REDUCTION OF THE OZONE LAYER

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Contents

Summary

Photochemical transformations of ozone in the stratosphere are considered briefly. The relevant measurements illustrate typical spatial distributions of ozone, and its seasonal variations. The causes and mechanisms of the Antarctic ozone hole formation are discussed. The typical features of Antarctic ozone holes of the early 1990s are outlined. The difference in behavior of ozone in the Northern and Southern hemispheres are analyzed. Finally, the global ozone trends of the last decades are studied.

1. Introduction

About 90% of total ozone content is concentrated in the stratosphere. Thus, just the stratospheric ozone determines whether or what portion of the disastrous ultraviolet radiation reaches the Earth’s surface (see item Tropospheric Ozone and Related Trace Gases). In addition, stratospheric ozone controls the radiative and thermal atmospheric regimes in many respects. Therefore, the Earth’s climate and survival of humans, animals and vegetation depend directly on the depth of stratospheric ozone layer. So the ozone problem is one of the major modern ecological ones. The theoretical studies supported by satellite, balloon and aircraft monitoring depict a sufficiently detailed picture of ozone distribution in the stratosphere and its evolution.

2. Photochemistry of stratospheric ozone

The stratospheric ozone balance is determined mainly by the same photochemical processes which are described for tropospheric ozone in item Tropospheric Ozone and Related Trace Gases. But the basic source of atomic oxygen in the upper stratosphere is molecular oxygen photolysis, proceeding at wavelengths smaller than 242 nm (1 nm = 1×10^{-9} m)

$O_2 + h\nu \rightarrow O + O.$

In the middle stratosphere it competes successfully with the NO_2 photolysis, but the latter is much more effective in the lower stratosphere.

As in the troposphere, the catalytic cycles predominate in the photochemical ozone destruction in the stratosphere. But various catalysts determine the photochemical sink at the various stratospheric altitudes. In the lower stratosphere, as in the troposphere, hydrogen oxides (OH and HO_2) are the main ozone destroyers. At the same time, hydrogen and nitrogen oxide concentrations ares controlled by each other. The nitrogen catalytic cycle prevails over others in the middle stratosphere. In the upper stratosphere, the share of nitrogen oxides NO and NO_2 in ozone photochemical destruction is large too, but it decreased steadily in the 1970s and 1980s because of growth of the chlorine catalytic cycle contribution. Shares of these cycles, nitrogen and chlorine, were comparable in the late 1980s with magnitudes of about 30-40%. This situation caused then the adoption of international restrictions on the production and use of halocarbons (see Halocarbons).

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Biographical Sketches

I.L. Karol was born on 27 July 1927 in Leningrad, USSR. In 1944 he entered the Hydrodynamics Dept. of Leningrad State University, Mathematics and Mechanics Faculty, graduating in 1949. He passed postgraduate studies from 1949 to 1952, when he received a scientific degree of Candidate in Maths & Physics. After three years of lecturing in mathematics at the Ural University in Sverdlovsk, in 1956 he entered the Institute of applied Geophysics USSR Academy of Sciences in Moscow as a senior scientist.

In 1959 he was transferred to Institute of Experimental Meteorology of USSR Hydrometeorological Service in Obninsk, near Moscow, where he was nominated as chief of laboratory in 1970. Since 1972 he has been with Main Geophysical Observatory of USSR Hydrometeorological Service in Leningrad (now St. Petersburg) after receiving the USSR scientific degree of Doctor of Math & Physics, presenting in 1970 his theses, which was published in 1972 as a book by Gidrometeoizdat Publishing House "Radioactive isotopes and global transport in the atmosphere". This book was translated into English and published in 1974. Since 1953 I.L. Karol has published 10 scientific monographs and more than 140 papers individually or with co-authors. The original papers are dealing with modeling of global atmospheric composition and climate changes due to natural and anthropogenic causes. During several periods he served as a member of various international commissions and committees of the International Association of Meteorology and Atmospheric Physics, of the World Meteorological Organization, of the World Climate Research Program Joint Scientific Committee. Since 1974 he has been the USSR (now Russian) co-leader of the joint project: "Composition of the atmosphere and climate changes" of the US-Russian Cooperation in Environmental Protection. He was the author or co-author of numerous scientific reports, which he presented at international and national scientific meetings throughout his scientific career.

A.A. Kiselev was born on 26 April 1953 in Leningrad, USSR. In 1970 he entered and in 1975 he graduated from the Hydrodynamics Dept. of Leningrad State University. From 1977 to 1981 he passed postgraduate studies at the Mathematics and Mechanics Faculty. In 1986 he received scientific degree of Candidate in Maths & Physics after presenting the candidate theses in geophysics. In 1975 he entered in the Main Geophysical Observatory of USSR Hydrometeorological Service in Leningrad as a junior scientist. Since 1990 he took position of senior research scientist in Main Geophysical Observatory. Since 1975 A.A. Kiselev has published about 30 papers individually and with coauthors. He is a contributor to the Intergovernmental Panel on Climate Change Reports of 1990 and 1999. The original papers are dealing with modeling of photochemical processes in the atmosphere, of global atmospheric composition change due to natural and anthropogenic causes.