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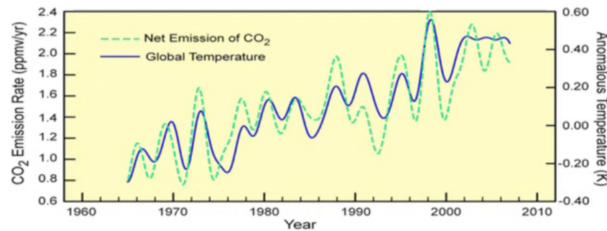
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The SALBY Hamburg conference: is CO2 the integral of temperature?

In this post I will reflect on the relationship between observed CO2 increase in the atmosphere and its relation to global temperature increase. Here I really can not quite see eye into eye with Prof. Salby. First a note on terminology, which is regrettably imprecise: when Salby speaks of temperature, he means temperature anomaly ΔT ; net CO2 emission is taken as the atmospheric mixing ratio in ppmV and the rate r as ppmV/year

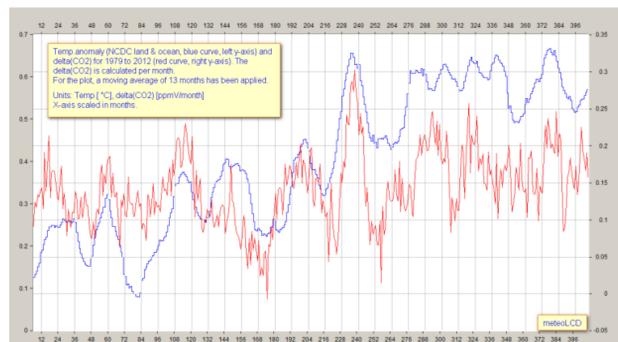
1. Time series CO2 and global temperature anomaly.

In a first graph, Salby shows (and says so) that CO2 annual variations are proportional to the annual variations of ΔT :



In this graph, ΔT (Anomalous Temp) effectively seems to follow the pattern of the CO2 emission rate (= yearly mixing ratio variation) EXCEPT during the last period from 2001 where clearly the relationship has changed. It is regrettable that Salby has not insisted on this departure from the usual pattern.

Let us check this graph using as in the previous post the MLO CO2 data from 1979 to 2012 and the NCDC land+ocean global temperature anomalies for the same period. A moving average of 13 months is applied before plotting.



There is quite a difference between the two figures; it seems that the CO2 data have been heavily smoothed in Salby's plot; probably he also used yearly data only, and not monthly ones.

2. The proportionality of CO2 rate to the integral of temperature anomaly.

Salby says that the CO2 molecules emitted into the atmosphere (by both natural and human sources) will stay there for a very long time. In that case the net emission rate per year is equal to the $\Delta(\text{CO}_2)$ derived from atmospheric measurements. As he says that global temp. anomalies are (linearly) correlated to $\Delta(\text{CO}_2)$, this assumption gives the following relations (where the second is simply the mathematical conclusion from the first):

$$\frac{dr_{\text{CO}_2}}{dt} = \gamma \cdot (T_s - T_{s0}),$$

\uparrow Temperature Sensitivity

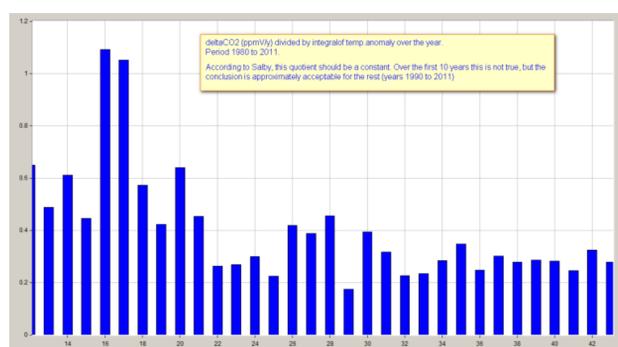
$$r_{\text{CO}_2}(t) - r_{\text{CO}_2}(0) = \gamma \int_0^t (T_s - T_{s0}) dt'$$

The oral explanations that Salby gives of the last (rather trivial) relation are a bit confusing; I listed carefully several times, but do not quite get the point when he explains the integral with the notion of "sum".

To check this last relation, I will assume that the initial rate r is zero. Here are the steps of my calculations:

- the available monthly data series are divided into chunks of 12 months.
- from the CO2 data, compute the annual mean, and then the yearly Δ (which reduces the 34 years period to 32 years, 1980-2011; this reduction comes from the use of the DADISP delay function).
- from the temperature anomaly chunks, compute the sum for each year, which is the integral over that year
- now divide the $\Delta(\text{CO}_2)$ data by the sums, which should give the "constant" temperature sensitivity γ .

Here is the figure with the results:



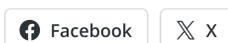
If we look at the full period, clearly the first 10 years (1980-1989) fall out. But restricting the computation to the last part (years 1990 to 2011) gives a "reasonable" constant sensitivity varying between 0.2 and 0.4 (unit is (ppmV/y)/(K)).

3. Conclusion

The assumption about the linear correlation between $\Delta(\text{CO}_2)$ and temp. anomaly should be taken with a grain of salt (better with quite a lot of grains!). As a consequence temperature sensitivity does not seem a constant over longer periods, and this parameter should be handled like a hot potato. As many authors have speculated, the atmosphere is too complicated to be content with proportionalities i.e. linear relationships!

26 June 2013: some minor housekeeping in the text.

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