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Data Quality Analysis of Different Receivers Based on Static Base Station

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ABSTRACT: With the global navigation and positioning system technology in various industries more and more widely used. As a result, higher requirements are made for the performance of GNSS receiver and the quality of receiving data. The quality of the received data is analyzed and compared to the receivers produced by different manufacturers. By comparison, The processing ability and data quality of different receivers for GNSS signals are analyzed. Data is collected for two different receiver from production M300Pro of ComNav and SPS 855 of Trimble. The quality analysis and discussion were carried out by using TEQC and CRU software respectively. The results show that the data quality of the two receivers conforms to the detection experience value, and is analyzed and compared by data quality. The two quality analysis software has Respective advantages. Combining different observation factors analysis that is important for the stable operation of the system and improving the positioning accuracy.
Keywords: receiver; data quality; Navigation and positioning; collection data

I. INTRODUCTION

GNSS receiver is an important part of the satellite navigation system, data processing receiver is also plays an important role in satellite navigation and positioning precision, With the development and perfection of the satellite navigation system, there are more and more kinds of receivers, In order to meet the needs of the domestic base enhancement system construction, the quality of static observation data of different GNSS receivers is analyzed, which is of great significance to ensure the stable operation of the system and improve the accuracy of navigation and positioning, M300Pro is Shanghai ComNav Technology Ltd for the foundation to enhance the Beidou system construction and design of a high performance GNSS receiver, Which is bulit Linux operating system, equipped with advanced high precision motherboard company completely independent intellectual property rights, support external event frequency standard input and large capacity data storage, input, support connection meteorograph, tiltmeter sensor input, is the foundation to enhance the Beidou common receiver system. Trimble SPS855 is a split type GNSS receiver, integrated with built-in radio station and external GPS antenna interface. The receiver can be placed in a safe environment, such as a trailer or cabin, in case the weather changes. Relatively inexpensive external antennas can be placed in clear and visible radio coverage of the sky.

1 Introduction To TEQC And CRU Software

TEQC(Translate/Edit/Quality Check/Coordinate) is a free software developed by UNAVCO Faclityfor studying data management services at geological GPS monitoring stations, and it can beused to check dynamic and static data quality and dual frequency GPS receivers. It has a vzery big advantage in the rapid evaluation of GPS data quality, on the one hand speed, no complicated steps, only a few simple commands; on the other hand can analyze the quality of the multi angle the full range of GPS observation data, respectively, from the satellite elevation angle, azimuth angle, multipath effect, ionospheric delay error, the rate of ionospheric delay and SNR in Qcview with a graphical intuitive reflect the quality of GPS data.

1.1 The Generation And Introduction Of RINEX File

RINEX is a standard data format commonly used in GPS measurement applications. This format uses text files to store data, and the format of recorded data has nothing to do with the manufacturer and the specific model of the receiver. The RINEX format defines 6 different types of data files, including the two documents necessary for data processing, analysis, and navigation messages. Trimble SPS855 collected original data is the T02 file format, and the data analysis need is the observation files and navigation files by file conversion tools, T02 format will be converted to standard RINEX file, ComNav M300Pro collected original data is the CNB format, can be directly converted by CRU software RINEX file.

1.2 Data editing

TEQC can implement various forms of file editing functions, including:

(1) RINEX file cutting, GPS observation data, usually beginning data accuracy for a period of time, so the time observation data file selection in imperative. In TEQC, the RINEX file can be cut arbitrarily by using the time window, which makes the extraction of RINEX files very easy.

(2) disable satellite system and the choice of a particular satellite receiver, for GPS/GLONASS binary, selection of TEQC can be used for satellite, such as removing the GLONASS satellite data instruction is: TEQC -R input file > output files; disable PRN # instruction observation data of the GPS satellite is: TEQC -G# input file > output file, Where PRN is the number of the satellite.

1.3 Quality analysis

According to whether or not navigation file information is used, TEQC is divided into two check modes, qc2lite and qc2full.

(1) qc2 lite mode, if the input file is only RINEX observation data file, and no navigation data file, then TEQC will run in qc2lite mode. Usually in the default state, check the quality of the results will generate a report file (*.s) and a data file including the ionospheric delay error (*.ion), the rate of ionospheric delay (*.iod) and L1 carrier C/A code or P code pseudorange multipath effect (*.mp1) and L2 carrier P code pseudorange multipath effect (*.mp2) and L1 carrier signal to noise ratio (*.sn1) and L2 carrier signal to noise ratio (*.sn2).

