INTERMITTENCY IN INTERPLANETARY CORONAL MASS EJECTIONS OBSERVED BY PARKER SOLAR PROBE AND SOLAR ORBITER

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INTRODUCTION

Interplanetary coronal mass ejections (ICMEs) are often observed as large-scale flux ropes with smoothly varying magnetic fields, but a spectrum of fluctuations is present at smaller scales. A well-known feature of solar wind plasma is that, when moving from large to small scales, distributions of fluctuation amplitudes become more non-Gaussian. This behaviour is a manifestation of intermittency, i.e., an increasingly uneven spatial distribution of energy with decreasing scale in the plasma. While intermittency has been studied extensively in the solar wind, few studies have considered intermittency within ICMEs.

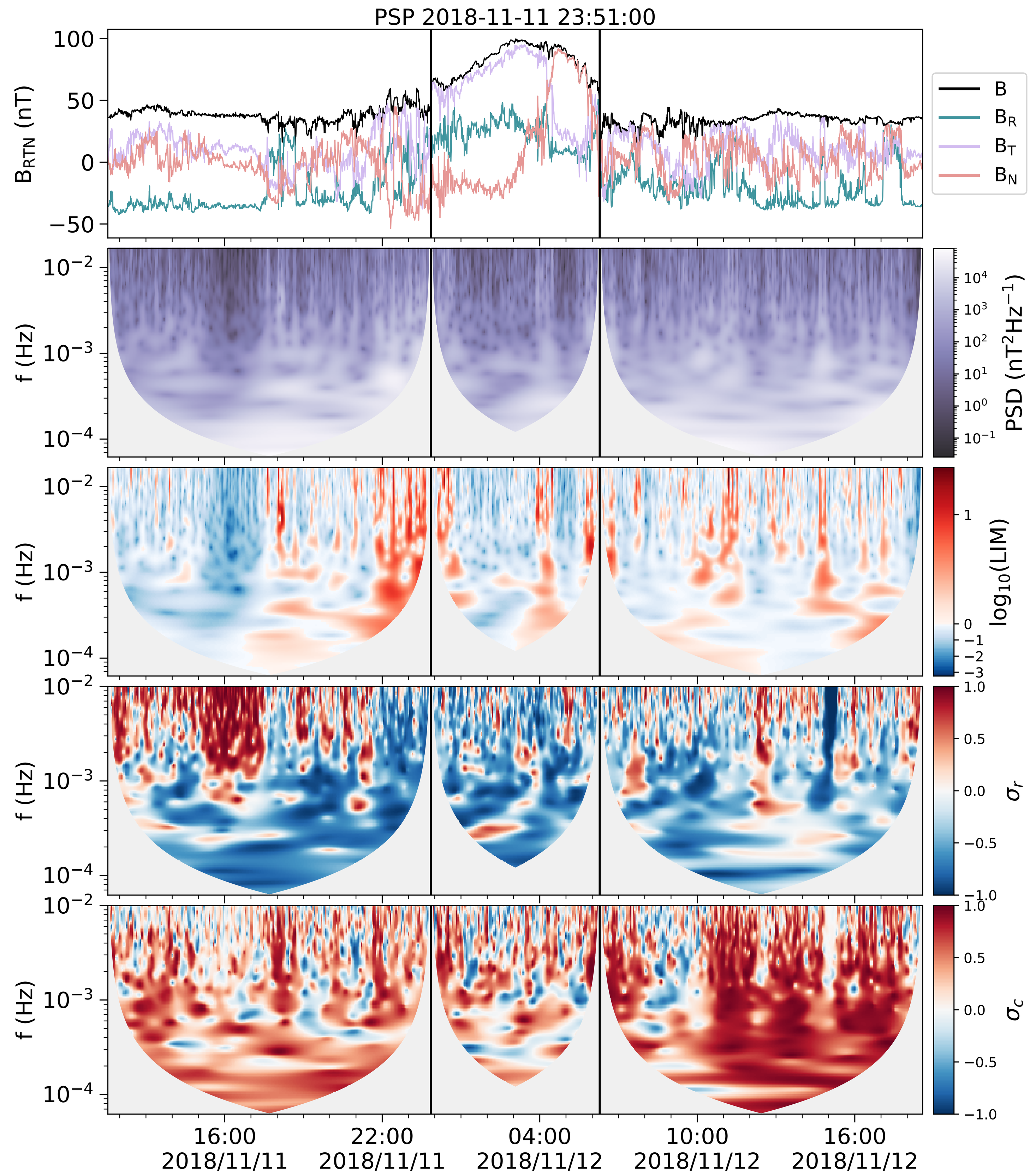

FIGURE 1: Magnetic field observations, wavelet power spectral density, local intermittency measure (LIM), residual energy, and cross-helicity for an ICME event observed by Parker Solar Probe

