

**University of New Brunswick
Department of Geodesy and Geomatics Engineering**

SHGEO software package

An UNB Application to Stokes-Helmert Approach for Precise Geoid Computation

Reference Manual III.

Auxiliary Programs

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Preface

The Stokes-Helmert Geoid software (SHGeo software) is a scientific software package for a precise geoid determination based on the Stokes-Helmert theory of determination of the gravimetric geoid. The software has been developed during a period of more than 10 years under the leadership of professor Petr Vaniček at the Department of Geodesy and Geomatics Engineering, University of New Brunswick in Fredericton. Authors of particular programs are: Juraj Janák, Pavel Novák, Mehdi Najafi-Alamdari, Jianliang Huang, Sander van Eck van der Sluijs, Robert Tenzer and Artu Ellmann. We also have to mention Z. Martinec, A. Kleusberg, L.E. Sjöberg, W.E. Featherstone and W. Sun whose research presented in their papers was incorporated into the SHGeo software. SHGeo software uses global geopotential models (e.g., GRIM4-S4, EGM-96, GGM-02) and a global elevation model (TUG-87 or JGP95 for instance). These global models play an important role in the geoid computation scheme. Therefore we acknowledge the contribution of all research teams that have developed these or other global models.

The present software version (SHGEO 3.1) is an upgrade of the three earlier SHGeo packages:

SHGEO vers. 1 (standard Helmert approach) was compiled by Dr. J. Janak in 2001

SHGEO vers. 2 (formulated for the NoTopography space) was compiled by Dr. R. Tenzer in 2003

SHGEO vers. 3 (capable of standard Helmert and the NoTopography) was compiled by Dr. A. Ellmann in 2005

This reference manual and the current version of the package, SHGEO 3.1 (standard Helmert and NoTopography) is compiled by D. Avalos in 2009. New programs (`dwnc08.c`, `res_anomaly.c` and `cogeoid2geoid.c`) as well as bug-fixes for the Stokes integral computation are included in this version.

The manual consists of three parts. Part I contains the theoretical description of the Stokes-Helmert method of the geoid determination by Dr. A. Ellmann. Part II is the reference user's guide with the description of the particular programs for the geoid computation, and Part III has the description of auxiliary programs, which can be used for data manipulation and format transformations.

Contents:

1. biint.c	4
2. g2xyz.c	4
3. insert.c	4
4. mmm_xyz.c	4
5. readhead.c	5
5.1 readhead_AUSTR	5
6. rgtopo.c	5
7. rough.c	5
8. sort.c	5
9. subarea.c	6
9.1 subarea_5m_c.c	6
10. sumdif.c	6
11. turn.c	6
12. Extract_HAgeo.c	6

Auxiliary programs:

Part III is complementary to the manual for SHGEO 3.1. The package is additioned with a handy set of auxiliary programs intended to facilitate some operations aside from the main flow chart presented in Part II. It is provided here a description the programs that can perform tasks like format transformations and data manipulation. The particular auxiliary programs are described below alphabetically.

1. biint.c

Program for bilinear interpolation within a regular grid file. The grid file should be in xyz-format (for example: latitude, longitude, height). Program requires the option file “biint.opt” in the following format:

```
geoid.xyz 7200          : input file, number of grid-nodes (i.e., lines in xyz file)
20.0 21.0 249.0 251.0 : South (S), North (N), West (W), East (E) boundary of the area [deg]
0.04166667 0.04166667 : step of the grid in latitude and longitude [deg]
coord.xy 21           : coordinate file (latitude, longitude) and number of records (lines) in it
ofile.xyz            : output file (latitude, longitude, interpolated value)
```

2. g2xyz.c

Program for format transformation from ASCII grid file to xyz table. The input grid file is expected to be sorted from North to South and from West to East. The output file will be sorted the same way. Program requires the option file “g1xyz.opt” in the following format:

```
h30rm.g   : input grid file
h30rm.xyz : output xyz file
```

For this program, mind the different number of decimals! For anomalies three decimals are required, i.e. 123.123, whereas the program’s “by default value” is one decimal only – 123.1, suited for the heights)

3. insert.c

This program inserts one regular grid file into another regular grid file replacing the values in certain sub-area. Both regular grid files are expected to be in a point list format (latitude, longitude, value [value2, value3]) sorted from North to South and from West to East. Both files must have the same spacing and the first grid file must cover the larger or the same area as the second grid file. Program requires the option file “insert.opt” in the following format:

```
grid1.dat 2          : first regular grid file, number of data columns (1, 2
                        or 3)
15.0 33.0 238.0 274.0 0.04166667 0.04166667 : boundaries S,N,W,E and step in latitude
                                                and longitude [deg]
grid2.dat          : second regular grid file
20.0 21.0 245.0 246.0 : boundaries S,N,W,E [deg]
ofile.dat         : output file
```

