Review of Gadhavi et al., 2025
AMT-2024-167

Summary

This manuscript describes results from ~9 months of observations of column-mean values of carbon dioxide (XCO2) and methane (XCH4) from a ground-based EM27 spectrometer operated at the rural Gadanki site in southern India. They perform two analyses with these datasets. First, they use them to validate a few satellite products of these gases, specifically one for methane and three for carbon dioxide. Secondly, they perform a modeling study using the FLEXPART model coupled with assumed natural and anthropogenic emissions products to model the XCH4 at the Gadanki site, in order to interpret the drivers of the variability of the column methane there.

General Comments

The authors included 3 satellite-based datasets for XCO2 (NIES GOSAT, ACOS GOSAT, and ACOS OCO2), but only one for XCH4 (NIES XCH4). I think the XCO2 comparison is great and useful. However, almost no one that I know of uses NIES XCH4 retrievals from GOSAT for scientific studies. Almost EVERYONE uses either the University of Leicester Proxy GOSAT XCH4 product (https://essd.copernicus.org/articles/12/3383/2020/), or one of several available TROPOMI XCH4 products. This document would be MUCH more useful if it included one or both of those XCH4 products in the validation section.

The modeling section of this manuscript is problematic. There is no visual correlation at all between their modeled XCH4 and the observed. Which is fine, except that when I plotted up the CAMS data at this location for the time period of interest, visually it matches reasonably well with the EM27 observations. It appears that there may be a problem with their model. Because this part of the paper is totally separate from the validation part of the paper, I suggest they remove it altogether, or fix their model so it at least partially agrees with other, more well-established models. I would like to be clear that I am not a methane modeler, so that is just my impression as a GHG data scientist.

Finally, there are MANY English grammar (and a few spelling) errors throughout this manuscript. They are too numerous for me to list individually. Please have a native/fluent English speaker read through the document and correct these mistakes.

Primarily because of the problems with the modeling section, ***I cannot recommend this paper for publication at this time***. If they were to remove this section and resubmit, especially if they included one or more standard XCH4 datasets (e.g. University of Leicester v9.0 XCH4 using the proxy approach, as well as a TROPOMI dataset), and fixed the numerous grammar errors, it would be suitable for publication.

Specific/Technical Comments

- Line 23: please add “methane” or “CH4” somewhere to make it clear which gas this sentence is referring to.
- Line 95: for OCO-2 v11.1, please reference Jacobs et al. 2024: https://doi.org/10.5194/amt-17-1375-2024.
- Line 161: You are referring specifically to the operational NIES full-physics retrieval. You should say this, and give a citation of the NIES retrieval. The latest citation that I know of for the NIES full-physics retrieval is Someya et al., 2023: https://amt.copernicus.org/articles/16/1477/2023/.
- Line 166: “Goddard Earth Science Data Information and Services Center” has a useful acronym: GES-DISC. I suggest you use it for future references to this center in the manuscript.
- Section 2.2: As I said above, please add the University of Leicester Proxy XCH4 product into your evaluation. Then your document the two operational NIES products (XCH4 and XCO2), as well as each gas from a more trusted retrieval (ACOS for XCO2; University of Leicester for XCH4).
- Line 176: Also please reference Jacobs et al. (2024) for v11.1 updates.
- Line 216: Please add “anthropogenic” in front of “emissions inventory”, to make it clear what kind of emissions the ECLIPSE dataset quantifies.
- Section 3: Please explain why a global model such as CAMS (assimilating in-situ data) is not suitable for your evaluation. It’s not clear why you had to build your own methane model over India, when many already exist.
- Section 4.1, regarding Colocation Criteria. First, Buchwitz et al. 2017 using +- 4 deg latitude +- 4 deg longitude, which is easily checked by reading the paper. +- 10 latitude and +- 30 deg longitude is ridiculous. It is huge, and isn’t even over India anymore! Second, please be clear if you are using only GOSAT observations over land, or if you include GOSAT observations over ocean. There would be many more of the latter than the former. Finally, have you tried to loosen your CAMS constraint? That seems perhaps overly tight.
- In section 4.1, you should point out that you do not make an averaging kernel (AK) correction, which could cause slight discrepancies. It would be better if you did this of course, but it seems like you do not.
- Line 319, at the end of the sentence add something like “over the 9 month period of comparison”.
- Near Line 320. It is worth pointing out that GOSAT v305 XCO2 performs significantly worse in the fall-winter months (Nov, Dec, Jan, Feb) than the spring months (Mar-Jul).
- Section 4.2 – add “of Methane” or “of CH4” to the title of this section, since CO2 is not studied here.
- While I am not a methane modeler, I loaded up and plotted the CAMS XCH4 dataset (version v20r1) from their top-down inversion that assimilates in-situ data. It looks nothing like the FLEXPART model result provided in this manuscript, but does look surprisingly similar to the EM27 observations. I can only conclude that something is

wrong with their model results, given that there is no visual correlation at all between their model results and the EM27 observations or CAMS. I really don't see the value in section 4.2, given the apparent problem with their model results.