THE IMPORTANCE OF THE TROPICAL HOT SPOT TO EPA'S ENDANGERMENT FINDING

On September 21, 2016, a new Research Report by James P. Wallace, III, John R. Christy and Joseph S. D'Aleo, *On the Existence of a "Tropical Hot Spot" & The Validity of EPA's CO2 Endangerment Finding, Abridged Research Report*, was published on ICECAP. https://thsresearch.files.wordpress.com/2016/09/wwww-ths-rr-091716.pdf. Applying statistical and econometric methods to data from the principal atmospheric temperature data sets, the Research Report claims to demonstrate that the hypothesized "Tropical Hot Spot" in the tropical upper troposphere does not exist. For the details of the analysis, consult the Report.

This so-called Tropical Hot Spot is a signature pattern of greenhouse gas warming in the tropical upper troposphere according to what EPA, the USGCRP (formerly US CCSP), and the IPCC claim is their basic physical understanding of the climate. The Tropical Hot Spot is thus fundamental to the theory of potentially catastrophic human-caused global warming.

If the Research Report is correct, it would invalidate EPA's "Endangerment Finding" ("EF") that Greenhouse Gases ("GHGs") endanger human health and welfare, a Finding that in turn is the basis for all of EPA's efforts to regulate CO2 emissions and the energy sector of the economy. In the EF, EPA attributes global warming to human GHG emissions based on what it calls three "lines of evidence." The first and most important "line of evidence" is stated by EPA to be "our *basic physical understanding* of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system." *See* 74 Fed. Reg. 66518:3 ("attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence") and 74 Fed. Reg. 66,523:2. (https://www3.epa.gov/climatechange/Downloads/endangerment/Federal_Register-EPA-HQ-OAR-2009-0171-Dec.15-09.pdf). *See also* Endangerment Finding Technical Support Document ("TSD"), p. 47 (listing the three lines of evidence)(https://www3.epa.gov/climatechange/endangerment/index.html#tsd).

But the authors of the new Research Report conclude that their findings invalidate all EPA's three lines of evidence, not just the physical understanding. This would in turn would invalidate EPA's attribution of warming to human emissions, and would leave the EF without support.

One of the early internet responses to the new paper has been to deprecate the importance of the Tropical Hot Spot to both the EF and to the vitality of AGW theory and modeling. *See*, e.g.,

https://wattsupwiththat.com/2016/09/22/study-tropical-hotspot-fingerprint-of-global-warming-doesnt-exist-in-the-real-world-data/#comment-2304559. The argument is that neither EPA's "physical understanding" line of evidence nor AGW theory generally rests upon the existence of the Hot Spot.

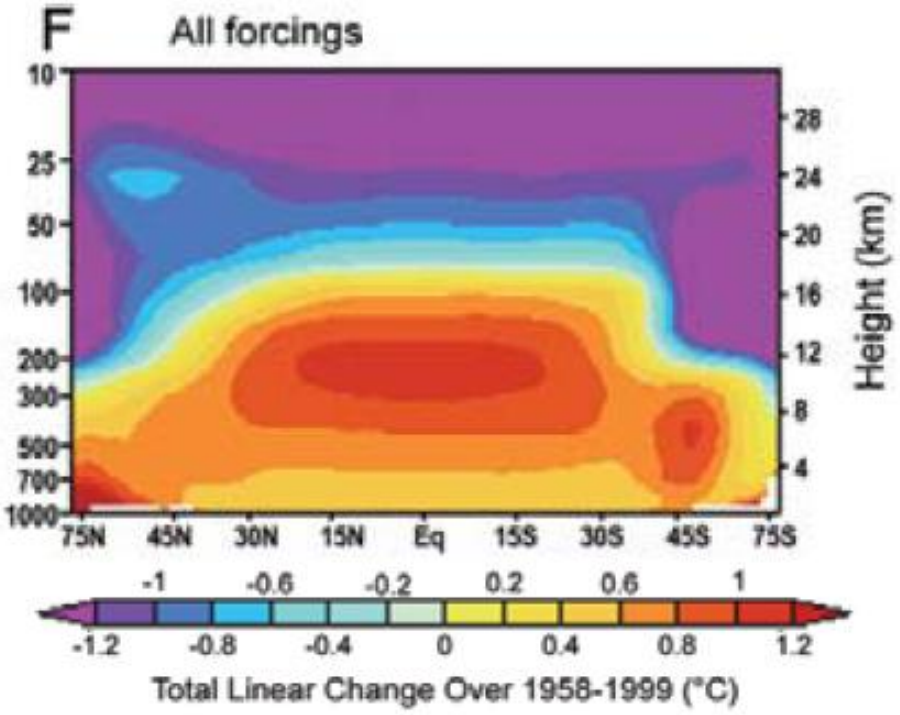
But examination of the Endangerment Finding itself, and of its supporting documents, as well as of the assessment literature on which EPA explicitly relies, makes crystal clear that the Hot Spot is in fact a critical and necessary component of the "physical understanding" of climate that EPA claims as the foundational line of evidence supporting the EF.

