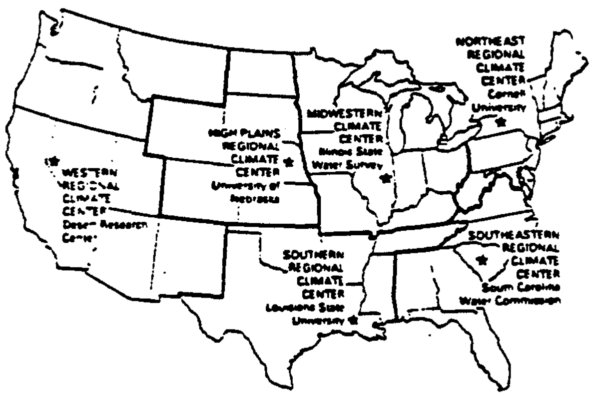
Western Region Technical Attachment
No. 91-07
February 19, 1991

STATEMENT ON CLIMATE CHANGE
AND THE GREENHOUSE EFFECT

STATEMENT ON CLIMATE CHANGE AND THE GREENHOUSE EFFECT



by
REGIONAL CLIMATE CENTERS

High Plains Climate Center - University of Nebraska
Midwestern Climate Center - Illinois State Water Survey
Northeast Regional Climate Center - Cornell University
Southern Regional Climate Center - Louisiana State University
Southeastern Regional Climate Center - South Carolina Water Commission
Western Regional Climate Center - Desert Research Institute

March 1990

STATEMENT

ON

CLIMATE CHANGE AND THE GREENHOUSE EFFECT

by
Regional Climate Centers

<u>The Issue</u>

Many scientists have issued claims of future global climate changes towards warmer conditions as a result of the ever increasing global release of Carbon Dioxide (CO_2) and other trace gases from the burning of fossil fuels and from deforestation. The nation experienced an unexpected and severe drought in 1988 which continued through 1989 in parts of the western United States.Is there a connection between these two atmospheric issues? Was the highly unusual 1988-89 drought the first symptom of the climate change atmospheric scientists had been talking about for the past 10 years?

Most of the scientific community say "no." The 1988 drought was probably not tied to the ever increasing atmospheric burden of our waste gases. The 1988 drought fits within the historical range of climatic extremes over the past 100 years.

Regardless, global climate change due to the greenhouse effect is an issue of growing national and international concern. It joins the acid rain and ozone layer issues as major atmospheric problems arising primarily from human activities.

The term "Greenhouse Effect" derives from the loose analogy between the behavior of the absorbing trace gases in the atmosphere and the window glass in a greenhouse. Carbon dioxide and other trace gases (ozone, methane, chlorofluorocarbons, nitrous oxide, etc.) present in the atmosphere are relatively transparent to solar radiation and allow most solar energy to reach and warm the earth's oceans and land surfaces. The presence of these gases in the earth's atmosphere therefore requires terrestrial and near surface temperature increases in order for outgoing long-wave radiation to balance incoming solar radiation. The net result is that global average air temperatures near the earth's surface are approximately 25-30° Celsius (45-54° Fahrenheit) warmer than would be the case if carbon dioxide and the other selectively absorbing gases were not present.

The greenhouse effect has been with us for as long as the earth has had an atmosphere containing selectively absorbing gases. Its functioning is essential for the existence of our present climate and the maintenance of life on earth as we know it. Present concern about anthropogenic enhancement of the greenhouse effect is based on the widely accepted hypothesis that an increase in the concentration of carbon dioxide and/or other absorbing trace gases in the atmosphere will increase the trapping of radiation emitted by terrestrial surfaces and thereby tend to increase surface temperatures globally and, more generally, to alter the earth's climate.

What Do We Know?

There is clear evidence that CO_2 and the other trace gases are steadily increasing; the decadal increase of CO_2, is 4% in the earth's cleanest air, that over the central Pacific. The concentration of carbon dioxide in the atmosphere is still quite low, about 350 parts per million at present, but has been increasing for more than a century largely as the result of increased burning of fossil fuels. Scientists agree that atmospheric carbon dioxide concentration has increased by about 25% since the 1850s with most of the increase occurring in the last three decades. Significant increases in the concentration of other absorbing gases, particularly chlorofluorocarbons and methane, have also been observed in recent decades. Typical projections based on estimates of future fossil fuel use suggest that the concentration of carbon dioxide in the atmosphere will double at some time in the next century.

Global climate models, which mathematically describe and simulate climate conditions over the earth, have been used to predict changes in climate that may result from future increases in the concentrations of absorbing gases. The several global climate models are consistent in predicting general warming of a global climate equilibrated with a doubled concentration of carbon dioxide. With twice the present carbon dioxide levels in the atmosphere, the models predict 2° to 6° Celsius increases in the global average temperature. The increased warming would increase the moisture in the atmosphere, altering clouds and precipitation. According to the GCMs, precipitation globally would tend to increase and its regional distribution would be changed.

What We Don't Know

Global Climate Models are based on many assumptions about the relative importance of different physical processes, and they are coarse in their spatial resolution because of limitations on available computing capabilities. Each of the currently operating models uses somewhat different mathematical descriptions and different sized spatial grids in attempting to predict global climate conditions several decades into the future.

We know that increased warming will increase the atmosphere's water holding capacity, but how this will affect the frequency and/or duration of clouds is not clear. Clouds reduce the amount of solar radiation reaching the surface, and added cloudiness might act as a "buffer" to reduce the overall global warming. The GCMs utilized to study global warming do not yet treat clouds in sufficient detail to allow a definitive study of this feedback process.

In many respects, present climate models are primitive, and cannot specify, with any accuracy, whether climate changes will occur gradually or in a series of major changes interspersed with years of little change. Such uncertainties over the transition of climate also make any association with the drought of 1988 impossible.

These models also have poor spatial resolution and exhibit substantial differences in their predictions of the future climate for a given region. Disagreement in predictions among the different climate models is particularly evident for precipitation. For example, the predictions of one global climate model, when used as a basis for predicting water levels of the Great Lakes, indicates that in 50 years, the level of Lake Michigan will be 2 feet lower than the current average, whereas the predictions from another climate model lead to a 9-foot decrease. This difference would create vastly different effects on water supplies, transportation, and the economies of the U.S. and Canada.

What Do We Need to Do?

We should not deny the seriousness of the Greenhouse-climate change issue. We need to understand it and to put it in perspective.

The major scientific uncertainties make it necessary, at present, to study specific actions in response to currently predicted climate changes. It would be prudent to aggressively explore our range of options.

We need to strengthen our deteriorating climate observing network to permit us to quantitatively measure changes in climate.

We recommend close and careful monitoring of the climate, including measurements to document physical conditions significant on a global scale (such as cloud albedo, effects of ice on radiation balance, and natural chemicals in the atmosphere).

We recommend research into the physical phenomena and special attention to the possible socioeconomic and environmental sensitivities of a changed climate.

Further development and refinement of the GCMs and mesoscale models are essential.