CHC® Geomatics Office 2.0

User Guide

Revision 1.0

July 19, 2018

Make your work more efficient

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Preface

Introduction

This user guide has been created to assist users to install, configure and use CHC® Geomatics Office Software v2.0 (CGO 2.0) in detail. The expression strives to be concise and easy to understand so that beginners can easily and quickly learn how to use each function.

Experience Requirements

To make better use of CGO 2.0, we recommend that you read this user guide carefully in advance. If you are not familiar with the workflow of CGO 2.0, please don't hesitate to contact us for relevant technical consulting and training.

Technology and Service

CGO 2.0 builds **[Feedback]** module, if you have any questions or suggestions, please send a message to support@chcnav.com (8:30 am - 5:30 pm UTC+8). We will reply to you within 24 h.

Installation and Licensing

Operating System Requirements

(1) **Recommend Operating Environment**

- **CPU**: Intel® Core™ i5
- **RAM**: 8 GB
- **Free Disk Space**: At least 10 GB
- **Operating System**: Microsoft® Windows 7 and above, with NET Framework 4.0

(2) **Minimum Operating Environment**

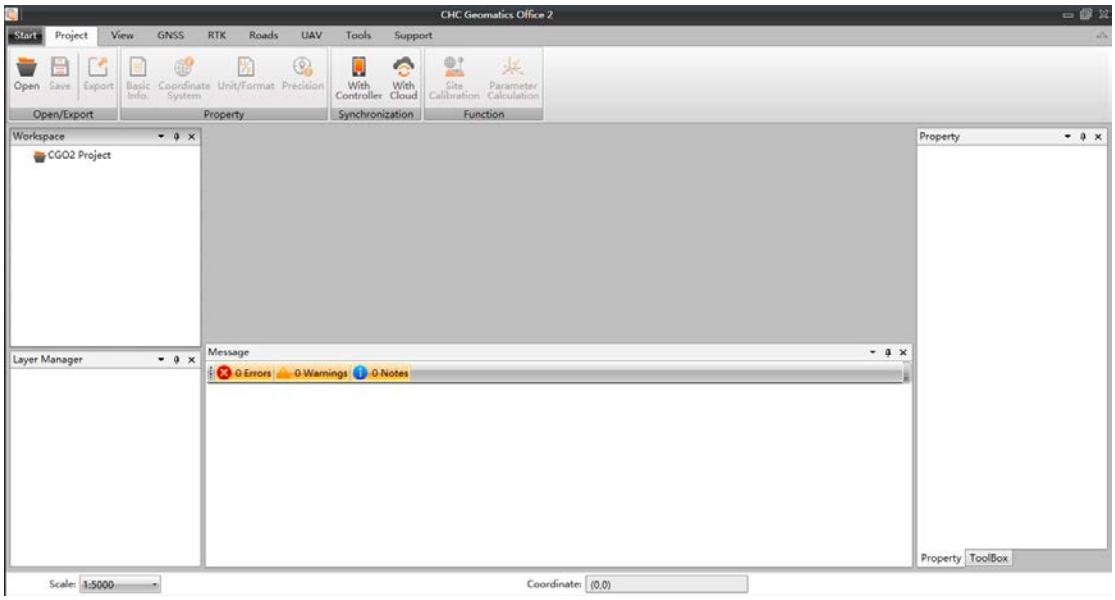
- **CPU**: Intel® Core™ i3
- **RAM**: 4 GB
- **Free Disk Space**: At least 10 GB
- **Operating System**: Microsoft® Windows 7 and above, with NET Framework 4.0

Installation and Registration

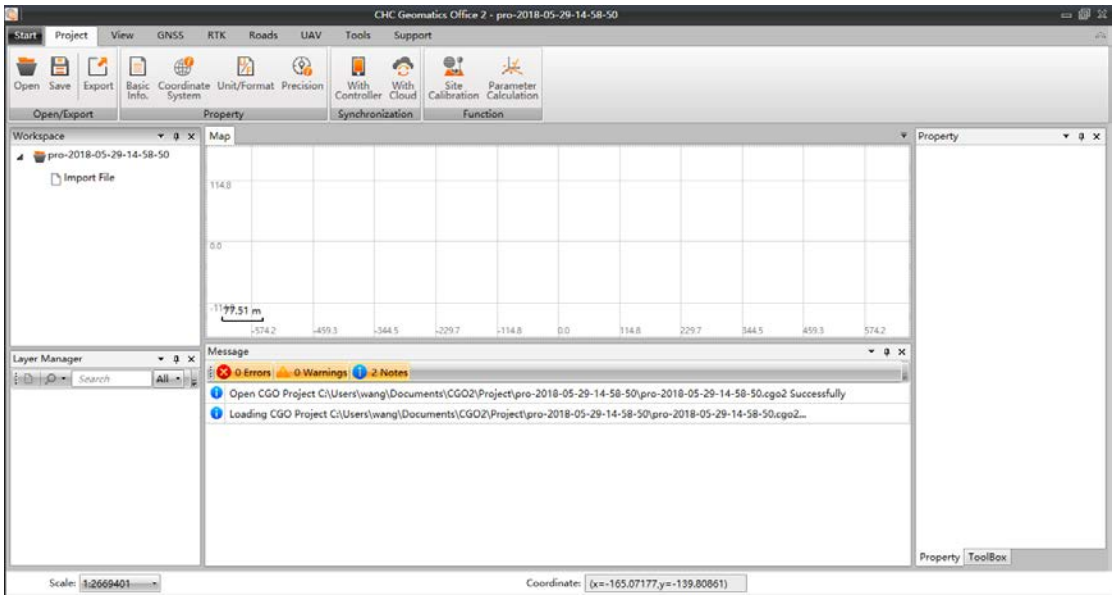
After copying the installation package to the device, you should click on the .exe file and follow the installation prompt step by step. If the installation is complete, an icon  will be generated in the desktop and you can start CGO 2.0 by double-click on it.

Get Started with CGO 2.0

Click **[Start]** → **[CHCNAV]** → **[CHC Geomatics Office 2.0]**, or double-click the desktop icon  to run CHC Geomatics Office 2.exe.



After creating or opening a project, the following interface appears, including the title bar, menu bar, workspace, layer manager, map, property, toolbox, message window and status bar.



[Title Bar]: Show software name.

[Menu Bar]: Include Start, Project, View, GNSS, RTK, Roads, UAV, Tools and Support modules.

[Workspace]: Show the name of the current project file, the imported points, lines, polygons and other imported files.

[Layer Manager]: Show import data layers and related layer operations.

[Map]: Show current project data and offline/online maps.

[Property]: Show properties of selected features.

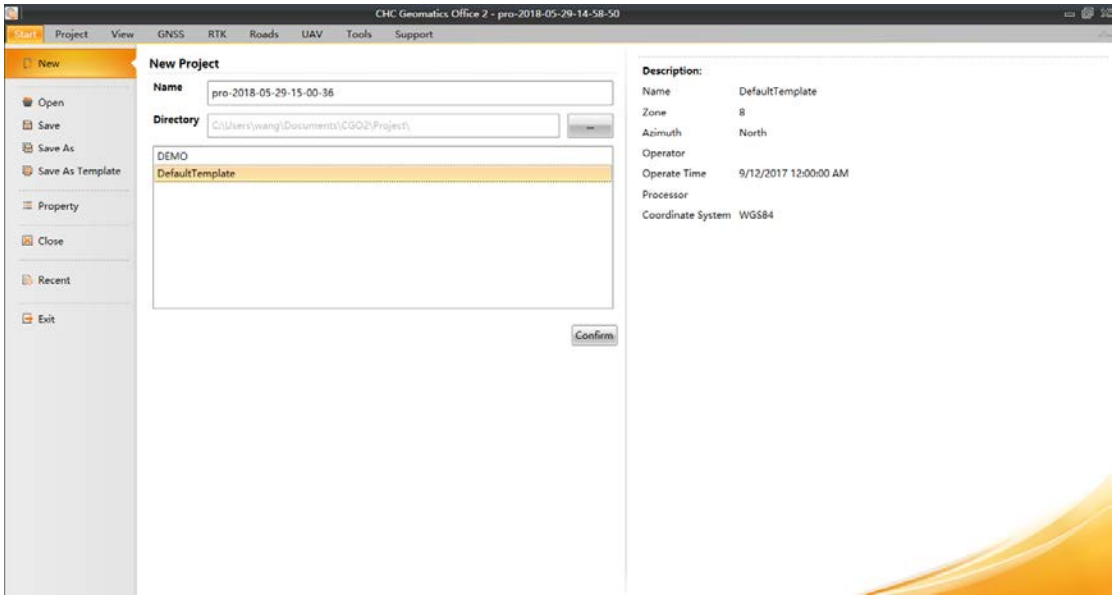
[Message]: Prompt errors, warnings and notes messages.

[Toolbox]: CGO tools.

1 Start

1.1 New

Click **[Start]** → **[New]**, then [**New Project]** dialog will pop up, details as shown below:



[Name]: The system default name is the local time, users can modify it as need.

[Directory]: The system default directory is "C:\Users\...\Documents\CGO2\Project\", users can modify it by clicking ... .

[Template]: The default template applies WGS 84 coordinate system, users can choose when there are several templates.

Click [**Confirm]** to create a new project.

Note: Users can change coordinate system parameters after opening the project and click **[Start]** → **[Save as Template]** to save. Then, users can choose it when create a new project.

1.2 Open

Click **[Open]**, users will see a pop-up file manager and can select an existing project file to open. Users can also double click a project in local disk or drag it in CGO 2.0 to

open it.

1.3 Save

Click **[Start]** → **[Save]**, users can save current project data in the same directory as the one you chose when you created a new project.

1.4 Save as

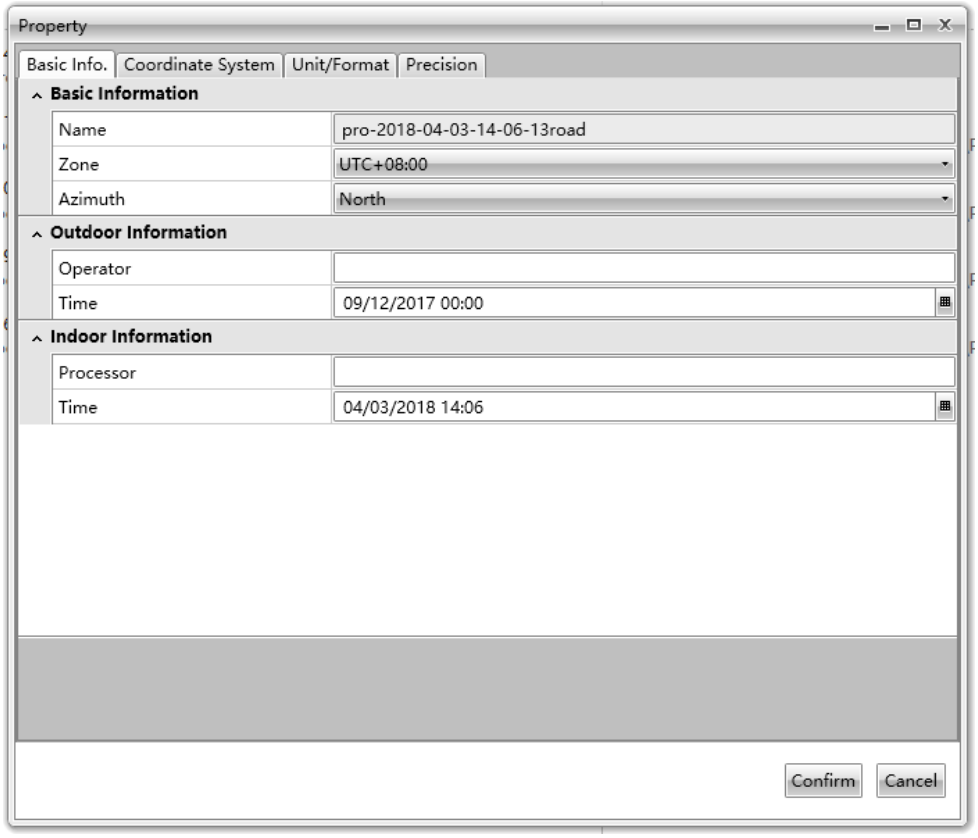
Click **[Start]** → **[Save as]**, users can choose another directory to save current project data.

1.5 Save as Template

Click **[Start]** → **[Save as Template]**, users can save current project property (includes basic information, coordinate system, unit, format and precision) as a template (.CGT).

1.6 Property

After opening or creating a new project successfully, users can click **[Start]** → **[Property]** to check and modify property information of current project, including basic information, coordinate system, unit/format and precision.



1.7 Close

Click **[Start]** → **[Close]**, users will see a pop-up dialog reads “The current project has been modified. Do you want to save it?”. Users can choose **[OK]** to save and close current project, or choose **[Cancel]** to close current project directly.

1.8 Recent

Click **[Start]** → **[Recent]**, users will view ten recent projects which are corresponding to the save directories. Users can open an existing project by double clicking it.

1.9 Exit

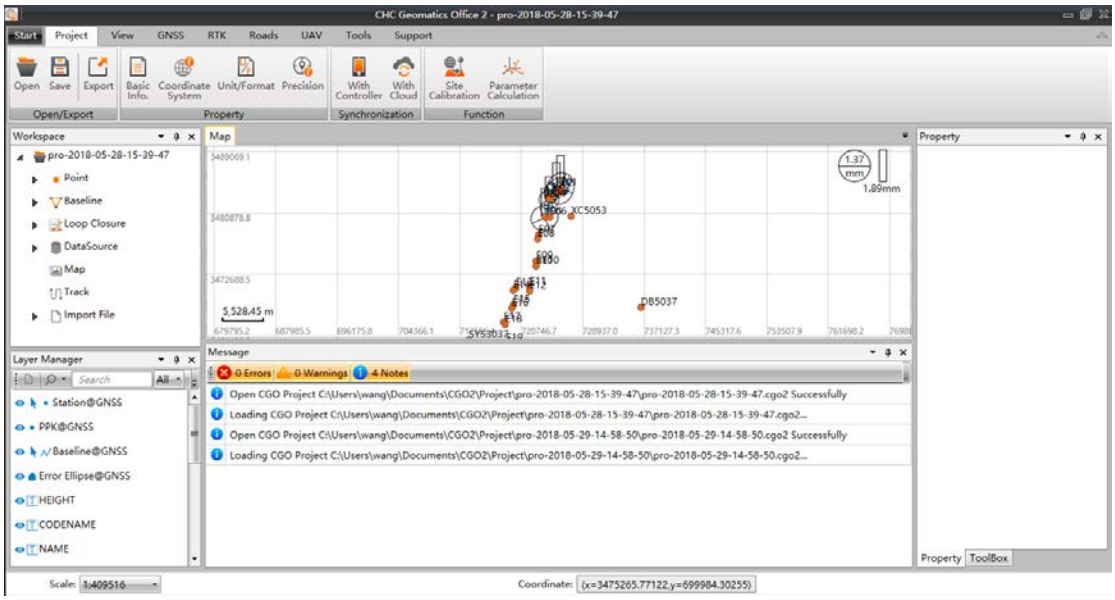
Click **[Start]** → **[Exit]**, users will see a pop-up dialog reads “The current project has been modified. Do you want to save it?”. Users can choose **[OK]** to save the current project and exist CGO2.0, or choose **[Cancel]** to exist CGO2.0 directly.

2 Project

2.1 Open/Export

2.1.1 Open

Click **[Project]** → **[Open]**, users will see a pop-up file manager and can select an existing project file to open. Then, users will see project information in workspace, layer manager, map, property and toolbox windows.



2.1.2 Save

Click **[Project]** → **[Save],** users can save current project data in the same directory as the one you chose when you created a new project.

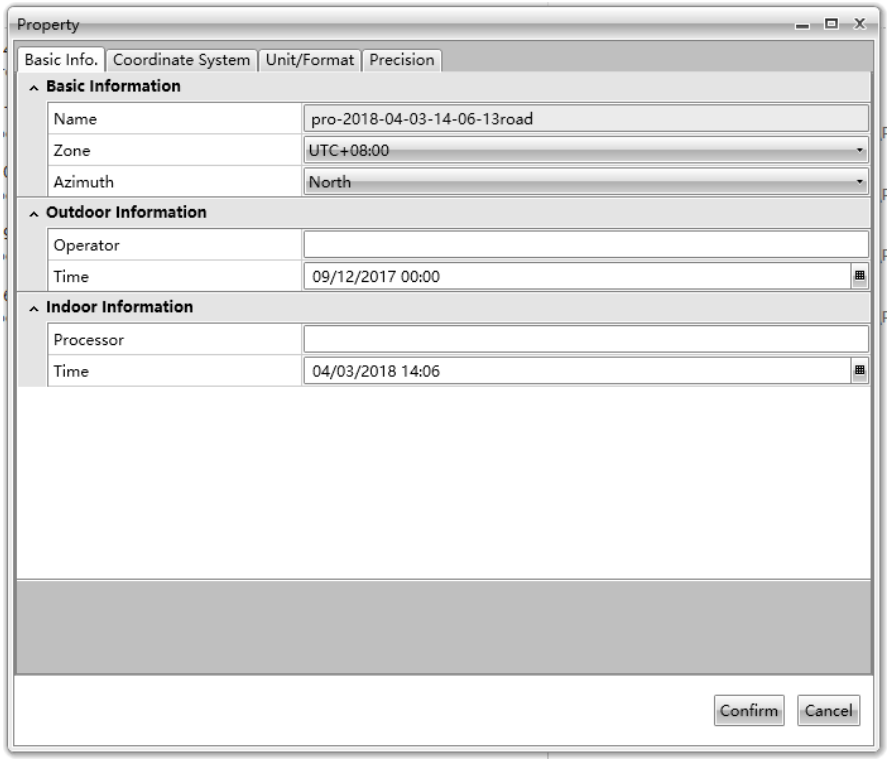
2.1.3 Export

Click **[Project]** → **[Export]**, users can choose a directory to export the coordinate system file (.CRD) of current project as a .ZIP file.

2.2 Property

2.2.1 Basic Info

Click **[Project]** → **[Basic Info]**, users can check and modify basic information of current project.



[Name]: This refers to the name of current project, and users can't modify it.

[Zone]: This refers to the time zone of current project, and users can modify it according to the real situation.

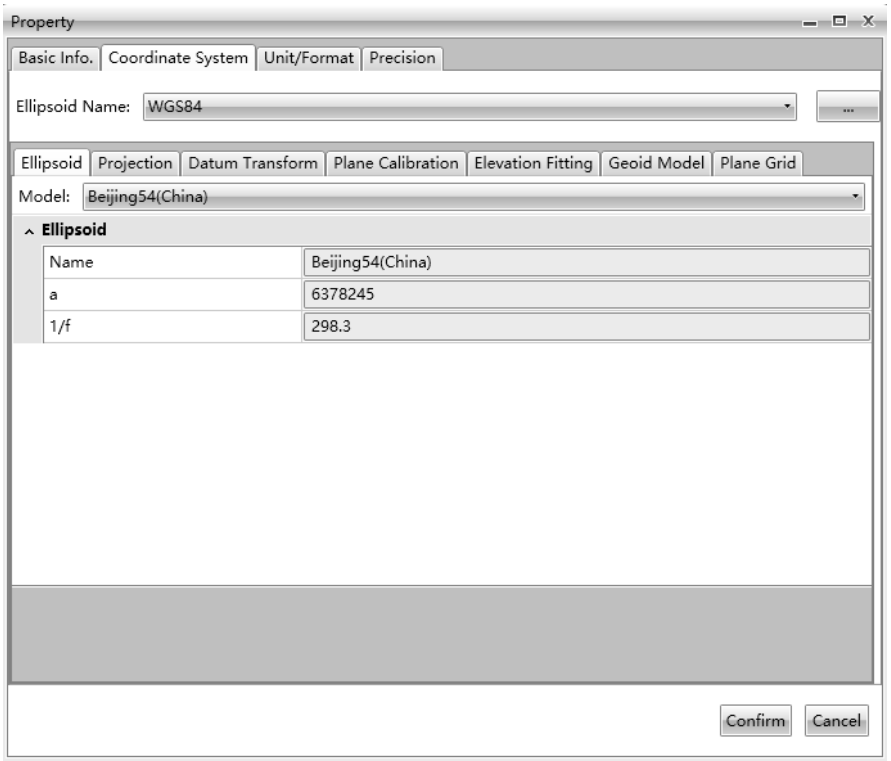
[Azimuth]: When users are in the southern hemisphere, users should choose **[North]**, otherwise, choose **[South]**.

[Operator]/[Processor]: Users can input the name of outdoor surveyor or indoor processor.

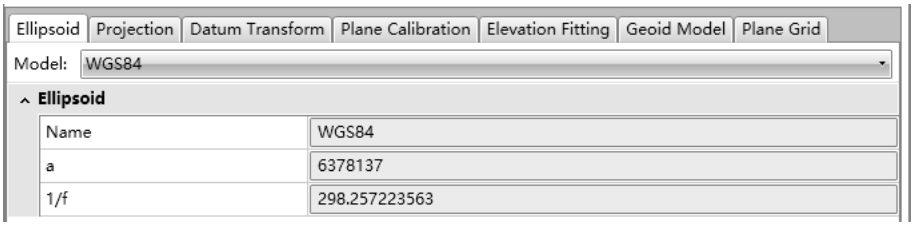
[Time]: Users can input the outdoor or indoor operation time.

2.2.2 Coordinate System

Click **[Project]** → **[Coordinate System]**, users can choose coordinate system by click ing the icon ..., check and modify coordinate system information.

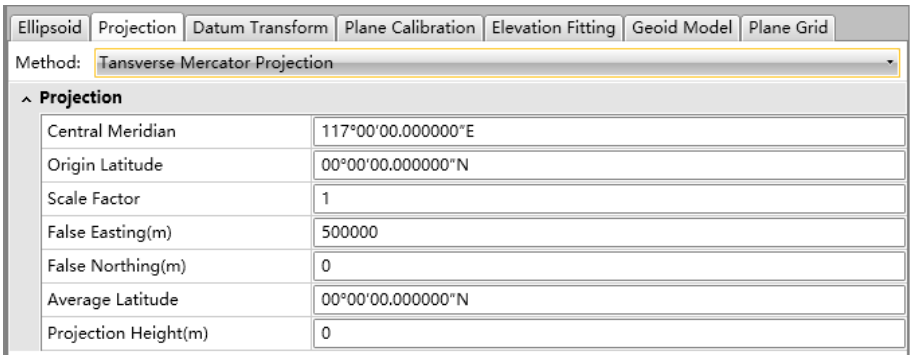


(1) **Ellipsoid**: Users can check and modify ellipsoid parameters.



[Model]: Users can choose the ellipsoid model in the pull-down menu.
[Name]: This refers to the ellipsoid name.
[a]: This refers to the semi-major axis of the ellipsoid.
[1/f]: This refers to the flattening of the ellipsoid.

(2) **Projection**: Users can check and modify projection parameters.



[Method]: Users can choose the projection method in the pull-down menu.

[Central Meridian]: This refers to the longitude of central meridian, users can modify it according to the real situation.

[Origin Latitude]: This refers to the origin latitude of the projection.

[Scale Factor]: This refers to the scale factor of the projection.

[False Easting]: This refers to the false easting coordinate of the projection.

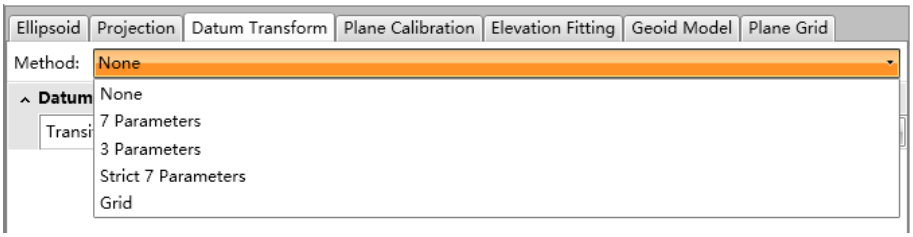
[False Northing]: This refers to the false northing coordinate of the projection.

[Average Latitude]: This refers to the average latitude of the projection.

[Projection Height]: This refers to the projection height of the projection.

As for customizing coordinate system, users should input the mean longitude of the survey area as central meridian (the longitude error requires less than 30 minutes).

(3) **Datum Transform**: Datum transform represents the mathematical model used for the transformation of the two coordinate systems. Users can check and modify datum transformation parameters.



[Method]: Users can choose the datum transformation method in the pull-down menu. Datum transformation methods include none parameters, 3 parameters, 7 parameters, strict 7 parameters and grid. Users can input the local 7 parameters directly, no needing the site calibration any more.

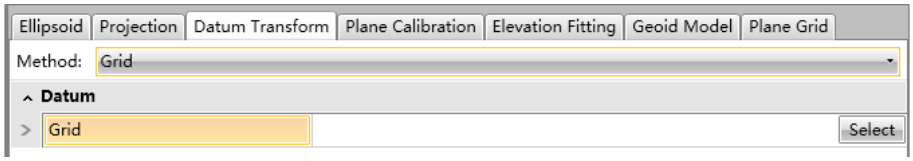
[None Parameters]: Users can choose coordinate transformation mode, from XYZ or from BLH.

[7 Parameters]: Users can input the corresponding 7 parameters according to the real situation.

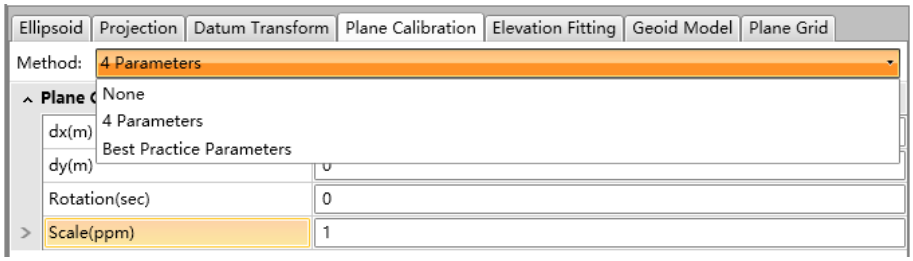
[Strict 7 Parameters]: This method uses Bursa modem, users can input the corresponding 7 parameters according to the real situation.

[3 Parameters]: Users can input the corresponding 3 parameters according to the real situation.

[Grid]: Users can use grid file for datum transformation by clicking **[Select].** The software currently supports the grid file of CGD/GRD/BYN formats.

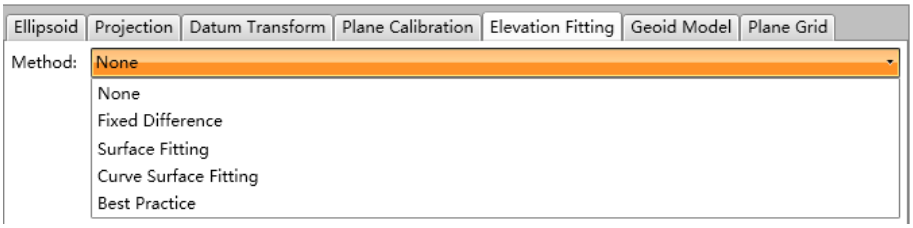


(4) **Plane Calibration:** Plane calibration represents the mathematical model used for the calibration of plane coordinates. Users can check and modify plane calibration parameters.



[Method]: Users can choose the plane calibration method in the pull-down menu. Plane calibration methods include none parameters, 4 parameters and best practice parameters. Users can input the parameters according to the real situation.

(5) **Elevation Fitting:** Elevation fitting represents the mathematical model used for the calibration of elevation. Users can check and modify elevation fitting parameters.



[Method]: Users can choose the height fitting method in the pull-down menu. Height fitting methods include none parameters, fixed difference parameters, surface fitting parameters, curve surface fitting parameters and best practice parameters.

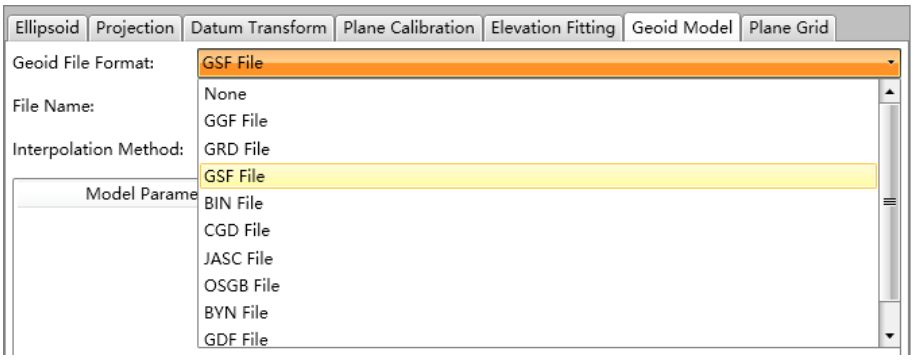
[Fixed Difference]: This refers to translation, requires at least one starting point.

[Surface Fitting]: This refers to the elevation anomaly corresponding to multiple leveling points to generate an optimal surface. When the surface is parallel to the horizontal surface, the surface fitting is equivalent to fixed difference correction. This fitting method requires at least three starting points.

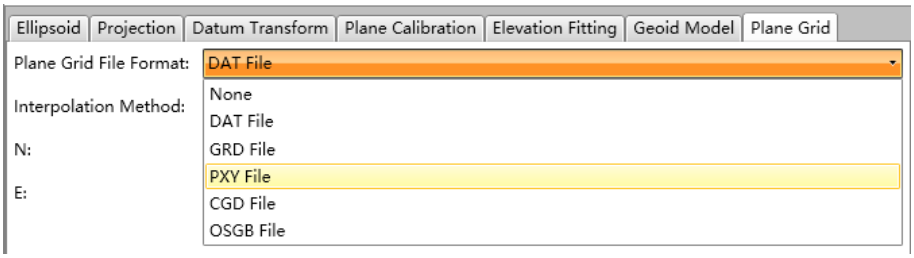
[Curve Surface Fitting]: This refers to the elevation anomaly corresponding to multiple leveling points to generate an optimal paraboloid. The curve surface fitting has a relatively high requirement on the starting data. If the fitting result is too bad, it may cause the divergence of elevation correction number in the work area. This fitting method requires at least six starting points.

[Best Practice]: Users can input the corresponding parameters according to the real situation.

(6) **Geoid Model**: Users can choose a geoid file and interpolation method according to the real situation. The software supports several kinds of geoid files, including none, CGD file, GGF file, GRD file, BYN file, GSF file, BIN file, BYN file, GDF file, JASC file and OSGB file.



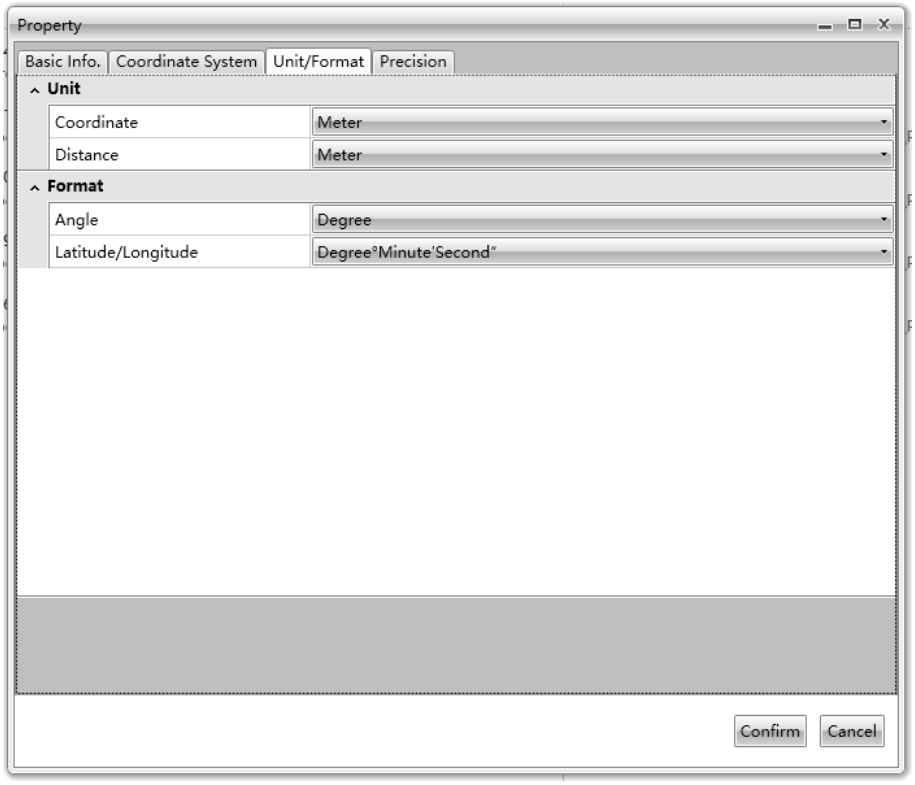
(7) **[Plane Grid]**: Supports plane horizontal east grid and plane horizontal north grid (CGD, GRD, PXY, OSGB, DAT formats).



2.2.3 Unit/Format

Click **[Project]** → **[Unit/Format]**, users can check and modify unit and format.

(1) **Coordinate**: This refers to the unit used in coordinates, including meter, international feet and U.S. feet.
(2) **Distance**: This refers to the unit used in distance, including meter, international feet and U.S. feet.
(3) **Angle**: This refers to the format used in angle, including Degree°Minute'Second", degree and radian.
(4) **Latitude and Longitude**: This refers to the format used in latitude and longitude, including Degree°Minute'Second", degree and radian.

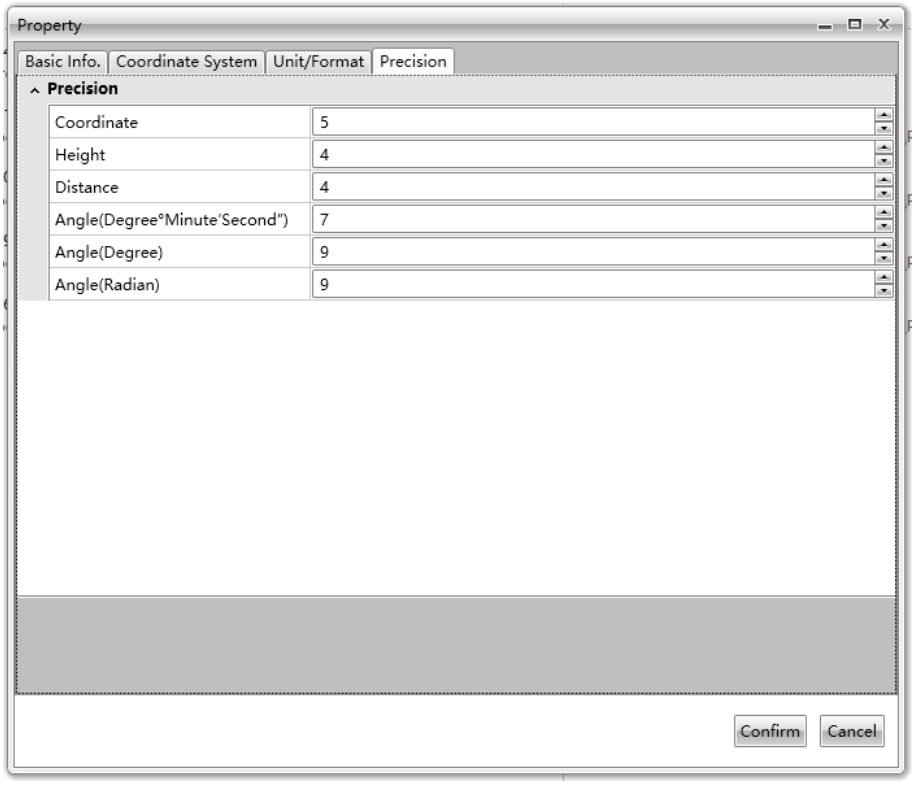


2.2.4 Precision

Click **[Project]** → **[Precision]**, users can check and modify precision of the value, including coordinate, height, distance and angle.

For coordinate, height and distance, that means the digits after the decimal point.

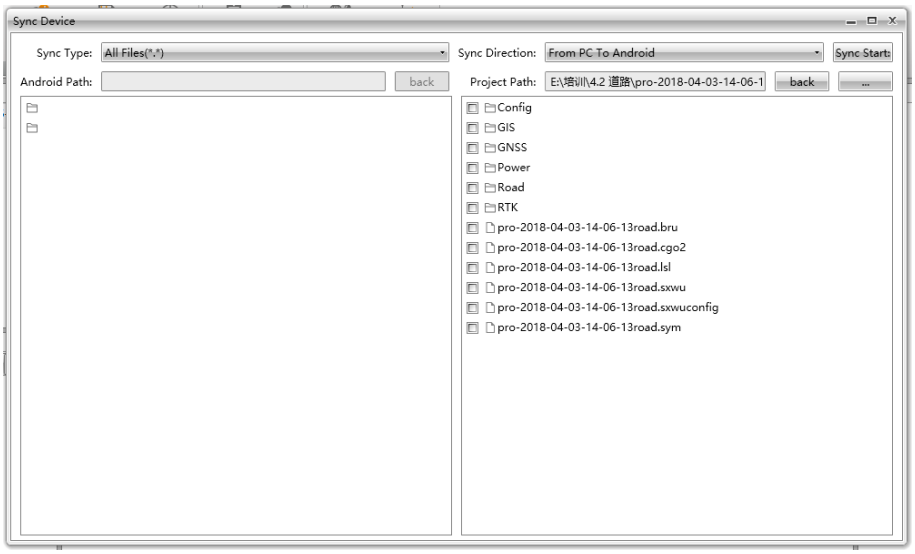
For angle, that means the digits after the decimal point of second, minute, degree and radian, respectively.



2.3 Synchronization

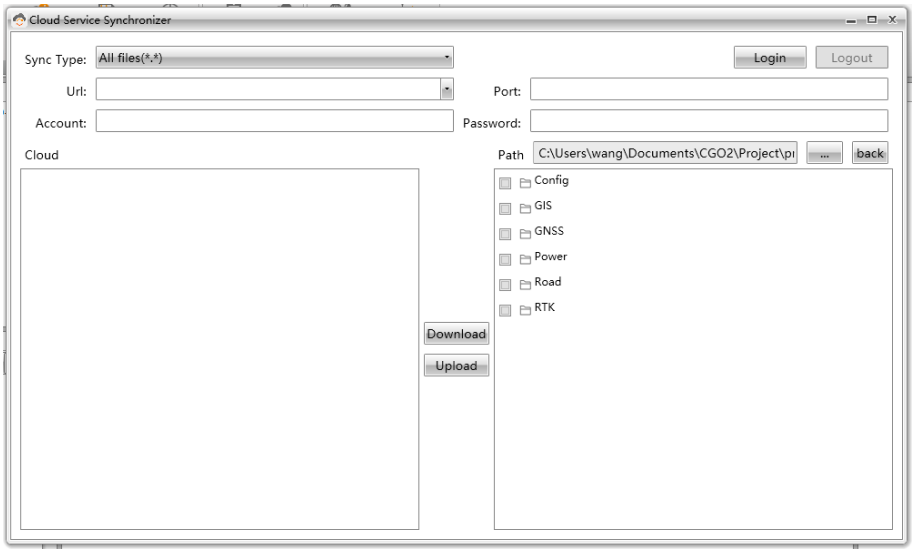
2.3.1 Synchronization with Controller

Click **[Project]** → **[With Controller]**, then the window for synchronous Android devices will pop up. Select the sync file type, sync direction and the direction, then click **[Start]** to sync. Users can sync both from PC and controller.



2.3.2 Synchronization with Cloud

Click **[Project]** → **[With Cloud]**, the cloud service window will pop up. Input URL, port, account and password of the cloud service, then click **[Login]** to log in. After login successfully, users can select the file in the cloud, click **[Download]** and choose a path of PC to download the file. Besides, you can select a file from PC and click **[Upload]** to upload it to the cloud.

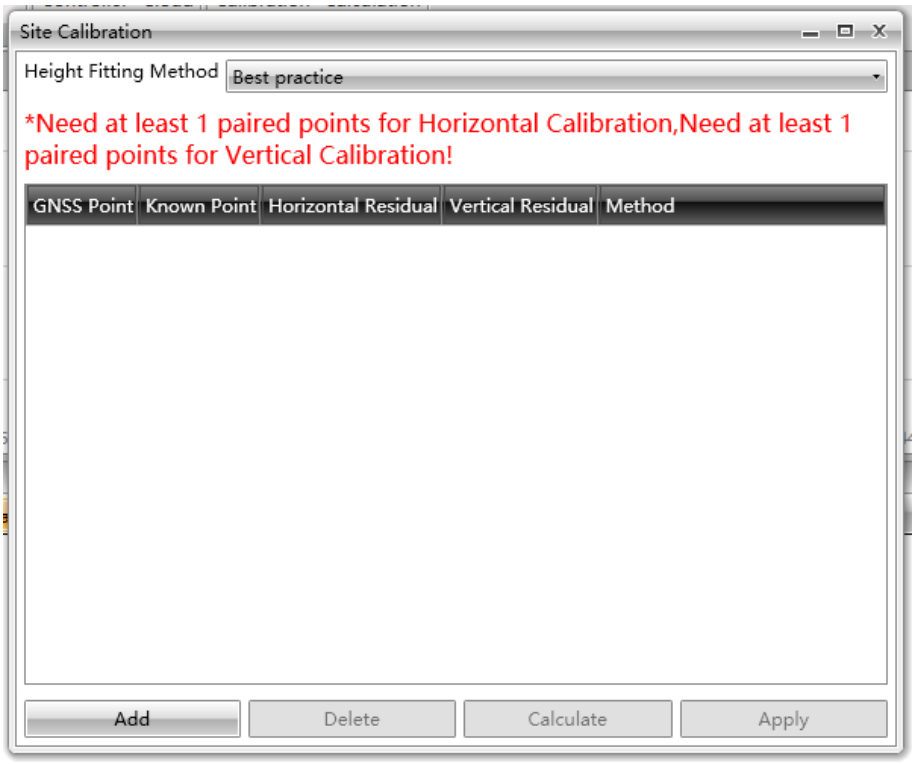


2.4 Function

2.4.1 Site Calibration

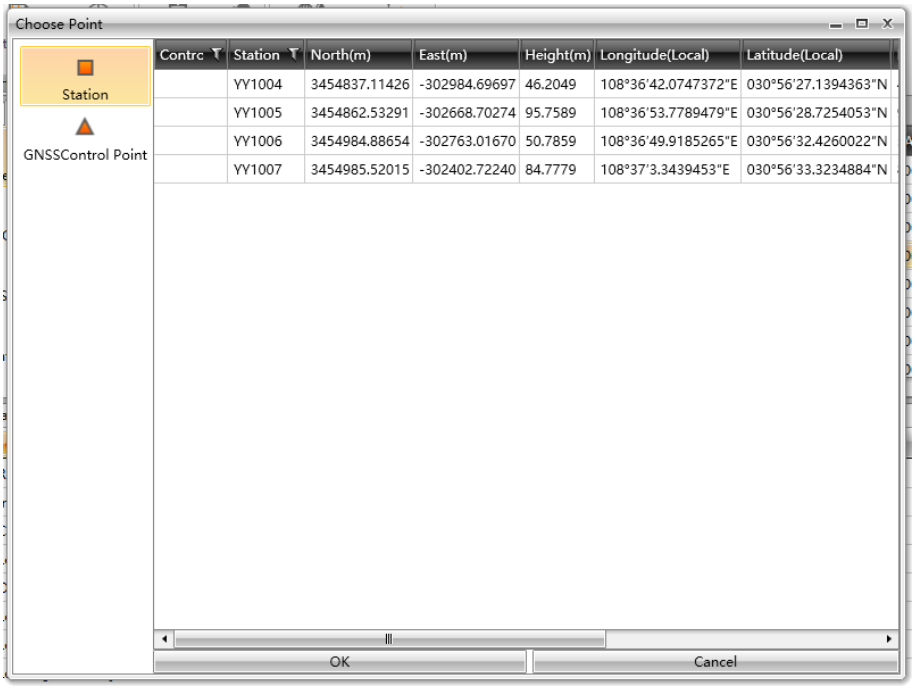
This function aims to do the localization between WGS-84 and the local coordinate system.

Click **[Project]** → **[Site Calibration]** to enter calibration interface.

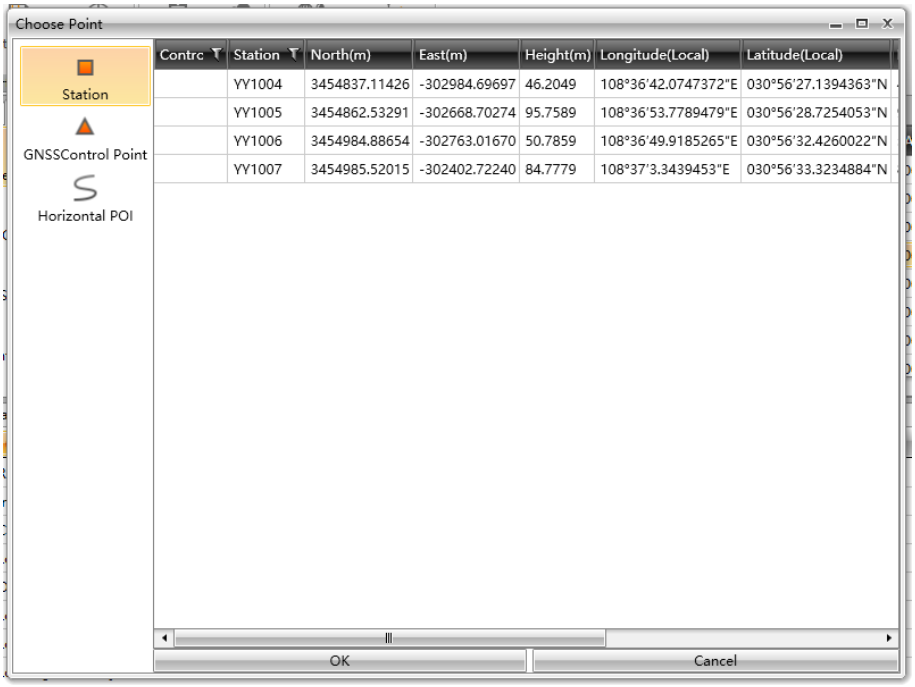


[Fixed Difference]: This refers to translation, requires at least one starting point.
[Surface Fitting]: This refers to the elevation anomaly corresponding to multiple leveling points to generate an optimal surface. When the surface is parallel to the horizontal surface, the surface fitting is equivalent to fixed difference correction. This fitting method requires at least three starting points.
[Curve Surface Fitting]: This refers to the elevation anomaly corresponding to multiple leveling points to generate an optimal paraboloid. The curve surface fitting has a relatively high requirement on the starting data. If the fitting result is too bad, it may cause the divergence of elevation correction number in the work area. This fitting method requires at least six starting points.
[Best Practice]: Users can input the corresponding parameters according to the real situation.
Click **[Add]**, select GNSS points and known points, select “horizontal and vertical”

when choosing correction methods. The default height fitting method is best practice method, which is selectable by the actual situation. It's best to add more than three pairs of points**.**



Users should choose station or GNSS control point as a known point.



Click **[Calculate]**. When the software prompt “Calculate successfully”, click **[OK]** and

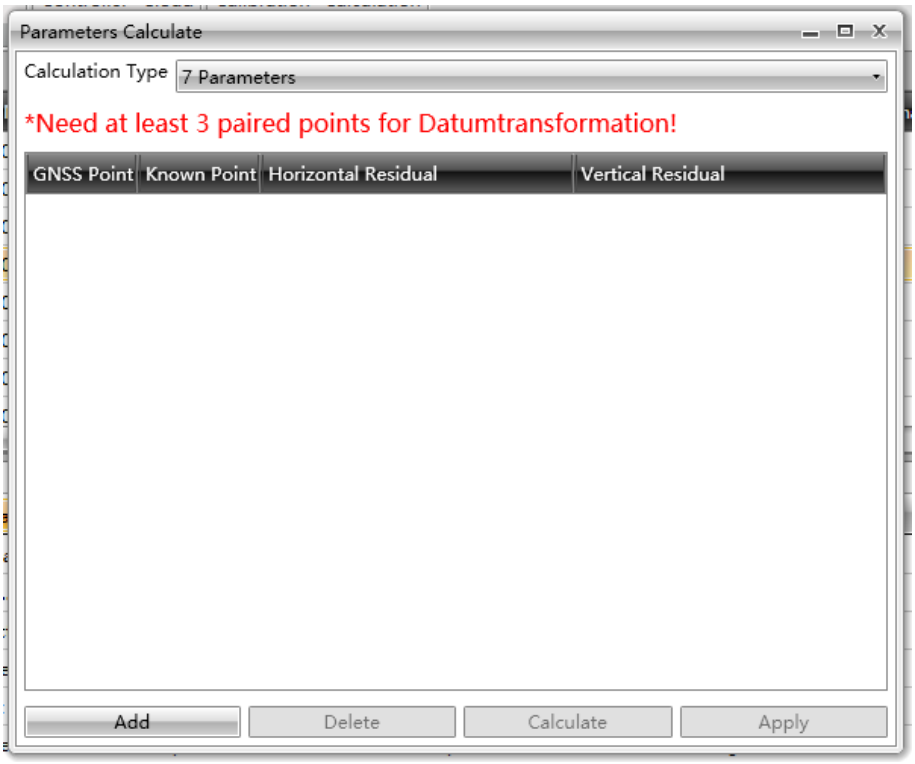
then click **[Apply]** to finish.

2.4.2 Parameter Calculation

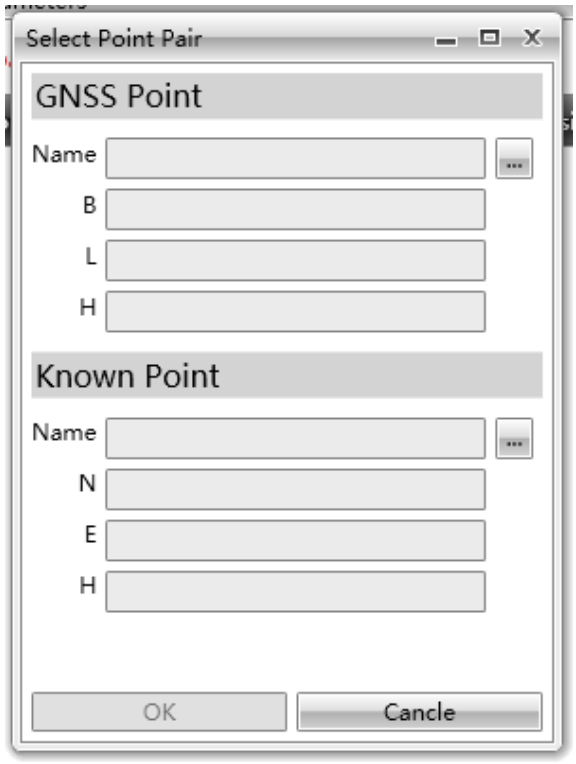
Parameter types includes 7 parameters and 3 parameters, taking 7 parameters as an example:

The application of 7 parameters is relatively large, generally greater than 50 kilometers. When calculating, the user needs to know the local coordinate system and WGS-84 coordinates that provide at least three known points, that is, the seven conversion parameters of the WGS84 coordinate transformation to the local coordinate system before the parameter calculation can be performed.

Click **[Project]** → **[Parameter Calculation]**, choose 7 parameters and click **[Add]** to add known point pairs.



Select three point-pairs by turn to add to the parameter calculation interface, click **[Calculate]**, after prompting "Calculate Successfully" on the window, click **[OK]** to apply the 7 parameters to the current project.



Three Parameters: Requires at least one known point, this method is used in a small range. The operating range determines the accuracy, the accuracy decreases with the working distance increases.

3 View

3.1 Select

3.1.1 Select

Click **[View]** → **[Select]**, users can press on left mouse button to select any single object on the current map, or press and hold left mouse button and drag a box to select multiple objects. The selected object will be highlighted, and users can see object properties in the property window, but if there are too many items selected in the box, all the geographical properties information of the selected items will not be displayed.

3.1.2 Pan

Click **[View]** → **[Pan]**, users can move to the target position.

3.1.3 Polygon

Click **[View]** → **[Polygon]**, users can press on left mouse button to create an irregular polygon and right click to complete, then all features in the polygon will be selected. The selected object will be highlighted, and users can see object properties in the property window, but if there are too many items selected in the box, all the geographical properties information of the selected items will not be displayed.

3.2 View

3.2.1 Full Screen

Click **[View]** → **[Full Screen]**, users can see all features in current view.

3.2.2 Zoom to Center

Click **[View]** → **[Zoom to Center]**, users can press on left mouse button to select features, then selected features will be displayed centrally. For completing the operation, users can right click.

3.2.3 Zoom in

Click **[View]** → **[Zoom in]**, users can click any point in the current view, then current view will be enlarged centrally on this point. For completing the operation, users can right click.

3.2.4 Zoom out

Click **[View]** → **[Zoom out]**, users can click any point in the current view, then current view will shrink centrally on this point. For completing the operation, users can right click.

3.2.5 Grid

Click **[View]** → **[Grid]** to open or close the grid. When the grid button is selected, users can see grid and coordinates in current view. Otherwise, users can't.

3.2.6 Previous View

Click **[View]** → **[Previous View]**, users can see the previous view.

3.2.7 Next View

C lick **[View]** → **[Next View]**, users can see the next view.

3.3 Capture

This function is used with measurement tool, users can measure point distance, angle, area/perimeter and point-line distance easier by capture the endpoint, midpoint, intersection and pedal of features.

3.3.1 Line Endpoint

Click **[View]** → **[Line Endpoint]**, users can set whether to capture line endpoints in the current view. When the line endpoints button is selected, the line endpoint in current view can be captured. Otherwise, can't be captured.

3.3.2 Intersection

Click **[View]** → **[Intersection]**, users can set whether to capture line intersection point in the current view. When the intersection button is selected, the line intersection point in current view can be captured. Otherwise, can't be captured.

3.3.3 Line Midpoint

Click **[View]** → **[Line Midpoint]**, users can set whether to capture line midpoint in the current view. When the line midpoint button is selected, the line midpoint in current view can be captured. Otherwise, can't be captured.

3.3.4 Pedal

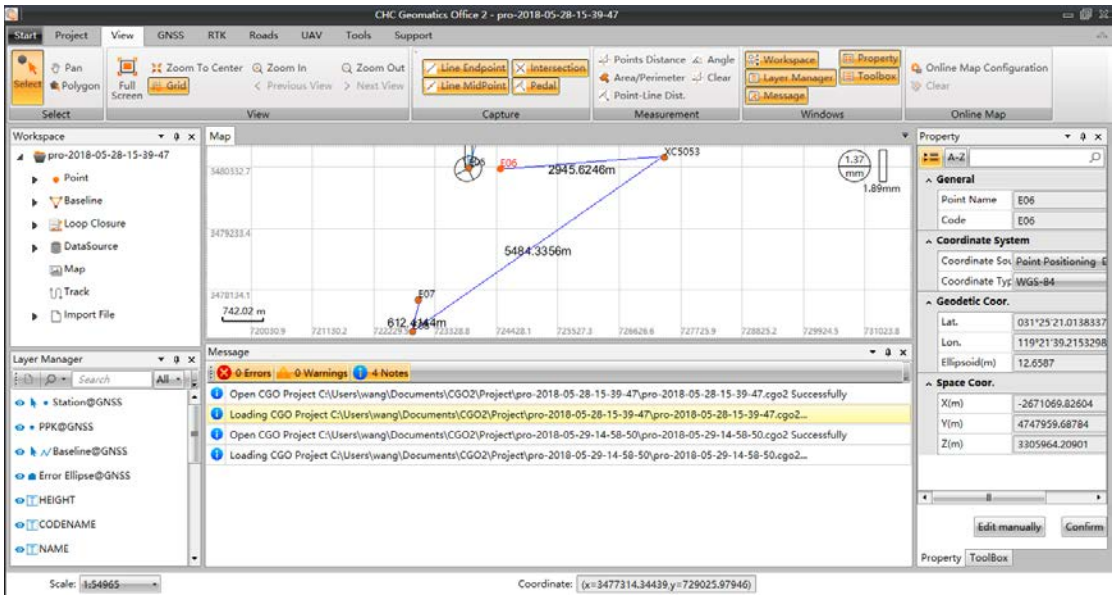
Click **[View]** → **[Pedal]**, users can set whether to capture perpendicular in the current view. When the pedal button is selected, the perpendicular in current view can be captured. Otherwise, can't be captured.

