Stochastic Approaches Within a High Resolution Rapid Refresh Ensemble- Part I: Sensitivity Testing

Isidora Jankov (CIRA affiliated with NOAA/ESRL/GSD and DTC)
Judith Berner (NCAR)
Jeffrey Beck (CIRA affiliated with NOAA/ESRL/GSD and DTC)
Jamie Wolff (NCAR)
Michelle Harrold (NCAR)
Georg Grell (NOAA/ESRL/GSD)
Joseph Olson (CIRES affiliated with ESRL/NOAA/GSD)
Tatiana Smirnova (CIRES affiliated with ESRL/NOAA/GSD)
John Brown (NOAA/ESRL/GSD)
Stanley Benjamin (NOAA/ESRL/GSD)

A stochastic parameter perturbation (SPP) scheme consisting of spatially and temporally varying perturbations of uncertain parameters was implemented in the Grell-Freitas (GF) convective scheme, the Mellor-Yamada-Nakanishi-Niino (MYNN) planetary boundary scheme and RUC land surface model (LSM) scheme within the Rapid Refresh (RAP)/ High Resolution Rapid Refresh (HRRR) physics suite. Ongoing efforts to implement SPP into corresponding microphysics as well as radiation schemes are also underway. Previous tests performed using the Rapid Refresh (RAP) ensemble with 13-km grid spacing and stochastic perturbations within GF and MYNN schemes showed that alone stochastic parameter perturbations generate insufficient spread. However, when combined with other stochastic parameterization schemes, such as the stochastic kinetic-energy backscatter (SKEB) scheme or the stochastic perturbation of physics tendency scheme (SPPT), the stochastic ensemble system has comparable forecast performance to a multi-physics ensemble. The ensemble combining all three stochastic methods consistently produces the best spread/skill ratio and generally outperforms the multi-physics ensemble.

For this work, the impact of SPP alone, and in combination with SKEB and SPPT, was tested on a storm-scale HRRR-based ensemble system. The continental United States (CONUS) HRRR-based ensemble consisted of 8 members with stochastic perturbations applied. Within MYNN, SPP was applied to sub-grid cloud fraction, mixing length, roughness length, mass fluxes and Prandtl number. In the RUC LSM, SPP was applied to hydraulic conductivity. The primary focus for this evaluation was assessing the impact of stochastic perturbations on near-surface variables such as 2-m temperature, 2-m dew point, 10-m wind and precipitation. Results illustrating sensitivity of evaluated variables to changes in stochastic perturbations for experiments performed over shorter periods of times will be presented at the workshop. Related, Wolff et al. (Part II) will present an expanded evaluation for multiple, 10-day period retrospective runs.