

GOCE Data and Formats

GOCE PDGS Team:

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GOCE Instruments and Products Overview



STR

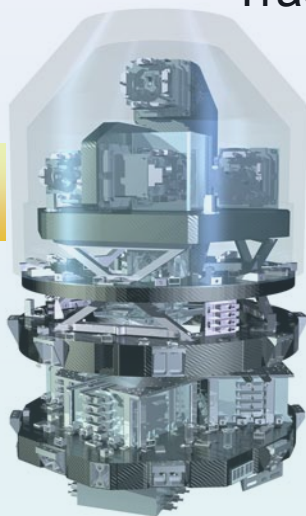


SSTI

Star Tracker

Satellite-to-Satellite Tracking Instrument

EGG

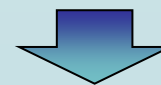


Electrostatic Gravity Gradiometer

Not Available

GOCE Telemetry

Extraction



Level-0 Products

Available to Users

Processing



Level-1b Products

Level-2 Products

Gravity Fields

GOCE single access point



<http://earth.esa.int/GOCE>

→ The GOCE portal is the single and comprehensive access point for all GOCE-related information, resources, **data access**, software, Mission News.

→ **Visit us !!**

→ *For any enquiry or request, send an e-mail to **eohelp@esa.int***

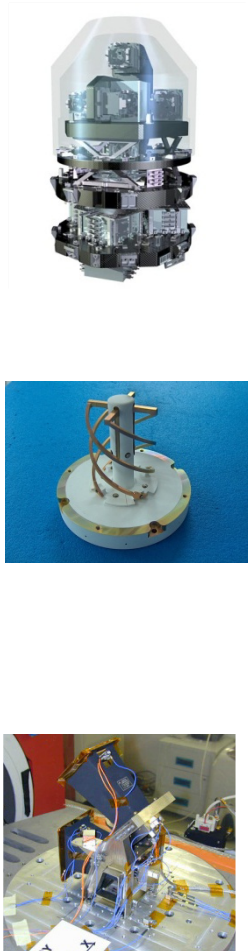
The screenshot displays the Earthnet Online portal for the GOCE mission. At the top, there is a navigation bar with the ESA logo, 'Earthnet Online', and links for 'Login My Earthnet', 'Register', and a search box. Below this is a secondary navigation bar with tabs for 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. The main content area is divided into several sections:

- What is GOCE?**: A section with a small image of the satellite and text describing it as ESA's dart-like Gravity field and Ocean Circulation Explorer (GOCE) Earth Explorer, launched in 2009.
- Latest Mission Operations News**: A list of news items, including 'GOCE Mass Properties File' (12 April 2012) and 'GOCE EOLI Archive: Invalid EGG products for day 01/11/2009' (26 January 2012).
- Latest Mission Results News**: A section with a small image of a map and text about 'Mapping the Moho with GOCE' (09 March 2012).

On the right side, there is a 'Missions' sidebar with a list of mission categories, including 'GOCE' with sub-links for Science, Objectives, Applications, Satellite, Instruments, and News. Below this is a 'Key Resources' section with a list of links such as 'GOCE User Toolbox (GUT)', 'GOCE Data Overview', and 'GOCE Data Access'.



GOCE Data Levels and Available Products



EGG_NOM_1b

SST_NOM_1b

SST_RIN_1b

STR_VC2_1b

STR_VC3_1b

Level-1b

EGG_NOM_2

EGG_TRF_2

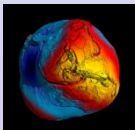
SST_PSO_2

SST_AUX_2

EGM_GOC_2

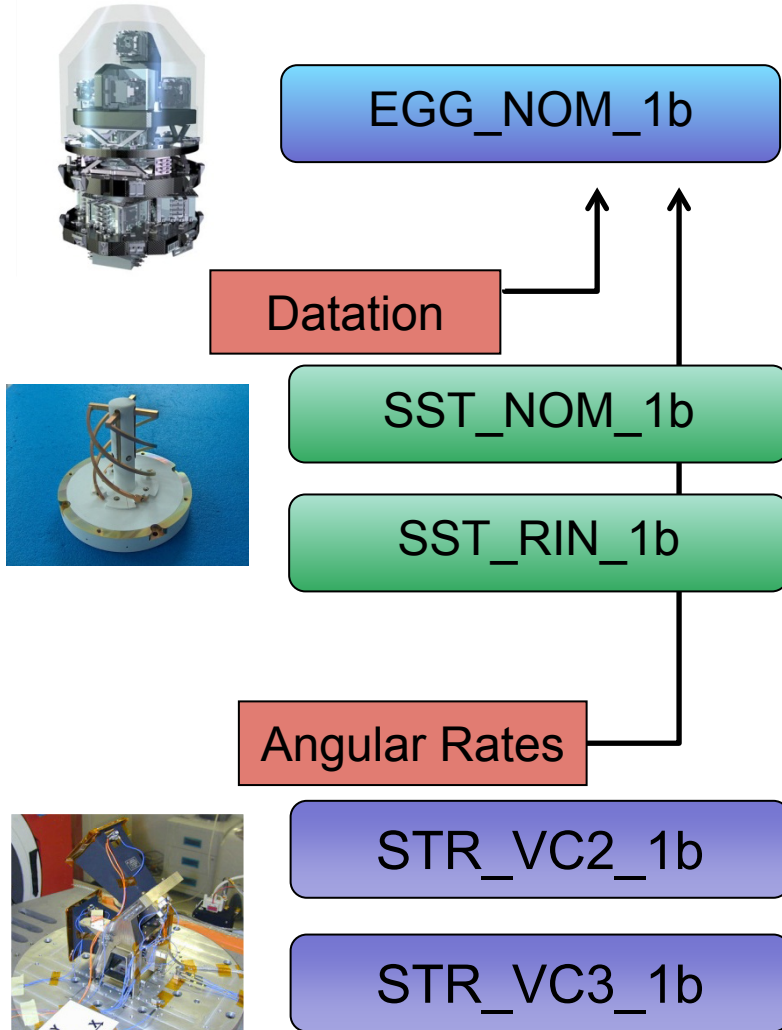
EGM_GVC_2

EGM_GCF_2



Level-2

Orbit-wise products, dated.

