COMMENT ON: HORIZONTAL STRUCTURE OF MARINE BOUNDARY LAYER CLOUDS, DAVIS ET AL. JGR 1999.

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Davis et al. (1999: D99) report observations from the Particulate Volume Monitor (PVM) probe that indicate a break of slope in the energy spectra of liquid water content at the 2–5 m length scales. These data were made in stratocumulus interacting with cumulus cloud during the SOCEX experiment (Boers et al. 1996) on a day of extensive drizzle and shower activity. In D99 the speculation is made that the scale break is not due to the Poissonian nature of the droplet concentration and proceed to demonstrate that the effect is not an instrument artifact.

In the simulation of the Poissonian data expected to be encountered by the PVM probe D99 assume that the population is best represented by a lognormal distribution. We believe that such a distribution will not adequately represent the drizzle sized drops that the PVM probe would encounter during drizzle conditions. As an alternative we propose a lognormal distribution to represent the cloud water droplets with an exponential distribution superimposed to represent the drizzle drops.

We produced a synthetic spectrum (figure 1) that is broadly similar to the observed spectra illustrated in Boers et al. (1996, e.g. Fig. 16) and proceeded to carry out the same steps as detailed in appendix A of D99. The exponential part of the spectrum has a volume radius of 30 μm and a concentration 200 l^{-3} and extends from 20 μm to 200 μm. Figure 2 is arranged in the same way to figure A2 in D99 with the top left figure showing the original observations. We picked values for the data after 2.5 m spatial averaging from figure A2b in D99 and followed that by interpolation with a bounded cascade model (Cahalan et al. 1994). The next step was to add the Poisson noise from the cloud drops and drizzle spectra before applying the low pass filter given in figure A1 of D99 and finally resampling. The final result shown in the top right panel of figure 2 has a spiky nature that is very similar to the original observations. We have assumed that the vignetting effect does not seriously affect the large droplets, although this assumption does represent the weak point in our argument. Further information on the vignetting effects for larger drops would be required to achieve more confident results.

Figure 3 shows energy spectra derived from the results presented in figure 2. In the top panel the cloud drops and drizzle case (open diamonds) leads to more energy in the spectrum at small length scales than for the case of just cloud drops alone (filled circles). The lower panel shows the ratio of these two spectra and indicates that the addition of the drizzle drops can result in an increase in spectral energy by up to a factor of three at scales below 5 m.

In conclusion we feel that the observation reported in D99 can be produced by Poissonian variability of drop spectra if the drizzle mode is included.

References

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[Davis *et al*, 1999] Davis, A. B., A. Marshak, H. Gerber, and W. J. Wiscombe, 1999: Horizontal structure of marine boundary layer clouds from centimeter to kilometer scales. *J. G. R.*, **104**(D6), 6123–6144.

