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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Large and increasing methane emissions from Eastern Amazonia derived from satellite data, 2010–2018" *by* Chris Wilson et al.

Anonymous Referee #3

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The author uses the GOSAT satellite-based columnar and surface observation of CH4 to optimize CH4 emissions for 2010-2018, focusing on South America, especially the Amazon river basin and Brazil. The author reported an increasing emission trend for optimizing emissions over Brazil. The author further observed the strong trend during the wet season and attributed the wetland emissions as the main driver. The author used the bottom-up model to investigate the causes of variations in wetland CH4 emissions. However, the fluxes neither match with variation in annual fluxes nor the positive trend in the inversion emissions. The author reported no change in fossil fuel emissions for the same period. Overall, the results are impressive, with detailed and careful investigations. The paper would greatly benefit from a full revision to ensure the authors'

key messages are easier to understand. Below I outline my substantive and minor comments.

Substantive Comments:

1) The paper looks lengthy, which make it difficult to understand key messages clearly. I would suggest revising the structure and moving the proxy information (e.g., Detailed of Bottom-up simulations) in the supplement part, as indicated by Luke Western.

2) Estimated error covariance is as essential as estimated fluxes, yet these are never shown. I would like to know what the decrease in error covariance is between the prior and posterior.

3) The accuracy of model transport plays a crucial role in interhemispheric gradients in CH4 near the Earth's surface and vertical gradient in the troposphere and stratosphere since the total column consists of 40% of stratospheric air, depending on seasons and latitude. Thus, it is crucial to test the accuracy of the troposphere and stratosphere vertical transport before optimization. Too fast transport of too slow transport in the model will directly hinder the optimization results. The vertical gradient in the stratosphere becomes more critical for simulating XCH4 data. Along with transport, the validation of chemical loss is also vital for optimizations. It would be useful if the authors reported the methyl chloroform e-folding lifetime as a way of assessing the prior OH and another proxy (SF6) simulations for validating the inter-hemispheric and vertical transport. Even if this is addressed in an earlier paper, some Supplementary or acknowledgement plots would be useful.

4) It is difficult to follow how authors get the uncertainty ranges (e.g., Fig. 4a, b). It would be generous to the reader if you state clearly this information in the text.

5) It is currently difficult to understand the spatial distribution of sectoral emissions to understand their role in the study region's methane emission changes. The spatial distribution of prior emissions (probably Figure in the supplementary Section), mostly like

wetland emissions, Enteric fermentation and manure management emissions, biomass burning, and Fossil Fuel, will help the reader.

6) It would be not easy to pinpoint the role of wetland emission in increasing trend compared to the decreasing wetland areas for the contemporary period. In such a case, the role of bottom-up simulations is challenging to connect the dots. What about the role of Enteric fermentation and manure management, and agricultural emission, which are also increasing over Brazil as per the updated version of EDGAR inventory (EDGARv4.3 and latest version)? Investigating such dimension will make the study interesting. The spatial sectorial emission map of or trend in the prior sectorial emissions can help excavate such information.

7) Using the histogram for the validation does not give enough information about how well the optimized emissions improved the fitting of the observed trend? It would be useful for the reader to show the observed and fitted XCH4 time-series (say over the region shown in Fig. 5) and the time series over two different altitude range of aircraft as shown in the Figure. 6.

Specific comments. L32: "Cannot match. . ." –> "Neither match. . .". Since you are using "nor" conjunction L31: "Much of CH4. . .." Consider giving the numerical fraction. L43: "remove "to the atmosphere" and "in the atmosphere". Can state like "However, the magnitude of global sources and sinks are still not well quantified..."

L50: The period is not matching with the previous studies.

L64: The authors could also cite Chandra et al. JMSJ. (2021) (https://www.jstage.jst.go.jp/article/jmsj/advpub/0/advpub_2021-015/_article), who also found an increase in both biogenic and fossil fuel emissions. Naus et al (2020) (https://doi.org/10.5194/acp-2020-624) and Patra et al. (2021) (https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020JD033862) also studied the OH trend using CH3CCl3 observations and observed no significant trend.

L58: Point 1st and 3rd have more or less the same conclusion. Consider it to merge. So basically, you will have two points of source uncertainty and sink uncertainty. L64: Better to state more conclusively. Worden et al. (2017) suggest that the equal contribution of both FF and biogenic sources is also possible if pyrogenic emissions are decreased for the same period.

Section 2.1.3. It is not mentioned in this Section the use of aircraft measurements in this study. After reading this paragraph, I thought the aircraft measurements are also used in optimizationâĂŤthe information regarding the use of these observations for the validation purpose is coming later.

L215. Not clear 250% of what? Is uncertainty 250% of prior emissions?

Section2.2.2 Consider showing all the sectoral emissions time series for the study region (maybe in Supplementary?)

L304. "The posterior residuals show no significant trend or seasonality" -→ Over where? Over Amazon Basin or the whole of South America?

L305. Similar emission maps for each sector in Supplementary will help the reader to understand the dominant emission sources over different regions.

L335. Figure S1 is not shown. Maybe you are talking about Figure A1. Correct others also throughout the manuscript. L345. How did you calculate the uncertainty? L346. "This means. . .." How does the previous sentence follow this conclusion? at least gives the number. . .. Consider reformulating

L353. What is the shoulder season?

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