Slovak
Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2004

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Report was elaborated by

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C O N T E N T

AMBIENT AIR

EMISSIONS

AMBIENT AIR

1

REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

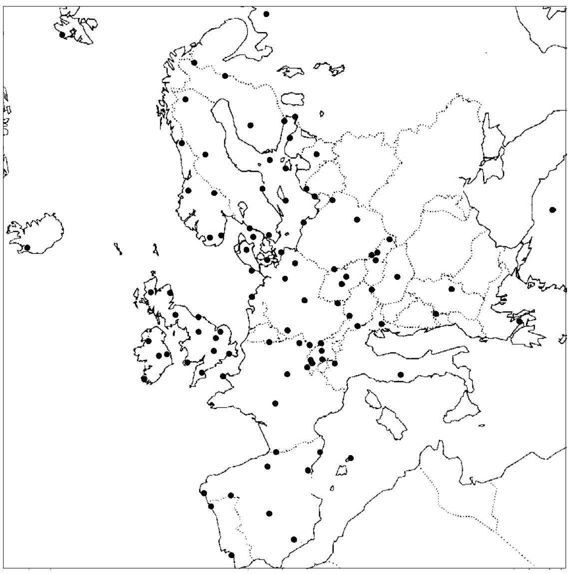
Regional air pollution is a pollution of a boundary layer of a rural country at a sufficient distance from local industrial and urban sources. The boundary layer of the atmosphere is a mixing layer extending itself from the Earth surface up to a height of about 1 000 m. In regional positions, the industrial emissions are more or less evenly vertically dispersed in the entire boundary layer and ground level concentrations are smaller than those in cities.

Pollutants coming from combustion processes such as sulphur dioxide, oxides of nitrogen, hydrocarbons or heavy metals, play an important role on a regional scale. Residence time of these pollutants in the atmosphere is several days and thus they may be transported in the atmosphere over a distance of several thousand kilometres from the source. The products of oxidation from primary gas pollutants, for instance sulphates, may reach the central troposphere by vertical transport, where they are involved in global circulation.

Since 1950, regional air pollution in Europe has been growing parallel with the emissions of pollutants from power generation, industry, heating and transport. The construction of high stacks showed to have a negative impact on the environment, as these prolonged the residence time of pollutants in the atmosphere. Acidity of precipitation, as well as the concentrations of secondary pollutants, such as ozone, hydrogen peroxide and others, has risen in the atmosphere as a result of uncontrolled emission development. At present, ozone and acid precipitation are considered to be the two main stress factors for the forest and agriculture ecosystems in Europe.

Unfavourable development along with the alarming growth of ecological damages did enhance international co-operation. The UN ECE Convention on Long Range Transboundary Air Pollution (CLRTAP) was signed in 1979. Since its entry into force in 1983 the Convention has been extended by eight protocols: Protocol on Long-term Financing of the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (Geneva, 1984); Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 Per Cent (Helsinky, 1985); Protocol Concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (Sofia 1988); Protocol Concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (Geneva 1991); Protocol on Further Reduction of Sulphur Emissions (Oslo, 1994); Protocol on Heavy Metals (Aarhus, 1998); Protocol on Persistent Organic Pollutants (Aarhus, 1998); The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg, 1999). The commitment to the first sulphur Protocol represented a 30 % reduction of European sulphur dioxide emissions by 1993 as compared to 1980. The Slovak Republic has fulfilled this commitment. Reduction of European emissions has already been manifested in a decrease of acidity in precipitation over the territory of Slovakia. In compliance with the second sulphur Protocol, the European sulphur dioxide emissions should be reduced 60 % by 2000, 65 % by 2005 and 72 % by 2010, as compared to 1980. According to the last sulphur Protocol the Slovak Re-

Fig. 1.1 **Network of EMEP monitoring stations**



public should reduce its emissions of sulphur dioxide 80 % by 2010 as compared to 1980, those oxides of nitrogen 42 %, ammonia 37 % and volatile organic compounds 6 % as compared to 1990.

Implementation of the Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe - EMEP is a part of the Convention. In accordance with the Convention, the EMEP is mandatory to all European countries. Its goal is to monitor, model and evaluate the long-range transport of air pollutants in Europe and elaborate foundations for the strategy to reduce European emissions. There are two EMEP coordinating centres in Norway, MSC W - Meteorological Synthesising Centre West - Norwegian Meteorological Institute in Oslo and CCC- Chemical Coordinating Centre - NILU-Norwegian Institute for Air Research in Kjeller. The third EMEP coordinating center is in Russia, MSC E - Meteorological Synthesising Centre East - Institute for Applied Geophysics in Moscow and the fourth EMEP coordinating center is in Austria, CIAM - Centre for Integrating Assessment Modelling - IIASA - International Institute for Applied Systems Analysis in Laxenburg. The EMEP monitoring network (Fig. 1.1) comprises approximately 100 regional stations. Five stations in the territory of Slovakia belonging to the national monitoring network of the Slovak Hydrometeorological Institute are at the same time also a part of EMEP network. The basic EMEP monitoring programme has been gradually enhanced, first for sulphate, oxides of nitrogen, ammonium and ozone. In 1994, the measurements of volatile organic compounds (VOCs) have begun to be carried out under the auspices of CCC - NILU. At present the EMEP monitoring programme includes also the monitoring of heavy metals (HMs), PM_{10} mass concentration and persistent organic compounds (POPs). The new monitoring strategy has been adopted and EMEP stations will be classified into the three levels according to the monitoring programmes (more details on www.emep.int).

Results of measurements from the regional network of stations in Slovakia are also used in other monitoring programmes like GAW/BAPMON (Global Atmosphere Watch/Background Air Pollution Monitoring Network) under WMO and UNEP/GEMS (United Nations Environment Programme/ Global Environment Monitoring System).

The level of regional air pollution is not assessed according to the primary ambient air quality standards, but according to the secondary ambient air quality standards and deposition limits, and thus on the long-term impact in the environment. Clean Air Act No 309/91 Coll. does include the category of secondary ambient air quality standards and deposition limits, but these have not been adopted in the Slovak Republic up to now.

The determination of secondary ambient air quality standards, or ecological limits are based on the conception of critical levels and critical loads.

Critical level (CL) is the highest concentration of pollutant which ecosystem may tolerate without being injured. Critical levels are different for individual pollutants and individual ecosystems. In the Draft Manual for Mapping Critical Levels/Loads, UN ECE, 1990, the following critical levels are suggested:

Pollutant	**Ecosystem**	**CL** [$\mu g.m^{-3}$]	**Period**
SO_2 - S	Forest Natural vegetation Agricultural crops	10 10 15	annual average
NOx - N	All categories	9	annual average
O_3	All categories	50 60 150	9-16 h average (1.4 - 30.9) 8- h average 1- h average

According to the Directive of European Community (1992), the critical ozone level for protection of vegetation was indicated 200 $\mu g.m^{-3}$ as 1-hour average and 65 $\mu g.m^{-3}$ as 24-hour average.

Executive body of Working Group on Effects within the framework of the Convention proposed the following cumulative critical levels for ozone:

- **Critical level for agricultural crops**, expressed as cumulative exposure of concentrations above 40 ppb. This index of exposure AOT40 (accumulated exposure over a threshold of 40 ppb) is calculated as the sum of the differences between 1-hour ozone concentrations in ppb for each daylight hour between 9.00 and 16.00 in which the concentration is over 40 ppb and average global radiation intensity 50 $W.m^{-2}$ or more during the period of three months May, June and July. AOT40 of 3 000 ppb h corresponds to a 5 % yield crop loss.
- **Short term critical level for agricultural crops and natural vegetation** AOT40 is 500 ppb h, cumulated within five subsequent days under low (water) vapour pressure deficit and 200 ppb h, cumulated within five subsequent days under high (water) vapour pressure deficit conditions. These values are related to daylight hours.
- **Critical level for forest ecosystems:** AOT40 is 10 ppm h. This cumulative exposure is calculated for 24 hours in a day, during a period of six months, when the trees are most sensitive to ozone.

Critical load is the deposition ecological limit and represents the maximum permissible deposition of pollutant in an ecosystem. Critical load is expressed in the mass of pollutant over the area unit per time unit (e.g. $g.m^{-2}.year^{-1}$, $kg.ha^{-1}.year^{-1}$, or $equivalent.ha^{-1}.year^{-1}$). This is a function of ecosystem sensitivity. Total deposition is composed of dry, wet and occult deposition. Dry deposition represents interception of gases and particles on the surface, mainly by vegetation. Wet deposition represents substances in rainwater and occult deposition is interception of droplets from clouds and fogs on the surface of predominantly vegetation, mainly in mountains. Dry deposition is calculated on the regional concentration of respective substances and surface behaviour, wet on annual concentration of respective substances in rainwater and annual totals of precipitation amount, occult in the differences between values from rain gauges placed under the tree canopy and those in free areas.

The territory of the Slovak Republic is ecologically mid-sensitive to sulphur deposition. The value of critical sulphur loads over the territory of Slovakia is represented by 1-3 $g\ S.m^{-2}.year^{-1}$, or 10-30 $kg\ S.ha^{-1}.year^{-1}$. However, the real sulphur deposition exceeded these values on approximately 25 % of the forest area within the last decade. Despite the fact, the European sulphur dioxide emissions have decreased, the values of total sulphur deposition are higher than the critical load. Typical values of sulphur deposition expressed in $g\ S\ m^{-2}.year^{-1}$ for the lowlands and mountain positions of Slovakia in 2004 are summarized in the following table:

Sulphur deposition	Danube lowlands	Mountain position (> 1 500 m)
Dry	0.34	0.08
Wet	0.38	0.66 (1.0)$^{+}$
Hidden	0.04	0.33 (0.5)$^{++}$
Total	**0.76**	**1.07 (1.58)**

Critical load	**1.0 - 3.0**

$^{+}$ *With regard to the correction of negative error in amount of precipitation measurements in mountains*

$^{++}$ *upper level of estimate at occult deposition*

A detailed assessment of critical loads (ecological sensitivity of the territory) and determination of target loads in Slovakia for sulphur, nitrogen, actual acidity, heavy metals and some other pollutants have not been completed yet. These data are needed for Environment Impact Assessment (EIA) on long-range transmission of air pollutants as well as the EIA studies of the new large air pollution sources.

1.2 REGIONAL STATIONS IN THE SLOVAK REPUBLIC

In 2004, there were 5 stations in operation in the Slovak Republic to monitor regional air pollution and chemical composition of precipitation. Location and elevation of the individual stations are indicated in Figure 1.2. All these stations are part of the EMEP network. Apart from the above-mentioned, monthly precipitation have been sampled in the meteorological garden of the Slovak Hydrometeorological Institute in the Bratislava-Koliba station, in elevation 286 m, and analyzed on the content of heavy metals.

Regional station

Chopok

Meteorological observatory of the Slovak Hydrometeorological Institute, located on the crest of the Low Tatras mountains, 2 008 m above sea level, 19°35'32" longitude, 48°56'38" latitude. Measurements started in 1977. Since 1978 the station has been a part of the EMEP network and GAW/ BAPMoN/ WMO network.

Topoľníky

The Aszód pump station on the small Danube river, 7 km south-east of the Topoľníky village, in plain terrain of the Danube lowlands, 113 m above sea level, 17°51'38" longitude, 47°57'36" latitude. Only family houses for employees of the pump station are situated nearby. Measurements have been carried out since 1983. Since 2000 the station has become a part of the EMEP network.

Liesek

Meteorological observatory of the Slovak Hydrometeorological Institute on east-western side of the Roháče mountains, nearby to the Liesek village, 692 m above sea level, 19°40'46" longitude, 49°22'10"latitude. Measurements started to be carried out in 1988. Since 1992 the station has become a part of the EMEP network.

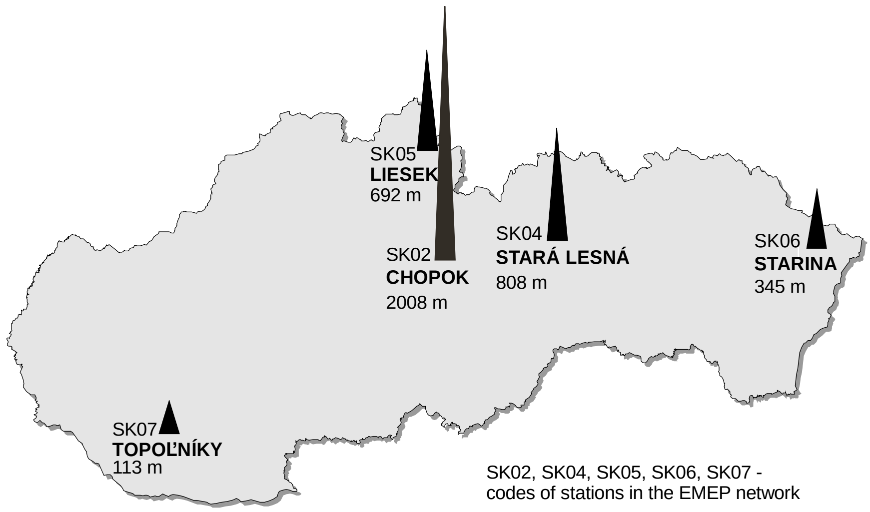
Stará Lesná

Station is situated in the area of the Astronomic institute of the Slovak Academy of Sciences on the south-eastern edge of TANAP (National Park of the Tatras), 2 km north from the Stará Lesná village, 808 m above sea level, 20°17'28" longitude, 49°09'10" latitude. The station started measurements in 1988. Since 1992 the station has become a part of the EMEP network.

Starina

Station is situated in the region of the Starina water reservoir, 345 m above sea level, 22°15'35" longitude, 49°02'32" latitude. Nearby are located only the buildings of the Bodrog river and Hornád river watershed. The station started to be operated in 1994. The same year the station has become a part of the EMEP network.

Fig. 1.2 **Regional stations in the Slovak Republic – 2004**



Measurement programme

AMBIENT AIR	Gas components	SO_2, NOx, HNO_3 - 24-hour sampling
		O_3 - continuous registration by analyzer
		VOCs C_2 - C_6 10-15 minute sampling 2x weekly at 12.00 noon
	Particulate matter	PM mass concentration - 7 day sampling interval
		Pb, Cu, Zn, Mn, Cr, Ni, Cd, As - 7 day sampling
		SO_4^{2-}, NO_3^- - 24- hour sampling
PRECIPITATION	Daily and weekly precipitation	pH, conductivity, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}
	Monthly precipitation	Zn, Cu, Cr, Ni, Pb, Cd, As

Methods of determination

		Collection	Determination
AMBIENT AIR	**SO_2**	cellulose filter W40 impregnated by KOH solution	IC - Dionex
	NOx	after oxidation into NaOH absorption solution with guajacol	spectrophotometrically, spectrophotometer Unicam/Helios α - modified Salzman method
	HNO_3	cellulose filter W40 impregnated by KOH solution	IC - Dionex
	O_3	registration by analyzer TEI, API and Horiba	principle - UV absorption
	VOCs C_2 - C_6	stainless steel canister	GC-Perkin Elmer + FID
	PM weight mass	nitrocellulose filter Sartorius	Gravimetrically, Sartorius/Mettler Toledo balances
	Heavy metals - Pb, Cd, Cu, Cr, Ni, Zn, As	nitrocellulose filter Sartorius	after digestion in MW-oven by ICP-MS and AAS Perkin Elmer in flame
	SO_4^{2-}	cellulose filter W40	ITP from water solution
	NO_3^-	cellulose filter W40	ITP from water solution
PRECIPITATION	**pH**	"wet only" - rain gauges WADOS "bulk" - NILU sampling PE vessel	pH meter Mettler Toledo
	Conductivity		conductometer Mettler Toledo
	SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}		IC - Dionex
	Zn, Cu, Cr, Ni, Pb, Cd, As		AAS - Perkin Elmer, in flame or graphite atomizer and MHS

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2004

SO_2, sulphate

Regional concentrations of sulphur dioxide (Tab. 1.1, Fig. 1.3) ranged between 0.44 µg S.m^{-3} (Chopok) and 1.81 µg S.m^{-3} (Topoľníky), in 2004. As compared to 2003, the values of sulphur dioxide were lower at the most of the stations, only at the Liesek station the value was almost the same as the previous year. The upper value of the concentration range represents less than 20 % of the critical sulphur dioxide level (critical level for forest and natural vegetation is 10 µgS.m^{-3} and for agricultural crop 15 µgS.m^{-3}). ***In coincidence with the Annex 1 to the Decree of the Ministry of Environment of the Slovak Republic No 705/2002, limit value for protection of ecosystems is 20 µg SO_2.m^{-3} in calendar year and winter season. This limit value did not reach even one fifth in any of the stations in calendar year and in winter season the highest value from all the stations was lower than one third of the mentioned limit value only in one station (Topol'níky).*** As compared to the previous year, the concentrations of sulphates in atmospheric aerosols in 2004 were very similar at Chopok, Starina and Topoľníky, the differences represented only hundredths of µg S.m^{-3} while in Liesek and Stará Lesná the difference was higher, in tenth of µg S.m^{-3} (Tab. 1.1, Fig. 1.3). The regional level of sulphates in Chopok was 0.40 µg S.m^{-3}; in Stará Lesná, Starina, Liesek and in Topoľníky the annual averages overstepped 1 µg S.m^{-3}, in Topoľníky the value was the highest 1.22 µg S.m^{-3}. Sulphates contributed to the total mass of particulate matter 16-25 % (Fig. 1.4). Concentration ratio of sulphates to sulphur dioxide, expressed in sulphur presents interval 0.7-1.8, corresponding to the regional level of pollution.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air – 2004**

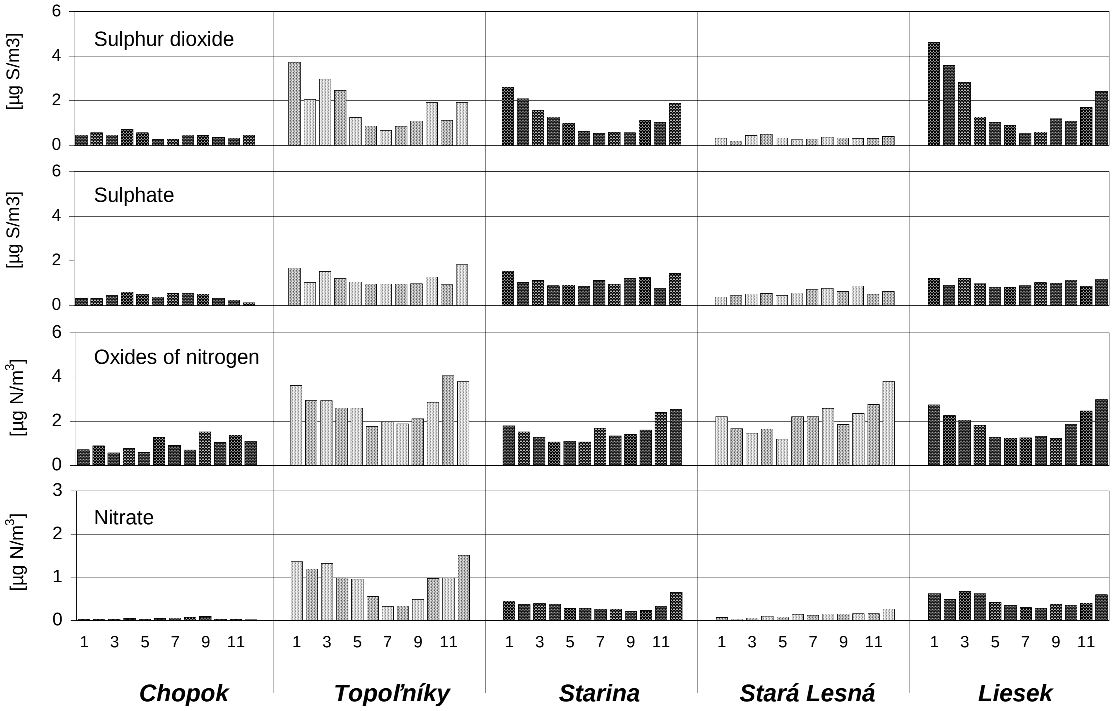
	SO_2-S µg/m^3	SO_4-S µg/m^3	NO_2-N µg/m^3	NO_3-N µg/m^3	HNO_3-N µg/m^3	O_3 µg/m^3	PM µg/m^3	Pb ng/m^3	Mn ng/m^3	Cu ng/m^3	Cd ng/m^3	Ni ng/m^3	Cr ng/m^3	Zn ng/m^3	As ng/m^3
Chopok	0.44	0.40	0.95	0.05	0.03	91	7.6	2.38	1.50	0.40	0.07	0.60	1.04	5.13	0.19
Topoľníky	1.81	1.22	2.76	0.95	0.06	59	20.2	11.6	6.56	3.00	0.28	1.12	1.23	17.21	0.97
Starina	1.24	1.09	1.57	0.34	0.05	66	16.3	12.8	3.89	1.72	0.51	0.71	0.62	17.49	0.60
Stará Lesná	0.66	1.17	2.15	0.24	0.04	62	13.8	8.46	4.03	1.68	0.25	0.79	1.35	16.44	0.67
Liesek	1.76	1.00	1.87	0.46	0.03	62	17.9	11.7	20.2	2.05	0.41	0.71	0.61	30.70	1.91

NOx, nitrates

Regional concentrations of oxides of nitrogen at regional stations, expressed in NO_2-N (Tab. 1.1, Fig. 1.3) varied within the range 0.95-2.76 µg N.m^{-3} in 2004. The smallest annual average value was recorded at Chopok 0.95 µg N.m^{-3}, the higher one at Starina 1.57 µg N.m^{-3}, at Liesek 1.87 µg N.m^{-3} and values over 2 µg N.m^{-3} in Stará Lesná 2.15 µg N.m^{-3} and value 2.76 µg N.m^{-3} at the Topoľníky lowlands station. A critical level of concentrations of nitrogen oxides (9 µg N.m^{-3} for all ecosystems) was not exceeded at any of the stations in 2004. The highest concentrations of oxides of nitrogen in Topoľníky 2.76 µg N.m^{-3} represents less than one third of critical level. ***In coincidence with the Annex 1 to the Decree of the Ministry of Environment of the Slovak Republic No 705/2002, limit value for protection of ecosystems is 30 µg NO_x.m^{-3} in calendar year. This limit value was not exceeded at any of the stations. The highest value from all the stations (in Topol'níky) is below 30 % of the limit value.*** Nitrates in ambient air occurred predominantly in the form of particulates (Tab. 1.1, Fig. 1.3) in 2004 and at the most of the stations were lower comparing to 2003. Concentrations of nitric acid (Tab. 1.1) were lower at all the stations comparing to particulate nitrates, however in Topoľníky, Starina, Stará Lesná and Liesek were lower one order of magnitude while at Chopok the level of nitric acid and particulate nitrate was at the same concentration level.

Though both these forms of nitrogen are collected on filters and measured separately, CCC EMEP does require reporting of their sum, because their phase division is dependent upon ambient air temperature and humidity. Nitrates contributed to the total mass of particulate matter 3-21 % (Fig. 1.4). Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NO_2 expressed in nitrogen represented the range 0.1-0.4.

Fig. 1.3 Monthly mean concentrations in ambient air – 2004



Particulate matter, heavy metals

Concentrations of particulate matter ranged from 7.6 to 20.2 µg.m^{-3} in 2004 (Tab. 1.1). As compared to 2003 PM (TSP and PM_{10}) concentration was lower at all the stations. The most distinctive decrease was at the Topoľníky station, more than one third; the less distinctive difference appeared at the Stará Lesná and Starina stations and the decrease over 20 % was recorded at the Chopok and Liesek stations. It is necessary to stress that values of PM introduced in tables for 2004 are as TSP for the Chopok and Topoľníky stations and as PM_{10} for the Stará Lesná, Liesek and Starina stations. In Table 1.1 and Figures 1.4 and 1.5 are introduced concentrations of heavy metals in regional stations in 2004. As far as the concentrations of the individual metals are concerned, at the Chopok station the decrease of lead, manganese, copper, cadmium, nickel and chromium was recorded, while increase of zinc and arsenic. At the Topoľníky station the significant decrease of all metals measured, mainly chromium, zinc, manganese, arsenic, lead and cadmium was found, to a lesser degree also copper and nickel. At the Starina station the lower values of lead, manganese, zinc, arsenic and chromium were measured than in 2003, the copper concentrations were higher; the concentrations of cadmium and nickel were almost the same as in 2003. At the Stará Lesná station the 2004 concentrations of lead, manganese, cadmium, zinc and arsenic were lower comparing to 2003, however copper, chromium and nickel showed higher values. At the Liesek station the values of lead, zinc, arsenic and chromium and to a lesser degree cadmium recorded lower values than in 2003; manganese, copper and nickel were higher in 2004 than in 2003. To assess the trend, the most outstanding decrease was at lead. This fact has been linked with the gradual lead decrease in petrol since 1982 and the production of lead-free petrol only at the present time. The share of the sum of all measured metals in mass of suspended particles varied within 0.2-0.4 % (Fig. 1.4).

Fig. 1.4 **Composition of PM mass and proportional share of heavy metals – 2004**

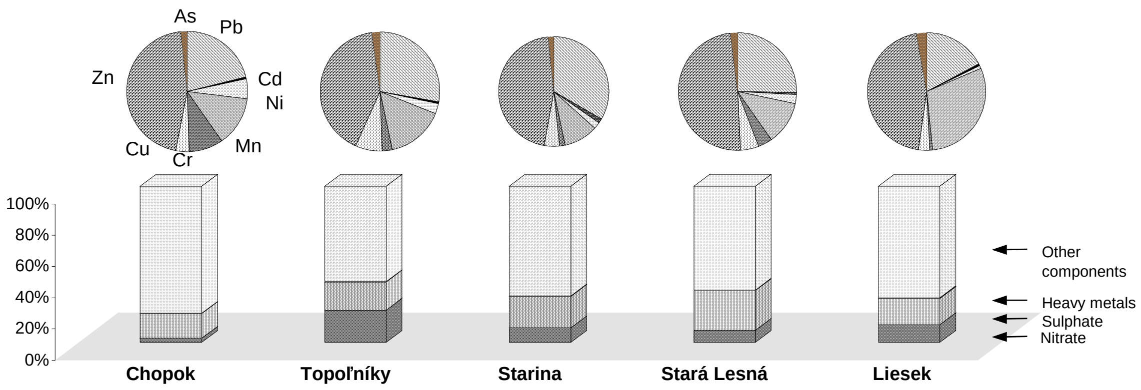
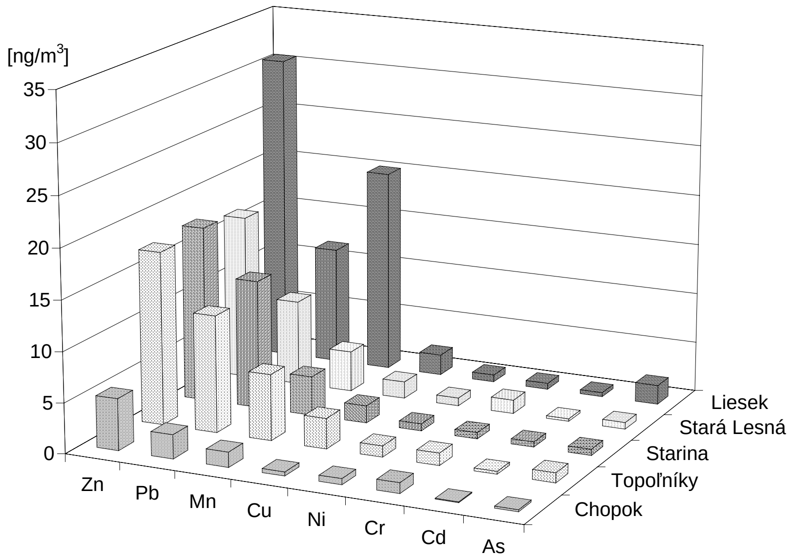


Fig. 1.5 **Heavy metals in ambient air – 2004**

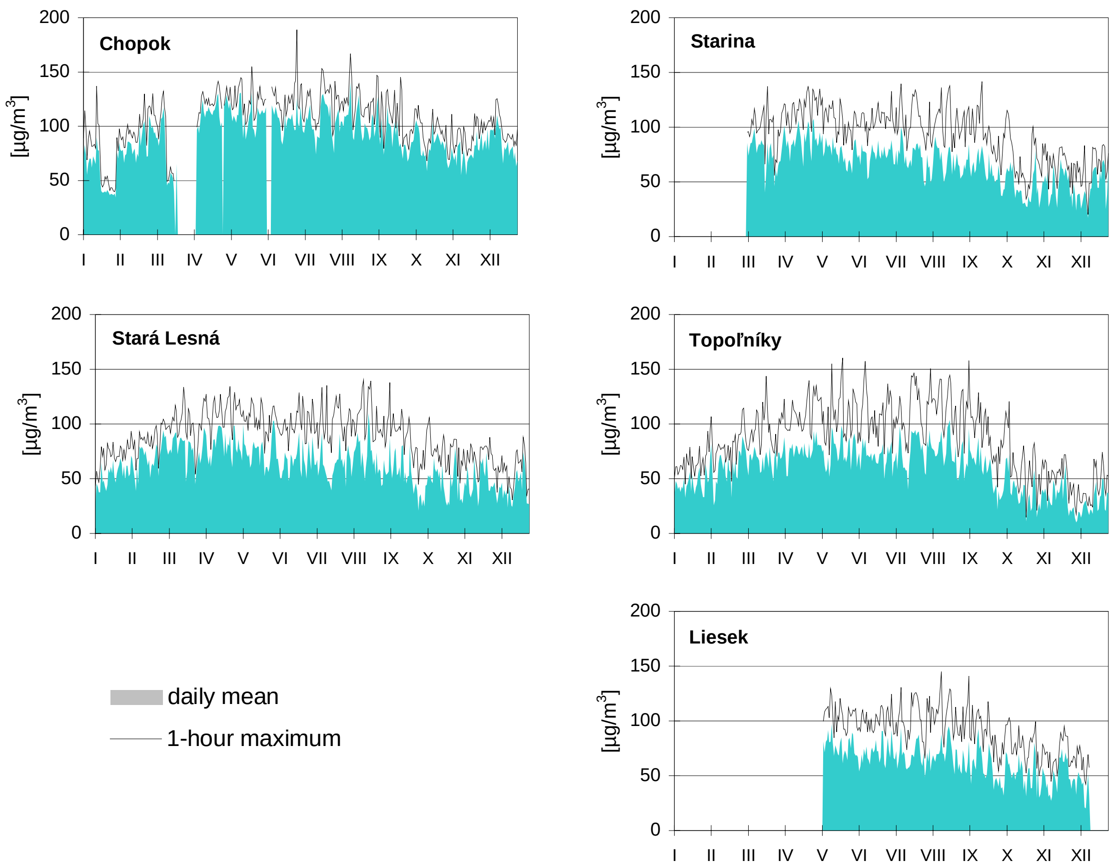


Ozone

In Figures 1.6 the annual course of ground level ozone concentrations at 4 regional stations Chopok, Stará Lesná, Starina and Topoľníky are depicted. The longest time series of ozone measurements is at the Stará Lesná station. The measurements of ozone in Topoľníky, Starina and Chopok began to be carried out later, in 1994 and in Liesek in 2004. In 2004, the annual average of ozone concentration at the Chopok station reached 91 $\mu g.m^{-3}$, at Starina 66 $\mu g.m^{-3}$, at Stará Lesná 62 $\mu g.m^{-3}$ and at Topoľníky 59 $\mu g.m^{-3}$ and in Liesek 62 $\mu g.m^{-3}$ (start of measurement 5.5.2004). Measurements of ozone and exceedances of critical levels are completely assessed in Chapter 3 Atmospheric Ozone.

An increase in ozone concentrations was observed within 1970-1990, on average 1 $\mu g.m^{-3}$ annually. After 1990 the increase slowed down or stopped in compliance with the other European observations. This trend does correspond to the European development of ozone precursors.

