TROPOSPHERIC OZONE AND BIOGENIC EMISSIONS IN THE CZECH REPUBLIC

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INTRODUCTION

Tropospheric ozone is a significant element of atmospheric pollution, especially in the summer period when photochemical reactions, which lead to ozone formation, are remarkably enhanced by intensive sunlight and high temperatures. Main ozone precursors such as nitrogen oxides (NOx) and volatile organic compounds (VOC) are released to the atmosphere not only from antropogenic sources, but they are also emitted in considerable amounts from biogenic sources as well.

Terms of formation, amount, spatial distribution of tropospheric ozone and the contribution of biogenic sources of VOC to ozone precursors were studied using numerical model for summer photochemical smog simulation (SMOG model, see *Bednar et al.*, 2001). North-eastern part of the Czech Republic, mostly forested mountainous area but neighbouring an industrial zone, was used as a model domain. Measured data in this region were available to compare model results with real ozone concentrations. In the first run of numerical model only anthropogenic emissions were taken into account. Using model of biogenic emissions of isoprene and monoterpenes proposed by *Guenther et al.* (1995) an estimate of emissions from natural sources had been established and used in the second run of the model.

Smog model

SMOG model is a chemical transport model which was developed at the Department of Meteorology and Environment Protection, Faculty of Mathematics and Physics, Charles University in Prague during 1995-98. Model has been used for studying summer photochemical smog episodes such as a presence of high ozone concentration. SMOG model is a lagrangian puff model where a continuous plume of pollution is divided into several separate puffs preserving the original intensity of emission fluxes from individual sources. Thanks to this approximation SMOG model is able to model non-stationary situations under varying meteorological conditions. Each puff has its own trajectory according to meteorological preprocessor - model ETA. A dispersion of puffs into all three dimensions with the normal distribution is expected as well as chemical interaction of individual puffs

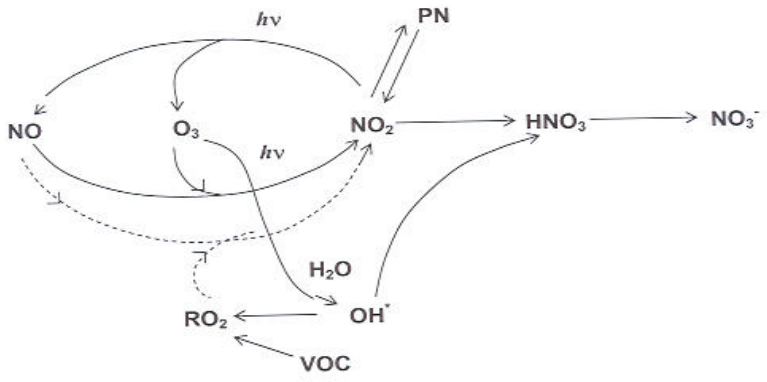

Fig. 1; Chemical reaction scheme of the SMOG model.

with each other. Further information about SMOG model can be found in *Bednar et al.* (2001). The scheme of chemical reactions considered in the model is shown in Figure1.

Model of biogenic emissions

Isoprene and monoterpens are considered to be the most prominent volatile organic compounds released from natural sources (*Simpson et al.,* 1995). Emissions of these compounds were estimated using model of *Guenther et al.* (1995) which had been slightly modified and is described below. Land cover of selected domain is shown in Fig. 2.

Emission flux F ($\mu g.m^{-2}.h^{-1}$) of each chemical compound is calculated as:

$$F = e \cdot D \cdot g \qquad (1)$$

where ε is an ecosystem dependent emission factor (μg $C.m^{-2}.h^{-1}$ at photosynthetically active radiation (PAR) flux of 1000 $\mu mol.m^{-2}.s^{-1}$ and leaf temperature of 303.15 K) , D is foliar density (kg dry matter.m^{-2}) and γ is a dimensionless correction factor that accounts for the influence of PAR and leaf temperature. Emission factor ε and foliar density D are ecosystem dependent; correction factor γ depends only on environmental conditions.

Parametrization of correction factor g

Isoprene emissions

Emissions of isoprene from plants show dependence on leaf temperature and sunlight. Therefore correction factor γ is a product of two coefficients (C_T for temperature and C_L for sunlight) which represent this relation.

$$C_T = \frac{\exp \frac{C_{T1}(T_A - T_S)}{R.T_A.T_C}}{1 + \exp \frac{C_{T2}(T_A - T_M)}{R.T_S.T_A}} \qquad (2)$$

Elements C_{T1}, C_{T2}, T_M in equation (2) are empirical coefficients, R is ideal gas constant (=8.314 $J.K^{-1}.mol^{-1}$), T_A is temperature of ambient air and T_S is standard temperature of 303.15 K.

