

Review of AMTD-8-13525-2015

General comments:

This manuscript is an instrument paper describing the new airborne mass spectrometer AIRS-H₂O, with in-flight calibration, for fast and accurate atmospheric water vapor measurements. The innovations of this instrument include:

- * a novel pressure-controlled gas discharge ion source designed for the direct ionization of ambient water vapor, which is different from the CIMS-H₂O instrument of NOAA (Thornberry et al., 2013).
- * a bypass flow to ensure short resident times (and consequently fast time response),
- * a new in-flight calibration source based on the catalytic reaction of H₂ and O₂ on Pt to generate H₂O.

In addition to instrument description, the paper also includes comparisons with other water vapor instruments.

The paper is very well-written and thorough. Its scope is a good match for AMT. The paper will be useful for presenting a new airborne hygrometer with in-flight calibration to improve accuracy at the low mixing ratios of the UT/LS. Section 1 Introduction is excellent motivating the need for this new instrument (to resolve past discrepancies in water vapor measurements). Section 2 Setup likewise is very well-written describing the instrument details, and I like the rest of the paper as well. The science merit is excellent and, in fact, I have no suggestions to improve the science content. My specific comments below are all minor points.

Specific comments:

1. page 13526, line 19: I recommend changing “well defined” to “well-defined”
2. page 13526, line 24: The Abstract and Table 1 list accuracy “between 7 and 15 %” but the Summary states accuracy between 8 % and 15 %. Is it 7 or 8? Please explain.
3. page 13526, lines 11 and 12: could you please add one sentence to explain how a residence time < 0.2 s results in a time resolution of 4 Hz? I would expect 5 Hz, unless there is a delay, smoothing or other aspect of mass spectrometry (I am not familiar with mass spec details).
4. page 13526, line 25 (and also on page 13528, line 28): change “Contrail and Cirrus Experiment” to “CONtrail and Cirrus ExpeRimenT” to capitalize the letters

of “CONCERT”.

5. page 13527, lines 7-10: I am not a mass spectrometry expert but would like a brief description (perhaps just a sentence or two) of the various techniques: CIMS, PTR-MS and “artificial ionization and characterization of ambient air”.

6. page 13527, line 26: please change “ppmv” to “parts per million by volume (ppmv)” here, the first time that ppmv appears in the manuscript.

7. page 13529, line 19: make the text clearer that backward-facing inlets sample gas phase only. I suggest writing “can be operated with either a backward or forward facing inlet geometry to sample the gas phase only or the sum of gas phase and (evaporated) particles, **respectively**.”

8. page 13529, line 21: please change “slm” to “standard liters per minute, slm”.

9. page 13533, line 25: at various places in this manuscript, the authors use flow units of sccm or slm. I recommend using the same units for consistency throughout the manuscript.

Minor editing comments:

1. page 13545, line 15 (and also page 13547, line 1): please change “focussed” to “focused”.

2. page 13547, line 24, please change “reserch” to “research”.

3. In Figure 2: please change “Inflight calibration” to “In-flight calibration” for consistency with the captions of Figures 2 and 3.

4. In the Figure 2 caption: please change “focussed” to “focused”.

5. In the Figure 4 caption: please change MOhm to Mohm.

6. In the Figure 8 caption: ML-CIRRUS campaign is 2014, not 2015. Also change “fligth” to “flight”.

7. In the Figure 9 caption: change “consequently” to “consistently”.