# Minority Report

## Comments Provided to the NRC Review Committee of the U.S. Climate Change Science Program's Synthesis and Assessment Product on Temperature Trends in the Lower Atmosphere

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Inclusion in the Executive Summary (ES) of the issues raised in this minority report would have provided a more complete and accurate assessment of our current scientific understanding of recent regional and global surface and tropospheric temperature trends. I also discuss aspects of the committee's processes that militated against reaching a consensus. I underscore that aside from the issues presented in this minority report, the report provides useful information on the current state of knowledge of globally-and zonally-averaged temperature trends. I would like to acknowledge the effort and professionalism of my colleagues on the Committee to reach an acceptable consensus on a range of difficult and challenging topics.

## Process Issues

There are several issues with respect to the tasks assigned to the Committee and in the selection of the Committee. First, the charge to the Committee was interpreted differently by different members. The majority view was of a highly limited focus of the report with the goal of explaining the apparent difference between recent observed and modeled annual zonally-averaged tropical tropospheric temperature trends. This was only finally clarified in the February 1, 2005 draft of the Executive Statement when the section "Motivation for this Report" was first shared among the Committee.

However, the charge to our Committee as summarized in the Preface (http://www.climatescience.gov/Library/sap/sap1-1/sap1-1prospectus-draft.htm), is that we were to assess the time and spatial patterns of surface and tropospheric temperature change. This should include establishing the accuracy of the data sets in observing, and of global and regional models in simulating, the regional trends in recent decades. The report, however, ultimately focused on the narrower issue.

Future charges to CCSP Committees should be unambiguous and differences in interpretation should be resolved prior to preparation of the report text. In addition, from the outset, the process for handling conflicting views among committee members should be clearly described, and not determined at the time of the conflict. The report would be stronger by allowing minority views to be included in the body of the report, identified as

such in a manner consistent with many other NRC reports, rather than relegating them to a minority report at the discretion of one or more members of the committee.

**Science issues**

**1. The major role of regional tropospheric temperature trends on large-scale circulation changes (and, therefore, weather patterns), and of seasonal trends were not assessed.**

The report offers no quantification of the skill of the GCM models that are reported in Chapter 5 to simulate regional surface and tropospheric temperature trends. As concluded by the NRC (2005; page 4) "Regional variations in radiative forcing may have important regional and global climate implications..." The report ignores this finding, which has an extensive peer reviewed literature to support it (see, for example, the summaries in Kabat et al. 2004; NRC 2005). The report therefore arbitrarily ignored the implications of numerous papers listed in those summaries and elsewhere on the significant role of regional heterogeneous climate forcings on regional temperature trends. The report also does not quantitatively assess seasonal trends and the effect of regional tropospheric temperature changes on circulation patterns (and, therefore, weather) at distances removed from the heterogeneous climate forcing. Indeed the influence of humans on the surface and tropospheric temperatures are clearest on the regional scale, yet the report ignores this information.

**2. The report focuses on globally-averaged and tropical zonally-averaged annual surface and tropospheric temperature trends and on an incomplete list of major climate forcings and responses. The following text is much too broad based on the assessment given in this report.**

"The improved consistency between modeled and observed temperature changes at the global scale described in this Report increases confidence in our understanding of recent climate changes." (lines 71-73; page 2)

Logically, identification of increased observational uncertainty, as discussed in the report, should not provide more confidence in the model results. It simply means that the model results cannot be definitively falsified based on the data presented. The model simulations discussed in Chapter 5 hardly bracket the possible climate responses associated with the spectrum of climate variables (see, for example, Figure 1-1 and 1-2 in NRC (2005).

Indeed the report sends a mixed message. The models are struggling to replicate the observed tropical zonally-averaged temperature trends, as reported in the ES, and these are the latest state-of-the-art global climate models. Therefore, any studies which provide regional-scale information for policymakers necessarily utilize simulation results with no proven predictive skill. This should have been a conclusion of the report.

**3**. **The influence of several major regional and global climate forcings, as they affect surface and tropospheric temperature trends are not adequately represented in the report.**

The ES acknowledges this for one forcing that is not included in the model simulations in Chapter 5 (the indirect aerosol effects). NRC (2005) provides a summary of additional important radiative and non-radiative forcings, which include, for example, the biological effect of increased carbon dioxide, the thermodynamic effect of aerosols, and the surface energy budget effect. Each one should have been discussed in Chapter 5 and in the ES with respect to what we know regarding their influence on global annual-mean surface temperature, and also the spatial and seasonal pattern of surface and tropospheric temperature trends. The Executive Statement makes the following claims which are at variance to the conclusions of NRC (2005) and thus arbitrarily ignore contradictory conclusions found in the peer-reviewed literature.

