1)Abstract is not adequate.

A new extended abstract is under preparation

2) 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, …”

corrected

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?

A discussion about 'what makes them stay there ' was added. About the effect of wind on particle deposition and removal I instead admit that this cannot be modeled properly using my (and literature) knowledges and tools, also because the wind effect is complicated by electrostatic effects occurring on the dielectric DS of ICE-CAMERA, the effective wind speed close to the DS surface is not known, (no micrometeorological data are available there). This would be the topic of a more specific work. I just added a discussion about the wind-speed threshold for wind drift (and thus for the removal of particles from the DS…) based on specific Dome-C results of Lebois et al., 2014, Etienne et al.,2016 .

3)1.2 Camera/1.3 Focusing and 2.1.2 Limitations:

Say something about resolution (resolving power). Pixel size corresponds to 7 um, but resolution does not seem to allow detecting particles smaller than 70um (70um, not 60um as you state in L333, is equivalent to 40000um2).

Corrected:

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?)

Corrected: The typical focus adjustment between two calibration if between 0 and ±0.25 mm. The calibration takes approximately 10 minutes and for this reason it is not performed after each measurement in order to spare PC resources for data processing.

Consider including a discussion of accuracy of provided particle sizes.

A discussion about the calibration of the measurement on the DS was added

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).

Corrected: **These conditions are maintained all-year round in all phases of the measurement cycle**

Unclear where Heater 1 and 2 are.

Heater 1 and 2 swapped in Fig 3.

Corrected

L179-181: “An indoor test (Fig.7), showed a heating of rate of 2.5°C min-1, and a cooling rate of 1 °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"?

Corrected: I also introduced a description of the ’sandwich’ and its thermal characteristics

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.

I prefer to keep this picture, as in steady-air the same thermal cycle (with just a different offset temperature) occurs outside, as the thermal constants of the instrument are always the same.

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?

Corrected: introduced a description of the ’sandwich’ ant its thermal characteristics

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

Done: The outside air is pumped (through a 3.5 l/m miniature pump) for five minutes every hour inside the instrument

Distance between glass sheets?

Corrected: 13 mm

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

Done: sealed

L192: “Heating is anyway interrupted if the DS temperature exceeds -5°C…”

How often does this happen?

Only in warmest summer days

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.

Corrected: better described the cycle in the ‘overview’

L190-192: “…sublimation of the majority of particles (D<1000 um) is complete within 20 minutes, with just a few big (D>>1 000 um) grains still present after 30 minutes.

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

“D” is not defined.

Corrected

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

Corrected

“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?

Corrected: (initial diameter>>1000 um)

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”.

corrected

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 um)? Would could then see how they sublimate in consecutive scans.

Corrected:
evaporative→sublimation

accumulation period→ 'Deposition period' (now defined)
Scan duration-> 2 minutes

-Would scanning more often be a way to study sublimation issues related to smaller particles (100 um)? Would could then see how they sublimate in consecutive scans.

This is possible, and can be planned (in summer), as a test ,on a few target particles, but in this specific instrument it cannot be done (and was not done) routinely, because the image processing of a typical population of one hundred ice particles takes 10 minutes or more. Small DD particles such as small (<100um) plates, the most interesting in a sublimation test, are very scarce in summer Moreover, in winter the instrument works unattended, and experiments of this type are virtually impossible.

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.

The figure was in fact confusing, and was totally removed

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.

Corrected

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 (e0ice(T_DS)/e0ice(T_amb))?

More intersting would be the inverse (e0ice(T_amb)/e0ice(T_DS)), i.e. RHice at DS if surrounding air is at RHice=100%. For dT=5K 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.

L214…..Fig.9 and its discussion were eliminated, as unnecessary: the simulations of sublimation contain the same information and lead to more readable results.

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

Corrected adopting super-saturation (thanks!)

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

Corrected

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

Sentence removed

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

Corrected in ‘sub-saturation’

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.

Text was modified and ‘steady-state shape’ removed

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

Unclear language (preliminary, points, edges).

Changed: The simulations assume that the preliminary sublimation of the high-curvature parts of the particle was already completed

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

Corrected

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

corrected

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)

Corrected:During the deposition period, the collected particles also undergo sublimation, although this is much slower than during the sublimation period.

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.

This experiment is possible, and can be planned (in summer) on a few particles, but in this specific instrument cannot be done routinely. In winter, the instrument works unattended and experiments of this type are almost impossible. Moreover, small DD particles such as small (<100um) plates are very scarce in summer.

