ISSUES OF INVESTIGATING CHEMICAL COMPOSITION OF PRECIPITATION IN URBAN AGGLOMERATIONS

V. S. Goryaeva, G. A. Tolkacheva, L. Yu. Shardakova
Research Hydrometeorological Institute at Uzhydromet, Tashkent, Uzbekistan
e-mail: tolkachevag@mail.ru

Приведены результаты исследования особенностей химического состава осадков в городах Ташкенте и Алмалыке. Выявлено, что масса выпадений минеральных компонентов с осадками для Ташкента и Алмалыка различается в 3–5 раз под влиянием промышленных выбросов различной мощности и состава. Выявлены различия в составе месячных и разовых проб осадков. Разработана схема анализа для разовых проб осадков на минеральные компоненты и тяжелые металлы с учетом специфики региона.

Objective: impact assessment of local sources of industrial emissions on chemical composition of atmospheric precipitation.

Tashkent and Almalyk cities located in 70 km from each other and inside the same climatic zone have been chosen for the investigations.

Tashkent is the capital of the Republic of Uzbekistan. It is a city with developed industrial infrastructure. Gross emissions from stationary sources amount 11.5 thousand ton per a year. Main atmospheric air pollutant in the city is carbonic oxide, which constitutes 34 % of all the pollutants.

Almalyk is an industrial city with maximal for Uzbekistan volume of gross emissions 98 thousand ton per a year. The emission composition is characterized by a high amount of sulfur dioxide, portion of which reaches 95 % of the emissions (fig. 1).

According the meteostation data located in the cities, annual precipitation amounts are close by their values: in Tashkent 521.2 mm/year, Almalyk — 538.4 mm/year.

Maximal precipitation amount in Tashkent and Almalyk is in the period from November to April (fig. 1). Tashkent and Almalyk meteostations are cites of precipitation monitoring network on which taking monthly precipitation samples are conducted.

Analysis of results of chemical analysis of the monthly samples has shown that values of flux density of mineral components for precipitations taken at Almalyk meteostation are higher than at Tashkent one (fig. 2). Maximal fluxes are observed in Almalyk in February, March, in Tashkent in March.

pH values obtained by monthly samples are within the limit of 5.0...6.88 for Tashkent and pH = 4.9...6.7 for Almalyk.

