Slovak
Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2015

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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

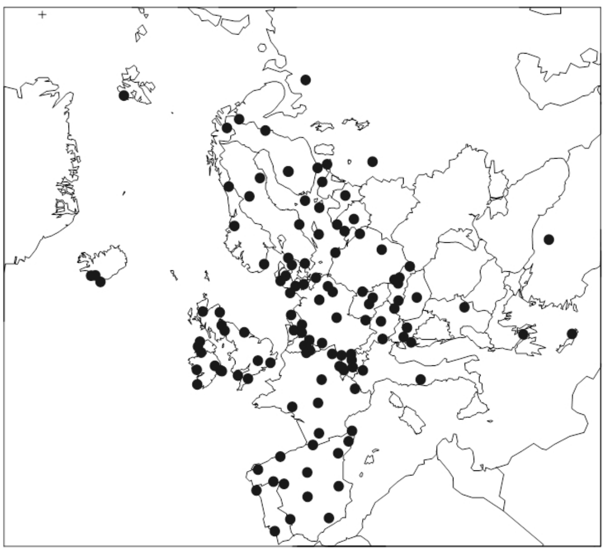
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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 evaluated for the new or revised protocol. Concerning heavy metal 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 particulate matter 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 200 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 a part of EMEP network. The EMEP monitoring programme has been gradually extended. The monitoring

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



of sulphur compounds and precipitation has been enhanced for oxides of nitrogen, ammonium in ambient air, particulate matter and ozone. In 1994, the measurements of volatile organic compounds (VOCs) have begun to be carried out under the auspices of Chemical Coordinating Centre - NILU (Norwegian Institute for Air Research). 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 2015, there were 4 EMEP stations of National Air Quality Monitoring Network in operation in the Slovak Republic to monitor regional air and precipitation quality. At the Bratislava-Koliba station the same precipitation monitoring programme is in operation as on regional stations, serving for comparison to the regional stations. Locations and elevations of the individual stations are indicated in Figure 1.2.

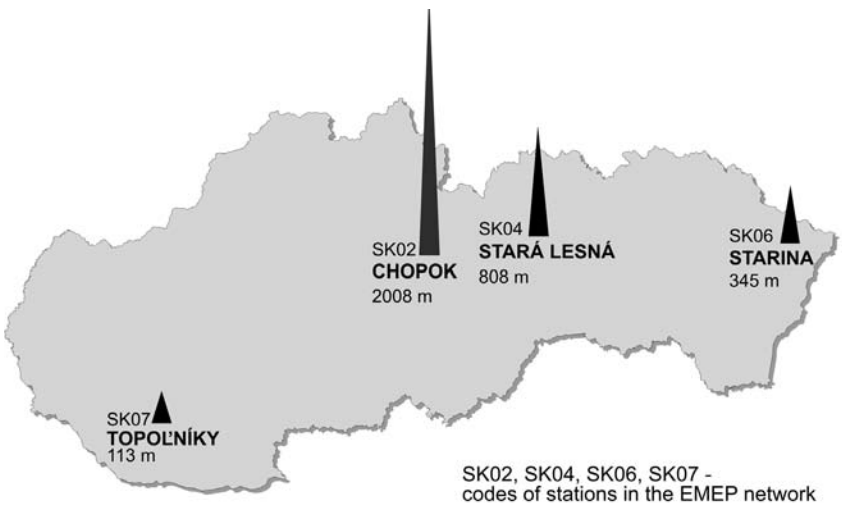
Chopok
Meteorological observatory of the Slovak Hydrometeorological Institute, located on the crest of the Low Tatras mountains, 2 008 m above sea level, 19°35'32" longitude, 48°56'38" latitude. Measurements started in 1977. Since 1978 the station has become a part of the EMEP network and GAW/WMO network.

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 – 2015**



Measurement programme

AMBIENT AIR	Ozone (O_3)	Sulphur dioxide (SO_2)	Oxides of nitrogen (NOx)	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Nitric acid (HNO_3)	Ammonia, ammon. ions (NH_3, NH_4^+)	Chlorides (Cl)	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	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	x
Stará Lesná	x										x		x	x	x	x	x	x	x

** TSP – Total suspended particles in ambient air*

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
	NOx	after oxidation into NaOH absor-ption solution with guajacol	spectrophotometry, 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 FID
	PM 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
PRECIPITATION	**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

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2015

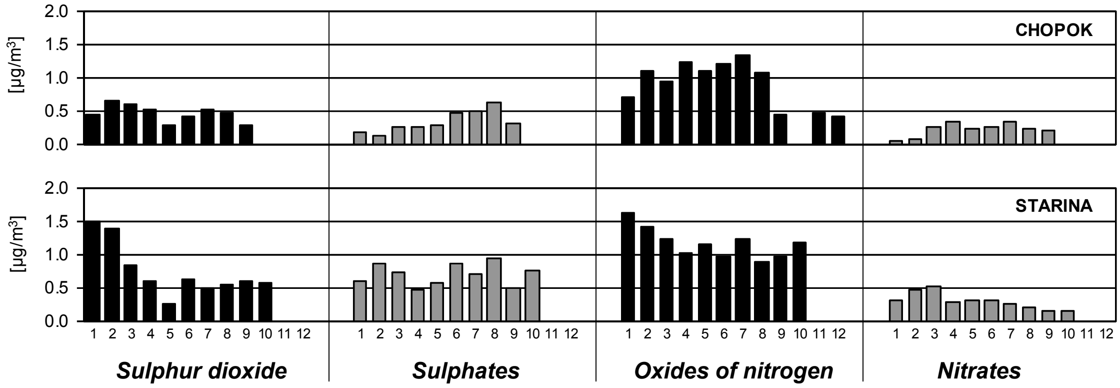
SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1) was 0.46 μg.m^{-3} on the Chopok station and 0.74 μg.m^{-3} on the Starina station, in 2015. ***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 0.92 μg $S0_2$.m^{-3} and Starina 1.48 μg $S0_2$.m^{-3}), nor in winter season (Chopok 0.9 μg $S0_2$.m^{-3} and Starina 2.1 μg $S0_2$.m^{-3}).*** Annual concentration of sulphates, recalculated in sulphur, was 0.33 μg.m^{-3} on the Chopok station and 0.69 μg.m^{-3} on the Starina station (Tab. 1.1). Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represented 0.72 on the Chopok station and 0.93 on the Starina station.

NO_x, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1) presented 0.92 μg.m^{-3}on the Chopok station and 1.16 μg.m^{-3} on the Starina station, in 2015 ***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 3.03 μg NO_x.m^{-3} a Starina 3.82 μg NO_x.m^{3}).*** Nitrates in ambient air on the Chopok and Starina stations occurred predominantly in the form of particles in 2015, as compared to gaseous nitrates, the difference on the Starina station is more distinctive than on the Chopok station (Tab. 1.1). 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. Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NO_x-NO_2 recalculated in nitrogen represented the value of 0.28 at the Chopok station and 0.31 at the Starina station.

Fig. 1.3 **Monthly mean concentrations of sulphur and nitrogen compounds in ambient air – 2015** (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 (NH3 and NH4 recalculated in nitrogen) from the Starina station in 2015 are listed in Table 1.1. Annual concentration of ammonia represents 0.64 μgN.m^{-3}. The concentration of ammonium ions reached the same value 0.64 μgN.m^{-3}. Concentration ratio of ammonium ions and ammonia expressed in nitrogen is 1.

Remark: Pollutants, collected on filters in 2015, SO_2, SO_4, NO_3, HNO_3, NH_3, Na, Ca, K, Mg were sampled approximately 3 months shorter due to the innovation of the monitoring network.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air – 2015**

	SO_2 (S) µg/m³	SO_4^{2-} (S) µg/m³	NO_x (N) µg/m³	NO_3^- (N) µg/m³	HNO_3 (N) µg/m³	Cl^- µg/m³	NH_3 (N) µg/m³	NH_4^+ (N) µg/m³	Na^+ µg/m³	K^+ µg/m³	Mg^{2+} µg/m³	Ca^{2+} µg/m³
Chopok	0.46	0.33	0.92	0.21	0.05	0.12	-	-	-	-	-	-
Starina	0.74	0.69	1.16	0.30	0.06	0.18	0.64	0.64	0.06	0.08	0.01	0.04

	O_3 µg/m³	PM_{10} µg/m³	Pb ng/m³	Cu ng/m³	Cd ng/m³	Ni ng/m³	Cr ng/m³	Zn ng/m³	As ng/m³
Chopok	88		0.91	1.37	0.03	0.39	0.53	3.06	0.31
Topoľníky	51		4.72	3.55	0.13	1.33	0.81	13.44	0.78
Starina	64		3.16	3.26	0.10	0.69	0.90	5.72	0.44
Stará Lesná	66		3.72	3.39	0.13	0.62	0.35	9.44	0.72

SO_2, SO_4^{2-} – recalculated in sulphur, *NOx, NO_3^-, HNO_3 – recalculated in nitrogen*
** TSP (total suspended particles)*

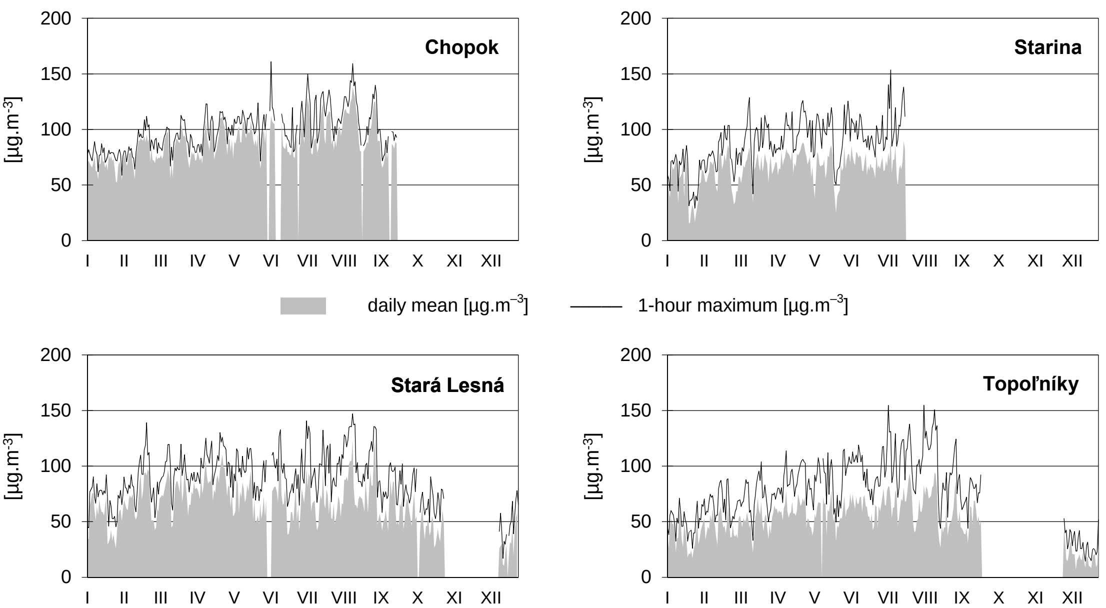
Particulate matter PM_{10}, TSP and heavy metals

Value of PM_{10} (Stará Lesná, Starina, Topoľníky) and TSP (Chopok) concentrations in 2015 are not representative due to often balances and PM_{10} samplers malfunctions. Concentrations of heavy metals from PM_{10}, resp. TSP are presented in Table 1.1

Ozone

In Figure 1.4 the annual course of surface level ozone concentrations at the Chopok, Stará Lesná, Starina and Topoľníky regional stations 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 2015, the annual average of ozone concentration at the Chopok station reached 88 µg.m^{-3}, at Starina 64 µg.m^{-3}, at Topoľníky 51 µg.m^{-3} and Stará Lesná 66 µg.m^{-3}. Measurements of ozone and exceedances of critical levels are completely assessed in Chapter 3 Atmospheric ozone.

Fig. 1.4 **Surface level ozone [µg.m^{-3}] – 2015**



Volatile organic compounds, 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 tenths of ppb up to several ppb. In Table 1.2 available analyses are for 2015.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina, 2015**

etane	etene	propane	propene	i-butane	n-butane	acetylene	butene	pentene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
2.400	0.699	0.788	0.175	0.171	0.308	0.047	0.033	0.044	0.153	0.056	0.055	0.069	0.030	0.206	0.199

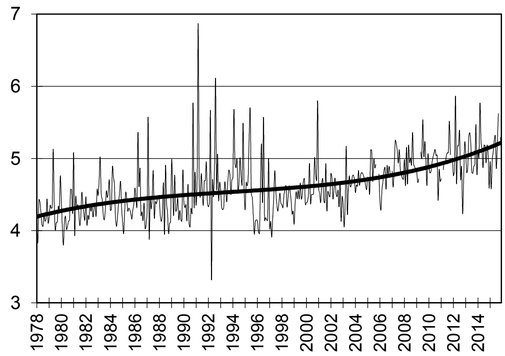
Atmospheric precipitation

Quality of atmospheric precipitation is monitored apart from four EMEP stations also at the Bratislava-Jeséniova station, which serves as the comparison to the regional stations.

Major ions, pH, conductivity

In 2015 the amount of precipitation recorded at background stations ranged between 347 and 992 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 at the Starina station with the low level of pH range 4.94 – 5.55 (Tab. 1.3, Fig. 1.6). Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity. Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Fig. 1.5 **pH in daily precipitation – Chopok**



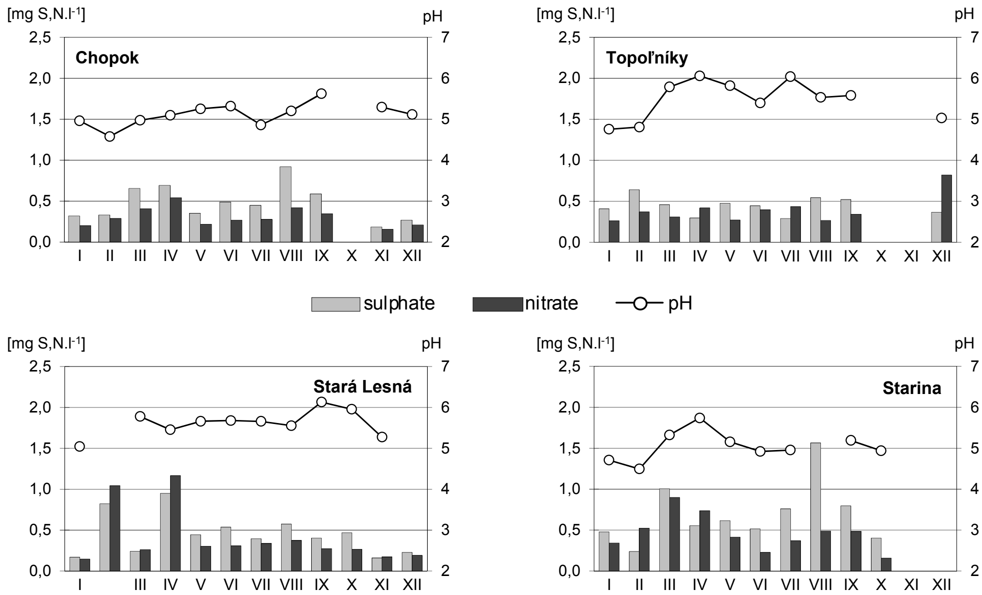
Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.43 – 0.60 mg.l^{-1}. Concentrations of sulphates at the Chopok and Stará Lesná stations represent the low value while the Starina the upper value of the sulphates range. The annual mean at the Topoľníky station shows minimum difference from the Stara Lesna and Chopok stations. 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 0.27 – 0.41 mg.l^{-1}. The low level of concentration range is represented by the Chopok station, while upper level of this range does belong to the Starina station. Ammonium ions also do belong to the major ions and their concentration range was 0.38 – 0.52 mg.l^{-1} (Tab. 1.3).

Heavy metals in atmospheric precipitation

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 measurements of the same set of heavy metals in precipitation was implemented as in background stations of Slovakia. This station serves for comparison and is not considered as the background station. The results of annual weighted means of heavy metals concentrations in atmospheric precipitation in 2015 are presented in Table 1.4. The decrease of heavy metals within the monitored period is most distinctive at lead.

Fig. 1.6 **Atmospheric precipitation – 2015**



Tab.1.3 Annual averages of main components in atmospheric precipitation – 2015

	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	992	5.07	11.60	0.43	0.27	0.38	0.19	0.13	0.06	0.04	0.25
Topoľníky	347	5.24	12.74	0.48	0.32	0.56	0.14	0.08	0.08	0.04	0.33
Starina	450	4.94	16.54	0.60	0.41	0.42	0.21	0.17	0.17	0.05	0.29
Stará Lesná	641	5.55	11.78	0.43	0.32	0.52	0.15	0.16	0.15	0.05	0.32
Bratislava-Koliba	669	5.16	14.35	0.46	0.49	0.55	0.20	0.17	0.10	0.07	0.45

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

Tab. 1.4 Annual averages of heavy metals in atmospheric precipitation – 2015

	Precip. mm	Pb µg/l	Cd µg/l	Cr µg/l	As µg/l	Cu µg/l	Zn µg/l	Ni µg/l
Chopok	925	2.00	0.06	0.33	0.25	1.06	15.86	0.48
Topoľníky	333	1.66	0.05	0.18	0.19	2.65	12.86	0.28
Starina	391	1.96	0.10	0.40	0.21	1.76	11.36	0.69
Stará Lesná	604	1.20	0.12	0.06	0.16	1.18	8.77	1.10
Bratislava-Koliba	829	2.54	0.09	0.19	0.21	3.63	17.67	0.35

AMBIENT AIR

LOCAL AIR POLLUTION

2

2.1 LOCAL AIR POLLUTION

The assessment of air quality follows Air Protection Act No. 137/2010 Coll. The air quality criteria (limit and target values, tolerance limits, upper and lower assessment thresholds and others) are quoted in Air quality Regulation No. 360/2010 Coll. Basis for air quality assessment in the Slovak Republic are the results of measurements of atmospheric concentrations of pollutants carried out by the Slovak Hydrometeorological Institute at the stations of the National Monitoring Network for Air Quality (NMSKO).

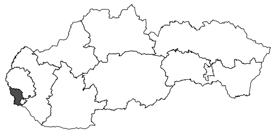
SHMÚ has been monitoring the level of air pollution since 1971, when the first manual stations in Bratislava and Košice were put into operation. Over the next few years, the measurements were gradually extended to the most polluted cities and industrial areas.

The modernization of the air quality monitoring network began in 1991. Manual stations have been successively replaced by automatic monitoring stations (AMS) enabling continual monitoring of air pollution and allowing to evaluate time course and the extremes of the short-term concentrations. The air quality monitoring network had been constantly developing over the past ten years. To monitor local air pollution, 38 automatic stations were located in the Slovak Republic in 2015, most of which monitored basic pollutants (SO_2, NO_2, NO_x, PM_{10}, $PM_{2.5}$). The automatic benzene (C_6H_6) measurements were carried out on 11 stations in the same year. Simultaneously, PM_{10} sampling was performed at 5 urban stations to analyze heavy metals (Pb, As, Ni, Cd). Particles less than or equal to 10 µm in diameter (PM_{10}) were measured at 32 urban (suburban) and 3 rural stations. Concentrations of benzo(a)pyrene (BaP) were measured at 6 monitoring stations.

In accordance with the requirements of Air Protection Act No. 137/2010 Coll. (amended by Act No. 318/2012 Coll. and regulation of the Ministry of Environment of the Slovak Republic No. 360/2010 Coll.), the territory of Slovakia was divided into 8 zones and 2 agglomerations. The boundaries of the zones are identical to the boundaries of the NUTS-3 regions, except for Bratislava and Kosice NUTS-3 regions from which territory of Bratislava and Košice are excluded and assessed separately as agglomerations. According to this division of the SR, the level of air pollution for SO_2, NO_2, NO_x, PM_{10}, $PM_{2.5}$, benzene and CO is evaluated. The air pollution assessment for Pb, As, Cd, Ni, Hg, BaP and O_3 is carried out for a less detailed regional breakdown, i.e. for agglomeration Bratislava and rest of the Slovak territory representing the zone Slovakia (except for Bratislava).

The list of air quality monitoring stations of the Slovak Hydrometeorological Institute as well as the rest of providers and their measurement programme in 2015 is presented in the corresponding tables. The detailed descriptions of stations (all requested data) is in the Annex to the Assessment. In the second half of 2015 the new instruments were installed in the frame of project innovations of National air quality monitoring network. Due to the technical reconstructions of the whole monitoring network the requested data completeness have not been reached in the most of the stations. In tables only data with completeness over 10% are presented.

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



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 419 678

The area characteristics

Bratislava

The capital city of Slovakia spreads out over an area of 368 km^2 along both banks of the Danube River at the boundary-line of the Danube plain and the Little Carpathians and the Bor lowlands at an altitude from 130 to 514 m. The wind conditions of the territory are affected by the slopes of the Low Carpathians reaching the northern part of the city. Orographic effects increase the wind speed from the prevailing directions. The air circulation in Bratislava is positively influenced by high wind speed of more than 5 m.s^{-1} (annual average). In regard to prevailing north-west wind, the city is situated suitably to major air pollution sources of which significant part is lying between the southern and north-eastern districts of Bratislava. The main contributors to air pollution represent the chemical industry, energetics and car traffic. Secondary suspended particles, the level of which depends upon meteorological factors, land use, agricultural activities and characteristics of surface, are significant source of air pollution by particular matter.

Location of stations

Bratislava - Jeséniova

The station is located in the area of the Slovak Hydrometeorological Institute at an altitude of 287 m. It is situated apart from the main urban pollution sources, in the sparse built-up area of family houses.

Bratislava - Kamenné námestie

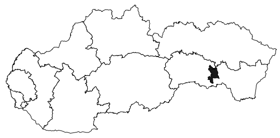
The station is located in the city center nearby TESCO supermarket, in an area with a higher density of road passenger transport.

Bratislava - Trnavské mýto

The station is situated near the large busy crossroads, Šancová and Trnavská street – Krížna and Vajnorská street. It represents a position with extreme high road transport emissions.

