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Comparisons between InSight IFG Surface Magnetic Field Measurements and MAVEN Observations

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Abstract

Variations in the surface magnetic field measured by the InSight Flux Gate magnetometer (IFG) can be related to changes in the plasma environment around Mars measured by MAVEN. Simultaneous measurements can help reveal these relationships.

InSight IFG Observations

With the landing of the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission on Mars in late 2018, magnetic field measurements from the surface of Mars can be made for the first time. The main purpose of the InSight Flux Gate magnetometer (IFG) is to measure the local magnetic field in order to remove magnetic field effects from the seismometer recordings. IFG measures the ambient magnetic field which has contributions from several sources including crustal magnetization, spacecraft generated fields, induced fields, and fields from ionospheric currents.

Large daily variations (several tens of nT) in the measured magnetic field are observed. Even though these large diurnal variations result primarily from spacecraft currents, significant diurnal variations resulting from changes in the interplanetary magnetic field (IMF) and solar wind still remain after spacecraft fields are removed. There are occasional prominent sol-to-sol variations in the nominal diurnal pattern. Additionally, shorter timescale variations down to frequencies of a few Hz are observed.

MAVEN Observations

The Mars Atmosphere and Volatile Evolution (MAVEN) mission, in an elliptical orbit around Mars since late 2104, carries a suite of plasma instruments as well as the only currently operating magnetometer in orbit. MAVEN measures the plasma properties and magnetic field as the spacecraft passes through the various plasma regimes around Mars including the solar wind, magnetosheath, magnetotail, and ionosphere.

InSight-MAVEN Comparisons

For the first time, we are able to compare changes in the plasma environment around Mars to changes in the surface magnetic field in order to determine the sources of the variability in the surface magnetic field. Here we mainly focus on variations in the solar wind and IMF as measured by MAVEN and the impact that these variations have on the surface level magnetic field as measured by InSight. Variations in the solar wind and IMF can modify ionospheric currents in the upper atmosphere. Changes in these currents reveal themselves as perturbations in the surface level magnetic field. Figure 1 shows the modeled variation in the surface magnetic field (red and blue lines) due to changing ionospheric currents (orange) over the course of a day [1]. We compare these predictions to simultaneous MAVEN and IFG observations.

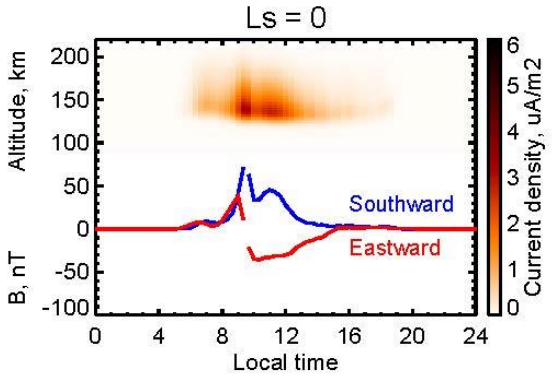

Figure 1: Modeled surface level magnetic field perturbations (red and blue lines) due to changing ionospheric currents (from [1]).

References

[1] Lillis, R. J., et al.: Modeling wind-driven ionospheric dynamo currents at Mars: Expectations for InSight magnetic field measurements, Geophys. Res. Lett., Vol. 46, doi:10.1029/2019GL082536, 2019.