(2) qc2full, if the input file for the RINEX data files and navigation data file, the results out of qc2lite generated data, but also add the location information of satellite and receiver antenna and two data files Azimuth (*.azi) and altitude angle (*.ele).

1.4 CRU Analysis

CRU software is developed for the detection of Shanghai Ian navigation receiver or board data quality and analysis of satellite positioning index's visualization software, the main function: This machine or a remote receiver card and data download, rename files (time, attributes, the antenna height) deleted, formatted memory and so on; satellite tracking situation such as: letter noise ratio (see numerical and histogram display), star map, location map, discrete positioning information display and so on; serial debugging simulation, according to the need to send a variety of card command or data output and so on; the RINEX data conversion, according to the need to convert the RINEX format data of single frequency and multi frequency data and the corresponding version of the.

II. DATA QUALITY EVALUATION

2.1 SPS 855 Data Quality Analysis

In the TEQC quality inspection report, the S file contains the data of each satellite and the status information of the received data. The MP1 and MP2 in the inspection report file are expressed in the form of RMS variance, and the formula is as follows:

$$M_{p1} = p_2 - \left[1 + \frac{2}{a-1}\right]\varphi_1 + \left[\frac{2}{a-1}\right]\varphi_2 \qquad (2\text{-}1)$$

$$M_{p2} = p_2 - \left[1 + \frac{2a}{a-1}\right]\varphi_1 + \left[\frac{2a}{a-1} - 1\right]\varphi_2 \qquad (2\text{-}2)$$

In the formula, p1 and p2 are double frequency pseudo range observations, φ_1 and φ_2 are phase observation values, and a is the square of the ratio of the frequency values of L1 and L2 bands.As a result file, the observation period, ionospheric delay, ion and rate of change iod, and the signal-to-noise ratio of L1 and SN1 are calculated as follows: L2 and sn2:

$$ion = \frac{1}{a-1}\left[n_1\lambda_1 - n_2\lambda_2 + m_1 - m_2\right] = \frac{1}{a-1}\left(L_1 - L_2\right) \qquad (2\text{-}3)$$

$$iod = \frac{\frac{a}{a-1}\left[\left(L_1 - L_2\right)_j - \left(L_1 - L_2\right)_{j-1}\right]}{t_j - t_{j-1}} \qquad (2\text{-}4)$$

Among them, λ_1 and λ_2 are wavelengths, L1 and L2 are dual frequency carrier phase observations, n1 and n2 are integer ambiguities, and m1 and m2 are multipath effects of dual carrier phase observations. If the rate of change of IOD is greater than 400 cm/min, phase slip is generally considered. Using SPS855 receiver, according to the observation data of Jiading District Observatory in Shanghai from 13:29 to 17:13 in May 4, 2017, the data quality was analyzed, and the sampling interval was 30s. Sometimes when there is no shutdown of the receiver is mobile measurement, which will cause the ephemeris error, in order to avoid this error, through the analysis of the interception of some data, improve the accuracy of observation data, the statistical data are shown in table 3-1.

Table 3-1 Statistics of TEQC software quality test results

Observation index	Analysis value	Observation index	Analysis value
Total satellites	12	mp2	0.42
o/slps	3262	S1	46.98
mp1	0.29	S2	36.12
Epochs repeated	0（0.00%）	IOD signifying a slip	>400cm/min
IOD slips	6	Epochs w/ obs	449

In the absence of interception before data can be calculated, the integrity of the data is 99.95%, according to the analysis of data detection experience, MP1 is less than 0.35, MP2 less than 0.45, fully meet the quality requirements of data, and data integrity is greater than 95%, the invalid observation value is less than 5%, S1 and S2 were L1 and L2 on the average noise the S1 and S2 standard deviation were 3.98, 6.62, 3262 points for use, and the observation data and the week jump very high ratio, indicating that the site of the receiver data in the ideal state, meet the data quality requirements.

2.2 dynamic processing data analysis

In order to observe the satellite tracking data, analysis of data quality directly, using QCView drawing quality report files, because win7 DOS does not support the drawing, using the software DOSBox, which will support data quality report file drawing output, as shown in figure.

