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GENERAL OVERVIEW OF NEAR-EARTH MAGNETIC ANOMALY EFFECTS ON SATELLITE ATTITUDE ESTIMATION

Abstract

This research provides a broad overview of several geomagnetic field models that are evaluated in order to investigate the errors caused by the representation of magnetic fields. To investigate the variations in the magnetic field components, intensity, and angle between the predicted and observed vector magnetic fields, magnetometer data from low Earth orbit satellites and geomagnetic models are first compared. To expose the impact of geomagnetic storms and substorms on the predicted and observed magnetic fields and angles, comparisons were done during geomagnetically active and quiet days. The angles are then used to estimate the spacecraft attitude, therefore the discrepancies between the model and the observations as well as between two models become crucial for finding out and minimizing the model-related errors under various space environment circumstances. The impacts of the near-Earth space environment on the satellite's attitude are examined using the geomagnetic models. Under both active and quiet environment conditions, the attitude error was found to be less than one degree. For magnetically active and quiet conditions, a variety of sensor combinations, including magnetometer, gyroscope, and sun sensor, are assessed for the estimated attitude angles. The significance of environmental elements for satellite attitude determination systems is emphasized. It is also significant to discuss about the limitations of the models and measurements that are being employed. Many error causes, like as bias in magnetometer data, may be corrected during ground tests before to spacecraft launch or during in-orbit calibration following launch. The magnetometers used in this study are presumably calibrated against biases and scaling errors. However, much like all other sensors, magnetometers have measurement noise. Depending on the selected sensor, the standard deviation of magnetometer measurement noise in small satellites might vary by up to two orders of magnitude (such as from 3nT to 300 nT). This could be as a result of the magnetometer's specifications for a particular mission, which might include price, size, accuracy, etc. Due to this discrepancy, the sensor itself may become a significant source of error. The external field may be suppressed and not reflected in the magnetic field readings if the magnetometer's noise level is high enough. This paper's objectives are to provide a detailed evaluation of these concerns and a broad overview for selecting the appropriate model for a specified noise level in attitude estimation applications. A thorough examination is performed for this purpose under various levels of magnetic activity and measurement noise.