Gravity, magnetic field, and geodynamic instruments

Description

This ‘category’ of instruments is used here to describe a variety of sensors and supporting systems used to derive information on either the Earth’s gravity field, magnetic field, or geodynamic activity.

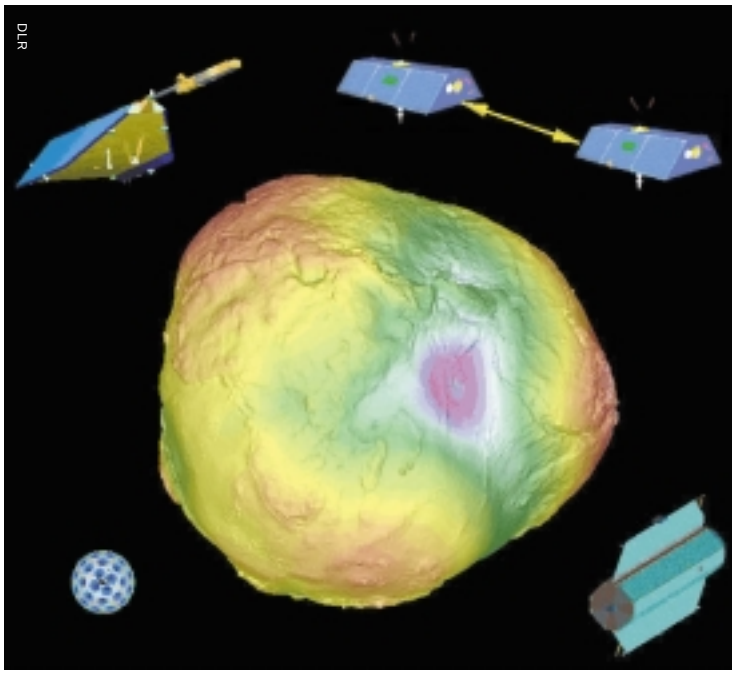
Gravity field measurements from space rely on one of three techniques:

– use of single or multiple accelerometers on one or more satellites to derive gravity or gravity gradient information;

– precise satellite orbit determination (using satellite to ground navigation systems such as GPS and satellite laser ranging systems), and separation of satellite motion induced by the Earth's gravitational force alone, from other forces (such as solar radiation and aerodynamic drag);

– satellite to satellite tracking (eg by GPS or microwave link) to measure relative speed variations of two satellites induced by gravitational force.

Satellite-borne magnetometers provide information on strength and direction of the internal and external Earth’s magnetic field and its time variations.



LAGEOS, CHAMP, GRACE, GOCE all provide new insights into Earth's gravity field.

Applications

Gravity field measurements from space provide the most promising advances for improved measurement of the ‘geoid’ and its time variations. The geoid is the surface of equal gravitational potential at mean sea level, and reflects the irregularities in the Earth's gravity field at the Earth's surface due to the inhomogeneous mass and density distribution in the Earth's interior.

More accurate models of the static mean geoid and its temporal variability are vital for:

– a precise marine geoid, needed for the quantitative determination, in combination with satellite altimetry, of absolute ocean currents and their transport of heat and other properties;

– a unified global height reference system for the study of topographic processes, including the evolution of ice-sheets and land-surface topography;

– new understanding of the physics of the Earth´s interior;

– estimates of the thickness of the polar ice sheets and its variations – through combination of bedrock topography derived from gravity measurements and ice-sheet surface topography from altimetry;

– estimates of the mass/volume redistribution of freshwater in order to further understand the hydrological cycle;

– improved understanding of post-glacial rebound processes on a global scale.

Magnetic field measurements are also valuable in a range of applications, including navigation systems, resource exploration drilling, spacecraft attitude control systems, and assessments of the impact of ‘space weather’ caused by cosmic particles.

The precision location capabilities of satellite laser ranging systems, DORIS and GPS are also used, sometimes in combination with interferometric SAR (INSAR), in support of studies of crustal deformation, tectonic movements, and Earth’s spin rate.

