SCIENCE CLASS CHALLENGE

OZONE Q&A FOR INSTRUCTORS

Thank you for participating in the **CAPCO Science Class Challenge!**

This document provides basic background information to answer questions on ozone-related issues in atmospheric science. Often students confuse ozone depletion with global warming or the Earth's protective upper ozone layer with ozone and smog at the ground level. This background Q&A will help you answer questions that may arise on these topics. After reading this, see "Instruction Guide: Our Atmosphere and the Ozone Layer," which provides a lesson plan focusing on the structure of the ozone layer and how we have learned to protect it.

Q: Are there Two Kinds of Ozone: Good Ozone and Bad Ozone?

A: Ozone is always the same O_3 molecule; its location in the atmosphere determines whether it is considered "good" or "bad" ozone. Ninety percent of ozone is "good" and is found in the stratosphere and it forms the Earth's protective ozone layer. The remaining ten percent is "bad" ozone, found in the troposphere close to the ground.

There are environmental concerns for both good and bad ozone, but the problems are unrelated to each other. Ozone depletion and the seasonal thinning of ozone near the Earth's Polar Regions (the ozone "hole"), relate to good ozone in the upper atmosphere; smog and ozone pollution that cause respiratory irritation, among other problems, involve bad ozone at ground level.

Q: What is the Earth's Protective Ozone Layer?

A: Ozone occurs naturally in the stratosphere, protects the earth and its inhabitants, and is produced and destroyed at a constant rate. It is gradually being depleted by certain classes of both naturally occurring and manmade chemicals. The latter are primarily chlorofluorocarbons (CFCs), halons, and other ozone depleting substances (used in refrigerants, foaming agents, fire extinguishers, and solvents). These ozone-depleting substances degrade slowly and can remain intact for many years as they move through the troposphere until they reach the stratosphere. There they are broken down by the intensity of the sun's ultraviolet rays and release chlorine and bromine molecules, which destroy "good" ozone. One chlorine or bromine molecule can destroy 100,000 ozone molecules, causing ozone to disappear much faster than nature can replace it.

It can take years for ozone-depleting chemicals to reach the stratosphere, and even though we have reduced or eliminated the use of many CFCs, their impact from years past is just starting to affect the ozone layer.

In the 1970s, American aerosol product manufacturers voluntarily took the lead in reducing CFC usage by switching to non-CFC propellants. In 1978, U.S. regulations banned CFC use as aerosol propellants, and now fewer than one percent – essential medical and pharmaceutical uses such as asthma inhalers – are permitted to use CFCs.

Throughout the 1980s, several countries – including Canada, Mexico, Australia and several European nations – passed regulations banning CFC use in aerosol containers. Under the international Montreal Protocol agreement, CFC propellant production was phased out as of January 1, 1996, in industrialized countries and will be phased out by 2010 in developing nations.

Q: What is Ground Level Ozone?

A: Bad ozone is found in the troposphere and is a component of "smog." It is totally unrelated to CFC use. Instead, motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major ozone precursors. Strong sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. Many urban areas tend to have high levels of bad ozone, but other areas are also subject to high ozone levels as winds carry motor vehicle exhaust and industrial emissions hundreds of miles away from their original sources.

Repeated exposure to ozone pollution may cause permanent damage to the respiratory system. It can worsen bronchitis, heart disease, emphysema, and asthma. Healthy people also experience difficulty in breathing when exposed to ozone pollution. Because ozone pollution usually forms in hot weather, anyone who spends time outdoors in the summer may be affected. Ground-level ozone damages plant life as it interferes with the ability of plants to produce and store food, making them more susceptible to disease, insects, other pollutants, and harsh weather.

Q: What is being Done About Bad Ozone?

A: The Clean Air Act Amendments of 1990 require states and cities to implement programs to further reduce emissions of ozone precursors from sources such as cars, fuels, industrial facilities and power plants. Power plants will be reducing emissions, cleaner cars and fuels are being developed, many gas stations are using special nozzles at the pumps to recapture gasoline vapors, and vehicle inspection programs are being improved to reduce emissions.

Q: Is There Really a "Hole" in the Ozone Layer?

A: The ozone "hole" is a well-defined, large-scale destruction of the ozone layer over Antarctica that occurs each Antarctic spring. The word "hole" is a misnomer; the hole is really a significant thinning, or reduction in ozone concentrations, which results in the destruction of up to 70% of the ozone normally found over Antarctica.

The science of ozone thinning is complicated. Unlike global ozone depletion, the ozone "hole" occurs only over Antarctica. Since most ozone-depleting substances are released in the northern hemisphere, a common question is why the ozone "hole" occurs over the Antarctic. The first part of the answer is that even though most of these chemicals are heavier than air, regardless of where they're released, they mix throughout the troposphere over about a year, and then mix into the stratosphere in two to five years. The second part of the answer is that although the overall process is similar between global ozone depletion and the ozone “hole”, there are two different types of ozone depletion chemistry.

The first kind is called homogeneous depletion; resulting from reactions as gases mix together, it is responsible for the reduction in global ozone levels. The 5-10% drop in ozone over the US is an example of homogeneous chemistry.

The second kind of ozone depletion chemistry, called heterogeneous, causes the radical destruction of ozone over the Antarctic each spring. It results from reactions on the surfaces of ice particles. The existence of these particles, and the seasonal and geographic location of the “hole,” all result from a combination of meteorological and other effects that are specific to Antarctica at that time of year.

Q: Does the Ozone Hole Cause Global Warming?

A: The greenhouse effect is a natural phenomenon that helps regulate the temperature of Earth. The sun heats the Earth, and clouds and greenhouse gases in the atmosphere trap some of this heat. Although water vapor is the most abundant greenhouse gas, fuel burning and other human activities release greenhouse gases, as well. The most important ones are carbon dioxide, methane and nitrous oxide.

Without any greenhouse gases, the Earth would be uninhabitable. Human activity has increased the level of greenhouse gases in the atmosphere, which may have contributed to the average warming of 1.1 degrees Fahrenheit over the last century.

Although many people confuse ozone depletion and global warming, they are primarily separate problems. While stratospheric ozone is a natural greenhouse gas that helps absorb heat, the ozone hole that has been shown to form over the polar region is not the cause of global warming.