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Study of intermittent dynamics in the terrestrial foreshock using the Cluster spacecraft records

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The paper concerns with the statistical investigation of the intermittent dynamics in the terrestrial foreshock. We use the 22.5 Hz FGM magnetic data of the four spacecraft of the Cluster mission from periods when the mission orbit traversed the solar wind (January-April in the years of 2001-2010). Intermittency is studied in terms of space and time through a sliding-window probability density function (PDF) analysis of the records. The spatial dependence of the appearance of intermittent fluctuations is monitored according to the distance from the bow shock (BS) and the angle measured between the BS normal and the IMF direction (quasi parallel and perpendicular conditions). Beside the intermittent turbulent fluctuations, the foreshock dynamics is dominated by various wave phenomena, that are, in most cases, more energetic than the turbulent activity. For this reason, a high-pass wavelet filtering is carried out on the time-series for extracting the small-amplitude intermittent fluctuations at high-frequencies. The level of intermittent fluctuations is measured through the deviation of the fourth statistical moments of the time-series increments (i.e. the flatness) from the Gaussian value, 3. Instead of temporal increments, the PDF analysis is also carried out with spatial differences among the records of the four Cluster spacecraft. In this case the Taylor hypothesis has not to be invoked in the interpretation of the obtained results. It is shown that the intermittency level measured by spatial differences decreases logarithmically with the inter-spacecraft distance. The level of intermittent fluctuations in the foreshock is studied in terms of different solar wind conditions. The strongest correlation turns out to be between the intensity of intermittent foreshock dynamics and the solar wind bulk velocity and Alfvén Mach number.
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