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.

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.

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.

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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.

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]

Abstract

Using state-of-the-art observational datasets and results from a large archive of computer model simulations, a consortium of scientists from 12 different institutions has resolved a long-standing conundrum in climate science – the apparent discrepancy between simulated and observed temperature trends in the tropics. Research published by this group indicates that there is no fundamental discrepancy between modeled and observed tropical temperature trends when one accounts for: 1) the (currently large) uncertainties in observations; 2) the statistical uncertainties in estimating trends from observations. These results refute a recent claim that model and observed tropical temperature trends "disagree to a statistically significant extent". This claim was based on the application of a flawed statistical test and the use of older observational datasets.

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.

QUESTION 1: What is the scientific context for the research published in the Santer *et al*. *International Journal of Climatology* paper?

Our paper compares modeled and observed atmospheric temperature changes in the tropical troposphere.[35] We were interested in this region because of an apparent inconsistency between computer model results and observations. Since the late 1960s, scientists have performed experiments in which computer models of the climate system are run with human-caused increases in atmospheric concentrations of greenhouse gases (GHGs).[36] These experiments consistently showed that increases in atmospheric concentrations of GHGs should lead to pronounced warming, both at the Earth's surface and in the troposphere. The models also predicted that in the tropics, the warming of the troposphere should be larger than the warming of the surface.[37]

Observed estimates of surface temperature changes are in good agreement with computer model results, confirming the predicted surface warming.[38] Until several years ago, however, most available estimates of tropospheric temperature changes obtained from satellites and weather balloons (radiosondes) implied that the tropical troposphere had actually cooled slightly over the last 20 to 30 years (in sharp contrast to the computer model predictions, which show tropospheric warming).

For nearly a decade, this apparent disconnect between models and reality has been used by some scientists and politicians to argue that:

- The surface thermometer record is wrong;
- The Earth has not experienced any surface or tropospheric warming since the beginning of satellite measurements of atmospheric temperature in 1979;
- Human-caused changes in greenhouse gases have no effect on climate;

[35]The troposphere is the lowest layer of the atmosphere, where most weather phenomena take place. In the tropics, the troposphere extends from the surface to a height of about 10 miles (16 km) above the Earth's surface.

[36]Both climate models and the experiments performed with them have become more realistic over time. Since the mid 1990s, many climate model experiments have incorporated not only human-caused changes in GHGs, but also changes in other "forcing agents" that have effects on global or regional climate. Examples include human-caused changes in various aerosol particles (such as sulfate and soot aerosols), and natural changes in the Sun's energy output and the amount of volcanic dust in the atmosphere.

[37]This prediction of larger warming aloft than at the surface holds for all factors that tend to warm the surface of the Earth – it is not unique to human-caused changes in GHGs.

[38]This agreement between models and observations was also found for complex geographical patterns of surface temperature changes – not simply for trends in temperature changes averaged over very large areas (such as the tropics).

- Computer models have no skill in simulating the observed temperature changes in the tropics, and therefore cannot be used to predict the climatic "shape of things to come" in response to further increases in greenhouse gases.

Our paper attempts to determine whether there is indeed a real and statistically significant discrepancy between modeled and observed temperature changes in the tropics, as was claimed in a paper published online in December 2007 in the *International Journal of Climatology*. As discussed in QUESTION 9, we find that this claim is incorrect.

QUESTION 2: What arguments were made to support this claim?

David Douglass, John Christy, Benjamin Pearson, and S. Fred Singer[i] devised a statistical test to determine whether modeled and observed atmospheric temperature trends in the tropical troposphere were significantly different. They applied this test in several different ways. First, they considered temperature trends in two different layers of the troposphere (the lower troposphere and the mid- to upper troposphere). In each of these layers, their test suggested that the modeled warming trends were larger than and significantly different from the warming trends estimated from satellite data. Second, they compared trends in the temperature differences between the surface and the lower troposphere – a measure of the "differential warming" of the surface and lower atmosphere. Once again, their test pointed towards the existence of statistically significant differences in modeled and observed trends.

The bottom-line conclusion of Douglass *et al*. was that "*models and observations disagree to a statistically significant extent*". As discussed in QUESTIONS 6-8, we show that this statistical test is flawed, and that the conclusions reached by Douglass *et al*. are incorrect.

QUESTION 3: But hadn't the scientific community already resolved this issue?

The community had already achieved a partial resolution of this issue in a 2006 Report issued by the U.S. Climate Change Science Program (CCSP)[ii]. The CCSP Report concluded that, when one examined temperature changes at the global scale, newer satellite and weather balloon datasets showed "*no significant discrepancy*" between surface and tropospheric warming trends, and were therefore consistent with computer model results. But the same CCSP Report noted that it was not possible (in 2006) to reconcile modeled and observed temperature changes in the tropics, where "*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".

