GLOBAL WARMING: MEDIA CHAOS
Can Mathematicians/Statisticians Help?

Invited Presentation

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GLOBAL WARMING is truly one of the most compelling and complicated problems facing our society. Wikipedia (on-line encyclopedia) defines the phenomenon of "**GLOBAL WARMING**" as the increase in the average temperature of the earth's near-surface air and oceans in recent decades and its projected continuation.

A recent Intergovernmental Panel on Climate Change (IPCC), in their report entitled "Climate Change 2007: The Physical Science Basis — Summary for Policymakers," concluded that an increase in global temperatures will result in an increase in sea level, unpredictable changes in the amount and patterns of rainfall, an increase in the frequency and intensity of extreme weather events such as hurricanes, alterations in agricultural yields, glacial retreat, a decrease in river flows and lake levels and the extinction of entire species. Their remarks have been supported by some professional societies such as the American Meteorological Society, the American Geophysical Union and the American Association for the Advancement of Science. Furthermore, in 2001, the National Academies put the blame of the subject problem on human activities. However, there are doubters to their (IPCC) findings and concluding remarks. Skeptics argue that everything from sunspots to cattle flatulence is causing the earth to warm and insist that scientists were stretching the truth.

Furthermore, the temperature increases that we are experiencing are infinitesimal, during the past 100 years — the mean global surface air temperature increased by approximately 1.3°F(0.32°F). Dr. Thomas G. Moore, Senior Fellow at

the Hoover Institute at Stanford University, in his article entitled "Climate of Fear: Why We Shouldn't Worry About Global Warming" is not concerned with such small changes in temperatures. Furthermore, in his interview with Newsweek, he said more people die from cold than warmth and an increase of a few degrees could prevent thousands of deaths.

Recently, Britain's Channel 4 has produced a documentary entitled "The Great Global Warming Swindle,"[1] adds significantly to the controversies. Also, NASA scientists believe that the sun is hotter than we previously thought. Thus, solar activity may play a greater role in global warming than the general consensus that mankind is the major cause.

Also, recently, the Danish National Space Center, conducted several experiments and their scientists concluded that the real cause of the temperature changes is due to fluctuations in the sun's output, causes changes in the earth's temperature. They further stated that "…there is absolutely nothing we can do to correct the situation."

It is well known that carbon dioxide, CO2, is the primary cause of "**GLOBAL WARMING**." Jim Verhult, Perspective Editor, *St. Petersbur*g *Times*, writes, "carbon dioxide is invisible — no color, no odor, no taste. It puts out fires, puts the fizz in seltzer, and it is to plans what oxygen is to us. Its hard to think of it as a poison." The U.S.A. is emitting approximately 5.91221 billion metric tons of CO2 in the atmosphere, which makes us the World leader; however, by the end of 2007, it is expected that the Republic of China will be the new leader. Temperatures and CO2 are related in that as CO2 emissions increase, the gasses start to absorb too much sunlight and this interaction warms up the globe. Thus, the rise in temperature and the debate of "**GLOBAL WARMING**."

Now, the media enters the picture — television, debates, documentaries, newspaper, magazine and journal articles (both pro and con), scientific controversies, townhall meetings, state and federal government commissions, among others, have debated this phenomenon. In fact, it has become somewhat humorous: "every weather extreme is global warming!" "They know how to propagandize: they know how to keep it alive," "Global warming has been called the most dire issue facing the planet and yet, if you are not a scientist, it can be difficult to sort out the truth." (Source: *Time*s Washington Bureau Chief, Bill Adair.)

[1] Parts of this can be seen at http://www.channel4.com/science/microsites /G/great_global_warming_swindle/index.html

We need to mention here that Australian scientists and beermaker Foster's are joining forces to determine if beer can solve global warming. They believe that they can convert a brewery's alcohol-rich wastewater into a battery with sugar consuming bacteria and produce enough electricity to power a building with green energy.

During the academic year, a small group (6) of statisticians and mathematicians at the University of South Florida has met weekly to study the problem of "**GLOBAL WARMING**" from an analytical perspective. In reviewing the published literature on the subject matter, we were astonished by the limited scientific effort that involves sophisticated statistical and mathematical analysis and modeling on various complex and interacting entities. After all, if you make a decision using historical data with a high degree of its correctness in a specific and important issue concerning the subject matter, it will minimize doubters and proceed to address the problem. Preliminary analysis and modeling convinced our group that with a well-defined mission, we can make a contribution to this global problem.

While our group was working on the subject matter, an article appeared on the front page of the *St. Petersbur*g *Time*s on January 23, 2007. This article, entitled "Global Warming: Meet Your New Adversary," was written by David Adams. The highlight of this article was a section called "By the Numbers," which stated some information concerning the continental United States: 2006 hottest year; U.S. top global warming polluter; 20% increase of CO2 since 1990; 15% of CO2 emissions by 2020; 78 number of days U.S. fire season has increased; and 200 million people that will be displaced due to global warming. Our data for the continental U.S. does not support the first four statistics, we have no data for the fifth, and the sixth is quite hypothetical. The final assertion, with "0" representing the number of federal bills passed by Congress to cap Americas global warming pollution, is of significant importance to our group's mission.[2] Also, very recently, the Supreme Court of the U.S., in one of its most important environmental decisions, ruled that the Environmental Protection Agency (EPA) has the authority to regulate the greenhouse gases that contribute to global climate changes unless it can provide a scientific basis for its refusal.

