Slovak
Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2005

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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

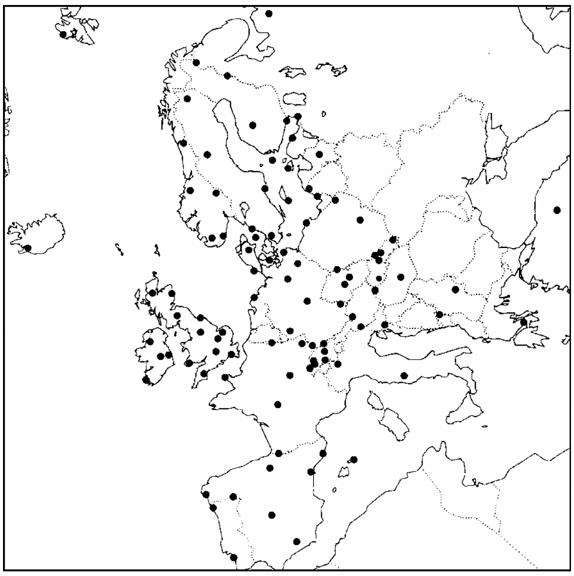
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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.

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 had to be reduced 60 % by 2000, 65 % by 2005 and have to be reduced 72 % by 2010, as compared to 1980. According to the last Protocol (Gothenburg, 1999) the Slovak Republic shall reduce sulphur dioxide emissions 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. 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 EMEP monitoring programme of sulphur compounds and precipitation has been gradually extended for oxides of nitrogen, ammonium in ambient air, particulate matter and ozone. In 1994, the measurements of volatile organic compounds (VOCs) have begun to be carried out under the auspices of CCC - NILU. Later on also heavy metals (HMs) and persistent organic pollutants (POPs) have been included under the measurement programme. In 2003 the new monitoring strategy has been adopted classifying stations into three levels (more details on www.emep.int).

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



1.2 EMEP STATIONS OF NATIONAL AIR QUALITY MONITORING NETWORK

In 2005, 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-Jeséniova station, in elevation 286 m, and analyzed on the content of heavy metals.

EMEP stations

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.

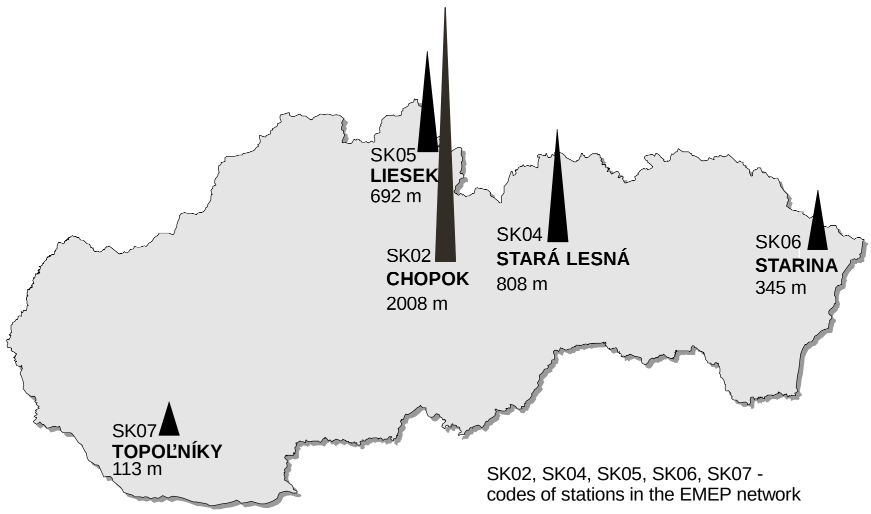
Stará Lesná

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 **EMEP stations in the Slovak Republic – 2005**



Measurement programme

AMBIENT AIR

Station	Sulphur dioxide (SO_2) manually	Oxides of nitrogen (NOx) manually	Nitric acid (HNO_3)	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Ozone precursors (VOC)	Ammonia, ammonium ions (NH_3, NH_4^+)	Alkali ions (K^+, Na^+, Ca^{2+}, Mg^{2+})	Ozone (O_3)	PM_{10} continuously	PM_{10} manually	TSP*	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
Chopok, EMEP	x	x	x	x	x				x			x	x	x	x	x	x	x	x
Topoľníky, Aszód	x	x	x	x	x				x	x		x	x	x	x	x	x	x	x
Starina, Vodná nádrž, EMEP	x	x	x	x	x	x			x		x		x	x	x	x	x	x	x
Stará Lesná, AÚ SAV, EMEP	x	x	x	x	x		x	x	x		x		x	x	x	x	x	x	x
Liesek, Meteo. st., EMEP	x	x	x	x	x				x		x		x	x	x	x	x	x	x

** TSP – Total suspended particles in ambient air*

ATMOSPHERIC PRECIPITATION

Station	pH	Hydrogen ions (H^+)	Conductivity	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Chlorides (Cl^-)	Ammonium ions (NH_4^+)	Alkali ions (K^+, Na^+, Ca^{2+}, Mg^{2+})	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
Chopok, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Topoľníky, Aszód	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Starina, Vodná nárdrž, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Stará Lesná, AÚ SAV, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Liesek, Meteo. st., EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2005

SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1, Fig. 1.3) ranged between 0.43 µg.m^{-3} (Chopok) and 1.74 µg.m^{-3} (Liesek), in 2005. Stations with lower elevation Topoľníky, Starina and Liesek showed higher concentrations of sulphur dioxide, exceeding 1 µg.m^{-3}, on the contrary the stations situated in higher positions Stará Lesná and Chopok showed values 2–4 times lower. ***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 calender year and winter season. This limit value did not reach even one fifth in any of the stations in calender year and in winter season the highest value from all the stations was reached at the Liesek station, namely 5.3 µg SO_2.m^{-3} representing lower than one third of the mentioned limit value.*** Background concentrations of sulphates in 2005 (Tab. 1.1, Fig. 1.3) were the lowest ones at the Chopok station 0.48 µg.m^{-3} and the highest ones at the Topoľníky station 1.31 µg.m^{-3}. Sulphates contributed to the total weight mass of particulate matter (Fig. 1.4) 15–24 % Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represents interval 0.7–1.3, corresponding to the background level of pollution.

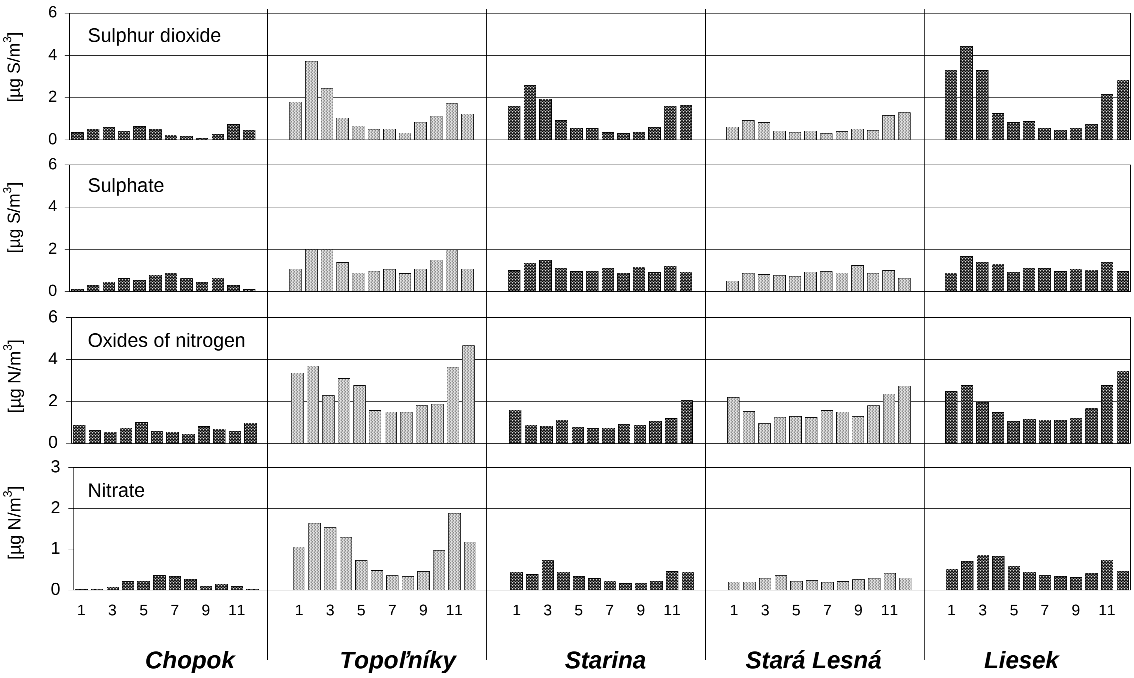
Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air, 2003–2005**

		SO_2-S	SO_4^{2-}-S	NOx-N	NO_3^--N	HNO_3-N	O_3	PM_{10}	Pb	Mn	Cu	Cd	Ni	Cr	Zn	As
		µg.m–3	µg.m–3	µg.m–3	µg.m–3	µg.m–3	µg.m–3	µg.m–3	ng.m–3	ng.m–3	ng.m–3	ng.m–3	ng.m–3	ng.m–3	ng.m–3	ng.m–3
Chopok EMEP	2003	0.61	0.39	0.73	0.11	0.10	109	*9.9	3.19	2.35	1.11	0.13	0.76	1.21	4.56	0.17
	2004	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
	2005	0.43	0.48	0.69	0.16	0.03	95	*6.0	2.44	1.50	0.68	0.06	0.64	1.35	4.47	0.25
Topoľníky Aszód EMEP	2003	2.44	1.26	3.03	1.05	0.10	65	*31.7	17.66	11.01	3.87	0.49	1.86	3.50	35.58	2.07
	2004	1.81	1.22	2.76	0.95	0.06	59	*20.2	11.62	6.56	3.00	0.28	1.12	1.23	17.21	0.97
	2005	1.31	1.31	2.64	0.98	0.05	60	*19.6	14.44	6.64	3.44	0.33	1.02	1.41	19.46	1.00
Starina Vod. nádrž EMEP	2003	1.39	1.08	1.21	0.27	0.16	72	20.7	14.37	4.77	1.65	0.52	0.73	0.74	18.11	0.84
	2004	1.24	1.09	1.57	0.34	0.05	66	16.3	12.78	3.89	1.72	0.51	0.71	0.62	17.49	0.60
	2005	1.07	1.09	1.06	0.36	0.04	66	18.4	12.43	4.10	1.75	0.44	0.75	1.11	14.34	0.72
St. Lesná AÚ SAV EMEP	2003	0.87	0.92	1.41	0.26	0.07	66	15.8	9.91	4.50	1.59	0.31	0.66	0.93	20.29	1.08
	2004	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
	2005	0.64	0.85	1.64	0.26	0.03	70	14.7	8.14	4.75	2.08	0.25	0.52	1.08	12.83	0.70
Liesek Meteo.st. EMEP	2003	1.71	1.17	1.93	0.48	0.08	-	24.2	13.52	14.40	1.86	0.49	0.61	0.78	34.64	2.42
	2004	1.76	1.00	1.87	0.46	0.03	62	17.9	11.66	20.2	2.05	0.41	0.71	0.61	30.70	1.91
	2005	1.74	1.14	1.84	0.54	0.04	67	22.3	13.76	18.51	2.52	0.43	0.69	0.99	26.61	1.56

SO_2, SO_4^{2-} – recalculated in sulphur, *NOx, NO_3^-, HNO_3 – recalculated in nitrogen*

* *TSP (total suspended particles)*

Fig. 1.3 **Monthly mean concentrations in ambient air – 2005**
(recalculated in sulphur, resp. nitrogen)



NOx, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1, Fig. 1.3) varied from 0.69 µg.m^{-3} (Chopok) to 2.64 µg.m^{-3} (Topoľníky) in 2005. ***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 vegetation is 30 µg NO_x.m^{-3} in calender year. This limit value was not exceeded at any of the stations. The highest value from all the stations 8.7 µg NO_x.m^{-3} (in Topoľníky) is below 30 % of the limit value.*** Nitrates in ambient air occurred predominantly in the form of particles (Tab. 1.1, Fig. 1.3) in 2005. Concentrations of nitric acid (Tab. 1.1) were lower at all the stations one order comparing to particulate nitrates. Both these forms of nitrogen are collected on filters and measured separately and their phase division is dependent upon ambient air temperature and humidity. Nitrates contributed to the total mass of particulate matter 3–21 % (Fig. 1.5). Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NOx-NO_2 recalculated in nitrogen represented the range 0.2–0.4.

Ammonia, ammonium ions and alkali ions

In coincidence with the requests of the EMEP monitoring strategy for the EMEP stations level one the measurements of ammonia, ammonium ions, ions of sodium, potassium, calcium and magnesium in ambient air started to be measured in May 2005. Averaged concentrations of these components (NH_3 and NH_4^+ recalculated in nitrogen) are presented in the following table for 8 months.

	NH_3-N [µg.m^{-3}]	NH_4^+-N [µg.m^{-3}]	Na^+ [µg.m^{-3}]	K^+ [µg.m^{-3}]	Mg^{2+}[µg.m^{-3}]	Ca^{2+} [µg.m^{-3}]
Stará Lesná, AÚ SAV, EMEP	0.39	0.88	0.18	0.16	0.02	0.15

Particulate matter PM_{10}, respectively TSP and heavy metals

In Tab. 1.1 the concentrations of PM_{10} (Stará Lesná, Liesek and Starina) and TSP (Chopok, Topoľníky) in 2005 measured manually are presented. In 2005 the continuous PM_{10} monitoring at Topoľníky began (annual average concentration 25.5 µg.m^{-3}).

In Table 1.1 and Figures 1.4 are introduced concentrations of heavy metals in PM_{10}, respectively TSP. The share of the sum of all measured metals in mass weight of suspended particles (PM_{10}, resp. TSP) varied within 0.19–0.29 % (Fig. 1.5).

Fig. 1.4 **Heavy metals in ambient air – 2005**

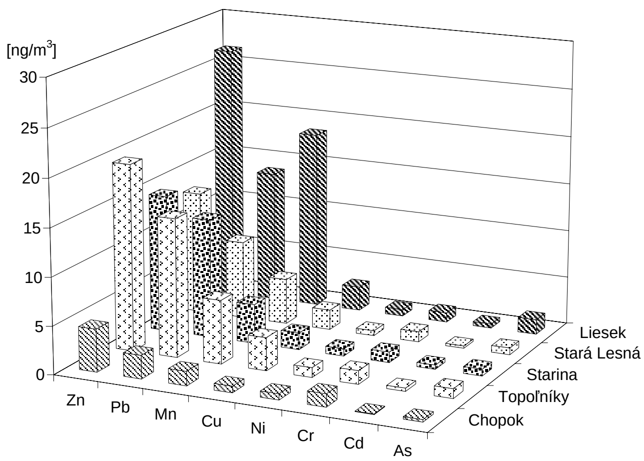
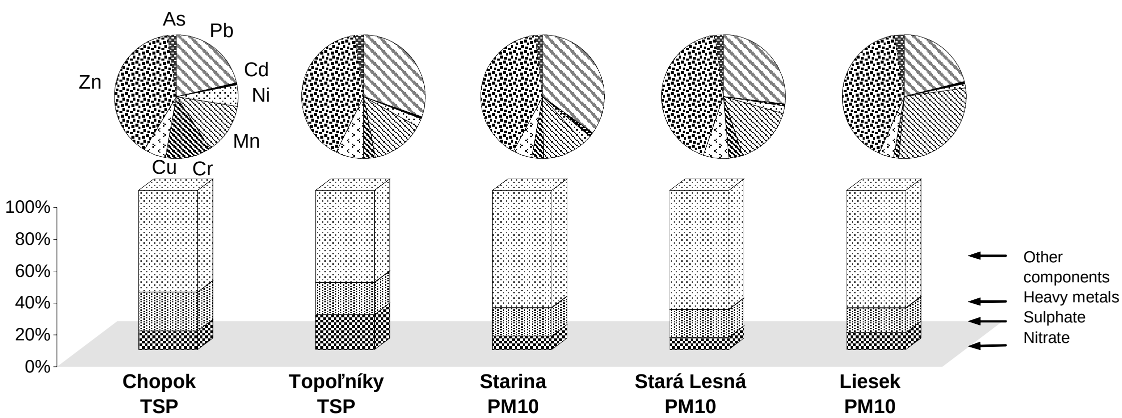


Fig. 1.5 **Composition of PM mass and proportional share of heavy metals – 2005**

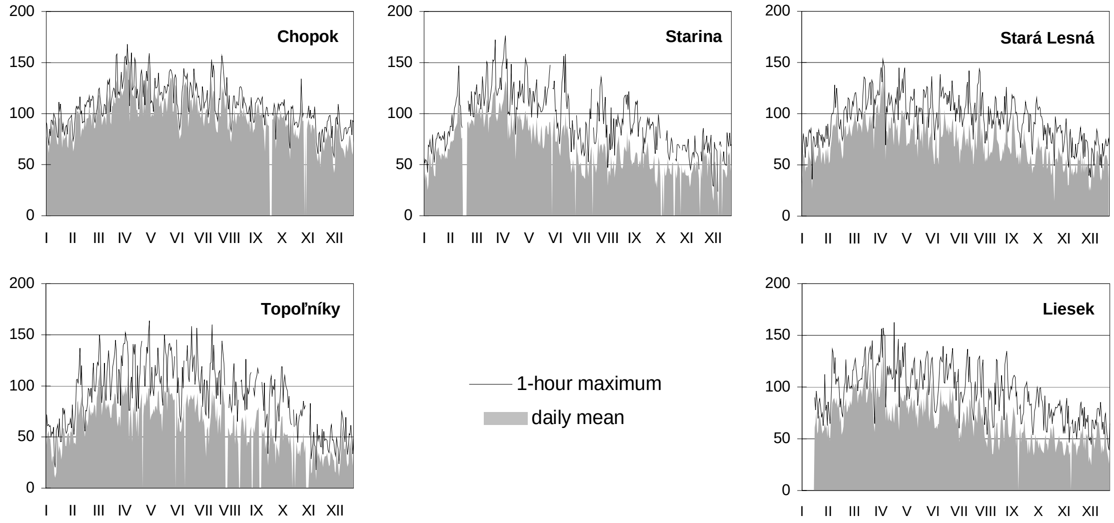


Ozone

In Figures 1.6 the annual course of ground level ozone concentrations at 5 regional stations Chopok, Stará Lesná, Starina, Topoľníky and Liesek are depicted. The longest time series of ozone measurements is at the Stará Lesná station, since 1992. The measurements of ozone in Topoľníky, Starina and Chopok began to be carried out later, in 1994 and in Liesek in 2004. In 2005, the annual average of ozone concentration at the Chopok station reached 95 $\mu g.m^{-3}$, at Starina 66 $\mu g.m^{-3}$, Stará Lesná 70 $\mu g.m^{-3}$, Topoľníky 60 $\mu g.m^{-3}$ and Liesek 67 $\mu g.m^{-3}$. 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 [$\mu g.m^{-3}$] – 2005**



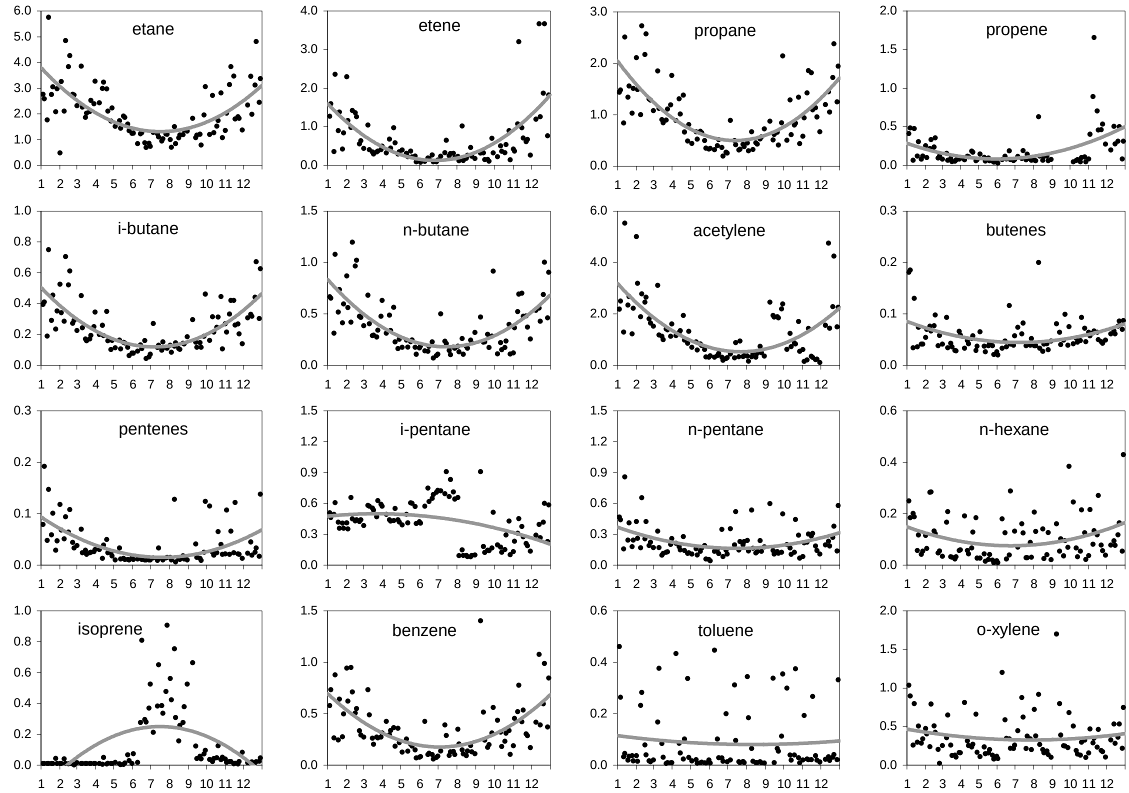
VOCs C_2–C_6

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 a few European stations, included into the EMEP network with regular sampling of volatile organic compounds. They are 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). Etane is the most abundant, then acetylene and propane. Remarkable is presence of isoprene releasing from the near forest

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina, 2003–2005**

	etane	etene	propane	propene	i-butane	n-butane	acetylene	butene	pentene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
2003	1.989	1.015	0.929	0.169	0.249	0.484	1.682	0.152	0.044	0.606	0.307	0.149	0.193	0.317	0.067	0.420
2004	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
2005	2.046	0.662	0.974	0.192	0.243	0.379	1.291	0.058	0.038	0.422	0.225	0.127	0.104	0.351	0.090	0.366

Fig. 1.7 **VOCs [ppb] – Starina – 2005**



Atmospheric precipitation

Major ions, pH, hydrogen ions, conductivity

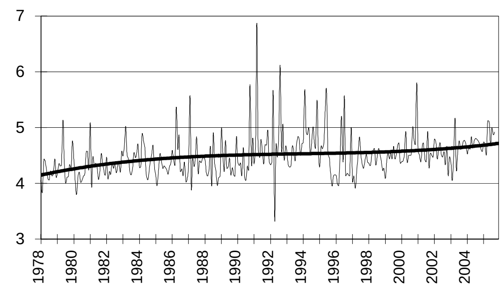
In 2005 the amount of precipitation recorded at background stations ranged between 619 and 1155 mm. Upper level of concentration range did belong to the highest situated station Chopok and lower level to lowest situated lowlands station Topoľníky. Acidity of atmospheric precipitation dominated at the Liesek and Starina stations at the lower level of pH range 4.60–4.96 (Tab. 1.3, Fig. 1.8). Concentrations of hydrogen ions are determined also by titration, however not regularly from daily samples of precipitation, only in cases when the sample is of sufficient amount enabling to provide titration.

Figure 1.8 illustrates the annual courses of pH, sulphates and nitrates based upon the daily sampling. Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity (Fig. 1.9). Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.41–0.62 mg.l^{-1}. Total decrease of sulphates in long-term time series has corresponded to SO_2 emission reduction since 1980.

