

Interactive comment on “On using radon-222 and CO₂ to calculate regional-scale CO₂ fluxes” by A. I. Hirsch

Anonymous Referee #1

Received and published: 12 February 2007

Radon-222 has been widely used to infer emissions fluxes of trace gases such as CO₂, CH₄, N₂O, CFCs and methyl-chloroform at the regional-scale. This technique uses radon-222 to calibrate the flux of a given trace gas based on a measurements only approach. The “radon-tracer” method strongly relies on the following assumptions: (1) a well-quantified radon-222 flux; (2) a uniform radon-222 flux; and (3) co-location of emissions sources of both radon-222 and the specie of interest. The inferred flux is representative of an area which remains to be determined. This is generally achieved using a model-based footprint analysis.

The paper by A. Hirsch uses synthetic radon-222 and CO₂ data for the months of July and September 2000 generated using EDGAR CO₂ fossil CO₂ flux, SIB2 Net Ecosystem Exchange (NEE) CO₂ flux, and a typical radon-222 flux of 1 atom.cm⁻².s⁻¹. It is

somewhat surprising that the author picked summer and fall months rather than summer and winter months for his study. The paper presents an alternative way to correct the “radon-tracer” method for radon-222 radioactive decay and dilution with the free troposphere (although is not always clear if dilution with the free troposphere is included). The author shows the difference between weighted average and evenly-weighted spatial average CO₂ flux inferred using the “radon-tracer” method and demonstrates that the “radon-tracer” method, as used in previous studies, needs to be corrected for covariance between the flux of CO₂ and the footprint sensitivity (unless the covariance term is small). The comparison of NEE and fossil fuel emissions inferred using the “radon-tracer” method and output model simulation is interesting and shows that the magnitude of the correction is quit large. The fact that this correction is on the same order of magnitude as the “radon-tracer” method inferred flux in July and September for both NEE and fossil fuel emissions is disturbing. Again, showing the difference between a winter and summer month would possibly draw a different picture. A detailed analysis of the uncertainties of the method and a comparison with other techniques are also shown. As mentioned by the author, it would be extremely valuable for the “radon-tracer” method to study the impact of a non-uniform radon-222 flux on inferred CO₂ fluxes. The paper paves the way for a study on bottom-up and top-down approaches using “real” rather than “synthetic” data, and regional inventories of NEE and fossil fuel emissions.

Overall, the paper reads easily and it will be well worth publishing in *Atmospheric Chemistry and Physics* after a few, relatively minor, problems have been addressed.

Notably:

1. Use the word radon-222 consistently through the whole paper (pick either radon-222 or radon).
2. Page 10931, line 24, NEE needs to be defined
3. Page 10933, line 5. ARM-CART is an acronym, and should be defined (Atmospheric

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

4. Page 10933, line 10. PBL should be defined as Planetary Boundary Layer.

5. Page 10934, line 12. The author mentions a “compact relationship” between the inert tracer and the radioactively decaying tracer. I believe “Table 1” should be referenced here. Correlation coefficients should be added to the table. How does the lack of cloud convection in STILT affect results in Table 1?

6. Page 10935, line 14. $^{222}\text{Rn}^*$ is actually radon-222 adjusted to remove both the effect of radioactive decay and dilution with the free troposphere.

7. Page 10936, line 14. To be consistent with the paper notation, “i” indices should not be omitted. Line 14 should read: “In (7), F'_i and f'_i terms represent the deviation...”

8. Page 10936, line 16. One intermediate line could be added to help the reader. “By definition, the summed cross terms for CO_2 vanish ($\sum_{i=1}^n (F'_{i,\text{CO}_2}) = 0$), leaving:”

$$\Delta[\text{CO}_2] = \overline{F_{\text{CO}_2}} \sum_{i=1}^n (\bar{f} + f'_i) + \sum_{i=1}^n (F'_{i,\text{CO}_2} f'_i)$$

$$\Delta[\text{CO}_2] = \overline{F_{\text{CO}_2}} \sum_{i=1}^n f_i + \sum_{i=1}^n (F'_{i,\text{CO}_2} f'_i)$$

9. Page 10938, line 13–14. Correlation coefficient, offset and gain should be calculated and included in the text for comparison with previous studies.

10. Page 10939, line 2–13. This paragraph does not belong in section “Deducing NEE using radon-222 and CO_2 ”, but should either be: (1) a stand-alone section on the impact of correcting for radioactive decay and dilution with the free troposphere, or (2) included in section 2.3 correcting for the effect of radon-222 decay. There is no mention of the dilution effect. Is this still included or did the author neglect this effect?

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

11. Page 10939, line 15. First time “RHS” is introduced. It needs to be defined.

12. Page 10941, line 21. A space character is between “the” and “detection”.

13. Page 10954, figure 2. A legend on the figure itself showing the different line styles would help reading the figure (dash: September – 25 m; thick line: July – 500 m; thin line: July – 25 m). This is especially true for figures 4 and 5 whose line styles are defined in Fig 1.

As a general comment, I think it would have been interesting to show the net CO₂ flux (NEE + Fossil fuel) inferred from the radon-tracer method, before breaking this study into NEE and Fossil fuel sections.

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

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper