BACKGROUND AIR POLLUTION PREDICTION OVER SLOVENIA BY QUALEARIA MODELLING SYSTEM - PRELIMINARY VALIDATION

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Abstract: Slovenia is a country of very complex terrain and many problems with air pollution in the valleys, canyon and basins, where industrial air pollution is combined with traffic and domestic heating air pollution, giving rise to problems for the health impact and the ecosystems directly or indirectly. Among indirect effects is also effect on solar radiation budget because of photochemical smog and especially particles air pollution. To assess air pollutants over the country, a preliminary application of an experimental forecast system is presented here, with the aim of exploring its potentials and limitations in modelling the background air quality, and to focus the aspects where improvements are needed for a true operational use.

Key words: *air pollution, prediction, modelling system, validation, complex terrain*

INTRODUCTION

Slovenia is a country predominantly characterized by complex terrain and with several problems of air pollution, mostly concerning PM10, NOx and ozone. The small scale air pollution control system "KOoreg" has been constructed for Zasavje region in the central part of the country (KOoreg, 2013), with details reported on the previous HARMO conference (Mlakar, P. et al., 2012). One of the important issues in construction of small scale air pollution modelling systems is the amount of the pollutants transport coming from other regions. Nevertheless, at present there are no operational modelling systems covering whole Slovenia and its neighbourhood in on-line mode, so to obtain an accurate estimation of the pollutants income into the Zasavje region we have connected KOoreg modelling system with QualeAria system (QualeAria, 2013) that is run continuously for Italy and neighbouring countries.. In order to correctly use air pollution transport data it has to be validated first.

QUALEARIA SYSTEM

QualeAria air pollution forecasting system (QualeAria, 2013) is operationally run by ARIANET (Milano), It is part of the MINNI Italian national modelling system (Zanini G. et al., 2005) and is based on the same meteorological and air quality models; specifically, its main components are:

- a meteorological downscaling produced by mean of the NWP Model RAMS, starting from GFS synoptic scale weather forecasts distributed by the US weather Service (NCEP);
- the Italian (ISPRA 2005, then updated to subsequent years) and European emission inventories (Denier van der Gon, HAC et al., 2009), developed by TNO within the EC FP7 Project MEGAPOLI, used to describe both point and area sources emissions;
- the FARM Eulerian chemical-transport model (Silibello, C. et al., 2008; EEA MDS, 2013), applied to predict transport and chemical transformations for gaseous and particulate pollutants;
- boundary conditions provided by the global scale chemical weather forecast produced by MATCH-MPIC model (Lawrence, M. G., 1999), run at the Max-Planck-Institut für Chemie in Mainz.

The system is currently configured on two nested computational grids, the wider covering Europe at 48 km horizontal resolution and the smaller covering Italy and Slovenia at 12 km resolution.

PREDICTION RESULTS OVER SLOVENIA

Slovenia is placed in the inner part of the second modelling domain, far enough from domain border so that the results for Slovene territory are well estimated. QualeAria produces air pollution forecasts for state of Slovenia for 2 days in advance in 1h time resolution.
Predictions of main pollutants from this configuration are included on a daily basis on KOoreg web site (Figure 1), to explore the potentials and limitations of the current system in modelling the background air quality in various part of the country, and to focus the aspects where improvements are needed.

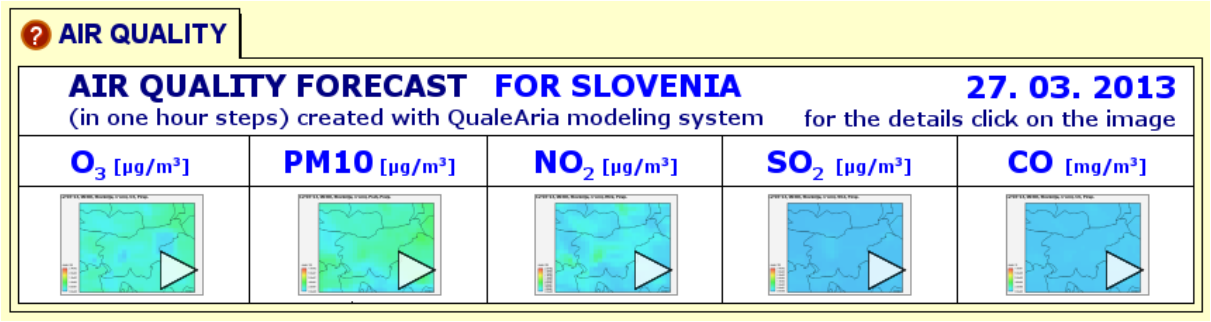

Figure 1. Presentation of results of on-line air pollution prediction available at www.kvalitetazraka.si (KOoreg, 2013)

PRELIMINARY SYSTEM VALIDATION

The paper presents preliminary results of validation of QualeAria ozone air pollution forecasts over Slovene territory. Several air pollution measuring stations will be used as data source for comparison with modelled data. Statistical evaluation as well as detail examples over complex topography will be presented.

