Manual Revision

Revision Date	Revision Level	Description
May, 2019	1	SGS User Manual 1.0 Version

Introduction

Welcome to the Satlab SGS data post processing software. This introduction describes how to use this software to do systematic static GPS data processing, for better baseline vector solution results.

Experience Requirement

In order to help you use the Satlab SGS data post processing software better, we suggest you carefully read the instructions. If you are unfamiliar with the software, please refer to http://www.satlab.com.se

Tips for Safe Use

Note: The contents here are special operations and need your special attention. Please read them carefully.

Warning: The contents here are very important. Wrong operation may damage the machine, lose data, break the system and endanger your safety.

Exclusions

Before using the product, please read these operating instructions carefully, they will help you to use it better. Satlab assumes no responsibility if you fail to operate the product according to the instructions, or operate it wrongly, due to misunderstanding the instructions.

Satlab is committed to constantly perfecting product functions and performance, improving service quality and we reserve the right to change these operating instructions without notice.

We have checked the contents of the instructions, the software and hardware, without eliminating the possibility of error. The pictures in the operating instructions are for reference only. In case of non-conformity with products, the products shall prevail.

Technology and Service

If you have any technical issues, please call Satlab's technology department for help.

Relevant Information

You can obtain this introduction by:

1. Purchasing Satlab products: you will find this manual in the instrument container to guide you on operating the instrument.

2. Logging onto the Satlab official website, downloading the electronic version introduction at Partners →Partner center.

Advice

If you have any comments and suggestions for this product, please email info@Satlab.com.cn. Your feedback will help us to improve the product and service.

Contents

Preface 3
Software Introduction 8
1.1 Installation 9
1.1.1 Software Installation 9
1.1.2 Software Register 9
1.2 Quick Start 10
1.2.1 Static GPS Data Processing 10
1.2.2 Dynamic GPS Data Processing 16
Software Interface 18
2.1 Main Interface 19
2.2 Menu & Toolbars 21
2.2.1 Menu 21
2.2.2 Toolbars 21
2.2.3 Navigation Area 21
2.3 Plan View 21
2.3.1 Graphic Operation Buttons 22
2.3.2 Right-click Menu Operation 22
2.3.3 Changing the Drawing Mode 23
2.4 Tree List View 23
2.5 Detail View 24
2.5.1 Pop-up Menu of Detail View 24
2.5.2 Property Window 25
Project Management 26
3.1 Create a New Project 27
3.1.1 Set the Project Properties 27
3.1.2 Coordinate Parameters Settings 28
3.2 Observation Data 29
3.2.1 Contents of Observation Data 29
3.2.2 Formats of Observation Data 30
3.2.3 Data Preparation 30
3.3 Observation Station 30
3.3.1 Observation Station Pop-up Menu 35
3.3.2 Property of Observation Site 36
3.4 Static Baseline 36
3.5 Repeated Baseline 37
3.6 Closed Loop 37
3.7 Satsurv Project 38

Contents

Static Baseline Processing 39

4.1 Baseline Processing Settings 40

4.1.1 General Settings 40

4.1.2 Ionosphere / Troposphere 43

4.1.3 Advanced 43

4.1.4 Baseline Processing Menu 44

4.1.5 Baseline Processing 44

4.2 Baseline Processing Result Test 46

4.2.1 Control Baseline Quality 46

4.2.2 Closed Loop Testing 46

4.2.3 Free Network Adjustment Test 47

4.3 Various Influence Factors 48

4.3.1 Influence Factors 48

4.3.2 Discriminate Influence Factors 48

4.4 Repeat Processing a Baseline 50

Dynamic Baseline Processing 51

5.1 Baseline Processing Settings 52

5.1.1 Dynamic Baseline Solution Data 52

5.1.2 Observation File and Site Properties Setting 53

5.2 Baseline Processing Menu 54

5.3 Baseline Processing 54

5.3.1 Stop&Go Dynamic Baseline Processing 55

5.3.2 PPK Dynamic Baseline Processing 56

Network Adjustment 58

6.1 Steps of Network Adjustment 59

6.2 Preparation of Network Adjustment 60

6.2.1 Coordinate Setting 60

6.2.2 Network Adjustment Setting 60

6.2.3 Control Points Information 60

6.3 Process of Network Adjustment 61

6.3.1 Get Baseline Vector Network 61

6.3.2 Connectivity Test of Baseline Vector Network 61

6.3.3 Adjustment Report 62

6.4 Adjustment Results Examination 63

Import & Export 64
7.1 File Import 65
7.1.1 Data File Import 65
7.1.2 Satsurv Project Import 66
7.1.3 Control Point File Import 67
7.1.4 Stop&GO RSP Files Import..67
7.2 Observation File Export..67
7.2.1 RINEX File Export..67
7.2.2 Point Coordinate File Export 68
7.2.3 Project Plot DXF Export 70
7.2.4 Control Point File Export 71
7.3 Project Result Report Export..71
7.4 Baseline Result Export 72
7.5 Satsurv Project Result Export 73
Software Tools 75
8.1 Antenna Manager 76
8.2 Coordinate Transformation Tool.. 76
8.2.1 Overview 76
8.2.2 Use Software to Transform Coordinates 79
8.2.3 Parameter Calculation.. 80
8.3 Star Report 81
8.3.1 Input Almanac Data 81
8.3.2 Setting of Coordinate and Time Zone 81
8.3.3 Star Report Status..83
8.3.4 Update Almanac Data..87
8.4 SP3 Gate..87
8.5 Rinex Convert Tool..87
Appendix 88
9.1 Terminology Note 89
9.2 RINEX Format Description..92
9.2.1 Observation Data File..92
9.2.2 Navigation Data File..95

Chapter 1

Software Introduction

This chapter contains:

- **Installation**
- **Quick Start**

1.1 Installation

1.1.1 Software Installation

The SGS software requires at least 1GB of RAM and 500MB of hard disk. Applicable environments are as follows:

- Microsoft ® Windows NT Service Pack 4 or higher

- Microsoft ® Windows XP/7/8

- Microsoft .Net Frameworks 2.0

Run the corresponding .msi file, follow the steps to set up, and click Next until the installation is complete.

Figure 1-1-1 Installation

1.1.2 Software Register

When you start the software for the first time, you will be prompted with Software Unregister! If you don't register, the PPK and the advanced baseline solution engine won't be available, and you will be reminded to register every time you restart the software;: other functions are free to use.

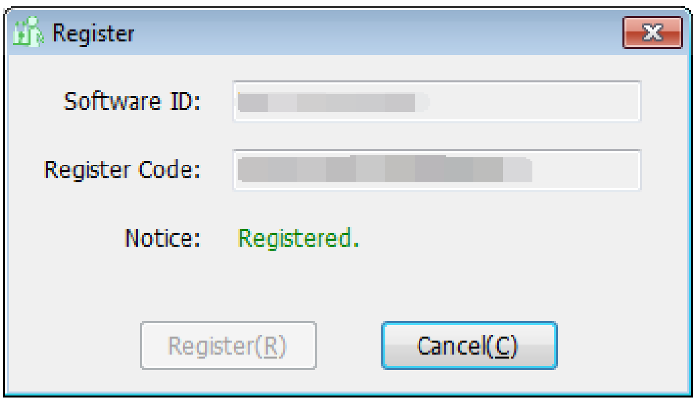


Figure 1-1-2 Register

1.2 Quick Start

This chapter explains the SGS data processing software solution, through an example. It enables users to quickly understand how to use the software. For more detailed and advanced usage, please see the following sections.

1.2.1 Static GPS Data Processing

The general procedure of static GPS data processing:

- Create a new project, and set up the coordinate system;
- Import data, and edit file antenna high information;
- Get the baseline solution, and adjust according to the residual information until the baseline quality is qualified;
- Do the network adjustment, after inputting the control point information, complete the free network adjustment → 84 constraint adjustment → local three-dimensional or two-dimensional constraint adjustment;
- Export various solution reports.

1. Create a new project

Select File → New to enter the New Project interface. Input the project name, select the folder where the project is stored, and click OK to complete the creation of the new project.

2. Project property modification

After setting the project name and working directory, it will automatically pop up the Project Properties setting interface; users can set the details of the project, including Information, Tolerance and Advanced options.

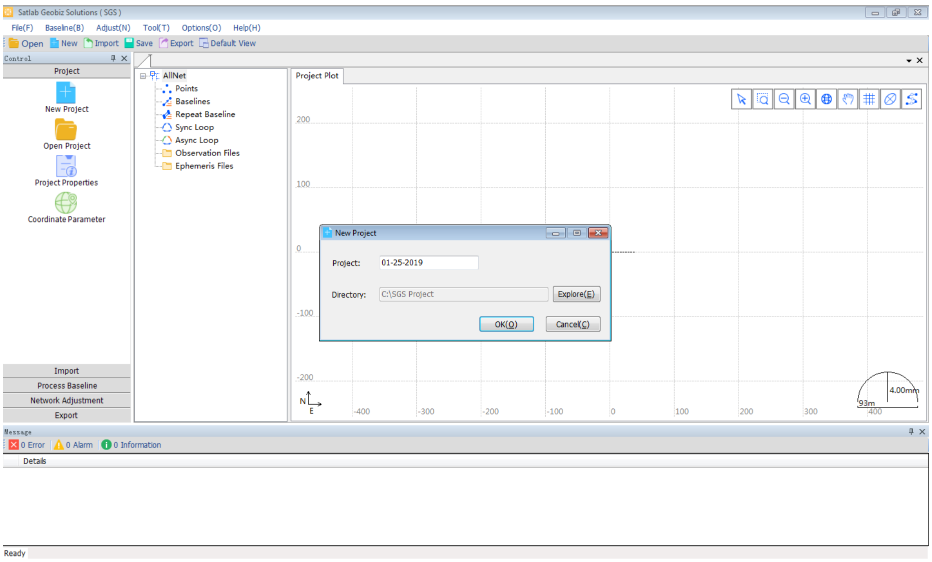


Figure 1-2-1 Create A New Project

Notice: The Project Properties setting interface can also be opened directly via the navigation bar. The navigation bar contains the general process of SGS data post-processing.

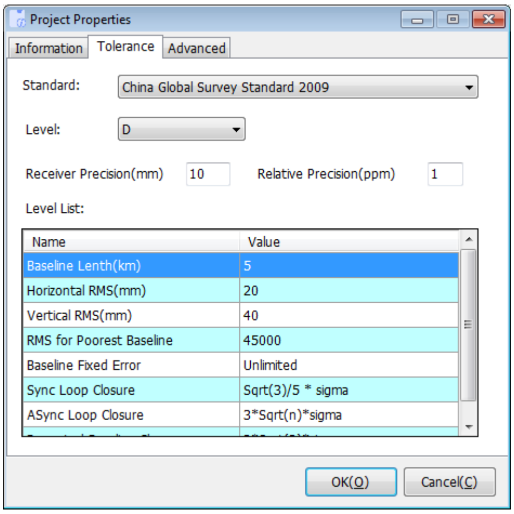


Figure 1-2-2 Project Properties

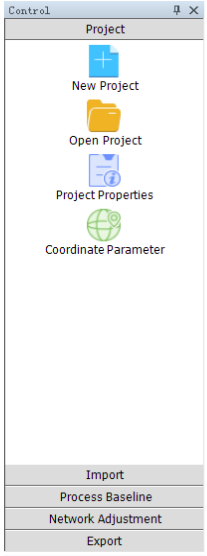


Figure 1-2-3 Navigation Bar

3. Coordinate system setting

Select File →Coordinate System, or open the Coordinate Parameter interface directly through the navigation bar to set the local reference ellipsoid, projection and other parameters.

4. File import

Select File → Import to choose the type of data to be loaded, click Select Files or Select Folder to choose the corresponding data.

Users can also import files through the navigation bar.

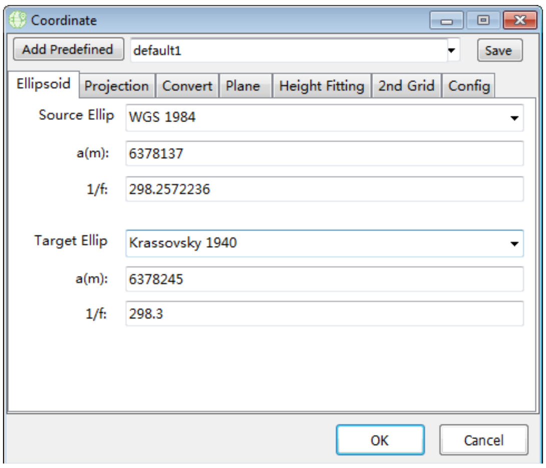


Figure 1-2-4 Coordinate Parameter Interface

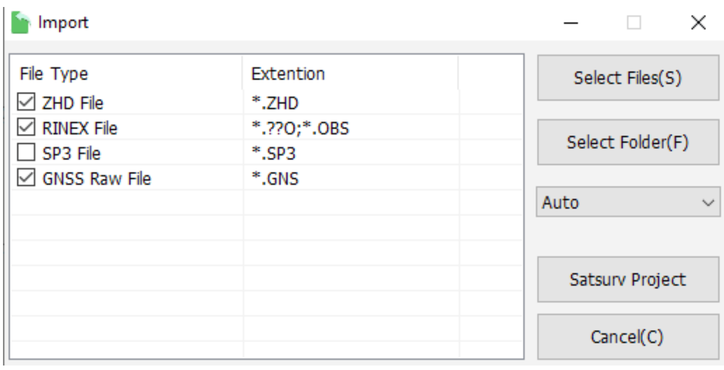
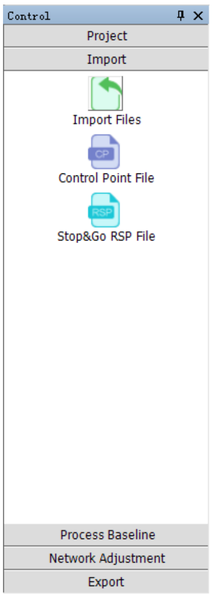


Figure 1-2-5 Import Interface

Users can also import files through the navigation bar.

After importing the data, the software will automatically form baselines, synchronization loop, asynchronous loop, and repeated baselines.



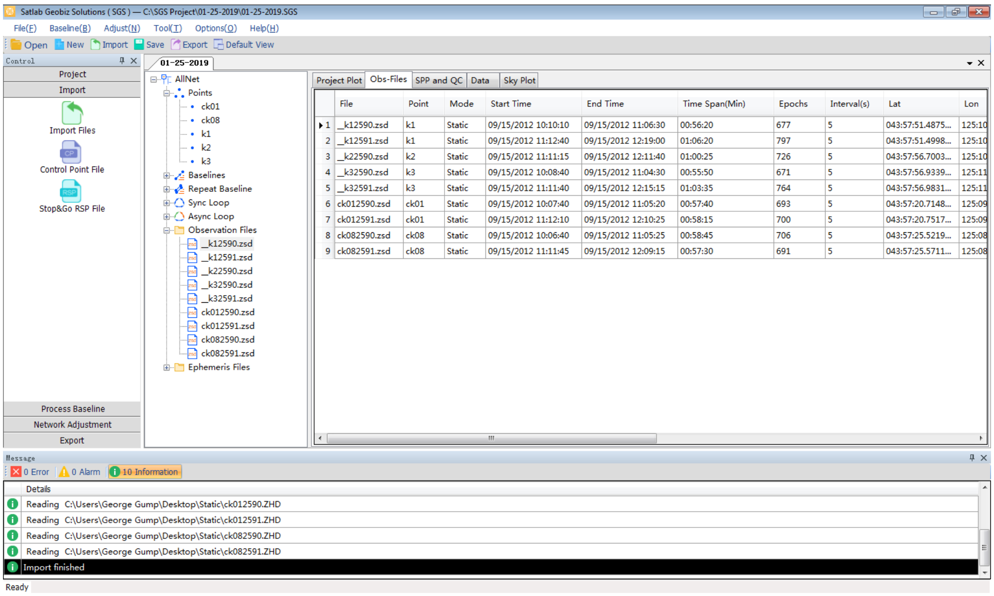


Figure 1-2-6 Import Navigation Bar

Figure 1-2-7 Import Data

5. File information editing

After the data is loaded, the system will display all the files, click Observation Files in the tree directory in the middle, and switch the right workspace tab to Obs-Files, to view the detailed file list. Double-click on a row to pop up the editing interface, to enter or edit the antenna height, receiver type and antenna type. Users can also directly modify the point name, antenna type and antenna height information in the file list.

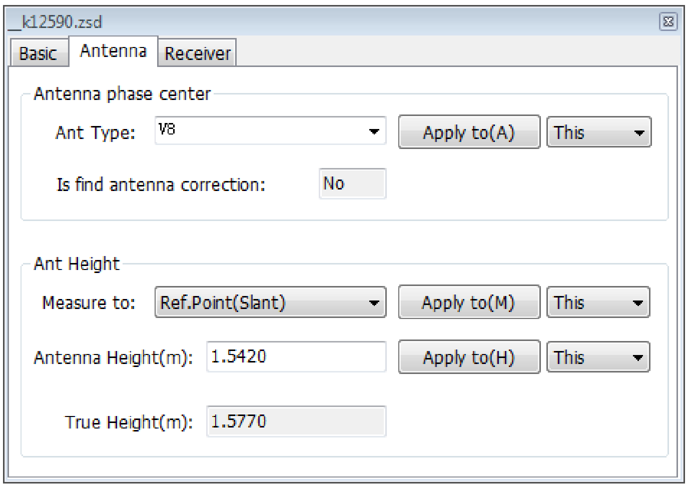


Figure 1-2-8 File Information

6. Baseline processing

After the data is loaded, the system will display all the GPS baseline vectors, and the Project Plot interface will display the entire GPS network. Click Process Baseline → Process All in the menu, the system will use the default baseline processing settings to process all baseline vectors.

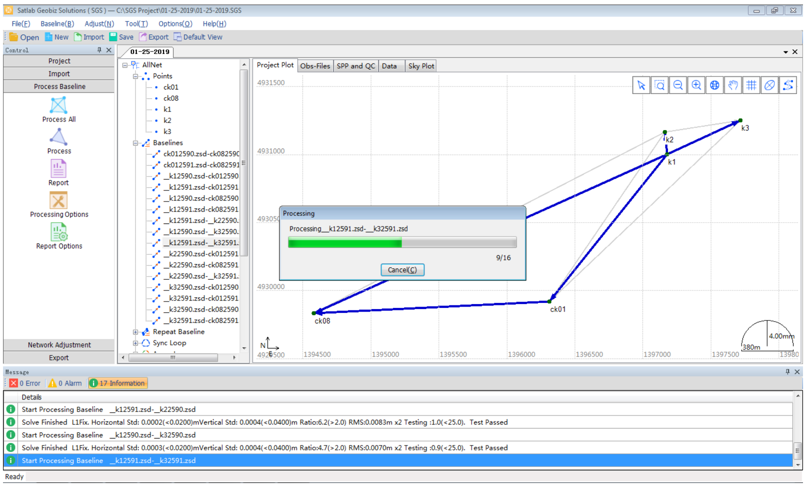


Figure 1-2-9 Baseline Processing

The progress of the entire baseline process is displayed during processing. The processing of each baseline can also be seen from the Baselines list.

The time of the baseline processing is affected by the number of baselines, the time of baseline observations, the baseline processing settings and the computer speed. After processing all the baseline vectors, all the solutions are listed in the baseline list. Original unsolved baselines in the network are also changed from a light color to a deep color.

7. Settings before adjustment

After the baseline processing is complete, the result needs to be checked. Since this chapter is a quick start, it's assumed that all baselines involved in the solution are qualified. Normally, if observation conditions are good, all baselines can be successfully processed at once. After the baseline solution is qualified, some baselines need to be removed, according to synchronized observation conditions, which won't be described here.

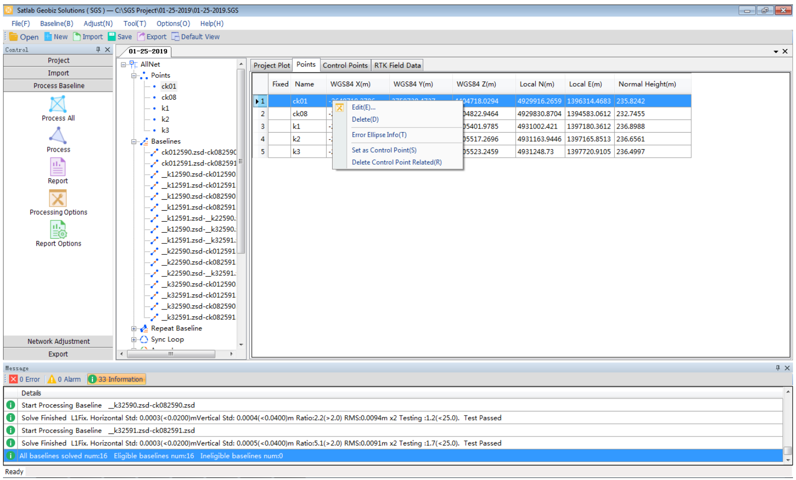


Figure 1-2-10 Set as Control Point

Now go directly to the preparation of the network adjustment. Firstly, users need to confirm which sites are control points.

Select Points in the tree directory and click the Points tab in the right workspace. Select Set as Control Point in the right-click menu of the selected site, and these points will be automatically added to the Control Points list. Switch to the Control Points list and double-click to edit it.

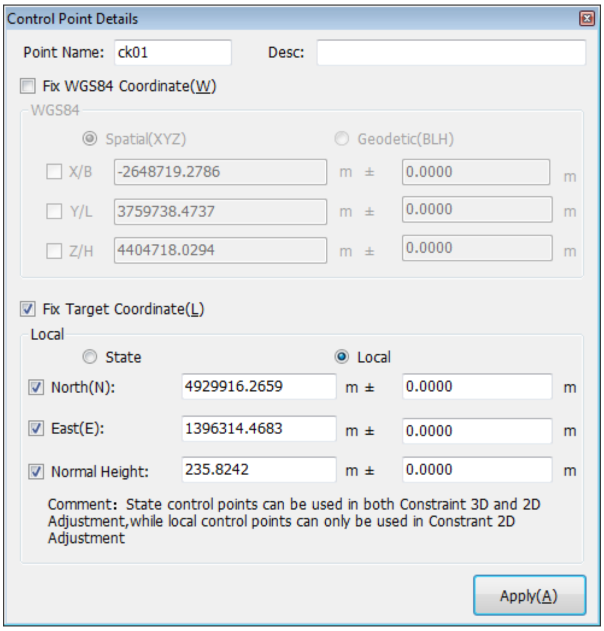


Figure 1-2-11 Control Point Details

Use the same method to enter all the known point coordinates.

Then select Network Adjustment → Adjust Options in the control menu to enter the Adjust Options interface to do settings.

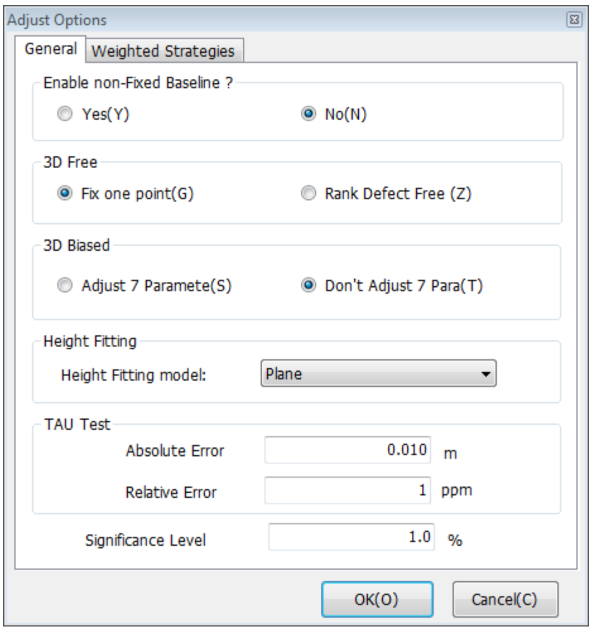


Figure 1-2-12 Adjust Options

8. Network adjustment

Select Network Adjustment → Adjust in the control menu, it will pop up the adjustment tool.

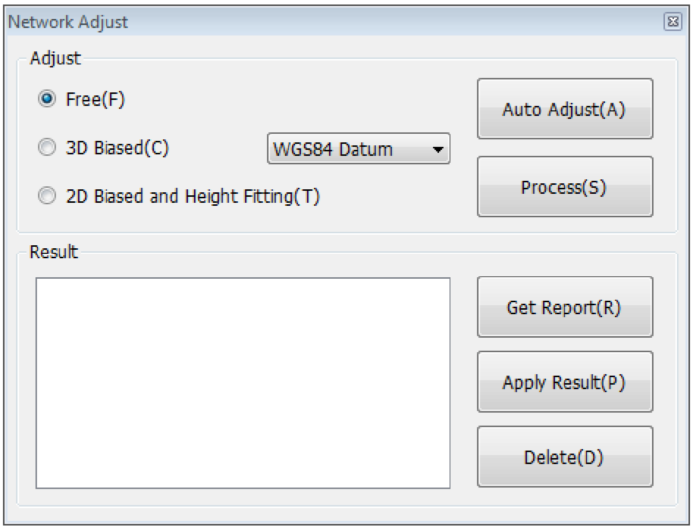


Figure 1-2-13 Adjustment Tool

Click Auto Adjust, the software will automatically complete the Free, 3D Biased in WGS84 Datum and 2D Biased and Height Fitting adjustment, according to the starting condition and form a list of adjustment results. Users can select the results they want to view, and click Get Report to view the report.

9. Report output

Select Network Adjustment → Report Options to specify and select the output content and format.

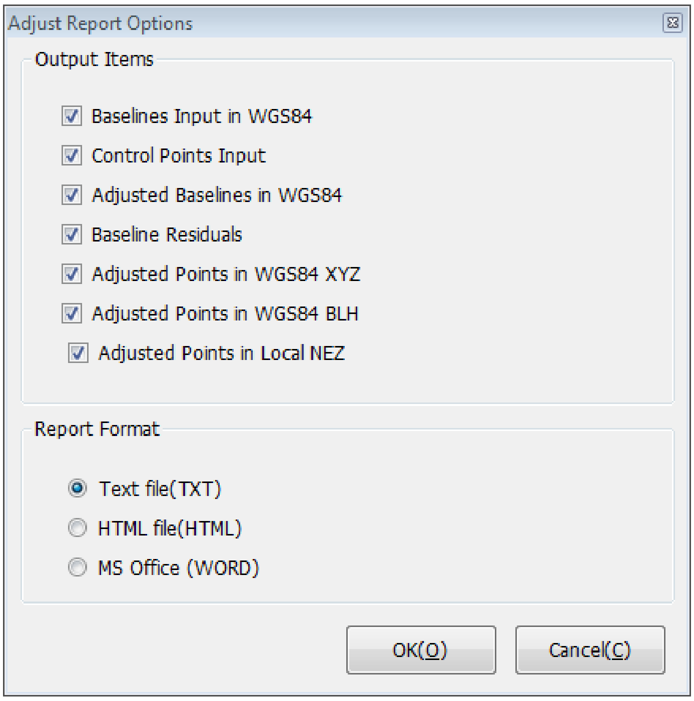


Figure 1-2-14 Adjust Report Options

Then click Get Report in the Network Adjustment → Adjust to export the corresponding adjustment report. Taking the HTML file report as an example, the entire content in the adjustment result is output as the HTML file form.

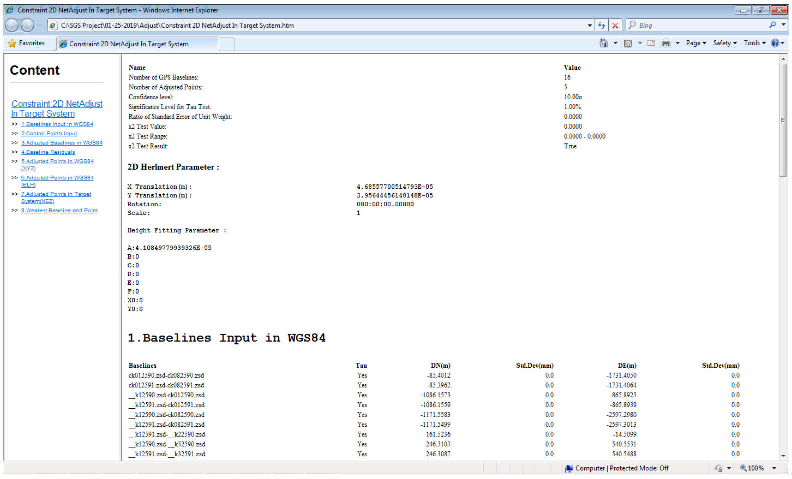


Figure 1-2-15 Adjust Report

Until now, the complete baseline solution result and coordinate results of each site have been obtained, and the static GPS data processing is complete.

1.2.2 Dynamic GPS Data Processing

The dynamic GPS data contains two files, including the base station data file and the rover station data file. After importing files, according to the method described above, set the rover station file to the dynamic type in the right-click menu, and then choose Process Baseline: the software will process the data according to the dynamic route mode.

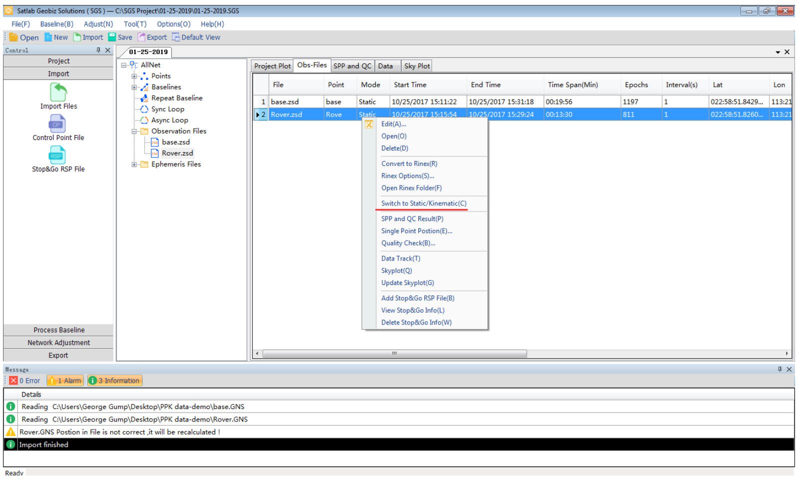


Figure 1-2-16 Switch to Static/Kinematic

Switch to the Baselines list, the type of the baseline formed by the two files will be Dynamic.

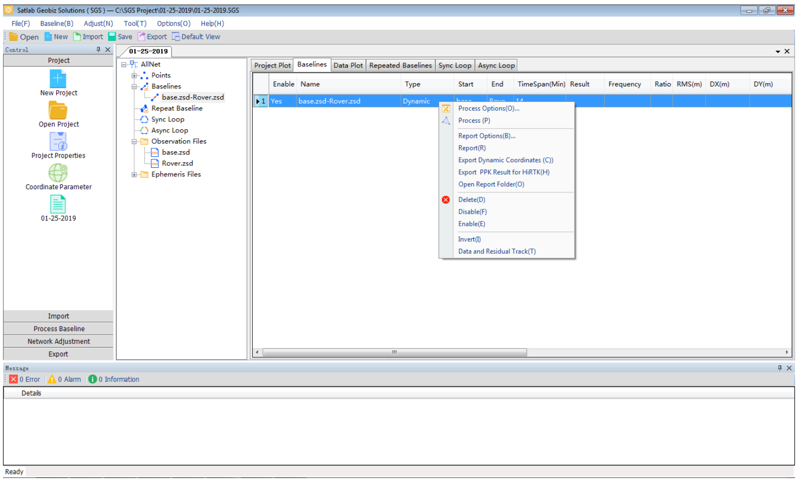


Figure 1-2-17 Baseline List

Select the dynamic baseline in the baseline list, right click and select Process to complete the baseline processing. After processing, users can right click and select Report to view the report, which forms the positioning result of each epoch.

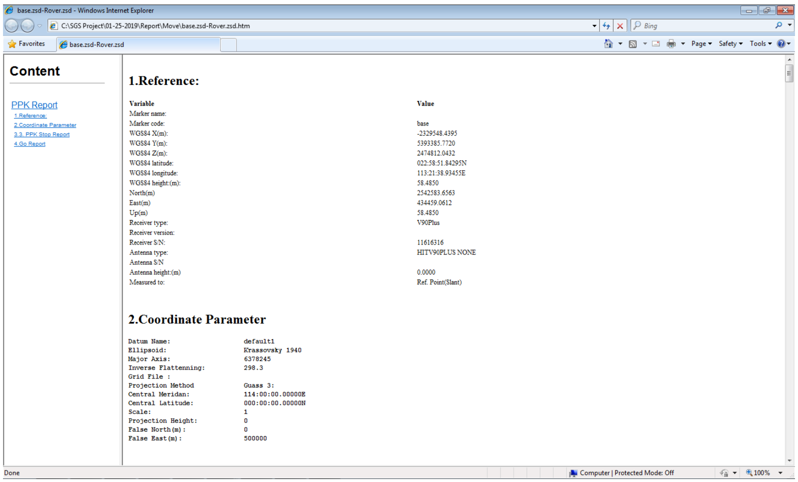


Figure 1-2-18 PPK Report

Chapter 2

Software Interface

This chapter contains:

- **Main Interface**
- **Menu & Toolbars**
- **Plan View**
- **Tree List View**
- **Detail View**

2.1 Main Interface

Run SGS.exe to enter the main program of the SGS software.

The software interface consists of Menu Bar, Tool Bar, Status Bar, Navigation Bar, Message Area, and Workspace.

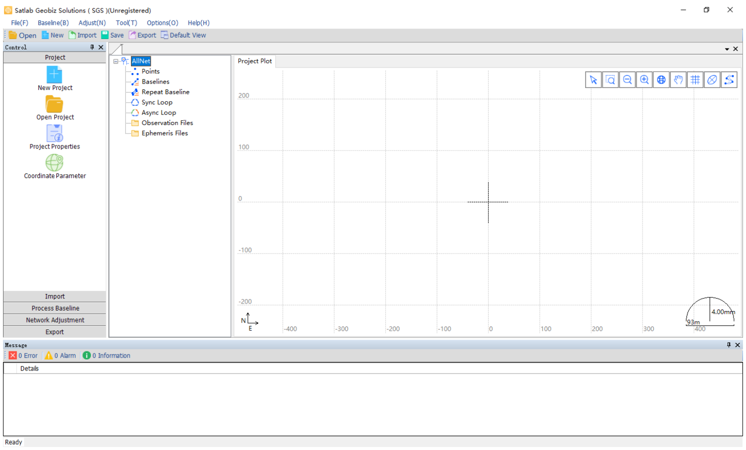


Figure 2-1-1 Main Interface

Select the File menu to open a project: the interface is divided into several areas.

1. Title Bar

The initial purpose of the title bar is to help you quickly determine the current application class. However, you can control for some basic programs, such as maximizing, minimizing, and exiting the software. If the project is currently open, the project path is displayed.

2. Menu Bar

The drop-down menu is an important part of any Windows application window. It provides the majority of commands for building projects, solving data and managing data.

3. Tool Bar

Provides most of the commonly-used shortcut commands to speed up various operations.

4. Status Bar

Shows tips for the current operation. The status bar can also be hidden.

5. Workspace

The user area is the main area for users to work, usually including views related to the project.

6. Navigation Bar

Stores the common shortcut commands.

7. Message Field

Outputs intermediate process information when processing data.

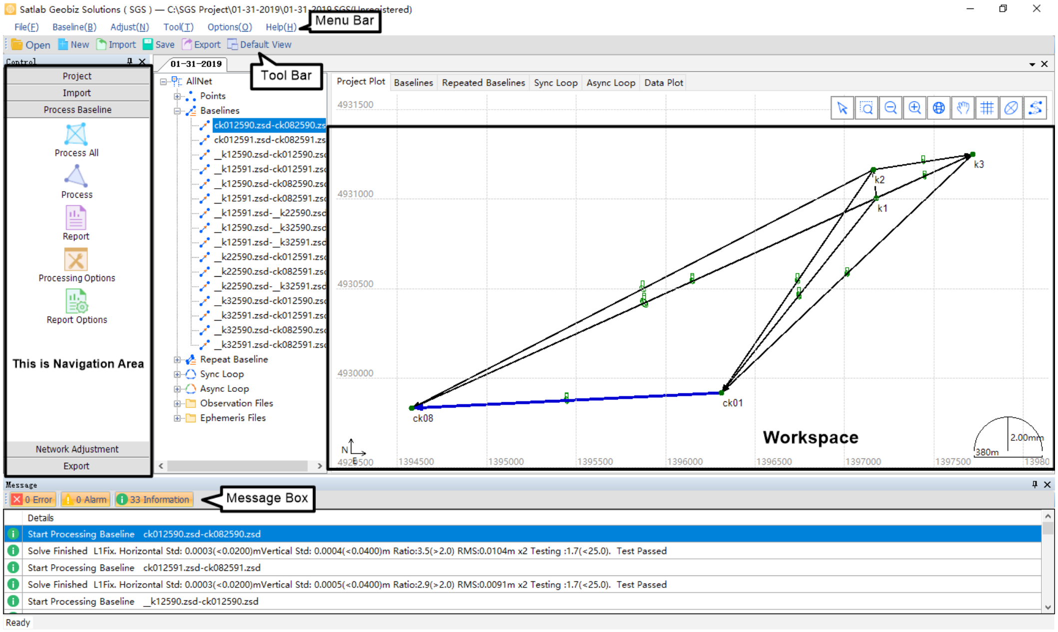


Figure 2-1-2 Several Areas of Interface

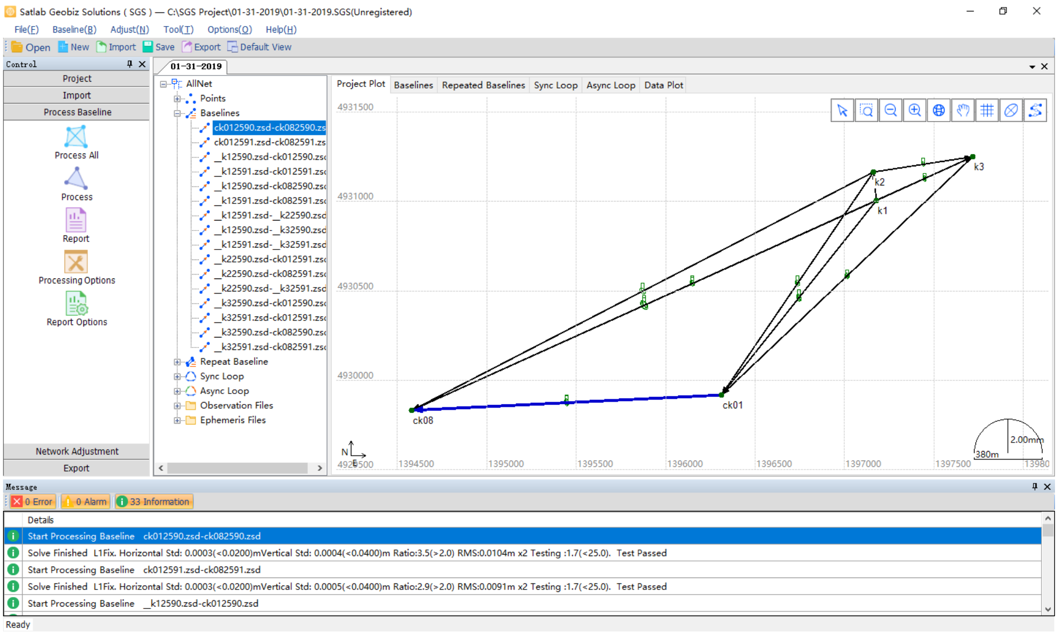


Figure 2-1-3 Working Interface

Next, we will introduce specific operations of the main program.

