mGlobe User Manual
(v1.0)

Michal Mikolaj
mikolaj@gfz-potsdam.de

GFZ German Research Centre for Geosciences
Section 5.4 Hydrology
Potsdam, Germany

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1 Introduction

The *mGlobe* toolbox allows user to estimate the contribution of global hydrology, atmosphere and oceans to surface gravity variations. This toolbox is available for Matlab and Octave.
System requirements: MATLAB R2012a or later; Mapping and Statistics toolboxes; 4 GB of RAM (8 GB recommended).
System requirements: Octave GNU 4.0 (for GUI) or later; 4 GB of RAM (8 GB recommended).
This *mGlobe* release is designed for reviewing purposes (submitted to Computers & Geosciences Journal).
Please always check for the latest version of *mGlobe*[1 2] and cite following paper:
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2 Structure

This section describes the file/folder structure required for the full functionality of *mGlobe*.

2.1 Functions

The toolbox consists of following functions:

- **mGlobe.m** ... **main function generating graphical user interface**. Run this function to start the *mGlobe* toolbox
- `mGlobe_calc_Atmo_ERA.m` ... function for the computation of the global and local atmospheric effects using ERA Interim atmospheric model
- `mGlobe_calc_Atmo_MERRA.m` ... function for the computation of the global and local atmospheric effects using MERRA atmospheric model
- `mGlobe_calc_atmo_loading.m` function used by the `mGlobe_calc_Atmo_ERA/MERRA.m` function for the computation of the atmospheric loading effect
- `mGlobe_calc_atmo_newton.m` ... function used by `mGlobe_calc_Atmo_ERA/MERRA.m` for the computation of the gravitational effect of the atmosphere
- `mGlobe_calc_Hydro.m` ... function for the computation of the global hydrological effect (continental water storage effect)
- `mGlobe_calc_Ocean.m` ... function for the computation of the non-tidal ocean loading effect
- `mGlobe_convert_DEM.m` ... function for the conversion of various digital elevation models to the *mGlobe* supported format, i.e. the Matlab structure array
- `mGlobe_convert_ECCO.m` ... function for the conversion of ECCO-JPL (kf080) and ECCO2 to the *mGlobe* supported file format (Matlab structure array)
- `mGlobe_convert_ERA.m` ... function for the conversion of the ERA Interim surface level model to the *mGlobe* supported file format (Matlab structure array)
- `mGlobe_convert_GRACE_tellus.m` ... function for the conversion of GRACE TELLUS land and ocean mass grid models to the *mGlobe* supported file format (Matlab structure array)
- `mGlobe_convert_OMCT.m` ... function for the conversion of OMCT/AOD1B spherical harmonics to the *mGlobe* supported file format (Matlab structure array)
- `mGlobe_convert_NCEP.m` ... function for the conversion of the NCEP Ranalysis-2 surface level model to the *mGlobe* supported file format (Matlab structure array)

[1] github.com/emenems/mGlobe
[2] github.com/emenems/mGlobe_octave

- `mGlobe_convert_OTHER.m` ... function for the conversion of Other models to the *mGlobe* supported file format (Matlab structure array)
- `mGlobe_download_GLDAS.m` ... function for a direct downloading and conversion of GLDAS and MERRA models. This function does not work in Octave. Function `mGlobe_convert_GLDAS.m` converts the GLDAS and MERRA models to supported file format in Octave.
- `mGlobe_elip2sphere.m` ... function for the transformation of ellipsoidal coordinates to spherical coordinates
- `mGlobe_elip2xyz.m` ... function for the transformation of ellipsoidal (longitude, latitude) coordinates to X,Y,Z
- `mGlobe_Global.m` ... function for the computation of the loading and gravitational effects of hydrological masses used by the `mGlobe_calc_Hydro.m` and `mGlobe_calc_Ocean.m` functions
- `mGlobe_interpolation.m` ... function used for the data interpolation and for the identification of continental and ocean grid cells
- `mGlobe_Local.m` ... function for the computation of the loading and gravitational effects of hydrological masses used by the `mGlobe_calc_Hydro.m` and `mGlobe_calc_Ocean.m` functions
- `mGlobe_readAOD1B.m` ... function for the reading of AOD1B products (see `mGlobe_convert_OMCT.m`)
- `mGlobe_tesseroid.m` ... function used for the computation of the gravitational effect of a tesseroid
- `mGlobe_view1D.m` ... function used for the visualization of time series
- `mGlobe_view2D.m` ... function used for the visualization of grids (longitude, latitude, z)
- `mGlobe_mGlobe_correctionFactor.m` *... function serves for the estimation of the site- and model-dependent correction factors. *This is a supplementary function that is not required to run *mGlobe* GUI

2.2 Data files

Additionally, the following data files are required:

- `mGlobe_DATA_dgE_Atmo.txt` ... file contains the gravity response to the atmospheric loading as a function of the spherical distance. Edit this file to use other Earth's model
- `mGlobe_DATA_dgE_Hydro.txt` ... file contains the gravity response to the hydrological loading as a function of the spherical distance. Edit this file to use other Earth's model or to divide the loading contribution to part related to density re-distribution and to change of the position
- `mGlobe_DATA_Load_degree_k.txt` ... file contains the degree-dependent k load Love numbers (used for the conversion of OMCT/AOD1B spherical harmonics to grid)
- `mGlobe_DATA_OceanGrid.mat` ... file contains a grid used for the identification of continental and ocean grid cells. Modify this file if high-resolution coastlines are required (default resolution 0.1°). This file (Matlab array) must contain following layers: oceans.lon for longitude vector (degrees), oceans.lat for latitude vector (degrees) and oceans.id with (mesh)grid of zeros (for continents) and ones (for oceans, seas and distinguishable/large lakes)

2.3 Folders

All above mentioned functions and files must be located in the same folder (/mGlobe/). The required folder structure is related to the sorting of supported global hydrological/land surface models (GHM), ocean bottom pressure models (OBPM) and GRACE mass grids. All hydrological and ocean models must be stored in these folders (*mGlobe* saves the converted models to these folders automatically). Digital elevation models and atmospheric models (ERA and MERRA) can be stored in arbitrary folders. *mGlobe* works in following path structure:

/mGlobe
/GHM
/CLM
/ERA
/MERRA
/MOS
/NCEP
/NOAH025
/NOAH10
/OTHER
/VIC
/GRACE
/LAND
/OCEAN
/OBPM
/ECCO1
/ECCO2
/OMCT
/OTHER

All test results and inputs are stored in the /EXAMPLES/ folder (optional).

