Geosci. Instrum. Method. Data Syst. Discuss., 2, C292–C295, 2012
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Geoscientific Instrumentation Methods and Data Systems
Discussions

Interactive comment on "A new automatic method for estimating the peak auroral emission height from all-sky camera images" *by* D. K. Whiter et al.

Anonymous Referee #2

Received and published: 29 November 2012

__General comments__ This is an interesting paper that presents a novel technique for estimating auroral arc height. This new technique is compared to another approach using synthetic data generated from a model of a single arc with a range of orientations and structuring. Results clearly show that the new technique has significantly lower bias than the other approach. However, the new technique has much larger variance. One possible source (orientation) of variance is considered briefly, but a more extensive examination seems appropriate. This study is a useful contribution to auroral studies, although it remains to be seen how effective it will be for more complicated cases, such as multiple arcs.

The manuscript is well written with appropriate use of figures. It provides a useful review of the literature.

Comments about specific issues are given below.

__Abstract__ This technique has only been demonstrated to be "fully automatic" on single arcs, which should be emphasised at appropriate points throughout this paper (including the abstract). Phrases like "more suitable" and "less consistent" should be replaced with precise statements using terms such as "bias" and "variance". This might help clarify why "it would be advantageous to apply both methods".

__Introduction__ Typo: 555.7 nm -> 557.7 nm

__Instrumentation__ "several all-sky cameras" <- how many exactly? "narrow passband" <- 1 nm? Are background (non-auroral) images collected? What are typical integration times?

__Previous work__ It is stated here that "The new method does not give information about the variation in height along an arc". Actually, it seems to provide estimated height profiles at multiple locations along the arc, but then averages away all this information. This may not be critical for synthetic data corresponding to a single height, but is likely to be important for real arcs. Even for synthetic data it seems likely that the set of profiles could be used, for example, to identify and remove outliers.

It is not obvious that "The new method presented in this work measures the height of peak emission". Estimates do seem to be centered around the peak height. However, for the nearly symmetric height profile used here the mean and peak heights are effectively indistinguishable. It would be interesting to try a more skewed profile (or multiple peaks) in order to determine what this technique is responding to.

__Section 4.2__ The description of method#2 could be made more clear. I would suggest starting with the concept of mapping a very thin arc onto a single field line, followed by a discussion of how outcomes will differ for the correct choice versus other footprints. This would help motivate the use of tests 1-3 and provide a better foundation for understanding how/why this method can fail. It would also be informative to show

how the method responds to increasingly thicker arcs, as this may be an important source of variance.

The next step would be to introduce the use of multiple randomly selected field lines. In that discussion you should consider using the word ‘set‘ or ‘selection‘ rather than ‘grid‘ which implies a certain degree of regularity. It would also be helpful to briefly discuss *why* to choose random over regular sampling. Using a regular grid (at least for the first pass) would allow pre-calculation of a large number of field line traces. This could significantly reduce computation time when analyzing large numbers of images.

While it does seem reasonable to select field lines from "the brightest feature within the overlapping portions of the images" this could be a source of bias towards lower altitudes, and deserves some discussion.

If the "clustering algorithm" is well known then provide a reference, otherwise provide a brief explanation.

For test#3 the phrase "centres of mass" should probably be replaced with something like "luminosity height profile average".

Presumably the final step for figure#2 of "averaging together the altitude profiles for all [good] field lines" is used for all subsequent analysis and discussion. If so, I would strongly suggest that the authors explore the variance around that average. At the very least this should provide a useful estimate of noise or uncertainty. It could motivate the introduction of additional tests to reject profiles that are significant outliers. It might also provide information about systematic height variation along the arc. Obviously there should be none for the synthetic data, but it would be reassuring to check.

__Section 5__ The authors clearly state here that synthetic data are constructed using a single arc with midpoint located midway between the two sites. They do consider a range of different lengths, widths, angles, and "bendiness". It appears that exactly the same (nearly symmetric) height profile is used for all cases.

Although the range of explored parameters is admirable, I can’t help but wonder what the effect would be of moving arcs north/south or vertically, It would be interesting to explore what these changes would do to the bias and variance of methods 1&2. Note that we might expect systematic effects given the results obtained by Romick and Belon 1967a. The effect of varying height profiles is also worth considering, as the one used for this study is nearly symmetric, with the mean very similar to the peak. Using a skewed height profile would test whether the analysis is actually responding to peak or mean brightness.

__Results__ Method#1 has lower variance and higher bias than method#2. If the bias is either constant or has a known dependence on geometry then it can be subtracted to produce a method#1a that has lower bias and lower variance than method#2. The authors need to do (at least) one of three things: 1) show that the bias in method#1 is so complicated as to be uncorrectable 2) reduce the variance in method#2 3) do not claim that method#2 is always superior to method#1 There are many applications where a constant 2km bias would be less troubling than a >5km uncertainty.

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 2, 893, 2012.