J5.7 IMPROVEMENT OF THE ONE-WAY NESTING OF AIR-POLLUTION MODEL SMOG TO NUMERICAL WEATHER PREDICTION MODEL ETA

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1. INTRODUCTION

In this contribution we deal with the problem of summer photochemical smog and the episodes of high concentration of it in case of Prague, which can serve as a typical example of a city where traffic density increased several times during last decade. Increasing traffic density gives rise to problems with air pollution that is met mainly in summer months and that includes not only high concentrations of air-pollution just in the city but the problems of urban plume as well.

We are mainly interested in its most important part – tropospheric ozone. Ground ozone concentration is measured in several monitors in Prague, but thanks to the complicated orography of Central Bohemia and limited number of monitors it is very problematic to obtain information about spatial distribution of this part of summer photochemical smog based on measured data. Another way how to estimate this distribution consists in using appropriate model. This approach supposes to use some meteorological diagnostic or prognostic model (depending on the fact, whether the aim of the activity is a diagnostic field of spatial ozone distribution or its forecast) together with chemical submodel involving the whole cycle of chemical reactions. In the subsequent paragraphs the chemical submodel called SMOG is briefly described together with links to the meteorological model. A future plans dealing with utilization of more detailed model of higher resolution are also mentioned.

2. CHEMICAL SUBMODEL SMOG

The presented chemical submodel SMOG (Bednar *et al*., 2001) has been developed in the framework of the project "Air Pollution in Prague" at the Department of Meteorology and Environmental Protection, Faculty of Mathematics and Physics, Charles University in Prague in the period 1995-8. It serves as a tool for studying summer photochemical smog episodes. Such episodes can be described as a presence of high ozone concentration produced by photochemical reactions of its precursors, as nitrogen oxides – NO_X and volatile organic compounds – VOC. This high ozone concentration is not caused only with local conditions (local emission) but it is also a consequence of long-range transport. In the model SMOG the attempt was based on the methods that tried to estimate the impact of the local city emission on the level of ozone and it precursors concentrations.

The model has conceptual base in the category of so-called "puff" models. The principle of this type of models consists in hacking of air-pollution plumes into series of puffs. Plume is then supplied by sequence of partly overlapped elements drifted by a wind flow from a source location down the trajectory. That approach allows to reply to rapid changes of meteorological conditions and emissions, however the main advantage of this approach is an ability to involve mixing and mutual chemical reacting parts of plumes proceeded from different sources.

The model chemical reactions can be characterized with the scheme presented in Bednar et al. (2001), where reactions involved are written in the form of chemical submodel equations and discussed in details. Usual output of the model involves fields of ground concentration distribution of NO, NO_2 and O_3 in $\mu g\ m^{-3}$. Input data that are necessary for running the submodel SMOG can be divided into three categories. First category can be called as permanent or constant information – this category involves data about orography of the investigated area (model domain). The second and the third category of the data sets consist of emission data and input of meteorological data. Firstly, we will mention emission data in more details as the meteorological data will be discussed in the section where meteorological prognostic model will be mentioned together with performed tests of the link between the meteorological model and chemical submodel.

Data information on emissions of NO_x and VOC from Prague emission sources and sources from its closest neighbourhood were involved, but there was also information about emission individual (point) sources from the whole area of central Bohemia (approximately to the distances of 70 km from the centre of Prague). The number of involved individual point sources was equal to 177, but the contribution of sources outside of Prague was relatively negligible. Individual point sources create one group of emission sources and these sources are treated in their real positions with corresponding parameters (building height, emission rate etc.). Model uses also emission data in gridded form; all the emissions of NO_x

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and VOC from traffic, area emission sources or small point emission sources are given in the middle of the emissions squares 5 $\times$ 5 km. The size of these emission squares is a consequence of a compromise between an attempt to have the most correct emission input and number of puffs that can be treated within one model run as a new puffs are launched from each source each time step.

