Giodis

User Manual

Version 1.0

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PREFACE

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About this Manual

This User Manual is designed to help you get familiar with the Giodis User Interface and introduce you to the Giodis main features. The Manual includes Glossary with terms explanation for better understanding unfamiliar or complicated terms.

Symbols and Typographic Conventions

This Manual uses the following text conventions:

Example	Description.
Port	Titles of dialog windows/boxes, names of menu options.

Screen Captures

This Manual includes sample screen captures. Your actual screen can look slightly different from the sample screen due to the receiver you have connected, operating system used and settings you have specified. This is normal and not a cause for concern.

Technical Support

Occasionally, Giodis users encounter problems during installation or use of the program. Should you have any problems with Giodis Software, please contact JAVAD GNSS Support (support@javad.com).

Chapter 1

INTRODUCTION

1.1. Welcome

Welcome to Giodis™, the full-featured office post-processing software. The Giodis software combines the modern fluent user interface with the established functionality. Geodis solves wide range of practical surveying tasks using advanced scientific approach. Geodis includes the following key features:

- tools for data files importing
- high-precision post-processing engine
- network adjustment of vectors and multi-site subnets
- extended coordinate systems database.

1.2. System Requirements

Before installing and running Giodis, be sure, that your computer satisfies the following requirements:

- Pentium III-compatible processor or higher
- Microsoft Windows XP, Vista
- RAM: 1GB (minimum) or 2GB or more (recommended)
- 150MB free disk space and 7GB additional free disk space (for World Map)

GIODIS USER INTERFACE

This chapter describes elements of the Giodis user interface. In general the Giodis user interface is clear and intuitive understandable. But getting acquainted with the main components of the user interface and its design concept is the best way to start job in Giodis. In future it helps users to avoid complexities on finding needed tools or options and to focus on making their jobs.

2.1. Main Window

When you start Giodis, the main window appears. If you start Giodis for the first time, you can see a map set by default. If an existing project has been opened, you can see a picture that looks like this (Figure 2-1)

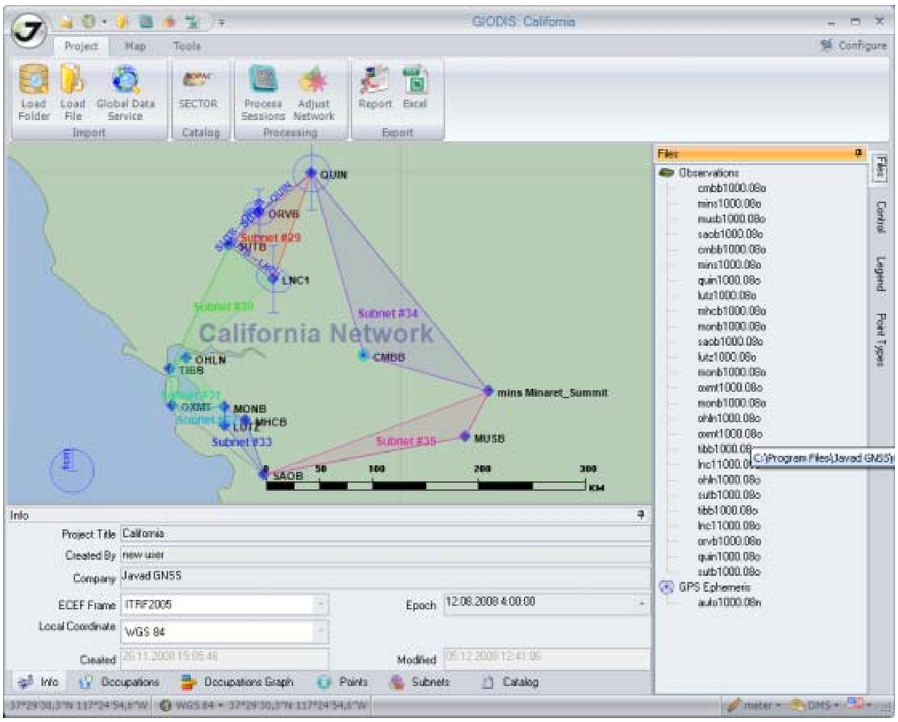


Figure 2-1. Giodis Main window

This window includes the following areas:

- Javad button
- Ribbon
- Quick Access Toolbar
- Map with Tab Collection
- Status bar and Language switch.

2.2. Javad Button

The Javad button enables you to access the program functions and capabilities from one point. Clicking the Javad button you open the *Projects* menu, displaying commands that operate on the project as a whole. The Figure 2-2 shows the such commands, these are: New, New Encrypted, Open, Save, Save as, Close, Exit.

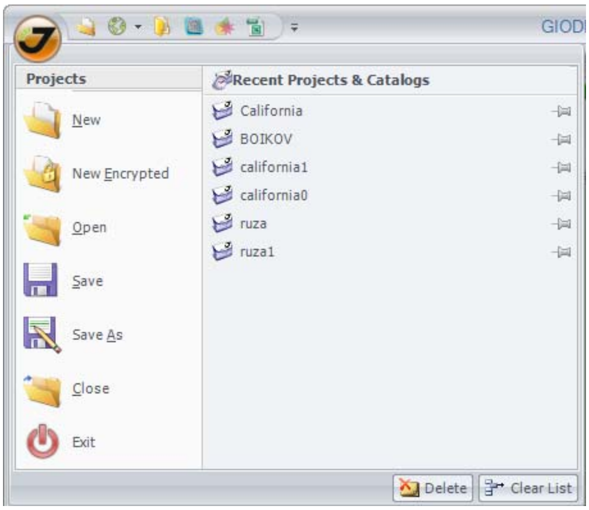


Figure 2-2. Javad button and Projects menu

2.3. Ribbon

The Ribbon represents a set of tabs. Each tab groups commands for activities, thus the quickly and easy access to the frequently used commands is provided. For example, the *Map* tab includes all options for map downloading and manipulation such as downloading background maps, changing map scale, panning, zooming, etc.

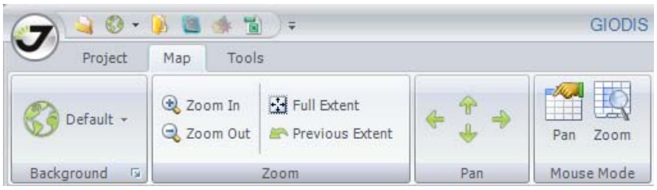


Figure 2-3. Ribbon Map Group

2.4. Quick Access Toolbar

The Quick Access Toolbar provides quick access for commonly used commands.

Figure 2-4. The Quick Access Toolbar

Depending on your needs icons can be added/deleted to/from the Quick Access Toolbar.

If you want to delete an icon from the Quick Access Toolbar, right-click this icon, in the pull-down menu, select the appropriate options, the icon will be deleted.

You can add one or more Ribbon items to the Quick Access Toolbar. Just right-click the item (for example, the *Pan* icon, see Figure 2-5) and in the pull-down menu, select the appropriate option, the corresponding icon will appear on the Toolbar.

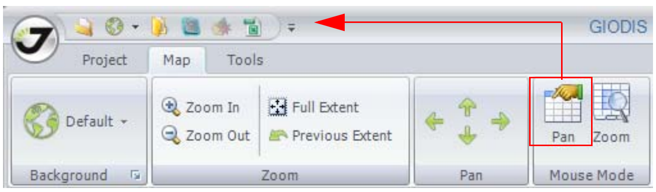


Figure 2-5. Adding the Ribbon item to the Quick Access Toolbar

2.5. Map and Tab Collection

The Map window with Tab Collection occupies the large area of the main window (Figure 2-6). This area is specifically designed as a map unrolled on a table. The map is surrounded with the collection of tabs. The design goal for Tab Collection is to be at hand. The Map window gives the graphical view of project elements. Tab Collection displays source data, the legend, preliminary and final results of data processing.

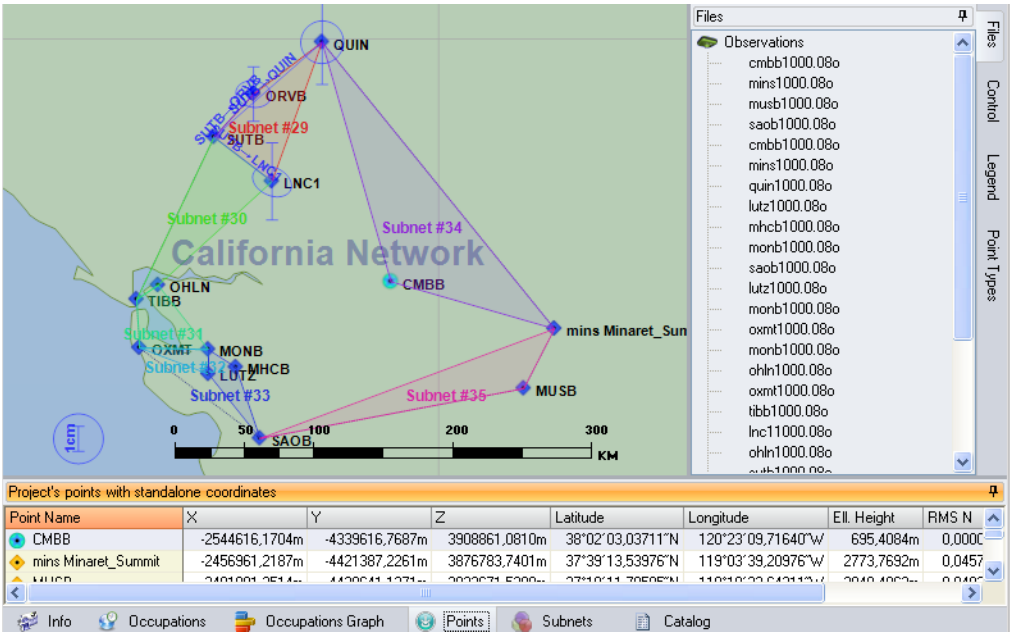


Figure 2-6. Map window and Tab Collection

2.6. Status Bar

The Status bar provides current information while using Giodis (Figure 2-7) and ability to change some settings. The Status bar includes the following elements:

1 The coordinates of the current mouse cursor position in WGS 84.

2 The Coordinate Systems split button allowing you to set a coordinate system for displaying coordinates of the current cursor mouse position.

3 The coordinates of the current mouse cursor position in the selected coordinate system.

4 The Linear Measurement Unit split button allowing you to select a unit for linear values. The default unit is meter.

5 The Angular Measurement Unit split button allowing you to select a unit for angular values. The default unit is degree, minute, second.

6 The Language switch allowing you to select the language for the user interface.

Figure 2-7. Status bar

Chapter 3

MANAGING PROJECTS

Giodis Project is intended to display (in graphical and tabular view) imported data, data processing and represent processing results. Only one project can be active. A project is saved automatically while closing the project. This chapter learns how to:

- create a new project
- create a new encrypted project
- open an existing project
- save a project
- set the configuration settings and use them for future projects
- close a project.

3.1. Creating a New Project

To create a new project, do the following steps:

1. Click on the Quick Access toolbar (Figure 3-1). Or click the *Javad* button, then the *New* button (Figure 3-1).

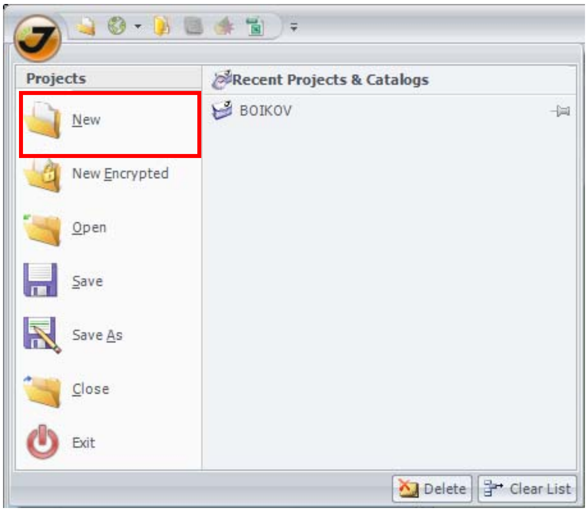


Figure 3-1. The New button

2. It opens the *Save as* dialog window (Figure 3-2). In this dialog window, navigate to the desired folder, enter a project name, and click *Save*.

Note: Notice that the file extension *.giodis is added automatically to all projects created with Giodis.

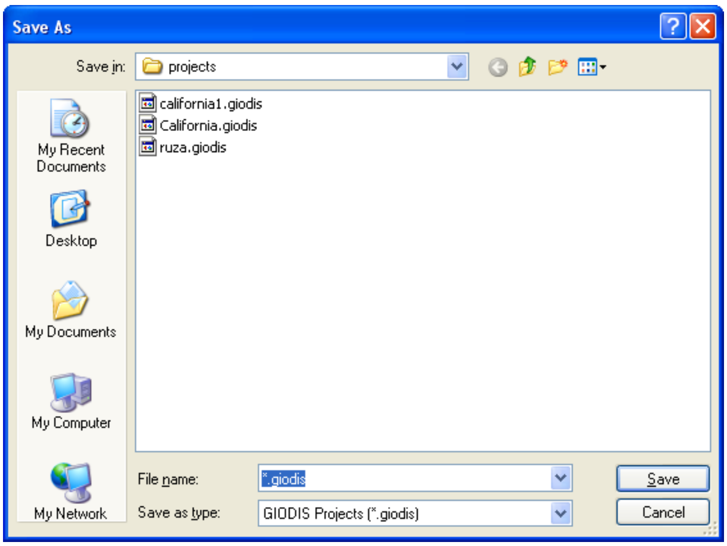


Figure 3-2. Save as dialog window

3. The new project saves on the computer and information on the new project appears in the *Info* tab (Figure 3-3).

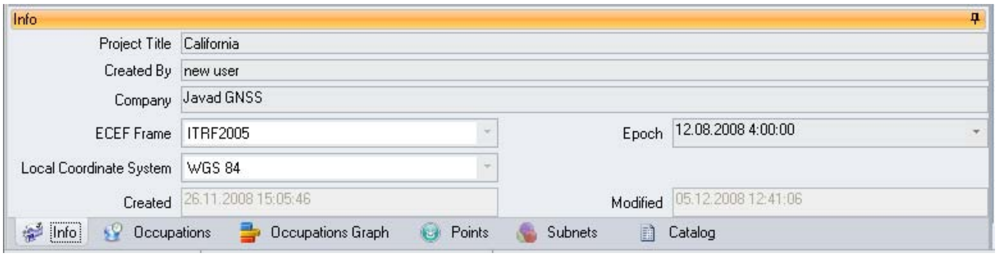


Figure 3-3. New project created

4. Enter the following information:
   - your name in the *Created By* field
   - your company name in the *Company* field
   - select the ECEF frame for IGS/CORS points, if they are planned to be used in the project
   - select an epoch at which the ITRF coordinates will be transformed from a specified epoch (e. g., 2000 or 2005). (To get information on ITRF general concepts, go to http://itrf.ensg.ign.fr/general.php).

Note: It is important to know, when you have selected the epoch, you should click (the SECTOR button on the Ribbon) to download the coordinates of the ECEF frame selected in the *ECEF Frame* field at the epoch in the *Epoch* field.

   - select the local coordinate system, which control positions in the project are referred to.

