**KNZ\_GeoTrackLab ver 1.5.1** 2024/10/26

Help documentation

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Project site address: [***https://github.com/KenanZhu111/KNZ\_GeoTrackLab***](https://github.com/KenanZhu111/KNZ_GeoTrackLab)

# **A. Operation introduction**

a.) Introduction:

a) Project development history:

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Version | Program Name | Update |
| 2024.09.21 | 1.0.0 | None (Console program) | New release |
| 2024.09.28 | 1.0.8 | SPP\_Calculate (GUI) | First release SPP\_Calculate. |
| 2024.10.05 | 1.1.0 | SPP\_Caluclate & SPP\_Plot (GUI) | First release SPP\_Plot |
| 2024.10.06 | 1.1.2 | SPP\_Caluclate & SPP\_Plot (GUI) | [See update notes](#_E._Update_notes:) |
| 2024.10.08 | 1.1.9 | KNZ\_Caluclate & KNZ\_Plot (GUI) | [See update notes](#_E._Update_notes:) |
| 2024.10.14 | 1.3.1 | KNZ\_Caluclate & KNZ\_Plot (GUI) | [See update notes](#_E._Update_notes:) |
| 2024.10.26 | 1.5.1 | KNZ\_GeoTrackLab (GUI) | [See update notes](#_E._Update_notes:) |

The project has undergone two renames, as well as major software updates. The first time is rename form SPP\_Calculate to KNZ\_Satnav. The second time is rename as KNZ\_GeoTrackLab, this update represents an important step forward for the project, entering a new phase.

From the very beginning of the console program, to now the full GUI interface, and the latest update of the 3D drawing module, cannot be separated from the support and encouragement of friends and relatives, but also accompanied by the guidance of good teachers, but also to learn and absorb the wisdom of many developers on the Internet, I would like to express my thanks here.

The development of this software is based on or using the products or open source software of the following companies, which are listed here to express my gratitude:

Microsoft: Visual Studio Community 2022, Visual Studio Code

JetBrains: PyCharm Community Edition 2024.2.1

MathWorks: MATLAB R2021b

RTKlib: RTKlib ver2.4.3 b34 ([***https://www.rtklib.com/***](https://www.rtklib.com/) )

b) Program main function introduction:

KNZ\_GeoTrackLab(later replaced by "this program"), mainly supports the following functions:

Support version of RINEX:

[RINEX of Observation of version 2.xx.](https://github.com/KenanZhu111/KNZ_Convert)(Support by KNZ\_Convert)

RINEX of Observation & Navigation of version 3.xx.

RINEX of Observation of version 4.xx.

Support system of GNSS:

GPS: Satellite position solving & Receiver station orientation.

Galileo : Satellite position solving & Receiver station orientation.

GLONASS : Satellite position solving.

BeiDou / Compass : Satellite position solving.

Support method of orientation:

Pseudorange positioning.

Features ：

Realize 3D display of satellite orbit.

c) Program interface introduction:

文本

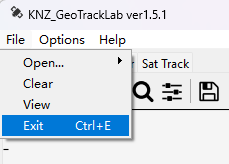
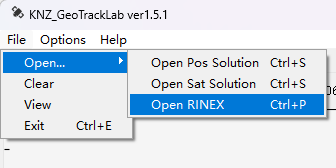
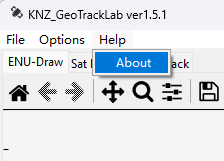
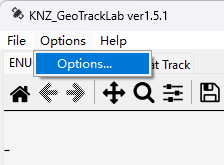
低可信度描述已自动生成The program is mainly composed of two parts, one is the executable file of the program, the second part is the function dynamic link library used to calculate the satellite position:

A-a-c-1. Program Structure

图表

描述已自动生成The following figure is the main interface of the program, which consists of the tool menu, drawing tab, drawing area and bottom status bar, The top toolbar consists of three parts, including file operations, setting options, and about information. The drawing tab mainly contains three types of image displays: ENU image of positioning accuracy, number of available satellites for positioning, and 3D satellite trajectory map.