2.2 Menu & Toolbars

2.2.1 Menu

The main menu of the program consists of File, Baseline Processing, Network Adjustment, Tools, Settings and Help. Each menu item has a corresponding Windows shortcut. Most of the data processing work can be done through the operations provided by the menu items. The menu covers the main process steps.

Figure 2-2-1 Menu

2.2.2 Toolbars

Through the toolbar of the main program, you can directly execute common functions, which can speed up the software.

The toolbar includes Open Project, New Project, Import Data, Save Project, Export Data, and Restore Default View.

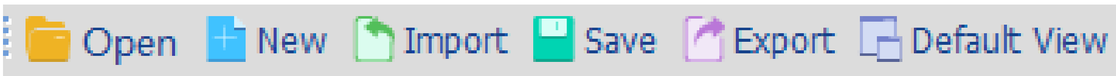


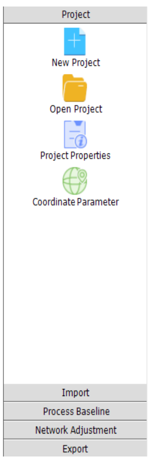
Figure 2-2-2 Tool Bar

2.2.3 Navigation Area

The navigation area is a shortcut entry to the menu bar, which can be displayed and hidden according to user habits. It is used to save user interface or speed up operations.

2.3 Plan View

The contents of the plan window mainly display auxiliary information such as the station, baseline information and scale, and grid reference line of the project.



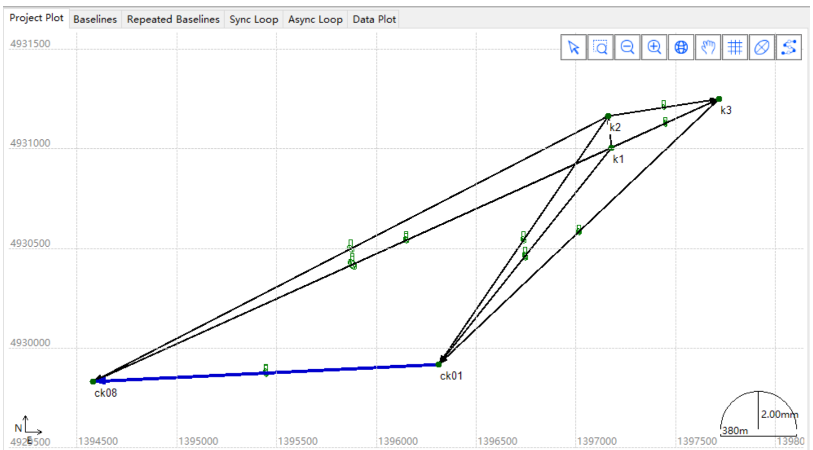


Figure 2-2-3 Navigation Area

Figure 2-3-1 Data Plot

1. Station

If the GPS observation station has been associated with the control point, it is indicated by ▲, and the point not associated with any control point is indicated by ●.

2. Baseline

Static baselines are represented by lines with arrows. When the baseline is not solved, or does not participate in the solution, the baseline is grey, and navy blue after solution.

Move the mouse, when the mouse clicks on the static baseline, above the observation site, the static baseline and the observation site will be highlighted. At the same time, the middle tree menu will be positioned to the baseline.

3. Error ellipse

After the baseline solution is completed, the error ellipse of the baseline and the residual in the direction of elevation are displayed in cyan to visually determine the quality of the solution for the baseline.

2.3.1 Graphic Operation Buttons

There is a row of graphic operation buttons in the upper right corner, you can click the button and then click on the plot to achieve the corresponding graphic operation.

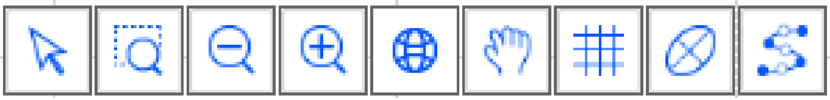


Figure 2-3-2 Graphic Operation Buttons

- Select the site and baseline of the network graph.
- Square select zoom
- Zoom out
- Zoom in
- Full screen
- Pan move
- Grid reference line displayed
- Error ellipse displayed
- Rover point displayed

2.3.2 Right-click Menu Operation

Right-click in the plan display area, to pop up the right-click menu, and click the relevant function to realize the corresponding graphic operation. The menu function corresponds to the graphic operation button.

- Select: Select a baseline or a station;
- Zone Frame Selection: Drag the mouse to select the area to be enlarged;
- Zoom Out/Zoom In: Click the mouse to zoom out/in the plan;

- Full Screen: Display plan in Full screen;
- Pan: Drag the mouse to move the graph;
- Grid Line Switch: Turn grid coordinates on/off;
- Error Ellipse switch: Turn error ellipse on/off;
- Save Graphics: The screenshot saves the current figure.

2.3.3 Changing the Drawing Mode

Choose Options→ Customize menu item, enter the custom configuration dialog, and you can set the drawing mode of the plan grid reference line as a plan or geodetic coordinate, by setting the second item. The software supports Meter, Feet or User Define Length unit settings.

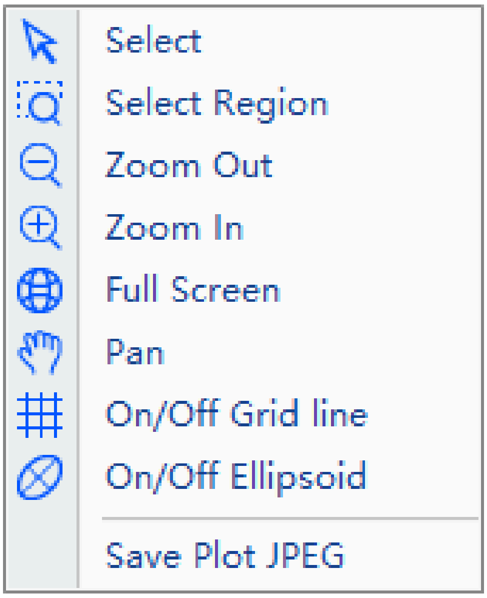


Figure 2-3-3 Right-click Menu

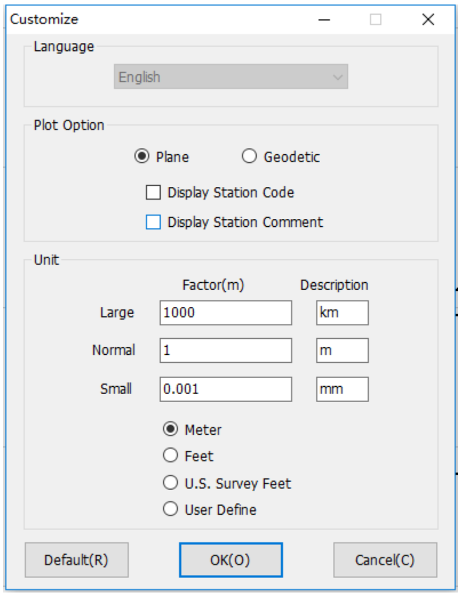


Figure 2-3-4 Customize Menu

2.4 Tree List View

The left of the work field is a tree list view. It is used to manage all contexts of the project, including points list, baselines list, synchronous loop list, asynchronous loop list, observation files list, ephemeris files list. Click on one node in the list, the detail view, which is in the work field, will display related information, according to the selected node. Click on an observation file in the tree list, the five tabs related to the file information will appear in the detailed view of the workspace, namely Project Plot, Obs-Files, SSP and QC, Data, Sky Plot, and show the data plot of the file.

The first letter of the name represents a different constellation type.

G: GPS R: GLONASS

C: BDS E: GALILEO

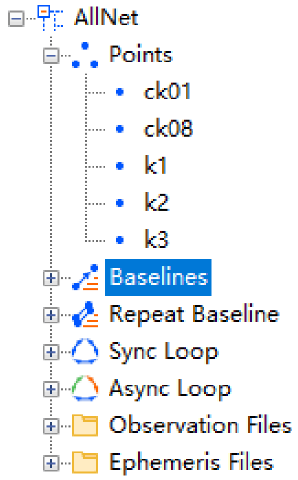


Figure 2-4-1 Tree List View

Figure 2-4-1 Tree List View

2.5 Detail View

The detail view of work field contains several tabs, every tab will display or hide to get different display combinations, according to the selected node of tree list.

Notice: The tabs of detail view will change automatically according to the selected node of tree list, users don't need to search.

2.5.1 Pop-up Menu of Detail View

Choose one item in the detail view and right click on it, the pop-up menu will display.

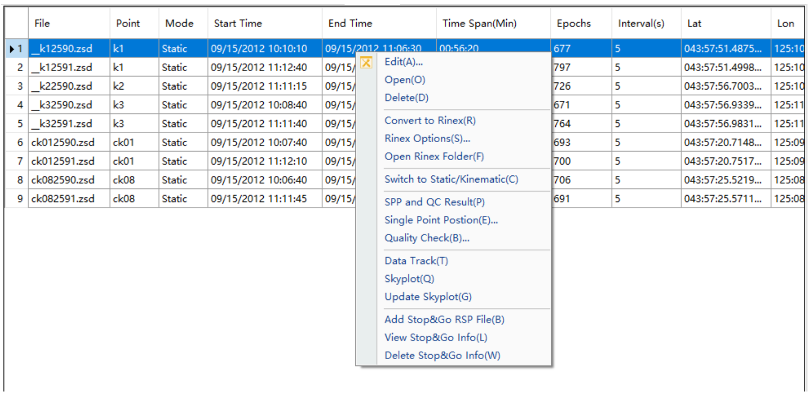


Figure 2-5-1 Pop-up Menu of Obs-Files

Choose one item in the detail view and right click on it, the pop-up menu will display.

- Edit: Open Edit to modify the basic information, antenna information, and receiver information of the selected file.

- Open: Open the selected original file

- Delete: Delete selected file

- Convert to Rinex (R): Convert selected files to Rinex format

- Rinex Options (S): Set options of Rinex output, including version, output system, output content, output sample interval, and type of antenna height
- Open Rinex Folder (F): Open the folder of the converted and stored Rinex files
- Switch to Static/Kinematic (C): Convert the type of the selected file to static/kinematic
- SPP and QC Result (P): Click to the Single Point Position and QC tab to view the single point position and QC results of the selected file.
-Single Point Position (F): Re-single point positioning for selected files
- Quality Check (B): Re-check the quality of selected file
- Data Track (T): Click and switch to the Data Plot tab to view the plot of the selected file.
- Skyplot (Q): Click to the Skyplot tab to view the satellite trajectory of the selected file.
-Update Skyplot (G): Regenerate the satellite trajectory of the selected file
-Add Stop&Go RSP File (B): Select and add the Stop&GO RSP file in the pop-up dialog box.
-View Stop&Go Info (L): Open the Stop&GO information file
- Delete Stop&Go Info (W): Delete Stop&GO information for the selected file

2.5.2 Property Window

You can open the property window by clicking Modify Properties in the pop-up menu, or by double-clicking an item in the list.

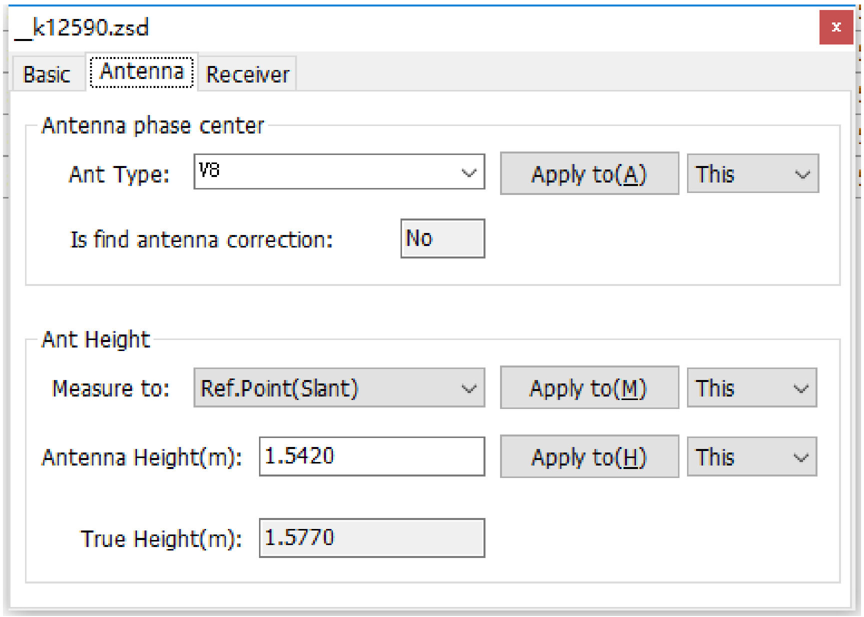


Figure 2-5-2 Property Window

Chapter 3

Project Management

This chapter contains:

- **- Create a New Project**
- **-Observation Data**
- **-Observation Station**
- **-Static Baseline**
- **-Repeat Baseline**
- **-Closed Loop**
- **-Satsurv Project**

SGS data processing software is project-oriented. Hence, whether you carry out single point positioning, static baseline processing, dynamic route processing, or network adjustment, first create a new project, or open an established project.

The following steps create a new project:

1. Establish a new project, determine the project name and the save path;
2. Set the project properties and determine the quality inspection standard;
3. Input coordinate parameters in the coordinate system management;

Then proceed to the next step.

3.1 Create a New Project

3.1.1 Set the Project Properties

TClick File Project Properties, set the project properties.

1. Basic Information

The basic information is displayed in the network adjustment report.

2. Tolerance

Setting tolerance is very important, you can use national standard or user-defined. Many tests are conducted according to the setting of tolerance during data processing. For the national standard of tolerance, please refer to its corresponding country. In this Software (SGS) you can adopt different standards.

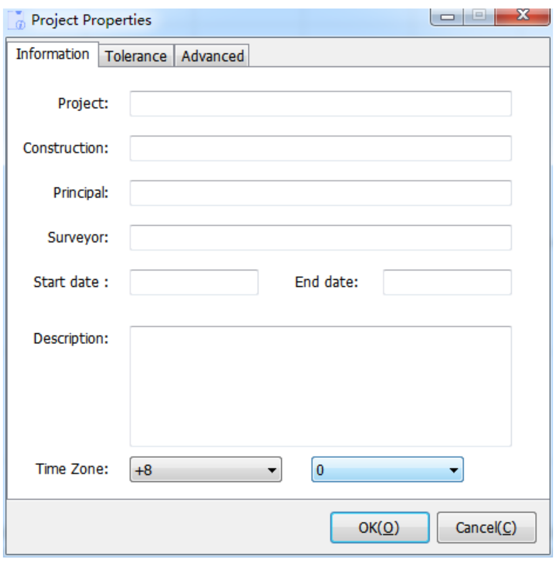


Figure 3-1-1 Project Properties

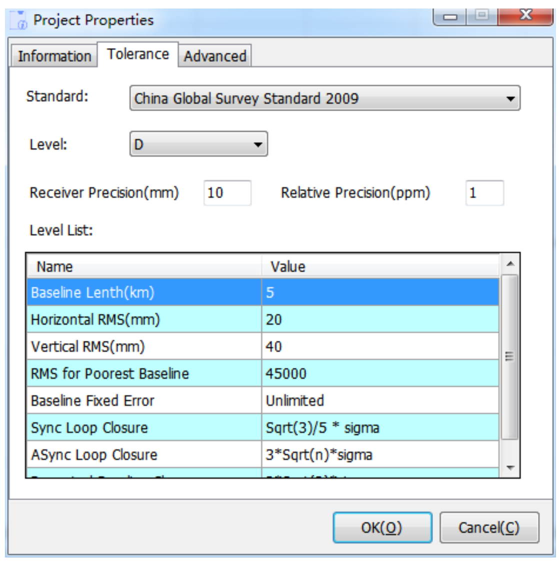


Figure 3-1-2 Project Properties

3. Advanced

Advanced settings decide the project control settings when processing data, such as using several characters in the front of *ZHD as the point name, minimum observation time of static baseline, minimum observation time of dynamic baseline, maximum length of baseline, forming repetitive baseline and time of closed loop, etc.

3.1.2 Coordinate Parameters Settings

Click the File menu→Coordinate System item to begin the setting.

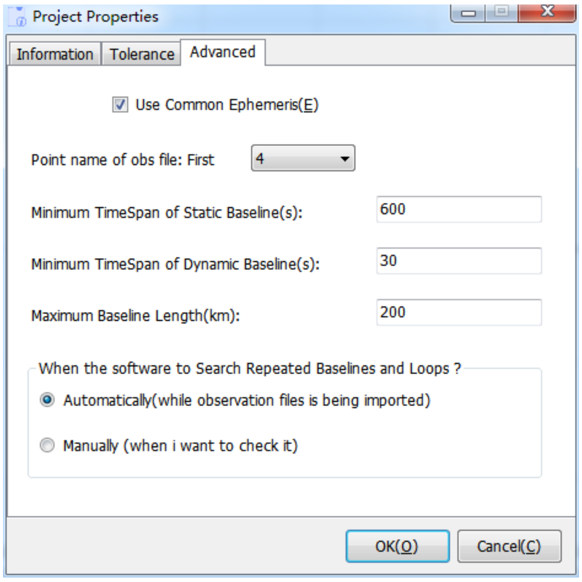


Figure 3-1-3 Project Properties

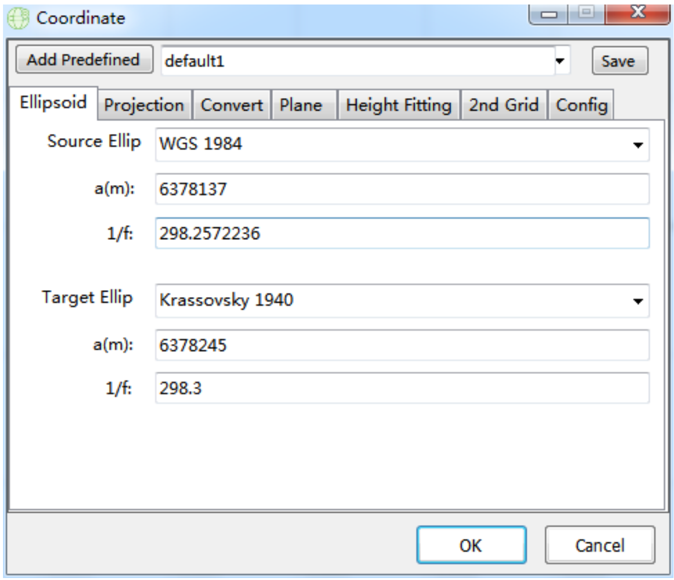


Figure 3-1-4 Settings

When a project is working, it generates some necessary files, which are saved in the project path and its s sub-catalogs. When we check these working catalogs, as shown in the figure, we can see the project file named *.SGS, a coordinate transformation file named .dam and 7 sub-catalogs under the working catalog. The Adjust file stores the Network Adjustment information, the Baseline file stores the intermediate information of the baseline processing, the Copy file backs up the last saved project, the EphBinData file stores the ephemeris data, the ObsBinData file stores the observation data, the Report catalog stores file report, and the Rinex file stores the Rinex files transformed from observation files.

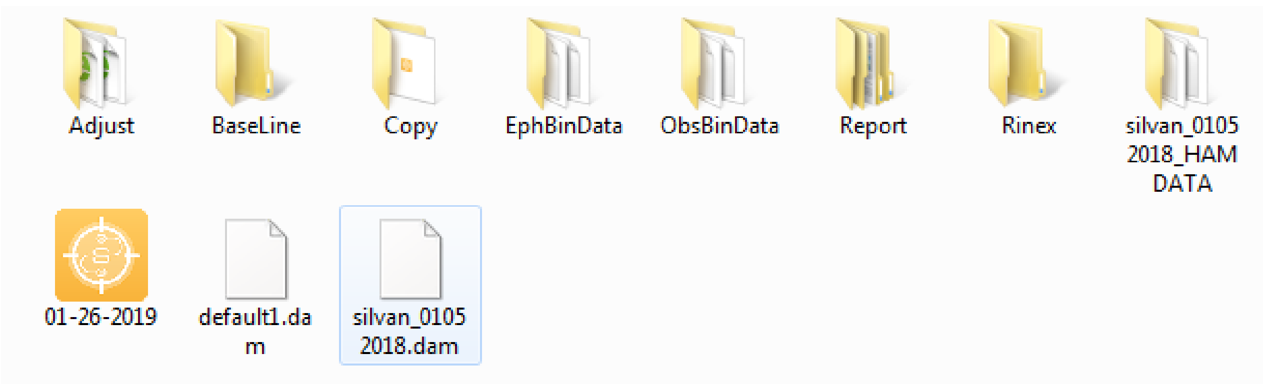


Figure 3-1-5 Report Catalog

In this way, all the data and intermediate processing result have been stored in the corresponding catalog. When one project is finished, the entire catalog and its sub-catalogs can be packed up and saved. In addition, the project file can be moved from one computer to another and run with no problem.

3.2 Observation Data

The data format of the GPS receiver is classified into two types: NMEA 0183 and original observation data.
SGS d ata processing software uses the original observation data of the GPS receiver. The raw observations of most GPS receiver outputs are binary data in different formats.
SGS can process user-defined GNS/ZHD format and standard RINEX text formatting.

3.2.1 Contents of Observation Data

The ObsBinData file mainly stores the original observation data of each epoch recorded by the GPS receiver. Each epoch includes the observation time, the satellite tracking information, C/A code pseudo range, P1 code pseudo range, P2 code pseudo range, L1 carrier phase and L2 carrier phase of each channel. For static observation files of SGS, the observation file is required to include at least the observation time, C/A code pseudo range, and L1 carrier phase, and for dynamic observation files, at least the observation time and C/A code pseudo range.
In addition to the above information, the observation file also includes position information, initial coordinate, and ephemeris information related to the observation file.
Observation files can be shown as the following Figure 3-2-1:

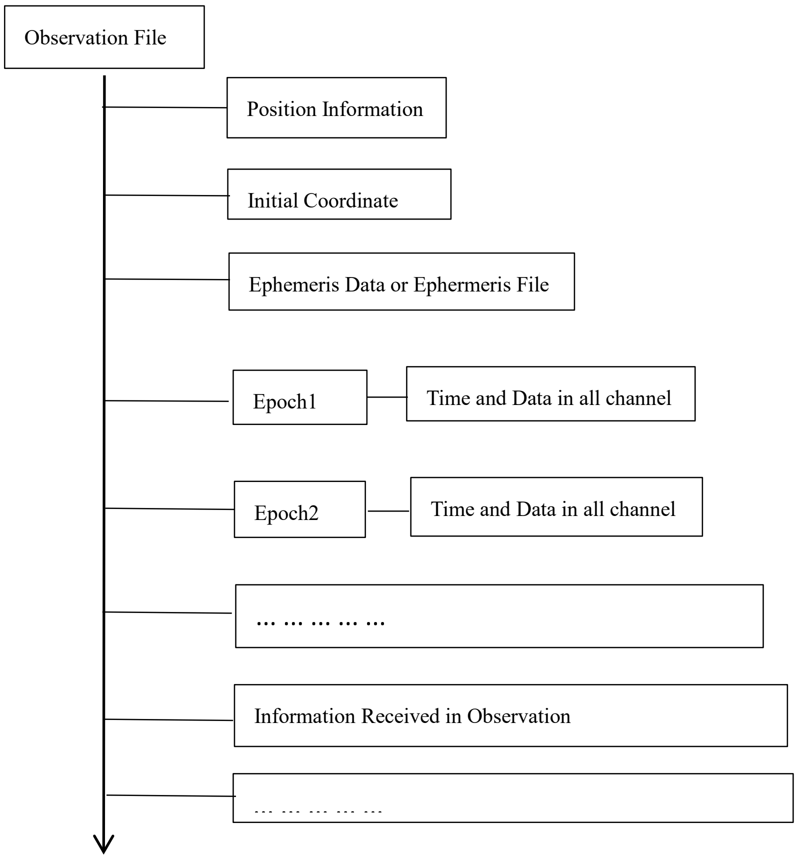


Figure 3-2-1 Contents of Observation data

3.2.2 Formats of Observation Data

1. Satlab ZHD/GNS Format

ZHD/GNS observed files are all included original observation data, ephemeris data, original coordinate of observation stations and so on. Some individual versions also include point coordinates and road information collected by dynamic acquisition.

2. RINEX Format

The RINEX format is a general data exchanged format to process data from different types of receivers. The RINEX format was proposed by the Institute of Astronomy of Bern University, Switzerland. Nowadays this format is widely used in schools, research institutions as standard input format, while preparing software. Moreover, GPS receivers at home and abroad can transfer observation data to RINEXT data.

At present, in order to adapt the demand of multi-system and multi-observed channels, the Rinex format has upgraded its vision to 3.x. For more details of RIENX 2.x, please consult relative contents and appendix C. For the Specification of 3.x format, please consult the official documentation.

3. Other Formats

SGS also supports other formats' observation data, such as the precision ephemeris file.

3.2.3 Data Preparation

SGS data processing software can process a variety of data formats. Generally, before the GPS data processing, it needs to follow the steps as below.

1. Data import

Click File menu→Import or click in the navigation field.

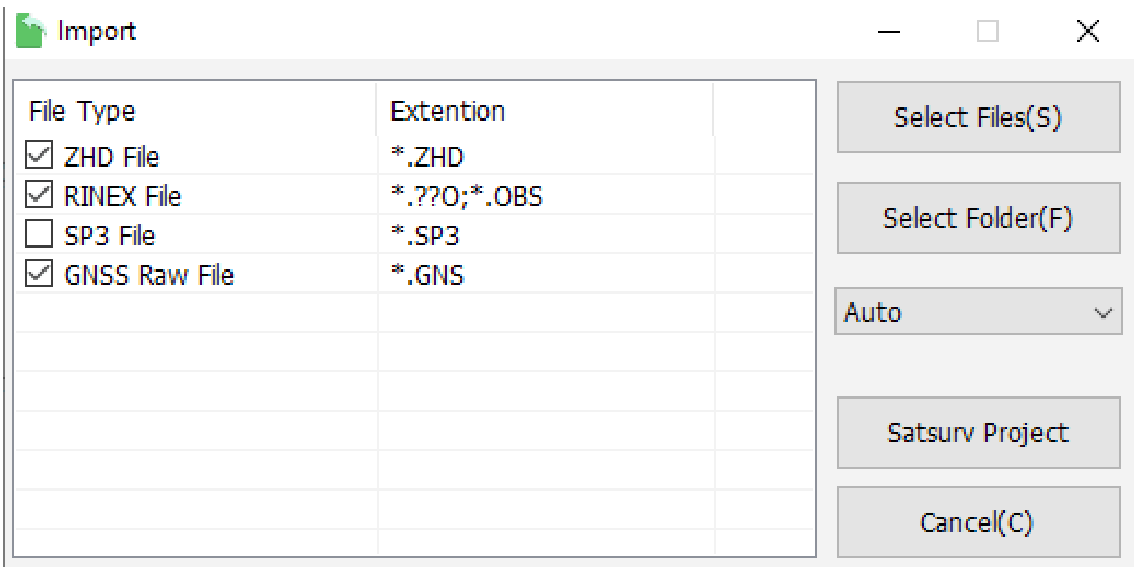


Figure 3-2-2 Data Import

On the right of the dialog box, there is a type of combo box for observing files, in this box the default content are automated and there are two options for static observing files and dynamic observing files.

The Import catalog will automatically traverse all the eligible files that meet the conditions. It is appropriate for multi data processing in large-scale projects, according to folder organization.

Now, if you choose the Rinex file, it will come out a file dialog box, as the picture shows below. The file dialog box will transfer automatically to the current file path and list the relative extension files under it. Users can choose one file or multiple files at a time.

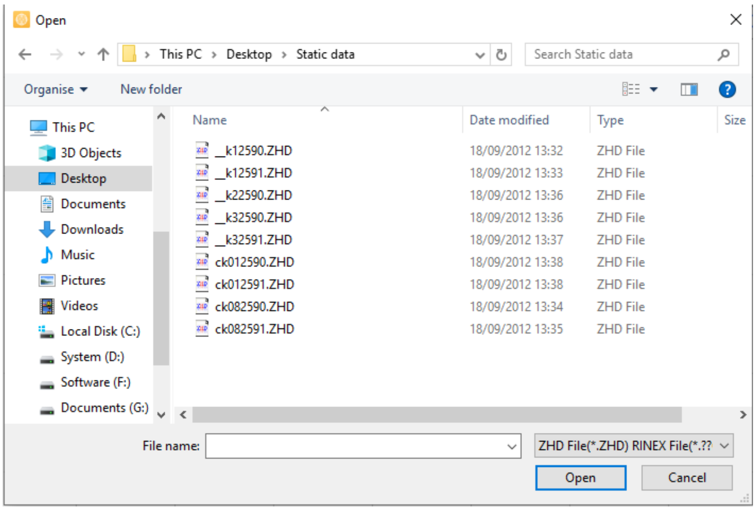


Figure 3-2-3 File Dialog Box

While importing the observation file, the software will search automatically and import corresponding ephemeris files. As for ZHD/GNS format's files, if observation files and ephemeris files are combined in the same document, they will be imported at the same time. However, for other formats, where observation files and ephemeris files are not in the same file, in this case, they should be placed in the same file, and the software will automatically distinguish and import the ephemeris files according to the format of observation files. Otherwise, users should input the ephemeris file in subsequent processing.

After finishing the importation, the software will extract observation points from the files and combine them automatically into static baselines and dynamic baselines based on their observation periods.

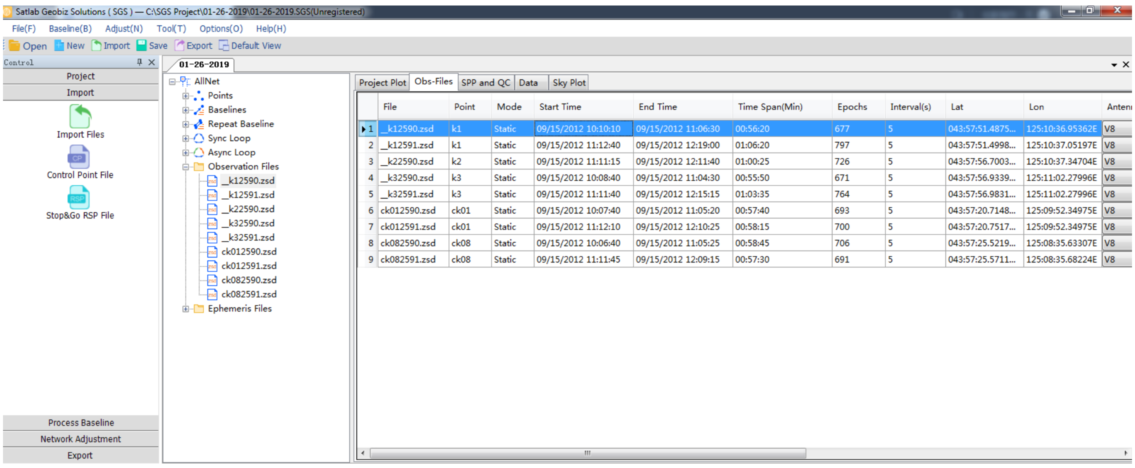


Figure 3-2-4 Observation Files

2. Observation File Name

Usually, the observation files will be identified by different file names. The usual name of the observation file consists of 8 file names and the extension. For example, the file name of an SGS GNS observation file is ABCD1234.GNS.

In a project, no duplicate file names are permitted. For example, ABCD1234.GNS and ABCD1234.01O can't exist at the same time.

An observation file name is usually formed by the station name and period, in this way, under the same project, it can make sure that all the file names are different.

- ZHD/GSN Observation File

For ZHD/GNS static observation files, the file name is formed by 8 characters:

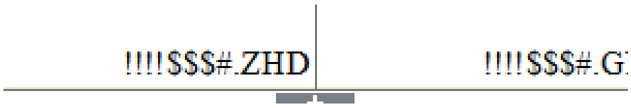


Figure 3-2-5 Observation File Name

The Point Name: In the observation file's name, the 4 !!!! significant point's name, it can be formed by characters and numbers. After loading the observation file, the software will automatically decompose the point name according to the file name. If the name is less than four characters, the data transmission software of the acquisition software or HD8200 will automatically make up 4 characters by adding underscore '_' before the point name. For example, the point name A will become "___A".

Period: The last three numbers and an English character, or numbers $$$# indicate the time period. Among them, the $$$ represents the day of year, that is, the order of the observation day in a year. For the day of year, see Appendix B. The # indicate the observation sequence of a day, which can be denoted by 1, 2, 3, … A, B, C,…, Z.

For the SGS GNS dynamic observation files, it's also denominated in the same way, but the name of the observation site doesn't have any meaning, it is only used for identifying different files.

- HDH observation files

HDH observation file has the same name as observation line file of marine survey software.

- RINEX observation files

The name in RINEX format is as follows:

Observations file: !!!!$$$#. yyO

Ephemeris file: !!!!$$$#. yyN

It is obvious that the naming rules of the RINEX file are similar to the ZHD/GNS file, except that yy indicates the year of observation. In the RINEX format, the name of the observation station is recorded in the part of the MARKER NAME. If this part is empty, the software will analyze the name of the observation file by reading the name of the station in the ZHD file to form a station and other information.

If some file names in RINEX format don't follow this rule, please rename those files before importing them to the SGS processing data software.

- Other Observation Files

Please consult other relative resources for other observation files.

3. Pop-up Menu of the Observation File

In the workspace detail view, choose one observation file in the list view of the Observation Files, then right-click this option to do the relative operation for the observation file.

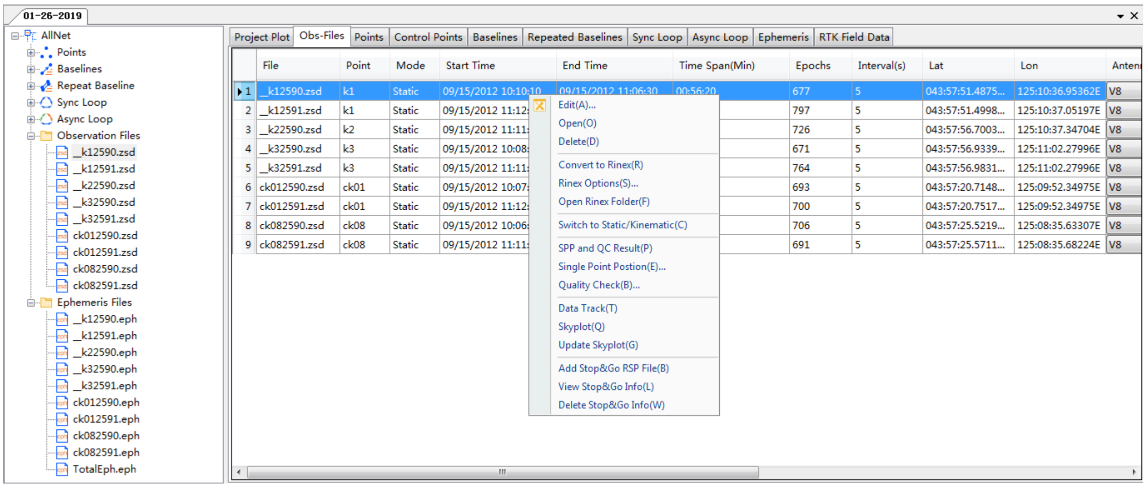


Figure 3-2-6 Pop Menu of Observation File

4. Observation File Attributes

In the workspace detail view, choose one observation file in the list view of the Observation Files, then right-click to select Edit. A label dialog box about the observation file will pop up.

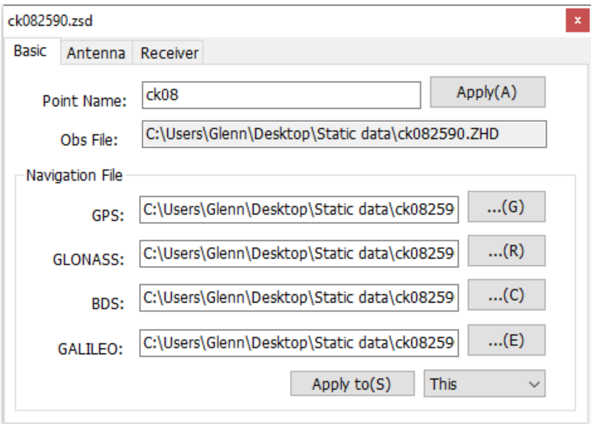


Figure 3-2-7 Edit Menu

The label dialog box is divided into three parts: Basic, Antenna, and Receiver.