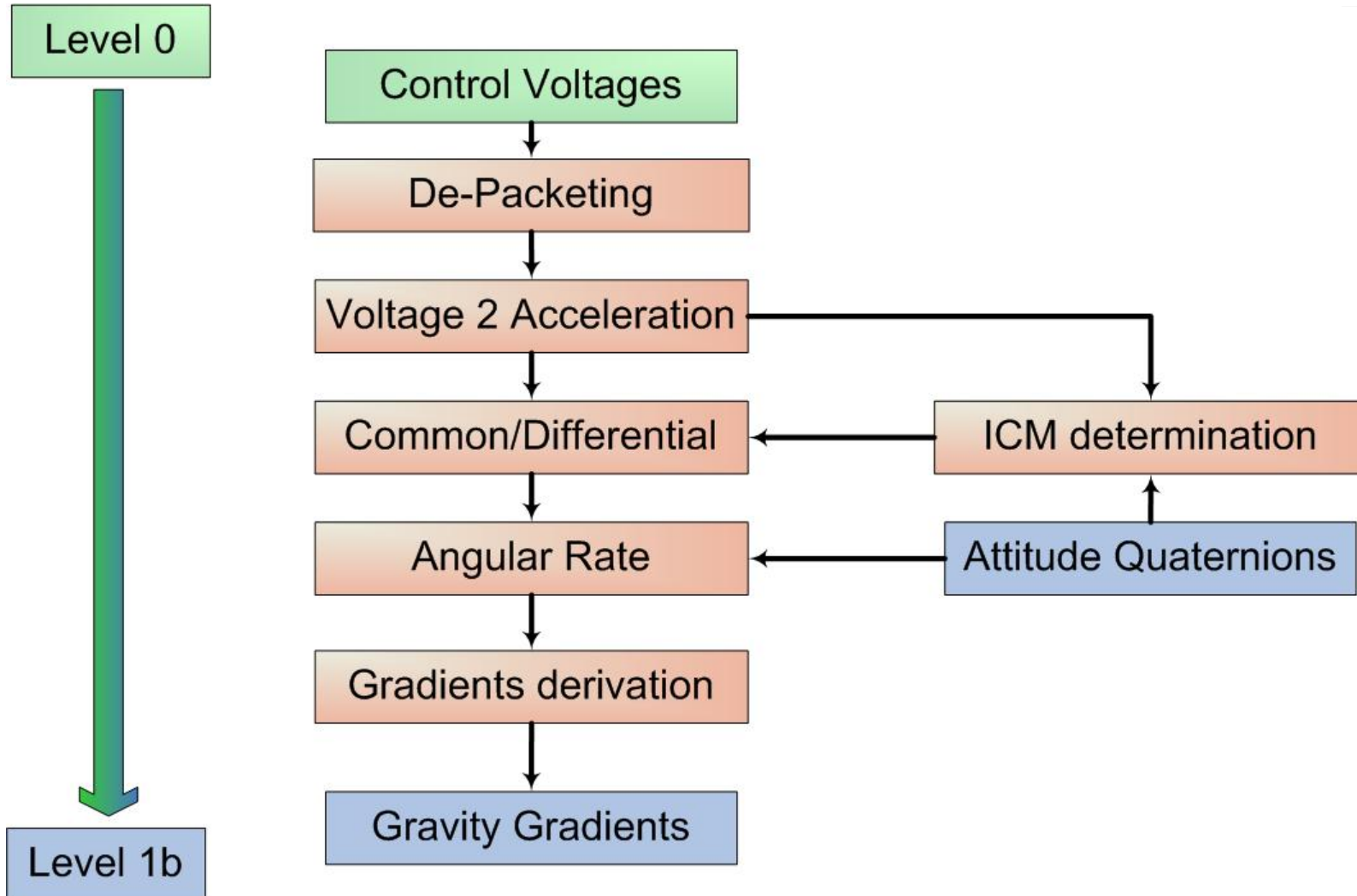


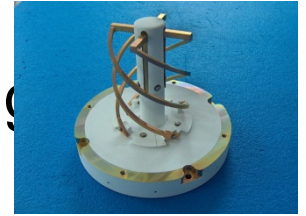
Nominal Gradiometer Instrument data.
Internally calibrated (Accelerometers in linear regime and accelerations calibration)

Nominal SSTI Instrument (GPS) data
Nominal SSTI Instrument (GPS) data in RINEX format

Star Tracker Data Virtual Ch #2
Star Tracker Data-Virtual Ch #3

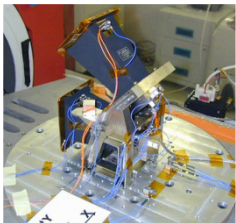
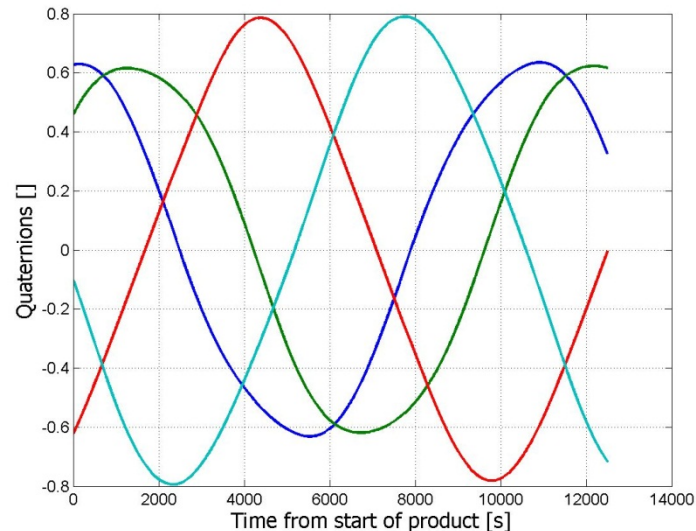
Gradiometer processing





- Nominal product contains position solution using code observations (**SST_NOM_1b**)
- Conversion into engineering units
- Correction of phase and code observations for instrument specific effects (IFB and ICB)
- Corrected observations form RINEX product (**SST_RIN_1b**)
- Position solution used to derive correlation between OBT and GPS time
- In case of single frequency measurements effect of ionosphere is corrected using ionosphere maps

- Conversion into engineering units
- Transform datation from On Board Time to GPS time and UTC
- Correction for orbital relativistic aberration
(annual relativistic aberration is corrected on-board)
- Resolve sign ambiguity to get continuous quaternion



Comprehensive GOCE Products documentation is available through the GOCE Portal.

All GOCE Dataset are fully described in the related Product Data Handbooks

→ <http://earth.esa.int/GOCE>.

→ Key Resources



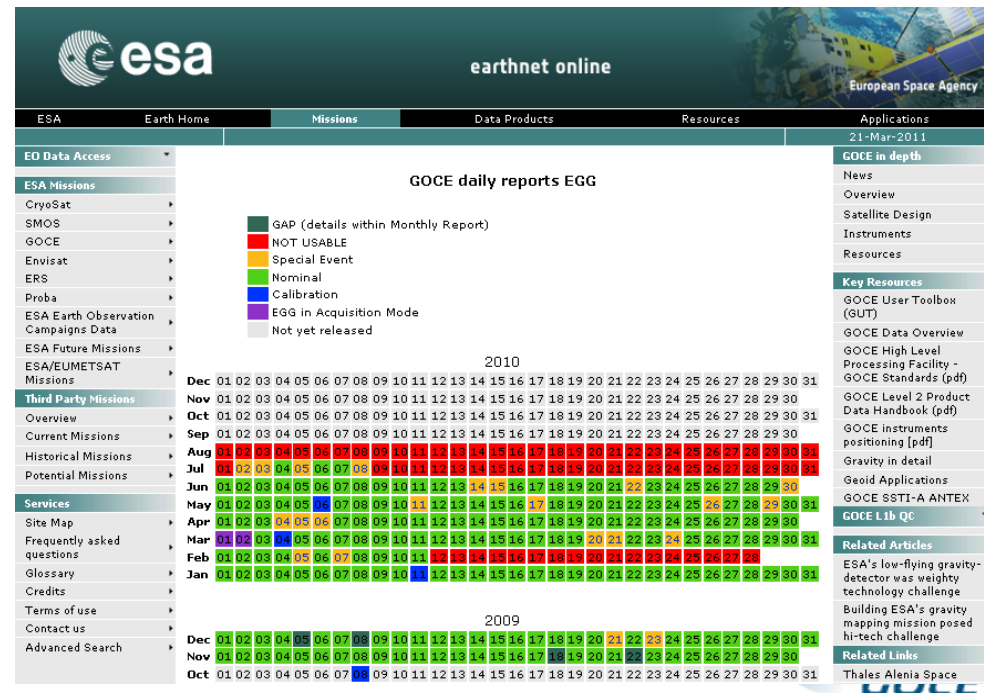
The screenshot shows the Earthnet Online GOCE portal. The page is titled "GOCE" and features a navigation menu with "Data Access", "Missions", "Earth Topics", and "PI Community". The main content area is divided into several sections: "What is GOCE?", "Latest Mission Operations News", and "Latest Mission Results News". The "What is GOCE?" section includes a description of the satellite and its mission. The "Latest Mission Operations News" section contains three news items, each with a "Read more" link. The "Latest Mission Results News" section contains one news item, "Mapping the Moho with GOCE". On the right side, there is a "Missions" sidebar with a "Key Resources" section highlighted by a red circle and a green arrow. The "Key Resources" section lists various links, including "GOCE User Toolbox (GUT)", "GOCE Data Overview", "GOCE Data Access", "GOCE High Level Processing Facility - GOCE Standards (pdf)", "GOCE Level 1 Product Data Handbook (pdf)", "GOCE Level 2 Product Data Handbook (pdf)", "GOCE L1b-L2 XML Parser", "GOCE Level-1b Matlab Readers", "Earth Explorer Ground Segment File Format Standard (pdf)", and "GOCE Instruments positioning (pdf)".

