Submission to "Climate Change E-Mails Review"

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Introduction

In order to give some context to my submission to the "Climate Change E-Mails Review", I provide below a brief summary of my employment, my scientific expertise, and my previous affiliations with the University of East Anglia (UEA) and with UEA's Climatic Research Unit (CRU).

My name is Dr. Benjamin D. Santer. I am a climate scientist in the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Laboratory in Livermore, California. I have been employed at PCMDI since August 1992. Prior to my employment at PCMDI, I worked for five years at the Max-Planck Institute for Meteorology in Hamburg – first as a post-doc, and then as a Research Scientist.

I completed my undergraduate degree in UEA's School of Environmental Sciences, graduating in 1976 with a B.Sc. in Environmental Sciences (with First Class Honors). I had no scientific interaction with CRU staff during my undergraduate career. I was, however, personally acquainted[1] with Tom Wigley, who was then a scientist at CRU. For the record, I note also that during my first and second years at UEA, I attended several lectures given by Professor Geoff Boulton (a member of the Climate Change E-Mails Review team).

[1] Both Tom and I were keen cavers.

In 1983, I returned to UEA to start work on a Ph.D. at CRU. As I wrote on December 2, 2009 in an "Open letter to the climate science community":

> "I went to CRU in 1983 because it was – and remains – one of the world's premier institutions for studying the nature and causes of climate change. During the course of my Ph.D., I was privileged to work together with exceptional scientists – with people like Tom Wigley, Phil Jones, Keith Briffa, and Sarah Raper".

My. Ph.D. supervisor was Professor Tom Wigley, who was then the Director of CRU. Professor Phil Jones (who was at that time a Senior Research Associate at CRU) was on my Ph.D. Advisory Committee, and was one of my internal examiners. The Hadley Centre's Dr. John Mitchell was the external examiner for my Ph.D.

The title of my thesis was "Regional Validation of General Circulation Models". My thesis work involved the use of Monte Carlo methods and multivariate statistics to assess whether then-available climate models were capable of reliably capturing important features of observed surface pressure fields over the North Atlantic.

During the first year of my Ph.D. thesis work at CRU, I also participated in a project seeking to identify non-climatic influences in surface temperature records.[2] My role in this research involved comparing temperature records from pairs of neighboring stations. This type of comparison helped to detect abrupt temperature "jumps" caused by changes in the location and type of thermometers. It also revealed the temperature effects of changes in the physical environment surrounding thermometers. I was a co-author on three "grey literature" documents describing various aspects of the construction of the CRU land surface temperature dataset.[3]

Since leaving CRU in 1987, I have continued to collaborate with present CRU staff (primarily Professor Phil Jones) and with former CRU staff (Professor Tom Wigley, who recently retired from the National Center for Atmospheric Research in Boulder, Colorado).

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[2]For example, non-climatic effects associated with progressive urbanization, and the concomitant changes in the physical environment surrounding surface temperature monitoring sites.

[3]These three publications are:

Jones, P.D., P.M. Kelley, and B.D. Santer, 1985: Global surface air temperature variations: 1983-1984, in *Proceedings of the Ninth Annual Climate Diagnostics Workshop*, U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, 1-10.

Jones, P.D., S.C.B. Raper, B.D. Santer, B.S.G. Cherry, C.M. Goodess, P.M. Kelly, T.M.L. Wigley, R.S. Bradley, and H.F. Diaz, 1985: A grid-point surface air temperature data set for the Northern Hemisphere. *Carbon Dioxide Research Division Technical Report No. TR022*. U.S. Dept. of Energy, Washington D.C., 251 pp.

Jones, P.D., S.C.B. Raper, B.S.G. Cherry, C.M. Goodess, T.M.L. Wigley, B.D. Santer, P.M. Kelly, R.S. Bradley, and H.F. Diaz, 1991: An updated global grid point surface air temperature anomaly data set: 1851-1990*. Oak Ridge National Laboratory Environmental Sciences Division Publication No. 3520*, Oak Ridge, Tennessee, 346 pp.

The scientific papers arising from my collaboration with CRU staff are documented in the current (February 2010) version of my *Curriculum Vitae*.[4] As my *Curriculum Vitae* indicates, I have published 80 papers in the peer-reviewed literature. Many of these papers were co-authored with Tom Wigley and/or Phil Jones.

Most of the "Issues for Examination" in the Independent Climate Change E-mail Review relate to two specific areas of climate science:

1. The development of gridded, "climate-quality" data records from raw (station) surface temperature data.

2. The use of proxy information (tree rings, ice and sediment cores, corals, *etc.*) to develop palaeoclimatic reconstructions of hemispheric- and global-scale changes in surface temperature over the last 1-2 millennia.

I do not have specific, detailed expertise in either of these two areas. I do, however, have familiarity with some of the general problems which scientists encounter in attempting to adjust raw measurements for non-climatic influences. Such non-climatic influences affect not only temperature measurements from surface thermometers, but also balloon- and satellite-based temperature measurements.

My own scientific expertise is primarily in the area of "climate fingerprinting". Fingerprint research:

> "…uses rigorous statistical methods to compare observed patterns of climate change with results from climate model simulations. The basic concept of fingerprinting is that each different influence on climate – such as purely natural changes in the Sun's energy output, or human-caused changes in atmospheric levels of greenhouse gases – has a unique signature in climate records. This uniqueness becomes more apparent if one looks beyond changes averaged over the entire globe, and instead exploits the much greater information content available in complex, time-varying patterns of climate change".[5]

I have led fingerprint studies which have compared simulated and observed changes in land and ocean surface temperature, vertical profiles of atmospheric temperature, stratospheric and tropospheric temperature, ocean surface temperature changes in hurricane formation regions,

[4]See ATTACHMENT A: Santer_CV_Feb_2010.pdf. In the list of publications contained in my Curriculum Vitae, the names of authors and co-authors presently or previously affiliated with CRU are highlighted in blue.

[5]Excerpt from "Close Encounters of the Absurd Kind". See: http://www.realclimate.org/index.php/archives/2010/02/close-encounters-of-the-absurd-kind/

tropopause height, and atmospheric water vapor. Both Tom Wigley and Phil Jones were (and are) key scientific collaborators in my fingerprint work.

In concluding this introduction to my scientific expertise and associations with CRU staff (past and present), I note that some of the "Issues for Examination" which are now before the Climate Change E-mails Review Panel pertain to Professor Jones's service with the Intergovernmental Panel for Climate Change (IPCC) and to Professor Jones's response to various Freedom of Information Act (FOIA) requests. Having served as an IPCC Convening Lead Author (CLA)[6], and having been the recipient of U.S. FOIA requests in 2008, I feel qualified to provide informed input on issues related to the FOIA requests and Professor Jone's service as an IPCC CLA.

Finally, I would like to point out that several dozen of my own emails to CRU's Professor Phil Jones and Dr. Tim Osborn were among the 1,000+ emails illegally obtained from UEA. On the basis of these stolen emails, it has been alleged that I exerted pressure on the *International Journal of Climatology* (*IJoC*) to delay publication of the print version of an *IJoC* paper by Professor David Douglass *et al*. This allegation is baseless. My detailed rebuttal is available.[7]

I append below my responses to specific "Issues for Examination". As noted above, my comments are restricted to those issues where I have sufficient scientific expertise to provide informed input.

Issues Arising on Para. 1.1 of the Terms of Reference

Point 4. "It is alleged that there has been an improper bias in selecting and adjusting data so as to favour the anthropogenic global warming hypothesis and details of sites and the data adjustments have not been made adequately available."

The general tenor of this claim is that CRU scientists engaged in data manipulation in order to "favour the anthropogenic global warming hypothesis". This allegation has absolutely no merit.

As I noted in an "Open Letter" to the climate science community on December 2, 2009,[8] CRU's development of land surface temperature datasets has been conducted in an open and transparent manner. This is documented in dozens of papers published by Phil Jones and his

[6]Ibid. I was Convening Lead Author for Chapter 8 of the IPCC's Second Assessment Report ("Detecting Climate Change, and Attributing Causes").

[7]Ibid. See also ATTACHMENT B: Open_Letter_3_to_Community.pdf

[8]See ATTACHMENT C: Open_Letter_1_to_Community.pdf

colleagues. CRU's finding of substantial warming of the Earth's surface has been independently substantiated by other groups, and is physically consistent with the changes in many other independently-monitored climate variables.

I reproduce below an excerpt from my December 2, 2009 "Open Letter":

> "Phil Jones and Tom Wigley (the second Director of the Climatic Research Unit) devoted significant portions of their scientific careers to the construction of the land component of the so-called "HadCRUT" dataset of land and ocean surface temperatures. The U.K. Meteorological Office Hadley Centre (MOHC) took the lead in developing the ocean surface temperature component of HadCRUT."
>
> "The CRU and Hadley Centre efforts to construct the HadCRUT dataset have been open and transparent, and are documented in dozens of peer-reviewed scientific papers. This work has been tremendously influential. In my personal opinion, it is some of the most important scientific research ever published. It has provided hard scientific evidence for the warming of our planet over the past 150 years."
>
> "Phil, Tom, and their CRU and MOHC colleagues conducted this research in a very open and transparent manner. Like good scientists, they examined the sensitivity of their results to many different subjective choices made during the construction of the HadCRUT dataset. These choices relate to such issues as how to account for changes over time in the type of thermometer used to make temperature measurements, the thermometer location, and the immediate physical surroundings of the thermometer. They found that, no matter what choices they made in dataset construction, their bottom-line finding – that the surface of our planet is warming – was rock solid. This finding was supported by many other independent lines of evidence, such as the retreat of snow and sea-ice cover, the widespread melting and retreat of glaciers, the rise in sea-level, and the increase in the amount of water vapor in the atmosphere. All of these independent observations are physically consistent with a warming planet."
>
> "Extraordinary claims demand extraordinary proof. The claim that our Earth had warmed markedly during the 20th century was extraordinary, and was subjected to extraordinary scrutiny. Groups at the National Climatic Data Center in North Carolina (NCDC) and at the Goddard Institute for Space Studies in New York (GISS) independently attempted to reproduce the results of the Climatic Research Unit and the U.K. Meteorological Office Hadley Centre. While the NCDC and GISS groups largely relied on the same primary temperature measurements that had been used in the development of the HadCRUT dataset, they made very different choices in the treatment of the raw measurements. Although there were differences in the details of the three groups' results, the NCDC and GISS analyses broadly confirmed the "warming Earth" findings of the CRU and MOHC scientists."

It is a formidable task to translate "raw" surface temperature measurements – made at many thousands of locations around the world – into estimates of global-scale changes in the

temperature of Earth's surface. Instruments change over time. Observing locations, times, and practices change. The fraction of the Earth's surface that is actually monitored changes over space and time, in a highly non-random way. The physical environment around monitoring sites can change over time, thus influencing the measurements themselves. The quality and availability of "metadata" (detailed station history information) can change over time, making it more difficult to separate non-climatic influences from *bona fide* climate change.

The effects of such non-climatic influences must be accounted for. If they are not, they introduce biases in estimates of the purely climatic component of surface temperature change. Phil Jones and his colleagues have spent much of their scientific careers engaged in the painstaking, yet vitally-important task of identifying and quantifying the effects of non-climatic factors on surface temperature records. They have published papers looking at the impact of applying different algorithms for mapping raw station data onto a regular latitude-longitude grid (the impact was minor). They performed so-called "frozen grid" tests, in which they tried to determine whether changes in data coverage over time biased their results (they did not). They attempted to put error bars on their data. They contrasted the behavior of urban and rural stations, and found that, after adjusting urban stations for non-climatic "urban warming" effects, urban and rural stations gave very similar estimates of land surface temperature change.

It is worth noting that adjustments for non-climatic effects are a fact of scientific life – they are certainly not unique to surface temperature datasets.[9] In weather balloon (radiosonde) measurements of atmospheric temperature, adjustments must be made for systematic changes in instrumentation and for changes over time in the effectiveness of thermal shielding (which protects thermometers from direct solar heating).[10] Satellite-based estimates of atmospheric temperature change – obtained with so-called Microwave Sounding Units, or MSUs – are also subject to a number of adjustments, for factors such as instrument calibration drift, biases in MSU instruments flown on different satellites, and the impact of satellite orbital drift on the sampling of the daily changes in Earth's temperature.[11,12] Inter-instrument biases and data

[9]See, *e.g.*, Karl, T.R., S.J. Hassol, C.D. Miller, and W.L. Murray, editors, 2006: *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*. A Report by the Climate Change Science Program and the Subcommittee on Global Change Research, Washington DC.

[10]Sherwood, S.C., J. Lanzante, and C. Meyer, 2005: Radiosonde daytime biases and late 20th century warming. *Science*, **309**, 1556-1559.

[11]Wentz, F.J., and M. Schabel, 1998: Effects of orbital decay on satellite-derived lower-tropospheric temperature trends. *Nature*, **394**, 661-664.

[12]Mears, C.A., and F.W. Wentz, 2005: The effect of diurnal correction on satellite-derived lower tropospheric temperature. *Science*, **309**, 1548-1551.

coverage changes also hamper attempts to reconstruct the history of changes in ocean heat storage.[13]

In constructing estimates of global-scale temperature change from surface thermometers, weather balloons, or satellites, there is no single "optimal" adjustment pathway that is demonstrably better than all others. Different groups make different choices regarding when and where adjustments are necessary, and how large adjustments should be.

The three primary groups involved in the construction of gridded surface temperature datasets from raw station data (the CRU/MOHC group, GISS, and NCDC) made very different choices in gridding raw station data, defining temperature departures from long-term averages, and adjusting for the non-climatic influences mentioned above. Despite these different choices in the dataset construction process, they independently obtained very similar estimates of large-scale changes in the Earth's surface temperature. This independent replication highlights the robustness of CRU's estimates of surface temperature change.

In my considered professional opinion, Phil Jones and the staff of the CRU have developed their land surface temperature datasets in an open, transparent, and thorough manner, and have routinely explored the sensitivity of their estimates of surface temperature change to different plausible "analyst choices". Their work represents world-class, cutting-edge science.

In summary, as Sir Arthur Conan Doyle's most famous literary creation once said, "It is a capital mistake to theorize without data." The work of Professor Phil Jones and his CRU colleagues supplied the "data" required by the climatological emulators of Sherlock Holmes. The surface temperature datasets produced by CRU and the Hadley Centre provided the first hard physical evidence of planetary-scale warming.

Issues Arising on Para. 1.2 of the Terms of Reference

Point 5. "It is alleged that there have been improper attempts to influence the peer review system and a violation of IPCC procedures in attempting to prevent the publication of opposing ideas."

I was not involved in the discussions regarding the specific papers referred to in the point. However, I do wish to provide some relevant background information.

[13] AchutaRao, K.M., M. Ishii, B.D. Santer, P.J. Gleckler, K.E. Taylor, T.P. Barnett, D.W. Pierce, R.J. Stouffer, and T.M.L. Wigley, 2007: Simulated and observed variability in ocean temperature and heat content. *Proceedings of the National Academy of Sciences*, **104**, 10768-10773.

Climate science is replete with examples of seriously-flawed scientific papers that, when published, are immediately hailed as "evidence of absence" of human effects on climate. In my opinion, the Soon and Baliunas paper in *Climate Research* was one such paper. Another seriously flawed paper, by Professor David Douglass *et al*. (which appeared in the online edition of the *International Journal of Climatology* in late 2007), was cited as definitive proof that "Nature, not humans, rules the climate".[14]

Such claims typically receive extraordinary publicity, and contribute to public misunderstanding of climate science.

Climate science is not magically "self-correcting". The work of rebutting seriously-flawed scientific papers – and the incorrect claims made on the basis of such work – is time-consuming and unsatisfying. Such work should be the job of the many, not of the few. Unfortunately, scientists like Professor Jones have often shouldered a disproportionately large share of the load in responding to flawed papers. I understand and sympathize with this problem. I also understand some of the frustrations expressed in the email excerpts reproduced in Point 5.