5. Single Point Position Result of Observation Files

In the workspace detail view, choose one observation file in the list view of the Observation Files, then right-click to select Single Point Position. The SPP and QC tab will be activated, and the single point position result of this file will be shown.

6. Data Quality Inspection of Observation Files

SGS has a function of data quality inspection, choose one observation file in the list view of the Observation Files, then right-click to select Quality Check, the software will analyze data automatically. While clicking HTML, it will show the result of the data quality inspection.

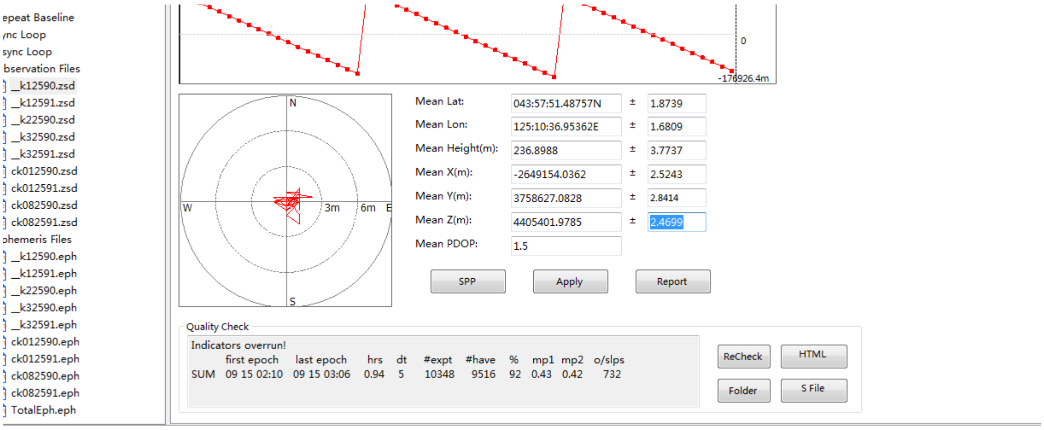


Figure 3-2-8 Single Point Position

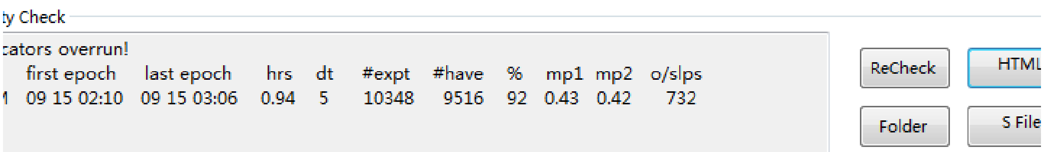


Figure 3-2-9 Quality Check

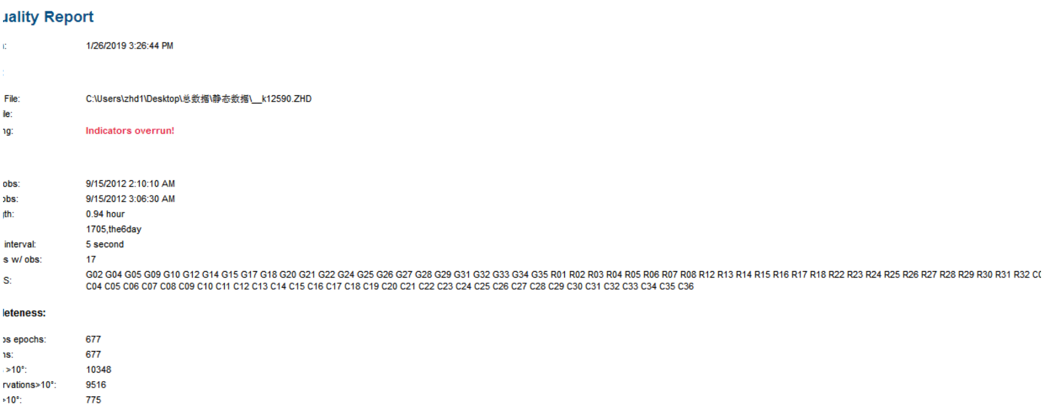


Figure 3-2-10 Quality Report

7. Observation sequence of observation files

In the workspace detail view, choose one observation file in the list view of the Observation Files, then right-click to select Data Track. It will show the tracking situation of satellite data, wherein the interruption indicates different situations, like the receiver lock-lose.

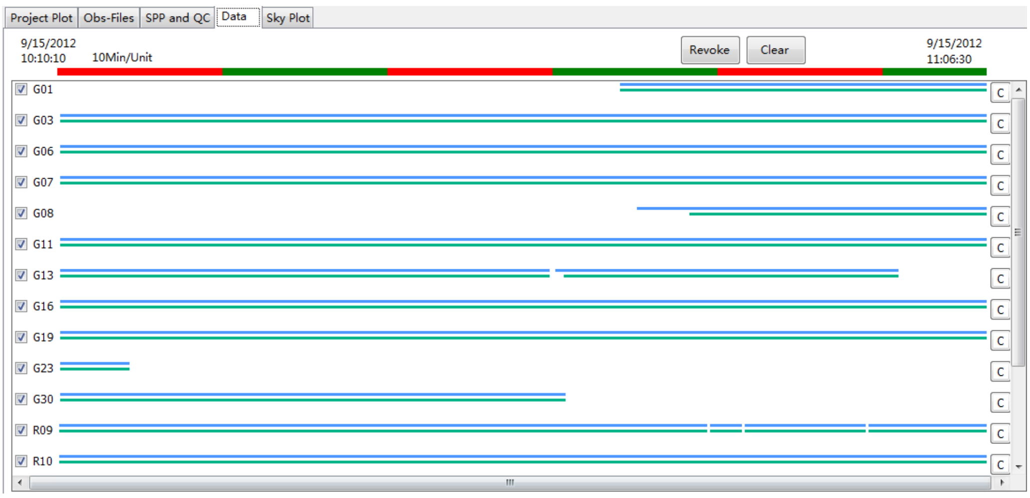


Figure 3-2-11 Data track

8. Sky plot and SNR Plot

In the workspace detail view, choose one observation file in the list view of the Observation Files, then right-click to select Skyplot, it will display the trajectory of the satellite in the file and the signal-noise ratio of the L2 band.

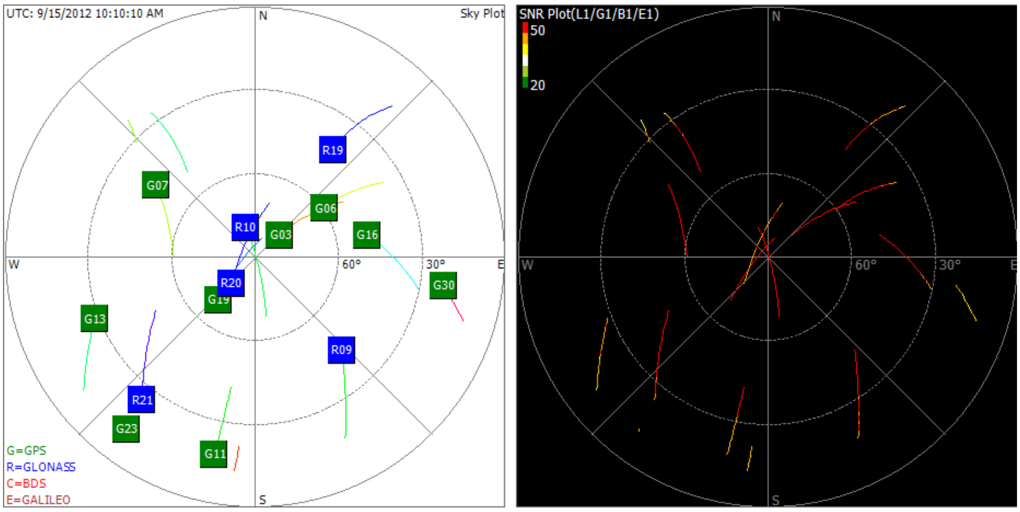


Figure 3-2-12 Sky plot

3.3 Observation Station

Click on Point in the tree view, the detailed display of the right work-space will show the tabs related to the observation site. There are two tabs, Points and Control points. The control point list is used for adjustment module, it is not related to baseline solution.

Project Plot | Points | Control Points | RTK Field Data

	Fixed	Name	WGS84 X(m)	WGS84 Y(m)	WGS84 Z(m)	Local N(m)	Local E(m)	Normal Height(m)
1		ck01	-2648720.7363	3759738.6151	4404717.9934	4929915.7288	1396315.6735	236.4868
2		ck08	-2647261.8647	3760637.8159	4404823.0669	4929829.9438	1394583.9597	233.9869
3		k1	-2649154.0362	3758627.0828	4405401.9785	4931002.421	1397180.3612	236.8988
4		k2	-2649100.6934	3758536.1759	4405524.2097	4931164.6013	1397167.0537	246.1528
5		k3	-2649548.0777	3758206.1121	4405522.6406	4931248.1276	1397722.1777	236.4176

Figure 3-3-1 Control Points

The list window lists the name of each observation station, whether it is fixed (associated with the control point), space coordinates or target coordinate.

3.3.1 Observation Station Pop-up Menu

Choose one observation station of the Points option in the workspace detail view, right –click to get the pop-up menu as shown below for site-related operations.

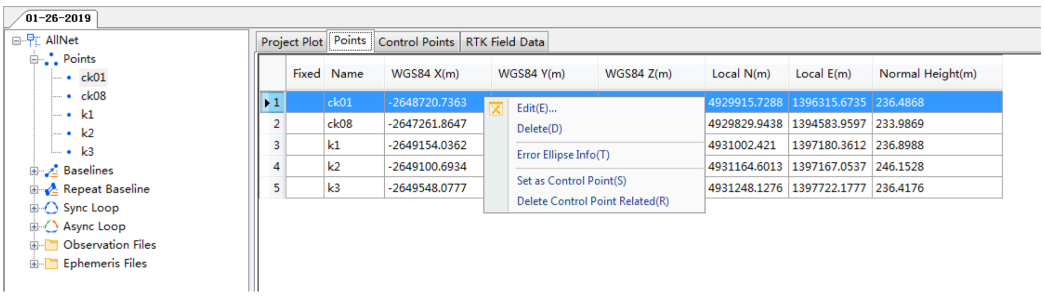
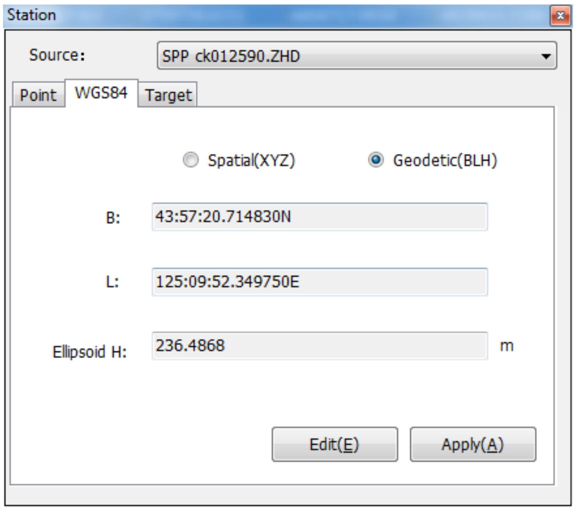


Figure 3-3-2 Pop Menu of Points

3.3.2 Property of Observation Site

Choose one point, double click or right-click to choose Edit, we can obtain the point name and information of coordinates through the property box.

The software records the coordinate information of all sources from the station. By changing the Coordinate Source, the coordinate values of different sources can be displayed. The coordinate information of the source can be assigned to the coordinate information used by the current station, by clicking the Save button, or manually edited.



Picture 3-3-3 Station

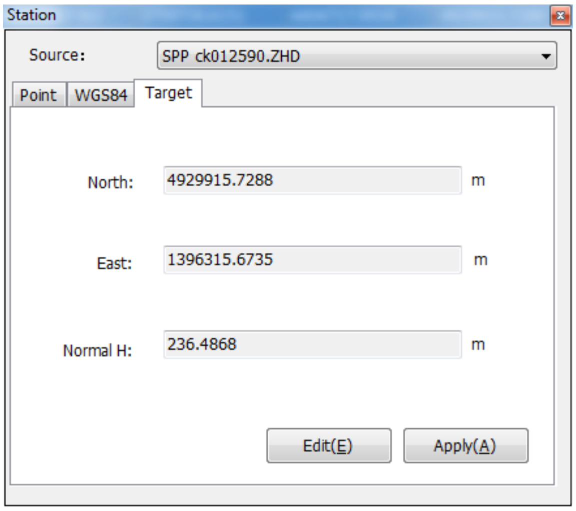


Figure 3-3-4 Station

3.4 Static Baseline

Click on the Baseline node in the tree view, and the detailed view of the right work space will display the tabs associated with the baseline.

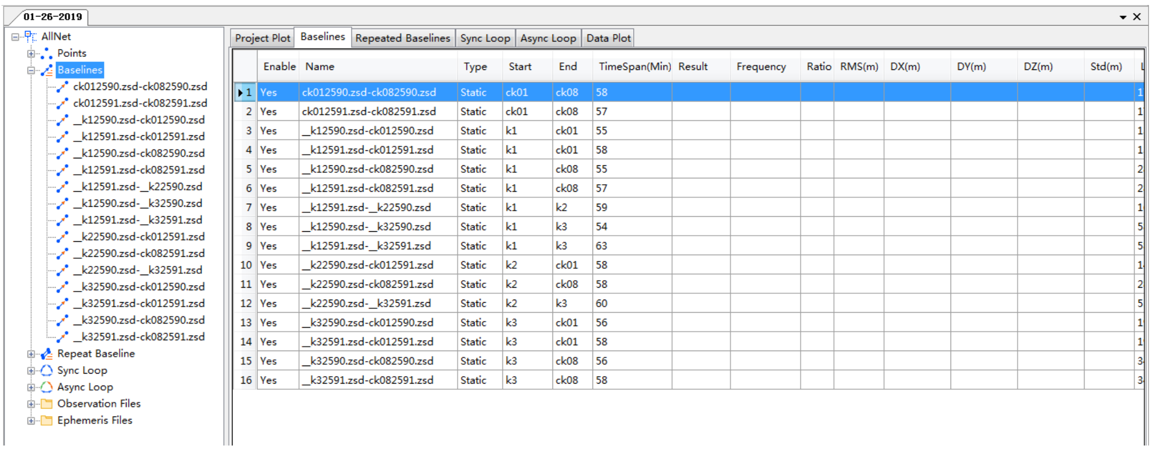


Figure 3-4-1 Baselines

The Baseline window lists the name of the baseline, the observation data used in the baseline solution, the solution used for the baseline, and the solution situation.
Choose one baseline of the Baselines option in the detailed view of working area, right-click and baseline related operations are available.

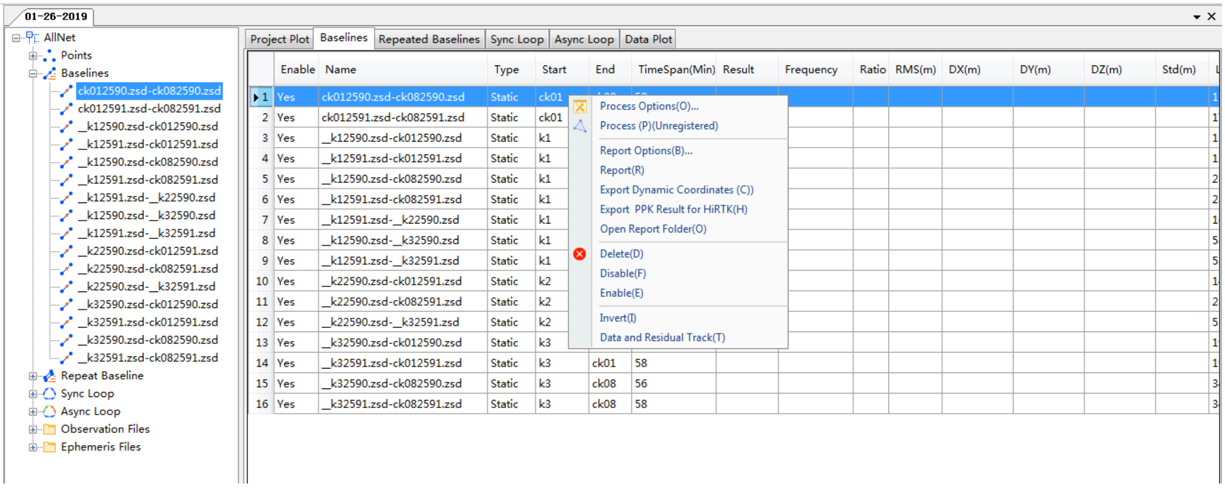


Figure3-4-2 Baseline Settings

3.5 Repeated Baseline

Click on the Repeated Baseline node in the tree view, and the detailed view of the right workspace will show tabs associated with the repeated baseline.

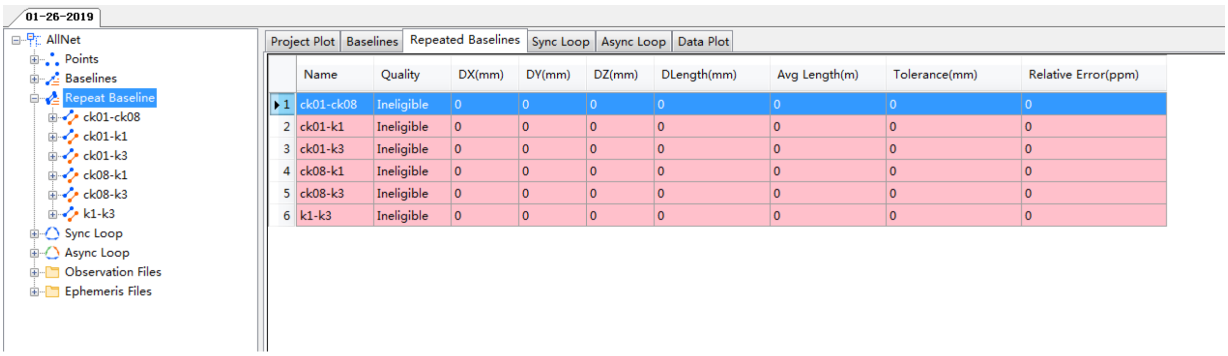


Figure 3-5-1 Repeated Baseline

3.6 Closed Loop

Click on the Sync loop or Async loop in the tree view, and the detailed view of the right workspace will show the tabs associated with the closed loop.

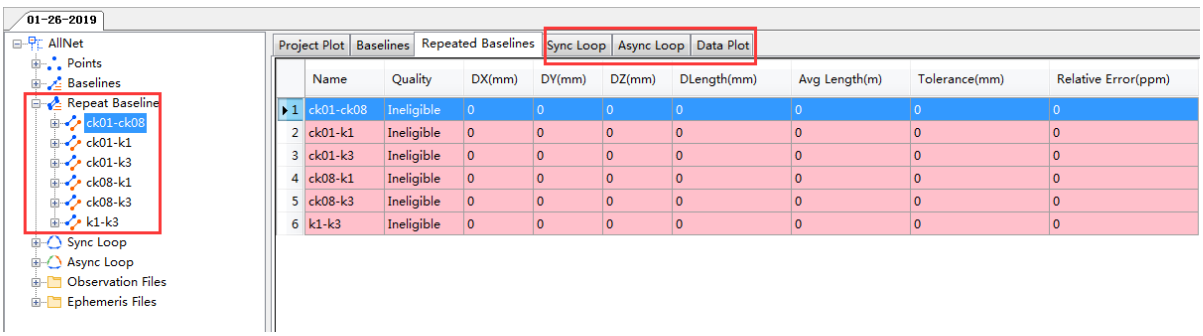


Figure3-6-1 Closed Loop

3.7 Satsurv Project

Satsurv projects can be imported into SGS software.

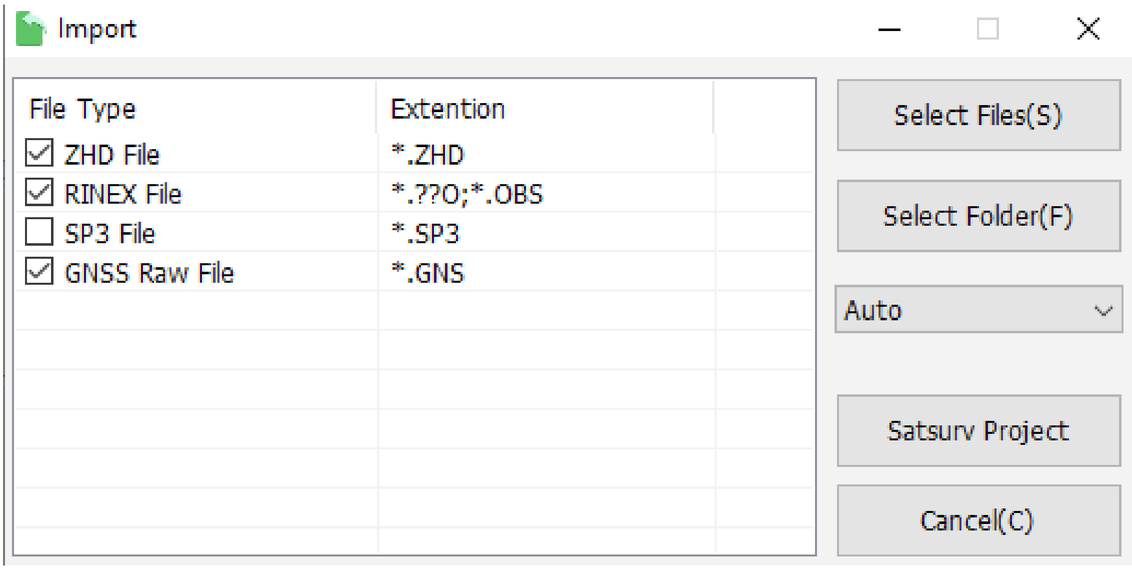
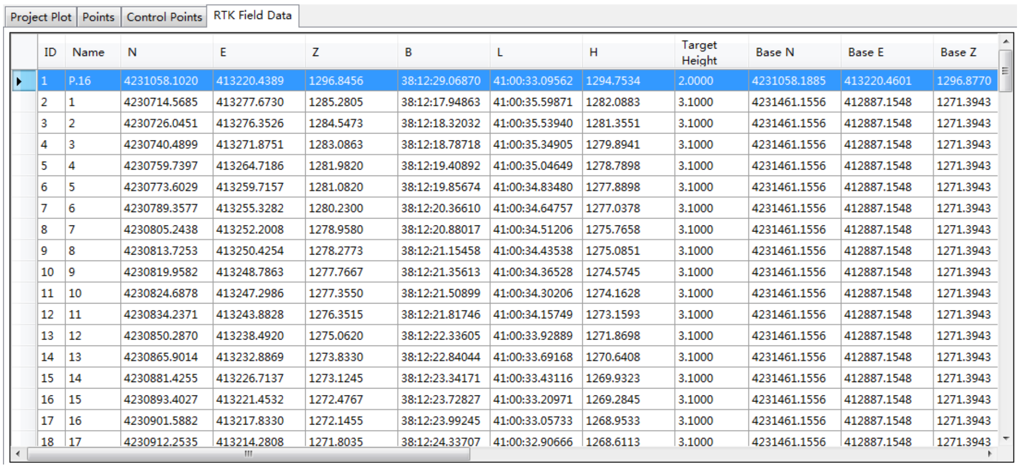


Figure 3-7-1 Import

While choosing the corresponding Satsurv project, SGS will load the project and display it.


Project Plot | Points | Control Points | RTK Field Data

ID	Name	N	E	Z	B	L	H	Target Height	Base N	Base E	Base Z
1	P.16	4231058.1020	413220.4389	1296.8456	38:12:29.06870	41:00:33.09562	1294.7534	2.0000	4231058.1885	413220.4601	1296.8770
2	1	4230714.5685	413277.6730	1285.2805	38:12:17.94863	41:00:35.59871	1282.0883	3.1000	4231461.1556	412887.1548	1271.3943
3	2	4230726.0451	413276.3526	1284.5473	38:12:18.32032	41:00:35.53940	1281.3551	3.1000	4231461.1556	412887.1548	1271.3943
4	3	4230740.4899	413271.8751	1283.0863	38:12:18.78718	41:00:35.34905	1279.8941	3.1000	4231461.1556	412887.1548	1271.3943
5	4	4230759.7397	413264.7186	1281.9820	38:12:19.40892	41:00:35.04649	1278.7898	3.1000	4231461.1556	412887.1548	1271.3943
6	5	4230773.6029	413259.7157	1281.0820	38:12:19.85674	41:00:34.83480	1277.8898	3.1000	4231461.1556	412887.1548	1271.3943
7	6	4230789.3577	413255.3282	1280.2300	38:12:20.36610	41:00:34.64757	1277.0378	3.1000	4231461.1556	412887.1548	1271.3943
8	7	4230805.2438	413252.2008	1278.9580	38:12:20.88017	41:00:34.51206	1275.7658	3.1000	4231461.1556	412887.1548	1271.3943
9	8	4230813.7253	413250.4254	1278.2773	38:12:21.15458	41:00:34.43538	1275.0851	3.1000	4231461.1556	412887.1548	1271.3943
10	9	4230819.9582	413248.7863	1277.7667	38:12:21.35613	41:00:34.36528	1274.5745	3.1000	4231461.1556	412887.1548	1271.3943
11	10	4230824.6878	413247.2986	1277.3550	38:12:21.50899	41:00:34.30206	1274.1628	3.1000	4231461.1556	412887.1548	1271.3943
12	11	4230834.2371	413243.8828	1276.3515	38:12:21.81746	41:00:34.15749	1273.1593	3.1000	4231461.1556	412887.1548	1271.3943
13	12	4230850.2870	413238.4920	1275.0620	38:12:22.33605	41:00:33.92889	1271.8698	3.1000	4231461.1556	412887.1548	1271.3943
14	13	4230865.9014	413232.8869	1273.8330	38:12:22.84044	41:00:33.69168	1270.6408	3.1000	4231461.1556	412887.1548	1271.3943
15	14	4230881.4255	413226.7137	1273.1245	38:12:23.34171	41:00:33.43116	1269.9323	3.1000	4231461.1556	412887.1548	1271.3943
16	15	4230893.4027	413221.4532	1272.4767	38:12:23.72827	41:00:33.20971	1269.2845	3.1000	4231461.1556	412887.1548	1271.3943
17	16	4230901.5882	413217.8330	1272.1455	38:12:23.99245	41:00:33.05733	1268.9533	3.1000	4231461.1556	412887.1548	1271.3943
18	17	4230912.2535	413214.2808	1271.8035	38:12:24.33707	41:00:32.90666	1268.6113	3.1000	4231461.1556	412887.1548	1271.3943

Figure 3-7-2 RTK Field Data

Users can click the CSV or HTML to let SGS to export the details of Satsurv projects.

Chapter 4

Static Baseline Processing

This chapter contains:

- **Baseline Processing Settings**
- **Baseline Processing**
- **Baseline Processing Result Test**
- **Discrimination of Various Influential Factors**
- **Repeat Processing a Baseline**

4.1 Baseline Processing Settings

Before the baseline vector processing, users need to do the baseline vector processing settings, and execute Processing Options under the menu Baseline, then the dialog box will appear.

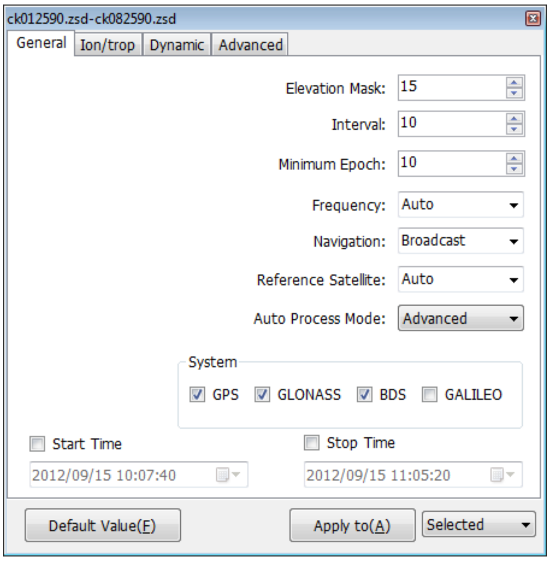


Figure 4-1-1 Processing Options

The dialog box consists of four pages, namely, general settings, tropospheric and ionospheric settings, dynamic solve mode and advanced settings.

The meaning of each item in the dialog box is briefly introduced below.

4.1.1 General Settings

1. Elevation mask

The elevation mask angle is used to restrict satellite data at a lower altitude, so that it does not participate in the baseline solution.

Because of the complicated influence of the atmosphere on the satellite signals with relatively low altitude, it is difficult to correct these signals with the model. In addition, these kinds of signals are easily affected by various factors such as multipath and electromagnetic waves, for that the signal quality is usually low. Therefore, in data processing, they are usually removed.

For example, from the perspective of the atmosphere refraction, the elevation angle can be reduced for short distance observation, and it should be increased for long distance observation, because the shorter the distance, the easier the atmospheric refraction is to be cancelled out. Of course, the setting of the elevation angle also depends on the surrounding environment of the observation station.

When observing in the field, the elevation angle should be reduced according to the satellite distribution, in order to collect as much data as possible for easy processing.

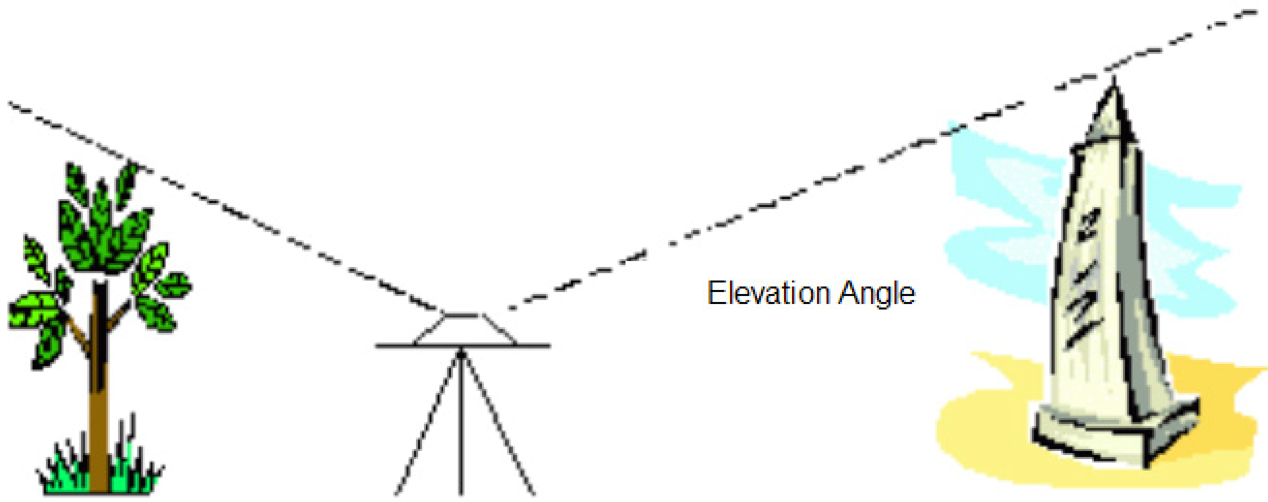


Figure 4-1-2 Elevation Mask

The default elevation angle is 20 degrees in SGS.

2. Sampling interval

The so-called epoch interval is the interval at which the software extracts data from the raw observation, during baseline processing.

For example, two instruments are set to collect a set of data every 5 seconds, during static observation, but when it comes to indoor processing, the high density of the observation data cannot significantly improve the baseline accuracy; on the contrary, it will greatly increase the time of the baseline processing. Therefore, to improve the speed of baseline processing, users can appropriately increase the sampling interval of data processing.

So, what is the appropriate sampling interval? It is generally considered that, for the short baseline, when the observation time is short, the sampling interval can be appropriately reduced, while for the long baseline, the sampling interval can be appropriately increased. For example, for a static baseline within 2 km and an observation time within 20 minutes, we can set a sampling interval of 5 seconds. However, when the baseline is long, the sampling interval can usually be increased to 60 seconds or 120 seconds.

So, why do we need to set a smaller sampling interval in the field observation? This is because, when the data is not very good, due to the certain randomness of the observation data and the limits of the software itself, the processing results can be improved by reprocessing the baseline after the modification of the epoch interval.

The default epoch interval of the software varies with the observation time, 5s in 10 minutes, 30s in 10 minutes to 2 hours, 60 seconds in 2 hours to 6 hours, and 120s in more than 6 hours.

3. Minimum epoch

Since the receiver must observe continuous carrier phase during the observation process, if there is a continuous cycle slip over a period of data, the quality of the data is usually very poor, which often affects the quality of baseline processing, so it should usually be eliminated. Therefore, during baseline processing, the software will eliminate data segments that do not exceed the minimum epoch.

4. Observations (frequency)

Different combinations of observations can be used for baseline solutions, such as wide lane combination Lw, narrow lane combination Ln, etc. When the automatic mode is adopted, the software will automatically select the type of observation, according to the length of the baseline.
Generally, a baseline less than 10km is solved by the L1 observation, and a baseline longer than 10km is solved by the observation of the Lc ionosphere-free combination.

5. Ephemeris (navigation)

The broadcast ephemeris, or the precise ephemeris, can be used for the baseline solution. For the long distance baseline, the precision of the baseline solution can be improved by using the precise ephemeris, and for the short baseline, the broadcast ephemeris meets the requirements.

6. Reference satellite

Since the double-difference observations are formed by the difference of the single-difference observations between the satellites, the software adopts the method of selecting the reference satellites in order to facilitate the processing of the double-difference observations.
The default setting is automatic. At this time, the software will select satellites with the most observation data and higher altitude angle as reference satellites. However, due to the influence of observation conditions, such selection may not be the most reasonable. When the reference satellite is not properly selected, it will affect the baseline processing results. At this moment, the user is required to reset the reference satellites, according to the observation data.

7. Auto process mode

SGS's baseline solution engine has the function of automatically eliminating the gross error in satellite data, which can help users reduce the manual data culling and make the baseline solution qualified in the shortest time. The function can be enabled when the item is set to Advanced and if the users want to manually erase data and do not want the software to automatically delete the problem data, set this item to Normal.

8. System

SGS software supports an arbitrary combination solution of GPS, GLONASS, COMPASS and GALILEO systems.

9. Processing time

The software handles all the public data of the base station and the rover by default. If you need to process the data for a fixed period of time, you can manually set the start and stop time.

4.1.2 Ionosphere / Troposphere

In general, there is no need to change troposphere and ionosphere settings. The medium and long baselines can be set according to the actual situation to improve the solution accuracy.

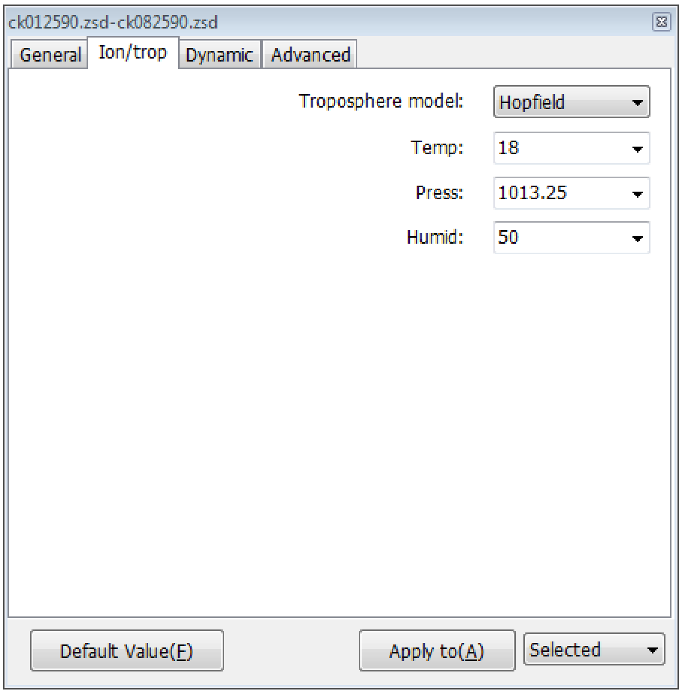


Figure 4-1-3 Ion/trop

4.1.3 Advanced

The figure below shows the advanced settings dialog. Under normal circumstances, the default value can be used to meet the requirements. It is not recommended for users to make illegal changes, which affects the stability of the solution engine.

*- Gross error detect: The coefficients of the gross error data that are automatically eliminated according to the dou ble difference residual size, when the baseline is solved, that is, when the double difference residual generated by an observation data is larger than the gross error coefficient *RMS, the observation data is eliminated.*

- Triple Diff. Max.: the tolerance threshold of the cycle slips repairing, but the cycle slips value is repaired when the difference between this value and the integer, obtained by rounding, is less than the threshold, otherwise it is regarded as gross error.

- Minimum Ratio: The threshold of the fixed ambiguity with the Lambda algorithm.

- Chi Probability: Confidence in the2 test of RMS.

- Pseudo range precision: Pseudo range observation error.

- Phase observation precision: Phase observation error.

- Split Sessions, if start time differs: When the baseline observation time exceeds the value, it will be solved in two periods.

- Use L1, if baseline shorter than: when using the automatic model for baseline solution, L1 model is adopted when the baseline is less than this value, when it is longer than this value, the Lc modulo is used to solve the problem.

- No L1 Fix: When the single-frequency baseline length is larger than this value, the ambiguity is not fixed, and the floating solution is directly output.

