MODELLED CONCENTRATIONS OF AIR POLLUTANT DEPENDING ON INPUT DATA

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INTRODUCTION

The output of atmospheric dispersion models is strongly influenced by the meteorological input. Ideally, hourly input parameters in dispersion models should be calculated from the measurements. Since it is not always possible to have measured data, Numerical Weather Prediction (NWP) models are employed to provide the input.

In this study, concentrations of SO_2 calculated using measured and modelled meteorological input data will be compared. Modelled input was obtained from the limited area NWP model ALADIN/HR (*Ivatek-Šahdan and Tudor, 2004*). The widely used steady-state Gaussian plume model ISC3 (*US EPA, 1995*) was applied to calculate the concentrations of air pollutants released from a point source situated in Zagreb, Croatia.

EXPERIMENTAL SETUP

The meteorological input for ISC3 model are hourly values of flow vector, wind speed, ambient temperature and dispersion parameters, i.e. stability and mixing height (MH). In this study two kinds of meteorological input were used, one from the measured and the other from the modelled data.

Hourly values of a flow vector, wind speed and the ambient temperature are routinely measured meteorological parameters and a part of a standard NWP model output. On the other hand, dispersion parameters had to be calculated.

Stability was determined from modelled data using a method based on vertical temperature gradient and a mean wind speed between the two model layers (*IAEA, 1980*). The MH was calculated using the bulk Richardson method (e.g. *Sørensen et al., 1996*) and the same MH data set was used as a meteorological input. *Jerčević et al. (2004)* have tested these methods and have shown that ALADIN model could be used for the calculations of the dispersion

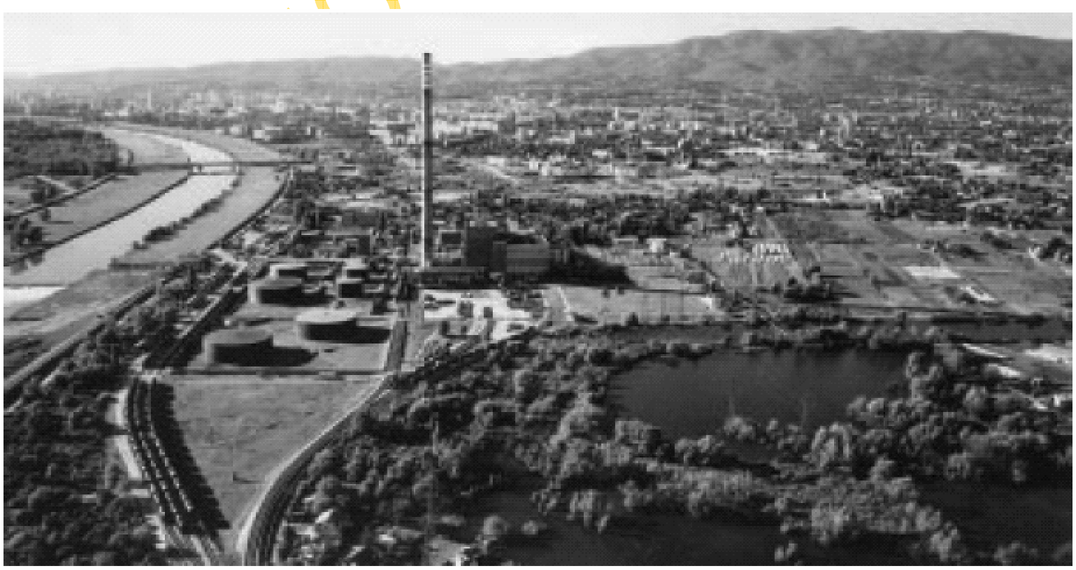

Figure 1 Aerial photgraph of the point source.

parameters. Stability was calculated from measured data using modified Pasquil method (*Lončar, 1974 according to Cividini and Šinik,1987*) which, besides wind speed, day-time insolation and night-time cloud cover, also includes meteorological phenomena (hail, fog and thunder). Data from two 15-day periods were used being representative for winter (25 January - 8 February 2002) and summer (7-21 August 2002).

The point source is a thermal power plant (Fig. 1) located in the outskirts of Zagreb (Croatia). Since the main fuel used in that power plant is oil, concentrations of SO_2 were analysed. The meteorological station is located within 5 km from the point source. Modelled meteorological input was derived for a NWP grid point nearest to the location of meteorological station.

