

## **Written Testimony for the House Committee on Science, Space, and Technology**

### **Hearing on “Examining the UN Intergovernmental Panel on Climate Change Process for the Process for the Fifth Assessment Report”**

**May 29 2014**

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**Short Biographical Summary** - At the University of Colorado-Boulder I currently am a Senior Research Scientist in CIRES and a Senior Research Associate in the Department of Atmospheric and Oceanic Sciences (ATOC) (November 2005 -present). I am also an Emeritus Professor of Atmospheric Science at Colorado State University. I have published books and peer reviewed papers on subjects in air pollution meteorology, hydrology, ecology, local, regional and global weather and climate.

### **Summary of my Main Points**

- The 2013 IPCC WG1 report and the 2014 US National Climate Assessment present a set of projections from global and downscaled regional climate models as the basis for projecting future societal and environmental impacts, offered as a guide to the future for decision makers.
- However, these projections may not be reliable guides to the future. In fact, we are unable to accurately quantify their reliability. The IPCC and NCA did not adequately discuss the skill run in hindcast predictions over the last several decades when fossil fuel emissions, and other climate forcings, are actually known.
- Except for limited exceptions the models cannot accurately represent over the last several decades the temporal evolution of major atmospheric circulation features over multi-decadal time periods such as El Niño and La Niña, the Pacific Decadal Oscillation, and the North Atlantic Oscillation. These major factors determine which regions have drought, floods, tropical cyclone tracks, and other societally and environmentally important weather events.
- The models have an even greater challenge in accurately predicting changes in the statistics of these major atmospheric circulation features over multi-decadal time scales.
- The IPCC and NCA needs to more accurately report the importance of these model limitations, that were available to them in the peer reviewed literature. By not alerting them to these limitations, they are giving decision makers who face decisions at the regional and local level a false sense of certainty about the unfolding climate future.

### **Weather and Climate Modeling**

Modeling studies have significant value to science and decision makers. However, the right tool is needed for the right job. There are three types of applications of models: for process studies, for diagnosis and for forecasting.

**Process studies:** The application of climate models to improve our understanding of how the system works. Adding CO<sub>2</sub> to a global model is an example of a process study.

**Diagnosis:** The application of models, in which observed data is inserted into the model, to produce an analysis that is constrained by real world observations. This procedure is used for weather and climate reanalyses in order to provide the most accurate retrospective weather maps.

**Forecasting:** Models are used to predict (project) the future state of the system. Forecasts can be made from a single realization, or from an ensemble of forecasts which are produced by slightly perturbing the initial conditions and/or the input forcings such as fossil fuel emissions. The National Weather Service routinely runs the forecasts using initial observations and the accuracy are examined for every forecast. These National Weather model predictions are of enormous societal value.

Forecasts can be made from a single realization, or from an ensemble of forecasts which are produced by slightly perturbing the initial conditions and/or.

The models used by the IPCC and NCA are far more appropriate for use in process studies and diagnosis. They are poorly suited for use as forecasting tools until they have shown a better ability to predict changes in regional climate statistics over the last several decades.

I present below several examples of recent peer research papers that document significant inadequacies in even simulating multi-decadal regional climate, much less changes in regional climate statistics that have been observed when the models are run using the actual human activity including actual emissions for the last several decades (these are referred to as hindcast runs).

### **Evidence of the Limitations on the Skill of Multi-Decadal Regional Climate Projections.**

The concern that I raise on using the multi-decadal regional climate predictions is shared by others. I list some examples as follows

Kim et al 2012 report that

*“Most of the models produce cooler than observed global mean temperature during the entire period and overestimate the observed trend in their hindcasts... The AMO index is relatively well predicted in all models for the entire prediction period with a significant skill, while the predictive skill for the PDO index is relatively low for the entire period.”*

Fyfe et al. (2011) concluded that

*“..for longer term decadal hindcasts a linear trend correction may be required if the model does not reproduce long-term trends. For this reason, we correct for systematic long-term trend biases.”*

Xu and Yang (2012) find that without tuning from real world observations, the model predictions are in significant error. For example, they found that

*"...the traditional dynamic downscaling (TDD) [i.e. without tuning] overestimates precipitation by 0.5-1.5mm-d-1...The 2-year return level of summer daily maximum temperature simulated by the TDD is underestimated by 2-6 C over the central United States-Canada region."*

