Space Weather of the Heliosphere: Processes and Forecasts
Proceedings IAU Symposium No. 335, 2017
C. Foullon & O.E. Malandraki, eds.

doi:10.1017/S174392131701002X

Determining the Polar Cusp Longitudinal Location from Pc5 Geomagnetic Field Measurements at a Pair of High Latitude Stations

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Abstract. We use low frequency geomagnetic field measurements at two Antarctic stations to statistically investigate the longitudinal location of the polar cusp. The two stations are both located in the polar cap at a geomagnetic latitude close to the cusp latitude; they are separated by one hour in magnetic local time. At each station the Pc5 power maximizes when the station approaches the cusp, i.e. around magnetic local noon. The comparison between the Pc5 power at the two stations allows to determine the longitudinal location of the cusp. Our analysis is conducted considering separately different orientation of the interplanetary magnetic field. The results, which indicate longitudinal shifts of the polar cusp depending on the selected conditions, are discussed in relation to previous studies of the polar cusp location based on polar magnetospheric satellite data.

Keywords. Solar-terrestrial relations, Earth magnetic field.

1. Introduction

The Pc5 ($1.7 - 7$ mHz) power at high geomagnetic latitudes can provide an indication of the polar cusp position which can depend on the season and the Interplanetary Magnetic Field (IMF) North-South (B_z) and East-West (B_y) components. In a previous study we found, indeed, that in the noon sector the power reaches a maximum at $\sim 75°$ geomagnetic latitude and it shifts from latitudes slightly lower than 75° during local winter (Nov-Dec-Jan-Feb, in the northern hemisphere) and for a southward GSM IMF ($B_z < 0$) to latitudes of $81 - 82°$ during summer and for $B_z > 0$, i.e. closed magnetospheric conditions (Lepidi and Francia 2002). These findings are consistent with the dependence of the cusp position on season and IMF obtained from optical and satellite observations. The seasonal dependence is related to the dipole tilt angle variations, in that when the dipole tilts more toward the Sun, the cusp moves poleward, to higher latitudes (Zhou *et al.* 1999). The IMF B_z and B_y components have been found to control respectively the latitudinal and longitudinal dynamics of the cusp, which moves from 80° to below 70° for strong positive and negative B_z respectively and, in the southern hemisphere, dawnward for B_y negative and duskward for B_y positive (Newell *et al.* 1989; Moen *et al.* 1999; Zhou *et al.* 2000; Pitout *et al.* 2006; McEwen *et al.* 2016). An IMF B_y component, linearly superposed with the magnetospheric field, can shift the magnetic local time (MLT) of the cusp by a maximum of 0.07-0.15 hour/nT (Stasiewicz 1991). In this study we use the Pc5 power at two Antarctic stations, Mario Zucchelli (MZS) and Scott Base (SBA), located at the same Corrected Geo-Magnetic

Table 1. Geographic and CGM coordinates and MLT noon for the two stations.

Station	Geog. Lat.	Geog. Long.	CGM Lat.	CGM Lon.	MLT noon
MZS	74.7° S	164.1° E	79.9° S	307.2° E	20 : 10 UT
SBA	77.8° S	166.8° E	79.8° S	326.5° E	19 : 00 UT

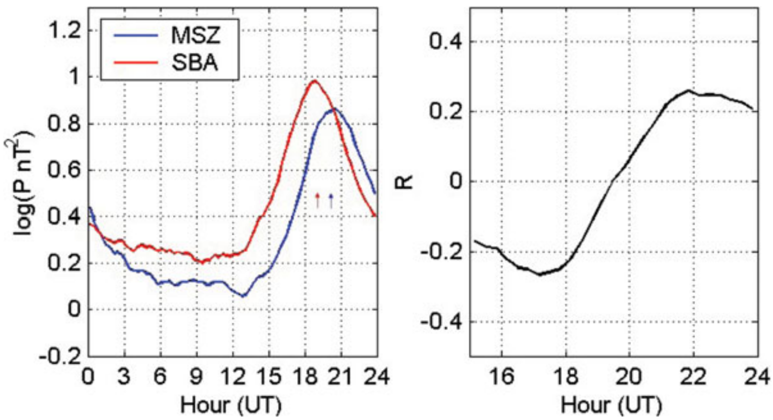

Figure 1. The UT dependence of the average Pc5 power at the two stations (left panel). The UT dependence of the ratio between Pc5 power at MZS and SBA (right panel).

(CGM, `https://omniweb.gsfc.nasa.gov/vitmo/cgm_vitmo.html`) latitude but separated by 1 hr in MLT (Table 1), to examine the longitudinal shift of the cusp for different conditions.

2. Experimental results

In this study we used 1-min values of the total horizontal component H for a year of maximum solar activity (2001). Data were differenced before computing the power spectra in order to reduce lower frequency variations. In Figure 1 (left) we show the UT dependence of the average Pc5 integrated power; it can be seen that at each station a clear power enhancement emerges around MLT noon (indicated by the arrow).

