TECHNICAL REPORT

Report No: ESSO-INCOIS-OMARS-TR-05(2026)

A Technical Report on

Data Quality Checking of GNSS Stations data of Andaman Nicobar Islands

by

Sapna Ghavri, M. Vijaya Sunanda, Sudheer Joseph, Dipankar Saikia, Pavan Kumar Jonnakuti, Ch. Patanjali Kumar, Kuppili Rajesh, Syed Mahaboob Moinudeen, Ponnam Laxmi Tharun, Shiva Prasad, E. Pattabhi Rama Rao, T.M Balakrishnan Nair

Indian National Centre for Ocean Information Services (INCOIS),

Earth System Science Organization (ESSO),

Ministry of Earth Sciences (MoES),

Hyderabad,

India

www.incois.gov.in

DOCUMENT CONTROL SHEET

Earth System Science Organization (ESSO)

Ministry of Earth Sciences (MoES)

Indian National Centre for Ocean Information Services (INCOIS)

ESSO Document Number: ESSO-INCOIS-OMARS-TR-05-(2026)

Title of the report: Data Quality Checking of GNSS data of Andaman Nicobar Islands

Author(s):

[Sapna Ghavri, M. Vijaya Sunanda Sudheer Joseph, Dipankar Saikia, Pavan Kumar Jonnakuti, Ch. Patanjali Kumar, Kuppili Rajesh, Syed Mahaboob Moinudeen ,Shiva Prasad, Ponnam Laxmi Tharun E. Pattabhi Rama Rao, , T.M. Balakrishnan Nair]

Originating unit: OMARS

Type of Document: Technical Report (TR)

Content

Abstract

1. Introduction
2. GNSS data monitoring in Andaman-Nicobar Islands: Implications
3. GNSS data observables/File format
4. Pre-processing of GNSS data
5. Major parameters for quality checking
   - 5.1 Percentage of observation
   - 5.2 MP values and ratio
   - 5.3 Cycle slip ratio
   - 5.4 Frequency of GNSS Observables
6. Station wise GNSS data quality report
7. Summary
8. References

Number of pages: 40

Number of figures: 29

Number of references: 11

Keywords: GNSS Data, Andaman Nicobar Islands, Cycle Slips, Percentage of Observation

Security classification: Open

Distribution: Open

Date of publication:

Abstract

Indian National Center for Ocean Information Services (INCOIS), Hyderabad, has established more than 30 GNSS stations in Andaman- Nicobar Islands. In this context, the observations and surveillance of geodetic networks by INCOIS play a vital role not only in assessing the potential of tsunamigenic seismic sources but also in issuing timely and regular early warnings with enhanced estimates of tsunami wave heights and arrival times generated by earthquakes in the Andaman and Nicobar Islands and along the coastal regions of the country. GNSS data quality checking is important to ensure that data going into the processing is complete, consistent, accurate, and reliable. GNSS measurements can contain errors caused by satellite geometry, atmospheric effects, multipath, receiver noise, and clock errors. Quality checking helps to detect observations that may produce inaccurate coordinates. GNSS data quality control involves identifying and correcting key errors such as cycle slips, multipath, satellite orbit, clock errors, atmospheric delays, antenna effects and data gaps. The percentage of observations and pseudo range observables (C1/C2, P1/P2) and carrier phase observables (L1/L2) are initially checked to assess the quality and completeness of GNSS data. Signals reflected from buildings, trees, water, or other surfaces can reach the receiver along with direct signals. A receiver/antenna needs availability of a sufficient number of satellites (>4) with good spatial distribution. Poor satellite geometry, often expressed using DOP (Dilution of precision), can reduce positioning accuracy even when the measurements themselves are good. However, the assessment of earthquake magnitude and source characteristics require several seconds to a few minutes, depending on the arrival of P- and S-waves and the magnitude of the seismic event. Real-time GNSS measurements from stations situated close to the earthquake epicentral region can provide rapid estimates of co-seismic ground displacement, which can be utilized to directly determine the seismic moment and earthquake magnitude, as well as the characteristics of fault motion, including strike-slip, dip-slip, and tensile dislocation. In the present report, the quality report of daily recorded (24-hour) GNSS data at each station operating from 2013 to 2025 has been generated using TEQC software based on the qualitative values of four major quality indicators, i.e., percentage of observation, root-mean-square value of multipath and its ratio corresponding to the major observables, cycle slip ratio, and average frequency of major observables. The threshold level corresponding to the major quality indicators has been considered from the stable/IGS GNSS stations. The QC of GNSS data indicates that the average values of quality indicators at most of the stations were at a satisfactory level (or lie within threshold level), except for the percentage of observation, which is low (<0.8) for most of the period of observations, specifically data before 2024. The QC indicates that GNSS data at 11 stations is useful for the purpose of understanding present day crustal deformation studies, including characterization of postseismic deformation due to 2004 megathrust, calculation of plate motion, strain build up rate and detection of potential seismic hazard zone/tsunamigenic zone in Andaman Nicobar Islands.

1. Introduction

Global Navigation Satellite System (GNSS) is a constellation of various satellites systems such as Global Positioning System (GPS), GLONASS, Galileo, BeiDou, NavIC etc. GPS is developed by United State Department of Defence and is fully operational since 1993. These satellite systems are designed to provide precise positioning (sub-millimeter level) and timings

and has wide application in the various fields such as mapping, surveying, navigation, aviation, military, etc. In past three decades, the GNSS observations has been used to measure the plate motion and to characterize the present-day tectonic deformation, varies from few millimeters to several centimeters, in a region. The geodetic senor is well enough to capture minute deformation within upper crustal along/across weak zones or faults caused by tectonic forces. The elastic rebound theory suggests that accumulation of strain energy along/across weak zones during inter-seismic phase of deformation and once the accumulated strain energy exceeds the strength of the crustal material a sudden release of energy takes place during the occurrence of earthquake, known as co-seismic phase of deformation. A tremendous strain energy is being released during occurrence of major to great earthquakes which may perturb the ductile zone of upper mantle and asthenosphere and produce a long span of post-seismic deformation which has also been reported during the 2004 Sumatra-Andaman earthquake. A significant advantage of GNSS sensor over seismograph is that the GNSS sensor can capture minute tectonic deformation prior to occurrence of earthquake which help in detecting seismically vulnerable zones and calculating maximum credible magnitude of earthquake in future. The daily data at stations with a satisfactory level (>0.8) of percentage of observation may be used for post-processing to obtain precise positioning after correction for atmospheric, tidal, multipath, ephemeris, etc.

GNSS measurements in Indian subcontinent have started in 1995 after installation of an IGS station in Hyderabad. Since then, various GNSS stations has been established by several organizations such as Wadia Institute of Himalayan Geology, Dehradun; CSIR-4PI, Bangalore; Institute of Seismological Research, Gandhinagar; CSIR-National Geophysical Research Institute Hyderabad, Indian Meteorological Department, New Delhi; Survey of India, etc. These GNSS networks has been established to detect and characterize the tectonic deformation in the Indian subcontinents and to upgrade national positioning infrastructure for establishing national horizontal/vertical reference frame. In past decades, high-rate GNSS sensor has also been used to characterize the dynamic changes during the earthquakes as can be recorded by seismographs for a detailed study of rupture zones and its behavior. Now a days, real-time monitoring of GNSS sensor may be utilized for a reliable characterization of source, mainly the nature of earthquake, its magnitude, within a very short interval after the occurrence of significant earthquakes and mostly useful for early warning of tsunami where our institute contribute significantly. The Institute has also installed more than 35 strong motion accelerographs in Andaman Nicobar Islands, Consequently, the combined use of real-time GNSS and strong-motion accelerograph observations can substantially improve the rapid detection and characterization of major undersea earthquakes (Mw > 6) and support the generation of accurate and timely tsunami early warnings, potentially within a few (<10) minutes of the earthquake occurrence. For this, the quality of GNSS data recorded at each epoch at stations should be at a satisfactory level.

In the present report, we check the quality of the data of our GNSS network in Andaman-Nicobar Islands which is important for getting precise estimation of site position in real-time or post-processing of data. Also, the accuracy of plate motion and detection of minute tectonic deformation depends on the quality of GNSS data. We introduced, in brief, GNSS data format and important quality check indicators such as multipath level, number of cyclic slips,

percentage of data, major GNSS observables such as L1 and L2 for the GPS satellites which, in general, is used to calculate precise positioning at stations. The influences are summarized from the reports of quality check parameters generated at each station for daily observation file from 2013 to 2025. The conclusion will help in the running and maintenance of GNSS stations, select data files for post processing and formulate the related technical standards and so on.

2. GNSS data monitoring in Andaman-Nicobar Islands: Implications

Andaman-Nicobar Islands is northern most part of a highly active subduction zone between the India and Sunda Plates. The Sumatra-Andaman subduction zone has experienced several devastating earthquakes in past such as 1797 M 8.4, 1833 M 9, 1861 M 8.5, 1907 M 7.8, 2004 Mw 9.2, 2005 Mw 8.6, etc. The 2004 megathrust Mw 9.2 has ruptured ~1400 km long segment of subduction zone and generated deadliest tsunami in history. More than 2 lakh people died caused by earthquake and tsunami. Most of the causality caused by the generated high-tide tsunami waves (>30 feet), at speed of ~800 km/hour, after megathrust which took ~ 1 hour to reach at Andaman-Nicobar coast. The deployment of effective early warning systems (within 10 minutes after earthquake) in the coastal area might be useful to reduce the causalities and economic loss expected by devastating earthquakes in future.

The INCOIS has established ~35 strong motion accelerographs and 37 GNSS stations in the Andaman-Nicobar Islands in the view of providing early warning for tsunami (Figure 1). The DART boys in the Indian Ocean and tide gauges at eastern and western coast of country are also deployed in same view/motive. The strong motion accelerograph can record great magnitude earthquakes with minimal/no saturation as observed in conventional seismographs. However, the determination of magnitude and nature of earthquakes may take few seconds to minutes based on arrival of p- and s-waves depending on the size of earthquake. The GNSS observations from nearby earthquake's source zone may be useful to get ground deformation values which can help in direct estimation of seismic moment or magnitude and nature of slip (strike-slip, dip–slip, or tensile dislocation). Therefore, real-time observation from GNSS and strong motion accelerograph together help in providing early warning of the high-tides tsunami generated by significant earthquakes (Mw > 6) under the sea within few (< 10) minutes with a reliable accuracy. The real-time monitoring and analysis of both types of data is important in the zones, potential for tsunami genesis in future.

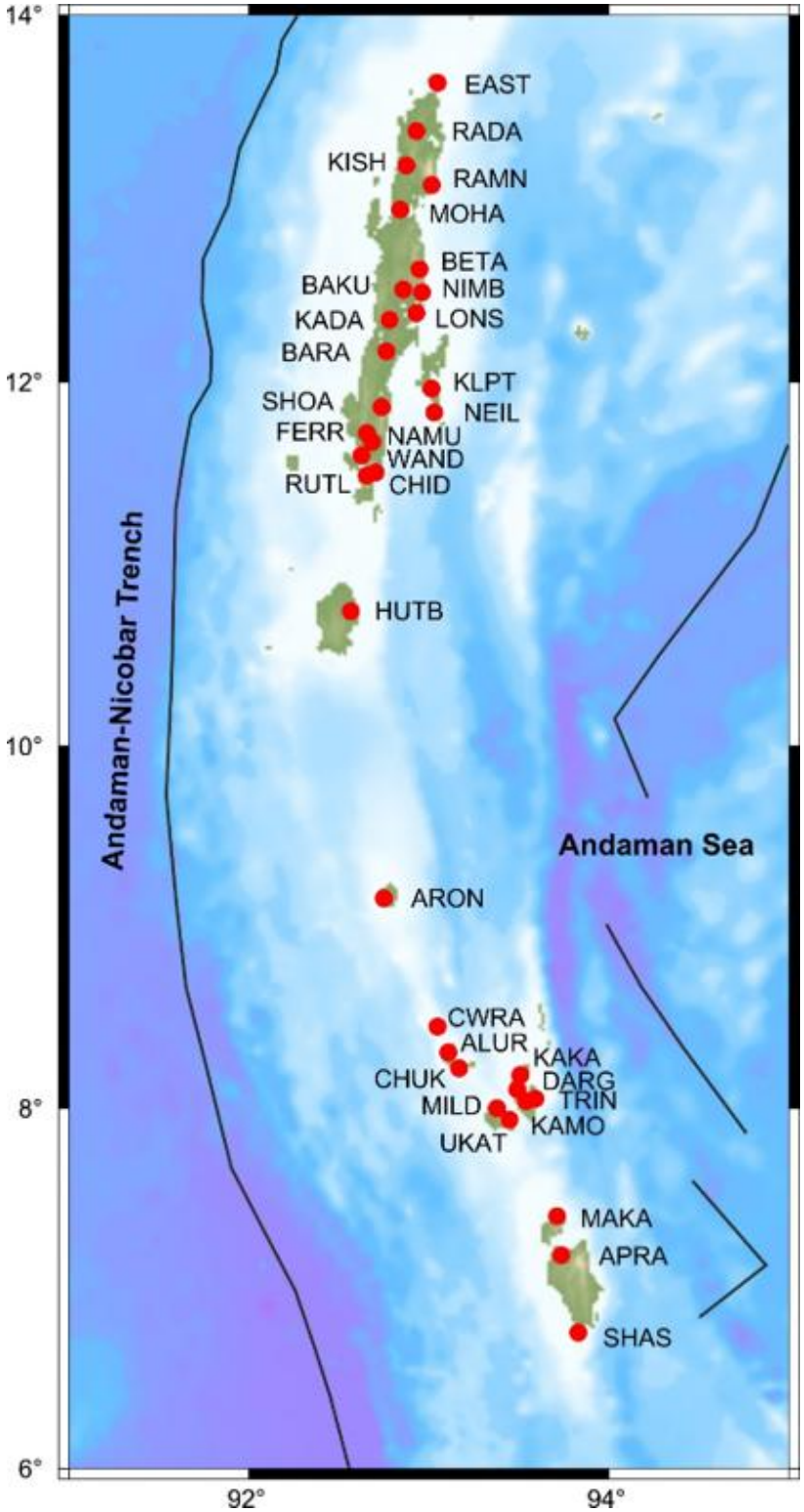


Figure 1: INCOIS GNSS stations in the Andaman-Nicobar Islands.

3. GNSS data observables/File format

The raw GNSS data recorded at stations are in BINEX "BINary EXchange" format; generally ".T00/.T01/.T02" or ".M00" for data recorded by Trimble or Leica manufacturer receivers, respectively; standard for GNSS research and operational purpose. Further, the raw data can be converted in the common ASCII exchange formats such as RINEX, SINEX, SP3, IONEX

etc. based on data conversion tools. The RINEX (Receiver independent Exchange Format) is the standard format that allow the management and disposal of the measures generated by a receiver, as well as their off-line processing by a multitude of applications, whatever the manufacturer of both the receiver and the computer application (enwikipedia.org/wiki/RINEX). The GNSS receivers installed in Andaman-Nicobar Islands by the institute are all Trimble manufacturer and hence a RINEX converter has been used to convert the raw data in RINEX format. A observation file (".o") and navigation file (".n") obtained after the conversion of raw data. The observation file contains the GNSS observables corresponding to available satellites which is important for the estimation of precise positioning with time. An example of RINEX observation (".o") file is represented as below,

```
     2.11           OBSERVATION DATA    Mixed(MIXED)        RINEX VERSION / TYPE
cnvtToRINEX 3.14.0  convertToRINEX OPR  20251009 082446 UTC PGM / RUN BY / DATE
------------------------------------------------------------ COMMENT
DGPR                                                         MARKER NAME
34                                                           MARKER NUMBER
GNSS Observer       Trimble                                  OBSERVER / AGENCY
5151K80820          Rogue                4.82                REC # / TYPE / VERS
5151K80820          TRM59800.00                              ANT # / TYPE
  -317891.3024  6203147.7011  1444432.1182                   APPROX POSITION XYZ
        0.0000        0.0000        0.0000                   ANTENNA: DELTA H/E/N
     1     1     0                                           WAVELENGTH FACT L1/2
     7    C1    C2    C5    L1    L2    L5    P2             # / TYPES OF OBSERV
  2023     1     2     0     0   0.0000000     GPS           TIME OF FIRST OBS
  2023     1     2    23    59  59.0000000     GPS           TIME OF LAST OBS
     0                                                       RCV CLOCK OFFS APPL
    18                                                       LEAP SECONDS
    31                                                       # OF SATELLITES
   G01 21466 21460 21460 21466 42898 21460 21438            PRN / # OF OBS
   G02 18964     0     0 18964 18870     0 18870            PRN / # OF OBS
   G03 23523 23513 23513 23523 47019 23513 23506            PRN / # OF OBS
   G04 15245 15244 15245 15245 30427 15245 15183            PRN / # OF OBS
   G05 16803 16803     0 16803 33580     0 16777            PRN / # OF OBS
   G06 17116 17114 17116 17116 34217 17116 17103            PRN / # OF OBS
   G07 17376 17376     0 17376 34752     0 17376            PRN / # OF OBS
   G08 14626 14626 14626 14626 29213 14626 14587            PRN / # OF OBS
   G09 14526 14525 14525 14526 29032 14525 14507            PRN / # OF OBS
```

The header of observation file contains information of observation data such as RINEX version, name of organization for the setup of station and four-character id for station name, aprori station X, Y, Z in WGS84 co-ordinate system, the start and end time of observations, sampling interval, etc. Further the data section contains GNSS observables (such as L1, L2, C1, P2) at each sample for the available satellites. The C1 and P2 is the pseudo-range corresponding C/A (or civilian)- and P (Precise)- codes which are important to calculate the travel time for the signals emitted by satellite to reach to antenna that is further multiplied by velocity of light to get pseudo-range, distance between the antenna and user at a particular time. The L1 and L2 indicates total carrier phase cycles of signals from satellite to reach up to antenna which is further multiplied by the wavelength of carrier waves L1 and L2 to get the pseudo-range value.

4. Pre-processing of GNSS data

The health of the GNSS data is important check to get useful data for precise estimate of position to detect/record signature of significant earthquake at a station with minimal uncertainly perturbation. A total of 30 GNSS stations at Andaman-Nicobar Islands has been

installed by INCOIS afterwards 2012 to capture the signature/record of significant earthquakes in the Sumatra-Andaman subduction zone to disseminate reliable early warning for tsunami in future.

There are several tools available for pre-processing of the GNSS data such as TEQC, GDA, G-Nut, GDPS, etc. (Estey and Meertens, 1999; Lau and Tai, 2023; Lu et al., 2024 Gao et al., 2025). TEQC (Translate, Edit, Quality Check) is a most common pre-processing tool for the GNSS data, designed and developed and also maintained by University Navstar Consortium (UNAVCO) facility in Boulder, Colorado. TEQC is also used for translation of data in other formats and editing or correction of RINEX header metadata, etc. TEQC tool is free to use and available for Windows, Linux, and Mac operating systems. In the present report, TEQC tool is used to check the data health of our GNSS network in the Andaman-Nicobar Islands. A detail documentation on TEQC is available by UNAVCO (https://www.unavco.org/). The QC post-processing tool/module of TEQC is used which uses the navigation information and generate a detailed quality report summary (".S") file. The quality report contains detail of observation data including the major parameters of quality check such as length of possible and complete observations, RMS of multipath corresponding C/A and P code-observations on L1 and L2 respectively, receiver clock slips, receiver cyclic slips, satellite elevation and azimuth angles, rate of change of ionospheric delay, frequency of received observables (such as L1, L2, C1, and P2) corresponding satellites etc. A typical example of generated quality check summary (".S") for station is attached in Annexure I.

5. Major parameters for quality checking

The GNSS signals emitted by satellites travel through ionosphere and troposphere where the signals get dispersed due to existing medium. Hence, the signals do not follow straight path to reach up to ground based antenna and get deviated and takes longer time to reach antenna. The multi-frequency receivers help in calculating the medium property, specifically, total electron content in the ionosphere and hence useful in reducing the path delay caused by ionosphere. The tropospheric delay is being minimized while using the atmospheric models that provide the content of dry and wet water molecules, responsible for delay in the troposphere based on meteorological data. Other than troposphere and ionosphere, the multipath, i.e. reflection of electromagnetic waves/signals from a metallic/smooth surface, cycle slip, health of observables and percentage of observations, etc. may affect the quality of data. The common and non-common clock errors can be reduced while post-processing of data using single and double difference models respectively (Chen et al., 2012). A few major parameters for GNSS data quality are described in brief and have been analyzed at our GNSS stations located in the Andaman-Nicobar region.

5.1 Percentage of observation:

The percentage of observation is the ratio of "complete observations to possible observations" where the "possible observations" indicate the total number of possible observation epochs in a given time window, and "complete observations" are the number of epochs that actually observed code and carrier-phase data. In the generated summary report of quality check both the values the possible and complete observations for the elevation angle 10-degree and above are included which is used to calculate daily basis percentage of observation at site in this

report. In general, the percentage of observation should be more than 0.8 (or 80%) to achieve a precise (sub-millimeter level) estimate of daily basis positioning of station during the post processing of the data.

5.2 MP values and ratio:

Multipath is one of the main sources of error in the GNSS data which depends on the satellite's space structure, the signals direction and reflection coefficients, distance between the reflector and observation station (Liu et al., 2010). The error caused by multipath depends on the surface property of reflection around antenna. The possible reflector can be ground, hills, buildings, water surface, etc. (Liu et al., 1993). The error introduced by multipath affect may reach up to 4-5 meter for a highly reflective object. The signals received from multiple path introduce cyclic slips and affect the receiver's phase-locked lose, which tracks the carrier phase of the signals. This results severe signal fading and drop in the signal-to-noise ratio and can introduce ~5 cm periodic errors in the distance by the phase deviation, and it would be ~15 cm in the elevation (Chen et al., 2010). A few suggestions advisable (Xiao et al., 2009) to reduce the multipath affect are ,like to avoid signals coming from below 10-degree elevation angle, station should not be established close to high-voltage line and must be kept far from signal obstructions caused by trees, buildings, etc.

The effect of pseudorange multipath (MP1 and MP2) in the signals C/A and P codes modulated on carrier frequencies L1 and L2, respectively can be computed by linear combination of the pseudorange and carrier phase observations. The equations for computation of MP1 and MP2 can be written as follows,

$$MP1 = P_1 - \left(1 + \frac{2}{\alpha - 1}\right)\lambda_1\phi_1 + \left(\frac{2}{\alpha - 1}\right)\lambda_2\phi_2$$

$$MP2 = P_2 - \left(\frac{2\alpha}{\alpha - 1}\right)\lambda_1\phi_1 + \left(\frac{2\alpha}{\alpha - 1} - 1\right)\lambda_2\phi_2$$

where P1, P2 are pseudo-range code measurements (in meters) on frequencies L1 and L2 respectively, $\boldsymbol{\phi}1$, $\boldsymbol{\phi}2$ are the carrier-phase observables (cycles) on frequencies L1 and L2 respectively, $\boldsymbol{\lambda}1$, $\boldsymbol{\lambda}2$ are the carrier wavelengths (in meters) for frequencies L1 and L2, and α is the ratio of squared frequencies of L1 and L2. A low value of MP1 and MP2 parameters is preferable. The past studies indicate that the value of MP1 and MP2 for the IGS stations were less than 0.5 and 0.75 respectively (Hu et al., 2016).

5.3 Cycle slip ratio:

The various obstructions in the direct receival of signals to antenna causes receiver loses lock, even for a very short interval, and then re-tracks the signal, the integer ambiguity of the carrier phase is lost, resulting in a sudden jump in the cycle count. In general, a cycle slip is a discontinuity in a receiver's phase lock on a satellite's signal. Therefore, carrier phase positioning accuracy suffers if cycle slips are not detected and repaired. The magnitude of the slip can range from a single cycle to thousands of cycles. The cycle slip can be due to several

reasons, the common reasons are signal interruption caused by buildings, hills, trees, etc. Also, the low signal to noise ratio caused by multipath effect, electromagnetic interference near the station, dramatic change in total electron content in the ionosphere, and low elevation angle of satellites, etc. (Chen Y, 2014).
The summary file of quality report includes the value of slips above 10-degree elevation. The cyclic slip ratio (CSR) can be computed by the ratio of complete observation and slips above 10-degree elevation angle are as follows,

$$CSR = \frac{1000}{complete\ \ observation / number\ \ of\ \ slips}$$

The value of CSR for the IGS stations is reported to be lower than 10 in past studies (Hu et al., 2016).

