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Interactive Comment

Interactive comment on "A wing pod-based millimeter wavelength airborne cloud radar" *by* J. Vivekanandan et al.

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I always appreciate papers describing new radar systems and am glad to see a paper on this new airborne radar. Besides providing information of use for radar designers of other new systems, they are important to document radars that will be used for future science measurements. Hence, his paper will presumably provide the documentation for interpreting future science measurements from HCR (and resulting publications). Overall, the paper is a clear description of HCR. I have some minor questions and/or comments below (some very minor).

p. 119, line20 – does "Polarization" require capitalization?

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Interactive Discussion

Discussion Paper

It has been corrected.

p. 121, line 14 – "HIAPER wing store instrumentation philosophy" – I don't quite understand this phrase, specifically "wing store".

The sentence has been revised as follows: 'The HIAPER instruments located in wing pods must conform to the basic infrastructure of the wing pod. Power available onboard GV is limited and also number and type of connections in the wing pod are pre-determined. Therefore the HIAPER instruments installed in the wing pod have to be designed taking into consideration of the above-mentioned parameters.'

p. 122, line1 – the authors could note here that the antenna choice is explained in section 3.2.

The following sentence has been added: ' The choice of the antenna is explained in section 3.2.'

p. 122, line 21 – will the 5% duty cycle allow the phase B pulse compression or will that require a larger duty cycle?

The 5% duty cycle will allow for pulse compression planned in phase B. The above sentence has been added.

p. 122, line 24 – is the receiver bandwidth also modified as the pulse width is changed? Presumably, yes (as implied p. 127, line 19).

Yes, the receiver bandwidth is adjusted to match the bandwidth of the transmit pulse.

p. 124, line 21 – were there any requirements on the antenna peak sidelobes?

The original requirement for antenna peak sidelobes was <-25 dB, measured off axis. This requirement was compromised slightly in favor of a more robust approach to achieving the desired cross-polar isolation over the anticipated temperature and vibration environment of the pod.

p. 124, line 25 – it would be good to also give the surface reflector accuracy in SI units. Is the quoted RMS surface accuracy sufficient to not raise far sidelobes?

The surface reflector accuracy in SI units has been included. Borrowing from the field of optics, RMS surface roughness should be < $\lambda/10$ in order to not distort the far field pattern. For the HCR, this translates to < 0.32 mm. The honeycombed, aluminum “sandwhich” material used for the reflector has an RMS surface roughness of 0.13 mm.

p. 126, line 22 and also Figure 5 – how is the velocity accuracy computed, via published formula (e.g., Bringi and Chandrasekar) or other?

The velocity variance equation 6.22b of Doviak and Zrnic, 1993 was used for estimating accuracy of velocity.

p. 127, line 9 - does this take into account that the samples are not independent? Equivalently, how many independent samples does this correspond to?

Yes, dependency between samples was taken into account. The numbers of samples in figure 6 are contiguous pairs. Time-to-independence (TD) determines number of independent samples for a specified dwell time and it is a function of spectrum width and transmit wavelength. For Doppler spectrum width of 0.2 m s-1, the value of TD is 0.0018 s. Averaging over 0.1 s corresponds to 55 independent samples for the above-specified parameters. Number of independent samples increase as the Doppler spectrum width increases.

p. 128, line 1 – this is number of independent samples based on 0.1 s averaging?

This number is based on Doppler spectrum width and not on the 0.1 s averaging. Time-to-independence (TD) determines number independent samples for a specified dwell time and TD is a function Doppler spectrum width and transmit wavelength. For a Doppler spectrum > 0.4 m s-1, the TD is > 0.0036 s.

p. 128, section 5.1 – what are your requirements (or goals) for calibration accuracy?

GID

5, C51–C55, 2015

Interactive Comment

Any estimates of the calibration accuracy you'll get with H pol (no noise diode) versus V pol (noise diode)?

The goal is to calibrate the system with in +/- 0.5 dB. We do not expect the performance of horizontal channel to be much different from the vertical channel based on the past calibrations. Continuous monitoring of only one of the two channels is a design trade off. The two channels have a known gain difference of 2.6 dB. Since the two channels are designed to be physically close to each other, they experience similar temperature fluctuation. Furthermore, low noise amplifiers of both channels are temperature-controlled for maintaining a stable gain. There is always the concern of slow degradation of the horizontal channel overtime as it is not monitored.

p. 129, section 5.1.2 – a problem with varying the DSD parameters over their naturally occurring ranges is that I think it implicitly assumes that the parameters are independent. However, if there is correlation between various DSD parameters, it is ignored in the simulations. Looking at it another way, the simulation DSD parameters, if varied independently, may visit regions of R-D-N space that are not seen in nature. A second problem here is that the rain rate is stated to be between 5 and 10 mm/h but the model uses between 5 and 20 mm/h. A third problem is that point measurements of rain rate (I didn't notice mention of how the 5-10 mm/h was ascertained) can't easily easily be compared with radar.

From a larger set of simulated database only radar reflectivities corresponding to rain rates between 5 and 15 mm h-1 and LWC > 0.1 g m-3 were presented in section 5.1.2. This procedure helped to eliminate reflectivities that are inconsistent with naturally occurring LWC and rain rates.

As per reviewer's suggestion the simulations results presented in this study will be refined by taking into account of correlations between DSD parameters in a future study.

The text with regard to range of the rain rates has been corrected to be consistent with

GID
5, C51–C55, 2015

results presented in the figure 9.

The rain rate for the radar measurements presented in figure 10 was ascertained from a rain gauge located within 100 m of the radar.

What is the difference in volumes of the two measurements? Lastly, to better pin down the expected reflectivity, wouldn't other DSD measurements be needed? The comparison here is interesting but, without an error analysis, concluding that the radar is low by 1.5 dB seems dubious.

It was a stratiform rain event as shown in the figure 10. Since the methodology is applicable to a range of rain rates and DSD parameters, only mean values of histograms are considered in the present study. As per reviewer's suggestion error analysis will be performed once larger enough statistics of radar observations of rain events between 5 and 15 mm h-1 are collected.

p. 134, lines 22 and 23 – do "Northwesterly" and "Southwest" need capitalization?

The errors have been corrected.

p. 140, Hubbert and Bringi – "copular" -> "copolar"

Made the suggested change.

p. 143, Table 1 – sensitivity should state the pulse width used

Pulse width has been included.

Figure 3 – I would recommend labeling the blocks with a larger font; even when blown up with a pdf reader, they are difficult for me to read.

The figure has been revised as per the reviewer's suggestion.

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 5, 117, 2015.