

Crux of AGW's Flawed Science (Wrong water-vapor feedback and missing ocean influence)

William M. Gray
Professor Emeritus
Colorado State University

There are many flaws in the global climate models. But the largest flaw is a result of the climate model's inability to realistically deal with the small horizontal scale (and model unresolvable) changes brought about by the globe's thousands of individual deep cumulonimbus (Cb) cloud elements (Figure 1). An increase in the totality of these deep Cb convective units adds drying to the upper troposphere (Figure 2). This is in contrast to the assumptions implicit in the General Climate Model (GCM) simulations which increase upper tropospheric water-vapor as a result of enhanced rainfall and Cb convection associated with rising levels of CO₂.

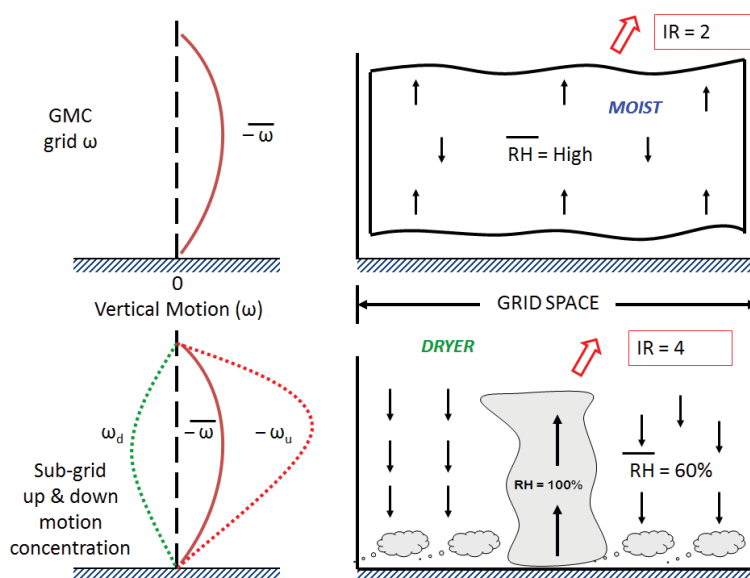


Figure 1. Illustration of how the large grids of the GCM models cannot resolve the individual convective cloud elements and all the local up-and-down vertical motion between the grid units. This sub-grid scale convection can result in enhanced IR loss to space and lesser amounts of warming than the coarser GCMs would allow for.