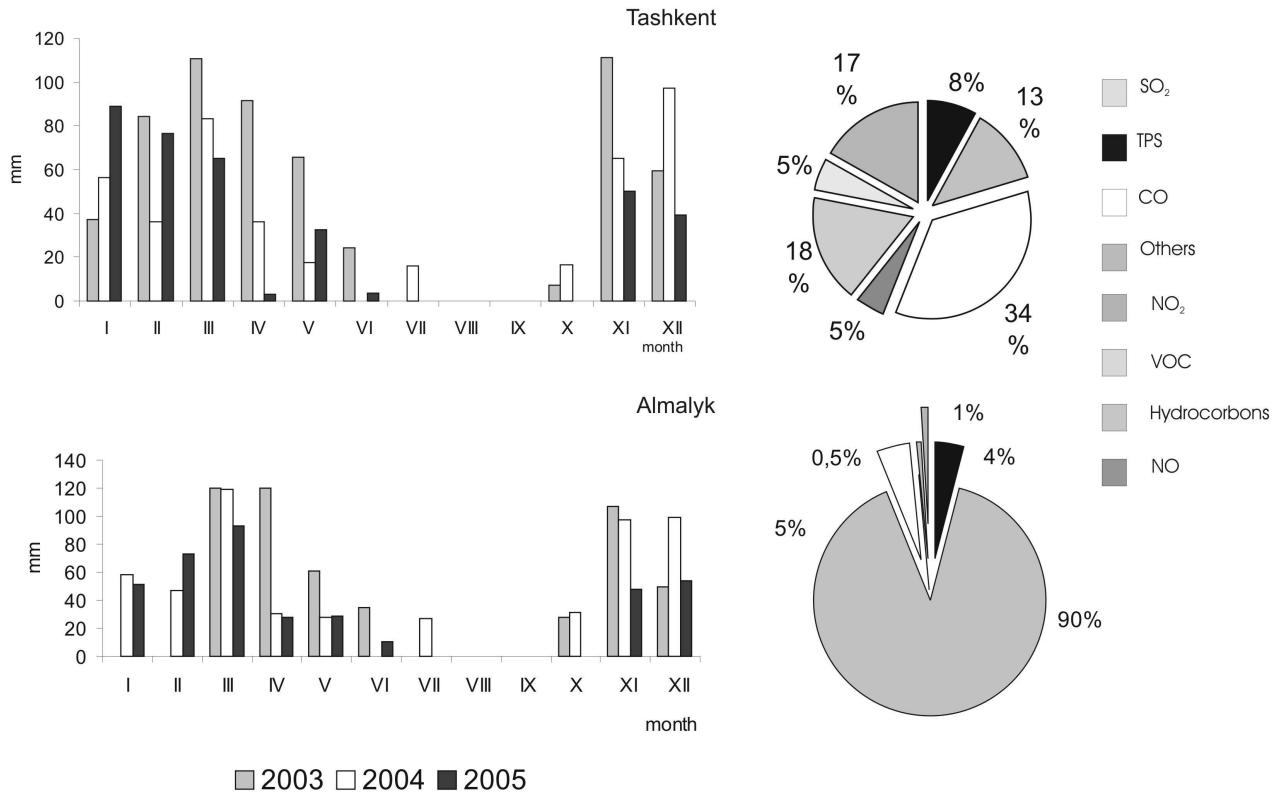

Fig. 1. Yearly trend of rainfall over a period of 2003–2005 and industrial emission structure for Tashkent and Almalyk.

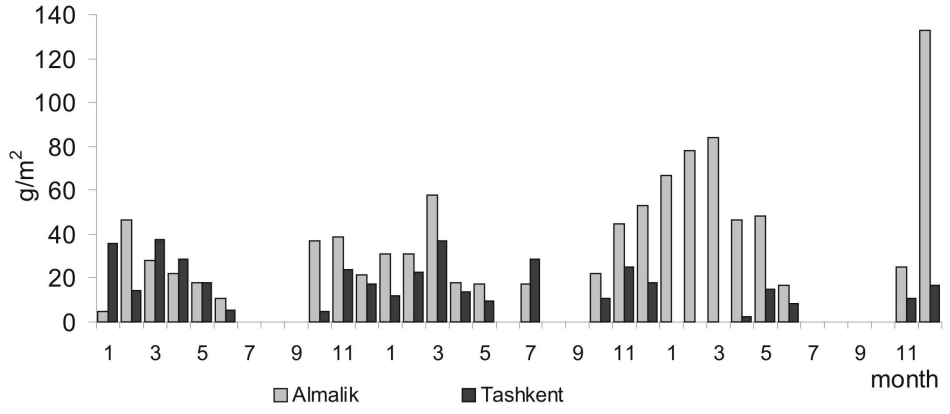

Fig. 2. The dynamics of annual trend of flux density of mineral components for monthly samples of precipitations over the period 2003–2005.

However, in last years in the areas adjoining to Tashkent and Almalyk in the spring period cases of mass fruit trees leaf damage and crop loss occurred. One of the most probable reasons might be acid precipitation falling. But analysis of average monthly precipitation samples has not revealed cases of precipitation with higher acidity.

In this connection in 2003 at Tashkent and Almalyk meteostations began to conduct taking of one-time precipitation samples. Methodology of the one-time samples coincided with monthly precipitation one, chemical analysis scheme for one-time samples was improved as it presented on the scheme (fig. 3).

As a result chemical composition data by 230 one-time precipitation samples have been obtained for the period 2003–2005, observed at Tashkent and Almalyk meteostations and for the cases the following parameters have been calculated:

— flux densities by ion sum determined components;

— flux densities by basic mineral components;

— flux densities by heavy metals.

The results of analysis of common flux density of mineral components are presented on the fig. 4. In spite of precipitation falls on the territory of the cities located in the same climatic zone spanned by a certain synoptic process, density peaks of contaminant emission flux in the cities fall on the diverse dates. It can be explained by impact of local pollution sources which bring in a considerable contribution in forming chemical composition of precipitation over urban territories.