Bratislava - Mamateyova

The monitoring station is located in the open space nearby playgrounds at a sufficient distance from the prefab building area. Its main sources of pollution include mainly traffic, energy sources and under the west wind direction the site is polluted by emissions from the petrochemical complex Slovnaft.



AGGLOMERATION - KOŠICE

AREA: 244 km^2 POPULATION: 239 464

The area characteristics

Košice

The city of Košice spreads out in the valley of Hornád River and the surrounding area. According to the orographic classification it belongs to the inner Carpathians, Slovenský kras reaches this region from the southwest, Slovenské rudohorie is situated in the north and Slánske vrchy in the east. Among these mountain ranges, Košice basin is situated. The composition of these mountains affects the climatic conditions of the area. The prevailing wind from the north is typical by the relatively higher wind speeds, reaching 5.7 m.s^{-1} on average. The annual average wind speed from all directions is 3.6 m.s^{-1}. The main share of air pollution in the area comes from heavy industry, in particular engineering, non-ferrous and ferrous metallurgy, as well as limestone processing. Energy sources, including the city heating plants and local boiler houses emit less amounts of pollutants.

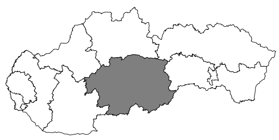
Location of stations

Košice - Štefánikova

The station is located in an urban area covered predominantly with family houses on a grass strip beside four-lane road.

Košice - Amurská

The monitoring station is located 100 m from the residential prefab building blocks (surrounding it from the north, south and west), about 30 m from the three-floor clinic building (to the southwest) and approximately 120 m from a small lake (to the east). It is the urban background station.



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 454 km^2 POPULATION: 655 359

The area characteristics

Banská Bystrica

The town is located in Bystrica valley, which is the northern part of the Zvolen basin surrounded by the Staré Hory hills from the north, by the Horehronské valley from the northeast and by the Kremnica hills from the southeast. The annual average temperature in Banská Bystrica is 8 °C. Prevailing wind circulation comes here from the north and north-east with an average speed 2.1 m.s^{-1} and high occurrence of temperature inversion in the valley. Air pollution is mainly influenced by a considerable number of local heating sources and partly by the wood processing industry as well. A significant traffic intensity contributes to the high level of air pollution in the town centre, as well.

Zvolen

The town of Zvolen spreads out in the southwestern part of Zvolen basin. It covers the central Pohronie valley up to the town of Banská Bystrica extending into Slatina, Detva and Sliač basins. Zvolen basin is bordered by the volcanic mountains of Štiavnica and Kremnica hills from the west, Javorie hills from the south and Poľana hills from the east. Climate assessment shows that in the spring and summer season there are good weather conditions for the dispersion of pollutants in Zvolen, while in the autumn and winter season conditions are worsening. This is mainly due to the frequent occurrence of fogs and ground inversions in autumn and winter. On the whole, deteriorated variation of the pollutants in the Zvolen basin is associated with a lack of wind and a very low air flow having average wind speeds below 1 $m.s^{-1}$ in 45% of days within the year.

Žiar nad Hronom

The area of Žiar basin is bordered by mountains from several sides – the Pohronský Inovec in the southwest, by the Vtáčnik and the Kremnica hills in the west up to the north, and the Štiavnica hills in the east up to the southeast. Very unfavourable meteorological conditions due to the level of air pollution by industrial emissions of the ground air layer is typical of the area. The annual average wind speed in all directions is 1.8 $m.s^{-1}$. The east and north-west wind directions occur here more often during a year.

Hnúšťa

The area is situated in the valley of the Rimava River. The relatively high mountain ranges spread out along a quite narrow valley. Short-term measurements confirm the predicted low level of wind speed flows of about 1.5 $m.s^{-1}$ on average and a high occurrence of calm weather.

Jelšava

The town is situated in the area lying in the southern part of Jelšava mountains surrounded by the Hrádek mountain range in the north-east, by Železnické foothills in the south-west and Jelšava kras in the south. The countryside along the central Muráň River, with northwest-southeast orientation, is a very rugged. The air circulation here is determined by the direction of the Muráň River valley. The annual average wind speed is relatively low, 2.5 $m.s^{-1}$. The frequent ground inversions during the night occurs due to the mountain rugged terrain as well as two mountain ranges, Skalka and Slovenská skala, bordering the valley. The major share in air pollution comes from the Slovak magnesite plants Jelšava and Lubeník, situated in the northwest of the town, and from the small local heating systems (mostly gas systems) as well.

Location of stations

Banská Bystrica - Štefánikovo nábrežie

The monitoring station is located close to a heavy traffic road connecting the region with the eastern part of Slovakia. In the vicinity of about 100 m lies the high-rise building of the Lux Hotel and housing estate built-up area. The station is situated in the valley of the city near the Hron River implicating adverse dispersion conditions of pollutants. It mainly represents a position with high road transport emissions.

Banská Bystrica - Zelená

The station is located in the SHMÚ area at an elevation of 427m apart from major air pollution sources. In the immediate vicinity there are housing estate buildings and family houses with gardens.

Zvolen - J. Alexyho

The station is located in the ground of the elementary school belonging to the Sekier large housing estate in the southeastern part of the city. It lies about 300 meters from a heavy traffic road of south draw leading to Košice. Besides traffic, the significant contribution to air pollution represents emissions from wood processing industry.

Hnúšťa – Hlavná

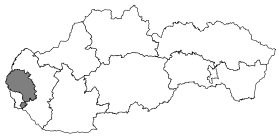
The monitoring station is located on the northern outskirts of the city (a sparse built-up area of family houses with gardens) in the open space 50 m from the state road no. 531.

Jelšava - Jesenského

The station is located in the periphery of the city, in a kindergarten area, on a hill opened from one side to the major polluter (SZM Jelšava). From the other side, about 100 m away, there is a housing estate built-up area.

Žiar nad Hronom - Jilemnického

The monitoring station lies in a suburb about 100 m from the main four-lane road directing to Prievidza. Four-floor prefab houses and the primary school are located nearby. There is no higher vegetation here due to close proximity of a high-voltage electricity line.



ZONE - BRATISLAVA REGION

AREA: 1 685 km^2 POPULATION: 205 489

The area characteristics

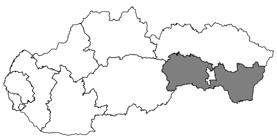
Malacky

The district Malacky spreads out north from the capital of the Slovak Republic, Bratislava. It lies in the southern part of the Záhorie lowland bounded by the River Morava in the west (bordering line with Austria) and by the Little Carpathians in the east. The district is part of the Bratislava NUTS-3 region. The administrative center and the largest city of the district is Malacky. The east-west and north-west wind directions occur here most frequently during a year. Annual average wind speed is about 2.7 m.s^{-1}.

Location of stations

Malacky - Mierové nám.

The monitoring station is located directly in the city centre on the main junction (5 m from the kerbside), roads that lead to the highway D2. In the immediate vicinity, there is a supermarket and residential houses.



ZONE - KOŠICE REGION

AREA: 6 511 km^2 POPULATION: 556 101

The area characteristics

Krompachy

The town Krompachy is located in a valley system with good local air circulation. The southern part of the town lies in the Slovinka River valley surrounding by hills with an elevation of 350 m. The northern part of the city is placed in the valley of the Hornád River with an east-west orientation determining airflow. The annual average wind speed here is low, approximately 1.4 m.s^{-1}. The main polluter in Krompachy is ferrous metal plant Kovohuty (located in the northeast) and local heating systems as well.

Strážske

The town Strážske is located to the east of Vihorlat hills in the northern part of the Eastern Slovak lowland in so called Brekov Gate area – with the orographically increased air flow, mainly from the north. The annual average wind speed here is 3.4 m.s^{-1}. The wind speed is characterized by significant daytime cycle with a low at night. The local chemical industry in the town represents the main source of air pollution.

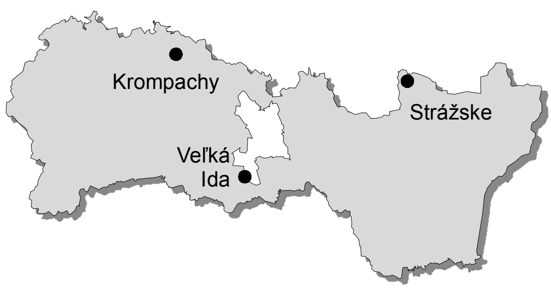
Veľká Ida

The town is located at the border line of the Košice Basin and the Moldava Lowland. The area is surrounded by the Abov hills in the south, by the Slovak Kras from the west and the Slovak Rudohorie from the north. Towards the west lies the valley of the Hornad River. The prevailing winds come here from north-east and south-west directions and its annual average is about 2.5 m.s^{-1}. The main air pollution source is the nearby ferrous metallurgy complex and large dumps from extracted ores.

Location of stations

Krompachy - SNP

The monitoring station is located close to the main road Košice - Spišská Nová Ves oriented to the east-west, on its left side in direction to Spišská Nova Ves. Behind this traffic station there is a residential area with about 8-floor block of flats in the east, south and west.

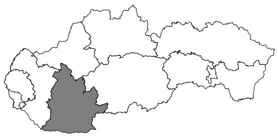


Strážske - Mierová

The station is situated in the center of the town, in the open area among buildings, gardens and park greenery, about 1.5 km east-southeast from the Chemko Strážske plant. Near the station there is the first class road Michalovce-Prešov detached from the station by a tree alley.

Veľká Ida - Letná

The station is located on the south-eastern edge of the village Veľká Ida near the US Steel Košice ferrous metallurgy complex, in the open area. In the neighbourhood there are family houses with gardens, a railway station, waste dump of blast furnace slag and steel not fully covered by grass and still plant.



ZONE - NITRA REGION

AREA: 6 344 km^2 POPULATION: 684 922

The area characteristics

Nitra

Most of the region, typical of small altitudes differences formed by Danube upland in the northeast, interferes into the Danube lowland. There is a predominance of north-south and south-west winds with a relatively low number of calm days.

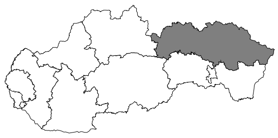
Location of stations

Nitra - Štúrova

The monitoring station is located on the right side of the roundabout (about 100 m) in the direction to the center of Nitra town, near the 4-floor buildings and green vegetation.

Nitra - Janíkovce

The measuring station lies in the area of elementary school Veľké Janíkovce, on a cascade slope facing the Nitra airport.



ZONE - PREŠOV REGION

AREA: 8 974 km^2 POPULATION: 819 977

The area characteristics

Prešov

Prešov lies in the northern projection of the Košice basin. The surrounding mountains of the Šariš highland and the Slánske mountain-range reach an altitude of 300 – 400 m. The highest peak Stráž, in the north, protects the city from the cool Arctic air. The city is situated on a south facing slope, enabling outflow of the cold air, settled at the bottom of the basin. The northern air flow, the strongest one, prevails during the year. The second maximum of wind flows comes from the south. Good ventilation of the town is provided by the widening of the valley at the confluence of the Sečkov and Torysa Rivers. The main air pollution sources in town originate from municipal boilers, traffic, wood processing industry and local heating systems.

Humenné

Humenné lies in the valley of the Laborec River, protected by a wide zone of the Carphatians from the north and the Vihorlat mountain range from the south. The valley has a northeastern orientation without predominant wind direction due to complex orography. The occurrence of calm days is relatively high. The local chemical industry is the main air pollution source of the area with the main polluter heating plant Chemes a.s., Humenné.

Vranov nad Topľou

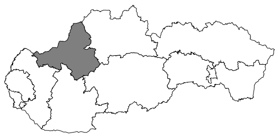
Town Vranov nad Topľou lies in the valley of the Topľa River, spreading into the East Slovak Lowlands. The locality is bordered by the Slánske hills in the west and by the wide strip of the Carpathians in the north. The air flow is determined by the north-west position of the Topľa River valley. The main air pollution sources of the site are the local wood processing industry and local heating systems.

Location of stations

Humenné - Nám. slobody
The monitoring station is located in the southern part of the city centre in open area on the edge of the pedestrian zone with minimal car traffic (goods supply and two small parking places for shopping). The surrounding buildings and multi-floor prefab houses are connected to a central heating Chemes Humenné plant within approx. 2 km distance from the station to the west.

Vranov nad Topľou - M. R. Štefánika
The station is situated in the town centre in a low built-up area with family houses and gardens, and higher buildings (centre of culture, 3-floor residential houses) approx. 2 km north-west from the Bukocel, a.s. Hencovce plant. It stands 30 m apart from the main road.

Prešov - Arm. gen. L. Svobodu
The monitoring station is located in the south-eastern part of the town in open area close to the Arm. gen. L. Svobodu road, with rather heavy traffic during the working days. To the east of the station, approximately 25 m, separated by a low greenery, there is a row of prefab 8-floor buildings. The station is conceived as a traffic one. Its distance from kerbside is 2 m.



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 591 233

The area characteristics

Horná Nitra

The monitored area includes part of the Horná Nitra basin from Prievidza to Bystričany. The direction of wind is considerably influenced by orography and position of the basin. Winds from north and north-east are here most common. A low value of annual wind speed 2.3 m.s^{-1} indicates the unfavourable conditions for emission dispersion and transport of emissions. The dominant share of air pollution in this area represents energetics. Besides, the sources of chemical industry and local heating emitting less emissions. The low quality of fuel and energy sources contributes to a high air pollution in this area significantly. The coal in use contains apart from sulphur also arsenic.

Location of stations

Prievidza - Malonecpalská

The monitoring station is located on the outskirts of the city in the open air area of the elementary primary school. Nearby there is a shopping centre and the 1st grade road No. 64 leading to Žilina.

Handlová - Morovianska cesta

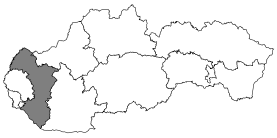
The station is located in a predominantly family houses built-up area within a territory of elementary school, and close to the municipal road. Energy sources and industry are the major polluters.

Bystričany - Rozvodňa SSE

The station is located in the distribution point of electric energy (SSE) at agricultural area among fruit trees. The major source of air pollution Nováky power plant (ENO) lies 8 km northern from the monitoring station.

Trenčín - Hasičská

The monitoring station lies between the stadium and the commercial built-up area, at the main road leading from the center of the town to Trenčianska Teplá.



ZONE - TRNAVA REGION

AREA: 4 147 km^2 POPULATION: 557 608

The area characteristics

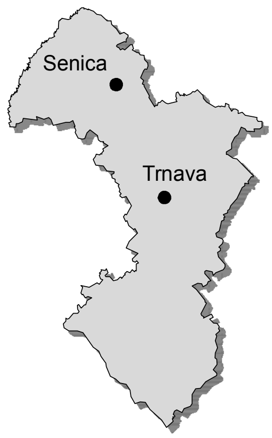
Senica

The town itself lies in the southern slopes of the Myjava hills at an altitude of 208 m. From the west and partly from the northern side is the area bordered by the Small Carpathians. It is open only alongside the Myjava River from the east reaching the Záhorie lowlands. In terms of dispersion and transmission emissions, the wind conditions are favourable here under the prevailing north-west wind due to relatively higher wind speeds.

Trnava

Trnava, one of the most important towns in Slovakia, lies in the centre of the Trnava downs, at an altitude of 146 m, 45 km from Bratislava. The prevailing wind comes here from the north-west, the second highest wind frequency is from the south-east. The location represents an area with a relatively well air circulation and low occurrence of calm days.

Location of stations

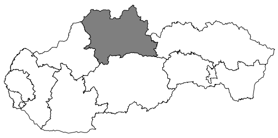


Senica – Hviezdoslavova

The monitoring station is placed 5 m from kerbside of the main road leading to Kúty with a relatively high transit traffic. Forty meters southern from the station, there is an area of prefab multi-floor block of flats and nearby a bus stop station as well. The trim greenery surroundings with trees can be found here.

Trnava - Kollárova

The monitoring station lies in the open area nearby a high-traffic crossroad at the edge of a large car park close to the railway station.



ZONE - ŽILINA REGION

AREA: 6 809 km^2 POPULATION: 690 449

The area characteristics

Ružomberok

The town's location includes the western part of Liptov basin at the confluence of the Váh, Revúca and Likavka Rivers. The border in the west makes up the Veľká Fatra mountains, in the north the Choč mountains of and in the south the Low Tatras. The air flow comes here mostly from the west with an average speed 1.6 m.s^{-1}.

Žilina

The town is spread out over the central valley of the Váh River, in the valley of central Považie. The Žilina basin is one of the medium-high basins. The Malá Fatra mountains reaches the area from the east, the White Carpathians from the south and the Javorníky Mountains from the northwest. In the basin, the relative air humidity is higher throughout the year. It is the area with the biggest number of days in the year with the fog. Slight windiness with average wind speed 1.3 m.s^{-1} and occurrences of calm days up to 60% characterise this area. From the standpoint of potential air pollution, the wind conditions in the Žilina basin are very unfavourable. Therefore relatively smaller emission sources cause a relatively high level of air pollution at the ground layer.

Martin

The town of Martin lies in the Turiec basin at the confluence of the Turiec and Váh Rivers, surrounded by the Veľká and Malá Fatra mountain ranges. The area of the basin, located between the high mountains, has unfavourable climatic conditions in terms of pollutant emission dispersion. Frequent inversions, low average wind speeds of 2.8 m.s^{-1} and high relative humidity contribute here to higher level of air pollution.

Location of stations

Žilina - Obežná

The station is situated in the northeastern part of the city at the edge of suburb in relative open area, close to the local poor frequency of transport. Its position is open in all directions and representative for measuring wind direction and speed.

Ružomberok - Riadok

The station lies within an area of the kindergarten on the edge of the suburb among family houses close to the road with poor frequency of transport.

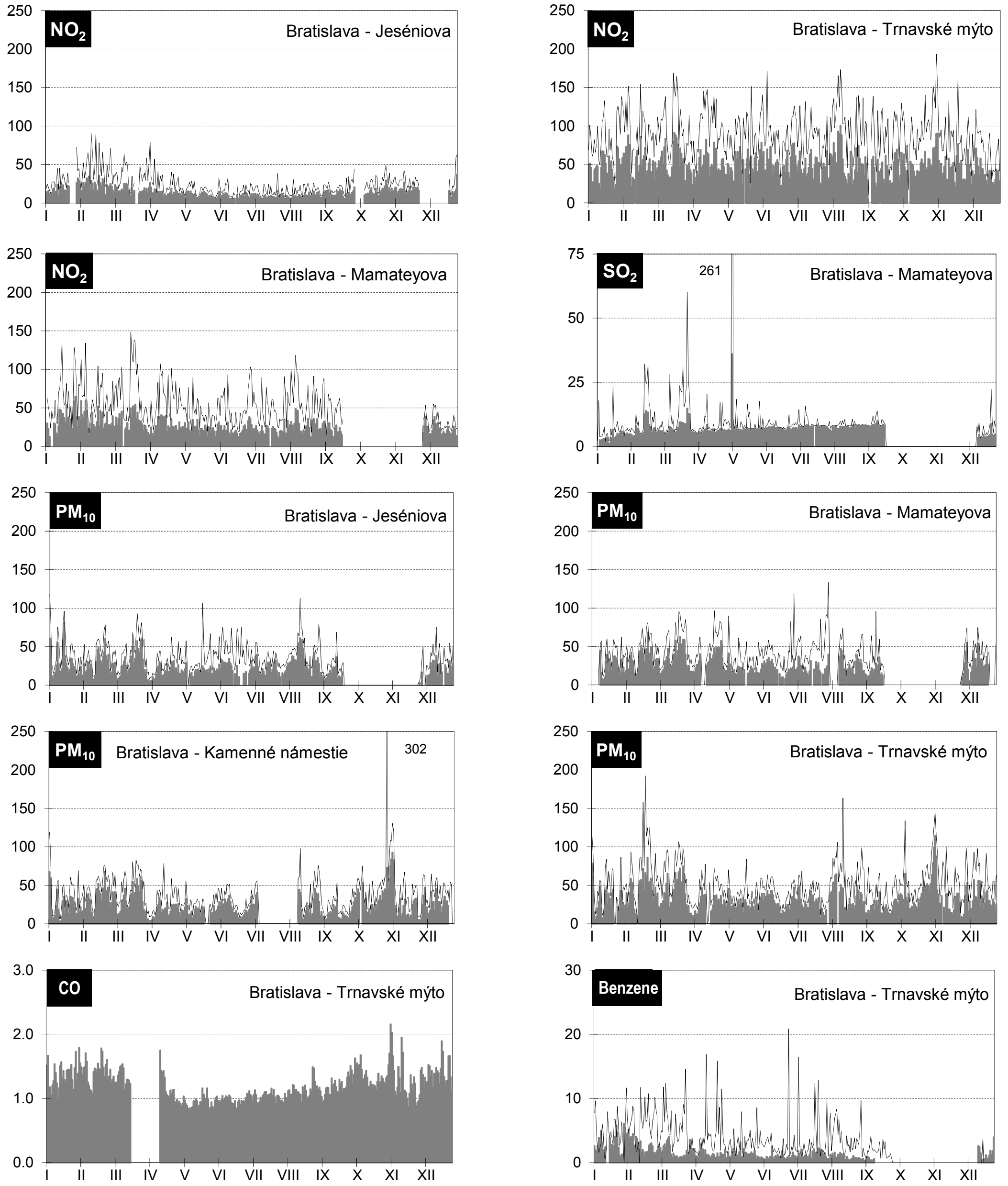
Martin - Jesenského

The station is located in the southern part of town nearby a residential two-floor house and family houses, 5 m from the kerbside of the rather busy road to Martin.

