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Atmospheric Measurement Techniques Discussions

Interactive comment on "Understanding cryogenic frost point hygrometer measurements after contamination by mixed-phase clouds" *by* Teresa Jorge et al.

Anonymous Referee #1

Received and published: 29 June 2020

Review of "Understanding cryogenic frost point hygrometer measurements after contamination by mixed-phase clouds" by Jorge et al.

It has been well known that stratospheric water vapor measurements may be heavily contaminated if the balloon payload passes through low and mid tropospheric clouds; however, the details of this mechanism have not yet been investigated. The manuscript by Jorge et al. investigates the parts of the balloon train that may generate this contamination and the physical processes that take place in the collection and release of the excess water.

The manuscript identifies that supercooled liquid water droplets may impinge on the

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insides of the inlet tubes of the instrument driven by a significant radial velocity due to the pendulum motion of the payload and the off-vertical orientation of the payload. Depending on the pendulum amplitude and amount of water drops, the upper parts of the inlet tubes may receive large ice coatings than farther down the tube.

Contamination by the balloon wake is more likely to become significant near the burst altitude and may not be as significant in the lower stratosphere.

The paper uses a fluid dynamical model to study the freezing and sublimation processes as well as the mixing processes inside the tube and compare these with a series of in situ observations that triggered this study.

The manuscript is overall well written and strongly suggests processes inside the inlet tubes to be dominant. I can recommend publication of this manuscript after a few mostly technical corrections.

Detailed comments:

Page 13, line 33: How important is the assumption that the inlet tube is at the same temperature? The recommendation at the end may point towards a heated inlet tube. However, is heating of a few degrees sufficient, or will heating of many 10s of degrees be required to be effective? How might a colder inlet tube (possibly through infrared cooling at night) make the problem worse? A little bit of discussion about this assumption may be useful for the reader.

A few more words about ANSYS/FLUENT might be useful for readers, who are not familiar with CFD. ANSYS seems to be the manufacturer of the FLUENT software.

The appendix expands the paper significantly, but supports the main arguments. I can't tell if the manuscript may be too long and I would not suggest to remove it. It could be shortened if needed.

Technical comments:

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Abstract, Line 1: delete “(sub)tropical”. UTLS water vapor measurements are important in all geographic regions, not just the (sub-) tropics.

Introduction, line 31 on page 2: better “instrument’s Styrofoam box”.

Section 2.1, line 11: “automated” instead of “automatized”

Line 12: The instrument seems to control the reflectivity, which may not directly correlate to thickness.

Page 5, line 3: CFH instead of CHF

Page 5, line 10: Why do the authors use 1 hPa instead of more obvious constant altitude or constant time interval?

Page 11, line 17; space missing before ‘cutcell’

Page 11: Remove the acronym SST, since it is not used except here.

Page 16, line 18, extra comma after “until”

Page 17, line 17; what means “extra ice saturation”? Maybe just delete this phrase.

Page 18, line 12; remove the hyphen after readily.

Page 19, line 10; add “the” before “CFH” (and a few other places).

Page 19, line 10; add “than” before “1.45 mg”

Page 19, line 29; maybe clearer: “which the balloon radius changed with pressure”

Figures 2 and other similar Figures: The colors are hard to distinguish, in particular pink, light purple and dark purple. Since there is no ambiguity about the ice or liquid on the mirror, maybe one of the traces could be removed.

Figure 2 b: The very high average mixing ratio near the top of the profile seems to go well above 10 ppmv, i.e. contaminated data may be part of this average.

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Figure 4: The font in the Figure is too small.

Figure 6 c: The arrow for the inlet flow does not seem to be vertical as I would have expected. I assume the difference is due to the rotational speed. Can this be indicated in the Figure?

Figure 10e: The bottom half of the flow tube seems to have been shifted a little.

Figure 13: What determines the lower and upper limit of the vertical integration interval?

Figure 14, legend: The second (a) should be (c)

Figure 3 and Figure A2: The estimated region for the supercooled mixed phase clouds seems to use different selection criteria.

Table 1 and Table 3 legend: Move NT007 into first place following the ordering in the table.

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