GOCE L1b Products Quality Control



- All L1b products delivered by ESA are quality-verified.
- Systematic data quality assessment is performed for:
 - Gradiometer Instrument (EGG),
 - Satellite-to-Satellite Tracking (SSTI),
 - Drag-Free and Attitude Control (DFACS),
 - Star Tracker (STR)

- Reporting on **EGG** and **SSTI** data quality (daily and Monthly), is made available through the **GOCE Portal**.



GG's with corrections for temporal gravity variations and validated against external a-priori gravity data. In the gradiometer (GRF) and in the terrestrial reference frame (TRF/LNOF).

- Precise Science Orbits (PSO)
- Time variable gravity field due to non-tidal mass variations
- GOCE Gravity solution
- Variance/covariance matrices associated to the Gravity solutions
- Gravity Coefficients (ICGEM format)

EGG_NOM_2

EGG_TRF_2

SST_PSO_2

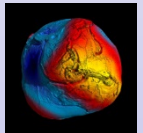
SST_AUX_2

EGM_GOC_2

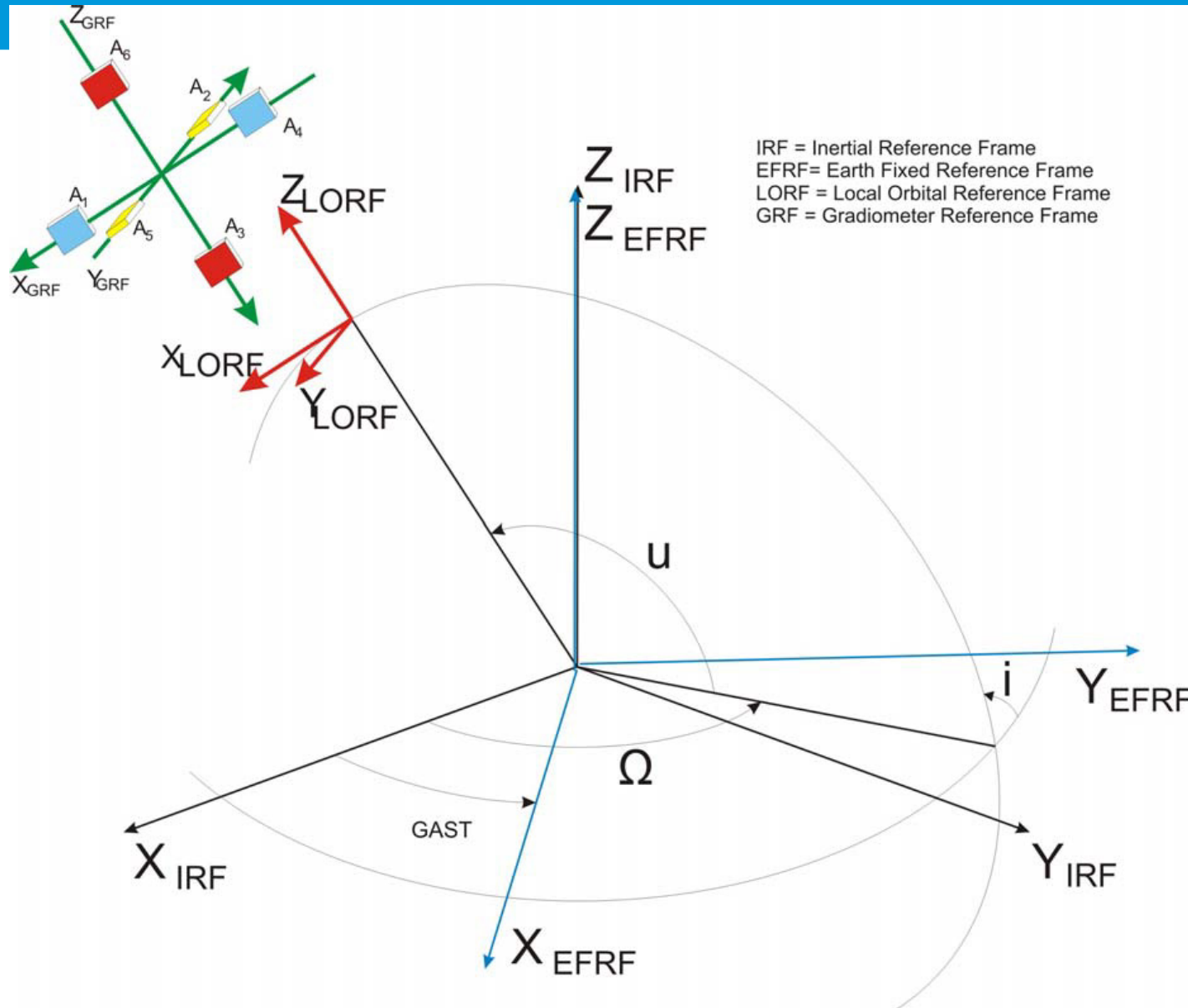
EGM_GVC_2

EGM_GCF_2

Level-2



Main GOCE Reference Frames



See the GOCE Standards

or the

GLOCE L2 Products Handbook

All available through GOCE Website

earth.esa.int/GOCE

GOCE Data Release strategy



“Batch-wise” release with Quality Control on L1b → 2 Months

EGG NOM 1b

EGG NOM 2

“Real-time” release → Monthly

STR VC2/3 1b

SST NOM/RIN 1b

SST PSO 2

(latency ≈ 6w)

SST AUX 2

<http://earth.esa.int/GOCE> --> GOCE L1b QC

Missions	Data Products	Resources	Applications
			11-Oct-2012
			GOCE in depth
			News
			Overview
			Satellite Design
			Instruments
			Resources
			Key Resources
			GOCE User Toolbox (GUT)
			GOCE Data Overview
			GOCE High Level Processing Facility - GOCE Standards (pdf)

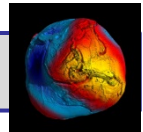
GOCE Monthly Statistics

The main objective of the GOCE Monthly Statistics is to give, on a regular basis, the status of EGG and SSTI data quality.

