Radar and Magnetometer Observations of Pulsations at a Quiet Time

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At the 1999 SuperDARN meeting Walker, Pinnock, Baker, Dudeney and Rash reported on flow bursts occurring on the night side when the solar wind was very quiet.The bursts exceeded 2 km/second in amplitude and were quasiperiodic with period 12 minutes. Figure 1 shows an example of the merge data from the Sanae and Halley SHARE radars during the event. IMF conditions were very quiet for 36 hours before the event They are shown in Figure 2. Wind speed was steady at 300 km/hr. The particle density was about 15 per cc. The total *B* was always less than 3nT with B_z < 2nT and northward throughout.

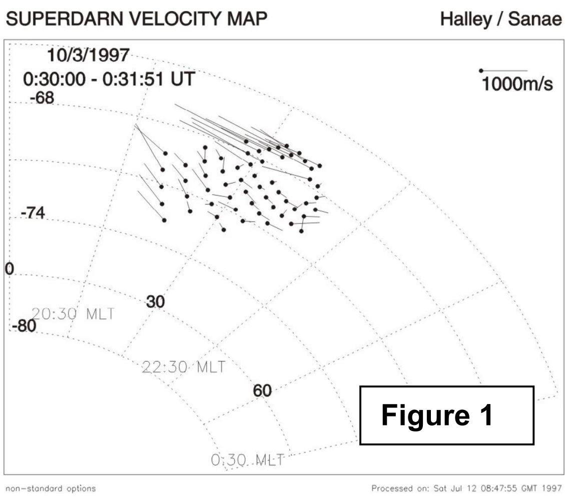

Figure 1

In this paper we study the pulsation activity on the night side associated with these flow bursts. First the x and y velocity components are extracted from merged radar data from Sanae and Halley and averaged in boxes which are 1° wide in magnetic latitude and 8° wide in magnetic longitude The data are filtered and Fourier analysed. The result is shown in Figure 3 which shows the time series of the *x* and *y* components of the convection velocity averaged as described. At the top of each panel is the filtered time series. Below this is the spectrum and, at the bottom, the filter transfer function. There are strong peaks in the spectrum. In particular the *y* component in the latitude band 67º to 68º has a strong peak at 1.5mHz corresponding to the 12 minute flow bursts.

