

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-62

Anonymous Referee #2

Referee comment on "ICE-CAMERA: a flatbed scanner to study inland Antarctic polar precipitation" by Massimo Del Guasta, Atmos. Meas. Tech. Discuss.,
<https://doi.org/10.5194/amt-2022-62-RC2>, 2022

The paper presents a new instrument to image snow and ice precipitation together with automated image processing. As such it is a worthy contribution to AMT as only few ice particle imaging instruments exist. The instrument is specifically designed for the Antarctic environment.

While interesting details are provided, they are not sufficient to describe a new instrument. Some aspects of the instrument's performance and the automatic image analysis are not discussed properly yet. Thus, I recommend publication after a major revision. In the following I highlight more important shortcomings first and then list other comments, suggestions, and corrections.

Major comments

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1)

Abstract is not adequate.

2)

Particles' collection?

L77-78: "The principle is simple: at low temperatures and low wind speeds (conditions encountered at DC), precipitation falling over

a flat glass accumulates with time and remains frozen until it sublimates, ..."

Language should be improved, but also the collection and issues with collection efficiency should be discussed here or later in the paper. Particles deposit on the DS, but what makes them stay there ("remains frozen")? What are the effects of wind both during collection (deposition) and after collection (can particles be removed by wind)? Could any biases be introduced based on wind effects or other effects depending on size or shape?

3)

1.2 Camera/1.3 Focusing and 2.1.2 Limitations:

Say something about resolution (resolving power). Pixel size corresponds to 7 μm , but resolution does not seem to allow detecting particles smaller than 70 μm (70 μm , not 60 μm as you state in L333, is equivalent to 40000 μm^2).

How much does the focus change between calibrations?

How long does focus calibration take? (Could it be done before each scan instead of 6h intervals?)

Consider including a discussion of accuracy of provided particle sizes.

4)

Thermal control:

L168-170: "The NI-Labview software controls the internal temperature of ICE-CAMERA above -40°C, and the DS temperature always under -5°C ("Heater 1" in Fig.3)."

Is this always possible?

Specify if this is general heating of ICE CAMERA or specific for sublimation (then refer to Sect 1.6.1).

Unclear where Heater 1 and 2 are.

Heater 1 and 2 swapped in Fig 3.

L179-181: "An indoor test (Fig.7), showed a heating of rate of $2.5^{\circ}\text{C min}^{-1}$, and a cooling rate of $1^{\circ}\text{C min}^{-1}$. The cooling rate is almost 50% of the heating rate just due to the sandwich heating-glass structure, with the heating layer at the middle."

"...just due to the sandwich...": is this passive cooling, what is "heating layer at the middle"?

Is the indoor test really relevant here? You then report the heating/cooling rates outside. So, Fig7 could maybe be replaced with a cycle outside.

In Sect 1.5 you mentioned about heated air between glass sheets (DS and second sheet) and keeping DS frost free; is that the actual heating of the DS?

Detail: how much air pumped inside and through the space between the windows?

Distance between glass sheets?

When air between glass sheets is not pumped, is it sealed or can air circulate?

L192: "Heating is anyway interrupted if the DS temperature exceeds -5°C ..."

How often does this happen?

5)

Deposition/scan/sublimation cycle:

The cycle of deposition, scan, and sublimation is not properly explained in detail. The reader gets the details somewhere between the lines.

L190-192: "...sublimation of the majority of particles ($D < 1000 \mu\text{m}$) is complete within 20 minutes, with just a few big ($D > 1000 \mu\text{m}$) grains still present after 30 minutes.

After these tests, the heating time was set at 10 min."

"D" is not defined.

"within 20 minutes": 20min after the 10 min heating period (after 10min heating was turned off)?

"few big grains" Can you be more specific? After 30 min grains were larger than 1mm? Or ice particles that original had D larger than about XY mm?

Then you continue to discuss the cycle and for how long the DS is "sensitive to falling ice particles" and that this time is variable depending on conditions and that there is an uncertainty associated with this.

