By Ken Gregory March 4, 2013

Water Vapor Decline Cools the Earth: NASA Satellite Data

An analysis of NASA satellite data shows that water vapor, the most important greenhouse gas, has declined in the upper atmosphere causing a cooling effect that is 16 times greater than the warming effect from man-made greenhouse gas emissions during the period 1990 to 2001.

The world has spent over $ 1 trillion on climate change mitigation based on climate models that don't work. They are notoriously poor at simulating the 20th century warming because they do not include natural causes of climate change – mainly due to the changing sun - and they grossly exaggerate the feedback effects of greenhouse gas emissions.

Most scientists agree that doubling the amount of carbon dioxide (CO_2) in the atmosphere, which takes about 150 years, would theoretical warm the earth by one degree Celsius if there were no change in evaporation, the amount or distribution of water vapor and clouds. Climate models amplify the initial CO_2 effect by a factor of three by assuming positive feedbacks from water vapor and clouds, for which there is little direct evidence. Most of the amplification by the climate models is due to an increase in upper atmosphere water vapor.

The Satellite Data

The NASA water vapor project (NVAP) uses multiple satellite sensors to create a standard climate dataset to measure long-term variability of global water vapor. NASA recently released the Heritage NVAP data which gives water vapor measurement from 1988 to 2001 on a 1 degree by 1 degree grid, in three vertical layers.[1] The NVAP-M project, which is not yet available, extends the analysis to 2009 and gives five vertical layers. Water vapor content of an atmospheric layer is represented by the height in millimeters (mm) that would result from precipitating all the water vapor in a vertical column to liquid water. The near-surface layer is from the surface to where the atmospheric pressure is 700 millibar (mb), or about 3 km altitude. The middle layer is from 700 mb to 500 mb air pressure, or from 3 km to 6 km attitude. The upper layer is from 500 mb to 300 mb air pressure, or from 6 km to 10 km altitude.

The global annual average precipitable water vapor by atmospheric layer and by hemisphere from 1988 to 2001 is shown in Figure 1.

The graph is presented on a logarithmic scale so the vertical change of the curves approximately represents the forcing effect of the change. For a steady earth temperature, the amount of incoming solar energy absorbed by the climate system must be balanced by an equal amount of outgoing longwave radiation (OLR) at the top of the atmosphere. An increase of water vapor in the upper atmosphere would temporarily reduce the OLR, creating a forcing of more incoming than outgoing energy, which raises the temperature of the atmosphere until the balance is restored.

