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

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Turnbull et al. present a thorough revisit of the entire Wellington atmospheric 14CO2 record. They re-measured archived samples and include new information from tree samples to better investigate known “noisy” periods of original record. Conceivable flagging criteria are formulated and the Wellington record is compared to independent data sets. Therefore this manuscript is of upmost scientific interest to the radiocarbon community and I definitely recommend publication in ACP. In addition to the data review the authors revisit and extend the key findings that the Wellington 14CO2 record provides. For some of the conclusions drawn from the data I would like to ask the authors to reinforce their arguments to overcome my minor concerns.

General comments to the authors:

P5 l212ff 14C measurements: Have you investigated if the use of IRMS-13C in the early AMS measurements introduces a bias? Such a potential bias could originate e.g. from a machine immanent fractionation. I assume you have IRMS-13C measurements also for the post-2005 samples. Did you compare the effect of offline and online 13C measurements for the D14C normalization directly? Such an investigation will also quantify the contribution to the scatter which is due to offline 13C analysis in the earlier AMS results.

P8 l338 Smooth curve fit: Fitting section by section may introduce problems at each overlap of the sections. Wouldn’t it be better to use a fit routine which can deal with a changing phase? Pickers et al. mention that STL per se does not require gap filling, only the current implementation of STL does. Pickers et al. also investigate HPspline which would allow for a change in phase. Why didn’t you chose this fitting algorithm? When you investigate the phase change in the 14CO2 signal, you find that the seasonal cycle weakens between 1978 and 1980, and then reverses. Could it be that this timing is related to the change in the fitting sections (1966-1979 and 1980 to1989). The described method for overlap and interpolation between different fits favors the weakening of the seasonal cycle at the section borders if both sections are out of phase. I wonder if you would find the same timing for the phase change if you chose different fitting sections…

P11 l450ff Hypothesis of reversed seasonal cycles in the early post-bomb era: The hypothesis behind the changing phase in the seasonal cycle should be backed up by a small (box-) model exercise. This model should include the seasonal cycles of the STE (in NH and SH) and the CEE (cross equator exchange) in the troposphere
and the stratosphere. The Mount Pinatubo eruption is a well-studied phenomenon when it comes to stratospheric transport. see e.g. Aquila et al. 2012. They find middle-stratospheric meridional pathways with mixing times of less than a year. The major stratospheric bomb-peak lasted for about 4-5 years (see HASL data compiled in Naegler et al 2006). Can you show in a (box-) model that with those boundary conditions your hypothesis is valid? Aquila, Valentina, et al. "Dispersion of the volcanic sulfate cloud from a Mount Pinatubo–like eruption." Journal of Geophysical Research: Atmospheres 117.D6 (2012).

P11 l47ff Interpretation of the seasonal cycles since 2005:

I have a couple of questions and comments to the comparison of the Wellington and Cape Grim seasonal cycles: - The comparison to the Cape Grim seasonal cycle is problematic since both mean cycles do not average the same time period. Figure 4b shows that there are obvious large inter-annual variations in the amplitude (phasing?) of the seasonal cycle. - What is the origin of the double maxima in the BHD cycle? - Is the Melbourne influence at Cape Grim detectable in CO2 or CO? - Fig 6 does not convince me that BHD is not influenced by anthropogenic emissions. Wellington is in the middle of the "red" area. When reading Pickers et al. they mention that in their data example of the BHD CO2 data they had to gap fill 10% of the data since they deviated from baseline conditions. - Sure, Melbourne emits 50 times more fCO2 than Wellington, however the distance between Melbourne and Cape Grim is 340km, whereas it is around 10km between Wellington and the BHD. - If STE is the driving mechanism for the seasonal cycle for the periods 1966 to 1979 and 1980 to 1990, how come that the seasonal cycle post 2005, which is also explained via the STE, is not in phase with the earlier one...
seem more realistic. P11 l456 fig 6 -> fig 5?? P11 l459 “Between 1978 and 1980 the
seasonal cycle weakened”. This is not really seen in fig 4b. Unfortunately 1978 to 1980
is a boundary of the fitting sections... since the seasonal cycles for the two sections
are opposed and the overlap is linearly interpolate between fits... a weakening can
also come from the applied method. P11 l460 5 per mil amplitude? Maybe two times
in this period... 3 per mil on average P11 l467 fig 5 -> fig 4 P12 l494 fig5 -> fig 4? P12
l497 “records that are indicated in figure 1” -> “records where the sampling locations
are indicated in figure 1” P13 l563 Model results from Levin et al. 2010 already suggest
the development of a interhemispheric gradient in the same magnitude for the same
time... without changing the southern ocean... although they admit that they are not
matching the data... P21 Table1: include sample no. to NZ/NZA, replace GC with gas
counting, change “measurement methods” to “measurement and sampling methods”
Table2: provide the unit to the 14C differences P22 Figure1: provide scales to the
goole earth pictures, indicate urban areas in the upper map. P23 consider vertical
grid lines to illustrate the different periods used in the paper. Consider indicating graphs
with a) and b) x-label of graph a) is cropped... p25 Consider indicating graphs with a)
and b) in a) use the same periods as in the text. b) consider vertical grid lines to
illustrate the different periods p27 Motivate the plot better. Not really used in the paper.
Explain the unit. P28 Consider indicating graphs with a) and b) Consider usage of open
symbols. Especially after 2000 it would be good to see all data.

Supplement:

S2.l74 state the surface area of the pyrex tray S4 l147 extraction follows -> extraction
from 1995 onward follows S5 l217f in total after flagging you have 427 targets, if you
split them between the machines you have 397 and 102... To me this does not add
up? What am I missing? S6. L262 Please state the main offset for the QC datasets
between the two AMS machines. S9 l394 What is RLIMS? S12.l457 Indicate the figure
S1 with a) and b). I assume a) is Eastbourne and b) is Baring Head? Correct? S12.l468
Since you cannot decide between “red” or “green” for the Baring Head tree, how can
you than state the excellent agreement? Is it excellent for both red and green? Please
include a link to the t-test or the mean difference to reinforce this statement. S13 l471
Define “NIK”. Why is there only one comparison for NIK and 4 comparisons for BHD?
S13 l473 please specify the t-test: I assume you use a dependent t-test for paired
samples? Since the applied formulas are easy it might be clearer if you just explicitly
state them. S13 l481 what is the mean difference if you use the one year shifted BHD
tree (red points in fig S1)?

Technical comments:

In the text please use a consistent ordering (e.g. temporally ascending) when citing
multiple papers.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/acp-2016-1110/acp-2016-1110-RC1-
supplement.pdf

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

C5