Transport of stellar energetic particles through planetary magnetospheres

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We analyze ACE/Wind measurements of energetic electrons from a number of solar particle events during which Wind was located close and magnetically connected to the Earth's bow shock while ACE was located at the libration point L1 far away from the influence of the magnetosphere. The electron fluxes onboard Wind show bi-modal pitch angle distributions (PAD), whereas ACE shows PADs with one peak, as usually observed for impulsive injection of electrons at the Sun. The observations rather suggest that the bi-modal electron PADs are due to reflection or scattering at an obstacle located at a distance of less than 150 RE in the anti-sunward direction, compatible with the bow shock or magnetosheath of the magnetosphere of the Earth. For a modeling of the observations we have performed transport simulations which include the effects of pitch angle diffusion, adiabatic focusing, and reflection at a boundary close to the point of observation. The results of the simulations demonstrate that the combined effects of reflection at the bow shock assuming an approximate conservation of the electron's adiabatic invariant, and diffusion in the magnetosheath governed by a mean free path of the order of 2 RE can reproduce the basic features of the dynamics of the bimodal Wind electron fluxes. Implications of our results for studies of pitch-angle dependent particle transport in magnetospheres of other planets, and in astrophysical shocks in general, will be discussed.