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A Matlab-based Tool for the Analysis of Global Gravity Effects

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Motivation

Major sources of gravity variations observed by superconducting and absolute gravimeters are related to atmospheric and hydrological mass variations. The gravity response to these variations must be considered at the regional to global scale. Otherwise, seasonal and inter-annual signals typical for large-scale variations remain in gravity residuals. The analysis of global hydrological effects is a challenging task as their amplitude may, depending on the location, exceed the contribution of local hydrology. Previous studies have shown major differences between atmospheric effects based on single admittance factor and those considering global weather models. However, the availability of these atmospheric reductions is limited to selected group of sites with superconducting gravimeters maintained within the GGP (Global Geodynamics Project).
The Matlab-based tool for the analysis of global gravity effects, **mGlobE**, enables the computation of the global contribution of atmosphere, continental water storage and ocean to gravity variation. The **mGlobE** results are evaluated at three superconducting gravimeter sites (Conrad, Vienna, Sutherland) and compared to data from other services (ATMACS, GGP/Strasbourg Loading service).

Conclusions

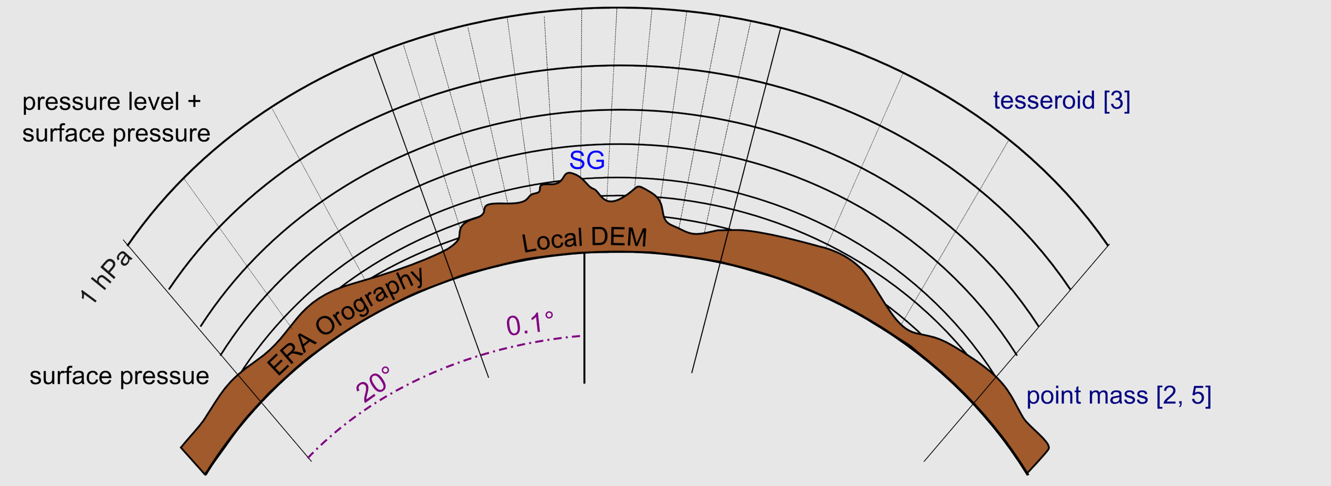
Main features and benefits of **mGlobE**:

- Computation of gravity response to large scale variations for any location worldwide, i.e. suitable for all absolute or superconducting/relative gravimeters
- Inclusion of five freely available global hydrological models, one ocean bottom pressure model and the GRACE monthly mass grids
- Easy implementation of other global hydrological models like WGHM or alternative ocean models such as OMCT
- The inclusion of different models allows the uncertainty estimation of gravity response to continental water storage and ocean bottom pressure variations
- Unified combination of oceanic and continental water storage models considering simplified mass exchange and identical coastlines
- The mGlobE will be freely available

