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Research Article

GLOBAL WARMING & OZONE LAYER DEPLETION – THE MISSING LINKS

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ABSTRACT

It is now long enough we have been struggling to control global warming and the depletion of the Ozone layer, but any concrete solution is yet farfetched. In this paper we shall budge step wise to understand and solve the issues. In this paper I have taken the problem from the very fundamentals and a stepwise approach to addressing the issue. The first step being what exactly is Ozone layer? How it is formed? What are the hazards of its depletion? Why the CO_2 levels have been rising? What are the hazards of increased levels of CO_2 in the atmosphere? Where does this extra CO_2 come from and what should be done to get rid of it? Why the O_2 levels are receding? What could be the potential effects of reduction in O_2 level? How to replenish the same simultaneously addressing the issues of Ozone depletion and Global warming? It will be important to note that we have reached to one simple solution to solve all the three problems; we shall see them step by step.

We came to the conclusion that the daily production and consumption of the gasses plays an important role and thus a balance of O_2 or CO_2 consuming and O_2 or CO_2 producing life forms are important. We calculated the deficit of daily O_2 production and the no. of trees required to cover it came to an overwhelming approx. 781 trees per person of the existing population of the earth, these trees will automatically consume the extra CO_2 thus the problem of global warming will be taken care of on the other hand the increased production of O_2 by these trees will increase the O_2 concentration in the atmosphere resulting in the correction of the Ozone layer.

What exactly is Ozone layer?

Ozone is a form of oxygen in which three oxygen atoms join together to form a molecule of ozone (0_3). It is formed by the action of sunlight on molecules of ordinary oxygen in the stratosphere. Thus, it is mainly scattered in a "layer" at altitudes between about 10 and 30 km above the earth's surface. Some ozone can also be formed close to the earth's surface by the action of sunlight on, for example, car exhaust fumes (1).

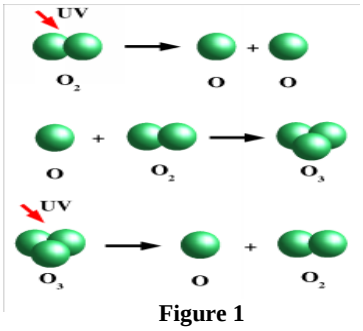

Figure 1

We all know that the ultraviolet ray from the Sun enter into the atmosphere and strikes the O_2 molecules to break them apart forming two oxygen atoms which react with other O_2 molecules forming O_3, and when the UV rays strike the O_3 molecule it again breaks them apart and the cycle goes on as shown in Fig. 1.

Thus we see that the density of the Ozone layer will depend upon the density of the O_2 molecules. If the density of the O_2 molecules is high at higher altitudes the UV rays will strike them and form Ozone but if the density of O_2 is low the rays will be able to penetrate deeper into the atmosphere. it is important to note that O_2 and not O_3 is actually responsible for blocking the UV rays, O_3 however is the outcome of the reaction of O_2 with UV rays but also assists in blocking the UV rays (as seen in Figure 2 & 3).

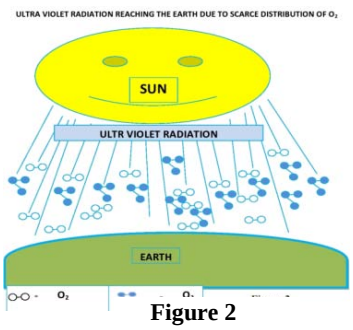

Figure 2

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Ozone Layer Depletion

The Suns output UVB radiation does not change. The Ozone layer prevents the harmful radiation from reaching the surface. The depletion of the Ozone layer allows more UVB rays to enter and reach the surface of the earth which may have several ill effects, not only on humans but on all life forms which may be listed as below:

