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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Reconstruction of Northern Hemisphere 1950–2010 atmospheric non-methane hydrocarbons" *by* D. Helmig et al.

Anonymous Referee #1

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Helmig et al reconstructs non-methane hydrocarbons from NEEM firn air, and presents flask measurements from five Arctic sites. I believe this study will make a useful contribution, and is generally well written. I have some minor comments that I believe will improve the paper.

1. I suggest adding a table to the Introduction section of the paper with the name and chemical formula for each NMHC considered, plus lifetime and relative diffusion coefficient in firn and perhaps mass. The names and formulas are not related/defined as far as I can see, but are used interchangeably throughout the paper, so a table would help people unfamiliar with NMHCs. The diffusion coefficient is already given in Table 1 of the supplement, but I think it should appear in the main paper (but not necessarily the other information from the Supplement table, apart from mass).

2. Page 13001, line 3 - what is a non-sinusoidal cycle?

3. page 13002, line 12 - "a robustness-oriented definition of the optimal solution that uses the ..." - awkward and not very informative. It is unfortunate that the reference for the inverse model is an extended conference abstract - can some of the main details of the inverse model be included here (in language that is not too technical)?

4. page 13002, lines 18-20 - repetitive, you have already referred to the depth profiles in Fig 2, suggest rewording to "There are some subtle differences in the four datasets of NMHCs shown in Fig 2, however ..."

5. page 13005, line 6 - 'low' rather than 'declining'

6. Page 13006, line 24 - could change to "Considering both the mean level and seasonality, none of these monitoring sites yielded ..."

7. Page 13007, 1st paragraph - put the reference to Fig 7 earlier in the paragraph.

8. Page 13007, line 2 - the decline for all except ethane is relative to the maximum around 1980? Be clear.

9. page 13007, line 4 - is it just "Interesting to note" or is it the explanation for the rate of decline?

10. Page 13008, line 21 - What do you mean by the "model chooses different slopes"? The top 40m of measurements have been excluded due to the influence of seasonality, how far back in time does this affect the solution? Similarly Page 13010, line 10 - how far back do you go until you can trust the trend?

11. Page 13009, line 28 - Do you really mean "not statistically significant" here, or is it more about not being reliably reconstructed?

12. page 13010, line 19-23 - this refers to the possibility that a sink change is the explanation? Say that.

13. page 13011, line 18 - "have also have"

14. page 13013 - could changes in the atmospheric lifetime be relevant to this comparison?

15. page 13014, line 5 - 'lower' rather than 'slower'

16. page 13014, line 15 - also using different reconstruction methods

17. Page 13014, line 17 onwards - although the difference in the maximum of the reconstructed ethane peaks is 7-10 years, these peaks are really quite flat at the top. We know from the network data that there is significant interannual variability so the actual atmospheric changes would not have been as smooth as the reconstructed changes, so I wouldn't make too much of this difference. Neither this study nor Worton et al closely fit the measured peak in ethane in the NGRIP firn (i.e. below 70m) - the reason for this may be unknown, but would lead to caution about interpreting the date for the peak based on NGRIP data. So I agree that the estimate from NEEM is probably more reliable, but still don't think the difference is that important.

18. page 13014, line 28 - Apart from the greater number of species at NEEM, I would expect that having used 14CO2 for NEEM calibration (as described in Witrant et al 2012) would have been particularly helpful here because the depth profile for the NMHCs are similar to 14CO2 with a peak in the lock-in zone.

19. page 13015, line 23 - do you mean "reflect a *recent* slowing down in the ethane decline rate"?

20. page 13015, line 24 - "seeen"

21. page 13015, line 24 - the network flask record is so short and has significant interannual variability, and the firn records lose the top 40m of measurements due to seasonality - can you really conclude much from the comparison?

22. page 13015, line 27 - Simpson et al show a trend in their fig 2b for 48.6-90 deg

N, and it is plotted at the high northern latitudes and appears to match the trend in the data there (as far as it is possible to tell from their figure). Could you use this rather than 30-90N, or is it possible to find the trend from the Simpson et al data for the high latitudes (the first author on this paper is a coauthor on Simpson et al)? Any of these estimates are probably significantly lower than the other trend estimates, and the discussion on page 13016 (particularly lines 3-10) seems unnecessarily complicated, and would benefit from being simplified.

23. page 13015, line 29 - is it appropriate to translate the trend to an earlier period when we know that the trend goes to zero and changes sign as you go back in time before 1984?

24. page 13016, line 3 - be clear here, 200% larger sounds like it could be 3 times the size. Could say "The ethane trends at ... are all on the order of 2-4 times the size of the trend seen by Simpson et al."

25. page 13016, line 24 - this is a bit confusing, when does the <1 refer to?

26. page 13027, line 3 - Simpson et al 2012 is in Nature not Nature Geoscience.

27. Page 13030, Table 2 caption - "Average last three columns list data reconstruction averaged over years ..." doesn't make sense to me.

28. Page 13030, Table 2 - put all superscripts on the references, instead of some on the data.

29. Fig 7 - put a) and b) into captions, or better still, could 7a and 7b be combined into one figure? Same for Figs S-1 and S-3 in the supplement?

30. Fig 9 - It would be easier to compare the panels if i-Butane also started from 1940. In the caption, should refer to Fig 3 not Fig 2.

31. Fig 11b - blue and black are a bit too similar, could you make the blue slightly lighter?

32. Fig S-1 - make the solid lines thicker and the dashed lines thinner. 'Dashed' rather than 'staggered' in caption?

33. Witrant et al 2012 missing from reference list

34. The NMHCs are sometimes referred to using their names in figures (eg fig 9), other times using their formulas (eg Fig 7), this should be made consistent.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 12991, 2013.