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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On using radon-222 and CO_2 to calculate regional-scale CO_2 fluxes" *by* A. I. Hirsch

A. I. Hirsch

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Final author comments responding to Referee #1 comments on "On using radon-222 and CO2 to calculate regional-scale CO2 fluxes" by A.I. Hirsch

Response to general comments:

1) I chose summer and autumn for the following reason: first, I noticed that very few studies using the radon-tracer method focused on summer, for the obvious reason that radon and CO2 concentrations are generally poorly correlated. I therefore asked whether it would be possible to calculate CO2 fluxes using an individual pair of radon and CO2 measurements. It is indeed possible, yet I noticed that the results were strongly influenced by covariance between transport and CO2 fluxes, even when averaged over a month. This bias has implications for studies that employ the radon-tracer

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method to monthly average values of radon and CO2 during the summer. I chose autumn because I hypothesized that it could be possible to have a good correlation between CO2 and radon (implying that the assumptions of the radon-tracer method are justified), yet still have a bias due to the covariance term. I found this to be the case, at least in my synthetic data study. To be honest, I did not think to question the accuracy of the radon-tracer method during the winter, since for the region I focus on it is the time that the technique is likely to be most accurate. The point of the paper is not that the radon-tracer method is always biased; rather, it is that there are times of year when care must be taken to account for possible biases. Covariance between CO2 flux and concentration footprint patterns during the growing season is known to be of fundamental importance when interpreting CO2 concentrations. I am trying to present a synthesis between the radon-tracer technique (which has not considered this effect) and inverse modeling studies (that do account for this effect). When I apply the technique to real data (boundary layer radon and CO2 are currently being measured continuously at the location I simulate in this paper), I will need to assess the accuracy during all seasons using synthetic data experiments like the one presented in this paper.

2) The method I present to correct radon for radioactive decay is only for radioactive decay. Dilution by the free troposphere is accounted for by the response function (concentration footprint), calculated by the transport model. This point will be clarified in the revised manuscript.

3) In breaking the CO2 signal into biospheric CO2 and anthropogenic CO2 I was following the convention of much of the inverse modeling and radon-tracer literature. I agree that it would be interesting to show the sum of NEE and fossil fuel fluxes; to keep the paper concise I felt it made sense to limit the paper to a focused study of the two different types of CO2 flux, especially since this is a synthetic data study.

Response to specific comments:

ACPD
6, S7279–S7282, 2007

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1) The term “radon-222” will now be used throughout the paper.

2) NEE is now defined (Net Ecosystem Exchange of carbon dioxide).

3) ARM-CART is now defined

4) PBL now defined

5) Table 1 now referenced. Correlation coefficients added to the table. I don’t have a way at this point to assess how the lack of cloud convection in STILT affects the results in Table 1. The reason is that only now are mass fluxes being developed for STILT that have realistic cloud convection. Once I have a good set of mass-fluxes from the B-RAMS model or the WRF model, I can explore this interesting question, and verify that this relationship still holds. I will mention this in the revised manuscript. I could also explore the issue using the LPDM “Flexpart” which I’ve been using for other studies, where I could turn convection on and off. However, when I wrote this paper, I had not started using Flexpart yet, so I considered the issue outside the scope of the paper.

6) As mentioned above, 222Rn* is only adjusted to account for radioactive decay. Even when treated as an inert tracer, the concentration is lowered by dilution by the free troposphere, an effect captured by the transport model.

7) “i” indices added back in

8) Intermediate line added as suggested by the Reviewer.

9) Correlation coefficient, offset and gain added for comparison with previous studies.

10) Lines 2-13 on page 10939 now included in Section 2.3. See above comments regarding the dilution effect

11) RHS now defined (Right Hand Side).

12) Space character added.

13) Legend now added to the figures 2, 4 and 5. Legend for figure 4 corrected.

ACPD
6, S7279–S7282, 2007

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 10929, 2006.

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6, S7279–S7282, 2007

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