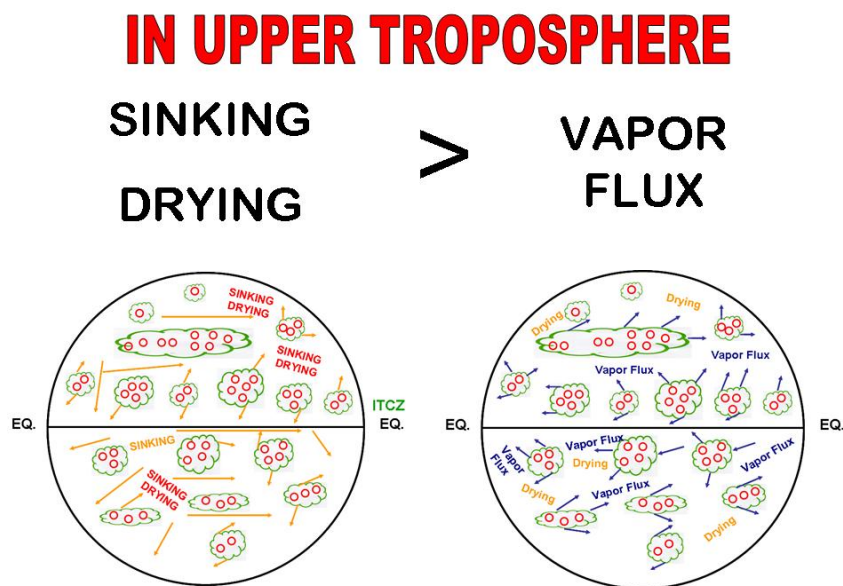


Figure 2. Idealized portrayal of global deep cumulus rain and cloud areas. The left diagram illustrates the upper-level sinking mass coming from the raining deep Cb cloud. This sinking acts to dry and warm the upper troposphere. The right diagram shows water-vapor and cloud particles being advected from the same high rain areas. Observations indicate that the sinking-drying in the upper troposphere is greater than the water-vapor and cloud water replacement by moist air outward advection and evaporation. Enhanced Cb convection leads to upper-level drying and extra IR loss to space.

The model simulations have followed the unrealistic physical ideas emanating from the National Academy of Science (NAS), 1979 (or Charney Report). This report speculated that as the troposphere warms from CO₂ increases that this warming would be accompanied (follow the Clausius-Clapeyron relationship between temperature and moisture) by a moisture increase such that the relative humidity (RH) of the air would remain near constant as the temperature increased. Implicit in this NAS assumption of CO₂ induced warming was the necessity that this increase of moisture would add additional blockage of infrared (IR) radiation to space beyond what the CO₂ gas did by itself. The net IR blockage to space from increasing CO₂ was thus assumed to occur not only from the CO₂ gas itself but also from the extra water-vapor gain needed to keep the RH near constant as the temperature rose. This additional water-vapor gain was shown by the models to have about twice as large an influence on reducing IR blockage to space as the CO₂ increase by itself. Thus, any CO₂ increase of one unit of IR blockage to space would simultaneously bring along with it an additional two units of water-vapor blockage of IR loss to space. This additional moisture related blockage of IR loss to space (associated with CO₂ induced warming) has been designated as 'positive water-vapor feedback'. All the CO₂ climate models have strong amounts of positive water-favor feedback.

It is this large and direct tie of water-vapor increase with CO₂ induced temperature rise which is the primary physical flaw in all of the GCM CO₂ doubling model simulations. This is the reason why all the GCMs have so strongly over-predicted the amount of global warming which will occur with a doubling of atmospheric CO₂.

Observations show that the warming or cooling of the upper troposphere does not occur with RH remaining close to constant. Temperature and RH tend to change oppositely from each other and not in unison as the models assume. My project's study of cumulus convection and tropical cyclone formation over many decades has taught me that the NAS 1979 (Charney) Report assessment that rising CO₂ amounts will occur with water-vapor increase is not a realistic assessment of how these parameters change in the upper troposphere.

The GCM CO₂ simulations are also constructed so as to have their moisture simulations arranged such that water-vapor changes occur uniformly at both upper and lower tropospheric levels. By contrast, the observations of moisture change at upper and lower tropospheric levels show them to be little related to each other (Figure 3).

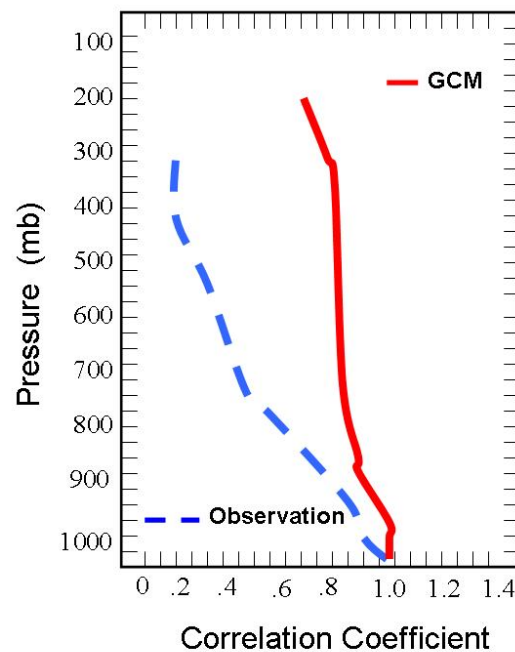


Figure 3. Correlation of lower and upper troposphere moisture changes. The GCM models simultaneously simulate the same moisture changes at both the lower and upper tropospheric levels – high correlation. The observations however, show very little correlation between upper and lower tropospheric moisture changes.

