



## ENVIRONMENT AND OZONE LAYER REDUCTION

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### ABSTRACT:

*Ozone, or O<sub>3</sub>, a stratospheric layer, plays a major role in human survival. It acts as a shield, absorbing most of the sun's UV radiation. It is approximately 15–35 kilometres above Earth's surface. There are regional and seasonal differences in the thickness of the ozone layer. It is necessary for a number of planetary, biological, and environmental events. There are many different situations where what people do have a significant effect on the environment. Ozone layer damage is one of these. Examining the causes, mechanisms, biological impacts, and mitigation strategies for the ozone layer's depletion is the aim of this essay. Chlorofluorocarbons and halons are potent ozone depleters. The ozone layer's predicted depletion is a major source of concern for both the environment and human health due to the expected increase in UV radiation received at the earth's surface. The prospects for ozone recovery are yet unknown. As part of a review study, data regarding the effects of ozone depletion on humans was analysed and compiled from a variety of sources, including e-books, yearly and environmental reports from respectable organizations, and several articles published in international journals.*

**Keywords:** UV radiation, chloro-floro carbon, atomic oxygen, ozone.

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### [1] INTRODUCTION

The ozone layer was discovered in 1913 by French physicists Charles Fabry and Henri Buisson. The ozone layer (O<sub>3</sub>) has a large concentration of ozone. Between 93% and 999% of the sun's high frequency ultraviolet light, which poses a threat to life on Earth, is absorbed by this layer. This region contains about 91% of the ozone present in the Earth's atmosphere[1]. If ozone were absent, the Earth's surface would be thoroughly cleaned by the Sun's strong UV radiation. If this shield were to degrade, the skin's surface would be exposed to more UV-B and UV-A radiation, which would accelerate the development of skin cancer and possibly lower plant harvest yields. When it comes to plants and lung tissue, ozone is a hazardous pollutant that we breathe in and damages

them close to the surface. The ozone layer shields us from the sun's damaging, dazzling energy. The ozone layer absorbs these dangerous radiations, keeping them from penetrating the atmosphere. The sun emits extremely energetic electromagnetic waves called brilliant radiations, which can lead to a variety of natural issues like rising global temperatures as well as health issues affecting all living things. since these dangerous photons are shielded from us by the ozone layer. After conducting a thorough investigation into its properties, British meteorologist G. M. B. Dobson developed the Dobson metre, a simple spectrophotometer that allowed for ground-based stratospheric ozone monitoring. Ozone depletion is causing UV rays to reach the surface of the earth[2]. The exposure of all life creatures on Earth, including humans, to these radiations is having a negative impact. According to numerous studies, the main effects of these radiations on people include immune system suppression, skin cancer, and permanent or temporary blindness. No indication of the possibility of ozone recovery has been found thus far. Corrective action must be taken immediately to address the current ozone depletion crisis in order to protect human lives on our planet[1,2,3].

## **[2] OZONE**

After being exposed to UV radiation, ordinary oxygen molecules containing two oxygen atoms (O<sub>2</sub>) break into individual oxygen atoms (atomic oxygen), which combine with unbroken O<sub>2</sub> to form ozone, or O<sub>3</sub>, in the Earth's stratosphere. The ozone-oxygen cycle is the result of the unstable ozone molecule splitting into an oxygen atom and an oxygen molecule when exposed to UV light, despite the ozone molecule having a long half-life in the stratosphere[4]. Chemically speaking, this is described as:

Ozone has an intense smell and is colourless. Regular oxygen occurs significantly more commonly than ozone. Only three of the ten million molecules of air are ozone, and the remaining two million are ordinary oxygen[5].

## **[3] OZONE HOLE**

Depletion of the ozone layer causes an ozone hole. The term "Ozone hole" is used when the depletion level is less than 200 Dobson Units (D.U.). Ozone concentrations are from 300 to 350 D on average. UV In Antarctica, the first ozone holes are discovered in 1970. A few years ago, ozone holes were also discovered in the Arctic. Since 2000, the rate of ozone depletion has increased annually by 0.5 percent[5,6]. UV rays are entering the troposphere as a result of ozone depletion, which leads to the development of additional ozone, which is toxic to human health.

