

## ***Interactive comment on “Simultaneous shipborne measurements of CO<sub>2</sub>, CH<sub>4</sub> and CO and their application to improving greenhouse gas flux estimates in Australia” by Beata Bukosa et al.***

### **Anonymous Referee #2**

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Bukosa et al. present a well thought out modelling analysis of a ship-based greenhouse gas measurement campaign around Australia. Tagged tracer model simulations and ratios between anomalies in CO<sub>2</sub>, CH<sub>4</sub>, and CO are used effectively to explore how different source processes impact atmospheric greenhouse gas distributions around Australia and identify biases in the flux estimates. While the work is generally sound, I have some recommendations that I feel will strengthen and clarify the paper.

Framing the analysis: The bulk of the paper is very descriptive, and much of the text works through the data explaining the processes driving each individual ship transect. It is hard work for the reader to find they key scientific findings of the study, and I'm

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concerned the paper will not attract the readership it deserves. The authors need to identify a few key results they wish to highlight, and re-focus their discussion of the data on what they need to tell that story.

One approach would be to re-write section 4, so that instead of the analysis going through cruise by cruise, the description focuses instead on what is learned about the key source/sink processes (e.g. fire, fossil, wetlands, etc.) These processes could then have their own sub-sections, to help guide the reader. Then, I would recommend better highlighting the importance and power of the co-enhancements explored in section 6 in the abstract, introduction, and conclusions, to bring this interesting analysis forward a bit. Please take this only as an example of how I might approach the problem, as there are a few equally valid paths the authors could take to focus the paper.

Incomplete use of data: I was surprised that the authors made no use of any of the land-based greenhouse gas measurements available during this time through CSIRO's observing network or TCCON. It is reasonable for the paper to focus on what is learned from the new ship data, but the other long-term data could be a powerful point of comparison.

Emissions fields: The authors have chosen emission fields that, in many cases, do not extend through the time period they wish to simulate (2012-2013), even when more updated fields are available. For example, why use EDGAR 4.2, which ends in 2008, when EDGAR 4.3 continues to 2012 and has been available since 2017? Why use net terrestrial exchanges from TansCom circa 2006, when biosphere estimates from a variety of land models and inverse models are available publicly? I don't think this is likely to cause a fundamental change in the findings, but it is always best practice to use up to date information where possible.

Publication of the data: This manuscript is built upon a measurements campaign, which the authors say will be described in a forthcoming paper by Kubistin et al. I have a high degree of confidence in the capabilities of the measurement team for this work. How-

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ever, there is a risk in accepting a paper that is underpinned by another manuscript, before that manuscript is fully peer reviewed or accepted.

Minor comments:

Introduction: For multi-species studies such as this one, I think it is very helpful to show a table of source/sink processes, highlighting which gases are affected by the source/sink. This way, the reader sees immediately what the common threads are, even if they don't know a specific gas particularly well.

Introduction: There is a strong focus in the introduction on the importance of Australian fluxes in driving global inter-annual variability in greenhouse gases. However, this paper doesn't shed a lot of light on inter-annual variability. Instead, it is a strong example of how in-depth analysis across multiple trace gases can be a powerful tool in source/sink attribution. I recommend re-framing the introduction this way, to attract the readers that are most likely to be enthusiastic about this work.

Page 5, line 10. The introduction spent so much time talking about inter-annual variability in Australian fluxes, it seems strange to read here that you think this isn't going to cause much error to use repeating fluxes in your model simulations.

In the introduction, the authors highlight the strong variability in greenhouse gas fluxes from Australia. It feels a little strange to read here that the variability to

Figures 6 and 8 are the most exciting results figures of the paper, yet they are quite small and difficult to read. Suggest sizing them up.

There were a few ?? left over from the LaTeX formatting. Be sure to check and resolve these.

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