

Dear Anette

We hereby submit the 2nd revision (both raw and annotated) together with reply letters. We made large re-structuring, and merged duplicated information to correct places. Since we had to include minimum explanation to answer the reviewers comment again (with new Table 8), we could save only 2 pages. In addition, we removed non-essential sentences and also moved the future work to Appendix B. Since this "roadmap" is what aurora community want to read, we kept as Appendix. With this modification, the main text was shortened from 33 pages to 28 pages, including 13 figures and 8 Tables.

For the error problem, we now distinguished the judging accuracy (error 10%) and significant ant digit (0.03%).

Sincerely
Yama

M. Yamauchi
Swedish Institute of Space Physics, Kiruna

2nd Reply to Reviewer #3 (first)

#comment

I want to congratulate with the authors because the quality of the paper significantly improved after the revision. Now it is possible to understand much better all the work, also for a wider community of scientist that are not extremely expert in this narrow field.

All the main critics of the first revision are now addressed in the paper, at least as a future work to be carried out.

There are still some technical issues to be corrected, mainly typos (please, see comments in the attached pdf). I still believe that Figure 5 is not immediately clear, and it can be improved.

In my opinion the paper is now eligible to be published.

Answer

Thank you for your encouraging comments and finding technical issues. Figure 5 (and caption) is modified, and explanation on Levee 5 (Table 6) is added.

The technical issues (lines 80, 138, 140, 153, 157, 167, 198, 200, 228, 465, and 468) are fixed.

2nd Reply to Reviewer #1

#comment

The provided content is good and relevant but a major revision is required regarding the entire paper structure. The chapters are very long, jump in content (results in the introduction, technical requirements are not presented in one chapter but here and there, the headings are often chosen rather artfully than scientifically, ...).

In addition to the points mentioned, jumping and often duplicating of content not only leads to an unnecessarily long manuscript but also to confusion for the reader, as important information (that would be necessary for understanding one part or another) is given late and thus problems of understanding are resolved too late.

Suggestions for improvement are given in the attached PDF.

Answer

Thank you again for your detailed comments with many helpful suggestions. We re-organized the entire paper, and merged duplicated information to correct places.

--- Abstract ---

#comment

line 3 "Joint Photographic Expert Group (JPEG)":

no need to explain this very common term. Better to tell the Reader what JPEG is. Maybe you can write ... "using ASC images in JPEG image format".

#comment

Line 43 "Joint Photographic Expert Group (JPEG) format":

see comment above. I dont think that the image format name needs to be explained here, but it's up to you.

Answer

Thank you for your suggestion. We added short explanation when it appeared in the introduction.

#comment

line 4 "The identification":

The identification of local arc breaking? There was no sentence before talking about some kind of identification

Answer

Yes. We now added.

#comment

line 9 "and H (hue)":

Is the hue value provided by the Kiruna images or is a color space transformation done in advance from RGB to HSL?

Answer

In the JPEG image, and we added explanation.

#comment

line 10-14:

nice explanation but hard to get all categories in this continuous text form. Would it be possible to provide a table? Showing, f.i., in one column the categories and in a second one the attributes (ordinary green colour by 557 nm emission, ...)?

Answer

We divided the sentence to improve readability.

#comment

line 16 "5": 5th?

Answer

Yes, and we obey journals format.

--- 1. Introduction ---

#comment

line 56 "AE":

real-time nowcast of the geomagnetic indices (obtained from multi-station data" such as Auroral Electrojet (AE) ...

Answer

Thank you for your suggestion. We added.

#comment

Figure 1 caption "Auroral emission is characterized by green colour at 558 nm wavelength.":

JPEG images are known to compress the stored image information. Furthermore, is Kiruna camera able to measure certain bands or is this a simple camera that uses a color filter to separate roughly the color to R, G and B? In the latter, I was wondering how you could get exactly the color by 558 nm with this camera as it is more or less a huge range of different greens to be stored in the green channel of a common camera?

Answer

We rewrote this misleading sentence. Of course the camera cannot distinguish this wavelength.

#comment

line 69 "to the "class" that is used for cyclone/hurricane.":

Unfortunately, I do not understand this comparison.... the class for aurora is similar to the class used for cyclones. OK, but using which classification procedure or model?

Answer

We removed this non-essential sentence.

#comment

line 70 "simple formats":

image formats?

Answer

We removed this sentence.

#comment

line 76, 78, 79, etc "simple":

there are many "simples" in the text ...

Answer

We replaced to better wording (e.g., a set of), and use "simple" only for criteria and calculations, which means minimum computation time.

#comment

line 80 "6 byte colour":

RGB+HSL?

line 138 "6 byte colour":

I miss the explanation of the 6 byte, but I still guess it is RGB and HSL colour information. Please provide this information to the reader.

line 165 "6-bit value (2 bit each for R, G, and B)"

?! Above you talk about 6 byte images, now 6 Bit? Which one is correct?

