Geophysical Research Abstracts
Vol. 16, EGU2014-3445, 2014
EGU General Assembly 2014

Interest of a combined electrostatic/cold atoms gradiometers configuration for airborne geodesy

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During these two last decades, the knowledge of the gravity field of the Earth has been considerably improved thanks to global positioning satellites constellations and to recent space gravity missions. However these gravity data do not address spatial resolution shorter than 90 km. Taking advantage of technologies, developed by ONERA for the GRACE and GOCE space missions, the GREMLIT airborne gravity gradiometer is more particularly developed to complete them at the short wavelengths in particular in the areas where spatial distribution and quality of ground data remain quite uneven like for example land/sea transition. Built using a double planar electrostatic gradiometer with eight proof-masses in a cubic configuration, the GREMLIT instrument is mounted on a dedicated stabilized platform which is controlled by the common mode outputs of the instrument itself to achieve a sufficient rejection ratio of the perturbations/vibrations induced by the airborne environment in the horizontal directions. The levitation of the proof-masses along the normal gravity and the vibration isolation of the platform are designed to allow the instrument to support 1g $\pm$ 1g along the vertical axis. In addition to be well suited to sustain the proof-mass levitation in the Earth's gravity field, the planar configuration of each accelerometer also presents an intrinsic linearity of the horizontal control loops which minimizes the aliasing due to high frequency vibrations or motions generated outside the measurement bandwidth. Taking into account the estimated performance of the platform and associated with its additional attitude and angular rate sensors, the gradiometer differential measurements along the two horizontal axes provide the necessary information to extract 5 of the 6 components of the gravity gradient tensor at the location of the instrument with a performance objective better than 1 Eötvös along the two Txx and Tyy horizontal components. The last vertical Tzz component of the gravity gradient tensor is nominally deduced from the null trace property. But using cold atoms interferometry along this vertical axis and combining its data (gravity gradient and absolute gravity magnitude) with the ones provided by GREMLIT can induce a very fruitful improvement for both instruments. A combined configuration based the GREMLIT electrostatic gradiometer associated with the GIBON cold atoms interferometer, both under development in ONERA's Physics Department, will be proposed. In spite of an increased technological complexity, the theoretical interest of such a configuration is to associate the high resolution of the electrostatic instrument with the absolute stability of the cold atoms interferometer.