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Impact of Wind Gusts on local Sea State Variability and generation of wave groups with increased wave height using High-Resolution Satellite-Based Radar Measurements

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Sea surface wind speed and the sea state fields were simultaneously estimated and analysed using X-band satellite-borne Synthetic Aperture Radar (SAR) images acquired over North Sea. The data were retrieved from TerraSAR-X (TS-X) satellite scenes with overflight covering $\sim$300km$\times$30km strips with resolution of 3m. The inhomogeneity of wind fields and the impact of wind gust systems on the local sea state are studied, based on space-covered remote sensing data and in-situ buoy measurements in the German Bight. The acquired and analysed weather conditions vary in range 0-7m for significant wave height and in range 0-25m/s of the surface wind speed. The collected, processed and analysed data set for the German Bight consists of more than 120 TS-X StripMap scenes/overflights/events with more than 300 images acquired since 2013.

The statistical analysis allows to connect the typical weather conditions with instabilities in wind field and the sea state inhomogeneity on local scale. This local inhomogeneity is mostly not present in prediction models due to the smooth wind input by the wave models. The results gained can be adopted in forecast modelling as an additional term for inhomogeneity of the wind field and sea state. The spatial comparison of sea state and wind field estimated form remote sensing data to the results of the wave prediction models show local variations due to distinctions in bathymetry and in wind front propagation. For the first time the local wave height increase of 1-2m systematically connected to wind gusts in kilometre-scale clusters was observed.