5.4 Frequency of GNSS Observables:

There are two types of GNSS observables in the RINEX data, known as pseudorange observables (such as C1/C2/P1/P2) and carrier phase observables (such as L1/LL2). The pseudorange observables consist of approximate range values calculated by C/A (C1/C2 represents "civilian") code and P- (P1/P2 represents "precise") code. The carrier wave observables are L1 and L2 on which the C/A- and P-codes modulate for the transmission of signals from satellites. L1 and L2 in the RINEX file represent the number of cycles travelled by the signals to reach to antenna, which can be multiplied by respective wavelength of the signals to get approximate range value from the satellite to antenna. Therefore, the presence of these observables is important to calculate positioning of station at each epoch. The summary report consists of frequency of GNSS observables recorded in the GNSS data corresponding to visible satellites. A minimum of four to six satellites is required to calculate precise site positioning, therefore frequency of each observable for a particular satellite system (such as GPS) must be more than four to six times of total number of epochs. The absence of L1 or L2 may represent an issue in capturing satellite signals by the antenna. As the C1/C2 and P1/P2 modulated on L1 and L2 frequencies, the health of L1 and L2 may also represent the presence of pseudorange observables. Therefore, in the present report, frequency of carrier waves observables i.e. L1 and L2 has been reported.

6. Station wise GNSS data Quality report

The pre-quality check of the recorded GNSS data from 2013 to 2025 at INCOIS network in the Andaman-Nicobar Islands has been performed and detailed in the report. The raw data has been converted using RINEX converter, and further TEQC tool is applied on RINEX data of each station. The quality check parameters, percentage of observations, RMS corresponding to multipath MP1 and MP2, Cycle Slip ratio (CSR), and frequency of L1 and L2 observables have been analyzed to report the health of GNSS stations. The station wise quality report is as follows (see annexure II for year wise quality check parameters at stations):

1. Station: BAKU

The value of ratio of complete and possible observation is lower than 0.6, with an average value of 0.3, which indicates the amount of data received is not sufficient at the station. The MP1 and MP2 values vary from 1 to 3 or more, with a mean value of ~2 that is again on the higher side as compared to reported values up to 0.75 for the IGS stations. The ratio of MP1 and MP2 is close to 1 or more, indicating signal obstructions caused by surrounding trees may be a cause for capturing limited signals at the station. The CSR value, which is 10 or less for good GNSS data, here it is reported that from march to May, it is greater than 60 at the station, which may be due to vegetation and trees. Also, the frequency of L1 and L2 varies from 0 to 400000, and it is less than 345600 for most of the range of data, which is expected to be more than 3,45,600 for one-day (24 hr) of data with a sampling interval of 1 sec and minimum visibility of 4 satellites. The sum of the frequency of L1, L2 observables varies with variation in the percentage of observations, hence, a low value of L1, L2 indicate incomplete length of daily basis recorded data at station.

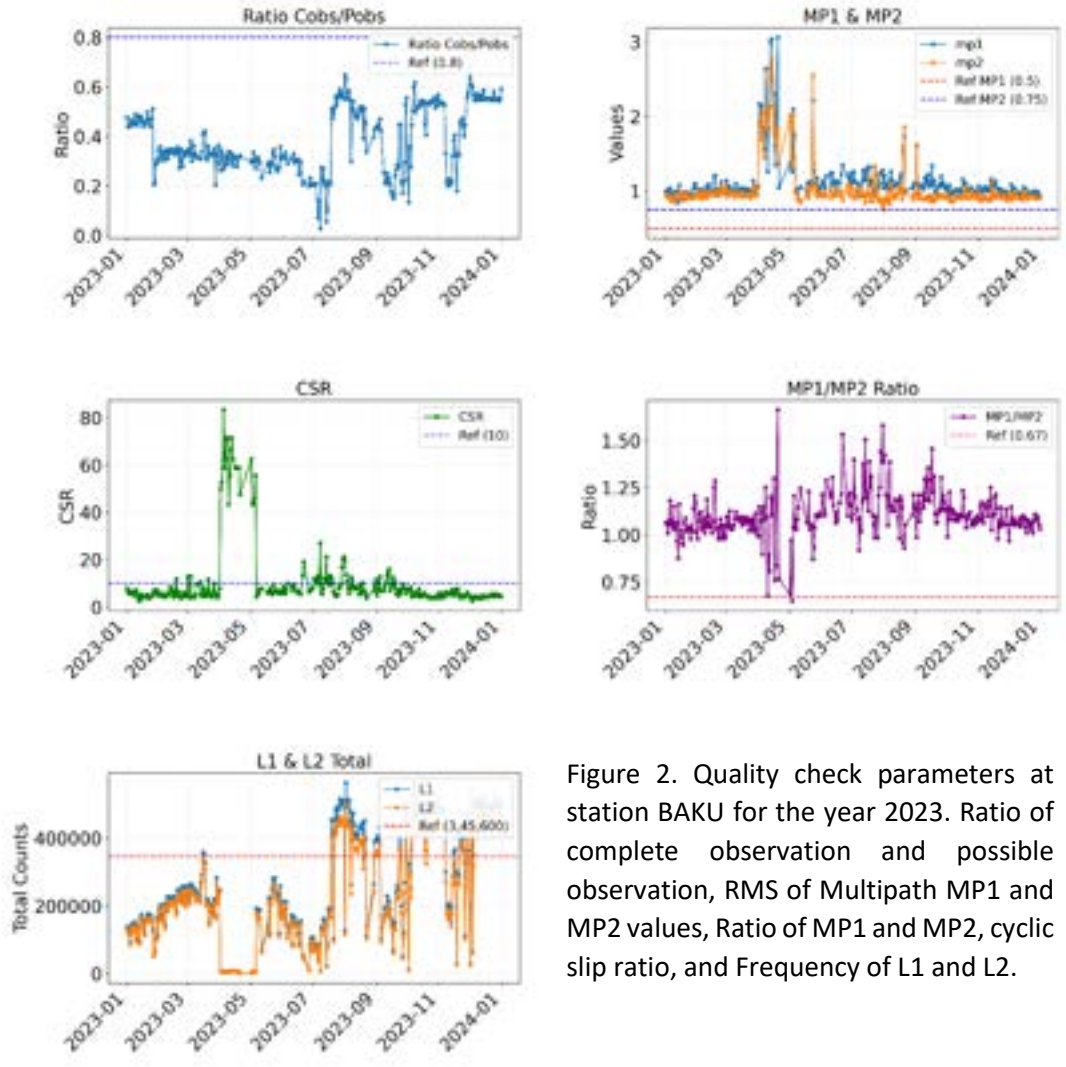


Figure 2. Quality check parameters at station BAKU for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

2. Station: DGPR

The percentage of observation is less than 0.7 and only few days of data consisting > 80% of data. The MP1 and MP2 is less than 0.6 for most of the daily basis observation, which shows the effect of multipath and the ratio of MP1 and MP2 reaches close to 1 indicating effect of multipath is minimal at the station but for the period from June to September it is observed that the value of MP1 and MP2 is greater than 2, which may represent some effect of multipath at the station. The CSR value for most of the days is lower than 10, hence the obstructions to signals is minimal. The sum of frequency of L1 and L2 for most of days is more than 4,00,000, which represents the healthy signal is received by the antenna.

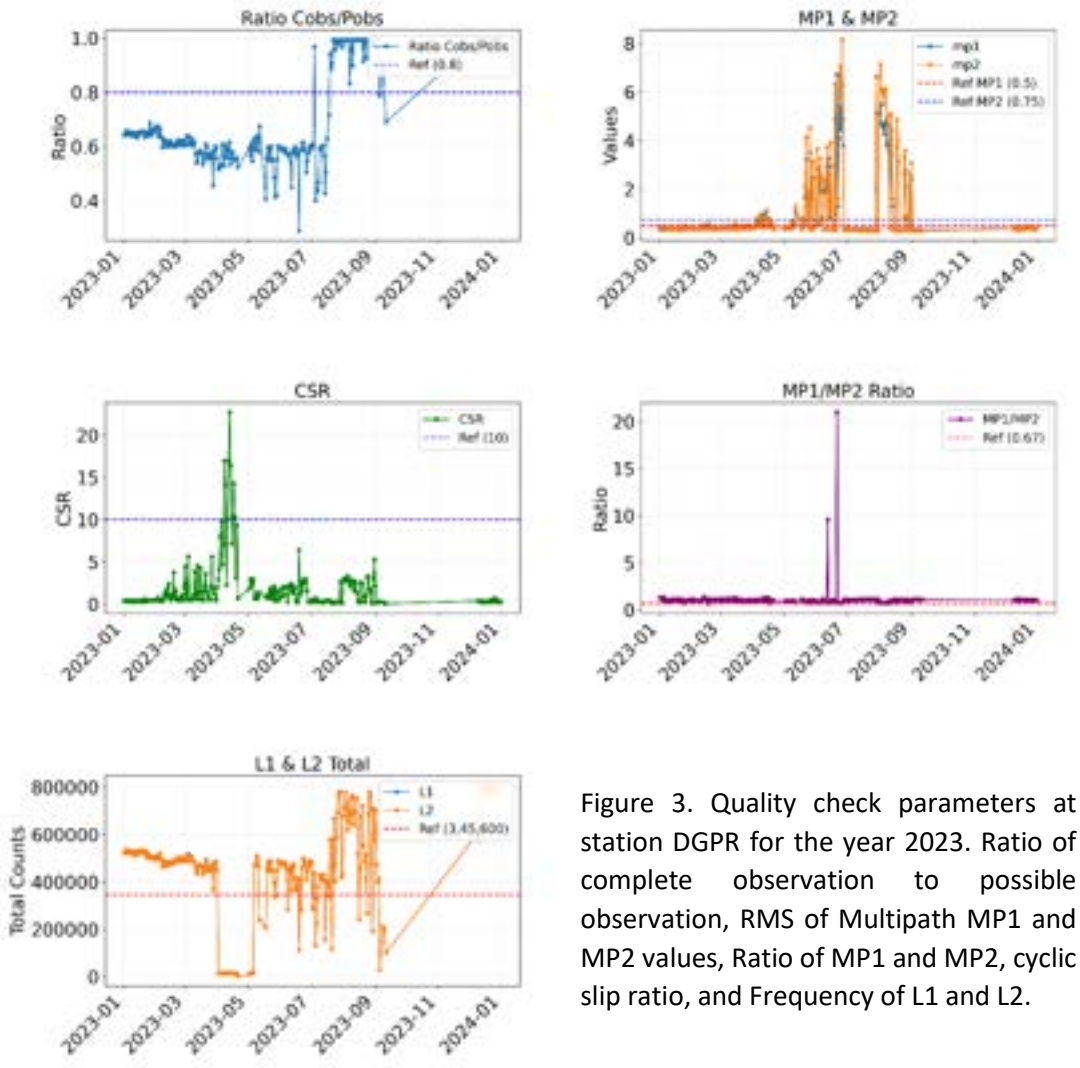


Figure 3. Quality check parameters at station DGPR for the year 2023. Ratio of complete observation to possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

3. Station: FERR

The value of ratio of complete and possible observation is lower than 0.6, with an average value of 0.48, which indicates amount of data received is not sufficient at the station, only for a few days, data is greater than 80%. The MP1 and MP2 values are below 2, with a mean value of ~1.2 that is again on the higher side as compared to the reported value up to 0.75 for IGS stations, and here also it is observed that from June to September, the multipath effect is more. The ratio of MP1 and MP2 is fluctuating between 0.7 and 1.2, with an average value of 0.9 indicating that surrounding obstruction may be present to weaken the signals. The CSR value, which is 10 or less for good GNSS data, varies between 20 to 35 at the station, which shows there is an obstruction to the signal. Also, the sum of frequency of L1 and L2 observables is less than 4,00,000 from January to July as compared to the minimum required frequency (3,45,600) for the full length of data of 1 second sampling interval and minimum visibility of 4 satellites, indicating issue with the incomplete length of data in a day. It is observed that only for the period September to December, it is greater than 345600, and a good signal is recorded.

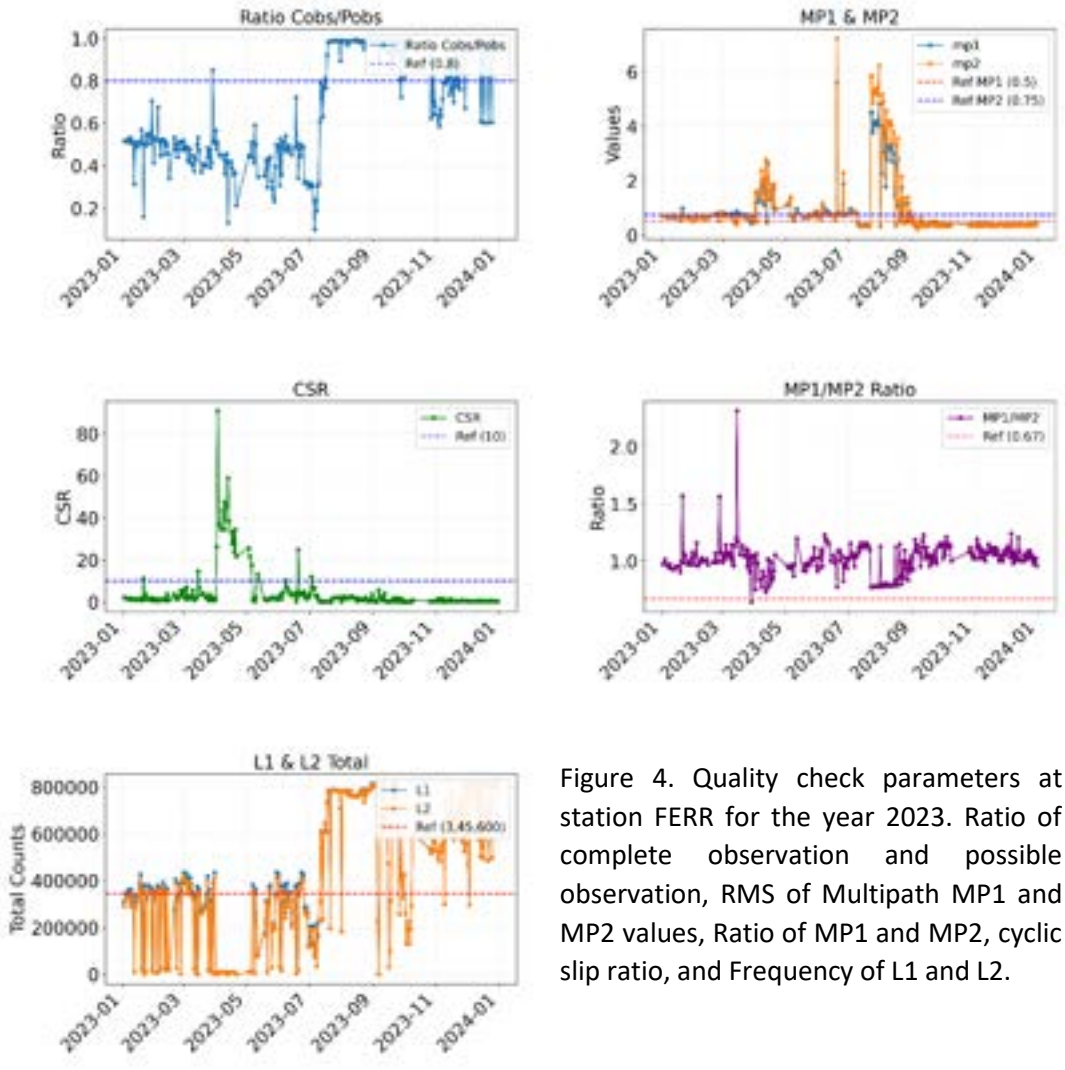


Figure 4. Quality check parameters at station FERR for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

4. Station: HAVE

The value of ratio of complete and possible observation is more than 0.8, which indicates data length is satisfactory at the station. The MP1 and MP2 values vary from 0.5 to 0.75 with a mean value of ~1, which is comparable to the reported values up to 0.75 for IGS stations, and its ratio is ~1, which shows the multipath effect is minimal. The CSR value, which is 10 or less for good GNSS data, is reported ~10 at the station. For the period from April to May, the CSR value is greater than 20, which may be due to nearby vegetation/trees. Also, the sum of the frequency of L1 and L2 is greater than 345600 for most of the data. It shows that the healthy signal is received by the antenna for the observation period.

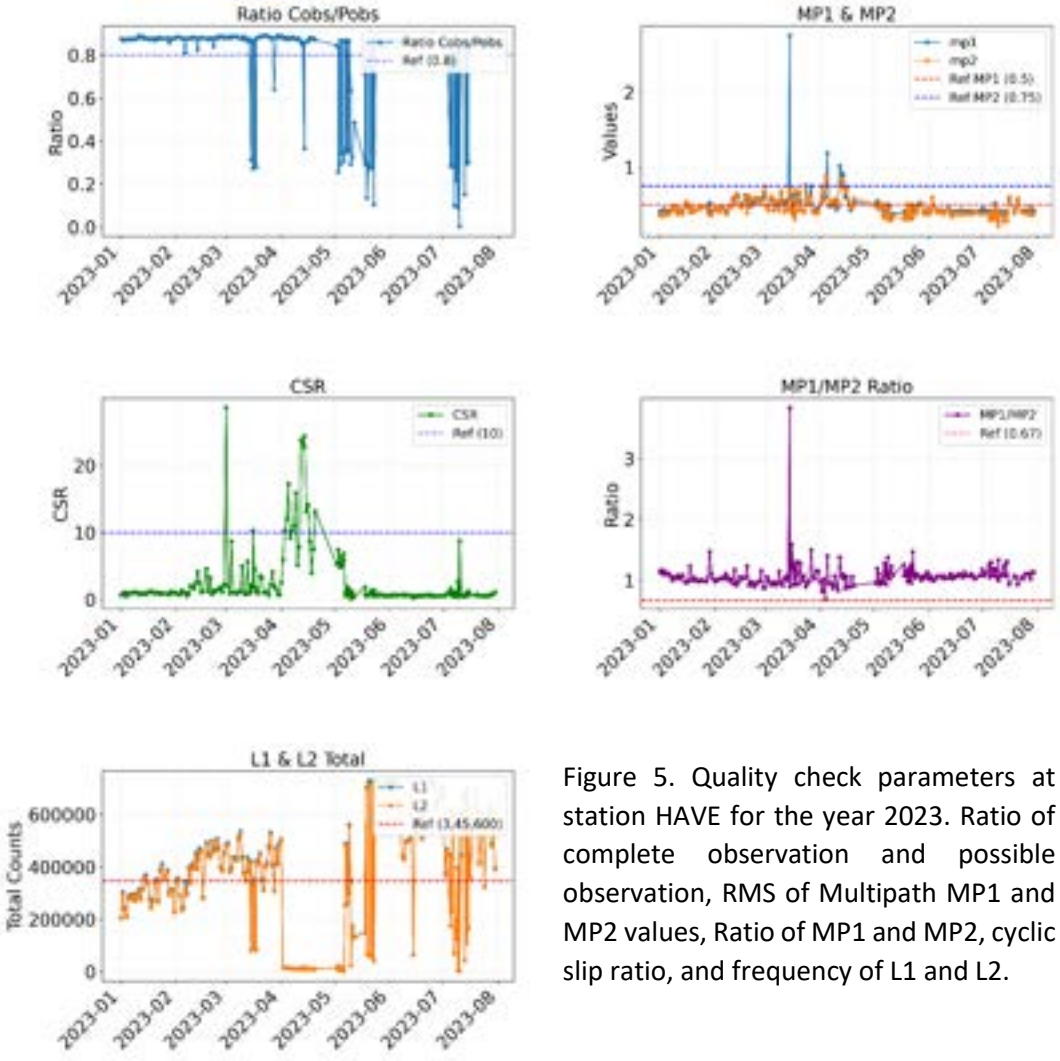


Figure 5. Quality check parameters at station HAVE for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and frequency of L1 and L2.

5. Station: HUTB

The value of ratio of complete to possible observations is less than 0.8, which indicates that sufficient data has not been received. The MP1 and MP2 values vary from 0.5 to 1.2, and its ratio is ~1. The CSR value, which is 10 or less for good GNSS data, is reported greater than 15 at the station, which indicates signal obstruction is present at the station. Also, the sum of frequency of L1 and L2 is less than (< 300000,), which is expected to be more than 3,45,600, for the complete/satisfactory length of data, referring either obstruction to signal by bad surroundings, or incomplete length of data, only for the periods of two months, L1 and L2 is greater than 345600.

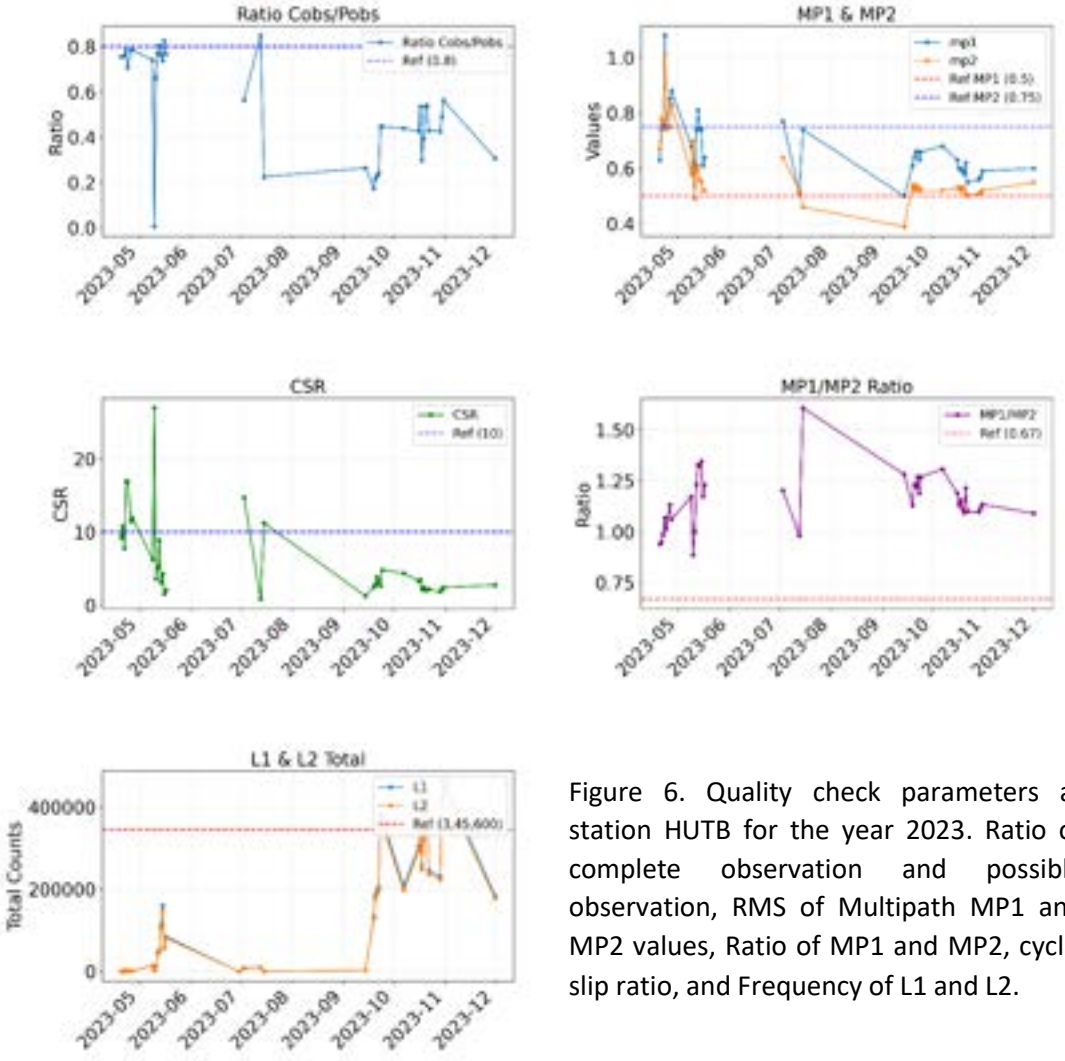


Figure 6. Quality check parameters at station HUTB for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

6. Station: KISH

A low value of percentage of observation (< 0.4) is noticed at the station. The value of MP1, MP2 varies from 0.5 to 1.3 and its ratio is more than 1 for most of the days, possibly it indicates the moderate multipath effect at the station. It is observed that the CSR is less than 10, which lies within acceptable limit, representing minimal effect on receiver loses lock. It is observed that for the period from April to May, the multipath effect is more. The value of L1, L2 is less than 345600 for most of the days, which indicates either the issue of incomplete length of data or unhealthy receival of observables by the antenna.

