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Reconnection signatures in the high-altitude cusp

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Several mechanisms of magnetosheath plasma entry into the magnetosphere have been suggested. These mechanisms range from impulsive penetration, through Kelvin-Helmholtz instability, up to diffusion. However, as an extensive discussion has shown, observational facts are generally consistent with magnetic reconnection being a dominant source of the cusp plasma, whereas other mechanisms can contribute to the cusp population under specific circumstances. A unique feature of reconnection is that it requires the relevant physical processes to take place only in a narrow diffusion region, while its consequences are global: Once the interplanetary and magnetospheric field lines become interconnected, they remain connected while being convected with the solar wind and plasma continues to enter the magnetosphere. This is in contrast to all other mechanisms that operate only locally and their occurrence at different locations is essentially uncorrelated.

As observed by the various spacecraft at both low and high altitudes, a cusp precipitation is often characterized by ion energy dispersion. During southward IMF, ion energy falls with increasing magnetic latitudes due to the convection electric field operating as a velocity filter on particles from the injection point to the observation point. The high-energy ions rapidly reach lower latitudes and the lower-energy ions appear later at higher latitudes. By contrast, if reconnection takes place in the tail lobes, the high-energy ions quickly reach higher latitudes, whereas the low-energy ions are convected to lower latitudes and thus the ion energy-latitude dispersion signifies the boundary of open and closed magnetic field lines. We are presenting case studies of crossings of the cusp region at high altitudes which reveal that both spatial and temporal changes should be taken into account for an explanation of the observed features. Moreover, our study shows that the cusp can be supplied from two reconnection sites simultaneously.