Matlab code associated with *Modeling deformation induced by seasonal variations of continental water in the Himalaya region: Sensitivity to Earth elastic structure*, Chanard et al. (2014)

Geodetic horizontal and vertical seasonal displacements recorded by continuous stations of the Global Positioning System (cGPS) can be fairly well predicted as the response of a spherical and layered elastic Earth to annual variations of continental water storage. For this purpose, we use satellite data from the Gravity Recovery and Climate Experiment (GRACE) to determine the seasonal time evolution of surface loading. We then compute the surface displacements induced by loading a layered non-rotating spherical Earth model (Farrell, 1972, Guo et al., 2004) based on the Preliminary Reference Earth Model (Dziewonski and Anderson, 1981) and and a continental crust based on the CRUST 5.1 model (Mooney et al., 1998).

1 Contents

To get started, download the "Matlab script-Chanard et al, JGR-2014" folder, containing the following files:

- `main.m`, main function of the code,

- `calendar.txt`, time vector of loading files

- `grace_global`, folder containing GRACE global loading grids for seasonal hydrology by date,

- `extraction_grace_area.m`, extracts loading zone form global GRACE data in `grace_global`

- `model_seasonal_var.m`, models displacements induced by seasonal variations of surface hydrology derived from GRACE,

- `cgps_sites.txt`, GPS stations location file,

- `prem.data`, input code table specific to the modified PREM Earth structure,

- `plot_disp_ts.m`, plots East/North/Vertical displacement time series at all locations specified in `cgps_sites.txt` file or at specific location using station name,

- `plot_grace_ts.m`, plots Equivalent Water Height time series derived from GRACE at a specific points given as inputs,

- `plot_tmaps.m`, plots GRACE loading map and East/North/Vertical displacement maps for extracted zone at specific date.

   Note: if you want to use other loading datasets, replace the loading files and the time vector `calendar.txt`.

2 Set up & Computation

1. You must have `Matlab` installed on your computer.

2. In `Matlab` environment, go to `Matlab script-Chanard et al, JGR-2014/code`.

3. Modify the continuous gps stations coordinates `cgps_sites.txt` to compute seasonal displacements at wished locations. The file must have 3 columns : station name - longitude (degree) - latitude (degree). Here, longitudes are expressed in [-180°;180°].

4. Run the main function with inputs longitude and latitude vectors of the chosen loading area and the name of your stations locations file. If you want to compute seasonal displacements at stations located in the Himalayas, run for example:
   `main(70.5:110.5,10.5:40.5,'cgps_sites.txt')`.
   Note that stations in `cgps_sites.txt` must be in the loading area to avoid NaN values of the seasonal displacements.

5. The `extraction_grace_area.m` function will automatically create a `grace_extract` folder containing loading files in the chosen area.

6. You will then be asked:
   `Do you want to compute Green function?  y/n`
   Compute the Green functions by answering `y` only once for a specific loading area. Note that the larger the area, the longer the computation. If you answer `y`, the code will create two files `green_functions_horizontal.mat` and `green_functions_vertical.mat`, surface displacements of the area induced by unit loads.

7. Finally, the code will create two output folders. The first one, `disp_zone`, contains `.mat` files of east,north and vertical displacements for all points in loading zone, by date (in `calendar.txt`). The second one, `disp_gps`, contains ascii files of t/east/north/vertical displacements at each location referenced in your gps location file.

3 Plotting tools

1. `plot_disp_ts` plots East/North/Vertical displacement time series at all locations specified in the gps location file or at a specific location using station name. The function does not require arguments. Figures will be saved as `.eps` files in the created folder `disp_gps/figures`.

2. `plot_grace_ts(lon,lat)` plots Equivalent Water Height (EWH) time series derived from GRACE at a specific lon/lat vectors given as inputs. Figures will be saved as `.eps` files in the created folder `grace_extract/figures`.

3. `plot_tmaps(lon,lat,fdate)` plots GRACE loading map and East/North/Vertical displacement maps for extracted (lon,lat) zone at specfic date (fdate). Figures will be saved as `.eps` files in the created folder `disp_zone/figures`.

References

K Chanard, JP Avouac, G Ramillien, and J Genrich. Modeling deformation induced by seasonal variations of continental water in the himalaya region: sensitivity to earth elastic structure. *Journal of Geophysical Research: Solid Earth*, 2014.

A.M. Dziewonski and D.L. Anderson. Preliminary reference Earth model. *Physics of the Earth and Planetary Interiors*, 25:297–356, 1981.

WE Farrell. Deformation of the Earth by surface loads. *Reviews of Geophysics*, 10, 1972.

JY Guo, YB Li, Y. Huang, HT Deng, SQ Xu, and JS Ning. Green's function of the deformation of the earth as a result of atmospheric loading. *Geophysical Journal International*, 159:53–68, 2004.

Walter D Mooney, Gabi Laske, and T Guy Masters. Crust 5.1: A global crustal model at 5× 5. *Journal of Geophysical Research: Solid Earth (1978–2012)*, 103(B1):727–747, 1998.