<u>Anonymous Referee #2</u>

Review of: "The AquaVIT-4 intercomparison of atmospheric hygrometers" by Brunamonti et al.

Overall impression and rating

The authors describe the laboratory comparison of four hygrometers in the Aida chamber in an excellent manner. The manuscript is of a very high standard, well structured, and easy to read. The figures are all clear and of excellent quality. The relevance to the community is also given because accurate water vapor measurements in UTLS are still very important for monitoring and process studies. I therefore recommend the manuscript for publication in AMT after a very few minor questions on my part have been answered.

Authors: We would like to thank the Referee for the constructive feedback that helped us to improve our manuscript. Below are the individual comments from the Referee (in black) and the replies from the Authors (in blue). Please note that page and line numbers given below refer to the revised manuscript without tracked-changes.

Specific comments/questions:

• **Page 2, lines 11-16:** I think it should also be mentioned that negative trends have been found in stratospheric water (Hegglin et al. 2014), depending on the reference period used. This is clearly shown in Toa et al. 2023. I think it would be good to mention this as well, even though the paper is not about trends.

Authors: We thank the Referee for this suggestion. The following sentence was added: "*The analysis of a composite of satellite observations showed negative trends in H_2O in the lower and mid-stratosphere, and positive trends in the upper stratosphere, due to methane oxidation (Hegglin et al., 2014; Tao et al., 2023).*" (page 2, lines 17-18).

• **Page, line 18:** In the upper troposphere and even in the LMS higher mixing ratios above 10ppmv are observed. I would rather change the sentence to: "In the UTLS and in particular above the tropopause mixing typical mixing ratios of < 10ppmv are found."

Authors: Changed as suggested.

• **Page 3, lines 2-4:** There are already alternatives for cooling frost point mirrors, such as dry ice or liquid nitrogen. The CFH for LN2 cooling can already be ordered from the manufacturer. I would therefore tone down the statement that there are already alternatives that still need to prove themselves in the future.

Authors: We agree with this observation and rephrased the sentence as follows: "*Alternative cooling solutions, such as the use of liquid nitrogen or a mix of dry ice and alcohol, are currently being implemented and validated (e.g., Rolf et al., 2020; Dirksen, 2024; Poltera et al., 2025).*" (page 3, lines 4-6).

References:

Dirksen, R: R23 replacement (HP-2), GRUAN Implementation and Coordination Meeting (ICM-15), Bern, Switzerland, 11-15 March 2014, https://www.gruan.org/gruan/editor/documents/meetings/icm-15/pres/pres_0610b_Dirksen_R23.pdf (last access 5 July 2025), 2024.

Poltera, Y., Luo, B., Wienhold, F. G., and Peter, T.: Observations of water vapor in the UT/LS of unprecedented accuracy with non-equilibrium corrected frost point hygrometers, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-19811, https://doi.org/10.5194/egusphere-egu25-19811, 2025.

Rolf, C., Khordakova, D., and Vömel, H.: CFH cooling agent alternatives, GRUAN Implementation and Coordination Meeting (ICM-12), 16-20 November 2020, https://www.gruan.org/gruan/editor/documents/meetings/icm-12/pres/pres_302_Rolf_CFH_Cooling-Agent-Tests.pdf (last access 5 July 2025), 2020.

• **Page 22, lines 6-8:** Why should the temperature directly influence the water vapor mixing ratio? Because of adsorption effects of the water vapor molecules on the tube wall? You should add a short explanation here.

Authors: Indeed, temperature affects the H_2O mixing ratio via temperature-driven adsorption/desorption effects on the inner walls of the sampling line. A short explanation was added to the manuscript: "*These fluctuations are a measurement artifact due to the heating controller of the sampling line, shared by both instruments, which modulates the temperature (hence the H_2O mixing ratio, via temperature-induced adsorption/desorption effects on the inner walls of the sampling line)*" (page 22, lines 8-10).

• **Page 26, lines 5-7:** How did you know the sampling efficiency of ice particles by the sampling line. Can you insure isokinetic sampling? Otherwise you need to correct or it to determine the ice water content. Maybe it is worth mentioning this also in the text.

Authors: Ice water content measurements from the same sampling system as used by MBW373LX and ALBATROSS during AquaVIT-4 were previously compared with in-situ measurements by FTIR, showing that a significant sampling loss only occurs for ice particle sizes larger than 7 µm (Haag et al., 2003). However, since a potential sampling loss would affect both instruments in the same way (as they share the same sampling line), this does not affect the comparison.

Reference:

Haag, W., Kärcher, B., Schaefers, S., Stetzer, O., Möhler, O., Schurath, U., Krämer, M., and Schiller, C.: Numerical simulations of homogeneous freezing processes in the aerosol chamber AIDA, Atmos. Chem. Phys., 3, 195–210, doi.org/10.5194/acp-3-195-2003, 2003.

Technical comments/suggestions:

• **Figure 3/4:** I would suggest to include the saturation mixing ratio as additional line. This would help the reader identify which points in the time series are supersaturated or subsaturated.

Authors: Done.

References

• Hegglin, M., Plummer, D., Shepherd, T. et al. Vertical structure of stratospheric water vapour trends derived from merged satellite data. Nature Geosci 7, 768–776 (2014). https://doi.org/10.1038/ngeo2236

• Tao, M., Konopka, P., Wright, J.S. et al. Multi-decadal variability controls shortterm stratospheric water vapor trends. Commun Earth Environ 4, 441 (2023). https://doi.org/10.1038/s43247-023-01094-9