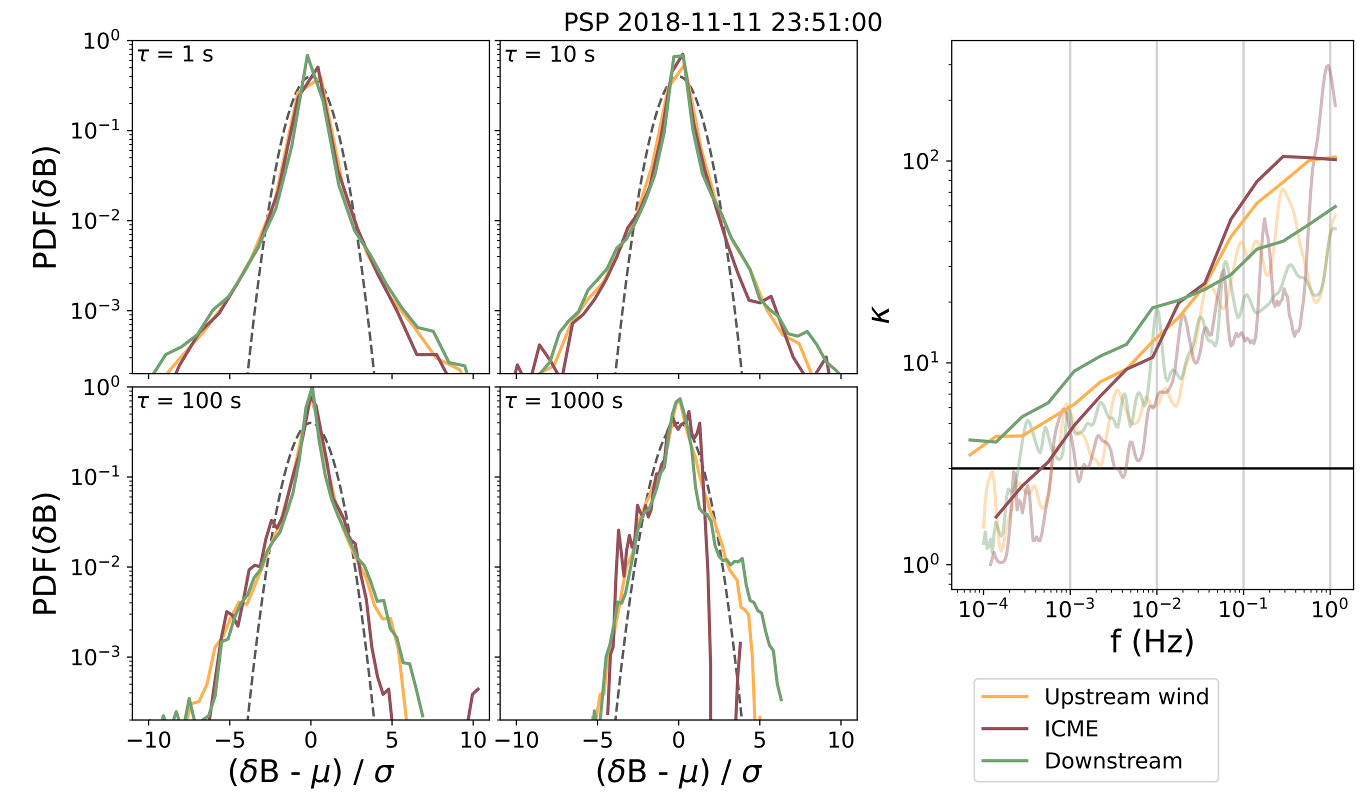

FIGURE 2: Distributions of magnetic field fluctuations at different scales (left) and kurtosis (right) for an example ICME event

KURTOSIS

Kurtosis is a measure of tailedness of PDFs and can be used as a measure of intermittency. It is a scale-dependent measure and larger the value, higher intermittency.

$$K = \frac{\langle|\delta\boldsymbol{B}(t,\tau)|^4\rangle}{\langle|\delta\boldsymbol{B}(t,\tau)|^2\rangle^2}$$

where $|\delta\boldsymbol{B}(t,\tau)| = |\boldsymbol{B}(t+\tau) - \boldsymbol{B}(t)|$ and τ is the scale.
$K = 3$ corresponds to Gaussian distribution.

