Ozone Layer Depletion

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Mamata Tiwari
Associate Professor,
Dept. of Chemistry,
R.R. College,
Alwar, Rajasthan, India

Abstract

Ozone depletion, a gradual depletion of the Earth's ozone layer in the atmosphere caused by the release of chemicals containing gaseous chlorine or bromine in industry and other human activities. The decline is most noticeable in cold climates, especially in Antarctica. Ozone depletion is a major environmental problem because it increases the amount of ultraviolet (UV) radiation reaching the earth's surface, which in turn increases the risk of skin cancer, eye cataract, and genetic and immune damage. The Montreal Protocol, ratified in 1987, was the first in a series of international agreements to stop the production and use of ozone-depleting chemicals. As a result of the ongoing international cooperation on this issue, the ozone layer is expected to return in time.

Keywords: Atmosphere, Bromine, Cataract, Chlorine, Depletion, Environmental.

Introduction

The most severe and astonishing ozone depletion was discovered to occur during the spring in Antarctica. Loss in this area is often called the "ozone depletion" because ozone depletion is very high and is localized. In response to the hope of declining ozone depletion, world governments have cited the 1987 United Nations Montreal Protocol as a global solution to the global problem. As a result of the development of potential “ozone-friendly” environments for the now controlled Ozone Depleting Substances (ODS), such as chloro-fluoro-carbons or CFCs used to create a. in many refrigeration and air conditioning systems, the overall global collection of ODS has decreased and started to decline and the first signs of ozone depletion have been discovered. The production and use of all major ODS in developed and developing countries have already been significantly reduced and will be completely shut down before the middle of the 21st century.

Those greenhouse gases, such as halon-1301 and HCFCs, will begin to decline in the coming decades if compliance with the Protocol continues. However, it was not until a century later that ODS active volumes were expected to drop to pre-Antarctic ozone levels in the early 1980's.

According to UNEP progress report (2015) 1, by 2013 the implementation of the Montreal Protocol had already achieved significant benefits with the ozone layer and, as a result, more UV-B radiation. Examination of the models showed that, without the Montreal agreement, the deep Arctic “ozone hole” could have existed in 2011 given the weather conditions of that year. The depletion of stratospheric ozone depletion in the mid-Northern Hemisphere would continue, more than doubling to about 15% in 2013 in relation to the onset of ozone depletion. In addition, Antarctic ozone depletion would be 40% larger by 2013 compared to what was expected, with improved ozone depletion and in the lower polar regions of the Southern Hemisphere.

Aim of the Study

The main focus of this research paper is to make understand the basics of Ozone layer depletion and what can be done to mitigate its effect.

What is stratospheric ozone and how is it formed

Ozone is made up of three composite atoms of oxygen formed in the upper part of the earth's atmosphere in small amounts when they form a layer. This layer is essential for human well-being and the health of the system as it absorbs most of the sun's harmful ultraviolet radiation. This region, called the stratosphere, is more than 10 miles (6 miles) above the earth's surface. There, about 90% of the ozone layer in the atmosphere is contained in the “ozone layer,” which shields us from the harmful effects of ultraviolet radiation from the Sun. In the mid-1970's, it was discovered that some man-made chemicals could lead to the depletion of the ozone layer.

In contrast, ozone depleting the earth's surface is considered “bad” because it is harmful to humans, plants, and animals, but naturally produced near-surface and low-lying ozone plays a key role in the chemical removal of pollutants from the atmosphere.

Global ozone depletion varies from place to place in timescales ranging from day to day. The level of ozone is generally low in the equator where it is produced and is highest in the region at high altitudes. The variance is due to the massive movement of stratospheric air as well as the chemical production and destruction of ozone. An important factor in seasonal ozone changes is the chemical degradation that occurs when sunlight persists in the summer polar stratosphere, causing total ozone depletion to its lowest autumn levels.

How is stratospheric ozone depleted?

