A GUIDE TO USE NET_DIFF

Version 1.14

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Contents

1 Overview

Net_Diff is a software for GNSS Download, Positioning and Analysis.

It enables users to perform SPP/PPP/PPP-AR/DSPP/DPPP/RTK/PPP-RTK. All the signals of the current GPS/GLONASS/BeiDou/Galileo/QZSS/IRNSS are supported from single-frequency to triple-frequency. It can also be applied in SPP/PPP with BeiDou augmentation information (authorized user).

It supports data analysis, including coordinate plotting, coordinate comparison, satellite number, PDOP, satellite skyview, satellite visibility, cycleslip, troposphere, ionosphere, observation minus correction, positioning residuals plotting and KML file writing.

It provides GNSS observation data and products download from many public FTP servers.

It also provides some useful tools such as time and coordinate system transferring, RTCM data receiving through Ntrip and TCP/IP, raw data converting, RINEX editing, ssr dumping, CLALIB and so on.

It provides a simple satellite orbit simulation.

Moreover, it supports multi-station PPP, clock estimation, DCB estimation based on GNSS net (authorized user).

The software is available on GitHub: https://github.com/YizeZhang/Net_Diff. You can find the latest version on the website.
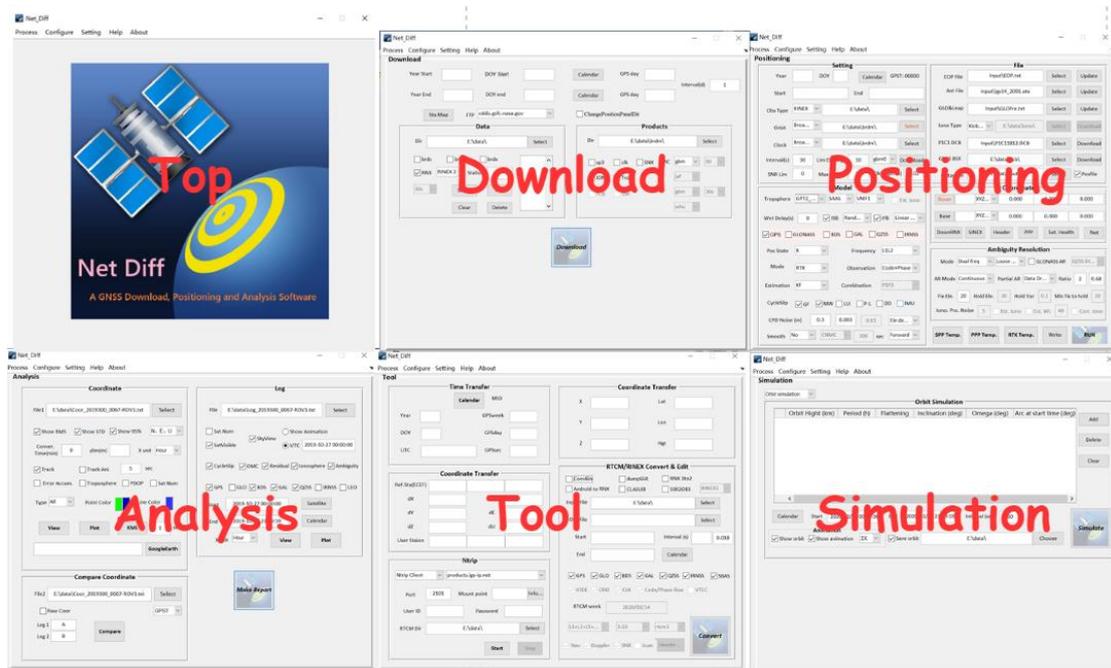
Fig 1. GUI of Net_Diff

➢ **New features of v1.1:**

1. Modify long baseline RTK;

2. More robust RTK under urban environment;

3. Add Time and Coordinate transfer tool;

4. Add RINEX editing;

5. Support command line input for better batch process;

➢ **New features of v1.2:**

1. Support tightly combined GNSS RTK;

2. Add .pos file output for RTKPLOT;

➢ **New features of v1.3:**

1. Support GLONASS AR in GNSS RTK;

2. Add Android raw data convert to RINEX;

➢ **New features of v1.4:**

1. Support mix-frequency mix-observation combination on each satellite system;

2. Support PPP-AR;

3. Support un-differenced un-combined PPP

➢ **New features of v1.5:**

1. Support triple-frequency un-differenced un-combined PPP;

2. Support PPP-RTK (CLAS)

➢ **New features of v1.6:**

1. Support new signal of BDS (B1c/B2a) and GLONASS (G3), Galileo (E6), QZSS (L6)

➢ **New features of v1.7:**

1. Support network PPP solution

2. Support loosely coupled PPP/INS and RTK/INS

➢ **New features of v1.8:**

1. Support SSR correction in PPP

2. Support receive RTCM message from Ntrip (Adapt from goGPS)

3. Support dump RTCM SSR and conversion of various types of raw data to RINEX (Adapt from RTKLIB)

➢ **New features of v1.9:**

1. Support DCB estimation, framework maintenance, and add tool of CLASLIB.

➢ **New features of v1.10:**

1. Support orbit simulation

2. Support BDS-3 PPP for all BDS signals.

➢ **New features of v1.11:**

1. Support moving baseline RTK

2. Support SSR based PPP-AR

3. Support ionospheric-free combination based PPP-AR

➢ **New features of v1.12:**

1. Support triple-frequency RTK/PPP-AR

➢ **New features of v1.13:**

1. Support SSR generation for PPP-RTK

2. Support fast PPP

2. Support PPP-AR for time and frequency transfer

➢ **New features of v1.14:**

1. Open functions of PPP-RTK, multi-station PPP

2. Fix bugs of data downloading

3. Open functions of positoning processing using command line

2 How to Install

After you download files from GitHub, please follow the steps to install Net_Diff.

➢ **1 Install gzip**

Click *gzip-1.3.12-1-setup.exe* and install gzip. For example, after installing it, gzip.exe is under C:\Program Files (x86)\GnuWin32\bin\

➢ **2 Install Net_Diff**

a) If you have installed MATLAB R2017a or MATLAB Runtime version 9.2 (R2017a) in your computer.

Open /for_redistribution_files_only/ and click *Net_Diff.exe*

b) If not.

Open /for_redistribution/ and click *Net_Diff_Installer_web.exe* to install MATLAB Runtime and Net_Diff. Please keep your computer connected to the internet while installing. It will take a few

minutes to download MATLAB Runtime, please be patient.

If error occurs in connecting MathWorks, try to rerun the installer, or check the firewall, proxy server or virus scanner settings.

If error occurs in downloading MATLAB Runtime 9.2, please download or update it by hand from: https://ww2.mathworks.cn/products/compiler/matlab-runtime.html.

If the above still doesn't work, go to a).

After finishing installing, you can find the execute file from the installed directory, for example, D:\Program Files\ Net_Diff\application\.

➢ **3 Set environment variables**

This step is to automatically unzip the downloaded file and convert the crx file to rinex file if you want to download or update files in Net_Diff. To do this, please:

Add the path of **gzip.exe** (C:\Program Files (x86)\GnuWin32\bin\) and **crx2rnx.exe** (C:\Net_Diff\application\) to the PATH of system environment variables on your computer:

My computer→Properties→Advanced system setting→Environment variables→Edit the PATH environment variable→Add path.
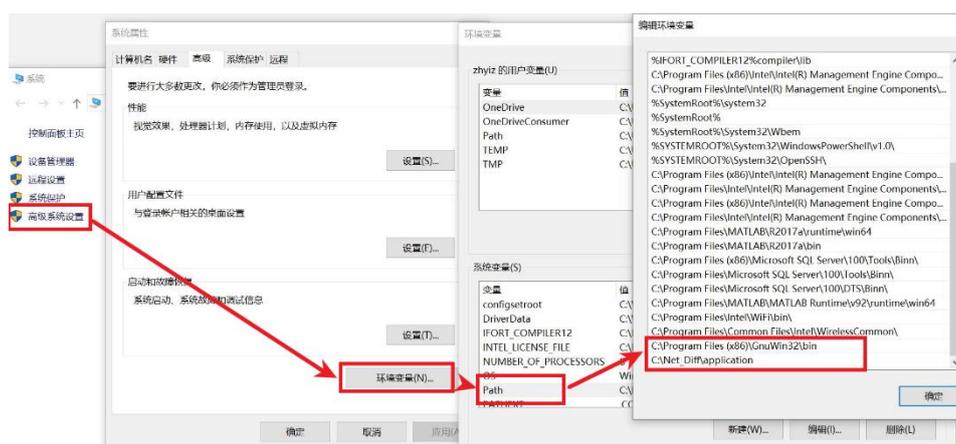
Fig. 2 Set environment variables

To check whether the environment variable of gzip and crx2rnx are properly set, you can check them in the command window.

Fig. 3 Check whether the environment variables of gzip and crx2rnx are set

If you have problems in setting the environment variables, you can simply copy C:\Program Files (x86)\GnuWin32\bin***gzip.exe*** to C:\Net_Diff\application and run Net_Diff from C:\Net_Diff\

application. When running Net_Diff from the Windows Start or the Desktop, you should also copy C:\Program Files (x86)\GnuWin32\bin***gzip.exe*** and C:\Net_Diff\application**crx2rnx.exe** to the folder of C:\Windows\System32 or Desktop.

Notes:

1. If you run Net_Diff from the Windows Start or Desktop, please select the correct directory of the EOP file, Ant File and GLO&Leap file in the ***Input*** folder (C:\Net_Diff\application\Input) every time. Therefore, it is recommended to run Net_Diff from the execute file (You can also copy the folder of C:\Net_Diff\application to any other directories).

2. If the directory of Net_Diff.exe is not allowed to write files, try to run Net_Diff.exe from the administrator.

3. When updating Net_Diff, you only need to copy the updated files in *for_redistribution_files_only/* to *C:\ Net_Diff\application*.

3 How to Run

After installing the software properly, you can start to run it.