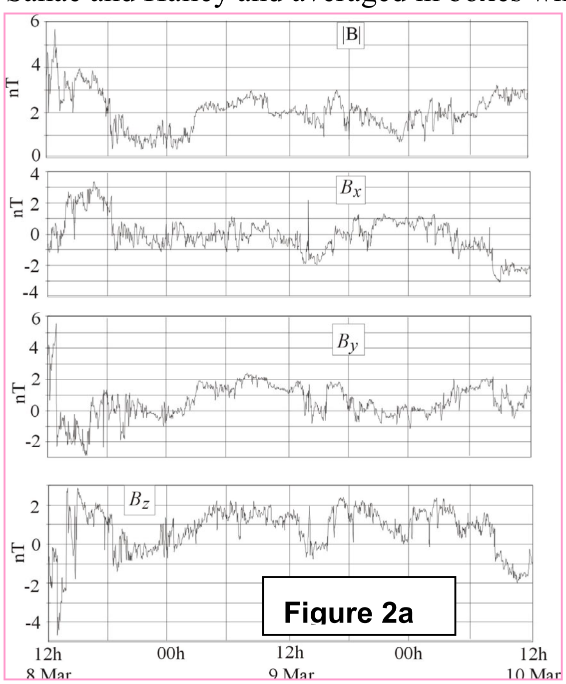

Figure 2a

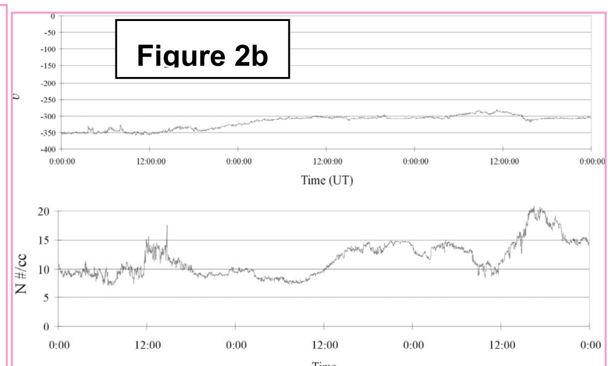

Figure 2b

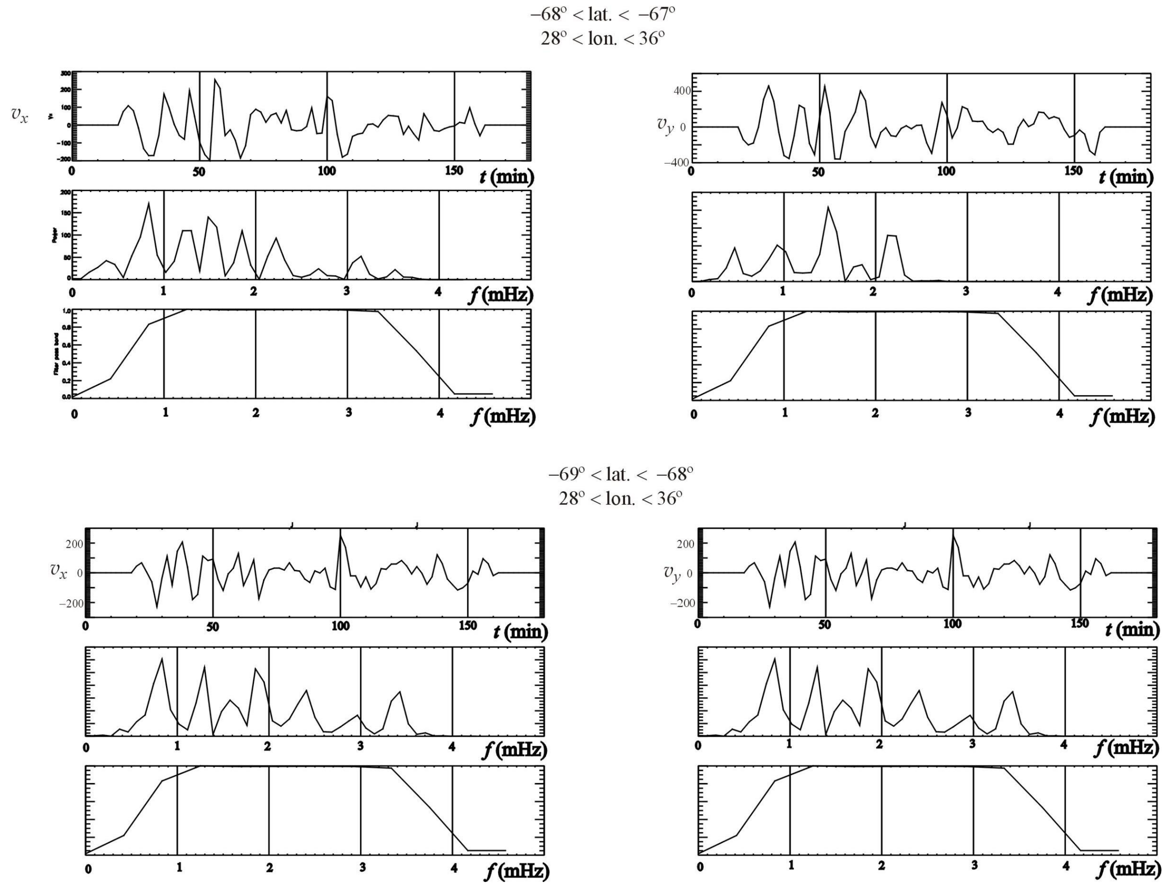

Figure 3

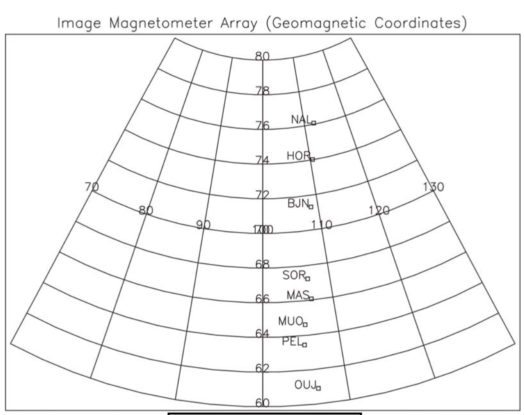

Figure 4

The IMAGE magnetometer chain was located in the early morning sector. The locations of a number of IMAGE stations are shown in Figure 4. They are well aligned with magnetic longitude. Not all of these stations are used in this study. During the time of the flow bursts the IMAGE magnetometers showed strong pulsation activity. This is illustrated in Figure 5. The x and y components of the magnetic field are shown for a period running for 8 hours from 20:00UT on 9 March. Also shown is the section of the radar data aligned with the magnetic field data in time. Note that the x component of the drift velocity ia aligned with the y component of