HIGH RESOLUTION ENVIRONMENTAL MODELLING AND EVALUATION PROGRAMME FOR CROATIA (EMEP4HR)

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INTRODUCTION

The EMEP4HR project, its main objectives, methodology and first results are presented. It is a joint project of Norwegian and Croatian meteorological services, University of Zagreb and Energy Research and Environmental Protection Institute (EKONERG) that started in 2006, and is due to last until 2010. The main purpose of this project is to develop and test an operative framework for environmental control of air pollution problems in Croatia. The project will allow for a stable long-term development of Croatia's scientific capacity to support the design of environmental protection strategies. In particular, the main objectives of this project involve:

1) the development of high resolution emission inventories of air pollutants in Croatia and in selected urban areas
2) the implementation and further development of a mesoscale version of the Eulerian EMEP Unified chemical transport model coupled with ALADIN and WRF NWP models
3) the development of a new capability for the assessment of urban air quality in main Croatian cities
4) the evaluation and testing of the new modeling capability according to international standards

In order to accomplish those tasks high resolution emission inventories need to be compiled and the EMEP model has to be further extended in order to include meteorological effects that are much more important on the finer spatial scale, such as turbulence and convection generated by complex terrain, imposing large differences in vertical eddy fluxes over short distances.

EMISSION INVENTORY COMPILATION

The quality of emission estimates is essential to any air quality assessment. In particular, for mesoscale applications, special attention should be given to guarantee the quality of both the extent and the spatial distribution of emission data.

Energy Research and Environmental Protection Institute (EKONERG) is responsible for compilation of official Croatian emission data reported to international Conventions, like LRTAP and IPCC. The participation of the institute will ensure that the methods developed during this project are discussed and adopted by the Croatian emissions experts.

The work begins with the evaluation of existing emission data in regional scale. The development of the metodology and compilation of activity data and emission data coming from local and national authorities will follow resulting in the development of gridded emission inventories in 10x10 km2 resolution for Croatia. Finally, the work will lead to the development urban gridded mission inventories in 1x1 km2 for the cities of Zagreb and Rijeka

MESOSCALE APPLICATION OF EMEP MODEL IN CROATIA

This project proposes to implement and make a further development of nested version of the EMEP model over Croatia – a setup called EMEP4HR, in order to quantify air quality at regional and local scale as well as the impact of regional as compared to urban air pollution.

The nested version of the EMEP model is developed recently (e.g., Wind et al. 2003) and it is suitable for national applications.

EMEP4HR model development

In order to apply the EMEP Unified Eulerian model at finer resolution, new input data for land use, gridded emissions, meteorological and climatological fields are compiled. A new software is developed in order to use ALADIN Numerical Weather Prediction (NWP) model developed by Aladin consortium, as EMEP4HR meteorological driver at 10 km resolution.

The quality of the high resolution input data should make a big impact on chemical transport model performance at this scale. Therefore it is very important to test and validate this model setup, which is a next step in this part of the project. Some preliminary results from EMEP4HR model setup are shown on Fig 1.

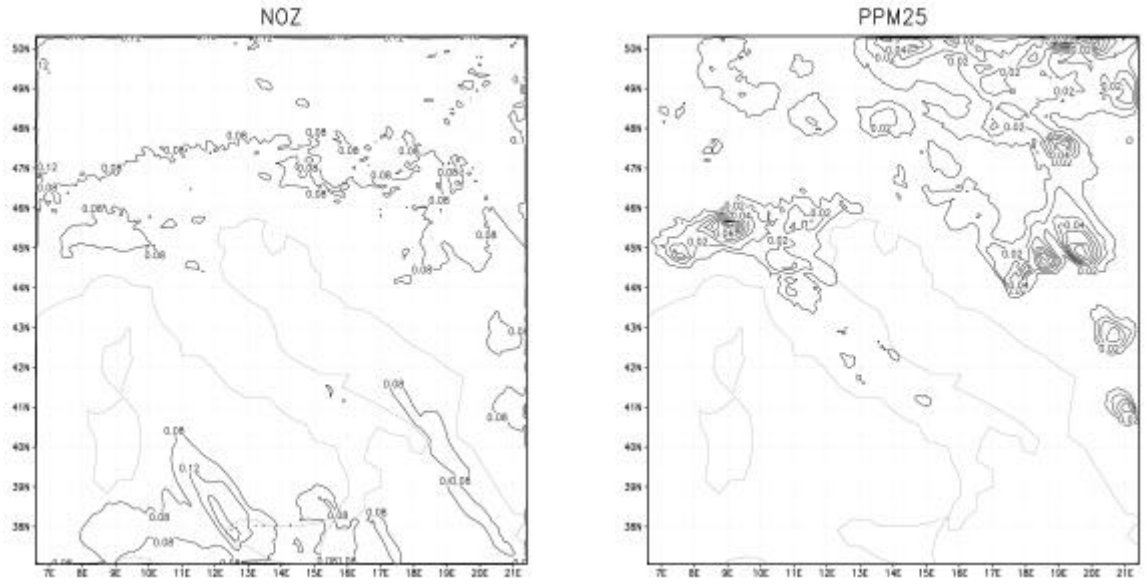

Fig.1; Horizontal fields of NOz (left) and PPM25 (right) concentrations calculated with EMEP4HR model with ALADIN as meteorological driver on 10x10 km resolution

Implementation of new vertical diffusion scheme in the EMEP model

A new vertical structure of the model is defined and it needs to be tested with respect to the model's vertical diffusion parameterisation to secure a consistent description of vertical exchange in the new EMEP4HR model.