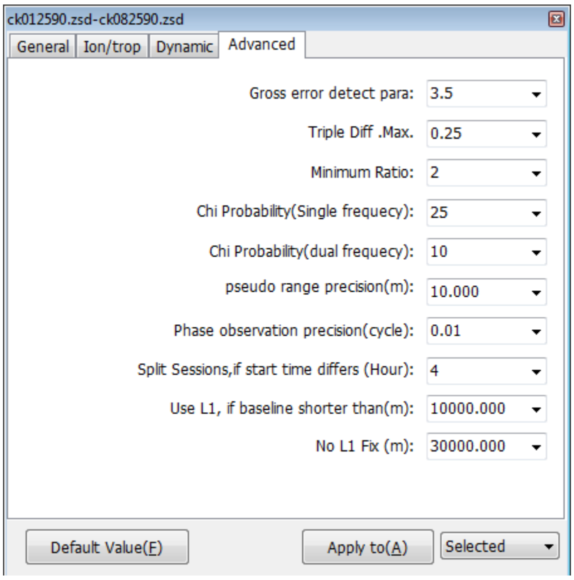


Figure 4-1-4 Advanced

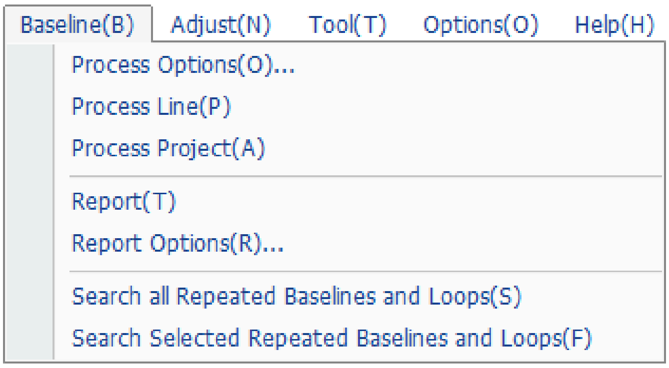


Figure 4-1-5 Baseline

4.1.4 Baseline Processing Menu

Click Baseline to bring up the baseline processing menu.
Among them:

- Search All Repeated Baseline and Loops: search all the repeated baseline and loops in the baseline network.

- Search Selected Repeated Baselines and Loops: Search for the closed loops and repeated baseline that meet the criteria, based on the set maximum number and the minimum number of edges of closed loops. The search results are displayed in the tree view on the left.

4.1.5 Baseline Processing

After the above preparations, execute Process All under the Process Baseline menu, and the program will start processing all the baselines, one by one, and the information dialog will appear. In the dialog, the name of each solution baseline, the progress of the baseline solution, and the information for each baseline solution are listed. Baseline solution runs in the background in multi-threading mode. In the process of operation, we can choose to cancel the baseline solution.

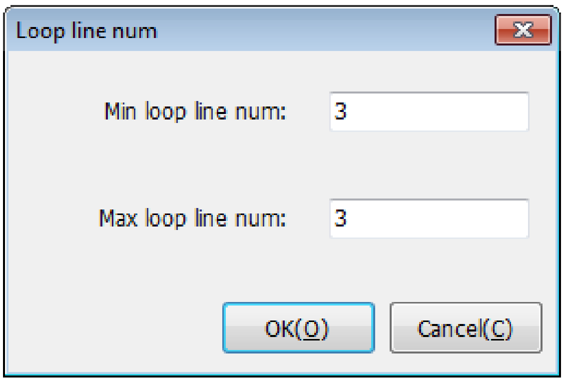


Figure 4-1-6 Loop Line Num

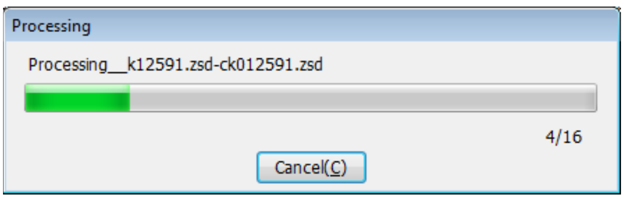


Figure 4-1-7 Processing

After the baseline solution, the result will be obtained in the calculation window.

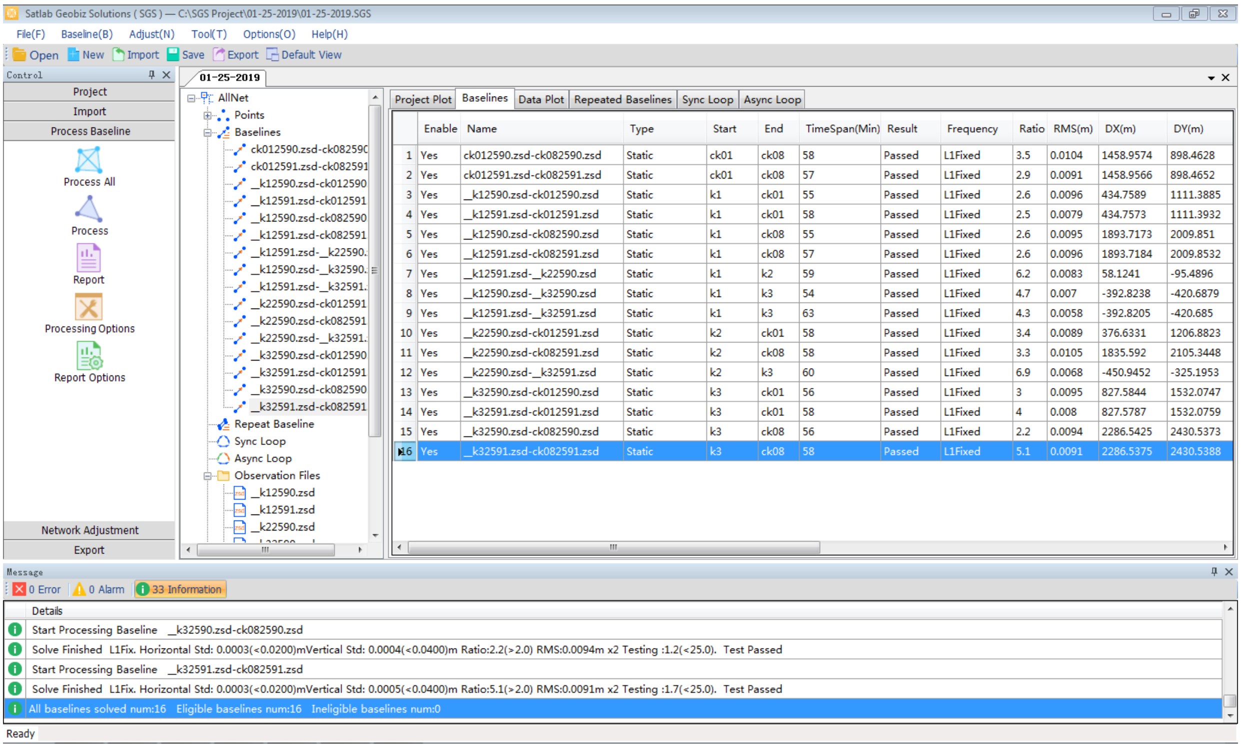


Figure 4-1-8 Result

The status bar will have a warning message, click on the warning message to display the corresponding baseline in the list.

The results of the baseline solution can also be generated by clicking Report in Process Baseline.

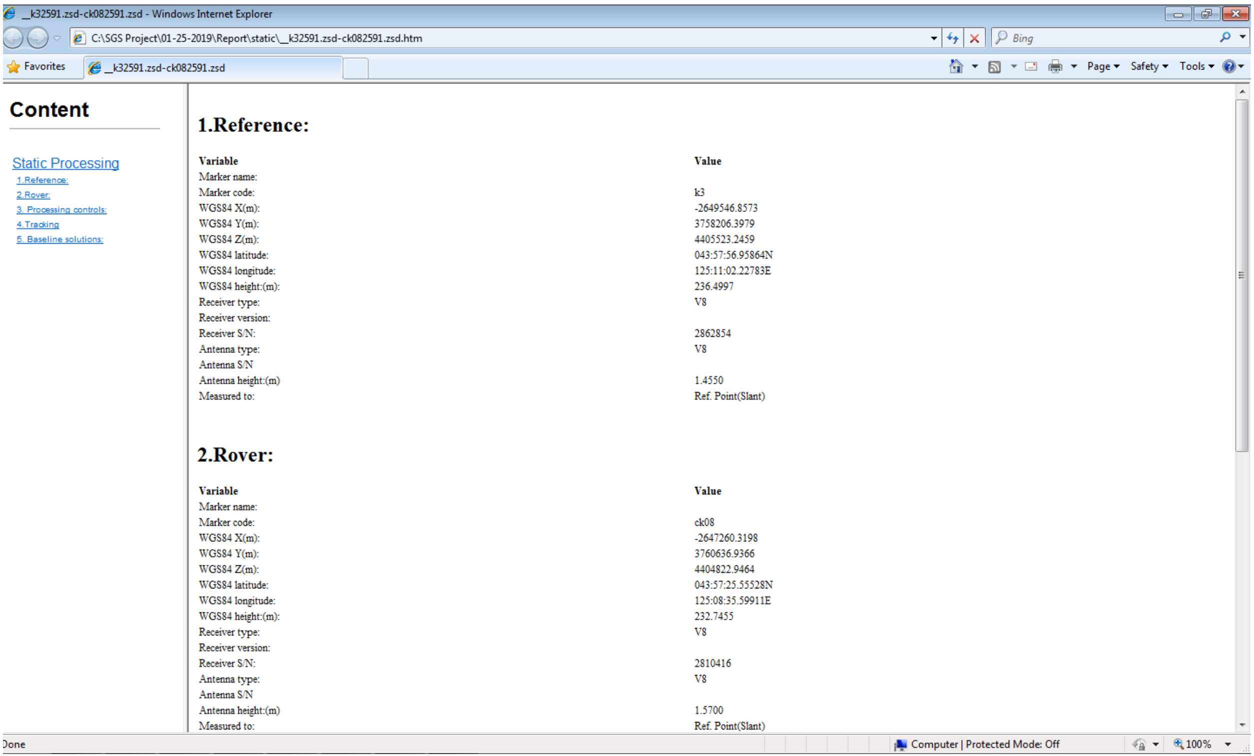


Figure 4-1-9 Baseline Process Report

4.2 Baseline Processing Result Test

4.2.1 Control Baseline Quality

After the baseline solution, the quality of the baseline solution can be measured by the quality indicators of RATIO, RMS, and positional accuracy.

1. RATIO

RATIO is the ratio of the sub-minimum RMS to the minimum RMS after the integer ambiguity resolution. That is:

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

RATIO reflects the reliability of the ambiguity parameters, which depends on a variety of factors. It's related to the quality of the observations and the observation conditions.

RATIO is the most critical value to reflect the quality of the baseline. Under normal circumstances, the RATIO value is greater than 1.8.

2. RMS

RMS is the Root Mean Square, that is: $RMS = \sqrt{\frac{V^T PV}{n-f}}$

Where:

V is the observation residual;

P is the weight estimation of the observations; n-f is the total number of observations, minus the unknown number.

RMS indicates the quality of the observations. The smaller the RMS, the better the quality of the observations. It is not affected by the observation conditions (such as satellite distribution).

According to the theory of mathematical statistics, the probability of the observation error falling within the range of 1.96 times RMS is 95%.

3. Point Accuracy

Point accuracy is an important indicator of accuracy in response calculation results. It is the result of the joint strength of GDOP and RMS. It can be divided into the horizontal direction accuracy, the vertical direction accuracy, and the baseline length accuracy, etc. The software will check the different precision indexes according to the setting of the limits of the project attributes.

4.2.2 Closed Loop Testing

1. Error of Closure

Closed loop test is a powerful way to detect baseline quality.

The closed loop can be divided into synchronous loop, asynchronous loop and repeated baseline.

The error of closure of the closed loop should theoretically be 0. In the actual measurement, it is allowed to deviate from a certain value. Please refer to the relevant documents about the closure difference of the closed loop.

The closure difference of the closed loop can be divided into:

- Component misclosure, that is: $\begin{cases} \varepsilon_{\Delta X} = \sum \Delta X \\ \varepsilon_{\Delta Y} = \sum \Delta Y \\ \varepsilon_{\Delta Z} = \sum \Delta Z \end{cases}$

- Total misclosure, that is: $\varepsilon = \frac{\sqrt{\varepsilon_{\Delta X}^2 + \varepsilon_{\Delta Y}^2 + \varepsilon_{\Delta Z}^2}}{\sum S}$

Where, $\sum S$ means ring length.

2. Synchronous loop, asynchronous loop and repeated baseline

- Synchronous Closed Loop

The closure error of the synchronous loop is the closure difference of the closed loop composed of synchronous observation baselines.

Due to the inherent relationship between the synchronous observation baselines, the closure error of the synchronous loop should always be 0. If the closure error of the synchronous loop is out of limit, it is wrong to have at least one baseline vector in the baseline of the synchronous loop. However, on the contrary, if the closure error of the synchronous loop is not exceeding the limit, only the static baseline is considered to be qualified, in most cases, it cannot be said that all the baselines that make up the synchronous loop are absolutely qualified in quality.

- Asynchronous Closed Loop

A closed loop, that is not completely composed of a synchronized observation baseline, is called an asynchronous loop, its closure error is called the closure error of the asynchronous loop.

When the closure error of the asynchronous loop satisfies the requirement of the limit difference, it indicates that the quality of the baseline vector making up the asynchronous loop is qualified. When it does not meet the requirement, it indicates that at least one baseline vector of the asynchronous loop is unqualified. Unqualified baselines can be carried out by multiple adjacent asynchronous loops or repeated baselines.

- Repeated Baseline

The observed results of different observation periods for the same two stations are called repeated baselines. The difference between these observations is the repeated baseline difference.

Notice: Each time the search is closed, there is information about the closed loop at the bottom of the calculation area. Double click on a message to find the corresponding baseline in the list.

4.2.3 Free Network Adjustment Test

For the free network adjustment test, please refer to the chapter "Network Adjustment".

4.3 Various Influence Factors

4.3.1 Influence Factors

There are several main factors affecting the results of the baseline solution:

1. The coordinates of the starting point is set inaccurately during the baseline solution. Inaccurate coordinates can cause deviations in the scale and direction of the baseline.

2. The observation time of the satellite is too short, so that the ambiguity parameters of these satellites cannot be accurately determined. For the baseline solution, the entire baseline processing result will be affected if the ambiguity parameters of the satellites participating in the calculation are not accurately determined.

3. There are too many cycle slips during the entire observation period, which make the cycle slips repairing imperfect.

4. The multipath effect is more serious during the observation period, and the correction value of the observation is generally larger.

5. The tropospheric and ionospheric refraction is too strong.

6. The electromagnetic wave is affected too much.

7. There is a problem with the receiver itself, resulting in poor data quality. For example, the accuracy of the phase measurement of the receiver is reduced, the clock is inaccurate, etc.

4.3.2 Discriminate Influence Factors

1. Discrimination of factors affecting GPS baseline solution results

- Introduction

Some factors that affect the GPS baseline solution result are easier to distinguish, such as - the satellite observation time is too short, the cycle slips are too great, the multipath effect is serious, the tropospheric or ionospheric refraction is too large, but for other factors it is difficult to discriminate, such as - the starting point coordinates are not accurate.

- Discrimination of baseline starting point coordinates

There is currently no way to discriminate the impact of inaccurate starting point coordinates on baseline solution quality. Therefore, in actual work, only the accuracy of the starting point coordinates should be increased as much as possible to avoid this effect.

- Discrimination of satellite observation time

The judgment on the problem that the satellite observation time is too short is relatively simple, as long as the number of observation data for each satellite in the recording document is viewed. The SGS GPS post-processing software also outputs the satellite visibility map, which is more intuitive.

- Discrimination of too many cycle slips

For the case of too many cycle slips in satellite observations, it can be analyzed from the observation residuals obtained after the baseline solution. At present, most of the baseline processing software generally uses double-difference observations. When an observation of a satellite in a station contains unrepaired cycle slips, all the residuals of the double-difference observations associated with it are present. There will be a significant integer multiplication.

- Discrimination of severe multipath effects and excessive tropospheric or ionospheric refraction

We also discriminate the multipath effects, tropospheric or ionospheric refraction by the observation residuals. However, unlike the cycle slips, when the multipath effect is severe and the tropospheric or ionospheric refraction is too large, the observation residuals has no integer multiple increase but only a non-integer multiple increase. It usually does not exceed 1 cycle, but is significantly larger than the residual of normal observations.

2. Solutions

- The solution to inaccurate baseline starting point coordinates

To solve the problem of inaccurate coordinates of the baseline starting point, we can use the point with higher coordinate accuracy as the starting point of the baseline solution. The more accurate starting point coordinates can be obtained by long-term single-point positioning, or by point-accurate measurement with WGS-84 coordinates. It is also possible to use the method that the coordinates of all baseline starting points are derived from a point coordinate, so that the baseline results have a certain system deviation, and then the system parameters are introduced in the GPS network adjustment processing to solve it.

- The solution to short satellite observation time

If the observation time of a satellite is too short, the observation data of the satellite can be deleted for that they are not allowed to participate in the baseline solution, thus ensuring the quality of the baseline solution result.

- The solution to too many cycle slips

If multiple satellites frequently have cycle slips during the same period of time, the method of deleting the severe period of the cycle slip can be used to improve the quality of the baseline solution results. If only individual satellites have frequently cycle slips, the method of deleting the observations of satellites with frequent cycle slips can be used to try to improve the quality of the baseline solution results.

- Multipath effects

Since the multipath effect tends to cause large residuals of observations, it is possible to eliminate the observations with large residuals by narrowing the editing factor, or eliminating the time period of large multipath effects or the satellites.

- The solution to excessive tropospheric or ionospheric refraction

Raise the elevation angle and eliminate the observation data of low elevation angle that is susceptible to the troposphere or ionosphere; this method is somewhat blind, because signals with low elevation angle are not necessarily affected by the troposphere or ionosphere.

Use the model respectively to correct the tropospheric and ionospheric delays.

If the observations are dual-frequency observations, the observations that eliminate the effects of ionospheric refraction can be used to do the baseline solution.

3. Residual map - the powerful tool for baseline processing

In the baseline solution, it is often necessary to determine the factors that affect the quality of the baseline solution, or to determine the unqualified observations of which satellite or which observation period. The residual map is very useful for accomplishing these tasks. It is a graph drawn from the residuals of the observations. Select the visible double difference residuals of the last and next satellites.

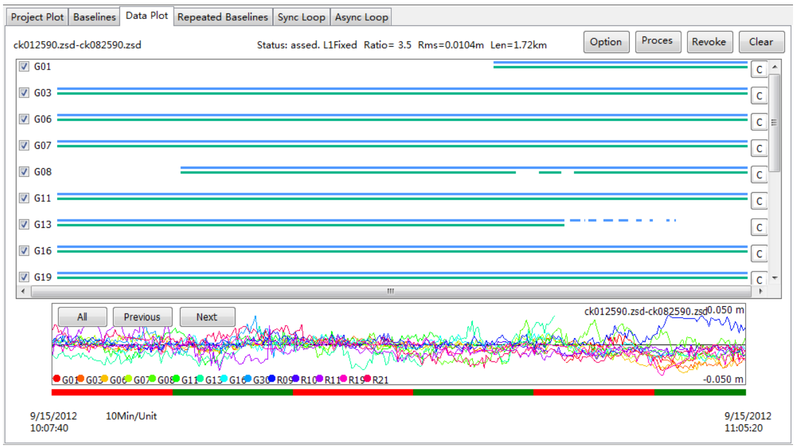


Figure 4-3-1 Data Plot

The figure above is a form of a residual map of common double-difference observations, whose horizontal axis represents the observation time and the vertical axis represents the residual of the observations.

4.4 Re peat Processing a Baseline

Once the cause of the baseline quality is identified, a baseline can be processed repeatedly by modifying the baseline processing settings, or editing the baseline period.

In the observation data graph, drag the mouse to select the data to be deleted. The data in the dotted line box will be blocked, not being processed by the software. Click Revoke in the previous step of recovery, and, to cancel all blocking, click Clear.

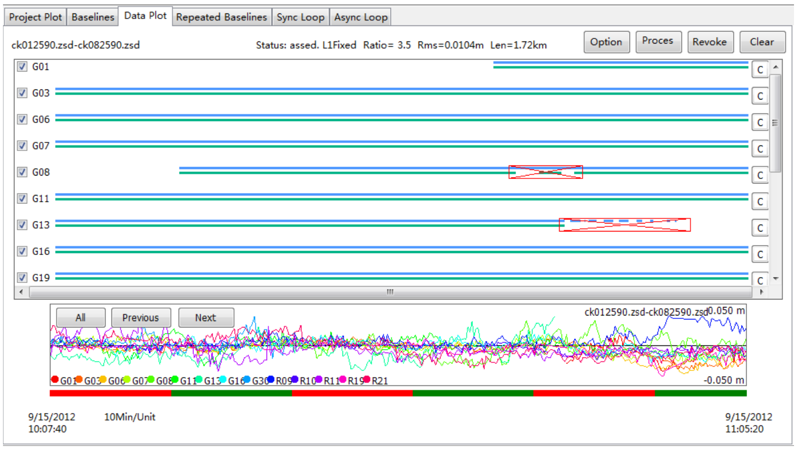


Figure 4-4-1 Data Plot

In the baseline measurement, the baseline processing is sometimes unsatisfactory. In this case, it may be necessary to modify the baseline processing setting or editing period repeatedly, even in the case where the baseline cannot obtain a qualified solution. When this happens, we need to make this baseline not participate in the network adjustment, or delete it. If this baseline is essential in the baseline control network, then this baseline needs to be retested.

Chapter 5

Dynamic Baseline Processing

This chapter contains:

- **Baseline Processing Settings**
- **Baseline Processing Menu**
- **Baseline Processing**

5.1 Baseline Processing Settings

Before processing a baseline vector, the baseline vector processing settings are necessary. Click Baseline → process options → Dynamic, there will be a dialog box about Dynamic settings, including four options: Auto, RTD, Stop&Go, PPK.

- Auto: According to whether there are RSP files to select its corresponding mode: Stop&Go or RTD.
- RTD: Pseudo-range difference, lower precision.
- Stop&Go: High precision, apply to the RSP file which needs to synchronously load time with long distance, higher requirement for outdoor operations.
- PPK: High precision, apply to media or short distance.

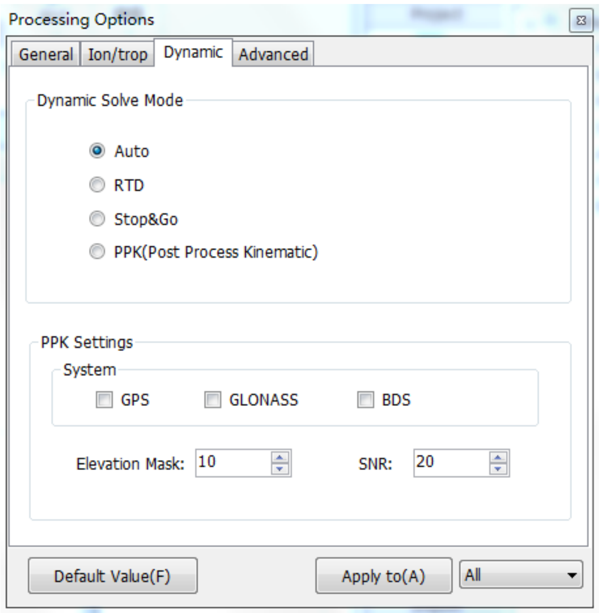


Figure 5-1-1 Dynamic Settings

5.1.1 Dynamic Baseline Solution Data

Dynamic GPS data processing generally includes two types of data, base station static data and rover dynamic synchronous data. Before importing data, confirm which is static data and which is dynamic data, and import them as static data.

SGS also supports PPK solution under the Satsurv Project. The data import process is: click Import → Satsurv Project, and import base station static data and rover dynamic synchronous data.

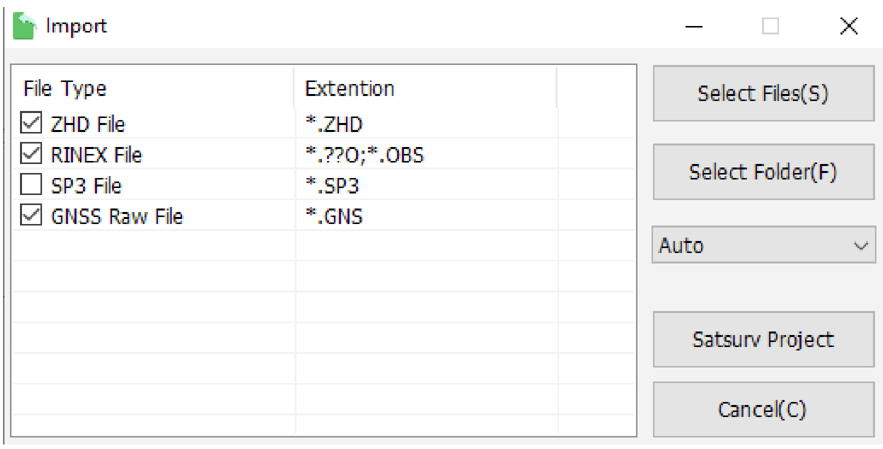
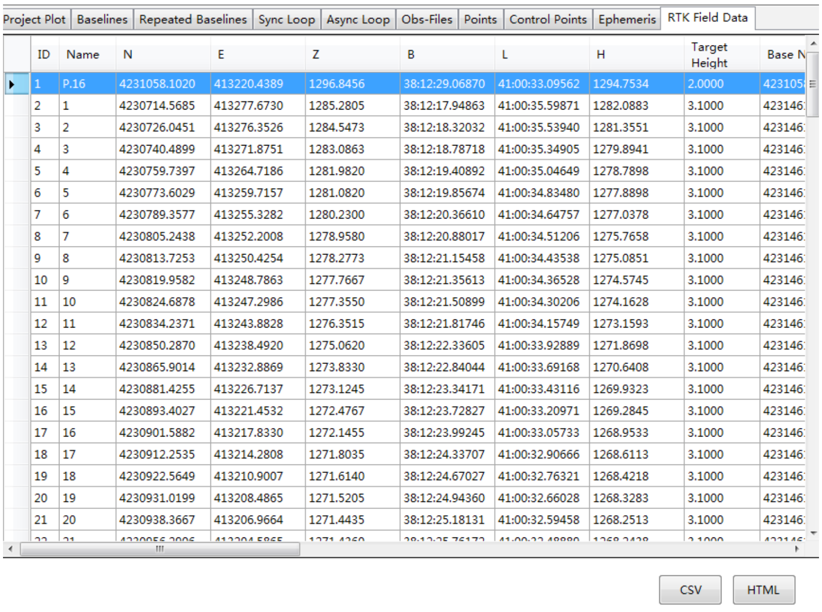


Figure 5-1-2 Data import

While choosing the corresponding Satsurv project, SGS will load the project and display as Figure 5-1-3:



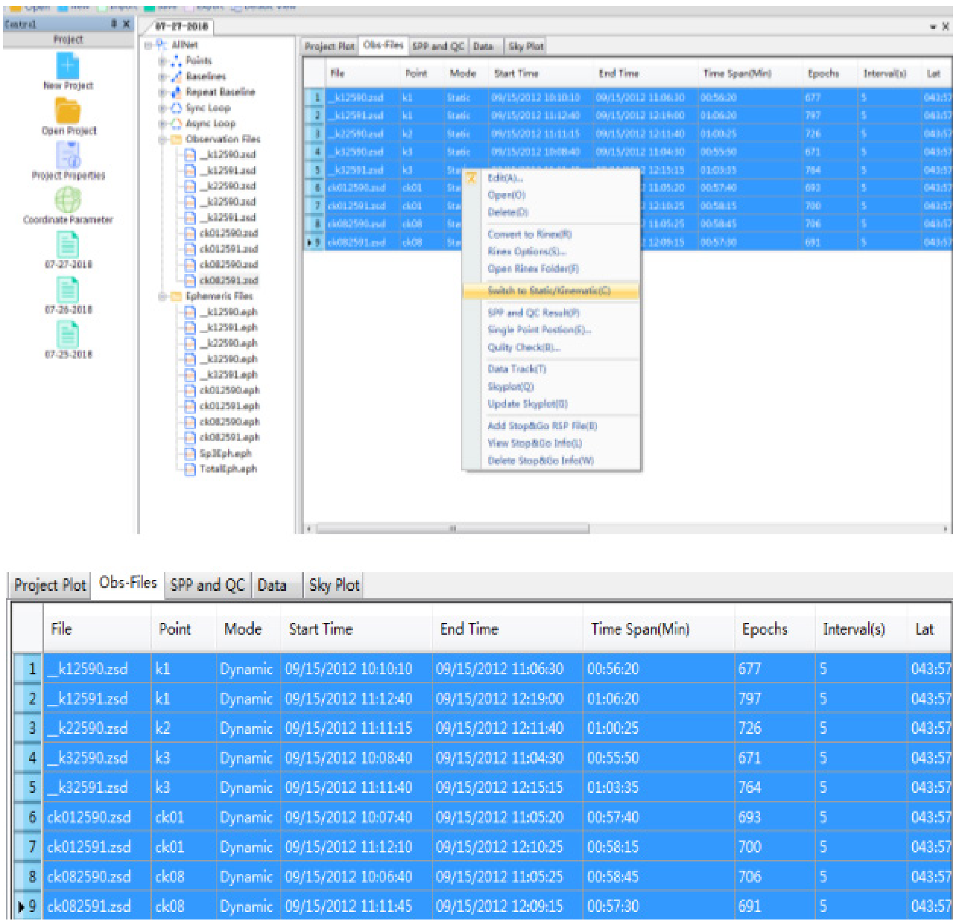
	ID	Name	N	E	Z	B	L	H	Target Height	Base N
▸	1	P.16	4231058.1020	413220.4389	1296.8456	38:12:29.06870	41:00:33.09562	1294.7534	2.0000	4231058
	2	1	4230714.5685	413277.6730	1285.2805	38:12:17.94863	41:00:35.59871	1282.0883	3.1000	423146
	3	2	4230726.0451	413276.3526	1284.5473	38:12:18.32032	41:00:35.53940	1281.3551	3.1000	423146
	4	3	4230740.4899	413271.8751	1283.0863	38:12:18.78718	41:00:35.34905	1279.8941	3.1000	423146
	5	4	4230759.7397	413264.7186	1281.9820	38:12:19.40892	41:00:35.04649	1278.7898	3.1000	423146
	6	5	4230773.6029	413259.7157	1281.0820	38:12:19.85674	41:00:34.83480	1277.8898	3.1000	423146
	7	6	4230789.3577	413255.3282	1280.2300	38:12:20.36610	41:00:34.64757	1277.0378	3.1000	423146
	8	7	4230805.2438	413252.2008	1278.9580	38:12:20.88017	41:00:34.51206	1275.7658	3.1000	423146
	9	8	4230813.7253	413250.4254	1278.2773	38:12:21.15458	41:00:34.43538	1275.0851	3.1000	423146
	10	9	4230819.9582	413248.7863	1277.7667	38:12:21.35613	41:00:34.36528	1274.5745	3.1000	423146
	11	10	4230824.6878	413247.2986	1277.3550	38:12:21.50899	41:00:34.30206	1274.1628	3.1000	423146
	12	11	4230834.2371	413243.8828	1276.3515	38:12:21.81746	41:00:34.15749	1273.1593	3.1000	423146
	13	12	4230850.2870	413238.4920	1275.0620	38:12:22.33605	41:00:33.92889	1271.8698	3.1000	423146
	14	13	4230865.9014	413232.8869	1273.8330	38:12:22.84044	41:00:33.69168	1270.6408	3.1000	423146
	15	14	4230881.4255	413226.7137	1273.1245	38:12:23.34171	41:00:33.43116	1269.9323	3.1000	423146
	16	15	4230893.4027	413221.4532	1272.4767	38:12:23.72827	41:00:33.20971	1269.2845	3.1000	423146
	17	16	4230901.5882	413217.8330	1272.1455	38:12:23.99245	41:00:33.05733	1268.9533	3.1000	423146
	18	17	4230912.2535	413214.2808	1271.8035	38:12:24.33707	41:00:32.90666	1268.6113	3.1000	423146
	19	18	4230922.5649	413210.9007	1271.6140	38:12:24.67027	41:00:32.76321	1268.4218	3.1000	423146
	20	19	4230931.0199	413208.4865	1271.5205	38:12:24.94360	41:00:32.66028	1268.3283	3.1000	423146
	21	20	4230938.3667	413206.9664	1271.4435	38:12:25.18131	41:00:32.59458	1268.2513	3.1000	423146

Figure 5-1-3 RTK Field Data

The users can click CSV or HTML to export the details of the Satsurv projects.

5.1.2 Observation File and Site Properties Setting

Select dynamic observation file and right click to choose static/kinematic for transferring to kinematic.



	File	Point	Mode	Start Time	End Time	Time Span(Min)	Epochs	Interval(s)	Lat
1	_k12590.zsd	k1	Dynamic	09/15/2012 10:10:10	09/15/2012 11:06:30	00:56:20	677	5	043:57
2	_k12591.zsd	k1	Dynamic	09/15/2012 11:12:40	09/15/2012 12:19:00	01:06:20	797	5	043:57
3	_k22590.zsd	k2	Dynamic	09/15/2012 11:11:15	09/15/2012 12:11:40	01:00:25	726	5	043:57
4	_k32590.zsd	k3	Dynamic	09/15/2012 10:08:40	09/15/2012 11:04:30	00:55:50	671	5	043:57
5	_k32591.zsd	k3	Dynamic	09/15/2012 11:11:40	09/15/2012 12:15:15	01:03:35	764	5	043:57
6	ck012590.zsd	ck01	Dynamic	09/15/2012 10:07:40	09/15/2012 11:05:20	00:57:40	693	5	043:57
7	ck012591.zsd	ck01	Dynamic	09/15/2012 11:12:10	09/15/2012 12:10:25	00:58:15	700	5	043:57
8	ck082590.zsd	ck08	Dynamic	09/15/2012 10:06:40	09/15/2012 11:05:25	00:58:45	706	5	043:57
▸ 9	ck082591.zsd	ck08	Dynamic	09/15/2012 11:11:45	09/15/2012 12:09:15	00:57:30	691	5	043:57

Figure 5-1-4 Observation File Settings

5.2 Baseline Processing Menu

Click Baseline in the menu bar and there will be a baseline processing menu.

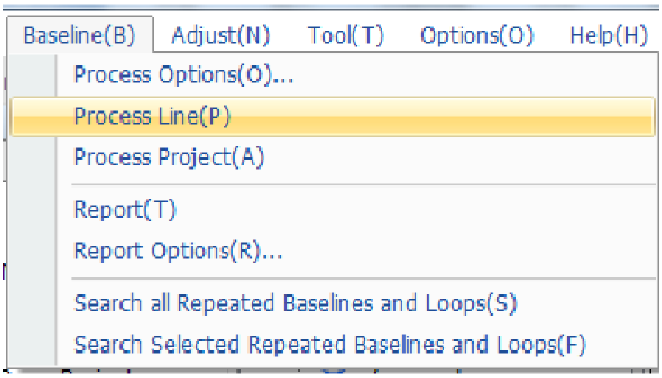
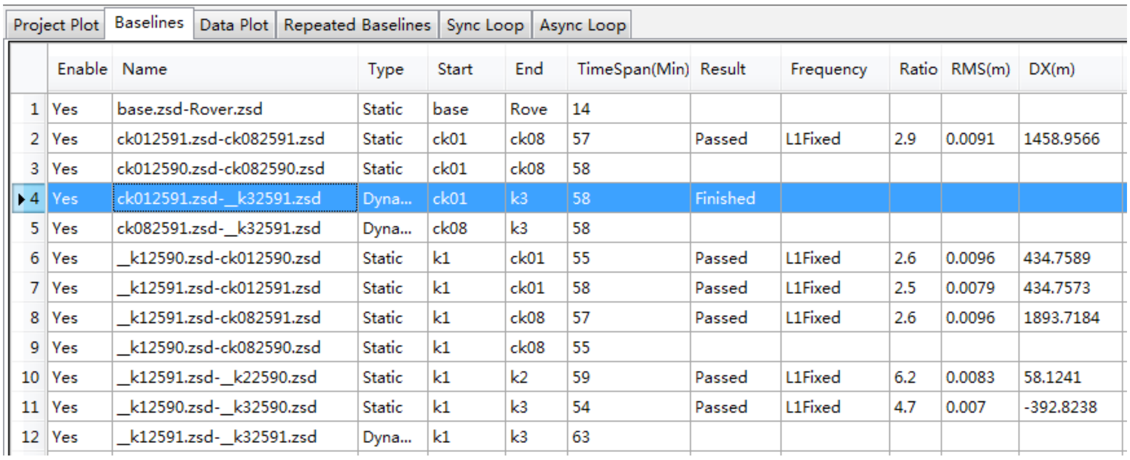


Figure 5-2-1 Baseline Processing Menu

Process Line: Process the dynamic baseline selected in the baseline list.

Process Project: SGS will automatically select the baseline solution engine, according to the type of baseline.