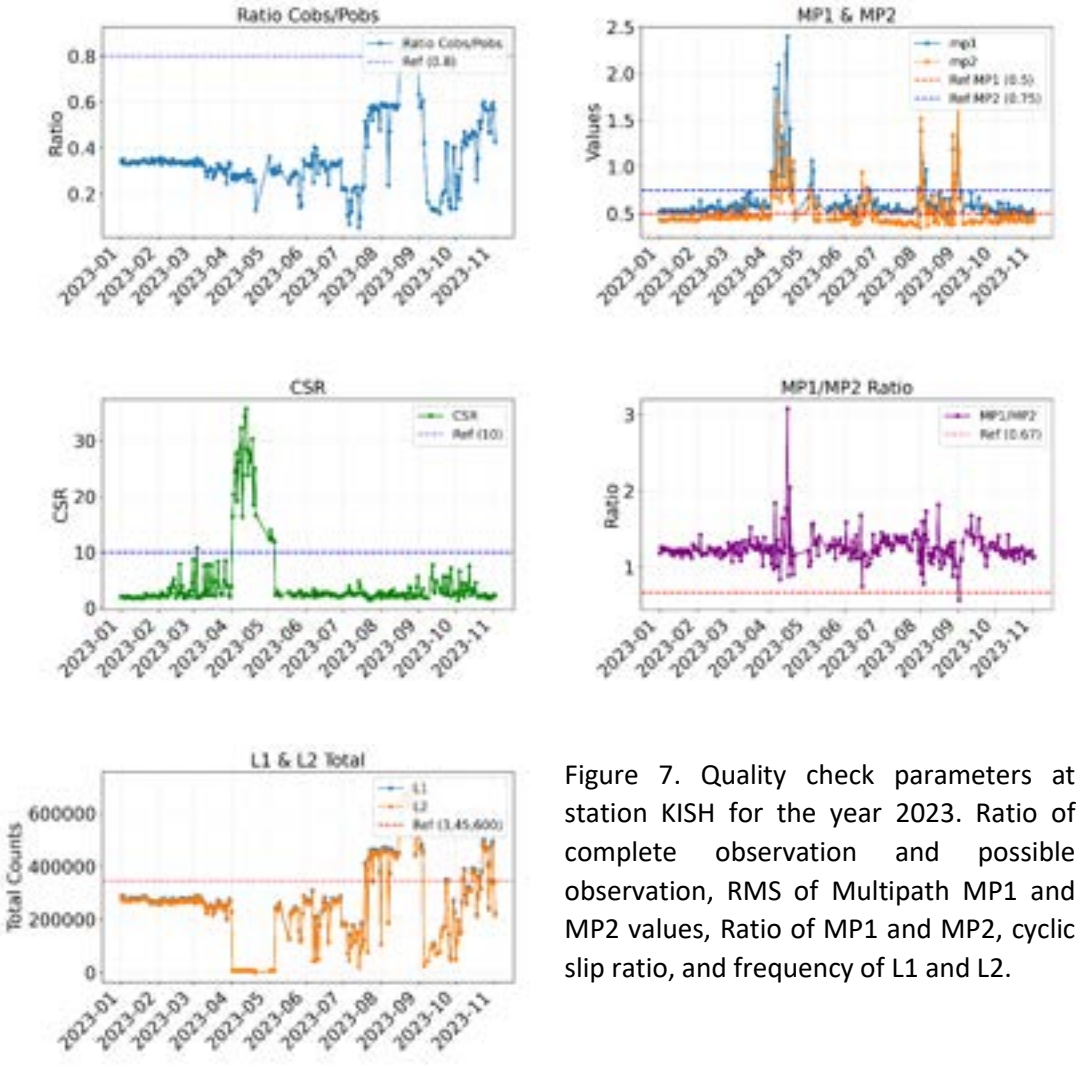


Figure 7. Quality check parameters at station KISH for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and frequency of L1 and L2.

7. Station: MAKA

The ratio of percentage of observation lies between 0.2 and 0.8, which is at lower side. The value of MP1 and MP2 ranges between 0.5 to 1.5 for most of the days and its ratio lies between 0.8 to 1.2. It is observed that CSR is less than 10 for most of the data, only for the period from April to May, it is greater than 20, it may be due to vegetation or trees. Here the sum of frequency of observables L1, L2 is > 345600 for most of the days. The observed parameters indicate the issue of incomplete length of data and it seems that the station is also moderately influenced by multipath effect.

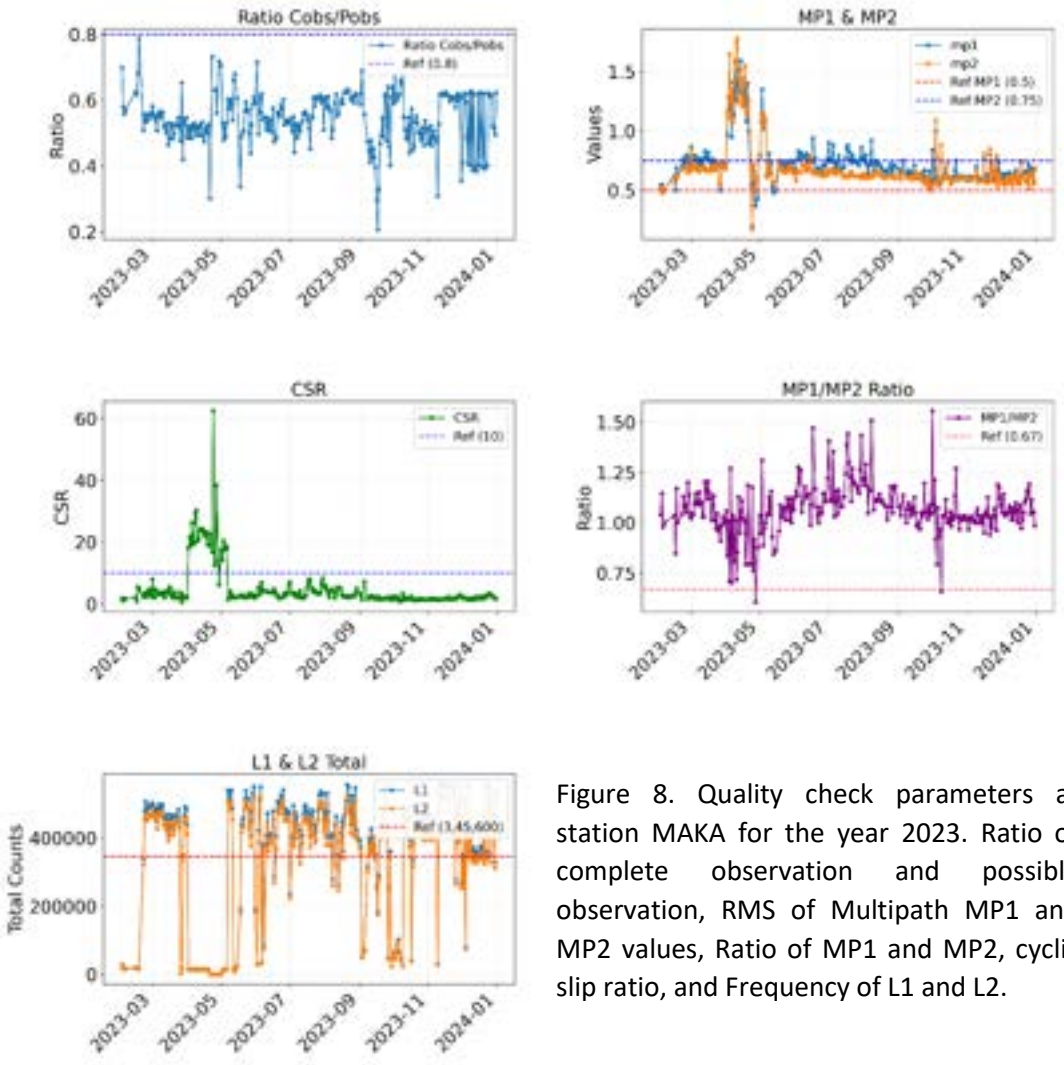


Figure 8. Quality check parameters at station MAKA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

8. Station: MBDR

The value of ratio of complete observations to possible observations varies between 0.2 to 0.8 with a mean value of ~0.4, the value of MP1 and MP2 parameters is ~0.5 and its ratio varies between 1 and 1.8. The CSR ratio is less than 10, which is acceptable, only for the duration from April to June, it is varying up to 20, which may be due to nearby vegetation or trees. The value of L1 and L2 is < 400000 for most of the days and it is observed that, it varies up to 600000 for few days. The low frequency of L1 and L2 indicates that either issue of incomplete length of data or limited capturing of observables by the antenna.

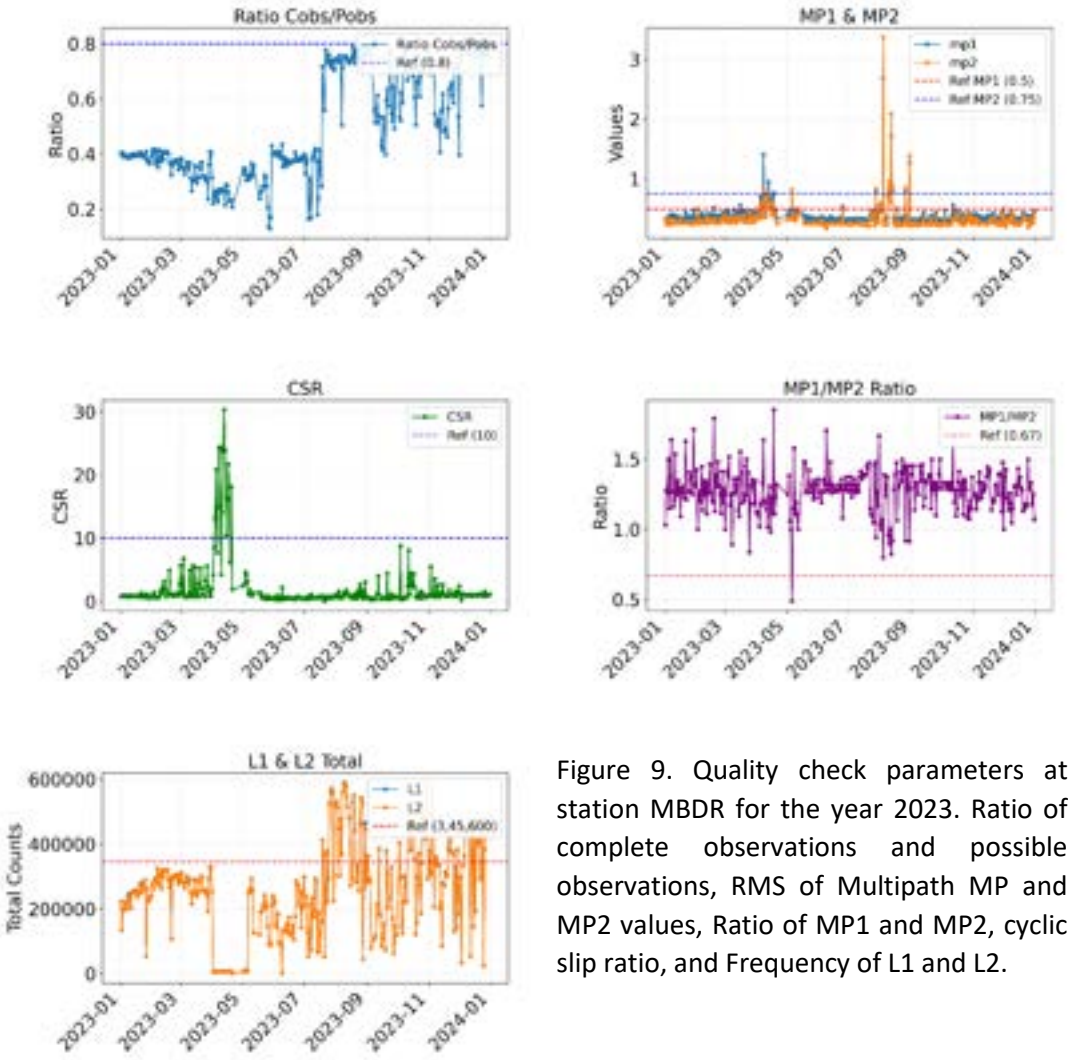


Figure 9. Quality check parameters at station MBDR for the year 2023. Ratio of complete observations and possible observations, RMS of Multipath MP and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

9. Station: MOHA

The percentage of observations varies between 0.1 to 0.8, the value of MP1 and MP2 parameters varies from 0.8 to 1.8. The ratio of MP1 and MP2 varies between 0.5 to 1.5. For the duration from April to May, it is varying up to 1.8. The CSR ratio is greater than 10 and even greater than 60 for few days, which is caused by obstruction to antenna, that is due to trees or vegetation. The value of L1 and L2 is noticed < 300000 for some days, where percentage of observation is also less < 0.2. But for most of the days the value of L1 and L2 is more than 400000, indicating healthy signal is received by the antenna.

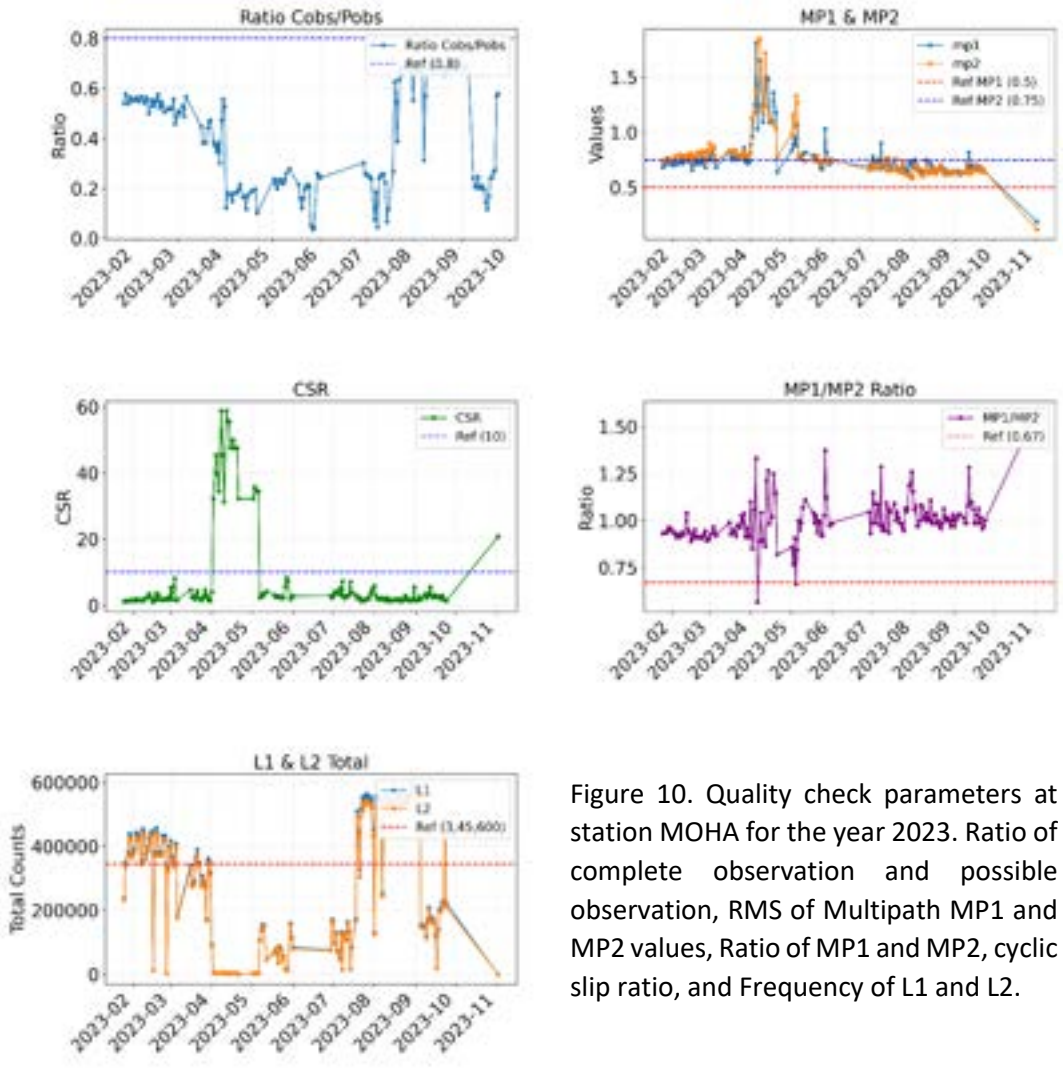


Figure 10. Quality check parameters at station MOHA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

10. Station: NAMU

The value of ratio of complete observations to possible observations varies between 0.2 to 1. The value of MP1 and MP2 is less than 0.6 for most of days. But its value is more than 2 during July to September indicating probable effect of multipath. The ratio of MP1 and MP2 varies between 0.5 to 1.8. The CSR ratio is less than 10 for most of days, which is acceptable. For the duration from April to May, it is greater than 30, which may be due to nearby trees/vegetation. The value of L1 and L2 is < 345600 for most of the days. But at later period, where percentage of observation is high (> 0.8), the value of L1, L2 is satisfactory. The observed parameters indicate that the multipath effect is minimal at the station. The low frequency of L1 and L2 indicates the issue of incomplete observation of data.

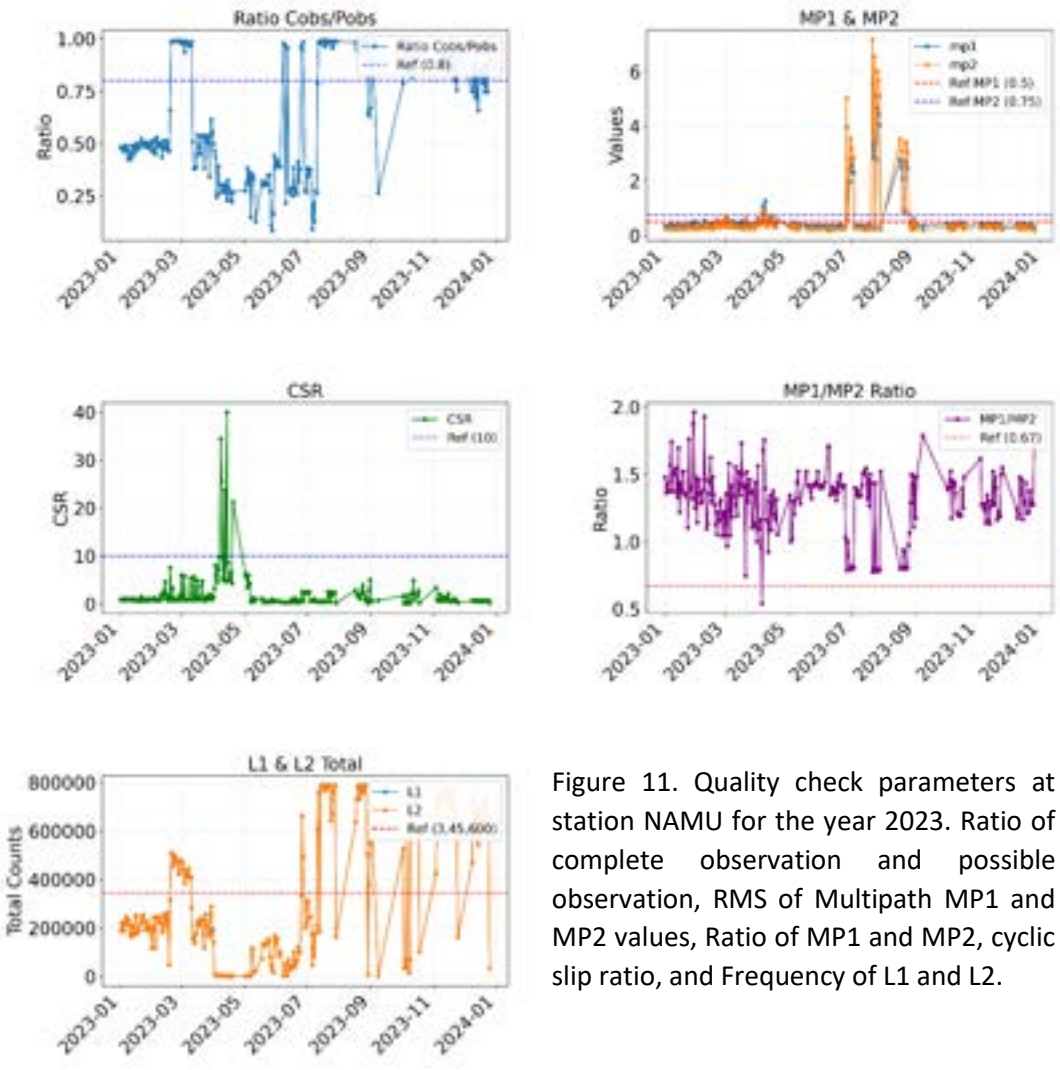


Figure 11. Quality check parameters at station NAMU for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

11. Station: RUTL

The value of percentage of observations varies between 0.1 to 0.8 for most of the days, the value of MP1 and MP2 is less than 1 for most of the days, but for the duration from April to May, it reaches upto 2, which may be due to multipath effect. The ratio of MP1 and MP2 varies between 0.5 to 1.4. The CSR ratio is less than 10, only for the duration from April to June, it is greater than 20, it can be due to trees/vegetation. The sum of frequency of L1 and L2 observables is < 345600 for most of the days, but again it increases as percentage of observation increases. It shows that the healthy signal is received by the antenna but issue of incomplete length of data.

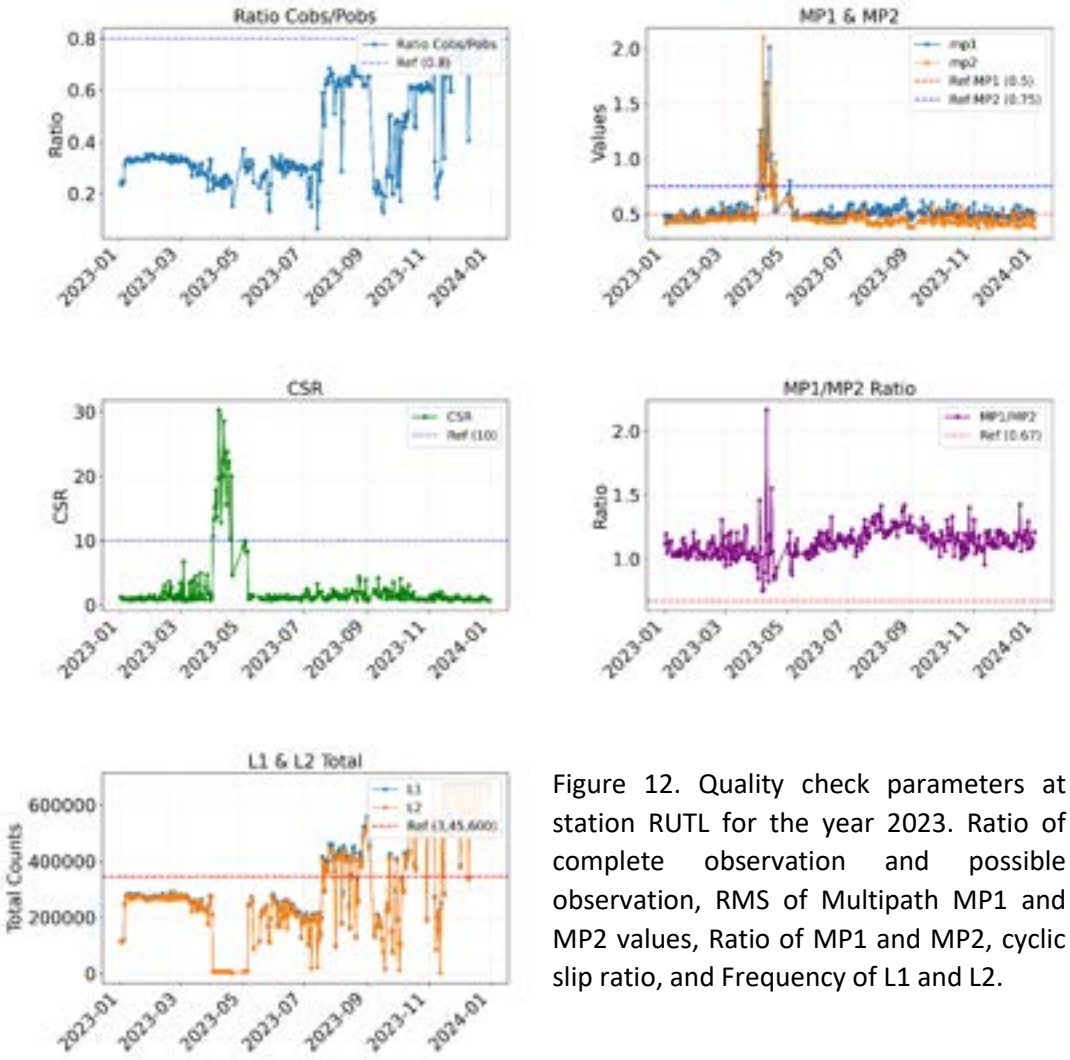


Figure 12. Quality check parameters at station RUTL for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

12. Station: SHOA

The percentage of observation is less than 0.8. The value of MP1 and MP2 is less than 1 for most of the days and its ratio is varying from 0.5 to 2. The value of CSR is less than 10 for most of the days and the value of L1 and L2 is less than 345600 for most of the days. However, its value is increasing at later period, with the increase of percentage of observation, that indicate that the healthy signal is received by the antenna but issue of incomplete length of data.