the magnetic field and *vice versa*. This is to take account of the 90 degree rotation that boundary conditions at the ionosphere impose on the signal.

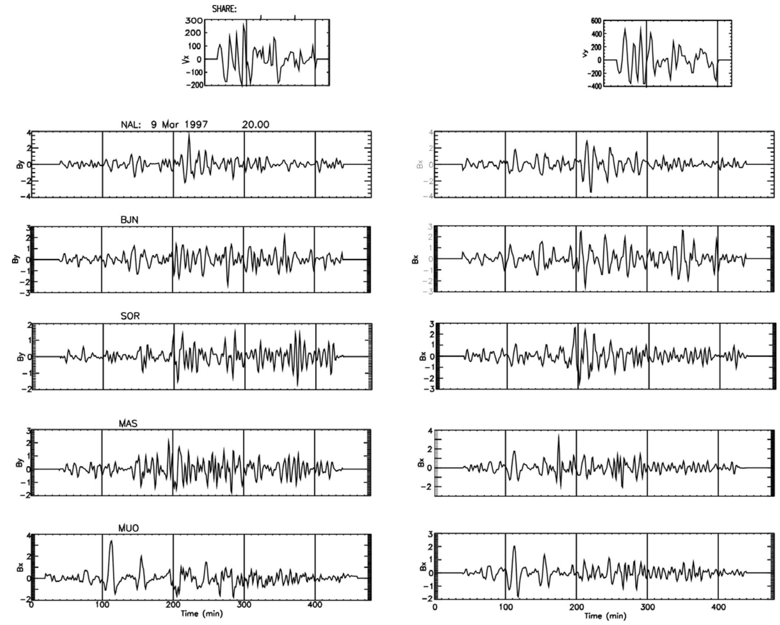

Figure 5

Note that the pulsation activity starts a significant time before the flow bursts are observed by the radar.

The magnetometer data has also been Fourier analysed and the results are shown in Figure 6.

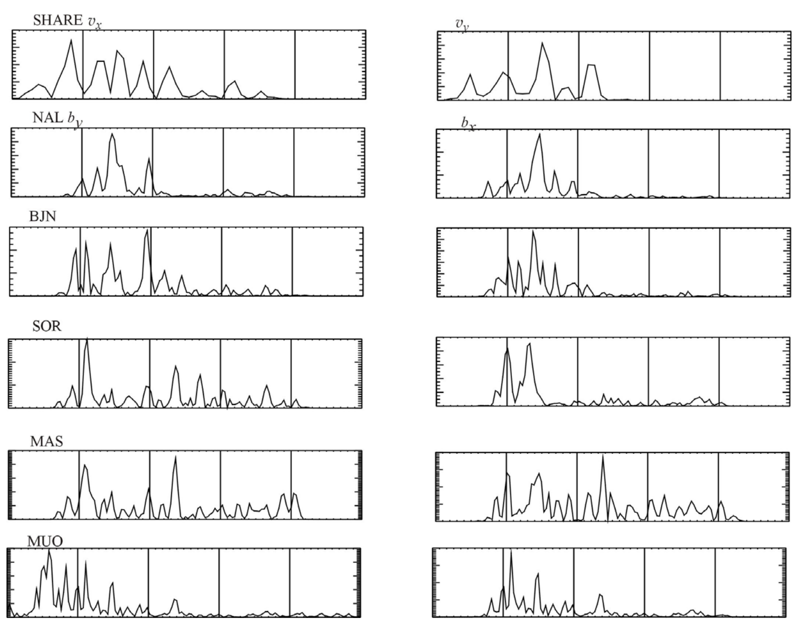

Figure 6

Again the spectrum is compared with the spectrum of the radar data. Notice the strong peak at approximately 1.5 mHz which occurs for the *x* component of the magnetic field and the *y* component of the velocity at all the stations. The magnetometer stations extend over a wide range of magnetic latitudes and are on the morning side of magnetic midnight where the radar is on the evening side.

