Greenhouse warming? What greenhouse warming?

The fingerprint of anthropogenic greenhouse warming predicted by computer models is absent from real-world, observed trends in atmospheric temperature change

by

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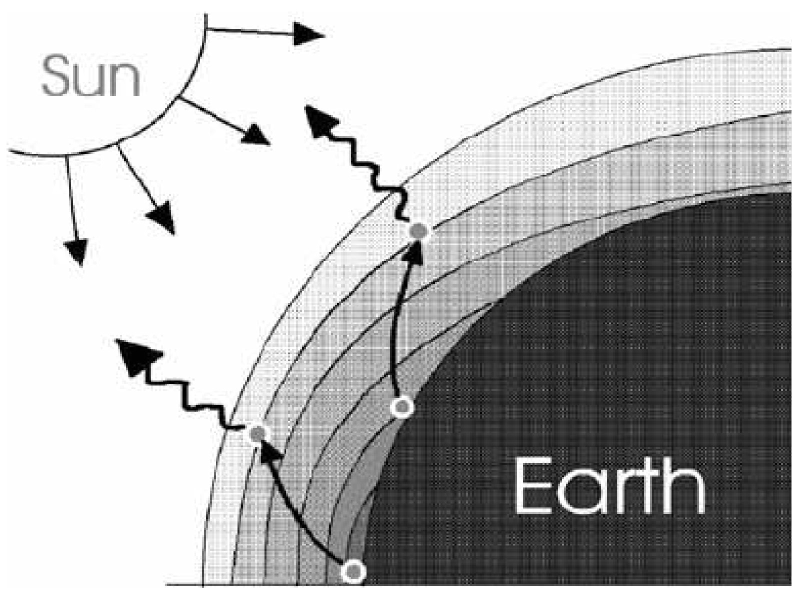
THE FACT of warming tells us nothing of the cause. Yet the scientific consensus is that, though the rapid climatic warming from 1906 to 1940 was a natural recovery from the historically low temperatures of the Little Ice Age, it is we who are chiefly to blame for the equally rapid warming from 1975 to the present. Since some climatologists challenge this consensus, can we settle the debate by predicting with models and then detecting by observation a characteristic "signature" in the climate data that allows us definitively to distinguish between anthropogenic and natural warming of the Earth's atmosphere? This paper answers that key question.

To identify the distinctive signature of anthropogenic warming caused by greenhouse-gas emissions, we begin with a little elementary atmospheric physics. [1]

The surface of the Earth does not cool primarily by thermal radiation. The main greenhouse gas, water vapor, generally maximizes at the surface in the tropics and sharply decreases with both altitude and latitude. There is so much greenhouse opacity immediately above the ground that the surface cannot effectively cool by the emission of thermal radiation.

Instead, heat is carried away from the surface by fluid motions ranging from the cumulonimbus towers of the tropics to the weather and planetary scale waves of the extratropics. These motions carry the heat upward and poleward to the "characteristic emission level" one optical depth into the atmosphere, known as $\tau=1$. From here emitted thermal radiation can escape to space. Crudely speaking, the emitted thermal radiation is proportional to the fourth power of the temperature at the characteristic emission level.

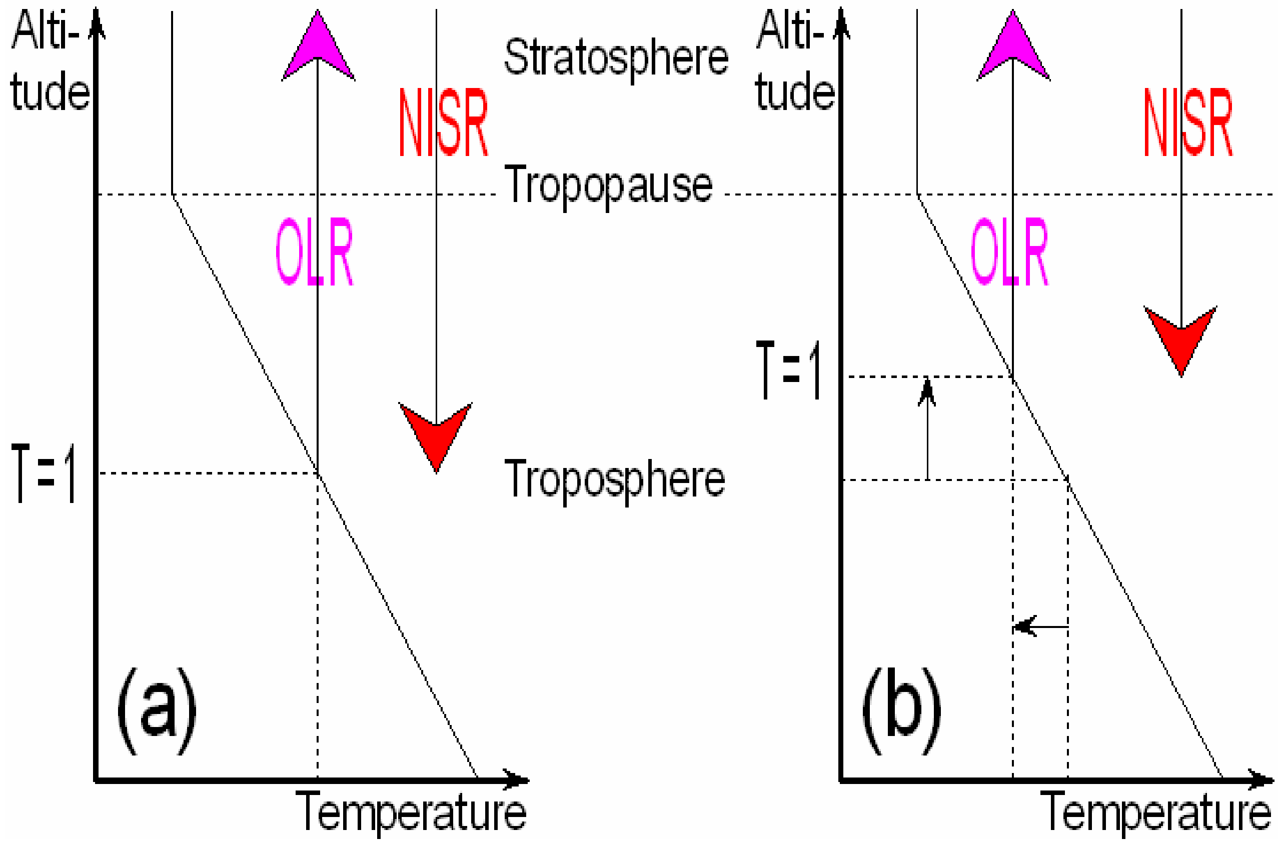
In the diagram, lighter shading represents reduced opacity as water-vapor density diminishes with altitude. Largely because of the motions of the atmosphere, the temperature decreases with altitude to a level known as the tropopause. The height of the tropopause varies with latitude. In the tropics it is about 16 km, dropping to about 12 km near 30 degrees latitude, and 8 km near the poles. Beneath the tropopause, we have the troposphere.



How heat is transferred away from the tropics. ***Source:*** *Lindzen (1990)*

[1] I am grateful to Richard Lindzen, Alfred P. Sloan Professor of Meteorology at the Massachusetts Institute of Technology, and to Dr. Asmunn Moene, former head of the forecasting centre, Meteorological Institute, Norway, for their excellent lecture notes, and to Friends of Science, Canada, for some helpful comments on the draft: but any errors in this paper are mine alone.

How the greenhouse effect changes global temperature



τ is infrared absorption measured from the top of the atmosphere looking down. ***Diagram (a):*** *When the earth is in radiative balance with space, net incoming solar radiation (NISR) is balanced by outgoing longwave radiation (OLR) from the characteristic emission level, τ=1.* ***Diagram (b):*** *When greenhouse gases are added to the atmosphere, the characteristic emission level is raised in altitude. Since atmospheric temperature decreases with altitude at about 10 ºC per mile, the new characteristic emission level is colder than the previous level. Therefore outgoing longwave radiation no longer balances net incoming solar radiation. The Earth is no longer in thermal balance with space. This imbalance is called "radiative forcing". To re-establish balance, the temperature at the new τ=1 level must increase to about the temperature that had existed at the initial τ=1 level, which is typically 7-8 km in the tropics and lower elsewhere. The warming at τ=1 is the fundamental warming associated with the greenhouse effect. How warming at the characteristic emission level τ=1 relates to warming at the surface is not altogether clear, but computer models can be helpful here.* ***Source:*** *Lindzen (2007).*

