Magnetic field experiment at Jupiter icy moons (JUICE J-MAG) and in-flight alignment calibration

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The magnetometer instrument (J-MAG) is one of the core instruments on the JUICE spacecraft and is critical for resolving prime science objectives of the mission. The importance of a magnetometer instrument on JUICE can be described under following themes. Firstly, the magnetic field drives the plasma processes occurring within the Jupiter system. Understanding such observations allows for a better understanding of dynamical plasma processes, of the generation of aurora and of the various current systems which arise within this rapidly rotating magnetosphere. Secondary, the magnetometer science which is unique to JUICE lies in being able to gain an understanding of the interior structure of the icy moons of Jupiter, specifically those of Ganymede, Callisto and Europa. Of particular interest are knowledge of the depth at which the liquid oceans reside beneath their icy surfaces, the strength of any internal magnetic fields such as at Ganymede and the strength of any induced magnetic fields arising within these oceans.

J-MAG science requirements result in a requirement on the spacecraft to determine accurate knowledge of the orientation of the fluxgate sensors (MAGIBS and MAGOB). Due to the long MAG boom it is not possible to meet J-MAG’s alignment requirement by mechanical stability alone, therefore the spacecraft includes two orthogonal coils mounted around its body. The coils can be driven with a current which produces a measurable magnetic field vector at the fluxgate sensors. This signal can then be used by the fluxgates to track the variation in the sensor alignment. This technical note describes the results of an analysis using an alignment recovery technique that was developed for the Kaguya mission, applied to the specific case of JUICE, considering the relative positions of the fluxgate sensors with respect to the JACS coils.

We derived equations to calculate the directions of the measurement axes in the frame fixed to the spacecraft, namely alignment angles, from the measurement results of reference magnetic fields generated by JACS. The errors of the alignment angle estimation and their dependence on measurement noise as well as inaccuracy of the coil current intensity are examined. Based on the quantitative results, the requirements to the JACS design and operation to satisfy the requests to the alignment accuracy are determined.

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