	Enable	Name	Type	Start	End	TimeSpan(Min)	Result	Frequency	Ratio	RMS(m)	DX(m)
1	Yes	base.zsd-Rover.zsd	Static	base	Rove	14					
2	Yes	ck012591.zsd-ck082591.zsd	Static	ck01	ck08	57	Passed	L1Fixed	2.9	0.0091	1458.9566
3	Yes	ck012590.zsd-ck082590.zsd	Static	ck01	ck08	58					
4	Yes	ck012591.zsd-_k32591.zsd	Dyna...	ck01	k3	58	Finished				
5	Yes	ck082591.zsd-_k32591.zsd	Dyna...	ck08	k3	58					
6	Yes	_k12590.zsd-ck012590.zsd	Static	k1	ck01	55	Passed	L1Fixed	2.6	0.0096	434.7589
7	Yes	_k12591.zsd-ck012591.zsd	Static	k1	ck01	58	Passed	L1Fixed	2.5	0.0079	434.7573
8	Yes	_k12591.zsd-ck082591.zsd	Static	k1	ck08	57	Passed	L1Fixed	2.6	0.0096	1893.7184
9	Yes	_k12590.zsd-ck082590.zsd	Static	k1	ck08	55					
10	Yes	_k12591.zsd-_k22590.zsd	Static	k1	k2	59	Passed	L1Fixed	6.2	0.0083	58.1241
11	Yes	_k12590.zsd-_k32590.zsd	Static	k1	k3	54	Passed	L1Fixed	4.7	0.007	-392.8238
12	Yes	_k12591.zsd-_k32591.zsd	Dyna...	k1	k3	63					

Figure 5-2-2 Process Line

5.3 Baseline Processing

When everything has been prepared, run process project under the Baseline processing menu. The program will process all the baselines and there will be a dialog showing the names, processing rate, and processing information of each baseline solution. The baseline solution works in the background with the multi-threaded manner. During the process, you can click Cancel to stop the solution.

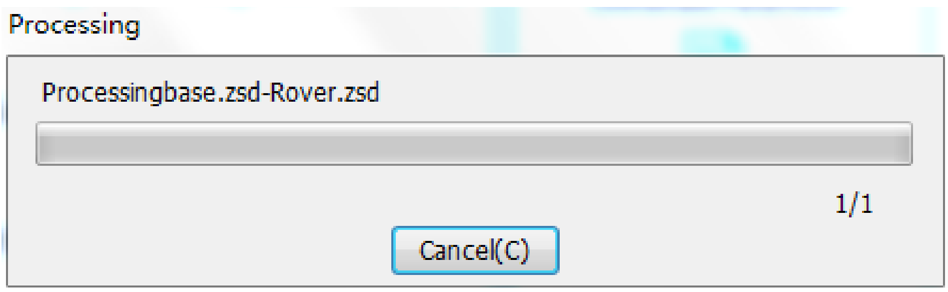


Figure 5-3-1 Processing

There will be a result of baseline processing in the calculation window after finishing the baseline solution.

5.3.1 Stop&Go Dynamic Baseline Processing

1. Baseline processing settings

In baseline list, select a dynamic baseline, and right-click Process Options for settings.

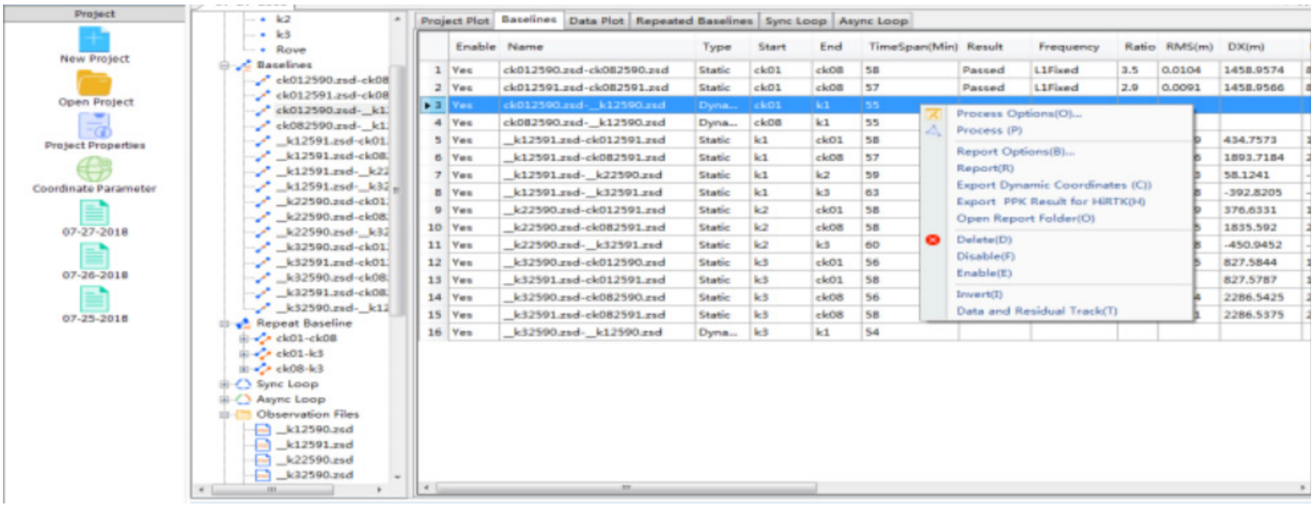


Figure 5-3-2 Baseline Process

Notice: While using Stop&Go mode, the minimum number of epochs is recommended to default to 180. If the number of epochs is too small, the baseline's ambiguity of whole cycles can't be fixed.

2. Baseline processing

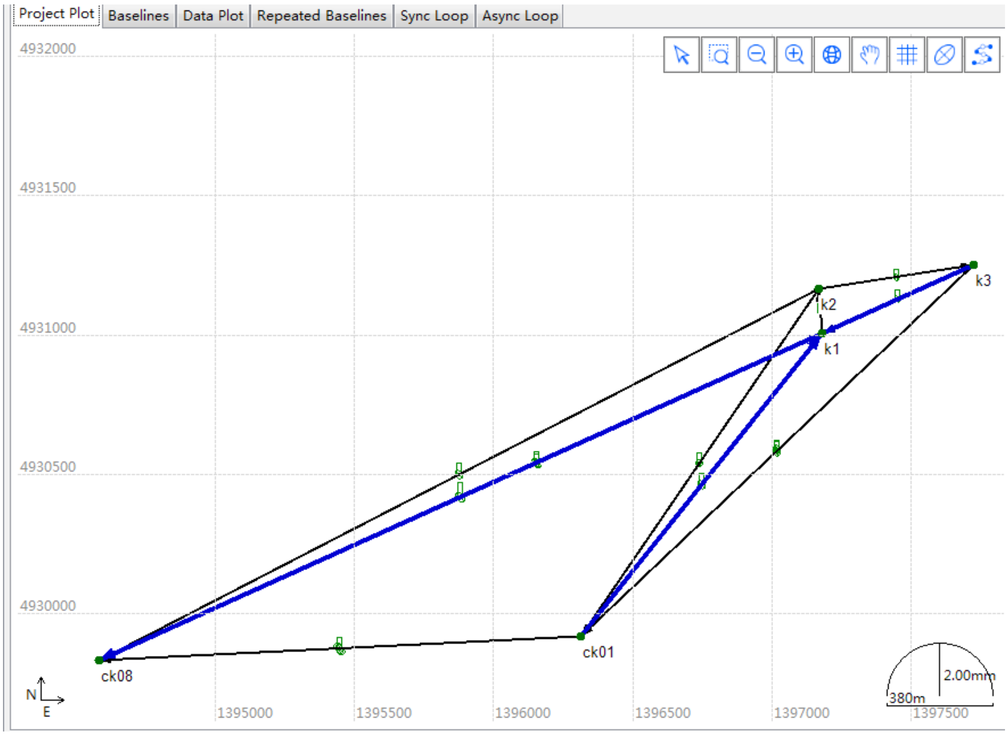
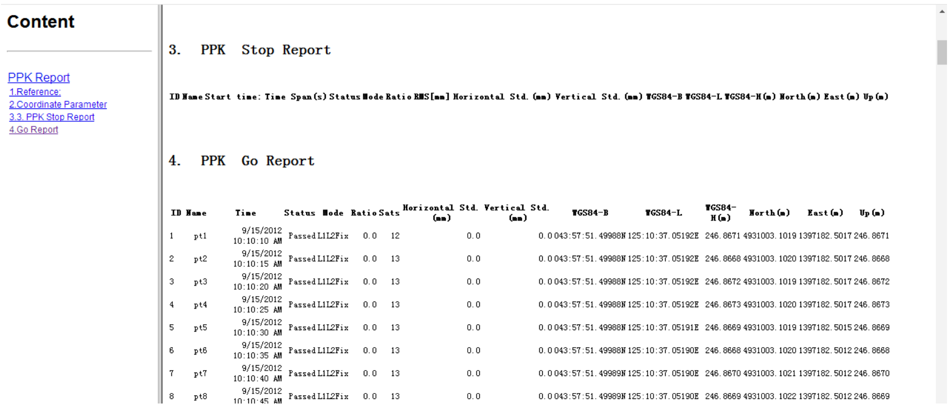


Figure 5-3-4 Project Plot

After setting, right click Process to start the solution. When it is done, the project plot will display the dynamic trajectory. It can be hidden by clicking button.

3. Report Export

Click Report., there will be a report of the dynamic solution.



Content

PPK Report
1.Reference:
2.Coordinate Parameter
3.3. PPK Stop Report
4.Go Report

3. PPK Stop Report

ID Name Start time: Time Span(s) Status Mode Ratio RMS[mm] Horizontal Std.(mm) Vertical Std.(mm) WGS84-B WGS84-L WGS84-H(m) North(m) East(m) Up(m)

4. PPK Go Report

ID	Name	Time	Status	Mode	Ratio	Sats	Horizontal Std.(mm)	Vertical Std.(mm)	WGS84-B	WGS84-L	WGS84-H(m)	North(m)	East(m)	Up(m)
1	pt1	9/15/2012 10:10:10 AM	Passed	L1L2Fix	0.0	12	0.0	0.0	043:57:51.49988N	125:10:37.05192E	246.8671	4931003.1019	1397182.5017	246.8671
2	pt2	9/15/2012 10:10:15 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49988N	125:10:37.05192E	246.8668	4931003.1020	1397182.5017	246.8668
3	pt3	9/15/2012 10:10:20 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49988N	125:10:37.05192E	246.8672	4931003.1019	1397182.5017	246.8672
4	pt4	9/15/2012 10:10:25 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49988N	125:10:37.05192E	246.8673	4931003.1020	1397182.5017	246.8673
5	pt5	9/15/2012 10:10:30 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49988N	125:10:37.05191E	246.8669	4931003.1019	1397182.5015	246.8669
6	pt6	9/15/2012 10:10:35 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49988N	125:10:37.05190E	246.8668	4931003.1020	1397182.5012	246.8668
7	pt7	9/15/2012 10:10:40 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49989N	125:10:37.05190E	246.8670	4931003.1021	1397182.5012	246.8670
8	pt8	9/15/2012 10:10:45 AM	Passed	L1L2Fix	0.0	13	0.0	0.0	043:57:51.49989N	125:10:37.05190E	246.8669	4931003.1022	1397182.5012	246.8669

Figure 5-3-5 Report

5.3.2 PPK Dynamic Baseline Processing

1. Baseline processing settings

In baseline list, select a dynamic baseline, and right-click Process Options for settings.

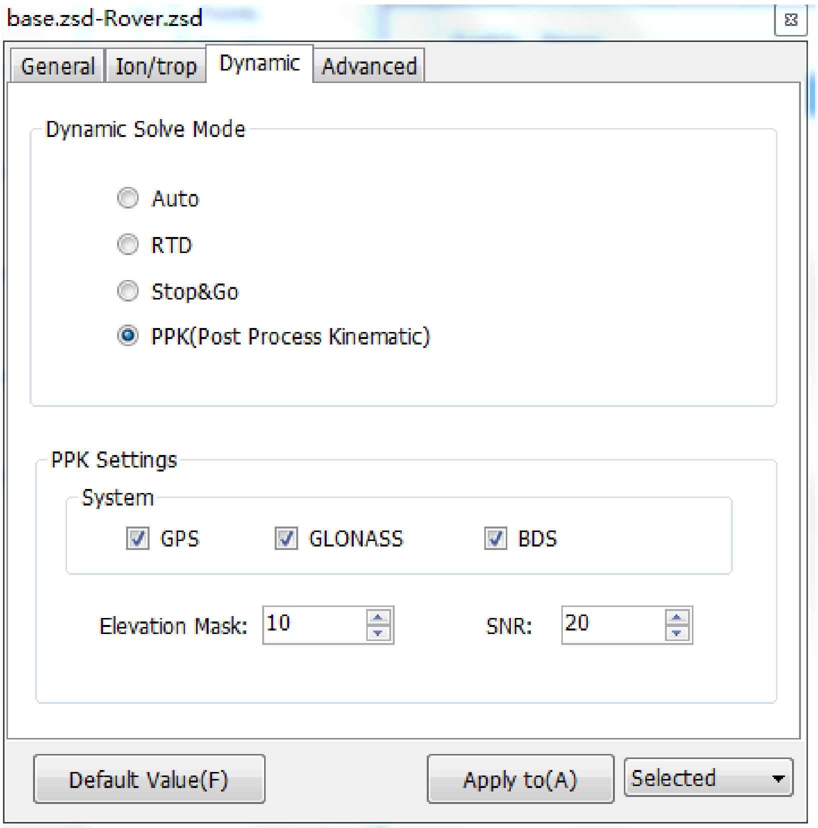


Figure 5-3-6 Settings

2. Baseline processing

When finished settings, click Process to start the baseline solution. In this part, green points represent the RTK fixed solution, and yellow points represent the RTK float solution.

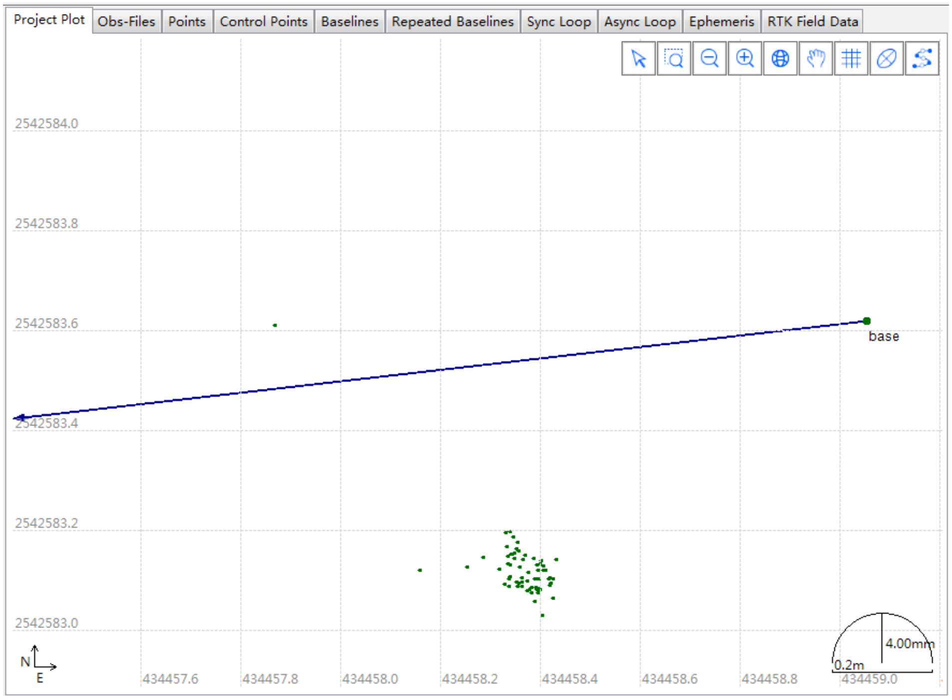
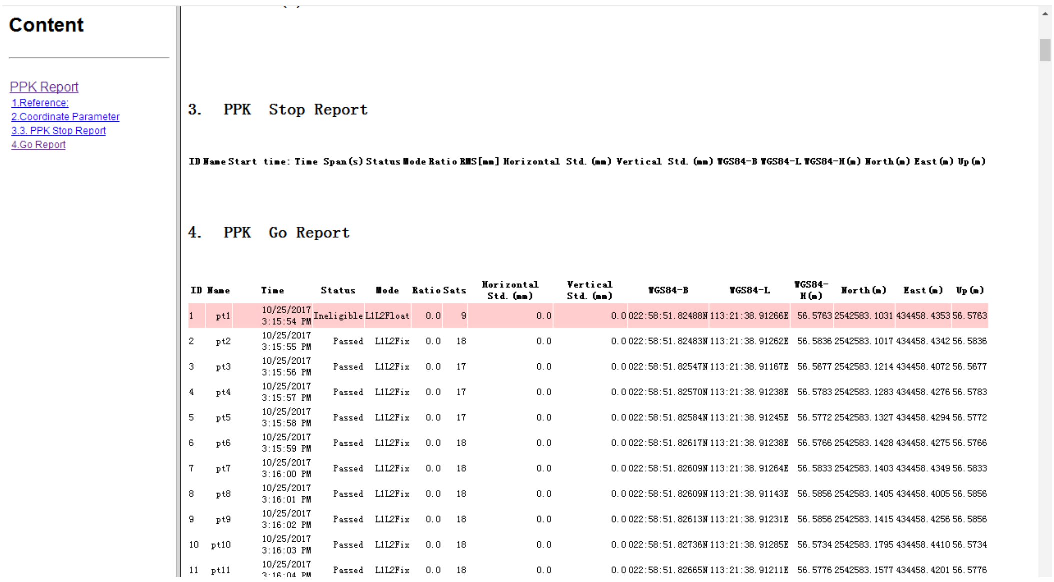


Figure 5-3-7 Project Plot

After finishing the solution, the project plot will display the dynamic trajectory line. It can be hidden by clicking button.

3. Report Export

Right-click and choose Report to check the dynamic solution. The fixed solution means qualified, and unqualified solution results are red.



Content

PPK Report
1.Reference:
2.Coordinate Parameter
3.3. PPK Stop Report
4.Go Report

3. PPK Stop Report

ID Name Start time: Time Span(s) Status Mode Ratio RMS[mm] Horizontal Std. (mm) Vertical Std. (mm) WGS84-B WGS84-L WGS84-H(m) North(m) East(m) Up(m)

4. PPK Go Report

ID	Name	Time	Status	Mode	Ratio	Sats	Horizontal Std. (mm)	Vertical Std. (mm)	WGS84-B	WGS84-L	WGS84-H(m)	North(m)	East(m)	Up(m)
1	pt1	10/25/2017 3:15:54 PM	Ineligible	L1L2Float	0.0	9	0.0	0.0	022:58:51.82488N	113:21:38.91266E	56.5763	2542583.1031	434458.4353	56.5763
2	pt2	10/25/2017 3:15:55 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82483N	113:21:38.91262E	56.5836	2542583.1017	434458.4342	56.5836
3	pt3	10/25/2017 3:15:56 PM	Passed	L1L2Fix	0.0	17	0.0	0.0	022:58:51.82547N	113:21:38.91167E	56.5677	2542583.1214	434458.4072	56.5677
4	pt4	10/25/2017 3:15:57 PM	Passed	L1L2Fix	0.0	17	0.0	0.0	022:58:51.82570N	113:21:38.91238E	56.5783	2542583.1283	434458.4276	56.5783
5	pt5	10/25/2017 3:15:58 PM	Passed	L1L2Fix	0.0	17	0.0	0.0	022:58:51.82584N	113:21:38.91245E	56.5772	2542583.1327	434458.4294	56.5772
6	pt6	10/25/2017 3:15:59 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82617N	113:21:38.91238E	56.5766	2542583.1428	434458.4275	56.5766
7	pt7	10/25/2017 3:16:00 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82609N	113:21:38.91264E	56.5833	2542583.1403	434458.4349	56.5833
8	pt8	10/25/2017 3:16:01 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82609N	113:21:38.91143E	56.5856	2542583.1405	434458.4005	56.5856
9	pt9	10/25/2017 3:16:02 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82613N	113:21:38.91231E	56.5856	2542583.1415	434458.4256	56.5856
10	pt10	10/25/2017 3:16:03 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82736N	113:21:38.91285E	56.5734	2542583.1795	434458.4410	56.5734
11	pt11	10/25/2017 3:16:04 PM	Passed	L1L2Fix	0.0	18	0.0	0.0	022:58:51.82665N	113:21:38.91211E	56.5776	2542583.1577	434458.4201	56.5776

Figure 5-3-8 Report

Chapter 6

Network Adjustment

This chapter contains:

- **Steps of Network Adjustment**
- **Preparation of Network Adjustment**
- **Process of Network Adjustment**
- **Network Adjustment Examination**

After the baseline vector processing, the user usually needs to further test the baseline processing result, optimize it and transform it to the required national or local coordinates, which is the content of the network adjustment. The method of this software network adjustment is the Least Squares Method.

6.1 Steps of Network Adjustment

The software has the functions of free net adjustment, 3D constrained adjustment, 2D constrained adjustment and height fitting.

The basic steps of SGS data processing software for network adjustment can actually be divided into three parts, as can be seen from Figure 6-1-1:

1. The preliminary preparation is done by users. It means to set up the coordinate, load the information of control points before network adjustment.
2. The process of network adjustment is done automatically by the software.
3. The quality analysis and control of the processing result. It requires the user to analyze the process.

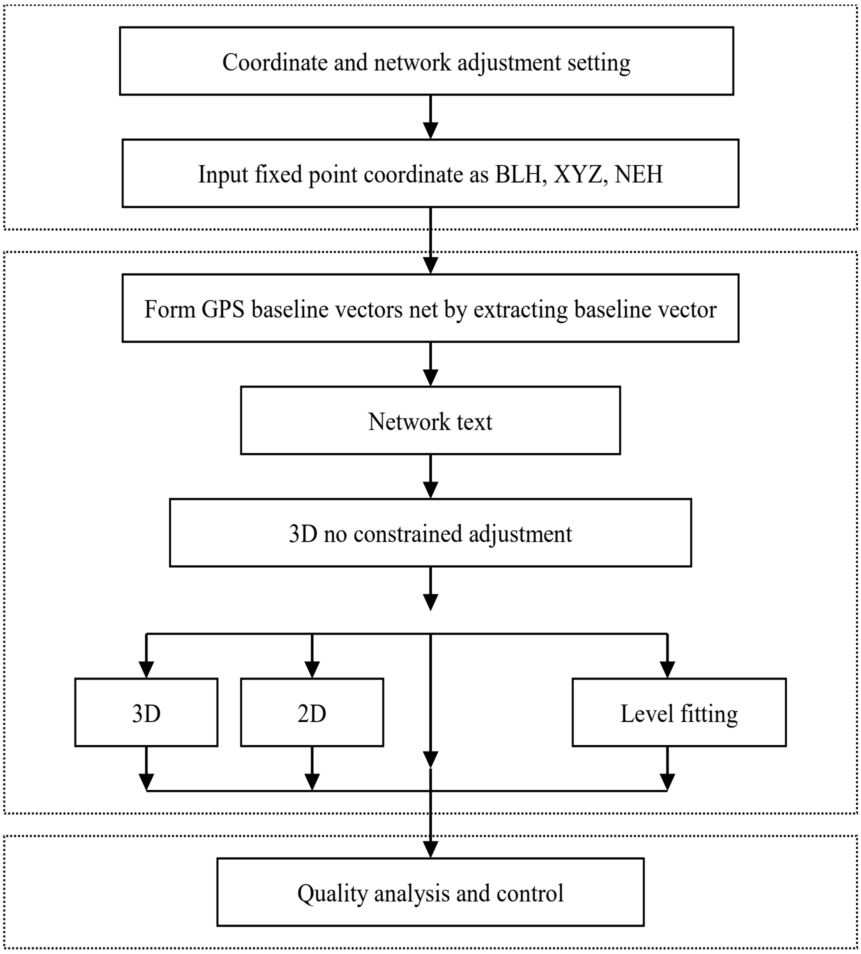


Figure 6-1-1 Network Adjustment Process

This shows that the software only realizes the calculation of the network adjustment. The more important is that the user participates and makes correct judgments. It should be noted that this is usually an interactive process.

6.2 Preparation of Network Adjustment

6.2.1 Coordinate Setting

Check the settings of the coordinates before setting up the network adjustment. Normally, the coordinate ellipsoid selected by the domestic user is Beijing 54. The user needs to set up the central meridian, the additive constants in the x and y directions and so on.

The setting of coordinates can be performed in the Coordinate Parameter of the Navigation bar.

When a user installs the software, the ellipsoid parameter of Beijing 54 has been set into the software and when creating a new project, the user usually has inputted the coordinate parameter. So, setting the coordinates before network adjustment is to check the coordinate parameters.

For the setting of the coordinate system, please refer to the relevant information.

6.2.2 Network Adjustment Setting

Choose Adjust → Adjust Options menu, here will be a dialog like Figure 6-2-2, we can set and test parameters of the adjustment.

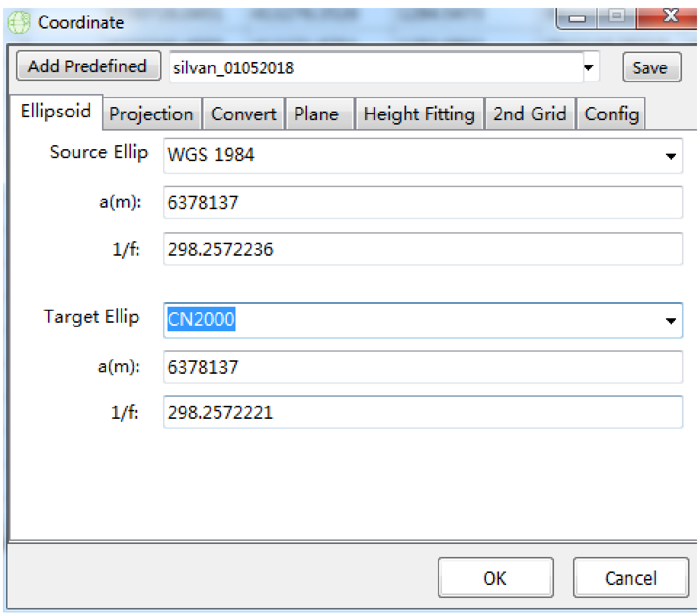


Figure 6-2-1 Coordinate Parameter

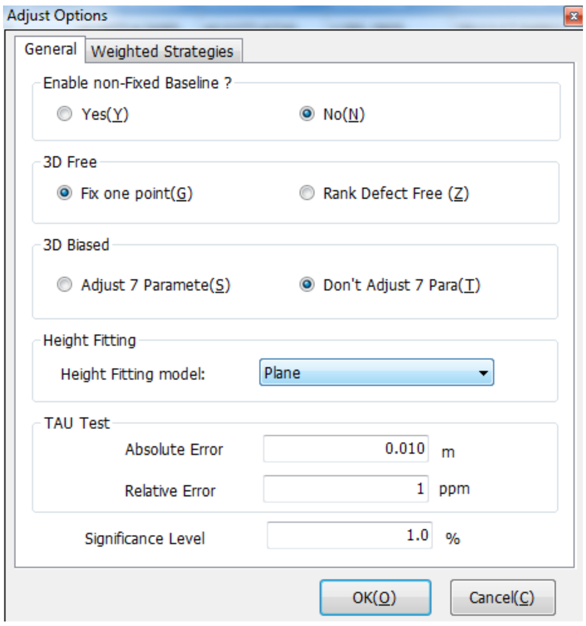


Figure 6-2-2 Adjust Options

6.2.3 Control Points Information

After the network adjustment settings, we need to input control points information. Otherwise, the constraint adjustment won't be performed. There are several methods to enter control point information:

1. Click on Set as Control Point in the right-click menu of sites list, to set the site into control point.
2. Click on Add Control Point in the right-click menu of control point list to enter the control point info.
3. Click on Import Control Point File, in the right-click menu of control point list, to import the existing control point file to the project.

After entering control point info, click on Save to Control Point File in the pop-up menu of control point list, to save as the individual file for next time.

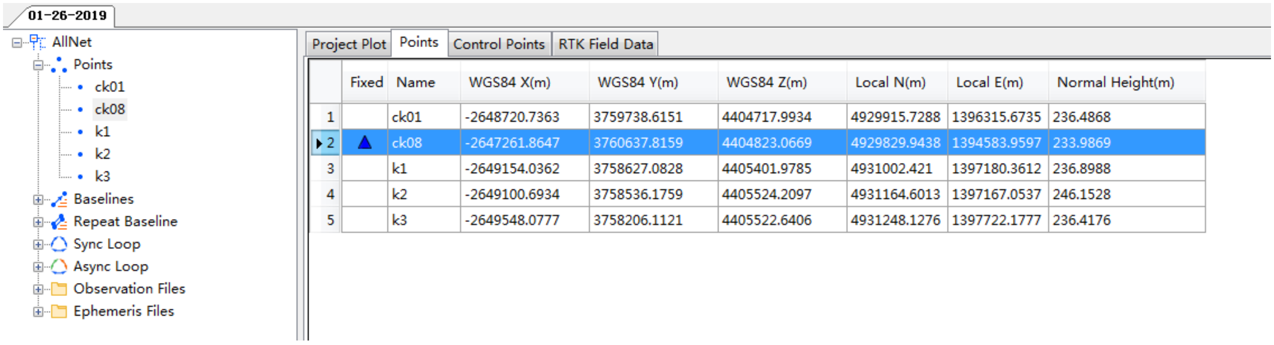


Figure 6-2-3 Control Point

6.3 Process of Network Adjustment

Click Adjust in the Adjust menu, the network adjustment tool will appear.

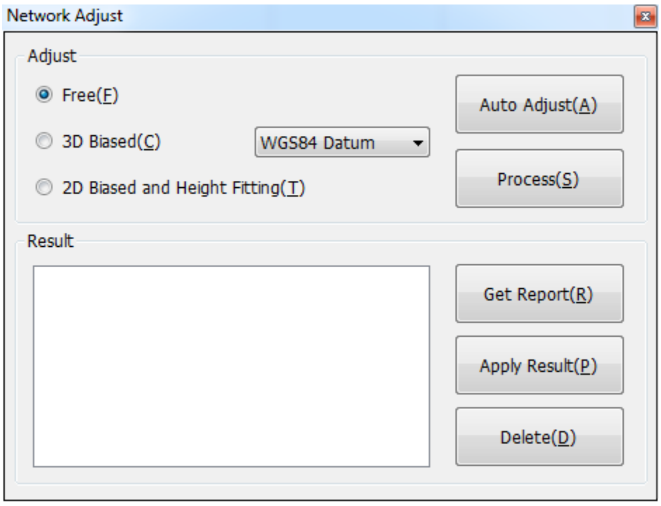


Figure 6-3-1 Network Adjust

Generally, just click Auto Adjust, the software can start adjustment based on the known baseline processing result and form the results list. Select one of the results and click on Get Report to view the corresponding report.

6.3.1 Get Baseline Vector Network

The first step of network adjustment is to get a baseline vector network. The principle to form the baseline vector network is as the following:

1. This baseline is in the project and must not be deleted;
2. This baseline is with the starting point name and calculating point name;
3. This baseline has been calculated and qualified in the baseline vector list;
4. This baseline isn't disabled.

All the baselines that satisfy the above four conditions will be loaded automatically in the first step of network adjustment, to form the baseline vector network.

6.3.2 Connectivity Test of Baseline Vector Network

If process adjustment is done without the network connected, the network adjustment result won't converge. So, the software will test automatically the connectivity of the baseline vector network before processing. If the network isn't connected, a prompt will appear. Please check the baselines that form the vector network, the observation station's name and so on. The steps to check are the following:

1. Check if the network is divided into several parts, or whether there is an isolated observation station or baseline. If so, delete the isolated points or separated parts to enable process adjustment;

2. Check if the critical baseline has been calculated unsuccessfully, or prohibited from participating in the network adjustment. If so, re-process it, or even re-observe it;

3. Check if there is the same observation station with different names. If so, the network will show that there is another station very close to the same station. These two stations can't form any baseline to make the network connected because they are same site at different time spans. The solution is to modify the error station name in the observation's property.

6.3.3 Adjustment Report

The adjustment report contains the results, and its output items and report format can be set in the Adjust Report Options (Figure 6-3-2) Taking the free network adjustment as an example, the web version of the adjustment result is as Figure 6-3-3:

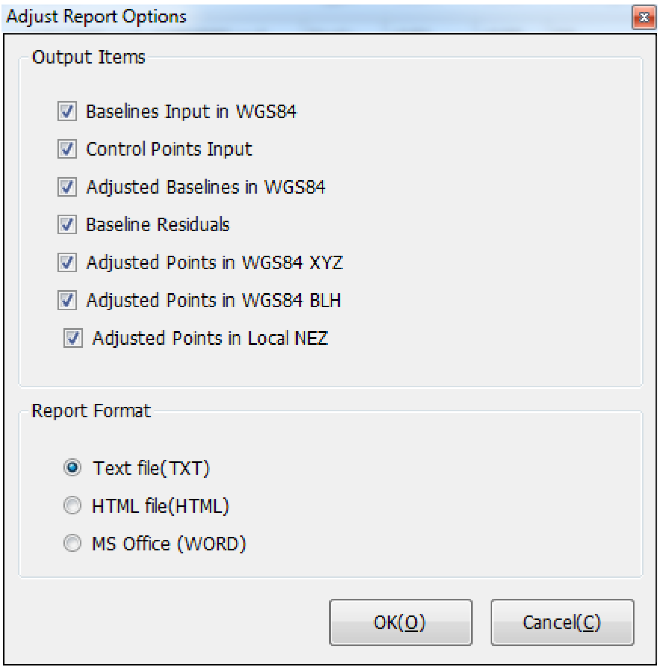
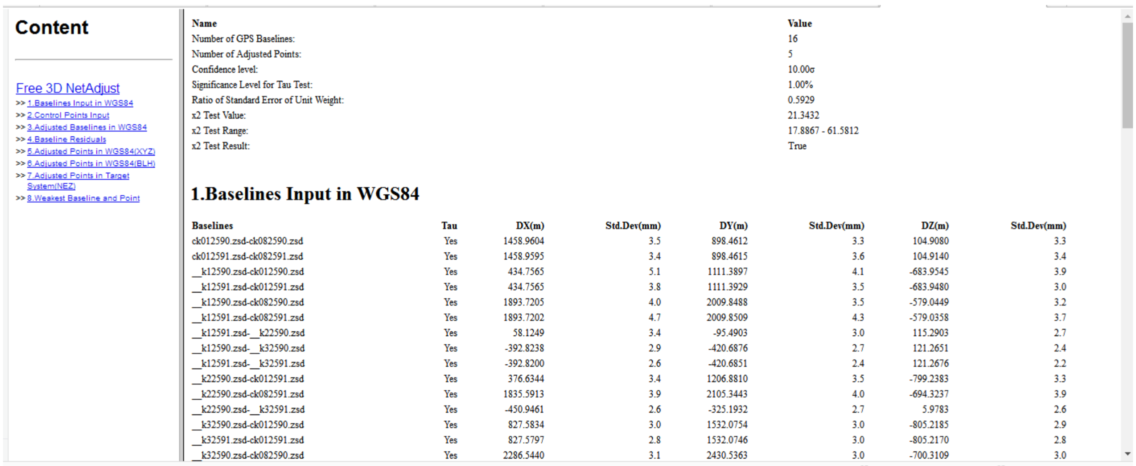


Figure 6-3-2 Adjust Report Options



Content

Free 3D NetAdjust
>> 1.Baselines Input in WGS84
>> 2.Control Points Input
>> 3.Adjusted Baselines in WGS84
>> 4.Baseline Residuals
>> 5.Adjusted Points in WGS84(XYZ)
>> 6.Adjusted Points in WGS84(BLH)
>> 7.Adjusted Points in Target System(NEZ)
>> 8.Weakest Baseline and Point

Name	Value
Number of GPS Baselines:	16
Number of Adjusted Points:	5
Confidence level:	10.00σ
Significance Level for Tau Test:	1.00%
Ratio of Standard Error of Unit Weight:	0.5929
x2 Test Value:	21.3432
x2 Test Range:	17.8867 - 61.5812
x2 Test Result:	True

1.Baselines Input in WGS84

Baselines	Tau	DX(m)	Std.Dev(mm)	DY(m)	Std.Dev(mm)	DZ(m)	Std.Dev(mm)
ck012590.zsd-ck082590.zsd	Yes	1458.9604	3.5	898.4612	3.3	104.9080	3.3
ck012591.zsd-ck082591.zsd	Yes	1458.9595	3.4	898.4615	3.6	104.9140	3.4
__k12590.zsd-ck012590.zsd	Yes	434.7565	5.1	1111.3897	4.1	-683.9545	3.9
__k12591.zsd-ck012591.zsd	Yes	434.7565	3.8	1111.3929	3.5	-683.9480	3.0
__k12590.zsd-ck082590.zsd	Yes	1893.7205	4.0	2009.8488	3.5	-579.0449	3.2
__k12591.zsd-ck082591.zsd	Yes	1893.7202	4.7	2009.8509	4.3	-579.0358	3.7
__k12591.zsd-__k22590.zsd	Yes	58.1249	3.4	-95.4903	3.0	115.2903	2.7
__k12590.zsd-__k32590.zsd	Yes	-392.8238	2.9	-420.6876	2.7	121.2651	2.4
__k12591.zsd-__k32591.zsd	Yes	-392.8200	2.6	-420.6851	2.4	121.2676	2.2
__k22590.zsd-ck012591.zsd	Yes	376.6344	3.4	1206.8810	3.5	-799.2383	3.3
__k22590.zsd-ck082591.zsd	Yes	1835.5913	3.9	2105.3443	4.0	-694.3237	3.9
__k22590.zsd-__k32591.zsd	Yes	-450.9461	2.6	-325.1932	2.7	5.9783	2.6
__k32590.zsd-ck012590.zsd	Yes	827.5834	3.0	1532.0754	3.0	-805.2185	2.9
__k32591.zsd-ck012591.zsd	Yes	827.5797	2.8	1532.0746	3.0	-805.2170	2.8
__k32590.zsd-ck082590.zsd	Yes	2286.5440	3.1	2430.5363	3.0	-700.3109	3.0

Figure 6-3-3 Adjustment Report

6.4 Adjustment Results Examination

After the network adjustment, the result should be checked. The result test is mainly evaluated by correction, mean square error and corresponding mathematical statistics test results.

