A NEW THRUST IN ATMOSPHERIC OZONE RESEARCH

Kalipada Chatterjee

International efforts like the Montreal Protocol ought to start moving beyond the mere phasing out of chlorofluorocarbons (CFCs), in their efforts to address the issue of atmospheric ozone in the future.

Atmospheric ozone (O_3) plays an important and dual role in affecting climate. The stratospheric ozone layer which evolved long ago surrounds the earth like a shield (fig1) and protects it from biologically harmful ultraviolet radiation, while allowing in visible light to support the various life forms on earth. O_3 is also of primary importance in determining the thermal structure of the atmosphere. Most of the source gases such as the CFCs along with CO_2 and water vapour (H_2O), are climatically significant and affect stratospheric O_3 levels by their influence on stratospheric temperature.

Ozone is an important absorber of infra-red radiation and thus, a very effective greenhouse gas, contributing to about 8 per cent of the total greenhouse effect at present. This percentage may go up considerably due to vehicular pollution in urban centres, which is responsible for the formation of ozone near the surface.

On the other hand, ozone depletion in the stratosphere increases the biologically harmful ultraviolet radiation (UV-B) reaching the earth's surface. If stratrospheric ozone concentration is decreased by as little as one per cent, the amount of biologically active UV-B radiation can be expected to increase by 2 per cent. The direct effects of such a reduction in ozone are skin cancer, particularly among the white population, increase in the incidence of severe eye diseases (e.g., cataracts), effects on the human immune system and increase in the incidence of malaria and dengue fever in developing countries. However leading scientists feel that risks involved for plants and micro organisms are much more serious than the direct effects on human health. The yields of many agricultural plants are adversely affected by UV-B, and may have serious consequences for regional food security.

Ozone is also toxic, and when formed near the earth's surface, has adverse effects on human health, air quality and vegetation, resulting in forest die-back and reduced agricultural yields and thus affecting food production and security.

With the discovery by Rowland and Molina in 1974, from their laboratory experiments, that the photolysis in the stratosphere of CFCs which are inert in the lower atmosphere (troposphere) leads to destruction of ozone, they drew attention to the importance of industrial CFCs as a source of chlorine radicals in the stratospheric. This landmark finding, now largely confirmed since the appearance of the ozone hole over Antarctica, has provided the focus of stratospheric research over the past decade on the causes and effects of depletion of the ozone layer.

Rowland and Molina's prediction was the basis for the Vienna Convention and Montreal Protocol for phasing out CFCs and other ozone depleting chemicals. There is a need to look into other human activities which may also contribute to the destruction of the ozone layer. Scientific research on atmospheric ozone must be given a new thrust to avoid any surprises.

There is a need to look into other human activities which may also contribute to the destruction of the ozone layer. As we know, atomic oxygen in the stratosphere combines with molecular oxygen to form the ozone molecule. This process is practically dormant or absent over Antarctica during the long polar nights in winter. In the various assessments and papers brought out so far to explain the atmospheric chemistry over Antarctica, this aspect has not been highlighted to explain the very low ozone levels over Antarctica particularly during winter. New thrusts in the field of atmospheric ozone should clearly bring out such aspects from actual measurements of atomic oxygen over Antarctica during various seasons, and particularly during the Antarctic winter. Such data should be integrated with the polar meteorology while explaining the formation of the ozone hole over Antarctica. Such an analytical approach may throw new light on the problem.

Such a unique combination of factors such as a high chlorine level, polar meteorology, long polar nights, a very cold stratosphere and heterogeneous chemistry in the atmosphere, for the occurrence of the ozone hole is very rare over the rest of the globe, with the possible exception of the Arctic region. However, there could be other factors that influence the stratospheric ozone levels in the lower latitudes and the new thrust in scientific research should look into the possibility or otherwise of the occurrence of ozone hole/ozone depletion over the vastly populated areas of Asia, Africa and Latin America in the future.

New thrusts in scientific research are also needed on the adverse effects of increased ultraviolet radiation at the earth's surface and surface ozone on human health, forests, vegetation, agriculture, aquatic life and materials. Based on this work, response strategies need to be designed and put in place to combat the effects. This is particularly necessary in developing countries, so that these countries are not caught unawares and incur heavy losses in human and material resources.

