

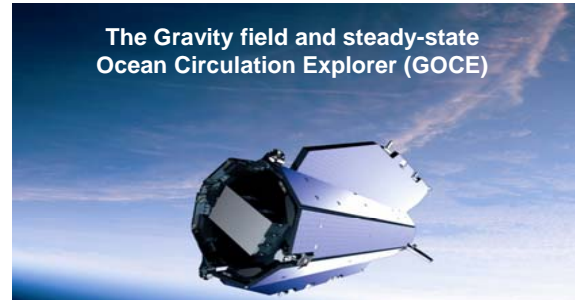
# The GOCE User Toolbox - GUT

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### The Gravity field and steady-state Ocean Circulation Explorer (GOCE)

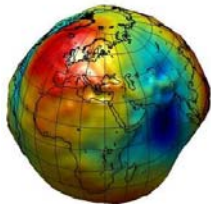


Its objectives are to improve understanding of:

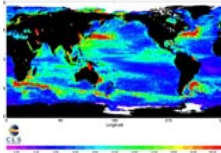
- global ocean circulation and transfer of heat
- physics of the Earth's interior (lithosphere & mantle)
- topographic processes, evolution of ice sheets and sea level change

[www.esa.int/livingplanet/goce](http://www.esa.int/livingplanet/goce)

### Examples of Scientific Applications



Gravity field map and improved global geoid models

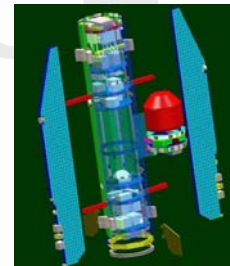
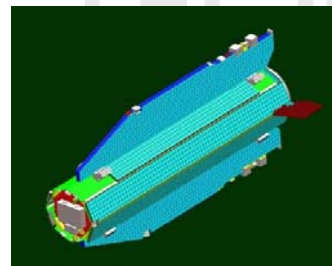


Improved understanding of ocean circulation and energy distribution



Global unification of height systems

### The satellite and its instruments



**Payload:** Three-axis diagonal gravity gradiometer; sat-to-sat tracking (geodetic quality multi-channel GPS receiver with Helix antenna)




**Main Technical Challenges** 



□ Highest sensitivity accelerometers in space

CHAMP:  $\sim 10^{-9} \text{ ms}^{-2}$   
 GRACE:  $\sim 10^{-10} \text{ ms}^{-2}$   
 GOCE:  $\sim 10^{-12} \text{ ms}^{-2}$




## GOCE Products

GOCE Level 2 products:

- EGG\_NOM\_2\_: Gravity Gradients in the Gradiometer Reference Frame (GRF),
- EGG\_TRF\_2\_: Gravity Gradients in Local North-Oriented reference Frame (LNOF),
- SST\_PSO\_2\_: Precise science orbits,
- EGG\_GOC\_2\_: Spherical harmonic series. As derived quantities grids of geoid heights, gravity anomalies and deflections of the vertical are additionally included as well as geoid height errors,
- EGG\_GVC\_2\_: Variance-covariance matrix for the coefficients.


No ocean circulation products are planned.



## The GOCE User Toolbox - GUT

In order to facilitate the use of GOCE products for oceanographers and other communities such as Solid Earth physicists, the development of a user toolbox was clearly requested by the users.

The aim of the toolbox is to facilitate the using, viewing and post-processing of GOCE Level 2 products in conjunction with radar altimetry from ERS and ENVISAT.



## GOCE User Toolbox - GUT

User requirements were developed by the potential users through the ESA supported GUT Specification Study - GUTS.

The purpose of GUTS was to:

- Consolidate the user requirements.
- Select the processing and viewing functions.
- Produce a Toolbox output specification document.
- Produce an algorithm specification document.
- Produce a Toolbox architectural design document.



## GOCE User Toolbox - GUT

GUT version 1 was developed with ESA support with the ability to:

- read the GOCE level 2 products and ancillary datasets, including a priori surfaces,
- compute geoid heights and gravity anomalies for a range of maximum degree and order expansions and grid sizes,
- compute Mean Dynamic Topography with the option of spatial filtering,
- transform data between different reference and tide-systems,
- produce final output products that are readable by the toolbox and by alternative analytical and display packages such as BRAT for visualisation purposes.

The toolbox was developed by S&T, Delft, Netherlands.