A-a-c-2. Main program interface

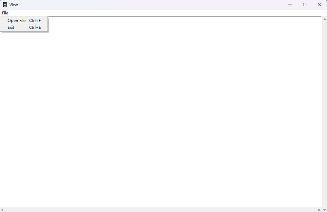
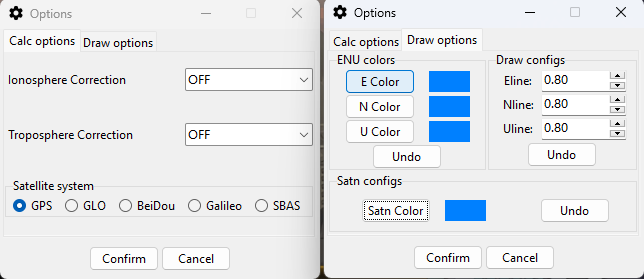
Click the top menu option to display the following interfaces:

A-a-c-6. Help card

A-a-c-4. File >Open… card

A-a-c-3. File card

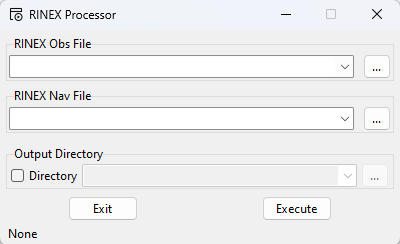
A-a-c-5. Options card

After clicking on the options such as Figure A-a-c-3(“View”). 4(“Open RINEX”). 5 . 6, the following windows will pop up respectively:

A-a-c-8. Options window(The two tabs are displayed on the left and right)

A-a-c-7. View window

For specific interface operation logic, please see the following text图形用户界面, 文本, 应用程序

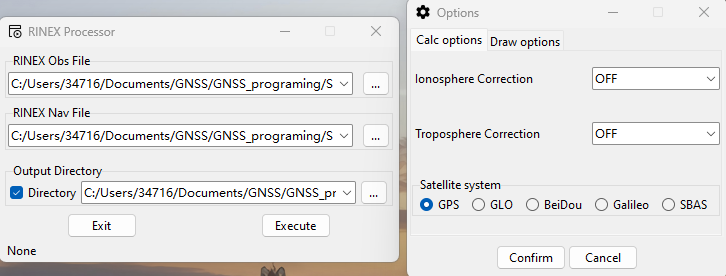
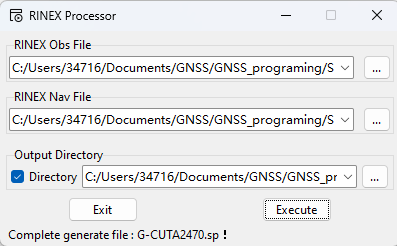
描述已自动生成.

A-a-c-10. About window

A-a-c-9. RINEX Processor window

b.) Read RINEX file:

a) Input the Obs & Nav file & Output sat solution file:

The current software only supports reading RINEX 3.xx version observations and broadcast ephemeris files. For specific support information, see A-b. First, open the File menu option, click the Open... secondary menu, select Open RINEX, and select the RINEX file input path in the pop-up interface. If the save path for the sat solution (.sp) is not selected, it will be generated in the same directory as the observation file. Click Execute, wait for the status bar to generate information like “Complete generate file : \*.sp”, and generate the sat solution (.sp). It should be noted that the specific generated GNSS needs to be selected by clicking the Options menu option (SBAS is not supported yet).