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in – 2015**

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, Mierové nám.	17°01'11"	48°26'12"	197	*		*	*	*	*					
Košice region	Veľká Ida, Letná	21°10'30"	48°35'32"	209	*	*			*	*	*	*	*	*	*
	Strážske, Mierová	21°50'15"	48°52'26"	133	*	*									
	Krompachy, SNP	20°25'26"	48°54'57"	372	*	*	*	*	*	*	*	*	*	*	*
Nitra region	Nitra, Štúrova	18°04'10"	48°18'00"	143	*	*	*	*	*	*					
	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	*	*	*			*					

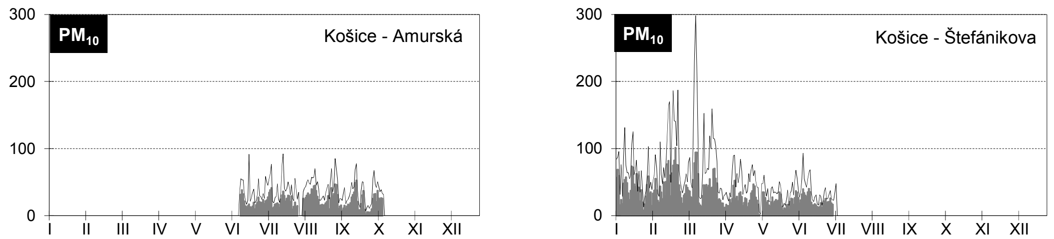
Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, benzene and CO – agglomeration Bratislava – 2015**



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

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

Fig. 2.2 **Concentrations of NO_2, PM_{10}, $PM_{2.5}$ and benzene – agglomeration Košice – 2015**



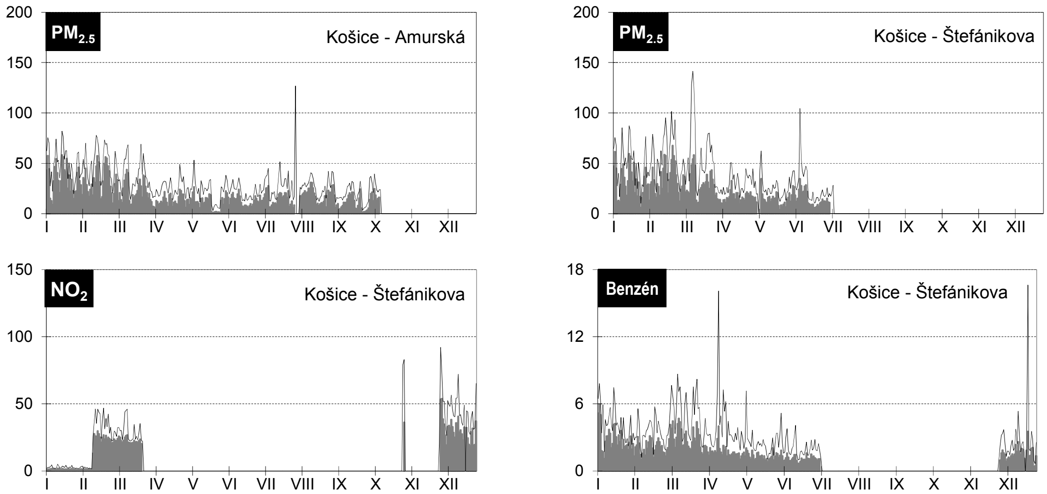
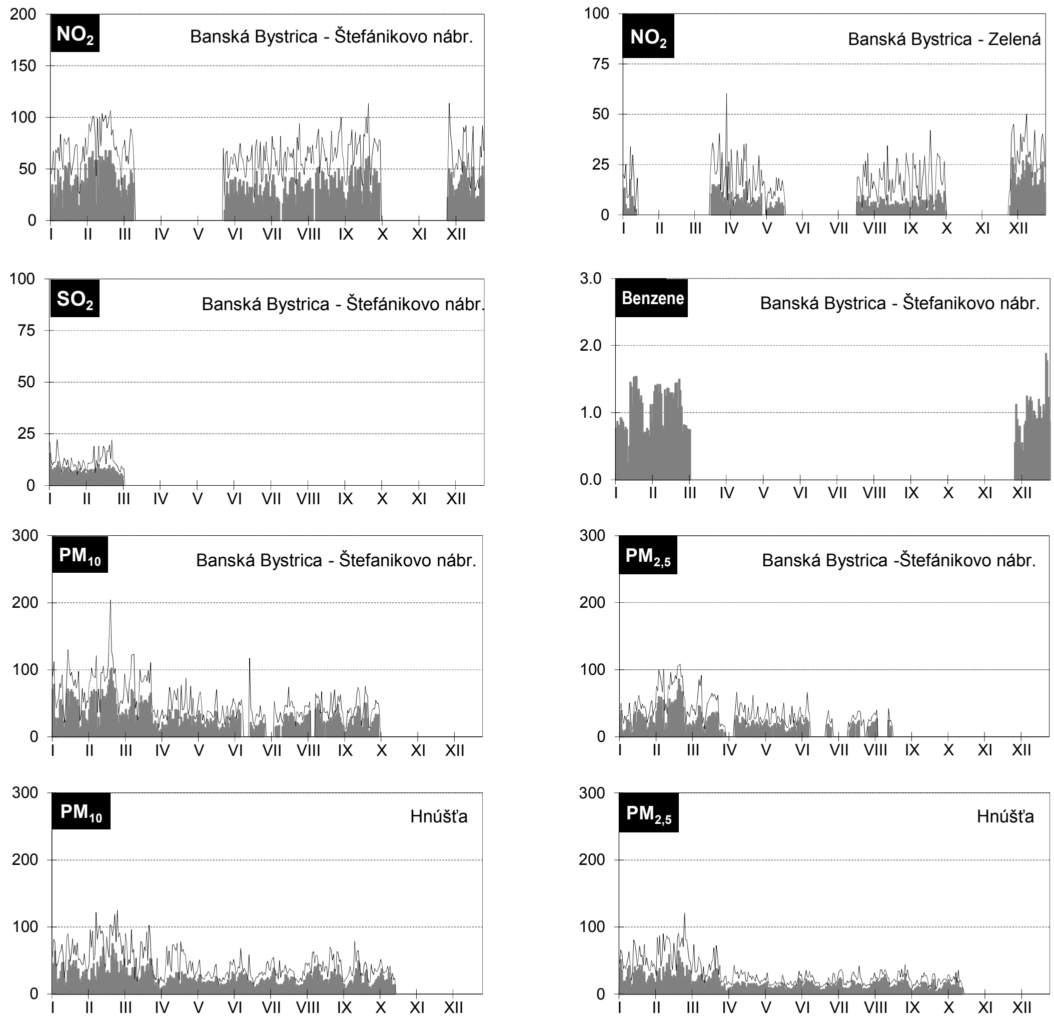


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Banská Bystrica region – 2014**



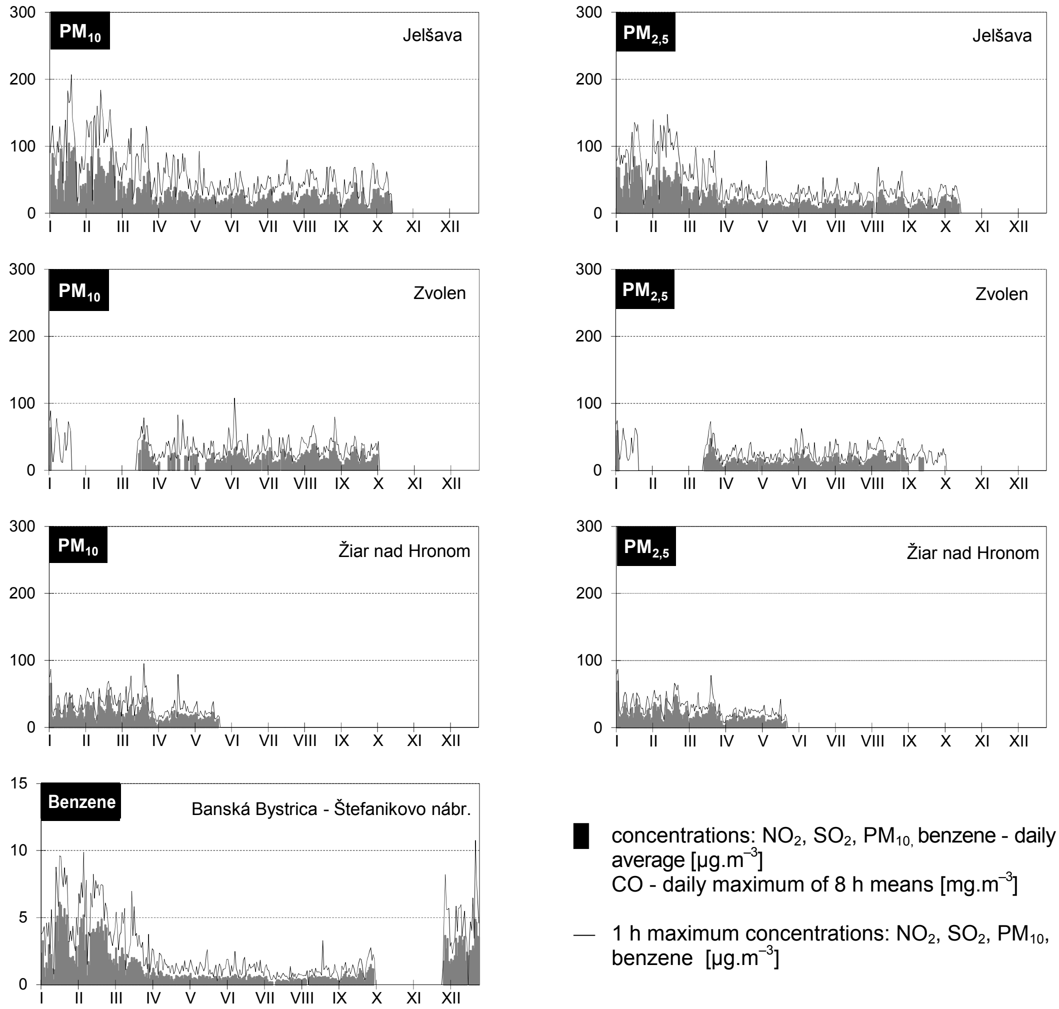
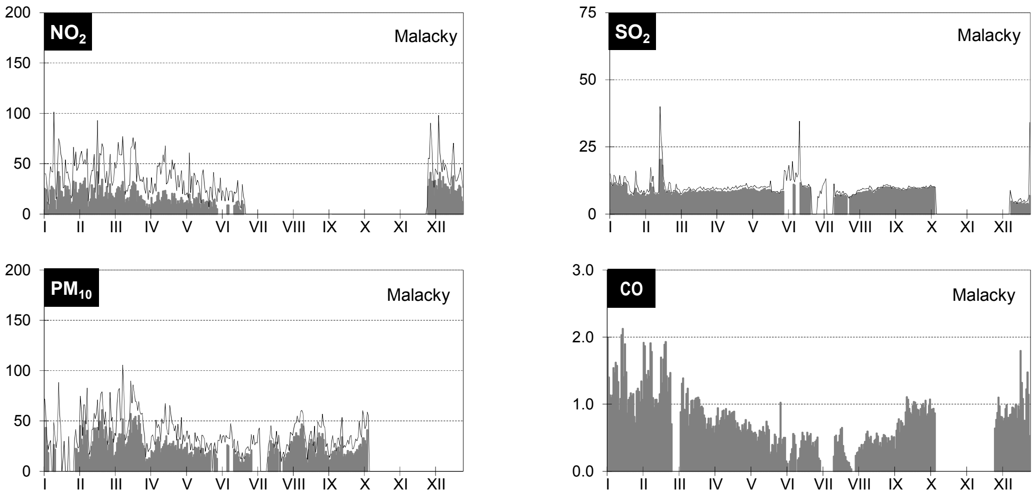
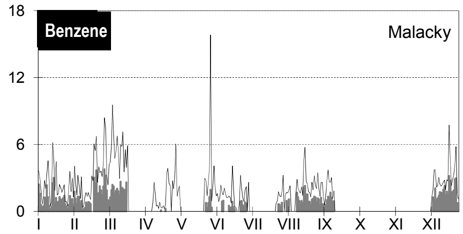


Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Bratislava region – 2015**

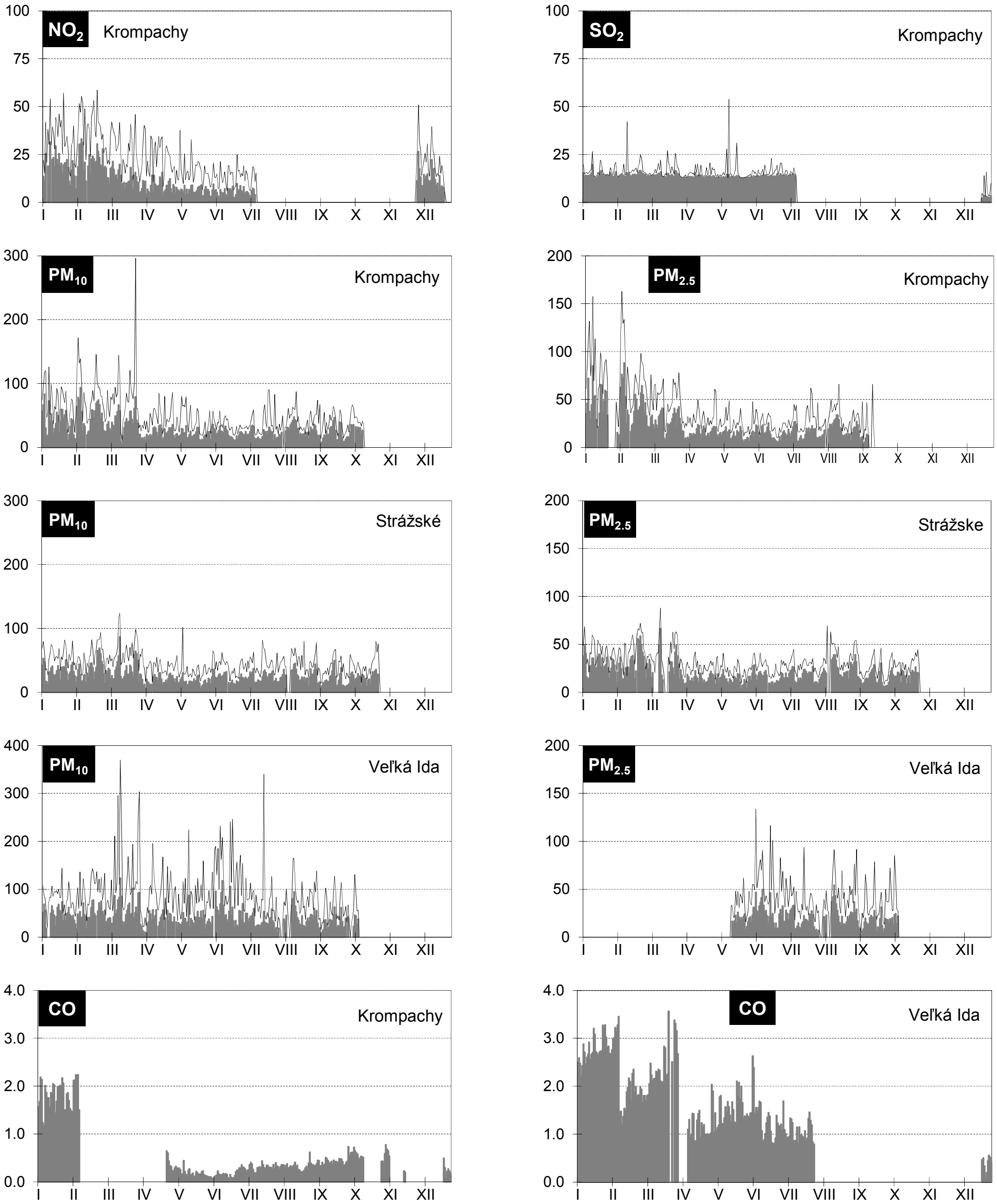


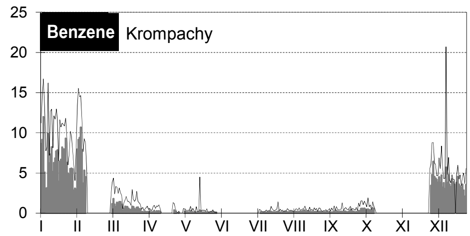


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [μg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 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 – 2015**





