# BYN Grid Format Description

The Canadian Geodetic Survey (CGS), Natural Resources Canada provides geoid heights and height system conversion files in ***BYN*** format. These are binary files and have the extension "**.byn**". The ***BYN*** format includes two sections, which are the Header (see Table 1) and the Data. The data are stored by rows starting from the north. Each row is stored from the west to the east. The data are either short (2 bytes) or standard (4 bytes) integers. The size of the bytes is defined in the header (see item #10 in Table 1).

The total size of the file is 80 bytes + (Row x Column x (2 or 4) bytes) where Row is the number of rows in the grid and Column is the number of columns in the grid. Row and Column can be calculated by these two equations:

Row = (North Boundary – South Boundary) / (NS Spacing) + 1
Column = (East Boundary – West Boundary) / (EW Spacing) + 1

The ***BYN*** files may contain **undefined data**. Depending on if the data are stored as 2-byte or 4-byte integers, the undefined data are expressed the following way:

a. 4-byte data (Standard integer): **9999.0*Factor**, the Factor is given in the header (see item #9 in Table 1)
b. 2-byte data (Short integer): **32767**

When CGS provides a geoid model in several 3-D geometric reference frames (e.g., NAD83(CSRS) and ITRF2008), the *BYN* header includes parameters to indicate in which realization the geoid is considered static. The Canadian Geodetic Reference System Committee (CGRSC) agreed in 2012 that the velocity of the geoid should be omitted in CGVD2013. However, the transformation between two 3-D geometric reference frames generates a drift. Thus, a velocity of zero in one frame does not correspond to a velocity of zero in another frame.

Canadian geoid models (e.g., CGG2013A) are considered static in NAD83(CSRS) while global geoid models (e.g., EGM2008) are considered static in their original 3-D geometric reference frame (e.g., ITRF2000).

Most of the parameters in the ***BYN*** header can be read by clicking the "Information" icon in the desktop version of **GPS-H** (see Figure 1). In addition, the GPS-H model information window allows extraction of a subset of a grid. The subset grid can be saved in either ***BYN*** or ***ASCII*** format.

