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Biogeosciences Discussions

Interactive comment on "Anthropogenic and biophysical contributions to increasing atmospheric CO_2 growth rate and airborne fraction" *by* M. R. Raupach et al.

M. R. Raupach et al.

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Author Comment on review by Scott Doney

We thank Scott Doney for his positive and careful review. The following responses are made to his specific suggestions.

Page 2868, line 12: The "Kaya identity" needs to be defined or described briefly to make the abstract more accessible to the non-specialist.

Since the Kaya identity is defined in detail at the start of Section 5, we have chosen to remove this reference to the Kaya identity in the abstract, where it may cause confusion. The relevant conclusion is now given in the abstract without reference to Kaya, as

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follows: "The increase in the CO2 growth rate (1.9%/y over 1959-2006) is expressed as the sum of the growth rates of four global driving factors: population (contributing +1.7%/y); per capita income (+1.8%/y); the total carbon intensity of the global economy (-1.7%/y); and airborne fraction (averaging +0.2%/y with strong interannual variability)."

Page 2868, line 17: The phrase "decline in the negative growth (improvement) in the carbon intensity" is hard to follow because of the double negative. Perhaps better just to use "decline in the improvement in the carbon intensity"

Agreed; text is changed accordingly.

Page 2872, line 20: The left panel of Figure 1 is not discussed in the text after the introduction of the figure. Many readers may not be as familiar with the interpretation of cumulative spectra, and it would be useful to explain briefly to the reader why the cumulative spectrum of atmospheric CO2 growth rate differs so significantly from ENSO.

We have added a physical explanation at the start of Section 3. To make this clearer to the BGC community, where spectral analysis is not widely used, we have included an extra figure showing the time series themselves (a new Figure 1).

Page 2873, line 8: Since the reasonable argument is made that the mechanistic links are to the surface-air exchange, not the atmospheric growth rate, would it make more sense to analyze surface-air exchange (Fs) on Page 2872 and in Figure 1.

We show results of spectral analysis with Ca' rather than FS at this early stage (Section 3.1) to stay as close as possible to the basic data in justifying the step of lowpass filtering all data for subsequent analysis. In fact the spectral analysis with FS yields results almost identical to those with Ca' (previous Figure 1, now Figure 2) as explained in a new paragraph at the end of Section 3.1 with reference to the time series in the new Figure 1.

Page 2878, line 20: It is inappropriate to infer properties for all of the climate-carbon

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models in the Friedlingstein et al. 2006 study based on multi-model average of the airborne fraction, which has a large range -0.27 +/-0.36 including several models with positive trends (e.g., NCAR CSM; Fung et al. PNAS 2005; there are likely others but that is one I am personally familiar with). The text should be modified to reflect the range of variability in the models (not that I am arguing any of the models is right or for the right reasons) and to be more careful in the conclusions drawn, particularly given the fact that a careful statistical analysis was required to show that the observational based estimate is likely positive within some probability bounds.

This comment is accepted. We definitely do not wish to lump all models together, or to make unjustified criticisms of carbon-climate models as a group. Therefore the wording of this paragraph has been changed to the following: "The observed increase in the airborne fraction can be compared with available predictions from C4MIP, the Coupled Climate-Carbon Cycle Model Intercomparison Project (Friedlingstein et al., 2006). Eleven participating models gave scattered predictions for r(aE) for 1959-2006, averaging r(aE) = 0.27%/y across all models and with 9 models predicting a negative trend, opposite in sign to the observation. Equation (9) shows that this is a sensitive test for carbon-climate model predictions of trends in total sinks, because the sign of r(aE) is determined by the small difference between the two larger quantities r(FE) and r(FS). Therefore, the fact that model predictions for r(aE) are not in agreement with each other or with observations is not an indication that all coupled carbon-climate model predictions should be dismissed.

Page 2880, line 6: change "with series are normalised to 1" to "with series normalised to 1"

Text is changed to fix this typo.

Page 2892, Figure 1 caption: units are needed for the frequency x-axis, "(1/y)".

Units have been added.

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Page 2895, Figure 4 caption: It would be useful to explain the Kaya identity and some of the terms in more detail in the caption.

Explanation has been added for both forms of the Kaya identity represented respectively in panels (a) and (b) of (old) Figure 4.

Interactive comment on Biogeosciences Discuss., 5, 2867, 2008.

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