Note: Notice that the *Created* and *Modified* field displaying the date and time when the project was created and modified are filled in and updated automatically (they are not editable).

5. View and edit, if needed, the configuration settings. To open the *Configuration* dialog window, click Configure in the upper right corner of the main window. (See the "How to Use the Configuration Settings" on page 24 for detailed information on the project configuration).

3.2. Creating a New Encrypted Project

You might want to protect your control and measurement data imported into a project from third-party access. In this case you should create an encrypted project with a password. Every time when opening the encrypted project, Giodis requests the password.

To create a new encrypted project, do the following steps:

1. Click the *Javad* button, to open the *Project* menu and then, click the *New Encrypted* button (Figure 3-4).

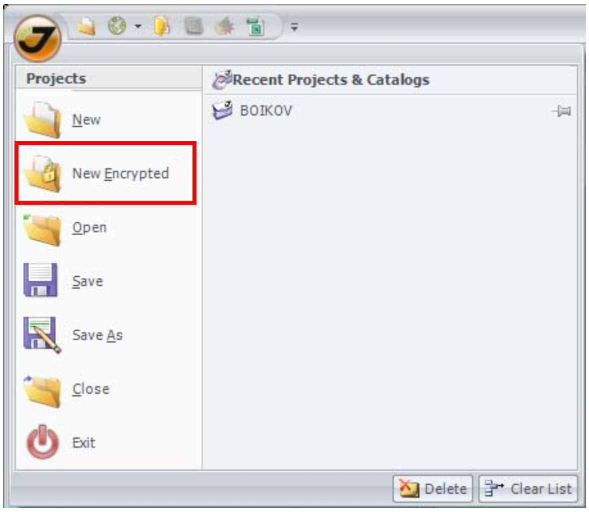


Figure 3-4. Projects menu. New Encrypted button

2. It opens the *Save as* dialog window (Figure 3-5). In this dialog window, navigate to the desired folder, enter the project name, and click *Save*.

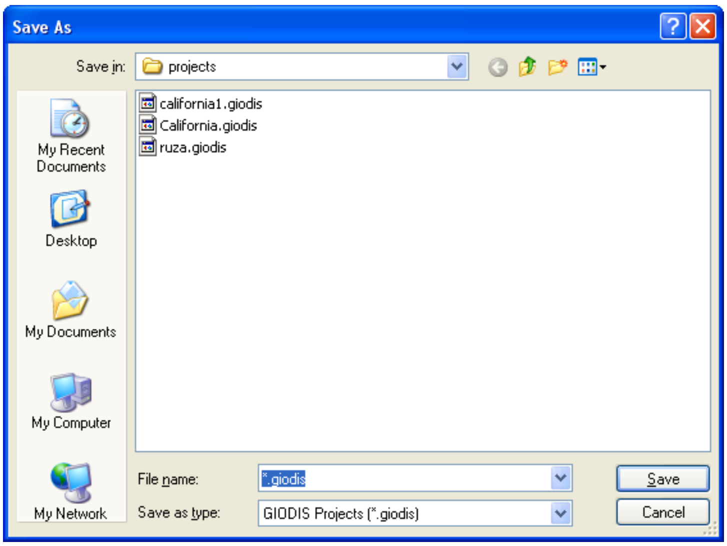


Figure 3-5. Save as dialog window

3. It opens the *Please Enter a Password* dialog window.

Figure 3-6. Please Enter a Password dialog window

4. Type a password. While you are typing the password, you can read the comments at the bottom of the dialog window regarding the secure degree of the password.
5. To confirm the password, type a password once more in the *Confirm* field.
6. Click *OK*. This dialog window closes. The new encrypted project saves on the computer and the main window changes displaying information on the new project in the *Info* tab.
7. Enter the following information:
   - your name in the *Created By* field
   - your company name in the *Company* field
   - select the ECEF frame for IGS/CORS points, if they are planned to be used in the project.
   - select an epoch at which the ITRF coordinates will be transformed from a specified epoch (e. g., 2000 or 2005). (To get information on ITRF general concepts, go to http://itrf.ensg.ign.fr/general.php).

Note: It is important to know, when you have selected the epoch, you should click (the SECTOR button on the Ribbon) to download the coordinates of the ECEF frame selected in the *ECEF Frame* field at the epoch in the *Epoch* field.

   - select the local coordinate system, which control positions in the project are referred to.

Note: Notice that the *Created* and *Modified* field displaying the date and time when the project was created and modified are filled in and updated automatically (they are not editable).

8. View and edit, if needed, the configuration settings. To open the *Configuration* dialog window, click Configure in the upper right corner of the main window. (See the “How to Use the Configuration Settings” on page 24 for detailed information on the project configuration).

3.3. Opening an Existing Project

To open an existing project, do the following steps:

1. Click the *Javad* button, to open the *Projects* menu.
2. Click the project you want to open in the *Recent Project & Catalogs* list (Figure 3-7).

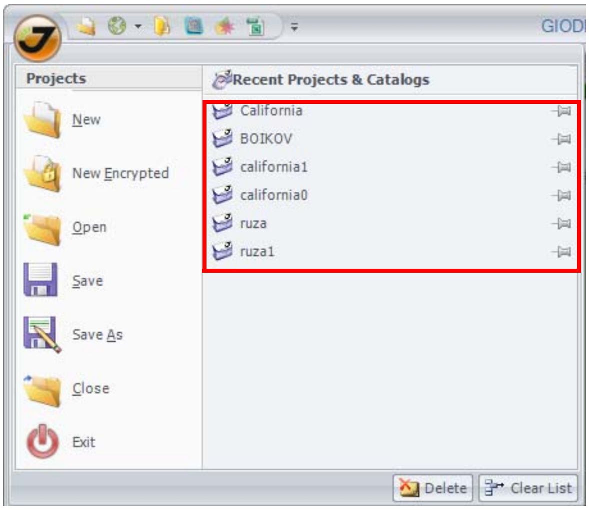


Figure 3-7. The Recent Projects & Catalogs list

Or click the *Open* button (Figure 3-8). It opens the standard *Open* dialog window allowing you to select the project you want to open.

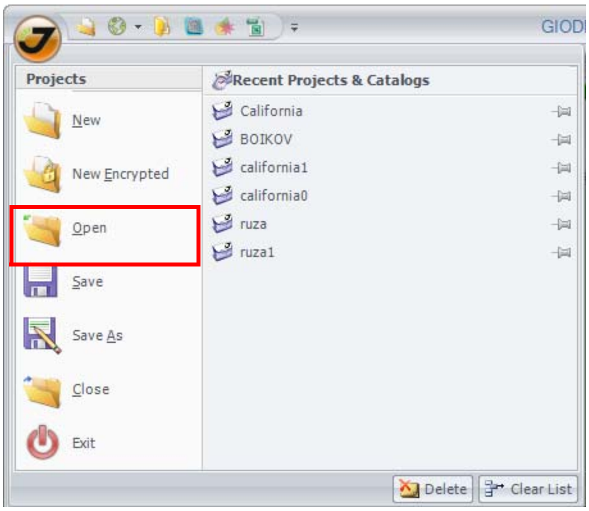


Figure 3-8. Projects menu. The Open button

3. If the project you want to open is encrypted, the *Please Enter a Password* dialog box appears (Figure 3-9). Enter a password and click *OK*.

Figure 3-9. Please Enter a Password dialog box

4. The project opens in the main window.

3.4. Saving a Project

There are two ways to save an active project: using the current project's name and specifying a different name and location.

To save the current project with the same name, do the following steps:

1. Click the *Javad* button, to open the *Projects* menu.
2. Click the *Save* button (Figure 3-10).

The project will be saved without changing its name and location.

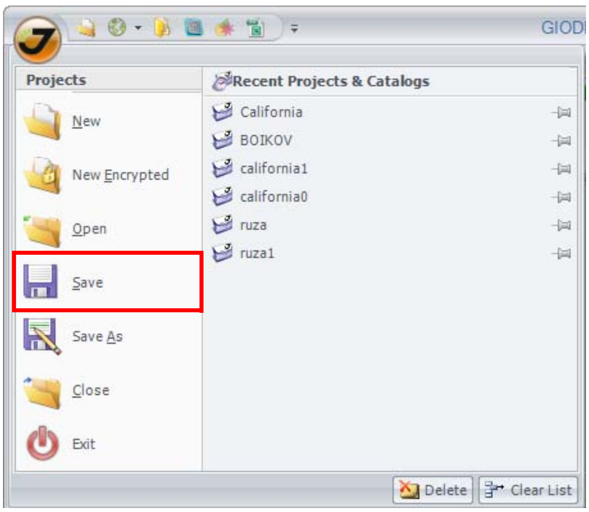


Figure 3-10. Projects menu. Save button

Note: The current project is saved automatically while closing the project or exiting the program. If you want to accept any changes without closing the project, use the Save option as described above.

To save the current project with a different name and in a different location, do the following steps:

1. Click the *Javad* button, to open the *Projects* menu.
2. Click the *Save as* button (Figure 3-11). It opens the *Save as* dialog window.

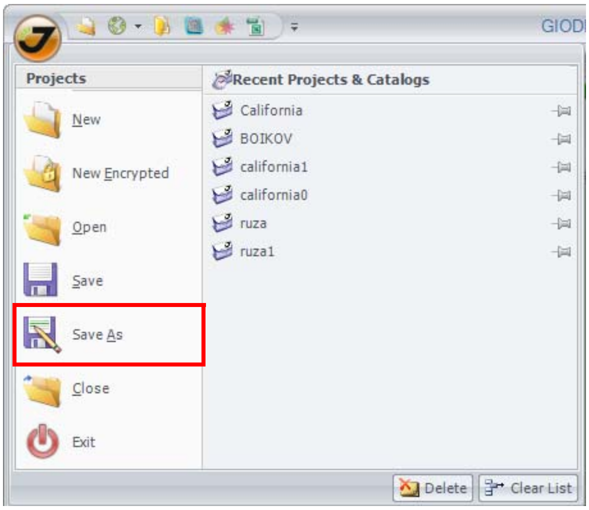


Figure 3-11. Projects menu. Save as button

3. In the *Save as* dialog window, select a folder, if you want to change the project location.
4. In the *Save as* dialog window, enter a new project name, if you want to change the project name.
5. Click the *Save* button, the project is saved with the name and location you defined.

3.5. How to Use the Configuration Settings

Giodis applies the configuration settings to any project. The configuration settings include measurement units and processing parameters. You can view and change the default configuration settings. The newly entered settings can be saved in the configuration file (*.giocfg) and used for other projects.

To change and save the configuration settings, do the following steps:

1. Click the  button in the upper right corner of the main window. It opens the *Configuration* dialog window (Figure 3-12).

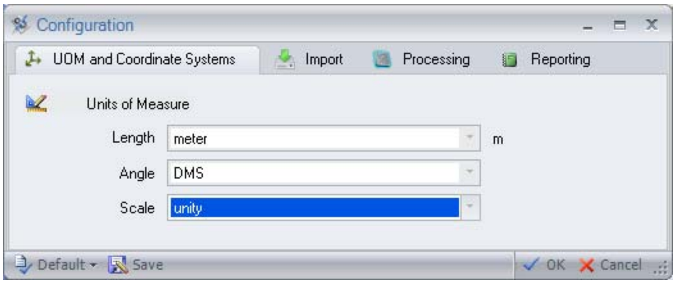


Figure 3-12. The Configuration dialog window

2. To change measurements units, click the *UOM and Coordinate System* tab (Figure 3-12).

Make the selections in the available fields:
Length indicates units for linear measurements. The default unit is meter.
Angle indicates units for angular measurements. The default unit is degree, minute, second.

3. To change the processing parameters, click the *Processing* tab.

Make the selections:
Confidence level defines a confidence interval to reject outliers. The default value is 99.7% 3σ.
Continuous processing check box, if marked, allows Javad GeoEngine to continuously process all sessions of the project one after another. If unmarked, Javad GeoEngine will stop each time when the session processing is complete. To process the next session, you should click *OK* in the *Javad-Geo Engine* dialog window. The *Continuous processing* check box is marked by default.

4. To save the new configuration settings and use them in other projects, click . It opens the *Save as* dialog window allowing you to enter a configuration file name and location. By default configuration files are stored in the *Configurations* subfolder of the installation folder.
5. Click , to apply changes to the current project and close this dialog window.

3.6. Closing a Project

To close a project, do the following steps:

1. Click the *Javad* button, to open the *Project* menu and then, click the *Close* button.

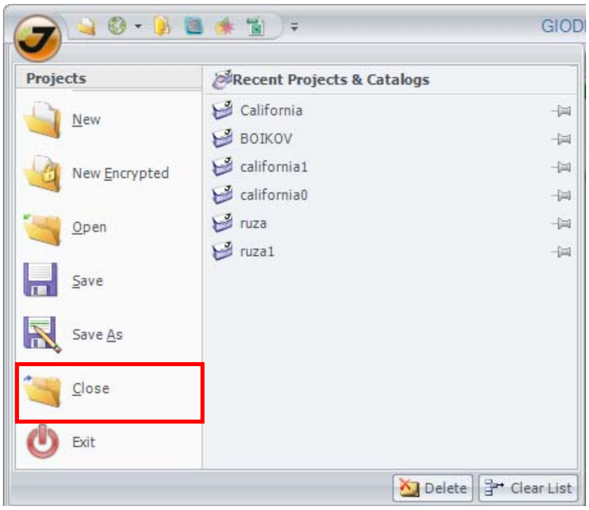


Figure 3-13. Close button

2. The active project will be closed.

Chapter 4

Working with Project

If the project is open, you can do the following tasks:

1. importing data files
2. processing data (static observations)
3. performing network adjustment
4. generating a report.

All these tasks are available to perform by using the *Project* tab of the Ribbon.

4.1. Importing Data Files

Giodis allows you to import data files to a project from a computer and from a remote server using the Internet.

This version of Giodis supports importing the JPS and RINEX files from a computer and coordinates of CORS/IGS reference stations as well as RINEX files via the Internet.

If you want to import files from your computer to the project, you can use one of the ways: importing a whole folder or a single file. The former allows importing all files and subfolders under the folder. The latter allows importing only a selected file (or multiple files). The ways are described in “Importing a Folder” on page 28 and in “Importing a File” on page 31 correspondingly.

Giodis allows you to download measurement data from web services that collect and archive this data. “Downloading Measurement Data from a Remote Server” on page 31 gives instructions on how to do it.

If you want to use the IGS/CORS reference points in your project, Giodis provides you the ability to download the IGS/CORS reference points positions from a web service to the project. “Downloading IGS/CORS Stations Positions” on page 33 gives instructions on how to do it.

4.1.1. Importing a Folder

You can import measurement data files, which are located in a folder of your computer, to the current project.

To import the folder, do the following steps:

1. On the ribbon, select *Project*, then click *Load Folder* 

.
It opens the *Browse For Folder* dialog window (Figure 4-1).

