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Characteristics of the Corotating Aurora Observed at Poker Flat (Extended Abstract)

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As part of the CRL-UAF cooperative middle atmosphere project, monochromatic imaging observations of aurora and airglow have been carried out at Poker Flat (65.1°N, 212.6′E ; 65.6 MLAT : MLT=UT-11 hours) since October 2000. Monochromatic images are obtained every 5 minutes using two all-sky imagers at 10 emission lines, i.e., $H\beta$ (486.1 nm), OI (557.7 nm), N2+(427.8 nm), background (572 nm), Na (589 nm), $H\beta$ background (481 nm), OI (630.0 nm), OI (844.6 nm), OI (777.4 nm), and OI (630 nm).

From these data, a new type of aurora which is stationary as keeping its patch structure was found in the magnetic evening sector by Kubota *et al.*, [2002]. These characteristics suggest that this type of aurora is corotating with the Earth. Figure 1 shows a corotating aurora event observed on October 27, 2000. It is apparent that their spatial structures and locations remained stationary for the time interval from 03 : 00 to 05 : 00 UT, and that after 05 : 00 UT the aurora drifted westward and disappeared in the field of view of the imager at about 7 : 00 UT. The aim of this study is to elucidate why the auroras corotate for a long period or occasionally move slowly as keeping their structures. We have investigated the characteristics of 29 corotating aurora events

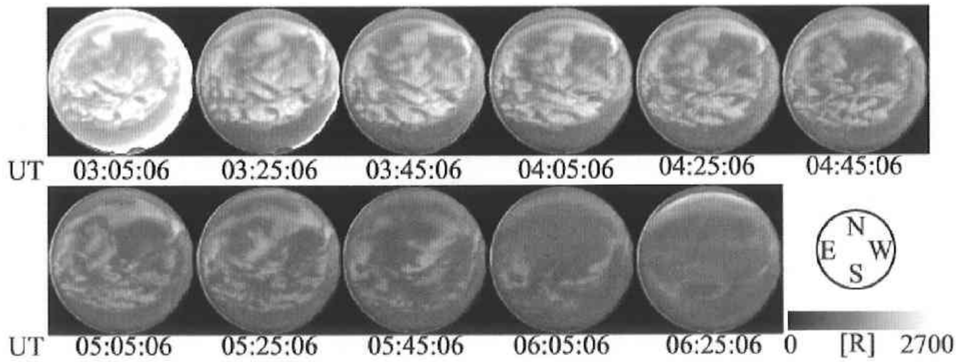

Fig. 1. An example of the corotating aurora observed on October 27, 2000. Images at OI 557.7-nm every 20 minutes are shown for the time interval 03 : 05–06 : 25 UT. Exposure time of each image is 3 seconds. The geomagnetic directions of images are indicated next to the last image. A gray scale indicates the emission intensity for the range 0–2700 R. Bright areas near the southwest edge before 03 : 45 UT is due to evening twilight.