3 Models

The computation of the gravity response to large scale effects requires the conversion of input models to the supported file format. Table 1 shows all supported models (as of 9th of May 2016). The first part of the table shows hydrological models, the second part ocean models (ocean bottom pressure models) and the last part shows the supported atmospheric models. The time resol. column shows the maximal possible time resolution. All GLDAS, MERRA and ERA Interim models are also available in monthly resolution. For Octave, see section **8. Octave version**.

Table 1: List of supported models

Model	time resol.	Format	Download via
GLDAS/CLM	3 hours	-	direct download using **Models** panel
GLDAS/MOS	3 hours	-	direct download using **Models** panel
GLDAS/NOAH025	3 hours	-	direct download using **Models** panel
GLDAS/NOAH10	3 hours	-	direct download using **Models** panel
GLDAS/VIC	3 hours	-	direct download using **Models** panel
MERRA/Land	1 hour	-	direct download using **Models** panel
NCEP Reanalysis-2	6 hours	NetCDF	`http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.gaussian.html`
ERA Interim	6 hours	NetCDF	`http://apps.ecmwf.int/datasets/data/interim-full-daily/`
GRACE/LAND	≈month	NetCDF	`ftp://podaac-ftp.jpl.nasa.gov/allData/tellus/L3/land_mass/RL05/netcdf/`
Other models	3 hours	txt	-
ECCO-JPL	month	txt	`ftp://podaac-ftp.jpl.nasa.gov/allData/tellus/L3/ecco_obp/`
ECCO-JPL	12 hours	NetCDF	`ftp://snowwhite.jpl.nasa.gov/data4/KalmanFilter`
ECCO2 (beta)	24 hours	NetCDF	`ftp://ecco2.jpl.nasa.gov/data1/cube/cube92/lat_lon/quart_90S_90N/PHIBOT.nc/`
GRACE/OCEAN	≈month	NetCDF	`ftp://podaac-ftp.jpl.nasa.gov/allData/tellus/L3/ocean_mass/RL05/netcdf/`
OMCT	6 hours	txt	`http://isdc.gfz-potsdam.de`
		txt	`ftp://podaac-ftp.jpl.nasa.gov/allData/grace/L1B/GFZ/AOD1B/RL05`
Other models	3 hours	txt	-
ERA Interim (atmo)	6 hours	NetCDF	`http://apps.ecmwf.int/datasets/data/interim-full-daily/?levtype=pl/`
MERRA (atmo)	6 hours	nc & hdf	`http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset.pl?LOOKUPID_List=MAI6NPANA`

The following text briefly describes few examples of model conversion.

3.1 Example: download GLDAS/NOAH10 model

This example shows how to download the GLDAS/NOAH10 model for 2012.

Run *mGlobe* and select the **Models** console. Select the NOAH10 model from the pop-up menu in the GLDAS/MERRA download sub-panel. In the Time sub-panel, change the date to *Start* = 2012 01

01 12 and *End* = 2012 12 31 12 (hours must be equal to 0/3/6/9/12/15/18). Than switch the *Step* to 'Day' (24 hour resolution is sufficient for most cases). Press the *Download* button. Subsequently, all soil moisture and snow layers (canopy water storage is neglected) of the NOAH10 model will be downloaded and saved to the /GHM/NOAH10/ folder. The model is stored in the supported format, i.e. the Matlab structure array. Please keep in mind that the `mGlobe_download_GLDAS.m` function uses the OPeNDAP server architecture and therefore requires Matlab R2012a or higher! The downloading may take several hours depending on the internet connection. To cancel the downloading (or the computation), go to the Matlab command line and press Ctrl+C.
To convert the GLDAS/NOAH10 model to supported file format in Octave, see section **8. Octave release**.

3.2 Example: convert ERA Interim model

This example shows how to convert the downloaded ERA Interim (surface level, not the pressure level) model to the supported file format.

First go to `http://apps.ecmwf.int/datasets/data/interim-full-daily/?levtype=sfc` and register/login if required. Than select the 2012 year (all months). Select the time: 00,06,12,18 (6 hour resolution). Select the step 0, i.e. the analysis. Than select the following parameters: Snow depth, Volumetric soil water layer 1-4 and press Retrieve NetCDF. If necessary change the attributes Grid to 0.75x0.75 and Area: Default (as archived = global coverage). Press Retrieve now. The downloading may take several hours depending on the internet connection (file size around 1 GB).

After you have downloaded the ERA Interim NetCDF file, run *mGlobe* and select the **Models** panel. Change the date to *Start* = 2012 01 01 00 and *End* = 2012 12 31 18 (hours must be equal to 0/6/12/18). Than switch the *Step* to '6 Hours'. Select the downloaded ERA Interim NetCDF file using the *Input* button in the ERA/NCEP convert (netCDF) sub-panel. Press *Convert ERA* to convert the model. The conversion should not take more than few minutes. The converted model is now stored in the /GHM/ERA/ folder. You may delete the original NetCDF file now.

3.3 Example: convert DEM

This example shows how to convert a digital elevation model (DEM) downloaded via the GEODAS Grid Translator to the supported file format. This is just an example. The use of ETOPO DEM is not suitable for areas close to seas because *mGlobe* requires zero DEM values over the seas and oceans! Only DEMs in geographic coordinate system can be transformed using this function.

The computation of the continental water storage effect allows the inclusion of a digital elevation model (optional). This DEM must cover an area up to a spherical distance of 1° deg (approx 110 km) from the point of observation. This model must be stored in the supported format (Matlab structure array). The DEM conversion sub-panel is used for the conversion of various DEM file formats.

First, go to `http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html`[3] and select ETOPO2-2 minute global relief (this is just an example, the computation often requires higher spatial resolution). Set the latitude to 46N - 50N degrees and the longitude to 14E - 19E. Select the 2-minute grid cell size. Choose the XYZ (lon,lat,depth) Raster Format and uncheck the Omit Empty Grid Cells. Then set your Grid ID and press Submit + Compress and Retrieve Your grid (if you have chosen the ASCII Raster, change the xllcenter and yllcenter to xllcorner/yllcorner manually).

After you have downloaded the DEM, run *mGlobe* and select the **Models** panel. To convert your DEM, use the *Input* button and select 'txt (Lon,Lat,Height)' file format from the DEM conversion sub-panel. Than select the output file (*.mat) and press the *Convert DEM* button. You may delete the original DEM file now.

3.4 Example: convert other models

This example shows how to convert other models that are currently not supported/freely available, e.g. WGHM, GRACE ICGEM water column, etc.. These models must have a global coverage (in longitude, -180:180 deg) and a constant spatial sampling. This tool can be use either for global hydrological models or ocean bottom pressure models.

