Reviewer -ACP Tu et al., 2021

General:

The authors apply both the ground-based (five COCCON instruments) and space-based (TROPOMI and TROPOMI+IASI) measurements to calculate the landfill CH4 emissions in the Madrid area. This study is practically interesting for the policy-makers in Spain, and it is also interesting for the relative scientist who would like to use these kinds of measurements to calculate the CH4 emissions at other places. In general, the topic fits well in the journal, the method is reasonable, and the uncertainties are considered. However, as the Referee #1 pointed out, there are some English grammar mistakes in the current version. In addition, the introduction lacks useful information and the formula remains unclear. I would like to recommend it to publish on ACP after answering my following comments.

Major comments

1. Reconsider the structure of the introduction. For the moment, I cannot capture what is the current status of the CH4 emission research from the ground-based and space-based measurements, what are the key issues, and what the authors will do in this work to solve/improve the issues. For example, I would like to suggest moving some texts in Section 2.1 and Section 2.2 to the introduction. Only keep the data description/technical part in Section 2.

2. In the abstract: "As CH_4 emission strength we estimate $7.4\times10^{25} \pm 6.4\times10^{24}$ molec s^{-1} from the TROPOMI XCH_4 data and $7.1\times10^{25} \pm 1.0\times10^{25}$ molec s^{-1} from the TROPOMI+IASI merged $TXCH_4$ data. " Why the uncertainty derived from the TROPOMI+IASI TXCH4 data is larger than that from the TROPOMI data? I thought that the advantage of using TROPOMI+IASI is to obtain more information in the troposphere so that users can reduce the uncertainty.

Minor/technical comments:

P2line36. It is confused with "that this". Please reword this sentence" That this strength is lower than the one derived from the satellite observations is a plausible result. ".

P2line45: "are to" -> "are"

P2line49: 'while' -> 'in which'

P2line49: What does '~55% uncertainty' mean? Please clarify it in the text.

P2line53: 'space borne' -> 'space-borne'. As you use both ground-based and space-based measurements in the study, why do you only highlight the space-based data here?

P2line62: 'TCCON' for the first time, please write down the full name

P3line70: 'column-average' -> 'column-averaged'

P3line81: ‘The BrukerEM27/SUN ’ -> ‘A BrukerEM27/SUN’

P4line115: ‘we apply a strict quality control’ - > ‘we apply strict quality control’

P4line124: ‘particular’ ->’particularly’

P5line128: ‘such synergetic’ ->’such a synergetic’

P5line146: ‘emssion’ ->’emission’

P7line171: ‘each individual landfill’ -> ‘each landfill’

P7line186: ‘in Madrid area’ -> ‘in the Madrid area’

P7line191: ‘which brings error’ -> ‘which brings an error’

P8line202: ‘Due to its coarser spatial resolution the TROPOMI XCH_4’ -> add a ‘,’ after resolution

P8line212: ‘This value fits well to’ -> ‘This value fits well with’

P9line228: ‘as attenuated signal’ -> ‘as an attenuated signal’

P9line229: ‘a time period of’ -> ‘a temporal window of’

P10line237:’during some years after sealing’ -> ‘for years after sealing’

P10line243: ‘To better representing’ -> ‘To better represent’

Plline276: ‘fusiform-shape plumes ’ - >’ fusiform-shaped plumes’

P12line283:’ is due to noise of’ -> ‘is due to the noise of ’

P12line295:’ CH_4 has a relatively longer lifetime than NO_2 ’ -> ‘CH_4 has a longer lifetime as compared to NO_2’

P16line333: ‘yields emission rates of close to’ -> ‘yields emission rates close to’

P18line374: ‘derived from source location’ -> ‘derived from the source location’

P19line396: ‘are indeed representative for’ -> ‘are indeed representative of ’

P19line397: ‘CH_4 has a long lifetime’ -> ‘CH_4 is a long-lived gas’

P20line423: ‘As outlook, this methodology…’ -> ‘This methodology…’

P25 A-3: “**personal communication of Omaira García**” Why do you write this? If I understand correctly, **Omaira García is one of the co-author.**

P26 Eq8. I would like to see a table or an expansion for the x_BG vector

P26 Eq 8. How do you calculate the K_BG? Perturbation? If yes, then how do you choose the perturbation size? How does the size affect the result?

P26line510: The authors mentioned that K_BG* is the same as K_BG, but set to zero for observations where the wind data suggest a significant impact of the CH_4 plume on the satellite data. What do you mean by "a significant impact"?

P26line513: I guess the authors is talking about x_BG instead of K_BG?

P26. Eq9: **It is also confusing me that you wrote y_BG in Eq.8 but y in Eq.9 without any explanation in the text.**

P26 line 519: How do you create the Sy,n and Sa matrices? If I understand correctly, these are key parameters for your y_BG calculation.

Although the authors said that" The matrix $\boldsymbol{S}_{y,n}$ stands for the noise covariance of the satellite data ", where are the noise of the satellite measurements come from? from the satellite L2 data?

For Sa "with a very low constraint value for the coefficient determining the constant and higher constraint values for the other coefficients ". What do you mean 'a very low' ? What are the diagonal values for each retrieval parameter?