# Observing Magnetic Fields and Currents at the Night and Terminator Sides of Mars Through the Mars Global Surveyor Data

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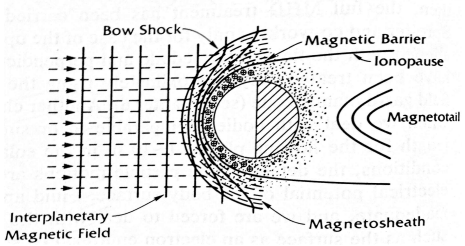
## I. Abstract

Mars has no global magnetic field. Changes in the solar wind and interplanetary magnetic field (IMF) can impact the upper atmosphere and induce currents in the ionosphere of Mars. During aerobraking maneuvers, Mars Global Surveyor (MGS) made over 1000 passes through Mars's ionosphere. During these passes, MGS measured the local magnetic field. From these measurements, we can determine the ionospheric currents. We restrict our analysis to passes where the radial component of the magnetic field is nearly zero. This restriction, along with some assumptions about the gradients in the magnetic field, allows us to estimate the horizontal ionospheric currents. Additionally, we focus on the magnetic field data acquired over regions above negligible crustal magnetic fields in order to simplify the analysis. At a maximum altitude of 250 km, the Mars map was segmented to 30 by 30 degrees east longitude and latitude for analysis. We find that on the night side, where the solar zenith angle (SZA) lies between 130 to 180 degrees, only 4% of the data is usable for computing currents, that is the radial component of the magnetic field is nearly zero. We also find that near the terminator, where the SZA lies between 50 to 130 degrees, an average of 2% of the magnetic field profiles are usable to compute currents. The currents computed from these profiles can give us insights into how the changing solar wind and interplanetary magnetic field can affect the upper atmosphere of Mars. For example, induced currents can lead to Joule heating of the atmosphere potentially modifying the neutral dynamics.

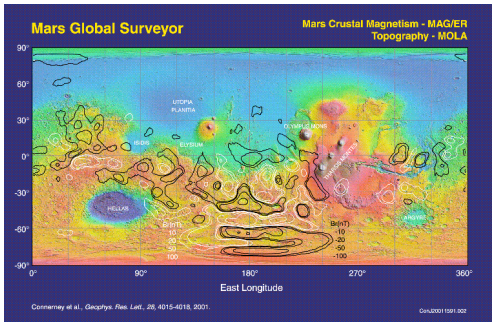
## II. Introduction

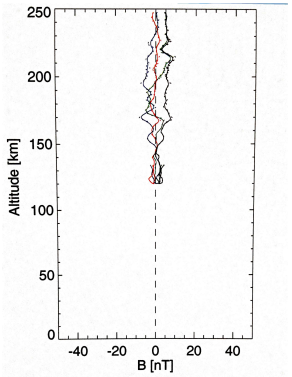
Mars is the fourth planet of our solar system. It is a terrestrial planet that is found to have a significant atmosphere of ions or charged particles called the ionosphere. The ionosphere is believed to be a source of current produced by the interaction of the solar wind plasma carrying a magnetic field interacting with the charged particles.




The Mars Global Surveyor data from the 1000 orbits around Mars was utilized to observe magnetic profiles for night side and terminator at a maximum altitude of 250 km. In order to detect significant current profiles for particular magnetic profiles, the radial component of the magnetic field must be around zero. The radial component of the magnetic field profile must be less than 5 nT. This provides the output of horizontal current profiles for its parallel and perpendicular components.

## III. Observations

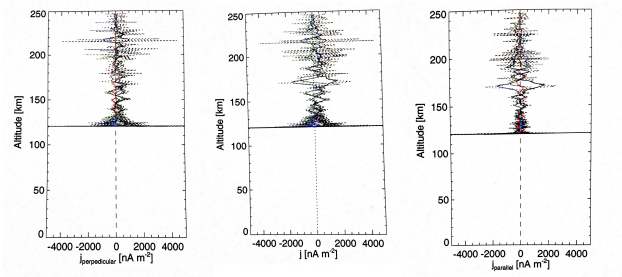



Elon_range [270, 300]
Lat_range [30, 60]
SZA [50, 130]
Alt [0, 250]

The terminator side gives decent magnetic profiles that are within the range of what is considered to be good data. Meanwhile, the night side of Mars shows no significant magnetic profiles that would produce relative current profiles.

## IV. Results




A good magnetic profile from the terminator side demonstrates a radial component that lies between zero and 5 nT produces promising current profiles. These current profiles are shown to exist where crustal fields, which are remnants of Mars' former global magnetic field, may no longer have a great influence.

At the night side of Mars, great magnetic field profiles were projected only at the presence of crustal fields. There is no indication of any particular magnetic field, that falls within the range of the limits from where the radial component must be less than 5 nT, that would produce currents due to ionospheric interactions.

## V. Future Work

The Mars Atmosphere and Volatile Evolution was launched in 2013 and will be taking data on September 2014. Data that is acquired can be used to determine currents from ionospheric activities more accurately.

## VI. Bibliography

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Fillingim, Matthew. "Scientific/Technical/Management Section". *Proposal to the NASA ROSES 2013 NINH13ZDA001N-MDAP: Mars Data Analysis*. 2013. Print.

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