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A Sea State Processor for full automatic estimation of the total significant wave height in shallow coastal waters from TerraSAR-X StripMap images

Pleskachevsky, Andrey - DLR, IMF

Jacobsen, Sven - DLR, IMF Maritime Safety and Security Lab

Tings, Björn - DLR, IMF Maritime Safety and Security Lab

Bruns, Thomas - German Meteorological Service DWD, maritime weather office

Kieser, Jens - German Meteorological Service DWD, maritime weather office

Schwarz, Egbert - DLR, German Remote Sensing Data Center, National Ground Segment

Krause, Detmar - DLR, German Remote Sensing Data Center, National Ground Segment

A new empirical algorithm for coastal applications XWAVE_C to estimate the total significant wave height (SWH) from TerraSAR-X (TS-X) and Tandem-X (TD-X) X-Band Synthetic Aperture Radar (SAR) data has been developed. It has been adopted to account for special coastal maritime conditions and phenomena with a focus on the German Bight of the North Sea including flooded and dry-out Wadden coast regions. The algorithm was implemented into the Sea State Processor (SSP) for fully automatic processing and near-real-time (NRT) services for both HH and VV StripMap images. The algorithm is based on the spectral analysis of subscenes and the model function uses integrated spectral image parameters as well as local wind information derived from the subscene. The mathematical function is designed to estimate the wave height not only for long waves which are distinctly visible in SAR images and translate to a pronounced peak in the image spectra, but also for short waves without visible wave pattern which produce only diffuse structures and noise in the SAR image spectra. The capability to assess the significant wave height from only short wave sea state is most crucial in many coastal areas such as the German Bight. The algorithm is also designed to identify and remove the influence of non-sea state signatures in the Wadden Sea areas such as dry sandbars as well as nonlinear SAR image distortions produced by e.g. short wind waves and wave breaking. The SSP was tuned with in situ data of six buoys (2013-2014) located in the German Bight covered by the model domain of the German Weather Service's (DWD) CWAM (Coastal Wave Model) with 900m horizontal resolution. Spatial tuning was performed with CWAM model data. Validation of the SSP accuracy was carried out with subsequent acquisitions (2015) and independent CWAM data and buoy measurements. The validation result for the SWH exhibits an RMSE of 25cm and a scatter Index of 20% for the SWH Hs on the basis of TS-X StripMap image sequences across the German Bight with a coverage of ~30km×300km. The data set consists of more than 100 TS-X StripMap sequences with more than 300 single images since 2013 with sea state acquired in the Hs range of 0m to 6m with a mean value of 1.25m over all available scenes at buoy locations. The SSP provides automatic raster processing of TS-X StripMap images and is currently integrated in the NRT processing chain at the DLR Ground Station Neustrelitz. An autonomous processing rule is called by the Processing System Management PSM control system based on the request parameter. The SSP procedure includes: a pre-filtering procedure for removing spectral contaminations such as ships, seamarks, buoys, offshore constructions and slicks before analysis (1), XWAVE_C function (2), an additional procedure performing a check of results based on the statistics of the whole scene (3), SSP control of input and output parameters, special points of interest, etc. (4). The delivery of NRT products from "Neustrelitz" to e.g. DWD occurs via E-mail and via FTP transfer. For common users. a