Slovak Hydrometeorological Institute

Ministry of Environment of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2010

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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

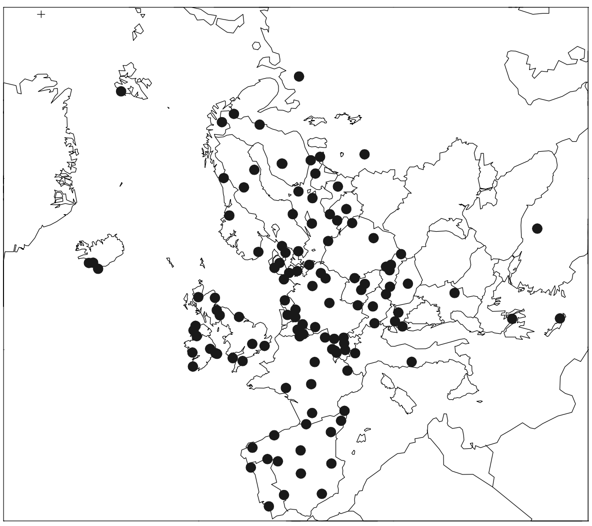
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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 72% by 2010, as compared to 1980. According to the last Protocol (Gothenburg, 1999) the Slovak Republic had to 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. For the time being three last protocols of CLRTAP undergo revision. As an addendum to the POP Protocol seven substances shall be revised and evaluate for the new or revised protocol. Concerning HM Protocol the priority remains on three main metals, cadmium, lead and mercury. The Gothenburg Protocol (1999) to abate acidification, eutrophization a ground level ozone undergoes revision and PM might be addressed either via the HM Protocol, or revised Gotheburg Protocol.

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 to 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 and four stations in the territory of Slovakia belonging to the national monitoring network of the Slovak Hydrometeorological Institute are at the same time also apart of EMEP network. The EMEP monitoring programme has been gradually extended. The monitoring of sulphur compounds and precipitation has been enhanced for oxides of nitrogen, ammonium in ambient air, particulate matter and ozone. In 1994,

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



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 into the measurement programme. In 2003 the new monitoring strategy has been adopted classifying stations into three levels (more details on www.emep.int).

1.2 EMEP STATIONS OF NATIONAL AIR QUALITY MONITORING NETWORK

In 2010, there were 4 EMEP stations of National Air Quality Monitoring Network in operation in the Slovak Republic to monitor regional air and precipitation quality. On station Bratislava-Jeséniova the same precipitation monitoring programme is running as on regional stations. Locations and elevations of the individual stations are indicated in Figure 1.2.

EMEP stations

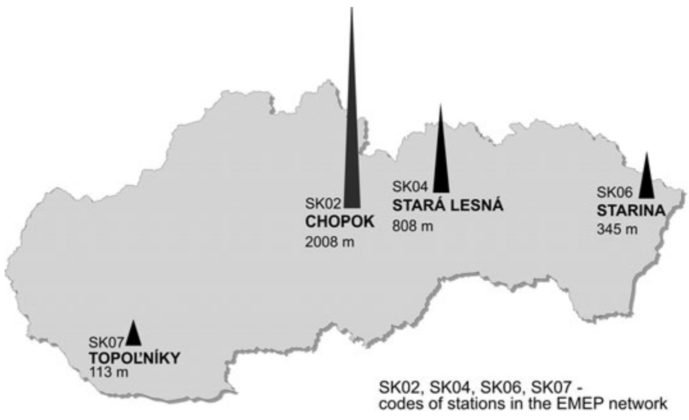
Chopok
Meteorological observatory of the Slovak Hydrometeorological Institute, located on the crest of the Low Tatras mountains, 2 008 m above sea level, 19°35'32" longitude, 48°56'38" latitude. Measurements started in 1977. Since 1978 the station has become a part of the EMEP network and GAW/BAPMoN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

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.

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 – 2010**



Measurement programme

AMBIENT AIR	Gas components	SO_2, NO_x, HNO_3, NH_3 – 24-hour sampling
		O_3 - continuous registration by analyzer
		VOCs C_2 - C_6 10-15 minute sampling 2x weekly at 12.00 noon
	Particulate matter	PM_{10} resp. TSP mass concentration – 7 day sampling interval
		Pb, Cu, Zn, Cr, Ni, Cd, As – 7 day sampling
		SO_4^{2-}, NO_3^- Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+} – 24-hour sampling
ATMOSPHERIC PRECIPITATION	Daily and weekly	pH, conductivity, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}
	Weekly and monthly	Zn, Cu, Cr, Ni, Pb, Cd, As

AMBIENT AIR		Ozone (O_3)	Sulphur dioxide (SO_2)	Oxides of nitrogen (NO_x)	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Nitric acid (HNO_3)	Ammonia, ammon. ions (NH_3, NH_4^+)	Alkali ions (K^+, Na^+, Ca^{2+}, Mg^{2+})	VOC	PM_{10}	TSP*	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
	Chopok	x	x	x	x	x	x					x	x	x	x	x	x	x	x
	Topoľníky	x									x		x	x	x	x	x	x	x
	Starina	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
	Stará Lesná	x									x		x	x	x	x	x	x	x

ATMOSPHERIC PRECIPITATION		pH	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	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Topoľníky	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Starina	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Stará Lesná	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Methods of determination

		Collection	Determination
AMBIENT AIR	**SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}**	cellulose filter W40	IC - Dionex
	NO_x	after oxidation into NaOH ab-sorption solution with guajacol	spectrophotometrically, modified Salzman method
	SO_2, HNO_3	cellulose filter W40 impregnated by KOH solution	IC - Dionex
	O_3	registration by analyzer	principle - UV absorption
	VOCs C_2 - C_6	stainless steel canister	GC and FID
	PM_{10} resp. TSP weight mass	nitrocellulose filter Sartorius	Gravimetrically
	Heavy metals - Pb, Cd, Cu, Cr, Ni, Zn, As	nitrocellulose filter Sartorius	after digestion in MW-oven by ICP-MS
PRECIP.	**pH**	"wet only" - rain gauges WADOS "bulk" - NILU sampling PE vessel	pH meter
	Conductivity		conductometer
	SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}		IC - Dionex
	Zn, Cu, Cr, Ni, Pb, Cd, As		AAS - in flame or graphite atomizer and MHS

**TSP – Total suspended particles in ambient air*

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2010

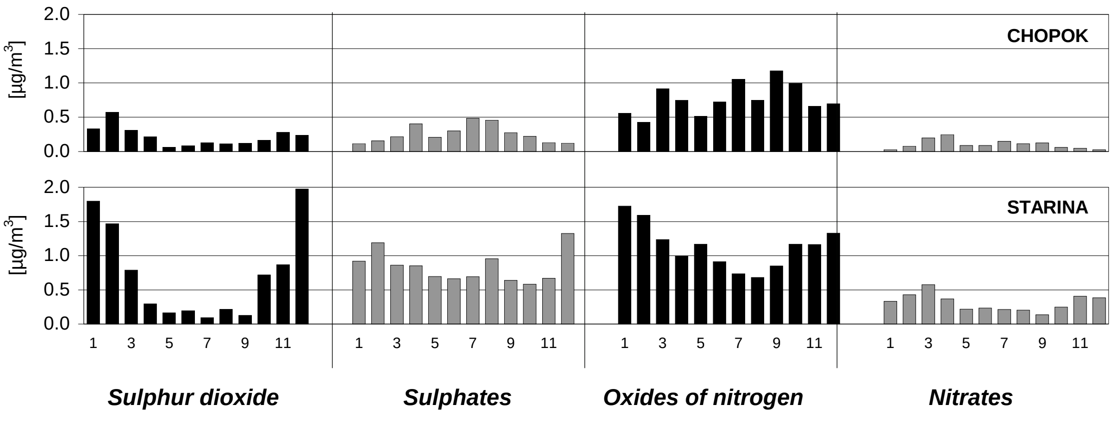
SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1, Fig. 1.3) reached 0.22 µg.m^{-3} on the Chopok station and 0.72 µg.m^{-3} on the Starina station, in 2010. ***In coincidence with the Annex 13 to the Decree of the Ministry of Environment of the Slovak Republic No 360/2010 on air quality, the critical value for protection of vegetation is 20 µg SO_2.m^{-3} in calendar year and winter season. This value has been exceeded neither at the calendar year (Chopok 0.44 µg $S0_2$.m^{-3} and Starina 1.44 µg $S0_2$.m^{-3}), nor in winter season (Chopok 0.6 $S0_2$.m^{-3} and Starina 2.0 $S0_2$.m^{-3}).*** Sulphates contributed to the total weight mass of particulate matter (Fig. 1.4) 15.54% on the Chopok station and 16.2% on the Starina station. Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represented 1.18 on the Chopok station and 1.16 on the Starina station.

NO_x, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1, Fig. 1.3) presented 0.76 µg.m^{-3}on the Chopok station and 1.13 µg.m^{-3} on the Starina station, in 2010. ***In coincidence with the Annex 13 to the Decree of the Ministry of Environment of the Slovak Republic No 360/2010 on air quality, the critical value for protection of vegetation is 30 µg NO_x.m^{-3} in calendar year. This value was not exceeded in calendar year (Chopok 2.51 µg NO_x.m^{-3} and Starina 3.72 µg NO_x.m^{3}).*** Nitrates in ambient air on the Chopok and Starina stations occurred predominantly in the form of particles in 2010. Concentrations of nitric acid were substantially lower in 2010 as compared to particulate nitrates on both stations. Both these forms of nitrogen are collected on filters separately and also measured separately and their phase division is dependent upon the ambient air temperature and humidity. Nitrates contributed to the total mass of particulate matter 9.2% on the Chopok station and 8.8% on the Starina station. Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NO_x-NO_2 recalculated in nitrogen represented the value of 0.14 at the Chopok station and 0.29 at the Starina station.

Fig. 1.3 **Monthly mean concentrations of sulpur and nitrogen compounds in ambient air – 2010**
(recalculated in sulphur, resp. nitrogen)



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 on the Stará Lesná station. These measurements were finished in September 2007. Since July 2007 the measurements started to be measured at the Starina station. Annual concentrations of the listed components (NH_3 and NH_4 recalculated in nitrogen) from the Starina station in 2010 are listed in Table 1.1. Ammonium ions in annual average 0,84 µg.m^{-3} share 7,1% of PM. Annual concentration of ammonia represents 0.27 µg.m^{-3}. Concentration ratio of ammonium ions and ammonia expressed in nitrogen is 3.1.

Tab. 1.1 **Annual averages of main components in ambient air – 2010**

	SO_2 (S) µg/m^3	SO_4^{2-} (S) µg/m^3	NO_x (N) µg/m^3	NO_3^- (N) µg/m^3	HNO_3 (N) µg/m^3	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
Chopok	0.22	0.26	0.76	0.10	0.01	-	-	-	-	-	-
Starina	0.72	0.84	1.13	0.31	0.02	0.27	0.84	0.08	0.15	0.02	0.09

	O_3 µg/m^3	PM_{10} µg/m^3	Pb ng/m^3	Cu ng/m^3	Cd ng/m^3	Ni ng/m^3	Cr ng/m^3	Zn ng/m^3	As ng/m^3
Chopok	87	*4.9	1.36	0.86	0.04	0.42	0.78	3.69	0.27
Topoľníky	55	23.8	10.34	3.34	0.28	0.69	1.01	19.68	1.20
Starina	51	15.5	5.94	1.63	0.20	0.61	0.91	11.55	0.56
Stará Lesná	67	13.2	6.37	2.30	0.18	0.44	0.73	14.51	0.65

SO_2, SO_4^{2-} – recalculated in sulphur, *NO_x, NO_3^-, HNO_3 – recalculated in nitrogen*
** TSP (Total suspended particles in ambient air)*

PM_{10}, TSP and heavy metals

In Table 1.1 are presented the concentrations of PM_{10} (Stará Lesná, Starina, Topoľníky), variating within range of 13.2 – 23.8 µg.m^{-3} and TSP 4.9 µg.m^{-3} (Chopok) in 2010. Concentrations of heavy metals from PM_{10}, resp. TSP are listed in Table 1.1 and Figure 1.4. The share of the sum of all measured metals in mass weight of suspended particles (PM_{10}, resp. TSP) varied at regional stations within 0.14 – 0.19%.

Fig. 1.4 **Heavy metals in ambient air – 2010**

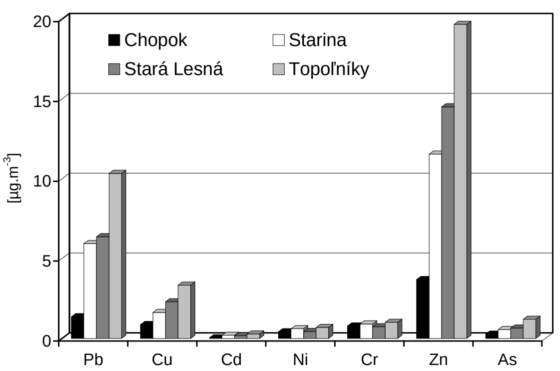
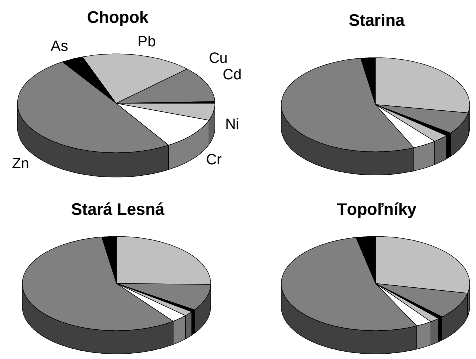


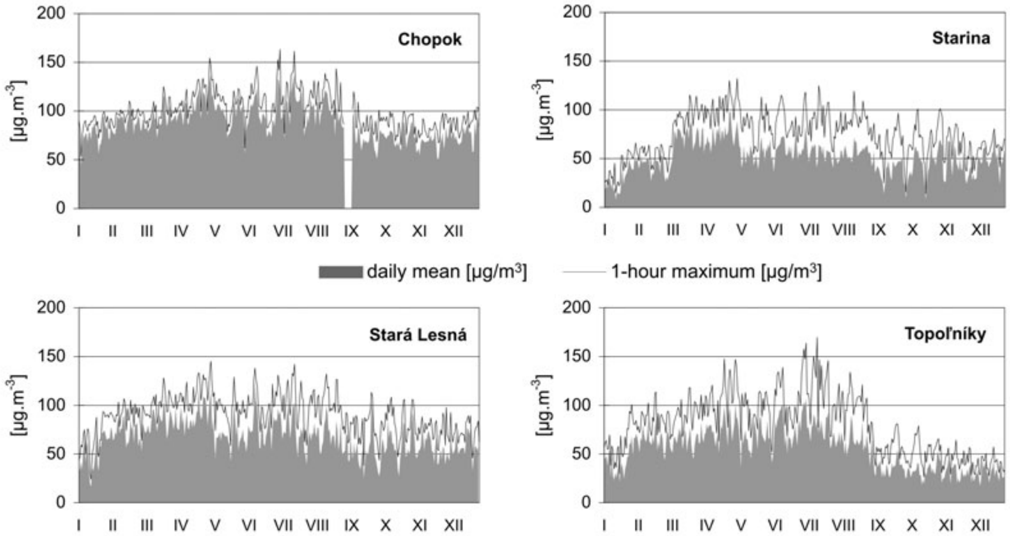
Fig. 1.5 **Proportional share of heavy metals – 2010**



Ozone

In Figures 1.6 the annual course of ground level ozone concentrations at the regional stations Chopok, Stará Lesná, Starina and Topoľníky are depicted. The longest time series of ozone measurements has been at the Stará Lesná station, since 1992. The measurements of ozone in Topoľníky, Starina and Chopok began to be carried out later, in 1994. In 2010, the annual average of ozone concentration at the Chopok station reached 87 µg.m^{-3}, at Starina 51 µg.m^{-3}, Stará Lesná 67 µg.m^{-3}, and Topoľníky 55 µg.m^{-3}. Measurements of ozone and exceedances of critical levels are completely assessed in Chapter 3 Atmospheric Ozone.

Fig. 1.6 **Ground level ozone [μg.m^{-3}] – 2010**



VOCs C_2–C_6

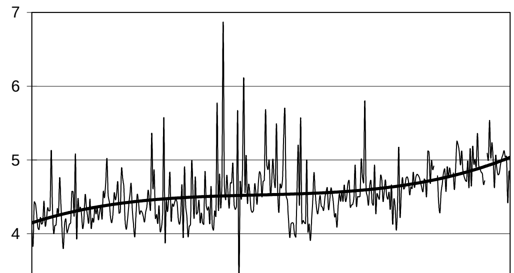
VOCs (Volatile Organic Compounds) C_2–C_6, or the so-called light hydrocarbons, started to be sampled in autumn 1994 at the Starina station. Starina is one of the few European stations, included into the EMEP network with regular sampling of volatile organic compounds. They are measured and assessed 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. However since October 2008 the VOCs measurements are not available due to long-lasting problems with the operation of new GC in Tested laboratory.

Atmospheric precipitation

Major ions, pH, conductivity

In 2010 the amount of precipitation recorded at background stations ranged between 926.3 and 1377.4 mm. The upper level of amount of precipitation does belong to the highest situated station Chopok and the lower one to Topoľníky with the lowest elevation. Acidity of atmospheric precipitation dominated on the Starina station at the low level of pH range 4.9 – 5.0 (Tab. 1.2, Fig. 1.8). Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity (Fig. 1.7). Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Fig. 1.7 **pH in atmospheric precipitation – Chopok**



Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.39 – 0.45 mg.l^{-1}. Concentrations of sulphates on the two stations Chopok and Starina were the same in annual mean and only slightly lower at the Stará Lesná station and slightly higher at the Topoľníky station. Total decrease of sulphates in long-term time series has corresponded to the SO_2 emission reduction since 1980.

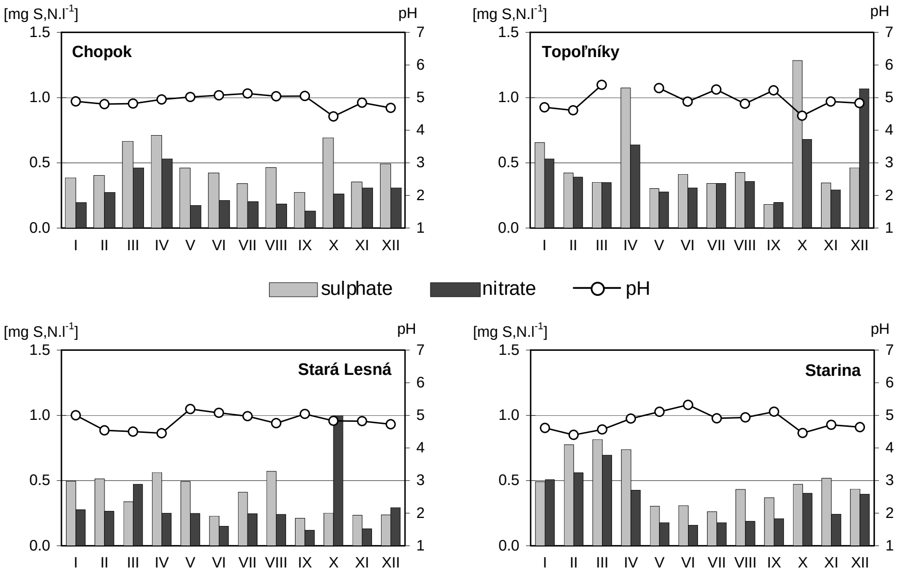
The share of nitrate (recalculated in nitrogen) in acidity of precipitation was substantially smaller than those of sulphates and varied within the concentration range 0.23 – 0.37 mg.l^{-1}. The low level of concentration range is represented by the Chopok and Stará Lesná stations, while upper level of this range does belong to the stations Topoľníky. Ammonium ions also do belong to the major ions and their concentration range was 0.28 – 0.44 $mg.l^{-1}$.

Tab.1.2 **Annual averages of main components in atmospheric precipitation – 2010**

	Precip. mm	pH	Cond. µS/cm	SO_4^{2-} (S) mg/l	NO_3^- (N) mg/l	NH_4^+ (N) mg/l	Cl^- mg/l	Na^+ mg/l	K^+ mg/l	Mg^{2+} mg/l	Ca^{2+} mg/l
Chopok	1377	5.00	10.3	0.42	0.23	0.36	0.13	0.12	0.08	0.04	0.15
Topoľníky	926	4.95	13.5	0.45	0.37	0.44	0.15	0.10	0.09	0.05	0.23
Starina	939	4.90	11.4	0.42	0.26	0.28	0.14	0.12	0.12	0.04	0.19
Stará Lesná	1038	4.93	10.7	0.39	0.23	0.29	0.13	0.11	0.10	0.04	0.19
Bratislava-Jeséniova	1007	5.03	13.60	0.37	0.24	0.42	0.09	0.31	0.07	0.04	0.14

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

Fig. 1.9 **Atmospheric precipitation – 2010**



Heavy metals

Since 2000 the measurement programme of heavy metals in precipitation has been gradually modified to meet the 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 (Tab. 1.3). This station serves for comparison and is not considered as the background station. The results of annual weighted means of heavy metals concentrations in monthly precipitation in 2010 are presented in Table 1.3.

Tab. 1.3 Annual averages of heavy metals in atmospheric precipitation – 2010

	Precip. mm	**Pb** µg/l	**Cd** µg/l	**Cr** µg/l	**As** µg/l	**Cu** µg/l	**Zn** µg/l	**Ni** µg/l
Chopok	1145	1.86	0.07	0.16	0.19	0.94	23.71	0.33
Topoľníky	873	0.95	0.04	0.22	0.13	0.63	5.71	0.25
Starina	967	0.95	0.05	0.09	0.10	0.93	9.94	0.42
Stará Lesná	1027	1.27	0.10	0.08	0.12	1.23	9.94	0.30
Bratislava-Jeséniova	1071	1.66	0.07	0.18	0.18	2.10	17.24	0.46

AMBIENT AIR

LOCAL AIR POLLUTION

2

2.1 LOCAL AIR POLLUTION

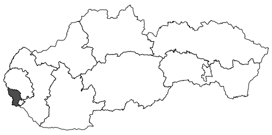
Air quality assessment is claimed by Air Protection Act No. 137/2010 Coll. Criterions for air quality assessment (upper and lower assessment thresholds, margin of tolerance, limit and target values) are given in Decree No. 360/2010 Coll. about Air Quality. Fundamental air quality assessment is performed on the basis of measured data. Slovak hydrometeorological institute (SHMÚ) carried out measurements at monitoring stations of National air quality monitoring network (NAQMN).

The SHMÚ 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 extended into the most polluted cities and industrial areas.

In 1991 modernization of the air quality monitoring network began. The manual stations were gradually replaced by automatic ones, which enable the continuous monitoring of pollution and made it possible to evaluate time changes and the extremes of the short-term concentrations. In the course of the last ten years the air quality monitoring network has kept developing. In 2010, 30 stations (without EMEP, rural and ozone stations) were located on the territory of the SR. Most of them monitored the level of pollution caused by the basic pollutants (SO_2, NO_2, NO_x, and PM_{10}, $PM_{2,5}$). In the year 2010 measurements of benzene were carried out at 10. The air pollution monitoring by heavy metals (Pb, Cd, As and Ni) were performed at five urban (suburban) and at 4 rural EMEP stations. Concentrations of benzo(a)pyrene were analysed at 8 sites totally.

In accordance to the Air Protection Act the territory of the Slovak Republic was divided into 8 zones and 2 agglomerations for the following pollutants: SO_2, NO_2, NO_x, PM_{10}, $PM_{2.5}$, benzene and CO. 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. According to the Decree No. 360/2010 Coll. about Air Quality for pollutants: Pb, As, Cd, Ni, BaP, Hg and O_3 was territory of Slovakia divided only into agglomeration Bratislava and rest of territory represents zone Slovakia.

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



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 432 801

Characterization of area

Bratislava

Bratislava spreads out over an area of 368 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 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.

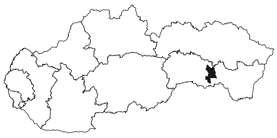
Location of stations

Bratislava - Jeséniova
The station is located in the ground of the SHMÚ, 287 m above sea. It is situated apart from the major city sources of air pollution, in a locality with middle built-up area, where family houses prevail.

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.

Bratislava - Trnavské mýto
The station is situated near to a busy crossroad formed by Šancová and Trnavská street - Krížna and 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 - Mamateyova
The station is located at open 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 a.s., Bratislava. The last mentioned contributes to the air pollution mainly under the east wind direction



AGGLOMERATION - KOŠICE

AREA: 237 km^2 POPULATION: 233 886

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.

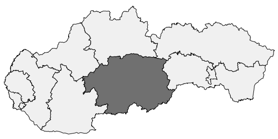
Location of stations

Košice - Štefánikova

Station is located in urban area predominantly surrounded by family houses separated by green alley from near road.

Košice - Amurská

Station is located in open area 100 m far from housing estate built-up area, which surrounded station from south, west and north directions. Easterly in distance of approximately 120 m is situated a small lake. It is typical urban background station.



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 455 km^2 POPULATION: 652 218

Characterization of area

Banská Bystrica

The town is located in the Bystrica valley, which is by the northern part of the Zvolen basin surrounded by the Staré Hory hills to the north, by the Horehron valley to the north-east and by the Kremnica 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.

Zvolen

The city is located in the south-western part of Zvolen basin. It is situated in the middle pohronie up to Banská Bystrica and it extends into Slatina, Detva and Sliač basin. Volcanic mountains Štiavnica a Kremnica hills lined the Zvolen basin from west, Javorie south and Poľana from east. The meteorological conditions for dispersion and transportation of pollutants in Zvolen are better in spring and summer periods. In autumn and winter periods the adverse meteorological conditions for dispersion of emission pollutants prevail. In these periods often occur calm and inversion of temperature situations. Generally lowered ability of pollution transport indicates low wind speeds, which are lower than 1 m.s^{-1} in 45% of days within the year.

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 Kremnica hills in the west up to the north, and by the Štiavnica 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 massifs, 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 - Štefánikovo nábrežie
Monitoring station is located closely to the frequented route providing transport into the eastern region of Slovakia. In the vicinity of about 100 m are situated housing estate buildings and hotel Lux. From the larger size scale the monitoring station is located in a valley part of city at the river Hron. This unfavourable location implicates adverse dispersion conditions of pollutants. The major part of air pollution is caused by emissions from transport and wood processing industry.

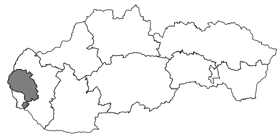
Banská Bystrica - Zelená
The station is located in the ground of the SHMÚ, 427 m above sea. In close vicinity the combination of housing estate buildings and family houses is presented. It is located apart from major pollution sources.

Zvolen - J. Alexyho
The station is located in the area of elementary school which is segment of the large housing estate Sekier in the south-eastern part of the city. In the vicinity of about 300 m is situated a frequented route into the Metropolis of Eastern Slovakia Košice. Besides of traffic the main contribution to air pollution represents emissions from wood processing industry.

Hnúšťa - Hlavná
The station is situated in open middle building area on the north edge of the town, approximately 50 m far from state road No. 531.

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.

Žiar nad Hronom - Jilemnického
The station is placed at the suburban part of the city in the vicinity of 4-storey buildings. Approximately in the distance of 100 m is located main route towards Prievidza. Close to the station is highvoltage electricity line under which is the ground covered with low vegetation.



ZONE - BRATISLAVA REGION

AREA: 1 685 km^2 POPULATION: 195 885

Characterization of area

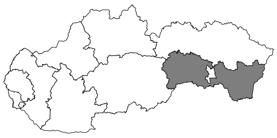
Malacky

Region Malacky spreads out northerly from the capital of the Slovak Republic, Bratislava. It is located in the southern part of Zahorie lowland, on western side borders it Morava river, which is as well bordering line with Austria and on the east are situated Low Carphatian mountains. Administrative centre as well the largest town of the region is Malacky. The east-west and north-west wind directions occur there most frequently within a year. Annual average wind speed is about 2.7 m.s^{-1}.

Location of stations

Malacky - **Sasinkova**

Monitoring station is located close to city centre. In the vicinity are located supermarkets and family houses. Stations is located 5 m from the kerbside of relative frequented road leading from the town towards the highway D2.



ZONE - KOŠICE REGION

AREA: 6 517 km^2 POPULATION: 546 114

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 surrounded by hills of about 350 m above sea level high. The northern part is placed 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.

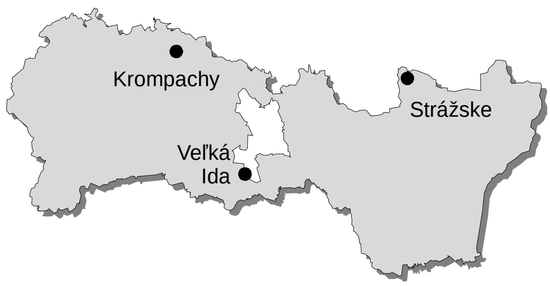
Strážske

Strážske is located easterly from Vihorlat in northern part of the Eastslovak lowland in area called Brekovská brána, 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 Abov 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 - SNP

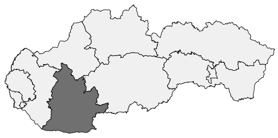
Monitoring station is located close to the main route Košice - Spišská Nová Ves. The surrounding built-up area comprises multi-storey houses.

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.

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 is not fully covered by grass.



ZONE - NITRA REGION

AREA: 6 344 km^2 POPULATION: 704 752

Characterization of area

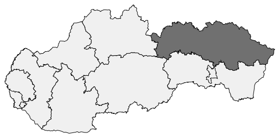
Nitra

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

Location of stations

Nitra - Janka Kráľa
Station is situated in the build up area of the town. It is placed at the courtyard of KÚ ŽP Nitra surrounded by 2 storey houses and threes. This location is temporally and it will be placed back on the former place at Štefánikova street.

Nitra - Janíkovce
Monitoring station is located in the area of elementary school Veľké Janíkovce. It is situated at cascade slope. Opposite is open area with airport Nitra.



