13.6 AN OPERATIONAL VERSION OF MM5-CMAQ MODELLING SYSTEM OVER MADRID CITY

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1. INTRODUCTION

The third generation of air pollution modeling system is represented by the MM5-CMAQ Community Multiscale Modelling System / Models-3 from EPA (U.S.). There are a few other systems which also have been run by our laboratory such as CMAx (ENVIRON Co.) and EURAD (MADE) (Ford Research Group and University of Cologne (Germany).

Our objective in the present contribution is to build an air quality modeling system which can be applied in operational mode over cities. The CMAQ modeling has been tested up to 3 km spatial resolution. In this contribution we have downscale until 1 km to be functional for urban scales. Former application of our OPANA modeling system (over Madrid (Spain), Bilbao (Spain), Leicester (U.K.) and Quito (Ecuador)) have used in the past years the OPANA modeling system (representative of the second generation of air pollution modeling systems). In both cases (MM5-CMAQ and OPANA) the Eulerian approach is used. MM5-CMAQ is a very robust system which includes several functionalities derived by the fully modular construction.

2. OPERATIONAL ARCHITECTURE

Different computer platforms have tested: COMPAQ, XP100-UNIX and PC-LINUX Red Hat 7.2 Both platforms are operational but in this contribution we will shown the platforms and structure shown in Figure 1. The MM5 is running over a PC-LINUX-II-400Mhz operationally over 81 and 27 spatial resolutions (mother and nexting level 1) (see poster 1.5). The CMAQ model is run over a reduced domain based on the MM5 domain with 81 and 27 spatial resolution. Two PC-LINUX (one Pentium 1,7 Ghz and AMD 1,3 Mhz, 1GbSRAM) are used to run the MM5 and CMAQ for 9, 3 and 1 km spatial resolution. The 9 km MM5 spatial resolution model domain has 54 x 54 km, the 3 km MM5 spatial resolution model domain has 33 x 39 km and finally the 1 km MM5 spatial resolution model domain has 30 x 30 km.

The corresponding CMAQ model domains are: 48 x 48 km, reference (-216000, -216000) in Lambert Conformal projection with 9 km spatial resolution; 27 x 33 km, reference (-54000, -9000) with 3 km spatial resolution and finally, 24 x 24 km, reference (-27000, 33000) with 1 km spatial resolution. The system uses the EMIMO and EMIMA models (San José et al. (1998)), both are bottom-up and top-down emission inventory approach by using DCW (Digital Chart of the World), GEIA, EMEP and EDGAR global emission inventories. Both model are running automatically and creating the corresponding emission data files with 1 hour temporal resolution for each CMAQ model domain. Figure 2 shows the landuse surface pattern for 1 km resolution as obtained from USGS NOAA/AVHRR land use classification.

The system takes 48 CPU hours running over 4 different computer platforms (1 COMPAQ-UNIX and 3 PC-LINUX). This architecture is capable to provide 48-72 hours forecasting data for a urban domain of 24 x 24 km (1 km spatial resolution). In this case the zooming has been done over the Madrid Municipal domain. A similar domain was built in the past for running OPANA over a regional domain similar to CMAQ 3 km spatial resolution nesting model domain and a nesting level 1 for OPANA over Madrid Municipal area.

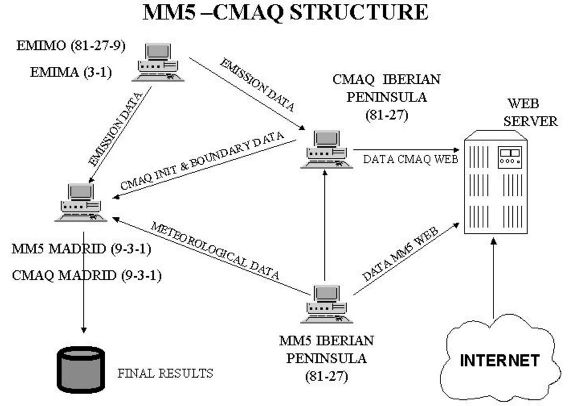

Figure 1.- MM5-CMAQ urban operational version.

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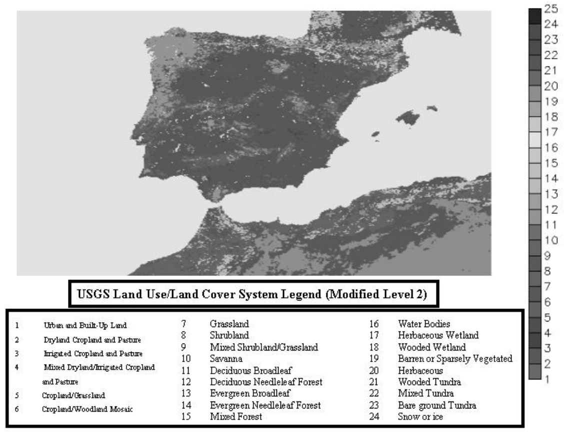

Figure 2.- Landuse USGS types.

2. RESULTS

The 1 km spatial resolution is the nesting level 4 in this experiment. The results of the simulated air quality concentrations have been tested against observational data. The Madrid Municipality Air Quality Network has 25 monitoring stations as shown in Figure 3.

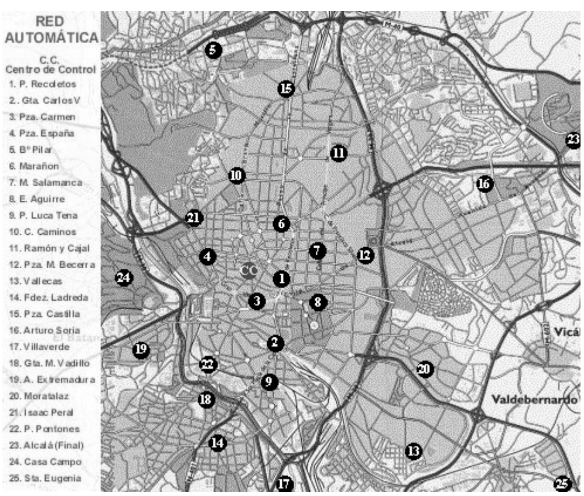

Figure 3.- Madrid Municipality air quality monitoring network

In general terms the results are in agreement with author authors and experiences (Eder B.K. et al. (2001)). We have studied one period for this contribution, February, 4-8, 2002 (Monday – Friday). This is a typical winter period in Madrid. The regression coefficient ® for O3 is found between 0,4 and 0,6. Figure 4 shows the regression analysis for station 24 (Casa de Campo, which is located in the center or a large city park) and Figure 5 shows the observed vs. simulated values for that monitoring station. Poorer values are obtained for NO2 (0,2-0,3) and CO (0,4-0,2). Improved emission inventory is a natural consequence of this analysis since this monitoring station is relatively far away of local traffic emissions and the results are better than at other monitoring stations.

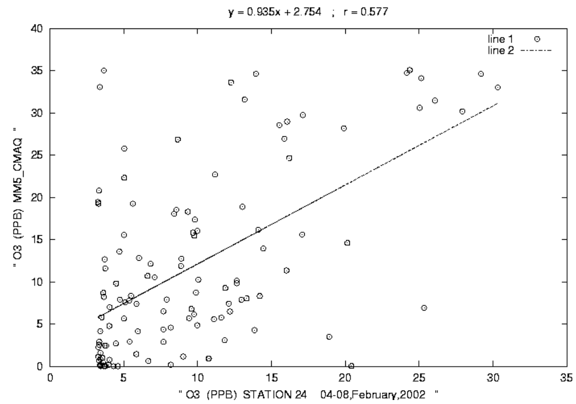

Figure 4.- Regression analysis for O3 simulated (MM5-CMAQ) and observed values at Casa de Campo Madrid Monitoring station.

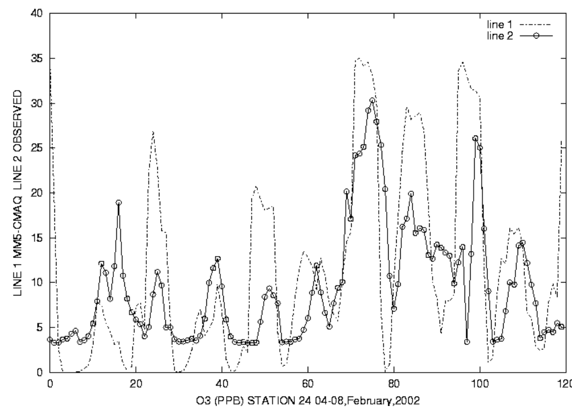

Figure 5.- Observed and simulated (MM5-CMAQ) O3 values for Casa de Campo Madrid Monitoring station.

The ozone concentrations are any way quite small so the results for this period of the year can be considered good. Many data is around 0-5 ppb. Further analysis and more simulations are required to investigate how to improve the results but a considerable improvement of emission inventories seems to be a key factor to improve the results.

4. REFERENCES

Eder B.K., Mebust M.R. and LeDuc S.K. (2001) A preliminary evaluation of MODELS-3 CMAQ. Using particulate matter from IMPROVE Network.

San José R., Cortés J., Prieto J.F and González R.M. (1998) Accurate ozone prognostic patterns for Madrid area by using a high spatial and temporal Eulerian photochemical model. Environmental Monitoring and Assessment, Vol. 52, pp. 203-212 (1998) Ed: Kluwer Academic Publishers. (ISSN: 0167-6369; ISBN: 0-7923-5127-4).