A-b-a-2. RINEX Process ok

A-b-a-1. RINEX Process into sat solution

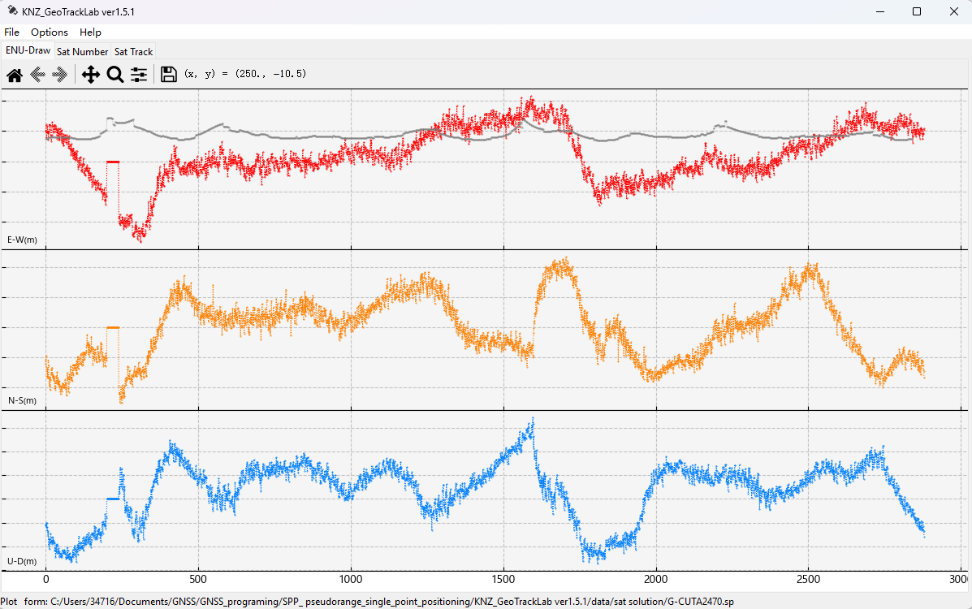
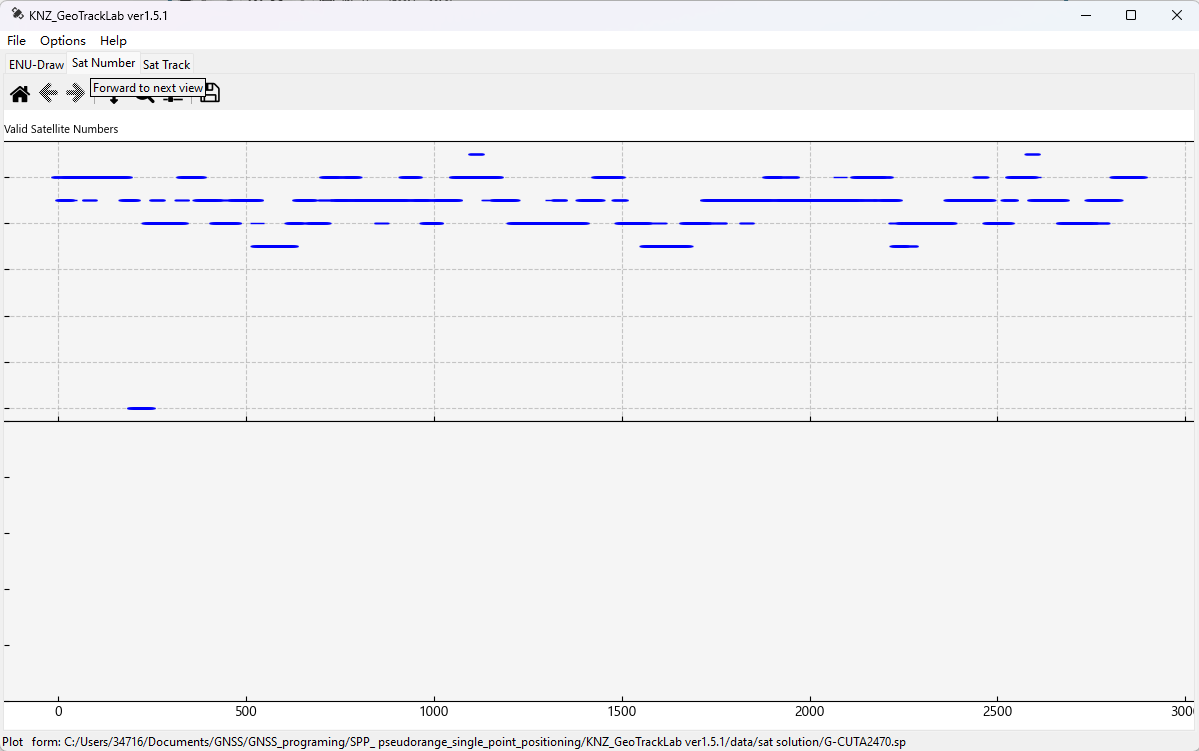
After processing, a sat solution (.sp) will be generated in the specified folder or in the same directory as the observations. For detailed information about the Sat solution (.sp) file, see section e.) of this chapter.

