

Increasing Atmospheric CO₂: Manmade...or Natural?

January 21st, 2009 by Roy W. Spencer, Ph. D.

I've usually accepted the premise that increasing atmospheric carbon dioxide concentrations are due to the burning of fossil fuels by humans. After all, human emissions average around twice that which is needed to explain the observed rate of increase in the atmosphere. In other words, mankind emits more than enough CO₂ to explain the observed increase in the atmosphere.

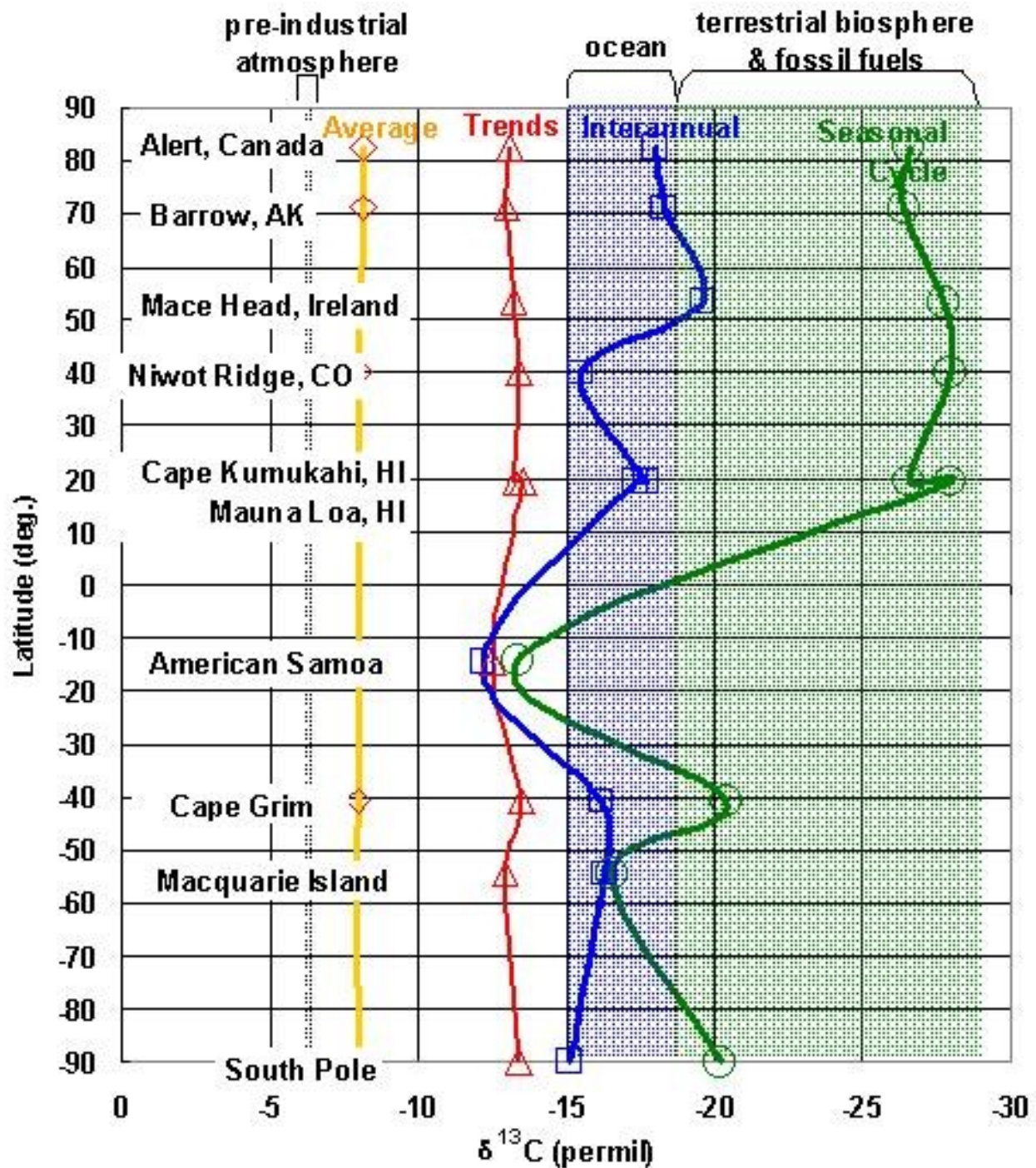
Furthermore, the ratio of the C¹³ isotope of carbon to the normal C¹² form in atmospheric CO₂ has been observed to be decreasing at the same time CO₂ has been increasing. Since CO₂ produced by fossil fuel burning is depleted in C¹³ (so the argument goes) this also suggests a manmade source.

