EARTH OBSERVATION SYMPOSIUM (B1)
Future Earth Observation Systems (2)

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THE MEASUREMENT OF EARTH'S GRAVITY FIELD AFTER THE GOCE MISSION

Abstract

GOCE (Gravity Field and Steady-State Ocean Circulation Explorer), the first Earth Explorer Core Mission in ESA's Living Planet programme, is now ready for launch. Employing an ultra-sensitive gradiometer on a very low altitude orbit in along-track drag-free condition, within about 2 years GOCE will provide global and regional models of the Earth's gravity field and of the geoid to unprecedented spatial resolution and accuracy, allowing to deepen our understanding of the Earth's interior physics, of the interaction of the continents and of the ocean circulation. Meanwhile, new requirements for monitoring the temporal variations of gravity with a spatial resolution similar to GOCE, but over much longer time periods than the lifetime of GOCE, are emerging. They are driven by the need to detect long term periodicity and trends in geophysical phenomena that involve large mass redistributions (e.g. melting of the polar ice sheets, changes in continental water storage, etc). These observations, as demonstrated by the GRACE mission, are extremely valuable for a better understanding of climate change. Since 2003, the European Space Agency (ESA) has initiated studies to establish the scientific requirements and to identify the most appropriate measurement techniques and system scenarios for a future space gravimetry mission aimed to provide this information. From these studies, three of which were led by Thales Alenia Space Italia (TAS-I), it emerged that a very promising technique for such a mission is the so-called Low-Low Satellite-to-Satellite Tracking based on laser metrology. The distance variations between two satellites flying in formation in a low-Earth orbit are measured by a laser interferometer. The non-gravitational (drag) accelerations acting on the satellites are also measured by means of accelerometers. From these observables, the information on the gravity variations (in space and time) that produced the inter-satellite distance changes can be derived. The large distance between the satellite (of the order of 10 km) and the very high resolution of the laser interferometer (of the order of 1 nanometer) makes this measurement system very sensitive to the tiny variations of the Earth's gravity (corresponding to a geoid variation rate of 0.1 mm/year), even at altitudes higher than GOCE where the satellites can be maintained for a much longer time. This paper presents the design of such a next-generation gravity mission and of its main

payload instrument (the laser interferometer) as defined in the studies performed the team led by TAS-I for ESA.