



Factors contributing to ozone layer depletion and its consequences on human health and the environment

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ABSTRACT

The stratosphere layer held the majority of the ozone concentration. Ozone is less abundant in the atmosphere as compared to oxygen. The ozone layer serves as a protective layer and a shield against the sun's harmful radiation. Ozone layer depletion increases the concentration of ultraviolet radiation on earth and in the atmosphere. These UV rays have an adverse impact on humans and the environment. Chlorofluorocarbons (CFC) are the main factors responsible for ozone layer depletion. Other substances, such as chlorine, bromine and uncontrolled rocket launching activities are also contributed in the depletion of ozone layer. Ozone layer depletion causes several severe disorders and diseases in humans. Depletion of the ozone layer also increases the risk of cataracts, eye damage, sunburn and skin cancer problems in humans. UV rays also directly influence aquatic and terrestrial ecosystems and their biota.

Keywords: Ozone, Depletion, Humans, Environment, Aquatic, Terrestrial, Disease

INTRODUCTION

Various human activities adversely influence ecosystem including ozone layer depletion (Sivasakthivel and Reddy, 2011). All living creature is protected and guarded from UV rays by stratospheric ozone layer which is also acting as sun cream and shield (US-EPA, 2010). Most of ozone part (90%) found in stratosphere layer at height of 10 to 17 kilometre and remaining ozone part (10%) present in troposphere layer (Gleason, 2008). Ozone layer absorbed medium frequency radiation up to 200nm to 315 nm and are 97 to 99 % absorbed by ozone layer (Albritton and Daniel, 1998). Ozone (O₃) is a colourless and has a very harsh odour. It is very rare as compare to oxygen. In 10 million air molecules, almost 2 million molecules are O₂ and only three molecules of ozone (AFEAS, 1995).

Striking of O₂ molecules with UV radiation leads to splitting of oxygen molecules (O₂) and formed free oxygen atoms. These atoms with O₂ molecules in upper atmosphere to form ozone, formation of ozone layer is known as Photolysis. Ozone is measured in Dobson unit; normal ozone concentration is ranges between 300-350 Dobson Unit (D.U.) (Sivasakthivel and Reddy, 2011). The majority of ozone is created around the equator, where sunlight present in higher amount, but due to high wind velocity, it goes in higher layer of atmosphere and formed stratosphere (Sivasakthivel and Reddy, 2011). The current review study examines the factor responsible for of ozone layer depletion and the effects of its depletion on human health and the environment.

1. Factor responsible for ozone layer depletion

Ozone depletion occurs when the production and destruction of ozone in the stratosphere are imbalanced. Generally, natural activities contribute in ozone depletion, but human activities such as the emission of chlorofluorocarbons (CFC) are also responsible for ozone layer depletion (Angell and Korshover, 2005). Chemical reactions with chlorine and bromine also contributed to ozone layer depletion (Anderson and Sarma, 2002). Chlorofluorocarbons are non-combustible and highly volatile gases; they are easily evaporated and reach the stratosphere, where they start ozone molecule depletion. It also causes adverse impacts on living beings, including humans (Chlorofluorocarbons, 2010). Ozone depletion also occurs due to the unregulated launching of rockets (Sivasakthivel and Reddy, 2011). Global warming is also responsible for ozone layer depletion (Sivasakthivel and Reddy, 2011). Nitrogenous compounds like NO, N₂O, NO₂ are also responsible for ozone layer depletion (Ravishankara *et al.*, 2009).

2. Impact of ozone depletion on environment and human health-

Increased surface UV causes an increase in tropospheric ozone, which poses a health risk due to ozone's harmful oxidant characteristics (Fears *et al.*, 2002). Ozone layer depletion adversely affects the environment and human health. Ozone depletion



allows UV radiation to reach the earth. These UV rays cause a variety of health problems in humans, including skin cancer, sunburn, mutation and eye damage (Angell and Korshover, 2005). Ozone depletion also had an impact on terrestrial ecosystem, biochemical cycles, aquatic life and air quality and also contributes to warming of earth and global warming (Sivasakthivel and Reddy, 2011). Ozone depletion increases the risk of cataracts by 0.3%-0.6% for every 1% decrease in ozone levels (UNEP, 1994). The lens of the eye can be damaged by oxidative agents. Oxidative oxygen is produced by UV radiation and UV radiation also causes damage to the cornea and eye lenses (Eaton, 1995; Lee *et al.*, 1999; Christenson *et al.*, 2005). UV radiation also causes skin cancer in humans. Because UV radiation alters the structure of biomolecules, altered biomolecules lead to a variety of diseases (Andersen and Sarma, 2002; Tian and Juan, 2009). Depletion of the ozone layer causes sunburn and skin cancer in humans and UV radiation is also responsible for leukaemia and breast cancer (Wargent and Jordan, 2013). UV radiation exposure can also impair the immune system's response to skin cancer, infectious illnesses and other antigens (Sivasakthivel and Reddy, 2011). UV radiations induce alterations in the skin's photoreceptors and antigen-presenting cells, which result in immunosuppression (UNEP, 2006). More ozone depletion contributes to a greater reduction in the immunological system (Andersen and Sharma, 2002). UV radiation poses the main environmental risk for the development of non-melanoma and melanoma skin cancers (NMSCs) in humans (WHO, 1994).

