The MM5-CMAQ Operational Air Quality Modelling System: Application over the Iberian Peninsula

A contribution to subproject GLOREAM

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Summary

The MM5 (PSU/NCAR) mesoscale meteorological model and the CMAQ (US/EPA) Community Air Quality Transport Modelling System has been implemented in the COMPAQ/XP1000-UNIX workstation and the PC-II/400-LINUX machines to run in operational mode to provide Air Quality Forecasts for the Iberian Peninsula through the Internet. The system runs every 48 hours (due to the computer power limitations) and simulates five days over two domains: 2916 x 2916 km for MM5 mother domain and 1863 x 1782 km for MM5 nesting level 1 domain; 2430 x 2430 km for CMAQ mother domain and 1701 x 1620 km for CMAQ nesting level 1 domain. In all cases with 23 vertical levels either for MM5 or CMAQ. The MM5 model runs with the two way nesting option and CMAQ uses the MEBI (Modified Euler Backward Iterative) solver for the Carbon Bond Mechanism (CBM-IV) with aqueous chemistry evolved from the RADM model (Chang et al., 1987) and the aerosol production mechanism due to Kulmala et al. (1998). The user is having access to output of several pollutant in different formats such as surface patterns or pollution time series once the user has selected the location in the Iberian Peninsula map. The system allows an easy and quick access to the output of the MM5-CMAQ modelling system through the Internet.

Introduction

The third generation of air quality transport mesoscale modelling systems represented by the MM5-CMAQ includes features based on the aerosol and cloud chemistry processes which were not parameterised in the so-called second generation of air quality mesoscale modelling systems (OPANA) (San José et al. (1999)). The increase on computer power and the extensive use of Internet allow us to move to advanced complex mesoscale meteorological and air quality systems in operational mode. The importance of medium and long range transport of pollutants on the air pollution concentrations at city or regional level has been apparent in the different scientific exercises of air quality mesoscale transport models. In order to increase the accurate of the results larger domains should be simulated in order to capture all the features along reasonable simulation times (5- 7 days). Obviously in order to simulate this complex system in real-time we should require a considerable increase on computer memory, speed and store capability.

In this contribution we have implemented and operational real-time version of MM5-CMAQ mesoscale transport modelling system into a dual computer platform PC based. We have used MM5v3 (The Fifth-Generation NCAR / Penn State Mesoscale Model (MM5)) to provide mesoscale meteorological fields to CMAQ (U.S./EPA Community Multiscale Air Quality Modelling System). The system is running to provide results every 48 hours in the Internet.

The Internet user can access to results in a friendly and quick mode by using the Internet interface we have built for this purpose.

Objectives

The main objective of this work is to upgrade the use of Air Quality Mesoscale Transport Models to the Third Generation in Operational mode. Due to the complexity of these systems and the difficulties to be use by environmental authorities in operational mode we have built an Internet interface to allow the user to have access to all the output data under daily basis. We have used the MM5-CMAQ modelling system to simulate two domains (mother and nesting level one) which contain the Iberian Peninsula in order to provide air quality forecasts through the Internet in operational mode and to allow the Internet user to generate theis own air pollution time series for any specific geographic location at any time. In addition the user can have access to surface pollution patterns over the Iberian Peninsula with some geographic attributes (Geographic Information System). The user can zoom over the Iberian Peninsula map and obtain any domain with the raster (pollutant) attributes and print or simply visualise the surface pollution maps.

Activities

We have used the MM5 mesoscale meteorological model (The Fifth-Generation NCAR / Penn State Mesoscale Model (MM5)) and the CMAQ (EPA Models-3 Community Multiscale Air Quality Modelling System) for performing the simulations. We have used the COMPAQ/XP1000-UNIX workstation and a PC-LINUX-Pentium-II-400Mhz in a combined way to perform the simulations (PC-AMD 1,3 Ghz produces a similar performance than the COMPAQ/XP1000 workstation). The system runs in operational mode producing simulations for 120 hours every 48 hours in a way that the Internet user can have access to forecasting air pollution data over the Iberian Peninsula every day. The script incorporates and automatic JAVA programme to obtain the MRF initial meteorological data from the NCAR / MRF web site.