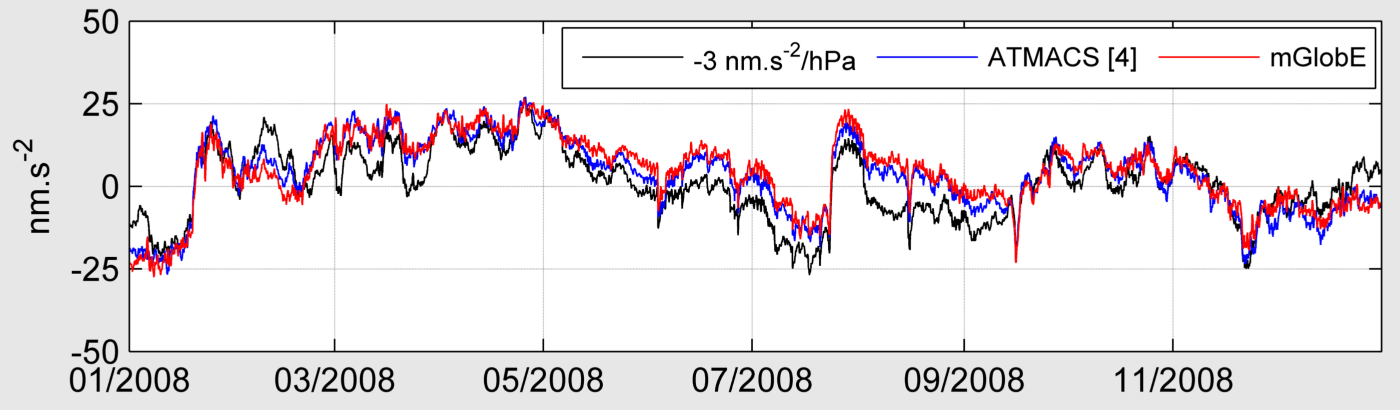
Atmosphere

- **Input**: ERA Interim surface and pressure level as retrieved from ECMWF server
  - surface pressure and geopotential (constant pressure levels in time)
  - specific humidity and temperature
  - ERA orography and local digital elevation model for zone up to 0.1°
- **Output**: local and global effect + model pressure, humidity and temperature
- **Settings**: position, time, time resolution, inclusion/exclusion of local zone

The computation of atmospheric effect using tesseroid and point approximation



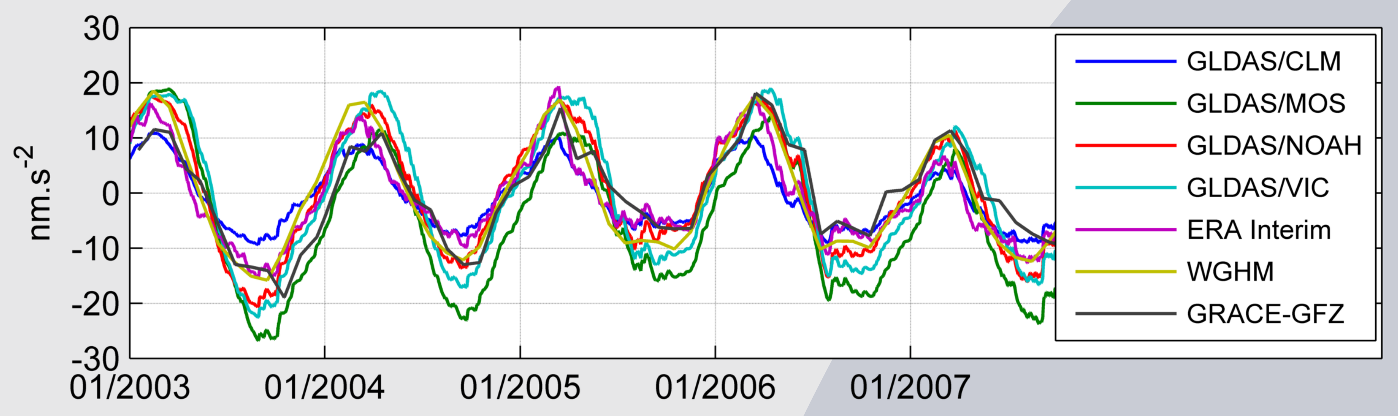
Gravity residuals corrected for atmospheric effect using different reductions at the Conrad observatory (altitude 1044 m)