But when we start examining the details, an anthropogenic explanation for increasing atmospheric CO₂ becomes less obvious.

For example, a decrease in the relative amount of C¹³ in the atmosphere is also consistent with other biological sources. And since most of the cycling of CO₂ between the ocean, land, and atmosphere is due to biological processes, this alone does not make a decreasing C¹³/C¹² ratio a unique marker of an anthropogenic source.

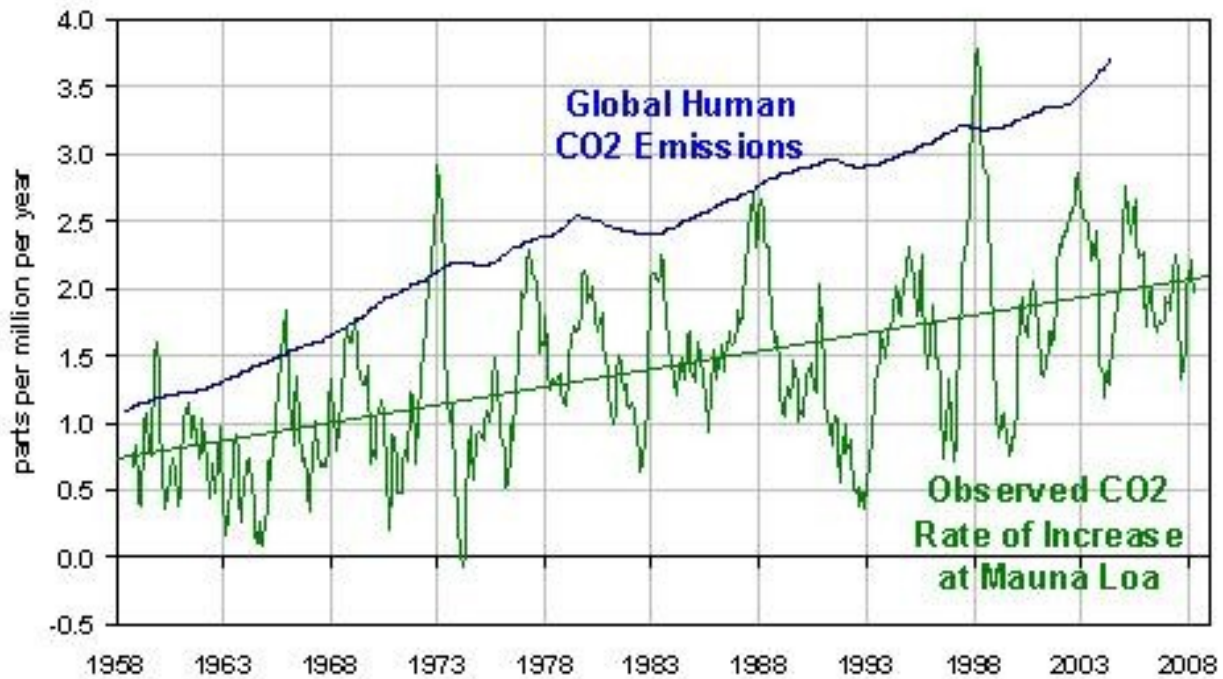
This is shown in the following figure, which I put together based upon my analysis of C¹³ data from a variety of monitoring stations from the Arctic to the Antarctic. I isolated the seasonal cycle, interannual (year-to-year) variability, and trend signals in the C¹³ data.