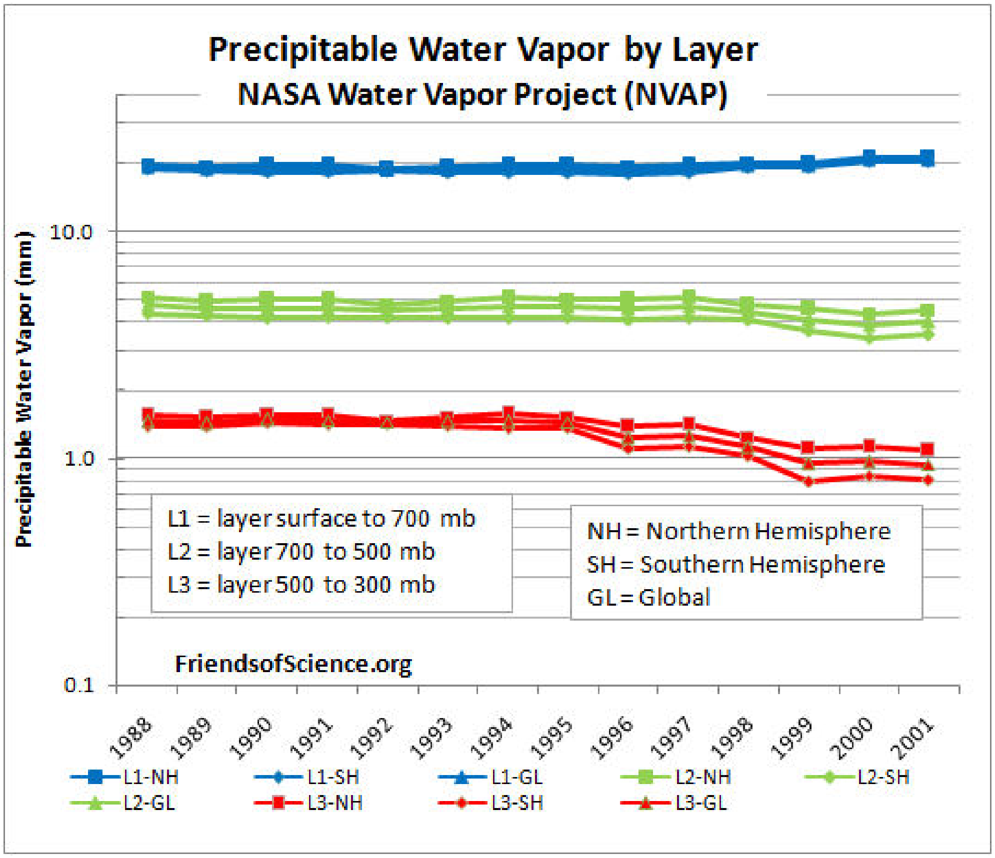


Figure 1. Precipitable water vapor by layer, global and by hemisphere.

The graph shows a significant percentage decline in upper and middle layer water vapor from 1995 to 2001. The near-surface layer shows a smaller percentage increase, but a larger absolute increase in water vapor than the other layers. The upper and middle layer water vapor decreases are greater in the Southern Hemisphere than in the Northern Hemisphere.

Table 1 below shows the precipitable water vapor for the three layers of the Heritage NVAP and the CO_2 content for the years 1990 and 2001, and the change.

Layer	L1 near-surface	L2 middle	L3 upper	Sum	CO_2
	1013-700	700-500	500-300		
	mm	mm	mm	mm	ppmv
1990	18.99	4.6	1.49	25.08	354.16
2001	20.72	4.03	0.94	25.69	371.07
change	1.73	-0.57	-0.55	0.61	16.91

Table 1. Heritage NVAP 1990 and 2001 water vapour and CO_2.

Dr. Ferenc Miskolczi performed computations using the HARTCODE line-by-line radiative code to determine the sensitivity of OLR to a 0.3 mm change in precipitable water vapor in each of 5 layers of the NVAP-M project.[2] The program uses thousands of measured absorption lines and is capable of doing accurate radiative flux calculations. Figure 2 shows the effect on OLR of a change of 0.3 mm in each layer.

The results show that a water vapor change in the 500-300 mb layer has 29 times the effect on OLR than the same change in the 1013-850 mb near-surface layer. A water vapor change in the 300-200 mb layer has 81 times the effect on OLR than the same change in the 1013-850 mb near-surface layer.

