

Clouds Have Made Fools of Climate Modelers

By Ken Gregory June 2009

Climate models used by the International Panel on Climate Change (IPCC) assume that clouds provide a large positive feedback, greatly amplifying the small warming effect of increasing CO₂ content in air. Clouds have made fools of climate modelers. A detailed analysis of cloud behavior from satellite data by Dr. Roy Spencer of the University of Alabama in Huntsville shows that clouds actually provide a strong negative feedback, the opposite of that assumed by the climate modelers. The modelers confused cause and effect, thereby getting the feedback in the wrong direction.

Climate sensitivity to increasing CO₂ concentrations is usually expressed as the equilibrium change in temperature resulting from a doubling of the CO₂ content in air. By itself, CO₂ has only a small effect on global temperatures if nothing else changed. Doubling the CO₂ content is calculated to cause only a 1.1 °C (IPCC 2007) temperature increase, if water vapour, clouds and albedo did not change. This is the no-feedback case. Climate models multiply the IPCC no-feedback change by 3 or more times by using positive feedbacks. The second largest feedback used in climate models (after water vapour) is an assumed positive feedback from clouds. If a small CO₂ induced temperature rise caused a reduction in low clouds, this would be a positive feedback as fewer clouds would let more sunlight through to warm the surface, resulting in a further temperature rise.

The modelers only do crude analysis of feedback from satellite data, by correlating temperature variation with the Earth's radiation balance, which is the difference between the absorbed incoming solar radiation and the outgoing longwave radiation. They also observe that low clouds tend to decrease with warming and assumed that the warming caused the low clouds to decrease. There are generally fewer clouds in summer than winter, allowing more sunlight through to warm the Earth. But cloud changes also cause temperatures to change. When a cloud moves to block the Sun, temperatures fall. The amount of clouds can change in response to a general circulation change. So cloud changes are partly a *cause* of temperature change, and partly an *effect* of temperature change. The false assumption that all cloud changes are the effect of temperature changes led modelers to vastly over estimate the feedback from clouds.

Dr. Roy Spencer has developed a method to separate cause and effect of cloud variability. His technique is to plot yearly and quarterly average temperature and net flux readings from satellite data on a graph. These averages are plotted every day allowing the time evolution to be visualized. He found that the plots have two types of patterns – a set of linear striations with a common slope, and superimposed slower random spiral patterns.

To understand these patterns, Spencer has developed a simple computer model where he can specify the amount of feedback, and can input radiative forcing that might be caused by random cloud changes. The model shows that the slope of the linear striations corresponds to the feedback in the climate system. These striations are due to changes in evaporation and precipitation which causes temperature

changes. The spiral patterns are caused by radiative forcing that might be due to changing the low cloud cover which varies the solar radiation warming the surface.

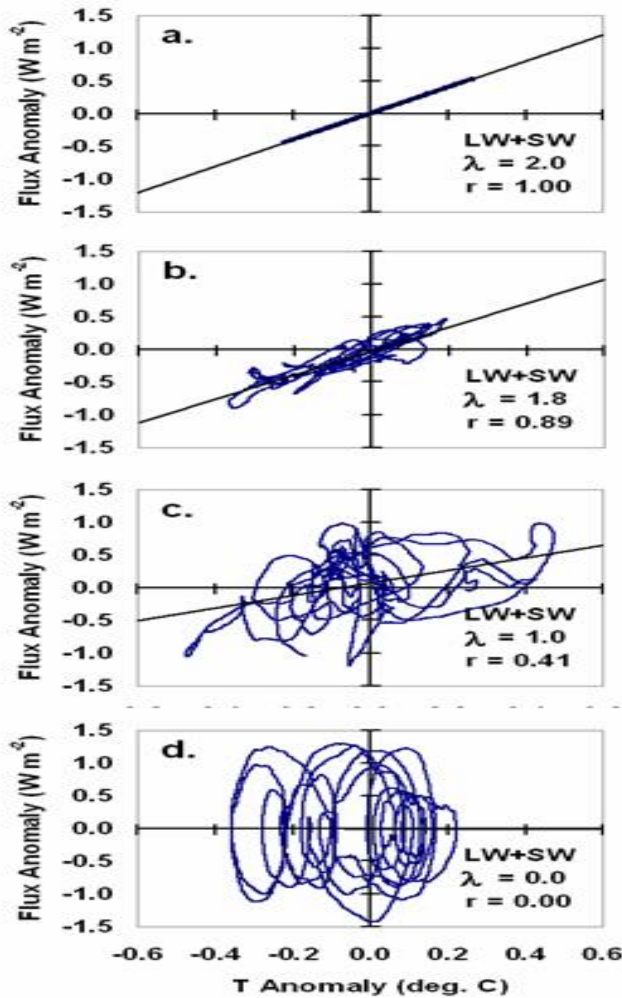


Figure 1. Simple model with 2 types of forcing.

Panel (a) of the above chart shows temperature changes due to only evaporation and precipitation (Spencer calls this non-radiative forcing), and gives a perfect feedback signal, with the temperature and the net radiation flux falling on a straight line. The slope of the line gives the strength of the feedback signal. When increasing amount of radiative forcing is added in panels (b) and (c), the spiral patterns appear and the slope of the best fit lines decrease. Panel (d) shows the result with 100% radiative forcing, and the slope falls to zero, even though the same feedback of 2 Watts/metre squares (W/m²) is specified in all four panels. The zero slope would usually be interpreted as an unstable, highly sensitive climate, or very high positive feedback. The spiral patterns are due to random changes in radiative forcing which simulates the effects of random cloud variability. To the extent that natural cloud variations are occurring, the usual interpretation by a best fit line would result in a much too high positive feedback, even when negative feedback is operating in reality.

