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Comment on acp-2022-679

Anonymous Referee #2

Referee comment on "Flaring efficiencies and NO_x emission ratios measured for offshore oil and gas facilities in the North Sea" by Jacob T. Shaw et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-679-RC2, 2022

Review of 'Flaring efficiencies and NOx emission ratios measured for offshore oil and gas facilities in the North Sea'

The authors present flaring efficiencies and emission ratios for 58 plumes measured during aircraft campaigns to investigate emissions from hydrocarbon production in the North Sea. They present combustion efficiencies, methane and ethane destruction removal efficiencies, and NOx emission factors. They find their estimates are roughly consistent with results from previous flaring studies, of which there are few. There has been little previous assessment of offshore flaring based on in-situ measurements. As a result, I find the work to be an important contribution to further the understanding of the full climate and air quality impacts of flaring during hydrocarbon extraction. The manuscript is well written and logically presented, however, there are few areas that I believe require further context and/or clarification. I detail these areas in my comments below.

Specific comments:

Lines 18-20: The authors provide combustion efficiency both with and without ethane. Is one thought to more accurate than the other?

Lines 119-120: 'However, as we used enhanced C2H6 mole fractions (background subtracted) in this work, the systematic altitude-dependent biases were effectively removed,' How does the use of enhanced C2H6 remove the altitude artifacts? Or, are the enhanced C2H6 mole fractions measured over a constant altitude, making the altitude-dependent biases irrelevant?

Line 128: What constitutes a 'small temporal' discrepancy? <1s? 10s? If it is large, is there a chence the plumes might be misaligned for other reasons?

Lines 149-157: The existence of correlated enhancements are used to select the flare plumes. Are expected signals such that you would be sure to see them given your instrument detection limits? Put another way, would it be possible that there are small signals you cannot see, and would this potentially bias your results to only larger flares?

Line 158 (and throughout): Why do you use the median and not the mean here and throughout your analysis? It does not seem wrong but is there a reason why you do not use the mean?

Line 164: What is 'enough' data?

Line 192: The calculation of combustion efficiency here assumes the fuel is 100% CH_4 and no CO_2 is present in the fuel gas. Later you say the gas is on average ~85% CH_4, so how does this assumption of 100% CH_4 affect your results. You say there is a 'slight overestimation' but what is slight? Some sort of test case would help provide context here.

Line 200: 'Eq. 3 will still overestimate the true combustion efficiency by some amount.' Similar to the previous comment, what is meant by 'some?'

Table 1: Is the assumption of 50% NO and 50% NO_2 commonly used? I have seen some NOx studies use only NO_2 when converting to mass, but I have not seen this 50/50 split before.

Line 358: Your NOx:CO_2 ratios (0.003 ppm/ppm) are an order of magnitude larger than the values in Torres et al. (0.0002 ppb/ppb). What do you think explains this large difference?

Lines 384-389: Are the values from other works cited here specific to flaring or total emissions? If these other values are total emissions ratios, what does the comparisons mean?

Section 3.4: I am assuming that the inventory data shown in this section (and Figure 9) is for only flaring, but that is not explicitly stated anywhere.

Section 4: Do you have a sense of why the ECLIPSE inventory overestimates flaring

methane emissions by such a large factor? The size of the discrepancy warrants a bit more discussion as to potential causes.

Lines 429-431: I do not see this global extrapolation number (7.6 Tg) in Plant et al., 2022. They do state their DRE_CH4 is ~91%, which is similar to the 92% used by the IEA to arrive at 8Tg of methane from global flaring.

Lines 479-482: In this concluding paragraph and previously in the results section, you discuss the skewed distribution of combustion efficiencies, but the median and mean values are close to expected. If I understand correctly, your emission estimate uses only this median value. So what does the skewness lead to, if anything?

Figure D1-2: It is interesting that no flaring emissions show up in the North Dakota, USA region. There are high flaring rates there. Does this suggest some other error in how ECLIPSE estimates flaring emissions?

Figure D3: Similar to the previous comment, there are no flaring emissions in the USA. That seems odd given it is one of the highest flaring nations.