The share of nitrate in acidity of precipitation was substantially smaller than those of sulphates and varied within the concentration range, calculated in nitrogen 0.25–0.40 mg.l^{-1}

Fig. 1.9 **pH in daily precipitation – Chopok**

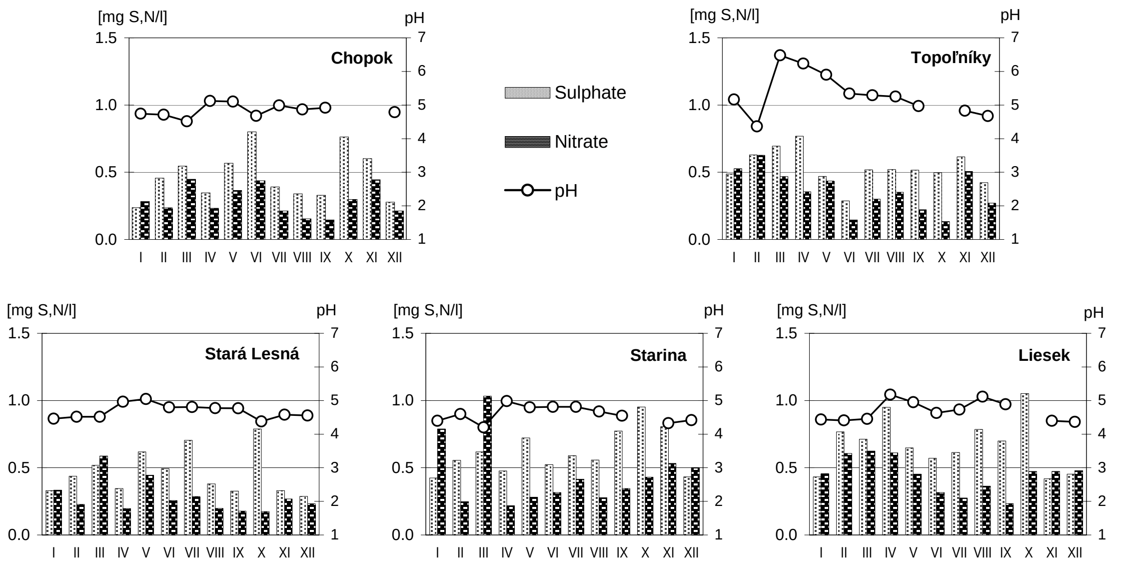


Tab.1.3 **Annual averages of main components in daily precipitation – 2005**

		precip. mm	pH	cond. µS.cm^{-1}	Na^+ mg.l^{-1}	K^+ mg.l^{-1}	Mg^{2+} mg.l^{-1}	Ca^{2+} mg.l^{-1}	Cl^- mg.l^{-1}	NH_4^+-N mg.l^{-1}	NO_3^--N mg.l^{-1}	SO_4^{2-}-S mg.l^{-1}
Chopok, EMEP	2003	843	4.57	24.0	0.29	0.26	0.055	0.36	0.36	0.57	0.43	0.93
	2004	1188	4.71	15.0	0.20	0.16	0.025	0.20	0.22	0.39	0.29	0.56
	2005	1155	4.85	10.9	0.14	0.08	0.019	0.15	0.15	0.37	0.25	0.41
Topoľníky, Aszód, EMEP	2003	368	4.84	21.5	0.27	0.21	0.086	0.62	0.35	0.57	0.48	0.86
	2004	571	4.83	16.2	0.31	0.24	0.045	0.33	0.22	0.60	0.39	0.67
	2005	619	4.96	15.2	0.20	0.13	0.073	0.41	0.25	0.52	0.35	0.52
Starina, Vodná nádrž, EMEP	2003	574	4.57	24.2	0.30	0.31	0.059	0.49	0.39	0.65	0.54	0.90
	2004	981	4.67	17.7	0.27	0.26	0.037	0.35	0.28	0.42	0.38	0.64
	2005	893	4.60	17.6	0.21	0.15	0.035	0.27	0.26	0.39	0.40	0.58
Stará Lesná, AÚ SAV, EMEP	2003	532	4.70	24.7	0.27	0.33	0.065	0.41	0.36	0.74	0.43	0.86
	2004	880	4.72	18.2	0.22	0.23	0.035	0.26	0.26	0.44	0.35	0.66
	2005	854	4.73	13.8	0.18	0.13	0.030	0.30	0.20	0.36	0.28	0.48
Liesek, Meteo. st., EMEP	2003	636	4.57	25.0	0.32	0.37	0.065	0.46	0.55	0.55	0.52	0.92
	2004	858	4.65	19.2	0.25	0.22	0.043	0.32	0.37	0.47	0.41	0.67
	2005	802	4.64	18.4	0.21	0.14	0.040	0.28	0.38	0.47	0.39	0.62

SO_4^{2-} – recalculated in sulphur, NO_3^-, NH_4^+ – recalculated in nitrogen

Fig. 1.8 **Daily precipitation – 2005**



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 Bratislava-Jeséniova the measurement of the same set of heavy metals in precipitation was implemented as in background stations of Slovakia (Table 1.4). This station serves however only for comparison and is not assessed as the background station.

- Concentration of lead in atmospheric precipitation achieved range between 1.55 µg.l^{-1} (Topoľníky) and 2.93 µg.l^{-1} (Starina). Within the last year of measurements the most of background stations showed moderate decrease in lead concentrations.
- Cadmium concentrations accomplished range between 0.05 µg.l^{-1} (Topoľníky) and 0.19 µg.l^{-1} (Stará Lesná). The biggest decrease, one order, was recorded in Chopok as compared to two previous years. (In Bratislava-Jeséniova concentration was the same within last two years).

- Zinc as the most abundant from set of the measured metals recorded very similar concentrations as in previous year at all background stations.
- Nickel and arsenic showed very similar concentration range at the background stations. Chromium concentrations were very similar at the Chopok station within last three years, however comparing to the rest of stations they were significantly highest ones within last two years.
- Copper decreased the most significantly at Liesek and Stará Lesná, approximately to half. Higher concentrations of copper have been found only at Topoľníky.
- For the time being, lead and cadmium as the metals of the first priority are not possible to assess more complex due to the short time period, similar as the other metals mentioned 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 particulate matter (PM_{10} and TSP).

Tab. 1.4 **Annual averages of heavy metals in monthly precipitation, 2003–2005**

		precip. mm	Pb $\mu g.l^{-1}$	Cd $\mu g.l^{-1}$	Cr $\mu g.l^{-1}$	As $\mu g.l^{-1}$	Cu $\mu g.l^{-1}$	Zn $\mu g.l^{-1}$	Ni $\mu g.l^{-1}$
Chopok, EMEP	2003	843	3.41	0.62	0.23	0.32	3.03	30.4	0.53
	2004	1077	2.57	0.52	0.21	0.28	1.76	18.1	0.54
	2005	934	2.39	0.09	0.20	0.31	1.40	19.4	0.29
Topoľníky, Aszód, EMEP	2003	368	1.41	0.15	0.14	0.15	0.89	5.5	0.41
	2004	529	1.31	0.06	0.04	0.23	0.51	5.1	0.13
	2005	598	1.55	0.05	0.08	0.28	0.82	5.7	0.71
Starina, Vodná nádrž, EMEP	2003	574	4.36	0.42	0.39	0.29	1.62	5.8	0.44
	2004	922	3.07	0.17	0.05	0.38	1.64	6.8	0.82
	2005	891	2.93	0.11	0.07	0.27	1.19	6.5	0.32
Stará Lesná, AÚ SAV, EMEP	2003	532	2.11	0.51	0.09	0.21	2.08	6.9	0.45
	2004	786	2.59	0.22	0.05	0.29	1.55	6.4	0.16
	2005	803	1.69	0.19	0.07	0.21	0.78	9.4	0.22
Liesek, Meteo. st., EMEP	2003	636	2.16	0.22	0.09	0.12	1.52	11.7	0.99
	2004	802	2.39	0.12	0.08	0.35	1.56	6.4	0.28
	2005	829	1.96	0.07	0.07	0.25	0.65	7.0	0.22
Bratislava, Jeséniova	2003								
	2004	537	2.83	0.07	0.15	0.40	2.13	3.9	0.41
	2005	683	3.05	0.07	0.08	0.37	1.47	10.5	0.38

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

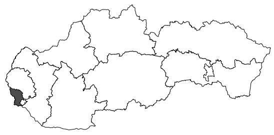
2.1 LOCAL AIR POLLUTION

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

The SHMI 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 3 stations measurements of $PM_{2.5}$ were put in operation. In 2005, 29 stations (without EMEP and ozone stations) were deployed on the territory of the SR. Most of them monitored the level of pollution caused by the basic pollutants. In the year 2005 measurements of benzene were carried out at 4 automatic stations and at 12 stations the measurements were performed by passive 2–weeks sampling. 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 Air Protection 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: 452 459

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 properly situated 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.

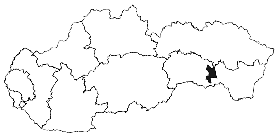
Location of stations

Bratislava - Jeséniova
The station is located in the ground 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.

Bratislava - Mamateyova
The station is located in open are at playing area in sufficient distant from housing estate built-up area. Among the major sources of air pollution belong traffic, power sources and the petrochemical complex, Slovnaft, Ltd. The last mentioned contributes to the 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. It represents location with extreme high emissions from road transport.

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



AGGLOMERATION - KOŠICE

AREA: 245 km^2 POPULATION: 234 871

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 typical 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.

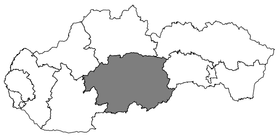
Location of stations

Košice - Štúrova

This is a city centre station. It is placed in an open area, at the edge of large parking area and small park. The station is located at a distance of about 10 m north from the inner circle roads and 50 m south from the second route of this circle.

Košice – Strojárenská

Station is situated in open area 10 m far from 2-storey buildings, separated by green alley from near road which is in distance of about 15 m.



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 455 km^2 POPULATION: 657 119

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} with high occurrence of temperature inversion in valley positions. Air pollution is affected by wood processing industries releasing emissions of suspended particles, but also by a large number of local heating sources. 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.

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 2.5 m.s^{-1}. The frequent occurrence of surface inversions during the night is due to the 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 at 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 - Dukelských hrdinov

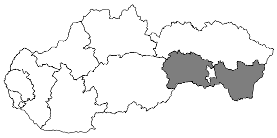
The station is placed on a boundary-line between 4-storey housing and an open space, passing down, out of the station.

Hnúšťa - Hlavná

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

Jelšava - Jesenského

The station is situated in the peripheral part of the city, in kindergarten, on a hill which is open to the major polluter (SZM Jelšava) from one side. From distance of about 100 m of the other side the building estate is located.



ZONE - KOŠICE REGION

AREA: 6 508 km^2 POPULATION: 537 076

Characterization of area

Krompachy

Krompachy is located in the valley system with good local circulation of air. Southern part of the city is situated in valley of the Slovinský potok and northern in the valley of Hornád, which is oriented to east-west direction. The average wind speed is low, approximately 1,4 $m.s^{-1}$. The main polluter is ferrous metal plant Kovohuty in Krompachy. To the air pollution contributes also the local heating systems.

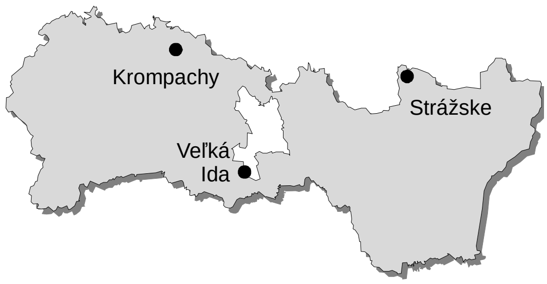
Strážske

Strážske is located easterly from Vihorlat in northern part of the Eastslovak lowland in area called Brekovska brana, which strengths wind speed from north directions. Annual average of the wind speed is 3.4 $m.s^{-1}$. The daily course of wind speed is significantly emphasized with minimum during night hours. The main source of air pollution is local chemical industry.

Veľká Ida

The station is located at the border line of Košice's basin and Moldava lowland. The area is surrounded from south by Abovské hills, from western by Slovenský kras and from northern by Slovenské rudohorie. The prevailing winds are from north-east and south-west directions. The annual average of wind speed is about 2,5 $m.s^{-1}$. The main air pollution source is the ferrous metallurgy complex and surrounding large dumps of extracting ores.

Location of stations



Krompachy - Lorenzova

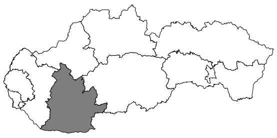
The station is located in the valley of the Slovinský potok, on the western edge of the town 2 km south-west of the ferrous metal plant Kovohuty Krompachy. The surrounding built-up area comprises multi-storey houses. It is a valley position with an increased occurrence of inversions.

Veľká Ida - Letná

The station is located in the south-eastern part of the Veľká Ida municipality, near the US Steel Košice ferrous metallurgy complex, in a relatively open area. In the vicinity of station are located family houses, gardens, railway stations and waste dumps of slag, which are not fully grassed.

Strážske - Mierová

Monitoring station is situated in the centre of town. It is placed in an open area among buildings, gardens and green areas approximately 1.5 km east-south-east out from the Chemko Strážske plant. In the vicinity is a middle frequented first class road Michalovce-Prešov, which is separated from stations by tree alley.



ZONE - NITRA REGION

AREA: 6 343 km^2 POPULATION: 708 498

Characterization of area

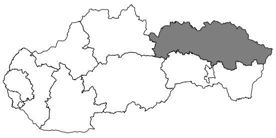
Nitra

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 winds are from north-east and south-west directions with a small occurrence of calm situations.

Location of stations

Nitra - Štefánikova

Station is located very close to the crossroad of Štúrova street and Štefánikova trieda with high frequency of traffic.



ZONE - PREŠOV REGION

AREA: 8 993 km^2 POPULATION: 798 596

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, which is located in the north 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 municipal boilers, mainly lacking separation techniques, traffic, as well as secondary suspended particles.

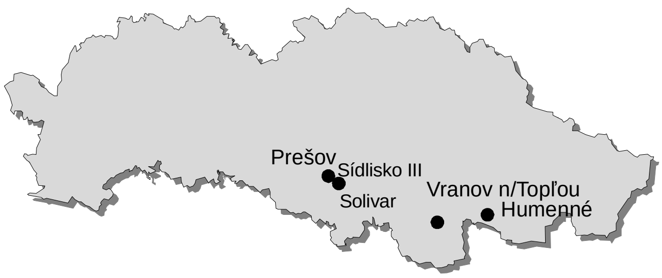
Humenné

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 is 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 sources in the area are the local wood processing industry and local heating systems.

Location of stations

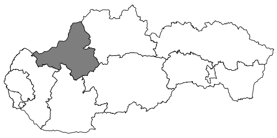


Prešov - Levočská
The station is situated in an open area at Torysa river near a supermarket Kaufland, at the boundary-line of a housing estate and historical town centre with high trees. Nearby, approximately 50 m away, is the main road to Poprad.

Prešov - Solivarská
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 Arm. gen. L. Svobodu cross-road with high frequency of transport. Station is located 10 m from kerbside.

Humenné - Nám. slobody
The station is located in the southern part of the town centre at the border of a pedestrian zone with minimum car transport. The surrounding buildings are connected to the central heating from Chemes Humenné source which is located approximately 2 km west from AMS.

Vranov nad Topľou - M. R. Štefánika
The station is situated in the town centre which is built up with a mixture of family houses and 2–3 storey residential houses approximately 2 km north-west out from the Bukocel Hencovce plant. It is distant from the main road, of about 30 m.



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 600 386

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 $m.s^{-1}$ indicates 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 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 - J. Hollého

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.

Handlová - Morovianska cesta

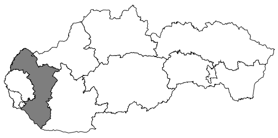
The station is located in a predominantly family house built-up area in territory of elementary school close to the municipal road. Among the major emission sources are power sources and industry.

Bystričany - Rozvodňa SSE

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

Trenčín - Hasičská

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



ZONE - TRNAVA REGION

AREA: 4 148 km^2 POPULATION: 554 172

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 intervene. From the standpoint of emission transport and dispersion 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. 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.

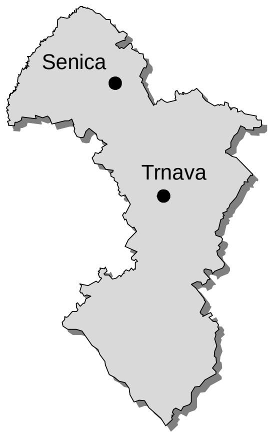
Location of stations

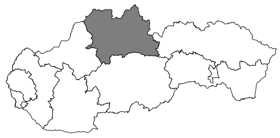
Senica - Hviezdoslavova

Station is situated very close to the bus stop. It is placed 5 m from kerbside of main route to Kúty with a relative high heavy-duty fraction of traffic. In distance of 40 m in south direction are located multi-storey buildings.

Trnava - Kollárova

Station is located at open area close to the crossroad with high frequency of traffic. It is located in the immediate vicinity of large parking area near a railway station.





ZONE - ŽILINA REGION

ROZLOHA: 6 788 km^2 POPULÁCIA: 694 763

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 $m.s^{-1}$. 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. Specific air pollution represents a mixture of predominantly organic-sulphur compounds.

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 - Obežná

The station is situated in the north-eastern part of the town at the edge of housing estate in relative open area close to the local roads with small traffic frequency. The position is open in all directions and representative for wind speed and wind direction measurements.

Ružomberok – Riadok

The station is located in the kindergarten 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

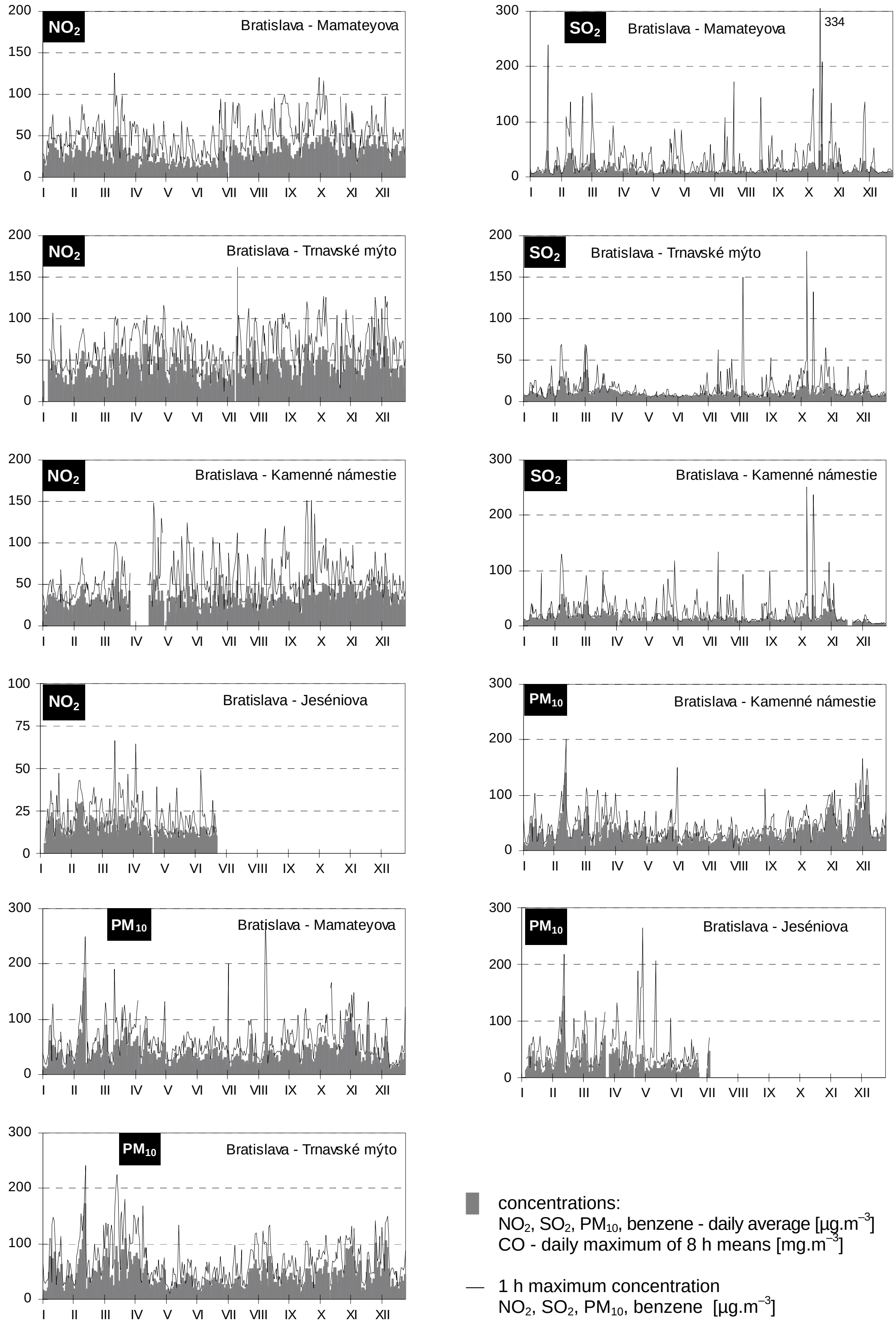
The station is located 5 m from the kerbside of the main street. Station is located in the southern part of the city in area mainly build up by family houses.

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in 2005**

AGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	SO_2	NO_2	PM_{10}	$PM_{2,5}$	CO	H_2S	C_6H_6	$^{+}C_6H_6$	Pb	Cd	Ni	As
BRATISLAVA	Bratislava, Kamenné nám	17°06'49"	48°08'41"	139	*	*	*					*	*	*	*	*
	Bratislava, Trnavské mýto	17°07'44"	48°09'31"	136	*	*	*		*		*		*	*	*	*
	Bratislava, Jeséniova	17°07'00"	48°10'00"	287		*	*					*	*	*	*	*
	Bratislava, Mamateyova	17°07'32"	48°07'30"	138	*	*	*					*	*	*	*	*
KOŠICE	Košice, Štúrova	21°15'39"	48°43'02"	199	*	*	*		*		*					
	Košice, Strojárska	21°15'07"	48°43'36"	202	*	*	*		*				*	*	*	*
Banská Bystrica region	Banská Bystrica, Nám. slobody	19°09'30"	48°44'12"	372	*	*	*		*			*	*	*	*	*
	Jelšava, Jesenského	20°14'25"	48°37'52"	289	*	*	*						*	*	*	*
	Hnúšťa, Hlavná	19°57'06"	48°35'01"	320	*	*	*									
	Žiar nad Hronom, Dukelských hrdinov	18°51'01"	48°35'09"	285	*	*	*						*	*	*	*
Bratislava region																
Košice region	Veľká Ida, Letná	21°10'31"	48°35'32"	209	*	*	*		*			*	*	*	*	*
	Strážske, Mierová	21°50'15"	48°52'27"	133	*	*	*					*				
	Krompachy, Lorenzova	20°52'21"	48°54'44"	387	*	*	*						*	*	*	*
Nitra region	Nitra, Štefánikova	18°05'08"	48°18'28"	142	*	*	*		*		*		*	*	*	*
Prešov region	Humenné, Nám. slobody	21°54'49"	48°55'51"	160	*	*	*						*	*	*	*
	Prešov, Levočská	21°13'45"	49°00'03"	246	*	*	*					*				
	Prešov, Solivarská	21°15'52"	48°58'40"	258	*	*	*		*			*	*	*	*	*
	Vranov nad Topľou, M. R. Štefánika	21°41'15"	48°53'11"	133	*	*	*						*	*	*	*
Trenčín region	Prievidza, J. Hollého	18°37'23"	48°46'11"	283	*	*	*	*					*	*	*	*
	Bystričany, Rozvodňa SSE	18°30'51"	48°40'01"	261	*	*	*									
	Handlová, Morovianska cesta	18°45'23"	48°43'59"	448	*	*	*									
	Trenčín, Hasičská	18°02'29"	48°53'47"	214	*	*	*		*			*	*	*	*	*
Trnava region	Senica, Hviezdoslavova	17°21' 48"	48°40'50"	212	*	*	*		*			*	*	*	*	*
	Trnava, Kollárova	17°35'06"	48°22'16"	152	*	*	*		*		*		*	*	*	*
Žilina region	Martin, Jesenského	18°55'19"	49°04'01"	383	*	*	*	*	*			*	*	*	*	*
	Ružomberok, Riadok	19°18'09"	49°04'45"	475	*	*	*			*		*	*	*	*	*
	Žilina, Veľká Okružná	18°44'38"	49°13'11"	332	*	*	*		*				*	*	*	*
	Žilina, Obežná	18°46'16"	49°12'43"	356	*	*	*	*								

+ passive sampling

Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – Agglomeration Bratislava – 2005**



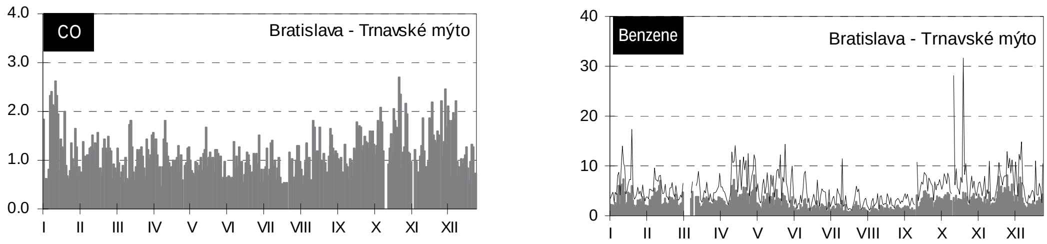


Fig. 2.2 **Concentrations of NO_2, SO_2, PM_{10}, benzene and CO – Agglomeration Košice – 2005**

