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The Saturated Greenhouse Effect

By Ken Gregory June 2008

The paper,**Greenhouse Effect in Semi-Transparent Planetary Atmospheres** by Ferenc M. Miskolczi shows that the current greenhouse effect equations are incomplete because they do not include the correct boundary conditions. The new theory presented in Miskolczi's paper shows that the atmosphere maintains a “saturated” greenhouse effect, controlled by water vapor content.

Considering that we are told "the science is settled", one would think that the strength of the greenhouse effect (GHE) on Earth would be calculated based on atmospheric physics. That is, the computer models of the atmosphere would incorporate the physics of how the greenhouse effect works, so that by inputting some measured physical properties, the atmospheric gases, the models would determine the strength of the greenhouse effect and the surface temperatures. Unfortunately, this is not the case.

There is no physics, there are no equations in the models that determines the strength of the GHE. Parameters are just set to obtain the observed temperature.

The GHE is dominated by water vapour, so how it changes with increasing CO2 is critical.
All the General Circulation Models, also know as Global Climate Models (GCM) just set various evaporation and precipitation parameters to achieve approximately the result:

Relative humidity = constant.

This result is based on short term observations of temperature changes while CO2 concentrations were approximately constant, so they only hold true over periods when CO2 does not change much. It is invalid to extrapolate these observations to long term periods with increasing CO2. The modellers just assume relative humidity is also constant while CO2 concentrations change.

There is no physics in support of this assumption, and no way to calculate its value from first principles. This assumption means that if temperatures increase for any reason, the amount of water vapour in the atmosphere increases. But water vapor is the most important greenhouse gas, so the GHE becomes stronger and temperatures increase more. The current theory does not determine this - it is only an assumption. If this assumption is only slightly wrong, it completely changes the expected response of increasing CO2 because water vapour is such a dominant greenhouse gas.

The assumption, that relative humidity is constant when CO2 concentrations increase, is completely absurd. This violates fundamental energy conservation laws. There are not separate energy balance equations for different greenhouse gases. There is not one set for water vapor, and a different set for CO2; there is one set of energy balance equations for the total atmosphere including all greenhouse gases. So it makes no sense to assign an arbitrary rule for one of the greenhouse gases.
There is a near infinite supply of greenhouse gases available to the atmosphere in the form of water vapor from the ocean to provide the greenhouse effect, but the relative humidity in the atmosphere is much less than one. Therefore, there **must** be some greenhouse equilibrium mechanism to control the strength of the greenhouse effect and the relative humidity. Otherwise, climate would be very unstable.

The global average relative humidity at the surface is about 78%. It generally decreases with altitude and is about 37% at an altitude where the atmospheric pressure is 300 millibars (mb). Relative humidity is the fraction of water vapour in a small parcel of air relative to the total amount of water vapour the air could contain at the given temperature and pressure. So why isn't the relative humidity 90%, or vary randomly? Relative humidity is at its current value because it is controlled by the laws of physics.

Specific humidity is the total mass of water vapor in a parcel of air divided by the mass of the moist air. Warmer air can hold more water vapor, so specific humidity increases with temperature.

If some temporary disturbance adds a large amount of greenhouse gases into the atmosphere, temperatures will temporarily increase, as it did in 1998 due to the super El Nino. If it is true that a temperature rise will cause more water vapor, which will cause more temperature rise, and more water vapor yet again, one would expect temperatures to continue to rise after 1998, and result in a run-away effect. But the opposite happened; temperatures fell as the greenhouse equilibrium mechanism restored the balance. The extra greenhouse gases rained out to restore the equilibrium.

The new Miskolczi theory describes this missing greenhouse equilibrium mechanism. He shows that the classical theory does not include all the necessary energy constraints. When these constraints are included in a new theory, the strength of the GHE is determined analytically. The result shows that the Earth's atmosphere is maintained at a nearly saturated greenhouse effect. Detailed calculation show that the greenhouse sensitivity to a doubling CO2 is about 0.24 K.

This greenhouse equilibrium mechanism doesn't care if an initial increase of greenhouse gases was water vapor or CO2. If somehow we suddenly released an amount of CO2 to the atmosphere equal in GHG effect of the 1998 El Nino water vapor, the temperature effect would be the same. Temperatures would increase by 0.6 Celsius, but would fall within a year to the original temperature, as the greenhouse equilibrium mechanism restores the greenhouse strength to the equilibrium value by raining out the excess greenhouse gases. Adding man-made CO2 to the atmosphere just rains out almost an equivalent amount of water vapor.

Current theory is based on the energy balance assumption that the total out-going long wave-length radiation is equal to the net incoming short wave radiation (net of albedo).
The most important of Miskolczi's innovations are:

- There is an energy balance between the emission from the ground that is absorbed by the atmosphere and the downward radiation from the atmosphere. He uses Kirchhoff's law, which is a law concerning thermal equilibrium, not to be confused with radiative equilibrium.