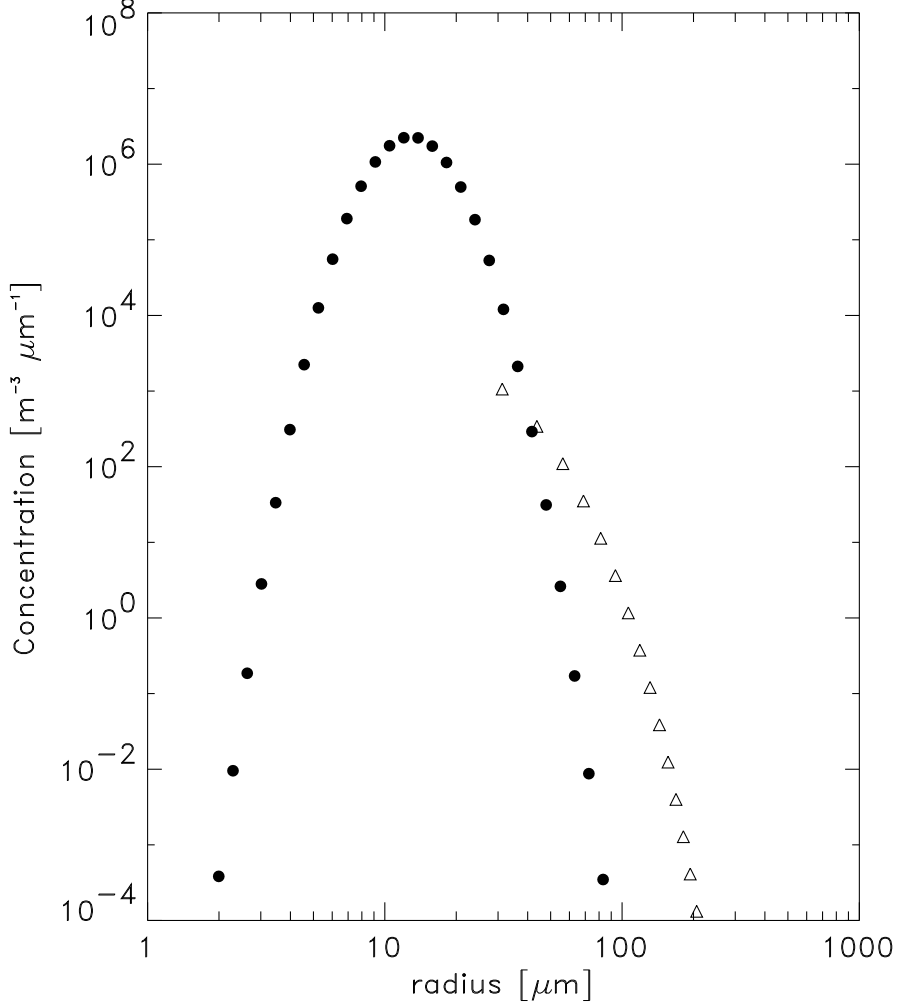

FIGURE 1. Droplet size spectra used in this study. The filled circles define the spectrum for the cloud drops and the triangles define the drizzle drop spectrum.

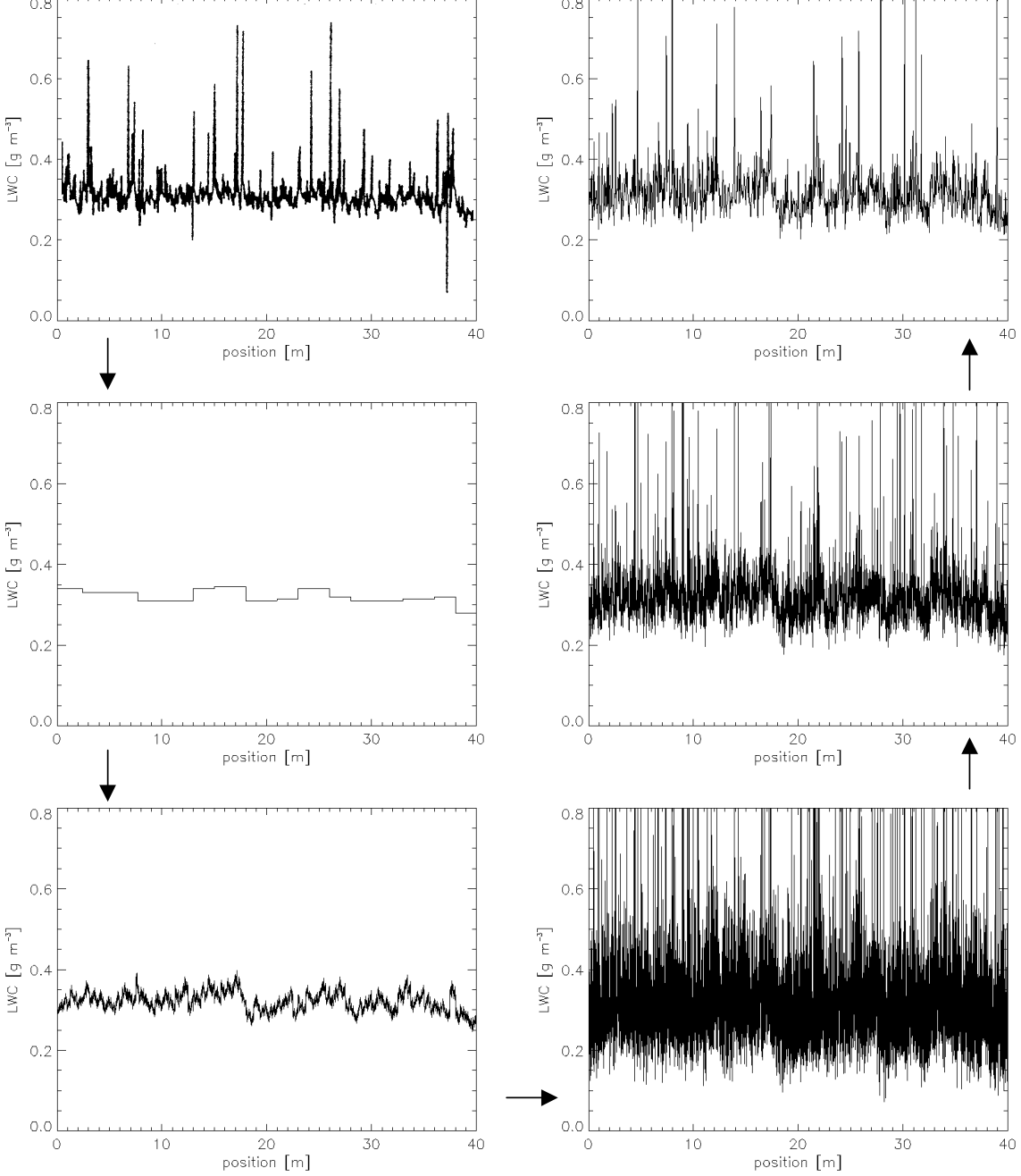

FIGURE 2. Top left panel: time series of PVM observations from D99. Middle left: time series after 2.5 m spatial averaging (from D99). Bottom left: result after interpolating with a bounded cascade model. Bottom right: result after series has had Poissonian noise generated from the cloud drop plus drizzle spectra added to it. Middle right: result after low pass filtering. Top right: final result after reampling.

