MagVector/MFX-2 – a Planetary Laboratory on the International Space Station (ISS): Electromagnetic Simulation and Inversion of Magnetic Field Data from Planetary and Asteroid Analogs

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SUMMARY

The MagVector/MFX-2 experiment was conducted in 2018 as part of Alexander Gerst's horizons mission on the International Space Station (ISS). It was planned and led by the German Space Agency at DLR and developed and built by Airbus Defense and Space GmbH with funds from the Federal Ministry for Economic Affairs and Energy. Its main objective was to enlarge the number of sensors for measuring effects of the Magvector/MFX core. Furthermore, the new sensor array gave an excellent opportunity to host 13 different material and planetary rock samples, for the first time measuring possible interactions with magnetic fields when travelling with orbital velocity in a laboratory experimental setup onboard the ISS. The magnetic environment around the samples was continuously monitored by 32 sensors measuring the magnetic flux density in three components. The meteorite samples and sample preparation were provided by the Museum für Naturkunde Berlin. The collected data material has been investigated using simulation and inversion software developed at the TU Freiberg. Here, we are going to report about the results of these virtual experiments that aim at reconstructing and understanding the observed magnetostatic and inductive responses generated by the samples. The magnetic susceptibility of the samples was successfully recovered by a newly developed magnetostatic inversion algorithm after preprocessing the data to remove unphysical signal components. Furthermore, we have carried out a series of induction experiments using our Nédélec finite element unstructured tetrahedral mesh time-domain forward modeling code. Both codes allow for a highly accurate incorporation of the experimental geometry and the shape of the samples. The induction experiments showed that a significant inductive effect of the samples at the nearest sensor location cannot be expected below 1 to 10 kHz. Based on these findings, the method can be scaled up for the investigation of larger objects.

Keywords: International Space Station (ISS), horizons mission, MFX-2 experiment, terrestrial planets, asteroids, magnetostatics, electromagnetic induction, numerical simulation