The paper van Oldenborgh et al. (2012) report just limited predictive skill in two regions of the oceans on the decadal time period, but no regional skill elsewhere, when they conclude that:

*"A 4-model 12-member ensemble of 10-yr hindcasts has been analysed for skill in SST, 2m temperature and precipitation. The main source of skill in temperature is the trend, which is primarily forced by greenhouse gases and aerosols. This trend contributes almost everywhere to the skill. Variation in the global mean temperature around the trend does not have any skill beyond the first year. However, regionally there appears to be skill beyond the trend in the two areas of well-known low-frequency variability: SST in parts of the North Atlantic and Pacific Oceans is predicted better than persistence. A comparison with the CMIP3 ensemble shows that the skill in the northern North Atlantic and eastern Pacific is most likely due to the initialisation, whereas the skill in the subtropical North Atlantic and western North Pacific are probably due to the forcing."*

Anagnostopoulos et al. (2010) report that

*".. local projections do not correlate well with observed measurements. Furthermore, we found that the correlation at a large spatial scale, i.e. the contiguous USA, is worse than [even] at the local scale."*

Stephens et al. (2010) wrote

*“models produce precipitation approximately twice as often as that observed and make rainfall far too lightly...The differences in the character of model precipitation are systemic and have a number of important implications for modeling the coupled Earth system ...little skill in precipitation [is] calculated at individual grid points, and thus applications involving downscaling of grid point precipitation to yet even finer-scale resolution has little foundation and relevance to the real Earth system.”*

van Haren et al. (2012) concluded from their study with respect to climate model predictions of precipitation that

*“An investigation of precipitation trends in two multi-model ensembles including both global and regional climate models shows that these models fail to reproduce the observed trends... A quantitative understanding of the causes of these trends is needed so that climate model based projections of future climate can be corrected for these precipitation trend biases.. To conclude, modeled atmospheric circulation and SST trends over the past century are significantly different from the observed ones.”*

Sun et al. (2012) found that

*“in global climate models, [t]he radiation sampling error due to infrequent radiation calculations is investigated .... It is found that.. errors are very large, exceeding 800Wm<sup>2</sup> at many non-radiation time steps due to ignoring the effects of clouds..”*

DiNezio (2014) reported that multi-decadal predictions of

*"El Niño-Southern Oscillation ....may be entirely unpredictable"*

He also wrote

*“Predicting whether the coming decades will bring an onslaught of strong ENSO events - or none at all - is crucial because of the impact of such weather events on weather patterns around the world.....changes observed in ENSO behavior during the twentieth century could very well be random fluctuations unrelated to natural or man-made changes in the climate of the tropical Pacific.”*

Fyfe et al (2013) wrote

*“Recent observed global warming is significantly less than that simulated by climate models. This difference might be explained by some combination of errors in external forcing, model response and internal climate variability.”*

Fyfe and Gillet (2014) followed up that study with the finding that

*“...based on the CMIP5 ensemble of climate simulations, the probability of simulating the recently observed eastern tropical Pacific cooling with a freely running climate model under the CMIP5 radiative forcing protocol is very low, and hence so too is the probability of simulating the observed global temperature change over the past 20 years.”*

There is a summary of the limitations in multidecadal regional climate predictions in Kundzewicz and Stakhiv (2010) who conclude that

*“Simply put, the current suite of climate models were not developed to provide the level of accuracy required for adaptation-type analysis.”*

