Temporal resolution PM and their precursors

Hnilicova H.[1], Dufek J.[2], Habonova J. [1], Keder J. [1]
hnilicova@chmi.cz
[1]Department of Air Quality Protection, Czech Hydrometeorological Institute, 14306, Prague 4, Czech Republic
[2]Department of Infrastructure and Enviromental, Transport Research Centre, 63600, Brno, Czech Republic

Mathematical models of pollution dispersion are the tool for air pollution assessment in addition to monitoring. These models enable to supplement information about air pollution level in the area where the monitoring network is scarce or none at all. The function of emission models is not substitutable by forecasts of air quality load or by variant assessment of proposal measures efficiency for air quality improvement. The uncertainties of model calculations depend, to a certain extent, on input emission data. As emissions from some types of sources show marked temporal variability, it is necessary to put temporal resolution emissions in the models.
For this reason the dataset will be prepared which will include annual emission data temporally disaggregated. The main focus will be laid on temporal disaggregation because spatial disaggregation is already well developed in our country.

1 Introduction

Dust is one of the most monitored pollutants in the long time period. Generally there is known an unfavourable impact on human health especially with interaction of other pollutants. The sources of PM emission are direct emission (primary, e.g. emission from fuel combustion, industrial productions) and the secondary particles formed from other pollutants. The precursors of secondary PM include also SO_2, NOx, NH_3 and anthropogenic and biogenic volatile compounds.
By the selection of emission sources category for disaggregation there was taken into the account their significant temporal variability (daily, weekly, monthly) and substantiality.

2 The selection of categories for disaggregation

The most important periodic emission sources are combustion processes and transport. The share of TSP from combustion of fuels (power plants, heating plants, domestic furnaces, and technological heat production) is about 55 % of total TSP emissions in the Czech Republic and contribution of the transport is 13 %. In addition, the combustion processes for heat production bring on the greatest share of pollutants in the period of unfavourable dispersion conditions. Therefore we focus mainly on these types of sources in the temporal resolution of emissions.
In technological sources, where we can expect periodicity of production and thus of emissions, the greatest share of solid particles pollution is caused by cement and lime

production. The processing of some plant products has also the seasonal production character.

3 Combustion

The time behaviour of emissions from combustion sources is related to the requirement on power supply and it is dependent on outside temperature. This can be stated on the account that the storing of heat and electric power is not efficient and their supply has to be relevant to their consumption.

3.1 Power plants

The emission disaggregation from power plants is processed on the basis of electricity consumption in the last five years in the Czech Republic (http://www.ceps.cz/detail_eng.asp?cepsmenu=13&IDP=330&PDM2=229&PDM3=0&PDM4=0). This long time series data allowed using the cluster analysis for data study.
The cluster analysis is multidimensional statistical method which is used to the object classification. It is used for sorting units in groups (clusters) thus so that the units belonging to the same group were more similar than objects from other groups.
It is possible to carry out the cluster analysis both with the set of objects each of which must be described by way of identical set of attributes, which are useful to be studied within the given set, and with the set of attributes which are characterized by a certain set of objects, which carry these attributes.
This method will objectively classify the time courses into natural groups.

3.1.1 Daily resolution

On the basis of hierarchical clustering method there was estimated that amount of clusters should not exceed 10. Consecutively, experiments were provided using K-means clustering method. An amount of 6 clusters has been chosen as optimal. These 6 clusters joined all cases into logical groups covering work days, Saturdays and Sundays in summer and winter period separately (see Fig.1)

