Utilizing the Heliophysics/Geospace System Observatory to Understand Particle Injections: Their Scale Sizes and Propagation Directions

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The injection region's formation, scale size, and propagation direction have been debated throughout the years, with new questions arising with increased plasma sheet observations. How do temporally and spatially small-scale injections relate to the larger injections historically observed at geosynchronous orbit? How to account for opposing propagation directions--earthward, tailward, and azimuthal--observed by different studies? To address these questions, we used a combination of multisatellite and ground-based observations to knit together a cohesive story explaining injection formation, propagation, and differing spatial scales and timescales. We used a case study to put statistics into context. First, fast earthward flows with embedded small-scale dipolarizing flux bundles transport both magnetic flux and energetic particles earthward, resulting in minutes-long injection signatures. Next, a large-scale injection propagates azimuthally and poleward/tailward, observed in situ as enhanced flux and on the ground in the riometer signal. The large-scale dipolarization propagates in a similar direction and speed as the large-scale electron injection. We suggest small-scale injections result from earthward-propagating, small-scale dipolarizing flux bundles, which rapidly contribute to the large-scale dipolarization. We suggest the large-scale dipolarization is the source of the large-sale electron injection region, such that as dipolarization expands, so does the injection. The >90 keV ion flux increased and decreased with the plasma flow, which died at the satellites as global dipolarization engulfed them. We suggest the ion injection region at these energies in the plasma sheet is better organized by the plasma flow.

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