ZONE - PREŠOV REGION

AREA: 8 974 km^2 POPULATION: 809 443

Characterization of area

Prešov

Prešov lies in the northern promontory of Košice's basin. The surrounding mountains of the Šariš's highland and the Slánske 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. In the course of a year the northern air circulation prevails which is also the strongest among all of directions. The next most frequently occurred wind directions are from south. Good ventilation of the town is provided by the widening of the valley itself at the confluence of the Sečkov and Torysa. The main air pollution sources in town constitute from municipal boilers, partly 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 is not so uniquely determined. The occurrence of calm is relatively high. The local chemical industry is the main air pollution source in this area. The main polluter is the heating plant Chemes a.s., Humenné.

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 river valley. The main air pollution sources in the area are the local wood processing industry and local heating systems.

Location of stations

Humenné - Nám. slobody

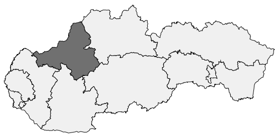
The station is located in the southern part of the town centre in open area at the edge of a pedestrian zone with minimum car transport. The surrounding buildings are connected to the central heating system of Chemes a.s., Humenné plant which is located approximately 2 km west from monitoring station.

Prešov - Arm. gen. L. Svobodu

Monitoring station is located in south-east part of the city in an open area close to the Arm. gen. L. Svobodu road, with high frequency of transport. Station is located 2 m from kerbside.

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 a.s., Hencovce plant. It is distant from the main road, of about 30 m.



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 598 819

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 for power generation sources contributes to air pollution in this area significantly. The coal in use contains apart from sulphur also arsenic.

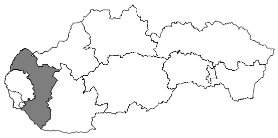
Location of stations

Prievidza - Malonecpalská
The station is located at the edge of town inside elementary school in open area. In the vicinity is situated local road No. 64 towards Žilina.

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. The major polluters are power generators and industrial sources.

Bystričany - Rozvodňa SSE
The station is directly placed in object of control room of SSE which is situated at agricultural area among fruit trees. The Nováky power plant (ENO) is in distance of 8 km northerly from the monitoring station.

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



ZONE - TRNAVA REGION

AREA: 4 147 km^2 POPULATION: 563 081

Characterization of area

Senica

The town itself is located on the southern slopes of Myjava hills in the altitude of 208 m. From 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 Záhorie lowlands intervenes. 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 (Slovenský hodváb a.s., Senica), 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-west, the second highest wind frequency is from south-east. The location is well ventilated with small occurrence of calm situations.

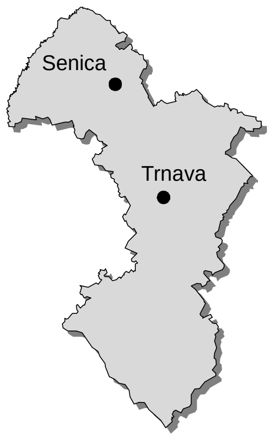
Location of stations

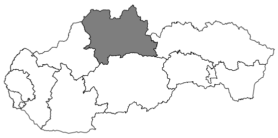
Senica - Hviezdoslavova

Station is 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

AREA: 6 754 km^2 POPULATION: 698 274

Characterization of area

Ružomberok

The location of the city comprises the area of the western part of the Liptov basin, on the confluence of rivers Váh, Revúca and Likavka. The Veľká Fatra mountains constitute the border in the west, the Choč mountains in the north and the Low Tatras in the south. The most frequently occur winds from west sector, at an average speed 1.6 m.s^{-1}. The North Slovakian pulp and paper processing plants (Mondi scp a.s., Ružomberok) are the largest industrial source of air pollution. A considerable share in 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 industry 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 temperature inversions, average wind speed 2.8 m.s^{-1} and high relative humidity contribute to higher level of pollution. Heavy engineering, central and local heating plants and car transport are the largest emitters of pollutants.

Location of stations

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 speeds and wind directions 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 pulp and paper processing plant - Mondi scp a.s., Ružomberok is situated north-east of the monitoring station.

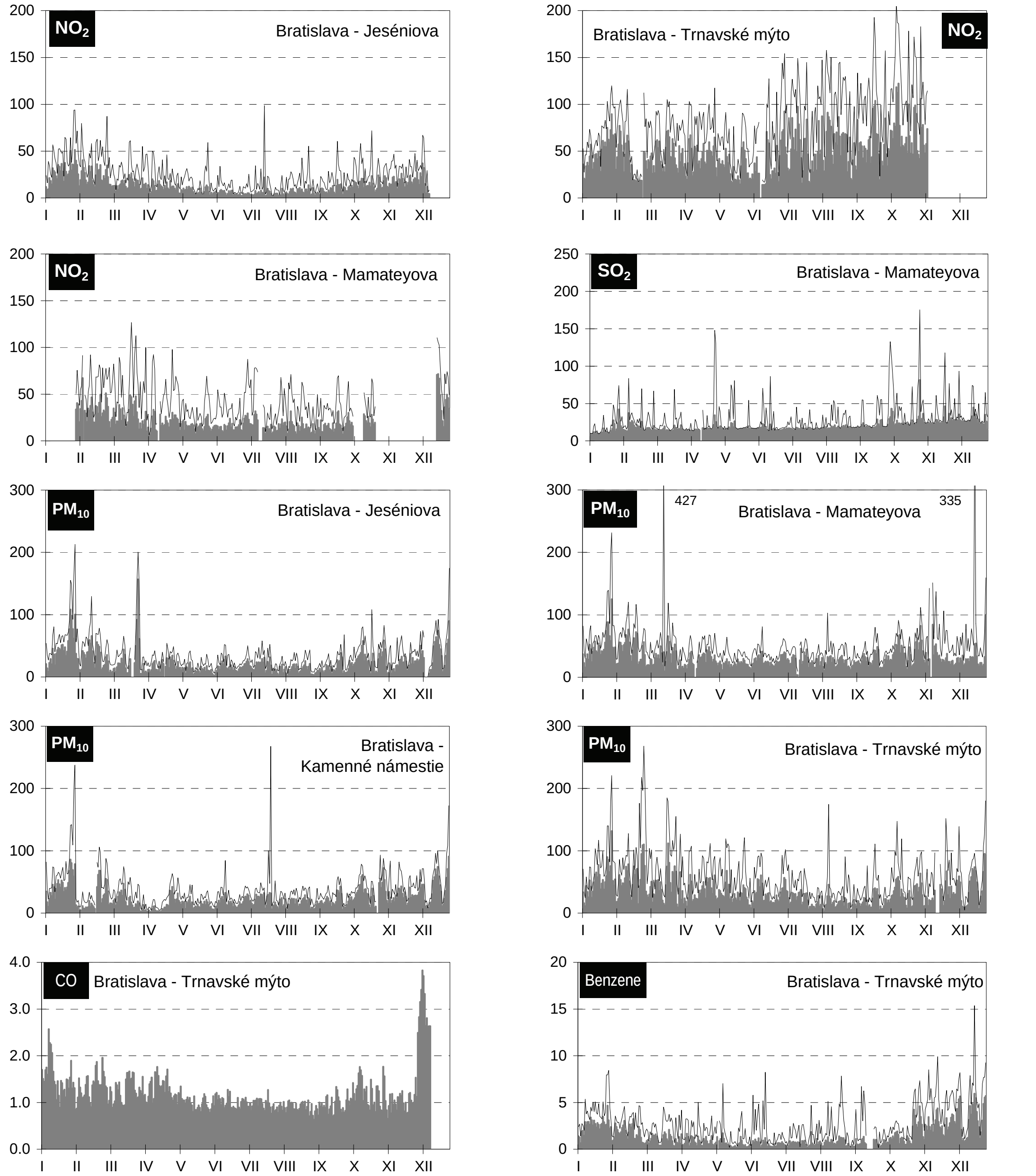
Martin - Jesenského

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 – 2010**

AGGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	PM_{10}	$PM_{2.5}$	NO_2	SO_2	CO	C_6H_6	Pb	Cd	Ni	As	BaP
BRATISLAVA	Bratislava, Kamenné nám	17°06'48"	48°08'41"	139	*										
	Bratislava, Trnavské mýto	17°07'43"	48°09'30"	136	*		*		*	*					*
	Bratislava, Jeséniova	17°06'22"	48°10'05"	287	*		*								*
	Bratislava, Mamateyova	17°07'32"	48°07'30"	138	*	*	*	*							
KOŠICE	Košice, Amurská	21°17'11"	48°41'28"	201	*	*									
	Košice, Štefánikova	21°15'33"	48°43'34"	209	*	*	*			*					
Banská Bystrica region	Banská Bystrica, Štefánikovo nábr.	19°09'16"	48°44'07"	346	*	*	*	*	*	*	*	*	*	*	
	Banská Bystrica, Zelená	19°06'55"	48°44'00"	425		*	*								
	Jelšava, Jesenského	20°14'26"	48°37'52"	289	*	*									
	Hnúšťa, Hlavná	19°57'06"	48°35'02"	320	*	*									
	Zvolen, J. Alexyho	19°09'24"	48°33'29"	321	*	*									
	Žiar nad Hronom, Jilemnického	18°50'32"	48°35'58"	296	*	*									
Bratislava region	Malacky, Sasinkova	17°01'11"	48°26'15"	198	*		*	*	*	*					
Košice region	Veľká Ida, Letná	21°10'30"	48°35'32"	209	*	*			*		*	*	*	*	*
	Strážske, Mierová	21°50'15"	48°52'26"	133	*	*									
	Krompachy, SNP	20°52'26"	48°54'57"	372	*	*	*	*	*	*	*	*	*	*	*
Nitra region	Nitra, Janka Kráľa	18°04'29"	48°18'38"	142	*	*	*	*	*	*					*
	Nitra, Janíkovce	18°08'27"	48°17'00"	149	*	*	*								
Prešov region	Humenné, Nám. slobody	21°54'50"	48°55'51"	160	*	*									
	Prešov, Arm. gen. L.Svobodu	21°16'03"	48°59'36"	252	*	*	*		*	*					
	Vranov nad Topľou, M. R. Štefánika	21°41'15"	48°53'11"	133	*	*		*							
Trenčín region	Bystričany, Rozvodňa SSE	18°30'51"	48°40'01"	261	*	*		*							
	Handlová, Morovianska cesta	18°45'23"	48°43'59"	448	*	*		*							
	Prievidza, Malonecpalská	18°37'40"	48°46'58"	276	*	*		*			*	*	*	*	*
	Trenčín, Hasičská	18°02'28"	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°55'17"	49°03'35"	383	*	*	*		*	*					
	Ružomberok, Riadok	19°18'10"	49°04'44"	475	*	*		*	*		*	*	*	*	
	Žilina, Obežná	18°46'15"	49°12'41"	356	*	*	*								

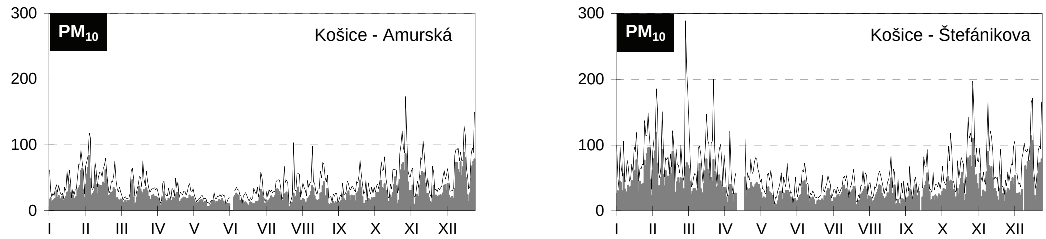
Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, benzene and CO – agglomeration Bratislava – 2010**



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

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [μg.m^{-3}]

Fig. 2.2 **Concentrations of PM_{10}, $PM_{2.5}$ and benzene – agglomeration Košice – 2010**



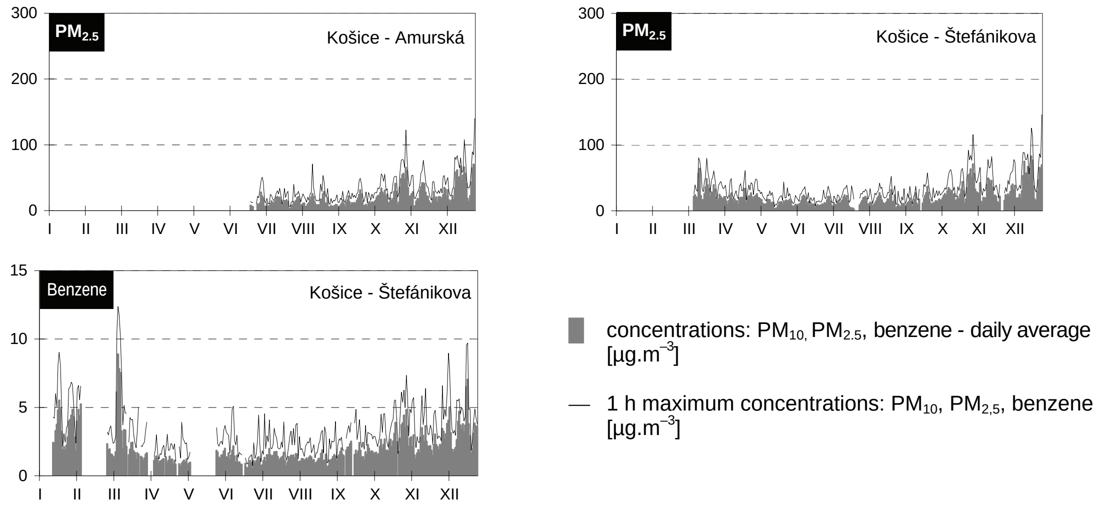
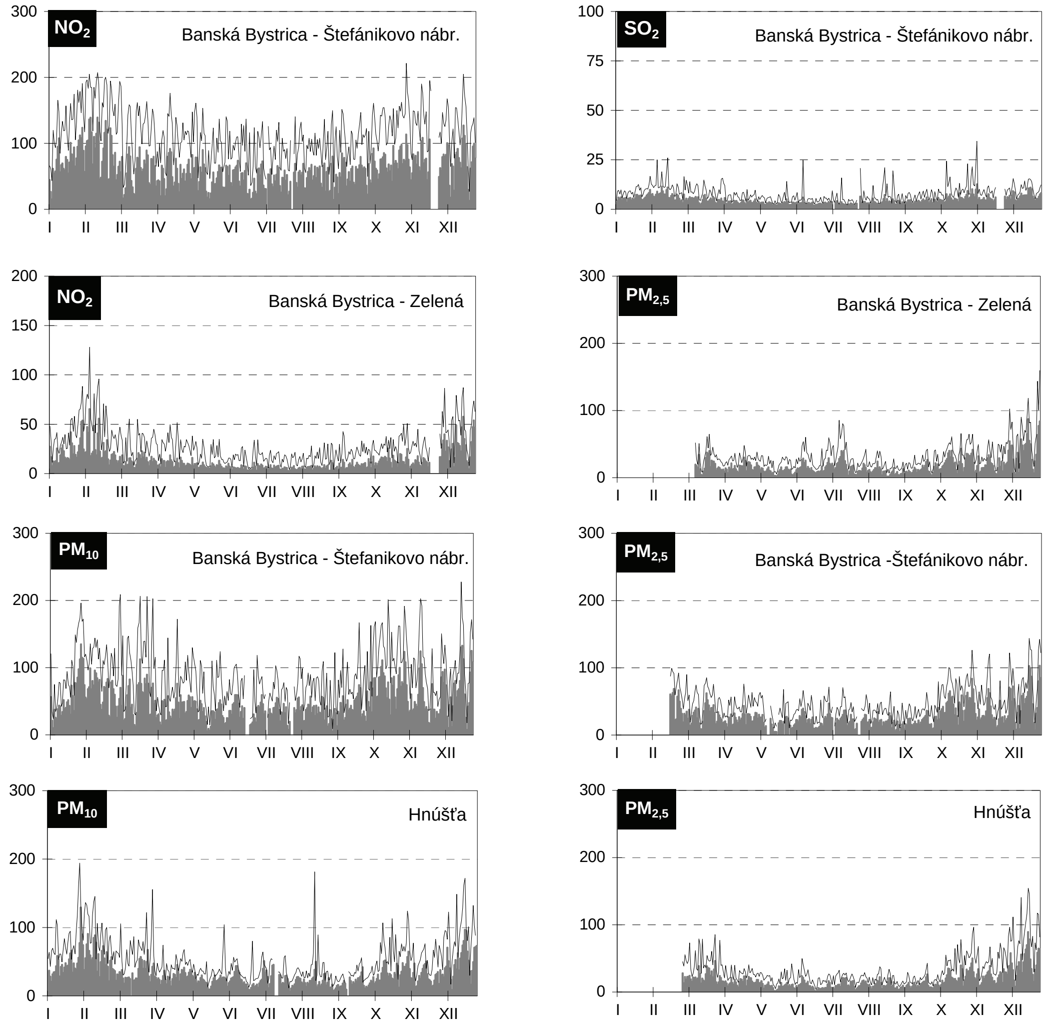
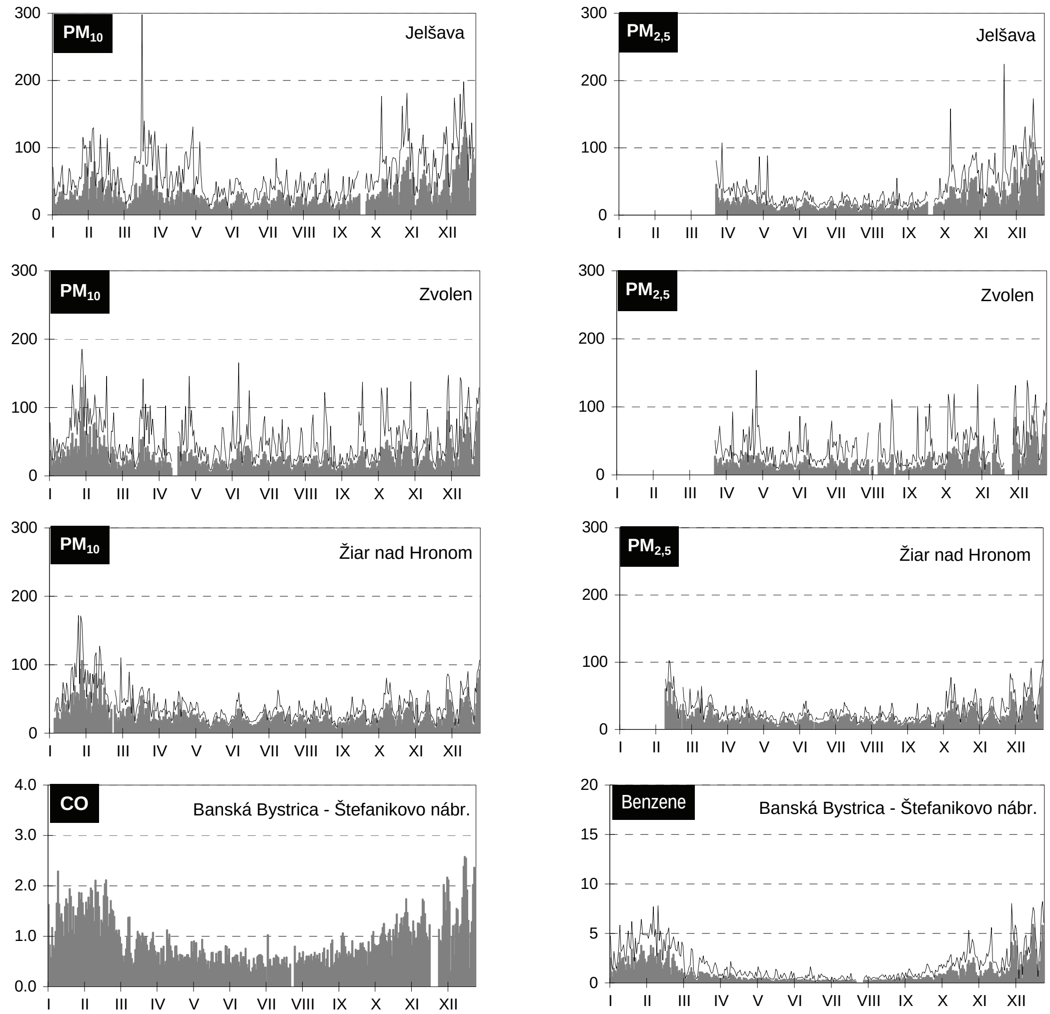


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Banská Bystrica region – 2010**

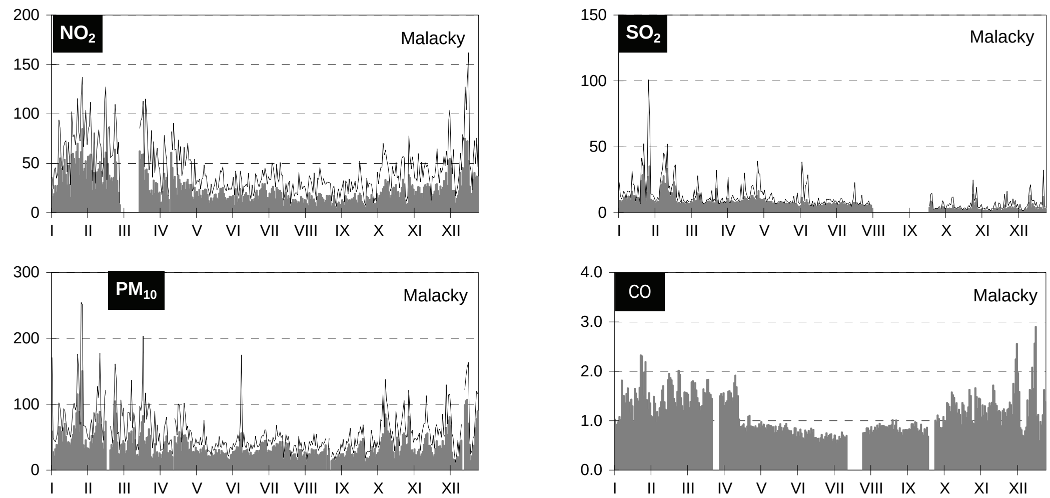


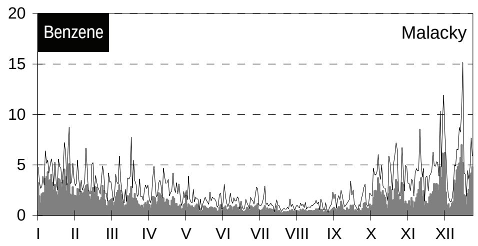


concentrations: NO_2, SO_2, PM_{10}, $PM_{2,5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, $PM_{2,5}$, benzene [µg.m^{-3}]

Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Bratislava region – 2010**

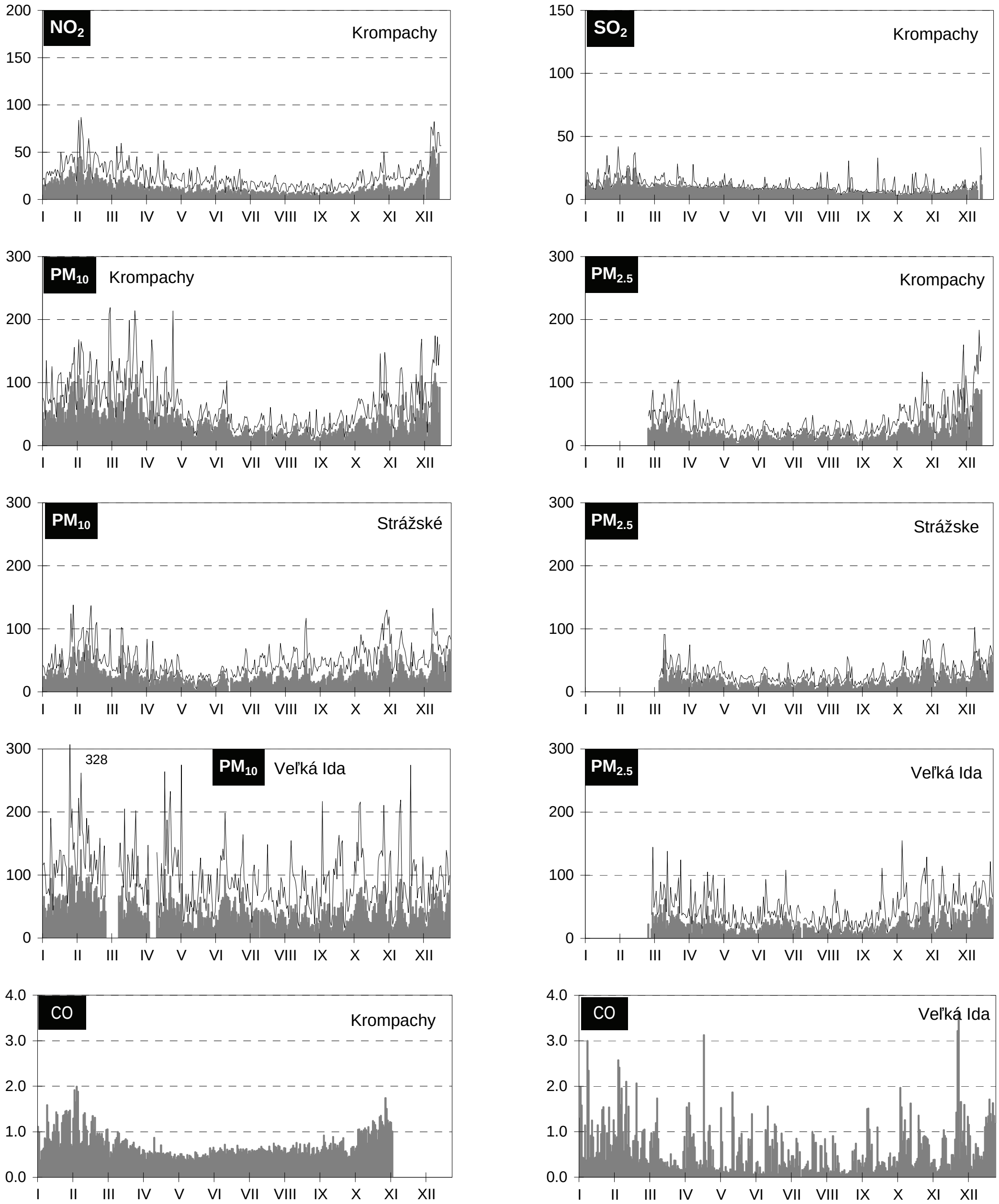


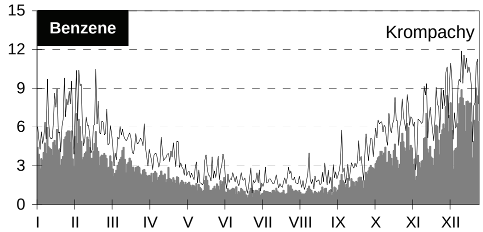


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [µg.m^{-3}]

Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Košice region – 2010**

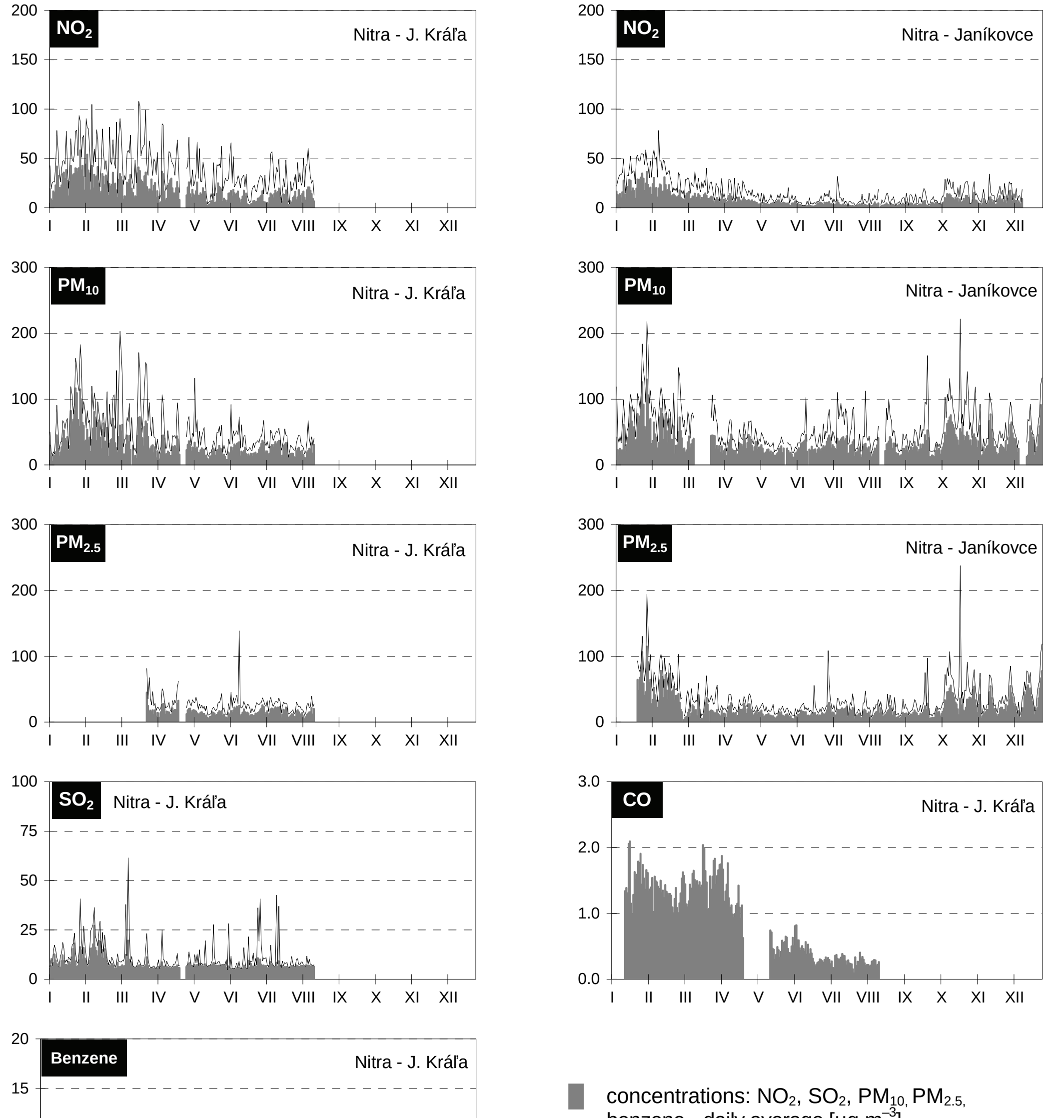




concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, $PM_{2,5}$, benzene [µg.m^{-3}]

