

Ion-neutral collision frequency from EISCAT observations in the polar lower ionosphere during geomagnetic disturbances

OYAMA, Shin-ichiro^{1*}, KURIHARA, Junichi², Brenton J. Watkins³, TSUDA, Takuo¹, TAKAHASHI, Toru¹

¹Solar-Terrestrial Environment Laboratory, Nagoya University, ²Graduate School of Science, Hokkaido University, ³Geophysical Institute, University of Alaska Fairbanks

One of the fundamental processes in the thermosphere-ionosphere coupled system is collision between ions and neutral particles. The collisional process contributes to, for example, ion drag and Joule heating. Ion drag transfers momentum of ions to neutral particles, and may temporally modulate thermospheric dynamics, in particular, at F-region heights. The ion-drag process can also be defined as increasing flow velocity of a bulk motion of neutral gas along the mean ion velocity. Collisions also result in increases of thermal energy of both ions and neutral species. These processes are called frictional heating and Joule heating, which elevate the ion temperature first then the thermospheric temperature. The ion-neutral collision frequency is an essential parameter to represent equations related to the ion drag and frictional/Joule heating. Then the ion-neutral collision frequency was estimated using data from the European Incoherent Scatter (EISCAT) radar at Tromsø, Norway during the Dynamics and Energetics of the Lower Thermosphere in Aurora 2 (DELTA-2) campaign in 2009. Vertical component of the ion velocity in the lower ionosphere (106-135 km) and the ion momentum equation were applied to the calculation. The calculated ion-neutral collision frequency was approximately equivalent to that predicted using modeled density data. However, notable increases were found above 126.8 km during natural ionospheric heating events. An obvious depression in calculated values was also found between 114.6 km and 126.8 km just after cessation of another heating event. This paper discusses contributions of the vertical thermospheric motion to variations of the ion-neutral collision frequency.

Keywords: Ionosphere, Thermosphere, High latitude, ion-neutral collision frequency, EISCAT radar