3.4 Measurement

3.4.1 Point Distance

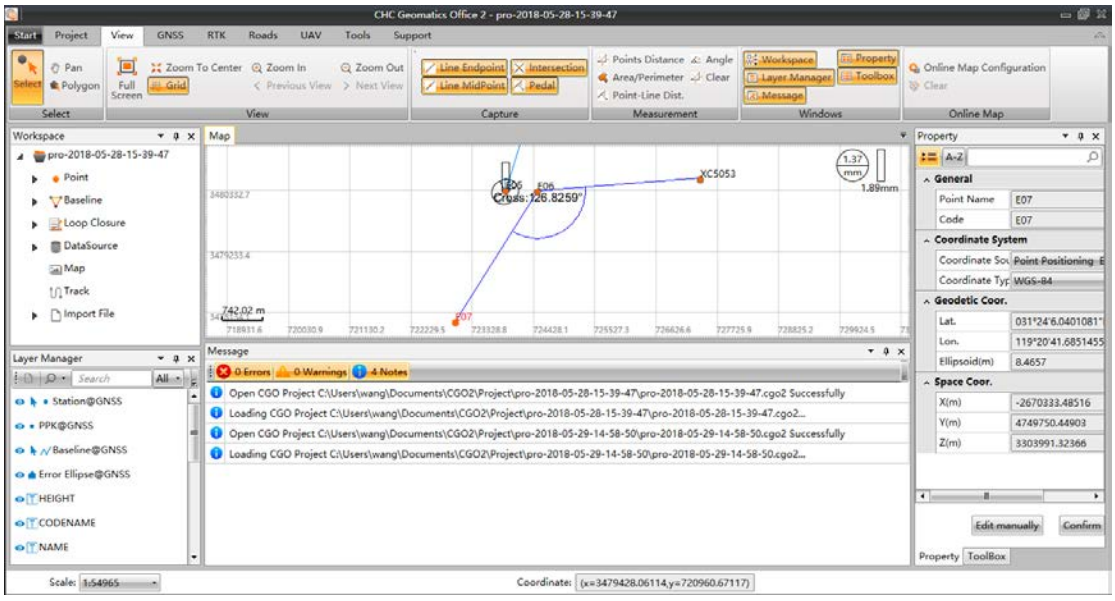
Click **[View]** → **[Point Distance]**, users can capture and select two points, then the software will calculate the distance between the two points. It also allows for selecting multiple points and calculating the distance of multiple line sections, respectively.

View



3.4.2 Angle

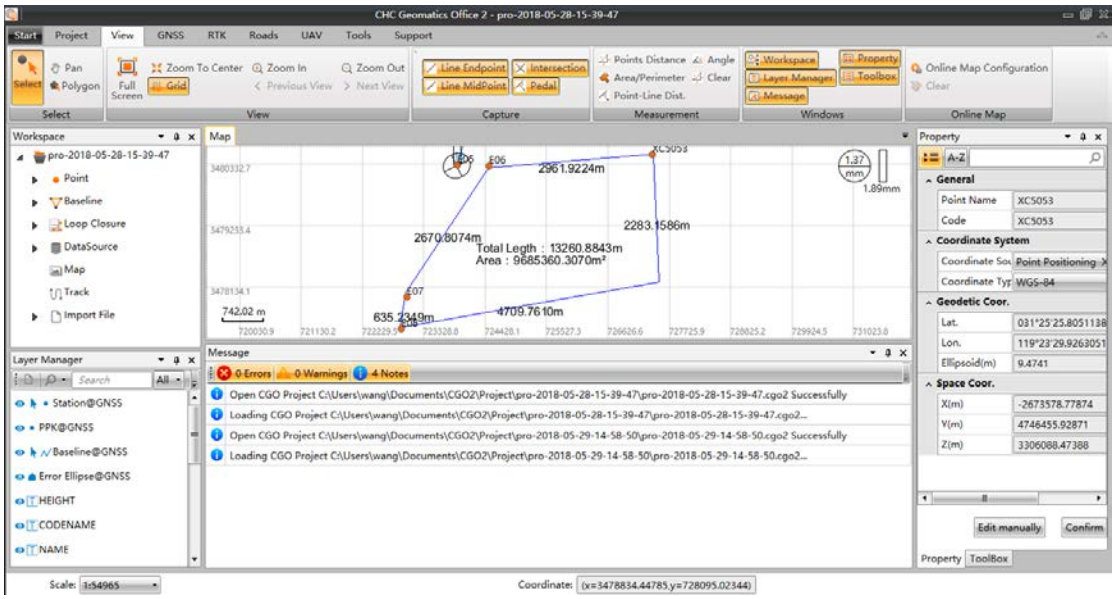
Click **[View]** → **[Angle]**, users can capture and select three points, then these points will connect to two line sections and the software will calculate the angle between the two line sections. It also allows for selecting multiple points and calculating the angle of multiple line sections, respectively.



3.4.3 Area/Perimeter

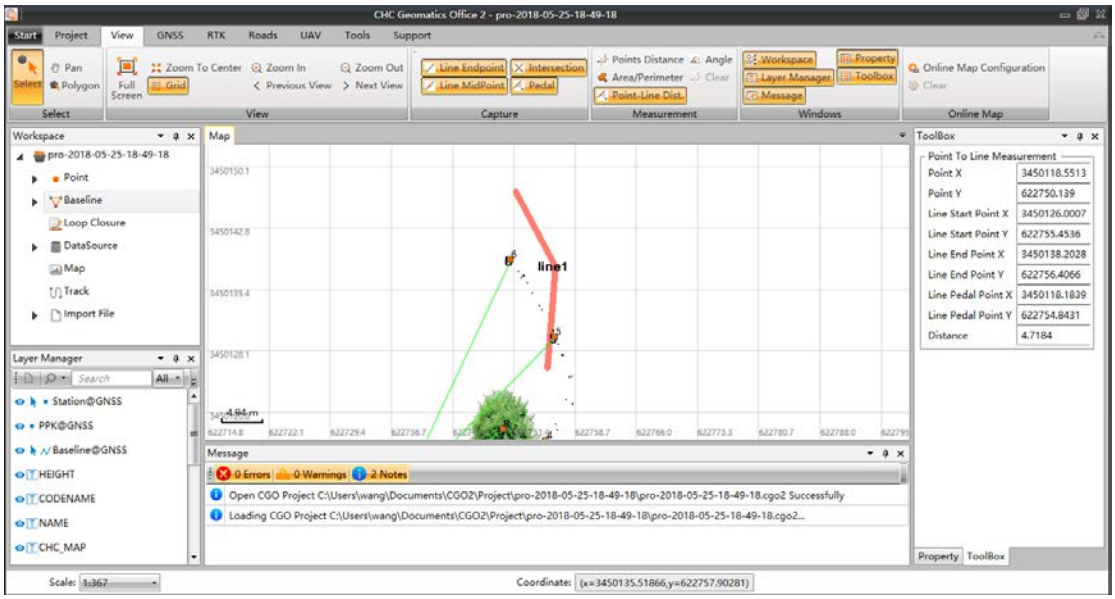
Click **[View]** → **[Area/Perimeter]**, users can capture and select multiple points, then

the software will calculate the distance of each line sections and the area of the formed surface.



3.4.4 Point-line Dist

Click **[View]** → **[Point-Line Dist]**, users can select a line and a point, then the software will calculate the distance between point and line, the result will be shown at **[ToolBox]** window. Users can also select a line first, and then select different point to see the different distance between different points and the line.



3.4.5 Clear

Click **[View]** → **[Clear]** to clear the measure data in the **[Map]** window.

3.5 Windows

3.5.1 Workspace

Users can see project name and all data items in the **[Workspace]** window. Click **[View]** → **[Workspace]** to control the display and hide of the workspace window. When the workspace button is selected, the workspace window is displayed. Otherwise, the workspace window is hidden.

3.5.2 Property

Users can check property of selected features in the **[Property]** window. Click **[View]** → **[Property]** to control the display and hide of the property window. When the property window button is selected, the property window is displayed. Otherwise, the property window is hidden.

3.5.3 Layer Manager

Users can check all layers of the current project in the **[Layer Manager]** window. Click **[View]** → **[Layer Manager]** to control the display and hide of the layer manager window. When the layer manager button is selected, the layer manager window is displayed. Otherwise, the layer manager window is hidden.

3.5.4 Toolbox

Toolbox shows the parameters of measurement tools and COGO tools, users can input parameters and check calculation result here. Click **[View]** → **[Toolbox]** to control the display and hide of the tool window. When the toolbox button is selected, the toolbox is displayed. Otherwise, the toolbox is hidden.

3.5.5 Message

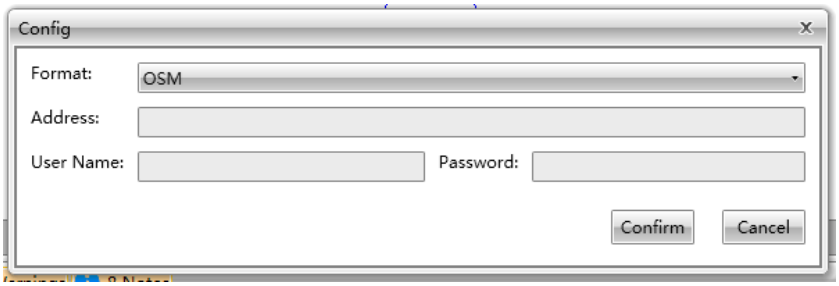
Users can check errors message, warnings message and notes message in the **[Message]** window. Click **[View]** → **[Message]** to control the display and hide of the message window. When the message window button is selected, the message window

displays. Otherwise, the message window is hidden.

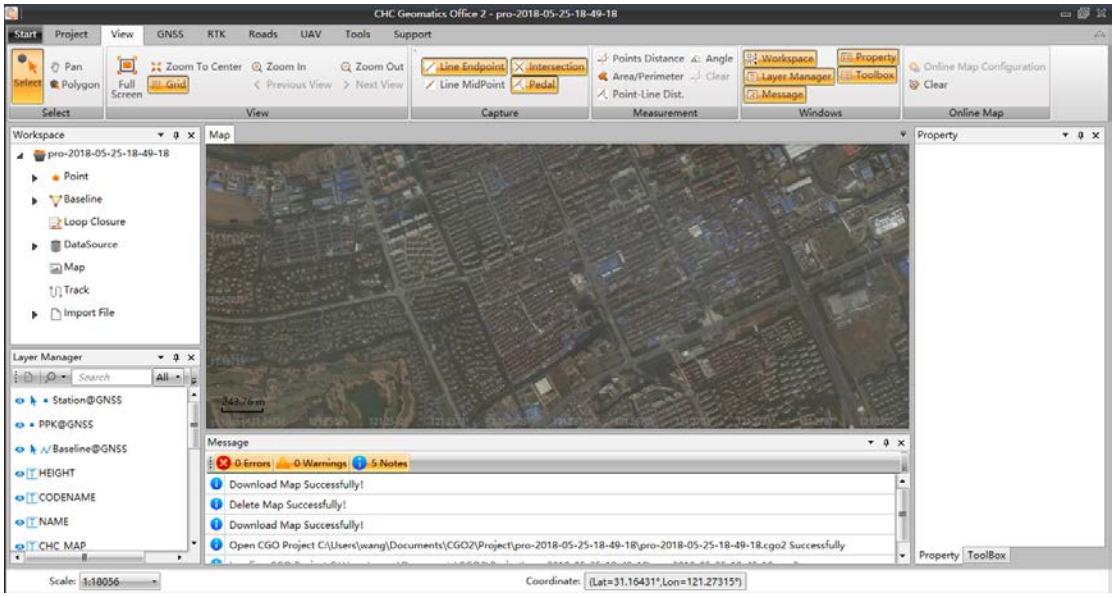
3.6 Online Map

3.6.1 Online Map Configuration

Click **[View]** → **[Online Map Configuration]**, users can choose online map format, input the address, user name and password in the pop-up window. When there is no address, user name or password of the online map (like OSM), please keep it blank and click **[Confirm]** directly.



Then the online map will be downloaded and users can see it in **[Map]** window.

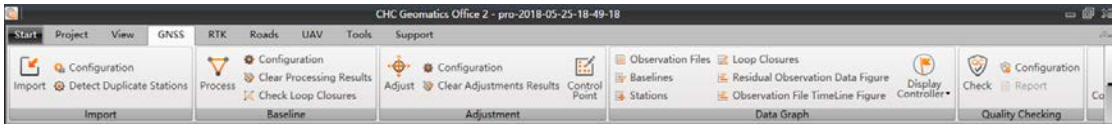


3.6.2 Clear

Click **[View]** → **[Clear]** to clear the downloaded online map and users won't see it in **[Map]** window.

4 GNSS

After creating a new project, click **[GNSS]** and get into GNSS sub-menu.

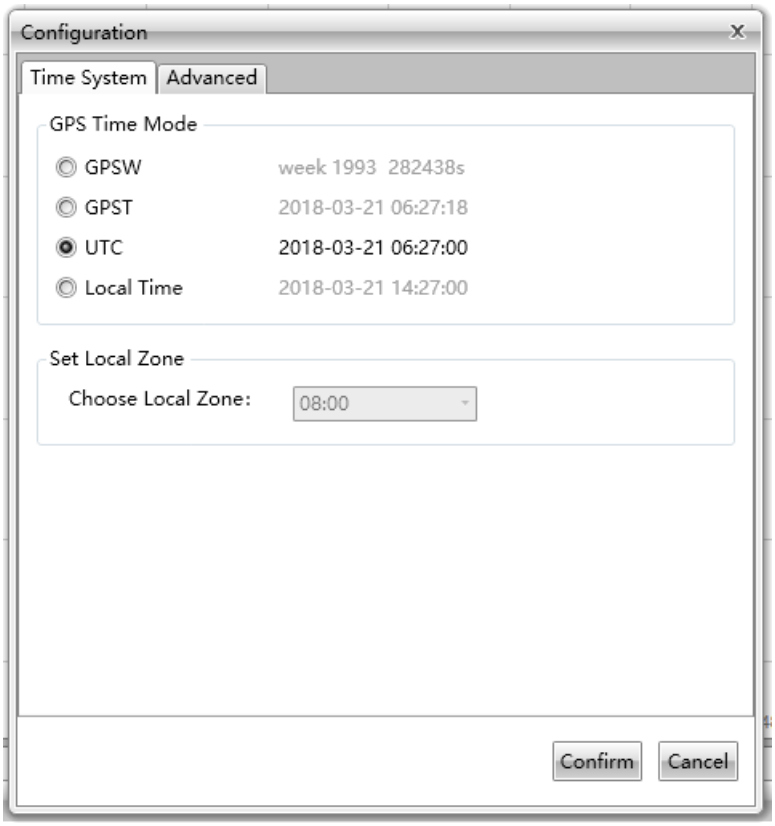


4.1 Import

4.1.1 Configuration

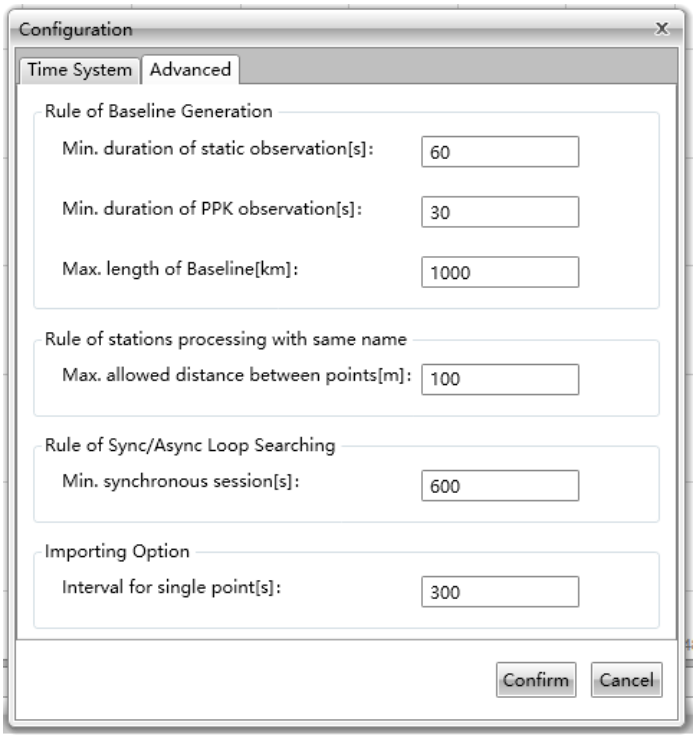
(1) **Time System**

This refers to the time system display format of observation file. There are four main time modes provided: GPSW, GPST, UTC and local time, users can set according to the real situation. When users choose local time, please remember to set local zone.



(2) **Advanced**

The Advanced option includes rule of baseline generation, rule of stations processing with same name, rule of sync/async loop searching and importing option.



- **Rule of Baseline Generation**

[Min. duration of static observation]: This refers to the minimum synchronous duration of static observation files, default is 60 s and users can modify it according to the real situation. The software won't generate any baseline based on the static observation file of which the synchronous duration is less than the setting value.

[Min. duration of PPK observation]: This refers to the minimum synchronous duration of the PPK observation file, default is 30 s and users can modify it according to the real situation. The software won't generate any baseline based on the PPK observation file of which the synchronous duration is less than the setting value.

[Max. length of Baseline]: This refers to the maximum length of the baseline, default is 10 km and users can modify it according to the real situation. The software won't generate the baseline which is longer than the setting value.

- **Rule of Stations Processing with the Same Name**

[Max. allowed distance between points]: This refers to the maximum allowed distance between two stations with the same name, default is 10000 m and users can modify it according to the real situation. If two stations used the same name, and the distance between them is less than the setting value, then the software will merge them to one station and users can change the coordinates in property window.

Otherwise, there is a warning from software and users should decide whether to merge those points.

- **Rule of Sync/Async Loop Searching**

  [Min. synchronous session]: This refers to the minimum synchronous session of sync/async loop, default is 600 s and users can modify it according to the real situation.

  The software won't generate a loop when the synchronous session is less than the setting value.

- **Importing Option**

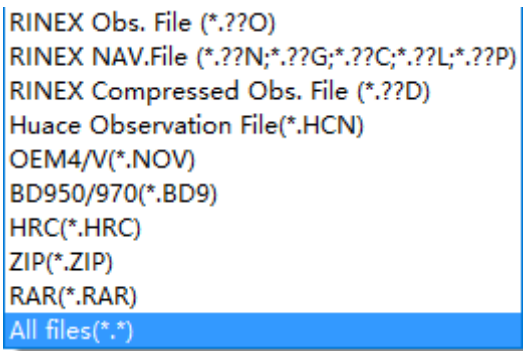
  [Interval for single point]: This refers to the sample interval of the observation epoch, default is 300 s and users can modify it according to the real situation.

4.1.2 Import

(1) **File Format**

CGO 2.0 is compatible with following data formats**:**

- V2.00 -V3.02 version of RINEX file (*.??O)
- Ephemeris file (*.??N;*.??G;*.??C;*.??L;*.?P)
- Compressed Rinex file (*.??D)
- CHC observation format (*.HCN)
- NOVATEL OEM4/V/6 board file (*.NOV)
- TRIMBLE BD950/BD970 board file (*.BD9)
- Compressed HCN file (*.HRC)

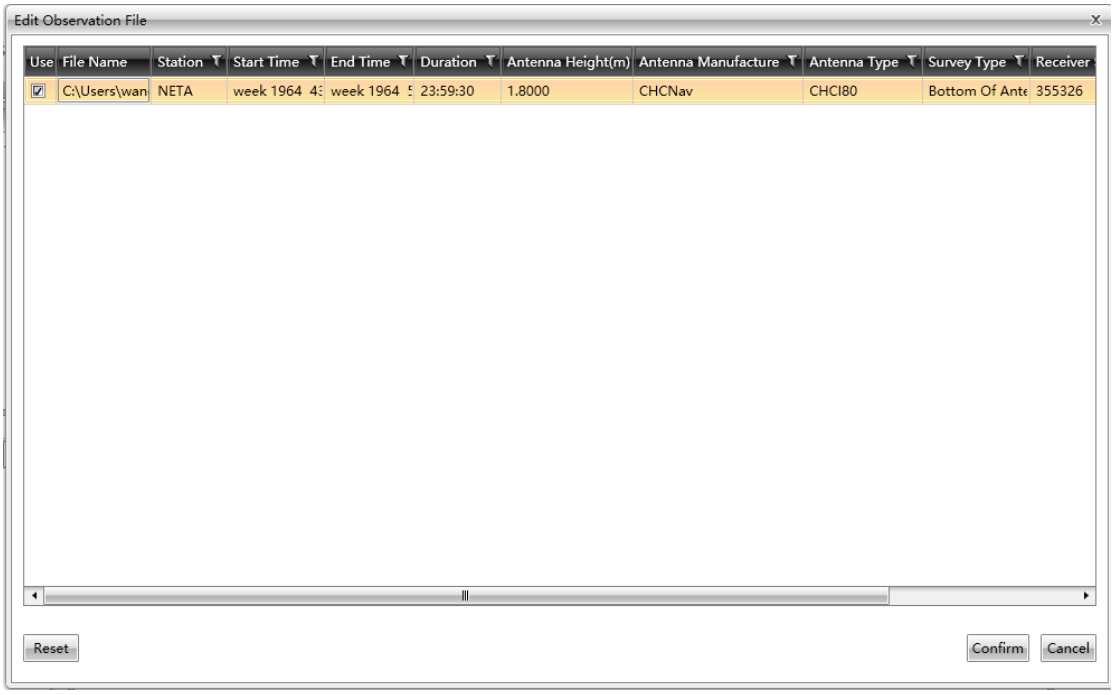


(2) **File Import**

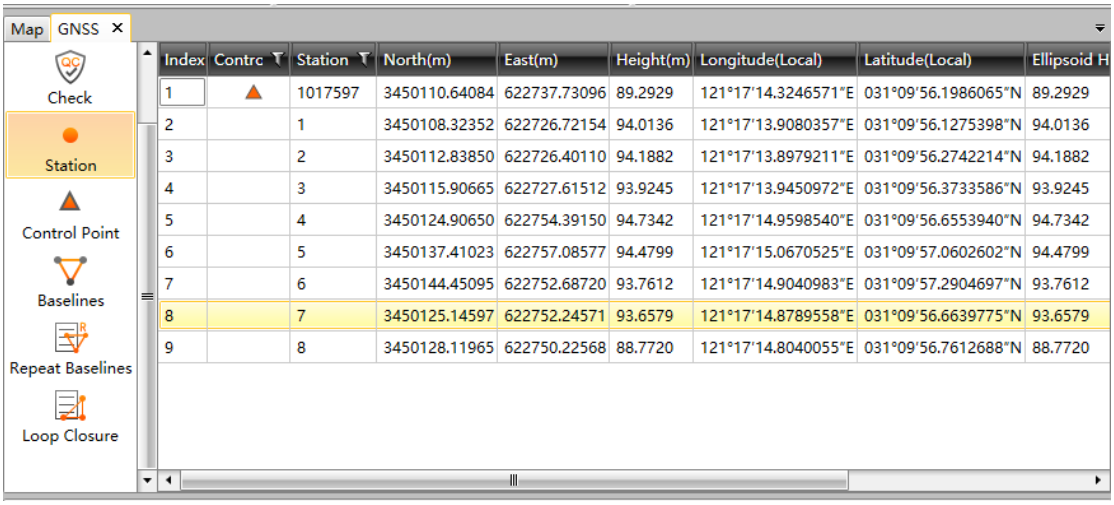
Click **[GNSS]** → **[Import]**, a window will pop up. Select the observation file, and click **[Open]** to import.

After that, **[Edit Observation File]** window will pop up, users can check and modify

station name, antenna height, antenna manufacture, antenna type, antenna survey type and receiver SN.

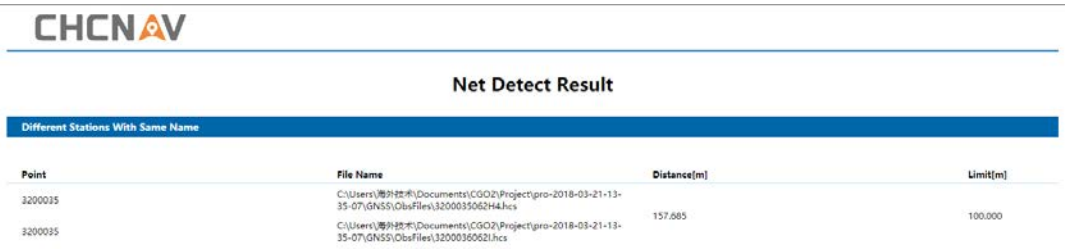


Click **[Confirm]**, and the software will automatically generate a Map table and a GNSS table, including the information of observation files, stations, baselines (repetitive baselines, baseline residual) and loops.



4.1.3 Detect Duplicate Station

After import step, it is necessary to check the imported data. Click **[Detect Duplicate Stations]**, then a webpage will be opened automatically and users can check the different stations with the same name.


CHCNAV

Net Detect Result

Different Stations With Same Name

Point	File Name	Distance[m]	Limit[m]
3200035	C:\Users\海外技术\Documents\CGO2\Project\pro-2018-03-21-13-35-07\GNSS\ObsFiles\3200035062H4.hcs	157.685	100.000
3200035	C:\Users\海外技术\Documents\CGO2\Project\pro-2018-03-21-13-35-07\GNSS\ObsFiles\3200036062I.hcs		

4.2 Baseline

4.2.1 Configuration

4.2.1.1 Basic Configuration

(1) **Elevation Mask (°)**

Elevation mask gives the restriction for the acquisition of navigation signals. During the baseline processing, the software won't use the data from the satellite which position is lower than the set elevation mask value.

Because the influence on satellite signals caused by the atmosphere is complex, it's difficult to use correction module. Also, the signal from a satellite with low elevation angle is easily affected by factors like multi-path and electromagnetic wave. As a consequence, the quality of the low elevation angle data is in poor quality. During the post-processing, the software usually disables the data with low elevation angle.

If only taking atmosphere refraction into account, for short distance survey, the user can set lower elevation mask; but for long distance survey, the user should set larger elevation angle because the effect of atmospheric refraction can't be counteracted during the long distance survey.

After all, the setting for elevation mask should depend on surrounding of stations. During the fieldwork, it is better to set lower elevation mask given the satellite configuration and acquire as much data as possible for the incoming post-processing. The default elevation mask value is 15.

(2) **Sample Interval (s)**

Sample interval is the interval of the observation epoch which is used to process baseline, and the default value of sample interval is 60 s. For example, when two receivers are doing a static survey, the acquiring interval is every 5 seconds. But for the

post-processing, this acquiring frequency cannot dramatically improve the baseline process result but time-consuming. Given those facts, increase the sample interval can speed up the baseline processing.

Normally, for short distance and short survey duration, you'd better to shorten sample interval. For example, for baseline within 2 km and the survey duration within 20 min, the user can set 5 s sample interval. But when the baseline is long, you'd better increase the sample interval up to 60 s or 120 s.

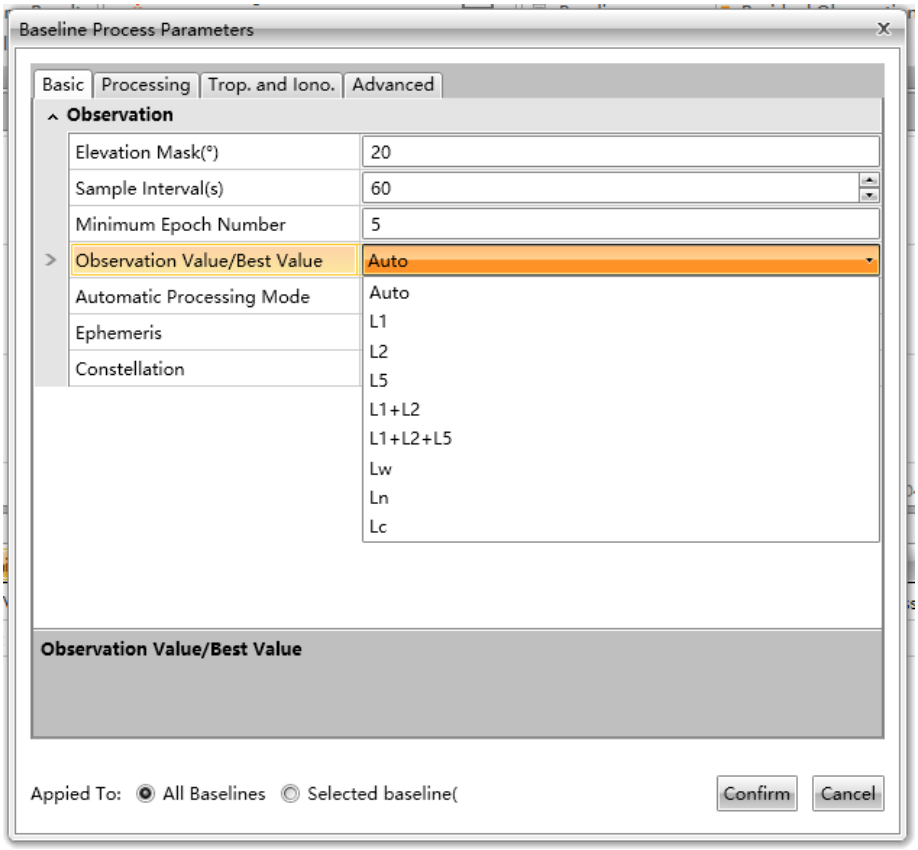
So, why the user should set short sample interval during the fieldwork? Because for the raw data with low quality, given the restriction from data's randomness and software's functionality, the baseline processing result can usually be improved through editing epoch interval.

(3) **Minimum Epoch Number**

During the observation, the receiver will record many continuous observation epoch to guarantee the good quality of the observation file. The minimum continuous observation epoch is 5 as default, and the minimum value that user can set is 2. Users are able to modify it according to the real situation and the software will disable the observation file of which the minimum continuous observation epoch is less than the set value.

(4) **Observation Value/ Best Value**

The combination of different frequency bands are compatible. For the auto combination, the software will automatically choose the frequency band depending on the length of baseline. The length limitation for using Lc can be set in the **[Advanced]** setting table, default distance is 10 km, and users can modify it according to the real situation. For the baseline which is shorter than the set value, the software chooses L1 or L1+L2. Otherwise, the software uses Lc to eliminate the influence from ionospheric delay.



(5) **Automatic Processing Mode**

There are two modes for automatic processing: common and advanced, and the default mode is advanced. The common mode means that the software will automatically process observation epochs and then automatically remove the unqualified observation epochs. The advanced mode performs better, the software will calculate one more time after removing the unqualified observation epochs.

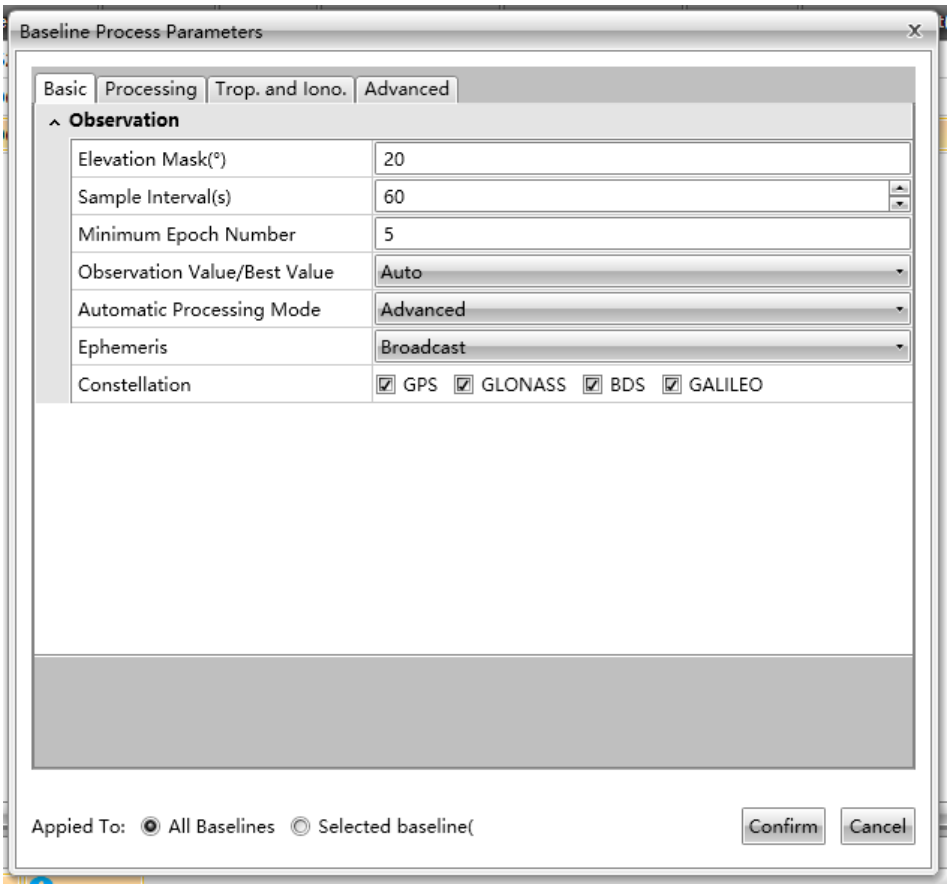
(6) **Ephemeris**

There are two modes: broadcast and precise, and the default option is broadcast. Users can set the length limitation of baseline in **[Advanced]** setting table to determine the ephemeris mode, the default value for using broadcast ephemeris is 200 km and for precise ephemeris is 2000 km. If the length of baseline is less than the set value, the software will use broadcast/precise ephemeris for processing. Otherwise, the software won't.

(7) **Constellation**

There are four checkboxes in front of 4 satellite system: GPS, GLONASS, BDS, and GALILEO, default are all chose. The receivers can process the data based on different types of the satellite signal.

There are varies options and compatible with customizing settings. The user can choose one, two or all signals of the constellations to attend processing. For example, if the navigation data acquired by 4 kinds of constellations, then you can choose all 4 options to process data. Otherwise, the user should choose the type which is corresponding to the real data.



4.2.1.2 Process

(1) **Processing Mode**

There are four modes: auto, static, PPK and DGPS, default is auto. For processing static data, users should choose **[Static]**. For processing multiple frequencies PPK data, users should choose **[PPK]**. For processing single frequency PPK data, users should choose **[DGPS]**.

(2) **Observation Time**

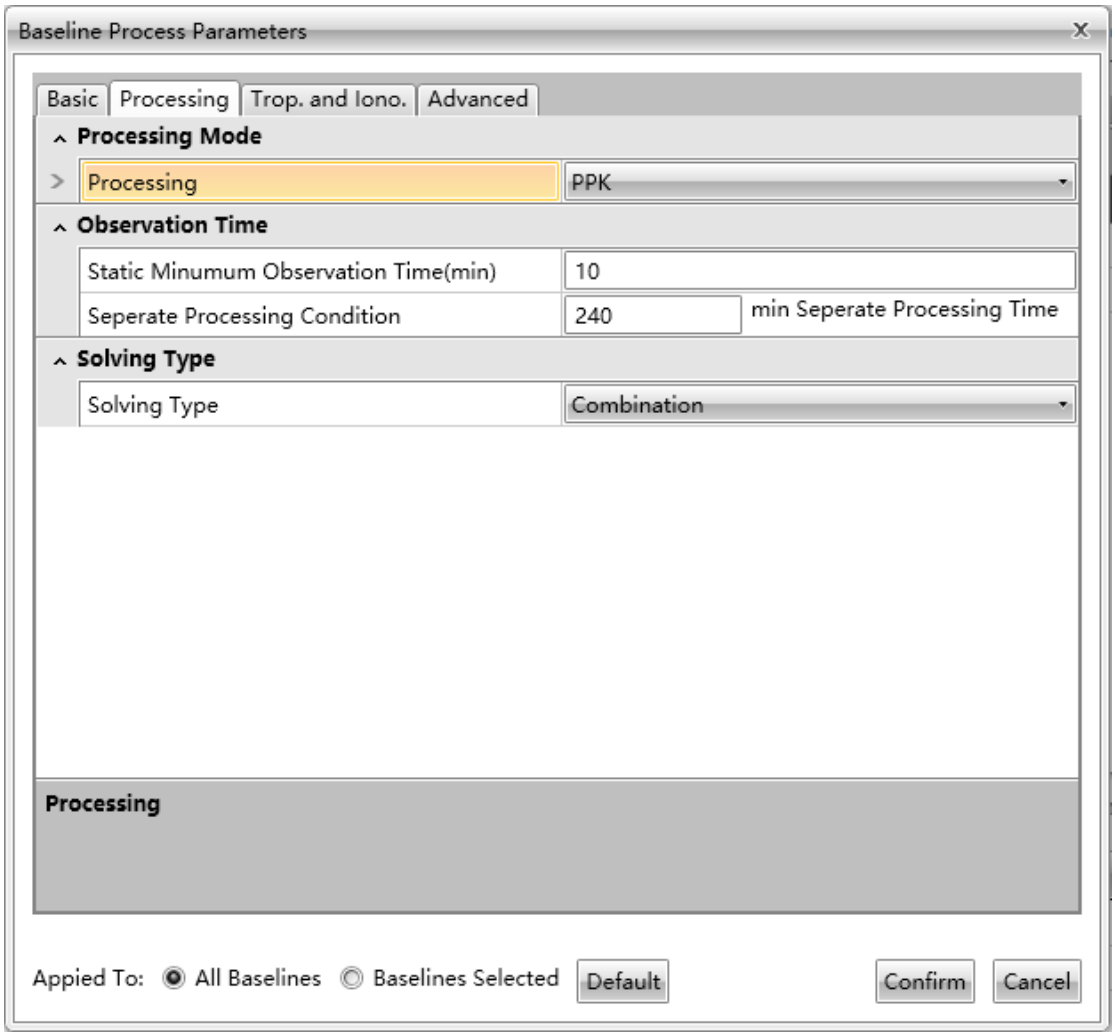
[Static Minimum Observation Time]: This refers to the minimum observation time of static observation file, the default is 10 min, and users should modify it according to the real situation. If the real observation time of static observation file is more than

the set value, the software will process the data. Otherwise, the software won't.

[Separate Processing Condition]: When the observation file is too big, users should set the condition of separate processing to save the processing time. The default value is 240 min, which means the software will process the data separately when the observation time is more than 240 min.

(3) **Solving Type**

When choosing PPK or DGPS processing mode, users can see three different solving type: forward, backward and combination.



4.2.1.3 Trop. and Iono.

In ordinary cases, there is no need to modify the Trop. and Iono. field. For a middle or long baseline, please modify the parameters depends on reality to improve the accuracy of the processing result.

(1) **Trop. and Iono.**

[Troposhperic Correction Model]: Includes Hopfield mode, Improved Hopfiled mode, Saastamoinen mode, Niell mode, Black mode, Goad_Goodman mode, NewBrunswick mode and uncorrected.

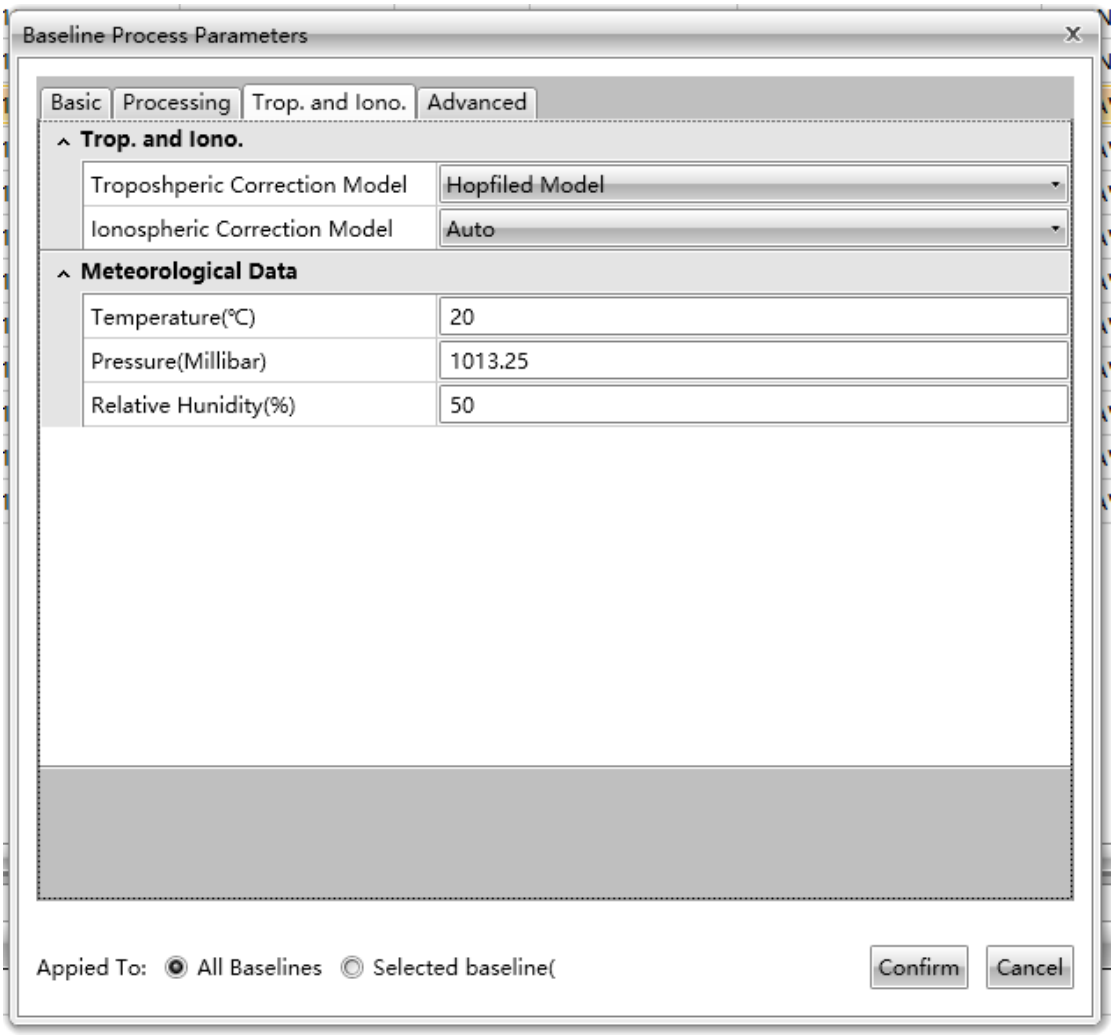
[Ionospheric Correction Model]: Includes Auto and uncorrected.

(2) **Meteorological Data**

[Temperature]: 20°C by default.

[Pressure (Millibar)]: 1013.25 by default.

[Relative Humidity]: 50 by default.



4.2.1.4 Advanced

(1) **Quality Control**

[Tolerance Coefficient]: This refers to the tolerance coefficient of the observation file error, the default is 3.5. When the error model is larger than the tolerance coefficient*RMS value, the software will automatically eliminate the observation data.

[RMS More Than]: The default value is 0.04, users should modify it according to the real situation. If the RMS is more than the set value, the software will show “unqualified” message.

[Ratio Less Than]: The default value is 1.8, users should modify it according to the real situation. If the ratio is less than the set value, the software will show “unqualified” message.

(2) **Cutoff Than**

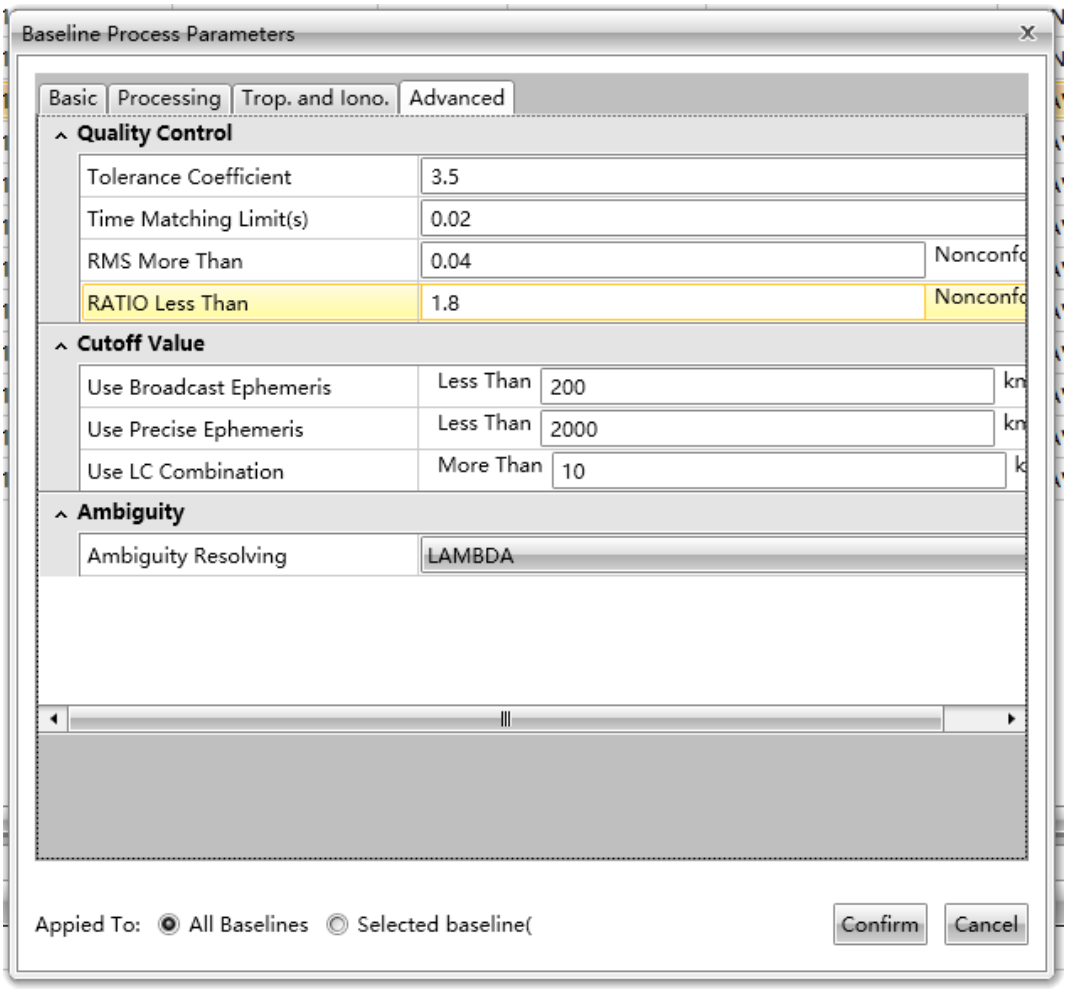
[Use Broadcast Ephemeris]: The default is 200 km. If the length of baseline is less than the set value, the software will use broadcast ephemeris for processing. Otherwise, the software won’t.

[Use Precise Ephemeris]: The default is 2000 km. If the length of baseline is less than the set value, the software will use precise ephemeris for processing. Otherwise, the software won’t.

[Use Lc Combination]: default distance is 10 km, and users can modify it according to the real situation.

(3) **Ambiguity**

[Ambiguity Resolving]: There are two options: LAMBDA and OMEGA.

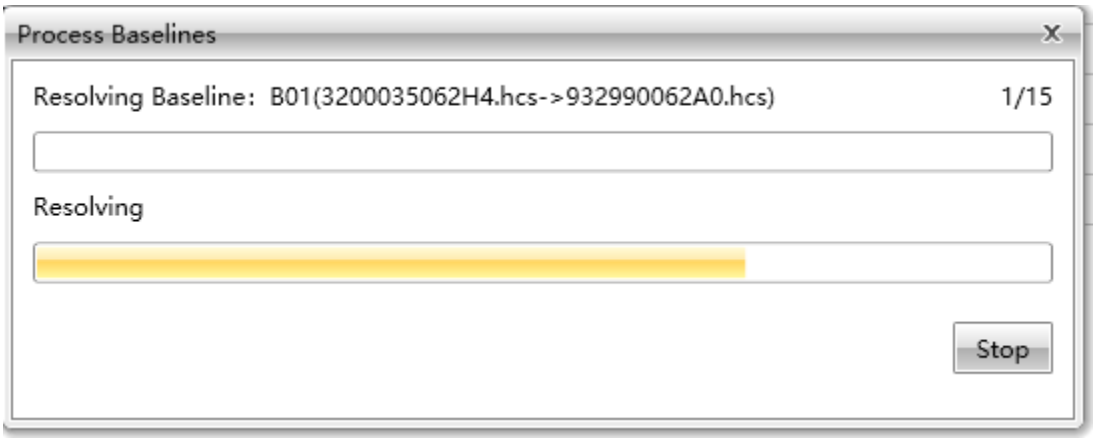


4.2.2 Process

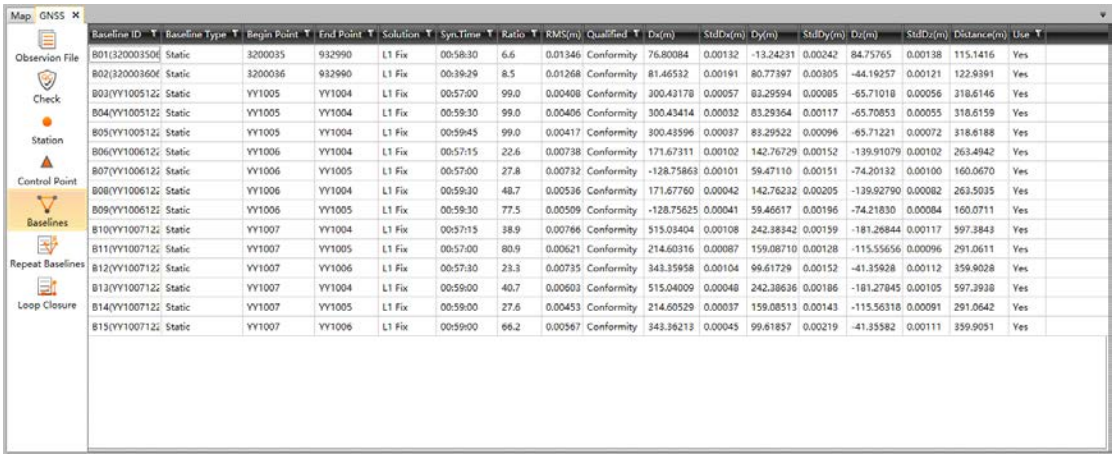
There are three ways to process baselines:

(1) Click **[GNSS]** → **[Process]** to process all baselines.
(2) Select the baseline in the **Workspace** window, press on right mouse button to choose process all baselines or process selected baselines. Users can press on Ctrl button on the keyboard and left mouth button simultaneously to select multiple baselines.
(3) Select the baseline in the **Baselines List** of **GNSS** window, press on right mouse button to choose process all baselines or process selected baselines. Users can press on Ctrl button on the keyboard and left mouth button simultaneously to select multiple baselines (Ctrl+A is for all selection).

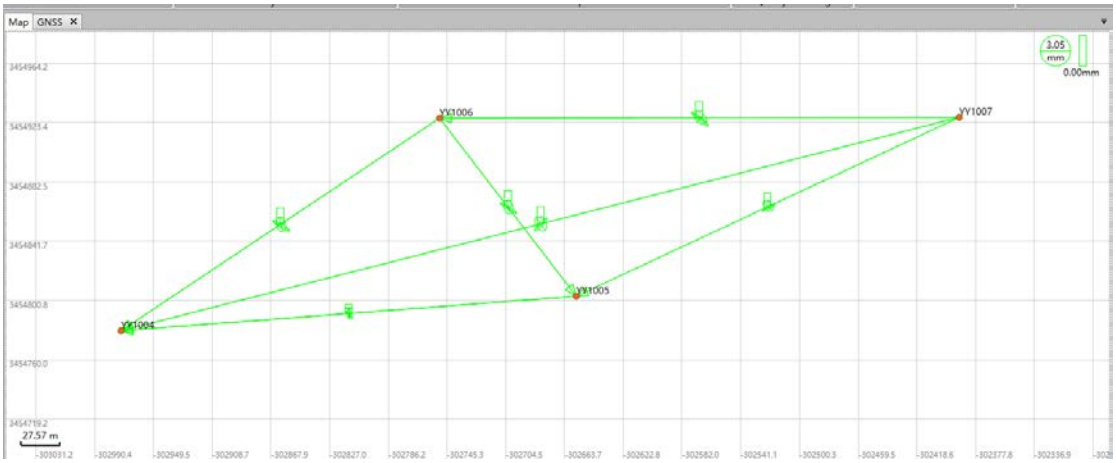
Then, there is a pop-out dialog box that displays the dynamic updating of the baseline processing process, and users can stop it as need.



The result of baseline processing will be shown in baseline list.



At the same time, the raw baseline in the black switch to green.



4.2.3 Checking Baseline Processing Result

4.2.3.1 Baseline Quality Control

Baseline quality is expressed by quality indexes like RATIO and RMS.

(1) **RATIO**

RATIO means the ratio of second minimum and minimum RMS after the ambiguity resolution available.

$$RATIO = \frac{RMS_{\text{sec}}}{RMS_{\text{min}}}$$

RATIO represents the reliability of the resolved ambiguity. This index based on various factors, including the quality of observation data as well as the observation conditions.

This value is a key value to show the quality of baseline. Normally, it should exceed 1.8.

(2) **RMS**

RMS means Root Mean Square:

$$RMS = \sqrt{\frac{V^T PV}{n-f}}$$

In this equation:

V – observation residual

P – the weight of observation

n-f – the number of observation minus unknowns

RMS is a key index for observation quality. The smaller the RMS value is, the better the quality of observation data is. This value is independent of observation conditions (satellite configuration for example).

Given the statistics theory, the probability of observation error within 1.96 times of RMS is 95%.

4.2.3.2 Loop Closure

(1) **Definition of Closure**

Loop closure error checking is an efficient way to test baseline quality. There are three loops: synchronous loop, asynchronous loop and repeat baselines.

Theoretical speaking, the closure error value should be 0. But in reality, it is tolerable to have a certain value of closure error.

There are two classes of loop closure error:

(a) Component closure error

$$\begin{cases} \varepsilon_{\Delta X} = \sum \Delta X \\ \varepsilon_{\Delta Y} = \sum \Delta Y \\ \varepsilon_{\Delta Z} = \sum \Delta Z \end{cases}$$

(b) Total length relative closure error

$$\varepsilon = \frac{\sqrt{\varepsilon_{\Delta X}{}^2 + \varepsilon_{\Delta Y}{}^2 + \varepsilon_{\Delta Z}{}^2}}{\sum S}$$

(2) **Sync/Async Loop and repeat baselines**

(a) **Synchronous Loop**

Synchronous loop closure is the closure error of the loop consist of baselines.

Because of the internal connection between synchronous baselines, the theoretical value of the closure error is 0. When the loop closure error exceeds the tolerance, then at least 1 baseline vector is wrong. On the contrary, when the closure error is within the tolerance, in the majority cases, the static baselines' quality is acceptable. But it is still not safe to say all the baselines of this synchronous loop are absolutely qualified.

