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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Estimation of continuous anthropogenic CO_2 using CO_2, CO, $\delta^{13}C(CO_2)$ and $\triangle^{14}C(CO_2)$" *by* S. N. Vardag et al.

Anonymous Referee #2

Received and published: 25 August 2015

This manuscript by Vardag et al. presents a modelling study of anthropogenic CO2 using simulated CO2 and CO mole fractions, as well as simulated δ13C(CO2) and Δ14C(CO2) isotope measurements, at three conceptual measurement sites representing urban, polluted and rural environments. Overall, the manuscript is well-written, and presents a thorough analysis of the sensitivity of different types of theoretical measurement site (e.g. rural, polluted, and urban) to anthropogenic CO2. The authors also assess the potential detection of anthropogenic CO2 from various sources at each type of measurement site using different combinations of CO2 and related tracers. This work will be useful to the atmospheric community, is well suited to the remit of ACP, and following some minor revisions is recommended for publication in ACP.

General Comments:

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Interactive Discussion
Discussion Paper

The title could be improved so that it is explicit that this is a modelling study.

This manuscript would benefit from either changing the site type descriptions 'urban' and 'polluted' to terms that are more dissimilar, or a more detailed description of these terms, since it is currently not clear what the difference between these two are, or which measurement site is expected to 'see' more anthropogenic CO2.

There are a few sentences (e.g. 3rd paragraph of section 2, and lines 24 - 25 of page 20190) where the authors state that a number of fluxes and/or processes have been excluded in the modelling analysis; some extra text justifying the exclusion of some fluxes, and the expected impact of these exclusions on the analysis is recommended.

There are some sections of the text, particularly in the results section, that are difficult to follow, and would benefit from greater clarity.

The authors state that it is not currently feasible to determine fuel CO2 at rural sites, owing to the high uncertainty to signal ratio typically found at such sites, however, the definition of 'rural' is somewhat subjective. It might be more helpful to provide a minimum detection limit of fuel CO2, since some measurement sites might be classified as rural, and yet might still detect fuel CO2 above the detection limit. The authors should therefore exercise caution in their recommendation of revising atmospheric network designs that aim to quantify fuel CO2, partly because some rural stations might still be suitable if they are located down-wind of large population centres, but also because improvements in understanding/quantification of fuel emission ratios in the near future and improved methods for determining fuel CO2 may nullify this issue by reducing the uncertainty of fuel CO2 quantification.

Specific Comments:

The introduction section mentions the current limitations of verifying anthropogenic CO2 emissions from inventories, however, the authors do not mention atmospheric transport modelling uncertainties, which also contribute to anthropogenic CO2 emis-

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sions uncertainties in 'top-down' verification studies.

The time period over which RF is averaged should be stated, as this is not currently clear from the text on lines 16 – 17, page 20185.

Line 5 of page 20189, section 2, states that 100 particles are released within STILT. This is rather low – has the potential bias of using so few particles been investigated? Is there justification for using so few particles?

The description of the term 'footprint' on lines 8 – 9 of page 20189, section 2, could be improved.

The fact that Δ14C(CO2) is not sensitive to biofuel contributions (lines 10 – 14, page 20193) might be advantageous, if one wishes to determine fossil fuel only anthropogenic CO2. Similarly, the fact that the CO method is insensitive to biofuel might be disadvantageous for some studies that wish to only determine fossil fuel CO2. This point of view should be acknowledged in the manuscript, since many readers will be interested in determining fossil fuel CO2 only, rather than all fuel CO2.

The abstract text does not currently accurately reflect all the key findings/conclusions of the manuscript.

Technical corrections:

The term 'short-cycle carbon' is ambiguous.

There are several grammatical errors in the introduction section that should be rectified for greater clarity, e.g. lines 23 – 27 of page 20185, lines 1 – 2 of page 20186, etc.

Typing error on line 13 of page 20194.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 20181, 2015.