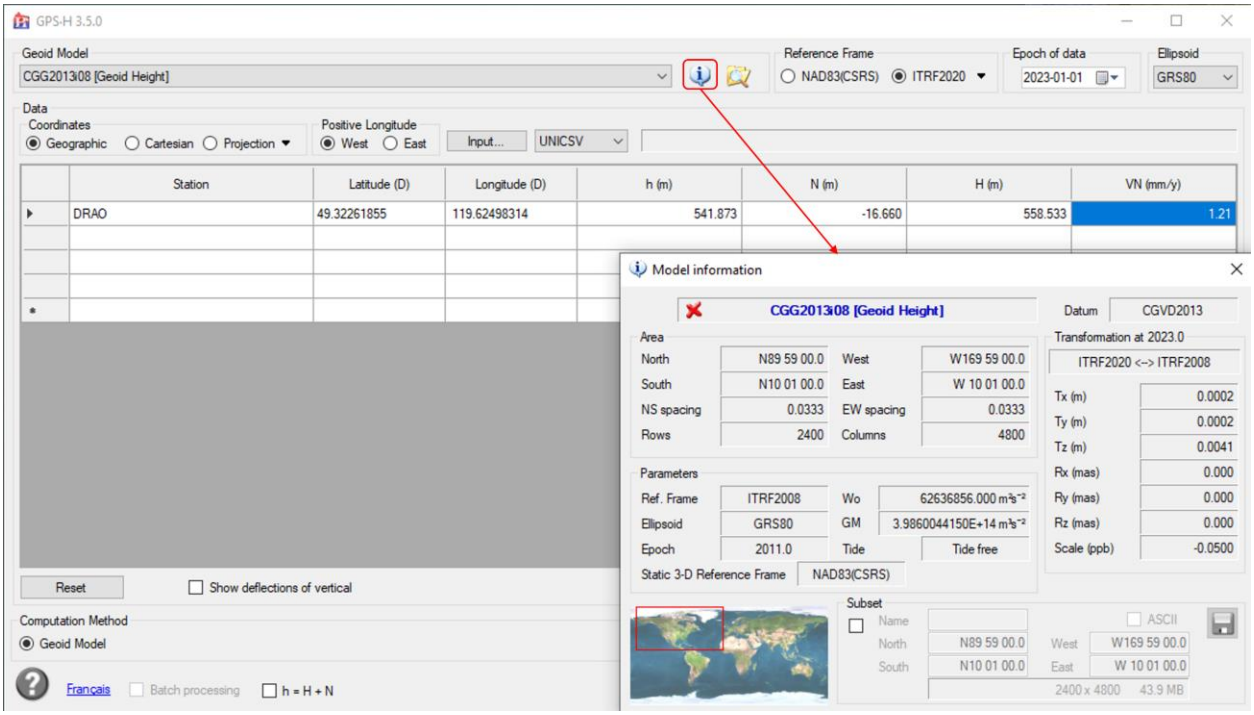


**Figure 1:** Desktop version of GPS-H highlighting the model information panel

**NOTE**: Files with extension "**.err**" are also in the ***BYN*** format. An "**.err**" file usually contains the error estimates of the ***BYN*** file of the same name (e.g., CGG2013n83.byn and CGG2013n83.err). The "**.err**" file will have variable Data (item #13 in Table 1) equal to 1 or 3.

**Table 1: Header description (80 bytes)**

| # | Variable | Description | Type | Byte | Sum | Comments/(Units) |
|---|---|---|---|---|---|---|
| 1 | South | South Boundary | long | 4 | 4 | (arcsec.) |
| 2 | North | North Boundary | long | 4 | 8 | (arcsec.) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | West | West Boundary | long | 4 | 12 | (arcsec.) |
| 4 | East | East Boundary | long | 4 | 16 | (arcsec.) |
| 5 | DLat | NS Spacing | short | 2 | 18 | (arcsec.) |
| 6 | DLon | EW Spacing | short | 2 | 20 | (arcsec.) |
| 7 | Global | Global | short | 2 | 22 | 0: Local/Regional/National grid |
| | | | | | | 1: Global grid |
| 8 | Type | Type | short | 2 | 24 | **See Table 2** |
| 9 | Factor | Data factor | double | 8 | 32 | Transform data from integer to real |
| 10 | SizeOf | Data size in bytes | short | 2 | 34 | 2: short integer (2 bytes) |
| | | | | | | 4: standard integer (4 bytes) |
| 11 | VDatum | Vertical Datum | short | 2 | 36 | 0: Unspecified |
| | | | | | | 1: CGVD28 |
| | | | | | | 2: CGVD2013 |
| | | | | | | 3: NAVD 88 |
| | | | | | | 4: NAPGD2022 |
| 12 | StaticSystem | Static 3-D Ref. System | short | 2 | 38 | 0: ITRF / WGS84 |
| | | | | | | 1: NAD83(CSRS) |
| | | | | | | 2: NATRF2022 |
| 13 | StaticFrame | Static 3-D Ref. Realization | short | 2 | 40 | Version number (e.g., 1, 2, 3, 4 or 1997, 2000, 2008) |
| 14 | Data | Data description | short | 2 | 42 | 0: Data (e.g., N) |
| | | | | | | 1: Data error estimates (e.g., $\sigma$N) |
| | | | | | | 2: Data velocity (e.g., N-dot) |
| | | | | | | 3: Velocity error estimates (e.g., $\sigma$N-dot) |
| 15 | SubType | Sub-Type | short | 2 | 44 | **See Table 2** |
| 16 | Datum | 3-D Ref. Frame | short | 2 | 46 | 0: ITRF / WGS84 |
| | | | | | | 1: NAD83(CSRS) |
| | | | | | | 2: NATRF2022 |
| 17 | Ellipsoid | Ellipsoid | short | 2 | 48 | **See Table 3** |
| 18 | ByteOrder | Byte Order | short | 2 | 50 | 0: Big-endian (e.g., HP Unix) |
| | | | | | | 1: Little-endian (e.g., PC, Linux) |
| 19 | Scale | Scale Boundaries | short | 2 | 52 | 0: No scale applied to boundaries and spacing |
| | | | | | | 1: Scale is applied (x1000) |
| 20 | Wo | Geopotential Wo | double | 8 | 60 | $m^2\ s^{-2}$ (e.g., W = 62636856.88) |
| 21 | GM | GM | double | 8 | 68 | $m^3\ s^{-2}$ (e.g., GM = 3.986 x $10^{14}$) |
| 22 | TideSystem | Tidal System | short | 2 | 70 | 0: Tide free |
| | | | | | | 1: Mean tide |
| | | | | | | 2: Zero tide |
| 23 | RefRealization | Realization (3D) | short | 2 | 72 | Version number (e.g., 2005 for ITRF) |
| 24 | Epoch | Epoch | float | 4 | 76 | Decimal year (e.g., 2007.5) |
| 25 | PtType | Node | short | 2 | 78 | 0: Point |
| | | | | | | 1: Mean |
| 26 | | Spares | | 2 | 80 | Always zero |

