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Discussions

Interactive comment on "Estimates of climatic influence on the carbon cycle" *by* Ian Enting and Nathan Clisby

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In our paper, equation (4) follows directly from equation (3) by using the relation $p\,r(p) = 1/(1+\beta(p))$ since these are both expressions for the airborne fraction (for growth with timescale p).

Equation (4) is also a direct generalisation of the relation which was defined by Friedlingstein et al. (2004) and is used extensively in interpretation of modelling calculations.
Apart from its relation to a widely-used formalism, in our view it is a reasonable process-oriented approach for describing the system. However, the formalism is less directly related to what can be observed. The relation between the process description and

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observations is the reason for some of the mathematical complexity.

Referee 2 is entirely correct in noting that we work from equation (3) and make no use of equation (4). However, the vast majority of studies of climate-to-carbon feedback are framed in terms of a restricted form of equation (4) and so we think it is important to note the connection.

One can factor in the warming from industrial CO_2 emissions and reduce equation (4) to the special case

$$q(p) = \frac{s(p)/p}{[1+\beta(p)][1-g(p)]}$$

However, this only applies if ALL the temperature variation is due to anthropogenic CO_2 emissions. We think that this assumption is unjustified. Our analysis of the pre-industrial period assumes that NONE of the pre-industrial temperature change and CO_2 variation was due to anthropogenic emissions. (Other studies have proposed a pre-industrial anthropogenic influence. The formalism of equation (4) could be used to explore such proposals.)

For the early 20th century, we want to keep open the possibility that some of the warming may not be due to CO_2 and so keep the terms in equation (4) separate. (There is, of course a contrarian view that almost none of the 20th century warming is due to anthropogenic CO_2 and merely represents a recovery from the Little Ice Age (LIA) and even that the CO_2 increase is due to the warming and not due to anthropogenic emissions. In terms of our formalism, this would require very small $r(p)$ and very large γ.)

Combining the direct and indirect consequences of CO_2 emissions as is done above, has the effect of replacing the CO_2 response $r(p)$ by a rescaled response $r_{FB}(p) = r(p)/(1-g(p))$. An old analysis by Enting (1992) showed that there is no possible response function that could explain CO_2 growth over the industrial period as a linear response to anthropogenic emissions, ruling out such a response r_{FB} as the SOLE

contribution to CO_2 changes. (Possible was defined by the response, in the time domain, being always positive, the derivative being always negative and the second derivative being positive.) The conclusion was that some of the CO_2 increase was the effect of warming during recovery from the LIA.

I.G. Enting. (1992). The incompatibility of ice-core CO_2 data with reconstructions of biotic CO_2 sources. II. The influence of CO_2-fertilised growth. *Tellus* **44B**, 23–32.

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