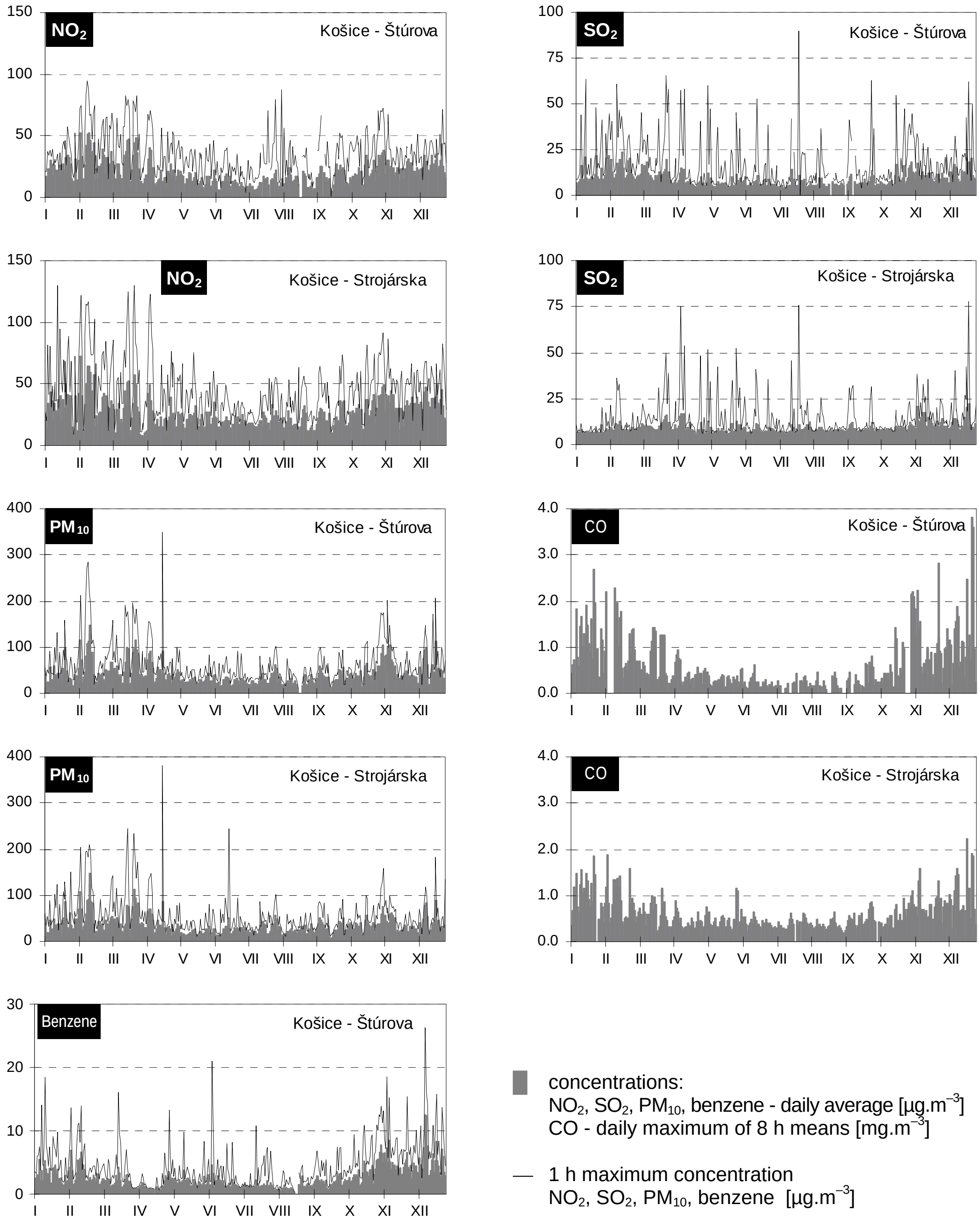
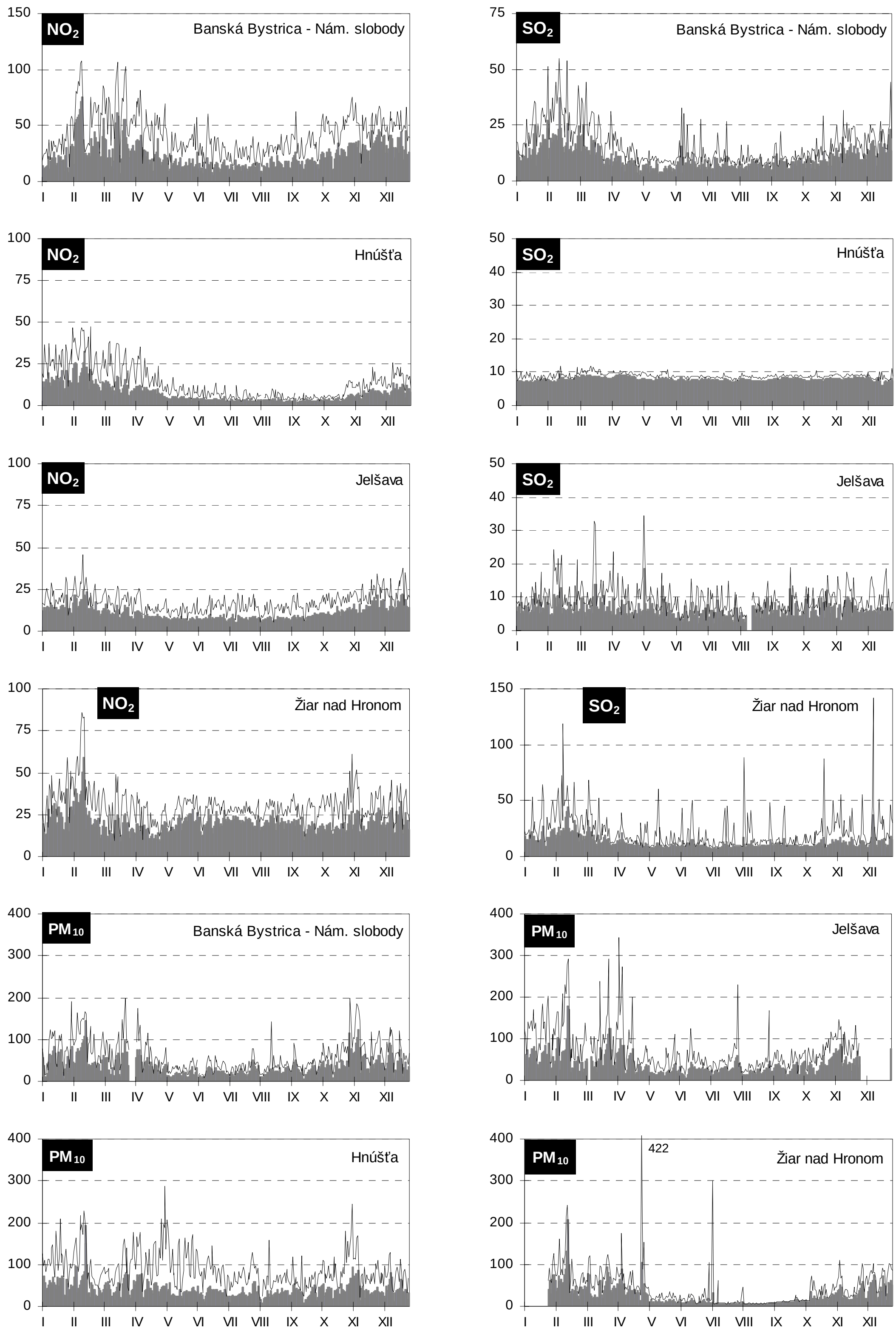


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10} and CO – zone Banská Bystrica region – 2005**



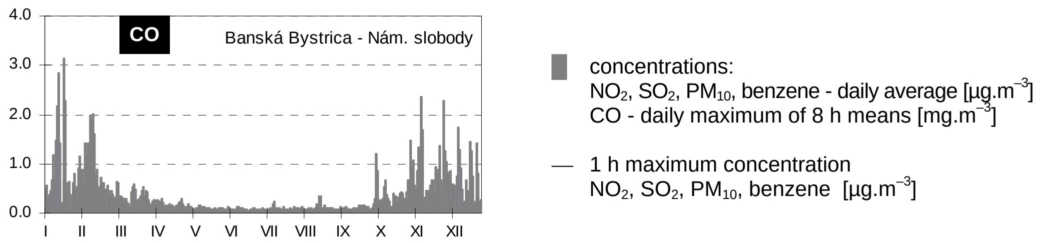


Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10} and CO – zone Košice region – 2005**

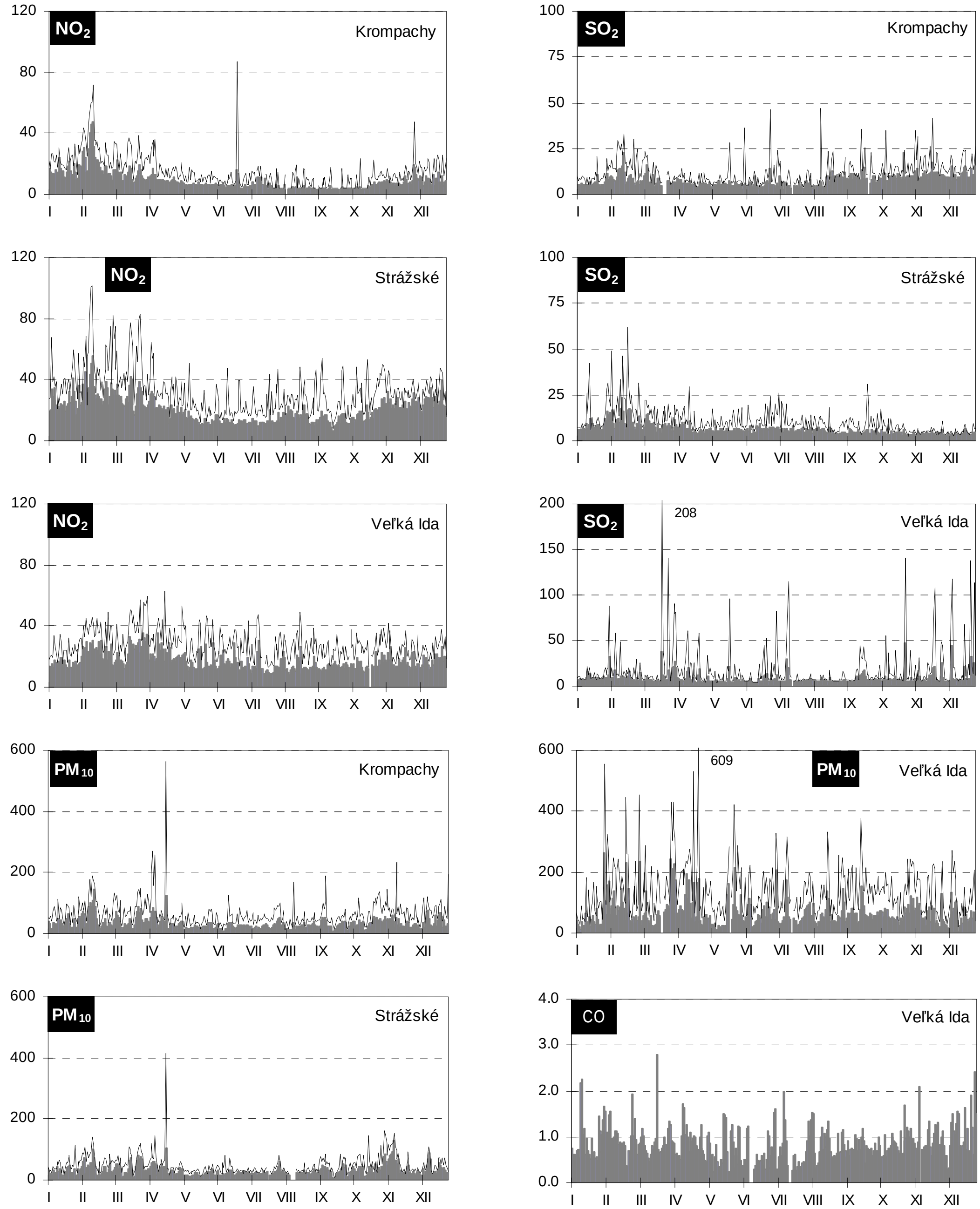


Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Nitra region – 2005**

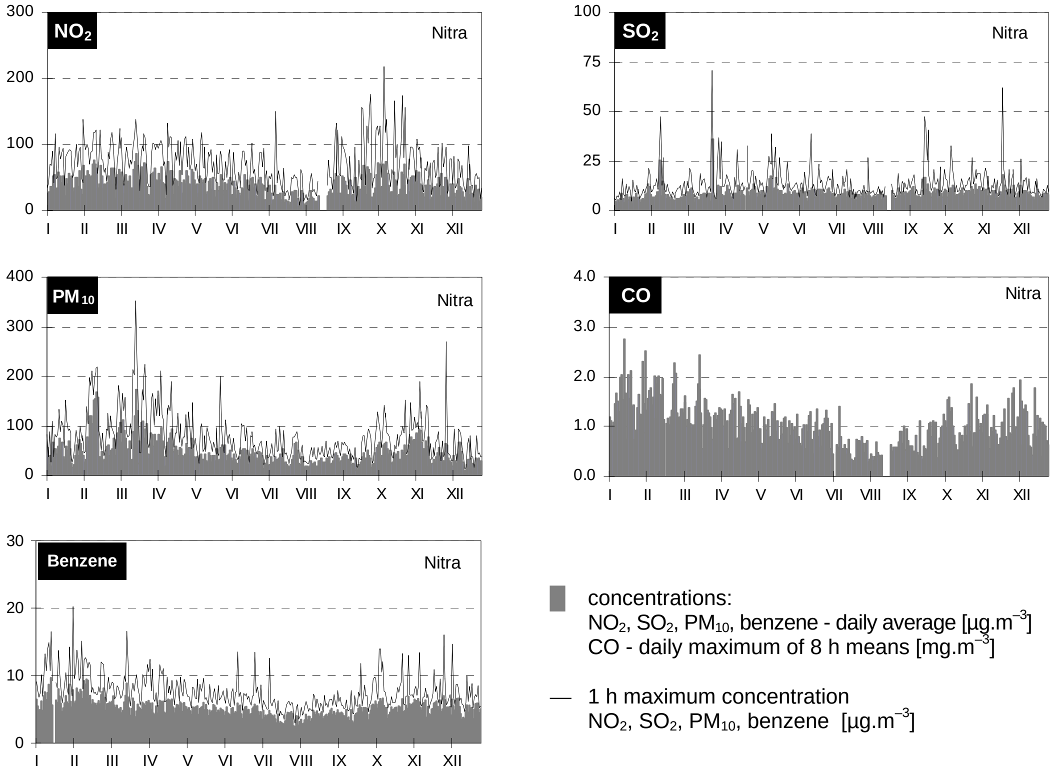
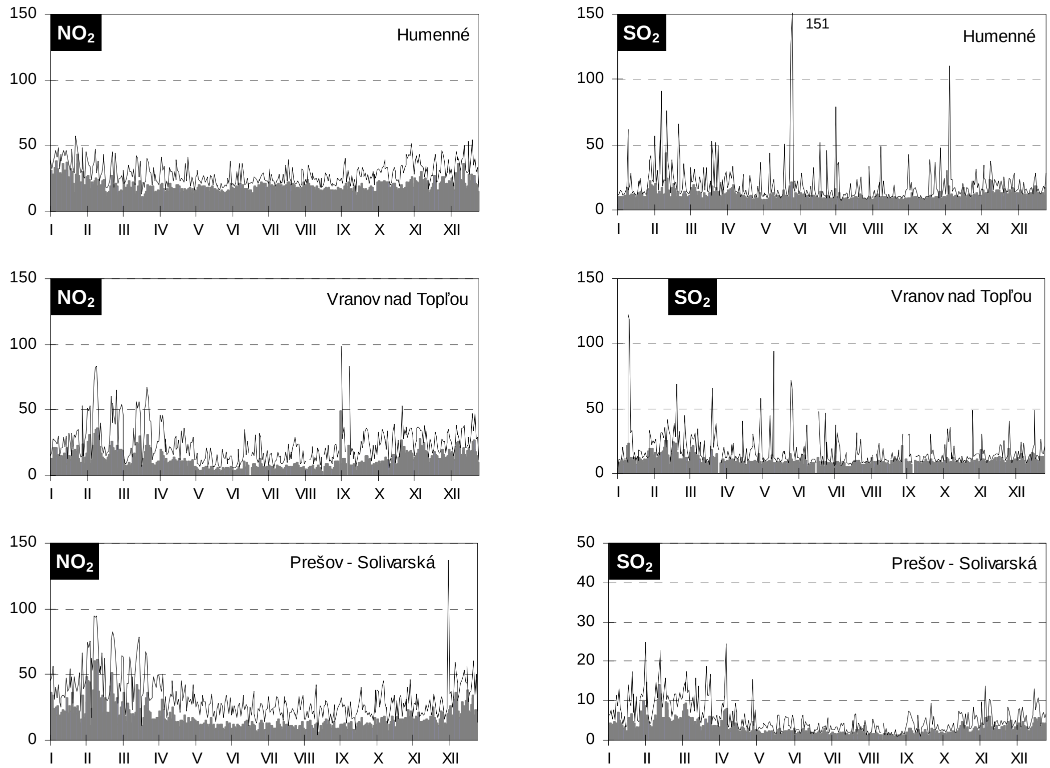


Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10} and CO – zone Prešov region – 2005**



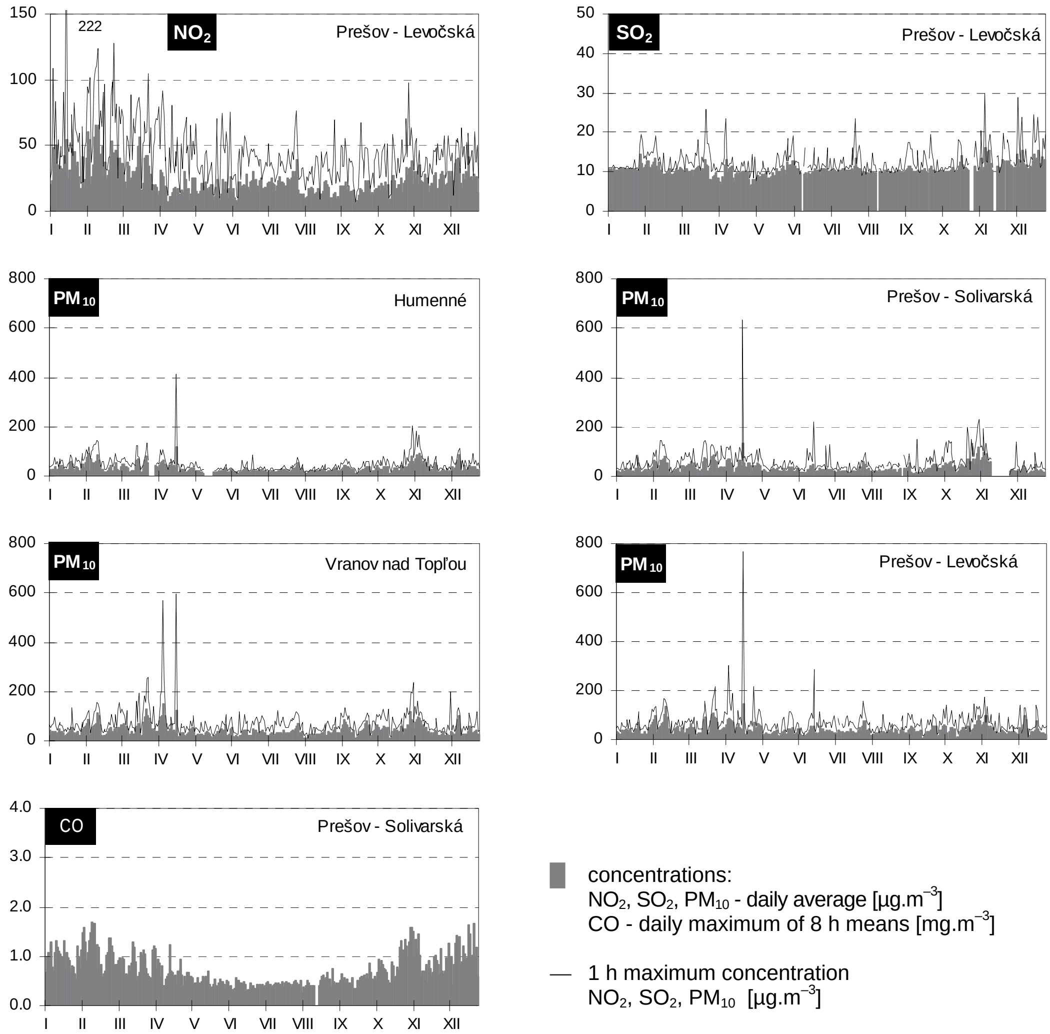
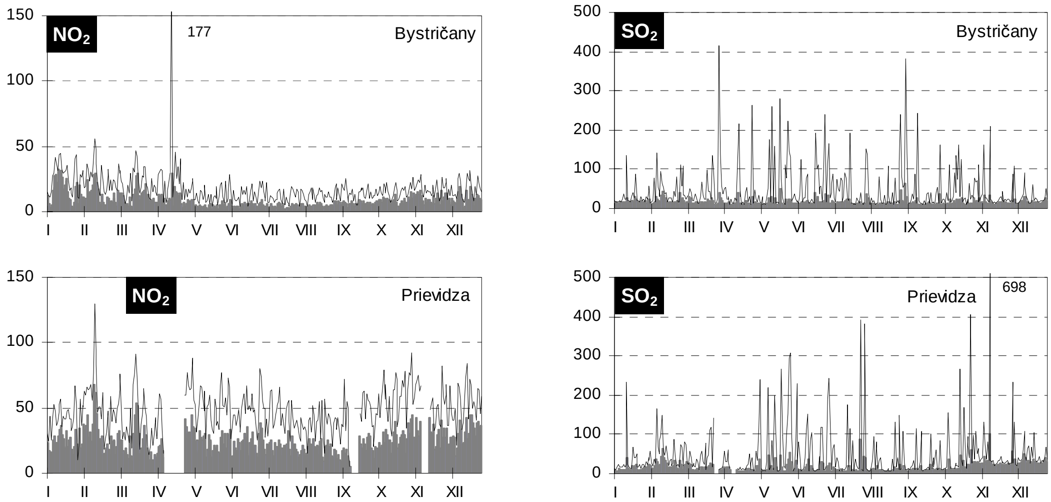
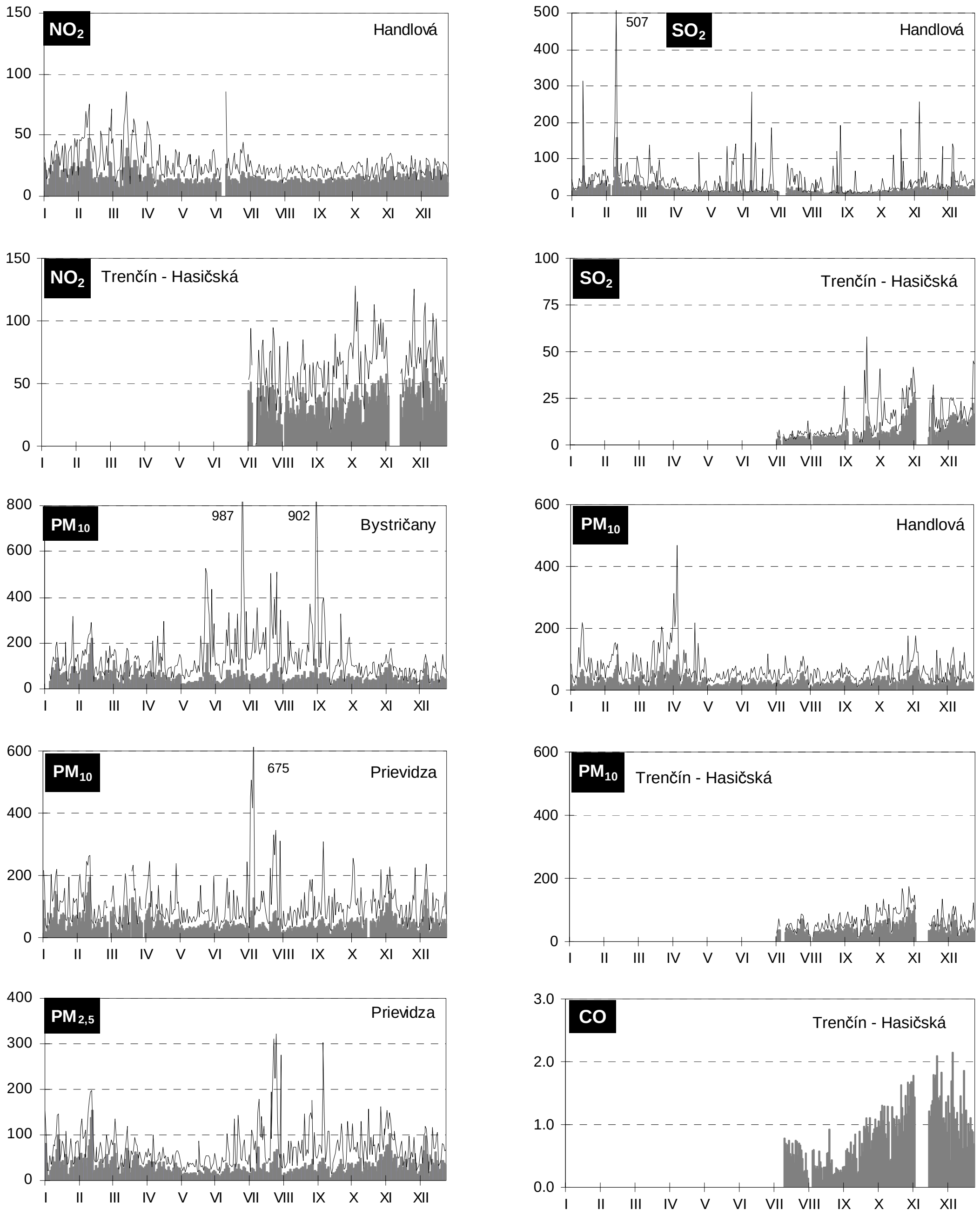


Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10} and $PM_{2.5}$ – zone Trenčín region – 2005**





concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$ - 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}, $PM_{2.5}$ [µg.m^{-3}]

Fig. 2.8 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Trnava region – 2005**

