NIH GREEN ZONE NEWSLETTER
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The Ozone Layer and It's Hole

Ozone is a chemical species that is frequently discussed with regards to the atmosphere. Each of us have likely heard for decades about the positive impact of the ozone layer. We may have also heard about the negative side effects from inhaling ozone. So, what is ozone and why is it sometimes referred to as "good" and other times as "bad"? Ozone (O_3) is a highly reactive gas compound composed of three oxygen atoms.[1] Whether it is viewed as good or bad is highly dependent on its location.

Humans live in the troposphere, which is the portion of the atmosphere that extends from the Earth's surface up to about six miles in altitude.[2] Ozone is most commonly produced in the troposphere through reactions of air pollutants like nitrogen oxides (NO_x) and volatile organic compounds (VOCs).[1] This ground-level ozone has a long list of negative effects on human health, primarily involving the respiratory system. When inhaled, ground-level ozone can cause the muscles in the airways to restrict, leading to difficult breathing, shortness of breath, coughing, lung damage and aggravation of asthma, emphysema and chronic bronchitis.[3] For these reasons, ground-level ozone is undesirable and considered one of only six "criteria air pollutants" designated for strict monitoring by the Clean Air Act.[4]

The effects of ozone are quite different in the stratosphere. The stratosphere begins where the troposphere ends, around six miles in altitude, and extends up to about 31 miles in altitude.[2] Ozone is naturally produced in the stratosphere when ultraviolet solar radiation cleaves the bond in molecular oxygen (O_2).[5] Each of the newly-produced and highly-reactive oxygen atoms (O) combines with an oxygen (O_2) molecule to form ozone (O_3).[5] Most of the ozone in the stratosphere is concentrated within 9 miles to 18 miles of altitude, forming the ozone layer.[2] This collection of ozone molecules absorbs certain wavelengths of incoming solar radiation, blocking a significant portion of dangerous UVB solar rays from reaching the Earth's surface.[6] UVB radiation has been shown to cause sunburn, skin aging and skin cancer.[6] You may have noticed your sunscreen claims "broad-spectrum sun protection." Most sunscreens are formulated specifically to include UVB radiation within their protection range since these are the most dangerous solar rays. The ozone layer acts as a first defense against UVB radiation to protect our skin.

The benefits provided from the ozone layer made it particularly worrying when scientists noticed a "thinning" of the ozone layer in the 1970s. The concentration of ozone in the stratosphere follows natural cycles based on sunlight intensity, season, latitude and many other variables.[2] These fluctuations are well-understood and allowed scientists to identify the depletion of ozone in the stratosphere beyond natural processes. The most well-known thinning of the ozone layer has become known as "the ozone hole." This does not refer to an actual hole, but rather to an area of low ozone concentrations that exists primarily over Antarctica from August through October due to a combination of stratospheric phenomena.[7] This "hole" was not the only location of ozone depletion in the stratosphere, but became the most widely-known example of a global problem. To learn about the progress towards preventing ozone depletion, please continue to our article "Fighting Ozone Depletion."

TAKE ACTION

How Can We Help the Ozone Layer?

The concentration of ozone within the ozone layer has decreased due to the presence of ozone-depleting substances (ODS). In this article, we discuss the most common ways you could encounter an ODS and what you should do.

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SPOTLIGHT

Fighting Ozone Depletion

Global efforts have been working to restore the ozone layer since the 1980's. In this article, we discuss the measures taken to prevent further ozone loss and the outlook for the ozone layer in the future.

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NEMS TRAINING

Did you know? The ozone hole is not a complete absence of ozone, but rather a drastic decrease in the concentration of ozone (defined as concentrations under 220 Dobson units). To learn more about emissions at the NIH, please visit the NEMS Training webpage to view a short (20 minute) NIH environmental awareness training video.