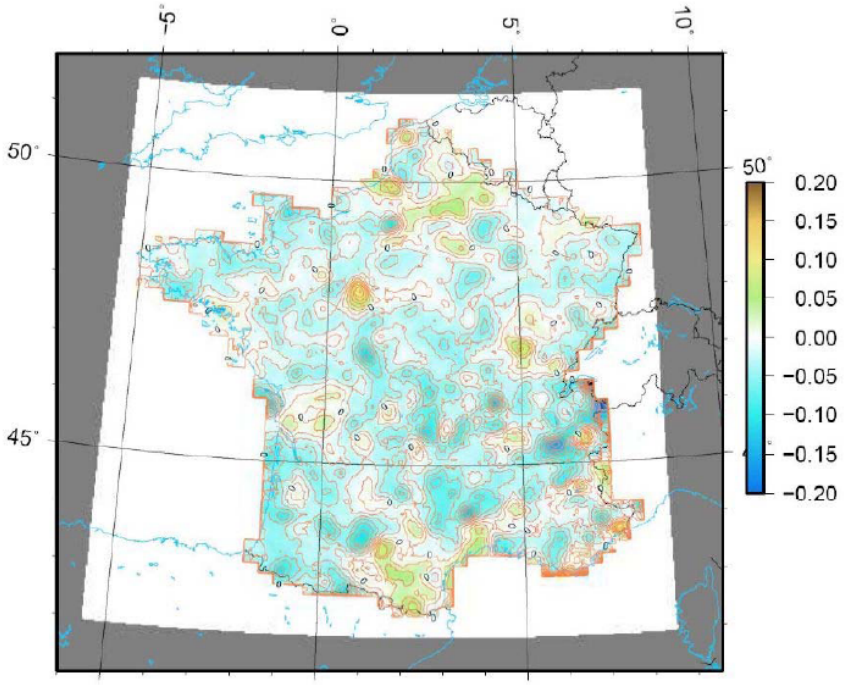
New Geoid Model for France and Information about Geoid File Formats

By Mircea Neacsu

RAF09 REPLACES RAF98

My last newsletter article was about the geoid model for Spain. This time France has come out with a new geoid model called RAF09 to replace the older RAF98. A document from IGN (Institut Geographique National) shows the differences between the old and the new model:



Deviation between RAF98 and RAF09, ruler in meter (+ or - 20cm)

Depending on where you are, the new model should give an undulation value that is +/- 20cm compared to the old one. A couple of things I wanted to point out:

- **Do what the HYPACK® manual says and check your GPS tide correction against a well established tide gauge.** Use the "Orthometric Height Correction" in the Geodetic Parameters program to adjust for any difference.

  If you have followed this advice and you install the new geoid model, you should recheck your calculated tide value and change the OHC correction value. In a perfect world the change should equal the difference between the two geoid models.

- **We were smart to make our own geoid file format (.geo) instead of trying to use other file formats.**

  The published format for the RAF09 geoid differs ever so slightly from the one used for RAF98. If we had tried to import all the different flavors of geoid files, we would have been scrambling to update our programs every time a new format came out. And that brings me to the second part of this article "Geoid File Formats".

GEOID FILE FORMATS

Geoid files are presumed to be simple stuff as they contain just one value (undulation - the separation between ellipsoid and geoid) in a regular, rectangular grid pattern. You would have expected that the few hundred people who are involved in generating those models would be able to agree on a format and follow that standard. Alas, the reality is far different. For us the story began at some point in the ’90s when we implemented the GEOID96 model for continental US. Figuring that there wasn’t much merit in inventing a new file format, we implemented the USGS format at the time: a binary format with the extension .GEO. Not long after, USGS decided to change the format and came out with another one called BIN. It didn’t take long for other organizations to come out with new formats, some ASCII some binary, some going from North to South, others going from South to North, from East to West and from West to East. You get the picture.

Luckily, we decided to stick to one format and created just a few conversion programs that can read and convert all the other formats and produce the GEO file. The rest of the article details the different formats we can currently read and convert. If you need a new geoid model integrated in HYPACK®, we can do it a lot easier if it is in one of these formats. However, we understand that in most cases the format of the data is not something that you, our user, can control but something created by a big bureaucratic organization and we will do our best to try to work with it. Just don’t expect that we can do it overnight.

