Preface: Special Issue of Atmospheric Environment for AQMEII

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In December 2008, a handful of European and North American scientists got together to discuss a possible collaboration on the evaluation of regional-scale air quality models. Thus, the Air Quality Model Evaluation International Initiative (AQMEII) was started with the support of the European Commission Joint Research Centre, US-EPA, and Environment Canada. AQMEII's main goals are:

- exchanging expert knowledge in regional air quality modelling,
- identifying knowledge gaps in air quality science,
- developing innovative methods for evaluating the uncertainty in air quality modelling
- building a common strategy on model development and future research priorities,
- establishing methodologies for model evaluation to increase knowledge on processes and to support the use of models for policy development
- preparing coordinated research projects and inter-comparison exercises.

While the model evaluation framework was developed already in 2007 during a workshop organised by US-EPA (Dennis *et al.*, 2010), in a follow-up meeting organised by the EC-Joint Research Centre, known as the Stresa workshop in 2009 (Galmarini *et al.*, 2010), the need for a comprehensive model evaluation activity was identified.

The two-continent model evaluation exercise (Rao *et al.*, 2011) was set up and the results are summarised in this issue of Atmospheric Environment. The idea was to put at work the four model evaluation modes identified by Dennis et al. (2010), namely, operational, diagnostic, dynamic and probabilistic evaluation. The aim of this exercise was to collect almost all regional-scale air quality models used for research and policy support in Europe and North America (NA) from public and private sectors and have them to simulate the air quality over North America and Europe for the year 2006. In the 15 month that followed the Stresa meeting, the two modelling communities where fully engaged and model results collected. Table 1 summarizes the groups that actively took part in this project and submitting their model results. The coordination of the NA activities was led by US-EPA while the EU ones by the Joint Research Center. A preparatory phase was set up to gather all necessary information needed by the modelling groups, namely, model input data. Toward this purpose, US-EPA and TNO (NL) prepared emission inventory for 2006 for NA and Europe respectively; Laboratoire des Sciences du Climat et de l'Environnement, IPSL (France) and USA-EPA prepared the 2006 European and NA meteorology respectively; JRC/IES, Environment Canada, and US-EPA collected compiled and harmonized, monitoring data for the two continents; ECMWF/Meteo France provided the boundary conditions for the modelling domains in the two continents.

Table 1. Participants to the AQMEII two-continent model valuation activity

A large number of research and operational monitoring networks in the two continents provided a massive amount of experimental evidence for. This includes 2006 for the two continents one year of continuous monitoring for almost 4000 stations for 6 gas phase species (O3, CO, SO2, HNO3 and NO2), 2700 stations of PMs, 4300 meteorology at surface monitoring points, 1300 meteorological profiles at 30 locations, 800 ozone profiles, and 2000+ aircraft profiles from MOZAIC. The large variety of sources of information led to a massive effort in data harmonisation and screening. All data were transferred to the JRC-ENSEMBLE system where model data were also collected as explained later.

A total number of 22 models took part to the simulation for the two continents and delivered results listed in Table2. None of the modelling groups had access to the full set of observational data.

3D fields Hourly resolution (averages for gas/aerosols; instantaneous for meteorology)	Gas phase • O3, SO2, NO, NO2, N2O5, PAN, HNO3, NH3, CO, VOC, HCHO, Isoprene, Toluene, Ethene, OH, HO2, H2O2, NOx(=NO+NO2), NOz(≈PAN+HNO3+N2O5), NOy=NOx+NOz Aerosol • PM2.5, PM10 mass • PM components: $PM_{2.5}$-SO_4, $PM_{2.5}$-NO_3, $PM_{2.5}$-NH_4, $PM_{2.5}$-EC, $PM_{2.5}$-POC, $PM_{2.5}$-TOC, $PM_{2.5}$-Crustal, $PM_{2.5}$-Sea_salt, $PM_{2.5}$-Inorganic_Total, p-SO_4, p-NO_3, p-NH_4 Meteorology • T, T_d, P, u , v , RH
2D fields Hourly resolution (averages for gas/aerosols; instantaneous for meteorology)	Other variables • Aerosol Optical Depth (AOD; vertical column) • Total column NO2 for comparison to satellite measurements • <u>Wet Deposition:</u> HSO_3^-, $SO_4^=$, NO_3^-, NH_4^+ • <u>Dry deposition:</u> SO_2, NO_2, HNO_3, NH_3, PAN, O_3, H_2O_2, HCHO, p-SO_4, p-NO_3, p-NH_4, p-TC, p-CM, p-SS, $PM_{2.5}$ Meteorology Liquid precip, PBL height, SW radiation at ground, cloud cover, soil moisture, snow depth