*On the global scale, John Christy provided me with this figure*

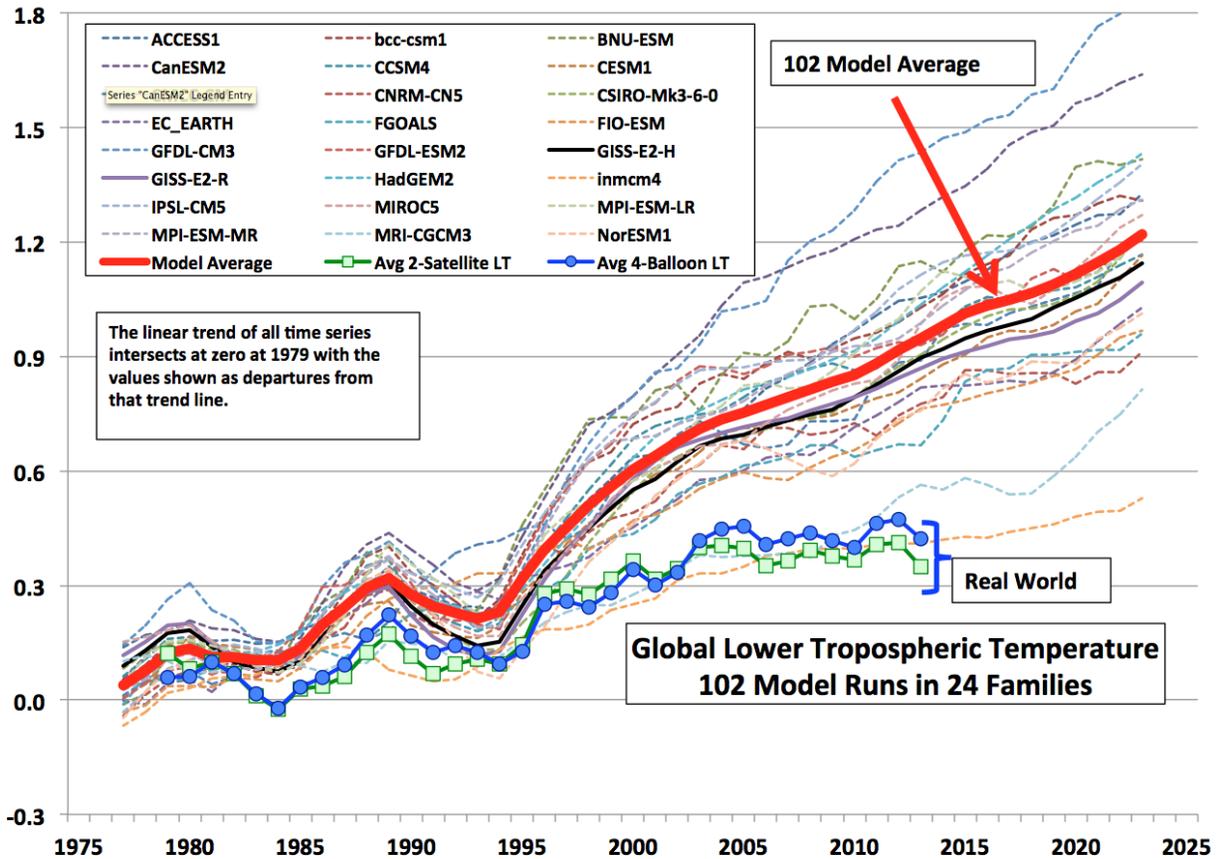


Figure: Model output of pressure-level temperature values provided by KNMI Climate Explorer. Observational values are those updated through 2013 from State of the Climate in 2012, Special Supplement, Bull. Amer. Meteor. Soc. 94, No. 8, August 2013.[figure prepared by John Christy, 2014]

The IPCC and NCA present a set of scenarios from global and downscaled regional climate model multi-decadal simulations in term of future potential societal and environmental impacts. They state that these are not predictions or forecasts, but projections focused on the modeled effect of the input forcings of fossil fuel emissions. However, the skill of these projections can be determined in hindcast runs since the fossil fuel emissions over the last several decades are known. In other words, the “scenario” over the last several decades can be prescribed in order to run the climate models. These studies should have been highlighted in both the NCA and IPCC WG1 reports so that policymakers can assess the expected skill of regional climate forecasts in the coming decades.

## **Appendix A Professional Credentials of Roger A. Pielke Sr.**

Senior Research Scientist in CIRES and a Senior Research Associate at the University of Colorado-Boulder in the Department of Atmospheric and Oceanic Sciences (ATOC) at the University of Colorado in Boulder (November 2005 -present) and an Emeritus Professor of Atmospheric Science at Colorado State University. A more detailed vita is available at <http://cires.colorado.edu/science/groups/pielke/people/pielke.html>

I have 28047 citations of my research papers in my career and 10123 since 2009 according to google scholar. <http://scholar.google.com/citations?user=ZCFFOQcAAAAJ&hl=en&oi=ao>

I have several recent books that are relevant to my background with respect to the topic of the Hearing.

Pielke Sr, R.A., Editor in Chief., 2013: Climate Vulnerability, Understanding and Addressing Threats to Essential Resources, 1st Edition. J. Adegoke, F. Hossain, G. Kallos, D. Niyoki, T. Seastedt, K. Suding, C. Wright, Eds., Academic Press, 1570 pp.

