Referee comments on:

"Measurement of low-ppm mixing ratios of water vapor in the upper troposphere and lower stratosphere using chemical ionization mass spectrometry" by T. D. Thornberry et. al.

- The manuscript by Thornberry et. al. gives a very detailed description of a new CIMS instrument for the accurate measurement of water vapour in the upper troposphere and lower stratosphere. This manuscript leaves no doubt that the new instrument wouldn't function in a very precise and accurate way when deployed in high altitude flights measuring low mixing ratios of water vapour or in laboratory experiments. The most convincing evidence of the instruments capability to detect very small concentrations of water from the sample air is the two calibration methods conducted both in-flight and also in the laboratory.

  The manuscript suggests that other analytical methods may suffer from yet unknown artifacts but this is method showing identical responses to water vapour mixing ratios measured in the lab or in-flight. The accurate measurement of water vapour is very important for the more detailed understanding of cloud particle formation, and Thorberry's study now provides a broader dynamical range for water vapour mixing ratio measurements with detection limit as low as of 0.5 ppm. It will be interesting see if other groups are capable of adopting this in-flight calibration method and see if it would result in identifying these discrepancies among other instruments.

  The manuscript is recommended for publication in AMT after minor revisions.

Specific comments:

- P. 385 L. 15, Please add a missing reference (Neuman et. al. 2000)! You should also be consistent using brackets, e.g. (Neuman et. al., 2000) and sometimes [xxx et.al., 2000].
- P.385 L.23, you only use one detector channel, could the other one be used for some other tracer gas simultaneously with water vapour measurement?
- P. 385 -> Inlet system: All the details are described in great detail but it lacks the information of the laboratory setup if it is identical. The authors start describing the inlet system and go into detailed flight mode description and then come back to the beginning of the instrument development such as choosing tubing materials and testing of the laboratory setup. I would like to see a clear segregation between the lab test and the flight mode in 2. Instrumental Description.
- P. 387 L. 25. "The near-ambient pressure region of the inlet from the sampling point to the flow control valve (BV1) had a volume of 4.7cm3 and presented the dominant source of sample residence time." But you add calibration gas 15 cm downstream of the inlet tip this

means you don’t include this region where the sample spends most of its time in the calibration at all? The calibration methods are described in so many sections (P. 387, P.392, P.397) it’s hard to follow what’s happening.

- P. 390, Ionization Method: You could add a schematic picture to clarify the reactions. This would be easier for the reader to follow with the text.
- P. 397, Uncertainty: The paragraph describes the sources of uncertainty but not any numbers are given. It would be nice to in this paragraph what the overall uncertainty is for this method.
- Table 1 and text P.389 L. 7: The limit of detection (LOD) is usually determined from the standard deviation of the blank (zero) sample and it is not the lowest calibration point so don’t call these values LOD. The lowest calibration point might actually be closer to your LOQ (limit of quantification). Also you give the limit a range of 0.5 – 0.8 ppm but where does it come from (also P. 396 L. 11) is it difference in the calibration gases or something else?
- Table 2 I would like to see the summary of these errors here, so put the total uncertainty also here.
- Figure 8: In the calibration region there is three spikes standing out, where do they come from? You could also point out if the measured points are averaged over 1 s?