

Interactive comment on “Determination of the Emission Rates of CO₂ Point Sources with Airborne Lidar” by Sebastian Wolff et al.

Anonymous Referee #1

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Manuscript “Determination of the Emission Rates of CO₂ Point Sources with Airborne Lidar” from Wolff et al., reports on integrated-path differential-absorption lidar CHARM-F aircraft observations during the Carbon Dioxide and Methane mission (CoMet) campaign in spring 2018. They describe the measurement system and how these measurements have been processed to obtain differential optical absorption depth (DAOD) used to quantify CO₂ emission rates of the coal-fired power plant Jänschwalde in Germany. They concluded that their results agree reasonable well with reported annual emission rates. However, they also found significant variations between individual over-flights up to a factor of 2. They suspected that these variations are mostly driven by turbulence and performed high-resolution large eddy simulations to investigate this.

The manuscript is very well written and covers a topic relevant for Atmos. Meas. Tech.

I recommend publication after the minor issues listed below have been considered by the authors.

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Abstract, line 8, sentence “Due to the large number of point sources and their global spatial distribution, a mobile measurement approach with fast spatial coverage is needed”: Unclear, why a “mobile measurement approach with fast spatial coverage is needed”? Why mobile? Why spatially fast? Regular on-site monitoring could be even better. Please consider to revise this sentence.

Abstract, line 15, sentence “emission rates can be derived in terms of the cross-sectional flux method”. I recommend to replace “in terms of” by “via” or equivalent.

Page 2, line 37, sentence “However, at the moment no operating satellite mission is able to reliably quantify emissions from large power plants.” Unclear what exactly is meant here taking into account publications such as Nassar et al., 2017, and Reuter et al., 2019, which need to be cited (details see below in “References”).

Page 2, line 60, sentence “Albedo variations basically influence the measurement precision (statistical uncertainty), not the bias.”: This is a bold statement. Is it really true that the impact of albedo variation on the bias is zero or are corresponding biases only expected to be very small?

Page 3, line 67, sentence “This principle has been applied for …”. The cross-sectional flux method has also been applied to satellite data, see Reuter et al., 2019. Please add this missing information.

Page 2, eq (2): Reader may wonder why delta sigma, the absorption cross section difference, does not depend on altitude. Later this aspect is addressed but I recommend to add some details on this aspect when presenting Eq 2.

Page 6, line 129: Reference to Strandgren et al., 2020: Unclear to which statement or fact the reference refers to. Please also add space between “2020)driven”.

Page 7, line 154, sentence “For the definition of the plume’s limits a running mean with



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such a width must be used that the plume enhancement is blurred." Not mandatory but please consider to improve this sentence.

Page 7, line 156, sentence: "Further on the data within the limits . . .". Please improve this sentence.

Page 9, Figure 4, right (photo): I wonder if the authors have the appropriate right to use the photo. Please confirm.

Page 10, line 213: What is "surface scattering elevation"? Just the surface elevation of the ground scene?

Page 10, line 214: Please add the unit for the reported delta sigma value. Caption Fig. 5 should be directly below the figure, not on the next page. Same for Fig. 1A.

Fig. 2A: Nice figure but please add information why "2 plumes" are visible in certain snapshots (is this related to different wind directions in different altitude?).

References:

Nassar, R., Hill, T. G., McLinden, C. A., Wunch, D., Jones, D., and Crisp, D.: Quantifying CO₂ emissions from individual power plants from space, *Geophys. Res. Lett.*, 44, 10045–10053, <https://doi.org/10.1002/2017GL074702>, 2017.

Reuter, M., Buchwitz, M., Schneising, O., Krautwurst, S., O'Dell, C. W., Richter, A., Bovensmann, H., and Burrows, J. P.: Towards monitoring localized CO₂ emissions from space: co-located regional CO₂ and NO₂ enhancements observed by the OCO-2 and S5P satellites, *Atmos. Chem. Phys.*, <https://www.atmos-chem-phys.net/19/9371/2019/>, 19, 9371–9383, 2019.

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