Abstract
Here we describe the software components and outputs from the NFIE-2015 (National Flood Interoperability Experiment-2015) forcing data engine. The NFIE-2015 forcing engine was a preliminary version of a comprehensive WRF-Hydro forcing engine developed for operational national streamflow prediction through the National Water Center. The NFIE-2015 system used real-time, operational data from the NSDL (National Severe Storms Laboratory) Multi-Meter Multi-Sensor System (MRMS) rain gauge corrected radar QPE (quantitative precipitation estimation) product, the NOAA/ESRL High Resolution Rapid Refresh (HRRR) output, and NCEP Global Forecast System (GFS) output to construct meteorological forcings for a gridded 3-km CONUS implementation of the WRF-Hydro and RAPID models. Following a 2-yr. spinup period the forcing engine data and the WRF-Hydro/RAPID modeling system were then forwarded executed in real-time from May 7, 2015 to create national streamflow forecasts.

Fig. 1 NFIE-2015 modeling system

Fig. 2. NFIE Model Execution Cycles:

Hourly Analysis Cycle:
MRMS - Precipitation
GFS/HRRR: wind, temperature, humidity, radiation
3-hourly, 0-15 hr Forecast Cycle:
GFS/HRRR: precipitation, wind, temperature, humidity, radiation

HRRR
High Resolution Rapid Refresh (HRRR) model hourly outputs with 3km horizontal resolution are regridded to the NFIE model domain (Figure 4). The HRRR domain is smaller than the NFIE model domain. The missing part is filled with GFS outputs.

MRMS - Processing
NSSL Multi-Meter Multi-Sensor (MRMS) Quantitative Precipitation Estimation are regridded to 3km horizontal resolution NFIE model domain and replace the HRRR rainfall in the analysis cycle (Fig. 3).

Forcing Engine: [ESMF Regridding, Mosaicking, Units Synchron., Formatting]
3km Gridded Analyses and Forecasts
WRF-Hydro/RAPID

Fig. 3. MRMS QPE a) original field, b) regridded field, c) MRMS product coverage map.

New Improvements in the forcing field
In the updated Forcing Engine, the forcing fields are further improved with using RAP outputs instead of GFS for the missing part and considering topographic effects (Fig. 6).

Fig. 6. Downward short wave radiation at 2016010415 for a) GFS+HRRR, b) RAP+HRRR, c) RAP+HRRR with downscaling.

GFS and combined fields
Global Forecast System (GFS) model outputs are used to fill the area not covered by HRRR output. Horizontal resolution 0.5 degree GFS outputs are regridded to 3km horizontal resolution NFIE model domain and fill the place where HRRR data are missing (Fig. 5).

Fig. 5. 2m temperature a) GFS original field, b) regridded/dropped GFS field, and c) final GFS and HRRR combined field.

Summary
1) NFIE forcing fields are constructed with MRMS, GFS and HRRR. The data are regridded and mosaicked to 3km resolution hourly forcing fields.
2) The forcing fields are further improved with using RAP outputs for the missing part and considering topographic effects.

On-going work: Conducting additional downscaling on the forcing fields, using RAP for short range and bias-corrected CFS for long range for the NWC WRF-Hydro real-time national forcing engine.

Email: lpan@ucar.edu