[3] alternatively: http://maps.ngdc.noaa.gov/viewers/wcs-client/

mGlobe supports the loading from txt files where the first two columns are reserved for the longitude/latitude and the third column is reserved for model values (water column). To load such files, each file name must have a prescribed structure: first ten characters are used for the model name followed by underscore and model year (YYYY), month (MM), day (DD), underscore and model hour (HH). Example: `MODEL_NAME_20120128_12.txt` (see folder /EXAMPLES/Models/ for such file).

Run *mGlobe* and select the **Models** panel. Select one of your input files using the *Input* button (all files must be stored in the same folder). Then select a file *Type* that corresponds to the input file (e.g. 'Lon,Lat, Water(m)' , where the longitude should be in a -180:180 and not in 0:360 degree system). Change the *Header* lines accordingly. Then set the *Start*, *End* and *Step* to required values and press *Convert model*. The converted model is now stored in the /GHM/OTHER/ folder. If you have transformed an ocean bottom pressure model, copy the created files to the /OBPM/OTHER/ folder.

The conversion function creates automatically *.mat files containing '`out_mat`' array including following layers: `lon` (for longitude in degrees), `lat` (latitude in degrees),`total` (total water storage in mm), `input_file` (input file name without path), `units` (output units, i.e. mm) and `time` (Matlab time, i.e. computed using datenum function). The `lon` and `lat` layers are created using Matlab meshgrid function.

3.5 Example: convert GRACE Tellus Land grid

This example shows how to convert GRACE land mass grid to Matlab structure array. First go to `ftp://podaac-ftp.jpl.nasa.gov/allData/tellus/L3/land_mass/RL05/netcdf/` and download the grid data file, e.g. `GRCTellus.GFZ.200204_201403.LND.RL05.DSTvSCS1401.nc` and the scaling matrix file, e.g. `CLM4.SCALE_FACTOR.DS.G300KM.RL05.DSTvSCS1401.nc`. This file is used to restore the energy lost due to the filtering (especially at the seasonal time scale).

Run *mGlobe* and select the **Models** panel and press the *Input* button from the GRACE sub-panel to select the downloaded mass grid file (e.g `GRCTellus.GFZ.200204_201403.LND.RL05.DSTvSCS1401.nc`). Change the prefix to required string, e.g. `GRC_GFZ_RL05_LND_vSCS1`. This name must be exactly 22 characters long. Change the pop-up menu to 'Land Grid' and check the *Scale* option. The downloaded scale matrix is designed for land grids not ocean grids. Change the *Start* and *End* time period as desired. The *Step* option is not use in this case. Press *Convert GRACE* to start the conversion. You will be prompted to select the downloaded scaling matrix file as well as the scaling matrix NetCDF layer (mostly denoted as `SCALE_FACTOR`). The converted model is now stored in the /GRACE/LAND/ folder. You can delete the input file now.

During the computation of GRACE global hydrological or non-tidal ocean loading effect, *mGlobe* changes the current folder to /GRACE/LAND/ or /GRACE/OCEAN/ and searches for all files with given name/prefix and within the given time period. This is in contrast to the use of hydrological or oceanic models where the algorithm selects only those files that matches current time epoch. This is related to the uneven GRACE time sampling.

3.6 Example: convert NCEP Reanalysis 2 model

This example shows how to download and convert NCEP Reanalysis 2 (NCEP-DOE Reanalysis 2: Gaussian Grid) model to the supported file format.

First go to `http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.gaussian.html` and download all soil moisture layers, i.e. 0–10 and 10–200 cm, and water equiv. of snow depth (4-times Daily Values or monthly). These data sets are stored in individual files for each layer and year, i.e., `soilw.0-10cm.gauss.2012.nc` for soil moisture 0–10 cm, `soilw.10-200cm.gauss.2012.nc` for 10–200 cm, and `weasd.sfc.gauss.2012.nc` for snow. Download these files into one folder. Do not rename these files.

After you have downloaded the NCEP NetCDF files, run *mGlobe* and select the **Models** panel. Change the date to *Start* = 2012 01 01 00 and *End* = 2012 12 31 18 (hours must be equal to 0/6/12/18). Than switch the *Step* to 'Day'. Select one downloaded ERA Interim NetCDF file using the *Input* button in the ERA/NCEP convert (netCDF) sub-panel. Press *Convert NCEP* to convert the model. The conversion should not take more than few minutes. The converted model is now stored in the /GHM/NCEP/ folder. You may delete the original NetCDF file now.

4 Hydro

This console is designed for the computation of the global hydrological effect (GHE), i.e. the contribution of continental water storage to surface gravity variations. User may choose from several supported models as well as other models converted via provided functions. See console **Model** for the model downloading/conversion. All results should be understood as relative results and not the gravity effect of the whole hydrosphere.

- Position: set the *Latitude*, *Longitude* and *Height* of your station.
  Ellipsoidal latitude: WGS84, -90:90 deg.
  Ellipsoidal longitude: WGS84, -180:180 deg.
  (Ellipsoidal) height: this height is used for the zone up to 1 deg from the given position. Set this value to zero if you do not want to use a DEM.

- Time: set the time coverage.
  Hour must be equal to 0,3,6...18. *Step* determines the time resolution (max. time resolution/step = 3 hours, min. time resolution/step = month).

