

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

**M. Fujiwara**

fuji@ees.hokudai.ac.jp

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Review report Dirksen et al., AMTD, 2014 Reference quality upper-air measurements: GRUAN data processing for the Vaisala RS92 radiosonde

by Masatomo Fujiwara

This paper describes and discusses a special data product of Vaisala RS92 radiosonde profiles using a special data processing developed by the GCOS Reference Upper Air Network (GRUAN) Lead Centre. This data product is named as the GRUAN RS92 data product. The details of the radiosonde data processing algorithms are usually

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not available for the user/science community, and therefore, the information on random errors (uncorrelated uncertainty) and systematic errors (correlated uncertainty) is very limited for measurements that a radiosonde covers. In this paper, the authors developed a full algorithm to process raw RS92 data (temperature, relative humidity, geopotential height, and horizontal winds), and also evaluated the vertical distribution of uncertainty for these variables. Where possible, intercomparisons with independent (manufacturer's) algorithm and measurements from other instruments were made to characterize the GRUAN RS92 data product and to confirm the uncertainty evaluation. This paper is also very valuable in that it discusses the details of the radiation error of the temperature and humidity sensors, which is a major source of uncertainty, and that it describes the detailed calculation procedures to obtain geopotential and geometric heights from pressure and GPS measurements.

One relatively major comment is that it would be helpful for the readers if the authors summarize the actual steps that the radiation correction is applied. The best place to do this is at the end of section 5.2. It was not very clear to me how the results from the field experiments (section 5.2.1) and from the radiative transfer model experiments (section 5.2.2) are used to obtain the GRUAN temperature data. (See below for some related comments.)

The following are all minor comments.

p. 3738, equation (1): Some discussion on the justification of this formulation is needed. Also, pressure is used as a variable; but, does this mean an air-density factor, i.e., the strength of convection (by comparison with radiation)? Actinic flux  $I_a$  also has a pressure dependence as the vertical dependence in this case. Please clarify what is meant by this pressure factor.

Infrared radiative heating and cooling are neglected here. The consequence of this treatment may be discussed. For example, the difference between the Vaisala product and GRUAN product shown in Fig. 9 might be in part due to this.

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Section 5.2.2 about the Streamer radiative transfer model: The distance between the Sun and the Earth changes in the course of a year (longer for NH summer and shorter for SH summer). Is this considered in the model? Is the contribution of this factor quite small?

It is very interesting (and problematic) to see that the cloud albedo is a major factor for actinic flux uncertainty particularly in the stratosphere where the radiation error becomes large.

p.3740: The air mass factor of  $\sin(\text{solar elevation angle})$  may be a good approximation for 90-30 degree, but beyond that, consideration of the curvature of the atmospheric layers may be necessary. The formulation may be found, for example, in the following paper: Solomon et al., On the interpretation of zenith sky absorption measurements, JGR, 1987 <http://onlinelibrary.wiley.com/doi/10.1029/JD092iD07p08311/abstract>

p. 3741, line 11: should introduce → should not introduce?

p. 3743, the second paragraph of section 5.3, and Figure 7 and Table 2: If the procedure of spikes removal actually removes only warm spikes (which may be reasonable), the error due to the spikes should be a systematic error and thus the uncertainty due to this should be "correlated." Also, in Table 2, uncertainty from spikes and from rotating radiosonde is separated and considered as independent. But, these two may be closely related.

Section 5.6 and Fig. 8: The uncertainty from the radiation error is actually divided into three factors, i.e., radiation field, correction model (obtained from field experiments?), and sensor orientation (the factor  $g$  in equation (2)?). Does the "radiation field" here include the contribution from various (but limited) radiative model calculation settings including the cloud albedo setting? It would be good to have a summary about each component and its contribution around the end of this section.

p. 3747, line 7: due to ?

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p.3762, line 8: Check the grammar.

p.3766, line 2: It would be valuable to evaluate the uncertainty in IPW from RS92 measurements.

p. 3767, line 3: an ascent

p. 3767, line 11: "reversed" should be "removed"?

p.3768, equation (A4):  $j$  should be from  $-M$  to  $M$ ?

Captions for Figures 5, 6, 7, 8, 9: Please also specify the solar elevation angle as well. This angle depends on the station latitude, day of year, and local time (i.e., universal time and station longitude).

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