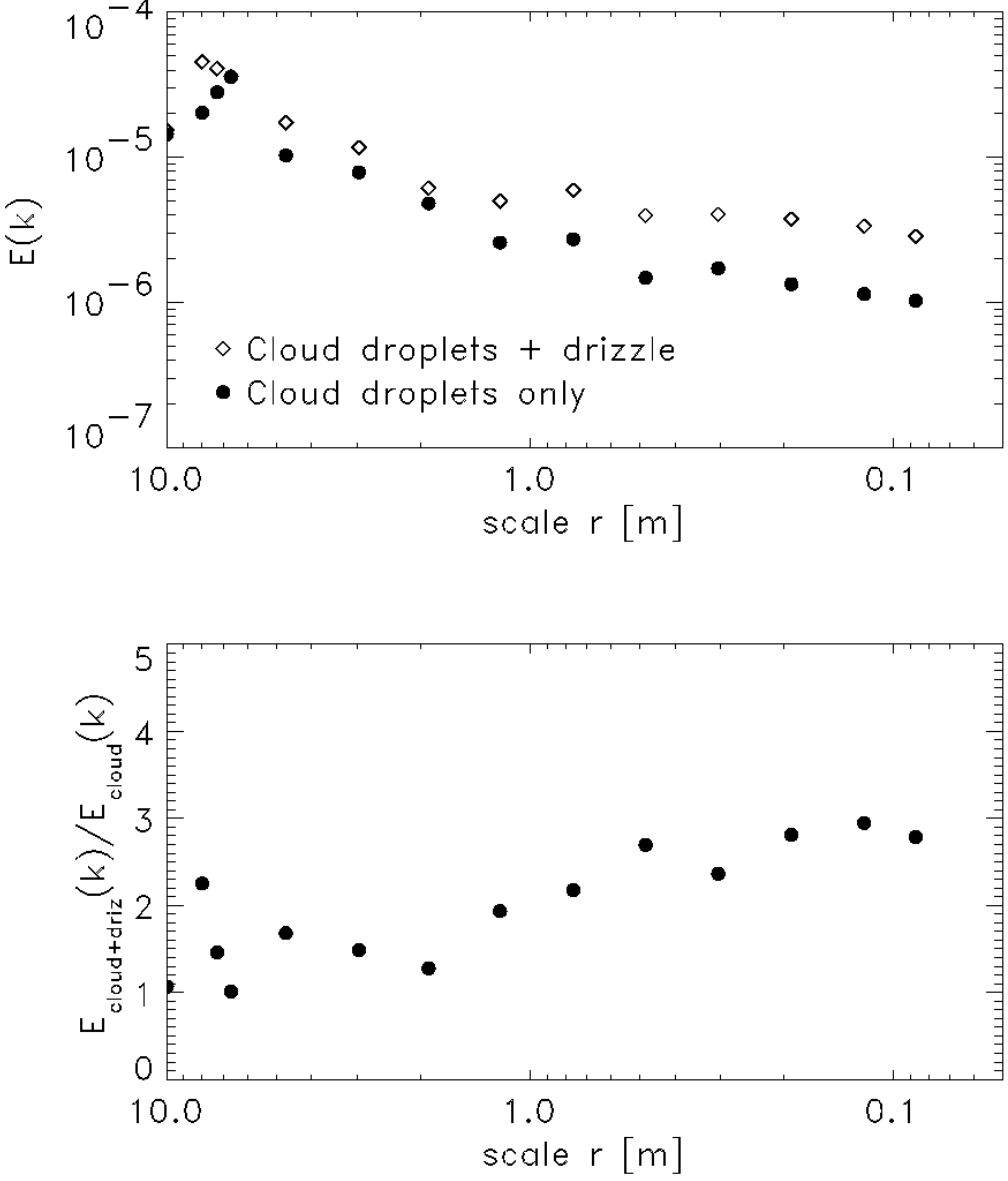

FIGURE 3. Top panel: energy spectra for the cloud drops plus drizzle spectra (open diamonds) and for the cloud drops alone (filled circles). Bottom panel: The ratio of the spectra depicted in the top panel.