Abstract

The response of the coastal ocean and estuaries to severe weather forcing (e.g., tropical and extra-tropical storms) and strong tsunamis vary significantly in space and time. Simulating and predicting this response require a) a fully coupled atmospheric-ocean model system that can resolve the multiscale current-wave interaction processes; b) grid flexibility to accurately represent irregular geometric shelf-estuarine-wetland regions; c) computational efficiency that allows an adjustable time step with changes in the model spatial resolution; and d) a Web Map Service (WMS) display system. The SMASSD-WHOI research team has upgraded FVCOM using the Earth System Modeling Framework (ESMF). The new FVCOM has a mass-conservative two-way nesting feature that allows varying time steps for the time integration of different multiscale global, basin, shelf, and estuarine/wetland processes. A parallelized version of WMS was also built into FVCOM, through which the model forecast fields can be viewed and analyzed directly using Google maps on the website. These new features have been implemented into the Northeast Coastal Ocean Forecast System (NECOFS) for the purpose of predicting coastal inundation caused by severe weather systems as they pass through the Northeast. The multi-domain nesting FVCOM system was also successfully used to simulate the Japan March 11 earthquake-induced tsunami waves, coastal inundation, and subsequent spread of Cs-137 into the Japan coastal ocean.

NECOFS is a 24/7 forecast operation model system with inclusion of the mesoscale meteorological model (WRF), regional ocean model (FVCOM), a high-resolution (up to 10 m) Mass Coastal FVCOM and Scituate inundation FVCOM model. The core local weather model/regional FVCOM system was first placed in operation in 2007 and upgraded as new modules and grids are developed and new applications arise.

FVCOM v3.16 is a fully ocean-ice, wave-current-sediment coupled, unstructured horizontal grid with generalized terrain-following coordinate transformation ocean model system implemented with user-defined multi-domain nesting function. The model includes two numerical solvers: 1) mode-splitting and 2) semi-implicit and can be run using either hydrostatic or non-hydrostatic dynamics. Data assimilation algorithms such as nudging, 4D-Var and Ensemble Kalman Filters are available in the code, which can be selected at the same time for different variables for both hindcast and forecast operation. FVCOM also includes both online and offline biological modules, such as GBM (Generalized Biological Model), UG- RCA (unstructured grid Roe-Colum Advanced water quality model), WQM (a water quality model based on the EPA Water Quality Analysis Simulation Program-WASP), and the unstructured-grid CE-QUAL-ICM (the Army Corps of Engineers water quality model).

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