Implementation of the WRF-Hydro Model in the Great Lakes Region

Poster# MMA-26

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Introduction

Beginning in the summer of 2016, the NOAA National Water Center (NWC) in partnership with the National Centers for Environmental Prediction (NCEP), the National Center for Atmospheric Research (NCAR) and other academic partners have produced operational hydrologic predictions for the nation using a new National Water Model (NWM), which is based on the community **W**eather **R**esearch and **F**orecasting model **hydro**logical extension package (**WRF-Hydro**) modeling system (Gochis et al. 2015). The WRF-Hydro modeling system is a physics-based, distributed hydrologic modeling system and has been used in several streamflow prediction applications in the U.S. and around the world.

Purpose

- The Great Lakes basin is not entirely included in the current NWM
  - Flooding
  - Lake Level
  - Water management
- Implementation of the WRF-Hydro modeling system
  - preparing high-resolution terrain data
  - parameterizing lakes and reservoirs
  - calibrating the model
- Provision of a coupled modeling system in the Great Lakes region
  - WRF for the Atmosphere
  - NoahMP for the land
  - WRF-Lake for the lakes
  - WRF-Hydro for the channel routing
  - SST (ocean model) for the Oceans

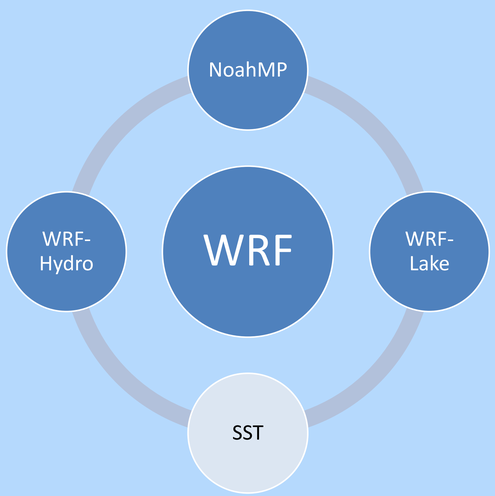

Figure 1 Framework of a WRF-centered air-land-water-ocean modeling system in a broad Great Lakes region (as in Figure 3).

Approach

Preparation of High-resolution Terrain Data in the Great Lakes Basin

- Hydrofabric
  - National Hydrography Dataset (NHD) Plus version 2 in U.S.
  - Great Lakes Hydrography Dataset (GLHD) for Canada
- Gauges
  - U.S. Geological Survey stream (USGS)
  - Environment and Climate Change Canada (ECCC)

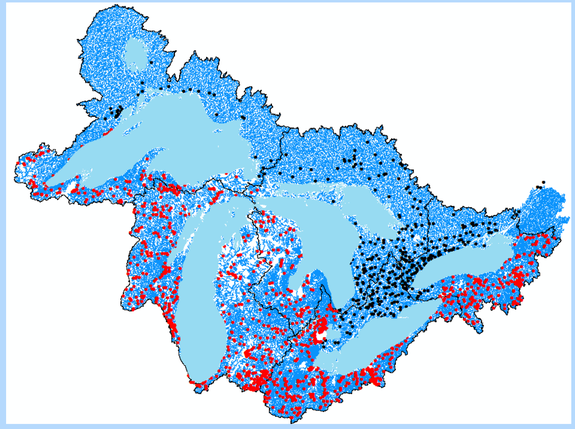

Figure 2. Great Lakes basin showing the seven waterbody polygons (lakes Nipigon, Superior, Huron, Michigan, St. Clair, Erie, and Ontario), the approximately 152,000 stream segments that connect to the lake waterbody polygons in over 3,000 locations. Stream gages are shown in black for ECCC and red for USGS.

Experimental Designs

- Offline WRF-Hydro (250 m)
  - North American Land Data Assimilation System version 2 (NLDAS2)
- Coupled WRF/WRF-Hydro (250 m)
  - Two nested domains (10 km -> 2.5 km)
  - NCEP North American Regional Reanalysis (NARR)

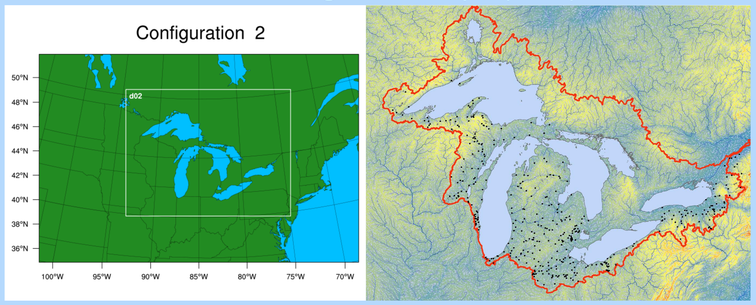

Figure 3. (left) 2-Nest WRF model domains and (right) Inner domain DEM from the HydroSHEDS with the river channels and outline of the Great Lakes watershed where USGS gauge stations are denoted with black dots.