Analysis of flux densities by basic mineral components (fig. 5, *a*) has been conducted in the following way:

— flux densities by ion sum of determined components have been calculated for monthly samples;

— monthly values of flux densities by basic mineral components using one-time samples (by means of summation) have been obtained;

— seasonal values of flux density by basic mineral components for one-time monthly samples have been calculated.

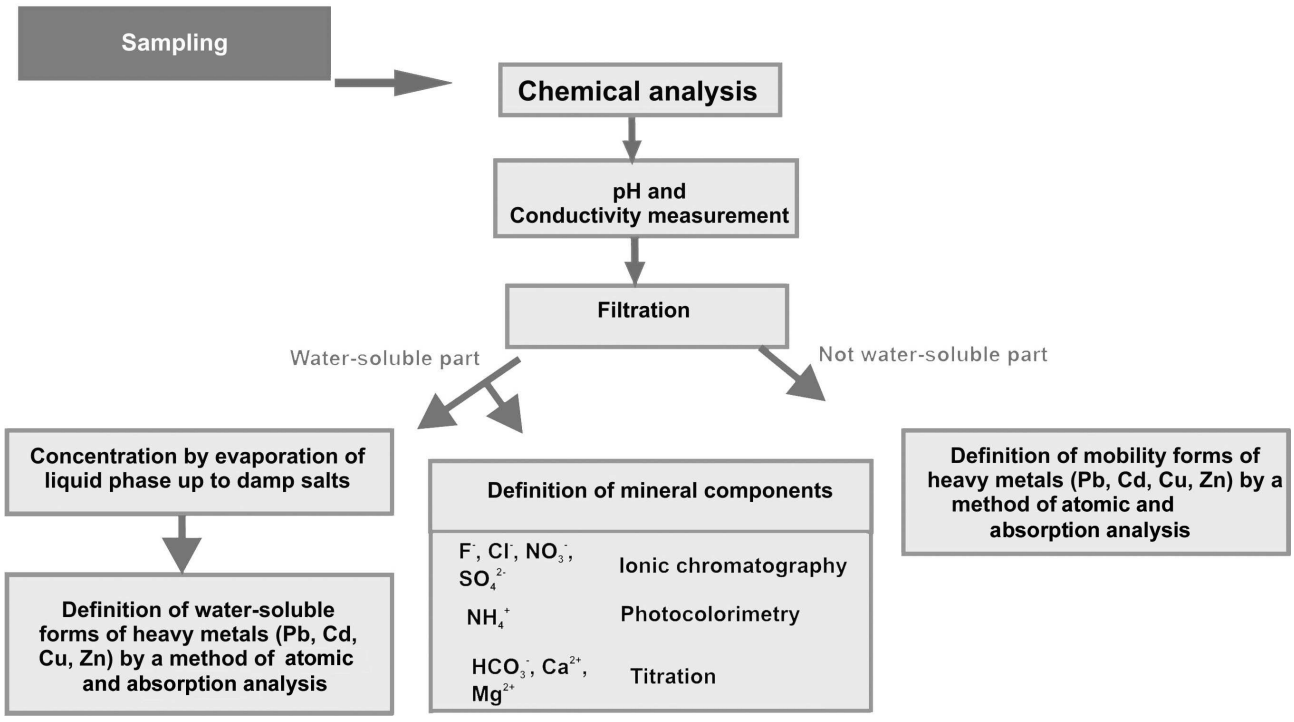

Fig. 3. The analysis scheme of precipitation one-time samples on water-soluble mineral components and heavy metals.