The Soon and Baliunas paper referred to in Point 5 was published in *Climate Research*, and was discussed in the 2007 IPCC Fourth Assessment Report (FAR). Likewise, five separate papers by Steven McIntyre and Ross McKitrick are cited and are discussed in the Palaeoclimate chapter of the IPCC FAR. Based on this evidence, any (imagined and imaginary) conspiracy to influence the peer-review system would be judged remarkably unsuccessful.

The peer-review process was not abused by Professor Jones. Nor did Professor Jones or other IPCC Lead Authors suppress views skeptical of "discernible human influence" findings.

In my opinion, when seriously-flawed papers are published in scientific journals, and when climate science is publicly misrepresented on the basis of such work, we have a professional responsibility to "set the scientific record straight". To his credit, this is exactly what Professor Phil Jones has tried to do over the course of his career. His sole concern has been for the accurate portrayal of our current understanding of the nature and causes of climate change in the peer-reviewed literature.

Issues Arising on Para. 1.3 of the Terms of Reference

Point 8. "Response to Freedom of Information requests."

[14] See ATTACHMENT B: Open_Letter_3_to_Community.pdf

Like Professor Jones, I have also been subject to recent requests for data and email correspondence under the U.S. Freedom of Information act (FOIA). I received these requests from Mr. Steven McIntyre, who has also made (or prompted) FOIA requests to Professor Jones.

My response to Mr. McIntyre's requests has been described elsewhere.[15]

I am not knowledgeable about the specific FOIA requests that CRU has received from Mr. McIntyre, or how Phil Jones and others responded to these requests. However, I would like to make some general remarks about the issue of FOIA requests.

In my own personal case, I do not believe that Mr. McIntyre's FOIA requests were reasonable or legitimate. As I noted in an "Open Letter" to the climate science community on February 24, 2010:[16]

> "…Mr. McIntyre's Freedom of Information Act requests were completely unnecessary. In my opinion, they were frivolous. Mr. McIntyre already had access to all of the information necessary to check our calculations and our findings."
>
> "When I invited Mr. McIntyre to "*audit*" our entire study, including the intermediate calculations, and told him that all the data necessary to perform such an "*audit*" were freely available, he expressed moral outrage on his blog. I began to receive threatening emails. Complaints about my "*stonewalling*" behavior were sent to my superiors at Lawrence Livermore National Laboratory and at the U.S. Department of Energy…."
>
> "As the "Climategate" emails clearly show, there is a pattern of behavior here. My encounter with Mr. McIntyre's use of FOIA requests for "*audit*" purposes is not an isolated event. In my opinion, Mr. McIntyre's FOIA requests serve the purpose of initiating fishing expeditions, and are not being used for true scientific discovery."

Based on my own personal experiences with Mr. McIntyre, I do not believe that the FOIA requests which Professor Jones received from Mr. McIntyre had (as their primary purpose) the goal of enhancing our understanding of the true uncertainties inherent in the construction of surface temperature datasets.

Summary

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) concluded that "Warming of the climate system is unequivocal". Much of the scientific

[15] http://www.realclimate.org/index.php/archives/2010/02/close-encounters-of-the-absurd-kind/

[16] Ibid.

underpinning for this statement comes from the body of research that Professor Phil Jones and his colleagues have published over the past 25 years. Phil's research has not only documented the warming of our planet – it has also helped to unravel the complex causes of observed climate change and variability, and helped us to "see" recent change against the backdrop of the past 2,000 years of climate history. The surface temperature datasets produced and distributed by Phil and collaborators have been used in literally thousands of scientific studies. These datasets have transformed our field, and transformed our understanding of human effects on climate. Based on his remarkable scientific contributions, Professor Philip D. Jones is deserving of the highest honors in science.

It is my opinion that Phil Jones has been under systematic attack because of the scientific importance of the work that he does, and because of the profound societal impact of his research findings. These attacks are deeply troubling. To use an analogy from one of my colleagues,[17] Phil's encounters with literally dozens of FOIA requests are similar to "Denial of Service" attacks on computer servers. This calculated "Denial of Service" strategy has prevented Phil from doing his job – from improving our scientific understanding of the nature and causes of climate change.

I am proud to call Professor Phil Jones a colleague and a friend. He is an exceptional scientist, and a gentle and kind man. He has been a scientific mentor to me and to dozens of other scientists in our community. The science he has done is robust and reproducible. It has changed our world. All of us – not just members of the scientific community – owe Phil Jones our thanks.

[17] Dr. Leo Haimberger at the University of Vienna.

ATTACHMENT A

Benjamin David Santer

Physicist/Atmospheric Scientist
Program for Climate Model Diagnosis and Intercomparison
Energy and Environment Directorate

Professional Address

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University of California
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Livermore, California 94550

Education

- Ph.D., 1987, Climatology, Climatic Research Unit, University of East Anglia, Norwich, U.K.
- NATO Research Studentship, 1977, Chemical Oceanography, University of East Anglia, Norwich, U.K.
- B.Sc. (First Class Honors), 1976, Environmental Sciences, University of East Anglia, Norwich, U.K.

Dissertation

Regional Validation of General Circulation Models. Supervisor: Prof. T.M.L. Wigley.

Honors and Awards

- 2008 Science and Technology Award, Lawrence Livermore National Laboratory ("*for key contributors to the Scientific Assessment Reports of the Intergovernmental Panel on Climate Change*").
- 2008 Lectureship, Dan and Carole Burack President's Distinguished Lecture Series, University of Vermont (for academic year 2008-2009).
- 2008 Inclusion of the 1995 *Climate Dynamics* paper by B.D. Santer *et al*. ("*Towards the detection and attribution of an anthropogenic effect on climate*") as one of 21 "landmark studies" in the compilation "*Climate Change and Anthropogenic Greenhouse Warming: A Selection of Key Articles, 1824-1995*" of the U.S. National Science Digital Library (http://wiki.nsdl.org/index.php/PALE:ClassicArticles/GlobalWarming).
- 2007 Contributor to all four Scientific Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC); as Convening Lead Author of the chapter on "*Detection of Climatic Change, and Attribution of Causes*" (in 1995), and as Contributing Author to a total of five chapters in the 1990, 2001, and 2007 Reports. The IPCC was awarded the 2007 Nobel Peace Prize (jointly with Al Gore) for its efforts to "*build up and disseminate greater knowledge about man-made climate change*".
- 2007 Selection as "*highly cited author in the field of global warming*" by Essential Science Indicators (see http://www.esi-topics.com/nhp/2007/january-07-BenjaminDSanter.html).
- 2005 Distinguished Scientist Fellowship, U.S. Dept. of Energy, Office of Biological and Environmental Research.
- 2003 Editors' Citation for Excellence in Refereeing, *Geophysical Research Letters.*
- 2003 Edward Teller Fellowship, Lawrence Livermore National Laboratory.
- 2002 Ernest Orlando Lawrence Award (for Environmental Science and Technology), U.S. Dept. of Energy.
- 2002 Editors' Citation for Excellence in Refereeing, *Journal of Geophysical Research (Atmospheres)*.
- 2001 Outstanding Scientific Paper Award, U.S. Dept. of Commerce, Environmental Research Laboratories, National Oceanic and Atmospheric Administration (for D.J. Gaffen, B.D.

Santer, J.S. Boyle, J.R. Christy, N.E. Graham and R.J. Ross, *Science*, 2000: "*Multi-decadal changes in the vertical structure of the tropical troposphere*".)

- 2000 Inclusion in "*Scientists at Work: Profiles of Today's Groundbreaking Scientists from Science Times*" (edited by Laura Chang).
- 1998 John D. and Catherine T. MacArthur Fellowship.
- 1998 Norbert Gerbier–MUMM International Award, World Meteorological Organization (for B.D. Santer *et al*., *Nature*, 1996: "*A search for human influences on the thermal structure of the atmosphere*").
- 1997 Outstanding Scientific Paper Award, U.S. Dept. of Commerce, Environmental Research Laboratories, National Oceanic and Atmospheric Administration. (for B.D. Santer *et al*., *Nature*, 1996: "*A search for human influences on the thermal structure of the atmosphere*").
- 1975 Project prize, best undergraduate research project, School of Environmental Sciences, University of East Anglia.
- 1974 Ford Travel Scholarship.

Research Interests

Identification of human-induced climate change in observations; evaluation of climate model performance.

Professional Employment and Research Projects

8/1992-Present

Physicist, Energy and Environment Directorate, Lawrence Livermore National Laboratory, Livermore, CA (statistical methods in climate model validation, climate-change detection and attribution studies).

1987-1992

Postdoc and Research Scientist, Max-Planck-Institut für Meteorologie, Hamburg, Germany (detection of greenhouse-gas-induced climate change, analysis of equilibrium and transient response to CO_2 forcing, paleoclimate studies, model validation and intercomparison, supervision of graduate students).

1983-1987

Research Associate, Climatic Research Unit, University of East Anglia, Norwich, U.K. Employed under research contracts with U.S. Department of Energy and Lawrence Livermore National Laboratory (validation of climate model control run results using Monte Carlo techniques, use of model data in climate impact analysis, quality control of observed surface temperature data, teaching).

1980-1983

Project Engineer in the Department of New Technologies, Air Pollution and Climatology Section, Dornier System GmbH, Friedrichshafen, Germany. Employed under research contracts with the European Community, Federal German Ministry for Research and Technology, Federal German Environmental Agency and NATO (impacts of greenhouse-gas-induced climate change, comparison of ambient air quality legislation in NATO countries, satellite measurement of meteorological parameters, technical translations).

1978-1979

Junior Research Associate, University of East Anglia, School of Environmental Sciences, Norwich, U.K. (investigation of eutrophication in the Norfolk Broads).

Professional Affiliations

American Geophysical Union.

Highlights of Professional Activities

Jan. 1990

Contributor to Chapter 8 ("*Detection of the Greenhouse Effect in the Observations*") of 1990 First Assessment Report of the Intergovernmental Panel on Climate Change.

Jan. 1992

Expert witness at German Bundestag Enquete Commission Hearings on Greenhouse-Gas-Induced Climate Change, Jan. 16-17, Bonn, Germany.

1992-1993

Consultant to Battelle Pacific Northwest Laboratory. Provided technical assistance in the development of a research strategy for detecting climate change due to anthropogenic emissions of greenhouse gases.

1994-1995

Convening Lead Author for Chapter 8 ("*Detection of Climatic Change, and Attribution of Causes*") of 1995 Second Assessment Report of the Intergovernmental Panel on Climate Change.

1995-1998

Member of the Climate Variability and Predictability (CLIVAR) Numerical Experimentation Group (NEG-2).

1995-2001

Member of Science Advisory Panel for NOAA "*Climate Change, Data and Detection*" Program.

1996-present

Editorial board, *Climatic Change*.

Apr. 1999-Jan. 2000

Member of National Research Council panel on "*Reconciling Observations of Temperature Change*".

2000-2001

Contributing Author to Chapter 12 ("*Detection of Climate Change, and Attribution of Causes*") of 2001 Third Assessment Report of the Intergovernmental Panel on Climate Change.

2001-present

Member of Climate Modeling Advisory Panel, Goddard Institute for Space Studies.

Jul. 2003-2009

Co-Chair of Climate Change Working Group, Community Climate System Model.

Aug. 2003-2008

Member of Science Review Group, Hadley Centre for Climate Prediction and Research.

Aug. 2003-2007

Member of Scientific Steering Committee, NCAR Community Climate System Model.

2004-2006

Convening Lead Author, Chapter 5 of U.S. Climate Change Science Program Report on "*Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*".

2006-2007

Contributing Author to Chapter 1 ("*Historical Overview of Climate Change Science*"), Chapter 9 ("*Understanding and Attributing Climate Change*") and Chapter 10 ("*Global Climate Projections*") of 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

2008-2009

Lead Author, "Global Climate Change" section of Unified Synthesis Product, U.S. Climate Change Science Program.

Other Professional Activities

1982

[1] *Jul. 1982:* Participant, Second International School of Climatology on "*Climate and Energy: Carbon Dioxide*". Erice, Sicily.

1983

[2] *Sep. 1983:* Invited participant, UNEP/ICSU/WMO Study Conference on "*CO_2 and the Biosphere*". Villach, Austria.

[3] *Oct. 1983:* Invited participant, Federal German Climatology Conference, Bad Sooden-Allendorf, Germany.

1984

[4] *Oct. 1984:* Participant, Ninth Annual Climate Diagnostics Workshop, Corvallis, Oregon.

1986

[5] *Jun. 1986:* Participant, NATO Advanced Study Institute on "*Physically-Based Modelling and Simulation of Climate and Climatic Change*", Erice, Sicily.
[6] *Oct. 1986:* Invited participant, Conference on "*Man and Climate: Anthropogenic Influences on Atmosphere and Climate*", Loccum, Germany.
[7] *Dec. 1986:* Invited lecturer, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. "*Regional Validation of General Circulation Models of the Atmosphere: The Application of Preisendorfer and Barnett Monte Carlo Techniques*".

1987

[8] *Mar. 1987:* Invited lecturer, Max-Planck-Institut für Meteorologie, Hamburg, Germany. "*Regional Validation of GCMs using Preisendorfer and Barnett Monte Carlo Techniques*".
[9] *Jun. 1987:* Invited lecturer, Hooke Institute for Atmospheric Research, Oxford, U.K. "*Regional Validation of GCMs using Preisendorfer and Barnett Monte Carlo Techniques*".

1988

[10] *Sep. 1988:* Participant, Workshop on Systematic Errors in Models of the Atmosphere, Toronto, Canada. "*Regional Validation of Means, Variances, and Spatial Patterns in GCM Control Runs*".
[11] *Dec. 1988:* Invited lecturer, German-French Society for Science and Technology, Munich, Germany. "*CO_2 - Die Suche nach dem Signal*" ("*CO_2 - The Search for the Signal*").

1989

[12] *Feb. 1989:* Participant, Workshop on Development of Regional Climate Scenarios for Impact Assessment, IIASA, Laxenburg, Austria.
[13] *May 1989:* Invited lecturer, DOE Workshop on Greenhouse-Gas-Induced Climatic Change, Amherst, U.S.A. "*Multivariate Methods for the Detection of Greenhouse-Gas-Induced Climatic Change*".
[14] *May 1989:* Invited lecturer, Climate System Research Program, Texas A&M University, College Station, Texas. "*Multivariate Methods for the Detection of Greenhouse-Gas-Induced Climatic Change*".
[15] *Aug. 1989:* Participant, EPA Scenarios Advisory Meeting, NCAR, Boulder, Colorado. "*Developing Climate Scenarios from GCM Equilibrium Results*".
[16] *Sep. 1989:* Participant, First International Conference on Modelling of Global Climate Change and Variability, Hamburg, Germany. "*An Attempt to Detect the Greenhouse-Gas Signal in a GCM Equilibrium Simulation*".

1990

[17] *Jan. 1990:* Participant, IPCC Workshop on Comparison of Transient Simulations with Observations, NASA, Washington D.C.
[18] *Feb. 1990:* Invited lecturer, Humboldt Universität, East Berlin. "*An Attempt to Detect the Greenhouse-Gas Signal in GCM Equilibrium Simulations*".
[19] *Aug. 1990:* Invited lecturer, Electric Power Research Institute, Palo Alto, California. "*Ocean Response to Greenhouse Warming*".
[20] *Aug. 1990:* Invited lecturer, Lawrence Livermore National Laboratory, Livermore, California. "*Recent Research Activities at the Max-Planck Institute for Meteorology in Hamburg*".
[21] *Aug. 1990:* Invited lecturer, University of Arizona, Tree Ring Laboratory, Tucson, Arizona. "*Ocean Response to Greenhouse Warming*".
[22] *Oct. 1990:* Participant, 15th Annual Climate Diagnostics Workshop, Asheville, North Carolina. "*Coupled Model Simulation of the Transient Response to Greenhouse Gas Forcing*".