Click ***Net_Diff.exe***, a DOS-like window will appear, then after a few seconds, the main GUI of Net_Diff will be shown as below.
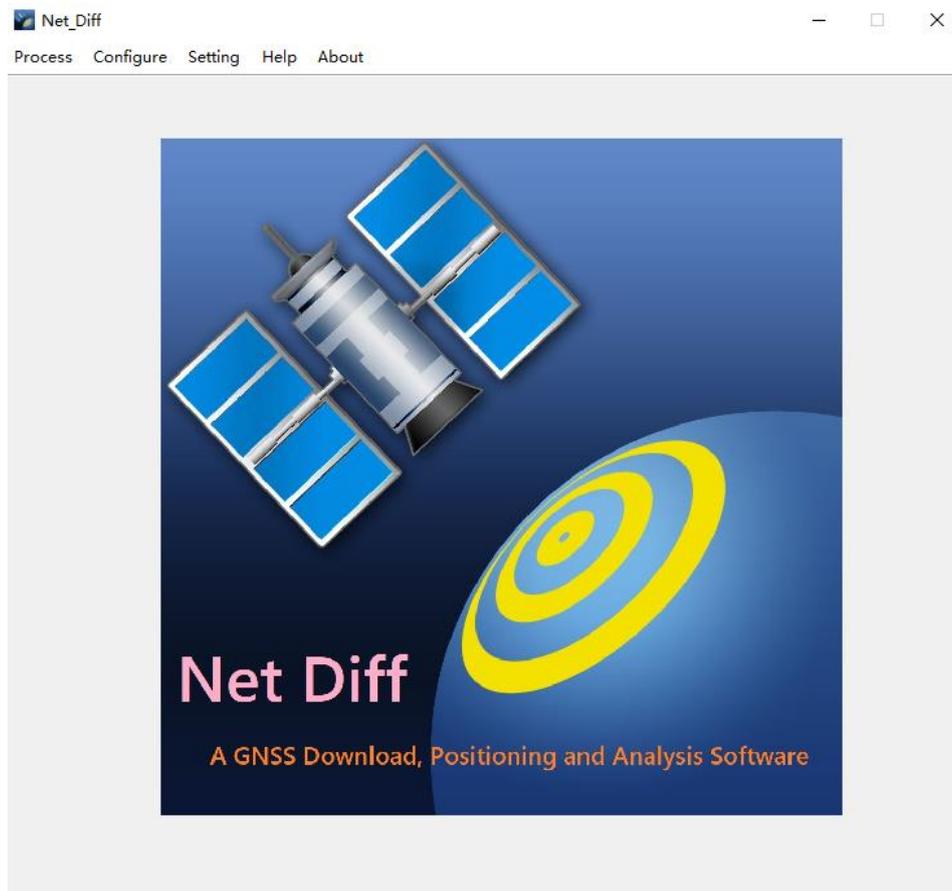
Fig. 4 Main GUI of Net_Diff

The DOS-like window is also the processing status window. It gives you the information of the processing status of Net_Diff.

Generally, the information can be divided into 3 kinds, i.e. **INFO**, **WARN**, **ERROR**. INFO just tells you the action you did in the software. WARN is a warning information when you use Net_Diff. It is not a severe problem. ERROR is the error information, which is a big issue and will certainly affect your positioning result if you don't handle it properly. Only after you solve the errors, you can get the best positioning results.

Fig. 5 INFO, WARN and ERROR information in processing status window

3.1 Download

Click *Process→Download* or *Ctrl+D* to change to the download page.
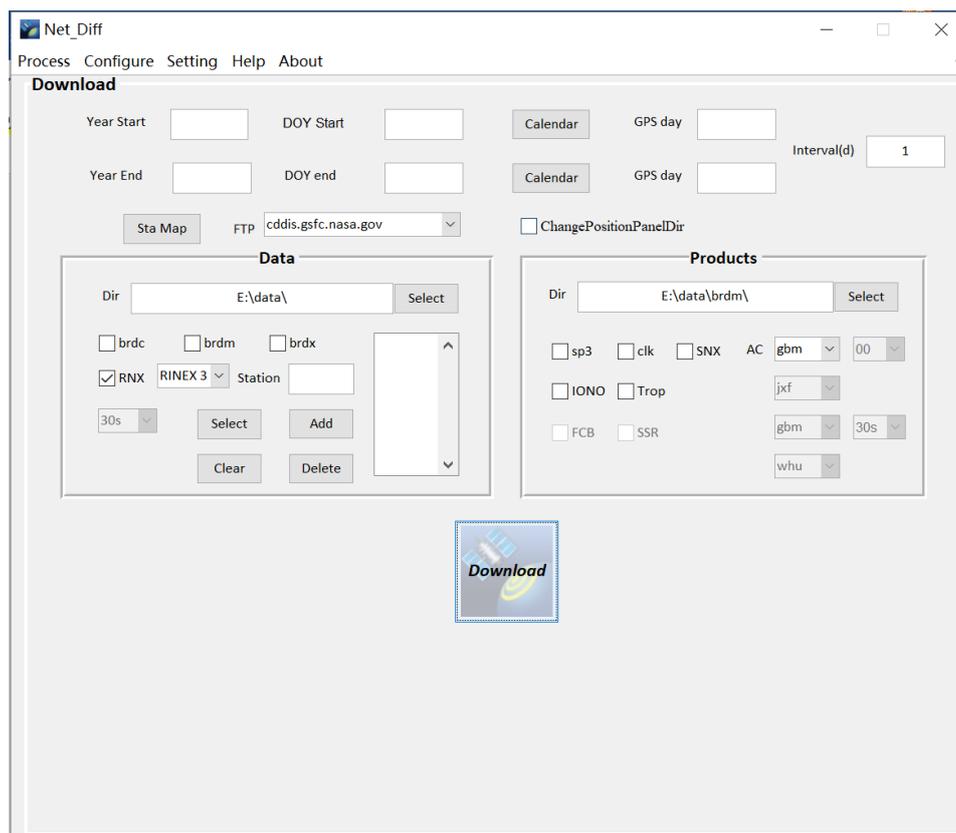
Fig. 6 Download Page

In this page, you can download the GNSS data and products from IGS or other servers.

Please check the hint information on each uicontrol to know its function.

Some tips in using the download function:

(1) When downloading IGS observation data, the station name is a four-character name. Although the file name of RINEX 3 has adopted the long filename format, the software will rename it as a RINEX 2-like file name.

(2) When downloading IGS final clock, although the clock file name is end with .clk_30s, the software will delete _30s and rename it as .clk. This is to unify the filename of all clock products from different ACs (Analysis Centers) for an easier use in data processing.

(3) When downloading the ultra-rapid products of igu, wuu, gbu, jxu, you can find the selection of 24 among the *update hour*, it means the update hour of the product is 0h of the next day. After decompression, the **_**.sp3 will change to **.sp3

(4) The long filename products will also rename as the traditional short filename products. For example, the WUM0MGXFIN_20193000000_01D_15M_ORB.SP3 will rename as wum20770.sp3. "gbm" means the short filename products from gbm, while "gbm0" means the new long filename products from gbm.

(5) Please make sure that you have added the environment variable of gzip (or have copy gzip.exe to the same folder of Net_Diff.exe), otherwise Net_Diff would not uncompress the

downloaded file.

(6) If you check **ChangePositionPanelDir**, and change to the **Positioning panel** from the **Download panel**, the directory of observation data, orbit, clock and output would also change to the same directory of products and data in **Download panel**.

(7) If you can't download data or product from FTP, check your internet connection or try another FTP.

(8) When choose different FTPs, the button of **Sta Map** will take you to the corresponding station map or product sites.

(9) If you want to download the observation file of many stations, the button of **Select** will help. It enables you to select a file (*.sta) that lists the station name. An example of the station list is as follows. Note that the last 4 characters of each line will be read if the string is longer than 4 (The space before and after the string will be ignored)
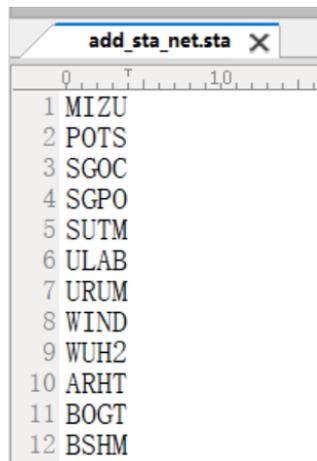
Fig. 7 Example of station list file

3.2 Positioning

Click **Process→Positioning** or **Ctrl+P** to change to the positioning page.
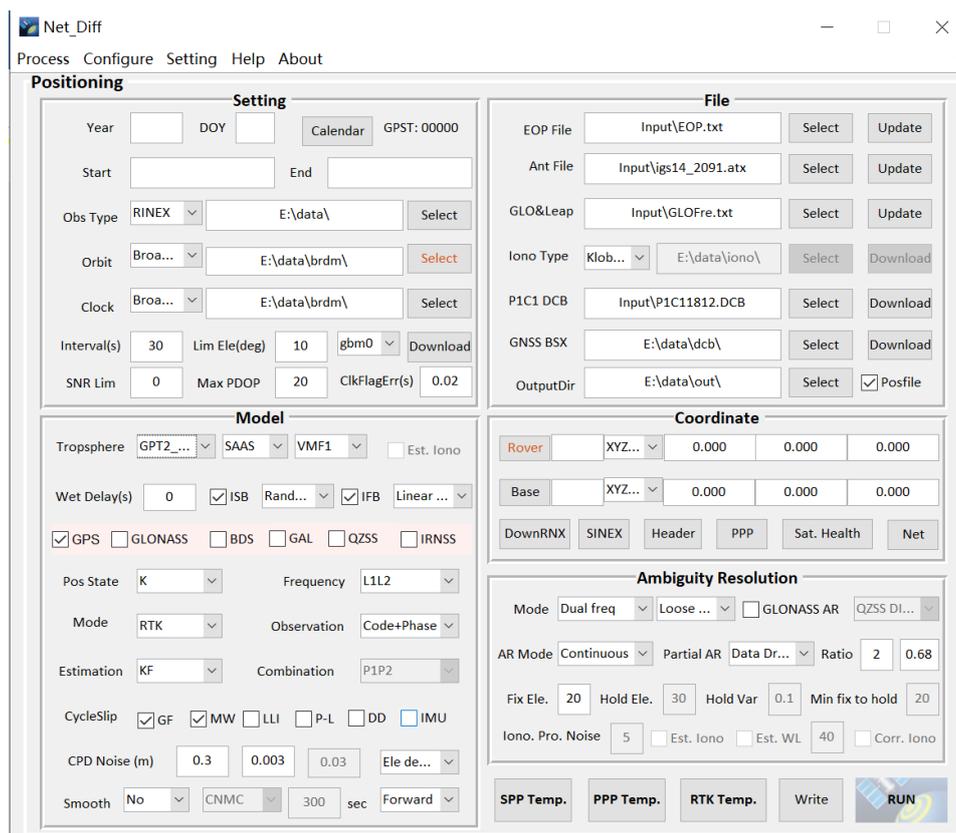
Fig. 8 Positioning Page

In this page, you can set your settings for different modes of positioning.

An easier way to start positioning is use positioning template firstly. When click pushbutton **SPP Temp**, it provides a basic SPP template. When click pushbutton **PPP Temp**, it provides a basic PPP template. When click pushbutton **RTK Temp**, it provides a basic RTK template. Based on the template, you can change the settings according to your own requirement.

When click pushbutton **Write**, it writes the control file *Control.txt* for positioning. This would be useful if you want to run Net_Diff by script or debug the source code of Net_Diff. When click pushbutton **Run**, it writes the control file and start positioning.