Fig. 1.6 **Ground level ozone – 2004**



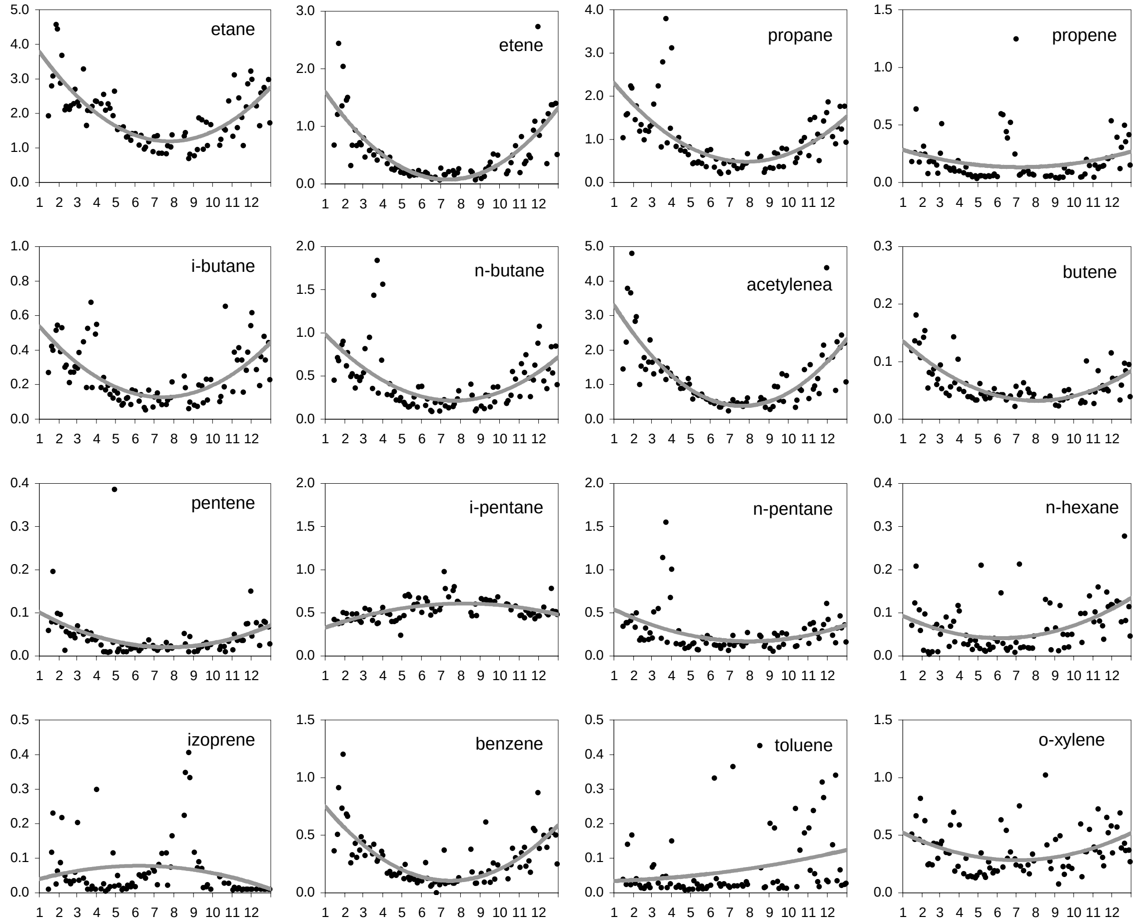
VOCs C_2-C_6

VOCs (Volatile organic compounds) C_2-C_6, or the so-called light hydrocarbons, started to be sampled in autumn 1994 at the Starina station. Starina is one of the small number of European stations, included into the EMEP network with regular sampling of volatile organic compounds. They are then measured and assessed according to the EMEP method elaborated by CCC-NILU. Their concentrations ranged within one order of magnitude from the tenth of ppb up to several ppb (Tab. 1.2, Fig. 1.7). In 2004 the ethene, n-hexane an izoprene showed lower values, approximately half of those ones in 2003. Butene was significantly higher and at the rest of hydrocarbons the differences were very small as compared to 2003. The presence of isoprene, releasing out of the near forest growth was remarkable. Measurements of identical samples carried out in the Slovak Hydrometeorological Institute and in EMEP CCC -NILU showed a high degree of agreement. The measurements carried out within the AMOHA (Accurate Measurements of Hydrocarbons in the Atmosphere) project, organised by NPL (National Physical Laboratory) in the United Kingdom and IFU (Fraunhofer Institute) in Germany, will be used for elaboration of European directive for optimum sampling and assessment of hydrocarbons. The VOC measurements are burdened with a considerable problems last couple of years, concerning not only the operation of a new gas chromatograph, but also the contamination of an indoor working space due to the building and other changes in the Slovak Hydrometeorological Institute.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air – Starina – 2004**

etane	etene	propane	propene	i-butane	n-butane	acetylene	butene	pentene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
1.904	0.539	0.976	0.181	0.250	0.431	1.209	0.509	0.043	0.535	0.268	0.060	0.066	0.296	0.068	0.362

Fig. 1.7 **VOCs [ppb] – Starina – 2004**



Precipitation

The natural acidity of precipitation in balance with atmospheric carbon dioxide is 5.65 pH. Atmospheric precipitation are considered to be acidic if the sum of anions is higher than the sum of cations and the value of pH is smaller than 5.65. Precipitation contains mainly sulphates, nitrates and chlorides as anions, but in a smaller amount also anions of weak mineral and organic acids. Sulphates contribute to the acidity of precipitation 60-70 %, while nitrates 25-30 %. Share of chlorides, weak mineral and organic acids is small. Chlorides are almost exclusively a part of neutral salts, predominantly of marine origin. Among the cations the dominant is ammonium, ions of calcium, magnesium, sodium and potassium. Ammonium is a special case because in soils it may be oxidized to nitric acid.

Major ions, pH, conductivity

Chemical analyses document a slight increase in acidity in 2004 as compared to 2003 at the stations with the lowest elevation, i.e. at the lowlands station Topoľníky and at Liesek. The Stará Lesná station showed the same pH annual value 4.7 in 2004 as in 2003, while at the Chopok and Starina stations the decrease in acidity was recorded. The interval of pH values in precipitation ranged between 4.6-4.8 (Tab. 1.3, Fig. 1.8).

Tab.1.3 **Annual averages of main components in daily precipitation – 2004**

	precip. mm	pH	cond. µS/cm	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	NH_4-N mg/l	NO_3-N mg/l	SO_4-S mg/l
Chopok	1188	4.7	15.0	0.20	0.16	0.025	0.20	0.22	0.39	0.29	0.56
Topoľníky	571	4.8	16.2	0.31	0.24	0.045	0.33	0.22	0.60	0.39	0.67
Starina	981	4.7	17.7	0.27	0.26	0.037	0.35	0.28	0.42	0.38	0.64
St. Lesná	880	4.7	18.2	0.22	0.23	0.035	0.26	0.26	0.44	0.35	0.66
Liesek	858	4.6	19.2	0.25	0.22	0.043	0.32	0.37	0.47	0.41	0.67

Fig. 1.8 **Daily precipitation – 2004**

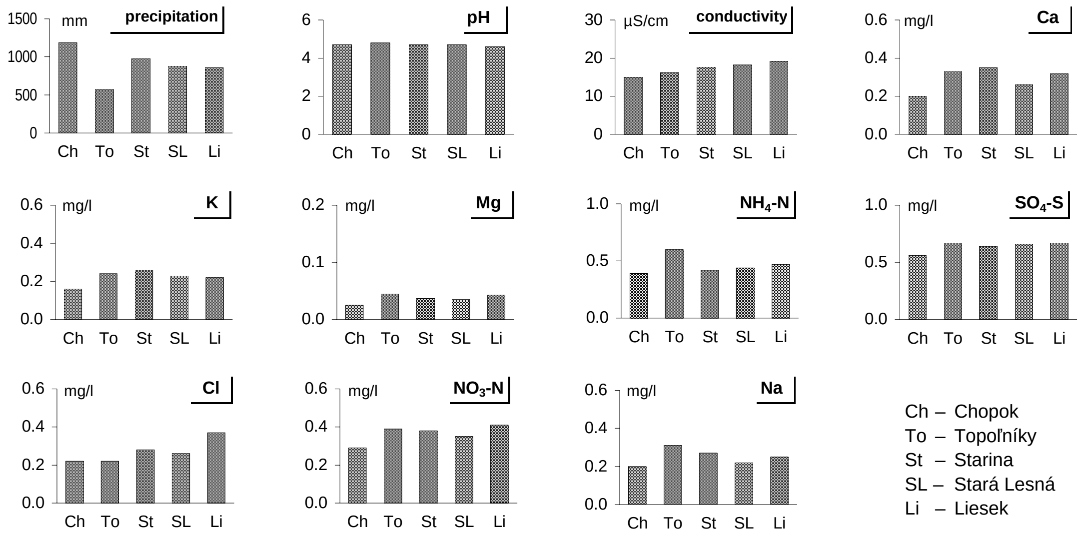


Fig. 1.9 **Daily precipitation – 2004**

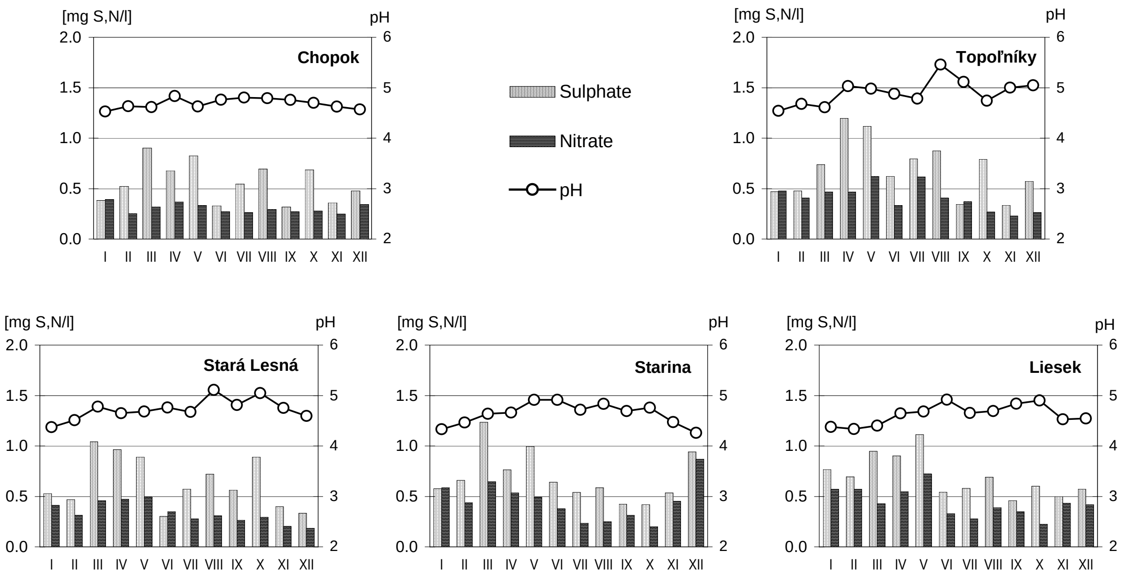
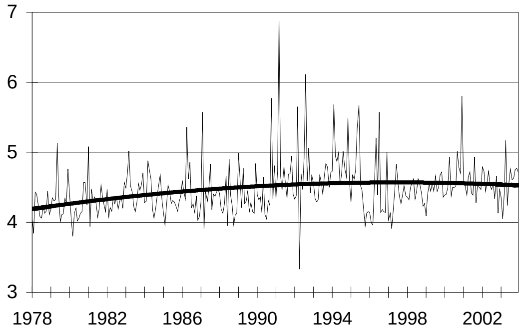


Figure 1.8 illustrates the amount of precipitation in 2004 varying from 571 mm up to 1188 mm, depending on the location of the individual stations. Annual course of sulphates, nitrates and pH based upon the daily measurements is depicted in Figure 1.9. Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity (Fig. 1.10). Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Fig. 1.10 **pH in daily precipitation – Chopok**



Station	Sulphur wet deposition [g $S.m^{-2}.r^{-1}$]
Chopok	0.66
Topoľníky	0.38
Starina	0.63
Stará Lesná	0.58
Liesek	0.58

Concentrations of dominant sulphates in precipitation varied within the range 0.56-0.67 mg $S.l^{-1}$, the values of sulphates were lower at all stations as compared to the previous year, the differences in concentrations were smallest at the Topoľníky station, approximately 15 %, at the Starina, Stará Lesná a Liesek stations approximately 25 %, but the biggest difference was recorded at the Chopok station, where annual mean value of sulphate in 2004 reached only 50 % of value in 2003. Total decrease in sulphates in long-term time series has corresponded to SO_2 emission reduction since 1980. The values of sulphur wet deposition ranged between 0.38 and 0.66 g $S.m^{-2}$. $year^{-1}$. Critical load of wet deposition has not been indicated yet. USA and Canada indicated the value of wet sulphate deposition 0.7 g $S.m^{-2}.year^{-1}$ as the target load for forests.

The share of nitrate in acidity of precipitation was substantially smaller than those of sulphates and varied within the concentration range 0.29-0.41 mg $N.l^{-1}$. The values of nitrate concentrations were remarkable lower at all stations as compared to the previous year. The differences were the most distinctive at the Chopok station up to 60 %, at the Topoľníky station the decrease of nitrate concentrations presented 20 %, at the other stations Liesek, Stará Lesná and Starina the nitrate values were lower up to 25 % as compared to 2003. Concentrations of ammonium were lower at all regional stations in 2004 as compared to 2003; the lowest decrease was recorded at the Topoľníky station, where the 2003 and 2004 values differed least. In decrease of ammonium dominate the Stará Lesná and Chopok stations, about 40 %, resp. 38 %.

Chlorides recorded lower values at all stations in 2004 comparing to 2003; at the Starina station the difference was very small, however at the Topoľníky, Stará Lesná and Liesek stations the difference was approximately 30 % and at the Chopok station even up to 50 %. The alkali metals sodium and potassium were similar in concentrations in 2004 and 2003. The decrease of calcium ranged from 20 % at the Liesek station, values lower 40 % at the Chopok, Stará Lesná and Starina and up to 60% at the Topoľníky station. In 2004 magnesium recorded half values of those in 2003 at the Chopok, Topoľníky and Stará Lesná stations and one fifth lower at the Liesek and Starina stations.

The values of conductivity were lower in 2004 at all stations compared to the previous year; at the Liesek station approximately 15 %, at the Topoľníky and Starina stations about one fourth, at the Stará Lesná station about one third and at the Chopok station almost 50 %. It is logical regarding to the distinctive ionization in atmospheric precipitation in 2004.

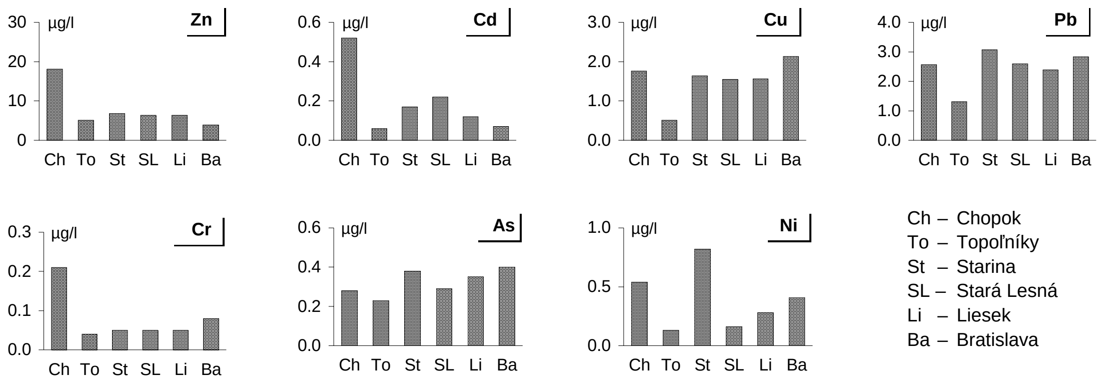
Heavy metals

Since 2000 the measurement programme of heavy metals in precipitation has been gradually modified to meet the present requirements of the CCC EMEP monitoring strategy. In 2000, lead and cadmium started to be determined in precipitation. Since 2002 aluminium and iron were excluded from the measurement programme and chromium, copper, nickel, arsenic and vanadium were implemented into the programme. Since 2004 vanadium was not analyzed in precipitation anymore, because it was not included in EMEP monitoring strategy. In Koliba the measurement of the same set of heavy metals in precipitation was implemented as in regional stations of Slovakia (Table 1.4).

Tab. 1.4 **Annual averages of heavy metals in monthly precipitation – 2004**

	precip. mm	Zn µg/l	Cd µg/l	Pb µg/l	Cr µg/l	Cu µg/l	Ni µg/l	As µg/l
Chopok	1077	18.1	0.52	2.57	0.21	1.76	0.54	0.28
Topoľníky	529	5.1	0.06	1.31	0.04	0.51	0.13	0.23
Starina	922	6.8	0.17	3.07	0.05	1.64	0.82	0.38
Stará Lesná	786	6.4	0.22	2.59	0.05	1.55	0.16	0.29
Liesek	802	6.4	0.12	2.39	0.08	1.56	0.28	0.35
Bratislava	537	3.9	0.07	2.83	0.15	2.13	0.41	0.40

Obr. 1.11 **Monthly precipitation – 2004**



Within the last year of measurements the most of regional stations showed decrease in lead concentrations, namely at the Chopok, Topoľníky and Starina stations as compared to the previous year. Even though the Stará Lesná and Liesek stations recorded slightly higher lead concentrations, but all differences were not significant as a whole comparing to 2003.

Cadmium concentrations were significantly lower at all stations in 2004 as in previous year; the biggest decrease was recorded in Starina, almost three times; at the Stará Lesná and Topoľníky stations the cadmium values were lower 2.5 times; at the Liesek and Chopok stations approximately one quarter. In 2004 zinc showed the most significant decrease, up to 50 % at the Liesek and Chopok stations; very similar values at the Topoľníky station, however slightly higher values at the Starina and Stará Lesná stations than in 2003. Chromium concentrations remarkably dropped at Topoľníky, Starina and Stará Lesná; values were almost the same at Chopok and Liesek as in 2003. Comparing to 2003 arsenic concentrations increased in 2004 at all stations apart from Chopok. Copper decreased the most significantly at Chopok, less at Topoľníky and Stará Lesná. Starina and Liesek recorded similar copper concentrations as in 2003. Nickel showed higher concentations only at Starina, the same at Chopok and smaller at the rest of stations.

For the time being, lead and cadmium as the metals of first priority is not possible to assess more complex due to the short time period, similar as the other metals introduced in the text above measured since 2002. However it is expected that the concentrations of metals in precipitation will copy the downward trends in concentrations of metals in atmospheric aerosol.

In coincidence with the EMEP measurements the Slovak Republic is situated on the south-east boundary of a territory with the highest regional air pollution and acidity of precipitation in Europe. Development of regional air pollution and chemical composition of precipitation corresponds to the development of European emissions.

AMBIENT AIR

LOCAL AIR POLLUTION

2

2.1 LOCAL AIR POLLUTION

Since 1st January 2003 the particular decree No 705 about Air Quality has been put into force in the Clean Air Act No 478/2002 Coll. The Clean Air Act has fully transposed the EU Air Quality legislation in the field of air quality assessment and management.

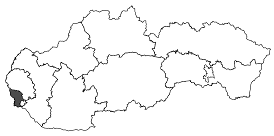
Decree No 705 defines:

- limit values and dates by which limit values are to be met, the margin of tolerance, averaging period, the number of times it can be exceeded, target values and long-term objectives for ozone, requirements for their monitoring, assessment, sampling, measurement and others technical specifications,
- upper and lower assessment thresholds for the main pollutants, requirements for the location of sampling sites, criterion for minimal numbers of sampling points for permanent measurements of air pollutants, QA/QC objectives, goals of data processing and air quality assessment, reference methods for particular pollutants, calibration of analysers, and the requirements for measurements of ozone precursors,
- agglomeration and zones (Annex 8, Decree No 705),
- details about information and data, presented in programs for air quality improvement,
- limit values for information and alert thresholds for smog warning and regulation systems, mandatory texts for the beginning and finishing smog levels and details about information and data which has to be available for the public when thresholds are exceeded.
- limit values and dates by which limit values are to be met, margin of tolerance, averaging period, number of allowed exceedances for main pollutants (tab. 2.4),
- upper and lower assessment thresholds for main pollutants (tab.2.5),
- in cases when the air pollution level is below the upper assessment threshold combined measurements with model results are allowed,
- in cases when the air pollution level is below the lower assessment threshold, for air quality assessment it is allowed to apply model results or expertise judgment,
- requirements for the location of sampling sites for air pollution measurements (Annex No 3, Decree No 705),
- criterion for the specification of minimal number of sampling sites for permanent measurements (Annex No 4, Decree No 705),
- objectives of QA/QC data level and goals of processing data and air quality assessment (Annex 5, Decree 705),
- reference methods of measurements and analyses of pollutants, calibration of analysers (Annex 6, Decree 705),
- requirements for measurements of ozone precursors (Annex 7, Decree 705),
- details about information and data which has to be involved in programs for air quality improvement. (Annex 9, Decree 705),
- information, alert thresholds and limit values for warning purposes for signals ”Information”, “Regulation” and ”Warning” (Annex No 10, Decree No 705),
- mandatory texts of beginning and finishing smog levels “Information”, “Regulation” and “Warning” (Annex No 11, Decree No 705),
- information and data which has to be available to the public when thresholds are exceeded (Annex No 12, Decree No 705).

The Slovak Hydrometeorological Institute has monitored the level of air pollution since 1971, when the first manual stations in Bratislava and Košice were put into operation. In the course of the following years the measurements were gradually disseminated into the most polluted towns and industrial areas.

In 1991 modernization of the air quality monitoring network began. The manual stations were gradually substituted by automatic ones, which enable the continuous monitoring of pollution and which made it possible to evaluate changes depending on time and on the extremes of the short-run concentrations. In the course of the last ten years the air quality monitoring network has kept developing. The number of the monitoring stations has changed from year to year and in the last three years the measurements of the particulate matter (PM) were gradually substituted by the measurements of the particulate matter concentrations with the aerodynamic diameter less than 10 μm (PM_{10}) and at selected stations measuremets of $PM_{2.5}$ were put in operation. In 2004, 28 stations were deployed on the territory of the SR. Most of them monitored the level of pollution caused by the basic pollutants (SO_2, NOx, NO_2, CO, O_3 and PM_{10}). In April - Maj 2004 the measurements were extended at the station Bratislava-Koliba (NO_2 and PM_{10}). At station in Trenčín manual measurements of heavy metals are only carried out. In the year 2004 the measurements of benzene have started out. The air pollution monitoring by heavy metals (Pb, Cd, As, Ni) were performed at 21 localities on the whole. At one station, beyond these pollutants, also the level of pollution by H_2S was monitored. In accordance to the Clean Air Act the territory of the Slovak republic was divided into 8 zones and 2 agglomerations. The delimitation of zones is identical with the higher administrative units – regions. From Bratislava and Košice regions geographical extension of cities Bratislava and Košice were selected and these cities are assessed separately as agglomerations.

2.2 CHARACTERISATION OF ZONES AND AGGLOMERATIONS, WHERE MONITORING IS CARRIED OUT



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 452 053

Characterization of area

Bratislava

Bratislava spreads out over an area of 370 km^2 along both banks of the Danube at the boundary-line of the Danube plain and the Little Carpathians and the Bor lowlands at an elevation of 130-514 meters. Wind patterns in this area are affected by the slopes of the Little Carpathians, which do interfere into the northern part of the city. Geographical effects enhance the wind speed from prevailing directions. The ventilation of the city is favourably affected by high wind speeds. In regard to prevailing north-west wind, the city is situated properly to major air pollution sources, which are concentrated in a relatively small area between the south and north-eastern periphery of Bratislava. The main share in air pollution is from the chemical industry, power generation and car transport. Secondary suspended particles, the level of which depends upon meteorological factors, land use and agricultural activities and characteristics of surface, are significant secondary source of air pollution in the city.

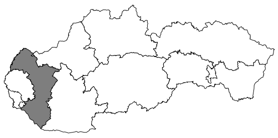
Location of stations

Bratislava - Koliba
The station is located in the grounds of the Slovak Hydrometeorological Institute, 287 m above sea. It is situated apart from the major city sources of air pollution, in a locality with scarce built-up area, where family houses prevail. From the pollutants only surface ozone is measured, because this is not a typical urban background station.

Bratislava - Mamateyova
The station is located 4 km to the south, out of the city centre, in a prefab housing estate built-up area, very close to a moderately busy road. Among the major sources of air pollution belong traffic, power sources and the petrochemical complex, Slovnaft, Ltd. The last mentioned contributes to city air pollution mainly under an east wind direction

Bratislava - Trnavské mýto
The station is situated near to a busy crossroad Šancová street - Vajnorská street. As far as traffic emissions are concerned, this location is an extremely polluted one.

Bratislava - Kamenné námestie
The station is situated in the city centre, close to the TESCO supermarket, in an area of heavy car traffic. Its position represents the old part of the city. The location is polluted by major sources, mainly Slovnaft, Ltd., with a south-east wind direction and by transport.



ZONE - TRNAVA REGION

AREA: 4 148 km^2 POPULATION: 547 173

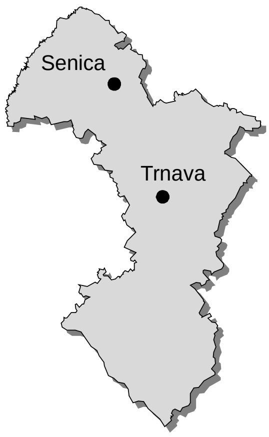
Characterization of area

Senica

The town itself is located on the southern slopes of Myjava hills in the altitude of 208 m. From its western and partly northern side as well, the territory is bordered by the Little Carpathians. It is open only alongside Myjava river from east side, where the promontory of Záhorska lowlands does intervene. From the standpoint of emission dispersion and transport, the wind conditions are favourable under the prevailing north-west wind, as this is associated with the relatively higher wind speeds. Main share in air pollution of the town is due to chemical industry (state enterprise Slovenský hodváb - Slovak Silk), power generation and car transport.

Trnava

Trnava – one of the most important cities in the Slovak Republic is located in the centre of the Trnava downs, at an altitude of 146 m, 45 km from the capital of the Slovak Republic, Bratislava. Since 1996 Trnava has became a regional centre with 70 000 inhabitants. The prevailing wind is from the north-east, the second highest wind frequency is from south-east. The location is well ventilated with small occurrence of calm situations.



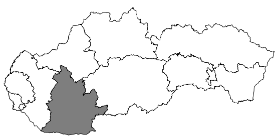
Location of stations

Senica

Station is located very close to the bus stop, near main route in the Kúty - Trnava - Hodonín direction.

Trnava

Station is located at the Dohnány and Kolárova street crossroads, approximately 2 m from the curbside in an area highly polluted by traffic emissions.



ZONE - NITRA REGION

AREA: 6 343 km^2 POPULATION: 718 358

Characterization of area

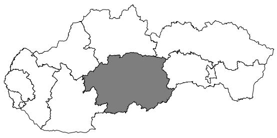
Nitra

Major part of the region interferes into Danube plain and the differences of high are very small in the whole area, higher altitudes in the north-east part are caused only by Danube downs. Prevailing wind is from north-east and south-west directions with a small occurrence of calm situations.

Location of stations

Nitra

Station is located very close to the crossroad of Štúrova street and Štefánikova trieda heavy polluted by traffic.



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 455 km^2 POPULATION: 664 072

Characterization of area

Banská Bystrica

The town is located in the Bystrické valley, which is by the northern part of the Zvolenská basin surrounded by the Starohorské hills to the north, by the Horehronské valley to the north-east and by the Kremnické hills to the south-east. The annual average temperature is 8°C. Prevailing wind is from the north and north-east, an average speed 2.1 m.s^{-1} and approximately 33 % occurrence of inversion in valley positions. Air pollution is affected by the cement and wood processing industries releasing emissions of suspended particles, but also by a large number of local heating sources. Heavy traffic does contribute to the high level of air pollution in the town centre, as well.

Žiar nad Hronom

The area of the Žiar basin is closed from more sides, bordered by the Pohronský Inovec in the south-west, by the Vtáčnik and the Kremnické hills in the west up to the north, and by the Štiavnické hills in the east to the south-east. The area is characterised by the very unfavourable meteorological conditions in regard to the level of air pollution by industrial emissions at a ground level layer. The annual average wind speed in all directions is 1.8 m.s-1. The east and north-west wind directions occur there most frequently within a year. The major share in air pollution is due to aluminium production and power generation.

Hnúšťa

The area is situated in the valley of the Rimava river. Along the quite narrow valley, the individual mountain ranges of relatively great elevation are extended. Short-term measurements confirm the expected low wind speeds of about 1.5 m.s^{-1} on average and a considerable high occurrence of calm. The area is polluted mainly by chemical production in Hnúšťa and the Magnesite plant in Hačov.

Jelšava

Jelšava is situated in the area, which lies in the southern part of the Jelšava's mountains, bordered in the north-east by the massive Hrádok, in the south-west by the Železnické foothills and in the south by the Jelšava's kras. The terrain is relatively broken along the central Muráň stream, oriented in a north-west – south-east. Air circulation is indicated by the direction of the Muráň river valley. The annual average wind speed is relatively low, only 2.5 m.s^{-1}. The frequent occurrence of surface inversions during the night is due to the broken mountain terrain. Two massives, Skalka and Slovenská skala, bordering the valley, also contribute to the occurrence of inversions. The major share in air pollution is from the Slovak magnesite plants Jelšava and Lubeník, situated to the north-west of the town and the small predominantly local gas heating system.

Location of stations

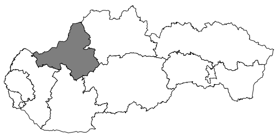
Banská Bystrica - Nám. slobody

The station is located in the city centre, 100 m from a local busy road junction, a distance of 50 m from one and two storey housing area. The station is located in the valley part of the city with poor dispersion conditions.

Žiar nad Hronom
The station is placed on a boundary-line between 4-storey housing and an open space, passing down, out of the station. Meteorological station is next of the monitoring station.

Hnúšťa
The station is situated on the north edge of the town, approximately 100 m far from state road No 531, in an open area.

Jelšava
The station is situated in the peripheral part of the city, in child garden, at a hill which is open to the major polluter (SZM Jelšava) from one side. From other side the housing estate is located.



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 608 990

Characterization of area

Horná Nitra

This area includes a part of the Horná Nitra basin from Prievidza to Bystričany. The direction of wind is affected considerably by the geography and orientation of the basin. The most frequent winds occur there from the north and north-east directions. A low value of annual wind speed 2.3 m.s^{-1} does refer to the unfavourable conditions for emission dispersion and transport. The dominant cause of air pollution in this area is power generation. To a lesser extent emissions from sources of chemical industry and local heating do contribute as well. The low quality of fuel sources for power generation contributes to air pollution in this area to a greater extent. The coal in use contains apart from sulphur also arsenic.

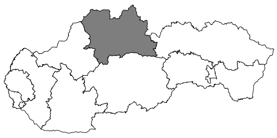
Location of stations

Prievidza
The station is located in the town centre, close to 4-storey residential houses and buildings of similar height. Near the station, passes slight traffic. Since the year 2004 building of commercial centre has started.

Handlová
The station is located in a predominantly one-family house built-up area. Among the major emission sources are power sources and industry.

Bystričany
The station is situated in agricultural area among fruit trees. The Nováky power plant (ENO) is of 8 km from the monitoring station.

Trenčín
Station is located between stadium and commercial biddings at the main street leading from Trenčín to Trenčianska Teplá.



ZONE - ŽILINA REGION

ROZLOHA: 6 788 km^2 POPULÁCIA: 682 983

Characterization of area

Ružomberok

The location of the city comprises the area of the western part of the Liptovská basin, on the confluence of rivers Váh, Revúca and Likavka. The Veľká Fatra mountains constitute the border in the west, the Chočské mountains in the north and the Low Tatras in the south. The most frequent wind blows from the west, at an average speed 1.6 m.s^{-1}. Air pollution by classical pollutants is due to the operation of heating plant technology. The North Slovakian pulp and paper processing plants are the largest industrial source of air pollution. A considerable share of this pollution is caused by small local sources, as well. A mixture of predominantly organic-sulphur compounds, leaking episodically from the technology of pulp production causes specific air pollution.

Žilina

The town itself is spread in the central valley of the Váh river, in the basin of central Považie. Žilina basin is classified as a moderately high basin. From the east the Little Fatra mountains intervene into the area, from the south the White Carpathians and from the north-west the Javorníky mountains. According to the climate characteristics the area belongs to a moderately warm region. In a basin area, the relative humidity of air is higher and also the number of foggy days is the highest throughout the year. Slight windiness of average wind speed 1.3 m.s^{-1} and the up to 60 % occurrences of calm characterise this area. From the standpoint of potential air pollution, the wind conditions in the Žilina basin are very unfavourable and thus relatively small sources of emissions lead to the high level of air pollution at the ground level layer. Air pollution by classical pollutants is due to the local heating plant of the Slovak Power Plants, but local chemical operations and mainly heavy traffic in the town centre contribute as well.

Martin

The town of Martin is situated in the Turčianska basin at the confluence of the rivers Turiec and Váh, and surrounded by the Veľká and Malá Fatra mountain ranges. The basin area is located between high mountains and has unfavourable climatic conditions from the standpoint of pollutant emission dispersion. The frequent occurrence of inversions, average wind speed 2.8 m.s^{-1} and high relative humidity contribute to higher concentrations of oxides of nitrogen, oxides of sulphur and suspended particulate matter. Heavy engineering, local heating plants of the Central Slovakian power plants and car transport are the largest emitters of pollutants.

Location of stations

Žilina - Veľká Okružná

The station is located in the town centre in a moderately dense built-up area of 1-5-storey buildings, 10 m from a busy road.

Žilina - Vlčince

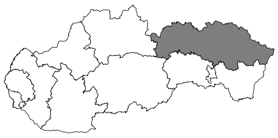
The station is situated in the north-eastern part of the town, in the Vlčince housing estate, about 0.7-1.5 km from industrial area. The position is open in all directions and representative for wind speed and wind direction measurements.

Ružomberok – Riadok

The station is located in the garden of an elementary school, close to a low traffic route way. In the surrounding built-up area low family housing prevails. A major pollution source the Ružomberok Slovak pulp and paper processing plants is situated north-east of the monitoring station.

Martin

The is located 5m from the kerbside of the main street. Station is located in the southern part of the city in area mainly build up by family houses.



ZONE - PREŠOV REGION

AREA: 8 993 km^2 POPULATION: 763 911

Characterization of area

Prešov

Prešov lies in the northern promontory of Košice’s basin. The surrounding mountains of the Šariš’s highland and the Slánské mountain range reach an altitude of 300- 400 m above sea level. The highest hill, Stráža, to the north out of the town, protects the town from the invasion of cool Arctic air. The town lies on the slope facing to the south and thus cool air runoff is provided, which settles under the calm at the bottom of the basin. In the course of a year the northern air circulation prevails and is also the strongest. The next highest air circulation belongs to the south direction. Good ventilation of the town is provided by the widening of the valley itself at the confluence of the Sečkov and Torysa. The main cause of air pollution in town is boiler rooms, mainly lacking separation techniques, traffic, as well as secondary suspended particles.

Humenné

Humenné lies in the valley of the river Laborec, which is protected in the north by a wide zone of the Carphatians and in the south by the Vihorlat mountain range. The valley is north-east oriented. Because of the complexity in geography, the prevailing wind direction varies. The occurrence of calm is relatively high. The local chemical industry presents the main air pollution source in this area.

Vranov

Vranov lies in the valley of the river Topľa, which passes into the East Slovakian lowlands. The location is bordered in the west by the Slánske hills and in the north by the wide zone of the Carpathians. Air circulation is influenced by the north-west orientation of the Topľa valley. The main air pollution source in the area is the local wood processing industry and local heating systems.

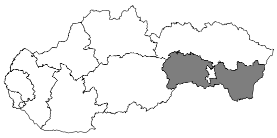
Location of stations

Prešov - Sídlisko III
The station is situated in an open area, near a supermarket, at the boundary-line of a new housing estate and the north-western part of the historical town centre. Nearby, approximately 50 m away, is the main road to Levoča. The town boiler room using gas fuel is about 1000 m north from the station.

Prešov - Solivar
The station is located in the south-eastern part of the town in an open zone of low density buildings in the vicinity of the Solivarská and General Petrov cross-road.

Humenné
The station is located in the southern part of the town centre at the border of a pedestrian zone with minimum car transport (parking 50-100 m from AMS). The surrounding buildings are connected to the central heating. The most important air pollution source - Chemes Humenné is located approximately 2 km west from AMS.

Vranov nad Topľou
The station is situated in the town centre, in front of the Civic house, approximately 2 km north-west out from the Bukóza Vranov plant. Alongside the main road, at a distance of about 30 m from the station is the surrounding built-up area, represented by 3 and 4-storey residential houses.



ZONE - KOŠICE REGION

AREA: 6 508 km^2 POPULATION: 512 934

Characterization of area

Krompachy

Krompachy is located in the valley system with good local circulation of air. Southern part is situated in valley of the Slovinský potok. Northern part of the city is located by the valley Hornád, which is oriented in east west direction. The average wind speed is low, approximately 1.4 km/s. The main polluter is Ferrous metal plant Kovohuty Krompachy. To the air pollution contributes also the local heating systems.

