Introduction
Simulated radar reflectivity and echo top are good indicators of detailed structure of convective clouds and precipitation forecast by mesoscale models, particularly as their resolutions have been increasing in recent years. Although these two products have been generated from NCEP's operational mesoscale models or systems for several years, their forecast performance has not been systematically evaluated nor compared. Recently we have dedicated much effort to do this work over CONUS. This paper summarizes the recent verifications of these two products using hourly 1 km National 88-D Radar Mosaic data as 'truth'. The evaluated mesoscale models include NAM, RUC and 4km-WRF (NMM, ARW of HiRes window), 32km-SREF (Short Range Ensemble Forecast System before and after its upgrade in 2009), and SREF in a downscaled 5 km form. The primary results based on short and long time period data are presented.

Objectives
- Current prediction performance for reflectivity (composite)
- Improvement in reflectivity (composite) and echo-top (height) ensemble prediction after new SREF implementation (Nov, 2009)
- Single SREF-NMM and ARW WRF controls (V2.0 = 2.2, same scheme but many improvements; Resolution: ARW 45 to 35km, NMM 40 to 32km)
- SREF-ensemble probability forecast
- Verification of SREF control models over hi-resolution WRF grid (4km) vs over coarse SREF-212 grid (32km)
- Downscaling SREF from 32km to 4km grid can improve skill?

Method
- Simulated radar reflectivity/echo-top in models (Ferrier)
  - Reflectivity Z = Grid scale Zvp + Convective Zvc (in mm6/m3)
    - Zvp ~ Do moment of assumed exponential droplet distributions of rain and ice (Rayleigh scattering)
    - Zvc ~ Zv0*100*Rfunc1.6 (original NEXRAD 890 ago), where Rfunc ~ Surface rain rate
- Ferrier's algorithm has been implemented in NCEP's WRF/Unified post processing package

Results
- Single models simulated reflectivity verified over hi-res (4km) grids
  - Aug 12, 2010 over eastern CONUS
  - Aug 12, 2010 over western CONUS
- Hi-res models have positive bias but better POD, low-res models have negative bias
- Lower reflectivity forecast has higher skill higher reflectivity forecast has lower skill
- Prediction for reflectivity > 40 dBZ has very small skill

SUMMARY
- Single model and ensemble simulated reflectivity and echo top forecasts from NCEP's NAM (12km), RUC (13km), SREF's base NMM (32km) and ARW (32km), hi-resolution WRF (4km) and ARW (4km), as well as before and after the new SREF implementation were verified against the national 88-D Radar MOSAIC grid (1km) data in limited time periods over CONUS. The results show that
  - Hi-resolution models have generally better detection and prediction skill than low resolution model, particularly for higher dBZ range, but this is in higher positive bias at a cost.
  - For all models, lower dBZ and lower echo-top ranges have higher prediction performance
  - For all models, prediction of simulated reflectivity is better than that of simulated echo-top
  - Coarse model reflectivity verified on fine grid has better score than on coarse grid
  - The performance of both reflectivity and echo-top from new implemented SREF is improved
  - For reflectivity > 40 dBZ, all models and ensemble system have no prediction skills

Reference