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Waiting time distributions of B_s and AE extreme events

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Abstract. We present a preliminary statistical study on the intermittency of B_s and AE, focusing in particular on the distributions of their respective extreme events, for different phases of the solar cycle. In order to recognize the extreme events affecting our statistics, we use a technique, called local intermittency measure (LIM), based on wavelet decomposition. Once we have selected all the extreme events we can measure the waiting time between consecutive events and build the relative distribution. Our analysis shows that these distributions are characterized by well defined power laws which would suggest the existence of long term correlations typical of turbulent processes. Moreover, we find that these distributions do not depend on the particular phase of the solar cycle considered.

Key words. Solar wind: intermittency – Magnetosphere: auroral activity

1. Introduction

Magnetic reconnection is generally considered as the the main mechanism for energy transfer between the solar wind and the magnetosphere. Within this framework, D'Amicis et al. (2004) focused on a comparative study between waiting time distributions of B_s events and those of AE for different phases of the solar cycle, in order to emphasize possible correlations. They found that waiting time distributions are characterized by power laws.

In the present study, we are interested in a subclass of those events, called extreme events, which make the Probability Distribution Functions (PDFs) deviate from a Gaussian causing intermittency. In fact, both AE and solar wind fluctuations show an intermittent behaviour, not being distributed in accordance with a Gaussian at small scales (Consolini et al. 1996; Burlaga 1991). We wonder whether extreme events in AE are linked to those in B_s and if waiting times for both variables can be still described by a power law.

2. Data analysis

By computing the flatness, or fourth order moment, we can state only if a signal is intermittent but we cannot use it as a tool to localize the structures causing intermittency at a given position and scale. This task is carried out by the local intermittency measure (LIM) introduced by Farge (1992), defined by means of the wavelet coefficients, that al-

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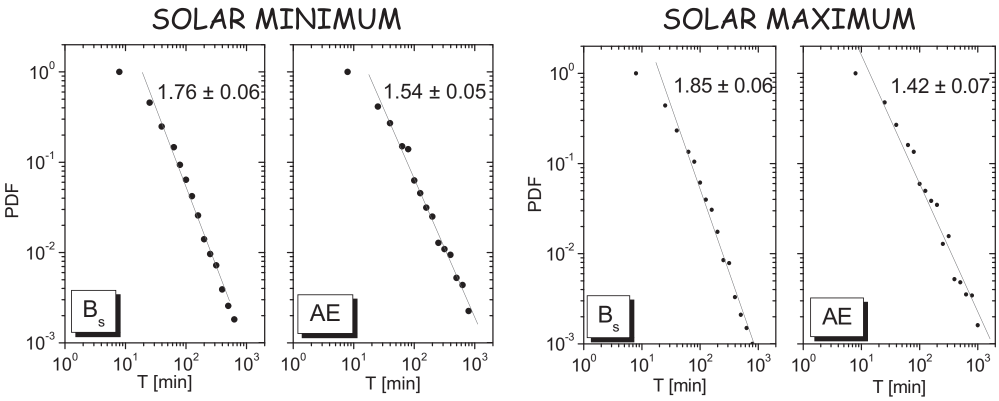

Fig. 1. Waiting time distributions of AE and B_s extreme events at solar minimum (left) and maximum (right). Each distribution is normalized to its maximum value (D'Amicis et al. 2008).

lows the signal decomposition. We adopted a recursive method similar to the one used in Onorato et al. (2000); Bianchini et al (1999); Bruno et al. (1999), consisting in eliminating, for each scale, those events which cause the LIM to exceed a given threshold.

After selecting the extreme events, D'Amicis et al. (2008) studied the time gap between successive events, defined as the end of an extreme event and the beginning of the next one and built the relative distributions at solar minimum and maximum for AE and B_s as shown in Fig. 1. D'Amicis et al. (2008) found that B_s extreme events are characterized by long term correlations both at solar minimum and maximum, as expected for a turbulent process. The same behaviour is observed for AE. This result seems to be in disagreement with standard SOC models, which should be characterized by a Poissonian distribution (Boffetta et al 1999). A further possibility is that the solar wind acts as a forcing and is thus responsible for the presence of long term correlations in AE (FSOC). The slopes of waiting time distributions in AE are smaller that the ones found in B_s both at solar minimum and maximum, meaning that long waiting time events in AE are more probable than the ones in B_s. This might confirm that magnetospheric conditions play a relevant role in AE behavior. The comparison between different phases of the solar cycle shows that the slopes of the power laws in B_s are similar (within error level). Analogous considerations are valid for AE.

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