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Finite element modelling of the Scheldt estuary and the adjacent Belgian/Dutch coastal zone

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A fundamental problem in coastal modelling is the need to simultaneously consider large- and small-scale processes, especially when local dynamics or local environmental issues are of interest. The approach widely resorted to is based on a nesting strategy by which coarse grid large scale model provide boundary conditions to force fine resolution local models. This is probably the best solution for finite difference methods, needing structured grids. However, the use of structured grids leads to a marked lack of flexibility in the spatial resolution. Another solution is to take advantage of the potential of the more modern finite element methods, which allow the use of unstructured grids in which the mesh size may vary over a wide spectrum. With these methods only one model is required to describe both the larger and the smaller scales.

Such a model is use herein, namely the Second-generation Louvain-la-Neuve Ice-ocean Model (SLIM, http://www.climate.be.SLIM). For one of its first realistic applications, the Scheldt estuary area is studied. The hydrodynamics is primarily forced by the tide and the neatest way to take it into account is to fix it at the shelf break. This results in a multi-scale problem since the domain boundary lies at the shelf break, and covers about 1000 km of the North Sea and 60 km of the actual estuary, and ends with a 100 km long section of the Scheldt river until Ghent where the river is not more than 50 m wide. Such a broad spectrum of characteristic length scales is an ideal test case for a multi-scale finite element model.

Two-dimensional elements are used to simulate the hydrodynamics from the shelf

break to Antwerp (80 km upstream of the mouth) and one-dimensional elements for the riverine part between Antwerp and Ghent. The model will be described in detail and the simulation results will be discussed. This modelling exercise actually falls within the framework of the interdisciplinary project TIMOTHY (http://www.climate.be/TIMOTHY) dedicated to the modelling of ecological indicators in the Scheldt area.