



# Implementation of the WRF-Hydro Model in the Great Lakes Region: A Maumee River Test Case

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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 Weather Research and Forecasting model hydrological 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
- Implementation of the WRF-Hydro: preparing high-resolution terrain data; parameterizing lakes and reservoirs; calibrating the model parameters.

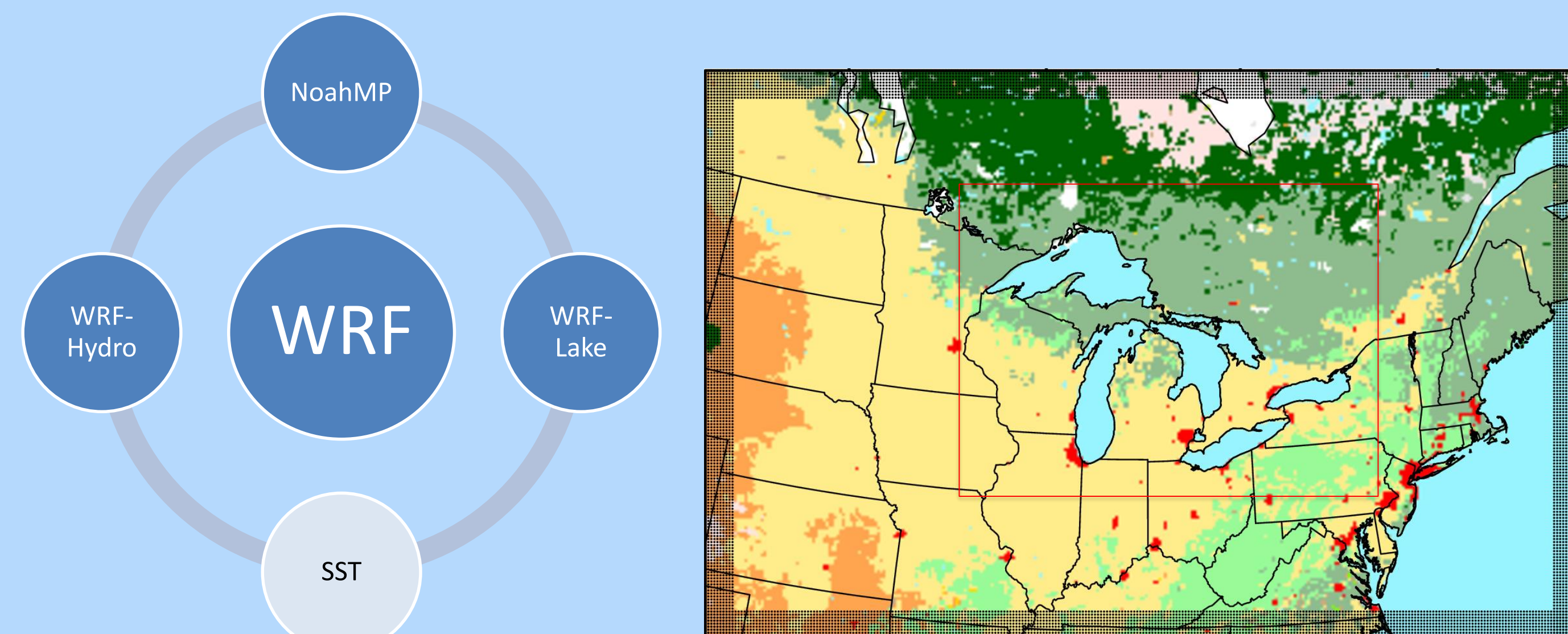


Figure 1. Framework and domain of a WRF-centered air-land-water-ocean modeling system in a broad Great Lakes region.

