- 1 Andrew Dzambo, Dave Turner, Eli Mlawer
- 2 **Replies to Interactive Comments on "Evaluation of two Vaisala RS92**

3 radiosonde solar radiative dry bias correction algorithms"

4 5

March 10, 2016

6

7 Prelude

8 The authors would like to thank the reviewers and Dr. Isaac Moradi for their 9 feedback on this study. The following document contains replies to each comment 10 posted on the <u>discussion board</u> at <u>http://www.atmos-meas-tech-discuss.net/amt-</u> 11 <u>2015-258/</u>.

This document is organized such that the name (if given) of each
referee/commenter is given, and their original comment will be bolded. Replies
from the author will be in *blue italics*.

In addition to addressing each individual comment provided, we have updated every figure in the paper to be neater and more professional looking – all plots are now in EPS (PDF) format, and are scalable such that image "graininess" is no longer an issue. Any comments or modifications made to the original text have

been marked using Microsoft Word's "Track Changes" tool. Specific comments and
 modifications are reproduced, where appropriate, to the reviewer's comment(s).

- Thank you again for taking the time to review our manuscript we already
 notice an immediate difference in the quality of the paper. We look forward to
 hearing back from you.
- 24
- 25 Sincerely,
- 26 Andrew, Dave and Eli
- 27
- 28
- 29

| 30 | <u>3. Comments from Anonymous Referee #5 (Referee)</u> |
|----|---|
| 31 | |
| 32 | 1. General comments |
| 33 | This is a solid article that I would recommend for the publication. |
| 34 | |
| 35 | This comment is much appreciated – thank you! |
| 36 | |
| 37 | 2. Specific comments |
| 38 | # Title: MILO is not only a radiation correction, it includes as second |
| 39 | component a time-lag correction. RH sensors of RS92 need time-lag correction |
| 40 | (see Dirksen et. al. 2014). |
| 41 | |
| 42 | Thank you for pointing this out. We implemented the RS92 time-lag correction |
| 43 | code following Miloshevich et al. (2004) and <u>www.milo-scientific.com</u> , where an |
| 44 | updated version of the time-lag correction code (including constants, equations, etc.) |
| 45 | can be found. For the purposes of the two radiative transfer experiments – especially |
| 46 | the upwelling experiment, however, we chose not to redo our results for the following |
| 47 | reason. When comparing the time-lag corrected RH with the non- time-lag corrected |
| 48 | results, we did find significant changes in the RH (especially in the upper-troposphere) |
| 49 | typically around 5-15% (sometimes higher), however, when averaging out the change |
| 50 | in RH for a range of altitudes (e.g. 25 hPa bins, as shown in the figures), the |
| 51 | mean/median change in RH due to time-lag correction is often less than 1%. Please see |
| 52 | the following figures demonstrating this – the first one is for the CJC site (where RH is |
| 53 | often measured around 10-15%) and the second one is for the SGP site. All CJC sondes |
| 54 | (around 150) and 1-month worth of SGP sondes (around 120) are represented in each |
| 55 | figure. |







We edited the footnote on p. 10759 to correct a wrong assumption made about
the RS92 RH sensor not requiring a time-lag correction. The footnote now reads, with
changes in **bold**:

61 *"Although the time lag correction was developed for RS80 radiosondes, RS92*62 *radiosondes also require a time lag correction. See Miloshevich et al. (2009) and*63 *Dirksen et al. (2014)* for more information."

64

Representative data set: See P10766 L22-24: In section 4 a data set of 5
years from site SGP is used. That sounds good and means for me 1825
soundings.

See P10768 L24: After removing all launches which are not fit several criteria
-> only 96 cases are used. Can you clarify, if these launches (5 % of full
dataset) are representative for whole dataset?

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72 During this 5-year period, there are 1721 AIRS files covering this time span. Of 73 these 1721 AIRS files, 630 of them fell within the 135-minute (2.25 hour) window (so 74 \sim 63% of cases are eliminated in this step). The second step of our criteria was to 75 eliminate cases where the brightness temperatures in the AIRS footprint (i.e. the 3x3 76 pixel) varied substantially (as in, cloud-cover is likely over or around the SGP site). We 77 took care to ensure our thresholds (Table 3) were reasonable given the time of year as 78 well. This criterion reduced the total number of cases from 630 to 308 (so ~18% of the 79 original dataset). Of the 308 cases that passed the time-window and pixel- T_B 80 thresholds, 15 of these cases were removed through QC flags that indicated the data 81 were suspicious/wrong/etc. (documented in the ARM files), leaving us with 292 cases. 82 Finally, the data were further filtered removing cases where the change in PWV 83 between the sonde launch and AIRS overpass (determined via our PWV sensitivity 84 analysis) was greater than 5% (50 cases), where RHI > 90% (105 cases), or (obviously) 85 where both criteria failed (41 cases), meaning 196 of the 292 remaining cases were 86 filtered out. This is how we arrived at 96 usable cases (~5% as you mentioned). 87 Given this methodology, we feel these sonde launches are indeed representative

67 Given this methodology, we feel these sonde launches are indeed representative
of the whole dataset considering that these 96 cases represent entirely clear-sky
conditions, which exemplify the conditions the WANG/MILO algorithms best
remediate. For the 292 candidate cases, the 105 removed (~36% of these cases) due to
high RHI is consistent with the idea that cirrus are likely present (e.g. Mace et al. 2006,
Liou 1986), and the remaining cases where the change in PWV changed by over 5%
(91 total cases) implies changing weather conditions.