Click the links below to download the Statistics report

2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct						
2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				

Gravity Field Releases - Yearly



EGM_GOC_2

EGM_GVC_2
EGM_GCF_2

Third Generation released Nov 2011

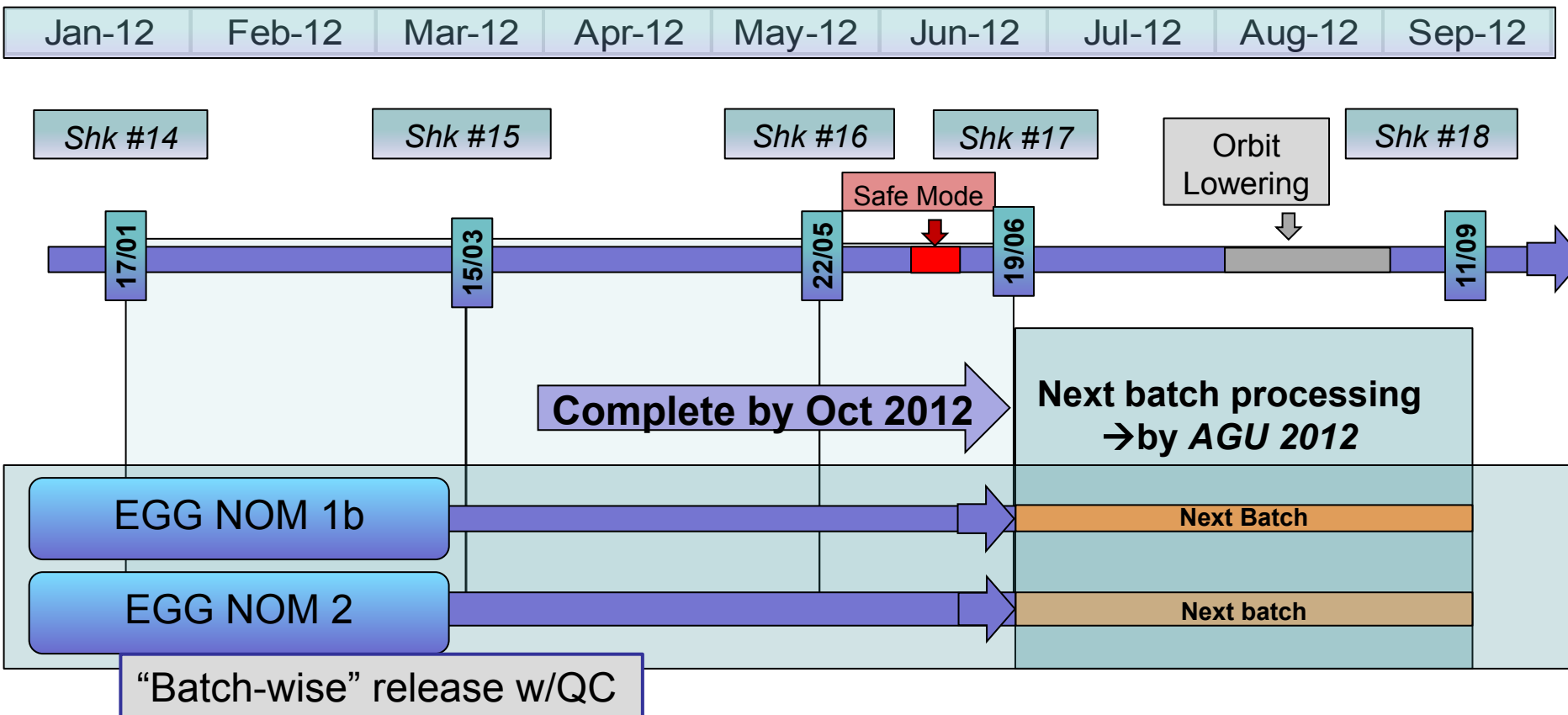
Fourth Generation → 2013 (ahead of EGU).

Based on re-processed gradiometer data.

Fifth Generation all data, till end of Mission



EGG L1b and L2 Release



Three generations of GOCE global **Gravity solutions** have been distributed so far. The latest one was released on November 2011, based on the data available between November 2009 to June 2011.

Three different solutions are available, accounting for three different processing paradigms:

- Direct solution (**DIR**)
- Time-wise (**TIM**)
- Space-wise (**SPW**)

Latest available GOCE Gravity Solutions

Model	Data span	D/O	Main features
SPW2	6 months	240	Pure GOCE; uses kinematic orbits & gradiometry
DIR3	12 months	240	Uses satellite-only normals + GOCE gradiometry
TIM3	12 months	250	Pure GOCE; uses kinematic orbits & gradiometry



Access to GOCE data is **open and free of charge**

Users are requested to perform a **simple registration**



The screenshot shows the ESA Earthnet Online Data Access page. The header includes the ESA logo, 'Earthnet Online', and navigation links like 'Login My Earthnet', 'Register', and 'Google Custom Search'. The main navigation bar has 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. The page content is organized into several sections:

- About:** Provides details on Earth observation data products and offers a 'From Delivery to Acquisition' sub-page for more information.
- How to access EO data:** Includes a list of links such as 'EO data distributed by ESA', 'How to access EO data online', and 'List of free datasets'.
- Browse Data Products:** Features a search form with dropdown menus for 'Earth Topic', 'Mission', 'Instrument', 'Typology', and 'Processing Level', along with a 'Go' button.
- Table of Instruments:** A table listing ESA missions and their instruments.
- Data Access:** A sidebar menu with links like 'Data Access Home', 'Browse Data Products', and 'Helpdesk'.
- Open Opportunities for Researchers:** Highlights projects like 'ELBARA-II' and 'G-POD'.

ESA MISSIONS					
Radar Imagery	Radar Altimetry	Optical / Multispectral Radiometry		Atmospheric Data	Gravimetry
		Low/Med Res.	Med/High Res.		
ENVISAT					
A SAR Wide	Doris	MERIS		GOMOS	

The GOCE Virtual On-line Archive (VOA)

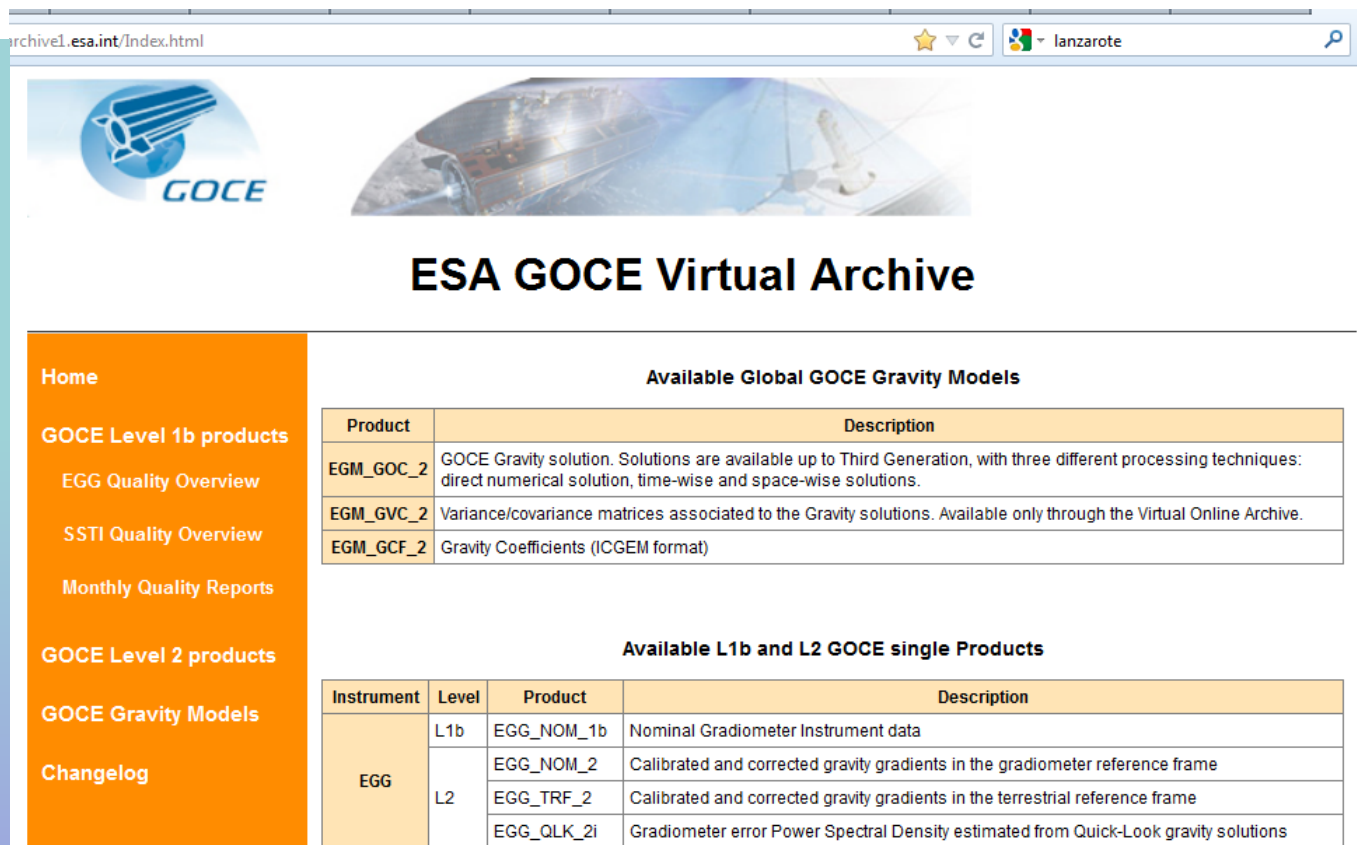
<http://eo-virtual-archive1.esa.int/Index.html>

