Orbit determination for the MICROSCOPE mission: specificities and performance

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Keyword: orbit determination, MICROSCOPE, drag-free, G-SPHERE-S, one-way Doppler

MICROSCOPE is a CNES 300-kg satellite launched in April 2016 into a 710km sun-synchronous orbit. The mission is a two-year in-orbit experimentation in collaboration with ONERA/OCA/ESA. The scientific objectives consist in testing the Weak Equivalence Principle with an accuracy never reached before. This challenge requires that the satellite follows the payload – a differential electrostatic accelerometer - in its pure gravitational motion: the external surface forces and torques are counterbalanced continuously thanks to a specific Acceleration and Attitude Control System and cold gas micro-thrusters.

CNES provides the accurate orbit determination (OD) which is needed to process the scientific data. This OD uses the CNES reference tool for operational Precise OD (ZOOM), and is based on GPS single-frequency measurements with one-way Doppler data as a back-up. The GPS data comes from a new spatial receiver, G-SPHERE-S, developed by SYRLINKS (FRANCE) from a CNES R&T program, and making its first flight on MICROSCOPE.

After a presentation of the mission, the specificities of the MICROSCOPE orbital dynamics (such as drag-free and satellite spin) are described. Cross-comparisons between modelled and measured satellite accelerations are discussed with respect to their contributions during the commissioning phase and for the payload in-orbit calibration.
The analysis of G-SPHERE-S first in-flight data has already enabled to improve the on-board software of the receiver and the current performance is presented here. The GPS-based OD accuracy is then assessed using the ionosphere-free combination (GRAPHIC) of C/A code and L1 carrier phase.
The error characteristics of one-way Doppler data are also examined along with a sensitivity study to the on-board OCXO temperature. It is showed that a sub-metric performance of the OD based on these conventional one-way Doppler data can be reached.