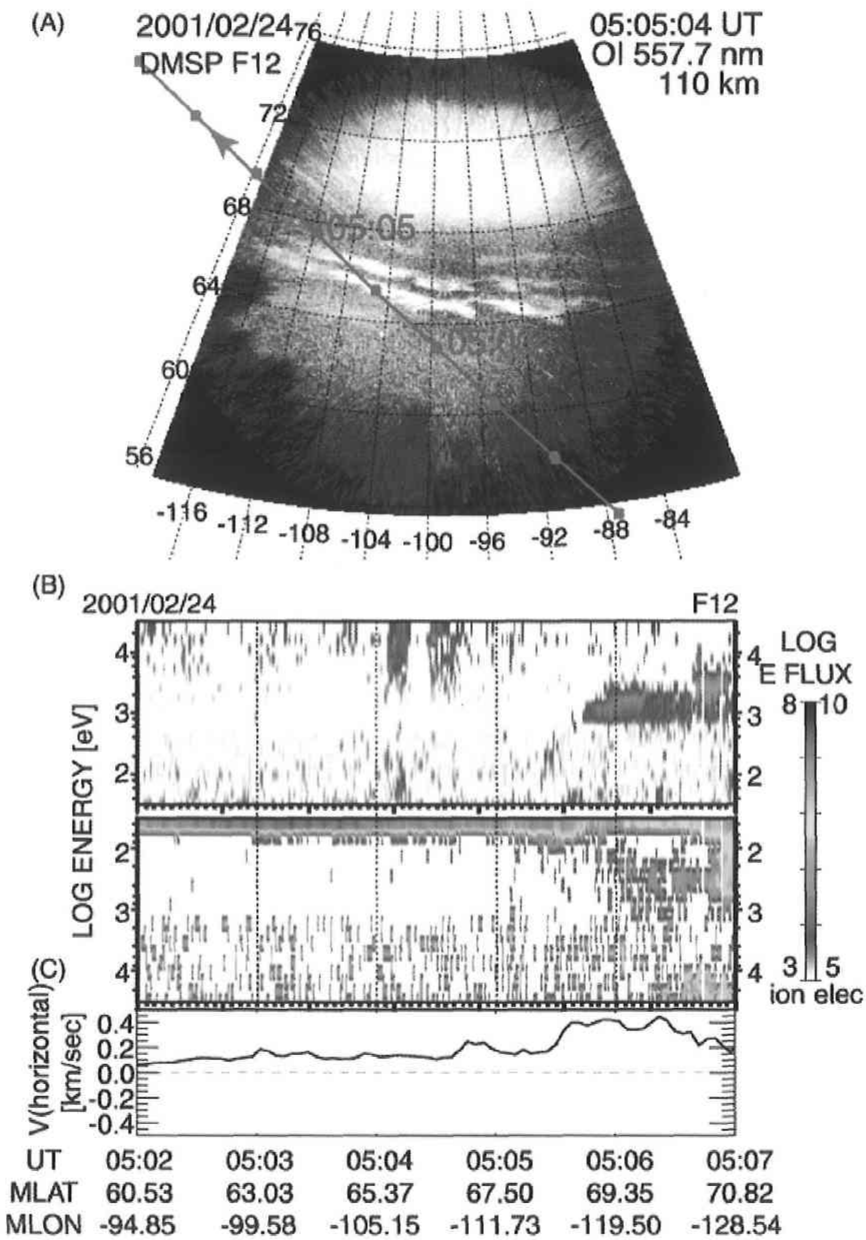

Fig. 2. Comparison between the structures of corotating aurora mapped to the geomagnetic coordinate system and the regions of precipitating electrons and ions obtained by the DMSP satellite on February 24, 2001. The foot print of the DMSP satellite is shown by a red line from 05 : 00 to 05 : 08 UT in the top panel (A). Energy spectra of precipitating electron and ion data obtained by the DMSP/Precipitating Electron and Ion Spectrometer are shown in the middle panel (B), while drift velocity obtained by the DMSP/Ion Drift Meter in displayed in the bottom panel (C) for the interval from 05 : 02 to 05 : 07 UT.

identified in the period from October 2000 to April 2002 in detail.

While imaging observation covers from 14 to 07 MLT, this type of aurora is observed only in the dusk to midnight sector (14-03 MLT), mainly in the evening sector (~25%). When the corotating aurora is observed, no substorms and no magnetic storms occur and the values of Kp range from 0 to 3+, suggesting that this type of aurora occurs on geomagnetic quiet conditions. The occurrences of this type of aurora are identified at emission lines, OI 557.7 nm, N2+ 427.8 and OI 844.6 nm, but not at OI 630.0 nm and $H\beta$ 486.1 nm. This feature suggests that this type of aurora is excited by precipitating hard electrons. Figure 2 shows a satellite-ground conjugation of a typical corotating aurora event at 05 : 04 UT on February 24, 2001. Displayed are a geomagnetically mapped