→ The GOCE Virtual On-line Archive (Cloud service)

→ The most complete and updated data archive.

→ Accessible through simple registration

→ Easy and fast download



The screenshot shows the ESA GOCE Virtual Archive website. At the top, there is a navigation bar with the ESA logo and the text 'ESA GOCE Virtual Archive'. Below this, there is a large banner image of the GOCE satellite in orbit. The main content area is divided into two columns. The left column is an orange sidebar with a 'Home' button and links to 'GOCE Level 1b products', 'GOCE Level 2 products', 'GOCE Gravity Models', and 'Changelog'. The right column contains two tables. The first table is titled 'Available Global GOCE Gravity Models' and lists three products: EGM_GOC_2, EGM_GVC_2, and EGM_GCF_2. The second table is titled 'Available L1b and L2 GOCE single Products' and lists four products: EGG_NOM_1b, EGG_NOM_2, EGG_TRF_2, and EGG_QLK_2i.

Product	Description
EGM_GOC_2	GOCE Gravity solution. Solutions are available up to Third Generation, with three different processing techniques: direct numerical solution, time-wise and space-wise solutions.
EGM_GVC_2	Variance/covariance matrices associated to the Gravity solutions. Available only through the Virtual Online Archive.
EGM_GCF_2	Gravity Coefficients (ICGEM format)

Instrument	Level	Product	Description
EGG	L1b	EGG_NOM_1b	Nominal Gradiometer Instrument data
		EGG_NOM_2	Calibrated and corrected gravity gradients in the gradiometer reference frame
	L2	EGG_TRF_2	Calibrated and corrected gravity gradients in the terrestrial reference frame
		EGG_QLK_2i	Gradiometer error Power Spectral Density estimated from Quick-Look gravity solutions



Obtaining data: User registration



<http://eopi.esa.int/Registration>

- Users shall perform a
- **“Fast Registration”** through ESA’s PI Community portal.
- An account with ordering privileges shall be obtained in order to access the GOCE Virtual Online Archive
- Users may also contact the ESA’s Help and Order Desk, ***EOHelp@esa.int***, for guidance on the registration process.

The screenshot shows the ESA Earthnet Online website. The header includes the ESA logo, 'Earthnet Online', and navigation links like 'Login My Earthnet', 'Register', and a search bar. The main navigation menu has categories: 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. The current page is 'Fast Registration' under the 'PI Community' section. The page content includes a welcome message, a list of registration guidelines, and a 'PI Community' sidebar with links to 'Fast Registration', 'Full Proposal', 'Campaigns', 'AO's', '3rd Party', 'Focus on PI', 'Toolboxes', 'Training', 'Proceedings', 'Events', 'News', and 'MyEarthnet'. A 'Related Content' section lists various datasets and policies. The footer contains 'Explore Earthnet' with sub-sections for 'Data access', 'Missions', and 'Earth topics'.



GOCE Gravity Field Model

Direct Solution - Third generation

[Back](#)

Home

GOCE Lev

EGG Qua

SSTI Qua

Monthly I

GOCE Lev

GOCE Gra

Changelog

Model Characteristics

GOCE Input Data:

- Gradients: EGG_NOM_2
- Orbits: SST_PKI (kinematic orbits)
- Attitude: EGG_IAQ_2C
- Data period: 20091101T000000-20110419T235959

The full list of input data to this direct-approach model is provided in the IHD file.

A-priori Information used:

A-priori gravity field for the processing of the GOCE gravity radiants:
The GOCE-model 2nd release from the direct approach GO_CONS_GCF_2_DIR_R2
up to degree/order 240

Processing Procedures:

The GOCE gravity gradients are processed without applying the calibration factors. The observation equations are filtered with a 10-125 mHz bandpass filter, and subsequently "SGG" normal equations to d/o 240 are computed individually for the gradient components Txx, Tyy and Tzz.

The Txx, Tyy and Tzz SGG normal equations are accumulated with the relative weight 1.0. To overcome the numerical instability of the GOCE-SGG normal equations due to the polar gaps and to compensate for the poor sensitivity of the GOCE measurements in the low degrees the following stabilizations were applied:

- 1) The GOCE-SGG normal equation was fully combined with a GRACE normal equation. Details about this GRACE contribution are given below.
- 2) A spherical cap regularization in accordance to Metzler and Pail (2005) was iteratively computed to d/o 240 using the GRACE data mentioned below to d/o 130.
- 3) Additionally a Kaula regularization was applied to all coefficients beyond degree 200

Details of the GRACE contribution:

GRACE normal equations to d/o 160 for the period 24 February 2003 through 30 June 2009, based on the improved data editing and solution regularization procedure of the

- Goce Level-1b and Level-2 data are **plain-text xml**.
- They can be **processed** by user-written routines.
- Basic **tools** are made available through the GOCE website, free of charge
 - XML Parser, Matlab routines.



Besides these, **GUT (GOCE User Toolbox)** is a comprehensive application for Level-2 data, supporting applications in Geodesy, Oceanography and Solid Earth Physics.



Release 2.1 includes the third **GOCE Gravity Field Solutions** (TIM and DIR) and the 2011 CNES-CLS Mean Sea Surface (in addition to DTU 2010 Mean Sea Surface).

It includes a tool for handling the **GOCE variance/covariance** matrices and for computing the Geoid height error variance and covariance functions.

→ GUT
The GOCE User Toolbox

What is the GOCE User Toolbox?
GUT is a tool to facilitate the use, viewing and post-processing of GOCE Level 2 mission data products in the fields of geodesy, oceanography and solid Earth physics.
GUT generates all output files in netCDF format in compliance with the CF (Climate and Forecast) Convention, and gridded results may be visualised using the BratDisplay tool from the Basic Radar Altimetry Toolbox (BRAT, available at <http://earth.esa.int/brat>) and many other commonly used plotting tools.

