

Some Thoughts on the Surface Mid-Tropospheric Temperature Trend Differences

Based on

Contribution of Stratospheric Cooling to Satellite-Inferred Tropospheric Temperature

Trends: Fu, Q., C.M. Johanson, S.G. Warren, and D.J. Seidel, May 6, 2004:

Nature, 429, 55-58

BY

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May 26, 2004

Fu et al.¹ conclude that their reassessment of Microwave Sounding Unit (MSU) tropospheric temperature trends results in a substantial warming of the troposphere over time from 1979 to 2001, yet the University of Alabama in Huntsville (UAH) results do not indicate as much warming². Using the Fu et al. model with UAH data as inputs, Fu et al. estimate a 1979-2002 trend of 0.11 C/decade (J. Christy, personal communication). This is an important scientific issue, since the global models in the National Assessment Synthesis Team³ predict a linear-regression warming rate of between +0.24 C to +0.37C

per decade at 500 mb over the 1979-2000 time period, which is still higher than even the Fu et al. estimate.

Our research group has specifically investigated the *lower troposphere* temperature trends using the NCEP/NCAR Reanalysis^{4,5}. We found that the NCEP/NCAR Reanalysis product does not document as much warming as shown in the global models. The NCEP/NCAR Reanalysis lower tropospheric layer-averaged temperature trend (1000-500 mb) has an average temperature increase between 1979 and 2001 of +0.05 C/decade (and +0.08 C/decade between 1979-2002), although with considerable interannual variability (and which is not statistically different from a zero trend). The Hadley Center, using radiosonde data, has computed a lower tropospheric trend (corresponding to the layer viewed by the UAH lower tropospheric data) for the period 1979-2002 of +0.05 C/decade (their data is described in Parker et al.⁶ and Folland et al.⁷), while the UAH lower tropospheric trend for 1979-2002 is +0.07 C/decade (J. Christy 2004, personal communication).

Unfortunately, Fu et al. did not discuss how their data compared to any published trend values from the NCEP/NCAR Reanalysis. Even though our work is with respect to the lower troposphere, if both data sets were accurate it would require that for Fu et al. to be correct, their reported warming must occur almost entirely in the upper troposphere.

As discussed in Pielke and Chase⁸, the NCEP/NCAR Reanalysis provides a robust *independent assessment* of the UAH MSU lower tropospheric temperature data, since the Reanalysis is routinely constrained by radiosonde observations. Christy et al.² provides documentation of the independence of their data set from the NCEP/NCAR Reanalysis. As further evidence of this independence, Christy and Norris⁹ specifically state that the

UAH dataset was fixed, and only afterwards did they contact the National Climate Data Center for Southern Hemisphere radiosonde station data to compare with their values. Radiosonde observations of the lower troposphere associated with their instrumentation also have had only small and fairly random shifts (Parker et al.⁶; Christy and Norris⁹), so that the constraint of the NCEP Reanalysis by radiosondes provides consistency across the time period 1979-present.

The Santer et al.¹⁰ claim, in response to the Pielke and Chase⁸ comment, that radiosonde data is used in the UAH products is incorrect. The use of the NCEP/NCAR Reanalysis, therefore, provides a particularly effective *independent* procedure to assess long-term lower tropospheric temperature trends since radiosonde observations are inserted into a global model, which provides a physically-based constraint to the data. Because issues of inhomogeneity of the MSU time series have led to a wide variety of differing trends depending on the processing procedure^{2,11,12}, the Fu et al. results need to be contrasted with other, independent results.

We agree that the NCEP Reanalysis contains imperfections, but, we examined this issue in Chase et al.¹³. In that study, we completed a detailed global and regional comparison analysis of the UAH lower tropospheric data and the NCEP/NCAR Reanalysis data, which adds to the confidence in the accuracy of the two data sets. We found large statistically significant regional positive and negative temperature trends in both the NCEP/NCAR 1000-500 mb thickness temperature and UAH lower tropospheric data sets that have larger magnitudes than documented biases in the data. A more complete and illuminating comparison for the Fu et al. data, therefore, would include contrasting their results to the regional and global trends obtained from the NCEP/NCAR

and ERA-40 Reanalyses (although there is a reported warm bias in recent years in the ERA-40 data set due to the assimilation of the SSM/I satellite data¹⁴).

The monitoring of tropospheric temperature trends, of course, is an important climate assessment. However, in addition to close scrutiny of this quantity, Fu et al. should also mention that surface temperature trends could be different from tropospheric trends for reasons that the General Circulation Models (GCMs) have not considered. This includes non-spatially representative surface temperature observing sites¹⁵, land-use change effects on surface temperature^(e.g.,16,17, 18,19), and incomplete representation of surface heat content²⁰. Why is there so much confidence in the robustness of the surface temperature trends, yet so much disagreement on the tropospheric trends?

Fu et al. also incompletely characterize other trends in the climate system. They state that there is a reduction of sea ice and snow cover. While Arctic sea ice cover has been decreasing, Antarctic sea ice cover and Northern Hemisphere snow cover have not²¹. The spatial extent of the coldest winter mid-tropospheric minimum temperatures has not become smaller²². Ocean heat storage, while warming, is at a rate that is smaller than predicted by most climate change models^{23,24}. Such observations, including the observed sudden transitions in the climate system²³, also make linear trend analyses such as presented in Fu et al. of less value.

While it is broadly recognized that humans are altering the climate system in diverse ways²⁵ the implication from the Fu et al. study is that, except for the issue of the tropospheric temperatures, which they claim to have resolved, the GCMs as decadal climate prediction tools have been validated. This claim, however, assumes that the models are correct, and that observational data that does not confirm model predictions is

incorrectly analyzed or interpreted. The focus is on seeking data that agrees with the predictions of the model. Data (such as surface temperature data) that conforms to the GCM predictions is not further scrutinized. Only data, such as the UAH tropospheric trends is questioned, since it does not fit the preconceived assumption concerning the skill of the GCM models. The NCEP/NCAR Reanalysis data, however, which we have analyzed, supports the accuracy of the UAH lower tropospheric data, and raises questions about the robustness of the Fu et al. results.

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