c.) Read sat solution:

a.) Read options:

First of all, you need to understand that the naming of the generated sat solution (.sp) file is related to the satellite system. A sat solution file only stores the solution of one satellite system, so mismatched system selection will cause data reading error. The operation is the same as when generating the solution. Open the Options window, select the ionospheric and tropospheric correction mode in Calc options, and select the matching satellite system. Switch to Draw options to adjust the image quality, such as the color and quality of the image.

图表

描述已自动生成 After completing the tab settings, you can open the sat solution (.sp) for positioning and analysis:

A-c-a-3. 3D figure of satellite trajectory

A-c-a-2. Figure of valid satellite numbers

A-c-a-1. Position solution figure of ENU(WSD)

Thanks to the powerful functions of the matplotlib open source module, you can use the toolbar above the image area to scale, move, save, and other operations on the image.

d.) Read pos solution:

a.) Generate source:

pos solution (.po) is the generation plan of sat solution, which is the positioning result of the receiver. It can be read through the Read Pos Solution menu tab. Unlike sat solution, the reading result of pos solution only contains the station positioning result, so it cannot generate the figure of satellite orbit track. For a detailed introduction to POS solution (.po), please refer to section f.) of this chapter.

e.) File format (.sp):

a.) Name of file (.sp) :

The sat position file name consists of two parts. The capital letter at the beginning indicates the satellite system to which the solution belongs:

G > GPS

E > Galileo

C > BeiDou / Compass

R > GLONASS

S > SBAS

The second part is the RINEX original observation file name, ending with the .sp extension.

b.) Header data of file (.sp) :

The header file data mainly indicates the necessary information of the file generation date and the original observation value. The following is a detailed introduction:

|  |  |  |
| --- | --- | --- |
| Header Label | Description | Format |
| GENERATE PROGRAM | Program that generate this file. | 24S 1X -40C |
| GENERATE TYPE | The data type of this file. | 24S 1X -20C |
| GENERATE TIME | The time of this file was generated:  DayofWeek Mon. DayofMonth Time Year | 24S 1X 3C 1X 3C 1X HH-MM-SS 1X 4D |
| OBS FILE PATH | File path of RINEX observation file. | 24S 1X -260C |
| NAV FILE PATH | File path of RINEX navigation file. | 24S 1X -260C |
| TIME OF FIRST OBS | Time of first observation record :  Year Month Day Hour Min Sec | 24S 1X 4D 4X 2D 1X 7.4F |
| TIME OF LAST OBS | Time of last observation record :  Year Month Day Hour Min Sec | 24S 1X 4D 4X 2D 1X 7.4F |
| APPROX POSITION XYX | The approximate position in ECEF of receiver station in observation file. | 24S 3X 13.4F |
| APPROX POSITION BLH | The approximate position in BLH of receiver station. | 24S 3X 13.4F |
| END OF HEADER | The end sign of header file. | 1S |

c.) Body data of file (.sp) :

The file body information mainly includes the satellite position data and pseudo-range measurement information in the ECEF coordinate system calculated from the observation values ​​and navigation files, which are necessary data for orbit trajectory mapping and station position settlement. The following is a detailed introduction:

|  |  |
| --- | --- |
| Data Format | Description |
| >4D 4D 2D 2D 2D 2D 7.4F | Epoch number & Epoch time |
| XX2D | 15.5F 15.5F 15.5F 15.5F 15.5F 15.5F 16.13F | XX > Satellite system:  G > GPS  E > Galileo  CB > BeiDou-2  CC > BeiDou-3  R > GLONASS  S > SBAS  2D > sPRN  15.5F 15.5F 15.5F > X. Y. Z.  15.5F 15.5F 15.5F > CX. CY. Elev. |
| Example | |
| >0025 2024 01 01 00 00 00.0000 | |
| G 01 | … (The data is too long, omitted here) | |

f.) File format (.po):

a.) Name of file (.po)

