STATEMENT TO THE COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM OF THE UNITED STATES HOUSE OF REPRESENTATIVES

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1. Introduction

I would like to thank the Chairman and the Committee for the opportunity to provide my perspective on the subject of political interference in government-funded science, as well as on the science of global warming.

I have been performing NASA-sponsored research for the last twenty-two years. Prior to my current position as a principal research scientist at the University of Alabama in Huntsville, I was Senior Scientist for Climate Studies at NASA's Marshall Space Flight Center. I am also the U.S. Science Team Leader for the Advanced Microwave Scanning Radiometer-E flying on NASA's Earth-observation satellite Aqua.

2. Political Interference in Government Climate Change Science

During my fifteen years as a NASA employee, I was well aware that any interaction between scientists and the press was to be coordinated through NASA management and public affairs. Understandably, NASA managers do not appreciate first reading of their scientists opinions in the morning newspaper. I understood that my position as a NASA employee was a privilege, not a right, and that there were rules I was expected to abide by. Partly because of those limits on what I could and couldn't say to the press on the subject of global warming, I voluntarily resigned from the government in the fall of 2001.

Some level of political influence on government-funded climate science has always existed, and likely always will exist. The influence began many years ago when the government climate research programs were first established. For instance, I once heard a high-level government official say that his success at helping to formulate the Montreal

Protocol restricting the manufacture of ozone-depleting chemicals was an example of the kind of success that global warming research could achieve to help restrict fossil fuel use. This is clearly a case of political and policy biases driving a scientific research agenda.

On the individual scientist level, if a government scientist wants to issue a press release addressing the theoretical possibility of catastrophic climate change in the future, and entitles it, "*Global Warming to be Much Worse than Previously Thought*", should the scientist's supervisors have the authority to intervene if they believe the title of the press release can not be justified by the research? What if the title reads, "*Global Warming Could Destroy Most of Humanity in the Next Five Years*"? Could managers intervene then? At some point, the agency for which the government scientist works must bear some responsibility for what that scientist, in his official capacity, says to the public and press. Managers can not simply give blanket approval to whatever the scientist wants to say just to avoid the impression of "muzzling the science". This is one reason why agencies like NASA and NOAA need to retain some level of control over how their employees portray their science to the public.

Political influences on climate research have long pervaded the whole system. Both government funding managers and scientists realize that science programs, research funding, and careers depend upon global warming remaining a serious threat. There seems to be an unspoken pressure on climate scientists to find new ways in which mankind might be causing a climate catastrophe -- yet no emphasis at all on finding possible climate stabilizing mechanisms.

Even the climate researchers themselves have biases that influence the direction they take their research. In psychology this is called "confirmation bias" (Klayman and Ha, 1987), and in my experience this is not the exception, but the rule. Researchers tend to be more accepting of data that confirms their preconceived notions or political or societal predilections. After all, what scientist would not want to be the one to discover an impending environmental disaster that awaits humanity…to "save the Earth"? Or, if one believes that modern technology is inherently evil, would not one then want to find sufficient evidence to put the fossil fuel industry out of business? If one has socialistic tendencies, then carbon permit trading provides an excellent mechanism for a redistribution of wealth from the richer countries to the poorer countries.

In my own case, I would rather be the researcher who discovers that global warming will be relatively benign **–** after all, what sane person could wish catastrophic global warming upon humanity for selfish political or social engineering reasons?

Bias in the expectation of policy outcomes was even shown in this committee's last hearing on this subject. On January 30, 2007, Rick Piltz, the Director of Climate Science Watch Government Accountability Project, told this committee:

"*Climate Science Watch engages in investigation, communication, and* ***reform advocacy*** *aimed at holding public officials accountable for using climate research with integrity and effectiveness in* **addressing the challenge of global climate change**." (emphasis added)

"*Reform advocacy*" and the phrase "*addressing the challenge of global climate change*" clearly presume that climate change is "a challenge" worthy of great worry and strong policy action. But based upon my own experience, it would have been at least as appropriate to have a separate advocacy group *"addressing the challenge of* <u>*unwarranted exaggeration*</u> *of global climate change".*

There is a way to reduce the impact of such biases in government-funded climate research programs. Years ago, the Department of Defense recognized the dangers of "group-think" and "tunnel-vision" when developing new defense systems. They formally instituted a "Red Team" approach where people are tasked with finding holes in the prevailing wisdom and consensus of how things should work. In my opinion, a Red Team approach to government funding of global warming research, especially in the climate modeling arena, would be very valuable.