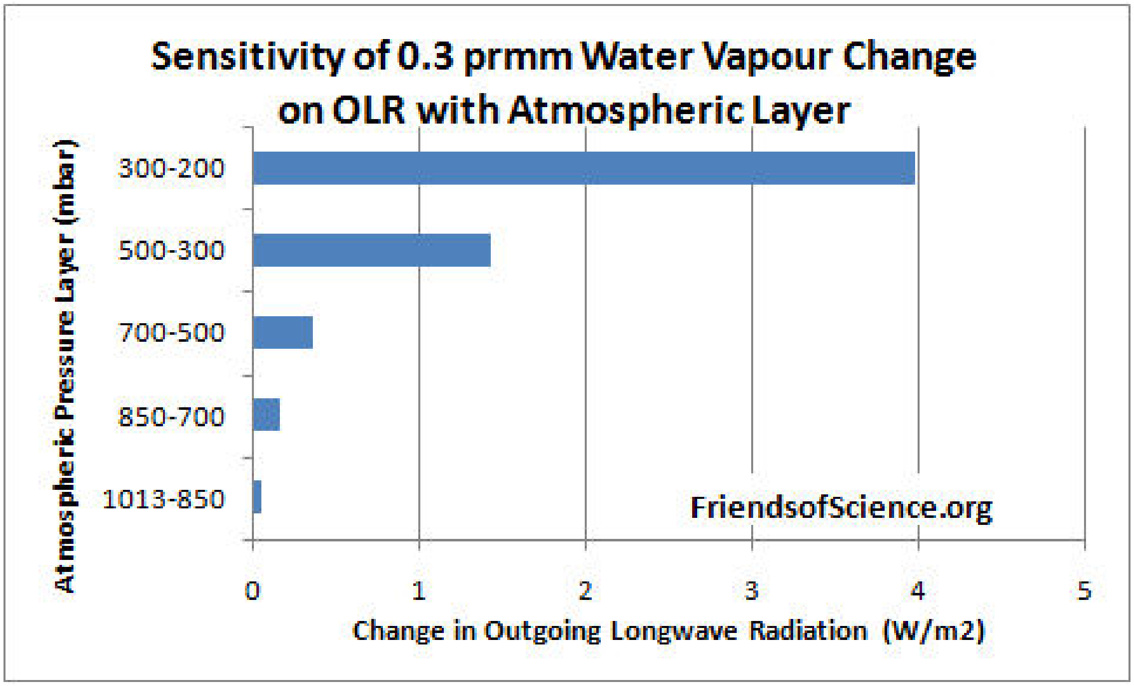


Figure 2. Sensitivity of 0.3 mm precipitable water vapor change on outgoing longwave radiation by atmospheric layer.

Table 2 below shows the change in OLR per change in water vapor in each layer, and the change in OLR from 1990 to 2001 due to the change in precipitable water vapor (PWV).

		L1	L2	L3	Sum	CO_2
OLR/PWV	W/m2/mm	-0.329	-1.192	-4.75		
OLR/CO2	W/m2/ppmv					-0.0101
OLR change	W/m2	-0.569	0.679	2.613	2.723	-0.171

Table 2. Change of OLR by layer from water vapor and from CO_2 from 1990 to 2001.

The calculations show that the cooling effect of the water vapor changes on OLR is 16 times the warming effect of CO_2 during this 11-year period. The cooling effect of the two upper layers is 5.8 times the warming effect of the lowest layer.

These results highlight the fact that changes in the total water vapor column, from surface to the top of the atmosphere, is of little relevance to climate change because the sensitivity of OLR to water vapor changes in the upper atmosphere overwhelms changes in the lower atmosphere.

The precipitable water vapour by layer versus latitude by one degree bands for the year 1991 is shown in Figure 3. The North Pole is at the right side of the figure. The water vapor amount in the Arctic in the 500 to 300 mb layer goes to a minimum of 0.53 mm at 68.5 degrees North, then increases to 0.94 mm near the North Pole.