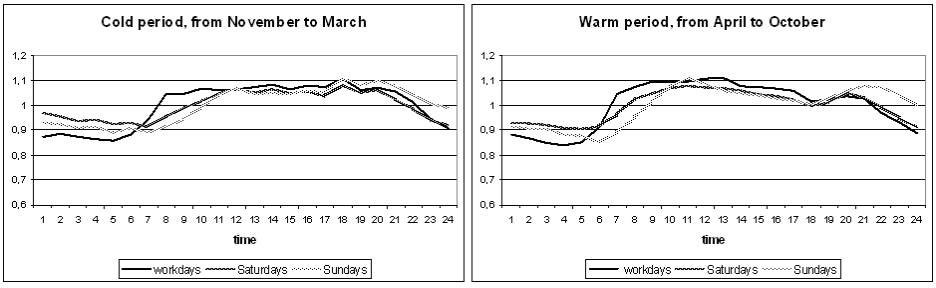

Figure 1 The emission disaggregation of power plants - daily resolution

3.1.2 Weekly resolution

The starting estimate of the number of clusters was 4. However, after the analysis of data assigned to individual clusters it was clear that most values were classified in one group, and the remaining groups included the weeks with public holidays. Consequently, the weekly course is not dependent on the season and is approximately the same throughout the year.

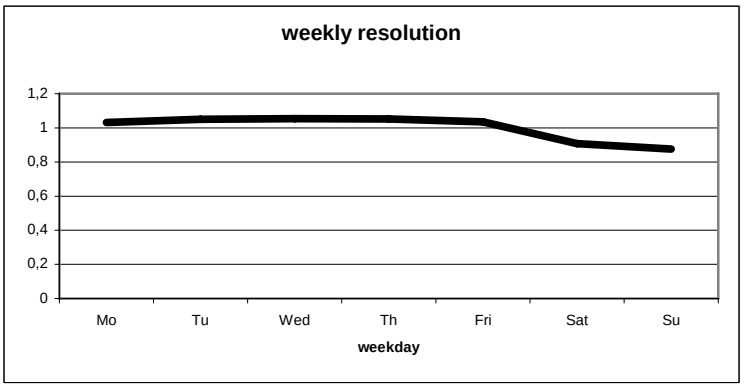

Figure 2 The emission disaggregation of power plants - weekly resolution

3.1.3 Annual resolution

The course was set on the basis of monthly normalized consumption of electricity.

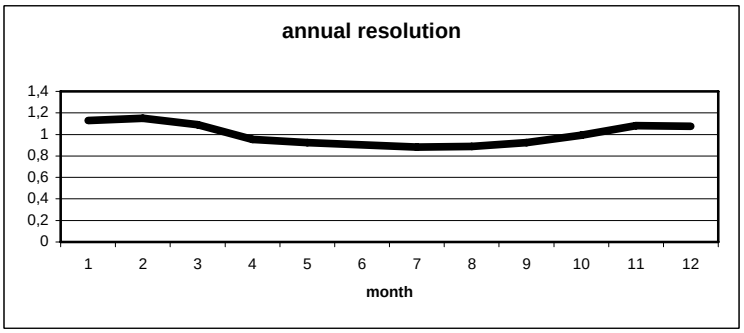

Figure 3 The emission disaggregation of power plants - annual resolution

3.2 Consumption of heat in households

The largest share of heat consumption in households is represented by heating, further part of heat (cca 20 %) is consumed for water heating and cooking. Household gas consumption in Prague seems to be a suitable indicator of emission distribution.

Due to the fact that the main heat medium in Prague is gas and the course of its consumption (http://www.ppdistribuce.cz/apptoky/index) could roughly correspond to time variations of emissions from this sector.

3.2.1 Daily resolution

Cluster analysis was applied again for normalized daily courses of gas consumption and the set of data was gradually divided into various numbers of groups. It appeared that the most natural division is the division into two groups, and namely part of the spring and the autumn periods with relatively cold mornings and warm days (approx. from 15 March to 15 May and from 15 September to 31 October), and the remaining part of the year. There was only slight difference between the courses of consumption in summer and winter months.

