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Proceedings

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SIZE DISTRIBUTED AEROSOL MASS CONCENTRATION AND CHEMICAL COMPOSITION IN BELGRADE DURING SUMMER-AUTUMN 2008

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Abstract

Physical and chemical characterizations of the atmospheric aerosol were carried out in urban area of Belgrade. This work focuses on the size-segregated aerosol chemical composition observed during the summer-autumn 2008th. Aerosol samples were submitted to gravimetric and chemical analyses. Mean random uncertainties associated with determination of Na⁺, NH₄⁺, K⁺, Mg²⁺, Ca²⁺, Cl⁻, NO₃⁻ and SO₄²⁻ were assessed.

Introduction

Due to the various atmospheric lifetimes because of various sizes of particles and complex chemical composition of atmospheric aerosols, their global distribution shows large regional differences and their properties are poorly known. Fine particles are produced by combustion processes, by coagulation of smaller particles, and by condensation of low-vapor-pressure products of gas-phase reactions. Mechanical action of the wind on the Earth's surface emits sea salt, soil dust, and vegetation debris into the atmosphere. These aerosols consist mainly of coarse particles ($1 < D_p < 10 \mu\text{m}$) but fine particles ($D_p < 1 \mu\text{m}$) are difficult to generate mechanically because they have large area-to-volume ratios and hence their surface tension per unit aerosol volume is high. Particles coarser than $10 \mu\text{m}$ are not easily lifted by the wind and have short atmospheric lifetimes because of their large sedimentation [1].

Sulphate, nitrate and ammonium ions are formed in the atmosphere in gas-particle conversion processes. Sulphates represent one of the main components of atmospheric aerosols. They are mainly obtained by the oxidation of SO₂, which was either directly emitted to the atmosphere (burning of fossil fuels, industrial processes, volcanoes, combustion of biomasses) or by the oxidation of lower

oxidation state sulphur compounds, mainly DMS, which is the dominant source of SO₂ in marine atmospheres. The main sources of NO_x are combustion of fossil fuels in high temperature processes (traffic, power plants, industry, and domestic fire-boxes), soil (microbiological activity), combustion of biomass, lightening [2] *etc.* The vapor pressure ensures that H₂SO₄ and HNO₃ are in the particulate phase in atmospheric conditions (with exception of HNO₃ in warm condition). Sulphate and nitrate aerosols can also be obtained by reaction of HNO₃ and H₂SO₄ in presence of salts or ammonia results in the neutralization of the acids and, together with NaCl from marine aerosol[2]. The sulphates in the atmosphere can also originate from other sources: *e.g.*, primary marine aerosol, gypsum CaSO₄ resuspended dust from the Sahara[3], *etc.*

The ammonia in precipitation is originating from the particulate phase. Seinfeld[4] reported that generally in the atmosphere ammonia occurs as (NH₄)₂(SO₄) but it is also possible to found in the form NH₄NO₃ [5]. The residence time of SO₂ and NO_x in the troposphere is 1 – 3 days[3], while the residence time of sulphates and nitrates is somewhat longer: for nitrates it is 3-9 days[3].

Very little is still known about the aerosol forcing related to the effect of particles on the size and number of cloud droplets [6].

This work focuses on the size-segregated aerosol chemical composition observed during the summer-autumn 2008th.

Experimental

During the June – December 2008th within the SIMCA project (INTERREG/CARDS-PHARE Adriatic New Neighborhood Programme) size-segregated aerosol was sampled using 6-stage High Volume Cascade Impactor. During the measured campaign were taken 32 samples every 6th day. Sampling duration for each sample was 48 hours. Particle size distribution in the size range 0.0 to 0.49 μm, 0.49 to 0.95 μm, 0.95 to 1.5 μm, 1.5 to 3.0 μm, 3.0 to 7.2 μm and > 7.2 μm in urban area of Belgrade were measured. Aerosol mass concentrations are determined by gravimetric measurements (m_{GM}). One-fifth of filter sample were extracted in 5 mL of ultra-pure water and analyzed by ion chromatography Metrohm for Na⁺, NH₄⁺, K⁺, Mg²⁺, Ca²⁺, Cl⁻, NO₃⁻ and SO₄²⁻.

Results and Discussion

The obtained results shown in Table 2 were done with the precisions 8% for Cl⁻, 2% for NO₃⁻, 2% for SO₄²⁻, 3.2% for Na⁺, 18% for NH₄⁺, 24% for Ca²⁺, 3% for Mg²⁺ and 8% for K⁺.

Table 1. Aerosol mass concentrations m_{GM} (μg m⁻³), mean ± standard deviation, of particles distributed through Dp intervals in urban area of Belgrade obtained in measured campaign.

Dp	0 to 0.49 μm	0.49 to 0.95 μm	0.95 to 1.5 μm	1.5 to 3.0 μm	3.0 to 7.2 μm	> 7.2 μm	Total
m _{GM}	2.4±1.5	4.4 ± 2.3	3.0±1.6	2.9±1.4	3.6±1.6	10.3±6.3	25.0±13.9

Table 2. Mass concentrations ($ng\ m^{-3}$), mean \pm standard deviation, of Cl^- , SO_4^{2-} , NO_3^- , NH_4^+ , Na^+ , K^+ , Mg^{2+} and Ca^{2+} distributed through Dp intervals in urban area of Belgrade obtained in measured campaign.

	0 to 0.49 μm	0.49 to 0.95 μm	0.95 to 1.5 μm	1.5 to 3.0 μm	3.0 to 7.2 μm	> 7.2 μm
Cl^-	21.1 \pm 20.1	11.5 \pm 12.0	9.7 \pm 8.8	8.0 \pm 7.0	12.3 \pm 11.1	6.5 \pm 5.9
SO_4^{2-}	226.8 \pm 227.2	86.7 \pm 96.2	38.9 \pm 48.9	17.9 \pm 20.4	22.1 \pm 20.3	8.5 \pm 7.8
NO_3^-	0.4 \pm 0.3					
NH_4^+	332.0 \pm 213.0	29.2 \pm 11.1	49.5 \pm 28.3	30.9 \pm 14.0	86.0 \pm 51.9	21.4 \pm 8.9
Na^+		16.3 \pm 19.5		7.0 \pm 5.6	5.0 \pm 5.5	
K^+	71.7 \pm 44.9	19.0 \pm 4.2	9.4 \pm 3.5	13.0 \pm 17.0		
Mg^{2+}	26.8 \pm 26.8					
Ca^{2+}	21.4 \pm 14.0	5.0 \pm 1.8	8.1 \pm 7.4	7.9 \pm 5.6	19.2 \pm 7.6	4.4 \pm 2.2

Conclusion

The largest contribution of SO_4^{2-} and NH_4^+ was in fine particles indicating main sources that are gas precursors SO_2 and NO_3 .

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