[23] *Nov. 1990:* Invited lecturer, Commission of the European Community Workshop on Socio-Economic Effects of Climate Change in Europe, Brussels, Belgium. "*Changes in Climate and Sea Level*".

1991

[25] *Nov. 1991:* Invited lecturer, First Demetra Meeting on Climate Variability and Global Change, Chianciano Terme, Italy. "*Selecting Components of a Greenhouse-Gas Fingerprint*".

[26] *Dec. 1991:* Participant, Dahlem Workshop on Global Changes in the Perspective of the Past, Berlin, Germany.

1992

[27] *Jan. 1992:* Invited lecturer, Freie Universität Berlin, Germany. "*Signal-to-Noise Analysis of Transient Greenhouse Warming Experiments*".

[28] *Apr. 1992:* Invited lecturer, Dept. of Statistics, North Carolina State University, Raleigh, North Carolina. "*Signal-to-Noise Analysis of Transient Greenhouse Warming Experiments*".

[29] *Apr. 1992:* Invited lecturer, Lawrence Livermore National Laboratory, Livermore, California. "*Signal-to-Noise Analysis of Transient Greenhouse Warming Experiments*".

[30] *Jun. 1992:* Invited lecturer, Fifth International Conference on Statistical Climatology, Toronto, Canada. "*Orthogonality of Signal and Noise in Time-Dependent Greenhouse Warming Experiments*".

[31] *Sep. 1992:* Participant, Second International Conference on Modelling of Global Climate Change and Variability, Hamburg, Germany. "*Orthogonality of Signal and Noise in Time-Dependent Greenhouse Warming Experiments*".

[32] *Oct. 1992:* Participant, Conference on Agricultural Dimensions of Global Climate Change, Cornell University, Cornell, New York. "*Issues in Detection of Climate Change Using General Circulation Models*".

1993

[33] *Jan 1993:* Invited lecturer, Climate System Research Program, Texas A&M University, College Station, Texas. "*Application of Optimal Detection Methods to Time-Dependent Greenhouse Warming Experiments*".

[34] Aug. 1993: Invited lecturer, Max-Planck-Institut für Meteorologie, Hamburg, Germany. "*Estimates of Detection Time for Ocean Greenhouse Warming Signals*".

[35] Oct. 1993: Invited lecturer, Goddard Space Flight Center, Greenbelt, Maryland. "*Signal-to-Noise Analysis of Time-Dependent Greenhouse Warming Experiments*".

1994

[36] Mar. 1994: Invited lecturer, Max-Planck-Institut für Meteorologie, Hamburg, Germany. "*Are Sulfate Aerosols Masking a Greenhouse Warming Signal?*"

[37] Mar. 1994: Invited lecturer, National Research Council Board on Atmospheric Sciences and Climate, Irvine, California. "*Are Sulfate Aerosols Masking a Greenhouse Warming Signal?*"

[38] Jun. 1994: Invited lecturer, Bureau of Meteorology Research Centre, Melbourne, Australia. "*Detecting Sulfate Aerosol and CO_2 Signals in the Observed Temperature Record*".

[39] Jul. 1994: Invited lecturer, 12th Conference of the Australian Statistical Society, Melbourne, Australia. "*Statistical Methods in Climate Change Detection Studies*".

[40] Jul. 1994: Invited lecturer, Commonwealth Scientific and Industrial Research Organization, Division of Atmospheric Research, Melbourne, Australia. "*Statistical Methods in Climate Change Detection Studies*".

[41] Jul. 1994: Invited lecturer, Workshop on Studies of Observed and Modelled Climate Variations, Cooperative Research Centre for Southern Hemisphere Meteorology, Melbourne, Australia. "*An Introduction to COMPARE - the Use of Monte Carlo Methods in Model Validation and for Assessing Significance in Climate Change Experiments*".

[42] Jul. 1994: Invited lecturer, NCAR Colloquium on Statistical Methods in Atmospheric Sciences. "*Fingerprint Methods in Climate Change Detection Studies*".

[43] Sep. 1994: Organizer, IPCC Workshop on "*Detection of Climate Change, and Attribution of Causes*", Livermore, California.

[44] Oct. 1994: Participant, Workshop on Global Coupled General Circulation Models, Scripps Institution of Oceanography, La Jolla, California.
[45] Nov. 1994: Participant, First IPCC Lead Authors' Drafting Meeting, Sigtuna, Sweden.

1995

[46] *Jan. 1995:* Invited lecturer, Conference on the "*Global Climate Observing System*", Asheville, North Carolina.
[47] *Mar. 1995:* Participant, Second IPCC Lead Authors' Drafting Meeting, Brighton, U.K.
[48] *May 1995:* Participant, First International AMIP Scientific Conference, Monterey, California. "*Statistical Evaluation of AMIP Model Performance*".
[49] *Jun. 1995:* Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey. "*Have sulfate aerosols masked regional-scale features of a greenhouse warming signal?*"
[50] *Jul. 1995:* International Union of Geodesy and Geophysics, Boulder, Colorado. "*An overview of recent multivariate climate change detection studies*".
[51] *Jul. 1995:* Participant, Third IPCC Lead Authors' Drafting Meeting, Asheville, North Carolina.
[52] *Sep. 1995:* Third International Conference on Modelling of Global Climate Change and Variability, Hamburg, Germany. "*Have sulfate aerosols masked regional-scale features of a greenhouse warming signal?*"
[53] *Sep. 1995:* First International Science Conference on Global Analysis, Interpretation, and Modelling, Garmisch-Partenkirchen, Germany. "*The search for a model-predicted signal in observed records of temperature change*".
[54] *Nov. 1995:* University of Washington, Seattle, Washington. "*The search for a model-predicted temperature-change signal in observed records of temperature change*".
[55] *Nov. 1995:* Fifth Session of Working Group I of the Intergovernmental Panel on Climate Change, Madrid, Spain. "*Detection of climate change and attribution of causes*".
[56] *Nov. 1995:* World Meteorological Organization Training Seminar on Climate Change Issues, Madrid, Spain. "*Climate change detection and attribution*".
[57] *Dec. 1995:* Hadley Centre for Climate Prediction and Research, Bracknell, United Kingdom. "*A search for the human influence on the thermal structure of the atmosphere*".
[58] *Dec. 1995:* Hadley Centre for Climate Prediction and Research, Bracknell, United Kingdom. "*Statistical evaluation of AMIP model performance*".

1996

[59] *Jan. 1996:* Seventy-Sixth Annual Meeting of American Meteorological Society, Atlanta, Georgia. "*Detection of climate change and attribution of causes*".
[60] *Feb. 1996:* American Association for the Advancement of Science, 1996 Annual Meeting, Baltimore, Maryland. "*Towards detection and attribution of anthropogenic climate change*".
[61] *Feb. 1996:* Environmental Programs Scientific Advisory Committee, Livermore, California. "*Detection of anthropogenic climate change*".
[62] *Mar. 1996:* Seventeenth Session, Joint Scientific Committee of the World Climate Research Programme, Toulouse, France. "*Detection of anthropogenic climate change*".
[63] *May 1996:* Invited seminar, U.S. Global Change Research Program, Washington, D.C. "*The search for a fingerprint of human activities in observed climate records*".
[64] *Jul. 1996:* Environmental Programs Director's Review, Livermore, California. "*The search for a fingerprint of human activities in observed climate records*".
[65] *Aug. 1996:* Participant, Aspen Global Change Institute, Aspen, Colorado. "*Detection and attribution assessment in IPCC proceedings, and the nightmare media aftermath*".
[66] *Nov. 1996:* Invited lecture, Muskie Symposium on the Environment and International Affairs, Bates College, Maine. "*The search for an anthropogenic signal: have human activities influenced global climate?*"

1997

[67] *Apr. 1997:* Keynote speaker, Tandy Technology Scholars Awards Ceremony, New Orleans. "*The search for a fingerprint of human activities in global climate records*".
[68] *Apr. 1997:* Invited lecture, Fifth U.S.-Dutch International Symposium on Air Pollution in the 21st Century, Noordwijk, Holland. "*Detection of climate change and attribution of causes*".

[69] *May 1997:* Lecture to Energy Directorate Advisory Committee, Lawrence Livermore National Laboratory, Livermore, California. "*The search for a human-induced signal in observed climate records*".

[70] *May 1997:* Invited lecture, Lawrence Berkeley National Laboratory, Berkeley, California. "*The search for a human-induced signal in observed climate records*".

[71] *Jun. 1997:* Invited lecture, Climate System Model Workshop, Breckenridge, Colorado. "*Uncertainties in estimates of 'observed' atmospheric temperature change: Implications for climate-change detection studies*".

[72] *Aug. 1997:* Invited lecture, Conference on the World Climate Research Programme: Achievements, Benefits and Challenges, Geneva, Switzerland. "*Detection of climate change and attribution of causes*".

[73] *Sep. 1997:* Invited lecture, Union of Concerned Scientists, Science Summit on Climate Change. "*Climate change detection – The discernibility of a human signal*".

[74] *Nov. 1997:* Invited lecture, ICF Program, Lawrence Livermore National Laboratory. "*The discernibility of a human-induced signal in observed climate records*".

[75] *Nov. 1997:* Invited lecture, Stanislaus Environment Education Project, Modesto, California. "*Global warming: natural or human-induced?*"

[76] *Dec.1997:* Invited lecture, American Geophysical Union, San Francisco, California. "*Physical interpretation of differences between near-surface and lower tropospheric temperature trends in the NCEP and ERA reanalyses*".

[77] *Dec. 1997:* Invited lecture, American Geophysical Union, San Francisco, California. "*Uncertainties in 'observational' estimates of temperature change in the free atmosphere*".

1998

[78] *Jan. 1998:* Lecture, Joint Institute for Study of Atmosphere and Oceans, Seattle, Washington. "*Physical interpretation of differences between near-surface and lower tropospheric temperature trends in the NCEP and ERA reanalyses*".

[79] *Jan. 1998:* Colloquium, Dept. of Atmospheric Sciences, Univ. of Washington, Seattle, Washington. "*Uncertainties in 'observational' estimates of temperature change in the free atmosphere*".

[80] *Feb. 1998:* Inaugural lecture, Environmental Studies Program, Bates College, Lewiston, Maine. "*Climate change: natural or human-induced?*"

[81] *Feb. 1998:* Public lecture, Bates College, Lewiston, Maine. "*A personal perspective on political reaction to the IPCC's "discernible human influence" conclusion*".

[82] *Mar. 1998:* Invited lecture, Euroclivar "Beyond Discernibility" meeting, Hadley Centre, Bracknell, U.K. "*Uncertainties in 'observational' estimates of temperature change in the free atmosphere*".

[83] *Mar. 1998:* Invited lecture, Symposium on Understanding Climate Change (in Honor of Syukuro Manabe), Princeton, New Jersey. "*Uncertainties in 'observational' estimates of temperature change in the free atmosphere*".

[84] *May 1998:* Invited lecture, Physics Dept., University of California, Davis, California. "*Climate change: natural or human-induced?*"

[85] *May 1998:* Invited lecture, Pacific Union College, Angwin, California. "*Climate change: natural or human-induced?*"

1999

[86] *Jan. 1999:* Invited lecture, Explorers Club, San Francisco, California. "*Climate change: natural or human induced?*"

[87] *May 1999:* Invited lecture, Global Climate Change Science Workshop, California Energy Commission, Sacramento, California. "*Climate change – natural or human-induced?*"

[88] *May 1999:* Lecture, Earth and Environmental Sciences Directorate Science Advisory Committee, Livermore, California. "*Interpreting differences between temperature changes at the Earth's surface and in the lower troposphere*".

[89] *Jun. 1999:* Keynote speaker, Conference on Global Climate Change, Trieste, Italy. "*Interpreting differences between temperature changes at the Earth's surface and in the lower troposphere*".

[90] *Jul. 1999:* Lecture, International Union of Geophysics and Geodesy, Birmingham, U.K. "*Interpreting differences between temperature changes at the Earth's surface and in the lower troposphere*".

[91] *Aug. 1999:* Invited lecture, Dept. of Atmospheric Sciences, Univ. of Washington, Seattle, Washington. "*Interpreting differences between temperature changes at the Earth's surface and in the lower troposphere*".
[92] *Oct. 1999:* Invited lecture, Northern California Geological Society, Orinda, California. "*Climate change: natural or human induced?*"

2000

[93] *Apr. 2000:* Invited lecture, Valley Study Group, Pleasanton, California. "*Climate change: natural or human induced?*"
[94] *Nov. 2000:* Invited lecture, University of California (Davis). "*Accounting for the effects of volcanoes and ENSO in comparisons of modeled and observed temperature trends*".
[95] *Dec. 2000:* Invited lecture, American Geophysical Union, San Francisco, California. "*A brief history of Chapter 8 of the IPCC's Second Assessment Report*".

2001

[100] *Jan. 2001:* Invited lecture, Workshop on Enhancing Caribbean Climate Data Collection and Processing Capability, University of the West Indies, Mona, Jamaica. "*Projections of climate change in the Caribbean Basin from General Circulation Models*".
[101] *Jan. 2001:* Keynote address, Pure and Applied Science Conference, University of the West Indies, Mona, Jamaica. "*Climate change: Natural or human-induced?*"
[102] *Feb. 2001:* Invited lecture, University of Michigan, Dept. of Atmospheric, Oceanic and Space Sciences, Ann Arbor, Michigan. "*Accounting for volcano and ENSO effects in comparisons of modeled and observed temperature trends*".
[103] *Feb. 2001:* Keynote address, Doctoral Student Conference, Yale University, New Haven, Connecticut. "*Investigating the causes of climate change*".
[104] *Mar. 2001:* Presentation, Valley Montessori School, Livermore, California. "*Volcanoes, and what they tell us*".
[105] *May 2001:* Invited lecture, American Geophysical Union Spring Meeting, Boston, Massachusetts. "*Accounting for volcano and ENSO effects in comparisons of modeled and observed temperature trends*".
[106] *Sep. 2001:* Invited lecture, U.S. Dept. of Energy Pollution Prevention Award Ceremony, Oakland, California. "*Studying the causes of climate change*".
[107] *Oct. 2001:* Presentation, U.S. Dept. of Energy Climate Change Prediction Program, San Diego, California. "*Detection and attribution research at PCMDI*".
[108] *Nov. 2001:* Participant, Climate Modeling Advisory Panel, Goddard Institute for Space Studies, New York.

2002

[109] *Jun. 2002:* Invited lecture, Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey. "*Using tropopause height changes to identify human effects on global climate*".
[110] *Jul. 2002:* Lecture, Community Climate System Model Workshop, Breckenridge, Colorado. "*Diagnosis of tropopause height behavior in PCM climate-change experiments*".
[111] *Aug. 2002:* Invited lecture, Energy Modeling Forum, Workshop on Climate-change Impacts and Integrated Assessment VIII, Snowmass, Colorado. "*Model verification and instrumental climate records*".
[112] *Aug. 2002:* Invited lecture, Lawrence Berkeley National Laboratory, Berkeley, California. "*Model evaluation research at PCMDI*".
[113] *Sep. 2002:* Invited lecture, National Climatic Data Center, Asheville, North Carolina. "*Model evaluation research at PCMDI*".
[114] *Oct. 2002:* Invited lecture, 10th Anniversary Kuehnast Lecture Program, University of Minnesota, Minneapolis, Minnesota. "*Studying the nature and causes of climate change*".
[115] *Oct. 2002:* Acceptance speech, E.O. Lawrence Award Ceremony, National Academy of Sciences, Washington D.C.
[116] *Dec. 2002:* Invited talk, Planning Workshop, U.S. Climate Change Science Program, Washington D.C. "*Resolution of disparities in tropospheric temperature records*".

