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On manifestation of the solar wind turbulence in fluctuations of the galactic cosmic ray intensity

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We study a relationship between the interplanetary magnetic field (IMF) and the solar wind speed (SWS) turbulence measured in the interplanetary space (in situ) and the galactic cosmic ray (GCR) intensity fluctuations measured by neutron monitors (at earth surface) for different time scales of ranges $5-60$ minutes and $1-24$ hours. We calculate the Probability Distribution Functions (PDF) of differences δB_τ, δV_τ , and δI_τ of the time series $B(t_i)$ of the IMF strength , $V(t_i)$ of the SWS, and $I(t_i)$ of the GCR intensity, respectively, as $\delta B_\tau = B(t+\tau)-B(t)$, $\delta V_\tau = V(t+\tau)-V(t)$ and $\delta I_\tau = I(t+\tau)-I(t)$ over varying time scales τ. Then, we find correlation coefficients among them and characteristic time scale τ_0 for which ($\tau > \tau_0$) the asymmetry (skewness) and kurtosis of PDFs are minimum, and in good approximation PDFs have Gaussian distributions. We show that the asymmetry and inhomogeneities of the IMF and solar wind turbulence generally are manifested for time scale $\tau < 1$ day, while for the GCR fluctuations for $\tau <$few hours. The characteristic time scale τ_0 depends on the level of solar activity and has various values for different periods to be analyzed. This kind of analysis is important in studying of Forbush decrease of GCR intensity. Particularly, when the IMF turbulence can be considered as isotropy and homogeneous for time scale $\tau > \tau_0$, and PDF has a Gaussian distribution, the IMF turbulence is characterized by the power spectral density (PSD), with parameters p and ν ($PSD = Pf^{-\nu}$, where P is power and f is a frequency). In this case diffusion of GCR particles could be described by the quasi linear theory (QLT), and diffusion coefficient K is proportional to the rigidity R, as $K \sim R^{2-\nu}$; correspondingly, the exponent γ of the rigidity R spectrum ($\delta D(R)/D(R) \propto R^{-\gamma}$) of the GCR intensity variations (e.g. of Forbush decrease) of the energy to which neutron monitors and muon telescopes (for rigidity $> 5-10$ GV) respond, is determined by the exponent ν of PSD of the IMF turbulence.