What does GUT do?
GUT is able to:
 > read the GOCE XML Level 2 Products (EGM_GOC_2), GRAVSOF, ICGEM, netCDF in CF-Convention (even multi-data), and ancillary datasets, including a priori surfaces (DEM, MSS, MDT);
 > compute geoid heights at a chosen maximum degree and order over a grid or transect;
 > compute gravity anomalies, height anomalies and vertical deflections on the surface of the terrain for a range of maximum degree and order expansions over a grid or transect;
 > compute gridded field from its spherical harmonic expansion;
 > compute the spherical harmonic expansion of a gridded field;
 > compute the ocean's mean dynamic topography and the geostrophic velocities with the option of anisotropic filtering in the spatial or spectral domains;
 > transform data between different reference ellipsoid and tide-systems;
 > translate a gridded surface to a different grid by bilinear or spline interpolation;
 > introduce a height correction term to geoid heights from an external file;
 > manage the time-system attribute of a time-varying surface;
 > support configurable high-level processing;
 > produce final output products in netCDF-CF format, GRAVSOF, KML and TIFF.

http://earth.esa.int/gut
The GUT software is a command-line processor that has been designed for users at all levels of expertise. For the novice user it includes pre-built workflows for rapid computation of geophysical parameters. More experienced users can generate their own workflows for enhanced or specialized processing or use the available API to develop their own tools based in GUT. GUT is supplied as fully open source software under GNU GPL license.

The GUT package available online or via DVD includes:
 > The source package for building on UNIX/Linux/Mac;
 > Binary packages for Windows/Linux/Mac (includes BratDisplay);
 > The GUT Algorithm Description and User Guide;
 > The GUT Tutorial;
 > The a priori data package (GOCE L2 EGM_GOC DATA/DEM_MSS_MDT)

GUT is being developed by a consortium of European research institutes and industry led by DTU Space under ESA contract.

Geodesy
Physical Oceanography
Solid Earth Physics

Logos at the bottom: gut, DTU, CLS, ICGEM, UH, National Oceanography Centre, Newcastle University, s&t, European Space Agency.

GUT: The GOCE User Toolbox



Multi-platform, cmd-oriented tool
Integrated with BRAT (Basic Radar Altimetry Toolbox)

The screenshot displays an Ubuntu 11.10 virtual machine environment. A terminal window shows the execution of the `gut spatialmdt_gf` command with various options, including input files, resolution, and output file names. A second terminal window shows the execution of `mdt-180_02.sh` and a subsequent `ls` command listing the contents of the `SpatialMdt_fhan32` directory. A PDF viewer window displays the GUT User Guide and Algorithm Descriptions, version 2.1, dated 01 Jun 2011.

```
alberto@mela: ~/GUT/MDT
#Use case n°11: Compute a global grid of Satellite-only MDT in geographi
#space from the GUT priori geopotential and Mean Sea Surface Height fil
#using a Hanning filter with a cut length of 3° in longitude and 2° in l
#
gut spatialmdt_gf \
-InShpFile
GO_CONS_EGM_GOC_2__20091101T000000_20100630T235959_0002.DBL \
-InSshFile
MSS_CNES_CLS_11_2M.nc \
-InLsmFile
GUT_LSM.nc
-Fhan 2,3 \
-Ellipse
TOPEX \
-R \
0.5:359.5,-89.5:89.5 \
-I 0.2:0.5 \
-OutFile \
SpatialMdt_fhan32.nc

#BratDisplay SpatialMdt_fhan32.nc

alberto@mela:~/GUT/MDT$ ^C
alberto@mela:~/GUT/MDT$ ^C
alberto@mela:~/GUT/MDT$ ls
mdt-180_02.sh
mdt-180_05.sh
mdt-1.sh
mdt-2.sh
mdt-3.sh
mdt-demo.sh
mdt.sh
mdt.sh.save
SpatialMdt_demo_0.5.nc
SpatialMdt_demo_1.nc
SpatialMdt_fhan32_0.2-0.2_180_90.nc
alberto@mela:~/GUT/MDT$
```

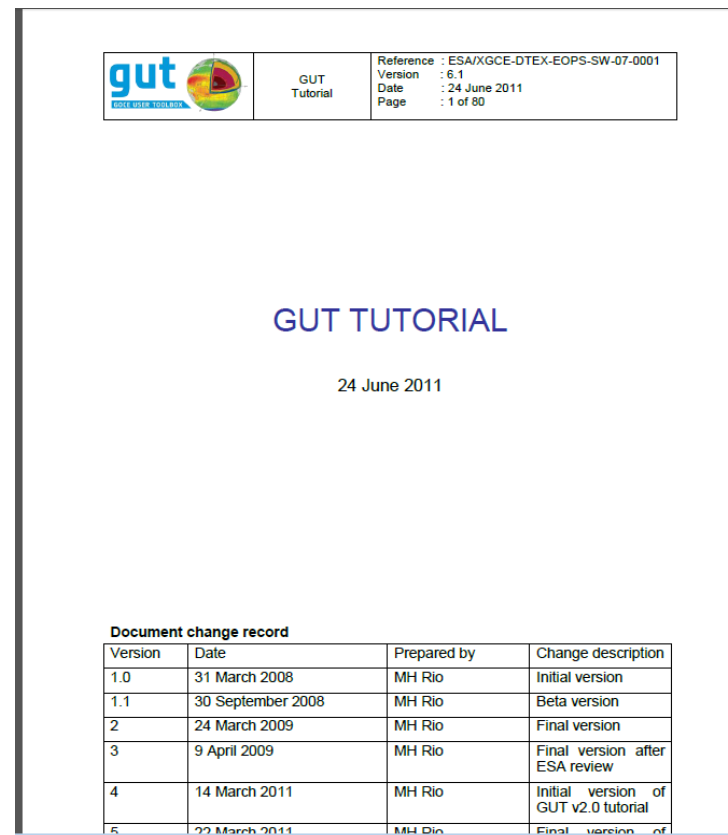
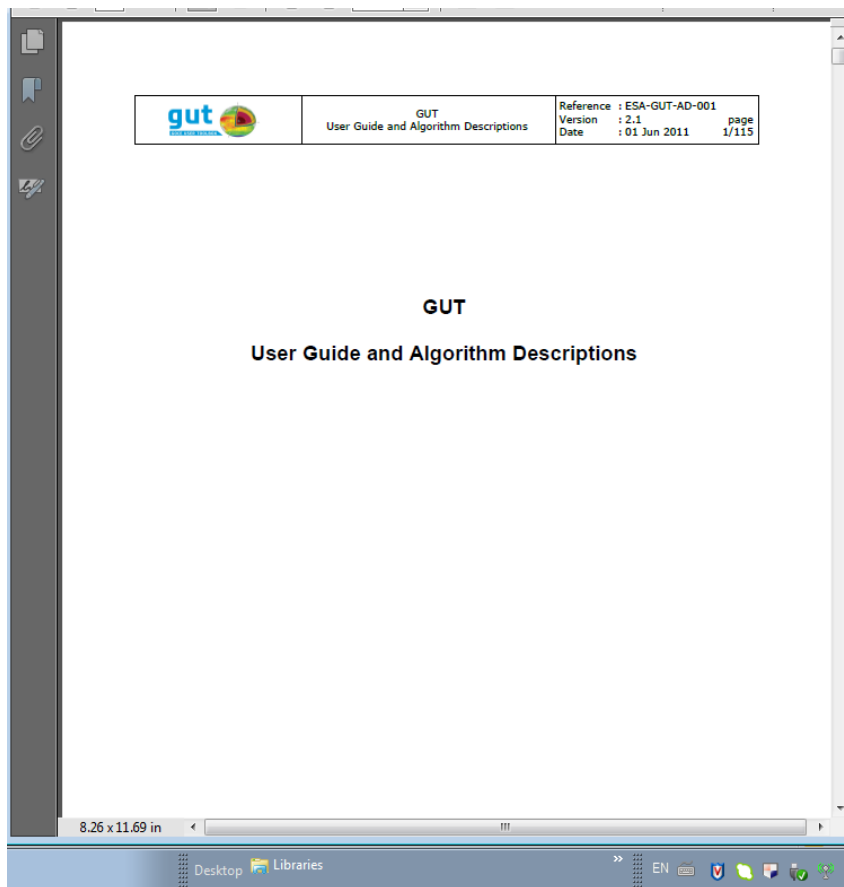
SpatialMdt_fhan32_0.2-0.2_180.nc
SpatialMdt_fhan32_0.2-0.2.nc
SpatialMdt_fhan32_0.2-0.5.nc
SpatialMdt_fhan32_0.5-0.5_180_90.nc
SpatialMdt_fhan32_0.5-0.5_180.nc
SpatialMdt_fhan32_0.5-0.5.nc
SpatialMdt_fhan32_0.5.nc
SpatialMdt_fhan32.nc
SpatialMdt_fhan32_v1.nc
SpatialMdt_fhan32_v2.nc