## **[4] OZONE LAYER DEPLETION OVER INDIA**

The rapid ozone depletion that is happening in many parts of the planet is cause for concern. Indian experts are keeping a close eye on any possible trends in the country's ozone layer loss. There are a variety of perspectives. S K Srivastava, head of the National Ozone Institute in New Delhi, says there is no trend that points to total ozone depletion in India. V. Thaphyal and S. M. Kulshresta of the Indian Meteorological Department also point out that from 1956 to 1986, "ozone observations demonstrate year-to-year fluctuation, but do not reveal any growing or declining trend across India". Remaining complacent is not an

option, warns M Chatterji, a former director of the National Ozone Centre who is currently employed by Development Alternatives. The rapid ozone depletion that is happening in many parts of the planet is cause for concern. Indian scientists are closely monitoring the o In October, when the Antarctic ozone hole is at its worst, he asserts that between 1980 and 1983, his estimates demonstrate an ozone depletion trend between New Delhi and Pune. India is about to face far more severe effects from ozone layer depletion, in addition to the high levels of ultraviolet (UV-B) radiation it currently faces. Even over the tropics, at higher altitudes of 30 to 40 km, there is some sign of ozone depletion, according to A P Mitra, a former director general of the Council of Scientific and Industrial Research, even though there is no trend in the overall ozone value. Using Dobson spectrophotometers, a network of stations covering Srinagar, New Delhi, Varanasi, Ahmedabad, Pune, and Kodaikanal measures total ozone six times a day. In addition, balloons are often employed in the surveillance of ozone profiles. The summertime has the highest concentrations of ozone, while November and December have the lowest levels. Differences exist around the country. In Kodaikanal, total ozone levels range from 240 to 280 Dobson units (DU), in New Delhi, from 270 to 320 DU, and in Srinagar, from 290 to 360 DU. A Dobson unit is equivalent to 0.01 mm of compressed gas at a temperature of zero degrees Celsius and 760 rare mercury pressure. B N Srivastava of the National Physical Laboratory, who has researched incidence UV-radiation levels, states that noon summer UV-B radiation at 290 nanometres (nm) is equivalent to what was felt in Antarctica during the ozone hole era[5,6,7]. He warns that even a tiny reduction in ozone could result in considerable percentage variations in UV-B radiation throughout India. They stated controlled trials are being conducted to look at how crops respond to changing UV-B radiation concentrations. Unfortunately, there haven't yet been any field studies conducted in the nation.

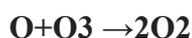
### **OZONE LAYER DEPLETION OVER ARTIC REGIONS**

The stratospheric ozone layer above the Arctic thins in the spring, creating the Arctic ozone hole. The Arctic has a generally milder climate than the Antarctic. The massive extent of the Antarctic ozone hole is mostly caused by strong winds and extremely low temperatures. When the amount of ozone in the Arctic stratosphere dropped to dangerously low levels in 2011, scientists discovered an ozone hole for the first time. This has to do with the Arctic vortex, which was brought on by the region's circling winds and consistently frigid temperatures. In 1985, British scientists found that the stratosphere over the Antarctic had unusually low quantities of ozone. The largest ozone holes ever measured in Antarctica were observed in 2000 and 2006, spanning over three and a half times the area of Australia at approximately 29.8 and 29.6 million square kilometres, respectively[8]. They sporadically covered populated areas of South America's Chile.

The Antarctic ozone hole is a springtime thinning or loss of ozone over the continent. This damage is caused in part by the distinct weather conditions over the Antarctic as well as the presence of bromine and chlorine in the stratosphere from ozone-depleting substances. The Antarctic is constantly colder than the rest of the planet and has powerful winds. When warmer temperatures disrupt the polar vortex's chemical interactions in late November, the Antarctic ozone hole vanishes, appearing in August[8,9].

## [5] OZONE CONVERSION CYCLE

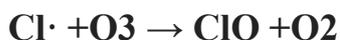
Three distinct types of oxygen are used in this process: ozone gas (O<sub>3</sub>), oxygen gas (O<sub>2</sub>), and oxygen (O). One O<sub>2</sub> is therefore divided into two atomic oxygen radicals. When the atomic oxygen radicals contact with two distinct O<sub>3</sub> molecules, two O<sub>2</sub> molecules are created. When UVB light strikes these ozone molecules, it breaks down into oxygen atoms and O<sub>2</sub> molecules. Subsequently, the oxygen atom joins forces with another oxygen molecule to form new ozone. The process ends when an oxygen atom reunites with an ozone molecule to generate two O<sub>2</sub> molecules. Notably, the only gas in the atmosphere with the ability to absorb UVB rays is ozone.



