On the potential of 2D-Video Disdrometer technique to measure micro physical parameters of solid precipitation

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Revision

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Manuscript revision

This document contains an anonymous review of the manuscript entitled: "On the potential of 2D-Video Disdrometer technique to measure micro physical parameters of solid precipitation ". The 2D-Video Disdrometer (2DVD) is nowadays a state-of-the-art instrument for the characterization and description of solid and liquid precipitation. Nevertheless, its actual measurement principle and some of its limitations are not very well described in the available literature on the subject (also because of the intellectual property of the software provided by the manufacturer, that it is not freely available nor distributable). There is therefore the need for technical papers like the present one, aiming at clarifying the potentials and limitation of the instrument. The paper fits well the scope of AMT.

The authors are tackling interesting topics: testing the matching algorithm, checking the (self- and cross-) consistency of particle descriptors, and testing the measurement of particle velocity.

The manuscript has a good potential and a good skeleton. The idea of using styrofoam particles to simulate complex shape hydrometeors is brilliant even though in my opinion not fully exploited. I believe that the manuscript should include more analysis in order to fully reflect its title. Several important aspects, listed below, need to be clarified or better explained and much more could have been done with the available set-up. I suggest also a major quality control of the writing style and organization of the paper and its table/figures.

General issues

1. English language. I am not a native speaker myself, so i understand very well this difficulty. I would recommend the revised manuscript to be checked by a native speaker before submission.

2. Introduction. I found particularly this section a little bit confused. Many concepts are condensed in few sentences. I would recommend to expand this section and take the opportunity to provide more detailed information about the microphysical significance of the 2DVD instrument. The manuscript is short and there is space to expand and improve the introduction.

3. Structure of the manuscript. The manuscript is rather short but it has a complicated nested structure of sections and subsections. I found it sometimes distracting and hard to follow.

4. The problem of horizontal distortion. Given the goal of the present manuscript the problem of horizontal distortion of the 2DVD images, caused by horizontal wind components, must be at least mentioned and discussed, and if possible experimentally tackled. Horizontal distortion is well described by Nespor et al. (2000), and this issue can be observed even in the most recent 2DVD designs. Distortion has a direct impact on microphysical retrievals but it can still generate self-consistent descriptors.

5. Microphysics (i). The title suggests that the microphysical interpretation of 2DVD data will be an important topic in the paper. I believe that the manuscript is instead focussed

on the consistency of 2DVD measurements only. Could the authors try to link these two aspects a bit more? I see quite some potential to do so, at least when the authors are dealing with actual measurements (e.g., Sec. 2.4.3).

6. Comparison with styrofoam objects. This interesting comparison has been really under-exploited. As a 2DVD user i would be interested to know other aspects than what shown in Fig. 10, 11, 12. For example, are the proposed shape descriptors accurately reproducing the shapes of the particle? And are they stable?

   To be more specific: if i throw 100 times the same styrofoam object of known geometry, what is the associated distribution of (e.g.) measured shape factors? Are they varying a lot? Are they consistent among the two cameras? Are there any shape descriptors that are more stable (and therefore more reliable) than others? Can we combine the two cameras efficiently?

   The styrofoam objects could also be used to understand how well the two camera views are capturing the complexity of 3D objects (non rotationally symmetrical like raindrops). My message here is that i see a lot of unexploited potential in terms of microphysical interpretation.

7. Statistical significance of the comparison with the styrofoam objects. The authors perform some comparison by: (i) dropping 5 times individual styrofoam objects, and (ii) dropping all the styrofoam objects (all together) a single time. There are 14 styrofoam objects. Could the authors do anything to increase these numbers? I am especially worried about (ii), when the exercise is performed only one time.

8. Equations. Please, check that all the equation are followed by the definition of all the terms (with units).

Specific issues

1. Title, and throughout the manuscript. The term "technique", as referred to the 2DVD instrument sounds not appropriate. In my view a "technique" is more a synonym of "algorithm", while the 2DVD is a measurement device.