So, rather than trying to eliminate political influence on the direction of government-funded research, this committee could help to at least balance those influences. After all, the science doesn't care what the answer is to the question of how much warming will occur in the future. And in my experience, the taxpayers would welcome a less biased approach to the spending of their money.

This committee now has the unique opportunity to help level the playing field for the scientific minority, and make sure that research programs are not biased by desired political outcomes. If only because scientists are human, political influence and biases will always exist in scientific research. But this committee can help by making sure that government is not contributing to the problem.

3. The Science of Global Warming

Even though globally averaged temperatures in recent decades have been unusually warm, there is no compelling evidence that they are either unprecedented in the last 1,000 years, or attributable to human greenhouse gas emissions. Given the extreme cost to humanity (especially the poor) that most economists claim will result from the restricting or otherwise penalizing the use of fossil fuels, a guiding principle for accepting claims of catastrophic global warming should be: *Extraordinary claims require extraordinary evidence*. Let us examine whether such extraordinary and compelling evidence exists.

3.1 Current Warmth in Its Historical Context

In June 2006, a National Research Council report (NRC, 2006) requested by congress examined claims that globally averaged temperature are warmer now than anytime in the last 1,000 years. That panel concluded that high confidence could only be given to the statement that we are now the warmest in 400 years – not 1,000 years. We should be thankful for this, since much of the last 400 years was enveloped in the "Little Ice Age" – a period that was particularly harmful to mankind.

Furthermore, actual temperature measurements (not proxies) in Greenland boreholes reveal the Medieval Warm Period (MWP) to be warmer than today (Fig. 1).

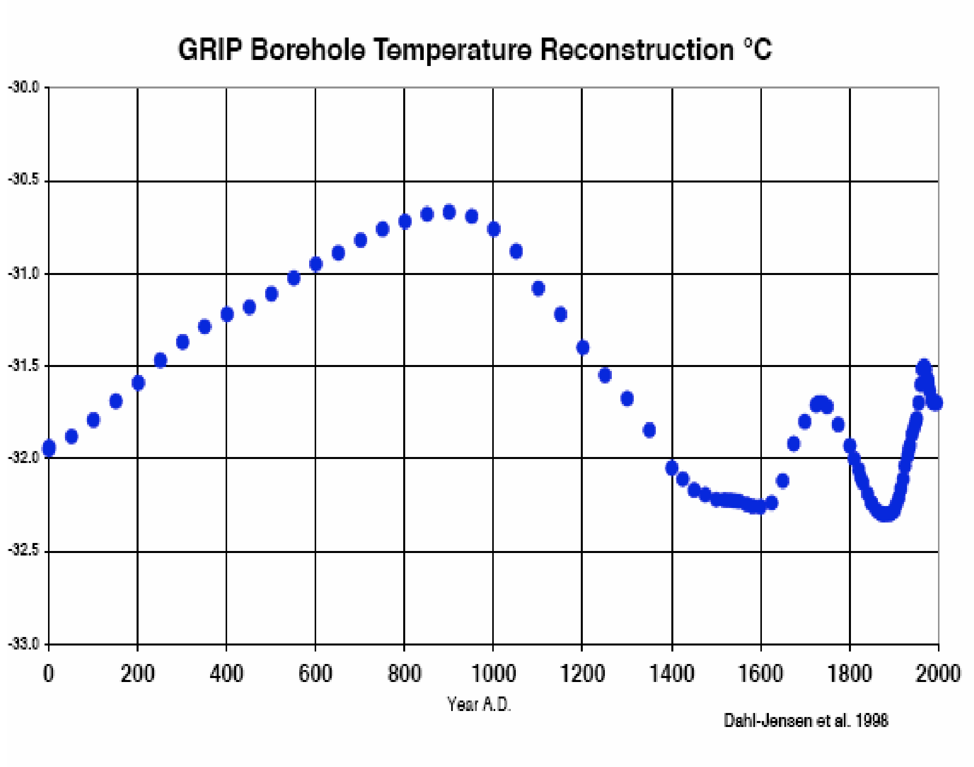

Fig. 1. The GRIP (Greenland) borehole temperature record is not a proxy, but a direct measure of temperature (Dahl-Jensen *et al.* 1998). It shows that current warmth is not unusual in the context of the last 2,000 years. A similar result for the last 1,000 years has also been obtained from borehole temperatures in the Ural Mountains (Demezhko and Shchapov, 2001).

