A comparison of Air Quality Simulation using MM5 and WRF for 2004 Summer High Ozone Episode in KOREA

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1. INTRODUCTION

The meteorology data is the one of the essential input data for air quality simulation and play an important role to simulate accurate dispersion and diffusion. The objective of this study is to evaluate the CMAQ results using MM5 and WRF. The WRF is the state-of-the-art system and it is useful to evaluate the WRF performance as an input of air quality modeling. The simulation period is June 2004, high ozone episode in Korea. The WRF version 3.0 and MM5 version 3.6.1 were used both with observation nudging in this study. In order to make a fair comparison, both MM5 and WRF use the same grid configuration (27km/9km), same initial and boundary condition and similar physics. In order to evaluate the result of air quality, the CMAQ version 4.5 was used with MCIP and SMOKE. We have used Korea Emission inventory which is CAPSS (Clean Air Policy Support System) to generate emission data in this study.

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2. MODEL CONFIGURATIONS

Both MM5 and WRF are simulated during 29 May - 20 June, 2004 period and the one-way nested simulations with the 43 vertical levels in the atmosphere for the 27km, 9km, and 3km resolution domains centered for Seoul Metropolitan area was made. The nested domain was setup with 109 X 109, 82 X 82, and 70 X 70 for the resolution of 27km, 9km, and 3km, respectively. The initial field was selected NCEP/NCAR CDAS reanalysis data that is prepared by 6 hourly data for time resolution and 2 X 2.5 degrees data for the horizontal resolution. The CMAQ 4.5 simulation was performed both with MM5 and WRF

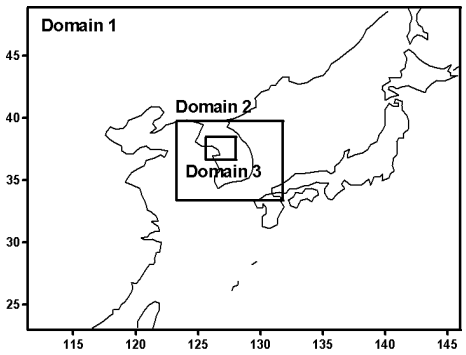


Figure 1. Modeling domain defined in MM5 and WRF

3. Result

Figure 2 shows the WRF and MM5 simulated and observed vertical profiles of zonal and

meridional wind for Osan station as the results of 3km resolution. Both WRF and MM5 were conducted observation nudging and 1 second(~30m) resolution landuse data and 3 second(~90m) resolution topography elevation data were used over a 3km resolution domain. As shown in Figure 2, the results of WRF have better relation compare to observation than that of MM5. Figure 3 shows the WRF and MM5 simulated and observed vertical profiles of temperature, wind speed and zonal and meridional wind. When we compare the simulated values to observed values for temperature, wind speed includes zonal and meridional values and wind direction, respectively, the WRF results shows good correlation for most cases.

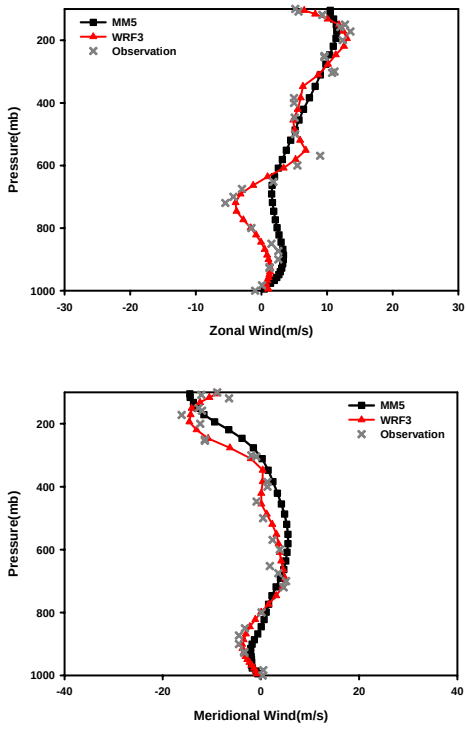


Figure 2. The vertical profile of zonal wind (upper) and meridional wind (lower) for observation (x), MM5 (black with squares) and WRF (red with triangles).

Table 1 represents the results of statistical analysis for WRF and MM5 results and observation values for U, V, wind speed and temperature during the period of June 1st ~ 10th, 2004. 71 AWS (Automatic Weather System) sites throughout the Seoul metropolitan area were used in the statistical analysis.