The total amount of ozone present in the stratosphere is determined by the equilibrium between photochemical generation and recombination. The bulk of OH and NO in the stratosphere today originate from natural sources, while the concentrations of chlorine and bromine have increased dramatically due to human activities[10]. These originate from both natural and artificial sources. These elements are found in stable organic compounds, especially chlorofluorocarbons, which are able to enter the stratosphere unharmed due to their low reactivity. The parent molecules' Cl and Br atoms are freed by atomic oxygen radicals in the stratosphere. To create the atomic combine action of UV light, for example, radicals must first split O<sub>3</sub> molecules apart[10,11].



The extremely reactive molecule ozone can be swiftly converted to the more stable form of oxygen with the aid of a catalyst. Cl and Br atoms break down ozone molecules in a variety of catalytic cycles. When a chlorine atom interacts with an ozone molecule (O<sub>3</sub>), it removes an oxygen atom to form chlorine monoxide (ClO) and leaves an oxygen molecule behind (O<sub>2</sub>). This is the most basic example of such a cycle. When the ClO combines with another ozone molecule, the chlorine atom can be liberated and two oxygen molecules are created. The chemical shorthand for these gas-phase reactions is as follows:



To create a ClO molecule, a chlorine atom takes an oxygen atom out of an ozone molecule.



The chlorine is free to continue this two-step cycle and can also take an oxygen atom from another ozone molecule. Although the impacts of null cycles might slow down these processes, the overall result is a reduction in the quantity of ozone. Moreover, more intricate processes for ozone depletion in the lower stratosphere have been found[12,13].

## [6] CAUSES OF OZONE LAYER DEPLETION

### Chlorofluorocarbons (CFCs)

Also known as Freon, CFCs are a non-flammable, non-toxic, and non-carcinogenic chemical. They contain atoms of fluorine, carbon, and chlorine. The five main chloropentafluoroethanes (CFCs) are dichloro-difluoromethane (CF<sub>2</sub>Cl<sub>2</sub>), dichloro-trichlorofluoromethane (CFC<sub>13</sub>), dichloro-trifluoroethane (C<sub>2</sub>F<sub>3</sub>Cl<sub>3</sub>), dichloro-tetrafluoromethanes (C<sub>2</sub>F<sub>4</sub>Cl<sub>2</sub>), and CFC-115. CFCs are widely used as propellants in aerosols, blowing agents in the production of foam (for use in products like fire extinguishers), solvents in cleansers, especially those for electronic circuit boards, and coolants in air conditioners and refrigerators. In actuality, the second half of the 20th century's modern lifestyle was greatly influenced by the use of CFCs. Nevertheless, man-made CFCs are the main cause of the loss of stratospheric ozone[14,15]. Ozone molecules are irreversibly destroyed by even one free chlorine atom from a CFC molecule because CFCs are only present in the atmosphere for 20 to 100 years. The industrialized world has significantly reduced its CFC emissions thanks to international control agreements, but the ozone layer depletion in the stratosphere will continue well into the twenty-first century.

### **Uncontrolled Rocket Launches**

Another significant cause of the general ozone exhaustion is rocket deployments. Research indicates that uncontrolled rocket launches contribute far more to ozone depletion than CFCs. By 2050, rocket launches are predicted to cause more ozone loss annually than CFCs did if they continue unchecked.

### **Global Warming**

Ozone layer depletion is another effect of global warming. Because of the greenhouse effect and an increase in Earth's average temperature; most of the warmth is trapped in the troposphere, which is the layer underneath the stratosphere. Since ozone is only found in the stratosphere, which keeps the troposphere cold and inhibits photosynthesis, the ozone layer can only regenerate in the stratosphere, where it receives the strongest sunlight and warmth[16,17].

