EDMS MODEL VERIFICATION CONSIDERING REMARKABLE CHANGES IN AIRPORT TRAFFIC SYSTEM

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INTRODUCTION

EDMS (Emissions and Dispersion Modeling System, Version 4.5) was adapted to Liszt Ferenc International Airport (Budapest, Hungary), which was used to calculate pollutant dispersion inside and around the airport.

The traffic at Budapest Airport show significant activity growth, thus developments connected to airport service were realized.

Due to economic crisis, the Hungarian Airlines (MALÉV) became bankrupt in 2011, thus Terminal Building 1 (T1) was closed in so that all aircraft traffic is transferred to Terminal Building 2 (T2).

The section of city close to the Airport showed remarkable developments, which infers the growth of vehicle traffic.

INPUT DATA

EDMS INPUT DATA

The runway usage of aircrafts could be simulated in accordance with the reality. All other aircraft movement (taxiing, Auxiliary Power Unit - APU) and aircraft operation related vehicle traffic were chosen as the default values from EDMS. Taxiing time was set to 12 minutes.

Simulations were made for daily averages on an 8,000 m × 8,000 m grid, with 200 m spatial resolution, for compounds CO, NO_X and PM_{10}. Emissions of significant point sources were also taken into account.

MONITORING DATA

In 2008, a monitoring station was installed on the terrace of T2, since then it has been continuously measuring hourly average concentrations of various compounds (CO, NO_X, PM_{10}, SO_2, O_3, CH_4).

BACKGROUND CONCENTRATION

EDMS calculates only the concentration distribution of specified compounds originating only from sources defined by the Airport. Due to the closeness of the city, it can be supposed that the urban pollution plume might also affect the air quality of the airport. The closest station of the Hungarian Air Quality Network is located ca. 3 km west from the Airport at Gilice tér (GT), which is at a suburban location, so the effect of local sources must be taken into account (road with important traffic, point sources).

Daily averaged corrected background concentrations for a certain *k* pollutant for the *i*-th day ($c_{bg,k}^{i}$) could be calculated from $c_{l,k}^{i}$ hourly averaged measured concentrations as

