LINKS BETWEEN the CONCENTRATIONS of GASEOUS POLLUTANTS MEASURED in DIFFERENT REGIONS of ESTONIA

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INTRODUCTION

The composition and concentrations of trace gases in the ambient air depend on many factors, e.g. on natural and anthropogenic (pollutant) emissions and transport, air chemistry, planetary boundary layer mixing state *etc*. In this study we are interested to find out the links between the patterns of the gas composition measured in various parts of Estonia.

We have used the measured two-year concentrations of hourly averaged values of O_3, NO_2 and SO_2 from the national air quality monitoring stations: background stations Lahemaa, Vilsandi and Saarejärve, urban stations Tallinn-Liivalaia, Tallinn-Õismäe, Tartu, industrial stations Kohtla-Järve, Kunda and Narva (national monitoring system, operated by Estonian Environmental Research Centre), and also the measured concentrations from the Tahkuse rural air monitoring station operated by the University of Tartu. We performed factor analysis (Varimax rotated) to search for the factors that determine the gas concentrations. Our special interest was to examine the regressions to model and predict the ozone concentration at Tahkuse, using the measured data from the same and from the other monitoring stations.

FACTORS that DETERMINE GAS CONCENTRATIONS

Table 1. The scores of the most important factors that determine NO_2 concentration variations at specific stations

Station (NO_2)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Tahkuse	-0.02	**-0.50**	-0.03	-0.24	0.06
Lahemaa	0.02	-0.32	0.09	**0.47**	**-0.42**
Vilsandi	0.03	0.19	**-1.04**	-0.02	0.01
Tartu	-0.03	-0.05	0.00	-0.29	**0.55**
Saarejärve	-0.08	**-0.57**	0.17	-0.16	0.02
Kohtla-Järve	-0.19	0.15	-0.01	0.34	0.33
Narva	-0.17	0.09	0.00	-0.04	**0.59**
Liivalaia	**0.76**	0.03	-0.02	-0.19	-0.22
Õismäe	**0.55**	0.06	-0.03	0.05	-0.16
Kunda	-0.11	0.19	-0.01	**0.75**	-0.10

Table 2. The scores of the most important factors that determine SO_2 concentration variations at specific stations