- He applies the Virial Theorem to the atmosphere, which states that the kinetic energy of a system is half of the potential energy. The internal kinetic energy is taken as the upward long wave energy flux at the top of the atmosphere, and the potential energy is the upward radiation flux from the surface. This result is used to determine the fraction of the upward radiation from the surface that is transmitted directly to space (rather than absorbed by the atmosphere), which is 1/6.

He uses Kirchhoff's law and the two energy balances (ground to lower atmosphere, upper atmosphere to space) to derive the result: The long wave upward radiation from the surface is limited to 1.5 times the short wave downward radiation from the Sun. This limits the temperature to very close to the current temperature. Therefore, Miskolczi concludes that almost all of the global warming of the last century must have been due to changes of the Sun or albedo. The Earth's atmosphere, satisfying the energy minimum principle, is configured to the most effective cooling of the planet with an equilibrium global average vertical temperature and moisture profile.

The current theory does not assume an energy balance between the surface and the lower atmosphere, and allows the upward radiation from the surface to be twice the short wave downward radiation from the Sun. Also, the current theory gives a large discontinuity between the surface temperature and the air temperature at the surface. This problem is corrected by ad hoc adjustments. The new Miskolczi theory assumes in its formulation that these temperatures are equal.

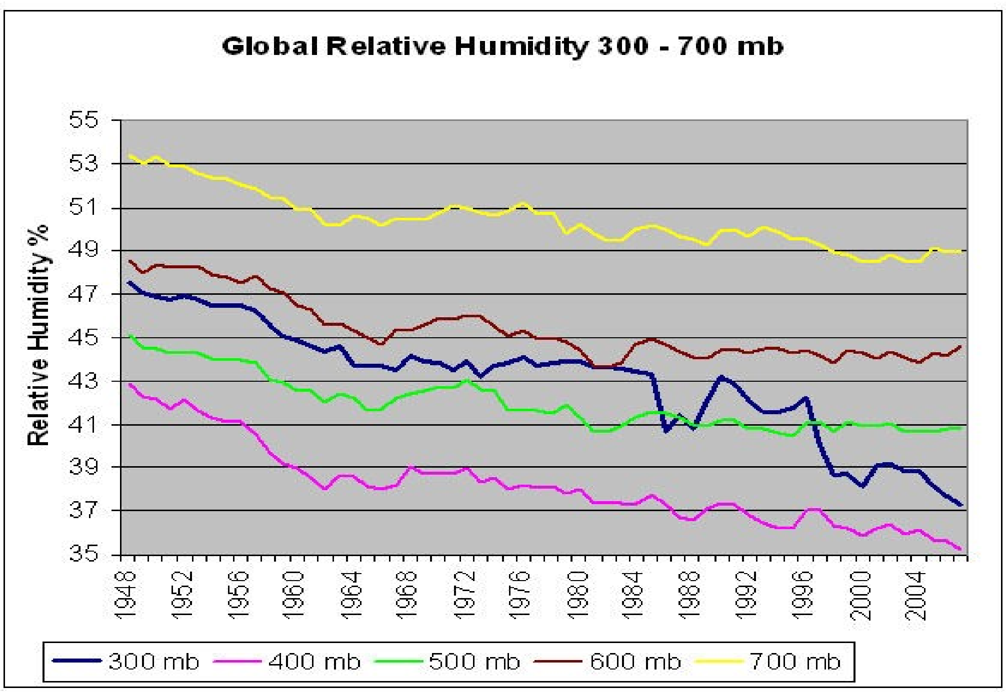
Miskolczi also provides empirical evidence of the two laws he applies (Krichhoff's law and Virial Theorum) for both the Earth and Mars.

Physicist Miklos Zagoni says, "It is nonsense to think that a system 'waits' for our CO2-emissions to elevate its temperature if otherwise the energetic conditions make possible to rise and the necessary resort (a practically infinite reservoir of greenhouse gases in the form of water vapor in the oceans) is at its hands."

Adding some greenhouse gases (CO2) to a near infinite supply of greenhouse gases in the form of water vapour available to the atmosphere has negligible effect.

The new theory implies that adding CO2 to the atmosphere would reduce the relative humidity, contrary to climate model assumptions. So, has relative humidity been falling with increasing CO2 concentrations?

