

Interactive comment on “Advancements, measurement uncertainties, and recent comparisons of the NOAA frostpoint hygrometer” by Emrys G. Hall et al.

Anonymous Referee #1

Received and published: 20 June 2016

General comments:

This paper provides both an excellent review of the history of the NOAA FPH water vapor soundings at Boulder since their inception in 1980 and a very thorough discussion of the present instrument's calibration and measurement uncertainty.

The historical review is included as part of the detailed description of the instrument in Section 2. It is extremely valuable given the importance of the Boulder water vapor data as a climate record. The description of the instrument itself is very thorough. Thermistor calibration and calibration curves are discussed in Section 3, including, again, a very thorough discussion of the older 3-point calibration technique and the 6-pt technique adopted in 2014 as well as the change to the continuous measurement

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technique.

Contributions to measurement uncertainty are discussed in Section 4. Figure 5 shows the dominance of the frost control stability error over the various systematic errors in the frostpoint measurement. Section 5 which follows is an interesting discussion of the mirror condensate and a clear explanation of the need for the mirror clearing that is done at -53°C .

The instrument description concludes in Section 6 with a discussion of the unique NOAA balloon valving system that enables the use of descent data. As pointed out in the paper, this has been the practice at NOAA since the early days in Washington, DC, as it guarantees that the hygrometer will be measuring air uncontaminated by the balloon and its train.

Section 7 focuses on inter-comparisons. The AquaVIT-2 activity in April 2013 is discussed in some detail and the authors conclude that the FPH showed good agreement with the MC-APicT-1.4 instrument that was used as a reference. The section concludes with an abbreviated discussion of flights with (a) two FPHs flown together and (b) a CFH flown with the FPH.

This is a significant paper for the important benchmarks it provides. It is also well-written. I recommend it be published pending technical revisions of the figures for legibility (as I discuss below) and a small number of typos. I also have some specific comments on the text that the authors may wish to take into account in the preparation of their final manuscript.

Specific comments:

1. in the discussion of the valving protocol in Section 6, it would have been nice to see a comparison of the uncontaminated descent profiles used by NOAA with the potentially contaminated ascent profiles. This is not an entirely academic question as other frost point records are based on ascent data only. This would certainly be a valuable addition

to the paper which the authors might want to consider.

2. As mentioned in the General Comments the discussion of the dual frost point flights is quite short. Figure 10a shows the FPH/FPH differences as function of height on both ascent and descent. However, no reference in the text is made to the presentation of both and what might - or might not be - concluded from it. Figure 11a is limited to the ascent profiles only. Is there a reason why only an ascent profile was done? Because this is standard CFH practice? These questions are connected to the previous comment.

3. A more important issue perhaps is raised by the inset (c) in Figure 11. Despite the excellent agreement between the CFH and FPH in this flight, the CFH error bars are substantially larger than the FPH. Indeed, above about 17.5 km the CFH error bars totally swamp the FPH error bars. This deserves some comment.

Technical corrections:

1. The labeling in the figures is too small. In my printed review copy, the legends in particular are barely readable. The axis labels as well could be at least half-again as big.

2. Also with respect to the labeling, the small size of the labels is not helped by the use of light gray and light blue. Nice to look at, but hard to read!

3. Typographically and grammatically the text is in very good shape. I list some of the few typos I found below.

4. One stylistic comment: I would remove the spaces between the numerals and percent signs.

Typos, etc.:

(a) p. 2, line 26: insert hyphen into “mid latitudes” (b) p. 3, line 8: insert hyphen into “balloon borne” (c) p. 4, line 4: insert comma after “cryogen” (d) p. 4, line 20: as in

(b) (e) There are a number of instances where adjectives are formed from a numeral and something else. For example “1 m” in line 29. These would benefit from hyphens. Though “1 Hz” works for me. (f) p. 7, line 9: change “the previously used Vaisala RS-80 radiosonde” to “the Vaisala RS-80 radiosonde used previously”. (g) p. 11, line 19: change “manufactures” to “manufacturer’s” [?]

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-160, 2016.

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