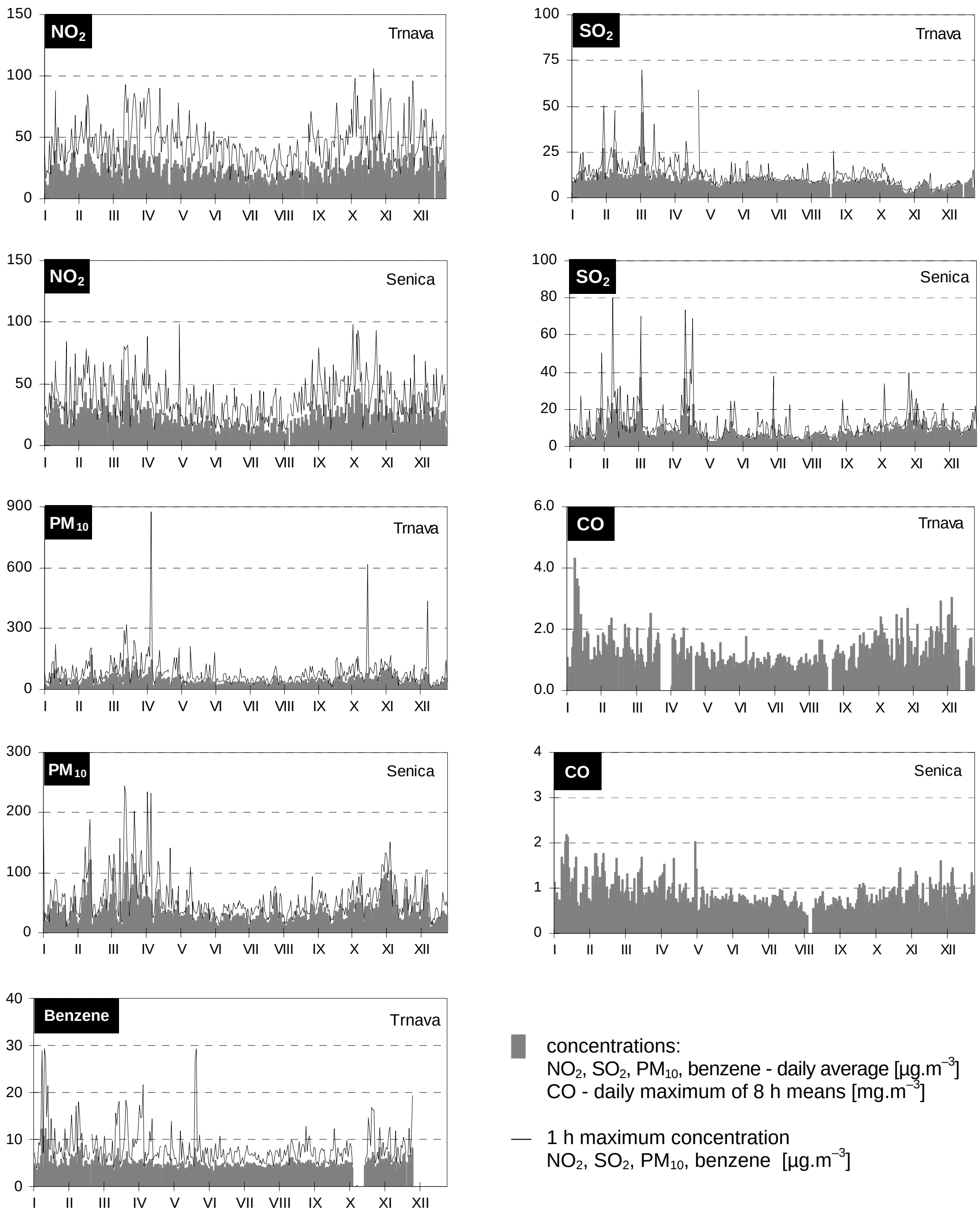
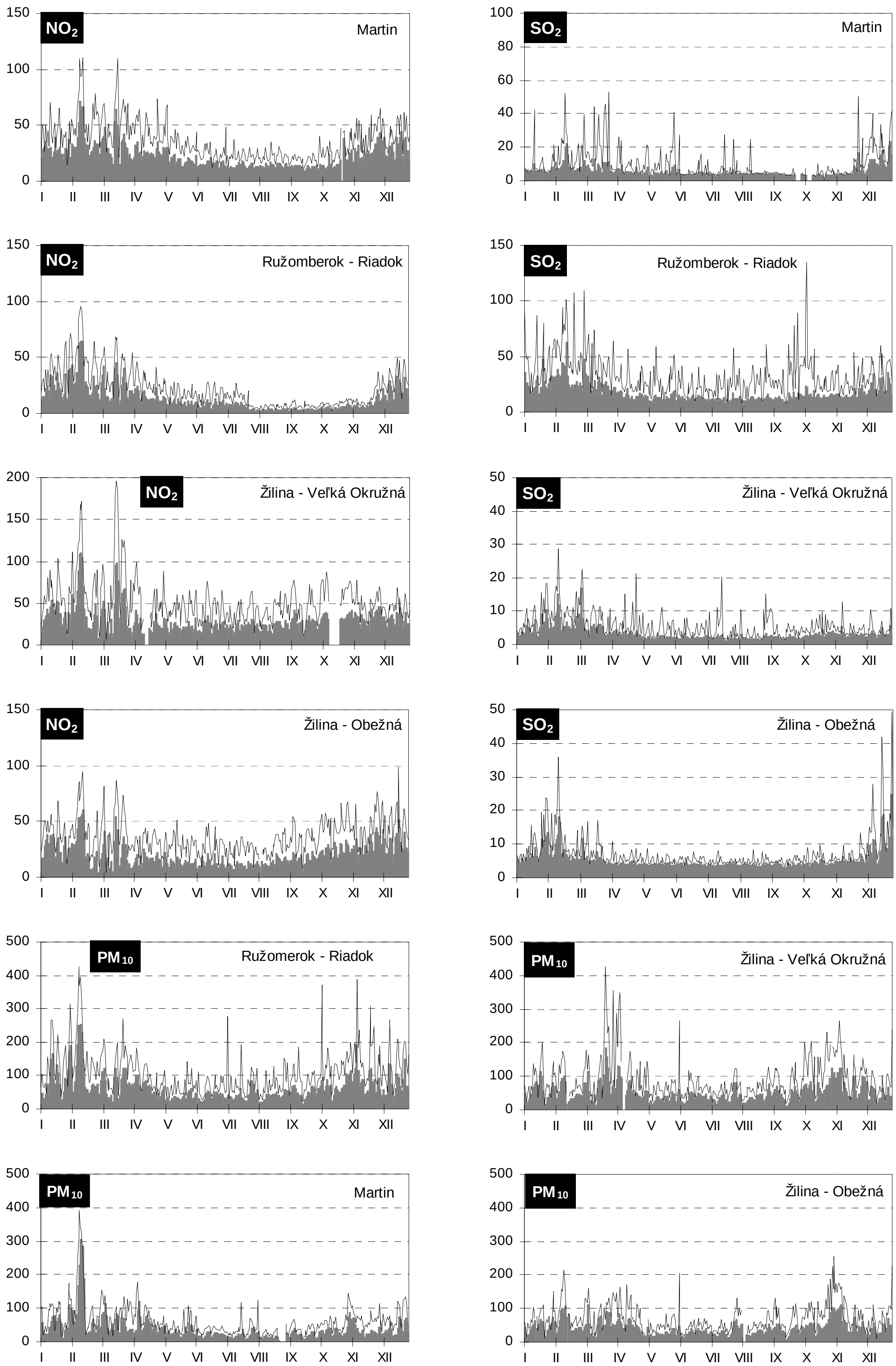


Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and H_2S – zone Žilina region – 2005**



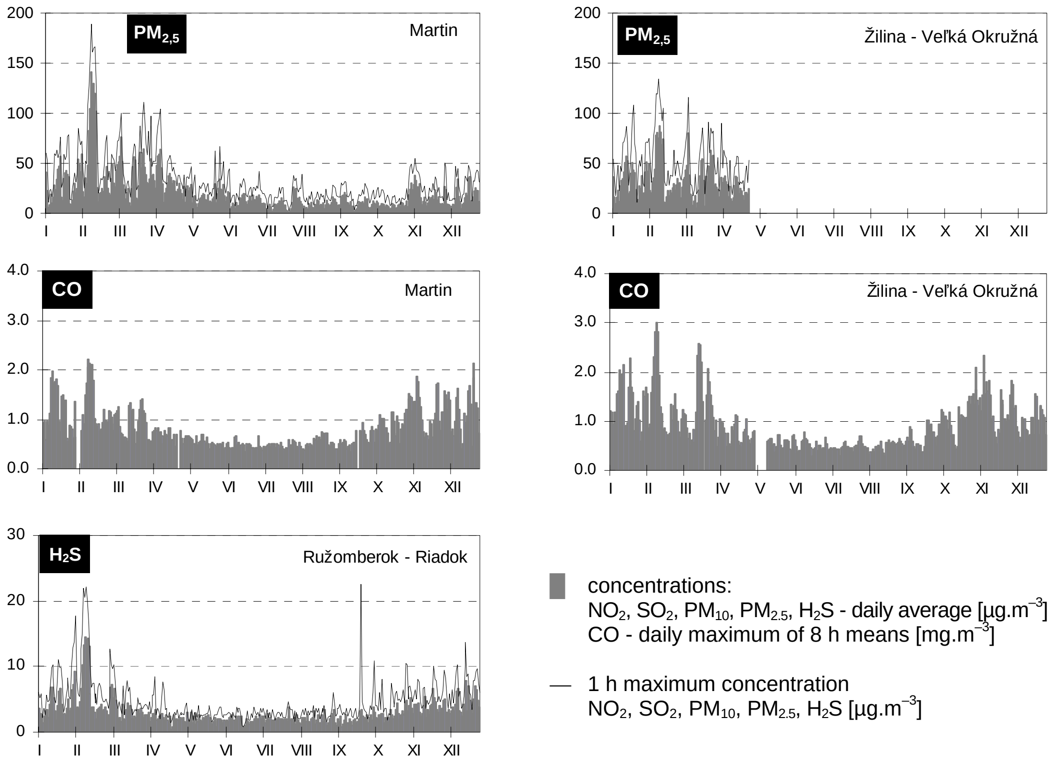
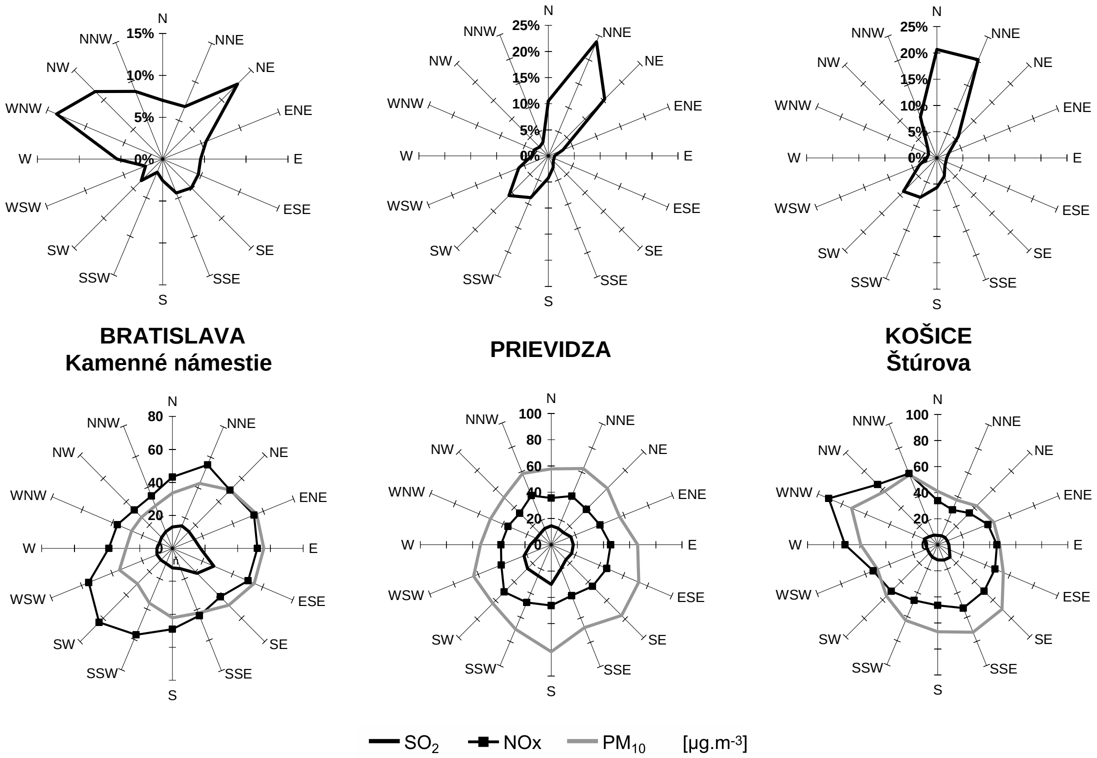


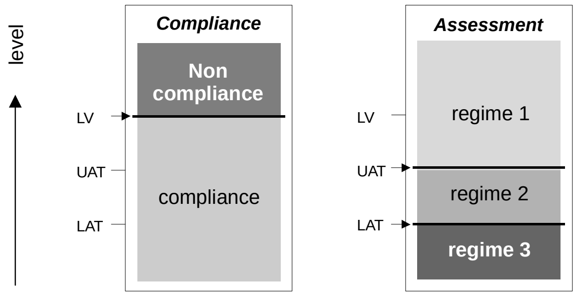
Fig. 2.10 **Wind and concentration roses – 2005**



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 picture 2.11, and in table 2.2 are specified requirements for air quality assessment for specific regimes.

Fig. 2.11 **Regimes of air quality assessment in relation to LV[1], UAT[2] a LAT[3]**



Tab. 2.2 **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

For several pollutants the margins of tolerance (MoT) were set up, table 2.4. 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(2005) the later are marked as **limit values 2005** in the following text**.** Limit values, upper and lower assessment thresholds defined in Decree No 705/2002 about Air Quality are presented in tables 2.3 and 2.4. 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 concentrations during 3 hours are above:

- SO_2 - 500 μg.m^{-3}
- NO_2 - 400 μg.m^{-3}

These limit values are assumed to be exceeded if the polluted area is larger than 100 km^2 or represent the whole zone. The stringer criteria is taken into account.

Results from continuous measurements are presented in graphical and tabular form. Concentration of benzene from passive samplers, which were carried out irregularly during two week periods can not be presented in similar form as continuously ones. For illustration purposes the concentrations and wind roses were evaluated for one station from west, middle and east part of Slovakia (Fig. 2.10).

Statistical characteristics were processed for all monitoring stations in Slovakia. The stations, where the limit values and limit values 2005 were exceeded, are highlighted in tables in bold (Tables 2.5–2.6).

In the year 2005 none of the alert threshold and warning limit values for SO_2 and NO_2 was exceeded.

Sulphur dioxide In the year 2005 in none agglomeration or zone the hourly or daily limit values were not exceeded in more cases than it is allowed. Contrary to the previous years none exccedances of alert thresholds occurred.

Nitrogen dioxide In the year 2005 there was not any case of exceedance of of the hour or annual limit value.

PM_{10} In 2005 PM_{10} was monitored at 29 stations. Parallel measurements of $PM_{2.5}$ fraction were carried out at 3 stations. For this fraction no limit values have been set up till now. PM_{10} concentrations were measured by automatic analyzers and were recalculated to the reference gravimetry method. Air pollution by suspended particulates PM_{10} is presently the major problem not only in Slovakia but in most European countries. Besides of 2 stations (Bratislava-Jeséniova and Humenné-Nám. Slobody) the daily limit value was exceeded at all other stations and at 10 of them the annual limit was exceeded as well.

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.

Benzene At some locations the air pollution level was slightly above the limit value 5 μg.m^{-3} (Nitra-Štefánikova – 5.2 μg.m^{-3}), which has to be met in the year 2010.

Pb At present air pollution by lead does not represent a serious problem in the Slovak Republic and does not exceed the upper assessment threshold.

Pb At present air pollution by lead does not represent a serious problem in the Slovak Republic and does not exceed the upper assessment threshold.

As, Ni, Cd From these pollutants only the target value for arsenic was exceeded at station Krompachy-Lorenzova.

Tab. 2.3 **Limit values plus limits of tolerance for respective years**

	Interval of averaging	Limit value* [µg.m⁻³]	To be met by	Margin of tolerance	Limit value + margin of tolerance [µg.m⁻³]										
					Since 31/12/00	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SO_2	1h	350 (24)	1/1/05	150 µg.m⁻³	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	10 000 (-)	1/1/2003 (1/1/2005)		16 000	16 000	16 000	14 000	12 000	10 000					
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. 2.4 **Limit values, upper and lower assessment threshold**

	Receptor	Interval of averaging	Limit value [µg.m⁻³]	Assessment threshold [µg.m⁻³]	
				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. 2.5 **Assessment of pollution according to limit values and limit values plus margin of tolerance (MT) in 2005**

AGLOMERATION / zone		Protection of health											AT 3)	
	Component	SO_2		NO_2		NO_2+MT		PM_{10}		CO	C_6H_6 2)	C_6H_6+MT	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	1 hour	1 year	24 hour	1 year	8 hour 1	1 year	1 year	3 subsequent hour	3 subsequent hour
	Limit value [µg.m⁻³] *(number of exceedances)*	350 (24)	125 (3)	200 18	40	250 (18)	50	50 (35)	40	10000	5	10	500	400
BRATISLAVA	Bratislava, Kamenné nám.	0	0	0	31.6	0	31.6	45	29.8		1.7(11)	1.7(11)	0	0
	Bratislava, Trnavské mýto	0	0	0	37.7	0	37.7	103	41.3	2780	2.9	2.9	0	0
	Bratislava, Jeséniova *			0	14.6	0	14.6	18	28.0		1.0(11)	1.0(11)		0
	Bratislava, Mamateyova	0	0	0	27.6	0	27.6	73	37.4		2.7(11)	2.7(11)	0	0
KOŠICE	Košice, Štúrova	0	0	0	19.4	0	19.4	75	39.2	3809	2.5	2.5	0	0
	Košice, Strojárska	0	0	0	25.1	0	25.1	45	32.5	2225			0	0
Banská Bystrica region	Banská Bystrica, Nám. slobody	0	0	0	22.8	0	22.8	70	34.9	3145	C		0	0
	Jelšava, Jesenského	0	0	0	10.6	0	10.6	74	38.5				0	0
	Hnúšťa, Hlavná	0	0	0	7.3	0	7.3	88	40.6				0	0
	Žiar nad Hronom, Dukelských hrdinov	0	0	0	19.9	0	19.9	46	25.2				0	0
Bratislava region #														
Košice region	Veľká Ida, Letná	0	0	0	17.2	0	17.2	198	64.7	2799	0.3(11)	0.3(11)	0	0
	Strážske, Mierová	0	0	0	20.3	0	20.3	45	31.6		0.5(11)	0.5(11)	0	0
	Krompachy, Lorenzova	0	0	0	9.2	0	9.2	43	33.0				0	0
Nitra region	Nitra, Štefánikova	0	0	1	38.0	0	38.0	125	46.2	2766	5.2	5.2	0	0
Prešov region	Humenné, Nám. slobody	0	0	0	19.7	0	19.7	35	30.0				0	0
	Prešov, Levočská	0	0	1	22.8	0	22.8	69	38.7		2.6(11)	2.6(11)	0	0
	Prešov, Solivarská	0	0	0	17.0	0	17.0	55	32.4	1692	2.6(11)	2.6(11)	0	0
	Vranov nad Topľou, M. R. Štefánika	0	0	0	12.3	0	12.3	87	40.0				0	0
Trenčín region	Prievidza, J. Hollého	6	0	0	24.0	0	24.0	131	49.2				0	0
	Bystričany, Rozvodňa SSE	2	0	0	8.6	0	8.6	147	51.2				0	0
	Handlová, Morovianska cesta	1	1	0	15.1	0	15.1	41	30.3				0	0
	Trenčín, Hasičská *	0	0	0	37.8	0	37.8	52	42.6	2147	2.4(11)	2.4(11)	0	0
Trnava region	Senica, Hviezdoslavova	0	0	0	21.0	0	21.0	69	36.0	2192	1.5(12)	1.5(12)	0	0
	Trnava, Kollárova	0	0	0	23.0	0	23.0	112	43.3	4327	5.0	5.0	0	0
Žilina region	Martin, Jesenského	0	0	0	21.3	0	21.3	67	36.0	2216	3.2(10)	3.2(10)	0	0
	Ružomberok, Riadok	0	0	0	12.3	0	12.3	173	58.9		2.3(10)	2.3(10)	0	0
	Žilina, Veľká Okružná	0	0	0	28.1	0	28.1	126	48.2	3014			0	0
	Žilina, Obežná	0	0	0	18.5	0	18.5	85	38.7				0	0

1) *maximal 8 hour value of moving average*
2) *(X) -passive 2 week measurements*
X – number of campaigns
3) *alert threshold limit values*

* *stations Bratislava-Jeséniova a Trenčín-Hasičská measured only half year in 2005*
\# *measurements will start in 2006*
C - contamination of samples

XX,X *Annual mean is above limit value*

XXX *Number of exeedances > allowed number of exceedances*

Tab. 2.6 **Assessment of pollution according limit values, limit values plus margin of tolerance (MT) and target values in 2005**

AGGLOMERATION / zone		Protection of health				
	Component	As	Cd	Ni	Pb	Pb+MT
	Time of averaging	1 year	1 year	1 year	1 year	1 year
	Limit value [ng.m^{-3}] *Target value* [ng.m^{-3}]	*6*	*5*	*20*	500	1000
BRATISLAVA	Bratislava, Kamenné námestie	1.8	0.4	3.0	26.1	26.1
	Bratislava, Mamateyova	1.7	0.4	2.9	31.0	31.0
	Bratislava, Trnavské mýto	1.6	0.5	4.2	24.3	24.3
	Bratislava, Jeséniova	1.8	0.4	2.7	18.6	18.6
KOŠICE	Košice, Strojárska	1.8	0.8	3.3	37.2	37.2
Banská Bystrica region	Banská Bystrica, Námestie slobody	5.1	1.3	4.4	58.3	58.3
	Jelšava, Jesenského	2.8	0.6	2.2	20.0	20.0
	Žiar nad Hronom, Dukelských hrdinov	2.8	0.8	1.7	22.8	22.8
Bratislava region						
Košice region	Veľká Ida, Letná	2.6	1.9	2.3	67.3	67.3
	Krompachy, Lorenzova	6.4	2.7	2.8	96.9	96.9
Nitra region	Nitra Štefánikova	2.8	0.5	3.8	26.8	26.8
Prešov region	Prešov, Solivarská	1.3	0.8	2.4	23.7	23.7
	Humenné, Námestie slobody	1.3	0.6	2.5	19.2	19.2
	Vranov nad Topľou M. R. Štefánika	1.6	0.6	4.6	19.9	19.9
Trenčín region	Prievidza J. Hollého	5.6	0.5	1.4	18.9	18.9
	Trenčín, Hasičská	2.1	0.7	1.8	24.7	24.7
Trnava region	Senica, Hviezdoslavova	2.0	0.5	4.6	18.6	18.6
	Trnava, Kollárova	1.9	0.7	3.3	26.5	26.5
Žilina region	Žilina, Veľká okružná	3.9	0.8	3.4	25.3	25.3
	Martin, Jesenského	3.5	0.5	1.6	20.6	20.6
	Ružomberok, Riadok	4.0	0.5	1.5	16.9	16.9

AMBIENT AIR

ATMOSPHERIC OZONE

3

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 no trend of the average concentration level of ground level ozone in Slovakia, like as in many European countries, has been observed. In spite of considerable decrease of ozone precursor emission reduction in Slovakia and in surrounding countries during nineties the effect was not adequate. Only ozone peaks decreased significantly. It was shown the average level of ozone concentration is 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 these 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. The level of concentrations in 2005 was only slightly lower as in 2003. 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 2000–2005

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 resp. threshold values	Concentration O_3 [$\mu g.m^{-3}$]	Averaging/accumulation time
Target value for the protection of human health	120*	8 hour
Target value for the protection of vegetation AOT40**	18 000 [$\mu g.m^{-3}.h$]	1 May–31 July
Information threshold	180	1 hour
Alert threshold	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.*

Assessment of ground level ozone in Slovakia during 2000–2005

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 2005 the number of missing data did not exceed 10 % at most of the stations (Tab. 3.2). Large gaps were only at the Gánovce, Prievidza and Štrbské Pleso stations.

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

Station	2000	2001	2002	2003	2004	2005
Banská Bystrica, Nám. slobody	3.0	9.3	3.8	1.1	1.6	0.3
Bratislava, Jeséniova	5.7	4.7	3.0	2.5	2.2	5.8
Bratislava, Mamateyova	18.6	3.6	1.6	3.6	2.7	6.3
Gánovce, Meteo. st.	25.4	6.0	4.7	1.4	24.9	15.9
Hnúšťa, Jesenského	2.7	3.3	5.8	6.8	7.9	2.7
Humenné, Nám. slobody	2.7	3.0	2.5	1.9	0.3	0.3
Chopok, EMEP	30.0	66.3	6.0	45.5	9.6	1.9
Jelšava, Jesenského	20.5	1.6	8.2	4.1	0	0.3
Kojšovská hoľa	24.0	7.9	1.1	9.9	1.1	9.9
Košice, Ďumbierska	9.6	4.4	4.1	1.4	0.5	8.6
Liesek, Meteo. st., EMEP	*	*	*	*	*	29.6
Prešov, Solivarská	16.7	3.3	1.1	5.5	0.8	1.1
Prievidza, J. Hollého	10.1	13.4	10.4	2.7	2.2	13.2
Ružomberok, Riadok	7.1	7.7	1.9	2.2	17.0	0.3
Stará Lesná, AÚ SAV, EMEP	8.7	2.4	0.8	4.7	0.5	0.3
Starina, Vodná nádrž, EMEP	8.2	3.6	0.5	2.2	17.3	7.1
Štrbské Pleso, Helios	*	11.2	0.8	4.1	3.8	26.7
Topoľníky, Aszód, EMEP	10.1	25.8	1.1	1.4	3.6	6.6
Trenčín, Janka Kráľa	*	*	*	*	*	4.4
Veľká Ida, Letná	34.2	15.0	6.6	40.8	3.6	2.7
Žiar nad Hronom, Dukelských hrdinov	53.0	63.0	5.5	1.1	0.5	0.3
Žilina, Obežná	13.1	1.4	6.8	2.7	0.3	0.5

** station installed later*

Tab. 3.3 **Annual averages of ground level ozone concentration [µg.m^{-3}]**

Station	2000	2001	2002	2003	2004	2005
Banská Bystrica, Nám. slobody	41	44	39	46	42	43
Bratislava, Jeséniova	52	54	56	71	64	68
Bratislava, Mamateyova	45	40	49	53	48	53
Gánovce, Meteo. st.	**51	51	59	68	66	67
Hnúšťa, Jesenského	48	49	53	60	48	50
Humenné, Nám. slobody	48	48	56	66	58	60
Chopok, EMEP	**75	–	97	**109	91	95
Jelšava, Jesenského	47	49	48	55	51	52
Kojšovská hoľa	100	89	86	91	86	86
Košice, Ďumbierska	48	47	64	68	60	67
Liesek, Meteo. st., EMEP	*	*	*	*	*	**67
Prešov, Solivarská	49	49	45	51	42	47
Prievidza, J. Hollého	46	45	43	51	47	46
Ružomberok, Riadok	39	46	41	32	46	47
Stará Lesná, AÚ SAV, EMEP	64	58	56	67	62	70
Starina, Vodná nádrž, EMEP	63	63	64	73	66	66
Štrbské Pleso, Helios	*	75	78	86	76	**86
Topoľníky, Aszód, EMEP	52	**41	47	67	59	60
Trenčín, Janka Kráľa	*	*	*	*	*	48
Veľká Ida, Letná	**47	40	43	**31	38	36
Žiar nad Hronom, Dukelských hrdinov	–	–	50	58	55	51
Žilina, Obežná	47	38	46	48	42	41

** station installed later – station closed down, resp. long-term failure ** 50–75% of measurements*

In 2005, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 36–60 µg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 60 and 90 µg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the summit station Chopok (95 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 Veľká Ida stations) in the interval of 84–104 µg.m^{-3}. The year 2005, according to vegetation period averages, belongs to the photochemically active years.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992–2005 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 from August 2005 were below average of the whole monitoring period.

