Depletion of stratospheric ozone layer is an example of both the complicated and global nature of contemporary environmental problems. Since the ozone layer prevents most harmful Ultra Violet B (UVB) Wavelengths (270-815nm) of ultraviolet light from passing through the Earth's atmosphere, observed and projected decreases in the ozone have generated worldwide concern leading to adoption of the various measures both at national and international level to contain the further depletion and to undo the damage already occurred which culminated in the adoption of Montreal Protocol which is being projected as an ideal model worth emulating in dealing with other serious environmental problems.

Before a closer look over the regime development in special reference to Montreal protocol and other preceding measured taken to deal with the issue of ozone depletion and their assessment should be done a brief yet concrete view of the problem and its consequences seems necessary.

### Ozone Layer and Its Significance

Ozone is naturally occurring gas found throughout the atmosphere, with a maximum mixing ratio at altitudes ranging from 15 to 30 Km above the earth. The region is frequently known as ozone layer. The layer is found in the stratospheric segment of the atmosphere. Besides this stratospheric concentration, ozone is also found in troposphere of the Earth.

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The presence of ozone layer in the stratosphere is of vital significance for all biota, because the harmful solar radiation, particularly UVB rays which are lethal to life on the earth are not allowed to enter the earth's atmosphere by this ozone umbrella. In the absence of this layer, all the ultraviolet rays of the sun will reach the earth's surface and consequently the temperatures of the lower atmosphere will rise to such an extent that the biological furnace of the biosphere will turn into blast furnace. Thus the ozone layer strongly absorbs or blocks the short wave ultraviolet rays and so protects the life on earth from several radiation damage.²

**Ozone Depletion : Meaning and Causes**

Ozone depletion describes two distinct but related observations- a slow and steady decline of about four percent in the total volume of the ozone in Earth's Stratosphere (the ozone layer) since the late 1970s and a much larger, but seasonal decrease in stratospheric ozone over Earth's polar regions during the same period. The latter phenomena's is commonly referred as ozone hole. In addition to this well known stratospheric ozone depletion, there are also troposphere ozone depletion events, which occur near the surface in polar regions during spring. The detailed mechanism by which the polar ozone holes form is different from that for the mid-latitude thinning, but the most important process in both trends is catalytic destruction of ozone by atomic chlorine and bromine.³

The discovery of Antarctic ozone hole by British Antarctic Survey Scientists (announced in paper 'Nature' in May 1985) came as a shock to the scientific community, because the observed decline in the polar ozone was far larger than anyone had anticipated. The Antarctic ozone hole is an area of the Antarctic stratosphere in which the recent ozone levels have dropped to as low 33% of their pre- 1975 values.

As mentioned above the most pronounced decrease in ozone has been in the lower

² Ibid.
stratosphere, however, the ozone hole is most usually measured not in terms of ozone concentrations at these levels (which are typically of a few parts per million) but by reduction in the total column ozone above a point on the Earth's surface, which is normally expressed in Dobson Units (DU).

**Causes:**

Ozone can be destroyed by a number of free radical catalysts, the most important of which are the hydroxyl radical (OH), the nitric oxide radical (NO), the atomic chlorine (Cl) and bromine (Br). All of these have both natural and man-made sources, at the present time, most of the OH, and NO in the atmosphere is of natural origin, but human activity has dramatically increased the levels of chlorine and bromine. These elements are found in certain stable organic compounds, especially Chlorofluorocarbons (CFCs), which may find their way to the stratosphere without being destroyed in the troposphere due to their low reactivity. Once in the stratosphere, the Cl and Br atoms are liberated from the parent compounds by the action of ultraviolet light e.g.

\[
CFCl_3 + hr \rightarrow CFCl_2 + Cl
\]

(Here 'h' is Planck's constant; 'r' is frequency of electromagnetic radiation)

The Cl and Br atoms may then destroy the ozone molecules through a variety of catalytic cycles. In the simplest example of such a cycle, a chlorine atom reacts with an ozone molecule, taking an oxygen atom with it (forming ClO) and leaving a normal oxygen molecule. The chlorine monoxide (i.e. the ClO) can react with a second molecule of ozone (O₃) to yields another chlorine atom and two molecules of oxygen.

\[
Cl + O_3 \rightarrow ClO + O_2
\]

\[
ClO + O_3 \rightarrow Cl + 2O_2
\]

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The overall effect is a decrease in the amount of ozone. More complicated mechanisms have been discovered that lead to ozone destruction in the lower stratosphere as well.

