

ALFVÉN WAVE SIGNATURES IN THE POLAR IONOSPHERE INDUCED BY SOLAR WIND PRESSURE PULSES: A CASE STUDY.

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We study the magnetosphere response to a pressure pulse which hit the magnetosphere at 21:47 UT on March 5th, 1998. The study is based on WIND solar wind data, on ionospheric plasma flow velocities observed by the Stokkseyri radar of the SuperDARN network, and on magnetometer data from Equator-S, the synchronous satellites GOES 8 and GOES 9, the low latitude station Shigaraki and the Greenland networks.

At the time of the pressure pulse, WIND observed an almost constant solar wind speed, the IMF was stable and directed northward and had been so for a long time.

Figure 1 contains data from WIND, GOES 9 and Equator-S from 20:00 to 23:00 UT. The WIND solar wind dynamic pressure (top panel) shows the pressure pulse start at $\sim 20:35$ UT; the pulse then hit the Earth's magnetosphere with a time lag of $\sim 1:15$ (in agreement with the observed solar wind velocity) and converted into an MHD compression seen in the GOES 9 B_z GSM component at $\sim 21:48$ UT and in the Equator-S magnetic field strength at $\sim 21:50$ UT (middle and lower panels).

Figure 2 shows the positions of Equator-S, near the dawn side magnetopause, GOES 8 and GOES 9, close to magnetopause nose, and the approximate locations on Earth of the Shigaraki geomagnetic observatory (geographic coordinates: 34.8° , 136.1°) and of the Greenland networks; the dashed line indicates the magnetopause. The pressure pulse was seen, in sequence, at GOES 9, GOES 8, Shigaraki and Equator-S. By using the observed delays, the propagation speed of the compression in the magnetosphere can be estimated. The time delays and related speeds suggest an orientation of the interplanetary structure front as drawn in Figure 2 (solid line).

Figure 3 shows four successive 2 minutes velocity plots for the Stokkseyri radar together with the D magnetic field component measured at three stations of the Greenland magnetometer array for the time interval 21:40 - 22:10 UT. The three stations are on the same geomagnetic meridian around 40° corrected geomagnetic longitude (20:30 MLT) at 5° interval in latitude; Narsarsuaq (NAQ) is the lower latitude station. The Stokkseyri field of view is just above the Greenland array. In the top panel grey scale, a lighter (darker)

pixel indicates a flow speed towards (away from) the radar. In the left hand plot all velocities point away from the radar, in agreement with the quiet time convection pattern; in the centre-left plot, between 67° and 70° in latitude we observe a speed of ~ 400 m/s towards the radar; this feature then moves to higher latitudes in the centre-right and in the right hand plot. We interpret such a feature as transient convection velocities in the F layer. Correspondingly, the three magnetic field D components in the lower panels all display a clear dip, which appears first at lower and later as higher latitudes and can be interpreted as due to Hall currents carried by electrons lower in the E ionosphere.

We conclude that, owing to the solar wind pressure pulse observed by WIND at 20:35, a compressional wave reached subsequently GOES 9, GOES 8, Equator-S and the equatorial ground stations; later on, it moved beyond the Earth, its speed increasing to 1000-1500 km/s, and hit first inner, then outer magnetic field lines in the tail; as a consequence, their conversion into shear Alfvén waves occurred first on lines mapping to lower then to higher latitudes in the ionosphere; eventually, the Alfvén waves reached the F layer, inducing a local plasma velocity disturbance seen by the Stokkseyri radar, and the E layer, producing Hall currents responsible for the signatures observed by ground magnetometers.

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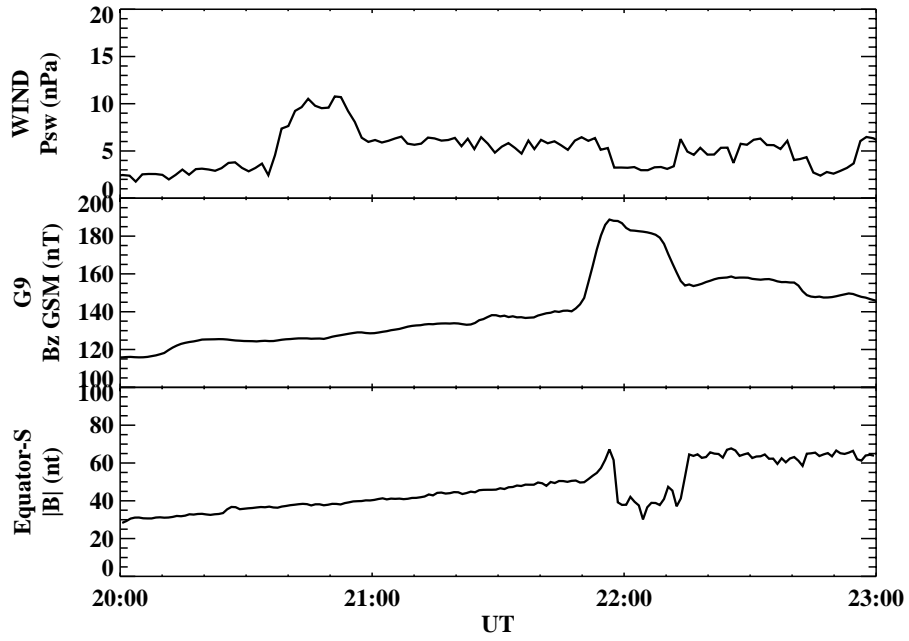


Figure 1: Solar wind dynamic pressure from WIND and magnetic field measurements from GOES 9 and Equator-S.

