EarthCube Building Block for Integrating Discrete & Continuous Data (DisConBB):
Building Cyberinfrastructure to Support a Real-time National Flood Model

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Use Case: National Flood Interoperability Experiment

DisConBB has organized through the Consortium for the Advancement of Hydrologic Science, Inc. (CAHIS) and partner agencies within the Integrated Water Resources Services and Sciences (IWRSIS) consortium (National Weather Service (NWS), United States Geological Survey (USGS), U.S. Army Corps of Engineers (USACE) and Federal Emergency Management Agency (FEMA)) to support a National Flood Interoperability Experiment (NFIE) to build a real-time, high-resolution national flood forecasting model for the country.

Research Questions

Connect national scale flooding models with local emergency planning and response
1. How can near-real-time hydrologic simulations at high spatial resolution, covering the nation, be carried out using the NHDP plus or next generation hydrofabric?
2. How can this lead to improved response and community resilience?
3. How can an improved interoperability framework support the first two goals and lead to sustained innovation in the research to operations process?

Operational Flood Forecasting

The National Weather Service (NWS) forecast streamflow at approximately 4,500 locations across the country through operations at 13 river forecast centers (RFC). Each RFC runs a calibrated SAC-SMA model over a designated forecast basin by initializing conditions five days in the past and simulating streamflow up to five days in the future. At major reservoirs, RFC personnel coordinate with regional reservoir operators to forecast reservoir releases. Simulated flows vary from one to six hour time steps and through the NFIE, it is intended to publish these values as WaterML web services using an approach similar to that of the USGS (http://waterforecast.usgs.gov).

National Flood Modeling: WRF-Hydro and RAPID

Through advancements in computer science and technology, large scale models of the atmosphere, land, surface and river network have been developed in recent years. As part of the NFIE, the NHC, 2, 3, and 1 km WRF-Hydro models (Gochis et al., 2014) and an NHDPPlus-based RAPID river routing model (David et al., 2011) have been developed over the contiguous U.S. to support surface and subsurface runoff calculations and streamflow calculations.

The WRF-Hydro framework provides a flexible modeling environment for integrating atmospheric forcing with defined physical processes across the land-surface (e.g. VIC, Noah, CML), while the RAPID modeling framework allows for coupling of surface and subsurface runoff processes through drainage catchments as defined by the NHDP; the RAPID model uses the Muskingum method to route flow volumes through the river network.

Data Interoperability: Scaling Runoff Forcing

Two distinct approaches are taken to connect runoff forcing to NHDPPlus catchments. Using NWS forecast basins (approximately 1,200 km²), runoff per unit area, provided by NWS RFCs, are downscaled to the catchment scale using the catchment area. Alternatively, gridded runoff output from WRF-Hydro are scaled up to the catchment scale using a weighted aerial average table derived from intersecting the WRF-Hydro grid with the NHDPPlus catchments. Runoff for each catchment is then organized in a RAPID runoff file stored as netCDF. Runoff forcing is then combined with reservoir releases to run a national scale RAPID model.

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