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Daily hydro- and morphodynamic simulations at Duck, NC, USA using Delft3D

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Operational forecasting of the coastal nearshore has wide ranging societal and humanitarian benefits, specifically for the prediction of natural hazards due to extreme storm events. However, understanding the model limitations and uncertainty is as equally important as the predictions themselves. By comparing and contrasting the predictions of multiple high-resolution models in a location with near real-time collection of observations, we are able to perform a vigorous analysis of the model results in order to achieve more robust and certain predictions. In collaboration with the U.S. Army Corps of Engineers Field Research Facility (USACE FRF) as part of the Coastal Model Test Bed (CMTB) project, we have set up Delft3D at Duck, NC, USA to run in near-real time, driven by measured wave data at the boundary. The CMTB at the USACE FRF allows for the unique integration of operational wave, circulation, and morphology models with real-time observations. The FRF has an extensive array of in-situ and remotely sensed oceanographic, bathymetric, and meteorological data that is broadcast in near-real time onto a publically accessible server. Wave, current, and bed elevation instruments are permanently installed across the model domain including 2 waverider buoys in 17-m and 26-m water depths at 3.5-km and 17-km offshore, respectively, that record directional wave data every 30-min. Here, we present the workflow and output of the Delft3D hydro- and morphodynamic simulations at Duck, and show the tactical benefits and operational potential of such a system. A nested Delft3D simulation runs a parent grid that extends 12-km in the along-shore and 3.5-km in the cross-shore with 50-m resolution and a maximum depth of approximately 17-m. The bathymetry for the parent grid was obtained from a regional digital elevation model (DEM) generated by the Federal Emergency Management Agency (FEMA). The inner nested grid extends 1.8-km in the along-shore and 1-km in the cross-shore with 5-m resolution and a maximum depth of approximately 8-m. The inner nested grid initial model bathymetry is set to either the predicted bathymetry from the previous day's simulation or a survey, whichever is more recent. Delft3D-WAVE runs in the parent grid and is driven with the real-time spectral wave measurements from the waverider buoy in 17-m depth. The spectral output from Delft3D-WAVE in the parent grid is then used as the boundary condition for the inner nested high-resolution grid, in which the coupled Delft3D wave-flow-morphology model is run. The model results are then compared to the wave, current, and bathymetry observations collected at the FRF as well as other models that are run in the CMTB.