The Ozone Factor

Current science shows no relationship between global warming and ozone levels. By ***Allan Abraham***

Ozone is a molecule consisting of three atoms of oxygen (formula O3). It is formed by the photolysis of stable O2 molecules in the atmosphere by ultraviolet light followed by the recombination of the resultant single oxygen atoms with O2 molecules. Ozone is relatively unstable, and therefore readily reactive.

Depending on where it occurs, ozone can be protective or harmful. In the stratosphere (20km to 50km above the earth's surface, it blocks off harmful ultraviolet radiation from the sun. In the troposphere, i.e. at ground level, where we can breathe it, it is a pollutant that damages lung tissue and plants. These two types of ozone are called “good ozone” and “bad ozone”, respectively.

After the “ozone hole” was discovered, industrialized countries moved quickly to reduce the production of ozone-depleting substances (under guidelines set out in the Montreal Protocol of 1985). It is now estimated that the ozone layer will return to its pre-1980 levels by 2050. Some scientists worry that this date could be delayed by another 10 to 20 years because of greenhouse gases in the troposphere. Scientists studying climate change have raised the issue of whether lower ozone levels in the stratosphere will “feed back” to further increase greenhouse gas levels and temperature in the troposphere. The mechanism of this feedback is believed to be due to two relationships.

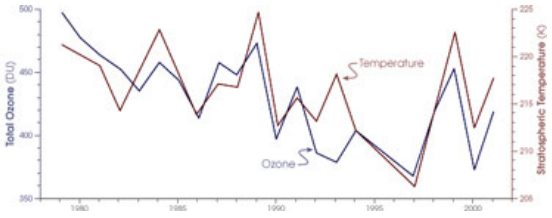
The first involves the fundamental finding about the ozone layer. During winter at the poles, clouds of ice crystals form in the stratosphere, providing sites for a series of complex chemical reactions that build up a supply of molecular chlorine, i.e. two bonded chlorine atoms (formula Cl2). With the coming of spring at the poles, temperatures increase and skies become clearer. Ultraviolet photolysis breaks up the chlorine molecules, releasing a flood of chlorine atoms. These atoms act as catalysts for the conversion of ozone into oxygen via the following two reactions:

Cl + O# = ClO + O#

ClO + O = Cl + O#

The net effect is to break down ozone molecules into oxygen molecules (O2) while leaving chlorine atoms free to break up more ozone molecules. So each chlorine molecule can break up a million ozone molecules. As a result of this chain reaction, ozone diminishes above the poles in spring leading to the ozone hole. The polar vortices, however, soon break down as spring temperatures rise further and fresh air carrying fresh ozone floods into the regions.

The relationship in the above process is between temperature and ozone levels. As stratospheric temperature drops, ozone levels decrease. The graph below shows stratospheric temperatures and ozone levels above the Arctic since 1979. Notice that stratospheric temperature and ozone levels are in step with each other. It is believed that the year-to-year temperature changes are driven by atmospheric movements, but the exact causes are not known.



The second relationship is the one of interest: that between stratospheric temperature and tropospheric temperature, which, if it exists, would create a link between stratospheric ozone levels and levels of greenhouse gases in the troposphere. Some scientists speculate that stratospheric cooling occurs because greenhouse gases absorb infrared radiation from the earth that would otherwise reach the stratosphere and raise temperatures. This in turn would increase ozone levels in the stratosphere (according to the first relationship). And more ozone, in its turn,

would block off more ultraviolet radiation, leading to lower surface temperatures. Conversely, lower ozone levels could cause higher surface temperatures. However, this is hypothesis. No reliable quantitative estimates are available for the various scenarios. And there is very little agreement on the hypothesis itself.

By way of conclusion, therefore, the following: Current research shows no relationship between global warming and ozone levels. It is widely believed that if there is a link it is tenuous and of negligible significance.

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SIDEBARS

Do Ozone Levels Affect Surface Temperature?

Scientists studying climate change have raised the issue of whether lower ozone levels in the stratosphere will "feed back" to further increase greenhouse gas levels and temperature in the troposphere.