Response to review by Darrel Baumgardner

We thank the reviewer for his positive comments on the submitted manuscript. Our response to the minor comments that were raised are given below in bold font.

1) The water content in all the figures is expressed as g kg^{-1} but the sensitivity of the Nevzorov is expressed in g m^{-3}. For the sake of consistency, I wonder if the units throughout should always be in g kg^{-1}? On the other hand, the cloud physics community usually uses g m^{-3} for water content units. Maybe a very brief explanation about the units being used is in order at the beginning of the manuscript.

We agree that the units should be consistent throughout the paper. We have therefore changed the units to g m^{-3} (to be consistent with what is typically used in the cloud physics community) and updated the figures and text as appropriate. The only exception is the reported dynamic range of the total water probe of 0 to 20 g kg^{-1}, which is from Nicholls et al. (1990).

2) The anti-shattering tips are mentioned when discussing the cloud spectrometers but nothing is discussed about the impact of shattering on the Total water probe or the CVI. Both have significant area of the inlet lip on which ice crystals can impact and shatter. The CVI is likely less impacted due to the 5 um cut point, but what about the total water probe. Can you give an estimate of the possible effect?

The approach with imaging and particle-counting probes has been to provide tips that are sharp-edged to minimize the blunt frontal area and to provide surfaces that as far as possible direct any particles and fragments away from the sample volume. The design of the total water probe intake follows the same principle. Furthermore, the probe was designed to have an isokinetic inlet and such comparisons that have been possible in warm liquid cloud give no reason to suspect that it is significantly over- or under-sampling cloud droplets. Hence, the sharp-edged intake should still be efficient in minimizing fragmentation effects, although it is not possible to quantify this without doing additional flow modelling or wind-tunnel tests with high speed photography, both of which are beyond the scope of this paper. We also agree that the CVI is not likely to be significantly impacted by shattering due to the 5 µm cut point.

3) In the discussion of water derived from PSDs you fail to mention that not only density but shape has to be assumed to derive water content. For the CDP I am assuming that you are assuming that these particles are quasi-spherical, but what do you use for D from the imaging probes?

For conditions dominated by liquid water droplets e.g. figure 1, we assume spherical particles for the CDP. For cases dominated by ice particles e.g. figure 4, we assume that the particles measured by the

CDP and SID-2 are quasi-spherical and modify the PSD as in Cotton et al. (2013). For the optical array probes the dimension *D* was chosen for simplicity as the maximum particle size in the direction parallel to the photodiode array. We have added this information to the revised text.

The above assumptions do not change the key point in the paper - that the different mass-dimension relations result in a large spread in the derived ice water content and that a particle habit appropriate mass-dimension relation needs to be used in order to obtain agreement with the bulk probe measurements.

4) In Fig. 2b, add to the caption what the gray band denotes. This is described in the text and also in Fig 3 onward.

This is now included in the revised figure caption.

5) Appendix C: The enhancement factor is mentioned but not discussed. What value was used and isn't it about air density and particle size dependent?

We make a distinction between the Enhancement factor (EF) for the CVI inlet system, and the size dependant collection efficiency of the CVI inlet.

EF is calculated by taking the volume of air swept out by the tip (True Airspeed x the inlet diameter) and dividing by the total sample volume flow within the instrument. This internal flow is the sum of measured flows through mass flow meters and the estimated flow through a critical orifice. The typical values are from EF = 30 at > 8km to EF < 10 in the boundary layer. This is calculated for volume flow not mass flow. The hygrometer measured concentration of water vapour particles and the local air density within the instrument are taken into account. The ratio between the ambient density and the density within the CVI is a very weak function of altitude, and varies by less than 5% across the depth of the atmosphere that the BAe-146 can access (ceiling @35kft) and is not considered. We have included additional text to the revised appendix that describes the calculation of EF and the typical values of EF.

The impact of the size dependant collection efficiency of CVI inlets has been shown in various studies to be important at sizes below 100 microns (e.g. Laucks and Twohy 1998). For the present study where we are measuring ice particles we do not expect this feature of CVI to have a significant impact on the measured condensed water contents. The impact would be larger and significant when using this inlet to make measurements in warm boundary layer cloud where mean drop size is comparable to the cut size of the inlet. This is discussed in section C3.