The dependence of isoprene emissions on the Sun light is estimated by the coefficient C_L

$$C_L = \left(1 - \frac{0.5c}{100}\right) \cdot \cos \Theta \qquad (3)$$

where c is relative cloud cover and Θ is a zenith angle of the Sun.

Monoterpene emissions

Emissions of monoterpenes seem to be controlled only by temperature. Correction factor γ for monoterpenes is defined by

$$g = \exp\left(b\left(T_A - T_S\right)\right) \qquad (4)$$

where β is empirical coefficient, T_A and T_S is ambient and standard temperature respectively.

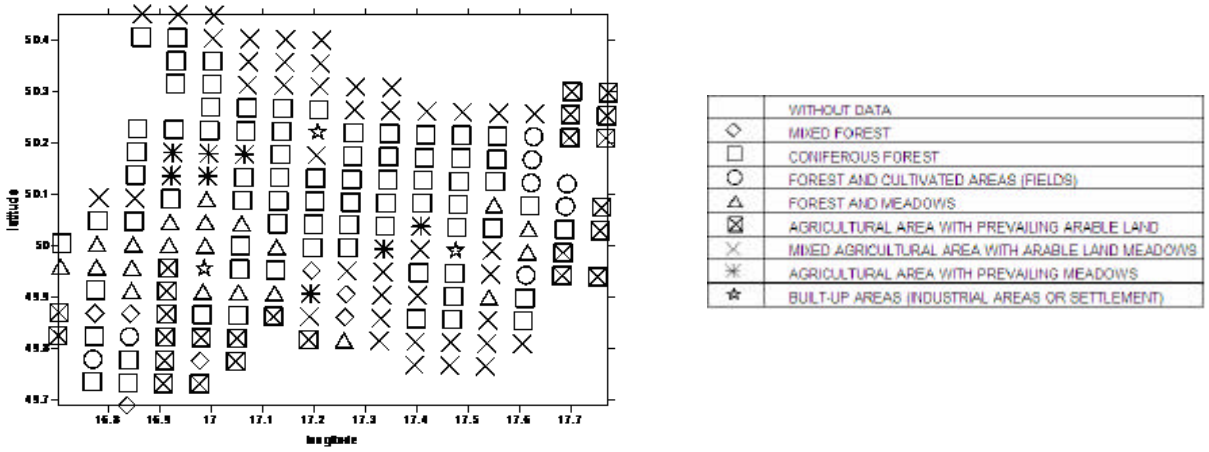

Fig. 2; Land cover of the selected domain.

MODEL RESULTS

Two representative points (Cervenohorske sedlo, Jesenik) of the model grid were selected to compare the model results with measured data. Daily mean ozone concentrations for June 2000 calculated with account of antropogenic sources of VOC only, with antropogenic contributions together with natural sources of VOC and measured values of ozone are shown in Fig. 3. and Fig. 4.

