

Interactive comment on “Greenhouse gas observations from Cabauw Tall Tower (1992–2010)” by A. T. Vermeulen et al.

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- Reply text from the authors is indicated by a hyphen "-" at the start of a paragraph. All other paragraphs stem from the reviewer text

- First of all we would like to thank Dr. Dave Lowry for his extensive and thorough review of the article. We agree with almost all of the corrections and remarks and changed the texts and figures where appropriate, according to the remarks in the review. In this reply we will only refer to and answer to the reviewer comments in the cases where we, for good reasons, did not fully implement the suggested changes, or need to answer specific questions from the reviewer. All the reviewer issues not repeated in this reply have been fully incorporated in the revised version of the article.

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- We would like to express our regrets that the impression has been raised that this article has been put together hurriedly and inconsistently, in fact the contrary was the case. The problem was that at submission the article had a substantial amount of figures and tables in a separate appendix, that in the editorial process was joined with the main text again, and in this process the numbering of figures and tables got mixed up.

- In the revised version of the article we have corrected all the figure and table numbering issues by using the automatic numbering mechanisms of (La)TeX. We understand that this numbering issue must have caused a negative overall impression of the article and a lot of confusion for the reviewers and readers. We therefore appreciate the efforts of the reviewers to still produce a consistent review despite this hurdle.

- Where possible for a descriptive and observations-only article we have replaced or extended the text with more quantitative measures for the data interpretation.

- Most figures in this revised version have been enlarged and cropped for the sake of better readability.

General issues

Beware 's' on the ends of words that are not required, such as 'concentrations gradient' and 'concentrations maxima' and 'gradients measurements'. This is a regular occurrence. Some words are missing 's' at the end.

- We found four occurrences of non required 's' that all have been corrected

The detailed points are outlined below:

Sections 1 to 3

Page 4180 line 12 – do all 3 stations follow the same analytical protocols?

- All stations were equipped with similar chromatographic systems and FID detectors and reported on the same concentration scale. Two round-robin campaigns have been

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performed to ensure minimal systematic differences. We extended the revised text here.

Figs. 12 and 13 have changed from 70.C to 76.C in the oven and 57.C in the GC. Following which protocol?

- In the revised article these figures are now numbered 6 and 7 resp. In the upgrade from period C1 to C2 also the internal and external tubing of the GC has been replaced with tubing with a more narrow bore, which caused that EPC settings and retention times changed. The main reason for the second external GC oven is that this allowed us to optimise separately the temperatures of the columns for FID and ECD, so that for this specific setup we could change from one compromise temperature of 70 degree C to an optimum of 57 and 68 degree C resp. We changed the figure to make this clear.

Page 4188 line 28 – could some of the high standard deviations not be due to rapidly changing mixing ratios over the period of 3 analyses within the calibration period?

- The standard deviation reported here is only for CO₂ and is the standard deviation of the 1 Hz CO₂ signal from the Licor instrument in the last minute of the five minute sampling period. We made this more clear in the revised text.

Page 4191 line 9 – Fig.4 shows only data from 2000 not 1992, and it shows data observed at multiple levels not just 200m.

- The text now refers to the correct figure with data from 1992-2010

Page 4191 line 22 – not convinced that the term bandwidth is the best to use here. Is it not better to refer to a range or a percentile limit?

- We replaced the term bandwidth with "noise" band

Page 4192 line 16 – 04:00 UTC – should also mention local time, the pronounced effects soon after dawn of inversion break-up and local urban sources are much more familiar to those of us at 06:00 local than 04:00 UTC.

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- we added the time in Local Solar Time here.

Page 4192 lines 19-20 – 'very small during day'. The figure suggests that they are very small in late afternoon.

- We replaced day with afternoon

Page 4192 line 24 – not sure what you mean by net uptake of CO₂, as opposed to assimilation (photosynthesis) as used later. Does this not also indicate that there is no evidence for vertical mixing.

- The only significant uptake process for CO₂ in this region could be assimilation (photosynthesis). There is always some vertical mixing, but a shallow boundary layer persists in these conditions even during day time, as is explained at the end of the next paragraph.

Page 4194 line 6 – it does not look as though there is a smaller seasonal variation of CH₄ baseline compared to CO₂, but it looks like there is an offset with the lowest mixing ratios of CH₄ being earlier in the year.

- Here we extended the analysis with some more quantitative results of the relative size of the seasonal cycle per component

Page 4194 line 15 – what are these extraordinary high concentrations due to?

- We added a possible explanation of emissions from nearby industrial sources

Page 4194 line 19 – need to refer to the figure at the end of this sentence. The seasons used in Fig. 6 need to be defined. Which months are you using for each? Is this Dec Jan Feb for Winter of Jan Feb Mar? Otherwise it is difficult to interpret early spring, which could be early March and not really spring at all. Similarly for all the seasons (early / late summer / autumn) because these terms as used in the text don't quite fit with expected trends.

- We added the used definition of the seasons (winter=Dec+jan+Feb etc.) to the text

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and the caption of figure 12.

Page 4195 line 17 – Omega blockade? This seems to be a popular term at KNMI but can you explain this for the readers. Why this detail here when there is no explanation for much of the variability discussed?

- Omega block is a common term in meteorology, not only at KNMI. Depending on location at the globe the weather patterns generated by regular occurring Omega blocks have quite distinct synoptic features. We think that for understanding the quite extreme features of winter time observations in the temperate and continental climate zones of Europe some discussion of the Omega block as occurring here is quite relevant and we extended the discussion for more clarity.

Page 4197 line 21 – the vertical gradient almost disappears for CH₄ as well and earlier in the year than CO₂.