The CCSP Report relied almost exclusively on published literature. At the time of its publication in 2006, there were no peer-reviewed studies on the formal statistical significance of differences between modeled and observed tropical temperature trends. The Douglass *et al*. paper attempted to assess the statistical significance of the model-versus-observed tropical trend differences noted in the CCSP Report.

QUESTION 4: What was the thrust of your new research?

Our primary goal was to determine whether the findings of Douglass *et al*. were sound. As noted above, Douglass *et al*. reported that "*models and observations disagree to a statistically significant extent*". They interpreted their results as evidence that computer models are seriously flawed, and that the projections of future climate change made with such models are untrustworthy. If Douglass *et al*. were right, this would imply that there was some fundamental flaw – not only in all state-of-the-art climate models, but also in our basic theoretical understanding of how the climate system should respond to increases in GHGs. We wanted to know whether such a fundamental flaw really existed.

QUESTION 5: What specific issues did you focus on?

We focused on two issues. First, Douglass *et al*. claimed that they had applied a "*robust statistical test*" to identify statistically significant differences between modeled and observed temperature trends. We sought to understand whether their test was indeed "*robust*" and appropriate. Second, Douglass *et al*. claimed to be using the "*best available updated observations*" for their study. We did not believe that this claim was accurate.

We decided to check their analysis by applying a variety of different statistical tests to modeled and observed temperature trends, and by employing temperature data from more recent observational datasets – datasets that were either unavailable to Douglass *et al*. at the time of their study, or which were available, but had not been used by them.

QUESTION 6: What did you learn about the appropriateness of the Douglass *et al*. test?

We found that there was a serious flaw in the "*robust statistical test*" that Douglass *et al*. had used to compare models and observations. Their test ignored the effects of natural climate "noise" on observed temperature trends, and the resulting statistical uncertainty

in estimating the "signal component" of these trends (see QUESTION 7 for a definition of the "signal component").

QUESTION 7: Why was this a problem?

We know that in the real world, changes in temperatures are due to a combination of human effects and natural factors. The "natural factors" can be things like volcanic eruptions or changes in the Sun's energy output. Another type of "natural factor" is referred to as "internal variability", which is unrelated to changes in the Sun or volcanic dust, and involves phenomena like El Niños, La Niñas, and other natural climate oscillations. In the tropics in particular, El Niños and La Niñas have a substantial effect on surface and atmospheric temperature. They introduce climate "noise", which complicates the separation of human and natural effects on temperature.

Douglass *et al*. effectively assumed that the observed surface and tropospheric temperature trends were perfectly-known, and that these trends were purely due to human-caused changes in greenhouse gases[39]. The inappropriateness of this assumption is immediately obvious by looking at any observed temperature time series, such as the surface and tropospheric temperature time series shown below.

[39]In their paper, Douglass *et al*. claim to be testing "*the proposition that greenhouse model simulations and observations can be reconciled*". The model simulations of 20th century climate change that they used to test this proposition, however, include a variety of different human and natural forcing factors, such as changes in sulfate and soot aerosols, volcanic dust, the Sun's energy output, and land surface properties. These so-called "20CEN" experiments are not just driven by human-caused increases in GHGs. Douglass *et al*.'s proposition that they are only testing the response of climate models to GHG increases is simply incorrect.