The sat position file name consists of two parts. The capital letter at the beginning indicates the satellite system to which the solution belongs:

G > GPS

E > Galileo

C > BeiDou / Compass

R > GLONASS

S > SBAS

The second part is the RINEX original observation file name, ending with the .po extension.

b.) Header data of file (.po)

The header file has the same function as .sp, so I won't go into details here.

|  |  |  |
| --- | --- | --- |
| Header Label | Description | Format |
| GENERATE PROGRAM | Program that generate this file. | 24S 1X -40C |
| GENERATE TYPE | The data type of this file. | 24S 1X -20C |
| GENERATE TIME | The time of this file was generated:  DayofWeek Mon. DayofMonth Time Year | 24S 1X 3C 1X 3C 1X HH-MM-SS 1X 4D |
| GENERATE SYS | Satellite system: | 24S 1X 1C >  G > GPS  E > Galileo  C > BeiDou  R > GLONASS  S > SBAS |
| IONOS OPT | Ionospheric Correction Model | 24S 1X 15S |
| TROPO OPT | Tropospheric Correction Model | 24S 1X 15S |

c,) Body data of file (.po)

|  |  |
| --- | --- |
| Data Format | Description |
| 4D/2D/2D/2D/2D/04.1F 12.4F 12.4F 12.4F 3D 10.5F 10.5F 10.5F | Year Month Day Hour Min Sec  Station > X. Y. Z.  Delta > B. L. H. |
| Example | |
| 2024/01/01/00/00.0 …(The data is too long, omitted here) | |

# **B. Plot introduction:**

图表, 折线图

描述已自动生成a.) ENU (WSD) Plot:

B-a-1. Figure of ENU(WSD)

This figure shows the deviation between the receiver position calculated after satellite pseudo-range positioning and the actual position. It is specifically shown in three directions: E (east), N (north), and U (up). After reading the sat solution, the GDOP value of the positioning will be displayed on the image in the E direction (gray thin line). Missing epoch information will be calculated by default as 0

图片包含 图表

描述已自动生成b.) Valid satellite number:

B-b-1. Figure of valid satellite numbers

This figure shows the number of satellites available for position solution in the solved epoch number, and the trend of the number of satellites is shown in the scatter plot.

图表

描述已自动生成c.) Satellite orbit track (3D):

B-c-1. Figure of satellite trajectory

This graph is only generated after reading the sat solution. Based on this graph, the satellite trajectory at the subsatellite point of the station can be analyzed, thereby analyzing the satellite trajectory and satellite visibility, and analyzing the impact of satellite distribution on the station solution.

# **C. Q&A:**

Q: Is the software and source code before this version still available?

A: No, because some fundamental calculation logic has changed after the module merger, and the output file format is not compatible, so it has been abandoned. The source code can be obtained in the code modification history.

Q: When will the pseudo-range single point positioning of GLONASS and BeiDou be realized?

A: Not sure yet, this is a systematic work and it will take more time to deal with the details.

Q: 3D drawing is running very slowly, can this be fixed?

A: This is a problem with the matplotlib module, which requires hardware support. I am not clear about the principles of graphics card hardware calls, so I will not consider changing it for the time being. However, I can improve fluency by changing the data sampling rate.

Q: What is the purpose of the blank area below the satellite count plot?

A: That is a drawing area reserved in advance for subsequent development. Later, we will consider developing data visualization analysis of RINEX observation files, such as the number of visible satellite bands. Combined with the broadcast ephemeris, we can draw images of satellite health status, etc. The specific details will be based on the development progress.

Q: Does the program support RINEX observation files and broadcast ephemeris files of version 2.xx?

