

Review of manuscript “Application of Generalized – Aurora Computed Tomography to the EISCAT_3D project” submitted by Tanaka et al. to Ann. Geophys.

This paper investigates the use of the Generalised Aurora Computed Tomography (G-ACT) method applied to auroral image data from the ALIS network and ionospheric electron densities measured by the upcoming EISCAT_3D radar. The results are compared to similar tomographic methods applied to only one of the two instruments. The results show that G-ACT can reconstruct the volumetric electron density, and precipitation characteristics, at higher resolution than using either instrument alone. This work is important to make efficient use of EISCAT_3D as soon as data becomes available.

Overall the paper is clear and well written, and I don't have any major comments. The main area where I think the paper could be improved is in the explanation of the G-ACT method. Although I realise this is already published in earlier papers, I think it would help readers to make the explanation a little bit clearer. I do not believe this will require any major changes, but just some improvements to the language. A figure or diagram graphically illustrating the steps of the method would also help I think, if possible. I've also listed some minor comments below, mainly minor language corrections, although there are probably other very minor things I've missed which can be fixed in copy editing.

Moderate comments

I follow most of the method, but am not sure I have a correct understanding of the difference between \mathbf{d}^{\sim} and \mathbf{d} . At the end of 2.3 it says the finally obtained modelled data are shown as \mathbf{d}^{\sim} and \mathbf{g}^{\sim} . Are they the same as \mathbf{d} and \mathbf{g} , but with noise added? If so this could be more explicitly stated.

The description of the inversion from line 187 onwards could be explained more clearly. I think the main issue is the words “as shown below:” on line 187 – does that refer to equation 13, or all of section 3 after line 187? I suggest adding some words before equation 13 to explain what the equation is for, and/or reordering the description. Perhaps you could add a flow chart showing all of the steps for maximising equation 12, to help the reader to understand?

The study found that ACT underestimates the electron density and electron flux in this case. Could you comment in the discussion on why that might be? Is it expected to be a common situation, or would the density/flux be overestimated just as often?

Minor comments

Is there a reason why you use x for the approximately north-south direction and y for the approximately east-west direction? It would be natural to me to name the directions the other way around, and then the axes in figure 3a would be more conventional.

Line 40 is missing a closing parenthesis).

Line 48/49: “It can measure... even though *they* can detect...” - This sentence mixes singular “it” (an optical imager) with plural “they”, so needs fixing.

Line 62: I believe the set of authors is not identical between the submitted paper and the papers cited on this line, and for clarity I suggest rewording to remove the use of “we”, e.g. “Aso et al., 2008 and Tanaka et al., 2011 extended the ACT method to generalized ACT (G-ACT).”

Line 81: Here (and other places) “field of views” should be “fields of view”. Also “each instrument’s field of views” should be “the instruments’ fields of view” (other wordings possible but the current wording is not quite correct).

Line 93: missing unit “pixels” after 256 x 256.

Line 105: “size” should be plural “sizes”.

Line 168: I think you are adding Gaussian noise to the auroral images, but I don’t think this is explicitly stated, and should be.

Figure 5: Did you try plotting this with a log scale for the color axis? It might show the electron flux between the arcs produced by the ACT method more clearly.

Line 217: “better improved” could be “more accurate”.

Line 241: I suggest “especially” instead of “significantly” (last word of the line).

Line 271: “the both two arcs” should just be “both arcs”.

Line 318: Could you comment on how the radar temporal resolution (scan time over all beams) compares to the optical exposure time? Is it relevant?

Line 330: “increasing electron density” should be “the electron density increases”.