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992–2005**

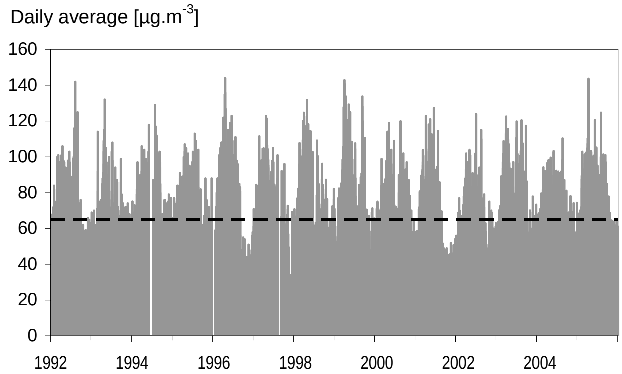
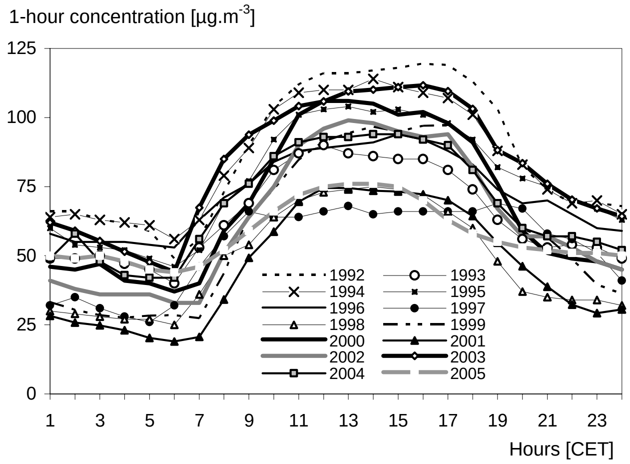


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992–2005**



The number of exceedances of ozone threshold values in Slovakia during 1999–2005 is summarised in Tables 3.4–3.6. The alert threshold when the public must be warned (240 µg.m^{-3}) was exceeded only once in 2005 (Tables 3.4). The information threshold to the public (180 µg.m^{-3}) in 2005 was exceeded at three stations, most frequent in Bratislava-Mamateyova station.

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 2003–2005. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2003–2005 was the number of 25 days overstepped at most of monitoring stations. Only three urban stations were exception. The highest exceedance was observed at Chopok station (78 days).

Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2000–2005**

Station	AT = 240 μg.m^{-3}						IT = 180 μg.m^{-3}					
	2000	2001	2002	2003	2004	2005	2000	2001	2002	2003	2004	2005
Banská Bystrica, Nám. slobody	0	0	0	0	0	0	0	0	0	0	0	0
Bratislava, Jeséniova	*	0	0	3	0	0	2	6	0	42	0	6
Bratislava, Mamateyova	0	0	0	3	0	0	6	3	0	32	0	8
Gánovce, Meteo. st.	*	0	0	0	0	0	0	0	0	0	0	0
Hnúšťa, Jesenského	0	0	0	0	0	0	0	0	2	0	0	0
Humenné, Nám. slobody	0	0	0	0	0	0	0	0	0	0	0	0
Chopok, EMEP	0	0	0	0	0	0	0	0	2	3	1	0
Jelšava, Jesenského	0	0	0	0	0	0	0	0	0	5	0	0
Kojšovská hoľa	*	0	0	0	0	1	45	0	0	0	0	2
Košice, Ďumbierska	0	0	0	0	0	0	2	0	0	0	2	0
Liesek, Meteo. st., EMEP	*	*	*	*	*	0	*	*	*	*	*	0
Prešov, Solivarská	0	0	0	0	0	0	23	0	0	7	0	0
Prievidza, J. Hollého	0	0	0	0	0	0	0	0	0	0	0	0
Ružomberok, Riadok	0	0	0	0	0	0	0	0	0	0	0	0
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Štrbské Pleso, Helios	*	*	0	0	0	0	*	0	0	0	0	0
Topoľníky, Aszód, EMEP	0	0	0	0	0	0	23	0	0	18	0	0
Trenčín, Janka Kráľa	*	*	*	*	*	0	*	*	*	*	*	0
Veľká Ida, Letná	0	0	0	0	0	0	2	0	0	0	0	0
Žiar nad Hronom, Dukelských hrdinov	0	0	0	0	0	0	5	0	0	0	0	0
Žilina, Obežná	0	0	0	0	0	0	0	0	0	0	0	0

* *station installed later*

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2003–2005**

Station	2003	2004	2005	Average 2003–2005
Banská Bystrica, Nám. slobody	49	11	28	29
Bratislava, Jeséniova	78	28	52	53
Bratislava, Mamateyova	52	15	42	36
Gánovce, Meteo. st.	54	7	21	30
Hnúšťa, Jesenského	72	10	19	34
Humenné, Nám. slobody	69	10	41	40
Chopok, EMEP	100	58	77	78
Jelšava, Jesenského	65	12	13	30
Kojšovská hoľa	96	42	59	66
Košice, Ďumbierska	65	20	33	39
Liesek, Meteo. st., EMEP	*	*	35	
Prešov, Solivarská	56	3	18	26
Prievidza, J. Hollého	33	7	12	17
Ružomberok, Riadok	8	1	23	11
Stará Lesná, AÚ SAV, EMEP	42	8	30	27
Starina, Vodná nádrž, EMEP	70	12	39	40
Štrbské Pleso, Helios	67	6	27	33
Topoľníky, Aszód, EMEP	102	27	47	59
Trenčín, Janka Kráľa	*	*	22	
Veľká Ida, Letná	0	0	4	1
Žiar nad Hronom, Dukelských hrdinov	66	23	39	43
Žilina, Obežná	57	7	19	28

* *station installed later*

Table 3.6 shows AOT40 values corrected on the missing data (ANNEX III, Directive 2002/3/EC). 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 target value averaged over five years was overstepped at all urban background and regional background stations.

Tab. 3.6 **AOT40 [μg.m^{-3}.h] (target value for the protection of vegetation is 18 000 μg.m^{-3}.h averaged over five years)**

Station	2003	2004	2005	Average 2001–2005
Banská Bystrica, Nám. slobody	24179	12927	22479	19512
Bratislava, Jeséniova	32087	15411	26278	22158
Bratislava, Mamateyova	21003	12608	23398	16975
Gánovce, Meteo. st.	24298	12232	20565	19283
Hnúšťa, Jesenského	28133	13058	14984	19437
Humenné, Nám. slobody	26022	14808	21575	17061
Chopok, EMEP	36501	27275	30514	31739
Jelšava, Jesenského	27111	13827	17543	19758
Kojšovská hoľa	36150	21513	23565	25157
Košice, Ďumbierska	25597	15831	20028	19770
Liesek, Meteo. st., EMEP	*	*	19712	
Prešov, Solivarská	28739	8964	14977	16092
Prievidza, J. Hollého	19341	10100	15948	13039
Ružomberok, Riadok	7754	7788	17764	11348
Stará Lesná, AÚ SAV, EMEP	16956	12156	19123	16586
Starina, Vodná nádrž, EMEP	27007	16589	15209	17180
Štrbské Pleso, Helios	31579	13365	21135	25974
Topoľníky, Aszód, EMEP	35220	17497	23065	19748
Trenčín, Janka Kráľa	*	*	16417	
Veľká Ida, Letná	5152	3793	6656	8165
Žiar nad Hronom, Dukelských hrdinov	26607	16698	21642	20160
Žilina, Obežná	23365	9436	15069	15804

* *station installed later*

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 Gothenburg 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 ground level ozone over Slovakia is mostly of advective origin. This conclusion 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 indicators in Slovakia in 2005 was in average close below the 2003 level.

3.3 TOTAL ATMOSFERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2005

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 (SHMI) 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 SHMI Centre of Aerology and Ozone Measurements has been providing 24 hour UV Index forecast for the public. During the period March 15–September 30 predicted UV Index daily course for clear day, half covered sky and overcast is presented on the SHMI Web site: (www.shmu.sk/ozon/).

The annual mean of the total atmospheric ozone was 330.3 Dobson Units in 2005. This is 2.3 % below the long-term average (calculated upon the Hradec Králové measurements in the period 1962–1990). The ozone layer state was more favourable comparing with the situation in 2004, when the deficiency was 4.1 %. Since 1994 it has been the fourth highest annual mean.

Total ozone statistics for the year 2005 (daily means, relative deviations from long term averages, monthly means, standard deviations and extremes) are in Table 3.7.

The monthly means above an average were observed in February, November and December. Average ozone deficiencies in the other months were from 1 to 7 %. The most significant negative monthly deficiency –7 % was in May. During that month Brewer instrument took part in the international comparison and calibration in Hradec Králové and 6 days of measurements are missing. Analysis of the ozone layer state during the instrument absence at the Poprad-Gánovce station confirmed that May was a month with the most attenuated ozone layer over our territory.

Tab. 3.7 **Total atmospheric ozone [DU] in 2005 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	290	–11	369	3	350	–8	388	0	341	–10	354	–3	330	–5	311	–6	284	–9	315	8	247	–14	289	–2
2	274	–16	340	–5	340	–10	391	1	321	–16	360	–1	349	0	300	–9	290	–7	295	1	262	–9	306	3
3	307	–6	299	–17	397	5	385	0	310	–18	350	–4	350	1	302	–8	293	–6	275	–5	274	–4	334	12
4	280	–15	318	–12	479	26	366	–5	343	–10	340	–7	330	–5	317	–4	297	–4	281	–3	261	–9	318	6
5	246	–25	321	–11	436	15	369	–4	364	–4	384	6	317	–8	322	–2	300	–3	283	–2	259	–9	318	6
6	302	–9	323	–11	473	25	369	–5	389	3	367	1	374	8	316	–4	303	–2	276	–4	282	–1	322	7
7	277	–16	361	–1	437	15	352	–9	394	4	380	5	343	–1	319	–3	302	–2	275	–5	266	–7	319	6
8	264	–21	371	2	417	10	388	0	406	7	380	5	337	–2	361	10	302	–2	280	–3	265	–7	304	1
9	322	–3	384	5	396	4	362	–6	412	9	376	4	334	–3	350	7	298	–3	285	–1	259	–10	315	4
10	249	–26	384	5	422	11	383	–1	389	3	383	6	374	9	321	–2	284	–7	283	–2	242	–16	309	2
11	277	–18	339	–8	413	8	346	–11	404	8	349	–3	359	5	311	–5	294	–4	280	–3	262	–9	295	–3
12	323	–4	312	–15	394	3	335	–13	400	7	362	1	329	–4	300	–8	286	–6	294	2	273	–5	296	–3
13	322	–5	422	14	390	2	354	–8	367	–2	350	–3	327	–4	309	–5	299	–1	306	6	280	–2	295	–4
14	345	2	429	16	362	–5	364	–6	345	–8	341	–5	335	–2	324	0	298	–1	301	5	289	0	296	–4
15	337	–1	423	14	357	–7	353	–9			336	–6	326	–4	315	–3	279	–7	280	–2	318	11	292	–5
16	297	–13	442	19	338	–11	380	–2			330	–8	328	–3	332	3	268	–11	295	3	271	–6	317	2
17	340	–1	415	12	328	–14	382	–1			328	–8	333	–2	348	8	295	–2	316	10	299	3	367	18
18	346	1	393	5	305	–20	385	0			318	–11	323	–5	324	1	308	3	299	4	286	–1	345	11
19	382	11	345	–8	316	–17	392	2			320	–10	299	–12	316	–2	305	2	267	–7	347	20	340	9
20	348	1	370	–1	311	–19	401	4			318	–11	317	–6	304	–5	279	–6	269	–6	341	18	307	–2
21	434	25	389	4	324	–16	398	3	335	–10	324	–9	342	1	298	–7	271	–9	245	–15	372	28	301	–4
22	438	26	401	7	318	–17	428	11	324	–12	331	–7	332	–1	288	–10	264	–11	252	–12	333	14	350	11
23	399	14	411	9	293	–24	415	8	322	–13	341	–4	346	3	322	1	265	–10	260	–9	333	14	342	8
24	403	15	409	9	319	–17	407	6	310	–16	322	–9	353	5	322	1	271	–8	280	–2	303	4	325	2
25	447	27	373	–1	329	–14	392	2	326	–12	323	–8	326	–3	302	–5	278	–5	268	–6	320	10	348	9
26	406	15	355	–6	340	–12	398	4	318	–14	315	–10	323	–3	285	–10	280	–5	274	–4	287	–2	361	13
27	402	14	365	–3	345	–11	389	2	319	–13	321	–9	307	–8	298	–6	282	–4	264	–8	309	5	360	12
28	391	10	382	1	343	–11	413	8	307	–16	329	–6	302	–9	292	–7	270	–8	262	–8	323	10		
29	369	4			356	–8	397	4	300	–18	310	–11	295	–11	287	–9	279	–5	253	–12	321	9	327	1
30	346	–3			387	0	372	–3	307	–16	319	–9	280	–16	281	–11	307	5	232	–19	312	6		
31	298	–17			392	2			335	–8			287	–14	281	–10			247	–14			331	2
∅	337	–1	373	1	368	–4	382	–1	348	–7	342	–4	329	–3	312	–4	288	–5	277	–4	293	1	322	4
Std	57	15	38	10	49	13	21	6	36	9	23	5	22	6	19	5	13	4	20	7	32	11	22	6
Max	447	27	442	19	479	26	428	11	412	9	384	6	374	9	361	10	308	5	316	10	372	28	367	18
Min	246	–26	299	–17	293	–24	335	–13	300	–18	310	–11	280	–16	281	–11	264	–11	232	–19	242	–16	289	–5

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

Total ozone weekly averages are in Figure 3.3. The graph illustrates behaviour of the ozone layer in the year 2005 and shows significant short-term variations in total ozone amount in our geographical region.

Solar ultraviolet radiation has many biological effects. If UV exceeds some critical limits it can be very harmful. Active band 290–325 nm which is significantly influenced by the total ozone amount in the atmosphere is indicated as UV-B radiation. To calculate UV-B radiation caused a particular biological effect wavelength-depending weighting factor to the spectral irradiance is applied. To express a detrimental effect on human health CIE Erythemal action spectrum is most frequently used.

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.

Fig. 3.3 **Total Atmospheric Ozone over the Territory of Slovakia in 2005**

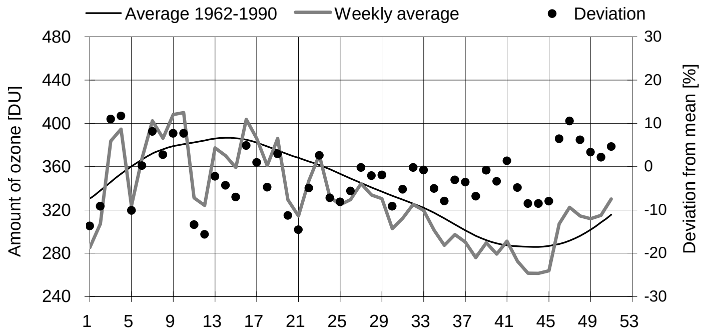


Fig. 3.4 **Annual Course of DUV (CIE) Radiation Noon Values Gánovce 2005**

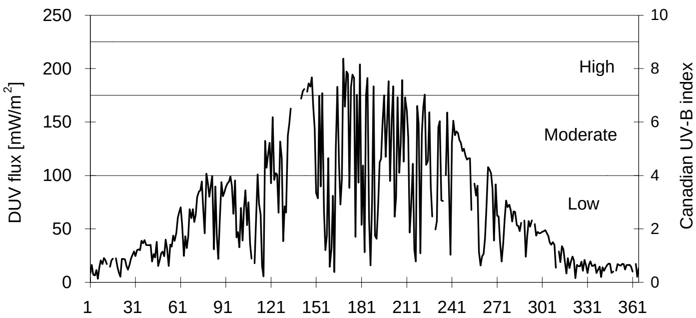
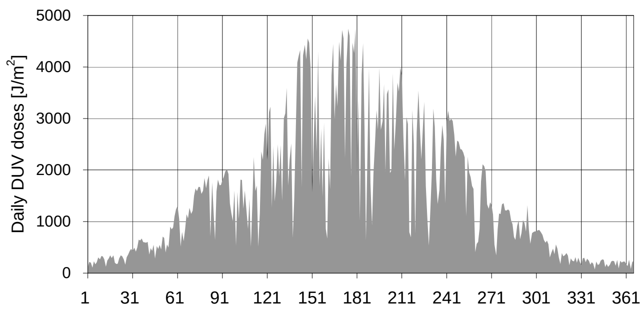


Fig. 3.5 **Annual Course of DUV (CIE) Daily Doses – Gánovce 2005**



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 has been defined for the most sensitive skin. 1 MED/hour 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 SHMI Web site.

The maximal noon value of CIE-weighted irradiance 209.2 mW/m^2 (which correspondents to 3.59 MED/hour) was measured on June 18. In that day a deficiency in total ozone of 11 % was measured.

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 4750 J/m^2 (which correspondents to 22.6 MED) was measured on June 29. In that day an ozone loss of 11 % was observed and the maximal noon value of CIE-weighted irradiance was 203.9 mW/m^2. It was the second of two values exceeding 200 W/m^2 in 2005.

Total CIE-erythemal dose for the period April–September 2005 was 440 144 J/m^2. This value is 0.2 % lower than in 2004.

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 of 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.

The NEIS system underwent extensive changes within 2004–2005 as a result of implementation of the Decree of Ministry of Environment of SR No 61/2004. In this context also the system has been renamed on National Emission Information System.

Positive contribution of NEIS

- Homogeneous system of data processing about sources and their emissions at local, regional and national level.
- Provision of an actual and effective tool to all primary data processors providing uniform level of acquisition, processing, control and verification of data about the sources and their emissions.
- Better transparency of procedure to concede the quantity of emissions by operators of the sources and thus pay taxes for air pollution owing to the built-in control system as well as 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 fulfil the tasks optimally at all levels and provides the input data for international emission inventories, respectively compilation of special emission inventories.
- Information available on the Internet website www.shmu.sk
- Establishment of archive of documents about sources of air pollution.

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 1990–2005 – evaluation

Large sources

REZZO 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.

NEIS Since 2000 the gathering of the selected data on sources and their emissions has been provided in the NEIS system. New system contained 843 large point sources from 79 the NEIS BU district databases in 2005. 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.

Middle sources

REZZO 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.

NEIS Since 2000 the data updating in the NEIS system has been provided each year. In 2005 system NEIS registered 12 082 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.

Small sources

REZZO 3 NEIS 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 revised1 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 1990–2005 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 PM, PM_{10}, $PM_{2.5}$ 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, PM_{10}, $PM_{2.5}$ emission balance from road transport are listed in Table 4.2a 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 4.1 a,b and Figure 4.1. and 4.2.

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 Ltd., Bratislava) 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, or by the quality of combustion fuel and volume of production. In 2004 and 2005 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 Ltd., Bratislava) and by the decreasing consumption of brown coal at large power sources. Increase of PM emissions in 2004 and 2005 was caused by the extended wood consumption in the sector small sources (heating households) as a result of growing price for natural gas and coal. Considerable decrease of SO_2 emission of about 77 % was observed from road transport in 2005. This decrease, contrary to the increase in consumption of propellent substances was caused by the implementation of measures referring to the content of sulphur in propellent substances (Decree No 53/2004).

[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 and 2005 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 slightly increased mainly at large sources (the amount of CO emissions specified upon the continuous measurement in U.S. Steel Ltd., Košice). The emission decrease in the sector road transport within 2004–2005 is associated with onward renovation of vehicle stock by the generational new vehicles equipped by the three-way control catalyser. In 2005 the decrease of CO emissions was recorded at large sources too, mainly as a consequence of agglomerate production cutting down in U.S. Steel Ltd., Košice and by implementation of a new technology with effective combustion at lime production (Dolvap Ltd, Varín). Emission increase of CO in 2005 in the sector small sources (heating households) is associated with the increase in consumption of wood as a consequence of price increase in natural gas and coal.

EMISSIONS OF OTHER POLLUTANTS

The Slovak Republic is bound by the Convention on Long Range Transboundary Air Pollution to provide inventory of the selected pollutants. The emission inventories of non-methane volatile organic compounds (NMVOC), heavy metals (HM), persistent organic pollutants (POPs) and particulate matter with aerodynamic diameter less than 10 or 2.5 µm (PM_{10} or $PM_{2.5}$) are processed in accordance with the international methodology in sense of the SNAP nomenclature and recommendations of TFEIP working groups. Emissions at national level are estimated in cooperation with the external experts and balanced on the base of activity data multiplied by the emission factors. Estimated emissions of pollutants mentioned above as well as the others are transformed into the international NFR system according to the requirements for reporting and annually reported to the UN ECE 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 asphalt mixture contains 5.5 % of asphalt and others is create by aggregate. 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 (Table 4.7, Figure 4.4). The NMVOC emissions increased in sector Use of paints and glues about 28 % since 2000 in consequence of increasing of industrial production especially in engineering but also increasing of print´s ink consumption and import of solvent paints.

POPs

Emission inventory of persistent organic pollutants (POPs) is processed 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 POPs emissions to the air is the most remarkable at the PAHs emissions in the 90-ties, when it was caused mostly by change of technology of aluminium production (use of pre-baked anodes) (Table 4.8, Figure 4.5). Increased emissions of PCB were influenced by the increased consumption in crude oil in the road transport and wood in residental sector. Increased consumption of wood in this sector influenced also total emission of PAHs. Emissions of PCDD/F have declined since 2000 because of reconstruction of some technologies (for example municipal waste incineration).

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 (Table 4.10, Figure 4.7) since 1996. The Pb emissions increased about 33 % since 2003 in consequence of increasing of production in sector Ore agglomeration and Copper production.

PM_{10}, $PM_{2.5}$

Emission of $PM_{10,}$ $PM_{2.5}$ are processed annually on the base of requirements of UN ECE TF on Emission Inventory, starting from the base year 2000. Emission of $PM_{10,}$ $PM_{2.5}$ are elaborated from amount of TSP according to methodology US EPA AP 42, Polish methodology and the results of project CEPMEIP, which give exhaust emissions from the petrol engines and abrasion, while other emissions of road transportation are calculated by COPERT III. The most important contribution to emissions of $PM_{10,}$ $PM_{2.5}$ in the sector of road transport is from diesel engines, the contribution of abrasion to emission of $PM_{10,}$ $PM_{2.5}$ is less important than in total PM. (Table 4.2 a, b). The most important contribution to total emissions of $PM_{10,}$ $PM_{2.5}$ has residential sector, increased emissions in this sector are caused by the increased consumption in wood as a consequence of increased price of natural gas and coal. (Table 4.9, Figure 4.6).

Share of individual sectors in total emissions of the Slovak Republic in the year 2005

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 emissions 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 2005

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 76.98 to 94.92 %. Table 4.5 lists top ten sources in administrative region according to the amount of emissions.