## GOCE User Toolbox - GUT

GUT is a command line processor.

```

C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Matija Horcagut --version

GOCE User Toolbox (GUT) Command-Line Processor      Version 1.0b

Installation directory      : C:\GUT\gut-1.0b\
Standard Output directory  : C:\GUT\gut-1.0b\output\
A priori Data directory     : C:\GUT\gut-1.0b\apriori\

GUT incorporates the third-party components
netCDF      Version : 2.6.2
cshp       Version : 2.01.2
libtiff     Version : 3.9.2
libproj     Version : 1.2.5
  
```

It may be used on Windows PCs, UNIX/Linux Workstations, and Mac.



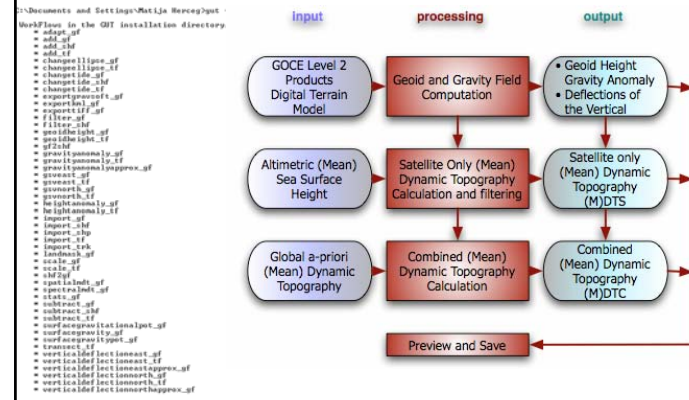
## The GUT Tutorials

The GUT Tutorials is a document that help the user by:


- Describing the GOCE products,
- Describing procedures for using GOCE products for Geodesy, Oceanography and Solid Earth studies,
- Defining workflows for a variety of tasks,
- Showing examples.



## GUT - Primary WorkFlows



## Workflow example



Workflow 1a      GUT\_WF1a


-Fg -R 89.75/-89.75/0.25/359.75 -I 0.5/0.5

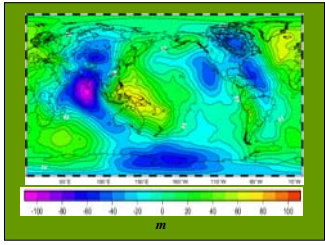
EIGENGL4S\_SH150\_coef.fic

EIGENGL4S\_SH40\_Etp\_MT\_grid.fic


**Input Data:**  
 EIGEN-GRACEGL4S SH coefficients  
 (reference ellipsoid=GRIM  
 Tide system=FREE )  
 Output Reference ellipsoid: TP  
 Output tide system: Mean Tide  
 Degree/order of expansion: 40

**Options:**  
 Output Grid : regular, 1/2° resolution grid





## Workflow example



Workflow 1b      GUT\_WF1b


-Fg -R 89.75/-89.75/0.25/359.75 -I 0.5/0.5

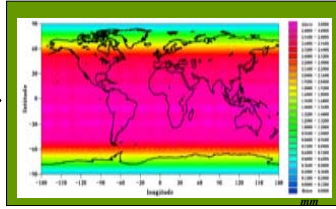
EIGENGL4S\_SH150\_cov\_mat.fic

EIGENGL4S\_SH50\_Etp\_MT\_com\_error\_grid.fic


**Input Data:**  
 EIGEN-GRACEGL4S error covariance  
 matrix of SH coefficients  
 (reference ellipsoid=GRIM  
 Tide system=FREE )  
 Output Reference ellipsoid: TP  
 Output tide system: Mean Tide  
 Degree/order of expansion: 50

**Options:**  
 Output Grid : regular, 1/2° resolution grid





## Workflow example



Workflow 3a      GUT\_WF3a


-Fg400 -O my\_filter\_matrix.fic

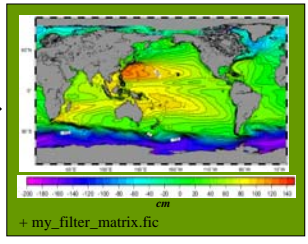
MSSCLS01\_grid.fic EIGENGL04S\_SH150\_grid.fic

MSSCLS01\_EIGENGL4S\_fg400\_grid.fic

**Input Data:**  
 MSSCLS01  
 EIGEN GL04S GRACE Geoid


**Options:**  
 Filter Type: Gaussian  
 Filter width=400 km





+ my\_filter\_matrix.fic

## GOCE User Toolbox - GUT



The GUT package includes:

- The source package for building on UNIX/Linux/Mac,
- Binary packages for Linux and Windows that include BratDisplay (v2.0.0b),
- The GUT Algorithm Description and User Guide,
- The GUT Tutorial,
- The GUT Install Guide,
- The a-priori data package.

More info at <http://earth.esa.int/gut/>