You can check the hint information on each uicontrol to know its function. However, as there are so many combinations of positioning settings, it is recommended to have your own try using your data.

For a quick start, you can finish positioning processing with just 4 steps. Figure 9 shows an example of GPS SPP.

After finishing running, there will be a message box asking you whether to go to the data *Analysis* panel, which will be explained in the next section.
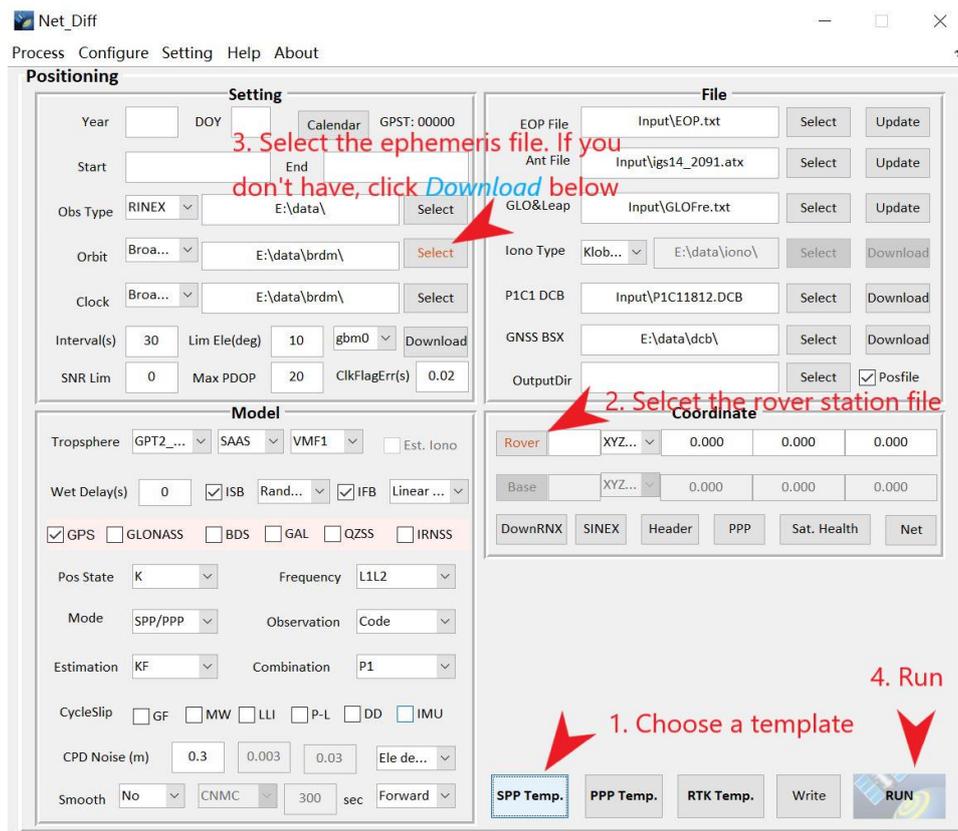
Fig. 9 An example of GPS SPP using Net_Diff.

For a detailed understanding of how to use Net_Diff, the following sections will explain the meaning of each options panel by panel.

3.2.1 Setting panel
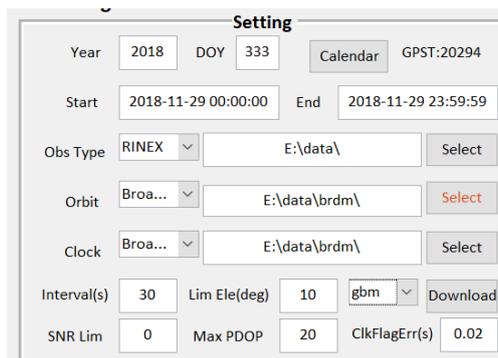
Fig. 10 The setting panel

The setting panel gives some basic settings.

(1) The *Year* and *DOY* indicates the year and day of year (DOY) of the processed data.

(2) When finish input Year and DOY, the corresponding GPST will be shown on the label. Meanwhile, the *Start* and *End* epoch to be processed will generate automatically. The default

epoch is from 00:00:00 to 23:59:59. The **Start** and **End** time should strictly follow the format like: 2017-06-07 00:00:00, which is a 19-character string.

(3) If you don't know the DOY, you can also select the year, mon, day from the button of **Calendar**.
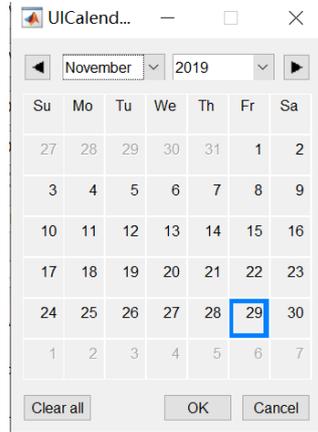
Fig. 11 The Year and DOY selection from calendar

(4) The default **observation file type** is RINEX. If you choose X71_I, X71_Q, or X11, you should have these types of data. If you don't have, please ignore them and don't choose these types.

(5) The **Orbit** type includes **SP3**, **Broadcast**, **Broadcast+APC** and **Broadcast+CoM**. The type of SP3 means that the orbit product is from the *.sp3 format orbit, while the latter three types mean that it is from the broadcast ephemeris. **APC** indicates that the SSR correction is corrected to the satellite antenna center, while the **CoM** means it is corrected to the center of satellite mass. When choosing Broadcast+APC or Broadcast+CoM, the input of SSR file will be shown in the **File** panel, please remember to choose an **SSR file** or a **RTCM file** that contains SSR correction, which will enable you to perform SSR based positioning. The SSR file is a self-defined text file that converted from the RTCM file in the **Tool** page. SSR file that generated from BNC software is also supported.

(6) For the **Clock** type, the **CLK** type means that the clock is from a *.clk format file. Other types are similar to those in the **Orbit** type.
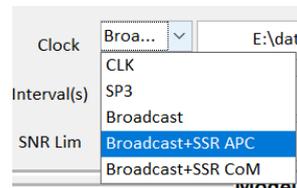
Fig. 12 The clock type options in Net_Diff

(7) When the **Orbit** or **Clock** type is SP3 or CLK, you can add IGS AC's name after the file directory or choose the AC name in the popupmenu. As gbm provides the most satellites products, the default precise orbit and clock product is from gbm. For example, the setting in Figure 13 both indicate that the precise orbit and clock from gbm is selected and the file name is E:\data\products\gbm20294.sp3 and E:\data\products\gbm20294.clk.

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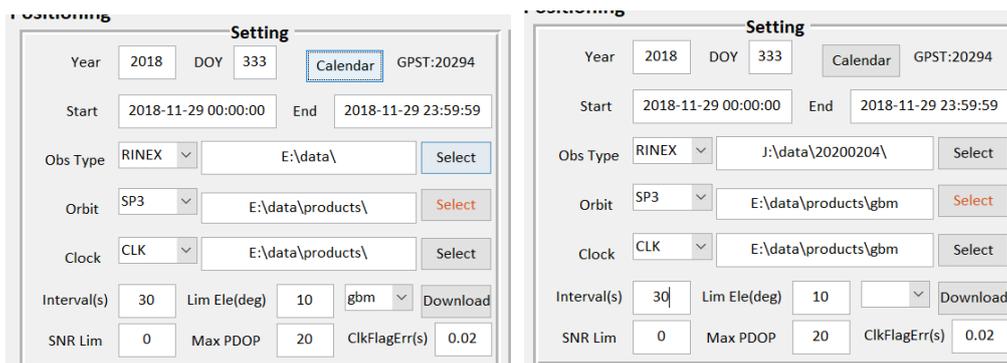
Fig. 13 Use precise and clock products from gbm

For comparison, the selection in Figure 10 indicates that the broadcast ephemeris is used and the directory of the navigation file is E:\data\brdm\brdm3330.18p (brdm***0.**p will set as default if the navigation file is not specified).

(8) When use the **Select** button to select the orbit and clock products, you can choose whether to select a file or a directory.
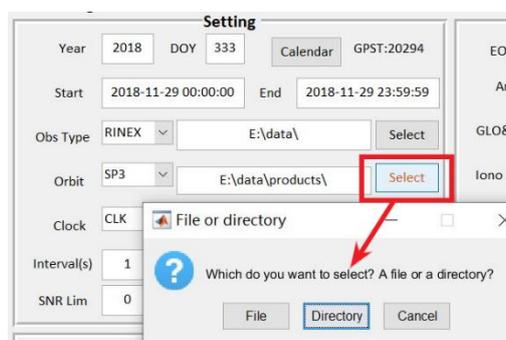
Fig. 14 Select orbit and clock product

(a) When a **File** is chosen for the orbit, the clock file will automatically change according to the clock type.

(b) When a **Directory** is chosen, if the **Orbit** and **Clock** type is Broadcast/Broadcast+SSR APC/Broadcast+SSR CoM, then the default navigation file required in Net_Diff would be brdm***0.**p. If the **Orbit** and **Clock** type is SP3/CLK, if you choose a directory, then the default precise orbit and clock file would be IGS AC+GPST.sp3 and AC+GPST.clk. For example, the precise orbit and clock file required in Figure 13 is E:\data\products\gbm20294.sp3 and E:\data\products\gbm20294.clk.

(9) You can use the **Download** button to download the satellite ephemeris.

(a) When the **Orbit** or **Clock** type is Broadcast/ Broadcast+SSR APC/ Broadcast+SSR CoM, it will download brdm***0.**p to the orbit or clock directory.

(b) When the **Orbit** or **Clock** type is SP3 or CLK, it will download the corresponding precise products according to the AC you choose. The rule of change and meaning of the precise products is the same as that in the **Download** page.

(10) The default data **interval** is 30 s. If you select an observation file of the rover station, the

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interval will automatically change to the data interval in that file.

(11) The **ClkFlagErr** defines the tolerance of the clock error, which means that if the clock error is not larger ClkFlagErr, it will assume this as the same epoch. The default value is 0.02 s. For data sampling higher than 0.04 s, users should change the ClkFalgErr.

3.2.2 File panel
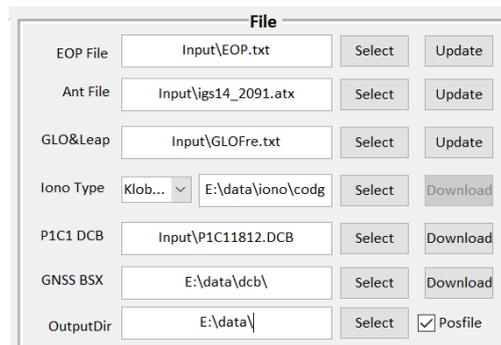
Fig. 15 The file panel

The file panel defines the input files and the output directory.

