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NF91-27 A Discussion of 'Greenhouse' Gases

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The Earth's Climate System

The earth's climate depends on the planet's receiving and disposing of energy from the sun. Except for a small fraction of heat from its inner core, all energy received at the earth's surface originates from the sun. Although the earth receives only about one two-billionth of the energy emitted by the sun, it is this energy that heats the earth, drives the oceans, and creates weather patterns.

The sun, which has a temperature of approximately 11,000° F, emits its energy in short wavelengths (wavelengths that can easily penetrate the earth's atmosphere). The earth absorbs this energy, warms up, and then releases this energy. One of the primary mechanisms for releasing this energy is through radiation in wavelengths that are relatively long compared to those of the sun's. If the earth did not release this energy, the earth's surface would become very hot and would be unable to support life.

The Role of Earth's Atmosphere

Earth's atmosphere is composed of many different gases, three of which make up about 99.95% of the atmospherenitrogen (78.08%), oxygen (20.95%), and argon (0.92%). However, it is the gases that comprise the other 0.05% of the atmosphere (often called "trace" gases) that have scientists concerned. Two trace gases in particular, carbon dioxide and methane, have a very important attribute. While being virtually transparent to the shorter wavelengths of energy received from the sun, these gases readily absorb the longer wavelengths of energy given off by the earth. Thus, a portion of the energy from the earth that would normally be released to space is absorbed by these trace gases and is then retransmitted back toward the earth. Therefore, these trace gases have been termed "greenhouse" gases because they are somewhat analogous to the glass of a greenhouse. That is, they allow the sunlight to pass through but they prevent much of the energy from radiating back through.

The levels of these trace gases in the atmosphere have been increasing steadily over the past century — paralleling the rapid growth of industrialization. Because of the number of anomalous warm periods in the past two decades, reports on these gases have been numerous and highly visible in the news media. The primary source of the increased level of carbon dioxide in the atmosphere is the burning of fossil

fuels such as coal, oil, and natural gas. However, the regional decline of boreal and tropical forests is also important because these areas that once removed carbon dioxide from the atmosphere are now a source of carbon dioxide as they are cut down and burned. The increased level of methane in the atmosphere comes from a variety of sources, which include: rice paddies (rice is the most abundant crop worldwide), the digestive tracks of bovine, and termites (termites give off methane as a natural process in the digestion of wood and other cellulose wastes — in fact, it is believed that there is about three-fourths of a ton of termites for every human being on earth and they produce between 5 and 10% of all the methane in the atmosphere).

Estimating the Influence of Increased Trace Gases on Climate Patterns

Several Global Circulation Models (GCMs) — complex computer programs that attempt to model the future climate of the earth — have been developed over the past 15 years on large supercomputers. All of these GCMs predict a warming of the earth's climate of some 2.5 to 10° F, when the preindustrial level of carbon dioxide in the atmosphere has doubled — estimated to occur around the middle of the next century. However, there are many nonproven assumptions built into these models. Due to these assumptions, the confidence placed in the GCMs accuracy is limited. The low geographical resolution and the lack of agreement between the different GCMs — in regard to the predicted magnitude of temperature and precipitation change by geographical location — are also a causes for decreased confidence.

A warming and cooling of the earth's climate by 2.5-10° F is not uncommon, it has occurred many times in the past. The difference between previous climate changes and the anticipated "greenhouse" warming is one of time. The climate changes of the past have occurred over many millennia, while the present "greenhouse" warming is envisioned to occur over a couple centuries.

In the past century, the concentration of carbon dioxide in the atmosphere has increased about 30%, while over the same period the average global temperature has increased between 1 to 2° F. Climatologist's calculate the average of many locations; some have gone up, some have gone down. This is much like the stock market — every day some stocks go up and some go down but by watching an appropriate sample, the analysts can say the stock market has risen or fallen.

But still, scientists don't consider this slight warming to be proof of a greenhouse warming, as there are too many other possible causes for fluctuations. There is no evidence that the 1 to 2° F temperature rise over the past century is beyond the range of naturally occurring variation. Besides, the temperature rise that has taken place has not been continuous. From 1890-1940 the climate became warmer in the Northern Hemisphere; from 1940-1960 the climate became colder; and since 1960 the climate has again warmed.

Estimating the Influence of Increased Trace Gases on Great Plains Agriculture

Although some models predict a warmer and drier climate for the Great Plains and Corn Belt region of the United States, not all models agree, especially with regard to precipitation. But since precipitation and soil water content, are such important resources in Nebraska and the Great Plains, it is important to have some idea as to the net change in precipitation and soil water with the anticipated change in climate. After all, it is precipitation and soil water that determines, to a great extent, the agricultural productivity in Nebraska and the Great Plains.

Obviously, a drier climate alone would be detrimental to agriculture in this region. However, since carbon dioxide is the "food" upon which vegetation sustains itself, an increase in carbon dioxide would

enhance plant growth. In addition, it has been shown that an increase in carbon dioxide translates into an increase in plant water use efficiency or more plant growth for a given amount of water used by the plant. Another benefit of a greenhouse warming would be an increase in the length of the growing season. This will be beneficial in some areas of the Great Plains where the growing season is currently shortened by cooler temperatures particularly toward the end of August — beginning of September.

Overall, the influence of greenhouse gases on agriculture in the Great Plains and Corn Belt regions may have its greatest effect in the "boundary" areas. In these areas there may be a switch in the major crops that can be grown there or there may be a switch from cultivated to noncultivated agriculture.

A major concern is that producers could possibly be forced to make major changes in equipment investments in order to shift from current crops to crops appropriate for a changed climate. Planting, irrigation, and harvesting equipment that are now appropriate may not be in the future. If major crops for an area are displaced then education programs would be essential to train producers to efficiently produce crops that are "new" to their area.

What Can Be Done in the Meantime

The climatic changes, if they occur, will take place over a relatively long period of time. Therefore, any necessary adjustments could be made without great upheaval. However, better management practices that conserve the resources currently at hand — such as water and energy — should be adopted and/or improved such that we all become more efficient managers of our resources. Most of all, do not panic but keep informed about what is going on.

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