GUT User Guide and Algorithm Descriptions
Reference : ESA-GUT-AD-001
Version : 2.1
Date : 01 Jun 2011
page 1/115

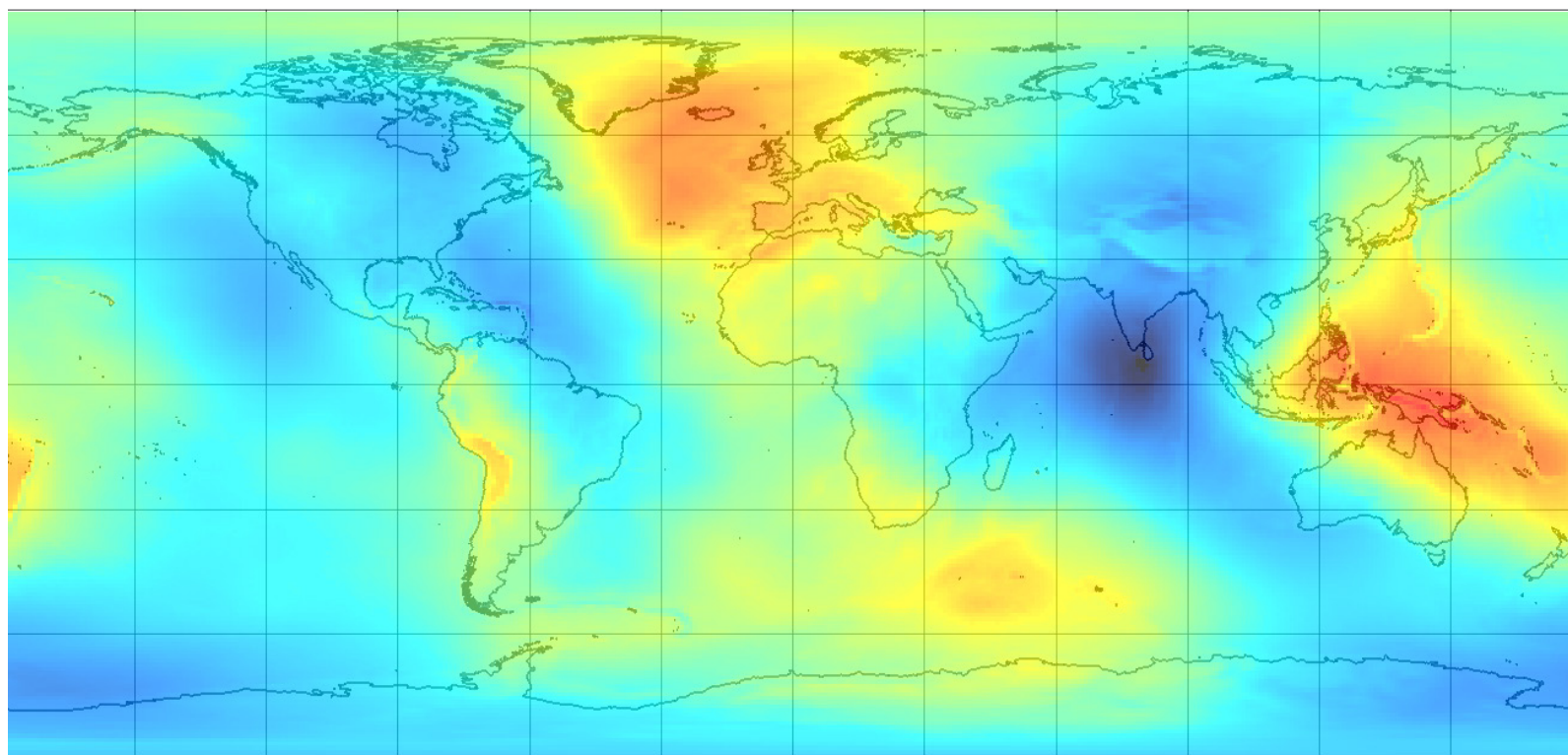
GUT: Main Documentation



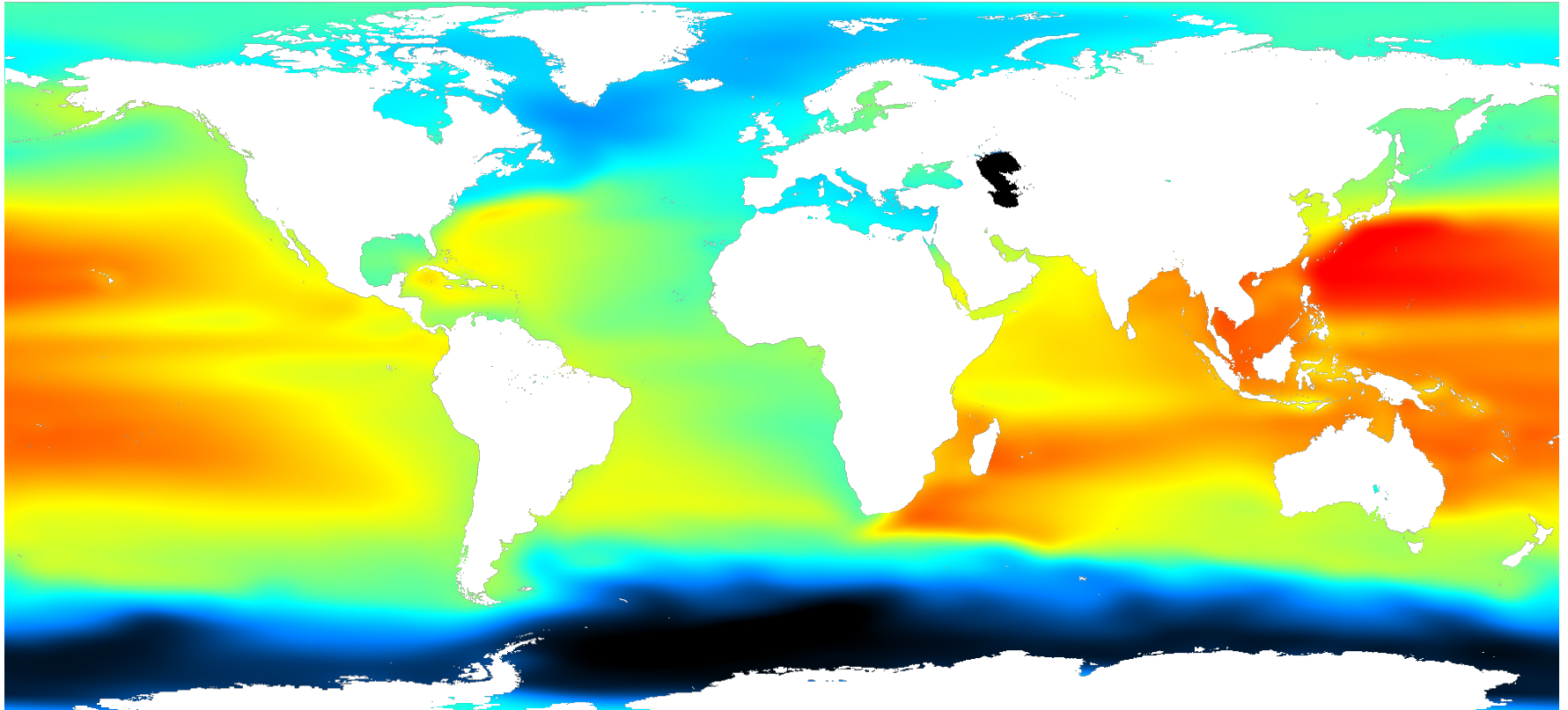
- User Guide and Algorithm Description
- The GUT Tutorial