The first step in depleting the ozone layer caused by human activities is the extraction of, on the surface of the earth, certain organic gases containing chlorine and bromine such as CFCs that are used in part because of their low toxicity and carbon tetrachloride (CC_{14}) and methyl chloroform (CH_3CC_{13}) and halons, which were used as fire extinguishers. Halogen gases are compared in their ability to destroy stratospheric ozone using their Ozone Depletion Potential (ODP) which is rated CFC-11, with an ODP defined as 1. Gas with a larger ODP kills more ozone over the course of space life. The lifespan of the main moving objects varies from 1 to 100 years. Because they are ineffective and do not melt easily when it rains or snows, these gases accumulate in the atmosphere below. Natural air transports these accumulated gases into the stratosphere, where they are converted into active molecules by ultraviolet radiation from the sun. Some of these molecules, such as chlorine radicals and chlorine monoxide (C_{10}), play a role in the ozone-depleting response in cyclic cycles formed by two or more different reactions. As a result, a single chlorine or bromine atom can destroy thousands of ozone molecules before they leave the stratosphere and return to the earth's surface where these active chlorine and bromine gases are removed from the earth's atmosphere by rain and ice.

The severe depletion of the Antarctic ozone layer known as the “ozone layer” is due to special climatic and chemical conditions in which the extremely low winter temperatures in the Antarctic stratosphere cause polar stratospheric clouds (PSCs) to form stratospheric winds. in the polar vortex and blocking the "new ozone" from the tropics to temporarily deplete the depleted ozone, thus producing the Antarctic ozone depletion. The depletion of the earth's ozone layer increased somewhat in the 1980's and reached nearly 5% in the early 1990's. The decline has declined since then and is now about 3% of the global average.

Significant depletion of the Arctic ozone layer also occurs over the years in late winter / early spring (January-March). However, the high tide is much smaller than what has been observed in the Antarctic and has a significant annual difference due to the changing climatic conditions found in the Arctic polar stratosphere.

Eventually other factors such as changes in the sun's rays, as well as the formation of stratospheric particles after a volcanic eruption, also affect and can affect the ozone layer.

What is the link between the ozone layer depletion and climate change?

Ozone depletion itself is not a major cause of global climate change. Changes in ozone and climate are directly linked to the ozone layer, which in turn absorbs most of the sun's rays. Stratospheric ozone depletion leads to global warming, while observed tropospheric ozone depletion and global warming lead to global warming. Ozone depletion has helped keep East Antarctica cold, but on the other hand it has helped to make the Maritime Antarctic region one of the warmest regions in the world. In contrast to the warming of the oceans, there is significant cooling in the North Atlantic between Greenland and Ireland. This is due to the weakening of the Gulf Stream which heats the North Atlantic, the coast of East America, and Northern Europe.

UV radiation has the potential to contribute to climate change by promoting the release of carbon monoxide, carbon dioxide, methane, and other biological variants from plants, plant waste and the earth's crust but their size, levels and local patterns remain very uncertain at the moment. These UV radiation processes can also increase the emission of trace gases that affect the radiation budget (forcing radiative radiation) which is why it changes the climate. Changes in rainfall patterns are related to environmental changes such as tree growth in Eastern New Zealand and agricultural expansion in southeastern South America. On the other hand, in Patagonia and East Antarctica, declining tree growth and moss have been linked to reduced water availability. A full understanding of the effects of ozone depletion on the earth's environment in these regions should be considered from UV rays and climate change.

UV radiation drives the production of large amounts of carbon dioxide from Arctic waters. Production is enhanced by changes in rainfall patterns, melting glaciers, ice and permafrost, resulting in many of the world's ecosystems being diverted to the Arctic, lakes, and coastal seas. UV rays degrade this organism, which in turn stimulates the release of CO_2 and CO into water bodies, both directly and indirectly by the decomposition of bacterial decay. New results show that up to 40% of the emissions of CO_2 from the Arctic could come from this source, much larger than previous figures. When photochemical priming plays a key role, changes in continental runoff and melting ice, due to climate change, may lead to UV degradation and microbial degradation of soluble organisms and the release of carbon dioxide (CO_2). Such a positive reduction is very significant in the Arctic leading to Arctic expansion of CO_2 emissions.

