This manuscript demonstrates via numerical simulation the in-beam interferometric imaging observations of ionospheric fine-scale structures using the EISCAT_3D radar, which is currently under construction in northern Fennoscandia and will be operational in the near future. The authors created ionospheric parameters by simulating the Kelvin-Helmholtz instability with the GEMINI model and converted them to incoherent scatter radar spectra with the ISRSpectrum package. The simulated radar data were then created by calculating interferometry measurements and adding normally distributed noise to them. The inversion was performed by Singular Value Decomposition (SVD) with Tikhonov regularization. This manuscript is useful to readers because it carefully describes the background of in-beam interferometric imaging observations, including many assumptions, and evaluates the performance of this method quantitatively. In addition, the authors provide information on computation time and consider future real-time data processing, which is important for the actual radar observations. Therefore, I believe this manuscript will be accepted for publication in Annales Geophysicae after some revisions.

Moderate comments:

1. Subsection 3.3: As far as I understand this subsection, the signal transmitted from the main panels is the far-field and the signal received by the outlier arrays is the radiative near-field. However, I think the description in this subsection may be somewhat confusing to the readers. Thus, I suggest that the authors explain at the beginning of the subsection the three types of electromagnetic fields, i.e., the far-field, radiative near-field, and reactive near-field, as well as a summary of this subsection.
2. In my opinion, the optimal value of the regularization parameter (α) cannot be

determined from SNR only, but should be tuned according to the type, spatial structure, and spatial scale of target phenomenon. If that is correct, it is difficult to predetermine α and time-consuming to determine the optimal value of α dynamically. Do authors have any ideas on how to determine it?

Minor comments:

1. Figure 1: The authors should explain what *u* and *v* mean in the caption.
2. Line 201: What does "N" mean? Is it the number of antenna panels?
   If so, is it N(N-1)/2 instead of N(N+1)/2?
3. Line 225: What are d_1 and d_2 the distances from? From the scattering point (x,y)?
4. Line 290: I think that α in Equation (9) is a mistake for α^2, or α^2 in Equation (7) is a mistake for α. Please check them.
5. Line 327: "moving to the right along the columns". → along the rows?
6. Line 328: "moving down along the rows". → along the columns?
7. Line 388-389 (after "for example"): I recommend that the authors add several reference papers for these various ionospheric phenomena.