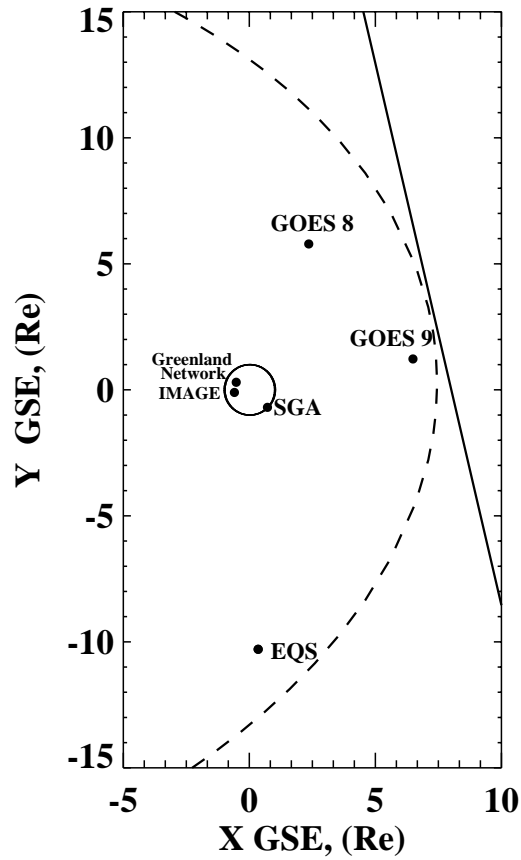


Figure 2: Satellites and ground stations positions for March 5th 1998, 21:55 UT. The dashed line is the magnetopause model from *Fairfield et al.* 1971.

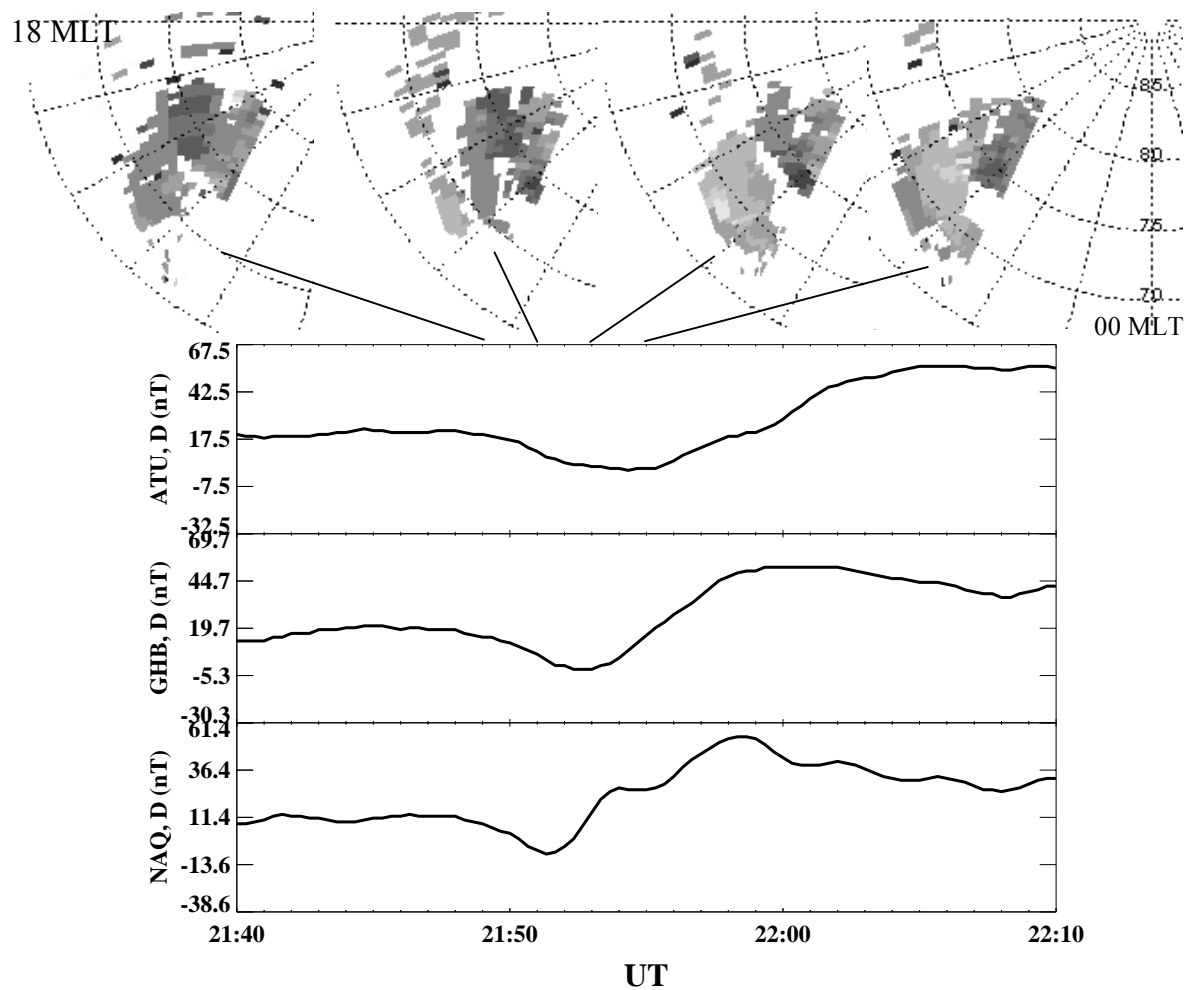


Figure3: Top panel: Stokkseyri 2 min flow speed plots in CGM, centred at 21:49, 21:51, 21:53, 21:55 UT. Lower panels: D component measured at ATU, GHB and NAQ.