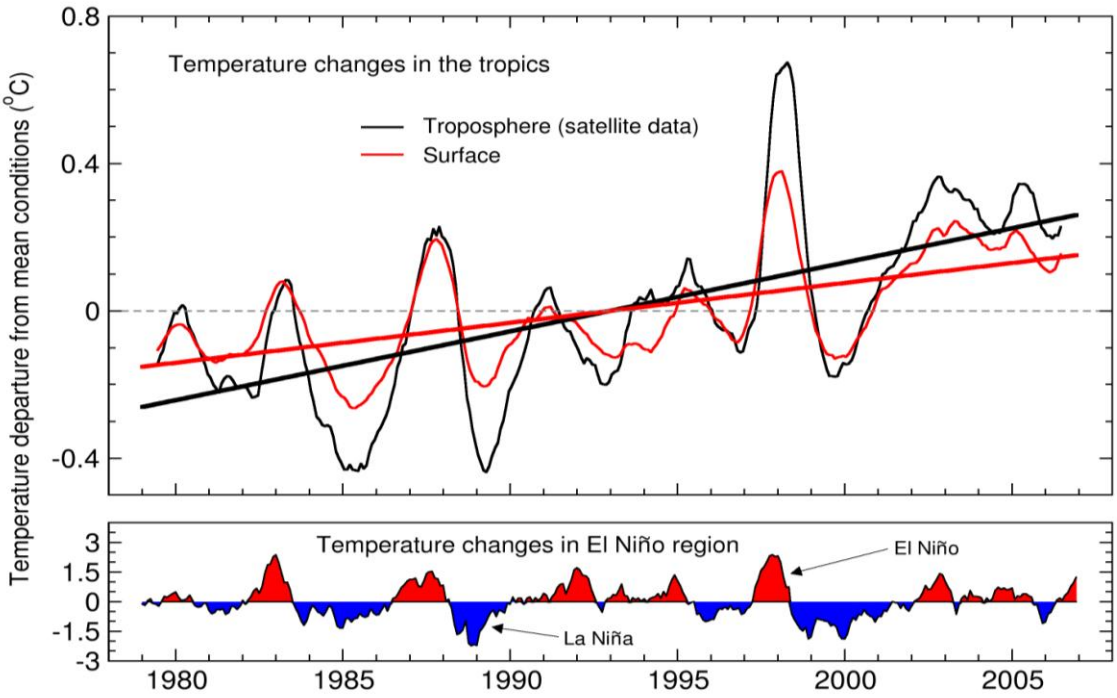

Figure Caption: Estimates of observed temperature changes in the tropics (30°N-30°S). Changes are expressed as departures from average conditions over 1979 to 2006. The top panel shows results for the surface[40] and lower troposphere.[41] The thin red and black lines in the top panel are 12-month running averages of the temperature changes for individual months. The thick straight lines are trends that have been fitted to the time series of surface and tropospheric temperature changes. The warming trend is larger in the tropospheric temperature data than in the surface temperature record, in accord with computer model results. The bottom panel shows a commonly-used index of El Niño and La Niña activity, consisting of sea-surface temperature changes averaged over the so-called Niño 3.4 region of the tropical Pacific. The bottom panel shows that much of the year-to-year variability in surface and lower tropospheric temperatures is related to changes in El Niños and La Niñas.

This Figure illustrates that both tropical surface and tropospheric temperatures have gradually warmed since 1979. Superimposed on this overall warming is climate "noise", which in this case arises primarily from El Niños and La Niñas. When temperatures are averaged over the tropics (and indeed, over the globe), El Niños tend to warm the surface and lower atmosphere, and La Niñas tend to cool these regions.[42] As is visually

[40]Surface data are from version 3 of the Extended Reconstructed Sea Surface Temperature Dataset (ERSST) produced by the National Oceanic and Atmospheric Administration (NOAA).
[41]Lower tropospheric temperatures are from version 3.0 of the TLT retrieval produced by Remote Sensing Systems in Santa Rosa, California.
[42]For example, 1998 was unusually warm because of the effects of a very large El Niño.

obvious, El Niños and La Niñas introduce considerable year-to-year variability in surface and tropospheric temperature.

Because of the climate noise introduced by El Niños and La Niñas, there is uncertainty in estimating any underlying temperature trend, such as that arising from slow, human-caused increases in GHGs. In the real world and in many model simulations of 20th century climate change, this underlying trend in temperature is not caused by GHG increases alone – it results from the combined changes in GHGs and other external forcing factors, and is partly masked by climate noise.

The underlying "signal trend" is what we really want to compare in climate models and observations. Any meaningful statistical test of the differences between modeled and observed temperature trends must therefore account for the statistical uncertainty in estimating this "signal trend" from noisy observational data. The Douglass *et al*. test did not account for this uncertainty.

QUESTION 8: What were the consequences of the flaw in the Douglass *et al*. test?

The primary consequence was that Douglass *et al*. reached incorrect conclusions about the true statistical significance of differences between modeled and observed temperature trends in the tropics. When we applied modified versions of their test – versions that properly accounted for uncertainties in estimating the "signal component" of observed temperature trends – we obtained results that were strikingly different from theirs. Like Douglass *et al*., we applied our tests to modeled and observed temperature trends:

- In individual layers of the troposphere;
- In the trend difference between surface and tropospheric warming rates.

Unlike Douglass *et al*., however, we found that most of our tests involving temperature trends in individual layers of the troposphere did not show statistically significant differences between models and observations. This result was relatively insensitive to which model or satellite dataset we chose for the trend comparison.

The situation was a little more complex for tests involving the trend difference between surface and tropospheric warming rates. In this case, the statistical significance of the differences between models and observations was sensitive to our choice of observational datasets. When we used a satellite-based tropospheric temperature

dataset developed at Remote Sensing Systems (RSS) in Santa Rosa, California, we found that the warming in the tropical troposphere was always larger than the warming at the surface.[43] This behavior is consistent with the behavior of the climate models and with our understanding of the physical processes that govern tropospheric temperature profiles. It is contrary to the findings of Douglass *et al*.

