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PII: S0032-0633(15)00148-8
DOI: http://dx.doi.org/10.1016/j.pss.2015.05.004
Reference: PSS3979

To appear in: *Planetary and Space Science*

Received date: 31 October 2014
Revised date: 25 March 2015
Accepted date: 11 May 2015

Cite this article as: J.G. Luhmann, Y-J. Ma, D.A. Brain, D. Ulusen, R.J. Lillis, J.S. Halekas and J.R. Espley, Solar Wind Interaction Effects on the Magnetic Fields around Mars: Consequences for Interplanetary and Crustal Field Measurements, *Planetary and Space Science,* http://dx.doi.org/10.1016/j.pss.2015.05.004

Solar Wind Interaction Effects on the Magnetic Fields around Mars: Consequences for Interplanetary and Crustal Field Measurements

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Abstract

The first unambiguous detections of the crustal remanent magnetic fields of Mars were obtained by Mars Global Surveyor (MGS) during its initial orbits around Mars, which probed altitudes to within ~110 km of the surface. However, the majority of its measurements were carried out around 400 km altitude, fixed 2AM-2PM local time, mapping orbit. While the general character and planetary origins of the localized crustal fields were clearly revealed by the mapping survey data, their effects on the solar wind interaction could not be investigated in much detail because of the limited mapping orbit sampling. Previous analyses (Brain et al., 2006) of the field measurements on the dayside nevertheless provided an idea of the extent to which the interaction of the solar wind and planetary fields leads to non-ideal field draping at the mapping altitude. In this study we use numerical simulations of the global solar wind interaction with Mars as an aid to interpreting that observed non-ideal behavior. In addition, motivated by models for different interplanetary field orientations, we investigate the effects of induced and reconnected (planetary and external) fields on the Martian field's properties derived at the MGS mapping orbit altitude. The results suggest that inference of the planetary low order moments is compromised by their influence. In particular, the intrinsic dipole contribution may differ from that in the current models because the induced component is so dominant.

Introduction

Our vision of Mars as a planet was significantly altered by the unambiguous detection of its crustal remanent magnetic fields by the Mars Global Surveyor (Acuna et al., 2001). Previous high altitude magnetic field measurements on Mariner 4 and by the USSR's Mars mission series and Phobos-2 spacecraft had indicated that if Mars had its own fields, they had minor influence on the solar wind interaction as at Venus (e.g. Luhmann et al., 1992 and references therein). Indeed, the presence of remanent fields were not so evident in the limited flyby data or in the Phobos-2 transition orbits whose ~850 km periapsis observed magnetosheath-like external field draping on the dayside. The main exception perhaps came from suprathermal electron measurements obtained from the circular orbits (at ~2.8 Rm) in the wake. These were suggested by Dubinin et al. (1994) to sometimes behave in ways not consisted with a purely induced magnetotail, but the known effects of solar wind and interplanetary field variations on induced magnetotails –and the limited duration of the Phobos-2 mission- prevented any certain conclusion from those observations. At the same time, the radio occultation results from Viking and Mariner 9 missions in particular showed a relatively robust dayside ionosphere whose