A single chlorine atom would keep on destroying ozone (thus a catalyst) for up to two years (the timescale for transport back down to the troposphere) were it not for reactions that remove them from this cycle by forming reservoir species such as hydrogen chloride (HCl) and chlorine nitrate (ClONO₂). On a per atom basis, bromine is even more efficient than chlorine at destroying ozone, but there is much less bromine in the atmosphere at present. As a result, both chlorine and bromine contribute significantly to the overall ozone depletion. Studies have shown that fluoride besides these elements causing to the depletion of ozone layer, few other factors too are responsible especially in case of polar (Antarctic) ozone depletion which is commonly known as 'ozone hole'. It is a hole which is a depression, not in the sense of 'a hole in the wind shield". G.M.B. Dobson⁵ mentioned that when springtime ozone levels, over Halley bay were first measured in 1956, he was surprise to find that they were ~320DU, about 150DU below spring level. These, however, were at this time the known normal climatological values because no other Antarctic ozone data were available. But further research on the issue confirmed that the fact of ozone hole being during the spring than in other season. The main factor responsible for this phenomenon is polar stratospheric clouds.

These Polar stratospheric clouds (PSC) form during winter, in the extreme cold. Polar winters are dark, consisting of three and iodine atoms participate in analogous catalytic cycles. However, in the Earth's stratosphere fluorine atoms react with water and methane to form strongly bound HF, while organic molecules which contain iodine react so rapidly in the lower atmosphere that they do not reach the stratosphere in significant quantities. Furthermore a single chlorine atom is able to react with 100,000 ozone molecules. This fact plus the amount of chlorine released into the atmosphere by chlorofluorocarbons (CFCs) yearly demonstrated how dangerous CFCs are to the environment⁶. It is calculated that a CFC molecule takes an average of fifteen (15) years

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⁶ Stratospheric Ozone depletion by chlorofluorocarbons (Nobel lecture)- Encyclopedia of Earth.
to go from the ground level up to the upper atmosphere, and it can stay there for about a century, destroying up to one hundred thousand ozone molecules during that time.\(^7\) The lack of sunlight contributes to a decrease in temperature and the polar vortex traps and chills air. Temperatures hover around or below -80\(^{\circ}\)C. These low temperatures form cloud particles that provide surface for chemical reactions that lead to ozone destruction.

The role of sunlight in ozone depletion is the reason why the Antarctic ozone depletion is greatest during spring. During winter, even though PSCs are at their most abundant, there is no light over the pole to drive the chemical reactions. During the spring, however the sun comes out, providing energy to drive photochemical reactions and melt the polar stratospheric clouds, releasing the trapped compounds. Warming temperatures near the end of spring break up the vortex around mid-December. As Warm, ozone-rich air flows in from lower latitudes, the PSCs are destroyed, the ozone depletion process shuts down, and the ozone hole closes.

**Effect and Consequences of Ozone Depletion**

As mentioned above, ozone, while a minority constituent in the Earth's atmosphere, is responsible for most of the absorption of UVB radiation. The amount of UVB radiation that penetrates through the ozone layer decrease exponentially with the slant path thickness/density of the layer. Correspondingly a decrease in atmospheric ozone is expected to give rise to significantly increased levels of UVB near the surface. Because it is this same UV radiation that creates ozone in the ozone layer from O\(_2\) (regular oxygen) in the first place, a reduction in stratospheric ozone would actually tend to increase photochemical production of ozone at lower levels (in the troposphere); All these changes brought into the atmospheric constitution may cause several ill-effects (though in few cases benefits too) which may broadly be discussed under three categories.\(^8\)

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\(^7\) Encyclopedia.com chlorofluorocarbons.

