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Comment on acp-2022-243

Anonymous Referee #1

Referee comment on "Factors influencing the temporal variability of atmospheric methane emissions from Upper Silesia coal mines: a case study from the CoMet mission" by Justyna Swolkień et al., Atmos. Chem. Phys. Discuss.,
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Review of "Factors that influence the temporal variability of atmospheric methane emission from Upper Silesia coal mines: A case study from CoMet mission", Swolkien et al., for ACP.

This paper presents temporally-resolved (mostly hourly) measurements of methane flux from 15 coal mine ventilation shafts in Poland, pointing out that temporal variability might be negatively impacting the inventory calculations which are based on much less frequent (unclear how much less) measurements or accounting. Overall, the measurements should be published, but I only recommend this manuscript after significant revisions for clarity mostly, but also I think the authors need to make their final points in a better way so they have more impact on the reader.

One of my main comments is that someone should carefully review the text for English language & clarity. Some sentences are awkward, and although I have noted some of them specifically below, I have not done so for all the language/grammar issues. Often (for example, the first paragraph of the summary), the poor English impacts the readability of the text and makes it impossible to understand the point. After that, there were a few places where it was not really clear where they are getting some of their numbers for final emissions (I've noted those below). The paper is organized fairly well but the discussion/conclusions should be strengthened to make some broader points more clearly. It's not obvious why top-down measurements (for example for an aircraft-based mass balance approach) would be incorrect exactly, or if it is correct.

Specific comments:

L34: Should this read "assumption that methane *emissions* are time-invariant", rather than "concentrations"? I would think most methods

for estimating emissions using concentration measurements still account for wind speed (if atmospheric) or air flow rate for example?

L48: awkward/grammar "when additional carbon footprint is considered".

L56: emission should be emissions

L68: omit "the" before "use"

L80-81: isn't FTIR an example of remote sensing, already mentioned? perhaps rephrase to mention satellite vs. ground-based remote sensing specifically?

L83-84: awkward grammar again.

L84: try "obtaining temporally-resolved emissions from "

L91: again it seems that this should say "emissions" rather than "concentrations"?

L98-99+: grammar issues with this list.

L102: the goal was

L109, grammar - whose importance? (what does "their" refer to? the factors that influence variability (concentration - should this be emissions?

L110 - presumably concentrations in the shaft are directly related to emissions? (is that true?).

L133 - 41% of total European emissions (add European for clarity here)

L136 add "the" before "European"

L138. Is 656 the WUG estimate supposed to correspond to the 604 kt from UNFCCC? (i.e. the estimates are of the same thing but estimated slightly differently using different methods?).

L139 insert "the" before "country's"

L143 what does "these" refer to here (resources or seams?)

L157. this was confusing until I realized that the combined entities are referred to as fronts, not the individual facilities - the parentheses are vague as to which they refer to. Actually re-reading I am still not sure what this means.

L193 should there be a "and" prior to "is determined"?

Fig 3b the legend in the figure indicates that the boxes are the 95% CI but the caption says it's the 25% to 75% percentile, which is more standard for a box plot.

L335: Why is the methane emission not calculated for each return and then summed, rather than summing the air flow and averaging all the concentration measurements in a weighted fashion? As long as they are weighted by the air flow (presumably that is what is meant here), this is the same procedure (result) but much easier to explain.

Also, why could these measurements not be done in the ventilation shaft itself so that fewer measurements would be needed?

L340 Cch₄ is in percent by volume, please note (not by mass). Concentration often refers to a mass per unit volume, so should be clarified here.

L340 shouldn't Q_{air} be in m^3 air per minute, not CH_4 ? (or change to Q_{ch4}).

L346 "uses it to report it" should be reworded.

L351 And where are these measurements made, are they also in the returns or the ventilation shafts? [I see later much more discussion of this, but perhaps earlier on this could be mentioned. How does the methane sensor "protect" faces & longwalls?] Maybe make this a little clearer.

