Short communication

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# Distribution of the total and dissolved mercury concentrations at the Irkutsk city snow sampling during winter 2021-2022

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**ABSTRACT.** We took 41 samples for a quantitative assessment of the total and dissolved mercury concentrations in the snow of the city of Irkutsk during winter 2021-2022. The maximum concentration of total mercury was recorded near the Eternal Flame memorial (248 ng/dm$^3$); the minimum concentration was 6 ng/dm$^3$ at the Jewish cemetery. The maximum concentration of dissolved mercury was recorded near the Aviation Plant (11.5 ng/dm$^3$), and the minimum – near the Maratovskoye traffic circle and Secondary School No. 66 (0.1 ng/dm$^3$). In four samples, we did not detect dissolved mercury. Determining the mass concentration of mercury revealed that the concentrations of mercury compounds in the snow from Irkutsk were much lower than the MPC. Based on the results of the analysed samples, we created a cartographic material.

***Keywords***: total and dissolved mercury, concentration, snow, winter, Irkutsk

## 1. Introduction

Mercury is a low-active metal that is liquid under normal conditions. Metallic mercury itself is less hazardous, but it easily evaporates, and its vapor is extremely toxic. In nature, mercury is found in all components of the environment: soil, water and air. The organic mercury compounds are the most toxic.

The unique geochemical and toxicological properties of mercury determine the specifics of its concentration and redistribution in various components of the environment. A characteristic feature of metallic mercury is low heat of vaporization, causing high volatility of its vapor and not only possible evaporation from the surface of metallic mercury but also diffusion through water layers (Antipov et al., 1999). Mercury evaporation occurs even at the temperature below its freezing point (-390°C), due to which a 'mercury atmosphere' is created, elucidating the mercury dispersion in various spheres of the Earth (Grebenshchikova et al., 2008). This explains the ability of mercury to accumulate in food chains, the diversity of migration forms and specifics of their transformation under natural and technogenic conditions as well as a wide and varied range of negative impacts on humans and other living organisms, their populations and ecosystems as a whole. Combined with the comparatively easy reduction of mercury to the metallic state under ambient conditions, this feature may lead to the global atmospheric transport of mercury. Mercury and its compounds are highly toxic and disrupt protein metabolism and the enzymatic activity of living organisms (Efimova et al., 2016).

Of great interest is the supply of mercury in the cold continental regions during winter where snow, being a specific accumulator of air pollutants, represents one of the intermediate stages in the general mercury cycle. A stable snow cover is formed in most of Russia. The duration of snow periods differs for different regions. Snow in winter is an effective sink for air pollutants from fuel combustion, industrial emissions, vehicle exhaust, and transboundary transport (Davidson et al., 1996). Therefore, snow is a subject of many studies as a reliable indicator of air pollution, which can provide information about pollutant sources.

This study aims at quantitative assessment of mercury concentrations in the snow from the city of Irkutsk.

## 2. Materials and methods

During winter 2021-2022, 41 snow samples were taken in the city of Irkutsk. Mercury concentration in snow was studied in Laboratory of Hydrochemstry and Atmosphere Chemistry at Limnological Institute SB RAS. Sample preparation for chemical analysis was carried out according to PND F 14.1:2:4.271-2012 "Method

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for measuring the mass concentrations of mercury in samples of natural, drinking, mineral, and waste water by the atomic absorption with Zeeman correction of non-selective absorption on an RA-915M (M 01-51-2012) mercury analyzer" with the RP-92 attachment. The snow samples were analysed for dissolved and total mercury by permanganate mineralization (Method A).

## 3. Results and discussion

Data on mercury concentrations at different sampling sites are presented in the form of cartographic material that was created in QGIS 3.10 using the QuickMapServices OSM Standard module. Figure 1 shows the distribution of total mercury concentrations in the snow samples from different areas of Irkutsk in winter 2021-2022.

As seen in Fig. 1, three samples were taken near the thermal power plant, and with distance from the pollution source, the mercury concentration decreased in the snow, from 178 ng/dm$^3$ to 121 ng/dm$^3$. In the samples collected near boiler houses located in Rabochee District, the mercury concentrations were 146 ng/dm$^3$, which is higher than the city average of 95 ng/dm$^3$. The maximum concentration of total mercury was recorded near the Eternal Flame memorial, 248 ng/dm$^3$. The minimum concentration of total mercury was 6 ng/dm$^3$ at the Jewish cemetery. Notably, maximum permissible concentration (MPC) of mercury in drinking water is 500 ng/dm$^3$.