\(^8\) Sharma B.K., Environmental chemistry, Krishna Prakashan Media (P) Ltd., p.310
Effects on Human Beings

1. With the depletion in atmosphere ozone there is danger of the increase in the flux of ultraviolet radiation over earth's biosphere. All the known effect of these radiation are harmful for man's life.

2. UV radiation- the narrow spectral bond which is thought to cause most biological damage- appears to trigger two quite distinct immunological effects. One is confined to patches of skin that are actually irradiated, while the other develops in the immune system as a whole.

3. Three types of skin cancer- based cell carcinoma, squamous cell carcinoma and melanoma- are rapidly climbing the list of human diseases caused by UV rays.

4. Langerhans cells in the epidermis of human skin are key players in immune surveillance. UV radiations get them first, breaking down the defences in skin. The pigment cells, melanocytes, produces melanin as a shield to absorb the damaging UV radiations. But most fair complexioned skin people do not produce enough melanin to protect than from excessive exposure to sunlight and are affected by several skin damages. Thus sun bathing on the beach may not be a pleasure anymore.

5. UV radiations cause blood vessels near the skin's surface to carry more blood making the skin hot, swollen or red, causing sun burn.

6. UV radiations are also absorbed by cornea and lens in the eye leading to photo Keratitis and Cataracts.  

7. Ozone at the ground level enters the body through inhalation and exerts its toxic effects directly on the lungs. Severe lung injury is associated with edema and hemorrhage. Results of experiments indicate a marked genetic alteration in the lung upon exposure to 0.7 ppm ozone continuously for five days.

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9 Ibid, P. 311.
8. Ozone exposure has also been implicated in dizziness and visual impairment - a sign of central nervous system damage. Enlargement of spleen and thymus and impairment of the immune system.

9. Photochemical among is the major cause of ozone-exposure causing urban air-pollution posing a threat to human health.

**Effect on biotic Community**

1. An increase of UV radiation would be expected to affect crops. A number of economically important species of plants, such as rice, depend on Cynobacteria residing on their roots for the retention of nitrogen. Cynobacteria are sensitive to UV light and they would be affected by its increase.\(^\text{10}\)

2. Many micro-phytoplankton's would die because of their exposure to UV solar radiation. The marked reduction in the productivity of phytoplankton's would in turn adversely affect zoo planktons. The main animals, fishes etc. will starve in the absence of sufficient supply of foot.

3. The loss of fish population would directly affect the inhabitants of coastal areas.

4. Ozone is reported to be highly toxic to fish in the concentration ranging from 0.1 to 1.0 ppm anaerobic breakdown of organic phosphorus compounds results in the formulation of phosphine and its concentration is highly lethal to fishes.

5. Studies carried out on micro organisms indicate that both irreversible and photo reversible types of injury are caused.

**Effect on plants**

1. Exposure to air containing ozone results in the lesions to plants, usually, confined to the upper surface of leaves. These lesions are characterized by the uniformly

distributed white or brown flecks and stipples in the irregularly distributed blotches.

2. Ozone flecking is observed with the plants of grape, citrus and tobacco. At 0.02 ppm it damages tomato, pea, pipe and other plants. In pine seeding it causes tip burn.

3. Plant proteins are also susceptible to UV injury, because they absorb strongly around 280nm. 20-50% chlorophyll reduction and harmful mutation have also been observed.

4. Ozone along with, other pollutants like NO and SO$_2$ is affecting crop losses of over 50% in European countries. In Denmark, O$_3$ affects spinach, potato, clover and alfalfa etc.

5. In plants O$_3$ enters through Stomata. It causes visible damage to leaves thereby reducing their photosynthetic rate. It thus decreases the yield of certain food crops and changes the effectiveness of agricultural chemicals. O$_3$ reduction thus damages the food production.

6. Due to ozone depletion. Intense UV radiation causes greater evaporation of surface water through the stomata of the leaves and decreases the soil moisture content. Thus, O$_3$ in the atmosphere protects us but it is lethal when it comes indirect contact with us and plants at earth's surface.

7. Ozone reacts with many fibers, such as cotton, nylon and polyester, dyes etc. The extent of damage appears to be affected by light and humidity.