*Items #12, #13, and #20 to 23 must be defined if the grid is a geoid model.*

**Table 2: Types and Sub-Types**

| # | Type (item #8) | # | Sub-Type (item #13) |
|---|---|---|---|
| 0 | Undefined | 0 | NULL |
| 1 | Ellipsoid-Potential separation | 0 | Geoid Height |
| | | 1 | Height Anomaly |
| | | 2 | Height Transformation (Hybrid) |
| | | 3 | Datum conversion using a single file |
| | | 4 | Datum conversion on the fly using two files |
| 2 | Deflections of the vertical NS | 0 | NULL |
| 3 | Deflections of the vertical EW | 0 | NULL |
| 4 | Gravity | 0 | Undefined |
| | | 1 | Absolute (m $s^{-2}$ instead of mGal) |
| | | 2 | Free-Air |
| | | 3 | Bouguer |
| | | 4 | Complete Bouguer |
| | | 5 | Helmert |
| | | 6 | Isostatic |
| 5 | DEM | 0 | MSL (General) |
| | | 1 | Orthometric |
| | | 2 | Normal |
| | | 3 | Dynamic |
| | | 4 | Ellipsoidal |
| 6 | Sea Surface Height (SSH) | 0 | NULL |
| 7 | Sea Surface Topography (SST) | 0 | NULL |
| 8 | Ocean current velocity | 0 | NULL |
| 9 | Others | 0 | NULL |

**Table 3: Ellipsoids**

| # | Name | Semi-major axis (m) | Inverse flattening | GM ($m^3$ $s^{-2}$) | Angular velocity (rad $s^{-1}$) |
|---|---|---|---|---|---|
| 0 | GRS80 | 6378137.0 | 298.257222101 | 3986005.0 x $10^8$ | 7292115 x $10^{-11}$ |
| 1 | WGS84 | 6378137.0 | 298.257223564 | 3986004.418 x $10^8$ | 7292115 x $10^{-11}$ |
| 2 | ALT1 | 6378136.3 | 298.256415099 | 3986004.415 x $10^8$ | 7292115 x $10^{-11}$ |
| 3 | GRS67 | 6378160.0 | 298.247167427 | 3986030.0 x $10^8$ | 7292115.1467 x $10^{-11}$ |
| 4 | ELLIP1 | 6378136.46 | 298.256415099 | 3986004.415 x $10^8$ | 7292115 x $10^{-11}$ |
| 5 | ALT2 | 6378136.3 | 298.257 | 3986004.415 x $10^8$ | 7292115 x $10^{-11}$ |
| 6 | ELLIP2 | 6378136.0 | 298.257 | 3986004.4 x $10^8$ | 7292115 x $10^{-11}$ |
| 7 | CLARKE 1866 | 6378206.4 | 294.9786982 | 3986004.4 x $10^8$ | 7292115 x $10^{-11}$ |