Explicit electrification and lightning forecasts and cloud-scale lightning data assimilation in the WRF-ARW model.

Alexandre O. Fierro[1,2], Edward R. Mansell[2], Conrad L. Ziegler [2] and Donald R. MacGorman[2]

[1] Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma

[2] NOAA/OAR/National Severe Storms Laboratory, University of Oklahoma, Norman, Oklahoma

Abstract

This talk will be divided into two distinct parts, labeled as "I" and "II":

I) Lightning threats in present-day numerical weather prediction models are currently diagnosed from model variables such as graupel mixing ratio and ice water content that are known to be well correlated with the occurrence of lightning. To provide a more physically sound assessment of lightning threat, an explicit charging/discharge model (with explicit elliptic solution of the 3D component of the ambient electric field) has been successfully implemented into the NSSL two-moment microphysics scheme within the WRF-ARW model. Results from convection-allowing (3-km) simulations of a major hurricane, a winter storm and a severe continental mesoscale convective system will be presented.

II) To improve forecasts of convection, a new technique for assimilating total lightning data into the WRF-ARW model at cloud-resolving scales has been developed. Assimilated lightning data forces deep, moist precipitating convection to occur in the model using a nudging function for the total lightning data, which locally increases the water vapor mixing ratio and virtual buoyancy via a computationally inexpensive, smooth continuous function. The assimilation of gridded pseudo-GOES-R resolution (9 km) flash rate via EarthNetworks® total lightning data for only a few hours prior to the forecast initialization significantly improved the representation of the convection at the initial analysis time and at the 1-hour forecast within the convection-permitting (≤ 5 km) and-resolving (≤ 2 km) grids. This simple, computationally inexpensive assimilation technique has also been implemented into the real-time operational 4-km CONUS WRF/NSSL forecast testbed, promising results of which will be briefly reviewed. Furthermore, recent evaluation of this lightning assimilation algorithm against standard 3DVAR techniques will be succinctly presented.