**Policy Responses and Regime Development**

Ozone layer depletion found its place as an issue of serious concern in political realms in the early 1970s in US in the discussion over the development of a commercial fleet of supersonic transport. After a 1976 report by the US National Academy of Science
concluded that credible scientific evidence supported the ozone-depletion hypothesis, a few countries including the US, Canada, Sweden, Denmark, and Norway moved to eliminate the use of CFCs in aerosol spray cans.\textsuperscript{11} Besides all these efforts at national level, the issue succeeded to draw international attention in 1980s. Consequently the United Nations Environmental Programme (UNEP) concluded a world plan of Action on the ozone layer, which called for intensive international research and monitoring of the ozone layer and in 1981 UNEP Governing Council authorized to UNEP to draft a global framework convention on stratospheric ozone protection. As a result in Vienna Convention negotiations countries discussed a possible protocol that would provide specific targets for certain chemicals. A working groups under UNEP began on a protocol, and the Montreal protocol was conducted in 1987, only nine months after the formal diplomatic negotiations ended in December, 1986. Besides these two-pronged effort at national and international level, four key factors are also important in understanding the evolution of stratospheric ozone policy.\textsuperscript{12}

- The recognition that ozone depletion is a global problem requiring an international response.

- The evolving scientific understanding of stratospheric ozone depletion and its influence on policymakers.

- Increasing public concern based on the threat of skin cancer and the perception of the potential for global catastrophe associated with the discovery of the Antarctic ozone hole.

- The availability of acceptable substitutes for CFCs.

Before we discuss the evolution of the regime at international level a brief look at those issues which played a crucial role in developing an interest in the issue at a limited scale is necessary.

\textsuperscript{11} Morrisett, Peter M. (1989) "The Evolution of Policy Responses to Stratospheric Ozone Depletion". Natural Resources Journal 29 P. 793

\textsuperscript{12} Ibid
The issue of Supersonic Transport

Concern over the depletion of stratospheric ozone first centered on the issue of water vapor and nitrogen oxide (NOx) emission from the proposed high flying fleet of commercial supersonic aircraft. During the 1960s, the Boeing Corporation with the help of a large federal subsidy, was working on developing a commercial transport (SST). Similar projects, the joint British French Concorde and the Soviet TU were under way in Europe. However, the project was left in US being controversial for economic and political reasons, and for other environmental problems (sonic booms and engine noise), long before the issue of stratospheric ozone depletion was raised. Thus, it was these other factors and no concern for the protection of the ozone layer that killed the U.S. SST Program in 1971.

Despite the fact that the US SST program was put on hold in 1971 concern over the SST's potential impact on the stratosphere and on climate remained because Britain and France planned to continue the Concorde program and the possibility remained that the U.S. program would be revived. As a result in late 1971 Congress authorized the Dept. of Transportation (DOT) to investigate the potential environmental impact of stratospheric flight. The mandate of DOT's climate impact Assessment program (CIAP) was to assess the impact that a fleet of high flying SSTs have on ozone layer and on climate be necessary to protect the stratosphere and to report its findings to congress by 1974. CIAP supported the SST/ozone depletion theory proposed by Johnston in 1970, and pointed to the potential skin-cancer hazard. In addition, a study by the National Academy of Science also supported the SST/Ozone depletion theory.

The debate over developing a commercial SST was important to the issue of CFC-induced stratospheric ozone depletion not only because it identified the potential threat

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13 Study of Critical Environmental Problems, Man's impact on the Global Environment (1970)
15 A Grobecker, S. Coroniti& R. Canon Supra note 14.
16 National Academy of Sciences, Environmental impact of stratospheric Flight (1975)
that human activity might pose to the ozone layer but, more generally because it marked
the beginning of a period in which technological development would increasingly have to
be balanced with other societal goals.\textsuperscript{17} Horwitch argues that "the SST conflict was clearly
both a catalyst and a harbinger of a new era."\textsuperscript{18}

\textbf{Spray Can Issue}

The spray can issue arose at a time the SST/ozone issue had already sensitized the
conscious of the people and public concern and fear towards environmental problems was
growing due to increasingly powerful environmental movement. The fear of skin cancer
from the propellants in the spray cans personalized the risk for many people. Through the
media, the public came to know that such nonessential products as aerosol hairspray and
doctorates could pose serious future environmental and health risk. Thus CFC-based
aerosols were denounced widely. As a result even before the aerosol ban of 1978, sale of
aerosol products fell sharply.