Specific territorial emissions in the year 2005

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: 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. 4.1a **Emissions of basic pollutants [thous. t] in SR within 1990–1999**

		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	14.489
	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	173.265
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. 4.1b **Emissions of basic pollutants [thous. t] in SR within 2000–2005**

			2000	2001	2002	2003	2004	2005
PM	**Stationary sources – NEIS**	Large sources [1]	29.923	29.722	25.037	20.166	17.670	18.719
		Middle sources [1]	4.958	4.405	3.767	3.259	2.748	2.392
		Small sources [2]	19.877	20.550	17.217	18.300	21.504	28.708
	Mobile sources	Road transport	7.648	8.567	8.866	8.910	9.480	10.689
		Other transport	0.399	0.404	0.366	0.329	0.343	0.359
	Total		62.805	63.648	55.253	50.964	51.745	60.867
SO_2	**Stationary sources – NEIS**	Large sources [1]	101.955	109.823	91.461	95.283	87.932	81.592
		Middle sources [1]	8.083	6.655	3.964	3.620	2.652	2.107
		Small sources [2]	16.055	13.764	7.127	6.384	5.382	5.073
	Mobile sources	Road transport	0.670	0.750	0.733	0.750	0.827	0.189
		Other transport	0.189	0.194	0.064	0.059	0.063	0.047
	Total		126.952	131.186	103.349	106.096	96.856	89.008
NOx	**Stationary sources – NEIS**	Large sources [1]	54.485	51.653	46.412	44.605	44.244	42.424
		Middle sources [1]	8.052	7.751	6.356	6.620	4.926	4.377
		Small sources [2]	7.993	8.391	7.137	7.356	7.582	8.866
	Mobile sources	Road transport	33.438	35.719	36.063	34.814	36.443	37.106
		Other transport	4.860	4.899	4.808	4.305	4.506	4.722
	Total		108.828	108.413	100.776	97.700	97.701	97.495
CO	**Stationary sources – NEIS**	Large sources [1]	120.609	115.177	122.225	141.047	147.317	133.787
		Middle sources [1]	10.779	10.280	9.150	9.394	7.531	5.853
		Small sources [2]	53.792	50.178	33.815	33.811	34.753	41.766
	Mobile sources	Road transport	120.190	131.954	119.757	116.050	111.602	107.122
		Other transport	1.719	1.626	1.591	1.463	1.509	1.566
	Total		307.089	309.215	286.538	301.765	302.712	290.094

[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 and 2005)
Emissions, as they were appointed to October 31, 2006

Tab. 4.2a **Emissions of PM [t] from road transport in the Slovak Republic within 1990–2005**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Emissions from diesel engine	2916	2339	2040	1889	2020	2200	2263	2292	2397	2260	1975	2167	2329	2262	2473	2461
Emissions from petrol engine	376	348	335	354	346	346	321	302	283	238	208	220	188	168	156	130
Total emissions from exhaust	3292	2687	2375	2243	2366	2546	2584	2594	2680	2498	2183	2387	2517	2430	2629	2591
Abrasion emissions	6737	5587	5102	5000	5765	5761	5897	6114	6324	5823	5465	6180	6349	6480	6852	8098
Total	10029	8274	7477	7243	8131	8307	8481	8708	9004	8321	7648	8567	8866	8910	9480	10689

Tab. 4.2b **Emissions of PM_{10} and $PM_{2.5}$ [t] from road transport in SR within 2000–2005**

	2000		2001		2002		2003		2004		2005	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Emissions from diesel engines	1975	1975	2167	2167	2329	2329	2262	2262	2473	2473	2461	2461
Emissions from petrol engines	208	208	220	220	188	188	168	168	156	156	130	130
Sum of exhaust emissions	2183	2183	2387	2387	2517	2517	2430	2430	2629	2629	2591	2591
Emissions from abrasion	437	168	497	190	514	198	526	203	560	217	669	261
Total	2620	2351	2884	2577	3031	2715	2956	2633	3189	2846	3260	2852

Emissions, as they were appointed to October 31, 2006

Fig. 4.1 Development trends in basic pollutant emissions within 1990–2005

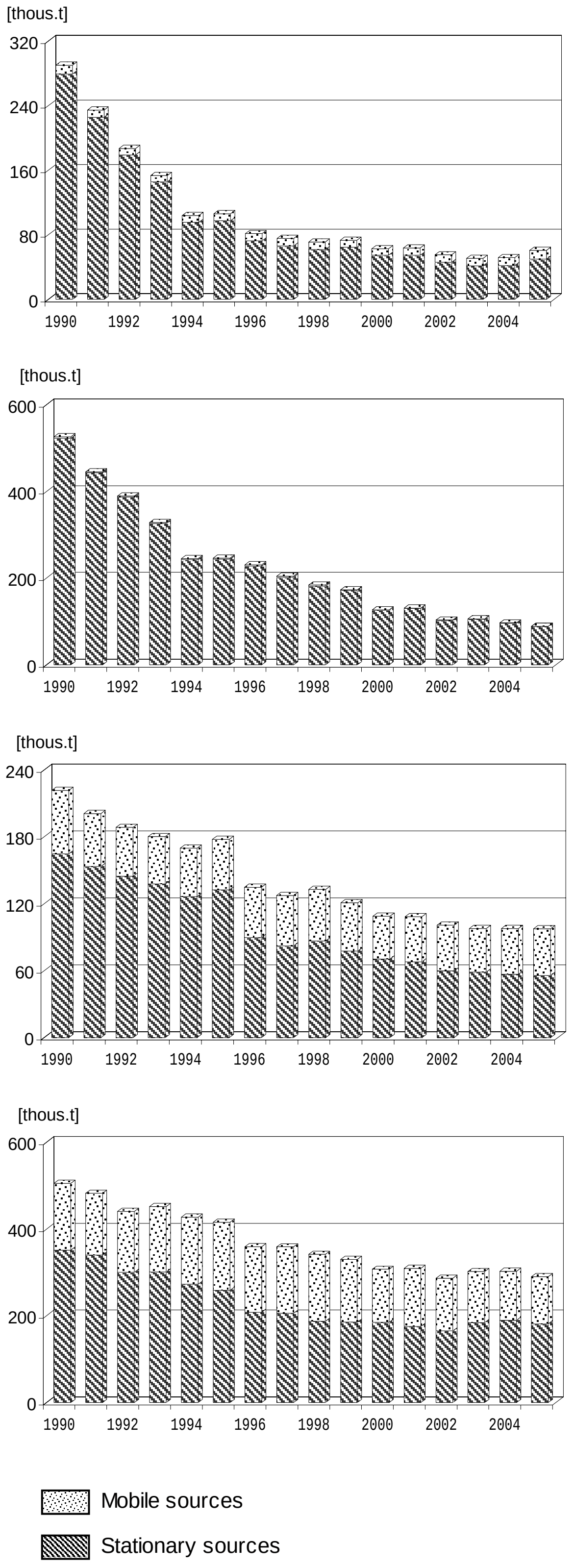
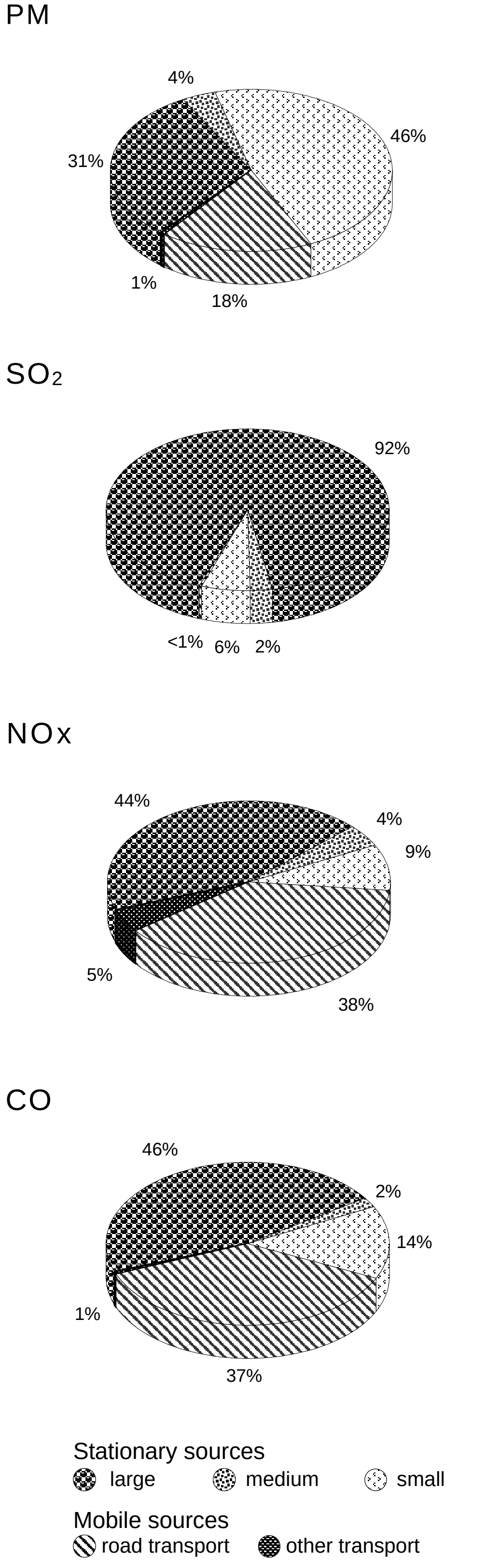


Fig. 4.2 Emissions of basic pollutants in 2005



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2000–2005**

PM		2000	2001	2002	2003	2004	2005
Agglomeration	Bratislava	942	477	444	482	467	472
	Košice	15758	17173	14601	9890	6806	4362
Zone	Bratislava region	501	546	493	465	456	506
	Trnava region	1518	1518	1284	1325	1522	1935
	Trenčín region	4607	4820	4199	4332	4804	5280
	Nitra region	3057	2921	2476	2478	2744	3414
	Žilina region	6585	6271	5298	5343	5852	7076
	Banská Bystrica region	6320	6355	5334	5346	5819	7378
	Prešov region	4207	4266	3491	3666	4588	5556
	Košice region	11262	10331	8400	8397	8864	13842
Total		54758	54677	46022	41725	41922	49820

SO_2		2000	2001	2002	2003	2004	2005
Agglomeration	Bratislava	13240	13594	11348	12263	9869	9285
	Košice	18307	12608	10500	10781	13113	12526
Zone	Bratislava region	384	380	208	150	289	377
	Trnava region	2160	2051	1166	1077	1141	1037
	Trenčín region	28625	45187	38305	46051	44108	40937
	Nitra region	4752	4749	3799	3648	2485	2336
	Žilina region	10775	10237	7140	7647	6147	5035
	Banská Bystrica region	10654	10043	8814	7983	6300	6197
	Prešov region	8372	8082	6320	6719	4864	4856
	Košice region	28825	23310	14952	8969	7650	6185
Total		126094	130242	102552	105287	95966	88772

NOx		2000	2001	2002	2003	2004	2005
Agglomeration	Bratislava	6393	5151	5313	5414	5260	4791
	Košice	12382	12172	12140	12343	11092	10929
Zone	Bratislava region	1792	1900	1972	1590	1650	1742
	Trnava region	2012	1966	1684	1670	1652	1667
	Trenčín region	9083	10489	9616	10198	9687	7822
	Nitra region	3905	3974	3843	3993	4424	3989
	Žilina region	5433	5170	4599	4483	4700	4674
	Banská Bystrica region	6541	6666	6316	5843	6146	6281
	Prešov region	3279	3443	3212	3224	3173	3459
	Košice region	19710	16864	11209	9824	8967	10314
Total		70530	67794	59905	58581	56752	55666

CO		2000	2001	2002	2003	2004	2005
Agglomeration	Bratislava	1528	1319	1264	1204	1254	1120
	Košice	84544	78619	83700	104600	107212	93197
Zone	Bratislava region	1951	1638	1488	2789	1767	1576
	Trnava region	4746	4682	3591	3397	3496	3865
	Trenčín region	11684	10334	7815	7801	8040	9331
	Nitra region	7964	7379	5470	5615	5700	6627
	Žilina region	19357	19287	16520	16459	17253	15924
	Banská Bystrica region	26309	26301	24299	25729	27834	29375
	Prešov region	12170	11838	9075	8796	8802	9282
	Košice region	14927	14237	11969	7861	8242	11109
Total		185180	175636	165191	184252	189601	181407

** 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 2005**

No	PM		SO_2		NOx		CO	
	Source	[%]	Source	[%]	Source	[%]	Source	[%]
1	SE a.s., Bratislava, Elektráreň Vojany I a II	48.18	SE a.s., Bratislava o.z., ENO Zem. Kostoľany	46.61	U.S.Steel s.r.o., Košice	18.91	U.S.Steel s.r.o., Košice	66.37
2	U.S.Steel s.r.o., Košice	18.78	U.S.Steel s.r.o., Košice	12.86	SE a.s. Bratislava, Elektráreň Vojany I a II	12.77	SLOVALCO a.s., Žiar nad Hronom	9.30
3	SE a.s., Bratislava o.z., ENO Zem. Kostoľany	4.41	SLOVNAFT a.s., Bratislava	10.85	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	8.18	DOLVAP s.r.o., Varín	2.21
4	BUKOCEL a.s., Hencovce	2.41	SE a.s. Bratislava, Elektráreň Vojany I a II	3.84	SLOVNAFT a.s., Bratislava	6.90	Slovmag a.s., Lubenik	1.84
5	Novácke chemické závo-dy a.s., Nováky	1.58	BUKOCEL a.s., Hencovce	2.98	TEKO a.s., Košice	3.25	OFZ a.s., Istebné	1.40
6	SLOVNAFT a.s., Bratislava	1.39	SIDERITs.r.o, Nižná Slaná	2.65	Holcim (Slovensko) a.s., Rohožník	2.83	Slovenské magnezitové závody a.s., Jelšava	1.28
7	Duslo a.s., Šaľa	1.06	Zvolenská teplárenská a.s., Zvolen	2.47	SPP a.s., závod Veľké Kapušany	2.63	KOVOHUTY a.s., Krompachy	1.24
8	Carmeuse Slovakia s.r.o., Vápenka Košice	0.90	Žilinská teplárenská a.s., Žilina	1.87	SPP a.s., závod Jablonov nad Turňou	2.05	Calmit s.r.o. Bratislava, záv. Margecany	1.01
9	Kronospan SK s.r.o., Prešov	0.86	TEKO a.s., Košice	1.84	SPP a.s., závod Ivanka pri Nitre	1.98	CEMMAC a. s., Horné Srnie	1.00
10	KVARTET a.s., Partizánske	0.76	SLOVALCO a.s., Žiar nad Hronom	1.57	Mondi business paper scp a.s., Ružomberok	1.86	BUKOCEL a.s. Hencovce	0.88
11	SLOVALCO a.s., Žiar nad Hronom	0.69	Martinská teplárenská a.s., Martin	1.36	SPP a.s., závod Veľké Zlievce	1.84	Považská cementáreň a.s., Ladce	0.84
12	Carmeuse Slovakia s.r.o., závod Lom Včeláre	0.60	CHEMES a.s., Humenné	1.34	Slovenské magnezitové závody a.s., Jelšava	1.84	CALMIT s.r.o. Bratislava, záv. Žírany	0.82
13	CHEMES a.s., Humenné	0.59	Duslo a.s., Šaľa	1.29	BUKOCEL a.s., Hencovce	1.73	CALMIT s.r.o. Bratislava, záv. Tisovec	0.74
14	SIDERITs.r.o., Nižná Slaná	0.58	Kappa Štúrovo a.s.	0.75	Duslo a.s., Šaľa	1.72	SIDERITs.r.o., Nižná Slaná	0.62
15	DOLVAP s.r.o., Varín	0.57	Slovenské magnezitové závody a.s., Jelšava	0.67	V.S.H. a.s., Turňa nad Bodvou	1.52	Kronospan SK s.r.o., Prešov	0.57
16	CALMIT spol. s r.o. Bratislava, záv. Žírany	0.54	ZSNP a.s., Žiar nad Hronom	0.49	Považská cementáreň a.s., Ladce	1.47	HNOJIVÁ a.s., Strážske	0.53
17	Považská cementáreň a.s., Ladce	0.53	KVARTET a.s., Partizánske	0.48	SLOVALCO a.s., Žiar nad Hronom	1.47	Holcim (Slovensko) a.s., Rohožník	0.53
18	Bučina Zvolen a.s.	0.43	Eastern Sugar Slovensko a.s., Dunajská Streda	0.36	CEMMAC a. s., Horné Srnie	1.42	SE a.s. Bratislava, Elektráreň Vojany I a II	0.51
19	Mondi business paper scp a.s., Ružomberok	0.41	Holcim (Slovensko) a.s., Rohožník	0.34	Kappa Štúrovo a.s.	1.41	SLOVNAFT a.s., Bratislava	0.43
20	TEKO a.s., Košice	0.39	Mondi business paper scp a.s., Ružomberok	0.30	Žilinská teplárenská a.s., Žilina	1.22	Wienerberger Slov.tehelne s.r.o., závod Boleráz	0.43
Total		85.67		94.92		76.98		92.55

Tab. 4.5 **Sequence of the sources within the region according to the amount of emissions – 2005**

BRATISLAVA 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 teplárenská a.s. Bratislava, Výhr. Juh	Bratislava II
5.	VOLKSWAGEN SLOVAKIA a.s., Bratislava	Bratislava IV	AG-EXPERT s.r.o., Bratislava	Bratislava I
6.	ALAS Slovakia s. r. o., kameňolom Sološnica	Malacky	PSB Nitra, kotolňa Viničné	Pezinok
7.	Bratislavská teplárenská a.s. Bratislava, Tepl. Západ	Bratislava IV	Odvoz a likvidácia odpadu a. s., Bratislava	Bratislava II
8.	Bratislavská teplárenská a.s. Bratislava, Tepláreň II	Bratislava III	Technické služby - čistenie s. r. o., Bratislava	Bratislava II
9.	AG-EXPERT s.r.o., Bratislava	Bratislava I	NAFTA a.s., Gbely	Malacky
10.	PSB Nitra, zdroj Viničné	Pezinok	PSB Bratislava, kotolňa Slovenský Grob	Pezinok
	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, Tepl. Západ	Bratislava IV	Bratislavská teplárenská a.s. Bratislava, Tepl. Západ	Bratislava IV
7.	Technické sklo a.s., Bratislava	Bratislava IV	Plastic Omnium Auto Exteriors, Lozorno	Malacky
8.	VOLKSWAGEN SLOVAKIA a.s., Bratislava	Bratislava IV	PSB Nitra, zdroj Viničné	Pezinok
9.	Swedwood Slovakia s.r.o., OZ Malacky	Malacky	VOLKSWAGEN SLOVAKIA a.s., Bratislava	Bratislava IV
10.	NAFTA a.s., Gbely	Malacky	NAFTA a.s., Gbely	Malacky

TRNAVA 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.	Slovenské cukrovary a.s., Sereď	Galanta	Slovenské cukrovary a.s., Sereď	Galanta
3.	Amylum Slovakia spol. s r. o., Boleráz	Trnava	Johns Manville Slovakia a. s., Trnava	Trnava
4.	Johns Manville Slovakia a. s., Trnava	Trnava	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
5.	Zlieváreň Trnava s. r. o.	Trnava	Slovenské elektrárne a. s., Jaslovské Bohunice	Trnava
6.	ALAS SLOVAKIA Trnava	Trnava	Mach-Trade, Sereď	Galanta
7.	ŽOS Trnava a. s.	Trnava	Baňa Záhorie, Čáry	Senica
8.	AGROPODNIK a. s., Trnava	Trnava	SH ENERGO, Senica	Senica
9.	Zentiva a.s., Hlohovec	Hlohovec	Zlieváreň Trnava s. r. o.	Trnava
10.	BELAR a.s., Dunajská Streda	Senica	SEGUM invest s.r.o., Senica	Senica
	NOx		**CO**	
	Source	District	Source	District
1.	Johns Manville Slovakia a. s., Trnava	Trnava	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
2.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Zlieváreň Trnava s. r. o	Trnava
3.	Slovenské cukrovary a.s., Sereď	Galanta	BEKAERT Hlohovec a.s.	Hlohovec
4.	Amylum Slovakia spol. s r. o., Boleráz	Trnava	Johns Manville Slovakia a. s., Trnava	Trnava
5.	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava	I.D.C. Holding a.s., Pečivárne Sereď	Galanta
6.	Swedwood Slovakia s.r.o., OZ Malacky	Trnava	Swedwood Slovakia s.r.o., OZ Malacky	Trnava
7.	Eissmann Automotive Slovensko s.r.o., Holíč	Skalica	Slovasfalt Bratislava, OS Moravský Sv. Ján	Senica
8.	Trnavská teplárenská a.s., Trnava	Trnava	Medea-S s.r.o., Sládkovičovo	Galanta
9.	SH ENERGO, Senica	Senica	Amylum Slovakia spol. s r. o., Boleráz	Trnava
10.	Mach-Trade, Sereď	Galanta	Slovenské cukrovary a.s., Sereď	Galanta

NITRA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Duslo a.s., Šaľa	Šaľa	Duslo a.s., Šaľa	Šaľa
2.	CALMIT spol. s r.o. Bratislava, prev. Žírany	Nitra	Kappa Štúrovo a.s.	Nové Zámky
3.	Kappa Štúrovo a.s.	Nové Zámky	Icopal a.s., Štúrovo	Nové Zámky
4.	SES REAL s.r.o., Tlmače	Levice	SES REAL s.r.o., Tlmače	Levice
5.	SES a.s., Tlmače	Levice	Wienerberger Slov. tehelne spol. s r. o., Zl. Moravce	Zlaté Moravce
6.	Lencos s.r.o., Levice	Levice	CALMIT spol. s r.o. Bratislava, prev. Žírany	Nitra
7.	Kameňolomy a štrkopieskovne, lom Pohranice	Nitra	PSB Nitra	Nitra
8.	ELEKTROKARBON a.s., Topoľčany	Topoľčany	Levická teplárenská spol. s r.o., Levice	Levice
9.	CERAM ČAB a.s., Čab	Nitra	KOVOTOPOĽ s.r.o., Topoľčany	Topoľčany
10	JUVA SLOVAKIA s. r.o. Svidník, prev. Zem. Olča	Komárno	ELEKTROKARBON a.s., Topoľčany	Topoľčany
	NOx		CO	
	Source	District	Source	District
1.	SPP a.s. Bratislava, závod Ivanka pri Nitre	Nitra	CALMIT spol. s r.o. Bratislava, prev. Žírany	Nitra
2.	Duslo a.s., Šaľa	Šaľa	Wienerberger Slov. tehelne spol. s r. o., Zl. Moravce	Zlaté Moravce
3.	Kappa Štúrovo a.s.	Nové Zámky	Kappa Štúrovo a.s.	Nové Zámky
4.	OPM1SR, Nitra	Nitra	Duslo a.s., Šaľa	Šaľa
5.	Nitrianska teplárenská spoločnosť, Nitra	Nitra	SES a.s., Tlmače	Levice
6.	Bytkomfort s.r.o., Nové Zámky	Nové Zámky	SPP a.s., závod Ivanka pri Nitre	Nitra
7.	DECODOM s.r.o., Topoľčany	Topoľčany	DANFOSS COMPRESSORS s.r.o., Zlaté Moravce	Zlaté Moravce
8.	COM_therm, Komárno	Komárno	Komárňanské tlačiarne s.r.o, Komárno	Komárno
9.	Fortunae, Levice	Levice	PSB Nitra	Nitra
10	Heineken Slovensko Sladovne Nitra, prev. Hurbanovo	Komárno	Eurofil drôty spol. s r.o., Nitra	Nitra

TRENČÍN REGION

	PM		SO_2	
	Source	District	Source	District
1.	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza
2.	Novácke chemické závody, a.s. Nováky	Prievidza	KVARTET a.s., Partizánske	Partizánske
3.	KVARTET a.s., Partizánske	Partizánske	HBP a.s. Banská mech. a elektrifikácia, Nováky	Prievidza
4.	Považská cementáreň a.s., Ladce	Ilava	Handlovská energetika s.r.o., Handlová	Prievidza
5.	HBP a.s. Banská mech. a elektrifikácia, Nováky	Prievidza	TEPLÁREŇ a.s., Považská Bystrica	Považská
6.	VETROPACK Nemšová s.r.o.	Trenčín	TSM Partizánske	Partizánske
7.	CEMMAC a. s., Horné Srnie	Trenčín	VETROPACK Nemšová s.r.o.	Trenčín
8.	TSM Partizánske	Partizánske	MATADOR a.s., Púchov	Púchov
9.	RONA a.s., Lednické Rovne	Púchov	ENERGOTRENS s.r.o., Trenčín	Trenčín
10.	Považský cukor a. s., Trenčianska Teplá	Trenčín	Posádková správa budov, Nové Mesto nad Váhom	Trenčín
	NOx		CO	
	Source	District	Source	District
1.	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza	CEMMAC a. s., Horné Srnie	Trenčín
2.	Považská cementáreň, a.s. Ladce	Ilava	Považská cementáreň a.s., Ladce	Ilava
3.	CEMMAC a. s., Horné Srnie	Trenčín	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza
4.	RONA a.s., Lednické Rovne	Púchov	KVARTET a.s., Partizánske	Partizánske
5.	VETROPACK Nemšová s.r.o.	Trenčín	TEPLÁREŇ a.s., Považská Bystrica	Považská
6.	MATADOR a.s., Púchov	Púchov	TERMONOVA Nová Dubnica	Ilava
7.	TEPLÁREŇ a.s., Považská Bystrica	Považská	Novácke chemické závody a.s., Nováky	Prievidza
8.	Novácke chemické závody a.s., Nováky	Prievidza	Považský cukor a. s., Trenčianska Teplá	Trenčín
9.	KVARTET a.s., Partizánske	Partizánske	HBP a.s. Banská mech. a elektrifikácia, Nováky	Prievidza
10.	TERMONOVA Nová Dubnica	Ilava	TSM Partizánske	Partizánske

BANSKÁ BYSTRICA REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom	Zvolenská teplárenská a.s., Zvolen	Zvolen
2.	Bučina Zvolen a.s.	Zvolen	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom
3.	Calmit s.r.o. Bratislava, prev. Tisovec	Rimavská Sobota	Slovenské magnezitové závody a.s., Jelšava	Revúca
4.	BUČINA DDD spol. s r.o., Zvolen	Zvolen	ZSNP a.s., Žiar nad Hronom	Žiar nad Hronom
5.	Slovenské magnezitové závody a.s., Jelšava	Revúca	Slovmag a.s., Lubenik	Revúca
6.	Slovmag a.s., Lubenik	Revúca	IZOMAT a.s., Nová Baňa	Žarnovica
7.	IZOMAT a.s., Nová Baňa	Žarnovica	Lovinit a.s., Lovinobaňa	Lučenec
8.	ZSNP a.s., Žiar nad Hronom	Žiar nad Hronom	PETROCHEMA a.s., Dubová	Brezno
9.	Zvolenská teplárenská a.s., Zvolen	Zvolen	Baňa Dolina a.s., Veľký Krtíš	Veľký Krtíš
10.	Lovinit a.s., Lovinobaňa	Lučenec	ÚS MV SR, Slovenská Ľupča	Banská Bystrica
	NOx		CO	
	Source	District	Source	District
1.	SPP, a.s., Bratislava, závod Veľké Zlievce	Veľký Krtíš	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom
2.	Slovenské magnezitové závody a.s. Jelšava	Revúca	Slovmag a.s., Lubenik	Revúca
3.	SLOVALCO, a.s. Žiar nad Hronom	Žiar nad Hronom	Slovenské magnezitové závody a.s., Jelšava	Revúca
4.	Zvolenská teplárenská a.s. Zvolen	Zvolen	Calmit s.r.o. Bratislava, prev. Tisovec	Rimavská Sobota
5.	Slovmag Lubenik Revúca	Revúca	ZSNP a.s., Žiar nad Hronom	Žiar nad Hronom
6.	ZSNP, a.s. Žiar nad Hronom	Žiar nad Hronom	IZOMAT a.s., Nová Baňa	Žarnovica
7.	SLOVGLASS, a. s. Poltár	Poltár	Železiarne Podbrezová a.s.	Brezno
8.	BUČINA DDD, spol. s r.o. Zvolen	Zvolen	INTOCAST Magnezit Hačava a.s., Hnúšťa	Rimavská Sobota
9.	Železiarne Podbrezová a.s.	Brezno	BUČINA DDD spol. s r.o., Zvolen	Zvolen
10.	Bučina Zvolen a.s.	Zvolen	Ipeľské tehelne a.s., Poltár	Poltár