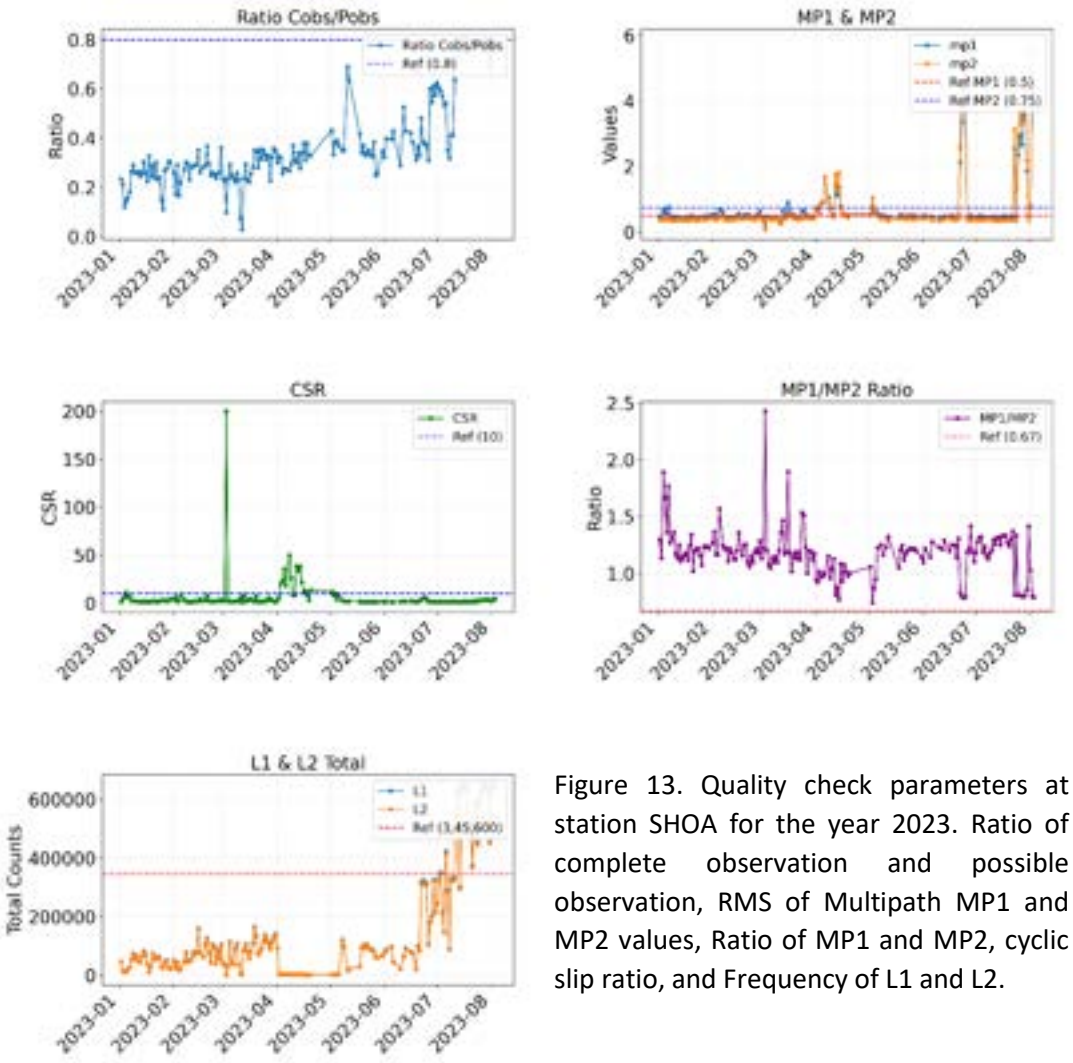


Figure 13. Quality check parameters at station SHOA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

13. Station: TRIN

The percentage of observation is less than 0.25. The value of MP1 and MP2 varies from 0.3 to 0.6 for most of the days. The ratio of MP1 and MP2 ranges from 0.8 to 1.2. The value of CSR is less than 15 for most of the days and the value of frequency of L1 and L2 observables is less than 3,00000 for most of the days. The observed value of sum of observables (L1, L2) indicate that the continuous signal is not received, this may be due to low percentage of observation.

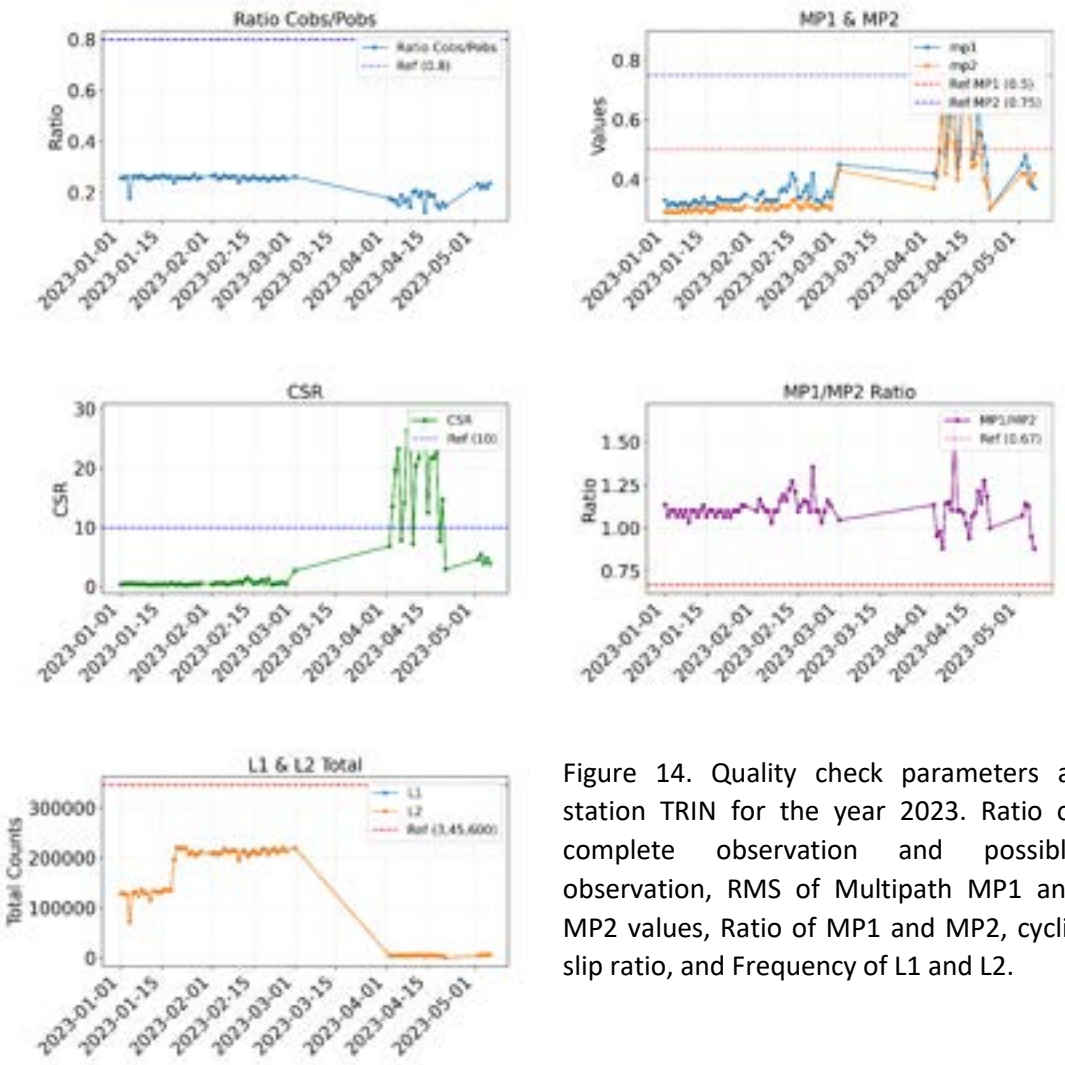


Figure 14. Quality check parameters at station TRIN for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

14. Station: ALUR

The percentage of observation is less than 0.6. The value of MP1 and MP2 is less than 0.5 and 0.75 for most of the days and the ratio of MP1 and MP2 is ~1. The value of CSR is less than 4 for most of the days. The value of L1 and L2 is less than 4,00000 for some days and it increases with the increase of percentage of observation. This low value of L1, L2 indicates the incomplete length of data and low percentage of observation.

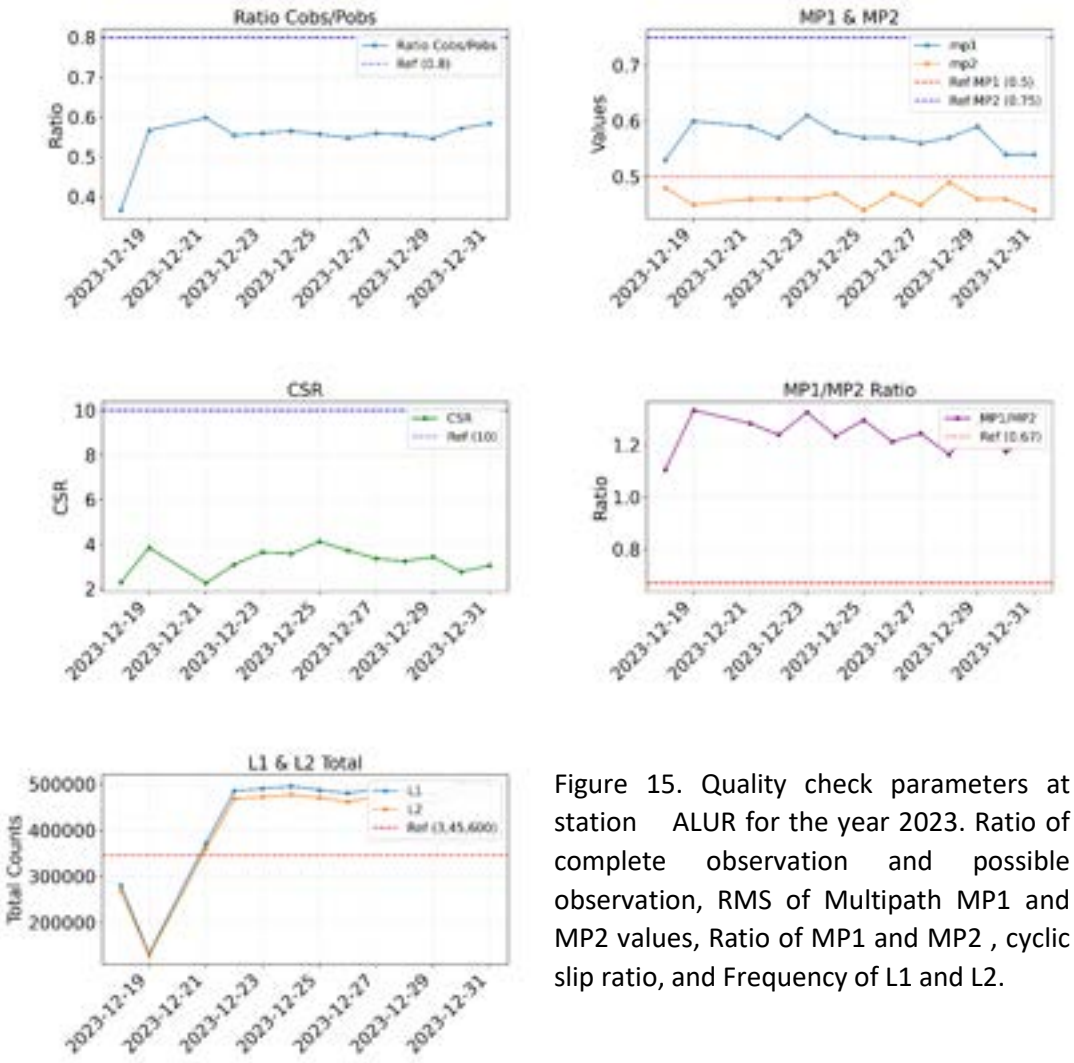


Figure 15. Quality check parameters at station ALUR for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2 , cyclic slip ratio, and Frequency of L1 and L2.

15. Station: APRA

The percentage of observation is less than 0.5. The value of MP1 and MP2 is less than 0.8 for most of the days and the ratio of MP1 and MP2 is ~1. The value of CSR is between 1 to 20. The value of L1 and L2 is < 300000 for most of the days. The observed parameters indicate that either low percentage of observation or continuous signal is not received by the antenna.

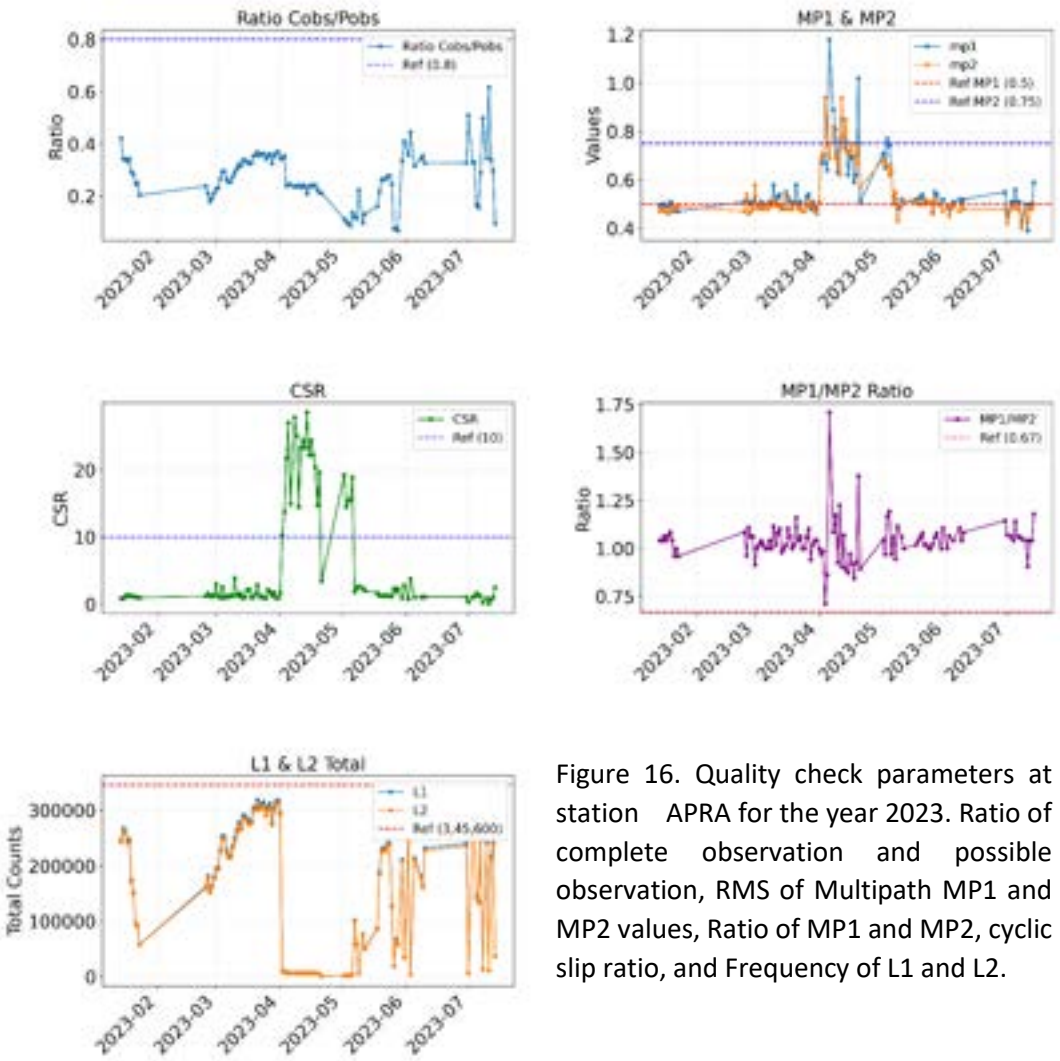


Figure 16. Quality check parameters at station APRA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

16. Station: ARON

The percentage of observation is less than 0.75. The value of MP1 and MP2 is less than 0.5 for most of the days and the ratio of MP1 and MP2 is ~1. The value of CSR is around 1 for most of the days. The value of L1 and L2 is > 400000. The observed parameters indicate that healthy signals are received by the antenna.

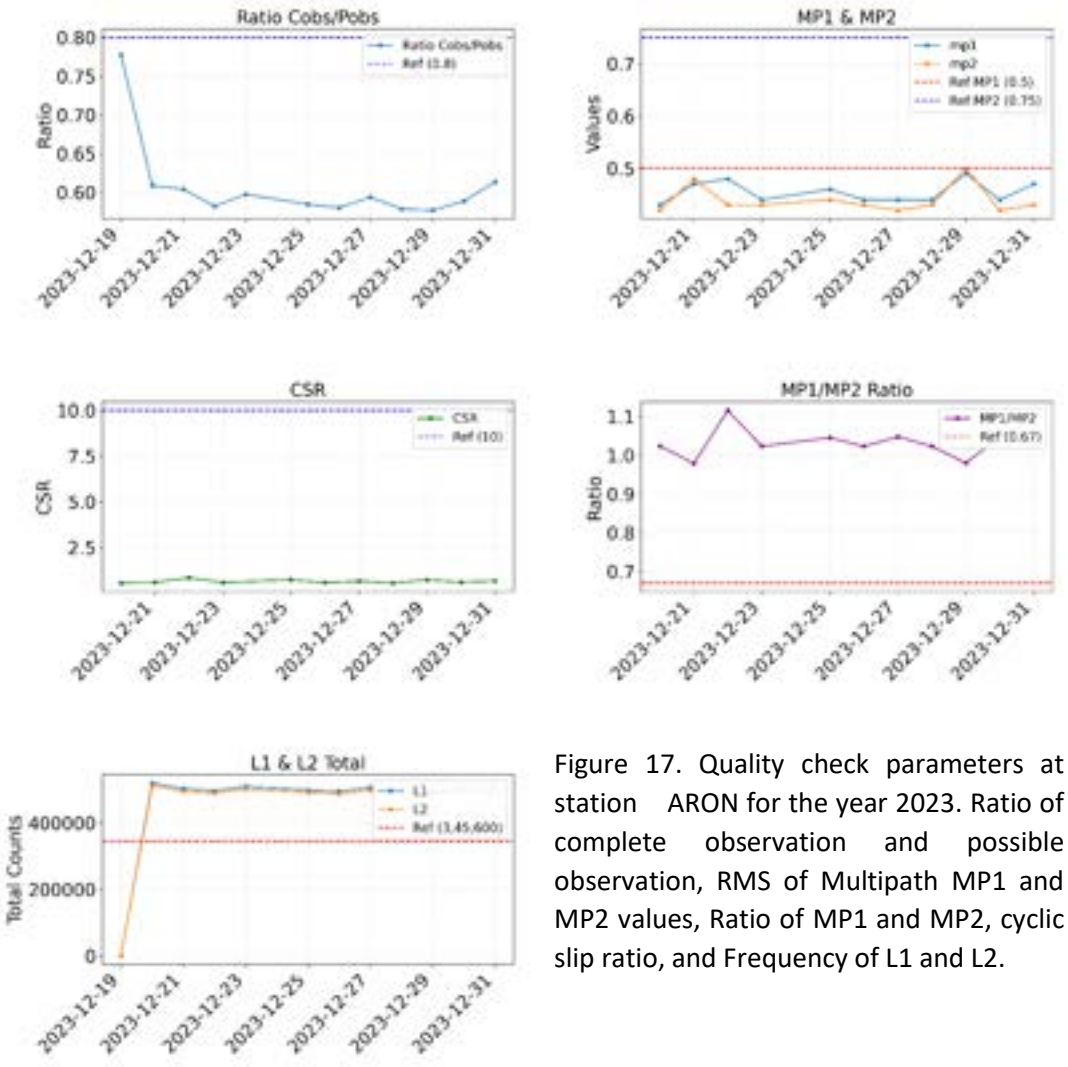


Figure 17. Quality check parameters at station ARON for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

17. Station: CWRA

The percentage of observation is less than 0.6. The value of MP1 and MP2 is less than 0.5 and the ratio of MP1 and MP2 is >1. The value of CSR is between 1 to 2.5 for most of the days. The value of L1 and L2 is < 400000 for most of the days and it increases with the increase of percentage of observation. The low value of L1, L2 is due to the incomplete length of data.

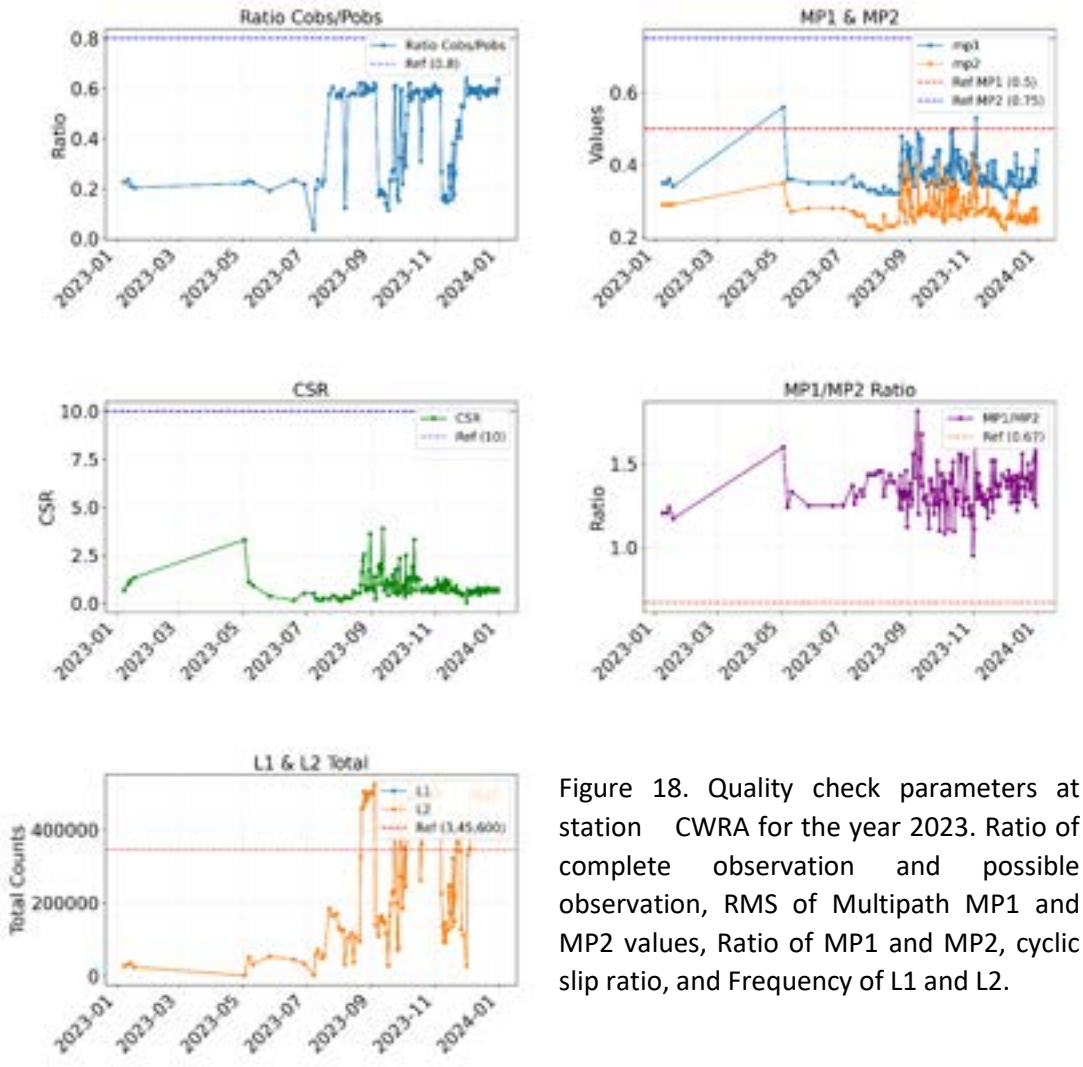


Figure 18. Quality check parameters at station CWRA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

18. Station: KADA

The percentage of observation is less than 0.7. The value of MP1 and MP2 varies from 1 to 1.5 for most of the days and the ratio of MP1 and MP2 is >1. The value of MP1 and MP2 is around 2, in month of August and September, which may be due multipath effect. The value of CSR is less than 10 for most of the days, but for month of April to June, it's value is more than 20, which possibly indicates signal obstruction caused by nearby vegetation/trees. But the value of L1 and L2 is < 400000 for some of the days and for other days it is higher than 400000, which is varying with the percentage of observation. The low value of L1, L2 indicates, incomplete length of data.