Since the temperature signal tends to get smoothed with depth (age), it can be safely assumed that temperature "spikes" were also superimposed on the MWP warm "dome" seen in Fig. 1. These spikes would make our current warmth seem even less noteworthy by comparison.

In summary, the evidence for today's global warmth being unusual for interglacial conditions is neither extraordinary nor compelling.

3.2 Attribution of Current Warmth to Mankind

Some have found it effective to use the close relationship between ice core-inferred temperatures and carbon dioxide variations to imply that we will see similar relationships from anthropogenic CO2 emissions. But this intepretation of ice core data is, at best, controversial. If indeed these measurements are what they are claimed to be (estimates of global temperature and carbon dioxide concentrations), then virtually all of the evidence points to the temperature changes *leading* the carbon dioxide changes -- not the other way around – by at least 100 years. The Earth's carbon dioxide budget is still poorly understood, with huge sources and sinks of carbon in the oceans and land, and so it is entirely possible that the carbon dioxide changes were the result of biogeochemical changes resulting from the temperature changes. Since the cause-and-effect relationships in these ice core records appear to be the reverse of what we expect with anthropogenic global warming, I believe that ice cores should not be used to promote any quantitative estimates of how much warming a given amount of extra carbon dioxide will "cause".

Nevertheless, it is indeed possible to construct a *possible* scenario of radiative forcing wherein carbon dioxide causes the warming we have seen over the last few decades (Hansen *et al.*, 2005). But this in no way constitutes extraordinary and compelling evidence that greenhouse gas changes caused the warming – it is merely one possible explanation. A small decrease in low level cloudiness or a small increase in high level cloudiness – too small to be reliably measured with current satellite technology – could also explain our current warmth. Detailed estimation of radiative imbalances from a wide variety of manmade greenhouse gases and aerosols, as in Hansen *et al.*, (2005), are popular activities, but those radiative imbalances are theoretically calculated, not measured. They are still too small to be reliably measured with our satellite systems. What we do know is that substantial natural fluctuations in the Earth's radiation budget do occur which are much more abrupt and larger than those due to manmade greenhouse gases (Wielicki *et al.*, 2002; Chen *et al.*, 2002). It seems that since science can measure atmospheric carbon dioxide changes much more accurately than small variations in global cloud amounts and other natural processes, science then tends to ignore the possibility that recently global warming could be more due to natural causes than manmade ones.

It is often stated (usually with grave concern) that atmospheric carbon dioxide concentrations are higher now than they have been for hundreds of thousands of years (or more). But objectively, one must ask: *so what*? As can be seen in Fig. 2, carbon dioxide concentrations in the atmosphere are extremely low, and even two or three times an extremely small number is still an extremely small number. The fact that carbon dioxide concentrations could "double" in this century might sound scary, but we need to first examine what processes determine Earth's natural greenhouse effect.