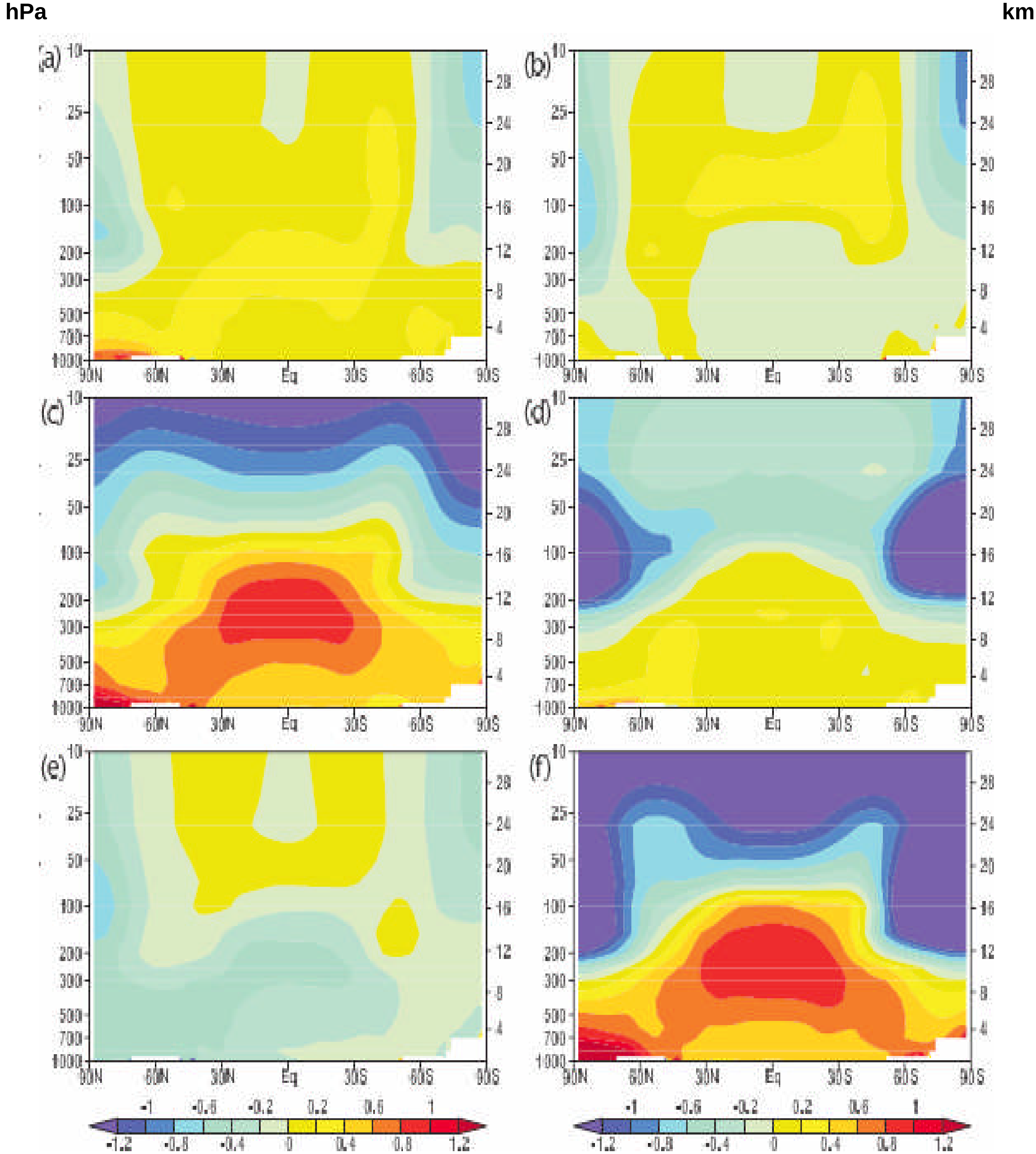
Computer models are able to assist us in distinguishing between the warming caused by adding greenhouse gases to the atmosphere and warming that is attributable to other causes.

The UN, in its 2007 climate assessment report, displays a series of plots of predicted rates of temperature change over the decades at altitudes from the Earth's surface to 30 km, at latitudes from the South Pole via the Equator to the North Pole. Colors are used to illustrate the rates of change in temperature which the UN's climate models predict, measured in degrees Celsius per decade. Each distinct cause of warming produces a visibly-distinct plot.

Six causes of atmospheric warming are considered. First, plots of natural warming caused by changes in total incoming solar radiation and changes in volcanic activity are shown, followed by plots of anthropogenic warming caused by emissions of greenhouse gases, changes in tropospheric and stratospheric ozone concentration, and the radiative forcing caused by sulphate aerosol particles (which actually cause cooling). Finally, the five plots of predicted warming are combined to create a single, sixth plot.

It is at once visible that the predicted warming caused by greenhouse-gas concentrations produces a pattern strongly distinct from other causes of warming. A "hot spot" appears between 8km and 12km of altitude in or near the tropics. At this computer-predicted "hot spot" high above the Earth, the UN's models project that greenhouse warming will cause temperature to rise over the decades at a rate up to three times faster than at the surface.

Greenhouse warming is distinguishable from other forcings



Zonal mean simulated atmospheric temperature change (ºC per century, 1890-1999), from two natural causes, three anthropogenic causes and one combined cause, simulated by the UN's PCM model. The "hot-spot" signature of greenhouse warming is visible in (c) and (f). (IPCC, 2007, p. 675, based on Santer et al, 2003. See also IPCC, 2007, Appendix 9C).

The UN's diagram shows the pattern of zonal mean simulated atmospheric temperature change from 1890 to 1999, in °C per century from six causes –

(a) natural radiative forcing from changes in solar activity;
(b) natural radiative forcing from changes in volcanic activity;
(c) anthropogenic radiative forcing from emissions of CO_2 and other well-mixed greenhouse gases;
(d) anthropogenic radiative forcing from changes in tropospheric and stratospheric ozone;
(e) anthropogenic radiative forcing from pollutant sulphate aerosol particles emitted to the atmosphere; and
(f) all natural and anthropogenic forcings combined.

These six plots, from 1,000 hPa to 10 hPa barometric pressure (left scale), equivalent to 0-30 km (right scale), demonstrate that anthropogenic emission of well-mixed greenhouse gases, **whether on its own (c) or combined with all other natural and anthropogenic forcings (f),** is predicted to produce a signature distinct from that of other forcings alone. The reason why the combined-forcings plot (f) appears so similar to the greenhouse-gas forcing plot (c) is that the UN's computer models predict that the impact of greenhouse-gas emissions on temperature is greater than that of all other forcings.

This instantly-recognizable "hot-spot" on the altitude-versus-latitude plot of predicted rates of temperature change is the unmistakable signature or characteristic fingerprint of greenhouse warming which we have been looking for. The warming which the computer models predict will arise from growing emissions of greenhouse gases is visibly distinct in its magnitude and in its altitudinal and latitudinal distribution from any other cause of natural or anthropogenic warming.

Following common meteorological practice, height is represented in these plots by atmospheric pressure level. Atmospheric pressure decreases approximately exponentially with height: 100 millibars corresponds roughly to 16 km; 200 mb to 12 km; 500 mb to 6 km; and 1000 mb to the surface. Predicted greenhouse-gas warming visibly peaks strongly in the tropical troposphere near the $\tau=1$ characteristic emission level, which differs from one computer model another because the amount of water vapor differs among the models.

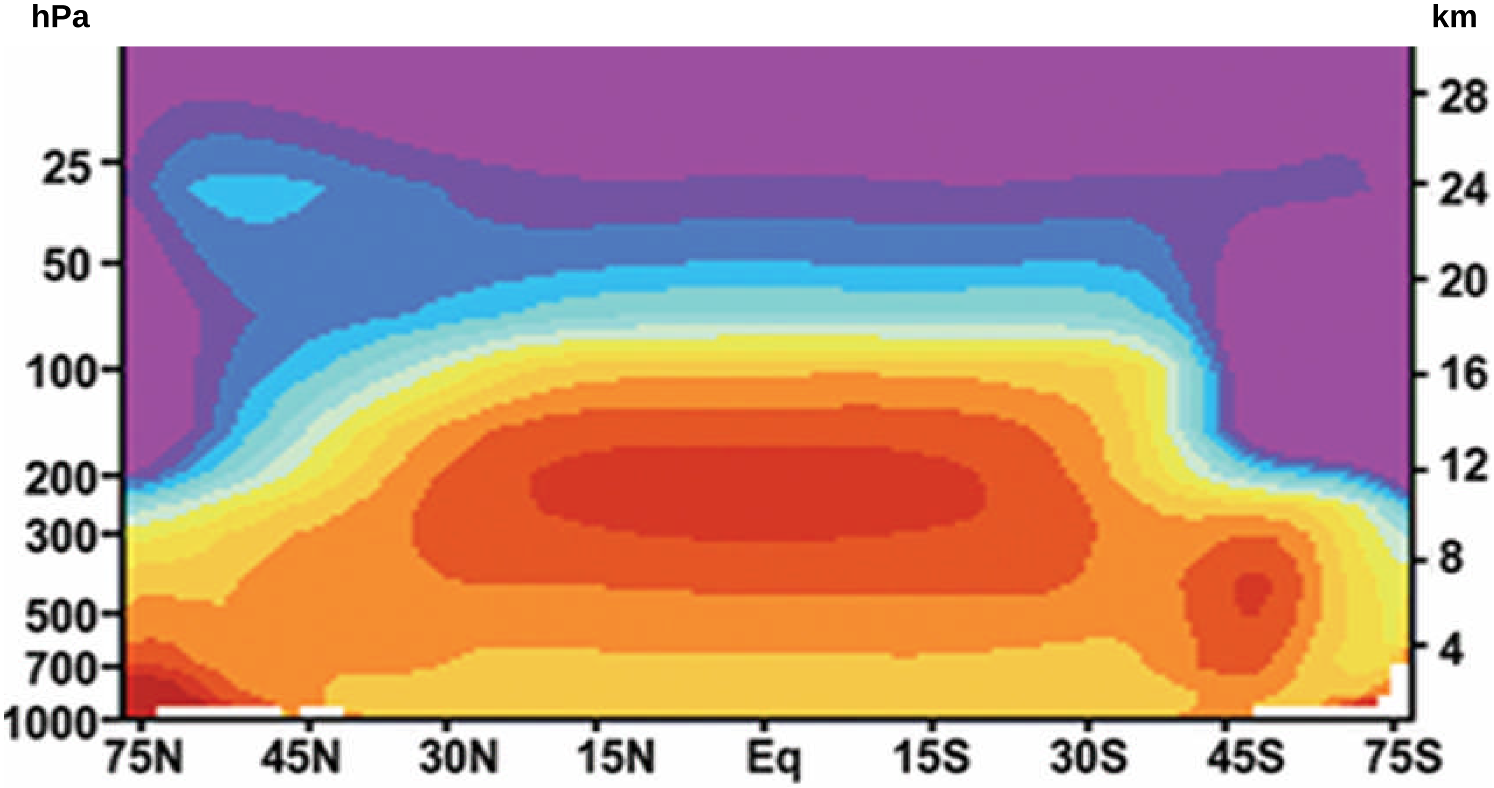
Within the tropical "hot-spot" at about 8 to 12 km altitude, the rate of increase in warming is more than twice and up to three times the rate of increase in warming at the Earth's surface. This does not mean that absolute temperature in the mid-troposphere is greater than at the surface. Far from it: the temperature at altitude is very much colder than at the surface. But the rate at which temperature is predicted to increase in the "hot-spot" over the decades is two or three times the rate at which temperature is predicted to increase at the surface.