- Hydrological model: select your *Model*, i.e. GLDAS/MERRA/ERA Interim/Other/GRACE.
  Hydrological layer: select your *Layer*, i.e. total (sum of all layers) or individual layer, e.g. soilm1. The model *Path* and name are fixed. Model values for each time epoch are stored in individual files (structure array: *.mat format) and must have a prescribed name (generated by provided functions).
  Exclude: exclude Greenland or Antarctica, i.e. the areas where hydrological models do not provide reliable information. For these areas, the water amount is set to zero. This option is automatically turned off if the *Mass conservation* is set to 'Continent + Ocean model'.
  Include only: optional loading of an inclusion polygon to set all values outside the given area to zero. The *mGlobe* supports the loading of a *.txt file without header lines, or header starting with % sign. First column is reserved for the longitude (degrees, -180:180) and the second column for the latitude (degrees, -90:90). An example of such a file is stored in /EXAMPLES/Hyro/`TEST_InclusionPolygon.txt`. The Matlab inpolygon function is used to identify grid cells (from GHM grid in original resolution) inside the polygon. The total mass used in *Mass conservation* principle enforcement does not take the inclusion polygon into consideration.
  Mass conservation: hydrological models tend to increase the amount of water in the system with respect to time. To minimize this artificial as well as natural (continent-ocean exchange) effect, choose 'Ocean layer (from mass excess)'. In such case, an uniform water layer over the ocean with variable thickness in time is created. For GLDAS, MERRA and ERA Interim models, a long term (2000-2010) average is used (same average regardless of selected *Layer*, i.e. computed for the sum of all layers). Thereby, the exclusion of Greenland/Antarctica is considered (not the inclusion polygon). The uniform water layer is then computed as a difference between the current epoch and the average value. For Other/GRACE models, the first time epoch is used as a reference value. The gravity response to global ocean level rise of one mm can by found in the output file. To substitute the ocean level variations driven by hydrological model by observed global mean sea level (GMSL) variations, subtract the computed ocean loading and newtonian part and replace it using GMSL variations (corrected for steric effect) multiplied by the given gravity response. If you are using a coupled model (Other) with water grid on oceans and continents, choose 'Continent + Ocean model'. This will compute also the contribution of Ocean as given by model values. The 'off' option will result in a gravity response to water storage variations as given by the model with no mass variation over the Ocean. The provided file `mGlobe_DATA_OceanGrid.mat` is used to identify Oceans/Continents. The enforced *Mass conservation* principle should be chosen in accordance with the Ocean bottom pressure model used for the non-tidal ocean loading effect.

- Topography: (Optional) Load a digital elevation model (*DEM to 1°*) for points up to 1 deg (spherical distance) from the given position. The loading of a DEM with an insufficient spatial extension will result in NaN values. The *mGlobe* supports *.mat files, where the DEM is stored as a structure array: dem.lon (meshgrid longitude in degrees, -180:180), dem.lat (meshgrid latitude in degrees, -90:90) and dem.height (height in meters). Use the **Models** panel for the conversion from other file formats. If the DEM is not loaded, the effect will be calculated for a spherical approximation. The height for points on the ocean must be equal to zero! To undo the selected DEM, simply press cancel when choosing the DEM file (same procedure for inclusion polygon). *Show*: plot DEM and the point of the computation.

- Output: select your output *File* (pick file = full file name + extension). The file extension will be changed automatically, but the selected output file must have three characters long file extension (e.g. `OutputFile.txt`).
  Results will be saved to the selected file formats (*txt, xls, tsf*). Please note that the *xls* output works only with installed Microsoft Office Excel. *mGlobe* will create a new file or will write in an existing xls file! It is recommended to delete the existing xls file before writing. The TSoft (*tsf*) format is not supported for monthly step.
  The *subtract average* option will subtract the mean value from all results. Do not use this option if you split the computation into several periods/files as the mean value changes in time.
- *Threshold (deg)*: set the threshold between the local and the global zone expressed in the spherical distance (degrees, min. = 0.05, max = 1.00 deg). This value is than applied to the re-interpolated mass grid and not the grid in the original resolution.

4.1 Example: Compute the GHE (GLDAS/NOAH10)

This example shows how to compute a global hydrological effect for Vienna (2012) using the GLDAS/NOAH10 model (assuming the GLDAS/NOAH10 model has been downloaded).

Run *mGlobe* and select the **Hydro** console. Set the *Latitude* to 48.24885, the *Longitude* to 16.35650 and the *Height* to 192.70 m. Set the *Start* time to 2012 01 01 12, the *End* time to 2012 12 31 12 and the *Step* to Day. Then change the hydrological model to GLDAS/NOAH (1°) and set *Layer* to total. Select the *Exclude: Greenland*, and switch the *Mass conservation* to 'Ocean layer (from mass excess)'.

Load the DEM using the *DEM to 1°* button (see section 2.3 for the conversion of DEM). If you want to compute a pure spherical approximation, do not load the DEM and set the *Height* to 0 m. Press *Show* to plot the position and the DEM. Choose your output file using the *File* button from the Output sub-panel (e.g. `TEST_GHE_NOAH10_012012_122012.txt`). Select the *subtract average* option to subtract the mean value. Change the *Threshold (deg):* to 0.1 and then press *Calculate*. The computation may take few minutes.

4.2 Outputs

The computed gravity effects can be written to a text, Excel or TSoft file. Besides information about position and used *mGlobe* settings, these files contain following columns/abbreviations:

- `time_matlab`: time in Matlab format, i.e., days since 0/0/0 00:00 (UTC)
- `Date`: calendar date, i.e., YYYYMMDD
- `Time`: time, i.e., HHMMSS (UTC)
- `total_eff`: total gravity effect (nm.s^{-2})
- `cont_load`: effect related to loading over continents (nm.s^{-2})
- `cont_newton`: gravitational effects related to masses over continents (nm.s^{-2})
- `ocean_load`: effect related to loading over oceans (nm.s^{-2})
- `cont_newton`: gravitational effects related to masses over oceans (nm.s^{-2})
- `local_TWS(mm)`: interpolated water storage in mm (see *Layer* setting)

5 Ocean

User may choose from default models as well as other models converted via provided functions. The ECCO models are converted from this console whereas the GRACE and Other models are converted from the **Models** console. It is recommended to use models that include the ocean response to atmospheric pressure variation. All results should be understood as relative results and not the gravity effect of the whole hydrosphere. The `mGlobe_DATA_OceanGrid.mat` file is used to identify Ocean and Continent grid cells.

- Position: same as for **Hydro**
- Time: same as for **Hydro**
- Model setup and conversion: select your *Model version*, i.e. ECCO1/Other/GRACE/ECCO2. The model *Path* is fixed. Each time epoch is stored in an individual file (structure array: *.mat format) and must have prescribed name.
  Use the *Convert (ECCO/OMCT)* button for the conversion of ECCO and OMCT models. The conversion of ECCO1 (JPL) 12 hours model requires the same folder structure as the distribution (`ftp://snowwhite.jpl.nasa.gov/data4/KalmanFilter`). Conversion of monthly ECCO1 model requires that all input files (unpacked) are store in the same folder. Same holds true for ECCO2 NetCDF files (beta version). All OMCT/AOD1B data files must be stored in one folder.

  The *Subtract area average* option serves for the subtraction of global weighted (area) mean that varies in time. The aim of this correction is to enforce a constant mass in time. Please keep in mind that the global area mean may have been already subtracted during the pre-processing. This is the case for monthly ECCO-JPL solutions (not for 12 hours). This option relates to the computation of NTOL, not to the conversion of models. The selection of 'Use mean pressure time series' will make visible additional options, i.e. selection of time series stored in an txt file. The loaded file must contain time in Matlab format (datenum function) and pressure variations in Pa (standard *mGlobe* txt output).
- Output: same as for **Hydro**
- *Threshold (deg)*: same as for **Hydro**

5.1 Example: convert the ECCO-JPL model

This example shows how to convert ECCO-JPL (ECCO1 monthly) data to *mGlobe* supported file format.

