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Reducing Pointing Induced Errors in the GRACE Follow-On Laser Ranging Measurement Using Dedicated Calibration Maneuvers

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The GRACE Follow-On mission, planned for launch in early 2018, will place a pair of identical satellites in a low Earth orbit, one trailing the other. The scientific goal of the mission is to derive the Earth's variable gravity field from inter-spacecraft distance variations, measured with high precision via laser interferometry. This measurement will be contaminated, however, by errors introduced from satellite pointing inaccuracies. Here we show how the measurement can be significantly improved by calibrating this error source using dedicated satellite maneuvers. Firstly, we show that the main error in the ranging measurement comes from terms linear in the spacecraft pitch and yaw angles, with the roll angle and second-order terms contributing much smaller errors. Secondly, we use simulations of the spacecraft dynamics equations to demonstrate that simple rotation maneuvers will produce brief sinusoidal angle excitations of pitch and yaw, thereby allowing accurate error estimation. Finally, we describe how this estimate can be exploited, using suitable processing techniques, to reduce the pointing induced ranging error level to about 100nm/rtHz at 1 mHz and dropping with 1/f2 towards higher frequencies.