To put it another way, if we observe warming in the tropical upper troposphere, then the models predict that the contribution to warming at the surface that is caused by our greenhouse-gas emissions should be between less than half and one third of the warming seen in the upper troposphere. There is, of course, some greenhouse warming, indicated by the observed cooling of the stratosphere as less outgoing long-wave radiation reaches it. But the absence of the predicted "hot-spot" in the tropical mid-troposphere severely constrains the magnitude of the greenhouse warming.

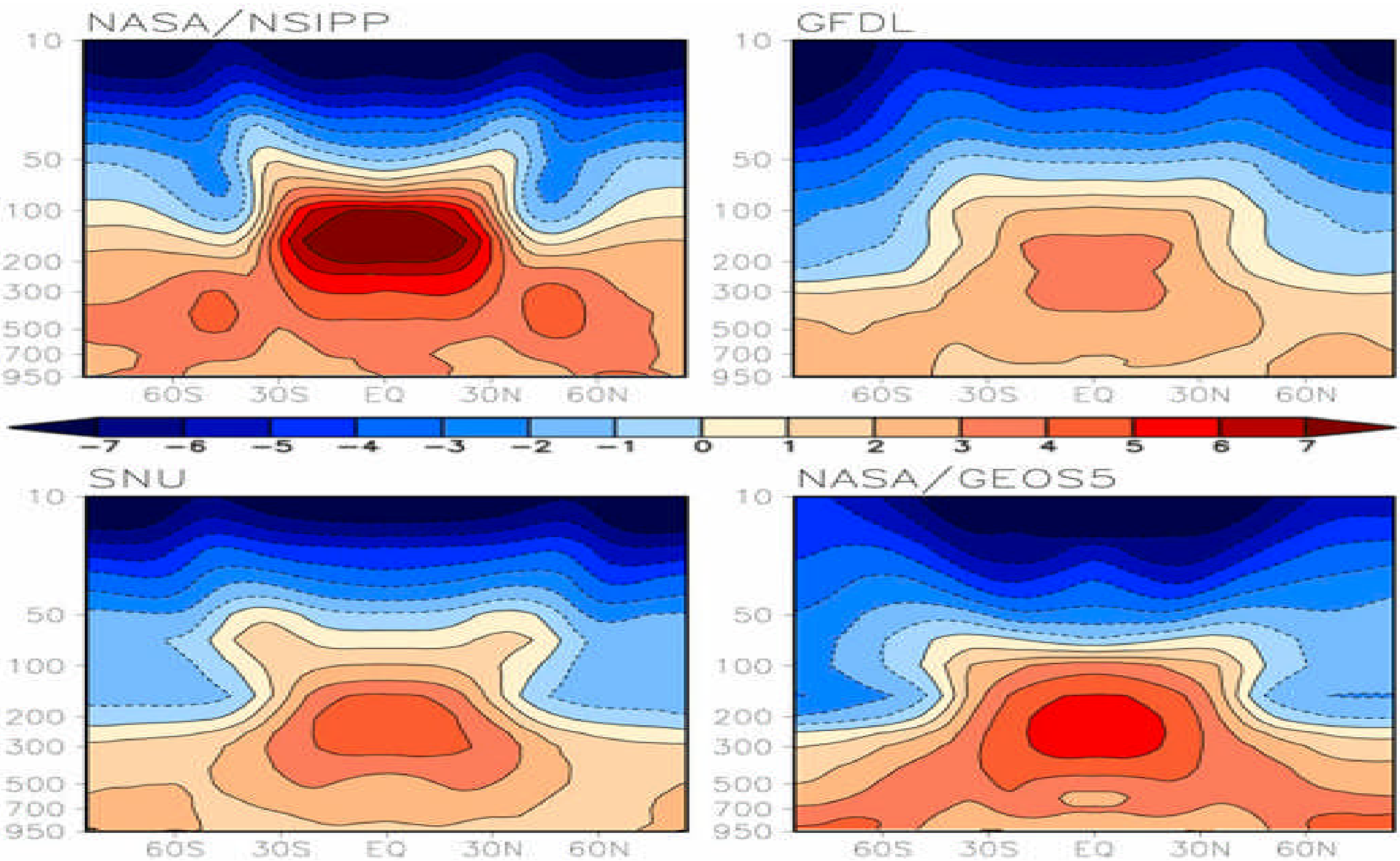
It is worth noticing that if we considered only global temperatures, as many climatologists do, this signature of anthropogenic as distinct from natural warming would not become visible. Accordingly, the objections of Essex and McKitrick (2002) and Essex *et al*. (2007) to the use of globally averaged temperature are justifiable. Had we used globally averaged temperatures, it would have been almost impossible correctly to relate the underlying physics to the observations.

We shall now demonstrate that several of the atmosphere-ocean general-circulation models relied upon by the UN do indeed predict the "hot-spot" in the mid-troposphere at low latitudes that is the signature of anthropogenic "global warming".

The computer-predicted signature of greenhouse warming



Zonally-averaged distribution of predicted temperature change (CCSP, 2006)