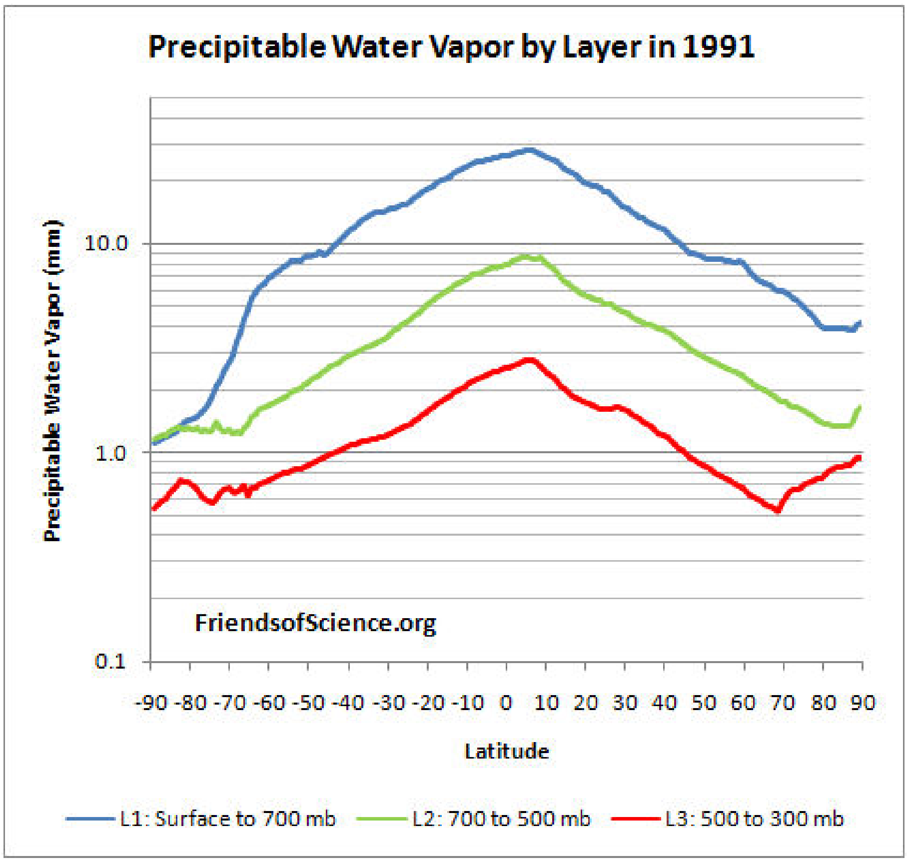
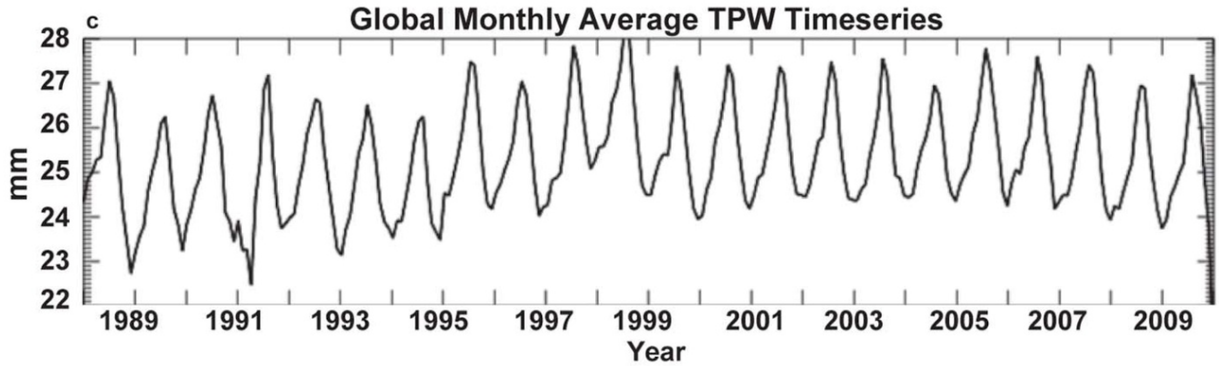


Figure 3. Precipitable water vapor by layer in 1991.