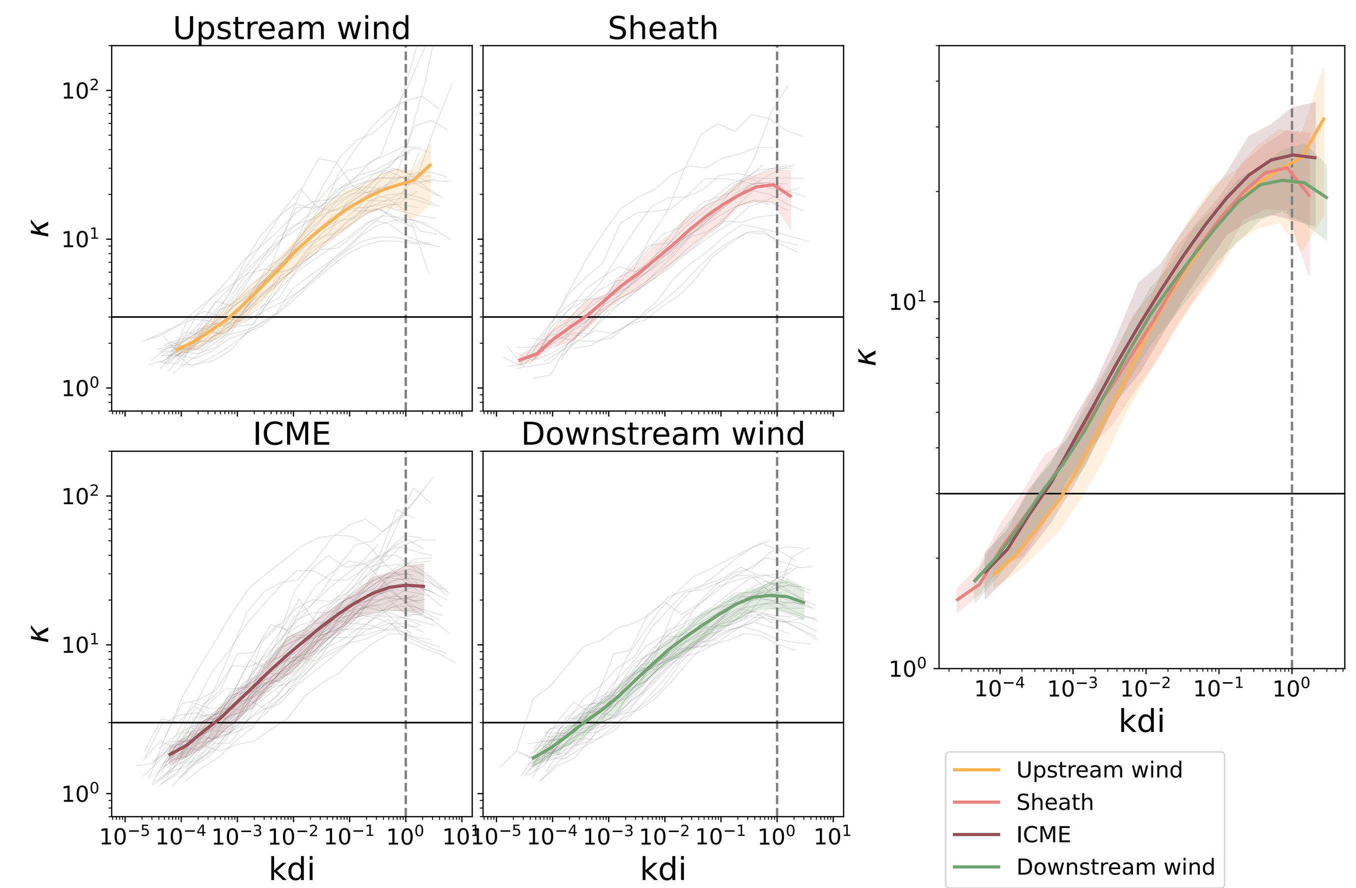

FIGURE 3: Kurtosis for 46 ICME events and their mean as a function of kd_i

Scale-dependent residual energy:

$$\sigma_r = \frac{S_2(V) - S_2(B)}{S_2(V) + S_2(B)}$$

Scale-dependent cross-helicity:

$$\sigma_c = \frac{S_2(z^+) - S_2(z^-)}{S_2(z^+) + S_2(z^-)}$$

where $\boldsymbol{z}^{\pm} = \boldsymbol{V} \pm \boldsymbol{B}$ and S_2 is the second order structure function