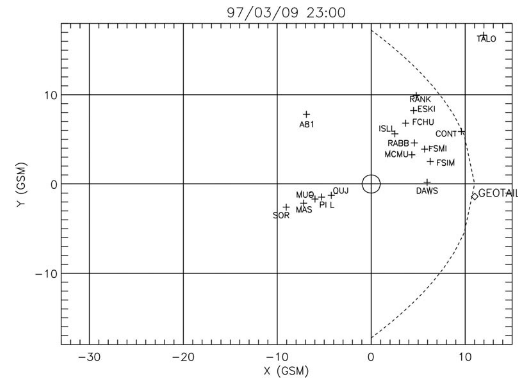

Figure 7a

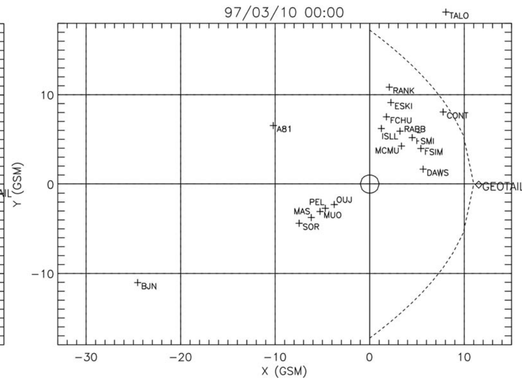

Figure 7b

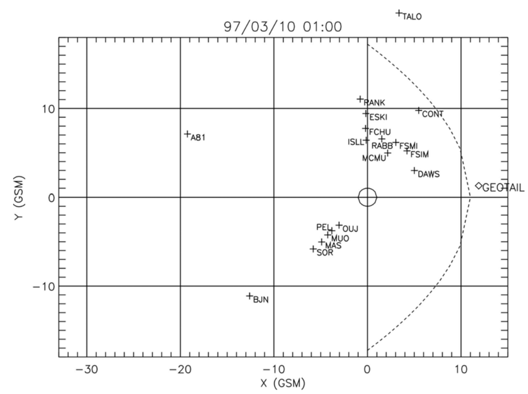

Figure 7c

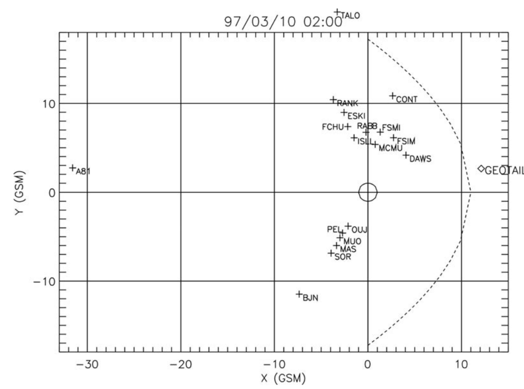

Figure 7d

It is interesting to observe the mapping of the position of the stations into the equatorial plane. This has been done using the T96 model for the appropriate solar wind conditions and is shown in Figure 7 at one hour intervals. The position of AGO A81 is also an indication of the field of view of the radar. Each panel of the figure is separated from the previous one by one hour. It is perhaps surprising how far into the tail the field of view moves. At 23:00 UT the field of view of the radar maps to an L value of about 7 earth radii: at 02:00 it maps to more than 30 earth radii. This implies that, if the location of the flow bursts is localised, the radar may pass through this region. The flow bursts may occur over a longer period than that observed by the radar.

Our conclusions are:

During extremely quiet solar wind conditions flow bursts occurred in the SHARE field of view in the pre midnight sector

In the post-midnight sector pulsations occurred near this frequency for more than an hour preceding the flow bursts

Mapping to the equatorial plane using T96 shows that the field of view was being convected much deeper into the tail towards the end of the flow burst event

Mapping of the magnetometer data suggests that oscillations with similar frequencies were occurring on field lines of very different lengths

Lower latitude magnetometer oscillations occurred at the same frequency as the flow bursts