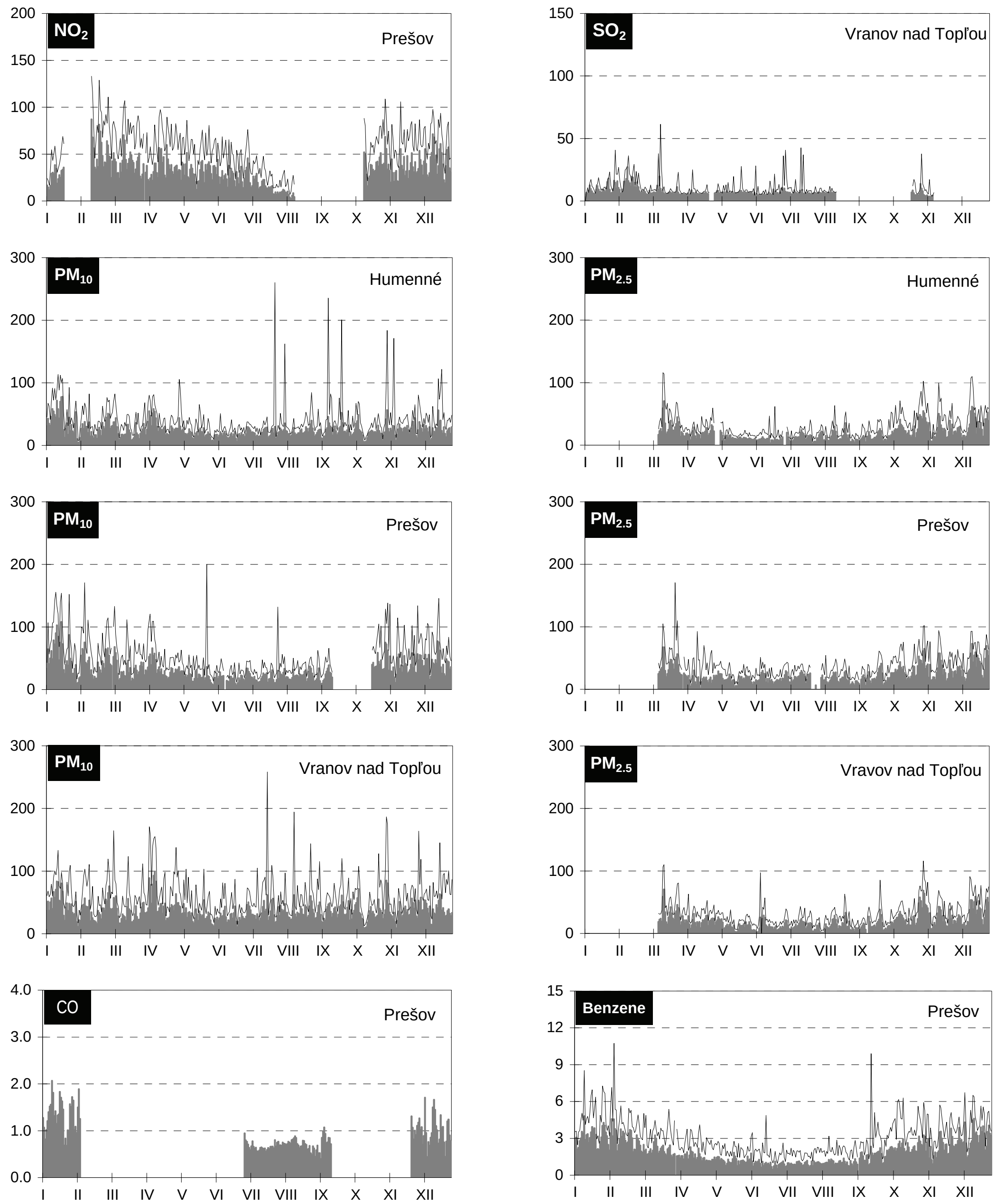
Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Nitra region – 2010**



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

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene [µg.m^{-3}]

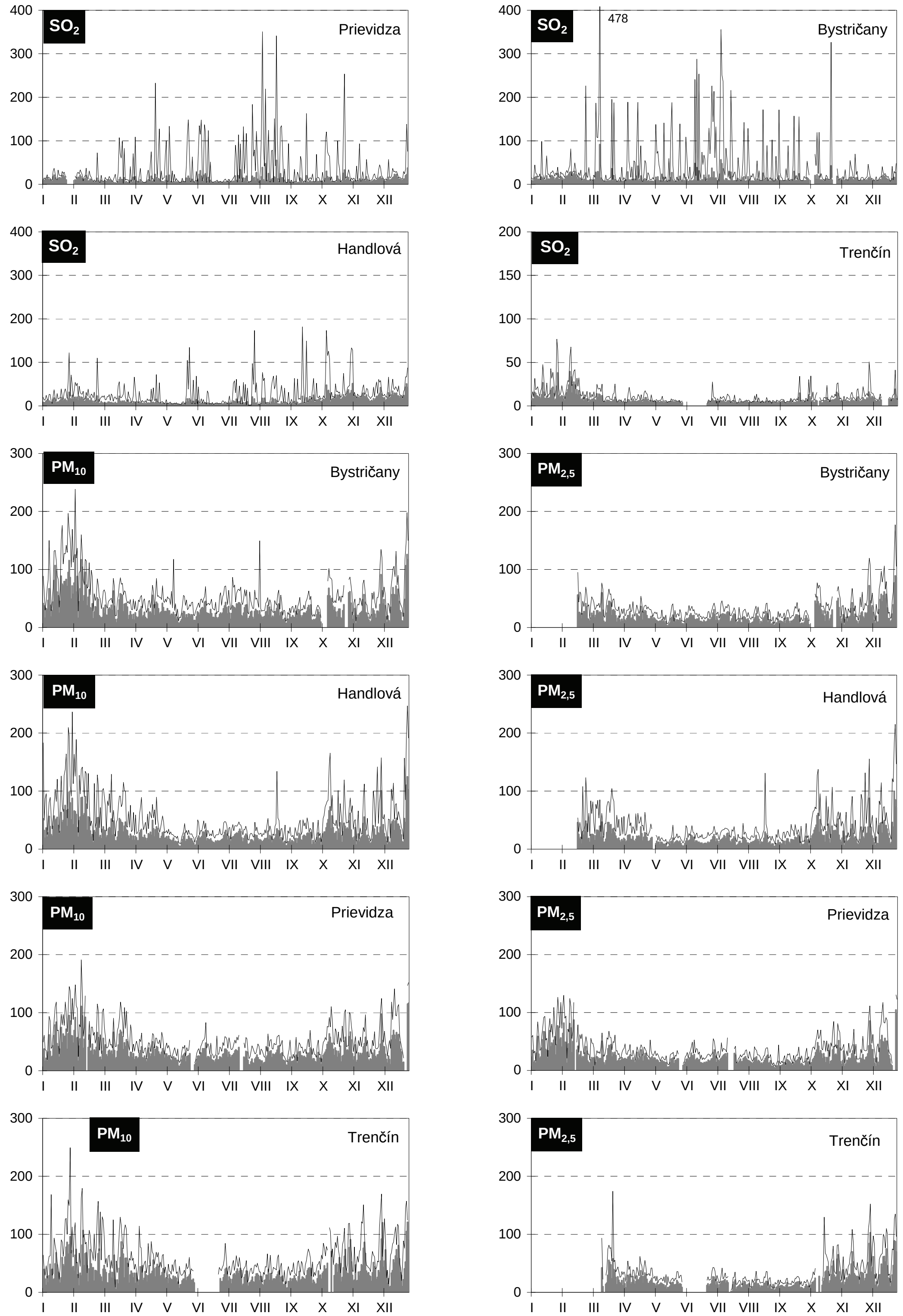
Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Prešov region – 2010**



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

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [µg.m^{-3}]

Fig. 2.8 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trenčín region – 2010**



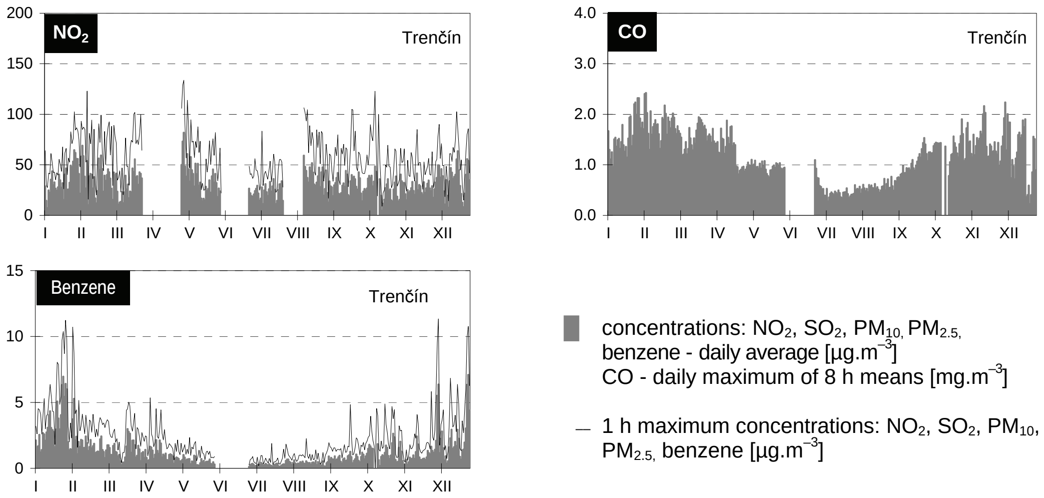


Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trnava region – 2010**

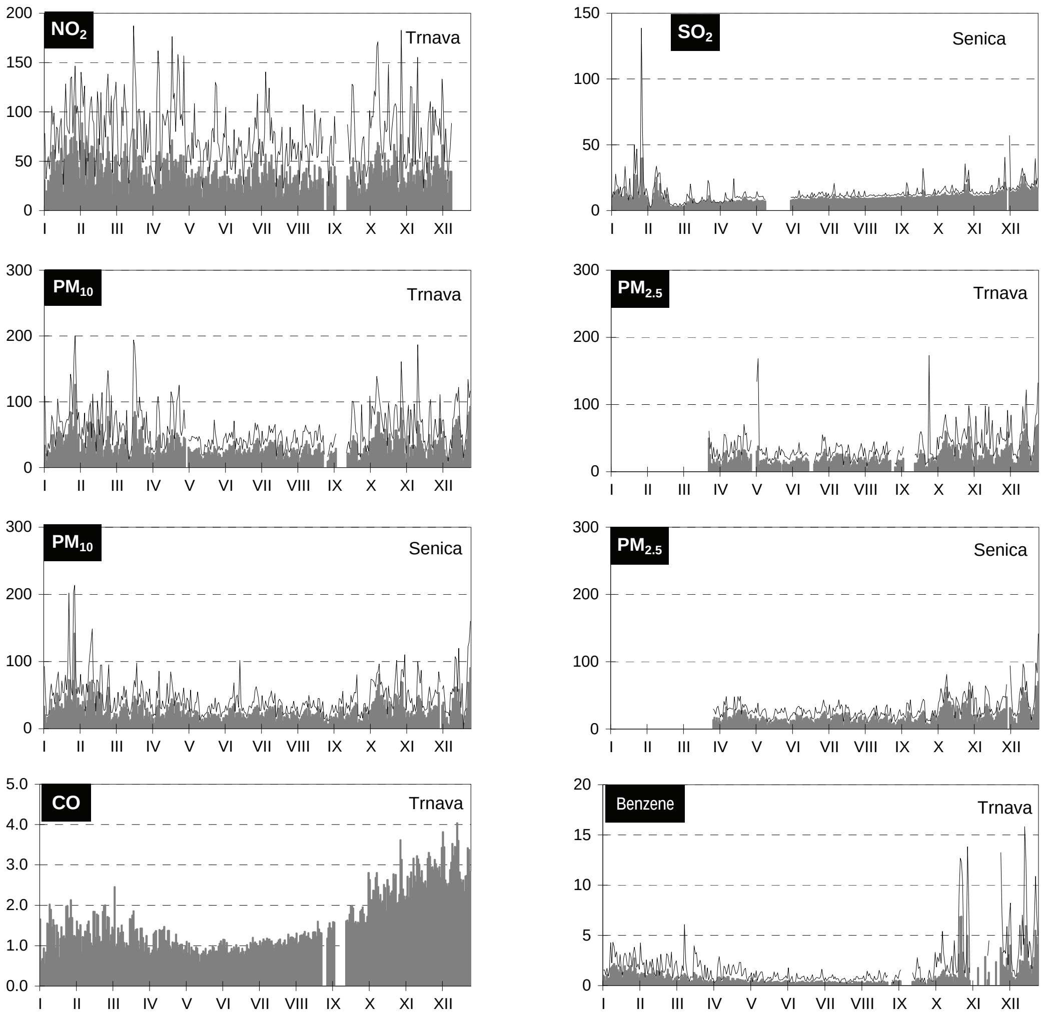


Fig. 2.10 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5,}$ CO and benzene – zone Žilina region – 2010**

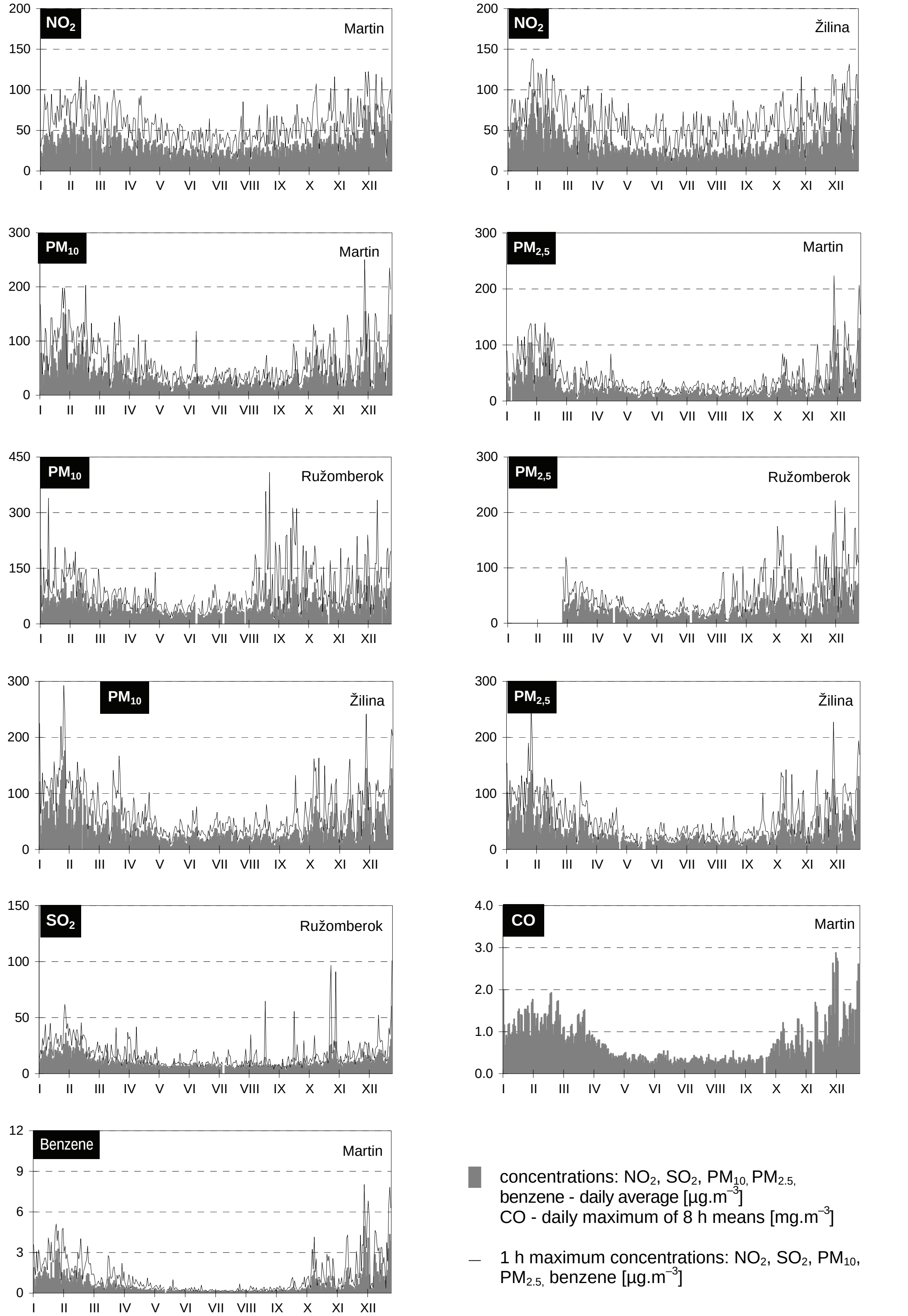
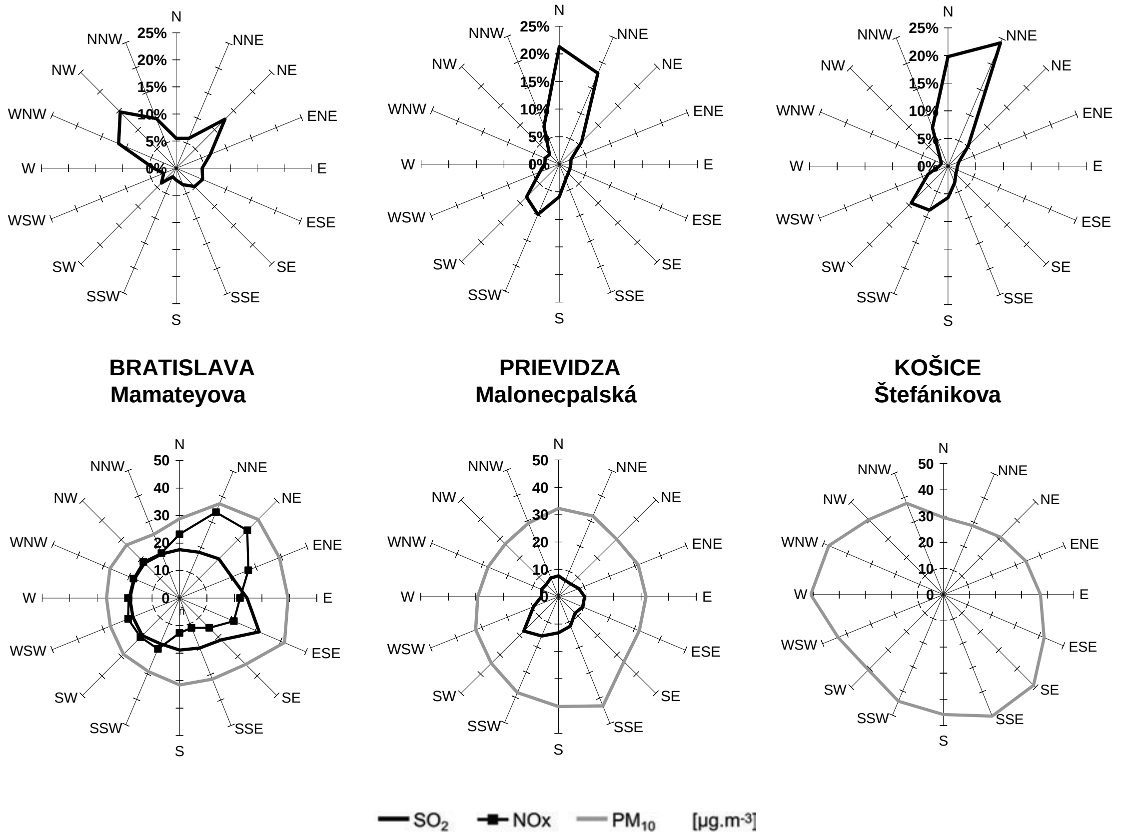


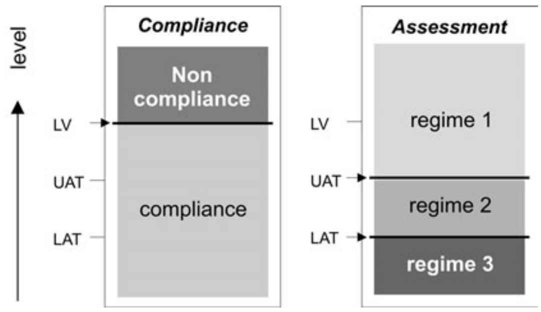
Fig. 2.11 **Wind and concentration roses – 2010**



2.3 PROCESSING OF MEASUREMENT RESULTS ACCORDING TO LIMIT VALUES

The Air Protection Act 137/2010 Coll.harmonized the principles of air quality assessment with the EU AQ legislation. Accordingly to these requirements 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 Figure 2.12 and in Table 2.2 are specified requirements for air quality assessment for specific regimes.

Fig. 2.12 **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.

In the year 2010 margin of tolerance was given only for daily limit values of PM_{10} for particular stations, at which EC approved these extension as legitimate. Limit values, upper and lower assessment thresholds defined in Decree No. 360/2010 Coll. about Air Quality are presented in tables 2.3 and 2.4. Alert thresholds values were set up for:

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

Alert thresholds values are exceeded if each of 3 consecutive 1 hour concentration exceeds the particular level given above.

[1] *Limit value as defined in Decree No. 360/2010 Coll.*
[2] *Upper assessment threshold as defined in Decree No. 360/2010 Coll.*
[3] *Lower assessment threshold, as defined in Decree No. 360/2010 Coll.*

But these limit values are assumed to be exceeded only in case, 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. For illustration the concentrations and wind roses were evaluated for one station from west, middle and east part of Slovakia (Fig. 2.11).

Statistical characteristics were processed for all monitoring stations in Slovakia. The stations, where the limit values and limit values plus margin of tolerance were exceeded, are highlighted in tables in bold (Tab. 2.5 – 2.7).

Sulphur dioxide In the year 2010 in none of agglomeration or zone the hourly or daily limit values were exceeded in more cases than it is allowed. Also none alert concentration has not been exceeded as well.

Nitrogen dioxide Annual limit value plus margin of tolerance was exceeded at stations Banská Bystrica-Štefánikovo nábrežie. In these location to the emissions from road traffic contributed also emissions from reconstruction works. Annual limit value 40 $\mu g.m^{-3}$ was exceeded also in Bratislava at the crossroad Trnavské mýto.

PM_{10} The major air pollution problem in Slovakia similarly to the whole Europe is pollution by particulate matter. In the year 2010 daily limit value was exceeded at 21 stations and at 4 of them annual limit value was exceeded as well. In the year 2010 SR obtained from EC exception for daily PM_{10} daily values according to the article 22 of Directive 208/50/ES. These exception practically applicable for the zones Trenčín, Trnava and Prešov region until 11^{th} of June 2011. At none of stations located in these zones the daily value plus margin of tolerance was exceeded.

$PM_{2,5}$ For $PM_{2,5}$ is given only annual limit 25 $\mu g.m^{-3}$, which come in force in 1. 1. 2015, but this value is valid since the year 2010, as target value. In the year 2010 this target value was exceeded at 4 stations.

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 The highest annual concentration 2.9 $\mu g.m^{-3}$ in Krompachy is deeply bellow the limit value 5 $\mu g.m^{-3}$.

Pb The highest level is observed in Krompachy-SNP, where metallurgy industry is major air pollution source. Despite of this the air pollution level at the whole territory is low even below the lower assessment threshold.

As, Ni, Cd In the year 2010 none of these pollutants exceeded the target value at any station. These target values has to be attained in the year 2012.

BaP The target value which has to be attained in the year 2012 was exceeded at stations Veľká Ida-Letná, Prievidza-Malonecpalská and Krompachy-SNP.

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. 2005	150 µg/m^3	500	470	440	410	380	350					
SO_2	24h	125 (3)	1. 1. 2005	-											
SO_2^e	1y, W[1]	20 (-)	1. 1. 2003	-											
NO_2	1h	200 (18)	1. 1. 2010	50%	300	290	280	270	260	250	240	230	220	210	200
NO_2	1y	40 (-)	1. 1. 2010	50%	60	58	56	54	52	50	48	46	44	42	40
NO_x^v	1y	30 (-)	1. 1. 2003	-											
PM_{10}	24h	50 (35)	1. 1. 2005	50%	75	70	65	60	55	50					
PM_{10}	24h	50 (35)	11. 6. 2011	50%											75***
PM_{10}	1y	40 (-)	1. 1. 2005	20%	48	46	45	43	42	40					
Pb	1y	0.5 (-)	1. 1. 2005	100%	1,0	0,9	0,8	0,7	0,6	0,5					
CO	max. 8 hour daily value	10000 (-)	1. 1. 2003 (1. 1. 2005)	6000	16000	16000	16000	14000	12000	10000					
Benzene	1y	5 (-)	1. 1. 2006 (1. 1. 2010)	100%	10	10	10	10	10	10	9	8	7	6	5
$PM_{2.5}$	1y	25**	1. 1. 2015												25**

[1] *winter period (October 1 - March 31)* ^{e} *for protection of ecosystems* ^{v} *for protection of vegetation*
** allowed exceedances per year are in brackets ** since the year 2010 is valid as target value*
**** exception is applicable for zones Trnava, Trenčín and Prešov region*

	Interval of averaging	Target value [ng/m^3]	To be met by
As	1y	6	31. 12. 2012
Cd	1y	5	31. 12. 2012
Ni	1y	20	31. 12. 2012
BaP	1y	1	31. 12. 2012

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	1r. 1/2r	20 (-)	12 (-)	8 (-)
NO_2	Human health	1h	200 (18)	140 (18)	100 (18)
NO_2	Human health	1r	40 (-)	32 (-)	26 (-)
NO_x	Vegetation	1r	30 (-)	24 (-)	19.5 (-)
PM_{10}	Human health	24h	50 (35)	30 (7)	20 (7)
PM_{10}	Human health	1r	40 (-)	14 (-)	10 (-)
$PM_{2,5}$	Human health	1r	25**	17**	12**
Pb	Human health	1r	0.5 (-)	0.35 (-)	0.25 (-)
CO	Human health	8h (maximum)	10 000 (-)	7 000 (-)	5 000 (-)
Benzene	Human health	1r	5 (-)	3.5 (-)	2 (-)

* *allowed exceedances per year are in brackets* ***valid since 1st January 2015*

Tab. 2.5 **Assessment of air quality according to limit values in 2010**

AGLOMERATION / Zone	Pollutant	Human protection										VHP [2)]	
	Pollutant	SO_2		NO_2		PM_{10}			$PM_{2.5}$	CO	Benzén	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	24 hour	1 year	24 hour [4)]	1 year	8 hour [1)]	1 year	3 subsequent hour	3 subsequent hour
	Limit value [µg.m⁻³] *(number of exceedances)*	350 (24)	125 (3)	200 (18)	40	50 (35)	40	75 (35)	25	10000	5	500	400
BRATISLAVA	Bratislava, Kamenné nám.					28	23.9	x					
	Bratislava, Trnavské mýto			[a] 1	[a] 48.9	73	34.1	x		3829	1.4		0
	Bratislava, Jeséniova			0	13.3	30	23.5	x					0
	Bratislava, Mamateyova	0	0	[b] 0	[b] 21.7	43	32.1	x	17.3			0	0
KOŠICE	Košice, Štefánikova			[c]	[c]	67	36.2	x	21.6		[a] 2.1		
	Košice, Amurská					30	25.2	x	20.9				
Banská Bystrica region	Banská Bystrica, Štefánik.nábr.	0	0	5	62.5	141	50.0	x	29.8	2578	1.0	0	0
	Banská Bystrica, Zelená			0	13.4				18.2				
	Jelšava, Jesenského					57	32.1	x	22.0				
	Hnúšťa, Hlavná					52	33.0	x	18.1				
	Zvolen, J. Alexyho					35	28.3	x	20.1				
	Žiar n/H, Jilemnického					29	27.1	x	18.3				
Bratislava region	Malacky, Sasinkova	0	0	0	24.7	66	37.6	x		2901	1.5	0	0
Košice region	Veľká Ida, Letná					132	46.7	x	23.9	3643			
	Strážske, Mierová					37	28.7	x	19.1				
	Krompachy, SNP	0	0	0	13.6	99	41.1	x	23.7	[a] 1995	2.9	0	0
Nitra region	Nitra, J. Kráľa	[b] 0	[b] 0	[b] 0	[b] 18.7	[b] 33	[b] 31.3	x	15.3	[b] 2097	[b] 0.6	0	0
	Nitra, Janíkovce			0	8.1	50	34.7	x	22.5				
Prešov region	Humenné, Nám. slobody					28	27.4	0	19.4				
	Prešov, Arm. gen. L. Svobodu			[a] 0	[a] 33.0	83	38.3	18	24.0	[c] 2070	1.9		
	Vranov n/T, M. R. Štefánika					61	34.7	11	19.7				
	Stará Lesná, AÚ SAV, EMEP [3)]					1	18.3	0	10.2				
	Kolonické sedlo, Hvezdáreň [3)]					5	23.3	0	12.9				
Trenčín region	Prievidza, Malonecpalská	1	0			51	33.6	11	24.7				
	Bystričany, Rozvodňa SSE	2	0			54	33.5	21	19.8			0	
	Handlová, Morovianska cesta	0	0			43	28.6	10	20.4			0	
	Trenčín, Hasičská	0	0	[a] 0	[a] 32.0	53	35.8	17	21.9	2423	1.3	0	0
Trnava region	Senica, Hviezdoslavova	0	0			27	28.6	4	19.5			0	
	Trnava, Kollárova			0	40.0	56	35.0	15	22.7	4036	0.9		0
	Topoľníky, Aszód, EMEP [3)]					25	24.6	2	18.4				
Žilina region	Martin, Jesenského			0	32.8	76	36.9	x	25.1	2877	0.6		
	Ružomberok, Riadok	0	0			143	50.6	x	26.7			0	
	Žilina, Obežná			0	34.8	83	38.4	x	31.2				0

[1)] *maximal 8 hour value of moving average* [2)] *alert threshold limit values*
[3)] *stations located in rural background areas*
[4)] *limit values plus margin of tolerance (exception is applicable till 11th June 2011); x - exception was not given*
Pollutants which exceeded limit values are in bold
Data coverage: > 90%, [a] 75 – 90%, [b] 50 – 75%, [c] < 50% of valid values

Tab. 2.6 **Assessment of air quality according to target and limit values for As, Cd and Ni for the protection of human health in 2010**

	Pollutant	As	Cd	Ni	Pb
AGLOMERATION/ zone	Target value [ng.m^{-3}]	6.0	5	20	
	Limit value [ng.m^{-3}]				500
	Upper assessment threshold [ng.m^{-3}]	3.6	3	14	350
	Lower assessment threshold [ng.m^{-3}]	2.4	2	10	250
Slovensko	Banská Bystrica, Štefánikovo nábr.	3.1	0.8	1.9	33.7
	Veľká Ida, Letná	1.8	0.9	1.9	40.2
	Krompachy, SNP	2.7	1.5	1.3	87.6
	Prievidza, Malonecpalská	6.0	0.3	0.9	10.7
	Ružomberok, Riadok	3.3	0.4	1.3	14.5

Tab. 2.7 **Assessment of air quality according to target values for BaP for the protection of human health in 2010**

	Pollutant	BaP
AGLOMERATION / zone	Target value [ng.m^{-3}]	1.0
	Upper assessment threshold [ng.m^{-3}]	0.6
	Lower assessment threshold [ng.m^{-3}]	0.4
BRATISLAVA	Bratislava, Trnavské mýto	1.1
	Bratislava, Jeséniova	0.4
Slovensko	Veľká Ida, Letná	4.9
	Krompachy, SNP [2]	2.6
	Starina, Vodná nádrž, EMEP	0.3
	Prievidza, Malonecpalská	1.8
	Trnava, Kollárova	1.0
	Nitra, Janka Krála	[a] 1.2
	Trenčín, Hasičská	[b] ~~3.8~~

[a] < 50% of valid values [b] < 20% of valid values, annual average is not representative

AMBIENT AIR

ATMOSPHERIC OZONE

3

3.1 ATMOSPHERIC OZONE

Most of the atmospheric ozone (approximately 90%) is in the stratosphere (11 – 50 km), 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 (NO_x, 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 2010 was 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 2005 – 2010

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 2005 – 2010

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) Topoľníky and Chopok (in operation since 1995) are part of the EMEP monitoring network. For monitoring of ground level ozone concentrations, the ozone analysers 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 2010 the number of missing data did not exceed 7% almost at all stations (Tab. 3.2). Large gaps were only at the Nitra Janíkovce a Kojšovská hoľa.

