Geophysical Research Abstracts
Vol. 19, EGU2017-17496, 2017
EGU General Assembly 2017

Operational forecasting with the subgrid technique on the Elbe Estuary

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Modern remote sensing technologies can deliver very detailed land surface height data that should be considered for more accurate simulations. In that case, and even if some compromise is made with regard to grid resolution of an unstructured grid, simulations still will require large grids which can be computationally very demanding.
The subgrid technique, first published by Casulli (2009), is based on the idea of making use of the available detailed subgrid bathymetric information while performing computations on relatively coarse grids permitting large time steps. Consequently, accuracy and efficiency are drastically enhanced if compared to the classical linear method, where the underlying bathymetry is solely discretized by the computational grid.
The algorithm guarantees rigorous mass conservation and nonnegative water depths for any time step size. Computational grid-cells are permitted to be wet, partially wet or dry and no drying threshold is needed.
The subgrid technique is used in an operational forecast model for water level, current velocity, salinity and temperature of the Elbe estuary in Germany. Comparison is performed with the comparatively highly resolved classical unstructured grid model UnTRIM. The daily meteorological forcing data are delivered by the German Weather Service (DWD) using the ICON-EU model. Open boundary data are delivered by the coastal model BSHcmod of the German Federal Maritime and Hydrographic Agency (BSH). Comparison of predicted water levels between classical and subgrid model shows a very good agreement. The speedup in computational performance due to the use of the subgrid technique is about a factor of 20. A typical daily forecast can be carried out within less than 10 minutes on standard PC-like hardware.
The model is capable of permanently delivering highly resolved temporal and spatial information on water level, current velocity, salinity and temperature for the whole estuary.
The model offers also the possibility to recalculate any previous situation. This can be helpful to figure out for instance the context in which a certain event occurred like an accident.
In addition to measurement, the model can be used to improve navigability by adjusting the tidal transit-schedule for container vessels that are depending on the tide to approach or leave the port of Hamburg.