

Interactive comment on “Estimation of fossil-fuel CO₂ emissions using satellite measurements of “proxy” species” by Igor B. Konovalov et al.

Anonymous Referee #1

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General comments

This study presents a method for estimating anthropogenic CO₂ emissions based on the proxy of NO_x and CO emissions. The method includes rigorous quantification of uncertainties due to the uncertainty in NO_x and CO emissions from inversions using satellite retrieved NO₂ and CO columns, respectively and to the emission factors. The method and its explanation are generally sound, however, I have a few specific comments. I recommend the manuscript for publication with minor corrections.

Specific comments

P2, L14-15: This statement needs a bit more explanation, the 2014 emissions will be the starting point for what?

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P3, L1: Technically speaking, the emissions (or emission parameters, depending on which is being optimized) are not in the transport model but are coupled to it.

Section 2.2: The authors do not mention what the boundary conditions were for other species used in the MELCHIOR scheme that react NO₂ and CO. Concentrations of NO₂ are strongly affected by atmospheric chemistry (lifetime of ~ 1 day) so how important is the correct representation of chemistry on the NO₂ simulations and thus in the emissions from the inversion? Similarly for CO, although owing to its longer lifetime this is perhaps not so important. How are the uncertainties in the lifetimes propagated into the emissions found from the inversions?

P9, L1-2: Why were cement emissions of CO₂ ignored? What is the impact of this if the system would be used in a region where cement emissions are more important?

P9, L12-15: Do the authors mean that their motivation for solving for 2 categories of sources (EHI and TCO) is to reduced the aggregation error, because these sources have different temporal/spatial errors? If so, this could be made clearer and stated early, e.g. P9, L3 when the grouping into these categories is first mentioned.

P12, Eq. 4: How well conditioned is this expression? The authors use no regularization method?

P13, L15-16: The condition given, i.e., that the control vector is smaller than the measurement vector is not sufficient. A sufficient condition is rather the condition number of the matrix inverted. One could imagine a case where there are more measurements than unknown variables but where each measurement provides only a weak constraint (or even no constraint) on the unknown variables.

P17, L18-25: Are the results of these 2 cases discussed? They are mentioned here but there is no conclusion given about the uncertainty in the posterior due to potential errors in the seasonal cycle.

P18, L3-7: How independent are the conversion factors among the three inventories?

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How are the factors determined? Do they rely on independent observations? This is important, as error in the conversion factor will translate directly into error in the CO₂ emissions.

P22, L31: It would help the reader to specify again what the analysis (in section 2.4) is being referred to here, the lower sensitivity of the IASI measurements to CO emissions?

P23, L23: I would suggest either removing “robust” here or rephrasing the sentence to e.g. “. . .uses an approach, which is deemed more robust at the global scale”, because the current formulation sounds somewhat contradictory, i.e., the EDGARv4.2 inventory is worse than EMEP in Europe but uses a more robust approach.

P25, L24-27: I’m somewhat confused. The conversion factors were determined from the ratios of CO₂:NO_x and CO₂:CO in the inventories, so if the inversion results for NO_x and CO are not significantly different from EDGARv4.2 then how can the result for CO₂ be significantly different from EDGARv4.2?

Technical comments

P2, L5: “the potential”

P2, L9: “. . .gas, the increase in which is the driving force of recent. . .”

P2, L10: although I understand what the authors mean, the future tense should be used to reflect changes that will occur in the future, i.e., “. . .is the driving force of recent climate change and will likely remain to be in the future. . .”

P2, L11: “in the past decade”

P2, L17: “the compilation of”

P2, L28: “the estimation”

P3, L2: “in contrast to”

P5, L19: although I don’t think all acronyms need to be specified, as some are well

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known satellite names, I do think KNMI should be specified as it is an institute's name and perhaps not widely known.

P5, L31: “constraints on”

P7, L4: “allows to take into account the most important atmospheric processes”

P17, L18-19: “. . .emissions more probably result in. . .”

P22, L26: remove “quite” before “surprising”

P22, L26: “a very large number of individual retrievals”

P25, L12: I'm not sure “replicate” is really the right word here but perhaps “correspond to ”

P28, L29: replace “smaller” by “lower”

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