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Geoscientific Model Development Discussions

Interactive comment on "Optimizing a dynamic fossil fuel CO_2 emission model with CTDAS (v1.0) for an urban area using atmospheric observations of CO_2, CO, NO_x, and SO_2" *by* Ingrid Super et al.

Anonymous Referee #2

Received and published: 17 February 2020

The paper describes a new modelling framework to describe urban fossil fuel emissions of CO2 (ffCO2) in which emission ratios vary in time in space. To achieve this, the authors use atmospheric gases that are co-emitted with ffCO2 and range of proxy data that are associated with typical sectors that lie within the urban domain. They apply the resulting framework to a synthetic numerical experiment focused on the Rijnmond area, Netherlands.

This is a nice piece of work that with some development will eventually address some of the outstanding challenges we face as a community to quantify urban ffCO2. My recommendation is to accept the manuscript for publication after the authors have ad-

dressed my comments.

Broad comments

This is a chunky piece of work that contains a lot of information. For the sake of readability I encourage the authors to consider judicious use of additional appendices.

I have seen the authors present this work before and the use of "dynamic" has always rankled me. They could have just as easily described their new inventory as an on-line model that is fed with time-dependent data with resulting emissions being passed directly to subsequent atmospheric calculations. This is in contrast with static or off-line inventories. Static inventories can also be dynamic in time and space, albeit on a discrete basis.

The figures are of low quality. Not sure why. I could barely read the text in Figure 1 and many of the other figures are grainy. Better quality figures will ultimately make the work easier to appreciate.

Figures would also benefit from being labeled directly, e.g A), B), C), etc. In some instances when columns are rows show something common a well-placed label would be useful. For example, Figure 4 would benefit from "Gas fired" and "Coal fired" labels for the top left and top right labels.

Bug bear: kindly please refrain from using "quite" as a descriptor throughout your paper. It is scientifically meaningless. Focus on the statistics that often accompany your statements.

Specific comments

Line 141: reason for greenhouses would be welcome here. Please mention tomatoes later but introduce the usage here.

Section 2.2.1. I think there might be a problem with units in your equation. Flux Fx should be mass/time but units of the contributing variables don't result in that unit.

Please clarify units for all variables shown in equation 1.

Figure 2. Please make this bigger.

Lines 203- 216 describe the definition of the time factor. I found the exposition of this point opaque, especially the accompanying mathematics. Please expound your argument.

Figure 3. The drop in relative gas consumption during May-Sept presumably reflects warmer weather. Are the spikes during this period due to cold days?

Pages 8-9 I was unclear reading through this text how much was based fact, e.g. the reason behind gas-fired power plants (weakly) negatively correlated with wind speed, and how much was interpretation. Please clarify. Generally, this reader would appreciate a summary table that explains which variables are being used as proxy data for various urban sector emissions.

Curiosity: are gas-fired power plants quicker to respond to shortfalls in energy provision than coal-fired plants? Does this explain the weaker correlation reported in lines 259-261?

Uncertainty analysis shown in Section 2.4.1. is important for inverse modellers. Is this a stop-gap approach or do you envisage this as a final method?

Section 2.2. Convention dictates that vectors and matrices are denoted as emboldened lower- and upper-case variables, respectively.

Section 2.2.1. There is a lot being described here. Worth a schematic?

Section 2.2.3. Closed-loop numerical experiments are considered useful only if the truth and prior are independent in some way. Some calculations might use independent inventories while others use independent transport models. Using the “dynamic” version of the static inventory is not sufficiently independent (e.g. Figures 5 and 6). Consequently, the authors have presented a very optimistic scenario. At least, the

author should acknowledge this situation.

Section 2.2.3. The authors assume no contribution from biogenic CO2 to the excess CO2 over the background. This is not a general assumption. How will they cope with an urban area with parks, for example?

Section 2.2.3. A few more details are necessary to describe the data. Ideally, earlier in the manuscript. I am surprised that the authors can achieve what they have with a handful of data collected at 10 metres a.s.l. Maybe this can only work in the Netherlands? Also, what is the origin of the values used in the R matrix?

Section 3. State that CI = confidence interval. Also, clarify “Below the annual scale” on line 543.

Section 3.2. The result associated with a shortened state vector was interesting and something this reviewer had not considered fully. How do we decide on the correct length of the state vector? Will this be location specific?

Minor comment: avoid using yellow in figures (Figure 10).

Figure 11 would benefit from a legend. It contains a lot of information that was all in the text and figure panel but it took a while to pick through it all.

Line 650. I would say that this approach provides a more detailed physical meaning of the results compared to estimating emission estimates.

Line 652. Non-included parameters?

Line 659. If your online inventory is using weather data to drive variations then you could use the correlation lengths associated with weather systems?

Section 4.2. Putting all your eggs in one basket with radiocarbon is not a wise move. It is one weapon in your arsenal. With the growth of biofuel combustion in urban regions, there will be a lot of combustion CO2 that is missed using radiocarbon. Something to consider in your discussion, especially since your group has just published work on this

topic that makes my point.

Line 774. Are you saying that your model has an advantage because it uses a source of information (emission-related parameters) that is often neglected by emission inventories?

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