PSEUDOBREAKUPS DURING JANUARY 10, 1997

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Abstract. The January 10, 1997 interplanetary pressure pulse (observed at 0053 UT at Wind) caused a dayside aurora, as seen in Polar Ultraviolet Imager (UVI) data, that propagates tailward and to lower *L*. After the solar wind has propagated ~150 R_e downtail, a substorm pseudobreakup (PB) was detected at 68° N magnetic latitude, at local midnight. The PB dimmed on time scales of minutes and rebrightened 9 min. later. This happened several times in succession. A quasiperiod of approximately 10 min. was noted. The scale size of the PBs was ~200 by 200 km in the ionosphere and there was no evidence of eastward drifts of the electrons causing the auroral brightenings.

1. Introduction

Pseudobreakups (PBs) were first discussed by *Elvey* [1957] and *Akasofu* [1964]. *Akasofu* [1964] associated these phenomena with activation of an arc structure other than the most equatorward one. *Davis and Hallinan* [1976] suggested that these are small local substorms. Since these original works, others have essentially confirmed the viewpoint of *Davis and Hallinan* [1976]. *Sergeev et al.* [1986] and *Koskinen et al.* [1993] have found local "flaring" in the magnetosphere/plasma sheet. *Koskinen et al.* observed an increase in AMPTE energetic particle enhancements (at 8.7 R_e), and a weak wedge-like current in the midnight sector ionosphere. *McPherron* [1991] has noted pi 2 micropulsations and a weak enhancement of the westward electrojet. *Ohtani et al.* [1993] and *Nakamura et al.* [1994] have noted (azimuthally) localized particle injections associated with PBs. *Nakamura et al.* [1994] found that dipolarization, tail current diversion, auroral brightness development and decay, all have time scales of 2-8 min. The scale sizes of the auroral features are several hundred km. All of the above references, as well as *Pulkkinen* [1996] and *Rostoker* [1998], agree that PBs are essentially the same phenomenon as magnetospheric substorms but for some reason the dipolarization, particle injection, and auroral activation are limited in intensity and spatial scale. Numerous arguments are given in the literature: from a lack of magnetotail energy storage, to a strong ionospheric coupling, to an ionosphere with unfavorable conditions (*Kan et al.* [1988]).

The *Lui and Murphree* [1998] substorm model is the only one that considers "localized" instabilities on ~1 R_e scale sizes. If this is a correct mapping from the ionosphere to the magnetosphere, this may be a very good model to start with.

2. Data Analyses

We use the Polar UV imager LBH-Long filter data with ~3-min. resolution. Images are available from the instrument which are interspersed with these. However, they were obtained either at a different filter setting (i.e., at a different UV wavelength) or using a shorter integration period with the same filter and so they are not used in these analyses. The Wind plasma and magnetic field data are used to determine the interplanetary conditions/potential interplanetary control. A 57-station ground array is used to determine equivalent currents.

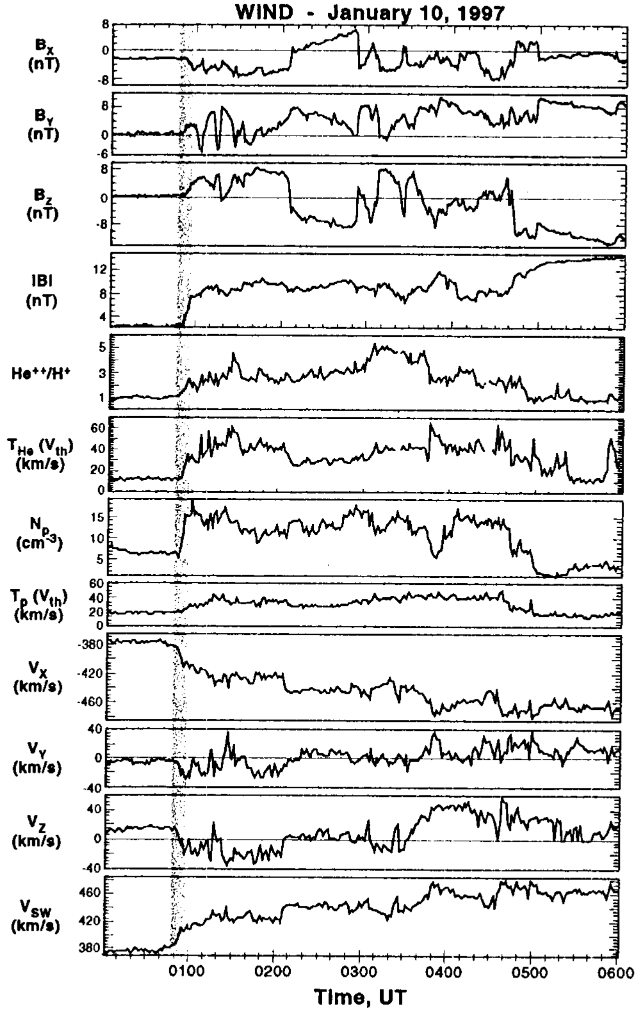

Figure 1. The Wind solar wind magnetic field and plasma data.