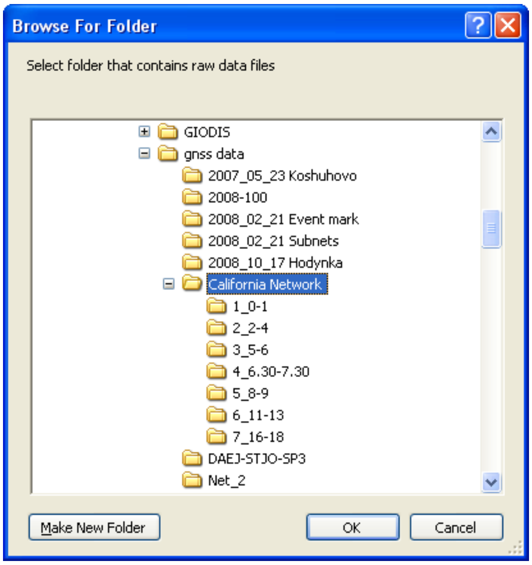


Figure 4-1. Browse For Folder dialog window

2. Select the desired folder and click *OK*. Files under the folder are being loaded. It may take several seconds.

Note: While importing data files, measurement data is splitted into sessions. The generated sessions are represented in the Map window and in the *Occupation Graph* tab.

3. When the files have been loaded, you can study the new information appearing:

- The imported files are arranged and listed in the *Files* tab.

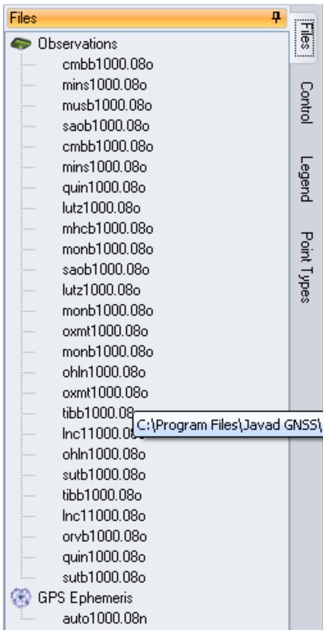
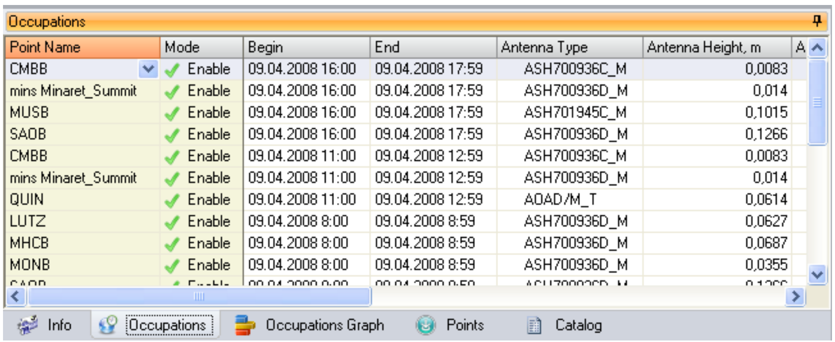


Figure 4-2. Files tab, data files have been imported

- Network view appears in the Map window.
- The detailed information on each point occupation is given in the *Occupation* tab (Figure 4-3).


Occupations

Point Name	Mode	Begin	End	Antenna Type	Antenna Height, m	A
CMBB	Enable	09.04.2008 16:00	09.04.2008 17:59	ASH700936C_M	0,0083	
mins Minaret_Summit	Enable	09.04.2008 16:00	09.04.2008 17:59	ASH700936D_M	0,014	
MUSB	Enable	09.04.2008 16:00	09.04.2008 17:59	ASH701945C_M	0,1015	
SAOB	Enable	09.04.2008 16:00	09.04.2008 17:59	ASH700936D_M	0,1266	
CMBB	Enable	09.04.2008 11:00	09.04.2008 12:59	ASH700936C_M	0,0083	
mins Minaret_Summit	Enable	09.04.2008 11:00	09.04.2008 12:59	ASH700936D_M	0,014	
QUIN	Enable	09.04.2008 11:00	09.04.2008 12:59	AOAD/M_T	0,0614	
LUTZ	Enable	09.04.2008 8:00	09.04.2008 8:59	ASH700936D_M	0,0627	
MHCB	Enable	09.04.2008 8:00	09.04.2008 8:59	ASH700936D_M	0,0687	
MONB	Enable	09.04.2008 8:00	09.04.2008 8:59	ASH700936D_M	0,0355	

Figure 4-3. Occupations tab. Measurements data files imported

The *Occupation* tab displays the following information: the point’s name, mode, observation period, antenna height and type, navigational coordinates and deviations.
The *Mode* column is editable. Check that all points in this example have the *Enable* mode. It means that all occupations will be accepted for further processing.

The *Deviation* column is shown for checking points that have the same name but referred to different locations. For a point that was occupied only once (and therefore no check data for its position is available), the zero deviation is shown. If a point was occupied more than one time, the deviations between navigation positions for its occupations are given, referred to the occupation position that has minimal RMS value (for this reference position, zero deviation is assigned).

- The graphical view of point occupation and sessions is given in the *Occupation Graph* tab.

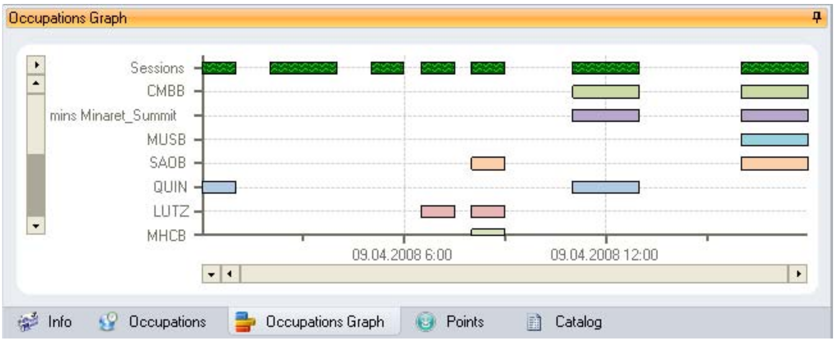


Figure 4-4. Occupations Graph tab. Measurements data files imported

The top green line shows the whole time of a session. To get the occupation graph in various scales, locate the mouse cursor over the graph, press and hold down the *Ctrl* key, hold down the left mouse button, move the mouse cursor up (it increases the graph size) or move the mouse cursor down (it decreases the graph size). You can also use ▸ and ▾ near the horizontal and vertical scroll bars correspondingly, to open the list of scales and select the desired scale.

- The *Points* tab displays average navigational geodetic and cartesian coordinates and RMS errors for each point.

4.1.2. Importing a File

You can import a measurement data file (or multiple files, not a whole folder), located on your computer, to the current project.

To import a file, do the following steps:

1. On the *Ribbon*, select *Project*, then click *Load File* 

.

It opens the *Open* dialog window.

2. Navigate to the folder in which the file is located, select the file and click *Open*.

Note: To select multiple sequential files, press **Shift** and then use the **Up** and **Down** keys. To select nonsequential files press **Ctrl** and click the desired files.

3. When the file has been loaded, you can study the new information appearing:

- The imported files are arranged and listed in the *Files* tab.
- Network view appears in the Map window.
- The detailed information on each point occupation is given in the *Occupation* tab (Figure 4-3).
- The graphical view of point occupations and sessions is given in the *Occupation Graph* tab (Figure 4-4).
- The *Points* tab displays average navigational geodetic and cartesian coordinates and RMS errors for each point.

4.1.3. Downloading Measurement Data from a Remote Server

Note: Before doing actions described below, be sure your computer is connected to the Internet and internet connection is not failed, otherwise it disables to retrieve data from web services.

To download measurement data from a remote server, do the following steps:

1. On the Map, draw a rectangle by using the drag and drop technique. The rectangle bounds a region for which measurement data will be downloaded.

2. Click 

on the Ribbon, the *Project* tab. It opens the *Global Data Service* dialog window (Figure 4-5).

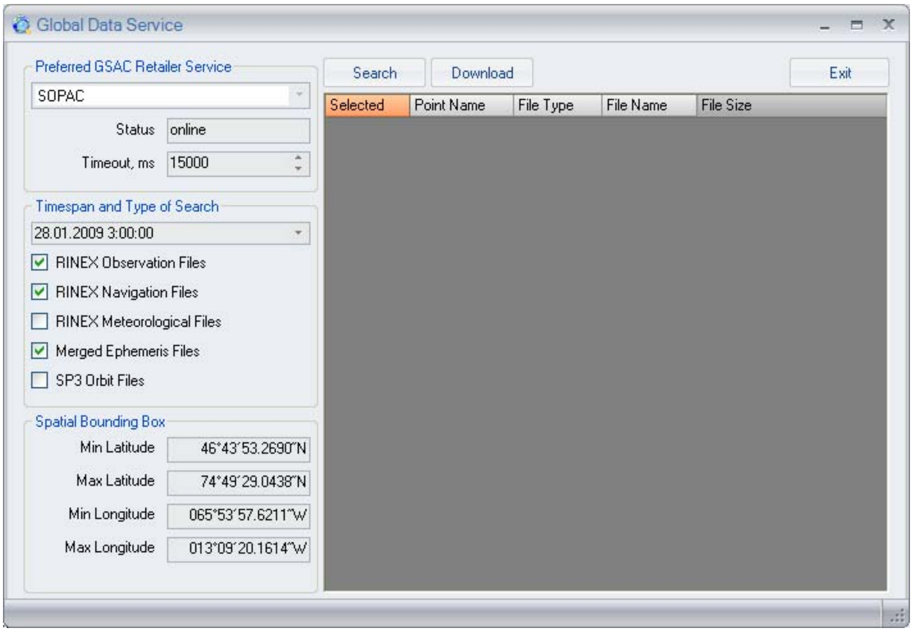


Figure 4-5. Global Data Service dialog window

3. In *Timespan and Time of Search*, select the needed observation date, it should be earlier than the current date. By default, the current date is set.
4. In *Spatial Bounding Box*, verify that the needed region is selected.
5. Click 

, the *Search* button. Giodis looks for CORS/IGS stations for the selected region and lists them in a table.

Note: If no stations appear in the table, increase a value in the *Timeout, ms* field or reduce the region in *Spatial Bounding Box* and click the *Search* button again.

6. Select stations for downloading. By default, all stations are specified as *Selected*.
7. Click 

, the *Download* button. Giodis downloads the data files to the project.
8. When the data files have been downloaded, click the *Occupations* tab, to see the imported data in the table. Also you can click the *Occupation Graph* tab, to view the observation sessions.
9. In the *Occupations* tab, select the data to be processed. In the *Mode* column, verify that *Enable* is selected for the points to be processed.

4.1.4. Downloading IGS/CORS Stations Positions

If you want to use the IGS/CORS reference points in your project, you can download their positions from the web service, that provides this data. Before doing actions described below, make sure that:

1. Your computer is connected to the Internet and internet connection is not failed.
2. The IGS/CORS points, included o your project, have the same four-character names as in the IGS/CORS data archive. If this is not so, you must correct them. To change the point's name, select the *Occupation* tab, double-click the point's name and type in the appropriate four-character name.

To download the IGS/CORS reference station positions to the current project, do the following steps:

1. On the Ribbon, click 

. Giodis connects to the SOPAC web server and requests positions for the IGS/CORS points of the project according to their four-character code names.
2. Select the *Catalog* tab, to view the downloaded the IGS/CORS reference points positions.

4.2. Processing Static Observations

After the measurement data has been imported and splitted into sessions, you are ready to start processing.

In Giodis the JavadGeo engine makes static observation processing. "The JavadGeo Engine Main Features" on page 34 describes main features of the JavadGeo engine. "Running the JavadGeo Engine" on page 35 learns you how to run the engine and keep track of preliminary results.

4.2.1. The JavadGeo Engine Main Features

The main features of the JavadGeo engine are as follows:

- multi-baseline (session) processing, that allows accounting for correlations between simultaneously observed vectors and removing the problem of trivial vectors. If a session includes two-points observation, the engine fulfills traditional baseline processing.
- Un-differenced (zero-differenced) phase and code data are processed.
- Lambda method of phase ambiguity resolution is used.
- The meteodata library is used for a priori troposphere delay calculating. The library contains the global spread meteodata. Meteodata for a surveyed point is interpolated based on the point geographical location and height, as well as the observation date and time.
- Direct impact and behavior of ionosphere and troposhere, satellite and receiver clocks on GNSS observations are estimated.
- Orbit relaxation parameters are determined.
- The IGS/CORS reference points data and the user collected observation data are processed jointly. This allows better estimating satellite clocks and orbit relaxation parameters thus improving the accuracy of surveyed points. This, in turn, enables to better determine long baselines even without precise ephemeris.
- The effects of solid Earth tide on point positions are accounted for.
- The result of the JavadGeo engine is:
    - a multi-vector subnet, if the IGS/CORS reference points data is not used for processing or
    - a multi-points subnet, if the IGS/CORS reference points data is used for processing.

4.2.2. Running the JavadGeo Engine

To run the JavadGeo Engine, do the following steps:

1. Create a project or open an existing project. (See Chapter 1 “Managing Projects”).
2. Import measurement data files (See “Importing Data Files” on page 27).

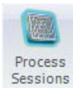
Note: While importing data files, measurements data is splitted into sessions. The generated sessions are represented in the Map window and in the *Occupation Graph* tab.

3. If you are working with IGS or CORS reference points, include the IGS/CORS point positions into the project. For this, you can use the following options:
   - manually specify a point as ECEF control (See “Setting ECEF Control” on page 36).

Note: If the point has been specified as ECEF Control, it changes from to in the *Points* tab and on the Map.

   - enable control data contained in the Control points catalog. Go to the *Catalog* tab, find the needed control point, mark one or several check boxes in the *Selected* column.

Note: If the control point has been selected in the Control points catalog and included to the project, it changes to in the *Catalog* tab and on the Map.

4. Process the sessions. Click *Process Sessions* 

on the Ribbon.

It opens the *JavadGeo Engine* dialog window displaying the processing progress bar and summary (Figure 4-6). Sessions of the project are processed one after another without stopping. When all sessions of the project have been processed, the *Javad GeoEngine* dialog window closes.

Note: If you want to see the results after finishing each session processing, clear the *Continuous processing* check box in the *Configuration* dialog window, the *Processing* tab. In this case you must click *OK* (Figure 4-6) to begin processing of the next session.

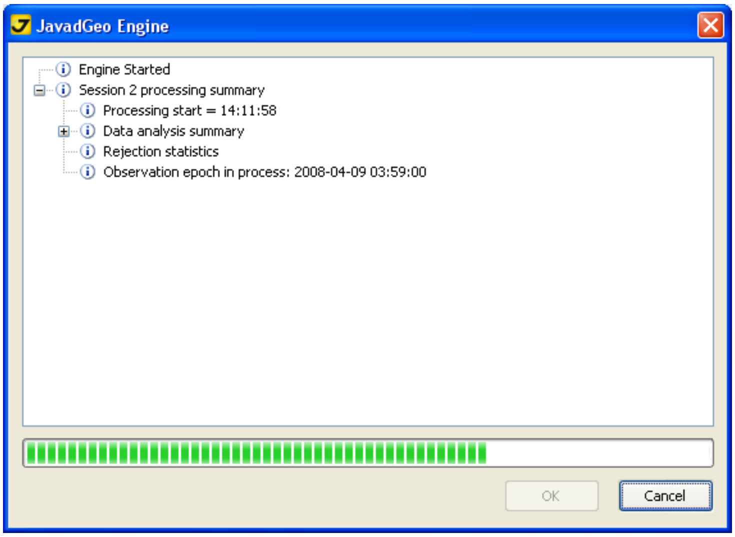


Figure 4-6. Javad GeoEngine dialog window

5. View the processing results:
   - The point image changes from ◆ to ◆ on the Map.
   - The *Subnets* tab appears underneath the Map showing the following information: subnet number, subnet type, points included in the subnet, point's coordinates, and RMS errors.