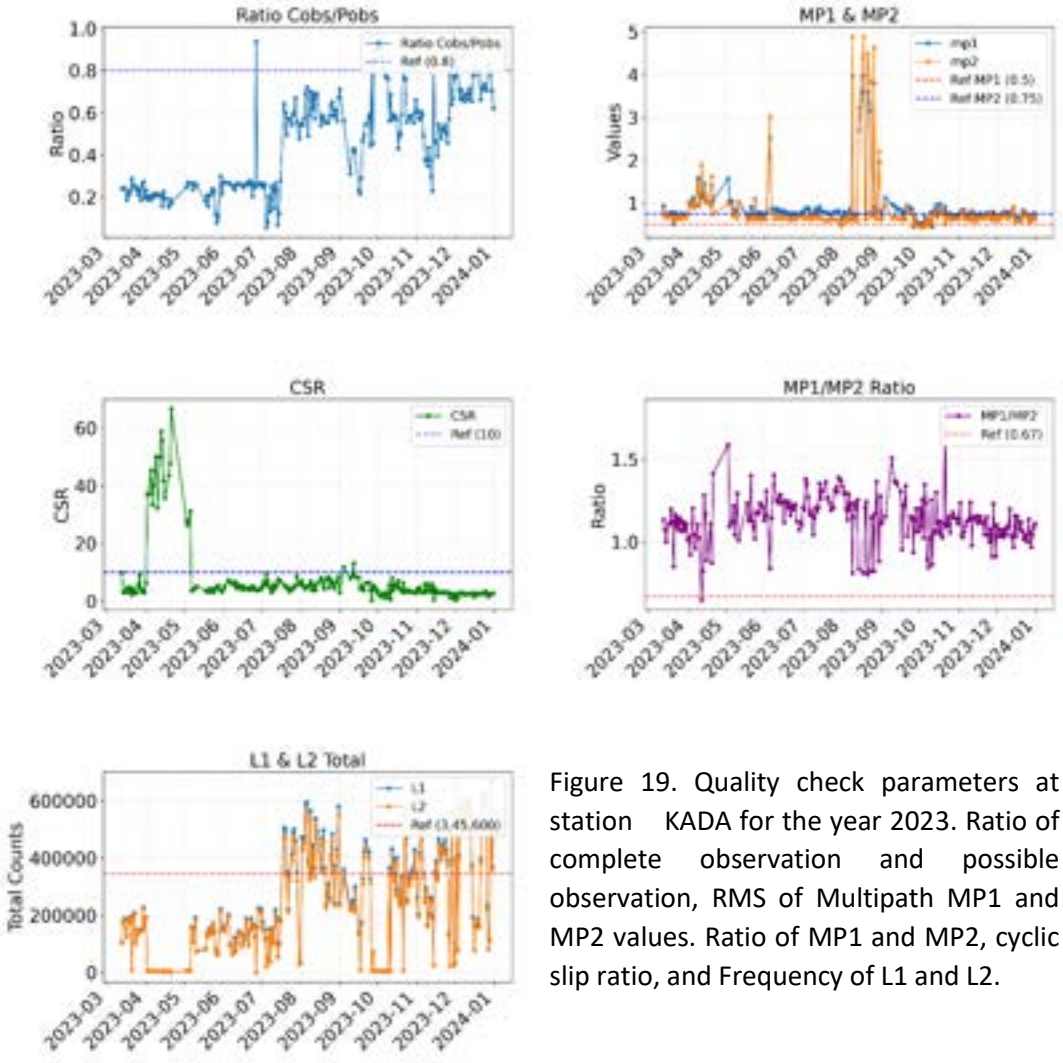


Figure 19. Quality check parameters at station KADA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values. Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

19. Station: KAKA

The percentage of observation is less than 0.7. The value of MP1 and MP2 varies from 0.2 to 1.2 and the ratio of MP1 and MP2 is >1. The value of CSR is around 10 for most of the days. The value of L1 and L2 is less than satisfactory value (345600) and for some days, it is upto satisfactory level (345600) or higher later and which is fluctuating with percentage of observation. The low value of L1, L2 observables, indicates either low percentage or incomplete length of data.

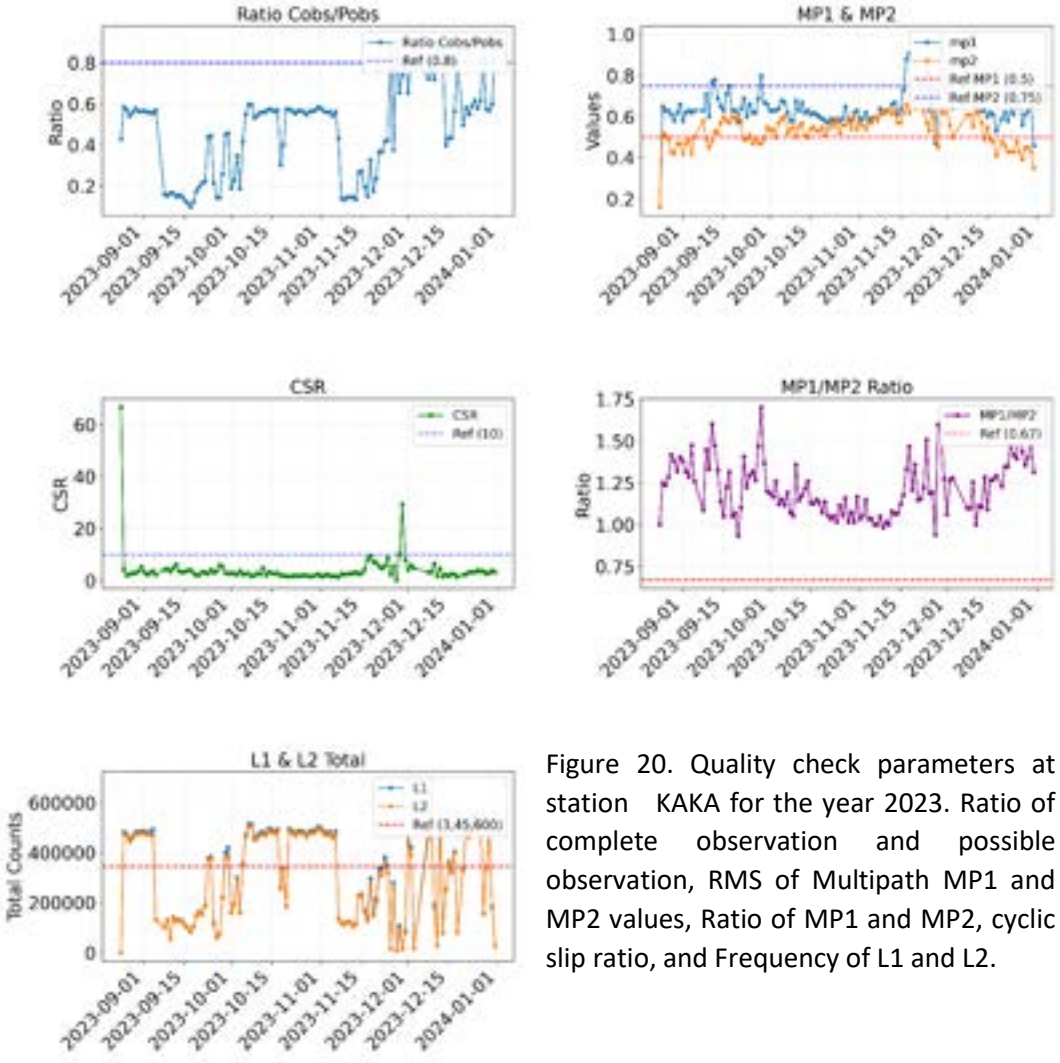


Figure 20. Quality check parameters at station KAKA for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

20. Station: WAND

The percentage of observation is less than 0.8. The value of MP1 and MP2 is 0.5 -0.6 for most of the days and the ratio of MP1 and MP2 is >1. The value of CSR is less than 5. The value of L1 and L2 is higher than satisfactory level (345600) for most of the days. Low value of L1, L2 is observed for few days, corresponding to low value of percentage of observation.

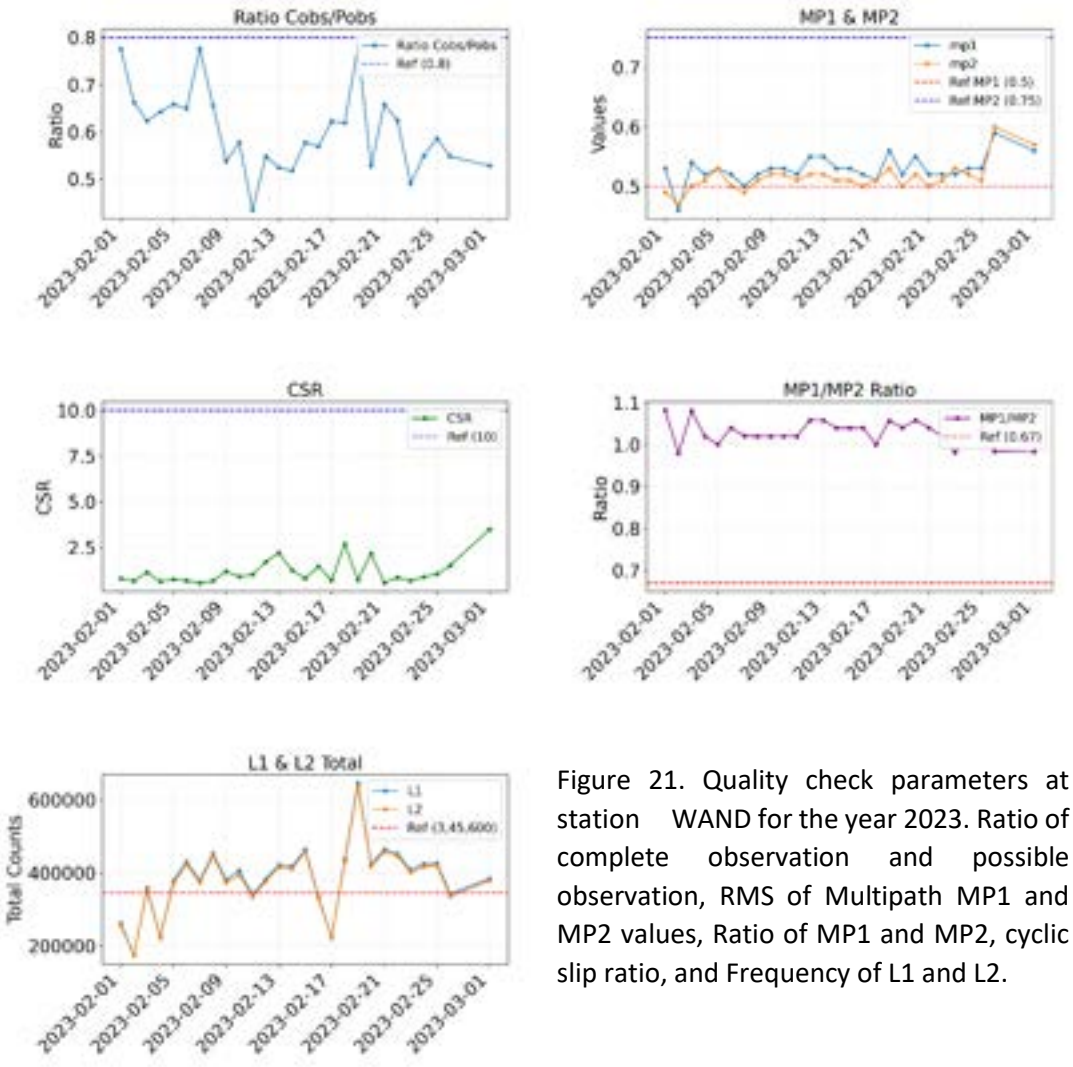


Figure 21. Quality check parameters at station WAND for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

21. Station: UKAT

The percentage of observation at station is very low (< 0.5). The value of MP1 and MP2 is less than 0.8 and its ratio is >1. The value of CSR is less than 10 for most of the days. The value of L1 and L2 is low (<300000). The observed quality check parameters indicate that either low percentage of observation or incomplete length of data.

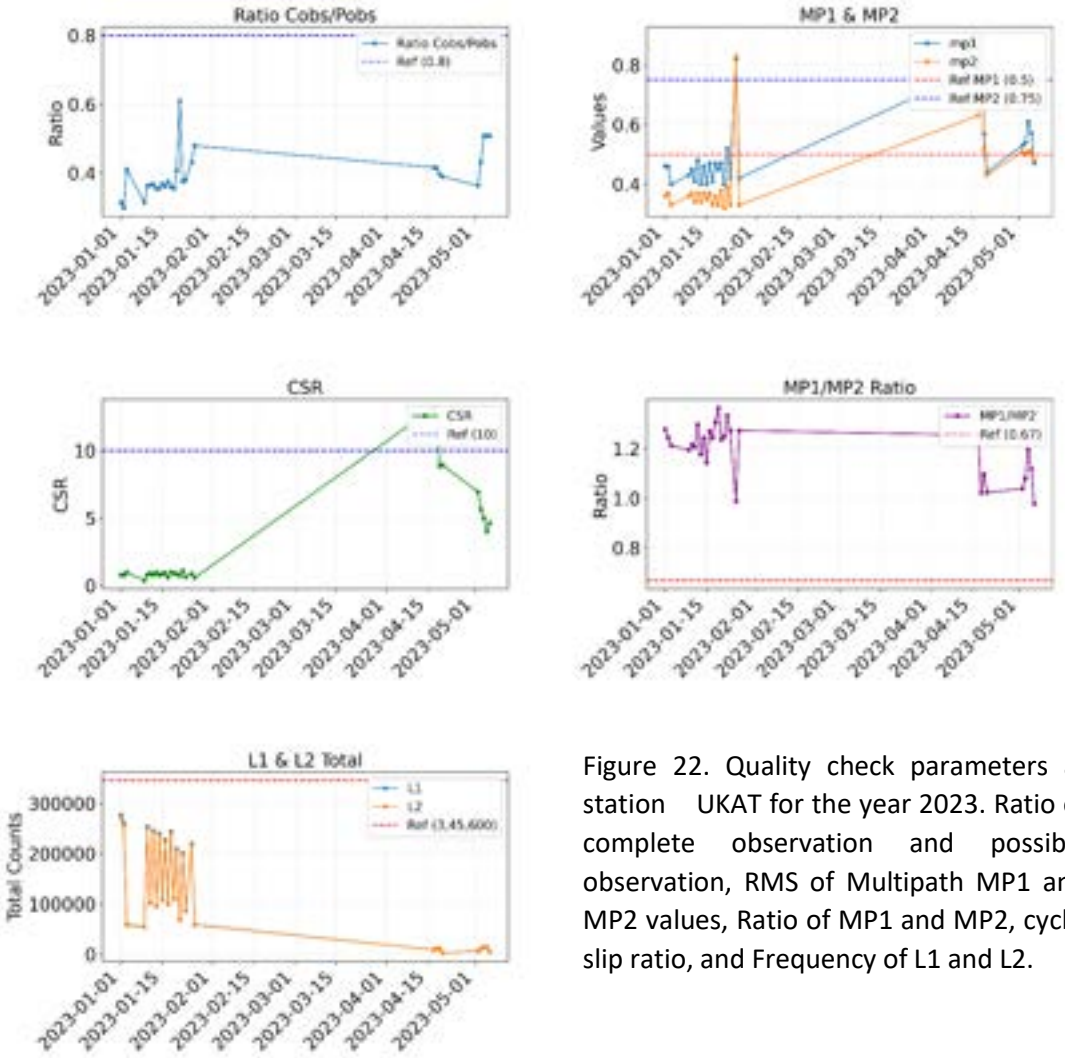


Figure 22. Quality check parameters at station UKAT for the year 2023. Ratio of complete observation and possible observation, RMS of Multipath MP1 and MP2 values, Ratio of MP1 and MP2, cyclic slip ratio, and Frequency of L1 and L2.

Table 1: Category of quality check parameters:

Quality check parameter	Value of parameter	Category of parameter
Percentage of observation (POB)	>0.8	Good (green)
	0.6-0.8	Fair (blue)
	<0.6	Bad(Red)
MP1 and MP2	<0.75	Good (green)
	0.75-1.5	Fair (Blue)
	>1.5	Bad (Red)
MP1/MP2	<0.75	Good (Green)
	0.75-1.5	Fair (Blue)
	>1.5	Bad (Red)
CSR	<10	Good (Green)
	10-20	Fair (Blue)
	>20	Bad (Red)
Sum of Frequency of L1 and L2 for 100% of daily observation for 1 sec sampling interval	>7,00,000	Good(Green)
	3,45,600 – 7,00,000	Fair(Blue)
	<3,45,600	Bad(Red)

Table 2: Station wise quality report based on average value of quality check parameters

S. o.	Station	Quality check parameters							Remarks based on quality check parameters
		POB	MP1 n meters)	MP2 n meters)	MP1/MP2	CSR	Sum equencies (in akh)		
							L1	L2	
1	ALUR	0.35	0.53	0.5	1.06	4.11	2.84	2.59	Very low POB and frequency of L1 and L2 observables
2	APRA	0.42	0.54	0.52	1.03	3.9	3.09	3.02	Very low POB and frequency of L1 and L2 observables.
3	ARON	0.64	0.19	0.19	1	0.85	2.14	2.11	POB is moderate and low frequency .
4	BAKU	0.42	0.84	0.78	1.07	6.43	2.21	2.02	Low POB and frequency of L1 and L2 observables. Also, moderate value of MP1 and MP2 indicate bad surroundings.
5	BARA	0.64	0.43	0.4	1.07	2.39	4.43	4.28	Low value of POB.
6	BETA	0.03	1.11	0.68	1.63	34.4	0.02	0.02	Very low POB and frequency of L1 &L2 observables. Also, high value of MP1, MP2, and CSR indicates bad surrounding.
7	CARN	0.77	1.52	0.44	3.45	0.17	6.44	5.58	Moderate value of POB and frequency of L1 and L2 observables.
8	CHID	0.39	0.49	0.44		3.99	2.2	2.12	Very low POB and frequency of L1 and L2 observables.
9	CHUK	0.09	0.29	0.3	0.96	0.59	0.57	0.57	Very low POB corresponding very low frequency of L1 and L2 observables.
10	CWRA	0.35	0.35	0.28	1.25	0.67	2.06	2.05	Low value of POB and frequency of L1 and L2 observables.
11	DARG	0.36	0.26	0.22	1.18	2.1	1.72	1.71	Low value of POB and frequency of L1 and L2 observables
12	DGPR	0.78	0.36	0.38	0.947	1.28	5.38	3.96	Moderate value of percentage of observation frequency of L1, L2 observables.
13	FERR	0.61	0.54	0.55	0.981	2	3.58	3.51	Moderate value of POB and frequency of L1, L2 observables.
14	HAVE	0.81	0.42	0.4	1.05	1.86	4.86	4.74	All parameters lie within satisfactory range.
15	HUTB	0.86	0.3	0.29	1.034	0.73	5.52	4.8	All parameters lie within satisfactory range
16	KADA	0.51	0.64	0.6	1.07	5.37	2.31	2.21	Low value of POB and frequency of L1 and L2 observables.
17	KAKA	0.52	0.24	0.21	1.14	3.66	1.66	1.61	Low value of POB and frequency of L1 and L2 observables.
18	KISH	0.38	0.41	0.35	1.17	3.38	2.01	1.97	A very low value of POB and frequency of L1 and L2 observables.
19	KLPT	0.51	0.15	0.13	1.153	1.72	2.01	1.99	A low value of POB and frequency of L1, L2 observables.
20	LONS	0.38	0.35	0.34	1.029	1.28	2.18	2.16	Low value of POB and frequency of L1 and L2 observables.
21	MAKA	0.49	0.54	0.52	1.038	3.61	2.61	2.47	Low value of POB and frequency of L1 and L2 observables.

22	MBDR	0.62	0.29	0.32	0.906	2.32	5.38	3.69	All parameters lie within satisfactory/moderate range
23	MILD	0.67	0.28	0.29	0.96	1.78	2.28	2.23	Moderate value of POB and a low value of frequency of L1 and L2 observables.
24	MOHA	0.54	0.56	0.58	0.96	2.86	2.86	2.77	Low value of POB and frequency of L1, L2 observables.
25	NAMU	0.64	0.6	0.59	1.02	1.8	4.02	4.01	Moderate value of POB and frequency of L1, L2 observables.
26	NEIL	0.64	0.36	0.37	0.97	3.08	2.18	2.05	Moderate value of POB and a low value of frequency of L1 and L2 observables.
27	NIMB	0.56	0.55	0.54	1.02	1.18	3.76	3.73	Low value of POB.
28	PORT	0.96	0.29	0.28	1.03	0.15	7.12	7.06	All parameter looks ok.
29	RADA	0.57	0.42	0.43	0.97	1.28	3.38	3.37	Low value of POB and moderate value of frequency of L1 and L2 observables.
30	RAMN	0.38	0.35	0.35	1	1.12	2.19	2.15	A very low value of POB and frequency of L1 and L2 observables.
31	RUTL	0.46	0.57	0.55	1.03	1.99	3.34	3.25	Low value of POB and low value of frequency of L1 and L2 observables.
32	SHAS	0.3	0.33	0.37	0.89	4.59	5.41	1.38	Low value of percentage of observables and frequency of L2.
33	SHOA	0.41	0.58	0.56	1.03	3.31	1.63	1.59	A very low value of POB and frequency of L1 and L2.
34	SLBY	0.56	0.63	0.61	1.032	2.51	2.01	1.91	Low value of POB and frequency of L1, L2.
35	TRIN	0.32	0.31	0.3	1.033	1.1	2.79	2.25	Low value of POB and frequency of L1, L2.
36	UKAT	0.33	0.46	0.39	1.18	1.46	1.84	1.81	Low value of POB and frequency of L1, L2.
37	WAND	0.52	0.48	0.43	1.12	1.66	3.81	3.75	Low value of POB and moderate value of frequency of L1, L2.

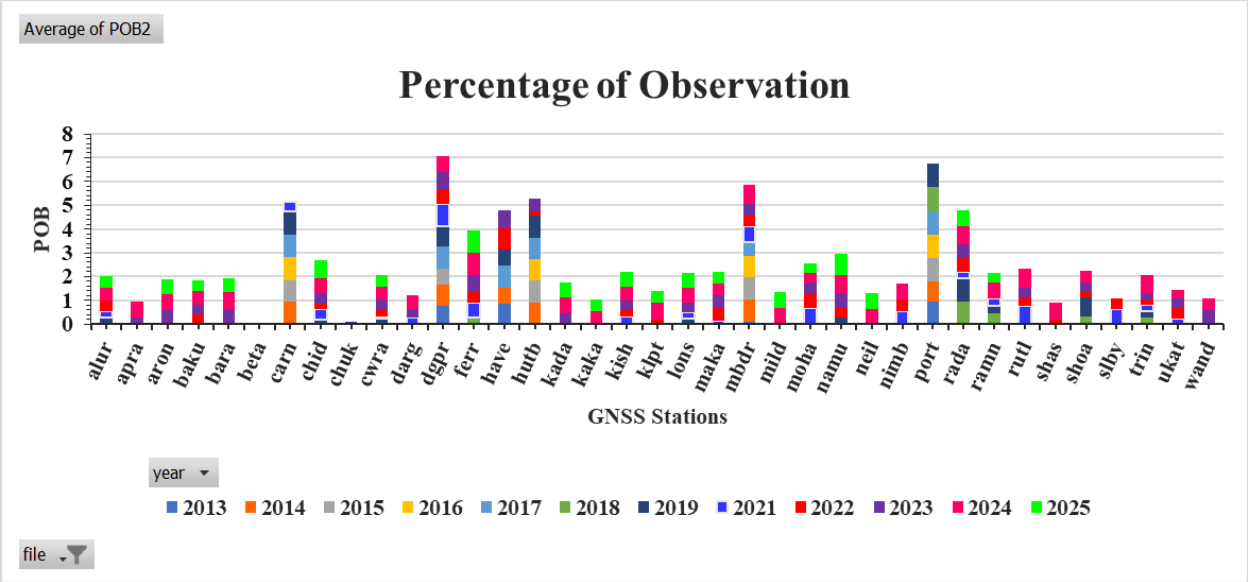


Figure 23: Year-wise percentage of observations at stations.

