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Discussions

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Interactive comment on "Measurements of atmospheric ethene by solar absorption FTIR spectrometry" *by* Geoffrey C. Toon et al.

Anonymous Referee #2

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This paper reports measurements of atmospheric ethene columns at a dozen sites. Downward trends were observed in Pasadena, likely related to regulations on vehicle emissions. This paper presents interesting information and should be published, but much of the discussion is too speculative and needs to be strengthened. Basic information about the sampling sites/times and instrument performance is needed. The impact of an apparently high detection limit on the results needs to be clarified, for example is lack of seasonality or "essentially no" C2H4 more related to the instrument rather than actual lack of seasonality? The presentation also needs some clarification and restructuring to make it easier for the reader to follow.

General comments:

Abstract: The abstract could be filled out by stating roughly where the dozen sites

are located, how many sites were clean-air vs urban, how many sites fell below the detection limit, and how many sites showed measurable trends. Currently only 4 clean air sites and one urban site are discussed.

General comment: There is a lot of colloquial language in the paper (L56, L65, L90, L335, L393, etc.). Use specific scientific language.

Introduction: The first sentence seems strange because it misses the biogenic source. What is the partitioning of combustive vs biogenic ethene in its global budget? If the biogenic source is 21 Tg/yr, how large is the combustive source? Were Poisson et al. measuring biogenic ethene? It's not in the references. Overall the first paragraph needs tightening up.

L65: "This is a "greatest hits" compilation . . . not always the latest version for every band of every gas". This is too vague . . . be more specific in describing the limitations and give some sense of your overall precision and how this varied over the years or at different sites.

L95: Before getting into specific Pasadena results we need a Table stating the 12 sites, their latitude, longitude and altitudes, and the dates over which measurements were taken, what time of day and for how long, whether various sites were considered clean or polluted, etc. For example the "Ground-based Sites and Observations (1985-2015)" table from http://mark4sun.jpl.nasa.gov/ground.html (L44) could be included, with sample number and dates added in (observation days are only listed until 2004 on the website).

L152: We still don't know basics such as the precision of the instrument (I'm assuming the detection limit is 10^{15} molec.cm2 based on the abstract, but it's not clearly stated). What is meant by "uncertainties" here, and what is the basis for choosing $<1\times10^{15}$?

L160: The finding of little seasonal variation is surprising, e.g. Herbin et al. (2009) saw clear seasonal ethene variations in both hemispheres. Is ethene's seasonal variation

below the detection limit, especially at clean sites? What detection limit would you need to detect seasonality, for example in Sweden (high northern latitude) in winter? On L164 ("there is essentially no C2H4") use more precise language. What exactly can you measure?

L162: "but never come close to zero". Why is this stated? CO has a non-zero background concentration, so it wouldn't be expected to approach zero. On L181 the statement that the CO decline is not as dramatic as ethene because it doesn't fall as low doesn't make sense for the same reason. By what factor did CO fall relative to its background, and how does that compare to ethene? What is the clean background value for CO at Pasadena latitudes in winter and summer?

L169: Where is the TMF site relative to LA (what direction)? Were winds from a clean or polluted direction? On L168 this is the first time we're told what season the measurements were made.

Figure 4 needs a legend to match color with site . . . which site goes with which altitude? Same with Figure 5. Though altitude may not be the best way to color-code . . . places as different as McMurdo and Texas come out as the same color and the 12 sites can't be distinguished.

L170: "The only sites where MkIV has ever detected C2H4. . ." What color is Sweden and what season was it measured (winter)? There seems to be some light blue around 1989 that is measurable? In each panel of Figure 4, a line should be drawn indicating the detection limit.

Line 175: The evidence for this is a little weak . . . a wind rose plot would clearly show how the ethene levels vary with wind direction and how much of the large range is related to wind direction versus other things like time of day or seasonality.

L183: The arguments in this paragraph, while most likely correct, are too speculative. Apart from the Clean Air Act of 1990, when did CARB policies and stronger enforce-

ment of smog checks occur? Is the ratio of C2H4/CO consistent with traffic? If you believe it's traffic, why is biomass burning raised as a possibility on L422-423? It may help to discuss the Sather and Cavender and Washenfelder et al. papers here rather than below.

L196: What do you mean by "not as tight"? What is the r2? What other sources do you expect ethyne to have in an urban center? Unlike ethane it's also a combustion tracer like ethene, so it should behave like CO and ethene. What does the correlation between CO and ethyne look like?

L205: Why "seems"? What does statistical analysis show? Do not use wording like "large values of the red points in the third row". Use scientific descriptions.

L230: Since the ratio appears to be changing over time, what is you ratio for 1999-2005, the same time-frame as Baker et al.? That would be better than comparing 1985-2016 to 1999-2005.

L334: Suggest condensing this section. It's sort of a laundry list of other projects without much synthesis. On L338 if SE Asian measurements are not relevant to this study, why are they presented (e.g., Blake et al., 2003; Figure 8)? Probably a Table would be a better way to intercompare results and show the different years, seasons and locations of each campaign.