[116] *Dec. 2002:* Invited talk, Director's Distinguished Lecture Series, Lawrence Livermore National Laboratory, Livermore, California. "*A brief history of climate-change detection research at the Program for Climate Model Diagnosis and Intercomparison*".

2003

[117] *Jan. 2003:* Invited talk, University of California President's Council Meeting, Lawrence Livermore National Laboratory, Livermore, California. "*A brief history of climate-change detection research at the Program for Climate Model Diagnosis and Intercomparison*".

[118] *Feb. 2003:* Invited talk, Neyman lecture series, Dept. of Statistics, University of California at Berkeley. "*Some statistical issues relevant to the detection of human-induced climate change*".

[119] *Mar. 2003:* Invited talk, CosmoCaixa Foundation, Madrid, Spain. "*Una discussion sobre el Cambio Climático*" ("*Understanding the causes of climate change*").

[120] *Apr. 2003:* Invited talk, Energy and Environment Directorate Review Committee, Lawrence Livermore National Laboratory, Livermore, California. "*A brief history of climate-change detection research at the Program for Climate Model Diagnosis and Intercomparison*".

[121] *Apr. 2003:* Invited "Earth Day" lecture, Lawrence Livermore National Laboratory, Livermore, California. "*Recent developments in climate-change detection and attribution research*".

[122] *Apr. 2003:* Invited talk, Lamont-Doherty Earth Observatory, Palisades, New York. "*Has the troposphere warmed over the satellite era?*"

[123] *Apr. 2003:* Lecture, *ad hoc* Detection Group, Duke University, Durham, North Carolina. "*Summary of recent detection and attribution research at PCMDI*".

[124] *Jun. 2003:* Invited talk, Statistical and Applied Mathematical Sciences Institute, Boulder, Colorado. "*Some statistical issues relevant to the detection of human-induced climate change*".

[125] *Jun. 2003:* Lecture, Community Climate System Model Workshop, Breckenridge, Colorado. "*Contributions of anthropogenic and natural forcing to recent tropopause height changes*".

[126] *Jul. 2003:* Invited lecture, Gordon Conference on Solar Radiation and Climate, Colby-Sawyer College, New London, New Hampshire. "*Recent developments in climate-change detection and attribution research*".

[127] *Jul. 2003:* Invited lecture, IRCCSI/SNRI/CEC Societal Impacts Workshop, Tenaya Lodge, California. "*A brief history of climate-change detection research at PCMDI*".

[128] *Aug. 2003:* Invited lecture, World Federation of Scientists, 30th Session of International Seminars on Planetary Emergencies, Erice, Sicily. "*New fingerprints of human effects on climate*".

[129] *Oct. 2003:* Invited lecture, Workshop on Vertical Temperature Trends, National Climatic Data Center, Asheville, North Carolina. "*Assessing consistency between simulated and observed atmospheric temperature trends*".

[130] *Nov. 2003:* Invited lecture, Workshop on Process-Oriented Validation of Coupled Chemistry-Climate Models, Garmisch-Partenkirchen, Germany. "*Statistical methods in model evaluation*".

[131] *Dec. 2003:* Lecture, Valley Montessori School, Livermore, California. "*Why should we care about climate change?*"

2004

[132] *Jan. 2004:* Invited lecture, Environmental Science and Engineering Seminar Series, California Institute of Technology, Pasadena, California. "*Are changes in tropopause height a fingerprint of human effects on climate?*"

[133] *Jan. 2004:* Invited lecture, Environmental Science and Engineering Department, California Institute of Technology, Pasadena, California. "*A brief history of Chapter 8 of the IPCC's Second Assessment Report*".

[134] *Feb. 2004:* Invited lecture, Climate and Energy Funders Group and Consultative Group on Biodiversity, Funders Strategy Meeting on Climate Change and Energy, Golden Gate Club, San Francisco, California. "*Climate change: Emerging science, and challenges for funding agencies*".

[135] *Mar. 2004:* Invited lecture, NASA/Goddard Space Flight Center Seminar Series, Greenbelt, Maryland. "*Changes in tropopause height and atmospheric temperature in a second-generation reanalysis*".

[136] *Apr. 2004:* Invited lecture, Haagen-Smit Symposium on Climate Change, Lake Arrowhead, California. "*Climate change detection and attribution: A personal view of the emerging science*".

[137] *Apr. 2004:* Lecture, *ad hoc* detection group, Oxford University, Oxford, U.K. "*An update on recent detection and attribution activities at PCMDI*".

[138] *Jun. 2004:* Invited lecture, Ninth Electric Power Research Institute Global Change Research Seminar, Washington D.C. "*Climate change detection and attribution: A personal view of the emerging science*".

[139] *Jun. 2004:* Invited lecture, First Annual Conference on Climate Change, Sacramento, California. "*Climate change detection and attribution: A personal view of the emerging science*".

[140] *Jun. 2004:* Invited lecture, American Association for the Advancement of Science, Pacific Division, Symposium of Future Climate Change: Implications for Western Environments, Utah State University, Logan, Utah. "*Changes in tropopause height: A new fingerprint of human effects on climate*".

[141] *Jul. 2004:* Lecture, 9th Annual CCSM Workshop, Climate Change Working Group Meeting, Santa Fe, New Mexico. "*Detecting climate change fingerprints against total natural variability noise*".

[142] *Aug. 2004:* Invited lecture, 129th American Association of Physics Teachers Annual Meeting, Sacramento, California. "*Fossil fuels and global warming concerns*".

[143] *Aug. 2004:* Invited lecture, 3rd SPARC General Assembly, Victoria, British Columbia, Canada. "*Are recent tropopause height changes a useful fingerprint of human effects on climate?*"

[144] *Aug. 2004:* Invited lecture, Conference on "*Hydrogen - Fueling the Clean Air Future*", Palm Desert, California. "*Recent developments in climate change detection and attribution research*".

[145] *Sept. 2004:* Invited lecture, Symposium on "*Climate Change: Past, Present and Future*", University of Iceland, Reykjavik, Iceland. "*Identifying human influences on global climate*" (Presentation to Carl XVI Gustaf, King of Sweden).

[146] *Sept. 2004:* Lecture, Workshop on Vertical Temperature Trends, Hadley Centre for Climate Prediction and Research, Exeter, U.K. "*Identification of anthropogenic climate change using a second-generation reanalysis*".

[147] *Sept. 2004:* Invited presentation to public meeting of California Environmental Protection Agency Air Resources Board, Los Angeles, California. "*Recent developments in climate change detection and attribution research*".

[148] *Oct. 2004:* Invited lecture, International Sustainability Days Conference, Stanford University, California. "*New developments in climate science: Progress in detection and attribution research*".

[149] *Oct. 2004:* Presentation, Science Team Meeting of U.S. D.O.E. Climate Change Prediction Program, Seattle, Washington. "*Progress in detection and attribution of climate change: Results from the ad hoc Detection and Attribution Group*".

[150] *Dec. 2004:* Invited lecture, Energy and Environment Colloquium, Lawrence Livermore National Laboratory, Livermore, California. "*Identifying human effects on global climate*".

2005

[151] *Feb. 2005:* Invited lecture, Whole Earth Systems Conference (in celebration of Steve Schneider's 60th birthday), Stanford University, Palo Alto, California. "*What does 'D&A' (detection and attribution) evidence tell us?*"

[152] *Feb. 2005:* Invited lecture, Annual Meeting, American Association for the Advancement of Science, Washington D.C. "*What does 'D&A' (detection and attribution) evidence tell us?*"

[153] *Feb. 2005:* Presentation to National Research Council Review Panel, Chicago, Illinois. "*Overview of Chapter 5 of U.S. Climate Change Science Plan Report on "Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*".

[154] *Mar. 2005:* Invited talk, Energy and Environment Directorate Review Committee, Lawrence Livermore National Laboratory, Livermore, California. "*An update on surface/troposphere temperature reconciliation*".

[155] *Apr. 2005:* Invited lecture, Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida. "*Tropical lapse rates: A constraint on uncertainties in MSU and radiosonde estimates of tropospheric temperature change?*"

[156] *Jun. 2005*: Invited lecture, Electric Power Research Institute 10th Annual Global Change Research Seminar, Washington D.C. "*Reconciling climate observations*".

[157] *Jun. 2005*: Invited lecture, 10th Annual Community Climate System Model Workshop, Breckenridge, Colorado. "*The IPCC historical forcing runs: PCMDI analyses of an ensemble of opportunity*".

[158] *Sep. 2005*: Invited lecture, Second Annual Climate Change Research Conference, Sacramento, California. "*Has the troposphere warmed since 1979?*"

[159] *Sep. 2005*: Invited lecture, 2005 World Sustainable Building Conference, Tokyo, Japan. "*Scientific aspects of the climate system and climate change*".
[160] *Oct. 2005*: Invited lecture, 2005 Chemistry-Climate Modeling Workshop, Boulder, Colorado. "*Overview of the IPCC climate simulations and assessment needs*".
[161] *Nov. 2005*: Presentation to University of California Regent Norman J. Pattiz, Livermore, California. "*Climate change research at LLNL*".
[162] *Dec. 2005*: Presentation to Bernard Bigot, French High Commissioner of Atomic Energy, Livermore, California. "*Climate change research at LLNL*".
[163] *Dec. 2005*: Invited presentation, Acterra, Palo Alto. "*Global warming: What we know and what's being done about it*".

2006

[164] *Jan. 2006*: Invited lecture, University of Texas, Institute for Geophysics, Austin, Texas. "*Causes of ocean surface temperature changes in Atlantic and Pacific tropical cyclogenesis regions*".
[165] *Jan. 2006*: Invited lecture, University of Texas, Dept. of Physics, Austin, Texas. "*The case for a human influence on global climate*".
[166] *Mar. 2006*: Invited lecture, Canadian CLIVAR Network Workshop, Victoria, Canada. "*Temperature changes in the free atmosphere: Confronting models with data, and data with models*".
[167] *Mar*. 2006: Lecture, Fairlands Elementary School, Pleasanton, California. "*Why should we care about climate change?*"
[168] *Apr. 2006*: Invited lecture, Cornerstone Research, Menlo Park, California. "*Identifying human influences on global climate*".
[169] *May 2006*: Public briefing on Synthesis and Assessment Product 1.1 of the U.S. Climate Change Science Plan, U.S. Department of Commerce, Washington, D.C. "*Chapter 5: How well can the observed vertical temperature changes be reconciled with our understanding of the causes of these changes?*"
[170] *May 2006*: Invited lecture, Stanford University, Palo Alto, California. "*Identifying human influences on global climate: A personal perspective on detection and attribution studies*".
[171] *Jun. 2006*: Lecture, 11th Annual Community Climate System Model Workshop, Breckenridge, Colorado. "*Causes of ocean surface temperature changes in Atlantic and Pacific tropical cyclogenesis regions*".
[172] *Aug. 2006*: Invited lecture, International Workshop on Countermeasures to Urban Heat Islands, Tokyo, Japan. "*Global climate change: Possible implications for urban environments*".
[173] *Sep. 2006*: Keynote speech, Third Annual Climate Change Research Conference, Sacramento, California. "*Recent advances in detection and attribution studies*".
[174] *Sep. 2006*: Invited lecture, University of California President's Council on Laboratory Affairs, Livermore, California. "*Causes of ocean surface temperature changes in hurricane formation regions*".
[175] *Oct. 2006*: Invited lecture, 2006 Lecture Series on Global Climate Change, Seymour Center at Long Marine Laboratory, Santa Cruz, California. "*Identifying human influences on global climate*".
[176] *Nov. 2006*: Presentation to PCMDI Advisory Committee, Livermore, California. "*Detection and attribution research at PCMDI: Recent highlights, and challenges for the future*".
[177] *Nov. 2006*: Presentation to Athenian School Applied Science Class, Livermore, California. "*Identifying human influences on global climate*".
[178] *Nov. 2006*: Invited lecture, Purdue Climate Change Research Center Distinguished Lecture Series, Purdue University, Indiana. "*Identifying human influences on global climate*".

2007

[179] *Jan. 2007*: Invited lecture, Faculty Resources Network Workshop on "*Global Warming: Science, Policy, Curriculum*". University of the Sacred Heart, San Juan, Puerto Rico. "*Global Climate Change I: Foundations*".
[180] *Jan. 2007*: Invited lecture, Faculty Resources Network Workshop on "*Global Warming: Science, Policy, Curriculum*". University of the Sacred Heart, San Juan, Puerto Rico. "*Global Climate Change II: Current research*".
[181] *Jan*. *2007*: Presentation to Symposium on "*Climate Change in the Caribbean*", University of Puerto Rico-Rio Piedras, Puerto Rico. "*Projections of climate change in the Caribbean Basin from global circulation models*".

[182] *Jan. 2007*: Invited lecture, American Meteorological Society's Environmental Science Seminar Series, Washington D.C. "*The case for a human effect on global climate: How do we know that human activities are important?*"

[183] *Feb. 2007*: Presentation to Dr. David L. Goodstein, Vice-Provost, California Institute of Technology. "*Identifying human influences on global climate: How do we know that human activities are important?*"

[184] *Feb. 2007*: Invited lecture, Unitarian Universalist Church, Palo Alto, California. "*Identifying human influences on global climate*".

[185] *Mar. 2007*: Presentation to Susan Hackwood, Executive Director, California Council on Science and Technology. "*Identifying human influences on global climate: How do we know that human activities are important?*"

[186] *Mar. 2007*: Presentation to Environmental Risk Assessment Class, University of San Francisco, San Francisco, California. "*Uncertainties in climate model simulations*".

[187] *Apr. 2007*: Lecture, Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida. "*Identification of human-induced changes in atmospheric moisture content*".

[188] *Apr. 2007*: Invited presentation, Earth Day Symposium, The Athenian School, Danville, California. "*Identifying human influences on global climate: How do we know that human activities are important?*"

[189] *Apr. 2007*: Invited lecture, Mathematical Sciences Research Institute, Symposium on Climate Change, Berkeley, California. "*Identifying human-induced climate change: An example*".

[190] *May 2007*: Presentation to U.S. Dept. of Energy Livermore Site Office, Lawrence Livermore National Laboratory, Livermore, California: "*Identifying human influences on global climate: How do we know that human activities are important?*"

[191] *May 2007*: Invited presentation, Electric Power Research Institute 12th Global Climate Change Research Seminar, Washington D.C.: "*Recent work on detection and attribution*".

[192] *Jun. 2007*: Invited presentation, Valley Study Group, Pleasanton, California: "*Identifying human influences on global climate: How do we know that human activities are important?*"

[193] *Jun. 2007*: Lecture, 12th Annual Community Climate System Model Workshop, Breckenridge, Colorado. "*Identification of human-induced changes in atmospheric moisture content*".

[194] *Jun. 2007*: Invited presentation, U.S. State Dept. Conference on "*Risky Climate: Disaster Preparedness and Foreign Policy in the 21st Century*", Arlington, Virginia: "*Building confidence in projections of future climate change*".

[195] *Aug. 2007*: Keynote speech, Consortium on Climate, Energy, Environment at Lawrence Livermore National Laboratory (C-CELL), Livermore, California: "*Identifying human influences on global climate: How do we know that human activities are important?*"

[196] *Sep. 2007*: Invited presentation, News Executives Roundtable: Covering Climate Change. Graduate School of Business, Stanford University, Stanford, California: "*How do scientists know human activities are influencing the global climate?*"

[197] *Sep. 2007*: Presentation, Fourth Annual California Climate Change Conference, Sacramento, California: "*Identification of human-induced changes in atmospheric moisture content*".

[198] *Sep. 2007*: Keynote speech, 2007 Grantham Prize Seminar on the State of Environmental Journalism, Metcalf Institute for Marine and Environmental Reporting, University of Rhode Island, Narragansett, Rhode Island: "*Causes of recent climate change, and the climatic shape of things to come*".

