

June 2001 Meeting: Gutzler on Global Warming

by Dave Thomas



At our Wednesday, June 13th, 2001 meeting, we heard Dr. David Gutzler, UNM Earth & Planetary Sciences, speaking on "Global Warming: Science and Policy Perspectives." Prof. Gutzler discussed greenhouse warming, the current status of climate change research, and the Kyoto protocol.

Gutzler first described the Greenhouse Effect, wherein sunlight emitted by the 6000^oK-hot sun passes through earth's transparent atmosphere, is absorbed by the ground, and is re-emitted as infrared radiation, which heats up the air. Almost all the energy emitted by the ground is absorbed by the atmosphere in one way or another. Gutzler emphasized that the Greenhouse Effect is not a "villain," if there were no Greenhouse Effect, the earth's temperature would be 33^oC (about 59^oF) cooler than it is today, making the average temperature a chilly 255^oK (-18^oC, or about 0^o F). What absorbs the infrared radiation? Nitrogen and oxygen gases (O₂ and N₂) are not good absorbers, so 99% of the atmosphere is not involved. Trace gases, including water vapor (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄) are the key players. Ozone (O₃) is a player only for incoming sunlight - it absorbs the ultraviolet well, but doesn't react to the infrared radiation emitted by the earth. Gutzler presented data showing that CO₂ levels are increasing, from a pre-industrial level of 280 ppmv to 315 ppmv (1958), and 355 ppmv (1988). There is no plausible explanation for this increase besides people, Gutzler said.

Temperatures have been rising also, but that gets more complicated. In the last century, temperatures increased by 0.6^oC. (See American Geophysical Union's *EOS*, Vol. 80, No. 39, September 28, 1999, p. 453, "Climate Change and Greenhouse Gases" by Tamara S. Ledley, et. al., online at http://www.agu.org/eos_elec/99148e.html). Gutzler noted that the "Little Ice Age" was a European phenomenon, not a worldwide one. Temperature records, based on oxygen isotopes, overlay beautifully with CO₂ levels, but is temperature responding to CO₂, or is CO₂ responding to temperature? For example, when earth's orbit makes the seas colder (the Milankovitch cycle), they absorb more CO₂. The Greenland ice-core record, going back 100 thousand years, shows that the last ten thousand years have been very stable, the most stable in the last thousand centuries. Gutzler said he is worried because "We shouldn't mess with a good thing."

We do understand some things quite well, like the Greenhouse Effect. We know that CO₂ levels are increasing due to humanity; global temperatures are increasing; and carbon dioxide and temperature are intimately connected in paleoclimate studies. Why is there any debate? One source of uncertainty is climate monitoring: we need to improve our climate observation system, for both present and past changes. Our knowledge of the global CO₂ cycle is incomplete -- what happens to CO₂ emissions? Some of it goes to the oceans, and some to vegetation on the land, but we don't know if it will become saturated in either reservoir. We need better understanding of particulate pollution, which in many cases, such as sulfates, *mitigates* warming. We don't understand climate feedbacks well enough. For example, if there are a lot of clouds, sunlight will be reflected, cooling the earth, but more infrared will be re-absorbed, heating the earth. If there are more glacial ice sheets, that reflects more sunlight, cooling the earth, creating more ice sheets; as ice sheets retreat, less sunlight is reflected, heating the earth and melting more ice. As water vapor absorbs more heat, the temperature rises, allowing more water vapor to form, which absorbs more heat, and so forth. The situation is so complicated that we need *models* to study it. Climate forecasts are incredibly difficult, and we've never predicted anything as complicated as this before. In older models, many state-sized parcels of air were used to represent the atmosphere, but clouds are much smaller than states, and could not be accurately analyzed. Newer models have the cell size down to about a degree of latitude (70 miles or so), but are still far larger than typical clouds. We can model some large scale phenomena like the trade winds, but are still having trouble with El Niño.

Prof. Gutzler concluded his talk with remarks on the Kyoto accords. The International Panel on Climate Change, IPCC, didn't issue any conclusion in their 1990 report. By 1995, they concluded there was a discernible effect of humanity on the climate. In 2001, they declared that most of the warming of the last 50 years is human-caused. Critics of the Kyoto accords point to discrepancies between various models as proof that they are all incorrect, but Gutzler noted that it is impossible for different models to agree exactly, and that we need humility in the face of so much uncertainty. The Kyoto protocol was based on the Ozone Depletion treaty of 1992. Its goals for "Annex I" (developed) countries include reductions of greenhouse gas emissions to at least 5% below 1990 levels by 2008-2012, with progress by 2005, and credit for CO₂ sinks (forests, for example). Goals for the 38 Annex I countries include 6% reductions in Japan and Canada, 7% in the USA, and 8% in Europe. There are no goals for non-Annex I countries, and that's one of the sticking points. Fully 55 countries, which include 55% of the emissions, must ratify the treaty before it can take effect; so far, *no* Annex I countries have ratified the treaty.

NMSR thanks Dave Gutzler for a very interesting talk.