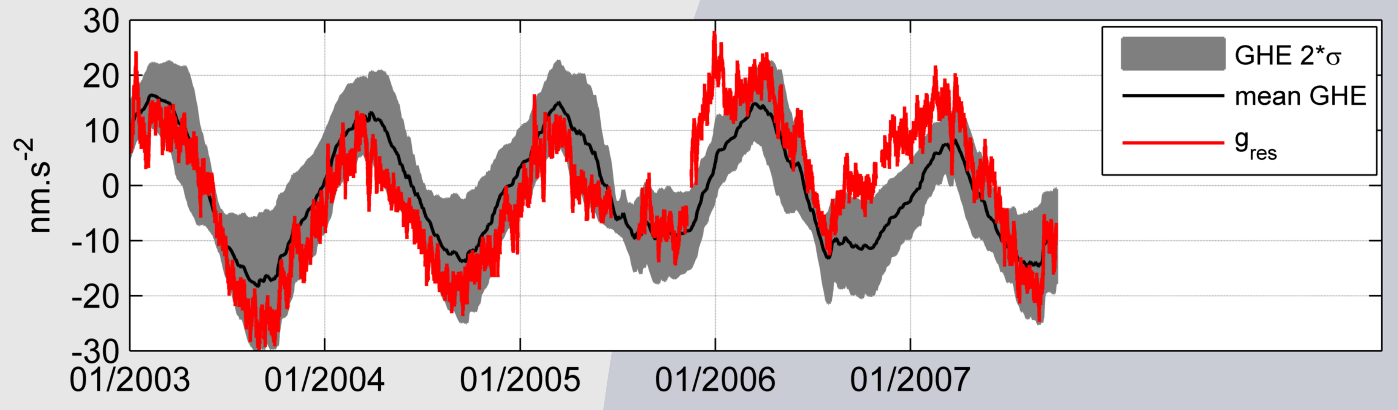
Continental water storage

- **Input**: gridded total water storage (see section *Other features* for the list of supported models)
- **Output**: global hydrological effect (GHE): loading and attraction part divided into continental and oceanic contribution
- **Settings**: position, time, time resolution, model, digital elevation model (up to 1°), exclusion of Greenland and Antarctica, mass conservation principle (uniform ocean layer based on model mass excess / input model includes ocean / no enforcement), local/global contribution threshold (0.05°–1°)

The comparison of computed global hydrological effects using **mGlobE** (Vienna)



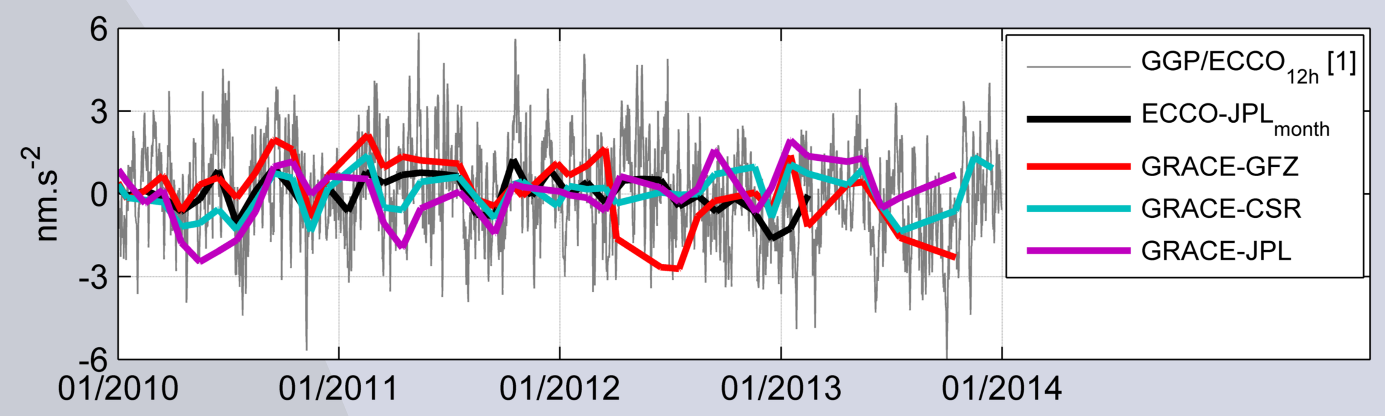
The comparison of gravity residuals (-local contribution) to average global hydrological effect (all models except GRACE) for the Vienna SG



