Dear Referree #2,

Thank you for your evaluation of our work. Please find your comments below followed by our responses in italics including line numbers in the revised manuscript where appropriate:

This was a really clear and well written paper. It is really handy to have all the carbon budget terms laid out in all their glory alongside all their uncertainty in this manner. I know I will often refer back to the paper. I did think the paper could improve by having a clever figure showing the magnitude of the errors side by side as well as a figure/table showing the error contributions – or perhaps a schematic of the study. But none of this is critical, as on second read I understood what the authors did. However, should the authors wish make to make their paper accessible right off the bat an explanatory figure or two would increase the usefulness of your paper. Below are a couple small points and a question.

Figure 1 is a conceptual figure illustrating the main process controlling the modern carbon cycle and their 2 σ errors. Similar figures are often presented; however, our contribution to this figure is really the error estimates for the major terms in the C budget.

The only place where I got lost was in the explanation of the suite of simulations run P 14946 1. Equation 9, why is the matrix shown as products of EF and EL when it seems to me it should be sum? 2. "we include 500" 500 what, permutations? 500 samples of the error space? Wouldn't this then lead to 9 x (500 x 500) simulations? What is the 52? 3. Again lost with the number of simulations in the last sentence . . . "randomly drew from our 100 simulations of dC/dt to perform 4500 calculations of sumN and AF"

The emission matrix (Eqn. 9) has been clarified and 'Σ' has been replaced with '+' to explicitly show the sum of the terms in the matrix. The text following Eqn. 9 has also been revised to explain this more clearly.

Aren't you artificially enlarging the error by taking random simulations from across 1959 to 2010? This means 2006 flux estimates contribute to the same pool as 1964 estimates and yet the trend contributes? You comment on the different 2 sigma error in dC/dt for 1959-1980 versus 1980-present day, would such a breakdown of decades have a different error budget for dC/dt and dNL/dt?

I am not certain which error the reviewer is referring to here. However, we can assume that they are referring to the fossil fuel emission errors which are the most important flux to the atmosphere. In our analysis, we have assumed that national error estimates are static through time according to Andres et al. (2014) and these errors have been reported in supplemental table 1. Therefore the increase in the global error of emissions is driven by the increased emissions from nations with higher error estimates (e.g. China, India) rather than changes in national level error estimates. The decrease in error in calculating dC/dt since 1980 is due to the expansion of the global observation network and it has resulted in a decrease in dNL/dt as well.

It would be really useful if you would tabulate N per year with errors. In fact, I expect many of the figures could be tabulated which may expand the usefulness of your paper.

The decadal estimates of uptake (assuming that's what the reviewer is referring to here by 'N'?) are included in Table 1 and we have added a supplemental table 2 of global, ocean, and terrestrial C uptake and associated errors as per the reviewers suggestion.

You seem to have avoided comparison with other estimates of AF in literature (e.g. le Quere et al vs Knorr in 2009).

This was pointed out by both reviewers, so this was clearly an oversight on our part. A new paragraph has been added to the discussion focusing on recent papers focusing on the AF.

Twice (in the abstract and in the discussion) you make statements about carbon sequestration/climate change possible being the greatest ecosystem service /challenge. Rather than making a claim like this I would advise saying it is one of the greatest ecosystem services, or one of the greatest challenges. For although it is a huge important challenge there are many other issues which would contend for primacy. For instance, air production is an even greater ecosystem service than CO2 sequestration and not driving the 6th mass extinction or avoiding large scale genocide via hunger, disease or war I would consider as greater challenges . . ..

These statements have been changed and a statement has been added to the land use emission discussion section explicitly stating:

'Although C uptake is one of the most important ecosystem services currently provided by the terrestrial biosphere at the global scale, it is certainly not the only ecosystem service provided by the terrestrial biosphere.'

I would adjust the statement that stabilizing the growth rate must be achieved before stabilizing concentrations can be achieved – this could be misleading. For although stabilizing the growth rate is a mathematical imperative on the path to stabilizing concentrations stabilizing the growth is not a target I would advise we strive towards, rather strive towards the goal of reducing concentrations. . .

This statement has been revised to read:

'The stabilization of atmospheric CO_2 concentrations is one of the greatest challenges to humanity; however, it is worth pointing out that in order to stabilize atmospheric CO_2 concentrations we must first stabilize the atmospheric CO_2 growth rate. Unfortunately, there is no indication that the atmospheric CO_2 growth rate is stabilizing; in fact, it has accelerated over the last 50 years (0.05 PgC yr^{-2}; P-value= 7.5 x 10^{-7}), such that every decade the growth rate has increased by half a petagram of C per year. '

Thus highlighting the mathematical requirement of stabilizing the growth rate before we can even dream of stabilizing the concentration.