(b) **Asynchronous Loop**

The loop that is not only composed by synchronous observed baselines is named asynchronous loop. The closure error of the asynchronous loop is asynchronous loop closure error.

The baseline vectors are considered qualified when the closure error fits the tolerance. When the loop closure error exceeds the tolerance, then at least 1 baseline vector is wrong. Through testing various asynchronous loop or repeat baselines, the user can

identify the baseline that is nonconformity.

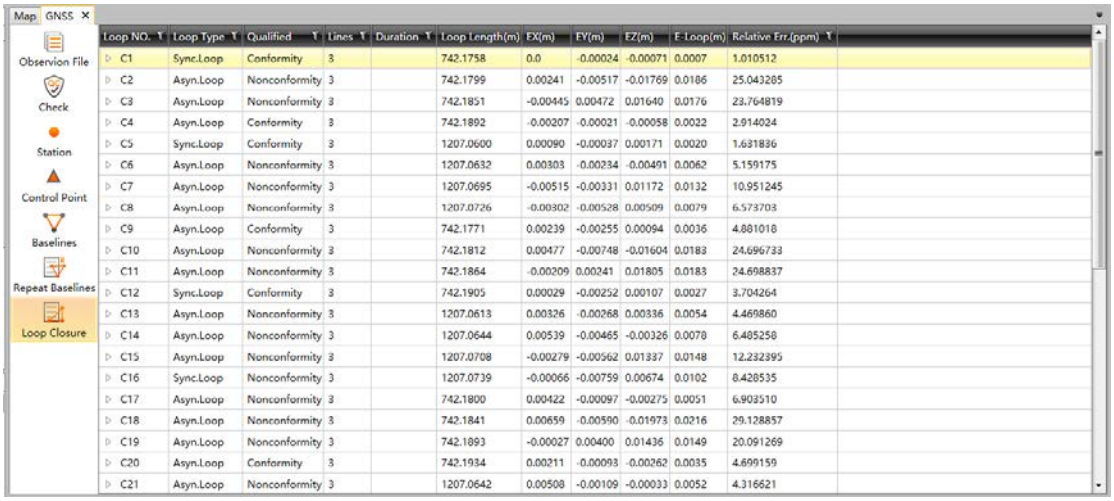
(c) **Repeat Baselines**

Observations on the same two stations during multiple periods are repeated baselines. The difference between observations is the repeat baselines' difference.

(3) **Closure Error Checking Guide**

To check the loop and repeat baselines, users can click **[Report]** - **[Loop Closure Report Configuration]**.

There are different tolerance and checking contents and the result of checking shows in Loop Closure list.



Loop NO.	Loop Type	Qualified	Lines	Duration	Loop Length(m)	EX(m)	EY(m)	EZ(m)	E-Loop(m)	Relative Err.(ppm)
C1	Sync.Loop	Conformity	3		742.1758	0.0	-0.00024	-0.00071	0.0007	1.010512
C2	Asyn.Loop	Nonconformity	3		742.1799	0.00241	-0.00517	-0.01769	0.0186	25.043285
C3	Asyn.Loop	Nonconformity	3		742.1851	-0.00445	0.00472	0.01640	0.0176	23.764819
C4	Asyn.Loop	Conformity	3		742.1892	-0.00207	-0.00021	-0.00058	0.0022	2.914024
C5	Sync.Loop	Conformity	3		1207.0600	0.00090	-0.00037	0.00171	0.0020	1.631836
C6	Asyn.Loop	Nonconformity	3		1207.0632	0.00303	-0.00234	-0.00491	0.0062	5.159175
C7	Asyn.Loop	Nonconformity	3		1207.0695	-0.00515	-0.00331	0.01172	0.0132	10.951245
C8	Asyn.Loop	Nonconformity	3		1207.0726	-0.00302	-0.00528	0.00509	0.0079	6.573703
C9	Asyn.Loop	Conformity	3		742.1771	0.00239	-0.00255	0.00094	0.0036	4.881018
C10	Asyn.Loop	Nonconformity	3		742.1812	0.00477	-0.00748	-0.01604	0.0183	24.696733
C11	Asyn.Loop	Nonconformity	3		742.1864	-0.00209	0.00241	0.01805	0.0183	24.698837
C12	Sync.Loop	Conformity	3		742.1905	0.00029	-0.00252	0.00107	0.0027	3.704264
C13	Asyn.Loop	Nonconformity	3		1207.0613	0.00326	-0.00268	0.00336	0.0054	4.469860
C14	Asyn.Loop	Nonconformity	3		1207.0644	0.00539	-0.00465	-0.00326	0.0078	6.485258
C15	Asyn.Loop	Nonconformity	3		1207.0708	-0.00279	-0.00562	0.01337	0.0148	12.232395
C16	Sync.Loop	Nonconformity	3		1207.0739	-0.00066	-0.00759	0.00674	0.0102	8.428535
C17	Asyn.Loop	Nonconformity	3		742.1800	0.00422	-0.00097	-0.00275	0.0051	6.903510
C18	Asyn.Loop	Nonconformity	3		742.1841	0.00659	-0.00590	-0.01973	0.0216	29.128857
C19	Asyn.Loop	Nonconformity	3		742.1893	-0.00027	0.00400	0.01436	0.0149	20.091269
C20	Asyn.Loop	Conformity	3		742.1934	0.00211	-0.00093	-0.00262	0.0035	4.699159
C21	Asyn.Loop	Nonconformity	3		1207.0642	0.00508	-0.00109	-0.00033	0.0052	4.316621

Note: Default automatic searching depth is 3 which means the software is automatically searching loops composed with 3 baselines.

The aspects of dealing with loops and repeat baselines which are unqualified are shown as below:

(a) Ensure the correctness of loop closure report configuration, when it is acceptable to reduce the tolerance.

(b) Edit baselines that form the loop and repeat baselines and stop the resolution until qualified. Methods include: disable partial observation data according to residual observation data figure and adjust sample interval.

(c) For individual baselines with poor solutions, it is acceptable to disable or remove them.

Note: Every baseline that forms the loop should meet following acquisitions:

- Every baseline that forms the loop should be used.

- Every baseline that forms the loop should be solved.
- Synchronous observing time should longer than Min. Synchronous value.
- Within the tolerance.
- When one baseline has been processed, loop information in **Loop Closure** list will be updated in real-time.

4.2.3.3 Influencing Factors of Baseline Processing Result

(1) **Factors that affect the result of baseline processing**

(a) The start point preciseness of the coordinate. It leads to errors in scale and direction aspects.

(b) The short duration of observation leads to uncertainty of ambiguity computation. When it comes to baseline, this situation adversely influences the baseline processing result.

(c) Too many cycle slip during a certain period, the corrections are large.

(d) Strong ionosphere and troposphere effect.

(e) Influence of the electromagnetic wave.

(f) The problem of receiver which causes the poor quality of the observation data. For example, the reducing of phase measurement accuracy, receiver clock uncertainty, etc.

(2) **Determination of influencing factors of GNSS baseline processing result**

(a) **Overview**

Some factors like short observation duration, over cycle slip, strong multipath and strong tropospheric and ionospheric refractions that influence the processing result are easy to be determined. But other factors like wrong start point's coordinate are not.

(b) **Determination of start point with the wrong coordinate**

Operators should level up the accuracy of the coordinate of the start point.

(c) **Determination of short observation duration**

It is easy to determine this factor. The user only needs to check the observation duration on each satellite. CGO 2.0 provides satellite visibility chart to make it intuitional.

(d) **Determination of over cycle slip**

To identify this factor, the user can analyze the residuals after baseline processing. At present, most of baseline processing software use dual differential observations. When there are cycle slips that have not been repaired inside the observation data of a certain satellite from a certain station, all the dual differential values increase in integer multiples.

(e) **Determination of strong multipath, ionospheric and tropospheric delays**

To determine these factors, our software uses observation residuals as well. The difference between them is, for these factors, the residuals increase in non-integer multiples. Normally, the value less than one cycle but significantly larger than residuals of normal observations.

(3) **Reacting Method**

(a) **The Wrong Coordinate of the Start Point**

To fix this problem, the user can use start point coordinate with high accuracy. The high accuracy of coordinate can be acquired by doing long-duration single point positioning or tying in with points with precise WGS-84 coordinate. Or, let all the start points of the baselines derived from a certain point, and the result of processing carries a system residual. Then, the user uses GNSS adjustment with system parameters to deal with it.

(b) **Short Observation Duration**

Disable the satellite with short observation duration.

(c) **Too Many Cycle Slips**

If observation data of numerous satellites carries frequent cycle slips, it is reasonable to disable the period with heavy cycle slip problems and try to improve the result of baseline processing. If the frequent cycle slips only show in observation data acquired from few satellites, the user can delete the relative observation data.

(d) **Multipath Effect**

Normally, multipath effect leads to significant residual. The user can reduce the index. Or, the user can disable period or satellite with strong multipath effect.

(e) **Ionospheric and Tropospheric Delay**

The methods to deal with Ionospheric and Tropospheric delay are:

Increasing the elevation mask, disable observation data with low elevation angle. This method is blindness given the fact that it is not always true that signals with low elevation suffer strong atmospheric affection.

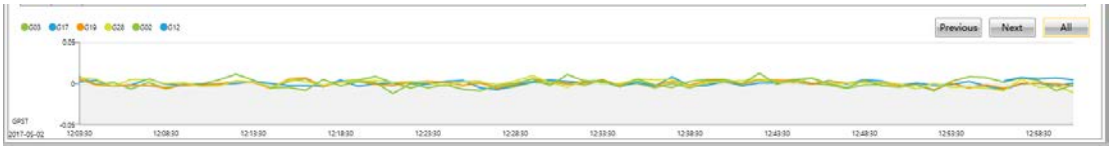
Using models to correct Ionospheric and Tropospheric delay.

For dual-frequency observation data, the user can use Lc combination disables the Ionospheric delay during the baseline processing.

(4) **A powerful tool for elaborate processing on baselines – residual observation data figure.**

During the baseline processing, it is necessary to determine the processing result's influencing factors or determine the quality problem on which period from which satellite. The residual observation data figure based on residuals.

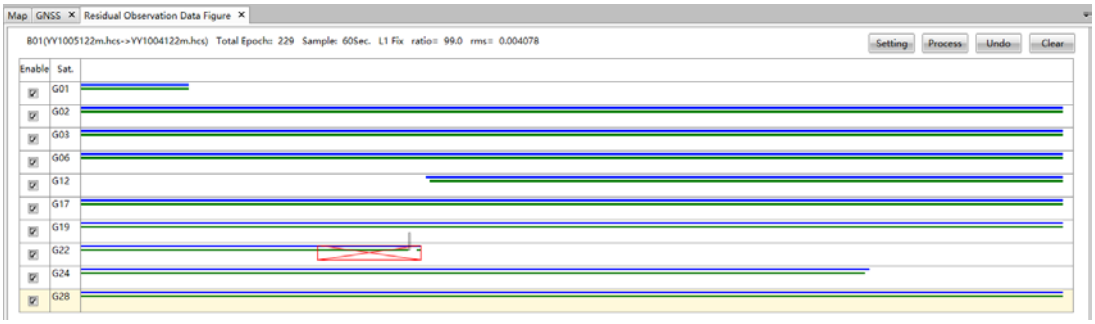
Click **[Previous]**, **[Next]**, user can see every dual-differential combination residual. In the residual figure, G represent GPS, R represents GLONASS, C represent BDS and E represents Galileo.



4.2.4 Processing Single Baseline Repeatedly

During the baseline survey, there are non-qualified baselines. After the influencing factors determined, the user can edit baseline processing settings or edit baselines to process the repeat baselines.

Open the residual observation data figure screen and select the baseline to be disabled. Data covered by red frame means that this baseline section is disabled. Right-click the red frame, then users can restore disabled data. Click **[Process]** on the upper right, software does baseline processing using edited data.

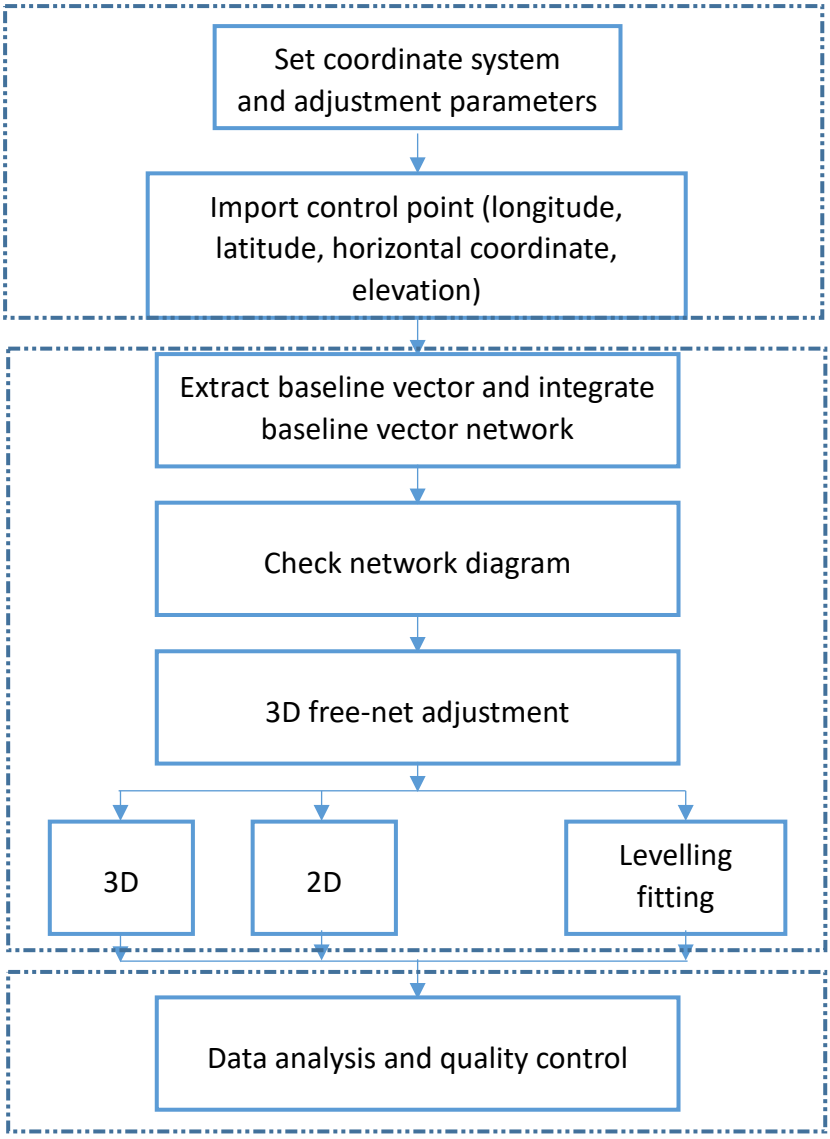


4.3 Adjustment

CGO 2.0 provides free-net adjustment, constraint adjustment and elevation fitting functions.

Basic adjustment steps show as below:

(1) Preparation. Coordinate system setting, loading control point information and baseline processing need to be finished in this step.
(2) Adjustment. Configure adjustment parameters and click **[Adjustment]**, then the software will automatically calculate.
(3) Analyze and controll the adjustment result.

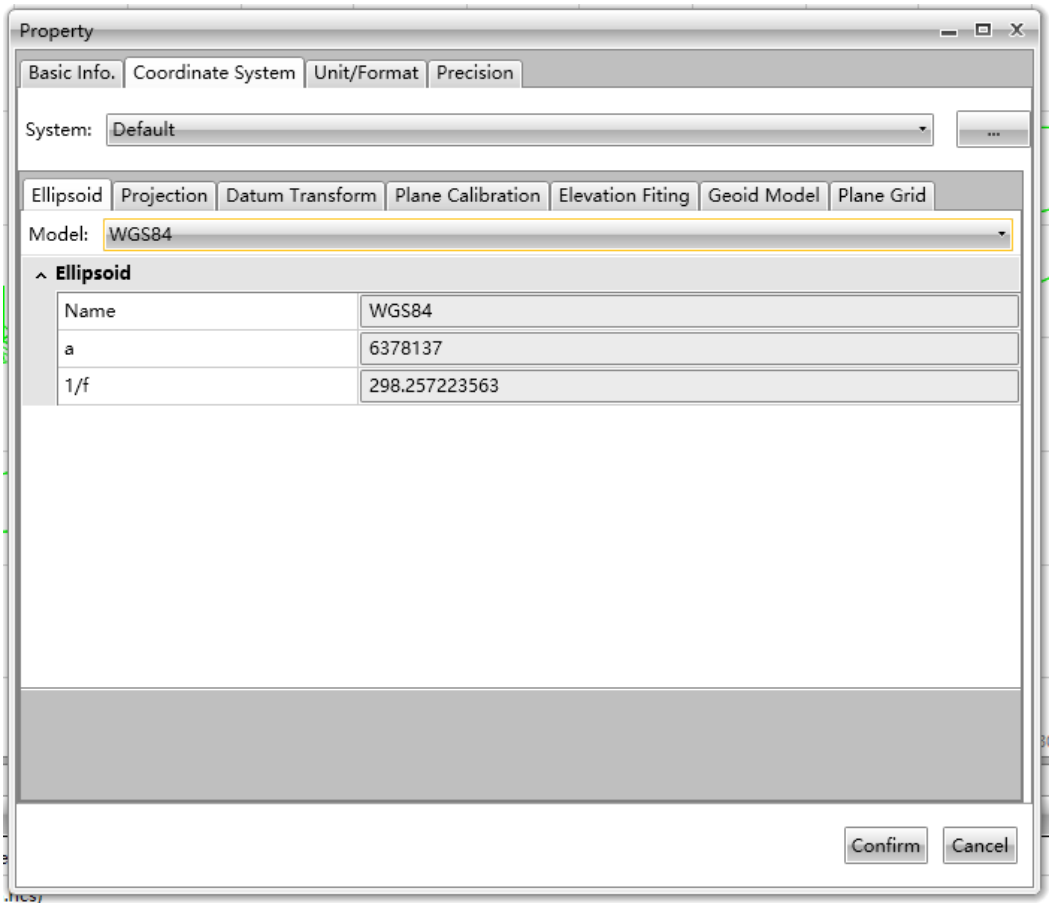


4.3.1 Preparation for Adjustment

4.3.1.1 Coordinate System Configuration

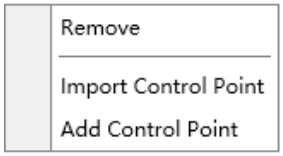
The purpose of this step is checking the coordinate system parameters. Before the adjustment, it is needed to ensure the correctness of coordinate system setting.

Users can edit the setting through **[Project]** → **[Coordinate System]**, or through **[Tools]** → **[Coordinate System Manager]**.

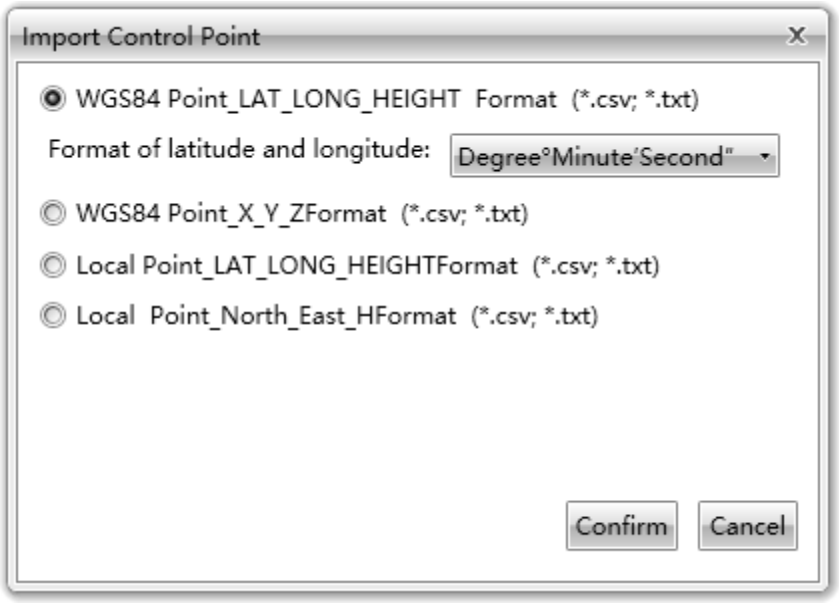


4.3.1.2 Import Control Point

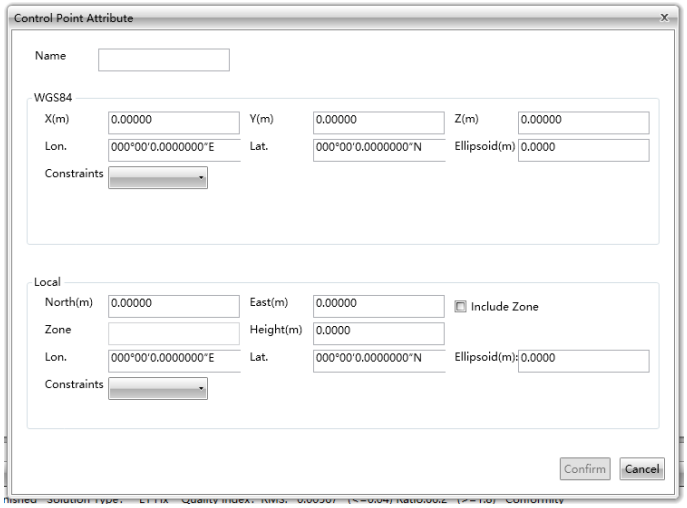
Click **[GNSS]** → **[Control Point]**, users can import control point or add control point by pressing on right mouse button in **[Control Point]** list.



(1) As for importing control point, users can select the coordinate system and data format, then click **[Confirm]**. A window will pop up and users can choose the file in local storage.

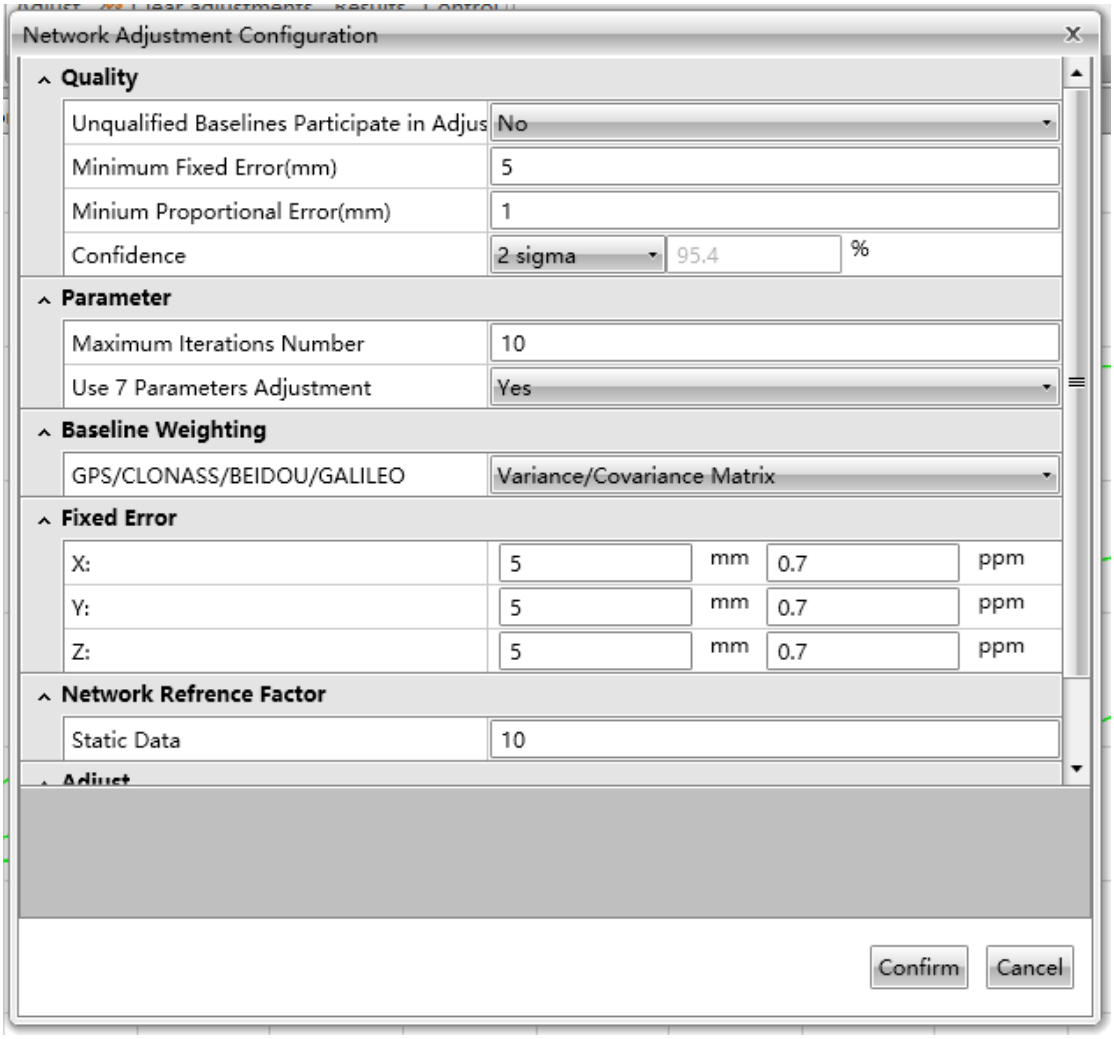


(2) As for adding control point, users need to input at least one kind of coordinate type, then click **[Confirm]** to finish.



4.3.1.3 Adjustment Configuration

Click **[GNSS]** → **[Adjustment]** → **[Configuration]**, users can see a pop-up window and modify the adjustment parameters as need.



[Unqualified Baseline Participant in Adjustment]: This refers to whether users want to use unqualified baseline for adjustment. If users choose **[No]**, the software won't use unqualified baseline for adjustment. Otherwise, the software will. The default option is **[No]**, and users can modify it as need.

4.3.2 Adjustment

4.3.2.1 Extract Baseline Vector Network

This is the first step of the adjustment processing. Following are principles of composing baseline vector network:

(1) This baseline exists and has not been disabled.
(2) This baseline is with start point and resolved point names.

(3) This baseline is qualified after baseline processing.
(4) This baseline has not been checked in “do not participate baseline processing and adjustment” box.

Only the baseline meets above four requirements can be added in network adjustment and composed as baseline vector network automatically.

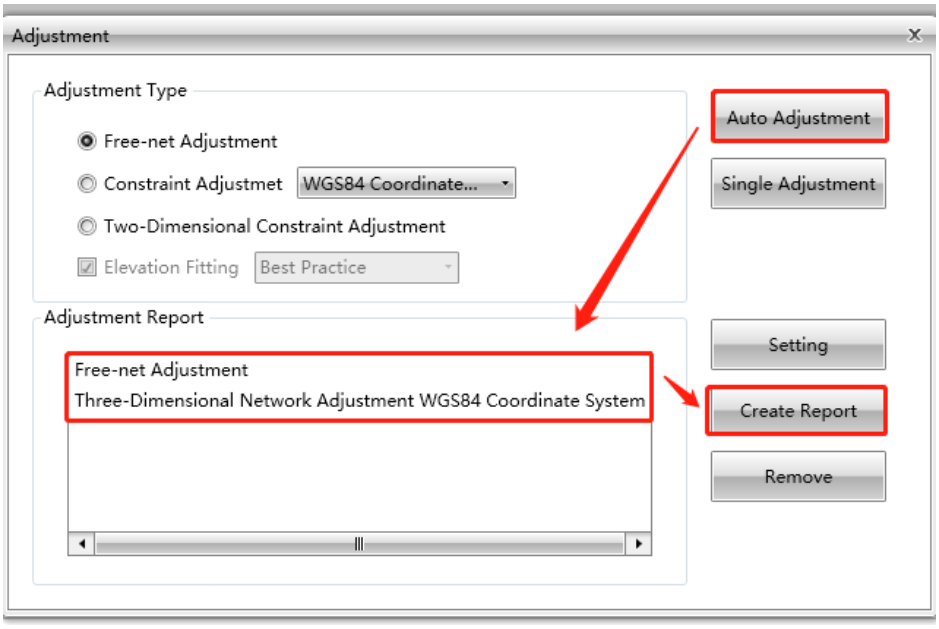
4.3.2.2 The Connection Test of the Baseline Vector Network

The adjustment can’t be convergence if the network is not connected. Therefore, our software will automatically conduct the connection test before the adjustment.

4.3.2.3 Auto Adjustment

There are three types to adjust data: free-net adjustment, 3D and 2D constraint adjustment.

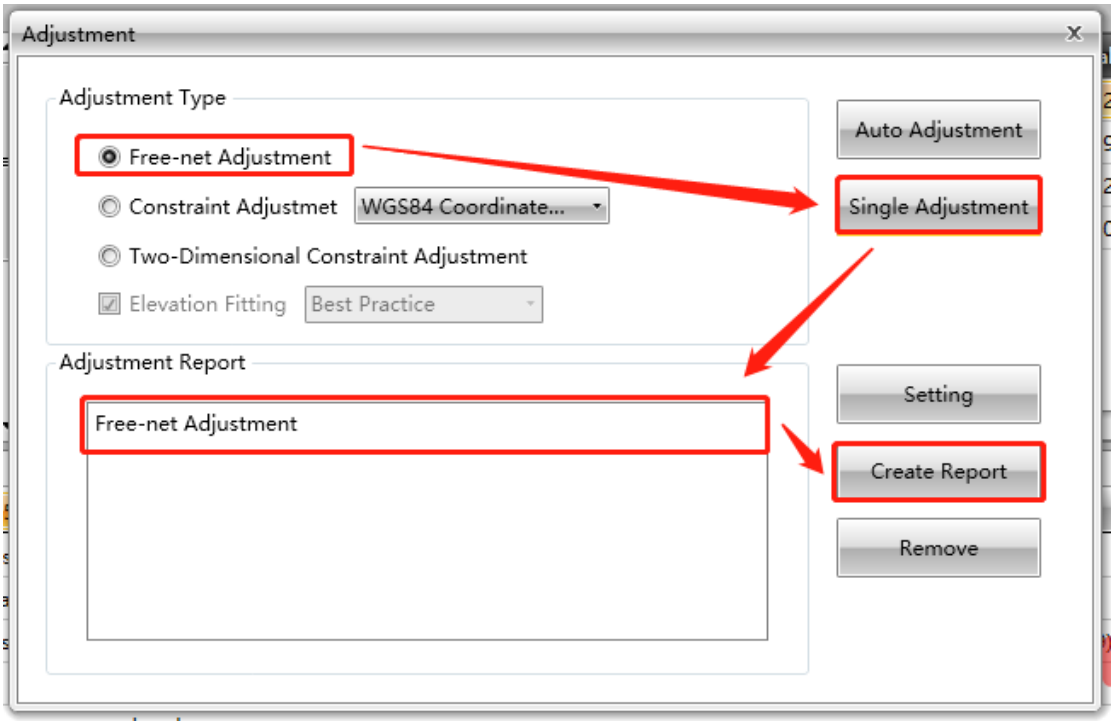
Auto adjustment means adjusting data with all three types according to the baseline processing results and control points, and users can select the target reports. There is no need to select the adjustment type one by one.



4.3.2.4 Free-net Adjustment

Free-net adjustment will be automatically calculated based on the known baseline processing result, the adjustment configuration and the stations’ coordinates. The result of the free-net adjustment shows in the network diagram screen, baseline list, station list and adjustment report.

Select **[Free-net Adjustment]**, click **[Single Adjustment]**, and then users can see the report type in **[Adjustment Report]** window. Click **[Create Report]** to create and open a HTML report, the default storage path of reports is: "CGO2/Project/(Project Name)/GNSS/Reports/".



The free-net adjustment report includes baselines input in WGS84, adjusted baselines in WGS84, adjusted geodetic coordinates in WGS84, adjusted ECEF coordinates in WGS84, adjusted grid coordinates and height in local system, worst baseline and station statistics, coordinate change and error ellipse.

[Baselines Input in WGS84]: Includes DX, Std.DX, DY, Std.DY, DZ, Std.DZ of each baseline after adjustment, respectively.

[Adjusted Baselines in WGS84]: Includes observation azimuth, ellipsoid height, ellipsoid distance, residual, horizontal precision ratio and 3D precision ratio of each baseline, respectively.

[Adjusted Geodetic Coordinates in WGS84]: Includes latitude, latitude error, longitude, longitude error, ellipsoid height and ellipsoid height error of each point after adjustment, respectively.

[Adjusted ECEF Coordinates in WGS84]: Includes X, X error, Y, Y error, Z, Z error and 3D error of each point after adjustment respectively in ECEF WGS84 Coordinate system.

[Adjusted Grid Coordinates and Height in Local System]: Includes North, North Error, East, East Error, Height and Height Error of each point after adjustment respectively in

the Local System.

[Worst Baseline and Station Statistics]: Shows the coordinates and errors of the worst baseline and the worst station.

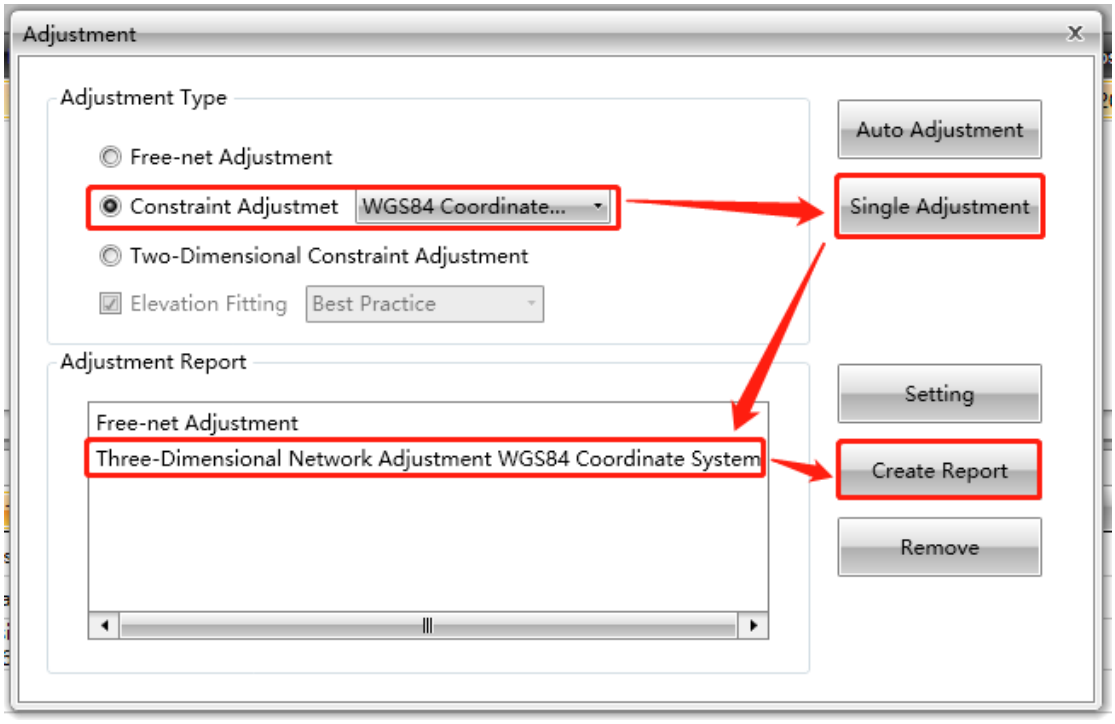
[Coordinate Change]: Includes ΔNorth, ΔEast and ΔEllipsoid Height of each point after adjustment respectively.

[Error Ellipse]: Includes Major Axis, Short Axis, Azimuth and picture of each error ellipsoid.

4.3.2.5 3D Constraint Adjustment

When the user wants to select constraint adjustment during the configuration, it is necessary to use XYZ or BLH to constrain at least one station of the baseline vector network in advance.

Select **[Constraint Adjustment]**, click **[Single Adjustment]**, and then users can see the report type in **[Adjustment Report]** window. Click **[Create Report]** to create and open a HTML report, the default storage path of reports is: "CGO2/Project/(Project Name)/GNSS/Reports/".



The three-dimensional network adjustment wgs84 coordinate system report includes baselines input in WGS84, adjusted baselines in WGS84, adjusted geodetic coordinates in WGS84, adjusted ECEF coordinates in WGS84, adjusted grid coordinates and height

in local system, worst baseline and station statistics, coordinate change and error ellipse.

[Baselines Input in WGS84]: Includes DX, Std.DX, DY, Std.DY, DZ, Std.DZ of each baseline after adjustment, respectively.

[Adjusted Baselines in WGS84]: Includes observation azimuth, ellipsoid height, ellipsoid distance, residual, horizontal precision ratio and 3D precision ratio of each baseline, respectively.

[Adjusted Geodetic Coordinates in WGS84]: Includes latitude, latitude error, longitude, longitude error, ellipsoid height and ellipsoid height error of each point after adjustment, respectively.

[Adjusted ECEF Coordinates in WGS84]: Includes X, X error, Y, Y error, Z, Z error and 3D error of each point after adjustment respectively in ECEF WGS84 Coordinate system.

[Adjusted Grid Coordinates and Height in Local System]: Includes North, North Error, East, East Error, Height and Height Error of each point after adjustment respectively in the Local System.

[Worst Baseline and Station Statistics]: Shows the coordinates and errors of the worst baseline and the worst station.

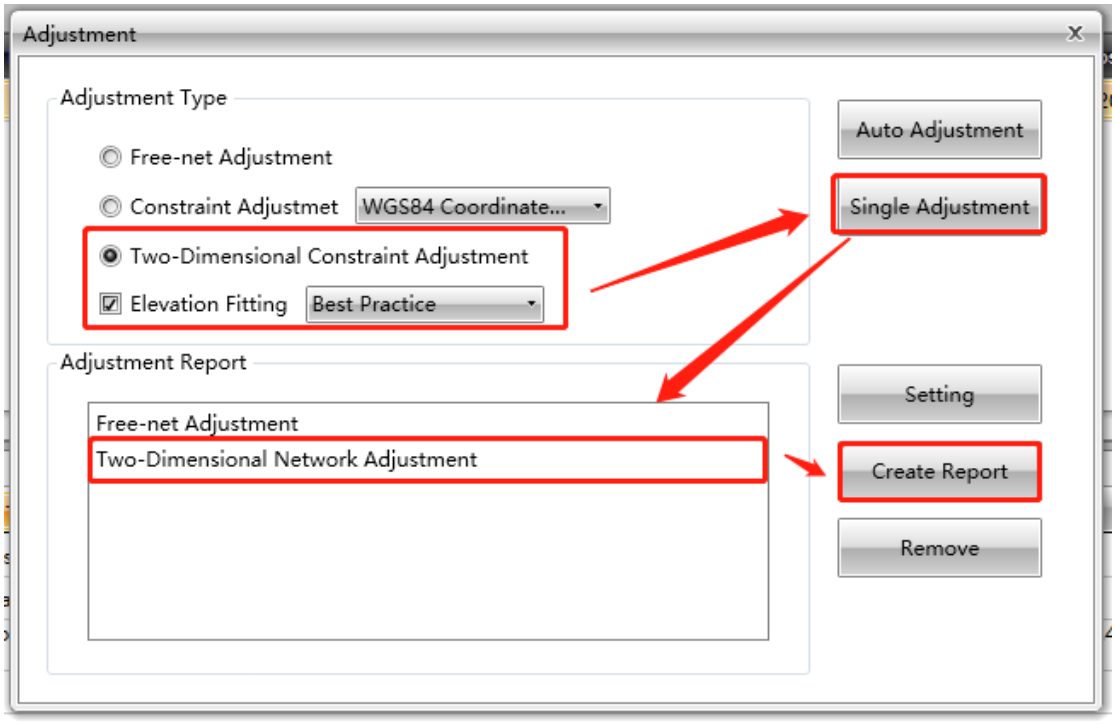
[Coordinate Change]: Includes ΔNorth, ΔEast and ΔEllipsoid Height of each point after adjustment respectively.

[Error Ellipse]: Includes Major Axis, Short Axis, Azimuth and picture of each error ellipsoid.

4.3.2.6 Two-dimensional Constrain Adjustment

When the user checks two-dimensional constrain adjustment for the adjustment, it is necessary to conducts N, E constrain on at least one station in baseline vector network.

Select **Two-dimensional Constraint Adjustment**, click **[Single Adjustment]**, and then users can see the report type in **[Adjustment Report]** window. Click **[Create Report]** to create and open a HTML report, the default storage path of reports is: “CGO2/Project/(Project Name)/GNSS/Reports/”.



The three-dimensional network adjustment wgs84 coordinate system report includes baselines input in WGS84, adjusted baselines in WGS84, adjusted geodetic coordinates in WGS84, adjusted ECEF coordinates in WGS84, adjusted grid coordinates and height in local system, worst baseline and station statistics, coordinate change and error ellipse.

[Baselines Input in WGS84]: Includes DX, Std.DX, DY, Std.DY, DZ, Std.DZ of each baseline after adjustment, respectively.

[Adjusted Baselines in WGS84]: Includes observation azimuth, ellipsoid height, ellipsoid distance, residual, horizontal precision ratio and 3D precision ratio of each baseline, respectively.

[Adjusted Geodetic Coordinates in WGS84]: Includes latitude, latitude error, longitude, longitude error, ellipsoid height and ellipsoid height error of each point after adjustment, respectively.

[Adjusted ECEF Coordinates in WGS84]: Includes X, X error, Y, Y error, Z, Z error and 3D error of each point after adjustment respectively in ECEF WGS84 Coordinate system.

[Adjusted Grid Coordinates and Height in Local System]: Includes North, North Error, East, East Error, Height and Height Error of each point after adjustment respectively in the Local System.

[Worst Baseline and Station Statistics]: Shows the coordinates and errors of the worst baseline and the worst station.

[Coordinate Change]: Includes ΔNorth, ΔEast and ΔEllipsoid Height of each point after adjustment respectively.

[Error Ellipse]: Includes Major Axis, Short Axis, Azimuth and picture of each error ellipsoid.

When the user selects the **Elevation Fitting**, it is necessary to conduct BLH or NEh, or h constrain on at least on one station in baseline vector network.

4.4 Data Graph

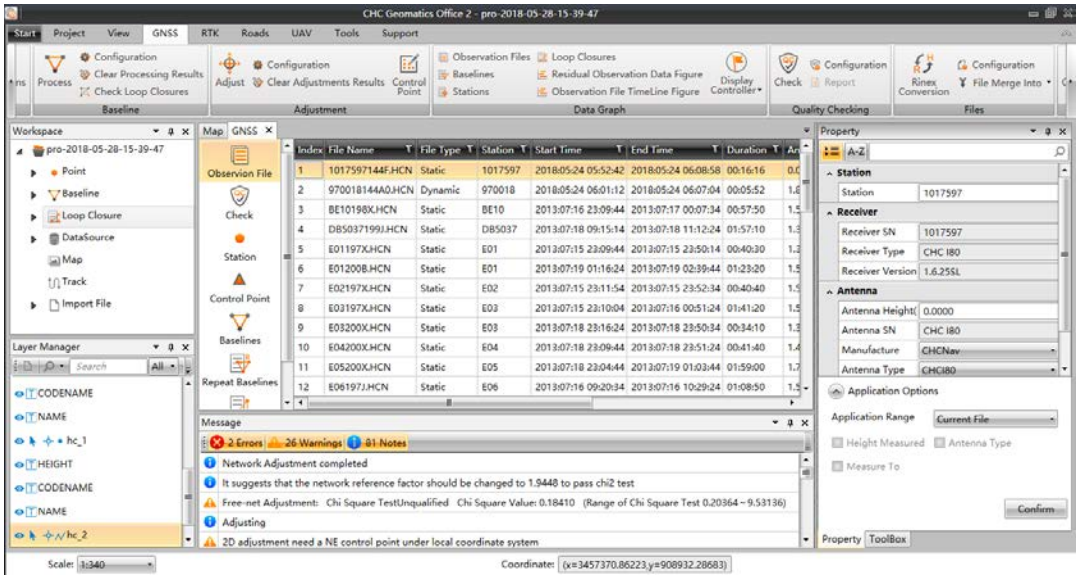
4.4.1 Observation File

After importing data in GNSS menu, users will see the observation file list in **GNSS** window.

4.4.1.1 Property

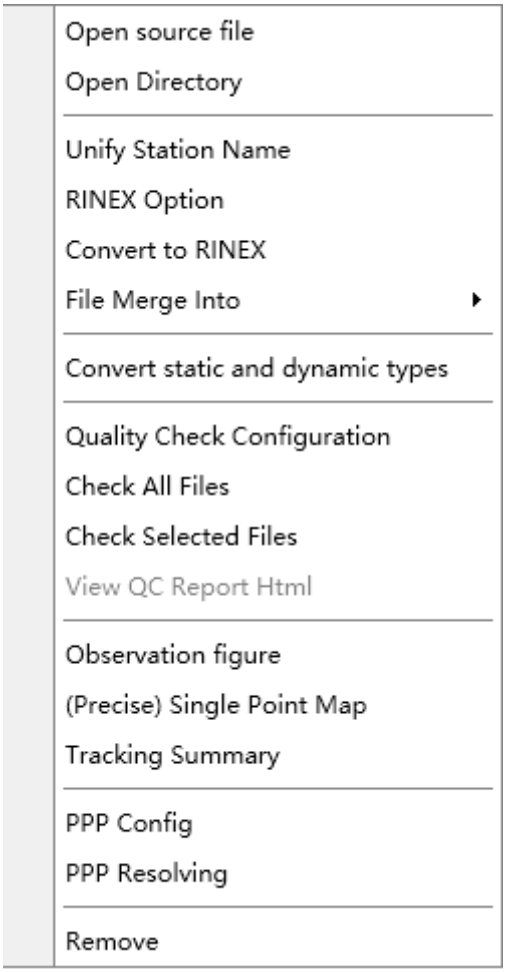
Click on one observation file, then users can see the file properties:

(1) In **[GNSS]** window, users can see file name, file type, station name, start and end time, duration, antenna height, antenna manufacture, antenna type, antenna measurement type, receiver SN, receiver type and file path.
(2) In **[Property]** window, users can see station name, receiver SN, receiver type, receiver firmware version, antenna height, antenna SN, antenna manufacture, antenna type and antenna measurement type, of which station name, antenna height, manufacture, antenna type and antenna measurement type are editable.



4.4.1.2 Sub-menu

After right clicking on the observation file, a sub-menu will pop up.



[Open source file]: View raw observation data by a pop-up notepad window.

[Open Directory]: Open storage path of observation file.

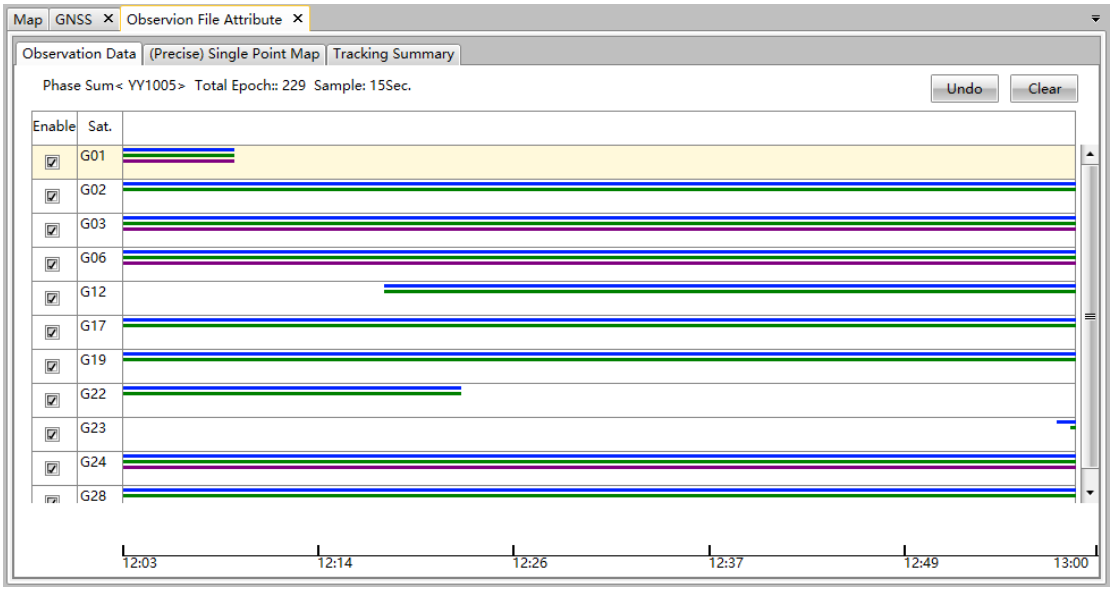
[Unify Station Name]: Unify two or more than two observation files into the same station name.

As for **[RINEX Option]**, **[Convert to RINEX]** and **[File Merge Into]**, please see details in **4.6 Files**.

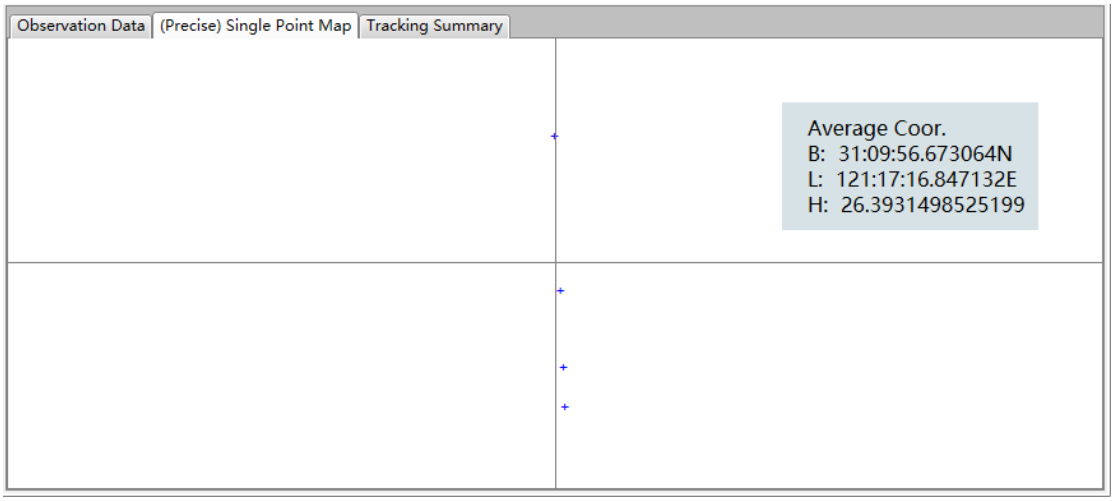
[Convert Static and Dynamic Types]: Switch observation data file type from static to dynamic or from dynamic to static.

As for **[Quality Check Configuration]**, **[Check All Files]**, **[Check Selected Files]**, **[View QC Report Html]**, please see details in **4.5 Quality Checking**.

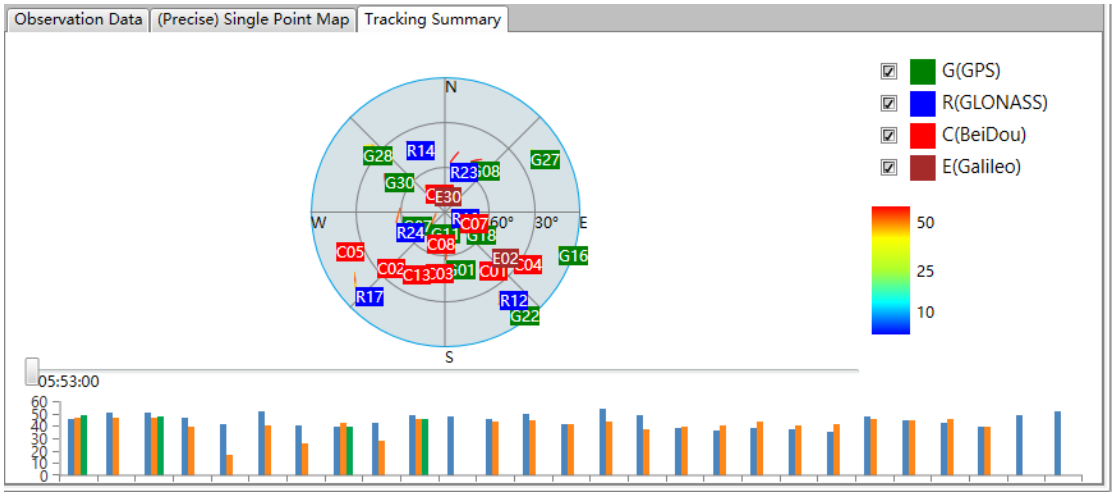
[Observation figure]: View satellite list and observation time.



[(Precise) Single Point Map]: View average coordinates.



[Tracking Summary]: View the tracking satellite image (The vertical axis refers to SNR) and satellite signal map.



As for **[PPP Config]**, **[PPP Resolving],** please see details in **4.7 PPP**.

[Remove]: Delete the station directly.

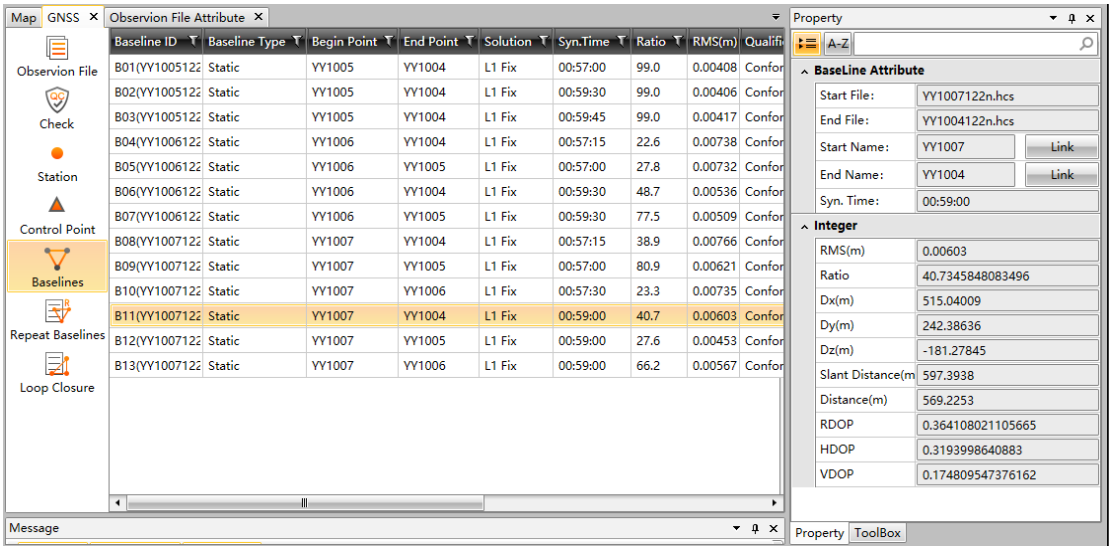
4.4.2 Baseline List

4.4.2.1 Property

Click on one baseline, then users can see the file properties:

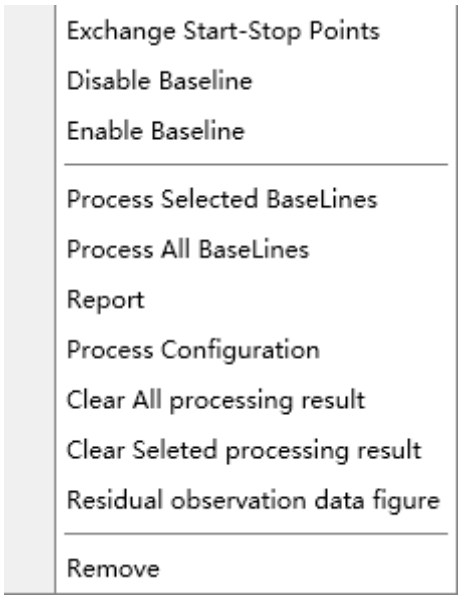
(1) In **[GNSS]** window, users can see baseline ID, baseline type, begin and end point, solution, syn. time, ratio, RMS, quality status, dx, std. D(x), dy, std. D(y), dz, std. D(z), distance and use status.