Subnet type displays *Vectors* or *Absolute*. Subnet is designated as "Vectors", if the IGS/CORS reference points data is not used. Subnet is designated as "Absolute", if the IGS/CORS reference points data is used.

Note: In the *Subnets* tab the first point of the list is *Initial Point*. This point is designated as *Initial Point* by the program and its coordinates are not assigned accuracy estimate, as you can see it in the corresponding *RMS* columns of the table.

Note: In the *Subnets* tab, if the subnet type is Absolute, IGS/CORS points coordinates are considered to be precise. So their coordinates are not assigned accuracy estimate, as you can see it in the corresponding *RMS* columns of the table.

Setting ECEF Control

Use this procedure to manually specify a point as ECEF Control.

1. In the *Points* tab, right click the *Point Type* cell next to the point you want to make a ECEF Control. It displays the *ECEF Control* option.

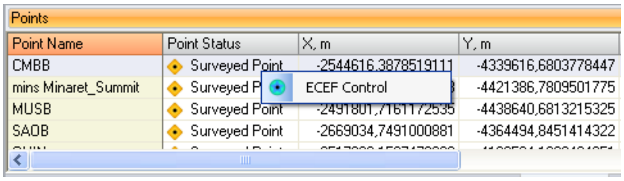


Figure 4-7. ECEF Control option

2. Click the *ECEF Control* option, it opens the *ECEF Control* dialog winow.

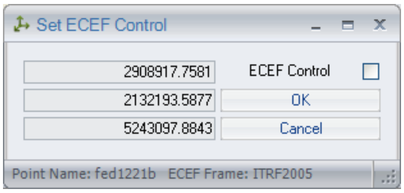


Figure 4-8. Set ECEF Control dialog window

3. Enter the point's coordinates.
4. Mark the *ECEF Control* check box.
5. Click *OK*. The *ECEF Control* dialog window closes. The point changes from  to  in the table and on the Map. The point appears in the *Catalog* tab underneath the Map and in the *Control* tab on the right of the Map.

4.3. Performing Network Adjustment

The adjustment has two main goals:

1. Detecting blunders in adjusted data.

2. Calculating the most reliable and accurate results (in our case -final local coordinates of surveyed points and their realistic error estimates).

The network adjustment is done in two steps:

First, the minimally constrained network adjustment (or, free adjustment) is performed in which only one station is held fixed. This allows to detect possible blunders in adjusted GNSS data (e.g., missed antenna heights), and in control positions (say, misprint errors in control data catalogs). For this, different statistical tests are applied like global (Chi square) test or Tau test.

If there are no blunders in the adjusted data, the second step can be done - the fully constrained adjustment in which all the known (published) coordinates of control points (horizontal and/or vertical) are held fixed. This allows to fit the GNSS network into the local control.

4.3.1. The Order of Adjustment

1. All the processed subnets are assembled into a common network. The integrity of the network is checked; it should not have any breaks.

2. The system of equations for the minimally constrained adjustment is formed. Depending on the approach that was chosen to processing, the following types of subnets can be adjusted:

- Single baseline solutions, i.e., vectors and associated 3x3 covariance matrices.
- Session processing solutions, i.e., a set of non-trivial vectors and the covariances between them.
- In case if field GNSS observations have been processed along with data from IGS/CORS reference stations, the adjusted subnet consists of absolute ECEF coordinates and the covariance matrix of the subnet.

All these types of processing subnets can be adjusted together.

3. Minimally constrained 3D adjustment of the GNSS subnets is performed; its results are analyzed based on the Tau and Chi square (VPV) statistical tests. Tau test allows to detect and reject blunders in adjusted observations. VPV, or global test, is used to check whether the

observation error estimates made by the processing engine, are close to the expected. If this is so, the standard error of unit weight output by adjustment, is close to 1.

4. After finishing the minimally constrained adjustment a fully constrained adjustment is run. The constraints are horizontal and/or vertical coordinates of local control points.

The Giodis software allows three types of constrained adjustment:

- Horizontal adjustment in which only horizontal control coordinates (geodetic or grid) are known. In this case the output results are adjusted horizontal positions of GNSS network.
- Vertical adjustment in which only elevations are used as control data. In this case the main goal is to calculate point elevations referred to a local vertical datum.
- Three dimensional adjustment with both horizontal and vertical control. In this case, horizontal coordinates and heights of surveyed points are adjusted.

5. Because GNSS subnets and local control refer to different datums, the constrained adjustment procedure estimates the datum transformation parameters. Depending on the type of constrained adjustment, Giodis estimates the following sets of transformation parameters:

- Horizontal transformation parameters - a shift (two parameters), azimuth rotation angle and scale - that describe the differences between horizontal positions given in global (e.g., WGS84) and local datum.

Note: If the subnets not referred to ITRF are adjusted (i.e., the subnets were not tied to CORS/IGS stations), only rotation angle and scale parameters are estimated.

- Three parameters - the values for a slope (two parameters) and vertical shift - that describe the difference between heights referred to global WGS84 ellipsoid and to local vertical datum.

Note: If the adjusted subnets were not tied to CORS/IGS stations, only slope parameters are estimated.

- Seven parameters for both horizontal (four above mentioned parameters) and vertical (three above mentioned parameters) transformation.

Note: If the adjusted subnets were not tied to CORS/IGS stations, only four parameters are estimated - three rotation angles and scale.

Checking the quality of control positions.

To check the quality of your local control, do the next steps:

1. Perform minimally constrained (free) adjustment of the GPS network.

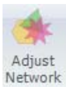
2. After the free adjustment is successfully finished (i.e., all blunder vectors have been detected and removed from the network), do the constrained adjustment with minimal control. At this step, constrain the adjustment solution by only one horizontal control position (in case of horizontal adjustment) or by one fixed height (when you are interested in adjusting vertical positions), or by both horizontal and vertical coordinates when doing three dimensional adjustment. Note that in the latter case you may use fixed horizontal coordinates and height that refer to different control points.

3. In this adjustment, for all points of your network (including control points) the local coordinates are calculated. Compare the calculated coordinates of the control points (other than the point that was used as fixed) with their published (true) values. If the differences are more than expected the corresponding coordinates may be incorrect. Check the suspect coordinates; at worst, do not use the corresponding control point positions in the final adjustment. It also may be so that the calculated position differences for all points are big but very close to each other. This may indicate that an error occurs in the position of the point that was chosen as fixed. In this case, select another control point and try Step 3 again.

4. After all your control coordinates have been successfully checked, you may do the final step, i.e., perform the fully constrained adjustment.

4.3.2. Running the JavadGeo Network Adjustment

To run the JavadGeo Network Adjustment, do the following steps:

1. Process the sessions and get the subnets, how it is described in “Running the JavadGeo Engine” on page 35.
2. Set the local control. For this, go to the *Info* tab, in the *Local Coordinate System* drop-down list, select the desired coordinate system.
3. Click 

on the Ribbon. It opens the *JavadGeo Network Adjustment* dialog window displaying the progress bar and summary

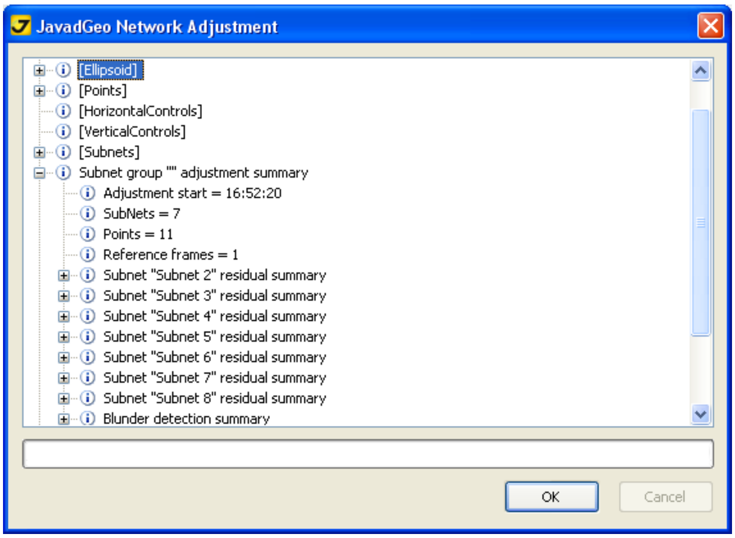


Figure 4-9. JavadGeo Network Adjustment

4. Click *OK*, when the message appears prompting you the Network Adjustment is complete.
5. View the adjustment results:

- The point image changes from  to  on the Map.
- The *3D Solution* tab appears underneath the Map and displays the results of minimally constrained adjustment: point positions in WGS (or ITRF) system and RMS errors.
- The Final Solution.

4.4. Generating a Report

You can export data (such as tables, charts, and maps) from the current project to the XLS file format. Creating a report allows you to output data in the same manner as it is organized in the project and then view, manipulate and print this data taking advantages of the standard Microsoft Excel application. The report contains several spreadsheets, including:

- Standalone_Points to represent point's coordinates similarly the Points tab
- Occupation_Charts to represent the graphical view of occupations and sessions similarly the Occupations Graph tab
- Map to represent the network view on a map.

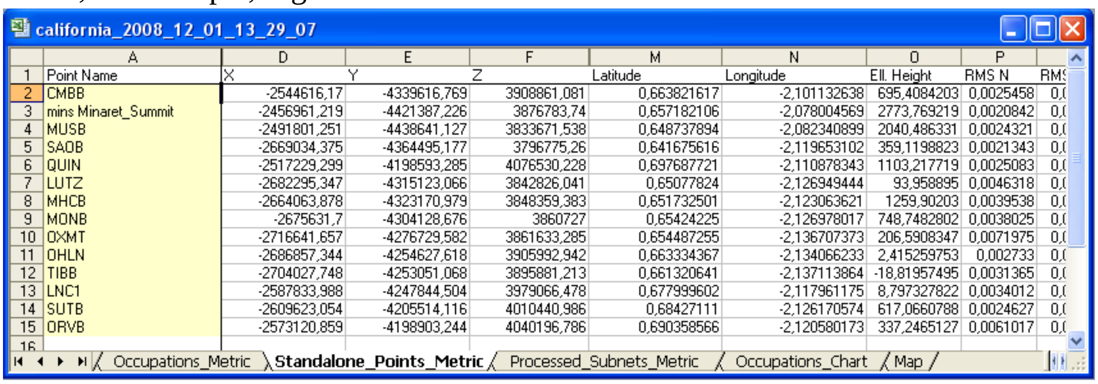
You can generate a report on each stage of your work with the project.

To generate a report, do the following steps:

1. Click on the Quick Access Toolbar or Excel on the Ribbon. The *Save as* dialog window opens.
2. Navigate to the location you want to save the file and type in the file name.

Note: By default, the file is saved in the Reports folder and the file name consists of the subnet's name and file creation date and time.

3. Click *Save* button, to export data to the file. It runs Microsoft Excel and opens this file. See, for example, Figure 4-10.


california_2008_12_01_13_29_07

	A	D	E	F	M	N	O	P	
1	Point Name	X	Y	Z	Latitude	Longitude	Ell. Height	RMS N	RMS
2	CMBB	-2544616,17	-4339616,769	3908861,081	0,663821617	-2,101132638	695,4084203	0,0025458	0,(
3	mins Minaret_Summit	-2456961,219	-4421387,226	3876783,74	0,657182106	-2,078004569	2773,769219	0,0020842	0,(
4	MUSB	-2491801,251	-4438641,127	3833671,538	0,648737894	-2,082340899	2040,486331	0,0024321	0,(
5	SAOB	-2669034,375	-4364495,177	3796775,26	0,641675616	-2,119653102	359,1198823	0,0021343	0,(
6	QUIN	-2517229,299	-4198593,285	4076530,228	0,697687721	-2,110878343	1103,217719	0,0025083	0,(
7	LUTZ	-2682295,347	-4315123,066	3842826,041	0,65077824	-2,126949444	93,958895	0,0046318	0,(
8	MHCB	-2664063,878	-4323170,979	3848359,383	0,651732501	-2,123063621	1259,90203	0,0039538	0,(
9	MONB	-2675631,7	-4304128,676	3860727	0,65424225	-2,126978017	748,7482802	0,0038025	0,(
10	OXMT	-2716641,657	-4276729,582	3861633,285	0,654487255	-2,136707373	206,5908347	0,0071975	0,(
11	OHLN	-2686857,344	-4254627,618	3905992,942	0,663334367	-2,134066233	2,415259753	0,002733	0,(
12	TIBB	-2704027,748	-4253051,068	3895881,213	0,661320641	-2,137113864	-18,81957495	0,0031365	0,(
13	LNC1	-2587833,988	-4247844,504	3979066,478	0,677999602	-2,117961175	8,797327822	0,0034012	0,(
14	SUTB	-2609623,054	-4205514,116	4010440,986	0,68427111	-2,126170574	617,0660788	0,0024627	0,(
15	ORVB	-2573120,859	-4198903,244	4040196,786	0,690358566	-2,120580173	337,2465127	0,0061017	0,(
16									

Occupations_Metric / Standalone_Points_Metric / Processed_Subnets_Metric / Occupations_Chart / Map

Figure 4-10. Report in XLS file format

MAP OPTIONS

Giodis displays maps as a background to show location of surveyed points and control data. Giodis uses maps developed by Map Suite™ from ThinkGeo. There are three types of maps available:

- *Global* includes major road level maps of the World
- *USA* includes scalable street level maps of USA
- *Canada* includes scalable street level maps of Canada.

This chapter learns how to:

- display a map
- move around a map
- display a layer
- get point coordinates.

5.1. Displaying a Map

You can select one of the several available maps for displaying in the Map window.

Giodis uses the Default map unless you select another from the list. The Default map is a non-detailed scalable map covering the globe.

Note: To display none of the maps in the Map window, clear the *Background Map* check box at the bottom of the main window (see Figure 5-1). It may be useful, if you want to increase the speed of processing data.

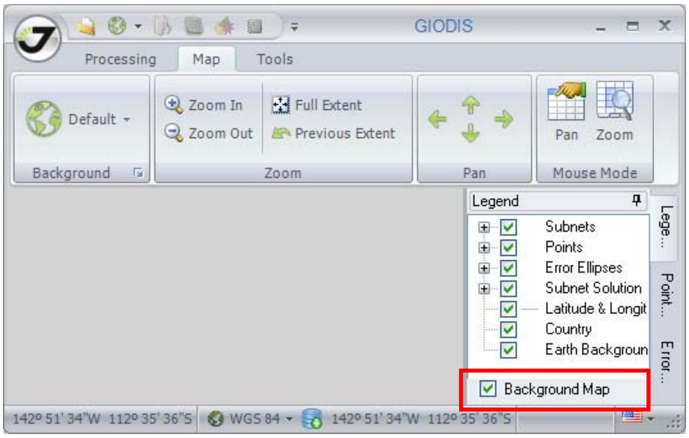


Figure 5-1. Background Map check box

To display a map, do the following steps:

1. Open the list of available maps. For this, use one of the two ways:

- On the Ribbon, select the *Map* tab. Then, in the *Background* group, click the button  (see Figure 5-2)

Figure 5-2. The Map tab

- On the Quick Access Toolbar, click the button  (see Figure 5-3)

Figure 5-3. The Quick Access Toolbar

Using either way, the list of available maps opens;

Figure 5-4. List of available maps

2. Select the desired map. This map displays in the Map window.

5.2. Moving Around a Map

You can zoom and pan your map in the Map window. Use the options of the *Map* tab on the Ribbon depending on your needs and explanations below.

