

Ionospheric control of space weather: plasma injections arising out of dynamic ionosphere

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We propose that ionospheric plasma injections to the magnetosphere (ionospheric injection) represent a new plasma process in the polar ionosphere. The ionospheric injection is first triggered by westward electric fields transmitted from the convection surge in the magnetosphere in association with dipolarization onset. Localized westward electric fields result in local accumulation of ionospheric electrons because of differing electron and ion mobility in the E-layer. This charge imbalance was quickly reduced by polarization electric fields generated in the ionosphere. Meanwhile, ion/electron populations are partially released as injections to the magnetosphere to sustain quasi-neutral equilibrium of the ionosphere. Resultant geomagnetic field lines are not in equipotential equilibrium during ionospheric injections but instead develop field-aligned potentials to extract ions/electrons ejected from the ionosphere.

Ejected plasmas were transported along the field lines to higher altitudes above the ionosphere by conserving the total energy and first adiabatic invariant. Temperature anisotropies of the plasmas develop in these plasma flows and grow local field-aligned potentials. These potentials are initially localized above the ionosphere and become global varying monotonically from ionosphere to the equator. However, magnetic mirror force decreased rapidly above 10,000 km and a rate of parallel potential change (parallel electric fields) may drop at these altitudes. The formation of parallel potentials described above is consistent with fundamental plasma properties that require quasi-neutral equilibrium.

We suggest that ionospheric injection generated electrostatic potentials in the ionosphere in a manner consistent with those of the Harang Discontinuity (HD) and field-aligned current patterns matching those in HD. Equatorial projection of potentials may alter existing plasma convection patterns in the midnight magnetosphere. Although the substorm onset would be triggered initially by the magnetospheric convection enhancement, we suggest that the time of auroral onset and its location may be controlled and determined by the auroral ionosphere.

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