Answer

It was also our mistake to write 6 byte. It is 3 byte (6 x HEX). We changed the explanation at relevant places.

#comment

line 85 "expert system":

To be honest, I still don't quite understand what is meant by this expert system. The development of the classification procedure that can later be used by non-experts to detect local-arc-breaking?

Answer

We introduced expert system when the "translation of manual classification" is mentioned first time.

#comment

line 87 "requires too much computation resource for low-performance processors."

"really? Do you have some time measurements that support this statement?"

Answer

We removed this statement. (According to Nanjo (private communication) Deep Learning classification takes about 20 sec).

#comment

line 90/91 break:

The "Introduction" section is very very long and contains motivation, related work, problems to be solved and explanation how this was done... please carefully revise the structure and give the section sub headings.

line 103 "activity.":

At this point. The Introduction should be closed and another section, like "Related work", should be opened.

Answer

We moved the machine-learning part to discussion, and data source part to the next section. This makes the introduction to nearly the half.

#comment

line 97-99 "Note that just... colour space":

I guess this may answer my comment given in Fig 1. In the caption, it sounds like that you are able to catch only the greens at 558 nm with your RGB image. Here, you state that the RGB images store mixed colors each with higher proportions in the targeted colour range (see Fig. 2a in, f.e., this paper: <https://onlinelibrary.wiley.com/doi/full/10.4218/etrij.16.0114.1371>)

I recommend revisiting the aspect of including individual colour bands in the images (if done with a simple camera that uses a colour filter, usually the bayer pattern), especially in Fig 1 caption.

Answer

We revised Figure 1 caption that caused the confusion (make it clear that we cannot extract any "wavelength").

#comment

line 109 "for each picture":

from consumer cameras or cameras that are able to measure individual bands?

Answer

It is consumer camera. To avoid confusion, we mentioned consumer camera in the introduction (3rd paragraph).

#comment

line 114 "ambiguous (Clausen and Nickisch, 2018) or "Aurora and cloud" (Nanjo et al., 2022).": could these outcomes serve as an approximation for your approach? E.g. to accelerate the processing and thus, enable the use of local operators instead of point operators to classify the image pixels?

Answer

Their classification applying to each pixel should approach to the present result (possible application of machine learning in improving our method is mentioned in the discussion section).

#comment

line 127 "different light": This part answers many questions.

I strongly recommend to provide a separate chapter that deals with the explanation of the camera, the keograms (together with Fig 1., 2, 3). ... almost everything that is related to the measurement system, aka your camera system.

I advise against putting all this important and well-described information scattered in the introduction.

Answer

We moved these paragraphs to the next "new" section

#comment

line 140/141 break:

This part is redundant to the introduction. Maybe here in this explicit section it would be enough?

line 152 "Raspberry Pi 4":

all this camera and controlling information is very interesting but has nothing to do with "Algorithms and source data". Please consider to provide a specific section (e.g. "Camera technology and hardware") where you can fuse all information about the camera.

Answer

We merged them and moved to the "new" section (same as above).

#comment

line 149 "Sony alpha7s":

this answers the filter matrix question. AFAIK Sony alpha 7s uses the RGGB bayer pattern.

Answer

Thank you.

#comment

line 161 "dynamic exposure":

*this is of course unfortunate if you want to calculate spectral indices...
is this never a problem for your approach? Hard to imagine...*

Answer

It is indeed a problem, but not critical for Level 6. We plan to deal with it in the next version (Appendix).

#comment

line 166 "2.1 How to classify each pixel":

Not very scientific... "Image classification"?

Answer

We changed to better wording.

#comment

line 172 "incoming light is filtered":

there is another filter implemented? Please provide more information about this when writing about the camera setup and Kiruna's specs

line 178 "R/G and B/G ratio in addition to high G values."

well, this is due to the RGGB pattern in sony alpha 7s (double amount of greens than reds and blues).

Together with an additional green filter (thats what I read from the line 170 to 175), you get almost no information in the red and blue channel.

Answer

No filter exists. We removed the word "Unless...filtered" and used "non-filtered". Sorry for confusing writing.

#comment

line 195: very interesting!

Answer

Thank you. This is another future task.

#comment

Figure 5:

the colour choice is unfavourable. I spent minutes thinking about how the RGB values of the boxes relate to the RGB coordinate system. Most readers first look at the graphic, then at the caption (especially if it is as long as this one), where it is pointed out that the colours here simply represent the classes and have nothing to do with the colour in the ASC image.

Answer

We redraw the figure with colors directly coupled with actual criterion.

#comment

line 209 "(further deviation from 558 nm)":

what is meant by further deviation? In numbers?

Answer
RGB values (actually H value). We rewrote it.

#comment
line 221 "we accept small errors":
what are small errors? how many pixels could be falsely classified with no impact to the alert function?