effect of
- local non traffic sources
- dilution

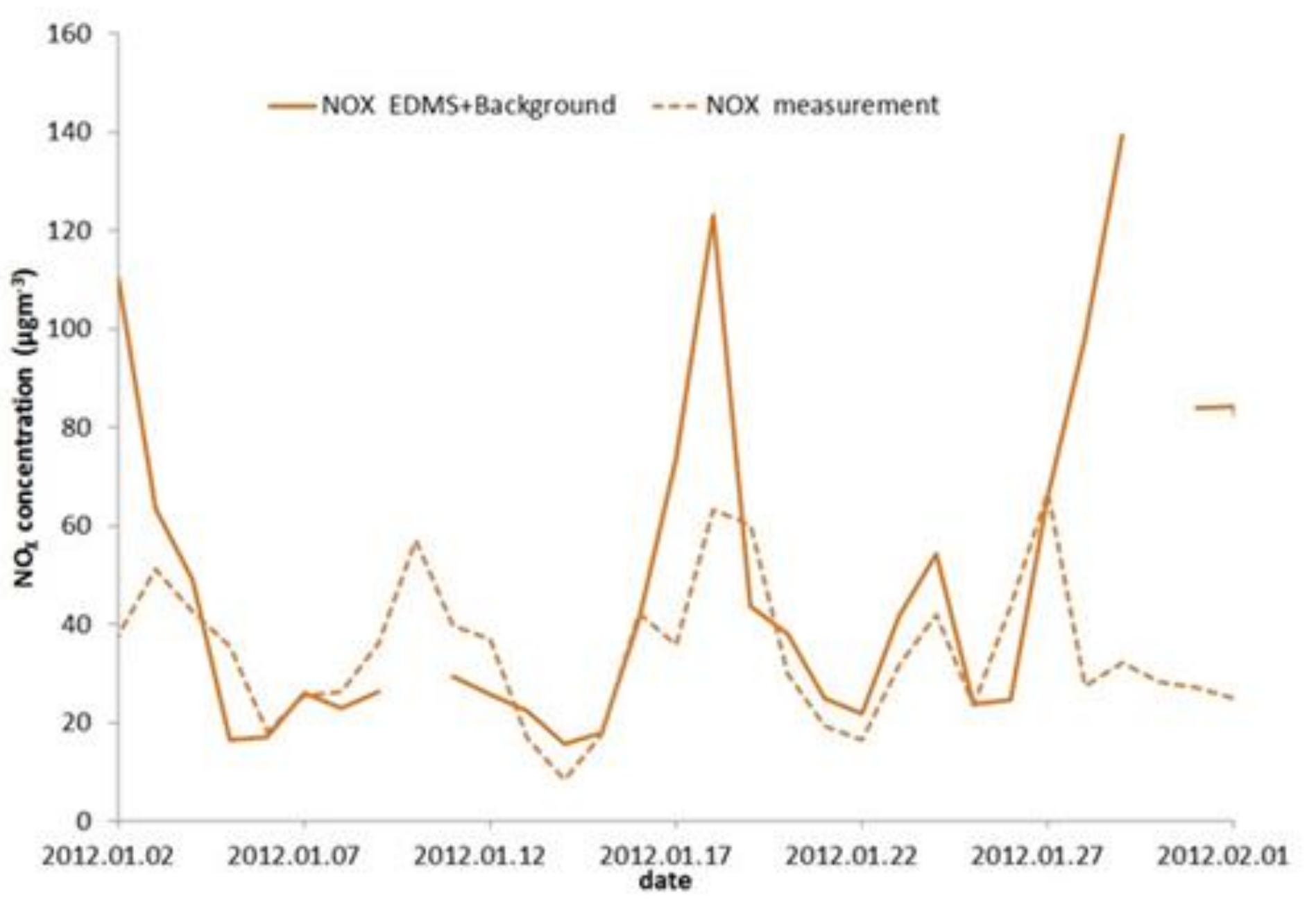
traffic rush hour correction

$$c_{bg,k}^{i} = \begin{cases} f_k \frac{1}{24}\left[\sum_{l \in \bar{H}} c_{l,k}^{i} + \sum_{l \in H}\left(1 - \frac{A_k}{\frac{1}{7}\sum_{j=1}^{7} \overline{c(\max)}_{j,k} - \overline{c(\min)}_{j,k}}\right) c_{l,k}^{i}\right] & if\ weekday \\ f_k \frac{1}{24}\sum_{l=1}^{24} c_{l,k}^{i} & if\ weekend \end{cases}$$

where: $_k$ is the amplitude of the Fourier component with 12h periodic time calculated from the Fourier spectra of the day-of-week averaged hourly concentrations (A_{CO}=78.29 μgm^{-3}, A_{NOX}=17.32 μgm^{-3}, A_{PM10}=1.04 μgm^{-3}), $\overline{c(\max)}_{j,k}$ and $\overline{c(\min)}_{j,k}$ are the averages of the *j*-th day minimum and maximum concentrations (*j*=1…7). *H* is the set of peak hours: *H* = {7,8,9,18,19,20}. f_k linear regression factor was calculated from the minimum values of 00h-06h periods at GT and Airport (f_{CO}=0.7, f_{NOX}=0.6, and f_{PM10}=0.4).

RESULTS:

TIME TREND OF MEASURED AND SIMULATED RESULTS



Daily averages of measured and simulated NO_X concentrations at T2 site in January 2012

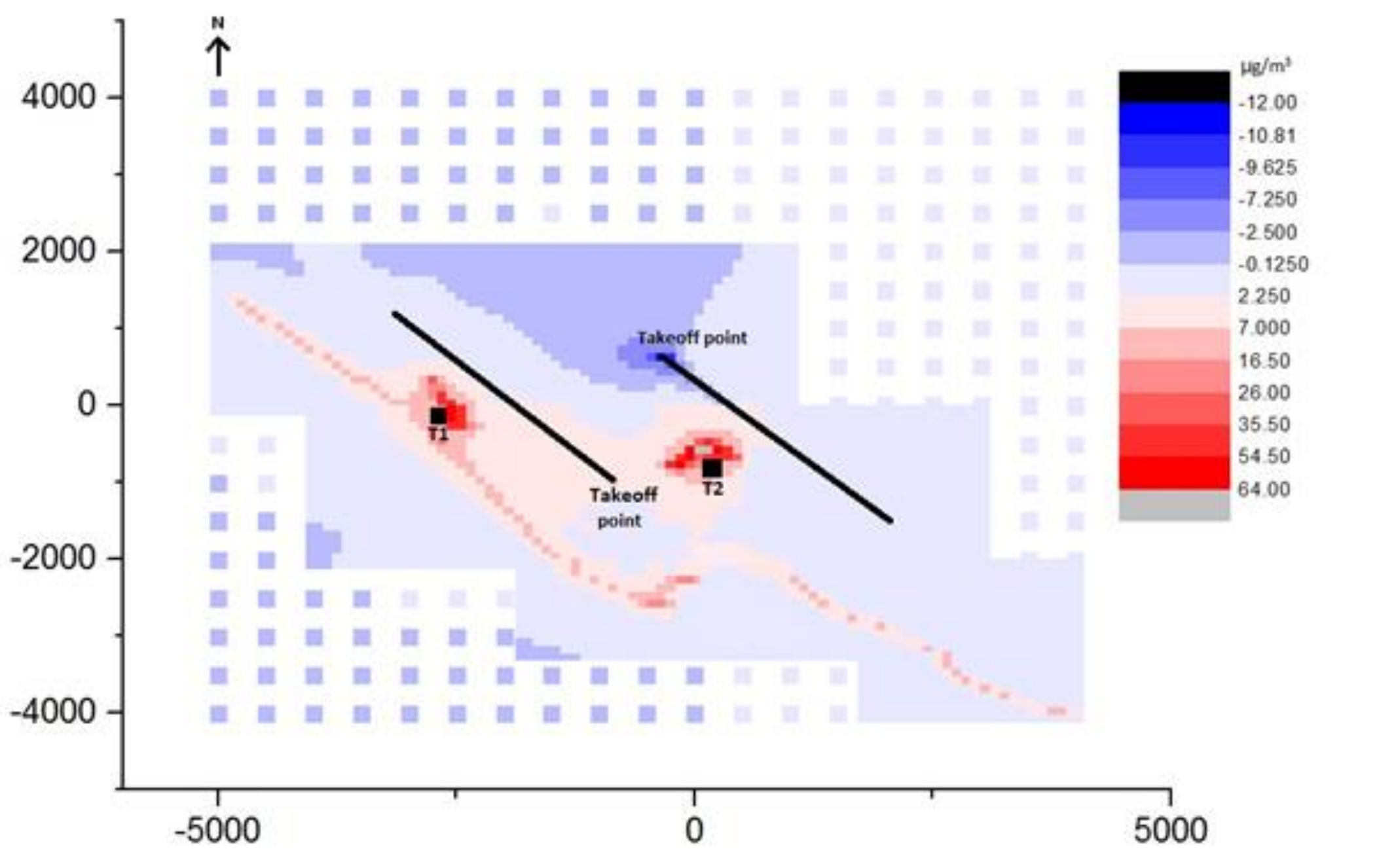
Two periods were chosen for the analysis: years 2006 and 2012. The obtained distributional difference for NO_X in annual averages (grid values for 2012 were subtracted from the ones calculated for 2006) is presented in Figure on the right side.