The mathematical statistics test of network adjustment includes the 2 test and TAU Test. The 2 test shows the reliability of the adjustment result. If the test value is smaller than the theoretical range, the error of adjustment result is smaller than the theoretical error, which means that it's better than the imagination. At this point, there is no need to process or select appropriate Coefficient of baseline Std. Dev (Relaxation factor) to pass the 2 test. If the test value is bigger than the theoretical range, it means that the error of adjustment result exceeds the allowable range. It could be caused by excessive error in the baseline calculation, or gross error in the control point information. It is necessary to find the problem baseline or control point to fix and re-calculate it until it passes the test.

Tau test is used to check the existence of gross error in the baseline involving adjustment. Generally, the test result depends on the correction of each baseline after adjustment. If a baseline can't pass the TAU Test, it needs to be re-calculated and re-participated in the adjustment, or to be prohibited.

Name	Value
Number of GPS Baselines:	16
Number of Adjusted Points:	5
Confidence level:	10.00σ
Significance Level for Tau Test:	1.00%
Ratio of Standard Error of Unit Weight:	0.5929
x2 Test Value:	21.3432
x2 Test Range:	17.8867 - 61.5812
x2 Test Result:	True

Figure 6-3-4 Result Tests

If the result of network adjustment fails to pass the test, it is necessary to find the reasons from the following aspects:

1. Check if the coordinate setting or others is correct.
2. Check if the control points are correct and in the same coordinate system.
3. Check if the baseline vector network is correct. For an unqualified static baseline, it can be prohibited from participating in the network adjustment. If this baseline can't be deleted or is very important in baseline network, it should be re-calculated. If necessary, make the field-work observation again.
4. Check if the observation station and antenna height in the observation files are correct. If not, the closed error or free network adjustment results is very poor.

It is acceptable to delete the poor quality observations. When adjusting, deleting the repeat baseline won't affect the adjustment structure and the result will meet the requirements as well.

Generally, if the network and the calculation of baseline are qualified, these two tests can be passed and 3D unconstraint adjustment can be done successfully.

Chapter 7

Import & Export

This chapter contains:

- **Files Import**
- **Data Files Export**
- **Project Result Export**
- **Baseline Result Export**
- **Satsurv Project Result Export**

From the above chapters, it is obvious that the SGS Software has a strong function but simple operation. In this chapter, we will introduce import and export of the software.

The SGS data processing software has rich import and export functions, including import files, control point files, Stop&GO RSP files, and export of data files, baseline results, and project reports.

7.1 File Import

Import files through Import in the navigation bar and Import in the File menu.

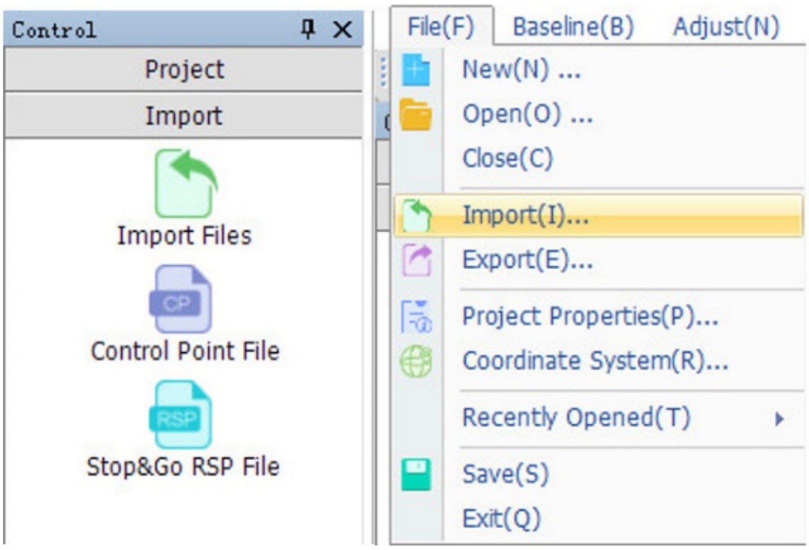


Figure 7-1-1 Import

7.1.1 Data File Import

Click Import to bring up the Import window. SGS software supports the import of static files (*.ZHD, *.GNS), Rinex files, and SP3 ephemeris files.

- Select Files (S): Import single or multiple data files.
- Select Folder (F): Import all data files under the selected folder.

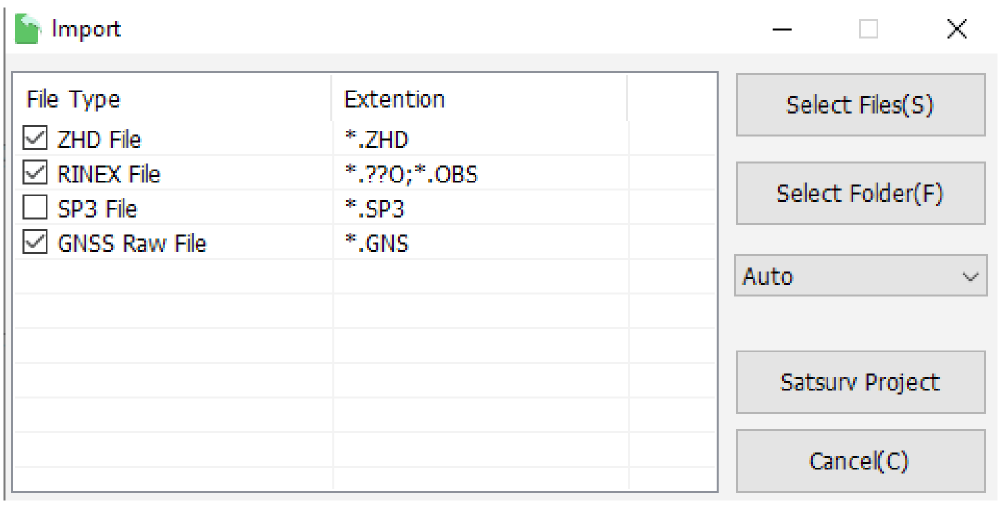


Figure 7-1-2 Import

7.1.2 Satsurv Project Import

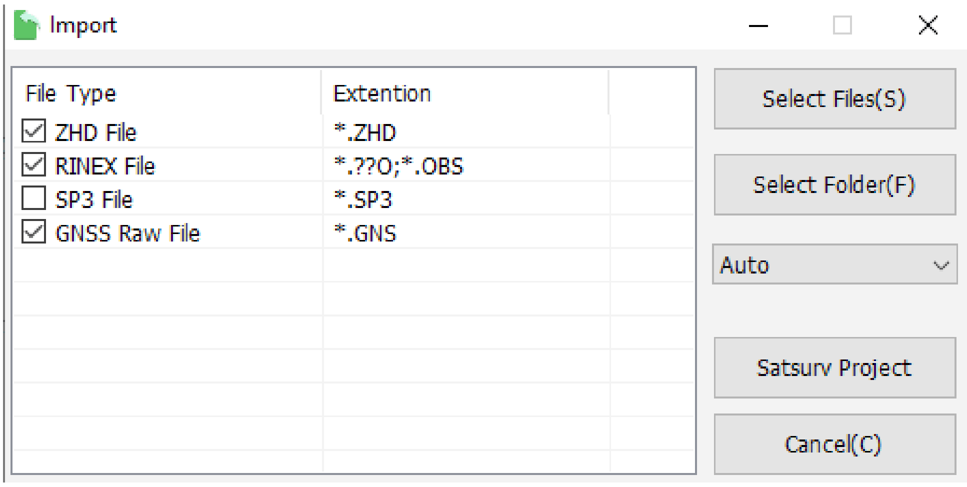
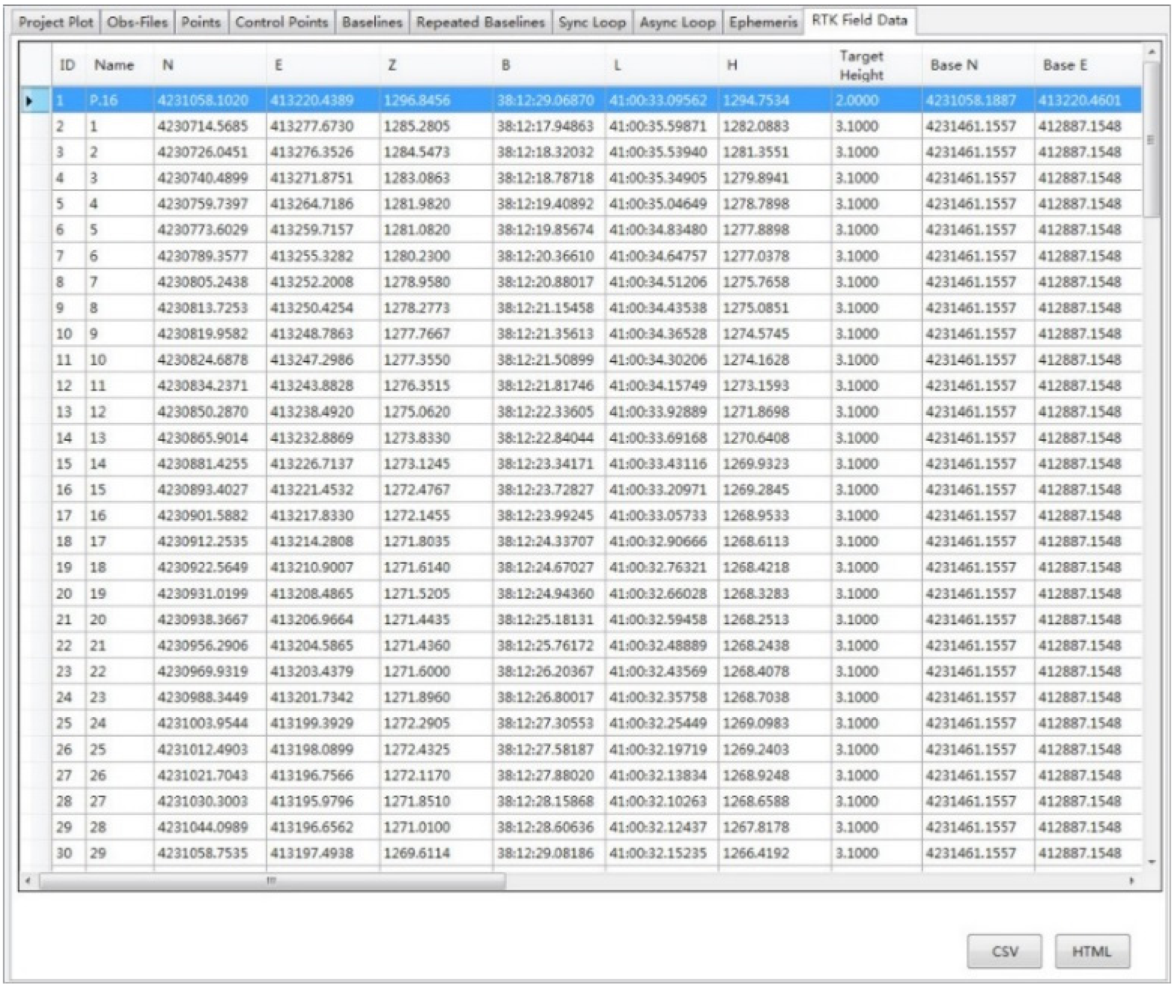


Figure 7-1-3 Interface of Import

After selecting the corresponding Satsurv project, SGS loads and displays the Satsurv project information as follows:



ID	Name	N	E	Z	B	L	H	Target Height	Base N	Base E
1	P.16	4231058.1020	413220.4389	1296.8456	38:12:29.06870	41:00:33.09562	1294.7534	2.0000	4231058.1887	413220.4601
2	1	4230714.5685	413277.6730	1285.2805	38:12:17.94863	41:00:35.59871	1282.0883	3.1000	4231461.1557	412887.1548
3	2	4230726.0451	413276.3526	1284.5473	38:12:18.32032	41:00:35.53940	1281.3551	3.1000	4231461.1557	412887.1548
4	3	4230740.4899	413271.8751	1283.0863	38:12:18.78718	41:00:35.34905	1279.8941	3.1000	4231461.1557	412887.1548
5	4	4230759.7397	413264.7186	1281.9820	38:12:19.40892	41:00:35.04649	1278.7898	3.1000	4231461.1557	412887.1548
6	5	4230773.6029	413259.7157	1281.0820	38:12:19.85674	41:00:34.83480	1277.8898	3.1000	4231461.1557	412887.1548
7	6	4230789.3577	413255.3282	1280.2300	38:12:20.36610	41:00:34.64757	1277.0378	3.1000	4231461.1557	412887.1548
8	7	4230805.2438	413252.2008	1278.9580	38:12:20.88017	41:00:34.51206	1275.7658	3.1000	4231461.1557	412887.1548
9	8	4230813.7253	413250.4254	1278.2773	38:12:21.15458	41:00:34.43538	1275.0851	3.1000	4231461.1557	412887.1548
10	9	4230819.9582	413248.7863	1277.7667	38:12:21.35613	41:00:34.36528	1274.5745	3.1000	4231461.1557	412887.1548
11	10	4230824.6878	413247.2986	1277.3550	38:12:21.50899	41:00:34.30206	1274.1628	3.1000	4231461.1557	412887.1548
12	11	4230834.2371	413243.8828	1276.3515	38:12:21.81746	41:00:34.15749	1273.1593	3.1000	4231461.1557	412887.1548
13	12	4230850.2870	413238.4920	1275.0620	38:12:22.33605	41:00:33.92889	1271.8698	3.1000	4231461.1557	412887.1548
14	13	4230865.9014	413232.8869	1273.8330	38:12:22.84044	41:00:33.69168	1270.6408	3.1000	4231461.1557	412887.1548
15	14	4230881.4255	413226.7137	1273.1245	38:12:23.34171	41:00:33.43116	1269.9323	3.1000	4231461.1557	412887.1548
16	15	4230893.4027	413221.4532	1272.4767	38:12:23.72827	41:00:33.20971	1269.2845	3.1000	4231461.1557	412887.1548
17	16	4230901.5882	413217.8330	1272.1455	38:12:23.99245	41:00:33.05733	1268.9533	3.1000	4231461.1557	412887.1548
18	17	4230912.2535	413214.2808	1271.8035	38:12:24.33707	41:00:32.90666	1268.6113	3.1000	4231461.1557	412887.1548
19	18	4230922.5649	413210.9007	1271.6140	38:12:24.67027	41:00:32.76321	1268.4218	3.1000	4231461.1557	412887.1548
20	19	4230931.0199	413208.4865	1271.5205	38:12:24.94360	41:00:32.66028	1268.3283	3.1000	4231461.1557	412887.1548
21	20	4230938.3667	413206.9664	1271.4435	38:12:25.18131	41:00:32.59458	1268.2513	3.1000	4231461.1557	412887.1548
22	21	4230956.2906	413204.5865	1271.4360	38:12:25.76172	41:00:32.48889	1268.2438	3.1000	4231461.1557	412887.1548
23	22	4230969.9319	413203.4379	1271.6000	38:12:26.20367	41:00:32.43569	1268.4078	3.1000	4231461.1557	412887.1548
24	23	4230988.3449	413201.7342	1271.8960	38:12:26.80017	41:00:32.35758	1268.7038	3.1000	4231461.1557	412887.1548
25	24	4231003.9544	413199.3929	1272.2905	38:12:27.30553	41:00:32.25449	1269.0983	3.1000	4231461.1557	412887.1548
26	25	4231012.4903	413198.0899	1272.4325	38:12:27.58187	41:00:32.19719	1269.2403	3.1000	4231461.1557	412887.1548
27	26	4231021.7043	413196.7566	1272.1170	38:12:27.88020	41:00:32.13834	1268.9248	3.1000	4231461.1557	412887.1548
28	27	4231030.3003	413195.9796	1271.8510	38:12:28.15868	41:00:32.10263	1268.6588	3.1000	4231461.1557	412887.1548
29	28	4231044.0989	413196.6562	1271.0100	38:12:28.60636	41:00:32.12437	1267.8178	3.1000	4231461.1557	412887.1548
30	29	4231058.7535	413197.4938	1269.6114	38:12:29.08186	41:00:32.15235	1266.4192	3.1000	4231461.1557	412887.1548

Figure 7-1-4 RTK Field Data

After the user clicks CSV or HTML, SGS can get the Satsurv project information.

7.1.3 Control Point File Import

Click Control Point File to bring up the Control Point File window. SGS software supports four types of control point files. Select the control point file format in the window, click OK.

7.1.4 Stop&GO RSP Files Import

Select an imported obs file, and then click Stop&GO RSP File to select the file to be imported in the pop-up dialog box.

If the obs file is not selected, click the Stop&GO RSP File, and a prompt dialog box will pop up.

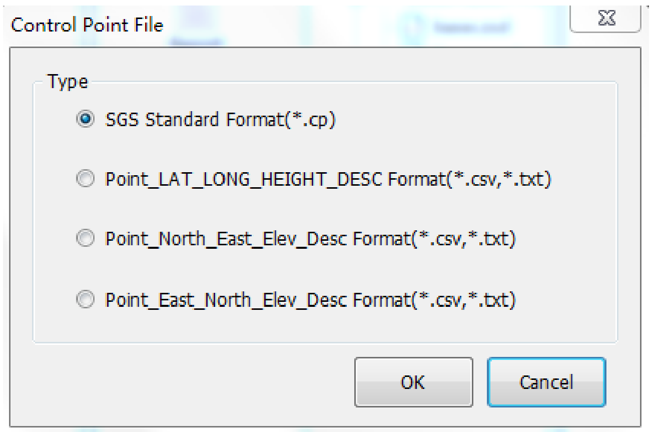


Figure 7-1-5 Control Point File

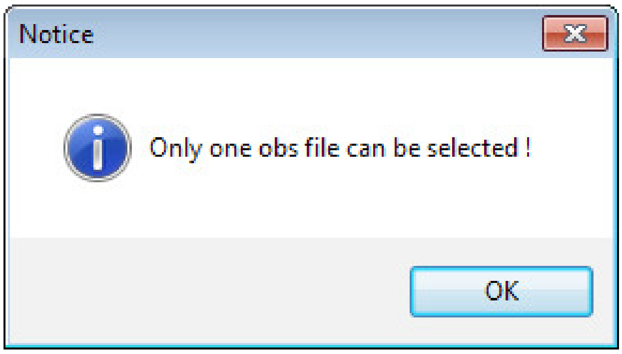


Figure 7-1-6 Notice

7.2 Observation File Export

Normally, when you submit your results, some of the output is sorted out and submitted as part of the results. SGS software provides a wealth of results export functions, including obs file, baseline result, and project report export.

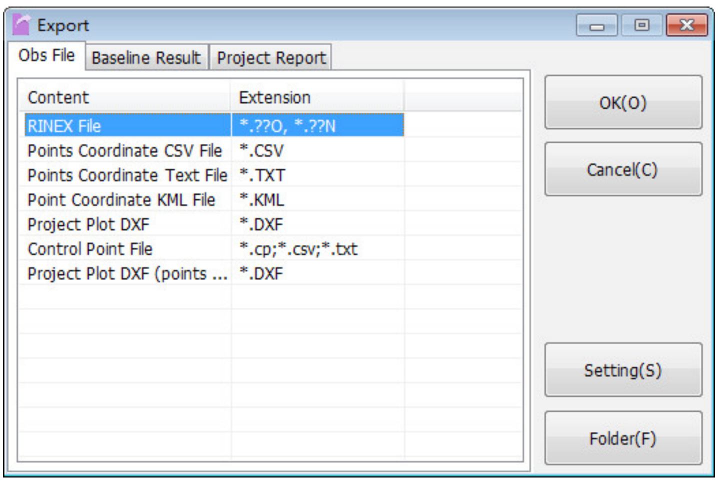


Figure 7-2-1 Export

7.2.1 RINEX File Export

Select RINEX File, click Setting to bring up RINEX Options dialog box, where the version, the satellites system, the export content, the interval, the start and stop time, the antenna height type can be set. After the setting is completed, click OK to return to the Export interface.

For the imported raw data, select the observation files in the file list, click Convert to Rinex in the right-click menu to convert; and also select Folder from Export-Obs File to perform batch conversion; the results will be located in the Rinex folder under the project folder.

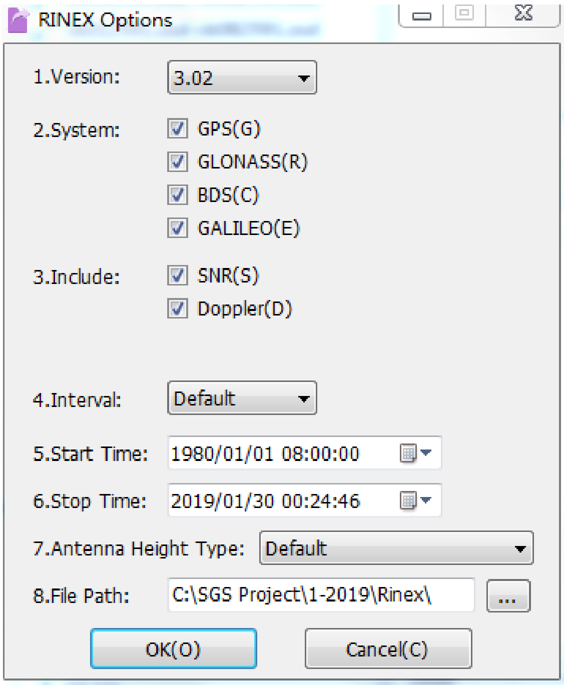


Figure 7-2-2 RINEX Options

Notice: The part of the Satsurv instrument is certified by the NGS antenna and has accurate antenna phase center correction parameters. SGS software has built-in parameters to automatically correct when solving. For the old HDS2003 and other manufacturers' data processing software, if the instrument phase center correction parameters are not built in, the antenna height type setting must be set to the antenna phase center.

7.2.2 Point Coordinate File Export

Select Point Coordinate CSV File or Point Coordinate Text File, click Setting to bring up the Options window, where the exported content can be outputted, including the name, the code, WGS84-BLH and the Grid-NEZ. After the setting is completed, click OK to return to the Export interface.

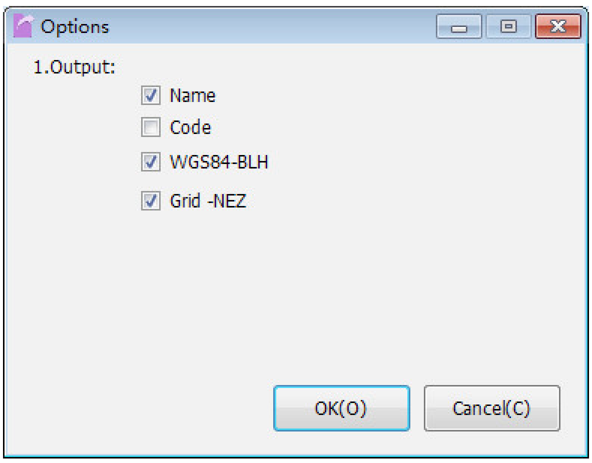


Figure 7-2-3 Options

Execute in Export→ Point Coordinate CSV File / Point Coordinate Text File OK, select the source of the point coordinate file to be exported in “Source of Point Coordinates”, and click OK in CSV format, or in text format to output the selected result information of each site.

SGS software supports the result output of the Project stations, free 3D NetAdjust Result, WGS84 Result, Target System Result and Constraint 2D NetAdjust in Target System Result.

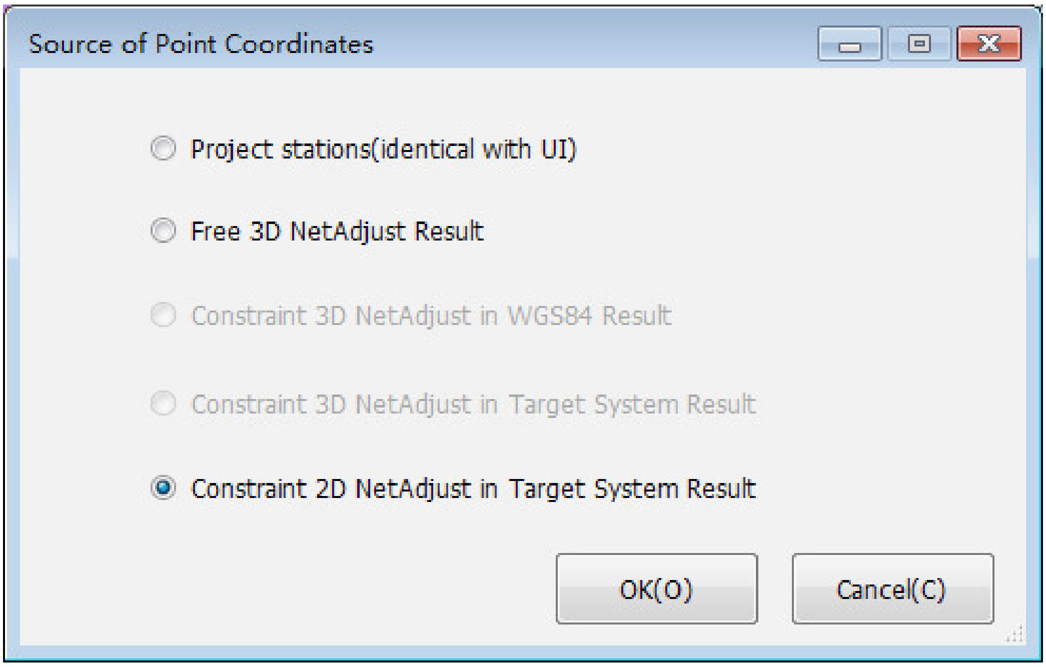


Figure 7-2-4 Source of Point Coordinates

The exported results are separated by commas in the format:

Name of points, B, L, H, N, E, U

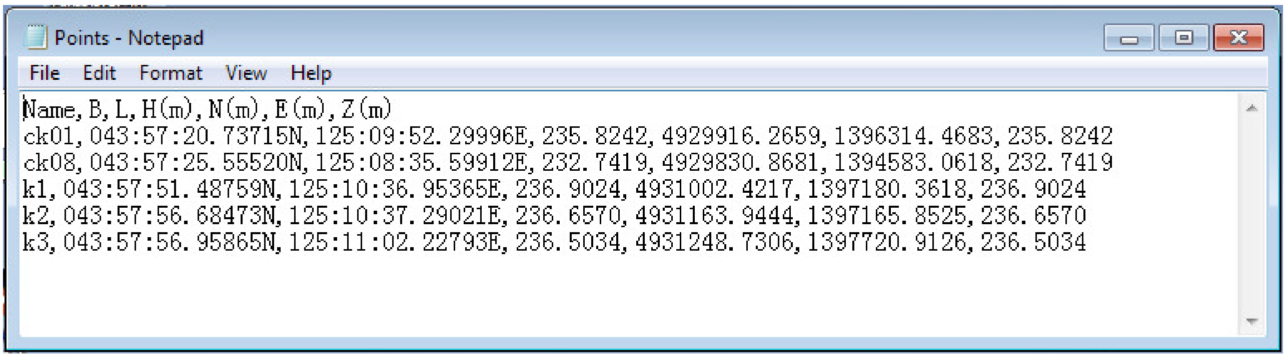


Figure 7-2-5 Results

Notice: The result format can be directly used in the parameter solving tool software as an import file.

7.2.3 Project Plot DXF Export

Select Project Plot DXF, click Setting to bring up the Options dialog box, choose whether or not to output the result Include "Go" points if "Stop&GO" Processing. After the setting is completed, click OK to return to the Export interface.

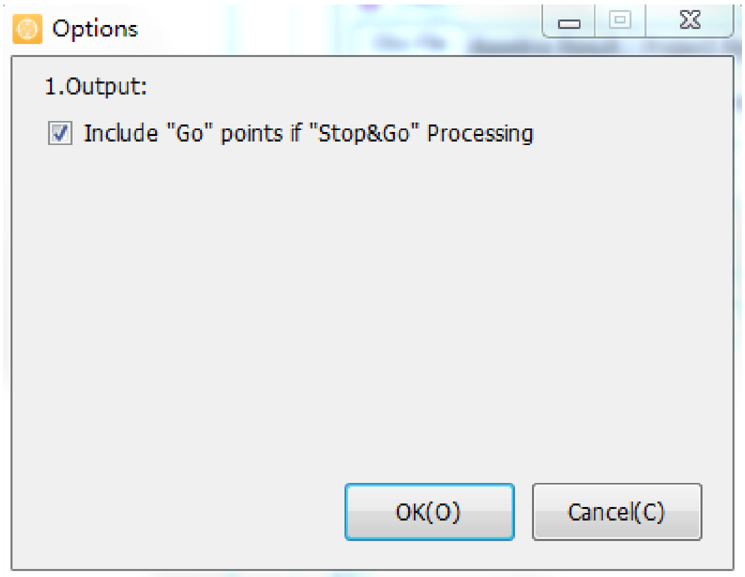


Figure 7-2-6 Options

Execute in Export→Project Plot DXF→OK, select the source of the point coordinate file to be exported in Source of Point Coordinates, and click OK to output the DXF file; the result is located in the project folder, the "Plot.dxf" file in the Report directory. Open with CAD software as follows:

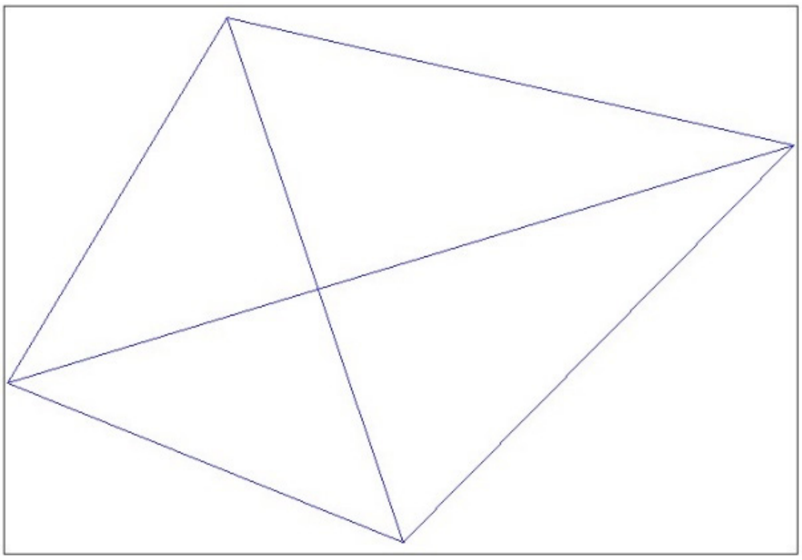


Figure 7-2-7 Display in CAD

Notice: If the graphics with CAD software can't be seen, the angle of view needs to be adjusted. Please enter the commands e, z in the CAD software to automatically zoom the graphics to the effective view area.

7.2.4 Control Point File Export

Execute in Export→Control Point File→OK, select the format of the control point file in Control Point File, and click OK to output the control point file.

7.3 Project Result Report Export

Select Project Result Report, click Setting, and the Project report option dialog box will pop up, customize the content to be output in the Word report. After the setting is completed, click OK to return to the Export interface.

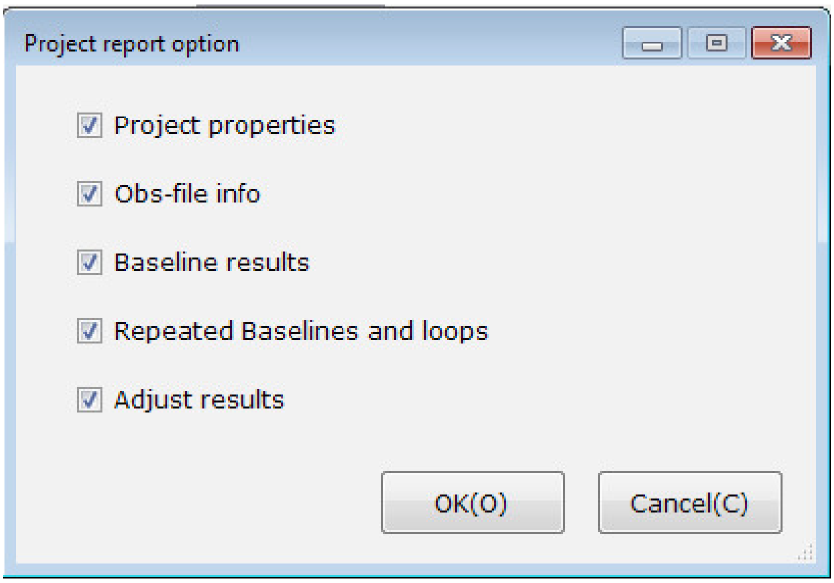


Figure 7-3-1 Project Report Option

Execute in Export→ Project Result Report, select the format of the project report, click OK to output the file. It can output the project reports in three forms: TXT, DOC, and HTML, as well as the Repeat Baseline and Closed Loop Result report.

The observation data list window, the baseline vector list window, and the observation site list window in the main program can print out the output project summary report, which we will not introduce here.

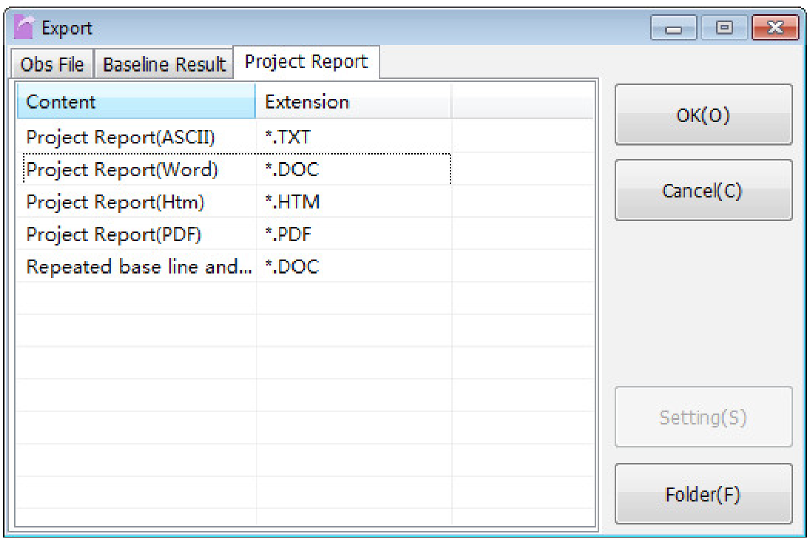


Figure 7-3-2 Project Report

7.4 Baseline Result Export

In order to exchange baseline data with other data processing software, we can export the baseline results to Trimble Data Exchange (for the adjustment data of Power Adj software), or Cosa Data Exchange (COSA); after selecting the format, click OK.

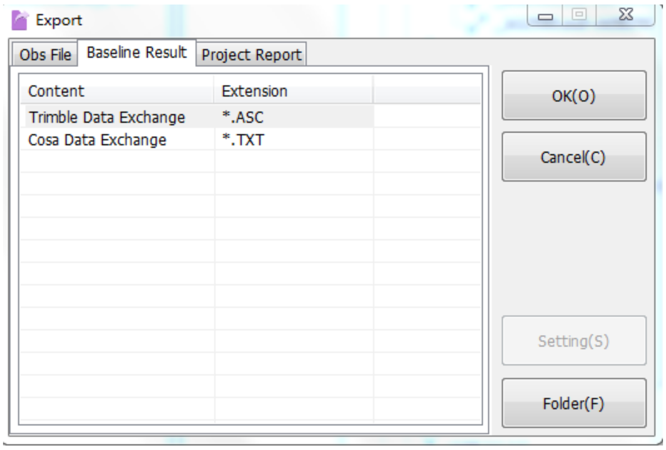
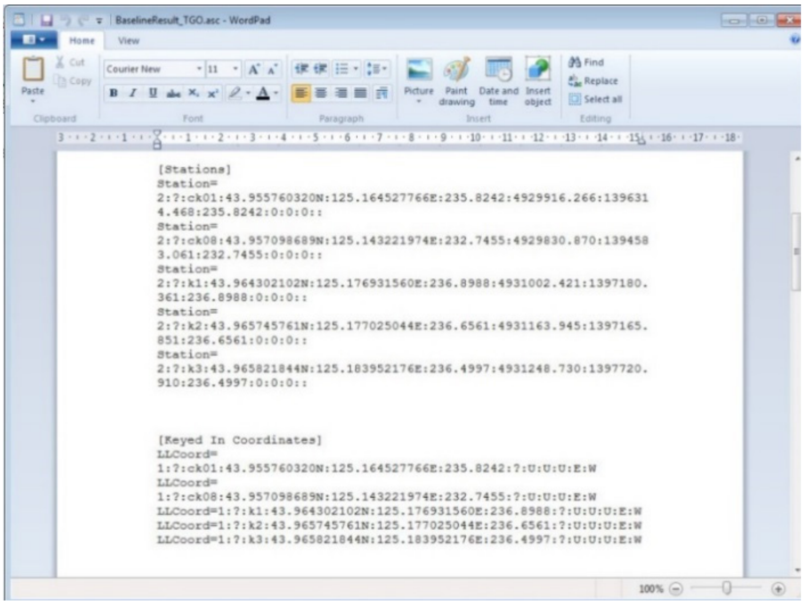


Figure 7-4-1 Baseline Result

The Trimble Data Exchange file is located in the BaselineResult_TGO.asc file under the Report directory of the project folder.