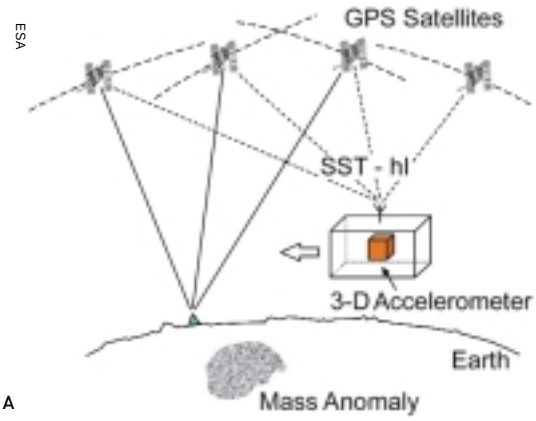
CHAMP: op.gfz-potsdam.de/champ/index_CHAMP.html

GRACE: essp.gsfc.nasa.gov/grace/

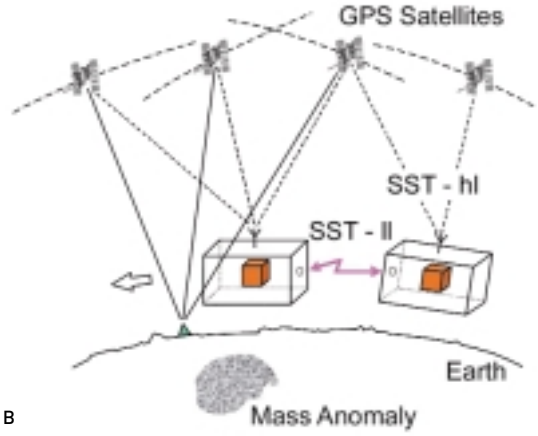
GOCE: www.esa.int/export/esaLP/goce.html

FEDSAT: www.crcss.csiro.au/fedsat1.htm

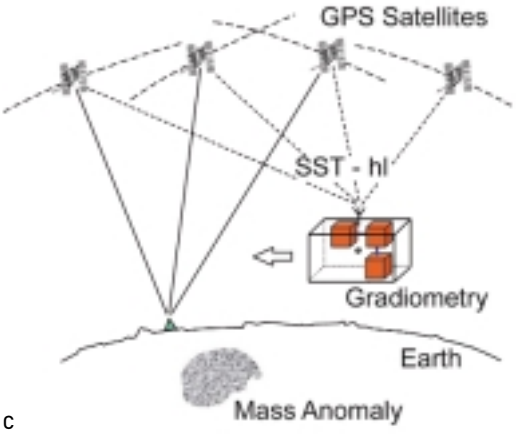
ESA



A



B



C

Concept of satellite-to-satellite tracking in the high-low mode (SST-hl). A low Earth orbiter is tracked by the high orbiting navigation satellites, relative to a network of ground stations. Non-gravitational forces on the low orbiter are measured by accelerometry; b). Concept of satellite-to-satellite tracking in the low-low mode (SST-ll) combined with SST-hl. The relative motion between two low orbiters following each other in the same orbit at a distance of a few hundred kilometres is measured by an inter-satellite link; c). Concept of satellite gradiometry combined with SST-hl. The second-order derivative of the gravitational potential of the Earth is measured in a low orbiting satellite by differential accelerometry.

Instrument catalogue

Gravity	
	CHAMP gravity package (Accelerometer+GPS)
	EGG
	HAIRS
Magnetic field	
	CHAMP magnetometry package (1 Scalar+2 Vector Magnetometer)
	EMA
	Fluxgate magnetometer
	IMSC
	LP/ RPA
	MMP
	PDA
	PEM
	Plasma-Mag
	SESS
	SSJ/4
	SSJ/5
	SSM
Precision orbit	
	CHAMP GPS Sounder
	DORIS
	DORIS-NG
	GPS
	GPS receiver
	GPSDR
	Laser reflectors
	Laser reflectors (ESA)
	LRA
	LRA (LAGEOS)
	RRA
	TRSR