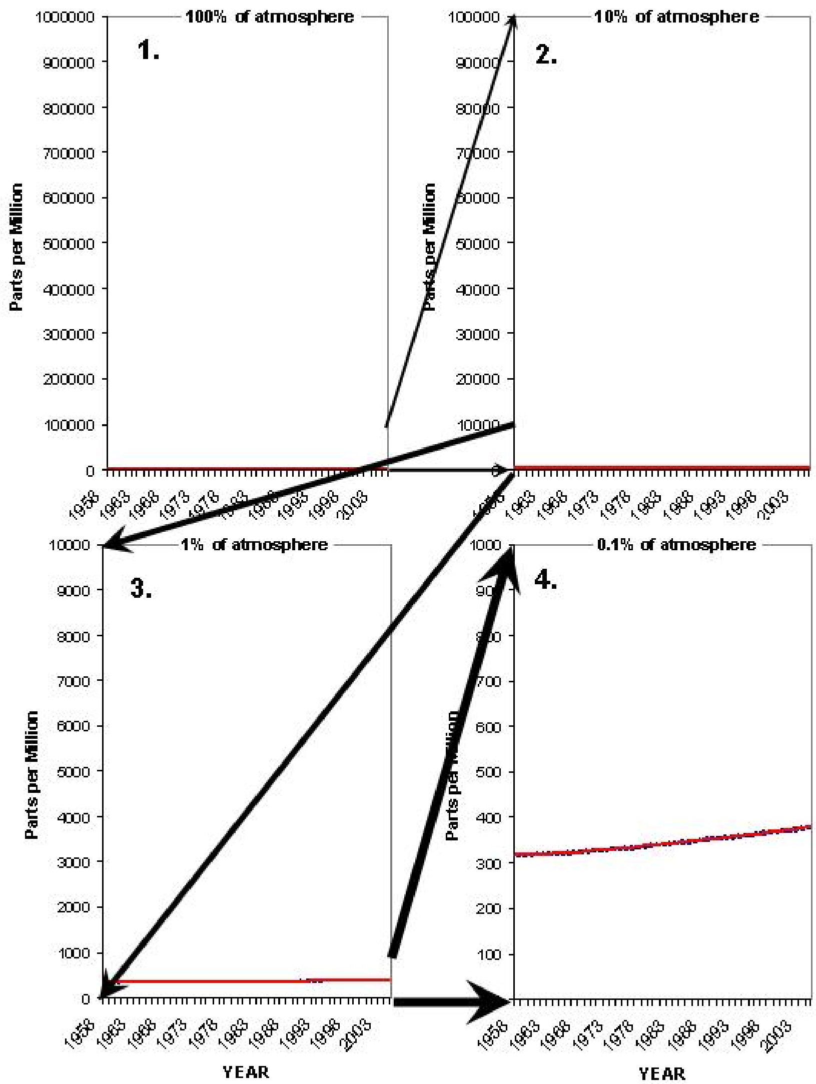

Fig. 2. In absolute terms, the increase in carbon dioxide concentrations since 1958 has been extremely small, as seen in this progressive zoom of CO2 concentration plots from 100% of the atmosphere (panel 1), to only 0.1% of the atmosphere (panel 4).

3.3 What Causes the Earth's Greenhouse Effect?

To understand what effect anthropogenic greenhouse gas emissions might have on global climate, we must first understand what causes the Earth's natural greenhouse effect. The atmosphere's greenhouse effect is mostly due to water vapor and clouds. Many climate modelers and researchers suggest that there is some sort of 'delicate balance' between the sunlight that the Earth absorbs (energy in), and the greenhouse-influenced infrared radiation that the Earth emits to outer space (energy out), but this 'delicate balance' view has no observational support, and reflects too simplistic a view of the role of weather in the climate system.

It is grossly misleading to say that the Earth's surface temperature is the "result" of a balance between absorbed sunlight and emitted infrared light, as it confuses cause and effect. Sunlight is what causes (energizes) our weather, but it is the weather that then largely "decides" how much greenhouse effect there will be. Simply put, the greenhouse effect is mostly the *result of* surface temperature-driven weather; it is not the *cause of* weather and surface temperatures.

While such conceptual distinctions are not important if the climate models contain the correct physics, it is our conceptual view that determines what physical processes we decide to include in a climate model. So, it is more than a little ironic that the atmospheric process which likely has the single strongest control over climate is the one that is understood the least: *precipitation*.

It seems that even many climate modelers do not realize that precipitation systems either directly or indirectly determine most of the Earth's greenhouse effect. Changes in precipitation efficiency, while poorly understood, are known to have a controlling effect on climate (Renno *et al.*, 1994). As tropospheric air is continuously recycled through rain and snow systems, precipitation processes remove excess water vapor, and the air flowing out of them contains varying amounts of water vapor and clouds: the dominant contributors to the natural greenhouse effect. For example, the dry air sinking over the world's deserts was dehumidified in precipitation systems. Similarly, the dry air that rapidly cools in wintertime high pressure areas was dehumidified by rain or snow systems. Deep layers of water vapor in the vicinity of precipitation systems might locally enhance greenhouse warming, but this extra heating helps maintain the circulation – *which then removes water vapor*.

