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Assimilation of high-frequency radar surface currents measurements to optimize tidal boundary conditions and wind forcing (Outstanding Young Scientist Lecture)

Alexander Barth (1,2), Aida Alvera-Azcárate (1,2), Klaus-Werner Gurgel (3), Joanna Staneva (4), Jean-Marie Beckers (1,2), Alexander Port (5), and Emil Stanev (4)

(1) GeoHydrodynamics and Environment Research (GHER), AGO/MARE, University of Liège, Liège, Belgium, (2) National Fund for Scientific Research, Belgium, (3) Institute of Oceanography, University of Hamburg, Germany, (4) Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany, (5) Institute for Chemistry and Biology of the Marine Environment (ICBM), University of Oldenburg, Germany

An ensemble smoother scheme is presented to assimilate high-frequency (HF) radar surface currents to improve tidal boundary conditions and wind forcings of a circulation model of the German Bight. To create an ensemble of dynamically realistic tidal boundary conditions, a cost function is formulated which is directly related to the probability of each perturbation. This cost function ensures that the perturbations are spatially smooth and that the structure of the perturbations satisfies approximately the harmonic linearized shallow water equations. Based on those perturbations an ensemble simulation is carried out using the full three-dimensional General Estuarine Ocean Model (GETM). Optimized boundary values are obtained using all observations within the assimilation period using the covariances of the ensemble simulation. The approach acts like a smoother scheme since past and future observations are taken into account. The final analysis is obtained by rerunning the model using the optimal perturbation of the boundary conditions. The analyzed model solution satisfies thus the model equations exactly and does not suffer from spurious adjustments often observed with sequential assimilation schemes. Model results are also compared to independent tide gage data. The assimilation also reduces the model error compared to those sea level observations. The same scheme is also used to correct surface winds. Surface winds are crucial for accurately modeling the marine circulation in coastal waters. The method is validated directly by comparing the analyzed wind speed to in situ measurements and indirectly by assessing the impact of the corrected winds on sea surface temperature (SST) relative to satellite SST.