

Response to Interactive Comment RC2 by Anonymous Referee #1 on Manuscript # amt-2019-11:

We would like to thank Reviewer #1 for their time and effort to provide detailed comments that have greatly improved the clarity of this work. We have responded to each comment below with the reviewer's comments shown in bold font and our responses immediately following them in plain font.

This is a clearly written manuscript that documents the performance of a closed-path absorption spectrometer for the measurement of NH₃ aboard an aircraft, with a particular emphasis on the utility of an active passivation technique. The manuscript is appropriate for AMT, and should be published after addressing the following issues:

General comments: In several places (e.g. P2, L29; P3, L32; P4, L27; P4, L33), the manuscript uses the term 'detector' to refer to the instrument itself, whereas in other places, including in Figure 1, 'detector' is used to refer to the MCT detector that collects the transmitted radiation, but is not in contact with the gas flow of the system. I found the more general use of the term somewhat distracting/confusing and would suggest using either 'QC-TILDAS', 'spectrometer', or 'instrument' in whichever case is appropriate.

We have changed this term throughout the manuscript according to the reviewer's suggestions.

In the section discussing the vibrational and structural issues, the authors mention (P5, L35) 'reinforcing' the 'strain relief'. It was not clear to me if this involved providing more slack in the sampling lines, or making them more rigid. A little more information would be helpful.

We have amended the last sentence of Sect. 2.2.4 to read as: "However, this motion sensitivity could be minimized by keeping tubing lengths to a minimum and reinforcing the strain relief of the sample tubing connected to the QC-TILDAS enclosure inlet and outlet ports (e.g., rigidly securing all flexible tubing to the frame of equipment rack with cable ties) prior to installation on the aircraft."

In Section 4.1, the authors describe a zero overflow experiment. Does the (> 500 sccm) refer to the difference between the flow of zero air being delivered and the flow pulled by the instrument? Clarification would be useful.

Yes, we mean the 500 sccm flow to be the difference between the flow of zero air being supplied to the inlet and the flow pulled by the instrument. We have added the following sentence to clarify: "An overflow > 500 sccm (e.g., the difference between the flow of zero air being supplied to the inlet and the instrument's sample flow) was maintained to ensure that the sample stream was truly NH₃-free during this test.

In Section 5.1, the authors explore the impact of inlet aging and the use of the passivant on the time response of the system. While the proportion of the time response governed by the slow,

“adsorptive”, term was typically quite low ($D < 10\%$), the magnitude of the step change in concentration was rather large (50 ppb), so caution should be taken in extrapolating that result to ambient observations.

We have added the following caveat to Sect. 5.1: “While the proportion of the time response governed by the slow, “adsorptive”, term was typically quite low ($D < 10\%$), the magnitude of the step change concentration utilized here is large (e.g., 50 ppb), so caution should be taken when extrapolating these results to ambient observations away from concentrated source regions.”

Section 5.2.1 presents an interesting case study in which two intercepts of an intense NH₃ plume led to much different sampling efficiencies depending on whether or not the passivant was being added to the inlet, as the result of a recent pre-flight contamination. I found this section a bit confusing because the time period between 13:20 and 13:23, when both the QC-TILDAS and the PTR-TOF-MS measured enhanced (and consistent) NH₃ is not described. One infers that the passivant was being used at the time, however it’s not clear.

We have added the following clarification to this section in the paragraph where the PTR-NH₃ measurements are described: “Passivant was not added to the PTR-ToF-MS; active continuous passivation was only applied the QC-TILDAS-based instrument during the selected times described above. It is clear by visual comparison to the PTR-ToF-MS that the non-passivated, “contaminated” QC-TILDAS instrument did not capture all of the expected ambient NH₃. This is evident from the differences in measured NH₃ mixing ratios reported in Fig. 8 during the time period between 13:20 and 13:23 when the QC-TILDAS was operated without passivant. During this time period the PTR-ToF-MS consistently measured more NH₃ than the QC-TILDAS, with the enhancement measured by the PTR during the plume intersect at 13:30 MDT showing an expected mixing ratio of ~45 ppbv. According to PTR-NH₃, the integrated NH₃ signal during the plume intersect at 13:30 MDT was only 14% less than the integrated NH₃ signal measured during the plume intersect at 14:00 MDT, and thus a significant enhancement in NH₃ should have been observed by the QC-TILDAS-based instrument. However, the non-passivated, “contaminated” QC-TILDAS-based instrument measured only a fraction of the NH₃ expected during the plume transect at 13:30 MDT, with the only attributable difference being NH₃ molecules adsorbing to the sampling surfaces.”

Specific comments:

P2, L11 – NH₃ is regulated under the Gothenburg protocol in some parts of the world.

We have added the following to the introduction: “While NH₃ is regulated under the Gothenburg protocol in some parts of the world (e.g., <http://www.unece.org/environmental-policy/conventions/air/guidance-documents-and-other-methodological-materials/gothenburg-protocol.html>), it remains an unregulated pollutant in the U.S. (Gilliland et al., 2008).”

P3, L33 – The ‘D’ in QC-TILDAS has traditionally stood for ‘differential’, not ‘direct’

We thank the reviewer for pointing out that prior usages of the acronym QC-TILDAS have referred to the 'D' as 'differential'. Aerodyne Research Inc., the manufacturer of the mini-TILDAS NH₃ monitor used in these experiments, has recently changed the 'D' to stand for 'direct' since they feel it better reflects the measurement method. While there are prior publications that use 'differential', newer papers and manufacturer's spec/product sheets (e.g., <http://www.aerodyne.com/sites/default/files/Product%20sheet%20NH3.pdf>) are now using the word 'direct'.

P7, L41 (and subsequently) 'Hydroscopic' should be 'hygroscopic'

We have made this correction.

Figure 8 caption – 'colorded' should be 'colored'

We have made this correction.