Upgrades to the NCEP North American Mesoscale (NAM) System

E. Rogers[1], J. Carley[2], B. Ferrier[2], E. Aligo[2], G. Gayno[2], Z. Janjic[1], Y. Lin[1], S. Liu[2], G.P. Lou[2], M. Pyle[1], W-S. Wu[1], Y. Wu[2], and **G. DiMego[1]**

[1]NCEP/EMC, College Park, MD
[2]IMSG – NCEP/EMC, College Park, MD

A major upgrade to the NCEP North American Mesoscale Forecast System (NAM) was implemented on 21 March 2017. This upgrade targeted the greatest deficiencies in the previous NAM system, such as excessive precipitation from the high-resolution CONUS nest and risks of failure exposed by Hurricane Joaquin. The development and testing of the NAM upgrade targeted these deficiencies with following changes:

1) **Resolution changes:** CONUS Nest from 4 km to 3 km, Alaska nest from 6 km to 3 km, CONUS Fire-weather nest from 1.333 km to 1.5 km
2) **Forecast model changes:**
   - Updated microphysics : improved stratiform precipitation, better anvil reflectivity, lower peak reflectivity, reduce areas of light/noisy reflectivity, significantly reduce CONUS nest high precipitation bias in the warm season
   - "Stability" changes : more frequent calls to physics, update specific humidity every model time step, calculate cloud condensation every time step, mix out superadiabatic layers
   - Changes in parameterized convection for the 12 km parent domain to improve low QPF bias in cool season
   - Radiation and land-surface physics changes to reduce 2-m temperature warm bias in summer, reduce high 2-m dew point temperature bias in cool season, and visibility forecast in coastal regions
3) **Data Assimilation (DA) changes :**
   - Replace 12-h DA with 3-h analysis/forecast updates for the 12 km parent domain with a 6-h DA cycle with hourly analysis forecast updates for the 12 km parent, 3 km CONUS nest, and 3 km Alaska nest domains
   - Use of lightning and radar reflectivity-derived temperature tendencies in the diabatic digital filter initialization
   - Assimilate new satellite radiance and cloud drift wind data
4) **Other science changes**
   - Tropical cyclone relocation in the 12 km domain
   - Reinstate use if USAF 557th Weather Wing (formerly AFWA) snow depth analysis
   - Use of a fresh water lake temperature climatology for the CONUS, Alaska, and Fire Weather nests
   - Use NESDIS burned area data in the fire weather nest to adjust greenness fraction, albedo, and top layer soil moisture

The NAM changes led to greatly improved warm-season precipitation forecasts from the 3 km model simulations (Figure 1), improved predictions of low visibility conditions in coastal regions, improved cool-season precipitation forecasts from the 12 km simulation, improved short-term (0-12 h) simulation of convective storms in the 3 km simulation (Figure 2), and a reduction of the moist bias for CONUS cool-season surface dew point temperatures and a reduction of the warm bias for CONUS summer surface temperatures.

This is the last science upgrade to the NAM forecast system as the EMC mesoscale modeling/data assimilation team will focus their efforts on developing high-resolution forecast systems based on the FV3 dynamic core.