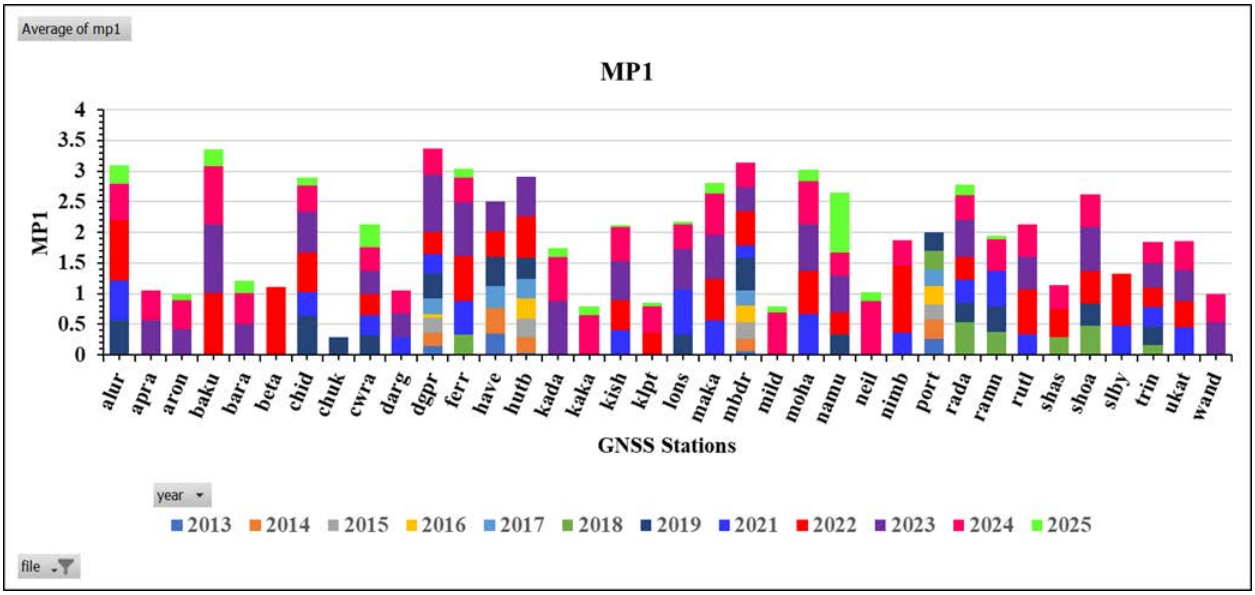


Figure 24: Year-wise value of MP1 at stations.

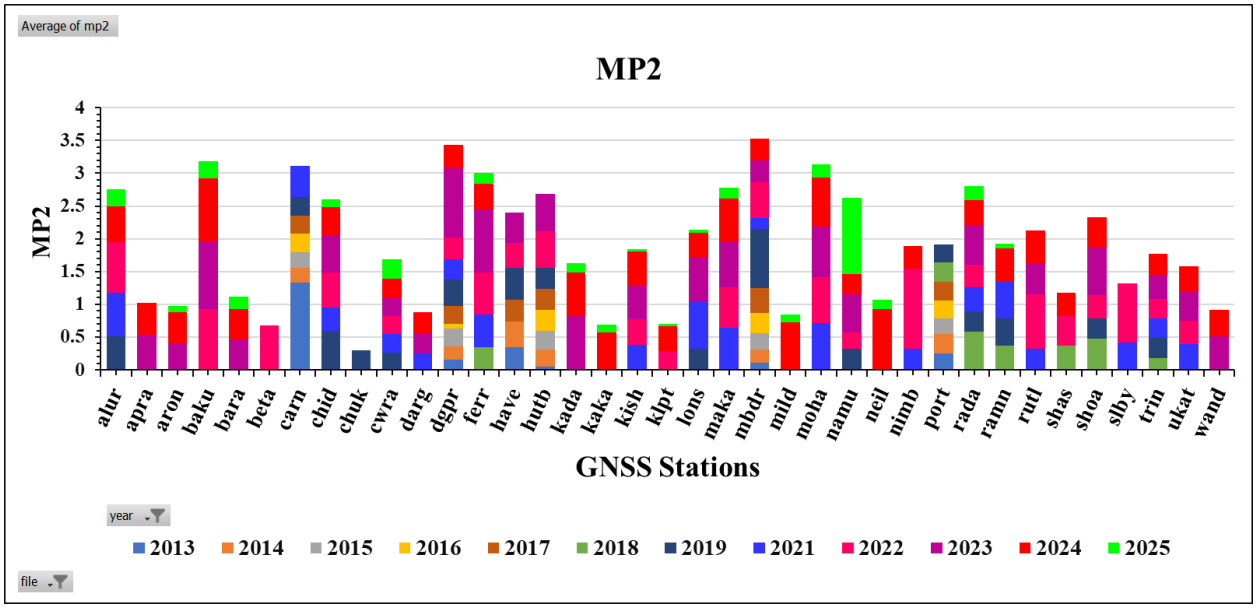


Figure 25: Year-wise value of MP2 at stations.

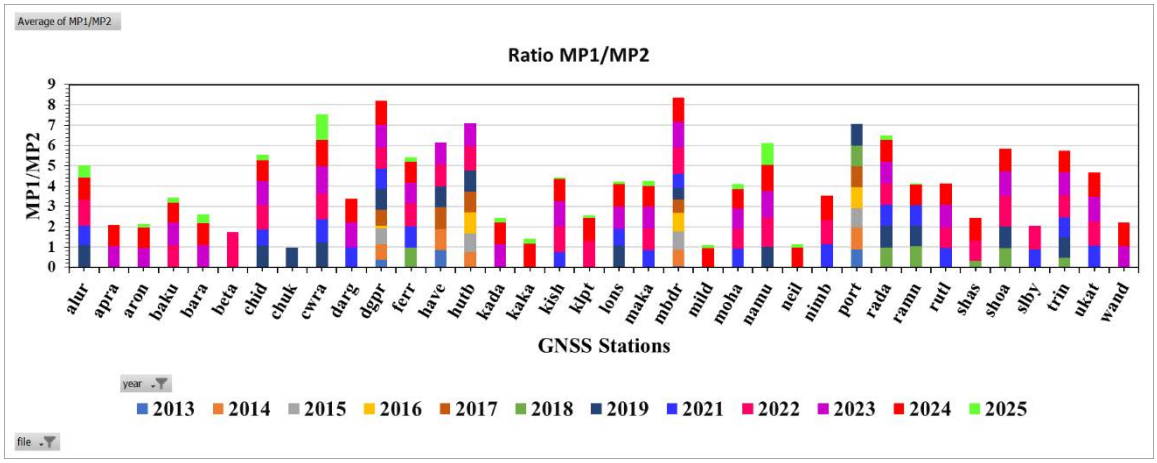


Figure 26: Year-wise ratio of MP1 and MP2 at stations.

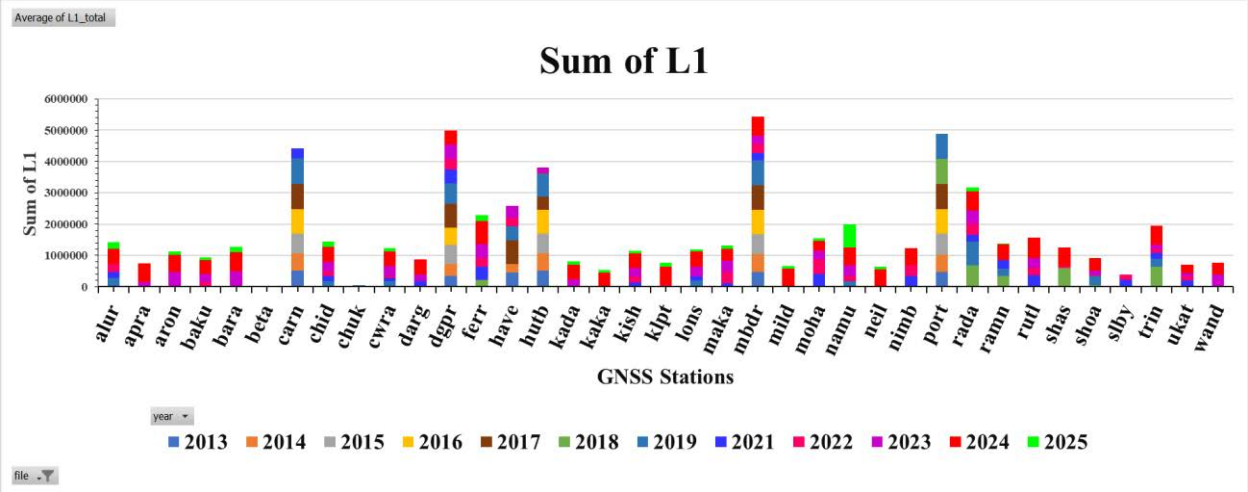


Figure 27: Year-wise value of the sum of frequency of L1 observable at stations.

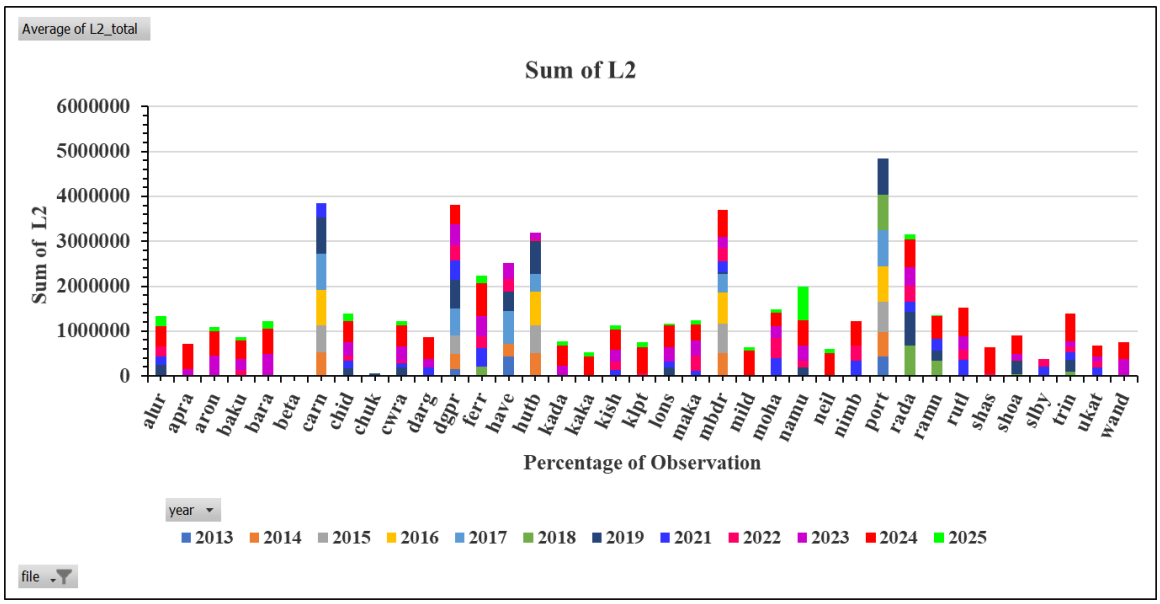


Figure 28: Year-wise value of sum of frequency of L2 observable at stations.

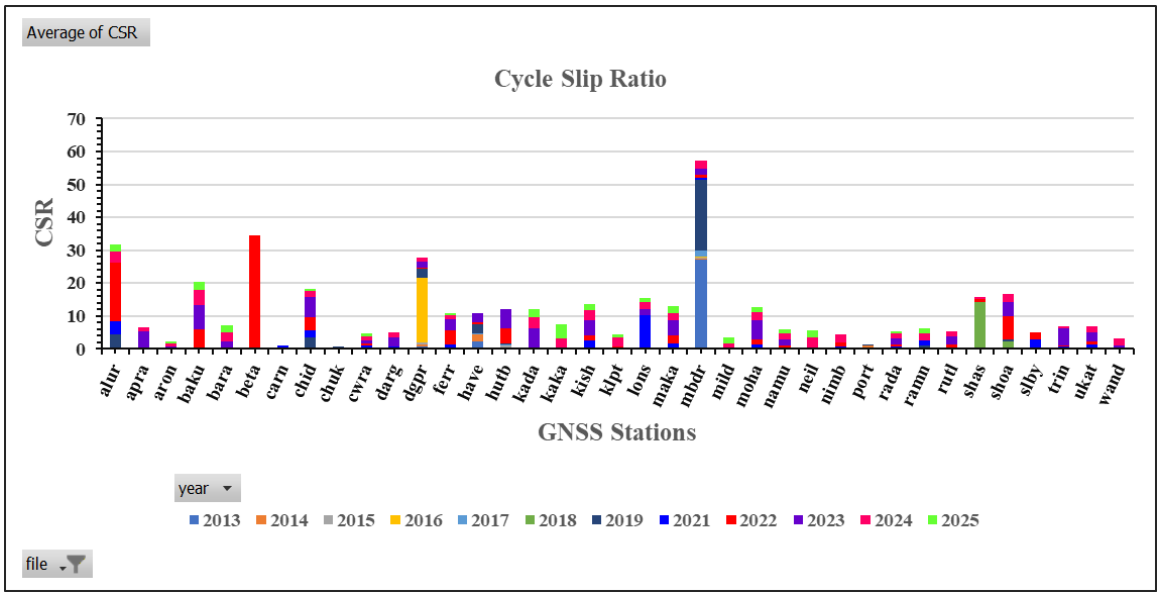


Figure 29: Year wise value of cycle slip ratio (CSR) at the stations.

7. Summary

The quality check of the GNSS data from 37 GNSS stations indicates that the percentage of GNSS observations at most stations is low for the entire period of the daily data. This affects the value of the sum of the frequency of L1 and L2 observables, as well as a robust estimate of other quality check parameters. Based on the value of the calculated quality check parameters, the parameters are categorized into three forms: good (green), fair (blue), and bad (red) (Table 1), which are listed above and used to tabulate station-wise quality check parameters listed in Table 2.The stations consisting of low percentage of observation reduces the value of frequency of observation even though the value of other quality check indicators lie within satisfactory/good to moderate/fair range. Moderate value of quality check parameters has been noticed at some of the stations such as BARA, DGPR, FERR, HAVE, HUTB, MBDR and NAMU. The value of other quality indicators lie within moderate range at stations NIMB, RADA and WAND except percentage of observation which is between 0.5 to 0.6. The issue of low value of L1, L2 observables, probably caused by low percentage of observation, i.e., incomplete length of data. A high mean value of MP1 and MP2 or CSR values at some of the stations (such as BETA and CARN) indicates these stations may have a strong reflector in the surroundings or signal obstruction caused by nearby high vegetation such as trees, buildings, etc. A higher value (>10) of multipath reported at station CARN for the year 2013 and for later period its value reaches to satisfactory level (<0.75). The other quality indicators lie within a moderate range. The quality of data at station PORT is satisfactory as values of all the parameters of quality check lie within the acceptable range. The QC indicates that GNSS data at ~11 stations (i.e., BARA, CARN, DGPR, FERR, HAVE, HUTB, MBDR, NAMU, NIMB, RADA and WAND) is useful for the purpose of understanding present-day crustal deformation

studies, including characterization of post-seismic deformation of the 2004 megathrust, calculation of plate motion, strain build-up rate, and detection of potential seismic hazard zone/tsunamigenic source in Andaman Nicobar Islands, however this data cannot be used for the operational purposes.

8. References

1. Chen Chaoxian, Chen Guang, Wang Qingping, Wang Ziyan, Yang Jinling, Xu Zhendong. Data examination and analysis for Fujian GPS observation network. J Geod Geodyn 2014;34(4):17e20.
2. Chen Kai, Yu qing. Study of GPS multipath effect principle and data post-processing method. Urban Roads Bridg Flood Control 2010; 4:171e2.
3. Chen Weitao, Gan Weijun, Xiao Genru, Liang Shiming, Sheng Chuanzhen. The impact of 2011 Tohoku-Oki earthquake in Japan on crustal deformation of northeastern region in China. Seismol Geol 2012;34(3):425e39.
4. Estey, L.H., Meertens, C.M., 1999. TEQC: The multi-purpose toolkit forGPS/GLONASSdata.GPSSolut.3,42 49.https://doi.org/10.1007/ PL00012778.
5. Gao, H., Wang, X., Yao, Y., Zhang, L., Zhao, Y., Li, Z. and Fang, S., 2025. GDA: A GNSS data processing software for quality analysis. Advances in Space Research, *75*(6), pp.4395-4407.
6. Hu, Y., Cheng, L. and Wang, X., 2016. Quality analysis of the campaign GPS stations observation in Northeast and North China. Geodesy and Geodynamics, *7*(2), pp.87-94.
7. Lau, L., Tai, K.-W., 2023. A Data quality assessment approach for high-precision GNSS continuously operating reference stations (CORS) with case studies in Hong Kong and Canada/USA. Remote Sens. 15,1925. https://doi.org/10.3390/rs15071925.
8. Liu Jiyu, Li Zhenghang, Wang Yuehu, Sang Jizhang. Global positioning system (GPS) principle and application. Beijing: The Surveying and Mapping Publishing House; 1993.
9. Liu Junqing, Li Ke, Liang Guojing, Wu Chengzhi, Sun Peizhong. The quality checking about Changbai ountain volcano GPS data. Seismol Geomagn Obs. Res. 2010; 31(2):83e7.
10. Lu, L., Hu, W., Wu, T., 2024. GDPS: anopen-source python-based software package for multi-GNSS data preprocessing. GPS Solut. 28, 138. https://doi.org/10.1007/s10291-024-01678-8.
11. Xiao Xuenian, Yue Jianli, Zhang Peng, Song Yaodong. Specifications for global positioning system (GPS) surveys (GB/T 18314-2009). Beijing: Standards Press of China; 2009.

Annexure

A separate sheet of annexure is attached.

Annexure I

Example of summary file of quality check using TEQC for station NAMU.

```
version: teqc  2019Feb25
03:22:19.000                                  17:24:53.000
2023 Jan  2                                   2023 Jan  2

**********
QC of RINEX  file(s) : namu0020.23o
input RnxNAV file(s) : brdc0020.23n
**********

4-character ID        : NAMU (# = 23)
Receiver type         : Rogue (# = 5303K49843) (fw = 5.37)
Antenna type          : UNKNOWN EXT

Time of start of window : 2023 Jan  2  03:22:19.000
Time of  end  of window : 2023 Jan  2  17:24:53.000
Time line window length : 14.04 hour(s), ticked every 3.0 hour(s)
 mean antenna; # of pos :     88
  antenna WGS 84 (xyz)  : -292554.7225 6240262.3071 1281908.7568 (m)
  antenna WGS 84 (geo)  : N  11 deg 40' 19.71"  E  92 deg 41'  2.99"
  antenna WGS 84 (geo)  :   11.672142 deg    92.684164 deg
        WGS 84 height : 15.3116 m
|qc - header| position  :  401.6030 m
qc position offsets     :  15.8562 m vertical   401.2899 m horizontal
Observation interval    : 1.0000 seconds
Total satellites w/ obs : 29
NAVSTAR GPS unhealthy SV: 28
NAVSTAR GPS SVs w/o OBS : 18  28  29
NAVSTAR GPS SVs w/o NAV :
Rx tracking capability  : unknown
Poss. # of obs epochs   :  50555
Epochs w/ observations  :  24493
Epochs repeated         :     0  (0.00%)
Possible obs >   0.0 deg: 597520
Possible obs >  10.0 deg: 465978
Complete obs >  10.0 deg: 222694
 Deleted obs >  10.0 deg:   2207
  Masked obs <  10.0 deg:    489
Obs w/ SV duplication   :     0  (within non-repeated epochs)
Moving average MP12     : 0.346860 m
Moving average MP21     : 0.275811 m
Moving average MP15     : 0.328985 m
Moving average MP51     : 0.238938 m
Points in MP moving avg : 50
Mean S1                 : 4.91 (sd=1.63 n=223586)
Mean S2                 : 8.17 (sd=1.08 n=224009)
Mean S5                 : 8.66 (sd=0.47 n=128858)
No. of Rx clock offsets : 0
Total Rx clock drift    :  0.000000 ms
Rate of Rx clock drift  :  0.000 ms/hr
Avg time between resets : Inf minute(s)
Freq no. and timecode   : 3 15702 03fff8
```

Report gap > than : 10.00 minute(s)
epochs w/ msec clk slip : 0
other msec mp events : 0 (: 182) {expect ~= 1:50}
IOD signifying a slip : >400.0 cm/minute
IOD slips < 10.0 deg* : 295
IOD slips > 10.0 deg : 255
IOD or MP slips < 10.0*: 288
IOD or MP slips > 10.0 : 240
* or unknown elevation
first epoch last epoch sn1 sn2 sn5
SSN 23 1 2 03:22 23 1 2 17:24 4.91 8.17 8.66
first epoch last epoch mp12 mp21 mp15 mp51
SMP 23 1 2 03:22 23 1 2 17:24 0.35 0.28 0.33 0.24
first epoch last epoch hrs dt #expt #have % mp1 mp2 o/slps
SUM 23 1 2 03:22 23 1 2 17:24 6.804 1 465978 222694 48 0.35 0.28 928

Processing parameters are:
Receiver tracking capability : unknown
Maximum ionospheric rate (L1) : 400.00 cm/min
Report data gap greater than : 10.00 min
Expected rms of MP12 multipath : 65.00 cm
Expected rms of MP21 multipath : 65.00 cm
Expected rms of MP15 multipath : 65.00 cm
Expected rms of MP51 multipath : 65.00 cm
Multipath slip sigma threshold : 4.00 sigma
% increase in MP rms for C/A | A/S : 100.00 %
Points in MP moving averages : 50
Minimum signal to noise for L1 : 4
Minimum signal to noise for L2 : 4
Minimum signal to noise for L5 : 4
Elevation mask (cutoff) : 10.00 degrees
Elevation comparison threshold : 25.00 degrees
SVs w/ code data for position try : 6
Width of ASCII summary plot : 72
Data indicators on summary plot : yes
Do ionospheric observable : yes
Do ionospheric derivative : yes
Do multipath observables : yes
Do 1-ms receiver clock slips : yes
Tolerance for 1-ms clock slips : 1.00e-02 ms
Do receiver LLI slips : yes
Do plot file(s) : no

Observations start : 2023 Jan 2 03:22:19.000
Observations end : 2023 Jan 2 17:24:53.000
Observation interval : 1.0000 second(s)

SV	#+hor	<ele>	#+mask	<ele>	#reprt	#compl	L1	L2	P1	P2	C1	C2	L5	C5
G01	36737	21.99	26275	28.26	11334	11202	11202	11334	0	11202	11202	11334	11334	11334
G02	6021	7.86	2218	11.99	1351	1351	1351	1351	0	1351	1351	0	0	0
G03	41120	20.93	29602	26.49	13290	13186	13186	13290	0	13186	13186	13290	13290	13290
G04	26074	38.51	21441	45.80	8946	8922	8922	8946	0	8922	8922	8946	8946	8946
G05	10285	34.51	8594	40.33	5195	5194	5194	5195	0	5194	5194	5195	0	0
G06	23716	40.14	22092	42.73	12552	12552	12552	12552	0	12552	12552	12552	12552	12552
G07	30107	34.40	23461	42.80	10665	10665	10665	10665	0	10665	10665	10665	0	0

G08 25266 35.98 20566 43.13 8555 8523 8523 8555 0 8523 8523 8555 8555 8555
G09 40502 21.45 20433 39.12 8704 8677 8677 8704 0 8677 8677 8704 8704 8704
G10 6957 23.56 5398 28.94 2369 2369 2369 2369 0 2369 2369 2369 2369 2369
G11 18691 38.10 17097 41.19 10303 10303 10303 10303 0 10303 10303 10303 10303 10303
G12 8650 27.76 7018 33.07 4233 4233 4233 4233 0 4233 4233 4233 0 0
G13 23781 10.02 11561 14.12 5948 5497 5948 5497 0 5497 5948 0 0 0
G14 34186 30.07 29644 33.89 15170 15156 15156 15170 0 15150 15156 15170 15170 15170
G15 3606 7.46 1193 13.01 715 514 514 715 0 514 514 715 0 0
G16 21626 43.51 18729 49.51 7769 7769 7769 7769 0 7769 7769 0 0 0
G17 32109 31.75 30575 33.09 16173 16169 16169 16173 0 16169 16169 16173 0 0
G19 27465 31.05 25667 32.87 14034 14034 14034 14034 0 14034 14034 0 0 0
G20 15333 47.50 13423 53.57 8176 8152 8176 8152 0 8152 8176 0 0 0
G21 33215 21.08 25947 24.84 11027 11005 11027 11005 0 11005 11027 0 0 0
G22 16728 32.07 15101 34.99 6284 5889 6284 5889 0 5889 6284 0 0 0
G23 2431 7.51 813 12.52 421 421 421 421 0 421 421 421 421 421
G24 13584 13.23 11085 14.97 6798 6267 6267 6798 0 6267 6267 6798 6798 6798
G25 5963 10.95 2788 18.07 1712 1631 1631 1712 0 1631 1631 1712 1712 1712
G26 15910 44.46 13673 50.95 5658 5576 5576 5658 0 5576 5576 5658 5658 5658
G27 23402 30.41 19518 35.19 7987 7932 7932 7987 0 7932 7932 7987 7987 7987
G30 26154 37.78 21471 44.99 10861 10834 10834 10861 0 10834 10834 10861 10861 10861
G31 16032 19.43 10660 26.65 4473 4473 4473 4473 0 4473 4473 4473 0 0
G32 11869 22.42 9935 25.79 4198 4198 4198 4198 0 4198 4198 4198 4198 4198