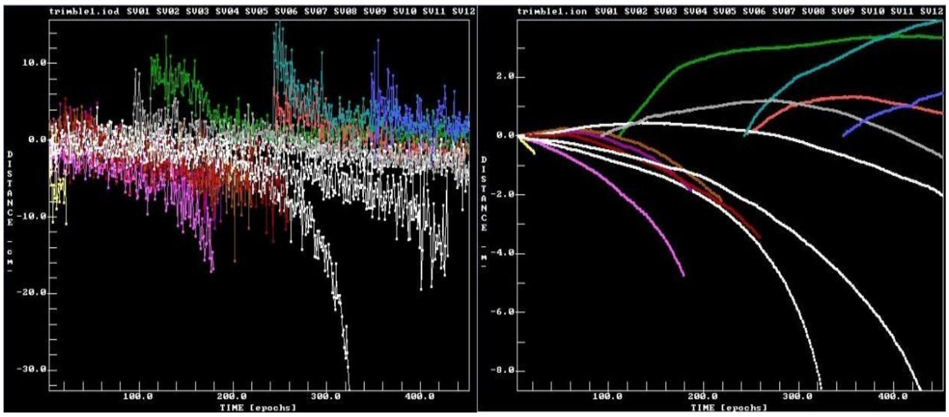

Figure 2-1 ionospheric delay IOD and rate of change ion

Of particular note is that, because SPS855 is a dual frequency receiver, to illustrate the problem, this paper only retains the GPS observations, excluding the value of other satellite observations, statistical data, the data in accordance with the quality requirements, consistent with the results of statistics.

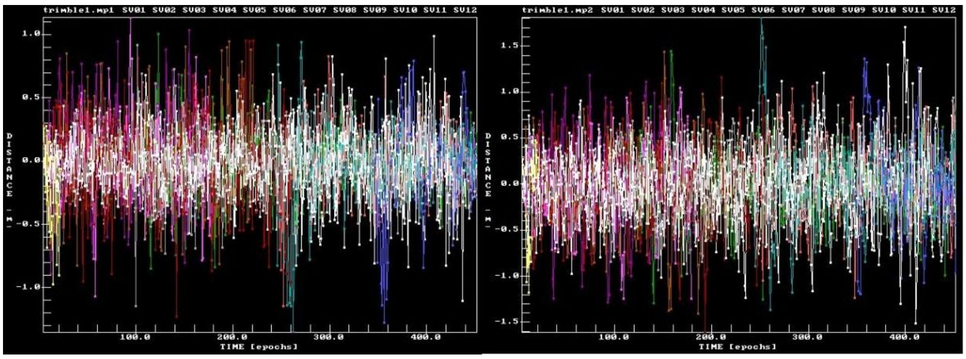

Figure 2-2 multiplexing effects MP1 and MP2

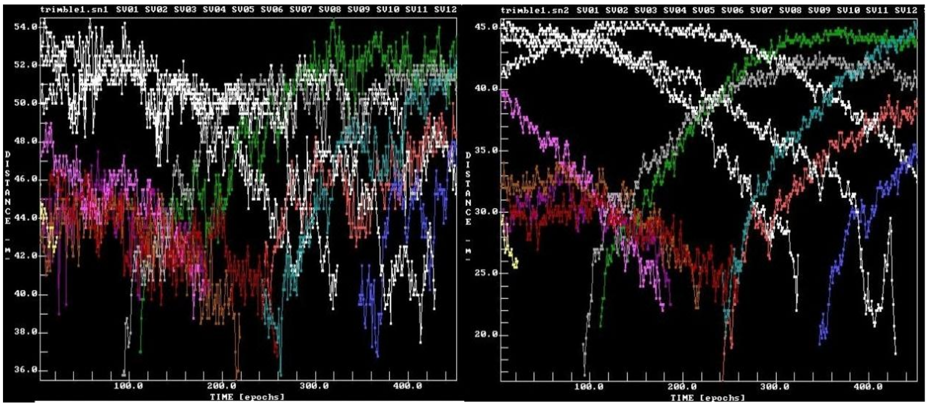

Figure 2-3 SNR SN1 and SN2

2.3 M300Pro data quality analysis

The use of CRU analysis software and visualization of data quality ComNav company to provide quality, can facilitate the analysis of observational data, and visual observation and analysis of data, CRU to achieve the real-time tracking of satellite signals, and reflect the relevant parameters of each satellite, and the data quality. In order to compare the data with the Trimble receiver, set the base station location unchanged, the sampling interval or 30s, also eliminate the data received from other satellites, only observe the GPS data at a certain moment, as shown in the following figure.

