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Atmospheric Measurement Techniques Discussions

Interactive comment on "Reference quality upper-air measurements: GRUAN data processing for the Vaisala RS92 radiosonde" *by* R. J. Dirksen et al.

Anonymous Referee #2

Received and published: 21 May 2014

1 Overall recommendation

The manuscript by Dirksen et al. describes data processing and uncertainty estimation for Vaisala RS92 radiosondes as performed in the GRUAN network. Scope and content of the manuscript are very well suited for AMT. While the manuscripts does not present a lot of fundamentally new information, it summarizes correction methods and their uncertainties quite well. It is also very important to document these in the scientific literature. After a few minor revisions, I think the manuscript will be well suited for publication in AMT.

2 General points

I think it is very important to have the relevant final numbers for temperature uncertainty and humidity uncertainty, geopotential height uncertainty, pressure uncertainty (for day and night when they differ) mentioned in the abstract. This important information should be available from the abstract, without having to read the paper first. So please add these numbers to the abstract.

Also, I highly recommend adding a table (or figures) that summarizes the obtained final uncertainties for temperature, humidity, geopotential height and wind as a function of height / pressure. This table / figures should also include the uncertainties given by Vaisala (and flag where Vaisala processing and/or uncertainty is believed to be wrong or biased). While this information is scattered in the manuscript, it would be very helpful to have it collected in one easy place.

Section 3 "Description of the RS92 Radiosonde" is not balanced. There is a lot of discussion (on pg 3732, 3733) of the humidity measurement/ sensor, but little or no corresponding discussion of the pressure and temperature sensors. Either discussion of the p and T sensors needs to be expanded here, or the details on humidity should be moved to Section 6 on humidity.

The same might be true for Section 3.2: I am not sure if this is that helpful here. It might be better to move it to Section 6. I agree with Larry Miloshevich's review, that the discussion of the ground-check is a bit scattered throughout the manuscript, and that the final recommendations on the ground-check and undoing of the Vaisala humidity correction may not be clear enough. The authors should address this. Since the authors think that one-point calibration of the humidity sensor by the ground-check is not useful, they should make this very clear (e.g. also in the recommendations in sections 10, 10.1).

What is the measurement principle of the humidity sensor? Does it measure water

vapor partial pressure that is then processed to humidity? What is a likely physical mechanism / explanation for the "out of the air" humidity correction in Table 3 / Section 6.3. Additional explanation is needed here (also on page 3757).

Is it possible to use the humidity displayed in the stratosphere as 0% RH for sensor calibration? Better than the problematic ground check?

Is it possible to give uncertainties on the wind data?

3 Detailed Comments

pg. 3278, line 26: I very much doubt that routine radiosondes have measured "up to about 40 km" for decades. 30 km seems more realistic. Water vapour is measured only up to 10 km (at best).

pg. 3729, lines 13 to 15: Suggest to drop the sentence after Wang et al. (2013). There are lots of approaches for homogenizing. This should not be simplified and jugded here.

pg. 3730, 3731: I have to admit that I am not happy about calling a systematic bias "correlated uncertainty" and random errors/uncertainty "uncorrelated uncertainty". Whenever I hear correlated and uncorrelated I have to ask "correlated with what?". But I guess this is GUM-speak and needs to be used now.

pg. 3731, line 20, "does not reduce its uncertainty" -> "does not reduce its systematic error" or "does not reduce its systematic uncertainty"

pg. 3733, lines 1 to 3: Are the p and T sensor calibrations SI traceable like the humidity calibrations? This should be stated here. Generally, throughout the manuscript, the authors have to be more careful about too much focus on humidity, and the lack of similar detail on the temperature measurement (and pressure). Temperature is also

a very important climate variable! Also a statement should be made about how good these Vaisala stated accuracies are. Are they very conservative? Are they consistent with the precisions found in twin flights? With the findings of the authors?

pg. 3736, line 17: Add version for Digicora software.

pg. 3736 lines 20 to 22: This 1 K warm bias needs to be qualified. Do the authors think that RS92s have a 1 K bias? If so, they should correct for it in the GRUAN processing. Does that mean that temperature measurements from Vaisala RS80s (which are colder in the stratosphere, Steinbrecht et al. 2008) were correct? Or is it likely that the radio occultation temperatures are too cold? Please clarify.

pg. 3737, line 6: add "(see Section 5.5)" after "negligible"

pg. 3738, line 18: extend -> extent (also in other places!). It would make sense to run a spell-checker over the manuscript!!

pg. 3742, section 5.2.4: Explain why there is no correction for long-wave cooling at night in the GRUAN processing. How big is the correction in the Vaisala software?

Section 5: One thing that never became clear to me is how solar zenith angle (SZA) is accounted for in the GRUAN radiation correction. Is there a lookup table for the conditions given in Table 1? Is that interpolated to the actual SZA? Depending on generalized cloud conditions? Section 5.2.2 only clarifies (to me) what is used for uncertainy estimation, but not what is used for the actual radiation correction. I think this needs clarification (and maybe a repetition later in the manuscript).

Section 5.3. Is it also possible that there are cold spikes at night, due to a cold balloon? (radiative cooling at night and large heat capacity making the balloon colder than ambient in the stratosphere)

page 3758, lines 26, 27: What is meant by calibrating? Is that not simply addition of a constant value, so that the GPS altitudes start with the altitude of the launch position? Please be more specific.

Section 9: Please explain the principle of the wind measurement. Is wind derived from the change of GPS position over time (derivative), or is it derived from Doppler shifts of the GPS carrier frequencies? Also, it would be good to give some numbers for the statistical uncertainties (page 3764, lines 9, δ_u, δ_v and then for $u(s)$ and $u(\Phi)$)

Table 2, caption: please add "temperature" before "uncertainty" to the caption, so the reader knows what this table is for.

Table 7, caption: Typo "temperuture"

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