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

Station	2005	2006	2007	2008	2009	2010
Banská Bystrica, Zelená					*42.5	0.03
Bratislava, Jeséniova	5.8	16.8	0.6	1.6	0.1	0.2
Bratislava, Mamateyova	6.3	2.3	0.8	1.1	7.2	6.2
Humenné, Nám. Slobody	0.3	10.3	9.5	0.5	0.1	3.8
Jelšava, Jesenského	0.3	8.2	5.0	0.1	3.0	2.8
Košice, Ďumbierska	8.6	44.4	1.1	0.1	2.1	0.4
Nitra, Janíkovce					*13.7	22.5
Prievidza, Malonecpalská			1.9	0.4	3.4	0.5
Žilina, Obežná	0.5	0.5	1.0	0.05	1.5	0.1
Gánovce, Meteo. st.	15.9	7.8	0.01	1.7	0.1	0.4
Chopok, EMEP	1.9	29.0	1.0	1.7	0.3	2.6
Kojšovská hoľa	9.9	6.3	0.7	1.9	0.1	14.2
Stará Lesná, AÚ SAV, EMEP	0.3	10.9	0.2	0.3	0.6	0.4
Starina, Vodná nádrž, EMEP	7.1	24.8	6.6	2.6	0.8	0.1
Topoľníky, Aszód, EMEP	6.6	1.7	1.4	0.6	0.6	2.9

** ozone measurement introduced in 2009*

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

Station	2005	2006	2007	2008	2009	2010
Banská Bystrica, Zelená					**53	56
Bratislava, Jeséniova	68	66	59	59	60	61
Bratislava, Mamateyova	53	50	49	48	48	46
Humenné, Nám. slobody	60	62	56	55	59	53
Jelšava, Jesenského	52	55	56	51	49	44
Košice, Ďumbierska	67	*49	57	56	81	63
Nitra, Janíkovce					**74	53
Prievidza, Malonecpalská			48	53	50	49
Žilina, Obežná	41	44	44	46	48	47
Gánovce, Meteo. st.	67	68	60	65	62	63
Chopok, EMEP	95	*96	91	92	90	87
Kojšovská hoľa	86	84	79	76	85	90
Stará Lesná, AÚ SAV, EMEP	70	73	68	74	61	67
Starina, Vodná nádrž, EMEP	66	*62	62	59	58	51
Topoľníky, Aszód, EMEP	60	60	58	60	59	55

** 50 – 75% of valid measurements* *** ozone measurement introduced in 2009*

In 2010, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 46 – 63 μg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 51 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 (90 μg.m^{-3}). The effect of ozone from the accumulation zone (800 – 1500 m over the ground) over the Europe is evident. The year 2010, according to vegetation period averages, belongs to the photochemically less active years. Annual averages of ground level ozone concentration in 2010 were lower than in record year 2003.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992 – 2010 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.

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, 2003 and 2007) as compared to those in less favourable years.

The number of exceedances of ozone threshold values in Slovakia during 2005 – 2010 is summarised in Tables 3.4 – 3.6. The alert threshold when the public must be warned (240 µg.m^{-3}) was in 2010 exceed at Bratislava-Jeséniova station (Table 3.4). The information threshold to the public (180 µg.m^{-3}) in 2010 was exceeded at two stations (Bratislava-Mamateyova and Bratislava-Jeséniova).

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992 – 2010**

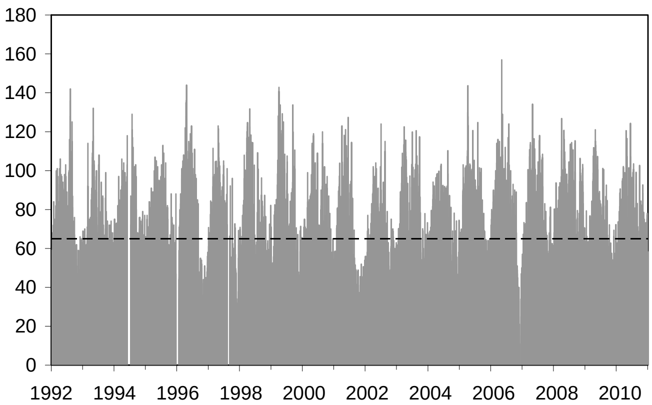
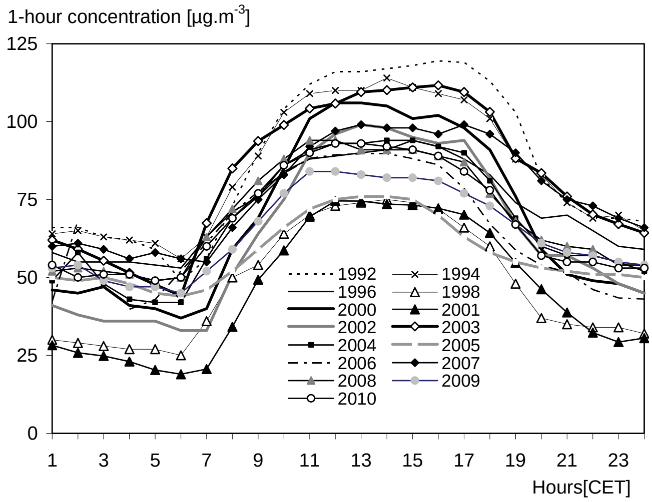


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992 – 2010**



Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2005 – 2010**

Station	AT = 240 µg.m^{-3}						IT = 180 µg.m^{-3}					
	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
Banská Bystrica, Zelená					0	0					0	0
Bratislava, Jeséniova	0	0	0	0	0	12	6	19	10	0	0	39
Bratislava, Mamateyova	0	0	1	0	0	0	8	11	17	1	2	3
Humenné, Nám. Slobody	0	0	0	0	0	0	0	1	0	0	0	0
Jelšava, Jesenského	0	0	0	0	0	0	0	3	6	0	0	0
Košice, Ďumbierska	0	0	0	0	0	0	0	0	0	0	0	0
Nitra, Janíkovce					0	0					1	0
Prievidza, Malonecpalská	0	0	0	0	0	0	0	0	1	0	0	0
Žilina, Obežná	0	0	0	0	0	0	0	8	0	0	0	0
Gánovce, Meteo. st.	0	0	0	0	0	0	0	0	0	0	0	0
Chopok, EMEP	0	0	0	0	0	0	0	1	0	0	0	0
Kojšovská hoľa	1	0	0	0	0	0	2	1	2	2	0	0
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	0	1	0	0	0	0
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	0	3	0	0	0	0
Topoľníky, Aszód, EMEP	0	0	0	0	0	0	0	0	4	0	0	0

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2008 – 2010**

Station	2008	2009	2010	Average 2008 – 2010
Banská Bystrica, Zelená		18	17	18
Bratislava, Jeséniova	32	32	24	**29**
Bratislava, Mamateyova	24	22	21	22
Humenné, Nám. slobody	10	43	8	20
Jelšava, Jesenského	22	17	4	14
Košice, Ďumbierska	6	106	14	**42**
Nitra, Janíkovce		85	16	**50**
Prievidza, Malonecpalská	13	19	9	14
Žilina, Obežná	21	36	20	**26**
Gánovce, Meteo. st.	14	5	7	9
Chopok, EMEP	66	62	36	**55**
Kojšovská hoľa	39	71	55	**55**
Stará Lesná, AÚ SAV, EMEP	32	15	15	21
Starina, Vodná nádrž, EMEP	5	22	2	10
Topoľníky, Aszód, EMEP	39	41	23	**34**

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	2008	2009	2010	Average 2006 – 2010
Banská Bystrica, Zelená		17178	15110	*
Bratislava, Jeséniova	20644	17765	21253	**22499**
Bratislava, Mamateyova	19894	13479	14712	**18991**
Humenné, Nám. slobody	14998	23878	9606	**21806**
Jelšava, Jesenského	18677	14469	8542	**18081**
Košice, Ďumbierska	12229	38806	12496	**20482**
Nitra, Janíkovce		32110	12991	*
Prievidza, Malonecpalská	16853	12742	11874	14734
Žilina, Obežná	16816	18767	16248	**20044**
Gánovce, Meteo. st.	19572	13990	12786	**18185**
Chopok, EMEP	32240	27828	20815	**28096**
Kojšovská hoľa	19811	25276	23077	**25822**
Stará Lesná, AÚ SAV, EMEP	19844	11536	12894	**18007**
Starina, Vodná nádrž, EMEP	11648	15215	5107	12823
Topoľníky, Aszód, EMEP	25159	20768	16764	**23245**

* *ozone measurement was introduced in 2009, the value is not accounted for in the average*

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 2008 – 2010. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2008 – 2010 was the number of 25 days overstepped at seven monitoring stations. The highest exceedance was observed at Chopok station (55 days) and Kojšovská hoľa (55 days).

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 (with the exception of two stations).

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 (NO_x, VOC and CO) in Slovakia (already below Gothenburg ceilings) and in Europe as well during the last 10 – 20 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 2010 was in average below the 2003 level.

3.3 TOTAL ATMOSPHERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2010

Since August 1993 total atmospheric ozone over the territory of Slovakia has been measured with the Brewer ozone spectrophotometer MKIV #097 in the Aerological and Radiation Centre (ARC) of the Slovak Hydrometeorological Institute (SHMÚ) at Gánovce near Poprad (49º02'N, 20º19'E, 706 m a.s.l.). As well the solar UV spectra is regularly scanned through the range 290 – 325 nm at 0.5 nm increments. Poprad-Gánovce station is a part of the Global Ozone Observing System (GOOS). The results are regularly submitted to the World Ozone Data Centre (WOUDC) in Canada and to the WMO Ozone Mapping Centre in Greece. Poprad-Gánovce station is included to Global Atmosphere Watch (GAW) network for total ozone and solar UV spectral radiation.

Information about the ozone layer state and intensity of harmful solar UV radiation is provided daily to the public via the SR Press Agency and by mobile phone service. Since April 2000 the SHMÚ Aerological and Radiation Centre has been providing 24 hour UV Index forecast for the public. Predicted UV Index for selected altitudes and its daily course for Poprad-Gánovce coordinates is presented for clear sky, half covered sky and overcast condition on the SHMÚ internet site: (www.shmu.sk/ozon/) from March 15 to September 30.

The annual mean of the total atmospheric ozone was 346.3 Dobson Units in 2010. This is 2.4% over the long-term average (calculated upon the Hradec Kralove measurements in the period 1962 – 1990).

Since 1994 annual means measured at Poprad-Gánovce station have been available. The 1994 – 2010 long-term average is 327.5 Dobson units. In mentioned period the annual mean in the year 2010 was the highest with the deviation of 5.8%. In comparison with the year 2009 the annual mean was higher by 4.4%. Taking into account other available data for our territory last higher annual mean was registered in 1981.

Total ozone statistics for the year 2010 (daily means, relative deviations from long term average, monthly means, standard deviations and extremes) are in Table 3.7. Despite of the positive average annual difference from the long-term average after long period of negative values, distribution of monthly differences was still not ideal in 2010. Total ozone monthly means, lower by 2 – 4% than long-term average, were observed from May to August which are the months with the highest solar elevation. Total ozone monthly means did not drop below the long-term average in other months. The December average deviation of total ozone from long-term average of +13% was the biggest positive one in the history of total ozone measurements at Poprad-Gánovce.

Total ozone weekly averages are shown in Figure 3.3. The graph illustrates the total ozone amount in year 2010 with respect to long-term mean values and shows significant short-term variations in total column ozone in our geographical region. Continuous period with negative deviations from the long-term average was found in period from 19 to 34 calendar week. At the beginning of the year longer periods with positive deviations alternated shorter periods with negative deviations. From 35 calendar week weekly averages dropped below long term average two times only.

Solar ultraviolet (UV) radiation has many biological effects. If UV dose exceeds critical limits for some biological processes it can be very harmful. An active band of wavelengths in range of 290 – 325 nm which is significantly influenced by the total ozone amount in the atmosphere is indicated as UV-B radiation. The wavelength-depending weighting factor is applied on the spectral irradiance to calculate the effective UV-B irradiance causing a particular biological effect. The CIE Erythemal action spectrum is most frequently used to express a detrimental effect on human health. McKinlay and Diffey derived the erythemal action spectrum in 1987. It is internationally accepted and indicated as the CIE (Commission Internationale de l´Eclairage). All values of solar ultraviolet radiation shown in this text and graphs are modified by the CIE erythemal action spectrum.

Fig. 3.3 **Total atmospheric ozone over the territory of Slovakia in 2010**

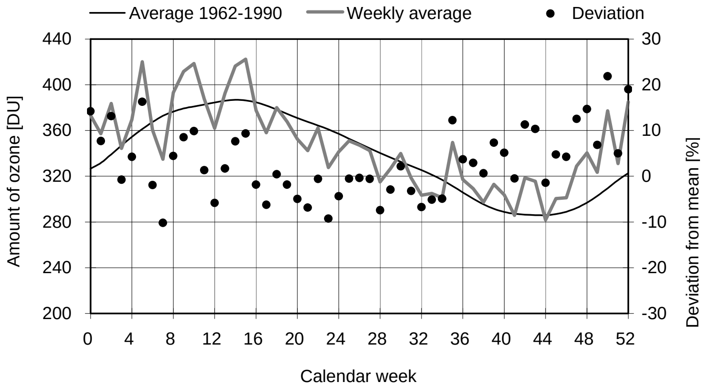


Fig. 3.4 **Annual course of CIE effective irradiance and UV Index noon values – Gánovce 2010**

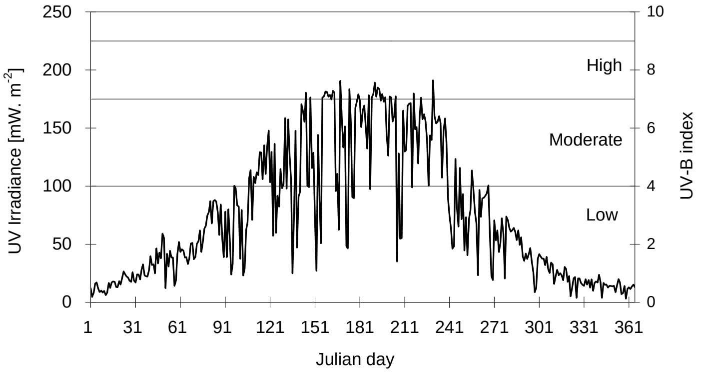


Figure 3.4 shows the biologically effective irradiance (in units of $mW.m^{-3}$). Values have been measured at local noon (about 10:39 UTC) when the daily maximal solar elevation is achieved. Daily UV-B maximum on clear sky days should be measured around local noon. A significant variability of values demonstrates the weather condition (especially cloudiness) influence. As the UV irradiance depends on the solar elevation it has a distinctive daily and annual course. Noon UV-B irradiances are more than 10-times lower in winter as compared to summer. Comparable attenuation is also caused by cloudiness and precipitation in summer. The annual course is not symmetrical by solstices after filtering of cloud and aerosol influence. Decreasing phase in annual course of total ozone causes shift in occurrence of the highest UV irradiances toward period after the summer solstice - to the last decade of June and early July. Solar UV irradiances observed before summer solstice are lower than those ones measured after the summer solstice by the same solar elevation, cloud and aerosol attenuation due to typical annual course of the total ozone.

The UV Index is also shown in Figure 3.4. It is a unit to simplify expression of the UV irradiance level relevant to the erythemal effect on human skin and has been standardised by relationship 1 UV Index = 25 $mW.m^{-3}$ of UV irradiance modified by CIE erythemal action spectrum. Its values are used to express a recommended sunburn time. Individual sunburn time has to be modified depending on skin type and skin adaptation by producing melanin. Values over 5 attained in spring and summer months are classified as high. The sun exposure without protection should be limited to several minutes. Values below 3 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 a quantity of the erythemal ultraviolet radiation is Minimal Erythemal 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 type. Irradiance 1 MED.hour^{-1} corresponds to 0.0583 W.m^{-2} for the dose 1 MED = 210 J.m^{-2}. More information about total ozone, solar UV radiation and the protection against a harmful solar radiation are available on the SHMÚ internet site.

Continuous measurements of the UV radiation have been performed with the broadband UV-Biometers (Solar Light comp.) in parallel with discrete spectral Brewer spectrophotometer measurements. Spectral response function of the UV-Biometer is close to CIE-erythemal action spectrum. Stability of the operational UV-Biometers has been checked by regular comparison with the reference UV-Biometer calibrated towards the Brewer spectrophotometer. That procedure ensures compatibility of UV-Biometers and the Brewer spectrophotometer UV radiation measurements. UV-Biometers enable to register the UV irradiances more densely (every 10 s) than with the Brewer spectrophotometer. The 1 min averages of the integral CIE-erythemal UV irradiance have been stored. More frequent recording of the UV radiation enables to determine more realistic daily maxima and daily doses, especially during cloudy days. All UV radiation characteristics below are obtained from UV-Biometer measurements.

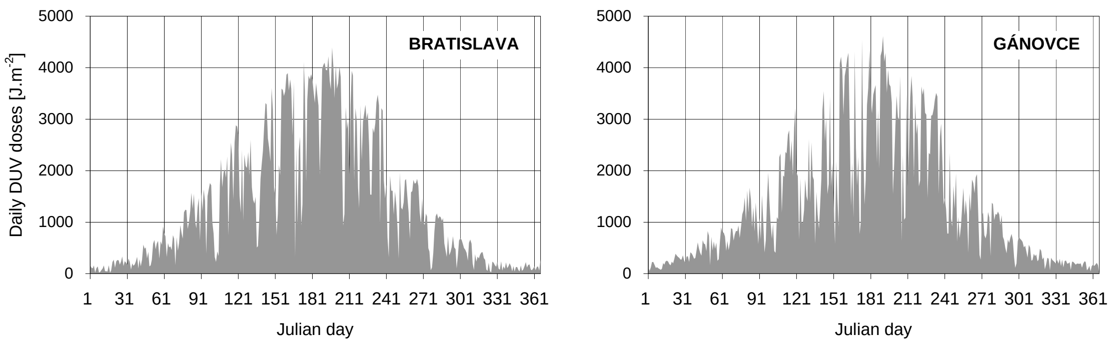
The biggest 1 min average of the CIE-erythemal UV irradiance of 211.6 mW.m^{-2} (3.63 MED.h^{-1}) was registered in Bratislava (48°10’N, 17º06’E, 304 m a.s.l.) on July 18. Deviation of the daily total column ozone from the long-term average was −7% on that day. The biggest 1 min average of the CIE-erythemal UV irradiance of 208.1 mW.m^{-2} (3.57 MED.h^{-1}) was registered at Poprad-Ganovce on June 24. Deviation of the daily total column ozone from the long-term average was −4% on that day.

The biggest hourly average of the CIE-erythemal UV irradiance of 182.2 mW.m^{-2} (3.12 MED.h^{-1}) was registered in Bratislava on July 16. Deviation of the daily total column ozone from the long-term average was −9% on that day. The biggest hourly average of the CIE-erythemal UV irradiance of 187.1 mW.m^{-2} (3.21 MED.h^{-1}) was registered at Poprad-Ganovce on July 10. Deviation of the daily total column ozone from the long-term average was −7% on that day.

Daily doses of the CIE-erythemal UV radiation are presented in Figure 3.5. Maximum daily dose of 4393 J.m^{-2} (which correspondents to 20.9 MED) was measured in Bratislava on July 16. Maximum daily dose of 4615 J.m^{-2}(22.0 MED) was measured at poprad-Ganovce on July 10.

In the period April – September 2010 total CIE-erythemal UV radiation dose in Bratislava was 417 278 J.m^{-2} (85% of yearly total). This value is 10% lower than the dose in 2009. Total CIE-erythemal dose at Poprad-Ganovce was 398 244 J.m^{-2} (82% of yearly total) for the same period. This value is 13% lower than the dose in 2009. Lower yearly totals of UV radiation in 2010 are caused by two factors. Sunshine duration in Bratislava was more than 100 hours and at Poprad-Ganovce more than 150 hours shorter in comparison with previous year and the ozone layer was in a good state.

Fig. 3.5 **Annual course of CIE effective UV radiation daily doses in 2010**



Tab. 3.7 **Total atmospheric ozone in Dobson units [DU] and its deviations from long-term average [%] at Poprad-Gánovce in 2010**

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	350	8	446	24	359	−5	405	5	353	−7	389	7	346	−1	311	−6	374	20	324	11	296	4	327	10
2	380	16	438	22	362	−5	395	2	340	−11	381	4	355	2	309	−7	331	6	317	9	281	−2	334	13
3	390	19	439	22	418	10	426	10	372	−2	361	−1	349	1	307	−7	344	11	308	6	284	−1	335	13
4	342	4	395	9	413	9	380	−2	346	−9	345	−5	364	5	310	−6	338	9	300	3	277	−3	335	12
5	341	3	374	3	437	15	431	11	358	−6	343	−6	379	10	309	−6	343	11	314	9	259	−9	355	19
6	343	4	416	15	458	21	428	11	375	−1	338	−7	348	1	320	−3	331	7	294	2	278	−3	319	6
7	347	5	433	19	436	15	409	6	411	9	334	−8	348	1	347	6	335	9	295	2	298	4	304	1
8	364	9	438	20	450	18	385	0	391	4	320	−12	343	0	327	0	314	2	308	7	305	7	316	5
9	359	8	390	7	423	11	378	−2	407	8	335	−7	336	−2	307	−6	304	−1	314	9	320	12	320	6
10	405	21	321	−12	415	9	440	14	370	−2	331	−8	318	−7	297	−9	314	3	301	5	297		351	15
11	409	22	340	−8	396	4	444	15	350	−7	321	−11	324	−5	309	−5	316	4	290	1	341	19	315	3
12	398	18	354	−4	387	1	432	12	384	2	325	−10	324	−5	307	−6	307	1	278	−3	303	5	339	11
13	383	13	350	−5	436	14	455	18	370	−1	327	−9	320	−6	304	−6	300	−1	285	−1	269	−6	353	15
14	396	17	330	−11	425	11	441	14	386	3	342	−5	321	−6	305	−6	303	0	275	−4	268	−7	366	19
15	376	10	331	−11	442	16	439	14	351	−6	332	−7	306	−10	296	−9	299	−1	272	−5	270	−6	381	23
16	365	7	330	−11	421	10	374	−3	363	−3	337	−6	310	−9	299	−7	309	3	288	1	268	−7	389	26
17	359	5	333	−10	416	9	393	2	343	−8	328	−8	310	−9	337	4	331	11	312	9	301	4	372	20
18	377	10	302	−19	409	7	370	−4	369	−1	336	−6	315	−7	304	−6	317	6	318	11	338	17	405	30
19	339	−2	316	−15	351	−8	357	−7	381	3	358	1	328	−3	310	−4	306	2	300	5	323	12	374	20
20	331	−4	349	−7	333	−13	381	−1	358	−3	358	1	327	−3	303	−6	323	8	311	8	305	5	313	0
21	379	9	382	2	342	−11	387	0	336	−9	380	7	324	−4	296	−7	319	7	355	24	305	5	308	−2
22	345	−1	350	−7	333	−13	406	5	334	−10	341	−4	324	−4	286	−11	302	2	306	7	314	8	314	0
23	312	−11	402	7	356	−7	401	4	347	−6	334	−5	308	−8	287	−10	292	−1	316	11	313	8	329	4
24	327	−7	396	5	338	−12	364	−5	339	−8	340	−4	325	−3	282	−11	276	−6	325	13	327	12	342	8
25	351	0	407	8	329	−14	348	−9	341	−8	359	2	350	5	296	−7	275	−7	355	24	336	15	339	6
26	374	6	410	9	339	−12	349	−9	323	−12	350	0	341	2	293	−7	295	0	357	25	348	19	372	16
27	373	5	431	14	385	0	362	−5	327	−11	352	0	355	7	288	−9	339	16	318	11	357	22	375	17
28	381	7	356	−6	456	18	396	4	354	−4	342	−2	361	8	319	1	286	−2	287	0	306	4	405	26
29	360	1			403	4	361	−5	347	−5	338	−3	343	3	343	9	304	4	293	2	374	27	393	22
30	366	3			356	−8	345	−9	367	0	337	−3	329	−1	325	4	313	7	297	4	323	9	377	16
31	383	7			384	−1			379	4			339	2	393	25			301	5			375	15
∅	365	7	377	2	394	3	396	3	360	−3	344	−4	335	−2	310	−4	315	4	307	7	306	6	349	13
Std	23	8	43	13	41	11	32	8	22	6	17	5	18	5	22	7	21	6	21	7	29	9	29	8
Max	409	22	446	24	458	21	455	18	411	9	389	7	379	10	393	25	374	20	357	25	374	27	405	30
Min	312	−11	302	−19	329	−14	345	−9	323	−12	320	−12	306	−10	282	−11	275	−7	272	−5	259	−9	304	−2

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

4

EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 EMISSION AND AIR POLLUTION SOURCE INVENTORY

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

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

- Decision making process of the responsible bodies.
- Information service for experts and public.
- Definition of environmental priorities and identification of causes of problems.
- Assessment of environmental impact on different plans and strategies.
- Assessment of environmental costs and benefits on different approaches.
- Monitoring of effect, respective effectiveness of adopted measures.
- Support by agreement with adopted national and international commitments.

STATIONARY SOURCES

In the period 1985 – 1999 information related to stationary sources of air pollution was compiled according to the Act 35/1967 Coll. on air in the EAPSI (Emission and Air Pollution Source Inventory) system. This system was divided by 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)

The changes in the air protection legislations in the 90's raised requirements to create entirely new tool for the evidence of stationary sources of air pollution. Development of the new system called NEIS – National Emission Inventory System started in year 1997 in the frame of project of the Ministry of Environment in coordination with Slovak Hydrometeorological Institute (SHMÚ) and close cooperation with the regional offices, district offices and selected operators. The NEIS is a multi-modular system with a yearly update following requirements of actual air protecting legislation. Module NEIS BU enables complex data collection and data processing in respective district offices, as well as the logical verification of emission calculation from the operator's input data. Also serves to issue the decisions on the tax height. Data acquisition is carried out by a set of printed questionnaires, or by the software module NEIS PZ. This module was created for the operators and enables besides electronically processing of the input data also the emission calculation. Operator's databases are sent to the corresponding district office, where they are imported to the local district NEIS BU database. Data from the district databases are then fed into the NEIS CU central database at SHMÚ, where they are controlled. The 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 the Slovak Republic and the system was accepted by cross-sectoral operative committee.

The NEIS system underwent extensive changes within 2004 – 2005 as a result of implementation of the Decree of Ministry of Environment of the SR No. 61/2004 Coll. In this context also the system has been renamed to National Emission Information System (NEIS). Within the system it was started archiving of the documents issued by district offices. Data acquisition was expanded also in terms of transposing EU policies and measures into national legislation (VOC sources, waste incineration, service stations and terminals a. o.)

Positive contribution of database 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 the NEIS database exclusively in coincidence with the legislative regulations.
- Establishment of a Slovak national database that enables the top state administration bodies to fulfill 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.air.sk.
- Establishment of air pollution operators and sources documents archive.

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 sources, change in categorization of sources and their division according to the output or capacity) caused that the EAPSI system may be compared with the NEIS module only on the national level. Comparison of the individual parts of EAPSI (1 and 2) with the NEIS module (large, medium-size sources), respectively comparison of individual sources in both systems is difficult.

According to the Act 137/2010 Coll. (§ 15, section 1, chapter e) as amended, the district offices are (according to the § 26, section 3, chapter g,m) obliged to elaborate yearly reports about the operational characteristics of air pollution sources in their district and provide them electronically at the latest till 31st May of the current year for the next processing to SHMÚ, the organization accredited by the Ministry of Environment to manage the central database NEIS CU and provide the data processing at the national level.

The NEIS system includes the sources of air pollution, which are assigned according to the category and input (Decree No. 356/2010):

Large sources	Stationary sources containing stationary combustion units having cumulative heating input over 50 MW and other technological units with a production capacity above the defined limit.
Middle sources	Stationary sources containing stationary combustion units having cumulative heating input 0.3 – 50 MW and other technological units with a production capacity under the defined limit for the large sources and above the defined limit.
Small sources	Stationary equipment – domestic heating equipment for combustion of solid fuels and natural gas with heating input less than 0.3 MW.