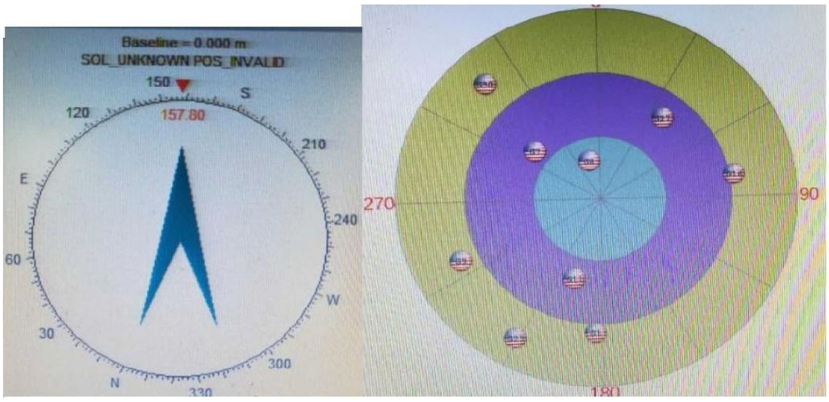

Figure 2-4 satellite pose view and star view

Set the cut-off angle of 15 degrees, figure 2-4 shows each real-time satellite tracking azimuth size, and real-time showing the plane chart, each GPS satellite range. To show that the relationship between the cut-off angle and the GDOP, respectively adjusted cut-off angle of 15 degrees, 20 degrees, 30 degrees, to observe the change of GDOP and a number of satellite tracking, results show that the cut-off angle is larger, the number of satellite tracking will be less, even when the cut-off angle the 30 degree satellite number 80% will be traced to the period of less than 4, does not meet the observation positioning requirements. Experiments show that the receiver's cut-off height angle is set at 15 degrees, which is most consistent with the observation requirements.

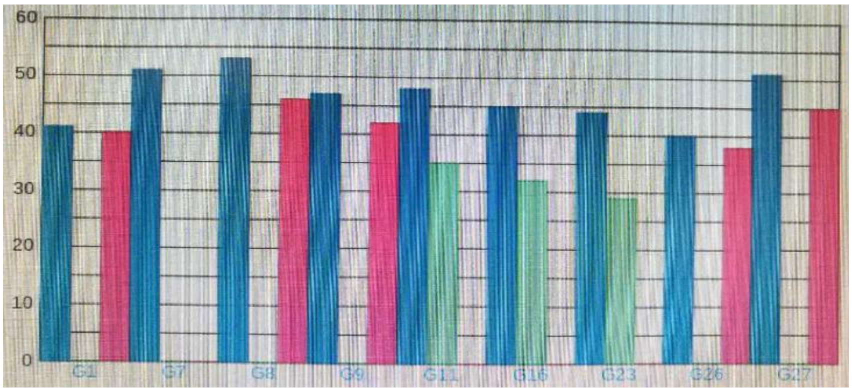

Figure 2-5 signal-to-noise ratio

Figure 2-5 shows the tracking satellite signal to noise ratio of the column chart, it can be seen from the figure, the signal in L1 frequency signal to noise ratio is significantly greater than the L2 frequency of the signal-to-noise ratio, at the same time, the L5 frequency on the signal-to-noise ratio is higher than the L2 frequency point on the signal-to-noise ratio by statistical chart you can also see all the satellites with L1 band, but not all of the satellite contained L2 and L5 bands, such as G26 only L1 band. because of the weather observation data, satellite tracking ability weakened, tracked 9 GPS satellites.

3 Conclusion

The quality analysis of raw data through the use of TEQC software receiver and Trimble navigation data, and generate quality documents, graphics rendering by QCVIEW, the graphics output, the observation quality curve directly, and use CRU software for data quality in Ian receiver real-time analysis, combining with two different receivers, through different data quality the analysis software, the experimental results show that the SNR is greater than L2 on SNR in any case on L1, the M300Pro data can be seen by satellite elevation angle is smaller, the smaller the value of the loss of lock, cut-off angle is bigger, the loss of lock value is larger, but less time 15 degrees of loss of lock value increases. From the comparative analysis of two kinds of receiver, the ability of tracking satellite signal receiver is better than Trimble company, this is just to do the reliability verification of data, there is no influence on the different environments for testing, waiting for the follow-up study.

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