

## **Energy Matters: Global Warming and Climate Change**

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Climate change has affected and displaced people in the past. The native Chaco pueblo people, who lived in northwest New Mexico from about 850 to 1250 AD, developed a robust, sedentary agricultural culture that sustained about 40 great houses and a larger number of small villages throughout the San Juan basin. After 400 years of continuous existence, the Chaco people experienced long periods of drought and were forced to immigrate to a more hospitable environment, abandoning their architectural monuments and structures. Changing precipitation was the reason.

Current climate models predict major changes in precipitation climate regions resulting from small increases in globally averaged temperatures. Water vapor is our most important greenhouse gas, a gas we cannot live without. A globally averaged increase in temperature produces more water vapor, which, because it is a greenhouse gas, produces more warming. That is known as a positive feedback. The increase in water vapor also produces more clouds, which reflect sunlight, thereby reducing solar heating of the ground and reducing global warming by cooling the ground and atmosphere. That is known as a negative feedback. The problem for the modelers is which effect is more important.

Over the past several decades, the “El Nino, La Nina” spatial temperature variations of less than a few degrees sea surface temperature in the tropical Pacific Ocean have been shown to affect the seasonal variations of temperature and precipitation in the United States. As the sea surface temperature pattern changes, so does the pattern of the amount of precipitation. Under current “La Nina” conditions, the NOAA National Center for Environmental Predictions forecasts drought in the southeastern United States and excess precipitation in the Pacific Northwest, the Northern Rockies and the Ohio River Valley. Perhaps the record snowfall totals in New England can also be attributed to “La Nina” temperature variations. The current climate models predict increased variations in extreme weather conditions as global warming increases.

Carbon dioxide and methane in the atmosphere have long been known to cause warming of the atmosphere. Indeed the earth would not be habitable without the greenhouse effect. Arrhenius, a Swedish Nobel prizewinner, made some of the earliest calculations of the greenhouse effect back in the 1890s. He calculated that a doubling of the amount of carbon dioxide in the atmosphere would increase the temperature by about 10° F. The current model estimates, based on a more complete understanding of atmospheric physics, estimate less than half that amount.

That the greenhouse effect could change the average temperature of the atmosphere has been known for a long time. The amount of the change has always been in question. The accurate observations needed to verify the actual temperature change for increases in carbon dioxide were not available. With the advent of satellite observations, we now have the tools needed to establish the validity of the model predictions. Observations made since 1970 show that global warming is occurring at an ever-faster rate and that the problem of climate change and the attendant changes need to sustain our way of life are real.