Simulation of Coastal Inundation Instigated by Storm Surge and River Discharge in the Chesapeake Bay Using Sub-grid Modeling Coupled with Lidar Data

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Simulation of Coastal Inundation Instigated by Storm Surge and River Discharge in the Chesapeake Bay Using Sub-grid Modeling Coupled with Lidar Data

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ABSTRACT

The sub-grid modeling approach was applied to the Chesapeake Bay for simulating two flooding cases (Table 1):

1. The Great Flood of 1936, which occurred in Washington, DC, was caused by the sudden increase of spring fresh water flood derived from heavy snowmelt in the upper Potomac River, resulting in a flood stage of 9 feet and widespread inundation of the entire capital mall area.

2. The second case is Back Bay in Poolesville near Langley Air Force Base for Hurricane Irene where heavy precipitation initiated a flash flooding event in 2011 for a large area of Popоquinton.

METHODS AND MATERIALS

The sub-grid modeling approach was applied to the Chesapeake Bay for simulating two flooding cases (Table 1):

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RESULTS

The Great Potomac River Flood of 1936 in Washington, DC

Lidar for Langley Research Center

Sub-grid modeling is a novel method by which water level elevations on the sub-grid level can be obtained through the combination of water levels and velocities efficiently calculated at the coarse computational grid, the discretized bathymetric depths, and local friction parameters without resuming to solve the full set of equations. Sub-grid technology essentially allows velocity to be determined rationally and velocity at the sub-grid level where characteristic sub-grid modeling can achieve accurate results upon comparison with NOAA observation data and replicate the results of a likewise-resolution true grid model, indicating that there is minimal loss of quantitative accuracy in the sub-grid approach (R^2 = 0.988). (2) Spatial comparison of GPS wrack line data with model results for 2011 hurricane Irene demonstrated that sub-grid model results accurately predicted the water level observed at Langley Research Center.

DISCUSSION

Great Flood of 1936 in Washington, DC

• The sub-grid modeling approach readily replicated the results of a likewise-resolution true grid model indicating:
  1) minimal loss of quantitative accuracy in the sub-grid approach, and
  2) both methods match the observation at Washington, DC (Figure 1a)

• All storms were compared on a Daily Time Series Formation with Windows XP Professional (64-bit edition); an Intel Neon Quad Core X5570 Processor (2.93GHz), with 6 GB RAM running UnTRIM® (Table 2 below)

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