L381: In comparing the mid-Pacific to the USA, you need to state what year and season the different missions flew and what impact this might have had (the figure is comparing winter/spring flights from 1994-1999 with HIPPO over a decade later). What phase of HIPPO is plotted? Are the mid-Pacific and USA HIPPO data from the same season? Is L381-382 referring only to the HIPPO data (which is blue and green in the figure; no red points)? On L384 what evidence was there for upward transport of Asian pollution to high altitude? Is this referring to HIPPO data? Overall this paragraph needs tightening and better links to the rest of the paper.

L409: Use less speculative arguments ... "tends to discount the possibility that the C2H4 measurements are wrong" is not convincing. Suggesting that the trajectories are wrong or that urban pollution isn't a major source of ethene or CO probably isn't the direction you want to go. Do you get better correlations when you remove data originating from the San Gabriel direction? L418-423 is too speculative. No evidence was provided for decreasing emissions from biomass burning in the Pasadena area ... if you believe this is the case your argument needs to be much more substantial.

Minor corrections/clarifications:

General: I suggest numbering your sections so they fall more clearly into Methods, Results etc.

L7: All acronyms need to be defined, even if they seem obvious. Define JPL. On L22 define PAR, and so forth (L98, L120, L220, L296).

L11: Ethane should be ethene. Same on L335 and L346.

L50: I don't see a black line in the lower panel.

L52: Many of these terms (continuum level, etc.) might not mean much to the average reader.

L56: "is less than 1% deep" ... use more specific wording or define deep.

L57: 0.235% is a very precise number ... is this the level of significance you intend?

L58: Use spaces to indicate minus rather than a hyphen in "measured-calculated".

L77: Is this what you used? Just this sentence is out of place without some link to your study.

L95: Give an exact lat/long and describe the site. In a field? Near a road? Wind direction?

L102: State which day. The caption just says March 2014.

L107-110: This is almost the same wording as the caption.

L125-126: Similar wording as the caption.

L131: Text uses ppt. Is the x-axis of the lower panels also ppt? Units aren't given and the text is very difficult to read because of scientific notation. Just use ppt and a scale from 0 to 500.

L136-148: This is more Methods than Results.

L144: "smallness" is a strange word. How about just "This small C2H4 column perturbation..."

L152: Units are needed for 1x10^15.

L164: Define TMF. This site designation doesn't mean anything to the reader.

L171: What was the season, time of day and wind direction for the Mountain View measurements?

L173: No capital for Northern.

L181: Change "The CO" to "CO" or "The CO column". Same on L203.

L183: State the r2 value after "tight correlation".

L193: "poorer" ... how poor compared to 0.93? How about Mountain View, the other urban site?

L198: Should be having not have.

L204: Awkward wording.

L208: 2016 not 2916.

L208: Typo ... "a 2.5% enhancements". Similar issue on L243.

L224: An emission ratio subtracts off the background. Was that done here for CO?

L229: What is the distinction between JPL ground-based data only (Table 1) and "all JPL data"?

L231: Did Baker et al. and Warneke et al. report uncertainties?

L263: Why 949.4 here but 949.35 on L246?

L272: Use consistent units. The text cites 65 ppt but Figure 7's x-axis uses 6x10-11. Just use ppt.

L297-298: Not sure of the point of this statement relative to your paper.

L305: Not necessary to include "their Table 2" and "Their Fig. 2".

L311: Correct "of et al." The paragraph needs some re-writing . . . it's too casual.

L314: Why "presumably"? Is it not clear from the paper? Same on L320 and L342.

L321: Typo, retrieval.

L335: Too colloquial. This paragraph needs proofing.

L347: 1848 is too precise for an average; add an error bar if they had one. Same for on L348 for the ER of 6.97.

L351: Typo, "fig.S1".

L368: No comma after measurements.

L377: HIAPER not HAIPER.

L381: I think you mean "green squares" rather than "red points". Same on L382.

L386, L394: No comma after al.

L387: No hyphen for precursor.

L399: When were the measurements in Mexico City? Are they ground-level?

L404: This is methods/results more than discussion.

The conclusions read more like a summary.

References need consistent formatting.

Table 1: The significant figures in the gradient and error need to match: 1.3 +/- 0.1 but not 1.28 +/- 0.1 and so forth.

Figure 1: Tidy up the graph for publication (stronger font, less writing on top – or if you include it define all the symbols). In Figures 2 and 6 the writing on top is cut off.

Figures 1 and 2: Is the top panel in Figure 1 the same as the middle panel in Figure 2? If so delete the top panel in Figure 1. The two figures could probably be merged.

Figure 3: Axis labels are not clear (are overlaid). Need a larger font.

Figure 5 could be on a log scale to better show the correlation at other sites.

Figure 5: Put the JPL r2 values on each graph.

Figure 5c: Ethene vs ethane seems to have a natural gas wing. Same with the light green data (New Mexico). Just interesting.

Figure 8 needs stronger fonts.

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