The data set is obtained from receptor network consisting of 1440 receptor points on 40 concentric rings spaced every 500 m. They are centred around the source. The receptors are placed along 36 direction radials beginning with 10° clockwise.

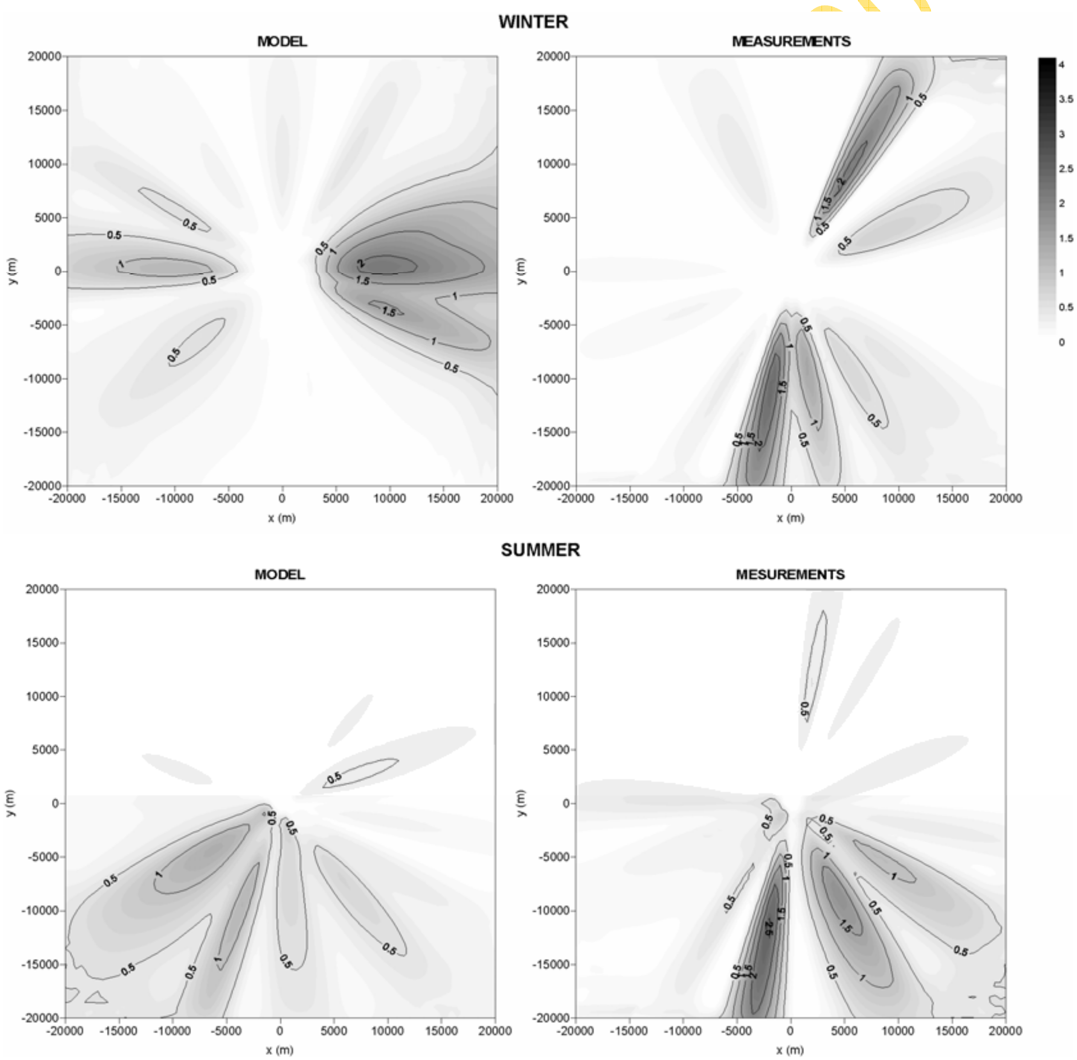

Figure 2. Mean predicted ground level concentrations of SO_2 $\mu g\ m^{-3}$ from modelled (left) and meteorological (right) input for winter (up) and summer (down) 15-day period, in radius of 20 000 m from point source located in Zagreb, Croatia.

