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Bottom friction. A practical approach to modelling coastal oceanography

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Coastal processes imply the interaction of the atmosphere, the sea, the coastline and the bottom. The spatial gradients in this area are normally large, induced by orographic and bathymetric features. Although nowadays it is possible to obtain high-resolution bathymetry, the details of the seabed, e.g. sediment type, presence of biological material and living organisms are not available. Additionally, these properties as well as bathymetry can also be highly dynamic. These bottom characteristics are very important to describe the boundary layer of currents and waves and control to a large degree the dissipation of flows. The bottom friction is thus typically a calibration parameter in numerical modelling of coastal processes. In this work, we assess this process and put it into context of other physical processes uncertainties influencing wind-waves and currents in the coastal areas. A case study in the North Sea is used, particularly the west coast of Denmark, where water depth of less than 30 m cover a wide fringe along the coast, where several offshore wind farm developments are being carried out.
We use the hydrodynamic model MIKE 21 HD and the spectral wave model MIKE 21 SW to simulate atmosphere and tidal induced flows and the wind wave generation and propagation. Both models represent state of the art and have been developed for flexible meshes, ideal for coastal oceanography as they can better represent coastlines and allow a variable spatial resolution within the domain. Sensitivity tests to bottom friction formulations are carried out into context of other processes (e.g. model forcing uncertainties, wind and wave interactions, wind drag coefficient). Additionally, a map of varying bottom properties is generated based on a literature survey to explore the impact of the spatial variability. Assessment of different approaches is made in order to establish a best practice regarding bottom friction and coastal oceanographic modelling. Its contribution is also assessed during storm conditions, where its most evident impact is expected as waves are affected by the bottom processes in larger areas, making bottom dissipation more efficient.
We use available waves and current measurements in the North Sea (e.g. Ekofisk, Fino platforms and some other coastal stations at the west coast of Denmark) to quantify the importance of processes influencing waves and currents in the coastal zone and putting it in the context of the importance of bottom friction and other processes uncertainties.