The results of the validation are important for several reasons. Firstly the confidence into pollutants transport forecasts is important to provide a correct background to KOoreg local air pollution modelling system, focused in specific power plant and industrial facilities. Secondly it is important how well the QualeAria forecasts correspond with measurements over Slovenia, because forecasts can be suitable for regulatory purposes and for reporting to EU. PM10 particles and photochemical air pollution will be also input data for study of solar energy availability over Slovenia (Soares, J. R. et al., 2004). And last, validation of regional air pollution system over mostly complex Slovene territory is an important scientific issue by itself.

Figure 2. Zasavje, Šoštanj and Celje with the locations of automatic air quality stations used in this presentation

Slovenia is a state of mostly very complex terrain. Only a few state air pollution measuring stations can be treated as representative of background conditions for large area. Most of the stations are in fact placed in the bottom of narrow valleys or in the basins or relatively close to major industrial emission sources. Therefore it is not expected to capture air pollution peaks details with an Eulerian model currently employed with a cell size (12 km x 12 km horizontally) that is much bigger than most of the terrain details dimensions around automatic air pollution stations. For instance hlTc (height and length of the Topographic complexity) index for Zasavje region (station Kovk) is “hlTc = (0.4 km, 1.5 km)” (Božnar, M. Z. et al., 2012b).

A second important fact is that the emission inventory currently employed for non-Italian countries, referred to year 2005, has nowadays several shortcomings regarding actual Slovene emissions. Several industrial facilities have been in fact closed, or their emissions have been significantly reduced due to constrain of IPPC. On the other hand economic recession is the reason for year by year highly increased domestic heating PM10 emissions, because people are burning low quality wood instead of gas or oil. Furthermore, only the location of main point sources is represented, while the actual stack parameters are assigned on the basis of typical values by activity type, without accounting for source-by-source actual values.

For all these reasons the actual results of QualeAria over Slovenia are to be considered only as preliminary, especially near largest sources and for what concern primary pollutants or pollutants having a significant component directly emitted from sources. Ozone, being a secondary pollutant also influenced by sources on a larger scale, is otherwise a better benchmark for the current situation.