Human Health

The impact of increased ultra violet radiation reaching the earth's surface on human health is a clear priority area for investigation. India, being in the ozone dip, is already exposed to a very high dose of UV-B (as compared to countries at higher latitudes), which is described as the threshold level(1).

a. **Cataracts:** In a large number of developing countries including India, people are suffering from visual impairment. Current treatment rates are not keeping pace with current incidence rates. In the developed countries, corrective surgery can prevent most cataracts. In India this is not the case and cataracts result in much higher incidence of blindness. The WHO estimated that cataracts were responsible for 17 million cases of avoidable blindness in 1985. In India the ratio of eye specialists to the number of people suffering from eye diseases is pitifully low. Epidemiological studies have identified a correlation between the prevention of various types of cataracts in humans (occupationally exposed individuals) and the ultraviolet radiation reaching the earth's surface. This relationship varies with individuals, but UV-B (280-320 nm) has a larger effect on younger people. In the global scenario, it has been estimated that for every 1 per cent decrease in the total ozone, there will be an increase in the incidence of cataracts by 0.6 per cent. This increase would amount to 100,000 additional blind persons, mainly in developing countries. In India a large number of people are engaged in agriculture and are exposed to direct solar radiation for at least 6-8 hours a day while working in fields during the cropping seasons.

b. **Skin Cancer:** The incidence of skin cancer (non-melanoma) for persons of Indian origin is low, in most cases one-fifth to one-tenth that of Caucasians. The low incidence is not limited to India alone but is true for all Asians. These characteristics are a consequence of genetic evolutionary responses to prevailing climatic conditions, and have occurred over a period of tens of thousands of years. The accelerated pace of climactic change and ozone depletion in recent times does not allow for this evolutionary escape route and leaves large sections of the world's population vulnerable to UV-B induced health problems.

c. **Immune System:** Another area of concern arises from the reported UV-B effects on the human immune system. These issues need to be investigated, particularly in developing countries, where existing medical infrastructure needs to be strengthened and facilities developed in areas where they are non-existent now.

A new thrust in ozone research in the area of agricultural yields and food security

It is well-documented that the effectiveness of UV-B is magnified when the levels of white radiation are below the optimum for photosynthesis. It is thought that natural UV-B protective mechanism do not become fully developed in plants in low-levels of visible light. Such a situation can arise during the monsoon period in India, when rice is grown. Rice production can be further impacted by increases in temperature due to climate change. An integrated research effort should be initiated and pursued vigorously for the Indian subcontinent in this regard. NGOs, government, and agricultural scientists should be inducted into such research studies.

These scientific studies must be integrated into India's agricultural policies, planning and programmes. The Montreal Protocol(2) must fund these important studies on a priority basis.

Research studies in the area of UV-B and aquatic life

n many developing countries, marine species supply more than 50 per cent of the dietary proteins. In India, salt water fishing is a very important source of income for fisherfolk living along the 7,000 km long India coastline and islands. Research on marine ecosystems is needed in India to improve our present understanding of how atmospheric ozone depletion could influence the world food supply and food security, with particular reference to India.

Global monitoring of stratospheric chlorine and bromine concentrations

he ozone layer is still being depleted even after the phasing out of 80 per cent of global CFCs consumption and production by the industrialised countries. But the worrisome and continued increase in bromine level in the upper atmosphere (bromine has much higher ozone depleting potential (ODP) than CFCs), is a matter of concern for the protection of the ozone layer. Bromine is mainly released when halons are used for fire fighting, and alternative materials need to be developed for this purpose. There should be a global effort to routinely monitor the chlorine and bromine loading of the stratosphere over different geographical belts and to disseminate such information to people. This is more important over the tropical belts of the hemisphere where most of the world's poor people live, and they have hardly any such resources to combat ill effects on human health, agriculture etc., due to increased UV-B reaching the earth's surface as ozone is being depleted.

Conclusion

International efforts like the Montreal Protocol ought to start moving beyond the mere phasing out of CFCs in their efforts to address the issue of atmospheric ozone in the future. The issues outlined above are relevant to the world as a whole, but have particular relevance for developing countries. Scientific research that addresses issues that are important for developing countries are equally the responsibility of international efforts, including the Global Environment Facility (GEF). The priorities for research programmes should emerge from the needs of the people. In addition there is an urgent need to develop monitoring, analysing and designing capacities for the prevention and remediation strategies of the adverse effects of atmospheric ozone. Towards this end, new research facilities should be established in the developing countries which have demonstrated competence in the field of atmospheric ozone and climate change.

References

(1) Chatterjee. K (1995): Implications of Montreal Protocol: With particular reference to India and other developing countries, Atmospheric Environment Vol. 29, No. 16 pp 1883-1903, Elsevir Science Ltd., Great Britain.

(2) The Montreal Protocol: Ashok Khosla: The first decade of the first global environment management, Development Alternatives' Newsletter Vol. 7 No. 10 October, 1997.