Feasibility of inversion analysis based on the generalized aurora computed tomography

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The generalized aurora computed tomography (CT) is a method to reconstruct differential flux of incident auroral electrons from multimodal data, such as auroral monochromatic images, electron density profile in the ionosphere, and cosmic noise absorption (CNA), simultaneously observed with the Swedish ALIS (Auroral Large Imaging System) cameras, the EISCAT radar, and the imaging riometer at Kilpisjarvi. The purpose of this study is to evaluate the feasibility of the generalized aurora CT by numerical simulation.

Assuming the differential flux of the incident electrons at 300 km over the EISCAT radar site, we solved the forward problem and obtained the auroral images, electron density profile in the ionosphere, and CNA. The differential flux of the incident electrons was reconstructed from the simulated observational data. The inversion analysis is based on the constrained least squares method. The hyper-parameters corresponding to weight of each data were determined by the cross-validation method. First, the reconstruction was performed using only auroral images. In addition, we examined a combination of the auroral images and the other data or constraints; (a) spatial smoothness constraint of electron flux, (b) electron density profile from the EISCAT radar, (c) nonnegative constraint of electron flux, and (d) CNA from the Kilpisjarvi imaging riometer. The results are summarized as follows: (1) This method is capable of reconstructing the total energy flux and the characteristic energy of incident electrons. (2) The spatial smoothness constraint was not always useful for the reconstruction. (3) The differential flux of incident electrons over the EISCAT radar was improved by the use of the electron density profile. (4) The nonnegative constraints improved the noise of differential flux in the weak auroral region.