Scientific Comment by Roger Pielke Sr. and Tom Chase
with Input from John Christy and Tony Reale

The comments provided here are referring to the Santer et al. (2004) Response to Comment in reply to the Pielke and Chase (2004) Technical Comment (see references below).

Pielke Sr. R.A., and T.N. Chase, 2004: Technical Comment: Comment on "Contributions of anthropogenic and natural forcing to recent tropopause height changes." *Science*, **303**, 1771b. http://blue.atmos.colostate.edu/publications/pdf/R-278.pdf

Santer, B.D., M.F. Wehner, T.M.L. Wigley, and R. Sausen, 2004: Technical Comment: Response to Comment on "Contributions of anthropogenic and natural forcing to recent tropopause height changes." *Science*, **303**, 1771c. http://blue.atmos.colostate.edu/publications/pdf/R-278a.pdf

In order to continue the discussion, I invited John Christy and Tony Reale to respond to the two papers. Their input provides further documentation of the value of using the NCEP Reanalysis for climate trend assessments, and as an independent assessment tool to the University of Alabama at Huntsville (UAH) lower tropospheric MSU trend analyses.

Roger A. Pielke Sr. and Thomas N. Chase, 28 March 2004

***Comments by John Christy*:**

ERA-15 tropospheric temperatures were examined in the course of preparing the IPCC 2001 temperature section. Because of spurious and abrupt shifts as new satellite data entered the short 15-year data stream, it was considered inadequate for trend estimation and was eliminated from the discussion (see pg. 120-121 IPCC 2001; also Stendel, M., J.R. Christy, and L. Bengtsson, 2000: Assessing levels of uncertainty in recent temperature time series. *Climate Dyn.,* **16**, 587-601. Stendel et al. clearly shows the abrupt shifts in ERA-15 at the time new satellites entered the mix.)

Because NCEP uses a wide variety of radiosondes to recalibrate the coefficients each week, the changes in one type of radiosonde has relatively little effect on the recalibration due to the large number being used. Christy and Norris, 2004, show that Southern Hemisphere radiosondes provide essentially the same long term trend values whether adjusted for instrument changes or not because there is a relatively random mix of radiosonde types in the SH. Christy et al. 2004 also show that there is no significant difference between the radiosondes and the UAH temperature products.

Regarding NCEP, it is important to know that the satellite retrieval coefficients are updated weekly by radiosonde comparisons (Christy et al. 2003). Thus the change in temperature with time is dependent on the radiosondes, not the satellites. As a result, the time series of NCEP and UAH data are essentially independent.

Santer et al (2004) claim we used radiosonde information in our UAH products. This is completely incorrect.

Comments by Tony Reale:

I am not so familiar with reanalysis techniques, etc, but can certainly address NESDIS sounding products. John is essentially correct; each week the coefficients (measurement vs. radiosonde temperature) for producing both the first guess and retrieval solution are updated. The methodology for generating the coefficients has undergone several changes since 1979. For example, from about 1979 to 1989 there were only retrieval coefficients and associated mean profiles (10 sets of coefficients and means stratified by latitude and terrain) that were updated on a weekly basis.

By 1989 this was replaced by a 2-step physical retrieval system. Step-1 used a library search approach (libraries consisting of approximately 30-60 day samples of collocated radiosonde and satellite observations updated daily), which also included the use of a radiance covariance matrix updated daily to determine the first guess (certainly not climatology as stated in Santer et al, and very radiosonde temperature dependent which we assume to be "truth"). Step-2 was a radiative transfer based retrieval solution constrained by a "regional" statistical covariance matrix, which was updated weekly. The statistical covariance matrices were based on collocated radiosonde and satellite derived first guess profiles (i.e., from the library search), and updated weekly.

This approach essentially remained in place through the 1990's (and currently for ATOVS), except that the samples used to populate the libraries and to generate coefficients were modified to insure better timeliness with respect to satellite overpass, thus resulting in a tendency for the samples per satellite to be more "exclusive" particularly over land. This is a concern because it could result in inter-satellite bias, but such effects seem to be outweighed by the overall noise and uncertainty (due to time windows and radiosonde errors) in the satellite/radiosondes collocation datasets.

