ROCSAT衛星で観測されたイオン密度とイオン温度の相関関係

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Correlation between ion density and temperature observed by the ROCSAT satellite

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Ion temperature (Ti) is determined by heating through the Coulomb collision with electron, cooling through inelastic collision with neutral species and heat conduction along the magnetic field line. Main heat source for electron is photoelectron produced by solar EUV. Therefore, ion is a relay point between energy of solar EUV and thermosphere. Ti has been considered to correlate with ion density (Ni) positively because energy loss to neutral species is strong; causing that Ti is close to neutral temperature (Tn). Tn generally increases with increase of Ni because Ni increase with increase of solar flux irradiance which leads increase of Tn. In order to energy budget of plasma in the ionosphere, understanding of Ti variation is key point because ion is the relay point from electron to neutral.

We investigated ROCSAT satellite which had a circular orbit at about 630 km from 1999 to 2004. The ROCSAT satellite housed the Ionospheric Plasma and Electrodynamics Instrument (IPEI) and measured Ti and Ni. The solar flux was from medium to maximum during the observation period. Ti shows negative correlation when Ni is lower than $6.3x10^5$ cm-3 and positive correlation when Ni is higher than $6.3x10^5$ around the magnetic dip equator under geomagnetically quiet condition (Kp less than or equal to 2). The Ni-Ti correlation looks U-shape. On the other hand, the Ti is nearly constant in dip Lat=25-15S and 15-25N irrespective of Ni while Ti shows positive correlation with Ni in |dip Lat|higher than 25 deg under Kp less than or equal to 2. The similar results were obtained in any longitudes and seasons. Ti increase with increase of the solar flux irradiance F10.7 with keeping the shape of Ni-Ti. In terms of geomagnetic disturbance, Kp dependence, Ni-Ti correlation is almost the same when Kp is less than 6. When Kp exceeds 6, Ti tends to increase especially in the minimum of the U-shape. Similar latitudinal dependence for electron temperature has been reported in Kakinami et al. [2011].

Distribution of electron/ion density has peaks beside the magnetic dip equator at the satellite altitude while integrated electron density along the magnetic field line has a peak at the magnetic dip equator [Kakinami et al., 2011]. Since electron/ion and ion/neutral collision frequencies at the satellite altitude are not significant compared to the heat conductions along the magnetic field line, the results of latitudinal dependency suggest that integrated ion density is important to determine Ti.

Reference

Kakinami, Y., S. Watanabe, J.-Y. Liu, and N. Balan (2011), Correlation between electron density and temperature in the topside ionosphere, J. Geophys. Res., 116, A12331, doi:10.1029/2011JA016905.