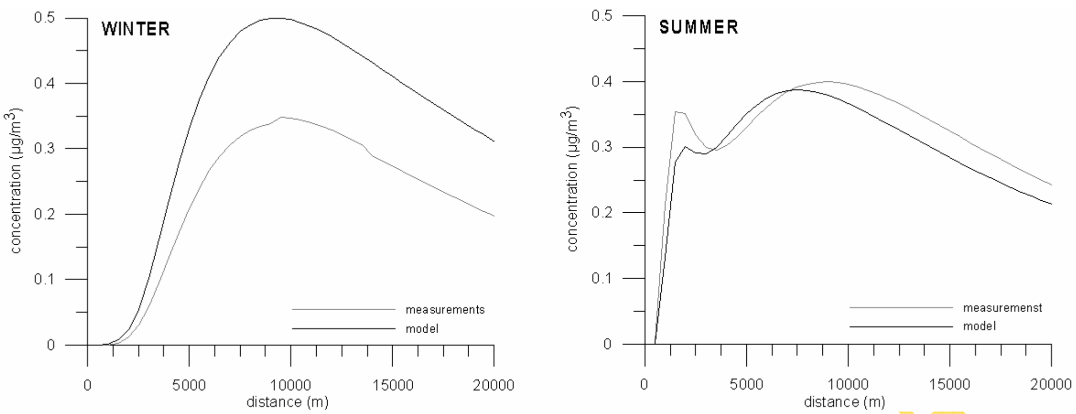

Figure 3. Comparison of mean predicted ground level concentrations depending on distance from point source located in Zagreb, Croatia for winter (left) and summer (right) 15-day period. The data set is obtained by averaging receptor locations for every distance along 36 directions.

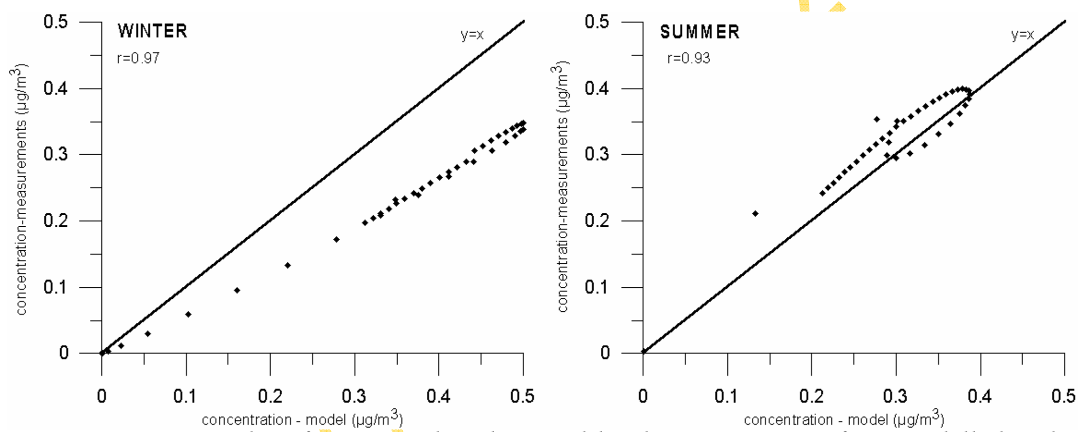

Figure 4. Scatter plot of mean predicted ground level concentrations from modelled and meteorological input for point source located in Zagreb, Croatia. The data set is obtained averaging receptor locations for every distance along 36 directions.

Table 3. Statistics for the differences between concentrations obtained by modelled and measured input for winter and summer period. All values (except N) are in µg/m³. N is number of data.

	MAE	RMSE	BIAS	MAX	MIN	N
winter	0.11670	0.04803	-0.11670	0.16206	0.00000	40
summer	0.29627	0.01719	0.02472	0.07817	0.00109	40

RESULTS AND DICUSION

Mean ground level concentrations were calculated both from measured and modelled input data and compared for the summer and winter periods. The results are shown in Fig. 2.
Concentrations obtained from the measured data were found to be higher in the winter period and lower in the summer period, compared to those calculated using the modelled input. Moreover, the areas of concentration maxima from different inputs are not corresponding, mainly due to a significant difference in wind direction of the two inputs (data not shown).