(1) The default directory of some files is a relative directory. When you open Net_Diff from the Windows Start or the Desktop, please change the relative directory to the absolute directory using the Select button.

(2) It is better to update **EOP file** and **Antenna file** when you are processing PPP/DPPP/Long Baseline RTK. If you use GLONASS data, please *update* **GLONASS Frequency & Leap second file**. Although most of the time, these files don't need to update very frequently or don't have much impact on the result. Please make sure that gzip is installed when updating GLONASS Frequency. If new leap second is added, please update *GLOFre.txt* manually.

(3) If you are processing PPP/DPPP/Long Baseline RTK, please check that if you have the **Ocean Load Coefficient** of the station in Tide.txt. The Tide.txt is under the same folder of **Input** but not shown in the GUI, you have to update it manually. In Net_Diff, the ocean load coefficient will apply to the surrounding areas within 0.25 degrees.

(4) **P1C1 DCB** file only provides the P1C1 DCB of GPS. As its value is very stable, you can **Update** it even once a year.

(a) When the processing mode is changed to **PPP-AR** and the code and phase bias is from **JAXA** or **SHA**, the P1C1 DCB will change to FCB or UPD (The SHA UPD product is currently not available via internet). You can download the corresponding JAXA FCB file through the **Download** button.

(b) When the processing mode is changed to **PPP-RTK(CLAS)**, the P1C1 DCB will change to L6 file, you can find the corresponding L6 file through the **Download** button.

(c) When the processing mode is changed to **PPP-RTK(Net_Diff)** or **FastPPP(Net_Diff)**, the

P1C1 DCB will change to SSRTropIono file, which is generated by Net_Diff (Authorized).

Fig. 16 The FCB/UPD file for JAXA/Net_Diff product-based PPP-AR, L6 file for PPP-RTK(CLAS), SSRTropIono file for PPP-RTK(Net_Diff)

(5) **GNSS BSX** file contains not only GPS P1C1 DCB, but also Multi-GNSS and Multi-frequency DCB. If you are processing single frequency or other combinations that is not the frequency combination of the clock product and not use the broadcast ephemeris (As DCB/TDG contains in broadcast file), you should **Update** GNSS BSX file.

When the processing mode is changed to **PPP-AR** and the code and phase bias is from **CNES/CNES(RT)/WHU/COD**, the P1C1 DCB will change to gbm/cnt/whu/cod bias file, you can download the corresponding bias file through the **Download** button. Note that corresponding precise orbit and clock is also changed and should be used.

Fig. 17 The bias file for CNES product-based PPP-AR (The P1C1 DCB file is optional)

(6) For **ION Type**, when you choose **Klobuchar** or **GIM** model, you can **download** the GIM file

(a) If you choose **GIM** model, the default GIM product is from cod.

(b) If you choose **Klobuchar** model, the software will find the brdm file in the orbit directory if the Orbit type is broadcast ephemeris. If it is SP3, then the software will find the brdm file in the Ionosphere file directory.

(c) If you choose **BeiDou 14** or **BeiDou Grid** model, you should have a standard BeiDou 14 parameter or grid file. If you don't have, please ignore it and don't use this model.

More ionosphere models will be added in the future.

(7) The output files including the coordinate file and log file will be output at the **OutputDir**. If you check the option of **Posfile**, Net_Diff will also output a *.pos format file, which is available for RTKPLOT.

3.2.3 Model panel
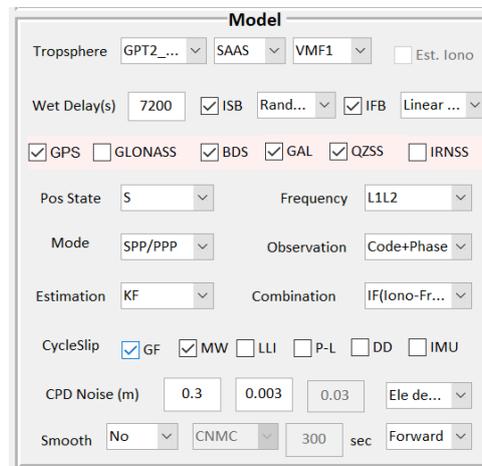
Fig. 18 The model panel

The model panel sets the processing mode and some other models, which is the core part of settings in Net_Diff.

(1) The default troposphere model is **GPT2_5w+SAAS+VMF1**, which means that the meteorological parameters are derived from the GPT2_5w model, and the ZHD (Zenith Hydrostatic Delay) and ZWD (Zenith Wet Delay) is calculated from the Saastamounien model, and the mapping function is VMF1 (Vienna Mapping Functions 1). When using the **NOM** to calculate the meteorological parameters, in fact Net_Diff uses the GPT model instead. You can also try other troposphere models such as **EGNOS**, **UNB3**, **UNB3m** or **SHATE**, which have their own meteorological parameters. The precision of the ZTD (Zenith total delay) is default as 5 cm, according to many statistical results.

(2) When you set **Wet delay** as 0, it means that Net_Diff will not estimate the troposphere parameter. If it is greater than 0, the residual part of zenith troposphere wet delay will be estimated. If the estimation mode is **LS** (Least Square), the troposphere will be estimated every wet delay interval (The default value is 7200 s). If it is **KF** (Kalman Filter), it will be estimated as a random walk model, with a 1cm/sqrt(hour) walking noise.

(3) The **ISB** model applied to estimate the inter-system bias among different GNSS systems, the **IFB** model is applied to estimate the inter-frequency bias for GLONASS. The default setting is **Random Walk** for ISB and **Linear Model** for IFB. You can also try other models such as **Constant**, **White Noise** for ISB and **Frequency Depend** for IFB. For GLONASS RTK/PPP-AR/PPP-RTK, if the **IFB** is not checked, then no differential IFB will be estimated.

(4) The default GNSS system used is **GPS**, you can also use other GNSS systems independently or combined.

(5) The **Pos State** defines the coordinate state of the rover station. **F** means the station coordinate is fixed and not estimated, **S** means the coordinate is estimated in a static mode, **K** means the coordinate is estimated in a kinematic mode, with a walking noise of 100 m

between two adjacent epochs.

(6) The positioning mode includes many different modes:
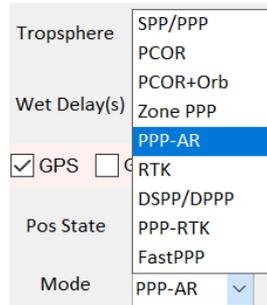
Fig. 19 Positioning modes that supported by Net_Diff

(a) **SPP** and **PPP** follow the commonly used correction models, which can be found on the IGS website (https://kb.igs.org/hc/en-us/articles/201271873-A-Guide-to-Using-the-IGS-Products), and estimate other parameters such as station coordinate, receiver clock, residual troposphere wet delay, ambiguities.

(b) When the positioning modes are **PCOR/PCOR+Orb/Zone PPP**, the BDS WADS PPP panel will show and you should have corresponding files. Currently it is only for authorized user.

(c) As for **PPP-AR**, currently Net_Diff supports products from **WHU** (recommended), **COD**, **CNES**, **CNES(RT)**, and **JAXA**. Note that the products of precise orbit, clock, code and phase bias should come from the correct AC. When processing PPP-AR, please remember to download the bias files in the **File panel**.

(d) As for **RTK**, two stations including the rover and base station are necessary, which should under the same folder.

(e) **DSPP** and **DPPP** are the differential SPP and PPP, which adopt the concept of station difference to eliminate the errors from satellite and atmosphere. Observation data from the base station and rover station are also required.

(f) **PPP-RTK(CLAS)** supports CLAS (Centimeter-Level Augmentation System), which is a public PPP-RTK service from QZSS. Detailed information and usage of CLAS corrections can be found in the interface specification documents of QZSS (https://qzss.go.jp/en/technical/ps-is-qzss/ps-is-qzss.html). Please remember to download the L6 file or use the OSR file in the **File panel** when using the function of PPP-RTK. Net_Diff will convert the **L6 file** to **OSR file** if the L6 file is used. The OSR file is a self-defined text file that converted from L6 file in the **Tool** page.

(g) **PPP-RTK(Net_Diff)** supports PPP-RTK that use the troposphere and ionosphere corrections generated by Net_Diff. To enable this, you need to input the Net_Diff defined troposphere and ionosphere correction file in the File panel.

(h) **FastPPP** supports fast PPP using the precise ionosphere or and troposphere correction, for both ionosphere-free and raw measurement based PPP. The supported format of the augmentation file includes the GIM format file and Net_Diff defined troposphere and ionosphere correction file.

(7) The **Frequency** and **Combination** option specifies the frequency used in the processing. There are three kinds of **frequency** combinations for all GNSS systems, i.e., **L1L2**, **L1L3**, and **L2L3**. The representation of L1, L2 and L3 are as follows:

Table 1. Representation of L1, L2 and L3 for different systems

Frequency	GPS	GLONASS	BeiDou	Galileo	QZSS	IRNSS
L1	L1	G1	B1	E1	L1	L5
L2	L2	G2	B2	E5a	L2	S
L3	L5	G3	B3	E5b	L5	
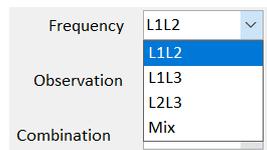
Fig. 20 Frequency combination selections in Net_Diff

As for the combination among the frequencies:

(a) **IF(Iono-Free)** means the ionospheric-free combination of the two frequencies selected, which is usually used in the traditional dual-frequency based SPP/PPP.

(b) **P1P2** means the raw observation on the two frequencies. This is usually used in RTK/PPP-AR/PPP-RTK and the uncombined SPP/PPP.

(c) **P1/P2/P3** means single-frequency based SPP/PPP. In which P1, P2, and P3 mean the frequencies of L1, L2 and L3, respectively.

(d) **G1/G2/G3** also indicates the single-frequency based SPP/PPP. However, the graphical combination of code and carrier phase (also known as Uofc model) is formed to eliminate the ionosphere delay. G1, G2, and G3 mean the graphical combination at frequencies of L1, L2 and L3, respectively.

