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An unstructured grid model of tidal intrusion in a complex mega delta

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The finite volume community ocean model (FVCOM) has been applied to the Ganges-Brahmaputra-Meghna (GBM) delta, in the northern part of the Bay of Bengal, in order to simulate tidal hydrodynamics and freshwater flow in a complex river system. This is the first 3D baroclinic model covering the whole GBM delta from deep water beyond the shelf break to 250 km inland, the limit of tidal penetration. The delta region is limited in observations of bathymetry and water level, which poses a challenge for configuration and validation of accurate hydrodynamic models in this area. We examine the controls on tidal penetration from the open coast into the intricate system of river distributary channels and creeks. The tidal simulation was validated against the limited available data in order to have confidence in the delta model results when it is used to investigate baroclinic processes, river salinity and future change in this area. The performance of the FVCOM tidal model configuration has been evaluated at a range of sites in order to assess its ability to capture water levels, which vary over both a tidal and seasonal cycle.

This modelling approach has been used to improve understanding of the hydrodynamics of the GBM delta system. Tidal penetration into the delta distributaries is controlled by a combination of bathymetry, channel geometry, bottom friction, and river flow. FVCOM is seen to capture the leading tidal constituents satisfactorily at coastal tide gauge stations, with small root-mean-squared errors of 10 cm on average. Inland, the model compares favourably with twice-daily observed water levels at thirteen stations where it is able to capture both tidal and annual timescales in the estuarine system. When the river discharge is particularly strong the tidal range can be reduced, as the tide and river flows oppose each other.

The bathymetry is found to be the most influential control on water levels within the delta, though tidal penetration can be significantly affected by the model's bottom roughness, and the inclusion of large river discharge. We discuss the generic problem of implementing a model in a data-poor region and the challenge of validating a hydrodynamic model from the open coast to narrow river channels.