The *Zoom* group includes the following options:

Figure 5-5. Zoom group

Zoom in increases the scale of the map.

Zoom out decreases the scale of the map.

Full Extent extents the map to its default maximum size.

Previous Extent saves all previous map extents and goes back any times you want.

The *Pan* group moves the map up, down, right and left (see Figure 5-6). Click the appropriate arrow to move the map in the direction indicated by the arrow.

Figure 5-6. Pan group

The *Mouse Mode* group includes the following options (see Figure 5-7):

Figure 5-7. Mouse Mode group. The Pan mode is on

Pan changes the mouse cursor to a hand and moves the map. Hold the mouse button down while dragging the map in the desired direction, then release the button.

Zoom allows to use the mouse wheel for zooming the map. Move the mouse wheel forward/ backward to zoom in/out the map.

5.3. Displaying a Layer

You can view layers that form the current map as well as display/hide a layer. The *Legend* tab allows you to view the list of layers and control layers appearing.

All layers are visible by default. To display/hide the layer, mark/clear the check box next to layer (see Figure 5-8).

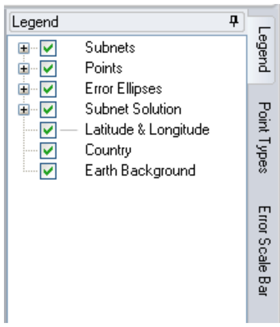


Figure 5-8. Legend tab

5.4. Getting Point Coordinates

You can get coordinates of the current mouse cursor position. Status bar displays these coordinates in two coordinate systems. One is WGS 84, the other can be selected.

To get point coordinates, do the following steps:

1. Locate the mouse cursor over the point, whose coordinates you want to know.
2. View the point coordinates in WGS 84 on the left (see Figure 5-9)

Figure 5-9. Point coordinates in WGS 84

3. If you want to get coordinates in another coordinate system, select it from the list of the Favorite coordinate systems (see Figure 5-10).

Figure 5-10. Favorite Coordinate System list

4. View the point coordinates in this coordinate system on the right (see Figure 5-11).

Figure 5-11. Point coordinates in the selected coordinate system

Note: If you want to change measurement units, use the corresponding split buttons on the Status bar. Both linear and angular measurement units are available for changing.

Chapter 6

TOOLS

6.1. Coordinate Calculator

Giodis Calculator is intended to transform point's coordinates from one coordinate system to another, as well as to convert an orthometric height to an ellipsoidal one and vice versa. Calculator allows you to perform transformation between any two coordinate systems if a transformation model between them is known.

6.1.1. Running Calculator

To run Calculator, do the following steps:

1. On the ribbon select the *Tools* tab, then click the *Calculator* icon.

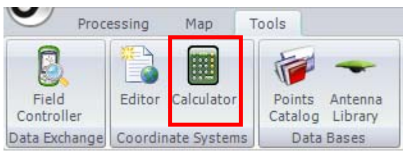


Figure 6-1. Calculator on the ribbon

2. It opens the *Coordinate Transformation* dialog box. The section below contains instructions on how you can use this dialog window.

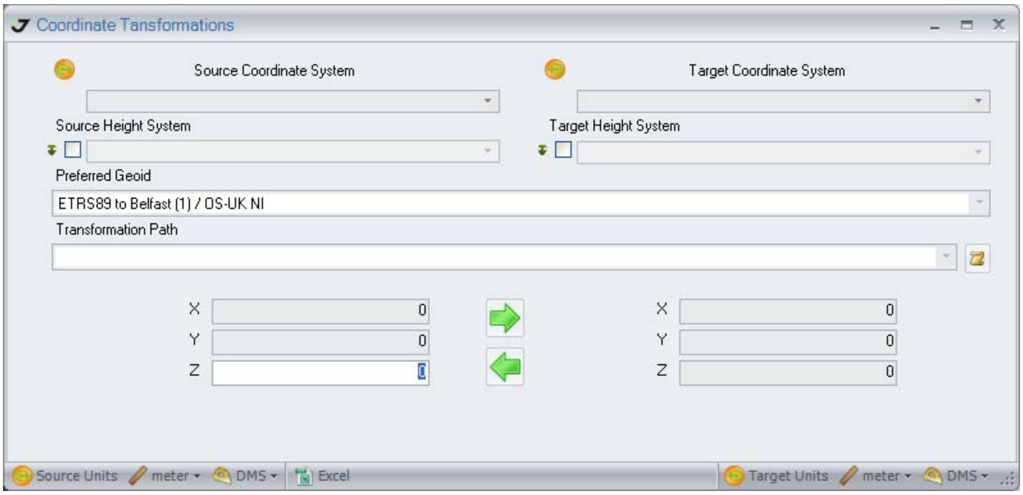


Figure 6-2. Coordinate Transformations dialog window

6.1.2. Using Calculator

If you have run Calculator you are ready to complete entries and perform coordinate transformation. In this manual it is supposed that you enter coordinates on the left and get result on the right. The coordinate transformation is performed from the Source coordinate system to the Target coordinate system.

In the *Coordinate Transformation* dialog window, you can do the following steps:

1. To set the source coordinate system, open the *Source Coordinate System* drop-down list and find the desired coordinate system.

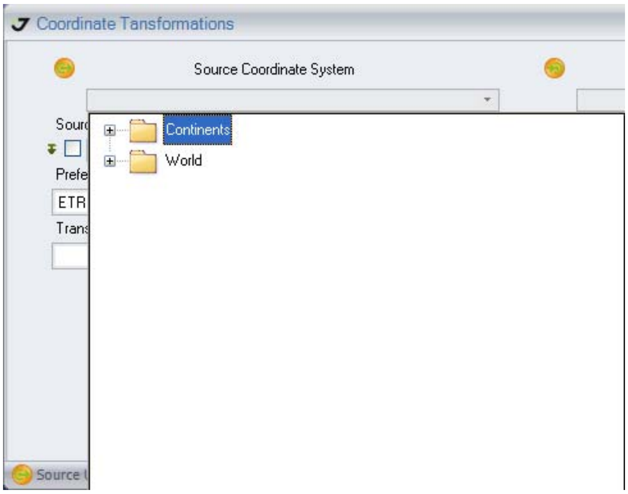


Figure 6-3. The Source Coordinate System drop-down list

When navigating to the desired coordinate system, use the rules and explanations below.

- If your source coordinates are given in a coordinate system associated with the appropriate country, open the *Continents* folder, then select the desired country.

  For example, if you want to set NAD83, click ⊞ next to the *Continents* folder, go to the *North America - NAD83* folder and open it. Double-click *NAD83* (see Figure 6-4).

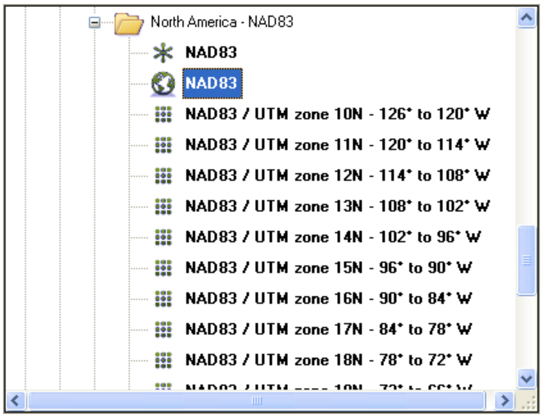
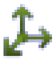


Figure 6-4. NAD83 selected

- If your source coordinates are given in a coordinate system associated with the whole world, open the *World* folder, then open one of the *WGS* folders or go to ITRF or other global systems.

- The icon next to each coordinate system indicates the coordinate system type. The four types are available:

   - 3D Cartesian

   - Geodetic

   - Grid

   - Local

   - Height System.

Note: If there is no needed coordinate system in the list, you should exit from Calculator, create one in Coordinate System Editor and then run Calculator again.

2. If you have found the coordinate system, double-click on it. It is designated as source and appears in the *Source Coordinate System* field (see Figure 6-5).

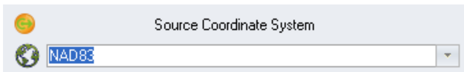


Figure 6-5. NAD83 is the source coordinate system

3. To set the target coordinate system, in the *Target Coordinate System* drop-down list, find the desired coordinate system and double click it. It appears in the *Target Coordinate System* field (Figure 6-6).

The *Target Coordinate System* list is organized the same way as *Source Coordinate System*. Use the rule described above, to find the desired target system.

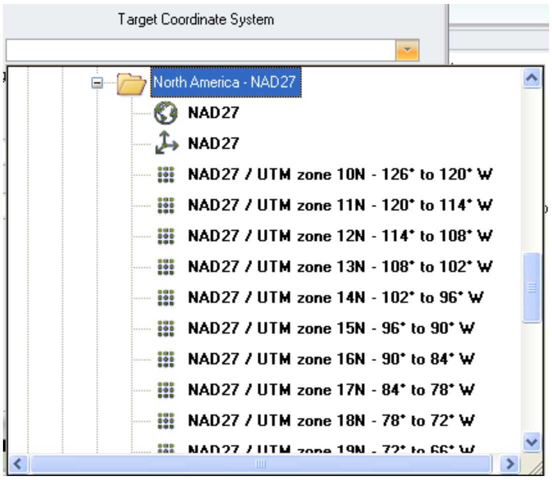


Figure 6-6. NAD27 selected

4. If you want to use orthometric heights for the source/target coordinates, mark the check box under *Source/Target Height System* (Figure 6-7), open the *Source Height System/*

Target Height System list and select the desired height system by double-clicking on it (Figure 6-8) .

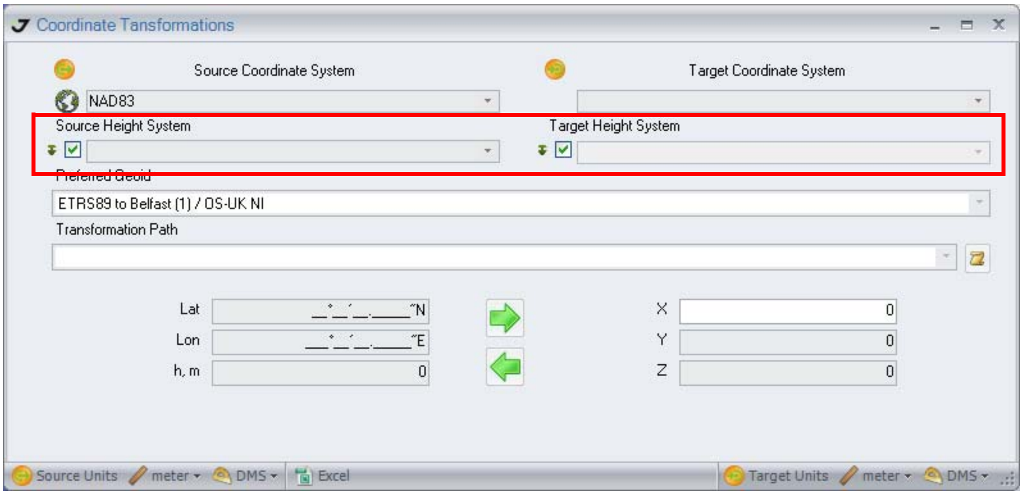


Figure 6-7. Setting orthometric heights.

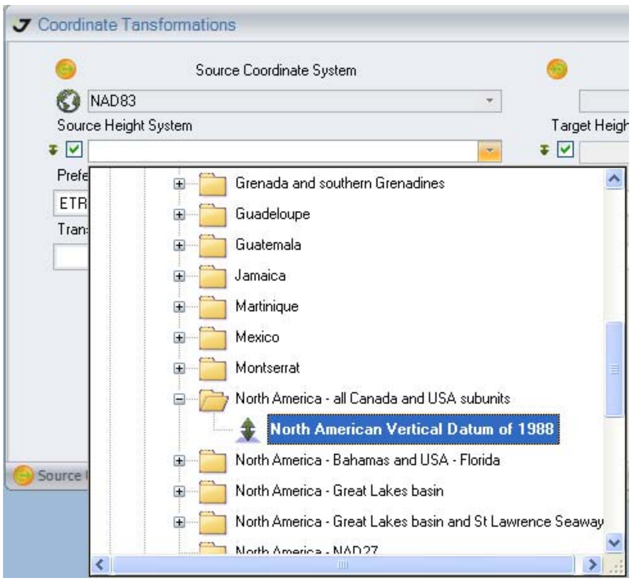


Figure 6-8. Source Height System drop-down list

Note: Leave the check box clear and the field empty, in the case of ellipsoidal heights, as Calculator uses ellipsoidal heights by default.

5. To set the desired geoid model, open the *Preferred Geoid* drop-down list and select a geoid. For example, see Figure 6-9

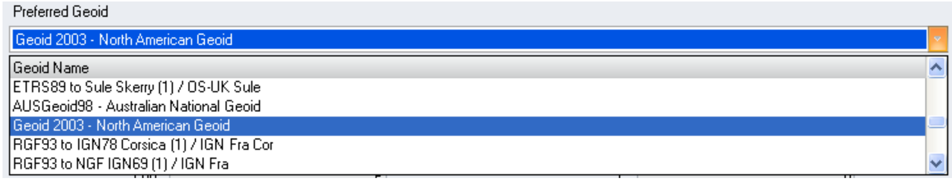


Figure 6-9. Preferred Geoid drop-down list

6. After the Height and Coordinate systems have been defined, select a transformation method from the *Transformation Path* drop-down list. The list of transformation methods is generated by Giodis. It can be different depending on a Coordinate and Height system defined by the user (Figure 6-10).

The button (Figure 6-10) opens the *Transformation XML* dialog window allowing you to get detailed information on the appropriate transformation methods and copy this information into the Clipboard by clicking the *Copy* button.

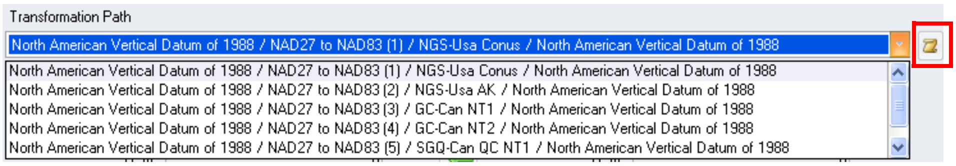


Figure 6-10. Transformation Path drop-down list

Note: If the “No transformation” message displays in this field, there may be two reasons:

1. there is some insufficient data for the coordinate transformation. To resolve this problem, try to input new parameters for the transformation model using Coordinate System Editor.

2. it is impossible to implement transformation between ellipsoidal and orthometric heights. To resolve this problem, try to define the geoid model in the *Preferred Geoid* list.

