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Atmospheric Measurement Techniques Discussions

Interactive comment on "A low activity ion source for measurement of atmospheric gases by CIMS" *by* Young Ro Lee et al.

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General Comments

1. Referee comment: "In several figures, the low activity source (1.5 mCi when new) was compared with the 'standard' source (20 mCi when new); however, these activities change over time due to the radioactive. In all figures, the age of the sources should be added"

Author response: We have added the age of the sources to the caption of each figures.

2. Referee comment: "As far as I know, ion sources with activity of <10 mCi only require white (NON-RQ) shipping papers, which a 20 mCi reaches after ∼5 months. Would using a half-year old 'standard' source be a viable alternative to the LAS described

here"

Author response: The referee is correct in stating that an ionizer below 9 mCi can be shipped as "NON RQ" packaged of UN2911, which requires documentation and a UN label on the package. For excepted package, the activity level has to be below 5.41 mCi (200 MBq). However, it is very difficult for us to use an "old" source due to the regulations at our Institute.

Minor Comments

line 9) consider replacing "complications" with "regulatory burden"

We have modified the texts as suggested.

line 11) missing comma following (HCO2H)

We have added comma following (HCO2H).

line 18) consider replacing "some field applications" with "short-term field deployments" or similar.

We have modified the texts as suggested.

line 60) "49-CFR 173.410; 49CFR 173.425, Table 4" What does this mean? Where is table 4?

The code in the parentheses represents federal regulation about shipping and handling of radioactive materials. Table 4 describes the activity limits for limited quantities and instruments and is included in the code of federal regulation (49CFR 173.425).

line 75-113) Interference from peroxyacetic acid (and how it was minimized - see Phillips et al. Atmos. Chem. Phys., 13, 1129-1139, 10.5194/acp-13-1129-2013,2013) should be mentioned.

The isotopically labelled PAN calibration standard was added to air drawn through a QF 40 nipple filled with heated stainless-steel wool, which limits the interference from am-

bient PAA. In addition, the background measurement used for the ATom was performed by NO addition. We have added Phillips et al. 2013 to discuss possible interference from peroxyacetic acid.

line 82-84) "PAN calibration standard" consider moving these 2 sentences to section 2.3.1 where the other calibration sources are described.

We have modified the texts as suggested.

line 100) remove comma following et al.

We have modified the texts as suggested.

line 112) replace "detected" with "quantified"

We have modified the texts as suggested

line 119) replace "as shown in Figure S2" with "and is shown in Figure S2"

We have modified the texts as suggested.

line 121) "effect from varying humidity". please state what is affected by RH (sensitivity?)

We have modified the texts from "effect from varying humidity" to "variations in instrument sensitivity affected by ambient humidity".

line 140) "In general, the sensitivity of the LAS is approximately 2 to 4 times lower than that of the standard source, whereas the activity ratio is roughly 13" Are the values obtained with the LAS consistent with a standard source aged to an activity of 1.5 mCi? This is partially discussed later on but perhaps worth mentioning here.

We have added "Thus, it is likely that the initial activity of the LAS can result in higher sensitivity than the standard source aged to an equivalent activity level ($\sim$18 months), where the time dependence of sensitivity for both sources is discussed in section 3.4"

line 149) "may be preferable in some applications." Another example would be in pol-

luted areas, where a LAS may be preferred also as the signals at m/z 59 may get large (>105)

As the referee mentioned, the LAS may be a preferable option in polluted areas that have elevated levels of ambient PAN (e.g., fire plumes).

line 137-151) "Performance of LAS". The results shown in Figures 3c and 3d are not talked about at all.

We have added more discussion on the experiments using a larger scroll pump (Figure 3c and 3d).

line 153) What ions were used to monitor formic acid, chlorine, and nitryl chloride? (should be stated here). The sensitivities reported for chlorine and nitryl chloride are 2 orders of magnitude larger than reported by others (e.g., Mielke et al., 2011) who observed similar PAN sensitivity under conditions similar to panel (a).

We have added the ion signals monitored for formic acid (m/z 179), Cl2 (m/z 197) and ClNO2 (m/z 208). Absolute sensitivity presented in this work is specific to the experimental conditions and instrument parameters including transmission efficiency and declustering strength. For the configuration used for I- adduct CIMS, the collision dissociation chamber (CDC) was operated at a relatively lower voltage (-10 V), resulting in electric field < $\sim$22 V cm-1 than that for TD-CIMS experiments (-25 V).

line 165) "Figure S4" is called out before "Figure S3"

We have renamed the figures from "Figure S4" to "Figure S3."

line 172) "less than the decay rate" Is this due to the generation of radioactive daughters?

We think that at 20 mCi you are not limited by the activity of the source due to space charge effects.

line 174) "Figure S2" should be Figure S3

We have renamed the figures from "Figure S2" to "Figure S4"

Figure 3b and 3 caption) correct typo in axis caption (ion source fow). Please specify the ions monitored in the caption

We have corrected typo in axis caption and added the ions monitored in Figure 3.

Figure 3) The difference between panels 3a and 3c isn't very clear. I suppose 3a was acquired at 2.7 slpm total flow and 3c at 6.5 slpm? Consider adding this information to textboxes to the figures (as was done in Figure 4).

As the referee suggested, we have added textboxes to Figure 3 to eliminate any confusion regarding the different total flows.

Figure 4 and 4 caption) consider increasing the contrast between squares and circles as they're challenging to tell apart (e.g., replace solid with open circles).

We have increased the contrast between squares and circles by using lighter colors for circles. The ions monitored has been added in the caption.

Figure S1c) 13C-PAN - is this m/z 61? Please clarify in the caption. "showing no obvious interference". The signal is plotted on a logarithmic scale, so changes in intensity are difficult to spot to begin with. It appears that there may some effect (factor of 2 perhaps) but it's difficult to see. Please show these data on a linear scale. To claim "no obvious interference" there would have to be some change in [NO] and [NO2]. Consider adding a scatter plot of the internal standard against [NO].

We have added the ion monitored for 13C-PAN (m/z 61) in the caption. We have illustrated the data on a linear scale, and modified the texts from "showing no obvious interference" to "showing a minimal interference." Figure S4d has been added to exemplify relative sensitivity of PAN as a function of NO concentrations, showing less than 20% reduction in the detected ion signal for PAN by NO mixing ratios below 100 ppbv.

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