In response to these public reactions towards the CFC-based aerosols in January 1975, an
adhoc inter-agency task force on inadvertent modification of the stratosphere (IMOS)
was established by the National Science Foundation and the Council on Environmental
Quality to develop a coordinated plan of action for federal agencies.\textsuperscript{19} In addition to
IMOS, the National Academy of Science (NAS) initiated an even more detailed study of
the CFC problem. The NAS study released in September, 1976, supported Molina and
Rowland's theory as well as the connection between ozone depletion and the increased
incidence of skin cancer. The study also noted that existing legislation was inadequate for
regulating CFC use and recommended that new legislation be enacted.

As an impact of studies and researches conducted, the US Canada, Sweden, Norway and
Denmark also banned the use of CFCs in aerosols, the Netherlands required warning

\textsuperscript{17} Morrisett, Peter M. (1989) "The Evolution of Policy Responses to stratospheric Ozone Depletion"
Natural Resource Journal 29.
\textsuperscript{18} M. Horwitch, Clipped Wings: The American SST Conflict (1982)
\textsuperscript{19} Federal Task Force on Inadvertent Modification of the stratosphere, Flurocarbons and the
Environment (1975)
labels on aerosol spray cans, and in west Germany industry agreed to a one-third reduction in CFC use in aerosols.\textsuperscript{20} In addition in 1980 the European Economic Community (EEC) required member nations not to increase CFC production and to reduce CFC use in aerosols by 30 percent from 1976 levels by the end of 1981, this act was mostly symbolic, Since aerosol use in Europe had already declined significantly from 1976 European production was far below capacity.\textsuperscript{21}

\textbf{United Nations Environmental Programme (UNEP) and Vienna Convention-}

The process of formulating an international response, had begun even before the U.S. aerosol ban. in 1978. In addition to research and regulatory efforts by the US and other countries, several international organizations become involved in the CFC/ ozone issue in the mid- 1970s, including United Nations Environmental Programme (UNEP), the World Meteorological Organisation (WMO), the Organisation for Economic Cooperation and Development (OECD), and EEC. UNEP in particular has played a central role in coordinating international research, efforts and in developing an international response to the CFC/Ozone problem, especially in terms of problem recognition and assessment, and the identification of policy alternatives.\textsuperscript{22}

In 1975 UNEP took the first step in introducing the issue of ozone depletion to the international arena when it funded a study by the World Meteorological Organization (WMO) on the theory advanced by the two U.S. scientists that the depletion of the ozone layer was caused by CFCs but the political definition of the issue in 1977 when the United States, Canada, Finland Norway and Sweden urged UNEP to consider the international regulation of the ozone.\textsuperscript{23} As a result, in 1976 the Governing Council of UNEP adopted a decision requesting that the executive director convene an international meeting on stratospheric ozone. The meeting was held in March 1977 in Washington DC and assessed current and future research needs. A second international meeting

\begin{thebibliography}{9}
\bibitem{20} T. Stoel, A. Miller and B. Mitroy, Flurocarbon Regulation (1980)
\bibitem{22} Usher, Determining the options- The Role of UNEP in addressing global issues P. 331.
\bibitem{23} Porter, Gareth and Brown, Janet Welsh, Global Environmental politics, west view Press P-72.
\end{thebibliography}
in April 1977, sponsored by EPA, assessed measures for protecting the ozone layer.

At UNEP 1977 meeting, a World Plan of Action for the Ozone layer was adopted. The plan outlined research needs in three areas namely.

- The natural Ozone layer
- Impact of changes in the natural Ozone layer and
- Socio-economic aspects.