ŽILINA REGION

	PM		SO_2	
	Source	District	Source	District
1.	DOLVAP s.r.o., Varín	Žilina	ŽILINSKÁ TEPLÁRENSKÁ a.s., Žilina	Žilina
2.	Mondi business paper scp a.s., Ružomberok	Ružomberok	Martinská teplárenská a.s., Martin	Martin
3.	ŽILINSKÁ TEPLÁRENSKÁ a.s., Žilina	Žilina	Mondi business paper scp a.s., Ružomberok	Ružomberok
4.	SOTE Čadca	Čadca	SOTE Čadca	Čadca
5.	Automobilová výroba Čadca	Čadca	Wienerberger-Slov. tehelne spol. s r.o., Ružomberok	Ružomberok
6.	Rettenmeier Tatra Timber s.r.o., Liptovský Hrádok	Liptovský Mikuláš	Rettenmeier Tatra Timber s.r.o., Liptovský Hrádok	Liptovský Mikuláš
7.	Martinská teplárenská a.s., Martin	Martin	ŽOS Vrútky a.s.	Martin
8.	DOLKAM Šuja a.s., Rajec	Žilina	OFZ a.s., Istebné	Dolný Kubín
9.	TATRA nábytkáreň a.s., Martin	Martin	Automobilová výroba Čadca	Čadca
10.	OFZ a.s., Istebné	Dolný Kubín	I.TRAN s.r.o, Turzovka	Čadca
	NOx		CO	
	Source	District	Source	District
1.	Mondi business paper scp a.s., Ružomberok	Ružomberok	DOLVAP s.r.o., Varín	Žilina
2.	ŽILINSKÁ TEPLÁRENSKÁ a.s., Žilina	Žilina	OFZ a.s., Istebné	Dolný Kubín
3.	Martinská teplárenská a.s., Martin	Martin	Mondi business paper scp a.s., Ružomberok	Ružomberok
4.	OFZ a.s., Istebné	Dolný Kubín	Wienerberger-Slov. tehelne spol. s r.o., Ružomberok	Ružomberok
5.	Slovenská paroplynová spoločnosť a.s., Ružomberok	Ružomberok	ŽILINSKÁ TEPLÁRENSKÁ a.s., Žilina	Žilina
6.	SPECIALITY MINERALS SLOVAKIA, Ružomberok	Ružomberok	SOTE Čadca	Čadca
7.	Rettenmeier Tatra Timber s.r.o., Liptovský Hrádok	Liptovský Mikuláš	ŽOS Vrútky a.s.	Martin
8.	Ružomberská energetická spol. a.s., Ružomberok	Ružomberok	STP Ružomberok spol. s r.o.	Ružomberok
9.	SOTE Čadca	Čadca	CEMENTÁREŇ LIETAVSKÁ LÚČKA a.s., Žilina	Žilina
10.	ŽOS Vrútky a.s.	Martin	Cestné stavby Liptovský Mikuláš	Tvrdošín

PREŠOV 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 SK, 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	Energy Snina a.s.	Snina
5.	Energy Snina a.s.	Snina	Zeocem Bystré	Vranov n/Topľou
6.	TATRAVAGÓNKA a.s., Poprad	Poprad	TESLA Stará Ľubovňa	Stará Ľubovňa
7.	HulicLegno Export, s.r.o.	Svidník	TP real spol. s r.o., Hrabušice	Poprad
8.	TP real spol. s r.o., Hrabušice	Poprad	Zastrova a.s., Spišská Stará Ves	Kežmarok
9.	Bukoza Preglejka a.s., Hencovce	Vranov n/Topľou	SAD Poprad	Poprad
10.	BEKY a.s., Snina	Snina	Základná škola s MŠ, Nižný Slavkov	Sabinov
	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 SK s.r.o., Prešov	Prešov
3.	Kronospan SK s.r.o., Prešov	Prešov	CHEMES a.s., HUMENNÉ	Humenné
4.	Vihorlat s.r.o., Snina	Snina	Vihorlat s.r.o., Snina	Snina
5.	Energy Snina a.s.	Snina	SCOTTISH WOODLANDS SLOVAKIA s.r.o, Dlhé n/ Cirochou	Snina
6.	DALKIA POPRAD a.s., Poprad	Poprad	Energy Snina a.s.	Snina
7.	CHEMOSVIT ENERGOCHEM a.s., Svit	Poprad	ZLIEVAREŇ SVIT a.s.	Poprad
8.	BARDTERM Bardejov	Bardejov	EUROVIA - Cesty a.s., Poprad	Poprad
9.	TATRAVAGÓNKA a.s., Poprad	Poprad	Inžinierske stavby a.s. Košice, OS Veľká Lomnica	Kežmarok
10.	Sanas a.s., Sabinov	Sabinov	DALKIA POPRAD a.s., Poprad	Poprad

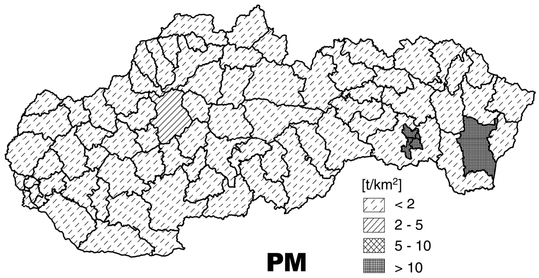
KOŠICE REGION

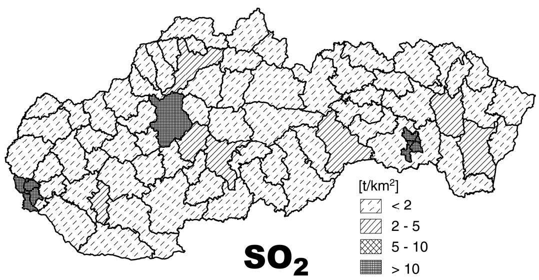
	PM		SO_2	
	Source	District	Source	District
1.	SE a.s. Bratislava, Elektráreň Vojany I a II	Michalovce	U.S.Steel Košice, s.r.o., Košice	Košice II
2.	U.S.Steel Košice, s.r.o. Košice	Košice II	SE a.s. Bratislava, Elektráreň Vojany I a II	Michalovce
3.	Carmeuse Slovakia s.r.o., závod Košice	Košice II	SIDERITs.r.o., Nižná Slaná	Rožňava
4.	Carmeuse Slovakia s.r.o., závod Lom Vcelare	Košice - okolie	TEKO a.s., Košice	Košice IV
5.	SIDERIT s.r.o., Nižná Slaná	Rožňava	KOVOHUTY a.s., Krompachy	Spišská N. Ves
6.	TEKO a.s., Košice	Košice IV	Slovenské magnezitové závody a.s., závod Bočiar	Košice II
7.	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie	KOSIT a.s., Košice	Košice IV
8.	Calmit s.r.o. Bratislava, prev. Margecany	Gelnica	Refrako s.r.o., Košice	Košice II
9.	Carmeuse Slovakia s.r.o., závod Slavec	Rožňava	Reliningserv Košice	Košice II
10.	Slovenské magnezitové závody a.s., závod Bočiar	Košice II	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie
	NOx		**CO**	
	Source	District	Source	District
1.	U.S.Steel Košice s.r.o., Košice	Košice II	U.S.Steel Košice s.r.o., Košice	Košice II
2.	SE a.s. Bratislava, Elektráreň Vojany I a II	Michalovce	KOVOHUTY a.s., Krompachy	Spišská N. Ves
3.	TEKO a.s., Košice	Košice IV	Calmit s.r.o. Bratislava, záv. Margecany	Gelnica
4.	SPP a.s., závod Veľké Kapušany	Michalovce	SIDERIT s.r.o., Nižná Slaná	Rožňava
5.	SPP a.s. Bratislava, závod Jablonov nad Turňou	Rožňava	HNOJIVÁ a.s., STRÁŽSKE	Michalovce
6.	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie	SE a.s. Bratislava, Elektráreň Vojany I a II	Michalovce
7.	Carmeuse Slovakia s.r.o., lom Vcelare	Košice II	Zlieváreň SEZ Krompachy a. s.	Spišská N. Ves
8.	Slov. magnezitové závody a.s. Jelšava, závod Bočiar	Košice II	SPP a.s., závod Veľké Kapušany	Michalovce
9.	SIDERIT s.r.o., Nižná Slaná	Rožňava	Slov. magnezitové závody a.s. Jelšava, závod Bočiar	Košice II
10.	HNOJIVÁ, a.s., STRÁŽSKE	Michalovce	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie

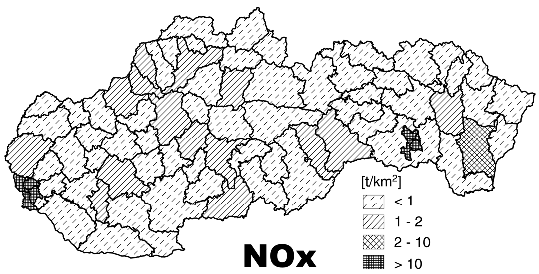
Tab. 4.6 **Stationary source emissions by districts in 2005**

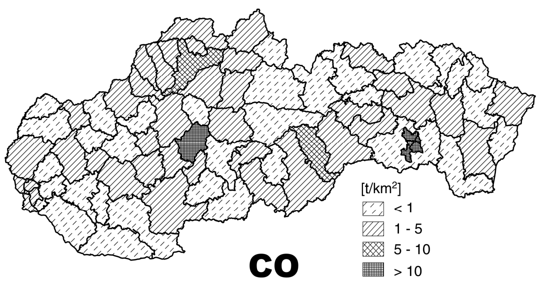
District	Emissions [t/year]				Specific territorial emis. [t/year.km²]			
	PM	SO_2	NO_x	CO	PM	SO_2	NO_x	CO
1. Bratislava	472	9285	4791	1120	1.28	25.26	13.03	3.05
2. Malacky	288	329	1537	1188	0.30	0.35	1.62	1.25
3. Pezinok	116	30	105	209	0.31	0.08	0.28	0.56
4. Senec	102	18	100	179	0.28	0.05	0.28	0.50
5. Dunajská Streda	464	375	382	619	0.43	0.35	0.36	0.58
6. Galanta	266	299	274	441	0.42	0.47	0.43	0.69
7. Hlohovec	129	24	91	315	0.48	0.09	0.34	1.18
8. Piešťany	234	42	136	360	0.61	0.11	0.36	0.94
9. Senica	345	81	164	539	0.50	0.12	0.24	0.79
10. Skalica	217	39	122	321	0.61	0.11	0.34	0.90
11. Trnava	280	177	497	1269	0.38	0.24	0.67	1.71
12. Bánovce n/B	254	45	95	384	0.55	0.10	0.20	0.83
13. Ilava	355	50	867	1649	0.99	0.14	2.42	4.60
14. Myjava	352	63	105	519	1.07	0.19	0.32	1.58
15. Nové Mesto n/V	334	62	156	513	0.58	0.11	0.27	0.88
16. Partizánske	335	524	176	588	1.11	1.74	0.58	1.95
17. Považská Bystrica	607	273	314	1142	1.31	0.59	0.68	2.47
18. Prievidza	2053	39577	4233	1644	2.14	41.24	4.41	1.71
19. Púchov	543	142	659	784	1.45	0.38	1.76	2.09
20. Trenčín	448	202	1218	2109	0.66	0.30	1.80	3.12
21. Komárno	419	76	247	672	0.38	0.07	0.22	0.61
22. Levice	1084	215	378	1660	0.70	0.14	0.24	1.07
23. Nitra	453	73	1241	1806	0.52	0.08	1.43	2.07
24. Nové Zámky	647	770	960	1051	0.48	0.57	0.71	0.78
25. Šaľa	356	1106	890	320	1.00	3.11	2.50	0.90
26. Topoľčany	209	45	168	341	0.35	0.07	0.28	0.57
27. Zlaté Moravce	244	51	105	778	0.47	0.10	0.20	1.49
28. Bytča	413	76	121	608	1.47	0.27	0.43	2.16
29. Čadca	1312	467	376	1971	1.72	0.61	0.49	2.59
30. Dolný Kubín	346	146	332	2436	0.70	0.30	0.68	4.97
31. Kysucké Nové Mesto	259	48	94	383	1.49	0.28	0.54	2.20
32. Liptovský Mikuláš	672	256	303	992	0.50	0.19	0.23	0.74
33. Martin	536	1337	589	893	0.73	1.82	0.80	1.21
34. Námestovo	1251	284	289	1771	1.81	0.41	0.42	2.56
35. Ružomberok	811	592	1502	1707	1.25	0.91	2.32	2.64
36. Turčianske Teplice	223	43	61	324	0.57	0.11	0.15	0.83
37. Tvrdošín	191	39	75	320	0.40	0.08	0.16	0.67
38. Žilina	1063	1746	933	4520	1.30	2.14	1.14	5.55
39. Banská Bystrica	615	136	350	937	0.76	0.17	0.43	1.16
40. Banská Štiavnica	266	53	71	377	0.91	0.18	0.24	1.29
41. Brezno	700	200	316	1212	0.55	0.16	0.25	0.96
42. Detva	433	102	126	654	0.96	0.23	0.28	1.46
43. Krupina	381	77	96	559	0.65	0.13	0.16	0.96
44. Lučenec	723	171	259	1053	0.88	0.21	0.31	1.28
45. Poltár	232	53	250	381	0.49	0.11	0.53	0.80
46. Revúca	601	843	1280	5086	0.82	1.15	1.75	6.96
47. Rimavská Sobota	1249	245	367	2787	0.85	0.17	0.25	1.89
48. Veľký Krtíš	534	135	1011	824	0.63	0.16	1.19	0.97
49. Zvolen	527	2169	880	702	0.69	2.86	1.16	0.93
50. Žarnovica	524	221	199	899	1.23	0.52	0.47	2.11
51. Žiar n/H	593	1791	1075	13903	1.15	3.46	2.08	26.86
52. Bardejov	426	79	159	630	0.45	0.08	0.17	0.67
53. Humenné	479	1187	587	616	0.63	1.57	0.78	0.82
54. Kežmarok	445	91	149	671	0.53	0.11	0.18	0.80
55. Levoča	224	45	74	345	0.63	0.13	0.21	0.96
56. Medzilaborce	187	34	48	270	0.44	0.08	0.11	0.63
57. Poprad	323	75	248	540	0.29	0.07	0.22	0.49
58. Prešov	666	91	522	1562	0.72	0.10	0.56	1.69
59. Sabinov	416	81	137	617	0.86	0.17	0.28	1.28
60. Snina	503	402	291	809	0.63	0.50	0.36	1.01
61. Stará Ľubovňa	555	120	159	829	0.89	0.19	0.26	1.33
62. Stropkov	149	27	46	216	0.38	0.07	0.12	0.56
63. Svidník	292	50	88	417	0.53	0.09	0.16	0.76
64. Vranov n/T	891	2574	948	1760	1.16	3.35	1.23	2.29
65. Gelnica	459	87	119	2050	0.79	0.15	0.20	3.51
66. Košice	4362	12526	10929	93197	17.97	51.60	45.02	383.89
67. Košice - okolie	978	161	982	1387	0.64	0.10	0.64	0.90
68. Michalovce	10345	3245	7497	1869	10.16	3.19	7.36	1.84
69. Rožňava	1066	2392	1284	2329	0.91	2.04	1.09	1.99
70. Sobrance	180	36	54	257	0.33	0.07	0.10	0.48
71. Spišská Nová Ves	406	189	177	2599	0.69	0.32	0.30	4.42
72. Trebišov	407	76	200	617	0.38	0.07	0.19	0.57
Slovakia	49820	88772	55666	181407	1.02	1.81	1.14	3.70

Fig. 4.3 **Specific territorial emission – 2005**







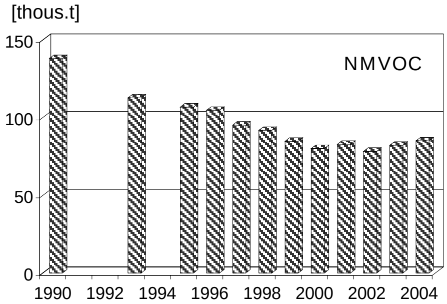


Tab. 4.7 **NMVOC emissions [t] in the Slovak Republic**

Sector / Subsector	1990	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Combustion on energy and transformation industries	335	276	258	257	247	265	228	201	221	215	214	203
Public power	223	190	187	189	182	192	166	139	159	147	161	156
District heating plants	112	85	71	68	65	73	62	62	62	67	53	47
Non-industrial combustion plants	12641	11269	9618	9750	8125	8472	8229	7927	8320	7087	7519	8943
Commercial and institutional plants	226	226	150	134	134	134	134	32	34	32	30	30
Agriculture	IE	IE	IE	IE	IE	IE	IE	14	15	15	15	14
Residential plants	12415	11043	9468	9616	7991	8338	8095	7881	8271	7040	7474	8899
Combustion in manufacturing industry	1171	1169	1083	1270	1291	993	632	868	850	685	700	1066
Comb. in boilers, gas turb. and stat. engines	206	152	150	152	144	126	124	159	231	147	169	121
Iron production	32	29	29	26	28	25	27	29	29	32	35	34
Ore aglomeration	628	500	635	582	601	443	462	679	480	421	405	716
Copper production	305	488	268	510	518	399	19	2	109	85	91	195
Production processes	28260	20029	12407	13122	12790	11411	9944	9877	9537	8933	8197	8146
Processes in petroleum industries	17188	12119	7474	8359	7717	7960	6563	6627	6306	5571	4545	4617
Coke production	1053	844	834	769	779	640	681	719	719	765	801	800
Steel production	43	35	36	31	31	32	33	34	37	40	42	41
Rolling mills	233	250	297	283	301	290	304	300	267	304	336	329
Aluminium production	0,101	0,058	0,049	0,167	0,165	0,162	0,164	0,16	0,17	0,165	0,167	0,235
Proc. in organic chemical industries	6437	3519	1369	1386	1364	870	785	651	644	690	941	970
Food production	3224	3233	2359	2252	2567	1590	1546	1538	1556	1556	1516	1373
Road paving with asphalt	82	28	37	42	30	29	31	7	8	7	16	16
Exploitation&distrib. of natural resources	8822	8868	8535	8104	9336	5854	6606	5929	6161	6024	7425	7696
Exploitation&distribution of crude oil	5198	5194	4298	4296	3803	3801	4193	3750	3848	3801	3993	4149
Distribution of fuel	3624	3674	4237	3808	5533	2053	2412	2179	2313	2223	3432	3547
Solvent and other products use	48071	38301	41166	39781	30762	32221	29429	29063	30515	30796	31568	33634
Use of paints and glues	32811	19349	20687	19122	15653	16035	14365	13214	14025	15110	16369	18457
Dry cleaning and degreasing	6650	10366	11838	12108	6498	7563	6483	7873	8021	7167	6765	6765
Processing of fat and oil	332	308	363	273	332	345	303	299	191	240	156	134
Products	8278	8278	8278	8278	8278	8278	8278	8278	8278	8278	8278	8278
Road traffic	32611	30332	32373	31235	31456	31238	28502	24479	26079	26755	25513	24224
Other traffic	953	543	599	609	584	659	571	528	524	500	460	469
Waste treatment and disposal	4538	1339	259	147	153	226	180	208	180	320	202	202
Incineration of municipal waste	102	102	102	59	77	98	95	133	93	75	132	132
Incineration of Industrial waste	157	157	157	74	67	122	79	66	81	204	52	52
Incineration of hospital waste		IE	IE	14	9	6	6	9	6	42	18	18
Agricultural waste*	4279	1080	–	–	–	–	–	–	–	–	–	
Agriculture	651	436	436	436	436	436	436	436	436	436	436	436
Total	138052	112562	106733	104710	95180	91755	84756	80116	82822	81750	82234	85021

Emissions, as they were appointed to February 15, 2006
* *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**

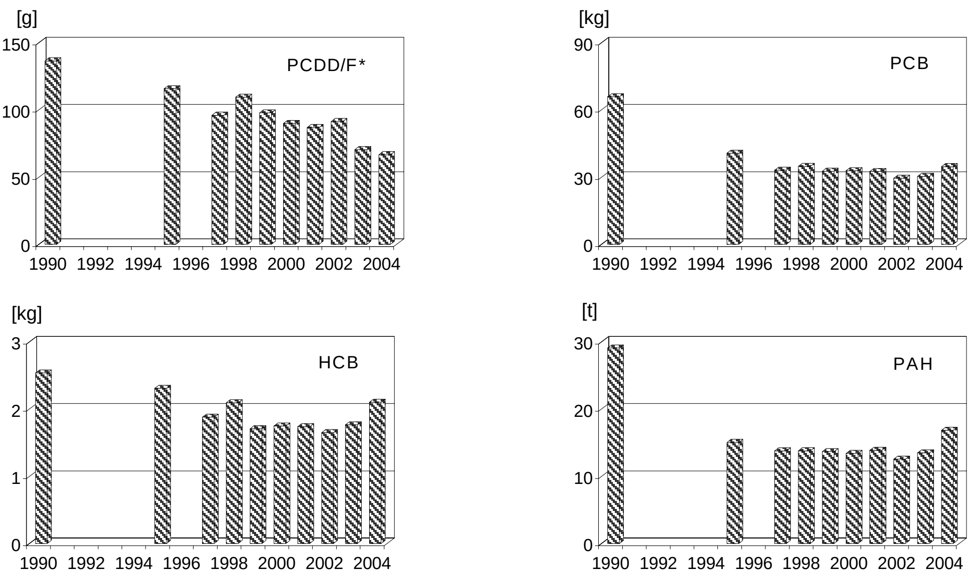


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2004**

Sector / Subsector	PCDD/F*	PCB	HCB	PAH				
				sum PAH	B(a)P	B(k)F	B(b)F	I(1,2,3-cd)P
	[g]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]
Combustion on energy and transformation industries	7.326	1.207	0.248	2173.644	751.079	444.504	444.723	533.338
Public power	1.969	1.203	0.247	0.553	0.058	0.125	0.271	0.099
District heating plants	0.025	0.004	0.001	0.212	0.021	0.043	0.115	0.034
Coke production	5.332			2172.878	751.000	444.337	444.337	533.204
Non-industrial combustion plants	4.503	11.247	0.167	12977.022	3625.763	1644.684	4774.542	2932.032
Commercial and institutional plants	0.038	0.014	0.004	0.367	0.010	0.154	0.186	0.017
Residential plants	4.456	11.228	0.163	12976.250	3625.727	1644.406	4774.143	2931.973
Agriculture	0.009	0.004	0.001	0.405	0.026	0.124	0.213	0.042
Combustion in manufacturing industry	28.216	8.005	0.661	196.699	77.760	32.449	64.870	21.620
Comb. in boilers, gas turb. and stat. eng.	0.732	0.884	0.141	30.476	1.862	9.626	15.966	3.021
Iron production	0.377	0.024		64.013	64.013			
Ore agglomeration	25.627	4.024	0.117	42.695	4.390	15.915	15.915	6.476
Cast iron production	0.088	0.017		0.014	0.003	0.005	0.005	0.002
Others	1.391	3.056	0.403	59.501	7.491	6.904	32.985	12.122
Production processes	6.123	1.942	0.292	1251.108	454.136	370.257	378.440	48.275
Aluminium production	0.969	0.161		575.988	188.273	182.011	182.011	23.692
Steel production	4.319	1.748		77.584	77.584			
Carbon mineral production				597.370	188.212	188.212	196.396	24.549
Wood impregnation				0.167	0.067	0.033	0.033	0.033
Others	0.835	0.033	0.292					
Road traffic	0.159	9.697	0.008	97.786	14.001	32.000	33.894	17.891
Other traffic	0.008	0.774	0.001	9.291	2.323	1.394	3.252	2.323
Waste treatment and disposal	20.363	1.776	0.722	120.563	33.853	23.971	49.787	12.952
Incineration of municipal waste	5.557	0.975	0.552	7.153	0.129	3.496	3.496	0.031
Incineration of industrial waste	3.974	0.530	0.159	2.059	0.037	1.007	1.007	0.009
Incineration of hospital waste	10.192	0.204	0.001	0.792	0.014	0.387	0.387	0.003
Others	0.639	0.067	0.010	110.558	33.673	19.081	44.897	12.908
Total	66.697	34.649	2.099	16826.113	4958.915	2549.260	5749.509	3568.430

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, 2006

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

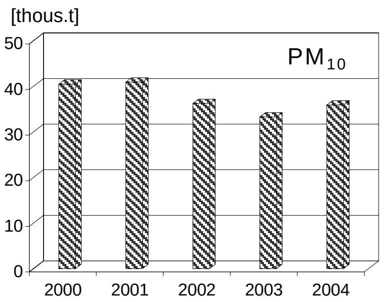


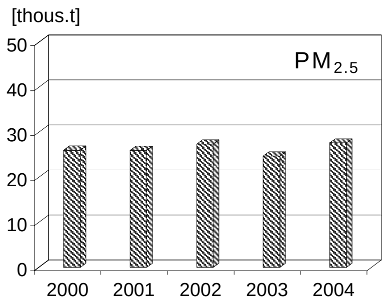
Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [thous. t] in the SR**

Sector / Subsector	2000		2001		2002		2003		2004	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Combustion processes I	5.845	2.487	5.452	2.355	4.701	1.847	5.206	2.800	5.246	2.598
Public Electricity and Heat Production	5.148	2.088	4.595	1.857	4.173	1.593	3.689	1.854	4.175	1.978
Petroleum refining	0.043	0.017	0.039	0.016	0.031	0.012	0.095	0.079	0.077	0.058
Coke production	0.653	0.382	0.818	0.483	0.498	0.242	1.422	0.867	0.995	0.562
Combustion processes II	18.325	13.589	19.021	14.802	16.347	13.676	17.368	14.773	20.435	17.994
Commercial and institutional plants	0.602	0.329	0.510	0.286	0.403	0.226	0.453	0.264	0.291	0.166
Agriculture	0.168	0.098	0.163	0.095	0.157	0.088	0.124	0.061	0.140	0.074
Residential plants	17.221	12.994	18.096	14.290	15.522	13.218	16.563	14.321	19.836	17.644
Other combustion processes	0.334	0.169	0.252	0.130	0.266	0.145	0.228	0.126	0.168	0.111
Combustion porcesses in industry	12.506	6.715	12.513	5.437	11.165	8.411	6.866	3.903	6.218	3.633
Production of iron and steel	8.743	4.329	9.141	3.196	8.105	6.347	3.953	1.982	2.676	1.324
Production of non-ferrous metals	0.132	0.107	0.169	0.126	0.147	0.106	0.128	0.100	0.133	0.110
Chemical industry	1.137	0.679	0.927	0.611	0.744	0.582	0.611	0.451	1.158	0.910
Production of paper and cellulose	0.375	0.275	0.293	0.201	0.306	0.209	0.360	0.265	0.530	0.232
Food production	0.091	0.054	0.109	0.067	0.094	0.061	0.079	0.045	0.091	0.061
Other combustion processes in industry	2.028	1.272	1.873	1.237	1.768	1.107	1.735	1.061	1.630	0.996
Transportation	2.999	2.710	3.268	2.941	3.379	3.045	3.269	2.930	3.515	3.156
Road traffic	2.620	2.351	2.884	2.577	3.031	2.715	2.957	2.633	3.189	2.846
Other traffic	0.379	0.359	0.384	0.364	0.348	0.330	0.312	0.296	0.326	0.310
Industrial technologies	0.761	0.539	0.651	0.490	0.640	0.439	0.513	0.346	0.473	0.294
Výroba minerálnych produktov	0.175	0.053	0.158	0.047	0.171	0.050	0.147	0.044	0.169	0.050
Other industrial processes	0.586	0.486	0.493	0.443	0.469	0.389	0.365	0.303	0.304	0.244
Total	40.436	26.041	40.905	26.025	36.233	27.419	33.223	24.751	35.886	27.674