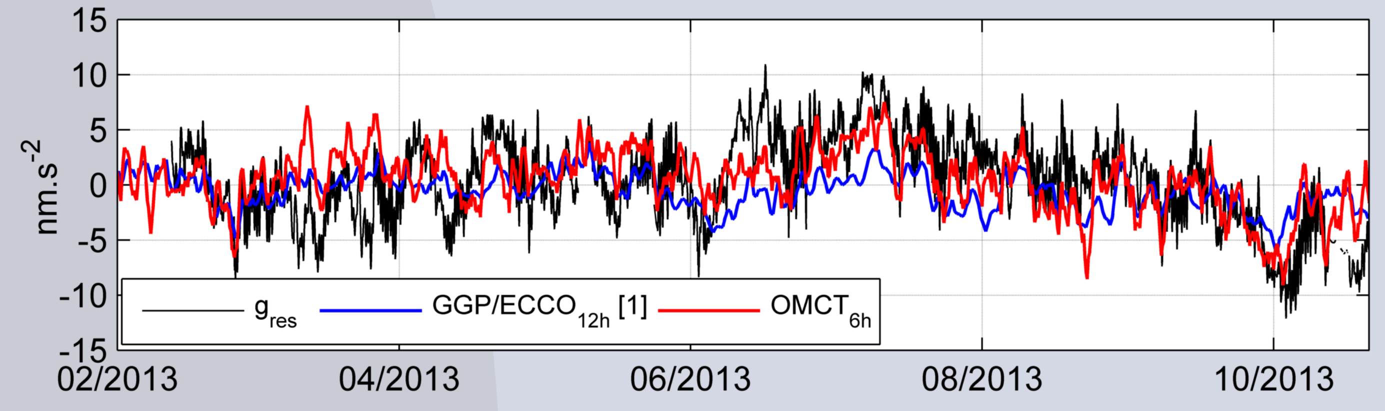
Non-tidal ocean loading effect

- **Input**: gridded ocean bottom pressure (see section *Other features* for the list of supported models)
- **Output**: non-tidal ocean loading effect: loading and attraction part
- **Settings**: position, time, time resolution, model, local/global contribution threshold (0.05°–1°)

The comparison of computed non-tidal ocean loading effects using **mGlobE** and GGP/Strasbourg Loading service [1] (Sutherland, distance to the coast 220 km)



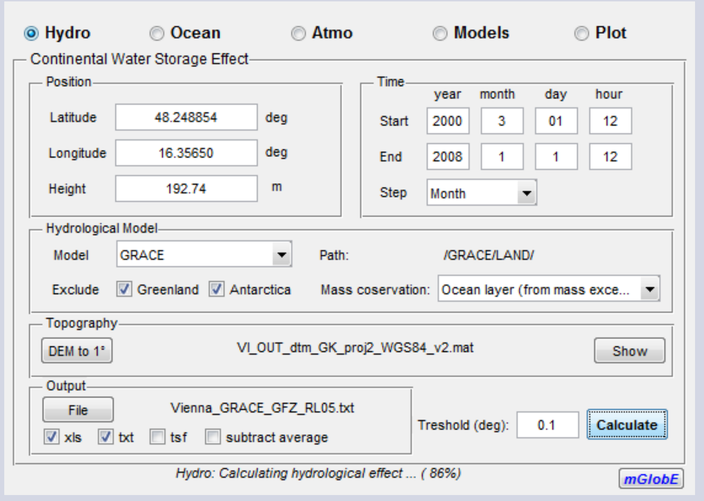
The comparison of the **mGlobE** OMCT model, GGP/Strasbourg Loading Service [1] and gravity residuals corrected for local soil moisture effect and GHE (Sutherland)



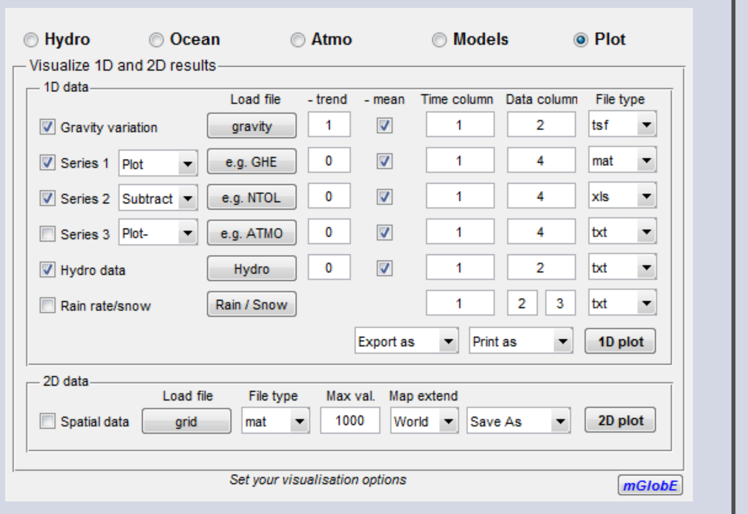
Other features

- Downloading and conversion of GLDAS models
  - All GLDAS models: CLM, MOSAIC, NOAH and VIC
  - direct download of GLDAS models using GrADS Data Server
- Conversion of various models to supported format (mat)
  - ERA Interim (NetCDF)
  - ECCO-JPL monthly ocean bottom pressure (txt)
  - GRACE Tellus (NetCDF) ocean and land mass grids (CSR, GFZ, JPL)
  - other hydrological/ocean models (txt)
  - digital elevation models (arc ascii, grd, NetCDF)
- Visualize time series of gravity variation
  - loading from and exporting to txt, Excel (xls) and TSoft (tsf) format
  - adding/subtracting time series, removal of trend and mean value
  - printing to eps, tiff or fig format
- Visualize loaded global hydrological and ocean models or digital elevation models
- User defined deformation coefficients (load Love numbers)
- System requirements: Matlab R2012a including Mapping toolbox and minimum 6 GB of RAM

GUI: continental water storage



GUI: visualisation tool



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