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

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

Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Nitra region – 2014**

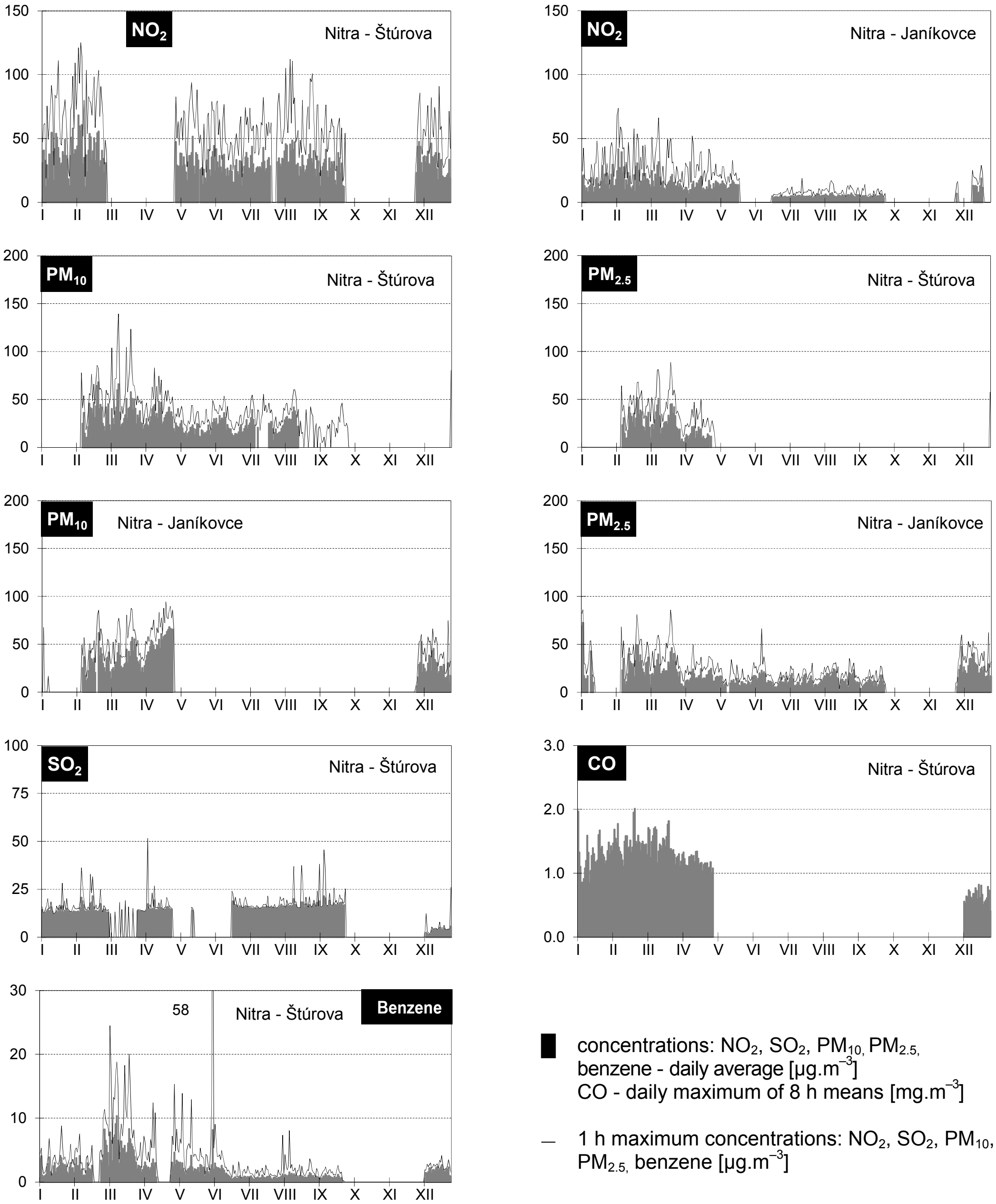


Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Prešov region – 2015**

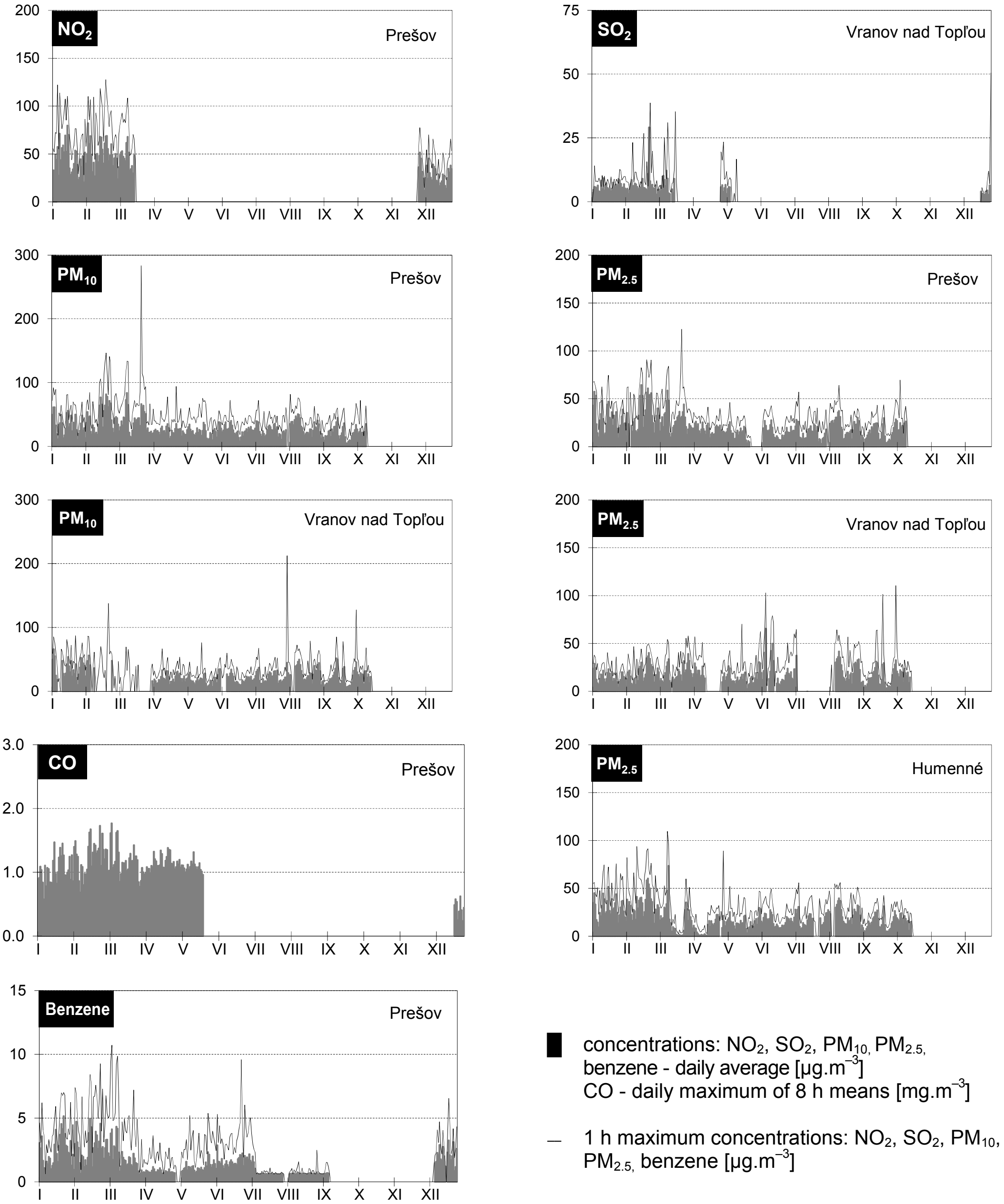
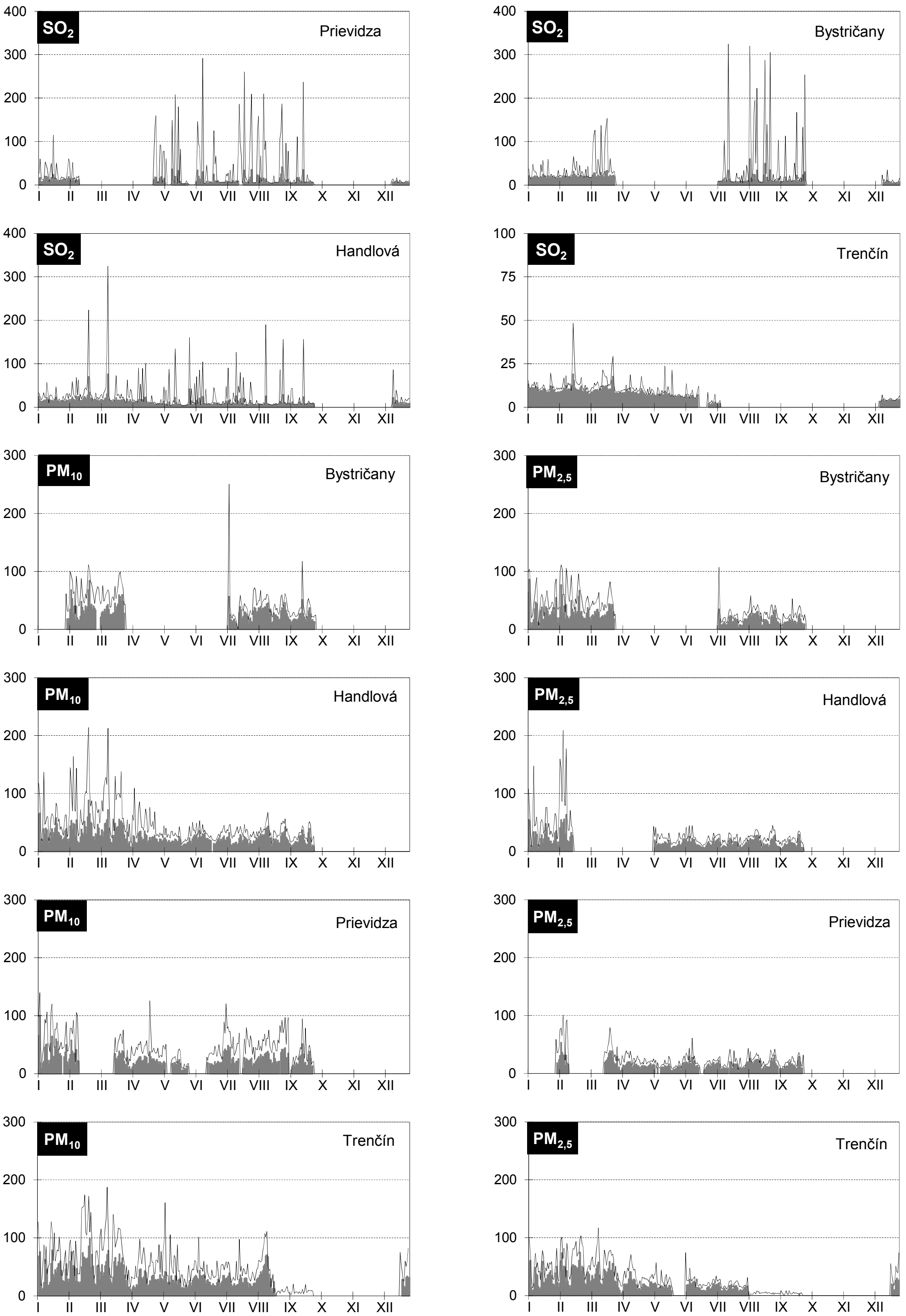
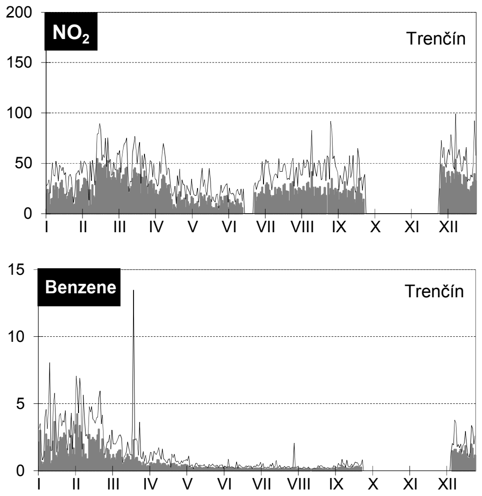
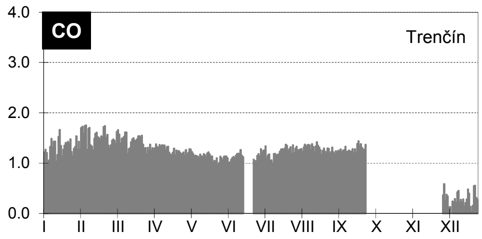


Fig. 2.8 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trenčín region – 2015**







█ 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. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trnava region – 2015**

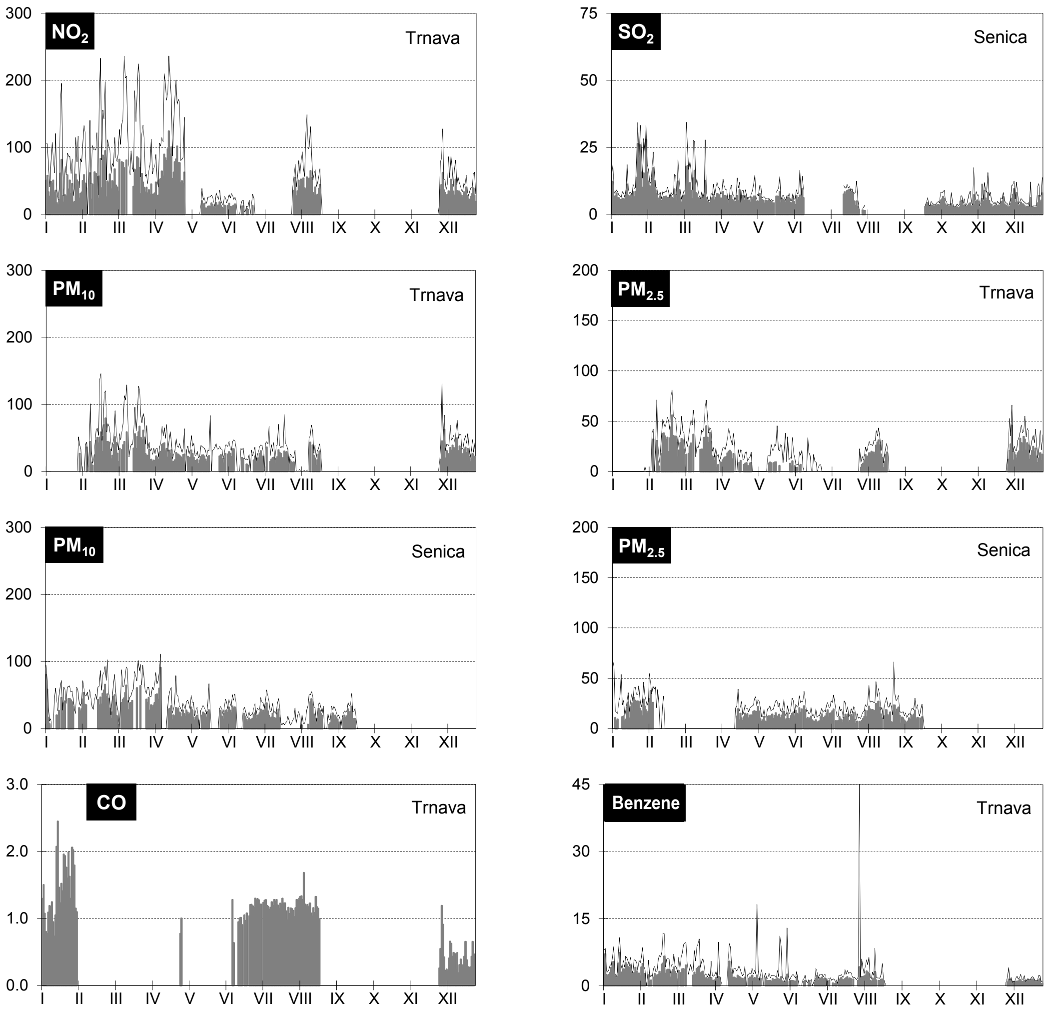
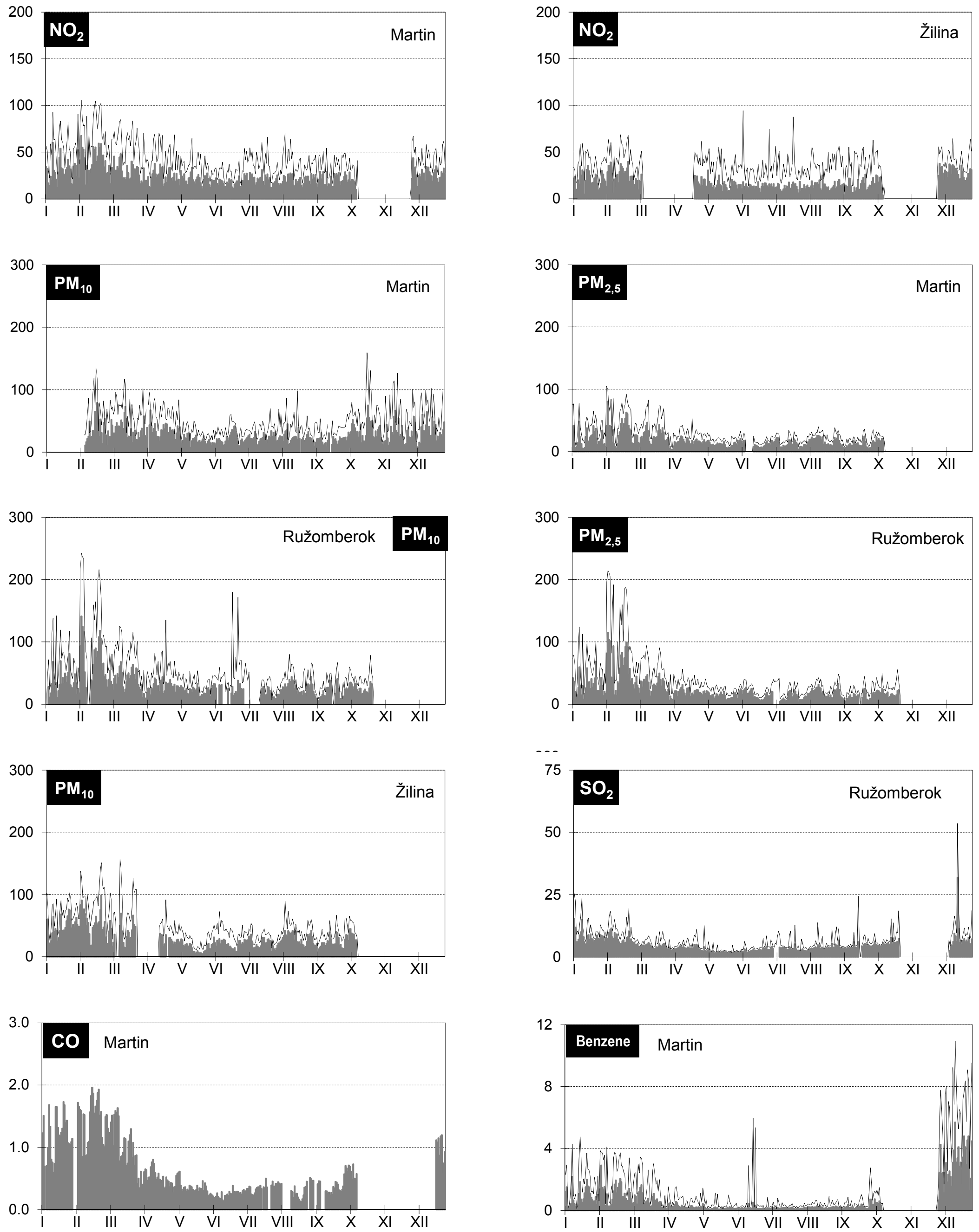


Fig. 2.10 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Žilina region – 2015**



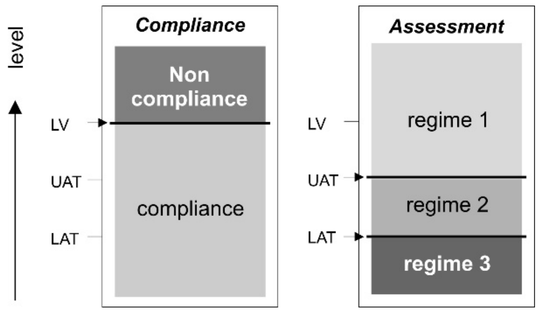
█ concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [$\mu g.m^{-3}$]
CO - daily maximum of 8 h means [$mg.m^{-3}$]

– 1 h maximum concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene [$\mu g.m^{-3}$]

2.3 PROCESSING OF MEASUREMENT RESULTS ACCORDING TO LIMIT VALUES

The air quality assessment is being carried out in each zone and agglomeration in line with the respective limit and target values for individual pollutants according to the Air Protection Act No. 137/2010 Coll. On the basis of pollution level results over the last five years, three different monitoring regimes are distinguished (Fig. 2.11). Table 2.2 shows air quality assessment requirements for a particular regime.

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**	Model computations, expert estimates and indicative measurements are sufficient.

Margins of tolerance were set for some pollutants (Tab. 2.3). These margins are gradually reduced to the zero value reaching it in the year when the limit values come into force. Tables 2.3 and 2.4 show air quality limit values, upper and lower assessment thresholds defined in Decree no. 360/2010 Coll. Alert thresholds were set only for:

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

Alert threshold values are exceeded if each of three consecutive 1 hour concentrations exceeds the alert thresholds stated above in case the polluted area is larger than 100 km^2 or the polluted area represents the whole zone (agglomeration, respectively). (The more strict criteria is taken into account.)

The results of continuous measurements are presented here in figures and tables. The statistics in tables were compiled for all monitoring stations. The stations where the limit values and limit values or target values were exceeded are marked in bold (Tab. 2.5 – 2.7).

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[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.*

Sulphur dioxide In 2015, the limit value of pollution was not exceeded in any agglomeration and zone. The limit values for the protection of human health have not been exceeded in more cases than it is stated by Air Quality Decree no. 360/2010 Coll. In 2015, there was no case of alert threshold exceedance. The critical value for the protection of vegetation is 20 $\mu g.m^{-3}$ per calendar year and winter season. This limit value was not exceeded during 2015 at any of the EMEP stations. All values were below LAT for protection of vegetation.

Nitrogen dioxide In 2015, the annual limit value was exceeded at the monitoring stations as follows: Bratislava-Trnavské mýto 49 $\mu g.\ m^{-3}$, Prešov-arm. Gen. L. Svobodu 42 $\mu g.\ m^{-3}$ and Trenčín-Hasičská 41 $\mu g.\ m^{-3}$. The number of exceedance Exceedance of the limit value of hourly concentrations for the protection of human health has not been surpassed at any monitoring station in more cases than it is stated in Air Quality Decree no. 360/2010 Coll. In 2015, there was no case of exceeding the alert threshold.

PM_{10} In 2015, the limit value of daily mean PM_{10} concentrations for the protection of human health has been exceeded at the stations as follows: Bratislava-Trnavské mýto 40 times, Banská Bystrica-Štefánikovo nábr. 41 times, Jelšava-Jesenského 39 times, Veľká Ida 71 times and Trenčín-Hasičská 43 times. The mean annual concentration limit was exceeded at the Veľká Ida station.

$PM_{2,5}$ For $PM_{2,5}$, is set only an annual limit of 25 $\mu g.\ m^{-3}$, which came into force on 1st January 2015. (Commission Implementing Decision 2011/850/EU, ANNEX 1, point 5). In 2015, this value was not exceeded at any monitoring station and the number of measured values did not reach 85% of data coverage.

Carbon monoxide None of the monitoring stations exceeded the limit value and the concentration levels for the previous period 2009 – 2015 is below LAT.

Benzene The highest level of benzene 2.1 $\mu g.\ m^{-3}$ which is noticeably below the limit of 5 $\mu g.\ m^{-3}$, was measured at Nitra-Štúrova and Trnava-Kollárova stations in 2015.

Pb, As, Ni, Cd The average annual concentrations of heavy metals at NMSKO stations are usually much smaller as compared to the target or limit values. Sporadic exceedance of the target value for arsenic at the Prievidza-Malonecpalská station appeared, the same as in 2015.

BaP The average annual concentration of benzo(a)pyrene at AMS Bratislava-Trnavské mýto did not exceed the target value. At other NMSKO monitoring stations in 2015, the sampling for BaP analysis was completed in August (Trnava-Kollárova, Bratislava-Jeséniova) or in September (Prievidza- Malonecpalská, Veľká Ida-Letná). For the assessment of the average annual concentration against the target value, the number of available measurements was not sufficient. As far as the long-term status is concerned, the target value for benzo(a)pyrene is usually exceeded at AMS Veľká Ida-Letná, Krompachy-SNP and Prievidza-Malonecpalská, as well as at the stations, which are mainly affected by road transport emissions – Trnava-Kollárova and Bratislava-Trnavské mýto in some years, depending on traffic intensity and meteorological conditions.