For example, the "physical understanding" of the atmospheric greenhouse mechanism set forth in U.S. Climate Change Science Program, Synthesis and Assessment Product 1.1, Temperature Trends in the Lower Atmosphere - Understanding and Reconciling Differences, ("SAP 1.1"), Chapter 1, § 1.1, The Thermal Structure of the Atmosphere, p. 17-19, https://www.gfdl.noaa.gov/bibliography/related_files/vr0603.pdf : explicitly relies upon the Hot Spot:

> The sense of the radiative-convective-dynamical balance above, together with the requirement of radiative balance at the top-of-the atmosphere (namely, equilibrium conditions wherein the net solar energy absorbed by the Earth's climate system must be balanced by the infrared radiation emitted by the Earth), can help illustrate the significance of long-lived infrared absorbing gases in the global atmosphere. The presence of such greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide, halocarbons) increases the radiative heating of the surface and troposphere. As specific humidity is strongly related to temperature, it is expected to rise with surface warming (IPCC, 1990), The increased moisture content of the atmosphere amplifies the initial radiative heating due to the greenhouse gas increases (Manabe and Wetherald, 1967; Ramanathan, 1981). The re-establishment of a new thermal equilibrium in the climate system involves the communication of the added heat input to the troposphere and surface, leading to surface warming (Goody and Yung, 1989; IPCC, 1990; Lindzen and Emanuel, 2002). From the preceding discussions, the lapse rate can be expected to decrease with the resultant increase in humidity, and also to depend on the resultant changes in atmospheric circulation. **In general, the lapse rate can be expected to decrease with warming such that temperature changes aloft exceed those at the surface.** As a consequence, the characteristic infrared emission level of the planet is shifted to a higher altitude in the atmosphere.

(Emphasis added). The bolded text precisely describes the Hot Spot phenomenon, and clearly demonstrates that it is fundamental to the orthodox physical understanding of the greenhouse warming mechanism.

The CCSP SAP 1.1 report depicted the Hot Spot graphically in figure 1.3, p. 25, as follows:



Similarly, the IPCC's Fourth Assessment Report (AR4) also states unequivocally that the Hot Spot is an integral feature of the "physical understanding" of the climate's hypothesized greenhouse warming mechanism. This is demonstrated by AR4 WG1, The Physical Science Basis, Chapter 9, Figure 9.1. Panel (c) shows the modeled effect of GHGs, and clearly depicts the hot spot:

