

Nightside Auroral Activity and the Midtail Total Pressure: A Morphological Study

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By using auroral image data from Polar and magnetic field and plasma data from Geotail, the relationship between nightside auroral

activity and the midtail total pressure is examined. It is found that there are three different patterns: (1) An auroral bulge with a latitudinal width less than 10

degrees appears in association with a small (or no) reduction in the midtail total pressure; (2) an auroral bulge grows expansively to 20 degrees in its latitudinal width, accompanied by a rapid decrease in the midtail total pressure; and (3) auroras are activated in a large auroral bulge, while the midtail total pressure sometimes increases or some other times decreases,

although very slowly.

The "unloading" process was introduced originally to explain the simultaneity of the expansion onset of substorms and a sudden

reduction in the magnetotail total pressure. The existence of their one-to-one correspondence, however, has not been confirmed yet, even by using data from the latest measurements. This is probably because both auroral activity and variations in the magnetotail total pressure are too

complex to identify such a particular relationship. It is thereby becoming one of the serious problems in magnetospheric physics that the "unloading" phenomena cannot be defined: Do all auroral activations in the midnight sector result from the unloading process? Are some of them yes, and others no?

In the present study, we inspect auroral images obtained from the Polar satellite on December 10, 1996, and March 3, 1997, to seek for a relationship between large-scale auroral activity in the midnight sector and variations in the midtail total pressure (P_{tot}). It is demonstrated that there are three different patterns in that relationship. (1) An auroral bulge with a latitudinal width less than about 10 degrees appears in association with a small (or no) reduction in the midtail total pressure; the reduction, if any, occurs rather slowly. (2) An auroral bulge grows expansively to about 20 degrees in its latitudinal width in association with a rapid decrease in the midtail total pressure (0.02 nPa/mn). (3)

Auroras are activated in a large auroral bulge. Latitudinally-aligned auroral structures are often seen in the bulge. The midtail total pressure sometimes increases or some other times decreases rather slowly, both in association with high auroral activity.

Auroral activations in these three different patterns have often been equally identified as "substorms" based on ground and spacecraft observations. It is argued that these phenomena should be distinguished from each other when one discusses their physical processes. According to the

conventional definition, the events furnished with a sudden decrease in P_{tot}

and a poleward expansion of the auroral oval are designated as "unloading" events. Hence auroral activity belonging to the pattern (2) can be called unloading events. It is inferred that the events belonging to the patterns (1) and (3) are both caused by activations in the distant tail reconnection.

If this is the case, they are distinguished only by the width of the auroral oval at the time when the event commences, or, in other words, by the history of the auroral oval before the event.