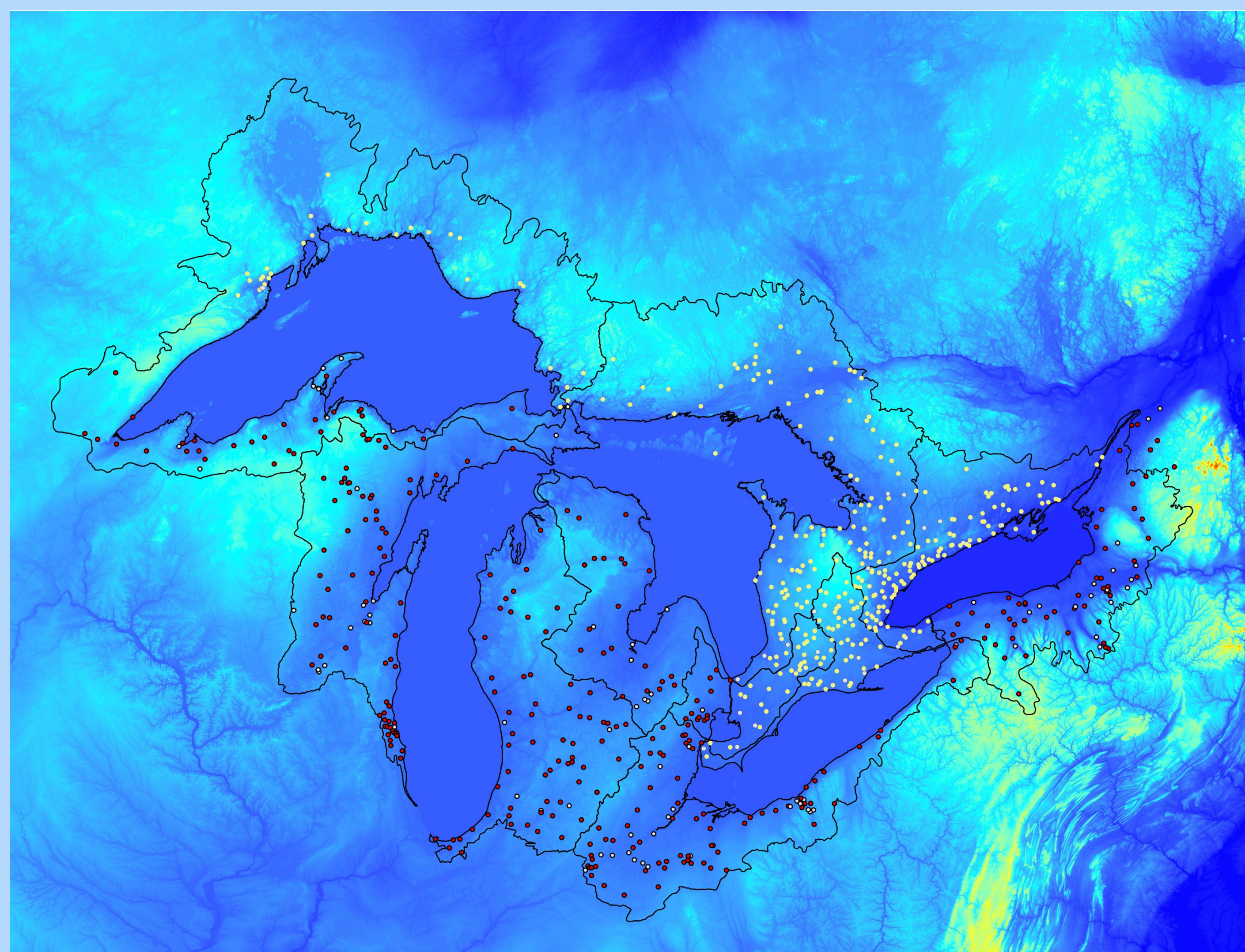


Figure 2. WRF\_hydro model (250 m) domain in the Great Lakes basin. Calibration stations in dot.