Results (1990 – 2010) – evaluation

Large sources

EAPSI 1 The EAPSI 1 database has been represented by a coherent set of data since 1990 – 1999. In the year 1999, the 967 air pollution sources, i.e. technological units owned by an operator, defined by the code of the area-administrative unit and the serial number. 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. The system contained 846 (703 of it in operation) large point sources in 2010. 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 not possible.

Middle sources

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

NEIS Since 2000 the data updating in the NEIS system has been provided each year. In 2010, NEIS registered 12817 (10876 of it in operation) medium sources. 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 not possible.

Small sources

EAPSI 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 according to the Decree No. 144/2000, since 2004 according to the Decree No. 53/2004, since 2010 according to the Decree No. 362/2010), consumption of natural gas for the inhabitants (register of SPP, a.s.) and specified emission factors. Local furnaces are assessed as the areal sources on the level of district. In 2004, the emission balance has been revised [1] following the emission recalculation since 1990. Within the revision the emission factors were updated (in coincidence with the valid legislation of air protection) as well the qualitative features of solid fuels (in sense of OTN ZP 2008) and the wood combustion emissions were additionally recalculated as its consumption have not been included in the balance before 2004. In the past the balance has not been carried out regularly (EAPSI 3 system had been updated annually only until 1997), in the missing years the data have been additionally calculated. In such a way the consistent data time series since 1990 have been obtained.

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

MOBILE SOURCES

Emissions from mobile sources have been down every year since 1990. To balance emissions from road transport has been used since the 2008 model program COPERT IV[2], approved and recommended Executive Committee, the UNECE Convention on Long-Range Transboundary Air Pollution[3]. Subsequently, using a new version of COPERT need to undertake retrospective conversion of the time series of emissions after the year 1990. Emissions, including carbon content of fuels and integrated national emission factor for petrol and diesel have been converted – recalculation with program COPERT version IV, 8.1. This version updates the technical information about the different categories of vehicles and the parameters specific to that country. The program allows to change parameters according to user requirements and update them. Calculation of emissions from road transport is based on five main types of input parameters such as total fuel consumption, vehicle fleet, driving conditions, emission factors and other parameters, such as average annual driving performance of vehicles. The upgrade and conversion of emissions from road transport was necessary to conduct a more detailed classification of vehicles into different categories according to age, type of energy and payload. When estimating emissions from road transport in 2010 should be based on development and international economic situation, economic crisis, which has strongly influenced the fuel consumption. Consumption of gasoline fell in 2010 to almost 5% compared to 2009, but consumption of diesel oil increased by 12% compared to 2009. The overall increasing trend in emissions is largely unchanged and still have increased the number of cars, number of traffic performance and increase emissions.

In addition to road transport emissions are evaluated and the sources of pollution and of rail, air and water transport in Slovakia. Methodology balances of emissions from the operation of railway traction units is processed according to the methodology EMEP/CORINAIR[4] and non-road sources using emission factors according to the methodological manual Emission Inventory Guidebook. The balance of production of emissions from water transport in the SR is limited to waterway activity in the Slovak Danube. Methodology used assessing the annual production of pollutants from the operation of waterway traffic traction activities of vessels on the Danube is a simplified methodology EMEP/CORINAIR non-road sources based on the calculations of applying average emission factors recommended by the CORINAIR working group. An important factor in the appraisal emissions in aviation is altitude. Different impacts on air pollution have emissions from air traffic on air and road to the landing and take-off maneuvers. The methodology for objectively assessing the impact of air pollutants in larger altitude from aircraft engines is not clearly developed yet, therefore, emission inventory is prepared on the base of local pollution on major airports in Slovakia. Operationally essential input – the number of statistics are made of aircraft movements, flight (LTO) cycle, fuel consumption and an overview of fuel sold. Innovative methodology is also based on knowledge of emission factors of individual aircraft types.

[2] *http://lat.eng.auth.gr/copert*
[3] *http://www.unece.org/env/lrtap/*
[4] *http://reports.eea.europa.eu/EMEPCORINAIR5/*

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 Tables 4.1a and 4.1b and Figures 4.1 and 4.2.

Particulate matter and SO_2

Emissions of particulate matter and SO_2 have been decreasing continuously since 1990. Apart from the decrease in energy production and energy efficiency, this was caused by the change of the 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 SO_2 emissions up to year 2000 was caused by the decreasing consumption of brown coal, hard coal, heavy fuel oil, use 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 fluctuations of SO_2 emissions within 2001 and 2003 were caused either by their partial or total operation, or by the quality of combusted fuel and volume of production of energetic sources. In 2004 till 2006 the another 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 and coal (Slovnaft Ltd., Bratislava, TEKO Ltd., Košice) and by the reduction of production volume (power plants in Zemianske Kostoľany and Vojany). 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 retail price of natural gas and coal. Considerable decrease of SO_2 emission of about 77% was observed in road transport category in 2005. This decrease, contrary to the increase in consumption of fuel substances was caused by the implementation of measures referring to the content of sulphur in fuel substances (Decree No. 53/2004). The decrease of particulate matter emissions in 2006 was achieved mainly by reconstruction of separators in some sources in energy and industry (Power plants in Zemianske Kostoľany, U.S. Steel Ltd., Košice). Another decrease of the particulate matter and SO_2 emissions in 2007 and 2008 for the large stationary sources was mostly caused by the power plant in Vojany, of which some combustion units was out of operation. Since 2008, the trend of emissions of SO_2 and PM is stable. Increase of SO_2 emissions from the large sources in 2010 of 8% was caused by the increase of brown coal consumption in power plant Slovenské elektrárne in Nováky, and by the slightly increase of sulphur-content in this fuel.

Oxides of nitrogen

Emissions of nitrogen oxides have showed a smooth decrease since 1990, although in the years 1994 – 1995 they increased slightly in order to the increase in consumption of natural gas. A decrease of emissions of NOx since 1996 was caused by the change of emission factor, taking into consideration the resent 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. In the further emissions decrease in years 2002 and 2003 participated the denitrification process (power plant Vojany). In 2006 NOx emissions decreased mainly at large and middle stationary sources. This decline is related to the reduction of production (power plants in Zemianske Kostoľany and Vojany) and consumption of solid fuel (since 2007 each year significantly reduces the consumption of anthracite, a downward trend has the consumption of Polish coal too) and natural gas (power plants in Zemianske Kostoľany, Slovak Gas Industry Ltd. Nitra). Significant decline of NOx emissions was achieved in mobile sources, mainly in the road transport. This decrease is connected to the renovation of rolling stock in case of both passenger and good vehicles, and to the use of more accurate emission factor.

CO

The downward trend in CO emissions since 1990 has been caused mainly by the decrease in consumption and by the change of composition of fuel combusted by retail consumers. Carbon monoxide emissions from the large sources have been slightly decreasing as well. The iron and steel industry participate most significantly in the total CO emissions, therefore the emission trend is following the iron and steel production volume. The decrease in CO emissions since 1996 was due to the effects of policy and measures (determined on the results of measurements) to reduce CO emissions from the most significantly sources. The emission trend changes of CO within 1997 and 2003 is also affected by the quantity of pig iron production as well as the fuel consumption. In 2004 the CO emissions slightly increased mainly at large sources (the CO emissions specified by continuous measurement in U.S. Steel Ltd., Košice), since then the emissions have had only moderately decreasing trend. In 2005 the decrease of CO emissions was announced at large sources too, mainly as a consequence of agglomerate production cutting down in U.S. Steel Ltd., Košice and by the implementation of a new technology with effective combustion at lime production (Dolvap Ltd., Varín). Significant decrease in CO emissions of major sources in 2009 was mainly due to decrease in iron and steel production as a result of economic recession. Increase of CO emissions was achieved only in the sector of small sources (residential heating) and it is related to the increase of wood consumption caused by the increasing price of natural gas and coal. The emission decrease in the sector road transport is associated with onward renovation of rolling stock by the generationally new vehicles equipped by the three-way catalysts. Emissions in year 2010 increased (about to the level of year 2002) due to increased production of iron and steel in facility U.S. Steel s.r.o., Košice.

Emissions of other pollutants

The Slovak Republic is bound by the Convention on Long Range Transboundary Air Pollution (1979) to provide inventory of the selected pollutants. The emission inventories of non-methane volatile organic compounds (NMVOC), heavy metals (HMs), persistent organic pollutants (POPs) and particulate matter with aerodynamic diameter less than 10 or 2.5 µm (PM_{10} and $PM_{2.5}$) are processed in accordance with the international methodology using the SNAP 97 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 other basic pollutants are transformed into the international NFR system according to the requirements for reporting and annually reported to the UNECE secretariat and EEA by the Ministry of Environment of the SR.

NMVOC

Emission inventory of NMVOC is elaborated according to EMEP/EEA (Air Pollutant Emission Inventory Guidebook). In 2001 a new subsector road paving with asphalt was included in the national emission inventory and as a result of this the emissions increased adequately in individual years. In 2004 the emission factor from the mentioned sector was revalued and changed. The previous emission factor was based on the highest emission production. New emission factor respects the fact that asphalt mixture contains 5.5% of asphalt. The rest consists of aggregate. The combustion of wood was for the first time included in the residential sector in 2004. Emissions increased slightly in the mentioned sector. In the sector of fuel distribution, LPG distribution has been included since 2001.

The NMVOC emissions have decreased since 1990 according to the balance. This development was caused by the decreased consumption of solvent based paints and the gradual 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 catalysts. The NMVOC emissions have increased in the sector of paints and glues by about 54% since 2000 because the paints and glues are used as part of a large spectrum of industrial activities and various technological operations. Continually the consumption and import of print's ink and solvent paints has increased, too. In years 2004 and 2005 occurred expansion in automotive industry in Slovakia, many of paint-shops was opened and so the consumption of paints has increased. Since 2007, entered into force Council Directive 1999/13/EC of 11 March 1999 with which operators had to adjust to emission limits. In 2007 was recalculated time series from sector dry cleaning and degreasing as a result of refinements counting solvent consumption in the use of paints and glues. In 2008, time series of land-filled and incinerated waste were recalculated on the basis of updated input data. Finally, emissions from road transport were recalculated in order to use an updated version of the model COPERT IV. In 2009 there was a decrease in NMVOC emissions associated with the decrease in industrial production. Emissions from road transport were recalculated until 2000, because of the use of a new version of the model COPERT IV in inventory. Due to updating of activity data, were emissions from waste sector for years 2008, 2005, 2004 and 2002 recalculated.

POPs

Emission inventory of persistent organic pollutants (POPs) is processed according to the methodology, elaborated in the frame of the project Initial Assistance to the Slovak Republic in Meeting Its Obligations Under the Stockholm Convention on Persistent Organic Pollutants, and updated according to the UNEP [5] and methodologies used in the Czech Republic and Poland. Emissions of polychlorinated dioxins and furans (PCDD/F) and polycyclic aromatic hydrocarbons (PAH) from road transport were recalculated by model COPERT IV.

Emissions of POPs from sector energy and waste incineration was recalculated in 2011. Recalculation was focused on the structure of combustion technologies and influence of implementation of limit value for PCDD/F emissions in 2006 to emissions of HCB.

Downward trend of POPs emissions to the air proved to be most remarkable in the area of PAH emissions in the 90-ties, when it was caused mostly by the change of aluminium production technology (use of pre-baked anodes) (Tab. 4.8, Fig. 4.5). Increased emissions of polychlorinated biphenyls (PCB) were influenced by the increase of consumption in crude oil in the road transport and using wood in the residential 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 and industrial waste incinerators). Total emissions PCDD/F depend on waste incineration, iron ore agglomeration and domestic heating., Variations in PCB and PAH emissions are given by variations of fuel consumption in road transport sector. HCB emissions are influenced by production of secondary copper and cement.

[5] *Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, February 2005*

HMs

Emission inventory of heavy metals (HMs) is estimated according to the EMEP/EEA (Air Pollutant Emission Inventory Guidebook). In 2004 wood burning was included in the residential sector and emissions since 1990 were revised. Heavy metals emissions markedly decreased compared to the emission value from year 1990. Except 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, by a change of raw materials used, and in particular by the elimination of leaded petrol since 1996. The Pb emissions increased since 2004 as a result of the increase of production in sector of ore agglomeration and copper production. In recent years slight variations in value have been typical for emission trends of HMs. In year 2007 emissions of Pb and Hg decreased in comparison to 2006 due to decrease in sector of ore agglomeration and glass production. At this stage we noticed increase of Cd emissions due to copper production increase. In 2008 increased emissions of lead, cadmium, mercury, copper, zinc and selenium due to increase of amount of incinerated industrial waste and due to increase of emissions in public electricity and heat production, combustion in manufacturing industry. In 2008 were recalculated time series in sector land-filling and incineration of waste based on updated input data. Road transport emissions were recalculated because of update version of the COPERT IV was used in inventory. In 2009 there was a decrease of emissions of heavy metals associated with the decrease in industrial production. Emissions from road transport were recalculated until 2000, because the new version of the model COPERT IV was used in inventory. Due to updating of activity data, were emissions from waste sector recalculated for years 2008, 2005, 2004 and 2002. Furthermore were recalculated emissions of cadmium from glass production. Recalculation was done for years 2007 and 2008 because of revision of emission factor for coloured glass.

PM_{10}, $PM_{2,5}$

Emissions of PM_{10} and $PM_{2.5}$ have been processed annually on the base of requirements of EMEP/EEA (Air Pollutant Emission Inventory Guidebook), starting from the base year 2000. Emissions of PM_{10} and $PM_{2.5}$ are estimated based on the amount of TSP from database NEIS and they are calculated according to the IIASA methodology. Emissions from the road transport are calculated by the COPERT IV[2] model. The most important contribution to emissions of PM_{10} and $PM_{2.5}$ in the sector of road transport is from diesel engines; the contribution of abrasion to emission of PM_{10} and $PM_{2.5}$ is less important than in total PM (Tab. 4.2 a, b). The most important contribution to total emissions of PM_{10} and $PM_{2.5}$ can be found in the 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. (Tab. 4.9, Fig. 4.6).

Calculation of emissions PM_{10} and $PM_{2.5}$ was elaborated using default indicators. Considering the fact that on the EU level are studies to determine the emission ceilings in Member States in accordance with GAINS [6] model (IIASA), the SR has decided to establish new methodology of emission estimation for PM_{10} and $PM_{2.5}$ in accordance with the GAINS model (input data, emission factors). GAINS model uses the data aggregated from energy balance of the SR from Slovak Statistical Office; whereas country specific methodology uses the input data from NEIS database. The estimated emissions of PM_{10} and $PM_{2.5}$ by country specific methodology are fully consistent with TSP emissions. This is a basic requirement for estimation of emission projections. The whole calculation is already programmed in NEIS database, and therefore it was necessary to recalculate the data back to year 2005.

[6] *Emission estimation of PM_{10} and $PM_{2.5}$ was performed with RAINS model, which has been replaced by GAINS model*

Share of individual sectors in total emissions of the Slovak Republic in 2010

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

Most important sources of air pollution in the Slovak Republic in 2010

Table 4.4 introduces twenty the most important air pollution sources in the SR. The share of these sources in the total air emissions of the SR varies from 73.11% to 97.14%. Table 4.5 lists top ten sources in administrative regions according to the amount of emissions of basic pollutants.

Specific territorial emissions in 2010

Table 4.6 and Figure 4.3 provide information that gives some idea about the territorial distribution of the emitted pollutants. 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 more distant areas, depending on the stack height and meteorological conditions.

4.3 VERIFICATION OF THE RESULTS

Verification of the data gathered during the emission inventory was carried out in comparison with:

- Updated 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 compared 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 in the balance calculation and the recalculation from the results of measurements were significant. In the 1996 and 1999 EAPSI 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 the control of emissions estimated on the district level and its implementation decreased the uncertainty of national emission estimates.

Note: The inventory results of the basic pollutants emitted in year N are completed to the 30th October (N+1) and the inventory results of the other pollutants emitted in year N are completed to the 15th February (N+2).

Tab. 4.1a **Emissions of basic pollutants [thous. t] in the 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	4.103	3.358	2.943	2.674	2.798	2.945	2.891	2.823	2.956	2.710
	Total	283.398	229.083	181.881	148.410	98.307	100.394	75.369	69.117	64.641	67.235
SO_2	EAPSI 1	421.983	347.084	296.036	246.413	182.747	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	2.968	2.402	2.135	1.978	2.101	2.254	2.293	2.326	2.498	1.088
	Total	525.657	445.168	389.377	328.024	245.008	246.052	230.351	204.461	183.886	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	61.479	50.718	45.652	43.586	44.843	46.585	45.618	44.841	45.889	42.718
	Total	226.245	204.145	190.310	181.299	171.108	178.841	135.276	127.168	132.526	120.315
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	164.003	151.872	151.295	161.360	165.921	163.931	153.841	153.968	155.118	144.215
	Total	515.262	492.105	451.285	462.408	438.554	422.833	362.025	359.574	342.726	329.572

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 the SR within 2000 – 2010**

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PM	Stationary sources – NEIS	LS [1]	29.923	29.722	25.037	20.166	17.670	18.719	13.992	6.020	5.406	4.966	4.936
		MS [1]	4.958	4.405	3.767	3.259	2.748	2.392	2.281	1.979	1.764	1.554	1.474
		SS [2]	19.877	20.550	17.217	18.300	21.504	28.709	26.980	26.821	26.921	27.083	26.214
	Mobile **sources**	RT	1.834	2.036	2.212	2.225	2.375	2.849	2.610	3.074	2.791	2.470	2.745
		OT	0.399	0.404	0.366	0.329	0.343	0.359	0.336	0.353	0.325	0.295	0.388
	Total		56.991	57.117	48.599	44.279	44.640	53.028	46.199	38.247	37.207	36.368	35.758
SO_2	Stationary sources – NEIS	LS [1]	101.956	109.822	91.461	95.283	87.932	81.592	80.104	64.974	64.059	59.739	64.798
		MS [1]	8.083	6.655	3.964	3.620	2.652	2.107	1.902	1.598	1.246	0.991	0.906
		SS [2]	16.055	13.764	7.127	6.384	5.381	5.073	5.524	3.735	3.844	3.116	3.424
	Mobile **sources**	RT	0.670	0.675	0.730	0.150	0.159	0.189	0.177	0.204	0.210	0.194	0.211
		OT	0.189	0.194	0.064	0.059	0.063	0.047	0.044	0.047	0.045	0.041	0.072
	Total		126.953	131.110	103.346	105.496	96.187	89.008	87.751	70.558	69.404	64.081	69.410
NOx	Stationary sources – NEIS	LS [1]	54.484	51.653	46.412	44.605	44.244	42.424	39.038	35.762	34.488	31.333	31.466
		MS [1]	8.052	7.751	6.356	6.620	4.926	4.377	4.992	3.542	3.575	3.389	3.485
		SS [2]	7.993	8.391	7.137	7.356	7.582	8.866	8.336	7.819	7.979	7.990	8.076
	Mobile **sources**	RT	32.027	35.072	35.495	34.914	37.794	41.473	39.561	43.838	43.249	37.638	40.510
		OT	4.860	4.899	4.808	4.305	4.506	4.723	4.427	4.654	4.568	3.854	5.010
	Total		107.416	107.766	100.208	97.800	99.052	101.863	96.354	95.615	93.859	84.204	88.547
CO	Stationary sources – NEIS	LS [1]	120.609	115.177	122.225	141.047	147.317	133.787	147.318	141.062	136.530	106.635	125.475
		MS [1]	10.779	10.280	9.150	9.394	7.531	5.853	5.350	5.330	4.518	4.104	4.446
		SS [2]	53.792	50.178	33.815	33.811	34.753	41.766	40.882	37.018	37.367	36.181	35.953
	Mobile **sources**	RT	113.171	127.348	123.273	106.268	101.161	89.077	77.516	59.244	65.068	59.568	53.489
		OT	1.719	1.626	1.591	1.463	1.509	1.566	1.452	1.533	1.446	1.360	1.926
	Total		300.070	304.609	290.054	291.983	292.271	272.049	272.518	244.187	244.929	207.848	221.289

LS - large sources, MS - middle sources, SS - small sources, RT - road transport, OT - other transport

[1] *According to the Decree of MPŽPaRR SR No. 356/2010 Coll.*

[2] *According to the Decree of MPŽPaRR SR No. 144/2000 Coll. (2001 – 2003), according to the Decree of MŽP SR No. 53/2004 Coll. (2004 – 2009, according to the Decree of MPŽPaRR No. 362/2010 Coll.*

Emissions from road transport estimated to January 31st 2012, emissions from other sectors to November 15th 2012.

Tab. 4.2a **Emissions of PM [t] from road transport in the SR within 1990 – 2010**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Emissions from diesel engine	2 221	1 826	1 571	1 417	1 452	1 501	1 413	1 338	1 362	1 228
Emissions from diesel engine	116	107	91	94	99	96	90	73	75	50
Emissions from LPG engine	0	0	0	0	0	0	0	0	0	0
Emissions from CNG engine	0	0	0	0	0	0	0	0	0	0
Total emissions from exhaust	2 337	1 932	1 662	1 511	1 551	1 597	1 503	1 411	1 437	1 278
Abrasion emissions	1 031	848	778	764	833	900	929	979	1 013	987
Total	3 368	2 780	2 440	2 276	2 385	2 497	2 432	2 389	2 451	2 265

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Emissions from diesel engine	955	1 025	1 182	1 150	1 253	1 488	1 305	1 606	1 261	1 060	1 223
Emissions from diesel engine	42	51	48	44	40	44	37	36	36	28	24
Emissions from LPG engine	1	1	1	1	1	1	1	1	1	1	1
Emissions from CNG engine	0	0	0	0	0	0	0	0	0	0	0
Total emissions from exhaust	998	1 077	1 231	1 196	1 294	1 533	1 343	1 643	1 299	1 089	1 248
Abrasion emissions	836	959	982	1 029	1 081	1 315	1 267	1 431	1 493	1 381	1 497
Total	1 834	2 036	2 212	2 225	2 375	2 849	2 610	3 074	2 791	2 470	2 745

Tab. 4.2b **Emissions of PM_{10} and $PM_{2,5}$ [t] from road transport in the SR within 2000 – 2010**

	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	955	955	1 025	1 025	1 182	1 182	1 150	1 150	1 253	1 253	1 488	1 488
Emissions from petrol engines	42	42	51	51	48	48	44	44	40	40	44	44
Total emissions from exhaust	998	998	1 076	1 076	1 229	1 229	1 194	1 194	1 292	1 292	1 532	1 532
Abrasion emissions	559	298	637	340	655	349	676	361	711	379	866	462
Total	1 556	1 296	1 713	1 416	1 884	1 578	1 870	1 555	2 003	1 672	2 398	1 994

	2006		2007		2008		2009		2010	
	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	1 305	1 305	1 606	1 606	1 261	1 261	1 060	1 060	1 223	1 223
Emissions from petrol engines	37	37	36	36	36	36	28	28	24	24
Total emissions from exhaust	1 342	1 342	1 642	1 642	1 297	1 297	1 088	1 088	1 247	1 247
Abrasion emissions	821	437	909	485	976	521	876	470	948	506
Total	2 163	1 779	2 551	2 127	2 273	1 818	1 965	1 558	2 195	1 753

Emissions estimated to January 31st, 2012

Fig. 4.1 **Development trends in basic pollutant emissions within 1990 – 2010**

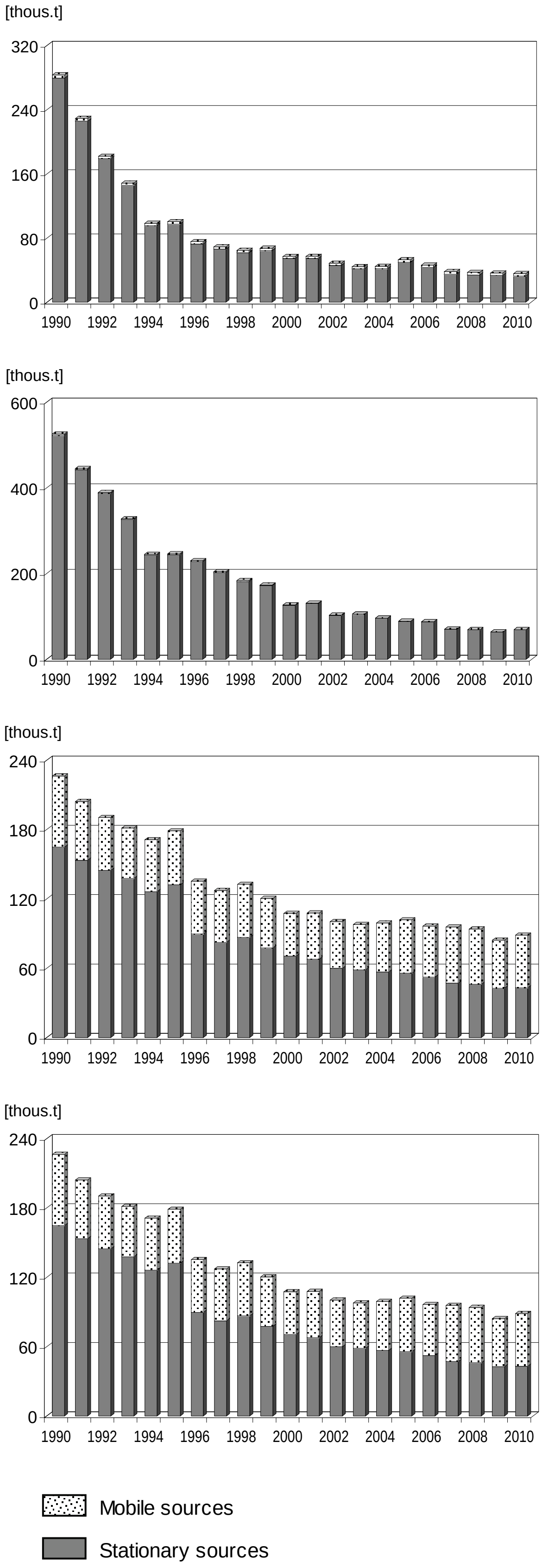
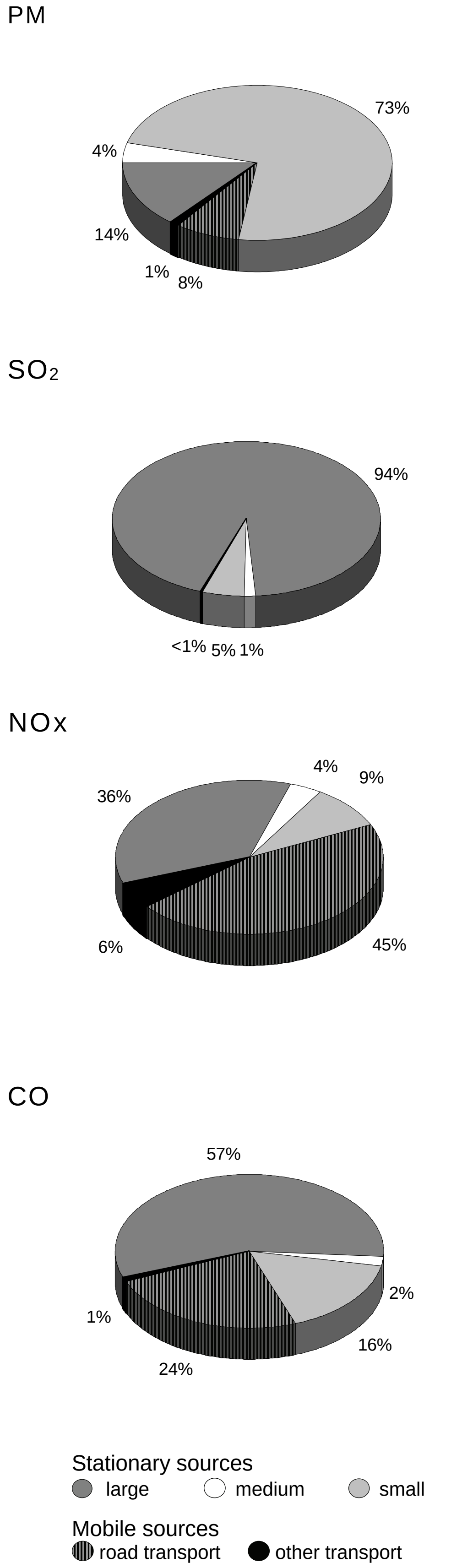


Fig. 4.2 **Emissions of basic pollutants in 2010**



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2000 – 2010**

PM		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agglo-meration	Bratislava	942	477	444	484	470	472	430	353	339	332	327
	Košice	15758	17173	14601	9890	6807	4362	4107	3418	3056	3009	3245
Zone	Bratislava region	501	546	493	466	457	506	452	469	477	469	447
	Trnava region	1518	1518	1284	1325	1522	1935	1825	1752	1770	1755	1742
	Trenčín region	4607	4820	4199	4331	4804	5280	4712	4464	4312	4145	3843
	Nitra region	3057	2921	2476	2474	2740	3414	3144	3074	3053	2991	2896
	Žilina region	6585	6271	5298	5344	5852	7076	6540	6443	6459	6447	6238
	Banská Bystrica region	6320	6355	5334	5346	5820	7378	6710	6579	6566	6497	6328
	Prešov region	4207	4266	3491	3667	4588	5556	5158	4606	4514	4608	4345
	Košice region	11262	10331	8400	8398	8862	13842	10176	3663	3545	3349	3213
Total		54758	54677	46022	41725	41922	49820	43254	34820	34090	33603	32625

SO_2		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agglo-meration	Bratislava	13240	13594	11348	12263	9869	9285	11764	8648	8302	9265	10276
	Košice	18307	12607	10500	10781	13113	12526	11417	10307	9910	9087	9671
Zone	Bratislava region	384	380	208	150	290	377	207	176	169	178	160
	Trnava region	2160	2051	1166	1077	1141	1037	1039	566	566	423	472
	Trenčín region	28625	45187	38305	46051	44108	40937	39659	33450	36114	33251	37232
	Nitra region	4752	4749	3799	3648	2485	2336	2367	1158	1134	1066	532
	Žilina region	10775	10237	7140	7647	6147	5035	4444	3751	3693	3384	2949
	Banská Bystrica region	10654	10043	8814	7983	6300	6197	6791	5022	4724	4119	4157
	Prešov region	8372	8082	6320	6719	4864	4856	4204	3407	1811	1945	2474
	Košice region	28825	23310	14952	8969	7649	6185	5639	3823	2727	1128	1203
Total		126094	130242	102552	105287	95966	88772	87530	70307	69149	63847	69127

