Using the Flow-3D General Moving Object Model to Simulate Coupled Liquid Slosh - Container Dynamics on the SPHERES Slosh Experiment aboard the International Space Station

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The SPHERES Slosh Experiment (SSE) is a free floating experimental platform developed for the acquisition of long duration liquid slosh data aboard the International Space Station (ISS). The data sets collected will be used to benchmark numerical models to aid in the design of rocket and spacecraft propulsion systems. Utilizing two SPHERES Satellites, the experiment will be moved through different maneuvers designed to induce liquid slosh in the experiment's internal tank. The SSE has a total of twenty-four thrusters to move the experiment. In order to design slosh generating maneuvers, a parametric study with three maneuvers types was conducted using the General Moving Object (GMO) model in Flow-3D. The three types of maneuvers are a translation maneuver, a rotation maneuver and a combined rotation translation maneuver. The effectiveness of each maneuver to generate slosh is determined by the deviation of the experiment's trajectory as compared to a dry mass trajectory. To fully capture the effect of liquid re-distribution on experiment trajectory, each thruster is modeled as an independent force point in the Flow-3D simulation. This is accomplished by modifying the total number of independent forces in the GMO model from the standard five to twenty-four. Results demonstrate that the most effective slosh generating maneuvers for all motions occurs when SSE thrusters are producing the highest changes in SSE acceleration. The results also demonstrate that several centimeters of trajectory deviation between the dry and slosh cases occur during the maneuvers; while these deviations seem small, they are measureable by SSE instrumentation.