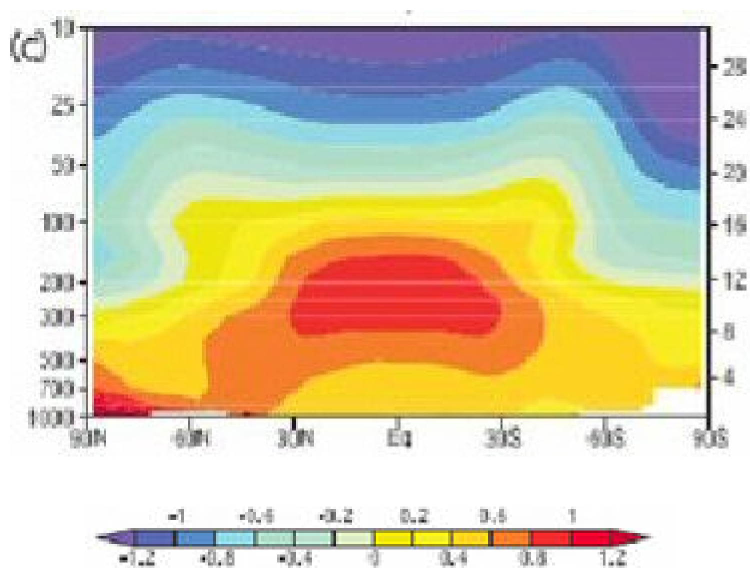
Here is a graph of global average annual relative humidity at various elevations in the atmosphere expressed in milli-bars (mb) from 300 mb to 700 mb for the period 1948 to 2007. The data is from the NOAA Earth System Research Laboratory here.



This graph shows that the relative humidity has been dropping, especially at higher elevations allowing more heat to escape to space. The curve labelled 300 mb is at about 9 km altitude, which is in the middle of the predicted (but missing) tropical troposphere hot-spot. This is the critical elevation as this is where radiation can start to escape without being recaptured. The average annual relative humidity at this altitude has declined by **21.5%** from 1948 to 2007!

Existing computer models forecast that the warming trend due to increasing CO2 concentrations will be greater in the troposphere in the tropics than at the surface. The graph below from the International Panel on Climate Change (IPCC) Fourth Assessment Report (4AR) shows the predicted tropical troposphere hot-spot at 8 to 12 km altitude as a distinctive red area. The vertical right hand scale is altitude in km, and the left hand scale is atmospheric pressure in mb. The horizontal axis is latitude with the equator (Eq) in the middle. The colours represent the predicted warming trend in Celsius per decade based on the assumption that relative humidity is constant.

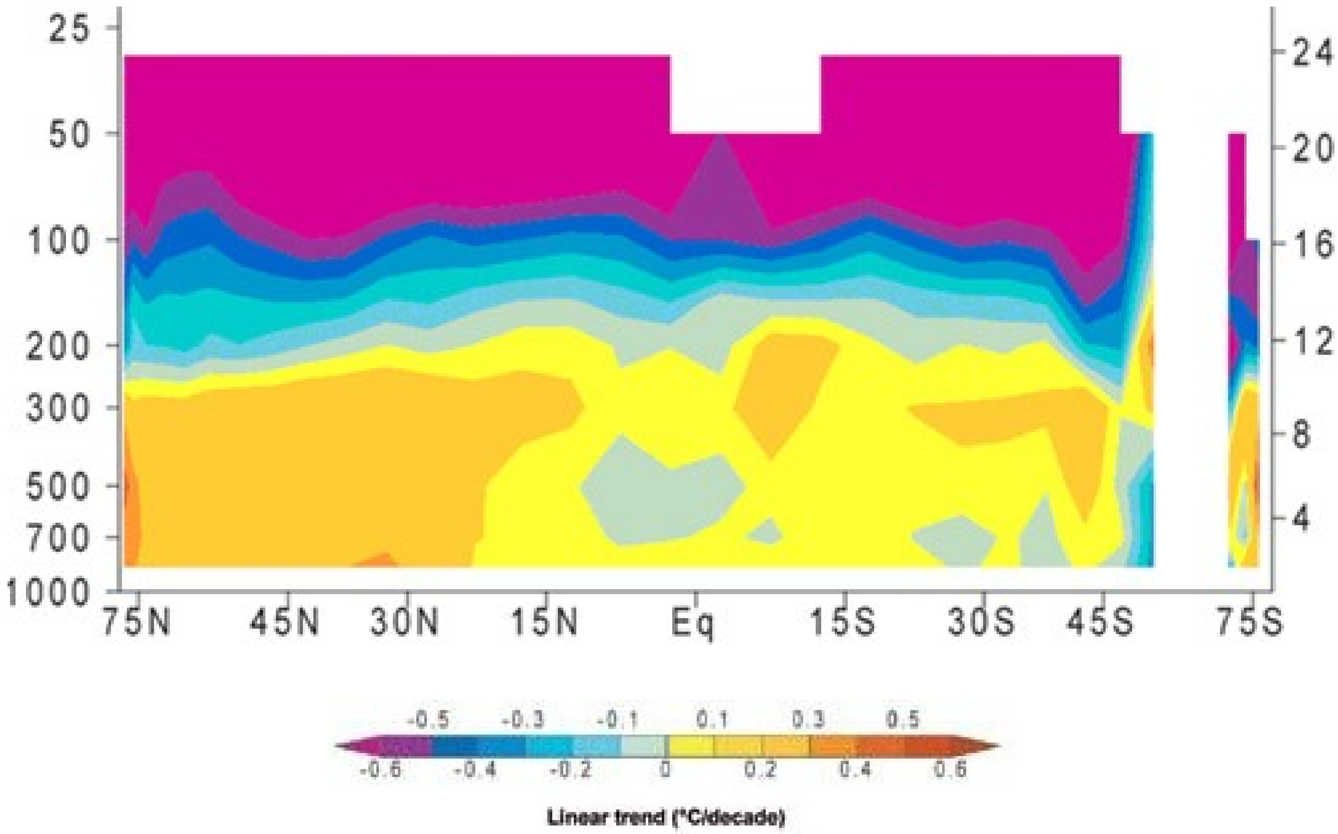
Forecast Temperature Trend from CO2 - IPCC 4AR