NO_x		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agglo-meration	Bratislava	6393	5151	5313	5462	5318	4791	4521	4110	4112	4142	4126
	Košice	12382	12172	12140	12355	11107	10929	12222	9975	8665	8167	9323
Zone	Bratislava region	1792	1900	1972	1602	1670	1742	1700	1882	1874	1739	1437
	Trnava region	2012	1966	1684	1675	1644	1667	1608	1470	1563	1381	1487
	Trenčín region	9083	10489	9616	10167	9677	7822	7835	7219	7588	7328	6892
	Nitra region	3905	3974	3843	3921	4356	3989	3653	2979	3465	3220	2603
	Žilina region	5433	5170	4599	4491	4709	4674	4479	4550	4397	4256	4757
	Banská Bystrica region	6541	6666	6316	5840	6160	6281	5522	5550	5699	4465	5399
	Prešov region	3279	3443	3212	3244	3168	3459	3284	2849	2490	2781	2785
	Košice region	19710	16864	11209	9825	8943	10314	7543	6538	6189	5233	4217
Total		70530	67794	59905	58581	56752	55666	52366	47122	46042	42712	43027

CO		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agglo-meration	Bratislava	1528	1319	1264	1224	1277	1120	1065	879	821	837	824
	Košice	84544	78619	83700	104605	107218	93197	109060	102663	94378	68477	88292
Zone	Bratislava region	1951	1638	1488	2794	1775	1576	1901	2020	2661	3520	3250
	Trnava region	4746	4682	3591	3399	3493	3865	3563	3459	3306	2627	2728
	Trenčín region	11684	10334	7815	7789	8036	9331	10854	9430	10043	10481	11476
	Nitra region	7964	7379	5470	5586	5672	6627	6459	5690	6849	6385	6185
	Žilina region	19357	19287	16520	16462	17257	15924	14990	14686	14210	11573	12059
	Banská Bystrica region	26309	26301	24299	25727	27840	29375	26835	27382	29303	27604	25728
	Prešov region	12170	11838	9075	8804	8800	9282	8714	7522	7080	7042	6795
	Košice region	14927	14237	11969	7862	8232	11109	10108	9680	9764	8374	8536
Total		185180	175636	165191	184252	189601	181407	193550	183410	178415	146920	165874

** According to the Decree of MŽP SR No. 360/2010 Coll., Annex 17*

Tab. 4.4 **The most important air pollution sources in the SR and their share in the emissions of pollutants (NEIS – large and middle sources*) in 2010**

	PM		**SO_2**		**NO_x**		**CO**	
	Operator	[%]	Operator	[%]	Operator	[%]	Operator	[%]
1	U.S. Steel, s.r.o., Košice	42.84	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	55.47	U.S. Steel, s.r.o., Košice	19.39	U.S. Steel, s.r.o., Košice	67.37
2	Carmeuse Slovakia, s.r.o., závod Košice	5.19	CM European power Slovakia, s.r.o., Bratislava	13.00	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	10.11	SLOVALCO, a.s., Žiar nad Hronom	10.37
3	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	5.19	U.S. Steel, s.r.o., Košice	12.68	CM European power Slovakia, s.r.o., Bratislava	4.98	CEMMAC, a.s., Horné Srnie	2.86
4	SLOVALCO, a.s., Žiar nad Hronom	2.29	SLOVNAFT, a.s., Bratislava	2.32	TEKO, a.s., Košice	4.56	KOVOHUTY, a.s., Krompachy	2.39
5	Mondi scp, a.s., Ružomberok	2.07	BUKÓZA ENERGO, a.s., Vranov nad Topľou	2.23	Mondi scp, a.s., Ružomberok	3.57	Holcim (Slovensko), a.s., Rohožník	1.52
6	Carmeuse Slovakia, s.r.o., závod Včeláre	1.75	SLOVALCO, a.s., Žiar nad Hronom	2.10	Slovenské magnezitové závody, a.s., Jelšava	2.88	CALMIT, spol. s r.o. Bratislava, prev. Žirany	1.45
7	CM European power Slovakia, s.r.o., Bratislava	1.75	TEKO, a.s., Košice	1.74	Holcim (Slovensko), a.s., Rohožník	2.87	Považská cementáreň, a.s., Ladce	1.32
8	Novácke chemické závody, a.s., Nováky	1.68	Zvolenská teplárenská, a.s., Zvolen	1.64	SE, a.s., Bratislava, Elektráreň Vojany I a II	2.84	DOLVAP, s.r.o., Varín	1.25
9	Duslo, a.s., Šaľa	1.44	Žilinská teplárenská, a.s., Žilina	1.40	eustream, a.s., prev. Veľké Kapušany	2.36	Slovenské magnezitové závody a.s., Jelšava	1.18
10	TEKO, a.s., Košice	1.44	Martinská teplárenská, a.s., Martin	1.10	SLOVNAFT, a.s., Bratislava	2.25	OFZ, a.s., Istebné	1.01
11	Považská cementáreň, a.s., Ladce	1.37	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.76	CEMMAC, a.s., Horné Srnie	2.03	Calmit, s.r.o., Bratislava, prev. Tisovec	0.92
12	Knauf Insulation, s.r.o., Nová Baňa	1.00	Dalkia Industry Žiar nad Hronom, a.s., Žiar nad	0.51	eustream, a.s., prev. Veľké Zlievce	1.92	Swedspan Slovakia Malacky	0.33
13	BUKOCEL, a.s., Hencovce	0.84	Knauf Insulation, s.r.o., Nová Baňa	0.39	Považská cementáreň, a.s., Ladce	1.82	Carmeuse Slovakia, s.r.o., závod Košice	0.33
14	DOLVAP, s.r.o., Varín	0.74	CHEMES, a.s., HUMENNÉ	0.39	Carmeuse Slovakia, s.r.o., závod Košice	1.79	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	0.31
15	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.72	TP 2, s.r.o., STRÁŽSKE	0.29	OFZ, a.s., Istebné	1.77	SLOVNAFT, a.s., Bratislava	0.30
16	Zvolenská teplárenská a.s., Zvolen	0.63	TEPLÁREŇ, a.s., Považská Bystrica	0.25	BUKÓZA ENERGO, a.s., Vranov nad Topľou	1.76	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.30
17	CHEMES, a.s., HUMENNÉ	0.54	Duslo, a. s. odštepný závod ISTROCHEM	0.22	V.S.H., a.s., Turňa nad Bodvou	1.68	BUKOCEL, a.s., Hencovce	0.28
18	SLOVNAFT a.s., Bratislava	0.54	Slovenské cukrovary, a.s., Sereď	0.22	Duslo, a.s., Šaľa	1.62	Mondi scp, a.s., Ružomberok	0.28
19	Žilinská teplárenská, a.s., Žilina	0.41	OFZ, a.s., Istebné	0.21	SLOVALCO, a.s., Žiar nad Hronom	1.49	HNOJIVÁ DUSLO, s.r.o., STRÁŽSKE	0.27
20	SOTE Čadca	0.41	Mondi scp, a.s., Ružomberok	0.21	eustream, a.s., prev. Jablonov nad Turňou	1.39	Slovmag a.s., Lubeník	0.23
Sum		72.87		97.14		73.11		94.26

** According to the Decree of MŽP SR No. 356/2010 Coll.*

Tab. 4.5 **Sequence of the sources within the region according to the emissions in 2010 (NEIS – large and middle sources*)**

BRATISLAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	CM European power Slovakia, s.r.o., Bratislava	Bratislava II	CM European power Slovakia, s.r.o., Bratislava	Bratislava II
2.	SLOVNAFT, a.s., Bratislava	Bratislava II	SLOVNAFT a.s., Bratislava	Bratislava II
3.	Swedspan Slovakia Malacky	Malacky	Duslo, a.s., odštepný závod ISTROCHEM Bratislava	Bratislava III
4.	Holcim (Slovensko), a.s., Rohožník	Malacky	Holcim (Slovensko), a.s., Rohožník	Malacky
5.	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	Bratislava IV	Bratislavská teplárenská, a.s., Bratislava, Výhr. Juh	Bratislava II
6.	PPC POWER, a.s., Bratislava	Bratislava III	BIONERGY, a.s.,Bratislava	Bratislava II
7.	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II	MO SR, PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok
8.	MO SR, PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok	Slovnaft Petrochemicals, s.r.o.,,Bratislava	Bratislava II
9.	ALAS Slovakia, s.r.o., kameňolom Sološnica	Malacky	Univolt-Remat, s.r.o., Pezinok	Pezinok
10.	Dalkia, a.s., Bratislava, zdroje v okrese BA 5	Bratislava V	NAFTA Gbely	Malacky
	NO_x		CO	
	Source	District	Source	District
1.	CM European power Slovakia, s.r.o., Bratislava	Bratislava II	Holcim (Slovensko), a.s., Rohožník	Malacky
2.	Holcim (Slovensko), a.s., Rohožník	Malacky	Swedspan Slovakia Malacky	Malacky
3.	SLOVNAFT, a.s., Bratislava	Bratislava II	SLOVNAFT, a.s., Bratislava	Bratislava II
4.	PPC POWER, a.s., Bratislava	Bratislava III	Termming, a.s., Bratislava, Malacky	Malacky
5.	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	Bratislava IV
6.	Bratislavská teplárenská, a.s., Bratislava, Tepl. západ	Bratislava IV	NAFTA Gbely	Malacky
7.	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	Bratislava IV	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II
8.	Odvoz a likvidácia odpadu, a.s., Bratislava	Bratislava II	Dalkia, a.s., Bratislava, zdroje v okrese BA 5	Bratislava V
9.	Dalkia, a.s., Bratislava, zdroje v okrese BA 5	Bratislava V	MO SR, PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok
10.	Swedspan Slovakia Malacky	Malacky	Bratislavská teplárenská, a.s., Bratislava, Tepláreň II	Bratislava III

TRNAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Amylum Slovakia spol. s r.o., Boleráz	Trnava	Slovenské cukrovary, a.s., Sereď	Galanta
2.	RaVOD Pata	Galanta	Johns Manville Slovakia, a.s., Trnava	Trnava
3.	TECHAGRA, a.s., zdroje v okrese	Dunajská Streda	Zlieváreň Trnava, s.r.o	Trnava
4.	Slovenské cukrovary, a.s., Sereď	Galanta	Mach-Trade Sereď	Galanta
5.	PENAM, a.s., Nitra, prev. Trnava	Trnava	Baňa Čáry, a.s.	Senica
6.	Johns Manville Slovakia, a.s., Trnava	Trnava	ENVIRAL Leopoldov	Hlohovec
7.	AGROPODNIK, a.s., Trnava	Trnava	PD Siladice	Hlohovec
8.	Zlieváreň Trnava, s.r.o	Trnava	Obec Lakšárska Nová Ves, ZŠ Lakšárska Nová Ves	Senica
9.	IMET, a.s., Skalica	Skalica	Slovasfalt Bratislava, obaľ. Moravský Sv. Ján	Senica
10.	ENVIRAL Leopoldov	Hlohovec	ZF SACHS Slovakia, a.s., Trnava	Trnava
	NOx		CO	
	Source	District	Source	District
1.	Johns Manville Slovakia, a.s., Trnava	Trnava	Službyt Senica	Senica
2.	Slovenské cukrovary, a.s., Sereď	Galanta	Swedwood Slovakia s.r.o., OZ Malacky prev. Trnava	Trnava
3.	ENVIRAL Leopoldov	Hlohovec	I.D.C. Holding, a.s., Pečivárne Sereď	Galanta
4.	Amylum Slovakia spol. s r.o., Boleráz	Trnava	ENVIRAL Leopoldov	Hlohovec
5.	Službyt Senica	Senica	Slovenské cukrovary, a.s., Sereď	Galanta
6.	Swedwood Slovakia s.r.o., OZ Malacky prev. Trnava	Trnava	Amylum Slovakia spol. s r.o., Boleráz	Trnava
7.	Mach-Trade Sereď	Galanta	Johns Manville Slovakia, a.s., Trnava	Trnava
8.	BEKAERT Hlohovec, a.s.	Hlohovec	Zlieváreň Trnava, s.r.o	Trnava
9.	PCA Slovakia TRNAVA	Trnava	Wienerberger Slov.tehelne, s.r.o., závod Boleráz	Trnava
10.	Zlieváreň Trnava, s.r.o	Trnava	Baňa Čáry, a.s.	Senica

NITRA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Duslo, a.s., Šaľa	Šaľa	Smurfit Kappa Štúrovo, a.s.	Nové Zámky
2.	BYTREAL Tlmače, s.r.o., Tlmače	Levice	Icopal, a.s., Štúrovo	Nové Zámky
3.	P.G.TRADE spol. s r.o., Komárno, zdroje v okrese	Nové Zámky	BYTREAL Tlmače, s.r.o., Tlmače	Levice
4.	Kameňolomy a štrkopieskovne, lom Pohranice	Nitra	Liaharenský podnik Nitra, a.s., Veľký Ďur	Levice
5.	PPC ČAB akciová spoločnosť Nové Sady	Nitra	M Agrokom Marcelová	Levice
6.	Lencos, s.r.o., Levice	Levice	MO SR, Posádková správa budov Nitra	Nitra
7.	Slovintegra Energy, s.r.o., Levice	Levice	EMGO Slovakia Nové Zámky	Nové Zámky
8.	DECODOM, s.r.o., Topoľčany	Topoľčany	Duslo, a.s., Šaľa	Šaľa
9.	PALMA Group, a.s., Levice	Levice	ELEKTROKARBON, a.s., Topoľčany	Topoľčany
10.	Agrochemický podnik, a.s., Levice	Nitra	CALMIT, spol. s r.o., Bratislava, prev. Žirany	Nitra
	NOx		CO	
	Source	District	Source	District
1.	Duslo, a.s., Šaľa	Šaľa	CALMIT, spol. s r.o. Bratislava, prev. Žirany	Nitra
2.	eustream, a.s., prev. Ivanka pri Nitre	Nitra	Slovintegra Energy, s.r.o., Levice	Levice
3.	Smurfit Kappa Štúrovo, a.s.	Nové Zámky	Duslo, a.s., Šaľa	Šaľa
4.	Slovintegra Energy, s.r.o., Levice	Levice	Wienerberger Slov. tehelne spol. s r.o., Zl. Moravce	Zlaté Moravce
5.	Bytkomfort, s.r.o., Nové Zámky	Nové Zámky	DANFOSS COMPRESSORS, s.r.o., Zlaté Moravce	Zlaté Moravce
6.	Nitrianska teplárenská spoločnosť Nitra	Nitra	eustream, a.s., prev. Ivanka pri Nitre	Nitra
7.	COM-therm Komárno	Komárno	Vicente Torns Slovakia, a.s., Veľké Kosihy	Komárno
8.	OPM2SR Nitra	Nitra	Smurfit Kappa Štúrovo, a.s.	Nové Zámky
9.	DECODOM, s.r.o., Topoľčany	Topoľčany	Liaharenský podnik Nitra, a.s., Veľký Ďur	Levice
10.	SES, a.s., Tlmače	Levice	Fibra Šahy	Levice

TRENČÍN REGION

	PM		SO_2	
	Source	District	Source	District
1.	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza
2.	Novácke chemické závody, a.s., Nováky	Prievidza	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica
3.	Považská cementáreň, a.s., Ladce	Ilava	VETROPACK NEMŠOVÁ, S.R.O.	Trenčín
4.	HBP, a.s., Banská mech. a elektrifikácia Nováky	Prievidza	HBP, a.s., Banská mech. a elektrifikácia Nováky	Prievidza
5.	LESS TIMBER SK, s.r.o., Lehota pod Vtáčnikom	Prievidza	Služby pre bývanie Trenčín	Trenčín
6.	TERMONOVA Nová Dubnica	Ilava	CEMMAC, a.s., Horné Srnie	Trenčín
7.	CEMMAC, a.s., Horné Srnie	Trenčín	SLOVZINK BRATISLAVA Košeca	Ilava
8.	Považský cukor a.s., Trenčianska Teplá	Trenčín	MO SR, zdroje v okrese Trenčín	Trenčín
9.	KVARTET, a.s., Partizánske	Partizánske	Prefabetón Koš, a.s., Nováky	Prievidza
10.	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica	Poľnohospodárske družstvo v Mestečku	Púchov
	NOx		CO	
	Source	District	Source	District
1.	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza	CEMMAC, a.s., Horné Srnie	Trenčín
2.	CEMMAC, a. s. Horné Srnie	Trenčín	Považská cementáreň, a.s., Ladce	Ilava
3.	Považská cementáreň, a.s., Ladce	Ilava	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza
4.	RONA a.s., Lednické Rovne	Púchov	Novácke chemické závody, a.s., Nováky	Prievidza
5.	VETROPACK NEMŠOVÁ, S.R.O.	Trenčín	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica
6.	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica	Považský cukor a.s., Trenčianska Teplá	Trenčín
7.	Novácke chemické závody, a.s., Nováky	Prievidza	TSM Partizánske	Partizánske
8.	Continental Matador Rubber, s. r.o. Púchov	Púchov	KVARTET, a.s., Partizánske	Partizánske
9.	TSM Partizánske	Partizánske	Služby pre bývanie Trenčín	Trenčín
10.	TERMONOVA Nová Dubnica	Ilava	Cestné stavby Žilina spol. s r.o., zdroje v okrese	Púchov

BANSKÁ BYSTRICA REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVALCO, a.s., Žiar nad Hronom	Žiar nad Hronom	SLOVALCO, a.s., Žiar nad Hronom	Žiar nad Hronom
2.	Knauf Insulation, s.r.o., Nová Baňa	Žarnovica	Zvolenská teplárenská,, a.s., Zvolen	Zvolen
3.	Zvolenská teplárenská, a.s., Zvolen	Zvolen	Dalkia Industry Žiar nad Hronom, a.s., Žiar nad	Žiar nad Hronom
4.	Smrečina HOLD, a.s., Banská Bystrica	Banská Bystrica	Knauf Insulation, s.r.o., Nová Baňa	Žarnovica
5.	Slovmag, a.s., Lubeník	Revúca	Slovenské magnezitové závody, a.s., Jelšava	Revúca
6.	Slovenské magnezitové závody, a.s., Jelšava	Revúca	Slovmag, a.s., Lubeník	Revúca
7.	Harmanec-Kuvert Brezno	Brezno	VUM, a.s., Žiar nad Hronom	Žiar nad Hronom
8.	PPS GROUP, a.s., Detva	Detva	Hriňovské tepelné hospodárstvo, spol. s r.o. Hriňová	Detva
9.	Calmit, s.r.o., Bratislava, prev. Tisovec	Rimavská Sobota	Baňa Dolina, a.s., Veľký Krtíš	Veľký Krtíš
10.	Dalkia Industry Žiar nad Hronom, a.s., Žiar n/Hronom	Žiar nad Hronom	Železiarne Podbrezová, a.s.	Brezno
	NOx		**CO**	
	Source	District	Source	District
1.	Slovenské magnezitové závody, a.s., Jelšava	Revúca	SLOVALCO, a.s., Žiar nad Hronom	Žiar nad Hronom
2.	eustream, a.s., prev. Veľké Zlievce	Veľký Krtíš	Slovenské magnezitové závody, a.s., Jelšava	Revúca
3.	SLOVALCO, a.s., Žiar nad Hronom	Žiar nad Hronom	Calmit, s.r.o., Bratislava, prev. Tisovec	Rimavská Sobota
4.	Zvolenská teplárenská, a.s., Zvolen	Zvolen	Slovmag, a.s., Lubeník	Revúca
5.	Dalkia Industry Žiar nad Hronom, a.s., Žiar n/Hronom	Žiar nad Hronom	Železiarne Podbrezová, a.s.	Brezno
6.	Slovmag, a.s., Lubeník	Revúca	VUM, a.s., Žiar nad Hronom	Žiar nad Hronom
7.	Slovglass Poltár, s.r.o., Poltár	Poltár	Knauf Insulation, s.r.o., Nová Baňa	Žarnovica
8.	Železiarne Podbrezová, a.s.	Brezno	Kremnické tepelné hospodárstvo, s.r.o., Kremnica	Žiar nad Hronom
9.	Calmit, s.r.o., Bratislava, prev. Tisovec	Rimavská Sobota	Smrečina HOLD, a.s., Banská Bystrica	Banská Bystrica
10.	Smrečina HOLD, a.s., Banská Bystrica	Banská Bystrica	Zvolenská teplárenská, a.s., Zvolen	Zvolen

ŽILINA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Mondi scp, a.s., Ružomberok	Ružomberok	Žilinská teplárenská, a.s., Žilina	Žilina
2.	DOLVAP, s.r.o., Varín	Žilina	Martinská teplárenská, a.s., Martin	Martin
3.	Žilinská teplárenská, a.s., Žilina	Žilina	OFZ, a.s., Istebné	Dolný Kubín
4.	SOTE Čadca	Čadca	Mondi scp, a.s., Ružomberok	Ružomberok
5.	TEHOS, s.r.o., Dolný Kubín	Dolný Kubín	SOTE Čadca	Čadca
6.	OFZ, a.s., Istebné	Dolný Kubín	ŽOS Vrútky, a.s.	Martin
7.	Swedwood Slovakia s.r.o., prev. Závažná Poruba	Liptovský Mikuláš	ZDROJ MT s.r.o., Martin - Priekopa	Martin
8.	Martinská teplárenská, a.s., Martin	Martin	DOLVAP, s.r.o., Varín	Žilina
9.	DOLKAM Šuja,a.s., Rajec	Žilina	AVEX Production, s.r.o., prev. Oravská Lesná	Námestovo
10	Cestné stavby Liptovský Mikuláš, zdroje v okrese	Tvrdošín	RABČAN, s.r.o., Rabča	Námestovo
	NOx		**CO**	
	Source	District	Source	District
1.	Mondi scp, a.s., Ružomberok	Ružomberok	DOLVAP, s.r.o., Varín	Žilina
2.	OFZ, a.s., Istebné	Dolný Kubín	OFZ, a.s., Istebné	Dolný Kubín
3.	Žilinská teplárenská, a.s., Žilina	Žilina	Mondi scp, a.s., Ružomberok	Ružomberok
4.	Martinská teplárenská, a.s., Martin	Martin	SOTE Čadca	Čadca
5.	SPECIALITY MINERALS SLOVAKIA Ružomberok	Ružomberok	Swedwood Slovakia, s.r.o., prev. Závažná Poruba	Liptovský Mikuláš
6.	Rettenmeier Tatra Timber, s.r.o., Liptovský Hrádok	Liptovský Mikuláš	Turzovská drevárska fabrika Turzovka	Čadca
7.	KIA Motors Slovakia, s.r.o., Žilina	Žilina	Rettenmeier Tatra Timber, s.r.o., Liptovský Hrádok	Liptovský Mikuláš
8.	TEHOS, s.r.o., Dolný Kubín	Dolný Kubín	Žilinská teplárenská, a.s., Žilina	Žilina
9.	SOTE Čadca	Čadca	ŽOS Vrútky, a.s.	Martin
10	KYSUCA, s.r.o., Kysucké Nové Mesto	Kysucké N.Mesto	LMT Liptovský Mikuláš	Liptovský Mikuláš

PREŠOV REGION

	PM		SO_2	
	Source	District	Source	District
1.	BUKOCEL, a.s., Hencovce	Vranov n/Topľou	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou
2.	CHEMES, a.s., HUMENNÉ	Humenné	CHEMES, a.s., HUMENNÉ	Humenné
3.	BIOENERGY BARDEJOV, s.r.o., Bardejov	Bardejov	Energy Snina, a.s.	Snina
4.	Kronospan SK, s.r.o., Prešov	Prešov	BUKOCEL, a.s., Hencovce	Vranov n/Topľou
5.	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou	Zeocem Bystré, a.s.	Vranov n/Topľou
6.	TATRAVAGÓNKA, a.s., POPRAD	Poprad	Zastrova, a.s., Spišská Stará Ves	Kežmarok
7.	Zeocem Bystré, a.s.	Vranov n/Topľou	DSS Spišský Št. Spišský Štvrtok	Levoča
8.	Spravbytherm, s.r.o., Kežmarok	Kežmarok	MO SR, kotolňa Kamenica n. Cirochou	Humenné
9.	SCHULE SLOVAKIA, s.r.o., Poprad	Poprad	ZŠ Malcov	Bardejov
10	Lesy Slovenskej republiky o.z. Vranov n. Topľou	Vranov n/Topľou	Podtatranská vodár. prevádzková spoločnosť, a.s.	Stará Ľubovňa
	NOx		**CO**	
	Source	District	Source	District
1.	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou	BUKOCEL, a.s., Hencovce	Vranov n/Topľou
2.	CHEMES, a.s., HUMENNÉ	Humenné	Leier Baustoffe SK s.r.o., Petrovany	Prešov
3.	BUKOCEL, a.s., Hencovce	Vranov n/Topľou	BIOENERGY BARDEJOV, s.r.o., Bardejov	Bardejov
4.	BIOENERGY BARDEJOV, s.r.o., Bardejov	Bardejov	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou
5.	Energy Snina, a.s.	Snina	CHEMES, a.s., HUMENNÉ	Humenné
6.	SPRAVBYT, a.s., Prešov	Prešov	SPRAVBYT, a.s., Prešov	Prešov
7.	DALKIA POPRAD, a.s.	Poprad	TENERGO BRNO, a.s., prev. Snina	Snina
8.	Kronospan SK, s.r.o., Prešov	Prešov	Energy Snina, a.s.	Snina
9.	Zeocem Bystré, a.s.	Vranov n/Topľou	Kronospan SK, s.r.o., Prešov	Prešov
10	TATRAVAGÓNKA, a.s., POPRAD	Poprad	SCHULE SLOVAKIA, s.r.o., Poprad	Poprad

KOŠICE REGION

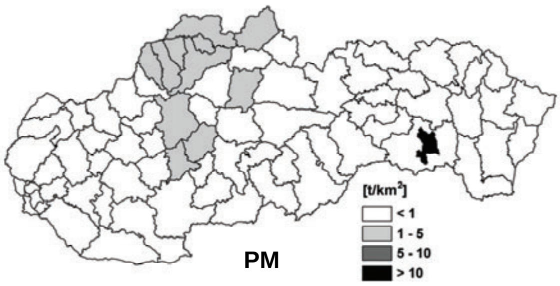
	PM		SO_2	
	Source	District	Source	District
1.	U.S. Steel, s.r.o., Košice	Košice II	U.S. Steel, s.r.o., Košice	Košice II
2.	Carmeuse Slovakia, s.r.o., závod Košice	Košice II	TEKO, a.s., Košice	Košice IV
3.	Carmeuse Slovakia, s.r.o., závod Včeláre	Košice - okolie	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
4.	TEKO, a.s., Košice	Košice IV	TP 2, s.r.o., STRÁŽSKE	Michalovce
5.	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	Slovenské magnezitové závody, a.s., závod Bočiar	Košice II
6.	EUROCAST Košice, spol. s r.o., Košice	Košice - okolie	KOVOHUTY, a.s., Krompachy	Spišská Nová Ves
7.	V.S.H., a.s, Turňa nad Bodvou	Košice - okolie	Refrako, s.r.o., Košice	Košice II
8.	KOVOHUTY, a.s., Krompachy	Spišská Nová Ves	V.S.H., a.s., Turňa nad Bodvou	Košice - okolie
9.	EMBRACO SLOVAKIA s.r.o., Spišská Nová Ves	Spišská Nová Ves	Carmeuse Slovakia s.r.o., závod Košice	Košice II
10	Carmeuse Slovakia, s.r.o., závod Slavec	Rožňava	Vulkmont Košice	Košice II
	NOx		**CO**	
	Source	District	Source	District
1.	U.S. Steel, s.r.o., Košice	Košice II	U.S. Steel, s.r.o., Košice	Košice II
2.	TEKO, a.s., Košice	Košice IV	KOVOHUTY, a.s., Krompachy	Spišská Nová Ves
3.	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	Carmeuse Slovakia s.r.o., závod Košice	Košice II
4.	eustream, a.s., prev. Veľké Kapušany	Michalovce	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
5.	Carmeuse Slovakia s.r.o., závod Košice	Košice II	HNOJIVÁ DUSLO, s.r.o., STRÁŽSKE	Michalovce
6.	V.S.H., a.s., Turňa nad Bodvou	Košice - okolie	Calmit, s.r.o., Bratislava, prev. Margecany	Gelnica
7.	eustream, a.s., prev. Jablonov nad Turňou	Rožňava	Slovenské magnezitové závody, a.s., závod Bočiar	Košice II
8.	Slovenské magnezitové závody, a.s., závod Bočiar	Košice II	TEKO, a.s., Košice	Košice IV
9.	TP 2, s.r.o., STRÁŽSKE	Michalovce	eustream, a.s., prev. Veľké Kapušany	Michalovce
10	Refrako, s.r.o., Košice	Košice II	TP 2, s.r.o., STRÁŽSKE	Michalovce

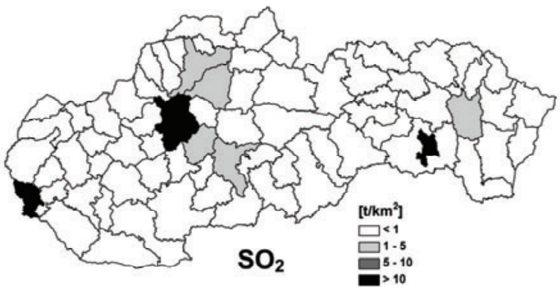
**According to the Decree of MPŽPaRR SR No. 356/2010 Coll.*

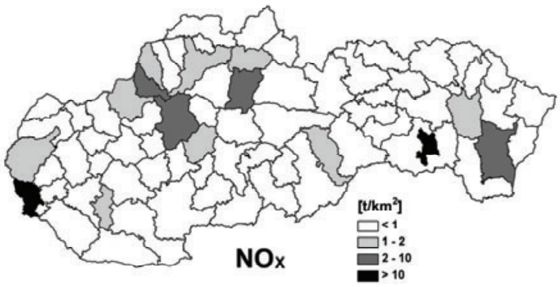
Tab. 4.6 **Stationary source emissions by districts in 2010**