Cotton, W.R. and R.A. Pielke Sr., 2007: Human impacts on weather and climate. Cambridge University Press, 330 pp.

Pielke Sr, R.A., 2013: Mesoscale meteorological modeling. 3rd Edition, Academic Press, 760 pp..

I have appeared before the House on two separate times and given the following written and oral testimony

Pielke Sr., Roger A., 2008: A Broader View of the Role of Humans in the Climate System is Required In the Assessment of Costs and Benefits of Effective Climate Policy. Written Testimony for the Subcommittee on Energy and Air Quality of the Committee on Energy and Commerce Hearing “Climate Change: Costs of Inaction” – Honorable Rick Boucher, Chairman. June 26, 2008, Washington, DC., 52 pp. View PDF of Oral Summary. <http://pielkeclimatesci.files.wordpress.com/2010/01/testimony-written.pdf>

Pielke Sr., R.A. 2011: Climate Science and EPA’s Greenhouse Gas Regulation. Oral Testimony to the House Subcommittee on Energy and Power. Written Testimony <http://republicans.energycommerce.house.gov/Media/file/Hearings/Energy/030811/Pielke.pdf>

My latest summary on my views of the climate issue is presented as Appendix B, which was prepared as a minority viewpoint as a member of the American Geophysical Union committee on climate change.

## Appendix B - My Perspective On Climate and My Involvement with the 2013 AGU Committee on Climate Change

Pielke Sr., R.A. 2013: Humanity Has A Significant Effect on Climate – The AGU Community Has The Responsibility To Accurately Communicate The Current Understanding Of What is Certain And What Remains Uncertain [May 10 2013]. Minority Statement in response to AGU Position Statement on Climate Change entitled: “Human-induced Climate Change Requires Urgent Action” released on 8/5/13.

The text is below

Humanity Has A Significant Effect on Climate – The AGU Community Has The Responsibility To Accurately Communicate The Current Understanding Of What is Certain And What Remains Uncertain [May 10 2013]

By Roger A. Pielke Sr.

I served on the AGU Panel to draft the updated Position Statement on “Human Impacts on Climate”. We were charged by the AGU to provide

*“.....an up-to-date statement [that] will assure that AGU members, the public, and policy makers have a more current point of reference for discussion of climate change science that is intrinsically relevant to national and international policy.”*

In my view, this means we were tasked to report on the most important aspects of climate change. This was incompletely done in the Statement, where they inaccurately, in my view, discuss a view of climate change that is dominated by the emission of CO<sub>2</sub> and a few other greenhouse gases. Indeed, the Committee, under the direction of Jerry North, with the report writing subgroup led by Susan Hassol, was clearly motivated to produce a Statement of this one particular view. Under his leadership, other views were never given an adequate opportunity to be discussed.

The Committee, instead of presenting the actual state of scientific understanding on the issue of climate change, used the following approach, as summarized in my son’s book “The Honest Broker”

*Scientific activity is diverse enough to provide information that can be used to support different perspectives on any topic ... [to] decide the course of action and then find information to back it up is a common practice across the political spectrum. ”*

The Committee leadership already had a course of action in mind even when we were appointed.

I presented to the Committee what I have concluded is a more scientifically robust Statement. I started from their Statement, and accepted what I could, as well as sought to remain close to their length.

I sought to answer the following questions, which the Statement accepted by the Committee incompletely does and/or does not address at all.

1. What is the definition of climate and climate change?
2. What are the societally and environmentally important climate metrics (e.g. a global average surface temperature trend; changes in ocean and atmospheric circulation patterns over multi-year time periods; sea level rise, trends in extreme weather etc)?
3. What are the main human and natural climate forcings?
4. What is the observational evidence for climate change?
5. What is the skill of the global and regional climate model projections (predictions) of changes in these metrics on multi-decadal time scales? 6. What are recommended pathways forward to reduce the risk from climate, including changes in climate over time?

My text of a more balanced Statement on “Human Impacts on Climate” is

Humanity Has A Significant Effect on Climate – The Scientific Community Has The Responsibility To Communicate The Current Understanding Of What is Certain And What Remains Uncertain

Climate is defined here as the statistical description of all the elements in the climate system (including the atmosphere, ocean, land surface and cryosphere), including both the mean state and any variations over time. Climate change is defined as a shift in the statistical description of climate. Climate change includes radiative, biophysical, biogeochemical and biogeographic effects. “Human-caused climate change” is a change resulting from one or more of the human climate forcings.

