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Solar wind-magnetosphere interaction as observed in the geomagnetic field variations in the polar regions

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Abstract. Relative few ULF measurements at extreme latitudes have been achieved so far. We review the results obtained in the last few years in the Pc3-5 range at cusp/cap latitudes, and present new results obtained from comparisons of the experimental observations at polar cap stations with those obtained at low latitudes. The experimental observations performed during a short term campaign at the new polar station Concordia (CGM latitude ≈-89^o) are also presented.

1. Introduction

The study of pulsations at high latitude regions, such as Antarctica, is very interesting in that local field lines reach magnetospheric regions close to the extreme magnetospheric boundary, the magnetopause, and to the polar cusp, the area which separate sunward, closed field lines from tailward, open lines. In these regions the energy transfer from the solar wind to the Earth's magnetosphere occurs and related generation mechanisms of ULF pulsations are active. In Antarctica, the Physics Department of the University of L'Aquila run magnetic instrumentation at the Italian geomagnetic station Mario Zucchelli at Terra Nova Bay (corrected geomagnetic latitude 80^{o}S) and at the Italian-French base of Concordia, at Dome C (89^{o}S) very close to the geomagnetic pole. Both stations are located in the polar cap, at the footpoints of open field lines, but, due to the Earth's rotation, Terra Nova Bay, which is at lower latitude, approaches the cusp around noon.

2. Experimental results

Our research is mostly focused on pulsations in the mid and low frequency range, from few mHz (Pc5 pulsations) to one hundred mHz (Pc3 pulsations). We find that the polar cap is not a quiet area for ULF activity in this frequency range (Villante et al. 2000). At 80S we observe that, independently on frequency, ULF power maximizes around noon, when the station approaches the cusp and closed field lines; moreover, in conflict with cusp observations, no evidence for substorm related activity is detected in the nighttime sector. On the other hand, in the deep polar cap at Dome C no power enhancement is detected at local noon and the power is almost uniformly distributed through the day. We also find that, during disturbed magnetospheric conditions, the pulsation activity at the two stations becomes very similar and appears driven by solar wind pressure pulses. We interpreted this result in terms of an interplanetary magnetic field dependence of the cusp position which moves toward lower latitudes during southward conditions; then Terra Nova Bay stays in the cap as Dome C through the whole day. The analysis of the correlation between the power of the fluctuations and the solar wind velocity reveals a high solar wind control of the pulsation amplitude, more explicit in the deep cap. This dependence can be considered indicative of a source wave due to the Kelvin-Helmoltz instability on the magnetopause, but can be also consistent with an enhanced transmission of upstream waves through the magnetopause. Indeed, evidence is found for a significant upstream wave contribution to Pc3 pulsations not only at Terra Nova Bay but also at Dome C, in the deep polar cap (De Lauretis et al. 2005). In the Pc5 frequency range, pulsations at discrete frequencies can be observed at these high latitudes and, simultaneously, at low latitudes and in the magnetosphere; they can be associated to magnetospheric cavity modes excited by solar wind pressure pulses (Samson et al. 1992), or might be directly driven by fluctuations in the solar wind (Kepko and Spence 2003).

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