Figure 2 shows the distribution of dissolved mercury in the Irkutsk snow at the same time.

In four samples, we did not detect dissolved mercury, which indicates extremely low concentrations of dissolved mercury in the snow. Like in Fig. 1, there was a trend to elevated concentrations of dissolved mercury at sites near the thermal power plant and its decrease with distance from the pollution source, from 4.1 to 2.2 ng/dm$^3$. In Rabochee District, the concentration of dissolved mercury was minimum compared to the concentration of total mercury. The maximum concentration of dissolved mercury was recorded near the Aviation Plant, one of the strategic industrial enterprises in Irkutsk, and accounted for 11.5 ng/dm$^3$. In all analysed samples, the concentration of dissolved mercury was below the lower detection limit of the PND F 14.1:2:4.271-2012 method.

## 4. Conclusions

Determining the mass concentration of mercury revealed that concentrations of mercury compounds in the snow sampling during winter 2021-2022 from Irkutsk were lower than the MPC of mercury in drinking water (500 ng/dm$^3$). The maximum concentration of total mercury was recorded near the Eternal Flame memorial (248 ng/dm$^3$); the minimum concentration was 6 ng/dm$^3$ at the Jewish cemetery. The maximum concentration of dissolved mercury was recorded near the Aviation Plant (11,5 ng/dm$^3$), and the minimum – near the Maratovskoye traffic circle and Secondary School No. 66 (0.1 ng/dm$^3$). In four samples, we did not detect dissolved mercury. Taking into account that snowfall contributes to the precipitation of pollutants from the atmosphere, we can state the minimum content of mercury compounds in the atmosphere of Irkutsk during winter 2021-2022.

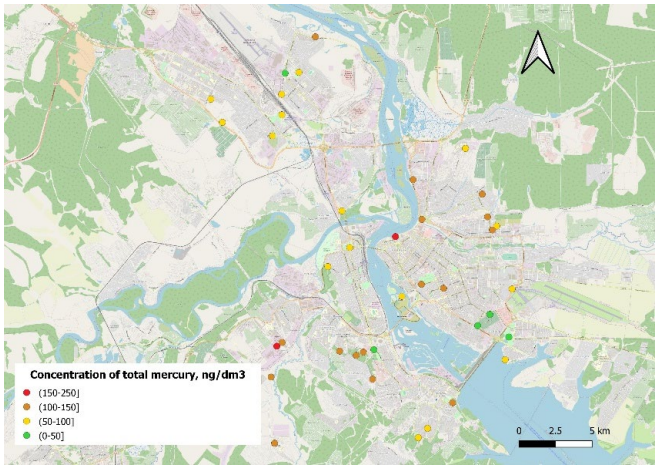


**Fig.1.** Schematic map of total mercury concentrations at snow sampling sites in Irkutsk.

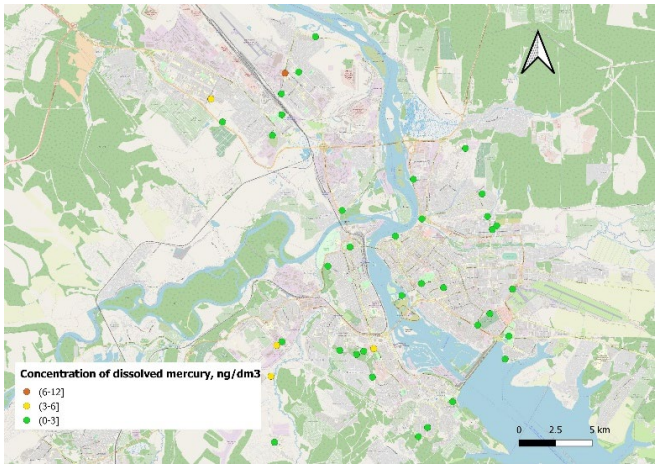


**Fig.2.** Schematic map of dissolved mercury concentrations at snow sampling sites in Irkutsk.

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## Conflict of interest

The authors declare no conflict of interest.

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