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Interactive comment on “The AquaVIT-1 intercomparison of atmospheric water vapor measurement techniques” by D. W. Fahey et al.

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This manuscript describes a comparison of the instruments which claim to make accurate measurements of water vapour amounts at the very low levels present in the upper troposphere and lower stratosphere (UTLS). This has been an area of some contention for many years as comparisons in the field have indicated real and variable differences. The AquaVIT activity thus represents an important step forward as it provided a comparison of the measurement quality of many instruments under the highly controlled conditions achievable in the AIDA chamber facility. This manuscript describes the results of the first part of AquaVIT in which the conditions in the chamber covered the pressure and temperature space encountered in the UTLS and were

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held approximately constant for significant lengths of time. As such they test the instruments operating under stable laboratory conditions, not under the dynamic conditions encountered in the real atmosphere during aircraft or balloon flights.

The manuscript contains important information which is clearly presented. It deals well with the complexities of operating the participating instruments in ways which are not necessarily optimal. This is a multi-layered, almost fractal problem and the authors do a good job of presenting the important points clearly. I think the manuscript should be published once the following comments have been addressed by the authors.

1. The main finding is that the measurements of the core instruments agree to within 10-20% over the range of conditions used. This level of agreement is better than seen in comparison flights in the real atmosphere. There is a section entitled “Atmospheric Implications....” which could usefully discuss what limitations this level of uncertainty puts on our quantitative understanding of UTLS water vapour (e.g., prevalence of supersaturation, understanding of ice-related dehydration).
2. In addition, it would be helpful to have some more discussion about other instrumental factors such as whether individual instruments are linear in the atmospherically important range from 2-150 ppm. Presumably something can be gleaned about this from Fig 7, even if it is relative to the reference values. For example the HWV & JLH seem to exhibit more of a positive deviation as the water vapour mixing ratio decreases, while the FISH deviations become more scattered.
3. It would be helpful to state what type of air was used in the chamber (synthetic?), and how clean it was of particles.
4. It is not completely clear whether the individual parts of the appendix are ‘owned’ by the PI or the whole author team as they often have a less balanced tone than the main paper. For example, the description of how stray light inside the chamber might be affecting the FLASH instrument is clearly written, but it is not obvious if this is the PI’s rationalisation of why FLASH did not perform as well as expected or if these

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arguments are accepted by all authors (or by the referees). Similar comments could be made about other parts of the Appendix.

5. Further, the descriptions of the instruments in the Appendix are somewhat uneven. For example, the opening paragraphs of the APicT spectrometer reads somewhat like a sales pitch with all papers listed, while that of the FISH instrument is rather terse with few publications listed. My personal preference is the style of the JLH instrument, but the main thing is to aim for a greater degree of consistency. In addition it would help the reader if phrases such as 'expected precision' (as picoSDLA do) could be used to indicate estimates of performance prior to AquaVIT.

6. The section on the additional CFH experiments (A2.4) is somewhat out of place and is not clearly written. I do not object in principle to the inclusion of these paragraphs here, but the aim and the result of each experiment needs to be made much clearer if it is to remain. For example the section on Controller Settings makes little sense to a new reader as it stands and the others are not much better.

Minor Comments 3192, 8-10 - please clarify whether this problem with FISH-1 was a one-off or whether it is always the case.

3195, 5 - delete 'very'

3207, 14 – '... likely the there...' – that?

3207, 21 – '... again too high...'

3207, 25 – '... the FISH-1 instrument...'

3212, 7-8 – not sure what the 2nd half of the sentence means.

Figure A3 – I do not get much out of this figure. It looks as though it is prepared for a talk rather than a publication

