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Mapping the gravity field in coastal areas: feasibility and interest of a new airborne planar gradiometer concept

Karim Douch (1,2), Isabelle Panet (3), Bernard Foulon (1), Bruno Christophe (1), Gwendoline Pajot-Métivier (3), and Michel Diament (2)

(1) DMPH, ONERA, Châtillon, France, (2) IPGP, Paris, France, (3) LAREG, IGN, Paris, France

Satellite missions such as CHAMP, GRACE and GOCE have led to an unprecedented improvement of global gravity field models during the past decade. However, for many applications these global models are not sufficiently accurate when dealing with wavelengths shorter than 100 km. This is all the more true in areas where gravity data are scarce and uneven as for instance in the poorly covered land-sea transition area. We suggest here, in line with spatial gravity gradiometry, airborne gravity gradiometry as a convenient way to amplify the sensitivity to short wavelengths and to cover homogeneously coastal region. Moreover, the directionality of the gravity gradients gives new information on the geometry of the gravity field and therefore of the causative bodies. In this respect, we analyze here the performances of a new airborne electrostatic acceleration gradiometer, GREMLIT, which permits along with ancillary measurements to determine the horizontal gradients of the horizontal components of the gravitational field in the instrumental frame. GREMLIT is composed of a compact assembly of 4 planar electrostatic accelerometers inheriting from technologies developed by ONERA for spatial accelerometers.
After an overview of the functionals of the gravity field that are of interest for coastal oceanography, passive navigation and hydrocarbon exploration, we present the corresponding required precision and resolution. Then, we investigate the influence of the different parameters of the survey, such as altitude or cross-track distance, on the resolution and precision of the final measurements. To do so, we design numerical simulations of airborne survey performed with GREMLIT and compute the total error budget on the gravity gradients. Based on this error analysis, we infer by a method of error propagation the uncertainty on the different functionals of the gravity potential used for each application. This finally enables us to conclude on the requirements for a high resolution mapping of the gravity field in coastal areas.