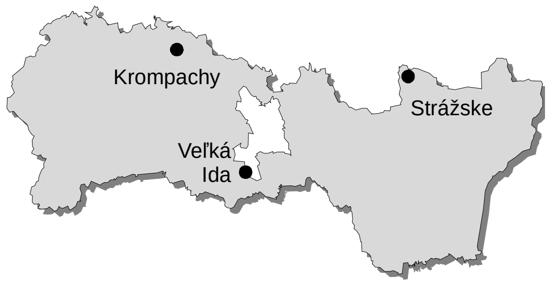
Strážske

Strážske is located easterly from Vihorlat in northern part of the Eastslovak lowland in area called Brekovsky tor, where the wind flow is strengthened from north directions. Annual average of the wind speed is 3.4 m/s. The daily wind speed has daily course with minimum during night hours. The main source of air pollution is local chemical industry.

Košice - Veľká Ida

The station is located in the boundary of Košice's basin and Moldav lowland. The area is surrounded from south by Abovské hills, from western by Slovenský kras and from northern by Slovenské Rudohorie. The prevailing wind directions are from east-west and south-wes directions. The annual average of wind velocity is about 2.5 m.s^{-1}. The main air pollution source is the iron works USS, and large dumps of extracting ores.

Location of stations



Krompachy

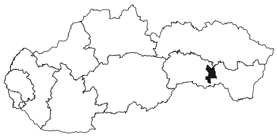
The station is located in the valley of the Slovinský potok, on the western edge of the town, away from the busy roads, 2 km south-west of the Ferrous metal plant Kovohuty Krompachy. The surrounding built-up area comprises multi-storey houses. It is a valley position with an increased occurrence of inversion.

Košice - Veľká Ida

The station is located in the south-eastern part of the Veľká Ida municipality, near the USS iron works, in a relatively open area. Southerly from the station are waste dumps and family houses, which are mostly gasified. Westerly about 10 m from station leads second class route. The complex of USS is located from northeast to north about 1000 m from measuring site.

Strážske

Strážske is situated in an open area, on the western edge of town, on a housing estate with a local boiler room, approximately 1km east-south-east out from the Chemko Strážske plant. In the vicinity of the station is a middle frequented road.



AGGLOMERATION - KOŠICE

AREA: 245 km^2 POPULATION: 240 915

Characterization of area

Košice

The city of Košice spreads out in the valley of the Hornád river and its surroundings. According to geographical classification it belongs to the zone of the inner Carpathians. From the south-west, the Slovenský Kras intervenes into this area, in the north the Slovenské Rudohorie and in the east the Slánske hills spread out. Among these mountain ranges, Košice's basin is situated. The mountain range configuration affects the climate conditions in this area. The prevailing wind from the north is distinguished by the relatively higher wind speeds, on average 5.7 m.s^{-1}. The annual average wind speed from all directions is 3.6 m.s-1. The major share in air pollution of this area is caused by heavy industry, mainly engineering, non-ferrous and ferrous metallurgy. Energy sources, including the city heating plants and local boiler rooms emit lesser amounts of pollutants.

Location of stations

Košice - Štúrova

This is a city centre station. It is placed in an open area, in the centre of the Osloboditeľov square, between the car park and symbolic cemetery. The inner circle roads, at a distance of about 15 m north and 50 m south from the station, go in an east-west direction. There is, in the vicinity of the station, no significant pollution source.

Košice – Strojárenská

This station is in the northern part of the historical city. It is located next to the town hall, in a densely built-up part of the city, about 50 m from the surrounding buildings. Approximately 15 m distant is the inner circle road. Under the south wind, the location is exposed to the exhaust gases coming from traffic in Moyzesova street.

Košice - Podhradová

The station is located in the grounds of the Slovak Hydrometeorological Institute, in a relatively open area, at the northern edge of the Podhradová housing estate and the city itself. From 2000, the station has monitored only surface ozone.

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in 2004**

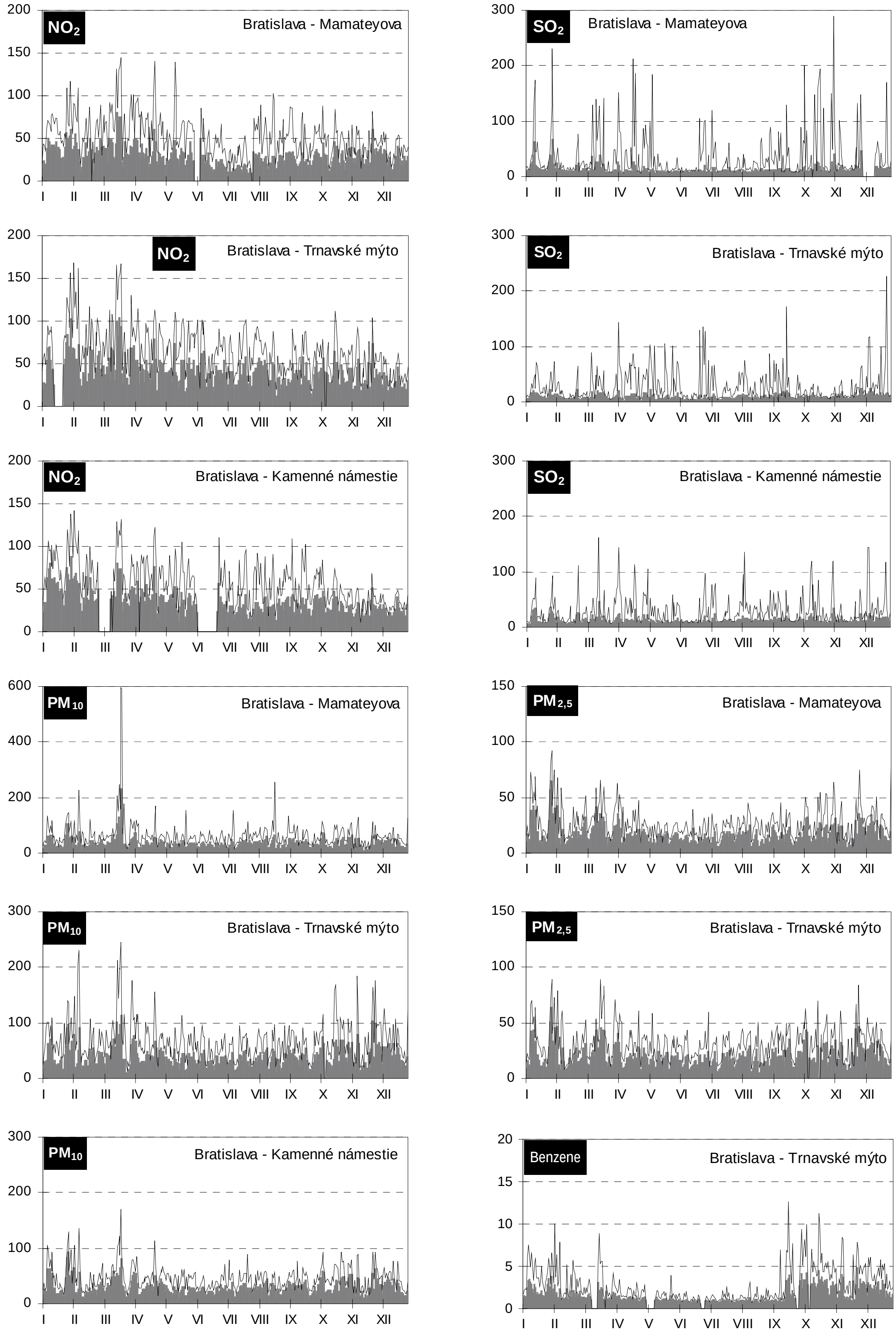
AGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	SO_2	NO_2	PM_{10}	$PM_{2.5}$	O_3	CO	H_2S	BZN	Pb	Cd	Ni	As
BRATISLAVA	Bratislava, Kamenné nám.	17°07'00"	48°08'45"	139	*	*	*						*	*	*	*
	Bratislava, Koliba	17°07'09"	48°10'20"	287		*	*		*				*	*	*	*
	Bratislava , Mamateyova	17°08'05"	48°07'43"	136	*	*	*	*	*	*			*	*	*	*
	Bratislava, Trnavské mýto	17°07'45"	48°09'32"	136	*	*	*	*		*		*	*	*	*	*
KOŠICE	Košice, Štúrova	21°15'47"	48°43'01"	199	*	*	*			*		*				
	Košice, Strojárenská	21°15'17"	48°43'37"	200	*	*	*	*		*			*	*	*	*
	Košice, Podhradová	21°14'45"	48°45'17"	248					*							
Trnava region	Trnava	17°35'06"	48°40'02"	251	*	*	*			*		*	*	*	*	*
	Senica	17°21' 48"	48°40'50"	212	*	*	*			*			*	*	*	*
Nitra region	Nitra	18°05'08"	48°18'28"	142	*	*	*			*		*	*	*	*	*
Trenčín region	Bystričany	18°31'00"	48°40'02"	251	*	*	*									
	Handlová	18°45'32"	48°44'00"	437	*	*	*									
	Prievidza	18°37'30"	48°45'11"	269	*	*	*	*	*				*	*	*	*
	Trenčín	18°02 '00"	48°53 '20"	210									*	*	*	*
Banská Bystrica region	Banská Bystrica, Nám. slobody	19°09'30"	48°44'12"	343	*	*	*		*	*			*	*	*	*
	Jelšava	20°14'18"	48°37'48"	255	*	*	*		*				*	*	*	*
	Hnúšťa	19°57'12"	48°35'04"	315	*	*	*		*	*						
	Žiar nad Hronom	18°51'07"	48°35'17"	263	*	*	*		*	*			*	*	*	*
Žilina region	Martin	18°55'26"	49°04'03"	396	*	*	*	*	*	*			*	*	*	*
	Ružomberok, Riadok	19°18'27"	49°04'32"	485	*	*	*		*		*		*	*	*	*
	Žilina, Veľká Okružná	18°44'18"	49°13'12"	390	*	*	*	*		*			*	*	*	*
	Žilina, Vlčince	18°46'20"	49°12'40"	368	*	*	*		*							
Košice region	Krompachy	20°52'24"	48°55'04"	385	*	*	*						*	*	*	*
	Strážske	21°49'48"	48°52'21"	134	*	*	*									
	Veľká Ida	21°10'34"	48°35'31"	207	*	*	*		*	*			*	*	*	*
Prešov region	Humenné	21°53'08"	48°54'35"	160	*	*	*		*				*	*	*	*
	Prešov, Sídlisko III.	21°13'54"	49°00'03"	245	*	*	*									
	Prešov, Solivar	21°15'59"	48°58'43"	255	*	*	*		*	*			*	*	*	*
	Vranov nad Topľou	21°41'26"	48°53'12"	128	*	*	*						*	*	*	*

Tab. 2.2 **Technical parameters of measuring instruments**

Pollutant measured	Principle of measurement	Range of measurement [mg/m³]	Detection limit [µg/m³]	Producer	Type
SO_2	UV - Fluorescence	0...2.6	2.6	TEI	Model 43C
	UV - Fluorescence	0...2.6	1.3	TELEDYNE Monitor Labs	ML 9850
	UV - Fluorescence	0...2.6	1.3	TELEDYNE API	Model 100A
H_2S	UV - Fluorescence	0...1.3	1.3	TELEDYNE Monitor Labs	ML9850 + ML 8770
NO, NO_2, NO_x	Chemilumiscence	0...1.9	0.9	TEI	Model 42C
	Chemilumiscence	0...1.9	< 0.9	TELEDYNE Monitor Labs	ML 9841
	Chemilumiscence	0...1.9	< 0.9	TELEDYNE Monitor Europe	ML 9841B
	Chemilumiscence	0...1.9	< 0.9	TELEDYNE API	Model 200A
CO	NDIR GFC	0...23.3	< 58.3	TEI	Model 48C
	NDIR GFC	0...23.3	< 11.7	TELEDYNE Monitor Labs	ML 9830
	NDIR GFC	0...23.3	< 11.7	TELEDYNE API	Model 300
Benzene	GC	0...0.162	0.3	Syntech Spectras	GC 855, GC 955
O_3	UV - Photometry	0...1	2	TEI	Model 49C
	UV - Photometry	0...1	2	TELEDYNE Monitor Labs	ML 9810,9811
	UV - Photometry	0...1	2	Horiba	APOA 360
	UV - Photometry	0...1	2	TELEDYNE API	Model 400
PM_{10} $PM_{2.5}$	Beta - absorbtion	0....1000	10	VEREWA	F 701
	Beta - absorbtion	0....1000	3	Thermo ESM	FH 62 I - R
	TEOM	0....5000	1	Rupprecht & Patashnick	1400, 1400A, 1400AB

All concentrations of measured pollutants are expressed in $\mu g.m^{-3}$ at standard conditions (298°K and 101.3 kPa)

Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – Agglomeration Bratislava – 2004**



█ concentrations:
NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene – daily average [µg/m^3], CO - daily maximum of 8 h means [mg/m^3]

— 1 h maximum concentration of NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene [µg/m^3]

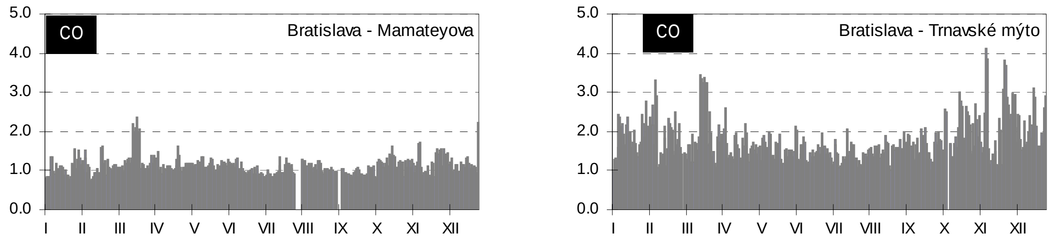


Fig. 2.2 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO – Aglomeration Košice – 2004**

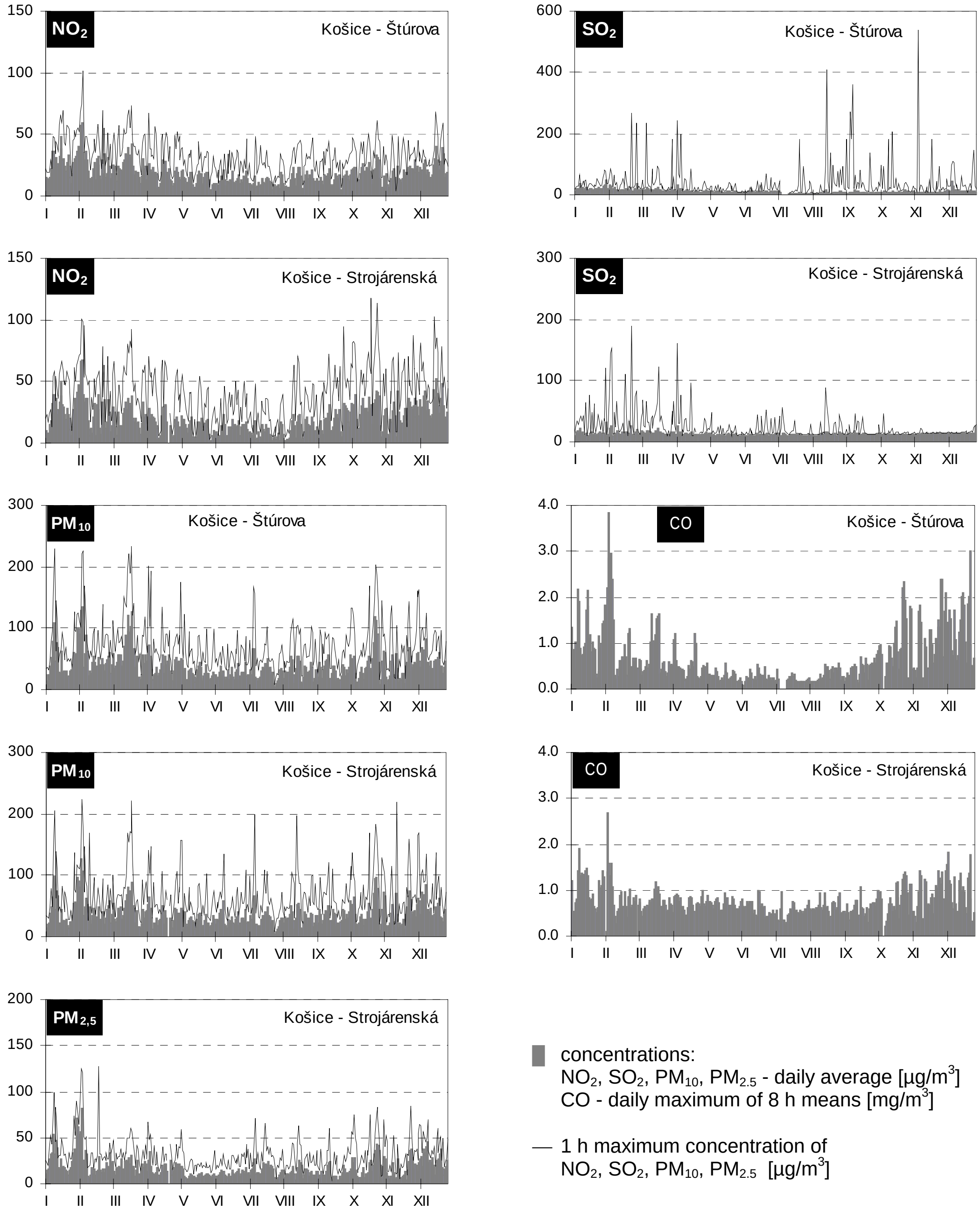


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Trnava region – 2004**

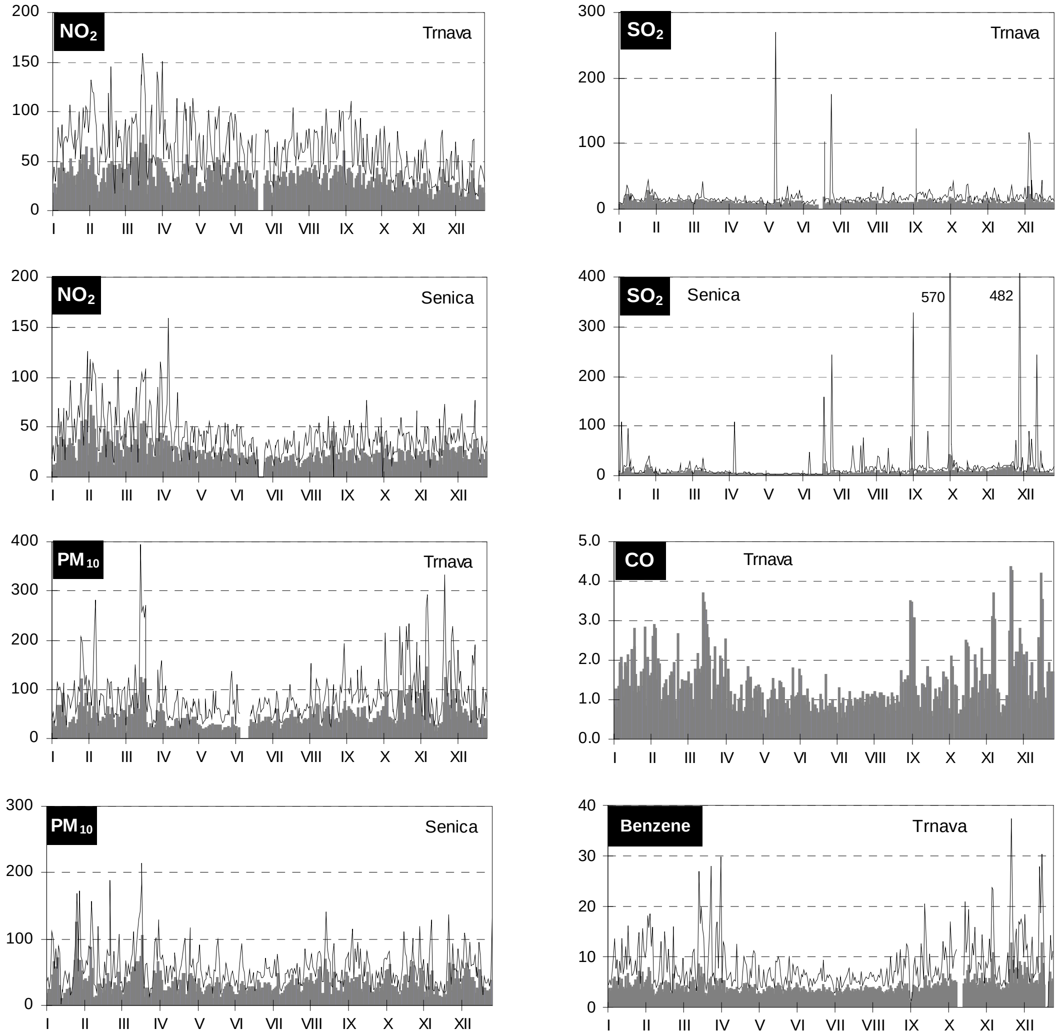
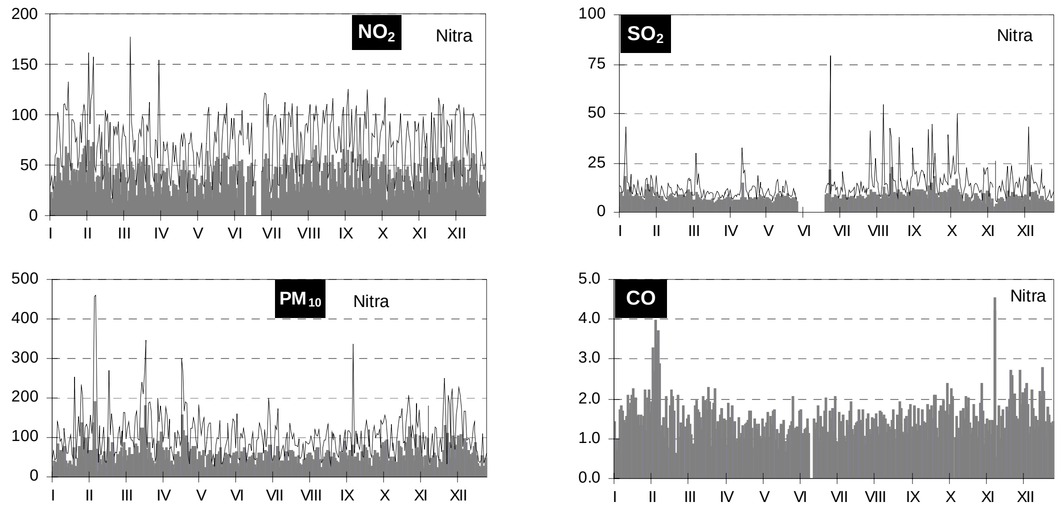
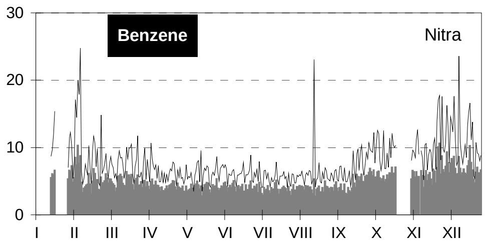


Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Nitra region – 2004**





concentrations:
NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [µg/m^3]
CO - daily maximum of 8 h means [mg/m^3]

— 1 h maximum concentration
NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene [µg/m^3]

Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO – zone Trenčín region – 2004**

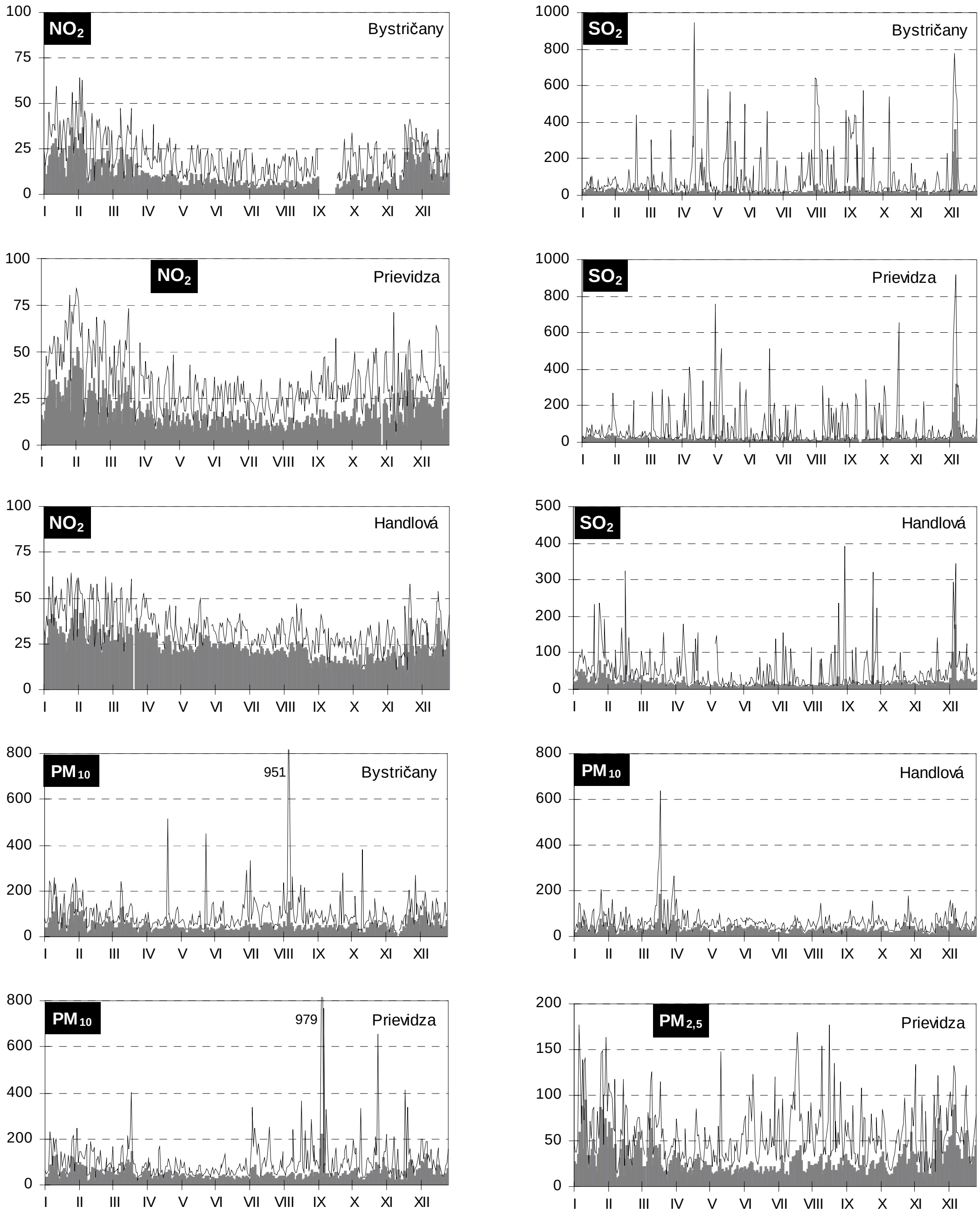
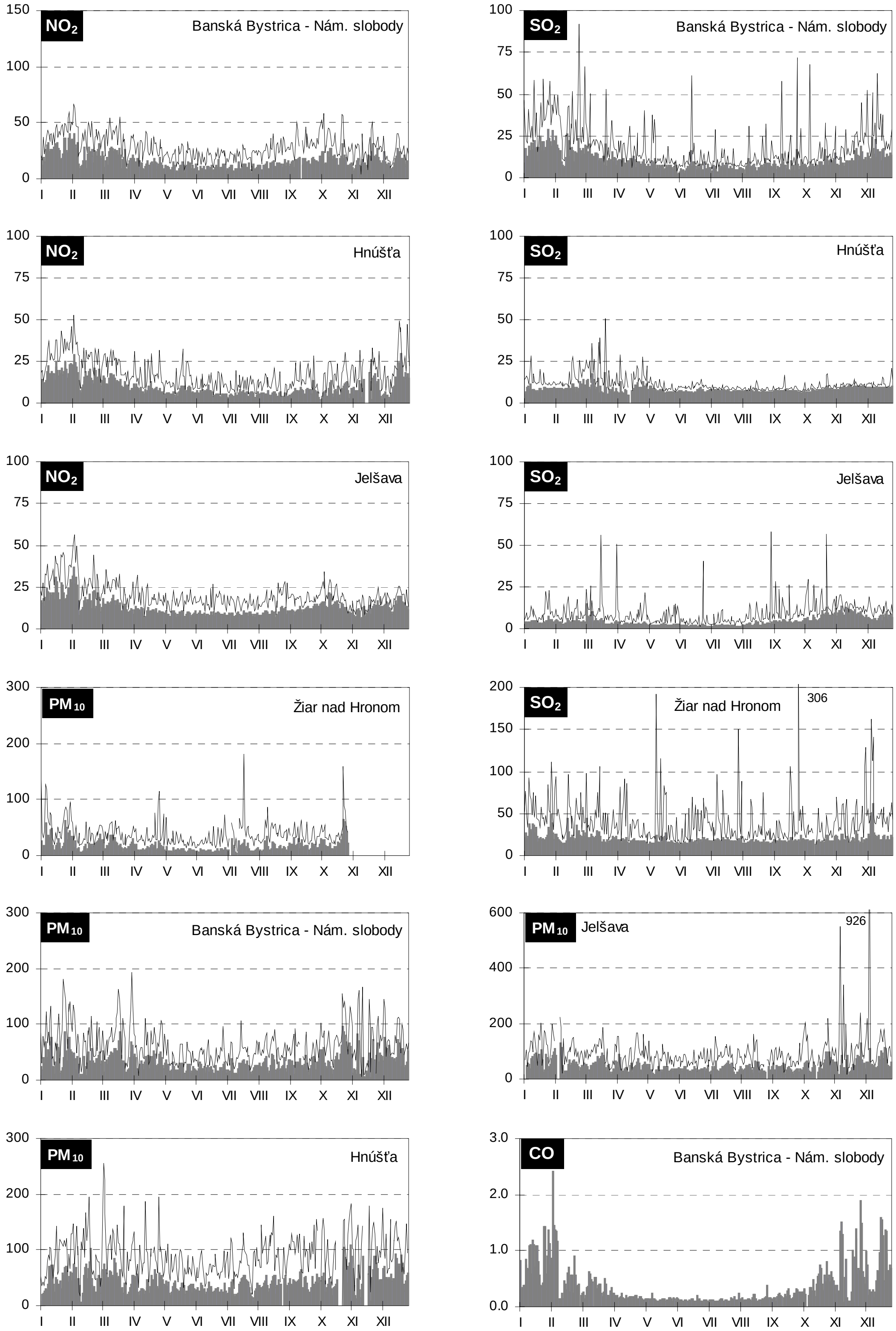


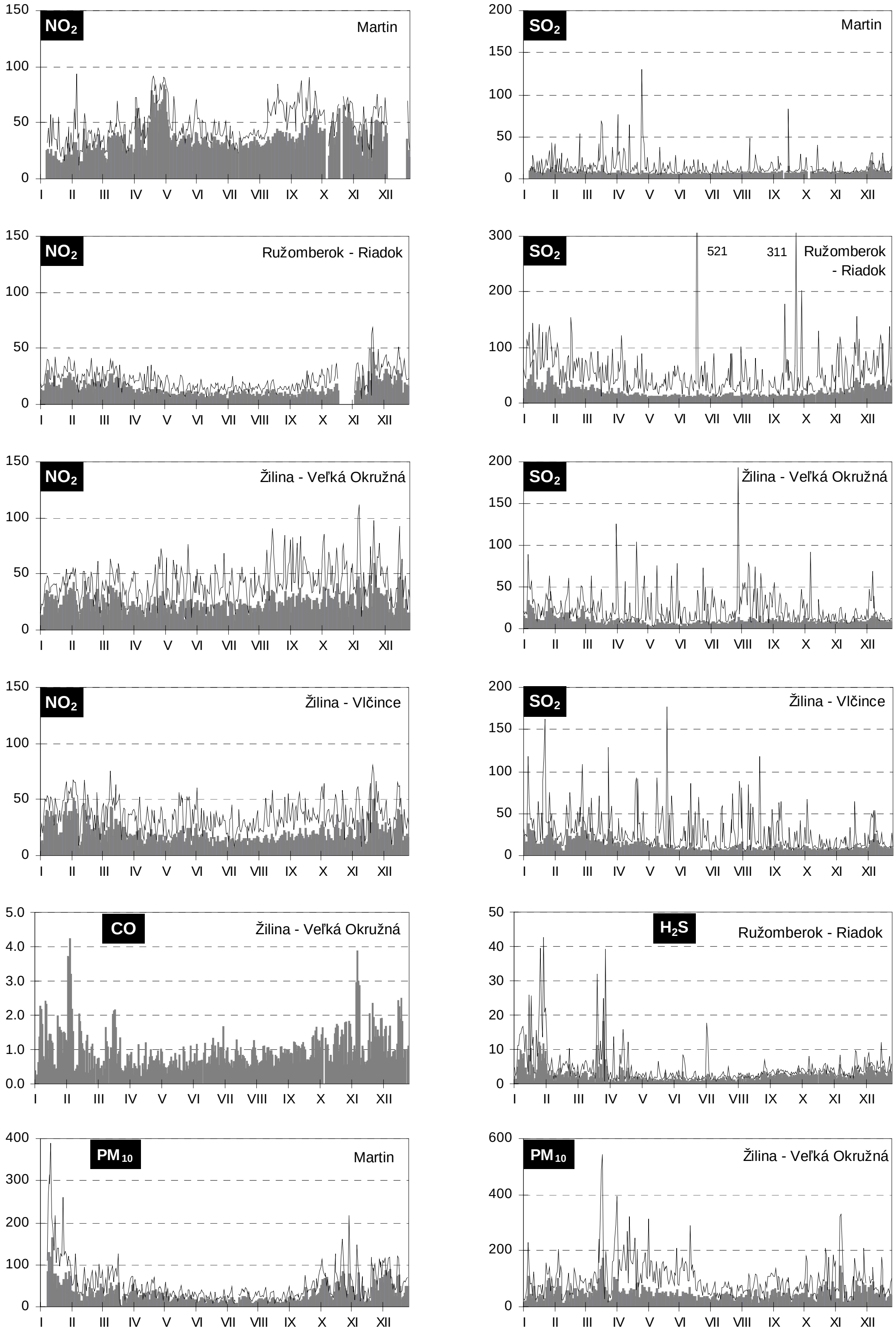
Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10} and CO – zone Banská Bystrica region – 2004**