First go to `ftp://podaac-ftp.jpl.nasa.gov/allData/tellus/L3/ecco_obp/` and download the ECCO model for the time period between December 2011 (`ECCO_kf080_2011335_2011365_AveRmvd_OBP.txt.gz`) and January 2013 (`ECCO_kf080_2013001_2013030_AveRmvd_OBP.txt.gz`). Unpack these files to one folder.

After you have downloaded and unpacked the ECCO-JPL data, run *mGlobe* and select the **Ocean** console. Set the *Start* time to 2011 12 01 12, the *End* time to 2013 01 31 12 and the *Step* to 'Month'. Then change the ocean model to 'ECCO-JPL (conversion: *.txt / calculate *.mat)'. Select one file from the folder with the downloaded and unpacked ECCO-JPL model using the *Input* button. Then press the *Convert (ECCO only)* button. The conversion should not take more then few minutes. The result is stored in the /OBPM/ECCO1/ folder.

If you want to convert the 12 hour version of the ECCO-JPL model, store the downloaded NetCDF files in the same folder structure as distributed via the JPL ftp server (`KalmanFilter/kf080_YYYY/n10days_XX_YY/`). Due to the latency of the model, you may need to rename the folder and the name of the last file to its full year equivalent, e.g. from `KalmanFilter/kf080_2014/n10day_28_33/OBPano_08_08.06480_07920_012.cdf` to `KalmanFilter/kf080_2014/n10day_28_37/OBPano_08_08.06480_08880_012.cdf`.

5.2 Example: convert the OMCT (oba) model

This function allows the conversion of AOD1B products, i.e. OMCT model, to grids. User can select the 'OMCT oba' (total ocean bottom pressure anomalies), 'OMCT ocn' (contribution of the ocean water column) or 'OMCT atm' (contribution of the atmosphere (ECMWF)) layer. The spherical harmonics will be converted to grid with spatial resolution of 1 degree. Keep in mind that the real resolution is lower as the maximal degree of the AOD1B products equals 100 (all degree coefficients are utilized, i.e. including 0 and 1).

The conversion is based on the paper by *Wahr et al., (1998)*: Time variability of the Earth's gravity field: Hydrological and oceanic effects and their possible detection using GRACE. Journal of Geophysical

Research, vol. 103, no. B12. The `mGlobe_DATA_OceanGrid.mat` grid is used to set all grid cells over the continents to NaN. This affects the difference between the gravity effect computed via *mGlobe* (based on Green's functions) and using directly AOD1B coefficients (synthesis of spherical harmonic coefficients).

First go to `http://isdc.gfz-potsdam.de` or `ftp://podaac-ftp.jpl.nasa.gov/allData/grace/L1B/GFZ/AOD1B/RL05` and download all 2013 AOD1B (Release 05) data files. Prior to the conversion, unpack all files. Then go to the **Ocean** console and set the *Start* time to 2013 01 01 12, the *End* time to 2013 12 31 12 and the *Step* to '6 hours' (monthly resolution is not supported). Select one of the downloaded and unpacked files using the *Input* button, e.g. `AOD1B_2013-01-01_X_05.asc`. Then switch the *Model version* to 'OMCT oba' and press the *Convert (ECCO/OMCT)* button. The conversion requires several hours. The result is stored in the /OBPM/OMCT/ folder. Always check the known issues of AOD1B coefficients[4].

5.3 Example: compute the NTOL effect (ECCO-JPL)

This example shows how to compute the non-tidal ocean loading effect for Vienna (2012) using ECCO-JPL monthly model (assuming the ECCO-JPL model has been downloaded and converted).

Run *mGlobe* and select the **Ocean** console. Set the *Latitude* to 48.24885, the *Longitude* to 16.35650 and the *Height* to 192.70 m. Set the *Start* time to 2011 12 01 12, the *End* time to 2013 01 31 12 and the *Step* to 'Month'. Then change the ocean model to 'ECCO-JPL'. Choose your output file using the *File* button from the Output sub-panel (e.g. `TEST_NTOL_ECCO-JPL_012012_122012.txt`). Set the *Subtract mean field* option to 'off'. Change the *Threshold (deg):* to 0.1 and then press *Calculate*. The computation may take several seconds.

5.4 Outputs

The computed gravity effects can be written to a text, Excel or TSoft file. Besides information about position and used *mGlobe* settings, these files contain following columns/abbreviations:

- `time_matlab`: time in Matlab format, i.e., days since 0/0/0 00:00 (UTC)
- `Date`: calendar date, i.e., YYYYMMDD
- `Time`: time, i.e., HHMMSS (UTC)
- `total_eff`: total gravity effect (nm.s^{-2})
- `cont_load`: effect related to loading over continents (zero for NTOL)
- `cont_newton`: gravitational effects related to masses over continents (zero for NTOL)
- `ocean_load`: effect related to loading over oceans (nm.s^{-2})
- `cont_newton`: gravitational effects related to masses over oceans (nm.s^{-2})
- `subtracted_press(Pa)`: pressure subtracted from each grid cell (see *Subtract mean field* options)

6 Atmo

This console is designed for the computation of the global+local atmospheric effect. The atmosphere is modelled by pressure levels (levels of constant pressure). The density variation is calculated from temperature, specific humidity and pressure given by the ECMWF ERA Interim (37 levels) or MERRA (42 levels) models. Additional introduction of a correction/admittance factor (e.g. $-3\,\mathrm{nm/s^2/hPa}$) is required due to the deficient spatial and temporal resolution of atmospheric models! This factor should be applied to the difference between the in-situ and model pressure variation and added to the computed local effect. No loading effect on ocean is computed. Therefore, the ocean response to atmospheric pressure variation should be considered within the computation of the Non-tidal ocean loading effect (panel **Ocean**).

[4]http://www.gfz-potsdam.de/en/research/organizational-units/departments/department-1/earth-system-modelling/services/aod1b-product/known-issues-aod1b-rl05/

6.1 ERA Interim

ECMWF (ERA Interim Analysis) data: No conversion is required. The *mGlobe* uses data stored in NetCDF format as retrieved from ECMWF servers.

