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Interaction of Solar Wind and Magnetic Anomalies – Modelling from Moon to Mars

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The crustal magnetic anomalies on both the Moon and Mars strongly affect the local plasma environment. On the Moon, the impinging solar wind is decelerated or deflected when interacting with the magnetic field anomaly, visible in the lunar surface as energetic neutral atom (ENA) emissions or as reflected protons, and may play a part in the space weathering of the lunar soil. At Mars, the crustal magnetic fields have been shown to be associated with, e.g., enhanced electron scale heights and modified convection of ionospheric plasma, resulting in the plasma environment being dominated by crustal magnetic fields up to altitudes of 400km.

Our previous modelling work suggested that Hall currents are a dominant feature in a Moon-like magnetic anomaly interaction at scales at or below the proton inertial length. In this work we study the solar wind interaction with magnetic anomalies and compare the plasma environments of a Moon-like anomaly with a Mars-like anomaly by introducing an ionosphere and an exosphere to probe the transition from an atmosphere-less anomaly interaction to an ionospheric one.

We utilize a 3D hybrid plasma model, in which ions are modelled as particles while electrons form a charge-neutralizing massless fluid. The hybrid model gives a full description of ion kinetics and associated plasma phenomena at the simulation region ranging from instabilities to possible reconnection. The model can thus be used to interpret both in-situ particle and field observations and remotely-sensed ENA emissions. A self-consistent ionosphere package for the model is additionally in development.