Presently in the EMEP model vertical diffusion coefficient, K(z), is first calculated throughout the domain with Blackadar (1979) method. The Richardson number method (e.g., Seibert et al. 2000, Jericevic and Grisogono 2006) is used to determine stability conditions. In stable conditions K(z) is set to minimal value K(z)=0.001 m^2/s and it is constant all through the domain. In unstable conditions K(z) is calculated due to O'Brien (1970) formula. The new approach uses generalized form of O'Brien's third-order polynomial K(z). It is an linear-exponential function with convenient analytic properties (Grisogono and Oerlemans, 2002):

$$K(z) = (K_{MAX} e^{1/2} / h) z \exp\left[-0.5(z/h)^2\right] \qquad (1)$$

RESULTS AND DISCUSSION

The new method for K(z) (Grisogono method) and the 'old' one (O'Brien method) are tested against measurements of surface NO_2, and SO_4 daily concentrations for January and July 2001 on EMEP model domain. The starting point is assumption that if only K(z) is changed in the model, the resulting differences can be accounted to vertical diffusion only.

In Fig. 2 we can see that for January NO_2 has higher correlation with the Grisogono method and for SO_4 biases are smaller. In Fig. 3 results for July are shown and here also biases are smaller with Grisogono method. Generally there is an improvement with a new method and verification process will continue with EMEP4HR model.