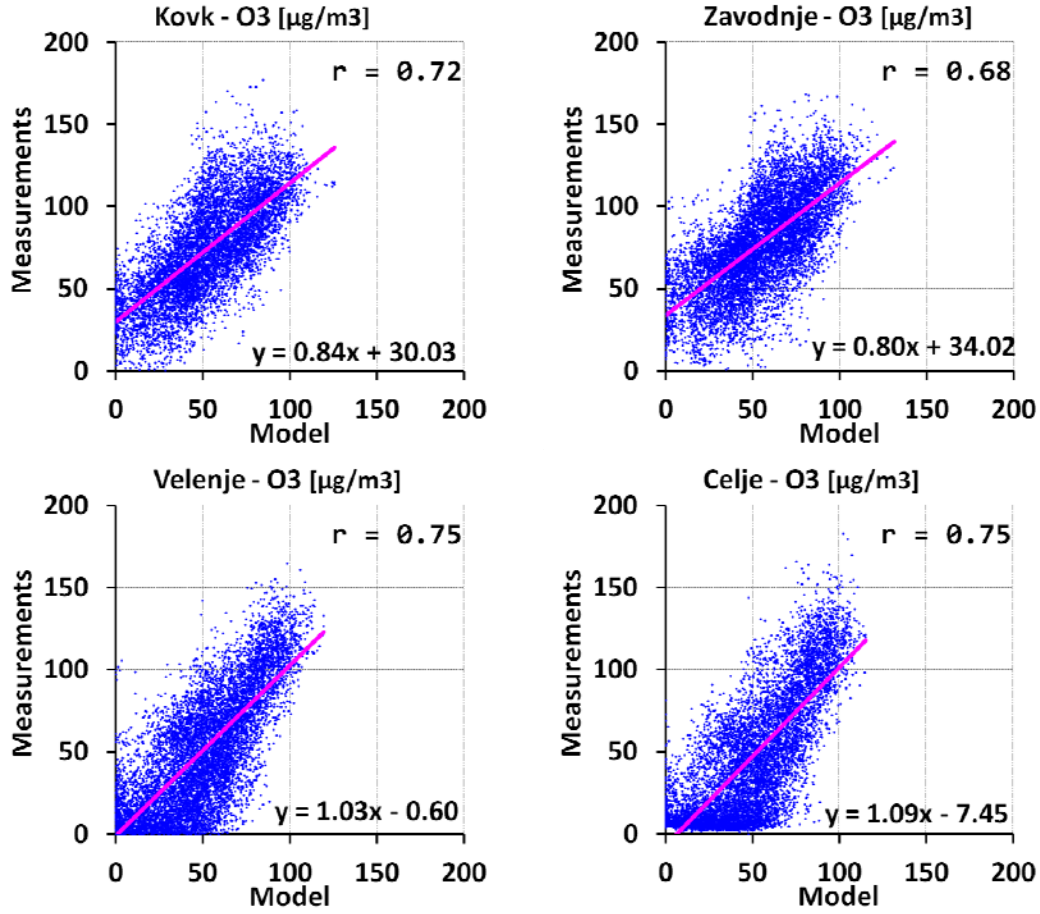

Figure 3. Scatter plot of O3 hourly values for 2012 for stations Kovk in Zasavje region, Zavodnje and Velenje in Šoštanj region and Celje

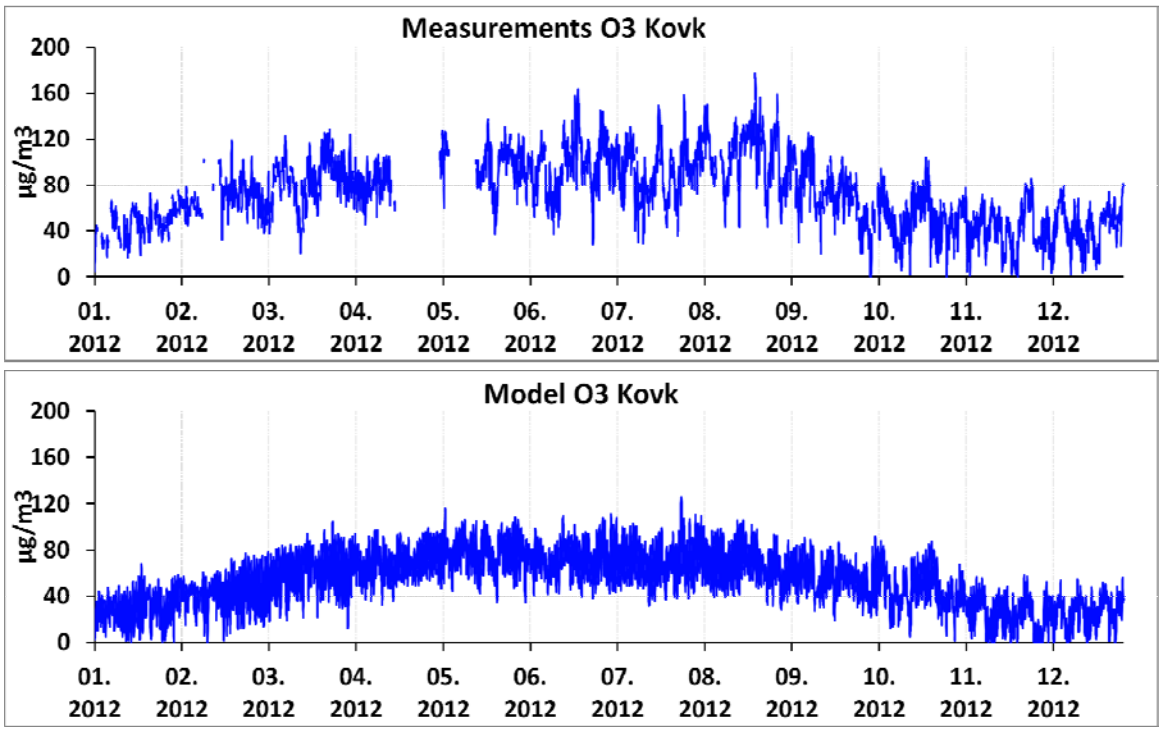

Figure 4. Graph of O3 hourly values for 2012 for station Kovk in Zasavje region, measurements and model results

The comparison is performed using the hourly ozone concentrations collected at the stations in Šoštanj, Zasavje and Celje regions, using the data produced by the forecast system one day in advance over the whole year 2012. O3 air pollution seems to be in fact reasonably reproduced by model. As an example O3 on Zavodnje station is well reproduced because Zavodnje is on the slope of the high hill in Šoštanj region (Božnar, M. Z. et al., 2012a) and far from traffic sources of NOx. Also station Kovk is on top of the hill, lying above the Sava river canyon.

