International workshop on Multiscale (Un)-structured mesh numerical ocean Modeling
Cambridge, MA, 17-20 August 2010

Pushing the Limits of Coastal Ocean Modeling: from Estuarine and Coastal Waters to Upstream River Floodplains

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Economic development, agriculture land use, and human activities in the coastal zone have altered the infrastructures and ecosystems in the coastal region and upstream river floodplain. Many restoration actions are currently being proposed or undertaken to improve habitats in the estuarine and river floodplain as well as the connectivity between the two regions. Traditionally, hydraulic analysis in floodplains is conducted with the assumption that the effect of tidal influences from the downstream boundary is small, using one-dimensional models. While this approach may be sufficient for engineering design for peak flood protection, it is inadequate when flood waters flow across the floodplain in a complex manner. Another limitation of 1-D model is the lack of details information on horizontal distributions of inundated water depths and current magnitudes in the floodplain, which are important to juvenile salmon downstream migration. Similarly, typical estuarine hydrodynamic modeling studies do not consider the effect of floodplains at the upstream end of the river due to the technical challenge of wetting and drying process in the large floodplains. High river slope also presents a stability challege. While various multi-scale model frameworks have been proposed for modeling the coastal oceans, estuaries, and rivers with a combination of 1-D, 2-D and 3-D models, this paper presents an approach for simulating the hydrodynamics in the estuary and river floodplain with smooth transition between the two regimes using a single unstructured-grid coastal ocean model. This approached was applied to the Skagit River estuary and floodplain of Puget Sound in the northwest coast of North America. The model was validated with observed data for water level and velocities under normal and flood conditions. This study successfully demonstrated that an estuarine and coastal ocean model could be extended much further upstream to simulate the inundation processes in the river floodplain and the dynamic interaction between the estuary and floodplain regimes.

Key words: modeling, unstructured-grid, floodplain, estuarine circulation

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