It also recommended that UNEP exercise a "coordinating and catalytic role" in implementing the plan by establishing a coordinating committee on the Ozone (CCOL). The coordinating committee on the Ozone layer, consisting of representatives of governmental agencies and NGOs, was established by UNEP to determine the extent of the problem. The fact finding process was protected because scientific estimates of the likely depletion fluctuated widely during the late 1970s and early 1980s. The methods of estimating further depletion of the Ozone were still being refined, in fact, when UNEP moved to the stage of multilateral negotiation on a framework convention for protection of the Ozone layer in 1981. The Adhoc working Group of legal and Technical Experts for Elaboration of a Global Framework convention for the protection of the Ozone layer, which included representatives from twenty four nations, began meeting in January 1982.24

United States which alone produced thirty percent of worldwide production was ready to lead the world in its resolve to find a viable solution to the problem. The European community with four major producing states (Britain, France, Germany, and Italy) accounting for 45 percent of world CFC output and exporting a third of their production to developing countries by the mid-1980s, constituted a potential veto coalition, Germany was willing to support controls on CFCs but the EC position was controlled by the other three producing countries, which wanted to preserve their industries overseas.

24 Ibid.
markets and avoid the costs of adopting substitutes for CFCs. Japan, which was a major user of CFCs, also become part of the coalition. The large developing countries- India, China, Indonesia, Brazil and Mexico- also had some potential but they did not take advantage of their veto power. No developing country played an active role in the early negotiations, and India remained outside the negotiations altogether until after the Montreal Protocol was signed in 1987.

United states, Canada and the Nordic States which led the discussions, firstly proposed a simultaneous negotiation of framework convention and of associated protocols with binding obligations to reduce CFC use. The veto coalitions as discussed above steadfastly rejected any negotiation of regulatory protocols, arguing that the state of scientific knowledge was not sufficient to support such a protocol. In 1985 United States projected the issue as one of serious urgency because of new evidence of the possibility of a collapse of the Ozone layer at a critical point. But the veto coalition was obstinate. The only agreement that could be forged, therefore was a framework convention thus the Vienna Convention for the protection of the Ozone layer came into emergence. It was essentially an agreement to cooperate on monitoring research and data exchanges. It imposed no specific obligations on the signatories to reduce production of Ozone depleting compounds. It simply out lined the responsibilities of states to protect "human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the Ozone layer". It was designed as an umbrella treaty to be supplemented by more specific protocols and sub.

While an effort made to include a protocol on controlling CFC production and use with the Convention failed a Resolution on a protocol concerning chlorofluorocarbons was adopted calling for "a protocol to control equitably global production, emissions and use of CFCs.

No protocol on controlling CFC production and use was adopted at the Vienna convention because of dispute between the US, Canada, Sweden, Norway and Finland.

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Regime on Depletion of Stratospheric Ozone Layer

(frequently referred to as the Toronto Group) on one side and the EEC countries on the other. The EEC favored a production capacity cap in non-essential aerosol use of CFCs, while the US, Canada and the Scandinavian countries (which had already banned nonessential aerosol use of CFCs) favored a 80 percent reduction or a complete ban in non essential aerosol use of CFCs. The dispute centered on the fact that the Toronto Group countries had already banned aerosol use of CFCs while the EEC countries had not. Furthermore, the EEC countries were only producing at 65 percent capacity and thus could still significantly increase production despite a capacity cap. The Toronto Group sought controls that would force the European countries to cut back on aerosol use of CFCs while the EEC opposed being forced to adopt regulations already adopted by the Toronto Group countries. The dispute polarized the negotiation.

The Vienna connection was important because it represented a common ground on which international consensus had been reached and also established the framework under which a protocol would be negotiated. Subsequently the key question was not so much whether there would be a protocol but rather how strong it would be.