*"Table 1: Summary of the most important climate forcing factors and their individual effects on global, annual-mean temperatures."* (page 18 line 440-441)

*"…it is likely that, at least at the global scale, the other most important climate forcings have also been included in current model simulations."* (page 20, lines 464-465)

"*New simulations of 20$^{th}$ Century climate change have been produced recently……. The most important deficiency common to all of these model simulations is their neglect of the indirect cooling effect of aerosols."* (page 25, line 583-586)

*The model simulations (from PCM) shown in Figs. 8 and 9 include the most important global scale forcings, but, because they ignore indirect aerosol forcing, almost certainly underestimate aerosol effects. These simulations also ignore forcings from land-use/land-cover changes. However, other simulations that do include land-use changes are very similar to those shown in Figs. 8 and 9*. (page 29, lines 638-641)

In the last sentence of the above text from the ES, no citation is provided to support the claim that other simulations show similar results due to land-use/land-cover changes. A robust literature that I have contributed to, and thus know well, shows a significant climate forcing due to land-use changes (LULC) (see summaries in Kabat et al. 2004; Pitman 2003; NRC 2005; Pielke 2001). These LULC changes continued through the 1990s at a large rate (Australia Conservation Foundation 2001; Lepers et al. 2005). A significant portion of these changes are in the tropics. The ES selectively presents LULC model runs, and does not include relevant global and regional modeling studies of the LULC effect on the climate system as summarized in NRC (2005), Kabat et al. (2004) and Pielke (2001). NRC (2005) clearly identifies a range of climate forcings which may influence the global annual-mean temperature, but all of these forcings not included in the model simulations in Chapter 5. Given that this work appears in the peer-reviewed literature, selectively de-emphasizing it in this report is difficult to understand.

The model results in Chapter 5 should, therefore, be considered as sensitivity studies, and not as reconstructions of the evolution of the climate system in recent decades (Pielke 2002). The results certainly show that the included climate forcings are major influences on the surface and tropospheric trends, but without including all of the forcings identified in NRC (2005) they are necessarily incomplete, and thus to compare them with observations as a test of predictive skill is misleading.

**4. The assessment of surface and tropospheric temperature trends focuses narrowly on global and zonally averaged tropical means.**

The selection of the figures in the ES emphasizes large-scale averages. Even with respect to the one figure (Figure 9) which presents a spatial map of trends, the report does not quantify the models' skill at skillfully simulating the regional trends and variations. This minimal presentation and analysis of the spatial patterns is chosen despite the first sentence in the following claim from the report;

*"The temperature change signal (i.e., the time-varying, three-dimensional pattern of changes due to the combined effects of natural and human-induced climate forcing) is a complex one. There are a number of ways that this signal may be visualized. Figure 2 is one method, where large-area average trends and their uncertainties are given at different levels in the atmosphere".* (page 21, lines 487-490)

The assessment of regional trends was part of our charge to provide "four-dimensional" trend information. Moreover, regions of tropospheric warming and cooling, even if they would average to near zero when calculating a global average, can still result in major alterations in the planetary weather circulations and have significant regional effects. By contrast, the global average is less closely related to these factors. The ES misses an opportunity to assess our current level of understanding of the regional tropospheric temperature trends, and the ability of the models to simulate them.

**5. The report ignores the obvious in that regional land-use/land-cover change and aerosol effects clearly influence the surface and tropospheric temperatures where this human-caused climate forcings occur.**

Considerable modeling and observational evidence of the substantial human changes in regional surface and tropospheric temperature trends exists, even if the analyses are not for the specific time period chosen in Chapter 5. The ES ignores the extensive literature which documents this evidence (see citations within NRC 2005; Pitman 2003; Kabat et al. 2004, for example). The statement below, therefore, severely qualifies itself to the "forcings included in the model simulations". This is unnecessarily hedged and is incomplete.

*"In other words, there is clear (and statistically significant) evidence that the signal of human-caused climate change, for the forcings included in the model simulations, is evident in the observations. This is true, not only for the cases shown here, but also for patterns of temperature change at the surface and in the stratosphere, and for indirect*

*indicators of temperature change such as the height of the tropopause."* ( page 29, lines 632-636).