Our observation analysis finds that increases in cumulonimbus (Cb) cloud intensity and frequency brings about a decrease in upper tropospheric water-vapor, not an upper tropospheric moistening as the model simulations show.

The deeper and/or the more intense Cb clouds become the higher is their rainfall efficiency. Cb clouds rain out most of their moisture as they overshoot from the top of their positive buoyancy layer near 300 mb (~ 10 km) and penetrate higher into the stabilizing upper troposphere where they become weaker and terminate their upward motion. The Cbs weakening upward vertical motion at these high levels leave little upper-level moisture as they die. Their updrafts deposit their saturated but miniscule moisture content air and liquid cirrus clouds high in the troposphere. These are the heights where the vertical gradients of saturation air is, percentage-wise, very large. Any subsidence of this cold upper-level saturated air parcels to lower and warmer levels causes an especially large reduction of the sinking air's RH.

For instance, a saturated air parcel at 200 mb (12 km height) and a temperature of - 53°C will contain little moisture even though it is saturated. If this parcel then sinks with no mixing to 300 mb (~10 km height) and takes on the temperature of the lower-level air it will have its RH reduced from 100 percent to only 12 percent (Figure 4). Such Cb induced upper-level air parcel subsidence to lower levels induces an upper-level drying and with it an increased infrared (IR) radiation loss to space. The contrast of these two processes is seen in Figure 5. The crucial flaw of the models is that they have not made a proper up-and-down mass balance of the upper-troposphere's vertical motion that would have accounted for the high rainfall efficiency of the Cb air which penetrates above 300 mb and the very dry return flow subsidence. See Figures 7-9 at the back for more graphical illustrations of this subsidence drying process.

<i>Sinking 100 mb Pressure Levels</i>	<i>RH Percent Decrease</i>	<i>Resulting RH at base of sinking</i>
125 mb to 225 mb	93	07
150 mb to 250 mb	90	10
175 mb to 275 mb	88	12
200 mb to 300 mb	86	14
225 mb to 325 mb	83	17
250 mb to 350 mb	77	23
275 mb to 375 mb	69	31
300 mb to 400 mb	63	37
325 mb to 425 mb	59	41
350 mb to 450 mb	56	44

Figure 4. Illustration of extreme upper troposphere vertical gradient of saturated air in the tropics. This table shows the amount of relative humidity (RH) decrease by saturated air sinking 100 mb between various pressure levels as it assumes the temperature of the lower-level air. The resulting lower-level humidity is given on the right. For instance, saturated air sinking from 200 mb to 300 mb without mixing and maintaining its moisture but taking on the temperature of the air at 300 mb would have a RH of only 14 percent (green bracket).