Polar satellites are sun-synchronous with specified local crossover times (except in polar regions). Given that radiosondes (at a given site) mainly report at (the same) synoptic times, their coincidence with polar satellite overpass tends to be exclusive, that is, they are collocated with one or the other satellite but not both. This of course depends on the time window of collocations, which (at NESDIS) is defined as 2 to 3 hours over land, and 4 to 5 hours over sea, therefore, samples tend to be more exclusive per satellite over land than over sea.

I would slightly disagree with John that change in temperature is solely dependent on the radiosondes, because if a satellite sounder channel changes abruptly, there would be a time lag in the response of our coefficients to compensate for this change (to agree with the radiosonde). However, I agree with John that all things being equal, if radiosonde report temperatures change, our products change along with them. Of course we use global samples and not any one specific radiosonde, so if 1 report out of a 100 changes, there should be no impact; but if 50 of 100 reports change, our products will be impacted (with a possible satellite dependent impact depending on which radiosondes change and where they are located).

Reale, Anthony L., 2001: NOAA operational sounding products from advanced-TOVS polar orbiting environmental satellites. NOAA Technical Report NESDIS 102, U.S. Dept of Commerce, Washington, DC, 57 pp.

Further Comments by John Christy:

Tony and I are on the same page. The change in temperature with time (dT/dt) to be considered here is the time scale long enough to influence temperature trends. So, a short term jolt by a new satellite coming online would have little impact on the longer time scale though it may take a few weeks to be correctly calibrated.

Reply from Tony Reale:

Yes, short-term jolts are corrected I would say within a couple of weeks, assuming the jolt is permanent. Typically we do not see jolts (greater than 1K) but a more long-term drift, which for the most part we can stay on top of.

Comment from John Christy:

When we looked at ERA-15 (Stendel et al. 2000) the jolts from new satellites coming online were huge and lasted for years sometimes. In comparing NCEP vs. UAH MSU, I was quite impressed that we could not pick out the points in time when new satellites came online knowing how independent our methods were. I suspect it relates to the fact there are always two satellites online, so an older satellite (that has had stable calibration) can act as a bridge to make the transition between a decommissioned satellite and the new one pretty smooth.

John Christy:

The key point here is that the MSU dataset we create and what goes on in the NCEP radiosonde-based retrievals areas different as night and day.

Tony Reale:

Yes, very different.

***Question from Roger Pielke Sr. and Tom Chase*.:**

How often do abrupt satellite sounder changes occur, and what is the time lag for the coefficients to respond?

Reply from Tony Reale:

Typically, abrupt changes are rare, and if it is too abrupt we remove the channel from use in production. For MSU I imagine John would know better than I the nature of such changes. AMSU-A has had some problems with channels 6, 7 11 and 14 that have resulted in channel use being discontinued.

***Question from Roger Pielke Sr. and Tom Chase*:**

Also, for locations around the world where radiosondes are absent, is the assumption made that since the soundings are tuned by the radiosondes where they are coincident, the same level of accuracy exists elsewhere?

Reply from Tony Reale:

Yes. We assume that the signals we are tuning to are valid globally. However, given the current state of affairs in which the collocated radiosonde and satellite samples for tuning each satellite are (geographically) different, this is a potentially risky assumption, which is one of the reasons I am proposing a small global network of radiosondes launching coincident with satellite overpass. But in a perfect world, your statement would be correct, and in general, the products appear to be consistent (although I could argue perhaps not very sensitive to this lack of collocation).

Given the use of extended time windows, that is, up to 3-hrs over land and 5-hrs over sea, we do obtain better global coverage (and consistency per satellite), but this is at the expense of added uncertainty, i.e., because we are not making like to like comparisons. This uncertainty (in my opinion) tends to de-sensitize the products (through routine product tuning based on collocations), for example, with respect to regional meteorological structures. The good news is that, in general, the products per satellite are consistent, but this consistency comes at the expense of their overall meteorological sensitivity, although perhaps not a concern for long-term climate.

Concluding Remarks by Roger Pielke Sr. and Tom Chase:

We feel these comments clearly address the concerns raised in the Santer et al (2004) Reply to our Technical Comment.

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