Obs below mask (10.00 deg) : 31025
Obs reported w/ code | phase : 255926
Obs deleted (any reason) : 33232
Obs complete : 222694

| G |
% Obs above mask w/ no L1 : 0.6
% Obs above mask w/ no L2 : 0.4
% Obs above mask w/ no L5 : 42.7

% Obs above mask w/ no P2 : 1.0
% Obs above mask w/ no C1 : 0.6
% Obs above mask w/ no C2 : 24.3
% Obs above mask w/ no C5 : 42.7

% Obs above mask w/ low L1 S/N: 22.1
% Obs above mask w/ low L2 S/N: 0.0
% Obs above mask w/ low L5 S/N: 0.0

No. of Rx clock offsets : 0
Total Rx clock drift : 0.000000 ms
Rate of Rx clock drift : 0.000000 ms/hr

elev (deg) tot slps <ION rms, m> 5=% 1|m 15=% 2|m
85 - 90 1332 0 0.000000
80 - 85 4122 0 0.000000
75 - 80 6172 0 0.000000
70 - 75 10194 0 0.000000
65 - 70 9495 0 0.000000
60 - 65 11150 0 0.000000
55 - 60 14842 0 0.000000
50 - 55 26478 0 0.000000
45 - 50 24466 0 0.000000
40 - 45 25773 0 0.000000

```
35 - 40  33197    0   0.000000
30 - 35  31656    0   0.000000
25 - 30  27594    0   0.000000
20 - 25  30029    2   0.000000
15 - 20  47848   28   0.000000
10 - 15  46081  225   0.000000
 5 - 10  42343  295   0.000000  =
 0 -  5     44    0   0.000000
   <  0      0    0   0.000000
```

MP12 RMS summary (per SV):

SV	obs>10	# del	<elev>	MP12 rms [m]	slips < 25	L1 rx < 25	L2 rx < 25	slips > 25	L1 rx > 25	L2 rx > 25
G01	11334	132	28.46	0.371608	0	105	105	0	0	0
G02	1351	0	11.98	0.461401	0	0	0	0	0	0
G03	13290	104	25.47	0.406570	0	123	123	0	0	0
G04	8946	24	45.96	0.293041	0	22	22	0	0	0
G05	5195	1	40.52	0.259623	0	2	2	0	0	0
G06	12552	0	43.85	0.278683	0	1	1	0	0	0
G07	10665	0	41.71	0.288426	0	3	3	0	0	0
G08	8555	32	43.37	0.313856	0	39	39	0	0	0
G09	8704	27	39.10	0.297608	0	28	28	0	0	0
G10	2369	0	29.90	0.287927	0	0	0	0	2	2
G11	10303	0	41.81	0.243631	0	0	0	0	0	0
G12	4233	0	33.31	0.292457	0	0	0	0	0	0
G13	5948	451	14.53	1.223252	16	157	157	0	0	0
G14	15170	14	35.57	0.314829	0	19	19	0	1	1
G15	715	201	13.15	0.887164	1	100	100	0	0	0
G16	7769	0	49.02	0.292149	0	6	6	0	2	2
G17	16173	4	31.90	0.316051	0	3	3	0	0	0
G19	14034	0	33.47	0.289686	0	16	16	0	0	0
G20	8176	24	53.74	0.293891	1	75	75	0	0	0
G21	11027	22	24.95	0.405316	7	12	12	0	0	0
G22	6284	395	36.44	0.285657	0	25	25	0	2	2
G23	421	0	13.01	0.363963	0	2	2	0	0	0
G24	6798	531	15.07	0.552046	0	307	307	0	0	0
G25	1712	81	18.24	0.484126	0	69	69	0	0	0
G26	5658	82	52.12	0.305365	0	58	58	0	2	2
G27	7987	55	35.41	0.319023	0	35	35	0	0	0
G30	10861	27	43.90	0.304717	0	40	40	0	0	0
G31	4473	0	27.47	0.359792	0	1	1	0	2	2
G32	4198	0	26.02	0.331013	0	0	0	0	2	2

```
mean MP12 rms       :  0.346859 m
total mean elevation : 35.77 degrees
# MP12 obs > 10     : 222694
# qc MP12 slips < 25 :    25
# Rvr L1 slips < 25  :  1248
# Rvr L2 slips < 25  :  1248
# qc MP12 slips > 25 :     0
# Rvr L1 slips > 25  :    13
# Rvr L2 slips > 25  :    13
```

```
elev (deg)  tot slps <MP12 rms, m>       5=%      1|m     15=%      2|m
 85 - 90   1013    0   0.180899  ||||
 80 - 85   2776    0   0.169987  |||
 75 - 80   4174    0   0.172719  |||
```

```
70 - 75   5997    0   0.171132  |||
65 - 70   5946    0   0.171934  |||
60 - 65   6540    0   0.176385  ||||
55 - 60   8375    0   0.188249  ||||
50 - 55  15313    0   0.199060  ||||
45 - 50  14366    0   0.214310  ||||
40 - 45  16844    0   0.237891  |||||
35 - 40  24032    0   0.262038  |||||
30 - 35  21600    0   0.289472  ||||||
25 - 30  18081    0   0.329030  |||||||
20 - 25  19537    0   0.368655  |||||||
15 - 20  28292    5   0.431274  |||||||||
10 - 15  29799   20   0.720176  ||||||||||||||
 5 - 10  26304   38   0.697215  ||||||||||||||
 0 -  5     22    0   0.601327  ||||||||||||
   <  0      0    0   0.000000
```

MP21 RMS summary (per SV):

SV	obs>10	# del	<elev>	MP21 rms [m]	slips < 25	L1 rx < 25	L2 rx < 25	slips > 25	L1 rx > 25	L2 rx > 25
G01	11334	132	28.46	0.265497	0	105	1	0	0	0
G02	1351	0	11.98	0.343738	0	0	0	0	0	0
G03	13290	104	25.47	0.268247	0	123	0	0	0	0
G04	8946	24	45.96	0.178872	0	22	0	0	0	0
G05	5195	1	40.52	0.126654	0	2	0	0	0	0
G06	12552	0	43.85	0.227473	0	1	0	0	0	0
G07	10665	0	41.71	0.161624	0	3	1	0	0	0
G08	8555	32	43.37	0.186626	0	39	0	0	0	0
G09	8704	27	39.10	0.157599	0	28	0	0	0	0
G10	2369	0	29.90	0.162541	0	0	0	0	2	2
G11	10303	0	41.81	0.185759	0	0	0	0	0	0
G12	4233	0	33.31	0.249850	0	0	0	0	0	0
G13	5948	451	14.53	1.629312	22	157	122	0	0	0
G14	15170	14	35.57	0.355444	1	19	0	0	1	0
G15	715	201	13.15	0.803321	1	100	1	0	0	0
G16	7769	0	49.02	0.208635	0	6	6	0	2	2
G17	16173	4	31.90	0.239652	0	3	0	0	0	0
G19	14034	0	33.47	0.224842	0	16	16	0	0	0
G20	8176	24	53.74	0.170187	1	75	73	0	0	0
G21	11027	22	24.95	0.407163	8	12	20	0	0	0
G22	6284	395	36.44	0.220209	0	25	5	0	2	2
G23	421	0	13.01	0.280830	0	2	1	0	0	0
G24	6798	531	15.07	0.397351	0	307	0	0	0	0
G25	1712	81	18.24	0.360817	0	69	0	0	0	0
G26	5658	82	52.12	0.233037	0	58	0	0	2	2
G27	7987	55	35.41	0.249800	0	35	0	0	0	0
G30	10861	27	43.90	0.157429	0	40	0	0	0	0
G31	4473	0	27.47	0.307242	0	1	0	0	2	2
G32	4198	0	26.02	0.278274	0	0	0	0	2	2

mean MP21 rms : 0.275811 m
total mean elevation : 35.77 degrees
MP21 obs > 10 : 222694
qc MP21 slips < 25 : 33
Rvr L1 slips < 25 : 1248
Rvr L2 slips < 25 : 246
qc MP21 slips > 25 : 0

Rvr L1 slips > 25 : 13
Rvr L2 slips > 25 : 12

elev (deg) tot slps <MP21 rms, m> 5=% 1|m 15=% 2|m
85 - 90 1013 0 0.081528 ||
80 - 85 2776 0 0.070645 |
75 - 80 4174 0 0.070723 |
70 - 75 5997 0 0.067163 |
65 - 70 5946 0 0.075960 ||
60 - 65 6540 0 0.082885 ||
55 - 60 8375 0 0.096658 ||
50 - 55 15313 0 0.107616 ||
45 - 50 14366 0 0.123921 ||
40 - 45 16844 0 0.159661 |||
35 - 40 24032 0 0.205020 ||||
30 - 35 21600 0 0.229926 |||||
25 - 30 18081 0 0.308715 ||||||
20 - 25 19537 0 0.278169 ||||||
15 - 20 28292 6 0.299562 ||||||
10 - 15 29799 27 0.813570 ||||||||||||||||
5 - 10 26304 44 0.511478 ||||||||||
0 - 5 22 0 0.227508 |||||
< 0 0 0 0.000000

MP15 RMS summary (per SV):

SV	obs>10	# del	<elev>	MP15 rms [m]	slips < 25	L1 rx < 25	L5 rx < 25	slips > 25	L1 rx > 25	L5 rx > 25
G01	11334	132	28.46	0.370602	0	105	1	0	0	0
G03	13290	104	25.47	0.406675	1	123	0	0	0	0
G04	8946	24	45.96	0.292179	0	22	0	0	0	0
G06	12552	0	43.85	0.278467	0	1	0	0	0	0
G08	8555	32	43.37	0.313655	0	39	0	0	0	0
G09	8704	27	39.10	0.297269	0	28	0	0	0	0
G10	2369	0	29.90	0.287735	0	0	0	0	2	2
G11	10303	0	41.81	0.243534	0	0	0	0	0	0
G14	15170	14	35.57	0.313967	0	19	0	0	1	0
G23	421	0	13.01	0.363629	0	2	1	0	0	0
G24	6798	531	15.07	0.542419	0	307	0	0	0	0
G25	1712	81	18.24	0.476835	0	69	0	0	0	0
G26	5658	82	52.12	0.301268	0	58	0	0	2	2
G27	7987	55	35.41	0.317042	0	35	0	0	0	0
G30	10861	27	43.90	0.303869	0	40	0	0	0	0
G32	4198	0	26.02	0.331744	0	0	0	0	2	2

mean MP15 rms : 0.328985 m
total mean elevation : 36.41 degrees
MP15 obs > 10 : 127749
qc MP15 slips < 25 : 1
Rvr L1 slips < 25 : 848
Rvr L5 slips < 25 : 2
qc MP15 slips > 25 : 0
Rvr L1 slips > 25 : 7
Rvr L5 slips > 25 : 6

elev (deg) tot slps <MP15 rms, m> 5=% 1|m 15=% 2|m
85 - 90 319 0 0.161606 |||
80 - 85 1346 0 0.158892 |||

```
75 - 80   1998    0   0.165193  |||
70 - 75   4197    0   0.162443  |||
65 - 70   3549    0   0.166411  |||
60 - 65   4610    0   0.174203  |||
55 - 60   6467    0   0.185839  ||||
50 - 55  11165    0   0.198254  ||||
45 - 50  10100    0   0.214160  ||||
40 - 45   8929    0   0.239177  |||||
35 - 40   9165    0   0.263260  |||||
30 - 35  10056    0   0.295746  ||||||
25 - 30   9513    0   0.331060  |||||||
20 - 25  10492    0   0.373144  |||||||
15 - 20  19556    0   0.431995  |||||||||
10 - 15  16282    1   0.534812  ||||||||||
 5 - 10  16039   22   0.633983  ||||||||||||
 0 -  5     22    0   0.601506  ||||||||||||
  <  0      0    0   0.000000
```

MP51 RMS summary (per SV):

SV	obs>10	# del	<elev>	MP51 rms [m]	slips < 25	L1 rx < 25	L5 rx < 25	slips > 25	L1 rx > 25	L5 rx > 25
G01	11334	132	28.46	0.279554	0	105	0	0	0	0
G03	13290	104	25.47	0.275723	0	123	0	0	0	0
G04	8946	24	45.96	0.173620	0	22	0	0	0	0
G06	12552	0	43.85	0.247424	0	1	0	0	0	0
G08	8555	32	43.37	0.215854	0	39	0	0	0	0
G09	8704	27	39.10	0.173758	0	28	0	0	0	0
G10	2369	0	29.90	0.183631	0	0	0	0	2	0
G11	10303	0	41.81	0.167659	0	0	0	0	0	0
G14	15170	14	35.57	0.242367	0	19	0	0	1	0
G23	421	0	13.01	0.217146	0	2	0	0	0	0
G24	6798	531	15.07	0.392429	1	307	0	0	0	0
G25	1712	81	18.24	0.335737	0	69	0	0	0	0
G26	5658	82	52.12	0.265778	0	58	0	0	2	0
G27	7987	55	35.41	0.258197	0	35	0	0	0	0
G30	10861	27	43.90	0.176647	0	40	0	0	0	0
G32	4198	0	26.02	0.327999	0	0	0	0	2	0

mean MP51 rms : 0.238939 m
total mean elevation : 36.41 degrees
MP51 obs > 10 : 127749
qc MP51 slips < 25 : 1
Rvr L1 slips < 25 : 848
Rvr L5 slips < 25 : 0
qc MP51 slips > 25 : 0
Rvr L1 slips > 25 : 7
Rvr L5 slips > 25 : 0

```
elev (deg)  tot slps <MP51 rms, m>       5=%      1|m     15=%      2|m
 85 - 90    319    0   0.051933  |
 80 - 85   1346    0   0.053052  |
 75 - 80   1998    0   0.058664  |
 70 - 75   4197    0   0.064003  |
 65 - 70   3549    0   0.068032  |
 60 - 65   4610    0   0.078349  ||
 55 - 60   6467    0   0.087917  ||
 50 - 55  11165    0   0.097408  ||
```

```
 45 - 50  10100    0   0.120188  ||
 40 - 45   8929    0   0.156486  |||
 35 - 40   9165    0   0.236444  |||||
 30 - 35  10056    0   0.257976  |||||
 25 - 30   9513    0   0.324136  ||||||
 20 - 25  10492    0   0.297083  ||||||
 15 - 20  19556    0   0.314858  ||||||
 10 - 15  16282    1   0.357547  |||||||
  5 - 10  16039   18   0.342607  |||||||
  0 -  5     22    0   0.323452  ||||||
   <  0      0    0   0.000000
```

S/N L1 summary (per elevation bin):

```
elev (deg)  tot SN1 sig    mean                0|5              1|0
 85 - 90   1013   0.506    6.311 ##|||||||||||||||||||||||
 80 - 85   2776   0.511    6.563 ##|||||||||||||||||||||||
 75 - 80   4174   0.488    6.647 ##|||||||||||||||||||||||||
 70 - 75   5997   0.450    6.733 ##|||||||||||||||||||||||||
 65 - 70   5946   0.395    6.818 ##|||||||||||||||||||||||||
 60 - 65   6541   0.443    6.745 ##|||||||||||||||||||||||||
 55 - 60   8375   0.465    6.304 ##|||||||||||||||||||||||
 50 - 55  15314   0.305    6.100 #|||||||||||||||||||||||
 45 - 50  14367   0.233    6.054 #|||||||||||||||||||||||
 40 - 45  16844   0.055    6.000 |||||||||||||||||||||||
 35 - 40  24033   0.284    5.913 #|||||||||||||||||||||||
 30 - 35  21601   0.493    5.395 ##||||||||||||||||||||
 25 - 30  18082   0.423    4.942 ##||||||||||||||||||
 20 - 25  19538   0.642    4.233 ###|||||||||||||||
 15 - 20  28330   0.815    3.124 ###|||||||||
 10 - 15  30655   0.901    2.181 ####|||||
  5 - 10  28755   0.620    1.409 ##||||
  0 -  5     25   0.569    1.360 ##|||
   <  0      0   0.000    0.000
```

S/N L2 summary (per elevation bin):

```
elev (deg)  tot SN2 sig    mean                0|5              1|0
 85 - 90   1013   0.318    8.969 #|||||||||||||||||||||||||||||||||||
 80 - 85   2776   0.225    8.975 #|||||||||||||||||||||||||||||||||||
 75 - 80   4174   0.241    8.957 #|||||||||||||||||||||||||||||||||||
 70 - 75   5997   0.241    8.952 #|||||||||||||||||||||||||||||||||||
 65 - 70   5946   0.368    8.856 #|||||||||||||||||||||||||||||||||
 60 - 65   6541   0.357    8.865 #|||||||||||||||||||||||||||||||||
 55 - 60   8375   0.320    8.896 #|||||||||||||||||||||||||||||||||||
 50 - 55  15314   0.233    8.948 #|||||||||||||||||||||||||||||||||||
 45 - 50  14367   0.265    8.935 #|||||||||||||||||||||||||||||||||||
 40 - 45  16844   0.824    8.506 ###|||||||||||||||||||||||||||||||
 35 - 40  24033   0.965    8.101 ####|||||||||||||||||||||||||||
 30 - 35  21601   0.963    8.262 ####|||||||||||||||||||||||||||
 25 - 30  18082   1.008    8.230 ####|||||||||||||||||||||||||||
 20 - 25  19539   1.012    7.777 ####|||||||||||||||||||||||||
 15 - 20  28437   0.943    7.622 ####|||||||||||||||||||||||||
 10 - 15  30970   1.336    7.121 #####|||||||||||||||||||||||
  5 - 10  28566   1.250    7.219 #####|||||||||||||||||||||||
  0 -  5     25   1.610    7.520 ######|||||||||||||||||||||||
   <  0      0   0.000    0.000
```

```
S/N L5 summary (per elevation bin):
elev (deg)  tot SN5 sig    mean                0|5               1|0
 85 - 90    319   0.504    8.972 ##||||||||||||||||||||||||||||||||||
 80 - 85   1346   0.245    8.993 #|||||||||||||||||||||||||||||||||||
 75 - 80   1998   0.201    8.995 #|||||||||||||||||||||||||||||||||||
 70 - 75   4197   0.139    8.998 #|||||||||||||||||||||||||||||||||||
 65 - 70   3549   0.151    8.997 #|||||||||||||||||||||||||||||||||||
 60 - 65   4611   0.133    8.998 #|||||||||||||||||||||||||||||||||||
 55 - 60   6467   0.112    8.999 ||||||||||||||||||||||||||||||||||||
 50 - 55  11165   0.085    8.999 ||||||||||||||||||||||||||||||||||||
 45 - 50  10101   0.090    8.999 ||||||||||||||||||||||||||||||||||||
 40 - 45   8929   0.095    8.999 ||||||||||||||||||||||||||||||||||||
 35 - 40   9165   0.094    8.999 ||||||||||||||||||||||||||||||||||||
 30 - 35  10057   0.090    8.999 ||||||||||||||||||||||||||||||||||||
 25 - 30   9513   0.303    8.907 #|||||||||||||||||||||||||||||||||||
 20 - 25  10492   0.494    8.387 ##||||||||||||||||||||||||||||||||
 15 - 20  19698   0.178    8.029 #|||||||||||||||||||||||||||||||
 10 - 15  17251   0.061    8.000 ||||||||||||||||||||||||||||||||
  5 - 10  18199   0.059    8.000 ||||||||||||||||||||||||||||||||
  0 -  5     25   1.600    7.680 ######|||||||||||||||||||||||||
   <  0       0   0.000    0.000
```

Annexure II

Year wise quality check parameters at stations

YEAR 2013

1. CARN

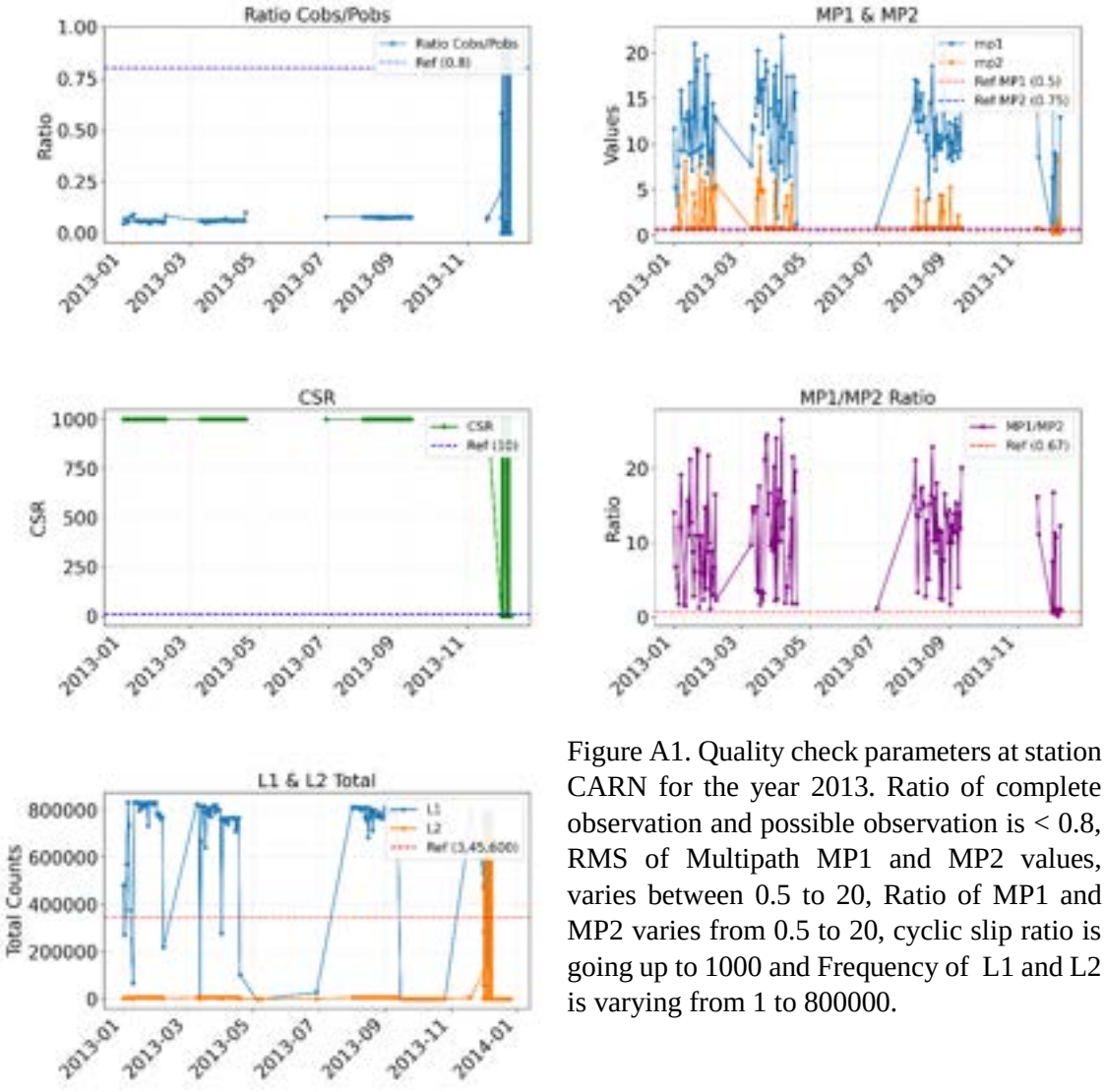


Figure A1. Quality check parameters at station CARN for the year 2013. Ratio of complete observation and possible observation is < 0.8, RMS of Multipath MP1 and MP2 values, varies between 0.5 to 20, Ratio of MP1 and MP2 varies from 0.5 to 20, cyclic slip ratio is going up to 1000 and Frequency of L1 and L2 is varying from 1 to 800000.