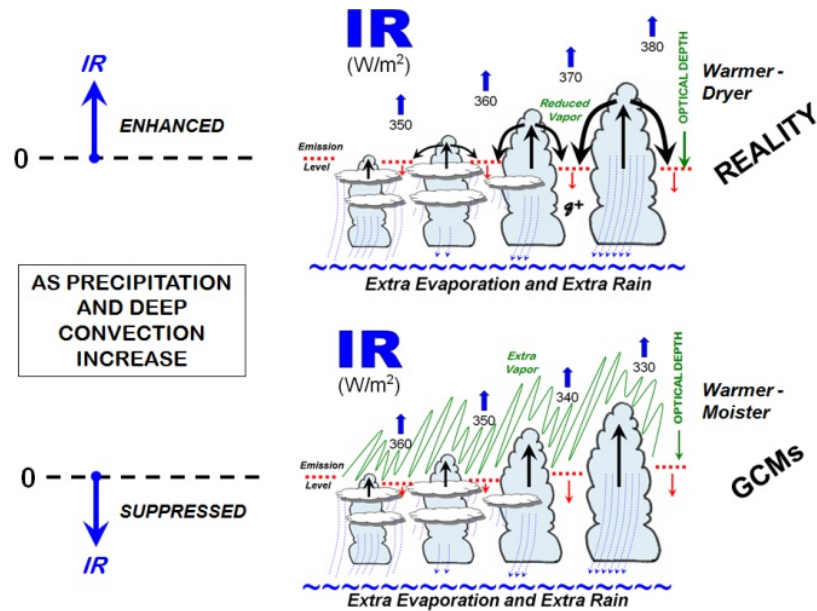


Figure 5. Two contrasting views of the effects of deep cumulus convection. The top diagram emphasizes the extra return flow mass subsidence drying associated with the deep convection. Extra IR energy flux is emitted to space. By contrast, the bottom diagram shows how the typical global climate models (GCMs) interpret the mass outflow from the deep cumulus as adding water-vapor to the upper troposphere and blocking more IR loss to space. The bottom diagram is not realistic as regards to the way Cb convection functions in the atmosphere.

Example. To balance the influence of a doubling of CO_2 by radiation alone it would be required that the temperature of the globe be warmed by 1°C . The models then assume that this CO_2 induced warming of 1°C will (following the Charney Report assumptions) cause a moisture increase that will further reduce IR loss to space, such that there will have to be an additional 2°C upper-level warming beyond the needed 1°C warming from the CO_2 by itself. The combination of these two processes is assumed to bring about an upper-level 3°C global warming over the whole tropics (30°N - 30°S). Of this 3°C warming 2°C would be designated as positive water-vapor feedback warming. Such an expected strong and positive temperature increase and positive water-vapor feedback of a doubling of CO_2 is quite unrealistic.

Our project's many years of analysis of the International Satellite Cloud Climatology Project (ISCCP) observations of IR loss to space in association with enhanced Cb convection and rainfall do not show a decreased IR blockage to space (as the models have indicated will occur) but rather an enhancement of IR loss to space. Our data analysis is, by contrast with the models, representation of a negative water-vapor feedback – the larger the rainfall rate, the lower the upper tropospheric water-vapor content and the greater the IR loss to space (Figure 6).

TROPICS (30°N-30°S; 0-360°)

Monthly (High – Low) Precipitation Values

Δ Rain (3.9%)							
(10 High) - (10 Low)	0	1	2	3	4	5	6
Avg. of each of 12 months	0-360	0-60E	60-120E	120E-180	180-120W	120-60W	60W-0
300 mb Temp. (°C)	0.02	0.13	0.27	0.23	(0.34)	(0.21)	0.02
Specific Humidity (q)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Relative Humidity (RH)	(1.66)	(1.34)	(2.33)	(1.73)	(0.41)	(1.20)	(2.69)

Δ Rain (2.0%)							
(95-04) - (84-94)	0	1	2	3	4	5	6
Avg. of each of 12 months	0-360	0-60E	60-120E	120E-180	180-120W	120-60W	60W-0
300 mb Temp. (°C)	0.16	0.26	0.24	0.11	(0.05)	0.13	0.25
Specific Humidity (q)	(0.03)	(0.02)	(0.03)	(0.05)	(0.04)	(0.02)	(0.04)
Relative Humidity (RH)	(3.92)	(2.84)	(3.53)	(4.84)	(3.83)	(3.24)	(5.23)

Figure 6. Changes in 300 mb temperature, specific humidity (q – gm/kg), and relative humidity (RH) by area between two reanalysis rainfall difference data sets for the tropics. Rain differences average 3.9 percent for the 10 highest minus 10 lowest monthly differences and 1.9 percent for the (95-04)-(84-94) data set differences. Negative values are in red. All 300 mb moisture parameters showed water-vapor and RH decreases with enhanced rainfall.

