Stratospheric (Protective) Ozone

Ozone or O_3 is naturally present in the stratosphere – high above the earth. This ozone layer acts like a shield and prevents dangerous parts of UV light from the sun to reach the earth. Due to human activities, the ozone in our stratosphere is getting depleted.

In New Zealand, they inform us there is a hole in the ozone layer and we are advised daily that "burn time" is so many minutes (this number varies). This means that we should remain in the sun only for that many minutes, say seventeen minutes, and then move into the shade. We are constantly advised to slap on "sun block", wear hats, thin long sleeves in summer and take precautions so that we aren't exposed to the dangerous parts of UV light from the sun.

There is a high risk of skin cancer in places whose ozone layer has been depleted by human activity. The harmful UV rays could also give us cataract, impaired immune systems, destroy plants and plankton which is food for marine life and the most effective carbon absorber on planet earth.

Which Human Activities cause ozone depletion in the Stratosphere?

Ozone-depleting agents are used in coolants, foaming agents, fire extinguishers, solvents, and aerosols. It sometimes takes these ozone-depleting chemicals years to reach the stratosphere. Substances released into the air today will contribute to ozone destruction well into the future. The main culprits are chlorine and bromine compounds.

One chlorine or bromine molecule can destroy 100,000 ozone molecules, so ozone is currently being destroyed much more quickly than nature can replace it.

Ground Level Ozone and Smog

The ozone that is dangerous to human health is ground level ozone. It is exactly the same chemical formula as stratospheric ozone – O_3. Yet, it is a major health hazard and a major constituent of photochemical smog.

Previously smog was a combination of just smoke and fog. Today smog is a chemical mixture of various gases and particulate matter (PM) that forms a brownish-yellow haze primarily over urban areas.

Nitrogen oxides and hydrocarbons (except methane) react in the presence of heat and sunlight to form ozone. It is a white haze that can be seen over many modern cities, especially the ones with sunny, warm, dry climates and a large number of motor vehicles. Because it travels with the wind, it can affect sparsely populated areas as well. It is close to the Earth in the troposphere and is called tropospheric ozone. This ozone is one component of smog. The others are:

- nitrogen oxides (NOx),
- volatile organic compounds(VOC),
- sulphur dioxide,
- acidic aerosols and gases, and

- particulate matter.

These react with each other in various ways to form the brownish yellow haze, the modern day smog, that we see over so many cities with a poorly controlled environment.

1. When fossil fuels (coal, petrol and diesel) are burnt in our cars, coal powered plants and factories there is intense heat. Thanks to the heat, sulphur present in these fossil fuels reacts with oxygen in the air to form sulphur oxides SO_x; Sulphur dioxide is especially bad for our health and environment and is a component of smog.

2. The combination of ozone and PM is also part of photochemical smog.

a. Nitrogen compounds present in petroleum and oxygen in the air react under high temperatures (close to car engines for example) to form oxides of nitrogen (NO_x).

b. Volatile Organic Compounds or VOCs are emitted into our atmosphere due to natural phenomena and from human activities like automobiles, chemical manufacturing facilities, pesticides, drycleaners, paint shops, degreasers, glues or adhesives and other commercial and residential sources.

c. These oxides of nitrogen (NO_x) and Volatile organic compounds (VOCs) combine with each other in the presence of sunlight to form ozone and tiny airborne particles known as particulate matter (PM).

NO_x + VOCs à O_3 + PMs

d. Finally this ozone reacts with the VOCs to form photochemical smog. These photochemical reactions often occur hundreds of miles from where the VOCs and nitrogen oxides are released, making ozone a very difficult pollutant to control.

3. As the smog levels build, polluted air can be trapped and re-circulated for days so that car exhaust fumes are found in our atmosphere even when we aren't driving. Ground level ozone becomes a threat to the functioning of all living things after it reaches 82 ppb (parts per billion).

What are the effects of ground level ozone on our environment and health?

- Human exposure to ozone can produce shortness of breath and, over time, permanent lung damage. Research shows that ozone may be harmful at levels even lower than the current federal air standard Excessive ground level ozone can cause breathing problems, irritation, congestion, coughing, chest pain and swelling in the lungs. It triggers asthma. Even healthy adults and children get affected.
- It affects the immune system. Many of the chemicals that cause ground-level ozone also contribute to other health effects, including cancer, and tissue and organ damage.
- High ozone concentrations also cause damage to the leaves of plants, resulting in the loss of agricultural crop yields and forest ecosystems.