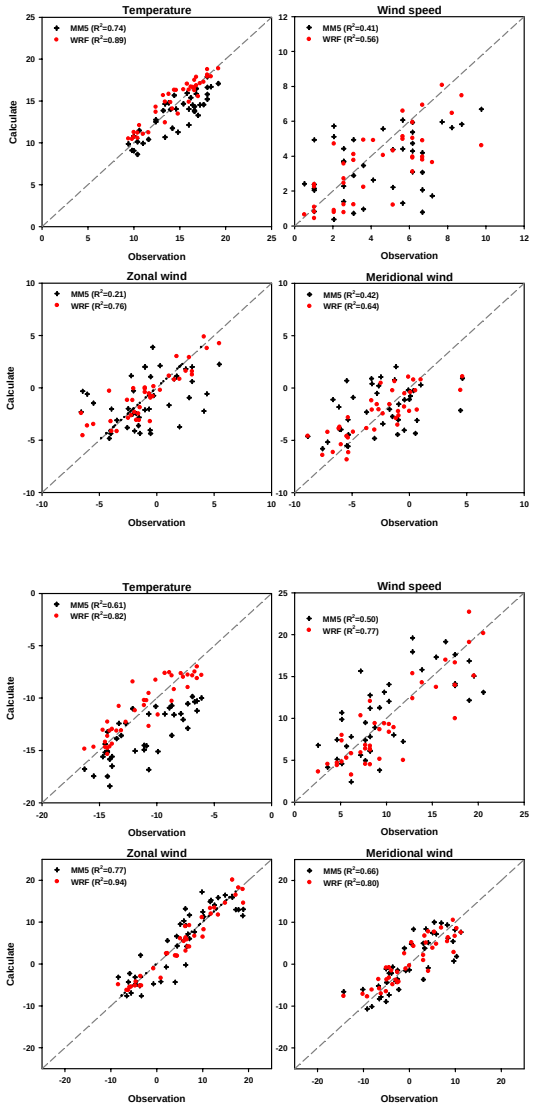


Figure 3. WRF and MM5 simulated wind anf temperature statistics at 850mb (upper) and

500mb (lower) during June 1st ~ 10th, 2004 on Osan station.

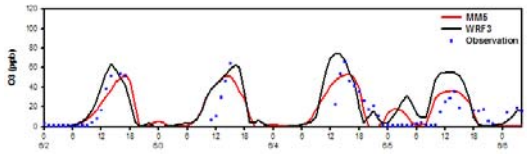
		U	V	WS	Temp.
WRF	**RMSD**	1.43	1.11	1.42	2.39
	IOA	0.66	0.61	0.55	0.94

		U	V	WS	Temp.
MM5	**RMSD**	1.53	1.27	1.27	2.17
	IOA	0.64	0.55	0.60	0.94

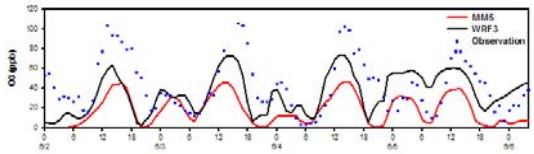
Table 1. Comparison of WRF and MM5 results to observation for temperature and wind component during June 1st ~ 10th, 2004 over 71 AWS sites throughout the Seoul metropolitan area.

Figure 4 represents the diurnal variation of CMAQ results for ozone during June 2nd ~ 6th, 2004 at three sites throughout the Seoul metropolitan area. We have used SMOKE emission processing systems and CB4 chemical mechanism with EBI (Euler Backward Iterative) solver in CMAQ simulations. The CMAQ/WRF results shows the better performance during daytime high ozone rather CMAQ/MM5 results. However we have not done the enough quality control studies for emissions in this study, so we can not simply jump to conclusion. We could just see the differences between CMAQ/WRF and CMAQ/MM5 results.

a) Jeong-Dong



b) Bulgwang-Dong



b) Whagok-Dong

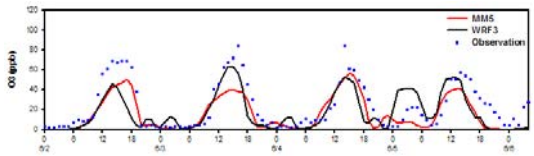


Figure 4. Time series of hourly ozone concentration (3km) for observation (dot), CMAQ/MM5 (red) and CMAQ /WRF (black).

4. Summary

In this study we have conducted MM5 and WRF simulation to prepare the better meteorological inputs for an air quality modeling. The WRF results show better relationship than MM5 results compare to the horizontal and vertical observation data for wind component and temperature. The CMAQ/WRF shows higher ozone concentration than CMAQ/MM5 during daytime. However the peak ozone concentration was not simulated for both CMAQ/WRF and CMAQ/MM5. The quality control and quality assurance studies for emissions and meteorology will be needed in the next step.

5. References

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