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Storm Tracking for Maritime Situation Awareness by Sentinel-1: High Resolution Sea State and Wind Fields in Near Real Time using Newest Satellite Techniques and Ground Infrastructures

Andrey Pleskachevsky (1), Sven Jacobsen (1), Björn Tings (1), Egbert Schwarz (2), Detmar Krause (2), and Holger Daedelow (2)

(1) German Aerospace Center (DLR), Maritime Safety and Security Lab, Bremen, Germany , (2) German Aerospace Center (DLR), German Remote Sensing Data Center, National Ground Segment, Neustrelitz, Germany

The rapid development of the satellite techniques, airborne and shipborne remote sensing, processors, algorithms and ground infrastructures made possible a series of new oceanographic applications in the last few years. These new techniques allow estimating a wide range of oceanographic information like properties of surface waves and internal waves, surface wind speed, sub-meso scale fronts and eddies, ice coverage, oil spills, coastal bathymetry, currents and others. This information is available not only on a global but also on local scales with wide coverage and high resolution.

In order to investigate geophysical processes, a new algorithm and processor for meteo-marine parameter estimation from satellite borne Sentinel-1 (S1) Synthetic Aperture Radar (SAR) imagery was developed for Near Real Time (NRT) applications and tested for storm observations. The sea state and wind fields estimated simultaneously from twice daily SAR acquisitions are combined with numerical forecast model results and in-situ measurements during storm evolution and propagation. The focus of investigations was the storm peak/center propagation, front movement and arrival of swell.

The S1 Interferometric Wide Swath Mode (IW) covers area-strips of thousand kilometres of earth and ocean surface with a pixel resolution of 10m by sequences of multiple individual IW images with an approximate size of 200km×250km. The developed information extraction algorithms infrastructures enable transferring the processed geo-coded raster information on wind speed and wave height to the weather services for validation of the forecasting models during several minutes after acquisition. The supplement data like ice coverage, oil spills etc. can be processed in parallel for the same image and combined for supporting Maritime Situation Awareness (MSA). The algorithms are integrated into a prototype processor for Sentinel-1 SAR imagery. The DLR Ground Station Neustrelitz applies this prototype as part of a near real-time demonstrator MSA service. The presented scientific service involves daily provision of surface wind and sea state parameters estimated fully automatically from S1 IW images of North and Baltic Sea in and around German territorial waters.

An example of efficient storm tracking in the Black Sea over three days is presented. The forecast spectral wave model of Helmholtz Center Geesthacht (HZG) running for the Black Sea reproduces the storm peak propagation near to the S1 observations. In detail, the storm peak observed by S1 is shifted about 80 km towards the south in comparison to the model simulations. Also, the tracking of hurricane Irma in 2017 with storm waves reaching up to 14 m significant wave height and moving towards Golf of Mexico will be shown.