Statistical study of EMIC wave-related electron precipitation at subauroral latitude

Asuka Hirai[1]; Fuminori Tsuchiya[2]; Takahiro Obara[3]; Yasumasa Kasaba[4]; Yuto Katoh[5]; Hiroaki Misawa[6]; Kazuo Shiokawa[7]; Yoshizumi Miyoshi[8]; Satoshi Kurita[8]; Martin Connors[9]
[1] PPARC, Tohoku Univ.; [2] Planet. Plasma Atmos. Res. Cent., Tohoku Univ.; [3] PPARC, Tohoku University; [4] Tohoku Univ.; [5] Dept. Geophys., Grad. Sch. Sci., Tohoku Univ.; [6] PPARC, Tohoku Univ.; [7] ISEE, Nagoya Univ.; [8] ISEE, Nagoya Univ.; [9] Centre for Science, Athabasca Univ.

Electromagnetic ion cyclotron (EMIC) waves are excited near the equatorial plane by anisotropic ring current ions. They mainly propagate along magnetic field lines and are observed on the ground as Pc1 geomagnetic pulsations. Pitch angle scattering of relativistic electrons by interaction with EMIC waves has been considered as one of the mechanisms to cause the loss of the outer radiation belt electrons. However, there are still questions left about the contribution of EMIC waves to the overall loss of radiation belt electrons and possible conditions favorable to pitch angle scattering. Here, we performed the statistical study about EMIC waves and associated electron precipitation from November 2016 to June 2018. We used a ground-based magnetometer and man-made VLF radio wave receiver installed at Athabasca, Canada. VLF radio waves propagate in the earth-ionosphere wave guide and are sensitive to ionization changes in lower ionosphere due to precipitating electrons with energies higher than 100 keV. We identified EMIC wave events with two different ways: manual inspection and an automatic detection algorithm based on Bortnik et al. (2007). At first, we manually detected EMIC wave events and electron precipitation that occurred simultaneously with the EMIC wave activity. In the period of analysis, simultaneous observation of the magnetometer and VLF radio waves were available for 286 days and we identified 162 EMIC wave events. We found that 19 of 162 EMIC wave events were clearly associated with electron precipitation (12%). Electron precipitation occurred more often on the duskside than dawnside. Also, we found that the preferential condition for electron precipitation is the main phase of geomagnetic storms.

In order to investigate which properties in EMIC waves correlate with electron precipitation, we used an automatic wave detection algorithm proposed by Bortnik et al. (2007). This technique allows us to remove incoherent noise signal from wave spectra, identify only polarized EMIC waves whose intensity is well above the background noise level, and derive quantitative spectrum information of the EMIC wave, such as wave frequency, bandwidth, and intensity. We applied this technique to the induction magnetometer data at Athabasca and confirmed that it worked successfully as designed. In addition, we found that this was also useful to distinguish broad band ELF wave events (e.g. Pi1B) from EMIC wave events. We will show statistical properties of EMIC waves derived from the automatic detection technique and their relation with the electron precipitation.