Conclusion and Discussion

- **Conclusion from Preliminary Experiments**
  - The WRF-Hydro capable of reproducing the channel flow variability
  - Sensitive to the meteorological forcing
  - Baseflow important in the Great Lakes region
- **Continuing Works**

  Lake/reservoir representation; Coupled WRF/WRF-Hydro experiments
  Model calibrations with more gauge stations; Long term simulations

Preliminary Results

Hydrofabric input for WRF-Hydro

- With the completion of the merging and editing of hydrology features the stream segment attributes were built and the stream network was tested for connectivity.
- Stream segments attributes were derived for the Canadian portion of the Great Lakes basin including unique identifiers, maximum elevation, slope, and stream order. The entire stream network was tested for connectivity to the outflow along the St. Lawrence Seaway.

WRF-Hydro Simulation

- A one-month offline testing simulation (July 2014)
- Selected USGS Stations (Table 1)

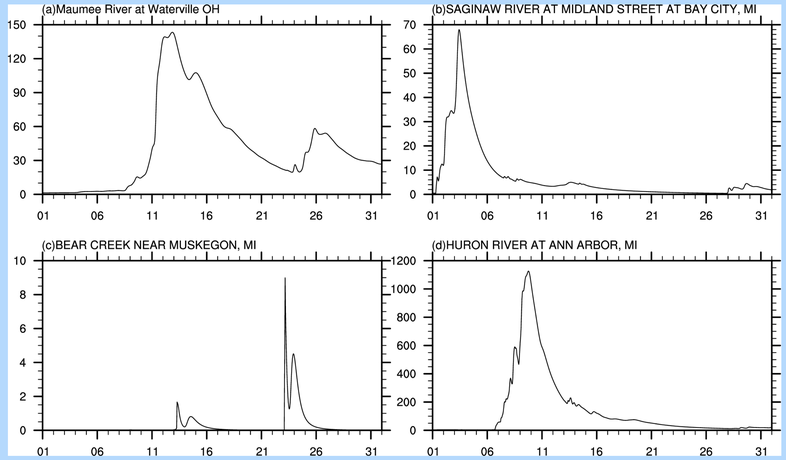

Figure 4. Stream flow (units: cfs,) simulated by the offline WRF-Hydro model with full routing options.

Table 1. USGS stream flow stations

FID	LON	LAT	STATION	NAME
1	-83.7128	41.50000	Maumee_River_at_Waterville_OH	4193500
2	-83.8917	43.60111	SAGINAW_RIVER_AT_MIDLAND_STREET_AT_BAY_CITY_MI	4157060
3	-86.2228	43.28861	BEAR_CREEK_NEAR_MUSKEGON_MI	4122100
4	-83.7339	42.28694	HURON_RIVER_AT_ANN_ARBOR_MI	4174500

Huron River test: a precipitation process is captured by the model while some discrepancy in magnitude, given the predominance of management and/or groundwater control.

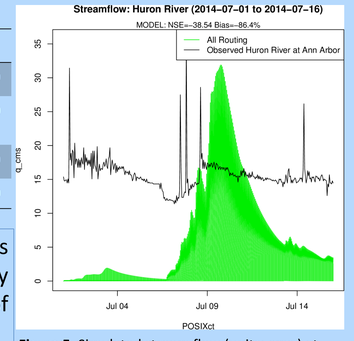

Figure 5. Simulated stream flow (units: cms,) at Huron River compared with the USGS observation.

Acknowledgment & Reference

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Gochis, D.J., W. Yu, and D.N. Yates, 2015: The WRF-Hydro model technical description and user's guide, version 3.0. NCAR Technical Document. 120 pages. Available online at: http://www.ral.ucar.edu/projects/wrf_hydro/ .