Manuscript Review

Date: April 14, 2014

Title: Hydrometeor classification from 2 dimensional videodisdrometer data

Authors: J. Grazioli et al.

Publication: Atmospheric Measurement Techniques (AMT).

General comments:

This study is unique in that it is the first attempt to quantitatively perform an automated hydrometeor classification of 2DVD measurements. Although their method does not classify individual hydrometeors, it does provide information that can be useful to several areas of research (e.g., validation of dual-polarimetric radar hydrometeor identification; numerical weather prediction, including cloud resolving models) and perhaps also has operational use as well. So this study is most definitely a worthwhile contribution and suitable for publication in AMT. The authors provide a thorough discussion of their scientific method, and there are only a few minor concerns that need to be addressed prior to publication.

Specific questions/issues:

1. There are numerous grammatical errors that must be addressed prior to publication. Although the grammatical mistakes are not major, they do somewhat detract the reader, and thus it is suggested that the authors enlist a person proficient in English grammar to help correct those mistakes. Many of these have been pointed out in the technical corrections section at the end of this review, but a more thorough review of the grammar would be better.

2. There is no mention of the wind effects induced by the 2DVD itself. This can be a concern for the representativeness of small rain particles sampled by the first generation taller profile version of the 2DVD (Nešpor et al. 2000). The wind effect is undoubtedly present and at lower wind speeds in snowfall. Although the proposed method may correctly represent the bulk type of hydrometeor within the 2DVD measurement, it may not be representative of the bulk ice crystal habit falling to the ground. It could mislead those who use this hydrometeor classification as a validation tool.   Thus the authors should mention the 2DVD induced wind effect and resultant possible under-sampling of the small and less dense type hydrometeors. In doing so, the authors need to specify which version(s) of the 2DVD is being used.

3. Some discussion about the variability of hydrometeors within the 400 time steps that were examined to construct the training dataset should be included. It seems like this information would provide a measure of uncertainty in the classification method and perhaps a starting point for future efforts to classify individual hydrometeors from the 2DVD measurements.

4. There is some uncertainty in how the authors calculate equivalent spherical volumetric diameter (D_e). They should either provide an equation for D_e or clarify if they are using the Huang et al. (2010) definition of particle diameter.

Technical corrections:

- Title…"videodisdrometer" should be two words, "video disdrometer"
- Abstract…line 7…change to "…trained over 60 second precipitation time steps and labeled by visual inspection."
- Abstract…line 8…"…algorithm achieves **nearly** accurate classification, with…"
- Page 2…line 13…change "…improved the use of ground observations…" to "…improves the ability …"
- Page 2…line 18…suggest replace "…compare rainfall observations to ground truth with weather radar measurements…" with "…validate weather radar rainfall estimates…"
- Page 2…line 21-22…replace "…conversion of weather radar observations to…" with "radar retrieval of…"
- Page 2…line 23…replace "…in agreement with…" with "…from…"
- Page 3…line 5…should mention that the use in validation of radar hydrometeor identiciation.
- Page 3…line 11…"sensors **enable the sampling of** large domains…" AND "…time lapse.." should be "..time **scale**.."
- Page 3…line 14…"…aircraft **flight** paths…"
- Page 3…line 15…replace "…specific measurement…" with "…intensive measurement…"
- Page 4…line 3…"…algorithms, **such** as the support vector…"
- Page 4…line 4…"nowadays **are** used to face **similar kinds of tasks. For** example**, such techniques have been used in** land cover…"
- Page 4…line 12-13…replace "…to be top ranked for weather prediction classification tasks…" with "…to perform relatively well at the prediction of weather type…"
- Page 4…line 17…remove "…into…" AND line 18…"…classes **as** the dominate…"
- Page 4…line 24…"…the **southern part of Ontario, Canada**…"
- Page 6…line 1…replace "..in the range of…" with "…around…"
- Page 6…lines 3-4…sentence would be better stated as follows, "…at 34 kHz, and the vertical distance between the measurement areas of both cameras A and B enables the measurement of fall velocity."
- Page 6…line 9…replace "…workflows…" with "…methods…"
- Page 6…line 10…sentence would be better as follows, "…those studies, which were interested in snowfall only, restricted the maximum fall velocity to 4 m/s and 6 m/s, respectively.
- Page 6…line 13…"…variation **found in** rain…"
- Page 6…line 16…the authors should mention what they believe the large UFOs (unidentified falling objects) present in some of their 2DVD measurements might be. They are likely either icicles or human limbs entering the measurement area during calibration.
- Page 6…line 21-22…the statement that the distortion due to the horizontal motion can be corrected for rain is too assertive. This effect can only be corrected for raindrops that possess

an axis of rotational symmetry (e.g., those undergoing axisymmetric oscillation at the time of measurement; Schönhuber et al. 2008; Thurai et al. 2013)