Sample GUT: Geoid heights



Sample GUT: Mean Dynamic Topography



GUT and BRAT integration



Multi-platform, cmd-oriented tool
Integrated with BRAT (Basic Radar Altimetry Toolbox)

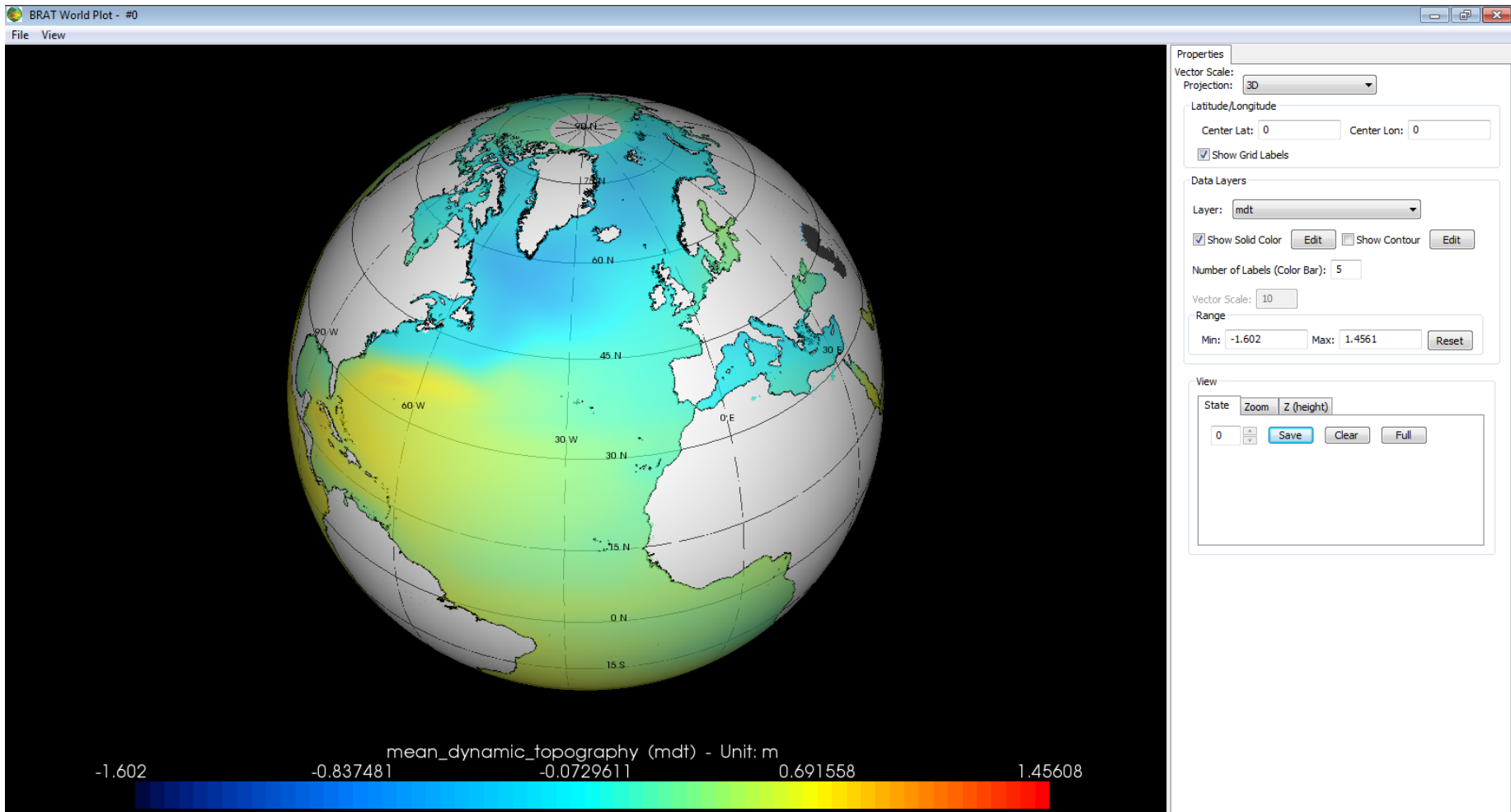
The screenshot displays the 'Brat Interface - brat_ws_geotiff' window. The interface includes a menu bar (Workspace, Datasets, Operations, Views, Help) and a toolbar with buttons for 'Execute', 'New', 'Duplicate', 'Delete', 'Export...', 'Edit Ascii export', 'Compute statistics', 'Delay execution', and 'Launch Scheduler'. The 'Operation Name' is set to 'Convert_MDT_to_geotiff'. On the left, there are panels for 'Datasets' (listing DIR_02, GOCE_DIR_1, GOCE_MDT, GOCE_MDT_2) and 'Fields' (listing various CRS and coordinate fields). The main area shows 'Data expressions' with a tree view containing 'X' (lon), 'Y (optional)' (lat), and 'Data' (mdt). Below this is a large 'Expression' text area. At the bottom, there are controls for 'Data Computation' (set to MEAN), 'Check syntax', 'Show info', 'Title / Comment', and 'Resolution and filter information' (with fields for X and Y resolution and a 'Set Resolution / Filter...' button). The bottom right corner features the 'GOCE' logo.

GUT and BRAT integration



BRAT Display
NET CDF input data format

Output Tiff, Kml, etc..



GOCE single access point



<http://earth.esa.int/GOCE>

→ The GOCE portal is the single and comprehensive access point for all GOCE-related information, resources, **data access**, software, Mission News.

→ Please, *visit us !!*

The screenshot shows the GOCE Earthnet Online portal. At the top, there is the ESA logo and the text 'Earthnet Online'. Navigation tabs include 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. A search bar and a 'Login My Earthnet' button are also present. The main content area is divided into several sections: 'What is GOCE?' with an image of the satellite and a brief description; 'Latest Mission Operations News' with three news items, each with a 'Read more' link; and 'Latest Mission Results News' with one news item, 'Mapping the Moho with GOCE', also with a 'Read more' link. On the right side, there is a 'Missions' sidebar with a list of mission-related links, including 'GOCE', 'Science', 'Objectives', 'Applications', 'Satellite', 'Instruments', 'News', 'Envisat', 'ERS', and 'Proba'. Below the sidebar is a 'Key Resources' section with a list of links such as 'GOCE User Toolbox (GUT)', 'GOCE Data Overview', 'GOCE Data Access', and various data handbooks and parsers.