Montreal Protocol

The Montreal protocol was an outgrowth of the 1985 Vienna convention which legitimised stratospheric ozone depletion as an international environmental issue and established the basis for negotiation that would eventually lead to the protocol. As mentioned earlier several other factors too contributed to the growth of regime on the controlling the depletion of Ozone layer. These factors were the evolving scientific understanding of stratospheric Ozone and its influence on policy making, increasing public concern based on the threat of skin cancer and the perception of global catastrophe associated with the discovery of the Antarctic ozone hole, and the availability of acceptable substitutes. It was the evolution of these factors that finally opened the door to the Montreal Protocol.26

The Montreal Protocol, result of nearly 15 years of political and public concern over the

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26 Ibid
impact of CFCs on the Ozone layer, outlines specific measures and timetables for reducing production and consumption of CFCs and halons. It reflects a convergence of interest of scientists who warned of growing threats to the Ozone layer, private industry that wanted a level playing field as companies responded to new national legislation controlling the harmful chemicals, nongovernmental organizations advocating environmental protection, and national governments that increasingly saw an international agreement as in their own best interests.²⁷

The protocol divides ozone-depleting compounds into two groups. Group I includes the fully halogenated CFCs (CFC-II, C-12, 113, -114, and -115) which are the most threatening to the Ozone layer, and Group II includes the halons. The protocol also makes an important distinction between developed countries and developing countries, which are referred to as "Article 5 countries" in the protocol. The difference between the developed countries and the Articles 5 countries concerns the timing of the production and consumption reductions.

For the developed countries, the protocol stipulated that the production and consumption of group I compounds was to be frozen at 1986 levels beginning in 1989. Production and consumption of Group I compounds must be reduced to 80 percent of 1986 levels by 1994, and 50 percent of 1986 levels by 1999. The protocol, however, permitted a 10 percent (15 percent after 1998) increase in production over the prescribed limits if the additional production was for export to Article 5 countries, or to be used for industrial rationalization (the transfer of production) between parties. The protocol stipulates that the production and consumption of Group II compounds were to be frozen at 1986 levels by 1993. For the Article 5 countries, the same restriction apply concerning group I and II compounds, but with a ten year delay in implementation. Article 5 countries could continue to increase production and consumption until 1999 as long as per capita consumption doesn't exceed 0-3 kilograms.

The protocol also requires parties to ban the import of Ozone depleting products from

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Regime on Depletion of Stratospheric Ozone Layer
nonparties, and the "discourage" the export technologies used in producing and utilizing Ozone depleting substances to non-parties. Finally, the Montreal protocol is flexible agreement, it includes mechanisms for re-evaluating and revising the protocol on the basis of new scientific information. Among these mechanisms the first is for Technology and Economic Assessment panels which provide regular export assessment. The second is for differentiated procedures for altering the obligations to control substances namely by adjustment and by amendments. In the adjustment process, parties may adjust the targets and timetables for phasing out chemicals that are already listed without having to go through a formal amendment process. Adjustments become effective six months after parties receive formal notice and find all countries party to the Protocol. A formal amendment is required to add new chemicals to the list of controlled substances. In contrast to the adjustment process amendments find only those countries that ratify them. As a result, different states are found by different obligations, countries joining the agreement after an amendment goes into effect assume the obligations as of that date, but must ratify any future amendment for it to find them.

There have been five amendments to the Protocol. The London, Copenhagen, Montreal, Beijing and Kigali Amendments. The 1990 London Amendment provided for an interim Multilateral fund to provide assistance to qualifying developing countries, for noncompliance procedures, for the addition of new chemicals to the list of controlled chemicals, and for other miscellaneous changes. In 1992 Copenhagen Amendment, parties made interim Multilateral Fund permanent and put additional chemicals under control, including methyl bromide and the HCFCs. The 1997 Montreal Amendment obligated countries to establish and implement a licensing system for the import and export of new, used, recycled and reclaimed controlled substances and to control trade in the banned substances by parties not in compliance with the protocol. The 1999 Beijing Amendment provided for a "basic domestic needs" exception for certain controlled substances. Kigali Amendment, the recent one to the Montreal Protocol adds powerful greenhouse gases Hydroflurocarbons (HFCs) to the list of substances controlled under the Protocol to be phased down. Use of HFCs is increasing rapidly as substitutes for ozone-
depleting substances. HFC phase down is expected to avoid up to 0.5 degree Celsius global temperature rise by 2100, while continuing to protect the ozone layer. The Kigali Amendment will enter into force on 1st of January 2019, provided that it is ratified by at least 20 parties to Montreal Protocol.\textsuperscript{28} Since the protocol went into effect, adjustments have also been made to the timetable for phasing out listed chemicals.