Other climate changes associated with depletion of the ozone layer include changes in wind patterns, temperatures, and rainfall across the Southern Hemisphere. Extreme winds lead to higher carbon-driven air currents and lower carbon dioxide emissions by the South Ocean, reducing sea power to act as a carbon sink (low carbon emissions). These winds also transport large amounts of dust from arid regions of South America to the sea and to the Antarctic. In the oceans this can improve the iron fertilization that has led to more plankton and increased krill numbers. On the mainland dust can contain particles of novels that increase the risk of invasion of non-native species and this transport from arid regions, such as South America, to the sea, can improve iron fertilization and lead to more plankton and greater carbon dioxide absorption.

Antarctic Ozone Hole

The worst case of ozone depletion was first reported in 1985 in a paper by British Antarctic Survey (BAS) scientists Joseph C. Farman, Brian G. Gardiner, and Jonathan D. Shanklin. Since the late 1970's, a dramatic and rapid depletion of total ozone depletion, often more than 60 percent compared with the global average, has been observed in the spring (September to November) above Antarctica. Farman and his colleagues began documenting the practice on their BAS channel in Halley Bay, Antarctica. Their analysis attracted the attention of the scientific community, which found that this depletion of the total ozone layer was more than 50 percent compared to the historical figures observed by both ground-based and satellite processes. Thanks to Farman's paper, a number of ideas were developed that tried to explain the Antarctic “ozone layer.” It was initially suggested that ozone depletion may be explained by the chlorine catalytic cycle, in which the chlorine atoms alone and their chemicals decompose single-oxygen atoms into ozone molecules. As more ozone depletion than could be explained by the supply of active chlorine that works in cold climates by processes known at the time, other theories emerged. A special measurement campaign conducted by the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) in 1987, along with recent estimates, proved that chlorine and bromine chemistry were actually responsible for ozone depletion, but one reason: the hole appears to be the product of chemical reactions that occur in particles that form polar stratospheric clouds (PSCs) in the lower stratosphere.

During the winter the Antarctic winds are very cold due to the lack of sunlight and the reduced mixing of low stratospheric winds in Antarctica and the out-of-state air. This reduced interaction is caused by a circumpolar vortex, also called a polar winter vortex. Surrounded by a stratospheric jet of air around 50 ° and 65 ° S, the wind over Antarctica and its nearby seas is well separated from the air outside the region. Extremely cold temperatures inside the vortex lead to the formation of PSCs, which occur at altitudes of approximately 12 to 22 kilometers (approximately 7 to 14 miles). The chemical reactions that occur in PSC particles convert small chlorine-containing molecules into more active forms such as molecular chlorine (Cl_2) that accumulate during the polar night. (Bromine compounds and nitrogen oxides can also react with these cloud particles.) When the sun returns to Antarctica in early spring, sunlight penetrates the cellular chlorine into chlorine atoms that can withstand ozone depletion. Ozone depletion continues until the polar vortex splits, which usually occurs in November. The dominant winter vortex also forms in the Northern Hemisphere. Generally, however, they are not as hard and cold as those of the Antarctic. Although polar stratospheric clouds can form in the Arctic, they do not usually last long enough to be depleted of ozone. Arctic ozone deplets by 40 percent. This decline occurs during the years when low temperatures in the Arctic vortex are low enough to lead to ozone-depleting processes similar to those found in the Antarctic ozone layer. As in Antarctica, a significant increase in concentration of active chlorine has been measured in Arctic regions where high levels of ozone depletion are occurring.

What are the impacts of ozone layer depletion and UV-B increases on terrestrial ecosystems

Various abiotic and biotic factors affect plants exposed to UV-B radiation in ways that can have both positive and negative effects on plant production and ecosystem function in complex and complex interference. Crop production may decrease slightly due to increased UV radiation while exposure to UV-B radiation can promote plant resilience, and improve plant resistance to herbicides and pesticides, improve quality, and increase or decrease yields for agricultural and agricultural products.