█ concentrations:
NO_2, SO_2, PM_{10} – daily average [µg/m^3], CO - daily maximum of 8 h means [mg/m^3]

— 1 h maximum concentration of NO_2, SO_2, PM_{10}, $PM_{2.5}$ [µg/m^3]

Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and H_2S – zone Žilina region – 2004**



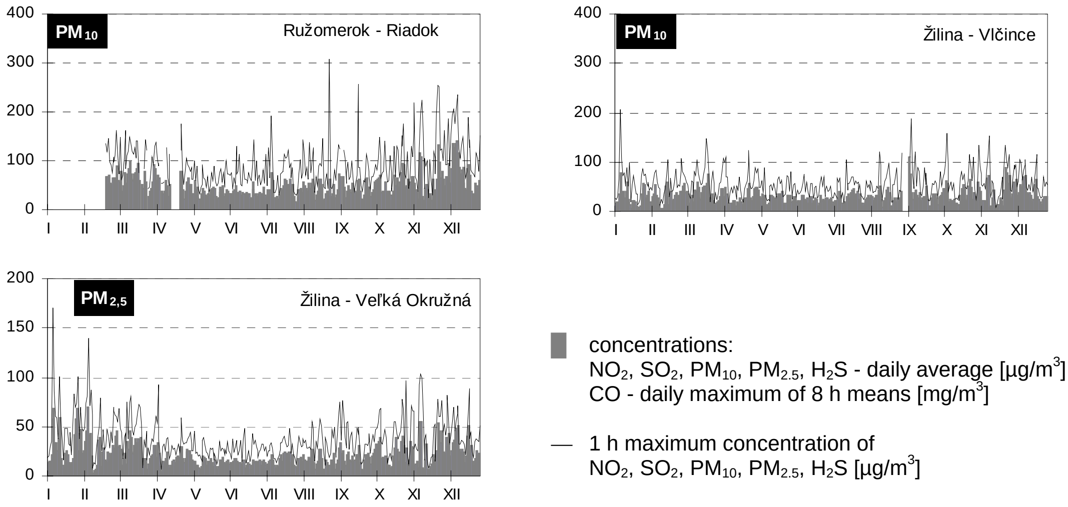
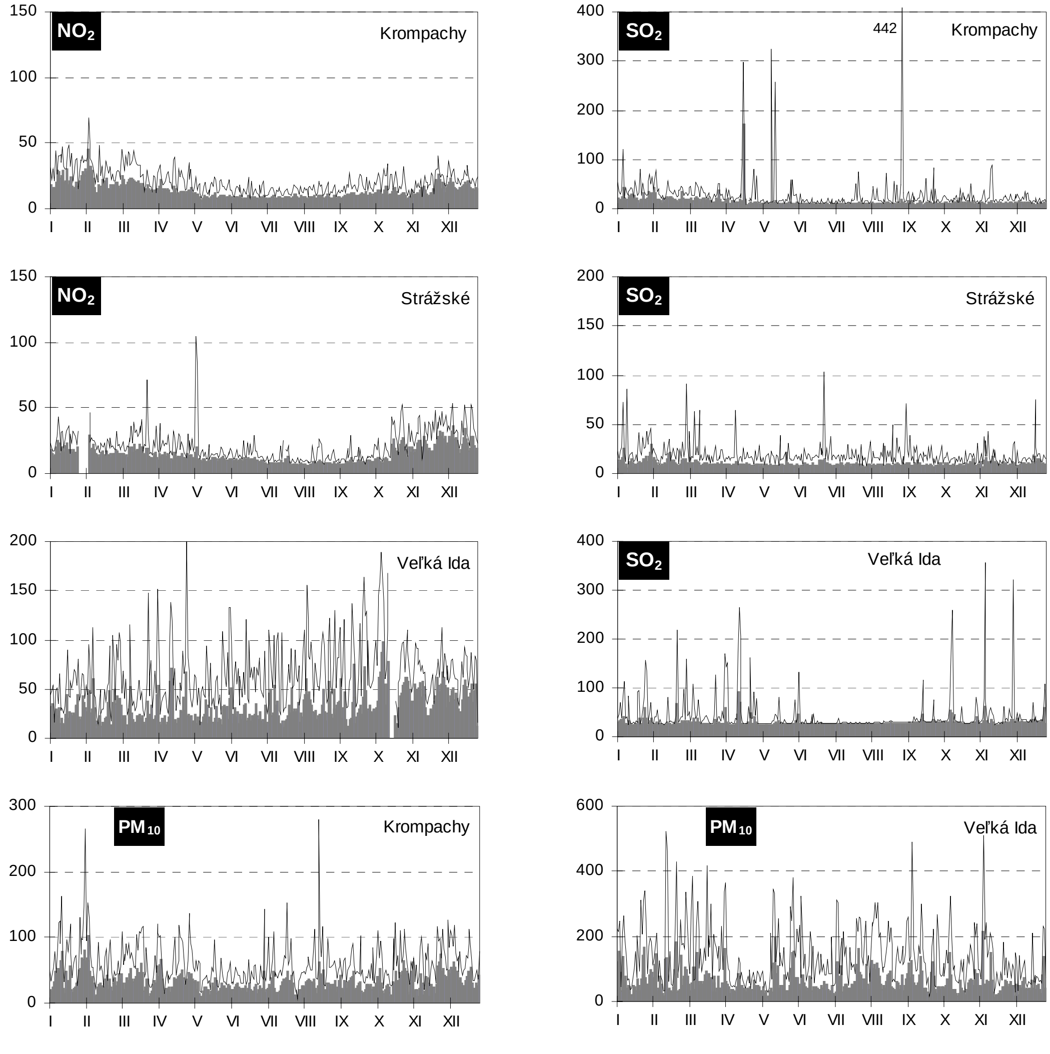


Fig. 2.8 **Concentrations of NO_2, SO_2 and PM_{10} – zone Košice region – 2004**



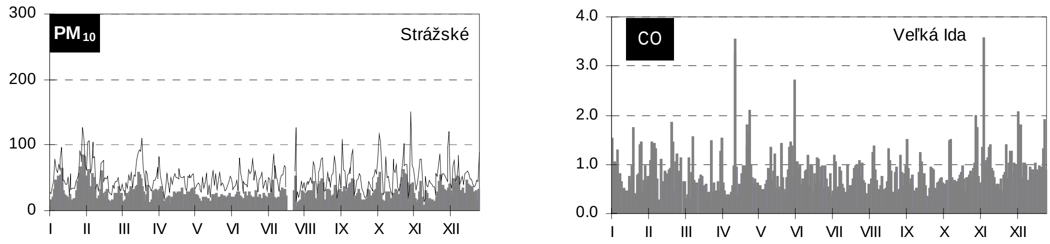
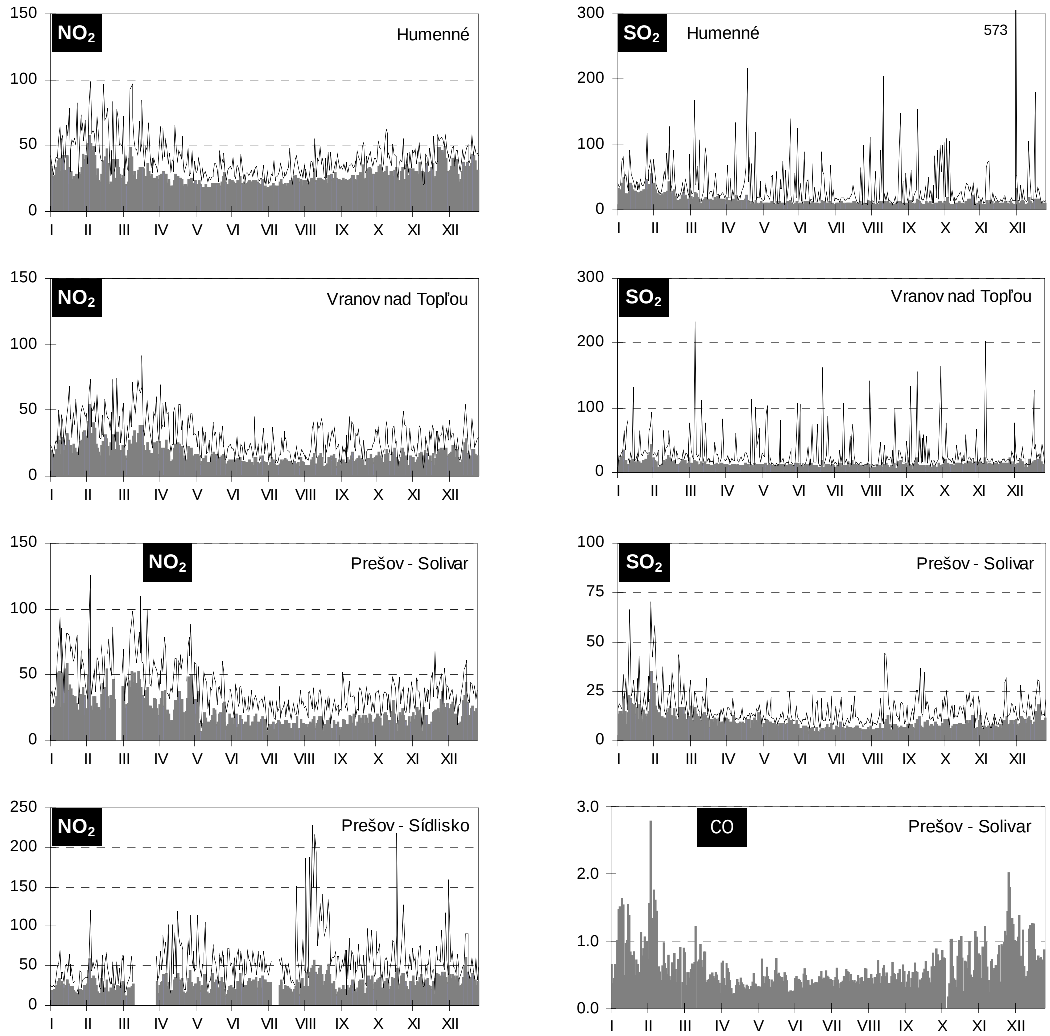
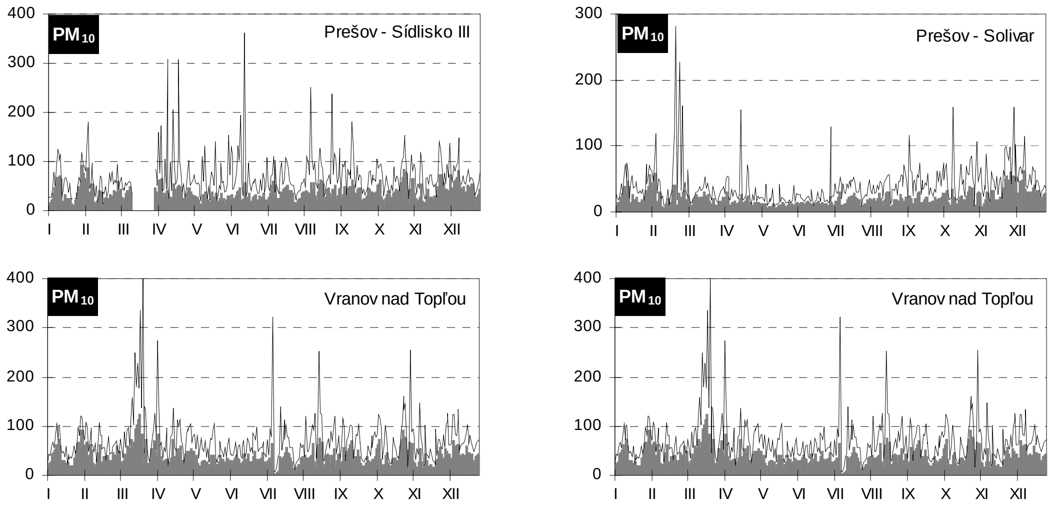


Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10} and CO – zone Prešov region – 2004**



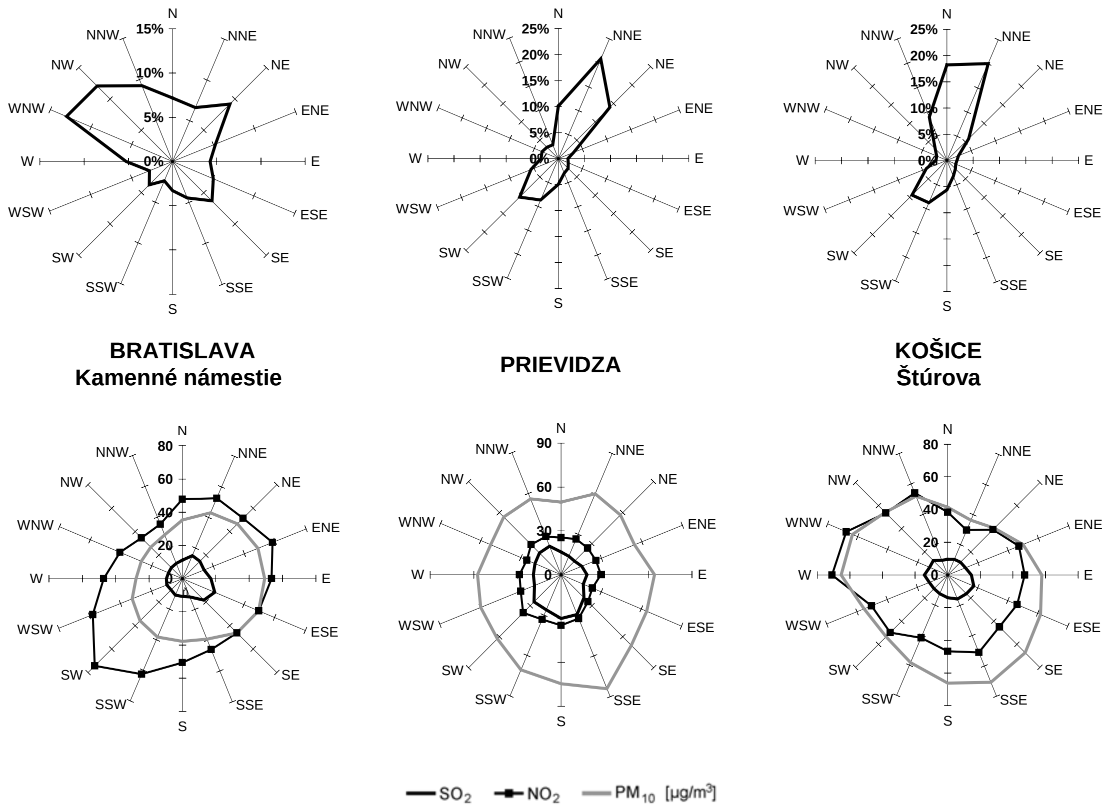
concentrations:
NO_2, SO_2, PM_{10} – daily average [µg/m^3], CO - daily maximum of 8 h means [mg/m^3]

— 1 h maximum concentration of NO_2, SO_2, PM_{10}, $PM_{2.5}$ [µg/m^3]



concentrations PM_{10} – daily average [µg/m^3]
— 1 h maximum concentration of PM_{10} [µg/m^3]

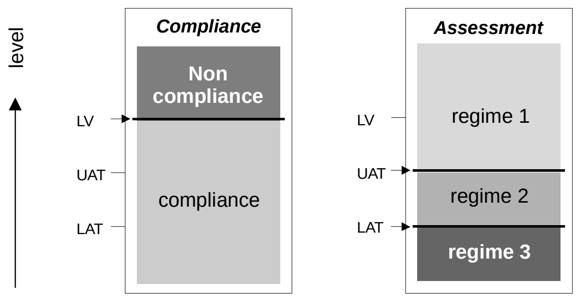
Fig. 2.10 **Wind and concentration roses – 2004**



2.3 PROCESSING OF MEASUREMENT RESULTS ACCORDING TO LIMIT VALUES

The New Clean Air Act 478/2003 harmonized the principles of air quality assessment with the EU AQ legislation. The whole territory of the Slovak Republic was divided into zones and agglomerations and on the basis of air quality assessment in each zone/agglomeration the monitoring regimes were defined. This assessment performed for the period of the last five years distinguishes three particular monitoring regimes. These are schematically illustrated on the Fig. 2.9, and in Table 2.3 are specified requirements for air quality assessment for specific regimes.

Fig. 2.9 **Regimes of air quality assessment in relation to LV[1], UAT[2] a LAT[3]**



Tab. 2.3 **Requirements for assessment in three different regimes**

Maximum level of pollution In agglomerations and zones	**Requirements for assessment**
REGIME 1 **Above upper assessment threshold**	High quality of measurements is obligatory. Measured data can be supplemented by further information, model computations including.
REGIME 2 **Below upper assessment threshold, but above lower assessment threshold**	Measurements are obligatory, however to a lesser extent, or to a lesser intensity, under the premise that the data are supplemented by other reliable sources of information.
REGIME 3 **Below lower assessment threshold**	
In agglomerations, only for pollutants, for which an alert threshold has been set	At least one measurement station is required in each agglomeration combined with the model computations, expert estimate and indicative measurements. Those are measurements based on simple methods, or operated in limited time. These are less accurate than continuous measurements, but may be used to control relatively low level of pollution and as supplementary measurements in other areas.
In all types of zones, apart from agglomeration zones, for all pollutants for which an alert threshold has been set	Model computations, expert estimates and indicative measurements are sufficient.

[1] Limit value as defined in Decree No 705 about Air Quality
[2] Upper assessment threshold as defined in Decree No 705 about Air Quality
[3] Lower assessment threshold, as defined in Decree No 705 about Air Quality

Limit values, upper and lower assessment thresholds defined in Directives 1999/30/EC and 2000/ 69/EC are presented in Tables 2.4 and 2.5. For several pollutants the margins of tolerance (MoT) were set up, Table 2.5. The margins of tolerance are gradually decreasing since, they will meet the zero value at the date when limit values will come into force. In order to distinguish **limit values**, from the limit values + MoT (2004) the later are marked as **limit values 2004** in the following text**.** Alert thresholds and warning limit values were indicated for:

Signal **Information**: If the values of moving average concentrations during 3 hours are above:
- SO_2 - 400 µg.m^{-3}
- NO_2 - 250 µg.m^{-3}

Signal **Regulation**: If the values of moving average concentrations during 3 hours are above:
- SO_2 - 500 µg.m^{-3}
- NO_2 - 400 µg.m^{-3}

Statistical characteristics quoted in tables were processed for all monitoring stations in Slovakia. The stations, where the limit values and limit values 2004 were exceeded, are highlighted in tables in bold (Tables 2.6 - 2.7). The annual concentrations of heavy metals are presented in Table 2.8. The statistical characteristics concentrations of NO_2 and PM_{10} from station Bratislava-Koliba were not evaluated because of insufficient number of measurements.

Sulphur dioxide An exceedance of limit values 2004 was recorded at one station, in Bystričany. Besides of the zone Trenčin region the general air quality can be considered therefore as good,

Nitrogen dioxide In the year 2004 the annual limit value for nitrogen dioxide was exceeded only at the station Nitra. Here the average concentration achieved 40.3 µg.m^{-3}, what is only about 0.3 µg.m^{-3} more then the limit value (40 µg.m^{-3}).

PM_{10} In 2004 PM_{10} was monitored at 27 stations. Parallel measurements of $PM_{2.5}$ fraction were carried out at 6 stations. For this fraction no limit values have been set up till now. PM_{10} concentrations are presented in tables 2.6-2.8 as values measured by automatic analyzers and as values recalculated to the reference gravimetry method (1.3*PM_{10}). For recalculation multiplying concentrations by a default factor of 1.3 is recommended. This factor was officially approved by the PM_{10} Working group and therefore all assessment was done from PM_{10} concentrations multiplying by 1.3. The limit value 2004 was exceeded at many stations in Bratislava agglomeration (Trnavské mýto, Mamateyova), in Trnava zone (Trnava), in Nitra zone (Nitra), in Banská Bystrica zone (Banská Bystrica, Hnúšťa, Jelšava), Trenčín zone (Prievidza, Bystričany), in Žilina zone (Veľká Okružná, Ružomberok, Martin), in Prešov zone (Prešov-Sídlisko III, Vranov nad Topľou), in Košice agglomeration (Strojárenská, Štúrová), and in Košice zone (Veľká Ida).

Carbon monoxide The level of pollution by carbon monoxide is considerably lower and the limit value was not exceeded at any of the monitoring stations.

Lead At present air pollution by lead does not represent a serious problem. in the Slovak Republic.

Benzene At some location the air pollution level is slightly below limit value 5 µg.m^{-3} (Nitra – 4.9 µg.m^{-3}) , which has to be met in the year 2010.

Tab. 2.4 **Limit values plus limits of tolerance for respective years**

	Interval of averaging	Limit value* [µg/m³]	To be met by	Margin of tolerance	Limit value + margin of tolerance [µg/m³]										
					Since 31/12/00	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SO_2	1h	350 (24)	1/1/05	150 µg/m³	500	470	440	410	380	350					
SO_2	24h	125 (3)	1/1/05	-											
SO_2[e]	1r, W[1]	20 (-)	19/07/01	-											
NO_2	1h	200 (18)	1/01/10	50 %	300	290	280	270	260	250	240	230	220	210	200
NO_2	1r	40 (-)	1/01/10	50 %	60	58	56	54	52	50	48	46	44	42	40
NOx[e]	1r	30 (-)	19/07/01	-											
PM_{10}	24h	50 (35)	1/01/05	50 %	75	70	65	60	55	50					
PM_{10}	1r	40 (-)	1/01/05	20 %	48	46	45	43	42	40					
Pb	1r	0.5 (-)	1/01/05	100 %	1.0	0.9	0.8	0.7	0.6	0.5					
Pb[2]	1r	0.5 (1.0) (-)	1/1/10 (1/1/05)	100 %	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5
CO	max. 8 hour daily value	10000 (-)	1/1/2003 (1/1/2005)		16000	16000	16000	14000	12000	10000					
Benzene	1r	5 (-)	1/1/2006 (1/1/2010)	100 %	10	10	10	10	10	10	9	8	7	6	5

[1] *winter period (October 1 - March 31)* [2] *only for specific point sources*
[e] *for protection of vegetation* ** allowed exceedances per year are in brackets*

Tab. 2.5 **Limit values, upper and lower assessment threshold**

	Receptor	Interval of averaging	Limit value [µg/m³]	Assessment threshold [µg/m³]	
				Upper*	Lower*
SO_2	Human health	1h	350 (24)		
SO_2	Human health	24h	125 (3)	75 (3)	50 (3)
SO_2	Vegetation	1y, 1/2y	20 (-)	12 (-)	8 (-)
NO_2	Human health	1h	200 (18)	140 (18)	100 (18)
NO_2	Human health	1y	40 (-)	32 (-)	26 (-)
NOx	Vegetation	1y	30 (-)	24 (-)	19,5 (-)
PM_{10}	Human health	24h	50 (35)	30 (7)	20 (7)
PM_{10}	Human health	1y	40 (-)	14 (-)	10 (-)
Pb	Human health	1y	0,5 (-)	0,35 (-)	0,25 (-)
CO	Human health	8h (maximum)	10 000 (-)	7 000 (-)	5 000 (-)
Benzene	Human health	1y	5 (-)	3,5 (-)	2 (-)

** allowed exceedances per year are in brackets*

Tab. 2.6 **Assessment of pollution according to limit values in the year 2004**

AGLOMERATION / zone	Component	Protection of health											AT	
		SO_2		NO_2		1.3*PM_{10}		PM_{10}		Pb	CO	Benzene	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	24 hour	1 year	24 hour	1 year	1 year	8 hour MA[1]	1 year	3 subsequent hour	3 subsequent hour
	Limit value [µg/m³] *(number of exceedances)*	350 *(24)*	125 *(3)*	200 *(18)*	40	50 *(35)*	40	50 *(35)*	40	500[2]	10 000	5	500	400
BRATISLAVA	Bratislava Kamenné nám.	0	0	0	33.7	25	28.3	3	21.8	25.8			0	0
	Bratislava Mamateyova	0	0	0	28.1	**56**	34.9	17	26.8	26.9	2368		0	0
	Bratislava Trnavské mýto	0	0	0	38.3	**78**	37.2	24	28.6	23.1	4111	1.6	0	0
	Bratislava Koliba									19.9				
Trnava region	Trnava	0	0	0	31.3	**104**	43.9	**51**	33.3	18.1	4370	4.4	0	0
	Senica	2	0	0	23.0	**47**	32.1	14	24.7	10.5			0	0
Nitra region	Nitra	0	0	0	40.3	**209**	56.7	**110**	43.6	15.5	4531	4.9	0	0
Banská Bystrica region	Banská Bystrica Nám. slobody	0	0	0	15.8	**53**	32.5	23	25.0	54.0	2410		0	0
	Hnúšťa	0	0	0	9.6	**100**	42.5	**41**	32.7				0	0
	Jelšava	0	0	0	12.6	**127**	46.5	**60**	35.8	23.9			0	0
	Žiar nad Hronom	0	0	0	7.9	6	17.0	1	13.1	14.2			0	0
Trenčín region	Bystričany	**33**	4	0	10.1	**117**	45.0	**51**	34.6				1	0
	Handlová	0	1	0	22.6	**43**	30.4	9	23.4				0	0
	Prievidza	21	3	0	17.5	**122**	47.4	**68**	36.4	13.9			1	0
	Trenčín									19.9				
Žilina region	Martin	0	0	0	35.0	**59**	31.1	31	23.9	15.8			0	0
	Ružomberok Riadok	0	0	0	13.3	**125**	49.0	**57**	37.7	15.1			0	0
	Žilina Veľká Okružná	0	0	0	23.5	**115**	45.0	**57**	34.6	24.1	4225		0	0
	Žilina Vlčince	0	0	0	19.2	**40**	30.2	12	23.3				0	0
Prešov region	Humenné	2	0	0	27.2	**44**	30.9	11	23.8	27.2			0	0
	Prešov Solivar	0	0	0	21.3	9	19.6	0	15.0	41.4	2783		0	0
	Prešov Sídlisko III	0	0	3	27.1	**60**	35.6	17	27.4				0	0
	Vranov nad Topľou	0	0	0	16.1	**82**	37.7	31	29.0	33.5			0	0
Košice region	Krompachy	0	1	0	13.3	35	31.2	9	24.0	186.3			0	0
	Strážske	0	0	0	13.8	24	27.6	3	21.2				0	0
	Veľká Ida	0	0	1	30.9	**172**	59.0	**115**	45.4	127.3	3582		0	0
KOŠICE	Košice Strojárenská	0	0	0	19.3	**60**	35.9	29	27.6	45.4	2674		0	0
	Košice Štúrova	0	0	0	18.0	**82**	38.4	33	29.5		3841	2.3	0	0

AT – alert threshold (number of days)

[1] *maximal 8 hour value of moving average* [2] *lead in ng/m³*

XX,X *annual mean is above limit value*

XXX *number of exceedances > allowed number of exceedances*

Tab. 2.7 **Assessment of pollution according to limit values 2004 in the year 2004**

AGGLOMERATION / zone	Component	SO_2		NO_2		1.3*PM_{10}		PM_{10}		Pb	CO	Ben-zene	AT SO_2	AT NO_2
		Protection of health											AT	
	Time of averaging	1 hour	24 hour	1 hour	1 year	24 hour	1 year	24 hour	1 year	1 year	8 hour MA[1]	1 year	3 subsequent hour	3 subsequent hour
	Limit value 2004 [µg/m³] *(number of exceedances)*	380 *(24)*	125 *(3)*	260 *(18)*	52	55 *(35)*	42	55 35)	42	800[2]	12000	10	500	400
BRATISLAVA	Bratislava Kamenné nám.	*0*	*0*	*0*	33.7	*17*	28.3	*3*	21.8	25.8			*0*	*0*
	Bratislava Mamateyova	*0*	*0*	*0*	28.1	***36***	34.9	*10*	26.8	26.9	2368		*0*	*0*
	Bratislava Trnavské mýto	*0*	*0*	*0*	38.3	***57***	37.2	*13*	28.6	23.1	4111	1.6	*0*	*0*
	Bratislava Koliba									19.9				
Trnava region	Trnava	*0*	*0*	*0*	31.3	***84***	43.9	***38***	33.7	18.1	4370	4.4	*0*	*0*
	Senica	*2*	*0*	*0*	23.0	*28*	32.1	*4*	24.7	10.5			*0*	*0*
Nitra region	Nitra	*0*	*0*	*0*	40.3	***172***	56.7	***83***	43.6	15.5	4531	4.9	*0*	*0*
Banská Bystrica region	Banská Bystrica Nám. slobody	*0*	*0*	*0*	15.8	***37***	32.5	*13*	25.0	54.0	2410		*0*	*0*
	Hnúšťa	*0*	*0*	*0*	9.6	***65***	42.5	*26*	32.7				*0*	*0*
	Jelšava	*0*	*0*	*0*	12.6	***95***	46.5	***39***	35.8	23.9			*0*	*0*
	Žiar nad Hronom	*0*	*0*	*0*	7.9	*4*	17.0	*0*	13.1	14.2			*0*	*0*
Trenčín region	Bystričany	***28***	*4*	*0*	10.1	***88***	45.0	***39***	34.6				*1*	*0*
	Handlová	*0*	*1*	*0*	22.6	*18*	30.4	*7*	22.8				*0*	*0*
	Prievidza	*17*	*3*	*0*	17.5	***99***	47.4	***51***	36.4	13.9			*1*	*0*
	Trenčín									19.9				
Žilina region	Martin	*0*	*0*	*0*	35.0	***50***	31.1	*26*	23.9	15.8			*0*	*0*
	Ružomberok Riadok	*0*	*0*	*0*	13.3	***102***	49.0	***40***	37.7	15.1			*0*	*0*
	Žilina Veľká Okružná	*0*	*0*	*0*	23.5	***89***	45.0	***37***	34.6	24.1	4225		*0*	*0*
	Žilina Vlčince	*0*	*0*	*0*	19.2	*27*	30.2	*8*	23.3				*0*	*0*
Prešov region	Humenné	*2*	*0*	*0*	27.2	*29*	30.9	*3*	23.8	27.2			*0*	*0*
	Prešov Solivar	*0*	*0*	*0*	21.3	*5*	19.6	*0*	15.0	41.4	2783		*0*	*0*
	Prešov Sídlisko III	*0*	*0*	*0*	27.1	***37***	35.6	*11*	27.4				*0*	*0*
	Vranov nad Topľou	*0*	*0*	*0*	16.1	***57***	37.7	*18*	29.0	33.5			*0*	*0*
Košice region	Krompachy	*0*	*1*	*0*	13.3	*20*	31.2	*4*	24.0	186.3			*0*	*0*
	Strážske	*0*	*0*	*0*	13.8	*15*	27.6	*2*	21.2				*0*	*0*
	Veľká Ida	*0*	*0*	*0*	30.9	***146***	59.0	***99***	45.4	127.3	3582		*0*	*0*
KOŠICE	Košice Strojárenská	*0*	*0*	*0*	19.3	***45***	35.9	*20*	27.6	45.4	2674		*0*	*0*
	Košice Štúrova	*0*	*0*	*0*	18.0	***60***	38.4	*24*	29.5		3841	2.3	*0*	*0*

AT – alert threshold (number of days)
[1] maximal 8 hour value of moving average *[2] lead in ng/m³*

XX,X *annual mean is above limit value 2004*

XXX *number of exceedances > allowed number of exceedances*

Tab. 2.8 **Annual average concentrations of heavy metals [ng/m^3] in PM_{10} particles in 2004**

	Cd	Ni	As
Bratislava Koliba	0.29	1.69	0.90
Bratislava Petržalka	0.31	2.12	0.95
Bratislava Trnavske mýto	0.26	4.16	0.97
Bratislava Kamenné nám.	0.30	2.34	0.91
Trnava	0.46	3.61	1.36
Nitra	0.38	2.01	1.99
Senica	0.28	7.42	1.06
Trenčín	0.54	1.69	1.98
Banská Bystrica Nám. slobody	1.40	2.05	4.50
Ružomberok Riadok	0.41	3.41	5.48
Žiar nad Hronom	0.55	0.95	2.46
Prievidza	0.37	1.65	8.34
Žilina Veľká Okružná	0.57	2.88	3.85
Martin	0.36	1.32	3.31
Jelšava	0.55	1.68	2.62
Košice Strojárenská	1.27	2.20	2.24
Veľká Ida	3.11	1.94	2.17
Prešov Solivar	1.15	1.65	1.79
Krompachy	2.85	1.81	13.03
Humenné	1.20	1.45	1.37
Vranov nad Topľou	1.56	1.48	1.89

AMBIENT AIR

3

ATMOSPHERIC OZONE

3.1 ATMOSPHERIC OZONE

Most of the atmospheric ozone (approximately 90 %) is in the stratosphere (11-50km), the rest in the troposphere. Stratospheric ozone protects our biosphere against lethal ultra-violet UV-C radiation and to a considerable degree weakens UV-B radiation, which may cause the whole range of unfavourable biological effects such as skin cancer, cataracts, etc. The depletion of stratospheric ozone and thus total ozone as well, observed since the end of the 1970s, is associated with the increase in intensity and doses of UV-B radiation in the troposphere and on the Earth's surface. The main share in stratospheric ozone depletion is due to the emissions of freons and halons, which are the source of active chlorine and bromine in the stratosphere. The concentration of active chlorine in troposphere culminated in the mid-1990s. At present the culmination in stratosphere is supposed. A slow recovery of ozone layer to the pre-industrial level is expected in the middle of this century.

The growth of ozone concentrations in the troposphere approximately 1 $\mu g.m^{-3}$ annually was observed over the industrial continents of the Northern Hemisphere by the end of 1980s. It is associated with the increasing emission of ozone precursors (NOx, VOCs, CO) from car transport, power generation and industry. Since the early 1990s the concentration of ground level ozone in Europe has been more or less stagnant, which is also evident in the measurements in Slovakia. In spite of considerable decrease of ozone precursor emission reduction in Slovakia and in surrounding countries during nineties the effect seems to be not adequate. Only ozone peaks decreased significantly. The average level of ozone concentration is probably more controlled by large scale processes (downward mixing from the free troposphere, long-range transport and global warming). The extremely warm and dry year 2003 represented the absolute exception from the current trends. Most of the ozone level indicators reached the highest values at all Slovak suburban, rural and mountain stations in the period 1993-2003. The alert thresholds 240 $\mu g.m^{-3}$ (the first time since 1995) was overstepped in six cases in south-west Slovakia. Concentrations in 2004 came back to the 2000-2002 level. The high ground level ozone concentrations, mainly during photochemical smog episodes in summer, impact unfavourably on human health (mainly on the respiratory system of human beings), vegetation (mainly on agricultural crops and forests) and various materials.

