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Examining the Sensitivity of MM5-CMAQ Predictions to Explicit Microphysics Schemes and Horizontal Grid Resolutions, Part I—Database, Evaluation Protocol, and Precipitation Predictions

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APPENDIX I
Meteorological Characteristics in August and December 2002

The meteorological conditions of the three week-long segments in August (i.e., August 6-13, 13-20, and 20-27) and four week-long segments in December (i.e., December 3-10, 10-17, 17-24, and 24-31) corresponding to the NADP weekly sampling periods are analyzed to contrast the differences in precipitation forcing mechanisms in the two months.

Little to no precipitation occur throughout NC during August 6-13. During the first portion of the week a cold front moved through NC as a low pressure system moved offshore and cool/dry continental high pressure built into the region. The remaining days experienced only scattered clouds in the western and central portions of NC and no passage of any major weather system. Instead, the continental high pressure system dominated the weather of week one. The week of August 13-20 began with cloudy conditions, but little precipitation. By the 15th, precipitation associated with afternoon convection developed in central and eastern NC. During this period, weather conditions were dominated by a Bermuda high pressure system with warm moist conditions present throughout the domain. These conditions supported the development of afternoon convection during most of week two. The week of August 20-27 began with scattered precipitation throughout the domain with a cold front positioned to the northwest of NC in the Great Lakes region. By the 21st, the scattered precipitation had ended and another continental high pressure built over the region. This weather pattern continued until late on the 25th when the front moved into NC, bringing clouds and precipitation. This cold front was stronger than the previous one and brought more intense rainfall. Therefore, dry conditions dominated during August 6-13, with typical warm, moist conditions supporting afternoon convection during August 13-20, and a stronger frontal passage during August 20-27, which brought the heaviest weekly rainfall totals among the three weeks. Throughout the domain and especially in eastern NC, localized afternoon convection dominated in August, which is typical of summertime precipitation events in this region.

The week of December 3-10 began with clear conditions and no precipitation throughout NC. However by the 4th, a cold front moved over the state bringing heavy cloud cover and widespread precipitation. These clouds and rainy conditions were associated with a cold air damming event (Bell and Bosart, 1988) that continued through the 6th. During the last days of the week, cloud cover was reduced and no precipitation was observed throughout the state. At the beginning of the week of December 10-17, heavy cloud cover and widespread precipitation were found throughout NC. During December 11-13 a coastal front (Bosart, 1975; Bell and Bosart, 1989; Appel et al., 2005) formed off the NC coast and moved inland and stalled bringing associated clouds and precipitation to central and eastern portions of the state. Conditions became clear on the 14th and remained cloud and precipitation free until a cold front passed late on the 16th, bringing spotty areas of clouds throughout the state. The week of December 17-24 began with spotty clouds and precipitation in central NC. More organized patterns were observed late on the 19th associated with the passage of a cold front. This system moved out of the state by the 21st leaving clear conditions with only light cloud cover in the western region returning on the 23rd. During the last week (December 24-31), light bands of clouds and precipitation oriented west-to-east existed during the first 3 days of the week. However, during the 27th-29th, conditions remained clear and dry. During the last two days a weak cold front moved down into NC and stalled, but the system brought only cloudy conditions with no associated precipitation. Compared with August, the December events show more organized, synoptic forcing with west to east movement through the domain and the highest precipitation amounts in the mountain region.

APPENDIX II

Observational Data Preprocessing for Model Evaluation

Because of different sampling time resolutions across observational networks, it is necessary to standardize time periods in statistical and spatial evaluations to minimize uncertainties and inconsistencies caused by different time resolutions. Monthly-average hourly values of precipitation and wet deposition are therefore calculated to create temporal consistency between ASOS/AWOS and NADP networks. Statistical evaluation is also based on monthly-average hourly precipitation and wet deposition values. The PM concentration evaluation is based on weekly- and daily-averages because there are only a few sites in each network and a monthly-average comparison of a few sites would reduce the overall significance of the statistical calculations. Spatial evaluations of all parameters are based on monthly averages, which allow a comparison of spatial trends for the entire month over the domain and a clear contrast between August and December. Temporal evaluations are based on the weekly and daily values, allowing for a close examination of discrepancies between the actual measured and modeled values. This approach also allows a more consistent evaluation across networks and at different time scales at each site of interest.

In addition to different sampling scales across networks, the locations of the particular sites within each network lead to an additional study limitation. While observations of parameters are available from numerous sites throughout the domain, the availability of co-located meteorological and chemical data is limited to only a few sites. Because the main objective is to examine the impacts of meteorological predictions on wet deposition and PM species concentration, co-located data would allow for a more consistent intercomparison of parameters. To address this problem in site-specific comparisons, the sites from the NADP network are matched to the nearest site from all other observational networks, wherever appropriate. Table A.1 shows the results of the site matching along with the distance between the matched sites. This site-matching and temporal-averaging methods allow for a cross-comparison across networks and time scales and may more or less provide qualitative (if not semi-quantitative or quantitative) linkages among different parameters. In addition, these methods may help identify critical data needs, such as similar timing and co-location of meteorological and chemical datasets that would allow for a more rigorous model evaluation.

Table A-1. Matching of NADP sites to the nearest site from all other observational networks.

NADP Site	ASOS Site	CASTNET Site	IMPROVE Site	STN Site
KY22	None	None	None	STN2 (34)
NC03	KRZZ (54)[1]	None	None	None
NC06	KEWN (43)	BFT (0)	SWAN (74)	None
NC25	None	COW (0)	None	STN13 (72)
NC29	KILM (86)	None	None	STN9 (49)
NC34	KCTL (62)	None	None	STN5 (65)
NC35	KFAY (54)	None	None	STN6 (57)
NC36	KMEB (22)	CND (42)	None	None
NC41	KRDU (22)	None	None	STN11 (18)
NC45	KAVL (51)	PNF (51)	SHRO (57)	STN3 (12)
TN00	None	None	None	STN14 (42)
TN04	None	SPD (0)	None	None
TN11	None	GRS (29)	GRSM (29)	None
VA13	None	VPI (0)	None	STN17 (56)

[1] The value in parentheses is the approximate distance (in km) between each site and its paired NADP site.