(2) In **[Property]** window, users can see start file, end file, start station name, end station name, syn. time, RMS, ratio, Dx, Dy, Dz, slant distance, distance, RDOP, HDOP and VDOP, of which station name, antenna height, manufacture, antenna type and antenna measurement type are editable.



4.4.2.2 Sub-menu

After right clicking on the baseline, a sub-menu will pop up.



[Exchange Start-Stop Points]: Click to change the accuracy of the process through exchange the start and stop points of the baseline. The software usually uses the start point coordinates to correct the end point, so it's better to change start point and stop point when the accuracy of stop point is higher than the start point.

[Disable/Enable Baseline]: Through these two options, users can choose whether the baseline is used for the baseline processing, adjustment and generating various reports.

[Process All/Selected Baselines]: Click to process all/selected baselines.

[Report]: Click to view the baseline report, and it will be opened automatically.

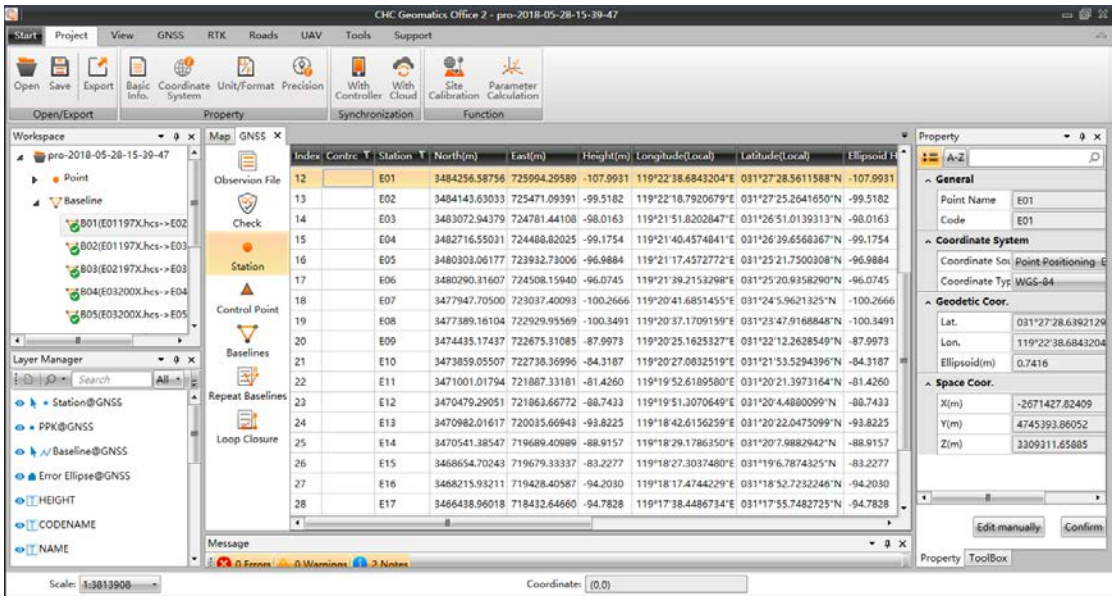
[Process Configuration]: Click to configure process parameters before processing.
[Clear All/Selected Processing Result]: Click to clear all/selected processing result.
[Residual Observation Data Figure]: Click to check residual observation data figure and deal with unqualified data manually.
[Remove]: Click to remove the selected baselines from current project.

4.4.3 Station List

4.4.3.1 Property

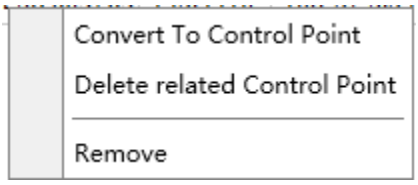
Click on one station, then users can see the file properties:

(1) In **[GNSS]** window, users can see control point status, station name, local north, east coordinates and height, local longitude, latitude and ellipsoid height, WGS84 X, Y, Z coordinates, WGS84 longitude, latitude and ellipsoid height.
(2) In **[Property]** window, users can see point name, code, coordinate source, coordinate type, latitude, longitude, ellipsoid height, X, Y and Z coordinates. Except point name and code, all properties are editable by clicking **[Edit manually]**.



4.4.3.2 Sub-menu

After right clicking on the station, a sub-menu will pop up.



[Convert to Control Point]: Convert selected point to control point.

[Delete Related Control Point]: Delete selected control point.

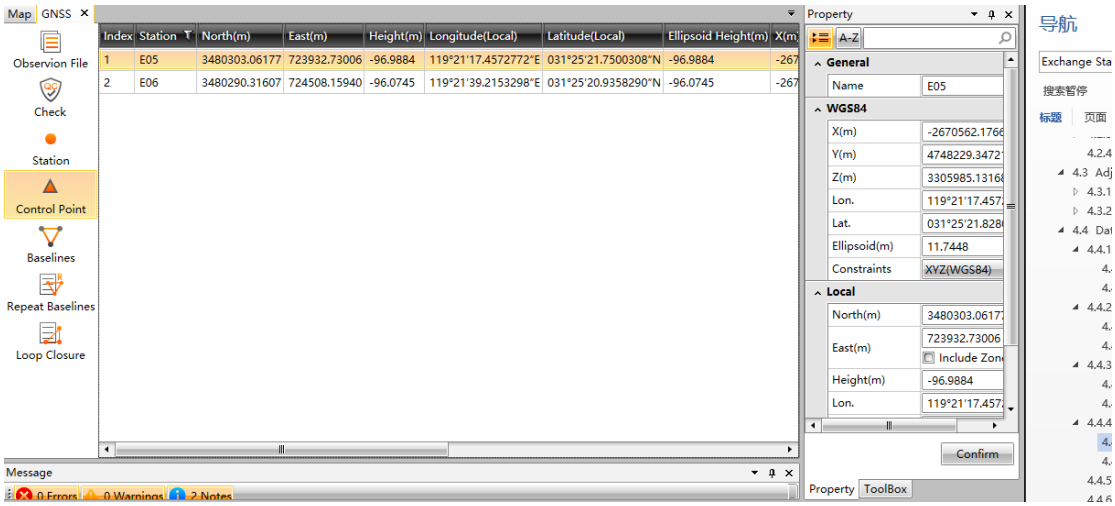
[Remove]: Delete the station.

4.4.4 Control Point List

4.4.4.1 Property

Click on one station, then users can see the file properties:

Users can check and modify all properties in both **[GNSS]** window and **[Property]** window, including station name, local north, east coordinates and height, local longitude, latitude and ellipsoid height, WGS84 X, Y, Z coordinates, WGS84 longitude, latitude**,** ellipsoid height and constraints.



4.4.4.2 Sub-menu

After right clicking on the station, a sub-menu will pop up.

[Remove]: Delete selected control point.

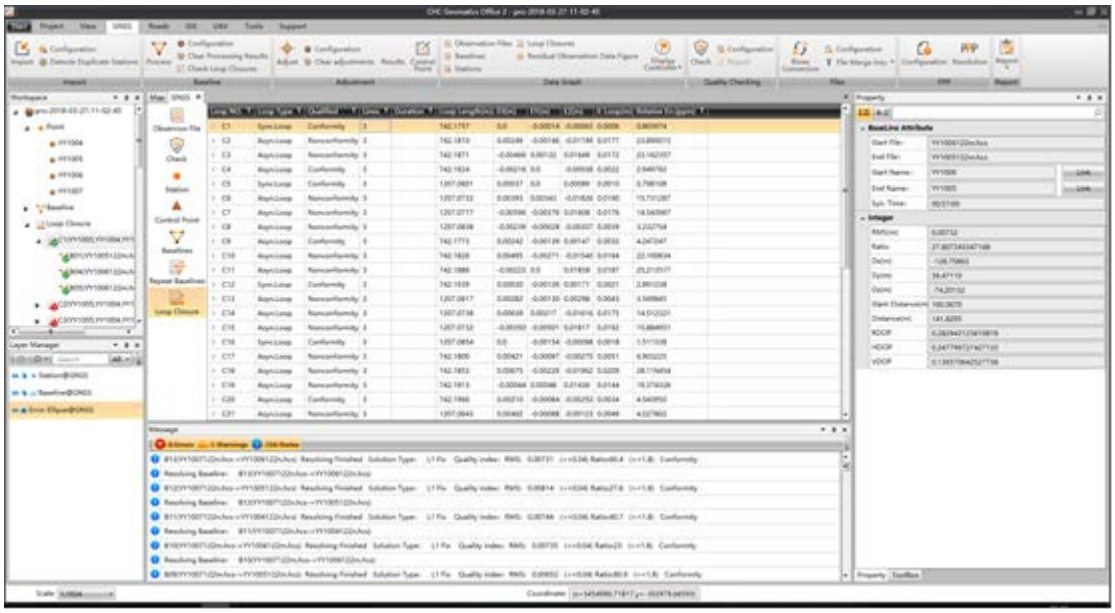
[Import Control Point]: Import control point, users can choose the coordinate type and file format of import file.

[Add Control Point]: Add a new control point.

4.4.5 Loop Closure List

Click on one loop, then users can see the file properties:

(1) In **[GNSS]** window, users can see loop number, loop type, quality status, baseline number, duration, loop length, EX, EY, EZ, E-loop and RMS
(2) In **[Property]** window, users can see start file name, end file name, start station name, end station name, syn. time, RMS, ratio, Dx, Dy, Dz, slant distance, distance, RDOP, HDOP and VDOP.



4.4.6 Residual Observation Data Figure

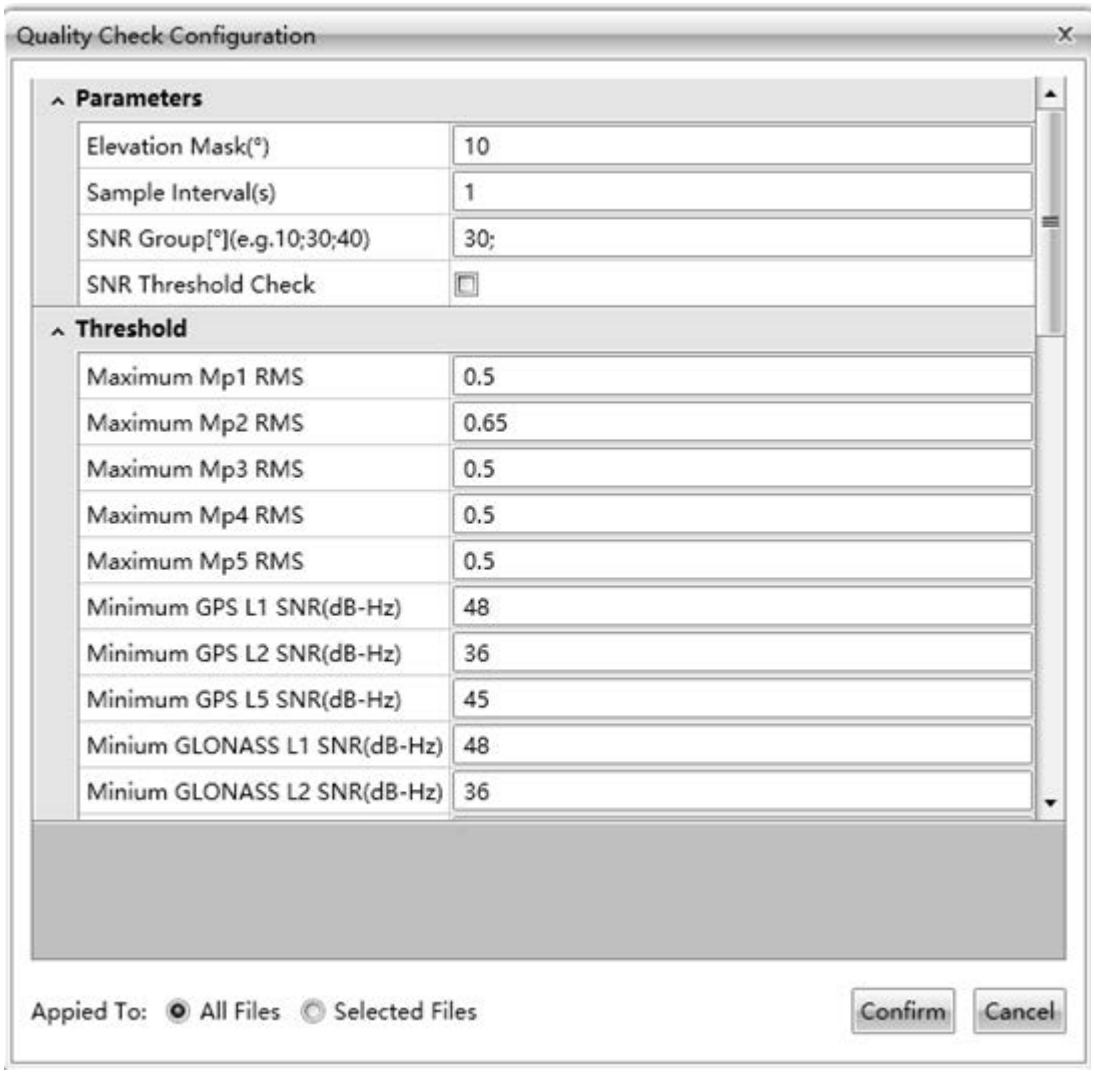
Users can check observation data quality in this interface, and manually disable the baseline in low quality. The RMS and ratio value are the standard for quality checking.

4.5 Quality Checking

4.5.1 Configuration

To check the quality of observation data, it is needed to configure the checking beforehand. Click **[Configuration]** in **[Quality Checking]** toolbar field and set the coefficient. They are parameters, threshold, constellation, minimum satellites for SNR.

At the bottom of the box, the user can choose files the setting applied to, and it is **[All Files]** by default. Also, the user can choose files in observation file list.



4.5.2 Checking

After setting completed, click **[Check]**. The software checks all the observation files by default.

4.5.3 Report

When the quality checking finished, users can click **[Report]** in **[Quality Checking]** toolbar field and check the report one by one.

CHCNAV

Quality Check Report

Real-time QC Result

Observation File Name	YY1005122m.HCN
Quality Check Result	passed

Observation Info

Name	Result
Time of First Epoch	2017-05-02 12:03:30
Time of Last Epoch	2017-05-02 13:00:30
Session(Days)	0
Time Span	00:57:00
Ele Mask	10
Data Interval(Sec.)	15
Systems	GPS;GLN;BDS;Galileo;
WGS84(X,Y,Z)(XYZ)m	-1747819.0292 5189063.2943 3260421.7221

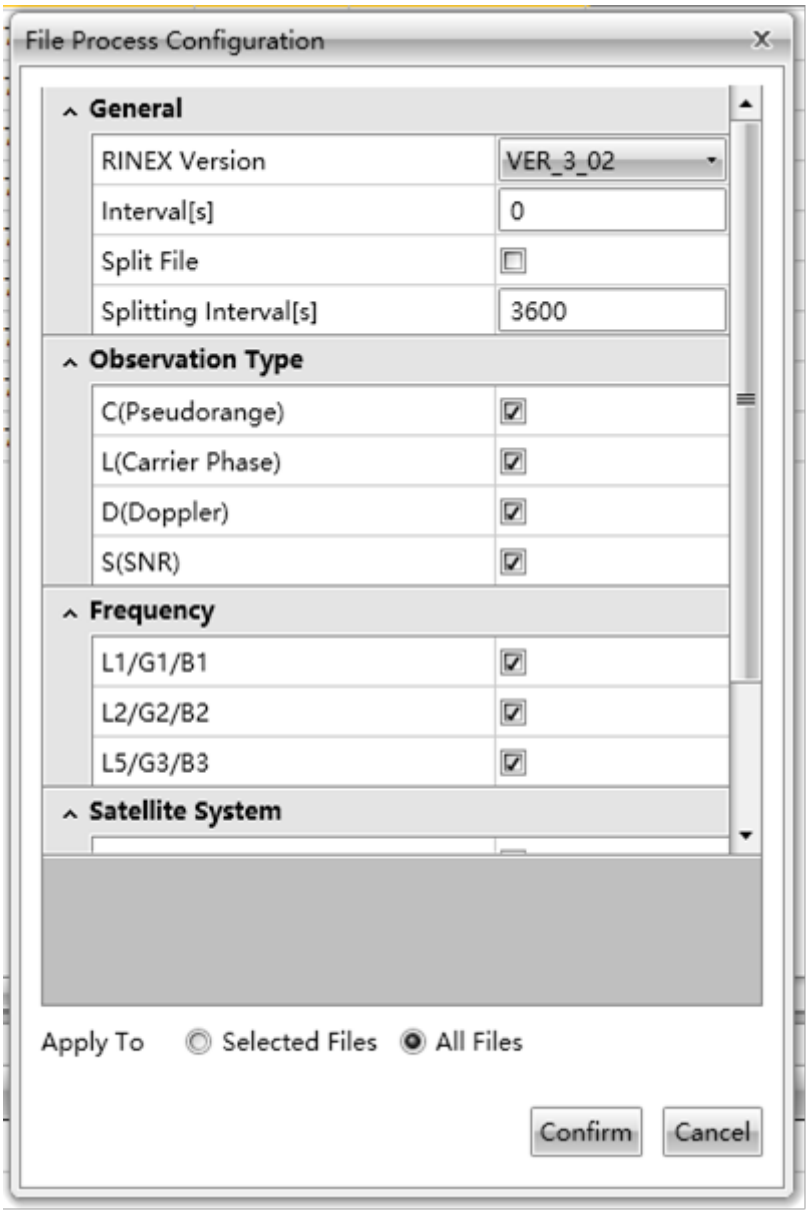
Multipath Effect

Prn	MP1 (m)	MP1 Threshold (m)	Result Judgement	MP2 (m)	MP2 Threshold (m)	Result Judgement	MP5 (m)	MP5 Threshold (m)	Result Judgement	MP6 (m)	MP6 Threshold (m)	Result Judgement	MP7 (m)	MP7 Threshold ((m)	Result Judgement
G02	0.35000	0.5000	passed	0.51000	0.6500	passed	0.00000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G03	0.34000	0.5000	passed	0.64000	0.6500	passed	0.33000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G06	0.34000	0.5000	passed	0.42000	0.6500	passed	0.35000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G12	0.88000	0.5000	unpassed	1.52000	0.6500	unpassed	0.00000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G17	0.340	0.5000	passed	0.400	0.6500	passed	0.00000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed

4.6 Files

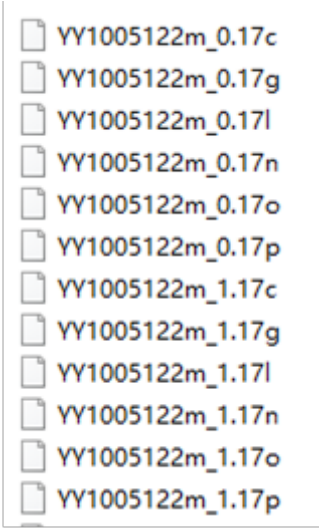
4.6.1 Convert to RINEX File

The HCN/RINEX file can be converted to RINEX file with version 2.11 or 3.02. Click **[Configuration]** in **[Files]** field at the top of the software screen. Then, set all parameters and click **[Comfirm]** in right click sub-menu at observation file list.



In file process configuration screen, the user can set Splitting interval, Observation Type, Frequency, and Satellite System. Also, the software provides file split service when the “Split File” is checked. Output folder can be opened after the converting, or

the user can open the folder by right click on the observation file list and choose **[Open Directory]**. The default folder to store the converted file named “RINEX”. If applied “Split File” function, there is sub-folder with the same name as the raw file, and the files end with an underline and numbers.



4.6.2 File Merging

Given the fact that most of the observation data are observed at the same station in multiple periods. And receiver separates the observation data into different files for each period. This leads to many repeat baselines when importing them into post-processing software like CGO 2.0. When the user wants to solve the entire period of the baseline, it is inconvenient. Because most of the post-processing software uses a single baseline solution model, which processes the generated baselines one by one. CGO 2.0 provides file merging functions, can merge the observation files of the same station in multiple periods into one main observation file, then imported into the post-processing software, it can resolve the total period baseline.

It is a simple operation to do file merging. Right-click in observation file screen, **[File Merge to] → [RINEX File]** / **[Primary File]**. See **Figure 4-56**.

Note: files that are selected for merging should observe at the same station and have not overlap duration.

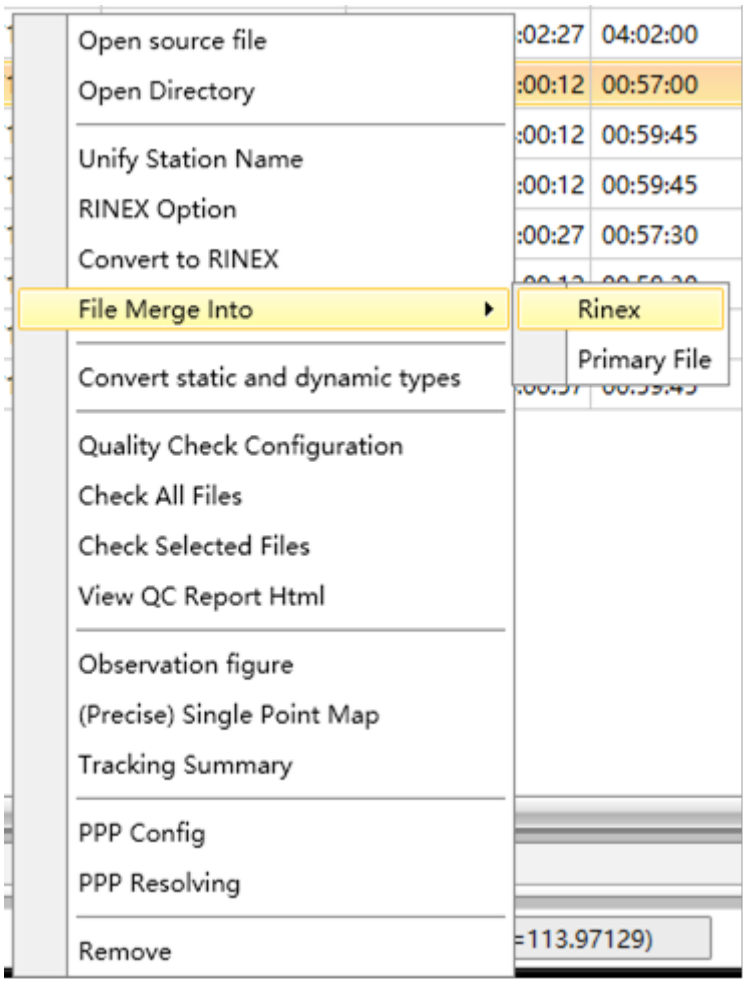


Figure 4-1

Merged files named in the way which is “station name”+”day of the year” + ”(combined)”. As the **Figure 4-57**.

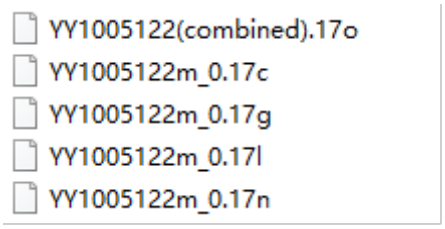
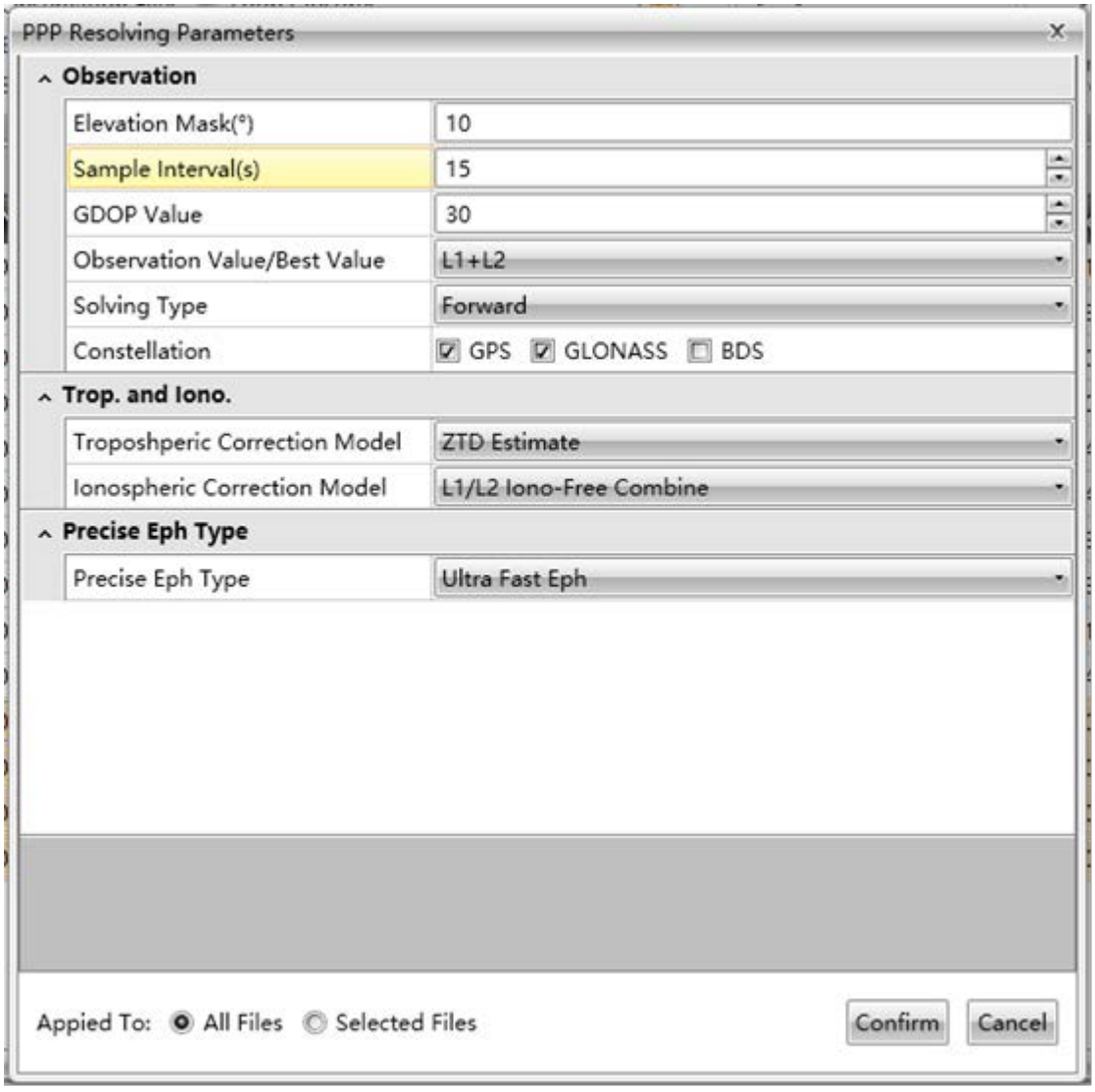


Figure 4-2

4.7 PPP

PPP means precise point positioning. The first step is setting, as following **Figure 4-58**, including Observation, Trop. And Iono. Models, Precise Eph Type. Among them, the precise Ephemeris needs to be download. Click **[Resolution]** button or click **[PPP Resolving]** in right click sub-menu at observation file list screen. The software downloads the Precise Ephemeris file and correction file and resolves the data automatically.



4.8 Report

CGO 2.0 provides report outputting function for baseline processing, loop closure, observation station, repeat baselines, and adjustment. The user can customize the

report contents and output corresponding report.

4.8.1 Baseline Report

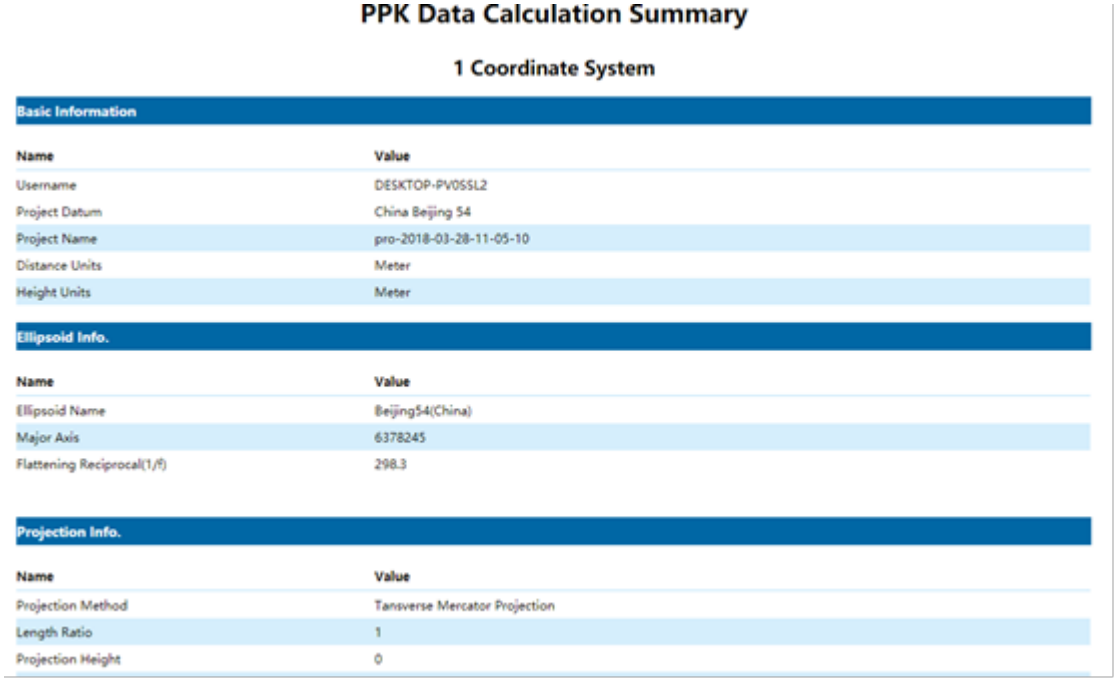
4.8.1.1 Static Baseline Processing Report

Click **[Report]** - **[Baseline Report]** and the software generates baseline report in HTML format. This report includes 6 modes: Baseline Summary, Occupations Data, Baseline Components, Tracking Summary, Residuals, Processing Style. The processing style includes static, basic setting, Troposphere, Ionosphere, Ambiguity, Quality.

4.8.2 PPK Data Calculation Summary

PPK data calculation summary includes Coordinate System, Map, and baseline information. And in baseline information section, there are three parts: base station information, rover, and baselines.

4.8.2.1 Coordinate System



PPK Data Calculation Summary

1 Coordinate System

Basic Information	
Name	**Value**
Username	DESKTOP-PV0SSL2
Project Datum	China Beijing 54
Project Name	pro-2018-03-28-11-05-10
Distance Units	Meter
Height Units	Meter

Ellipsoid Info.	
Name	**Value**
Ellipsoid Name	Beijing54(China)
Major Axis	6378245
Flattening Reciprocal(1/f)	298.3

Projection Info.	
Name	**Value**
Projection Method	Tansverse Mercator Projection
Length Ratio	1
Projection Height	0

4.8.2.2 Map

There is a map of processed dynamic baselines. The user can view the configuration of the rovers and the base stations.

4.8.2.3 Baseline Information

(1) Base Station Information

The number of the base station is not limited to one in dynamic data. It is also possible to have two or more base stations. In the same way, the number of the rover is not limited to one. But the PPK report is in one rover one base format.

3.1 Base Station Information

Name	Value
ReferenceStation Name	YY1005
Receiver SN Number	123456
Start Time	05/02/2017 12:03:30 (week 1947 216210s)
End Time	05/02/2017 13:00:30 (week 1947 219630s)
Antenna Type	3S-02-TSADM NONE
Survey Type	Antenna Phase Center
Antanna Height(m)	0.0000
Latitude	030°56'28.8072129"N
Longitude	108°36'53.7687326"E
Ellipsoid Height(m)	204.5639
North(m)	3454862.69245
East(m)	-302668.96476
Height(m)	95.8508
Constraint Type	

(2) Rover

Before output information about each station, it is needed to calculate overall information including total epoch, participate in observation count and number of fixed solution. Not all the epochs join the calculation and not all the epochs joined the calculation can get the fixed resolution. The unfixed solution named as float solution.

3.2 Rover

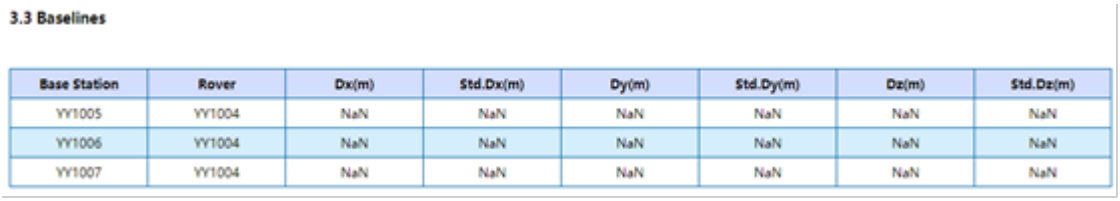
Total Epoch:2 Participate In Observion Count: 2 Fixed : 0

Epoch(GPST)	Rover	Type	Solution Type	Satellite Count	Latitude(Local)	Std.B(s)	Longitude(Local)	Std.L(s)	Ellipsoid Height(m)	Std.H(s)
2017-05-02 13:01:00	YY1004	Static(Stop)	Pseudo-range Diff	5	030°56'27.2778765"N	0.0373	108°36'41.9972805"E	0.1063	157.5206	4.6433
2017-05-02 13:01:15	YY1004	Static(Stop)	Pseudo-range Diff	5	030°56'27.2614391"N	0.0368	108°36'42.0210330"E	0.1062	156.1386	4.6514

(3) Baselines

One base station and one rover can generate many baselines. The number of baselines

is the same as the number of stop point.

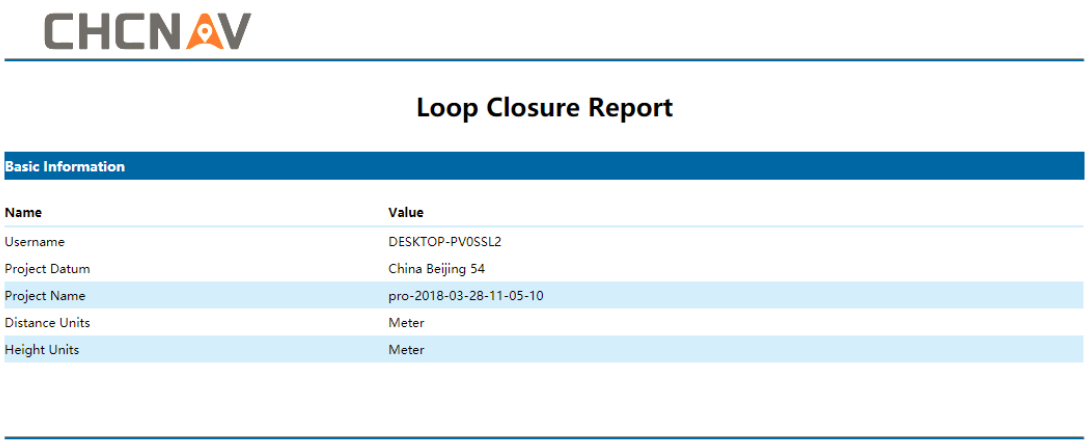


3.3 Baselines

Base Station	Rover	Dx(m)	Std.Dx(m)	Dy(m)	Std.Dy(m)	Dz(m)	Std.Dz(m)
YY1005	YY1004	NaN	NaN	NaN	NaN	NaN	NaN
YY1006	YY1004	NaN	NaN	NaN	NaN	NaN	NaN
YY1007	YY1004	NaN	NaN	NaN	NaN	NaN	NaN

4.8.3 Loop Closure Report

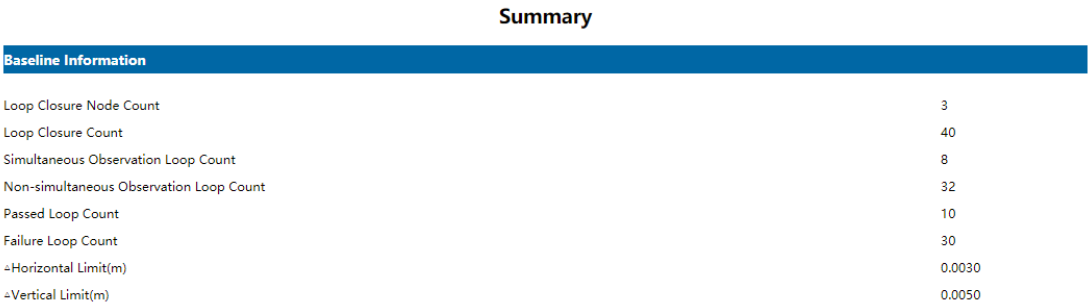
Click **[Report] → [Loop Closure Report],** and the software generates loop closure report in HTML format. This report includes basic information, Loop Closure Node Count, Loop Closure Count, Simultaneous Observation Loop Count, Non-simultaneous Observation Loop Count, Passed Loop Count, Failure Loop Count, △Horizontal Limit(m), △Vertical Limit(m).



CHCNAV

Loop Closure Report

Basic Information	
Name	**Value**
Username	DESKTOP-PV0SSL2
Project Datum	China Beijing 54
Project Name	pro-2018-03-28-11-05-10
Distance Units	Meter
Height Units	Meter



Summary

Baseline Information	
Loop Closure Node Count	3
Loop Closure Count	40
Simultaneous Observation Loop Count	8
Non-simultaneous Observation Loop Count	32
Passed Loop Count	10
Failure Loop Count	30
△Horizontal Limit(m)	0.0030
△Vertical Limit(m)	0.0050

C3LoopReport

Name	Value
Loop Type	Asyn.Loop
Quality Inspection	Conformity

C3(YY1005,YY1004,YY1006)

Loop Parts(m)	Loop Length(m)	-Horizontal(m)	-Vertical(m)	PPM
B01(YY1005122n.hcs->YY1004122n.hcs)-B08(YY1004122m.hcs->YY1006122m.hcs)-B02(YY1006122m.hcs->YY1005122m.hcs)	742.1771	0.0029	-0.0022	4.8804

BaseLines in Loop	Solution	Ellipsoid Distances(m)	StartTime(GPST)
B01(YY1005122n.hcs->YY1004122n.hcs)	L1 Fix	318.6159	2017:05:02 13:01:00
B08(YY1004122m.hcs->YY1006122m.hcs)	L1 Fix	263.4942	2017:05:02 12:03:30
B02(YY1006122m.hcs->YY1005122m.hcs)	L1 Fix	160.0670	2017:05:02 12:03:30

4.8.4 Adjustment Report

Click **[Report]** - **[Adjustment Report]** and the software generates adjustment report in HTML format. The report includes adjustment settings, adjustment statistics, control point, free adjusted coordinates.

4.8.5 Other Reports

4.8.5.1 Station Report

This report consists of project attributes, station list including Lat-Lon-Height (WGS84) and NEH (local) of each station.

CHCNAV

Station Report

Basic Information

Name	Value
Username	DESKTOP-PV0SSL2
Project Datum	China Beijing 54
Project Name	pro-2018-03-28-11-05-10
Distance Units	Meter
Height Units	Meter

Station List

Lat-Lon-Height(WGS84)

Station ID	Latitude	Latitude Relative Error (s)	Longitude	Longitude Relative Error (s)	Ellipsoid Height(m)	Height Relative Error(m)	3D Relative Error (m) (m)
YY1004	030°56'27.2610283"N	000°00'6.7033122"	108°36'42.0420390"E	000°00'4.7368197"	156.2571	0.0014	0.0014
YY1005	030°56'28.8079786"N	000°00'6.4774206"	108°36'53.7690739"E	000°00'4.4645588"	204.5842	0.0013	0.0013
YY1006	030°56'32.5016964"N	000°00'8.6813545"	108°36'49.8875157"E	000°00'6.2300817"	159.1545	0.0018	0.0018
YY1007	030°56'33.3995339"N	000°00'9.5664710"	108°37'3.3434859"E	000°00'5.9943791"	193.4565	0.0017	0.0017

NEH(Local)

Station ID	North(m)	North Coordinate Relative Error (s) (m)	East(m)	East Coordinate Relative Error (s) (m)	Elev.(m)	Elevation Relative Error (m) (m)	3D Relative Error (m) (m)
YY1004	3454838.55076	0.00100	-302985.46547	0.00062	47.5440	0.0014	0.00183
YY1005	3454862.71546	0.00097	-302668.95386	0.00059	95.8712	0.0013	0.00173
YY1006	3454984.89884	0.00130	-302763.84789	0.00082	50.4414	0.0018	0.00239
YY1007	3454985.48154	0.00143	-302402.73765	0.00079	84.7434	0.0017	0.00237

4.8.5.2 Repeat Baseline Report

This report includes project attributes, baseline list including baseline corrections and tolerance.

4.8.6 Quality Checking Report

Click **[Report]** –> **[Quality Checking Report]**, and the software generates quality checking report in HTML format. This report displays result, Observation info, Multipath Effect, Data Completeness, SNR Information.

(1) Result

Real-time QC Result

Observation File Name	YY1004122n.HCN
Quality Check Result	unpassed

(2) Observation info

Observation Info	
Name	**Result**
Time of First Epoch	2017-05-02 12:03:30
Time of Last Epoch	2017-05-02 13:00:30
Session(Days)	0
Time Span	00:57:00
Ele Mask	10
Data Interval(Sec.)	15
Systems	GPS;GLN;BDS;Galileo;
WGS84(X,Y,Z)(XYZ)m	-1747819.0292 5189063.2943 3260421.7221

(3) Multipath Effect

Multipath Effect															
Prn	**MP1 (m)**	**MP1 Thresh old (m)**	**Result Judgement**	**MP2 (m)**	**MP2 Thresh old (m)**	**Result Judgement**	**MP5 (m)**	**MP5 Thresh old (m)**	**Result Judgement**	**MP6 (m)**	**MP6 Thresh old (m)**	**Result Judgement**	**MP7 (m)**	**MP7 Thresh old ((m)**	**Result Judgement**
G02	0.35000	0.5000	passed	0.51000	0.6500	passed	0.00000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G03	0.34000	0.5000	passed	0.64000	0.6500	passed	0.33000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G06	0.34000	0.5000	passed	0.42000	0.6500	passed	0.35000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G12	0.88000	0.5000	unpassed	1.52000	0.6500	unpassed	0.00000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed
G17	0.340	0.5000	passed	0.400	0.6500	passed	0.00000	0.5000	passed	0.00000	0.5000	passed	0.00000	0.5000	passed

(4) Data Completeness

GNSS

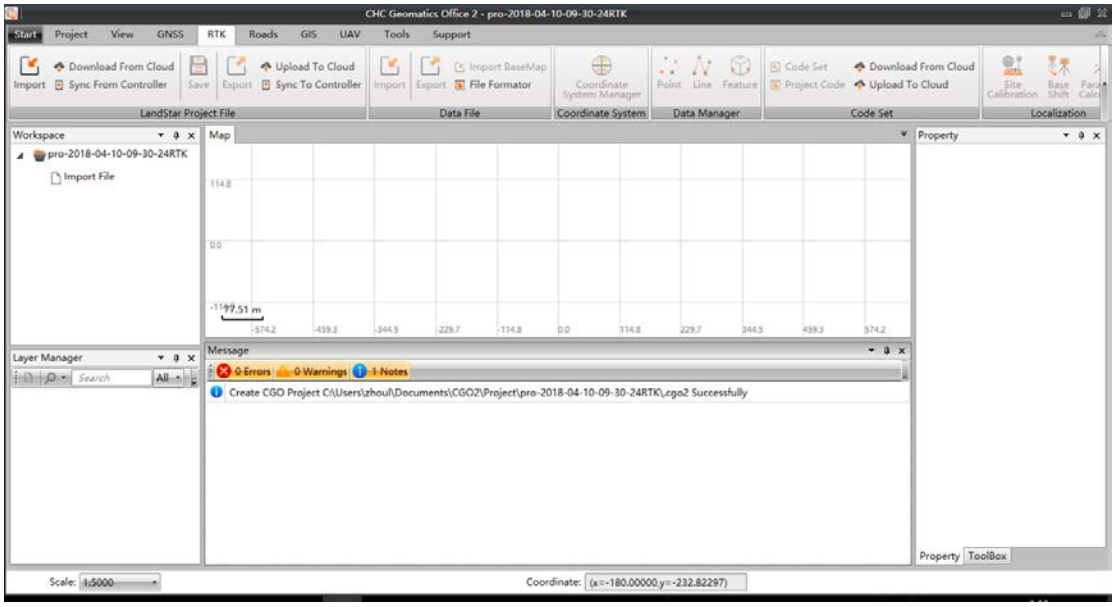
Data Completeness								
Prn	Possible Obs	Complete Obs	Data Completeness	Threshold	IOD or MP Slips	Cycle Slip Ratio	Threshold	Result Judgement
G02	239	239	100.0%	95.0%	0	99999999	400	passed
G03	69	69	100.0%	95.0%	0	99999999	400	passed
G05	201	201	100.0%	95.0%	0	99999999	400	passed
G06	239	239	100.0%	95.0%	0	99999999	400	passed
G09	239	134	56.1%	95.0%	0	99999999	400	unpassed
G12	239	239	100.0%	95.0%	0	99999999	400	passed
G17	239	239	100.0%	95.0%	0	99999999	400	passed
G19	239	239	100.0%	95.0%	0	99999999	400	passed
G23	239	213	89.1%	95.0%	3	71	400	unpassed
G28	172	55	32.0%	95.0%	1	55	400	unpassed

(5) SNR Information

SNR Information1										
Satellite System			Carrier Frequency/Elevation Angle		[0,30)			[30,90]		
GPS			L1		43.18			50.00		
			L2		38.40			45.98		
			L5		-			-		
GNSS	L1/B1/G1/E1	47.01	L2/B2/G2/E5a	42.71	L5/B3/G3/E5b	-	E5	-	E6	-

5 RTK

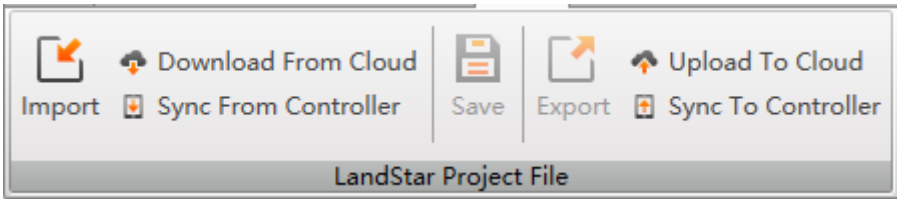
Click **[RTK]** in the main toolbar, and the user can switch to the RTK panel.



The RTK panel consists of 7 parts: LandStar (version 7.3.0 and above) project file, data file, coordinate system, data manager, code set, localization and report.

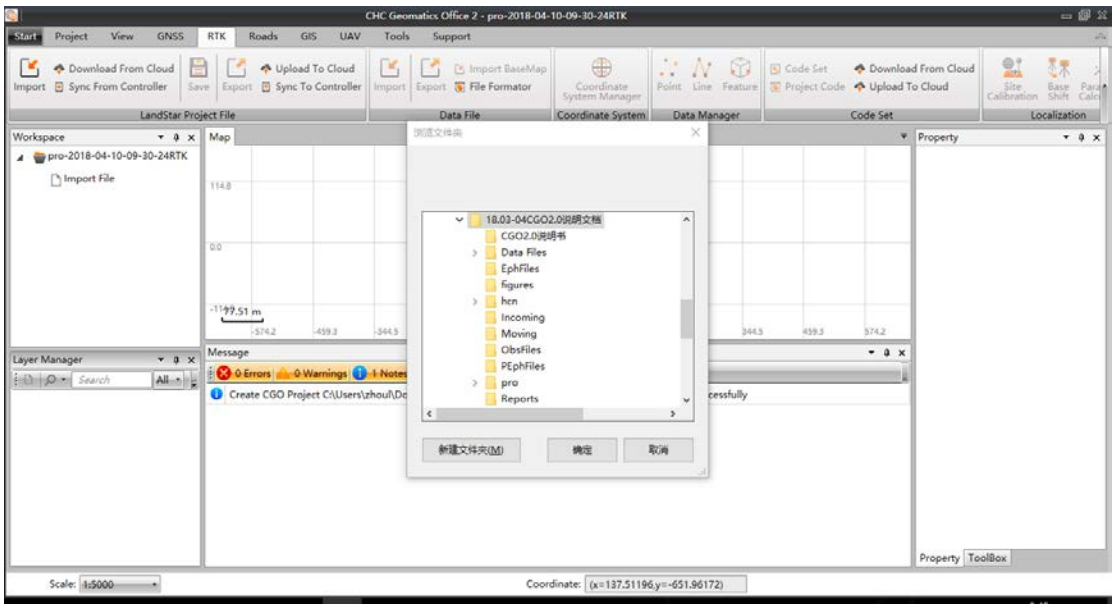
5.1 LandStar Project File

This part includes 7 functions: import, download from cloud, sync from controller, save, export, upload to cloud and sync to controller. CGO 2.0 only support to open the LandStar 7.3.0 project file.

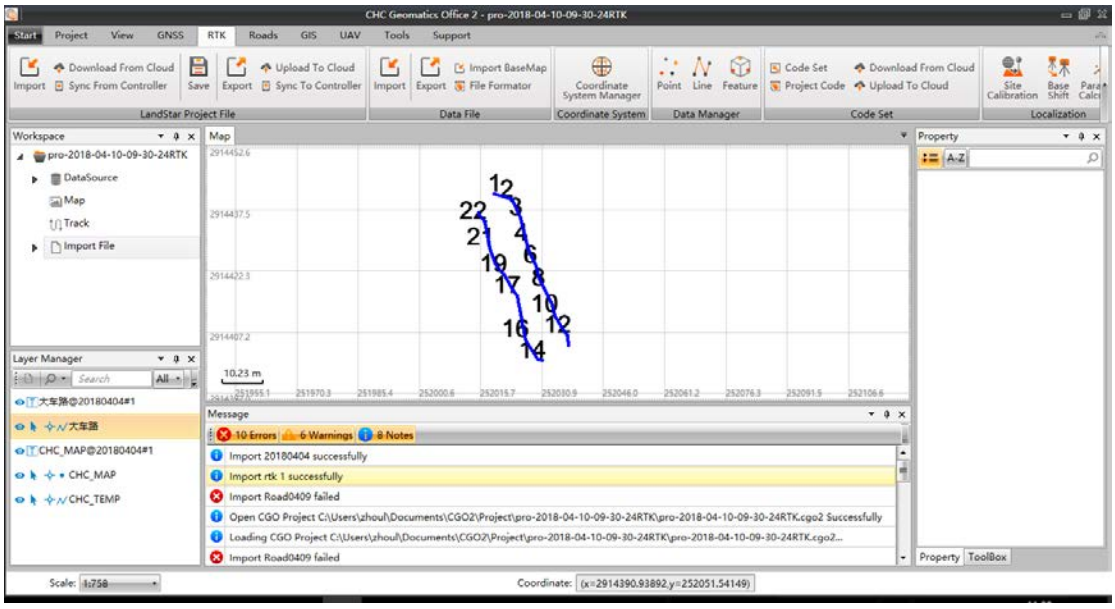


5.1.1 Import

This function is for importing LandStar project. Click the **[import]** button; a pop-up box shows out.

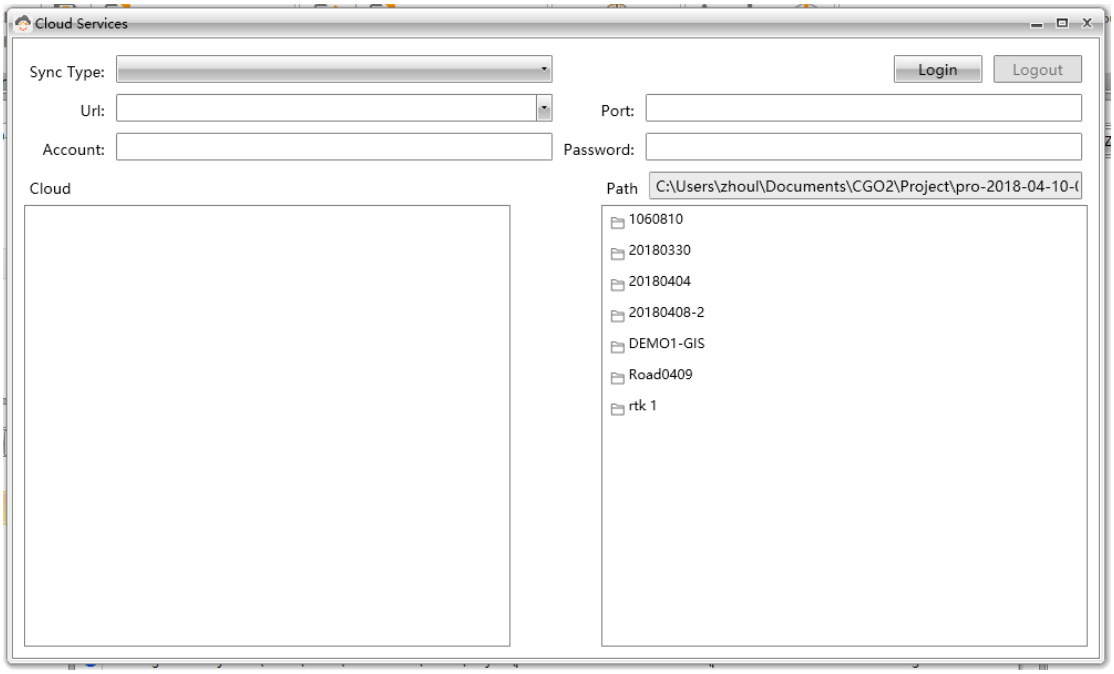


After selecting a project file, click **[Confirm]** and the LandStar project imported successfully. CGO 2.0 loads the project data automatically.

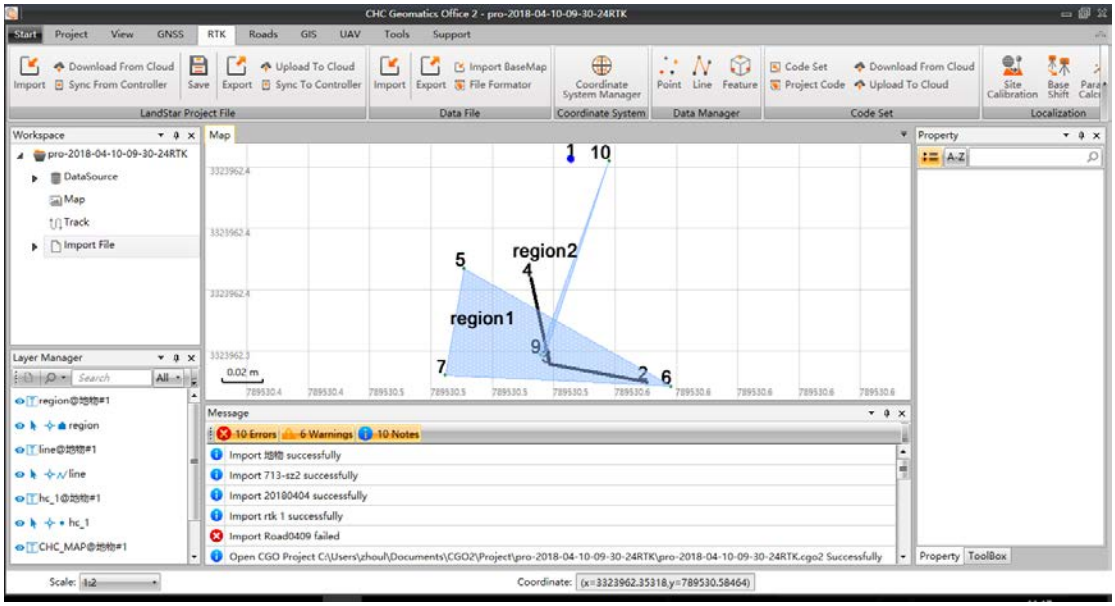


5.1.2 Download from Cloud

This function downloads and imports the LandStar project from the Cloud. Click the **[Download from Cloud]** button, and there is a Cloud login interface.