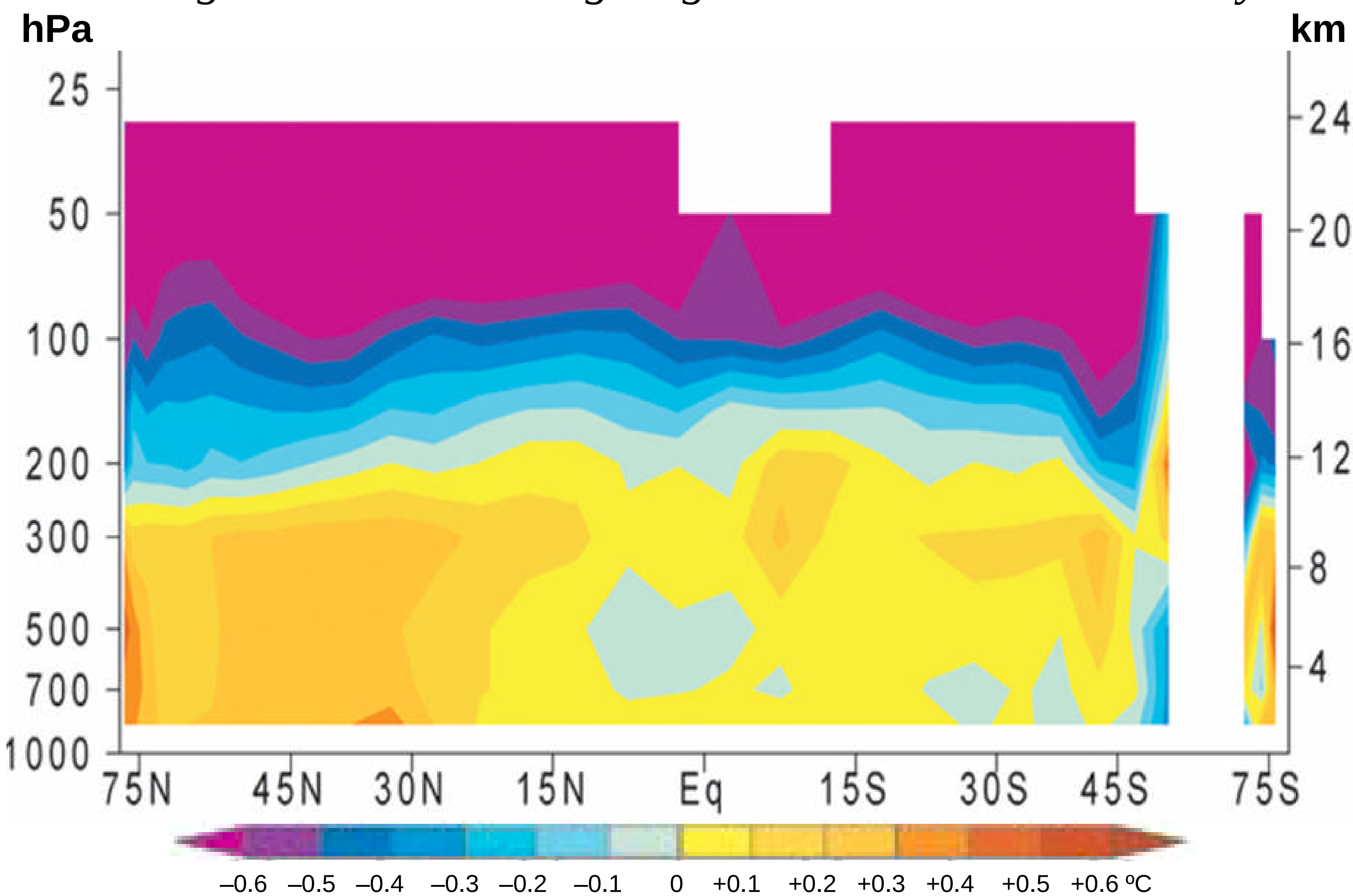
Zonally-averaged distributions of predicted temperature change in ºK at CO_2 doubling ($2xCO_2$ – control), as a function of latitude and pressure level, for four general-circulation models ***(****Lee et al., 2007).*

Predicted acceleration in the rate of temperature increase in tropical mid-troposphere in response to continuing emission of well-mixed greenhouse gases, compared with surface temperature change, generates a distinctive "hot-spot" graph that is the signature of anthropogenic as opposed to natural "global warming". All general-circulation models show this characteristic amplification of the decadal rate of change in temperature with altitude at low latitudes, up to a factor of ~ 3 at 10 km over the equator.

All five of the computer models whose plots are shown above unmistakably predict the characteristic "hot-spot" signature that UN's graphs show to be unique to warming of the atmosphere caused by emissions of greenhouse gases. But does observation demonstrate what the models predict?

Real-world temperatures in the upper atmosphere have been measured with balloons since at least the 1960's and with microwave satellite sensors since 1979. However, the Hadley Centre's plot of real-world radiosonde observations does not demonstrate the "global warming hot-spot" at all. The predicted phenomenon is startlingly and entirely absent from the observational record –

No "greenhouse warming" signature is observed in reality



No "hot-spot" signature of anthropogenic "greenhouse warming" appears in the record of real-world temperature observations.
Source: *HadAT2 radiosonde observations, from CCSP (2006), p. 116, fig. 5.7E.*

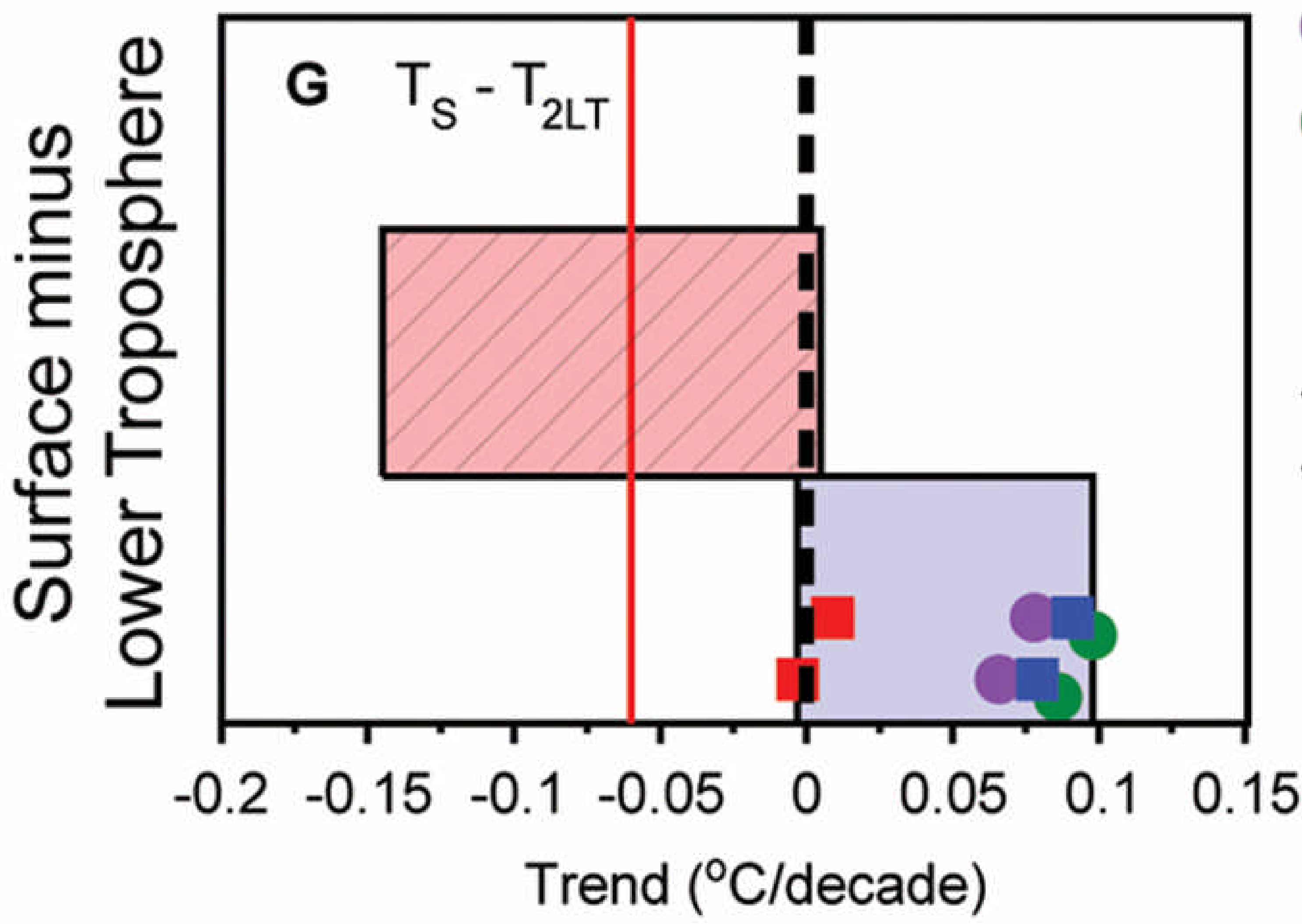
The contrast between the five computer models' predicted signature of greenhouse warming and the Hadley Centre's plot of observed decadal rates of change in temperature could not be starker. This astonishing result is explicitly confirmed by the UN's 2007 assessment report, which describes the near-total absence of its own predicted "hot-spot" signature of anthropogenic greenhouse warming in the observed temperature record, but apparently without appreciating its significance –

"9.4.4.1 Observed Changes

"... All data sets show that the global mean and tropical troposphere has warmed from 1958 to the present, with the warming trend in the troposphere slightly greater than at the surface. Since 1979, it is likely that there is slightly greater warming in the troposphere than at the surface, although uncertainties remain in observed tropospheric warming trends and whether these are greater or less than the surface trend. The range (due to different data sets) of the global mean tropospheric temperature trend since 1979 is 0.12°C to 0.19°C per decade based on satellite-based estimates (Chapter 3) compared to a range of 0.16°C to 0.18°C per decade for the global surface warming."