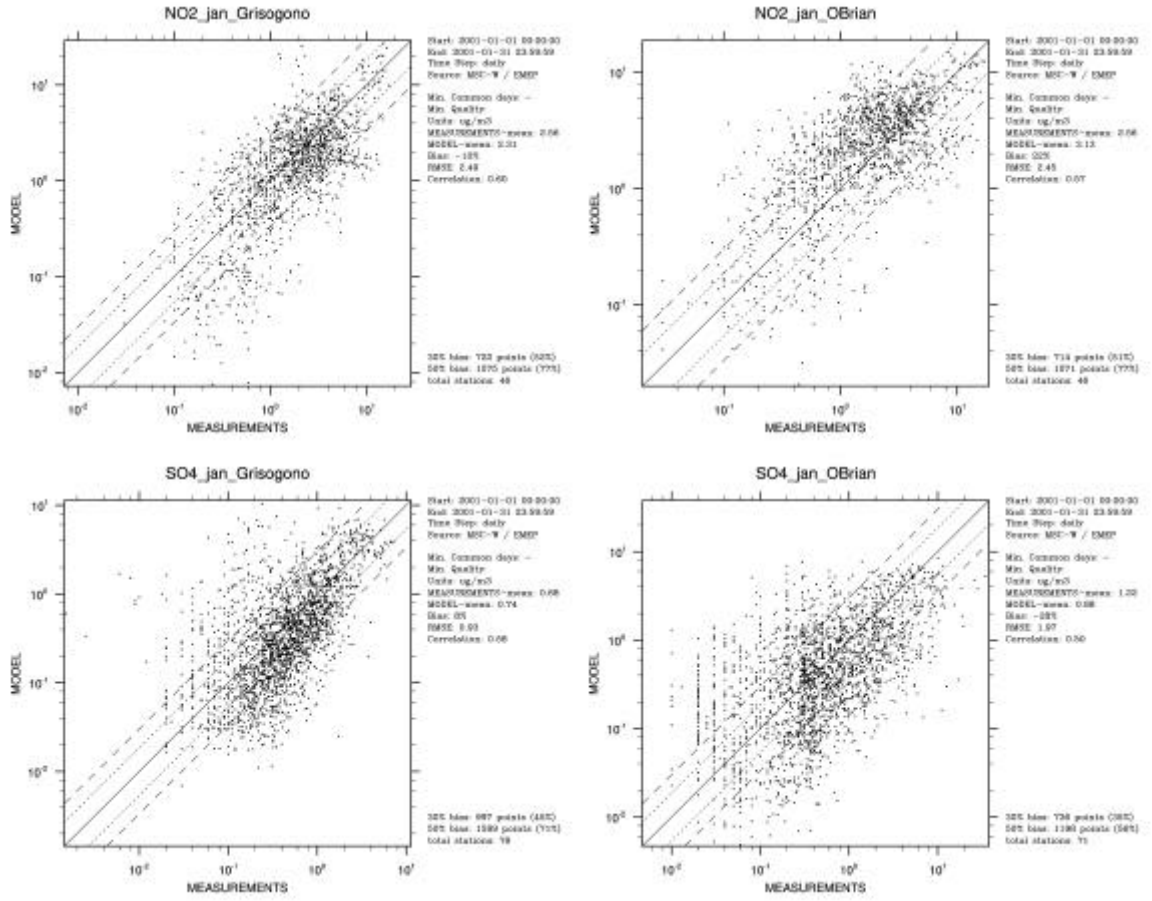

Fig. 2; Scatter plots between the measured the modeled daily concentrations of NO_2 and SO_4 with Grisogono method (left) and O'Brien method (right) for January 2001.

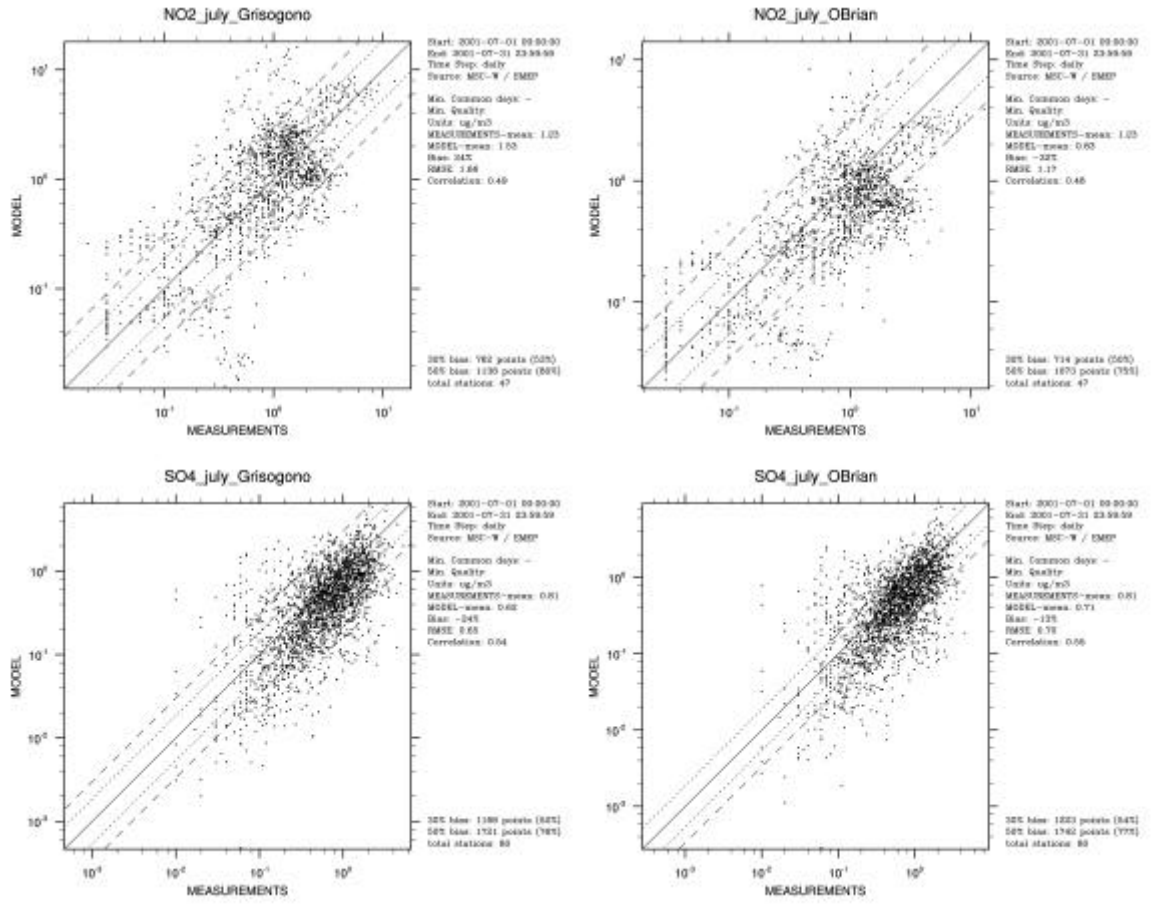

Fig. 2; Scatter plots between the measured the modeled daily concentrations of NO_2, and SO_4 with Grisogono method (left) and O'Brien method (right) for July 2001.

CONCLUSION

This project will allow Croatian experts to produce their own assessments of air quality at national and at urban level, evaluate the national consequences of proposed international environmental control options, analyze the effect of future emission scenarios and identify new instruments for implementation of the air quality standards in Croatia. The research work will be carried out as a contribution to the UNECE Convention on Long-Range Transboundary Air Pollution and will facilitate the integration of Croatia to conform with European Community air quality regulations.

ACKNOWLEDGEMENTS

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