(e) For **P1P2P3** and **IF12+IF13**, the triple-frequency data is used, in which the first two frequencies are what we chose, while the third frequency is always the L3 frequency, i.e., L5/G3/B3/E5b/L5 for GPS/GLONASS/BeiDou/Galileo/QZSS, respectively. If one of the first two frequencies is L3, then it indicates that only two frequencies will be used in the end. In the P1P2P3 combination, the uncombined observation will be used, while in the IF12+IF13 combination, two ionospheric-free combinations are used.
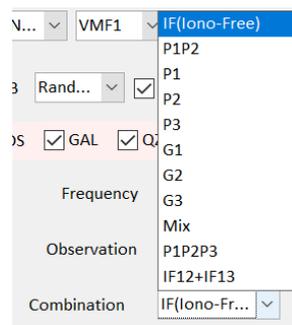
Fig. 21 Combination among the frequencies

(f) If you want to use different frequencies or different frequency combinations for different GNSS systems, you can choose the **Mix** in the frequency and combination popupmenu, in which the B1c, B2a signal for BDS, E6 signal for Galileo, and L6 signal for QZSS is supported.
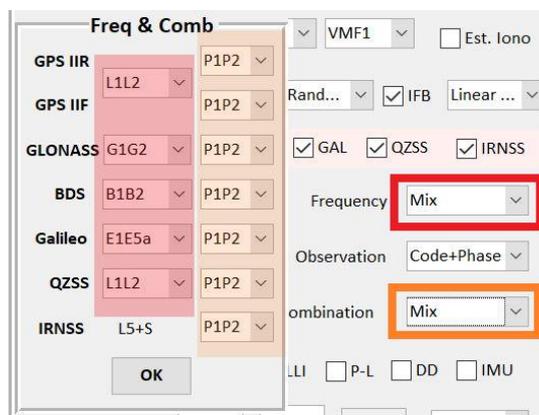
Fig. 22 Mixed frequency and combination selections in Net_Diff

(g) For the positioning mode of **PPP-AR/RTK/PPP-RTK** which related to ambiguity resolution, the combination here is forced to **P1P2** (single- and dual-frequency) and **P1P2P3** (triple-frequency). For the detailed observation combination, please go to the observation combination **MODE** in the Ambiguity resolution panel.

(8) The **Observation** option specifies the observation types used in the processing. For SPP/DSPP, the **Code** observation is used, for other processing types, the **Code+Phase** observation is used. **Doppler** observation can be used in real kinematic scenario.

(9) Please properly set the **CPD**(Code/Phase/Doppler) noise according to the real observation data quality. The default value is 0.3/0.003/0.03 m for them.

(10) For the cycle slip method, **GF** and **MW** are commonly used for dual-frequency and triple-frequency data, while **LLI** and **P-L** are often used for single frequency data. The **DD** method in cycle slip is only valid for static station. You can also use **LLI** and **P-L** for dual-frequency data. Note that in RTK/PPP-AR/PPP-RTK, when the method of **LLI** or **P-L** is used, if there is only single-frequency data for a satellite, Net_Diff will also use this observation.

(11) **INS** is for loosely coupled PPP/INS, currently it is only for authorized user.

(12) For the **stochastic model** of the observations, the default and the recommended option is elevation depended by **Ele(a+b/sind(Ele))**. **Ele(1,1/2sind(Ele))** is another elevation

dependent stochastic model. The **SNR** dependent model is that the stochastic model is decided by the SNR value, while ***Ele+SNR*** model indicates the combination of Ele(a+b/sind(Ele)) and SNR model . You can try these different stochastic models.
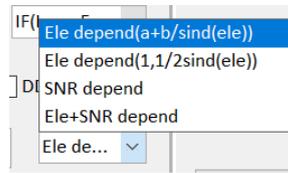
Fig. 23 Different stochastic models supported in Net_Diff

(13) For the **Smooth** method, ***Yes*** means the code observation will be smoothed by the carrier phase or Doppler observation. For dual-frequency data, ***Hatch*** filter smooths the ionospheric-free observation, while the ***CNMC*** filter smooths both the raw observation on P1/P2 and the ionospheric-free observation. The ***P1***, ***P2***, ***P3*** is used for the smoothing of single frequency data, in which the length of a smoothing window is required. The ***Dop*** means smoothing the code observation from the Doppler observation.

(14) The default processing mode is ***Forward***, similar as real-time processing mode. For the processing mode of ***Forward+Backward***, it is only available in RTK, in which Net_Diff will process the data both in forward and backward mode, and output a combined result. Detailed algorithm can be referred from RTKLIB (http://www.rtklib.com/).

3.2.4 Coordinate panel
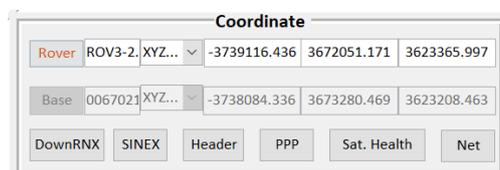
Fig. 24 The coordinate panel

The coordinate panel sets the file and coordinate of the observation data and the satellite information.

(1) You can name your observation file as you like or following the IGS RINEX2 format. If the file name is the same as the short filename format of IGS, when input the file name of the rover or base station, you can input the four-character of the station. For example, if your observation file name is abcd001.19o, then you can just input abcd in the text box in the coordinate panel. Nevertheless, a simpler way is to just click **Rover** and **Base** button, then select the observation file. The start and end epoch, the data interval, and the directory file directory in the Setting panel will automatically change according to the rover station.

(2) When processing RTK or DSPP/DPPP, the file of the rover station and base station should under the same folder.

(3) You can download the observation data using the ***DownRNX*** button, it will take you to the

Download page.

(4) The pushbutton of **SINEX**, **Header**, and **PPP** means reading station coordinate from a SINEX file, from the header of an observation file, and from the coordinate file from Net_Diff, as the initial station coordinate. For the base station, it is better to set the approximate coordinate of the base station. Otherwise, the SPP result of the first epoch will be adopted. As for the rover station, if you don't know the approximate coordinate of the first epoch, please set it as zero, and Net_Diff will calculate the approximate coordinate using SPP.

(a) When reading coordinates from **SINEX**, note that as the SINEX file uses the four-character format, so the first four character of the station name is used to find the corresponding station name and coordinate. You can download the SINEX file of the corresponding week and read the coordinate from it if you don't select a SINEX file.

(b) When using the **PPP** file from Net_Diff, you can choose whether to use the mean coordinate or the final coordinate in the file.

(c) The input approximate coordinate will be regarded as the reference coordinate when calculate coordinate error in North, East, and Up direction in the result file. Therefore, if you input the true coordinate as the approximate values, the NEU results will directly mean the positioning error in the NEU direction. If the approximate coordinate is zero, then the reference coordinate for the NEU error will be the SPP results of the first epoch. If you input the wrong coordinate of the station of the first epoch, then Net_Diff will calculate a new approximate coordinate from SPP.

(d) When the coordinate type of the base station is **Moving_Baseline**, the RTK or DSPP/DPPP mode will change to Moving Baseline. The input approximate coordinate of the rover and base station will not be used, and the output result in NEU direction will be the baseline between the rover station and base station.

(5) If you don't want to use some satellites, you can click **Sat. Health** (Satellite Health) and uncheck the satellites in the **Satellite Health** panel. If you uncheck **CheckHealth**, Net_Diff will not check satellite healthy in the broadcast ephemeris.
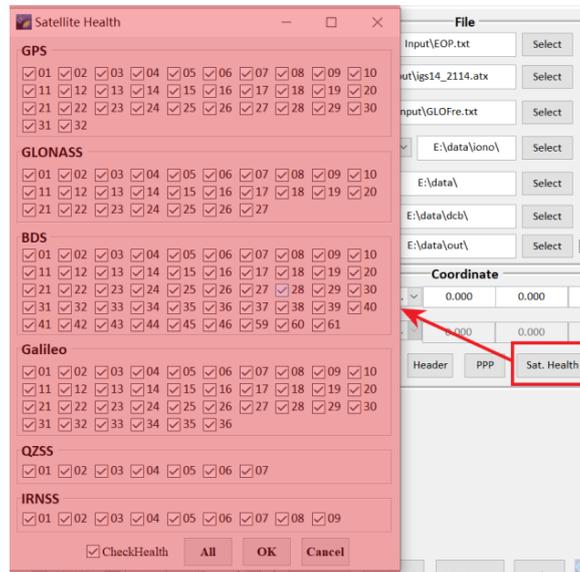
Fig. 25 The Satellite Health panel

(6) The **Net** button is for multi-station PPP, clock solution and DCB estimation based on a network, which is only available for multi-station PPP currently.
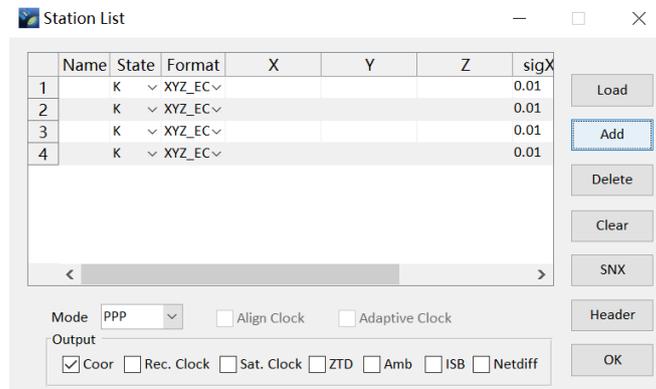
Fig. 26 Multi-station PPP panel

In the Muti-station PPP panel, you can **Load** all stations using the station list file (See Figure 7), you can also **Add**, **Delete** or **Clear** stations. The coordinates (X, Y, Z) of the stations can be read from **SNX** file or RINEX file **Header**. You can output results including coordinate, receiver clock, satellite clock, ZTD, ambiguity, ISB according to the functions (Currently on DCB, Clock, UPD is not open). Please note that the format of the default coordinate result is different from single station PPP. When only one station is added, you can output Net_Diff format solutions by checking **Netdiff**.

3.2.5 Ambiguity resolution panel
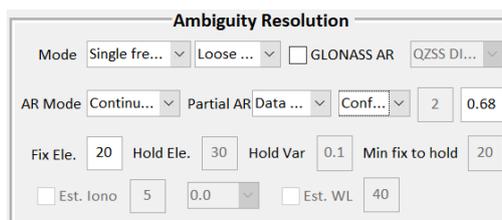
Fig. 27 The ambiguity resolution panel

The ambiguity resolution panel is available and appears when the processing mode is **PPP-AR/RTK/PPP-RTK** that related to ambiguity resolution.

(1) The **Combination** in the **Model panel** will be forced to **P1P2** (single- or dual-frequency) or **P1P2P3** (triple-frequency) when the positioning mode is **PPP-AR/RTK/PPP-RTK**. The **Mode** in this panel enables you to choose using different combination of observation data. **Dual/Triple freq** means the dual- or triple- frequency data will be used, while the **Single freq 1** means the only the single-frequency data on the first frequency will be used, and the **Single freq 2** means the second frequency. The **Wide Lane(Dual/Triple)** means the wide lane combination will be formed using dual- or triple frequency data. The **Long Baseline(Dual/Triple)** means the mode for long baseline RTK or PPP-AR will be enabled.