What is in L195 the "evaporative removal of particles during the accumulation period"? Is this wind related; why evaporative now and not related to sublimation; what is accumulation period".

All these details should be explained more clearly and then the issues discussed clearly too. In particular, make it clear that the deposition phase is not clearly defined (only its end due to the scan). I think I have not seen how long a scan takes. Would scanning more often be a way to study sublimation issues related to smaller particles (100 μm)? Would

could then see how they sublime in consecutive scans.

6)

Fig 8:

What measurements does the figure show? For one 1h cycle, how many temperature measurements are shown?

Fig 8 left) at what wind speed?

+25degC at still air, +20degC at 8m/s: are those temperatures averages, median, or ? (I can see a large range, maybe 20degC to 35degC.)

Wide spread in blue; two regions (sublim and deposition phases)?

Left: better also show dT instead of DS temperature.

Could Fig8 be separated in one fig. only the deposition periods of 20 min prior to scan, one for after/during sublimation heating? This could be clearer instead of heaving heated and not heated temperatures mixed in one figure.

7)

Sect 1.6.2 Sublimation of ice particles

You discuss sublimation, both unwanted and wanted sublimation here. When saying "negative effect" you refer to the unwanted sublimation. Be careful to keep clarity in this section.

L214: "as DS ice is always super-saturated relative to the surrounding air"

Wrong as it is stated. It is also unclear what "DS ice" refers to.

At the heated DS the equil. vap. pressure will be higher; thus the surrounding air will have a lower RH at the heated DS and ice on the DS will experience sub-saturated conditions.

L215-216: "the vapour pressure of ice on the DS relative to the surrounding air (saturated relative to ice..."

Wrongly or unclearly stated: "the vapour pressure of ice on the DS..." should be something like:

"the vapour pressure saturated relative to ice at the DS temperature".

Fig 9: Why show this ratio ($e_{\text{ice}}(T_{\text{DS}})/e_{\text{ice}}(T_{\text{amb}})$)?

More interesting would be the inverse ($e_{\text{ice}}(T_{\text{amb}})/e_{\text{ice}}(T_{\text{DS}})$), i.e. RH_{ice} at DS if surrounding air is at RH_{ice}=100%. For $dT=5\text{K}$ this would range between 45% at -80degC to 65% at -10degC . It shows the sub-saturation. Fig 9 is not further discussed or used later on. If you want to keep it, I suggest to plot inverse.

You use over saturation, oversaturation, over-saturation, and super-saturation. Only use one term for clarity, I would suggest super-saturation.

L228: "growth rate of the facial area" Growth perpendicular to facets?

L229-230: Unclear what critical super-saturation and critical temperature are.

L231 "0.05% to 5% under-saturation". How is "under-saturation" defined here?

L234 "The steady-state shape of the sublimating crystal depends"

Unless explained or defined, it seems contradicting: a sublimating particle is not in steady state.

L246-247 "The simulations assume the completion of preliminary sublimation of points and edges of the particle"

Unclear language (preliminary, points, edges).

L252 "still evaporate" Unclear what the "still" refers to => "sublimate".

L253 "could survive along the heating period" => "will survive longer than the heating period"?

L259: Meaning of "After the sublimation period, DS is exposed to falling crystals."?

DS is always exposed. Particles depositing during the sublimation period may partially sublimate and then be included in "collected" particles. (see comments for Deposition/scan/sublimation cycle above)

Fig11: Do you have any experimental data on sublimation times for actual particles (similar to your spheroids)? That would help to set your statement in L270 in relation, or that you only see few particles with partial sublimation.

8)

Sect. 2.1.2

1) Specify better: 2000 per scan?

2) Explain what you mean with "By default". Relate to resolution (see 3) above).

3) Specify the segmentation error (particles are overlapping?). How can a particle be counted twice (double counting)? What is 12% in your worst case (overlapping particles account for 12% of particles in one scan)?

4) Two issues are brought up together but are rather two limitations that should be listed/discussed separately. It is unclear how and on what basis these spheroidal particles are disregarded.

