7.10 DIAGNOSTIC EVALUATION AND VALIDATION OF MM5 SIMULATION OF A PRECIPITATION EVENT WITH NC ECO NET OBSERVATIONS

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We evaluate the performance of MM5 to simulate the boundary layer structure and mesoscale processes over a complex land-use, land cover region during summer over North Carolina. An investigative study of the effect of mesoscale processes on the boundary layer structure has profound importance in the understanding of circulation patterns and regional scale predictability. North Carolina has significant geographical variability providing a wide variety of weather events and climatological regimes. There are many challenges for numerical modeling due to heterogeneity in land use and soil type, presence of the ocean and the Gulf Stream, occurrences of weather anomalies such as hurricanes, droughts, winter weather storms, and mesoscale weather events with intense convection. These heterogeneous attributes and complex topography features an excellent location for simulations and validation of the MM5 numerical modeling system. MM5 is utilized for a convective case including precipitation with a 5-km domain centered over the Carolinas. Model integration is for 72 hours from 0000Z August 1, 2000 to 0000Z August 4, 2000. The focus of evaluation is comparing the precipitation distributions across the Carolinas. Comparison between explicit physics only and the Kain-Fritsch cumulus parameterization in conjunction with the explicit physics is addressed. Observed precipitation amounts are used to validate the simulated patterns and amounts. In addition to evaluation of precipitation patterns, simulated hourly surface and sub-surface values are also evaluated against in-situ surface observations.

The acquisition and combination of different agro-meteorological data across NC and SC provides high-resolution observations used for validation at multiple model grid points. For this study, these data incorporate observation sites throughout North Carolina including 19 ASOS (Automated Surface Observing Sites / owned and operated by the NWS and FAA) sites and 15 ECONet (Environmental and Climate Observing Network maintained by State Climate Office of North Carolina) sites. Multiple parameters compared and investigated using this network of observations include: ECONet: Air Temperature (2m), Relative Humidity (2m), Wind Speed (10m), Wind Direction (10m), Soil Temperature (10 cm), Soil Moisture (10cm), Hourly Precipitation rate; ASOS: Air Temperature (2m), Dewpoint (2m), Wind Speed (10m), Wind Direction (10m), Hourly Precipitation, Weather Conditions, and Cloud Layers.

Following a graphical comparison precipitation amounts and patterns, statistical methods are applied to other 2D and 3D fields to provide quantitative relationships for errors and biases in the simulations. This analysis gives additional insight into model performance. This is especially important when validating complex and comprehensive interactions and processes that occur in North Carolina. Statistical measures used include: absolute correlation, root mean square error (RMSE), bias, and the index of agreement.

During the simulation, explicit physics alone underpredict the magnitude and distribution of the precipitation. Precipitation distributions are better simulated by the addition of Kain-Fritsch with explicit physics. In general, diurnal variation is handled well by the model indicating that the thermodynamic structure of the atmosphere is well simulated. Nocturnal boundary layer processes are poorly simulated and heterogeneous surface features have significant effects on regional scale processes. Model performance degrades over regions with complex terrain signifying that more observations are needed for data assimilation and better predictability of convective rainfall.

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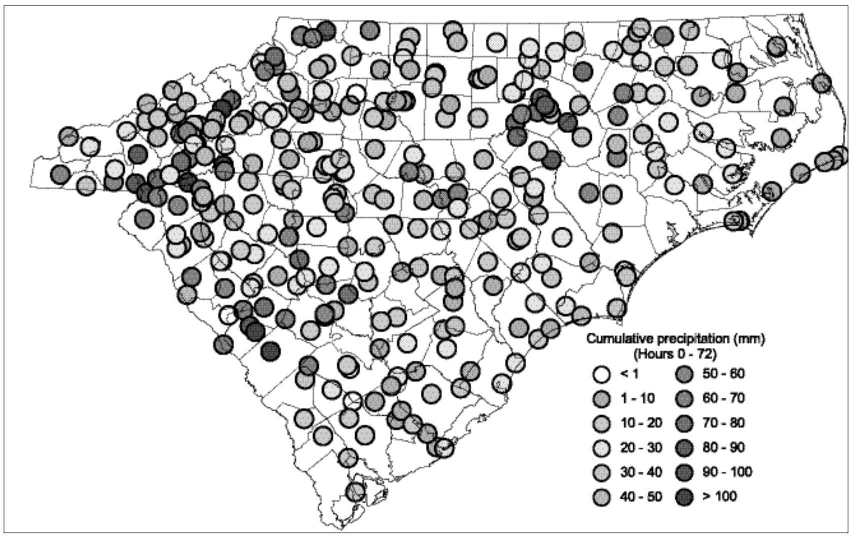
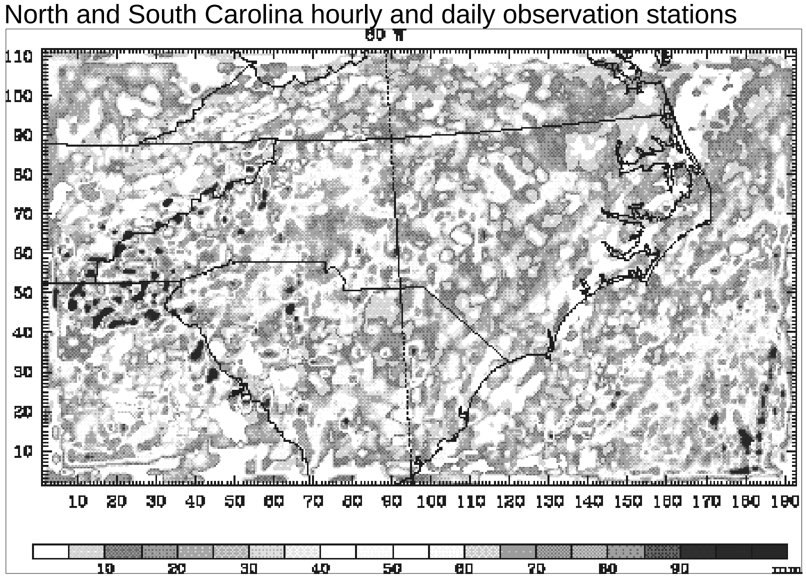
Hourly surface observation stations across North Carolina. Triangle markers indicate ASOS stations. Circle markers indicate AgNet stations. The square marker indicates the location of the SODAR station



Cumulative observed precipitation amounts for the 24-hour period from 0000Z August 3, 2000 to 0000Z August 4, 2000 for North and South Carolina hourly and daily observation stations



Cumulative simulated precipitation amounts for the 5 km domain for the 72-hour period from 0000Z August 1, 2000 to 0000Z August 4, 2000 using the Kain-Fritsch cumulus parameterization scheme in conjunction with Dudhia's explicit cloud physics.