Time series show that the yearly behaviour of ozone is correctly reproduced, but that otherwise the daily variation in the observation is underestimated. This could be related to the presence of local sources and of smaller scale circulation patterns, that at the current resolution cannot be resolved.

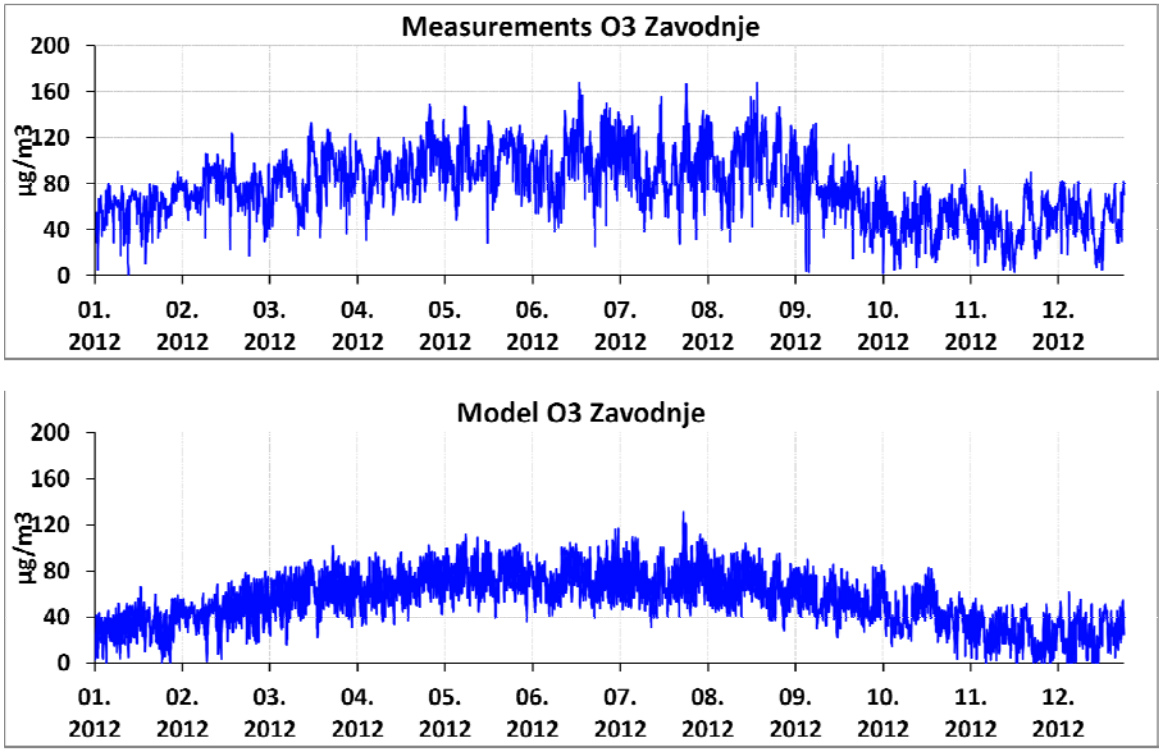

Figure 5. Graph of O3 hourly values for 2012 for station Zavodnje in Šoštanj region, measurements and model results

CONCLUSIONS

The preliminary application confirmed that as expected Eulerian models with relatively big cell size in comparison to valley's and basin's dimensions, while can be capable to reproduce the behaviour of background concentrations influenced by sources over a large domain, they cannot be used for detailed prediction of pollutants over Slovenian complex terrain. Their results can only be used in larger areas where emissions are dispersed over flat areas or rather smooth complex terrain, and where large point sources are not in the vicinity.

On the other hand Eulerian modelling is still the only possible approach to evaluate pollution over the whole state of Slovenia and when dealing with secondary pollutants. But it should be stated that when looking for agreement in time and place, errors are big in the cases when only few cells define pollution over a town or valley. Therefore to enhance the system presented here a »zoom in« is necessary, at least for regions over very complex terrain. A cell size of horizontal size around 1 km or less with better location information of main sources (roads, domestic heating and main point sources) is the next planned step to enhance the results.

ACKNOWLEDGEMENT

The study was partially financed by the Slovenian Research Agency, Projects No. L1-4154.

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