EGU21-8339
https://doi.org/10.5194/egusphere-egu21-8339
EGU General Assembly 2021

Variability of the interplanetary magnetic field as a driver of electromagnetic induction in Mercury's interior

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Mercury's magnetosphere is considered to be a unique and dynamic system, primarily due to the proximity of the planet to the Sun. The interaction between solar wind and embedded Interplanetary Magnetic Field (IMF) and the dayside Hermean magnetosphere drive an electric current on the magnetopause boundary of the system. The influence of the time-dependent magnetic field generated by this magnetopause current on Mercury's interior is key to understanding the subsurface structure of the planet, as electromagnetic induction is a valuable technique for delineating electrical properties of planetary interiors. Here we assess the impact a changing IMF direction has on the Hermean magnetopause currents, and the resulting inducing magnetic field. Analytical models of conditions at the magnetopause are combined with measurements made by MESSENGER's magnetometer as the spacecraft crossed the subsolar magnetopause boundary during the first 'hot season'.

These MESSENGER magnetopause boundary crossings show that the introduction of the external IMF changes the direction of the magnetopause current by ~50°, compared to the case where only the internal planetary field is considered. Analytical modelling suggests that for a heliospheric current sheet crossing without any change in solar wind dynamic pressure (an east-west reversal of the IMF polarity typical at Mercury), the inducing field at Mercury's surface caused by the resulting magnetopause current sheet dynamics is of the order of 10% of the global planetary field. The results suggest that variability of the IMF alone can have an appreciable effect on Mercury's magnetopause current direction and generate a significant inducing magnetic field around the planet. The arrival of the BepiColombo mission will allow this response to be further explored as a method of probing Mercury's interior.