[199] *Sep. 2007*: Invited talk, Climate Change and Policies: Economic Impacts on Energy Producers in the Western U.S., San Ramon, California: "*How do we know that human activities influence global climate?*"

[200] *Sep. 2007*: Presentation to 9th grade "*Forensic Science*" class, Granada High School, Livermore, California: "*Global warming: Whodunnit?*"

[201] *Oct. 2007*: Invited talk, American Statistical Association Workshop on "*A Statistical Consensus on Global Warming",* Boulder, Colorado: *"Detection and attribution of climate change*".

[202] *Oct. 2007*: Invited lecture, American Meteorological Society's Environmental Science Seminar Series, Washington D.C. "*Identifying human-caused changes in atmospheric moisture content*".

[203] *Nov. 2007*: Invited lecture, Stanford Linear Accelerator Center Colloquium Series, Menlo Park, California: "*How do we know that human activities have influenced global climate?*"

[204] *Dec. 2007*: Keynote speech, Annual Meeting of Pew Fellows Program in Marine Conservation, Morro Bay, California: "*The search for a human-caused climate change signal in the world's oceans*".

2008

[205] *Jan. 2008*: Presentation to Annual Meeting of International Detection and Attribution Group, Boulder, Colorado: "*Human-induced changes in the hydrological cycle of the Western U.S.*"

[206] *Jan. 2008*: Presentation to Annual Meeting of International Detection and Attribution Group, Boulder, Colorado: "*Detection and attribution research at PCMDI: Research activities and future work*".

[207] *Mar. 2008*: Invited lecture, 2008 American Physical Society Meeting, New Orleans, Louisiana: "*Objective methods for detecting climate change and attributing causes*".

[208] *Mar. 2008*: Invited lecture, University of Michigan, Ann Arbor, Michigan: "*How do we know that human activities have influenced global climate?*"

[209] *Apr. 2008*: Invited lecture, Miami Science Museum FYI Lecture Series, Miami, Florida: "*Effects of human activity on global climate change: What do we know, and how do we know it?*"

[210] *Apr. 2008*: Keynote lecture, Second Annual Electric Aircraft Symposium, San Francisco, California: "*How do we know that human activities have influenced global climate*?"

[211] *Apr. 2008*: Presentation to Global Security Directorate Review Committee, Lawrence Livermore National Laboratory, Livermore, California: "*The history and future of climate change research at LLNL*".

[212] *May 2008*: Fourth Fred Keeley lecture on Environmental Policy (previous lecturers: Bruce Babbitt, Paul Ehrlich, and Jane Lubchenko), University of California at Santa Cruz, Santa Cruz, California: "Climate fingerprints: *How do we know human activities have influenced global climate change?*"

[213] *May 2008*: Presentation to Chemistry, Materials, Earth and Life Sciences Directorate Review Committee, Lawrence Livermore National Laboratory, Livermore, California: "*The history and future of climate change research at LLNL*".

[214] *Jul. 2008*: Invited lecture, University of Adelaide, Adelaide, Australia: "*How do we know that human activities have influenced global climate?*"

[215] *Jul. 2008*: Invited presentation, Energy Modeling Forum, Snowmass, Colorado: "*Making use of climate information from large multi-model archives: Lessons for integrated assessment*?"

[216] *Sep. 2008*: Presentation, Fifth Annual California Climate Change Conference, Sacramento, California: "*Including model quality information in detection and attribution studies: One model, one vote?*"

[217] *Nov. 2008*: Lecture, Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida. "*Including model quality information in detection and attribution studies: One model, one vote?*"

2009

[218] *Jan. 2009*: Invited lecture, Marine Geology and Geophysics Seminar, Oregon State University, Corvallis, Oregon: "*Including model quality information in detection and attribution studies: One model, one vote?*"

[219] *Jan. 2009*: Invited lecture, Geosciences/College of Oceanic and Atmospheric Sciences "Global Climate Change" lecture series, Oregon State University, Corvallis, Oregon: "*How do we know that human activities have influenced global climate?*"

[220] *Jan. 2009*: Invited lecture, Laboratory Energy Research and Development Working Group, Washington D.C.: "*Consistency of modeled and observed temperature trends in the tropical troposphere*".

[221] Feb. 2009: Presentation to University of Vermont Statistics Journal Club, Burlington, Vermont: "*Consistency of modeled and observed temperature trends in the tropical troposphere*".

[222] *Feb. 2009*: Invited lecture, University of Vermont, Burlington, Vermont: "*Including model quality information in detection and attribution studies: One model, one vote?*"

[223] *Feb. 2009*: Dan and Carole Burack Distinguished Lecture Series, University of Vermont, Burlington, Vermont: "*How do we know that human activities have influenced global climate?*"

[224] *Feb. 2009*: Invited lecture, Earth Science Seminar Series, Jet Propulsion Laboratory, Pasadena, California: "*Including model quality information in detection and attribution studies: One model, one vote?*"

[225] *Feb. 2009*: Invited lecture, Environmental Science and Engineering Seminar Series, California Institute of Technology, Pasadena, California: "*Including model quality information in detection and attribution studies: One model, one vote?*"

[226] *Feb. 2009*: 16th Charles and Thomas Lauritsen Memorial Lecture, California Institute of Technology, Pasadena, California: "*How do we know that human activities have influenced global climate?*" (Previous lecturers: Aage Bohr, Sir Fred Hoyle, Luis W. Alvarez, Victor F. Weisskopf, John Archibald Wheeler, Sir Denys Wilkinson, Frank Press, Steven Weinberg, Hans A. Bethe, Edwin H. Land, Sir Martin Rees, Richard L. Garwin, Sidney Drell, Ken Deffeyes, and Matthew R. Simmons).

[227] *Mar. 2009*: Invited lecture, Berkeley Atmospheric Science Center Seminar Series, University of California at Berkeley: "*Including model quality information in detection and attribution studies: One model, one vote?*"

[228] *Apr. 2009*: Invited lecture, 20th Anniversary Symposium, Program for Climate Model Diagnosis and Intercomparison, Bethesda, Maryland: "*The history and future of climate change detection and attribution research*".

[229] *Apr. 2009*: After-dinner lecture, W.L. Gates Symposium, Bethesda, Maryland: "*Larry Gates, the founding of PCMDI, and the rise of the MIPs*".

[230] *Apr. 2009*: Invited lecture, Climate Change Science Workshop, Field Museum, Chicago, Illinois: "*Human influence? How do we know?*"

[231] *Apr. 2009*: Invited lecture, Third Annual CAFE Electric Aircraft Symposium, Hiller Aviation Museum, San Carlos, California: "*Current update on climate science*".

[232] *Apr. 2009*: Invited talk, "*All Hands on Green*" Conference and Green Jobs Expo, City College of San Francisco, San Francisco, California: "*Current update on climate science*".

[233] *May 2009*: Invited lecture, Environmental Risk Management Course, University of San Francisco, San Francisco, California: "*Living with uncertainties in climate models: Lessons from the CMIP-3 archive*".

[234] *May 2009*: Invited lecture, Environmental Forum, Woods Institute for the Environment, Stanford University, Palo Alto, California: "*The MSU debate, climate auditing, and the Freedom of Information Act*".

[235] *Jun. 2009*: Lecture, Wigley Symposium, National Center for Atmospheric Research, Boulder, Colorado: "*Scientific adventures with Tom: Detecting human-induced climate change, and the great MSU debate*".

[236] *Jul. 2009*: Invited lecture, Statistics Department, Stanford University, Palo Alto, California: "*The history and future of climate change detection and attribution research*".

[237] *Sep. 2009*: Invited lecture, Workshop on Climate Feedbacks and Future Remote Sensing Observation, Keck Institute for Space Studies, Pasadena, California: "*Observational constraints on the water vapor feedback: A search for the Hall effect*".

[238] *Sep. 2009*: Invited lecture, Keck Institute for Space Studies, Pasadena, California: "*The MSU debate, climate auditing, and the Freedom of Information Act*".

[239] *Sep. 2009*: Invited talk, Rotary Club, Livermore, California: "*Current update on climate science*".

[240] *Sep. 2009*: Invited presentation to the Board of Directors, Apache Corporation, Denver, Colorado: "*How do we know that human activities have influenced global climate?*"

[241] *Sep. 2009*: Lecture, Working Group on Coupled Modeling, Cavallo Point, Sausalito, California: "*The International Detection and Attribution Group (IDAG)*".

[242] *Oct. 2009*: Invited remote lecture, Texas A&M University, College Station, Texas: "*The MSU debate, climate auditing, and the Freedom of Information Act*".

[243] *Dec. 2009*: Invited lecture, American Geophysical Union Fall Meeting, San Francisco, California: "*Global climate change impacts in the United States: Summary of the 'Global Climate Change' chapter*".

[244] *Dec. 2009*: Invited lecture, American Geophysical Union Fall Meeting, San Francisco, California: "*Incorporating model quality information in detection and attribution studies*".

2010

[245] *Jan. 2010*: Invited lecture, Director's Distinguished Lecture Series, Lawrence Livermore National Lab, Livermore, California: "*The MSU debate, climate auditing, and the Freedom of Information Act*".

[246] *Jan. 2010*: Keynote lecture, IPCC Expert Meeting on "Assessing and Combining Multi-Model Climate Projections", Boulder, Colorado: "*The difficulties involved in identifying the 'best' model from a large, multi-model archive*".

[247] *Feb. 2010*: Invited lecture, Continuing Studies Class, Stanford University, Stanford, California: "*The MSU debate, climate auditing, and the Freedom of Information Act*".

Publications

Peer-Reviewed Publications

1985

[1] Santer, B.D., 1985: The use of general circulation models in climate impact analysis - a preliminary study of the impacts of a CO2-induced climatic change on western European agriculture. *Climatic Change*, **7**, 71-93.

1990

[2] Mikolajewicz, U., B.D. Santer, and E. Maier-Reimer, 1990: Ocean response to greenhouse warming. *Nature*, **345**, 589-593.

[3] Santer, B.D., and T.M.L. Wigley, 1990: Regional validation of means, variances and spatial patterns in GCM control runs. *J. Geophys. Res*., **95**, 829-850.

[4] Wigley, T.M.L., and B.D. Santer, 1990: Statistical comparison of spatial fields in model validation, perturbation, and predictability experiments. *J. Geophys. Res*., **95**, 851-865.

1991

[5] Lautenschlager, M., and B.D. Santer, 1991: Atmospheric response to a hypothetical Tibetan ice-sheet. *J. Climate*, **4**, 386-394.

1992

[6] Cubasch, U., K. Hasselmann, H. Höck, E. Maier-Reimer, U. Mikolajewicz, B.D. Santer, and R. Sausen., 1992: Time-dependent greenhouse warming computations with a coupled ocean-atmosphere model. *Climate Dynamics*, **8**, 55-69.

1993

[7] Santer, B.D., T.M.L. Wigley, and P.D. Jones, 1993: Correlation methods in fingerprint detection studies. *Climate Dynamics*, **8**, 265-276.

1994

[8] Santer, B.D., W. Brüggemann, U. Cubasch, K. Hasselmann, H. Höck, E. Maier-Reimer, and U. Mikolajewicz, 1994: Signal-to-noise analysis of time-dependent greenhouse warming experiments. Part 1: Pattern analysis. *Climate Dynamics*, **9**, 267-285.

[9] Cubasch, U., B.D. Santer, A. Hellbach, G. Hegerl, H. Höck, E. Maier-Reimer, U. Mikolajewicz, A. Stössel, and R. Voss, 1994: Monte Carlo climate change forecasts with a global coupled ocean-atmosphere model. *Climate Dynamics*, **10**, 1-19.

[10] Lal, M., U. Cubasch, and B.D. Santer, 1994: Effect of global warming on Indian monsoon simulated with a coupled ocean-atmosphere general circulation model. *Current Science*, **66**, 430-438.

1995

[11] Santer, B.D., U. Mikolajewicz, W. Brüggemann, U. Cubasch, K. Hasselmann, H. Höck, E. Maier-Reimer, and T.M.L. Wigley, 1995: Ocean variability and its influence on the detectability of greenhouse warming signals. *J. Geophys. Res*., **100**, 10,693-10,725.

[12] Santer, B.D., K.E. Taylor, T.M.L. Wigley, J.E. Penner, P.D. Jones, and U. Cubasch, 1995: Towards the detection and attribution of an anthropogenic effect on climate. *Climate Dynamics*, **12**, 77-100.

[13] Cubasch, U., B.D. Santer, and G.C. Hegerl, 1995: Klimamodelle - wo stehen wir? *Physikalische Blätter*, **51**, 269-276.

[14] Cubasch, U., G. Hegerl, A. Hellbach, H. Höck, U. Mikolajewicz, B.D. Santer, and R. Voss, 1995: A climate change simulation starting at an early time of industrialization. *Climate Dynamics*, **11**, 71-84.

1996

[15] Santer, B.D., K.E. Taylor, T.M.L. Wigley, T.C. Johns, P.D. Jones, D.J. Karoly, J.F.B. Mitchell, A.H. Oort, J.E. Penner, V. Ramaswamy, M.D. Schwarzkopf, R.J. Stouffer, and S. Tett, 1996: A search for human influences on the thermal structure of the atmosphere. *Nature*, **382**, 39-46.

[16] Santer, B.D., K.E. Taylor, T.M.L. Wigley, T.C. Johns, P.D. Jones, D.J. Karoly, J.F.B. Mitchell, A.H. Oort, J.E. Penner, V. Ramaswamy, M.D. Schwarzkopf, R.J. Stouffer, S. Tett, J.S. Boyle, and D.E. Parker, 1996: Human effect on global climate? *Nature*, **384**, 523-524.

[17] Santer, B.D., T.M.L. Wigley, T.P. Barnett, and E. Anyamba, 1996: Detection of Climate Change, and Attribution of Causes, in *Climate Change 1995: The Science of Climate Change*, edited by J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg and K. Maskell, Cambridge University Press, Cambridge, 407-443.

[18] Barnett, T.P., B.D. Santer, P.D. Jones, R.S. Bradley, and K.R. Briffa, 1996: Estimates of low frequency natural variability in near-surface air temperature. *The Holocene*, **6**, 255-263.

[19] Hegerl, G.C., H.v. Storch, K. Hasselmann, B.D. Santer, U. Cubasch, and P.D. Jones, 1996: Detecting anthropogenic climate change with an optimal fingerprint method. *J. Climate*, **9**, 2281-2306.

[20] Wigley, T.M.L., B.D. Santer, J.F.B. Mitchell, and R.J. Charlson, 1996: Climate change report. *Science*, **271**, 1481-1482.

1997

[21] Jones, P.D., T.J. Osborn, T.M.L. Wigley, P.M. Kelly, and B.D. Santer, 1997: Comparison between the microwave sounding unit temperature record and the surface temperature record from 1979 to 1996: Real differences or potential discontinuities? *J. Geophys. Res*., **102**, 30,135-30,145.

1998

[22] Barnett, T.P., G.C. Hegerl, B.D. Santer, and K.E. Taylor, 1998: The potential effect of GCM uncertainties and internal atmospheric variability on greenhouse signal detection. *J. Climate*, **11**, 659-675.

[23] Wigley, T.M.L., R.L. Smith, and B.D. Santer, 1998: Anthropogenic influence on the autocorrelation structure of hemispheric-mean temperatures. *Science*, **282**, 1676-1679.

[24] Wigley, T.M.L., P.J. Jaumann, B.D. Santer, and K.E. Taylor, 1998: Relative detectability of greenhouse-gas and aerosol climate change signals. *Climate Dynamics*, **14**, 781-790.

1999

[25] Barnett, T.P., M. Chelliah, K. Hasselmann, G.C. Hegerl, P.D. Jones, E. Rasmusson, C. Ropelewski, and B.D. Santer, 1999: Detection and attribution of recent climate change: A status report. *Bull. Amer. Met. Soc.*, **80**, 2631-2659.

