Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2016-160-AC1, 2016

Atmospheric Measurement Techniques Discussions
Open Access
EGU

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

Emrys G. Hall et al.

emrys.hall@noaa.gov

Received and published: 25 July 2016

The authors would like to thank all of the anonymous referees for their constructive comments helping to improve this manuscript. Below, we provide detailed responses to each of the comments. Manuscript changes are listed below the author's response when warranted.

Anonymous Referee #1

Received and published: 20 June 2016

General comments:

Printer-friendly version

Discussion paper

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 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 -53âŮęC.

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 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.

Author's response: We added a new paragraph with statistics showing contamination from the balloon and flight train at the site in Lauder, New Zealand. We also refer to Krächi et al. (2016) that shows a profile from an FPH with contamination on the ascent. We felt that adding another figure to the already significant number of figures would make the paper unwieldy.

Author's change in manuscript: We added the following paragraph after the first paragraph in section 6: "Kräuchi et al. (2016) show an example of stratospheric contamination on an ascent profile starting near 25 km with uncontaminated measurements from the descent extending the profile above 27 km. When analyzing 141 flights from Lauder, New Zealand, instruments flown without a sunshield encounter contamination starting in the stratosphere below 25 km $\sim$ 15 % of the time whereas instruments flown with a sunshield prior to 2010 see contamination $\sim$ 52 % of the time. Although eliminating the sunshield has significantly improved stratospheric data collection with regards to contamination on the ascent, the controlled uncontaminated valved descent profiles continue to provide stratospheric data reaching above the contaminated ascent data."

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.

Author's response: For figure 11a (now 12a), we only display data from the ascent profile for both the CFH and FPH due to an unexplained loss of cryogen at the top of the balloon flight on both instruments. See next comment for changes in the manuscript. We have also added text describing the FPH dual flight. This includes an explanation regarding the ascent and descent data collected along with some problems that sometimes occur during a flight.

Author's change in manuscript: The following text was added to the first paragraph to address the first point: "Instrument "1105" had frost control oscillations after the valved balloon turn on this flight resulting in missing descent data until 21 km. Although the descent data often captures high quality data above the ascent data, there are times when the descent data suffers depending on atmospheric conditions or unknown instrumental issues. In these cases, the descent data are flagged bad and removed during quality control after the flight."

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.

Author's response: We have added a new reference, Vömel et al. (2016) that describes how the CFH proportional, integral, differential (PID) controller was tuned. New text was added to explain the larger error bars on the CFH during this dual sounding.

Author's change in manuscript: The following text was added: "Only ascent data was compared due to an unexplained cryogen loss at the top of the flight. The CFH is tuned to be a fast responding instrument with some oscillations in order to quickly respond

to changes in water vapor during a profile. The error bars are larger on the CFH compared to the FPH during this flight (Fig. 12c) partially due to incomplete sunlight filtering coupled with fast responding stratospheric PID controller values (Vömel et al., 2016)."

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.

Author's response: Agreed. We have increased the size of both the legends and the axes for all figures.

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!

Author's response: We have increased the line trace size and changed gray to orange in some figures to make it easier to read. We have also increased the size of the labels on all plots.

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.

Author's response: The AMT manuscript preparation typesetting guidelines specify to use spaces.

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” [?]

Author’s response: We have changed all typos as listed above except for hyphens as the AMT manuscript preparation typesetting guidelines shows using spaces in between the unit and the value.

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

Printer-friendly version

Discussion paper