

Wu et al., 2022: Towards sector-based attribution using intra-city variations in satellite-based emission ratios between CO₂ and CO. ACP

General comments:

- Interesting and relevant addition to existing literature.
- Comprehensive description of the methodology, including many relevant figures detailing steps in the process. Clearly a substantial effort was put into the work.
- Discussion of the results (section 3.2) is somewhat limited in depth compared to the rest of the study.
- Good discussion of the limitations. However, one potentially relevant limitation is not covered (see major specific comments).
- Overall, paper is well written. The writing in some sections could still be improved by a thorough read through (e.g. section 4.3).

Major specific comments:

- The authors combine satellite data on XCO and XCO₂ that are collected at different overpass times. The authors have identified 3 factors that may complicate the combination of this data into accurate ER_CO values, which are discussed at length and properly considered in the data processing and interpretation. However, it appears one potentially relevant factor is missing, namely the timing of the CO and CO₂ emissions themselves. While possibly less relevant for industrial sources, other emission sources, such as road transport and residential combustion, may follow a specific temporal pattern where a time difference of 1-3 hours could lead to a mismatch in observed XCO and XCO₂ even when wind conditions remain relatively constant. Example: XCO₂ is observed during rush hour and XCO two hours later. This could add to the uncertainty in derived ER_CO values when overpass time differences are larger but remain < 3 hours.

Minor specific comments:

Abstract

- 15: "After removing those cases..." is the exclusion of cases only on the basis of a $t > 3$ hours' time difference or also separately on significant wind direction or plume shape changes?
- 18-19: This statement seems incorrect. If I understand correctly, a low ER translates to a higher combustion efficiency (... of heavy industry in LA compared to the city-wide value). In the comparison between cases, it would be preferable to talk either of the combustion efficiency or the ER, and not compare the combustion efficiency with the ER as this may lead to confusion.

1 Introduction

- 37: This statement is a bit tricky. In my opinion, for greenhouse gas emissions, the only key solution would be avoiding combustion of fossil fuels altogether. For some air pollutants such as NO_x, higher thermodynamic efficiencies may actually be accompanied with higher emissions. For many air pollutants, abatement technologies such as particulate filters or catalytic converters are more successful in reducing emissions than increasing the combustion efficiency.

2 Data and methodology

- Figure 2: “FF XCO₂ enhancements...”. Have the concentrations in these images indeed been corrected for the background/non-FF sources?
- 216-217: None of these 3 methods involve prior information on emissions, correct?
- 231-232: How does this method exclude observations elevated by another city? Simply by spatially limiting the plume definition sufficiently to avoid interference from another city?

3 Results

- Section 3.1: Here a discussion of a potential interference of changes in the emission of CO₂ and CO in the target area between two overpasses that may be up to 3 hours apart would seem appropriate (see major comments).
- 319-320: Not clear why the effect of biogenic and pyrogenic contributions itself is limited by removing overpasses interfered by wind shift.
- 348-349: Urban-background gradients in biogenic anomalies would not change FF (fossil fuel) enhancement by definition.
- 382: While it is clear for the enhancements, why the lockdown should influence ER_CO in a specific direction is not directly clear. Perhaps comment on a potential mechanism here. Also, for Zibo the enhancements on 2020-02-11 appear larger than on 2019-12-28.
- 392-394: “In contrast to LA, ...”. It is suggested here that wind speeds and direction do not change dramatically for LA, while the opposite appears to be suggested in line 386.
- 425: This is an important point for interpreting the results in terms of “combustion efficiency”. While in many industrial processes, hydrocarbons are combusted with the intention of achieving as high as possible combustion efficiencies, in iron/steel production, CO actually serves an important function during the process. While an iron/steel plant will aim at burning as much as possible the CO before release to the atmosphere, it still is a tricky comparison with other sectors under the concept of ‘combustion efficiency’. Perhaps a short mention of this would be appropriate.

4 Discussion

- 459-460: “...constraint can be relaxed”. This statement may need to be reconsidered when also taking into account the changes in emissions of (FF) CO₂ and CO during the day (see major comments).
- 461-462: This sentence is not clear to me. The text appears to suggest that the plumes during the overpasses on May 31, 2020 are sufficiently similar. Still, in figure 8 it is marked as an outlier (*). This also makes the relation to the next sentence (461-462) unclear.
- 497: I had to reread the paragraph on VOC’s several times and I’m still not really sure what is the conclusion on the relevance for the present work. Please consider guiding the reader a bit more.
- 516: “using the industry emissions from EDGAR”. Does this comparison indeed only consider industry emissions or also the other sectors (e.g. those shown in Fig S11d-f)?

Supplementary information

- Figure S7: The figure does not show the overpass time, that could for example explain the difference between the lower right figures (Zibo 2020-05-05 and Zibo 2020-06-21). Perhaps the colour can be used to indicate overpass time instead of the month (which is already shown above each graph).

Technical corrections:

Abstract

- 3: Consider using “combustion efficiency” consistently instead of “burning efficiency”.

1 Introduction

- 43-45: “Benefit ... reported”. Please check the sentence structure, it is not fully clear.
- 50: “be difficult.” some words are missing. Perhaps “...be difficult to identify”?
- 56: “diagnosed”. consider using a different term, e.g. “analysed”.
- Figure 1:
 - What sector(s) is “biofuel + ff” referring to? All anthropogenic combustion sectors?
 - In fig.1b the vertical (minor) grid lines fall in between years. The figure may be easier to read if these lines coincide with the years.
- 65-66: Not clear what is meant by “...the generalization and representation of gridded ERs.” Also, the next few sentences could be written a bit more clearly.

2 Data and methodology

- 107: “and surrounded coal-fired” → “surrounding”? or “presence of multiple coal-fired power plants”
- 109: “that is the spatial extent” → “that is in the spatial extent”
- 111: “that estimated” → “that are estimated”
- 111: “FF enhancements” this term is a bit vague.
- 116: “we illustrate how much ERs ... can be extracted.” What does this mean?
- 124: “north hemisphere”. This term appears to be more commonly spelled as “northern hemisphere”.
- 163: “interfere the calculation” → “interfere with the calculation”
- 218: “swaths of stretching” → “swaths stretching”
- 220: “have been emphasized” → “has been emphasized”

3 Results

- 375: No need to present two decimals for the crude iron production.

4 Discussion

- 451: “considered ~~for~~ when”
- 456: “Interfering the” → “interfering with the”.
- 456-457: Please rephrase, as the lack of concurrence is not itself inducing the wind directional shift.
- 464: “future geostationary satellite” singular or plural?
- 464: What is meant by “spontaneously” here?
- 468: “a urban” → “an urban”
- 512: “efficiency can” → “efficiency, which can”
- 513-514, 521: “inventory” → “inventories”
- Section 4.3. the readability of the text in this section could be improved by a thorough read-through

5 Conclusion

- 545: “industry-related ER_CO slightly lower” —> “industry-related ER_CO are slightly lower”

Supplementary information

- Figure S10: “distribution is stewed towards” —> “distribution is skewed towards”