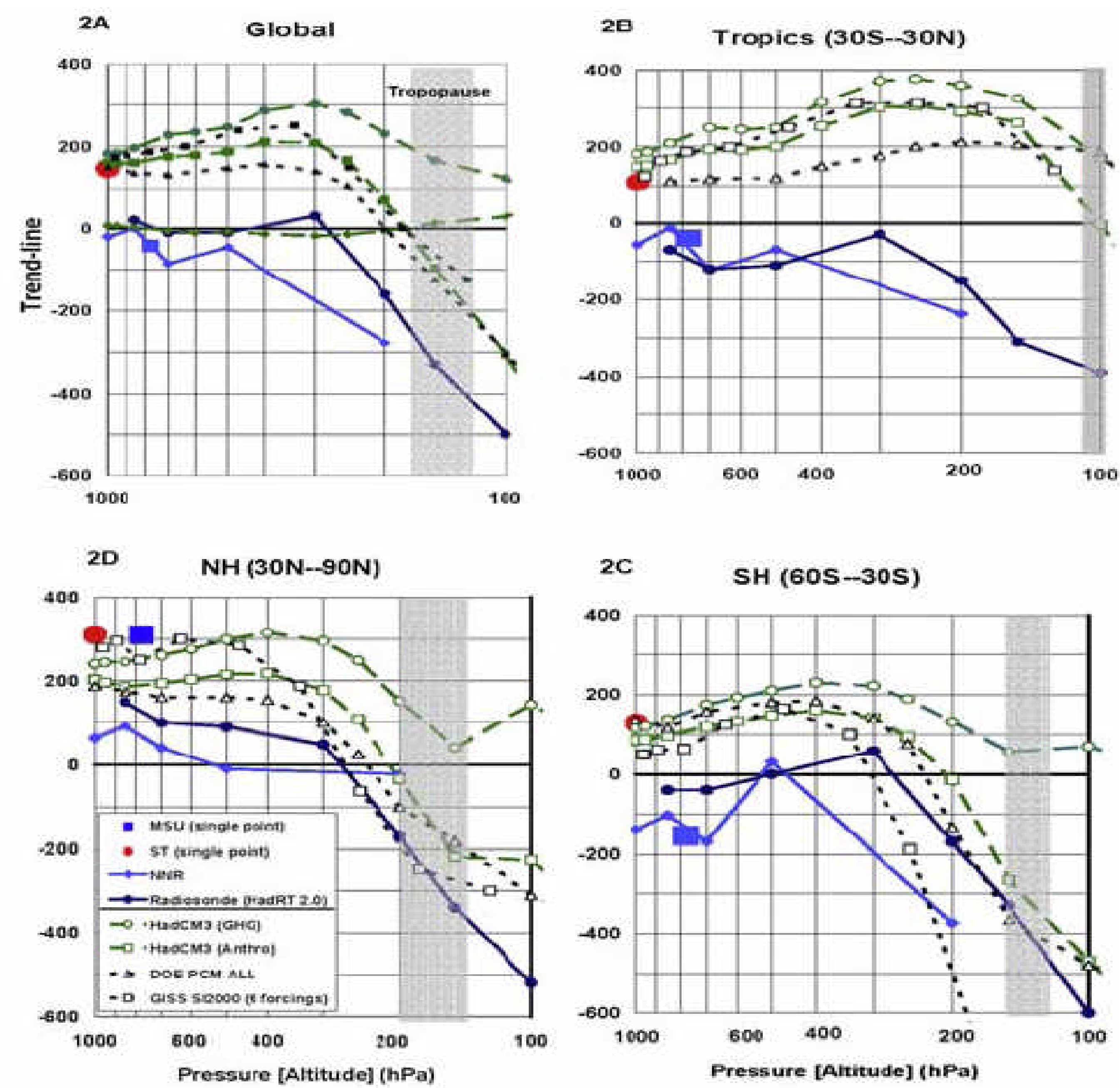
Global observation of tropospheric temperatures by balloon-borne radiosondes has been available since 1958, and by satellite telemetry since 1979. Therefore there are several multi-decadal observational rate-of-temperature-change datasets that demonstrate the absence in reality of the "hot-spot" signature that the general-circulation computer models predict in theory –

No overlap between theoretical modeling and real-world observation



Model-predicted differentials between decadal rates of increase in temperature at the surface (T_S) and in the lower troposphere (T_{2LT}) from latitude 20º N – 20º S in response to anthropogenic enhancement of the natural greenhouse effect by emission of carbon dioxide and other well-mixed greenhouse gases (pink hatched rectangle) do not overlap at any point with real-world observations from RATPAC radiosondes (purple circles); HadAT2 radiosondes (green circles); University of Alabama at Huntsville satellites (blue squares); and RSS satellites (red squares). Source: CCSP (2006), Executive Summary.

Observed temperature change is less than predicted



Temperature trend-line (10^{-3}K / decade) versus log pressure (altitude) for different zonal averages. Observations (filled symbols, solid lines): MSU, ST (Hadley), NNR, HadRT2.0 radiosondes. Models (open symbols, dotted lines): Hadley model CM3, DOE PCM, and GISS SI2000. Tropopause range is shaded. Tropopause data can be found at http://cdc.noaa.gov/. (a) Global average. All of the data sets have an average taken from 90S to 90N with exception of ST (Hadley), whose average was taken from 67.5S to 67.5N. (b) Tropics. (30S to 30N). (c) Southern Hemisphere (60S to 30S). (d) Northern Hemisphere. (30N to 60N). The tropical "hot-spot" at 300 hPa (about six miles up in the troposphere) is not significant enough to indicate a high climate sensitivity to anthropogenic enhancement of the natural greenhouse effect. . From Douglass et al. (2004).

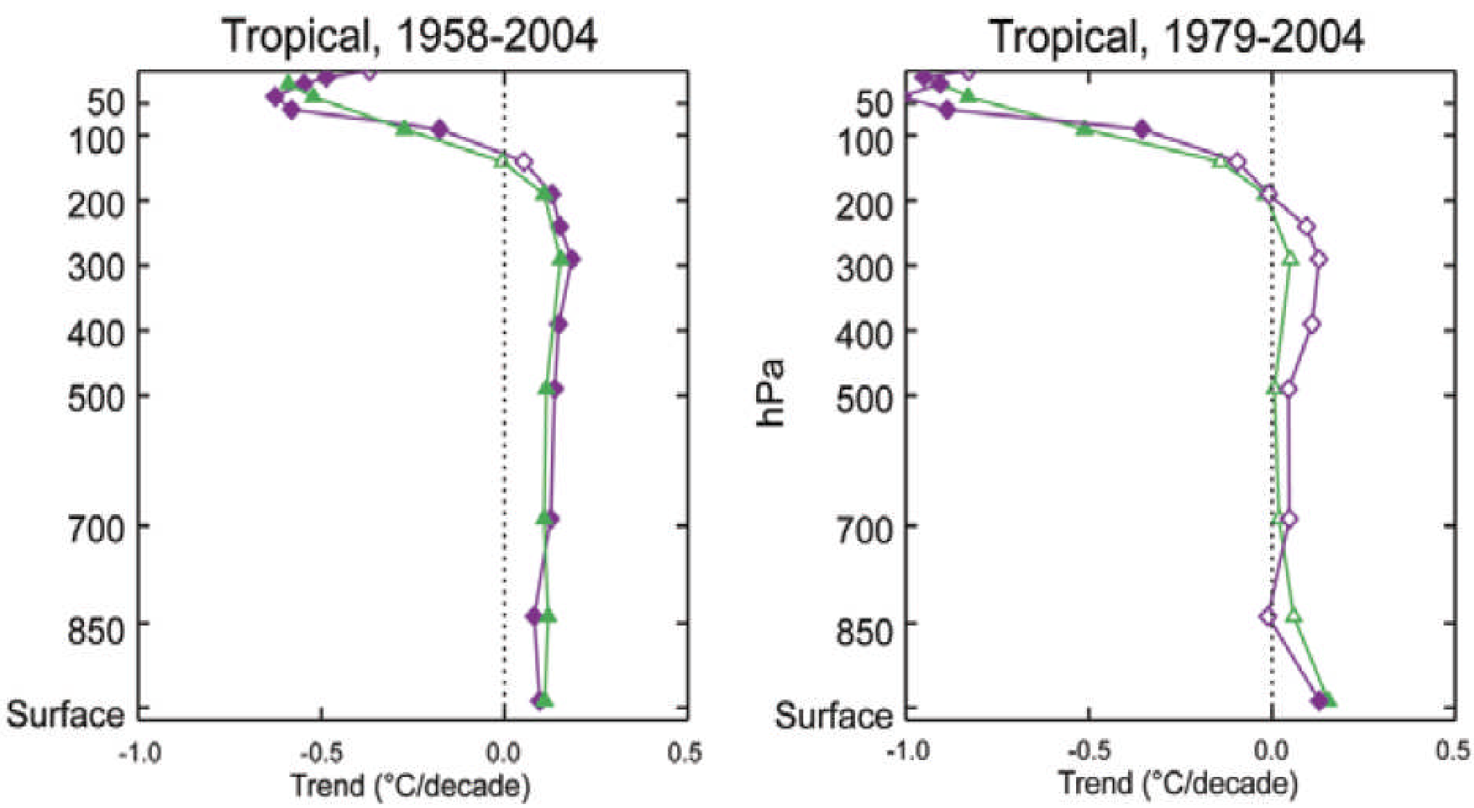
The discrepancy between the predicted "signature" of anthropogenic greenhouse warming and its absence in half a century of observed temperature records is currently under active discussion among climatologists. A report by the US Climate Change Science Program (CCSP, 2006), says –

> "For longer-timescale temperature changes over 1979 to 1999, only one of four observed upper-air data sets has larger tropical warming aloft than in the surface records." *[Even this single dataset does not show enough troposphere warming to match the models' predictions that justify the UN's*

high central estimate of climate sensitivity to anthropogenic greenhouse warming]. "All model runs with surface warming over this period show amplified warming aloft. These results could arise due to errors common to all models; to significant non-climatic influences remaining within some or all of the observational data sets, leading to biased long-term trend estimates; or a combination of these factors. The new evidence in this Report (model-to-model consistency of amplification results, the large uncertainties in observed tropospheric temperature trends, and independent physical evidence supporting substantial tropospheric warming) favors the second explanation. A full resolution of this issue will require reducing the large observational uncertainties that currently exist. These uncertainties make it difficult to determine whether models still have common, fundamental errors in their representation of the vertical structure of atmospheric temperature change."