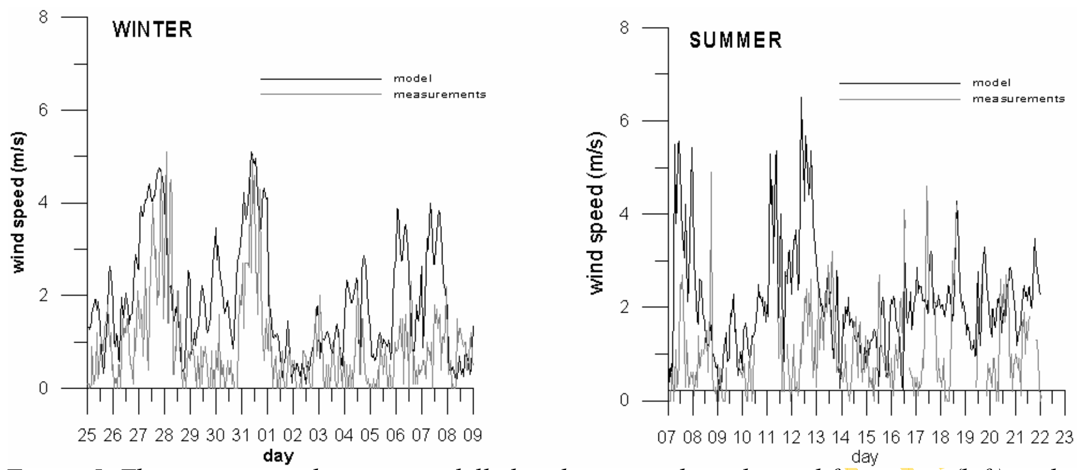

Figure 5. The comparison between modelled and measured wind speed for winter (left) and summer (right) in Zagreb

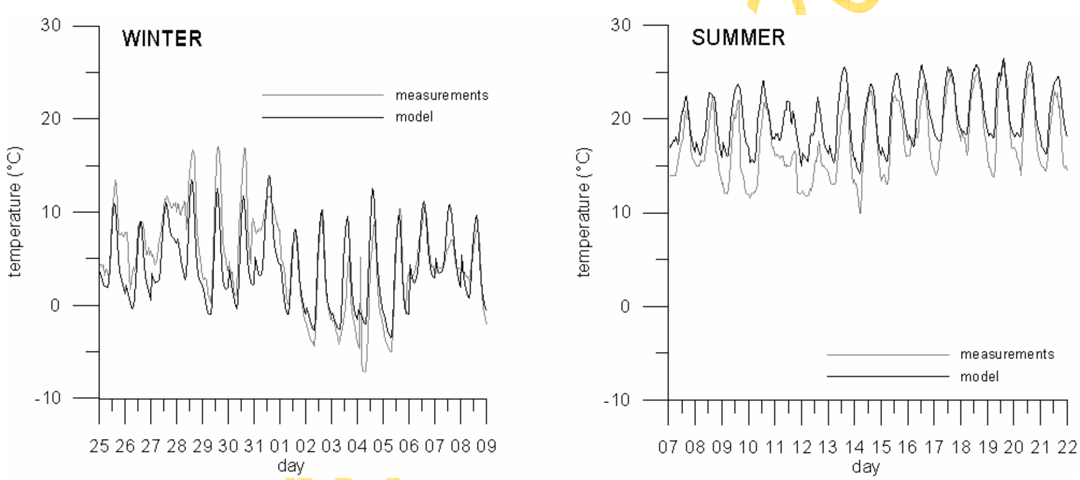

Figure 6. The comparison between modelled and measured temperature for winter (left) and summer (right) in Zagreb.

The NWP model has 8 km resolution is not able to resolve the wind direction on one specific location. To exclude the impact of wind direction, the concentrations were compared depending on distance from point source as shown in Fig. 3. The curves of concentration derived from modelled and measured input have the same trend. Furthermore, the concentration from modelled input is greater than that from measured input in winter, and smaller in summer. Scatter plots of these parameters are shown in Fig. 4. The comparison shows that the concentrations are in very good agreement with each other. The correlation coefficients are very high. Table 1. shows some statistical parameters for differences between modelled and measured data: mean absolute error, MEA, root mean squared error, RMSE; and the differences between the averages of two data sets, BIAS.
Since the occurring differences in concentrations can only result from the initial differences in measured and modelled input (namely wind speed and ambient temperature, which are the base for MH and stability estimate), the input data were compared as shown in Figs. 5 and 6. The NWP model generally overestimates wind speed for as much as 5 m/s. The temperatures

fit in trend. In winter, the model mostly underestimates temperature and in summer it tends to overestimate it.

CONCLUSION

The modelled input gives very high accuracy of predicted mean ground level concentrations depending on the distance from the point source for the studied periods. Nevertheless the predicted ground level concentrations derived from modelled input should be used with care since the wind direction is not confident parameter from the NWP model.

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