Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-349-RC2, 2017

Atmospheric Measurement Techniques Discussions

Interactive comment on "Greenhouse gas measurements from a UK network of tall towers: technical description and first results" *by* Kieran M. Stanley et al.

Anonymous Referee #2

Received and published: 22 December 2017

Review of the manuscript: "Greenhouse gas measurements from a UK network of tall towers: technical description and first results", submitted to Atmos. Meas. Tech., by Kieran M. Stanley et al.

The paper is describing the setup for greenhouse gases measurements at four sites in UK. The authors are providing a very detailed description of the inlet parts, analyzers, and calibration protocols. In the last section of the paper atmospheric signals (diurnal and seasonal cycles, trend) are very briefly discussed. Considering the purpose of the manuscript I am not fully convinced by the need for this very general discussion on the observed variabilities, coming after very detailed technical descriptions of the setup

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and protocols. From my point of view, the most problematic point of this manuscript is the lack of analysis of the measurements in terms of uncertainties and quality control. There are very few quantitative indicators which could help to justify some choices in the protocols. For CRDS measurements only precisions estimates are provided, whereas repeatability's are provided for GCs. Even more problematic is the use of the precision (based on standard deviations calculated over one minute intervals) as a 'demonstration' that measurements are compliant with WMO recommendation for compatibility of monitoring sites. But it seems that few efforts were put to characterize the possible biases (e.g. no measurement of a target gas as recommended by WMO/GAW). I would expect at least some analysis of the existing information (e.g. variability of the calibration residuals), description of the troubleshooting, etc... Also I am very surprised some suspicious signals are not discussed at all, even though the protocol described in the manuscript claims a significant emphasis of the data review.

Page 1, line 14: "A network of ...three... tall tower"

Page 1, line 24: "The long-term 1-minute mean precisions (1s)" You should show an indicator comparable to GC

Page 3, line 2: "the accuracy of the inversion is limited by the number and distribution of measurement locations available": I would suggest to mention also the capacity of models to properly represent the observed time series, which lead to favor tall towers over flat terrains.

Page 3, line 9: "Measurements...constrained global or hemispheric scale fluxes": I would not say that atmospheric measurements constrained the fluxes (also on the next line of the same paragraph). Hopefully they can give some constraints to the estimation of the fluxes by inverse method.

Page 4, line 3: I do not think the list of species measured by Medusa is needed in Table 1. Please refer to a publication.

Page 5, line 4: 51% of marine air at MHD: please give a reference

Page 6, line 2: Is there a reason why you chose to sample N2O, SF6, CO at 100m a.g.l. and not at the highest point of the tower (185m). Also, why did not you adopt the same sapling strategy at TTA where you have a single inlet for CO2, CH4, whereas you set up 2 or inlets at the other tall towers ? Could you please explain your choices ?

Page 7, line 10: What do you mean by: 'Horizontal sections of tubing at the base of the tower were kept to a minimum' ? Please clarify.

Page 7, line 17: Have you tested the Perspex H2O decanting bowls to ensure the non-contamination of the measurements ? Why did you changed from the previous system used at TTA ?

Figure 2: Can you precise the meaning of TOC on the figures.

Page 8, line 20: "This has the advantage of eliminating sample contamination from the pump, reducing the likelihood of a torn diaphragm introducing laboratory air into the sample and improving the performance of Nafion dryers." Can you please elaborate on this sentence ? The first point is clear, but I understand that the inlet is slightly under pressure which is not an advantage to avoid the contamination from lab air.

Page 10, line 20: "The correction applied is minimized due to the removal of most H2O using the Nafion dryer." In return you introduced a possible CO2 bias due to the nafion. How have you quantified this bias ?

Page 12, line 17: "Each cylinder is now individually analysed as a sample to check for contamination prior to use". Can you precise how frequently you get problem with the purity of the carrier gas ?

Page 15: "4.1 Sampling sequence" : Is there any justification of the different configurations at the sites. For example why 20 or 30 min sampling time ? Is it because of the number of sampling levels ? Also could you clarify if the GCs are measuring at only one level ?

Page 16, line 5: Can you precise the lifetimes of the standard and calibration gases like you have done for the GCs standards ? Are the standards mixing ratios reevaluated at the end ?

Page 16, line 9: “line flushing”: are you choices in duration, number of cycle and frequency of the calibration gases measurements based on specific tests ?

Page 16, line 16: “long-term precision”: what about the measurement repeatability ?

Page 16, line 19: “CRDS precision within the UK DECC network is within the WMO compatibility guidelines for CO2 ($\pm$ 0.1 μmol mol-1) and CH4 ($\pm$ 2 nmol mol-1) (WMO-GAW, 2014)”: Indeed the precision is lower than the WMO recommendation for compatibility, but this is comparing apples and oranges. The WMO compatibility has to take into account the measurement repeatability, non-linearity, calibration uncertainties, H2O correction, dryer and inlet biases. Please remove or rephrase correctly this sentence.

Regarding WMO recommendations it should be noted that you are not following the recommendation of measuring a target tank (“Each analysis system must include at least one ‘target tank’ which is a very important quality control tool “, WMO/GAW report n$^\circ$ 229, 2015)

Page 17, line 16: “Calibration scales vary depending on the gas species”: the CH4 scale for GC-FID measurements is not given. Is it a different scale compared to CRDS measurements ? If so what about the compatibility of the two scales ? Also the CH4 is not mentioned at all in paragraph 5.2 (GC data processing).

Page 17, line 24: “periodically in the field”: Can you precise the frequency of the non-linearity tests for N2O and SF6 ?

Page 19, line 4: “H2O level too high”: what is the reason of rejecting values with high H2O level ? what is the typical threshold values ?

Page 19, line 14: “A second order function can then be fitted to the data to provide

a non-linearity correction": CRDS instruments have the reputation to be quite linear. Why do you apply a non-linear correction? Have you estimated the importance of this term ?

Page 20, line 11: "using sample integrated height or area": can you precise which one you are using for the different species ?

Page 23, line 3: "There is an approximate 0.8 nmol mol-1 northern hemisphere mid-latitude seasonal trend": if you give an estimate of the trend for N2O, I would suggest to do the same for all species, and gather this information in a table.

Figure 5: How do you explain the low N2O and SF6 concentrations measured at RGL in the first year (2012) ? Those data look suspicious considering that such event do not appear later on. According to your description of the final data processing (5.3) you are evaluating the time series by comparing the stations with MHD. From my understanding this is typically a case where such comparison could lead to flagging the first year of measurements. Can you provide a possible explanation of this atmospheric signal ?

Figure 7: Please precise if you are using local or UTC time on this figure.

Figure 7c: CH4 diurnal cycle at RGL shows a very high standard deviation in mid-day/summer. Outliers which could cause such anomaly on the 2012/2015 average signal are not visible in the time series on figure 4.

Page 25, line 5: "Fig. 8(b) demonstrates a regionally polluted period at RGL for CH4 on 30/11/2014, where air has passed over Europe and the south of the UK before arriving at the site": in such a case we could expect higher CH4 concentrations at MHD compared to TAC, due to the additional contribution from south UK. Do you such 'reverse' gradients sometimes ?

Page 26, line 6: "Results from the network give good spatial and temporal coverage": I fully agree for the temporal resolution, but I would remove the comment on the spatial coverage, the relevance of which depends on the intended scientific purpose.

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