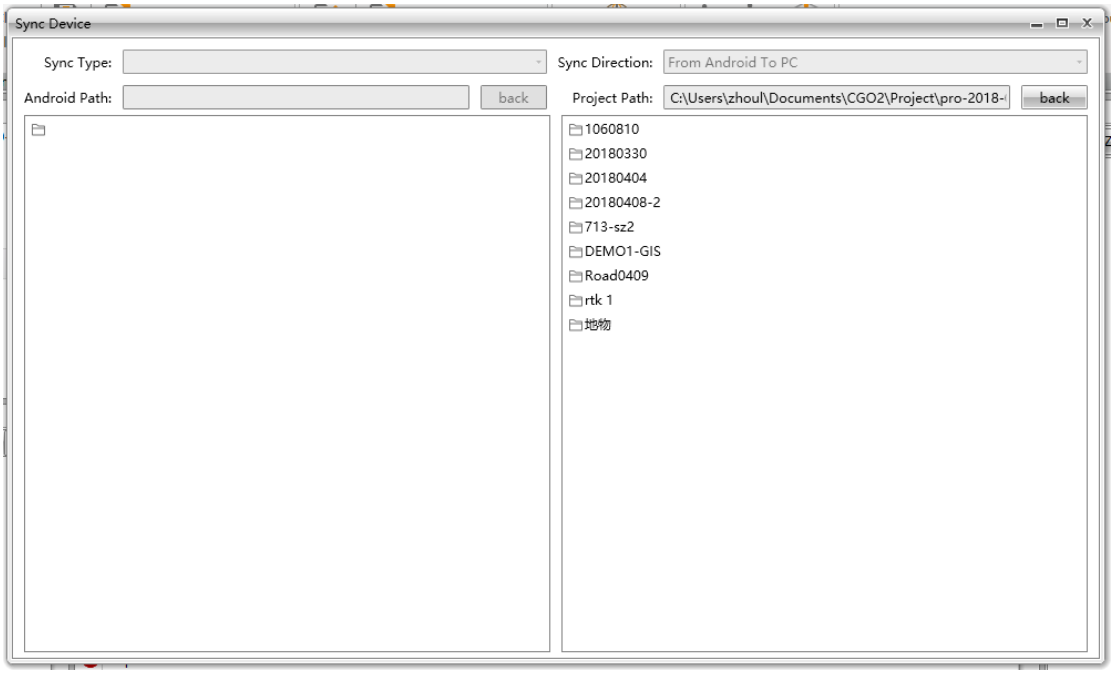


Input address, port, account, password and click **[login]** button. After the user login successfully, select the project name and click **[Input]** button at the end of the same row of each project. And after the project download successfully and the user confirms to input the project, the software loads the project.

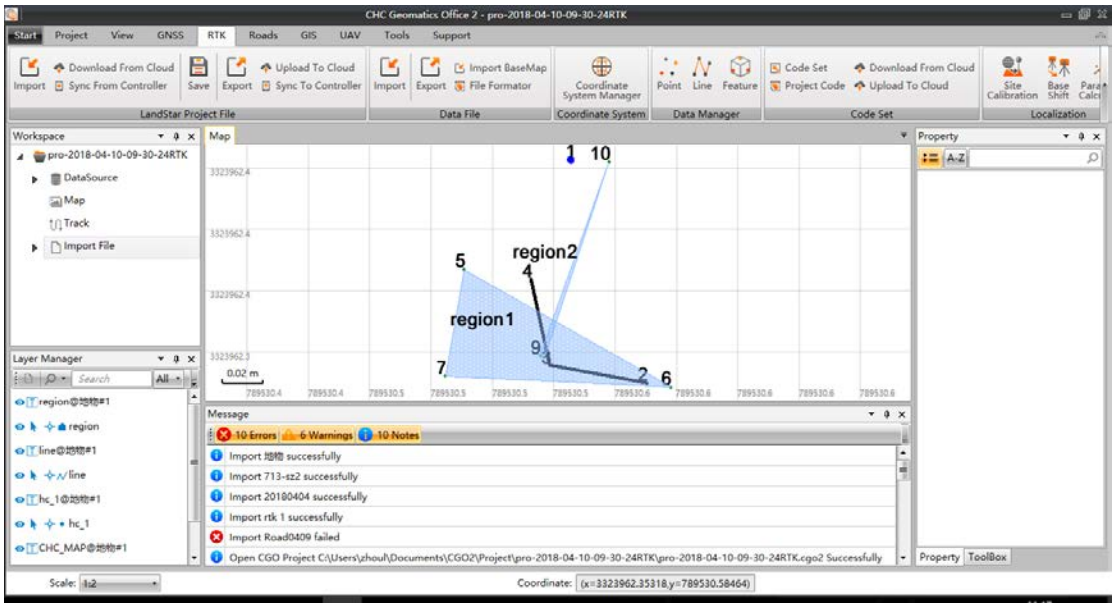


5.1.3 Sync from Controller

This function sync and input the LandStar project from the controller. Connecting the controller and click **[Sync from Controller]**, and there is a Sync Device interface.



Select LandStar Project needed and clicked **[Input]** button. After the successful inputting, CGO 2.0 load the project data.



5.1.4 Save

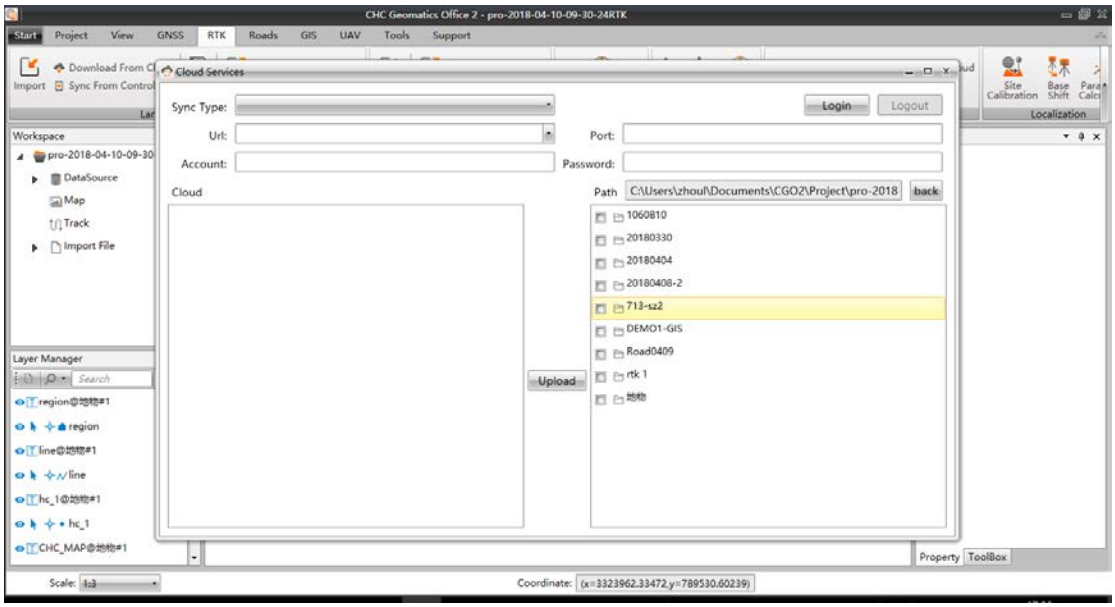
This function is for LandStar project saving whereby clicking the **[Save]** button.

5.1.5 Export

Click **[Export]**, and an export interface will pop up. Select the export path and click **[OK]** to finish.

5.1.6 Upload to the Cloud

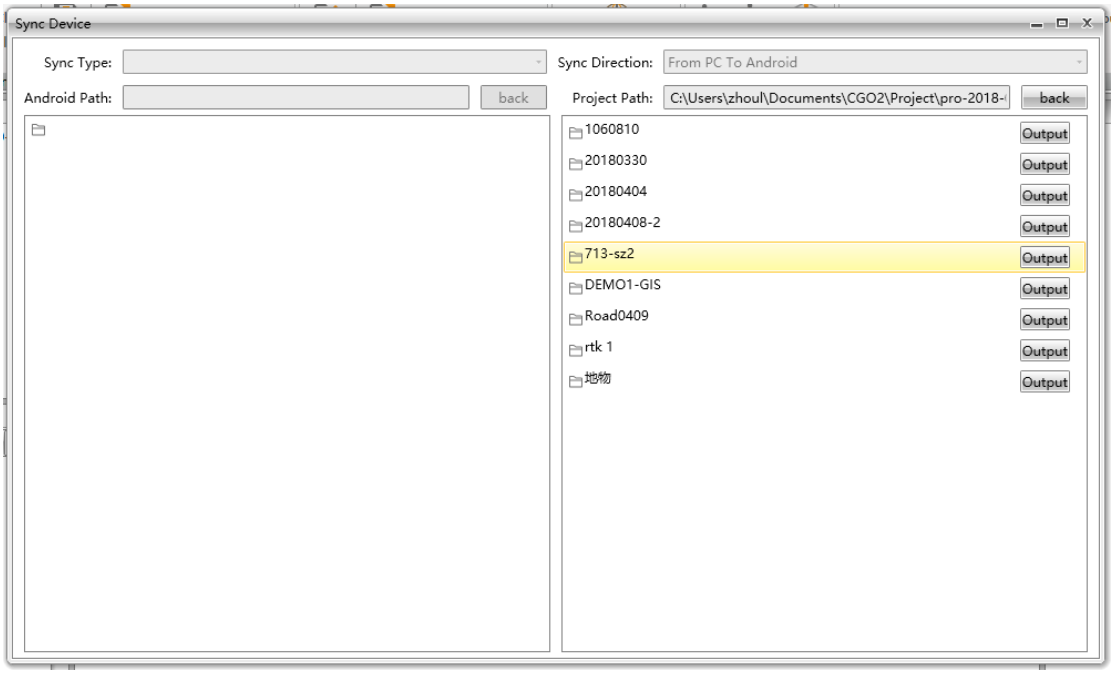
This function uploads LandStar project to the Cloud by clicking **[Upload to Cloud]** button, and there is a Cloud login interface pops up.



Input address, port, account, password and click **[login]** button. After the user login successfully, select the target project name and click **[Upload]**. The software uploads the selected project to the Cloud.

5.1.7 Sync to Controller

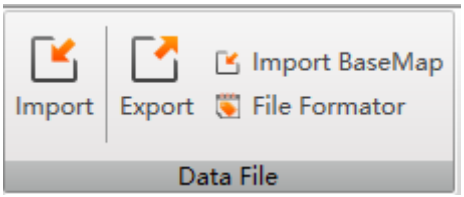
This function sync LandStar project from PC to the connected controller. Click the **[Sync to Controller]** button after successfully connect the PC to the controller. And after successfully synchronized with the controller, there is a pop-up interface.



Please select the path of the controller and select the right LandStar project file, click **[Export]** button. The CGO 2.0 export the selected LandStar project to the connected controller.

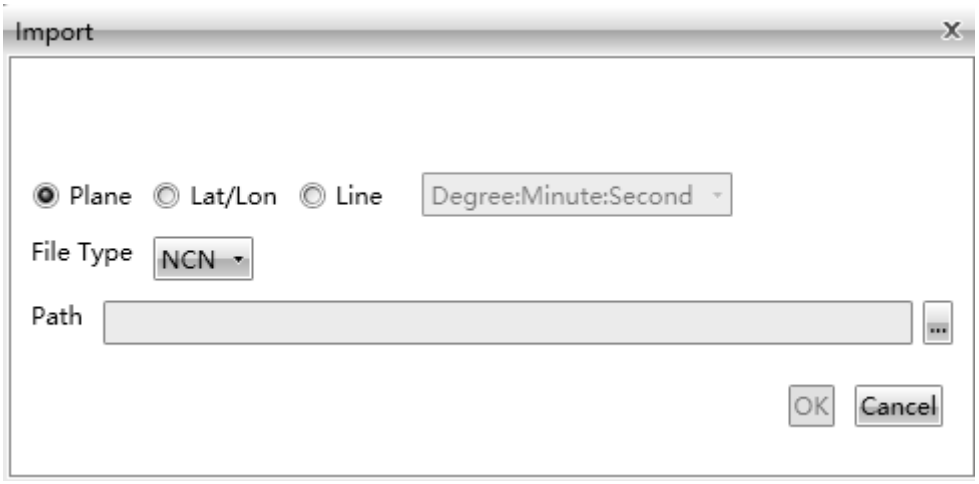
5.2 Data File

Data file part includes 4 functions: import, Export, Import BaseMap, File Formator.



5.2.1 Import

For importing the data, click the **[Import]** button, and the user can see the data selection interface.

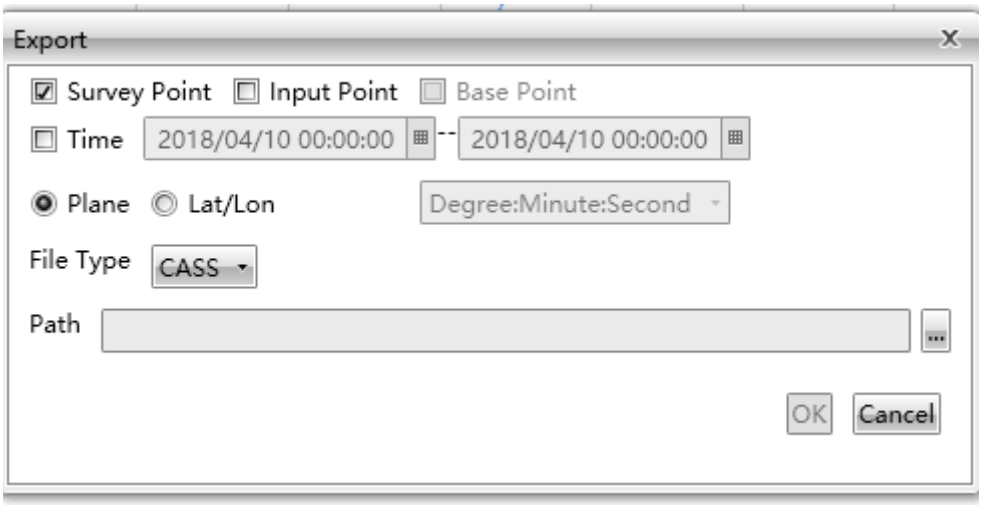


Select coordinate system type, File Type, path. Click the **[OK]** button and the software import the selected project.

Note: selected file type should match the selected data file, otherwise, the import will be failed!

5.2.2 Export

This function is for data exporting.

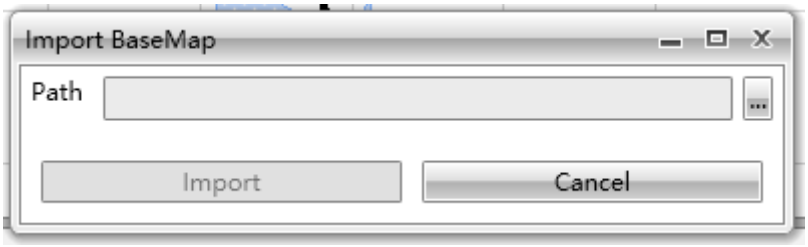


Select export point type, time, coordinate system type, File Type, and Path. Click **[OK]** and finish the exporting stage.

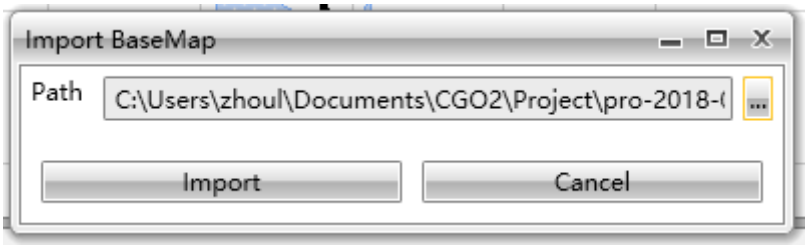
5.2.3 Import Base Map

To import basemap, click the **[Import Base Map]** button and the user can see the

basemap selection interface.



Click the **[path selection]** button  and enter the base map path selection interface.

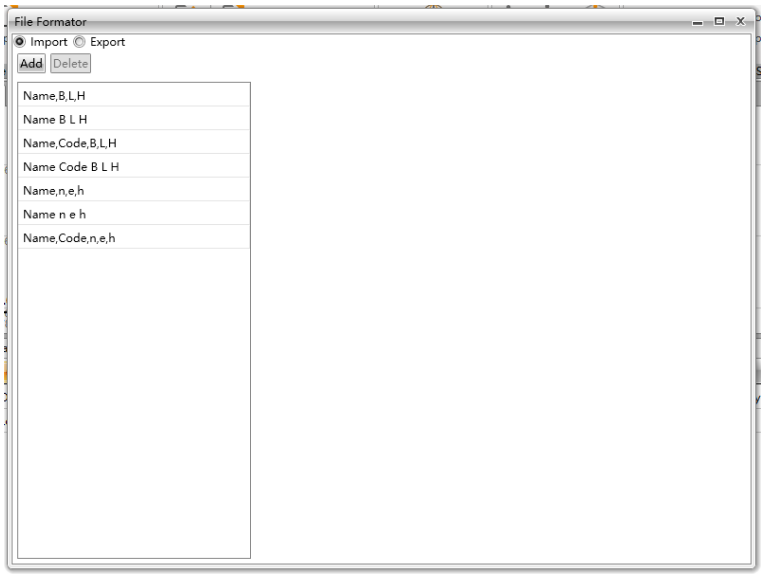


Select the needed base map and click **[Import]** and the importing of base map finish.

Note: currently, CGO 2.0 compatible with only three formats: .dxf, .shp, .sit.

5.2.4 File Formator

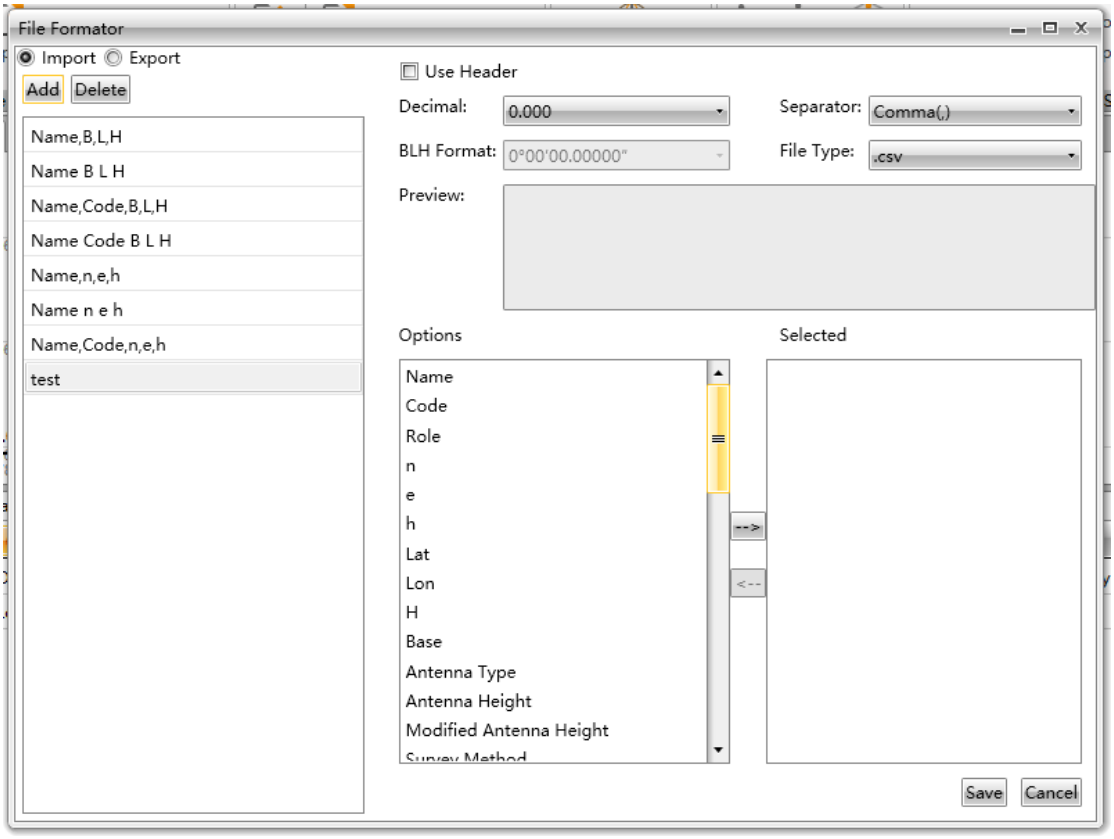
This function is for editing imported and exported file's format. Click **[File Formator]**, and there is a pop-up interface.



[Import]: imported file's format, it is addable and deletable.

[Export]: exported file's format, it is addable and deletable. By clicking the second checkbox front the word "Export", the switching finish.

[Add]: by clicking this button, there is a pop-up parameter interface.



Edit the relevant parameters and click **[Save]** to finish format addition.

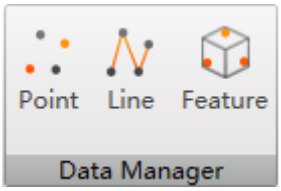
[Delete]: the user selects the format and clicks the button to delete the format.

5.3 Coordinate System

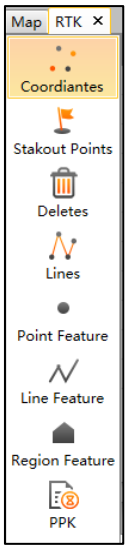
This is refers to the coordinate system of LandStar 7 project, which is separate from the CGO 2.0 project and isn't influenced by it. After importing a LandStar 7 project, users can check and modify the coordinate system, please see 2.2.2 Coordinate System in detail. It also allows for saving the modification of coordinate system and uploading to the cloud server.

5.4 Data Manager

This part mainly manages the imported LandStar 7 project data, including point, line, and feature.



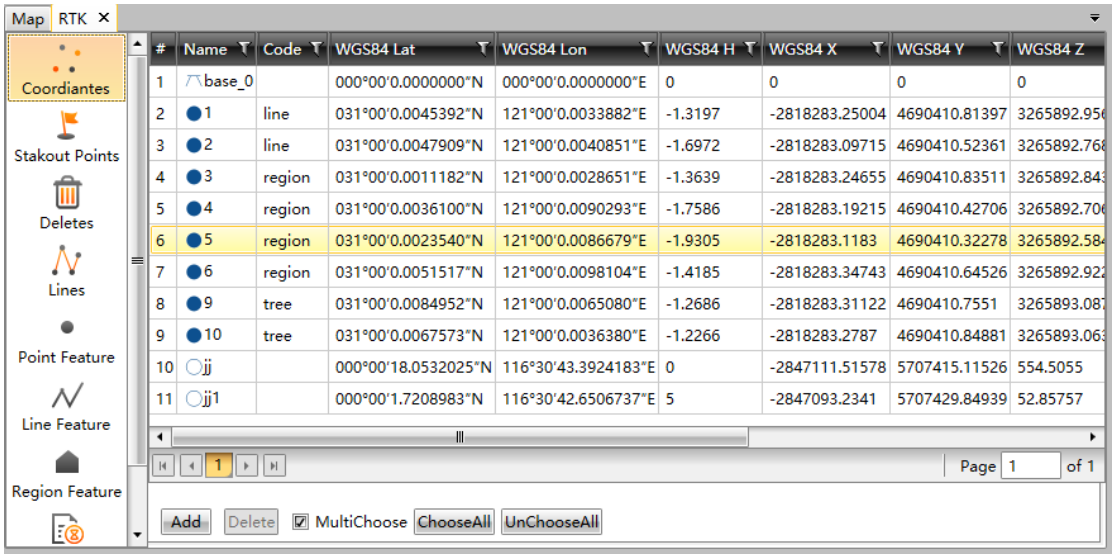
Click one of the three icons, users will see an information list and can check the data of the imported LandStar 7 project.



The information list includes coordinates, stakeout points, deletes, lines, point feature, line feature, region feature and PPK tables.

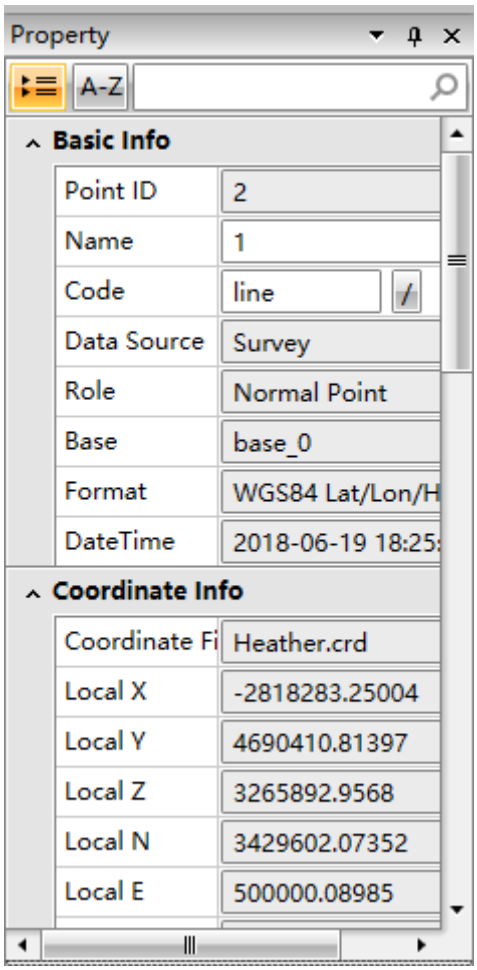
5.4.1 Coordinates

Click **[Coordinates]**, users can view the information of measured points, including point name, point code, latitude, longitude, height, X, Y, Z in WGS84 and local coordinate system, N, E, H in local coordinate system, the observation date and time.

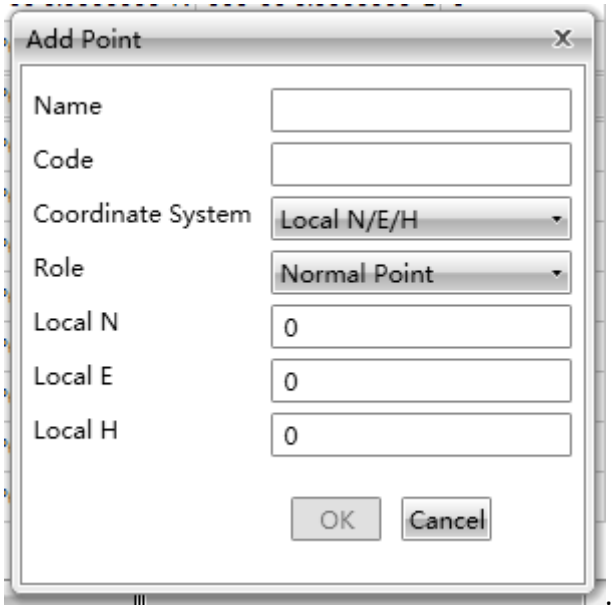


#	Name	Code	WGS84 Lat	WGS84 Lon	WGS84 H	WGS84 X	WGS84 Y	WGS84 Z
1	base_0		000°00'0.0000000"N	000°00'0.0000000"E	0	0	0	0
2	1	line	031°00'0.0045392"N	121°00'0.0033882"E	-1.3197	-2818283.25004	4690410.81397	3265892.95
3	2	line	031°00'0.0047909"N	121°00'0.0040851"E	-1.6972	-2818283.09715	4690410.52361	3265892.76
4	3	region	031°00'0.0011182"N	121°00'0.0028651"E	-1.3639	-2818283.24655	4690410.83511	3265892.84
5	4	region	031°00'0.0036100"N	121°00'0.0090293"E	-1.7586	-2818283.19215	4690410.42706	3265892.70
6	5	region	031°00'0.0023540"N	121°00'0.0086679"E	-1.9305	-2818283.1183	4690410.32278	3265892.58
7	6	region	031°00'0.0051517"N	121°00'0.0098104"E	-1.4185	-2818283.34743	4690410.64526	3265892.92
8	9	tree	031°00'0.0084952"N	121°00'0.0065080"E	-1.2686	-2818283.31122	4690410.7551	3265893.08
9	10	tree	031°00'0.0067573"N	121°00'0.0036380"E	-1.2266	-2818283.2787	4690410.84881	3265893.06
10	jj		000°00'18.0532025"N	116°30'43.3924183"E	0	-2847111.51578	5707415.11526	554.5055
11	jj1		000°00'1.7208983"N	116°30'42.6506737"E	5	-2847093.2341	5707429.84939	52.85757

[Property]: Select one point, users will view the detailed information in the **[Property]** window and modify it according to the real situation.

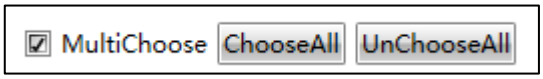


[Add]: This is refers to add a point. Input the point name, point code and point coordinates, choose the coordinate system type and role, then click **[OK]** to finish. If you don't want to add a point, you can click **[Cancel]** or close the window directly.



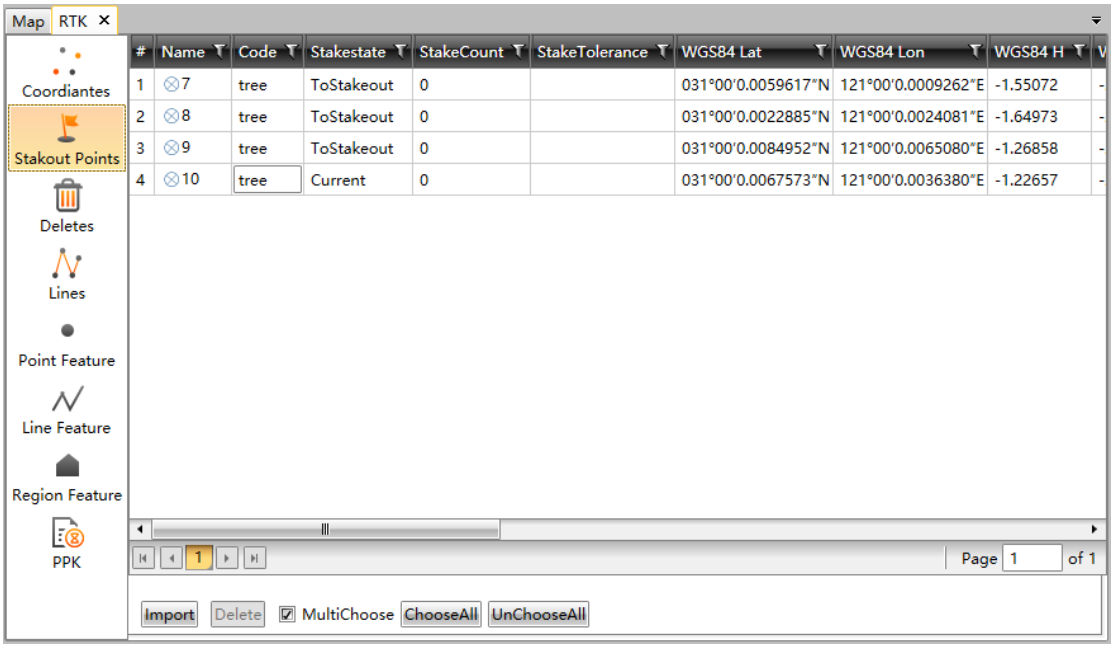
[Delete]: Select the target points and click **[Delete]**, then a message box reads "Are you sure to delete?" will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

[MultiChoose]: After checking the **[MultiChoose]**, users can select multiple points in the list. It also allows for selecting all points by clicking **[ChooseAll]** or cancelling selection by clicking **[UnChooseAll]**.

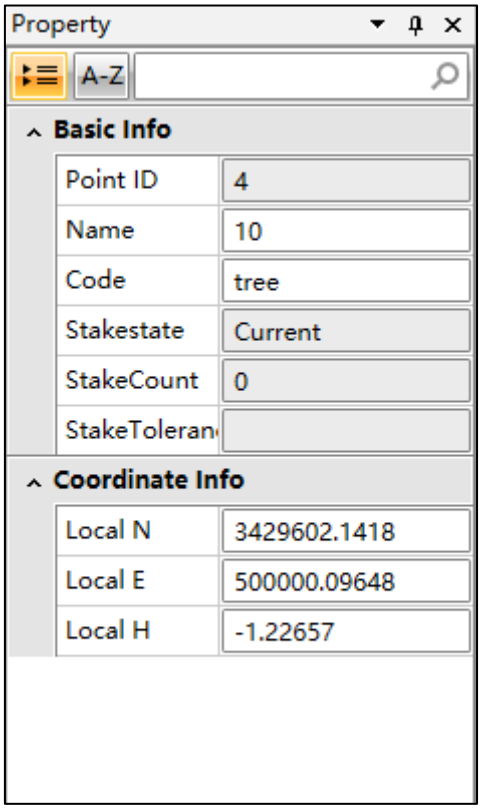


5.4.2 Stakeout Points

Click **[Stakeout Points]**, users can view the information of stakeout points, including point name, point code, stake status, stake count, stake tolerance, the latitude, longitude, height, X, Y, Z in WGS84 and local coordinate system, N, E, H in local coordinate system, the stakeout date and time.

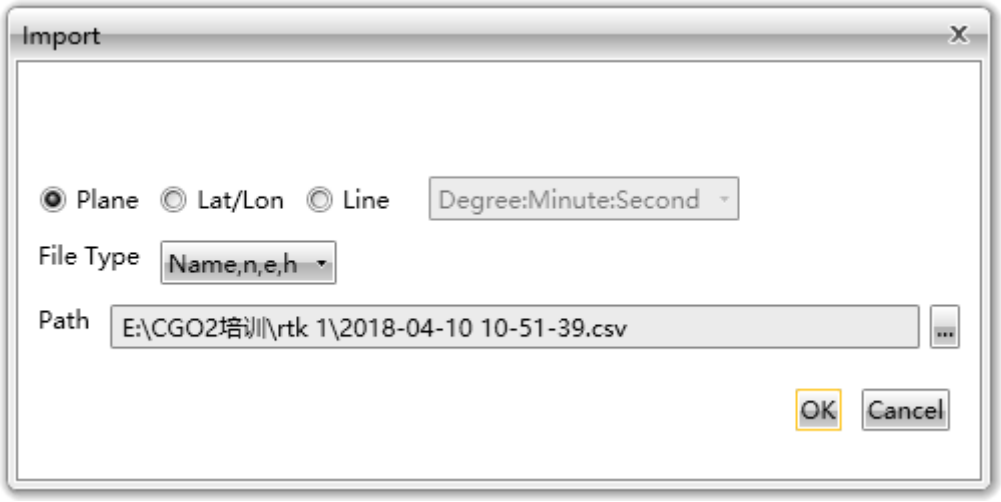


[Property]: Select one point, users will view the detailed information in the **[Property]** window and modify it according to the real situation.



[Import]: Users can import stakeout points by clicking **[Import]**. Choose point coordinate type, file type and local directory, and then users can import points by

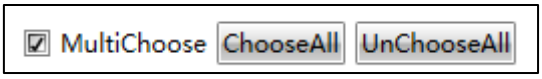
clicking **[OK]**, or click **[Cancel]** to exit.



Note: Selected file type must match the real file type of the selected file, otherwise, the import will be failed.

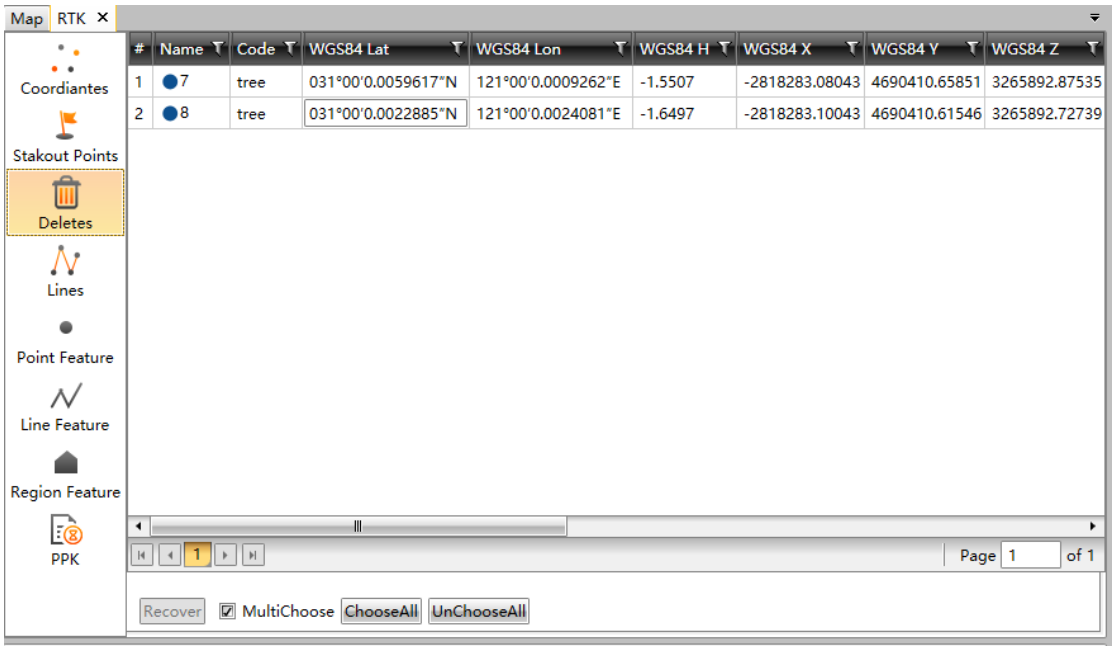
[Delete]: Select the target points and click **[Delete]**, then a message box reads "Are you sure to delete?" will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

[MultiChoose]: After checking the **[MultiChoose]**, users can select multiple points in the list. It also allows for selecting all points by clicking **[ChooseAll]** or cancelling selection by clicking **[UnChooseAll]**.

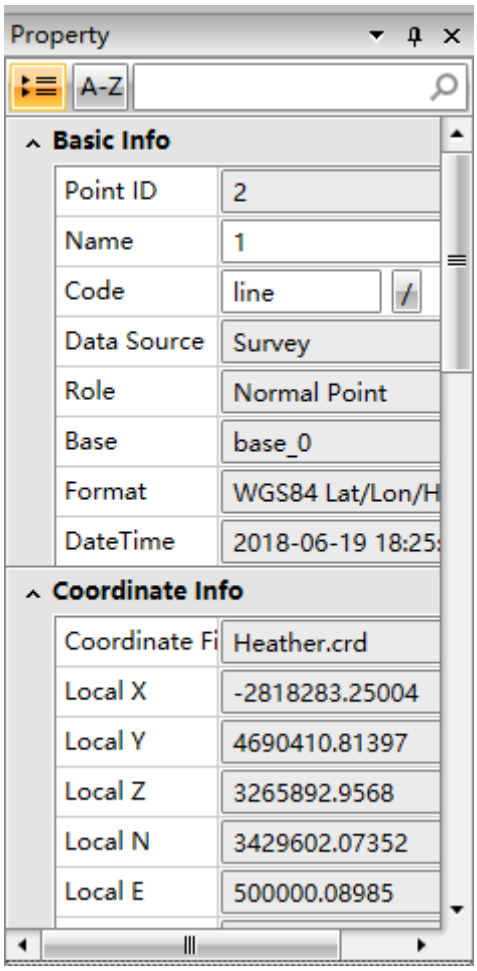


5.4.3 Deletes

Click **[Deletes]**, users can view the information of deleted points, including point name, point code, the latitude, longitude, height, X, Y, Z in WGS84 and local coordinate system, N, E, H in local coordinate system, the stakeout date and time.



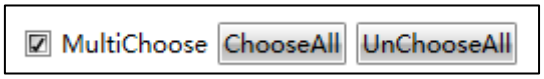
[Property]: Select one point, users will view the detailed information in the **[Property]** window and modify it according to the real situation.



[Recover]: Select the target points and click **[Recover]**, then the software will recover the selected points, users can view them in **[Coordinates]** again.

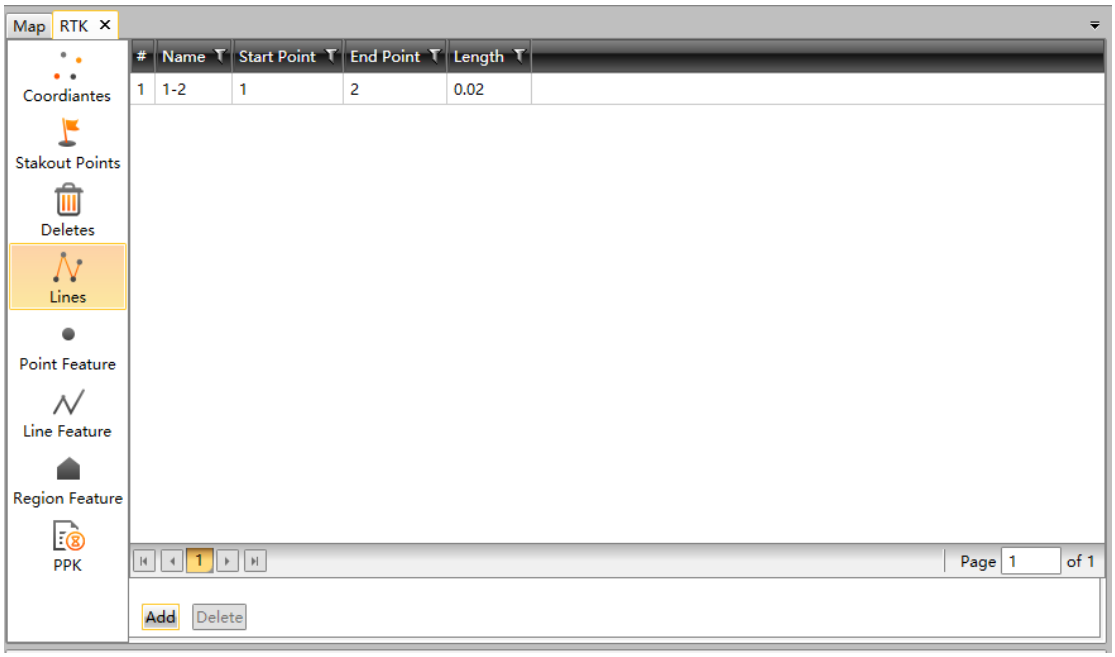
[Delete]: Select the target points and click **[Delete]**, then a message box reads “Are you sure to delete?” will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

[MultiChoose]: After checking the **[MultiChoose]**, users can select multiple points in the list. It also allows for selecting all points by clicking **[ChooseAll]** or cancelling selection by clicking **[UnChooseAll]**.

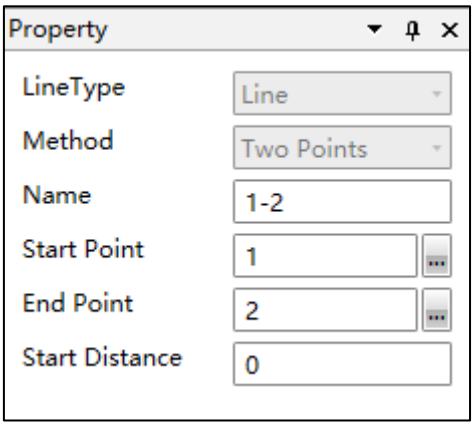


5.4.4 Lines

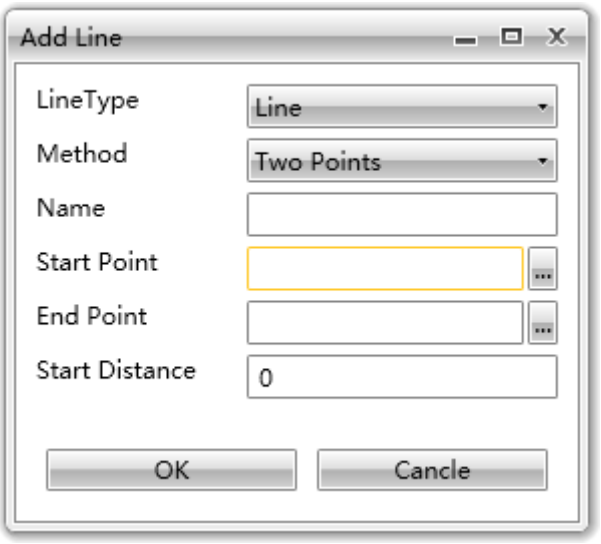
Click **[Lines]**, users can view the information of lines, including line name, start point, end point and length.



[Property]: Select one line, users will view the detailed information in the **[Property]** window and modify it according to the real situation.



[Add]: This refers to add a line. Input the line type, method, name, start point, end point, and start distance, then click **[OK]** to finish. If you don't want to add a line, you can click **[Cancel]** or close the window directly.

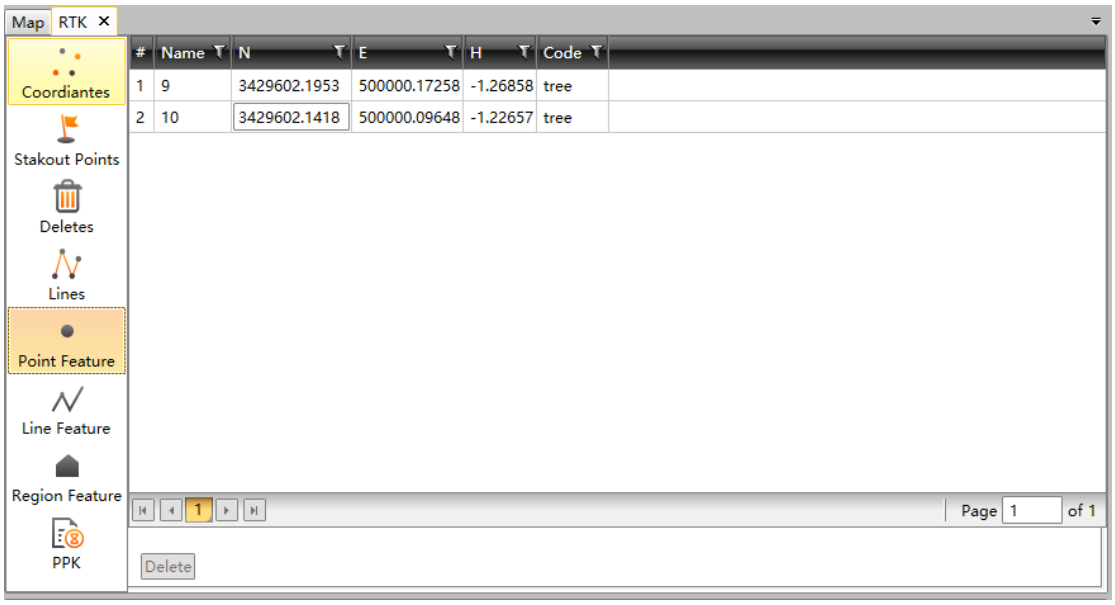


Note: The line added here is consist of points in coordinates list.

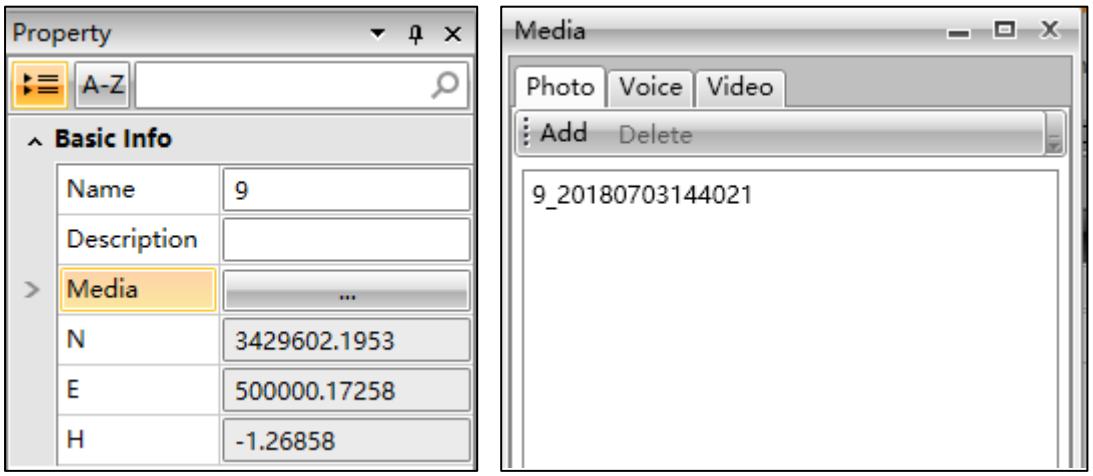
[Delete]: Select the target line and click **[Delete]**, then the line will be deleted immediately.

5.4.5 Point Feature

Click **[Point Feature]**, users can view the information of point features, including point name, N, E, H and code.



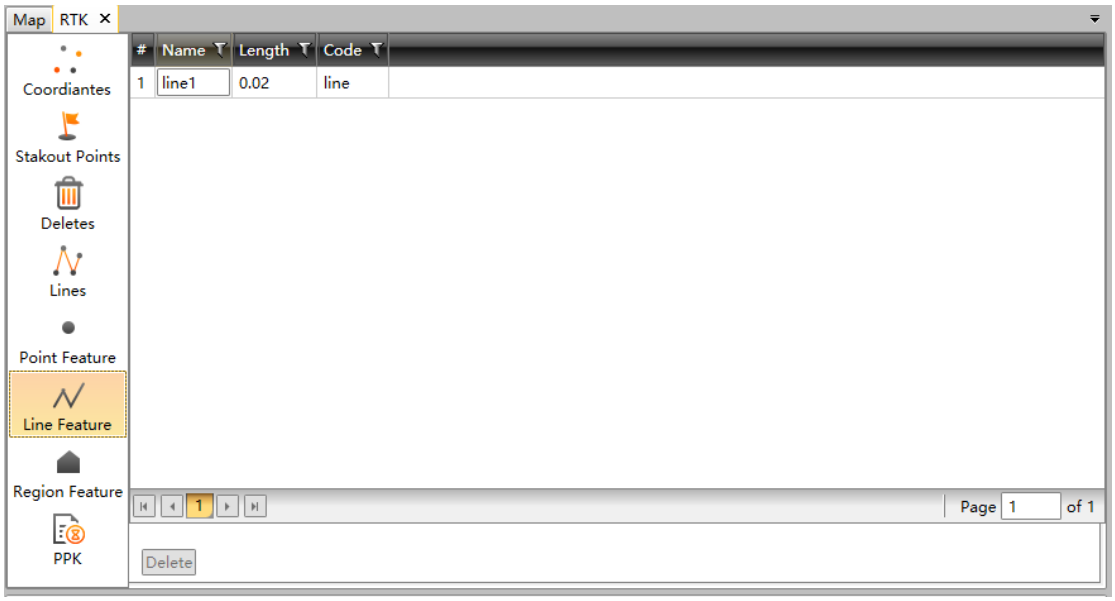
[Property]: Select one point, users will view the detailed information in the **[Property]** window and modify it according to the real situation. It allows for adding media attributes from local directory.



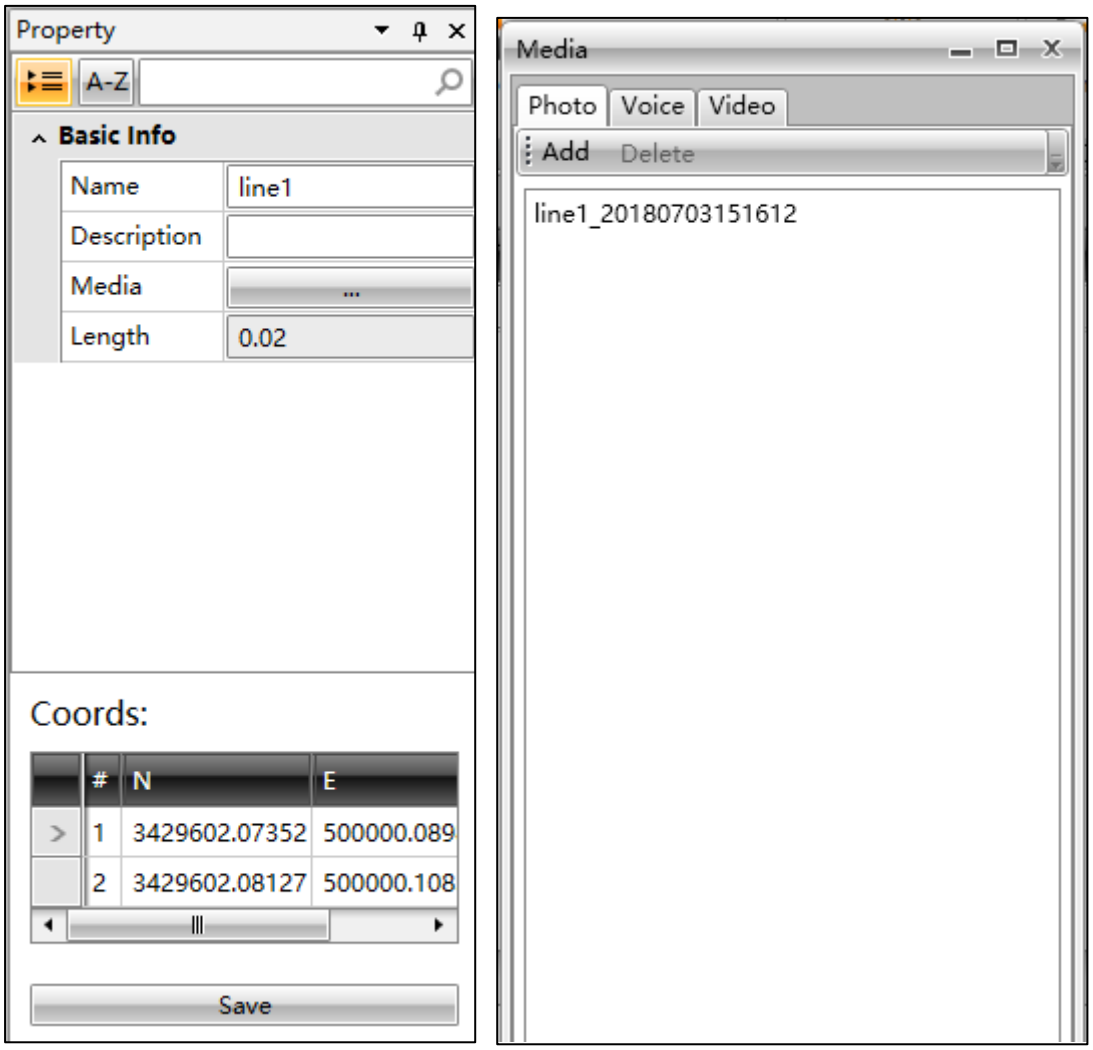
[Delete]: Select the target feature and click **[Delete]**, then a message box reads "Delete can not be recovered, go on?" will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

5.4.6 Line Feature

Click **[Line Feature]**, users can view the information of line features, including line name, length and code.