7. Enter the coordinate values in the corresponding fields (Figure 6-11.

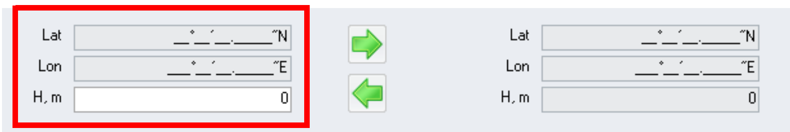


Figure 6-11. Entering the coordinates

8. Click to get the resulting coordinates in the corresponding fields.

6.2. Coordinate System Editor

Coordinate System Editor is intended to view, create, and edit

- coordinate systems
- vertical datums
- coordinate transformations
- geoid models.

6.2.1. Understanding Main Window Elements

To run Coordinate System Editor, select *Tools* on the Ribbon and click 

.

The main window of Coordinate System Editor includes the Ribbon and area divided into three parts: Coordinate Systems, Transformations, and Properties (Figure 6-12).

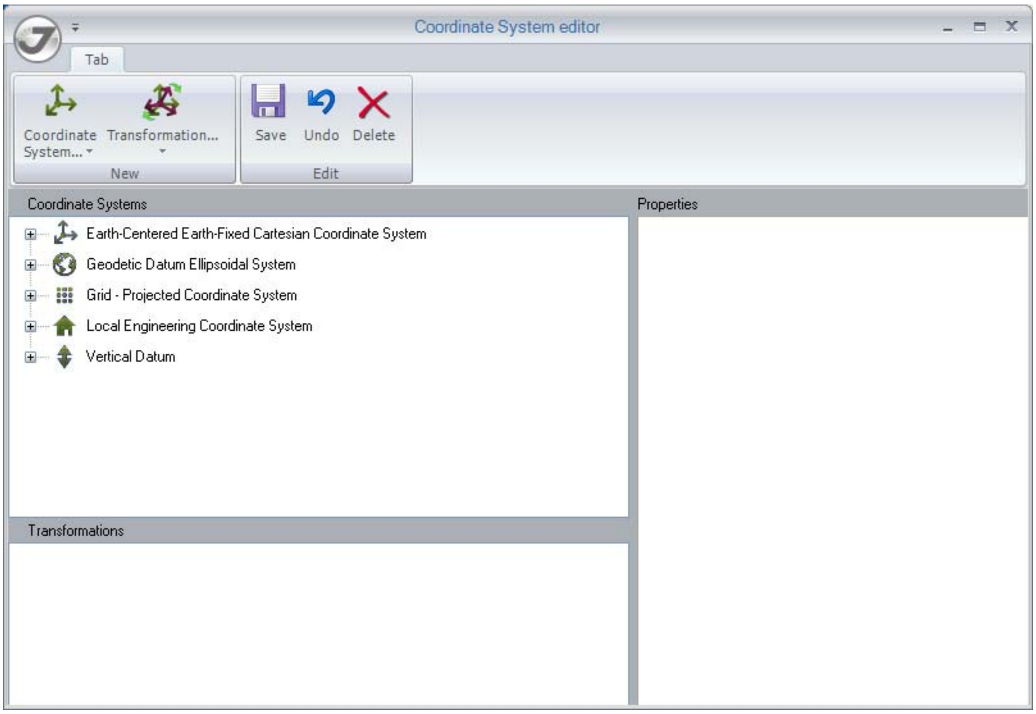


Figure 6-12. Coordinate System Editor main window

Coordinate Systems

Coordinate Systems part represents available coordinate systems, which are organized into five groups:

- Earth-Centered Earth-Fixed Cartesian Coordinate System
- Geodetic Datum Ellipsoidal System
- Grid-Projected Coordinate System
- Local Engineering Coordinate System
- Vertical Datum

Each group reveals the list of available coordinate systems and allows to select on of them. If the coordinate system has been selected, the *Transformations* and *Properties* parts display transformations associated with the coordinate system and its properties.

Transformations

Transformations part shows *Transformations* and *Geoids* groups if any coordinate system selected in the *Coordinate Systems* part. When *Transformations* or *Geoids* indicates a number 1 (or more) next to its title, the group can be opened to display the list of available transformations or geoids. If the transformation or geoid has been selected, the *Properties* parts changes to display the transformation or geoid properties.

Properties

Properties part displays either coordinate system properties or transformation properties, depending on where the currently selected item is located - in *Coordinate Systems* or in *Transformation*.

Each group of the coordinate systems is characterized by its own set of the properties. *Properties* displays:

- Name for the Earth-Centered Earth-Fixed Cartesian Coordinate System
- Name, Related ECEF system, Ellipsoid for the Geodetic Datum Ellipsoidal System
- Name, Geodetic Datum Ellipsoidal System, Projection for the Grid-Projected Coordinate System
- Name for the Local Engineering Coordinate System
- Name for Vertical Datum

6.2.2. Viewing Properties

Viewing Coordinate System Properties

To view coordinate systems properties, do the following steps:

1. In *Coordinate Systems*, click ⊞ next to the desired group, to open the list of available coordinate systems.
2. Scroll the list, to find the desired coordinate sytem.
3. Click the coordinate system. The coordinate system is highlighted and its properties appear in *Properties* (Figure 6-13). In *Transformations*, the information on transformations and the geoid models associated with the coordinate system appears (see the details in “Viewing Transformations and Geoids Properties” on page 59).

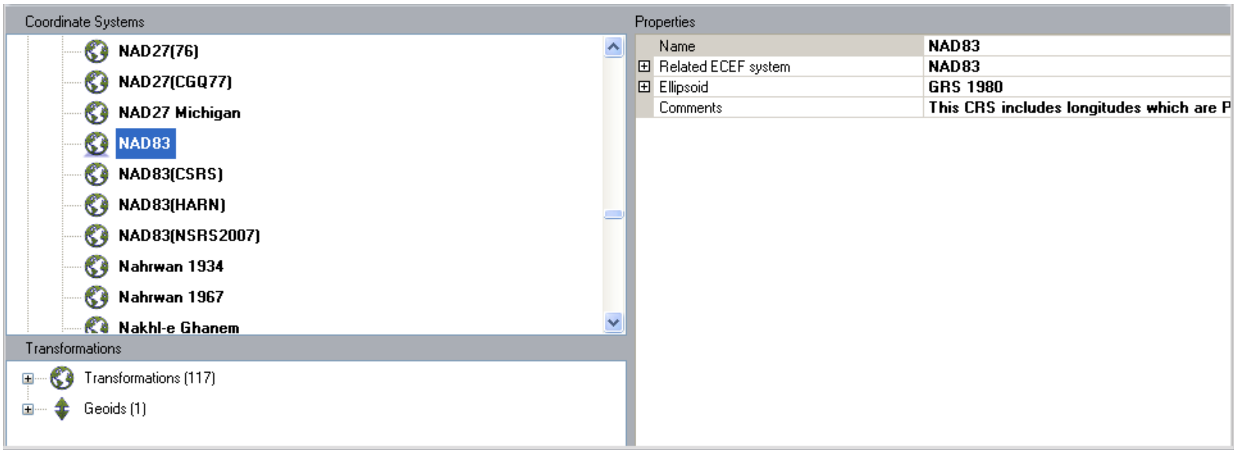


Figure 6-13. Viewing Coordinate System Properties

Viewing Transformations and Geoids Properties

To view transformations and geoids properties, do the following steps:

1. In *Coordinate Systems*, click ⊞ next to the desired group, to open the list of available coordinate systems.
2. Scroll the list, to find the desired coordinate sytem.
3. Click the coordinate system. It enables the *Transformation* part contents:
   - Transformations group
   - Geoids group
   - Projection group (if *Projected Coordinate System* has been selected)
4. In *Transformations*, click ⊞ next to the desired group and select the desired item (Figure 6-14).

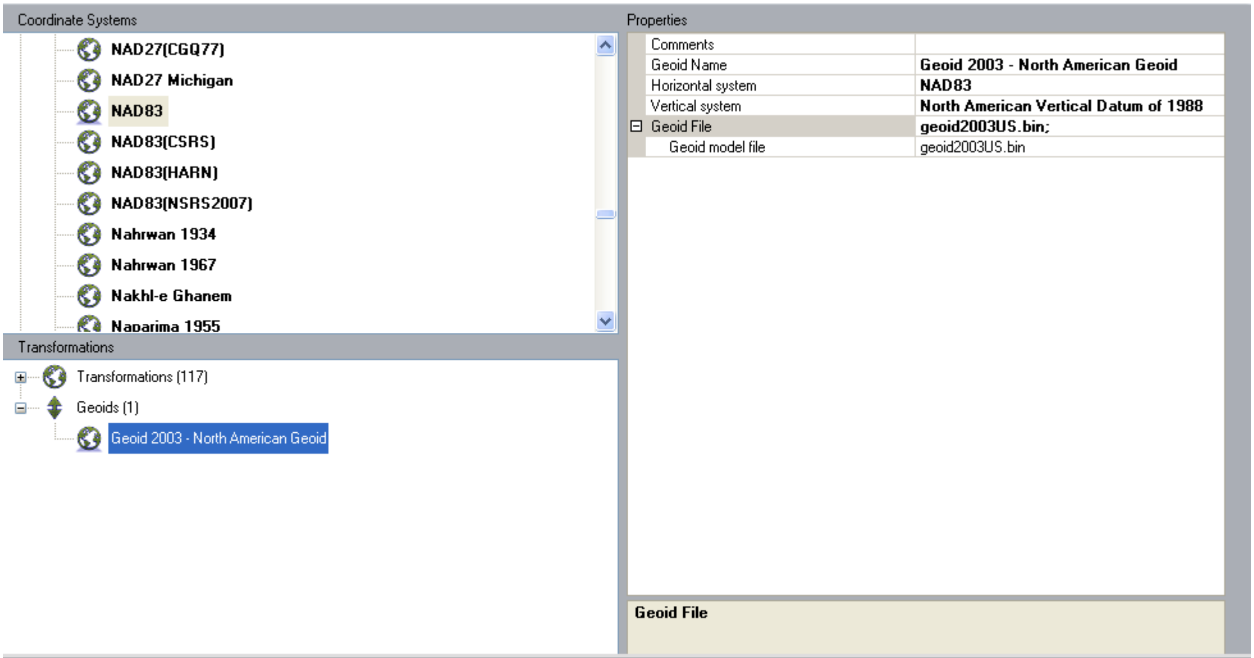


Figure 6-14. Viewing Transformations and Geoids Properties

5. View the item's properties in the *Properties* part.

6.2.3. Creating a New Coordinate System, Transformation Parameters and Geoids

Creating a New Geodetic Datum Ellipsoidal System

To create a new geodetic datum ellipsoidal system, do the following steps:

1. Click 

on the Ribbon, in the pull-down menu, select *Geodetic*. In *Coordinate Systems* the *Geodetic Datum Ellipsoidal System* group opens displaying a new item *New geodetic coordinate system* at the top (Figure 6-15).

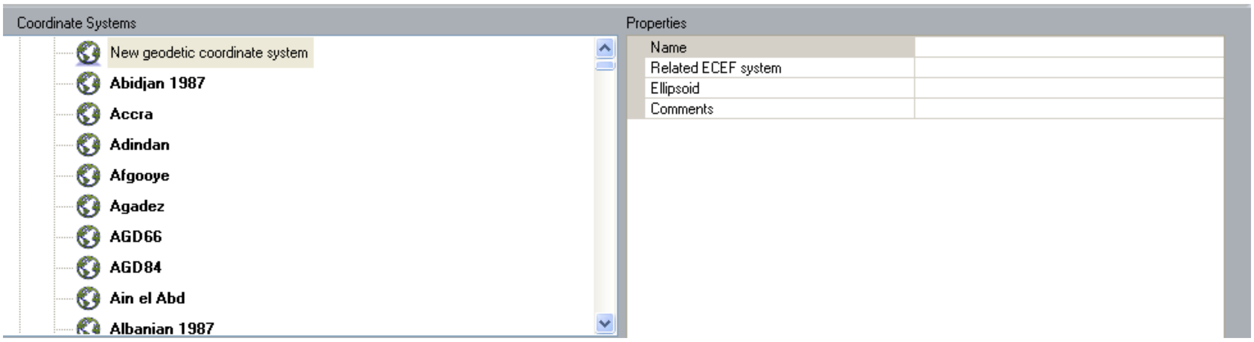


Figure 6-15. New geodetic coordinate system

2. In *Properties*, select and fill the following fields:
   - *Name*. Type in the new coordinate system name.

Note: Pay attention that the new coordinate system name must not be identical with the existing coordinate system name.

   - *Related ECEF System*. Select the one of the available ECEF systems from the pull-down list. Here you can also create a new ECEF system. For this, select *Create new related Ecef CS* from the pull-down list and enter a name in the *Name* field.
   - *Ellipsoid*. Select one of the available ellipsoids from the pull-down list.

3. Click 

the *Save* button on the Ribbon. The new geodetic datum ellipsoidal system appears in the list.

Creating a New Grid - Projected Coordinate System

To create a new grid - projected coordinate system, do the following steps:

1. Click 

on the Ribbon, in the pull-down menu, select *Grid*. In *Coordinate Systems* the *Grid - Projected Coordinate System* group opens displaying a new item *New grid coordinate system* at the top (Figure 6-16).

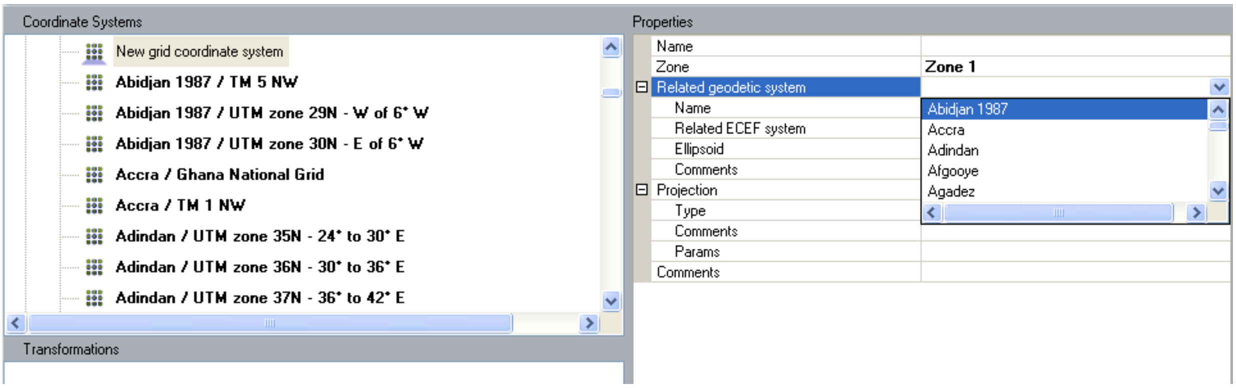


Figure 6-16. New grid coordinate system

2. In *Properties*, select and fill the following fields:
   - *Name*. Type in the new coordinate system name.

Note: Pay attention that the new coordinate system name must not be identical with the existing coordinate system name.

   - *Zone*. Type in the zone name.
   - *Related geodetic system*. Select one of the available systems from the pull-down list (Figure 6-16).
   - *Projection*. Click ⊞ next to *Projection*.
     - Select the *Type* field. Click ⌄, to open the pull-down list of the available projection types. Select the desired projection.
     - Click ⊞ next to the *Params* field. It opens the list of available parameters. Select the desired parameter and edit it.

