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Abstract

Estimates of exposure times in the Wadden Sea: a comparison of methods

Research article (work in progress)

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The vertical tide in the Wadden Sea causes alternate flooding and drying of the intertidal flats, the duration of which is affected by wind surges, secondarily. To estimate, for instance, the potential growth of microphytobenthos and foraging time of suspension-feeding bivalves and benthos-feeding waders, it is important to have spatio-temporal data of these exposure times. In this study, we have compared two methods to determine the exposure times of tidal flats in the Dutch Wadden Sea. The first method is based on a triangulation of the sea level elevations measured at the tidal gauges surrounding the Dutch Wadden Sea following developed by Rappoldt et al. (2004); whereas in the second method numerical simulations with the General Estuarine Transport Model (GETM) are used. The methods show a good agreement for the western Dutch Wadden Sea, where the coverage with tidal gauges is relatively good, and the density of intertidal flats is low. However, the methods show differences of as much as 20% for the much shallower eastern part of the Dutch Wadden Sea, where tidal gauges are few and more distant.

To explore the influence of the number and distribution of tidal gauge stations on these differences, virtual tidal gauges were added to the existing network of tidal gauge stations and differences in sea level height variations in the simulation with GETM and those obtained using the triangulation method recalculated. Within the triangle formed by the tidal gauge stations of Harlingen, West-Terschelling and Nes, for example, a reduction of the present difference (expressed as root-mean-square) in average sea level height of 0.33 m to 0.15 m would require 47 extra tidal gauge stations. This limited added value compared to large investments is largely due to the highly non-linear behavior of the tidal wave in the model compared to the linear approach adopted in the triangulation method.

An alternative approach for the prediction of the exposure time is developed in which the both methods are combined. The tidal prediction is obtained from a applying a Least Squares Harmonic Analysis on the simulated Sea Level Height in the simulation with GETM at every grid point. Moreover, the unpredictable part, e.g. the setup induced by wind and swell from the North Sea, is determined by applying the triangulation method to the setups observed at the tidal gauge stations. In this so-called HYBRID method, the setup is defined as the observed sea level height minus the tidal predication and its long-term mean value. This combination of previous methods offers a new approach to determine exposure times in the Wadden Sea more accurate than either method individually.

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