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Detailed algorithm on Long baseline RTK, please refer to (https://doi.org/10.1080/14498596.2019.1646676). The ***Iono-Free(Dual/Triple)*** mode use the wide-lane ambiguity to fix the ionospheric-free observation based narrow-lane ambiguity (https://doi.org/10.1007/s00190-007-0187-4), which is also used in long baseline RTK or PPP-AR.
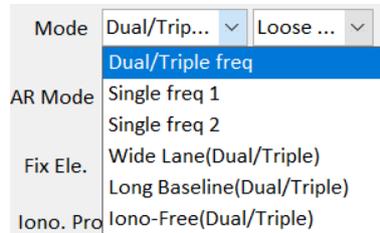
Fig. 28 Different processing modes in ambiguity resolution

(2) The ***Loosely Combined*** option process each GNSS system as a separate system in ambiguity resolution, while the ***Tightly Combined*** option process all GNS systems together and only one reference satellite will be used with code and phase bias estimated for other GNSS systems. The default setting is Loosely Combined mode.

(3) If GLONASS data are used, you can choose whether to fix GLONASS ambiguity by checking the checkbox of ***GLONASS AR***.

(4) If GPS and QZSS data are used, you can choose whether to treat them as a same system or two different systems. The default setting is ***QZSS separate***, which means that GPS and QZSS are two different systems, while ***QZSS no DISB***, ***QZSS DISB code***, ***QZSS DISB code/phase*** indicates that the GPS and QZSS are treated as the same system, but DISB (Differential Inter-System Bias) is ignored, or only code bias is estimated, or both code and carrier phase bias is estimated between GPS and QZSS. Usually, when you are using two identical receivers, you can treat GPS and QZSS as the same system and ignore the DISB. However, if you are using different receivers, it is better to estimate it.
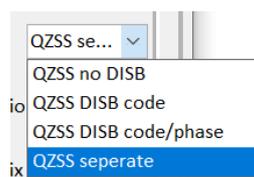
Fig. 29 Different ambiguity processing modes for QZSS when combined with GPS

(5) ***AR Mode*** Includes different ambiguity resolution modes, which is quite similar to RTKLIB. The default mode is ***Continuous***, which means that the ambiguity is estimated as a constant value if no cycle slip occurs and the satellite elevation is higher than the ***Fix Ele***. The ***Instantaneous*** mode is a single-epoch AR mode, which means that ambiguities are re-initialized every epoch. The ***Fix&Hold*** mode means that when the satellite elevation is higher than ***Hold Ele*** and the satellite ambiguity doesn't change for at least ***Min fix to hold*** epochs, the covariance of the ambiguity will add a constraint of ***Hold Var*** cycles.
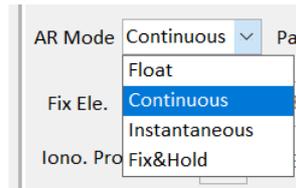
Fig. 30 Ambiguity resolution mode

(6) As for **Partial AR**, Net_Diff provides three options of **No Full AR**, **Data Driven AR**, **Model Driven AR**, **Data+Model Driven**. The **No Full AR** always try to fix the ambiguities of all satellites. However, it is recommended that you choose **Data Driven Par AR** or **Model Driven Par AR**, although it may take a little more time, but it is worthy in the aspect of fix rate and precision. **Model Driven Par AR** is the traditional partial AR in LAMBDA method, which try to fix part of the satellite after ambiguity decorrelation, while **Data Driven Par AR** is a modified partial AR which try to fix part of the satellite before ambiguity decorrelation. **Data+Model Driven** is the combination of model driven and data driven partial AR. In Net_Diff, Data Driven Par AR is set as default.
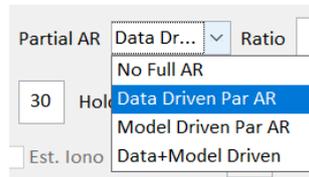
Fig. 31 Partial ambiguity resolution method

(7) The default ratio option of **AR fixed dependence** is a confidence level with 90.0%. You can also set threshold of the ratio to a fixed value (usually 2~3). For the AR **success rate**, it is only effective when the partial AR mode contains model driven. You can set it as 0.99 (the default value is 0.68 in Net_Diff) to get a reliable fixed result. If you just need to get a more accurate result and don't consider the fixing reliability, you can set success rate as 0.

(15) If you use **Long Baseline RTK** mode, please remember to check **Est. Iono** to estimate the residual ionosphere difference. If you don't estimate ionosphere parameter, it is same as **Dual freq** mode, which is usually for short baseline.

3.2.6 Command line

You can run the positioning function of Net_Diff with command line.

After proper change the settings or successful run a sample in the positioning panel, you can click **Write** or **Save Configure** (Ctrl+S) to write/save the configuration file. The default file name is "Control_Net.txt". With this file, and the Net_Diff.dll file in the Input folder, you can run Net_Diff with command line. The usage is "Net_Diff.dll Control_Net.txt".

3.3 Analysis

Click **Process→Analysis** or **Ctrl+A** to change to analysis page. If you are from positioning page,

the coordinate file and log file will automatically change to the results you just processed.
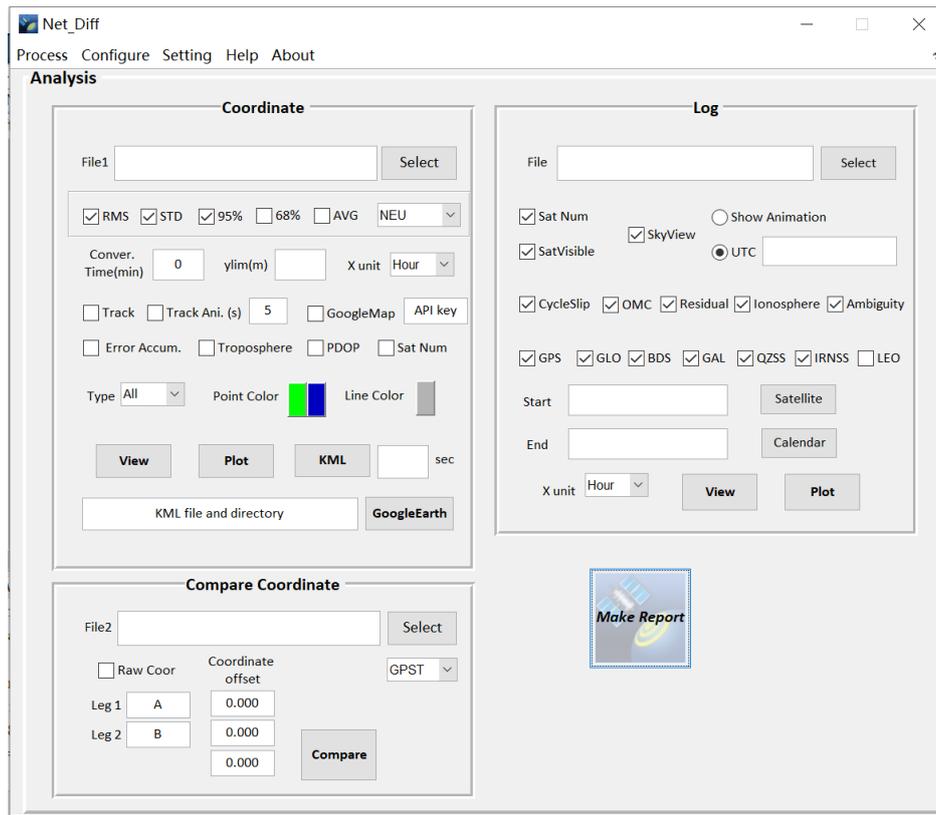
Fig. 32 Analysis Page

In this page, you can get analysis the positioning results and make positioning report through pushbutton of **Plot** in the **Coordinate panel** and **Make Report**.

When the **GoogleMap** is checked, you need to input your GooleMap API key to set Google Map as the figure background.

You can also make the kml file in pushbutton **KML** and check the real positioning track on Google earth using pushbutton **GoogleEarth** (Make sure that you have installed Google Earth).

You can compare two positioning results in the **Compare Coordinate** panel. Time difference (such as GPST and UTC) and coordinate offset can be set before comparison.

Moreover, you can also analysis the satellite and positioning information by pushbutton of **Plot** in the **Log panel**.
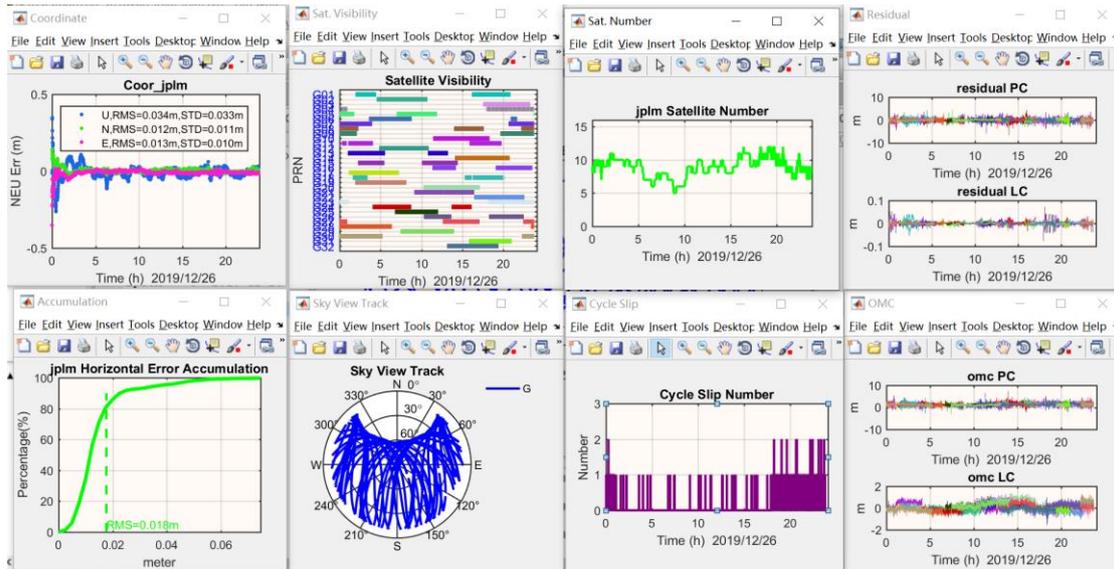
Fig. 33 Example of analysis results

There are some tips in using the Analysis page:

(1) For coordinate type, currently it supports Net_Diff coordinate file, Net_PPP coordinate file, pos file from RTKLIB, NMEA file, csv file from POSLV. A simple format of the file is also supported, but should be named as "*.pos", the explanation of the format is as follows:

Fig. 34 Format explanation of the self-defined pos file

(2) You can choose whether to plot *All* coordinates or just plot the *Fixed*, or the *Float* solutions and separate the color of the points for different solutions. For positioning modes that are not related to ambiguity resolution, the solution is considered as Float.

(3) When plotting coordinate file, the software will also check *Start* and *End* epoch in the *Log* panel. So please carefully check the time when you plot another coordinate file. If you are

not sure about the detailed epoch, just clear the time in the Start and End epoch.