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	2011	2012	2013	2014	2015
SO_2	1h	350 (24)	1.1.2005	150 µg/m³	500	470	440	410	380	350	350	350	350	350	350	350	350	350	350	350
SO_2	24h	125 (3)	1.1.2005	-																
SO_2^v	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	200	200	200	200	200
NO_2	1y	40 (-)	1.1.2010	50 %	60	58	56	54	52	50	48	46	44	42	40	40	40	40	40	40
NO_x^v	1y	30 (-)	1.1.2003	-																
PM_{10}	24h	50 (35)	1.1.2005	50 %	75	70	65	60	55	50	50	50	50	50	50	50	50	50	50	50
PM_{10}	1y	40 (-)	1.1.2005	20 %	48	46	45	43	42	40	40	40	40	40	40	40	40	40	40	40
Pb	1y	0.5 (-)	1.1.2005	100 %	1,0	0,9	0,8	0,7	0,6	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
CO	max. 8 hour daily value	10000 (-)	1.1.2005	6000 µg/m³	16000	16000	16000	14000	12000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Benzén	1y	5 (-)	1.1.2010	100 %	10	10	10	10	10	10	9	8	7	6	5	5	5	5	5	5
$PM_{2.5}$	1y	25	1. 1. 2008	5 µg/m³										30	29	28	27	26	26	25
$PM_{2.5}^{**}$	1y	25	1. 1. 2015	-																

[1] winter period (October 1 - March 31) *[v] critical level for protection of vegetation*
** allowed exceedances per year are in brackets* *** target value*

	Interval of averaging	Target value [ng/m³]	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	1y. 1/2y	20 (-)	12 (-)	8 (-)
NO_2	Human health	1h	200 (18)	140 (18)	100 (18)
NO_2	Human health	1y	40 (-)	32 (-)	26 (-)
NO_x	Vegetation	1y	30 (-)	24 (-)	19.5 (-)
PM_{10}	Human health	24h	50 (35)	35 (35)	25 (35)
PM_{10}	Human health	1y	40 (-)	28 (-)	20 (-)
Pb	Human health	1y	0.5 (-)	0.35 (-)	0.25 (-)
CO	Human health	8h (maximum)	10 000 (-)	7 000 (-)	5 000 (-)
Benzene	Human health	1y	5 (-)	3.5 (-)	2 (-)
$PM_{2,5}$	Human health	1y	25**	17	12

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

Tab. 2.5 **Assessment of air quality according to limit values for protection of human health – 2014**

AGLOMERATION / Zone		Human protection									VP [2)]	
	Pollutant	**SO_2**		**NO_2**		**PM_{10}**		**$PM_{2.5}$**	**CO**	**Benzene**	**SO_2**	**NO_2**
	Time of averaging	1 hour	24 hour	1 hour	1 year	24 hour	1 year	1 year	8 hour [1)]	1 year	3 subsequent hour	3 subsequent hour
	Limit value [μg.m^{-3}] *(počet prekročení)*	350 *(24)*	125 *(3)*	200 *(18)*	40	50 *(35)*	40	25	10000	5	500	400
BRATISLAVA	Bratislava, Kamenné nám.					16	24					
	Bratislava, Trnavské mýto			0	**49**	**40**	32		2155	1,6		0
	Bratislava, Jeséniova			0	17	12	23					0
	Bratislava, Mamateyova	0	0	0	26	11	27				0	0
KOŠICE	Košice, Štefánikova			0	18	30	33	24		2,0		0
	Košice, Amurská					1	23	19				
Banská Bystrica region	Banská Bystrica, Štefánik.nábr.	0	0	0	36	**41**	32	24	1877	1,3	0	0
	Banská Bystrica, Zelená			0	9							0
	Jelšava, Jesenského					**39**	30	22				
	Hnúšťa, Hlavná					11	26	18				
	Zvolen, J. Alexyho					3	20	16				
	Žiar n/H, Jilemnického					2	21	19				
Bratislava region	Malacky, Mierové nám.	0	0	0	19	7	26		2123	1,2	0	0
Košice region	Veľká Ida, Letná					**71**	**43**	20	3564			
	Strážske, Mierová					11	26	20				
	Krompachy, SNP	0	0	0	12	30	29	22	2239	1,8	0	0
Nitra region	Nitra, Janíkovce			0	11	20	35	17				0
	Nitra, Štúrova	0	0	0	32	7	27	23	2023	2,1	0	0
Prešov region	Humenné, Nám. Slobody							19				
	Prešov, Arm. gen. L. Svobodu			0	**42**	24	30	21	1770	1,6		0
	Vranov n/T, M. R. Štefánika	0	0			7	24	18			0	
	Stará Lesná, AÚ SAV, EMEP [3)]					0	13	11				
	Kolonické sedlo, Hvezdáreň [3)]					0	12	9				
Trenčín region	Prievidza, Malonecpalská	0	0			9	26	15			0	
	Bystričany, Rozvodňa SSE	0	0			9	30	23			0	
	Handlová, Morovianska cesta	0	0			14	25	16			0	
	Trenčín, Hasičská	0	0	0	24	**43**	31	22	1750	0,7	0	0
Trnava region	Senica, Hviezdoslavova	0	0			14	28	14			0	
	Trnava, Kollárova			14	**41**	12	28	18	2449	2,1		0
	Topoľníky, Aszód, EMEP [3)]					3	18	14				
Žilina region	Martin, Jesenského			0	25	17	26	17	1961	0,7		0
	Ružomberok, Riadok	0	0			27	31	23			0	
	Žilina, Obežná			0	18	32	30					0

[1)] *maximal 8 hour value of moving average* [2)] *alert threshold limit values*
[3)] *stations located in rural background areas*

Pollutants which exceeded limit values are in bold

Data coverage: *≥ 85 % 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 2015**

AGLOMERATION/ zone	Pollutant	As	Cd	Ni	Pb
	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
Slovakia	Banská Bystrica, Štefánikovo nábr.	3,7	0,3	10,0	8,7
	Veľká Ida, Letná	3,8	0,6	18,7	105,1
	Krompachy, SNP	2,5	1,3	4,5	110,4
	Prievidza, Malonecpalská	**6,4**	0,2	2,6	3,6
	Ružomberok, Riadok	4,2	0,2	12,9	7,3

Tab. 2.7 **Assessment of air quality according to target values for BaP for the protection of human health in 2015**

AGLOMERATION / zone	Pollutant	BaP
	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	0,8
	Bratislava, Jeséniova	0,6
Slovakia	Veľká Ida, Letná	**6,2**
	Krompachy, SNP	**1,9**
	Prievidza, Malonecpalská	**1,4**
	Trnava, Kollárova	0,8

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 (NOx, VOCs, CO) from car transport, power generation and industry. Since the early 1990s no trend of the average concentration level of ground level ozone in Slovakia, like as in many European countries, has been observed. In spite of considerable decrease of ozone precursor emission reduction in Slovakia and in surrounding countries during nineties the effect was not adequate. Only ozone peaks decreased significantly. It was shown the average level of ozone concentration is more controlled by large scale processes (downward mixing from the free troposphere, long-range transport and global warming). The extremely warm and dry year 2003 represented the absolute exception from these trends. Most of the ozone level indicators reached the highest values at all Slovak suburban, rural and mountain stations in the period 1993 – 2003. The level of concentrations in 2015 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 2010 – 2015

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 137/2010 Coll. on Air, 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 2010 – 2015

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. The number of missing data at almost all stations in 2015 was due to the overall renewal of monitoring network more than 10%.

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

Station	2010	2011	2012	2013	2014	2015
Banská Bystrica, Zelená	0.03	0.1	0.6	8.8	4.0	32.5
Bratislava, Jeséniova	0.2	1.3	1.6	0.3	8.3	20.1
Bratislava, Mamateyova	6.2	4.9	3.9	21.3	9.0	24.6
Humenné, Nám. Slobody	3.8	7.5	0.7	0.3	34.5	12.1
Jelšava, Jesenského	2.8	61.6	73.1	31.8	5.6	13.2
Košice, Ďumbierska	0.4	0.1	3.3	3.9	0.8	1.2
Nitra, Janíkovce	22.5	-	11.8	26.7	10.2	17.6
Prievidza, Malonecpalská	0.5	4.6	1.9	11.3	0.8	36
Žilina, Obežná	0.1	0.4	3.1	25.4	10.1	14.4
Gánovce, Meteo. st.	0.4	0.2	2.4	16.1	0.3	59.2
Chopok, EMEP	2.6	2.2	3.4	22.0	47.6	30.6
Kojšovská hoľa	14.2	2.5	4.2	1.5	13.4	30.8
Stará Lesná, AÚ SAV, EMEP	0.4	2.2	3.2	0.8	10.8	13.8
Starina, Vodná nádrž, EMEP	0.1	0.2	1.6	5.0	0.7	45.2
Topoľníky, Aszód, EMEP	2.9	-	18.9	30.1	0.1	19.2

- long-term failure

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

Station	2010	2011	2012	2013	2014	2015
Banská Bystrica, Zelená	56	60	66	66	58	48
Bratislava, Jeséniova	61	63	65	62	60	71
Bratislava, Mamateyova	46	51	53	48	46	54
Humenné, Nám. Slobody	53	53	55	60	40	41
Jelšava, Jesenského	44	-	-	41	36	45
Košice, Ďumbierska	63	73	62	61	55	57
Nitra, Janíkovce	53	-	62	58	52	63
Prievidza, Malonecpalská	49	51	52	50	53	54
Žilina, Obežná	47	48	49	53	42	36
Gánovce, Meteo. st.	63	64	66	67	58	66
Chopok, EMEP	87	96	93	96	52	88
Kojšovská hoľa	90	87	83	78	75	61
Stará Lesná, AÚ SAV, EMEP	67	65	63	71	56	66
Starina, Vodná nádrž, EMEP	51	59	60	64	55	64
Topoľníky, Aszód, EMEP	55	-	59	64	51	51

- long-term failure

In 2015, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 36 – 71 μg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 51 and 88 μg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the station Chopok (88 μg.m^{-3}). The year 2015, according to vegetation period averages, belongs to the photochemically less active years. Annual averages of ground level ozone concentration in 2015 were lower than in record year 2003.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992 – 2015 is depicted. The seasonal course is typical for lowlands and valley (not summit) positions of industrial continents. Original spring maximum 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 an 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 2010 – 2015 is summarised in Tables 3.4 – 3.6. The alert threshold when the public must be warned (240 μg.m^{-3}) was in 2015 exceed at Bratislava-Jeséniova station (Table 3.4). The information threshold to the public (180 μg.m^{-3}) in 2015 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 – 2015**

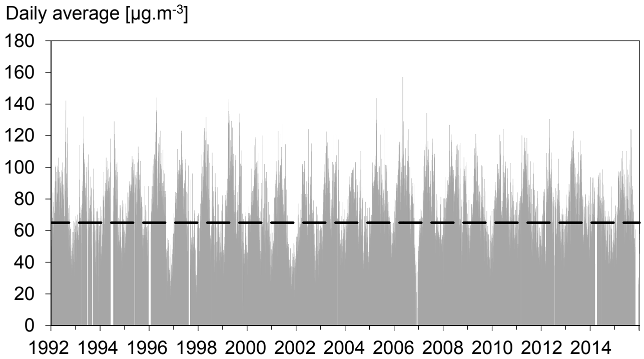
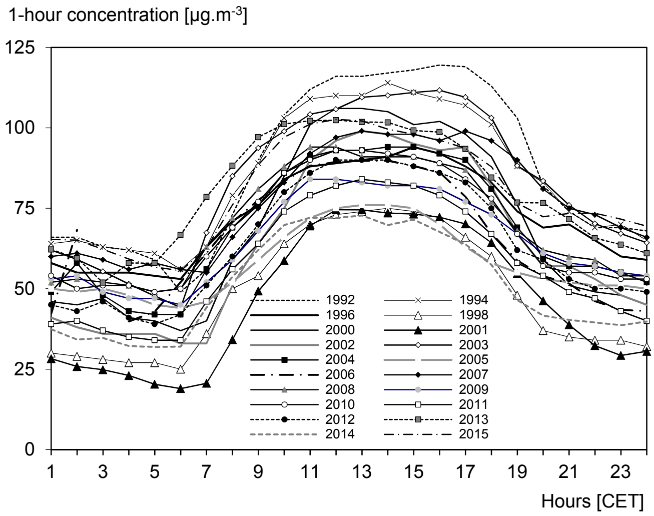


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992 – 2015**



Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2010 – 2015**

Station	AT = 240 μg.m^{-3}						IT = 180 μg.m^{-3}					
	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
Banská Bystrica, Zelená	0	0	0	0	0	0	0	0	0	0	0	0
Bratislava, Jeséniova	12	0	0	0	0	1	39	3	0	3	0	12
Bratislava, Mamateyova	0	0	0	0	0	0	3	0	0	0	0	2
Humenné, Nám. Slobody	0	0	0	0	0	0	0	0	0	0	0	0
Jelšava, Jesenského	0	0	0	0	0	0	0	0	0	0	0	0
Košice, Ďumbierska	0	0	0	0	0	0	0	0	0	0	0	0
Nitra, Janíkovce	0	-	0	0	0	0	0	-	0	0	0	0
Prievidza, Malonecpalská	0	0	0	0	0	0	0	0	0	0	0	0
Žilina, Obežná	0	0	0	0	0	0	0	0	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	0	0	0	0	0
Kojšovská hoľa	0	0	0	0	0	0	0	0	0	3	0	0
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Topoľníky, Aszód, EMEP	0	-	0	0	0	0	0	-	0	0	0	0

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 2013 – 2015. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2013 – 2015 was the number of 25 days overstepped at four monitoring stations. The highest exceedance was observed at Bratislava-Jeséniova station (39 days).

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2013 – 2015**

Station	2013	2014	2015	Average 2013 – 2015
Banská Bystrica, Zelená	36	30	*6	**33**
Bratislava, Jeséniova	38	20	60	**39**
Bratislava, Mamateyova	*19	16	38	**27**
Humenné, Nám. slobody	20	*0	0	10
Jelšava, Jesenského	*6	0	2	1
Košice, Ďumbierska	17	11	24	17
Nitra, Janíkovce	26	11	39	25
Prievidza, Malonecpalská	*10	12	24	18
Žilina, Obežná	*26	8	0	4
Gánovce, Meteo. st.	*11	5	*1	5
Chopok, EMEP	46	*7	27	**36**
Kojšovská hoľa	20	*3	*2	20
Stará Lesná, AÚ SAV, EMEP	27	0	15	14
Starina, Vodná nádrž, EMEP	21	3	*4	12
Topoľníky, Aszód, EMEP	32	16	7	18

** the year is not included in the average, because of the station's missing valid measurements in the summer time interval*

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 7 stations.

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

Station	2013	2014	2015	Average 2011 – 2015
Banská Bystrica, Zelená	19904	26688	*2526	**23523**
Bratislava, Jeséniova	19886	*23690	28166	**22555**
Bratislava, Mamateyova	*15274	17336	20418	**18444**
Humenné, Nám. slobody	14790	*6116	315	9484
Jelšava, Jesenského	*6748	*8974	6111	6111
Košice, Ďumbierska	12305	15591	15111	**18369**
Nitra, Janíkovce	18852	*22478	21800	**20326**
Prievidza, Malonecpalská	*9528	17785	*16823	16012
Žilina, Obežná	*37306	14965	5269	14580
Gánovce, Meteo. st.	*14697	13600	*13719	14918
Chopok, EMEP	*24263	*22647	15557	**25327**
Kojšovská hoľa	12935	*16676	*4098	**19697**
Stará Lesná, AÚ SAV, EMEP	14132	6880	9441	11729
Starina, Vodná nádrž, EMEP	12552	11568	*10528	10954
Topoľníky, Aszód, EMEP	21587	18024	9545	16035

** the year is not included in the average, because of the station's missing valid measurements in the summer time interval*

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 2015 was in average below the 2003 level.

3.3 TOTAL ATMOSPHERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2015

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 spectral intensity is regularly scanned at 0.5 nm increments. Since September 2014 after more sophisticated Brewer spectrophotometer MKIII installation the measured spectral area has been extended to 286.5 – 363 nm. Poprad-Gánovce station is a part of the Global Ozone Observing System (GOOS). The results are 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 by TV, radio, the press and mobile phone services. 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 332.6 Dobson Units in 2015. This is 1.6% below 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 – 2015 long-term average is 327.4 Dobson units. In the mentioned period a deviation of the annual mean in the year 2015 was +1.6%.

Total ozone statistics for the year 2015 (daily means, relative deviations from long term average, monthly means, standard deviations and extremes) are in Table 3.7. Positive differences from the long-term average were in January (+7%), February (+2%), March (+1%), October (+2%) and November (+1%). The most significant negative differences of –6% were in July, August and December. In the period April – September differences fitted in the interval of –3% to –6%.

Total ozone weekly averages are shown in Figure 3.3. The graph illustrates the total ozone amount in the year 2015 with respect to long-term mean values and shows significant short-term variations in total column ozone in our geographical region.

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 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´Éclairage). 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 2015**

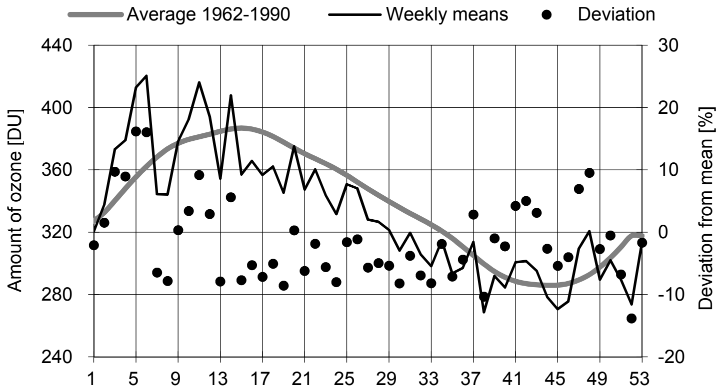


Fig. 3.4 **Annual course of CIE effective irradiance and UV index noon values – Gánovce 2015**

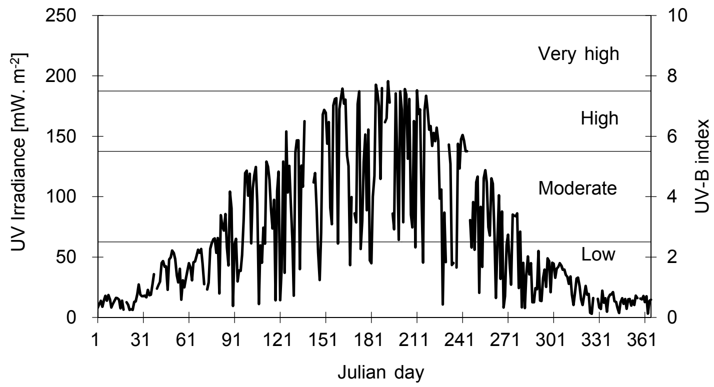


Figure 3.4 shows the biologically effective irradiance (in units of mW.m^{-2}). Values have been measured at local noon (about 10:39 UTC) when the daily maximal solar elevation is achieved. Daily UV-B maximum on clear sky days should be measured around local noon. A significant variability of values 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^{-2} 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.

Tab. 3.7 **Total atmospheric ozone in Dobson units [DU] and its deviations [%] from long-term average at Poprad-Gánovce in 2015**

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	304	-7	473	32	387	2	420	9	404	6	348	-5	327	-6	319	-4	283	-9	283	-3	253	-12	304	3
2	300	-8	469	31	357	-6	458	19	390	2	351	-4	321	-8	310	-6	291	-7	282	-3	258	-10	306	3
3	324	-1	472	31	392	3	455	18	359	-5	338	-7	321	-8	324	-2	298	-4	280	-3	272	-5	295	-1
4	354	8	441	22	379	0	368	-5	325	-14	349	-4	320	-8	311	-6	292	-6	276	-5	259	-10	277	-7
5	362	10	446	23	414	9	420	9	307	-19	350	-4	316	-9	301	-9	304	-2	300	4	273	-4	274	-8
6	324	-2	385	6	427	13	425	10	314	-17	340	-6	309	-11	298	-9	328	6	288	0	278	-3	263	-12
7	306	-8	337	-7	409	7	410	6	358	-5	329	-9	311	-10	302	-8	321	4	302	4	280	-2	294	-2
8	302	-9	392	7	369	-3	344	-11	353	-6	330	-9	308	-11	303	-7	325	6	296	3	275	-4	295	-2
9	354	6	386	6	391	3	323	-17	369	-2	336	-7	351	2	302	-8	326	7	308	7	283	-1	302	0
10	343	2	347	-5	377	-1	345	-11	391	4	325	-10	358	4	301	-8	322	5	311	8	267	-7	308	1
11	372	11	335	-9	411	8	325	-16	384	2	329	-9	315	-8	300	-8	317	4	300	4	276	-4	318	4
12	396	17	319	-13	434	14	327	-15	360	-4	332	-8	335	-2	296	-9	301	-1	311	8	259	-10	302	-1
13	309	-8	316	-14	438	15	350	-9	369	-2	337	-6	348	2	297	-9	285	-6	303	5	245	-15	295	-4
14	332	-2	354	-4	431	13	355	-8	407	9	332	-7	327	-4	297	-8	278	-8	303	5	300	4	301	-2
15	390	15	355	-4	432	13	340	-12	382	2	316	-12	330	-3	299	-8	270	-10	293	2	299	4	296	-4
16	392	15	396	7	413	8	361	-7	377	1	340	-5	315	-7	298	-8	262	-13	291	1	297	3	301	-3
17	384	12	339	-9	401	5	375	-3	347	-7	347	-3	318	-6	296	-8	257	-14	309	8	297	3	284	-9
18	409	19	334	-10	384	0	444	15	354	-5	337	-5	310	-8	323	0	259	-13	301	5	284	-2	300	-4
19	412	19	312	-16	387	1	414	7	336	-9	353	-1	303	-10	307	-4	266	-11	291	2	273	-6	293	-6
20	393	14	321	-14	387	1	363	-6	359	-3	380	7	311	-8	320	0	289	-3	316	10	299	3	252	-20
21	387	12	340	-9	383	0	347	-10	357	-4	383	8	311	-8	316	-1	290	-2	305	7	349	20	256	-19
22	366	5	369	-2	404	5	348	-9	335	-9	355	0	296	-12	319	0	291	-2	296	3	367	26	266	-16
23	379	8	388	3	349	-9	362	-6	337	-9	355	1	303	-10	323	1	295	0	294	3	358	23	265	-16
24	360	3	346	-8	352	-8	367	-4	354	-4	342	-3	304	-9	301	-5	290	-2	278	-3	331	14	270	-15
25	357	2	386	2	359	-7	354	-8	348	-6	356	1	307	-8	313	-2	303	3	286	0	294	1	281	-12
26	399	13	350	-7	396	3	355	-7	356	-3	344	-2	326	-2	298	-6	305	4	305	6	304	4	273	-15
27	377	7	370	-2	371	-4	351	-8	385	5	341	-3	319	-4	297	-6	271	-8	280	-2	317	8	306	-5
28	349	-2	422	12	329	-15	334	-13	370	1	346	-1	337	1	289	-8	276	-6	277	-3	332	13	275	-14
29	379	7			325	-16	348	-9	352	-4	339	-3	313	-6	276	-12	296	1	283	-1	309	5	298	-8
30	426	19			379	-2	349	-8	355	-3	353	1	312	-6	281	-10	298	2	284	-1	308	4	321	-1
31	488	37			355	-8			358	-2			328	-1	284	-9			268	-6			313	-4
∅	365	7	375	2	388	1	371	-4	360	-4	344	-4	320	-6	303	-6	293	-3	294	2	293	1	290	-6
Std	41	10	48	14	29	8	39	10	23	6	14	4	14	4	12	3	20	6	12	4	30	10	18	7
Max	488	37	473	32	438	15	458	19	407	9	383	8	358	4	324	1	328	7	316	10	367	26	321	4
Min	300	-9	312	-16	325	-16	323	-17	307	-19	316	-12	296	-12	276	-12	257	-14	268	-6	245	-15	252	-20

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

Continuous measurements of the UV radiation have been performed with the broadband UV-Biometers 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.