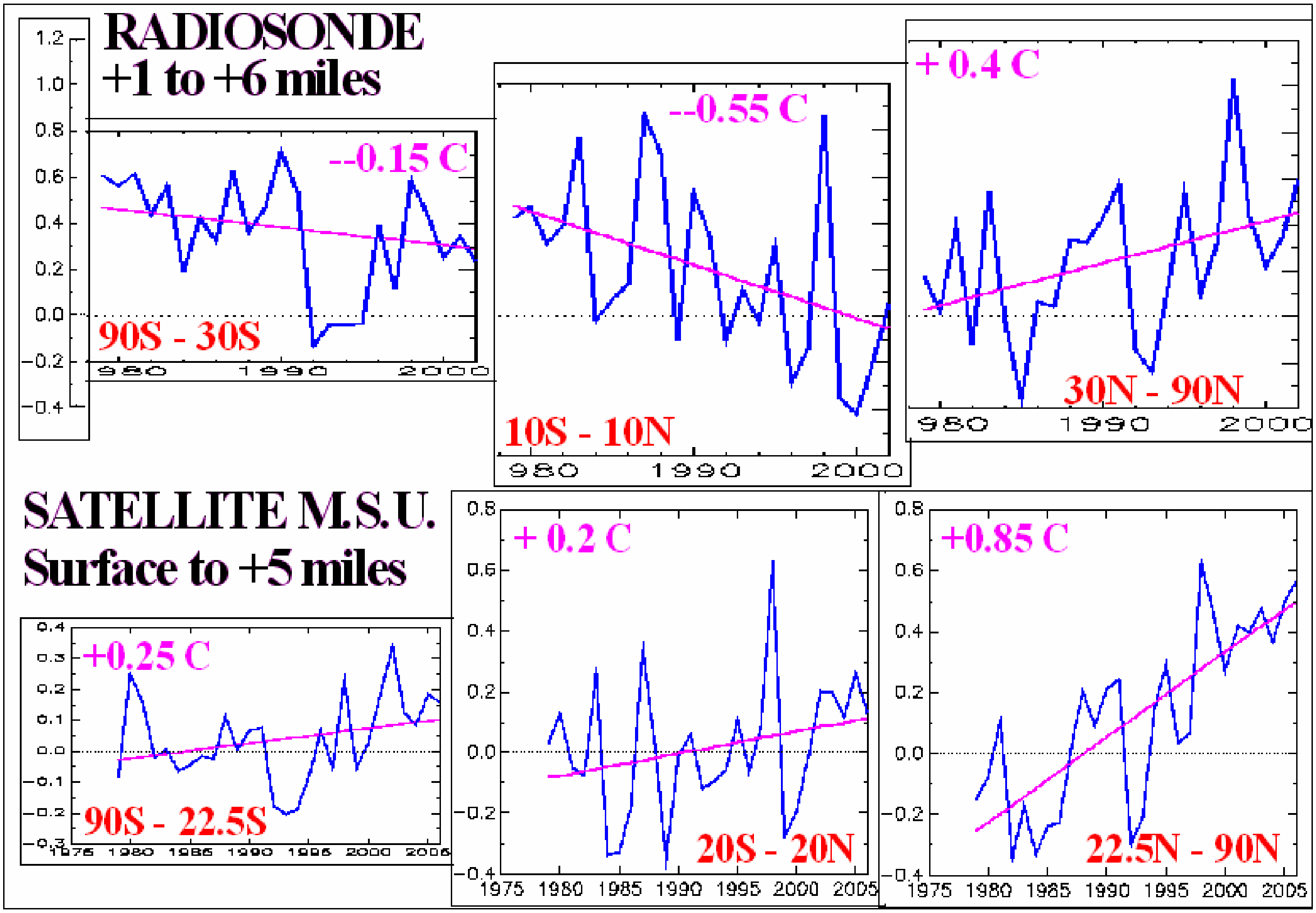
Applying Occam's Razor, the simplest explanation for the discrepancy between theoretical modeling and real-world observation is that the models on which the case for alarm about climate change are based are very substantially overestimating the effect of anthropogenic greenhouse warming on global temperatures. The Climate Change Science Program, however, prefers to assume that it is observation, rather than theory, that is deficient. Yet the plot of its latest synthesis of all corrections to satellite and balloon radiosonde data to date (CCSP, 2006), shown below, shows no significant difference between surface and mid-tropospheric decadal temperature trends, and indicates a trend of no more than 0.05 +/- 0.07 ºC per decade (Spencer *et al*, 2007):

No difference between surface and mid-troposphere trends



Vertical profiles of temperature trend in °C per decade for 1958-2004 (left) and 1979-2004 (right) as a function of altitude expressed as pressure from 1000 (surface) to 25 hPa, computed from the RATPAC (violet) and HadAT2 (green) radiosonde datasets, and based on temperature that has been averaged over the tropics, 20º N - 20º S. Filled symbols denote trends estimated to be statistically significantly different from zero (at the 5% level) (CCSP, 2006).

Further to investigate whether the tropical mid-troposphere "hot-spot" signature of anthropogenic greenhouse warming exists, a three-way test was developed using the Microwave Sounding Unit satellite temperature record for the atmosphere between the surface and an altitude of 5 miles, and the radiosonde record for the region between 1 mile and 5 miles above the surface. Regression lines were plotted using the online routine at www.co2science.org –



Upper panel: *Radiosonde temperature data for 850 to 300 hPa (1 mile to 6 miles above surface), 1979 to 2004, for latitudes 90S to 30S, 10S to 10N, and 30N to 90N. From Angell et al. (1999), updated.* ***Lower panel:*** *Satellite microwave sounding unit data for 0 to 400 hPa (surface to 5 miles), 1979 to 2006, for latitudes 90S to 22.5S, 20S to 20N, and 22.5N to 90N. From Christy et al. (2000), updated.*

The purpose of the test was to study whether the rate of temperature change between the commencement of the satellite record in 1979 and the beginning of the 21st century was a little higher in the tropics than in the northern or southern hemispheres, as it should be if the tropical mid-troposphere "hot-spot" were strong enough to justify the IPCC's chosen 3-degrees-Celsius central estimate of climate sensitivity to CO_2 doubling.

First, the satellite record showed that the rate of temperature change in the tropics was lower than in either the northern or the southern hemisphere.

Secondly, the radiosonde record also showed that the observed tropical rate of change in temperature was less than the northern or southern hemisphere rates of change: in fact, it showed a steep decline over the period.

Thirdly, the radiosonde record should have showed a slightly greater rate of temperature change over the period than the satellite record, since the former was closer to the altitude at which the models predict the "hot-spot" to be present than the latter. However, the satellite record shows a decline in temperatures over the period, while the radiosonde record shows an increase.

The conclusion of this three-part experiment is clear – all three of the tests fail to show any evidence of the expected differential between tropical and non-tropical rates of change in temperature, or between the tropical radiosonde and satellite readings. The tropical mid-troposphere "hot-spot" indeed seems to be absent.

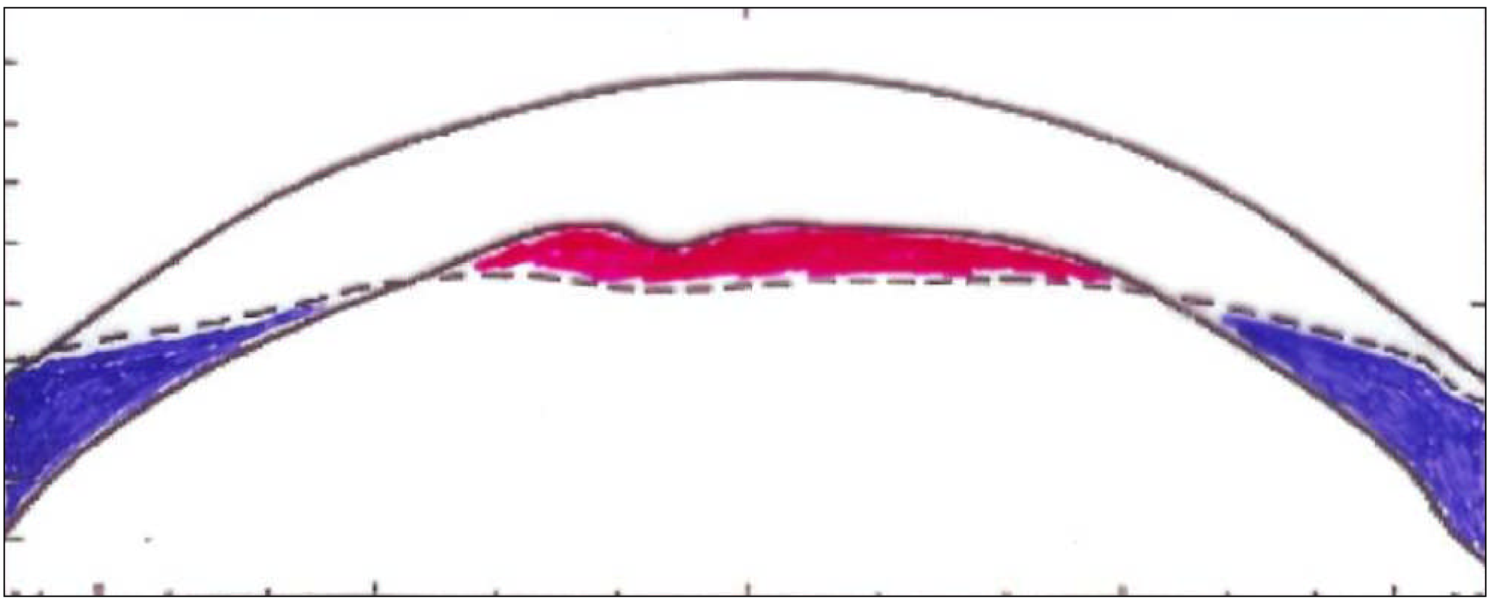
Since theoretical modeling and real-world observation differ so markedly, and since all or nearly all observations from many sources over half a century, confirmed by our own experiment, fail to establish the model-predicted existence of the tropical mid-troposphere "hot-spot" signature of greenhouse warming caused by human activities, either the models or the observations or both are wrong.

