**Atmospheric
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Interactive comment on "Optical properties of pristine ice crystals in mid-latitude cirrus clouds: a case study during CIRCLE-2 experiment" *by* J.-F. Gayet et al.

Anonymous Referee #3

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This paper describes in-situ measurements in ice clouds during CIRCLE-2, as well as modeling work for crystal scattering phase functions. I am not sure I fully grasped the main point(s) of this paper, since it is relatively poorly written and somewhat disconnected (details below). It is undeniable that the "Gayet combination" of instruments is highly valuable for ice cloud research, especially with the problems at hand that the authors allude to in the abstract (CALIOP enhanced backscatter). The figures and the data shown therein almost tell a story by themselves. However, I have a hard time finding a bottom line when going through the accompanying text: In the abstract it seems as though the authors will explain the previously observed enhanced lidar backscattering signal with in-situ measurements. In section 2, they mention the radar/lidar system,

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but don't use it later. On lines 7-12 (page 24765) the authors state that in fact, this is done in a different paper by the same group (Mioche et al., 2010). So, what is this paper about? Is it fair to summarize it in the following way: "We know that plates can potentially explain the high lidar backscatter (specular effects), but plates should also have a halo feature which is not always observed. The paper shows two case studies for clouds with a high fraction of plates, one where a halo occurs, and one where it doesn't. Using observations and model calculations, we show that even for plates (where a halo would be expected) the phase function can be smoothed out by ...(list explanations), which leads to a suppression of the halo." If this is indeed the purpose of the paper, this is a very important contribution, and I would write something like that in the abstract/introduction/conclusions. In order to support the main point(s), the paper needs to be revised and better connected. For example, if the lidar observations are not needed, it is probably not necessary to even include the instrument in section 2. Vice versa, if the authors feel it necessary, they should at least briefly summarize the paper by Mioche et al. (2010) that was all about the backscatter. The language needs to be improved. There are many run-on sentences, and some statements cannot be understood out of context. This is not just about the usage of English, but also about the structure in general. The lack of "the" or "a" on many occasions makes it hard to understand (details under "minor comments"). I don't think that these revisions are hard to do, but they are more substantial that "minor", in my opinion.

Major comments:

* General question: After reading the abstract, one could ask naively: "What does the backscatter have to do with the 22deg halo?" Please say exactly why it does have something to do with it (plates needed to explain backscatter, but they should have halo). I would recommend re-writing the abstract completely.

* p24765,ll7-11: Since this is a large part of motivation for this paper, this needs to be much better explained.

* p24765,l11: onto –> on

* p24765: You only use data from one of the planes, correct?

* p24766,l8-12: The explanation of updraft velocity and relative humidity comes out of the blue. So far, we don't know we will need it. It would be better if you explain beforehand that you will look into these parameters to explain the differences between the two cases. Otherwise, you will leave the reader somewhat confused.

* p24766,l5: Why does the range of FSSP-300 only start at 3micron? I would believe this for FSSP-100, but 300 starts at smaller sizes than that.

* p24766,l20: Why is the CALIPSO overpass of relevance for this manuscript?

* p24767,l13-15: At this point, the red circles are not explained. They are explained much later, but you should try to mention already here that they correspond to model calculations. I am not sure that showing calculations for spheres is very useful. If you do show them, it could be instructive to talk about the discrepancies between model and measurements. For example: why would spheres not be able to reproduce a high backscatter etc... Also, legends are missing in the figures, and the captions are not descriptive. Please improve!

* p247676,l21: "Because...this proves" - You cannot combine "because" and "proves" in this way. Please explain this better. It is obvious what you mean, but you need to get the point over better.

* p24676,l25: Are you sure Heymsfield defines 250 microns as the "cutoff" for shattering? Even if he does, I would be careful making a statement like that.

* p24768,l2: Do not use "we note in passing". This sentence is very important and should not be a "by the way" statement. It isn't entirely clear what it conveys though, and I would highly recommend to re-write it completely.

* p24768/Figure 2/4: (a) The size distributions cannot be distinguished from one an-

other. Please add a color legend. The same is true for (b), the phase functions.

* Figure 2/4: Why are the size distributions in 4a continuous, while the ones in 2a have a gap from 20-30 microns? Please show *all* your data, or explain why the individual size distributions from the different instruments do not match.

* p24770,l2-5: This sentence does not make sense (grammar). Please rewrite.

* p24770,l15-24: Please rewrite this section. It is unclear what you are trying to convey.

* p24771,l8: The "red point" explanations come far too late at this point - this is nearly the end of the article.

* A summary of results is missing.

language comments (some of them major):

* I would recommend using "in-situ" rather than "in situ" throughout the manuscript.

* General over-use of "in terms of" throughout manuscript. Please reduce.

* p24764,l2: preferential –> preferentially

* p24764,l11: "evidence" is not a verb (at least one more occurrence after this)

* p24764,l19: insert "the" before 22

* p24765,l23: "was carrying" –> "carried a"

* p24766,l14: "two well identified cases characterized" - Do you mean "two well characterized cases"?

* p24766,l20: Insert "a" before CALIPSO.

* p24767,l2: "criteria" is plural, singular is "criterion" (please use singular)

* p24767: Multiple occurrences of missing "a": l3 (before "High"); l3 (before "well-pronounced"), l5 (before "smaller").

* p24768: "The example concerns cirrus cloud" - fix English (for the very least, add "a" before "cirrus").

* p24769,l3: Insert comma after "feature"

* p24769,l14: "which remarkably occurs with" - please fix language (you cannot use "remarkably" in this way)

* p24770,l6: "non halo" –> "non-halo" - please replace other occurrences throughout document

* p24770,l18-19: "If quite...with including well recognizable lattices." Please break up this sentence. Also, "with including" does not work.

* p24770,l21: "This proves the consistency....". Please simplify: "Our data and model calculations show that the halo feature is only observed for pristine plates."

* p24770,l25: Delete "do" before "hamper"

* p24770,l27: double usage of "used"/"by using"

* 24771,l4: "smooth" is not a verb

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 24763, 2010.

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