94

95 **# Comparison with a reference: See Fig.5, Fig. 8, Fig. 9, Table 2, Table 4**

96 If I want to compute a bias or other difference to a reference, I would use
97 following formula: bias = data - reference

98 Unfortunately, in a couple of figures and tables the author computes it in a

99 different way (reference - data) as a residuum. Because that, it is confusing for

100 me to follow at a couple of passages. Particularly if the author uses in the text

101 other values then in the figures. One example: - See P10770 L6:

102 'approximately 0.2 to 0.4 K' - See Fig. 8: all differences are below zero

103

104 Thank you for pointing this out. This inconsistency has been corrected in the 105 text as well as Figures 5, 8 and 9 and in Tables 2 and 4. Every bias in the text, figures 106 and tables is now computed as: bias = data – reference. 107 108 3. Technical corrections 109 # P10759 L1: Footnote 1 is not correct. RS92 needs a time-lag correction (see 110 Dirksen et. al. 2014). 111 112 Thank you for pointing this out. Another reviewer (Larry Miloshevich himself) 113 also identified this error in our paper. We have updated the footnote to correct this 114 *error; the footnote now reads (changes are bolded):* 115 "Although the time lag correction was developed for RS80 radiosondes, RS92 radiosondes also require a time lag correction. See Miloshevich et al. (2009) and 116 117 Dirksen et al. (2014) for more information." 118 119 # P10759 L6: Vaisala published DigiCora v3.64 in December 2010. Note: it was 120 possible to deactivate these new RH corrections (time-lag and radiation) in 121 configuration. 122 123 This is a very interesting pointer – one that we were both not aware of. We 124 have modified the text, starting at line 6, to read (changes are **bolded**): 125 "In 2011, Vaisala upgraded its DigiCORA® software to version 3.64, which 126 included their own **time lag and** SRDB correction algorithm. **Although** the details of 127 this algorithm are not freely available to the public, it is possible to deactivate the 128 time lag and SRDB during configuration of the sonde." 129 130 # P10764 L26-27: Values should not have fraction with three digits. The 131 results are not so exact. 132 133 Thank you for pointing out the precision of the values in this section of the 134 paper. These values have been changed such that they have precision up to 2 decimal 135 places, which is consistent with the precision of other numbers presented in this 136 manuscript. The sentence, starting at **L24**, now reads (changes are **bolded**): 137 "At 183.0 and 183.31 GHz, the MonoRTM-derived T_B calculations for the WANG 138 calculation **are** warm biased by **0.42** K and **0.33** K respectively, whereas the T_B 139 calculations using the MILO-corrected radiosondes are warm biased by 140 approximately 1.8 K." 141 142 # Figure 3: Ordinate is labeled with 'PWV(MWR) - PWV(SONDE) (cm)'. But it 143 should labeled with 'PWV(SONDE) - PWV(MWR) (cm)', because plot shows dry 144 bias of radiosonde against MWR. 145 146 Thank you for pointing out this inconsistency. Figure 3 has been updated to 147 address this change, and is reproduced here. Additional changes have been made to 148 the figure based on comments from reviewer Dr. Isaac Moradi, which are mostly 149 apparent in the SGP results (the error bar is larger for 5.0 cm \leq PWV \leq 5.5 cm).



4. Typos

P10760 L22: 'ile' at begin of line is too much

This "ile" was never intended to be in the paper, so thank you for noticing this typo. The manuscript has been updated such that this typo has been removed.

P10777 L31-: List of authors is wrong for Seidel et al., BAMS, 2009. Correct citation is: D. J. Seidel, F. H. Berger, F. Immler, M. Sommer, H. Vömel, H. J. Diamond, J. Dykema, D. Goodrich, W. Murray, T. Peterson, D. Sisterson, P. Thorne, and J. Wang, 2009: Reference Upper-Air Observations for Climate: Rationale, Progress, and Plans. Bull. Amer. Meteor. Soc., 90, 361–369.

Thank you very much for pointing this out. We updated the citation for Seidel et al. (2009) in the **References** section. The reference now reads:

- Seidel, D. J., F. H. Berger, F. Immler, M. Sommer, H. Vömel, H. J. Diamond, J.
- Dykema, D. Goodrich, W. Murray, T. Peterson, D. Sisterson, P. Thorne, and J. Wang,
- 2009: Reference Upper-Air Observations for Climate: Rationale, Progress, and Plans.
- Bull. Amer. Meteor. Soc., 90, 361-369, doi:10.1175/2008BAMS2540.1