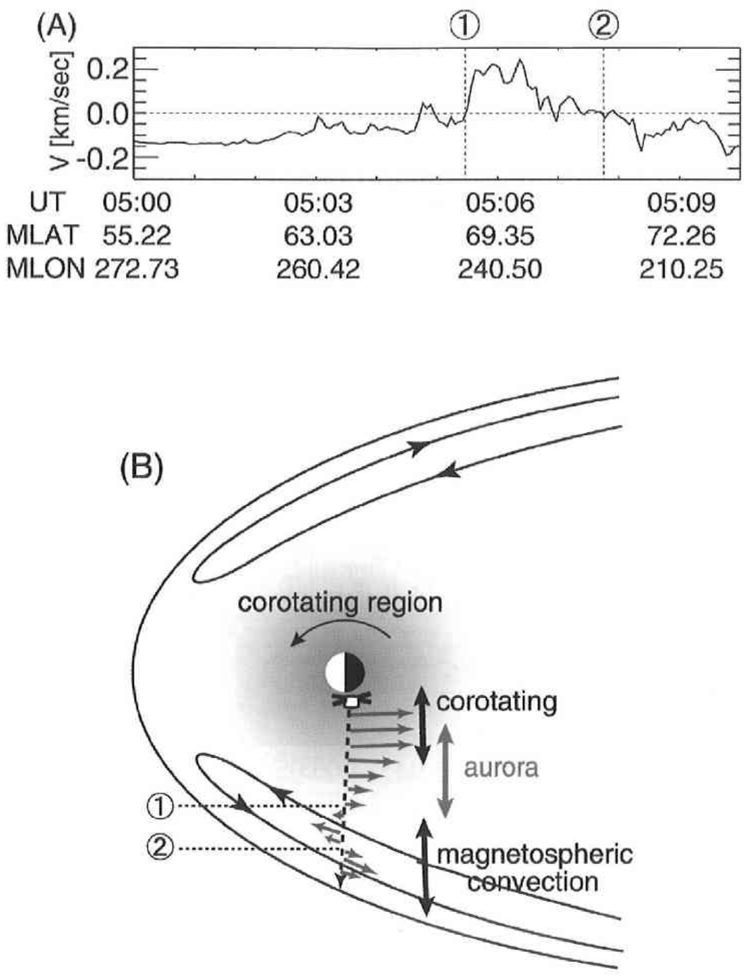

Fig. 3. Drift velocity of corotating aurora and its spatial structure in the magnetosphere for the February 24, 2001 event. Drift velocity calculated from the DMSP/IDM data from 05 : 00 to 05 : 10 UT is shown in the top panel (A). The drift velocity and the corotating aurora region on the equatorial plane are shown in the bottom panel (B).

image of aurora in the top panel (A), energy spectra of precipitating electrons and ions obtained by the DMSP/Precipitating Electron and Ion Spectrometer (SSJ) in the middle two panels (B) and drift velocity obtained by the DMSP/Ion Drift Meter (IDM) in the bottom panel (C). A red line in the top panel (A) shows the DMSP F12 foot prints from 05 : 00 to 05 : 08 UT. The middle two panels (B) show that the precipitating electrons with energies above few keV are the source of this aurora (see the times between 05 : 04 UT and 05 : 05 UT), and that precipitating ions are absent in this aurora. We investigated the particle data of DMSP/F12-14 satellites passing above 20 corotating aurora events, and found that all of them had the same characteristics. The values of drift velocity (V horizontal) in the bottom panel (C) are the values after the corotation velocity has been subtracted. Positive values show sunward flows perpendicular to the satellite trajectory (mostly westward). It is found that the drift velocity is slightly positive which means the drift velocity is slightly less than the corotating velocity at Poker Flat (~2 km/sec). Figure 3 shows the drift velocity in the magnetosphere on February 24, 2001 in the top panel (A) and the source region of the corotating aurora on the equatorial plane in the magnetosphere in the bottom panel (B). Note that the values of drift velocity in the top panel (A) represented the drift velocity in the magnetosphere because these values are after the corotation velocity at Poker Flat has been added. The drift velocity in the panel (A) increases from 05 : 03 UT (①), and change to positive between 05 : 05 to 05 : 06 UT, and then change to negative from about 05 : 08 UT (②). Note that the times ① and ② in the panel (A) correspond to the locations ① and ② in the panel (B). It is apparent that the corotating aurora is mapped to the transition region between the corotating