[26] Santer, B.D., J.J. Hnilo, J.S. Boyle, C. Doutriaux, M. Fiorino, D.E. Parker, K.E. Taylor, and T.M.L. Wigley, 1999: Uncertainties in observationally-based estimates of temperature change in the free atmosphere. *J. Geophys. Res*., **104**, 6305-6333.

[27] Gates, W.L., J.S. Boyle, C. Covey, C.G. Dease, C.M. Doutriaux, R.S. Drach, M. Fiorino, P.J. Gleckler, J.J. Hnilo, S.M. Marlais, T.J. Phillips, G.L. Potter, B.D. Santer, K.R. Sperber, K.E. Taylor, and D.N. Williams, 1999: An overview of the results of the Atmospheric Model Intercomparison Project (AMIP I). *Bull. Amer. Met. Soc*., **80**, 29-55.

[28] M.I. Hoffert, K. Caldeira, C. Covey, P.B. Duffy and B.D. Santer, 1999: Solar variability and the Earth's climate. *Nature*, **401**, 764.

[29] Wigley, T.M.L., R.L. Smith, and B.D. Santer, 1999: The autocorrelation function and human influences on climate. Response to comment by Tsonis and Elsner. *Science*, ***285***, 495a.

2000

[30] Gaffen, D.J., B.D. Santer, J.S. Boyle, J.R. Christy, N.E. Graham and R.J. Ross, 2000: Multi-decadal changes in the vertical structure of the tropical troposphere. *Science*, **287**, 1242-1245.

[31] National Research Council, 2000: *Reconciling observations of global temperature change*. National Academy Press, Washington, D.C., 85 pp.

[32] Santer, B.D. and T.M.L. Wigley, 2000: Reply to S. Fred Singer. *EOS*, Transactions, American Geophysical Union, **81**, 35,40.

[33] Santer, B.D., T.M.L. Wigley, J.S. Boyle, D.J. Gaffen, J.J. Hnilo, D. Nychka, D.E. Parker, and K.E. Taylor, 2000: Statistical significance of trend differences in layer-average temperature time series. *J. Geophys. Res*., **105**, 7337-7356.

[34] Santer, B.D., T.M.L. Wigley, D.J. Gaffen, L. Bengtsson, C. Doutriaux, J.S. Boyle, M. Esch, J.J. Hnilo, P.D. Jones, G.A. Meehl, E. Roeckner, K.E. Taylor and M.F. Wehner, 2000: Interpreting differential temperature trends at the surface and in the lower troposphere. *Science*, **287**, 1227-1232.

[35] Wigley, T.M.L., B.D. Santer, and K.E. Taylor, 2000: Correlation approaches to detection. *Geophys. Res. Lett.*, **27**, 2973-2976.

2001

[36] Duffy, P.B., C. Doutriaux, I.K. Fodor, and B.D. Santer, 2001: Effect of missing data on estimates of near-surface temperature change since 1900. *J. Climate*, **14**, 2809-2814.

[37] Govindasamy, B., K.E. Taylor, P.B. Duffy, B.D. Santer, A.S. Grossman and K.E. Grant, 2001: Limitations of the equivalent CO2 approximation in climate change experiments. *J. Geophys. Res*., **106**, 22593-22603.

[38] Santer, B.D., T.M.L. Wigley, C. Doutriaux, J.S. Boyle, J.E. Hansen, P.D. Jones, G.A. Meehl, E. Roeckner, S. Sengupta, and K.E. Taylor, 2001: Accounting for the effects of volcanoes and ENSO in comparisons of modeled and observed temperature trends. *J. Geophys. Res*., **106**, 28033-28059.

2002

[39] Hansen, J., M. Sato, L. Nazarenko, R. Ruedy, A. Lacis, D. Koch, I. Tegen, T. Hall, D. Shindell, B.D. Santer, P. Stone, T. Novakov, L. Thomason, R. Wang, Y. Wang, D. Jacob, S. Hollandsworth, L. Bishop, J. Logan, A. Thompson, R. Stolarski, J. Lean, R. Willson, S. Levitus, J. Antonov, N. Rayner, D. Parker, and J. Christy, 2002: Climate forcings in GISS SI2000 simulations. *J. Geophys. Res*. **107(D18)**, 4347, doi:10.1029/2001JD001143.

2003

[40] Santer, B.D., R. Sausen, T.M.L. Wigley, J.S. Boyle, K. AchutaRao, C. Doutriaux, J.E. Hansen, G.A. Meehl, E. Roeckner, R. Ruedy, G. Schmidt, and K.E. Taylor, 2003: Behavior of tropopause height and atmospheric temperature in models, reanalyses, and observations: Decadal changes. *J. Geophys. Res*., **108(D1)**, 4002, doi:10.1029/2002JD002258.

[41] Santer, B.D., T.M.L. Wigley, G.A. Meehl, M.F. Wehner, C. Mears, M. Schabel, F.J. Wentz, C. Ammann, J. Arblaster, T. Bettge, W.M. Washington, K.E. Taylor, J.S. Boyle, W. Brüggemann, and C. Doutriaux, 2003: Influence of satellite data uncertainties on the detection of externally-forced climate change. *Science*, **300**, 1280-1284.

[42] Santer, B.D., M.F. Wehner, T.M.L. Wigley, R. Sausen, G.A. Meehl, K.E. Taylor, C. Ammann, J. Arblaster, W.M. Washington, J.S. Boyle, and W. Brüggemann, 2003: Contributions of anthropogenic and natural forcing to recent tropopause height changes. *Science*, **301**, 479-483.

[43] Santer, B.D., T.M.L. Wigley, G.A. Meehl, M.F. Wehner, C. Mears, M. Schabel, F.J. Wentz, C. Ammann, J. Arblaster, T. Bettge, W.M. Washington, K.E. Taylor, J.S. Boyle, W. Brüggemann, and C. Doutriaux, 2003: Response to J.R. Christy and R.W. Spencer. *Science*, **301**, 1047-1049.

[44] Sausen, R., and B.D. Santer, 2003: Use of changes in tropopause height to detect human influences on climate. *Meteorologische Zeitschrift*, **12**, 131-136.

[45] Smith, R.L., T.M.L. Wigley and B.D. Santer, 2003: A bivariate time series approach to anthropogenic trend detection in hemispheric mean temperatures. *J. Climate*, **16**, 1228-1240.

2004

[46] Gillett, N.P., B.D. Santer, and A.J. Weaver, 2004: Quantifying the influence of stratospheric cooling on satellite-derived tropospheric temperature trends. *Nature*, doi:10.1038/nature03209.

[47] Santer, B.D., T.M.L. Wigley, A. Simmons, P. Kållberg, G. Kelly, S. Uppala, C. Ammann, J.S. Boyle, W. Brüggemann, C. Doutriaux, M. Fiorino, C. Mears, G.A. Meehl, R. Sausen, K.E. Taylor, W.M. Washington, M.F. Wehner, and F.J. Wentz, 2004: Identification of anthropogenic climate change using a second-generation reanalysis. *J. Geophys. Res.*, **109**, doi:10.1029/2004JD005075.

[48] Santer, B.D., M.F. Wehner, T.M.L. Wigley, R. Sausen, G.A. Meehl, K.E. Taylor, C. Ammann, J. Arblaster, W.M. Washington, J.S. Boyle, and W. Brüggemann, 2004: Response to comment on "Contributions of anthropogenic and natural forcing to recent tropopause height changes". *Science*, **303**, 1771c.

2005

[49] Barnett, T.P., F. Zwiers, G. Hegerl, M. Allen, T. Crowley, N. Gillett, K. Hasselmann, P.D. Jones, B.D. Santer, R. Schnur, P. Stott, K.E. Taylor, and S.F.B. Tett, 2005: Detecting and attributing external influences on the climate system: A review of recent advances. *J. Climate*, **18**, 1291-1314.

[50] Barnett, T.P., D. Pierce, K. AchutaRao, P. Gleckler, B.D. Santer, J. Gregory, and W. Washington, 2005: Penetration of human-induced warming signal into the world's oceans. *Science*, **309**, 284-287.

[51] Eyring, V., N.R.P. Harris, M. Rex, T.G. Shepherd, D.W. Fahey, G.T. Amanatidis, J. Austin, M.P. Chipperfield, M. Dameris, P.M. de F. Forster, A. Gettleman, H.F. Graf, T. Nagashima, P.A. Newman, S. Pawson, M.J. Prather, J.A. Pyle, R.J. Salawitch, B.D. Santer, and D.W. Waugh, 2005: A strategy for process-oriented validation of coupled chemistry-climate models. *Bull. Amer. Met. Soc*., **86**, 1117-1133.

[52] Santer, B.D., T.M.L. Wigley, C. Mears, F.J. Wentz, S.A. Klein, D.J. Seidel, K.E. Taylor, P.W. Thorne, M.F. Wehner, P.J. Gleckler, J.S. Boyle, W.D. Collins, K.W. Dixon, C. Doutriaux, M. Free, Q. Fu, J.E. Hansen, G.S. Jones, R. Ruedy, T.R. Karl, J.R. Lanzante, G.A. Meehl, V. Ramaswamy, G. Russell, and G.A. Schmidt, 2005: Amplification of surface temperature trends and variability in the tropical atmosphere. *Science*, **309**, 1551-1556.

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2006

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Non-Scientific Publications

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Santer, B.D., 1995: Plastering Holes, in *Reflections of Light*, edited by C. Sullivan and J.L. Esterby, The National Library of Poetry, Watermark Press, Owings Mills, MD, page 416.

Interests

Rock-climbing, mountaineering, poetry, marathon running.

Selection of Alpine climbs

Mt. Rainier (Cascades, U.S.); Mt. St. Helens (Cascades, U.S.); Mt. Adams (Cascades, U.S.); Sloan Peak (Cascades, U.S.); Mt. Shuksan via Hourglass Route (Cascades, U.S.); Chair Peak (Cascades, U.S.); The Tooth (Cascades, U.S.); Three-Fingered Jack (Cascades, U.S.); West Ridge of Prussik Peak (Enchantments, U.S.); Dragontail (Enchantments, U.S.); Leaning Tower via Leaning Tower Traverse (Yosemite; U.S.); Little Annapurna (Enchantments, U.S.); Cathedral Peak via South-East Buttress (Tuolumne Meadows, U.S.); Mönch (Bernese Oberland, Switzerland); North Ridge of Piz Badile (Bregaglia, Italy/Switzerland); Piz Bernina via the Bianco Ridge (Switzerland); Gletschhorn via South Ridge (Urner Alps, Switzerland); Freiheit via South Face (Appenzeller Alps, Switzerland); Altmann (Appenzeller Alps, Switzerland); Aiguille du Midi-Aiguille du Plan Traverse (Alps, France); Aiguille d'Argentiere via the Milieu Glacier (Alps, France); Aiguille de l'M via North-North East Ridge (Alps, France); Cima Presanella (Dolomites, Italy); Roggalspitze via Roggalkante (Lechtaler Alps, Austria); participation in 1986 Lampertheimer Himalayan expedition to Ama Dablam and Kangtega (Nepal).

Rock-climbing routes

Yosemite (California, U.S.); Tuolumne Meadows (California, U.S.); The Pinnacles (California, U.S.); Smith Rocks (Oregon, U.S.), Peshastin Pinnacles (Washington, U.S.); Lake District (U.K.); Peak District (U.K.); Snowdonia (U.K.); Gower Peninsula (U.K.); Danube Valley (Germany); Kreuzberge (Appenzeller Alps, Switzerland).

Marathons

Frankfurt, Munich, New York, Portland, Vancouver. Also completed the Engadin Ski-marathon.

ATTACHMENT B

Open Letter to the Climate Science Community:

Response to "*A Climatology Conspiracy?*"*

Summary

A paper by D.H. Douglass, J.R. Christy, B.D. Pearson, and S.F. Singer, published online in the *International Journal of Climatology* (*IJoC*) in December 2007, contained a serious error in a statistical test.[1] This error led Douglass *et al*. to make the incorrect claim that modeled and observed tropical temperature trends "*disagree to a statistically significant extent*". These incorrect conclusions received considerable publicity.

The nature of the statistical error is clearly explained in a paper my colleagues and I published in the online edition of the *IJoC* in October 2008.[2] The statistical flaw is also explained in readily-understandable terms in the attached "*fact sheet*" (see Appendix A below).

Douglass and Christy have now focused on the selective interpretation of emails stolen from the U.K.'s Climatic Research Unit (CRU). Their suggestively-titled article, "*A Climatology Conspiracy?*", was recently published online in "*American Thinker*".[3]

In "*A Climatology Conspiracy?*", Douglass and Christy make a number of allegations against the primary authors of the 2008 Santer *et al. IJoC* paper and against the editor of the *IJoC*. The focus here is on addressing two of the most serious allegations. The first allegation is that there was a conspiracy to deny Douglass *et al*. the opportunity to respond to the Santer *et al*. *IJoC* paper. The second allegation is that there was collusion between the editor of the *IJoC*

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* This open letter was sent by email to over 150 members of the climate science community on February 3, 2010.

[1] Douglass, D.H., J.R. Christy, B.D. Pearson, and S.F. Singer, 2007: A comparison of tropical temperature trends with model predictions. *International Journal of Climatology*, **27**: doi:10.1002/joc.1651.

[2] Santer, B.D., P.W. Thorne, L. Haimberger, K.E. Taylor, T.M.L. Wigley, J.R. Lanzante, S. Solomon, M. Free, P.J. Gleckler, P.D. Jones, T.R. Karl, S.A. Klein, C. Mears, D. Nychka, G.A. Schmidt, S.C. Sherwood, and F.J. Wentz, 2008: Consistency of modelled and observed temperature trends in the tropical troposphere. *International Journal of Climatology*, **28**, 1703-1722. DOI: 10.1002/joc.1756.

[3] "*A Climatology Conspiracy?*", by David Douglass and John Christy, was published online in "*American Thinker*" on December 20, 2009. See http://www.americanthinker.com/2009/12/a_climatology_conspiracy.html

and some of the authors of the Santer *et al*. *IJoC* paper. Douglass and Christy suggest that the aim of this collusion was to subvert the normal, rigorous, peer-review process.

With regard to the first allegation, the authors of the 2008 Santer *et al*. *IJoC* paper performed a substantial amount of new and original scientific research. It was therefore entirely appropriate for the editor of the *IJoC* to treat the Santer *et al*. *IJoC* paper as an independent scientific contribution, and to publish Santer *et al*. as a 'stand alone' paper rather than simply as a comment on the 2007 Douglass *et al. IJoC* paper. This editorial decision did not – as Douglass and Christy incorrectly allege – deny Douglass *et al*. the opportunity to respond to the scientific issues raised by the Santer *et al*. *IJoC* paper.

Douglass and Christy have had every opportunity to respond to scientific criticism of their 2007 *IJoC* paper, both in the pages of the *IJoC* and elsewhere. For example, they could have contributed a new scientific article to the *IJoC*, or submitted a comment on the Santer *et al. IJoC* paper. They have not done so. Nor has the Douglass and Christy "*American Thinker"* article adequately addressed concerns regarding the use of a seriously flawed statistical test in the Douglass *et al*. *IJoC* paper.

The second major allegation (collusion between the *IJoC* editor and the authors of the Santer *et al*. *IJoC* paper) is also baseless. The Santer *et al. IJoC* paper underwent a normal review process, involving two rounds of peer review by two highly-knowledgeable reviewers. The authors of the Santer *et al*. paper provided over 30 pages of detailed responses to the review comments. These responses clearly document the rigorous nature of the review process, and provide the strongest defense against unfounded "collusion" allegations. To date, however, I have not been able to obtain permission from the publishers of the *International Journal of Climatology* to publicly release the responses to the peer review comments on the Santer *et al. IJoC* paper. I am hopeful that this permission will be forthcoming in the near future.