- Position: same as for **Hydro**. The input height will not be considered. The computation uses orography heights.
- Time: set the time coverage.
  Hour must be equal to 0,6,12,18. *Step* determines the time resolution (max. time resolution/step = 6 hours, min. time resolution/step = 2 days).
- Atmospheric model data

  Geopotential: netCDF file containing: 'longitude','latitude','time','levelist','z' layers. The height in m is obtained after dividing by 9.80665 nm/s^2. These layers must have the same dimensions (latitude, longitude) as *Orography*. One file contains one (or part of) year sampled every 24 hours, e.g. year = 2011, hour = 06. Fix file name must be used, i.e. last 7 characters (without file extension *.nc) = `arbitrary_HH_YYYY.nc`, e.g. `ERA_Interim_Geopotential_06_2011.nc`.
  File downloaded via `http://apps.ecmwf.int/datasets/data/interim-full-daily/?levtype=pl`.
  Downloading options:
  Type of level = pressure level,
  ERA Interim fields = daily,
  Level = 1 to 1000,
  Retrieve netCDF,
  Area = default,
  Grid = 0.75x0.75 deg.

  Specific humidity = netCDF file containing: 'longitude','latitude','time','levelist','q'. These layers must have the same dimensions (latitude, longitude) as *Orography*. The same downloading settings as for *Geopotential*.

  Temperature = netCDF file containing: 'longitude','latitude','time','levelist','t'. These layers must have the same dimensions (latitude, longitude) as *Orography*. The same downloading settings and file name structure as for *Geopotential*.

  Surface data = netCDF file containing: 'longitude','latitude','time','t2m' (2 metre temperature),'d2m' (2 metre dew-point temperature),'sp' (Surface pressure). These layers must have the same dimensions (latitude,longitude) as *Orography*. One file contains one full (or part of) year and ALL hours (e.g. year = 2011, hour = 00,06,12,18 i.e. 6 hour sampling)! Fix file name must be used, i.e. last 6 letters (without extension *.nc) = `arbitrary_D_YYYY.nc`, e.g. `ERA_Interim_Surface_D_2011.nc`.
  File downloaded via `http://apps.ecmwf.int/datasets/data/interim-full-daily/?levtype=sfc`.
  Downloading options:
  ERA Interim fields = daily,
  Type of level = surface,
  Select time = 0,6,12,18,
  Step = 0, i.e. analysed fields, not forecast. This option is not related to *mGlobe* *Step* setting!
  Retrieve netCDF,
  Area = default,
  Grid = 0.75x0.75 deg.

  Orography = netCDF file containing: 'longitude','latitude','z' layers (height is obtained after dividing by 9.80665 nm/s^2). This is a reference grid used for the computation, i.e. this grid defines the spatial resolution. All the other ERA Interim input data must have the same resolution (longitude, latitude). File name is not fixed (e.g. `ERA_Interim_Invariant.nc`).

File downloaded via `http://apps.ecmwf.int/datasets/data/interim-full-invariant/`.
Downloading options:
ERA Interim fields = invariant,
Parameter = geopotential,
Retrieve NetCDF,
Area = default,
Grid = 0.75x0.75 deg.

MERRA surf.p = for MERRA model only

- Output: same as for **Hydro**. Local zone is fixed to 0.1°.

6.2 MERRA/Atmosphere

MERRA data: No conversion is required. The *mGlobe* uses data stored in NetCDF and hdf format as retrieved from MERRA servers. The computation combines two products, i.e., MAI6NPANA for pressure levels and MAT1NXFLX for surface data. Additionally, the orography belongs to the MAC0NXASM data subset.

- Position, Time and Output: same as for ERA Interim.

- Atmospheric model data

  Geopotential = netCDF file containing: 'longitude','latitude','time', 'levels', 'h' (geopotential height). One file contains on full day (0,6,12,18 hour). The file name/suffix must be used: last 15 letters = `arbitrary_YYYYMMDD.SUB.nc`, e.g. `MERRA300.prod.assim.inst6_3d_ana_Np.20131218.SUB.nc`.
  File downloaded via `http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset.pl?LOOKUPID_List=MAI6NPANA`.
  Downloading options:
  Select Data Products: `DAS 3d analyzed state on pressure (inst6_3d_ana_Np)`
  Area of Interest: West = -180, North = 90, South = -90, East = 180
  Time interval: set required time interval
  Select Parameters: 'H = Geopotential Height'
  Time subset: Time 1: –, Time 2: – , i.e. do not select. Leave 'Mean' unchecked.
  Vertical Level Subset: check all layers (1-42).
  Select format: NetCDF or NetCDF compressed (recommended). For convenient downloading and decompressing, use wget `http://ftp.gnu.org/gnu/wget/`.

  Specific humidity = netCDF file containing: 'longitude','latitude','time','levels','qv'. These layers must have the same dimensions (latitude, longitude) as *Orography*. The same downloading settings as for *Geopotential*, except for selected Parameter: 'QV = Specific humidity (kg kg-1)'.

  Temperature = netCDF file containing: 'longitude','latitude','time','levels','t'. These layers must have the same dimensions (latitude, longitude) as *Orography*. The same downloading settings and file name structure as for *Geopotential*, except for selected Parameter: 'T = Air Temperature (K)'.

  Surface data = netCDF file containing: 'longitude','latitude','time','tlml' (temperature),'glml' (spec. humidity). These layers must have the same dimensions (latitude,longitude) as *Orography*. One file contains one full (or part of) day, i.e. all hours (0:30, 1:30 ... 23:30)! The file name/suffix must be used: last 15 letters = `arbitrary_YYYYMMDD.SUB.nc`, e.g. `MERRA300.tavg1_2d_flx_Nx.20131218.SUB.nc`.
  File downloaded via `http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset.pl?LOOKUPID_List=MAT1NXFLX`, alternatively `http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset.pl?LOOKUPID_List=MAT1NXSLV`
  Downloading options:
  Select Data Products: `DAS 2d surface turbulent flux diagnostics (tavg1_2d_flx_Nx)`

Area of Interest: West = -180, North = 90, South = -90, East = 180
Time interval: set required time interval
Select Parameters: 'TLML =Temperature of lowest model layer' and 'QLML =Specific humidity of lowest model layer', alternatively, 'T2M = Temperature at 2 m above the displacement height' and 'QV2M = Specific humidity at 2 m above the displacement height'. Note that these products are time averages, not instantaneous fields as in case of pressure level products.
Time subset: Time 1: –, TIme 2: – , i.e. do not select. Leave 'Mean' unchecked.
Select format: NetCDF or NetCDF compressed (recommended)

Orography. In Matlab version, both, hdf and netCDF files are supported. Octave version supports only netCDF files. To download the netCDF file go to `http://disc.gsfc.nasa.gov/SSW/#keywords=MACONXASM5.2.0` and select time span 01/01/1971 - current + Search for data set. Then, select the found subset in netCDF format and download the file to desired folder. The downloaded file must contain following layers: 'XDim','YDim','PHIS'.