(4) When comparing two coordinate files, you can set the time difference if the two files are in different time system. For example, time system of NMEA is usually in UTC. Please change the time system to *UTC*, and you can set the difference between file 1 and file 2. For example, if the time system in file 1 is in GPST, while the time system in file 2 is in UTC, then the time difference is 18 s. If the time system in file 1 is in UTC, and the time system in file 2 is in GPST, then the time difference is -18 s. The default setting is that both file 1 and file 2 is under GPST thus no time difference issue needs to consider. You can also set the *Coordinate offset*, which expressed in North, East and Up, between file 1 and file 2.

Please check the hint information on each uicontrol to know its function.

3.4 Tool

Click *Process→Tool* or *Ctrl+T* to change to the tool page.
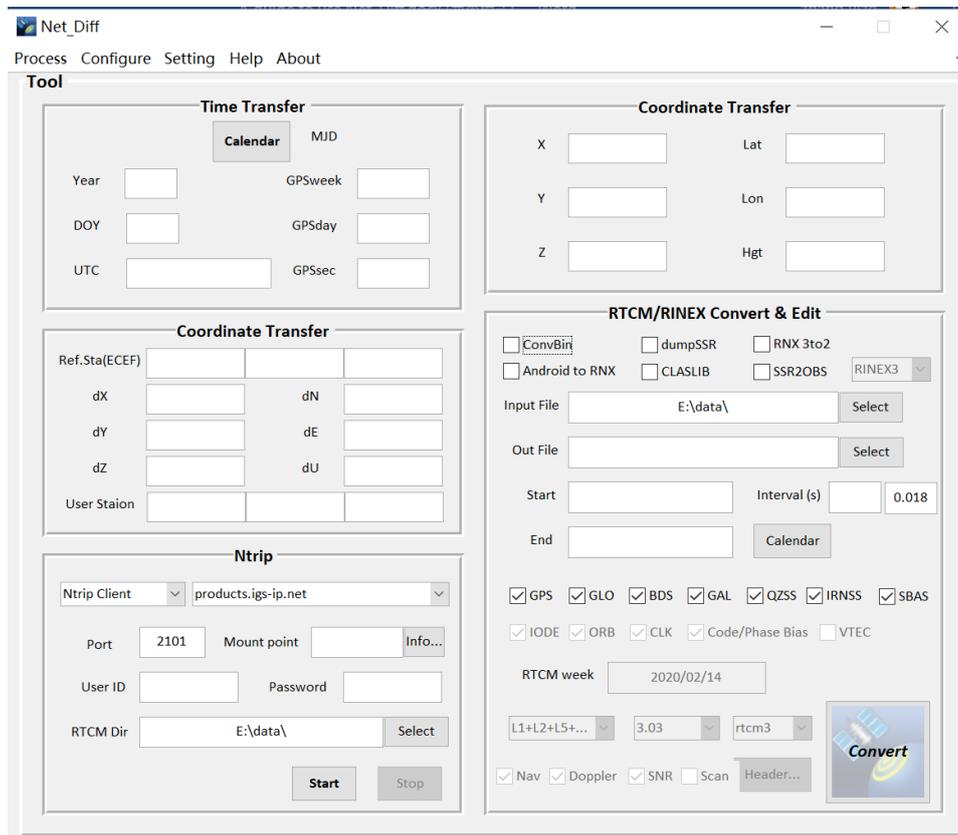
Fig. 35 Tool Page

In this page, you can transfer between different time format and transfer coordinate system. RTCM data receiving through Ntrip, RNX data editing and data converting are also supported.

Some explanation on using the Tool page:

(1) In the *Ntrip* panel, you need a user ID and password. You can also set your own caster host. The saved file is in RTCM format, which can be converted to RNX and ssr file in the

RTCM/RINEX Convert & Edit panel. The part of receiving real-time data is referred from goGPS (https://gogps-project.github.io/).

(2) In the **RTCM/RINEX Convert & Edit** panel, there are different data editing and converting tools.

(a) The **ConvBin**, which is modified from RTKLIB, enables you to convert different types of raw observation data (including RTCM) to standard RINEX format.

(b) The **dumpSSR**, also modifies from RTKLIB, means you can dump the SSR information in the RTCM file to a text file. As SSR file doesn't include week information, you should select an approximate **RTCM week** that is in the same week of your SSR file.

(c) If you choose **RINEX3 To 2**, it allows you to change to RINEX3 format to RINEX2 format.

(d) If you choose **Android to RINEX**, you can change Android raw data to RINEX format. The raw data of Android means the raw data recorded from the GNSSLogger, which is released by Google. You can find the APP and some sample data here: (https://github.com/google/gps-measurement-tools/releases).

(e) Net_Diff also provide an easy use of **CLASLIB**, which is released by QZSS and supports CLAS positioning. You can also use the **SSR2OBS** to convert the L6 file from QZSS to **OSR** file, **RINEX** file, and **RTCM MSM** file. When using CLASLIB and SSR2OBS, some basic files such as the configuration file, navigation file, L6 file, or observation file should be prepared. Net_Diff provided a sample of configuration file and some other files which is required by CLASLIB and SSR2OBS. You should change some setting of the configuration file and prepare the navigation file and L6 file, or observation file.

(f) If you don't select any of the above options, you can edit your RINEX 3 file, similar as TEQC.

For the detailed use of each function, please check the hint information on each uicontrol to know its function.

3.5 Simulation

Click **Process→Simulation** or **Ctrl+X** to change to the simulation page.
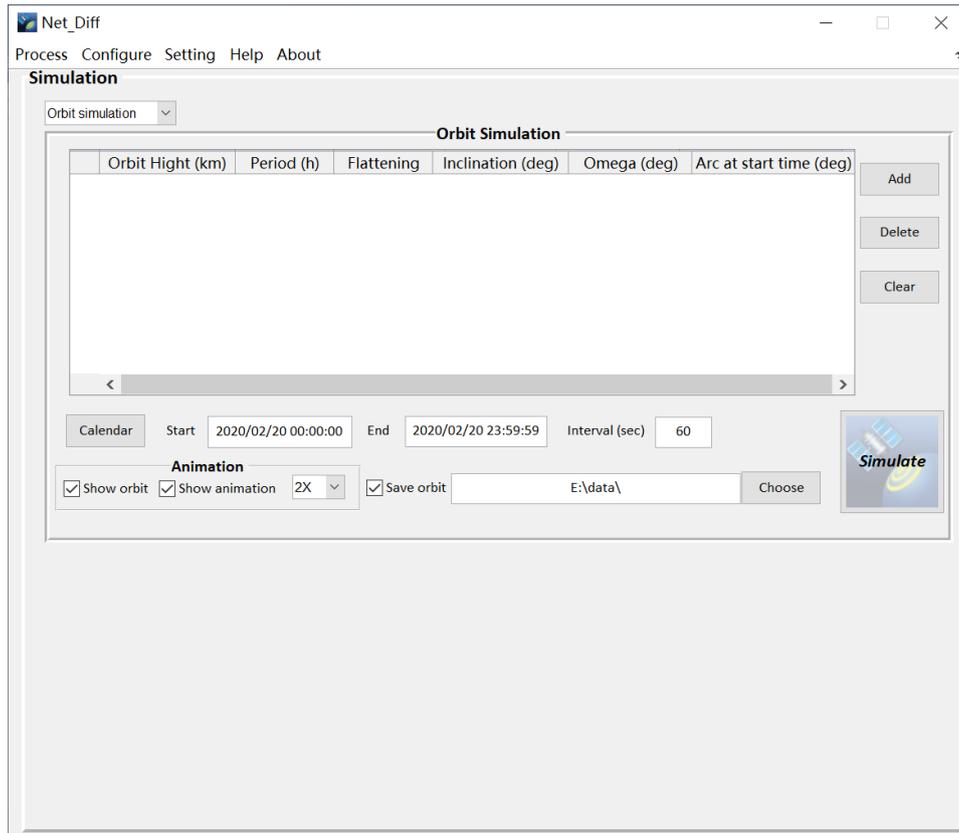
Fig. 36 Simulation Page

In this page, you can simulate satellite orbits after setting their parameters. The simulation of GNSS observation is not open currently.

To simulate satellite orbit, you should first define the satellite Kepler parameter in the table. By Add button, a sample of GPS satellite will be added. You can change other parameters as you like.

In the *Animation* panel, the figure of the satellite orbit and the and the animation can be shown if you check them. The orbit information can also be saved as files.
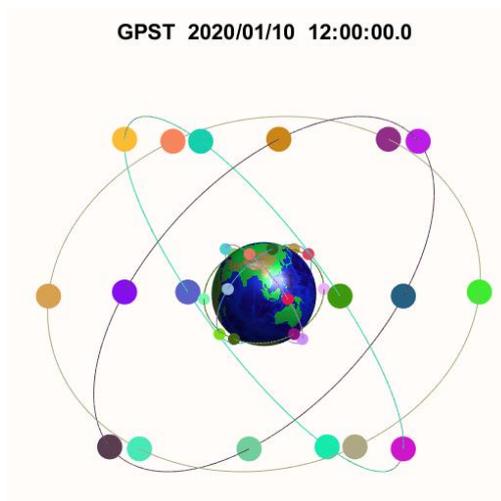
Fig. 37 Simulated orbit

3.6 Others

In the Configure menu, you can select **Save Configuration** or **Ctrl+S** to save your settings in the positioning panel as a .cfg file. And you can select **Load Configuration** or **Ctrl+L** to load the existed .cfg file. This would be helpful if you want to do the same or similar positioning next time.

In the Setting menu, you can select voice hint in Chinese (**Voice(中文)**) or English (**Voice(English)**). If you don't want to use this function, please uncheck it.

If the voice is selected, when you are processing the positioning in the Positioning Panel or reading log file in the Analysis Panel, a song will be played at the same time. It is named "We Will Change" from Komas Mida, one of my favorite post-rock. Hope you like it. (https://www.last.fm/music/Komas+Mida/Oh!+Thee+Glory+Days+of+Ignorance/We+Will+Change)

In the Setting menu, **Enable Terminate** allows to terminate the positioning process, otherwise you can only terminate the processing through management window.

In the Setting menu, **Close All Files** is the same as the meaning. It is usually used in some occasions that Net_Diff doesn't work properly and doesn't close the opened file.

In the Help menu, you can also open this help document using **How to use** or **Ctrl+H**. You can also find some resource website on **DataSource**. Besides, you can find the **Website** of Net_Diff on GitHub, the latest version of Net_Diff will be uploaded on it, you can update it if a new version is released.
There are some examples in the folder of test on GitHub, including data, results and .cfg file. You can load the .cfg file and test them with your Net_Diff.

4 Others

Please keep an eye on the processing status window when you are using Net_Diff, which will tell you the processing status. Or open the voice hint so that you can turn to do other things while waiting.