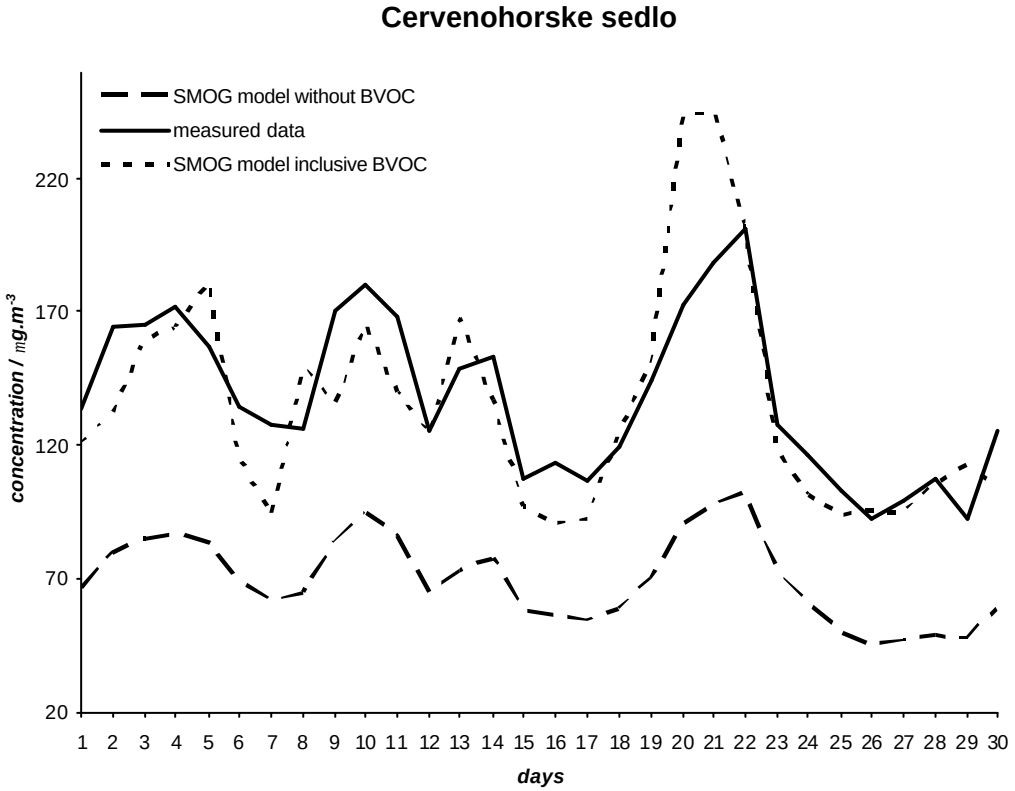

Fig. 3; Model results and measured data for Cervenohorske sedlo station.

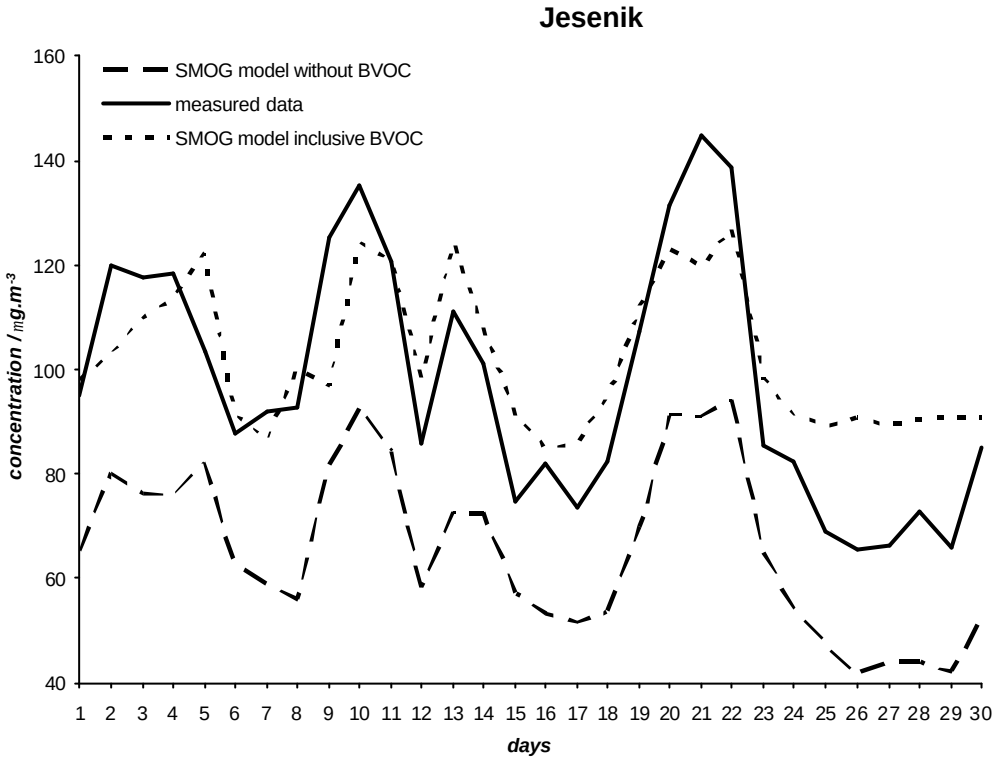

Fig. 4; Model results and measured data for Jesenik station.

CONCLUSION

According to Fig.3 and Fig.4 it is visible that including biogenic emissions of volatile organic compounds, which mainly in forested area may even exceed antropogenic sources (Simpson, 1995), into model inputs brings significant improvement of SMOG model results. Nevertheless model results are not completely satisfactory, in some periods model under- or over-estimates ozone concentrations. Our research work is now focused on extension of studied domain to whole area of Czech Republic and on specification of biogenic emissions using more detailed forest composition description.

ACKNOWLEDGEMENT

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