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Gravity from space by Cold Atom Interferometry: the MOCASS study and preliminary results

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MOCASS (Mass Observation with Cold Atom Sensors in Space) is an on-going study project funded by the Italian Space Agency in the framework of preparatory activities for future missions and payloads of Earth Observation. The object of the proposal is an innovative satellite gravity mission based on advanced cold atom interferometry (CAI) accelerometers, with the aim of modelling the static and time-variable gravity field of the Earth with high accuracy and resolution and of monitoring mass variations that occur on and below the Earth surface.

The basic idea is a GOCE mission follow-on, launching a unique spacecraft with an on-board instrument capable of measuring some functionals of the Earth gravitational potential. The improvement with respect to the GOCE mission concept can only be achieved by going beyond the technology of electrostatic gradiometers, taking advantage of a new generation of sensors, such as cold atom interferometers. In the framework of the MOCASS study, the instrument characteristics are defined in terms of long-term stability, accuracy, and spectral responses. Then simulations on gravity field recovery based on the space-wise approach already used for the GOCE data processing are implemented. Finally an analysis on the geophysical signals that can be detected given the simulated mission performance are performed, with particular attention to hydrologic and tectonic modelling of changing masses.

First simulations have already been performed by considering the GOCE orbit parameters but assuming that a CAI gradiometer is on board the spacecraft. This allows direct comparisons between GOCE and MOCASS performances. Instrument error spectra have been defined depending on the orbit and CAI configurations, all of them characterized by a flat error spectrum in the low frequencies, differently from the one of the GOCE electrostatic accelerometers. Given the error spectrum and the interferometer integration spectral response, simulated observations have been produced and processed by the space-wise approach, which basically consists in a sequential application of a Wiener filter, a local collocation gridding and a spherical harmonic analysis. From sample statistics, the accuracy of the recoverable gravity field model can then be evaluated and compared with the expected gravity signal from selected geophysical phenomena, e.g. orogen geodynamics and glacier melting.

Although the study is at this time not complete, these preliminary investigations show promising results.