- Page 6…line 25..replace "Couples…" with "Pairs…"
- Page 6…section 2.3.1…D_e needs to be better defined (see fourth specific questions/issue above).
- Page 6…section 2.3.2…It would be useful to the savvy reader if the authors indicated which level of 2DVD data (i.e., AB or HYD) they are using to calculate the particle characteristics, especially since only some of the data is readily available for most data users.
- Page 8…line 21…"…16 **derived** from…"
- Page 10…line 14…"…riming processes **smooth** the shape…"
- Page 17…line 1…"…in total as **a** training set…"
- Page 17…line 18…"…now on 200 realization**s** of…"
- Page 18…line 18…"…outperforms LDA by more than **20%** and NN by more than **10%** in terms of…" (i.e., assuming SVM performs 20% and 10% better)
- Page 18…line 22…"…60s), account**ed** for…"
- Page 19…line 14…replace "In a second time…" with "During the next relatively stable phase…"
- Page 19…lines 17-20…" **The median** PF is around 0.7 during the **entire event**…" "**The median** D_e is initially below 1 mm (SP phase)…**in the latter part of the event characterized mostly by G and RIM classes**."
- Page 19…line 21…graupel is misspelled
- Page 19…final 2 lines…remove "in median value." Place the median descriptor prior to the mention of D_e…"…with median D_e ranging…"
- Page 20…line 5… "…with **median** PF below 0.7 through**out** the event, **and** slightly…"
- Page 20…line 6-7…"…and dendrites **relative to** small particles…"
- Page 20…line 16-17…"**The** rain is characterized by **small D_e and** 2 ≤ v ≤ 5 m/s (**i.e.,** light rain)**, which is** larger than the…and very high compactness with **a median** PF around 0.9."
- Page 20…line 20-21…"…around 1 m s^{-1}, the **spread** of D_e increases…median PF drops **to** 0.6 in…"
- Page 20…line 23…"**Generally**, the transition…"
- Page 20…lines 24…"Figure 12 shows the **relative number of classifications** for each of these three types…"
- Page 20…line 25…The classification type as a function of temperature is somewhat confusing. Was temperature used as an input for the classification? If not then perhaps state that it was not used by the classification algorithm (even if stated earlier)…that is an interesting result. This also raises the question of freezing rain and how would that be classified by the algorithm. Perhaps it is worth mentioning something about freezing rain in the summary/conclusions.
- Page 21…line 8…"…is provided, **which is** of particular importance…"
- Page 21…lines 14-15…"**Each of** the classes are identified with **a median overall** accuracy **exceeding** 84%."
- Page 21…lines 20-21…"…classification of hydrometeors **from the 2DVD measurements** provides additional information that can also…"
- Page 21…lines 22-23…"This work also **has** the potential…"

- Page 21…line 24…"…products **derived** from polarimetric weather radars. It could **also** be adapted and implemented in **other** particle imaging systems, **both** ground-based…"
- Can it be also applied to one dimensional particle imagers (e.g., Snow Video Imager, optical spectrometer, etc.)? If so, then it should be mentioned too.

References:

Nešpor, Vladislav, Witold F. Krajewski, Anton Kruger, 2000: Wind-Induced Error of Raindrop Size Distribution Measurement Using a Two-Dimensional Video Disdrometer. *J. Atmos. Oceanic Technol.*, **17**, 1483–1492.

Schönhuber, M., G. Lammer, and W. L. Randeu, 2008: The 2D-video-distrometer. *Precipitation: Advances in Measurement, Estimation and Prediction,* S. Michaelides, Ed., Springer, 3–32.

Thurai, M., V. N. Bringi, W. A. Petersen, P. N. Gatlin, 2013: Drop Shapes and Fall Speeds in Rain: Two Contrasting Examples. *J. Appl. Meteor. Climatol.*, **52**, 2567–2581.