

## Response to Referee #2's comments

In preparing this revision, we have fully considered the reviewer (Dr. M. van Oijen)' comments and have revised the manuscript accordingly.

This paper provides an introduction to a special issue of Biogeochemistry. The issue consists of 17 papers on the impact of extreme climatic events and disturbances on ecosystem carbon dynamics. Fifteen of the studies are on terrestrial ecosystems, one study is on mangroves and one on lakes. The papers differ strongly in their choice of ecosystem, research question and methodology. That raises the question: what is the purpose of providing an introduction to such a heterogeneous collection? The authors show (Fig. 2) that more than 200 papers are now being published each year on the response of carbon dynamics to extreme events and disturbances, so why do the 17 issue papers merit special attention? The obvious justification for such an introduction is that it provides an opportunity to place recent papers in context, i.e. review the state of the art and identify remaining research gaps. This is attempted in the paper but could be done more systematically, as discussed in the following.

We thank the reviewer for the constructive comments on our preface. We have revised the manuscript as suggested.

The first section of the paper ("Introduction") can be summarised as follows: (1) Interannual variability (IAV) of GPP is especially large in the tropics, (2) extreme events and disturbances can affect carbon dynamics and will become more frequent and intense in the future, (3) their impacts can be studied with measurements and models - and many papers are being published; the ones here were the outcome from AGU-sessions.

This is fine as far as it goes, with the possible exception of the text on IAV measured as multi-annual standard deviation of GPP (Fig. 1), which seems an unnecessary distraction. Extreme events are outliers, not standard deviations, and occur worldwide - and not just in the tropics.

We have replaced the interannual variability (IAV) map measured by standard deviation with the map measured by the coefficient of variation (CV;  $CV = \text{standard deviation}/\text{mean}$ ). CV better measures the IAV of carbon fluxes. We have also added a figure of the number of extreme annual values (i.e., outliers) (listed as Fig. 2). We identified the outliers on a per-pixel basis using the Boxplot concept. An outlier is defined as an annual GPP value that is either larger than the 75% quartile + 1.5 \* interquartile range or smaller than the 25% quartile - 1.5 \* interquartile range.

A brief analysis of the existing literature could be added to this introductory section, flagging up both what research has been done and what has not been done. Which ecosystem types, which extreme event types, which disturbances, at which locations and spatiotemporal scales have been studied so far, and which were overlooked? And which are likely to become more important in the future? Can we distinguish direct and indirect effects of disturbances and extreme events both on the same location and elsewhere? Do the 17 papers address any of the research gaps? I think the paper would gain from being more comprehensive and analytical - otherwise there is no added value compared to the special issue papers themselves. I understand that you want to keep the preface short, but you could delete the IAV-text and figure, replacing it with say 20-30 lines on the state of the art.

We agree that an overview of the literature would be of interest but, as noted in Figure 3 (originally listed as Figure 2), a large number of manuscripts have been published on the topic of

‘extreme events’ and on ‘disturbances’. Any brief summary of this body of literature would barely do it justice. We feel that in this instance, a full review paper may be able to adequately (but probably not comprehensively) synthesize existing literature. We highlight the novel findings of the manuscripts - this is designed to communicate the gaps in knowledge addressed by each. Instead, we improved Figure 1 to also include an outlier analysis as an alternate approach for identifying regions of the globe that are prone to annual GPP values that exceed the normal statistical range.

The final section ("Conclusions") states future research needs. Three topics are mentioned: (1) studying interactions between extreme events and disturbances, (2) collecting more data on disturbances, (3) improving models for disturbances. Whilst these certainly constitute worthwhile efforts, they seem an arbitrary and small selection of topics; many others could have been mentioned. And are there no research needs left for extreme events rather than disturbances? Also, there is no discernible relationship between the three listed research needs and the 17 papers of the special issue, so it remains unclear what the papers collectively have contributed. For example, at least five of the 17 papers used models: if those models still need to be improved, does that disqualify their current results?

We have revised this section by adding research needs for extreme events. The need for further improve does not disqualify the current results of these models but indicates our understanding of the underlying mechanisms of extreme climate events and disturbances and their representation in models are still limited.

#### SPECIFIC COMMENTS

l. 36-37: The Introduction begins with discussion of "terrestrial biosphere" and "Terrestrial carbon fluxes". This suggests that the special issue only considers terrestrial ecosystems, which is not the case. Begin by setting the scene (what kind of studies are being introduced by you) before delving into details like the IAV.

We have removed “terrestrial”, and changed “terrestrial carbon fluxes” to “biospheric carbon fluxes”.

l. 41: Add a reference to the MODIS work.

We have added a reference for the MODIS data product (Zhao et al. 2005).

l. 99-100: Those reductions of 28 and 38% are for which period? During the event, the year following the event, : : :?

The drought reduced GPP and carbon sink by 28% and 38% in the drought year – 2012. We have clarified this.

l. 172-174: What happened around 1970 that caused the trend break?

l. 215-216: Here you explain what partial cutting is, after having discussed the impacts of it already on l. 207.

We have moved the explanation of partial cutting to where the phrase first appeared in the paragraph.

l. 231-238: This section seems to ignore the current understanding that it is increased N-deposition, not elevated CO<sub>2</sub>, that has increased forest sink strength.

We have explicitly mentioned that N deposition – a factor enhancing ecosystem carbon uptake was not explicitly considered, although the effects of nitrogen deposition carbon sink strength have been controversial (Magnani et al., 2007; Nadelhoffer et al., 1999).

l. 252: Which two studies?

We have clarified what this study only applies to Bond-Lamberty et al. 2015.

## TECHNICAL CORRECTIONS

l. 24: Missing space after "by".

l. 28: Remove "layers".

We have made these changes.

l. 42: "the Amazon" should be "Amazonia".

l. 43, 45, 46: Remove "on the order".

l. 50-51: Remove "terrestrial"?

l. 59-61: "We can only : : : scales" can safely be removed.

l. 65: Replace "mechanistic responses" by "mechanisms underlying responses".

l. 71: Add "the" before "consequences".

l. 76: The total number increases by 200 articles per year, not 20. Replace "total" with "annual".

We have made these changes.

l. 82: AGU meeting: in which year(s)?

We have clarified that the AGU meeting was in 2011-2013.

l. 85-87: "We feel : : : change" can be removed.

We have retained this sentence as part of our evaluation of the authors' contribution..

l. 93-96: "That being said, : : : 2008": more waffling, please remove.

l. 110: Replace "have" with "has".

l. 145-146: replace "occurred" with "occurring".

l. 179: Remove "potential".

l. 182: Replace first dash with a space.

l. 201: Write "hurricanes".

l. 203: Remove "annual".

l. 256: Why write "data layers" instead of simply "data"? There is some GIS-jargon here (including the "polygons" of line 259 and two further "layers" in lines 290 and 292).

l. 260: "source of information".

l. 265: What does "conforming" mean?

l. 293: Remove "systematically".

These changes have been made as suggested.