

### **Response to Anonymous Referee #3**

Thank you for your comments on the manuscript. Please find our responses to your comments below.

#### **Anonymous Referee #3**

This paper describes the details of measuring and retrieving water vapor from the SHOW instrument on a high altitude aircraft, including some first results compared to a nearby radiosonde profile. The development of the SHOW instrument is an exciting capability for the research community. Most of the paper involves characterization of the instrument and measurement details on the aircraft and in the laboratory. Overall, the paper provides a comprehensive explanation of these aspects, although I am not an expert on any of these details and cannot provide critical comments. Hopefully these will come from other reviewers. The comparison of the SHOW retrieval and the single radiosonde water vapor profile (Fig. 19) looks quite reasonable, although I question why the uncertainties are so small in both measurements (see below). Overall the paper is clearly organized and well written, the figures are reasonable, and the topic is appropriate for AMT. I only have a few minor comments to contribute:

1) The uncertainties in Fig. 19 seem small to me. The radiosonde measurements (Vaisala RS41) probably makes accurate measurements (to a few %) in the upper troposphere down to 10-20 ppmv, but there are larger uncertainties for lower H<sub>2</sub>O amounts at higher altitudes. Where do the uncertainties (error bars) shown in Fig. 11 come from? The 1 ppmv uncertainty quoted here may be on the small side at upper levels. Likewise, the uncertainties in the SHOW retrieval look remarkably small, given all of the uncertainties and corrections discussed in the paper. I have to say this is a relatively minor point, given the quite good agreement in Fig. 19.

The uncertainties in Figure 19 only include an estimate of the measurement uncertainty calculated using the specifications for the Vaisala RS41. The raw measurement uncertainty on any given radiosonde sample is on the order of 1-2 ppm; however, these uncertainties are further reduced since they are transformed to the lower vertical resolution retrieval grid of the SHOW measurements. The radiosonde error bars do not include any estimates of the accuracy of the measurement. In the manuscript we point out that the accuracy of the measurements is a function of relative humidity and the temperature and that these accuracies vary from sensor to sensor. Similarly, the error bars on the SHOW water vapour measurements only include measurement noise. In our case, the errors due to measurement noise are quite small due to the high SNR of the measurements.

We agree that the error bars are too small to be useful in the Figures. We have removed from the figure and the text has been edited to make it clear that these uncertainties are not the limiting errors in the measurements.

2) Some definitions need to be included: N (page 8, line -4 and elsewhere), and DN, PRNU (p. 11, Table 2 and elsewhere).

The text has been edited to provide definitions of these quantities.

3) Figure 9a reproduces quite poorly, and no need to have a black background.

This figure was provided by AFRC and it not available with another background.