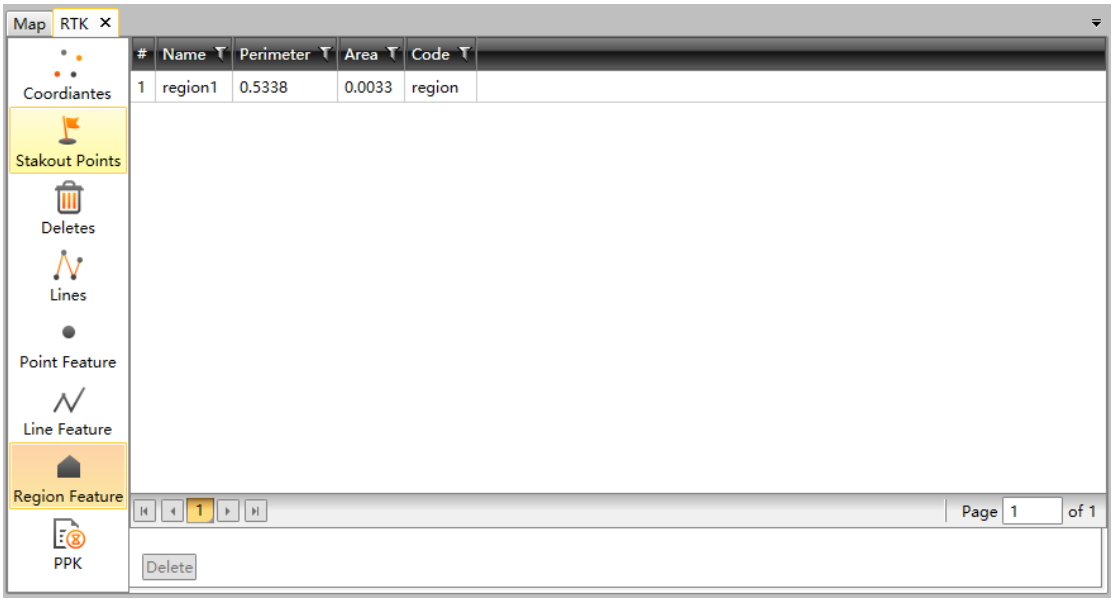
[Property]: Select one line, users will view the detailed information in the **[Property]** window and modify it according to the real situation. Users can also view the point coordinates of the selected line, and it allows for adding media attributes from local directory.



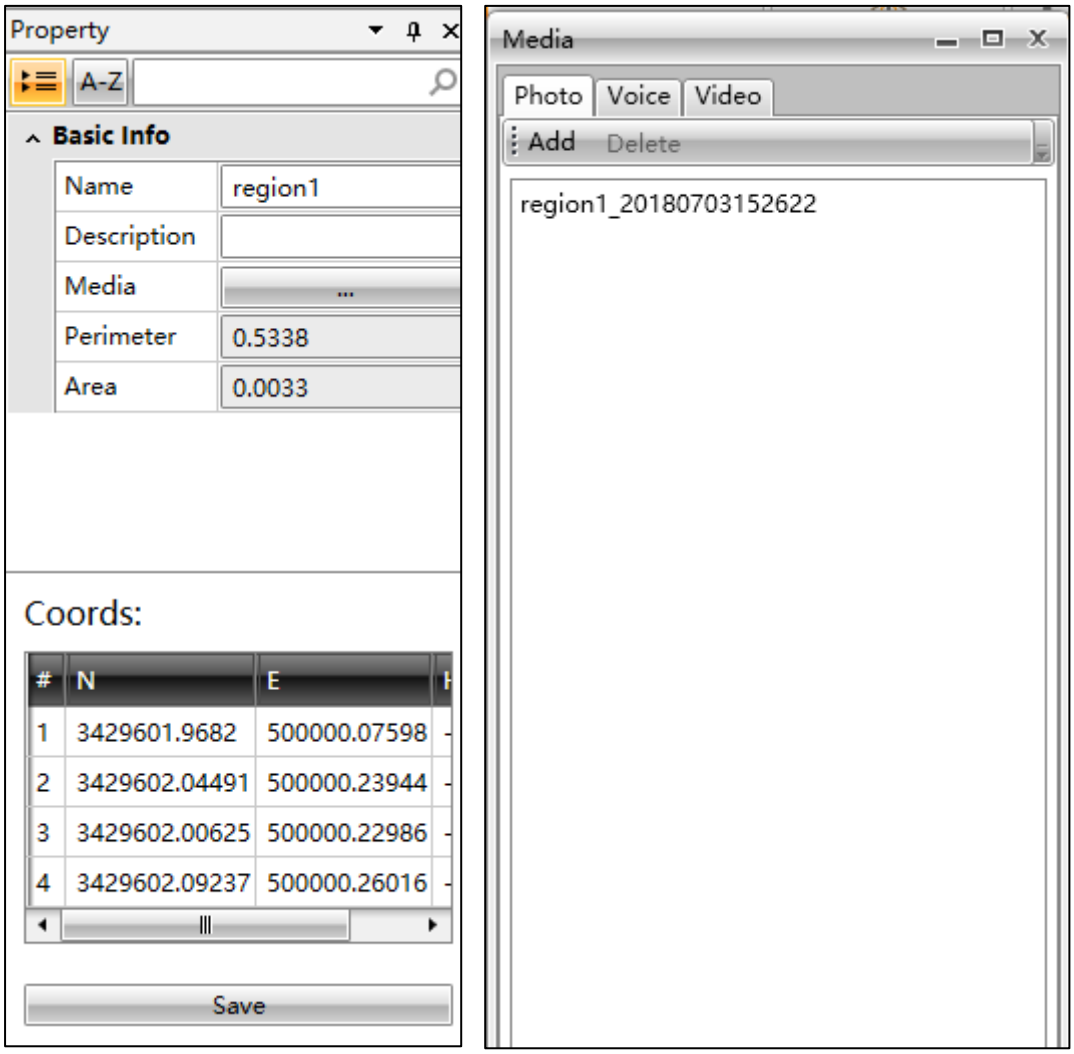
[Delete]: Select the target feature and click **[Delete]**, then a message box reads “Delete can not be recovered, go on?” will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

5.4.7 Region Feature

Click **[Region Feature]**, users can view the information of polygon features, including polygon name, perimeter, area and code.



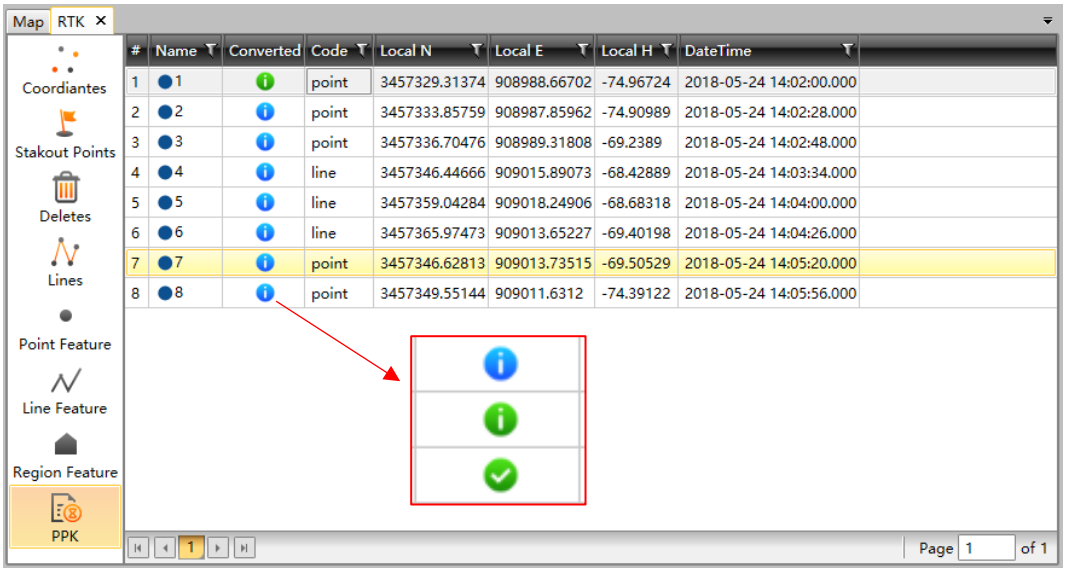
[Property]: Select one polygon, users will view the detailed information in the **[Property]** window and modify it according to the real situation. Users can also view the point coordinates of the selected polygon, and it allows for adding media attributes from local directory.



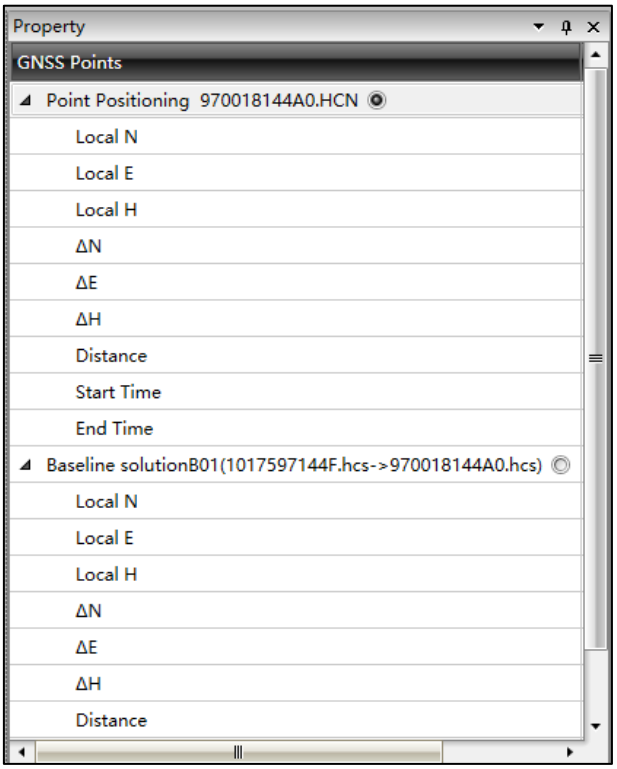
[Delete]: Select the target feature and click **[Delete]**, then a message box reads “Delete can not be recovered, go on?” will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

5.4.8 PPK

Click **[PPK]**, users can view the information of PPK data, including point name, converted status, code, local N, Local E, Local H, observation date and time. There are three kinds of icons to represent three converted status: the blue “I” icon refers that there is no operation on the point, the green “I” icon refers that the point is selected, and the green “√” icon refers that the point is converted successfully.



[Property]: Select one point, users can choose the coordinates in the **[Property]** window according to the real situation. The coordinates show in the PPK list are the dynamic coordinates surveyed from LandStar 7, users can compare it with the post-processing result and choose the high accuracy one as the coordinates of the point.



After selecting one point or multiple points, users can do several operations by right clicking on it.

[Modify]: Click to modify the coordinates of single point after selecting from the **[Property]** table.

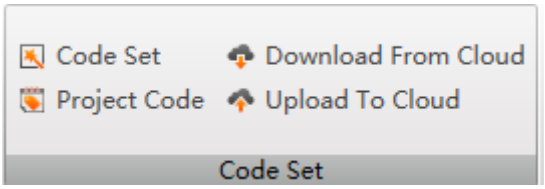
[Modify All]: Click to modify the coordinates of multiple points after selecting from the **[Property]** table one by one.

[Export]: Click to export the data as shape file, and users can check in the pop-up folder.

[Refresh]: Click to refresh the data list.

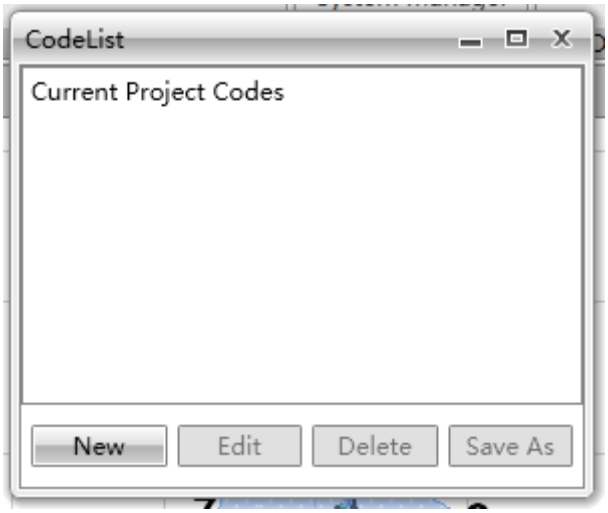
5.5 Code Set

This part manages the code in LandStar 7 project including code set, project code, download from cloud, upload to cloud.



5.5.1 Code Set

This function is for managing the codelist of the LandStar 7 project. Click **[Code Set]** and users can check or modify all codelists.



[New]: Create a new codelist.

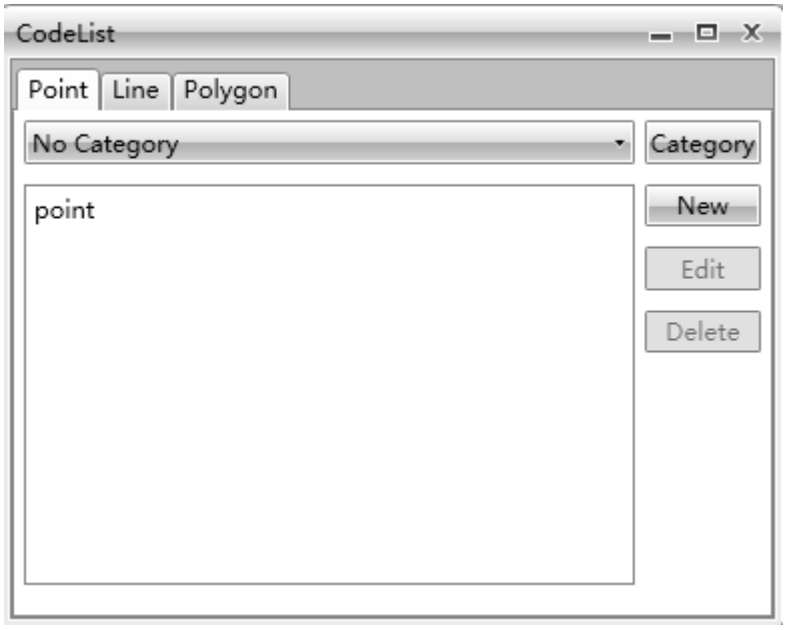
[Edit]: Edit an existed codelist.

[Delete]: Delete an existed codelist.

[Save As]: Save an existed codelist as another codelist and give it a new name.

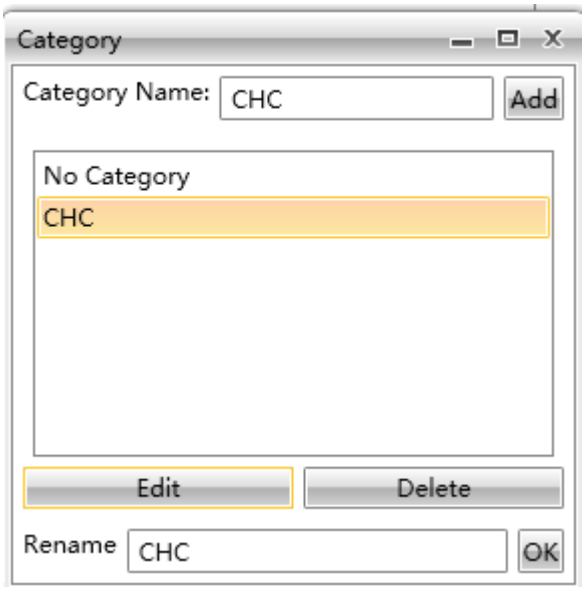
5.5.2 Project Code

This function is used for managing the codelist of the current LandStar 7 project. Click **[Project Code]**, and users can check or modify current codelist.



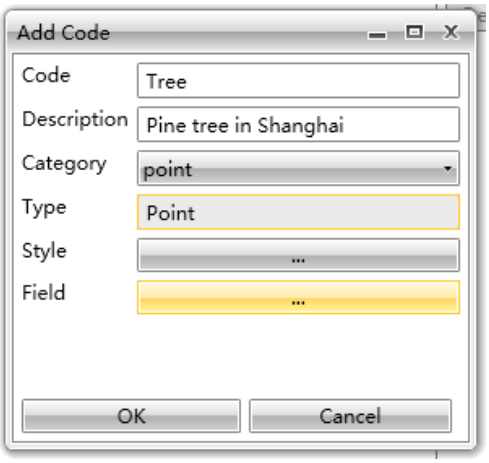
[Category]: Click to view all categories, users can edit the name of existed categories,

add new categories or delete existed categories.

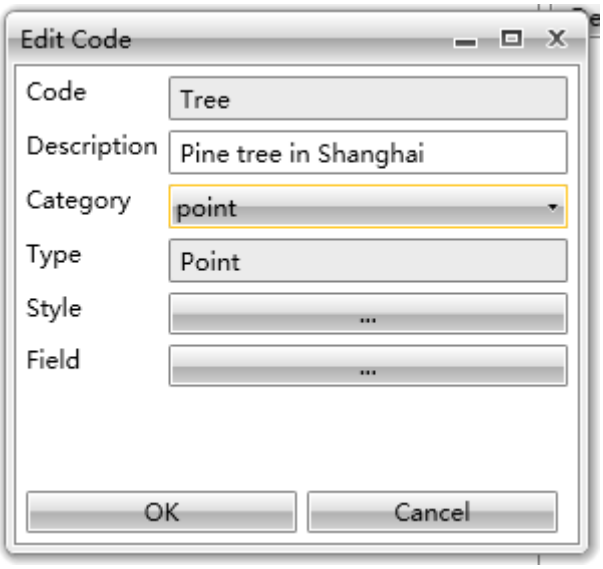


Note: “No Category” is the default category, which can’t be edited or deleted.

[New]: Click to create a new code. One code is consist of name, description category, type, style and field, and users should set according to the real situation.



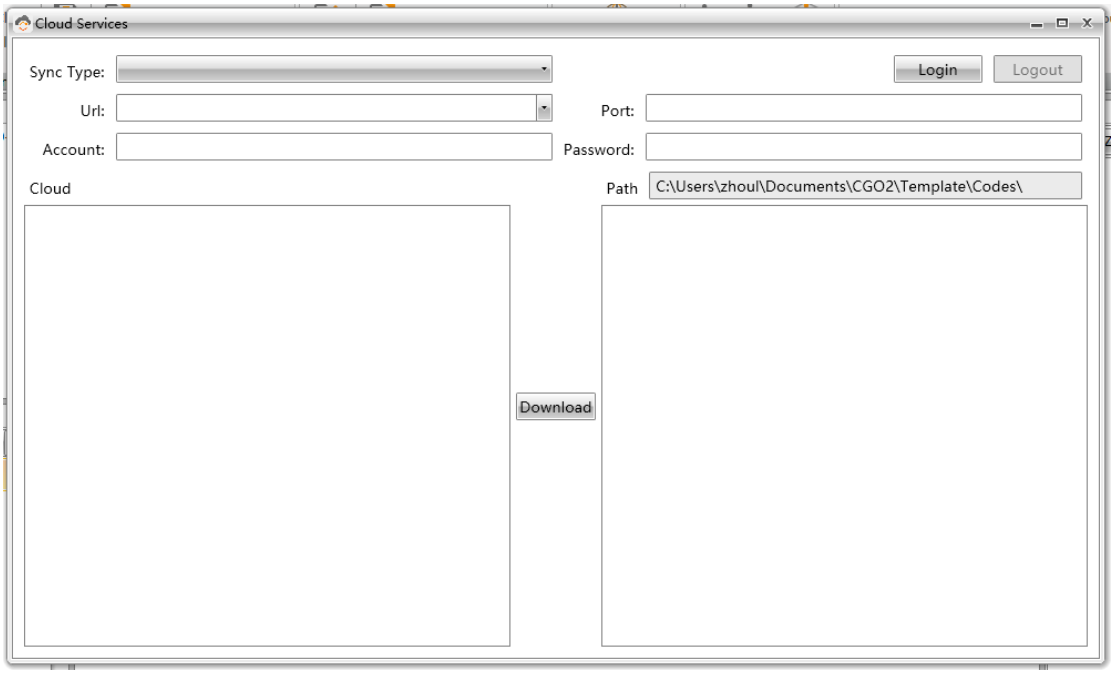
[Edit]: Select a code and click **[Edit]** to edit the description, category, style and field of the code.



[Delete]: Select a code and click **[Delete]**, then a message box reads “Sure to delete code?” will pop up. Click **[OK]** to confirm, or click **[Cancel]** to exit.

5.5.3 Download from Cloud

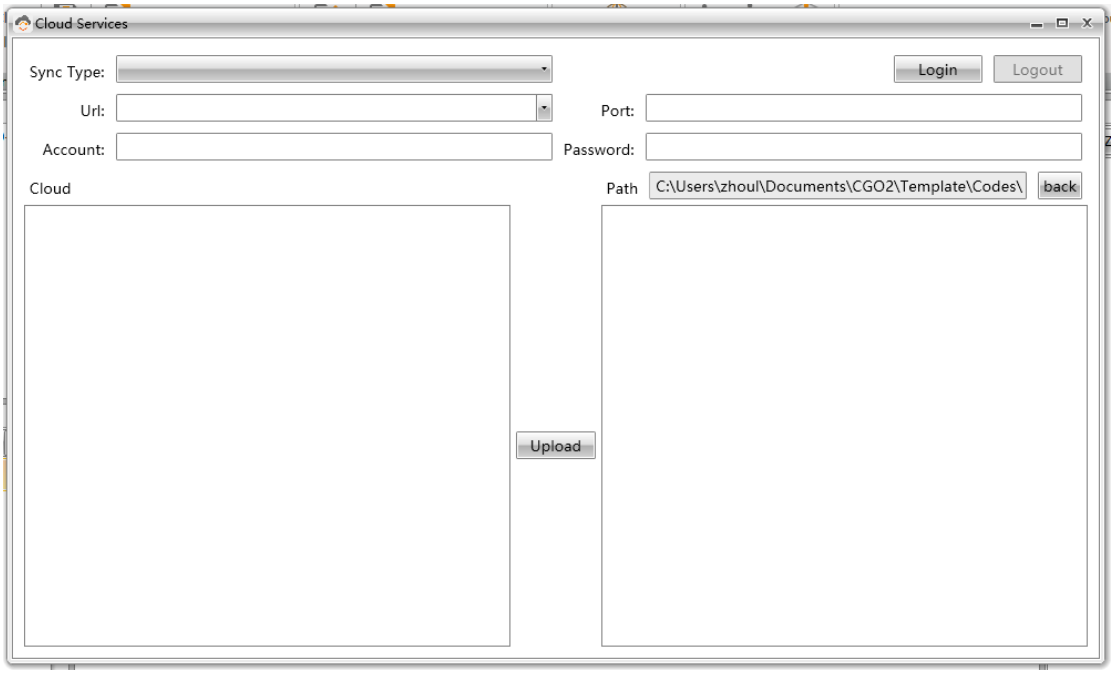
This function is used to download the codelist from the cloud server. Click **[Download from Cloud]**, users will see a pop-up window.



Input URL, port, account and password of the cloud server, then click **[Login]** to login the cloud server. After logging in the cloud server successfully, users can choose the codelist from the cloud server and click **[Download]** to download it in the local storage.

5.5.4 Upload to Cloud

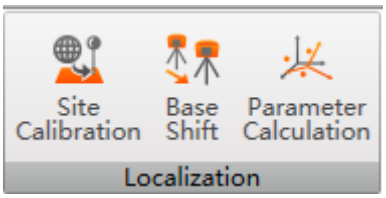
This function is used to upload the codelist from the cloud server. Click **[Upload from Cloud]**, users will see a pop-up window.



Input URL, port, account and password of the cloud server, then click **[Login]** to login the cloud server. After logging in the cloud server successfully, users can choose the codelist from the local storage and click **[Upload]** to upload it to the cloud server.

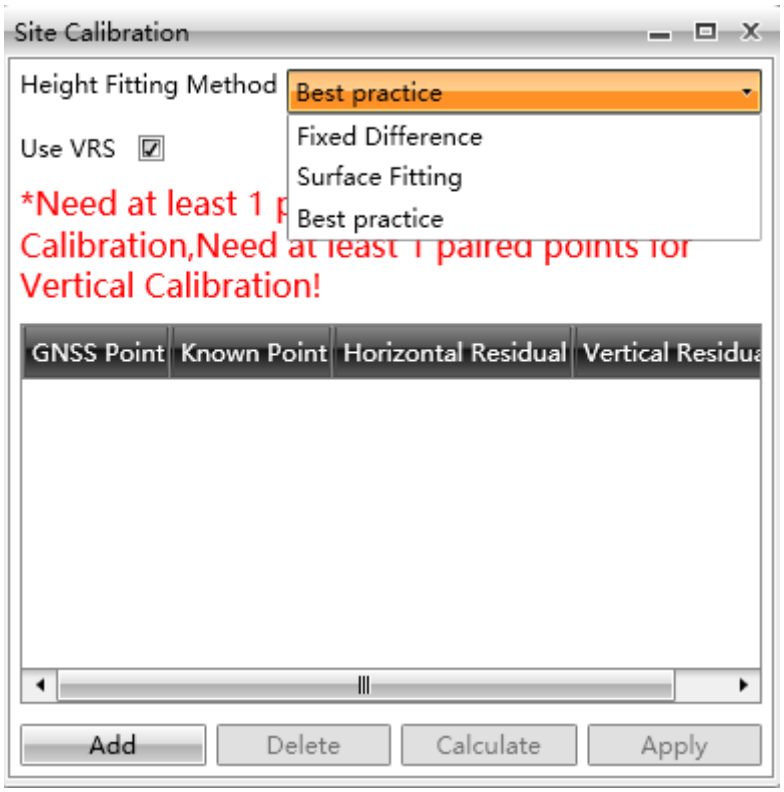
5.6 Localization

This part includes 3 functions: site calibration, base shift, parameter calculation.



5.6.1 Site Calibration

To compute the mathematical transformation relation (transformation parameters), click the **[Site Calibration]** button and enter the site calibration interface.



The CGO 2.0 provides 3 height fitting methods: Fixed Difference, surface fitting, best practice.

[Fixed Difference]: At least 1 known point is needed.

[Surface Fitting]: At least 6 known points are needed.

[Best Practice]: the elevation fitting model of Trimble TGO software, including 5 parameters: Origin North, Origin East, Slope North (ppm), Slope East (ppm), dH (m).

[Use VRS]: Check the **[Use VRS]**, the software will use base coordinates generated by VRS to do site calibration.

[Add]: Click to select correspond GNSS points and Known points. Select [**Horizontal + Vertical Calibration]**. The best choice is to choose 3 couples of points based on actual situation.

[Delete]: Click to delete the point pairs in the list.

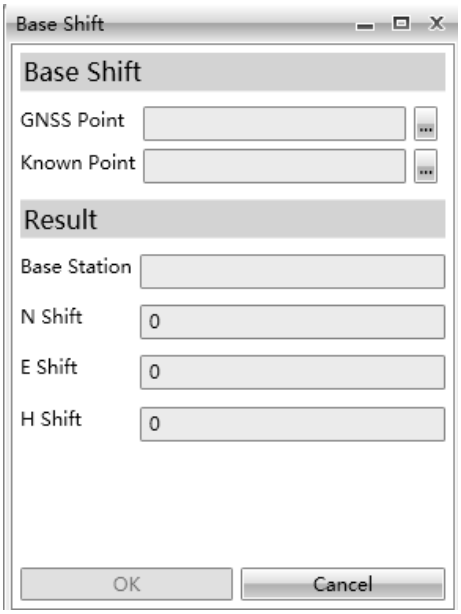
[Calculate]: Click to calculate. The software will prompt “plane correction success, height fitting success”.

[Apply]: Click to apply the calculation result, then a message box reads “Whether replace the current project engineering parameters or not” will pop up. Select [**Yes]** will make current calculated correction parameters apply in the coordinate system

which can affect into the whole project.

5.6.2 Base Shift

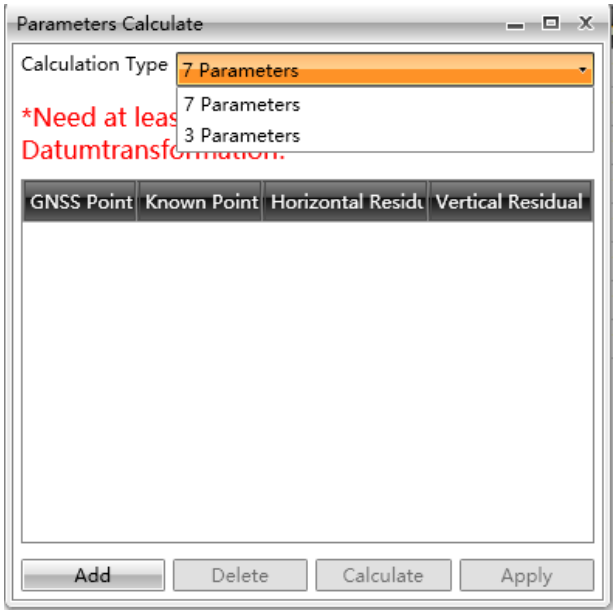
When moving or setting up the base again in auto base mode, base shift is required to ensure all the current points are belong to the same coordinate system as before.



Click to enter base shift interface. In base shift Interface, click the icon beside GNSS Point to select a current point surveyed at a control point, click the icon beside Known Point to select the corresponding control point. The calculation results will show automatically. Then click **[OK]**. The software prompts “Apply Shift Parameters or not?” click **[Yes]**, then the software prompts “Shift base and Related Survey Points, Whether Open Point Library or Not?”. Click **[Yes]**, the point library is opened and the plane coordinates are changed because shift parameters have been applied to all the points surveyed on this base.

5.6.3 Parameter Calculate

This function is for calculating the 7 parameters or 3 parameters by using several point pairs.



[7 Parameters]: Need at least three known point pairs. This method is for the big survey area.

[3 Parameters]: Need at least one known point pair. This method is for the small survey area. The precision depends on the working range, which is decreasing as the increasing of the working distance.

[Add]: Click to select correspond GNSS points and known points.

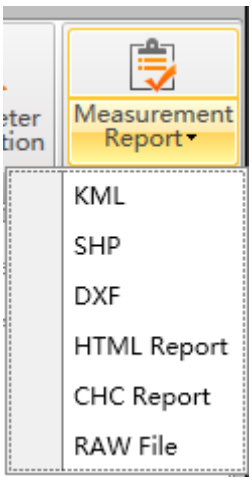
[Delete]: Click to delete the point pairs in the list.

[Calculate]: Click to calculate.

[Apply]: Click to apply the calculation result.

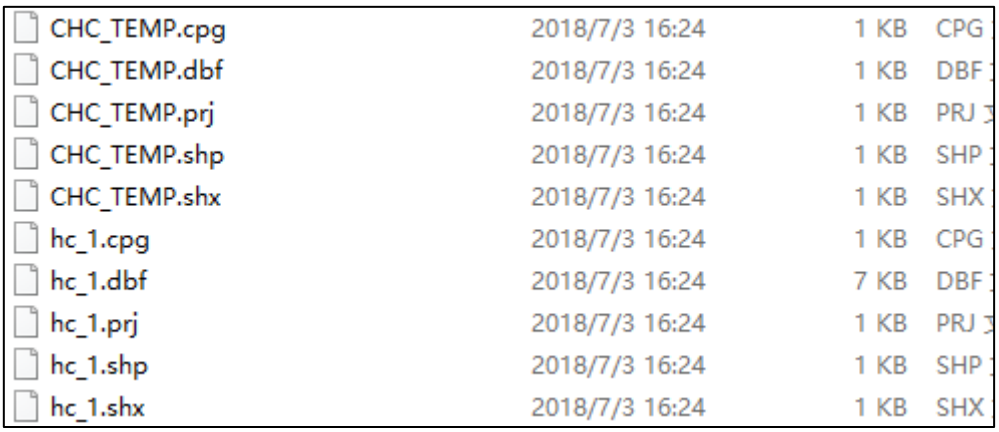
5.7 Report

This part is for exporting the data, there are 6 kinds of report formats: KML, SHP, DXF, HTML, CSV and RAW.

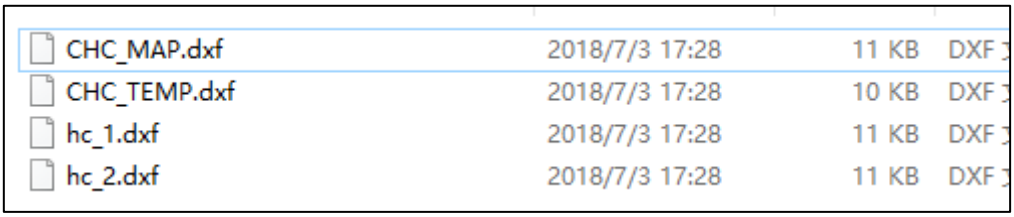


[KML]: Click **[KML]**, the software will automatically open the Google Earth after exporting successfully. Users can view KML data in Google Earth.

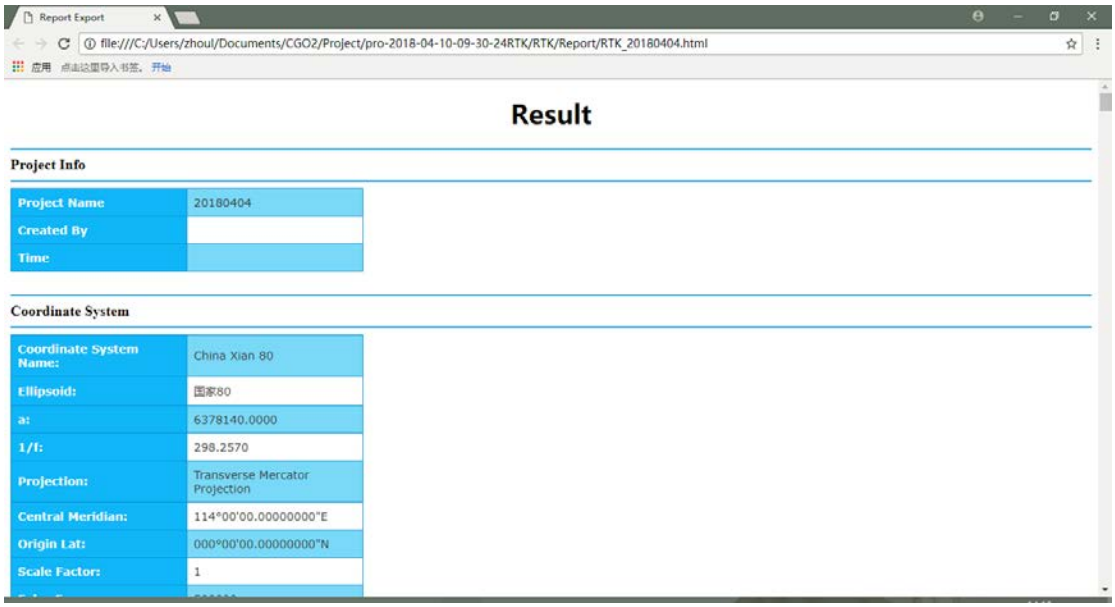
[SHP]: Click **[SHP]**, the software will automatically open a folder. Users can view SHP data in the folder.



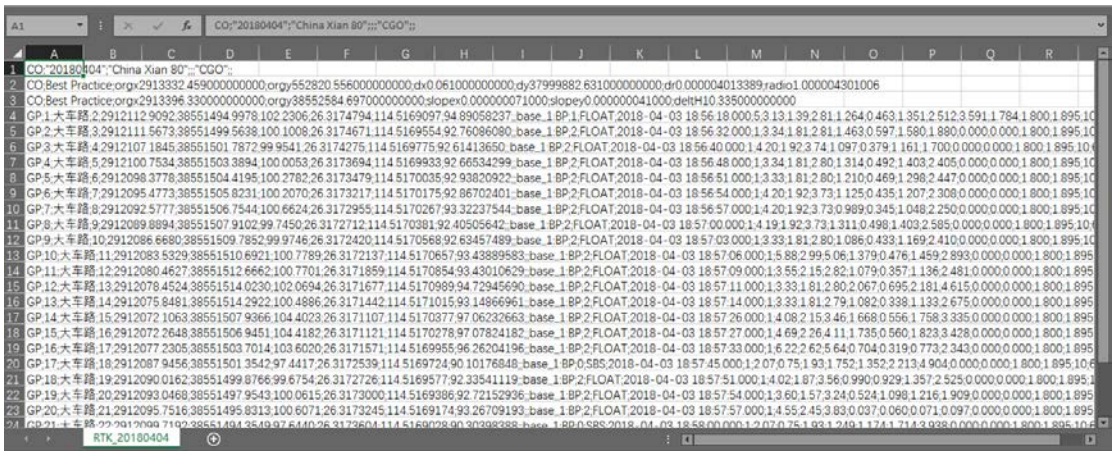
[DXF]: Click **[DXF]**, the software will automatically open a folder. Users can view DXF data in the folder.



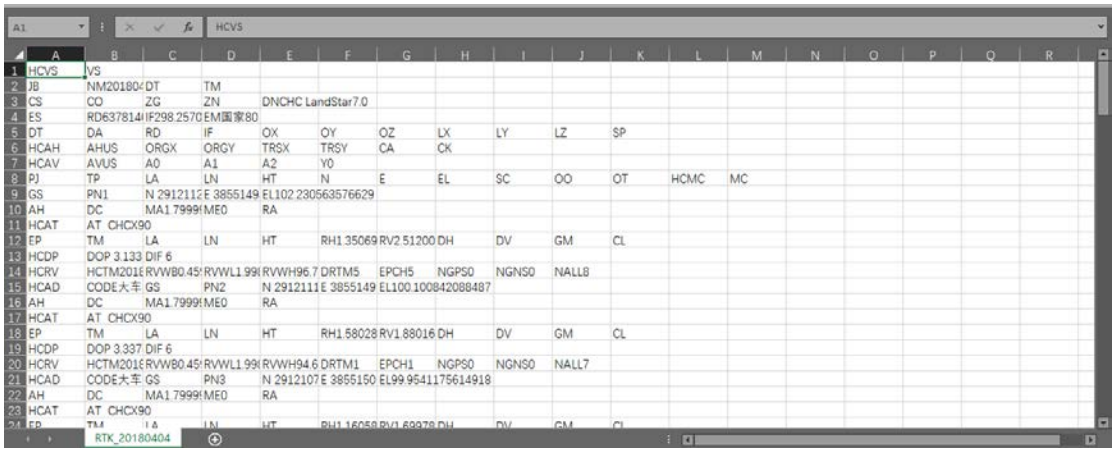
[HTML Report]: Click **[HTML Report]**, the software will automatically open the HTML file in browser. Users can view data information in it.



[CHC Report]: Click **[CHC Report]**, the software will automatically open the CSV file. Users can view data information in it.

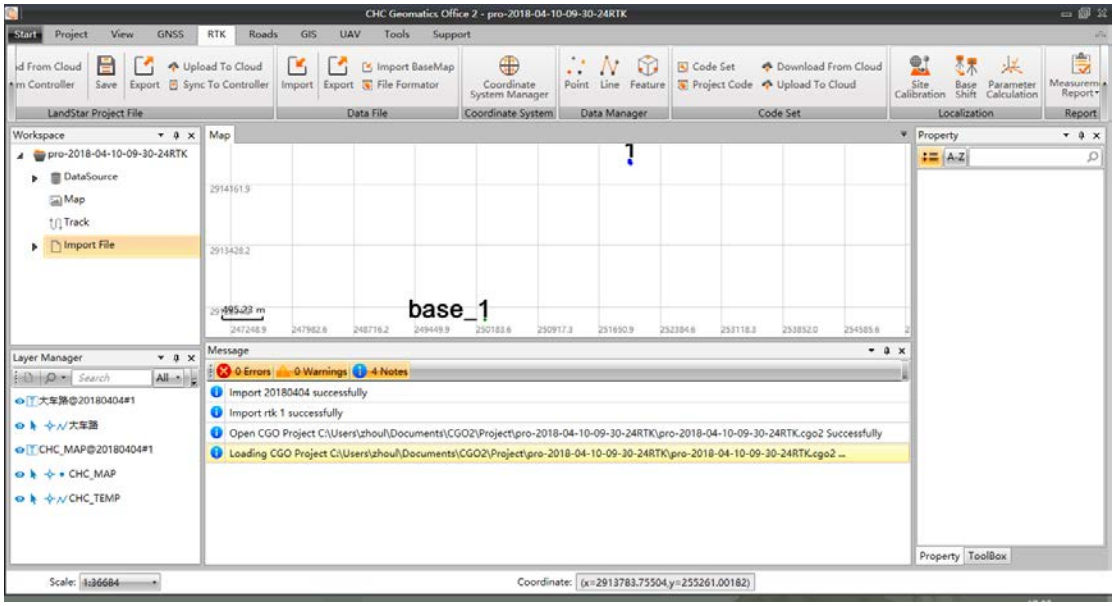


[RAW File]: Click **[RAW File]**, the software will automatically open the RAW file. Users can view data information in it.



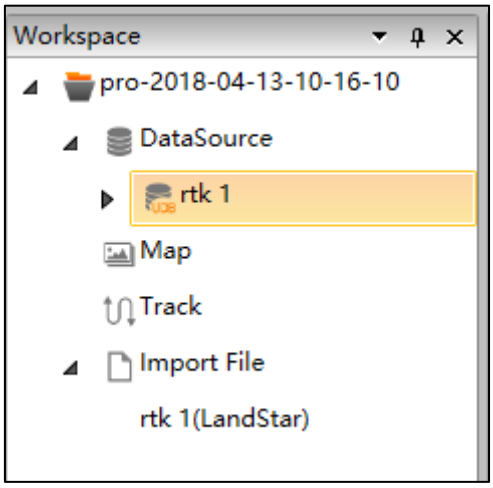
5.8 Operation in the Window

This section expresses the relevant window operation after the user imports the project, including workspace, layer manager, view window, property window.



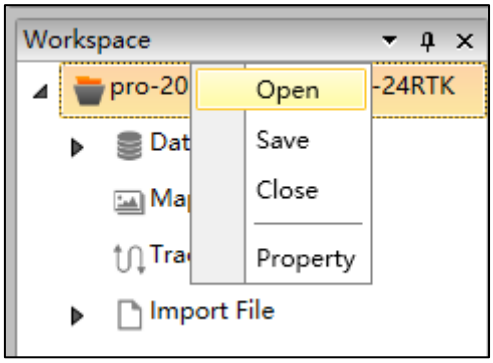
5.8.1 Workspace

This window displays the project and imported files.



The Workspace includes project name, data source, map, track and import file. The user can right-click in the menu to operate relevant operation.

[Project]: The top row in the workspace window is the current CGO project. Right click on it and users can do several operations.



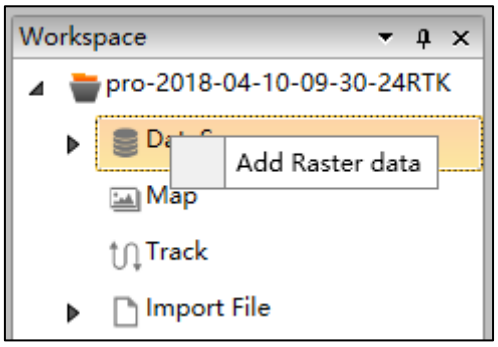
[Open]: open a new project.

[Save]: save the current project.

[Close]: close the current project.

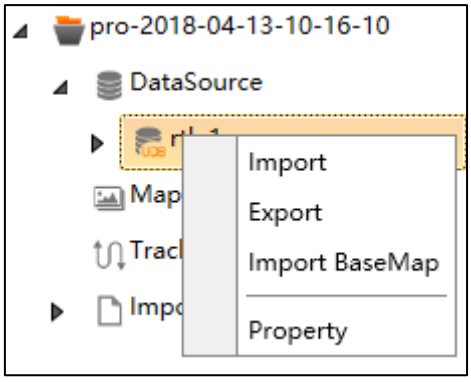
[Property]: check the property of the current project.

[DataSource]: The next level of the project is the DataSource. Right-click the DataSource and users can do several operations.



[Add Raster Data]: Add the raster data (compatible with SIT, CDI file) into the current project.

[Data Source of the RTK project]: The next level of the data source is UDB data source of the RTK project. Right-click the data source and users can do several operations.



[Import]: Import the RTK project.

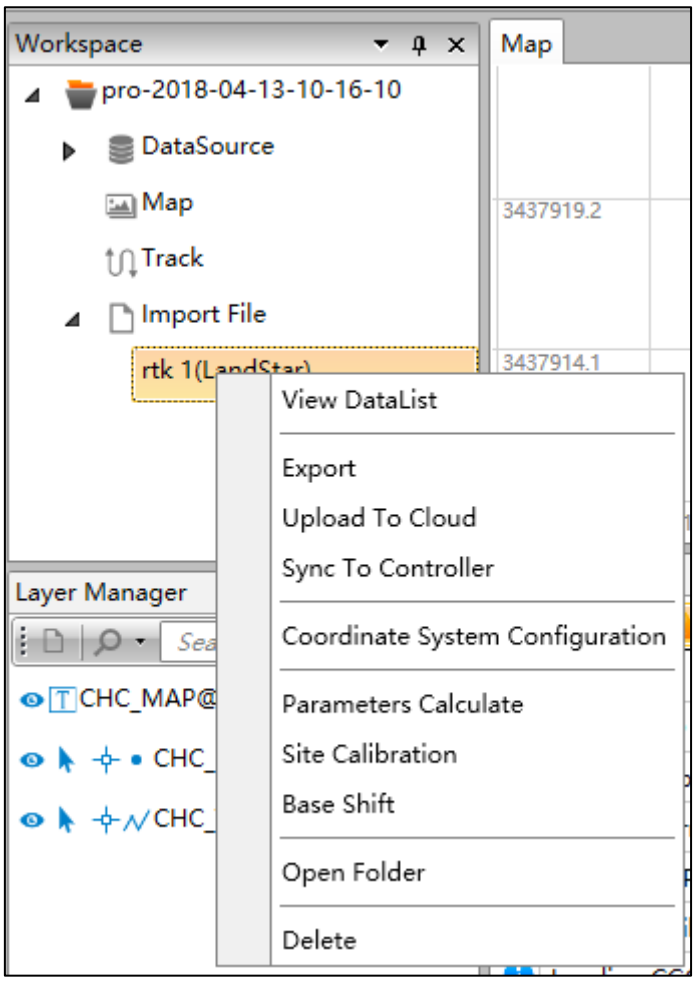
[Export]: Export the RTK project.

[Import BaseMap]: Import the base map (compatible with .shp, .dxf, .sit file).

[Property]: Check the property of the current RTK project.

[RTK data set]: There is no relevant operation available of this level.

[Import File]: The last row in the workspace window is **[import File]**. Right-click the imported project file and users can do several operations.



[View DataList]: Check the RTK data list imported into data list.

[Export]: Export the RTK project.

[Upload to Cloud]: Upload the RTK project to the cloud.

[Sync to controller]: Synchronize the RTK project to the controller;

[Coordinate System Configuration]: Configure the coordinate system of the RTK project.

[Parameters Calculate]: Conduct the parameter calculation.

[Site Calibration]: Conduct site calibration.

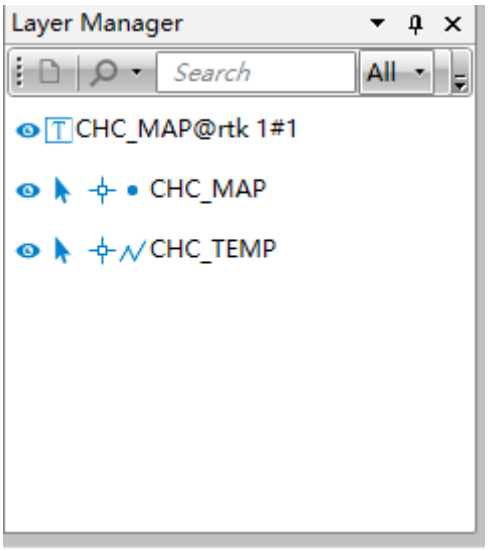
[Base Shift]: Conduct base shift.

[Open Folder]: Open the path of the current RTK project.

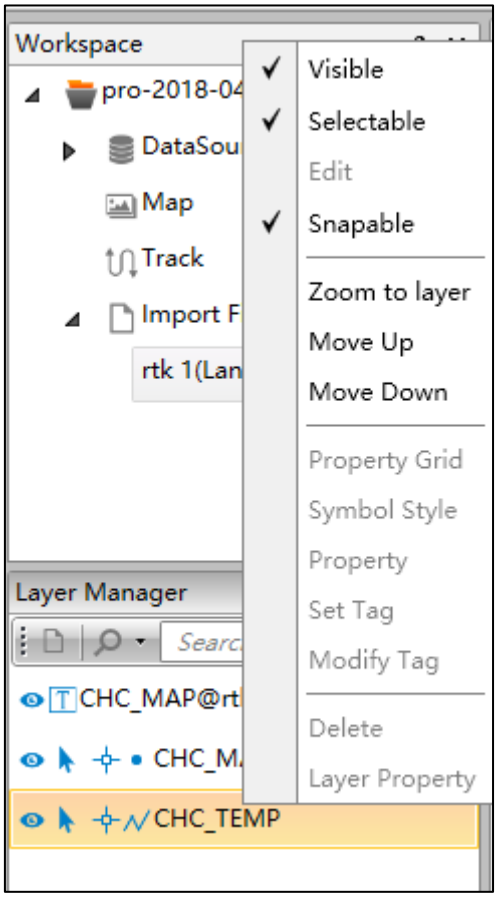
[Delete]: Delete the RTK project file.

5.8.2 Layer Manager

This window displays the layers of the current RTK project.



Right-click on the selected layer and users can do several operations.



[Visible]: Click **[Visible]** button or the visible checkbox in front of each layer , and the user can control the visibility of the layer. All the layers are visible by default after the user imported the project, as well as the created new layer or thematic map. After the user set the layer invisible, the visible icon in front of each layer turns grey . The user can re-checks the icon and turns the layer visible again.

[Selectable]: Click the check icon in front of each layer and the user can control whether the layer in the view window. All the layers are visible by default after the user imported the project. The user can click the check icon and set the layer not selectable, at the same time, the icon turns grey, and the user can check the icon again, and the icon turns blue again. It is the same through click the selectable option.

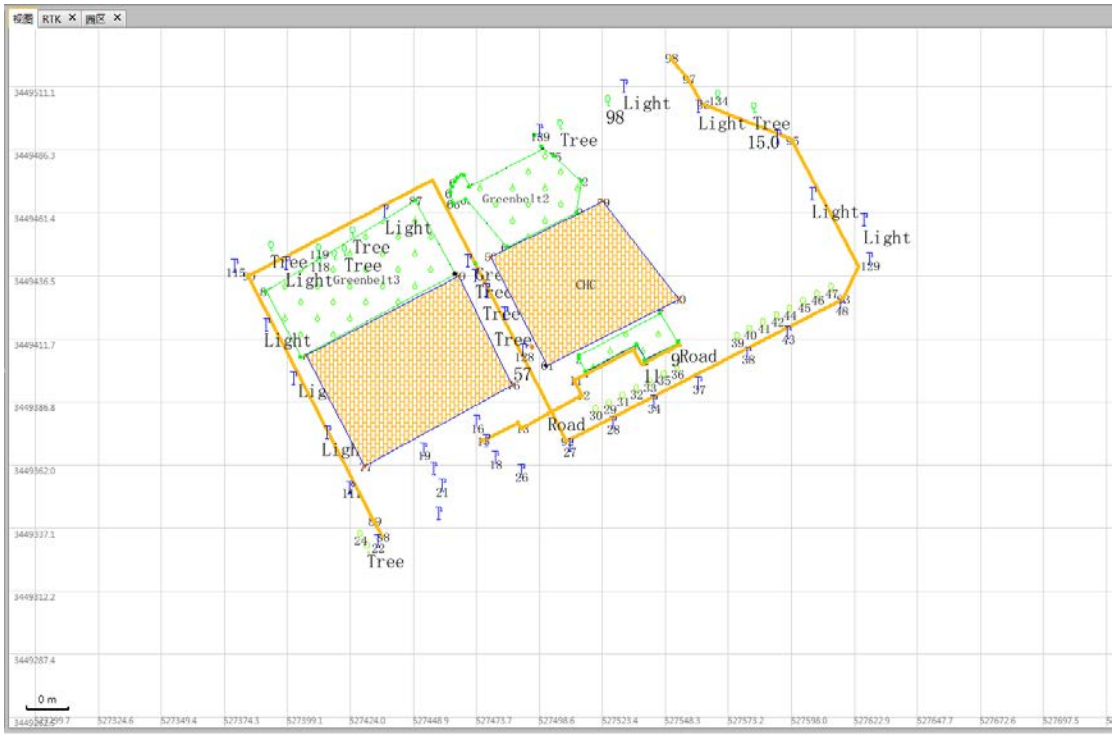
[Snapable]: The user can also click the check icon in front of each layer . All the layers are visible by default after the user imported the project. The usage as introduced above.

[Zoom to Layer]: Click the option, and the software conducts zoom to layer in the view layer.

[Move Up/Down]: Select the layer or thematic map and choose to move up or move down option to control the display order of the current layer in the view window.

5.8.3 View

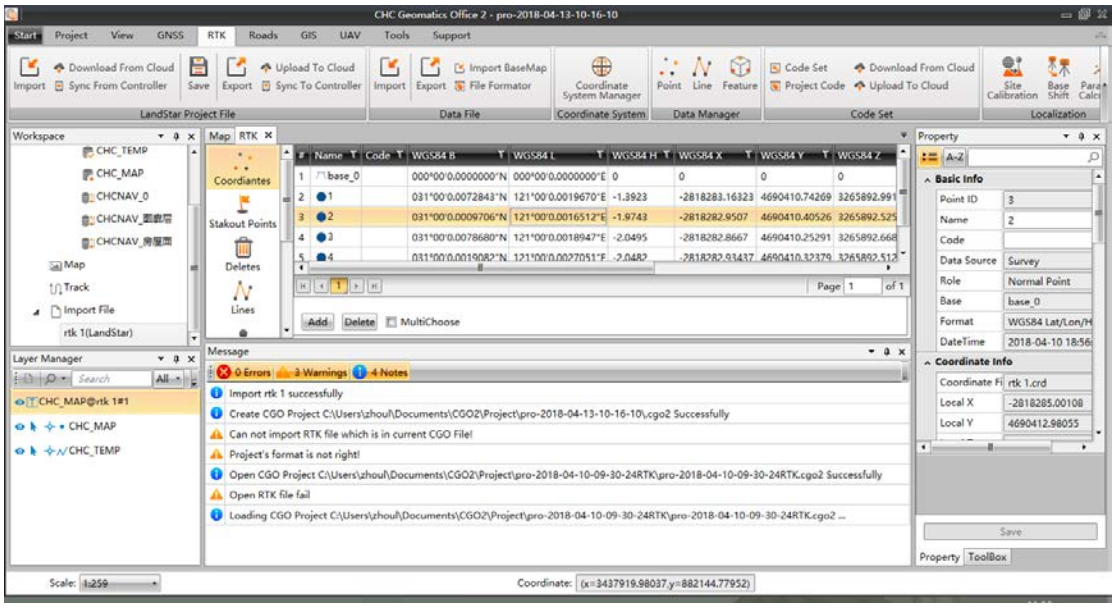
This window displays the data of the current imported RTK project.



The selected feature shows in the property window.

