

CHAMP Mission Science Data System

Operation and Generation of Scientific Products

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Almost 3 years ago, on July 15, 2000 the georesearch mission CHAMP was launched into a near polar, circular, low altitude orbit from the cosmodrome Plesetsk / Russia. Since then the satellite is in a free-drifting orbit and is passing through different resonant regimes when decaying. Due to high solar activity in the last year and corresponding high atmospheric drag, CHAMP's orbital altitude was decreasing faster than predicted for a 5 year mission profile. Therefore 2 thrusters controlled orbit lift manoeuvres were carried out in 2002 raising the orbit each time by about 15 km. With these orbit altitude changes the mission could last until 2008, if the satellite subsystems and science instruments function properly over such a long operation period.

The CHAMP overall system, composed of a space- and ground-segment was commissioned and validated by the project teams of GFZ Potsdam and the German Aerospace Center DLR during the first 9 months of the mission and was proven to function as planned and specified – with the exception of one electrode of the accelerometer.

Since this time the operation of the spacecraft, handled by DLR's German Space Operation Center in Oberpfaffenhofen, is running very smoothly and effectively and CHAMP's multifunctional and complementary instrumentation, controlled by the GFZ project team, is in full operation. This instrumentation is composed of sensors for the observation of:

Earth Gravity Field:

a new generation GPS flight receiver for continuous tracking of CHAMP by the satellites of the GPS constellation for accurately and continuously monitoring of the orbit perturbations, a high-precision three-axes accelerometer for measuring the surface force accelerations and a star camera pair for precise attitude determination of the spacecraft body.

Earth Magnetic Field:

a high performance Fluxgate magnetometer set measuring the three components of the ambient magnetic field in the instrument frame combined with a star camera pair determining the attitude of the assembly with respect to the stellar frame and a Overhauser scalar magnetometer serving as precise magnetic reference.

Atmosphere / Ionosphere:

the instrumentation used for the recovery of the magnetic and gravity fields constitutes at the same time a powerful assembly of sensors for observing many parameters relevant for the characterisation of the state and dynamics of the neutral atmosphere and ionosphere: GPS/CHAMP radio occultation measurements for the derivation of temperature and water vapour distribution in the atmosphere, digital ion driftmeter measurements for sensing the electric field, GPS/CHAMP soundings to determine the electron density distribution in the ionosphere and the high resolution accelerometer to sense the air density variations in CHAMP's orbital environment.

This instrumentation provides for the first time in space geodesy's history an almost continuous tracking of the spacecraft motion at a low altitude, a high precision in-situ measurement of the forces acting on the satellite surface and simultaneously a global mapping of the magnetic field with a precision and spatial resolution never achieved before.

- a global network of 1 Hz GPS ground stations with rapid data transmission capability,
- a science data control and data decoding facility,
- processor systems for data pre-processing and processors for orbit and gravitational field modeling, magnetic field determination and determination of atmospheric and ionospheric parameters,

CHAMP's ground segment comprises all ground-based components which perform the operational control of the spacecraft and instruments, the data flow from the on-board memory and supporting ground networks to the processors and users. Figure 1 shows the general scheme of the overall data and product flow and the responsibilities within the CHAMP Mission Operation System (MOS - DLR responsibility) and the CHAMP Science Data System (SDS - GFZ responsibility).

is being operated by the GFZ CHAMP team almost 'round the clock' now, after a number of optimisations and automation procedures were introduced. National and international users have easy and quick access to all data, products and meta-information desired via the CHAMP ISDC data management system. The SDS is connected via its communication links and data systems with the CHAMP mission control facility at the German Space Operation Center of DLR.

The CHAMP SDS, consisting of

- an S-band station in Spitsbergen for fast monitoring of the scientific equipment and fast science data reception,

CHAMP's standard science products are labelled from level-1 to level-4 according to the number of processing steps applied to the

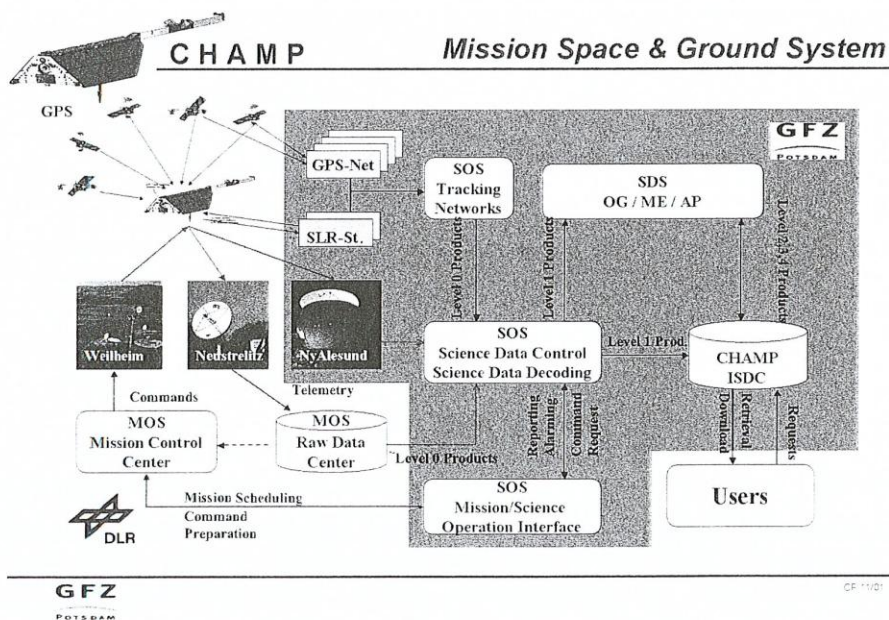


Figure 1: CHAMP ground segment.

original data. Decommutation and decoding of level-0 data results in level-1 products. These are daily files, associated with each individual instrument and source aboard CHAMP, and the data content is transformed from the telemetry format and units into an application software readable format and physical units. Level-1 products also include the ground station GPS and laser data. Level-2 products are necessary spacecraft housekeeping data and arranged in daily files. Level-3 products comprise the operational rapid products and fine processed, edited and definitely calibrated experiment data. Finally, level-4 leads to the geoscientific models derived from the analysis of CHAMP experiment data, supported and value-added by external models and observations.

The excellent operational performance of the CHAMP mission operation and science data system, reflected in an almost continuous flow of high quality CHAMP sensor and GPS ground network data into the system with low latency, has resulted up to now in the generation of about 2.5 million data products for a total of 114 different product types. These level-0 to level-4 data products are archived for internal and external user access in the CHAMP Information and Data Center (ISDC). More than 200 external user groups, including those from the Geotechnology Programme, access presently CHAMP products via the ISDC. Accesses are almost equally distributed over the application areas gravity field, magnetic field, atmosphere/ionosphere sounding.

In 2002 science and application users from 22 different countries retrieved data products of different level from the CHAMP-ISDC, most intensively groups from Germany (37 %, GFZ excluded), USA (24 %), Japan (21 %), China (10 %), Taiwan (3 %), Denmark (2 %) and the Netherlands (1 %).