The natural Earth’s climate system, even in the absence of humans, is nonlinear in which forcings and response are not necessarily proportional; thus change is often episodic and abrupt, rather than slow and gradual. Climate has always changed over time. As Earth’s population has grown, however, human climate forcings have become significant on the local, regional and global scales. These human forcings include greenhouse gas emissions (e.g. CO<sub>2</sub>, methane, CFCs), aerosol emissions and deposition [e.g., black carbon (soot), sulfates, and reactive nitrogen], and changes in land use and land cover. A number of these forcings are spatially heterogeneous and include the effect of aerosols on clouds and associated precipitation. Most, if not all, of these human radiative, biophysical, biogeochemical and biogeographic influences on

regional and global climate will continue to be of concern during the coming decades. Natural climate forcings and feedbacks will also continue to be major effects on this time period.

With respect to human climate forcings, among their effects is their role in altering atmospheric and ocean circulation features away from what they would be in the natural climate system. While the greenhouse and aerosol emissions, in particular, have resulted in changes to the global average radiative forcings, the use of a global averaged radiative forcing or a global average surface temperature are grossly inadequate metrics to diagnose such effects as circulation changes on multi-decadal time scales. It is these regional scale atmospheric and ocean circulations that have the dominant effect on societally and environmentally important weather events such as droughts, floods, tropical cyclones, etc and any possible alteration by human climate forcings is a major concern.

It is also important to recognize that changes in the global radiative forcings (global warming or cooling) represent only a subset of climate change. The ocean is the component of the climate system that is best suited for quantifying climate system heat change. There are major unresolved issues concerning the ability of a global average surface temperature trend to accurately measure climate system heat changes. "Global Warming" can be much more accurately monitored in terms of an increase in the global annual average heat content measured in Joules.

Scientific confidence of the occurrence of climate change include, for example, that over at least the last 50 years there have been increases in the atmospheric concentration of CO<sub>2</sub>; increased nitrogen and soot (black carbon) deposition; changes in the surface heat and moisture fluxes over land; increases in lower tropospheric and upper ocean temperatures and ocean heat content; the elevation of sea level; and a large decrease in summer Arctic sea ice coverage and a modest increase in Antarctic sea ice coverage. Over the last ten years, lower tropospheric and upper ocean temperatures increases, however, have been less than in the preceding years, for reasons that are actively being debated.

These climate changes are a result of human and natural climate forcings and feedbacks - the relative role of each in altering atmospheric and ocean circulation features, and even the global annual average radiative forcing, however, is still uncertain. We do know that added carbon dioxide is the largest human-caused, and black carbon the second largest positive annual, global-averaged radiative forcing, while sulfates are among the largest human-caused negative annual, global-averaged radiative forcing. The importance of decadal and longer variations in natural annual, global-averaged radiative forcing (e.g. due to solar, and from internal natural climate feedbacks, such as from cloudiness), however, remains uncertain.

Climate models, unfortunately, are still unable to provide skillful predictions of *changes* in regional climate statistics on multi-decadal time scales at the detail desired by the impacts communities. Even on the global scale, the annual, global-averaged radiative forcing predicted by the models is significantly greater than has been observed based on the accumulation of

Joules in the climate system. The summer arctic sea ice extent, in contrast, has been significantly under predicted by the models, while the summer Antarctic sea ice extent increase has been missed by the models. Also attribution of specific extreme weather events to multi-decadal changes in climate has not yet been shown, and is likely not even possible.

We recommend a way forward that promotes effective policy decisions even with these uncertainties. The Statement on Climate Change that was adopted by the majority on the Committee, unfortunately, does not provide an accurate summary of our understanding of climate change issues, and, thus, is not an effective policy framework to reduce risks from the climate system.

The effective use of mitigation and adaption to reduce the risk to water resources, food, energy, human health and well-being, and ecosystem function from climate (including changes in the climate system) requires a multi-disciplinary, multi-faceted approach. Attempts to significantly influence climate impacts based on just controlling CO<sub>2</sub> and a few other greenhouse gases emissions is an inadequate and incomplete policy for this purpose. The goal should be to seek politically and technologically practical ways (with minimal cost and maximum benefit) to reduce the vulnerability of the environment and society to the entire spectrum of human-caused and natural risks including those from climate, but also from all other environmental and social threats.

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