Added: Some small plates (observed mainly in winter, when sublimation in the deposition period is very slow) showed smoothed corners, but it is not clear if this is induced by local sublimation or is a natural shape

8)Sect. 2.1.2

1) Specify better: 2000 per scan?
yes, corrected

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

Corrected

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?)?

Corrected : 12% of particles in one scan. More details were added

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.

Corrected

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?

Changed: period 2014-2017. About the size of the dataset, it was already stated in the text, and their distribution among classes was already shown in fig.15

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

Changed

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?

You are perfectly right: for the testing I used a testing data set including approximately 50% of training images and 50% of unused images. This ‘error’ was corrected in the new version: now 80% of the whole dataset used for the CNN training was used as training data set, 10% for validation data set, 10% for testing data set. Moreover, I increased the number of training particles for most classes. Trigonal plates are rare, and their number in the training dataset was thus artificially augmented by duplicating the training images for this class, in order to avoid their absence inside most of the small (64-images) training mini-batches. Image augmentation during training contributes to a partial spatial randomization of this special class.

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)?

There is no formal answer to this question: Image augmentation is introduced randomly (within the fixed limits and transformation types) to each image of each mini-batch used during the CNN training. Each mini-batch represents a random sample of the data base.

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.

I increased the number of training particles for most classes in order to better equalize their numbers. Trigonal plates are rare, and their number in the training dataset was thus artificially augmented by duplicating the training images for this class, in order to avoid their absence inside the small (64-images) training mini-batches. Image augmentation during training contributes to a partial spatial randomization of this special class. The resulting CNN is more performant, with 90%

classification accuracy of the training data set just after 3 epochs, compared with 83% (after 5 epochs) of the first version of the paper. The accuracy in the detection of trigonal plates is now reasonable 86% (on training data set). Sections 2.2.3, and 3 were modified, accordingly.

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).

Fig.14 already shows examples of good quality ICE-CAMERA images

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.

I will share the CNN and sample data-set for each of the 14 class. I cannot share the entire data set as it is still under analysis, and is going to be used for a second paper. The actual paper is intended to describe the instrument and its software.

Minor comments

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Consistency with terminology and spelling in various places.

E.g.

GoogLeNet, Dataset

Corrected both

I would expect that Introduction is Sect 1.

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

Corrected

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

Should perhaps refer to “precipitating diamond dust”.

Corrected

“cooling speed” => “cooling rate”

Corrected

“eventual” => “occasional” (2 x)

Corrected

“deposition window” => “DS”

Corrected

“By the way” is not good English for an article.

corrected

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

corrected

Fig 13: Remove title “ICE-CAMERA: Summary of detected grains…”

corrected

Be consistent: what is synthesis image?

summary-image,synthesis image,mosaic, summary image

corrected

L325 “measures” is not a noun.

corrected

L325 and L83: specify what weather data are.

Added a sentence

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).

I will follow this indication in the next version of the paper, but not done yet because I must change accordingly most of the labels in the software

L401: Why refer to “insoluble”?

corrected

L451 “3.1 Precision of the classifier” should be “3.1 Accuracy of the classifier”

corrected

L460 “mistaken” = “mistaken with each other”

corrected

L 462 “Compact columns are misclassified almost 20%”

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

A new discussion about the (updated) CNN results will be rewritten

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).

Even if is quite complicated to find ‘clear’ examples, I’ll try to introduce a specific figure for this problem.

L498-499

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

corrected

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

The image data set used for training/validation includes images from 2014 to 2017 (so, also jan-feb 2017). But just a random sample of the whole image data set was used for training/testing, and only a few images from the Jan-Feb 2017 period were thus used in training/validation

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?

Corrected, my mistake! Lower and upper whiskers mark one interquartile below the 25th percentile and one interquartile above the 75th percentile, respectively

L507 “some relevant differences” seems to refer to one relevant difference.

corrected

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

Yes: To be corrected in the final version of the figure

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.

corrected

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?

removed

L548 “convolutive” => “convolutional”

corrected

L552 “precisely” Do you mean precise here, or accurate?

Anyway, neither of the two was discussed.

removed

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)?

To be added in the final version. Unfortunately, only unpolluted ,very cold, low humidity, low precipitation environments could host a similar instrument (high-mountain tops, dry arctic environments)