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Efficient Calibration of a Global Tide and Surge Model

xiaohui wang[1], Martin Verlaan[1,2], and Hai Xiang Lin[1]
[1]Delft University of Technology, Faculty of Electrical Engineering, Mathematics & Computer Science, Applied Mathematics, Netherlands (x.wang-13@tudelft.nl)
[2]Deltares

Combined tide and surge models are very useful tools to issue warnings for storm surges as well as for assessment of the potential impacts of sealevel rise. Over the past decade, a Global Tide and Surge Model (GTSM) has been developed by Deltares with improvements in physics, grid resolution and skill in the each new version. The uncertainties in bathymetry and friction are currently a major part of the remaining model uncertainty. Improved estimates of these parameters would be desirable, but the required computing speed and memory storage are limiting the possibilities at the moment. Here, we propose an efficient coarse grid parameter estimation scheme for the high resolution GTSM to estimate the bathymetry. OpenDA software is combined with GTSM using DUD algorithm (Does not Use Derivative) making use of the FES2014 dataset as observations in deep water. Even though parallel computing is implemented for model simulation, calibration of the fine grid model directly would still require too much computer time, for instance, e.g. it takes 9 hours on 20 cores to simulate 45 days and calibration typically requires many of these simulations. Therefore, a coarse-to-fine strategy is developed by replacing the fine grid with coarse grid in parameter estimation iterations to reduce the computing cost by 67%. Moreover, via a sensitivity analysis we are able to reduce the parameter dimension from $O(10^6)$ to $O(10^2)$ which leads to a further reduction of the required computation and memory. The results of the estimation and model validation demonstrate the parameter estimation scheme to improve the accuracy of the model by approximately 30% with affordable computational and storage demands.