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**Atmospheric Measurement Techniques Discussions**

# *Interactive comment on* "Towards the improvement of cloud microphysical retrievals using simultaneous Doppler and polarimetric radar measurements" *by* Y. Dufournet and H. W. J. Russchenberg

**Anonymous Referee #2**

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This paper presents a preliminary investigation of the value of spectral polarimetric parameters in cloud microphysical retrievals. The three spectral polarimetric parameters used in this study are sZdr, sRHOco and sLdr, which are constructed from sets of Doppler spectra that also contain polarimetric information. The results of using these three parameters in an analysis of TARA data collected on one day during COPS are presented.

The use of parameters based on both Doppler spectra and polarimetric data is a natural next step in the evolution of cloud microphysical retrieval algorithms. As such, my



opinion is that this study is timely and is headed in a direction which, in time, will have an important role to play. The authors state on Page 539 of their manuscript that "this method is still in a preliminary stage and is therefore only described in order to illustrate the potential of using the spectral polarimetric parameters in the microphysical retrievals." This is an accurate statement in regards to their paper. This paper describes a first investigation of the three spectral polarimetric parameters that appear to have value in identification of ice crystal types and their orientations during a short period of time of the COPS experiment. As such, the paper is illustrative and not definitive or exhaustive.

Overall, the paper is well-organized with the material presented in a logical sequence. I found this to be a strong point of the paper, allowing me to understand the essence of the message that the authors wanted to convey. That said, I did struggle with individual word choices, phrases and explanations throughout the paper. As I read the paper I somehow got sucked into making detailed comments throughout the manuscript. I have attached my marked-up manuscript for the authors use. I would hope that they consider each of the comments that I make (I hope that they are able to read them all as some of them may be illegible due to lack of space) on the manuscript before rejecting them outright. Those comments of mine on the manuscript that I do want them to address explicitly follow in the "Detailed Comments" below.

I rate this manuscript as "accepted subject to minor modifications". While I have made a lot of comments on the manuscript and I would like the authors to address them, along with the changes/clarifications that I recommend below, they are all minor in nature. They are intended to improve the information content and readability of the manuscript. None of them pertain to disagreement on scientific content.

Detailed Comments:

1) The authors mention that 45 degree elevation angles are often optimal for polarimetric measurements. How about for Doppler spectral measurements? It would seem

to me that off vertical measurements, for which horizontal advection of hydrometeors might contribute to the information content of the Doppler spectra, is more problematic than for vertically pointing measurements. Might this be the case? My opinion is that addressing this issue in the paper, albeit even briefly, would be of value. Are Doppler spectral and polarimetric measurements optimized at the same or different elevation angles?

2) As I see it, at the heart of this paper is establishment in an illustrative way only the connection between the three spectral polarimetric parameters and ice crystal types and orientations. As such, these connections have to made as clear as possible in the paper. The two places in the paper where this is currently done are Figures 2 and 8 with their associated text. And I struggled to understand the details of these two figures and their associated text.

Consider Figure 2 first. This looks to me to be a cartoon schematic with important details left out. For example, what attribute of the ice crystals in the schematic gives them different velocities? I could not find this information on Page 533 or in the caption for Figure 2. In the schematic it looks like the orientation of a prolate spheroid is doing it: when the prolate spheroid symmetry axis is vertical the velocity is low and sZdr is low; when the prolate spheroid symmetry axis is horizontal the velocity is high as is sZdr. Is this what the curve for sZdr is meant to connote? Is having the circle just left of the zero meant to indicate that sZvv, sZhh and sZdr are zero for all velocities? This is never stated. Finally, I have no idea what particle sizes and shapes are associated with sZvv and sZhh. Is "Velocity" radial velocity or fall velocity? What elevation angle is intrinsic to this figure? This is never addressed. Figure 2 is an important figure and I know that I am not taking from it what I ought to in its current form.

Perhaps a better Figure 2 would start with explicit size distributions of some sort for appropriately shaped spheroids. Then, explicit calculations of sZvv, sZhh and sZdr for these distributions could be made for an explicit TARA viewing geometry. Such an exercise ought to lead to a Figure 2 with lots of information and no ambiguity if



the process used to generate it is clearly described in the text and caption. Whatever you choose to do for Figure 2, the information content associated with it needs to be improved.

I have many of the same comments for Figure 8. Again, these look to me to be schematic diagrams with important details left out. For example, you must have in mind the idea that different mixtures of what look to be oblate spheroids, prolate spheroids and spheres lead to different trends of sZdr with velocity. But it is not clear to me what aspects of particle type concentrations, particle type sizes and particle type orientations lead to the different sZdr spectra that you show. You provide two sentences of description for Figure 8 on Page 540 but these are not enough for me to understand in any detail what is going on in Figure 8. Figure 8 is a challenge. It is full of important information for this paper and how can one make clear the microphysical underpinnings of each of the 16 categories in a succinct way?

3) "unwanted echoes" are mentioned in the last sentence of Sec. 2.2.2. After reading this sentence I did not know what to look for in Fig. 3b. Show me the unwanted echoes in Fig. 3a and where they go in Fig. 3b and then I think I will understand what you mean here.

4) In the last sentence of Sec. 2.2.3 the phrase "the velocity window" was used. But I had yet to see any definition of this "velocity window" so was not sure what was meant by it. As I later worked through Figure 4 I figured out that by "velocity window" the authors meant the region of spectral data that survived all of the tests. I think showing explicitly the thresholds and regions of data that survive them would make the idea of these windows clear in Figures 3 and 4. I have added dashed lines on Figure 4 to illustrate one possible way of doing this.

5) What does "on consecutive Doppler bins" mean at the bottom of Page 535? Is this consecutive in velocity at one time or consecutive in time at one velocity? I need to be sure that I understand clearly what is meant by Delta sRHOco.

6) I am not sure what is meant by “gradient” in Fig. 6 because it looks to me like the gradient of “std” in Fig. 6b is most always negative but with positive slope from the 12th to 13th spectra averaged. Yet the gradient is always positive in Fig. 6 and never changes sign. I found this confusing. The same is true of Fig. 6c.

7) The explanation of Eq. (8) needs a bit of work. See my comments on Page 542. I hope that these comments are at least legible.

8) I think using discrete and more distinct colors for Figs. 10b and 10e would greatly improve the clarity of these figures, especially for Fig. 10b.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/4/C869/2011/amtd-4-C869-2011-supplement.pdf

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Interactive comment on Atmos. Meas. Tech. Discuss., 4, 527, 2011.