Spencer has analyzed the temperature-radiative patterns of two satellites; the NASA Aqua satellite and the NASA Terra satellite. The Terra data starts in March 2000, and its temperature-radiative plot is shown below.

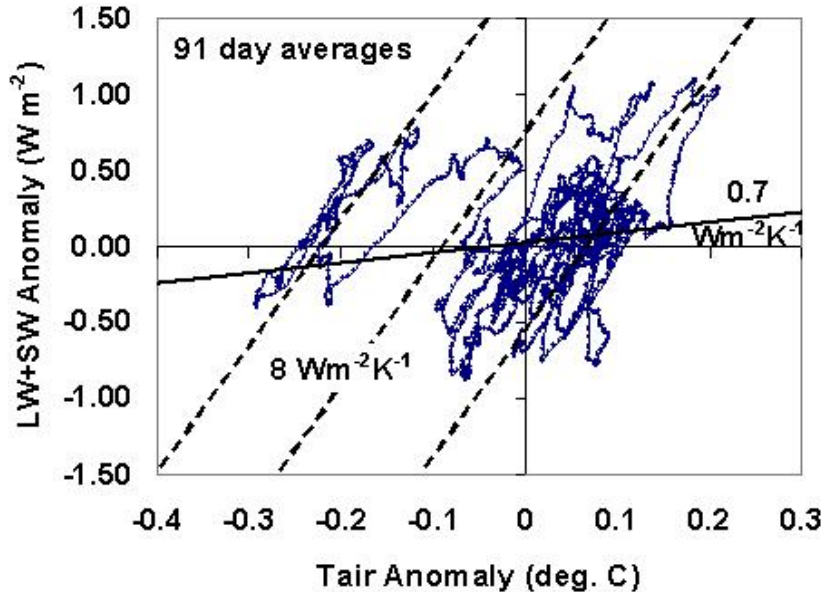


Figure 2. Terra CERES radiative flux versus tropospheric temperature variations.

The plot shows two types of patterns; linear striations and random spiral patterns. The usual interpretation of this data by climate modelers would be to use the best fit line which shows a slope of $0.7 \text{ W/m}^2/\text{C}$, which is a very high positive feedback. The actual feedback should be determined by the slope of the linear striations, which is $8 \text{ W/m}^2/\text{C}$, which is a very high negative feedback. A value of $3.3 \text{ W/m}^2/\text{C}$ corresponds to no feedback. (This means if the temperature of the atmosphere were uniformly increased by 1 C and nothing else changed, the top of the atmosphere would radiate 3.3 W/m^2 more radiation to space.) The feedback is observed to occur on shorter time scales in response to evaporation and precipitation events, which are superimposed upon a more slowly varying background of radiative imbalance due to natural fluctuation in cloud cover changing the rate of solar heating Earth's surface.

The satellite data shows that over short time scales, clouds provide strong negative feedbacks. Spencer also analyzed the radiative flux and temperature variations from climate models used by the IPCC to determine if the short term negative feedback found in the satellite data is also applicable to long term feedback. He found that the short term linear striations and the spiral patterns show up all 18 climate models that he analyzed.

Spencer says the slopes of the linear striations do indeed correspond to the long term feedbacks diagnosed from these models' response to anthropogenic greenhouse gas forcing. This strongly

suggests that the short term negative feedback shown in satellite data also applies to long term global climate change. The figure below shows the results from the GFDL climate model.

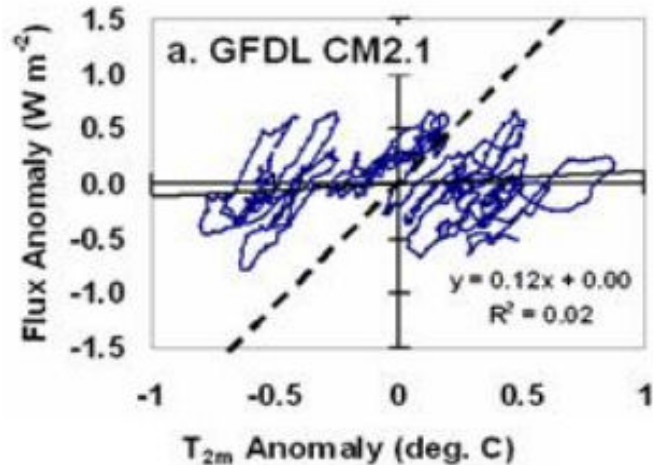


Figure 3. Sixty years of global average variations of temperature versus infrared radiation flux from the GFDL climate model.

Spencer says, " The comparisons modelers make between their models and satellite data are typically rather crude and cursory. They are not sufficiently detailed to really say anything of substance about feedbacks. The main reason for the current inadequacy of such methods of comparison between models and observations is the contaminating effect of clouds causing temperatures to change (forcing) when trying to estimate how temperatures cause clouds to change (feedback)."

The feedback estimate for a hypothetical doubling of carbon dioxide, using the IPCC estimate of CO₂ forcing of 3.71 W/m², and the feedback determined from the Terra satellite data of 8 W/m²/C from Figure 2 gives a climate sensitivity of 0.46 C (3.71/8).

For further information, see "On the diagnosis of radiative feedback in the presence of unknown radiative forcing" by Roy W. Spencer and William Braswell, Journal of Geophysical Research 2010.
<http://www.drroyspencer.com/wp-content/uploads/Spencer-Braswell-JGR-2010.pdf>
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