9)

Sect 2.2.2 Training dataset

I would like to see a better description of the various datasets.

What is the "image dataset" (L437)? How many images; from what time period?

How have these images been selected out of all available images? Randomly or by some other selection criteria?

This image dataset is then apparently split in 10% validation dataset and 90% training dataset (25705 images).

What about a testing dataset?

Say how testing (see Sect 3) was performed, in Sect 2.2.2 or Sect 3 for example. How many and which particles were used to test the CNN after training is complete, i.e. to produce the results shown in Sect 3?

Provide more details about the augmentation: To what size is the original training dataset of 25705 images increased after augmentation? Each class augmented the same (number of images increased by same factor)?

10)

Biases during training

The number in each class is different. This can generate biases in the CNN, please comment. In particular, I think that part of the low performance for trig plates is due to the fact that this is the smallest class in the training dataset.

11)

Data

A few example images in the full resolution should be included in the paper. This will help when discussing resolution and sizing accuracy (see Major point 3) above).

Reconsider if you interpreted government policies with respect to sharing data correctly. It would be useful to share the whole image dataset. Should that not be possible, then please share at least a sample dataset.

Minor comments

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Consistency with terminology and spelling in various places.

E.g.

GoogLeNet

dataset

I would expect that Introduction is Sect 1.

Sect 2 is on instrument; 2.1 Overview (instead of 1.1)....

L69: "In this work, the term 'precipitation' will include both diamond dust and"

Should perhaps refer to "precipitating diamond dust".

"cooling speed" => "cooling rate"

"eventual" => "occasional" (2 x)

"deposition window" => "DS"

"By the way" is not good English for an article.

Fig 12: "Reg.growed" Use correct label and be consistent with text.

Fig 13: Remove title "ICE-CAMERA: Summary of detected grains..."

Be consistent: what is synthesis image?

summary-image

synthesis image

mosaic, summary image

L325 "measures" is not a noun.

L325 and L83: specify what weather data are.

L384 "hexagonal prism"

I would call this class "long column" or something else with "column"

Fig 14 "compact prism" should be "compact column" (as in L395).

L401: Why refer to "insoluble"?

L451 "3.1 Precision of the classifier" should be "3.1 Accuracy of the classifier"

L460 "mistaken" = "mistaken with each other"

L 462 "Compact columns are misclassified almost 20%"

I read 15.4% in the bottom row, not 20%.

L473-474 "The three-dimensional structure of the ice particles is lost in the ICE-CAMERA images, so that some thick ice forms such as C4a, P1b, G3b, CP1a, etc. (Kikuchi et al, 2013), if any, are likely to be misclassified"

Be a bit more specific (or give at least one example).

L498-499

"The classifier was used..." You are showing results of the classifier but then also of the "image measurements" for the resulting classes.

Is the Jan-Feb 2017 period not part of the image dataset used for training/validation and testing?

L506 "maximum whisker length is here equal to the interquartile" seems wrong.

Total box height is equal to the interquartile range. What do the whisker lengths indicate?

L507 "some relevant differences" seems to refer to one relevant difference.

Fig 20: can you include a grid line for 100um?

L532 "diameter of the circle equivalent to the bounding box"

definition is ambiguous:

"diameter of the circle with the same area as the bounding box

Similarly, in L533: ambiguous definition.

Fig 23: Suggestion: put (as whiskers only) on scatter plot Feret-box vs projected-surface equiv. diameters. In that way direct visual comparison is possible.

L543-544 "Commercial or customized instruments do not have this flexibility, more typical of old-style handcrafted products"

Purpose of this comparison, what instruments are you comparing to?

L548 "convolutive" => "convolutional"

L552 "precisely" Do you mean precise here, or accurate?

Anyway, neither of the two was discussed.

See Major point 3) above.

Concluding remarks on potential improvements (in particular with respect to the sublimation problem). Use of ICE-CAMERA in other environments (not Antarctica)?