Real global warming to be expected. Without upper-troposphere water-vapor change and without enhanced surface evaporation cooling associated with extra rainfall, the pure radiation response to a doubling of CO_2 would indicate we should expect about a 1.0°C global warming. But even with zero assumed water-vapor change this 1°C warming is two to three times larger than what will likely take place. This is because about 60 percent of the 3.7 Wm^{-2} IR blocking to space from a doubling of CO_2 will be balanced by an enhancement of surface evaporation and an increase of the global hydrologic cycle by about $2\frac{1}{2}$ to 3 percent. A zero water-vapor feedback will thus be expected to only bring about a 0.4°C global temperature rise from CO_2 doubling.

We show that there is a very modest degree of negative water-vapor feedback of 0.1 to 0.2°C . With this occurring we should expect that the real amount of global warming that will occur from a doubling of CO_2 would be only about 0.2 - 0.3°C or about 5-10 percent the amount projected by the many global models of 2 - 4°C . The AGW threat and especially the catastrophic AGW (or CAGW) threat cannot be a realistic assertion of how the planet's climate system functions.

Author's Background. The author holds an MS (meteorology) and Ph.D. (geophysical sciences) from the University of Chicago. He has been a weather-climate forecaster, researcher, and university graduate school professor for 60 years. He has supervised 50 MS and 20 Ph.D. students. He originated and has been involved with Atlantic basin seasonal hurricane forecasting for the last 31 years.

Gray has never received any research funding from any fossil-fuel source. His position on the global warming issue has led in recent decades to loss of all federal research support he had previously received. His research on this topic continues only through his own funding.

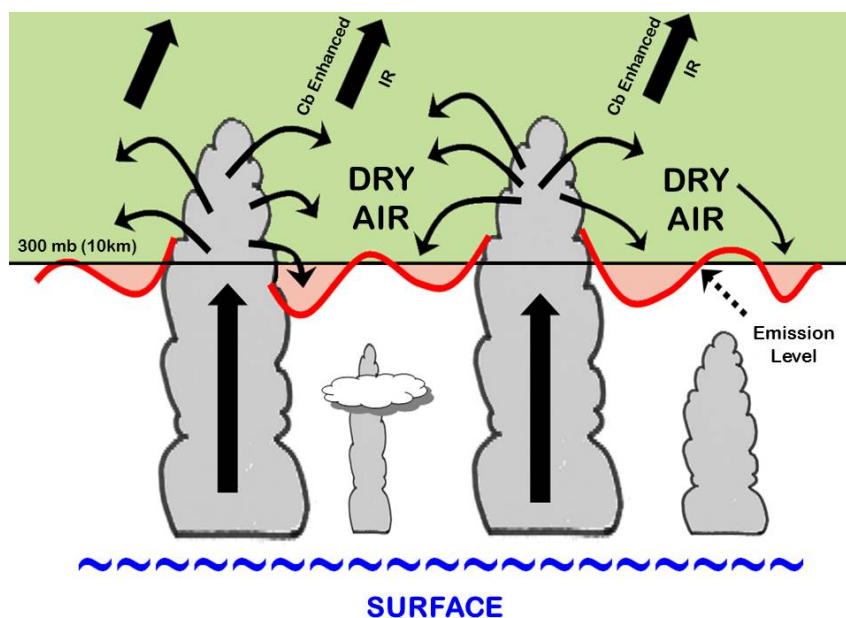


Figure 7. Idealized portrayal of how the outflow and sinking from the upper levels of Cb clouds generates upper-tropospheric drying and a general lowering of the infrared emission level (red line).