EXTENSION ".BIN"

The files are produced by NGS. The following information was taken from US National Geodetic Survey (NGS) Web site.

Data type and area covered is encoded in filename. A typical filename, "tyyyyrnn.BIN", would indicate:

t	The type of data contained in the file . • **G:** Hybrid geoid model undulations (i.e. GEOID96, GEOID99 , HTv1.01 , HTv2.0) • **S:** Gravimetric geoid model undulations (i.e. G99SSS, G96SSS , GSD95 , CGG2000) • **X:** Deflections of the vertical in the North/South direction (?) • **E:** Reflections of the vertical in the East/West direction (?)
yyyy	The year the data was created

r	Region: • **U:** Conterminous USA (CONUS) • **A:** Alaska • **H:** Hawaii • **P:** Puerto Rico and Virgin Islands • **C:** Canada • **M:** Mexico
nn	Sub-region number of this file.
	For CONUS there are 8 sub-regions: 01 - Pacific Northwest 02 - Central Northwest 03 - Central Northeast 04 - Atlantic Northeast 05 - Pacific Southeast 06 - Central Southwest 07 - Central Southeast 08 - Atlantic Southeast
	For Alaska there are 4 sub-regions: 01 - Northwest 02 - Northeast 03 - Southwest 04 - Southwest
	For Canada there are 3 sub-regions: 00 - whole Canada 01 - Western Canada 02 - Eastern Canada

Each file has a 44-byte header with the following structure:

Offset	Length	Type	Description
0	8	double	South boundary in decimal degrees
8	8	double	West boundary in decimal degrees
16	8	double	Latitude spacing in decimal degrees
24	8	double	Longitude spacing in decimal degrees
32	4	int	Number of latitude values (NR)
36	4	int	Number of longitude values (NC)
40	4	int	Data type: 1 = "float"

The Header is followed by data values, each a 4-byte floating point number. Data is arranged from west to east and from south to north.

Total number of bytes in file is 44 + 4 * NR * NC.

EXTENSION ".BYN"

These files are produced by Natural Resources Canada. The following information was taken from Natural Resources Canada Web site.

Files with the extension ".byn" are binary. The "byn" file is split into two sections: header and data.

Header has the following structure:

TABLE 1. *BYN File Structure*

Offset	Length	Type	Description
0	4	int	South boundary in arc-seconds
4	4	int	North boundary in arc-seconds
8	4	int	West boundary in arc-seconds (negative west)
12	4	int	East boundary in arc-seconds (negative west)
16	2	short int	North-South spacing in arc-seconds
18	2	short int	East-West spacing in arc-seconds
20	2	short int	Model type 0=local model, 1=global model
22	2	short int	Data type: 0 = undefined 1 = geoid heights 2 = N/S deflections 3 = E/W deflections 4 = gravity 5 = elevations 6 = sea surface heights 7 = sea surface topography 8 = other
24	8	double	Scaling factor for data
32	2	short int	Data size: 2=short int, 4 = long int
34	2	short int	Standard deviation (0 = std. dev. not available)
36	8	double	Scaling factor for standard deviation

Offset	Length	Type	Description
44	2	short int	Datum: 0=ITRF, 1=NAD83
46	2	short int	Ellipsoid: 0 = GRS80 1 = WGS84 2 = TOPEX/EGM96 3 = GRS67
48	2	short int	Byte ordering: 0=big endian, 1=little endian
50	2	short int	Scale for boundaries: 0=no scale, 1=scale applied
52	28	byte	Reserved

The data are stored by rows starting from the north. Each row is stored from the west to the east. All data are stored as short or long integer, as indicated in the header (see Size of data). For the transformation from integer to float, the user must divide the integer value by the Scaling Factor. The file may contain undefined values. These values are indicated by 9999.0*Factor when the data are stored as long integer. For the data in short integer, the undefined values are expressed as 32767.

Size of file in bytes = (80 bytes + Rows*Columns*(2 bytes or 4 bytes)).