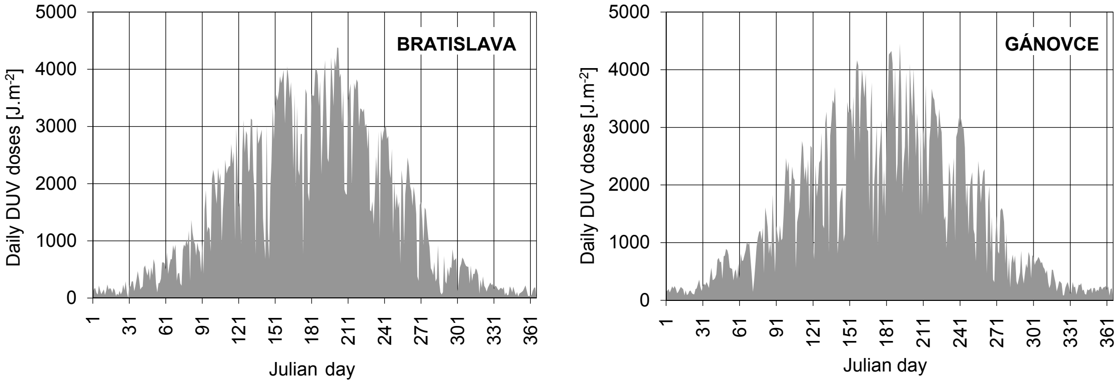
The biggest 1 min average of the CIE-erythemal UV irradiance of 205.8 $mW.m^{-2}$ (3.53 $MED.h^{-1}$) was registered in Bratislava (48º10'N, 17º06'E, 304 m a.s.l.) on July 20. The biggest 1 min average of the CIE-erythemal UV irradiance of 195.3 $mW.m^{-2}$ (3.35 $MED.h^{-1}$) was registered at Poprad-Ganovce on July 2.

The biggest hourly average of the CIE-erythemal UV irradiance of 188.8 $mW.m^{-2}$ (3.24 $MED.h^{-1}$) was registered in Bratislava on July 21. The biggest hourly average of the CIE-erythemal UV irradiance of 181.8 $mW.m^{-2}$ (3.12 $MED.h^{-1}$) was registered at Poprad-Ganovce on July 11. Deviation of the daily total column ozone from the long-term average was –8% in both days.

Daily doses of the CIE-erythemal UV radiation are presented in Figure 3.5. Maximum daily dose dates correspond with biggest hourly average dates. Maximum daily dose of 4 380 $J.m^{-2}$ (which correspondents to 20.8 MED) was measured in Bratislava on July 21. Sunshine duration was 13.8 hours on that day. Maximum daily dose of 4451 $J.m^{-2}$ (21.2 MED) was measured at Poprad-Ganovce on July 11. Sunshine duration was 14.3 hours on that day.

In the period April-September 2015 total CIE-erythemal UV radiation dose in Bratislava was 459 426 $J.m^{-2}$. This value is 7.8% higher than the dose in 2014. Total CIE-erythemal dose at Poprad-Ganovce was 436 429 $J.m^{-2}$ for the same period. This value is 10.2% higher than the dose in 2014. High doses in 2015 were caused by big number of days with small cloud cover in summertime. During that period the number of sunshine hours was in Bratislava by 9.3% and in Poprad-Gánovce by 15.8% higher than in the same period in 2014.

Fig. 3.5 **Annual Course of CIE effective UV radiation Daily Doses in 2015**



4

EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 EMISSION AND AIR POLLUTION SOURCE INVENTORY

Anthropogenic emissions of pollutants in 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 effects, 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, so-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, a multi-modular system, follows requirements of current air protecting legislation and it is based on annual update cycle. Module NEIS BU enables complex data collection and data processing in respective of district offices, as well as the logical verification of emission calculation from the operator's input data. It also serves as a base tool in decision making for determination of pollution charge value. 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. It enables besides processing of the input data electronically 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. Subsequently, data from the district databases is fed into the NEIS CU central database at SHMÚ, where the following control is carried out. The NEIS uses the support of standard database products MS ACCESS and MS SQL server.

The function of the 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, the system has been renamed to National Emission Information System (NEIS). Archiving of the documents issued by district offices has started within the system. Data acquisition was extended 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.
- Enhance the 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 optimal task fulfilment throughout all levels of the top state administration bodies and provides the input data for international emission inventories, respectively compilation of special emission inventories.
- Availability of information on the Internet website www.air.sk.
- Establishment of the 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 is currently comparable with the NEIS module only at 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 the air pollution sources in their district and provide them electronically by 31st May of the current year at the latest in order to additional processing by 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. 410/2012 as amended):

Large stationary sources	Technological units containing combustion plants having total rated thermal input more than 50 MW and other technological units with a capacity above the defined limit.
Medium stationary sources	Technological units containing combustion plants having total rated thermal input between 0.3 – 50 MW and other technological units with a capacity under the defined limit for the large sources but over the defined limit for the medium sources.
Small stationary sources	Domestic heating equipment for combustion of solid fuels and natural gas with total rated thermal input less than 0.3 MW.

Results (1990 – 2015) – 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, NO_x, 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 916 (751 of it in operation) large point sources in 2015. 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.

Medium 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 2015, NEIS registered 12860 (10521 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

The emissions from category 1.A.3 Transport include subcategories International aviation (1A3ai), Domestic aviation (1A3aii), Road transport (1A3b), Railways (1A3c), International inland waterways (1A3di), National navigation (1A3dii) and Pipeline transport (1A3ei). The emissions of pollutants from other mobile sources are included in Road transport. In this publication, the emissions from Road transport are reported as "Road transport" (RT) and sum of emissions from aviation, railways, navigation and pipeline transport are reported as "Other transport" (OT). Transport has very special position in the energy sector, as it is not included in any legislative regulations, emissions in this category are very difficult to regulate. During recent years the shift from a public transportation to individual passenger cars has been observed. The level of transit transport (HDV) has been increased at the same time. The consumption of fuels in railways is decreasing continuously, while the consumption of fuels in road transportation is sharply increasing.

In 2015, the emissions from the pipeline transport were calculated from 2000 onwards. These emissions were included in "Other transport" (OT) in this report.

In September 2010, the amendment of the national Directive No 362/2010 Coll. that laying down the requirements for the quality of fuels and maintenance of fuel evidence took into force. The content of sulphur in the fuels declined from original 50 mg/kg of fuel to new value of 10 mg/kg of fuel. As a results of the QA/QC process in this category in 2015, the emission factor of SO_X for diesel for the rail transport has been modified in order to reflect the legislative changes and recalculations of SO_X emissions has been performed in the category 1A3c (Railways) for the years 2011 and 2012 and in the categories 1A3b (Road transport) for the years.

VOC emissions in category 1A3bv road transport were improved for the gasoline evaporation and estimated by the model COPERT for the years 2011 onwards.

The Slovak Republic was using the tier 1 methodology for the emissions estimation in aviation, for all relevant pollutants for the time series 2001-2004. This methodology was based on numbers of LTO cycles. These categories are not key categories. In the absence of national data on the exact numbers of domestic and international LTO cycles (only total numbers of LTO cycles is available), the total aviation emissions are reported in Domestic aviation. The numbers of LTO cycles are known from the important Slovak airports (Bratislava, Kosice, Poprad, Sliač, Piešťany and Žilina). The airports are managed by the Slovak Management of Airports, except for the airport in Žilina, where exercises with light aircrafts of the Žilina University predominate. Other smaller civil airports (Nitra, Prievidza, Ružomberok, Lučenec) are operated by aero-clubs with predominating character of sport flights. Emissions estimation was calculated based on data directly provided by the individual airports based on detailed statistics on LTO cycles, aircrafts type, their weights and type of engines. Described approach is maintained for a time series from 2001 to 2004. For time series 2005 – 2014 were used EUROCONTROL data on the number of flights, fuel consumption and division of domestic and international flights. For the years 2005 – 2014 Slovakia decided to proceed to use the data from EUROCONTROL in this submission. The decision follows an analysis of the national data and data obtained from Eurocontrol and the approval by the Ministry of Transport. The data is available on the basis of work of the EEA in collaboration with EUROCONTROL and DG CLIMA. These aggregated national fuel and emissions data is calculated by EUROCONTROL using a Tier 3 methodology applying the Advanced Emissions Model (AEM). For time series 2005 – 2014 were used EUROCONTROL data on the number of flights, fuel consumption and division of domestic and international flights. The emissions of NO_X, SO_2, PMs and CO were taken from Eurocontrol file for LTO and Cruise and reported in Domestic and International Aviation. The emissions of NMVOC were calculated using the EUROCONTROL date on fuel consumption of Aviation Gasoline and Jet Kerosene for LTO and Cruise phase and on numbers of LTO. The used emission factors of NMVOC are in according with EMEP/EEA emission inventory guidebook 2013. For the years 2000 – 2004, we did not received better and more accurate data and that is why we did not recalculated these years.

Software program COPERT 4 has been used for balance calculation of road transport emissions. Since 2008 COPERT 4 is approved and recommended by Executive Committee the UNECE Convention on Long-Range Transboundary Air Pollution. The calculation of emissions from the road transport sector in Slovakia for the year 2013 has been provided in the COPERT 4 version 9.0. Applied input data was activity data such as numbers of vehicles for each category defined in program COPERT 4 and average annual mileage in each category of vehicles. Emissions were calculated according to fuel type as well as vehicle type. Additional input data was levels of pollutants in fuels (gasoline, diesel, LPG, CNG) and fuel consumption including the share of biofuels. Model COPERT v.9.0 takes into account the share of biofuels in the energy consumption of different types of vehicles. However, model COPERT does not count Total Suspended Particulates (TSP) from abrasion of tires and brakes neither it does not provide any solid particles from road abrasion. Therefore these missing emissions were calculated separately from the traffic performance in fleet mileage (detected from the COPERT from numbers of vehicles and annual mileage) and emission factors Tier 1 set out in EMEP/EEA air pollutant emission inventory guidebook to complete emission balance.

Railways transport represents the operation of diesel traction using the simple methodology tier 1 according to the EMEP/EEA emission inventory guidebook 2013. The emissions of the pollutants are calculated from the consumed fuels by diesel rail traction multiplied by the appropriate emission factor. The consumption of diesel oil for the motor traction in the Slovak Republic was obtained from the Railways Company, Ltd. for the whole time series. It is assumed that the consumption of diesel oil in motor traction of railways transportation is equal to the diesel oil sold for the railways. The mobile sources of pollution in the railways transport include vehicles of motor traction of the Railways Company Ltd. of the Slovak Republic (ZSSK). This motor traction is divided into 2 basic groups of vehicles: motor locomotives (Traction 70) and motor wagons (Traction 80). The motor traction has been operated by 4 depots in the organizational structure of the Railways Company Ltd. since 2002 (Bratislava, Zvolen, Žilina and Košice). Fuel consumption of the new companies operated on the Slovak rails (REGIOJET) are also included in inventory.

The subcategory National navigation includes emission from shipping between ports on Danube River. This activity represents movements of ships between Slovak ports (Bratislava, Devin and Komarno). The emissions of pollutants are calculated based on fuel consumption. The numbers of movements are used to the model of calculating fuel consumption. The emission factors for off-road transport are used to calculated emissions of pollutants in this category. Because of lack of information on division to domestic and international movements, the total emissions from Danube River are reported under National navigation.

The emissions in the category Pipeline transport are obtained directly from the NEIS database.

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,b and Figures 4.1 and 4.2.

Particulate matter

Emissions of particulate matter (PM) have been decreasing continuously since 1990. 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 and a further spreading of separation techniques used, respectively advancing of its effectiveness. 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. The decrease of PM emissions in 2006 was achieved mainly by reconstruction of separators in some sources in energy and industry (power plant Slovenské elektrárne, a.s. plant Nováky, U.S. Steel s.r.o. Košice). Another decrease of the PM emissions in 2007 was mostly caused by the power plant Slovenské elektrárne, a.s. in Vojany, of which two low-ecological blocks were terminated. Since 2008, the trend of PM emissions is stable. A slight increase in PM emissions in 2011 occurred in the sector of small sources - households, where the consumption of firewood increased at the expense of natural gas. In years 2012 – 2014 was only an insignificant increase of emissions. In 2015 there was a decrease of emissions by 5.5% compared to the previous year.

SO_2

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 (Slovnaft a.s., Bratislava replaced it with low-sulphur fuel oil). On the decreased emission was significantly contributing the installation of desulphurisation systems in 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 another decrease of SO_2 emissions was recorded. This decrease was caused mainly by the combustion of low-sulphur-content fuel oils and coal (Slovnaft a.s. Bratislava; TEKO a.s. Košice) and by the reduction of production volume (power plants in Zemianske Kostoľany and Vojany). 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). Another decrease of SO_2 emissions in 2007 was mostly caused by the power plant in Vojany, of which two outdated blocks were terminated. Since 2008, the trend of SO_2 emissions is stable. Minor increase of SO_2 emissions from the large sources in 2010 of 8% was caused by the increase of brown coal consumption in Slovenské elektrárne - power plant Nováky, and by the slightly increase of sulphur-content in this fuel. The reduction of SO_2 emissions in 2012 of 14.6% was mainly due to installation of a new desulphurisation unit in the heating plant CM European Power Slovakia, s.r.o. Bratislava. On the reduction was also contributing Slovenské elektrárne, a.s., plant Nováky, where was operated only one boiler. Another decrease in 2013 of 9.5% was caused by residential combustion (less amount of combusted brown coal) and large combustion plants CM European Power Slovakia, s.r.o. Bratislava (lower output concentration of SO_x) and Slovenské elektrárne, a.s., plant Nováky (lower S-content in combusted coal). Decrease of emissions continues in 2014: the record high average temperature influenced the consumption of solid fuels in households. With lowering SO_2 emissions in Slovenské elektrárne a.s., plant Nováky, has decreased the share of this plant on the national emissions of 5% in comparison with the share in previous year. In 2015 there was a large temporal increase of emissions by 50% (compared to 2014) due to higher usage of low-ecological blocks 3-4 in Elektrárne Nováky during the massive reconstruction of blocks 1-2.

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 NO_x 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 NO_x emissions. In the further emissions decrease in years 2002 and 2003 participated the denitrification process (power plant Vojany). This decline is related to the reduction of production (power plants in Zemianske Kostoľany and Vojany) and consumption of natural gas (Slovenský plynárenský priemysel – preprava a.s., compressor stations Nitra and Veľké Zlievce). Significant decline of NO_x 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. Significant decrease of emissions in 2009 was mainly due to decrease in iron, steel and magnesite sinter production as a result of economic recession (U. S. Steel Košice, s.r.o., Slovenské magnezitové závody a.s.). Another decrease was occurred in 2012 by the significant reduction in the amount of transported natural gas in pipeline compressor stations operated by eustream, a.s. In 2013 was only an insignificant decrease of emissions. The record high average temperature in year 2014 has impact on the consumption of natural gas in households, therefore the emissions of NO_x are clearly lower.

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 2002 is also affected by the quantity of pig iron production as well as the fuel consumption. In 2003 the CO emissions slightly increased mainly at large sources (the CO emissions specified by continuous measurement in U.S. Steel s.r.o., Košice). In 2005 the decrease of CO emissions was mainly caused by cutting down the agglomerate production. 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. Decrease of emissions in 2006 was mainly due to increase of steel and pig iron production. Significant decrease of 22% in CO emissions of major sources in 2009 was mainly due to decrease in iron and steel production as a result of economic recession. 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 and 2011 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. Whereas in years 2012-2013 was only insignificant decrease in emissions, in year 2014 raised the agglomerate production in facility U.S. Steel Košice by 20%, this reflects the higher CO emissions.

POPs

Emission inventory of POPs (PCB, DIOX, PAH-benzo(a)pyrene, benzo(k)fluoranthene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene) for the Slovak Republic are elaborated according to EMEP/EEA Air Pollution Emission Inventory Guidebook and in coincidence with requirements of the respective of working group for emission inventory (UN ECE Task Force on Emission Inventory).

The individual sectors are defined in the sense of the SNAP nomenclature. In the sense of the requirements for the NFR reporting the NFR codes were assigned to the individual sectors upon the base of SNAP nomenclature. Emission factors for the emission estimation have been taken over from literature, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals) and smaller amount comes from the measurements on sources in the SR, Poland and Czech Republic and from EMEP/EEA Air Pollution Emission Inventory Guidebook. Emissions of polychlorinated dioxins and furans (PCDD/F) and polycyclic aromatic hydrocarbons (PAH) from road transport were recalculated by model COPERT IV.

Emissions trend in POPs mostly influenced by changes in Slovak industry. Emissions of PCDD/F have declined because of reconstruction of some technologies (waste incineration, iron ore agglomeration), increase in 2014 reflects the increase of iron ore agglomeration. Downward trend of PAHs emissions to the air proved to be most remarkable in in the 90-ties, when it was caused mostly by the change of aluminium production technology (use of pre-baked anodes). After year 2000 there is slightly increase of PAHs emissions, from the year 2005 PAHs emissions are stabilize. Emissions of HCB in 90-ties and after 2000 decreased because of reconstruction of waste incineration plants. The greatest change in this sector occurred in 2006, when those plants, which did not proved compliance with emissions limit for PCDD/F were closed. Recent variations of HCB emissions are given mainly by changes in production of secondary copper. Slightly 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. The significant impact on POPs emission in industry sector has PCB emissions from secondary lead production, which arise within the improvement of inventory.

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. In 2010 there was an increase of emissions of heavy metals compared to year 2009 due to increase of metal and glass production. Changes and updates in the waste incineration sector led into recalculations of emissions within 2000 – 2010. In 2011 the slight abatement in HM`s emissions was noticed compare to recalculated year 2010 as well as in waste incineration sector. In the other of sectors, the increase was identified. The latest emission recalculation in the waste sector which was performed in the submission 2015 has influence also to the HMs emissions. The entire time series of activity data were updated in range of years 1990 to 2013 and consequently the emissions. The update of input data was concerned to the amounts of incinerated and landfilled waste in downscale type portioning at industrial, municipal and clinical (only incineration) waste. The sector was not completely revised according to methodological changes already applied in last reporting cycle. The planned revision will be performed during the next reporting cycles.

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

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 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, c). 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.

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 GAINS5F2 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 entire calculation is already programmed in NEIS database.

Share of individual sectors in total emissions of the Slovak Republic in 2015

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 17 to the Decree No. 360/2010 Coll.).

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

Most important sources of air pollution in the Slovak Republic in 2015

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 74.04% to 96.74%. Table 4.5 lists top ten sources in administrative regions according to the amount of emissions of basic pollutants.

Specific territorial emissions in 2015

Table 4.6 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 31th 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**
NO_x	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 – 2008**

			2000	2001	2002	2003	2004	2005	2006	2007	2008
PM	**Stationary sources – NEIS**	LS [1]	29.923	29.722	25.037	20.166	17.670	18.719	13.992	6.020	5.406
		MS [1]	4.958	4.405	3.767	3.259	2.748	2.392	2.281	1.979	1.764
		SS [2]	19.877	20.550	17.217	18.300	21.504	28.709	26.980	26.821	26.921
	Mobile sources	RT	1.834	2.036	2.212	2.225	2.375	2.849	2.610	3.074	2.791
		OT	0.399	0.404	0.366	0.329	0.343	0.357	0.335	0.352	0.322
	Total		**56.991**	**57.117**	**48.599**	**44.279**	**44.640**	**53.026**	**46.198**	**38.246**	**37.204**
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
		MS [1]	8.083	6.655	3.964	3.620	2.652	2.107	1.902	1.598	1.246
		SS [2]	16.055	13.764	7.127	6.384	5.381	5.073	5.524	3.735	3.844
	Mobile sources	RT	0.670	0.675	0.730	0.150	0.159	0.189	0.177	0.204	0.210
		OT	0.189	0.196	0.065	0.059	0.064	0.077	0.080	0.085	0.088
	Total		**126.953**	**131.112**	**103.347**	**105.496**	**96.188**	**89.038**	**87.787**	**70.596**	**69.447**
NO_x	**Stationary sources – NEIS**	LS [1]	54.484	51.653	46.412	44.605	44.244	42.424	39.038	35.762	34.488
		MS [1]	8.052	7.751	6.356	6.620	4.926	4.377	4.992	3.542	3.575
		SS [2]	7.993	8.391	7.137	7.356	7.582	8.866	8.336	7.819	7.979
	Mobile sources	RT	32.027	35.072	35.495	34.914	37.794	41.473	39.561	43.838	43.249
		OT	8.467	7.025	7.423	6.632	7.385	6.271	6.041	6.402	6.906
	Total		**111.023**	**109.892**	**102.823**	**100.127**	**101.931**	**103.411**	**97.968**	**97.363**	**96.197**
CO	**Stationary sources – NEIS**	LS [1]	120.609	115.177	122.225	141.047	147.317	133.787	147.318	141.062	136.530
		MS [1]	10.779	10.280	9.150	9.394	7.531	5.853	5.350	5.330	4.518
		SS [2]	53.792	50.178	33.815	33.811	34.753	41.766	40.882	37.018	37.367
	Mobile sources	RT	113.172	127.348	123.273	106.268	101.161	89.077	77.516	59.244	65.068
		OT	1.300	1.210	1.261	1.101	1.049	0.895	1.047	1.059	1.067
	Total		**299.652**	**304.193**	**289.724**	**291.621**	**291.811**	**271.378**	**272.113**	**243.713**	**244.550**

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

[1] *According to the Decree of MŽP SR No. 410/2012 Coll. as amended*
[2] *According to the Decree of MŽP SR No.144/2000 Coll. (2001 – 2003), according to the Decree of MŽP SR No. 53/2004 Z. z. (2004 – 2009), according to the Decree of MPŽPaRR No. 362/2010 Z. z.(since 2010)*

Emissions estimated to April 30th 2017

Tab. 4.1c **Emissions of basic pollutants [thous. t] in the SR within 2009 – 2015**

