Optimisation of a coastal circulation model by 4DVAR estimation of uncertain parameters using HF radar, tide gauge and ADCP observations

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Introduction

The modelling of circulation processes in the German Bight is complicated by the shallow bathymetry and non-linear processes, e.g., generation of overtides. In addition, there are several uncertain model parameters like e.g., bottom roughness, water depth or parameters regulating turbulence. In this study, a parameter optimization is performed using a variational (4DVAR) method in combination with surface current observations from HF radar, tide gauge measurements and current profile observation from ADCP instruments.

Methods

The cost function gradients required for 4DVAR are estimated using an adjoint model code. The considered 3D circulation model uses the same bathymetry, open boundary forcing and metereological forcing as the operational model run at the Federal Maritime and Hydrographic Agency (BSH). The BSH model is used as a reference to put the the optimised model into perspective.

Results

The optimised model shows improved agreement with HF radar and tide gauge observations. The tuned model was also compared with drifter data. In this case, drifter simulations based on the BSH model and the respective operational drift model were used as a reference. These comparison showed very similar results overall, with some larger errors of the tuned model in very shallow areas, where no observations were used for the tuning and surface wave effects, which are only explicitly considered in the BSH model, play a more important role. The tuned model seems to be slightly more dissipative than the BSH model.

Conclusions

The combined use of current and water level observations seems to be efficient for the estimation of uncertain parameters in a coastal 3D circulation model. There are still some ambiguities remaining, e.g. related to errors in the open boundary forcing. More observations near the open boundary would be desirable.