The hdf file can be downloaded via `ftp://goldsmr2.sci.gsfc.nasa.gov/data/s4pa//MERRA_MONTHLY/MACONXASM.5.2.0/1979/MERRA300.prod.assim.const_2d_asm_Nx.00000000.hdf`. This file contains identical layers as the netCDF version. All the other MERRA input data must have the same resolution (longitude, latitude) as orography. File name is not fixed (e.g. `MERRA_Atmo_Orography.hdf` or `MERRA_Atmo_Orography.nc`).

MERRA surf.p = netCDF file containing: 'longitude','latitude','time', 'ps' (surface pressure). One file contains on full day (0,6,12,18 hour). The file name/suffix must be used: last 15 letters = `arbitrary_YYYYMMDD.SUB.nc`, e.g. `MERRA300.prod.assim.inst6_3d_ana_Np.20131218.SUB.nc`.
File downloaded via `http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset.pl?LOOKUPID_List=MAI6NPANA`.
Downloading options:
Select Data Products: `DAS 3d analyzed state on pressure (inst6_3d_ana_Np)`
Area of Interest: West = -180, North = 90, South = -90, East = 180
Time interval: set required time interval
Select Parameters: 'PS = Surface pressure (Pa)'
Time subset: Time 1: –, TIme 2: – ,i.e. do not select (leave 'Mean' unchecked)
Vertical Level Subset: do not check any layer.
Select format: NetCDF or NetCDF compressed (recommended)

6.3 Example: download the ERA Interim temperature

This example shows how to download and store the ERA Interim temperature data required for the computation of the atmospheric effect.

First go to `http://apps.ecmwf.int/datasets/data/interim-full-daily/?levtype=pl` and Login/register. Than select the 2012 year (all months). Select time 12:00:00 and the Temperature parameter (all levels, i.e. 1000 to 1 hPa). Press Retrieve NetCDF. Ensure that the Area is set to 'Default (as archived)', i.e. global coverage and the Grid is equal 0.75x0.75. Then press Retrieve now. Save the file respecting the prescribed suffix, e.g. `ERA_GEOPOT_24hStep_12_2012.nc`, to your folder with the temperature data.

To download the surface temperature go to `http://apps.ecmwf.int/datasets/data/interim-full-daily/?levtype=sfc`. Select the whole year (2012), all time check-boxes (0,6,12,18) and step 0. Then select following parameters: 2 metre temperature, 2 metre dewpoint temperature and Surface pressure. Press Retrieve NetCDF as in the case of the pressure level data. Save the file respecting the prescribed suffix, e.g. `ERA_SP_2T_2D_ALLh_06hStep_D_2012.nc`, to your folder with the surface data.

6.4 Example: download MERRA/Atmosphere temperature

The following example shows how to download the (pressure level) temperature data.

To download the MERRA model, go to `http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset.pl?LOOKUPID_List=MAI6NPANA`. Make sure the 'Area of Interest' contains following values: -180, 90, -90, 180. Set the time start to: 2012 JAN 01 and end time to 2012 DEC 31. Check the 'T = Air Temperature (K)' parameter as well as all 42 pressure levels (1000 hPa to 0.1 hPa). Make sure the Time 1, Time 2 are set to '–' and the 'Mean' is unchecked. Then change the Output file format to NetCDF compressed (.gz) and press Start search. This will open new window/tab with all requested files. Download the list of URLs and use 'wget' to download all files. After downloading, uncompress these file to one folder (it is recommended to use separate folders for each Parameter as the generated names do not contain information about the parameter).

6.5 Example: compute the Atmospheric effect

This example shows how to compute the atmospheric effect for Vienna (2012) using ERA Interim model.

Run *mGlobe* and switch to the **Atmo** console. Set the *Start* time to 2012 01 01 12, the *End* time to 2012 12 31 12 and the *Step* to '12 Hours'. Locate the geopotential NetCDF file by pressing *Geopotential*. Keep in mind that all geopotential files must be stored in this folder. Do the same for *Temperature*, *Specific humidity*, *Surface data* and *Orography*. Choose your output file using the *File* from the Output sub-panel (e.g. `TEST_ATMO_ERA_012012_122012.txt`). Press *Calculate ERA*. The computation may take several hours to days depending on the CPU (Intel Core i7 @ 3.7 GHz + 64 GB of RAM: 2.5 hours , Intel Core i7 @ 2.67 GHz + 8 GB of RAM: 7.8 hours). Subsequently, introduce the local residual effect by adding $a_{factor} * (p_{insitu} - p_{model})$, where the a_{factor} is the correction/admittance factor and the p stands for the pressure variation observed close to the gravimeter (in situ) and interpolated from the atmospheric model. To obtain the site-specific correction factor, use the `mGlobe_mGlobe_correctionFactor.m` function. See function help for more information.

6.6 Outputs

The computed gravity effects can be written to a text, Excel or TSoft file. Besides information about position and used *mGlobe* settings, these files contain following columns/abbreviations:

- `time_matlab`: time in Matlab format, i.e., days since 0/0/0 00:00 (UTC)
- `Date`: calendar date, i.e., YYYYMMDD
- `Time`: time, i.e., HHMMSS (UTC)
- `total_eff`: total gravity effect (nm.s^{-2})
- `global_load`: loading effect of atmospheric masses beyond 0.1° (nm.s^{-2})
- `global_newton`: gravitational effect of atmospheric masses beyond 0.1° (nm.s^{-2})
- `local_load`: loading effect for local zone (nm.s^{-2})
- `local_newton`: gravitational effects for local zone (nm.s^{-2})
- `model_pressure(Pa)`: interpolated pressure (Pa)
- `model_temp(K)`: interpolated temperature (K)
- `model_temp(sh)`: interpolated specific humidity (kg/kg)

7 Plot

This panel is designed for the visualization of gravity time series and 2D grids. User can add/subtract and plot various time series.

- 1D data: The 1D plot will create a window with 3 rows, e.g. for gravity, hydro data and rain/snow data. The gravity plot can include up to 4 different time series. The time of the gravity variation is set as a reference. User can then add, subtract (linear interpolation) or plot (opposite sign for -plot) the variations loaded to *Series 1 - 3*. For a comparison, hydrological data like soil moisture (*Hydro*) can be plotted in the same window, but in another panel (second row). Each time series can be loaded from txt, mat, xls or tsf format. Use a comment sign = % for the header in the txt file format. No header is expected in xls or mat files.