People who live near the equator have a higher risk of cutaneous malignant melanoma cancer because sun light exposure is greater at the equator than at the poles (Kanavy and Grestenblith, 2011; Lin *et al.*, 2012). UV exposure to the human eye causes damage to the cornea and lens, which can result in cataracts, photokeratitis and blindness. UV light exposure can cause bronchitis, emphysema and possibly obstructive pulmonary disease in humans. Humans exposed to excessive UV exposure leads to DNA breakage, inhibition and modification of DNA replication and premature aging (Wargent & Jordan, 2013).

In humans, UV radiation causes photoaging of the skin, which is characterized by wrinkly, leathery texture and a loss of elasticity and eventually leads to the development of squamous cell carcinoma. Photoaging originates from the UV-induced breakdown of extracellular matrix proteins such as collagen and elastin in the dermis. UV-A radiation may be the primary cause of persistent photoaging due to its deeper penetration (Lowe *et al.*, 1995). UV-B radiation directly altered structural proteins in the skin, including fibrillin and fibronectin, which are involved in dermal structure maintenance (Naylor *et al.*, 2011).

UV radiation also causes malignant melanoma, a type of skin cancer that is less prevalent but significantly more harmful. Its link with UV exposures is not fully understood; however, UV-A and UV-B are likely implicated (Setlow *et al.*, 1993). Cutaneous malignant melanomas are associated with exposure with harmful radiations of sun, severe sunburns and the number of moles, which is in turn associated with exposure of harmful radiations (Bauer *et al.*, 2005). Pterygium is a proliferative, inflammatory and invasive growth that arises on the cornea and conjunctiva of the human eye due to intracellular damage caused by UV-B light (Di Girolamo *et al.*, 2005). Pterygia develop toward the centre of cornea and responsible for impaired vision in humans. There is found positive correlation between pterygium and exposure of environmental UV-B (Taylor *et al.*, 1989; McCarty *et al.*, 2000; Al Bdour and Al Latayfeh, 2004) and this is applicable to all age groups (Threlfall and English, 1999), indicating that eye protection for young and old will reduce the risk of both cataracts and pterygium.

3. Impact of ozone depletion and UV exposure on ecosystem

Various direct impacts of UV-B have been observed on terrestrial species. In general, Photosynthesis activities of lichens, mosses and higher plants are unaffected at higher altitude while UV-B radiation interfere in the biomass of stem, branches and leafs (Ballare *et al.*, 2001; Phoenix *et al.*, 2002; Robson *et al.*, 2003; Rozema *et al.*, 2005). In certain instances, substantial growth decreases have been documented (Day *et al.*, 2001; Ruhland *et al.*, 2005; Xiong and Day, 2001).

The *Grimmia antarctici* (Arctic moss) have decreased amounts of photo protective chemicals and greater leaf morphological abnormalities, when exposure with higher UV-B radiations (Robinson *et al.*, 2005). Variations in UV-B may affect the plant biomass to root systems. Despite the fact that this phenomenon is not always observed (Rinnan *et al.*, 2006), these findings show that root mass may be reduced, which may have consequences for plant survival (Rinnan *et al.*, 2005; Zaller *et al.*, 2002; Ruhland *et al.*, 2005; Rinnan *et al.*, 2006). Most of land animals are protected from UV-B radiations by hairs and feathers, but exposure of UV-B radiation interfere in composition of pigment concentration in Arctic collembolan (Leinaas, 2002).

Recent studies show that exposure to UV-B radiation influences microbes and plant interactions. UV-B also influences mycorrhizae, fungi associated with roots, which are important for plant growth (Van-de-Staaij *et al.*, 2001). According to Van-de-Staaij *et al.* (2001), UV-B exposure reduced the nutrient content of plants by up to 20%. Ultraviolet light can have a deleterious



impact on aquatic ecosystems and their species composition (Hader *et al.*, 2003). Declination in thickness of ozone layer in stratospheric ozone in Antarctica and Arctic also increased UV-B radiation exposure in this region. These changes adversely affect marine and freshwater ecosystem (Helbling *et al.*, 2003). Fish are also sensitive to and affected by ultraviolet radiation. The skin and eye of fishes are also damaged by exposure to UV-R (Zamzow, 2004), while some species are adapted to UV-R stress (Chatzifotis *et al.*, 2005; McCarty *et al.*, 2000).

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