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Wave modelling and field measurements in a complex estuary

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The Eems-Dollard estuary is part of the shallow Wadden Sea in the north of the Netherlands. This highly complex estuary consists of deep channels and tidal flats. These complexities pose a challenge for the numerical models that determine the design wave conditions at the flood defences in the area. Of particular interest is the dike section north of the town of Delfzijl (Figure 1), which is partly sheltered from offshore waves and north-westerly storm winds.

Despite the offshore directed winds, the phase-averaged wave model SWAN predicts surprisingly large and onshore directed wave heights. As little measurements are available, hardly any nearshore calibration is possible, leading to uncertainties in e.g. the required crest level of the dikes. Identifying the weaknesses in the currently used models is an important step towards improving them. Therefore, an extensive 12-year long field measurement campaign in this estuary started in 2018. The nearshore waves are measured with a comprehensive set of instruments; wave buoys and ADCPs (point measurements), as well as X-band radars, which give a 2D-image of the waves as they propagate in the estuary.

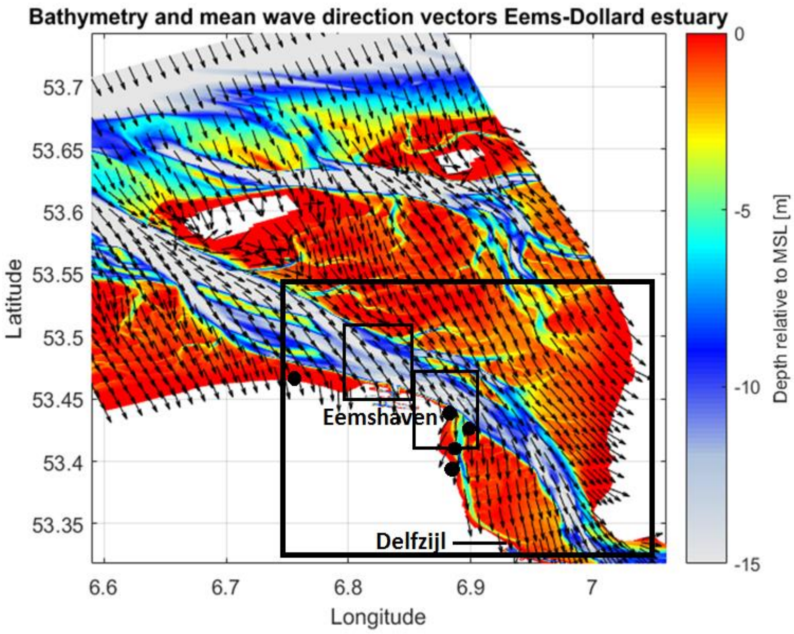

Figure 1. Bathymetry of the Eems-Dollard estuary and mean wave direction vectors during a design condition according to SWAN. Area of interest indicated by large rectangle. Field of view X-band radars indicated by smaller rectangles, new wave buoy and ADCP locations indicated by black dots.

The focus lies on the evolution of the wind waves as they propagate through the tidal channels, around the corner at Eemshaven, and onto the shallow areas in front of the flood defence. From previous research there are indications that the linear refraction approach in SWAN may have fundamental limitations in areas with steep slopes, and suggestions have been made that diffraction, wave tunnelling, and nonlinear effects may play a role.

The paper will present a comparison of SWAN with the phase-resolving model SWASH for several schematized cases with increasing complexity, to gain more insight in the physical processes that play a role in the wave evolution in this complex area, aiming to improve the physical parameterisations of SWAN. In a next step of the study, additional field measurements will be used to evaluate and improve the SWAN model as waves propagate from the North Sea into the estuary.