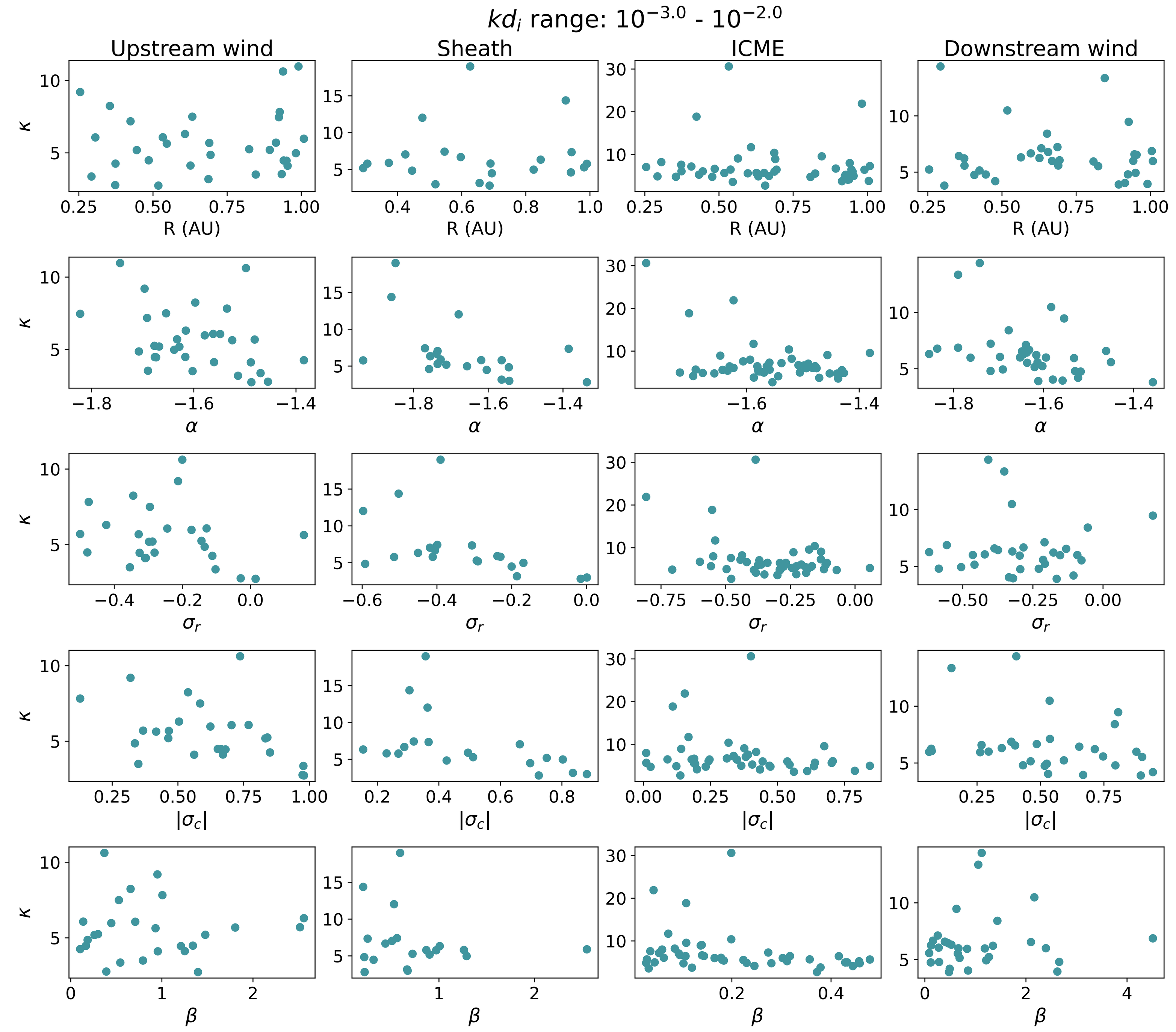

FIGURE 4: Mean kurtosis in kd_i range $10^{-3} - 10^{-2}$ as a function of heliospheric distance, spectral index, residual energy, magnitude of cross-helicity, and plasma β

RESULTS

Kurtosis behaves similarly in ICMEs as it does in sheaths and upstream and downstream intervals. Kurtosis in upstream interval reaches the Gaussian level at highest kd_i value. Some variation in kurtosis can be seen at higher kd_i values between different intervals.

We do not note clear dependence between kurtosis and heliospheric distance, spectral index, residual energy, cross-helicity, nor plasma β for ICME intervals. Same can be said about sheaths and upstream and downstream intervals.