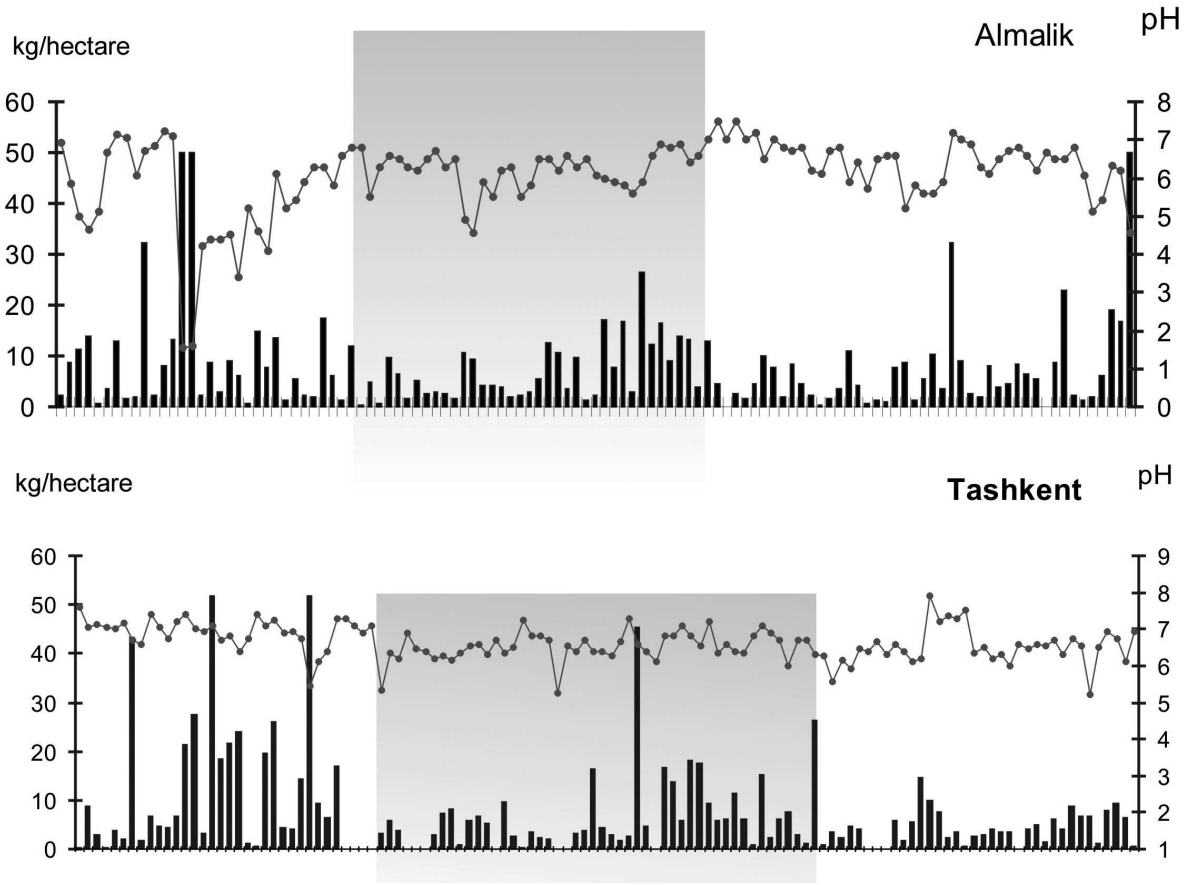

Fig. 4. Flux density of mineral components falling with precipitation (one-time samples) over a period of 2003–2005.

From figures can be seen the following:

— main flux of falling mass by mineral components both in Tashkent and in Almalyk falls in winter-spring period;

— falling mass of mineral components differs by 3–5 times for sampling points of Tashkent and Almalyk meteostations for all types of samples;

— content of atmospheric precipitation differs considerably. In Almalyk SO_2 emissions impact on forming precipitation chemical composition and as a consequence that leads to acidation of precipitation. In Tashkent HCO_3^- ions are prevalent in atmospheric precipitation. It is connected with CO_2 emissions into the atmosphere which along with nature sources (soils) impact on forming chemical composition of precipitation;

— it is noticeable the difference in values of flux densities between one-time and monthly samples of precipitation. Most likely a significant change of such parameters as pH, conductivity and concentration of main water-soluble components in the atmospheric precipitation occur when storing a sample during a month. This issue requires further research.

The results of analysis of flux density by heavy metals are presented on the fig. 5, *b*.

