High-Energy Electron Beam-Induced Ionospheric Modification Experiments

Authors: Brian Gilchrist; Torsten Neubert; Linda H. Krause; MICHIGAN UNIV ANN ARBOR SPACE PHYSICS RESEARCH LAB

Abstract: The University of Michigan Space Physics Research Laboratory was given the task of providing scientific investigations of beam propagation physics associated with the injection of a MeV electron beam into the earth's atmosphere. Motivation for this study was driven by the reduction in weight and size of electron beam accelerators in this energy regime to the point which enables them to be flown on balloons, rockets, or spacecraft. Program goals included the modeling of dynamics of MeV electron beams injected from LEO spacecraft into the atmosphere, analysis of the collisional and beam-plasma interactions, and modeling of ionospheric modification induced in the atmosphere, such as enhanced plasma densities, optical emissions and conductivity changes. Results show that, for downward directed beams, radial defocusing of beam electrons due to scattering by the atmospheric neutrals is significantly mitigated by the presence of the earth's magnetic field. In addition, substantial ionospheric modification occurs due to the beam atmosphere interaction, resulting in plasma densities and conductivities significantly above the ambient values. Proposed future work includes the study of optical and bremsstrahlung emissions to be used for diagnostics of beams injected from space, beam propagation dynamics over long distances, and modification of the atmospheric electric potential.

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