

# Estimation of gravity field using moving vector gravimetry and Kalman filtering

In geodesy, it is important to know the gravity field, particularly for determination of high resolution geoid models. However, application domains of gravimetry are beyond the usual physical geodesy. Indeed, mass transfers at surface or inside the Earth modify the terrestrial gravity field, and those variations can be determined using modern gravimetry techniques. Thus, measuring spatial and time variations of the gravity field allow us to define not only the inner structure of the earth, but also to follow time variations of several phenomena such as deformations induced by earthquakes, oceanic circulation or evolution of ice sheets.

Today, global models of gravity fields, given as spherical harmonic expansion are built from all the measurements provided by spatial, terrestrial or marine gravimetry and spatial altimetry. All those techniques cover the entire earth. But, the wavelength covered by those techniques are different, and gaps exist. Nowadays, spatial resolution is about 125 km for model GGM02S using GRACE satellite. This resolution should attain 100 km with data acquired with GOCE satellite in 2008. Satellite altimetry permits to determine the gravity field over oceans at a resolution of 10 km, but coastal regions (a band of 50 km along the coast) cannot be measured with such a technique. Terrestrial and marine gravimetry can reach high resolutions of few kilometres but only on limited areas. Furthermore, some regions which are difficult to access like volcanos, islands, and regions of deserts or dense vegetation (Amazonian forest) have nearly no gravity measurements. Thus, the gravity field of those regions can be only determined with resolutions of satellite gravimetry. The resolutions between 10 and 100 km, unreachable with satellite techniques are still poorly covered with terrestrial or marine gravimetry. Computation of global gravity field (under 10 km resolution) or local models in interesting regions for geodynamics need a densification of the measurements for wavelengths between 10 and 100 km and a better coverage in regions with a lack of data.

To acquire those data, the IGN (Institut Géographique National) with the collaboration of the ESGT (Ecole Supérieure des Géomètres et Topographes) develop an autonomous system of moving vector gravimetry usable on terrestrial vehicles, boats or planes. The system is composed of three high resolution accelerometers mounted on a triad in order to have their sensitive axes non coplanar, to measure the components of the specific force. The determination of the movement of the vehicle and its attitude is obtained respectively with a dual frequencies GPS receiver and a 4 antenna GPS receiver. The rest of the system is custom made and has no equivalent on the market. The overall system is budgeted at 50000 euros which is far less expensive than classical gravimetric apparatus.

This presentation will describe the system, its physical design and a processing method based on a Kalman filter. The choice of the filter parameters (noise models) is based on the analysis of a synthetic model deduced by interpolation of real position, attitude and gravity measurements. Forces and weakness of this method and its consequences on the estimation of the gravity field will be discussed and illustrated using a simulation of marine gravity data.