Fig 5 pressure is misspelled

~L400: Can the authors compare the approximate accuracy of this measurement with that of the other method that occurs quarterly? Also, when the uncertainty is stated as 0.1%, that is 0.1% of CH_4 concentration, not as a percentage of the value? (as later it is stated the uncertainties are close to 20% on the flux).

L435 spelling appropriate

L436 "analyzes" - > analysis?

L469-470 I'm not sure I follow the logic of why the fact that the peak concentration is higher than the average is important for verifying aircraft data - perhaps another sentence to connect these dots is needed?

Figure 8 (a) is not labeled (a).

Figures 7 and 8a & 8b should probably be re-made into a single figure with 3 panels that would go in better order: concentration, air flux, and then methane flux. Also why bars instead of box plots for the air flow figure? I like the box plots for all three if possible; that would allow for understanding the fluctuations in air flow as well as concentration.

Table 3 why do some shafts only have monthly averages? Is hourly data not available? How is there a standard deviation calculated on the monthly average when the period in question is mid-May to mid-June, i.e. one month. Is that the standard deviation of two values (one for May and one for June)?

Table 3 caption should probably mention the period again.

L496 much more complex than what?

L511. awkward last sentence, perhaps rephrase: "Increased mining activities will always result in methane outflow, regardless of the form the outflow takes"?

L520 is the uncertainty on these numbers $\sim 0.1\%$ (from earlier?). I.e., when it ranges from 0.1% to 0.2%, that means $0.1\% \pm 0.1\%$ to $0.2\% \pm 0.1\%$? Seems like a very high uncertainty when looking at these figures - is that correct, or perhaps the authors note if some of this variability is just uncertainty?

L556 and caption fig. 11, again, this is a language clarity issue - the total of all the mines was between 186 and 349 kg/min, not the emissions from the individual mines. The way this is written I would have thought that each mine was emitting that much, until I look at the figure.

L558 - I do not see 61 or 60 kg/min as a maximum anywhere in table 3?

L560, how is this number arrived at ? (142.68 kt/yr?). Is the average over all the mines 390.92 kt/day, how is that equal to 142.68 kt/year? what am I missing here? (a unit issue most likely?).

Table 4 - seems to be an extra column for some of the shafts? Not clear what this is, perhaps explain in the title.

L587 - is the more important assumption rather that the emissions from the shafts are stable? (i.e. we know the air flow rate is changing as well, so the flux is what is important here right?). fig 11 shows fluxes, not concentrations. This is a question actually, some of the text indicates air flow varies between mines (L486), but perhaps is more constant in time than the concentration. This could just be stated more clearly when the authors use concentration to stand in for flux. I would think that if a mine has an event with a high emission, the air flow is increased in order to maintain safe concentration levels so there would be some variability there.

L587+ Does either inventory method use the quarterly measurements in the ventilation shafts described earlier and also described here in line 593? L589 suggests that the inventories (MUG and EPRTR) are using measurements from "only one month" to estimate

across the entire year, but later L599 it is indicated they are based on a single measurement for each month. Please clarify.

L603 - ? unclear grammar but is this saying that the hourly fire telemetry data is not as accurate as the monthly or quarterly data? So would using the less accurate hourly data still be an improvement over the less frequent but more accurate existing measurements? This is an important question if this is what is being advocated, or is the paper advocating for improving the fire telemetry data (at what cost?) in order to get better averages? Also, if the telemetry data is not accurate enough for reporting, does that undermine the entire study here, because we cannot believe the hourly data over the current quarterly measurements?

L631 revolved is not the right word here? Maybe revealed?

L631 Where are these 61 and 60 kg/min numbers from, they are also in L558 presented as the maximum values for 2 specific shafts, and here they are presented as a range of values from all the mines. $60 \text{ kg/min} * 60 \text{ minutes/hour} * 24 \text{ hrs/day} = 86,400 \text{ kg/day} = 86 \text{ tons per day}$. The annual number of 142 kt/yr also does not match any of these, although it does work if the number is 390.92 tons (not kt) per day. This math needs to be clarified, units checked, etc. here and in the rest of the paper!

L634. Both over *and* underestimated

L645 - also air flow rates would need to be part of this yes?