The seasonal cycle clearly shows a terrestrial biomass (vegetation) source, as we expect from the seasonal cycle in Northern Hemispheric vegetation growth. The interannual variability looks more like it is driven by the oceans. The trends, however, are weaker than we would expect from either of these sources or from fossil fuels (which have a C¹³ signature similar to vegetation).



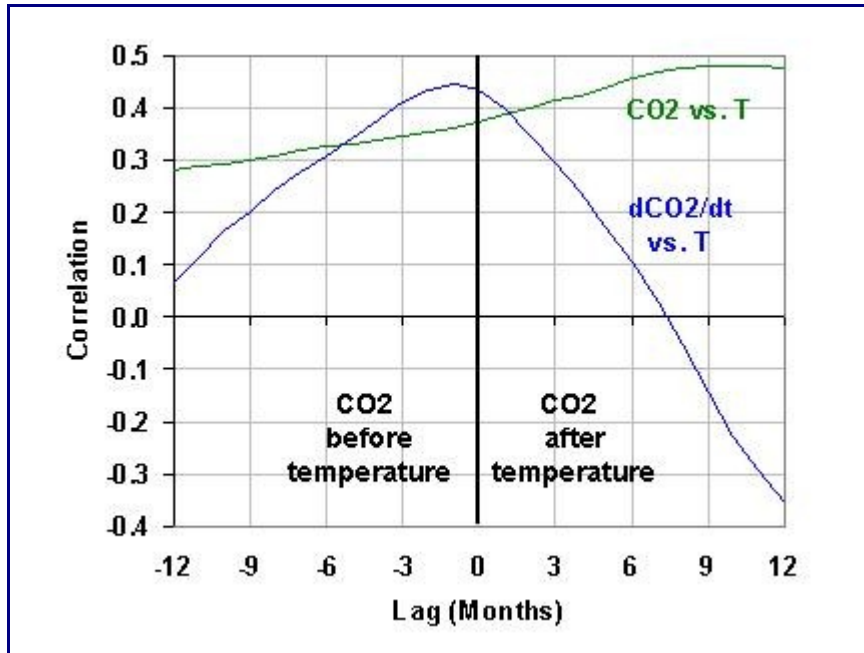
C13/C12 isotope ratios measured at various latitudes show that CO2 trends are not necessarily from fossil fuel burning.

Secondly, the year-to-year increase in atmospheric CO2 does not look very much like the yearly rate of manmade CO2 emissions. The following figure, a version of which appears in the IPCC's 2007 report, clearly shows that nature has a huge influence over the amount of CO2 that accumulates in the atmosphere every year.



The yearly increase of CO₂ measured at Mauna Loa shows huge natural fluctuations which are caused by temperature changes.

In fact, it turns out that these large year-to-year fluctuations in the rate of atmospheric accumulation are tied to temperature changes, which are in turn due mostly to El Nino, La Nina, and volcanic eruptions. And as shown in the next figure, the CO₂ changes tend to follow the temperature changes, by an average of 9 months. This is opposite to the direction of causation presumed to be occurring with manmade global warming, where increasing CO₂ is followed by warming.



Year to year CO₂ fluctuations at Mauna Loa show that the temperature changes tend to precede the CO₂ changes.

If temperature is indeed forcing CO₂ changes, either directly or indirectly, then there should be a maximum correlation at zero months lag for the change of CO₂ with time versus temperature ($dCO_2/dt = a + b \cdot T$ would be the basic rate equation). And as can be seen in the above graph, the peak correlation between these two variables does indeed occur close to zero months.