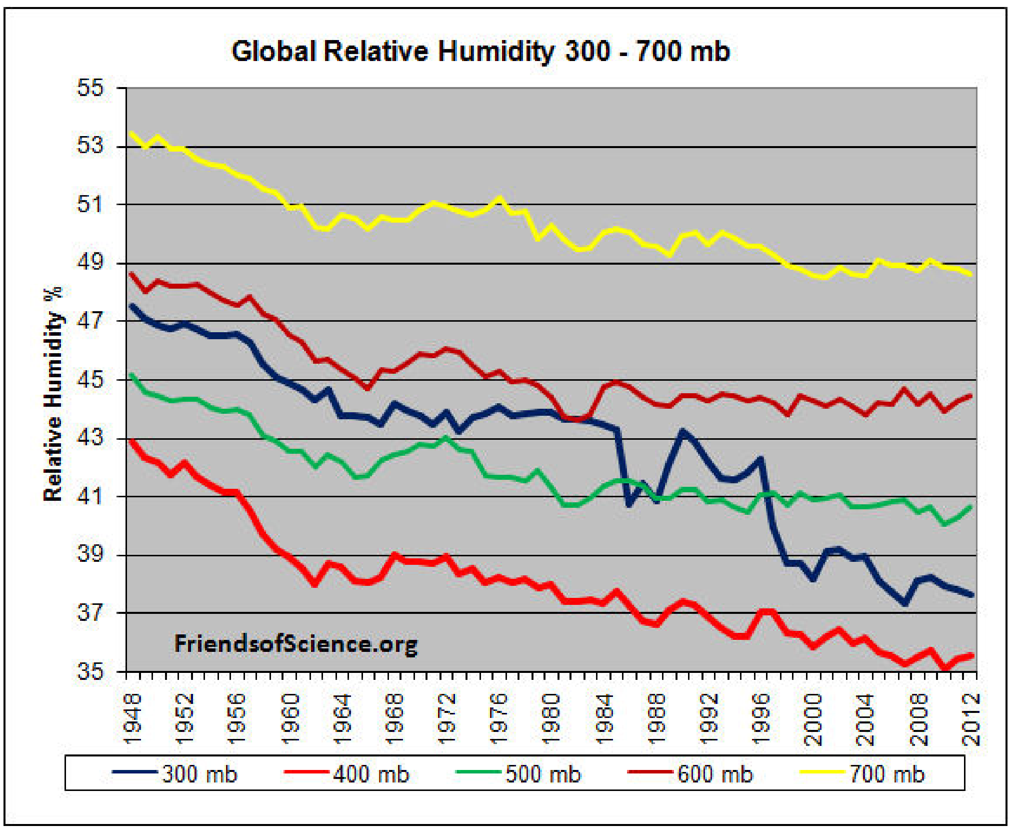
The NVAP-M project extends the analysis to 2009 and reprocesses the Heritage NVAP data. This layered data is not publicly available. The total precipitable water (TPW) data is shown in Figure 4, reproduced from the paper Vonder Haar et al (2012) here. There is no evidence of increasing water vapor to enhance the small warming effect from CO_2.



[Figure 4](). Global month total precipitable water vapor NVAP-M.

The Radiosonde Data

Water vapor humidity data is measured by radiosonde (on weather balloons) and by satellites. The radiosonde humidity data is from the NOAA Earth System Research Laboratory [here]().



[Figure 5](). Global relative humidity, middle and upper atmosphere, from radiosonde data, NOAA Earth System Research Laboratory.

A graph of the global average annual relative humidity (RH) from 300 mb to 700 mb is shown in Figure 5. The specific humidity in g/kg of moist air at 400 mb (8 km) is shown in Figure 6. It shows that specific humidity has declined by 14% since 1948 using the best fit line.