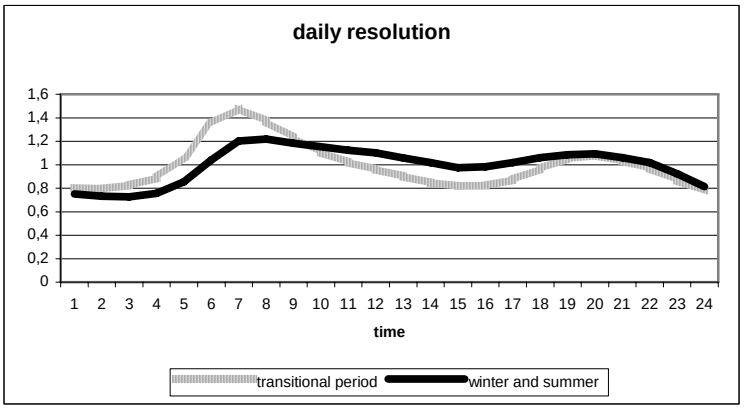

Figure 4 The emission disaggregation of domestic heating – daily resolution

3.2.2 Weekly resolution

The weekly course of gas consumption in Prague shows the decline in consumption on weekends, mainly on Saturdays, which is caused by the fact that the inhabitants leave Prague on Friday afternoon for their weekend cottages in rural areas where solid fuels combustion prevails. As solid fuels have the decisive influence on the amount of emissions, the considerations on weekly variations will not be realized for the time being, and the weekly course will be regarded as constant.

3.2.3 Annual resolution

A model diagram of supply will be used for annual resolution, drawn up by the gas distributor on the basis of long-time experience with annual variability of consumption.

Figure 5 The emission disaggregation of domestic heating – annual resolution

4 Transport

For a time disintegration of emissions from transport, the day and week variation of traffic in a highway regime has been processed. For the determination of variations, the data collected from continual measurement with a help of automatic traffic counters operated by Czech Directory of Roads and Highways have been used. These counters use a system of the loop detection where the device is connected to induction loops placed inside the road pavement. This automatic counter is used for the monitoring of 4 lanes involving both directions of a motorway.

With respect to completely different traffic flows during workdays and weekend days, the evaluations of workdays period and Saturday and Sunday period have been done separately. In cases of national day feasts and holidays that were in working period from Monday to Friday, the extreme abnormal values were found and excluded from statistics.

4.3 The time resolution of emission

The data from field measurement for a period of three months in 2003 (September, October, November) was available. The numbers of passed vehicles in each lane were available per every 15 minutes and it was aggregated to hour traffic volumes. For consequent calculations of emission disintegrations the vehicles split to passenger and freight transport were extracted.

4.3.1 Daily resolution

4.3.1.1 Out-of-city regime

As there was no sufficient amount of data for application of the cluster analysis from traffic study, daily, monthly and annual courses were divided into groups on the base of

the graphical expression. For each of these groups the graph was compiled from average values.

The daily resolution was divided into three groups which represent work days, Saturdays and Sundays.

The freight transport does not display such big differences in peak and evening hours as the passenger one. The freight transport at night is about 2 % while passenger transport in night represents only 0.5 % of total day traffic.

There are clear three tendencies in Figure 6: a decrease in evening hours representing Saturday and an increase of traffic on Sunday, when the traffic of heavy vehicles is allowed from 10 p.m.

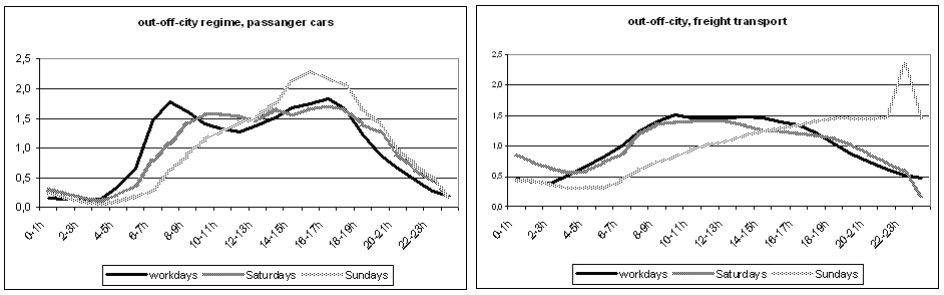

Figure 6 Out-of-city regime – daily resolution

4.3.1.2 Urban regime

For the urban traffic, the data about day-to-day variation in Prague and other Czech big cities, obtained from Institute of Traffic Engineering, were used.