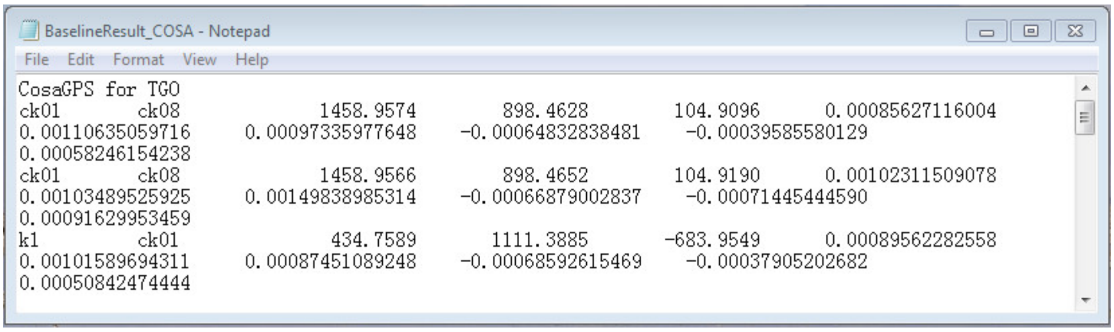


```
[Stations]
Station=
2:?:ck01:43.955760320N:125.164527766E:235.8242:4929916.266:139631
4.468:235.8242:0:0:0::
Station=
2:?:ck08:43.957098689N:125.143221974E:232.7455:4929830.870:139458
3.061:232.7455:0:0:0::
Station=
2:?:k1:43.964302102N:125.176931560E:236.8988:4931002.421:1397180.
361:236.8988:0:0:0::
Station=
2:?:k2:43.965745761N:125.177025044E:236.6561:4931163.945:1397165.
851:236.6561:0:0:0::
Station=
2:?:k3:43.965821844N:125.183952176E:236.4997:4931248.730:1397720.
910:236.4997:0:0:0::


[Keyed In Coordinates]
LLCoord=
1:?:ck01:43.955760320N:125.164527766E:235.8242:?:U:U:U:E:W
LLCoord=
1:?:ck08:43.957098689N:125.143221974E:232.7455:?:U:U:U:E:W
LLCoord=1:?:k1:43.964302102N:125.176931560E:236.8988:?:U:U:U:E:W
LLCoord=1:?:k2:43.965745761N:125.177025044E:236.6561:?:U:U:U:E:W
LLCoord=1:?:k3:43.965821844N:125.183952176E:236.4997:?:U:U:U:E:W
```

Figure 7-4-2 BaselineResult_TGO.asc

The Cosa Data Exchange file is located in the BaselineResult_COSA.txt file under the Report directory of the project folder:



```
CosaGPS for TGO
ck01        ck08          1458.9574        898.4628        104.9096        0.00085627116004
0.00110635059716       0.00097335977648     -0.00064832838481     -0.00039585580129
0.00058246154238
ck01        ck08          1458.9566        898.4652        104.9190        0.00102311509078
0.00103489525925       0.00149838985314     -0.00066879002837     -0.00071445444590
0.00091629953459
k1          ck01           434.7589       1111.3885       -683.9549        0.00089562282558
0.00101589694311       0.00087451089248     -0.00068592615469     -0.00037905202682
0.00050842474444
```

Figure 7-4-3 BaselineResult_COSA.txt

7.5 Satsurv Project Result Export

After importing the Satsurv Project, when the PPK dynamic solution is not performed, the project result can be exported by CSV and HTML:

Coordinate Parameter

Datum Name:	silvan_01052018
Ellipsoid:	GRS 1980
Major Axis:	6378137
Inverse Flattening:	298.2572221
Grid File :	
Projection Method	Transverse Mercator
Central Meridian:	042:00:00.00000E
Central Latitude:	000:00:00.00000N
Scale:	1
False North(m):	0
False East(m):	500000

X Translation(m):0
Y Translation(m):0
Z Translation(m):0
X Roatation(m):0
Y Roatation(m):0
Z Roatation(m):0
Scale: 0

ID	Point Name	N	E	Z	B	L	H	N_WGS84	E_WGS84	Z_WGS84	B_WGS84	L_WGS84	H_WGS84	Target H
1	P.16	4231058.1020	413220.4389	1296.8456	38:12:29.06870	41:00:33.09562	1296.8456	4231058.1020	413220.4389	1294.7534	38:12:29.06870	41:00:33.09562	1294.7534	2.0000
2	1	4230714.5685	413277.6730	1285.2805	38:12:17.94863	41:00:35.59871	1285.2805	4230714.5685	413277.6730	1282.0883	38:12:17.94863	41:00:35.59871	1282.0883	3.1000
3	2	4230726.0451	413276.3526	1284.5473	38:12:18.32033	41:00:35.53940	1284.5473	4230726.0451	413276.3526	1281.3551	38:12:18.32032	41:00:35.53940	1281.3551	3.1000
4	3	4230740.4899	413271.8751	1283.0863	38:12:18.78718	41:00:35.34905	1283.0863	4230740.4899	413271.8751	1279.8941	38:12:18.78718	41:00:35.34905	1279.8941	3.1000
5	4	4230759.7397	413264.7186	1281.9820	38:12:19.40893	41:00:35.04649	1281.9820	4230759.7397	413264.7186	1278.7898	38:12:19.40892	41:00:35.04649	1278.7898	3.1000
6	5	4230773.6029	413259.7157	1281.0820	38:12:19.85674	41:00:34.83480	1281.0820	4230773.6029	413259.7157	1277.8898	38:12:19.85674	41:00:34.83480	1277.8898	3.1000
7	6	4230789.3577	413255.3282	1280.2300	38:12:20.36611	41:00:34.64757	1280.2300	4230789.3577	413255.3282	1277.0378	38:12:20.36610	41:00:34.64757	1277.0378	3.1000
8	7	4230805.2438	413252.2008	1278.9580	38:12:20.88017	41:00:34.51206	1278.9580	4230805.2438	413252.2008	1275.7658	38:12:20.88017	41:00:34.51206	1275.7658	3.1000
9	8	4230813.7253	413250.4254	1278.2773	38:12:21.15459	41:00:34.43538	1278.2773	4230813.7253	413250.4254	1275.0851	38:12:21.15458	41:00:34.43538	1275.0851	3.1000
10	9	4230819.9582	413248.7863	1277.7667	38:12:21.35614	41:00:34.36528	1277.7667	4230819.9582	413248.7863	1274.5745	38:12:21.35613	41:00:34.36528	1274.5745	3.1000
11	10	4230824.6878	413247.2986	1277.3550	38:12:21.50899	41:00:34.30206	1277.3550	4230824.6878	413247.2986	1274.1628	38:12:21.50899	41:00:34.30206	1274.1628	3.1000
12	11	4230834.2371	413243.8828	1276.3515	38:12:21.81746	41:00:34.15749	1276.3515	4230834.2371	413243.8828	1273.1593	38:12:21.81746	41:00:34.15749	1273.1593	3.1000
13	12	4230850.2870	413238.4920	1275.0620	38:12:22.33605	41:00:33.92889	1275.0620	4230850.2870	413238.4920	1271.8698	38:12:22.33605	41:00:33.92889	1271.8698	3.1000
14	13	4230865.9014	413232.8869	1273.8330	38:12:22.84044	41:00:33.69168	1273.8330	4230865.9014	413232.8869	1270.6408	38:12:22.84044	41:00:33.69168	1270.6408	3.1000
15	14	4230881.4255	413226.7137	1273.1245	38:12:23.34171	41:00:33.43116	1273.1245	4230881.4255	413226.7137	1269.9323	38:12:23.34171	41:00:33.43116	1269.9323	3.1000
16	15	4230893.4027	413221.4532	1272.4767	38:12:23.72828	41:00:33.20971	1272.4767	4230893.4027	413221.4532	1269.2845	38:12:23.72827	41:00:33.20971	1269.2845	3.1000
17	16	4230901.5882	413217.8330	1272.1455	38:12:23.99245	41:00:33.05733	1272.1455	4230901.5882	413217.8330	1268.9533	38:12:23.99245	41:00:33.05733	1268.9533	3.1000
18	17	4230912.2535	413214.2808	1271.8035	38:12:24.33707	41:00:32.90666	1271.8035	4230912.2535	413214.2808	1268.6113	38:12:24.33707	41:00:32.90666	1268.6113	3.1000
19	18	4230922.5649	413210.9007	1271.6140	38:12:24.67027	41:00:32.76321	1271.6140	4230922.5649	413210.9007	1268.4218	38:12:24.67027	41:00:32.76321	1268.4218	3.1000
20	19	4230931.0199	413208.4865	1271.5205	38:12:24.94361	41:00:32.66028	1271.5205	4230931.0199	413208.4865	1268.3283	38:12:24.94360	41:00:32.66028	1268.3283	3.1000
21	20	4230938.3667	413206.9664	1271.4435	38:12:25.18132	41:00:32.59458	1271.4435	4230938.3667	413206.9664	1268.2513	38:12:25.18131	41:00:32.59458	1268.2513	3.1000
22	21	4230956.2906	413204.5865	1271.4360	38:12:25.76172	41:00:32.48889	1271.4360	4230956.2906	413204.5865	1268.2438	38:12:25.76172	41:00:32.48889	1268.2438	3.1000
23	22	4230969.9319	413203.4379	1271.6000	38:12:26.20367	41:00:32.43569	1271.6000	4230969.9319	413203.4379	1268.4078	38:12:26.20367	41:00:32.43569	1268.4078	3.1000

Figure 7-5-1 Project Result

After importing the Satsurv Project, when the PPK dynamic solution is performed, we can export the project result replaced by the PPK solution through the toolbar Export:

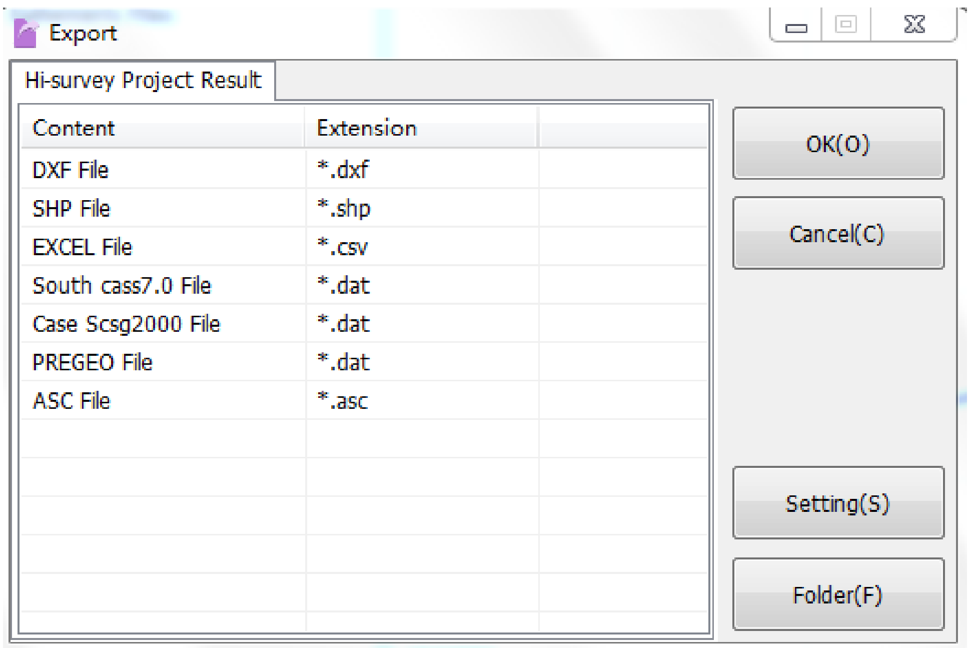


Figure 7-5-2 Satsurv Project Result

S121

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	ID	Name	N	E	Z	B	L	H	AntH	σN	σE	σZ	Ave Ti	Status	StartLocal tim	EndLocal time
2	1	P.16	4231058	413220.4	1296.846	38:12:29	41:00:33	1294.753	2.0922	0.0034	0.0055	0.0046	10	RTK Fix	2018/5/1 20:25	2018/5/1 20:
3	2	1	4230715	413277.7	1285.281	38:12:17	41:00:35	1282.088	3.1922	0.0038	0.0098	0.0067	4	RTK Fix	2018/5/1 20:53	2018/5/1 20:
4	3	2	4230726	413276.4	1284.547	38:12:18	41:00:35	1281.355	3.1922	0.0484	0.0072	0.0017	3	RTK Fix	2018/5/1 20:53	2018/5/1 20:
5	4	3	4230740	413271.9	1283.086	38:12:18	41:00:35	1279.894	3.1922	0.0136	0.0546	0.0052	3	RTK Fix	2018/5/1 20:53	2018/5/1 20:
6	5	4	4230760	413264.7	1281.982	38:12:19	41:00:35	1278.79	3.1922	0.0059	0.0253	0.0062	3	RTK Fix	2018/5/1 20:54	2018/5/1 20:
7	6	5	4230774	413259.7	1281.082	38:12:19	41:00:34	1277.89	3.1922	0.032	0.0214	0.002	2	RTK Fix	2018/5/1 20:54	2018/5/1 20:
8	7	6	4230789	413255.3	1280.23	38:12:20	41:00:34	1277.038	3.1922	0.0153	0.0262	0.0037	3	RTK Fix	2018/5/1 20:54	2018/5/1 20:
9	8	7	4230805	413252.2	1278.958	38:12:20	41:00:34	1275.766	3.1922	0.0322	0.0218	0.004	2	RTK Fix	2018/5/1 20:55	2018/5/1 20:
10	9	8	4230814	413250.4	1278.277	38:12:21	41:00:34	1275.085	3.1922	0.0317	0.0127	0.0049	3	RTK Fix	2018/5/1 20:55	2018/5/1 20:
11	10	9	4230820	413248.8	1277.767	38:12:21	41:00:34	1274.575	3.1922	0.0101	0.0056	0.0021	3	RTK Fix	2018/5/1 20:55	2018/5/1 20:
12	11	10	4230825	413247.3	1277.355	38:12:21	41:00:34	1274.163	3.1922	0.0094	0.0016	0.005	2	RTK Fix	2018/5/1 20:55	2018/5/1 20:
13	12	11	4230834	413243.9	1276.352	38:12:21	41:00:34	1273.159	3.1922	0.0043	0.0021	0.0045	2	RTK Fix	2018/5/1 20:55	2018/5/1 20:
14	13	12	4230850	413238.5	1275.062	38:12:22	41:00:33	1271.87	3.1922	0.0468	0.0505	0	2	RTK Fix	2018/5/1 20:56	2018/5/1 20:
15	14	13	4230866	413232.9	1273.833	38:12:22	41:00:33	1270.641	3.1922	0.0077	0.0455	0.006	2	RTK Fix	2018/5/1 20:56	2018/5/1 20:
16	15	14	4230881	413226.7	1273.125	38:12:23	41:00:33	1269.932	3.1922	0.0265	0.0199	0.0115	2	RTK Fix	2018/5/1 20:56	2018/5/1 20:
17	16	15	4230893	413221.5	1272.477	38:12:23	41:00:33	1269.285	3.1922	0.0341	0.1033	0.0062	3	RTK Fix	2018/5/1 20:56	2018/5/1 20:
18	17	16	4230902	413217.8	1272.146	38:12:23	41:00:33	1268.953	3.1922	0.0379	0.0127	0.0025	2	RTK Fix	2018/5/1 20:56	2018/5/1 20:
19	18	17	4230912	413214.3	1271.804	38:12:24	41:00:32	1268.611	3.1922	0.0088	0.0067	0.0025	2	RTK Fix	2018/5/1 20:57	2018/5/1 20:
20	19	18	4230923	413210.9	1271.614	38:12:24	41:00:32	1268.422	3.1922	0.0064	0.0095	0.001	2	RTK Fix	2018/5/1 20:57	2018/5/1 20:
21	20	19	4230931	413208.5	1271.521	38:12:24	41:00:32	1268.328	3.1922	0.0033	0.0944	0.0055	2	RTK Fix	2018/5/1 20:57	2018/5/1 20:
22	21	20	4230938	413207	1271.444	38:12:25	41:00:32	1268.251	3.1922	0.1029	0.0708	0.0065	2	RTK Fix	2018/5/1 20:58	2018/5/1 20:
23	22	21	4230956	413204.6	1271.436	38:12:25	41:00:32	1268.244	3.1922	0.0306	0.0087	0.003	2	RTK Fix	2018/5/1 20:58	2018/5/1 20:
24	23	22	4230970	413203.4	1271.6	38:12:26	41:00:32	1268.408	3.1922	0.0341	0.0156	0.001	2	RTK Fix	2018/5/1 20:58	2018/5/1 20:
25	24	23	4230988	413201.7	1271.896	38:12:26	41:00:32	1268.704	3.1922	0.1209	0.0839	0.0051	3	RTK Fix	2018/5/1 20:58	2018/5/1 20:
26	25	24	4231004	413199.4	1272.291	38:12:27	41:00:32	1269.098	3.1922	0.0104	0.0099	0.0065	2	RTK Fix	2018/5/1 20:59	2018/5/1 20:
27	26	25	4231012	413198.1	1272.433	38:12:27	41:00:32	1269.24	3.1922	0.0201	0.0026	0.0105	2	RTK Fix	2018/5/1 20:59	2018/5/1 20:
28	27	26	4231022	413196.8	1272.117	38:12:27	41:00:32	1268.925	3.1922	0.0031	0.0013	0.004	2	RTK Fix	2018/5/1 20:59	2018/5/1 20:
29	28	27	4231030	413196	1271.851	38:12:28	41:00:32	1268.659	3.1922	0	0	0	1	RTK Fix	2018/5/1 20:59	2018/5/1 20:
30	29	28	4231044	413196.7	1271.01	38:12:28	41:00:32	1267.818	3.1922	0.0252	0.0404	0.003	2	RTK Fix	2018/5/1 20:59	2018/5/1 20:
31	30	29	4231059	413197.5	1269.611	38:12:29	41:00:32	1266.419	3.1922	0.0616	0.0154	0.0055	5	RTK Fix	2018/5/1 21:00	2018/5/1 21:

Figure 7-5-3 Satsurv Project Result

Chapter 8

Software Tools

This chapter contains:

- **Antenna Manager**
- **Coordinate Transformation Tool**
- **Star Report**
- **SP3 Gate**
- **Rinex Convert Tool**

8.1 Antenna Manager

The antenna manager is designed for updating and editing the receiver parameter file (the HitAnt.ini file). When users apply the unknown receiver and know its geometric parameter and phase center height parameters, then add the needed receiver through this tool.

Choose Tools → Receivers in the software menu, there will be pop-up window shown in Figure 8-1-1. This window shows the relevant parameters of used antenna, such as radios, phase center height.

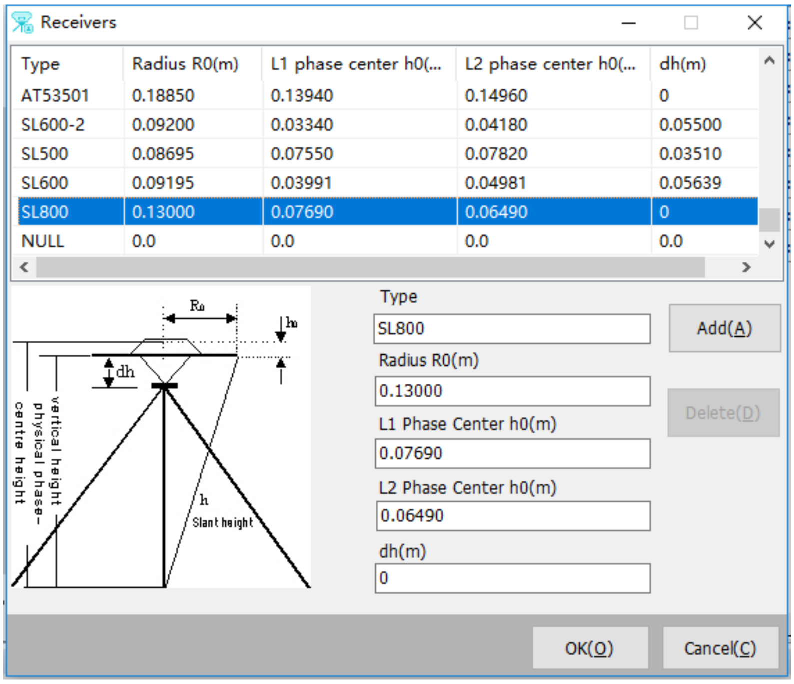


Figure 8-1-1 Receivers

In the window, choose the antenna name and can change directly the corresponding parameter.

Notice: This document will influence the data result. Please don't change it without thought!

8.2 Coordinate Transformation Tool

The SGS supplies the coordinate transformation tool. Choose Tools → Coord Tool in the software menu to start the tool.

This tool can transform between the local coordinate and the WGS-84 coordinate and has the function of solving parameters. Description of this tool are as follows.

8.2.1 Overview

First of all, it's necessary to figure out the representation method of several coordinates. There are three common coordinate representations: Geodetic (BLH), Cartesian (XYZ) and Grid (xyh/NEU). The ellipsoid height is a geometrical quantity, and the levelling height is a physical quantity.

The WGS-84 coordinate is based on the longitude, latitude and ellipsoid model; while Beijing 54 coordinates adopt the description of plane coordinates and leveling height.

Now it comes to rigor issues of the transformation. In the same ellipsoid, the geometrical transformation is strict (BLH<—>XYZ). But the transformation in the different ellipsoid is not strict. For example, there isn't a method that can be used universally for the transformation between WGS-84 and Beijing 54. Because the first one is the geocentric coordinate system and the second one is the ellipsoid-centered coordinate system. The elevation's transformation is between geoidal height and physical quantity. Therefore, local fitting must be performed with an ellipsoid in each place, usually with the Bursa-Wolf Parameters model.

So, what should be the transformation between the different ellipsoids? Generally, the more strict model is the Bursa-Wolf. That is the X plane, Y plane, Z plane, X spin, Y spin, Z spin and scale dilution K. For these seven parameters, it is necessary to have more than three known points in a location. (At least seven equations can be solved for Bursa-Wolf formula, so three points are needed to list nine equations.) If the area is not large and the distance between the farthest points is within 30km (empirical value), it's acceptable to use the three parameters model, which means X plane, Y plane, Z plane. The X spin, Y spin, Z spin and scale dilution K are regarded as zero. So this model is the special case of the Bursa-Wolf model.

The essence of the seven parameters model is to fit the shape of local coordinates with a local ellipsoid. So, after the transformation, the local ellipsoid height obtained is the leveling height. Of course, plane and elevation can be fitted separately. For example, fit the plane with a 2D+Helmert model and fit the elevation with a quadric surface model and others. This mode of handling separately confers more freedom than the Bursa-Wolf model. However, this is only used for small regional coordinate transformations, because of the fewer parameters and weaker expression ability of the 2D+Helmert model.

In summary, the SGS coordinate transformation tool provides two methods for customers to choose:

1. Bursa-Wolf model, to get local plane and level data in one step.
2. 2D+Helmert model and elevation fitting model, to get local plane and level data in two steps.

Since the model and process definition of each manufacturer may be different, below is the transformation process.

1. The process of Bursa-Wolf model

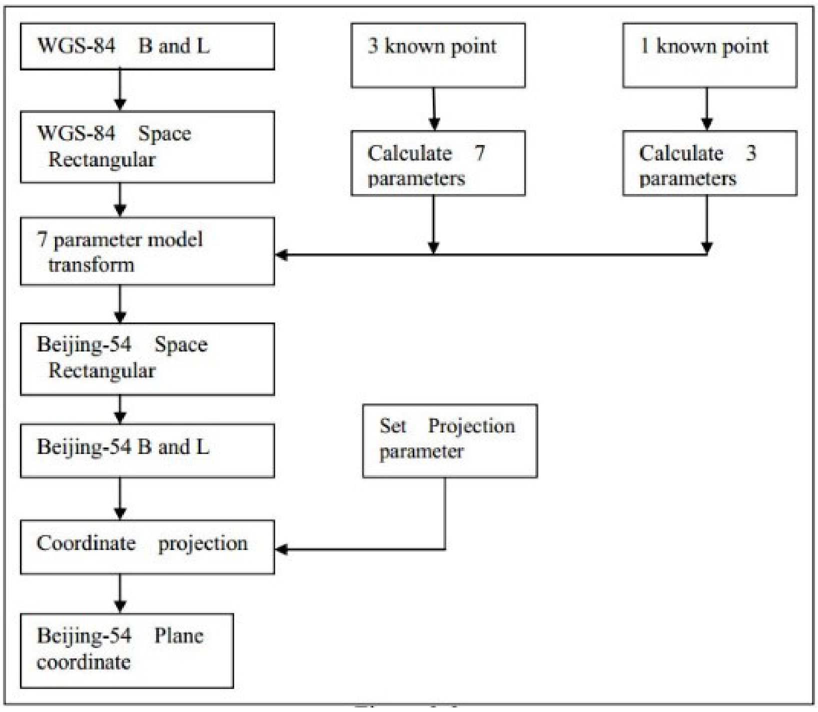


Figure 8-2-1 Bursa-Wolf Model Process

2. The process of the 2D+Helmert model

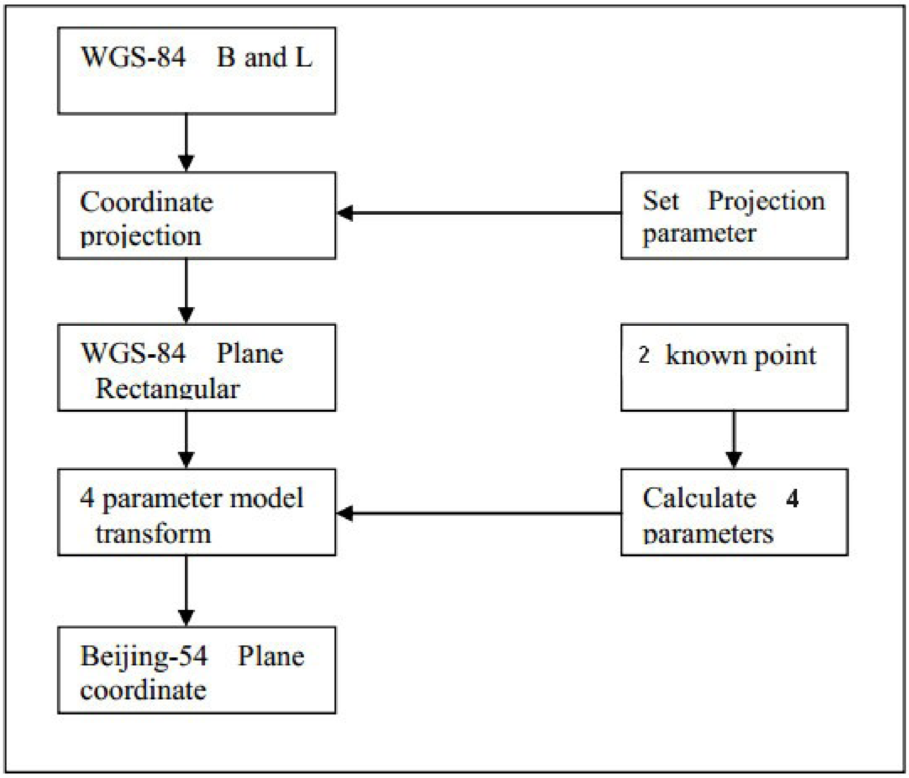


Figure 8-2-2 2D+Helmert Model Process

3. The process of elevation fitting:

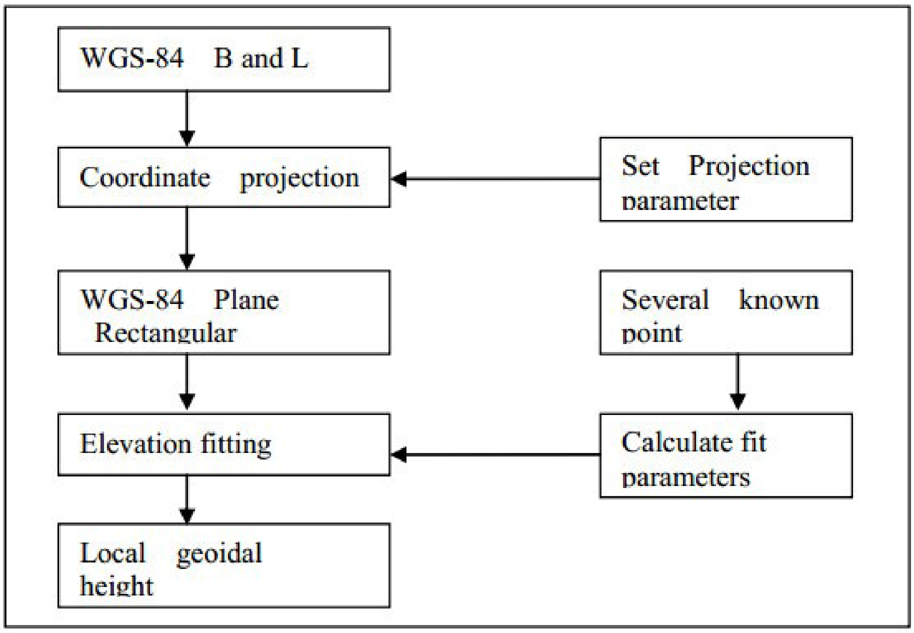


Figure 8-2-3 Elevation Fitting Process

8.2.2 Use Software to Transform Coordinates

The software manages the coordinate transformation parameters as a file. Users can save the defined settings of transformation parameters as a file (*.dam) and open this file to transfer all the saved parameters for the next use. The parameters involved in the coordinate transformation refer to the ellipsoid parameter, projection parameter, seven parameters, four parameters, elevation fitting parameter and level grid files. All of these parameters are integrated into the following window (like figure 8-2-4) for input. After the input, take a name for the file and click on Save to create a "*.dam" parameter file in the GeoPath directory under the Program folder.

Click on Tool →Coord Tool → Parameter.

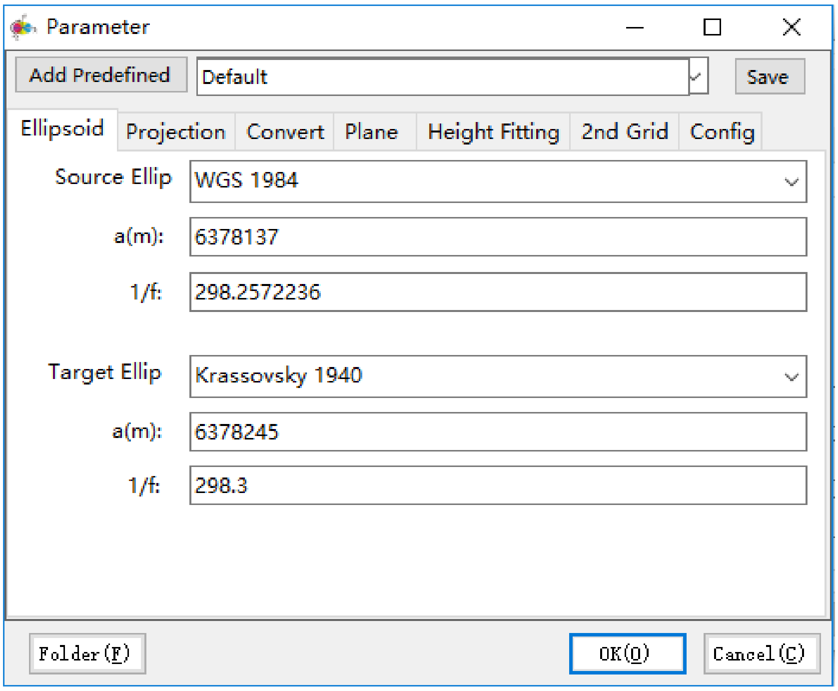


Figure 8-2-4 Parameter

Input the parameters in the window or click on Add Predefined to use the saved coordinate transformation files, then click on OK to return to the main surface for the direct and inverse calculation of coordinate:

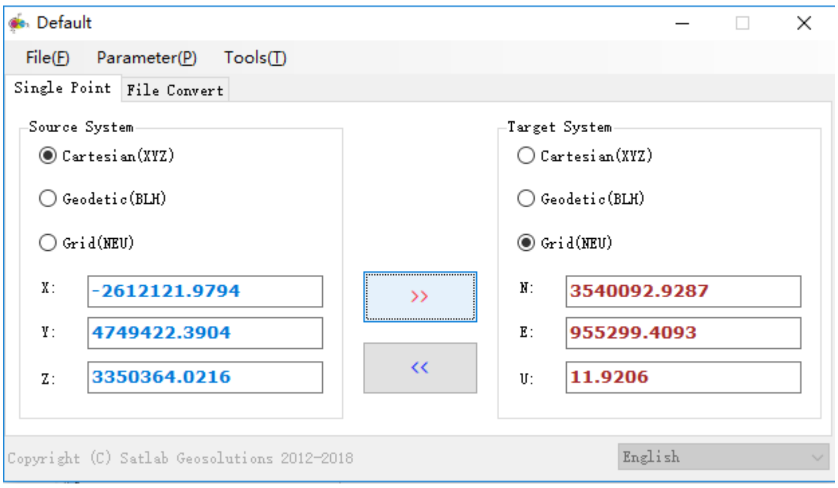


Figure 8-2-5 Transform Coordinate

8.2.3 Parameter Calculation

When users have a group of control points (these points have the WGS-84 coordinate and local coordinate), the software can be used to solve the parameters. As mentioned above, the software provides the Bursa-Wolf model and 2D+Helmert model and elevation-fitting model solution that can completed in the same interface. It's convenient for users to compare and choose different precision models. In the main interface of Coord Tool, click on Tools → Parameter Calc to open the parameter calculation interface (if the ellipsoid and projective parameters are not entered, the Parameter interface will be prompted and pop up).

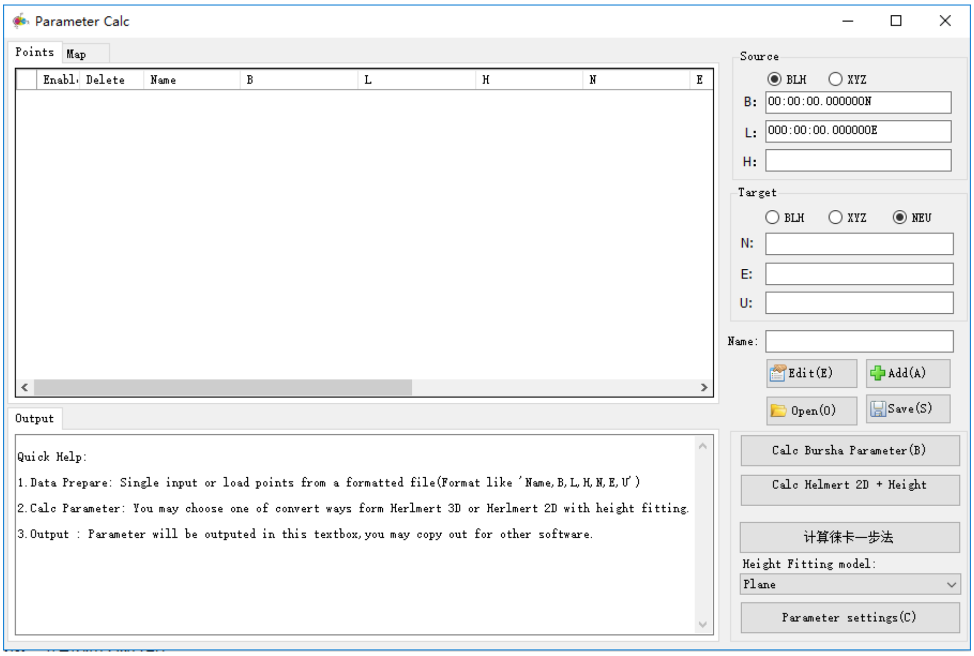


Figure 8-2-6 Parameter Calculation

The process of parameter calculation is:

1. Input the basic parameters: local ellipsoid and projection parameters.
2. Import data: add the points coordinate one by one or prepare the text file and click on Add Predefined (notes: the file format is: Name,B,L,H,N,E,U).
3. Calculate parameter: the software supports two coordinate transformation models. Click on Calc Bursa Parameter or Calc Helmert 2D + Height. If you use the second model, please select the elevation fitting model first.
4. Check the results: the calculated parameter will be output in the result bar and you can copy out to save them.
5. Use parameters: click on Parameter settings to check the transformation parameter, ellipsoid parameter and projection parameters. After confirmation, name and save it as "*.dam" file for use in other Satlab software.

Notice: Please switch to the Map interface to check the geometric distribution of the starting point (avoiding the linear distribution that leads to instability and poor applicability of parameters).

8.3 Star Report

The SGS supplies the satellite prediction software. Click on Tool Star Report to open it.

The satellite prediction is based on the satellite almanac data, received by the GPS receiver, and reports to the users the satellite distribution in a specific location and period in the future. Therefore, it is planned to select a suitable time for GPS field data acquisition, so as to improve the efficiency of the field work and data utilization.

The steps of the star report tool are follows:

1. Update historical data;
2. Set station position and time, elevation mask.
3. Conduct the forecasting, check the satellite number and DOP value and choose the observation time.

8.3.1 Input Almanac Data

Star report requires software to load the recent almanac data. The program will use the information of satellite orbits recorded in the almanac data to calculate the satellite position. The almanac data is generally in YUMA format, and the ephemeris file can be downloaded in the Status window.

8.3.2 Setting of Coordinate and Time Zone

After loading the almanac data, set the station BL, Height, elevation mask, observation time and so on, which will be used to calculation.

Set the date in the Status window. The default date is the computer system time. The user can select any day by clicking Pre, Today, Next or Manual.

Figure 8-3-1 Ephemeris File

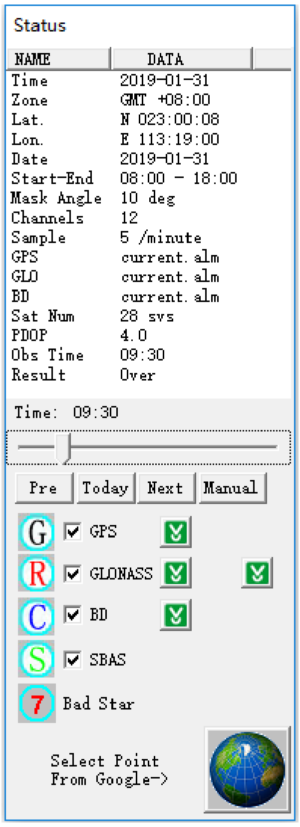


Figure 8-3-2 Status

Click Options in Navigation bar to set the BL, height, elevation mask and observation time.