Emissions, as they were appointed to February 15, 2006

Fig. 4.6 **Development tends in PM_{10} a $PM_{2.5}$ emissions**



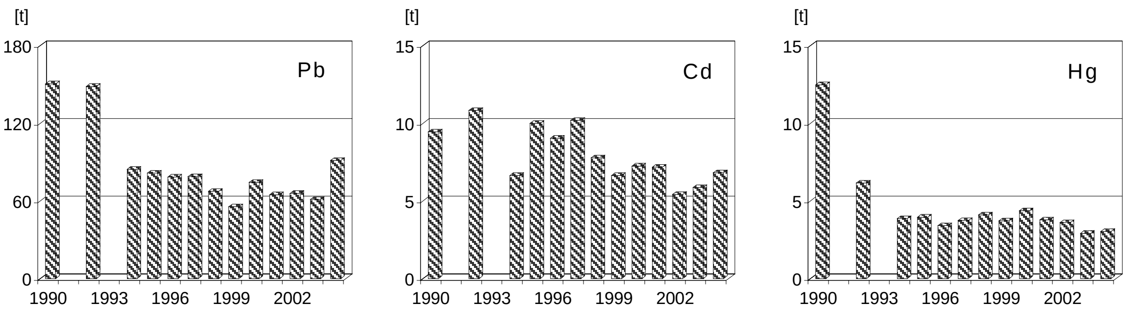


Tab. 4.10 **Emissions of heavy metals [t] in the SR in 2004**

Sector / Subsector	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn	Sn	Mn
Combustion on energy and transformation industries	0.402	0.977	0.016	0.779	0.703	0.028	0.942	0.166	0.859	0.134	4.019
Public power	0.389	0.969	0.015	0.772	0.699	0.027	0.852	0.163	0.843	0.134	4.000
District heating plants	0.013	0.008	0.001	0.007	0.004	0.001	0.090	0.002	0.016	0.000	0.018
Non-industrial combustion plants	0.904	0.859	0.027	0.332	0.408	0.027	0.383	0.036	2.631	0.066	2.824
Commercial and institutional plants	0.085	0.142	0.004	0.052	0.050	0.003	0.044	0.005	0.151	0.012	0.484
Residential plants	0.775	0.696	0.021	0.270	0.351	0.022	0.245	0.029	2.418	0.053	2.287
Agriculture	0.044	0.021	0.002	0.010	0.008	0.002	0.094	0.003	0.062	0.001	0.054
Combustion in manufacturing industry	75.545	16.163	6.056	3.262	28.726	1.961	12.920	8.456	41.842	2.611	5.956
Comb. in boilers, gas turb. and stat. engines	3.306	0.668	0.151	0.653	0.407	0.001	8.053	0.230	4.468	0.034	1.130
Iron production	0.128	0.011	0.203	0.968	0.075	0.324	3.223	0.041	8.062		
Glass production	22.340	3.810	5.574	0.640	0.160	0.013	0.506	4.798	2.932		
Ore agglomeration	44.183	0.610	0.026	0.972	14.521	1.573	1.114	2.051	23.117	1.661	4.825
Copper production	5.402	11.016	0.098		13.556	0.012		1.335	3.204	0.917	
Cement production	0.183	0.002	0.001	0.020		0.038	0.021	0.0003	0.047		
Aluminium oxide production											
Magnesite production	0.002	0.046	0.003	0.010	0.007	0.0002	0.002		0.012		
Production processes	1.667	0.088	0.038	0.962	2.813	0.462	7.867	0.014	16.237	0.046	12.752
Steel production	1.260	0.068	0.014	0.160	2.487	0.014	2.515	0.014	5.248	0.046	1.045
Aluminium production			0.016				1.569		1.569		
Ferro alloys production	0.206	0.015	0.006	0.070	0.008		0.002		1.009		11.589
Pig iron production	0.112	0.005	0.002	0.019			0.009		0.079		0.035
Galvanizing	0.082			0.713	0.246		3.772		7.134		0.082
Alloys (Cu-Zn) production	0.007				0.072				1.197		
Inorganic chemical industry						0.448					
Road traffic	1.886		0.016	0.080	2.712		0.112	0.016	1.595		
Other traffic			0.001	0.004	0.132		0.005	0.001	0.077		
Waste treatment and disposal	10.816	0.013	0.675	0.871	1.363	0.548	0.509	0.007	4.629		
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	91.219	18.100	6.827	6.290	36.857	3.026	22.739	8.694	67.871	2.857	25.550

Emissions, as they were appointed to February 15, 2006

Fig. 4.7 **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 the context of joining of the Slovak Republic the European Union (1.5.2004), raised the new requirements for legislative implementation in the field of air protection. The European Union considers the area of climate change for the one of the four environmental priorities.[2] The Slovak Republic submit the data about GHG emissions in the relevant extend to the January, 15. annually, according the Decision No 280/2004/EC of the European Parliament and of the Council concerning a Mechanism for Monitoring Community GHG emissions and for implementing the Kyoto Protocol.[3] The ground for the implementing of the Decision were the following criteria:

1. Monitoring of the all anthropogenic emissions of GHGs in the EU member states,
2. Ensure the progress in the fulfilling the reduction targets UNFCCC and the Kyoto Protocol,
3. Implement Convention and Kyoto Protocol in the view of the national programs, GHGs inventory, national system and register EU and the member states,
4. Ensure completeness, transparency, consistency, accuracy, comparability and the timing in the EC reporting.

The KP targets for the “old” EU member states represent the 8 % reduction of all GHGs against base year for the 2008–2012 period. The different emission or reduction targets were agreed for each “old” member state with the EU approval as “burden-sharing agreement” (Article 4, KP).

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[1] http://www.unfccc.de
[2] *New environmental action program: Environment 2010 Our Future, Our Choice*
[3] *OJ L 49, 19.2.2004, p. 1.*

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), 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.[4] 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.

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[4] *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.*

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 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 semiconductors, 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 "new" EU member states reduced together the GHG emissions in average about 32 % in the 1990–2004 period. The main reason for this important emission reducing is above all the strong although temporary decreasing of the economy activities, following restructuring of the economy joined with the implementing of new, more effective technologies, reducing the share of the intensive energy industry and increasing the share of services in the GDP generation. The important exception is transport (mostly road transport), with the increasing of emissions. The continuous pressure is made in the field of the formulating the effective strategy and policy for the further reducing the emissions.

The emissions of greenhouse gases 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[5], Good Practice Guidance[6] (GPG) and in the SHMÚ's reports. The Fourth National Communication of the SR on the Climate Change was submitted on December, 31. 2005 to the secretariat of the UNFCCC, completed with the Report on Demonstrable Progress to the Kyoto Protocol. The Communication is accessible on the web page www.enviro.gov.sk.

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[5] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory, Volume 1-3*

[6] *Good Practice Guidance and Uncertainty Management in National GHGs Inventories, IPCC 2000; Good Practice Guidance for LULUCF, IPCC 2003*

Total GHG emission represented 51 046.16 Gg in 2004 (without from land use, land use change and forestry (LULUCF)). This represents a reduction by 30 % (22 000 Gg) in comparison with the reference year 1990. In comparison with 2003, the emissions decreased by 1 % (50 Gg). The emissions signified in the literature as net emissions with the LULUCF in 2004 were 46 795.27 Gg. Total GHG emissions including LULUCF sector are peaked and exceeded 1998. Total GHG emissions in the Slovak Republic are stable or slightly increasing due to recovery of economic activities, increase in transport, and expected increase in actual emissions of F-gases (mainly HFCs and SF_6). Significant methodology changes and recalculations occurred in the emission inventory 2004 submitted 2006. According the recommendations of the UNFCCC Expert Review Team, the new CRFReporter software was used with the automatic generation of the reporting tables in Access software. The new reporting program was used also for recalculation the time series in the consistency way. The recalculation of the base year 1990 was needed, with the context of the Kyoto period (2008–2012). The base year was agreed by national authority (Ministry of Environment). 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[7] anthropogenic emissions of GHG [Tg] in SR in 1990–2004**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Net CO_2	58.1	48.6	44.2	41.1	39.1	41.1	42.0	43.3	41.7	41.0	38.5	38.7	36.7	37.5	38.2
CO_2*	60.5	52.1	48.4	45.4	42.4	43.8	44.4	44.7	43.6	42.6	40.9	43.9	41.9	42.4	42.5
CH_4	6.4	5.9	5.5	5.1	5.0	5.2	5.2	5.0	4.7	4.6	4.5	4.5	4.6	4.6	4.3
N_2O	6.1	5.2	4.5	3.9	4.1	4.2	4.2	4.3	3.9	3.8	3.8	4.1	3.9	4.0	4.1
HFCs, PFCs, SF_6	0.27	0.27	0.25	0.16	0.14	0.15	0.08	0.11	0.08	0.09	0.10	0.11	0.13	0.17	0.19
Total (with net CO_2)	71.0	60.0	54.5	50.3	48.4	50.7	51.5	52.6	50.5	49.5	47.0	47.3	45.3	46.3	46.8
Total*	73.4	63.5	58.6	54.6	51,7	53.4	54.0	54.0	52.4	51.2	49.4	52.5	50.5	51.1	51.0

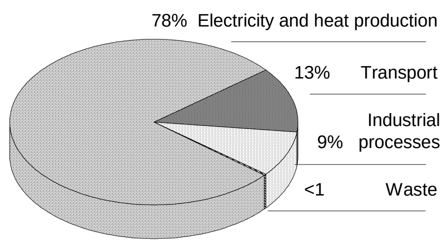
Emissions, as determinated to April 15, 2006
** GHG emissions without LULUCF*

CO_2 – carbon dioxide

Emissions

A most important anthropogenic source of CO_2 emissions in the atmosphere is combustion and transformation of fossil fuels, which account for about 90 % 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).

Fig. 5.1 **CO_2 emissions in 2004**



Total net CO_2 emissions increased moderate in 2004 by less than 1 % compared with the previous year, totally decreased by more than 30 % compared with the reference year 1990. The most feasible explanation of the significant CO_2 reduction is gradual decrease in energy demands in certain heavy energy demanding sectors (except for metallurgy) from 1993, higher share of services in the

[7] *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*

generation of the GDP, higher share of gas fuels in the primary energy resources consumption, restructuring of industries and the impact of air protection legislative measures influencing directly or indirectly the generation of greenhouse gas emissions.

At the same time, the moderate increasing trend in the CO_2 emissions is observed from 2000. This year is considered for the break year in the regeneration of the economy. It is expected the long-time increasing of the CO_2 emissions, approved by national projections.[8] 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 not only at the regional level, but it is a European problem, too.

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 1950–2004, 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). The new IPPC methodology[6] was implemented in the last inventory year for the estimation the emissions and sinks in the LULUCF sector according the good practice. According the recommendations and requirements amended in the COP7, were in the sense of the time series consistency the emissions and sinks recalculated for the 1990–2004. The changes and the base year were evaluated. Total emissions and sinks are balanced as changes in the area of the following categories: forest, cropland (arable land), grassland, wetlands, settlements and other land.

Tab. 5.2 **Total emissions and sinks of CO_2 [Gg] within 1990 and 1995–2004**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Net CO_2	58 131	41 145	41 967	43 260	41 710	40 994	38 521	38 671	36 702	37 529	38 247
CO_2*	60 537	43 841	44 389	44 662	43 649	42 630	40 924	43 896	41 945	42 362	42 498
Fossil fuel combustion	57 053	41 062	41 628	41 803	40 089	39 010	37 666	40 563	38 551	39 183	38 593
Electricity and heat prod.	51 982	36 685	37 186	37 196	35 136	34 191	33 345	35 669	33 513	34 035	33 153
Transport	5 071	4 377	4 441	4 607	4 953	4 819	4 321	4 894	5 038	5 148	5 440
Industrial processes	3 484	2 779	2 761	2 859	3 560	3 620	3 102	3 198	3 251	3 039	3 757
Mineral products	2 942	2 342	2 250	2 331	3 032	3 052	2 522	2 590	2 602	2 336	2 982
Production of metals	542	437	512	528	528	567	580	608	649	703	775
LULUCF	–2 407	–2 696	–2 422	–1 402	–1 939	–1 636	–2 403	–5 225	–5 243	–4 833	–4 251
Forest	–4 454	–4 399	–3 968	–2 717	–3 130	–2 800	–4 318	–5 551	–5 641	–5 156	–3 995
Cropland	3 287	2 063	2 063	3 226	1 798	1 711	4 394	1002	1 174	1 416	–14
Grassland	536	256	93	–50	70	–126	797	–880	–874	–1 363	–373
Other land	–1 775	–615	–609	–1861	–677	–420	–1 682	204	98	269	132
Waste	IE	IE	IE	IE	IE	IE	156	135	143	140	148
Waste incineration	IE	IE	IE	IE	IE	IE	156	135	143	140	148
Burning biomass**	314	326	316	349	303	269	263	417	508	555	582
International bunkers**	NE	38	44	39	36	37	37	35	37	48	65

Emissions, as determinated to April 15, 2006

* *CO_2 emissions without LULUCF*

** *CO_2 emissions are not being accounted into the total emissions*

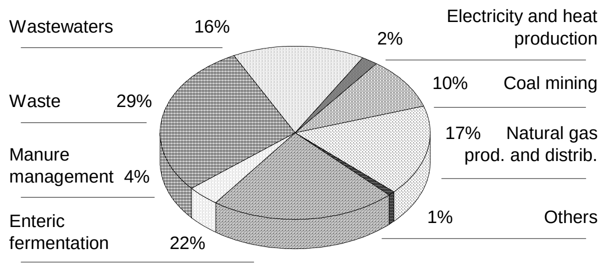
[8] *The Fourth National Communication of the SR on the Climate Change and the Report on Demonstrable Progress, December 2005*

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).

Total methane emissions reached in 2004 203.9 Gg, a decrease compared to the previous year by 7 %. However, emissions decreased by 33 % 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).

Fig. 5.2 **CH_4 emissions in 2004**



Tab. 5.3 **Total emissions of CH_4 [Gg] within 1990 and 1995–2004**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total CH_4 emissions	306.9	247.2	250.0	236.2	222.9	220.2	216.5	212.2	217.6	218.4	203.9
Energy	73.9	68.6	69.6	70.2	72.2	70.2	70.7	68.8	65.2	62.8	59.4
Fossil fuel combustion	22.3	9.8	9.8	9.6	9.1	8.7	7.8	7.6	5.7	5.7	5.3
Electricity and heat prod.	*21.3*	*8.7*	*8.6*	*8.4*	*7.8*	*7.4*	*6.7*	*6.3*	*4.5*	*4.4*	*4.0*
Transport	*1.0*	*1.1*	*1.2*	*1.2*	*1.3*	*1.3*	*1.1*	*1.3*	*1.2*	*1.3*	*1.3*
Fugitive emissions	51.7	58.8	59.8	60.6	63.2	61.5	62.9	61.2	59.4	57.0	54.1
Coal mining	*27.2*	*29.7*	*30.1*	*30.6*	*31.2*	*29.5*	*28.8*	*26.3*	*25.7*	*21.1*	*19.8*
Natural gas produc.&distrib.	*24.5*	*29.1*	*29.7*	*3.,0*	*32.0*	*32.0*	*34.1*	*34.9*	*33.7*	*35.9*	*34.3*
Agriculture	133.8	86.9	80.3	74.1	65.2	63.2	61.8	61.9	59.1	57.0	52.9
Enteric fermentation	116.3	73.6	67.7	62.5	55.0	53.3	52.3	52.4	49.4	47.8	45.1
Manure management	17.6	13.3	12.6	11.6	10.2	9.9	9.5	9.5	9.7	9.3	7.8
LULUCF	0.7	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.8
Forest	0.7	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.8
Waste	98.5	91.3	99.6	91.3	84.9	86.2	83.4	80.8	92.7	97.9	90.8
Solid waste disposal sites	50.3	50.9	59.6	51.0	45.8	46.6	48.3	45.4	57.2	65.8	58.7
Wastewaters	48.2	40.4	40.0	40.3	39.1	39.6	35.1	35.4	35.5	32.1	32.1
International bunkers *	NE	0.8	0.9	0.8	0.7	0.8	0.8	0.7	0.8	1.0	1.3

Emissions, as determinated to April 15, 2005

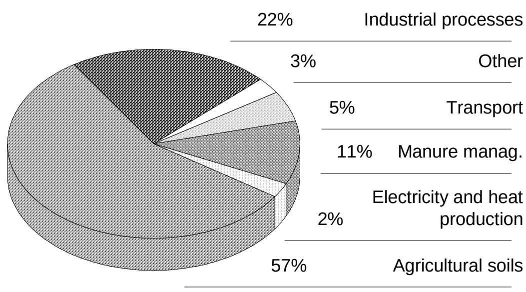
** CH_4 emissions are not being accounted into the total emissions*

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 unfavourable 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.[6] The N_2O emission, arising by manipulation of sewage and sludge has been estimated also for municipal and industrial wastewater treatment plants (Figure 5.3).

In 2004, the total N_2O emissions slightly increased compared with the year 2003 and reached 13.15 Gg. However, the drop compared to the reference year 1990 is almost 33 %. The N_2O emissions raised from 2000, continuously. 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). The higher increase of N_2O emissions is observed in waste, sector, the emissions raised about 50 % from base year. This relates to the amount of industrial wastewater treatment and detailed methodology and changes in the consideration of the waste categories. Emissions of N_2O are show the higher level of uncertainty and the time series is slightly inconsistent comparable with other gases (Table 5.4).

Fig. 5.3 **N_2O emissions in 2004**



Tab. 5.4 **Total emissions of N_2O [Gg] within 1990 and 1995–2004**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total N_2O emissions	19.76	13.49	13.69	13.77	12.88	12.38	12.34	13.08	12.54	12.88	13.15
Fossil fuel combustion	1.10	0.83	0.87	0.89	0.92	0.91	0.82	0.91	0.90	0.96	1.00
Electricity and heat prod.	0.58	0.39	0.39	0.38	0.35	0.33	0.29	0.30	0.29	0.31	0.30
Transport	0.52	0.44	0.48	0.51	0.57	0.57	0.53	0.61	0.61	0.65	0.70
Industrial processes	1.64	2.03	2.42	2.50	2.34	2.46	2.27	2.58	2.00	2.53	2.92
Chemical industry	1.64	2.03	2.42	2.50	2.34	2.46	2.27	2.58	2.00	2.53	2.92
Solvent use	NE	NE	NE	NE	0.02	0.02	0.03	0.10	0.18	0.19	0.26
Agriculture	16.94	10.57	10.35	10.33	9.55	8.95	9.16	9.42	9.33	9.09	8.86
Manure management	3.53	2.36	2.18	2.00	1.76	1.66	1.62	1.63	1.55	1.50	1.43
Agricultural soils	13.41	8.22	8.17	8.33	7.79	7.29	7.54	7.79	7.78	7.59	7.44
LULUCF	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Forest	0.01	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	0.09
Wastewaters	0.06	0.04	0.04	0.04	0.04	0.04	0.03	0.06	0.11	0.08	0.08
Waste incineration	IE	IE	IE	IE	IE	IE	0.01	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	0.18

Emissions, as determinated to April 15, 2006

** 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 the Slovak Republic. The procedure was carried out in coincidence with the methodology IPCC[5,6] and the actual and potential emissions were estimated within 1995–2004 (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 2004, 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 2003, the emissions increased by 11 %. However, compared to the reference year 1990, the decease is more than 30 %. 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 and 1995–2004**

	GWP		1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total emissions CO_2 *eq.*		[Gg]	271.40	146.38	82.85	107.09	78.64	91.48	100.69	108.08	156.29	169.42	189.64
HFCs emissions CO_2 *eq.*		[Gg]	0.00	22.15	37.58	61.13	41.00	65.19	75.79	82.81	103.10	133.16	154.43
HFC-23	11 700	[Mg]		<0.01	0.06	0.07	0.05	0.05	0.06	0.06	0.04	0.08	0.08
HFC-32	650	[Mg]			0.02	0.10	0.13	0.20	0.62	1.15	2.30	3.69	4.78
HFC-41	150												
HFC-43-10mee	1 300												
HFC-125	2 800	[Mg]		0.01	0.07	0.19	0.41	0.73	1.85	3,27	5.58	7.91	9.85
HFC-134	1 000												
HFC-134a	1 300	[Mg]		9.17	22.77	38.60	27.76	43.88	45.94	42,75	47.19	60.07	66.49
HFC-152a	140	[Mg]			<0.01	0.13	0.29	0.60	0.83	1,02	1.21	1.36	1.22
HFC-143	300												
HFC-143a	3 800	[Mg]			0.11	0.30	0.44	0.78	1.85	3,37	5.35	7..20	8.70
HFC-227ea	2 900	[Mg]		3.52	2..29	2.92	0.48	0.80	0.80	0,80	0.44	0..23	0.09
HFC-236fa	6 300								0.05	0,22	0.38	0..22	0.50
HFC-245ca	560												
PFCs emissions CO_2 *eq.*		[Gg]	271.37	114.32	34.51	34.62	25.40	13.60	11.65	11.43	11.41	20.87	19.32
CF_4	6 500	[Mg]	36.6	15.44	4.68	4.70	3.45	1.88	1.57	1.54	1.54	2.81	2.60
C_2F_6	9 200	[Mg]	3.60	1.53	0.45	0.44	0.32	0.15	0.15	0.15	0.15	0.28	0.26
C_3F_8	7 000												
C_4F_{10}	7 000												
c-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	12.69	13.25	13.84	14.78	15.39	15.89
SF_6	23 900	[Mg]	0.001	0.415	0.450	0.474	0.512	0.531	0.555	0.579	0.618	0.644	0.665

Emissions, as determinated to April 15, 2006

5.3 ASSESSMENT

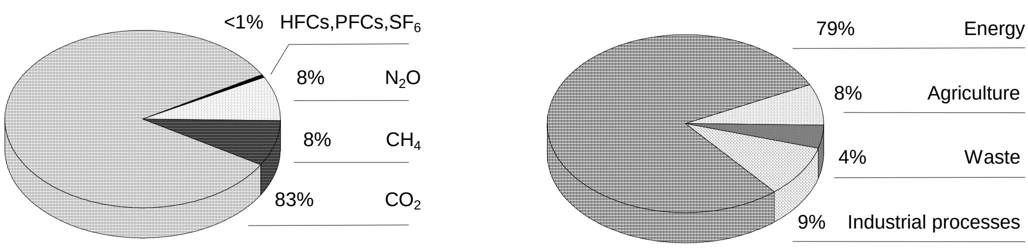
In accordance with the generally expected results, the aggregated emission of GHGs in year 2004 moderate decreased comparable to the year 2003 about more than 50 Gg without sinks from LULUCF (app. 1 %). There is the significant decreasing of aggregated emission against the base year (1990) about approximately 22 000 Gg it means the decreasing about more then 30 % without sinks A major share of aggregated emission covers the energy sector by about 80 %, the industrial processes sector covers about 10 %, the agriculture sector about 8 % and the waste sector about 4 %. The solvent use sector covers less than 1 % of the total emissions. These shares are determined as emissions in CO_2 of aggregated equivalents[7] (Table 5.6).

Tab. 5.6 **Aggregated emissions of GHGs according the sectors in CO_2 *eq*. [Tg] within 1990–2004**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Energy*	58.95	51.21	47.42	44.53	41.46	42.76	43.36	43.55	41.89	40.77	39.40	42.29	40.20	40.80	40.15
Industrial processes**	4.26	3.37	3.35	3.04	3.36	3.56	3.59	3.74	4.36	4.47	3.91	4.11	4.00	3.99	4.85
Solvent use	NE	NE	NE	NE	NE	NE	NE	NE	0.01	0.01	0.01	0.03	0.06	0.06	0.08
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	3.86
LULUCF	–2.39	–3.50	–4.14	–4.27	–3.31	–2.68	–2.41	–1.39	–1.93	–1.62	–2.39	–5.21	–5.23	–4.81	–4.23
Waste	2.09	2.03	1.99	1.91	1.92	1.93	2.11	1.93	1.80	1.82	1.92	1.86	2.13	2.22	2.08

*Emissions, as determinated to April 15, 2006 *Including transport **Including F-gases*

Fig. 5.4 **Aggregated emissions of GHGs in 2004**



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[6] estimated that the GHG emission inventory of 2004 is 9.7 % (according level assessment) and 3.6 % (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[6] method. In 2004, the Slovak Republic determined 16 key sources to be assessed according to the level and 24 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.

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).

A comparison of the GDP trend with the trend of aggregate emissions of greenhouse gasses shows that Slovak Republic is one of few countries where the trend of emissions is decoupled from the GDP increase. However, by international comparison, the generation of greenhouse gasses per capita still remains one of the highest in Europe. Without introduction of effective measures the SR will contribute to further increase of GHG emissions due to anticipated growth of the GDP and recovery of economic activities. Therefore, the investment strategy to tackle GHG emissions is one of the most important objectives.

Concerning the actual and proposed dynamics of GDP growth in the Slovak Republic there exist legitimate assumption that GHG emissions will increase in line with it. Due to this scenario there is necessary to prepare investment strategies and programmes that allow us to achieve permanent distribution of GDP growth and emissions growth with the regards to the further the post-Kyoto reduction goals.

AIR POLLUTION

IN THE SLOVAK REPUBLIC

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