Some fundamental considerations in elementary atmospheric physics, as well as some additional atmospheric measurements, suggest that it is the theoretical models that are more likely to be in error than the data from actual observations.

We established at the outset that the atmosphere and the oceans act together as a conveyor of radiant energy from the tropics toward the poles. Satellite measurements confirm that this is indeed the case –

Measurements show no increase in global greenhouse effect

Wm^{-2}



90N 60N 30N Eq 30S 60S 90S

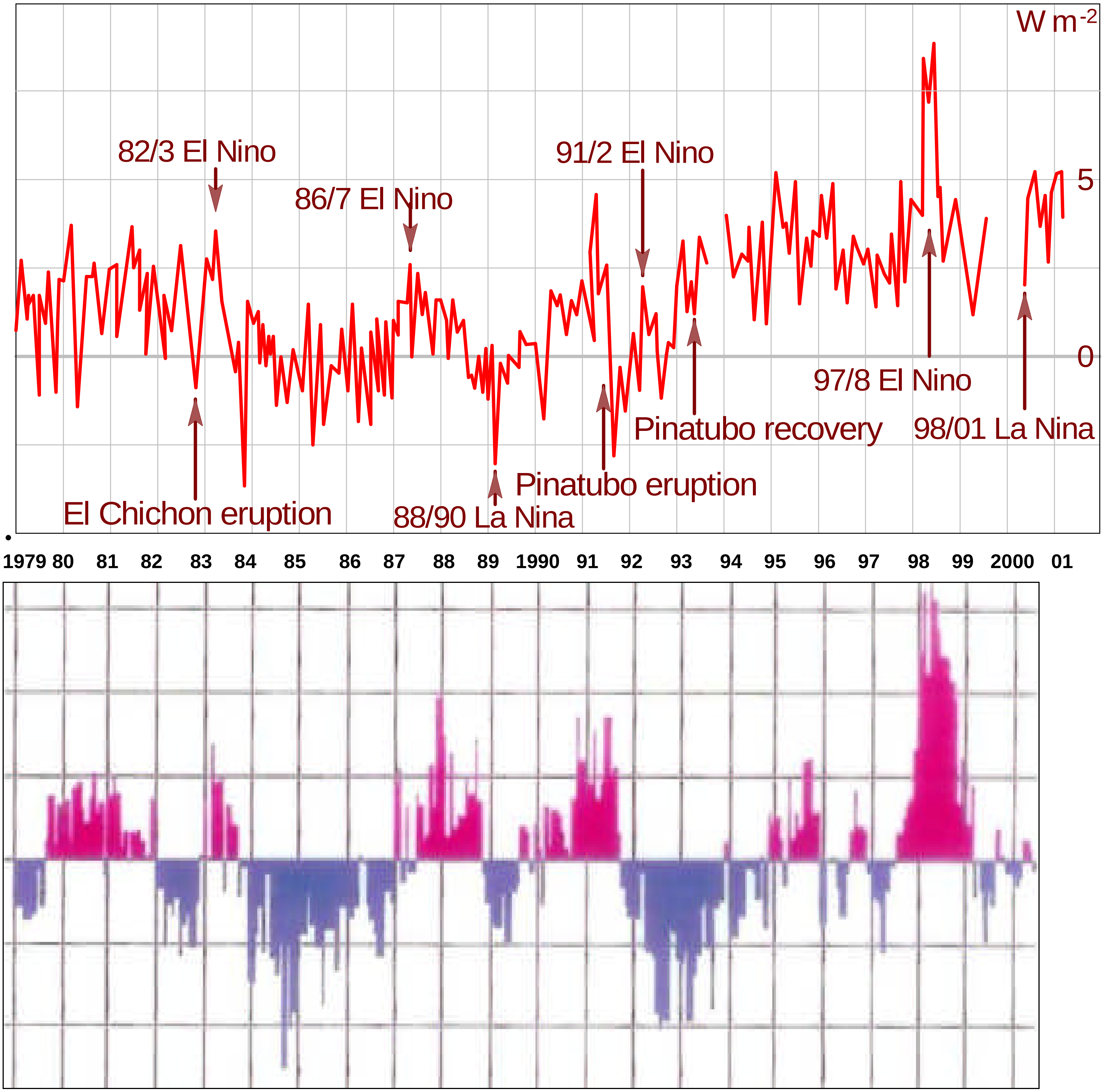
The Earth's radiation balance (watts per square meter: y axis) against latitude (degrees: x axis). Latitudinal spacing is proportional to the area of the Earth's surface between latitudes (i.e. the sine of the latitude). ***Upper solid curve:*** *mean flux of solar energy reaching the outer atmosphere.* ***Lower solid curve:*** *mean 1974-1978 satellite-observed solar energy.* ***Dashed curve:*** *mean 1974-1978 satellite-observed outgoing long-wave radiation.* ***Red:*** *accumulated energy.* ***Blue:*** *the necessary energy transfer via ocean and atmosphere currents to Polar Regions to maintain mean radiation balance.* ***Distance between solid curves:*** *mean Earth albedo (here 25%): tropical albedo fluctuations are caused by variations in cloud cover between 10% and 40%.* ***Source:*** *Winston et al. (1979), vol. 2.*

The observations in the above diagram, though they only cover a short period, strongly suggest that it is variations in outgoing longwave radiation in the tropics that are the principal influence on increases in global temperature, and that any increase in tropical outgoing longwave radiation will have a disproportionately large impact on temperatures in the polar regions, through transport of surplus radiative energy from the tropics to the poles by advection and other atmospheric and oceanic processes.

Therefore the disproportionately rapid observed increase in temperature at high latitudes, particularly in the northern hemisphere, is not – as has often been suggested – an indication of anthropogenic "global warming". It is what is likely to occur regardless of the source of the warming. In particular, it will occur if there is an increase in outgoing longwave radiation in the tropics. Such an increase can occur either in response to an increase in solar activity or in response to a decrease in tropical cloud cover. Volcanic eruptions and El Nino or La Nina events can also have an effect.

A simple question arises. Does observation demonstrate that increases in outgoing longwave radiation in the tropics lead to increases in observed global temperature? The answer to that question is Yes –