And the role of precipitation systems on the Earth energy budget does not end there. The change of tropospheric temperature with height is also under the control of these systems, and that vertical temperature structure affects cloud formation elsewhere. For instance, air sinking in response to the heat release in precipitation systems helps create a temperature inversion on top of the boundary layer, underneath which vast expanses of marine stratus and stratocumulus clouds form. These clouds have strong cooling effects on the climate system, and any change in them with warming is thus partly controlled by precipitation system changes. Modelers agree that changes in these low-level cloud decks with warming is still an open question; what I am pointing out is that precipitation systems are integral to the maintenance of those cloud decks.

Precipitation systems are indeed nature's "air conditioner". Since weather processes have control over the greenhouse effect, it is reasonable to assume that the relative stability that globally averaged temperatures exhibit over many years is due to natural negative feedbacks in the system which are, quite likely, traceable to precipitation systems. Since climate models have a history of temperature *drift*, it is clear that they have not contained all of the temperature-stabilizing influences that exist in nature. And the stronger those stabilizing influences, the less warming we can expect from anthropogenic greenhouse gas emissions.

3.4 Positive or Negative Feedbacks?

It is certainly true that (1) greenhouse gases warm the lower atmosphere, (2) carbon dioxide is a greenhouse gas, and so (3) increasing carbon dioxide concentrations can be expected to warm the surface. But one must ask: *To what extent*?

Climate modelers know that the direct surface warming effects of even a doubling of carbon dioxide concentrations would be very small – only about 1 deg. F, probably sometime late in this century. The greatest concern, then, centers around the *positive feedbacks* exhibited by climate models which amplify this small warming tendency. But just how realistic are these positive feedbacks? The latest published comparison of the sensitivity of climate models to changes in radiation reveal that *all* climate models tested are more sensitive than our best available radiation budget satellite data suggest (Forster and Taylor, 2006, Fig. 3). Taken at face value, this means that all the models produce too much global warming.

Most researchers who believe in substantial levels of global warming claim that water vapor feedback is surely positive, and strong. They invariably appeal to the fact that a warming tendency from the extra carbon dioxide will cause more water vapor to be evaporated from the surface, thus amplifying the warming. But again we see a lack of understanding of what maintains tropospheric water vapor levels. While abundant amounts of water vapor are being continuously evaporated from the Earth's surface, it is precipitation systems that determine how much of that water vapor is allowed to remain in the atmosphere -- not the evaporation rate. This, then, is one example of researchers' bias toward an emphasis on *warming* processes (water vapor addition), but not *cooling* processes (water vapor removal). The fact that warmer air masses have more water vapor is simply the result of the greater amounts of solar heating that those air masses were exposed to; it is not evidence for positive water vapor feedback in response to increasing carbon dioxide levels.

I also see widespread bias in the way researchers talk about the Earth's greenhouse effect, *i.e.* that it "keeps the Earth habitably warm". They totally ignore the fact that at least 60% of the surface warming that the greenhouse effect "tries" to cause never happens because of the cooling effects of weather (evaporation, convection, cloud formation, etc.; see Manabe and Strickler, 1964). Thus, it is quantitatively more accurate to say that "the cooling effects of weather keep the Earth habitably cool", than it is to say, "the greenhouse effect keeps the Earth habitably warm". So again, we see a "warm" bias in the way many climate researchers talk about climate change.

3.5 Validation of Climate Models

Climate models are usually validated by comparing their average behavior, such as the monthly average temperature at different locations, to observations of the real climate system. But recently, it has been persuasively argued that meaningful validation of climate models in the context of their *feedbacks* can only be made by comparing the *instantaneous* relationships in climate models and observations (Aries and Rossow, 2003; Stephens, 2005). For instance, daily changes in clouds, radiation, and temperature can be measured by satellites during interannual variations in the climate system. This makes physical sense, since it is at daily time scales where most weather action takes place.

At UAH, we have begun doing just that, and we have documented a negative feedback due to changes in precipitation systems (Spencer *et al.,* 2007, now in peer review for publication). As rain system activity and tropospheric warmth reach peak levels during tropical intraseasonal oscillations (ISOs), we measured an increase in outgoing infrared radiation (Fig. 3) which was traced to a decrease in cirrus cloudiness (Fig. 4). This evidence, at least at the intraseasonal time scale of the ISO, supports Lindzen's controversial “infrared iris” hypothesis of climate stabilization (Lindzen *et al.*, 2001).

