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Sea state and its coastal interaction in near-shore zones observed by high resolution TerraSAR-X satellite radar images

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Due to their high resolution, daylight and weather independency and global coverage, space borne SAR's (Synthetic Aperture Radar) are particularly suitable for many ocean and coastal observations. SAR is a unique sensor providing two dimensional information of the ocean surface. The new German radar satellite TerraSAR-X (TS-X) is able to image the sea surface with a resolution up to 1m. Individual water waves with wavelengths down to 20m are delectable. TS-X data are used for many oceanographic applications e.g. underwater shallow area (bank and bars) and coastal line detection, derivation of wind fields, sea state parameters and the underwater topography.

The refraction of long swell at a water depth smaller than 50m is caused by the influence of underwater topography in the coastal areas. The satellite scenes render patterns of well developed swell at the sea surface in optical as well as in radar images. Analysis of the SAR image spectra allows to obtain the peak wavelength, direction and significant wave height. A method was developed for tracking of wave rays influenced by bathymetry and depending on changing of swell wavelength and direction. In addition, the individual breaking waves leave a signature in high-resolution SAR images, which permits derivation of the height of breaking waves. This two-dimensional information can be successfully applied to validate the numerical models.

Wave energy reaches high values during storms. The increasing of sea level leads to strengthening of waves. Wave energy passed towards the coast increases. Estimating its impact is an important task for coastal protection. We estimate the wave energy flux propagation along the wave tracks from deep water to the coastal line based on SAR information: wave height and wavelength are derived from TS-X image spectra. The obtained results are compared with the outcome of a numerical wave model, run at fine spatial horizontal resolution of 100m. For the numerical simulations, the wind field and the swell at model mesh boundaries, obtained from TS-X data, were used. An example for the German Bight (North Sea) is shown. Storm surge cases are discussed.