SLIM: A multi-scale model of the land-sea continuum

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The hydrosphere is made up of a number media, such as the oceans, the shelf seas, the estuaries, the rivers, the land surface and ground water as well as the sea ice - which, for the sake of simplicity, is considered herein to be part of the hydrosphere. The processes taking place in these domains are vastly different in nature and are characterized by a wide range of space- and time-scales. The components of the hydrosphere interact with each other. For instance, the shallow marine and estuarine regions, though accounting for less than 1% of the volume of the oceans, have a biomass far from negligible as compared to that of the oceans, implying that they play a significant role in global biogeochemical cycles. This is one of the reasons why models are now needed that deal with most, if not all, of the components of the hydrospheric system.

Numerical models of each of the components of the hydrosphere already exist. However, an integrated model of the whole hydrosphere has yet to be developed. Building such a model is a daunting task, requiring the development of multi-scale/physics simulation tools. Numerical methods for dealing with multi-scale problems are developing rapidly. Unstructured meshes offer an almost infinite geometrical flexibility, allowing the space resolution to be increased when and where necessary. In addition, time steppings for dealing with a wide spectrum of timescales while retaining a high order of accuracy have been developed over recent years (e.g. multi-rate schemes).

The Discontinuous Galerkin Finite Element (DGFE) framework SLIM is at his third implementation. It has been build on the GMSH code (http://geuz.org/gmsh), which a state-of-the-art open-source meshing tool. This allows the use of the same definitions and easy interactions between the mesher and the model. Moreover, this provides the same user interface for meshing and visualizing results. It also enables the use of the most recent advances in mesh generation, as GMSH has a large and very active community of users/developpers. The DGFE code himself is coded in C++ and uses a python user-interface. Each simulation is build in a python script, which allows a total flexibility, and the core of the code is compiled, which allows for optimal performances.

We well present the current status of SLIM, as well as current developments. Informations on SLIM can be found at http://www.climate.be/slim.