

Chemistry of Ozone Shield Destruction*

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Abstract

A layer of ozone in the atmosphere, called the ozone shield, protects the earth ultraviolet rays. Over the years the ozone shield has been destroyed, and a hole has appeared that allows UVB rays to harm living organisms. The main 'ozone depleting substances', chlorofluorocarbon, is of anthropogenic origin.

The chemistry involved is unusual – occurs only if a polar vortex and polar stratospheric clouds (PSC) are present. During the polar winter, when there is no sunlight, the cold temperatures in the 'vortex' lead to the formation of PSC. Heterogeneous reactions convert the reservoir forms of the ozone destroying chemical species, chlorine and bromine, to their more active molecular forms on the surface of the PSC. The main long-lived inorganic carriers of chlorine are hydrochloric acid, HCl (aq) and chlorine nitrate, ClONO₂ (aq). When the sunlight returns to the polar region in the Southern Hemisphere spring (Northern Hemisphere autumn), the Cl₂ and Br₂ are rapidly split into Cl and Br atoms, and initiate the catalytic ozone destruction cycles, which result in rapid ozone loss. Br is 40 times more effective than Cl.

Keywords: *Ozone, ozone shield, ozone hole, ozone destruction cycles, ozone depleting substances (ODS), chlorofluorocarbon (CFC), polar stratospheric clouds (PSC), polar vortex, heterogeneous reactions, chlorine nitrate.*

Introduction

The ozone shield is a layer of ozone gas in the stratosphere – the upper atmosphere some 10km above the earth. It prevents harmful UV or ultraviolet rays from reaching the earth's surface.

The ozone molecule is made up of three oxygen atoms and has the chemical formula O₃. There are two important properties of ozone, which have a direct impact on the environment. Firstly, ozone is a strong oxidant and is capable of destroying organic tissues.

This occurs in the troposphere and is harmful. Secondly, ozone absorbs UV light. It therefore screens out UV radiation and prevents UV from reaching the earth. This occurs in the stratosphere and is beneficial.

For nearly a billion years, ozone molecules in the atmosphere have safeguarded life on this planet. But over the past half-century, humans have placed the ozone layer in jeopardy. The first observation of the ozone hole was in 1985, when a team of British atmospheric scientists discovered a gaping 'hole' in the layer over Antarctica (Fig. 1). The ozone level there was 50% less than normal (Newman 2000).

The largest ozone hole ever recorded, an area approximately three times the size of the United States, a 11.5 million square-mile hole – actually a severe thinning of earth's protective ozone layer (Kywe 2001), was announced on 4 October 2000 by scientists at NASA's Goddard Space Flight Center.

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