Project Details

ROSES ID: NNH07ZDA001N
Selection Year: 2008
Program Element: Focused Science Topic

Topic: Joint Focus Topics with Planetary Science: Extreme Space Weather Events in the Solar System

Project Title:
Study of the Martian Ionospheric and Atmospheric Responses to Extreme Space Weather Events

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Summary:
As a weakly magnetized planet, Mars directly interacts with the solar wind. Under extreme solar wind conditions, the ion escape rate is estimated to be more than an order of magnitude larger than in normal situations. We propose to study the detailed responses and long-term consequences of the Martian ionosphere and atmosphere to extreme space weather events using two sophisticated 3D models. One is a global multi-species MHD model with a very high spatial resolution (~10 km inside the Martian ionosphere). This model calculates the densities of the solar wind protons and all the major ion species in the Martian ionosphere, as well as the plasma bulk velocities and energies. The Mars-solar wind interaction is self-consistently calculated in the model by including the effects of the crustal magnetic field, ion-neutral collisions, and major chemical reactions. Another numerical tool is a newly-created highly-parallelized test particle model, which is to address the kinetic effects of pick-up ions in the Martian plasma environment. The most novel feature of the test particle model is that more than one billion test particles are launched in the simulation domain. This substantial improvement enables an unprecedented examination of the pickup ion flux distribution in velocity space, which is not achievable in previous studies. In this proposal, the ionospheric and atmospheric particle escape from and precipitation into the Mars will be studied under the impact of extreme space weather events by comparing a variety of representative model runs. The study will also provide useful information for the understanding of the energetic charged particle environment on the surface of Mars, thus important for the evaluation of the survivability of life on or near the surface, including the health of future human explorers on Mars.

Publication References:

Summary: no summary

Reference: Fang, Xiaohua; Bougher, Stephen W.; Johnson, Robert E.; Luhmann, Janet G.; Ma, Yingjuan; Wang, Yung-Ching; Liemohn, Michael W.; (2013), The importance of pickup oxygen ion precipitation to the Mars upper atmosphere under extreme solar wind conditions, Geophysical Research Letters, Volume 40, Issue 10, pp. 1922-1927, doi: 10.1002/grl.50415