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Comment on angeo-2022-5

Anonymous Referee #2

Referee comment on "Reconstruction of precipitating electrons and three-dimensional structure of a pulsating auroral patch from monochromatic auroral images obtained from multiple observation points" by Mizuki Fukizawa et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2022-5-RC2>, 2022

This paper describes work done to reconstruct the 3D volume emission rate of a pulsating aurora patch, determine the altitude and vertical thickness of the patch, as well as the horizontal distribution of the characteristic energy and flux of the electron precipitation producing the pulsating aurora. Overall the manuscript is well written and the work is worthy of publication. I have some questions for the authors and suggest some minor corrections below. I also suggest the authors consider what is the most important result from the work. Currently it comes across to me as if the technical process of obtaining the results is the most important aspect of the work, but I wonder if the finding that "the horizontal distribution of E_c was neither uniform nor stable" is at least as important, if not more important. If they authors agree, I suggest they draw more attention to the scientific results (as opposed to the technical process, which is nevertheless impressive) in the abstract and conclusions.

Minor comments:

Line 51: What is a "typical" field of view?

Line 56: Did all four WMI CCD cameras have 427.8 nm filters? What exactly do you mean by compositing auroral images from these cameras?

Line 63: I think there's a mistake with the energy range here, are you sure it should be 300 eV to 100 eV? Also, I think it would help readers unfamiliar with the method if you could add a very brief explanation of what the energy axis actually means, before stating its range.

Line 75: Determination of the inverse covariance matrix – you say this is the standard deviation from each auroral image, but the standard deviation over which dimension? Do you mean the standard deviation of the 1024 pixel intensities in the 32x32 region? I think this could be explained more clearly.

Line 80: c_{SKB} fixed at 1 – should each camera not have a different value, to account for their absolute intensity calibration? Or do you already use calibrated images? Also in the next sentence you say c_j was different for each camera, which contradicts $c_{SKB} = 1$, and in the conclusions say you included the relative sensitivity between ASCs, which also contradicts $c_{SKB} = 1$ I think.

Line 81: “during” should be “for”.

Line 90: I think forming the plural of delta this way could be confusing – it's probably better to write “over 5 values of $\delta(\dots)$, which were...” (replacing “ $\delta(\dots)$ ” with the relevant symbols).

Line 95: Is it valid to assume a constant background in all voxels? Should there not be a strong altitude dependence, if the background is diffuse auroral emission? Presumably the breakdown of this assumption in the altitude dimension would result in an error in the VER altitude profile of the PsA? Perhaps you could comment on this in the paper, or even better see if the altitude profile of the background could be determined from the “off” pulsating periods (although I understand this may be very challenging).

Sect 3.1: Why is the error in the northwest different to the rest of the edge of the patch? On line 129 you say that part of the reconstruction from the observed images is expected to be underestimated, but does the error depend on the patch location and size? i.e. if you repeated the reconstruction from pseudo images with the patch in a different location, would the horizontal distribution of error change?

Fig 4: How were the errors in Figures 4d and 4f determined? These are different to the errors in Figure 2.

Line 149: “residual squared sum” should be “sum of the squares of the residuals”.

Line 148: I believe Movie S1 should be Movie A1, but if not please can you add a link or reference.

Line 158: "see Appendix" should be "see Appendix B".

Line 175: It took me a few moments to understand your point here. I think what you are saying is that the time-dependent continuity equation must be solved to determine the electron density, it cannot be determined instantaneously from the VER (which I agree with). I suggest rewording the last few sentences of this paragraph to make it clearer, probably removing "time derivative term" in favor of some other wording. Also I suggest adding the word "even" on line 174 - "... to some extent even after the auroral emission intensity decreased..."

I don't think Appendix A is mentioned in the main text, but probably it should be, I guess in section 3.3.

Please note that the filename for Movie A1 is confusingly Movie S1 – probably they are in fact the same thing?

Line 206: "residual squared sum" should be "sum of the squares of the residuals".