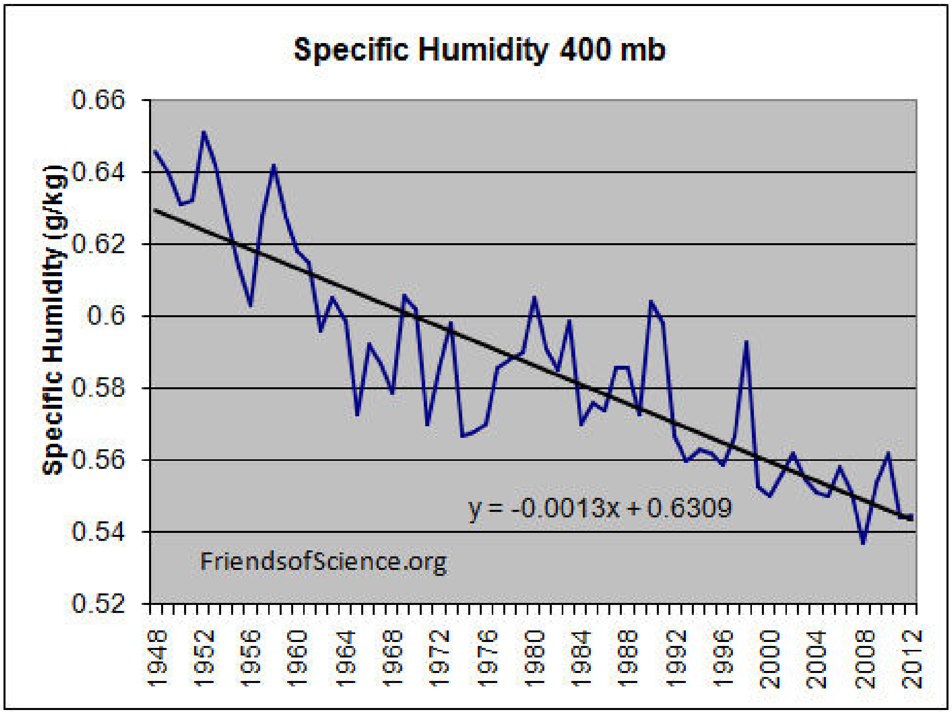


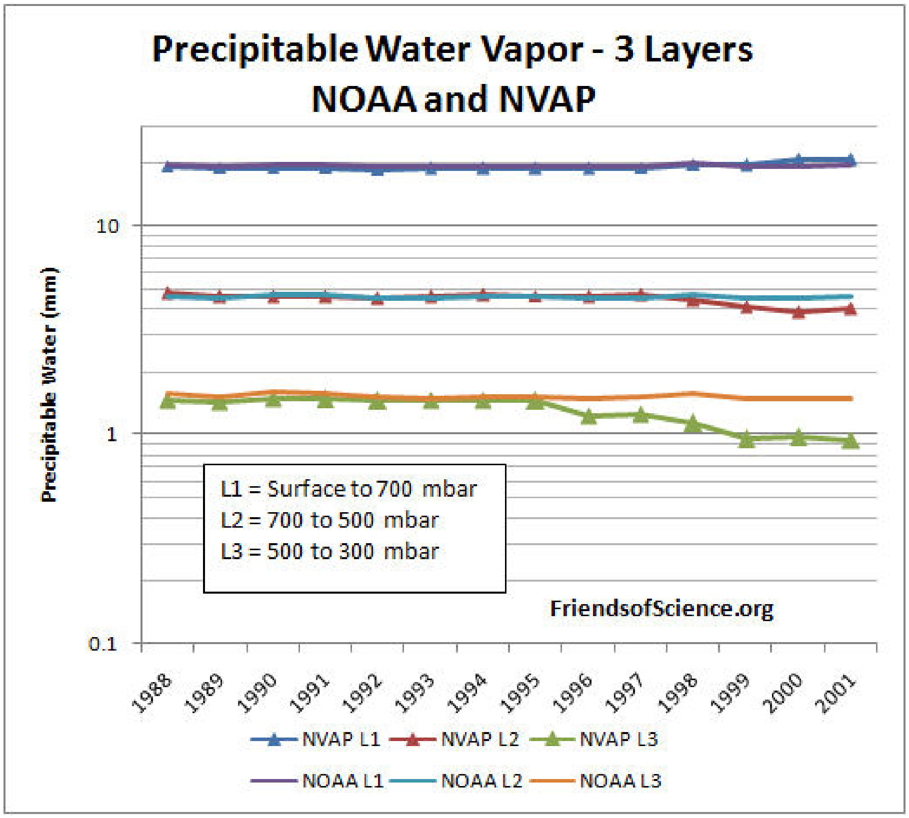
Figure 6. Specific humidity at 400 mb pressure level

In contrast, climate models all show RH staying constant, implying that specific humidity is forecast to increase with warming. So climate models show positive feedback and rising specific humidity with warming in the upper troposphere, but the data shows falling specific humidity and negative feedback.