3.2 GROUND LEVEL OZONE IN THE SLOVAK REPUBLIC DURING 1999-2004

Target and thresholds values for ground level ozone

In Table 3.1 the target values for ground level ozone are listed according to the Act 478/2002 Coll. on air protection, that in accordance with EU legislation have to be fulfilled to 2010, and information and alert thresholds. If ground level ozone concentration exceeds some of the threshold values the population has to be informed or warned.

Tab. 3.1 **Target values for ground level ozone, information and alert thresholds**

Target and threshold values	Concentration O_3 [$\mu g.m^{-3}$]	Averaging/accumulation time
for protection of human health	120*	8 hour
for protection of vegetation AOT40**	18 000 [$\mu g.m^{-3}.h$]	1 May - 31 July
for information of population	180	1 hour
alert thresholds for population	240	1 hour

* *Maximum daily 8-hour average 120 $\mu g.m^{-3}$ not to be exceeded on more than 25 days per calendar year averaged over three years.*

** *AOT40, expressed in $\mu g.m^{-3}$.hours, means the sum of the difference between hourly concentrations greater that 80 $\mu g.m^{-3}$ (= 40 ppb) and 80 $\mu g.m^{-3}$ over a given period using only the 1 hour values measured between 8:00 and 20:00 of Central European Time each day, averaged over five years.*

Measurements of ground level ozone in Slovakia during 1999-2004

The measurement of ground level ozone concentrations in Slovakia started in 1992, within the operation of monitoring network under the Slovak Hydrometeorological Institute. The number of monitoring stations has been gradually extended. The stations at Stará Lesná, Starina (in operation since 1994) and Chopok (in operation since 1995) are part of the EMEP monitoring network. In 2001 new ozone measurements were introduced at Štrbské Pleso station. For monitoring of ground level ozone concentrations, the ozone analysers of the US companies Thermoelectron and MLU and of Japan Horriba have been used. All these analysers operate on the principle of UV absorption. In 1994, the secondary national ozone standard was installed in the Slovak Hydrometeorological Institute and regular audits by portable calibrator started to be carried out in the stations. A secondary standard of the Slovak Hydrometeorological Institute is regularly compared with the primary ozone standard in the Czech Hydrometeorological Institute in Prague. In 2004 the number of missing data did not exceed 10 % at most of the stations (Tab. 3.2). Exceptional data gaps were only at the Poprad, Ružomberok and Starina stations.

Tab. 3.2 **Number of missing daily averages of ground level ozone concentrations** [%]

Station	1999	2000	2001	2002	2003	2004
Banská Bystrica	2,5	3,0	9,3	3,8	1,1	1,6
Bratislava - Koliba	*	5,7	4,7	3,0	2,5	2,2
Bratislava - Petržalka	0,5	18,6	3,6	1,6	3,6	2,7
Hnúšťa	4,9	2,7	3,3	5,8	6,8	7,9
Humenné	15,1	2,7	3,0	2,5	1,9	0,3
Chopok	32,8	30,0	-	6,0	45,5	9,6
Jelšava	4,9	20,5	1,6	8,2	4,1	0
Košice -Podhradová	17,8	9,6	4,4	4,1	1,4	0,5
Kojšovská hoľa	*	24,0	7,9	1,1	9,9	1,1
Martin	6,3	1,4	90,4	46,3	9,3	-
Poprad (Gánovce)	*	25,4	6,0	4,7	1,4	24,9
Prešov	10,9	16,7	3,3	1,1	5,5	0,8
Prievidza	9,3	10,1	13,4	10,4	2,7	2,2
Ružomberok	47,4	7,1	7,7	1,9	2,2	17,0
Stará Lesná	3,8	8,7	2,4	0,8	4,7	0,5
Starina	0,8	8,2	3,6	0,5	2,2	17,3
Štrbské Pleso	*	*	11,2	0,8	4,1	3,8
Topoľníky	11,2	10,1	25,8	1,1	1,4	3,6
Veľká Ida	4,7	34,2	15,0	6,6	40,8	3,6
Žiar nad Hronom	5,7	53,0	63,0	5,5	1,1	0,5
Žilina	7,4	13,1	1,4	6,8	2,7	0,3

** station installed later*   *– station closed down, respectively long-term failure of station*

Tab. 3.3 **Long-term characteristics of ground level ozone concentrations** [µg.m^{-3}]

Station	1999		2000		2001		2002		2003		2004	
	AA	AVP	AA	AVP	AA	AVP	AA	AVP	AA	AVP	AA	AVP
Banská Bystrica	42	93	41	90	44	90	39	88	46	101	42	88
Bratislava - Koliba	–	–	52	85	54	85	56	87	71	111	61	90
Bratislava - Petržalka	40	69	45	75	40	74	49	86	53	99	48	86
Hnúšťa	42	79	48	91	49	92	53	102	60	109	48	89
Humenné	46	72	48	80	48	74	56	93	66	104	58	90
Chopok	**92	**111	**75	**83	–	–	97	112	**109	112	91	101
Jelšava	50	97	47	88	49	92	48	96	55	105	51	92
Košice - Podhradová	41	62	48	81	47	74	64	104	68	104	60	94
Kojšovská hoľa	*	*	100	120	89	98	86	101	91	110	86	98
Martin	49	83	46	81	–	–	49	91	50	90	-	-
Poprad (Gánovce)	61	93	51	82	51	77	59	96	68	103	66	90
Prešov	45	74	49	90	49	86	45	88	51	100	42	80
Prievidza	46	81	46	91	45	78	43	78	51	95	47	86
Ružomberok	**34	**62	39	77	46	79	41	80	32	64	46	77
Stará Lesná	66	105	64	97	58	91	56	87	67	97	62	92
Starina	59	83	63	90	63	86	64	93	73	105	66	96
Štrbské Pleso	*	*	*	*	75	95	78	99	86	109	76	91
Topoľníky	52	85	52	73	**41	**75	47	77	67	113	59	95
Veľká Ida	44	73	**47	**85	40	73	43	87	**31	66	38	70
Žiar nad Hronom	40	72	**43	**72	–	–	50	88	58	105	55	95
Žilina	42	82	47	88	38	72	46	89	48	97	42	79

AA – annual average   AVP – average from daily hours (9-16) during vegetation period (April-September)
** station installed later   – station closed down, resp. long-term failure   ** 50-75% of measurements*

In 2004, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 38-58 µg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 59 and 91 µg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the summit station Chopok (91 µg.m^{-3}). The effect of ozone from the accumulation zone (800-1500 m over the ground) over the Europe is evident. The average from daily hours (9:00-16:00), during the vegetation period (April – September) ranged at all stations (with exception of Ružomberok, Veľká Ida and Žilina stations) around the level of 90-95 µg.m^{-3}. The year 2004, according to vegetation period averages, belongs to the photo-chemically active years.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992-2004 is depicted. The seasonal course is typical for lowlands and valley (not summit) positions of industrial continents. Original spring maximums of ozone concentrations, associated with the transport of ozone from upper atmospheric layers, is extended for the whole summer period, as a consequence of photochemical ozone formation in a atmospheric boundary layer. At the same time it follows from this Figure, that the ambient air quality standard for protection of vegetation 65 µg.m^{-3} (daily average, not in use at present) is exceeded in Stará Lesná during the whole vegetation period.

The daily average course of ground level ozone concentration in August in Stará Lesná is depicted in Figure 3.2 (higher values for this month are mostly of anthropogenic origin). The figure documents the increase in daily maximum values of ozone concentrations about 30-40 µg.m^{-3} in photochemically active years (1992, 1994, 1995, 1999, 2000, 2002 and 2003) as compared to those in less favourable years. Values in 1997, 1998 and 2001 are the smallest in the whole monitoring period.

Fig. 3.1 **Seasonal change of ground level ozone concentration in Stará Lesná during 1992-2004**

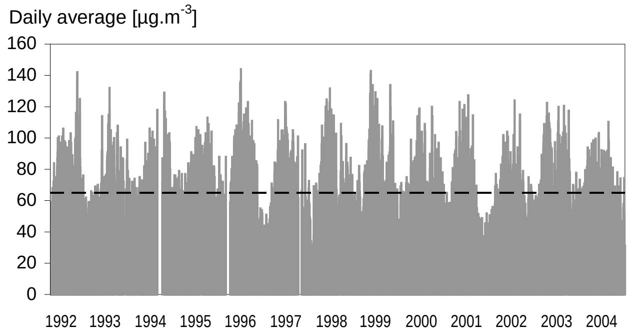
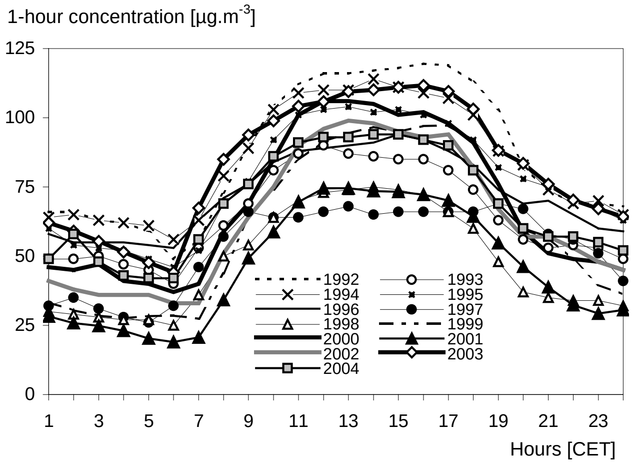


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992-2004**



The number of exceedances of ozone threshold values in Slovakia during 1999-2004 is summarised in Tables 3.4-3.6. The alert threshold when the public must be warned (240 µg.m^{-3}) was not exceeded in 2004. The information threshold to the public (180 µg.m^{-3}) in 2004 was exceeded in three cases at Chopok and Košice-Podhradová stations.

In Table 3.5 is presented the number of exceedances of ozone target value for protection of human health (8 h mean 120 µg.m^{-3}) averaged over 2002-2004. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2002-2004 was the number of 25 days overstepped at most of monitoring stations. The highest exceedance was observed at Chopok (86 days).

Tab. 3.4 **Number of exceedances in ozone information threshold (IT) and alert threshold (AT) for information and alert of the public during 1998-2004**

Station	AT_{1h} = 240 μg.m^{-3}						AT_{1h} = 180 μg.m^{-3}					
	1999	2000	2001	2002	2003	2004	1999	2000	2001	2002	2003	2004
Banská Bystrica	0	0	0	0	0	0	0	0	0	0	0	0
Bratislava - Koliba	0	-	0	0	3	0	-	2	6	0	42	0
Bratislava - Petržalka	0	0	0	0	3	0	5	6	3	0	32	0
Hnúšťa	0	0	0	0	0	0	0	0	0	2	0	0
Humenné	0	0	0	0	0	0	0	0	0	0	0	0
Chopok	0	0	0	0	0	0	0	0	0	2	3	1
Jelšava	0	0	0	0	0	0	0	0	0	0	5	0
Košice - Podhradová	0	0	0	0	0	0	0	2	0	0	0	2
Kojšovská hoľa	*	*	0	0	0	0	*	45	0	0	0	0
Martin	0	0	0	0	0	-	0	4	0	0	0	-
Poprad (Gánovce)	*	*	0	0	0	0	*	0	0	0	0	0
Prešov	*	0	0	0	0	0	0	23	0	0	7	0
Prievidza	0	0	0	0	0	0	0	0	0	0	0	0
Ružomberok	-	0	0	0	0	0	0	0	0	0	0	0
Stará Lesná	0	0	0	0	0	0	0	0	0	0	0	0
Starina	0	0	0	0	0	0	0	0	0	0	0	0
Štrbské Pleso	*	*	*	0	0	0	*	*	0	0	0	0
Topoľníky	0	0	0	0	0	0	0	23	0	0	18	0
Veľká Ida	*	0	0	0	0	0	0	2	0	0	0	0
Žiar nad Hronom	0	0	0	0	0	0	0	5	0	0	0	0
Žilina	0	0	0	0	0	0	30	0	0	0	0	0

** station installed later – station closed down, resp. long-term failure*

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2001-2004**

Station	2002	2003	2004	Average 2002-2004
Banská Bystrica	14	48	11	24
Bratislava Koliba	27	78	21	42
Bratislava Petržalka	24	55	16	32
Hnúšťa	38	79	10	42
Humenné	19	68	13	33
Chopok	92	103	62	86
Jelšava	37	66	13	39
Košice Podhradová	57	64	21	47
Kojšovská hoľa	65	97	43	68
Martin	14	29	-	21
Prešov Solivar	17	61	5	28
Prievidza	1	33	8	14
Ružomberok Riadok	5	6	1	4
Stará Lesná	10	39	10	20
Starina	13	67	17	32
Štrbské Pleso	34	71	9	38
Topoľníky	26	103	30	53
Veľká Ida	30	-	0	10
Žiar nad Hronom	11	66	25	34
Žilina Vlčince	27	57	8	31

** station installed later – station closed down, resp. long-term failure*

Table 3.6 shows AOT40 values calculated from measurements and also AOT40 values corrected on the missing data. The target AOT40 value for the protection of vegetation is 18 000 μg.m^{-3}.h averaged over five years. If five year average cannot be determined the valid data for at least three years can be used. From the table one can see, that AOT40 averaged over five years overstepped the target values for the protection of vegetation only at mountain stations (Chopok and Kojšovská hoľa) and also in Jelšava.

In the period 1999-2004 the former ambient air quality standard for the protection of vegetation (1-hour average) 200 µg.m^{-3} was exceeded only in several cases. In 2004 no exceedances were observed (Tab. 3.7). Former ambient air quality standard, 65 µg.m^{-3} (24-hour average) is exceeded regularly each year over the whole territory of Slovakia, mostly in higher mountain positions. In 2003 the most of exceedances was observed at Štrbské Pleso station, 285 cases (Tab. 3.7). Both standards are not applied at present.

Tab. 3.6 **AOT40** [µg.m^{-3}.h]

Station	AOT40	AOT40cor[1]	Average
Bratislava Koliba	12149	14494	2000-2004
Bratislava Petržalka	8289	9336	2000-2004
Banská Bystrica	13951	15331	2000-2004
Hnúšťa	14397	16146	2000-2004
Humenné	8999	9705	2000-2004
Chopok	17679	23532	2000-2004
Jelšava	15830	18327	2000-2004
Košice Podhradová	9387	10879	2000-2004
Kojšovská hoľa	23482	26671	2000-2004
Martin	-	-	2000-2004
Prešov Solivar	11220	11810	2000-2004
Prievidza	8844	10276	2000-2004
Ružomberok Riadok	6146	7384	2000-2004
Stará Lesná	12212	13286	2000-2004
Starina	10853	11777	2000-2004
Topoľníky	9180	11639	2000-2004
Štrbské Pleso	14695	17448	2000-2004
Veľká Ida	6167	8720	2000-2004
Žiar nad Hronom	9151	11317	2002-2004
Žilina Vlčince	11503	12885	2000-2004

[1] corrected on the missing data according to the relation
AOT40 (cor) = AOT40 (measured) x total possible number of hours / number of measured hourly values

Tab. 3.7 **Number of exceedances in ozone short-term ambient air quality standards (AQS) for protection of vegetation during 1998-2004** (these standards already are not applied, the data is presented only for information)

Station	AQS$_{1h}$ = 200 µg.m^{-3}						AQS$_{24h}$ = 65 µg.m^{-3}					
	1999	2000	2001	2002	2003	2004	1999	2000	2001	2002	2003	2004
Banská Bystrica	0	0	0	0	0	0	63	72	88	57	98	70
Bratislava - Koliba	-	0	0	0	16	0		112	116	134	191	182
Bratislava - Petržalka	0	2	0	0	16	0	105	115	50	97	125	95
Hnúšťa	0	0	0	0	0	0	53	78	126	128	160	86
Humenné	0	0	0	0	0	0	111	56	110	137	196	158
Chopok	0	0	–	0	0	0	**217	**147	–	279	211	302
Jelšava	0	0	0	0	0	0	115	80	109	111	149	122
Košice – Podhradová	0	0	0	0	0	0	12	143	147	178	217	186
Kojšovská hoľa	*	8	0	0	0	0	*	259	298	300	273	304
Martin	0	0	–	0	0	-	89	48	–	53	89	-
Poprad (Gánovce)	*	0	0	0	0	0	*	65	56	120	192	156
Prešov	0	9	0	0	0	0	8	93	109	68	97	52
Prievidza	0	0	0	0	0	0	134	88	78	55	121	89
Ružomberok	0	0	0	0	0	0	**0	38	56	65	25	55
Stará Lesná	0	0	0	0	0	0	173	132	124	117	178	158
Starina	0	0	0	0	0	0	128	157	157	182	224	167
Štrbské Pleso	*	*	0	0	0	0	*	*	206	261	285	270
Topoľníky	0	1	0	0	2	0	100	133	39	65	201	167
Veľká Ida	0	0	0	0	0	0	44	**36	27	64	7	10
Žiar nad Hronom	0	2	–	0	0	0	76	**46	–	86	154	142
Žilina	4	0	0	0	0	0	48	85	41	85	116	60

* *station installed later* – *station closed down, respectively long-term failure of station*

** *50-75 % of measurements*

It may be stated in conclusion, that in the extremely warm, dry and photochemical active year 2003 the highest values of the most ground level ozone indicators in Slovakia were observed from the beginning of observations (since 1992). This reality is to some extend surprising taking into account a massive decrease of anthropogenic precursor emissions (NOx, VOC and CO) in Slovakia (already below Göteborg ceilings) and in Europe as well during the last 10-15 years. It documents the large share of “uncontrollable” ozone at the territory of Slovakia. Downward mixing, long-range transport (including intercontinental transport), formation of ozone from biogenic precursors and climate change apparently play much more significant role as was previously assumed. The year 2003 demonstrates the limitations of national ozone mitigation strategy. One of the conclusions the European TOR2 project (ended in 2003) is proposal to shift the ground level ozone problem among global issues, for example into Kyoto Protocol. The level of surface ozone concentrations in 2004 decreased and was close to the average from the all available data (1992-2004).

3.3 TOTAL ATMOSFERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2004

Since August 1993 total atmospheric ozone over the territory of Slovakia has been measured with the Brewer ozone spectrophotometer MKIV #097 in the Centre of Aerology and Ozone Measurements of the Slovak Hydrometeorological Institute (SHMÚ) at Gánovce near Poprad. As well the solar UV spectra is regularly scanned through the range 290-325 nm at 0.5 nm increments. Poprad-Gánovce station is a part of the Global Ozone Observing System (GOOS). The results are regularly submitted to the World Ozone Data Centre (WOUDC) in Canada and to the WMO Ozone Mapping Centre in Greece. Poprad-Gánovce station is included to Global Atmosphere Watch (GAW) network for total ozone and solar UV spectral radiation.

Information about the ozone layer state and intensity of harmful solar UV radiation is provided daily to the public via the SR Press Agency and by mobile phone service. Since April 2000 the SHMÚ Centre of Aerology and Ozone Measurements has been providing 24 hour UV Index forecast for the public. Predicted UV Index daily course for clear day, half covered sky and overcast is presented on the SHMÚ Web site: (www.shmu.sk/ozon/).

The annual mean of the total atmospheric ozone was 324.2 Dobson Units in 2004. This is 4.1 % below the long-term average (calculated upon the Hradec Kralove measurements in the period 1962-1990). The ozone layer state was less favourable comparing with the situation in 2003, when the deficiency was 1.3 %. However in last decade the year 2004 is not unusual, because the same or lower annual mean was recorded 6 times.

Total ozone statistics for the year 2004 (daily means, relative deviations from long term averages, monthly means, standard deviations and extremes) are in Table 3.8.

The monthly means above an average were observed in January, February and December. Average ozone deficiencies in the other months were from 3 to 9 %. From mid April to early October all weakly averages and 90 % daily values remained below long term average.

Total ozone weekly averages are in Figure 3.3. The graph illustrates a behaviour of the ozone layer in the year 2004 and shows significant short-term variations in total ozone amount in our geographical region.

Figure 3.4 shows the biologically effective irradiance (in units of mW/m^2) weighted by CIE erythemal action spectra (McKinlay and Diffey 1987). Values have been measured at local noon (about 10:39 UTC), when the daily maximal solar elevation is achieved. During a day of clear sky daily UV-B maximum should be measured. A significant scattering of values demonstrates the weather condition influence. Clouds depending on their optical depth can significantly reduce the UV irradiance. As the UV irradiance depends on the solar elevation it has a distinctive daily and annual course. UV-B values in winter are more than 10-times lower as compared to summer. Comparable attenuation is also caused by cloudiness and precipitation in summer. After filtering of cloud, precipitation and aerosol influence the annual course is not symmetrical by solstices. Decreased annual course of total ozone causes the highest UV irradiance after solstice in last decade of June and early July.

The UV Index is also shown in Figure 3.4. It is a unit to express the UV level relevant to the erythemal effect on human skin. Its values are used to derive a recommended sunburn time. Individual sunburn time has to be modified depending on skin type and skin adaptation by producing melanin. Values over 7 attained in spring and summer months are classified as high. The sun exposure without protection should be limited to several minutes. Values below 4 attained from October to March are classified as low. Sunburn time over one hour is not dangerous even if the ozone layer is attenuated. The only protective tool should be glasses. However considerably high UV-B radiation doses are relevant in snowy high mountain positions at the beginning of spring. Practical unit to describe intensity of erythemal ultraviolet radiation is Minimal Erythema Dose (MED). 1 MED is defined as the minimal UV dose that causes a reddening of previously unexposed human skin. However, because the sensitivity of human individuals depends on skin type, the relationship between MED and physical units was defined for the most sensitive skin. 1 MED/hod corresponds to 0.0583 W/m^2 for 1 MED = 210 J/m^2. More information about total ozone, solar UV radiation and the protection against a harmful solar radiation are available on the SHMÚ Web site.

Fig. 3.3 **Total atmospheric ozone over the territory of Slovakia in 2004**

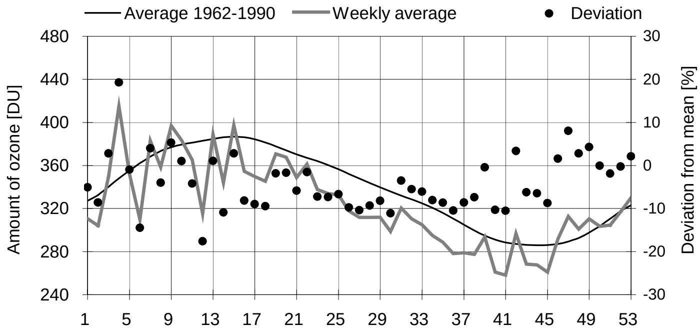


Fig. 3.4 **Annual course of DUV (Diffey) radiation noon values Gánovce 2004**

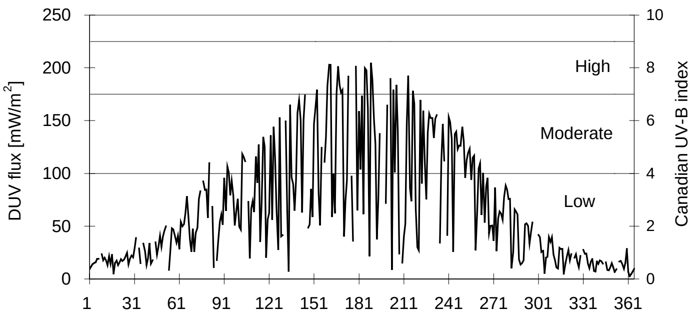
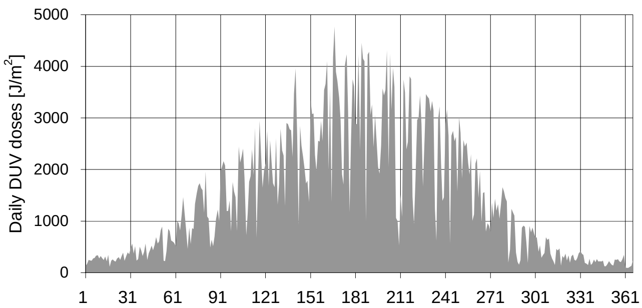


Fig. 3.5 **Annual course of harmfull ultraviolet solar radiation daily doses – Gánovce 2004**



The maximal noon value of CIE-weighted irradiance 204.7 mW/m^2 (which correspondents to 3.51 MED/hod) was measured on July 7. That was the last of four values with irradiance over 200 mW/m^2 in 2004.

UV-B radiation has been monitored every day at regular 1-hour or half an hour increments. The observing schedule was only temporarily stopped during thunderstorms. Daily CIE-erythemal doses are presented in Figure 3.5. A maximum of 4771 J/m^2 (which correspondents to 22.7 MED) was measured on June 15. In that day an ozone loss of 14 % was observed and the maximal noon value of CIE-weighted irradiance was 201.5 mW/m^2.

Total CIE-erythemal dose for the period April-September 2004 was 440 992 J/m^2. This is a lower value than in 2003 when the state of ozone layer was better but sunny weather was more frequent. In period April-September 2004 the sunshine duration was 1279 hours at Poprad-Ganovce. During the same period in 2003 it was 1550 hours.

Tab. 3.8 **Total atmospheric ozone [DU] in 2004 and the deviations from long-term average**

Day	I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII	
	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev
1	322	-1	286	-20	459	21	330	-15	335	-12	326	-11	301	-14	298	-10	293	-6	270	-7	262	-8	284	-4
2	303	-7	330	-8	413	9	335	-13	333	-12	330	-10	306	-12	312	-5	283	-9	264	-9	251	-12	286	-4
3	322	-2	303	-16	400	5	340	-12	373	-2	336	-8	318	-9	302	-8	278	-10	240	-17	244	-15	320	8
4	295	-10	317	-12	417	10	361	-7	354	-7	345	-5	316	-9	295	-11	276	-11	241	-17	255	-11	323	8
5	340	3	280	-23	378	0	366	-5	348	-8	345	-5	288	-17	309	-6	272	-12	240	-17	241	-16	317	6
6	329	0	276	-24	329	-13	395	2	362	-4	350	-4	278	-20	318	-3	260	-16	245	-15	252	-12	335	12
7	287	-13	286	-21	356	-6	423	9	384	2	332	-8	292	-15	331	1	265	-14	246	-15	296	3	274	-9
8	287	-14	378	3	391	3	427	10	382	1	329	-9	303	-12	310	-5	294	-4	246	-15	288	1	295	-2
9	274	-18	392	7	424	11	404	4	375	0	314	-13	304	-11	308	-6	287	-6	270	-6	299	4	314	4
10	305	-9	374	2	400	5	417	8	391	4	310	-14	324	-6	308	-6	281	-8	282	-2	299	4	313	3
11	307	-9	375	2	384	1	372	-4	363	-3	327	-9	327	-5	296	-9	279	-8	278	-3	296	3	307	1
12	334	-1	440	19	400	5	346	-11	369	-2	344	-4	356	4	288	-11	279	-8	273	-5	285	-1	307	1
13	334	-1	378	2	310	-19	345	-11	368	-2	357	-1	349	2	302	-7	267	-12	277	-4	299	4	315	3
14	331	-2	353	-5	305	-20	356	-8	354	-5	358	0	335	-2	325	0	271	-10	297	3	271	-6	306	0
15	366	7	369	0	335	-12	362	-6	363	-3	308	-14	328	-4	311	-4	278	-8	313	9	292	2	301	-2
16	328	-4	372	0	301	-21	367	-5	381	2	329	-8	302	-11	307	-5	278	-7	302	5	278	-4	288	-7
17	365	7	356	-4	305	-20	355	-8	376	1	334	-6	287	-15	298	-8	288	-4	311	8	307	6	265	-15
18	391	14	355	-5	302	-21	346	-10	353	-5	339	-5	294	-13	298	-7	273	-9	304	6	291	1	331	6
19	408	18	385	3	316	-17	344	-11	327	-12	347	-3	288	-15	286	-11	281	-6	289	1	328	13	302	-3
20	409	18	360	-4	376	-2	326	-16	332	-10	335	-6	291	-14	275	-14	274	-8	280	-2	354	22	339	8
21	459	32	341	-9	294	-23	368	-4	326	-12	337	-5	297	-12	290	-9	256	-14	267	-7	323	11	320	2
22	447	28	342	-9	314	-18	357	-7	348	-6	326	-8	290	-14	325	2	324	9	258	-10	308	6	383	21
23	440	26	335	-11	350	-9	336	-13	373	1	326	-8	296	-12	292	-8	308	4	259	-10	312	7	332	5
24	380	8	379	1	367	-4	345	-10	384	4	308	-13	292	-13	285	-10	298	1	258	-10	371	27	304	-4
25	364	4	380	1	387	1	364	-5	377	2	309	-12	301	-10	289	-9	291	-1	269	-6	281	-4	270	-15
26	341	-3	394	4	394	2	353	-8	356	-3	343	-2	324	-3	301	-5	296	1	264	-8	248	-15	290	-9
27	329	-7	398	6	429	11	346	-10	359	-2	311	-11	338	1	301	-5	283	-3	277	-3	276	-6	319	-1
28	350	-1	435	15	429	11	347	-9	360	-2	302	-14	337	1	276	-12	263	-10	286	0	304	4	341	6
29	365	3	454	20	366	-5	350	-8	364	-1	324	-7	325	-2	280	-11	267	-9	283	-1	315	7	342	6
30	431	21			344	-11	334	-12	362	-1	329	-6	326	-2	289	-8	283	-3	258	-10	307	4	364	13
31	362	1			333	-14			353	-4			307	-7	285	-9			243	-15			274	-16
Ø	352	3	359	-3	365	-5	361	-6	361	-3	330	-8	310	-9	300	-7	281	-7	271	-6	291	1	312	1
Std	49	13	45	11	45	12	27	7	17	5	15	4	20	6	14	4	14	5	21	7	30	10	27	8
Max	459	32	454	20	459	21	427	10	391	4	358	0	356	4	331	2	324	9	313	9	371	27	383	21
Min	274	-18	276	-24	294	-23	326	-16	326	-12	302	-14	278	-20	275	-14	256	-16	240	-17	241	-16	265	-16

O_3 - *total ozone* Dev - *relative deviation from long-term mean (Hradec Králové 1962-1990)*
Std - *standard deviation [DU]*

4

EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 EMISSION AND AIR POLLUTION SOURCE INVENTORY

Anthropogenic emissions of pollutants into the atmosphere cause many present and potential problems, such as acidification, ambient air quality deterioration, global warming/climate change, destruction of buildings and constructions, disruption of ozonosphere.

Quantitative information on these emissions and their sources are necessary requirements for:

- the information of the responsible bodies, expert and lay public
- the definition of environmental priorities and identification of causes of problems
- the assessment of environmental impact on different plans and strategies
- the assessment of environmental costs and benefits on different approaches
- the monitoring of effect, respective effectiveness of adopted measures
- the support by agreement with adopted commitments

STATIONARY SOURCES

Information related to stationary sources of air pollution was in period 1985-1999 compiled according the Air act No 35/1967 in system EAPSI (Emission and Air Pollution Source Inventory). This system was divided according to the heating output into 3 subsystems:

EAPSI 1............. Stationary sources of the heating output over 5 MW and selected technologies (updated annually)

EAPSI 2............... Stationary sources of the heating output 0.2-5 MW and selected technologies

EAPSI 3............... Stationary (local) sources of the output below 0.2 MW (consumption of fuels for inhabitants)

According to the changes in the air protection legislations the amendment of EAPSI was not occurring, therefore was created the new module NEIS (National Emission Inventory System) in 1997 in the frame of project of the Ministry of Environment in coordination with SHMI and close cooperation with the regional offices, district offices and selected operators. The NEIS software product is constructed as a multi-module system, corresponding fully to the requirements of current legislation in air protection. Module NEIS BU enables the execution of complex data acquisition and their processing in respective district offices, as well as carrying out the logical control on correctness in emission calculation on input data and provides the decision about the height of tax. It enables the feeding of the input data on sources exclusively in a way corresponding to the legislation. Data acquisition is carried out by a set of questionnaires, but it is possible also to use software module NEIS PZ, which also enables filling the questionnaires in electronic form and also emission calculation and data feeding from respective operators into the NEIS BU district databases. Data from district databases are then fed into the NEIS CU central database. NEIS employs the support of standard database products MS ACCESS and MS SQL server.

The function of system was attested during preliminary testing in the selected regions within all area of SR and the system was accepted by interdepartmental operative committee.

Positive contribution of NEIS

- Homogeneous system of processing data about sources and their emissions at local, regional and national level.
- Provision of an actual and effective tool to all primary process the data and thus give a guarantee for uniform level of acquisition, processing and control of data about the sources and their emissions.
- Better transparency of procedure to concede the quantity of emissions and thus payment of taxes for the pollution of the air by operators of the sources due to the built-in control system, and the necessity to provide the input data into NEIS exclusively in coincidence with the legislative regulations.
- Establishment of a Slovak national database that enables the top state administration bodies to optimally fulfill their tasks on the all ranks and to provide the input data for international emission inventories or special emission inventories.

The comparison of the EAPSI and NEIS systems

Changes in the air protection legislation carried out within 1990-2000, e.g. identification/delimitation and definition of source, change in categorization of sources and their division upon the output caused that the EAPSI system may be compared with the NEIS module only on the national level. Comparison of the individual parts of EAPSI (EAPSI 1and EAPSI 2) with the NEIS module (large, medium-size sources), respectively comparison of individual sources in both systems is difficult.

According to the Act No 478/2002 Act. Coll. as amended, the district offices are obliged to elaborate yearly reports about the operational characteristics of air pollution sources in their district and provide them electronically at the latest till May 31 of the current year for the next processing to SHMI, the organization accredited by the Ministry of Environment to manage the central database NEIS CU and provide the data processing at the national level (Bulletin of MoE No 6/2000).

The NEIS system includes the sources of air pollution, which are assigned following the input and category according to the Decree No 706/2002, Act. Coll.

Large sources	Stationary sources containing stationary combustion units having cumulative heating input over 50 MW and other processes

Middle sources	Stationary sources containing stationary combustion units having cumulative heating input 0.3-50 MW and other processes

Small sources	Stationary equipment – domestic heating equipment for combustion of fuels (solid, natural gas) with heating input less than 0.3 MW (According to the Decree of MoE SR No 53/2004)

Results 1990-2004

EAPSI 1

The EAPSI 1 database has been represented by a coherent set of data since 1990-1999. In the year 1999, the 967 air pollution sources, i.e. the area-administrative units, defined according to the organisation inventory number, were in operation. For each of these units, the data about quantity, type and quality of fuel consumed, technical and technological parameters of combustion and separation technique, are updated annually. Using these data, the emissions of CO, NOx, SO_2 and particulate matter for the individual sources are calculated by using the emission factors. Since 1996, these values for selected sources have been substituted by the data provided by the operators using the recalculations from the results of measurements. Emission data from technologies are provided by the individual sources based on their own findings. Emissions from combustion processes and technologies of individual sources are further summarised at the level of area administrative units. Sources registered in EAPSI 1 are provided by the geographical co-ordinates, which enable the projection of them in a geographical information system.

