

Interactive comment on “Evaluation of two Vaisala RS92 radiosonde solar radiative dry bias correction algorithms” by A. M. Dzambo et al.

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I found this to be an interesting and useful study. As author of the MILO correction I'd like to offer the following feedback for your consideration:

1. p 10759, especially footnote 1 where it states that RS92 does not require a time-lag correction.

This is not correct. While the RS92 RH sensor does respond much faster than RS80, time-lag error can still be substantial when $T < -45\text{C}$. The sensor time-constant at -45C is about 15 s, and at -70C it is 105 s. At a 5 m/s ascent rate this corresponds to a 63% sensor response on vertical scales of 75 m and 525 m respectively, which is the scale over which humidity features are "smoothed" by slow sensor response. It's

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also relevant that Vaisala themselves implemented a RS92 RH time-lag correction in their Digicora v3.64 software (along with a solar radiation correction), so clearly Vaisala thinks that a TL correction is needed. Also, note that a more appropriate reference on this is my 2009 paper, not 2004 (which preceded widespread adoption of RS92).

The character of time-lag error is complicated in that it affects the shape of the RH profile in the UT/LS, leading mostly to increased variability in statistical comparisons to other measurements but also to a small bias component in certain circumstances. The nature of time-lag error is illustrated in M09 Figs. 1a (red vs black) and 15a (red vs yellow). The RH generally decreases above the tropopause, so TL error in this 1–2 km region is a moist bias, and a correction decreases the WV in this region. It is also common to see a high-RH layer that is capped at the tropopause, where TL error causes a dry bias below the base of the layer where the RH is increasing.

Time-lag error in the UT has little relevance for the MWR and GVRP comparisons, but may be notable and may explain some results for the AIRS comparisons. I wonder whether uncorrected TL error might explain some of the behavior you observed in individual altitude bins? The bias component is not a function of altitude and varies between profiles, so it might come across in altitude-based comparisons mostly as enhanced variability.

For the paper I recommend removing or changing footnote 1 and either: 1) implement a time-lag correction and repeat the analysis; or 2) give a better explanation of why the MILO time-lag correction was not applied and what its impact on the comparisons might be.

I suspect that you had both EDT and FLEDT RS92 data files, the former having integer RH values and a stairstep appearance in plots, and the latter having higher-resolution RH data. While it is very complicated to construct a TL correction for EDT data following the recipe in M04, it's fairly straightforward to implement a TL correction for FLEDT data because the profile is physically realistic. The data must be smoothed so that the

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TL correction doesn't amplify noise, but my fancy IDL smoothing algorithm is available on my radiosonde webpage at milo-scientific.com/radiosonde.php (click "RS92 Correction Method" and see especially the Overview, Notes on TL Correction, and IDL Code sections). Note also that there is a one-line time-constant expression in the Overview section (Fig. 1), which is an improvement over what's in the M04 paper (this fig is also published in Dirksen et al., 2014, AMTD).

2. Very dry conditions (Chile, lower stratosphere, occasionally in SGP or NSA tropospheric profiles)

It is correctly mentioned in the paper that the coarse 1% RH resolution of EDT data may be a big factor in the accuracy of the GVRP comparisons for very dry conditions (p 10764, top half). It may also be a factor for some of the AIRS comparisons. The $\pm 0.5\%$ RH uncertainty in the rounded EDT data corresponds to $\pm 10\%$ uncertainty at 5% RH, and $\pm 25\%$ uncertainty at 2% RH.

A suggestion for the paper is to explore the sensitivity of the comparisons to data precision/filetype by applying the solar radiation corrections to the original profiles after first reducing them by 0.5% RH or increasing them by 0.5% RH, to illustrate the impact of precision-related uncertainty on the comparisons.

It would be a service to the community to mention somewhere that users of Digicora III hardware should output the high RH precision FLEDT files rather than the standard/default 1% RH precision EDT files (see first bullet of "Best Practices" link on my radiosonde webpage, or refer to Appendix A of M09; also note the bullet that the 1% RH values in Vaisala data are not real).

3. Some other misc comments

- In Conclusions, it might be important enough to repeat that standard Vaisala data beginning with Digicora v3.64 software include by default both time-lag and solar radiation corrections. It's important to raise awareness about this because, unfortunately,

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it's not apparent in data files whether or not Vaisala corrections have been applied, which is somewhat of a "nightmare situation" for Data Continuity (see final bullet under Best Practices on my radiosonde webpage).

FYI regarding data continuity, you may be interested in the following paper that compares Vaisala's empirical RS92 solar radiation correction with their new sensor that properly eliminates solar radiation error and the need for a correction altogether by measuring the RH sensor temperature: "Comparison of Vaisala radiosondes RS41 and RS92 at the ARM Southern Great Plains Site" <http://www.atmos-meas-tech-discuss.net/8/11323/2015/amtd-8-11323-2015.html>

- Regarding the suggestion of adjusting WANG "cf" for cloudiness, this is an interesting idea. Conceivably, assumptions could be made allowing clouds to be inferred relative to the ice-saturation curve (see the experimental cloud adjustment approach on my Correction Method webpage (section "Algorithm changes since the published version of the bias corrections in 2009", final bullet and Fig. 4). However, this approach is really quite complicated and subject to error because there's a huge difference in cloud extinction per km for cirrus vs lower-altitude clouds, ice vs liquid, and in general just the huge variability that arises from cloud microphysical properties. Any "cf" cloudiness adjustment will at a minimum need to vary with altitude (or temperature) and water phase.

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