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Localized Hybrid Simulation of Martian Crustal Magnetic Cusp Regions

Yaxue Dong (1), David A. Brain (1), Riku Jarvinen (2, 3), Andrew R. Poppe (4), and Xiaohua Fang (1)
(1) Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, USA (yaxue.dong@lasp.colorado.edu), (2) Department of Electronics and Nanoengineering, Aalto University, Aalto, Finland, (3) Finnish Meteorological Institute, Helsinki, Finland, (4) Space Sciences Lab, University of California, Berkeley, CA, USA

Abstract

We present a 2-D hybrid model of the plasma environment in the Martian magnetic cusp region with a focus on the potential structures and the plasma distribution and transportation.

1. Introduction

Mars does not have a global dipole magnetic field, but has localized crustal fields [1], which plays a part in the ionosphere and solar wind interaction. The Martian crustal fields are involved in various physical processes in the induced magnetosphere, such as particle precipitation, field-aligned currents, and ion outflow. These processes usually occur in the magnetic 'cusp' regions with mostly vertically aligned and open field lines. Due to the small spatial scale of the Martian crustal magnetic cusps, localized models with high spatial resolutions and ion kinetics are needed to understand the physical processes in the cusp regions.

2. Model description

We use the HYB hybrid simulation platform developed at the Finnish Meteorological Institute. The hybrid model treats ion as particles and electrons as a neutralizing massless fluid, and calculates the electromagnetic field that is self-consistent with the ion dynamics. The HYB platform has been applied to, for example, localized simulations of lunar magnetic anomalies [2], [3]. We will adapt the HYB model to a moderately strong magnetic cusp on the nightside of Mars with a 2-D simulation domain using periodic field and particle distributions in the 3rd dimension. Two plasma sources: hot protons from solar wind and cold heavy ions from the ionosphere, will be included in the simulation.

3. Results

We will report on the plasma, electromagnetic field, and electric potential spatial distributions, as well as ion dynamics in the cusp region from the hybrid model. These results will also be compared with those from a particle-in-cell model [4] to assess the importance of electron kinetics in the cusp region.

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