3. Click 

the *Save* button on the Ribbon. The new grid - projected coordinate system appears in the list.

Creating a New Local - Engineering Coordinate System

To create a new local engineering coordinate system, do the following steps:

1. Click 

on the Ribbon, in the pull-down menu, select *Local*. In *Coordinate Systems* the *Local Engineering Coordinate System* group opens displaying a new item *New local coordinate system* (Figure 6-17).

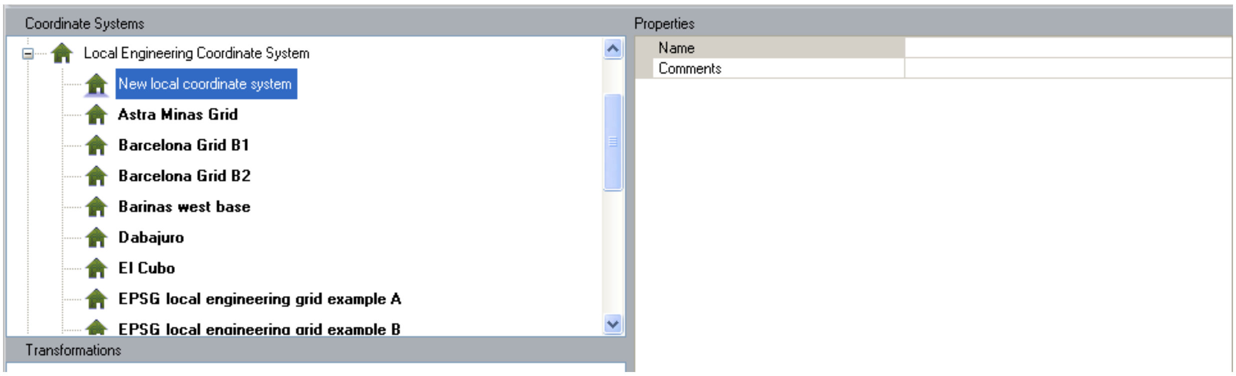


Figure 6-17. New local - engineering coordinate system

2. In *Properties*, select and fill the following fields:

- *Name*. Type in the new coordinate system name.

3. Click 

the *Save* button on the Ribbon. The new local - engineering coordinate system appears in the list.

Creating a New Vertical Coordinate System

To create a new vertical coordinate system, do the following steps:

1. Click 

on the Ribbon, in the pull-down menu, select *Vertical*. In *Coordinate Systems* the *Vertical Datum* group opens displaying a new item *New vertical coordinate system* at the top.
2. In *Properties*, select and fill the following fields:

- *Name*. Type in the new coordinate system name.

3. Click  the *Save* button on the Ribbon. The new vertical coordinate system appears in the list.

Creating Transformation Parameters

Transformation parameters allow transforming positions from one coordinate system to another.

In this version of Giodis, seven parameter transformation can be specified between two ECEF (Earth Centered Earth Fixed) cartesian coordinate systems. One system is considered as source and the other as a target.

To define new seven transformation parameters set, do the following steps:

1. In the *Coordinate Systems* part, select the source coordinate system.
2. Click  on the Ribbon, then select *Transformation*. The *New transformation* item appears in the *Transformation* part. The sample to be filled appears in the *Properties* part (Figure 6-18).

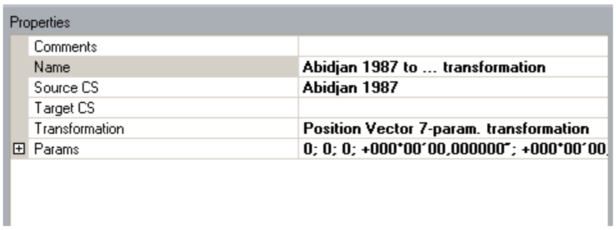


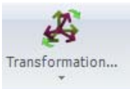
Figure 6-18. The sample in the Properties part

3. In *Properties*, select and fill the following fields:
  - *Name*. The name for the new transformation parameters used to be formed of the names of the two systems they are referred to. By default, the new transformation name contains the source coordinate system name. You can edit the final name as you wish.
  - *Source CS*. Select one of the available systems from the pull-down list.
  - *Target CS*. Select one of the available systems from the pull-down list
  - *Params*. Click  next to *Params*. It opens the list of available parameters. Select the desired parameter and edit it. By default, transformation parameter values are equal to zero. Fill in the fields, taking into account the units of measure.
4. Click  the *Save* button on the Ribbon. The new transformation appears in both *Transformation* groups for the source and target coordinate systems.

Creating a New Geoid Model

Geod heights interrelate ellipsoidal and orthometric heights. Therefore geoid model can be specified for Geodetic Datum Ellipsoidal Coordinate System or Grid - Projected Coordinate System.

To create a new geoid model, do the following steps:

1. In Coordinate Systems, select the desired coordinate system in the *Geodetic Datum Ellipsoidal Coordinate System* or the *Grid - Projected Coordinate System* group.
2. Click 

on the Ribbon, then select *Geoid*.
3. In *Properties*, select and fill the following fields:

- *Name*. The geoid name is generated automatically. You can edit it as you wish.
- *Vertical system*. Select one of the available systems from the pull-down list.
- *Geoid File*. Click next to *Geoid File*. In the *Geoid model file* field click , to open the dialog window that allows you to select the needed geoid file.

4. Click 

the *Save* button on the Ribbon. The new geoid appears in the list of geoids for the selected coordinate system.

APPENDIX 1. GLOSSARY

Terms	Definition
A	
Accuracy	Closeness of measured or computed value to the correct or standard value.
Adjustment (Least Squares)	A method of determining a best-fit solution by minimizing the sum of the squares of the measurement residuals.
Adjustment, minimally constrained	The type of network adjustment where only one point is held fixed. The minimally constrained adjustment is used to detect blunders and obtain realistic observation error estimates.
Adjustment, fully constrained	The adjustment performed to best fit the survey observations to the local control. For the fully constrained adjustment, the horizontal and/or vertical coordinates of all control stations are held fixed to their published values.
Algorithm	A special method or instruction for solving a certain type of mathematical problem.
Almanac	A set of parameters broadcast by a GNSS satellite to predict the approximate satellite positions and the clock offset. Each satellite contains and transmits the almanac data for all the satellites of a system (GPS or GLONASS).
Ambiguity	The unknown number of integer cycles contained in an unbroken set of phase observations of a satellite. It must be computed (resolved) when the carrier-phase data are processed.
Antenna Height	The height of a GPS antenna phase center above the surveyed point.
Antenna Phase Center	The electronic center of an antenna at which the radio signal is measured. The location of the phase center is defined by its offset from a specified physical point on the antenna called Antenna Reference Point (ARP). The phase center of a typical antenna can change by as much as many centimeters as the position of the satellites change. The "phase center stability" is the main characteristics of an antenna for precision applications.
Anti Spoofing	Encryption of the P-code signal by changing its characteristics resulting in the Y-code which is not available to civilian users.
Atmosphere	The 500 km thick layer of air that surrounds the Earth.
Attribute	A characteristic of a mapped feature (point, line, or area) in a Geographic Information System (GIS).
Autonomous position	The absolute position estimated using data from a single GNSS receiver without using any differential correction.
Azimuth	The horizontal angle, from 0° to 360°, measured clockwise from the North.
Azimuth, grid	The azimuth measured from grid North.

B	
Base Station	A GNSS receiver that is set up on a known location to collect data for differentially correcting rover files. See also ***Differential GPS (DGPS)***.
Baseline	The measured vector between a pair of stations which simultaneously collect GNSS data.
Benchmark	A survey mark that is used for elevation reference.
Bias	Constant or variable systematic deviation of a measurement from true value.
Blunder	A serious mistake typically caused by ignorance, carelessness, or confusion.
C	
C/A-Code	The standard (coarse acquisition or clear acquisition) code modulated onto the GPS L1 signal. Also known as the "civilian code" or S-code. The C/A-Code allows a receiver to quickly lock on to a satellite.
Calibration	Process of determining systematic errors in an instrument by comparing its measurements with a standard.
Carrier frequency	The basic frequency of an unmodulated radio signal. In GNSS, satellite signals are broadcast on two L-band frequencies, L1 and L2.
Carrier phase	The cumulative phase of either the L1 or L2 carrier of a satellite signal, measured by a receiver since locking onto the signal.
Catalog	Catalog (geodetic): A database that contains positions and other geodetic data for control and surveyed points.
Central meridian	A line of constant longitude that passes through the center of a zone. The central meridian is defined by the angle it forms east or west of the Greenwich meridian. In a map projection, it is used as one of constants defining the projection.
Channel	In a receiver, a hardware to receive the signal from a single GNSS satellite.
Chi square test	(Also referred to as global or VPV test). The global statistical test of the network adjustment. It is used to reject or to accept the hypothesis that the variances for the adjusted observation are close to expected.
Clock bias	The difference between the satellite or receiver clock's indicated time and a time scale reference such as UTC (Coordinated Universal Time), TAI (International Atomic Time) or GPS Time.
Clock correction	The quantity added to the time shown by a clock to obtain the correct time.
Clock rate	The rate of change of a clock correction.
Constraint	A restriction to the behavior of a variable. In network adjustment, the coordinates of control points are constrained or fixed to their known values.
Contour	A line on a map joining points of equal elevation.
Control	1) Points which are used as reference for other surveys. 2) The reference coordinates of control points (horizontal or vertical).
Control segment	Ground-based component of a GNSS system that controls the satellites for proper function.
Coordinate System	A reference frame used to define the location of points in three or two dimensional space.

Coordinate system, geocentric	Any coordinate system with origin at the center of the Earth. See also ***ECEF (Earth Centered, Earth Fixed)***.
Coordinate system, grid	A plane rectangular coordinate system based on a map projection.
Coordinate system, height	A system, or datum, adopted as the fixed vertical reference.
Coordinates	Angular and/or linear quantities used to specify the position of an object in a given reference system.
Coordinates, geodetic	A set of coordinates (latitude, longitude, and height) referred to a reference ellipsoid: Geodetic latitude: an angle between the equatorial plane of the ellipsoid, and the line normal to the ellipsoid. Geodetic longitude: an angle between the plane of local geodetic meridian, and the plane of the initial (prime) geodetic meridian. Geodetic height: see Ellipsoid height.
Coordinates, grid	Coordinates in a plane rectangular coordinate system based on a map projection. Grid coordinates are normally referred to as Easting and Northing.
Correlation	Standardized covariance between two variables varying from -1 (negative correlation) through 0 (no correlation) to +1 (positive correlation).
CORS	Continuously Operating Reference Stations. GPS base stations on the U.S. territory that provide carrier phase and code range measurements for real-time and post-processing applications.
Covariance	A measure of the stochastic dependence between two observed or derived quantities. Covariance also refers to an off-diagonal term in a covariance matrix.
Covariance matrix	(Also referred to as variance- covariance matrix). A measure of the correlation of errors between observations or derived quantities. The elements along the main diagonal of covariance matrix are the variances of the corresponding variables; those off the main diagonal are the covariances.
Cycle slip	A discontinuity in carrier-phase observations, usually of an integer number of cycles, resulting from temporary loss of lock in the receiver's carrier tracking loops.
D	
Datum	A set of parameters defining the coordinate system used for horizontal or vertical control.
Deflection of the vertical	The angle between the vertical (plumb line) at a point and the line normal to the reference ellipsoid.
Degrees of freedom	Number of observations minus the number of estimated parameters.
Differential GPS (DGPS)	A technique of correcting GPS-positions recorded at an unknown location using additional data collected simultaneously by a reference receiver at a known position (GPS Base Station).

Dilution of precision (DOP)	A dimensionless number that represents the contribution of the satellite configuration geometry to the positioning and time accuracy. A low DOP value indicates a higher probability of accuracy. Standard GNSS applications are: PDOP - position (three coordinates) HDOP - horizontal (two coordinates) VDOP -vertical (height only) TDOP - time (for clock offset only) GDOP - geometric (three coordinates and clock offset).
Double Difference	The difference between two single differences for two simultaneously observed satellites.
E	
Earth tide	The periodic sub-meter motion of the solid earth due to the attraction of the Moon, the Sun and loading of the adjacent seabed by ocean tides.
Easting	The distance of a point east of the reference meridian for a grid system.
Easting, false	A constant value added to all Eastings so that only positive values of Easting are recorded.
Eccentricity	A Keplerian element describing the geometric shape of a satellite orbit. The eccentricity is a measure of the departure from a circle.
ECEF (Earth Centered, Earth Fixed)	A geocentric coordinate system where the X-axis is coincident with the zero meridian, the Z-axis is coincident with the earth's mean rotation axis, and the Y axis lies on the equatorial plane thus completing a right-handed coordinate system.
EGNOS	European Geostationary Navigation Overlay Service. A European system of satellite navigation that provides satellite navigation correction and validation throughout Europe. It consists of three geostationary satellites and a network of ground stations. EGNOS will augment the two satellite navigation systems now operating, GPS and GLONASS.
Elevation	The distance from a point to a reference surface (most often the geoid) measured along a plumb line.
Elevation angle	The angle above the horizon, measured from the horizontal plane.
Elevation mask	(Also referred to as mask angle, and cut-off angle) The elevation angle below which satellite signals are no longer tracked or processed.
Ellipsoid	In geodesy, a mathematical model of the earth formed by rotating an ellipse around its minor axis. The ellipsoid is described by dimensions for the semi-major axis (a) together with the semi-minor axis (b) or by the semi-major axis and flattening $f = (a - b)/a$.
Ellipsoid height	The distance from a point to the reference ellipsoid measured along a line normal to the ellipsoid.
Ellipsoid, reference	An ellipsoid associated with a specified geodetic datum or reference system.
Ephemeris	A set of parameters that describes the position of a celestial object as a function of time.
Ephemeris, broadcast	The ephemeris transmitted in the Navigation Message of a GNSS satellite. The broadcast ephemeris is used to calculate the positions of a GNSS satellite and its clock behavior.
Ephemeris, precise	Post-processed positions of a GNSS satellite. Precise ephemeris is computed by various global agencies from data collected at worldly distributed reference stations.