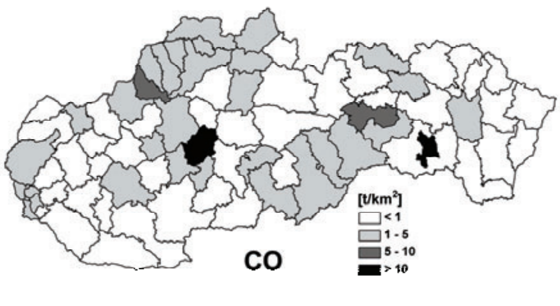
District	Emissions [t.year^{-1}]				Specific territorial emis. [t.year^{-1}.km^{-2}]			
	PM	SO_2	NOx	CO	PM	SO_2	NOx	CO
1. Bratislava	327	10276	4126	824	0.89	27.92	11.21	2.24
2. Malacky	250	125	1244	2910	0.26	0.13	1.31	3.06
3. Pezinok	105	23	92	181	0.28	0.06	0.25	0.48
4. Senec	92	12	102	159	0.26	0.03	0.28	0.44
5. Dunajská Streda	372	47	210	517	0.35	0.04	0.20	0.48
6. Galanta	255	192	323	408	0.40	0.30	0.50	0.63
7. Hlohovec	120	20	154	195	0.45	0.07	0.58	0.73
8. Piešťany	211	27	123	306	0.55	0.07	0.32	0.80
9. Senica	316	59	165	624	0.46	0.09	0.24	0.91
10. Skalica	205	27	96	284	0.57	0.08	0.27	0.80
11. Trnava	263	100	417	394	0.36	0.13	0.56	0.53
12. Bánovce n/B	220	31	78	304	0.48	0.07	0.17	0.66
13. Ilava	317	38	778	2038	0.88	0.11	2.17	5.69
14. Myjava	322	42	90	436	0.98	0.13	0.28	1.33
15. Nové Mesto n/V	299	39	139	425	0.52	0.07	0.24	0.73
16. Partizánske	153	23	110	409	0.51	0.08	0.36	1.36
17. Považská Bystrica	555	240	284	1020	1.20	0.52	0.61	2.20
18. Prievidza	1134	36573	3870	1664	1.18	38.10	4.03	1.73
19. Púchov	484	72	452	683	1.29	0.19	1.21	1.82
20. Trenčín	360	172	1090	4496	0.53	0.26	1.62	6.66
21. Komárno	384	48	220	565	0.35	0.04	0.20	0.51
22. Levice	992	151	449	1490	0.64	0.10	0.29	0.96
23. Nitra	320	45	650	2375	0.37	0.05	0.75	2.73
24. Nové Zámky	564	216	384	809	0.42	0.16	0.29	0.60
25. Šaľa	217	17	658	251	0.61	0.05	1.85	0.70
26. Topoľčany	190	26	136	274	0.32	0.04	0.23	0.46
27. Zlaté Moravce	231	30	104	421	0.44	0.06	0.20	0.81
28. Bytča	375	50	106	516	1.33	0.18	0.38	1.83
29. Čadca	1132	271	322	1679	1.49	0.36	0.42	2.21
30. Dolný Kubín	330	180	734	1733	0.67	0.37	1.49	3.52
31. Kysucké Nové Mesto	241	30	92	328	1.39	0.17	0.53	1.88
32. Liptovský Mikuláš	584	79	308	976	0.44	0.06	0.23	0.73
33. Martin	447	852	440	714	0.61	1.16	0.60	0.97
34. Námestovo	1098	173	257	1528	1.59	0.25	0.37	2.21
35. Ružomberok	770	225	1528	1243	1.19	0.35	2.36	1.92
36. Turčianske Teplice	200	29	54	275	0.51	0.07	0.14	0.70
37. Tvrdošín	178	22	73	238	0.37	0.05	0.15	0.50
38. Žilina	882	1039	842	2829	1.08	1.27	1.03	3.47
39. Banská Bystrica	516	68	354	805	0.64	0.08	0.44	0.99
40. Banská Štiavnica	243	37	59	327	0.83	0.13	0.20	1.12
41. Brezno	622	109	267	1167	0.49	0.09	0.21	0.92
42. Detva	409	68	168	586	0.91	0.15	0.37	1.31
43. Krupina	345	49	90	480	0.59	0.08	0.15	0.82
44. Lučenec	595	79	203	832	0.72	0.10	0.25	1.01
45. Poltár	198	31	194	287	0.42	0.06	0.41	0.60
46. Revúca	484	248	1270	2477	0.66	0.34	1.74	3.39
47. Rimavská Sobota	1054	147	382	2641	0.72	0.10	0.26	1.80
48. Veľký Krtíš	485	93	811	710	0.57	0.11	0.96	0.84
49. Zvolen	352	1119	604	495	0.46	1.47	0.80	0.65
50. Žarnovica	481	314	179	665	1.13	0.74	0.42	1.56
51. Žiar n/H	543	1797	820	14256	1.05	3.47	1.58	27.52
52. Bardejov	397	54	221	621	0.42	0.06	0.24	0.66
53. Humenné	358	302	329	502	0.48	0.40	0.44	0.67
54. Kežmarok	407	62	134	572	0.49	0.07	0.16	0.68
55. Levoča	204	31	65	288	0.57	0.09	0.18	0.81
56. Medzilaborce	170	22	42	230	0.40	0.05	0.10	0.54
57. Poprad	279	34	191	424	0.25	0.03	0.17	0.38
58. Prešov	463	60	292	893	0.50	0.06	0.31	0.96
59. Sabinov	382	50	123	528	0.79	0.10	0.25	1.09
60. Snina	401	134	199	621	0.50	0.17	0.25	0.77
61. Stará Ľubovňa	494	69	144	692	0.79	0.11	0.23	1.11
62. Stropkov	136	18	41	190	0.35	0.05	0.11	0.49
63. Svidník	256	35	74	347	0.47	0.06	0.13	0.63
64. Vranov n/T	399	1602	930	889	0.52	2.08	1.21	1.16
65. Gelnica	380	50	98	704	0.65	0.09	0.17	1.21
66. Košice	3245	9671	9323	88292	13.35	39.80	38.37	363.34
67. Košice - okolie	886	114	845	1100	0.58	0.07	0.55	0.72
68. Michalovce	191	705	2102	1096	0.19	0.69	2.06	1.08
69. Rožňava	847	115	743	1222	0.72	0.10	0.63	1.04
70. Sobrance	163	24	48	221	0.30	0.05	0.09	0.41
71. Spišská Nová Ves	377	141	190	3653	0.64	0.24	0.32	6.22
72. Trebišov	369	54	191	540	0.34	0.05	0.18	0.50
Slovakia	32625	69127	43027	165874	0.67	1.41	0.88	3.38

Fig. 4.3 **Specific territorial emission in 2010**







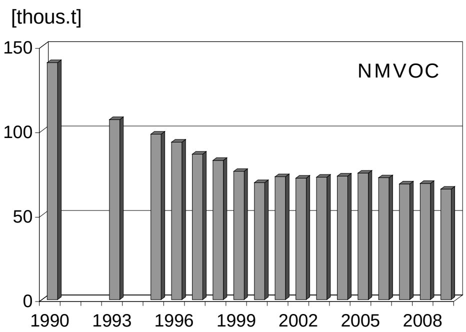


Tab. 4.7 **NMVOC emissions [t] in the SR in 1990 – 2009**

Sector / Subsector	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Combustion processes I	335	258	201	221	214	214	203	185	174	158	172	157
Public power	223	187	139	159	147	161	156	139	131	121	130	119
District heating plants	112	71	62	62	67	53	47	46	43	37	42	38
Combustion processes II	12641	9618	7913	8305	7070	7505	8931	11934	11162	11113	11173	11273
Commercial and institutional plants	226	150	26	27	23	24	25	28	27	29	32	49
Agriculture	IE	IE	6	7	7	7	7	9	8	6	6	6
Residential plants	12415	9468	7881	8271	7040	7474	8899	11897	11127	11078	11135	11218
Combustion processes in industry	981	805	584	772	646	703	751	806	897	881	883	662
Comb. in boilers, gas turb. and stat. eng.	206	150	158	231	146	168	120	121	117	94	94	90
Iron production	32	29	28	29	32	35	34	33	37	36	32	27
Ore agglomeration	438	358	396	403	383	409	402	384	390	367	338	213
Copper production	305	268	2	109	85	91	195	268	353	384	419	332
Production processes	27029	11129	8717	8343	7728	7152	7104	6434	5821	5474	4903	4338
Processes in petroleum industries	17188	7474	6627	6306	5571	4672	4617	4058	3469	3166	2804	2623
Coke production	1053	834	719	719	765	801	800	783	787	783	720	450
Steel production	43	36	34	37	40	43	41	41	47	47	42	36
Rolling mills	233	297	300	267	304	336	329	341	361	372	347	295
Aluminium production	0.101	0.049	0.165	0.165	0.165	0.167	0.235	0.2	0.2	0.3	0.2	0.2
Proc. in organic chemical industries	6437	1369	651	644	690	941	970	870	845	793	667	609
Food production	2073	1118	385	370	357	358	346	340	311	312	322	324
Road paving with asphalt	2.4	1.0	0.5	0.5	0.5	0.6	0.5	0.7	1.0	0.7	0.8	0.8
Exploitation&distrib. of natural resour.	8822	8535	5929	6161	6024	7431	7696	7104	6276	6170	6363	6207
Exploitation&distribution of crude oil	5198	4298	3750	3848	3801	3999	4149	4280	4472	4266	4272	4324
Distribution of fuel	3624	4237	2179	2313	2223	3432	3547	2824	1804	1904	2091	1883
Solvent and other products use	52875	37065	26978	28724	31020	32272	32760	33561	34634	33579	33964	33330
Use of paints and glues	32811	20687	13214	14025	15110	16369	18457	18918	19522	20003	20385	20365
Dry cleaning and degreasing	11500	7695	5091	6171	7332	7408	5822	6101	6600	5057	5052	4412
Processing of fat and oil	332	363	299	191	240	156	134	189	152	147	138	144
Products	8232	8320	8374	8337	8338	8339	8347	8353	8360	8372	8389	8409
Road transport	31435	29128	17599	18999	17732	15508	14372	13454	11785	9876	9882	8209
Other transport	953	599	528	524	500	460	477	496	449	477	442	485
Waste incineration	4631	388	428	322	570	759	439	543	510	382	614	330
Municipal waste	71	107	147	93	111	115	130	130	135	128	112	126
Industrial waste	281	281	281	229	459	642	306	411	371	251	499	201
Hospital waste	IE	IE	0.1	0.1	0.1	2	2.1	2.8	3.7	2.5	2.5	2.9
Agricultural waste*	4279											
Agriculture	651	436	436	436	436	436	436	436	436	437	438	439
Total	140353	97961	69313	72807	71940	72440	73169	74953	72144	68547	68834	65430

Emissions from transport estimated to December 14th, 2011, emissions from the other sectors estimated to February 15th, 2011.
IE = included in other source category
** Agricultural waste combustion is prohibited since 1994*
Because of changeover from EAPSI to NEIS in year 2000 some changes of source appointment have to be done in the framework of subsectors combustion in boilers, gas turbines and stationary engines; commercial and institutional plants and new sector agriculture (sector non-industrial combustion plants) was established.

Fig. 4.4 **Development trends in NMVOC emissions in 1990 – 2009**

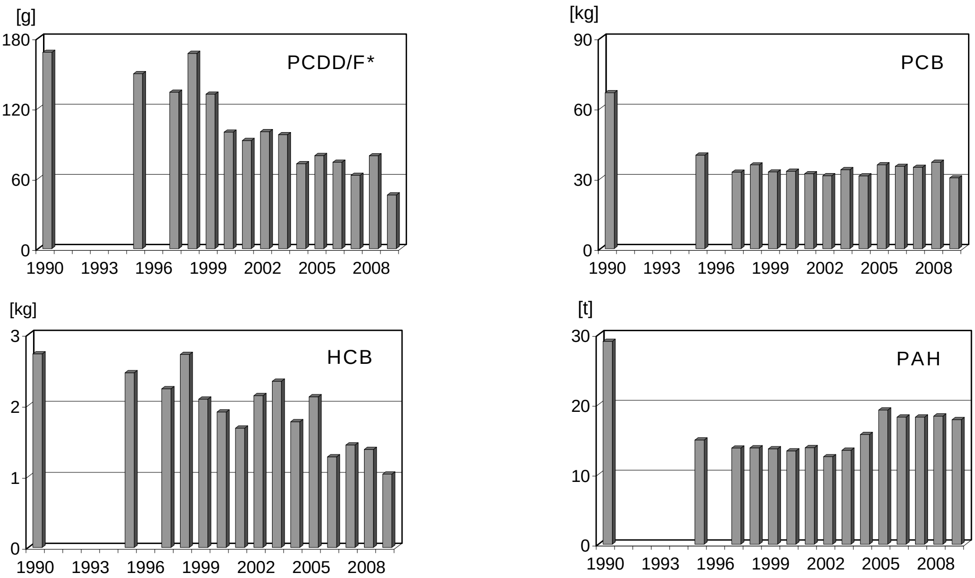


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2009**

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 processes I	4.808	0.615	0.188	981.230	172.665	254.179	254.279	300.107
Public power	1.659	0.604	0.178	3.203	0.047	1.489	1.586	0.081
District heating plants	0.149	0.011	0.010	5.423	0.014	2.690	2.693	0.026
Coke production	3.000			972.604	172.604	250.000	250.000	300.000
Combustion processes II	3.205	8.664	0.167	15245.306	4366.165	1902.187	5731.652	3245.303
Commercial and institutional plants	0.028	0.007	0.002	0.730	0.006	0.351	0.364	0.010
Residential plants	3.172	8.657	0.165	15244.466	4366.156	1901.791	5731.231	3245.288
Agriculture	0.005	0.001	0.000	0.110	0.003	0.046	0.056	0.005
Combustion processes in industry	14.827	3.000	0.189	96.073	55.471	13.969	20.254	6.380
Comb. in boilers, gas turb. and stat. eng.	0.540	0.666	0.106	19.678	1.512	5.262	10.454	2.450
Iron production	0.302	0.019	0.000	51.325	51.325	0.000	0.000	0.000
Ore agglomeration	13.523	2.125	0.062	22.545	2.318	8.404	8.404	3.419
Cast iron production	0.070	0.013	0.000	0.011	0.002	0.004	0.004	0.002
Others	0.392	0.176	0.022	2.515	0.314	0.300	1.393	0.509
Production processes	5.469	1.618	0.419	1218.618	436.899	363.083	371.323	47.313
Aluminium production	0.239	0.040	0.000	549.204	179.525	173.544	173.544	22.590
Steel production	4.209	1.528	0.000	67.836	67.836	0.000	0.000	0.000
Carbon mineral production	0.000	0.000	0.000	601.578	189.538	189.538	197.779	24.722
Wood impregnation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Others	1.020	0.050	0.419	0.000	0.000	0.000	0.000	0.000
Road transport	0.400	13.004	0.011	120.862	15.662	43.049	42.832	19.319
Other transport	0.003	0.269	0.0002	3.233	1.983	1.190	2.776	1.983
Waste incineration	17.168	3.035	0.058	151.224	41.840	30.754	62.628	16.001
Municipal waste	0.071	0.942	0.018	6.909	0.124	3.377	3.377	0.030
Industrial waste	14.850	1.980	0.028	7.696	0.139	3.762	3.762	0.034
Hospital waste	1.472	0.029	0.000	0.114	0.002	0.056	0.056	0.001
Others	0.775	0.083	0.012	136.504	41.575	23.559	55.433	15.937
Total	45.880	30.206	1.032	17816.547	5090.685	2608.411	6485.744	3636.405

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 from transport estimated to December 14th, 2011, emissions from other sectors estimated to February 15th, 2011.

Fig. 4.5 **Development trends in POPs emissions in 1990 – 2009**

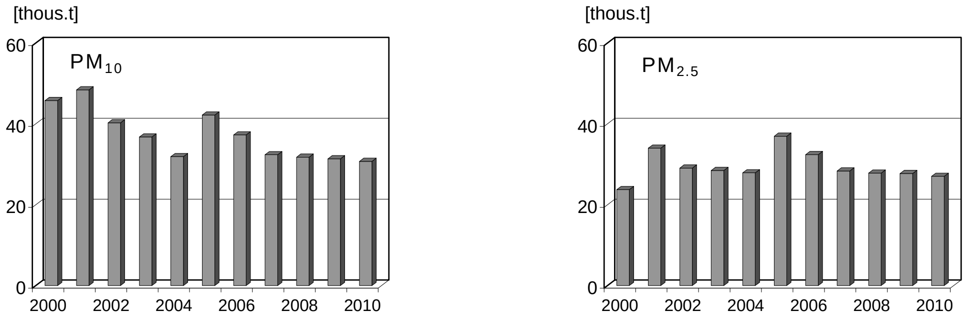


Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [thous. t] in the SR in 2005 – 2010**

Sector / Subsector	2005		2005		2007		2008		2009		2010	
	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]
Combustion processes I	8.623	7.723	5.756	5.172	1.438	1.048	1.307	0.939	1.221	0.878	1.200	0.877
Public Electricity and Heat Production	7.566	7.074	5.053	4.735	0.743	0.612	0.696	0.561	0.643	0.518	0.619	0.522
Petroleum refining	0.095	0.075	0.099	0.078	0.112	0.089	0.076	0.061	0.083	0.066	0.049	0.039
Coke production	0.962	0.573	0.604	0.359	0.583	0.346	0.535	0.317	0.495	0.294	0.532	0.316
Combustion processes II	27.217	24.563	25.399	22.740	25.296	23.048	25.431	23.145	25.589	23.460	24.773	22.594
Commercial and institutional plants	0.226	0.164	0.173	0.123	0.136	0.094	0.173	0.124	0.137	0.102	0.147	0.114
Residential plants	26.742	24.230	25.016	22.485	25.044	22.903	25.137	22.967	25.353	23.311	24.508	22.431
Agriculture	0.097	0.045	0.084	0.038	0.067	0.031	0.077	0.035	0.068	0.031	0.081	0.034
Other combustion processes	0.152	0.124	0.126	0.094	0.048	0.019	0.044	0.020	0.032	0.016	0.036	0.016
Combustion processes in industry	2.901	2.023	2.693	1.931	2.041	1.485	1.762	1.295	1.603	1.158	1.518	1.109
Production of iron and steel	0.773	0.574	0.794	0.601	0.556	0.395	0.470	0.324	0.395	0.287	0.515	0.376
Production of non-ferrous metals	0.191	0.165	0.145	0.123	0.136	0.117	0.193	0.166	0.178	0.155	0.169	0.146
Chemical industry	0.497	0.363	0.385	0.281	0.225	0.179	0.226	0.187	0.243	0.193	0.218	0.183
Production of paper and cellulose	0.294	0.127	0.226	0.096	0.086	0.056	0.082	0.049	0.149	0.102	0.106	0.056
Food production	0.094	0.078	0.093	0.077	0.048	0.028	0.042	0.022	0.036	0.019	0.036	0.019
Other combustion processes in industry	1.053	0.717	1.051	0.753	0.991	0.710	0.748	0.546	0.601	0.404	0.475	0.329
Transport	2.741	2.320	2.483	2.084	2.889	2.447	2.583	2.113	2.247	1.826	2.565	2.105
Civil aviation	0.009	0.009	0.010	0.010	0.010	0.010	0.012	0.012	0.009	0.009	0.012	0.012
Road transport	1.533	1.533	1.343	1.343	1.643	1.643	1.299	1.299	1.089	1.089	1.248	1.248
Road transport - abrasion	0.866	0.462	0.821	0.437	0.909	0.485	0.976	0.521	0.876	0.470	0.948	0.506
Railways	0.137	0.130	0.146	0.139	0.141	0.133	0.128	0.122	0.111	0.105	0.113	0.107
Navigation	0.195	0.185	0.163	0.155	0.185	0.176	0.169	0.160	0.161	0.153	0.244	0.231
Industrial technologies	0.173	0.062	0.177	0.072	0.151	0.063	0.148	0.058	0.124	0.052	0.120	0.051
Mineral products	0.043	0.004	0.047	0.004	0.041	0.003	0.043	0.004	0.033	0.003	0.033	0.003
Chemical industry	0.058	0.036	0.083	0.051	0.069	0.042	0.063	0.039	0.058	0.036	0.057	0.035
Paper and pulp	<0.001	<0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Other industrial processes	0.072	0.023	0.045	0.015	0.040	0.016	0.041	0.015	0.032	0.013	0.029	0.012
Total	41.655	36.691	36.508	31.999	31.814	28.091	31.230	27.551	30.784	27.374	30.176	26.735

Emissions from road and other transport estimated to January 31st, 2012, emissions from other sectors estimated to December 1st, 2011.

Fig. 4.6 **Development trends in PM_{10} and $PM_{2.5}$ emissions in 2000 – 2010**

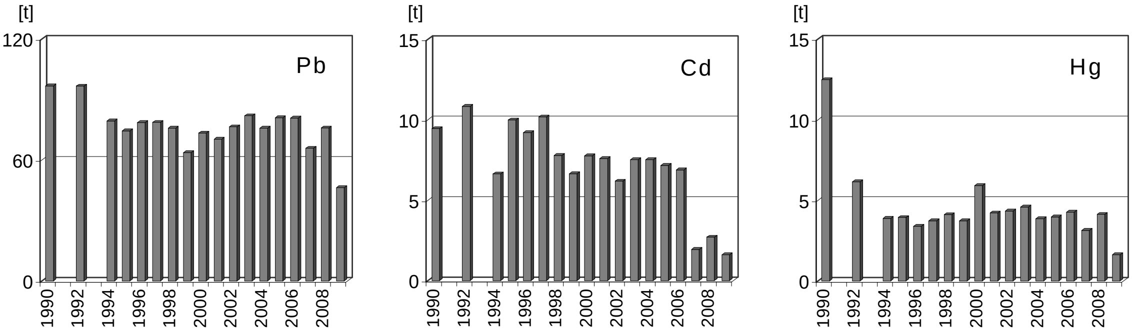


Tab. 4.10 **Emissions of heavy metals [t] in the SR in 2009**

Sector / Subsector	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Combustion processes I	1.025	0.349	0.044	0.071	0.067	0.032	0.165	0.008	1.504
Public power	0.032	0.268	0.001	0.068	0.050	0.004	0.162	0.008	0.084
District heating plants	0.993	0.081	0.043	0.003	0.017	0.028	0.003	0.0001	1.420
Combustion processes II	1.113	0.489	0.032	0.239	0.360	0.031	0.232	0.038	3.272
Commercial and institutional plants	0.136	0.051	0.006	0.014	0.015	0.004	0.012	0.001	0.203
Residential plants	0.961	0.432	0.025	0.224	0.343	0.026	0.219	0.037	3.045
Agriculture	0.016	0.006	0.001	0.001	0.002	0.001	0.001	0.0001	0.024
Combustion processes in industry	27.725	16.301	0.438	2.099	26.288	0.441	9.787	7.871	22.942
Comb. in boilers, gas turb. and stat. engines	1.679	0.314	0.080	0.415	0.211	0.106	6.379	0.165	2.147
Iron production	0.103	0.009	0.163	0.776	0.060	0.260	2.584	0.033	6.464
Glass production	3.554	0.141	0.041	0.602	0.151	0.013	0.477	4.517	2.760
Ore agglomeration	13.108	0.019	0.008	0.288	4.308	0.031	0.330	0.609	6.858
Copper production	9.136	15.809	0.145		21.557	0.001		2.547	4.674
Cement production	0.145	0.002	0.0004	0.016		0.030	0.017	0.0002	0.037
Aluminium oxide production									
Magnesite production	0.0003	0.007	0.0005	0.002	0.001	0.00002	0.0003		0.002
Production processes	1.34	0.069	0.031	0.834	2.444	0.19	7.291	0.012	13.816
Steel production	1.101	0.060	0.012	0.140	2.175	0.012	2.199	0.012	4.589
Aluminium production			0.015				1.496		1.496
Ferro alloys production	0.074	0.005	0.002	0.001	0.003		0.001		0.358
Pig iron production	0.084	0.004	0.002	0.014			0.007		0.060
Galvanizing	0.078			0.679	0.234		3.588		6.786
Alloys (Cu-Zn) production	0.003				0.032				0.527
Inorganic chemical industry						0.178			
Road transport	2.696		0.023	0.382	9.534		0.181	0.025	4.276
Other transport			0.0002	0.001	0.046		0.002	0.0003	0.027
Waste incineration	15.043	0.019	1.048	0.897	1.707	0.927	0.501	0.014	7.246
Municipal waste	8.010	0.009	0.445	0.801	1.104	0.320	0.481	0.002	3.026
Industrial waste	6.930	0.010	0.594	0.095	0.594	0.594	0.020	0.012	4.158
Hospital waste	0.103	0.0001	0.009	0.001	0.009	0.009	0.0003	0.0002	0.062
Cremation						0.004			
Total	48.942	17.227	1.616	4.523	40.446	1.621	18.159	7.968	53.083

Emissions from transport estimated to December 14th, 2011
emissions from other sectors estimated to February 15th, 2011

Fig. 4.7 **Development trends in heavy metals emissions in 1990 – 2009**



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 stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

In the Slovak Republic, the UN Convention came into force on March 21, 1994. The Slovak Republic accepted all the commitments of the Convention. Currently, there are 195 Parties (194 States and 1 regional economic integration organization, which is the European Union) to the UN FCCC. Most members of the Organization for Economic Cooperation and Development (OECD) including Slovak Republic – known collectively as Annex I countries – committed themselves to adopting policies and measures aimed at reducing their greenhouse gas (GHG) emissions under the Convention. Regarding the specific economic situation in 1992, was the Slovak Republic together with the Russian Federation and other countries from the Eastern and Central Europe, included in the special subgroup under Annex I countries called Economies in Transition (EIT).

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. All Annex I countries that ratified the Kyoto Protocol (KP), formally defined their reduction targets in articles of the KP. The Kyoto Protocol entered into force on February 16, 2005 in accordance with Article 25, paragraph 1, that is the ninetieth day after the date on which not less than 55 Parties to the UN FCCC, incorporating Parties included in Annex I which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 of the Parties included in Annex I, have deposited their instruments of ratification, acceptance, approval or accession. Detail rules for the Kyoto Protocol implementation was adopted on COP7 in 2001 and are known as Marrakesh Accords.

Developed countries included in Annex B of the Kyoto Protocol have individual or common target to reduce emissions of six greenhouse gases during the commitment period (2008 – 2012) by 5.2% in comparison with the base year 1990. The Slovak Republic and the most countries of Central and East Europe agreed to reduce base year level of all six GHG emissions by 8% during period 2008 – 2012. The KP targets for the “old” EU-15 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 member state with the EU-15 approval as “burden-sharing agreement” (Article 4, KP).[2] The priority of the Annex I countries to the KP is to achieve reduction target with the most effective economic tools called as flexible mechanisms (joint implementation, clean development and emission trading system). The share of flexible mechanisms utilization is limited, the most important is reduction achieved by domestic measures.

Member states that joined the European Community after 2004 have individual targets under the Kyoto Protocol. The Czech Republic, Estonia, Bulgaria, Latvia, Lithuania, Romania, Slovakia and Slovenia have reduction targets of 8% from the base year, while Hungary and Poland have reduction

[1] http://www.unfccc.de

[2] *In the Council decision (2002/358/EC) on the approval by the EU of the Kyoto Protocol the various commitments of the Member States are expressed as percentage changes from the base-year. In 2006 the respective emission levels were expressed in terms of tonnes of CO_2-equivalent in the Commission Decision 2006/944/EC. In connection with Council decision 2002/358/EC, the Council of Environment Ministers and the Commission have, in a joint statement all community and MS initial reports which have been reviewed under the Kyoto Protocol.*

targets of 6%. Cyprus and Malta have no Kyoto target, while Croatia has a reduction target of 5%. The additional EEA member countries Norway and Iceland are allowed to increase emissions under the Kyoto Protocol, by 1% and 10% respectively, from their base year emissions. The candidate country Turkey has ratified the UNFCCC, but not the Kyoto Protocol. Lichtenstein and Switzerland have a reduction target of 8%.

Post-Kyoto period

The main point of today's discussion is to reach the consensus about the future regime of cooperation (post-Kyoto period) between developed and developing countries in committing a reduction target (often defined as an objective to safeguard that overall global annual mean surface temperature increase should not exceed 2°C above pre-industrial levels).

After not very successful negotiations on COP15 and CMP5 (5. session of the Kyoto Parties) in Copenhagen (December 2009), when the EU political targets were not fulfilled, the actual challenge is to negotiate further international agreement for adaptation and mitigation of negative climate change impacts after 2012. EU together with the other Annex I countries support "step wise approach", based on progressive fulfillment of tasks set to reach agreed reduction targets. Final decision is expected on the COP18 in Doha (Qatar, November 2012).

More specifically, mitigation trajectories for developed and developing countries up to 2050 with regard to keep 2°C global target, necessity to keep indicator CO_2/per capita on level 2 tons/per capita and the definition for a rigorous, robust and transparent system for Monitoring, Reporting and Verification (MRV) of commitments need to be set out. The aim of the EU policy is to support transparent reporting system for developing countries that would provide accurate and comparable emission reporting, information on effectiveness of financial support for adaptation actions and effects of policies and measures.

The EU and legislative framework

In the context of integration of the Slovak Republic into the European Union (May 1, 2004), new requirements related with legislative implementation were necessary in the field of air protection. The European Union considers the area of climate change to be the one of the four environmental priorities. The Slovak Republic submits the data concerning GHG emissions in the relevant extend by 15 January each year according to the Decision 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 (MMD).[3] The ground for the implementing of the decision were the following criteria:

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

This decision is currently being revised, following developments at international level (mostly in the context of the UN FCCC) and in EU legislation (e.g. Effort Sharing Decision 406/2009/EC and Emission Trading System Directive 2009/29/EC) as well as based on lessons learned from the implementation of the MMD.

In the spring 2007, the European Parliament adopted the unilateral commitment to reduce EU GHG emissions by at least 20% by 2020 compared to 1990 levels. Furthermore, the EU proclaimed that this reduction will be increased to 30% if other developed countries commit themselves to comparable emission reductions and if economically more advanced developing countries contribute adequately according to their responsibilities and respective capabilities.

[3] *OJ L 49, 19.2.2004, p. 1.*

The integrated Climate and Energy Package (CEP)[4] officially introduced by European Community on January 23, 2008 is principal, complex and ambitious plan for GHGs emission reduction, energy efficiency improvements, decoupling economic growth from fossil fuel dependence and supporting of innovative, low-carbon technologies.