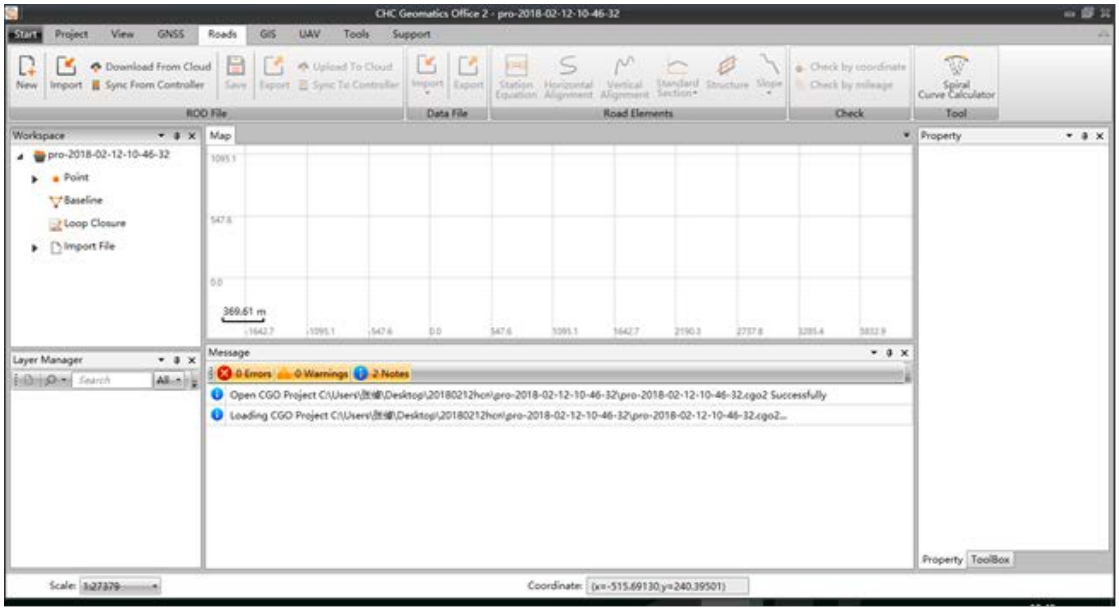
5.8.4 Property Window

This window shows the data of the selected data list. Open the data list and select one, then, the relevant property information in detail displays in the property window.



6 Road

Click **[Road]** in the main toolbar, and the user can switch to the road panel.



The road panel consists of 5 parts: ROD file, data file, road elements, check and tool.

6.1 ROD File

6.1.1 New

Click **[New]**, input name to create road file and choose a path to save.

6.1.2 Import

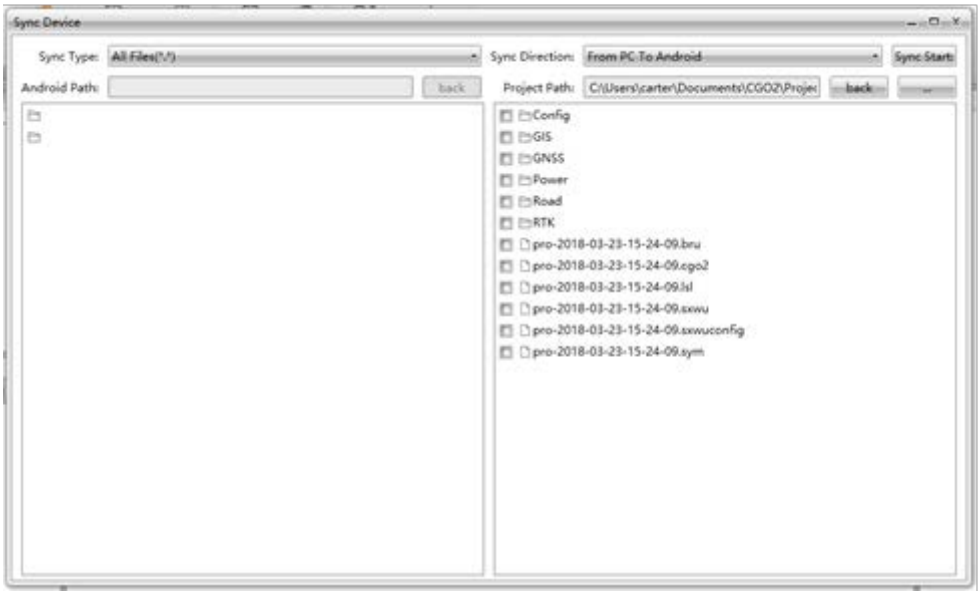
Click **[Import]**, users can choose ROD file to import. After importing road data, the interface shows as following:

6.1.3 Download from Cloud

Click **[Download from Cloud]**, input URL, port, account, and password, click **[Login]**. After logging in successfully, users can choose road file from cloud server and click **[Download]** to download in the local storage.

6.1.4 Sync from Controller

Click **[Sync from Controller]**, users can choose road file from the controller and click **[Sync Start]** to sync it in the local storage.



6.1.5 Save

Click **[Save]**, users can save current road file.

6.1.6 Export

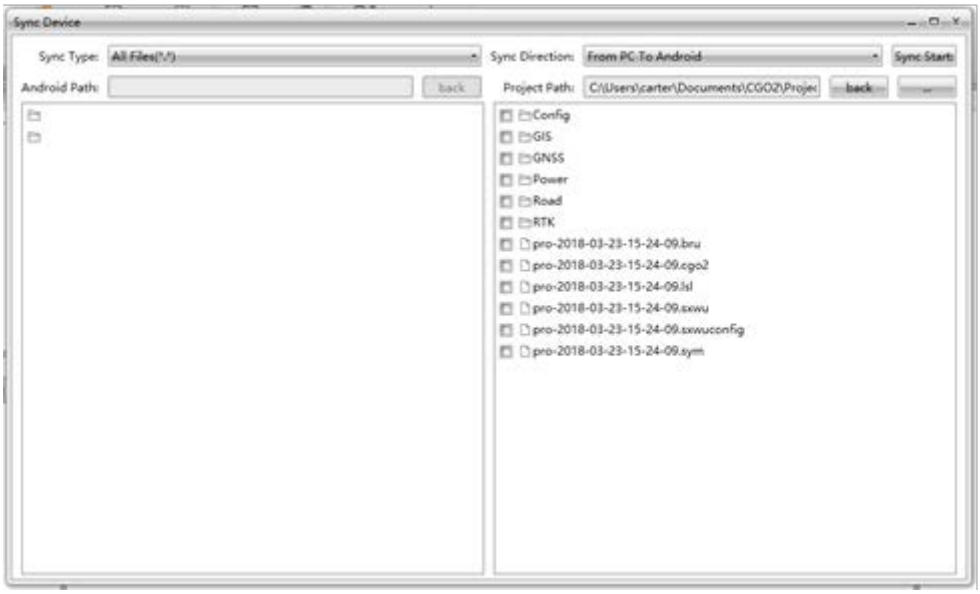
Click **[Export]**, users can export current road file.

6.1.7 Upload to Cloud

Click **[Upload to Cloud]**, input URL, port, account, and password, click **[Login]**. After logging in successfully, users can choose road file from cloud server and click **[Upload]** to upload it to cloud server.

6.1.8 Sync to Controller

Click **[Sync to Controller]**, users can choose road file in the local storage and click **[Sync Start]** to sync it to the controller.



6.2 Data File

6.2.1 Import

Click **[Import]**, users can import pile data, Hard data and Hint data.

6.2.2 Export

Click **[Export]**, users can export the data as DAT, CSV, KML, KMZ file. It also allows for generating data by inputting start station, end station, interval and offset value.

6.3 Road Elements

6.3.1 Station Equation

[Add]: This is used to add station equation. Click **[Add]**, users can input before station and end station. After clicking **[Apply]**, the software will calculate the length of the short equation or long equation.

[Insert]: Choose a station equation data, click **[Insert]**, users can insert one station

equations data above the selected data, and input the before station and end station mileage.

[Delete]: It is used to delete selected station equation data.

6.3.2 Horizontal Alignment

(3) **Horizontal POI**

[Add]: Input start coordinate and stake, click next to input curve type and parameters. Users can choose curve type at the pull-down list, and input required parameters.

[Arc]: Input coordinates and radius.

[Spiral|Spiral]: Input coordinates, in and out transition length.

[Spiral|Arc|Spiral]: Input coordinates, radius, in and out transition length.

[Insert]: Insert roads parameters.

[Delete]: Delete selected roads parameters

(4) **Horizontal Element**

[Add]: Choose type, and input coordinates, etc.

[Line]: Input azimuth and length.

[Arc]: Input radius and length, and choose direction.

[Transition]: Input start radius, end radius and length.

[Next]: Click until all curve parameters inputted, click Finish, and then Apply.

[Insert]: Insert roads parameters.

[Delete]: Delete selected roads parameters

6.3.3 Vertical Alignment

Edit vertical alignment, enter the mileage, height and radius (no negative or positive).

Note: Before entering vertical curve, please enter the flat curve.

[Add]: Click to add a road.

The first line: Input mileage, height.

The second line: Input mileage, height, and radius.

.....

The last line: Input mileage, height.

[Apply]: Click to complete input.

6.3.4 Standard Cross Section

Road surface and base data are consist of the standard cross section and plate width, side slope transformation (superelevation and widening).

By cross-sectional plates, two sides are input one by one from graphic design line. Each dish is defined by the width, the horizontal slope, and the height difference. The height difference is the height difference between the block and the last one.

[Height design line]: Include the plane design line, the sides of the middle belt, the left side of the road, the right side of the road, the outside of the bend, the inner side of the curve, and the height design line can select according to the actual way.

[Add]: Click to add cross-section, select plate name, input plate width, plate standard cross slope, click **[Save]** to complete the standard cross-section of the new.

[Insert]: Select a data recording file, input wait for edit road data before selected data.

[Delete]: Delete selected data recording.

6.3.5 Super Elevation

In order to counteract the centrifugal force while running one the curve section, the lateral side of the section needs to be designed higher than the inside section. The elevation difference is called super elevation. The change of the slope is superelevation, and this software is to distinguish the superelevation.

There are two types of slope change: linear, cubic.

[Add]: Click to add super elevation, input mileage, method and cross slope.

[Insert]: Select a data recording file, input wait for edit road data before selected data.

[Delete]: Delete selected data recording.

[Apply]: Click to complete input.

6.3.6 Widening

When the car runs on the bend, the track of each wheel is different. The path radius of the rear wheel is the smallest in the inner side of the bend, and the path radius of the front wheel near the side of the bend is the largest. In order to ensure that vehicles do not occupy adjacent lanes when turning, the curve sections with less than the specified radius need to be widened.

[Add]: Click to add super elevation, input mileage, widen and method.

[Insert]: Select a data recording file, input wait for edit road data before selected data.

[Delete]: Delete selected data recording.

[Apply]: Click to complete input.

6.3.7 Structure

Click **[Add]**, structure including slab culvert, circular culvert, passageway, overpass. Methods including skew as orthotropic, skew as skew. Input cross angle, forward width, backward width, left length, right length, center height, and slope. After finishing input all parameters, click on apply.

6.3.8 Slope Section Library

Users always meet several slopes with the same slope type in a road section, and it's really annoying to input the same slope elements again and again. So we make slope library function, you only need to input the slope type once, find the position and then you can use the slope element directly. Click to view all slopes.

[Add]: Click to add slope parameters, input height, slope denominator, width, slope percentage, interior height, bottom width, outer width, and outer height

[Insert]: Insert roads parameters.

[Delete]: Delete selected data.

[Apply]: Click to complete input.

6.3.9 Slope Section

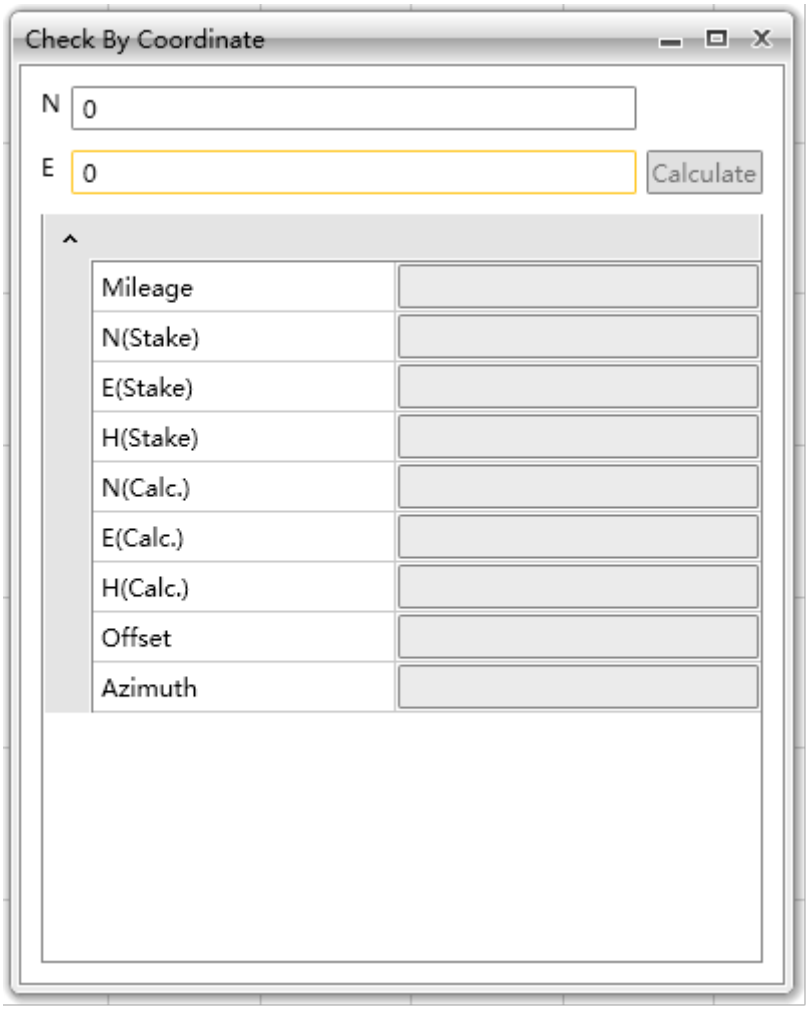
The slope refers to the slope surface, which is made on both sides of the subgrade, to ensure the stability of the subgrade.

Select the left or right-side slope, click **[Add]**, users can input the initial mileage, choose the slope template, terminate mileage and slope template. Before creating a new slope, it is necessary to add the slope template in the slope section library.

6.4 Check

6.4.1 Check by Coordinate

Click on **[Check by Coordinate]**, Input North, East coordinate. Click on **[Calculate]**, display mileage, calculation coordinate, offset and azimuth and so on.



6.4.2 Check by Mileage

Click on **[Check by Mileage]**, input Interval, offset, Mileage. Show coordinate of road cross-section. Support click on Previous and Next to view coordinate of road cross-

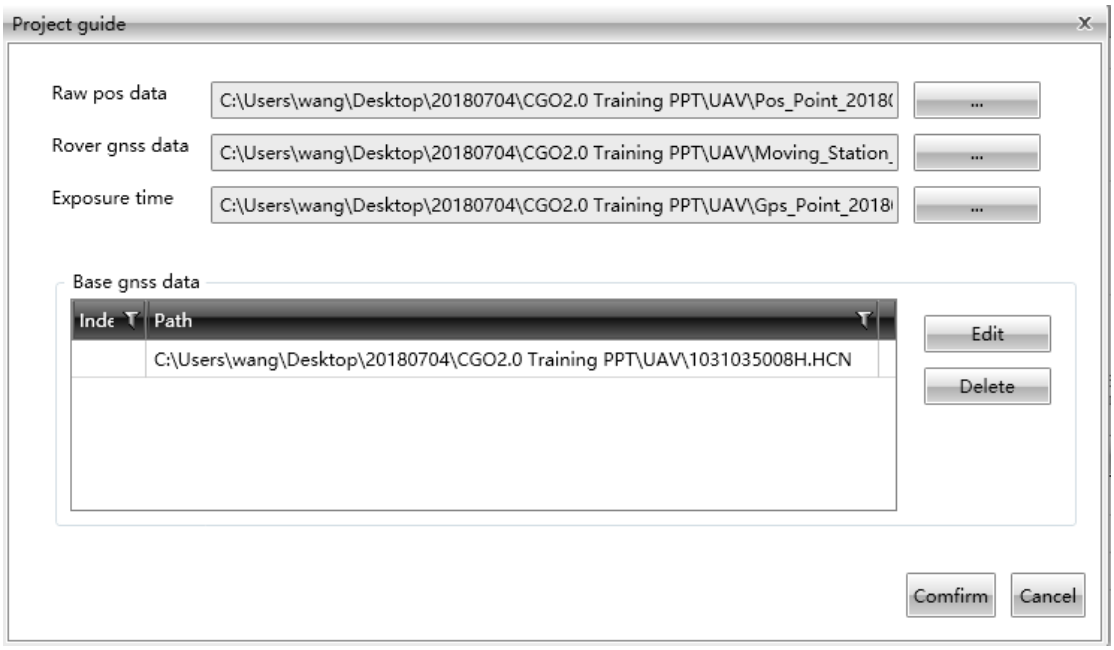
section at different mileages.

7 UAV

7.1 Open/Export

7.1.1 Import

Click **[Import]**, users can import the UAV data.

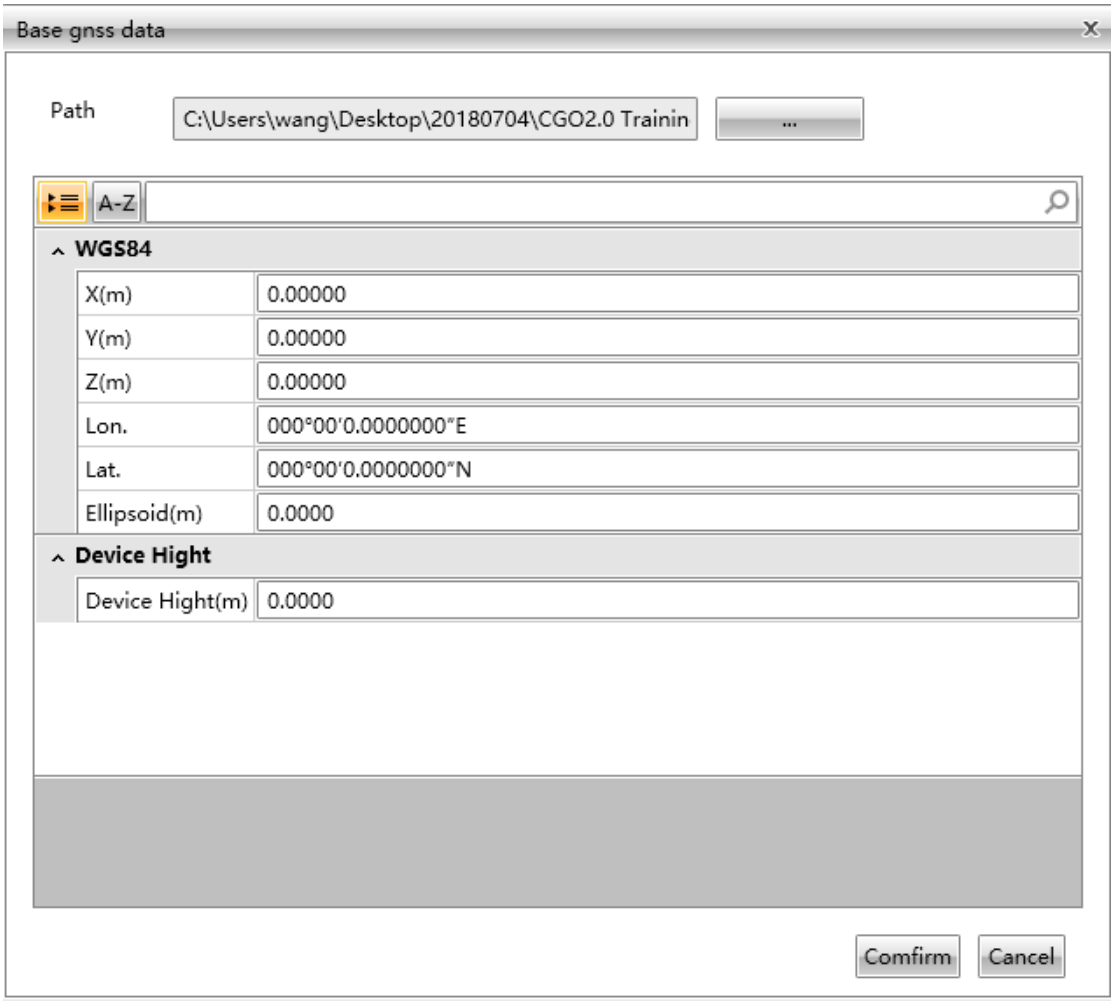


[Raw POS Data]: This refers to the POS data recorded by UAV, users should import the POS data in TXT format.

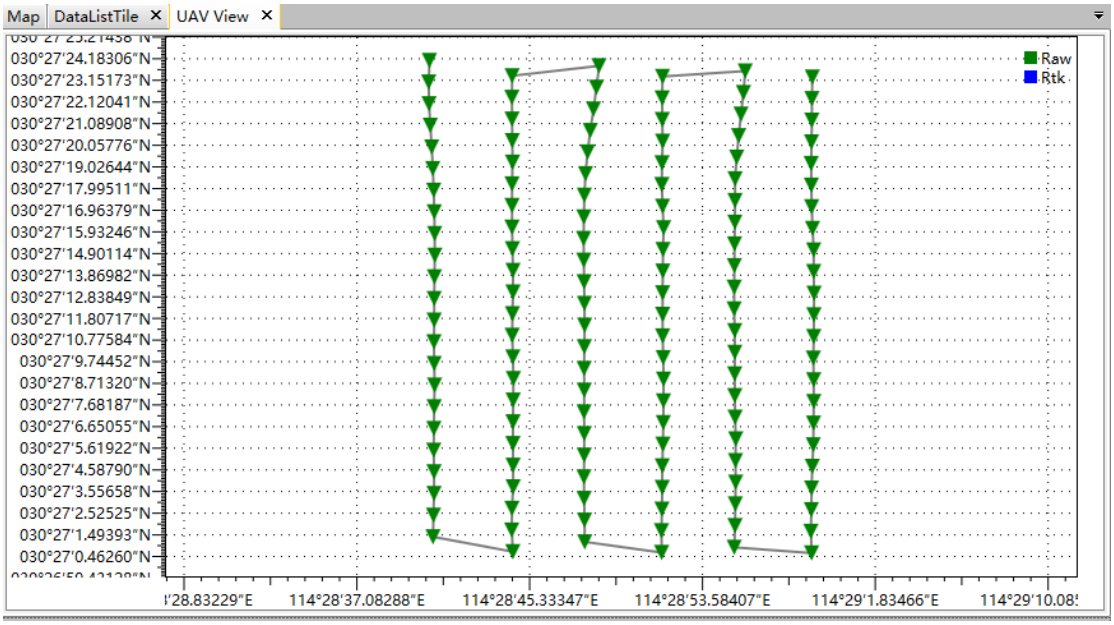
[Rover GNSS Data]: This refers to the GNSS data recorded by the rover station on UAV, users should import the rover station observation data.

[Exposure Time]: This refers to the exposure time of each capture, users should import the exposure time file in TXT format.

[Base GNSS Data]: This refers to the GNSS data recorded by the ground station, users should import the base station observation data. It also allows for modifying the configuration of the base GNSS data.

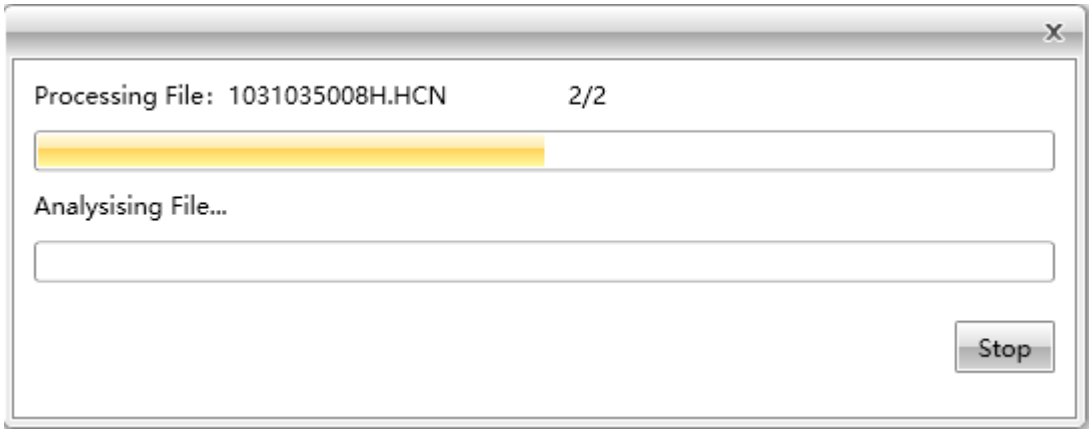


[Confirm]: Click to start importing data, and users can check the data in UAV view once the data has been imported successfully.

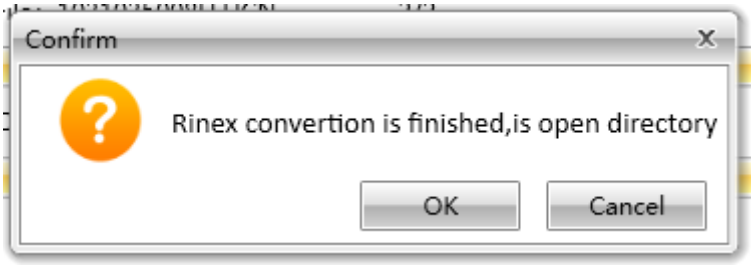


7.1.2 Export Rinex

Click **[Export Rinex]**, users will see two options: Rinex version 2.11 and 3.02. Choose whichever you want, and then the UAV data will be automatically exported.

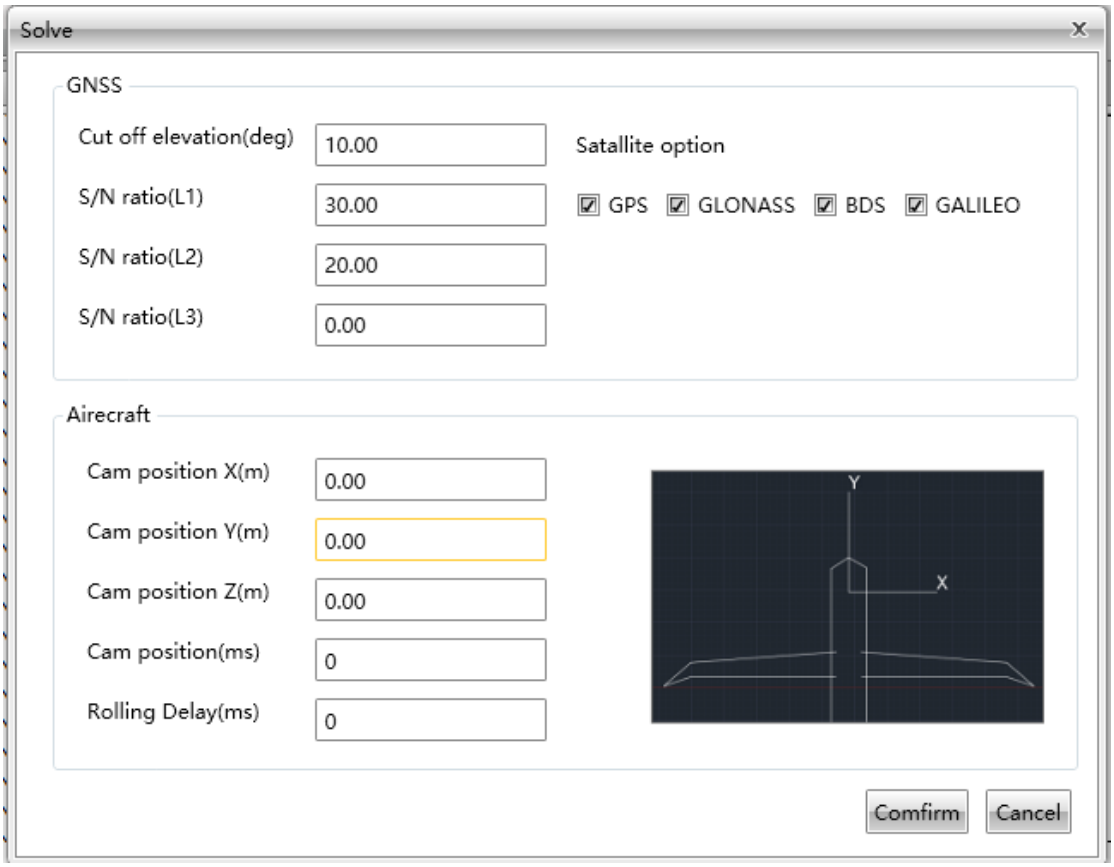


After exporting successfully, an option window will pop up, and users can decide whether to open the directory of the exported file (the default directory is the same as the imported file.).



7.2 Process

Click **[Process]**, users will see the configuration window.



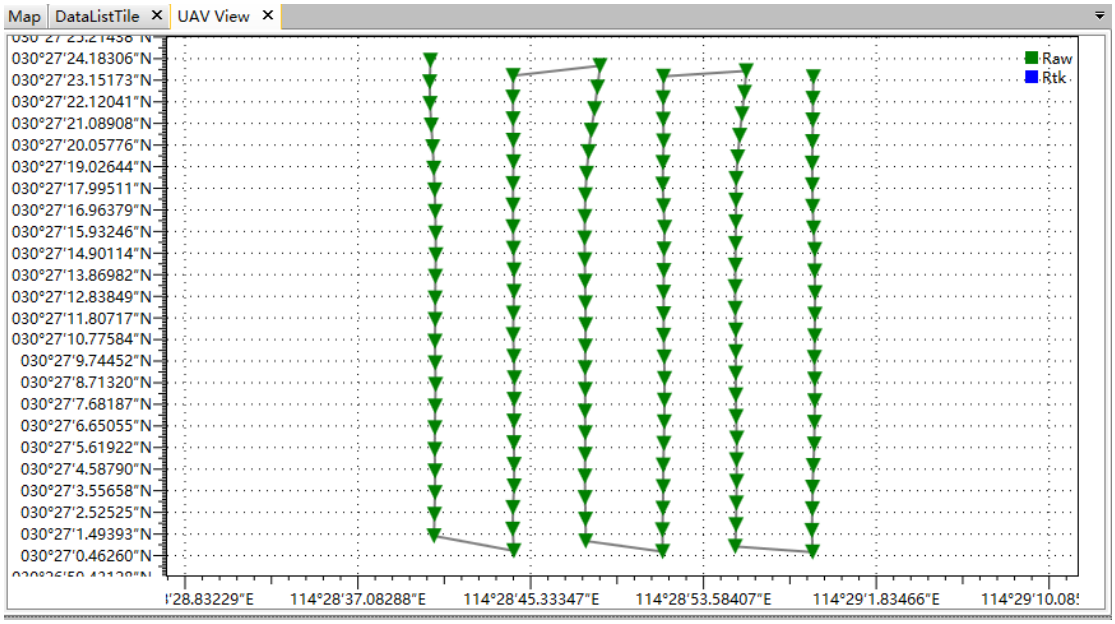
[GNSS]: Users should input the cut off elevation angle, the S/N ratio

[Aircraft]: Users should input the relative position between the camera and the UAV, including the coordinates and the rolling delay parameters.

7.3 Data Graph

7.3.1 UAV View

Click **[UAV View]**, users can call out the window to vie UAV data.



7.3.2 Information

Click [Information], users can view the information of each capture, including the picture name and coordinates.

Pic	X	Y	Z	Longitude(WGS84)	Latitude(WGS84)	Ellipsoid Height(WGS84)
DSC00001	-2280122.97316	5008384.76169	3214246.06604	114°28'40.5480000"E	030°27'24.0948000"N	254.8000
DSC00002	-2280128.45908	5008399.12976	3214218.43787	114°28'40.5120000"E	030°27'23.0688000"N	254.0274
DSC00003	-2280134.99995	5008412.56984	3214190.44150	114°28'40.5264000"E	030°27'22.0392000"N	252.7171
DSC00004	-2280142.71946	5008425.58541	3214162.37651	114°28'40.5876000"E	030°27'21.0060000"N	251.4600
DSC00005	-2280150.79984	5008438.93003	3214134.70416	114°28'40.6560000"E	030°27'19.9764000"N	250.7892
DSC00006	-2280158.72354	5008453.08948	3214107.42970	114°28'40.7064000"E	030°27'18.9468000"N	250.9036
DSC00007	-2280166.62166	5008467.42451	3214080.11435	114°28'40.7532000"E	030°27'17.9136000"N	251.1259
DSC00008	-2280173.76699	5008481.49685	3214052.60365	114°28'40.7784000"E	030°27'16.8840000"N	250.7745
DSC00009	-2280180.87184	5008495.94386	3214025.15498	114°28'40.7964000"E	030°27'15.8508000"N	250.7341
DSC00010	-2280187.61366	5008510.28891	3213997.56330	114°28'40.8036000"E	030°27'14.8176000"N	250.4118
DSC00011	-2280193.80599	5008525.04960	3213970.18878	114°28'40.7856000"E	030°27'13.7880000"N	250.3295

7.3.3 Display Controller

Click **[Display Controller]**, users can choose whether to display raw data or RTK data in the UAV view window.

7.4 Report

Click **[Report]**, users can see two options: UAV POS and Track. Users can choose **[UAV POS]** to export the POS data in TXT format, or choose **[Track]** to export the flying track of the UAV in TXT format.

POS data:

```
* ReferenceStation Name          : 1031035
* Start Time                     : 01/08/2018 07:43:12  (week 1983  114192s)
* End Time                       : 01/08/2018 08:29:04  (week 1983  116944s)
* Antenna Type                   : 0
* Antanna Height(m)              : 0.0000
* Latitude                       : 030°27'30.3247442"N
* Longitude                      : 114°28'57.1629097"E
* Ellipsoid Height(m)            : 7.7052
* Fixed solution ratio           : 0%
**********************************************************************************************************
Epoch(GPST),      Rover,    X(m),         Y(m),         Z(m),        Latitude(WGS84),        Longitude(WGS84),        Ellipsoid Height(m)
2018-01-08 08:43:22.675,DSC00001,  NaN,     NaN,     NaN,     ,
                                                 NaN,
    2018-01-08 08:43:23.998,DSC00002,  NaN,     NaN,     NaN,     ,
                                                      NaN,
    2018-01-08 08:43:25.294,DSC00003,  NaN,     NaN,     NaN,     ,
                                                      NaN,
    2018-01-08 08:43:26.563,DSC00004,  NaN,     NaN,     NaN,     ,
                                                      NaN,
    2018-01-08 08:43:27.788,DSC00005,  NaN,     NaN,     NaN,     ,
                                                      NaN,
    2018-01-08 08:43:29.021,DSC00006,  NaN,     NaN,     NaN,     ,
                                                      NaN,
    2018-01-08 08:43:30.278,DSC00007,  NaN,     NaN,     NaN,     ,
                                                      NaN,
    2018-01-08 08:43:31.553,DSC00008,  NaN,     NaN,     NaN,     ,
                                                      NaN,
```

Track moving data:

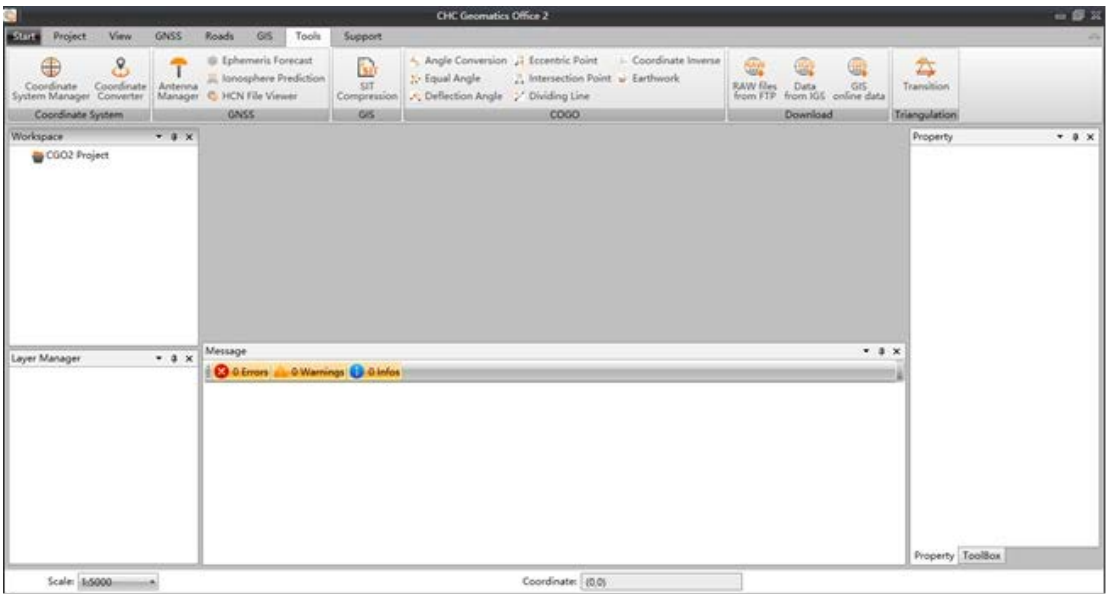
```
* ReferenceStation Name          : 1031035
* Start Time                     : 01/08/2018 07:43:12  (week 1983  114192s)
* End Time                       : 01/08/2018 08:29:04  (week 1983  116944s)
* Antenna Type                   : 0
* Antanna Height(m)              : 0.0000
* Latitude                       : 030°27'30.3247442"N
* Longitude                      : 114°28'57.1629097"E
* Ellipsoid Height(m)            : 7.7052
* Fixed solution ratio           : 0%
**********************************************************************************************************
Epoch(GPST),      Rover,    Type,     Solution Type,Dx(m),    std.Dx(m), Dy(m),    std.Dy(m), Dz (m),    std.Dz (m),Latitude,        Longitude,        Ellipsoid Height(m)
2018-01-08 08:38:18.000,P11,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0863,
   2018-01-08 08:38:18.050,P12,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0902,
   2018-01-08 08:38:18.100,P13,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0715,
   2018-01-08 08:38:18.150,P14,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.1013,
   2018-01-08 08:38:18.200,P15,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0923,
   2018-01-08 08:38:18.250,P16,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0966,
   2018-01-08 08:38:18.300,P17,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0813,
   2018-01-08 08:38:18.350,P18,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0910,
   2018-01-08 08:38:18.400,P19,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0913,
   2018-01-08 08:38:18.450,P20,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0669,
   2018-01-08 08:38:18.500,P21,     Kinmatic(Go),None,     0.00000,  0.00000,  0.00000,  0.00000,  0.0000,   0.00000,  030°27'30.0879164",114°28'57.0542018",6.0764,
```

8 Tool

Click on **[Spiral Curve Calculation]**, choose calculation content， input related parameters, click on **[Calculate]**.

8.1 Tools

Click **[Tools]** in the Menu bar to switch to tool section.



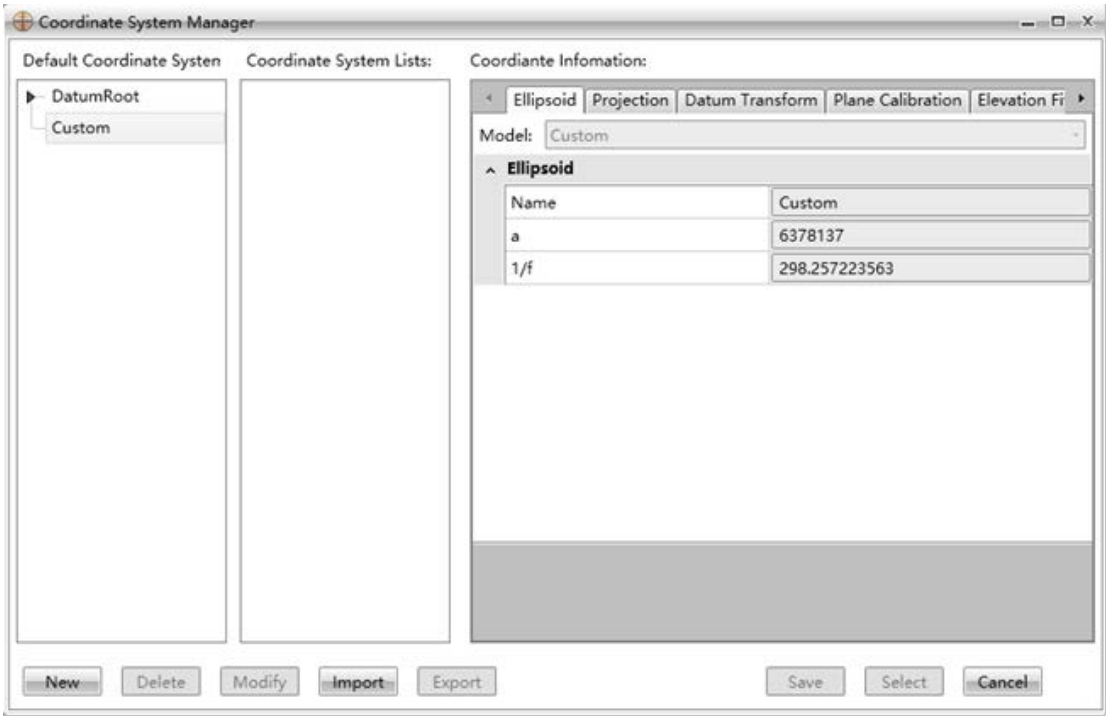
This section is for some separated tools, containing coordinate system, GNSS, GIS, COGO, download, and triangulation.

8.2 Coordinate System

This part consists of the coordinate system manager and coordinate converter**.**

8.2.1 Coordinate System Manager

The tool is used to set the coordinate system parameters for the current project.

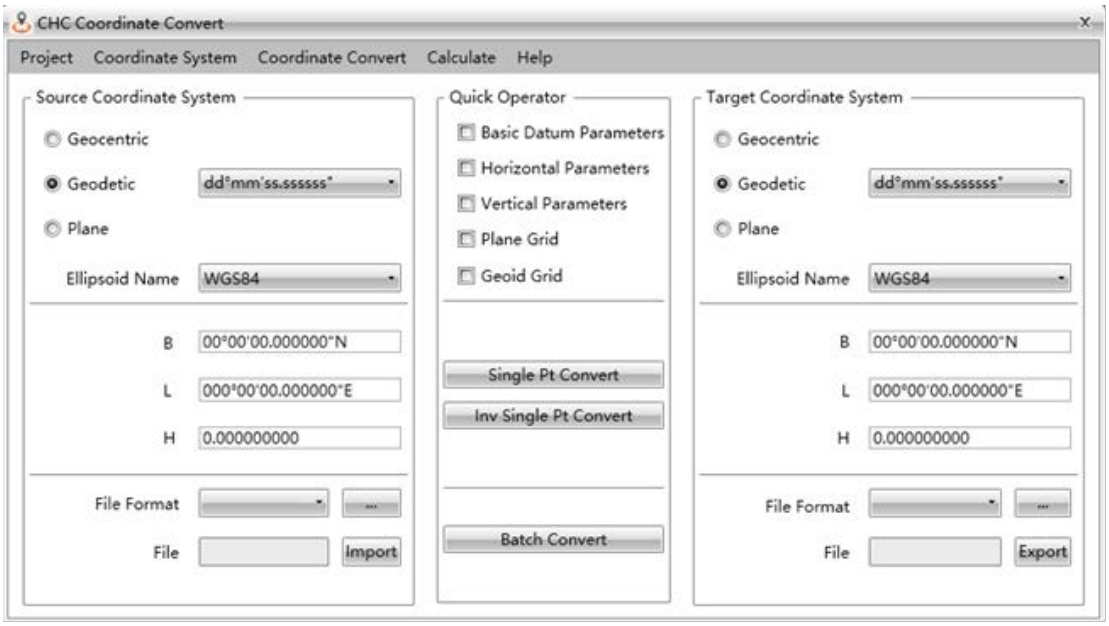


Users can check the specific coordinate list by selecting a specific group in the left coordinate system group. And users will also get the detailed parameters when selecting the specific coordinate system in the coordinate system list. Please see 2.2.2 Coordinate System in detail.

8.2.2 Coordinate Converter

This is for coordinate converter by clicking the button 

, users will see a pop-up converting interface.

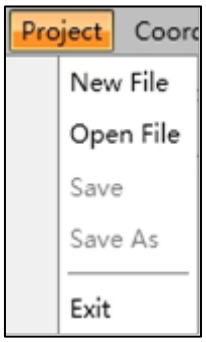


The menu bar includes five options: project, coordinate system, coordinate convert, calculate and help**.**

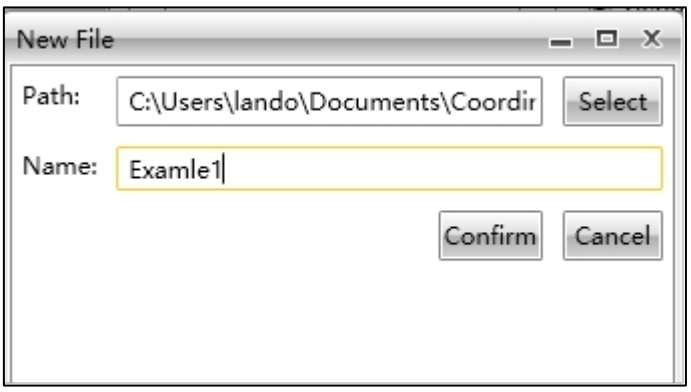
Transference interface is as following, source coordinate system, quick operator, and target coordinate system included**.**

8.2.2.1 Project

Click **[Project]**, users can see five options.



[New File]: Click **[New File]** to create a new project, users can select the storage path and click **[Confirm]** to finish.



Note: The default path can’t be changed, otherwise it can’t be read.

[Open File]: Click to open the existed project file.

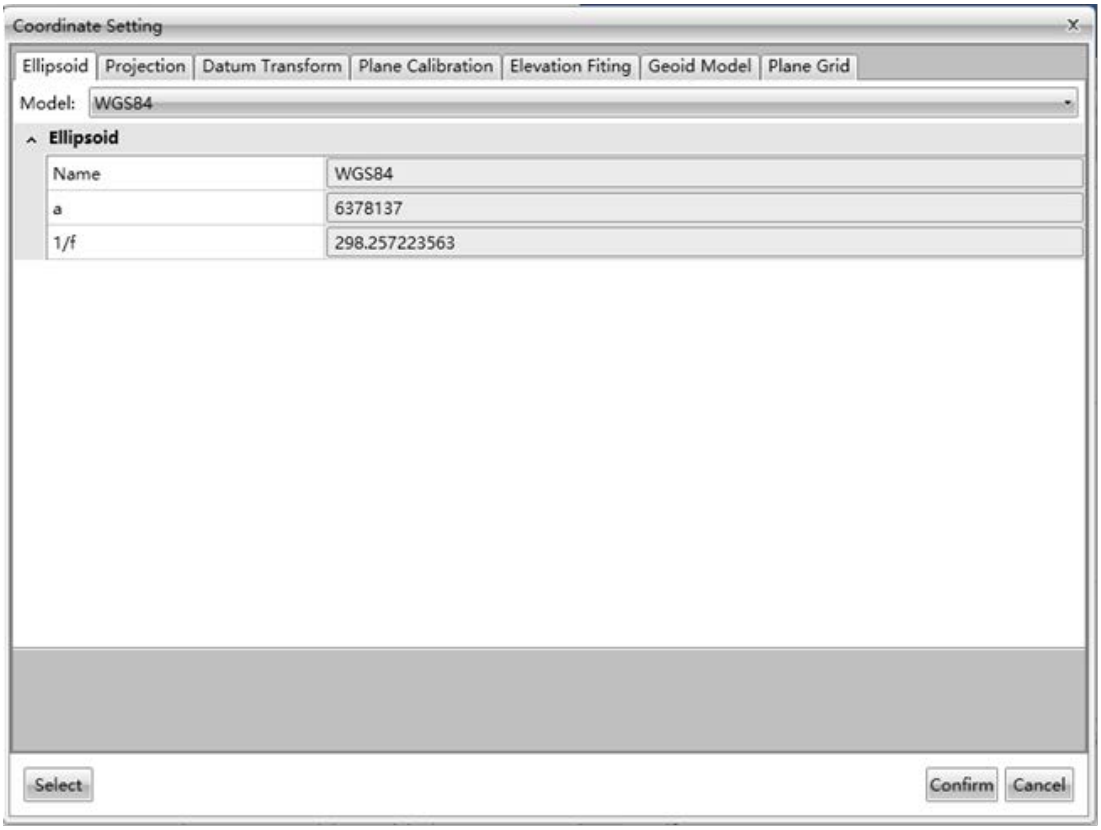
[Save]: Click to save the current project.

[Save as]: Click to save the project in another path and rename it.

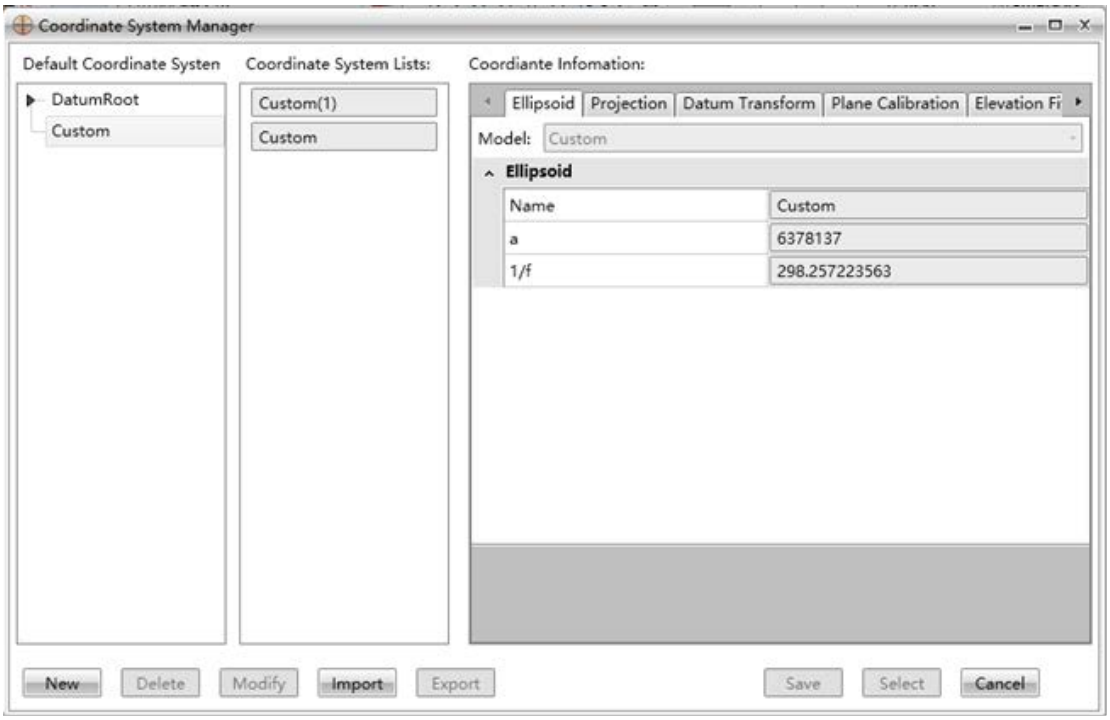
[Exit]: Click to quit the current operations.

8.2.2.2 Coordinate System

An interface for coordinate setting will pop up after clicking **[Coordinate setting]**, users can configure all parameters about the system.

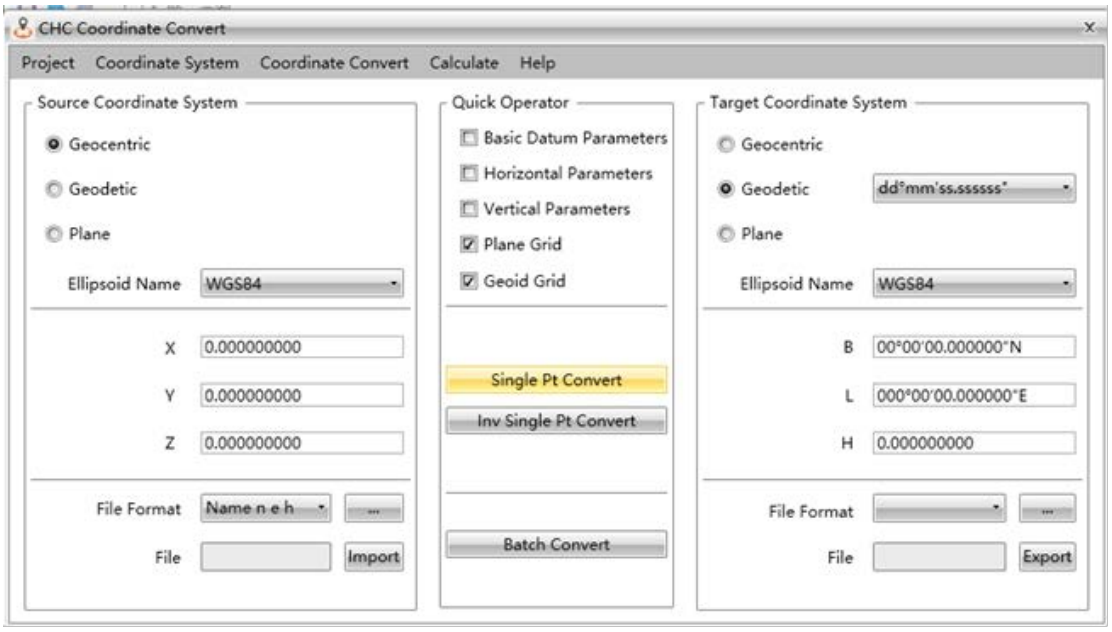


[Coordinate System Manager]: Click **[Select]** to come into the interface of coordinate system manager.