Many climate scientists dismiss the radiosonde data because of changing instrumentation and the declining humidity conflicts with the climate model simulations. However, the radiosonde instruments were calibrated and the data corrected for changes in response times. The data before 1960 should be regarded as unreliable due to poor global coverage and inferior instruments. The near surface radiosonde measurements from 1960 to date show no change in relative humidity which is consistent with theory. Both the satellite and radiosonde data shows declining upper atmosphere humidity, so there is no reason to dismiss the radiosonde data. The radiosonde data only measures humidity over land stations, so it is interesting to compare to the satellite measurements which have global coverage.

Comparison Between Radiosonde and Satellite Data

The specific humidity radiosonde data was converted to precipitable water vapor for comparison with the satellite data. Figure 7 compares the satellite data to the radiosonde data for the years 1988 to 2001.



[Figure 7](). Comparison between NOAA radiosonde and NVAP satellite derived precipitable water vapor.

The NOAA and NVAP data compares very well for the period 1988 to 1995. The NVAP satellite data shows less water vapor in the upper and middle layers than the NOAA data. In 2000 and 2001 the NVAP data shows more water vapor in the near-surface layer than the NOAA data. The vertical change on the logarithmic graph is roughly equal to the forcing effect of each layer, so the NVAP data shows water vapor has a greater cooling effect than the radiosonde data.

The Tropical Hot Spot

The models predict a distinctive pattern of warming - a “hot-spot” of enhanced warming in the upper atmosphere at 8 km to 13 km over the tropics, shown as the large red spot in Figure 8. The temperature at this “hot-spot” is projected to increase at a rate of two to three times faster than at the surface. However, the Hadley Centre's real-world plot of radiosonde temperature observations from weather balloons shown below does not show the projected hot-spot at all.

The predicted hot-spot is entirely absent from the observational record. If it was there it would have been easily detected.

The hot-spot is forecast in climate models due to the theory that the water vapor profile in the tropics is dominated by the moist adiabatic lapse rate, which requires that water vapor increases in the upper atmosphere with warming. The moist adiabatic lapse rate describes how the temperature of a parcel of water-saturated air changes as it move up in the atmosphere by convection such as within a thunder cloud. A graph here shows two lapse rate profiles with a larger temperature difference in the upper atmosphere than at the surface. The projected water vapor increase creates the hot-spot and is responsible for half to two-thirds of the surface warming in the IPCC climate models.