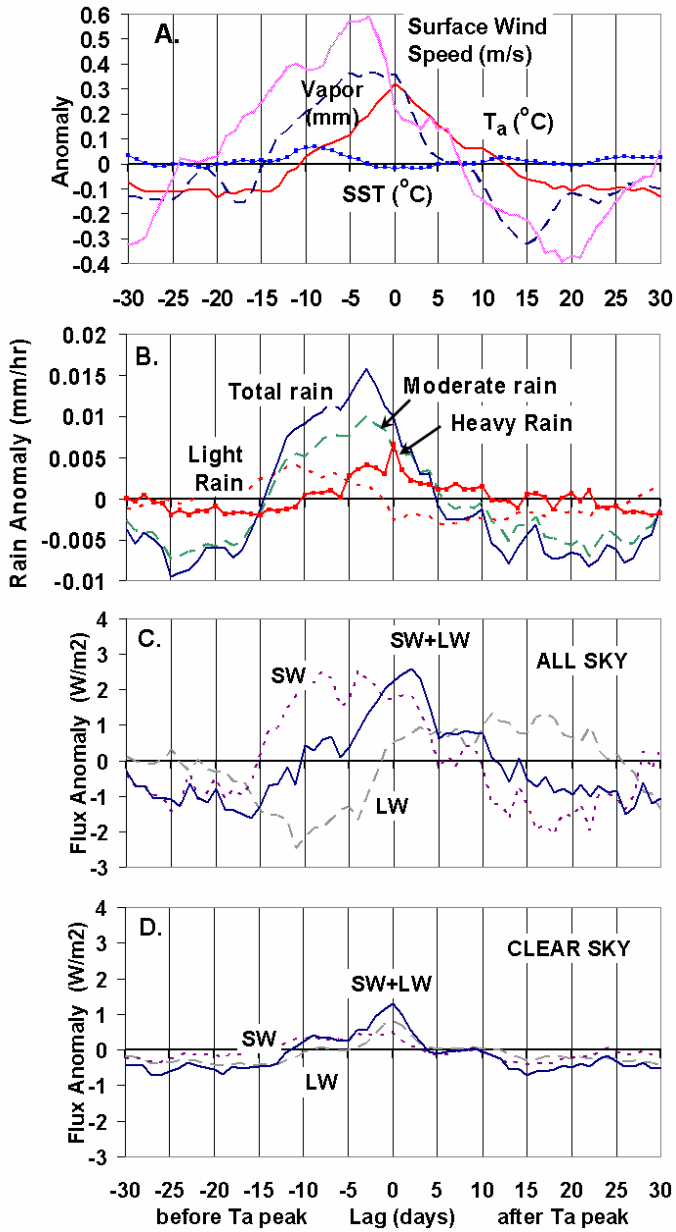

Fig. 3. Composite analysis of satellite-measured daily zonal average oceanic anomalies (20°N to 20°S) associated with 15 tropical intraseasonal oscillations, relative to the date of peak tropospheric temperature (T_a): (a) AMSU T_a, and surface wind speed, integrated water vapor, and SST from the TRMM TMI; (b) TMI rain rate; (c, d): CERES top-of-atmosphere outgoing longwave (*LW*) and reflected shortwave (*SW*) fluxes for all-sky and clear sky, respectively.