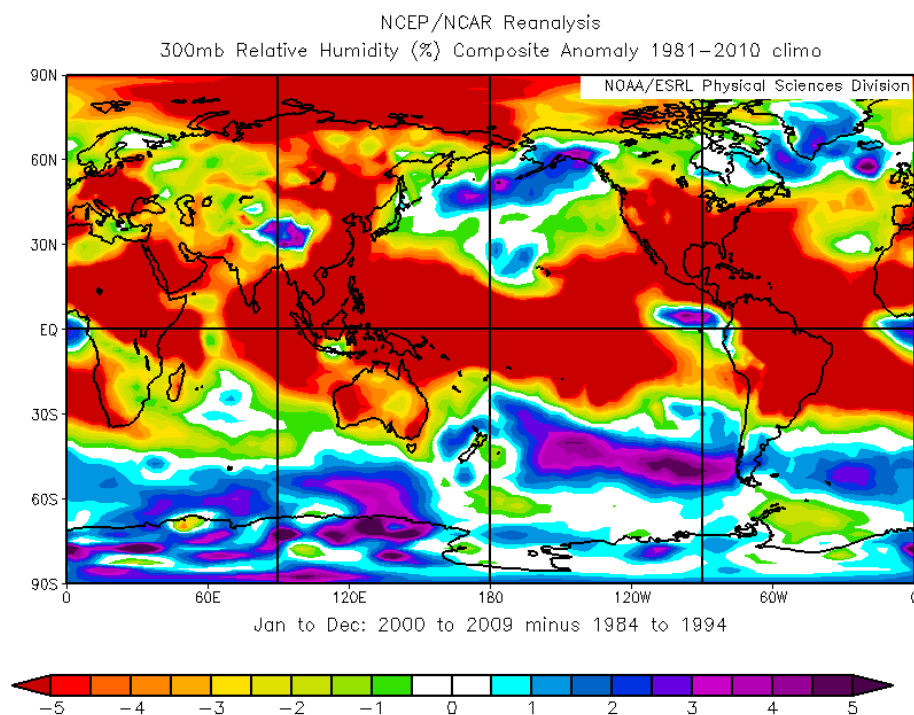


Figure 10. Average relative humidity (RH) decrease from (1984-1994) to (2000-2009) while global precipitation increased by 3 percent.

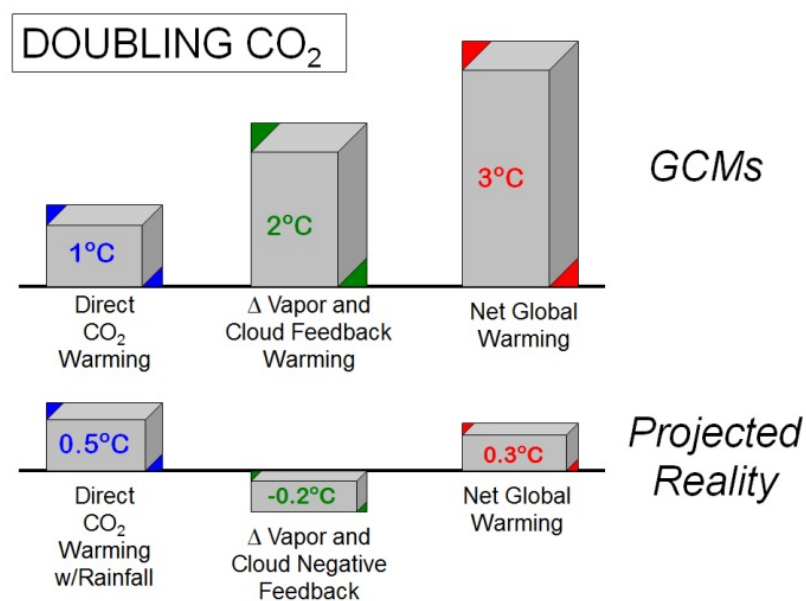


Figure 11. Contrast of what the GCMs give vs. what our observations indicate as to the likely global temperature changes which can be expected from a doubling of CO_2 .