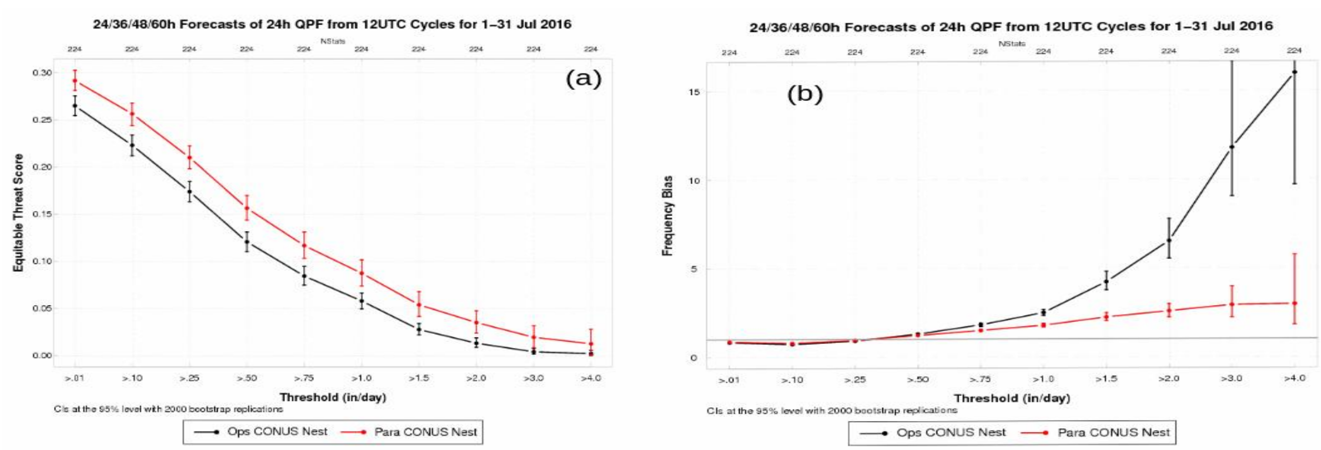

Figure 1: (a) CONUS 24-h forecast precipitation equitable threat score for all 1200 UTC runs of the operational 4 km CONUS nest (black) and the parallel 3 km NAMv4 CONUS nest (red) from 1-31 July 2016. (b) Same as (a) but for bias.

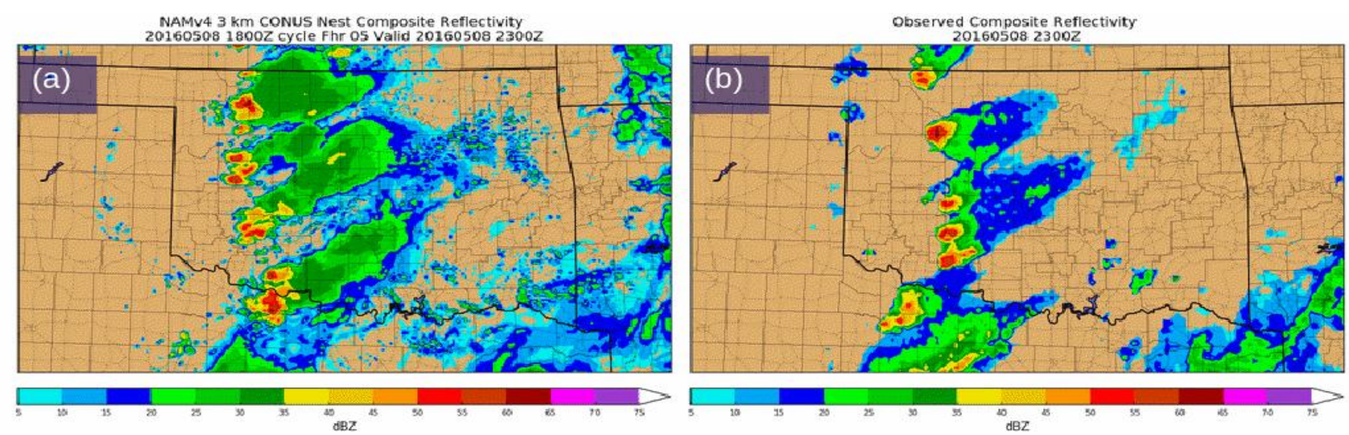

Figure 2: (a) 5-h forecast of composite reflectivity (dBZ) from the 1800 UTC 8 May 2016 run of the NAMv4 3 km CONUS nest valid at 2300 UTC 8 May 2016. (b) Observed composite reflectivity (dBZ) valid at 2300 UTC 8 May 2016.