## Approach

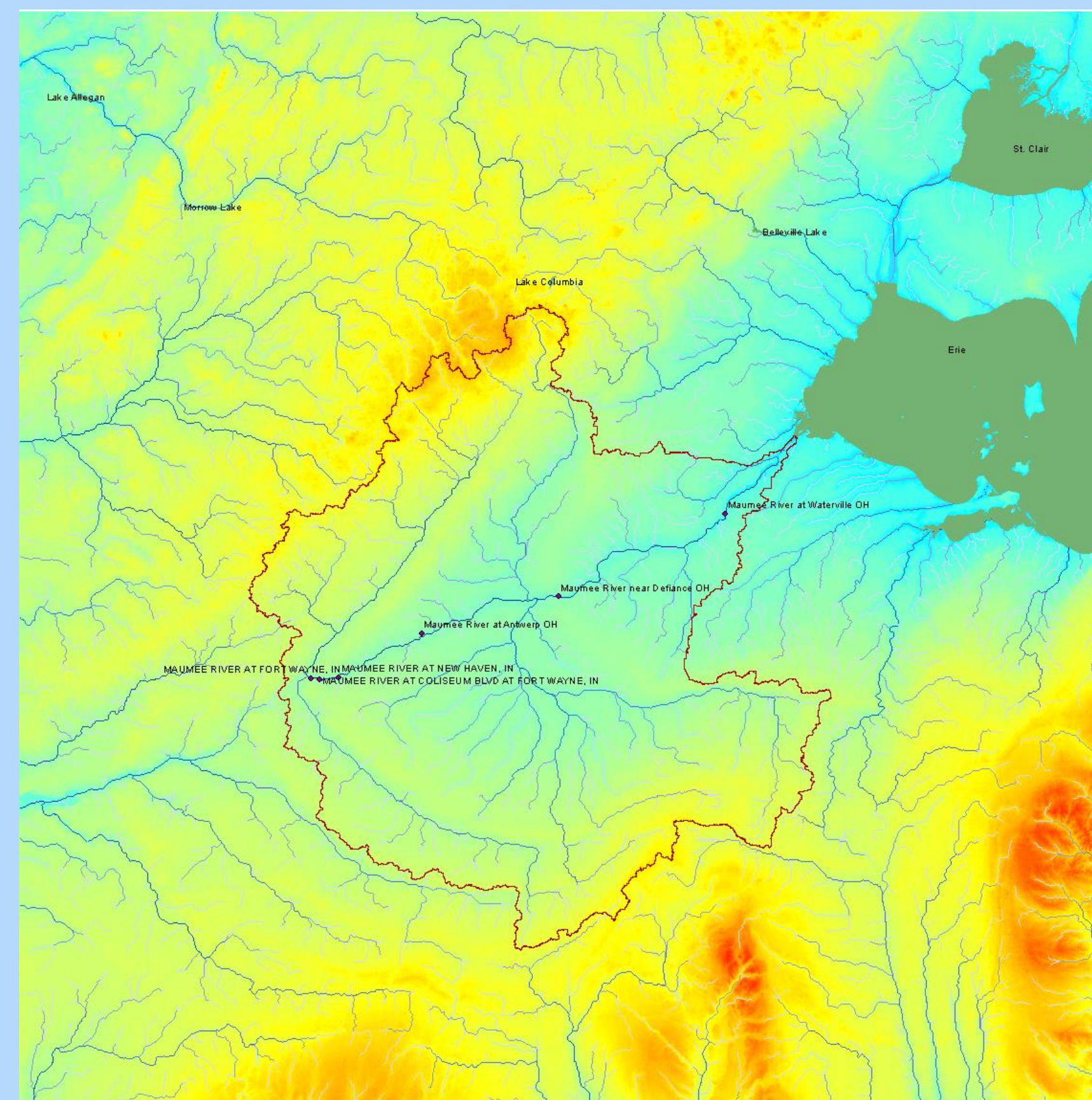
### Preparation of High-resolution Terrain Data in the Great Lakes Basin

- 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)

### Experimental Designs

- Offline WRF-Hydro (250 m)
  - North American Land Data Assimilation System version 2 (NLDAS2)
  - Special Precipitation: NCEP/CPC Stage IV
- Coupled WRF/WRF-Hydro (250 m)

## Experiment: Maumee River Basin Test Case



### Offline WRF-Hydro Simulation

- Start at Jan 2014
- Aug -Oct 2014
- Experimental designs (Table 2)
- Validation (Table 1)

Table 1. Selected USGS Stations on Maumee River

| STATION                           | NAME    |
|-----------------------------------|---------|
| MAUMEE RIVER AT FORT WAYNE, IN    | 4182900 |
| MAUMEE RIVER AT COLISEUM BLVD, IN | 4182950 |
| Maumee River near Defiance OH     | 4192500 |
| Maumee River at Waterville OH     | 4193500 |

Figure 3. WRF-Hydro domain DEM from the HydroSHEDS with the river channels and outline of the Maumee River watershed where USGS gauge stations are denoted with black dots.