And this raises an intriguing question:

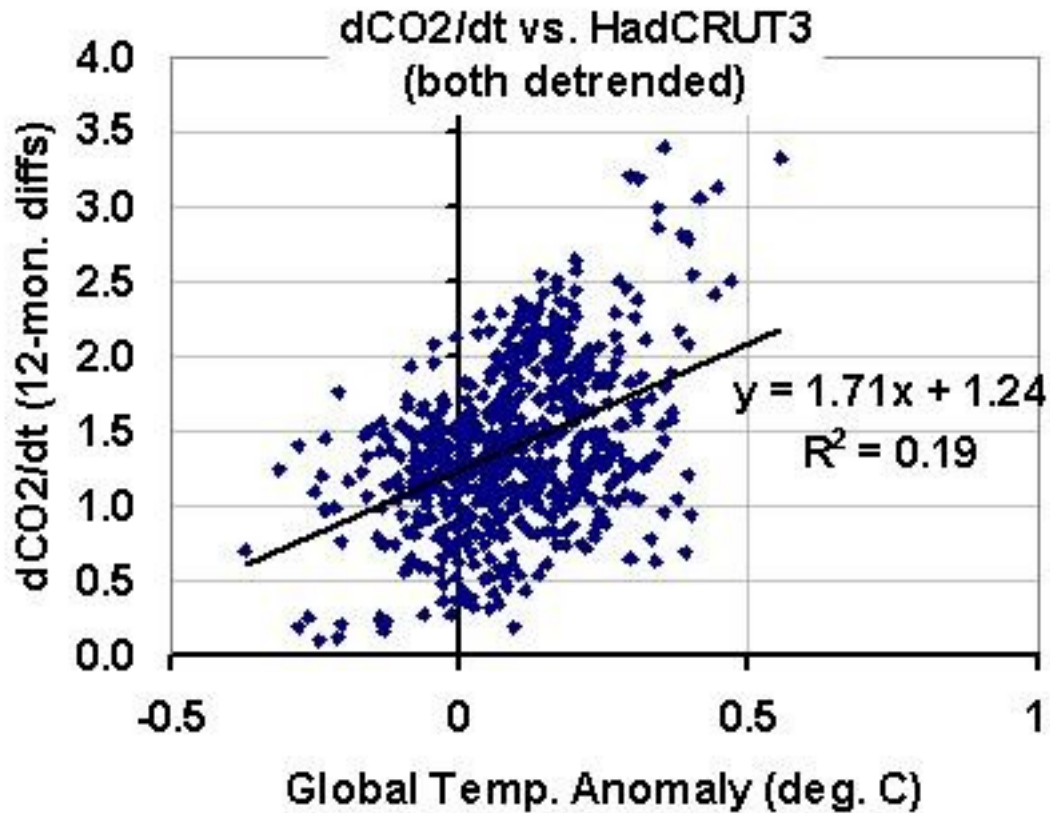
If natural temperature changes can drive natural CO₂ changes (directly or indirectly) on a year-to-year basis, is it possible that some portion of the long term upward trend (that is always attributed to fossil fuel burning) is ALSO due to a natural source?

After all, we already know that the rate of human emissions is very small in magnitude compared to the average rate of CO₂ exchange between the atmosphere and the surface (land + ocean): somewhere in the 5% to 10% range. But it has always been assumed that these huge natural yearly exchanges between the surface and atmosphere have been in a long term balance. In that view, the natural balance has only been disrupted in the last 100 years or so as humans started consuming fossil fuel, thus causing the observed long-term increase.