As can be seen from the figure, Zn is prevalent in Tashkent precipitation, Zn, Pb in Almalyk. It is connected with high background zinc content in soils of Tashkent region and likely with heavy metal emission from chemical industry in Almalyk city.

pH value analysis of one-time samples. The analysis allowed to reveal cases of acid precipitation falling. At Almalyk meteostation in 2003 precipitation with pH = 1.5 and 1.6 has been

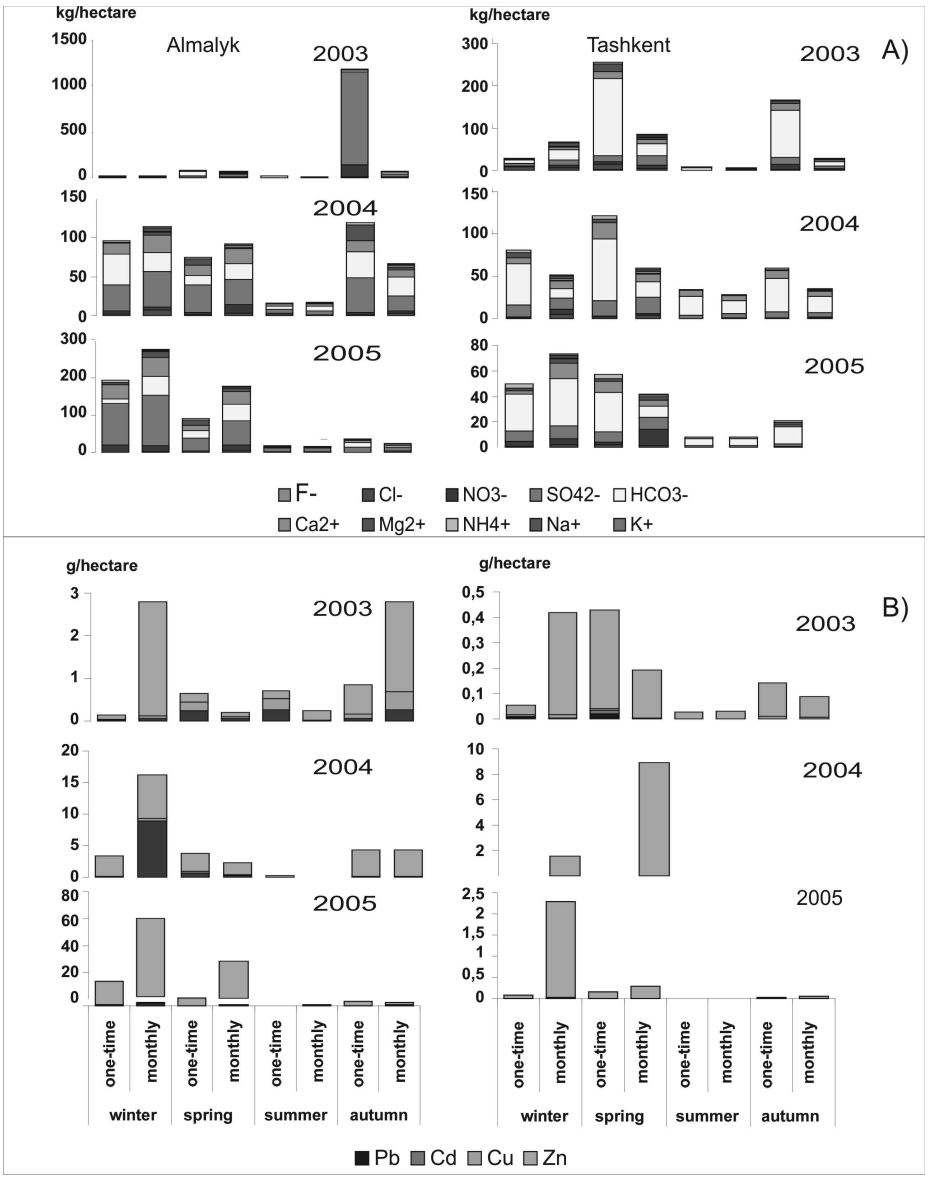

Fig. 5. Comparative values of seasonable flux density of mineral components (*a*) and heavy metals (*b*).

observed. That came out from a high SO_4^{2-}content in precipitation. On the whole in Almalyk pH values vary $3 < \text{pH} > 7$. In Tashkent pH of atmospheric precipitation amounts $5 > \text{pH} < 7$ in average.

The results of investigations have been shown that further one-time precipitation sampling is necessary and important for environment quality assessment.

References

[1] Smirnova T., Tolkacheva G. Precipitation quality in different zones of the Tashkent region in relation to photo-chemical reactions // Environmental Simulation Chambers: Appl. to Atmosp. Chem. Processes. NATO Sci. Ser. IV. Earth and Environmental Sci. 2004. Vol. 62. P. 393–403.

Received for publication 9 November 2006