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Et Tu LT?

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In **previous posts** we have stressed that discrepancies between models and observations force scientists to re-examine the foundations of both the modelling and the interpretation of the data. So it has been for the apparent discrepancies between the Microwave Sounding Unit (MSU) lower tropospheric temperature records (MSU 2LT), radiosonde records and the climate models that try to simulate the climate of the last few decades. Three papers this week in ***Science Express***, **Mears et al**, **Santer et al** (on which I'm a co-author) and **Sherwood et al** show that the discrepancy has been mostly resolved – in favour of the models.

It is worth encapsulating exactly what the problems have been and why they have taken so long to resolve. The MSU records are derived from a series of satellites that have been in orbit since late 1978. Each satellite has had different calibration problems (due to orbital decay, sensor issues etc.) and stringing them together has been fraught with difficulty. Different groups have made different decisions about how to do this and this has lead to quite some differences in MSU products particularly between the **UAH group** (Spencer and Christy) and the **RSS group** (Wentz, Mears and colleagues) . The differences have been mostly seen in the *trends*, rather than the monthly or interannual variability, and so have been more difficult to validate. Incidentally, it is a clear sign of 'cherry-picking' when people only report their favorite one of the groups' trends instead of the range.

There have been three principle MSU products: Channel 4, Channel 2 and the 2LT records. MSU-4 is a record of lower stratospheric temperatures, MSU-2 is mainly mid-troposphere combined with a significant chunk of the lower stratosphere, and MSU-2LT is an attempt to use more viewing angles to try remove the stratospheric influence from MSU-2 and leave a lower-tropospheric record. (Recent upgrades to newer satellite instruments with more channels have lead to the 2LT record being renamed the TLT record).

The disagreement with the models related mainly to the MSU 2LT record. Models do quite well at matching the history of MSU-4 (whose variability is a function mainly of ozone depletion and volcanic aerosol effects), and models also match the lack of significant trend in MSU-2 (which is affected by stratospheric cooling and tropospheric warming which cancel out to some degree) (i.e **Hansen et al 2002**). So the problem has been principally with MSU 2LT, which despite a strong surface temperature trend did not seem to have been warming very much – while models and basic physics predict that it should be warming at a slightly larger rate than the surface.

In the first *Science Express* paper, Mears et al produce a new assessment of the MSU 2LT record and show that one of the corrections applied to the UAH MSU 2LT record had been applied incorrectly, significantly underplaying the trend in the data. This mistake has been acknowledged by the UAH team who have **already** updated their data (version 5.2) so that it includes the fix. This correction (related to the drift in crossing times at the equator) mainly affects the tropics, and was most important for one particular satellite (NOAA-11). Interestingly, **Fu and Johansen (2005)** singled out this same satellite and this same correction as being the source of divergence between the different records, though without being able to say exactly what the problem was. The fix leads to an increase of about 50% in the UAH global mean trend (0.086 to 0.12 deg/decade). The new RSS version of the 2LT record still shows a higher trend (0.19 deg/decade), with the difference being due to the methodology used to splice the different satellites.

In a related paper, Santer et al compare the surface/lower-troposphere coupled tropical variability at different timescales in the data and in model simulations performed for the new IPCC assessment. At monthly timescales (which should not be affected by trends in the model or possible drifts or calibration problems in the satellites or radiosondes) there is a very good match. In both models and data there is the expected enhancement of the variability in the lower-troposhere (based simply on the expected changes in the moist adiabatic lapse rate as the surface temperature changes). The models have large differences in their tropical variability (which depends on their represenation of El Nino-like processes in the Pacific) but the results all fall on a line, indicating that the lower tropospheric amplification is robust across a multitude of cloud and moist convective parameterisations.

At longer (decadal) time scales, the models still show very similar results (which makes sense since we anticipate that the tropical atmospheric physics involved in the trend should be similar to the physics involved at the monthly and interannual timescales). However, the original UAH 2LT data show very anomalous behaviour, while the new RSS 2LT product (including the latest correction) fits neatly within the range of model results, indicating that this is probably physically more consistent than the original UAH data.

One additional piece of evidence that has been discussed frequently was the claim that the trends in UAH MSU 2LT closely matched those of the radiosonde (balloon) network (Christy et al, 2003). Since the UAH team have acknowledged the error in their analysis, the apparent match to the radiosondes now seems to have been fortuitous. This may partly be due to the coverage of sondes used in that analysis being biased to the high latitudes (since the effect of the error was principally in the tropics), or it may be because of undetected biases in the radiosonde network itself. In the third paper this week, Sherwood et al report on an apparent bias in the daytime readings of these radiosondes which, again, appears to have suppressed the trends in the data sets (Steve discusses this more fully in an **accompanying piece**).

It will not have escaped the notice of keen observers that the satellite/model discrepancy has been used extensively in certain circles to cast doubt on the models, surface temperature record and our understanding of basic physics. Some **recent examples** for instance, used the UAH 2LT record absolutely uncritically (despite the fact that there have been many previous revisions, and that other analyses give very different results). Recently, **one of these authors** was quoted as saying:

> … as long as weather satellites show that the atmosphere is not warming, I cannot put much faith into theoretical computer models that claim to represent the atmosphere but contradict what the atmosphere tells us.

Since the satellites now clearly show that the atmosphere is warming at around the rate predicted by the models, we will report on his no-doubt imminent proclamation of a new found faith in models as soon as we hear of it…

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