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Comment on acp-2022-41

Anonymous Referee #1

Referee comment on "Quantifying CH_4 emissions in hard coal mines from TROPOMI and IASI observations using the wind-assigned anomaly method" by Qiansi Tu et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-41-RC1, 2022

This paper estimates the methane (CH4) emissions from one of the most outstanding CH4 sources in Europe using a multi-platform of reference data sets (space-based observations, atmospheric simulations, emission inventory) and a novel, robust, simple approach. The paper provides new and interesting findings, and is written and structured well; therefore, I suggest it to be suitable for publication in ACP after specific and technical comments (listed below) are addressed.

Specific comments:

Title: The title suggests that the CH4 emission quantification is jointly done using TROPOMI, IASI, and CAMS products. However, the CAMS data was mainly used as a validation tool of the wind-assigned anomaly method. Section 3.2 indeed shows and discusses briefly an example day using the CAMS and space-based observations, and Figure 8 summarizes the CH4 emission rates using all different data sets, but this figure is not discussed in the text. I would recommend to change it to "Quantifying hard coal mines CH4 emissions from TROPOMI and IASI observations, high-resolution CAMS forecast data and the wind-assigned anomaly method"

Section Data sets and method:

A subsection describing the USCB region would help the reader, for example, including the orography, the predominant wind regimes, etc. In addition, given that the COMet inventory is used in this paper, I would also recommend including a subsection providing some details about it.

Line 100: Include some reference and explanation about the expected uncertainties of the CAMS-GLOB-ANT inventories.

Line 135-136: Include information about the TROPOMI overpass (time, frequency,...) similar to IASI.

Line 138: Include information about the number of quality-filtered TROPOMI dataset (and also for the combined TROPOMI+IASI product in the next paragraph). Is the space-based data set robust enough for CH4 emission estimates?

Line 144: Include reference for the improvement of IASI on the NWP systems.

Line 145: Is the statement about "different atmospheric trace gas profiles" referring to only CH4 or to all the MUSICA products? If the latter, please consider including other references for completeness such as Schneider et al. (2022), Dieckmann et al. (2021) or García et al., (2018).

Line 151: Some information about the improvements/differences of the wind-assigned anomaly method with respect to other top-down approaches would help the reader to have a better idea of novelty and benefit of this method.

Line 176: Describe slightly the results obtained (first validation of the wind-anomaly method) in Madrid experiment (Tu et al., 2021) to highlight the robustness and reliability of the method.

Results and Discussion:

Line 205: During the COMet campaign, high-resolved aircraft profiles were performed allowing CH4 emission rates to be estimated (e.g. Fiehn et al., (2020), Kostinek et al. (2021)). Have the authors analyzed the aircraft dataset to corroborate that the wind fields at 300 m are the optimal option? As discussed in the "Uncertainty analysis", the vertical wind shear is the most critical factor to estimate the CH4 emission rates.

Line 206-209: Please provide more details about this statement (ie, the small changes in wind could not be properly captured by ERA wind fields). What would the net effect of ruling out these pixels be in the total estimations?

Figure 5: Why is there more scatter in the positive anomalies?

Line 224: As mentioned before, section 3.2 shows and discusses briefly an example day using the CAMS and space-based observations, but the emission rates using the whole data set is not included and discussed. If I understand well, the analysis was done because Figure 8 summarizes the CH4 emission rates using all different data sets for the discussion of effect of wind at different levels, but this figure is not discussed in the text (neither in section 3.2 and section 3.3). Including this information in the text would help to compare the results with COMet inventories (discarding the influence of space-based observations uncertainties).

Line 247: There is a significant change of slope for the combined TXCH4 product (Figure 7 f). Do the authors have some explanation for this?

Technical comment:

Line 19 and line 76: Include the period covered by this study in the abstract and introduction.

Line 70: Include acronym for tropospheric XCH4 (TXCH4).

Line 89: Consider plural for "aerosol".

Figure 1: The colours used for "Off Road transportation" and "Fugitives" are quite similar and make it hard to distinguish them only by looking at the plot. The final full stop is missing.

Line 154: Please consider moving the description of the ERA wind model to line 164.

Line 166: 08:00 UTC or 09:00 UTC as in the CAMS products description. Why do not use the CAMS products starting at 08:00 UTC?

Line 180: Correct "500 m" and "three-year average" in the figure caption.

Figure 3: Correct "TROPOMI" in the figure caption.

Figure 5: Include the meaning of the error bars in the figure caption (is the STD given by Eq 1?).

Figure 6: To be consistent with the other figures, please consider modifying this figure accordingly (coloured bars, labels (a, b, c), “modelled” in the title of third subplot, definition of first subplot,...)

Figure 7: Correct “TXCH4” in subplot (e).

Figure 8: Correct “wind” in the x-label for 300 m. Correct “300 m, 500 m”.

Line 284: Correct Figure A-1 to plain text.