### **Nitrogenous Compound**

Nitrogenous compounds like NO, N<sub>2</sub>O, and NO<sub>2</sub> that are released in small amounts by human activity are thought to have a significant role in the ozone layer's depletion

## **[7] EFFECTS OF OZONE LAYER DEPLETION**

### **On Human Health**

Ozone depletion has a detrimental effect on both human health and the ecosystem because it allows UV rays to reach Earth[18]. Individuals who are subjected to these radiations may experience genetic defects, leukaemia, breast cancer, melanoma, vision impairment, and other catastrophic disorders. Globally, cataracts are the leading cause of blindness[19,20]. The risk of cataract would increase by 0.3% to 0.6% if there was a 1% decrease in ozone levels. It is possible for oxidative substances to damage eye lenses. Because UV radiation produces oxidative oxygen, it also seriously destroys the eye's lens and cornea[21,22].

### **On Terrestrial Plants**

UV light affects the physiological and developmental processes of plants[23,24]. It would seem reasonable to assume that a decrease in the ozone layer and an increase in UVB radiation would cause more DNA damage to plants. When plants were exposed to UVB radiation, which is similar to stratospheric ozone depletion, there was a slight decrease in shoot biomass and leaf area but no appreciable change in plant height or leaf mass. However, it has been shown that the photosystem II quantum yield is lowered by UVB light. The majority of plants have UVB-absorbing flavonoids that aid in their ability to adapt to the radiation, and only excessive exposure to UVB causes injury. Plants are exposed to different amounts of UV radiation during the day. It is commonly recognized that they possess the ability to alter the kinds and amounts of flavonoids, which are UV sunscreens, throughout the day. As a result, they are more equipped to protect themselves from UV radiation[25,26]. For plants exposed to radiation throughout their growth, the incapacity to catch light through a larger leaf area is more harmful than photosynthetic system degradation. The biogeochemical cycles, herbivory, plant diseases, and plant aggressive parity may all be significantly impacted by these advances.

### **On Aquatic Ecosystem**

It is believed that increased UV exposure levels may have a detrimental effect on the output of aquatic systems, given that the ocean alone provides more than 30% of the animal protein that humans eat globally. The foundation of aquatic food webs, phytoplankton dispersion, may be impacted by high exposure in the tropics and subtropics. Rising UV-B levels were shown to be the cause of a 6–12% drop in phytoplankton productivity in the marginal ice zone, according to results from a recent study. UV-B radiation can also injure fish, prawns, crabs, amphibians, and other early animal life stages; the most damaging effects include poor larval development and decreased reproductive potential [25,26,27].

### **On Biogeochemical Cycle**

By affecting terrestrial and marine biogeochemical cycles, increases in UVB radiation may alter the sources and sinks of emergent and synthetically essential follow gases (e.g., carbon dioxide, carbon monoxide, carbonyl sulphide, ozone, and perhaps different gases). Additional effects of increased UV-B radiation include changes in the production and decomposition of plant matter, a decrease in primary production, changes in the uptake and release of significant atmospheric gases, a decrease in bacterioplankton growth in the Upper Ocean, changes in the degradation of aquatic dissolved organic matter (DOM), etc. If there is an impact on the marine sulphur cycle, there could be differences in the sea-to-air emissions of dimethyl sulphide (DMS) and carbon monoxide (COS)[15,16]. These gases are transformed into sulphate aerosols in the troposphere and stratosphere, respectively.

### **On Air Quality**

Concerning Air Quality Greater photodissociation rates of significant trace gases, which control the chemical reactivity of the troposphere, are caused by increased penetration of UV-B radiation and decreased stratospheric ozone. As a result, ozone and related

oxidants—like hydrogen peroxide, which is known to have detrimental effects on human health, terrestrial plants, and materials exposed to the elements—may become more abundant and more destructive. Changes in the atmospheric concentrations of hydroxyl radicals (OH) may have an impact on the climate[28].

## **[7] CONCLUSION**

The ozone layer is being threatened, and the world needs to act to protect it as quickly as possible. Scientists fear that if global warming doesn't stop, there will be protracted ozone depletion and destruction. Ozone depletion gets worse when the stratosphere, which contains the ozone layer, gets colder. Global warming will cause less heat to enter the stratosphere, resulting in a cooler stratosphere. Greenhouse gasses cover the troposphere and cool the stratosphere. Chlorofluorocarbons are the principal cause of ozone depletion. These substances ought to be outlawed or replaced in order to shield future generations from the harmful effects of UV radiation.

The United Nations General Assembly created the International Day for the Protection of the Ozone Layer, also referred to as "World Ozone Day," in 1994. The name commemorates the signing of the Montreal Protocol in 1987.

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