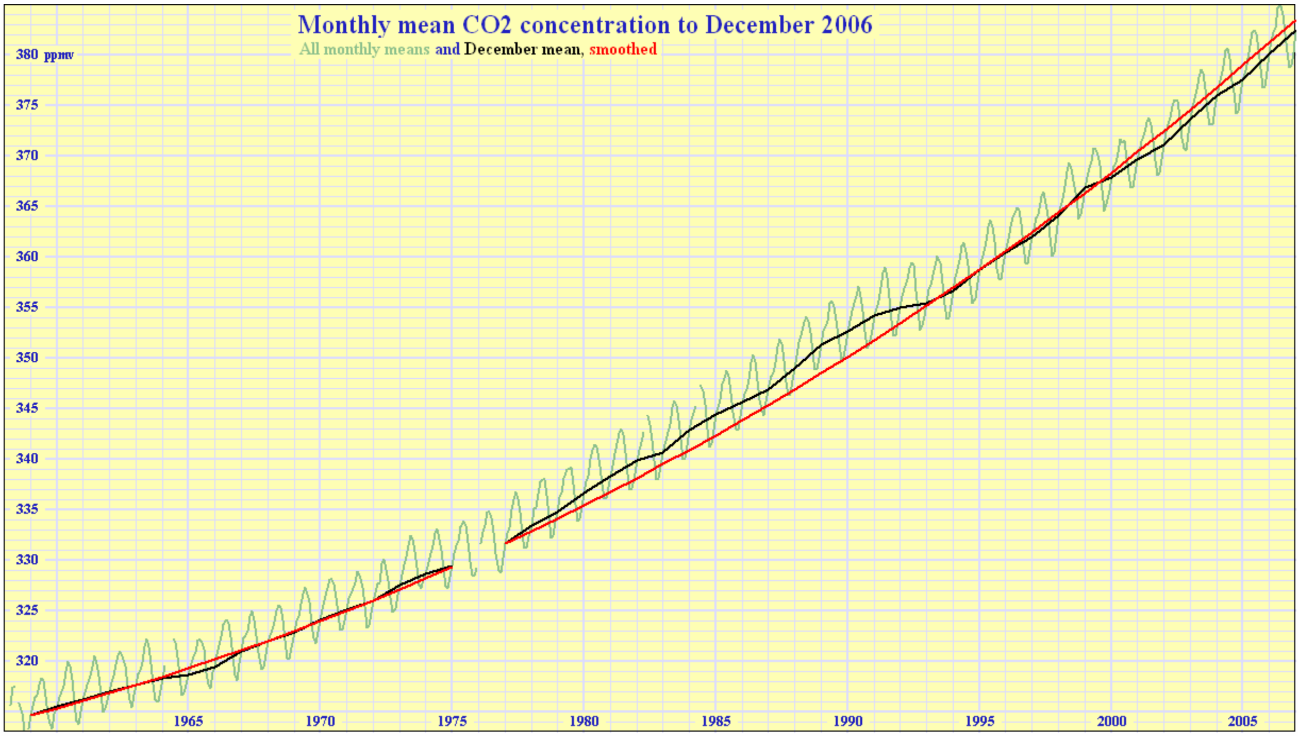
Tropical outgoing longwave radiation determines global temperature



Upper figure: *Tropical outgoing long-wave radiation (W m^{-2}), 20 ºS to 20 ºN, 1979-2001, chiefly oceanic, from six satellites. Variations in tropical cloud cover, periodic El Nino and La Nina events, and short-term increases in albedo following volcanic eruptions are principal causes of changes.* ***Lower figure:*** *Global lower-troposphere temperature anomalies (intervals 0.2 ºC), 1979-2000. Correction analysis yields a significant linear correlation of 0.92, indicating that anomalies in outgoing long-wave radiation from the tropical oceans cause about 85% of global lower-troposphere temperature anomalies.* ***Source:*** *Moene (2006).*

Given the startlingly close correlation between outgoing long-wave radiation in the tropics and global temperatures throughout the 30-year period of satellite observation, a correlation which atmospheric physics would lead us to expect and which is indeed observed, one question remains. Is there a similarly close correlation between atmospheric concentrations of carbon dioxide and global temperatures? The answer is No –

No correlation between CO_2 concentration and global temperature



*There is no correlation between the exceptionally smooth year-on-year increases in global atmospheric CO_2 concentration (above) and the noticeably sharp annual changes in global temperature (previous graph). The "sawtooth" variations in atmospheric CO_2 concentration **(green)** are chiefly caused by the seasonal exchanges of CO2 between the atmosphere and the biosphere, chiefly in the Northern Hemisphere. The multi-decadal December trend of carbon dioxide concentrations **(black)** shows a monotonic increase: in each succeeding year, mean CO_2 concentration is higher than the previous year. The graph is exponential: the rate of increase in CO_2 concentration is accelerating, albeit very slowly, as the smoothed curve **(red)** shows. However, the increase in global temperature arising from the additional greenhouse-gas concentrations is logarithmic and hence very small: indeed, the scientific consensus (Oreskes, 2004, IPCC, 2007) holds no more than that at least 0.25ºC of the 0.5ºC global temperature increase since 1958 is anthropogenic. **Data source:** Mauna Loa Observatory, Hawaii. Missing data are omitted, not extrapolated.*

Conclusion

Though correlation does not always imply causation, and absence of correlation does not always imply absence of causation, atmospheric physics would lead us to expect what is in fact deduced from observation: that approximately five-sixths of global temperature anomalies are attributable to variations in outgoing long-wave radiation in the tropics; that these variations owe nothing to anthropogenic "global warming"; and that increases in the concentration of carbon dioxide are comparatively insignificant. This last conclusion is supported, to some extent, by the limitations on the definition and extent of the scientific "consensus" on climate sensitivity to additional greenhouse-gas concentrations (Oreskes, 2004; IPCC 2007).

The UN's fourth assessment report on climate change (IPCC, 2007) confirms that computer modeling predicts the existence of a unique and distinct signature or fingerprint of anthropogenic warming caused by our emissions of greenhouse gases. That signature is the instantly-recognizable tropical, mid-troposphere "hot spot" about 10km above the Earth's surface. In the "hot spot", the models predict that the rate of increase in atmospheric temperature, measured in degrees Celsius per decade, will be two or three times greater than at the Earth's surface.

In IPCC (2007), this predicted "hot-spot" signature of anthropogenic greenhouse warming is clearly visible on plots of modeled greenhouse forcing and of all forcings including the dominant greenhouse forcing, but is not visible on plots of solar, volcanic, tropospheric and stratospheric ozone, or sulphate aerosol forcings. The UN's models accordingly distinguish clearly between greenhouse warming and other climate forcings: at least five separate general-circulation computer models of the climate all predict the existence of the "hot-spot" signature of anthropogenic greenhouse warming in the tropical mid-troposphere.

Yet in the plot from the Hadley Centre's radiosondes, showing actual, observed temperatures in the troposphere, presented in the same altitude-vs-latitude fashion as the predictions made by the five computer models, the computer models' repeatedly-predicted "hot-spot" signature of anthropogenic greenhouse warming is entirely absent. Indeed, very nearly all observational data on mid-tropospheric temperature trends over the past half-century show no tropical "hot-spot" at all; and, in the one record that shows it at all, the magnitude of the observed effect is insufficient to justify the UN's choice of a very high central estimate of climate sensitivity to anthropogenic enhancement of the greenhouse effect. Our own small experiment also fails to demonstrate even the existence of the "hot-spot" fingerprint of anthropogenic warming, still less a magnitude sufficient to justify the IPCC's high climate sensitivity. These surprising results present a very real difficulty for the conventional "global warming" theory – a difficulty that is not resolved either in CCSP (2006) or in IPCC (2007).

Thorne *et al.* (2007) have attempted to resolve this difficulty by suggesting that the error-bars in the observational datasets are so large that they could in theory encompass the model-predicted "hot-spot", that the datasets are not designed to identify small temperature trends, and that the outputs are exceptionally sensitive to the choice of limiting dates. However, it is on the basis of the observed data that the models are contrived, and, if the observed data are inadequate for drawing conclusions about whether the characteristic fingerprint of anthropogenic greenhouse warming exists, then *a fortiori* the outputs from theoretical models founded upon those data will be inadequate, and no conclusion about the magnitude of the temperature response to anthropogenic enhancement of the natural greenhouse effect can be legitimately drawn.

The observational and experimental graphs reproduced here contain between them a dozen different observed-temperature datasets, not one of which exhibits the "hot-spot" signature of anthropogenic "greenhouse warming" that is predicted by the computer models upon which the UN so heavily relies. In every one of these datasets, the trend in the troposphere is no greater, and generally smaller, than the trend near the surface. According to Spencer *et al.* (2007), the tropospheric temperature trend is now 0.05 ± 0.07 degrees Celsius per decade. Therefore, the contribution of the anthropogenic enhancement of the greenhouse effect to surface warming is somewhere between -0.02 and 0.12 degrees Celsius per decade, with a central estimate of 0.5 degrees Celsius, or approximately one-sixth of the UN's central estimate of 3 degrees Celsius for a doubling of atmospheric carbon dioxide concentration.

This result is broadly consistent with that of Schwartz (2007), who supports the conclusions of Lindzen (2006), calculating by entirely different methods that the temperature increase to be expected from a doubling of atmospheric carbon dioxide concentration will be one-half to one-third of the UN's central estimate.

Can the discrepancy between prediction and observation be explained, as the CCSP suggests, by uncertainties in the observed data? The very close correlation between anomalies in tropical outgoing long-wave radiation and anomalies in global lower-troposphere temperatures, taken with the near-total absence of correlation between monotonic increases in CO2 concentration and chaotic temperature anomalies, suggests that it is the computer models, not real-world observations that are likely to be at fault. Ultimately this question can only be resolved by collecting further data: but the CCSP's predisposition in favor of theoretical modeling and against the results of direct observation is commonplace among official climate-science bodies. Or does the discrepancy arise because the predictions are carried through to equilibrium climate response, while the observations are perforce carried only to a transient response? Professor Lindzen comments that this failure of observation to match prediction cannot be so easily explained, since the transient response would be likely to exceed the equilibrium response. He concludes that no more than about a third of the observed trend at the surface is likely to be due to greenhouse warming, and adds: "This is about as close as one ever gets to proof in climate physics."

On this analysis, "global warming" is unlikely to be dangerous and extremely unlikely to be catastrophic.

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