3. LINK TO METEOROLOGICAL CONDITIONS

Meteorological information consists of data, which were in the first step intended to test our nesting routines considered to be homogeneous in model domain, e.g. surface air temperature, cloud cover, solar zenith angle, total amount of O_3 in Dobson units. For wind field vertical changes were taken into account. For practical use and with respect to the relatively complicated shape of orography in the Central Bohemia it is evident, that a link to some meteorological “pre-processor” that would create more realistic flow field is necessary. At least the flow field could display deformation due to the shape of orography parametrized or modelled in a desired resolution (it means if the model SMOG is used for simulating the impact of the city plume on the surrounding areas, then resolution given with up to now used “US NAVY” orography is sufficient and flow field could be given in the same resolution).

As a source of driving fields for nesting we are using for our first experiments with real driving of our SMOG model so-called ETA model (Black, 1988) with resolution of 0.25 degree. The example of the results is presented in Fig. 1, however, this is not typical case of photochemical smog production. Unfortunately mainly the effect of high velocity of wind can be seen there, it should be mentioned that only concentration of produced ozone is displayed although the effect of background concentration is parameterised as well. Moreover, as it is a preliminary study, in this case only trajectories of puffs are driven by wind field from ETA model taking other parameters to be constant and homogeneous in the domain. As the second step we are going to fully couple fields of other parameters like temperature, height of mixing layer, cloudness etc. as well for purposes of regional air pollution transport modelling. Finally, we are taking into account the possibility of experiments with coupling of our chemical submodel to high resolution models MM5 and spectral LAM Aladin.

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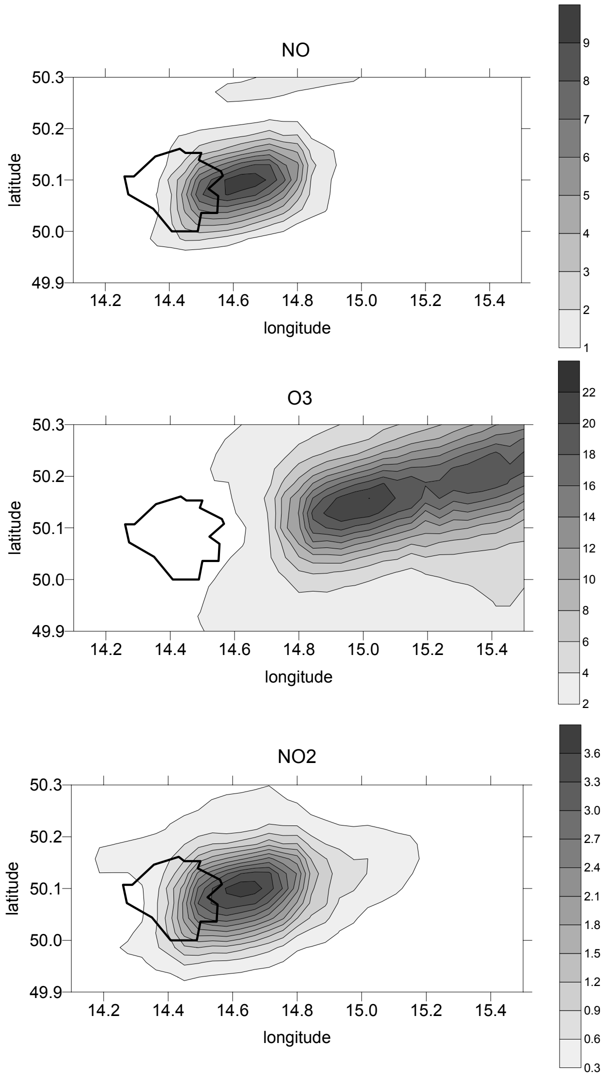

Figure 1. Ground concentration of selected compounds in $\mu g/m^3$ for 10th September 2001, 12 UTC, based on wind field from ETA model.