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Perpendicular Diffusion in the Transport of Solar Energetic Particles

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We numerically calculate a relatively complete model of solar energetic particle (SEP) transport in three-dimensional interplanetary magnetic field, with emphases on the effects of perpendicular diffusion. As typical cases, intensity-time profiles and anisotropies of protons with tens of MeV and electrons with tens of keV are calculated. Together with our previous investigations, we show that by means of perpendicular diffusion, some interesting phenomena, such as SEP reservoirs, counterstreaming particle beams, and longitudinally asymmetric distribution of SEPs, can be quantitatively explained or reproduced. The longitudinally asymmetric distribution of SEP events results from the east-west azimuthal asymmetry in the topology of heliospheric magnetic field as well as the effects of perpendicular diffusion on the transport of SEPs in the heliosphere. We demonstrate that the perpendicular diffusion mechanism plays a very important role in the transport of SEPs, particularly when an observer is not directly connected to the acceleration region by interplanetary magnetic field lines.