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Cosmic ray ionization in the Venusian atmosphere

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Abstract

The interaction of solar and galactic cosmic rays with the atmosphere of Venus has been investigated using full Monte Carlo modelling of the interaction of cosmic ray primary and secondary particles with atmospheric neutrals. Based on these results, we have computed atmospheric ionization profiles between 0-100 km at solar minimum and solar maximum conditions.

1. Introduction

The atmospheres of the terrestrial planets are constantly exposed to solar and galactic cosmic rays, the most energetic of which are capable of affecting deep atmospheric layers through nuclear and electromagnetic particle cascades. The energy deposited by these interactions is thought to be an important driver for atmospheric chemistry and may possibly affect cloud microphysics, and in regions beneath the penetration of ultraviolet radiation, cosmic rays are the primary ionization agent. It is therefore crucial to quantify the amount of energy deposited by cosmic rays in the atmosphere by altitude, as this is required to estimate ionization and conductivity profiles.

2. Cosmic Ray ionization in the Venusian atmosphere

Detailed studies have considered the propagation of cosmic rays in the atmospheres of Earth, Mars, Titan and the Giant Planets. However, to date, only a few studies [1] [2] have considered such interactions in the Venusian atmosphere, notably using Boltzmann transport approximations. Using the capabilities of the Geant4 [3] particle physics framework and Planetocosmics [4], we have carried out full Monte Carlo modelling of the discrete interactions between atmospheric neutrals and cosmic ray primary and secondary particles. The primary cosmic ray spectrum has been derived from the CRÈME-2009 [5] engineering model at 1 AU , with scaling of the primary fluxes to the Venusian orbit. Based on this input spectrum we have simulated atmospheric energy deposition by cosmic rays at solar minimum and maximum conditions and computed cosmic ray ionization profiles between 0-100 km in the Venusian atmosphere. In future work we plan to apply these results to investigations of electrical processes and radiation hazard in the Venusian atmosphere.

References

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