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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Intercomparison of mid-latitude tropospheric and lower stratospheric water vapor measurements and comparison to ECMWF humidity data" *by* Stefan Kaufmann et al.

Anonymous Referee #2

Received and published: 23 August 2018

Review of acp-2018-744:

Short Summary: The authors present an intercomparison of gas-phase (i.e. clear sky) airborne in situ water vapor measurements onboard the DLR research aircraft HALO during the mid-latitude ML-CIRRUS mission. This publication is important as the first comprehensive intercomparison of all the major research hygrometers of the German research community: HAI, SHARC, WARAN, AIMS, and FISH. Although the agreement of the hygrometers has improved significantly compared to studies from recent decades, systematic differences remain under specific meteorological conditions (differences on the order of 10% for mixing ratios below 10 ppm). The authors compare

the measurements to model data where we observe a model wet bias in the lower stratosphere close to the tropopause, likely caused by a blurred humidity gradient in the model tropopause.

Review: General Comments

This is an excellent manuscript and of significant interest to the water measurement community. The authors justify the importance of accurate water vapor measurements, and then carefully quantify the differences between state-of-the-art instruments. Since the focus of this paper is on intercomparison, and very brief on scientific analysis, this manuscript is more appropriate for AMT. Other key water intercomparison papers appear in AMT (e.g., Fahey et al., 2014). Subject to the other reviewers and the editor, I recommend that the authors submit this manuscript to AMT instead of ACP.

Specific Comments

1. Page 7, line 20: For measurements within clouds, how do you know that the relative humidity should be 100% with respect to ice? Anvil ice are likely close to ice saturation, but there is much literature that other ice clouds are expected to be supersaturated (for instance, upper parts of ice clouds and ice clouds forming in-situ). The asymmetric tails of relative humidity toward higher supersaturation (e.g. Figure 5, Figure 6 and page 11) are evidence of supersaturated environments.

2. In the data analysis, is it possible for you take into consideration where (vertically) in the cloud the measurements were made?

3. 3a. Which flight number is used for Figure 5? The discussion on page 12 identifies specific flights where supersaturation is expected. 3b. Were these flight segments (e.g. high updraft velocity) excluded from Figure 5 and the relative humidity analysis?

4. Page 9, line 13: Sahara dust is mentioned twice in the manuscript (e.g. pages 9 and 14). What is the significance of Saharan dust to humidity measurements?

5. Page 15, lines 31-32: this manuscript concludes that ECMWF model bias is due

to a too-small humidity gradient across the tropopause. I recommend that the authors add a figure that shows example vertical profiles of H2O from model and aircraft, with the tropopause height labelled, to demonstrate this gradient.

Technical Corrections Below are minor editing comments,

1. Page 1, line 18: change “number relevant scientific questions” to “number of relevant scientific questions”

2. When pointing to a section, capitalize “Section”, examples on page 3, line 20, and page 4, line 1.

3. Page 8, line 2: remove double period.

4. Page 14, line 27: change “cloud” to “clouds”.

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