities, from supporting local ocean circulation research, to storm surge monitoring. These opportunities are presented to promote further exploitation, and identify synergies with other efforts focused on relevant oceanic variables societal applications.