4.1 Towards the Implementation of Fully Integrated Flood Model

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OVERVIEW

Record flood producing rainstorms of July 17-19 1996 in the Chicago metropolitan area provide an ideal test bed to evaluate a high-level fully integrated flood model (IFM) being developed by the Environmental Hydrology Team of the National Computational Science Alliance (NCSA)[1]. The storms produced 24 hr rainfall ranging from 35-43 cm in an area exceeding 4400 sq km and rainfall exceeding 15 cm in an area approaching 10,000 sq km. This resulted in record flood levels in most rivers across Northern Illinois/Southern Wisconsin. The integrated flood model links output from the Penn. State/National Center for Atmospheric Research mesoscale model (MM5[2]) to a fully Java-based watershed runoff model (JANSWERS[3]). JANSWERS in turn provides input to a high-level CFD-based river flow model (RIVER3D[4]). The resulting local and regional flood stage and inundation mapping should prove useful both in terms of basic research and direct application to flash flood impact and response considerations.

Numerical simulations of the atmosphere's evolution are performed using the MM5 mesoscale model[5]. The simulations center three nested grids over northern Illinois that employ 27-km, 9-km and 3-km horizontal resolution. The model uses a stretched vertical grid that places the highest resolution near the surface (approximately 50-m) and the coarsest resolution at the domain top. The simulations' initial state derives from 40-km resolution analysis fields generated by the Rapid Update Cycle (RUC) numerical model. In addition, subjective analysis of satellite and radar observations is used to introduce areas of clouds and precipitation into the initial model data. The surface temperature of Lake Michigan is refined using the Great Lakes Surface Environmental Analysis

Output from the MM5 analysis calibrated using local rain gauge data for several drainage basins serves as input to the JANSWERS watershed model. JANSWERS, a Java-based distributed runoff model predicts surface runoff timing and volumes for several smaller and midlevel-sized watersheds feeding into several Northern Illinois rivers. By utilizing higher resolution grid cell sizes (5 m square), relatively short time steps, and high performance computing (made available by NCSA), a more accurate characterization of runoff delivery dynamics to streams is possible. High frequency (short time interval) output from the runoff model is then routed into the river flow model (RIVER3D).

In a similar manner, by combining detailed (higher resolution) bathymetric data for river reach portions immediately downstream of selected basins, GIS based 3D channel friction determinations, high performance computing, and the 3D CFD capabilities provided by RIVER3D, more accurate channel flow characterization is possible. Resultant model flood timing, flood levels and inundation determinations are compared to available stage data.

In summary, a new integrated flood model (IFM) permits a new level of detailed analysis. This is accomplished by coupling and running high spatial and temporal resolution models, namely MM5, JANSWERS, and RIVER3D, on high performance computer platforms.

Results will be shown at the conference and available on the web[6].

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[1] http://www.ncsa.uiuc.edu/Science/EnHydro/
[2] http://box.mmm.ucar.edu/mm5/mm5v3.html
[3] http://www.geomorphology.uiowa.edu/janswers/
[4] http://www.iihr.uiowa.edu/~river3d/
[5] http://redrock.ncsa.uiuc.edu/~peckham/flood.html
[6] http://redrock.ncsa.uiuc.edu/AOS/home_pubs.html