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Interactive comment on "Dynamics of global atmospheric CO_2 concentration from 1850 to 2010: a linear approximation" *by* W. Wang and R. Nemani

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Additional comment 4: On ambiguity and feedback.

In my initial report (Enting, 2014) on the paper by Wang and Nemani (Wang and Nemani, 2014a), I questioned their claim to estimate an additional carbon flux by combining their carbon model with their temperature effect.

With regard to their equation (2b) (i.e.
$\dot{E}' - \dot{A} = [\alpha_A + \alpha_S] \cdot A' - \alpha_S \cdot E' - \beta_T \cdot T'$, Wang and Nemani (2014a) state that 'collinearity between the two regressors prevents us from determining the coefficients associated with them separately'. (i.e. only a combination of α_S andα_S can be estimated).

My argument is that one needs to go one step further and acknowledge that because of the high degree of collinearity between T', E' and A' only a combination of β_T, α_S andα_S can be estimated. Wang and Nemani (2014a) have an estimate of β_T derived from their earlier work, but my argument implies that the estimate of the combination of α_S andα_S will depend on the value of β_T.

In discussing this issue, my report (Enting, 2014) refered to some of my earlier work (Enting, 2010). Since some readers may find this work difficult to access, I reproduce the discussion. The analysis is in terms of perturbations $Q(t)$ and $W(t)$ for concentration and temperature, non-CO_2 radiative forcing $F(t)$, anthropogenic emissions $S(t)$. Response functions $U(t)$ and $R(t)$ connect forcing to warming and emissions to concentrations respectively. A response function $H(t)$ describes CO_2 emissions due to temperature change. A factor η (α in the original) gives the (linearised) radiative forcing from CO_2). The Laplace transforms of these functions are specified by lowercase letters: $q(p)$, $w(p)$, $f(p)$, $s(p)$, $u(p)$, $R(p)$ and $h(p)$ respectively. Under the Laplace transform the convolutions with the response functions reduce to products so one has

$$w(p) = u(p)[f(p) + \eta q(p)]$$

and

$$q(p) = r(p)[s(p) + h(p)w(p)]$$

whence

$$q(p) = \frac{r(p)[s(p) + f(p)\,h(p)\,u(p)]}{1 - \eta u(p)\,r(p)\,h(p)}$$

Thus the observed airborne fraction γ, is not given by $p\,r(p)$ but rather by $pr(p)/[1 - \eta u(p)\,r(p)\,h(p)]$ (in the absence of other forcing). Thus estimates of $r(p)$ (or parameters thereof) based on γ are going to depend on $h(p)$ (i.e. on β_T in the specific model of Wang and Nemani (2014a)). Furthermore, there is no scope for estimating an addtional flux $\Phi(t)$ by taking $q(p) = r(p)[s(p) + h(p)w(p) + \phi(p)]$ $\phi(p) = q(r)/r(p) - s(p) - h(p)w(p)$ with $q(r)/r(p) - s(p)$ set to zero on the basis that

$r(p)$ is fitted to the observed airborne fraction. S noted above, the observed airborne fraction will be $pr(p)/[1 - \eta u(p)\, r(p)\, h(p)]$.

In my view the responses Wang and Nemani (2014b,c) have not addressed this criticism.

References

Enting, I. G.: Inverse Problems and Complexity in Earth System Science, in: Complex Physical, Biophysical and Econophysical Systems., edited by Dewar, R. L. and Detering, F., World Scientific, Singapore, 2010.

Enting, I. G.: Interactive comment on "Dynamics of global atmospheric CO_2..." (initial report by 1st referee), Biogeosciences Discussions, 11, C6416–C6422, 2014.

Wang, W. and Nemani, R.: Dynamics of global atmospheric CO_2 concentration from 1850 to 2010: a linear approximation., Biogeosciences Discussions, 11, 13 957—13 983, 2014a.

Wang, W. and Nemani, R.: Interactive comment on "Dynamics of global atmospheric CO_2..." (response to first referee's report), Biogeosciences Discussions, 11, C6624–C6629, 2014b.

Wang, W. and Nemani, R.: Interactive comment on "Dynamics of global atmospheric CO_2..." (response to second referee and additional comment (1) by 1st referee, Biogeosciences Discussions, 11, C7237–C7249, 2014c.

Interactive comment on Biogeosciences Discuss., 11, 13957, 2014.