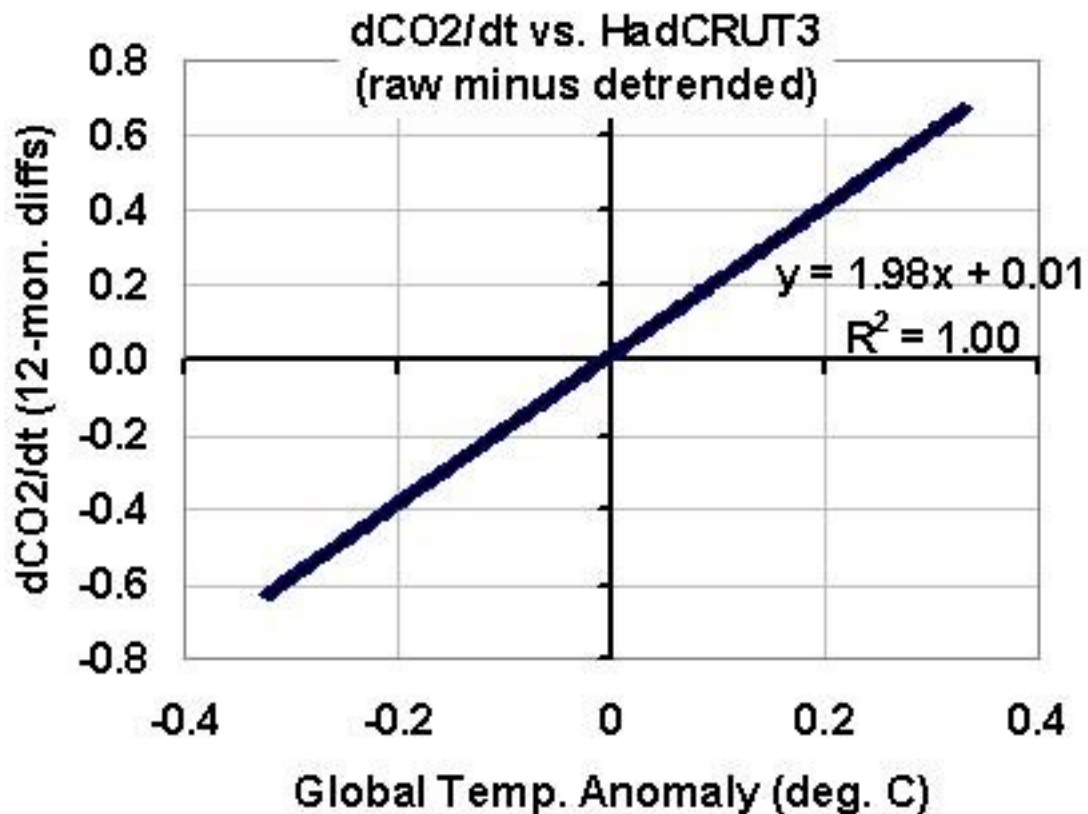
But since the natural fluxes in and out of the atmosphere are so huge, this means that a small natural imbalance between them can rival in magnitude the human CO₂ input. And this clearly happens, as is obvious from the second plot shown above!

So, the question is, does long-term warming also cause a CO₂ increase, like that we see on in the short term?

Let's look more closely at just how large these natural, year-to-year changes in CO₂ are. Specifically, how much CO₂ is emitted for a certain amount of warming? This can be estimated by detrending both the temperature and CO₂ accumulation rate data, and comparing the resulting year-to-year fluctuations (see figure below).



Although there is considerable scatter in the above figure, we see an average relationship of 1.71 ppm/yr for every 1 deg C. change in temperature. So, how does this compare to the same relationship for the long-term trends? This is shown in the next figure, where we see a 1.98 ppm/yr for every 1 deg. C of temperature change.



This means that most ($1.71/1.98 = 86\%$) of the upward trend in carbon dioxide since CO2 monitoring began at Mauna Loa 50 years ago could indeed be explained as a result of the warming, rather than the other way around.

So, there is at least empirical evidence that increasing temperatures are causing some portion of the recent rise in atmospheric CO2, in which case CO2 is not the only cause of the warming.

Now, the experts will claim that this is all bogus, because they have computer models of the carbon budget that can explain all of long term rise in CO2 as a result of fossil fuel burning alone.

But, is that the ONLY possible model explanation? Or just the one they wanted their models to support? Did they investigate other model configurations that allowed nature to play a role in long term CO2 increase? Or did those model simulations show that nature couldn't have played a role?

This is the trouble with model simulations. The ones that get published are usually the ones that support the modeler's preconceived notions, while alternative model solutions are ignored.

If an expert in this subject sees a major mistake I've made in the above analysis, e-mail me and I'll post an update, so that we might all better understand this issue.

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