3. Results

Figure 1 shows the Wind IMF and plasma data for the first 6 hours of January 10, 1997. A pressure wave occurs at Wind at ~0053 UT (see the gray-shaded region in Figure 1). This can be noted from the sharp jump in magnetic field magnitude, temperature, density, and velocity. B_Z is essentially northward for the following hour. Also, note the approximate 10 min. variations in the IMF B_Y during this hour.

Figure 2 is a sequence of Polar UVI images. The images have a ~3 min. temporal spacing (start of image to start of next image) and are shown in a magnetic local time (MLT) coordinate system with local midnight at the bottom of each panel. The order of the sequence is from the upper left, at 0107:10 UT, increasing in time down and then across. The final image is at the bottom right at 0140:54 UT. The image at 0107 UT shows a brightening of the dayside aurora. The light intensity is substantially greater than in the image 3 min. prior (not shown). The aurora progresses from the noon sector towards dawn and dusk, and also radially inward with increasing time. Compression of the magnetosphere could cause betatron acceleration of pre-existing ring current/ trapped magnetosphere particles, leading to the onset of the loss cone instability.

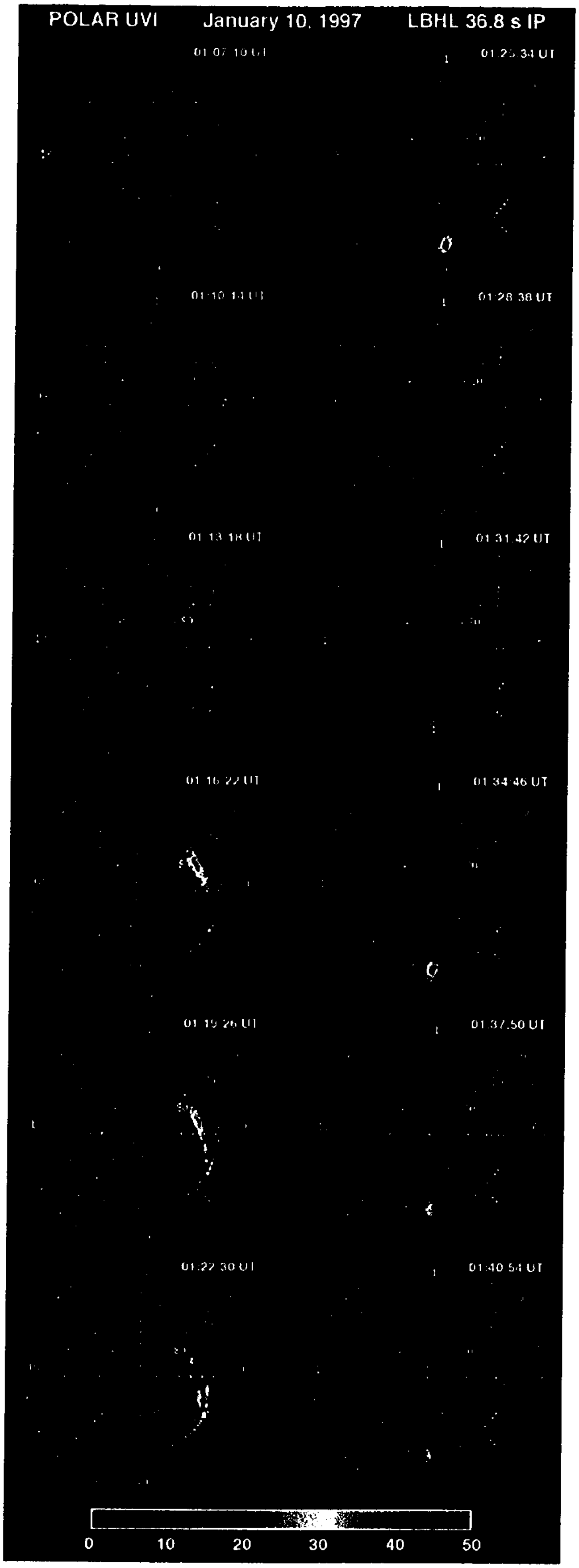

Figure 2. Polar UV auroral images from 0107:10 UT to 0140:54 UT.

Through wave-particle interactions, precipitation into the ionosphere and the aurora would occur. At 0122:30 UT, there is still an auroral gap in the midnight sector. At 0125:34, there is a brightening near local midnight at ~68° latitude. The midnight sector is otherwise quiet. This bright spot decays and rebrightens slightly to the west and at a magnetic latitude of ~69° at 0134:46 UT. It again dims and then rebrightens at 0143:58 UT. The bright spot is then at local midnight at 70° latitude.

Figure 3 shows the equivalent current diagrams for the same intervals as in Figure 2. What is interesting is that there are indications of a vortex current near the PB regions.

Using the elapsed time from the first detection of the pressure wave in the auroral UV images (~0107:10 UT) and the first PB at 0125:34 UT, and the knowledge that the solar wind speed is ~450 km s^{-1}, we calculate that the solar wind has propagated ~75 R_e downstream by the time of first PB appearance in the auroral region ionosphere.

