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Atmospheric Measurement Techniques Discussions

Interactive comment on "Estimating observation and model error variances using multiple data sets" *by* Richard A. Anthes and Therese Rieckh

Anonymous Referee #3

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General comments:

This is a very well written paper describing how one can estimate the error variances of different datasets of atmospheric profiles using the differences between three or more independent datasets of the same variable. The method ("N-cornered hat") is used to estimate the error variances in tropospheric profiles of four variables in five datasets at four locations in Japan and in Guam. The results indicate that the main assumption of neglecting error correlations between the datasets is reasonably valid.

I enjoyed reading the paper and have only a few minor specific comments and technical corrections.

Specific comments:

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Page 3, line 4: "Paper 1" is only referred to once a few lines below (line 9). Thus it seems overkill to introduce it as "Paper 1" here. Perhaps in line 9 you can just say something like "Because the focus in Rieckh et al. (2017) was ...".

Page 3, section 2.1. Please clarify if you are using analysis or forecast products from ERA-Interim. If you are using forecast products, that would be another good argument for small correlations, since the ERA forecasts only contain earlier observations via the assimilation, and are therefore independent of the observations that they are compared to.

Figs. 6-9: The results without RO (those involving only RS,GFS,ERA) are listed twice in b,c,d panels. I would have expected identical curves, but there are small differences (e.g. refractivity from GFS,ERA,RS below 900 hPa in Fig 9c - light and dark gray dotted curves). Why is that?

Page 15, line 26: "... mean of the six estimates of the error variances ...". But it looks like the light and dark results are separated. Is the mean only over three estimates each? How is the standard deviation with only three estimates taken? For small samples, it becomes important that the denominator in the expression for the sample variance is more correctly written as N-1 (N=3 here). This would also alter the shaded areas in the appendix.

Page 21, line 30: "... dry and wet water vapor biases ...". Needs reformulation.

Page 24, line 26: Shouldn't it be Eqs. (3), (5), and (6)? And the same for the following eqs.

However, eqs. (10), (11), and (12), with (13), (14), and (15) inserted are not additional independent equations (as you also write). For example, (10) with (13) inserted is equivalent to (7) + (8) - (9). In general, you could get many more (infinitely many) equations if you don't care that they are dependent, namely A*(7)+B*(8)+C*(9), where A, B, and C are any numbers, except those where A+B+C=0. Thus, there are not only

six different ways. There are three independent ways and infinitely many if you also count dependent ones that can be formed by linear combinations of the first three. I think you need to make clear that there is nothing unique about the three additional equations that you choose. As it is, one could get the impression that they are in some way special (in line 5 you write "the full six equations" and in line 18 "the remaining three estimates"). Perhaps they are special if one can show that they give rise to the smallest possible standard deviation of the variance estimates. I don't know if that is the case. In the first three independent equations, there are 3/2 MS terms, and 3 COV terms involved. In the additional three equations there are 5/2 MS terms and 5 COV terms. The more terms there are, the larger the standard deviation of the variance estimates will become, at least potentially. Interesting stuff!

Page 25, line 15-16: I do not understand this part of the sentence: "...the set of observations in the pairs (RO,ERA), (RO,GFS), (GFS,ERA), (RO,RS), (RS,ERA) and (RS,GFS) are the same (they are in our case)..." What are the set of observations here?

Technical corrections:

Page 2, line 3: model -> modeled

Page 3, line 14: Missing "a" in front of global.

Page 11, line 6: Acronym STD should be written out first time.

Page 12, line 32: that -> than

Page 15-16, lines 30,1-2: Should RS and RO be switched in the text here? RO is the one that oscillates between 0.1 and 0.3 (% squared). RS is fairly constant about 0.1.

Page 21, line 17: Missing "to" in front of RO.

Page 22, line 27: Vogelznang -> Vogelzang

Page 25, line 18: "in are in"?

Page 29, line 6: "... four locations?" There are only results for two here, Guam and Mina.

Page 30, line 20: that -> than

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