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Global acceleration processes of solar and terrestrial particles in the Earth's magnetosphere (Julius Bartels Medal Lecture)

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The processes which accelerate solar and ionospheric particles inside the magnetosphere are reviewed in the light of data obtained from the magnetospheric missions, Cluster, Interball, Demeter and Double Star, plus satellite data obtained in the inner magnetosphere. We start with a brief review of plasma sources. Particle accelerations and their observed characteristic signatures are then examined, starting with processes found at the external boundaries of the magnetosphere and within the ionosphere. During quiet magnetic periods adiabatic acceleration processes (Fermi and Betatron) inside the magnetosphere can explain the particle distribution responsible for electron diffuse aurora and the corresponding proton aurora, while ions are accelerated non-adiabatically in the more distant tail. Close to the Earth the low energy plasma distribution near the inner edge of the plasma sheet is shown to result from the balance between the transport of ions of solar or ionospheric origin, and loss processes including charge exchange. During substorms and storms, rapid reconfiguration of the magnetosphere and the associated redistribution of the electric current is shown to cause sporadic acceleration of ions of various origins and, on the contrary, during the phase preceding substorms adiabatic deceleration prevails. Finally we consider the resonant interaction during storms of radiation belt particles with natural ULF waves and VLF waves of natural or man-made origin, which leads to the acceleration/diffusion of these particles.