Effects of static electric fields and Alfvén waves on Joule heating in the cusp

*Tomokazu Oigawa[1], Hiroyuki Shinagawa[2], Satoshi Taguchi[1]

1. Department of Geophysics, Graduate School of Science, Kyoto University, 2. National Institute of Information and Communications Technology

Remarkable enhancements of the thermospheric mass density around the 400-km altitude in the cusp region have been observed by the CHAllenging Minisatellite Payload (CHAMP) satellite. Many modeling studies have been conducted to reproduce the mass density anomaly. Under geomagnetically disturbed conditions, previous studies have partially been successful in reproducing the mass density anomaly, while still facing difficulties in reproducing sufficient mass density enhancements under quiet conditions. In this study, we first employed a high-resolution two-dimensional local model to gain insights into what extent the static electric field and electron precipitation can explain the mass density enhancements. We found that the calculated mass density enhancement is 10% at most, which is significantly smaller than the observations by the CHAMP satellite (33% on average). The results also showed that the neutral-ion drag process suppresses Joule heating and neutral mass density enhancements, as well as the chemical reaction process. In contrast to the previous modeling studies, the model calculation imposing only the static electric field and electron precipitation cannot explain the mass density anomaly. The discrepancy between our modeling result and the satellite observation suggests the existence of additional energy sources. Recent studies have reported that electric field variability by Alfvén waves can play an important role in the neutral response in the auroral region. Alfvén waves are reflected between the *E* layer and the sharp slope of the Alfvén velocity above the *F* layer, and some are finally absorbed. This process is known as the ionospheric Alfvén resonator (IAR). Joule heating rates generated by Alfvén waves are maximized at *F* layer altitudes, with the altitude profile depending on wavelength and frequency. In contrast, static electric fields maximize Joule heating rates at *E* layer altitudes. In this study, we include Alfvén waves in our numerical model, and the impacts on Joule heating are evaluated. We will report the effects of both static electric fields and Alfvén waves on Joule heating using model calculations.

Keywords: mass density anomaly, cusp, Joule heating, Alfvén wave, ionospheric Alfvén resonator, numerical model

