**Atmospheric
Measurement
Techniques**
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Discussions

Interactive comment on
"Megha-Tropiques/SAPHIR measurements of humidity profiles: validation with AIRS and global radiosonde network" *by* K. V. Subrahmanyam and K. K. Kumar

Anonymous Referee #1

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REVIEWER COMMENTS

GENERAL COMMENTS

The paper by Subrahmanyam and Kumar is another approach to validating satellite measurement quality. The paper discusses validation between two satellite instruments (SAPHIR and AIRS) and between a satellite and radiosondes (SAPHIR and an ensemble if 140 tropical radiosonde observations). The paper fits the aspects necessary for an AMT publication; however, there are a number of mistakes or errors that

need to be considered before publication.

The authors need to define level vs. layer. Is 1000-850 hPa actually a level or is it a layer? A comparison is made between SAPHIR humidity data at six pressure layers, i.e.., 1000-850 hPa, 850-700 hPa, 700-550 hPa, 550-400 hPa, 400-250 hpa, and 200-100 hPa) with AIRS humidity data at six fixed pressure levels (not listed). They should address, in some detail, their procedure about how the SAPHIR humidity layers were manipulated to allow correspondence with AIRS fixed levels. The assumption that the SAPHIR humidity data are layer averages suggests that the average value be assigned to the center of the layer, for example the 700-550 hPa layer center is at about 620 hPa? A clear discussion of how the data comparison with AIRS was accomplished, i.e. how a layer averaged value can be compared with a fixed pressure level, is important?

In Figures 5 and 6 the authors believe the SAPHIR data agree well with the corresponding AIRS data based only on the correlation coefficients. There is no indication in the paper that they looked at the slopes of the data in each layer. There is a clear disconnect between the interpretation of the 1000-850 hPa layers of Figure 5 and 6. Why was the 1000-850 hPa layer included in Figure 6 since the authors state AIRS measures between 850-300 hPa over land, that would exclude the 1000-850 hPa layer. Further, if 300 hPa is AIRS upper limit as recognized in the paper, why was the 250-100 hPa layer included; this is listed as 200-100 hPa in Table 2. Table 2 also lists the mean biases over land and oceans and the extreme differences between 'over land' and 'over ocean' biases that should have been questioned. Is this expected? The paper's objective is to validate SAPHIR, none-the-less I'm surprised the authors didn't question the reason for the obvious large bias differences. Perhaps determining the reason for the differences could add strength to the paper.

Radiosonde data from 140 sites are used in the regression analysis. The authors should explain why they chose to average these data. This would seem to be a logical choice but, on the other hand, the error of each humidity sensor type is different which suggests that the results may be skewed toward the largest set of the same

radiosonde type. Carbon hygristor sensors are known to have errors as large as 50 percent, or larger, at the colder temperatures. It also is possible there were 3-5 different radiosonde types and humidity sensors active during the period of the analysis. Determining the humidity sensor types available during the test period of July-August-September (although June-July-August is also mentioned in the paper) should be an important part of this study. At the least, as a simpler approach, perhaps a regression with only carbon hygristors as one set, and another regression with capacitive type sensors as a second set would be appropriate. The issue of which sondes (sensors) and where and when used is serious and can make a major impact on this paper if considered. The authors indicated that the radiosonde data came from the Univ Wyoming Weather URL; they should be able to access the upper air coded data from the same files to determine the radiosonde type. There also are other sources for this information.

Although this is a publishable paper there are numerous mistakes needing correction before the paper should be accepted.

SPECIFIC COMMENTS

ABSTRACT

Page 11406-line 4: The correct title of the AIRS instrument is Atmospheric Infrared Sounder.

INTRODUCTION

Page 11408-lines 9 thru 14: The tense of these two sentences is confusing. Replace 'was' by 'is'.

Page 11408-line 17: The word 'subsequently' is redundant.

Page 11409-line 3: Would 'smaller spatial' rather than 'shorter spatial' be more appropriate?

DATA AND METHODOLOGY

Page 11410-line 1: Replace 'Sects.' with 'Sections'.

Page 11410-line 13: I find the use of '$\pm$' when describing the frequency range confusing. Please make it clear how the $\pm$ operates to select the frequency? It is not clear whether Table 1 and 2 are related? If related, combine the tables. Does sensitivity in Table 1 have a unit? What is it?