We found interesting to show the logarithmic average ratio R between the Pc5 power at MZS and SBA (Figure 1, right). The average value of R has been subtracted to eliminate any systematic difference in power level at the two stations and make more evident the different time dependence of the power. R is zero (i.e. logarithm of one) at the time T_0 ($\sim 19:30$ UT) when the power at the two stations is the same. From the power time dependence, we expect R to be equal to zero at a time between MLT noon at SBA and MZS, negative before MLT noon at SBA and positive after MLT noon at MZS.

Then, we considered different IMF conditions, restricting our analysis to a few hours containing the MLT noon, i.e. the 15-24 UT time interval (Figure 2). As can be seen, T_0 does not change significantly for different IMF B_z conditions, while it shifts to earlier times ($\sim 19:15$ UT) for positive B_y with respect to negative B_y ($\sim 19:45$ UT).

3. Conclusions

The use of the Pc5 power ratio between two stations longitudinally spaced at the same polar CGM latitude is shown to be useful to provide the polar cusp longitudinal position.

https://doi.org/10.1017/S174392131701002X Published online by Cambridge University Press

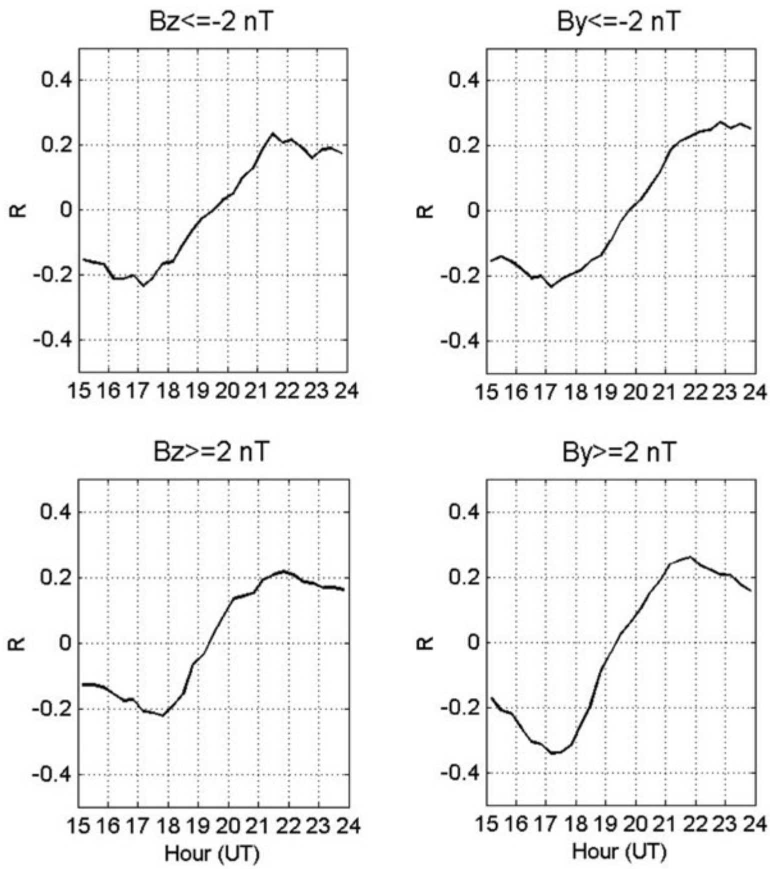

Figure 2. The ratio R during different B_z (left panels) and B_y (right panels) conditions.

It is found that the cusp position depends on the IMF B_y component, shifting to earlier times for positive B_y. The observed shift (of about 0.5 hr) is consistent with the estimate found by Stasiewicz (1991).

References

Lepidi, S. & Francia, P. 2002, *Proceedings "SOLSPA: The Second Solar Cycle and Space Weather Euroconference"*, Vico Equense (Italy), Sept. 24-29, 2001, ESA SP-477, 447-450

McEwen, *et al.* 2016, *Geophysical Mon. 215, Y. Zhang and L. J. Paxton eds.*, AGU

Moen, J., Carlson, H. C. & Sandholt, P. E. 1999, *Geophys. Res. Lett.*, 26, 1243-1246

Newell, P. T., Meng, C.-I., Sibeck, D. & Lepping, R. 1989, *J. Geophys. Res.*, 94, 8921-8927

Pitout, F., Escoubet, C. P., Klecker, B. & Reme, H. 2006, *Ann. Geophysicae*, 24, 3011-3026

Stasiewicz, K. 1991, *J. Geophy. Res.*, 96, doi: 10.1029/91JA01420

Zhou, X. W., Russell, C. T., Le, G., Fuselier, S. A. & Scudder, J. D. 1999, *Geophys. Res. Lett.*, 26, 429-432

Zhou, X. W., Russell, C. T., Le, G., Fuselier, S. A. & Scudder, J. D. 2000, *J. Geophys. Res.*, 105, 245-252

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