  User must select the *Time column* and *Data column*. All time columns, except for the tsf format,

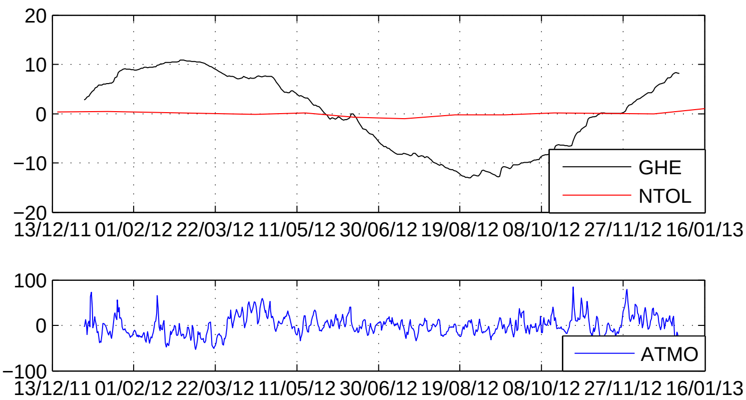
must be in Matlab format (created by the datenum function). For tsf format, the *Data column* is equal to the channel (*Data column* = channel + 6) and the time vector is created automatically. Two *Data columns* can be selected for the rain/snow file.
The *-trend* option is used for the subtraction of trend of n-th degree (using polyfit function).
The *-mean* check-box is used for the subtraction of an average value from selected time series.
User can *Export* the plotted result to a txt/mat/xls/tsf format or *Print* the plotted window to a fig/eps/tiff file. However, the *Export* works only if some time series is loaded using the *gravity* button.

- 2D data: plot variables as a function of longitude and latitude.
  User can change the *File type* to *.mat (variable.lon,variable.lat,variable.data), grd 6 txt (Grapher output), arc ascii (arcgis) and the NetCDF format (user will be prompted to select the longitude, latitude and data layer). Do not load 4D data like ERA Interim atmosphere as these are too big to be loaded! An interpolation will be performed prior to the plotting if a txt file type is used.
  The *Exclude/Include* option works as the option in the computation of the GHE. However, the grids in a coordinate system with longitude 0:360 deg (e.g. ERA Interim or NCEP) are not transformed to -180:180 system and therefore the exclusion of Greenland does not work for these grids (works only in GHE computation).
  The *max val.* option determines the maximal plotted value (z axis).
  User can plot the loaded data in a predefined projections using the *Map extend* option (All Matlab projections can be found after selecting the 'Other' option).
  The plotted window can be printed to (*Save as*) a fig/eps/tiff file.

7.1 Example: plot the GHE, NTOL and ATMO

This example shows how to plot time series of the continental water storage (GHE) and the non-tidal ocean loading effect (NTOL) in the first plotting row. The second row of the plotting windows will be used for the atmospheric effect. Finally, the plotted result will be written to a tsf file.

Run *mGlobe* and select the **Plot** console. Then press the *gravity* button and load the file with GHE (`/EXAMPLES/Hydro/TEST_GHE_NOAH10_012012_122012.txt`). Locate the non-tidal ocean loading effect by pressing the *e.g. NTOL* button (`/EXAMPLES/Ocean/TEST_NTOL_ECCO-JPL_012012_122012.txt`). For the atmospheric effect press *Hydro* (`/EXAMPLES/Atmo/TEST_ATMO_ERA_012012_122012.txt`). In all these files, the time vector is in the first column and the gravity effect in the fourth column. Change the *Time column* and *Data column* accordingly. Ensure that the *File type* is switched to 'txt' and the mean value will be subtracted from all time series (*-mean*). No trend line will be subtracted if you set the *-trend* value to zero. In the pop-up menu *Export as* select the 'tsf' and press the *1D plot* button. User will be prompted to select the output file where all loaded time series will be written (`/EXAMPLES/Plot/TEST_PLOT_1D.tsf`). The legend entries can be changed manually. You should obtain a result like the one shown in the following figure.



8 Octave version

The Octave *mGlobe* GUI works only under Windows. When using *mGlobe* under Linux, i.e., via command line, see header of each function for help (*mGlobe* has not been tested under Mac OS). Folder EXAMPLES contains several scripts that show how to use *mGlobe* without GUI. Many *mGlobe* functions use Octave netcdf package. Install this package before running *mGlobe* (`pkg install -forge netcdf`). Additionally, install netcdf library for Linux (`apt-get install netcdf-bin` and `apt-get install libnetcdf-dev`).

The results acquired using Matlab and Octave may slightly differ, however, the relative differences (not absolute values) should not exceed 0.1 nm.s^{-2}. Please keep in mind that the *mGlobe* GUI and functions have been primarily developed for Matlab. Therefore, the buttons response (function calls) may take some time.

8.1 Octave convert GLDAS and MERRA models

When using Octave, download GLDAS and MERRA models via:

Table 2: Octave models downloading

Model	Hourly	Monthly
GLDAS/CLM	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_CLM10SUBP_3H`	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_CLM10_M`
GLDAS/MOS	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_MOS10SUBP_3H`	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_MOS10_M`
GLDAS/NOAH025	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_NOAH025SUBP_3H`	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_NOAH025_M`
GLDAS/NOAH10	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_NOAH10SUBP_3H`	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_NOAH10_M`
GLDAS/VIC	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_VIC10_3H`	`disc.gsfc.nasa.gov/SSW/#keywords=GLDAS_VIC10_M`
MERRA/Land	`disc.gsfc.nasa.gov/SSW/#keywords=MAT1NXLND`	`disc.gsfc.nasa.gov/SSW/#keywords=MATMNXLND`

Before pressing 'Search for Data Sets', specify the 'Data Range' and leave the 'Spatial Bounding Box' empty. For GLDAS models select following 'Subset Variables': Average layer soil moisture and Snow Water Equivalent. For MERRA model, select: Total water store in land reservoirs. Make sure no other subset is selected. For all models, change the output file format to NetCDF and press 'Subset Selected Data Sets'. Download the prepared files after pressing 'View Subset Results'. For convenient downloading use wget. Do not rename the downloaded files. To convert the downloaded netcdf files to mat format, use the **Models** console. User will be prompted to select one NetCDF file after pressing 'Convert button'. All other models are downloaded/converted as described in previous sections.

Thank you for using *mGlobe* toolbox. Please do not hesitate to contact me (mikolaj@gfz-potsdam.de) should you have any questions or comments.