As an additional response to the "collusion" charge, I note that our 2008 *IJoC* paper was the first and only paper I have ever submitted to the *International Journal of Climatology.* I have never met the editor of the *IJoC* (Professor Glenn McGregor), and did not have any correspondence or professional interaction with Professor McGregor prior to 2008.

As is clearly shown in the more detailed discussion given below, the "conspiracy" and "collusion" allegations – and a number of other claims made in "*A Climatology Conspiracy?*" – are simply false.

It is troubling that Professors Douglass and Christy persist in ignoring the serious statistical error in their 2007 *IJoC* paper. I would welcome an independent review by the U.K. Royal Meteorological Society[4] of the scientific issues raised by the Douglass *et al*. and Santer *et al*. *IJoC* papers. Such a review would be timely and appropriate.

[4]The *International Journal of Climatology* is published on behalf of the Royal Meteorological Society by Wiley InterScience.

ATTACHMENT B

1. Introduction

In a recently-published commentary entitled "*A Climatology Conspiracy?*", Professors D.H. Douglass and J.R. Christy have accused me and several of my colleagues of serious professional misconduct.[5] The allegations by Douglass and Christy were made on the basis of emails stolen from the University of East Anglia's Climatic Research Unit (CRU). I am writing this open letter to address these allegations. They are baseless and false.

The claims of professional misconduct relate to a paper published by myself and 16 co-authors in the *International Journal of Climatology* (*IJoC*), a journal of the U.K. Royal Meteorological Society. This paper appeared in the online edition of the *IJoC* on October 10, 2008.[6] I will refer to it below as "S08".

Many of the stolen CRU emails analyzed by Douglass and Christy were written by me. These emails discuss both the S08 *IJoC* paper and a previously-published 2007 *IJoC* paper by Douglass, Christy, and two of their colleagues.[7]

Here is a brief history of the genesis of the S08 paper.

2. The Karl *et al.* CCSP report

Between 2004 and 2006, I acted as Convening Lead Author for one particular chapter of "*Synthesis and Assessment Product 1.1*" of the U.S. Climate Change Science Program (CCSP). This was the first in a series of 21 reports commissioned by Congress. The aim of the CCSP reports was to provide "*current evaluations of climate change science to inform public debate, policy, and operational decisions*".[8] Thomas Karl (the Director of the U.S. National Climatic Data Center in Asheville, North Carolina) had the overall responsibility for this CCSP report, which was entitled "*Temperature Trends in the Lower Atmosphere: Steps for Understanding and*

[5] See footnote 3.
[6] See footnote 2.
[7] See footnote 1.
[8] Karl, T.R., S.J. Hassol, C.D. Miller, and W.L. Murray (eds.), 2006: *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, USA, 164 pp (the quote is from the unnumbered page immediately before the Table of Contents).

Reconciling Differences". The report was published in April 2006. Professor Christy was the Convening Lead Author of Chapter 2 of this report.

The Karl *et al*. CCSP report reached the following conclusion regarding global-scale changes in surface and atmospheric temperature:

"*Previously reported discrepancies between the amount of warming near the surface and higher in the atmosphere have been used to challenge the reliability of climate models and the reality of human-induced global warming. Specifically, surface data showed substantial global-average warming, while early versions of satellite and radiosonde data showed little or no warming above the surface. This significant discrepancy no longer exists because errors in the satellite and radiosonde data have been identified and corrected. New data sets have also been developed that do not show such discrepancies*".[9]

In the tropics, however, the Karl *et al*. CCSP report found that "*most observational datasets show more warming at the surface than in the troposphere, while most model runs have larger warming aloft than at the surface*".[10] Although the CCSP report did not reach a definitive conclusion about the cause or causes of these tropical discrepancies between models and observations, it noted that uncertainties in the observations were very large. Residual errors in the weather balloon and satellite data were judged to be the most likely explanation for the "*discrepancies in the tropics*".

3. The 2006 Douglass *et al. GRL* paper

Roughly six months after publication of the CCSP report, I received an email from Dr. Chris Reason, an editor for the scientific journal *Geophysical Research Letters*.[11] I was asked to review a paper by D. H. Douglass, R. Knox, B.D. Pearson, and S.F. Singer entitled "*Tropical temperature trends during the satellite era: Do model predictions agree with observations?*" I will refer to this paper below as "D06".

[9] Ibid, abstract, page iii.
[10] Ibid, page 90.
[11] The email from Dr. Reason was dated September 10, 2006.

I agreed to review the D06 paper, which performed comparisons between observed tropical temperature trends (obtained from satellites and weather balloons) and climate model results. D06 used the same model and observational data we had employed in both the Karl *et al*. CCSP report and in an earlier paper my colleagues and I had published in 2005 in *Science* magazine.[12]

The bottom-line finding of D06 was that models "*fail to reproduce observed trends*", and that "*these conclusions are in strong contrast with those of recent publications based on the same data and models*". It was my professional opinion that the D06 paper had serious scientific flaws, particularly with regard to the statistical test used to compare modeled and observed temperature trends. In my review of the paper, I recommended rejection. I signed my review, and transmitted it to Dr. Reason on September 25, 2006. The D06 paper was not published in *Geophysical Research Letters*.

4. The 2007 Douglass *et al*. *IJoC* paper

The next chapter in this story begins on November 30, 2007. On that date, I received an email from Mr. Andy Revkin, who until recently worked as a reporter on climate-related issues at the *New York Times*.[13] The email was also sent to Dr. Tony Broccoli and Dr. Carl Mears. Mr. Revkin asked us to comment on a paper by Douglass, Christy, Pearson and Singer. The paper was entitled "*A comparison of tropical temperature trends with model predictions*". As an attachment to his email of November 30, 2007, Mr. Revkin appended the page proofs of the Douglass *et al*. paper, which was scheduled to appear shortly in the *International Journal of Climatology*.

[12]Santer, B.D., T.M.L. Wigley, C. Mears, F.J. Wentz, S.A. Klein, D.J. Seidel, K.E. Taylor, P.W. Thorne, M.F. Wehner, P.J. Gleckler, J.S. Boyle, W.D. Collins, K.W. Dixon, C. Doutriaux, M. Free, Q. Fu, J.E. Hansen, G.S. Jones, R. Ruedy, T.R. Karl, J.R. Lanzante, G.A. Meehl, V. Ramaswamy, G. Russell, and G.A. Schmidt, 2005: Amplification of surface temperature trends and variability in the tropical atmosphere. *Science*, **309**, 1551-1556.

[13]In "*A Climatology Conspiracy?*", Douglass and Christy imply that Mr. Revkin and I had engaged in some "*prior correspondence*" regarding the Douglass *et al*. *IJoC* paper. This is untrue. No such "*prior correspondence*" had occurred. Douglass and Christy also incorrectly claim that Mr. Revkin sent his email of November 30, 2007, to "*three team members*" (*i.e*., to three of the authors of the S08 *IJoC* paper). This, too, is incorrect. Dr. Tony Broccoli never was a co-author of the S08 paper.

ATTACHMENT B

As noted by Douglass and Christy in "*A Climatology Conspiracy?*", the Douglass *et al*. *IJoC* paper was published online on December 5, 2007.[14] I'll refer to this version of the paper below as "D07-online". The paper quickly received significant publicity. Its finding that "*models and observations disagree to a statistically significant extent*" was highlighted by Fox News. The D07-online paper was the centerpiece of a press conference held by one of its co-authors (S.F. Singer) at the U.S. National Press Club. A press release from this conference claimed that the Douglass *et al*. findings represented "*an inconvenient truth*", and proved that "*Nature rules the climate: Human-produced greenhouse gases are not responsible for global warming*".[15] The Douglass *et al*. results were also featured prominently in a report issued by the Heartland Institute in March 2008.[16]

After reading D07-online, it immediately became obvious that the paper contained a serious statistical error. The nature of this error is explained in detail below in Appendix A.[17] I use the word "error" advisedly. This was not simply a difference of opinion between two groups of scientists. Douglass *et al*. had devised and applied what they described as a "*robust statistical test*" to reach their finding of a statistically significant discrepancy between modeled and observed tropical temperature trends. The test they devised is inappropriate for comparing models and observations. It cannot be used for determining whether or not the data sets considered in D07-online (observed and model temperature trends) show significant differences.

This can be demonstrated unequivocally by applying the Douglass *et al.* test in a situation where the answer is known *a priori*. Such "stochastic simulation" methods rely on randomly generated data with known statistical characteristics. With the aid of stochastic simulation, it can be shown quite easily that the Douglass *et al.* "*robust statistical test*" fails to give correct results. In fact, it fails in a very obvious way. In cases where there is no significant

[14]Douglass, D.H., J.R. Christy, B.D. Pearson, and S.F. Singer, 2007: A comparison of tropical temperature trends with model predictions. *International Journal of Climatology*, **27**: doi:10.1002/joc.1651.

[15]Press release from conference held at U.S. National Press Club, January 2008.

[16]S. Fred Singer, ed., March 2008: *Nature, Not Human Activity, Rules the Climate: Summary for Policymakers of the Report of the Nongovernmental International Panel on Climate Change*, Chicago, IL: The Heartland Institute, 50 pp.

[17]Appendix A consists of a "fact sheet" which was distributed at the time of online publication of the S08 *IJoC* paper.

difference between two data sets, the test frequently yields the incorrect answer that there is a significant difference.[18]

D07-online relied on "*essentially the same data*"[19] used in Chapter 5 of the 2006 Karl *et al*. CCSP report[20] and in the 2005 Santer *et al*. *Science* paper, yet reached very different conclusions from either of those previous publications. In my opinion, it was incumbent on the authors of D07-online to ask why they had reached radically different findings from previous work, and to investigate whether their statistical test was appropriate. They did not attempt to explain why their results differed from those previously published, nor did they attempt to show that the test they used was suitable for their task.

5. The 2008 Santer *et al. IJoC* paper

Given the serious nature of the statistical flaw in D07-online, the incorrect claims being made on the basis of the paper, and the widespread publicity that it had received, I decided that it was necessary to conduct an independent scientific assessment of the methods and results in D07-online. This decision was taken after discussions with a number of my colleagues at LLNL and at scientific institutions around the world. I sought the advice and guidance of experts in climate modeling, statistical analysis, and the development of observational temperature datasets.

My colleagues and I quickly reached the conclusion that we needed to do more than simply write a short note identifying the statistical flaw in the D07-online paper. Although the error in the paper could be easily demonstrated, the issue of statistical significance testing was too complex to cover in a short comment on D07-online. Furthermore, we decided that it would be much more illuminating to do the significance testing[21] properly, with several

[18] These tests with randomly-generated data were performed in Section 6 of the S08 *IJoC* paper.

[19] This quote is from the abstract of D07-online.

[20] Santer, B.D., J.E. Penner, P.W. Thorne, W.D. Collins, K.W. Dixon, T.L. Delworth, C. Doutriaux, C.K. Folland, C.E. Forest, J.R. Lanzante, G.A. Meehl, V. Ramaswamy, D.J. Seidel, M.F. Wehner, and T.M.L. Wigley, 2006: How well can the observed vertical temperature changes be reconciled with our understanding of the causes of these changes? *In: Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Karl, T.R., S.J. Hassol, C.D. Miller, and W.L. Murray (eds.)]. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, USA, pp. 89-108.

[21] Of differences between modeled and observed temperature trends.

different statistical tests, and with some discussion of how these tests performed under controlled conditions.[22] We also concluded that if we were going to invest substantial effort in a "do over" of the Douglass *et al*. significance testing strategy, we should use a wide range of observational temperature datasets. Many of the datasets we eventually used in the S08 *IJoC* paper were new, and had not been available to us at the time of our work on the 2006 Karl *et al*. CCSP report.

The bottom line is that the authors of the S08 *IJoC* paper performed a substantial amount of new and original research. S08 was not simply a brief comment on the statistical error in the D07-online paper – it was much more than this. This distinction should be obvious to anyone who has read S08. When substantial new research is performed, and a paper based on that research is submitted to a peer-reviewed scientific journal, it is customary for the journal to treat the new research as a 'stand-alone' paper – not to classify it as a 'comment'. It was therefore entirely appropriate for the editor of the *IJoC* to regard our paper as an independent contribution to the *IJoC*, and not to treat it as a comment on D07-online.

6. The '*preventing a response*' allegation

In "*A Climatology Conspiracy?*", Douglass and Christy (based on their analysis of the stolen CRU emails) assert that I tried to prevent them "*from providing what is considered normal in the peer-reviewed literature: an opportunity to respond to… critique*." This is untrue. Douglass and Christy have had every opportunity to comment on S08, to defend their own "*robust statistical test*", and to criticize the statistical tests we applied to compare modeled and observed temperature trends. In particular, they have had every opportunity to try to explain why their test fails to perform correctly when applied to randomly-generated data, or why it fails when applied to climate model data only.[23] To date, such explanations have not been forthcoming.

[22] With randomly-generated data having known statistical characteristics.

[23] To illustrate how the use of the Douglass *et al*. statistical test could lead to incorrect inferences, S08 applied the test to climate model data only. The temperature trend in each of the 19 models used by S08 was tested in turn against the average trend calculated from the remaining 18 models. The Douglass *et al*. statistical test provided the bizarre result that more than half of the 19 models were inconsistent with the average model trend! A test which rejects more than half of the population of samples on which it is based is clearly flawed.

They are certainly not available in the "*scientific discussion*" provided by Douglass and Christy in "*A Climatology Conspiracy?*".[24]

No one has prevented Douglass and Christy from submitting a comment on S08 to the *IJoC*. Nor has anyone prevented Douglass and Christy from performing substantive new research, and submitting a 'stand-alone' paper to the *IJoC*. In fact, in one of the stolen email excerpts that Douglass and Christy reproduced, I explicitly stated that "*Douglass et al. should have the opportunity to respond to our contribution, and we should be given the chance to reply. Any response and reply should be published side-by-side, in the same issue of the IJC*". These are clearly not the words of someone intent on advancing a sinister conspiracy to suppress scientific debate. Nor do these words sound like the words of someone who would "*fear a response*" from Douglass *et al*.[25]

7. The "*strategy of delaying*" allegation

The S08 paper was published in the online edition of the *IJoC* on October 10, 2008 – ten months after the online publication of the Douglass *et al*. paper on December 5, 2007. As noted above, the D07-online paper garnered considerable attention in the 10 months following its publication. Extraordinary – and incorrect – claims were made on the basis of D07-online (see section 4 above). The paper received high-level attention within the U.S. Department of Energy and the National Oceanic and Atmospheric Administration.

Douglass and Christy claim that there was a "*strategy of delaying*" publication of Douglass *et al*. They make this claim because the print version of their paper was published on November 15, 2008 – some 11 months after its first online publication. The print version of the S08 paper was also published on November 15, 2008 (36 days after its online publication).

The decision to publish the print versions of the Douglass *et al*. and Santer *et al*. *IJoC* papers on the same date was an editorial decision. It was not my decision. In view of the serious statistical flaw in Douglass *et al*., I believe that the editor's decision to publish the

[24]This is "*Climate Conspiracy Appendix A*" in the Douglass and Christy "*American Thinker*" article.
[25]The "*fear a response*" quote is from Douglass and Christy, "*A Climatology Conspiracy?*"

Douglass *et al*. and Santer *et al*. papers side-by-side (in the "hardcopy" version of the journal) was entirely appropriate.

The "*strategy of delaying*" allegation is baseless. In the scientific world, most journals now publish papers online before they appear in hardcopy form. The online publication is generally considered to be the publication of record, and attracts the majority of the scientific and media attention – as was the case with D07-online. The relevant point here is that the online version of the Douglass *et al. IJoC* paper was released 10 months prior to the appearance of S08-online. Any (imagined or imaginary) conspiracy to delay publication of Douglass *et al*. would therefore have to be judged remarkably unsuccessful.