4. mmm_xyz.c

Program for the computation of the minimal, maximal and mean values. Program also computes the standard deviation, r.m.s. and the number of unknown values. Program requires the option file “mmm_xyz.opt” in the following format:

```
geoid.xyz 7200 : input file in xyz-format, number of points
9999.0       : value used to mark an unknown value (these points are not
              included into some statistical characteristics).
```

5. readhead.c

Program for reading a binary file header of the files in *.byn format. Program requires the option file “readhead.opt” in the following format:

```
dem.byn      : binary file
header.txt   : header of the file in text format
```

5.1 readhead_AUSTR.c

This program reads the header of the AUS-SEGM binary file header. There is no need for a separate opt-file since the program is interactive, the name of the binary file is requested after the execution. The results are displayed.

6. rgtopo.c

Program for preparation of the ASCII grid format from GTOPO30 digital elevation model. Program can produce the original 30" × 30" output file or mean values (60" × 60", 90" × 90" etc.). The mean values are computed as a simple average of the values within a particular cell. Program requires the option file “rgtopo.opt” in the following format:

```
W140N40.DEM   : western GTOPO30 file
W100N40.DEM   : eastern GTOPO30 file
-10 40 220 260 : boundaries of the western GTOPO30 file S,N,W,E [deg]
-10 40 260 300 : boundaries of the eastern GTOPO30 file S,N,W,E [deg]
15 0 0        : South boundary of the output file [deg, min, sec]
33 0 0        : North boundary of the output file [deg, min, sec]
238 0 0       : West boundary of the output file [deg, min, sec]
274 0 0       : East boundary of the output file [deg, min, sec]
300 300       : step in the output file in latitude and longitude [sec]
ofile.grd     : output file in ASCII grid format
```

7. rough.c

Program for the estimation of the optimal mode for program “STC_near_zone.c”. Program produces the optimal mode for every 1° × 1° cell in a chosen area. Program requires the option file “rough.opt” in the following format:

```
hmex30.grd 1 : input file (in byn or ASCII grid format), mode (0-byn, 1-ASCII)
rough.dat    : output file
15 33 238 274 : output file boundaries S,N,W,E [deg]
```

8. sort.c

Program for reordering of the regular grid file in point list format from North to South and from West to East. Program requires the option file “`sort.opt`” in the following format:

```
anom.dat 2160           : input file, and number of points
anom_ord.dat           : output file
49.0 52.0 235.0 240.0 : boundaries of the regular grid S,N,W,E [deg]
```

9. subarea.c

Program for the preparation of the sub-area from the regular grid file in point list format. Program requires the option file “`subarea.opt`” in the following format:

```
area.dat 68544         : input file, and number of points
subarea.dat           : output file
49.0 42.0 235.0 240.0 : boundaries of the sub-area S,N,W,E [deg]
```

For this program, mind the different number of decimals! For anomalies three decimals are required, i.e. 123.123, whereas the program’s “by default value” is one decimal only – 123.1, suited for the heights)

9.1 subarea_5m_c.c

The same as above. However, the option file need to be given at the execution of the file: `./subarea_5m_c.e SUB.opt`. This feature allows to use this program in the scripts (i.e when assembling the H-files for downward continuation.

10. sumdif.c

Program for summation or differentiation of two files in xyz format. The corresponding points in both files should be identical. Program requires the option file “`sumdif.opt`” in the following format:

```
file1.xyz 7200 0 : first input file, number of points, mode (0-sum,1-dif)
file2.xyz       : second input file
ofile.xyz       : output file
9999.0          : value marking unknown values
```

11. turn.c

Program for reordering of the regular grid file in point list format sorted from South - North to North - South sorting or vice-versa. Program is interactive.

12. Extract_HAgeo.c

A program for extracting desired data-columns from the output of other programs. For instance, this program can be used for writing the “*post-DWC*” Helmert anomalies into a separate three-column file. Another application could be to write the “*post-Stokesian*” residual cogeoidal heights into a separate file. These cases may occur when assembling the results or “turning around” the results. Each time check whether the code contains correct names of the input/output filenames, number of columns, and the number of the data-points.