Page 11410-line 21: From Tables 1 and 2 one would assume that the channels in Table 1 are related in linear order with the Level (mb) in Table 2. What are the lowest levels? If we believe that Channel C6 corresponds to pressures of 200-100, clearly this is not a low level. Therefore, are we correct in believing that Channel C1 corresponds to pressures of 1000-850?

Page 11410-line 23: The noise temperature requires come explanation of its meaning, effect, and source. What is SAPHIR's noise temperature? Can it be more than 1 K?

Page 11411-line 4: Space rather then sky may be a better descriptive.

Page 11411-line 17: What does dynamic variability mean? Variability stands by itself.

Page 11411-lines 19-20: Text and figures need agreement. SAPHIR data are stated to cover the period June-July-August 2012. Figure 4 has examples for December 2011, and Figures 5 and 6 examples are for JAS 2012 that I assume stands for July-August-September.

Page 11411-line 22: Correct spelling (SAPHIR vs. SPAHIR).

Page 11412-line 7: Do the authors mean 'cloud-free only cases' for 'clear-only cases'?

Page 11412-lines 12-15: It is mentioned that AIRS has its own limitations...this is followed with 'Keeping these in view....' What, specifically, are the limitations? These limitations could be identified for the reader who may not be familiar with AIRS. Furthermore, 'its own' is redundant.

Page 11412-line 23-25: The accuracy of 5 percent is only a recommended measurement requirement by WMO in the CIMO Guide; some radiosonde RH sensor errors are as large as 50 percent especially at cold temperatures. The authors have based their discussion by assuming all radiosonde humidity accuracies are 5 percent. Radiosonde humidity measurement accuracy varies with the sensor employed, altitude, and also temperature. Intercomparisons are conducted periodically, but I would not call these routine. Regarding the citation (WMO Guide, 1996), the authors are referred to the latest CIMO Guide published in 2008 with updates in 2010. Also refer to the latest radiosonde intercomparison report, WMO intercomparison of high quality radiosonde systems Yangjiang, China, 12 July – 3 August 2010. By J. Nash etal. IOM 107, TD 1580.

Page 11412-line 27 onward: Miloshevich et al (2005) did not provide absolute accuracy measurements of six radiosondes, but rather looked at comparative differences.

Page 11413-line 19: In the Figures (1a and 1b) the colors need to be identified for each satellite.

Page 11413-line 26: oceanic, not Ocenic.

RESULTS AND DISCUSSION

Page 11414-line 10: Complete Section. It would be an improvement if this section could be broken into 2 parts, i.e., Section 3 for satellite evaluation and Section 4 for radiosonde evaluation.

Page 11414-line 12/13: What was the reason for not being able to retrieve data?

Page 11415-lines 17 onward: The authors should explain why they think Figure 5(c-f) agrees very well. I estimate no correlation between AIRS and SAPHIR at levels 1. The fit indicates a SAPHIR instrumental error, i.e., SAPHIR apparently is locked between 70-90 percent RH. I have a problem with the authors estimate of levels 3-6. Figure 5c, (Level 3 suggests bias and indicates SAPHIR is over-estimating the RH values

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compared with AIRS. And, the wide scatter at 60-90 percent RH that seemingly corresponds with AIRS 10-40 percent RH is problematic.. Figure 5d (Level 4) agrees better but suggests that SAPHIR is under-estimating AIRS RH values. Figures 5e (Level 5) and 5f (Level 6) indicate SAPHIR is under-estimating AIRS and have different slopes than the best fit; especially Figure 5f . Could SAPHIR measurements be deteriorating with height? Replace mb with hPa in Figure 5. The data presented actually are 'layers' and not levels.

Page 11415-line 20: Spelling SAPHIR not SPAHIR.

Page 11416-lines8-10: AIRS measures to 300 hPa, then why was level or layer 6 (250-100 hPa included?

Page 11417-line 12: The configuration containing grouped radiosonde profiles should be reviewed carefully. Each radiosonde type has different RH errors. What are the radiosonde types? How does each sonde's errors affect the validation process? The following information may be helpful in this regard: the National Weather Service operates 10 sites in the tropics: San Juan, Hilo, Lihue, Pago Pago, Guam, Majuro, Chuuk, Yap, Pohnpei, and Koror. All use a carbon hygristor (Mark IIA sonde) except Guam changed to the Vaisala RS92 (capacitance sensor)in July 2012; San Juan went to the RS92 in March, 2013; Pago Pago went to the LMS-6 (capacitance sensor) in April, 2013. In addition, the following sites changed from carbon hygristors to Vaisala capacitive sondes between April and June 2012: Barbados, Belize, Santo Domingo, Grand Cayman, Jamaica, San Andres, St. Maarten, Trinidad, These represent only a few of the 140 radiosonde sites used. One can realize comparisons with radiosondes may not be as simple as one supposes. Perhaps grouping all radiosonde profiles creates a convenient average, but no matter, satellite validation must be more precise. Is it possible to group the different sonde types to conduct the analysis?