A comprehensive set of fundamental legal standards for the Climate and Energy Package was published in the Official Journal of the European Union of 5th June 2009, as follows:

- Regulation (EC) 443/2009 of the European Parliament and of the Council of 23rd April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles.
- Directive 2009/28/EC of the European Parliament and of the Council of 23rd April 2009 on the promotion of the use of energy from renewable resources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
- Directive 2009/29/EC of the European Parliament and of the Council of 23rd April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission trading scheme of the Community.
- Directive 2009/30/EC of the European Parliament and of the Council of 23rd April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland navigation and repealing Directive 93/12/EEC.
- Directive 2009/31/EC of the European Parliament and of the Council of 23rd April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) 1013/2006.
- Decision 406/2009/EC of the European Parliament and of the Council of 23rd April 2009 on the effort sharing of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

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 by more than 30%, methane (CH_4), nitrous oxide (N_2O) and ozone (O_3), all three together by 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 in contrast with previously mentioned gases, is caused exclusively 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

[4] *Assessment Report and Implementation of the Climate-Energy Package in the Slovak Republic, November 2009.*

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 UNFCC 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[5]. 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 compared to the year 1990, the 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 – 1260 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 by burning coal, oil and natural gas carbon stored in these "fossil fuels" is released at an unprecedented rate. Likewise, deforestation is weakening natural sink mechanism. Current annual emissions amount to over 23 billion m^3 of CO_2, or almost 1% of the total mass of carbon dioxide in the atmosphere.

A second important human influence on climate is aerosols. These clouds of microscopic particles are not a greenhouse gas, but after their interaction with other pollutants (sulphur dioxide) emitted mainly by power stations, they significantly exaggerate the greenhouse effect of the atmosphere. Aerosols persist in the atmosphere only few days, but they have a substantial impact on climate.

Methane levels have already increased by a factor of two and a half since the pre-industrial era and methane currently contributes 18% of the enhanced greenhouse effect. The rapid rise in methane started more recently due to anthropogenic activities such as intensive agriculture (mainly rice fields), animal husbandry, coal mining, natural gas mining, its transport and use as well as the biomass burning. Unlike CO_2, methane is disintegrated in the atmosphere 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 approximately 0.4 billion tons, while the global growth rate of methane budget seems to be steady. Permafrost contains large reservoirs of organic carbon and methane accumulated in ice structure. Rapid global warming and subsequent melting of permafrost in polar areas present potentially high risk of releasing methane into the atmosphere.

Nitrous oxide (with an "adjustment-time" of 114 years), a number of industrial gases and ozone contribute the remaining 20% to the enhanced greenhouse effect. Compared to pre-industrial levels, nitrous oxide levels have risen by 19%, mainly due to intensive agriculture, over-use 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.

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[5] *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 (Conference of Parties), where the latest knowledge in association with the global warming is included.*

While chlorofluorocarbons (CFCs) have been stabilized due to emission controls introduced under the Montreal Protocol to protect the stratospheric ozone layer, levels of long-lived gases such as HFCs, PFCs and SF_6 continue to increase. They are used as carrier gases for sprays, fillings in cooling and extinguishing systems, insulating substances, solvents for the production of semiconductors, etc. Apart from the fact that they are harmful to the stratospheric ozone layer, they are very inert gases so that even minor emissions have a great negative effect on the environment.

5.2 GREENHOUSE GAS EMISSIONS IN THE SLOVAK REPUBLIC

Total EU-27 greenhouse gas emissions were equal to 4 615 Mt CO_2-equivealents in 2009, this represent a decrease (−7.1%) compared to 2008, bringing emissions at the lowest level (−17.4%) since 1990 without sinks from land use, land use change and forestry (LULUCF) and international bunkers. The projected decrease in EU-27, compared to 1990, can reach 19% in 2020 if additional domestic policies and measures are implemented. Based on these data, it can be assumed, that the share of EU-27 GHG emissions on global emissions is 11.2%, without LULUCF.

Between 1990 and 2009, EU-27 per capita emissions declined to 9.1 tonnes CO_2 equivalents. The main decrease occurred particularly in the early 1990s. Compared to other world regions, emissions are high (7 t CO_2 equivalents per capita). Emissions per capita differ significantly among EU countries and correlate with energy intensity (primary energy consumption per capita) and energy mix (influence emissions per produced energy unit). All new member states, except Cyprus, Malta and Slovenia have decreased their per capita emissions substantially since 1990. Total aggregated GHG emissions decreased in new member states by 36.9% in 2009 compared to the base year 1990, mainly due to introduction of market economies and the consequent restructuralization or closure of heavy polluting and energy-intensive industries, introduction of more efficient low-carbon technologies and increased share of services on total Gross Domestic Product (GDP). The transport sector, especially road transport is most growing sector in all EU member states, where additional policies and measures are required.

Aggregated GHG emissions in the Slovak Republic represent 0.4% of the world emissions. The emissions of greenhouse gases in the Slovak Republic are estimated in accordance with the requirements of the 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 the IPCC Guidelines[6], Good Practice Guidance (GPG)[7] and in the SHMÚ's reports. The Fifth National Communication of the SR on the Climate Change was submitted on December 31, 2009 to the secretariat of the UN FCCC. The Communication is accessible on the web page www.enviro.gov.sk and was revised by expert review team. In August 2011, the National Inventory System of the Slovak Republic[8] was revised under the in-country review for the inventory submission 2011 of the SR by expert review team under responsibility of the secretariat of the UN FCCC. The list of potential problems was published into the outcome report from the review in order to provide information to the Ministry of the Environment of the SR and SHMÚ. Revision is a tool for assessment of current status in the parties of the KP and to get eligibility for participation in the Kyoto flexible mechanisms. Further information about the National Inventory System is available on the website http://ghg-inventory.shmu.sk.

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[6] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory, Volume 1-3*
[7] *Good Practice Guidance and Uncertainty Management in National GHGs Inventories, IPCC 2000*
[8] *Vestnik MZP SR, 2007, 3, pages 19-45*

Total GHG emission represented 43 426.07 Gg in 2009 (without sinks from land use, land use change and forestry). This represents a reduction by more than 41% in comparison with the base year 1990. In comparison with 2008, the emissions decreased by 9.9%. The emissions signified in the literature as net emissions with the sinks from LULUCF in 2009 were 39 997.06 Gg and decreased against base year by 44%. This decline was caused by the recession in economy and industry due to the global crises.

According to the decision of the Convention body and for the purpose of elaborating the inventories, reporting software CRFReporter is recommended. This software generates the required CRF tables automatically. The new reporting program was used also for recalculation of the time series to assure the consistency of data after adjustments in methodologies. The base year was agreed by national authority (the Ministry of the Environment). Total GHG emissions in the Slovak Republic during years 1990 – 2009 had decreasing trend and were slightly stabilized after the year 2000, with returned decrease after the year 2008 due to economic recession and gas crisis. The first results of preliminary GHG inventory for 2010 show the increase of emissions and decrease of sinks caused by increasing economic activity (Tab. 5.1).

Tab. 5.1 **Aggregate[9] anthropogenic emissions of GHG [Tg] in Slovakia in 1990, 1995 – 2009**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2*	62.77	44.84	43.30	42.20	42.80	42.34	41.18	42.38	40.83	42.17	41.97	41.50	40.79	39.00	39.10	35.09
CH_4	4.81	4.27	4.23	4.26	4.53	4.72	4.44	4.49	5.05	4.88	4.79	4.59	4.66	4.55	4.69	4.35
N_2O	6.31	4.09	4.24	4.17	3.77	3.30	3.51	3.64	3.77	3.79	3.83	3.81	4.19	4.04	4.08	3.65
HFCs	NO	0.02	0.04	0.06	0.04	0.07	0.08	0.08	0.10	0.13	0.15	0.17	0.20	0.23	0.26	0.30
PFCs	0.27	0.11	0.03	0.03	0.03	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.04	0.02	0.04	0.02
SF_6	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Total without LULUCF *	74.15	53.35	51.85	50.74	51.18	50.46	49.24	50.62	49.78	51.01	50.78	50.11	49.89	47.86	48.19	43.43
Total with LULUCF	71.20	50.00	48.74	48.30	48.29	47.77	46.16	44.33	43.28	45.20	45.67	48.68	45.76	43.90	45.01	39.98

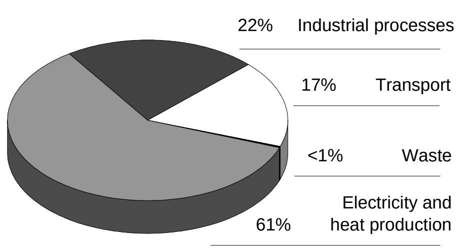
Emissions, as submitted in April 15, 2011
** GHG emissions without sinks from LULUCF, national total under KP*

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 from technological processes during the production of cement, lime, magnesite and usage 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 due to the conversion of grasslands and forest areas into agricultural land, and forest fires (Fig. 5.1).

Fig. 5.1 **CO_2 emissions in 2009**



[9] *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*

Total net CO_2 emissions without LULUCF decreased in 2009 compared with the previous year by 10%, totally decreased by more than 44% compared with the reference year 1990. The most reasonable 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 generation of the GDP, higher share of gas fuels in the primary energy resources consumption, restructuralization of industries and the impact of air protection legislative measures influencing directly or indirectly the generation of greenhouse gas emissions. In the year 2009 drop in emission trend was caused also by significant changes of energy sources and economic recession which led to the decrease of energy consumption in the Slovak Republic.

According to national projections CO_2 emission trend is expected to have progressive character.[10] Among the most important reasons appear to be expected recovery of the Slovak economy, accompanied by introduction of 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 expected within the transport sector. Gradual increase of CO_2 emissions in this sector is anticipated not only at the regional level, but also at European level.

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 from 1950 onwards, the amount of carbon fixed in the forests of the SR was increased approximately by more than 50 Tg as a consequence of the forest area enlargement and increase in hectare stock of wood mass. Fixation of carbon in forest ecosystems of the SR was estimated on the basis of carbon balance in the above the ground part (trees, plant canopy, overlying humus) and that, under the ground (roots, humus in soil) of the forest, including an assessment of wood exploitation and forest fires (Tab. 5.2). After implementation of new IPCC methodology[11], changes were introduced. 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. The special category is controlled (burning of biomass residues) and wild (forest fires) biomass burning. All GHGs are estimated in these categories.

Tab. 5.2 **Total emissions and sinks of CO_2 [Gg] in 1990, 1995 and 2000 – 2009**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Net CO_2	59 784	42 092	38 063	36 067	34 305	36 334	36 851	40 045	36 634	35 016	35 897	31 610
CO_2*	62 765	44 788	41 183	42 379	40 826	42 166	41 975	41 503	40 787	39 002	39 096	35 087
Fossil fuel combustion	53 493	36 696	32 344	33 486	31 467	32 946	31 913	31 695	30 981	29 189	29 692	27 211
Electricity and heat prod.	48 601	32 437	28 219	28 789	26 631	28 014	26 693	25 525	25 286	22 728	23 071	21 091
Transport	4 892	4 259	4 125	4 696	4 836	4 932	5 220	6 170	5 695	6 461	6 621	6 120
Industrial processes	9 079	7 991	8 711	8 772	9 260	9 115	9 951	9 700	9 669	9 719	9 311	7 784
Mineral products	2 690	2 120	2 244	2 337	2 373	2 061	2 507	2 651	2 715	2 822	2 991	2 286
Chemical industry	617	751	786	811	792	715	848	862	752	766	711	763
Production of metals	5 772	5 120	5 682	5 624	6 095	6 339	6 596	6 188	6 201	6 132	5 609	4 735
Solvent use	130	91	65	70	75	78	83	85	88	86	88	87
LULUCF	−2 981	−3 359	−3 120	−6 312	−6 521	−5 831	−5 124	−1 457	−4 153	−3 986	−3 199	−3 477
Forest land	−3 035	−2 740	−1 979	−5 449	−5 461	−4 936	−4 185	−827	−3 279	−3 267	−2 454	−2 834
Cropland	−148	−238	−459	−294	−543	−625	−613	−630	−719	−642	−697	−696
Grassland	−347	−619	−947	−857	−754	−512	−502	−353	−403	−366	−376	−426
Settlements	123	97	93	107	90	105	82	92	82	93	104	217
Other land	426	141	171	182	148	136	94	260	165	195	224	262
Waste	63	63	63	52	25	26	28	22	49	8	6	5
Waste incineration	63	63	63	52	25	26	28	22	49	8	6	5
Burning biomass**	794	1 183	1 426	1 632	1 622	1 734	2 183	3 045	2 901	2 976	5 257	2 660
International bunkers**	128	103	45	69	72	79	86	91	132	150	167	144

Emissions, as submitted in April 15, 2011

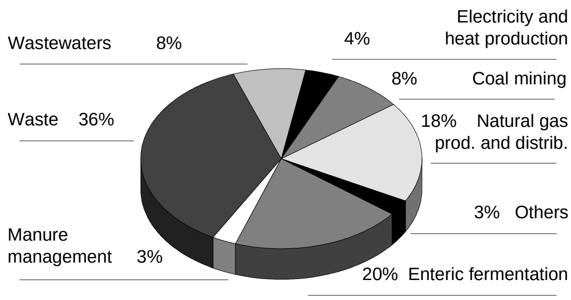
* *CO_2 emissions without sinks from LULUCF* ** *CO_2 emissions are not being accounted into the total emissions*

[10] *The Biennial Report 2011 according to the Decision 280/2004/EC*

[11] *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, 2003*

CH_4 – methane

Fig. 5.2 **CH_4 emissions in 2009**



Agriculture, large-scale beef cattle and pig breeding, are major sources of methane in our territory. The CH_4 does arise as the direct product of the metabolism in herbivores and as the product of animal excrement degradation. 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 leaks into the atmosphere also because of brown coal mining and biomass burning. In addition, municipal waste dumps and sewage (predominantly septic tanks) are important methane sources. Methane arises without the direct access of oxygen (Fig. 5.2).

Total methane emissions estimated in 2009 were 208.1 Gg, representing slight decrease compared to the previous year. Emissions decreased by 10% compared to the reference year 1990. The most important changes were recorded in the sector of solid waste disposal sites (SWDS). The revision of emission factors and selection of appropriate parameters were carried out by cooperation of sectoral expert with the expert for uncertainty. The revision dealt with the data from 1960. Using the Tier 2 method - First Order Decay, uncertainties in emissions inventories of methane were eliminated and accuracy of whole time series was increased. The implementation of the kinetic model for SWDS´s emission balance was one of requirement for the acceptation of annual inventory by expert review team during in-depth review. Another important methodology change was introduced in agricultural sector. Change was performed based on Tier 2 methodology and regional input activity data in enteric fermentation of the key animal categories (cattle, sheep, swine). The methane emissions decreased in all sub-sectors except LULUCF and waste, this decrease was however caused by implementation of above mentioned new methodologies (Tab. 5.3).

Tab. 5.3 Total emissions of CH_4 [Gg] in 1990, 1995 and 2000 – 2009

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total CH_4 emissions	229.76	203.98	212.15	214.36	241.36	233.32	228.73	219.58	222.77	217.64	224.48	208.10
Energy	73.44	72.46	74.21	72.58	68.68	66.59	64.40	60.77	58.71	59.37	68.11	63.33
Fossil fuel combustion	21.79	13.63	11.33	11.39	9.24	9.55	10.31	12.64	11.91	10.41	17.26	8.64
Electricity and heat prod.	*20.76*	*12.49*	*10.48*	*10.45*	*8.39*	*8.75*	*9.53*	*11.84*	*11.29*	*9.75*	*16.58*	*8.00*
Transport	*1.03*	*1.14*	*0.84*	*0.95*	*0.85*	*0.80*	*0.78*	*0.80*	*0.63*	*0.66*	*0.68*	*0.64*
Fugitive emissions	51.65	58.83	62.88	61.19	59.44	57.04	54.09	48.13	46.80	48.96	50.86	54.69
Coal mining	*27.20*	*29.70*	*28.82*	*26.33*	*25.69*	*21.11*	*19.77*	*16.17*	*14.67*	*13.52*	*15.95*	*16.92*
Natural gas produc.&distrib.	*24.45*	*29.13*	*34.06*	*34.86*	*33.74*	*35.93*	*34.32*	*31.96*	*32.13*	*35.45*	*34.91*	*37.77*
Industrial processes	1.17	1.25	1.32	1.34	1.33	1.19	1.36	1.40	1.17	1.19	1.08	1.09
Chemical industry	1.17	1.25	1.32	1.34	1.33	1.19	1.36	1.40	1.17	1.19	1.08	1.09
Agriculture	112.32	80.15	59.68	61.08	59.52	56.91	52.69	53.19	52.28	51.36	48.98	47.15
Enteric fermentation	94.77	66.90	50.16	51.44	49.78	47.65	44.85	45.53	44.79	44.51	43.13	41.20
Manure management	17.56	13.25	9.52	9.63	9.74	9.26	7.84	7.66	7.49	6.84	5.85	5.94
LULUCF	0.67	0.46	0.56	0.68	0.67	0.72	0.82	1.07	0.90	0.89	1.00	0.99
Forest	0.67	0.46	0.56	0.68	0.67	0.72	0.82	1.07	0.90	0.89	1.00	0.99
Waste	42.16	49.66	76.38	78.68	111.16	107.90	109.46	103.15	109.71	104.83	105.30	95.54
Solid waste disposal sites	22.37	30.85	57.47	59.94	87.90	84.59	89.32	82.67	88.26	84.45	84.80	75.45
Wastewaters	19.71	18.67	18.77	18.56	18.57	18.52	18.33	18.08	18.04	17.97	17.84	17.36
Composting	0.08	0.14	0.15	0.17	4.69	4.79	1.81	2.40	3.41	2.42	2.65	2.73
International bunkers *	0.010	0.004	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.004	0.004

Emissions, as submitted in April 15, 2011

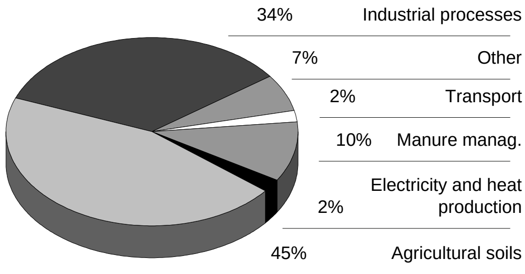
** CH_4 emissions are not being accounted into the total emissions*

N_2O – nitrous oxide

In comparison to the other greenhouse gases, the mechanism of nitrous oxide emissions and sinks is not fully explored. The values are subject to relatively considerable degree of uncertainty. Excess of mineral nitrogen in soil (consequence of intense fertilizing) and unfavorable aerial soil conditions (heavy mechanical tillage) are the main cause of N_2O emissions. Emissions in energy industry and transport were estimated on the basis of fossil fuel consumption, by applying the default emission factors according to the IPCC methodology.[6,7] The N_2O emissions arising from manipulation of sewage and sludge have been estimated also for municipal and industrial wastewater treatment plants (Fig. 5.3).

In 2009, the total N_2O emissions slightly decreased compared with the year 2008 and reached 11.81 Gg. However, the drop compared to the reference year 1990 is more than 42.1%. The N_2O emissions trend is stable since 1993. The most substantial increase is expected in energy (use of biomass) and industrial processes (regards to increase in nitric acid production) sectors. The highest increase of N_2O emissions was observed in waste sector, the emissions raised by more than 4% compared to 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 subject to high level of uncertainty and the time series are to certain extent inconsistent comparable with other gases (Tab. 5.4).

Fig. 5.3 **N_2O emissions in 2009**



Tab. 5.4 **Total emissions of N_2O [Gg] in 1990, 1995 and 2000 – 2009**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total N_2O emissions	20.39	13.21	11.33	11.76	12.17	12.25	12.36	12.31	13.53	13.05	13.17	11.81
Fossil fuel combustion	0.92	0.66	0.49	0.53	0.52	0.55	0.53	0.60	0.56	0.53	0.64	0.50
Electricity and heat prod.	0.53	0.33	0.28	0.29	0.30	0.33	0.31	0.34	0.33	0.29	0.41	0.26
Transport	0.39	0.33	0.21	0.24	0.22	0.22	0.23	0.25	0.23	0.24	0.23	0.24
Industrial processes	3.73	3.66	3.36	3.79	3.40	3.75	4.29	4.16	5.47	4.69	4.93	4.02
Chemical industry	3.73	3.66	3.36	3.79	3.40	3.75	4.29	4.16	5.47	4.69	4.93	4.02
Solvent use	0.06	0.10	0.06	0.10	0.18	0.19	0.26	0.28	0.27	0.26	0.25	0.25
Agriculture	15.18	8.37	7.06	6.99	7.34	7.06	6.82	6.76	6.66	7.06	6.85	6.54
Manure management	3.47	2.31	1.60	1.55	1.53	1.49	1.39	1.34	1.31	1.28	1.24	1.22
Agricultural soils	11.71	6.06	5.46	5.45	5.81	5.58	5.43	5.42	5.35	5.78	5.61	5.33
LULUCF	0.04	0.01	0.01	0.01	0.00	0.02	0.01	0.02	0.01	0.03	0.01	0.02
Forest	0.04	0.01	0.01	0.01	0.00	0.02	0.01	0.02	0.01	0.03	0.01	0.02
Waste	0.46	0.41	0.35	0.34	0.72	0.67	0.44	0.50	0.57	0.48	0.48	0.48
Wastewaters	0.45	0.39	0.33	0.32	0.35	0.29	0.29	0.30	0.30	0.29	0.27	0.26
Waste incineration	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.01
Composting	0.01	0.01	0.01	0.01	0.35	0.36	0.14	0.18	0.26	0.18	0.20	0.20
International bunkers *	0.004	0.026	0.001	0.013	0.014	0.011	0.006	0.003	0.016	0.018	0.019	0.017

Emissions, as submitted April 15, 2011
* *N_2O emissions are not being accounted into the total emission*

HFCs, PFCs, SF_6

On the territory of the Slovak Republic sources and emissions of F-gases have been assessed. The procedure was carried out in accordance with the IPCC methodology[6,7] and the actual and potential emissions are estimated annually since 1990 (Tab. 5.5). These gases are not produced in the SR. Emissions are released into the atmosphere during 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 from aluminium production. Use of HFCs and SF_6 has risen since 1995 and this trend is expected to continue in the future. The PFCs emissions increase is not expected since they are not used anymore and currently emissions originate only from process of their removal .

Tab. 5.5 **Total emissions of HFCs, PFCs and SF_6 in 1990, 1995 and 2000 – 2009**

	GWP		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total emissions CO_2 *eq.*		[Gg]	271.40	146.38	100.49	111.86	130.88	169.00	188.68	209.20	251.87	269.31	317.91	336.75
HFCs emissions CO_2 *eq.*		[Gg]		22.15	75.59	82.43	102.35	131.96	152.88	172.34	198.90	226.99	263.24	299.61
HFC-23	11 700	[Mg]		<0.01	0.06	0.06	0.04	0.08	0.08	0.08	0.08	0.08	0.07	0.07
HFC-32	650	[Mg]			0.30	0.56	1.15	1.85	2.39	3.55	5.02	7.06	8.78	10.73
HFC-41	150													
HFC-43-10mee	1 300													
HFC-125	2 800	[Mg]		0.01	1.85	3.27	5.58	7.91	9.85	12.48	15.98	19.80	23.64	27.74
HFC-134	1 000													
HFC-134a	1 300	[Mg]		9.17	45.94	42.75	47.19	60.07	66.49	70.69	76.57	81.76	91.85	103.65
HFC-152a	140	[Mg]			0.83	1.02	1.21	1.36	1.22	1.22	1.22	1.22	1.22	1.10
HFC-143	300													
HFC-143a	3 800	[Mg]			1.85	3.37	5.35	7.20	8.70	10.21	12.51	14.66	17.23	19.45
HFC-227ea	2 900	[Mg]		3.52	0.80	0.80	0.44	0.23	0.01		0.01	0.01	0.01	0.40
HFC-236fa	6 300				0.05	0.22	0.38	0.22	0.50	0.53	0.43	0.60	0.86	0.66
HFC-245ca	560													
PFCs emissions CO_2 *eq.*		[Gg]	271.37	114.32	11.65	15.59	13.75	21.65	19.91	20.25	35.82	24.88	36.16	17.76
CF_4	6 500	[Mg]	36.60	15.44	1.57	2.18	1.90	2.93	2.69	2.73	4.83	3.35	4.88	2.39
C_2F_6	9 200	[Mg]	3.60	1.53	0.15	0.15	0.15	0.28	0.26	0.27	0.48	0.33	0.49	0.24
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	13.25	13.84	14.78	15.39	15.89	16.61	17.15	17.44	18.51	19.39
SF_6	23 900	[Mg]		0.42	0.56	0.58	0.62	0.64	0.67	0.70	0.72	0.73	0.77	0.81

Emissions, as submitted in April 15, 2011

In 2009, total F-gases emissions increased considerably. This trend was expected due to a special feature of the emissions. Because of their long lifespan both actual and potential emissions are taken into account. Compared with 2008, the emissions in 2009 increased by 6% and exceeded their level estimated for the reference year 1990.

5.3 ASSESSMENT

The aggregated emission of GHGs in year 2009 decreased and are on the lowest historical level since 1990 (without LULUCF). Aggregated emission dropped against the base year (1990) by more than 30 000 Gg, representing decrease of approximately 41% without LULUCF. A major share of aggregated emissions is covered by the energy sector (66%), the industrial processes sector covers 22%, the agriculture sector approximately 7% and the waste sector more than 5%. The solvent use sector covers less than 1% of the total emissions. These shares are determined as emissions in CO_2 of aggregated equivalents[9] (Tab. 5.6).

The GHG emission inventory should be assessed complexly considering also uncertainties that are caused and influenced by inaccuracies in statistical data on fuel consumption. The applied emission 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 cannot be quantified. In spite of this, the uncertainty analysis determined by the Tier 1 method of the IPCC[7] estimated that uncertainty of the GHG emission inventory of 2009 is 13.8% (according to level assessment) and 8.2% (according trend assessment). The uncertainty calculation by using the more sophisticated Tier 2 - Monte Carlo method was used for evaluation of the solid waste disposal site category, energy sector and industrial processes. The essential result from the Monte Carlo estimation for landfill emissions is fact that total uncertainty was reduced compared to recommended IPCC default value by Tier 1 (50%). This value is in the interval (–76.54%; +78.24%) for total methane emissions from SWDS according to time series from 1960. The uncertainty assessment of the sector energy, category combustion of fossil fuels was performed by Monte Carlo method and set unsymmetrical interval of uncertainty (–2.33%; +3.42%). The Monte Carlo uncertainty assessment of the industrial processes sector set unsymmetrical interval of uncertainty (–2.85%; +2.88%).

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[7] method with and without LULUCF sector. In 2009, the Slovak Republic determined 23 key sources without LULUCF and 27 key sources with LULUCF to be assessed according to the level. According to anticipated trends 27 key sources were assessed without LULUCF and 32 with LULUCF. 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. In the next submission the more detailed key source analyses will be prepared.

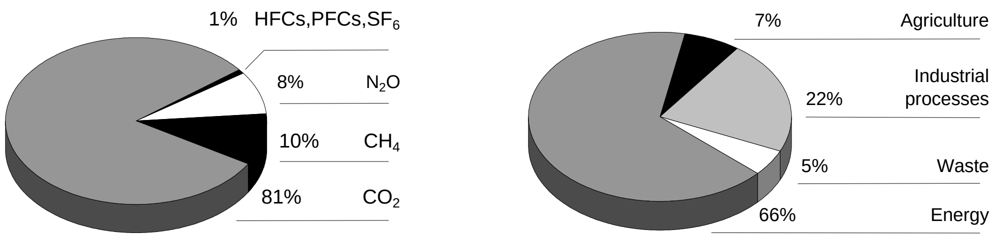
The GHG emissions reached the highest level at the end of 80-ies. In the period of 1990 – 1994 the reduction was about 25%. From 1994, the emissions have been stable. The economic recessions as the impact of the global crisis started in 2008 and other local influences (gas crises in 2009) caused the further decrease of GHG emissions in 2009. (Fig. 5.4).

Tab. 5.6 **Aggregated emissions of GHGs according to the sectors in CO_2 *eq*. [Tg] in 1990, 1995 and 2000 – 2009**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy*	55 321	38 421	34 054	35 174	33 071	34 516	33 430	33 156	32 387	30 599	31 320	28 694
Industrial processes**	10 531	9 297	9 880	10 088	10 471	10 473	11 498	11 229	11 640	11 469	11 183	9 389
Solvent use	147	122	85	100	132	137	163	172	171	166	167	164
Agriculture	7 064	4 278	3 441	3 451	3 527	3 385	3 220	3 213	3 162	3 268	3 153	3 019
LULUCF	-2 955	-3 346	-3 071	-6 294	-6 505	-5 810	-5 102	-1 430	-4 131	-3 959	-3 176	-3 449
Waste	1 091	1 233	1 775	1 809	2 582	2 499	2 464	2 342	2 529	2 358	2 366	2 159
Total with LULUCF	71 200	50 005	46 164	44 327	43 278	45 200	45 674	48 682	45 758	43 901	45 012	39 977

*Emissions, as submitted in April 15, 2011 *Including transport **Including F-gases*

Fig. 5.4 **Aggregated emissions of GHGs in 2009**



A comparison of the GDP trend with the trend of aggregate emissions of greenhouse gasses shows that the Slovak Republic is one of few countries where the trend of emissions is decoupling from the GDP increase. However, by international comparison, the generation of greenhouse gasses per capita still remains high. This is a result of the energy-intensive economy with the higher share of metallurgy, chemical and mineral industry). Without introduction of effective measures, GHG emissions of the Slovak Republic will have progressive trend 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 anticipated dynamics of GDP growth in the Slovak Republic there exists assumption that GHG emissions will increase in line with it. Due to this scenario it is necessary to prepare investment strategies and programs that would allow the Slovak Republic to achieve permanent dynamics of GDP growth and emissions growth with the regards to the further the post-Kyoto reduction goals. The EC commitments include 20% reduction the GHG emissions after 2020 against 1990. In the context of commitments for the Slovak Republic it is the strategic target to apply low-energy effective technologies for the energy production (for the new sources), emission trading, restructuralization of industry and agriculture, development of service sector and the improvement of the industry and public awareness in the environment issues.

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