The effect of shoreline and bathymetry simplification on simulation predictive accuracy

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Simulations on unstructured meshes are becoming increasingly popular in the field of ocean modelling. This is largely due to the ability of unstructured meshes to follow complex boundaries and to comprise cell/element lengths which can vary across multiple orders of magnitude. Shorelines are particularly complex boundaries featuring a wide range of scales and an accurate representation must capture the smallest scales. This can impose a very fine mesh resolution in the vicinity of the shoreline, leading to high computational costs. Therefore, in shorelines away from the region of interest, geometry simplification methods are employed to remove the smaller scales. In the present work, we will survey existing contour simplification methods and contrast them to a new simplification method, based on Principal Component Analysis (PCA) [Avdis et al. 2015]. The PCA-based simplification is a robust and efficient method which systematically removes small-scale features associated with the higher modes of the PCA analysis. The effect of the simplified boundaries on tidal simulation results will be examined, using the open-source ocean modelling codes Fluidity and Telemac2D. Results from simulations on several meshed domains will be presented, of increasing geometrical detail and mesh resolution. The simulation results will then be compared with widely used tidal databases and tidal gauge data, to assess the predictive accuracy as the geometry and mesh are refined. This information will then be used to assess the accuracy of paleo-tidal simulations, where a PCA analysis of given shorelines and bathymetry can be used to identify the missing geometry scales and thus quantify the accuracy of a simulation. We will then show how the PCA analysis of the geometry can be used to parameterise sub-grid scale surface roughness.