## Results I: Parameter Calibration

- Hydrographic volume:
  - infiltration factor **REFKDT** (0.1-10)
  - surface retention depth **RETDEPRTFAC** (0.0-10.0)
- Hydrographic shape
  - surface roughness **OVROUGHRTFAC** (0.1-1.0)
  - channel Manning roughness **MANN** (0.4-2.0)

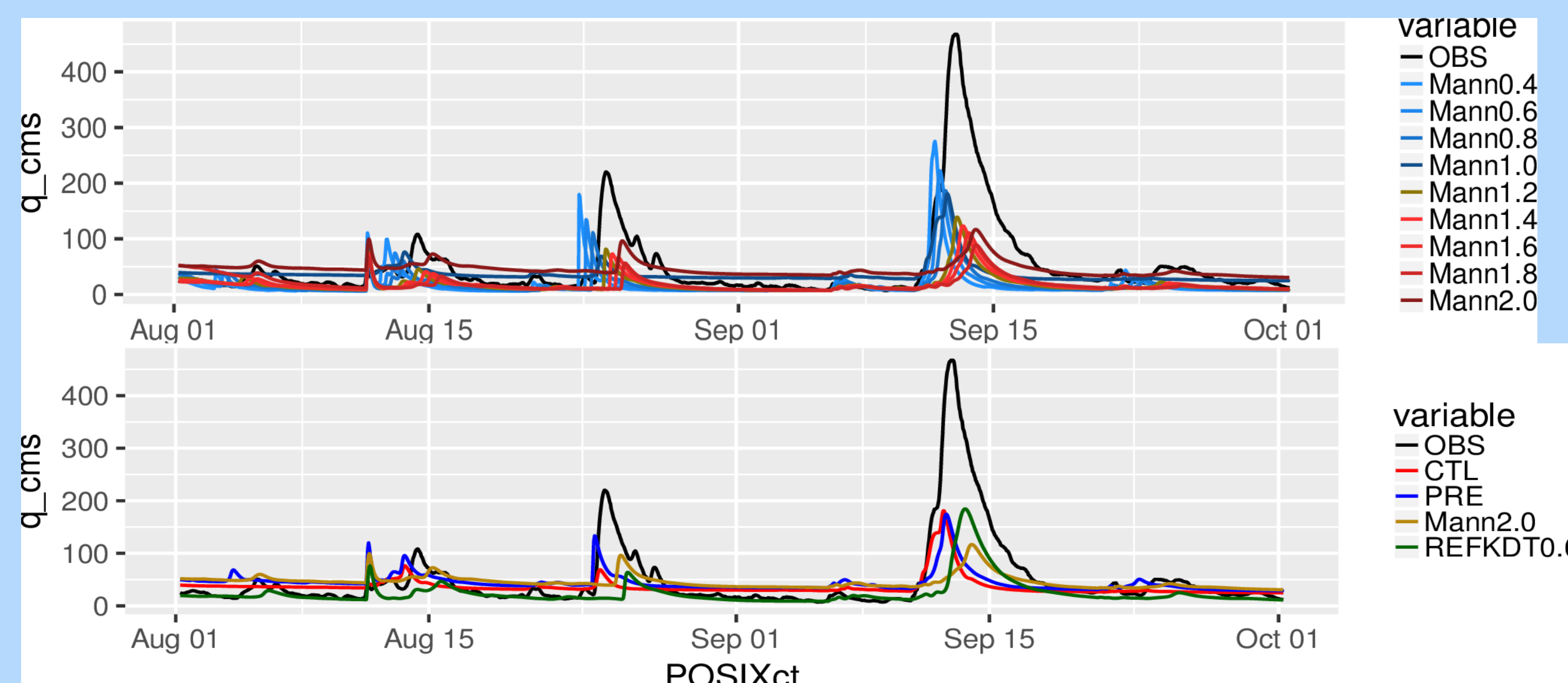


Figure 5. Stream flow (units: cfs, q\_cms) at Stations 0419355 simulated by the offline WRF-Hydro model for difference Mann and REFKDT

## Results I: Forcing Sensitivity

Table 2. Experimental designs

| Experiments | Meteorological Forcing | Precipitation         |
|-------------|------------------------|-----------------------|
| CTL         | NLDAS2                 | -                     |
| IDL         | ideal                  | Stage IV              |
| PRE         | NLDAS2                 | Stage IV              |
| PRE2        | NLDAS2                 | Stage IV * $\sqrt{2}$ |

