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Non-resonant cross-field diffusion of energetic particles due to their interaction with interplanetary magnetic decreases (MD): a computational study

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Our interest in this work is to study non-resonant cross-field diffusion of energetic particles due to their interactions with Interplanetary Magnetic Decreases (MDs) in high heliospheric latitudes. To do this, we use a geometric model introduced by Tsurutani et al. (Nonlinear Processes in Geophys., 6, 235, 1999) that makes possible evaluating perpendicular diffusion to the ambient magnetic field as a function of: particle's gyro radius, MDs radius, ratio between fields outside and inside the MDs, and a characteristic impact parameter. We use Ulysses magnetic field data between days 242 and 268 of 1994 to identify the MDs and get the empirical size and magnetic field decrease distribution functions. To obtain an estimative perpendicular diffusion, we let particles with specific energies interact with one hundred MDs with random sizes and magnetic field decreases. The random MD characteristics are taken from the observational distribution functions using Monte Carlo method. Here we present the diffusion distance obtained for protons with energies ranging from 100 keV to 100 MeV due to their interaction with MDs at high heliospheric latitudes. The diffusion distance, in terms of gyroradius, decreases as energy particle increases. The method we use can be employed to calculate cross-field diffusion of heavy ions and electrons, and for other space environment regions such as interplanetary space at low latitudes, planetary magnetosheaths, interplanetary shock sheaths, and heliosheath.