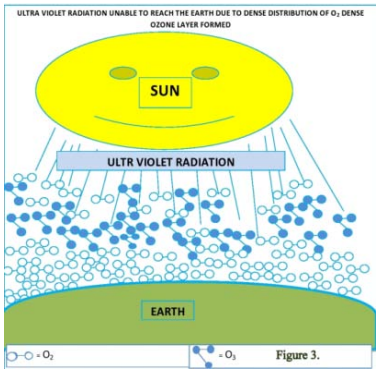

Figure 3

- **Effects on Human health(2):**
  - Laboratory and epidemiological studies demonstrate that UVB causes non-melanoma skin cancer and plays a major role in malignant melanoma development.
  - UVB can cause cataract and clouding of the Lens in the eyes.
- **Effects on Plants(2):**
  - Plant growth can be directly affected by UVB radiation, Physiological and developmental processes of plants are affected even by the amount of UVB in present-day sunlight by UVB radiation.
  - Indirect changes caused by UVB (such as changes in plant form, how nutrients are distributed within the plant, timing of developmental phases and secondary metabolism) may be equally, or sometimes more, important than damaging effects of UVB.
- **Effects on Marine ecosystems(2):**
  - Exposure to solar UVB radiation has been shown to affect both orientation mechanisms and motility in phytoplankton, resulting in reduced survival rates for these organisms. Scientists have demonstrated a direct reduction in phytoplankton production due to ozone depletion-related increases in UVB. One study has indicated a 6-12% reduction in the marginal ice zone.
  - Solar UVB radiation has been found to cause damage to early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development. Even at current levels, solar UVB radiation is a limiting factor, and small increases in UVB exposure could result in significant reduction in the size of the population of animals that eat these smaller creatures.
- **Effects on biochemical cycles(2):**
  - Increases in solar UV radiation could affect terrestrial and aquatic biogeochemical cycles, thus altering both sources and sinks of greenhouse and chemically-important trace gases e.g., carbon dioxide (CO2), carbon monoxide (CO), carbonyl sulfide (COS) and possibly other gases, including ozone. These potential changes would contribute to biosphere-atmosphere feedbacks that attenuate or reinforce the atmospheric buildup of these gases.
- **Effects on Materials(2):**
  - Synthetic polymers, naturally occurring biopolymers, as well as some other materials of commercial interest are adversely affected by solar UV radiation. Today's materials are somewhat protected from UVB by special additives. Therefore, any increase in solar UVB levels will therefore accelerate their breakdown, limiting the length of time for which they are useful outdoors.

Hazards of Increasing CO_2 levels in the atmosphere

The concentration of **carbon dioxide (CO2) in Earth's atmosphere** has reached 391 ppm (parts per million) as of October 2012(3)(4) and rose by 2.0 ppm/yr during 2000–2009 and faster since then. (4)(5) This current concentration is substantially higher than the 280 ppm concentration present in pre-industrial times, with the increase largely attributed to anthropogenic sources.(6) The present level is higher than at any time during the last 800 thousand years.(7) CO_2 is an important component of the earth's atmosphere as it is responsible for the global warming and climate change on the one hand and food production for all the species directly or indirectly through photosynthesis. Hence, on the one hand increase in the concentration of CO_2 will lead to increase in the rate of food production and on the other hand it will result in increasing global temperatures which is resulting into increase in the sea level due to melting of the glaciers.

REDUCING O_2 LEVELS

The reducing O_2 levels in the atmosphere is also an issue to be addressed, although the world scientific community has not yet taken this very seriously because the reducing levels have not raised an alarm due to the fact that there is still enough O_2 available and the reducing levels do not seem to pose any serious problems in the near future. Looking into

the facts and the figures we see that the O_2 levels have been falling.Dr. Ralph Keeling who made observations of the level of atmospheric oxygen over a period of about 20 years from his stations stretching north from Antarctica to areas in and around the Pacific and Atlantic Oceans (specifically, in La Jolla, California and Cape Grim, Tasmania), Dr. Keeling found a 0.0317% decline in atmospheric oxygen from 1990 to 2008 (8).