Answer
We specified numbers of pixels (explained at the first time when "tolerance" appeared)

#comment
line 226 "2.2 Three categories for auroral pixels":
same problem as above. I don't get the point of the caption.
line 229:
there is a lot of redundant information in this part (because it has already been presented in the previous sections). please revise.

Answer
We re-arranged the subsection (paragraphs are moved) and changed the title accordingly.

#comment
Table 1 "filter":
what is the filter column supposed to tell me?

Answer
We added definition of "filter" in Figure 5 and text.

#comment
Table 1:
may it be possible to generate an (pseudo) "image" out of this table where each "pixel" is colored by the mentioned RGB value here and have an overlay with the manually detected class? Like in this picture here (justed a first hit after googling to find an example to illustrate what I mean:
<https://i.stack.imgur.com/FHDGG.png>

In this manner, the reader gets a feeling what experts detect as strong or arc or diffuse, etc...

Answer
Since the re-construction of "strong", "arc", "diffuse" is shown in Figures 1c-1e (this is now stated at the Table), we would not add more figure and explanation to keep the paper not too long (editor asked to shorten the paper).

#comment
Table 2:
"W" for Diffuse?

Answer
Yes, we changed to small character in Table 1, and explained there.

#comment

line 286 "some":

line 290 "Some":

again, here are many "vague" statements. Please explain what is "some" in your opinion (in numbers)

Answer

We rewrote both paragraphs.

#comment

line 291 "about 100 pixels out of 1.5×10^5 pixels":

yes! This is what I meant by numbers. This helps a lot to judge the results as a reader.

Answer

We moved this information to much earlier (beginning of new section 3).

#comment

line 319 "we do not include any correction in the present version":

I guess this is also not necessary for your goals of Aurora detection and alert, isn't it? Or do you expect to quantify the size of aurora after undistorting and rectification in a later version?

Answer

Not important, but we still plan some type of compensation in the future as a subproduct of "position detection" of strong aurora.

#comment

line 325 "Therefore, an accuracy of 0.03% in numbers of pixels (about 50 pixels) is sufficient to judge the activity level.":

This is not much but I think, a better accuracy value would be the ratio of pixels detected as "strong" by the given approach and detected manually as "strong" (which would require some manual labeling of images by experts)

same for the following accuracy values

Answer

We have rewritten the entire paragraph. Yes it is about 10% of occupied area and we now use the correct word "significant digit"

#comment

line 370 "We started this alerting system from 5th November 2021.":

again, some information was actually given in the very long introduction. Perhaps reduce the information there ore here in favor of the paper length and reading flow.

Answer

We shortened the introduction by moving duplicated information to the relevant sections.

#comment

line 383 "[]":

in brackets ?

Answer

We added

--- 4 Examples ---

#comment
line 401 "dB/dt":
explanation?

Answer
We added the definition in the text in addition to the figure caption

#comment
Figure 7:
Unit covered by ASC image

Answer
We redrew the figure.

#comment
line 473
Very large section 3 with many interesting information but very text-intensive!
Would it be possible to sum up all the findings (moon, twilight-effect, etc.) in a graphic or table?

Answer
We preliminary added Table 8. We call "preliminary" because the paper is already long and editor might ask to cut it.

#comment
line 482 "Table 7 lists date that Level 6 was detected":
sentence?

Answer
We corrected the sentence

#comment
line 487 "vThe Level 6 auroral activity was not detected only 9 nights out of nearly 50 nights with the Local-Arc-Breaking in the ASC.":

is "only" correct here if the success is 90%?

Answer
We removed the subjective word "only". From actual observation viewpoint, this is quite good rate.

#comment
Section 4.1 to 4.8:
this section could be a new paper introducing all the adjustment options. I recommend to reduce the following paragraphs to a minimum and provide the improvements in a second paper.

Answer
We moved section 4.1-4.8 (future plan) to Appendix B (did not delete) because the auroral community readers need this information.

#comment

*5. Summary and conclusion:
future work before summary of present approach?*

Table A1:

Please revise the structure. Usually, the conclusion does not contain new information like this table here.

I also do not understand the content of the table at this point in the text.

Appendix A:

Appendix before references? uncommon.

Answer

The Table A1 is for Appendix A. Location of misplaced Appendix and Table A1 is due to journal's Latex macro, and we make sure that final layout is streamlined according to the journal's style

Typos are also fixed

#comment

line 10 "HLS":

HLS? I only know HSL. Typo or different color system?

line 181 "HSL":

this answers the color space question at the beginning. please fix the typo there.

Answer

It is typo. HSL is correct.

#comment

line 24 "condition":

add ''

line 186 "SONY":

why capital letters? => Sorry, it is Sony.

#comment

*line 465 "(%arc?3% and %strong?0.2%):
formatting!*

Answer

We corrected to Latex \geq