We believe that a contributing factor in creating controversies among scientists (and this is passed on to the policymakers and the media) is a lack of precise and accurate statistical analysis of historical data with an appropriate degree of confidence. The problem of "**GLOBAL WARMING**" is very complex with a very large number of contributing entities with significant interactions. We believe that

statisticians/mathematicians can help to create a better understanding of the subject problem that hopefully will lead to the formulation of legislative policies.

Can Statisticians Help?

During the past academic year at USF, a group of my graduate students and I have been studying several aspects of "**GLOBAL WARMING**," as related to the U.S. Our initial systematic and analytical approach to the problem is based sequentially in the following areas:

1. To determine the available data/information that exists globally (and especially in the U.S.) with respect to the following contributing factors:

   (a) Temperatures
   (b) Carbon dioxide (CO2) in the atmosphere
   (c) Carbon dioxide (CO2) from the burning of fossil fuels
   (d) The key attributable variables that contribute to carbon dioxide, namely: (1) emission (fossil fuel combustion); (2) deforestation and destruction; (3) terrestrial plant respiration; (4) respiration; (5) the flux from oceans to atmosphere; (6) terrestrial photosynthesis; (7) the flux from atmosphere to oceans; and (8) burial of organic carbon and limestone carbon (among others).

   The available data and its reliability is essential in our effort to our proposed analysis and modeling. We have obtained a significant amount of information from several sources in the U.S. to proceed with our studies.

2. To develop accurate statistical forecasting models to predict the temperatures in the U.S. in the near future as well as in the more distant future. The subject models should predict temperatures on a monthly or yearly basis (as needed).

   Temperature is a key entity in the study of global warming. Thus, we have developed some accurate seasonal statistical models that will play a significant role in its relation to carbon dioxide and strategic planning.

   Furthermore, our model shows two time periods in particular where there were marked temperature increases—one back in the early 1900s and one during the last 15 years.

[2] See the attached response to the *St. Petersburg Times* dated March 19, 2007.

3. Determine any temperature patterns that might exist on an annual basis in the U.S.

   Yes, there are seasonal temperature patterns which we have statistically identified that will lead to a better understanding of its behavior.

4. Determine the probability distribution that analytically characterizes the behavior of CO2 both with respect to the atmosphere and the burning of fossil fuels.

   Carbon dioxide is a random phenomenon and, thus, its measurement can be best characterized probabilistically. We have identified a classical extreme value probability distribution that characterizes its behavior very well. Thus, not only can we obtain basic statistical information about CO2, but we can identify its measure with a specified and acceptable degree of confidence.

5. Develop forecasting statistical models to predict the CO2 in the atmosphere and the burning fossil fuels as a function of time.

   We have developed analytical seasonal statistical models to predict CO 2 in the atmosphere and CO2 from emission-fossils. Although these models are analytically complicated, they produce good estimates. Estimating both CO2 in the near and distant future is essential in monitoring its behavior and for strategic planning.

6. Develop a statistical analytical model that accurately identifies the relationship of temperature and carbon dioxide.

   Using existing data for both temperature and CO 2 in the continental U.S., we have developed a two-stage model that, by knowing the temperature, we can predict CO 2 levels in the atmosphere. Although this is a preliminary model, it has been tested and the estimates of CO2 are very encouraging.

7. Develop a statistical model to estimate CO2 (the response) as a function of at least the eight attributable variables that we have defined above.

   This is an important and difficult statistical model that we are presently studying. Having such a model, we will be able to estimate the response, CO2, based on data from the attributable variables. In addition, we will be able to identify significant interactions among the attributable variables. Having knowledge of such a ranking could be quite useful in developing research policies to begin addressing the entities that most contribute to CO2 and not

allocate our limited resources to minor contributors.
Furthermore, having such a model we can identify, with a priorily specifying the degree of confidence, the range of values that the attributable entities can assume so as to either minimize or maximize the carbon dioxide.

8. Develop differential systems that identify the rate of change of CO2 as a function of time.

   There are some publications that address the subject area under a deterministic environment. The subject problem is anything but deterministic in nature. Thus, we propose to study the rate of change of CO2 with a system of stochastic (random) differential equations that more realistically characterize the number of uncertainties involved in a given environment.

Remarks

During our studies of "**GLOBAL WARMING**," we were in close communication with Dr. T. J. Blasing, an internationally-recognized Climatologist from the Carbon Dioxide Information Analysis Center (CDIAC), Environmental Science Division, Oak Ridge National Laboratory, U.S. Department of Energy. He was very helpful in guiding us to data sources and advising us on the relevance of our efforts. Recently Dr. Blasing participated in a two-day symposium, open to the public, that included round-table discussions on the broad scientific complexity of global warming. Of specific importance was the evaluation of the preliminary statistical and mathematical analysis and modeling that was mentioned above. As a result of these discussions, we feel quite confident that statisticians/mathematicians can make a difference. In conclusion, we believe that when we have reliable analysis and facts in place it will motivate our legislators at the state and national levels to formulate needed legal policies to address this very important problem that our society is facing.