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Using Superconducting Gravimeter iGrav for detecting small mass change in field measurements (a case study)

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A number of geophysical and geodetic measuring techniques can be used to monitor phenomena related to geohazards and geodynamics at the earth surface, but are unable to observe subsurface mass transfer of man-made or natural origins. Because of drift and low signal resolution, a spring-type gravimeter has limited applications in areas such as monitoring geological CO_2 storage, hydrocarbon reservoirs, and episodic tremor and slip (ETS). The drift and resolution problems make it even more complicated to detect non-periodic gravity signals that are associated with mass change. These limitations may be overcome by deploying a superconducting gravimeter (SG) such as i'Grav. i'Grav uses a magnetically levitated sphere as a test mass, and has considerably lower drift and a higher sensitivity in the time and frequency domains than conventional spring gravimeters. With these attributes, SG is able to record precise and continuous gravity variations over a long time for monitoring gravity change caused by geohazards and geodynamics activities. Parallel GPS and gravity records are necessary to explain the surface and subsurface movement.

In order to determine offsets in the gravity signals due to horizontal and vertical movement of the gravity instruments, we performed various lab experiments with iGrav (#001) and Micro-g LaCoste's absolute gravimeter A10 in a quiet indoor environment (UofC). We used a professional camera dolly with a track and an electric lift table for a controlled movement to take gravity measurements at different locations. Offsets up to a 0.68 μGals due to the 210 pounds are placed on the top of iGrav. In our simulation, we concluded that the gravimetric method can be used to monitor surface gravity change at μGal level, which ETS is found to be associated with surface deformation at a few millimeters at a site Cascadia Subduction Zone.