Development of the NFIE-2015 forcing engine

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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 NSSL (National Severe Storms Laboratory) Multi-Radar/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 data engine and the WRF-Hydro/RAPID modeling system were then forward executed in real-time from May 7, 2015 to create national streamflow forecasts.

Fig. 1 NFIE-2015 modeling system

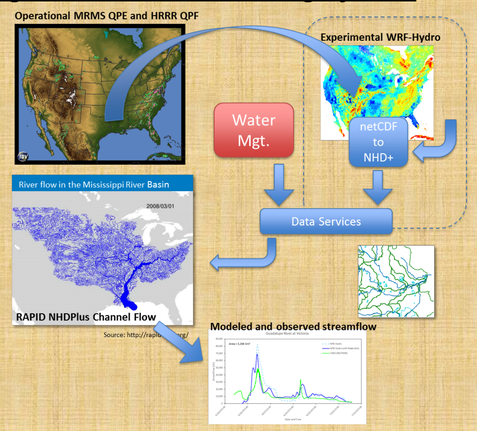
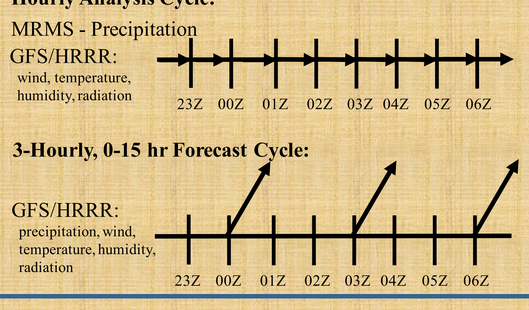


Fig. 2. NFIE Model Execution Cycles:

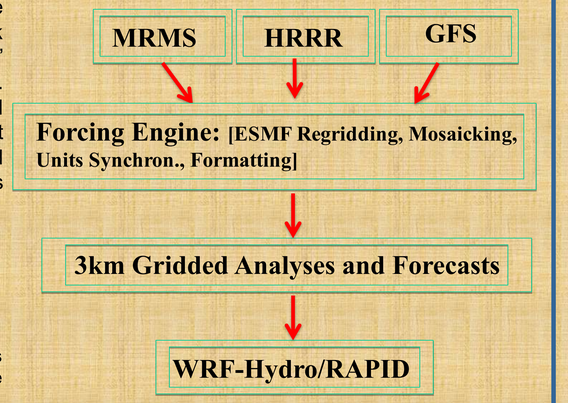


NFIE-2015 Forcing Engine

The NFIE-2015 Forcing Engine used the Earth System Modeling Framework (ESMF) regridding tools available in 'ncl' to regrid all data to a common 3km grid. The Forcing Engine also standardized all variable units and mosaicked and output hourly meteorological analyses and forecasts. The meteorological variables processed were:

Hourly precipitation , Temperature,
Humidity, Air Pressure,
10m U & V Wind Speed,
Incoming Short and Longwave* Radiation

* Because longwave radiation from HRRR was not available values from the GFS model were used over the full domain.



MRMS - Processing

NSSL Multi-Radar 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).

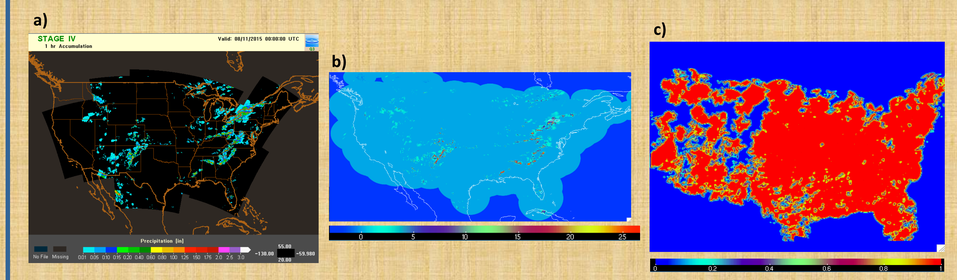


Fig.3 MRMS QPE a) original field, b) regridded field, c) MRMS product coverage map.

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.

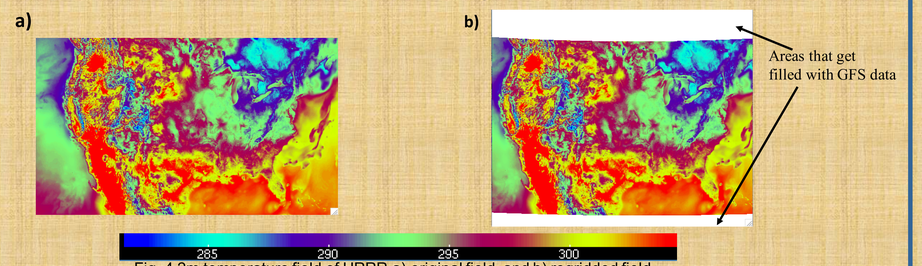


Fig. 4 2m temperature field of HRRR a) original field, and b) regridded field

GFS and combined fields

Global Forecast System (GFS) model outputs are used to fit 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).

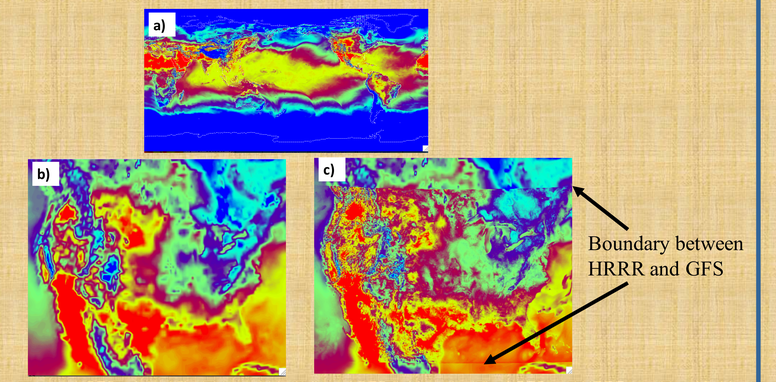


Fig. 5 2m temperature a) GFS original filed, b) regridded/clipped GFS field, and c) final GFS and HRRR combined field.

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).

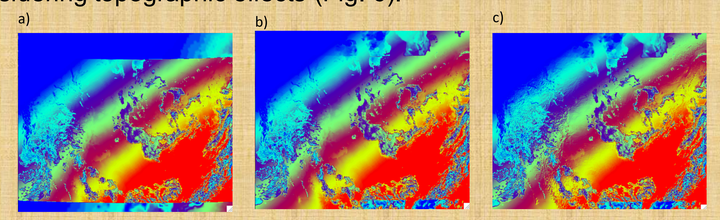


Fig. 6 Downward short wave radiation at 2016010415 for a) GFS+HRRR, b) RAP+HRRR, c) RAP+HRRR with downscaling

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.*

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