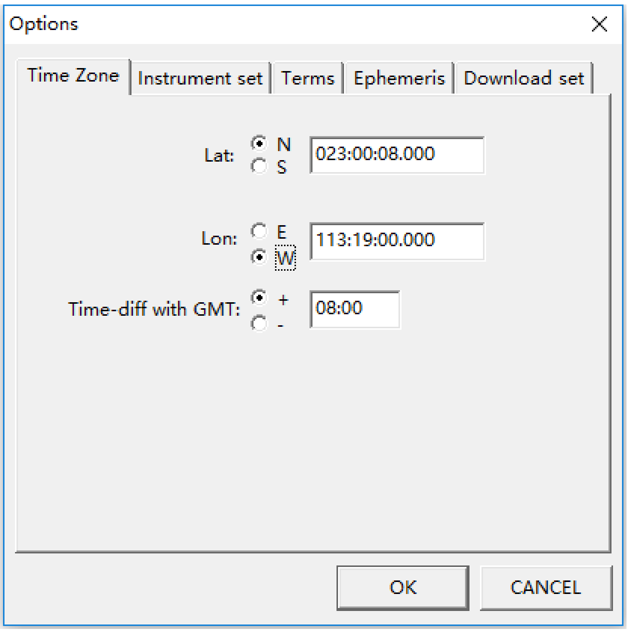


Figure 8-3-3 Time Zone

Longitude and latitude generally do not need to be very precise, and about one or two kilometers of precision can be acceptable.

If users do not know their latitude and longitude, the following methods can be used:

With the included coordinate transformation software, the user can convert the known standard rectangular coordinates into latitude and longitude system, and then input them into the software for star report.

Get the BLH format coordinate by specific GPS instruments such as V90 Plus and iRTK5.

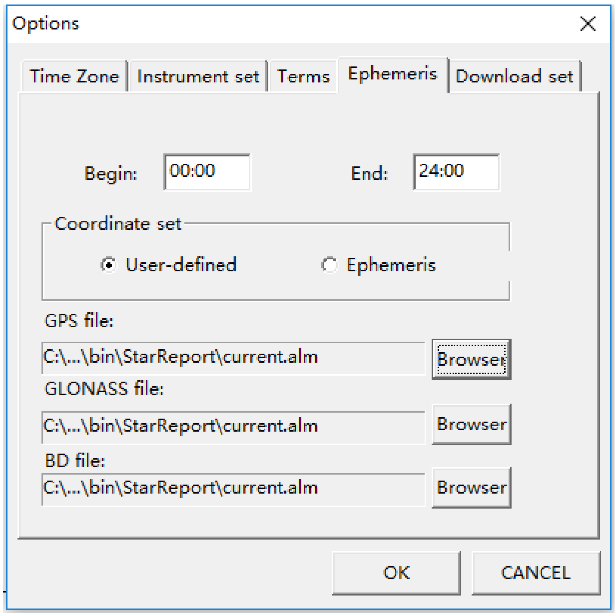


Figure 8-3-4 Ephemeris

When setting the time, please pay attention to the local time and GPS time. When inputting the observation period in local time setting, confirm the time difference between local time and UTC time. Usually, when installing the operating system, the computer will prompt to select the time zone. For example, Beijing time is 8 hours earlier than UTC time (International Standard Time). If the local time method isn't used, the software defaults that the input time is Beijing time.
Generally, when setting the observation period, the difference between the start time and the end time is several hours to 24 hours while the start time is always ahead of the end time.

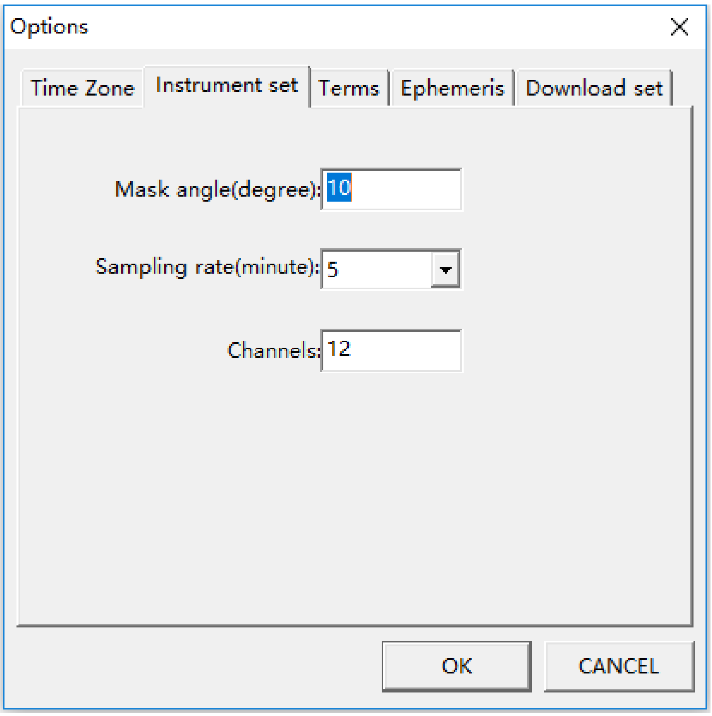


Figure 8-3-5 Instrument Setting

The elevation mask controls the azimuths of the forecasting satellite, and only the satellite that exceed the setting azimuths will be displayed. Sampling rate controls the time interval of the text output. The lower the sampling rate, the more detailed the output data are.

8.3.3 Star Report Status

After inputting the observation station and period and clicking on OK, the status of the star can be seen in the software.

1. Satellite detail textout

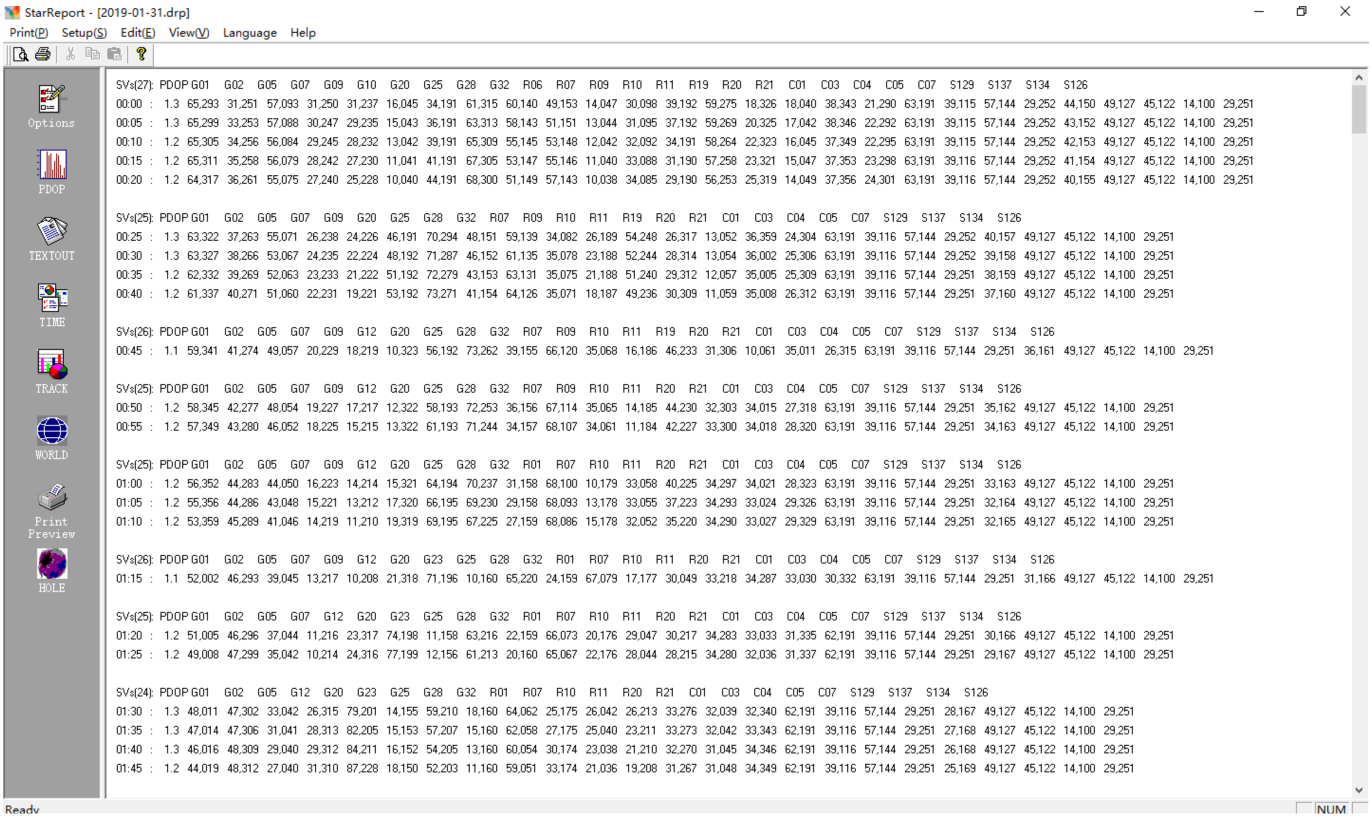


Figure 8-3-6 Satellite Detail Textout

2. Satellite time plot

Satellite time plot shows the change of the number of the visible satellites, with the time elapsing in the limited period. The abscissa is the span of time and the ordinate is the number of the satellite. According to the time plot, it is possible to select the planned observation time in which the number of satellites is relatively enough to conduct a higher-accuracy fieldwork measurement.

3. Satellite track plot

Satellite track plot shows the distribution and movement of satellites at a certain time, in a certain area. Since GPS satellites are always in motion, we use visual satellite plot to represent the number of visible satellites in the sky at the observation time. The visible satellites number is closely related to the elevation mask. From Figure 8-15, the Satellite 26 travels from north to south and the Satellite 10 will rise in the sky in the southeast during the observation process. The plot shows the BL coordinate as well as the observing period.

The direction displayed by this view is the same as maps which the north points to the up and the east points to the left. As shown in figure, the outermost circle represents the ground plane, the two dotted circles indicate that the cutoff angle is 60 degrees and 30 degrees, and the center of the circle represents the zenith.

The satellite distribution at half an hour intervals in the segment can be seen by pulling the time slider in the Status window.

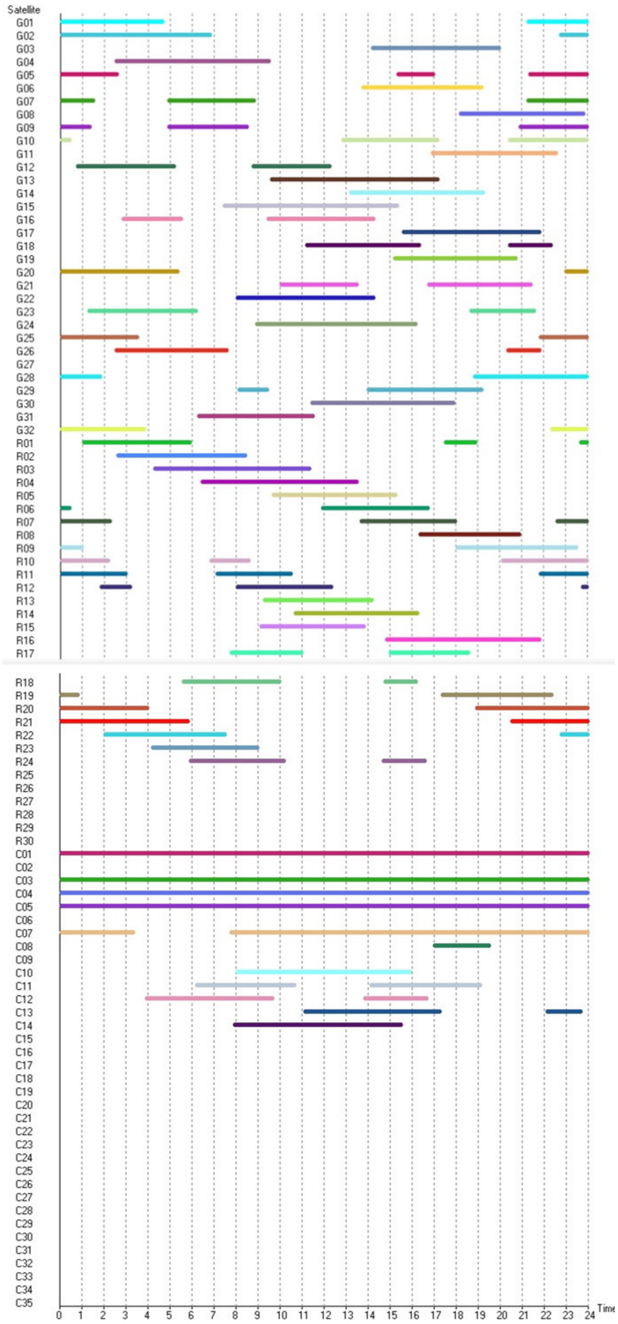


Figure 8-3-7 Satellite Time Map

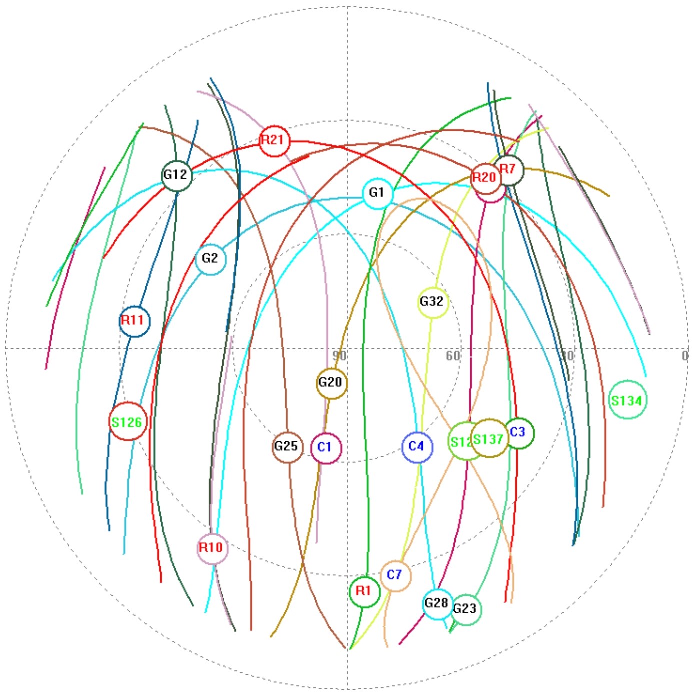


Figure 8-3-8 Satellite Track Map

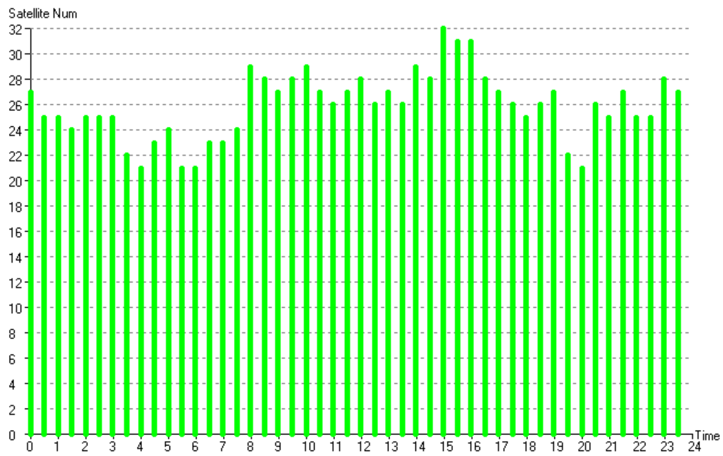


Figure 8-3-9 Number of the visible satellites

4. Number of the visible satellites

The number of the visible satellites are expressed in a rectangular coordinate that counts the visible satellites in the given period and represents visually the relationship between star numbers and time.

5. Position dilution of precision

Position Dilution of Precision (PDOP) denotes the influence of the satellites' distribution on the positioning accuracy. In some cases, more visible satellites don't mean better positioning accuracy. Generally, when the PDOP value is less than 4, the observation result is considered to be reliable.

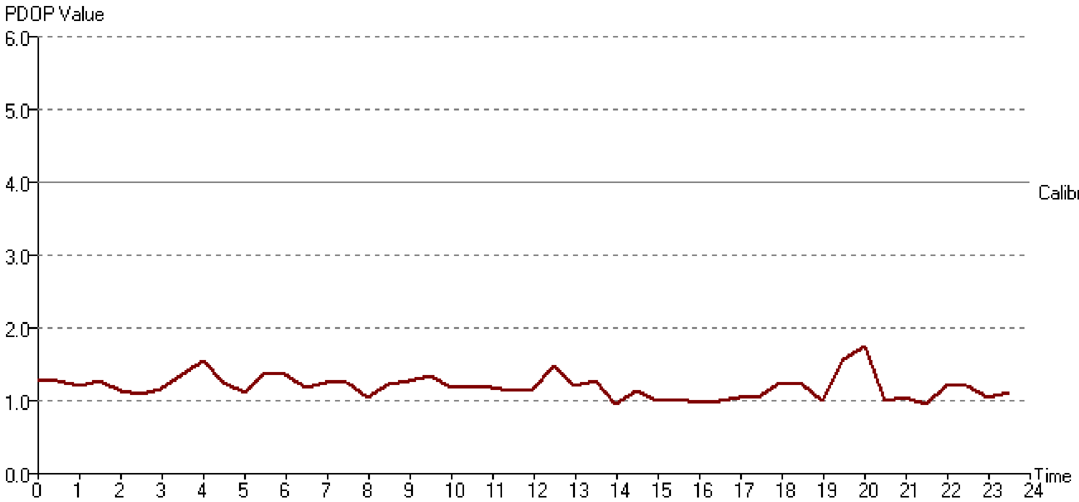


Figure 8-3-10 Position Dilution of Precision

6. World plot

The trajectories of satellites can be seen in the world plot and the distribution in current time which be adjusted by the slider button in status tab. When viewing the world plot, just select the GPS and BDS system.

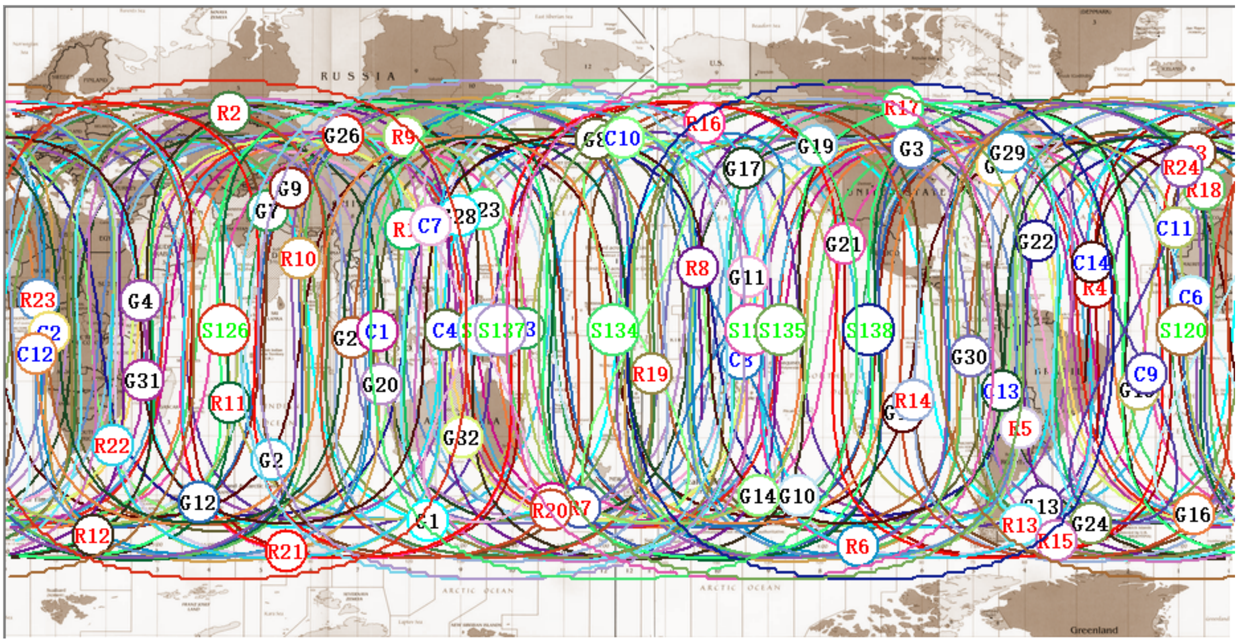


Figure 8-3-11 World Map

7. Print preview

Textout, number of satellites, PDOP value, and satellite sky distribution can be printed out through print preview and print functions.

8. Hole plot

The satellite Hole Map indicates that the area receives too few satellites to collect data.

8.3.4 Update Almanac Data

For accurate satellite forecasting, the almanac should be updated frequently. It is generally recommended that users do not use the calendar for more than one month. The software will prompt for outdated data and limit its usage.

8.4 SP3 Gate

SP3 Gate can provide users with precise satellite orbit and clock error files issued by IGS.

Click Tool → SP3 Gate, the window like Figure 8-19 will be displayed. Users can download the precise ephemeris needed with a simple configuration.

The steps of using SP3 Gate include:

1. Set the Date Span;
2. Set the folder to save;
3. Set the FTP Server to download (some sites may not be available).
4. Set the type of the ephemeris (Ultra rapid, Rapid SP3, Final SP3)
5. Click Star to download.

8.5 Rinex Convert Tool

Rinex convert tool can convert the static data collected by the Satlab receiver to the Rinex file. Click Tool → RINEX Convert Tool, a window like Figure 8-5-1 will be displayed.

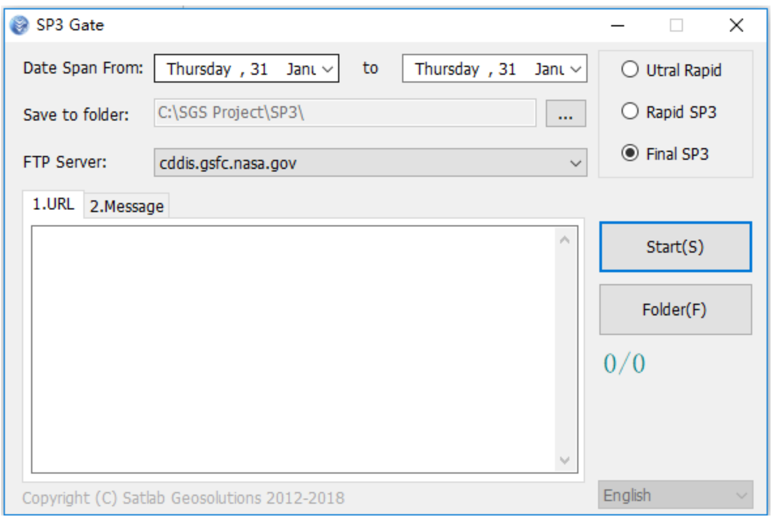


Figure 8-4-1 SP3 Gate

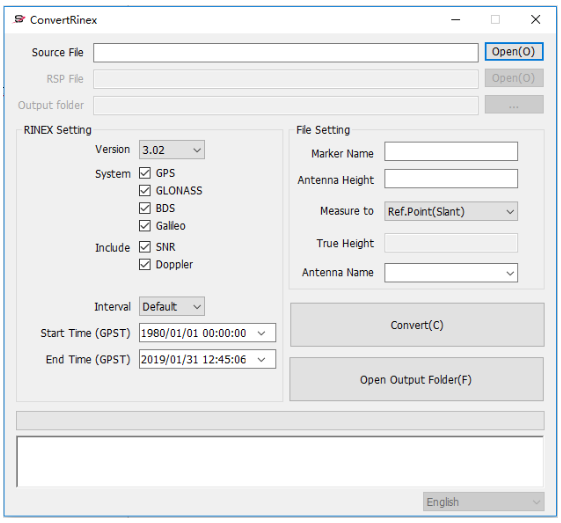


Figure 8-5-1 Convert Rinex

This tool is identical to the Rinex conversion settings and functions of the SGS main interface, so that won't be covered again here. After setting the configuration item, click Convert to complete the work.

The SGS tools include Antenna Manager, Star Report, Coordinate Transformation, SP3 Gate, Rinex Convert and so on. This chapter focuses on how to use these tools and how to deal with frequently asked problems. When installing SGS software, select all the installations and these tools will be installed in the "Bin" directory of the software and provide shortcuts.

Chapter 9

Appendix

This chapter contains:

- **Terminology Notes**
- **RINEX Format Description**

9.1 Terminology Notes

1. IGS

International GPS Service (IGS), based on the global ground-based GPS continuous operation station, is an example of GPS continuous operation network and comprehensive service system. It provides GPS users with various free information, such as GPS precise ephemeris, fast ephemeris, forecast ephemeris, IGS station coordinates and their motion rate, phase and pseud-orange data of GPS signals received by IGS stations, and earth rotation rate. It supports countless scientific projects in geodesy and geodynamics, including ionosphere, meteorology, reference frames, precise time transfer, high-resolution Estimate of Earth's rotation rate and its changes, and crustal movement. DORIS in France and PRARE in Germany are also considering the establishment of similar international organizations to make sure such space geodetic observation system are more efficient, automated, accurate and reliable.

2. Ambiguity

The unknown integer number of cycles of the reconstructed carrier phase contained in an unbroken set of measurements from a single satellite pass at a single receiver.

3. Baseline

The length of the three-dimensional vector between a pair of stations for which simultaneous GPS data has been collected and processed with differential techniques.

4. Broadcast Ephemeris

Satellite orbital parameters obtained by demodulation in a message published by a satellite.

5. SNR (Signal-to-noise Ratio)

The ratio of signal power to noise power at an endpoint.

6. Cycle Slip

A phenomenon under the interference, the loop jumps from a balance point for several cycle and stabilizes at a new equilibrium point, causing the integer period of phase to produce an error.

7. Carrier Wave

A radio wave having at least one characteristic (e.g., frequency, amplitude, phase) which may be varied from a known reference value by modulation.

8. C/A Code

The Coarse/Acquisition GPS code modulanted on the GPS L1 signal. This code is a sequence of 1203 pseudorandom binary biphase modulations on the GPS carrier at a chipping rate of 1.023 MHz, thus having a code repetition period of one millisecond.

9. Difference Measurement

GPS measurements can be differenced across receivers, across satellites and across time. Although many combinations are possible, the present convention for GPS phase measurement differencing is to perform the differences in the above order: first across receivers, second across satellites and third across time.

- Single difference measurement (across receivers) is the instantaneous difference in phase of a received signal, measured by two receivers simultaneously observing one satellite.
- Double difference measurement (across receivers and satellites) is obtained by differencing the single difference for one satellite with respect to the corresponding single difference for a chosen reference satellite.

- Triple difference measurement (across receivers, satellites and time) is the difference between a double difference at one epoch of time and the same double difference at another epoch of time.

10. Difference Positioning

Determination of relative coordinates between two or more receivers which are simultaneously tracking the same GPS signals.

11. Geometric Dilution of Precision

In dynamic positioning, a factor describing the contribution of satellite geometry position to error. Expression:

$DOP = \sqrt{tr\left(Q^T Q\right)^{-1}}$ Where Q is the matrix factor of the instantaneous dynamic position solution (depending on the location of the receiver and satellite).

Table 9-1-1 Several Standard Terms in GPS

Name	Meaning
GDOP	4-D geometric factor
PDOP	3-D coordinate geometric factor
HDOP	2-D coordinate geometric factor
VDOP	Elevation geometric factor
TDOP	Clock difference factor 1:40,000
HTDOP	Elevation and clock difference geometric factor

12. Dynamic positioning

A method determining the coordinate of the moving rover changed with time.

Each measurement result is obtained from a single data sample and calculated in real time.

13. Eccentricity

$e = \sqrt{\frac{a^2 - b^2}{b^2}}$ a: semi-major axis
b: semi-minor axis.

14. Ellipsoid

In geodesy, a mathematical figure formed by revolving an ellipse about its minor axis. Two quantities define an ellipsoid; these are usually given as the length of the semi-major axis a and the flattening f. $f = \frac{1}{a}(a - b)$

15. Ephemeris

The energetic parameters of the position of a celestial body with time.

16. Flattening

Relating to Ellipsoids $f = \frac{1}{a}(a - b) = 1 - \sqrt{(1 - e^2)}$ a: semi-major axis; b: semi-minor axis.; e: eccentricity

17. Geoid

The particular equipotential surface which coincides with mean sea level, and which may be imagined to extend through the continents. This surface is always perpendicular to the direction of the force of gravity.

18. Ionosphere Delay

A wave propagating through the ionosphere (which is a non-homogeneous and dispersive medium) experiences delay. Phase delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.

19. L-band

The radio frequency band extending from 390 MHz to 1550 MHz.

20. Multipath Error

A positioning error resulting from interference between radio waves which have travelled between the transmitter and the receiver by two paths of different electrical lengths.

21. Observing Session

A period of time for collecting GPS data simultaneously using more than two receivers

22. Pseudo Range

A measure of the apparent signal propagation time from the satellite to the receiver antenna, scaled into distance by the speed of light. The apparent propagation time is the difference between the time of signal reception (measured in the receiver time frame) and the time of emission (measured in the satellite time frame).

23. Receiver Channel

The Radio, Mixing and Intermediate frequency channel in the GPS receiver which can receive and track the two carrier frequency signals of the satellite.

24. Satellite Configuration

The state of the satellite constellation at a specific time, relative to a specific user or set of users.

25. Static Position

The measurement of point position, without taking into account the motion of the receiver.

26. Universal Time

Local solar mean time at Greenwich Meridian.

UT: Abbreviation for universal time UT0.

UT0: As deduced directly from observation of stars.

UT1: UT0 corrected for polar motion.

UT2: UT1 corrected for seasonal variations in the Earth’s rotation rate.

UTC: Universal Time Coordinated; uniform atomic time system kept very close to UT2 by offsets.

27. Interval

The process of taking a continuous variable value at periodic intervals.

28. Condition of Observation

The geometric figure and trajectory of the satellite constellation.

9.2 RINEX Format Description

9.2.1 Observation Data File

This file contains header blocks and data blocks. Figure 9-2-1 lists the header blocks for this file and figure 9-2-2 lists the data blocks for this file. Here are just a few of the nouns in the observations.

1. Time: Refers to measuring time which signal arrives at the receiver
2. Pseudo range: Measurement of the apparent signal propagation time from the satellite to the receiver antenna, scaled into distance by the speed of light. In RINEX, there are three kinds of pseudo range observations: C1 is L1's C/A code, P1 is L1's P code and P2 is L2's P code. Because of the AS policy, many receivers cannot get the P code of L2, instead of that, adopting the related technology to find out the Y2-Y1 time delay to eliminate ionosphere influence. In this case, in RINEX, the time delay between C/A code and Y2-Y1 is converted to the synthesized P2 code.
3. Phase: It is a small value over the entire week of the beat frequency at the L1 and L2 frequencies. When the square technique extracts the phase, it is a small value in half a week and must be converted to an entire week.
4. Doppler: The receiver uses a specific processing software to record the Doppler value D1 and D2 and take Hz as the unit.

In all above records, the three observations must be consistent in time. If the external frequency standard is used to correct and set the time error correction number as τ, the following measurements are as follows:

$\rho(corr) = \rho(recv) - c \times \tau$

$T(corr) = T(recv) - \tau$

$L1(corr) = L1(recv) - F \times \tau$

Figure 9-2-1 Description of Navigation File Header Block

Header Name 61 ~ 80 Columns	Description	Format
RINEX VERSION/TYPE	Version format (2) File type O——Observation data Positioning system G——GPS R——GLONASS M——MIXED	16, 14X A1, 19X A1, 19X
PGM / RUN BY / DATE	Name of file outline Name of file institution Date of document creation	A20, A20, A20
COMMENT	Comments	A60
MARKER NAME	The name of measuring point	A60
MARKER NUMBER	The number of measuring point	A20
OBSERVER / AGENCY	Name or agency of the observer	A20, A40

REC# / TYPE / VERS	Receiver number, model and software version	3A20
ANT# / TYPE	Number and type of antenna	2A20
APPROX POSITION XYZ	Approximate position XYZ	3F14.4
ANTENNA: DELTA H/E/N	Antenna height H Eastward eccentricity of antenna E Westward eccentricity of antenna N	3F14.4
WAVELENGTH FACT L1/2	Wavelength factors of L1/L2 1: Integer ambiguity 2: Semi-cycle ambiguity 0: L1 Single frequency Number of tracking satellites (maximum 7, more than 7 duplicate re-cords) PRN Satellite number	2I6 I6 7(3X,A1,12)
# / TYPES OF OBSERV	The number of different observation types in the file Definition of observation type: L1, L2: L1, L2 phase observations(cycle) C1: C/A pseudo range measurements of L1 (m) P1, P2: L1, L2 P code pseudo range measurement (m) D1, D2: Doppler pseudo range measurement of L1 and L2 (Hz) T1, T2: The integral Doppler observation of meridian instrument (cycle) After the implementation of AS, L2 and P2 are changed.	I6 9(4X,A2)
INTERVAL	Interval of observation (s)	I6
TIME OF FIRST OBS	Starting time of observation (year, month, day, hour, minute, second) Time system: GPS=GPS time system GLO=UTC time system Default value in GPS/GLONASS: GPS=plain GPS file GLO=plain GLONASS file	5I6, F12.6 6X, A3
TIME OF LAST OBS	Ending time of observation (year, month, day, hour, minute, second) Time system: GPS=GPS time system GLO=UTC time system Default value in GPS/GLONASS: GPS=plain GPS file GLO=plain GLONASS file	5I6,F12.6 6X,A3
LEAP SECONDS	In GPS/GLONASS, the slip second from January 6, 1980,	I6
#OF SATELLITES	The observation numbers of satellite contained in the document	3X, A1 ,I2,9I6 6X, 9I6
END OF HEADER	Header block terminator	60X

Figure 9-2-2 Description of Data Block of Observation File

Observation Record	Description	Format
EPOCH /SAT Or EVENT FLAG	Epoch: year, month, day, hour, minute, second Epoch sign 0: Normal 1: Interruption of epoch ≥1: Epoch flag The number of satellites in the current calendar The satellite number in the current epoch, if there are more than 12, then another line (A1, I2) Receiver clock (s) If there are more than 12 satellites, records continuously; If Epoch flag>1 then Epoch sign: 2: Start moving the antenna 3: Placed at a new point, the end of the moving 4：Header information 5: Exception (the epoch is too large) 6: The record of cycle slip The satellite numbers are recorded in both signs 2 and 5.	5I3, F11.7 I3, I3 I2(A1, I2) F12.9 32X,12(A1, I2)
OBSERVATIONS	Observation date LLI Signal strength The above data for each satellite is recorded in EPOCH/SAT. If more than 5 observations (80 byte), continue the next record. Observations： Phase: expressed as integer Pseudo range: expressed as meter Indicates that the measurement is lost LLI: Indicates the satellite lock status (0 ~ 7) Normal Default value AS exists Signal intensity 1: Minimum signal intensity 5: Moderate signal intensity 9: Maximum signal intensity 0: Do not consider	m (F14.3, I1, I1)

9.2.2 Navigation Data File

The satellite ephemeris is broadcast navigation message taken from the satellite, which is the basic data for calculating the ground position.

In the navigation message, the number of orbits, the satellite clock parameter, etc. are included. In order to accelerate the calculation of the ground point, the satellite sends the broadcast navigation message once per second, while the broadcast navigation message update every hour. So, each observation only needs to record a set of broadcast navigation messages. Figure 9-2-3 and figure 9-2-4 list the navigation file header block and data block, representatively.

Figure 9-2-3 Description of Navigation File Header Block

Header Name 61 ~ 80 Columns	Description	Format
RINEX VERSION / TYPE	Version format (2) File type (N——navigation data)	I6, 14X, A1, 19X
PGM / RUN BY / DATE	Name of file outline Name of file institution Date of document creation	A20 A20 A20
COMMENT	Comments	A60
TON ALPHA	Ionosphere parameters A0—A3	2X, 4D12.4
ION BETA	Ionosphere parameters B0—B3	2X, 4D12.4
DELTA-UTC	almanac parameters for calculating UTC time	
A0, A1,T,W	A0, A1: Calculate the parameter of time correction T : Reference time of UTC data W : Reference weeks of UTC	
LEAP SECONDS	Time variation due to leap seconds	I6
END OF HEADER	Header block terminator	60X

Figure 9-2-4 Description of Navigation File Header Block

Observation Record	Description	Format
PRN /EPOCH / SV CLK	PRN Satellite number Epoch: TOC——Time of clock Year (two digits); Month; Day; Hour; Minute; Second. Satellite clock error (S) Satellite clock drift (s/s) Rate of satellite clock drift (s/s2)	5I3, F11.7 I3, I3 I2(A1, I2) F12.9 32X,12(A1,I2)
BROADCAST ORBIT-1	IODE Expiry date of ephemeris data Crs (m) Δ n (rad/s) M0 (rad)	3X, 4D19.12
BROADCAST ORBIT-2	Cuc (rad) e flattening Cus (rad) ()	
BROADCAST ORBIT-3	Toe time of ephemeris Cic (rad) Ω (rad) Cis (rad)	3X,4D19.12
BROADCAST ORBIT-4	I (rad) Crc (m) Ω (rad) Ωdot (rad/m)	3X,4D19.12
BROADCAST ORBIT-5	Idot (rad/s) L2 TOE L2 P Data label	3X,4D19.12
BROADCAST ORBIT-6	Satellite precision (m) Mobile Station Based (MSB) TGD (S) IDOC Expiry date of clock data	3X,4D19.12
BROADCAST ORBIT-6	Message sending time (GPS week seconds - counting from the Z of the word HOW)	3X,4D19.12

Headquarter:
Datavägen 21B
SE-436 32 Askim,Sweden
info@satlab.com.se
Regional Offices:
Warsaw, Poland
Jičín, Czech Republic
Ankara, Turkey
Scottsdale, USA
Singapore
Hong Kong
Dubai, UAE

www.satlab.com.se

19M221