A: The software itself does not support it. The software was originally developed based on RINEX 3.xx observations and broadcast ephemeris files. However, you can use another tool software developed by me to convert the 2.xx version of RINEX observation files to perform the corresponding pseudorange positioning. However, the software does not natively support the reading of RINEX 2.xx version of broadcast ephemeris. As for other types of files other than RINEX 3.xx observations and broadcast ephemeris files, the software does not support them. There is no relevant development plan for the time being.

Q: Does the software support phase observation type, differential positioning, precise single-point positioning and other positioning methods?

A: No, due to limited knowledge accumulation and development experience, I am not yet able to carry out relevant development

# **D. Quote:**

Websites:

| [*https://blog.csdn.net/why1472587?type=blog*](https://blog.csdn.net/why1472587?type=blog)  
| [*https://zhuanlan.zhihu.com/p/416072448*](https://zhuanlan.zhihu.com/p/416072448)  
| [*https://www.pygmt.org/latest/index.html*](https://www.pygmt.org/latest/index.html)  
| [*https://blog.csdn.net/FrankXCR/article/details/135438701*](https://blog.csdn.net/FrankXCR/article/details/135438701)

| [*https://www.csno-tarc.cn/system/constellation*](https://www.csno-tarc.cn/system/constellation)

| [*https://www.researchgate.net/figure/GLOANSS-ground-tracks-of-satellites\_fig2\_383590476*](https://www.researchgate.net/figure/GLOANSS-ground-tracks-of-satellites_fig2_383590476)

|

Papers:

| *[1]葛奎,王解先. GLONASS卫星位置计算与程序实现[J]. 测绘与空间地理信息,2009,32(02):137-140.*

| *[2]龚明杰."GPS与GLONASS多频组合伪距单点定位精度分析." 测绘与空间地理信息 45.02(2022):115-117+122.*

| *[3]王强昆, 谢卫杰,and 王耀鑫."BDS-2/BDS-3伪距单点定位精度分析." 测绘与空间地理信息 44.10(2021):156-159.*

# **E. Update notes:**

Rename the Project & Update: 2024/10/26 ver 1.5.1

1. First release KNZ\_GeoTrackLab.
2. KNZ\_Calculate: Merged with KNZ\_Plot.
3. KNZ\_Plot: Merged with KNZ\_Calculate.
4. KNZ\_GeoTrackLab: Support GPS & BeiDou & Galileo & GLONASS.

Update: 2024/10/14 ver 1.3.1

1. KNZ\_Calculate: Support GPS & BDS & Galileo.
2. KNZ\_Plot: Support GPS & Galileo.

Update: 2024/10/09 ver 1.2.0

1. KNZ\_Calculate: Modify some crash.
2. KNZ\_Calculate: Optimize use experience.
3. KNZ\_Plot: Modify UI..

Rename the Project & Update: 2024/10/08 ver 1.1.9

1. First release KNZ\_Plot ,KNZ\_Calculate.
2. KNZ\_Plot: Modify UI.
3. KNZ\_Calculate: Modify UI.

Update: 2024/10/06 ver 1.1.2

1. SPP\_Plot: Fix some bug.
2. SPP\_Plot: Optimize use experience.
3. SPP\_Calculate: Optimize code structure.
4. SPP\_Calculate: Modify UI.

Update: 2024/10/05 ver 1.1.0

1. First release SPP\_Plot
2. SPP\_Calculate: Modify UI.

Update: 2024/09/28 ver 1.0.8

1. First release SPP\_Calculate.
2. Optimize code structure.

Update: 2024/09/26 ver 1.0.3

1. Fix some bug.
2. Optimize use experience.

Update: 2024/09/23 ver 1.0.2

1. Fix some bug.
2. Modify some crash.

Update: 2024/09/22 ver 1.0.1

1. Fix some bug.
2. Modify UI.

Update: 2024/09/21 ver 1.0.0

1. Fix some bug.
2. Optimize use experience.

Update: 2024/09/20 ver 0.9.1

1. First release.