However, when we used a satellite-based tropospheric temperature dataset developed at the University of Alabama at Huntsville (UAH)[44], the tropospheric warming was less than the surface warming. But even when we employed UAH data, our statistical test showed that the observed difference between surface and tropospheric warming trends was not always significantly different from the trend difference in model simulations. Whether or not trend differences were statistically significant was dependent on the choice of model and the choice of observed surface dataset used in the test.[45]

QUESTION 9: So what is the bottom line of your study?

The bottom line is that we obtained results strikingly different from those of Douglass *et al*. The "*robust statistical test*" that they used to compare models and observations had at least one serious flaw – its failure to account for any uncertainty in the "signal component" of observed temperature trends (see QUESTION 7). This flaw led them to reach incorrect conclusions. We showed this by applying their test to randomly generated data with the same statistical properties as the observed temperature data, but without any underlying "signal trend". In this "synthetic data" case, we knew that significant differences in temperature trends could occur by chance only, and thus would happen infrequently. When we applied the Douglass *et al*. test, however, we found that even randomly generated data showed statistically significant trend differences much more frequently than we would expect on the basis of chance alone. A test that fails to behave properly when used with random data – when one knows in advance what results to expect – cannot be expected to perform reliably when applied to real observational and model data.

Q10: Final question: Have you reconciled modeled and observed temperature trends in the tropics?

[43]Irrespective of which one of four different observational datasets was used to characterize changes in tropical surface temperatures.
[44]Developed by John Christy (one of the co-authors of the Douglass *et al*. paper), Roy Spencer, and colleagues.
[45]See Table V in our paper.

We've gone a long way towards such a reconciliation. There are at least two reasons for this.[46] The first reason is that we have now applied appropriate statistical tests for comparing modeled and observed temperature trends in the tropics. Unlike the Douglass *et al*. test, our test properly accounts for uncertainty in estimating the "signal component" of observed temperature trends. Results from these more appropriate tests do not support the claim that there are fundamental, pervasive, and statistically significant differences between modeled and observed tropical temperature trends. This claim is not tenable for temperature trends in individual layers of the troposphere. Nor is it tenable for the differences in the warming rates of the surface and troposphere.

Second, we now have many more estimates of recent temperature changes. These have been produced by a number of different research groups, often using completely independent methods.

Research groups involved in the development of newer sea surface temperature datasets have reported improvements in the treatment of information from buoys and satellites. This has led to slightly reduced estimates of the warming of the tropical ocean surface (relative to the warming in the earlier surface temperature datasets used by Douglass *et al*. and in the CCSP Report). Additionally, newly-developed satellite and radiosonde datasets now show larger warming of the tropical troposphere than was apparent in the datasets used by Douglass *et al*. The enhanced tropospheric warming is due to improvements in our ability to identify and adjust for biases introduced by changes over time in the instruments used to measure temperature.[47]

Access to such a rich variety of independently produced datasets has provided us with a valuable perspective on the inherent uncertainty in observed estimates of recent climate change. Based on our current best estimates of these observational uncertainties, there is no fundamental discrepancy between modeled and observed tropical temperature trends. In fact, many of the recently-developed observational datasets now show tropical temperature changes that are larger aloft than at the surface – behavior that is entirely consistent with climate model results.

[46]A third reason is that several studies published within the last 12 months provide independent evidence for substantial warming of the tropical troposphere. These studies have documented pronounced increases in surface specific humidity and atmospheric water vapor that are in accord with tropospheric warming.

[47]Several of the newer radiosonde and satellite datasets that exhibit pronounced tropospheric warming are based on novel approaches to the construction of homogeneous datasets. These approaches often involve bringing in data from new sources (such as hitherto unused satellite data, or data on the physical relationship between temperature and wind) in order to better constrain uncertainties in estimated tropospheric temperature changes.

One of the lessons from this work is that even with improved datasets, there are still important uncertainties in observational estimates of recent tropospheric temperature trends. These uncertainties may never be fully resolved, and are partly a consequence of historical observing strategies, which were geared towards weather forecasting rather than climate monitoring. We should apply what we learned in this study toward improving existing climate monitoring systems, so that future model evaluation studies are less sensitive to observational ambiguity.

[i] Douglass DH, Christy JR, Pearson BD, Singer SF. 2007. A comparison of tropical temperature trends with model predictions. *International Journal of Climatology* **27**: doi:10.1002/joc.1651.

[ii] Karl TR, Hassol SJ, Miller CD, Murray WL (*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, 164 pp.