EXTENSION ".GGF"

The GGF format is used by Trimble software. The following information was ‘glanced’ by looking at various GGF files.

GGF files are binary files containing a 146-byte header followed by data. Header structure:

TABLE 2.

Offset	Length	Type	Description
0	2	short int	Value 1
2	14	byte	File type (the text "TNL GRID FILE")
16	32	byte	Data description (free text)
48	8	double	South boundary in decimal degrees
56	8		North boundary in decimal degrees
	8		West boundary in decimal degrees
	8		East boundary in decimal degrees
	8		Longitude spacing in decimal degrees
88	8	double	Latitude spacing in decimal degrees
96	4	Int	Number of latitude values (NR)

Offset	Length	Type	Description
100	4	Int	Number of longitude values (NC)
104	42	byte	Unknown

The Header is followed by data values, each value being a 4-byte floating point number. Data is arranged from west to east and from south to north.

Size of file in bytes = (NR*NC*4) + 146

EXTENSION ".GRD"

GRD is an older format used by Natural Resources Canada (didn't I tell you that these organizations have the habit of changing formats).

The files with the extension ".grd" are ASCII.

The data are stored by rows from the north to the south. Each row is stored from the west to the east. Each record has one value with the exception of the first record, which is the header.

The header is made of 6 values describing the area of the grid and its spacing. The values of the header are in this following order: North latitude, South latitude, West Longitude, East Longitude, North-South spacing and East-West spacing. These 6 values are in decimal degrees.

Extension ".SLV"

Yet another format used by Natural resources Canada. The following information was taken from Natural Resources Canada Web site.

The "slv" format is made of two files: One file with the extension ".slv" and a second file with the extension ".bin". The "slv" file is ASCII and contains information related to the data grid such as the boundaries of the grid and its spacing. The second file is binary and contains the data.

The data are stored by rows starting from the north. Each row is stored from the west to the east. All data are stored as short integers. For the transformation from integer to float, the user must divide the integer value by the Scale Factor, which is given in the "slv" file. The file may contain undefined values. The undefined values are expressed as a value of 32767.

Size of file in bytes = (Rows*Columns*2 bytes).

EXTENSION ".MNT"

This format is used by French geoid models.

The MNT file is an ASCII file with space-separated values. Header contains the following fields:

- South boundary in decimal degrees
- North boundary in decimal degrees
- West boundary in decimal degrees

- East boundary in decimal degrees
- Longitude spacing in decimal degrees
- Latitude spacing in decimal degrees

Each data field is followed by a quality field with the following values:

- 01 1 to 5 cm
- 02 5 to 10 cm
- 99 > 1m

HYPACK® ". GEO" FILES

The files with extension .GEO are binary files with fixed length records. First record contains the file header and has the following structure:

TABLE 3.

Offset	Length	Type	Description
0	1	byte	Byte ordering 'L' = little endian, 'B' = big endian
1	29	byte	Data description (free text)
30	8	double	Semi-major axis of the ellipsoid in meters
38	8	double	Inverse of ellipsoid flattening
46	1	byte	Datum: 0 - unspecified 1 - NAD83 (NSRS/CSRS) 2 - ITRF
47	9	byte	Reserved
56	8	byte	Creator program name (free text)
64	4	int	Number of columns (longitude values) in data set. (NC)
68	4	int	Number of rows (latitude values) in data set. (NR)
72	4	int	Number of values per cell (always 1)
76	4	float	Longitude of SW corner in degrees (negative values in Western hemisphere).
80	4	float	Longitude grid spacing in degrees
84	4	float	Latitude of SW corner in degrees (negative values in Southern hemisphere)
88	4	float	Latitude grid spacing in degrees
92	4	float	Encoding of undefined value

Each record (including the header record) has 4*(NC+1) bytes and there are (NR+1) records.

Records 2 to (NR+1) have the following structure:

TABLE 4.

Offset	Length	Type	Description
0	4	byte	Reserved
4	4*NC	float	Ellipsoid-geoid separation values in meters

Notes:

- Data is stored in rows from west to east and in columns from south to north.
- Grid spacing in both latitude and longitude must represent an integer number of arc-seconds.
- A file cannot cross the 180º meridian.