Comparison Between Equatorial Ionospheric and Surface Level Magnetic Fields at Mars

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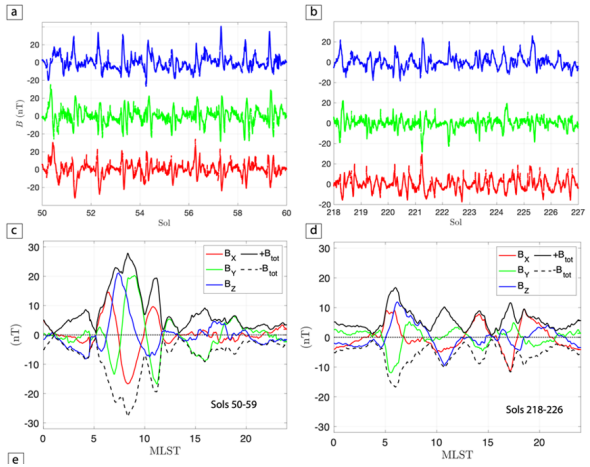
InSight/IFG

The Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport (**InSight**) mission landed on Elysium Planitia (4.5 N, 135.6 E) in November 2018 carrying the InSight FluxGate magnetometer (**IFG**), **the first magnetometer on the surface of Mars**.

IFG is sensitive to equatorial* ionospheric currents which change over the course of a day and over the course of weeks (see Johnson et al., *Nat. Geosci.* [2020] and Mittelholz, this conference).



MAVEN Overflights

Since September 2014, the Mars Atmosphere and Volatile Evolution (**MAVEN**) mission has been measuring the upper atmosphere and plasma environment around Mars.

Due to orbital precession, MAVEN periapsis (~ 150 km) passes over the latitude of InSight every 5 to 6 months.

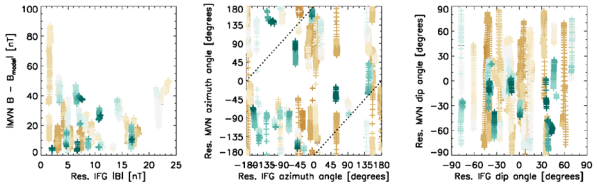
During overflights MAVEN measures the **ionospheric** magnetic field (very nearly) directly overhead InSight while InSight simultaneously measures the **surface level** magnetic field.

Comparing ionospheric and surface level magnetic fields gives us information about the ionospheric currents flowing between the measurement points.

We analyze 36 overflights over 4 seasons when MAVEN was below 300 km and within +/- 5° (~ 300 km) of InSight and data are available from both spacecraft: https://bit.ly/3pb5KGN.

Altitude Dependence

We compare the ***residual*** IFG magnetic field (static field subtracted) to the ***residual*** MAVEN field (model* field subtracted):
→ **compare surface ΔB to ionospheric ΔB.**
(*crustal field model of Langlais et al., 2019)



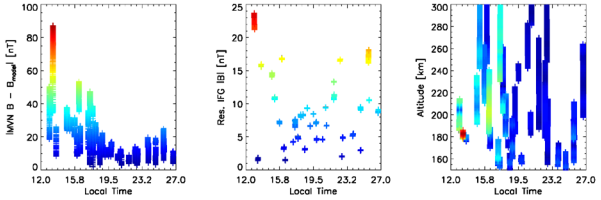
Color-coded by MAVEN altitude: brown shades < 200 km (in the **ionospheric dynamo region**; blue shades > 200 km (above the dynamo); white ~ 200 km.

If ΔB due to ionospheric currents, then ΔB at the surface should be 180° in azimuth away from ΔB above the ionosphere (blues); expect points to fall along dashed lines in the middle panel.

But **no clear correlations** are seen between the residual surface field and residual ionospheric field magnitude, azimuth angle, or dip angle. May indicate that currents are weak, small scale, and/or time varying.

Local Time Dependence

There is evidence of local time dependence in the magnitude of the residual magnetic fields



Magnitude of the ionospheric (left) and surface (middle) residual fields as a function of local time color coded by magnitude; altitude of the ionospheric observations as function of local time (right) colored coded by magnitude of the residual ionospheric field.

Largest residual fields at MAVEN (left) and InSight (middle) occur near local noon. [But not at the same time; the "red" interval in the left and middle panels is not the same]

The right panel shows that the strongest residual ionospheric fields occur in the daytime (LT < 18) at altitudes below 200 km.

This is in agreement with expectations; strongest ionospheric currents (hence ΔB) should occur on the dayside (where ionospheric densities are largest) in the dynamo region (where currents are driven).

*Granted, "equatorial" doesn't have quite the same connotation at Mars due to the lack of a global dipole field. However, the magnetic field is predominantly horizontal (at least on the dayside) such as near the magnetic equator at magnetized planets.