Epoch	1. A specific instant in time for which GNSS observation data are given. 2. The date, usually expressed in decimal years, for which published coordinates are valid.
Epoch interval	(Also referred to as measurement interval, epoch rate).Time interval between two consecutive observation epochs.
Error	The difference between a measured or computed value of a quantity and its standard or true value.
Error ellipse	A graphical representation of the magnitude and direction of the positional error. Error ellipse is centered at the estimated position and shows the region where the least squares estimate falls with 39.4%. (one sigma), 95% (two sigma) or other confidence.
F	
Fast static	(Also referred to as rapid-static or quick-static). A method of GPS surveying similar to static GPS, but with a shorter observation period (from 5 to 30 minutes) and usually with a faster epoch interval (5 seconds or less). To achieve a centimeter level of accuracy (10 mm + 1 ppm), Fast static technique is used on baselines up to 20 kilometers in length.
Feature	A representation of a real-world object in a layer on a map as a distinct set of characteristic.
Firmware	A software embedded into hardware of a GNSS receiver that controls its operation.
Fixed solution	A vector solution where the integer ambiguities have been correctly resolved and held fixed.
Float solution	A vector solution where the ambiguities could not be fixed to their integer values so they were left to float as a real numbers.
Frequency	The number of oscillations per second existing in any form of periodic motion.
G	
Galileo	The European Union's satellite navigation system. Galileo is expected to be completed after 2012 and be interoperable with the GPS and GLONASS systems. The system will use 30 satellites (27 operational + 3 spares) in three uniformly spaced circular orbits at a height of 23,000 kilometers, with inclination of 56 degrees.
Geodesy	Science of measuring the size and shape of the earth and its gravitational field.
GIS	Geographic Information System. A computer-based system for the input, storage, retrieval, analysis, and display of geographically referenced data.
Geoid	The equipotential surface which is everywhere normal to the direction of gravity and best fits, in a least squares sense, with mean sea level in the oceans. The geoid is main reference surface for elevations.
Geoid model	A mathematical representation of the geoid for a specific area (regional geoid model), or for the whole earth (global geoid model).
Geoid height	The height of geoid above a reference ellipsoid. Also referred to as the geoid separation or geoid undulation. Geoid height is equal to the difference between ellipsoidal and orthometric height (i.e., elevation).
Global Navigation Satellite System (GLONASS)	Russian **Glo**bal **Na**vigation **S**atellite **S**ystem designed to use 24 satellites in three uniformly spaced circular orbits at height 19,140 kilometers, at an inclination of 64.8 degrees.

GLONASS System Time	The time scale (UTC (SU)) to which GLONASS signals are referenced.
Global Positioning System (GPS)	The US fully functional Global Positioning System. As of September 2007, there are 31 actively broadcasting satellites orbiting at height 20,200 kilometers in six planes at an inclination 55 degrees.
GNSS	Global Navigation Satellite Systems. GNSS is a common term for GPS and GLONASS. Another GNSS planned for the future is European Union's Galileo, China's Compass, Japan's QZSS, etc.
GPS System Time	An atomic time system to which GPS signals are referenced. GPS time is directly relatable to UTC. UTC-GPS = 14 seconds (in April 2007).
GPS week	The number of weeks since Saturday/Sunday midnight, January 6, 1980. The week number sequentially increments at Saturday/Sunday midnight in GPS system Time.
Greenwich Mean Time (GMT)	See also ***UTC***.
Grid north	The direction of the vertical grid lines of a map projection.
H	
HTDP	Horizontal time-dependent positioning software that allows to predict horizontal displacements at locations throughout the United States.
Histogram	A histogram is a graphical display of the size and distribution of residuals in a network adjustment.
I	
Inclination	The angle between the orbital plane and the celestial equator.
Independent baselines	(Also referred to as non-trivial baselines). A set of baselines where no individual baseline is a linear combination of others. For any given session there are n-1 independent baselines where n is the number of receivers operating.
Integrity	The ability of a system to provide timely warnings to users when the system should not be used for navigation as a result of errors or failures in the system.
Interface Control Document (ICD)	A government document that contains the full technical description of the interface between the components of a GNSS system.
IGS	International GPS Service for Geodynamics. A voluntary federation of many worldwide agencies working cooperatively to operate a permanent global GPS tracking network and generate precise GNSS products: post-mission GPS satellite ephemeris, tracking station coordinates, earth orientation parameters, satellite clock corrections, tropospheric and ionospheric models.
Ionosphere	The layer of the atmosphere approximately 80 to 640 kilometers above the earth's surface that contains electrically charged particles (ions). The ionosphere causes a delay in the propagation of a GNSS signals.
Ionospheric delay	The variable delay in propagation of a GNSS signal introduced by the ionosphere. The ionospheric delays can be either predicted using models, or estimated using the sophisticated algorithms of GNSS data processing, or measured using two frequency receivers.

ITRF	International Terrestrial Reference Frame. A set of more than 350 globally distributed points with their ECEF coordinates which realize the global International Terrestrial Reference System (ITRS). New ITRF solutions for coordinates and velocities of the points (e.g. ITRF-2005) are produced every few years.
ITRS	International Terrestrial Reference System. The most precise, geocentric, globally-defined coordinate system. The various "frames" (such as ITRF2005, etc.) are the realizations of the ITRS for a particular epoch in time.
J	
Job file	A file that contains survey data gathered with the data collection software embedded in a field controller.
K	
Keplerian Elements	A set of six parameters that define elliptical (Keplerian) orbit. These are: the semimajor axis and eccentricity of the orbital ellipse, the inclination of the orbital plane to the equatorial plane, the right ascension (or longitude) of the ascending node of the orbit, the argument of perigee, and the time the satellite passes through the perigee.
Kinematic GPS	A method of GPS surveying in which at least one receiver is set up over a known (base) point and remains stationary, while another (rover) receiver is moved from point to point. The base receiver and rovers are initialized as in stop and go. Lock on the satellites must be maintained at all times or a new initialization must be performed. Data sampling shall have an epoch interval of 2 seconds or less. Typical achieved accuracy is few centimeters. Kinematic GPS surveys can be either Continuous or Stop-and-Go. See also ***Stop-and-Go***.
L	
L1 & L2	The designations of the two basic carrier frequencies transmitted by GPS satellites that contain the navigation signals. L1 is 1,575.42 Mhz and L2 is 1,227.60 Mhz.
Layer	A thematic set of spatial data described and stored in a database. Each layer has its own set of parameters defining the graphical representation on a map document for each object from the given collection. So modifying the style parameters (e.g.visibility) user can modify such parameters for all objects of the layer.
L-band	The radio frequency range extending from 390 MHz to 1550 MHz.
Length of Session	The maximum time interval at which data is collected simultaneously from all the receivers in a session.
Local grid system	A local plane coordinate system usually arbitrary defined for use on a small survey area.
Localization	(Also, referred to as site calibration). The process of determining transformation parameters between GPS-surveyed coordinates and the coordinates of known points given in a local coordinate system.
M	
Map projection	A set of functions relating latitudes and longitudes at ellipsoid into map grid coordinates.
Map scale	The relationship between a distance on a map and the corresponding distance on the ground.
Meridian, geodetic	The curve in which a plane through the minor axis of a reference ellipsoid intersects the ellipsoid. All points at this curve have the same geodetic longitude.

Multipath	Interference caused by GPS signals reflected from nearby objects or other reflective surfaces.
N	
NAD 27	North America datum of 1927. Horizontal coordinate system used throughout the U.S. until 1986. Based on Clarke ellipsoid of 1866.
NAD 83	North America datum of 1983. Three dimensional coordinate system for U.S., Canada and Mexico. Originally published in 1986. Based on the GRS 80 ellipsoid.
NAVD 88	North American Vertical Datum of 1988. Vertical (elevation) reference system for U.S., Canada and Mexico. The NAVD 88 replaced the National Geodetic Vertical Datum of 1929 (NGVD 29).
Navigation message	The data message broadcast by each GPS satellite at 50 bits per second. This message contains ephemeris and clock data for that particular satellite, and almanac for all GPS satellites.
NAVSTAR	NAVigation Satellite for Timing And Ranging. The official name for the GPS satellites.
NGVD 29	National Geodetic Vertical Datum of 1929. Vertical (elevation) reference system for U.S. prior to NAVD 88.
NMEA 0183	National Marine Electronics Association interface standard for interfacing marine electronic devices, GPS receivers and other types of equipment.
Node, ascending	The point in an orbit at which a satellite crosses the equatorial plane from south to north.
Noise	Random, unpredictable interfering signals that mask the desired information content.
Normal	In geodesy, a normal is the straight line perpendicular to the surface of the ellipsoid.
Northing	The distance of a point northwards from the east-west line that passes through the origin of a map grid system.
Northing, false	A constant value added to all Northings so that only positive values of Northing are recorded.
O	
Obstruction	An object that completely or partly blocks an antenna from the incoming satellite signal.
Occupation	The period of recorded data for a point or trajectory.
Offset	The distance from a surveyed point (or line) measured to the point (or line) for which data are desired.
Orbit	The path followed by the center of mass of a satellite around the Earth.
Origin	The point where the axes of a coordinate system intersect.
Orthometric height	The distance from the geoid to a point, measured along the direction of gravity. See also ***Elevation***.
Outlier	Poor quality observation.
P	
P-code	The Precise or Protected code of the GPS signal. A 267 days long sequence of pseudo-random binary biphase modulations on the GPS carrier at a chip rate of 10.23 MHz. Each satellite has a unique one-week segment of P-code that is reset at Saturday/Sunday midnight.

PDOP Mask	The highest PDOP value at which a GPS data is collected.
Perigee	The point in an orbit at which the satellite is closest to the Earth's center of mass.
Phase center	The electronic center of an antenna at which the radio signal is measured.
Point Positioning	(Also, Absolute Positioning). GNSS positioning with use of a single receiver in a standalone mode.
PPM	Parts per million.
Post-processing	The differential processing GNSS data after it has been collected in the field and stored on a computer.
Precise Positioning Service (PPS)	The most accurate single-receiver GPS positioning based on the dual frequency P-code.
Precision	A degree of agreement of an estimate with its mean value in repeated sampling. Precision estimates reflect random error and are not affected by bias.
Prime meridian	The reference line for measurements of longitude. The meridian passing through Greenwich, England, is almost universally accepted as the prime meridian.
Pseudorange	The range between the GPS receiver antenna and the GPS satellite, measured by the receiver using either the C/A- or P-code.
PZ-90	A global ECEF coordinate system established as the reference frame for GLONASS. GLONASS broadcast Ephemeris is given in PZ-90.
Q	
R	
Random Errors	The unpredictable, typically small, deviations of a random variable from its expected value. It is not possible to correct for random error.
Raw data	GNSS observation data which has not been processed or differentially corrected.
Real Time Kinematic (RTK)	The GPS relative positioning technique whereby carrier-phase data (or corrections) are transmitted in real time from a reference receiver (base station) to a rover receiver enabling the rover to compute it's position and check the quality of measurements in real time.
Refraction	The bending of sonic or electromagnetic rays by the medium through which the rays pass. The amount and direction of bending are determined by the refractive index of the medium.
Relative positioning	The determination of relative positions of GNSS receivers simultaneously tracking the same satellites.
Residual	Difference between the observed and the computed quantity.
RINEX	The Receiver-INdependent EXchange format. A standard GNSS raw data file format used to exchange files from multiple receiver manufacturers.
RMS	Root Mean Square. The square root of the arithmetic mean of the squared errors. In one dimension RMS is equivalent to Standard deviation.
Rover	A mobile GPS receiver and data logger collecting data in the field. The rover position is computed relative to another, stationary (base) GPS receiver.

RTCM SC-104 format	A standard format developed by Radio Technical Commission for Maritime Services (RTCM) Special Committee 104, that is used in the transmission of DGPS differential corrections.
S	
Selective availability	Intentional degradation of the GPS signal available for civilian use by the U.S. military, accomplished by artificially creating a significant clock and/or broadcast ephemeris error in the satellites.
Semi-minor axis	One half the minor axis of an ellipsoid.
Semi- major axis	One half the major axis of an ellipsoid.
Session	A time interval covering all observations of all receivers which should be processed together in one run.
Sigma	A mathematical symbol or term for standard error.
SINEX	Solution (Software/technique) INdependent EXchange Format developed by the IGS for station position and velocity solutions obtained from GPS and other space geodesy techniques. It may contain information about stations, sources, estimates of the parameters, their covariance matrix, constraint equation, right-hand side of constraint equations and weight matrix of constraint equations.
Single difference	The difference between raw (one-way) carrier phases simultaneously measured by two receivers tracking the same satellite.
Slant height	The distance measured from the survey marker to the lower outside edge of the antenna ground plane.
SPCS	A U.S. State Plane Coordinate System. Two sets of zones, one for NAD27 datum (SPC27) and another for NAD83 datum (SPC83).
Standard deviation	A measure of how close the random values are from the arithmetic mean.
Standard Error of Unit Weight	A measure of how close the residuals from all observations in the network adjustment are to the pre-adjustment estimated errors of the observations. It is the square root of the sum of the weighted squares of the residuals divided by the degree of freedom. If the standard error of unit weight is around 1.0, the errors in a network have been weighted correctly.
State Plane Coordinates	Grid coordinates in SPC27 or SPC83 systems based on Transverse Mercator and Lambert Conformal map projections.
Static survey	A method of GPS surveying using long occupations (hours in some cases) to collect GPS raw data at static points. The data from two or more receivers is then post processed to achieve sub-centimeter accuracy.
Stop-and-Go	A type of GPS Kinematic technique by which the rover data is collected for a few minutes at stationary points. Lock on the satellites must be maintained during the survey or a new initialization must be performed.
Subnet	A result of session processing. It includes (absolute or relative) positions of a set of points and variance-covariance matrix determined in one session processing run. A baseline is the simplest type of a subnet.
Systematic errors	The errors that are not random and follow certain physical or mathematical rules. They often occur with the same sign and magnitude in a number of related observations.

SV	Satellite vehicle or space vehicle.
T	
Tau test	A statistical technique for blunder detection.
Tectonics	Large-scale motion of Earth's surface plates.
Trajectory	The path followed by an object moving through space.
Transformation parameters	A set of parameters that transform one coordinate system to another. Transformation parameters may be user defined or estimated either in the constrained network adjustment or localization process.
Tribrach	A platform on three short legs each having leveling screws. Tribrach is used for leveling and centering a surveying instrument.
Tripod	A three-legged adjustable stand used to set an instrument and eliminate or reduce its movement during survey.
Triple difference	The arithmetic difference of sequential, doubly differenced carrier-phase observations.
Trivial baseline	The baseline that is mathematically correlated with other baselines derived from the same observing session, because the data used for this baseline has already been used to process the independent baselines.
Troposphere	The lower level of the atmosphere extending from the Earth's surface to a height varying from about 9 km at the poles to about 17 km at the equator.
Tropospheric Delay	The propagation delay of a GNSS signal introduced by the electrically neutral atmosphere. The tropospheric delay consists of wet and dry components, with the wet component be responsible for approximately 10 percent of the total delay.
U	
UTC	Universal Time Coordinated (synonymous with GMT or Greenwich Mean Time). Uniform atomic time system maintained by time laboratories around the world, including the U.S. Naval Observatory.
UTM	The Universal Transverse Mercator. A grid coordinate system based on WGS-84 ellipsoid and a special case of the Transverse Mercator projection. UTM consists of 60 north-south zones, each 6 degrees wide in longitude.
V	
Variance	The square of the standard deviation.
Vector	In GPS surveying, a 3D vector is the product of processing in relative positioning mode. GPS vector connects two points simultaneously tracking the same satellites.
W	
Weight	A factor assigned to a quantity in order to change its effect on the results of the adjustment.
WGS 84	World Geodetic System 1984. A global ECEF coordinate system maintained by the U.S. Department of Defense and used as the reference for the Global Positioning System. The GPS broadcast Ephemeris is given in WGS-84.
X	
Y	
Y code	The encrypted P-code.

Z	
Zenith	The point on the celestial sphere that is vertically above the observer's position.
Zenith delay	A tropospheric delay of a GPS signal observed from a satellite directly overhead.
Zenith distance	The angular distance from the observer's zenith to the object observed.
Zone	The geographic region over which the grid coordinates relate with respect to a single origin.

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