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Loss of high-energy electrons into the atmosphere during the magnetic storm and sub-storm

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Man-made VLF/LF radio wave observation at Ny-Alesund in Norway was used to study precipitations of high-energy (>100keV) electrons into the atmosphere during the geomagnetic storm and substorm. The observation system was installed at the NIPR station on March 2010 and measures transmitter signals operated at UK (60.0 kHz) and Germany (77.5 kHz). During three magnetic storms occurred on 5 Apr., 2 May, and 29 May, strong phase variations in the received signals were detected. Comparison of the phase change with the precipitation electron flux observed by the MEPED instrument onboard the NOAA/POSE satellites above the LF wave propagation paths showed the good correlation between them. It is expected that plasma waves excited in the magnetosphere are responsible for the energetic electron precipitation into the atmosphere through the pitch angle scattering. Therefore, local time distribution of the plasma wave would cause the local time dependence of the electron precipitation region. To investigate this process, local time distribution of the electron precipitation events was examined by using the LF wave observation and was compared with the substorm onset timing. At present, the substorm onset timing was determined by the Kakioka Pi2 and the positive bay observed by low-latitude magnetometers located near the local midnight. In the morning and noon sectors, it is found that onset of the precipitation is delayed ten to several tens minutes from the substorm onset. The delay time is consistent with the drift time of energetic electron with energy of >100 keV. On the other hand, the electron precipitation onset found in the dusk sector occurred at or just before the substorm onset. This implies that different types of plasma waves are responsible for the dependence of the electron precipitation characteristics on local time.