GOCE User Toolbox and Tutorial

– An ESA effort to facilitate the use of GOCE Level-2 products

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Abstract
The GOCE User Toolbox GUT is a compilation of tools for the utilisation and analysis of GOCE Level 2 products. GUT support applications in Geodesy, Oceanography and Solid Earth Physics. The GUT Tutorial provides information and guidance in how to use the toolbox for a variety of applications. GUT consists of a series of advanced computer routines that carry out the required computations. It may be used on Windows PCs, UNIX/Linux Workstations, and Mac. The toolbox is supported by The GUT Algorithm Description and User Guide and The GUT Install Guide. A set of a-priori data and models are made available as well.

Background
The Gravity and Ocean Circulation Experiment - GOCE satellite mission is a new type of Earth observation satellite that will measure the Earth gravity and geoid with unprecedented accuracy. Combining GOCE geoid models with satellite altimetric observations of the sea surface height substantial improvements in the modelling of the ocean circulation and transport are foreseen. No ocean circulation products are planned to be delivered as level-2 products as part of the GOCE project so that a strong need exists, for oceanographers, to further process the GOCE level-2 geoid and merge it with Radar Altimetry. The primary requirement of oceanographers is to have access to a geoid and its error covariance at the highest spatial resolution and accuracy possible, although required resolution depends on application. For effective use of the geoid data, knowledge of the error covariance is mandatory.

The GOCE User Toolbox - GUT
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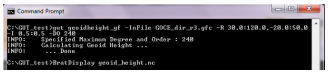
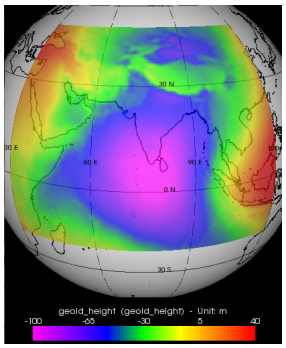
GUT is a command line processor. An example is the following command that will make GUT compute the geoid in a specified region to a specified maximum harmonic degree and order. That is:





Geoid heights from a GOCE gravity model

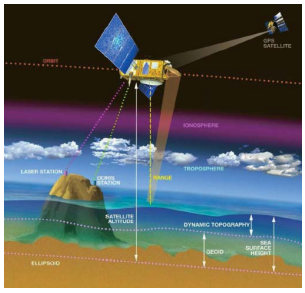
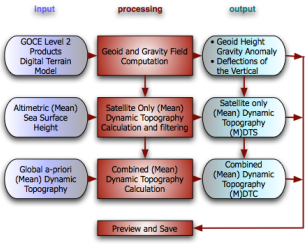


Figure 1: *Sketch showing the relationship between the geoid, the Mean Dynamic Topography (MDT – the mean value of the Dynamic Topography) and the Mean Sea Surface (MSS – the mean value of the Sea Surface Height).*
The basic definition of the ocean dynamic topography is simply the difference between the sea surface height and the geopotential reference surface called the geoid. Hence, the topography is a geometrically surface that describes the shape of the Earth. Simultaneously the dynamic topography may be considered as a reference surface for the ocean circulation at the ocean surface.

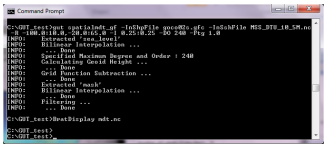


GUT - Primary WorkFlows

Use the GUT workflow for computing a MDT: spatialmdt_gf

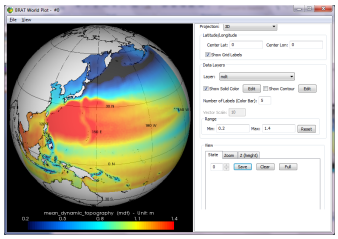
The workflow ensure consistency in
- Grids
- Reference frame
- Tidal system

Furthermore GUT perform filtering considering a land mask using a user specified filter wrt type and width (see below in the next column).

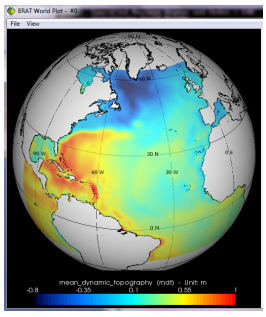


An example is shown below where MDTs have been computed using different filters having half-width lengths of 2.0, 1.0, and 0.5 degrees.

Also geostrophic current components may be computed. Below are shown the east-west cunts associated with the MDTs.

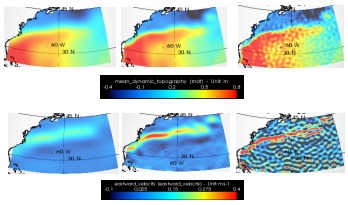


gut
GOCE USER TOOLBOX



GUT is available at http://earth.esa.int/gut/
The GUT package includes
* The source package for building on UNIX/ Linux/Mac
* Binary packages for Linux and Windows that include BratDisplay
* The GUT Algorithm Description and User Guide
* The GUT Tutorial
* The GUT Install Guide
* A set of a-priori data and models.

Demo: Filtering using 2.0, 1.0, and 0.5 deg.



Filters:
-F[filter_type] filter_scale
- -Fg: Gaussian with given Half-Width at Half-Maximum (HWHM = 1.1774 sigma)
- -Ftg : Truncated Gaussian (- at a radius of 3 sigma)
- -Fsc : Spherical Cap
- -Fhan : Hanning
- -Fham : Hamming
- -Fbox : Pill Box

Both isotropic and simple anisotropic.

Also Spectral filtering through spherical harmonic expansion.

Current Work
The GUT is further developed through a collaborative effort where the scientific communities participate aiming on an implementation of remaining functionalities facilitating a wider span of research in the fields of Geodesy, Oceanography and Solid earth studies.
The objective of the new GUT project is to further develop GUT by implementing functionalities that have been requested by the general science community. Accordingly, the **GUT version 3** will have:
• An attractive and easy to use Graphic User Interface (GUI) for the toolbox,
• radients, anisotropic diffusive filtering and computation of Bouguer and isostatic gravity anomalies.
• An associated GUT VCM tool for analyzing the GOCE variance covariance matrices.
Also, in this new project an independent validation of GOCE Level-2 Gravity Field Models including their error covariance matrices will be carried out. Side activities are the toolbox maintenance, user support and toolbox outreach and promotion.

The GUT Team:
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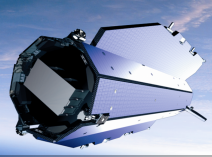
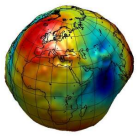
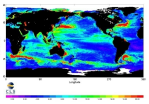
The Gravity field and steady-state Ocean Circulation Explorer (GOCE)



Its objectives are to improve understanding of:
– global ocean circulation and transfer of heat
– physics of the Earth's interior (lithosphere & mantle)
– topographic processes, ice sheets and sea level change

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

GOCE