Large sources

Since 2000 the gathering of the selected data on sources and their emissions has been provided in the NEIS system. New system contained 921 large point sources from 79 the NEIS BU district databases in 2003. As the sources of 5 MW and above were included to the evidence of large point sources in the EAPSI system, the comparison of numbers of sources in both systems is difficult.

EAPSI 2

Updating of EAPSI 2 data is carried out in several-year cycle. Inventory and acquisition of data from individual sources were carried out continuously. Summarising was carried out in 1985 and 1989. However, the number of sources registered in EAPSI 2, was growing to such an extent, that the data are not comparable. The third updating was carried out in cooperation with the Offices of Environment within the period 1993-1996 and ended in December 1996.

Middle sources

Since 2000 the data updating in the NEIS system has been provided each year. In 2003 system NEIS registered 12 436 medium sources from 79 the NEIS BU district database. System EAPSI 2 registered only sources of heating output 0.2-5 MW and therefore to compare the number of sources in the individual systems is difficult.

EAPSI 3 and small sources

The emission balance is being processed in the system NEIS CU and is based on the data about the selling of solid fuels for households and retail users (years 2001-2003 in sense of the Decree No 144/2000, year 2004 in sense of the Decree No 53/2004), consumption of natural gas for the inhabitants (register of SPP,a.s) and respective emission factors. Local furnaces are assessed as the areal sources on the level of district. In 2004 the emission balance has been revised[1] following the emission recalculation since 1990. Within the revision the emission factors were updated (in coincidence with the valid legislation of air protection) as well the qualitative features of solid fuels (in sense of OTN ZP 2008) and the wood combustion emissions were additionally recalculated as its consumption have not been included in the balance before 2004. In the past the balance has not been carried out regularly (EAPSI 3 system had been updated annually only until 1997), in the missing years the data have been additionally calculated. In such a way the consistent data time series within 1990-2003 have been obtained.

[1] *Balance of the air pollution small sources in the Slovak Republic, Profing 2003*

Mobile sources

Emissions from mobile sources are calculated since 1990 annually. Emission calculation is being done by the COPERT method, recommended to the signatories of the UN ECE Convention on Long Range Transboundary Transmission of Air Pollutants. It is based on the number of individual types of cars, the amount of kilometers driven and the consumption of individual fuel types. Apart from road transport, inventory of mobile sources includes the railway, air and shipping transport, as well. These emissions are estimated according to the methods provided in IPCC Guidelines. In year 2002 emissions of mobile sources were estimated using COPERT III version based on the latest know-how in this area. In 2004 the solid matter emission balance from road transport was completed about the emissions from exhausts of petrol engines and about the abrasive emissions (abrasing of road surface, tyres and brake facing) in coincidence with the requests of the updated method EMEP/ CORINAIR[2] and in coincidence with the requests for reporting of these emissions for UN ECE (NFR[3]). For the calculation the method and emission factors recommended by the TNO-MEP agency were used. The results of PM emission balance from road transport are listed in Table 4.1. In 2005 the input data used for the calculation of emission from road transport were revised and consequently the correction of the 2002 emissions was carried out (Table 4.1 and 4.2b).

4.2 DEVELOPMENT OF TRENDS IN BASIC POLLUTANTS

Emissions of basic pollutants

Trends in basic pollutants compiled in systems EAPSI and NEIS are listed in Table 4.2 a,b and Figure 4.1.

Particulate matter and SO_2

Emissions of particulate matter and sulphur dioxide have been decreasing continuously since 1990. Apart from the decrease in energy production and consumption, this was caused by the change of fuel base in favour of high-grade fuels, as well as the improvement of fuel quality characters used. A further spreading of separation techniques used, respectively advancing of its effectiveness shared in the particulate matter emission reduction. The downward trend of sulphur dioxide emissions up to 1996 continued also in 2000 and was caused by the decreasing consumption of brown coal, hard coal, heavy fuel oil, usage of low-sulphur fuel oil (Slovnaft) and installation of the desulphurisation systems for the large power sources (Power plants in Zemianske Kostoľany and Vojany). The fluctuation of SO_2 emissions within 2001 and 2003 was caused either by their partial or total operation, by the quality of combustion fuel and volume of production. In 2004 the decrease of SO_2 emissions was recorded mainly at large sources. This decrease was caused mainly by the combustion of low-sulphur-content fuel oils in continuously growing extent (Slovnaft). Slight increase of PM emissions in 2004 was caused by the extended wood consumption in the sector small sources (households) in 2004 as compared to 2003.

[2] *Emission Inventory Guidebook – 3rd edition*
[3] *New format for reporting*

Oxides of nitrogen

Emissions of oxides of nitrogen have showed a smooth decrease since 1990. A slight emission increase in 1995 was associated with the increase in consumption of natural gas. A decrease of emissions of oxides of nitrogen in 1996 was caused by the change of emission factor, taking into consideration the present condition of technique and technology in combustion processes. Since 1997, the decrease in solid fuel consumption has led to a further decrease in NOx emissions. The further emissions decreasing in years 2002 and 2003 was caused by denitrification process (Power plant Vojany). In 2004 the emission trend was without more considerable changes.

CO

A downward trend in carbon monoxide emissions since 1990 has been caused mainly by the decrease in consumption and a change of fuel composition in the sphere of retail consumers. Carbon monoxide emissions originating from combustion processes of the major sources have been slightly decreasing, as well. The iron and steel industry participate most significantly in the total carbon monoxide emissions from major sources. Carbon monoxide emission decrease in 1992 was due to a decrease in iron and steel production volume. In 1993, when the iron and steel production increased again, reaching the 1990 level, the carbon monoxide emissions increased proportionally, as well. A decrease in carbon monoxide emissions in 1996 was due to the effects of measures (determined on the results of measurements) being taken to limit carbon dioxide emissions in the most important source in this sector. The fluctuation of CO emissions within 1997 and 2003 is connected also with the quantity of pig iron production as well as the fuel consumption. In 2004 the CO emissions increased mainly at large sources, however at the same time they decreased in the sector road transport. The increase at large sources was recorded at U.S. Steel, joint stock company, Košice where the amount of CO emissions was improved upon the continual measurement. The emission decrease in the sector road transport is related to the decrease of petrol consumption as well as to the onward renovation of vehicle stock by the generational new vehicles equipped by three-way control catalyser.

EMISSIONS OF OTHER POLLUTANTS

The Slovak republic is bounded to provide inventory of selected pollutants by the Convention on Long Range Transboundary Air Pollution. The emission inventories of non-methane volatile organic compounds (NM VOC), heavy metals (HM) and persistent organic pollutants (POPs) are processed in accordance with international methodology in the sence of the SNAP nomenclature and recommendations of TFEIP working groups. Emissions are estimated at national level in cooperation with external experts and are balanced on the base of activity data multiplied by emission factors. Estimated emissions of mentioned pollutants as well as others are transformed into international NFR system according to requirements for reporting and annually are reported to the UNECE secretariat through the Ministry of Environment of SR.

NMVOC

Emission inventory of NMVOC is elaborated according to Joint EMEP/CORINAIR „Atmospheric Emission Inventory Guidebook“. In 2001 a new subsector *road paving with asphalt* was included in emission inventory in consequence of emissions adequate increased in each years. In 2004 the emission factor from mentioned sector was revalued and changed. The previous emission factor was based on highest emission production. New emission factor respect that aspalt mixture contains 5.5 % of asphalt and others is create by agregate. In the sector Residential was included combustion of wood for the first time. Emission increased slightly in mentioned sector. In the sector fuel distribution was included

LPG distribution since 2001. The NMVOC emissions have decreased since 1990. This development was caused by decreased consumption of solvent based paints and the step-by step introduction of low solvent paint, broad introduction of measures in the crude oil processing and fuel distribution sectors as well as a change of fuels in the energy sector and alteration of the cars in favour of cars equipped with catalytic converters (Tab. 4.7, Fig. 4.4).

POPs

Emissions of persistent organic pollutants (POPs) were recalculated according to methodology, elaborated in the frame of the project *Initial assistance to the Slovak republic to meet its obligations under Stockholm Convention on Persistent Organic Pollutants*, and updated according to Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, February 2005 and methodologies used in the Czech Republic and Poland. Emissions of PCDD/F and PAH from road transportation were calculated by program COPERT III. Downward trend of emissions to the air is the most remarkable at the emissions of PAH in the 90-ties, also emissions of PCDD/F have declined since 2000 because of reconstruction of some technologies (for example municipal waste incinerator). Recently, the question of emission of PCDD/F from residential combustion is still opened, it is possible, that measurement will show, that contribution of this sector to the total emissions is more significant (Tab. 4.8, Fig. 4.5).

HMs

Emission inventory of Heavy metals is elaborated according to Joint EMEP/CORINAIR „Atmospheric Emission Inventory Guidebook“. In 2004 was included combustion of wood the sector Residential and emissions since 1990 were revised. Heavy metals emissions also show a decreasing trend after 1990. Beside the ceasing of several obsolete ineffective metallurgy plants this trend has been effected by a broad reconstruction of electrostatic precipitators and other dust control equipment, a change of raw materials used and in particular by the elimination of leaded petrol (Tab. 4.9, Fig. 4.6) since 1996.

Share of individual sectors in total emissions of the Slovak Republic in the year 2004

Figure 4.2 represents the contribution of stationary and mobile sources to air pollution. The graphs show that the share of traffic in air pollution by oxides of nitrogen and carbon monoxide is significant. On the other hand, combustion processes and industry do contribute to air pollution mainly by oxides of sulphur and particulate matter. Table 4.3 shows the total emission values in individual agglomerations and zones (in sense of the Annex No 8 to the Decree No 705/2002 Act Coll.).

Most important sources of air pollution in the Slovak Republic in the year 2004

Table 4.4 introduces 20 of the most important air pollution sources in Slovakia. The share of these sources in the total air emissions of Slovakia varies from 76.02 to 92.90 %. Table 4.5 lists top ten sources for each of 8 administrative regions based on basic pollutant emissions.

Specific territorial emissions in the year 2004

Table 4.6 and Figure 4.3 provide us with a certain imagination about the territorial distribution of the pollutants emitted. However, it is necessary to distinguish between the amount of pollutants emitted from the respective territory and the ambient air concentrations, because the pollutants emitted may impact on more distant areas, depending on the stack height and meteorological characteristics.

4.3 VERIFICATION OF THE RESULTS

Verification of the data gathered during the emission inventory was carried out by a comparison of:

- updated data to the data from previous years and by the verification of reasons for their changes (e.g. change in fuel base, respectively fuel quality characters, technology, separation technique, etc.)
- data listed in the EAPSI 1 questionnaires to the data provided by operators to the district offices for identification of a tax height. Differences appeared mostly in fuel quality characters and this may significantly affect the quantity of the emission calculated in dependence on the quantity of fuel consumed. Further differences arose as a consequence of the fact, that district offices enabled sources to report the emission quantity calculated on their own measurements. In some cases the differences between the levels found out on the balance calculation and the recalculation from the results of measurements were significant. In the 1996 and 1999 EAPSI 1 balance, for the selected sources such measurement results were taken into account, where the level of results measured as well as the procedure of recalculation were satisfactory.
- Module NEIS BU enables to control emissions estimated on the district level and its implementation will decrease the uncertainty of national estimates.

Note: Structural changes of the current national emission inventory system, in accordance with the new air protection act (transposition of EU air pollution legislation), is ongoing process. Harmonisation of all pollutant inventories and ISO9001 are introducing. In accordance with these requirements the inventory results for the year N are completed to the 31 October (N+1) and the inventory results of the basic pollutants for the year N are completed to the 15 February (N+2).

Tab. 4.1 **Emissions of PM from road transport in the Slovak Republic within 1990-2004 [t]**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Emissions from diesel engine	2916	2339	2040	1889	2020	2200	2263	2292	2397	2260	1975	2167	*2329*	2262	2473
Emissions from petrol engine	376	348	335	354	346	346	321	302	283	238	208	220	*188*	168	156
Total emissions from exhaust	3292	2687	2375	2243	2366	2546	2584	2594	2680	2498	2183	2387	*2517*	2430	2629
Abrasion emissions	6737	5587	5102	5000	5765	5761	5897	6114	6324	5823	5465	6180	*6349*	6480	6852
Total	10029	8274	7477	7243	8131	8307	8481	8708	9004	8321	7648	8567	*8866*	8910	9480

Tab. 4.2a **Emissions of basic pollutants in SR within 1990-1999 [thous. t]**

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
PM	EAPSI 1	208.075	153.590	110.545	79.925	52.335	55.770	38.461	36.646	31.168	34.813
	EAPSI 2	36.425	[1] 36.425	[1] 36.425	[1] 36.425	[1] 17.097	[1] 17.097	9.478	[2] 9.478	[2] 9.478	[2] 9.478
	EAPSI 3	34.795	35.710	31.968	29.386	26.077	24.582	24.539	20.170	21.039	20.234
	EAPSI 4	10.764	8.855	7.978	7.644	8.544	8.755	8.940	9.142	9.509	8.766
	Total	290.059	234.580	186.916	153.380	104.053	106.204	81.418	75.436	71.194	73.291
SO_2	EAPSI 1	421.981	347.084	296.034	246.411	182.746	188.590	197.308	176.564	153.723	147.111
	EAPSI 2	37.509	[1] 37.509	[1] 37.509	[1] 37.509	[1] 27.091	[1] 27.091	10.577	[2] 10.577	[2] 10.577	[2] 10.577
	EAPSI 3	63.197	58.173	53.697	42.124	33.069	28.117	20.173	14.994	17.088	14.189
	EAPSI 4	3.424	2.722	2.390	2.175	2.313	2.490	2.536	2.554	2.724	1.088
	Total	526.111	445.488	389.630	328.219	245.219	246.288	230.594	204.689	184.112	172.965
NOx	EAPSI 1	146.474	135.389	127.454	122.169	111.616	118.040	76.853	70.583	74.322	65.436
	EAPSI 2	4.961	[1] 4.961	[1] 4.961	[1] 4.961	[1] 5.193	[1] 5.193	3.960	[2] 3.960	[2] 3.960	[2] 3.960
	EAPSI 3	13.331	13.077	12.243	10.583	9.456	9.023	8.845	7.784	8.355	8.201
	EAPSI 4	56.850	47.375	43.738	42.362	43.535	45.453	45.038	44.914	46.210	43.225
	Total	221.616	200.802	188.396	180.075	169.800	177.709	134.696	127.241	132.847	120.822
CO	EAPSI 1	162.047	160.591	132.874	160.112	168.561	165.715	129.388	141.636	118.581	122.149
	EAPSI 2	27.307	[1] 27.307	[1] 27.307	[1] 27.307	[1] 11.409	[1] 11.409	12.037	[2] 12.037	[2] 12.037	[2] 12.037
	EAPSI 3	161.905	152.335	139.809	113.629	92.663	81.778	66.759	51.933	56.990	51.171
	EAPSI 4	154.199	142.135	140.621	150.676	154.804	156.743	151.133	153.216	153.946	144.655
	Total	505.458	482.368	440.611	451.724	427.437	415.645	359.317	358.822	341.554	330.012

EAPSI 1-3 – stationary sources *EAPSI 4 – mobile sources (road and other transport)*
[1] *data based on expert estimate* [2] *the 1996 data*

Tab. 4.2b **Emissions of basic pollutants in SR within 2000-2004 [thous. t]**

			2000	2001	2002	2003	2004
PM	**Stationary sources – NEIS**	Large sources [1]	29.923	29.722	25.037	20.166	17.670
		Middle sources [1]	4.958	4.405	3.767	3.259	2.748
		Small sources [2]	19.877	20.550	17.217	18.300	21.504
	Mobile sources	Road transport	7.648	8.567	*8.866*	8.910	9.480
		Other transport	0.399	0.404	0.366	0.329	0.343
	Total		62.805	63.648	55.253	50.964	51.745
SO_2	**Stationary sources – NEIS**	Large sources [1]	101.955	109.823	91.461	95.283	87.932
		Middle sources [1]	8.083	6.655	3.964	3.620	2.652
		Small sources [2]	16.055	13.764	7.127	6.384	5.382
	Mobile sources	Road transport	0.670	0.750	*0.733*	0.750	0.827
		Other transport	0.189	0.194	0.064	0.059	0.063
	Total		126.952	131.186	103.349	106.096	96.856
NOx	**Stationary sources – NEIS**	Large sources [1]	54.485	51.653	46.412	44.605	44.244
		Middle sources [1]	8.052	7.751	6.356	6.620	4.926
		Small sources [2]	7.993	8.391	7.137	7.356	7.582
	Mobile sources	Road transport	33.438	35.719	*36.063*	34.814	36.443
		Other transport	4.860	4.899	4.808	4.305	4.506
	Total		108.828	108.413	100.776	97.700	97.701
CO	**Stationary sources – NEIS**	Large sources [1]	120.609	115.177	122.225	141.047	147.317
		Middle sources [1]	10.779	10.280	9.150	9.394	7.531
		Small sources [2]	53.792	50.178	33.815	33.811	34.753
	Mobile sources	Road transport	120.190	131.954	*119.757*	116.050	111.602
		Other transport	1.719	1.626	1.591	1.463	1.509
	Total		307.089	309.215	286.538	301.765	302.712

[1] *according to the Decree of MoE SR No 706/2002 Act. Coll.*
[2] *according to Decree of MoE SR No144/2000 Act. Coll. (2001-2003),*
according to Decree of MoE SR No 53/2004 Act. Coll. (2004)
Emissions, as they were appointed to October 31, 2005

Fig. 4.1 Development trends in basic pollutant emissions within 1990-2004

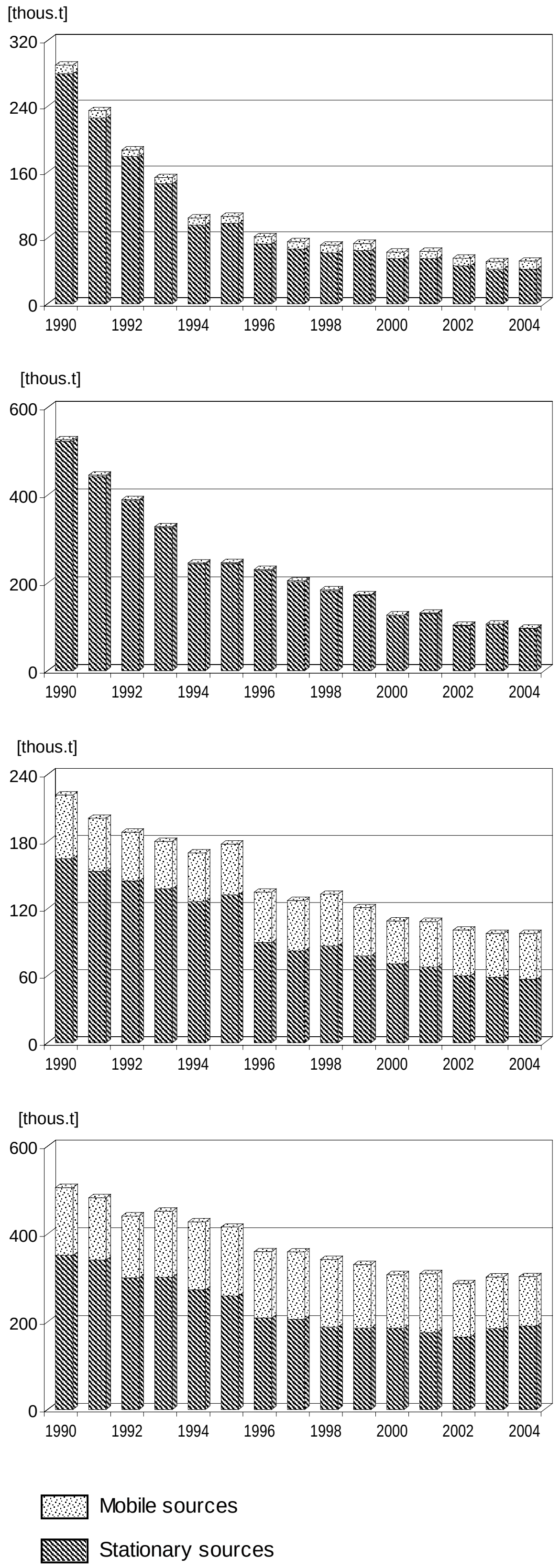
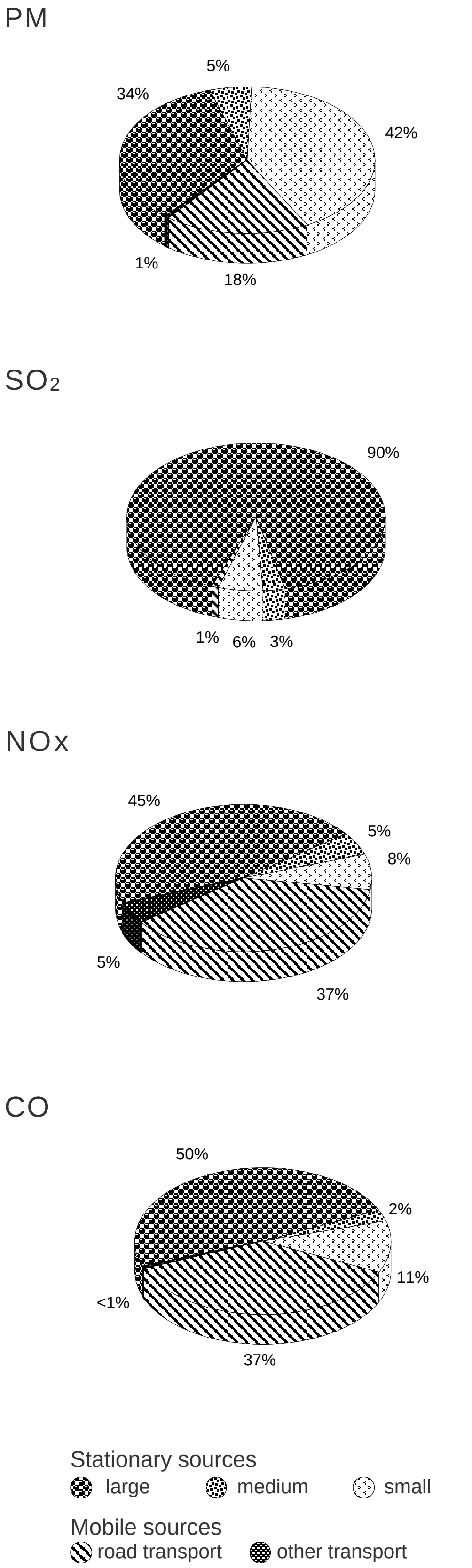


Fig. 4.2 Emissions of basic pollutants in 2004



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2000-2004**

Year			TZL	SO_2	NOx	CO
2000	Aglomeration	Bratislava	942	13240	6393	1528
		Košice	15758	18307	12382	84544
	Zone	Bratislava region	501	384	1792	1951
		Trnava region	1518	2160	2012	4746
		Trenčín region	4607	28625	9083	11684
		Nitra region	3057	4752	3905	7964
		Žilina region	6585	10775	5433	19357
		Banská Bystrica region	6320	10654	6541	26309
		Prešov region	4207	8372	3279	12170
		Košice region	11263	28824	19710	14927
	Total		54758	126093	70530	185180
2001	Aglomeration	Bratislava	477	13594	5151	1319
		Košice	17173	12608	12172	78619
	Zone	Bratislava region	546	380	1900	1638
		Trnava region	1518	2051	1966	4682
		Trenčín region	4820	45187	10489	10334
		Nitra region	2921	4749	3974	7379
		Žilina region	6271	10237	5170	19287
		Banská Bystrica region	6355	10043	6666	26301
		Prešov region	4266	8082	3443	11838
		Košice region	10330	23311	16864	14238
	Total		54677	130242	67795	175635
2002	Aglomeration	Bratislava	444	11348	5313	1264
		Košice	14601	10500	12140	83700
	Zone	Bratislava region	493	208	1972	1488
		Trnava region	1284	1166	1684	3591
		Trenčín region	4199	38305	9616	7815
		Nitra region	2476	3799	3843	5470
		Žilina region	5298	7140	4599	16520
		Banská Bystrica region	5334	8814	6316	24299
		Prešov region	3491	6320	3213	9075
		Košice region	8401	14952	11209	11968
	Total		46021	102552	59905	165190
2003	Aglomeration	Bratislava	482	12263	5414	1204
		Košice	9890	10781	12343	104600
	Zone	Bratislava region	465	150	1590	2789
		Trnava region	1325	1077	1670	3397
		Trenčín region	4332	46051	10198	7801
		Nitra region	2478	3648	3993	5615
		Žilina region	5343	7647	4483	16459
		Banská Bystrica region	5346	7983	5843	25729
		Prešov region	3666	6719	3224	8796
		Košice region	8398	8968	9823	7862
	Total		41725	105287	58581	184252
2004	Aglomeration	Bratislava	467	9869	5260	1254
		Košice	6806	13113	11092	107212
	Zone	Bratislava region	456	289	1650	1767
		Trnava region	1522	1141	1652	3496
		Trenčín region	4804	44108	9687	8040
		Nitra region	2744	2485	4424	5700
		Žilina region	5852	6147	4700	17253
		Banská Bystrica region	5819	6300	6146	27834
		Prešov region	4588	4864	3174	8803
		Košice region	8864	7650	8967	8242
	Total		41922	95966	56752	189601

** according to the Decree No 705/2002 Annex 8*

Tab. 4.4 **The most important air pollution sources in the SR and their share in the emissions of pollutants (NEIS) in 2004**

No	PM		SO_2		NOx		CO	
	Source	[%]	Source	[%]	Source	[%]	Source	[%]
1	U.S. Steel s.r.o., Košice	31.09	SE a.s., Bratislava, o.z. ENO Zem. Kostoľany	46.11	U. S. Steel s.r.o., Košice	18.49	U. S. Steel s.r.o., Košice	68.91
2	SE a.s., Bratislava, Elektráreň Vojany I a II	29.20	U.S. Steel s.r.o., Košice	12.46	SE a.s., Bratislava, o.z. ENO Zemianske Kostoľany	10.86	SLOVALCO a.s., Žiar n/Hronom	8.40
3	Novácke chemické závody a.s., Nováky	4.84	SLOVNAFT a.s., Bratislava	10.68	SE a.s., Bratislava, Elektráreň Vojany I a II	9.52	Dolvap s.r.o., Varín, Kameňolom a vápenka	3.42
4	SE a.s., Bratislava, o.z. ENO Zem. Kostoľany	3.30	SE a.s., Bratislava, Elektráreň Vojany I a II	4.54	SLOVNAFT a.s., Bratislava	7.66	OFZ a.s., Istebné	1.78
5	BUKOCEL a.s., Hencovce	3.29	SIDERIT s.r.o., Nižná Slaná	2.71	Tepláreň Košice a.s., Košice	3.19	SLOVMAG a.s., Lubeník	1.66
6	SLOVNAFT a.s., Bratislava	1.52	BUKOCEL a.s., Hencovce	2.48	SPP a.s.,Bratislava, závod Veľké Kapušany	2.62	Slovenské magnezitové závody a.s., Jelšava	1.19
7	Duslo a.s., Šaľa	1.37	Zvolenská teplárenská a.s., Zvolen	2.34	SPP a.s., Bratislava, závod Ivanka pri Nitre	2.49	BUKOCEL a.s., Hencovce	1.09
8	Carmeuse Slovakia s.r.o., Vápenka, Košice	1.00	TEKO a.s., Košice	1.69	HOLCIM (Slovensko) a.s., Rohožník	2.48	CEMMAC a.s., Horné Sŕnie	0.99
9	Mondi business paper scp a.s., Ružomberok	0.79	Žilinská teplárenská a.s., Žilina	1.66	SPP a.s., závod Veľké Zlievce	2.30	KOVOHUTY a.s., Krompachy	0.69
10	Žilinská teplárenská a.s., Žilina	0.75	SLOVALCO a.s., Žiar n/Hronom	1.52	SPP a.s., závod Jablonov n/Turňou	2.17	Calmit s.r.o., Bratislava, závod Margecany	0.68
11	Dolvap s.r.o., Varín, Kameňolom a vápenka	0.75	CHEMES a.s., Humenné	1.49	Mondi business paper scp a.s., Ružomberok	1.82	HOLCIM (Slovensko) a.s., Rohožník	0.67
12	KRONOSPAN SLOVAKIA s.r.o., Prešov	0.67	Martinská teplárenská a.s., Martin	1.25	Slovenské magnezitové závody a.s., Jelšava	1.78	Calmit s.r.o., Bratislava, závod Žirany	0.51
13	KVARTET s.r.o., Partizánske	0.67	Mondi business paper scp a.s., Ružomberok	1.21	Kappa Štúrovo a.s.	1.68	Calmit s.r.o., Bratislava, závod Tisovec	0.47
14	Carmeuse Slovakia s.r.o., závod Lom Včeláre	0.64	Duslo a.s., Šaľa	1.03	Duslo a.s., Šaľa	1.61	SLOVNAFT a.s., Bratislava	0.47
15	CHEMES a.s., Humenné	0.52	Kappa Štúrovo a.s.	0.99	CEMMAC a.s., Horné Sŕnie	1.57	KRONOSPAN SLOVAKIA s.r.o., Prešov	0.45
16	SLOVALCO a.s., Žiar n/Hronom	0.51	KVARTET s.r.o., Partizánske	0.50	Považská cementáreň a.s., Ladce	1.52	Považská cementáreň a.s., Ladce	0.41
17	HOLCIM (Slovensko) a.s., Rohožník	0.43	ZSNP a.s., Žiar n/Hronom	0.49	BUKOCEL a.s., Hencovce	1.26	SE a.s., Bratislava, Elektráreň Vojany I a II	0.41
18	Slovenské magnezitové závody a.s., Jelšava	0.42	Eastern Sugar Slovensko a.s., Dunajská Streda	0.44	VETROPACK Nemšová s.r.o.	1.19	SE a.s., Bratislava, o.z. ENO Zemianske Kostoľany	0.32
19	Calmit s.r.o., Bratislava, závod Žirany	0.41	Handlovská energetika s.r.o., Handlová	0.35	VS a.s., Turňa n/Bodvou	1.17	ZSNP a.s., Žiar n/Hronom	0.29
20	TEKO a.s., Košice	0.41	HB a.s., Banská mech. a elektrifikácia Nováky	0.33	Žilinská teplárenská a.s., Žilina	1.13	Wienerberger Slov, tehelne s.r.o., závod Boleráz	0.26
Total		82.57		94.25		76.48		93.05

Tab. 4.5 **Sequence of the sources within the region according to the amount of emissions – 2004**

BRATISLAVSKÝ REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVNAFT a.s., Bratislava	Bratislava II	SLOVNAFT a.s., Bratislava	Bratislava II
2.	HOLCIM (Slovensko) a.s., Rohožník	Malacky	HOLCIM (Slovensko) a.s., Rohožník	Malacky
3.	Swedwood Slovakia s.r.o., OZ Malacky	Malacky	ISTROCHEM a.s., Bratislava	Bratislava III
4.	Paroplynový cyklus a.s., Bratislava	Bratislava III	Bratislavská vodárenská spol. a.s., Bratislava, ČOV	Bratislava V
5.	VOLKSWAGEN SLOVAKIA a.s., Bratislava	Bratislava IV	Bratislavská teplárenská a.s., Bratislava, Výhrevňa Juh	Bratislava II
6.	Bratislavská teplárenská a.s., Bratislava, Tepláreň II	Bratislava III	VÚ 1238 - PSB Nitra	Pezinok
7.	Bratislavská teplárenská a.s., Bratislava, Tepláreň Západ	Bratislava IV	Stredná odborná škola policajného zboru, Pezinok	Pezinok
8.	KARPATY plus s.r.o., Senec	Senec	Technické služby – čistenie s.r.o., Bratislava	Bratislava II
9.	HASIT SLOVAKIA s.r.o., Lozorno	Malacky	AG - EXPERT Bratislava	Bratislava I
10.	ALAS Slovakia s.r.o., Bratislava, Kameňolom Sološnica	Malacky	NAFTA a.s., Gbely	Malacky
	NOx		**CO**	
	Source	District	Source	District
1.	SLOVNAFT a.s., Bratislava	Bratislava II	HOLCIM (Slovensko) a.s., Rohožník	Malacky
2.	HOLCIM (Slovensko) a.s., Rohožník	Malacky	SLOVNAFT a.s., Bratislava	Bratislava II
3.	Paroplynový cyklus a.s., Bratislava	Bratislava III	Swedwood Slovakia s.r.o., OZ Malacky	Malacky
4.	Odvoz a likvidácia odpadu a.s., Bratislava	Bratislava II	Paroplynový cyklus a.s., Bratislava	Bratislava III
5.	Bratislavská teplárenská a.s., Bratislava, Tepláreň II	Bratislava III	Bratislavská teplárenská a.s., Bratislava, Tepláreň II	Bratislava III
6.	Bratislavská teplárenská a.s., Bratislava, Tepláreň Západ	Bratislava IV	Bratislavská teplárenská a.s., Bratislava, Tepláreň Západ	Bratislava IV
7.	NAFTA a.s., Gbely	Malacky	Slovenská Grafia a.s., Bratislava	Bratislava III
8.	TECHNICKÉ SKLO a.s., Bratislava	Bratislava IV	ISTROCHEM a.s., Bratislava	Bratislava III
9.	VOLKSWAGEN SLOVAKIA a.s., Bratislava	Bratislava IV	VÚ 1238 - PSB Nitra	Pezinok
10.	Swedwood Slovakia s.r.o., OZ Malacky	Malacky	NAFTA a.s., Gbely	Malacky