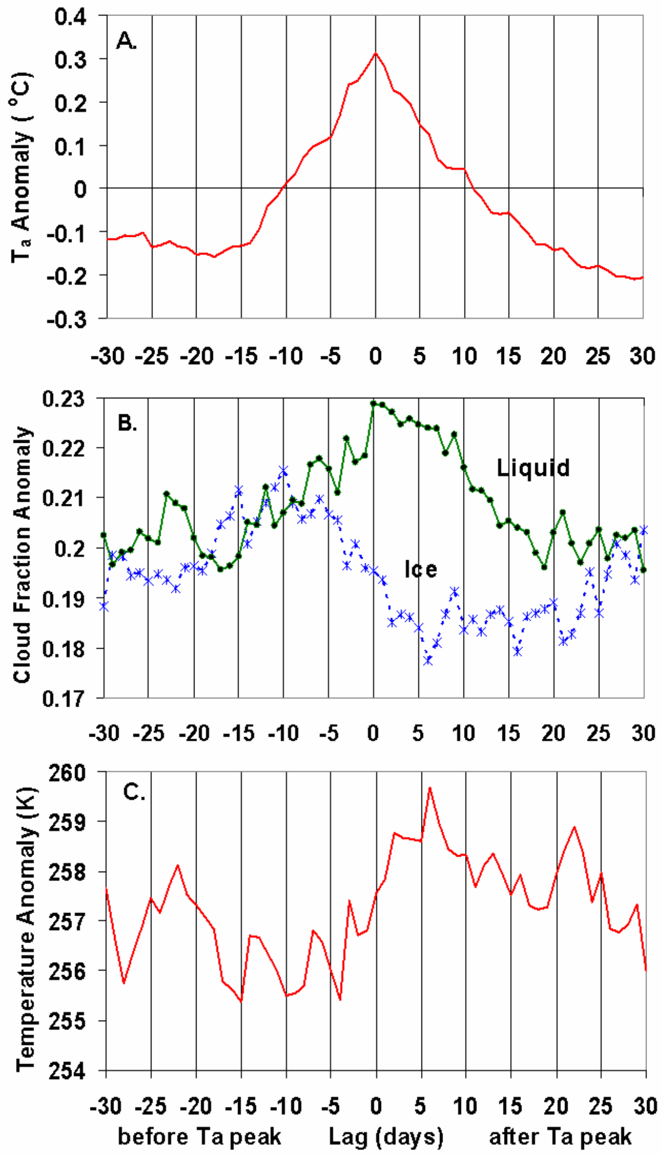

Fig. 4. As in Fig. 3 but for a composite of nine ISO's that had sufficient MODIS data to analyze: (a) tropospheric temperature, (b) MODIS liquid and ice cloud fractions, and (c) cloud top temperature (all clouds). Note that ice (cirroform) cloudiness starts decreasing before peak tropospheric temperatures are reached, which explains the increase in LW radiation in Fig. 3c -- this constitutes a negative feedback on warming. The warming of the cloud tops that remain (seen in c) also constitutes a negative feedback.

4. Conclusion

4.1 Political interference in climate change science

Government agencies and their managers have a long history of requiring employees to coordinate research results with management and public affairs officials before talking to the press. As a NASA employee of fifteen years I accepted this as part of my responsibility to support NASA's mission as a "team player" in support of overarching agency goals, and I believe there are good reasons for maintaining such a practice.

A much bigger political influence problem is the governmental bias towards a specific type of climate research that supports specific political or policy outcomes. This research is almost always biased toward the finding of climate destabilizing mechanisms, rather than climate stabilizing mechanisms. Because it takes a higher level of complexity in any physical system to produce self-regulation and stabilization, such findings do not naturally flow out of the existing research. An active effort, analogous to the Department of Defense "Red Team" approach, could be utilized to alleviate this inequity. Given the immense cost (especially to the poor) of proposed carbon control policies that most economists foresee, it is not helpful for tax dollars to be funneled in a research direction that unfairly favors certain political or policy outcomes.

4.2 Global warming science

I believe that there is good theoretical and observational support for the view that how precipitation systems respond to warming is the largest source of uncertainty in global warming predictions by climate models. There is good reason to believe that the models still do not contain one or more negative feedbacks related to cloud and precipitation changes associated with warming. Therefore, it is imperative that critical tests of model processes with satellite observations be carried out before warming predictions from those models be given much credence. Only through a large dose of either faith or ignorance can one believe current climate models' predictions of global warming.

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Member, Japanese Marine Observation Satellite (MOS-1) Validation Team, 1978-1990.
Chairman, Hydrology Subgroup, Earth System Science Geostationary Platform Committee, 1978-1990.
Executive Committee Member, WetNet - An Earth Science and Applications and Data System Prototype, 1987-1992.
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AWARDS:

1996: AMS Special Award "for developing a global, precise record of earth's temperature from operational polar-orbiting satellites, fundamentally advancing our ability to monitor climate."
1991: NASA Exceptional Scientific Achievement Medal
1990: Alabama House of Representatives Resolution #624
1989: MSFC Center Director's Commendation

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