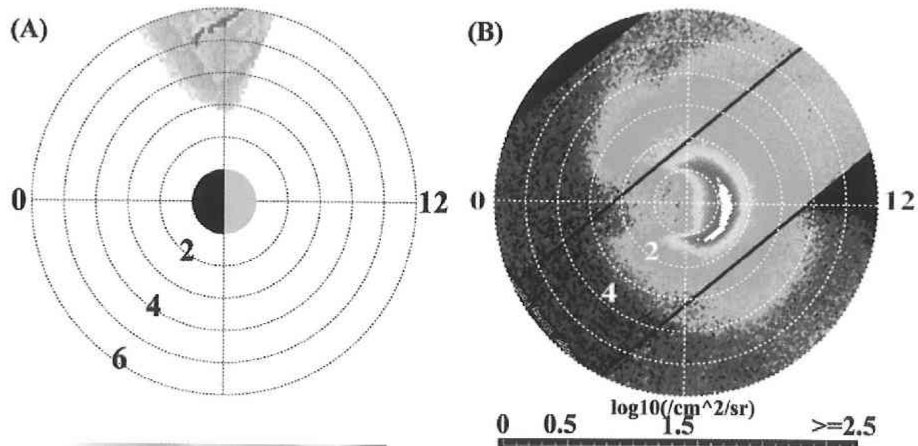

Fig. 4. Relationship between the corotating aurora mapped to the equatorial plane and the structure of the plasmasphere obtained by the IMAGE/EUV at 05 : 35 UT on February 24, 2001. The corotating aurora image mapped to the equatorial plane using the Tsyganenko'96 model is shown in the right panel (A), while the IMAGE/EUV image is shown in the left panel (B). The color scales indicate the intensity of aurora and the plasma density. The nightside is left and the dayside is right, and numbers on circles represent L values.

plasma region (plasmasphere) and the convection region in the outer magnetosphere. We investigated 13 events and all of them had the same characteristics.

Using concurrent observation data of IMAGE/EUV (Extreme Ultraviolet Imager), we have examined the relationship between the corotating aurora region mapped to the magnetospheric equatorial plane using the Tsyganenko '96 model and the structure of the plasmasphere for three events. Figure 4 shows such a relationship for on event observed on February 24, 2001. The aurora image mapped to the equatorial plane at 05 : 35 UT is shown in the left panel (A), while the IMAGE/EUV image at the same time is shown in the right panel (B). Note that the nightside is left and the dayside is right, and that numbers on circles represent L values in both images. It is found that the aurora is mapped to the region at $L>5$ in the dusk sector. This region on the EUV image is a region with a plasma density of $\sim 10^2/cm^2$ outside the ordinary plasmapause. It is concluded that the corotating aurora occurs in the region like the plasma tail in the EUV image.

Studies on the corotating aurora would give us a clue to investigate the coupling processes between the polar magnetosphere and the plasmasphere. If this the coupling mechanisms are clarified, this aurora would be used as a useful method for monitoring the temporal and spatial variations of the transition region between the corotating plasma region and the magnetospheric convection region in the magnetophere as well as the fine structures of the plasmasphere near the plasmapause. Further data analysis using more spacecraft and ground-based data will be performed to finally elucidate the generation mechanism of this type of aurora.

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