Linear trend (Celsius/decade)

However, the Hadley Centre's real-world plot of radiosonde temperature observations shown below does not show the projected CO2 induced global warming hot-spot at all. The predicted hot-spot is entirely absent from the observational record.

Actual Temperature Trend HadAT2 Radiosonde Data 1979 - 1999



The mystery of the missing hot spot is solved by the Miskolczi greenhouse effect theory and confirmed by the declining relative humidity, especially at the altitude of the predicted hot spot. The declining relative humidity reduces the temperature compared to the model projections so there is no hot spot. The GCM assumption of constant relative humidity is wrong and is yet another proof that the climate predictions of the IPCC are wrong.

A NASA study from here says:

A NASA-funded study found some climate models might be overestimating the amount of water vapor entering the atmosphere as the Earth warms. They found the increases in water vapor were not as high as many climate-forecasting computer models have assumed. In most computer models relative humidity tends to remain fixed at current levels. "The increases in water vapor with warmer temperatures are not large enough to maintain a constant relative humidity," Minschwaner said.

Dr. Roy Spencer's article Global Warming and Nature's Thermostat here , describes the role of precipitation systems in controlling the greenhouse effect. It is an extension of Richard Lindzen's "Infrared Iris" hypothesis. Dr. Spencer says we don't know why the greenhouse effect is limited to its current value.

Miskolczi provides the detailed explanation of why the greenhouse effect is limited to its current value for a constant external Sun forcing. Adding CO_2 to the atmosphere just replaces an equivalent amount of water vapour to maintain a constant greenhouse effect. This would have negligible effect on global temperatures.

The global warming the Earth has experienced over the twentieth century is mostly due to the Sun, including the Sun's effects on clouds via cosmic rays. Increasing Sun activity adds to the greenhouse effect by increasing the specific humidity; increasing CO_2 concentration in the atmosphere does not. The actual 20th century warming results may be considered the sum of two processes:

1. Solar forcing increase with constant CO_2; plus,
2. Increasing CO_2 concentration with constant solar forcing

1. An increase of the Sun's radiation input net of albedo with no change in CO_2 concentrations would cause no change to relative humidity. Global temperatures would increase causing an increase in specific humidity with the greenhouse effect (in W/m2) increasing by one-half of the solar input change (also in W/m2).

2. An increase of CO_2 with constant net solar radiation causes relative humidity to fall, especially at the 400 mb and 300 mb level, as this is at the characteristic emission level. Changes of humidity near the surface has little effect on the strength of the greenhouse effect as the high water vapor content already captures most of the long wave-length radiation, so relative humidity would not change much near the surface. The CO_2 replaces water vapour to maintain a constant greenhouse effect, so global temperature changes would be negligible.

The sum of these two processes describe the 20th century warming results. Specific humidity has increased at lower altitudes, but has decreased at high altitudes. The decreasing relative humidity (especially at 300 and 400 mb levels) almost totally offsets the GHE of increasing CO_2 content. The warming was caused by the increased solar forcing amplified by a positive water vapour feedback.

The Sun has recently become quiet resulting in declining global temperatures since 2002 despite increasing CO_2 content in the atmosphere.

A summary of the Miskolczi theory by Miklos Zagoni is here.
A four part critique by David Stockwell is here.

Reference:
Ferenc M. Miskolczi, "Greenhouse Effect in Semi-Transparent Planetary Atmospheres", Quarterly Journal of the Hungarian Meteorological Journal, Vol. 111, No. 1, January - March 2007. [Alternate link here.]

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