To make the protocol effective, countries prohibited exports and imports of controlled substances with countries not party to the protocol. In the second stage, the trade ban would extend to products containing a controlled substance, and in a third stage to products produced with the substances. The last has been dropped from the agenda.

One of the most significant innovations of the protocol is the process established to address problems of non-compliance. Parties established an Implementation committee to review annual reports from parties and developed a suite of measures that could be used in case of noncompliance, including technical assistance to enable the country to comply. This precedent has been widely followed in other environmental agreements, such as the Convention on Long Range Trans-boundary Air pollution and its Protocols, UNECE Aarhus convention on Access to information, public participation in Decision Making and Access to justice in Environmental matters and the Protocols to the UN FCC.

Since the Ozone depleting substance regulated under the Protocol are also potent greenhouse gases, the Protocol has contributed to mitigating climate change. However, the ban on CFCs had led to some substitution of HCFCs for these chemicals HCFCs are controlled but not banned under the Protocol. This lessens to some extent the Protocol's effect on climate change.

**Conclusion**

Regime over the depletion of stratospheric Ozone depletion is being projected as the most successful among all the environmental regimes till date it is because of the fact it is the first international agreement aimed at resolving a global atmospheric problem. It is

important not only because it outlines measure agreed to by the international community to the project the Ozone layer, but also because it signifies that innovative approaches to major global environmental problems are possible. It is said to be an ideal model for finding solutions to other environmental problems, but the policies formulated to solve the issue of Ozone depletion could not succeed to keep itself immune from criticism.

Ben Lieberman in "Doomsday Deja Vu : Ozone depletion's lessons for Global Warming" written for comparative Enterprise Institute (CEI), a Washington, DC-based think tank cautioned against the repetition of the mistakes of the Montreal Protocol in efforts to deal with other environmental problems. Vehemently criticizing the Montreal Protocol he said that the compliance with the protocol proved to be hugely costly for US. The protocol failed to bring compliance and there was no adequate enforcement mechanism to deter violators. The hypothesis that without protection against UVB, human would face an increased risk of skin cancer and blindness have also not materialized because it was not driven by any sound objective science. Hibermoto considers the fact that the agreement was a successful application of the precautionary principle, a myth because rather than averting a dire environmental threat, the Montreal Protocol has proven to be an overreaction to a largely non existent problem.

But the above criticism seems to be exaggerated in the light of the fact that since the Montreal protocol came into effect, the atmospheric concentration of the most important chlorofluorocarbons and related chlorinated hydrocarbons have either leveled off or decreased. Halon concentrations have continued to increase, as the halons presently stored in fire extinguishers are released, but their rate of increases has slowed and their abundances are expected to begin to decline by about 2020. Also, the concentration of the HCFCs increased drastically at least partly because for many uses CFCs (eg. used as solvents refrigerating agents) were substituted with HCFCs while there have been reports of attempts by individuals to circumvent the ban e.g. by snuggling CFCs from undeveloped to developed nations, the overall level of compliance has been high. In consequence, the Montreal Protocol has often been called the most successful international agreement to date. In 2001 report, NASA found the Ozone thinning over
Antarctica had retained the same thickness for the previous three years, however in 2003 the Ozone hole grew to its second largest size. The most recent scientific evaluation of the effects of the Montreal protocol states, "The Montreal Protocol is working : There is clear evidence of a decrease in the atmospheric burden of ozone depleting substances and some early signs of stratospheric Ozone recovery.\(^{29}\)

Within 25 years of signing, parties to the MP celebrate significant milestones. Significantly, the world has phased-out 98% of the Ozone-Depleting Substances (ODS) contained in nearly 100 hazardous chemicals worldwide; every country is in compliance with stringent obligations; and, the MP has achieved the status of the first global regime with universal ratification; even the newest member state, South Sudan, ratified in 2013. UNEP received accolades for achieving global consensus that "demonstrates the world’s commitment to ozone protection, and more broadly, to global environmental protection".\(^{30}\)


\(^{30}\) ozone.unep.org