

Interactive comment on “Sixty years of radiocarbon dioxide measurements at Wellington, New Zealand 1954 – 2014” by Jocelyn C. Turnbull et al.

J. Miller (Referee)

john.b.miller@noaa.gov

Received and published: 1 March 2017

General comments.

This paper documents and analyzes the longest atmospheric radiocarbon time series from a single site. Obtained near Wellington, New Zealand starting in 1954 and continuing to the present, these data represent a signature time series of carbon cycle science. The authors document the revision and evaluation of the data, which should lead to a significant improvement in its scientific utility. The seasonal cycle and trend are analyzed convincingly, although too much attention is paid to the hypothesis that an increased Southern Ocean CO₂ sink can explain the changing $\Delta^{14}\text{C}$ atmospheric north-south gradient. While it's true that the change in the north-south ^{14}C gradient

C1

supports this idea, there is no new analysis of the time series to bolster it. One additional point is that it would be good to provide the internet location of the data in addition to the static spreadsheet provided. Presumably the ftp site would contain the data set of record including the latest data, flags, and corrections. Nonetheless, this is a strong paper that is entirely appropriate for ACP; it should be published after a few modifications.

Below, I list some edits and comments by line number.

Specific comments.

L21,22. While Cape Grim air samples may contain anthropogenic signals in winter, air samples have often been collected during times when the wind is not coming from the north.

L44. 'exchanges' is a bit vague. Why not spell it out to say that ^{14}C reacts immediately with O₂ to form ^{14}CO , which is subsequently oxidized to $^{14}\text{CO}_2$

L68-70. This is redundant with text around L44.

L75. Perhaps strike 'now', and add 'in the two decades following the atm. test ban treaty' at the end of the sentence.

L77. I don't agree that the additions of fossil fuels became the dominant factor influencing the $^{14}\text{CO}_2$ trend. If fossil fuel CO₂ additions are 'dominant' I would think of them being an order of magnitude or so larger than other processes. Presently (and more or less in the 1990s), fossil fuel combustion alone would reduce the atmospheric $\Delta^{14}\text{C}$ by ~ 10 per mil/yr; cosmogenic production would increase it by 5 per mil/yr; the land-atmosphere and ocean-atmosphere disequilibrium fluxes would be roughly +4 and -4 per mil/yr. It might be reasonable to try and calculate a point at which the negative trend in atmospheric $\Delta^{14}\text{C}$ was driven more by fossil fuel emissions than by absorption of bomb ^{14}C atoms into the biosphere and oceans. But this would not equate to 'dominant' in my opinion. L80. Change 'especial' to 'special'

C2

- L129. Use 'M' (molar) or 'mol/L'
- L158. 'Faithfully' record $\Delta^{14}\text{C}$, but not the ^{14}C content, which is offset by ~ 34 per mil.
- L210. Was testing done do see if the samples could be stored for up to three years before analysis without introducing artifacts.
- L216-218. Could using an offline $\delta^{13}\text{C}$ value produce bias or just add noise? Any tests to examine this?
- L227. Considering that the multi-target averaging resulted in differences of up to 5 per mil, I think that this deserves a detailed explanation, at the very least in the supplement.
- L243. S+P's Δ is the same as the presently used $\Delta^{14}\text{C}$; their $\Delta^{14}\text{C}$ is defined differently.
- L255. How was the weighting done? Inverse square of the measurement precision?
- L280. Wondering if 'excursion' is the best word here. Anomaly?
- L283. As mentioned in comments on L22, Cape Grim sampling can be 'tuned' just for a clean air sector. If the issue is integrated sampling, then I would say that.
- L284. Change 'terrestrial' to 'mainland'?
- L303-304. 'preparation was conducted' to 'was prepared'.
- L313. 'or thereafter' to 'and thereafter'
- L325. I don't see the reduction of scatter shown in any plot. It would be useful to show how the reprocessing improved the noise.
- L351. Change 'ccgvu' to 'ccgrv' which is the actual name of the curve fitting code.
- L362. Insert 'day' after 80. Good that this important detail was included.
- L395. Add a sentence explaining what a footprint is.

C3

- L403. I think 'roughly "natural"' can be deleted; natural is ambiguous. Maybe 'roughly pre-industrial'?
- L421-422. By 'long-term' to you mean decline since the 1960s? For many in the radiocarbon world, that wouldn't be very long, so maybe define the time period more explicitly. Also, insert 'known' prior to 'long-term trend in...'
- L434. As mentioned earlier, I don't think 'dominant' can be justified.
- L469. I'm wondering about the value of an untestable hypothesis. What you say sounds plausible, but maybe refer to it as speculation?
- L507. Should Levin et al reference by 2010? 2013 paper appears to deal with Europe.
- L527-534. I would like to see the math of how this was calculated, at least in the supplement. Also, one important factor is to know the state of ENSO during the 1963-1965 period, because La Nina, for example, can significantly increase inter-hemispheric exchange. Finally, the SF6 derived value is based purely on surface data, whereas the $\Delta^{14}\text{C}$ method has a significant upper atmosphere component. It would be good to comment on how the estimates might differ.
- L544 – 596. I felt that the text at the end of the Results and Discussion section focusing on the interhemispheric gradient and the Southern Ocean was a bit out of place. The Wellington $\Delta^{14}\text{C}$ data confirm the gradient observed earlier and extend it in time. However, at present, the two paragraphs (starting at line 565) sound more like a review of the Southern Ocean uptake hypothesis, because there doesn't appear to be any new analysis. If it's not possible to add any new analysis using the Wellington data, I think it would be better to be very concise, essentially saying something like 'our data suggest the S.O sink continues to explain... Numerous recent studies using methods x, y and z further support... Our data set will be a powerful constraint to understanding the evolution of the gradient in a quantitative model framework...'
- L571. Change 'natural' to 'mass-dependent'?

C4

L650. Perhaps acknowledge Scott Lehman and Ingeborg Levin for providing unpublished data.

Table 2. WLG is already taken as a site code (for Mt. Waliguan Observatory, China), at least with respect to the WMO GAW program. Wouldn't MAK and BHD work here?

Figure 2. Can you distinguish the symbols and/or colors for the two versions of the EN-Tandem: i.e. 12,13,14 vs. 13,14, since the results seemed to be significantly different.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-1110, 2016.