Results

In Figure 1 we see a scheme of the computer network which is used to provide in real-time the MM5-CMAQ results through the Internet.
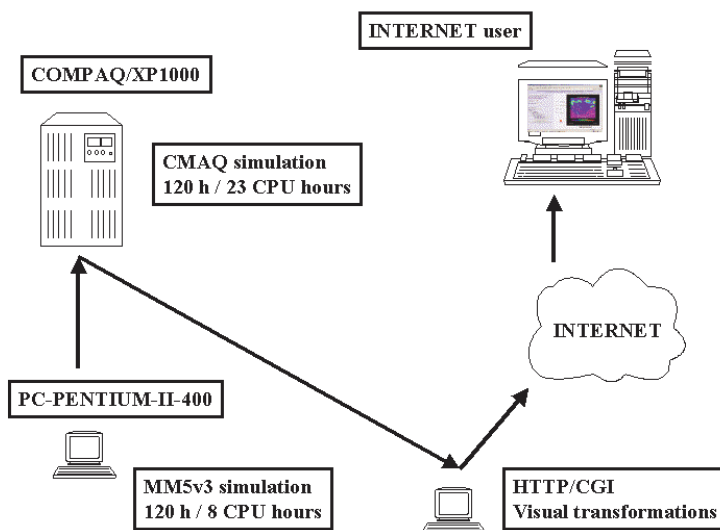

Figure 1. MM5-CMAQ operational INTERNET system scheme.

In Figure 2 we show an example of the surface NO2 pattern at 18h00 GMT on January, 5, 2002 as seen by the Internet user in operational mode. The user can also select an "air pollution time series" section and clicking on the map on the desired location we can show the pollutant time series for the desired period of time at the selected geographic location.
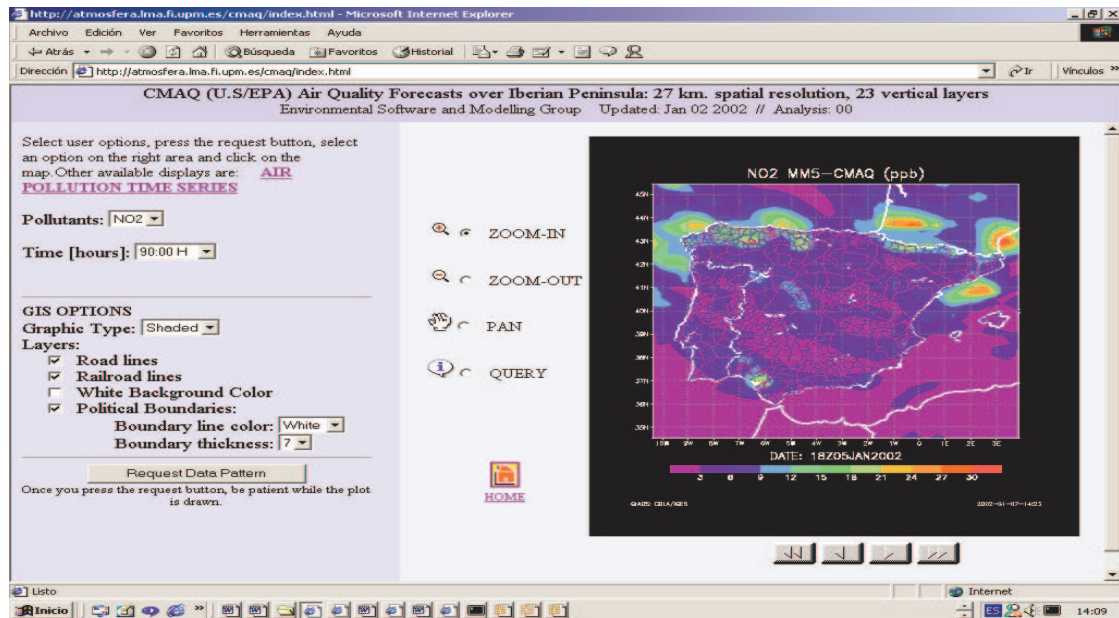

Figure 2. NO2 surface patterns for Iberian Peninsula domain in operational mode for January, 5, 2002 at 18h00 GMT.

Conclusions

The importance of providing air quality forecasts by using third generation mesoscale meteorological and air quality transport models (MM5-CMAQ) through the Internet is out of question since the environmental authorities (and the citizen) can make use of the information on real-time with the technical and scientific support of the research groups which can handle the complexities of such a models leaving the user (authorities and citizen) to focus on the information itself in an easy and friendly way. The Internet interfaces allow an easy and quick access to the results at any geographical location and any time of the simulation period. The software script allows and automatic procedure to provide Internet operational air quality forecasts from MM5-CMAQ air quality modelling system.

Acknowledgements

References

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