- The figure for CH₄ now has been replaced with the correct hourly average plot in stead of the day time minimum plot.

Page 4198 lines 10 and 11 – it is not clear if these amplitudes are for differences between vertical height as in Fig. 7 or the range of amplitudes for different years in the record.

- We added the reference to the correct Figure (now 13)

Page 4198 – before Section 4.5 – It is possible that 2.2 Concentration Footprint section will go better here than where it is directly ahead of the instrumentation description.

- We think that the footprint description section fits better when direct following the station description

Page 4199 lines 9-11 – based on your comments here and the precisions given in Table 2 is it wise to use the 1992-1997 data in the comparison with Globalview data?

- The lower precision during period A, will cancel out for the largest part when the trend

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analysis is performed, for as far as the errors are random. We think that the regular calibration against NOAA standards and daily corrections of offset and concentration scale using working tanks minimise the average systematic offset during this observation period.

Page 4199 line 20 – the choice of method used to derive the figures used in Table 3 does not match those used to derive figures 8 and 9.

- The choice of methods does not influence significantly the absolute values of the derived trend estimates. The method used does influence the correlation coefficient and the derived uncertainty estimates. We choose to report here for each component the method with the highest correlation coefficient and lowest uncertainty. We extended the text in this line.

Page 4200 line 17 – Do you have any reasons for this? Poor emissions data? Sources continuing to emit after so-called closure e.g. landfills, coal mines?

- We added a number of possible reasons to the text

Page 4202 line 9. The IPCC report is not in the reference list and this does not cover your period C anyway so no comparison with your best period of data.

- The IPCC 4th AR report is in the ref list (Forster et al, 2007) and is used in the text and table.

Tables Table 3 a) You are using Mace Head only so this might be typical of 40-60.N globally, but not be termed a Global trend. b) How can you use 2010 as part of the period as it is an incomplete year to work out a global trend? Secondly I doubt that the Mace Head data is available yet for much of the year.

- The used fit procedure is due to the use of four different harmonics not very sensitive to the use of incomplete years, unless big discontinuities exist in the trends. As we fit here for one average linear trend over the whole period this is not a big issue. However, the influence of data gaps or incomplete years on estimates of the interannual

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variability of the growth trend will be substantial.

c) How much of the differences in observed CH₄ trends can be related to improvements in analytical precision of your instrumentation?

- None, as precision relates to the repeatability of the observations and not to the accuracy. The measurement accuracy is hard to estimate, but the accuracy of yearly averages or trends based on a fit through all of the observations should be much smaller than the precision of individual observations if frequent calibrations and offset corrections have taken place.

d) Why display the results of only one of the methods used to derive the trend, particularly when for CO₂ and CH₄ they are not the results of method B that you have used to plot the graphs for Figs. 8 and 9? Are these the methods with the closest fit to the Mace Head data?

- The choice of methods does not influence significantly the absolute values of the derived trend estimates. The method used does influence the correlation coefficient and the derived uncertainty estimates. We choose to report here for each component the method with the highest correlation coefficient and lowest uncertainty. We extended the text in this line.

Tables 6 and 7. b) The text mentions the achievement of 95% data coverage in recent years but these tables suggest that even for Period C2 they are varying between 81 and 92%. Is this the figure after both instrument failure and bad data have been removed?

- Correct

c) There are some surprisingly large jumps in the lowest percentile data means that correlate with your change from Period A to B and B to C and these don't correspond to global trends. Are these purely down to meteorology?

- Even in period C1 and C2 jumps in the 1 and 99 percentile values can be observed so we expect that these must be explained by synoptic variability, as a period of just

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three days with abnormal high or low values will show up here.

Figures

General – the axes labels are very small and difficult to read on most figures, particularly in printout and without going to very big enlargement on the PDF version.

- We improved both cropping and size of the picture to increase readability

Fig.1 – A scale would be useful

- We added the size of the extent of the area displayed to the figure caption.

Fig.4 – Because of the order of plotting of the data series, it is not possible to see if the baseline varies from one height to the next

- As the baseline does not vary with height the order of plotting has no influence, they will always overlap

Fig.5 – This nicely shows how little background air the Cabauw site records. The text suggests that this figure is showing averaged data for 2005-2009 not 2008. Does this figure show the complete dataset without any filtering?

- Yes, no filtering has been applied, the caption is correct in mentioning the period 2005-2008

Fig.6 – a) This figure is for CO₂ as in text and caption, but the axes are labelled CH₄.

- We corrected the axes labels

b) This is where the lack of definition of the seasons in Fig.5 causes some difficulty. Otherwise 22 May to June 19 would be purely late spring, and 20 Aug – 10 Sep would be late summer and not Autumn.

- The season definition has been added to the relevant captions and article text

c) No explanation that the large diurnal cycles at this time of year are enhanced bio-

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logical cycles in the main growing season.

- Winter time is not exactly growing season in this region, the large diurnal cycles are part of the synoptical pattern caused by the winter time Omega block, as discussed in the text.

Fig.7 – Need to specify which method has been used to calculate the means used in this figure. Is it the middle 50% of the data only (method B) as used in Figs 8 and 9 and specified in those captions.

- All method B except for fig a which is method C, we adapted the figure caption and text accordingly.

Figs.8 and 9 – Specify method B in these captions for ease of cross-referencing with the text. The methane harmonic fit has an interesting double peak with the first in autumn. Is there evidence from local sources to explain this, that could be mentioned in the text?

- We added the method in the captions. We have no evidence from local sources that can explain the double peak.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 4169, 2010.