

On the spatial variation of tidal currents in the Marsdiep

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The Marsdiep basin is the most western basin of the Dutch Wadden Sea. Flow velocities in the Marsdiep can be up to 2 m/s and make this area potentially interesting for tidal energy extraction. Tocardo B.V. has planned to construct a test tidal energy plant in the Marsdiep and therefore it is important to know the spatial (and temporal) variability of currents. Temporally, the current magnitude varies due to changes in the tidal forcing as a result of, for example, the diurnal inequality and the spring-neap cycle. Spatially, the current magnitude varies due to large depth variations on relatively small spatial scales (500-1000 m). In the channels, water depths are between 10 to 40 meters, whereas on the shoals water depths are smaller than 10 m. Furthermore, the flow field is complicated by longitudinal, lateral and vertical density gradients and by the influence of the wind. In this study, the spatial variability of tidal currents is investigated using an extensive spatial dataset of current velocity measurements in the Marsdiep.

A least-squares harmonic analysis with the dominant semi-diurnal tidal constituent M2 is performed to gain insight in the spatial variability and vertical flow structure of tidal currents in the Marsdiep. It is shown that friction influences the flow for water depths smaller than 15 m. Bathymetric effects influence the flow strength for water depths larger than 15 m. A depth-dependent variation of the flow strength due to a change in the tidal range, i.e. the pressure gradient, is observed, which results in a modulation of the lateral velocity shear. The depth-dependent variation of the flow strength and the modulation of the lateral velocity shear are expected to have implications for the advection patterns of salt, heat, nutrients and suspended matter in the basin.