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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Measurement of fossil fuel derived carbon dioxide and other anthropogenic trace gases above Sacramento, California in Spring 2009" *by* J. C. Turnbull et al.

Anonymous Referee #1

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General Comments: This well-written paper presents an interesting study in which multiple trace gas measurements from a campaign-based flask and in-situ data set are analyzed. The analysis is sounded and well structured also giving all details on sample retrieval and treatment. Using 14CO2 as tracer for fossil fuel CO2 is a well established technique, yet the use of fossil fuel CO2 as a means to improve knowledge about the emission of other anthropogenic tracers (such as VOC, . . .) in an urban environment is not discussed thoroughly in other publications. This study conclusively shows how a combined interpretation of 14CO2, CO2, CO, VOC and other trace gases can be very beneficial.

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One issue which should be further discussed in this study is a potential bias of the flux (and x:CO2ff ratio) estimates due to the limited amount of data. Both flights presented were conducted within 8 days and always at the same time of day 2 pm – 5 pm . Hence any seasonal and diurnal variation of the fossil fuel CO2 fluxes and the tracer:fossil fuel CO2 ratio are not accounted for. The question arising is: Are the fluxes derived during these 3 hours at 2 days comparable to mean annual emission estimates? Although this is mentioned, it should be further discussed as the results indicate a strong influence from road traffic emissions (p21580 l.24/25) which is known to have a substantial diurnal variation of emission (Easily a factor of 2-3 during rush-hours compared to other times of day). Hence the derived flux estimates could be biased towards higher values. Furthermore, the emissions from domestic heating (usually) show a distinct correlation with the ambient temperature thus this might also lead to a bias in the estimate of the CO2 ff fluxes and the mean annual ratio of e.g. CO:CO2ff as this should vary within in the year as the fossil fuel CO2 source mix changes (Rather constant emissions from the road traffic sector throughout the year, while domestic heating emissions vary from winter to summer) .

A typical mean diurnal cycle of road traffic emissions and the seasonal variability of other sources should/could be used to adjust the estimated fluxes to derive a more “representative” estimate to compare with the mean annual fluxes from bottom-up inventories.

Besides this single issue, that in my opinion needs further discussion, only minor changes are suggested. As beside the high quality the overall topic of this study is completely in the scope of ACP and I recommend this paper for publication, after revisiting the mentioned point.

Specific and technical comments:

p.21571 l.22 At this point I think an influence from biomass burning on the local CO2 levels cannot be generally ruled out and should be mentioned.

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p.21573 l.20 As the water correction for the CO2 data of SAC306 is quite large (5ppm) the uncertainty of this correction would be of interest and if this is accounted for in the latter calculations?

P.21577 l.11 Besides the respiration (from the soil) do you also "principally" consider an influence from BMB to CO2_other?

P21578 l.18/19 The comparison to the tower measurements seems to also have some potential to further investigate the diurnal changes of at least the CO:CO2 ratio using the Walnut Grove in-situ measurements and might be worthwhile including.

P21579 l.4 " removal [of CO] is negligible. . . because the samples were collected within a day of emissions from the source region" Your assumption seems to rule out any influence from sources farther away. Without a conclusive modeling result I would hesitate to believe that all of the excess CO2, CO2ff, and so on, originate from Sacramento alone. Usually I would expect the footprint to be larger maybe also including surrounding counties/states.

P21579 l.20ff For the comparison of the derived CO:CO2ff ratios from the flasks with the vehicle tail pipe emissions the representative issue arises again (see general comments)

P21580 l.24/25 the found "strong influence from road-traffic" may imply that the diurnal variability of fluxes (and emission ratios) from this emitter group has to be more deeply discussed. (see general comments)

P21582 l.23/24 I would assume that the given 10-20% uncertainty derived from the comparison of two bottom-up inventories should be regarded as lower bound for the uncertainty, as both bottom-up techniques surely share a significant amount of statistical information and might both have similar methodological biases (missing sources, emission displacements).

P21583 l.28 Given the (seasonally) changing contributions of different emission sectors

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to the CO2ff and CO overall emission was there a specific reason assume “flat emission throughout the year” for Sacramento County ?

P21584 l.4 What is the rational for an exponential extrapolation of the emission decrease?

P21485 l.14 At this point the potential influence of the sampling interval and the comparison of campaign data to annual mean fluxes is mentioned, I guess here the needed further clarification on that issue would be very beneficial.

Section 3.6. Using a mass-balance approach is a generally valid approach, yet many assumptions have to be made (single source etc.). Nevertheless even with the limited accuracy of this approach nice results are found, still to fully exploit the available an accompanying modeling study would have been insightful.

P21591 l.5 Again comparing annual means with this campaign-based data maybe needs careful attention.

Figure 4. A combined fit for SAC227 and SAC306 seems not reasonable for total CO2, as you pointed out they seem to display two different regimes.

Caption Fig.4. In the given color version: CO:CO2ff(black line) -> CO:CO2ff(green line), CO:CO2 (grey line) -> CO:CO2 (blue line)

Figure 7. Changing dates to more human-friendly ones, (time of day in local time or UTC) could ease the interpretation of this plot.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 21567, 2010.