			2009	2010	2011	2012	2013	2014	2015
PM	Stationary sources – NEIS	LS [1]	4.966	4.936	5.139	5.283	5.417	5.449	4,916
		MS [1]	1.554	1.474	1.404	1.348	1.306	1.271	1,211
		SS [2]	27.083	26.214	28.507	28.745	29.298	28.405	29,623
	Mobile sources	RT	2.470	2.741	2.579	2.733	2.665	2.673	3,107
		OT	0.293	0.383	0.328	0.318	0.123	0.124	0,194
	Total		36.366	35.748	37.957	38.427	38.809	37.922	39,051
SO_2	Stationary sources – NEIS	LS [1]	59.739	64.798	64.321	54.235	49.013	42.118	64,191
		MS [1]	0.991	0.906	0.839	0.894	0.945	0.906	0,928
		SS [2]	3.116	3.424	3.102	3.169	2.802	2.168	2,326
	Mobile sources	RT	0.194	0.042	0.041	0.042	0.040	0.042	0,043
		OT	0.072	0.085	0.060	0.039	0.037	0.039	0,221
	Total		64.112	69.213	68.363	58.379	52.837	45.273	67,709
NO_x	Stationary sources – NEIS	LS [1]	31.333	31.466	31.199	27.465	25.818	24.759	24,425
		MS [1]	3.389	3.485	3.716	3.978	4.259	4.356	4,661
		SS [2]	7.990	8.076	8.215	8.241	8.334	7.737	8,235
	Mobile sources	RT	37.638	40.524	36.329	36.329	37.324	40.344	36,613
		OT	5.421	5.215	5.216	2.657	3.012	2.567	3,099
	Total		85.771	88.766	84.675	78.670	78.747	79.763	77,033
CO	Stationary sources – NEIS	LS [1]	106.635	125.475	136.615	133.264	130.608	146.879	145,606
		MS [1]	4.104	4.446	4.680	4.913	5.098	4.894	4,811
		SS [2]	36.181	35.953	37.710	38.172	38.113	35.701	37,487
	Mobile sources	RT	59.568	53.217	46.722	44.871	42.930	36.483	35,783
		OT	0.849	0.856	0.806	0.630	0.662	0.629	0,733
	Total		207.337	219.947	226.533	221.850	217.411	224.586	224,420

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

[1] *According to the Decree of MŽP SR No. 410/2012 Coll. as amended*
[2] *According to the Decree of MŽP SR No.144/2000 Coll. (2001 – 2003), according to the Decree of MŽP SR No. 53/2004 Z. z. (2004 – 2009), according to the Decree of MPŽPaRR No. 362/2010 Z. z.(since 2010)*

Emissions estimated to April 30th 2017

Fig. 4.1 **Development trends in basic pollutant emissions within 1990 – 2015**

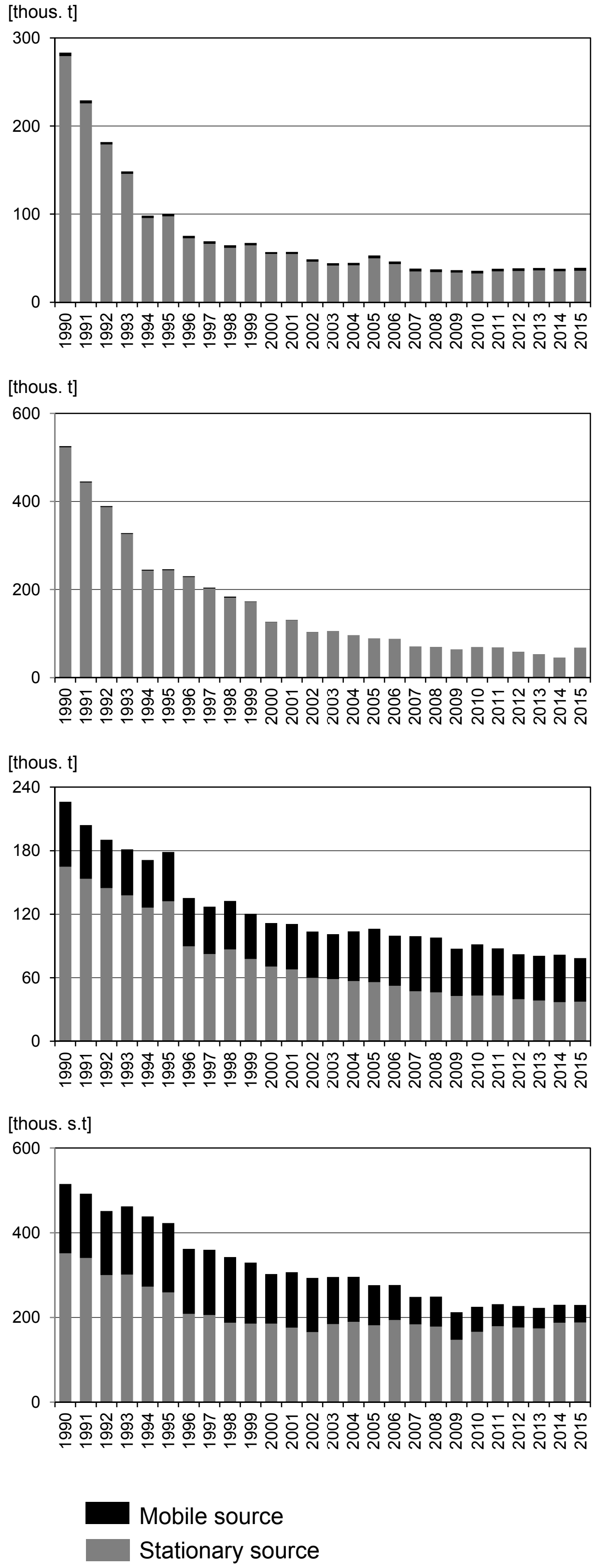
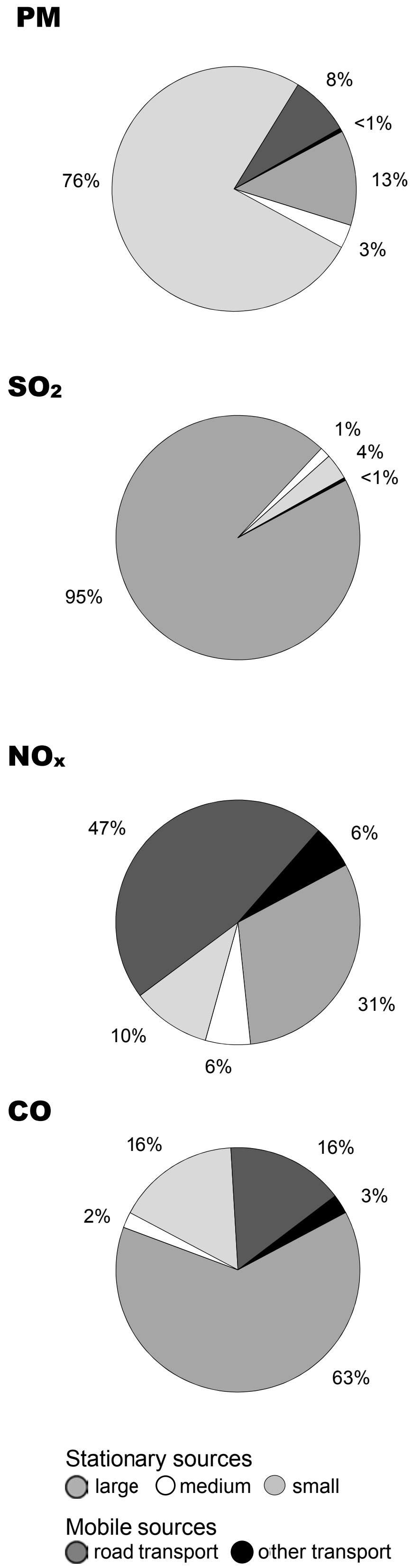


Fig. 4.2 **Emissions of basic pollutants in 2015**



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* in 2001, 2005 and within 2010 – 2015**

PM		2001	2005	2010	2011	2012	2013	2014	2015
Aglome-ration	Bratislava	477	472	327	309	281	283	226	230
	Košice	17173	4362	3245	3268	3443	3467	3511	3009
Zone	Bratislava region	546	506	447	482	485	492	507	490
	Trnava region	1518	1935	1742	1902	1886	1934	1894	1956
	Trenčín region	4820	5280	3843	4197	4171	4301	4275	4563
	Nitra region	2921	3414	2896	3194	3176	3255	3145	3291
	Žilina region	6271	7076	6238	6831	6875	7080	6782	6912
	Ban. Bystrica region	6355	7378	6328	6772	6854	6918	6731	7007
	Prešov region	4266	5556	4345	4671	4800	4846	4722	4841
	Košice region	10331	13842	3213	3422	3404	3445	3334	3449
Total		54677	49820	32625	35050	35376	36021	35125	35750

SO_2		2001	2005	2010	2011	2012	2013	2014	2015
Aglome-ration	Bratislava	13594	9285	10276	7422	3239	2074	2284	2264
	Košice	12607	12526	9671	9247	9920	8837	7742	8402
Zone	Bratislava region	380	377	160	191	246	201	202	167
	Trnava region	2051	1037	472	494	498	602	576	579
	Trenčín region	45187	40937	37232	40144	33947	31490	25105	47184
	Nitra region	4749	2336	532	382	400	390	358	377
	Žilina region	10237	5035	2949	2606	2598	2306	2073	2196
	Ban. Bystrica region	10043	6197	4157	4978	4212	4165	4060	3490
	Prešov region	8082	4856	2474	1487	1988	1788	1919	1801
	Košice region	23310	6185	1203	1310	1250	908	875	983
Total		130242	88772	69127	68262	58298	52760	45193	67444

NO_x		2001	2005	2010	2011	2012	2013	2014	2015
Aglome-ration	Bratislava	5151	4791	4126	3710	3252	2884	2306	2538
	Košice	12172	10929	9323	7883	8286	8538	8611	7816
Zone	Bratislava region	1900	1742	1437	1712	1527	1723	1993	1932
	Trnava region	1966	1667	1487	1774	1630	1667	1538	1637
	Trenčín region	10489	7822	6892	7639	6960	6676	6837	7263
	Nitra region	3974	3989	2603	3003	2444	2499	2320	2478
	Žilina region	5170	4674	4757	4964	4857	4365	4105	4340
	Ban. Bystrica region	6666	6281	5399	5840	5203	5263	4843	4813
	Prešov region	3443	3459	2785	2500	2621	2447	2237	2351
	Košice region	16864	10314	4217	4105	2904	2349	2061	2154
Total		67794	55666	43027	43130	39684	38410	36852	37321

CO		2001	2005	2010	2011	2012	2013	2014	2015
Aglome-ration	Bratislava	1319	1120	824	868	778	811	812	932
	Košice	78619	93197	88292	101053	99454	100635	114352	113059
Zone	Bratislava region	1638	1576	3250	3037	1769	2040	2039	2213
	Trnava region	4682	3865	2728	2967	2963	2946	2671	2808
	Trenčín region	10334	9331	11476	11151	10918	10502	11762	10982
	Nitra region	7379	6627	6185	6283	5532	5731	5417	6112
	Žilina region	19287	15924	12059	12370	12528	12223	11732	11175
	Ban. Bystrica region	26301	29375	25728	26445	27266	25649	26257	26572
	Prešov region	11838	9282	6795	7010	7128	7349	6901	7277
	Košice region	14237	11109	8536	7820	8012	5931	5531	6774
Total		175636	181407	165874	179005	176349	173819	187474	187904

** 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 medium sources*) in 2015**

	PM			**SO_2**		
	Operator – plant locality	**[t]**	**[%]**	**Operator – plant locality**	**[t]**	**[%]**
1	U. S. Steel Košice, s.r.o.	2882.13	47,03	Slovenské elektrárne, a.s., prevádzka Nováky	46754.65	71,77
2	Slovenské elektrárne, a.s., prevádzka Nováky	510.06	8,32	U. S. Steel Košice, s.r.o.	7450.26	11,44
3	Považská cementáreň, a.s.	190.72	3,11	Slovalco, a.s.	1656.63	2,54
4	FORTISCHEM a. s.	180.05	2,94	SLOVNAFT, a.s.	1531.98	2,35
5	Duslo, a.s.	158.34	2,58	BUKÓZA ENERGO, a. s.	1256.25	1,93
6	Slovalco, a.s.	98.97	1,61	Tepláreň Košice, a. s.	868.83	1,33
7	BUKOCEL, a.s.	90.40	1,47	CM European Power Slovakia, s. r. o.	527.26	0,81
8	Mondi SCP, a.s.	77.16	1,26	Slovenské elektrárne, a.s., prevádzka Vojany	510.57	0,78
9	DOLVAP, s.r.o.	62.80	1,02	Zvolenská teplárenská, a.s.	487.48	0,75
10	OFZ, a.s.	52.34	0,85	Žilinská teplárenská, a.s.	473.91	0,73
11	Carmeuse Slovakia, s.r.o.	44.50	0,73	OFZ, a.s.	435.66	0,67
12	Knauf Insulation, s.r.o.	43.46	0,71	Martinská teplárenská, a.s.	365.35	0,56
13	SLOVNAFT, a.s.	37.67	0,61	Knauf Insulation, s.r.o.	332.67	0,51
14	Tepláreň Košice, a. s.	37.43	0,61	SLOVENSKÉ CUKROVARY, s.r.o.	195.92	0,30
15	CRH (Slovensko) a. s.	36.69	0,60	Duslo, a.s.	180.93	0,28
16	Žilinská teplárenská, a.s.	35.67	0,58	Mondi SCP, a.s.	163.61	0,25
17	Energy Edge ZC s. r. o.	31.17	0,51	Veolia Utilities Žiar n/H, a.s.	145.67	0,22
18	Zvolenská teplárenská, a.s.	28.37	0,46	CRH (Slovensko) a. s.	118.14	0,18
19	SLOVENSKÉ CUKROVARY, s.r.o.	28.09	0,46	BUKOCEL, a.s.	108.30	0,17
20	CM European Power Slovakia, s. r. o.	27.72	0,45	Johns Manville Slovakia, a.s.	102.02	0,16
Total		**4653,74**	**75.93**	**Total**	**63666,10**	**97.73**

	NO_x			**CO**		
	Operator – plant locality	**[t]**	**[%]**	**Operator – plant locality**	**[t]**	**[%]**
1	U. S. Steel Košice, s.r.o.	6652.60	22,87	U. S. Steel Košice, s.r.o.	112565.31	74,84
2	Slovenské elektrárne, a.s., prevádzka Nováky	3819.76	13,13	Slovalco, a.s.	14239.50	9,47
3	CRH (Slovensko) a. s.	1428.71	4,91	CEMMAC a.s.	2849.06	1,89
4	Mondi SCP, a.s.	1077.68	3,70	SMZ, a.s. Jelšava, prevádzka Jelšava	2141.34	1,42
5	SLOVNAFT, a.s.	843.42	2,90	Považská cementáreň, a.s.	2080.01	1,38
6	CM European Power Slovakia, s. r. o.	785.58	2,70	KOVOHUTY, a.s.	1427.54	0,95
7	Považská cementáreň, a.s.	735.66	2,53	Calmit, spol. s r.o.	1336.66	0,89
8	SMZ, a.s. Jelšava, prevádzka Jelšava	687.17	2,36	CRH (Slovensko) a. s.	1071.74	0,71
9	CRH (Slovensko) a. s.	631.18	2,17	OFZ, a.s.	1007.62	0,67
10	Duslo, a.s.	628.87	2,16	Mondi SCP, a.s.	964.32	0,64
11	CEMMAC a.s.	556.84	1,91	BUKOCEL, a.s.	633.14	0,42
12	Tepláreň Košice, a. s.	461.05	1,58	SLOVNAFT, a.s.	516.77	0,34
13	OFZ, a.s.	445.42	1,53	Slovenské elektrárne, a.s., prevádzka Nováky	364.92	0,24
14	Slovalco, a.s.	443.30	1,52	Slovenské elektrárne, a.s., prevádzka Vojany	342.70	0,23
15	Carmeuse Slovakia, s.r.o.	424.31	1,46	IKEA Industry Slovakia s. r. o.	299.10	0,20
16	BUKÓZA ENERGO, a. s.	417.24	1,43	FORTISCHEM a. s.	286.25	0,19
17	Zvolenská teplárenská, a.s.	408.51	1,40	HNOJIVÁ Duslo, s.r.o.	285.52	0,19
18	RONA, a.s.	301.25	1,04	SLOVMAG a.s. Lubeník	282.15	0,19
19	Žilinská teplárenská, a.s.	292.88	1,01	SLOVINTEGRA ENERGY, a.s.	264.05	0,18
20	BUKOCEL, a.s.	261.90	0,90	SMZ, a.s. Jelšava, prevádzka Bočiar	215.02	0,14
Total		**21303.32**	**73.23**	**Total**	**143172.73**	**95.18**

** According to the Decree of MŽP SR No. 410/2012 Coll. as amended*

Tab. 4.5 **Sequence of the sources within the region according to the emissions in 2015 (NEIS – large and medium sources*)**

BRATISLAVA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	SLOVNAFT, a.s.	Bratislava II	37.67	SLOVNAFT, a.s.	Bratislava II	1531.98
2.	CRH (Slovensko) a. s.	Malacky	36.69	CM European Power Slovakia, s. r. o.	Bratislava II	527.26
3.	CM European Power Slovakia, s. r. o.	Bratislava II	27.72	Duslo, a.s.	Bratislava III	180.93
4.	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	25.27	CRH (Slovensko) a. s.	Malacky	118.14
5.	TERMMING, a.s.	Bratislava II	7.39	Min. obrany SR - kotolňa Sl. Grob a Viničné	Pezinok	7.38
6.	Bratislavská teplárenská, a.s.	Bratislava III	5.35	Bratislavská teplárenská, a.s.	Bratislava IV	5.87
7.	ALAS SLOVAKIA, s.r.o.	Malacky	4.68	Odvoz a likvidácia odpadu, a.s.	Bratislava II	5.18
8.	Min. obrany SR - kotolňa Sl. Grob a Viničné	Pezinok	4.54	BPS Senec, s. r. o.	Senec	4.13
9.	Bratislavská teplárenská, a.s.	Bratislava IV	3.88	AGROCROP a. s.	Senec	1.50
10.	Veolia Energia Slovensko, a. s.	Bratislava V	3.81	Pezinské tehelne - Paneláreň, a.s.	Pezinok	1.50
	NO_x			CO		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	CRH (Slovensko) a. s.	Malacky	1428.71	CRH (Slovensko) a. s.	Malacky	1071.74
2.	SLOVNAFT, a.s.	Bratislava II	843.42	SLOVNAFT, a.s.	Bratislava II	516.77
3.	CM European Power Slovakia, s. r. o.	Bratislava II	785.58	IKEA Industry Slovakia s. r. o.	Malacky	299.10
4.	Bratislavská teplárenská, a.s.	Bratislava III	117.60	TERMMING, a.s.	Malacky	146.23
5.	IKEA Industry Slovakia s. r. o.	Malacky	104.82	Bratislavská teplárenská, a.s.	Bratislava III	39.42
6.	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	99.85	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	32.63
7.	Odvoz a likvidácia odpadu, a.s.	Bratislava II	89.31	Veolia Energia Slovensko, a. s.	Bratislava V	29.20
8.	Veolia Energia Slovensko, a. s.	Bratislava V	78.54	Min. obrany SR - kotolňa Sl. Grob a Viničné	Pezinok	27.79
9.	TERMMING, a.s.	Bratislava II	73.38	Obec Rohožník	Malacky	26.98
10.	Bratislavská teplárenská, a.s.	Bratislava IV	53.07	TERMMING, a.s.	Bratislava II	21.49

TRNAVA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	28.09	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	195.92
2.	Tate & Lyle Boleraz, s.r.o.	Trnava	21.76	Johns Manville Slovakia, a.s.	Trnava	102.02
3.	Johns Manville Slovakia, a.s.	Trnava	17.29	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	27.59
4.	Agropodnik a.s. Trnava	Dun. Streda	8.94	MACH TRADE, spol. s r.o.	Galanta	26.99
5.	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	6.27	ECO PWR, s. r. o.	Dun. Streda	12.46
6.	Agro Boleráz, s.r.o.	Trnava	5.74	RUPOS, s.r.o.	Trnava	9.03
7.	PCA Slovakia, s.r.o.	Trnava	5.37	Baňa Čáry, a.s.	Senica	5.73
8.	Bekaert Slovakia, s.r.o.	Galanta	4.85	BioREn s. r. o.	Piešťany	5.35
9.	ENVIRAL, a.s.	Hlohovec	4.13	BPS Hubice, s. r. o.	Dun. Streda	5.27
10.	Agropodnik a.s. Trnava	Senica	3.54	BPS Juh, s. r. o.	Galanta	4.89
	NO_x			CO		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	171.44	Službyt, spol. s r.o.	Senica	166.36
2.	Johns Manville Slovakia, a.s.	Trnava	123.54	IKEA Industry Slovakia s. r. o.	Trnava	26.41
3.	ENVIRAL, a.s.	Hlohovec	58.72	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	21.95
4.	Tate & Lyle Boleraz, s.r.o.	Trnava	51.12	ENVIRAL, a.s.	Hlohovec	19.95
5.	Službyt, spol. s r.o.	Senica	34.41	Tate & Lyle Boleraz, s.r.o.	Trnava	17.55
6.	IKEA Industry Slovakia s. r. o.	Trnava	28.07	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	13.38
7.	TEPLÁREŇ, a.s., Pov. Bystrica	Dun. Streda	25.49	I.D.C. Holding, a.s.	Galanta	12.61
8.	Bekaert Hlohovec, a.s.	Hlohovec	21.89	Johns Manville Slovakia, a.s.	Trnava	10.86
9.	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	17.22	UNIASFALT s.r.o.	Trnava	10.24
10.	ECO PWR, s. r. o.	Dun. Streda	14.00	ASTOM ND, s. r. o.	Dun. Streda	9.77