### Validation of the Channel flow at Maumee River

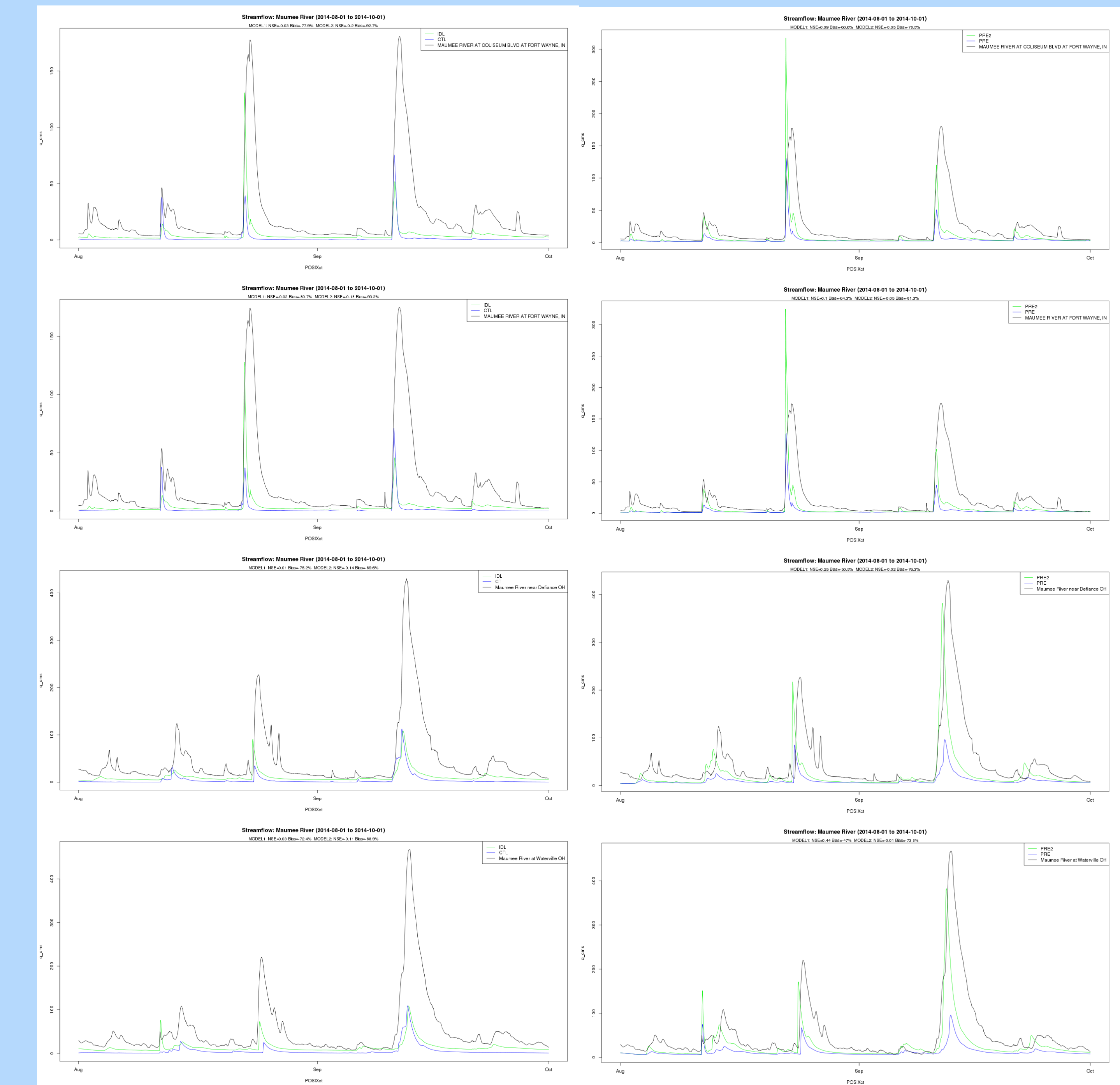


Figure 4. Stream flow (units: cfs,) at four stations simulated by the offline WRF-Hydro model for difference experiments compared with USGS gauge observations.

## Conclusion and Discussion

- Conclusion from Preliminary Experiments
  - The WRF-Hydro capable of reproducing the channel flow variability
  - More sensitive to precipitation compared to 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

## Acknowledgment & Reference

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