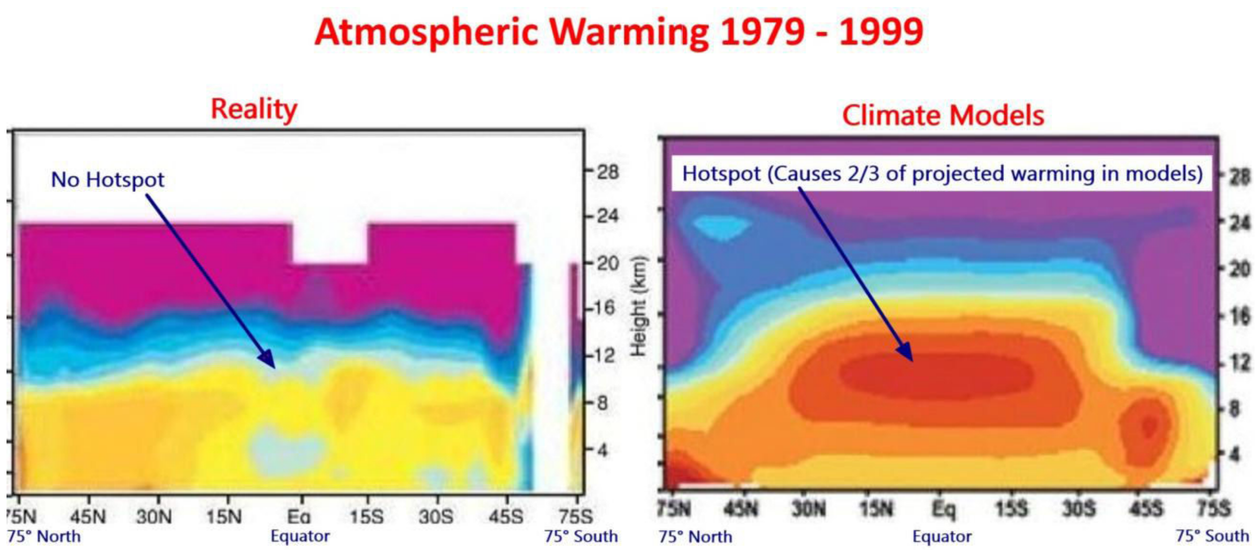


Figure 8. Climate models predict a hot spot of enhanced warming rate in the tropics, 8 km to 13 km altitude. Radiosonde data shows the hot spot does not exist. Red indicates the fastest warming rate. Source: http://joannenova.com.au

The projected upper atmosphere water vapor trends and temperature amplification at the hot-spot are intricately linked in the IPCC climate theory. The declining upper atmosphere humidity is consistent with the lack of a tropical hot spot, and both observations prove that the IPCC climate theory is wrong.

A recent technical paper Po-Chedley and Fu (2012) here compares the temperature trends of the lower and upper troposphere in the tropics from satellite data to the climate model projections from the period 1981 to 2008.[3] The upper troposphere is the part of the atmosphere where the pressure ranges from 500 mb to 100 mb, or from about 6 km to 15 km. The paper reports that the warming trend during 1981 to 2008 in the upper troposphere simulated by climate models is 1.19 times the simulated warming trend of the lower atmosphere in the tropics. (Note this comparison is to the lower atmosphere, not the surface, and includes 10 years of no warming to 2008.) Using the most current version (5.5) of the satellite temperature data from the University of Alabama in Huntsville (UAH), the warming trend of the upper troposphere is only 0.973 of the lower troposphere in the tropics for the same period. This is different from that reported in the paper because the authors used an obsolete version (5.4) of the data. The satellite data shows not only a lack of a hot-spot, it shows a cold-spot just where a hot-spot was predicted.

Conclusion

Climate models predict upper atmosphere moistening which triples the greenhouse effect from man-made carbon dioxide emissions. The new satellite data from the NASA water vapor project shows declining upper atmosphere water vapor during the period 1988 to 2001. It is the best available data for water vapor because it has global coverage. Calculations by a line-by-line radiative code show that upper atmosphere water vapor changes at 500 mb to 300 mb have 29 times greater effect on OLR and temperatures than the same change near the surface. The cooling effect of the water vapor changes on OLR is 16 times the warming effect of CO_2 during the 1990 to 2001 period. Radiosonde data shows that upper atmosphere water vapor declines with warming. The IPCC dismisses the radiosonde data as the decline is inconsistent with theory. During the 1990 to 2001 period, upper atmosphere water vapor from satellite data declines more than that from radiosonde data, so there is no reason to dismiss the radiosonde data. Changes in water vapor are linked to temperature trends in the upper atmosphere. Both satellite data and radiosonde data confirm the absence of any tropical upper atmosphere temperature amplification, contrary to IPCC theory. Four independent data sets demonstrate that the IPCC theory is wrong. CO_2 does not cause significant global warming.

Note 1. The NVAP data in Excel format is here.

Note 2. The conversion of water vapour prmm to ppmv and distribution by layer is shown here.

Note 3. The lower troposphere data is: http://www.nsstc.uah.edu/public/msu/t2lt/uahncdc.lt

The upper troposphere data is calculated as 1.1 x middle troposphere – 0.1 x lower stratosphere; where middle troposphere is: http://www.nsstc.uah.edu/public/msu/t2/uahncdc.mt and the lower stratosphere is: http://www.nsstc.uah.edu/public/msu/t4/uahncdc.ls