GENERAL PROBLEMS OF THE STRATOSPHERIC OZONE

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General characteristic is given to the problem of transformations of the ozone layer in the Earth's atmosphere; general approaches to solving this problem, being developed at the Institute of Atmospheric Optics SB RAS, are described; brief information about the Scientific Session of the Department of Oceanology, Atmospheric Physics, and Geography of RAS is presented.

The ozone molecule, consisting of three oxygen atoms, being in the atmosphere, interacts with a great number of gases of both natural and anthropogenic origin, as well as with aerosols. Among the latter, the aerosols of volcanic origin are most destructive for ozone because they occupy the altitudes of maximum ozone concentration and their optical thickness is some orders of magnitude greater than that of the background aerosols and aerosols of anthropogenic origin. Such an "eating away" of ozone by volcanic aerosol was observed in the stratosphere over Tomsk by the researchers from the Siberian Lidar Station at the Institute of Atmospheric Optics S" RAS after very severe eruption of Mt. Pinatubo (Philippines) in June 1991.

In numerous airborne expeditions, the researchers of our institute conducted over practically the entire territory of the former USSR, the results of ozone interaction with both aerosol and gaseous components in the troposphere were observed many times. Thus, for example, our measurements have shown that the ozone concentration in the atmosphere of such cities as Khabarovsk and Komsomol'sk–on–Amur decreases, as a rule, but may also increase due to its interaction with aerosols of industrial origin. Similar airborne research into the ecological situation in the atmosphere over the city of Nizhnevartovsk, a new city in oil fields of the Tyumen' region, several times revealed zero ozone concentrations at altitudes of several hundreds meters resulting from the joint effect of NO and NO_2.

A unique conclusion about the anthropogenic impact on the concentration of ozone in the troposphere can be drawn from the above. This impact may be of both positive and negative sign. In this connection, it should be emphasized that the reliable quantitative data available are insufficient to make justified conclusions without additional systematic research.

Even more important is the problem on depletion of the ozone layer on the global scale due to both anthropogenic impact and natural factors. As follows from the data of the World Meteorological Organization, for few last decades, the total ozone content has been decreasing by 0.4% per year on average. Supposing that this process will have the same rate onward, already in the near future a global disaster will happen with our planet, since the ozone screen will no longer protect all living organisms on the Earth from the harmful short-wave solar radiation. Certainly, the problem of ozone is now an urgent one for all mankind, and its study, as a very important complex global program, permits of no delay. This is also true for Russia, although it is in a deep crisis now.

The ozone hole was detected for the first time in spaceborne measurements. That time it was localized over the Antarctic. Then it was observed to expand over the southern hemisphere, and recently ozone holes were detected in the northern hemisphere, in particular, over the vast territory of West Europe and over East Siberia. Having no reliable data on the causes of the ozone holes over vast territories of the Earth and reasoning only qualitatively we can assume that probably natural, rather than anthropogenic, factors play here a leading role. The study of separate and joint effects of both these factors should be considered now as an important part of the ozone problem.

Complex study of the ozone problem requires a development of methods and instrumentation for, first of all, remote sensing of ozone concentration and all main components of the ozone cycle from space, from airplanes and ships, and from the ground with stationary and mobile systems. The results obtained in such a way from the ground and from airplanes and ships, albeit having their own significance, should also be used to validate the data obtained from space. The significance of such problems should be especially emphasized that are aimed at solution of the problem of revealing the mechanism of ozone destruction under different meteorological conditions and synoptic situations.

The analysis of the state-of-the-art in the problem of ozone shows that space methods of obtaining ozone profiles are not used now for a variety of important reasons, measurements from airplanes and especially ships give only fragmentary data, the existing network of aerological stations does not provide acquiring of ozone profiles with needed frequency in space and time. Thus, for example, ozone balloons are not launched over the entire territory of Russia. A network of

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ground-based stations, determining the total ozone content in the atmospheric column, can be considered as an important supplement to the above-mentioned method of space sensing. Lidar stations, providing sensing of ozone profiles from the ground, are nonuniformly distributed and are few in number (no more than 30 all in all), moreover, the sensing at them is performed irregularly.

Investigation into the physical and chemical mechanisms of the ozone destruction requires simultaneous obtaining of reliable quantitative data on the profiles of ozone concentration first in the maximum, i. e., in the lower stratosphere and in the entire tropospheric column, including the planetary boundary layer, as well as near the ground. Although, lower tropospheric layers do not make somewhat significant contribution into the problem of ozone holes, markedly increased ozone concentration, hazardous to human health, were occasionally recorded in the near-ground atmospheric layer, that is why more attention should be paid to this problem.

As an example of serious attempt to reveal physical and chemical mechanisms of destruction of the ozone layer from the ground up to the altitudes about 50 km, one can consider the creation, development, and use of the unique Siberian Lidar Station at the Institute of Atmospheric Optics S" RAS, to dispose which a specialized four-floor building was constructed. At present the Station provides simultaneous sensing of the profiles of ozone concentration, ratio of the aerosol to Rayleigh backscattering coefficients, aerosol concentration and size spectrum, air temperature and humidity at a lot of wavelengths. Lidar signals are recorded through independent channels in receiving systems of telescopes with mirror diameters of 2.2, 1.0, 0.5, and 0.3 m. In addition to lidar sounding, the sensing of NO_2 profiles is conducted with a twilight spectrophotometer. "y the end of 1996 the measurements of NO_3 with a spectrophotometer are to be started. During the measurements, radiosonde and ozone balloon measurements are also performed. In addition, if necessary, mobile lidars are used for sensing the wind velocity profiles and other parameters. Certainly, besides creating the above-described unique instrumentation complex at the Station, the researchers have done a lot of work to solve very complicated ill-posed inverse problems.

Using this system, the sensing of aerosols (scattering ratio) was started in 1986, microphysical parameters of aerosol – in 1991, ozone – in 1989, temperature – in 1994, NO_2 profiles – in 1995. Simultaneous profiles of aerosol characteristic and ozone were obtained systematically starting from the moment of appearance of volcanic clouds from Mt. Pinatubo, since the first day of their appearance over Tomsk (June 29, 1991) and till vanishing of their traces in 1995.

Taking into account the obvious urgency of the ozone problem, the Department of Oceanology, Atmospheric Physics, and Geography of the Russian Academy of Sciences has held special scientific session devoted to this problem. The participants of this session have discussed 21 reports and it was decided to publish these reports in the topical issue of the journal *Atmospheric and Oceanic Optics* (you just have it at hand now). It should be emphasized that the reports were made by the leading specialists in the problems they concerned with in Russia. Among the problems that remained beyond the scope of these reports, I would like to note only the problems of active action on the ozone layer by technical means in order to increase the ozone concentration in the region of its maximum. These problems however require further development, including the evaluation of climatic and ecological hazard of impact of such actions, as well as the estimation of expenses and their efficiency.