Page 11417-line 14: Are the four locations geophysically different? Need to identify these on Figure 7.

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Page 11417-line 19 to end of paragraph: Could the inconsistent differences in the 4 locations in Figure 7 be due to a preponderance of a single radiosonde type in each location?

Page 11417-lines 24-27: Suggest that the three regions be analyzed separately. Section 2.3 mentions four locations. The present graphs are difficult to read with any confidence. Rather then locations consider whether comparisons with each radiosonde type wouldn't be better? Sections rather than Sect.

Page 11417-line 25 and reference to Figures 8a-e-the panels of the figure marked a-e should also clearly state in the Caption for this figure what each level is, i.e., Figure 8a represents 1000-850 Pressure layer, as seen in Figures 5 and 6. I think 'layer' needs to be used wherever the authors refer to 'levels', except AIRS which uses fixed levels.

Page 11418-lines 4/5: I believe temperature goes 'down' to 210-230 K, not 'up'.

Page 11418-lines 4-5: Because the authors chose to use RH data from all of the radiosonde types in the discussion they should not use the term 'hygristors' to embody all of the different sensors, some which are capacitive types. The WMO report that is cited concluded that caution was necessary when accepting RH measurements at temperatures lower than -35°C to -40°C; 210 K is -63°C and well out of the recommended range.

Page 11418-line 18: 'best fit line' or 1:1 line?

Page 11418-line 19: Concerning layers 4 (550-400 hPa) and 5 (400-250 hPa), the authors should examine the radiosonde RH data closer. The East-Asian data are predominately on the left of the best fit line. This graph is not very convincing since it disguises the true fit at the three locations. The three locations would be clearer and carry more weight if shown on separate graphs.

Page 11419-line 10: Mention is made of reference humidity magnitudes. Is there a reference RH instrument, i.e., a standard used in the analysis?

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Page 11419-line 23: My examination of Figure 9 indicates that the change in direction of the bias occurs near 77 percent RH, not 60 percent.

Page 11419-line 29: Figures 10a-c need labels.

Page 11420-line1: increment of 10…Figure 10 is marked in increments of 20.

Page 11420-line 10: Not clear. Use 'upper pressure levels' rather then 'higher pressure levels'.

Page 11420-line 13: The term SAPHIR measurement accuracies are not what is being examined. A better description would be SAPHIR agreement with radiosonde RH data. Perhaps the variation depends on the radiosonde measurements that may all be different especially at the upper levels.

SUMMARY AND CONCLUDING REMARDS

Page 11422-line 10: How does CFAD show the number of occurrences? Figure 10 shows percent differences, but I fail to see how this is interpreted as numbers.

TABLES

Can Tables 1 and 2 be combined?

Table 1: What are the units of the last column?

Table 2: Column 1, Pressure units, hPa rather then mb.

FIGURES

For consistency all figure panels should have complete information and all formatted in a like manner. In a few cases the figures are incomplete and it was necessary to fill in missing information from the text. Figures should stand alone as much as possible.

Figure 1: Two colors are shown to represent SAPHIR and AIRS footprints but the caption or the figure does not tell us which color represents which instrument.

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Figure 2: East Asian and South Pacific needs different symbols. The crosses all appear to be East Asian. Height scale is not necessary.

Figure 3-Caption: use 700-550 hPa layer rather then level 3.

Figure 5: Labels on all panels (e.g., Pacific-JAS-2012). Or is it (JJA) as stated in text?

Figure 6: Same comment as for Figure 5.

Figure 7: Caption-What does randomly chosen mean? The text mentions four randomly selected locations. If these are important, what are the locations.

Figure 8: Remove 'global' from caption. Include the layer, i.e., 1000-850 hPa, etc., on each panel. Also include the time period, e.g., JAS 2012. Figures should be as much 'stand alone' as possible.

Figure 9: What layer is this? Neither the caption or figure reveals this information.

Figure 10: Text refers to 'levels' but figure correctly uses 'layers'. Labels for locations are missing and should be included in the figure.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 11405, 2013.

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