

Interactive comment on “Detecting long-term changes in point source fossil CO₂ emissions with tree ring archives” by E. D. Keller et al.

Anonymous Referee #1

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In this study tree ring 14C archives were used to detect long-term changes in fossil CO₂ emissions from point sources at Taranaki, New Zealand. The atmospheric transport model WindTrax was used to simulate constant point source fossil CO₂ emissions over the observation period to quantify the amount of variability that can be attributed to transport and meteorology. Model simulation results were compared to observations and the minimum detectable amount of change in emissions over a one-year period, two years, and four years of sampling was investigated. Determining changes that occur in CO₂ emissions relative to a baseline measurement is very useful, as it can facilitate the verification of relative emission reduction targets without a precise knowledge of the absolute emission level.

Overall the manuscript is well structured and fits the scope of ACP. I recommend some revisions before this manuscript can be published.

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1. The authors describe the site to be located in a flat terrain dominated by Mount Taranaki. They also point out that the wind direction and speed can be very different at sites only a few kilometers apart due to the mountain influence on atmospheric flow. Hawera is considered to be representative of Kapuni in the manuscript, but comparisons of wind speed and direction were made for a very short time interval "14 August-26 October 2012, with some significant data gaps" as specified by the authors (page 9, line 1). I doubt that two months of measurements (with significant gaps) are sufficient to consider the two locations similar from this prospect. Also, the wind speed at Hawera is approximately double compared to the wind speed at Kapuni (not "slightly higher speeds" as mentioned on page 9, line 10). I wonder how much does this affect the model results? It is not clear to me what data is used in Fig. 2 for the wind rose "Kapuni 2013".

2. It is not clear from the text how many trees were sampled from each species. How many replicates were used and how was the data analyzed? Please specify and expand this paragraph (page 6, lines 9-24) rather than pointing to papers only. The reader should have a clear idea about the tree ring observation methodology without reading Norris, 2015 and Turnbull et al, 2014.

3. When describing the model, the authors state that this is appropriate for estimating emission rates from a source over short distances (page 7, line 4). They also show that the time interval recommended for the meteorological observations used for the model is 10-30 min. How reliable are the model results for these simulations given that one hour time-step was used for wind speed/direction? Also, the chestnut tree is located at the limit of the simulation capability, 1 km. How does this influence the result?

4. The authors present this method to be useful for verifying emission changes at other locations where the point sources are much stronger, mentioning that there are approximately 800 power plants worldwide that emit more than 10 times the annual total CO₂ff at Kapuni (page 18, line 17). They also explain that "WindTrax is not applicable to complex terrain or larger distance scales and caution is urged when applying our

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methodology to other sites". I have a feeling that Kapuni site is very specific and I am not sure that there are so many other sites with flat terrain, trees within 300-600m of the point source located downwind, and consistent winds through time. What other model would then be most suitable for complex terrain and larger distances? Add suggestions for other model(s) that would be suitable in this case.

Specific comments:

Check the table captions. Information is missing (e.g. Table 2 – column 4 not explained).

Check figure captions. The reader should understand what those figures represent without reading the text.

Figure 2: name the two panels a) and b) and refer to them in text accordingly. Expand the caption.

Figure 4: Same as for Fig. 2.

Page 5, line 18: 2008 should be 2007.

Page 16, lines 26-28: "Indeed, looking at the results in Fig. 4, there is no significant decline at the chestnut tree in 2007; there is a small decline in CO₂f at the pine tree but it is too small to conclude that emissions have changed. " As I estimate from the figure, the observed value is smaller in 2007 than in 2006 at the chestnut tree by ~1.3 ppm, and by ~0.3 ppm at the pine tree. Isn't the former significant? I recommend using the same scale for the two graphs.

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