While UV-B radiation does not penetrate the soil at any significant depth, it can affect many underground processes by altering the surface of vegetation, micro-organisms and plant debris. These include altering the interactions between plant roots, bacteria, soil organisms and neighboring plants, with potential impacts on soil fertility, carbon retention, plant production and species formation. UV-B radiation can also affect the photodecomposition levels of a dead plant and is now considered an important driver of decay, although uncertainty exists in measuring its value. UV radiation is known to aid in the decomposition of pesticides and in some cases can increase the toxicity of certain pesticides and / or their degradation products.

What are the impacts of ozone layer depletion on aquatic ecosystems?

The formation of species and the distribution of many marine ecosystems may be strongly influenced by warm oceans due to the recurrence between heat, UV rays and the concentration of greenhouse gases.

High air temperatures raise the water temperature of many lakes and oceans, while many large lakes are twice as warm as the air temperature in some regions. Warming of the oceans results in a stronger rigidity that lowers the depth of the mixed layer at the top and reduces the higher transport of nutrients to the thermocline from deeper layers.

The decrease in the depth of the surface layer exposes the organisms in it to a large number of visible sunlight and UV rays that can defeat their protective and repair power by producing UV-absorbing chemicals. On the other hand, the increase caused by climate change in the concentration of dissolved organisms in land and coastal waters reduces the depth of UV radiation.

Increased concentrations of atmospheric CO2 continue to create oceanic acidification, which also alters marine chemical properties and disrupts the calculation process in which substances such as phytoplankton, macroalgae and many other species including molluscs, zooplankton and corals, produce sunscreens of UV.

Phytoplankton (basic feed producers) is declining on the western side of the Antarctic Peninsula due to increased UV-B radiation and rapid climate change. For some as corals, warming can alter their tolerance to other pressures. This warming can also remove organic heat from the pole and cause changes in the public structure. Changes in ice phenology and the availability of light and nutrients can affect the formation of species.

Reduced UV radiation also reduces the natural disinfection of surface water containing bacteria, germs, and parasites. In contrast to UV-disinfection of excess water, exposure to high levels of UV radiation can suppress or suppress participating antibodies, making them more susceptible to infection. Finally, microplastics debris generated at sea by UV rays from the beaches of plastic waste beach beaches is also a growing environmental problem. These microplastic particles concentrate on toxic chemicals dissolved in seawater and are absorbed by zooplankton, thus providing a possible way to transmit contaminants into the seafood web.

Is ozone layer depletion affecting air quality?

UV rays are known to be a sensitive driver of photochemical smog formation, e.g. ozone and aerosols. UV rays can also play a role in the destruction of aerosol particles. Ozone depletion of the low-lying ozone layer is likely to increase dramatically in large parts of the world due to the combination of ozone stratospheric ozone depletion and climate change for decades to come. UV radiation is an important driver of photochemical smog formation, consisting mainly of earth-level ozone and particle matter. Excessive exposure to these pollutants has been linked to an increased risk of cardiovascular disease in humans and has been linked worldwide to several million premature deaths each year. Tropospheric ozone (low levels) can alter biodiversity and affect the function of natural organisms and also have adverse effects on plant products. Future changes in UV radiation and climate change and massive emissions will alter global ozone levels and the issue and should be considered in predicting air quality and human and environmental health outcomes.

Hydroxyl (OH) radicals, which are responsible for UV radiation, are also affected by UV radiation changes. However, on global scales, the models differed in their predictions of uncertainty that would result.

No new adverse environmental effects of ozone depletion or degradation products have been found even if some of the other ozone-depleting agents continue to contribute, albeit much less than previous ozone depletion such as CFC, on global climate change if the focus is on rises above current levels.

Has the increase of UV-radiation an impact on materials resistance

UV rays and climate change affect the outdoor use of PVC building materials, the most widely used plastics in construction and polypropylene containing recycled plastic with changes in morphology in bulk which also cause shrinkage. Nanoscale inorganic fillers can provide high stability when combating UV rays with respect to the usual filling of coverings especially those in plain wood or fabric coverings and fabric coverings. The benefits of nanofiller on most plastics, but require more details to test their effectiveness.