TRNAVSKÝ REGION

	PM		SO_2	
	Source	District	Source	District
1.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda
2.	AMYLUM SLOVAKIA s.r.o., Boleráz	Trnava	Slovenské cukrovary a.s., Sereď	Galanta
3.	ŽOS Trnava a.s.	Trnava	Johns Manville Slovakia a.s., Trnava	Trnava
4.	Zlieváreň Trnava s.r.o.	Trnava	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
5.	Slovenské cukrovary a.s., Sereď	Galanta	Baňa Záhorie a.s., kotolňa Čáry	Senica
6.	Považský cukor a.s., Trenčianska Teplá, záv. Trnava	Trnava	ON SEMICONDUCTOR Slovakia a.s., Piešťany	Piešťany
7.	Johns Manville Slovakia a.s., Trnava	Trnava	Poľnohospodárske družstvo, Siladice	Hlohovec
8.	Poľnohospodárske družstvo, Jaslovské Bohunice	Trnava	SH ENERGO a.s., Senica	Senica
9.	Mach-Trade s.r.o, Sereď	Galanta	Tehelňa Gbely s.r.o., Gbely	Skalica
10.	AGROPODNIK a.s., Trnava	Trnava	Zlieváreň Trnava s.r.o.	Trnava
	NOx		**CO**	
	Source	District	Source	District
1.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
2.	Johns Manville Slovakia a.s., Trnava	Trnava	Zlieváreň Trnava s.r.o.	Trnava
3.	AMYLUM SLOVAKIA s.r.o., Boleráz	Trnava	BEKAERT Hlohovec a.s.	Hlohovec
4.	Slovenské cukrovary a.s., Sereď	Galanta	Johns Manville Slovakia a.s., Trnava	Trnava
5.	SH ENERGO a.s, Senica	Senica	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda
6.	Trnavská teplárenská a.s., Trnava	Trnava	INA Skalica s.r.o., Skalica	Skalica
7.	SWEDWOOD SLOVAKIA s.r.o., o.z. Trnava	Trnava	I.D.C. Holding a.s., Pečivárne Holíč	Galanta
8.	Považský cukor a.s., Trenčianska Teplá, záv. Trnava	Trnava	Považský cukor a.s., Trenčianska Teplá, záv. Trnava	Trnava
9.	BEKAERT Hlohovec a.s.	Hlohovec	SWEDWOOD SLOVAKIA s.r.o., o.z. Trnava	Trnava
10.	SOUTHERM s.r.o., Dunajská Streda	Dunajská Streda	Medea-S s.r.o., Sládkovičovo	Galanta

Tab. 4.5 **Sequence of the sources within the region according to the amount of emissions - 2004**

NITRIANSKY REGION

	PM		SO_2	
	Source	District	Source	District
1.	Duslo a.s., Šaľa	Šaľa	Duslo a.s., Šaľa	Šaľa
2.	CALMIT.s.r.o. Bratislava, závod Žirany	Nitra	Kappa Štúrovo a.s.	Nové Zámky
3.	Kappa Štúrovo a.s.	Nové Zámky	Icopal a.s., Štúrovo	Nové Zámky
4.	Lencos s.r.o., Levice	Levice	Wienerberger Slov.tehelne s.r.o., Zlaté Moravce	Zlaté Moravce
5.	SES a.s.,Tlmače	Levice	KOVOTOPOĽ s.r.o., Topoľčany	Topoľčany
6.	IDEA NOVA s.r.o., Nitra	Nitra	VÚ 1238 - PSB Nitra	Nitra
7.	Kameňolomy a štrkopieskovne a.s., Lom Pohranice	Nitra	Levická teplárenská.s.r.o., Levice	Levice
8.	ELEKTROKARBON a.s., Topoľčany	Topoľčany	Združenie agropodnikateľov, Dvory n.Žitavou	Nové Zámky
9.	CERAM ČAB a.s.,Čab	Nitra	Zelex Slovakia s.r.o., Komárno	Komárno
10	Levická teplárenská s.r.o., Levice	Levice	CALMIT s.r.o. Bratislava, závod Žirany	Nitra
	NOx		**CO**	
	Source	District	Source	District
1.	SPP a.s., Bratislava, závod Ivanka pri Nitre	Nitra	CALMIT s.r.o. Bratislava, závod Žirany	Nitra
2.	Kappa Štúrovo a.s.	Nové Zámky	Wienerberger Slov.tehelne s.r.o., Zlaté Moravce	Zlaté Moravce
3.	Duslo a.s., Šaľa	Šaľa	Kappa Štúrovo a.s.	Nové Zámky
4.	Nitrianska teplárenská spoločnosť a.s., Nitra	Nitra	SPP a.s., Bratislava, závod Ivanka pri Nitre	Nitra
5.	OPM1SR s.r.o., Nitra	Nitra	Duslo a.s., Šaľa	Šaľa
6.	Bytkomfort s.r.o., Nové Zámky	Nové Zámky	SES a.s., Tlmače	Levice
7.	Leven a.s., Levice	Levice	DANFOSS COMPRESSORS s.r.o., Zlaté Moravce	Zlaté Moravce
8.	COM-therm s.r.o., Komárno	Komárno	Komárňanské tlačiarne s.r.o., Komárno	Komárno
9.	TOMA s.r.o., Topoľčany	Topoľčany	VÚ 1238 - PSB Nitra	Nitra
10	SES a.s.,Tlmače	Levice	IDEA NOVA s.r.o., Nitra	Nitra

TRENČIANSKY REGION

	PM		SO_2	
	Source	District	Source	District
1.	Novácke chemické závody a.s., Nováky	Prievidza	SE a.s., Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza
2.	SE a.s., Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza	KVARTET s.r.o., Partizánske	Partizánske
3.	KVARTET s.r.o., Partizánske	Partizánske	Handlovská energetika s.r.o., Handlová	Prievidza
4.	Považská cementáreň a.s., Ladce	Ilava	HBP a.s., Banská mech. a elektrifikácia Nováky	Prievidza
5.	HBP a.s., Banská mech. a elektrifikácia Nováky	Prievidza	VETROPACK Nemšová s.r.o.	Trenčín
6.	DNV -ENERGO a.s., Dubnica n.Váhom	Ilava	MATADOR a.s., Púchov	Púchov
7.	VETROPACK Nemšová s.r.o.	Trenčín	Tepláreň a.s., Považská Bystrica	Považská
8.	CEMMAC a.s., Horné Srnie	Trenčín	TSM s.r.o., Partizánske	Partizánske
9.	TSM s.r.o., Partizánske	Partizánske	ENERGOTRENS s.r.o.,Trenčín	Trenčín
10.	RONA a.s., Lednické Rovne	Púchov	DNV –ENERGO a.s., Dubnica n.Váhom	Ilava
	NOx		**CO**	
	Source	District	Source	District
1.	SE a.s., Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza	CEMMAC a.s., Horné Srnie	Trenčín
2.	CEMMAC a.s., Horné Srnie	Trenčín	Považská cementáreň a.s., Ladce	Ilava
3.	Považská cementáreň a.s., Ladce	Ilava	SE a.s., Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza
4.	VETROPACK Nemšová s.r.o.	Trenčín	KVARTET s.r.o., Partizánske	Partizánske
5.	RONA a.s., Lednické Rovne	Púchov	Novácke chemické závody a.s., Nováky	Prievidza
6.	Novácke chemické závody a.s., Nováky	Prievidza	HBP a.s., Banská mech. a elektrifikácia Nováky	Prievidza
7.	MATADOR a.s., Púchov	Púchov	Linea – D s.r.o., Bánovce n/Bebravou	Bánovce n/Bebr.
8.	KVARTET s.r.o., Partizánske	Partizánske	POVAŽSKÝ CUKOR a.s., Trenčianska Teplá	Trenčín
9.	Tepláreň a.s., Považská Bystrica	Považská	TSM s.r.o., Partizánske	Partizánske
10.	Handlovská energetika s.r.o., Handlová	Prievidza	POSÁDKOVÁ SPRÁVA BUDOV s.r.o., Trenčín	Trenčín

BANSKOBYSTRICKÝ REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVALCO a.s., Žiar n/Hronom	Žiar n/Hronom	Zvolenská teplárenská a.s., Zvolen	Zvolen
2.	Slovenské magnezitové závody a.s., Jelšava	Revúca	SLOVALCO a.s., Žiar n/Hronom	Žiar n/Hronom
3.	Calmit s.r.o., Bratislava, závod Tisovec	Rimavská Sobota	ZSNP a.s, Žiar n/Hronom	Žiar n/Hronom
4.	Bučina a.s., Zvolen	Zvolen	Slovenské magnezitové závody a.s., Jelšava	Revúca
5.	SLOVMAG a.s., Lubeník	Revúca	SLOVMAG a.s., Lubeník	Revúca
6.	BUČINA DDD s.r.o., Zvolen	Zvolen	IZOMAT a.s., Nová Baňa	Žarnovica
7.	IZOMAT a.s., Nová Baňa	Žarnovica	Lovinit a.s., Lovinobaňa	Lučenec
8.	BLOOMSBURY PACIFIC SLOVAKIA a.s., Lučenec	Lučenec	PETROCHEMA a.s., Dubová	Brezno
9.	Lovinit a.s., Lovinobaňa	Lučenec	BAŇA DOLINA a.s, Veľký Krtíš	Veľký Krtíš
10.	Smrečina Holding a.s., Banská Bystrica	Banská Bystrica	Slovenské cukrovary a.s., Rimavská Sobota	Rimavská Sobota
	NOx		**CO**	
	Source	District	Source	District
1.	SPP a.s., závod Veľké Zlievce	Veľký Krtíš	SLOVALCO a.s., Žiar n/Hronom	Žiar n/Hronom
2.	Slovenské magnezitové závody a.s., Jelšava	Revúca	SLOVMAG a.s., Lubeník	Revúca
3.	SLOVALCO a.s., Žiar n/Hronom	Žiar n/Hronom	Slovenské magnezitové závody a.s., Jelšava	Revúca
4.	Zvolenská teplárenská a.s., Zvolen	Zvolen	Calmit s.r.o., Bratislava, závod Tisovec	Rimavská Sobota
5.	SLOVMAG a.s., Lubeník	Revúca	ZSNP a.s., Žiar n/Hronom	Žiar n/Hronom
6.	ZSNP a.s, Žiar n/Hronom	Žiar n/Hronom	IZOMAT a.s., Nová Baňa	Žarnovica
7.	Slovglass a.s., Poltár	Poltár	Železiarne Podbrezová a.s.	Brezno
8.	Železiarne Podbrezová a.s.	Brezno	BUČINA DDD s.r.o., Zvolen	Zvolen
9.	Bučina a.s., Zvolen	Zvolen	Ipeľské tehelne a.s., Lučenec	Poltár
10.	BUČINA DDD s.r.o., Zvolen	Zvolen	Lovinit a.s., Lovinobaňa	Lučenec

ŽILINSKÝ REGION

	PM		SO_2	
	Source	District	Source	District
1.	Mondi business paper scp a.s., Ružomberok	Ružomberok	Žilinská teplárenská a.s., Žilina	Žilina
2.	Žilinská teplárenská a.s., Žilina	Žilina	Martinská teplárenská a.s., Martin	Martin
3.	Dolvap s.r.o., Varín, Kameňolom a vápenka	Žilina	Mondi business paper scp a.s., Ružomberok	Ružomberok
4.	ŽOS a.s, Vrútky	Martin	OFZ a.s., Istebné	Dolný Kubín
5.	OFZ a.s., Istebné	Dolný Kubín	SOTE s.r.o.,výhrevňa Sihly	Čadca
6.	SOTE s.r.o.,výhrevňa Sihly	Čadca	ŽOS a.s, Vrútky	Martin
7.	Automobilová výroba a.s., Čadca	Čadca	MAYTEX a.s., Liptovský Mikuláš	Liptovský Mikuláš
8.	ZŤS Strojárne a.s., Námestovo	Námestovo	ENERGODIT s.r.o., Liptovský Mikuláš	Liptovský Mikuláš
9.	Martinská teplárenská a.s., Martin	Martin	ZŤS Strojárne a.s., Námestovo	Námestovo
10.	DOLKAM Šuja a.s., Rajec	Žilina	Automobilová výroba a.s., Čadca	Čadca
	NOx		**CO**	
	Source	District	Source	District
1.	Mondi business paper scp a.s., Ružomberok	Ružomberok	Dolvap s.r.o., Varín, Kameňolom a vápenka	Žilina
2.	Žilinská teplárenská a.s., Žilina	Žilina	OFZ a.s., Istebné	Dolný Kubín
3.	OFZ a.s., Istebné	Dolný Kubín	STP s.r.o., Martin	Martin
4.	Martinská teplárenská a.s., Martin	Martin	STP Ružomberok s.r.o.	Ružomberok
5.	Slovenská paroplynová spol. a.s., Ružomberok	Ružomberok	SOTE s.r.o.,výhrevňa Sihly	Čadca
6.	SPECIALITY MINERALS SLOVAKIA s.r.o., Ružomberok	Ružomberok	Žilinská teplárenská a.s., Žilina	Žilina
7.	MAYTEX a.s., Liptovský Mikuláš	Liptovský Mikuláš	ŽOS a.s, Vrútky	Martin
8.	Ružomberská energ. spoločnosť a.s., Ružomberok	Ružomberok	Mondi business paper scp a.s., Ružomberok	Ružomberok
9.	SOTE s.r.o.,výhrevňa Sihly	Čadca	TATRA nábytkáreň a.s., Martin	Martin
10.	ŽOS a.s, Vrútky	Martin	Cementáreň Lietavská Lúčka a.s.	Žilina

PREŠOVSKÝ REGION

	PM		SO_2	
	Source	District	Source	District
1.	BUKOCEL a.s., Hencovce	Vranov n/Topľou	BUKOCEL a.s., Hencovce	Vranov n/Topľou
2.	KRONOSPAN SLOVAKIA s.r.o., Prešov	Prešov	CHEMES a.s., Humenné	Humenné
3.	CHEMES a.s., Humenné	Humenné	Vihorlat s.r.o.,Snina	Snina
4.	Vihorlat s.r.o., Snina	Snina	Zeocem a.s., Bystré	Vranov n/Topľou
5.	Kronospan SK s.r.o., Prešov	Prešov	TESLA a.s., Stará Ľubovňa	Stará Ľubovňa
6.	TATRAVAGÓNKA a.s., POPRAD	Poprad	TP real s.r.o., Hrabušice	Poprad
7.	TP real s.r.o., Hrabušice	Poprad	SAD a.s., Poprad, prevádzkáreň Kežmarok	Poprad
8.	Legno Export s.r.o., Beňadikovce	Svidník	Zastrova a.s., Spišská Stará Ves	Kežmarok
9.	Vranovská tehelňa s.r.o, Vranov n/Topľou	Vranov n/Topľou	Vranovská tehelňa s.r.o, Vranov n/Topľou	Vranov n/Topľou
10.	Bukoza Preglejka a.s., Hencovce	Vranov n/Topľou	Posádková správa budov, Poprad	Kežmarok
	NOx		CO	
	Source	District	Source	District
1.	BUKOCEL a.s., Hencovce	Vranov n/Topľou	BUKOCEL a.s., Hencovce	Vranov n/Topľou
2.	CHEMES a.s., Humenné	Humenné	KRONOSPAN SLOVAKIA s.r.o., Prešov	Prešov
3.	Vihorlat s.r.o., Snina	Snina	Vihorlat s.r.o., Snina	Snina
4.	KRONOSPAN SLOVAKIA s.r.o., Prešov	Prešov	CHEMES a.s., Humenné	Humenné
5.	Spravbyt a.s., Prešov	Prešov	Kronospan SK s.r.o., Prešov	Prešov
6.	Kronospan SK s.r.o., Prešov	Prešov	Posádková správa budov, Michalovce	Humenné
7.	Dalkia a.s., Poprad	Poprad	SCOTTISH WOODLANDS SLOVAKIA s.r.o., Dlhé n/Cirochou	Snina
8.	Chemosvit-Energochem a.s., Svit	Poprad	CH STROJCHEM a.s., SVIT	Poprad
9.	BARDTERM s.r.o., Bardejov	Bardejov	Spravbyt a.s., Prešov	Prešov
10.	Pivovar Šariš a.s., Veľký Šariš	Prešov	Posádková správa budov, Prešov	Prešov

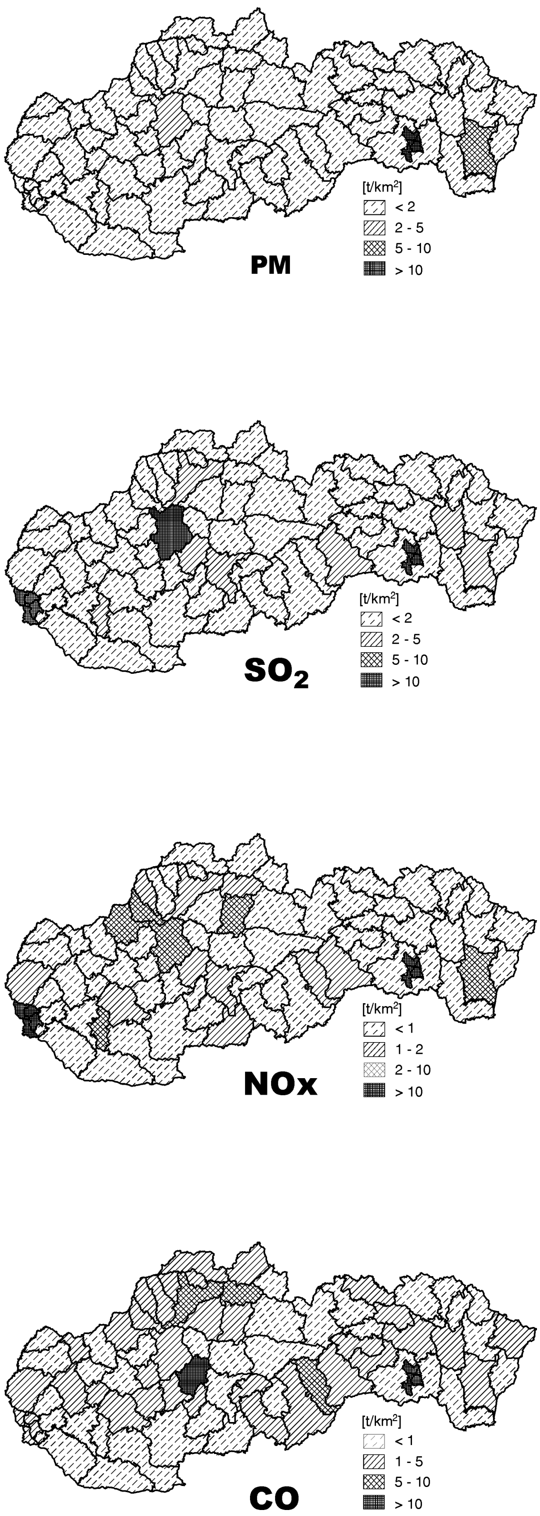
KOŠICKÝ REGION

	PM		SO_2	
	Source	District	Source	District
1.	U.S. Steel s.r.o., Košice	Košice II	U.S. Steel s.r.o., Košice	Košice II
2.	SE a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	SE a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
3.	Carmeuse Slovakia s.r.o., Vápenka Košice	Košice II	SIDERIT s.r.o., Nižná Slaná	Rožňava
4.	Carmeuse Slovakia s.r.o., závod Lom Včeláre	Košice - okolie	TEKO a.s., Košice	Košice IV
5.	TEKO a.s., Košice	Košice IV	ENERGETIKA s.r.o., Strážske	Michalovce
6.	SIDERIT s.r.o., Nižná Slaná	Rožňava	KOVOHUTY a.s., Krompachy	Spišská Nová Ves
7.	Carmeuse Slovakia s.r.o., Slavec	Rožňava	Slovenské magnezitové závody a.s., Jelšava	Košice II
8.	KERKO a.s., Košice, závod Michalovce	Michalovce	Železničná spoločnosť Cargo Slovakia a.s., Bratislava, Rušňové depo Košice	Košice IV
9.	VSH a.s., Turňa n/Bodvou	Košice - okolie	KOSIT a.s., Spaľovňa odpadov,Krásna n/ Hornádom	Košice IV
10.	Železničná spoločnosť Cargo Slovakia a.s., Bratislava, Rušňové depo Košice	Košice IV	Refrako s.r.o., Košice	Košice II
	NOx		CO	
	Source	District	Source	District
1.	U.S. Steel s.r.o., Košice	Košice II	U.S. Steel s.r.o., Košice	Košice II
2.	SE a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	KOVOHUTY a.s., Krompachy	Spišská Nová Ves
3.	TEKO a.s., Košice	Košice IV	Calmit s.r.o., Bratislava, závod Margecany	Gelnica
4.	SPP a.s., závod Veľké Kapušany	Michalovce	SE a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
5.	SPP a.s., závod Jablonov n/Turňou	Rožňava	HNOJIVÁ a.s., STRÁŽSKE	Michalovce
6.	VSH a.s., Turňa n/Bodvou	Košice - okolie	Zlieváreň SEZ Krompachy a.s.	Spišská Nová Ves
7.	Carmeuse Slovakia s.r.o., Vápenka Košice	Košice II	SIDERIT s.r.o., Nižná Slaná	Rožňava
8.	Slovenské magnezitové závody a.s., Jelšava	Košice II	SPP a.s., závod Jablonov n/Turňou	Rožňava
9.	SIDERIT s.r.o., Nižná Slaná	Rožňava	Slovenské magnezitové závody a.s., Jelšava	Košice II
10.	KOSIT a.s., Spaľovňa odpadov,Krásna n/Hornádom	Košice IV	Carmeuse Slovakia s.r.o., Vápenka Košice	Košice II

Tab. 4.6 **Stationary source emissions by districts in 2004**

District	Emissions [t/year]				Specific territorial emis. [t/year.km^2]			
	PM	SO_2	NO_x	CO	PM	SO_2	NO_x	CO
1. Bratislava	467	9869	5260	1254	1.27	26.85	14.31	3.41
2. Malacky	291	235	1460	1433	0.31	0.25	1.54	1.51
3. Pezinok	86	37	103	186	0.23	0.10	0.28	0.49
4. Senec	80	18	87	149	0.22	0.05	0.24	0.41
5. Dunajská Streda	368	470	386	610	0.34	0.44	0.36	0.57
6. Galanta	203	336	268	384	0.32	0.52	0.42	0.60
7. Hlohovec	100	28	97	341	0.37	0.11	0.36	1.28
8. Piešťany	178	55	130	317	0.47	0.15	0.34	0.83
9. Senica	261	89	168	460	0.38	0.13	0.25	0.67
10. Skalica	164	47	90	329	0.46	0.13	0.25	0.92
11. Trnava	249	116	513	1055	0.34	0.16	0.69	1.42
12. Bánovce n/B	197	48	86	374	0.43	0.10	0.19	0.81
13. Ilava	277	90	898	972	0.77	0.25	2.50	2.71
14. Myjava	265	68	91	436	0.81	0.21	0.28	1.33
15. Nové Mesto n/V	259	66	146	446	0.45	0.11	0.25	0.77
16. Partizánske	272	568	181	571	0.90	1.88	0.60	1.90
17. Považská Bystrica	472	220	222	807	1.02	0.48	0.48	1.74
18. Prievidza	2282	42559	5821	1605	2.38	44.34	6.07	1.67
19. Púchov	427	215	629	665	1.14	0.57	1.68	1.77
20. Trenčín	354	274	1612	2164	0.52	0.41	2.39	3.21
21. Komárno	316	85	246	579	0.29	0.08	0.22	0.53
22. Levice	822	217	346	1421	0.53	0.14	0.22	0.92
23. Nitra	361	79	1565	1435	0.41	0.09	1.80	1.65
24. Nové Zámky	516	1047	1132	946	0.38	0.78	0.84	0.70
25. Šaľa	380	956	880	282	1.07	2.69	2.47	0.79
26. Topoľčany	163	46	151	302	0.27	0.08	0.25	0.51
27. Zlaté Moravce	185	55	104	736	0.35	0.10	0.20	1.41
28. Bytča	335	95	102	519	1.19	0.34	0.36	1.84
29. Čadca	1008	494	330	1706	1.33	0.65	0.43	2.24
30. Dolný Kubín	295	317	510	3173	0.60	0.65	1.04	6.47
31. Kysucké Nové Mesto	201	53	83	328	1.16	0.31	0.48	1.89
32. Liptovský Mikuláš	526	350	315	870	0.39	0.26	0.24	0.65
33. Martin	464	1401	544	997	0.63	1.90	0.74	1.36
34. Námestovo	999	368	233	1485	1.45	0.53	0.34	2.15
35. Ružomberok	722	1280	1574	1103	1.12	1.98	2.43	1.70
36. Turčianske Teplice	166	43	51	278	0.42	0.11	0.13	0.71
37. Tvrdošín	148	46	71	245	0.31	0.10	0.15	0.51
38. Žilina	987	1700	886	6549	1.21	2.09	1.09	8.04
39. Banská Bystrica	497	145	331	795	0.61	0.18	0.41	0.98
40. Banská Štiavnica	205	58	59	324	0.70	0.20	0.20	1.11
41. Brezno	551	268	312	1041	0.44	0.21	0.25	0.82
42. Detva	325	88	104	542	0.72	0.20	0.23	1.21
43. Krupina	284	77	81	467	0.49	0.13	0.14	0.80
44. Lučenec	585	247	300	945	0.71	0.30	0.36	1.14
45. Poltár	180	55	245	342	0.38	0.12	0.51	0.72
46. Revúca	527	542	1281	5044	0.72	0.74	1.75	6.91
47. Rimavská Sobota	963	261	317	2163	0.65	0.18	0.22	1.47
48. Veľký Krtíš	409	161	1262	699	0.48	0.19	1.49	0.82
49. Zvolen	416	2218	789	622	0.55	2.92	1.04	0.82
50. Žarnovica	414	269	187	839	0.97	0.63	0.44	1.97
51. Žiar n/H	461	1912	880	14011	0.89	3.69	1.70	27.07
52. Bardejov	323	83	142	527	0.34	0.09	0.15	0.56
53. Humenné	377	1415	649	616	0.50	1.88	0.86	0.82
54. Kežmarok	340	101	130	576	0.40	0.12	0.15	0.69
55. Levoča	170	48	64	281	0.48	0.13	0.18	0.79
56. Medzilaborce	140	36	42	225	0.33	0.08	0.10	0.53
57. Poprad	261	83	232	459	0.24	0.07	0.21	0.42
58. Prešov	525	103	499	1393	0.57	0.11	0.54	1.50
59. Sabinov	314	88	117	514	0.65	0.18	0.24	1.06
60. Snina	398	342	286	824	0.49	0.43	0.36	1.02
61. Stará Ľubovňa	426	134	133	704	0.68	0.21	0.21	1.13
62. Stropkov	113	28	42	180	0.29	0.07	0.11	0.46
63. Svidník	225	53	81	352	0.41	0.10	0.15	0.64
64. Vranov n/T	977	2350	757	2150	1.27	3.05	0.98	2.79
65. Gelnica	346	93	102	1592	0.59	0.16	0.17	2.72
66. Košice	6806	13113	11092	107212	28.04	54.01	45.69	441.62
67. Košice - okolie	796	171	811	1160	0.52	0.11	0.53	0.76
68. Michalovce	6126	4394	6267	1348	6.01	4.31	6.15	1.32
69. Rožňava	817	2662	1363	1431	0.70	2.27	1.16	1.22
70. Sobrance	136	38	54	218	0.25	0.07	0.10	0.40
71. Spišská Nová Ves	317	206	169	1954	0.54	0.35	0.29	3.33
72. Trebišov	326	86	202	540	0.30	0.08	0.19	0.50
Slovakia	41922	95966	56752	189601	0.86	1.96	1.16	3.87

Fig. 4.3 **Specific territorial emission – 2004**



Tab. 4.7 **NMVOC emissions in the SR** [t]

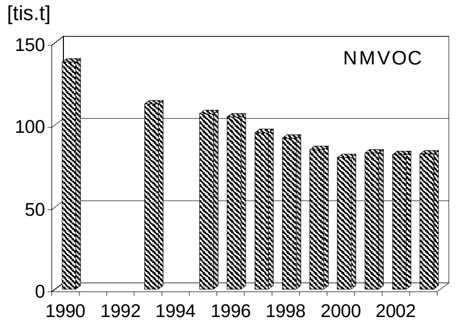
Sektor / Subsektor	1990	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003
Combustion on energy and transformation industries	335	276	258	257	247	265	228	201	221	215	214
Public power	223	190	187	189	182	192	166	139	159	147	161
District heating plants	112	85	71	68	65	73	62	62	62	67	53
Non-industrial combustion plants	12641	11269	9618	9750	8125	8472	8229	7927	8320	7087	7519
Commercial and institutional plants	226	226	150	134	134	134	134	32	34	32	30
Agriculture	IE	IE	IE	IE	IE	IE	IE	14	15	15	15
Residential plants	12415	11043	9468	9616	7991	8338	8095	7881	8271	7040	7474
Combustion in manufacturing industry	1171	1169	1083	1270	1291	993	632	868	850	685	700
Comb. in boilers, gas turb. and stat. engines	206	152	150	152	144	126	124	159	231	147	169
Iron production	32	29	29	26	28	25	27	29	29	32	35
Ore aglomeration	628	500	635	582	601	443	462	679	480	421	405
Copper production	305	488	268	510	518	399	19	2	109	85	91
Production processes	28260	20029	12407	13122	12790	11411	9944	9877	9537	8933	8197
Processes in petroleum industries	17188	12119	7474	8359	7717	7960	6563	6627	6306	5571	4545
Coke production	1053	844	834	769	779	640	681	719	719	765	801
Steel production	43	35	36	31	31	32	33	34	37	40	42
Rolling mills	233	250	297	283	301	290	304	300	267	304	336
Aluminium production	0,101	0,058	0,049	0,167	0,165	0,162	0,164	0,16	0,17	0,165	0,167
Proc. in organic chemical industries	6437	3519	1369	1386	1364	870	785	651	644	690	941
Food production	3224	3233	2359	2252	2567	1590	1546	1538	1556	1556	1516
Road paving with asphalt	82	28	37	42	30	29	31	7	8	7	16
Exploitation&distrib. of natural resources	8822	8868	8535	8104	9336	5854	6606	5929	6161	6024	7425
Exploitation&distribution of crude oil	5198	5194	4298	4296	3803	3801	4193	3750	3848	3801	3993
Distribution of fuel	3624	3674	4237	3808	5533	2053	2412	2179	2313	2223	3432
Solvent and other products use	48071	38301	41166	39781	30762	32221	29429	29063	30515	30796	31568
Use of paints and glues	32811	19349	20687	19122	15653	16035	14365	13214	14025	15110	16369
Dry cleaning and degreasing	6650	10366	11838	12108	6498	7563	6483	7873	8021	7167	6765
Processing of fat and oil	332	308	363	273	332	345	303	299	191	240	156
Products	8278	8278	8278	8278	8278	8278	8278	8278	8278	8278	8278
Road traffic	32611	30332	32373	31235	31456	31238	28502	24479	26079	26755	25513
Other traffic	953	543	599	609	584	659	571	528	524	500	460
Waste treatment and disposal	4538	1339	259	147	153	226	180	208	180	320	202
Incineration of municipal waste	102	102	102	59	77	98	95	133	93	75	132
Incineration of Industrial waste	157	157	157	74	67	122	79	66	81	204	52
Incineration of hospital waste		IE	IE	14	9	6	6	9	6	42	18
Agricultural waste*	4279	1080	–	–	–	–	–	–	–	–	–
Agriculture	651	436	436	436	436	436	436	436	436	436	436
Total	138052	112562	106733	104710	95180	91755	84756	80116	82822	81750	82234

Emissions, as they were appointed to February 15, 2005

* *agricultural waste combustion is prohibited from the year 1994* IE *included in other source category*

Because of changeover from EAPSI to NEIS in the year 2000 some changes of source appointment have to be done in the framework of subsectors Combustion in boilers…, Commercial and institutional plants and new subsector Agriculture (sector Non-industrial combustion plants) was established.

