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Solar wind and geomagnetic activity effects on the radiation belt particle population using over a solar cycle of satellite and riometer data

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In this study, we investigate the relationship between the flux of high- and low-energy particles, as obtained from LANL satellite observations (1989-2008), NOAA observations (1998-2005) and riometer observations (1989-2005), with respect to solar wind and geomagnetic conditions. The spatial coverage provided by satellite observations is quite low and so, in addition to NOAA satellites, we employ absorption data from the NORSTAR riometer array as a measure of particle precipitation over a range of latitudes and local times. A new method employing probability distribution functions (PDF), normalized by solar wind velocity and density, is employed to investigate the flux-velocity-density relationship. The PDF's for low ($\sim$30 keV) and 2-day delayed relativistic fluxes are very similar, and the maximum probability in the flux probability distributions depends upon both velocity and density across all energies. The probability is higher for larger Vsw, and the maximum probability larger for a given Vsw than for density. The results indicate that Vsw may be more important for determination of fluxes than density, espcially for periods of high Vsw. We also present evidence of a solar cycle and solar wind activity dependence of trapped and precipitating fluxes, and statistically show that riometer absorption responds only to the lower-energy fluxes ($\sim$60-100 keV), with the agreement increasing during co-rotating interaction region (CIR) periods, and associated high solar wind speed. The study contributes to our understanding of the effects of loss and acceleration of electrons over long time periods, and during different solar wind conditions. It also provides a first step towards a new method of remote sensing the radiation belts through the use of ground-based observations. The results are consistent with the proposed mechanism of acceleration of MeV electrons by chorus waves, which take free energy from the lower energy particles. The presented climatological data sets will be used in the future to make long-term predictions of the radiation environment.