

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-309

Anonymous Referee #1

Referee comment on "Global distribution of methane emissions: a comparative inverse analysis of observations from the TROPOMI and GOSAT satellite instruments" by Zhen Qu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-309-RC1>, 2021

This work estimates the global methane emission for the year 2019 at $2^{\circ} \times 2.5^{\circ}$ spatial resolution based on inverse modeling technique by utilizing the TROPOMI and GOSAT satellite observations. It validates TROPOMI and GOSAT observation against TCCON methane column measurements, using the GEOS-Chem CTM and also provides the sensitivities parameters such as averaging kernel and degrees of freedom for signal which quantify the number of independent pieces of information on the distribution of methane emissions. The paper provides the discussion on estimated methane emission at different major methane source regions around the world using GOSAT, TROPOMI, and joint data-set. I recommend its acceptance after the minor revision with following specific/minor comments:

specific comments:

1). There are techniques such a 4-dimensional variational data assimilation (4D-var) and local ensemble Kalman filter (LETKF) that also provides grid-based flux estimation of methane by assimilating satellite observations. How close the inversion technique used in this study is to those techniques? I suggest author to add a paragraph that discuss the limitations of the high-resolution Bayesian inversion technique using satellite observations.

2). The methane emission has been estimated using annual mean methane concentration data of GOSAT and TROPOMI. How would the seasonal variability of methane concentration affect such emission estimate? Is it possible to extend such inverse modeling set-up to estimate the methane emission at monthly scale?

Minor comments:

Line 367, We conducted grid cell.

How significant it is to apply equal ratios to all sectors in the grid cell. How better this is in comparison to isotopic fractionation method.

Line 371, Study claimed that 2x2.5o grid makes sectoral attribution more accurate, but we don't know true sectoral contribution.

Line 385, In China,.....Plain. Please cite the figure number here.

Line 399, the analysis is performed for 2019, why did the author cite 2014 report.

In Figure 3, large difference between GOSAT and TROPOMI can be seen during DJF at northward of 30oN. How does it affect inversion estimate?

Figure 7, Over India the estimate looks pretty close from all the methods, over Brazil, the joint inversion estimate is close to GOSAT, almost same story for Europe, but over CONUS the joint inversion is very high compared to both the inversion. How would you explain the joint inversion behavior over CONUS?