Table 2. Data requested to modelling groups

Given the scale of this exercise and the number of participating models, this *Atmospheric Environment* special issue as been organised as follows. The first four papers will concentrate in setting-up the case study by presenting the model input information used by the modelers in a comparative way between NA and Europe. The papers on emissions (Pierce et al.), meteorology (Vautard et al.), boundary conditions (Schere et al.), monitoring data (Eder et al.) present the quality of the data and relevancy to both continents . The last three papers concentrate more on the operational and diagnostic evaluations of the models. In those papers, the motivation for the selection of 2006 as case study will also be included. Galmarini et al. will describe in what way the information collected (modelling and monitoring) was centrally managed through the JRC-ENSEMBLE system and what other tools such as US-EPA AMET, have been an important aid in model evaluation in AQMEII and the way in which it was adapted for the two-continent exercise. In the paper, the importance of centralizing data gathering, compilation and harmonization in a web facility that guarantees accessibility to the information in numerical and graphical forms to all participations in support to model development and evaluation is stressed. Solazzo et al. (a and b) present the collective analysis and evaluation of all model results for the two most relevant pollutants, namely, Ozone and PM. While the ozone analysis concentrates on ensemble investigation (probabilistic evaluation), the PM is analysed from the episode and operational evaluation view point. The rest of the papers are individual contributions of the modelling groups that have analysed diagnostically the model performances. With respect to the model evaluation framework (Dennis et al., 2010), the research described in this issue covers very extensively operational, diagnostic and probabilistic model evaluation.

The contribution presented in this issue is just a drop in the ocean of what can still be learned from air quality model evaluation activities and monitoring data analysis. The huge effort made in gathering monitoring data from all data providers (listed in the acknowledgment hereafter), will remain, together with the model results produced to simulate them. As noted by Galmarini and Rao (2011), this information is made available to the science community for future research and will still be used by the present consortium. The collection of all available information is equivalent to the performance of two continental scale air quality experiments. Other information available for 2006 and not considered in this activity can still be included to complete the picture and provide an even deepeer set of data to the modelling community.

Model evaluation still remains the central point of any activity, namely, integrated assessment that considers model simulations as starting point of analysis past, current or future scenario. AQMEII in terms of initiative, enthusiastic participation, and massive effort has demonstrated among other things that a large amount of existing information is out there and can be used in a very effective way with the help of technology to improve science in the model . We need to summarize lessons learned before we introduce Phase 2 activity and its importantance.

While model evaluation research activities will continue beyond this phase, AQMEII will move to another important aspect of regional scale air quality modelling. A new model evaluation activity is in fact being set up relates to

coupled modelled and the analysis of model capabilities to simulated chemistry-radiation-dynamics coupled processes (Alapaty et al. 2012). The activity will still involve the North American and European modelling communities in line with the AQMEII mission and will still relate to the simulation of air quality in the two continents with the specific attention to coupled processes. Interaction with other international modelling programs like the Hemispheric Transport of Air Pollution (HTAP) program of Longrange Transport of Air Pollution (LTRAP/UNECE) is also being explored.

Disclaimer

Although this paper has been subjected to review and clearance by the U.S. Environmental Protection Agency, it does not necessarily reflect the views and policies of the Agency

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