The ES also adopts a very specific definition of detection and attribution, and then uses this narrow definition to exclude other relevant literature. When the signal of human influence on climate is very strong, such as with the locations where land-use/land-cover change occur, "sophisticated statistical techniques" are not required (see, for example, the demonstration using models of a land-use change effect on regional temperatures in Marshall et al. 2004 and Pitman et al. 2004, and the global effect of land-use change on temperatures in Chase et al. 2000a and Chase et al. 2001). The regional climate modeling community has extensive literature which documents observationally and with models the "fingerprint" of LULC change and of aerosols on the surface and tropospheric temperatures. Many of these studies are summarized in NRC (2005) and Kabat et al. (2004). Despite being scientifically robust, the ES ignores such studies because they do not employ the narrow approach to attribution and detection presented here. This focus is unnecessarily restrictive and results in incomplete information being presented in the report.

**6. The surface temperature record, which underpins so much of the report, is considered a robust characterization of large-scale averages, despite unresolved issues on its spatial representativeness**

The report fails to acknowledge unresolved issues on uncertainties associated with the robust characterization of large-scale surface temperature trends. These include the influence of surface water vapor content changes on the trends (Pielke et al. 2004), microclimate exposure of the observing sites (Davey et al. 2005) and of continued substantial landscape conversion, including rapidly changing tropical urban landscapes (Lepers et al. 2005). Since much of the observed warming has been reported for land in the Northern Hemisphere, there needs to be more scrutiny placed on the spatial representativeness of the stations selected to compute the areal averages. This problem is recognized by the climate community, which is why there is general support for the U.S. Climate Reference Network, but the need to reduce surface temperature observational uncertainty is not represented in the ES.

Moreover, while there is discussion in the report regarding the lack of agreement between the models and the observations in the tropical troposphere, there is no examination as to whether, given the large land-use changes in the tropics (Lepers et al. 2005) with a possible effect on surface temperature trends, the agreement between the models and the observations of the tropical surface temperatures is actually robust. Indeed the report does not question the accuracy of data when it agrees with the models.

Also, the report's abstract that

"*We now have ..... and three [analyses] for the surface (from ships, satellites, weather stations, and buoys) that have been heavily scrutinized and adjusted for potential data biases."* (page 2, lines 53-56.)

can be misinterpreted. Each of the three analyses uses essentially the same raw data such that they are not independent assessments of the surface temperature trends. This point should be made clear in the abstract (as it is on page 16 of the text in the ES).

**7. The current reanalyses were not effectively used to assess lower tropospheric temperature trends since 1979.**

The text listed below fails to recognize that reanalyses, despite inhomogeneities in time, provide valuable information on long term lower tropospheric temperature trends. The reanalyses are essentially independent of the UAH analysis. The NCEP reanalyses assimilate observed winds (Pielke et al. 2001), which provide additional information on the temperature fields that is not used in any of the other observational data sets discussed in the report.

*"For the lower troposphere, only one data set (UAH) exists, so the constructional uncertainties cannot be assessed directly. This is an important deficiency." (page 17, lines 418-419).*

Published work (e.g., Chase et al. 2000b) has documented a close agreement of the UAH lower tropospheric data set with the NCEP Reanalysis on the global and regional scales, such that there should be more confidence in that lower tropospheric MSU data then stated in the ES. The NCEP reanalysis trend work has not been refuted in the literature, yet the ES chose arbitrarily to ignore the support for the lower tropospheric UAH data.

**8. Overstatement of the skill of the GCM simulations to explain the spatial and temporal changes in tropospheric temperatures from 1979-1999.**

The ES reports on the inability of the simulations to skillfully simulate the zonally-averaged tropospheric temperature changes in the tropics. Moreover, even the ES admits to excluding a major climate forcing (the indirect aerosol effect) in all of the GCM simulations. Figure 9 also shows clear, obvious inconsistencies in the ability of the PCM to simulate the spatial pattern of temperature trends as measured by the RSS, while Figure 8 illustrates that even in the zonal means, the PCM does a poor reconstruction of the HadAT2 radiosonde data. The statement that there is "improved consistency between modeled and observed temperature changes at the global scale…" is not scientifically robust. A more accurate conclusion would be that "the models demonstrate that natural and anthropogenic climate forcings have influenced the temporal and spatial patterns of tropospheric and surface temperature changes during the period 1979-1999, however the quantification of the relative roles of the important forcings remains incomplete, and the ability of the GCMs to skillfully reconstruct the observed globally-averaged, zonally-averaged and regional patterns has not been demonstrated."

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