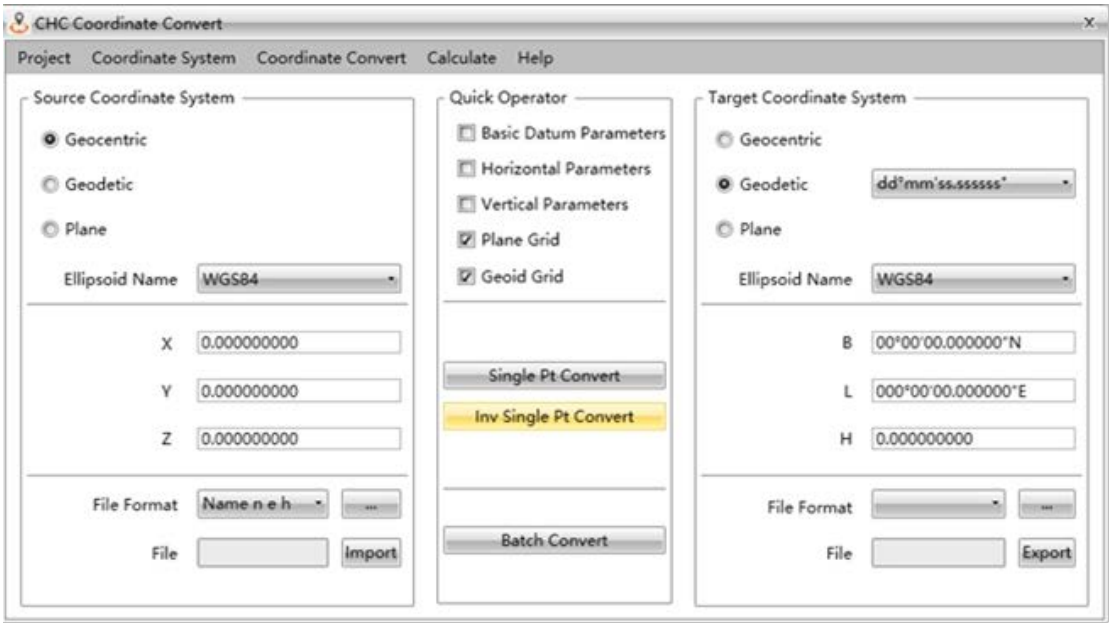


8.2.2.3 Coordinate Convert

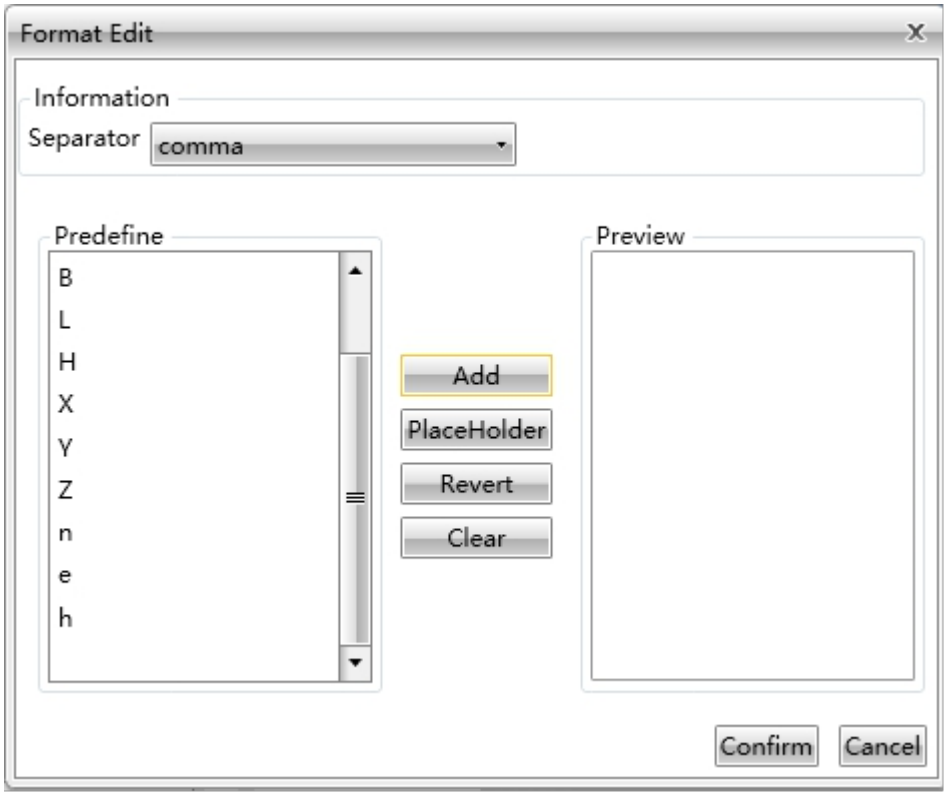
[Single Pt Convert]: This refers to the converting between single points. Confirm the source coordinate system parameters, type, conversion method, target coordinate system parameter, and then users can click **[Single Pt Convert]** to finish converting.



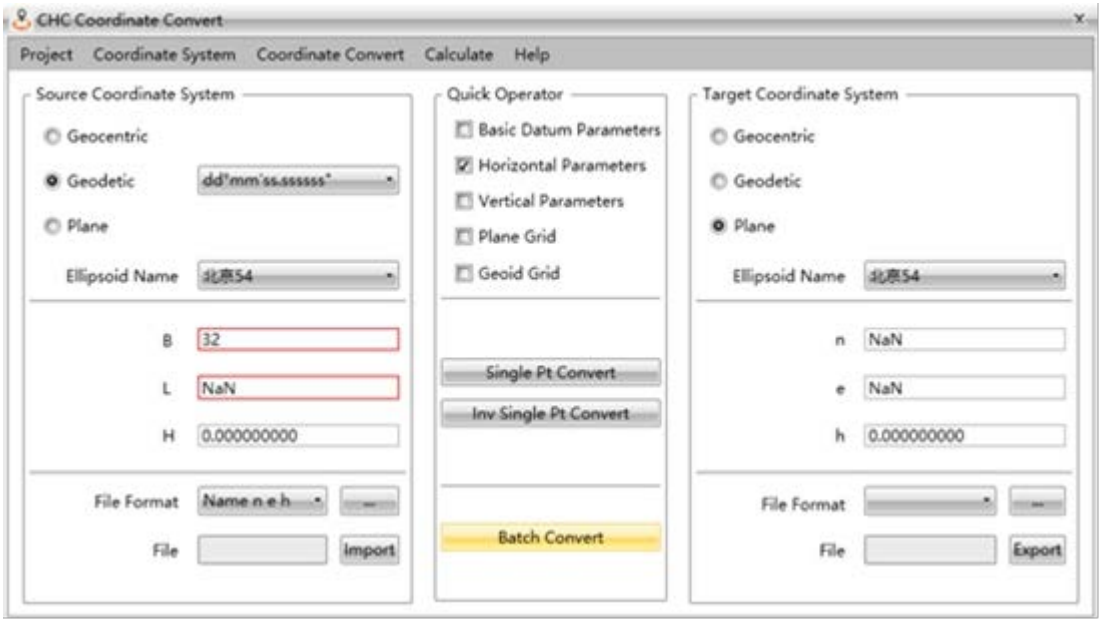
[Inverse Single Pt convert]: This refers to the inverse-converting between single points. Confirm the source coordinate system parameters, type, conversion method, target coordinate system parameter, and then users can click **[Inv Single Pt Convert]** to finish converting.



[Batch Convert]: This is used to batch convert the coordinates. Firstly, confirm the source coordinate system parameters, type, conversion method, target coordinate system parameter that is set in Coordinate System Setting, target coordinate system type and file formats, then click ... to the interface of modifying file format.



Click **[Confirm]** to finish.



Set the file format, and click **[Import]** to choose files needed to batch convert.

Choose the target file, click **[Open]** to import it. Later, then click **[Batch Convert]** in the. After the conversion set the format and path to export.

Note: Please keep the format of setting files and chosen files are in common. Otherwise, it will fail.

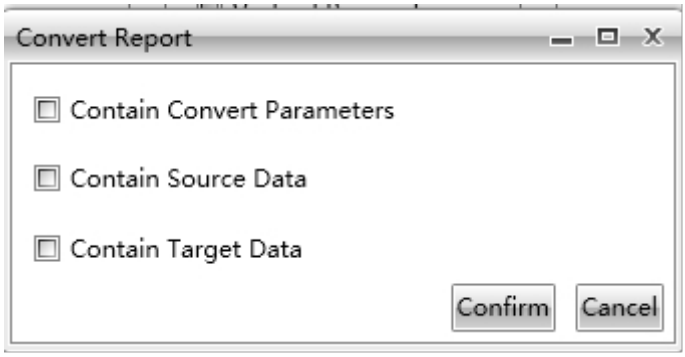
[Import Conversion File]: Click **[Import Conversion File]** to import conversion files for batch converting.

[Export Conversion File]: Click **[Export Conversion File]** to export conversion files after batch converting. Input file name, and click **[Save]** to save it.

[Export File Format Editor]: Click **[Export File Format Editor]** to set the format for the batch conversion files.

[Conversion Report]: Click **[Conversion Report]** to save the corresponding report. Users should input a name for report and press button **[Save]**.

[Conversion Report Config]: Users can configure parameters for the report and click **[Confirm]** to finish.

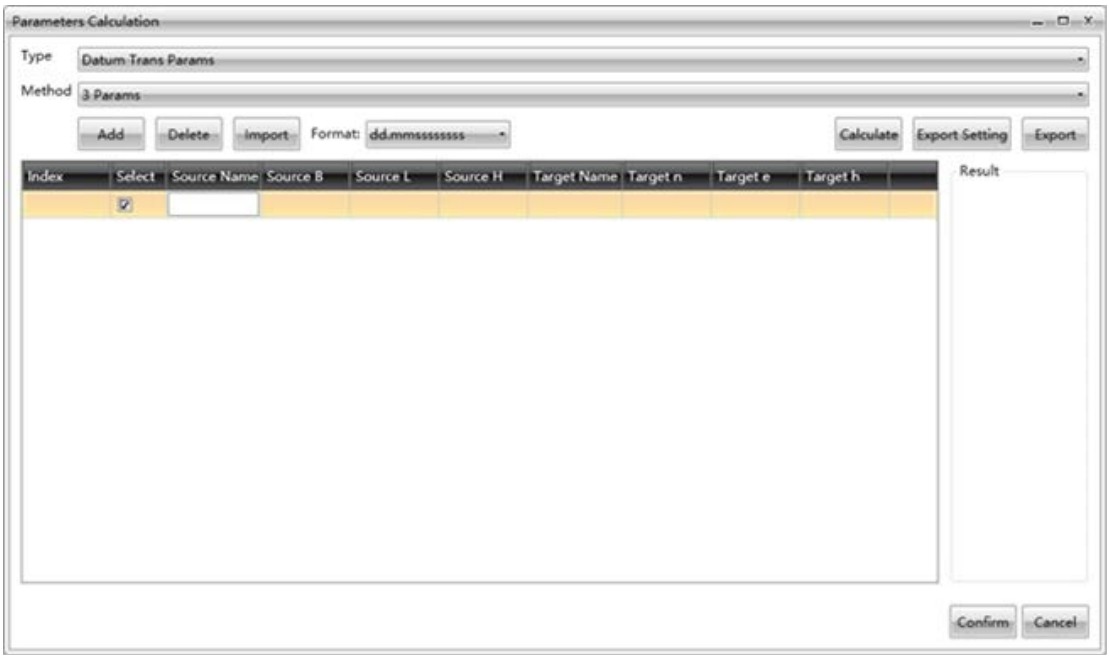


8.2.2.4 Calculate

The calculation parameters include datum transference parameters, plane adjustment parameters, and height fitting parameters.

[Datum Transference Parameters]: There are three calculating methods including 3-parameter, 7-parameter and strict 7-parameter for datum transference parameters.

Select parameter type, calculating method and set the data format, then click **[Add]** to add points to calculate.

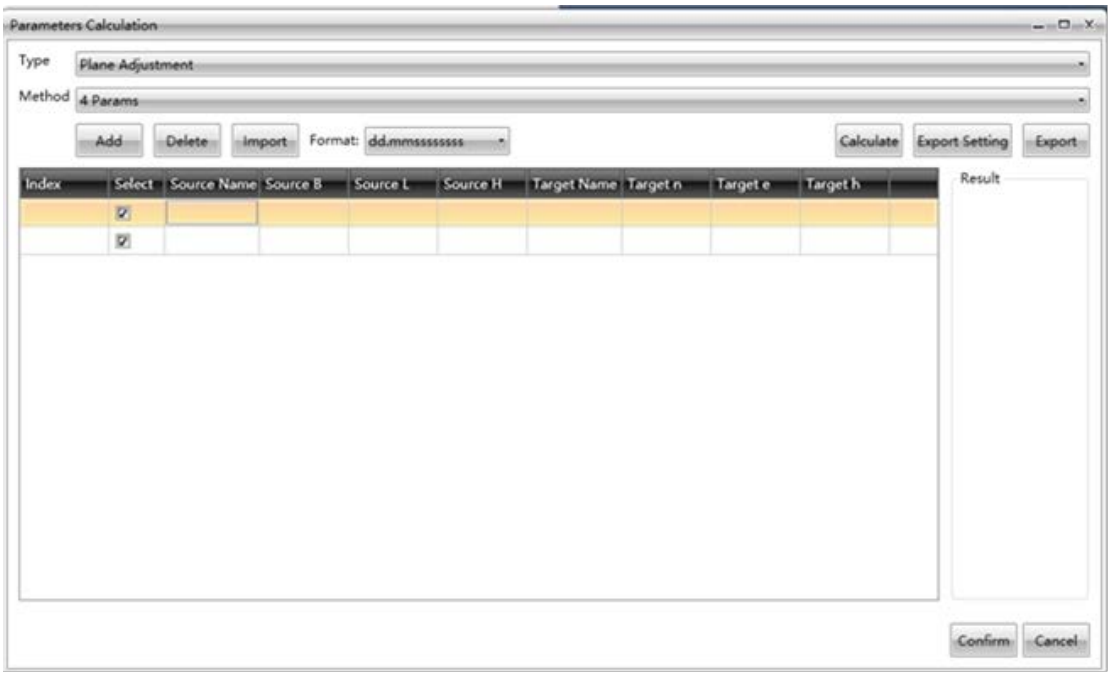


Set the related parameters and add points, then click **[Calculate]** to finish.

[Plane Adjustment Parameters]: There are 4-parameter and best practice for plane adjustment.

4-parameter contains four parts of North offset, East offset, rotation angle and scale factor.

Users should set the related parameters and add points, then click **[Calculate]** to finish.



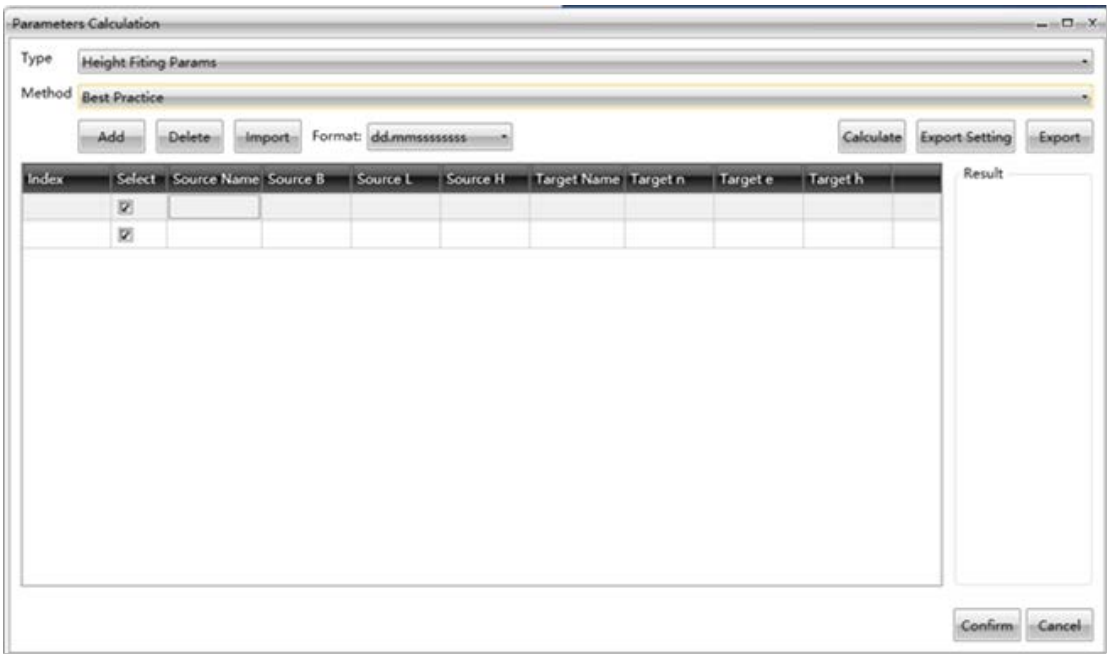
[Height Fitting Parameters]: Include four options of fixed difference, plane fitting, curve fitting and best practice.

[Fixed difference]: Need at least one point.

[Plane fitting]: Need three points at least.

[Curve fitting]: Need at least six points.

[Best Practice]: It adopts transference model from TGO, includes five parameters, north origin point, east origin point, north slope, the east slope and the high difference constant. Users should set the related parameters and add points, then click **[Calculate]** to finish.



[Import]: Click to import the conversion data.

[Export setting]: Click to set the content of the export file.

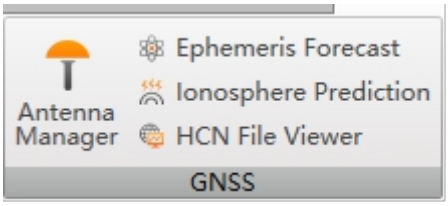
[Export]: Click to export the conversion parameters.

8.2.2.5 About

Users can check the info of the tool software, like version and brand

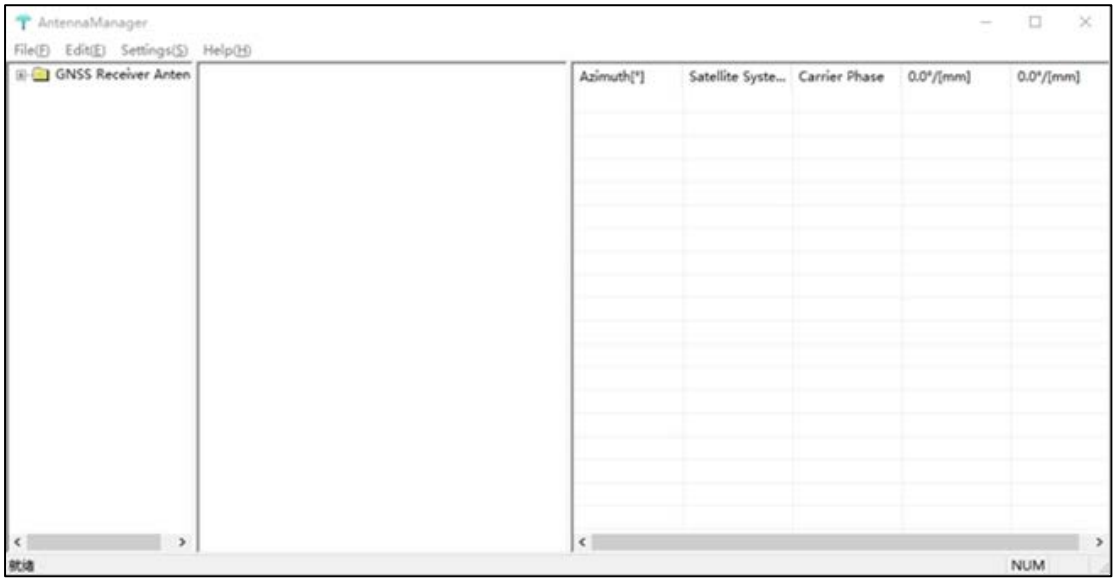
8.3 GNSS

This menu contains four tools: antenna manager, ephemeris forecast, ionosphere prediction and HCN file viewer.

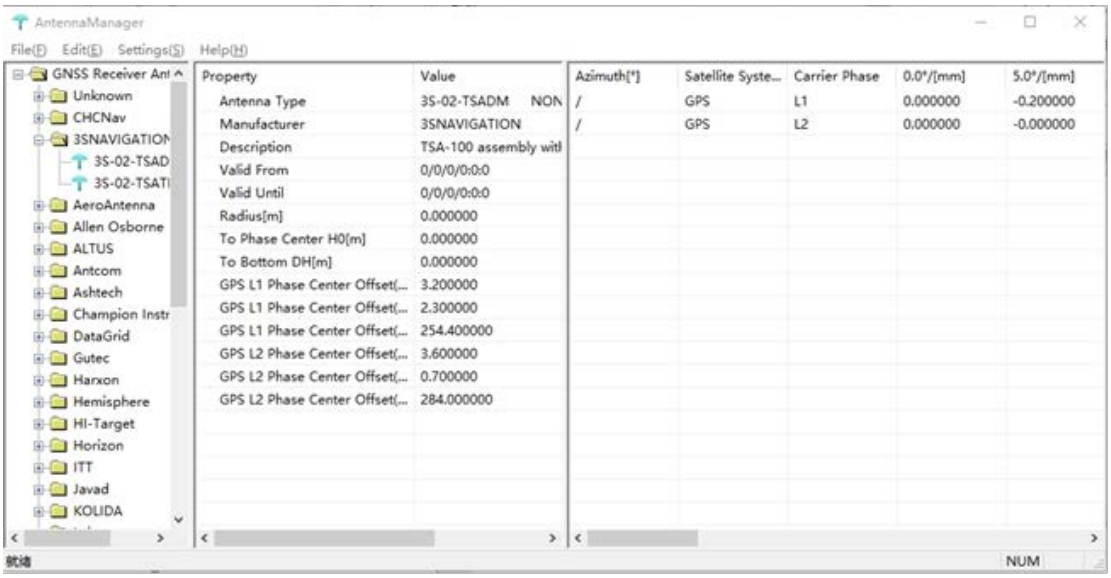


8.3.1 Antenna Manager

Click **[Antenna Manager]** to check and modify antenna parameters.



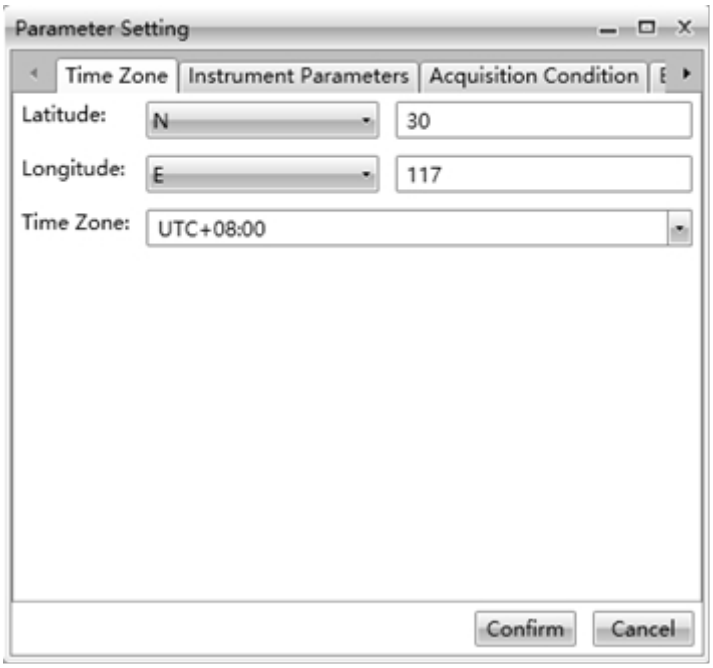
Users can select some antenna from the left list to check the details.



8.3.2 Ephemeris Forecast

Click **[Ephemeris Forecast]**, users can analyze and check the ephemeris.

[Parameter Setting]: Click to set time zone, instrument parameters, acquisition condition and ephemeris file.



After that, click **[Confirm]**, it will calculate automatically to show the results.

Users can change elevation, satellite counts, sky map, visibility, dops and world projection to check the results.

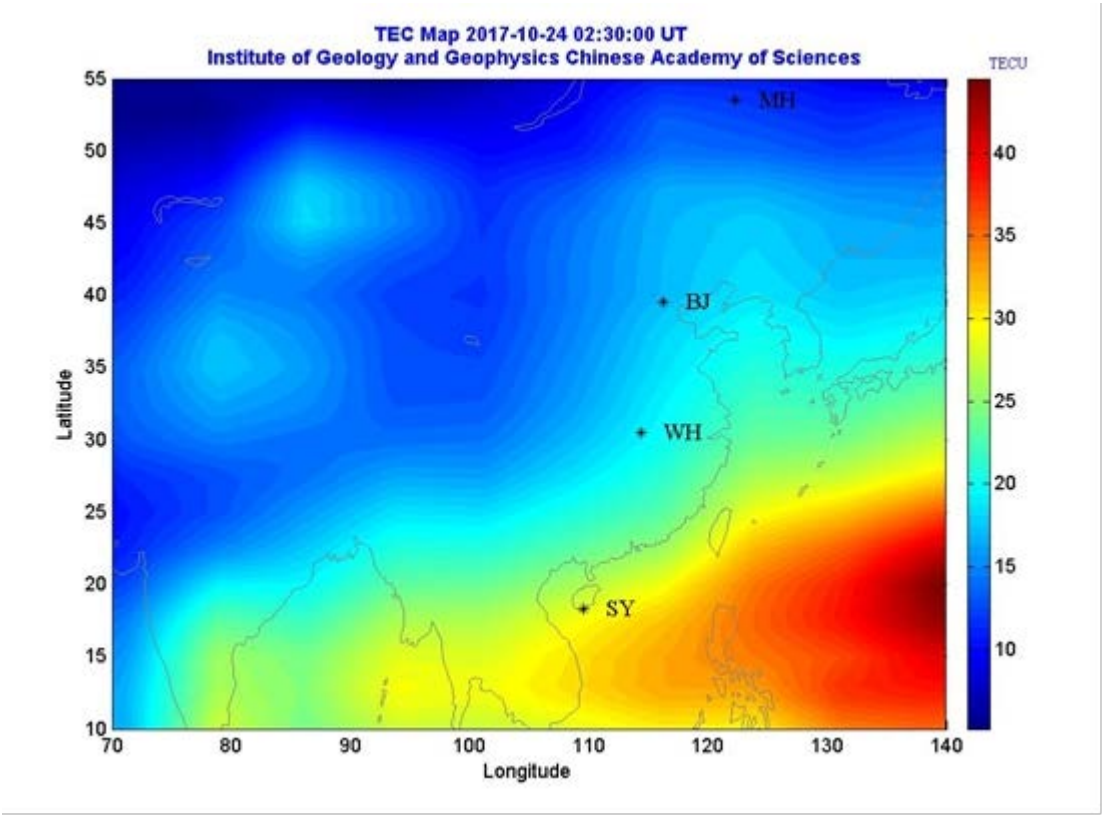
[Graphic]: Click to see the information like elevation and satellite counts

[Language]: It supports Chinese and English.

[Help]: Users can view the version of the software and the ownership of the company.

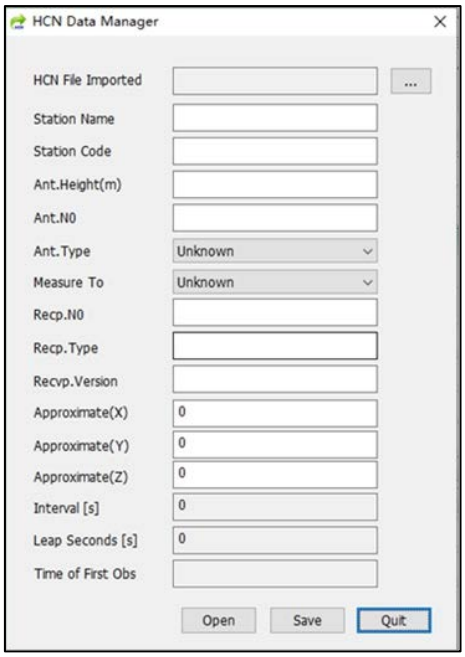
8.3.3 Ionosphere Prediction

Display ionospheric conditions at present and update every 10 minutes. Solar storms occur once every 11-year, along with the period of sun pot activity. The frequency and intensity of ionospheric storm is related to sun pot. When the solar wind swept the Earth, it will change the electromagnetic field, causing geomagnetic storms and ionospheric storm, affect communications, especially short-wave communications, for example GNSS.



8.3.4 HCN File Viewer

Click **[HCN File Viewer]** to check HCN data.



Press button  to choose the HCN file.

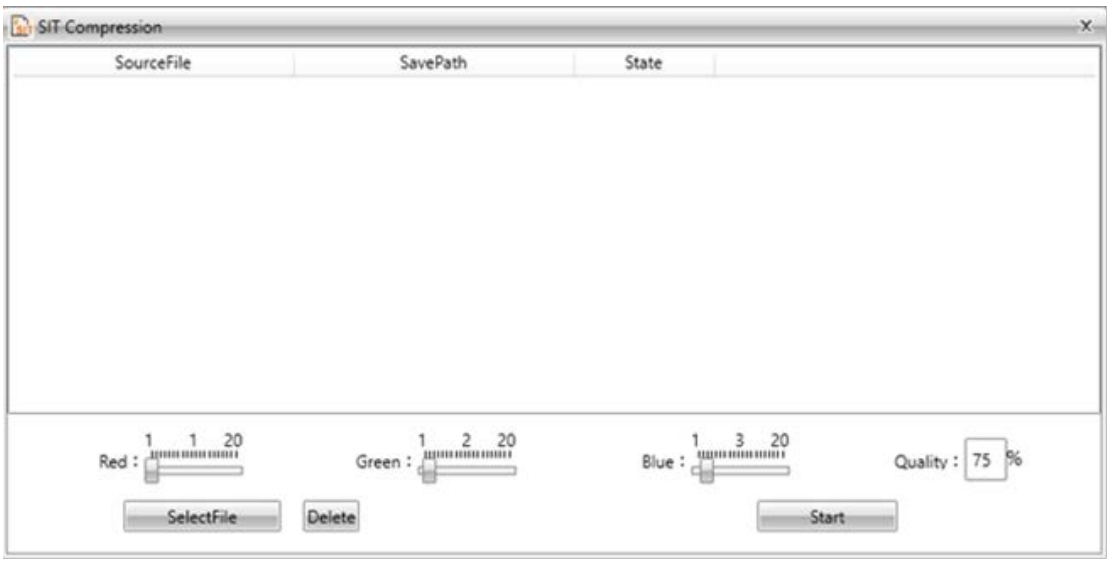
[Open]: Click to open the file.

[Save]: Click to save the modification.

[Quit]: Click to exit the current interface.

8.4 GIS

[SIT Compression]: It is used to compress and transfer a TIFF file to SIT file.

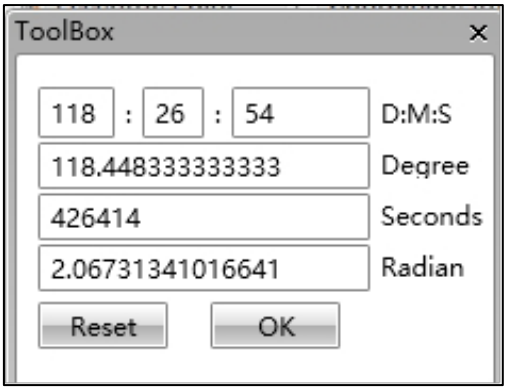


Click **[Select File]** to select a file to be compressed, then click **[Open]**, and the file will appear in the tool interface, users can click **[Start]** to start compressing.

8.5 COGO

8.5.1 Angle Conversion

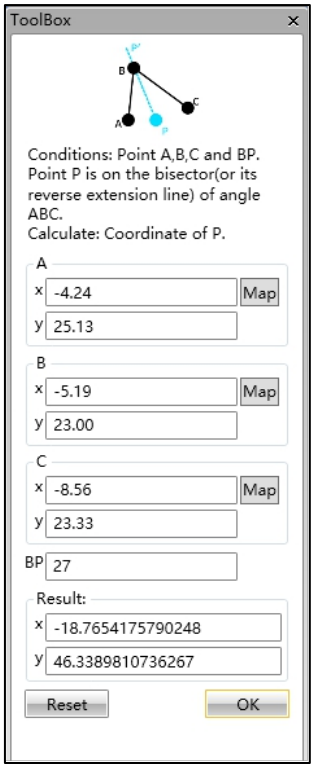
Angle conversion can convert degrees, minutes, seconds and radians among these 3 types of converter.



Enter a value in degrees, minutes and seconds edit box, click on the **OK** button to calculate the value of the corresponding degrees and radians.
Similarly, it can convert radians to degrees and degrees, minutes and seconds, or converts degrees to radians and the value of every minute.

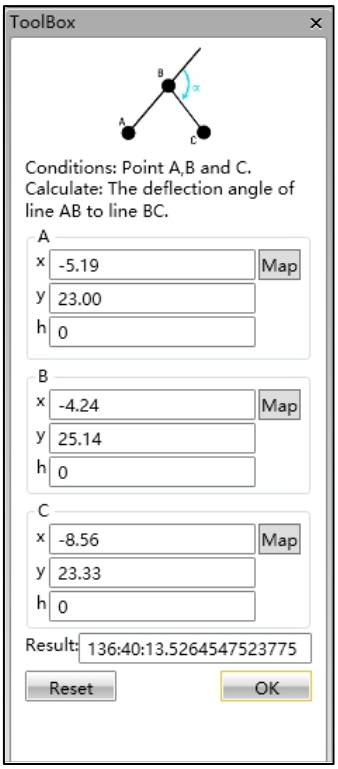
8.5.2 Equal Angle

Choose three points A, B and C in the map, and input the distance BP, then click **[OK]**to get the result, the coordinate of point P.



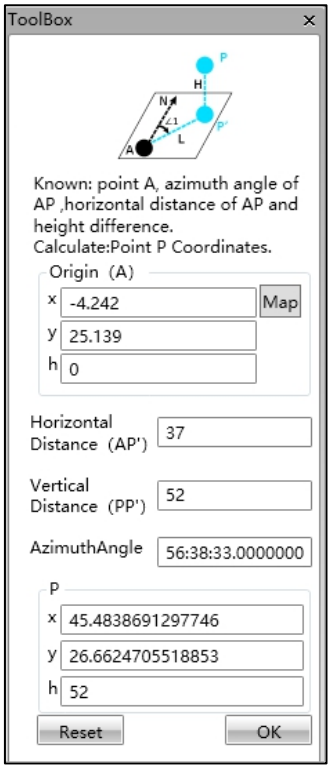
8.5.3 Deflection Angle

Choose three points A, B, and C on the map, and click **[OK]** to get the result, the deflection angle from AB to BC.



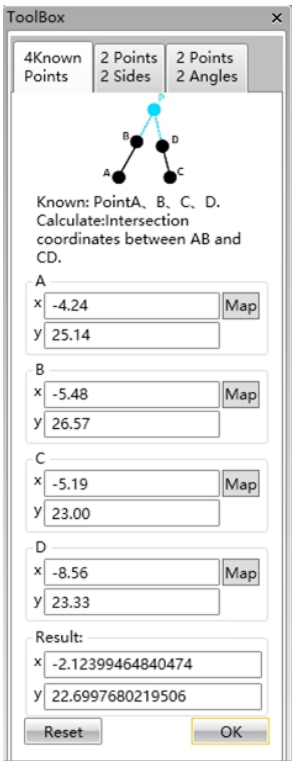
8.5.4 Eccentric Point

Choose the point A in the map and input horizontal distance AP, vertical distance PP1 and Azimuth angle of AP, then click **[OK]**to get the result, coordinate of point P.



8.5.5 Intersection Point

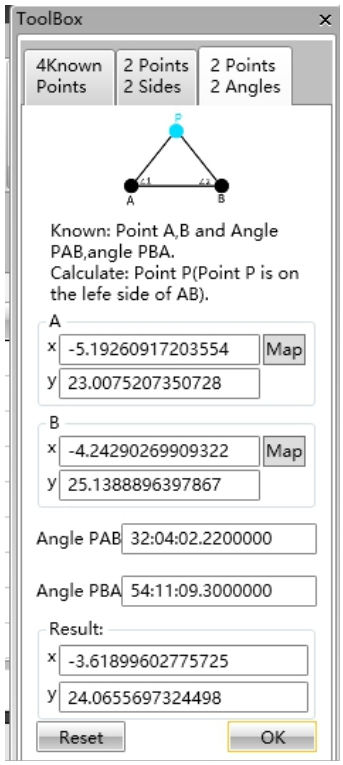
Click **[Eccentric Point]**to pop up the interface as **Figure 7-52** shows. There are three methods to reckon the coordinate of point P.



If there are four known points, users choose point A, B, C and D in the map, then click **[OK]** to get the result, coordinate of point P.

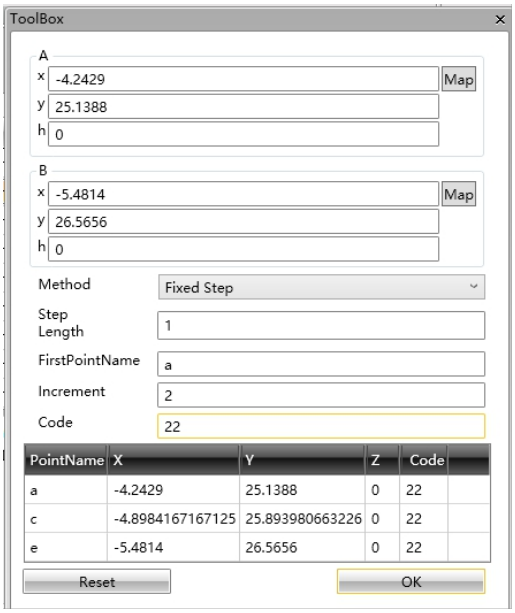
If users know two points and two sides, choose **[2 Points 2 Sides]**.

If users know two points and two angles, choose points A and B, and input angle PAB and PBA, then click **[OK]** to get the result.



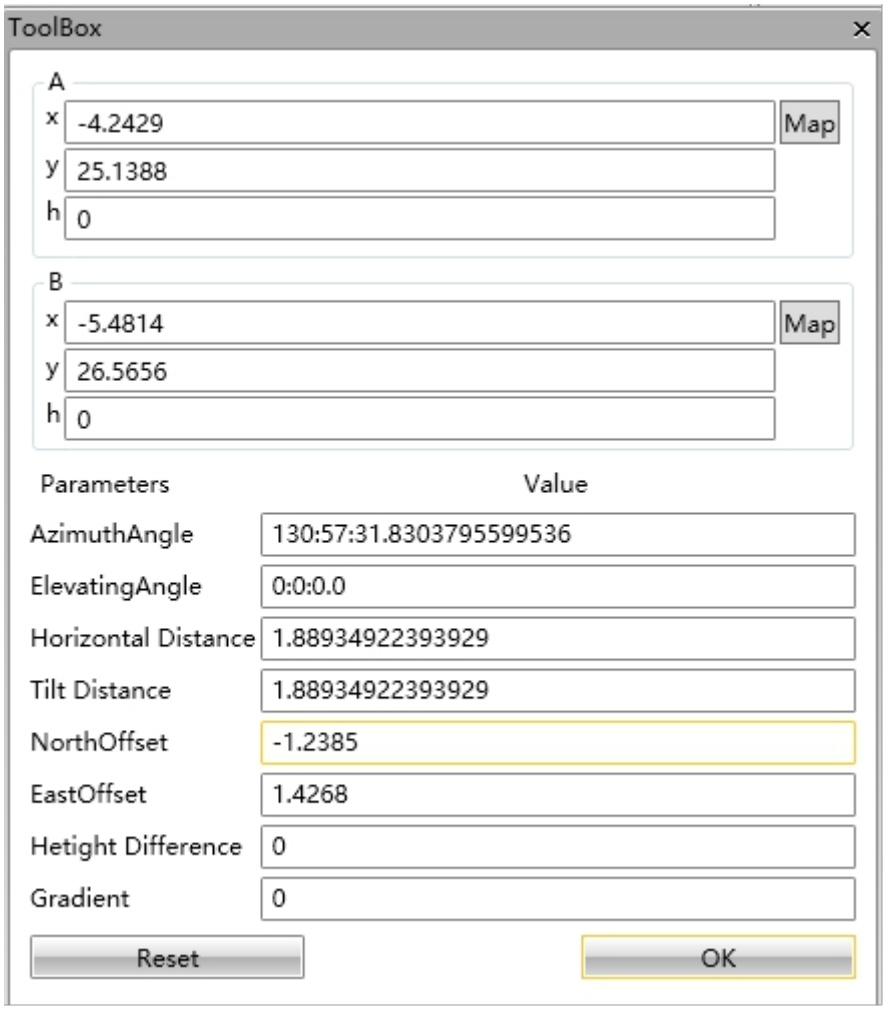
8.5.6 Dividing Line

Select start point and end point, select method, input step and first point name, then click **[OK]**; it will remind users a successful division.



8.5.7 Coordinate Inverse

Choose points A and B on the map, then click **[OK]** to get the result.

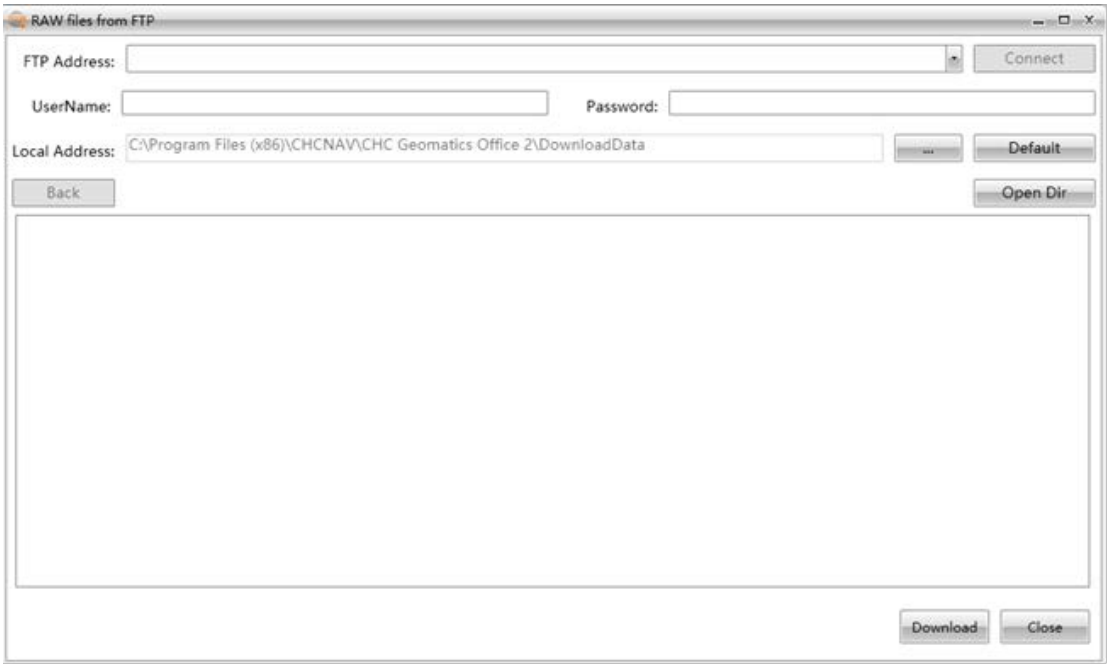


8.6 Download

8.6.1 RAW Files from FTP

Use this tool to log in FTP to download RAW files through connecting receiver.

Tool

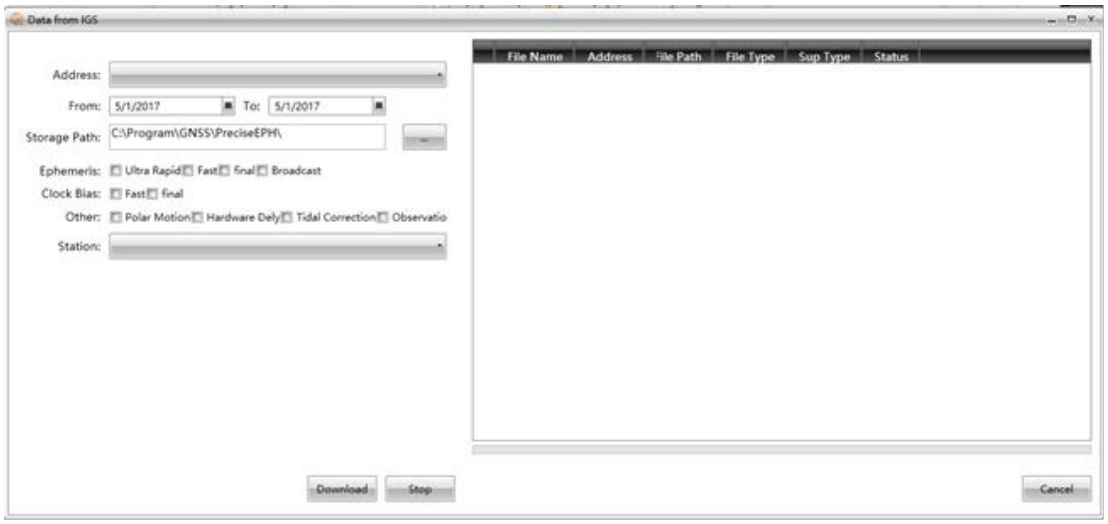


Steps:

(1) Connect smart receiver via WIFI.
(2) Enter FTP address, username, password to log in to download.
(3) Enter the file download directory, select the files to download and click the **[Download]** button to do it.
(4) Click on the **[Open Dir]** button to enter the directory of the downloaded file and check the downloaded RAW file.

8.6.2 Data from IGS

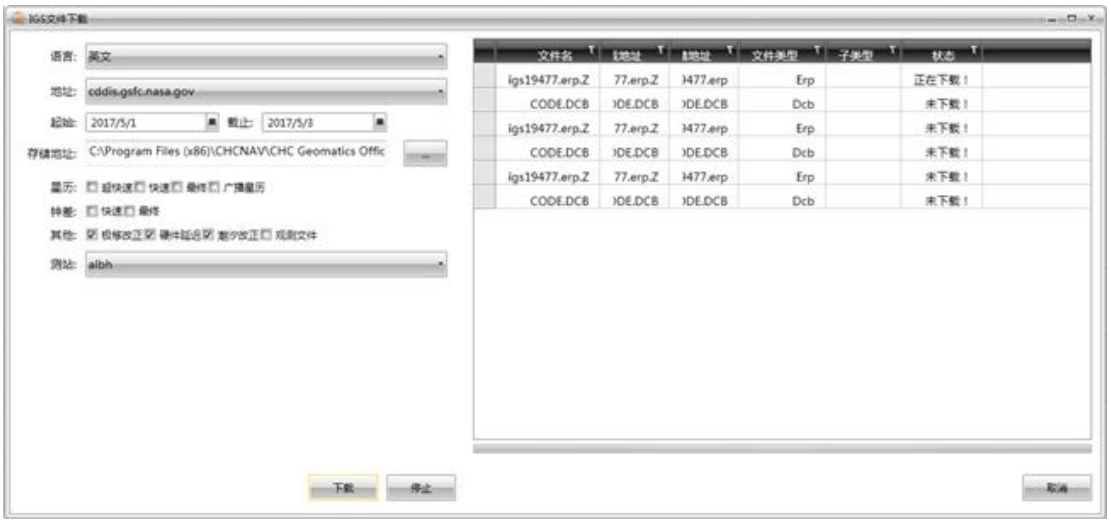
Users can download data from IGS by using this tool.



It is used to download the ephemeris data, the clock difference information data, and the observational values of various IGS stations from IGS.

Steps:

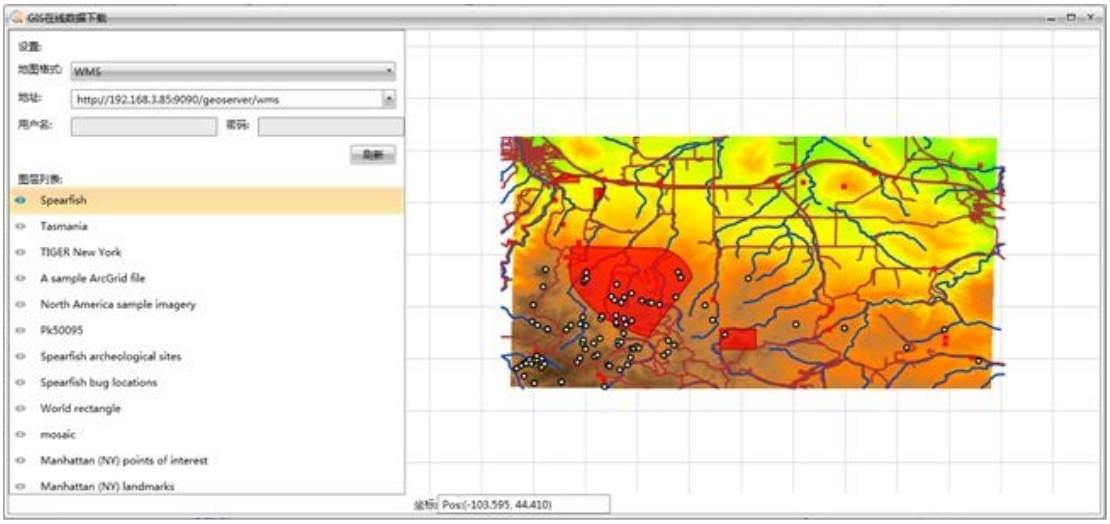
(1) Select an IGS website.
(2) Select time periods, such as May 1, 2017, to May 1, 2017, it will download all the observations on May 1st.
(3) Select the storage path; the default path is the PreciseEPH folder under the GNSS directory of CGO Project.
(4) Select the file type to be download and check it.
(5) When the observation file is checked, the name of the station needs to select. Otherwise, the observation value file will not be downloaded.
(6) Click the download button, and the downloaded file will be displayed in the list on the right, and the downloading status is displayed.



8.6.3 GIS Online Data

It is used to download GIS online data.

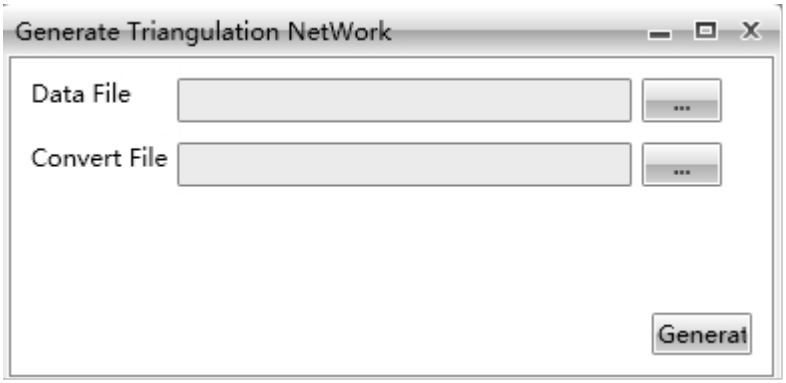
Enter the address and right format, and click **[Refresh]** to complete downloading.



Click the button  to make the layer visible or invisible.

8.7 Triangulation

Users can use this tool for triangulation of data files.

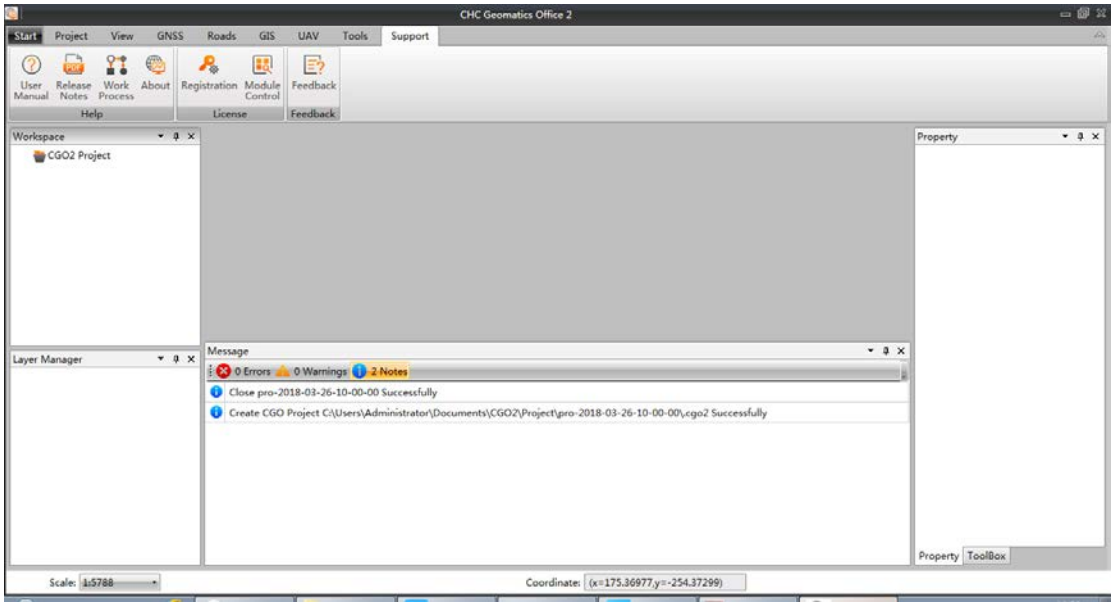


Choose right files and press **[Open]**. In the same way, after selecting the same path of the conversion file, you can click **[Generate]** to complete the transformation of the triangulation.

Note: It supports two current formats, DAT and DXF.

9 Support

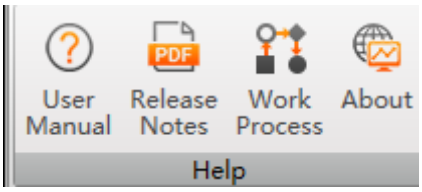
Click **[Support]** in the menu bar to switch to the support module.



The module includes three parts: help, license, and feedback.

9.1 Help

This section mainly shows basic software-related information, including a User Guide, Release Notes, Work Process, and About.



9.1.1 User Manual

This function is used to view the help files used by the software. Click the **[User Manual]** button to view the help document interface.

9.1.2 Release Notes

This function is used to view related information of the current version of the software and click the **[Release Notes]** button to pop up the version description viewing interface.

9.1.3 Work Process

This function is used to view the description of the software workflow. Click the **[Work Process]** button to pop up the workflow description view interface.

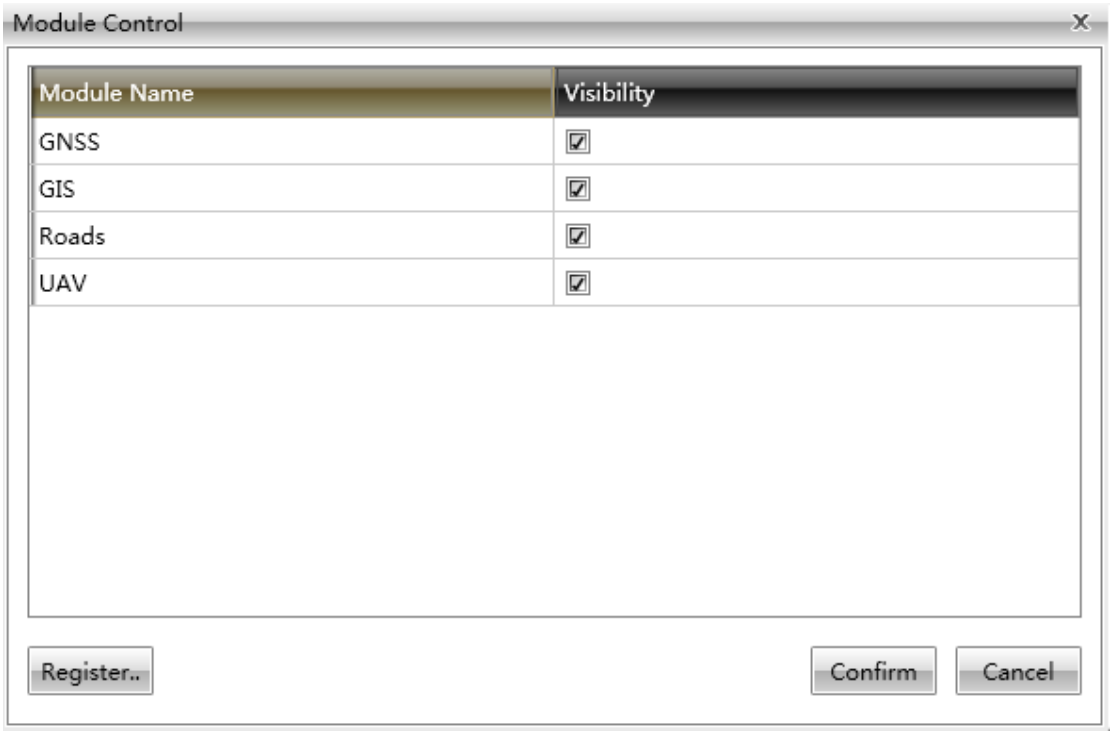
9.1.4 About

This function is used to view the software name, version, company, and other related information. Click the **[About]** button to play the interface**.**

9.2 License

This part mainly controls the display and concealment of software modules.

Considering of module control, this function is used to control the display and concealment of each module. Click the **[Module Control]** button to enter the module control interface.



Check or uncheck the checkbox next to the module name can control the display and hiding of the module.

9.3 Feedback

This part is mainly for the convenience of the user to feedback the relevant improvement opinions of the software, including a function of feedback.

This function is used to feedback the relevant improvement opinions of the software. Click the **[Feedback]** button to pop up the feedback interface**.**

The **[Facebook]** QR code is a micro-community for China test technology support.

WeChat scans can enter. Questions or feedback about CGO 2.0 software technicians will respond promptly.

Scanning **[Facebook]** QR can visit our website.

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