Fig. 4.4 **Development trends in NMVOC emissions**

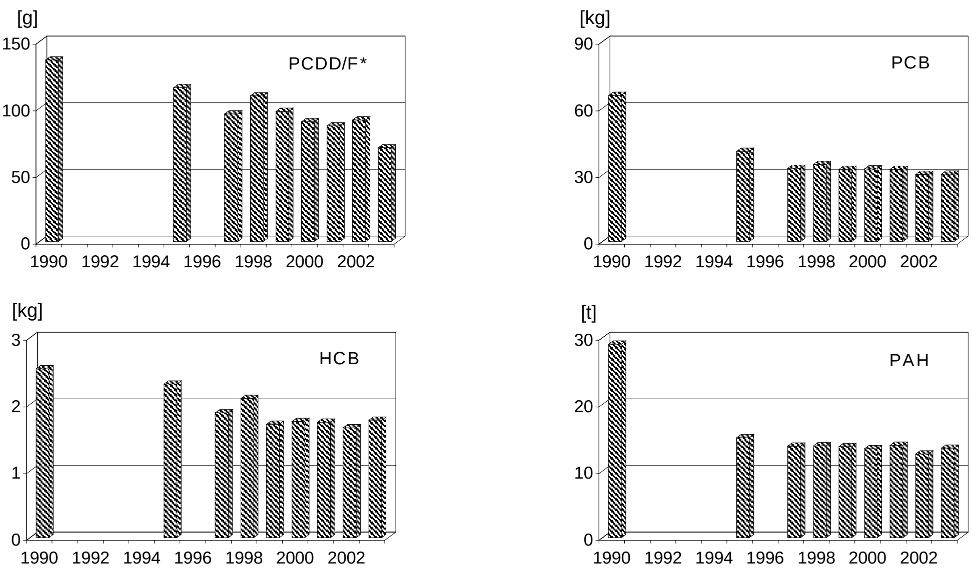


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2003**

	PCDD/F* [g]	PCB [kg]	HCB [kg]	PAH sum PAH [kg]	B(a)P [kg]	B(k)F [kg]	B(b)F [kg]	I(1,2,3-cd)P [kg]
Combustion on energy and transformation industries	7.395	1.167	0.251	2039.244	615.085	444.980	445.221	533.958
Public power	2.029	1.161	0.249	0.438	0.057	0.068	0.213	0.099
District heating plants	0.028	0.006	0.002	0.303	0.028	0.067	0.163	0.045
Coke production	5.338			2038.503	615.000	444.845	444.845	533.814
Non-industrial combustion plants	3.113	8.678	0.125	10016.399	2814.059	1231.669	3685.709	2284.961
Commercial and institutional plants	0.045	0.017	0.004	0.373	0.017	0.136	0.193	0.028
Residential plants	3.058	8.658	0.120	10015.666	2814.024	1231.408	3685.330	2284.904
Agriculture	0.009	0.003	0.001	0.359	0.018	0.126	0.186	0.029
Combustion in manufacturing industry	28.508	7.606	0.574	173.249	76.724	29.524	50.557	16.444
Comb. in boilers, gas turb. and stat. eng.	0.742	0.925	0.148	29.571	1.905	9.040	15.537	3.089
Iron production	0.389	0.025		66.170	66.170			
Ore aglomeration	26.054	4.093	0.119	43.419	4.465	16.185	16.185	6.585
Cast iron production	0.080	0.015		0.013	0.002	0.004	0.004	0.002
Others	1.244	2.548	0.307	34.076	4.181	4.295	18.831	6.768
Production processes	5.675	1.987	0.180	1033.634	385.288	300.785	308.225	39.336
Aluminium production	0.929	0.155		409.779	133.942	129.491	129.491	16.855
Steel production	4.043	1.800		79.893	79.893			
Carbon mineral production				543.171	171.131	171.136	178.577	22.322
Wood impregnation				0.791	0.316	0.158	0.158	0.158
Others	0.702	0.032	0.180					
Road traffic	0.164	8.469	0.007	90.207	13.255	28.751	31.044	17.157
Other traffic	0.007	0.743	0.001	8.914	2.228	1.337	3.120	2.228
Waste treatment and disposal	25.628	1.688	0.626	109.604	30.719	21.855	45.278	11.752
Incineration of municipal waste	4.906	0.861	0.487	6.315	0.114	3.087	3.087	0.028
Incineration of Industrial waste	3.206	0.428	0.128	1.662	0.030	0.812	0.812	0.007
Incineration of hospital waste	16.930	0.339	0.002	1.316	0.024	0.643	0.643	0.006
Others	0.585	0.061	0.009	100.311	30.552	17.313	40.736	11.711
Total	70.490	30.338	1.765	13471.251	3937.359	2058.901	4569.155	2905.836

B(a)P - Benzo(a)pyrene, B(k)F - Benzo(k)fluorantene, B(b)F - Benzo(b)fluorantene, I(1,2,3-cd)P - Indeno(1,2,3-cd)pyrene
**Expressed as I-TEQ; I-TEQ is calculated from the values for 2,3,7,8 - substituted co-geners of PCDD and PCDF under using of I-TEF according NATO/CCMS (1988)*
Emissions, as they were appointed to February 15, 2005

Fig. 4.5 **Development trends in POPs emissions**

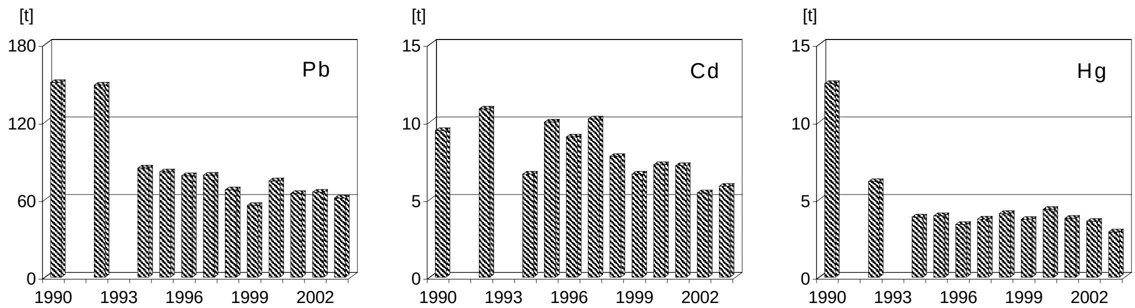


Tab. 4.9 **Emissions of heavy metals in the SR in 2003** [t]

Sektor / Subsektor	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn	Sn	Mn
Combustion on energy and transformation industries	0.410	1.187	0.016	0.792	0.705	0.029	0.919	0.163	0.897	0.142	4.213
Public power	0.384	1.152	0.015	0.775	0.692	0.027	0.793	0.159	0.858	0.139	4.108
District heating plants	0.026	0.035	0.001	0.017	0.013	0.002	0.126	0.004	0.038	0.002	0.105
Non-industrial combustion plants	0.830	1.084	0.026	0.710	0.661	0.022	0.652	0.044	1.174	0.169	7.219
Commercial and institutional plants	0.089	0.207	0.004	0.075	0.070	0.003	0.075	0.006	0.170	0.017	0.704
Residential plants	0.694	0.850	0.020	0.624	0.582	0.017	0.509	0.036	0.934	0.150	6.440
Agriculture	0.047	0.027	0.002	0.011	0.009	0.002	0.068	0.002	0.070	0.002	0.075
Combustion in manufacturing industry	45.346	9.016	5.097	3.190	15.606	1.918	13.051	6.500	30.245	1.441	5.615
Comb. in boilers, gas turb. and stat. engines	3.183	0.980	0.145	1.007	0.726	0.173	8.588	0.309	4.404	0.093	2.884
Iron production	0.132	0.012	0.210	1.000	0.078	0.335	3.332	0.043	8.334		
Glass production	14.217	2.207	4.668	0.590	0.148	0.012	0.467	4.428	2.706		
Ore agglomeration	25.003	0.433	0.015	0.550	8.218	1.128	0.630	1.161	13.082	0.940	2.731
Copper production	2.545	5.321	0.054		6.375	0.216		0.559	1.636	0.407	0.000
Cement production	0.264	0.003	0.001	0.029	0.054	0.054	0.031		0.067		
Aluminium oxide production											
Magnesite production	0.003	0.060	0.004	0.013	0.008	0.0002	0.003		0.016		
Production processes	1.668	0.087	0.033	1.034	2.900	0.396	7.856	0.014	16.331	0.047	11.282
Steel production	1.297	0.070	0.014	0.164	2.561	0.014	2.589	0.014	5.405	0.047	1.076
Aluminium production			0.011				1.116		1.116		
Ferro alloys production	0.179	0.013	0.005	0.070	0.007		0.002		0.881		10.086
Pig iron production	0.096	0.004	0.002	0.016			0.008		0.068		0.030
Galvanizing	0.090			0.783	0.270		4.140		7.830		0.090
Alloys (Cu-Zn) production	0.006				0.062				1.031		
Inorganic chemical industry						0.382					
Road traffic	1.989		0.015	0.075	2.560		0.105	0.147	1.506		
Other traffic			0.001	0.004	0.126		0.005	0.001	0.074		
Waste treatment and disposal	10.816	0.013	0.675	0.871	1.363	0.548	0.509	0.007	4.629	0.000	0.000
Incineration of municipal waste	8.372	0.009	0.465	0.837	1.153	0.335	0.502	0.002	3.163		
Incineration of Industrial waste	1.823	0.003	0.156	0.025	0.156	0.156	0.005	0.003	1.094		
Incineration of hospital waste	0.621	0.001	0.053	0.009	0.053	0.053	0.002	0.001	0.373		
Cremation						0.004					
Total	61.060	11.388	5.862	6.676	23.922	2.913	23.096	6.876	54.855	1.798	28.329

Emissions, as they were appointed to February 15, 2005

Fig. 4.6 **Development trends in heavy metals emissions**



5

GREENHOUSE GAS EMISSIONS

5.1 GREENHOUSE GAS EMISSIONS

Framework Convention on Climate Change (UN FCCC)

Global climate change due to the anthropogenic emission of greenhouse gases is the most important environmental problem in the history of mankind. The framework Convention on Climate Change (UN FCCC)[1] - the basic international legal instrument to protect global climate was adopted at the UN conference on the environment and sustainable development (Rio de Janeiro 1992). The final goal of the Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that has not yet developed any dangerous interference in the climate system.

In the Slovak Republic, the UN Convention came into force on November 23, 1994. The Slovak Republic accepted all the commitments of the Convention. The Framework Convention ratified 183 countries including the European Union until present. Most members of the Organization for Economic Cooperation and Development (OECD) – known collectively as Annex I countries – committed themselves to adopting policies and measures aimed at returning their greenhouse gas (GHG) emissions to 1990 levels by the year 2000. This target was successfully executed.

Kyoto protocol

The Kyoto Protocol, adopted by consensus at the third session of the Conference of the Parties (COP-3) in Kyoto, December 1997, enforced the international responsibility for the climate change. Emissions targets for the post-2000 period are addressed by the Kyoto Protocol for the all Annex I countries. The Slovak Republic and the most countries of the Central and East Europe should reduce the total emissions of GHGs by 8 % until 2008 compared to the base year (1990) and hereby hold this level by 2008-2012. The Kyoto Protocol has generally extended the options of the countries to choose the way and the instruments that are most appropriate for achievement of their reduction targets, taking into account the specific circumstances of the country. The common feature of new mechanisms is the effort to achieve the maximum reduction potential in the most effective way.

In May 2004, Slovakia joined the European Union. Relevant European legislation is expected to have additional positive direct and indirect effects to reduction of GHG emissions, mainly in the energy sector. The introduction of emission trading scheme will allow for the implementation of further reduction measures.The European Union considers the area of climate change for the one of the four environmental priorities.[2]

Greenhouse effect of the atmosphere

The greenhouse effect of the atmosphere is a similar effect to that which may be observed in greenhouses, however the function of glass in the atmosphere is taken over by the "greenhouse gases" (international abbreviation GHGs). Short wave solar radiation is transmitted freely through the greenhouse gases, falling to the earth's surface and heating it. Long wave (infrared) radiation, emitted by the earth's surface, is caught by these gases in a major way and partly reemitted towards the earth's surface. As a consequence of this effect, the average temperature of the surface atmosphere is 30 °C warmer than it would be without the greenhouse gases. Finally, this enables the life on our planet.

Greenhouse gases

The most important greenhouse gas in the atmosphere is water vapour (H_2O), which is responsible for approximately two thirds of the total greenhouse effect. Its content in the atmosphere is not directly affected by human activity, in principle it is determined by the natural water cycle, expressed in a very simple way, as the difference between evaporation and precipitation. Carbon dioxide (CO_2) contributes to the greenhouse effect more than 30 %, methane (CH_4), nitrous oxide (N_2O) and ozone (O_3),

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[1] http://www.unfccc.de
[2] *New environmental action program: Environment 2010 Our Future, Our Choice*

all three together 3 %. The group of man-made (artificial) substances - chlorofluorocarbons (CFCs), their substitutes, hydrofluorocarbons (HCFCs, HFCs) and others such as perfluorocarbons (PFCs) and SF_6, also belong to the greenhouse gases, but their presence in atmosphere is caused by anthropogenic activity. There are other photochemical active gases as well, such as carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane organic compounds (NMVOCs), which do not belong to the greenhouse gases, but contribute indirectly to the greenhouse effect of the atmosphere. They are registered together as the precursors of ozone in the atmosphere, as they influence the formation and disintegration of ozone in the atmosphere.

The Kyoto Protocol defines an obligation to register and inventory the emission of greenhouse gases (CO_2, CH_4, N_2O and F-gases, included HFCs, PFCs and SF_6) according to the adopted IPCC methodology.[3] The growth in concentrations of greenhouse gases in the atmosphere (caused by anthropogenic emission) leads to the strengthening of the greenhouse gas effect and thus to the additional warming of the atmosphere. The present climate models estimate that global average temperature will rise by about 1.4-5.8 °C by the year 2100.

Concentrations of greenhouse gases in the atmosphere are formed by the difference between their emission (release into the atmosphere) and sink. It follows then that the increase of their content in the atmosphere operates by two mechanisms:

- emissions into the atmosphere
- weakening of natural sink mechanisms

Stabilizing atmospheric concentrations of greenhouse gases will demand a major effort. Without emissions – control policies motivated by concerns about climate change, atmospheric concentrations of carbon dioxide are expected to rise from today's 367 ppm to 490-1 260 ppm by the year 2100. This would represent a 75-350 % increase since the year 1750. Stabilizing concentrations at, for example, 450 ppm would require world-wide emissions to fall below 1990 levels within the next few decades. Carbon dioxide is currently responsible for over 60 % of the "enhanced" greenhouse effect. This gas occurs naturally in the atmosphere, but burning coal, oil and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Likewise, deforestation releases carbon stored in trees. Current annual emissions amount to over 23 billion m^3 of CO_2, or almost 1 % of the total mass of carbon dioxide in the atmosphere.

A second important human influence on climate is aerosols. These clouds of microscopic particles are not a greenhouse gas, but in addition to various natural sources, they are produced from sulphur dioxide emitted mainly by power stations. Aerosols settle out of the air after only a few days, but they have a substantial impact on climate.

Methane levels have already increased by a factor of two and a half during the industrial era and currently contribute 20 % of the enhanced greenhouse effect. The rapid rise in methane started more recently due to intensive agriculture (mainly rice fields), animal husbandry, coal mining, natural gas mining, its transport and use as well as the biomass burning are all anthropogenic activities. As distinct from CO_2, the disintegration of methane in the atmosphere is via chemical reactions (by OH radical). Residence time of methane in the atmosphere is 10-12 years. At present, the annual total anthropogenic methane emission is said to be approximately 0.4 billion tons, but the global growth rate of methane budget seemed to have been at steady-state.

Nitrous oxide (with an "adjustment-time" of 114 years), a number of industrial gases and ozone contribute the remaining 20 % of the enhanced greenhouse effect. Nitrous oxide levels have risen by

[3] *Intergovernmental panel (IPCC - Intergovernmental panel on Climate Change http://www.ipcc.ch) was established in 1988 commonly by ECE (UNEP) and World Meteorological Organisation (WMO). Its task is to reach the authoritative international consensus in the scientific opinions on climate change. The working groups of IPCC (under the participation of the scientists from the whole world) prepare regular updated information for COP (Congress of Parties), where the latest knowledge in association with the global warming is included.*

16 %, mainly due to intensive agriculture, overusing of fertilizers and inconvenient agriculture-technical procedures. Fuel combustion, some industrial technologies, large-scale livestock breeding and sewage are the sources of N_2O emissions. Global anthropogenic emission is estimated to be 3-7 million tons of nitrogen per year. Natural sources are approximately twice as large as anthropogenic ones. While chlorofluorocarbons (CFCs) are stabilizing due to emission controls introduced under Montreal Protocol to protect the stratospheric ozone layer, levels of long-lived gases such as HFCs, PFCs and sulphur hexafluoride are increasing. They are used as carrier gases for sprays, fillings in cooling and extinguishing systems, as insulating substances, as solvents at the production of semi-conductors, etc. Apart from the fact that they attack atmospheric ozone, they are very inert gases so that even minor emissions have a great negative effect.

5.2 GREENHOUSE GAS EMISSIONS IN THE SLOVAK REPUBLIC

The emissions of greenhouse gas in the Slovak Republic are estimated in accordance with the requirements of UN FCCC[1] and the Kyoto Protocol. The values listed in Tables are updated annually if information provided in the Statistical yearbook of the Slovak Republic is revised and/or if methodology is changed. Emissions were estimated in compliance with the methods provided in IPCC Guidelines,[4] Good Practice Guidance (GPG)[5] and in the SHMÚ's reports.

Total GHG emission represented 46 758.8 Gg in 2003 (without sinks from land use, land use change and forestry (LULUCF)). This represents a reduction by 33 % in comparison with the reference year 1990. In comparison with 2002, the emissions increased by 1.5 %. Total GHG emissions in Slovakia are stable or slightly increasing (in 2003) due to recovery of economic activities, increase in transport, and expected increase in actual emissions of F-gases (mainly HFCs and SF_6). Total GHG emissions including sinks from LULUCF sector are peaked and exceeded 1998. Significant changes are expected in the next year (2004 inventory) as the EU legislation came into effect in Slovakia. Also, revisions of the NEIS database and changes in balance methodology in sector agriculture and LULUCF were applied. This indicates that achieving the Kyoto Protocol 2008-2012 is feasible, however in order to reach sustainability, additional strategies and measures should be endorsed. (Table 5.1).

Tab. 5.1 **Aggregate[6] anthropogenic emissions of GHG [Tg] in Slovakia in 1990-2003**

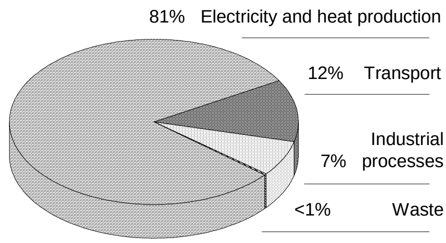
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2	59.4	52.1	48.4	45.4	42.4	43.8	44.4	44.7	43.6	42.6	40.1	42.6	42.3	42.8
CH_4	6.3	5.9	5.5	5.1	5.0	5.2	5.2	5.0	4.7	4.6	4.6	4.5	4.7	4.7
N_2O	6.0	5.2	4.4	3.9	4.1	4.2	4.2	4.3	4.0	3.8	3.8	4.0	3.9	3.9
F-Gases	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
GHGs*	72.1	63.5	58.6	54.6	51.7	53.4	54.0	54.0	52.4	51.2	48.6	51.3	50.9	51.6

Emissions, as determinated to April 15, 2005 ** GHG emissions without sinks from LULUCF*

[4] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory, Volume 1-3*
[5] *Good Practice Guidance and Uncertainty Management in National GHGs Inventories, IPCC 2000*
[6] *According to the currently valid convention the emission reduction expressed in CO_2 equivalent should be reported, Climate Change 1995, The Science of Climate Change GWP100: CO_2=1, CH_4=21, N_2O=310, F-gases =140-23 900*

CO_2 – carbon dioxide

Fig. 5.1 **CO_2 emissions in 2003**



Emissions

A most important anthropogenic source of CO_2 emissions in the atmosphere is combustion and transformation of fossil fuels, which account for about 95 % of the total CO_2 emissions in the SR. In addition, carbon dioxide arises during technological processes during the production of cement, lime, magnesite and using of limestone. The balance includes also the production of coke, iron and steel, as well as CO_2 emissions arising during aluminium and ammonia production. Emission factors, estimated on the carbon content in fuels, were used. Carbon dioxide enters the atmosphere via the conversion of grasslands and forest areas into agricultural land, and forest fires (Figure 5.1).

Total net CO_2 emissions increased in 2003 by more than 1 % compared with the previous year, totally decreased by more than 33 % compared with the reference year 1990. The most important changes occurred in the energy sector; a significant increase by 1 000 Gg of CO_2 emissions compared to 2002 was caused by stationary sources. Among the most important reasons appears the recovery of the Slovak economy, followed by new sources of pollution, and a shift to solid fuels due to the increased prices of natural gas. Similarly, increased trend in CO_2 emissions is also at the transport sector. It is anticipated a gradual increase of CO_2 emissions in this sector.

Sinks

The Slovak Republic covers a territory of 49 036 km^2, of which 41 % is forest areas. Since the beginning of the century part of the agricultural land has been gradually transformed into forest. In the period 1950-2002, the amount of carbon fixed in the forests of the SR was increased approximately to the more than 50 Tg as a consequence of the forest area enlargement and an increase in hectare yield of wood mass. Fixation of carbon in forest ecosystems of the SR was estimated on the carbon balance in the part of the forest above the ground (trees, plant canopy, overlying humus) and that, under the ground (roots, humus in soil) including an assessment of wood exploitation and forest fires (Table 5.2).

Tab. 5.2 **Total emissions and sinks of CO_2 [Gg] within 1990-2003**

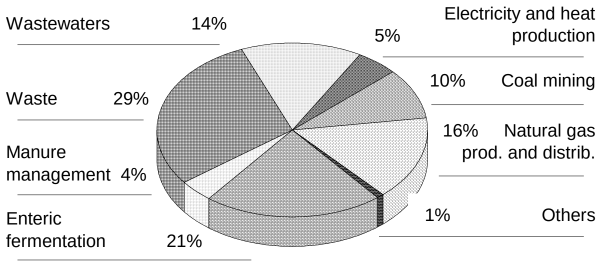
	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Net CO_2 emissions / sinks	57 019	41 158	41 961	43 250	41 712	40 978	37 703	37 337	36 975	37 934
CO_2 emissions (without LULUCF)	59 446	43 841	44 389	44 662	43 649	42 630	40 148	42 603	42 254	42 817
Fossil fuel combustion	55 962	41 062	41 628	41 803	40 089	39 010	36 947	39 270	38 866	39 692
Electricity and heat production	50 890	36 685	37 186	37 196	35 136	34 191	32 628	34 377	33 276	34 549
Transport	5 071	4 378	4 442	4 607	4 953	4 819	4 319	4 893	5 590	5 143
Industrial processes	3 484	2 779	2 761	2 859	3 560	3 620	3 102	3 198	3 245	2 984
Mineral products	2 942	2 342	2 250	2 331	3 032	3 052	2 522	2 590	2 596	2 282
Production of metals	542	437	512	528	528	567	580	608	649	703
Forest ecosystems	-2 427	-2 683	-2 428	-1 412	-1 937	-1 652	-2 444	-5 266	-5 279	-4 883
Changes in stock of wood mass	-1 753	-1 786	-1 734	-975	-1 474	-1 107	-1 410	-4 761	-4 779	-4 262
Deforestation	141	119	111	111	131	125	113	115	117	120
Aforestation	-815	-1 016	-805	-547	-594	-669	-1 147	-620	-617	-741
Waste	IE	IE	IE	IE	IE	IE	98	135	143	140
Waste incineration	IE	IE	IE	IE	IE	IE	98	135	143	140
Burning biomass*	1 686	326	316	349	303	269	263	417	508	555
International bunkers*	NE	38	44	39	36	37	37	35	37	48

Emissions, as determinated to April 15, 2005
* *CO_2 emissions are not being accounted into the total emissions*

CH_4 – methane

Agriculture, large-scale beef cattle and pig breeding, are major sources of methane on our territory. The CH_4 does arise as the direct product of the metabolism in herbivores and as the product of organic degradation in animal excrement. Calculations of emissions for the Slovak Republic are based on the data listed in the Statistical yearbooks and the Green Report of the Slovak Ministry of Agriculture. Leaks of natural gas in the distribution networks are a very important source of methane. Methane is also leaking into the atmosphere in brown coal mining and biomass burning. In addition, municipal waste dumps and sewage (predominantly septic tanks) are also important methane sources. Methane arises without the direct access of oxygen (Figure 5.2).

Fig. 5.2 **CH_4 emissions in 2003**



Total methane emissions reached in 2003 an increase compared to the previous year by 1 %. However, emissions decreased by 26 % compared to the reference year 1990. The most important changes were recorded in the sector of fugitive emissions from mining of brown coal, mining and transport of oil and natural gas. The revision of emission factors and selection of appropriate parameters were carried out. The revision dealt with the data from 1990. The most significant increase in methane emissions was in the case of landfill waste. This was caused by a higher percentage of landfilling mainly by waste of industrial character. This trend is anticipated in the future as well (Table 5.3).

Tab. 5.3 **Total emissions of CH_4 [Gg] within 1990-2003**

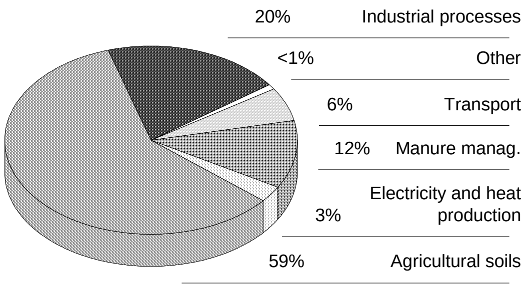
	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total CH_4 emissions	302.1	247.2	250.0	236.2	222.9	220.2	216.9	216.6	222.7	224.3
Energy	69.1	68.6	69.6	70.2	72.2	70.2	71.1	73.2	70.3	68.6
Fossil fuel combustion	17.4	9.8	9.8	9.6	9.1	8.7	8.2	12.0	10.8	12.3
Electricity and heat prod.	16.4	8.7	8.6	8.4	7.7	7.5	7.1	10.7	9.5	11.1
Transport	1.0	1.1	1.2	1.2	1.3	1.3	1.1	1.3	1.4	1.2
Fugitive emissions	51.7	58.8	59.8	60.6	63.2	61.5	62.9	61.2	59.4	56.3
Coal mining	27.2	29.7	30.1	30.6	31.2	29.5	28.8	26.3	25.7	21.1
Natural gas produc.&distrib.	24.5	29.1	29.7	30.0	32.0	32.0	34.1	34.9	33.7	35.2
Agriculture	133.8	86.9	80.3	74.1	65.2	63.2	61.8	61.9	59.1	57.0
Enteric fermentation	116.3	73.6	67.7	62.5	55.0	53.3	52.3	52.4	49.4	47.8
Manure management	17.6	13.3	12.6	11.6	10.2	9.9	9.5	9.5	9.7	9.3
Forest ecosystems	0.7	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7
Biomass burning/forest fires	0.7	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7
Waste	98.5	91.3	99.6	91.3	84.9	86.2	83.4	80.8	92.7	97.9
Solid waste disposal sites	50.3	50.9	59.6	51.0	45.8	46.6	48.3	45.4	57.2	65.8
Wastewaters	48.2	40.4	40.0	40.3	39.1	39.6	35.1	35.4	35.5	32.1
International bunkers*	NE	0.8	0.9	0.8	0.7	0.8	0.8	0.7	0.8	1.0

Emissions, as determinated to April 15, 2005   ** CH_4 emissions are not being accounted into the total emissions*

N_2O – nitrous oxide

In comparison to the other greenhouse gases, the mechanism of nitrous oxide emissions and sinks is not explored fully. The values are charged with a relatively considerable degree of uncertainty. Surpluses of mineral nitrogen in soil (consequence of intense fertilizing) and unfavorable aerial soil conditions (heavy mechanical tillage) are the main cause of N_2O emissions. Emissions in power industry and traffic were estimated on the balance in fossil fuel consumption, by applying the default emission factors according to the IPCC methodology.[4,5] The N_2O emission, arising by

Fig. 5.3 **N_2O emissions in 2003**



manipulation of sewage and sludge has been estimated also for municipal and industrial wastewater treatment plants (Figure 5.3).

In 2003, the total N_2O emissions slightly increased compared with the year 2002. However, the drop compared to the reference year 1990 is almost 35 %. The most substantial increase was recorded in transport sector and industrial processes sector (chemical industry). The later regards to increase in chemical production (nitric acid). After the surprising increase of N_2O in 2002 in wastewater, in 2003, a slight decrease is recorded. This relates to the amount of industrial wastewater treatment (Table 5.4).

Tab. 5.4 **Total emissions of N_2O [Gg] within 1990-2003**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total N_2O emissions	19.51	13.48	13.69	13.82	12.86	12.36	12.32	13.03	12.46	12.73
Fossil fuel combustion	0.85	0.83	0.87	0.94	0.92	0.91	0.85	0.95	0.99	1.00
Electricity and heat production	0.60	0.39	0.39	0.38	0.35	0.33	0.32	0.34	0.33	0.35
Transport	0.25	0.44	0.48	0.56	0.57	0.57	0.53	0.61	0.67	0.65
Industrial processes	1.64	2.03	2.42	2.50	2.34	2.46	2.27	2.58	2.00	2.53
Chemical industry	1.64	2.03	2.42	2.50	2.34	2.46	2.27	2.58	2.00	2.53
Agriculture	16.94	10.57	10.35	10.33	9.55	8.95	9.16	9.42	9.33	9.09
Manure management	3.53	2.36	2.18	2.00	1.76	1.66	1.62	1.63	1.55	1.50
Agricultural soils	13.41	8.22	8.17	8.33	7.79	7.29	7.54	7.79	7.78	7.59
Forest ecosystems	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Biomass burning/forest fires	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Waste	0.06	0.04	0.04	0.04	0.04	0.04	0.03	0.07	0.12	0.09
Wastewaters	0.06	0.04	0.04	0.04	0.04	0.04	0.03	0.06	0.11	0.08
Waste incineration	IE	IE	IE	IE	IE	IE	0.01	0.01	0.01	0.01
International bunkers*	NE	0.10	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.13

Emissions, as determinated to April 15, 2005 ** N_2O emissions are not being accounted into the total emission*

HFCs, PFCs, SF_6

Sources and emissions of the so-called F-gases have been assessed on the territory of Slovak Republic. The procedure was carried out in coincidence with the methodology IPCC[4,5] and the actual and potential emissions were estimated within 1995-2003 (Table 5.5). These gases have not been produced in the SR. Sources of emissions are in their usage as coolants, extinguishing agents, foam substances, solvents, SF_6 as insulating gas in transformers and in the metallurgical industry. CF_4 and C_2F_6 arise in aluminium production. Using of HFCs, PFCs, SF_6 has risen since 1995 and this trend is expected in the future, as well.

In 2003, total F-gases emissions considerable increased. This trend was expected due to a special feature of the emissions. They have a long lifespan and both actual and potential emissions are taken into account. Compared with 2002, the emissions increased by 24 %. However, compared to the reference year 1990, the decease is more than 37 %. The most significant increase of emissions was recorded in the case of HFCs that substituted use of the PFCs. Emissions of CF_4 a C_2F_6 together with emissions of SF_6 are released in the production of aluminium. Their concentrations increased due to an increased production capacity (Table 5.5).

Tab. 5.5 **Total emissions of HFCs, PFCs and SF_6 within 1990-2003**

	GWP		1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total emissions CO_2 *eq.*		[Gg]	271.40	148.33	90.77	114.36	79.63	92.62	103.06	108.14	129.57	169.73
HFCs emissions CO_2 *eq.*		[Gg]	0.00	24.52	44.86	69.83	43.58	66.01	78.30	83.23	103.74	133.83
HFC-23	11 700	[Mg]		<0.01	0.07	0.07	0.05	0.05	0.05	0.06	0.04	0.08
HFC-32	650	[Mg]			0.02	0.11	0.07	0.10	0.32	0.58	1.20	1.92
HFC-41	150											
HFC-43-10mee	1 300											
HFC-125	2 800	[Mg]		0.01	0.08	0.26	0.43	0.76	1.91	3.37	5.76	8.14
HFC-134	1 000											
HFC-134a	1 300	[Mg]		10.98	25.45	41.80	29.18	44.43	47.73	42.88	47.41	60.43
HFC-152a	140	[Mg]			<0.01	0.14	0.32	0.61	0.83	1.01	1.20	1.38
HFC-143	300											
HFC-143a	3 800	[Mg]			0.12	0.31	0.46	0.80	1.92	3.48	5.50	7.38
HFC-227ea	2 900	[Mg]		3.52	3.52	4.39	0.71	0.80	0.80	0.80	0.44	0.23
HFC-236fa	6 300								0.05	0.22	0.38	0.22
HFC-245ca	560											
PFCs emissions CO_2 *eq.*		[Gg]	271.37	113.90	35.15	33.19	23.81	13.93	11.65	11.43	11.41	20.87
CF_4	6 500	[Mg]	36.6	15.40	4.70	4.54	3.24	1.93	1.57	1.54	1.54	2.81
C_2F_6	9 200	[Mg]	3.60	1.50	0.50	0.40	0.30	0.15	0.15	0.15	0.15	0.28
C_3F_8	7 000											
C_4F_{10}	7 000											
$c\text{-}C_4F_8$	8 700											
C_5F_{12}	7 500											
C_6F_{14}	7 400											
SF_6 emissions CO_2 *eq.*		[Gg]	0.03	9.91	10.76	11.34	12.24	12.68	13.11	13.48	14.41	15.03
SF_6	23 900	[Mg]	0.001	0.415	0.450	0.474	0.512	0.531	0.549	0.564	0.603	0.629

Emissions, as determinated to April 15, 2005

5.3 ASSESSMENT

In 2003, the aggregated emissions compared to 2002 slightly increase by 1.5 % representing more than 700 Gg (without sinks from LULUCF). However, compared with the reference year 1990, the emissions of greenhouse gases showed a significant decrease by 20 465 Gg, or 28 % respectively (without sinks from LULUCF). The energy sector has the most significant impact on the GHG emissions, representing almost 80 % share in 2003. Other sectors (industrial processes, agriculture) contribute together by 8 % each on the total emissions. Waste sector contributes by 4 %. These shares are determined as emissions in CO_2 of aggregated equivalents (Table 5.6).

The GHG emissions reached the highest level at the end of 80-ies. In the period of 1990-1994 the reduction was about 25 %. From 1994, the emissions have been stable. In 2000, a significant decrease was recorded. In recent years, emissions increased, mainly emissions of CO_2, due to recovery of the industrial production, transport and changes in fuels used (Figure 5.4).

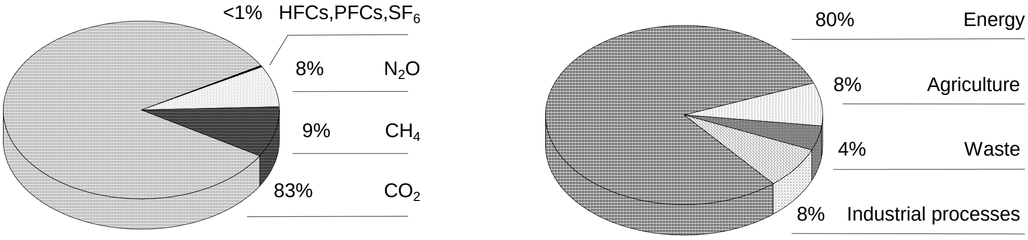
The share of Slovak Republic in the global anthropogenic greenhouse gas emission accounts for about 0.2 %. Annual per capita emission is approximately 7.7 t/year and thus ranks Slovak Republic among the countries with the greatest per capita emissions in the world and the second greatest in Europe.

Tab. 5.6 **Aggregated emissions of GHGs according the sectors in CO_2 *eq*. [Tg] within 1990-2003**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy*	57.68	51.14	47.35	44.47	41.46	42.76	43.36	43.57	41.89	40.77	38.70	41.10	40.65	41.44
Industrial processes**	4.26	3.37	3.35	3.04	3.36	3.56	3.60	3.75	4.37	4.47	3.91	4.11	3.99	3.94
Solvent use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	8.06	6.89	5.87	5.13	4.94	5.10	4.89	4.76	4.33	4.10	4.14	4.22	4.14	4.02
LULUCF	-2.41	-3.46	-4.12	-4.25	-3.28	-2.67	-2.42	-1.40	-1.92	-1.64	-2.43	-5.25	-5.26	-4.86
Waste	2.09	2.03	1.99	1.91	1.92	1.93	2.11	1.93	1.80	1.82	1.86	1.86	2.13	2.22

*Emissions, as determinated to April 15, 2005 *Including transport **Including F-gases*

Fig. 5.4 **Aggregated emissions of GHGs in 2003**



The GHG emission inventory should be assessed based upon its complexity due to uncertainty. These are caused and influenced by uncertainties of statistical data on fuel consumption. The applied emissions factors are another source of uncertainty. An additional error in calculation of the other GHG emissions may occur as a result of less exact methods and it can not be quantified. In spite of this, the uncertainty analysis determined by the Tier 1 method of the IPCC[5] estimated that the GHG emission inventory of 2003 is 9.99 % (according level assessment) and 3.15 % (according trend assessment).

In order to reduce uncertainty of emission inventory, it is necessary to determine and classify key sources and categories. The key sources were selected according to a cumulative contribution to the total emissions. They represent more than 95 % of total GHG emissions. Key sources and categories were determined according to the IPCC[5] method. In 2003, the Slovak Republic determined 14 key sources to be assessed according to the level and 16 key sources to be assessed according to anticipated trends. The most important key categories are combustion of fossil fuels, road transport, and agricultural emissions, waste disposal, enteric fermentation, production of nitric acid, cement, iron and steel productions. Composition of key sources has not been changed.

AIR POLLUTION

IN THE SLOVAK REPUBLIC

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