8. The '*bias in review process*' allegation

Douglass and Christy imply that the review process for the S08 *IJoC* paper was irregular, and that unusual favors were extended to Santer *et al*. by the editor of the *International Journal of Climatology*. This allegation is baseless. Let me briefly review the facts relevant to this allegation.

First, the time from submission to online publication of the S08 paper was just under 4 months. For the Douglass *et al*. paper, the submission to online publication time was very similar (just over 4 months). The Santer *et al*. paper did not, therefore, receive an unusually '*quick turn-around*' in the review process.

Second, the S08 paper was thoroughly and comprehensively examined by two reviewers. The review process consisted of two separate rounds. Our response to the first set of review comments was finalized on June 3, 2008. The response is 27 pages long. Our 7-page response to the second set of review comments was completed on July 16, 2008. These responses clearly document that the Santer *et al*. *IJoC* paper was rigorously reviewed. It was not given a free pass. The responses also document how thoroughly and professionally we addressed the comments of the two reviewers.

In my opinion, public release of the detailed responses to the review comments on the S08 paper would provide the strongest refutation of the "*bias in review process*" allegations

made by Douglass and Christy. To date, however, I have not been able to obtain permission from the publishers of the *International Journal of Climatology* to publicly release these responses. Should this permission be forthcoming in the future, I am very willing to provide (upon request) our responses to the anonymous reviews of the Santer *et al. IJoC* paper.

9. Response to allegations regarding neglect of weather balloon datasets

Douglass and Christy make the serious allegation that I intentionally withheld weather balloon data "*that does not support his view.*"[26] This allegation is false. The S08 paper analyzed 7 different weather balloon datasets. It showed weather balloon results from both the Hadley Centre and IUK datasets – datasets Douglass and Christy accuse me of intentionally ignoring.

Douglass and Christy also state that I "*cut off*" observational datasets in 1999. Again, the implication is that I am guilty of intentionally withholding inconvenient data. This allegation is false.

All of the comparisons between climate model and observational data in S08 are made over the 21-year period from 1979 to 1999. This is because most of the climate model experiments examined by both S08 and Douglass *et al*. end in 1999. The model experiments are attempts to simulate 20th century climate changes. In these simulations, many of the models incorporated estimates of historical changes in both human-caused climate "forcings" (like changes in atmospheric levels of greenhouse gases) and in natural "forcings" (like changes in the Sun's energy output, or the amount of volcanic dust in the atmosphere). Such changes in human and natural forcings influence surface and atmospheric temperature. To facilitate meaningful comparisons between models and observations, it is important to compare the two over the same period of time – which is exactly what we did in S08.[27]

[26] In other words, "*my view*".

[27] Note, however, that in the Supporting Material for the S08 paper (which was available online from *IJoC*), my colleagues and I did "*extend*" observational datasets beyond 1999, making the necessary assumption that the model temperature trends and trend uncertainties were the same over a longer period of time (such as 1979 to 2006) as they were over the shorter period 1979 to 1999. This sensitivity test enabled us to look at the issue of whether tests of modeled and observed temperature trends were sensitive to the length of the observational record. Douglass and Christy fail to mention that we performed such tests.

10. Response to allegations regarding the 2008 Thorne *Nature* paper

In May 2008, Dr. Peter Thorne (one of the co-authors of the S08 *IJoC* paper), published a "*News and Views*" piece in the journal "*Nature Geosciences*".[28] A *News and Views* piece is not a scientific paper, although Douglass and Christy refer to it as a "paper". As the "*News and Views*" title suggests, Dr. Thorne's contribution was actually a commentary on a scientific paper published by Dr. R.J. Allen and Dr. S.C. Sherwood in the same issue of *Nature Geosciences*.[29]

The 2008 Thorne contribution (referred to below as "T08") briefly referenced the S08 *IJoC* paper. T08 did not reference any papers by Professor Douglass. As described in "*A Climatology Conspiracy?*", Douglass wrote to me on May 27, 2008 (two days after publication of T08), requesting a copy of our *IJoC* paper, which at that point had not yet been accepted for publication by *IJoC*.[30] I declined. I was hesitant to release a version of the paper that was still undergoing revision[31] and had not yet been accepted for publication.[32]

11. Concluding remarks

I have addressed above the major allegations made by Professors Douglass and Christy in "*A Climatology Conspiracy?*" There was no "conspiracy", and no attempt to interfere with the ability of Douglass and Christy to explain and defend why they applied a flawed statistical test

[28]Thorne, P.W., 2008: The answer is blowing in the wind. *Nature Geosciences*, **1**, 347-348.

[29]Allen, R.J. and S.C. Sherwood, 2008: Warming maximum in the tropical upper troposphere deduced from thermal winds. *Nature Geosciences*, **1**, 399-403.

[30]The S08 *IJoC* paper was not formally accepted for publication until July 20, 2008.

[31]As noted above in Section 9, our responses to the first set of review comments on S08 were not finalized until June 3, 2008. Our responses to the second set of review comments on S08 were not completed until July 16, 2008.

[32]Douglass and Christy also imply that Professor Douglass voluntarily provided me with a pre-publication copy of D07-online, and that – as a kind of scientific *quid pro quo* – I should have voluntarily provided them with a pre-publication copy of our S08 *IJoC* paper. In fact, Douglass never gave me a pre-publication copy of D07-online. I received a preprint of the D07-online paper from Andy Revkin of the *New York Times* – not from Professor Douglass. I received this preprint only five days before the paper's online publication in the *IJoC.* Additionally, Douglass and Christy attempt to argue that I already had an advance copy of their D07-online paper, since I had been a reviewer of the D06 *GRL* paper. They maintain that that the version of the paper they finally published online in *IJoC* in December 2007 was "*only slightly changed*" relative to the D06 version. This claim is also incorrect. The two papers are noticeably different. Even the cast of authors is different. R. Knox (an author on D06) is not an author on D07-online. Professor Christy (who is not an author on D06) is an author on D07-online.

in the 2007 Douglass *et al*. *IJoC* paper. Nor was there a "conspiracy" to subvert the normal peer review process for the 2008 Santer *et al*. *IJoC* paper which identified this statistical flaw.

It is of concern that Douglass and Christy have (to date) failed to acknowledge the existence of any error in the "*robust statistical test*" they used to compared modeled and observed temperature trends, despite the fact that their test was clearly incorrect. Because of this concern, and in view of the extraordinary nature of the claims made on the basis of the 2007 Douglass *et al. IJoC* paper (one of its coauthors asserted that the paper "*clearly falsifies the hypothesis of anthropogenic greenhouse warming*"),[33] I believe it would be timely and appropriate for the U.K. Royal Meteorological Society (on whose behalf the *International Journal of Climatology* is published) to investigate the scientific issues raised by the 2007 Douglass *et al*. and 2008 Santer *et al. IJoC* papers.

In summary, the emails stolen from the University of East Anglia's Climatic Research Unit have been used by Douglass, Christy, and others to claim that there is a conspiracy to suppress scientific views critical of a "*discernible human influence*" on global climate. Yet the fact remains that the 2007 Douglass *et al. IJoC* paper was <u>not</u> suppressed. It <u>was</u> published, despite the authors' use of an incorrect statistical test. The energy Douglass and Christy have now expended in searching for a non-existent conspiracy could have been more productively directed towards understanding and correcting errors in their *IJoC* paper.

Benjamin D. Santer

John D. and Catherine T. MacArthur Fellow

San Ramon, California

February 2, 2010[&]

[33] S. F. Singer, *op cit*. 16.

[&] These remarks reflect the personal opinions of Benjamin D. Santer. They do not represent the official views of Lawrence Livermore National Laboratory or the U.S. Department of Energy.

ATTACHMENT B

Timeline of key events related to the publication of the Douglass *et al*. and Santer *et al. International Journal of Climatology* papers

November 30, 2007	I receive a preprint of the Douglass *et al. International Journal of Climatology* paper from Andy Revkin, a *New York Times* reporter.
December 5, 2007	Douglass *et al. International Journal of Climatology* paper is published online. The paper claims that "*models and observations disagree to a statistically significant extent*".
January 2008	S. Fred Singer holds a press conference at the U.S. National Press Club. A press release from this conference claims that the Douglass *et al.* paper proves that "*Nature rules the climate: Human-produced greenhouse gases are not responsible for global warming*".
March 2008	Heartland Institute Report ("*Nature, not human activity, rules the climate: Summary for Policymakers of the Report of the Nongovernmental International Panel on Climate Change*") is published. The Douglass *et al.* paper is featured prominently in this Report.
October 10, 2008	Santer *et al. International Journal of Climatology paper is published online.* It identifies a serious statistical error in the Douglass *et al.* paper.
November 15, 2008	Douglass *et al*. and Santer *et al.* papers are published in the print version of the *International Journal of Climatology.*
November 2009	Over 1,000 personal emails are stolen from the Climatic Research Unit of the U.K.'s University of East Anglia. The stolen emails are publicly disseminated via the internet.
December 20, 2009	Based primarily on their analysis of these emails, David Douglass and John Christy publish "*A Climatology Conspiracy?*" in "*American Thinker*", and falsely allege that I am guilty of serious professional misconduct.

APPENDIX A[#]

Fact Sheet for "*Consistency of Modelled and Observed Temperature Trends in the Tropical Troposphere*", by B.D. Santer *et al*.[34]

Ben Santer, Peter Thorne, Leo Haimberger, Karl Taylor, Tom Wigley, John Lanzante, Susan Solomon, Melissa Free, Peter Gleckler, Phil Jones, Tom Karl, Steve Klein, Carl Mears, Doug Nychka, Gavin Schmidt, Steve Sherwood, and Frank Wentz

October 6, 2008

[#] Appendix A was written in October 2008. It was prepared to provide a simple, non-technical introduction to some of the scientific issues raised by the Douglass *et al*. and Santer *et al*. *International Journal of Climatology* papers.

[34]This paper will be published online in the *International Journal of Climatology* during the week of Oct. 6-10, 2008.

ATTACHMENT C

Open Letter to the Climate Science Community: In Support of Dr. Phil Jones[1]

Dear colleagues and friends,

I am sure that by now, all of you are aware of the hacking incident which recently took place at the University of East Anglia's Climatic Research Unit (CRU). This was a criminal act. Over 3,000 emails and documents were stolen. The identity of the hacker or hackers is still unknown.

The emails represented private correspondence between CRU scientists and scientists at climate research centers around the world. Dozens of the stolen emails are from over a decade of my own personal correspondence with Professor Phil Jones, the Director of CRU.

I obtained my Ph.D. at the Climatic Research Unit. I went to CRU in 1983 because it was – and remains – one of the world's premier institutions for studying the nature and causes of climate change. During the course of my Ph.D., I was privileged to work together with exceptional scientists – with people like Tom Wigley, Phil Jones, Keith Briffa, and Sarah Raper.

After completing my Ph.D. at CRU in 1987, I devoted much of my scientific career to what is now called "*climate fingerprinting*", which seeks to understand the causes of recent climate change. At its core, fingerprinting is a form of what people now call "*data mining*" – an attempt to extract information and meaning from very large, complex climate datasets. The emails stolen from the Climatic Research Unit are now being subjected to a very different form of "*data mining*". This mining is taking place in the blogosphere, in the editorial pages of various newspapers, and in radio and television programs. This form of mining has little to do with extracting meaning from personal email correspondence on complex scientific issues. This form of mining seeks to find dirt – to skew true meaning, to distort, to misrepresent, to take out of context. It seeks to destroy the reputations of exceptional scientists – scientists like Professor Phil Jones.

I have known Phil for over 25 years. He is the antithesis of the secretive, "*data destroying*" character being portrayed to the outside world by the miners of dirt and disinformation. Phil Jones and Tom Wigley (the second Director of the Climatic Research Unit) devoted significant portions of their scientific careers to the construction of the land component of the so-called "HadCRUT" dataset of land and ocean surface temperatures. The U.K. Meteorological Office

[1] This letter was distributed (by email) to over 100 members of the climate science community on December 2, 2009.

ATTACHMENT C

Hadley Centre (MOHC) took the lead in developing the ocean surface temperature component of HadCRUT.

The CRU and Hadley Centre efforts to construct the HadCRUT dataset have been open and transparent, and are documented in dozens of peer-reviewed scientific papers. This work has been tremendously influential. In my personal opinion, it is some of the most important scientific research ever published. It has provided hard scientific evidence for the warming of our planet over the past 150 years.

Phil, Tom, and their CRU and MOHC colleagues conducted this research in a very open and transparent manner. Like good scientists, they examined the sensitivity of their results to many different subjective choices made during the construction of the HadCRUT dataset. These choices relate to such issues as how to account for changes over time in the type of thermometer used to make temperature measurements, the thermometer location, and the immediate physical surroundings of the thermometer. They found that, no matter what choices they made in dataset construction, their bottom-line finding – that the surface of our planet is warming – was rock solid. This finding was supported by many other independent lines of evidence, such as the retreat of snow and sea-ice cover, the widespread melting and retreat of glaciers, the rise in sea-level, and the increase in the amount of water vapor in the atmosphere. All of these independent observations are physically consistent with a warming planet.

Extraordinary claims demand extraordinary proof. The claim that our Earth had warmed markedly during the 20th century was extraordinary, and was subjected to extraordinary scrutiny. Groups at the National Climatic Data Center in North Carolina (NCDC) and at the Goddard Institute for Space Studies in New York (GISS) independently attempted to reproduce the results of the Climatic Research Unit and the U.K. Meteorological Office Hadley Centre. While the NCDC and GISS groups largely relied on the same primary temperature measurements that had been used in the development of the HadCRUT dataset, they made very different choices in the treatment of the raw measurements. Although there were differences in the details of the three groups' results, the NCDC and GISS analyses broadly confirmed the "*warming Earth*" findings of the CRU and MOHC scientists.

Other extraordinary claims – such as a claim by scientists at the University of Alabama that Earth's lower atmosphere cooled since 1979, and that such cooling contradicts "*warming Earth*" findings – have not withstood rigorous scientific examination.

In summary, Phil Jones and his colleagues have done a tremendous service to the scientific community – and to the planet – by making surface temperature datasets publicly available for

scientific research. These datasets have facilitated climate research around the world, and have led to the publication of literally hundreds of important scientific papers.

Phil Jones is one of the gentlemen of our field. He has given decades of his life not only to cutting-edge scientific research on the nature and causes of climate change, but also to a variety of difficult and time-consuming community service activities – such as his dedicated (and repeated) service as a Lead Author for the Intergovernmental Panel on Climate Change (IPCC).

Since the theft of the CRU emails and their public dissemination, Phil has been subjected to the vilest personal attacks. These attacks are without justification. They are deeply disturbing. They should be of concern to all of you. We are now faced with powerful "*forces of unreason*" – forces that (at least to date) have been unsuccessful in challenging scientific findings of a warming Earth, and a "*discernible human influence*" on global climate. These forces of unreason are now shifting the focus of their attention to the scientists themselves. They seek to discredit, to skew the truth, to misrepresent. They seek to destroy scientific careers rather than to improve our understanding of the nature and causes of climate change.

Yesterday, Phil temporarily stepped down as Director of the Climatic Research Unit. Yesterday was a very sad day for climate science. When the forces of unreason win, and force exceptional scientists like Professor Phil Jones to leave their positions, we all lose. Climate science loses. Our community loses. The world loses.

Now, more than at any other time in human history, we need sound scientific information on the nature and causes of climate change. Phil Jones and his colleagues at CRU have helped to provide such information. I hope that all of you will join me in thanking Phil for everything he has done – and will do in the future – for our scientific community. He and his CRU colleagues deserve great credit.

With best regards,

Ben Santer[2]

John D. and Catherine T. MacArthur Fellow
San Ramon, California
December 2, 2009

[2] These remarks reflect the personal opinions of Benjamin D. Santer. They do not represent the official views of Lawrence Livermore National Laboratory or the U.S. Department of Energy.