There are two possible mechanisms by which an external signal can propagate into the distant tail. The first is when a magnetosonic/Alfvén wave is generated at the dayside magnetopause by the pressure pulse and then propagates through the Earth's magnetosphere/magnetotail system in the downtail direction. The fastest signal would be a magnetosonic wave propagating in the lobes. This speed is ~1000 km s^{-1} in the tail lobe, but varies greatly with lobe density. A second mechanism is when interplanetary ram and thermal and field pressure squeeze the magnetosphere. *Ho et al.* [1997] have shown this to be the dominant mechanism in the distant tail. This pressure wave travels at the solar wind speed (~450 km s^{-1} in this case).

Using the latter, conservative number, and assuming that the earthward plasma jetting has the approximate same speed, this would imply that the solar wind pressure pulse "triggers" reconnection at about X = -30 to -35 R_e downtail. If there are any internal magnetotail delays in forming current disruptions, bursty bulk flows would place this X-line location closer to the Earth.

4. Conclusions

We have briefly examined the effects of the interplanetary pressure pulse of January 10, 1997. The ram pressure pulse causes dayside auroras which propagate towards nightside and toward lower L. The squeezing of the magnetosphere by interplanetary ram and thermal pressures presumably further enhances the dawnside aurora intensities. When the leading edge of the interplanetary pressure pulse has attained a distance of 65 R_e downstream of the Earth, a small (2° by 2°) pseudobreakup occurs at local midnight at 68° N magnetic latitude. This pseudobreakup repeatedly fades and then brightens again with a quasiperiod of ~10 min. Each time the pseudobreakup occurs at approximately the same place (along the auroral oval), at local midnight. The pseudobreakup quasiperiodicity may be caused by 10 min. IMF B_Y variations (still being investigated). Eventually, this hot spot region drifts to polar latitudes and becomes part of the polar arc which intersects the high latitude region of the auroral oval.

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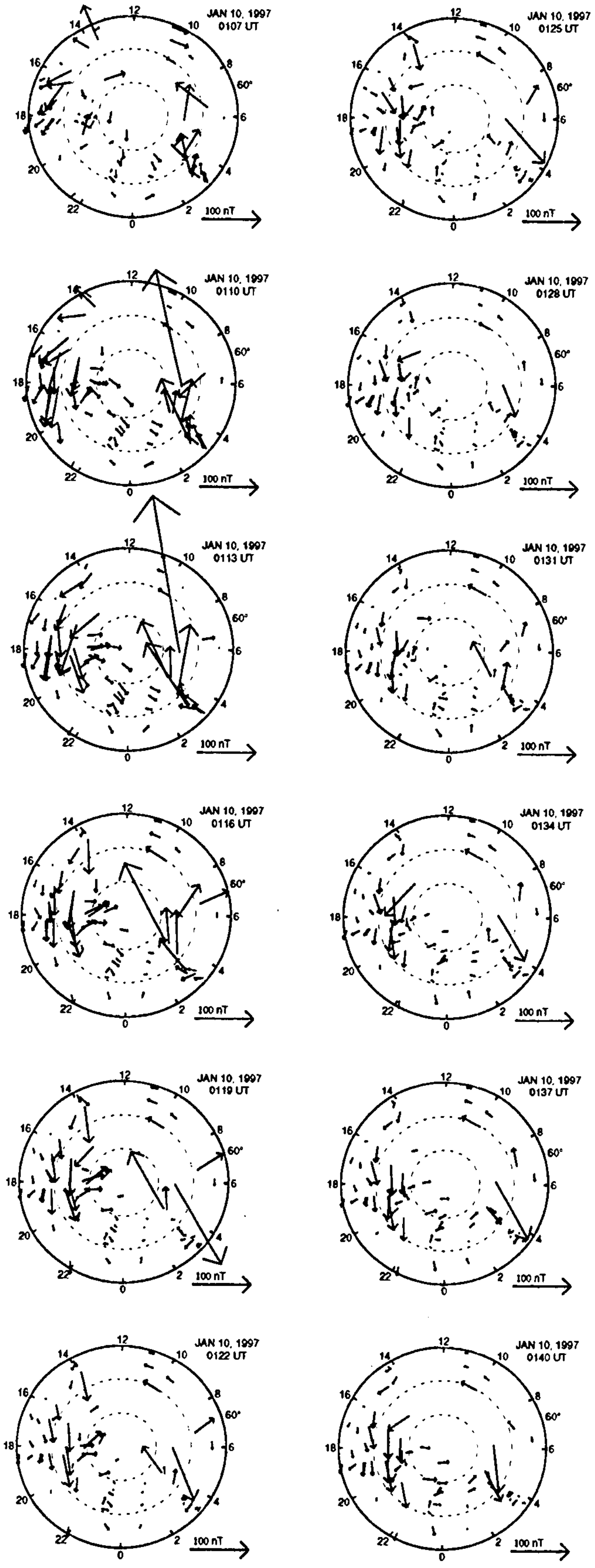

Figure 3. Equivalent current diagrams corresponding to the image times in Figure 2.

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