TRANSFORMATION OF THE OZONE LAYER OF THE EARTH'S ATMOSPHERE: A TECHNOGENIC CATASTROPHE OR A NATURAL PHENOMENA

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The problem of atmospheric ozone as a natural protector of biological life on the Earth is discussed in this paper. This problem becomes more and more actual during the last twenty years because of steady variation of the atmospheric ozone content. Technogenic and natural reasons for this process are treated. The programs are reviewed in the context of which investigation of the atmospheric ozone is conducted at the Institute of Atmospheric Optics of the SB RAS.

In the last few decades much attention has been devoted to ozone layer transformation problem. Results of longstanding observations of vertical distribution of the ozone concentration performed in Höenpaisenberg Observatory on the south of Germany have pointed out two opposite trends: the decrease of the stratospheric ozone concentration and the increase of the tropospheric one (see Fig.1). An ecological hazard of the first trend is associated with the decrease of absorbability of the ozone layer causing harmful action of short-wave (300 nm) UV radiation of the Sun on the Earth's biosphere. The second trend is dangerous due to high toxicity and chemical activity of ozone, even small doses of which may cause immediate poisoning and death of a living being.

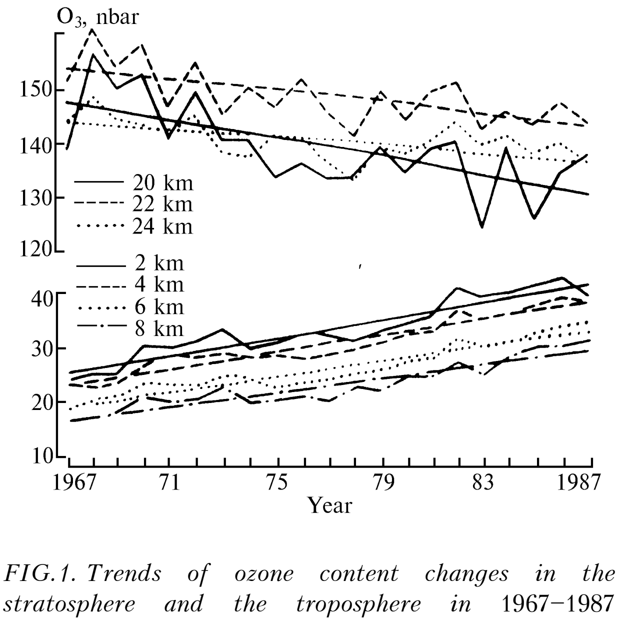

FIG.1. Trends of ozone content changes in the stratosphere and the troposphere in 1967–1987 *obtained from the data of Höenpaisenberg Observatory.*

Destruction of the ozone layer in the Earth's atmosphere is manifested not only through much talked-of ozone holes but also through the steady decrease of the total ozone content (TOC) in the last few decades at a rate of 0.4% per year. Unfortunately, the underlying reason for these processes is yet unknown. It is caused by either ordinary natural phenomena associated with global changes of atmospheric circulation or anthropogenic action on the atmosphere. The latter, as a rule, is associated with technogenic emissions, into the atmosphere, of long-lived freons and halides that after entering the stratosphere can produce chlorine and bromine atoms by photodissociation upon exposure to UV solar radiation. These halogens can be further involved in the process of catalytic ozone destruction according to the following scheme illustrated by the example of the chlorine atom:

$$Cl + O_3 \rightarrow ClO + O_2 ,$$

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By the official version, tecnogenic freons have already been recognized as the main and practically single culprit of approaching the ecological catastrophe, namely, destruction of the ozone layer. However, compelling evidence in favor of this version has not yet been presented and it is unlikely that it will be presented in the near future. Three reasons for this situation can be pointed out. First, series of large-scale extended stratospheric ozone observations are still insufficiently long in geophysical sense. In addition, these observational data were obtained during relatively "dirtyB period when the stratosphere was influenced by eruptions of Fuego (1974), Sent-Helens (1980), El-Chichon (1982), Del-Ruis (1985), and Pinatubo (1991) volcanos. Second, variations of

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the ozone concentration to be recorded are always the superposition of dynamics and chemistry of the atmosphere. Contribution of chemical processes where the anthropogenic factor can manifest itself is, as a rule, significantly “washed outB by dynamics of the atmosphere. Third, intensification of stratospheric ozone destruction by chlorine cycle was recorded only for the Antarctic ozone hole (see Ref.1), above unique region of the Earth farthest from the main sources of technogenic freon pollution and by no means connected with these sources by air circulation. Besides, Syvorotkin[2] has cast doubt on the version not without foundation and considered the ozone hole formation to be associated with decontamination of the Earth.

Hence, the concept of technogenic freon influence on the stratospheric ozone layer is still unsound although it provides the basis for some international agreements. From the other hand, the trend of ozone layer destruction is ample proof. Thus, correct prediction of this process and estimation of its environmental hazard remain the subjects for further scientific research.

Investigations on atmospheric ozone in the Institute of Atmospheric Optic have been performed since the late 80s (see Ref. 3). These studies were integrated into the SATOR program on tropospheric and stratospheric ozone which has been implemented at the IAO on its initiative since 1991 up to now (see Ref.4). The program combines experimental means and efforts of scientists from seven IAO laboratories. Some results of five-year investigations as part of the SATOR program obtained in the course of field integrated measurements in the stratosphere and the troposphere in Tomsk and the Tomsk region are presented in this issue of the journal (see Refs. 5 and 6).

Studies of stratospheric ozone dynamics in Tomsk during the last 5–6 years indicate that natural factors are dominant in atmospheric ozone variability. First, this is due to dynamics of the atmosphere. Second, eruptive products after the most powerful Pinatubo volcano eruption have strong effect on the stratosphere in this period.

In addition, the five-year series of ozone concentration measurements in the surface atmospheric layer have shown strong effect of dynamic factors on the variability of tropospheric ozone on the scale of synoptic processes. Comparison of our data with those obtained from tropospheric ozone observations in Western Europe as part of “EUROTRACKB project of the “EUREKAB European program indicates that the increase of ozone content in the troposphere is observed only in the zones of heavy industrial pollution. Almost all Western Europe represents such an integrated zone. Thus, an important role of the anthropogenic factor in tropospheric ozone transformation, in contrast with stratospheric one, is beyond question.

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