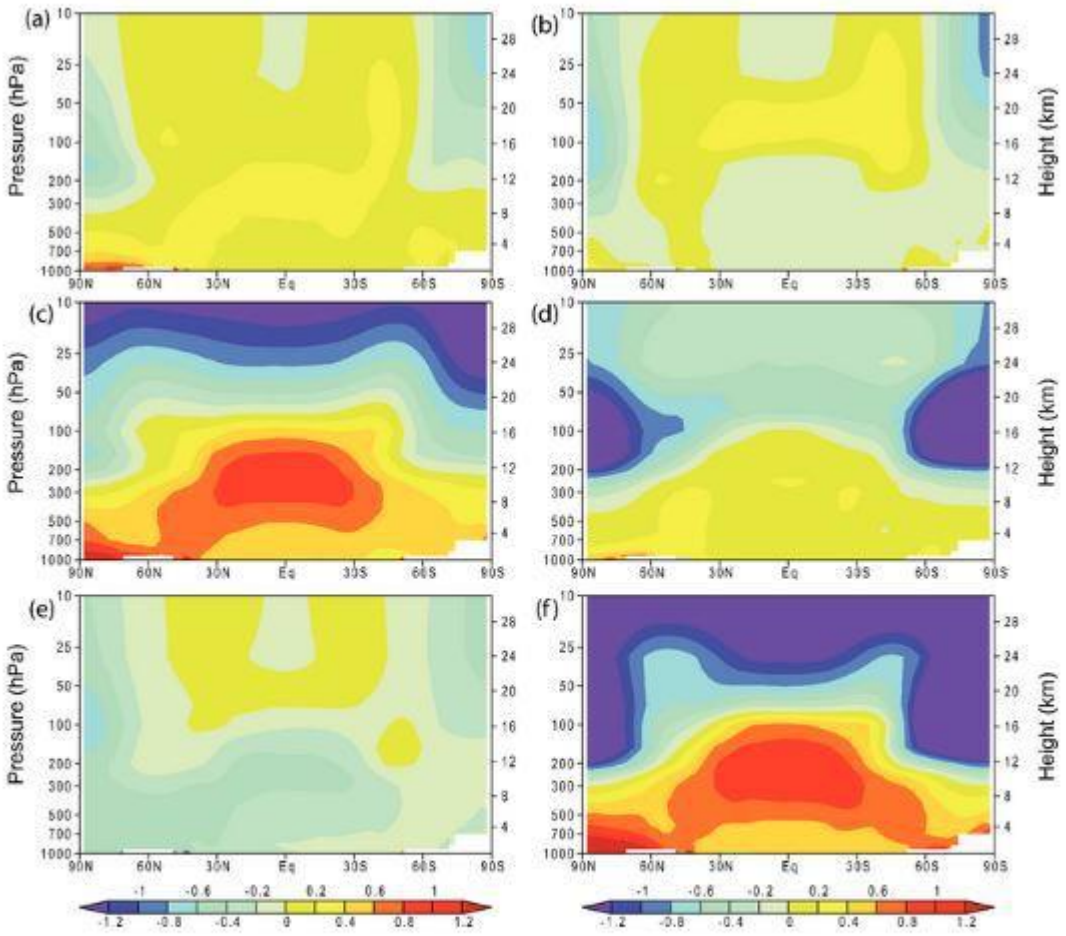


Figure 9.1. Zonal mean atmospheric temperature change from 1890 to 1999 (°C per century) as simulated by the PCM model from (a) solar forcing, (b) volcanoes, (c) well-mixed greenhouse gases, (d) tropospheric and stratospheric ozone changes, (e) direct sulphate aerosol forcing and (f) the sum of all forcings. Plot is from 1,000 hPa to 10 hPa (shown on left scale) and from 0 km to 30 km (shown on right). See Appendix 9.C for additional information. Based on Santer et al. (2003a).

The text accompanying this figure explains that "The major features shown in Figure 9.1 are robust to using different climate models." IPCC AR4 WG1 § 9.2.2. (http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch9s9-2-2.html). "Greenhouse gas forcing is expected to produce warming in the troposphere, … ." *Id.*

In connection with its adoption of the EF, EPA explicitly placed primary reliance on the US CCSP reports and the IPCC AR4. *See* TSD Box 1.1, p 4. These assessments are cited thousands of times in the full set of documentation for the EF. EPA has well and truly bound itself to these reports.

Whether the Hot Spot exists has been a white-hot point of controversy in the climate debate for many years. The history of the controversy through 2011 is recounted in *Tropospheric Temperature Trends: History Of An Ongoing*

Controversy, January 1, 2011, http://onlinelibrary.wiley.com/doi/10.1002/wcc.80/full. No one would care if the Hot Spot were not critically important to AGW theory and modeling.

The arguments over the Hot Spot have all been about data quality or interpretation. At no point have any of the participants said it would not matter if there were no Hot Spot, or otherwise deprecated the importance of the Hot Spot to the physical understanding of how GHGs are claimed to warm the climate.

Thus, the CCSP report cited above said if the Hot Spot were missing it would be a "*potentially serious inconsistency*." Yet it ultimately sided with those claiming the mismatch between observations and prediction was not fatal. SAP 1.1, p. 11. (Emphasis added).

Given the controversy over the Hot Spot, EPA could not ignore the issue. EPA's team, including Tom Karl, followed the lead of the CCSP (led by the same Tom Karl) and concluded there was no dispositive conflict between prediction and observation:

> However, *an important inconsistency* may have been identified in the tropics. In the tropics, most observational data sets show more warming at the surface than in the troposphere, while almost all model simulations have larger warming aloft than at the surface (Karl et al., 2006). Karl et al. (2009) state that when uncertainties in models and observations are properly accounted for, newer observational data sets are in agreement with climate model results.

TSD p. 50 (emphasis added). To say the least, this was itself a controversial conclusion.

The New Research Report deals with this EPA's use of models to validate the Hot Spot as follows:

> **Section III. Research Design**
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> Unlike some research in this area, this research does not attempt to evaluate the existence of the THS in the real world by using the climate models. This would constitute a well-known error in mathematics and econometrics in that such climate models obviously must include all relevant theories, possibly including some not even known today; many, if not all, of which could impact Tropical temperatures.

> Thus, it is never mathematically proper to attempt to validate any theory embedded in a model using the model itself. Each such theory needs to be tested outside of the model construct.
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> **Section IV. Tropical Hot Spot Hypothesis Testing**
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> The proper test for the existence of the THS in the real world is very simple. Are the slopes of the three trend lines (upper & lower troposphere and surface) all positive, statistically significant and do they have the proper top down rank order?

Research Report, p. 14.

In summary, both EPA and the assessments on which it relies expressly recognize the importance of the Hot Spot and treat evidence that it does not exist as a "serious" or "important" "inconsistency" between theory and observation.

The Research Report is a powerful demonstration that the Hot Spot does not exist. The significance is obvious: definitive proof there is no Hot Spot would logically invalidate the physical understanding on which the EF, AGW theory and climate models are founded. This would, in turn, invalidate the entire edifice of U.S. and international climate policy.

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