2. The present manuscript does not present any specific microphysical application of 2DVD data but it is focussed on its potentials. In this context it is crucial that the authors show a complete knowledge of the state-of-the-art of the literature on the subject. I believe that some valid additional references should be considered. As an example:

   - Nespor et al. (2000). This is an important piece of literature about the potential limitations of the instrument.
   - Cao et al. (2008)
   - Schönhuber et al. (2008)

3. Page 3089, line 20. "hydrometeor classification" instead of "snow event classification"?

4. Page 3090, line 10. Add a sentence describing the structure of the paper in the end of the Introduction. "Section 2 is about XXX, Section 3 describes YYY..."

5. Page 3091, line 22. You might also underline that the velocity of "winter" hydrometeors is lower, and explain why it is so.

6. Page 3093, list of items. Here the authors list some hydrometeor descriptors. Why these descriptors have been chosen among the ones of Grazioli et al. (2014)? Are these the best possible ones to describe geometrical properties or is there any other reason?

7. Page 3093, points (a) and (b). It can be misleading to say that rain or graupel have elongation and roundness of approximately one. I suggest to clarify that rain and graupel have higher roundness (with respect to other hydrometeors) but raindrops are more and more oblate as their size increase, and graupel can exhibit quite peculiar conical shapes. About dendrites: they have high roundness if they are "seen" along their major planar dimension. If we see a dendrite "from the side" it will look very elongated.

8. Page 3094, point (f). Please clarify the definition of D_{eqd}. Is it the same as Huang et al. (2010); Grazioli et al. (2014)? If i look at your definition of the volume (point e) it seems not the case.

9. Page 3095, line 4. Any additional information about this correction factor f_{corr} (if possible for copyright-related reasons) would be greatly appreciated by the scientific community that works with 2DVD data.

10. Page 3099, line 20. Could you be more specific? Could you provide any quantitative value to support this statement? As an example, how much can the calibration values change over time? Or, how often should the instrument be calibrated?

11. Page 3100, line 23. Could you add a reference for the blurring edge filter?

Figures and tables

The caption of tables and figures need to be much more descriptive and precise. Please, provide the units of measurement, either in the table/figure itself or in the caption, of any quantity appearing in the table/figure. Secondly, a caption should include the explanation of what is shown, while the interpretation of the authors should be included in the main body of the paper.

1. Table 1. The definition of the terms appearing in the table should be included in the caption.

2. Table 2 and 3: ditto.

3. Figure 1. I suggest to avoid the "interpretative" sentences (you can mention in the main body of the text that this design is less prone to wind effects)

4. Figure 1. The first time that i went fast through the manuscript and i saw this set-up (2DVD ending up into a precipitation gauge), i was expecting some interesting comparisons (i.e., calculation of the density of specific types of snowflakes), while it seems that the gauge is never used in this work. If this is the case, it should not even be mentioned nor shown.

5. Figure 1. Is it the instrument installed on the edge of a wall or a balcony? Please note that it should be avoided to install disdrometers and gauges on "edge" locations.

6. Figure 2. Is this an adaptation of Fig.3 of Kruger and Krajewski (2002)? If this is the case, please mention it.

7. Figure 4. The fact that the rain falls much faster makes you choose a wide range on the y-axis, and the difference among ice-phase hydrometeors is not evident any more. Could you split this figure in two (rain vs other) or use a logarithmic y-axis to allow better readability?

8. Figure 9. Could you define in the text how the relative standard deviation is calculated? Could these high values be only due to a normalization with respect to small quantities? To answer to this questions it would be helpful to show also the absolute standard deviation.

9. Figure 10 and 11. The caption of these two figures is an interpretation and not an explanation of what is actually shown in the different panels. Please, leave the interpretation in the main body of the manuscript.

10. Figure 12: ditto. Also, has the "whole ensemble" experiment been performed only once? Why not repeating this experiment multiple times as well?

11. Figure 13: ditto. As mentioned before, could you maybe try to provide something more about the microphysics? Here we only observe self-consistency of 2DVD measurements.

Bibliography

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Grazioli, J., D. Tuia, S. Monhart, M. Schneebeli, T. Raupach, and A. Berne, 2014: Hydrometeor classification from two-dimensional video disdrometer data. *Atmos. Meas. Tech.*, **7 (9)**, 2869–2882, doi:10.5194/amt-7-2869-2014, URL `http://www.atmos-meas-tech.net/7/2869/2014/`.

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Kruger, A. and W. F. Krajewski, 2002: Two-dimensional video disdrometer: a description. *J. Atmos. Oceanic Technol.*, **19 (5)**, 602–617.

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