TRENČÍN REGION

	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské elektrárne, a.s., prev. Nováky	Prievidza	510.06	Slovenské elektrárne, a.s., prev. Nováky	Prievidza	46754.6 5
2.	Považská cementáreň, a.s.	Ilava	190.72	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	42.72
3.	FORTISCHEM a. s.	Prievidza	180.05	Hornonitrianske bane Prievidza, a.s.	Prievidza	24.69
4.	Hornonitrianske bane Prievidza, a.s.	Prievidza	19.45	BIOPLYN HOROVCE 3, s. r. o.	Púchov	7.70
5.	TERMONOVA, a.s.	Ilava	17.00	Považská cementáreň, a.s.	Ilava	7.22
6.	Považský cukor a.s.	Trenčín	17.00	FORTISCHEM a. s.	Prievidza	6.76
7.	Kameňolomy, s.r.o.	Trenčín	9.46	RONA, a.s.	Púchov	5.17
8.	CEMMAC a.s.	Trenčín	7.58	BPS Myjava, s. r. o.	Myjava	5.10
9.	KVARTET a.s.	Partizánske	7.28	CEMMAC a.s.	Trenčín	4.76
10.	ALAS SLOVAKIA, s.r.o.	Prievidza	6.72	AGROSERVIS-SLUŽBY, spol. s r.o.	Partizánske	4.59
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské elektrárne, a.s., prev. Nováky	Prievidza	3819.76	CEMMAC a.s.	Trenčín	2849,06
2.	Považská cementáreň, a.s.	Ilava	735.66	Považská cementáreň, a.s.	Ilava	2080,01
3.	CEMMAC a.s.	Trenčín	556.84	Slovenské elektrárne, a.s., prev. Nováky	Prievidza	364,92
4.	RONA, a.s.	Púchov	301.25	FORTISCHEM a. s.	Prievidza	286,25
5.	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	178.65	Považský cukor a.s.	Trenčín	180,73
6.	TEPLÁREŇ, a.s., Pov. Bystrica	Pov. Bystrica	87.46	TEPLÁREŇ, a.s., Pov. Bystricaa	Pov. Bystrica	114,12
7.	FORTISCHEM a. s.	Prievidza	66.52	Technické služby mesta Partizánske s r. o.	Partizánske	102,92
8.	TERMONOVA, a.s.	Ilava	47.29	COFELY a.s.	Myjava	90,39
9.	Služby pre bývanie, s r.o.	Trenčín	45.18	Služby pre bývanie, s r.o.	Trenčín	41,89
10.	Continental Matador Rubber, s.r.o.	Púchov	32.46	KVARTET a.s.	Partizánske	41,02

NITRA REGION

	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Duslo, a.s.	Šaľa	158.34	Calmit, spol. s r.o.	Nitra	26.87
2.	SLOVENSKÉ ENERGETICKÉ STROJÁRNE a.s.	Levice	9.84	BIONOVES, s.r.o.	Nitra	23.03
3.	DECODOM, spol. s r. o.	Topoľčany	9.63	P.G.TRADE, spol. s r.o.	Nové Zámky	15.54
4.	P.G.TRADE, spol. s r.o.	Nové Zámky	9.52	AT GEMER, spol. s r.o.	Nové Zámky	10.02
5.	SLOVINTEGRA ENERGY, a.s.	Levice	9.08	Bioplyn Cetín, s. r. o.	Nitra	8.24
6.	Prvá energetická a teplárenská spol., s.r.o.	Zlaté Moravce	9.01	Liaharenský podnik Nitra, a.s.	Levice	8.20
7.	TOP PELET, s.r.o.	Topoľčany	8.82	Icopal a.s.	Nové Zámky	6.44
8.	ACHP Levice a.s.	Nitra	7.81	BPS Lipová 1 s.r.o.	Nové Zámky	6.16
9.	MENERT - THERM, s.r.o.	Šaľa	7.51	BIOGAS, s.r.o.	Nitra	5.82
10.	LENCOS spol. s r.o.	Levice	6.82	Ministerstvo obrany SR, kotolne v okrese	Nitra	3.70
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Duslo, a.s.	Šaľa	628.87	Calmit, spol. s r.o.	Nitra	1336.66
2.	BIOENERGY TOPOĽČANY s.r.o.	Topoľčany	127.93	SLOVINTEGRA ENERGY, a.s.	Levice	264.05
3.	SLOVINTEGRA ENERGY, a.s.	Levice	126.39	Bytkomfort, s.r.o.	Nové Zámky	145.65
4.	Bytkomfort, s.r.o.	Nové Zámky	42.40	Duslo, a.s.	Šaľa	98.64
5.	VICENTE TORNS SLOVAKIA, a.s.	Komárno	33.82	Secop s.r.o.	Zlaté Moravce	45.21
6.	P.G.TRADE, spol. s r.o.	Nové Zámky	22.65	Wienerberger slov. tehelne, spol. s r.o.	Zlaté Moravce	31.72
7.	Veolia Energia Vráble, a.s.	Nitra	20.49	SLOVINCOM, spol. s r.o.	Komárno	22.72
8.	SLOVENSKÉ ENERGETICKÉ STROJÁRNE a.s.	Levice	18.41	Bioplyn Cetín, s. r. o.	Nitra	20.72
9.	Nitrianska teplárenská spoločnosť, a.s.	Nitra	18.28	VICENTE TORNS SLOVAKIA, a.s.	Komárno	19.02
10.	DECODOM, spol. s r. o.	Topoľčany	17.03	K.T. spol. s r.o.	Komárno	17.18

ŽILINA REGION

	PM			SO$_2$		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Mondi SCP, a.s.	Ružomberok	77.16	Žilinská teplárenská, a.s.	Žilina	473.91
2.	DOLVAP, s.r.o.	Žilina	62.80	OFZ, a.s.	Dolný Kubín	435.66
3.	OFZ, a.s.	Dolný Kubín	52.34	Martinská teplárenská, a.s.	Martin	365.35
4.	Žilinská teplárenská, a.s.	Žilina	35.67	Mondi SCP, a.s.	Ružomberok	163.61
5.	TEHOS, s.r.o.	Dolný Kubín	11.12	SOTE s.r.o.	Čadca	84.66
6.	Kia Motors Slovakia s.r.o.	Žilina	9.81	ŽOS Vrútky a.s.	Martin	80.99
7.	D O L K A M Šuja, a.s.	Žilina	9.30	AFG, s.r.o.	Turč. Teplice	12.51
8.	KYSUCA s.r.o.	Kys. N. Mesto	8.23	BPS BORCOVA, s.r.o.	Turč. Teplice	8.97
9.	Martinská teplárenská, a.s.	Martin	7.52	ZDROJ MT, spol. s r.o.	Martin	6.81
10.	LMT, a. s.	Lipt. Mikuláš	7.07	Cementáreň Lietavská Lúčka, a.s.	Žilina	4.14
	NO$_x$			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Mondi SCP, a.s.	Ružomberok	1077.68	OFZ, a.s.	Dolný Kubín	1007.62
2.	OFZ, a.s.	Dolný Kubín	445.42	Mondi SCP, a.s.	Ružomberok	964.32
3.	Žilinská teplárenská, a.s.	Žilina	292.88	LMT, a. s.	Lipt. Mikuláš	181.71
4.	Martinská teplárenská, a.s.	Martin	221.50	SOTE s.r.o.	Čadca	105.84
5.	Rettenmeier Tatra Timber, s.r.o.	Lipt. Mikuláš	123.11	Žilinská teplárenská, a.s.	Žilina	59.48
6.	SPECIALTY MINERALS SLOVAKIA, spol. s r.o.	Ružomberok	63.73	Rettenmeier Tatra Timber, s.r.o.	Lipt. Mikuláš	59.22
7.	Kia Motors Slovakia s.r.o.	Žilina	43.88	ŽOS Vrútky a.s.	Martin	55.30
8.	LMT, a. s.	Lipt. Mikuláš	40.57	DOLVAP, s.r.o.	Žilina	38.85
9.	KYSUCA s.r.o.	Kys. N. Mesto	30.11	TURZOVSKÁ DREVÁRSKA FABRIKA s.r.o.	Čadca	38.77
10.	SOTE s.r.o.	Čadca	26.32	KYSUCA s.r.o.	Kys.N.Mesto	30.36

BANSKÁ BYSTRICA REGION

	PM			SO$_2$		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovalco, a.s.	Žiar n/H	98.97	Slovalco, a.s.	Žiar n/H	1656.63
2.	Knauf Insulation, s.r.o.	Žarnovica	43.46	Zvolenská teplárenská, a.s.	Zvolen	487.48
3.	Energy Edge ZC s. r. o.	Žarnovica	31.17	Knauf Insulation, s.r.o.	Žarnovica	332.67
4.	Zvolenská teplárenská, a.s.	Zvolen	28.37	Veolia Utilities Žiar n/H, a.s.	Žiar n/H	145.67
5.	Veolia Utilities Žiar n/H, a.s.	Žiar n/H	15.39	SLOVMAG a.s. Lubeník	Revúca	91.81
6.	SLOVMAG a.s. Lubeník	Revúca	12.56	KOMPALA a.s.	B. Bystrica	78.64
7.	Nemak Slovakia s.r.o.	Žiar n/H	10.50	SMZ, a.s. Jelšava, prevádzka Jelšava	Revúca	31.19
8.	Bytes, spol. s r.o.	Detva	9.91	VUM, a.s.	Žiar n/H	20.08
9.	PPS Group a.s.	Zvolen	8.84	Calmit, spol. s r.o.	Rim. Sobota	15.72
10.	KA Contracting SK, s.r.o.	B.Bystrica	8.15	Družstvo Agrospol, družstvo	Lučenec	11.86
	NO$_x$			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	SMZ, a.s. Jelšava, prevádzka Jelšava	Revúca	687.17	Slovalco, a.s.	Žiar n/H	14239.50
2.	Slovalco, a.s.	Žiar n/H	443.30	SMZ, a.s. Jelšava, prevádzka Jelšava	Revúca	2141.34
3.	Zvolenská teplárenská, a.s.	Zvolen	408.51	SLOVMAG a.s. Lubeník	Revúca	282.15
4.	Veolia Utilities Žiar nad Hronom, a.s.	Žiar n/H	189.28	Železiarne Podbrezová a.s.	Brezno	196.84
5.	SLOVMAG a.s. Lubeník	Revúca	152.87	VUM, a.s.	Žiar n/H	179.60
6.	Železiarne Podbrezová a.s.	Brezno	152.50	Energy Edge ZC s. r. o.	Žarnovica	140.71
7.	KOMPALA a.s.	B. Bystrica	115.43	Veolia Utilities Žiar nad Hronom, a.s.	Žiar n/H	133.70
8.	Energy Edge ZC s. r. o.	Žarnovica	108.20	STEFE ECB, s.r.o.	Rim. Sobota	114.51
9.	BUČINA ZVOLEN, a.s.	Zvolen	96.25	Calmit, spol. s r.o.	Rim. Sobota	99.28
10.	Bučina DDD, spol. s r.o.	Zvolen	95.85	Zvolenská teplárenská, a.s.	Zvolen	72.47

PREŠOV REGION

	PM			SO$_2$		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	BUKOCEL, a.s.	Vranov n/T	90.40	BUKÓZA ENERGO, a. s.	Vranov n/T	1256.25
2.	BIOENERGY BARDEJOV, s.r.o.	Bardejov	13.33	BUKOCEL, a.s.	Vranov n/T	108.30
3.	BUKÓZA ENERGO, a. s.	Vranov n/T	8.02	CHEMES, a.s. Humenné	Humenné	19.79
4.	CHEMES, a.s. Humenné	Humenné	7.42	ZEOCEM, a.s.	Vranov n/T	10.45
5.	Domov sociálnych služieb v Spiš. Štvrtku	Levoča	4.72	Roľnícke družstvo v Plavnici	Stará Ľubovňa	7.79
6.	IS-LOM s.r.o., Maglovec	Prešov	4.61	BPS Ladomirová, s. r. o.	Svidník	7.77
7.	TATRAVAGÓNKA a.s.	Poprad	4.59	MM ENERG, s.r.o.	Vranov n/T	5.71
8.	ZEOCEM, a.s.	Vranov n/T	4.11	AGROKOMPLEX, spol. s r.o. Humenné	Humenné	5.28
9.	VSK MINERAL s.r.o.	Vranov n/T	3.62	Ministerstvo obrany Slovenskej republiky	Humenné	2.03
10.	LOMY, s. r. o.	Prešov	3.43	Domov soc. služieb v Spišskom Štvrtku	Levoča	1.96
	NO$_x$			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	BUKÓZA ENERGO, a. s.	Vranov n/T	417.24	BUKOCEL, a.s.	Vranov n/T	633.14
2.	BUKOCEL, a.s.	Vranov n/T	261.90	Leier Baustoffe SK s.r.o.	Prešov	191.50
3.	SPRAVBYTKOMFORT a.s. Prešov	Prešov	85.72	BUKÓZA ENERGO, a. s.	Vranov n/T	146.23
4.	BIOENERGY BARDEJOV, s.r.o.	Bardejov	82.84	Schüle Slovakia, s.r.o.	Poprad	118.41
5.	CHEMES, a.s. Humenné	Humenné	26.92	Teplo GGE s. r. o.	Snina	33.67
6.	CHEMOSVIT ENERGOCHEM, a.s.	Poprad	26.72	SPRAVBYTKOMFORT a.s. Prešov	Prešov	30.42
7.	Veolia Energia Poprad a.s.	Poprad	17.52	Spravbytherm s.r.o.	Kežmarok	24.79
8.	Leier Baustoffe SK s.r.o.	Prešov	13.64	BYTENERG spol. s r.o.	Medzilaborce	23.75
9.	AGROKOMPLEX, spol. s r.o. Humenné	Humenné	12.62	CHEMES, a.s. Humenné	Humenné	22.86
10.	ZEOCEM, a.s.	Vranov n/T	10.49	CHEMOSVIT FOLIE, a.s.	Poprad	11.68

KOŠICE REGION

	PM			SO$_2$		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	U. S. Steel Košice, s.r.o.	Košice II	2882.13	U. S. Steel Košice, s.r.o.	Košice II	7450.26
2.	Carmeuse Slovakia, s.r.o.	Košice - okolie	44.50	Tepláreň Košice, a. s.	Košice IV	868.83
3.	Tepláreň Košice, a. s.	Košice IV	37.43	Slov. elektrárne, a.s., prevádzka Vojany	Michalovce	510.57
4.	Slov. elektrárne, a.s., prevádzka Vojany	Michalovce	22.67	KOVOHUTY, a.s.	Spišská N. Ves	82.71
5.	CRH (Slovensko) a. s.	Košice - okolie	19.46	TP 2, s.r.o.	Michalovce	69.85
6.	Carmeuse Slovakia, s.r.o.	Košice II	14.46	SMZ, a.s. Jelšava, prevádzka Bočiar	Košice II	52.94
7.	KOVOHUTY, a.s.	Spišská N. Ves	12.15	Bioplyn Rozhanovce, s.r.o.	Košice - okolie	18.03
8.	RMS, a.s. Košice	Košice II	9.42	RMS, a.s. Košice	Košice II	17.02
9.	Tepelné hospodárstvo Moldava, a.s.	Košice - okolie	8.86	CO.BE.R. spol. s r.o.	Sobrance	8.06
10.	Mesto Sobrance	Sobrance	8.61	Danubian Biogas s.r.o.	Košice - okolie	7.61
	NO$_x$			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	U. S. Steel Košice, s.r.o.	Košice II	6652.60	U. S. Steel Košice, s.r.o.	Košice II	112565.31
2.	CRH (Slovensko) a. s.	Košice - okolie	631.18	KOVOHUTY, a.s.	Spišská N. Ves	1427.54
3.	Tepláreň Košice, a. s.	Košice IV	461.05	Slov. elektrárne, a.s., prevádzka Vojany	Michalovce	342.70
4.	Carmeuse Slovakia, s.r.o.	Košice II	424.31	HNOJIVÁ Duslo, s.r.o.	Michalovce	285.52
5.	eustream, a. s.	Michalovce	226.93	SMZ, a.s. Jelšava, prevádzka Bočiar	Košice II	215.02
6.	Košická energetická spoločnosť, a.s.	Košice IV	70.36	Tepelné hospodárstvo Moldava, a.s.	Košice - okolie	94.39
7.	Slovenské elektrárne, a.s.	Michalovce	63.85	Carmeuse Slovakia, s.r.o.	Košice II	91.40
8.	HNOJIVÁ Duslo, s.r.o.	Michalovce	56.24	Embraco Slovakia s.r.o.	Spišská N. Ves	82.19
9.	Tube City IMS Košice, s.r.o.	Košice II	53.19	CRH (Slovensko) a. s.	Košice - okolie	51.92
10.	TP 2, s.r.o.	Michalovce	48.26	Tepláreň Košice, a. s.	Košice IV	46.93

**According to the Decree of MŽP SR No. 410/2012 Coll.*

Tab. 4.6 **Stationary source emissions by districts in 2015**

District	**Emissions** [t.year⁻¹]				**Specific territorial emis.** [t.year⁻¹.km⁻²]			
	PM	SO_2	NO_x	CO	PM	SO_2	NO_x	CO
1. Bratislava	230	2264	2538	932	0.63	6.16	6.90	2.54
2. Malacky	269	135	1717	1852	0.28	0.14	1.81	1.95
3. Pezinok	114	18	84	193	0.30	0.05	0.22	0.51
4. Senec	107	14	132	168	0.30	0.04	0.37	0.47
5. Dun. Streda	412	52	275	557	0.38	0.05	0.26	0.52
6. Galanta	297	267	411	418	0.46	0.42	0.64	0.65
7. Hlohovec	134	14	164	201	0.50	0.05	0.61	0.75
8. Piešťany	239	29	137	321	0.63	0.07	0.36	0.84
9. Senica	354	36	152	619	0.52	0.05	0.22	0.91
10. Skalica	225	18	96	289	0.63	0.05	0.27	0.81
11. Trnava	294	163	402	403	0.40	0.22	0.54	0.54
12. Bánovce n/B	247	20	79	320	0.54	0.04	0.17	0.69
13. Ilava	446	27	888	2424	1.24	0.08	2.48	6.76
14. Myjava	363	34	121	545	1.11	0.10	0.37	1.66
15. Nové Mesto n/V	339	26	133	444	0.58	0.05	0.23	0.77
16. Partizánske	166	21	128	374	0.55	0.07	0.42	1.24
17. Pov. Bystrica	625	50	247	898	1.35	0.11	0.53	1.94
18. Prievidza	1437	46846	4160	1634	1.50	48.81	4.33	1.70
19. Púchov	542	70	510	714	1.45	0.19	1.36	1.90
20. Trenčín	398	90	997	3629	0.59	0.13	1.48	5.38
21. Komárno	429	33	254	632	0.39	0.03	0.23	0.57
22. Levice	1103	96	483	1665	0.71	0.06	0.31	1.07
23. Nitra	348	100	307	1868	0.40	0.11	0.35	2.15
24. Nové Zámky	627	92	347	969	0.47	0.07	0.26	0.72
25. Šaľa	302	15	719	279	0.85	0.04	2.02	0.78
26. Topoľčany	223	20	258	292	0.37	0.03	0.43	0.49
27. Zlaté Moravce	260	21	110	408	0.50	0.04	0.21	0.78
28. Bytča	426	33	113	535	1.51	0.12	0.40	1.90
29. Čadca	1238	184	333	1699	1.63	0.24	0.44	2.23
30. Dolný Kubín	394	461	564	1466	0.80	0.94	1.15	2.98
31. Kys. N. Mesto	269	20	110	356	1.55	0.12	0.63	2.05
32. Lipt. Mikuláš	648	54	369	1088	0.48	0.04	0.28	0.81
33. Martin	491	495	389	700	0.67	0.67	0.53	0.95
34. Námestovo	1233	111	276	1570	1.79	0.16	0.40	2.27
35. Ružomberok	800	223	1337	1926	1.24	0.35	2.07	2.98
36. Turč. Teplice	227	41	97	301	0.58	0.11	0.25	0.77
37. Tvrdošín	187	18	82	241	0.39	0.04	0.17	0.50
38. Žilina	999	554	669	1291	1.23	0.68	0.82	1.58
39. Ban. Bystrica	572	130	416	793	0.71	0.16	0.51	0.98
40. Banská Štiavnica	267	24	63	339	0.91	0.08	0.22	1.16
41. Brezno	667	76	338	1126	0.53	0.06	0.27	0.89
42. Detva	462	36	190	597	1.03	0.08	0.42	1.33
43. Krupina	384	52	117	500	0.66	0.09	0.20	0.86
44. Lučenec	670	63	203	851	0.81	0.08	0.25	1.03
45. Poltár	222	19	68	303	0.47	0.04	0.14	0.64
46. Revúca	537	169	994	3100	0.74	0.23	1.36	4.25
47. Rim. Sobota	1188	111	442	1707	0.81	0.08	0.30	1.16
48. Veľký Krtíš	552	62	179	737	0.65	0.07	0.21	0.87
49. Zvolen	389	517	729	614	0.51	0.68	0.96	0.81
50. Žarnovica	545	371	301	757	1.28	0.87	0.71	1.78
51. Žiar n/H	551	1861	773	15148	1.06	3.59	1.49	29.26
52. Bardejov	446	36	192	548	0.48	0.04	0.21	0.59
53. Humenné	368	57	139	491	0.49	0.08	0.18	0.65
54. Kežmarok	454	37	142	606	0.72	0.06	0.22	0.96
55. Levoča	230	20	62	289	0.55	0.05	0.15	0.69
56. Medzilaborce	195	15	48	264	0.46	0.04	0.11	0.62
57. Poprad	509	41	273	859	0.54	0.04	0.29	0.92
58. Prešov	509	65	279	860	0.55	0.07	0.30	0.92
59. Sabinov	429	33	118	546	0.79	0.06	0.22	1.00
60. Snina	453	35	133	619	0.56	0.04	0.17	0.77
61. Stará Ľubovňa	553	52	150	699	0.78	0.07	0.21	0.99
62. Stropkov	152	12	40	193	0.39	0.03	0.10	0.50
63. Svidník	286	31	82	370	0.52	0.06	0.15	0.67
64. Vranov n/T	466	1409	792	1255	0.61	1.83	1.03	1.63
65. Gelnica	424	34	99	537	0.73	0.06	0.17	0.92
66. Košice	3009	8402	7816	113059	12.34	34.47	32.07	463.85
67. Košice - okolie	902	97	917	1246	0.59	0.06	0.60	0.81
68. Michalovce	179	593	503	921	0.18	0.58	0.49	0.90
69. Rožňava	952	78	262	1267	0.81	0.07	0.22	1.08
70. Sobrance	191	30	71	262	0.36	0.06	0.13	0.49
71. Spišská N. Ves	400	115	153	2020	0.68	0.20	0.26	3.44
72. Trebišov	401	37	149	521	0.37	0.03	0.14	0.49
Slovakia	35750	67444	37321	187904	0.73	1.38	0.76	3.83