In the case of wood, graphene, zirconium dioxide, iron oxide, titanium, and cerium oxide can control UV-yellow emissions in several types of wood. Similarly, the conversion of wood to wood with nanocellulose and poxidised soybean oil also leads to better UV resistance. The effectiveness of certain fabrics depends on the symptoms of weaving but can be further enhanced by treating the fibers with a UV absorber. Fabric covers prevent exposure to UV rays, and glass is particularly sensitive to UV-B rays. The glare of the windows is enhanced to further enhance their thermal properties and to result in increased filtering of UV rays for the health benefits of people and in-house architecture and art. In jack-cables with new aluminum-based retardants, the initial degradation of UV radiation reveals a rich surface layer that fills the base polymer with further degradation.

Ozone Layer Recovery

Acceptance of the risks posed by chlorine and bromine in the ozone layer highlighted an international effort to curb the production and use of CFCs and other halocarbons. The 1987 Montreal Convention on Ozone Discrimination initiated the abolition of CFCs in 1993 and sought to achieve a 50 percent reduction in global consumption from the levels in 1986 in 1998. Strengthen the control of CFCs and other halocarbons. In 2005 the use of contracted ozone-depleting chemicals decreased by 90-95 percent in the countries that were part of the agreement.

In the early 2000s, scientists expected that stratospheric ozone levels would continue to rise steadily in the following decades. Indeed, some scientists have argued that as chlorine and bromine levels in the atmosphere decline in the stratosphere, severe ozone depletion will pass. Writing about the variability in air temperature (contributing to the size of the ozone layer), scientists expect that further depletion of chlorine loads will lead to smaller ozone deplets above Antarctica (since 1992 cut more than 8 million square miles [8 million sq km]) after 2040. The expected increase in ozone will be slow, especially because of the prolonged stay of CFCs and other halocarbons in the atmosphere. The total amount of ozone levels, as well as the distribution of ozone in the troposphere and stratosphere, will also depend on other changes in the atmosphere - for example, changes in carbon dioxide levels (affecting temperatures in both the troposphere and stratosphere), methane (which affects the levels of active hydrogen oxides in the troposphere and the stratosphere that can react with ozone), and nitrous oxide (which affects the levels of nitrogen oxides in the stratosphere that can react with ozone).

Scientists in 2014 saw a slight increase in cold ozone - for the first time, they thought, in more than 20 years - that they were doing so in line with international agreements on ozone depletion and high mountain cooling due to increased carbon dioxide emissions. On closer inspection, however, scientists in 2016 announced that the concentration of stratospheric ozone was actually increasing in the upper stratosphere since 2000 when the size of the Antarctic ozone hole decreased. Overall the concentration of ozone away from the poles continues to fall since 1998; However, a 2018 study shows that the decrease in ozone depletion in the lower stratosphere compared with gains made in the upper stratosphere between 60 ° N and 60 ° S. Another sign of ozone recovery occurred in September 2019, when scientists recording the smallest ozone depletion since 1982 (about 16.3 million square miles [6.3 billion square miles] at the highest point) above Antarctica. Since ozone is a greenhouse gas, the depletion and expected recovery of the ozone layer are affecting the earth's climate. Scientific analysis shows that the depletion of fossil ozone depletion since the 1970s has produced a cooling effect - or, more accurately, to counteract a small fraction of the heat that has led to an increase in the concentration of carbon dioxide and other greenhouse gases during this period. As the ozone layer slowly recovers in the coming decades, this cooling effect is expected to decrease.

Conclusion

Ozone layer depletion is a serious threat to humanity as well as to the whole environmental system. The ozone layer protects us from harmful UVB radiation which can cause cancer and several other serious health conditions. It can also adversely affect the growth of plants and thus also crop yields.

Although there are some natural causes for ozone depletion like sunspots or volcanic eruptions, the main part of the issue is made from human behavior.

Thus, in order to mitigate the ozone depletion issue, we have to make sure that both private persons as well as industries contribute their part.

This could be either done by regulations or also by increasing the financial pressure for substances that are harmful to the ozone layer. By applying several measures, we will be able to sustain the ozone layer and therefore to ensure a livable future for the next generations.

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