VISUALISING ALL THREE ISSUES AS ONE

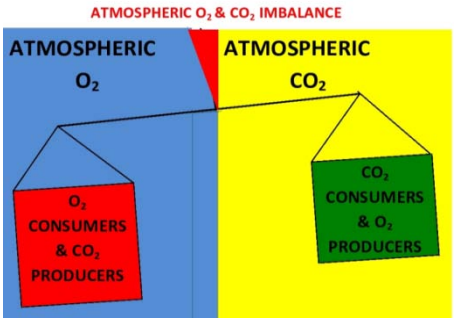

Figure 3

We see that the three issues to be handled are the reduction in the O_2 levels, Ozone depletion and an increase in the CO_2 levels; they are all related to each other. We have to first understand that CO_2 and O_2 are being consumed and produced daily and thus not permanent in the atmosphere, there level is maintained at a constant by a balance between the daily consumption and release of the gasses. The cycle of CO_2 consumers and O_2 producers and vice versa are responsible for maintaining this balance we find that, the imbalance between the two results into a daily deficit of O_2 production and excess of CO_2 production. Instead of reducing the CO_2 production if we think of increasing its consumption the solution comes easy. Trees are a common factor that can affect all the three in different ways. Trees take in CO_2 and release O_2 during the process of photosynthesis and thus are very important in maintaining the balance between the two. Visualizing the scenario in the light of this we can understand that we are running a deficit in daily production of O_2 while we have a surplus production of CO_2. The surplus CO_2 is coming from O_2 consumers and the deficit of O_2 is coming from the CO_2 consumers (see Figure.2).

So we see that with reduced population of trees the production of O_2 has gone down while the production of CO_2 has *increased hence by* planting more trees we can tilt the balance towards CO_2 consumers and O_2 producers which can easily solve the problem of the imbalance between the two and this will automatically take care of the Ozone depletion. Thus we have to see how much deficit or surplus we are running into and how many trees will be required to cover it up.

Total weight of air in the atmosphere	=	5148 trillion tones (9)
% of O_2 in the atmosphere	=	20.95%
Total wt. of O_2 in the atmosphere	=	20.95/100 × 5148 trillion Tonnes
	=	1078.51 trillion Tonnes

If the % of O_2 is reduced by 0.0317% the total % of O_2 is:

20.95 – 0.0317 = 20.918%

i.e. is equal to = 1076.859 trillion tons

Total daily deficit thus is 1078.51 – 1076.859 = 1.651 trillion tons

O_2 Produced by trees:

Tree oxygen production varies by tree size. Based on data from Minneapolis, Minnesota (10), trees 1–3_ dbh produced ≈2.9 kg O2/year (6.4 lb O2/year); trees 9–12_ dbh: 22.6 kg O2/year (49.9 lb O2/year); 18–21_ dbh: 45.6 kg O2/year (100.5 lb O2/year); 27–30_ dbh: 91.1 kg O2/year (200.8 lb O2/year); and greater than 30_ dbh: 110.3 kg O2/year (243.2 lb O2/year)(11).

Now if we take the largest trees i.e. more than 30_dbh as a standard, the no. of trees required for covering the deficit will be:-

Required O_2 in kgs = 1.651 × 10000000000000 = 16510000000000 kg/day

One tree produces 110.3kg per year

Per day production by a tree = 110.3/365 = 0.302kg

No. of trees required = 16510000000000/0.302 = 5466887417218.543 trees. These many trees will increase the O_2 concentration to the desired level thus eliminating the Ozone depletion and the amount of CO_2 consumed by these trees will eliminate the problem of global warming.

The current population of the world is app. 7000000000

This means each individual has to plant app. 781 trees to make up for the deficit which will take several decades for these trees to be planted and grow to their full size, if it is taken as a mission to save the planet.

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