

# ***Interactive comment on “Can a regional-scale reduction of atmospheric CO<sub>2</sub> during the COVID-19 pandemic be detected from space? A case study for East China using satellite XCO<sub>2</sub> retrievals” by Michael Buchwitz et al.***

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Many thanks for taking the time to review our manuscript and for providing very useful feedback. Your comments and the comments from the other two referees have been carefully taken into account when generating the revised version of our manuscript. Please see below our response to each of your comments.

Referee: General comments The authors prepared an analysis of available satellite CO<sub>2</sub> observations to quantify impact of CO<sub>2</sub> emission reduction in early 2020 on the

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amplitude of the regional XCO<sub>2</sub> anomaly observed over East China. The analysis is made without detailed transport modeling and thus has to rely on the magnitude of the regional mean CO<sub>2</sub> concentration enhancements. Positive outcome of the analysis is that the change in the regional CO<sub>2</sub> difference relative to the background was possible to detect, and the negative one was that the uncertainty appears to be of the same order as signal. Authors cite weak signal, large variability in observation/cloud coverage and impact from biospheric fluxes on XCO<sub>2</sub> as complicating factors. The elaborate analysis is a valuable addition to a body of evidence on capability of global carbon observing system to detect the short and long-term changes in CO<sub>2</sub> emissions and sinks. The paper is well written and can be published after applying minor revisions and technical corrections.

#### Detailed comments

Referee: Introduction. Authors can use opportunity to mention more recent publications on the topic, complimentary to this study (Chevallier et al. 2020; Tohjima et al. 2020; Zeng et al. 2020)

Author's response: We have added references to these publications for the revised version of our manuscript.

Referee: L205-210 Not clear if the CarbonTracker-derived scaling of XCO<sub>2</sub> to FF emissions helps correcting for year to year variability in wind speed, or it is a climatology. Need to clarify. It can be mentioned Zheng et al, 2020b used transport model for a similar purpose.

Author's response: CarbonTracker data until end of 2018 were available when we started carrying out our study and for this study we used the last four years (2015-2018). During this time period we did not observe any time dependency such as a trend or anomalous years when looking at scaled XCO<sub>2</sub> anomalies versus FF emissions (see our Fig. 5). However, it cannot be ruled out that 2019 or 2020 were significantly different compared to previous years with respect to aspects relevant for our

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study. We essentially assume that this is not the case or that unconsidered variability is captured by our uncertainty estimates, which are based on differences of the October 2019 to May 2020 period and previous October to May periods. We improved related explanations in the revised version of our paper. We prefer not to refer to Zheng et al, 2020b, in this context as they used a different method and because this would require to also cite and summarize several other publications which would lengthen the paper with probably only limited added value.

Referee: L336 The DAM method is not supposed to extract exclusively anthropogenic emission contributions to XCO<sub>2</sub>, it is better to revise the sentence accordingly.

Author's response: Agreed. We will add the following: "(note however that the FMI method is not supposed to extract exclusively anthropogenic emission contributions to XCO<sub>2</sub>, see Hakkarainen et al., 2019)".

Referee: L355-362 The discussion gives impression that the satellite observation/retrieval errors are most important, while the contribution of the short and long-range transport including both biogenic and fossil signals is not explicitly mentioned, while it is likely to contribute to differences between different time periods, especially across GOSAT products.

Author's response: Agreed. To consider this, we have added the following: "Of course also other sources of uncertainty are relevant in this context, in particular time dependent atmospheric transport and varying biogenic CO<sub>2</sub> contributions (e.g., Houweling et al., 2015, and references given therein).".

Referee: L365 If errors do not scale with the inverse of the square root of number of observations, then those may be not random enough.

Author's response: Yes, this is true. There are (unknown) systematic errors and error correlations. We have added this information. Technical corrections

Referee: L92 Suggest checking reference format: Sussmann and Rettinger, 2020, or

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(2020)

Author's response: Many thanks. We have harmonized the reference format.

Referee: L770 Zheng et al. paper status changed to published.

Author's response: We have updated this.

## References

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