If the processing status window doesn't refresh, try to press enter in the processing status window to refresh.

If the positioning process doesn't work, check if *Net_Diff.dll* from the last operation is still working using the task management window. If yes, please kill it and then retry Net_Diff. If it still doesn't work, close Net_Diff and restart it. Therefore, it is recommended to save the configuration every time.

If you have any questions or suggestions, please contact me by E-mail: zhyize@163.com or join the QQ group: 838636621.

Thank you for using Net_Diff.

Appendix: Format Description

Two kinds of files, i.e., the coordinate file (Coor****.txt, or Coor****.pos) and log file(Log****.txt), are the output of Net_Diff after every data processing. Here gives the format description of these files.

A1 Coordinate file

The coordinate file (Coor****.txt) contains the output message of coordinate, coordinate error, solution type, satellite number, PDOP, ZTD, satellite clock (only for SPP/PPP/DSPP/DPPP).

In the coordinate file, the header information gives the settings of the data processing. After the line of "++Coordinate===", it comes to the coordinate solution result.

Fig. A1 Example of the coordinate solution

The detailed description is as follow:

Table A1. Description of the coordinate solution.

Example	Description	Format
1	Epoch	I5
2020 5 30 1 0 0.0	Year, Mon, Day, Hour, Min, Sec	I6, 4(I4), F5.1
0.6709 0.3150 1.3412 1.5323	Error in North, East, Up and 3D (*)	4(F12.4)
3	Solution type: 0: Float, SPP/PPP/DSPP/DPPP 1: Fixed, full AR 2: Fixed, partial AR 3: Float, AR failed	I4
1.38	PDOP	F8.2
2.377	ZTD (**)	F8.3
7	Satellite number (***)	I3
-3817116.502 3094954.252 4052672.074	XYZ(ECEF)	3(F15.3)
39.701082706 140.964533051 260.692	Latitude/Longitude/Height (WGS-84)	2(F15.9), F15.3

| -0.22102646E-06 | Receiver clock (****) | E17.8 |

(*) The coordinate error is the compared with the approximate coordinate given in the Positioning page (See 3.2.4). If the approximate coordinate is zero or the error is larger than 30m, Net_Diff will calculate a new approximate coordinate from SPP. For Moving-Baseline RTK, the coordinate error is the baseline in NEU direction.

(**) For short baseline RTK mode, ZTD is always zero; for long baseline RTK, ZTD is the ZTD difference between the base and rover station.

(***) For RTK/PPP-AR/PPP-RTK, satellite number here means the satellite number after satellite differencing.

(***) For multi-GNSS, only the receiver clock of the first system is outputted among GPS/GLONASS/BDS/Galileo/QZSS/IRNSS. For multi-frequency solution, only the receiver clock of the first frequency is outputted among L1/L2/L3. For DSPP/DGNSS, satellite clock is the clock difference between the rover and base station. For PPP-AR/RTK/PPP-RTK, the satellite clock is not outputted.

The coordinate file (Coor****.pos), which is quite similar to the pos file from RTKLIB, can also be plotted using RTKPLOT.

```
% (lat/lon/height=WGS84/ellipsoidal,Q=1:fix,2:float,ns=# of satellites)
%  GPST              latitude(deg) longitude(deg)  height(m)   Q  ns     X(ECEF/m)        Y(ECEF/m)       Z(ECEF/m)
 2020/05/30 01:00:00.000   39.701082706  140.964533051   260.6917   2   7   -3817116.502    3094954.252    4052672.074
 2020/05/30 01:00:30.000   39.701077175  140.964531018   260.8609   2   7   -3817116.798    3094954.717    4052671.709
 2020/05/30 01:01:00.000   39.701077472  140.964532278   260.5546   2   7   -3817116.667    3094954.471    4052671.539
 2020/05/30 01:01:30.000   39.701075362  140.964534497   260.5764   2   7   -3817116.916    3094954.428    4052671.373
 2020/05/30 01:02:00.000   39.701076437  140.964534631   260.3894   2   7   -3817116.752    3094954.281    4052671.345
 2020/05/30 01:02:30.000   39.701076153  140.964534161   260.2348   2   7   -3817116.650    3094954.250    4052671.222
 2020/05/30 01:03:00.000   39.701076063  140.964533627   260.0993   2   7   -3817116.545    3094954.224    4052671.128
```

Fig. A2 Example of the coordinate solution

After the header information, the detailed description of as follow:

Table A2. Description of the coordinate solution.

Example	Description	Format
2020/05/30 01:00:00.000	Year, Mon, Day, Hour, Min, Sec	I4,2(A1,I2.2),1X,2(I2.2,A1),F6.3
39.701082706 140.964533051 260.6917	Latitude/Longitude/Height (WGS-84)	2(F15.9), F12.4
2	Solution type: 1: Fixed, 2: Float	I4
3	Solution type: 0: Float, SPP/PPP/DSPP/DPPP 1: Fixed, full AR 2: Fixed, partial AR 3: Float, AR failed	I4
7	Satellite number (*)	I4
-3817116.502 3094954.252 4052672.074	XYZ(ECEF)	3(F15.3)

12.345 23.456 34.567	Baseline length in North, East, and Up (**)	3(F12.3)

(*) Same as in Table A1.

(*) This is only outputted in RTK mode.

A2 Log file

The log file records the messages during data processing. In Net_Diff, it can be separated into two kinds, i.e., one related to ambiguity resolution (RTK/PPP-AR/PPP-RTK), and one is not (SPP/PPP/DSPP/DGNSS).

A2.1 RTK/PPP-AR/PPP-RTK

One example of the zero-difference part is as follow:

Fig. A3 Example of the zero-difference log

Table A3. Description of the zero-difference log

Symbol	Description	Format
A	Approximate receiver clock(s)	E15.6
B	PRN	A1, I2
C	Satellite elevation (deg)	F8.2
D	Satellite azimuth (deg)	F8.2
E	Pseudo-range at P1 (m)	F13.3
F	Carrier phase at L1 (m)	F13.3
G	Geometric distance (m) (*)	F13.3
H	Satellite clock (s) (**)	E15.7
I	Slant troposphere delay (m)	F7.2
J	Slant ionosphere delay (m)	F7.2
K	Satellite relativity correction (m)	F7.2
L	OMC of P1 (m) (***)	2X, F7.2
M	OMC of P2 (m)	F7.2
N	OMC of L1 (m)	F13.2
O	OMC of L2 (m)	F13.2

| P | Initial ambiguity of L1 (cycle) (****) | F13.2 |
| Q | Initial ambiguity of L2 (cycle) | F13.2 |

(*) The geometric distance is the distance after earth rotation correction, and it doesn't include receiver and satellite PCO/PCV correction.

(**) The satellite clock includes satellite DCB/TGD correction. For RTK, the satellite clock is referred to P1; for PPP-AR and PPP-RTK, the satellite clock is referred to ionosphere-free combination of P1 and P2.

(***) OMC: Observation minus correction, also known as the pre-fit residuals.

(****) The value will be 9999.00 if there is no carrier phase observation on this frequency.

One example of the station-difference and double-difference part is as follow:

Fig. A4 Example of the station-difference and double-difference log

Table A4. Description of the station-difference and double-difference log

Symbol	Description	Format
A	SD: Symbol of station-difference (*) DD: Symbol of double-difference	A6
B	PRN	1X, A1, I2
C	OMC of P1 (m)	F8.3
D	OMC of P2 (m)	F8.3
E	SD: OMC of L1 (m) DD: OMC of L1 (cycle)	F13.3
F	SD: OMC of L2 (m) DD: OMC of L2 (cycle)	F13.3
G	SD: OMC of L1 or WL or Ionosphere-free (m) (**) DD: OMC of L1 or WL or Ionosphere-free (cycle)	F13.3
H	SD: OMC of L2 or reserved (m) DD: OMC of L2 or reserved (cycle)	F13.3
I (***)	DD: OMC of MW (cycle) (****)(*****)	F13.3

(*) SD will not appear in PPP-AR/PPP-RTK mode.

(**) L1 is for RTK, WL is for long-baseline mode of PPP-AR/PPP-RTK, ionosphere-free is for ionosphere-free mode of PPP-AR/PPP-RTK.

(***) This row will appear in PPP-AR/PPP-RTK mode.

(****) The value will be 99.000 for long-baseline mode of PPP-AR/PPP-RTK.

(*****) For triple-frequency RTK, the value from C to H will be OMC of P1, P2, P3, L1, L2, L3 for SD; the value from C to I will be OMC of P1, P2, P3, L1, L2, L3, MW for DD.

One example of the solution part is as follow:

Fig. A5 Example of the solution log

Table A5. Description of the solution log

Symbol	Description	Format
A	Float solution of coordinate (dx, dy, dz in ECEF) and troposphere (dztd) (m) (*)	4F7.2
B	Post-fit residuals of pseudorange and carrier phase (m)	F7.3
C	Float solution of slant ionosphere delay (diono) (m)	I6, F8.2
D	Float solution of ambiguity (damb) (cycle)	I6, F8.1
E	Fixed solution of ambiguity (damb) (cycle)	I6, F8.1
F	Ratio, Solution type (**), accumulated fixed solution number, reserved	F7.2, I7, I6, F10.3
G	Fixed solution of coordinate (dx, dy, dz in ECEF) (m)	3F7.2
H	Float or fixed solution of coordinate (NEU) (m)	F10.3

(*) For short baseline RTK, there is no troposphere correction. The troposphere delay doesn't include the model correction part.

(**) The meaning of solution type can be found in Table A1.

A2.2 SPP/PPP/DSPP/DPPP/FastPPP

One example of the log file is as follow:

Fig. A3 Example of the log file

Table A3. Description of the log file

Symbol	Description	Format
A	See Fig. A3 and Table A3 (*)	
B	Solution of coordinate (dx, dy, dz in ECEF) (m) and troposphere (dztd) (m) (**)	A1, I2
C	Coordinate (X, Y, Z in ECEF) (m)	F8.2
D	Slant ionosphere delay (diono) (m) (**)	I6, F8.2
E	Post-fit residual (m)	F10.4
F	Satellite elevation	F10.2

(*) The meaning of this part is generally the same as Fig. A3 and Table A3. Some differences are: (1) For ionosphere-free combination, the satellite clock is the satellite clock is referred to ionosphere-free combination of P1 and P2; for other combination, the satellite clock is referred to the first frequency of the combination. (2) For ionosphere-free combination and single frequency, the geometric distance includes receiver and satellite PCO/PCV correction; for dual-frequency/triple-frequency with raw measurements, it doesn't include receiver and satellite PCO/PCV correction. (3) For ionosphere-free combination, the outputted OMC is ionosphere-free combination of PC and LC.

(**) The troposphere and ionosphere delay doesn't include the model correction part.