Areas of T2 and roadways beside Airport area have the highest concentration.

Due to the decrease of aircraft traffic, annual average CO and PM_{10} concentrations were lower in 2012 at the entire Airport area.

A notable difference could be found for NO_X concentrations at takeoff starting points: northern takeoff point showed remarkable NO_X contribution in 2012. This was due to meteorological and operational causes, since in case of no wind Airport operators direct the aircrafts to closer takeoff point. After the closure of T1, the usage of starting points was changed, thus the ratio between the two takeoff starting points have been equalized. It has had significant effect on T2 apron air quality.

EFFECT OF CHANGE IN TRAFFIC



Difference between yearly average of NO_X concentration distribution for 2006 and 2012.

BIVARIATE POLLUTION ROSES

For CO, it was found that emissions originating from the apron area are slightly underestimated. Remarkable difference occurs in the direction of south from receptor point, which area contains the parking places for passenger cars. This amount of shortcoming can be partly explained with the incomplete data of parking usage, but also the weakness of EDMS built-in emission parameters for passenger cars.

For NO_X, the apron and the passenger parking area's emission is underestimated by a factor of 0.3. At the same time, the influence of aircraft emission during takeoff is demonstrable (segment from north to northeast), since concentration distribution shows local maximum in that direction as well.

In case of PM_{10}, a significant underestimation is demonstrated from statistical indicators, however apron area and passenger parking emission shows similar magnitude of emission in EDMS results, which corresponds to the reality. Although background values are determined with assumable uncertainty, the magnitude of PM_{10} concentrations is certainly underestimated by EDMS.

VERIFICATION OF EDMS

One receptor point was used for the verification. Time tendencies of pollutant concentrations were compared for daily averages of measured and simulated (EDMS + background) results. The best agreement was found for CO, and surprisingly good statistical indicator values for PM_{10}. The correlation between measured and modeled NO_X concentrations is the weakest. Since background values are typically small, the discrepancy should originate from modeling.

	Correlation coefficient	BIAS	Relative BIAS	RMSE	Concentration span (μg/m³)
CO	0.71	-0.29	-8,38×10^{-4}	142.16	1234
NO_X	0.53	13.73	0.555	24.59	103
PM_{10}	0.76	-2.31	-0.44	5.11	43

CONCLUSION:

EDMS gives reliable and realistic results for long term data and applicable for air quality management for Budapest Airport.

Some small discrepancies should be corrected by a more precise determination of ground vehicle traffic.

In general, air quality at Airport area became better between the period of 2006 and 2012, while the number of passengers slightly increased, which means that the operational optimization was successful from the environmental aspects.

As a result of rearrangement of aircraft movements, the effect of NO_X contribution due to takeoff emission at Terminal Building 2 depending on meteorological situation can be detectable.

The contribution to Budapest city contamination can be determined by EDMS, especially in critical meteorological situations, when Airport operation related emission cannot be neglected.