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SEP Precipitation at Mars using a Monte Carlo model

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Abstract

At weakly magnetized planets, energy deposition in the upper atmosphere can drive changes in the chemistry, structure and subsequent evolution. Solar energetic particles (SEP) are an important source of energy deposition because they deposit energy through collisions, causing ionization of neutral particles that may have enough energy to escape the atmosphere. We present the effects of SEP precipitation in the upper atmosphere of Mars using a full Lorentz motion particle transport simulation to study.

1. Introduction

A Lorentz motion particle transport model has been developed to trace different populations of energetic ions in the Martian atmosphere to predict secondary electron production, atmospheric heating, and energy deposition. The model calculates the energy loss and scattering for collisional processes such as ionization, excitation and dissociation with major atmospheric constituents using a Monte-Carlo initialization scheme. The model uses the background magnetic fields from a multispecies MHD code and 3-D neutral densities from a global circulation model (MTGCM) [1,2] in order to simulate energetic ion precipitation in the upper atmosphere of Mars. Secondary electrons are simulated using MarMCET [3]. Preliminary results show charge exchange and ionization rates are shifted upwards as particle beam angle increases.

2. Results

We present 3-D ionization rates for different locations near areas of strong and weak crustal magnetic fields. We will compare these results with a basic guiding center approximation and discuss isotropic and beamed SEP events. Using a test particle model [4], beamed SEP events observed can be simulated from observed events and used to calculate the energy deposition at a given time for specific locations in Mars' upper atmosphere. This work provides a better understanding of how Mars' upper atmosphere and ionosphere respond to particle precipitation for a variety of conditions, which has direct implications for atmospheric evolution.

References

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