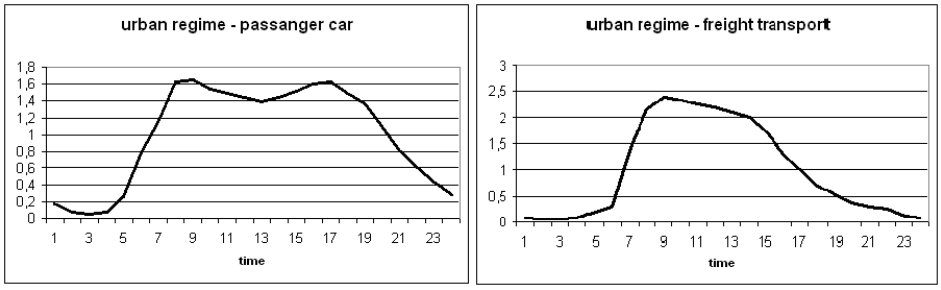

Figure 7 Urban regime – daily resolution

4.3.2 Weekly resolution

Transport intensity is practically constant during work days, on Saturdays and Sundays falls.

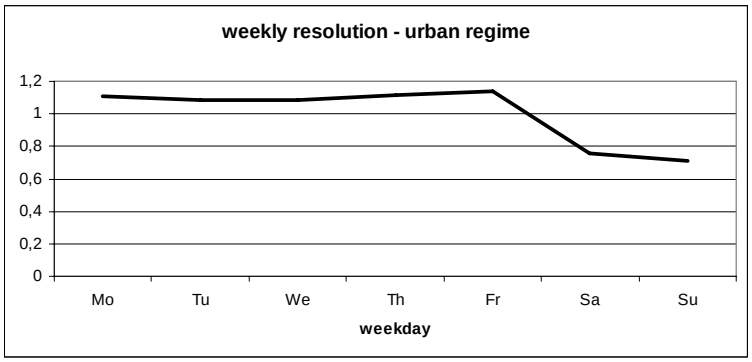

Figure 8 Weekly resolution of transport emission

4.3.3 Annual resolution

The impact of winter traffic reducing is evident mainly in the beginning of a year after Christmas. Due to increased activity before and after the Christmas period, the winter start is accompanied by traffic increase (Fig. 9)

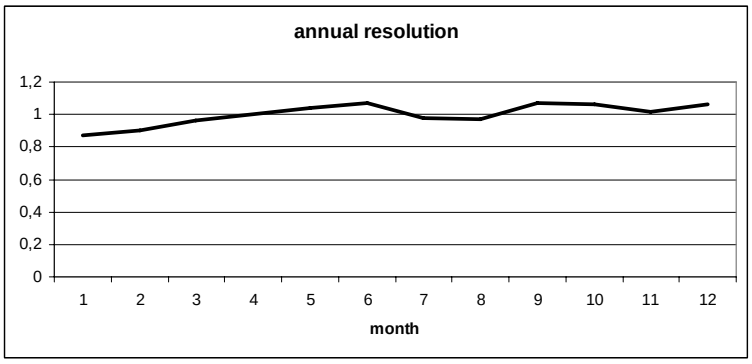

Figure 9 Annual resolution of transport emission

The summer holidays impact is indicated by slight mitigation in urban regime, which is compensated, however, by increase of out-of-city traffic.

5 Conclusions

Fuel combustion and transport contribute to anthropogenic emissions of particles and their precursors substantially. By means of time desegregation, the majority of

emissions arisen from human activities may be decomposed into components with different periods.
Weekly and daily emissions will be decomposed according to distribution of working time along a week and day.
Uncertainties of such decomposition depend, besides of particulate emissions estimates themselves, on the aptness of decomposition indicator choice as well.
Time decomposition of natural emissions and emissions from agriculture are also necessary for assessment of time course of particulate emissions into air.

6 References

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