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Multiparametric Sea State from Spaceborne Synthetic Aperture Radar for Near Real Time Services

Andrey Pleskachevsky[a], Björn Tings[a], Sven Jacobsen[a], Egbert Schwarz[b], Detmar Krause[b]

[a] DLR, Maritime Safety and Security Lab Bremen, Germany
[b] DLR, German Remote Sensing Data Center, National Ground Segment, Germany

Spaceborne synthetic aperture radar (SAR) is a powerful tool for monitoring seas. The ability to work independently of sun illumination, cloud coverage and atmospheric conditions, as well as the capability of delivering spatial information, makes SAR one of the most perceptive instruments. The newest methods for processing SAR data with increased precision allow sea state fields to be estimated with local variabilities. For large areas in oceans where no *in-situ* measurements and only forecast predictions are available, this information is indispensable for global shipping and over human activity. Due to newest developments, the derived meteo-marine parameters can be transferred to weather services and to a ship's bridge several minutes after acquisition, where the ship route can be optimized.

The study presents a method and application for estimating series of integrated sea state parameters from satellite-borne SAR, allow processing of data from different satellites and modes in near real time (NRT). The developed Sea State Processor (SSP) estimates total significant wave height H_s, dominant and secondary swell and windsea wave heights, first, and second moment wave periods, mean wave period and period of wind sea. The algorithm was applied for the Sentinel-1 (S1) C-band Interferometric Wide Swath Mode (IW), Extra Wide (EW) and Wave Mode (WM) Level-1 (L1) products and also extended to the X-band TerraSAR-X (TSX) StripMap (SM) mode. The scenes are processed in raster and result in continuous sea state fields with the exception of S1 WV. Each 20 km × 20 km WV imagette, acquired every 100 km along the orbit, presents averaged values for each sea state parameter.

The SSP was tuned and validated using two independent global wave models WAVEWATCH-3 (NOAA) and CMEMS (Copernicus) and NDBC buoys. The accuracy of H_s reaches an RMSE of 0.25 m by comparison with models (S1 WV); comparisons to NDBC worldwide buoys result into an RMSE of 0.3 m. Due to implemented parallelization, a fine rater step for scene processing can be practical applied: for example, S1 IW scene with coverage of 200 km × 250 km can be processed using raster step of 1 km (corresponds to ~50.000 subscenes) during minutes.

The DLR Ground Station "Neustrelitz" applies SSP as part of a near real-time demonstrator service that involves a fully automated daily provision of surface wind and sea state parameters estimates from S1 IW for the North and Baltic Sea. All results and the presented methods are novel and provide a wide field for applications and implementations in prediction systems.