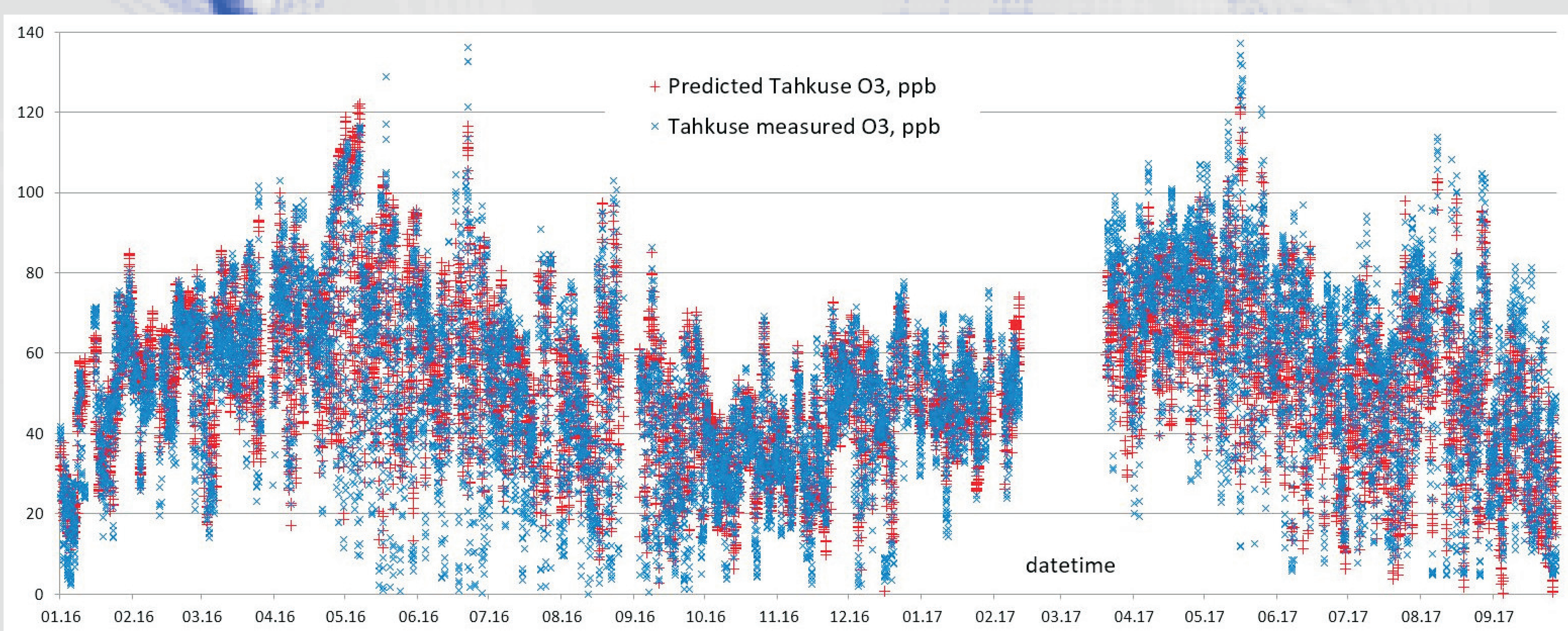
Station (SO_2)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Tahkuse	0.03	-0.04	**0.45**	-0.03	0.18
Lahemaa	**0.44**	-0.07	0.06	0.10	-0.12
Vilsandi	0.20	0.18	-0.14	-0.13	**0.69**
Tartu	-0.27	-0.16	0.02	-0.01	**0.61**
Saarejärve	-0.06	0.04	**0.80**	-0.09	-0.19
Kohtla-Järve	0.01	**-0.65**	-0.05	0.02	-0.10
Narva	0.04	**-0.59**	0.04	-0.04	0.06
Liivalaia	-0.06	0.03	-0.04	**0.53**	-0.05
Õismäe	-0.13	0.00	-0.07	**0.58**	-0.07
Kunda	**0.70**	-0.01	-0.06	-0.18	0.01

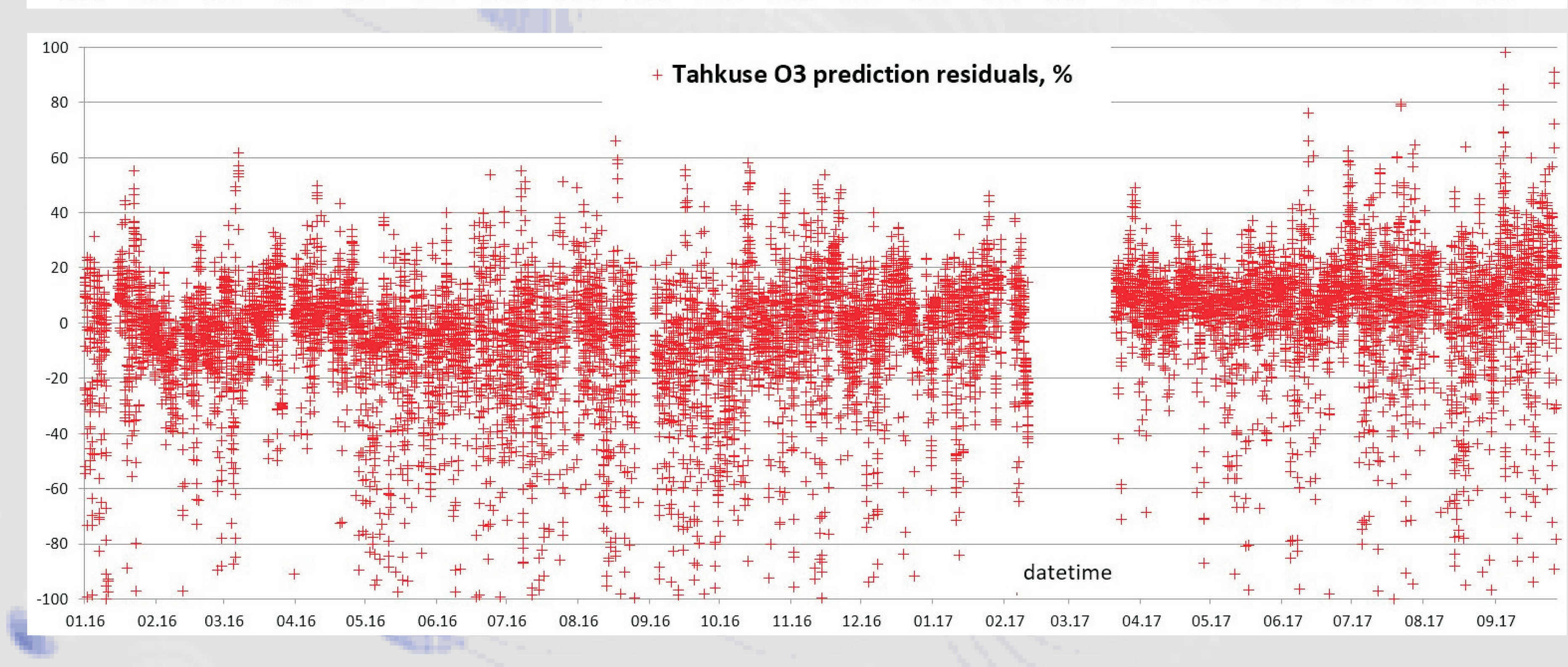
Table 3. The scores of the most important factors that determine ozone concentration variations at specific stations

Station (O_3)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Tahkuse	0.69	0.02	-0.06	-0.14	**-0.51**
Vilsandi	-0.34	-0.10	-0.27	**-1.20**	-0.13
Lahemaa	0.14	-0.12	0.11	0.18	0.20
Tartu	**0.45**	0.17	-0.12	-0.02	-0.18
Saarejärve	**0.76**	-0.07	-0.19	0.21	-0.14
Kohtla-Järve	-0.30	0.00	-0.16	0.07	**0.79**
Narva	**-0.47**	0.06	-0.21	-0.04	**0.88**
Liivalaia	-0.22	0.00	**0.89**	0.17	-0.26
Õismäe	-0.13	-0.08	**0.64**	0.06	-0.14
Tahkuse (NO_2)	0.07	**-0.98**	0.12	-0.14	0.01

The MODEL to PREDICT the OZONE CONCENTRATIONS at TAHKUSE STATION

We made attempts to calculate the Tahkuse ozone concentrations by multiple linear regression analysis using the data from other stations as independent variables. When to consider the simple regressions with only one argument, the highest coefficient of determination R corresponds to the regression where the ozone data from Saarejärve are used as independent variables (R=0.797). In the case of the multiple linear regressions where the data from Vilsandi, Tartu and Lahemaa were added, coefficient R values become equal to 0.854, 0.872 and 0.883, respectively. In the case of the multiple regression where the ozone data from the all stations and also the NO_2 data measured at Tahkuse station were used as independent variables, the determination coefficient R=0.889. The ozone prediction results for the case with four regression arguments (ozone concentrations from Saarejärve, Vilsandi, Tartu and Lahemaa) are depicted in the Figures below.





SUMMARY

We studied the factors that determine the variations in the ambient trace gas O_3, NO_2 and SO_2 concentrations measured at several monitoring stations in Estonia and in particular examined the regressions to predict (model) the ozone concentrations for the Tahkuse station. The SO_2 concentration variantions are quite location-specific, the most important five factors only enable to determine about 67% from the overall variations. The ozone concentrations in general are determined mainly by the first factor that can be roughly rural background mixed with urban-industrial difference (determination coefficent R=0.67), but four more factors can also be distinguished. The ozone concentration at a specific location (Tahkuse) can be predicted using the multiple linear regression model where the measured ozone concentrations at Saarejärve, Vilsandi, Tartu and Lahemaa are taken as the independent variables. In this case the determination coefficient R=0.883 whereas the median of the residuals is equal to about 1.2% (the predicted concentrations are slightly overestimated). Nevertheless, at times the residuals can reach several tens of percents. Unexpectedly we detected that the NO_2 concentrations can not be used as an effective argument to predict the ozone concentration, the corresponding determination coefficient was only about 0.27.

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