Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2015-919-RC2, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Detecting long-term changes in point source fossil CO_2 emissions with tree ring archives" *by* E. D. Keller et al.

Anonymous Referee #2

Received and published: 15 February 2016

This is an excellent paper showing the use of radiocarbon analysis of tree rings to document changes in fossil fuel CO2 emissions on a small spatial scale. It describes a study using two trees close to a natural gas processing plant and a urea processing plant in New Zealand, far removed from other major anthropogenic sources of CO2. Radiocarbon measurements of annual tree rings are used as proxies for CO2ff and compared with the known emissions of the natural gas processing plant, using results from atmospheric transport modeling by WindTrax. The modeling results are used to evaluate the sources of uncertainty and to determine what magnitude variations in emissions could be detected from point sources using this method. The magnitude of detectable inter-annual variations depends heavily on the magnitude of the emissions source. For a small source, such as that studied here, the change in emissions from one year to the next must be 42%, 22% for four years of new samples. However,

for a more typical source, such as a major power plant, a 10% sustained change in emissions would be detectable, if the sampling location is appropriate in terms of wind direction and speed. This method could be very important for monitoring emissions reductions from major point sources.

Overall this paper is very well written and the arguments are generally easy to follow. It is appropriate for publication in Atmospheric Chemistry and Physics with some revisions.

Comments: I have questions about the meteorology used for the modeling. You compare the limited data set at Kapuni, close to the sampling site, with the much more complete set at Hawera, 20 km southwest of the sampling site. You state that the correlations between wind speed and wind direction between the two sites are consistent enough to warrant using the complete Hawera data set, as shown in a direction comparison for limited dates during August-October 2012 (Fig. S2). But is the limited period in 2012 adequate for evaluating whether Hawera data are appropriate for modeling wind transport at the Kapuni site? Moreover, Figures 2 and S1 show that the wind speed at Hawera (6-7 m/s) averages on the order of twice that at Kapuni (2-3 m/s). Have you done any sensitivity calculations to see how this difference in wind speed affects the modeling? The wind directions seem to be fairly consistent at the two sites.

p.1, line 25: change "lowers" to "is reduced"

p.2, line 9: rearrange "reduction targets are commonly agreed as" to "commonly agreed upon reduction targets are"

p. 3, lines 16-17: You mention here and again later "the [photosynthesis] process faithfully recording the 14C content in new plant material", but you only reference the work showing this significantly after the mention on p. 11. It might help the reader to have this discussion earlier, since it is critical to the method.

p. 5, line 18: "2008" should probably be "2007".

p. 6, line 13: insert Δ14C before “measured”.

p. 6, lines 15-20: How long are the more local sites’ records? Is it important that the background site have data back to the early 1970s if the data you are looking at only starts in 2004?

p. 6, line 32: Add “end of” before “Sect. 2.7”.

p. 9, line 18: Add “at Hawera” after “eight years”.

p. 11, lines 14-16: Is this also true for the moderately unstable conditions used here?

p. 11, line 18: Add “as explained below” after “variable”.

p. 11, line 23: Is there any Cbio (local biosphere contribution)?

p. 11, line 27: Since background is very important to these calculations and the thesis describing these background samples is not readily available, can you describe what samples were used for background and how they were determined to be appropriate background samples?

p. 12, lines 1-7: Can you move this to earlier in the discussion, perhaps above the equations?

p. 14, line 7: You need a conclusion statement explicitly relating these numbers to meteorology.

p. 14, lines 13-14: The hypothetical sensor at W 600 m has smallest variability.

p. 14, line 19: Add “(Table 2)” at the end of the sentence.

p. 18, Conclusions: Add context to the names of the trees, since some people might read only abstract and conclusions! Examples below.

p. 18, line 31: After “pine tree”, add “, 400 m from the major source”.

p. 19, line 1: After “chestnut tree”, add “1 km from the major source”.

Figures: In general, increase font sizes for labels. Label panels within figures “a”, “b”, “c” to make it easier to refer to them in the text.

Figure 1: Can you add a large-scale location map locating Taranaki in New Zealand, as well as Hawera and Mount Taranaki? Add a label for Kapuni stream.

Figure 2: Font sizes. Label the legend (m/s).

Figure 4: The bottom axis of the top panel is missing. Increase the font size of the axis tick labels in all panels. The dates don’t line up between the top two panels and the bottom panel. Increase all font sizes for the bottom panel. You use a subscript for CO2 in the bottom panel, but not in the top two. In the caption: “Dotted and dashed lines show modeled and observed six-year means, respectively.”

Figure 5: What do the different colors for the circles indicate? The legend only shows the purple color.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-919, 2016.