Moscow's environmental pollutants monitored with a new technique

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Members of the Faculty of Chemistry of the Lomonosov Moscow State University have elaborated a new approach to monitor the environmental status in Moscow, which could detect larger quantities of environmental components and so enlarge the list of environmental and human health hazards. The project results have been published in the *Environmental Pollution* journal.

Assessment of the environmental status and, in particular, atmosphere, in Moscow entails detection of several scores of nonorganic and organic substances by fixed-site laboratories subordinate to Mospriroda. However, ecological laboratories don't monitor everything beyond this short list. The Lomonosov Moscow State University scientists have detected novel pollutants in Moscow air using gas chromatography-mass spectrometry analysis.

Albert Lebedev, Doctor of Chemistry, Professor at the Organic Chemistry Department at of the Faculty of Chemistry of the Lomonosov Moscow State University and the article author, says, "The main project result is the enlargement of the list of determined substances and detection of novel ones posing potential environmental and human health hazard. The composition of organic air pollutants is not stable, so it's important to monitor regularly in order to provide early recognition of new threats both to the city ecosystem and citizens' health."

The scientist notes that monitoring is useful for many purposes. First of all, it could provide update information about water, soil and

atmosphere. Secondly, via monitoring, researchers can detect the source of a hazardous substance and eliminate it and decrease the level of pollutant inputs. After elimination, researchers could apply methods of treatment and "green" technologies as additional measures.

Scientists deal with targeted as well as non-targeted analyses. The latter implies looking for as many substances as possible. Targeted analysis is the purposeful detection of compounds known in advance. All analyses are made on snow samples, collected for research by scientists. In this connection this monitoring method is applicable only for cold-climate areas and mountains. This method could be applied all over Russia as the climate almost nationwide is with prominent alternation of seasons. However, one should take into consideration that pollution picture could strongly vary in different regions.

The basic technique used by scientists in their research is gas chromatography-mass spectrometry analysis (GC-MS). It's a single device, combining two analytical approaches. Gas chromatography is used for separation of organic compounds, which then feed into a mass-spectrometer one by one, where ionization and fragmentation take place. Each individual substance is then characterized by mass spectrum, which reveals its structure. The mass spectrum of any substance is unique, making it possible to use computer libraries.

The process results in a diagram of the dependence of signal intensity on time (a chromatograph), where each identified substance is represented by a separate peak whose area is proportional to its quantity in the mixture. So as a result of this technique, an unknown mixture consisting of hundreds of compounds evolves into the full profile information. Mass spectrometry has proved to be the most informative, sensitive, reliable and fast analytical technique, which could also be applied for environmental studies. Modern mass spectrometry is able to identify the nature of unknown ecotoxicants among a wide range of other

compounds, even though these ecotoxicants are represented in traces. Today, it's the basic method used for environmental control of any environmental objects.

With the help of this novel technique, the list of substances detected in Moscow's environment is much larger in comparison with other laboratories. But at the moment, scientists focus on volatile and semi-volatile compounds, which could be analyzed by the GC-MS technique. Consequently, among known hazardous categories of ecotoxicants, chemists are able to detect phenols, phthalates, organochlorine compounds, pesticides, and polycyclic aromatic hydrocarbons. Albert Lebedev says, "We don't deal with detection of compound toxicity. It's the domain of toxicologists. Any substance is toxic; the question is its concentration. Depending on the structure of compounds, their toxicity varies in a very wide range, from grams to femtograms. Today, the most hazardous ones are polychlorinated dibenzodioxins and dibenzofurans, polychlorinated biphenyls, benz[a]pyrene, some pesticides. However, following the increase of novel substances in environmental objects, the list of the most hazardous ones could be enlarged."

The scientist adds, "Detection of novel potentially hazardous substances in the environment is crucially important for conservancy of natural ecosystems and human health concerns. Transfer of this data provides deeper understanding of pollution and allows effective detection of contamination sources. The scientific value of the project lies in enlargement of mass spectrometry usage. Besides that, the project assists in elaboration of protocols for identification of organic substances in difficult, multicomponent matrices whose composition is not known. We can monitor samples of snow, ice, water of various types, including sea, drinking, fresh, waste water and cloud water, phytogenous extracts, food, beverages, cosmetics, industrial products, amphibians' secretion, etc."

More information: D.M. Mazur et al, Novel pollutants in the Moscow

atmosphere in winter period: Gas chromatography-high resolution time-of-flight mass spectrometry study, *Environmental Pollution* (2017). DOI: 10.1016/j.envpol.2016.12.049