

***Interactive comment on* “On what scales can GOSAT flux inversions constrain anomalies in terrestrial ecosystems?” by Brendan Byrne et al.**

Anonymous Referee #1

Received and published: 22 January 2019

————— Review of Byrne et al. —————

Holistic suggestions

The authors have written an interesting paper that is very relevant to current inverse modeling efforts using satellite data.

Overall, I think the science in this paper is very sound. The authors have been very thorough and thoughtful. With that said, the manuscript contains enormous detail and discussion. I worry that the main takeaway messages can get lost in this detail. I think the main science question posed in this paper could have a relatively straightforward answer; I think one could answer that question in a more succinct way that brings to the forefront the unique results of the paper. Here are a few ways that one could shorten

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the paper: (1) Some text in the introduction seems better-suited for the methods (see below), and I think the intro could end with a more focused, succinct list of the study goals. (2) Some of the details on the proxies and the flux products could go into a Supplement, though I think it could go either way. (3) I would consider merging the results and discussion into a single section. These two sections can feel repetitive in places. (4) I think the Conclusions could be half the current length and focus on bringing the analysis together into snappy, punchy take-away messages. These are just a few ideas, and I think the authors should make whatever changes feel most appropriate to them. I want to be sure this article gets the attention it deserves when published and ensure that the authors don't lose readers in the detail.

Below are several detailed suggestions.

Abstract

- You may want to either define FLUXCOM or use a non-technical term here.
- What is $R_{NINO3.4}$? Again, you might want to either define this term or use a less technical term.
- Line 14: Could you define “regional scales” more precisely? I.e., what size regions are you referring to here?
- Line 14: It could be helpful to give the reader a hint on what aspects of the configuration you're referring to here.

Introduction and methods

- pg. 2, Line 23, “We also examine the posterior fluxes from two publicly available flux inversion estimates...”: Can you provide a bit more detail here. In what way do you examine these fluxes, and how does this examination contribute to the study?

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- I would write out abbreviations like MERRA-2, FLUXNET, and FLUXCOM the first time you use them.
- Pg. 2, line 32 to pg. 4, line 9: The introduction is relatively long. You could condense or eliminate some of this information to produce a shorter, punchier introduction.
- Pg. 4, line 3 to line 15: This material could be a better fit for the methods sections.
- Pg. 4, lines 16-27: Again, I think you could shorten the descriptions here to make the main objectives more concise and punchy. There's a lot of detail to digest in this paragraph. It could be helpful to give a more succinct overview of the paper and leave some of the details for later.
- Pg. 7, line 3: I recommend experimenting with covariance matrices that include off-diagonal elements. I worry that you could overestimate the information content of the satellite observations by using a diagonal observational covariance matrix. Existing studies suggest that GOSAT retrievals have spatially and temporally coherent errors. My guess is that the estimated fluxes would be less detailed or less informative if you included off-diagonal elements in the observational covariance matrix. The overall goal of this study is to estimate the robustness of the flux constraint using GOSAT observations, and I think that the structure of the covariance matrices could have an important impact on these conclusions.

Results and conclusions

- Pg. 10, line 26, “As scales decrease....”: It could be clearer to rephrase to “As the size of the regions decrease....”.
- Pg. 10, line 32: I would be clearer about what you mean by “regional and larger scales.” Different readers might have different concepts of what this phrase means.

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- In general, there's a lot of detail in Sect. 3. I think you could shorten this section and/or potentially move some of the text to an SI without losing key information. An upside of being so thorough is that you won't omit anything from the text. However, a danger is that the key messages of the paper can become buried in all of the detailed descriptions.
- Sect. 3.1.1 title: I think it would be more appealing to a reader to use a descriptive title here instead of using a relatively technical abbreviation in the header title. Someone who is scanning through the paper wouldn't know what $GC_{2x2.5-200\%}$ is or what the scientific importance of this section is.
- Pg. 14, line 18: Consider starting this section with a stronger topic sentence that helps guide the reader through the material. For example, you could state the main take-away message of the OSSEs in the tropics and then explain the results in subsequent sentences.
- Sect. 3.3.1: I think you could add a few more sentences somewhere in this section explaining what the implications of the OSSE's are for your real data results. What have you learned from the OSSE's, and what are the implications for using GOSAT to constrain flux anomalies?
- Pg. 20, line 1: I think it is a bit too informal to start a paragraph with a question. You might want to rephrase with a guiding topic sentence (e.g., one that states the main result or take-away of the paragraph).
- You use the term "flux anomalies" a lot throughout the paper. I would make sure it's very clear to the reader what type of anomalies you are referring to (e.g., over what time periods). I know that you specify this information in the Methods, but it doesn't hurt to use very clear and unambiguous terminology whenever possible.
- Pg. 21, line 19 "significant impact": Is this result statistically significant? I would

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reserve the word “significant” for instances when you explicitly tested for statistical significance. Otherwise, you could unintentionally confuse a reader.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-909>, 2019.

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