2. DGPR

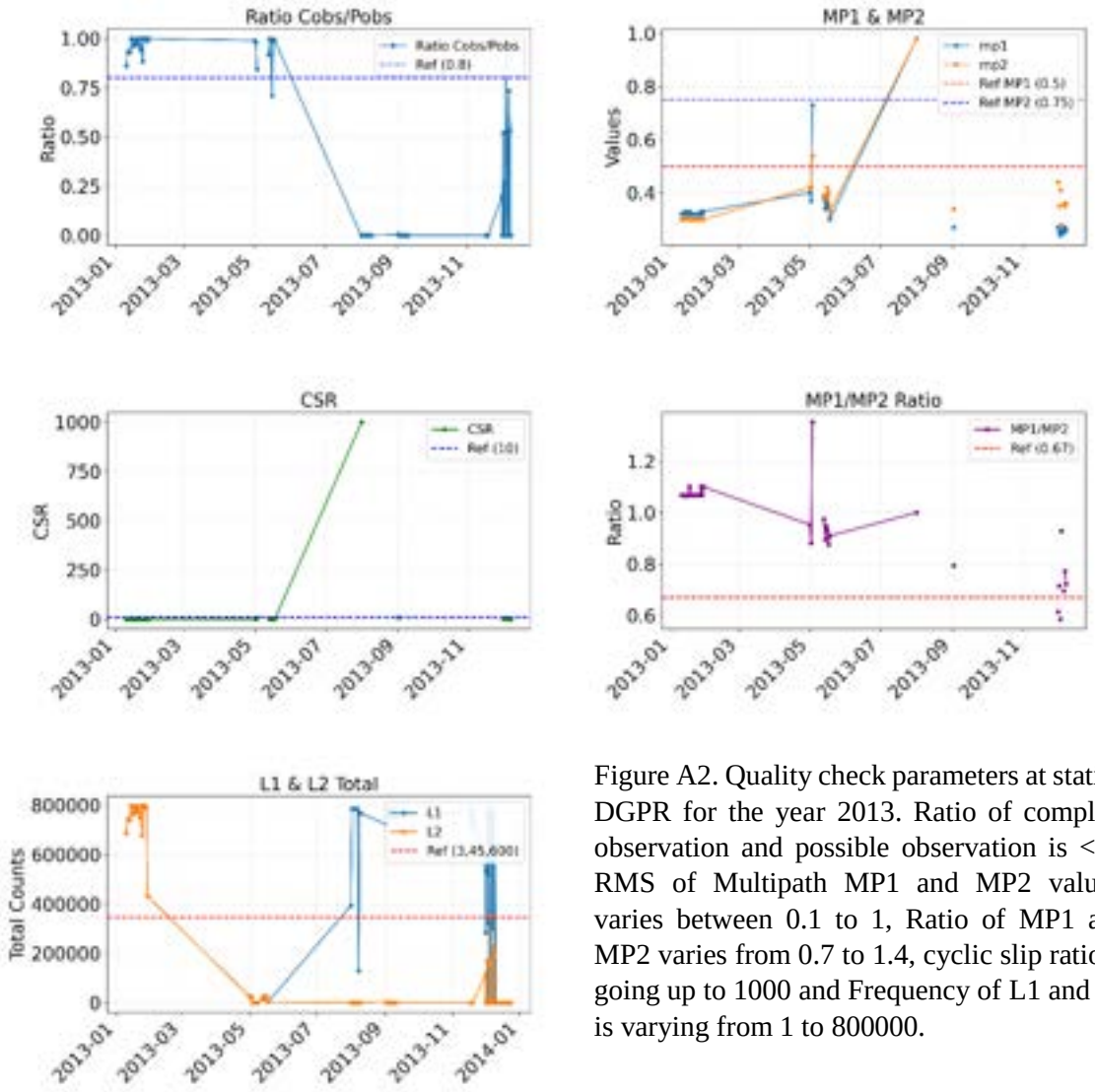


Figure A2. Quality check parameters at station DGPR for the year 2013. Ratio of complete observation and possible observation is < 1, RMS of Multipath MP1 and MP2 values, varies between 0.1 to 1, Ratio of MP1 and MP2 varies from 0.7 to 1.4, cyclic slip ratio is going up to 1000 and Frequency of L1 and L2 is varying from 1 to 800000.

3. HAVE

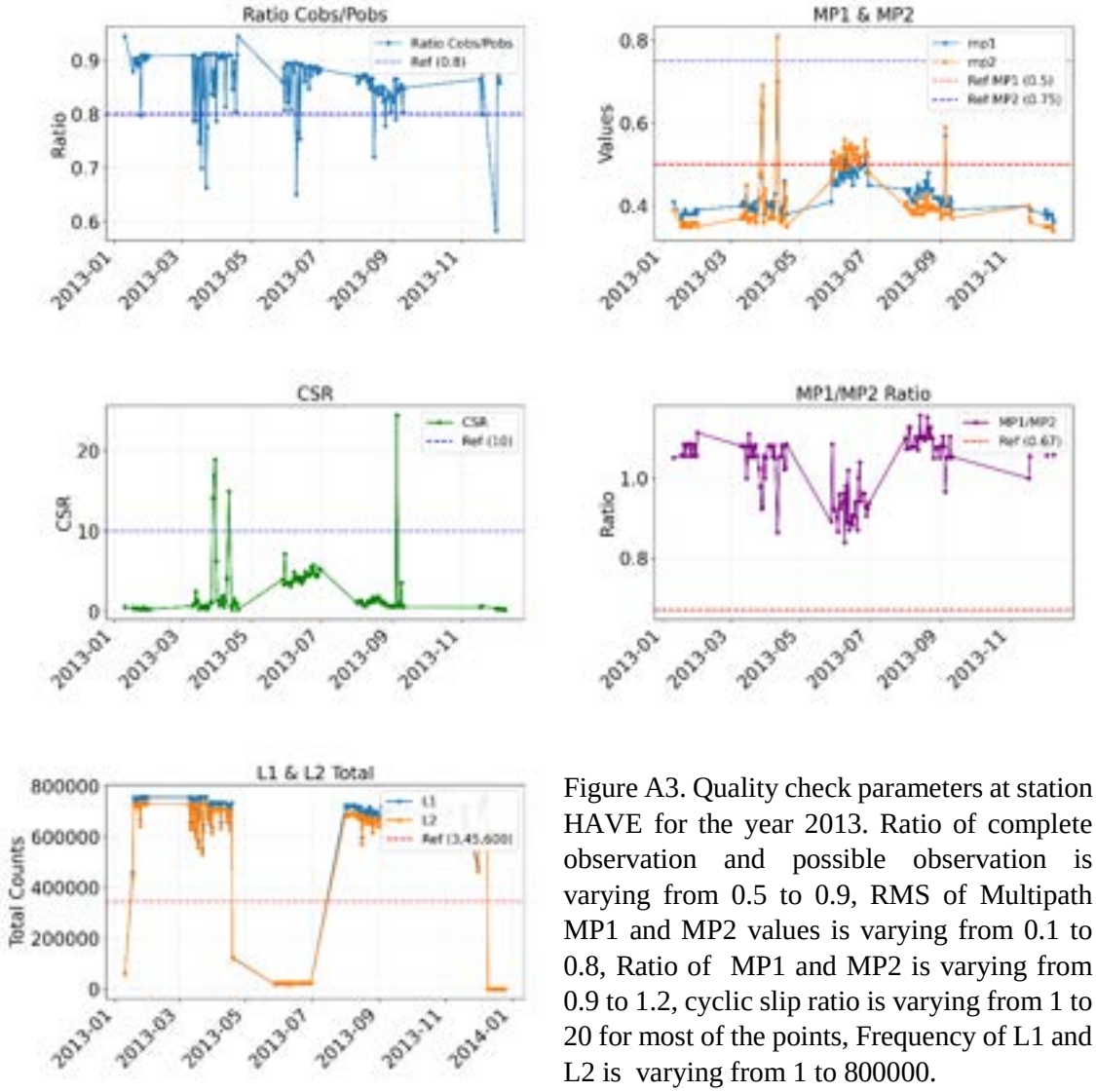


Figure A3. Quality check parameters at station HAVE for the year 2013. Ratio of complete observation and possible observation is varying from 0.5 to 0.9, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.8, Ratio of MP1 and MP2 is varying from 0.9 to 1.2, cyclic slip ratio is varying from 1 to 20 for most of the points, Frequency of L1 and L2 is varying from 1 to 800000.

4. HUTB

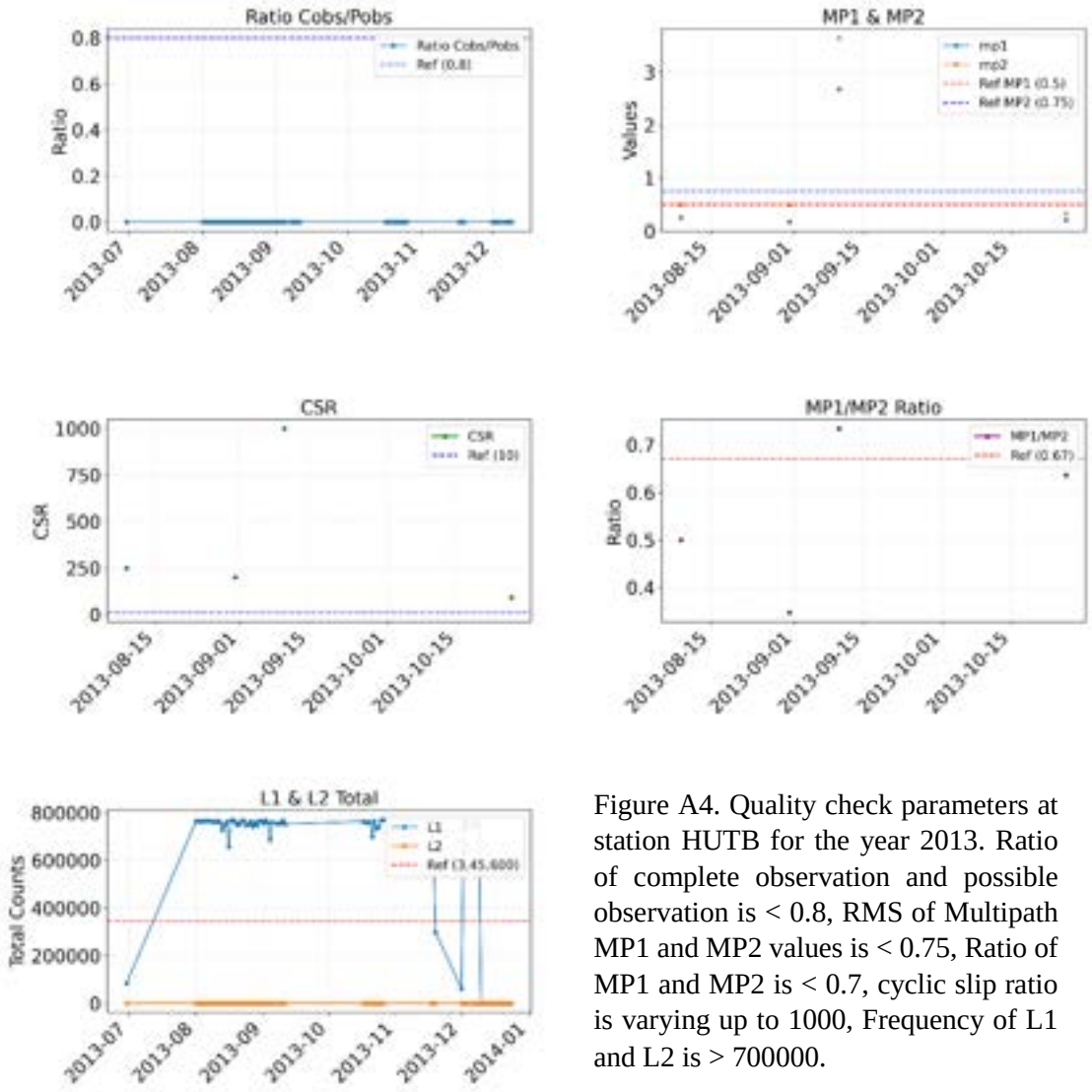


Figure A4. Quality check parameters at station HUTB for the year 2013. Ratio of complete observation and possible observation is < 0.8, RMS of Multipath MP1 and MP2 values is < 0.75, Ratio of MP1 and MP2 is < 0.7, cyclic slip ratio is varying up to 1000, Frequency of L1 and L2 is > 700000.

5. MBDR

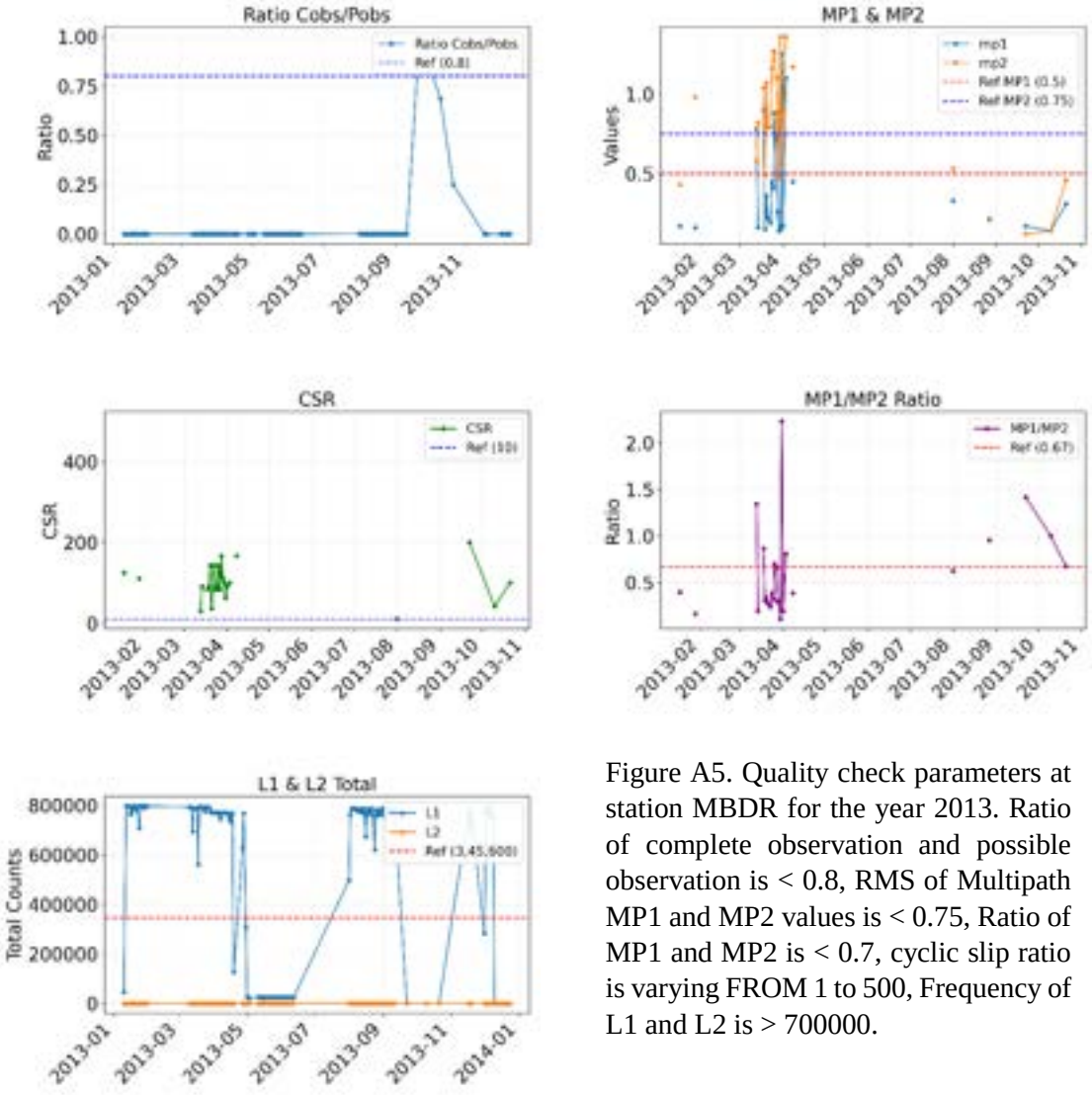


Figure A5. Quality check parameters at station MBDR for the year 2013. Ratio of complete observation and possible observation is < 0.8, RMS of Multipath MP1 and MP2 values is < 0.75, Ratio of MP1 and MP2 is < 0.7, cyclic slip ratio is varying FROM 1 to 500, Frequency of L1 and L2 is > 700000.

6. PORT

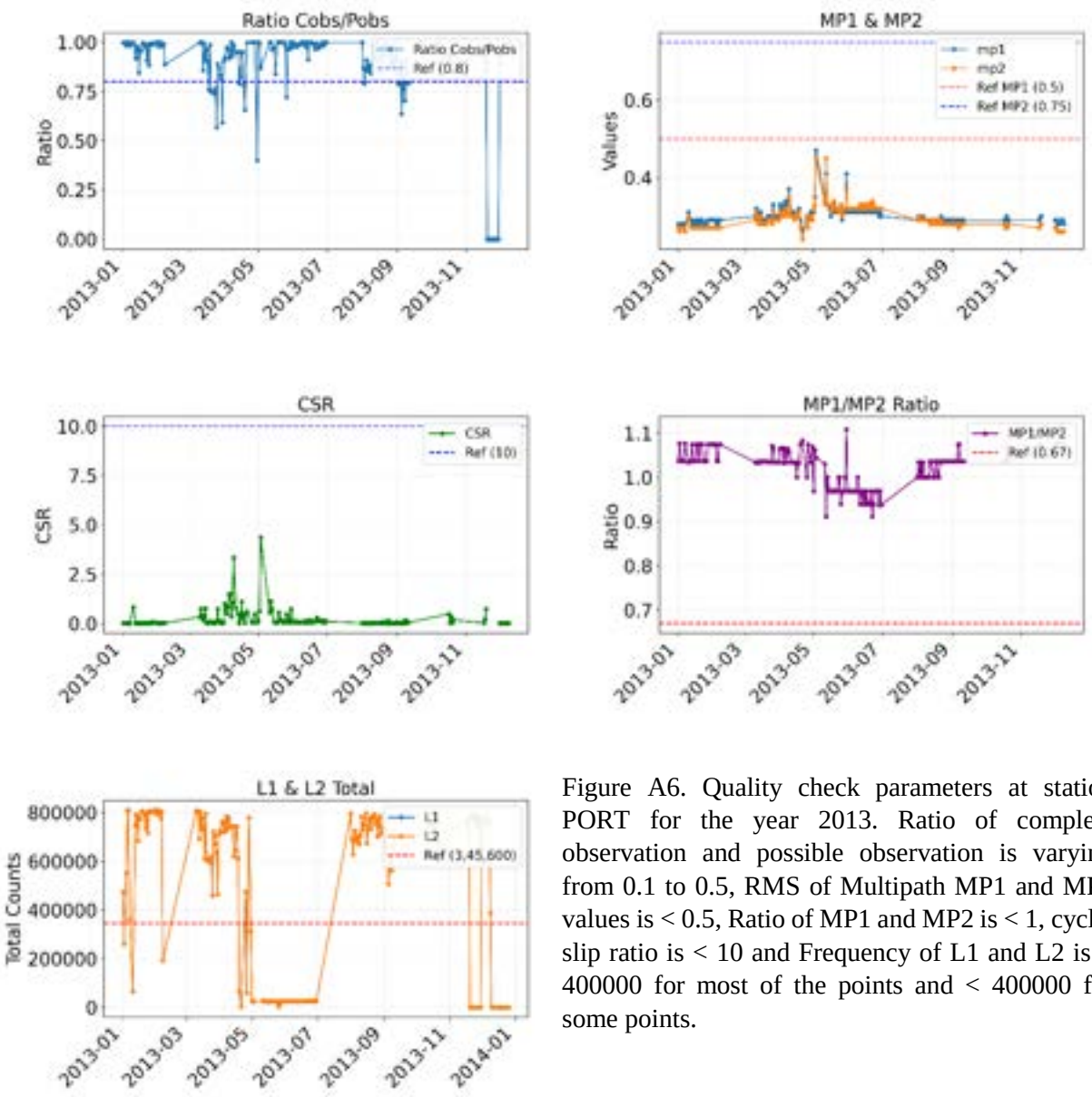


Figure A6. Quality check parameters at station PORT for the year 2013. Ratio of complete observation and possible observation is varying from 0.1 to 0.5, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is < 1, cyclic slip ratio is < 10 and Frequency of L1 and L2 is > 400000 for most of the points and < 400000 for some points.

YEAR 2014

1. CARN

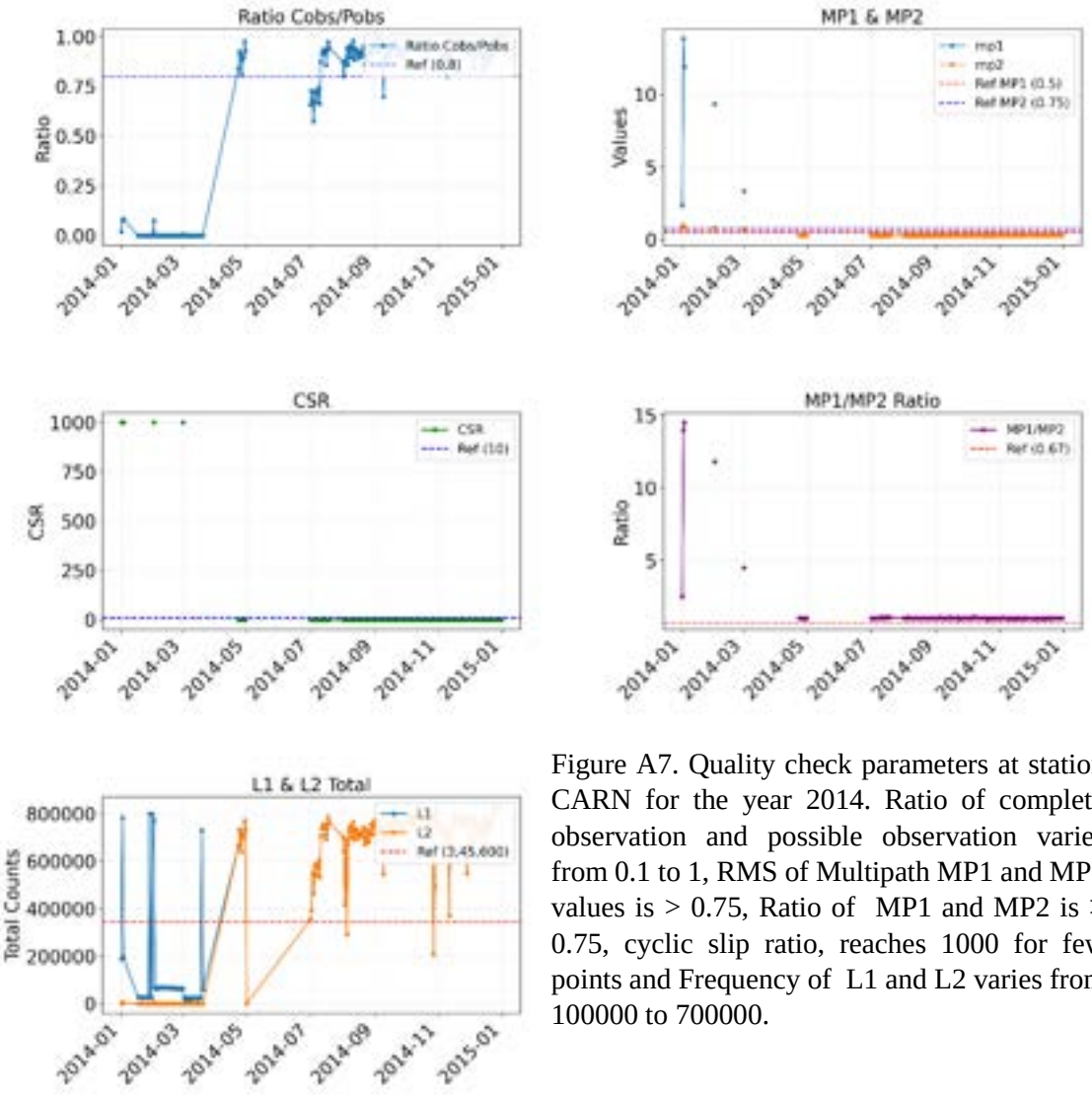


Figure A7. Quality check parameters at station CARN for the year 2014. Ratio of complete observation and possible observation varies from 0.1 to 1, RMS of Multipath MP1 and MP2 values is > 0.75, Ratio of MP1 and MP2 is > 0.75, cyclic slip ratio, reaches 1000 for few points and Frequency of L1 and L2 varies from 100000 to 700000.

2. DGPR

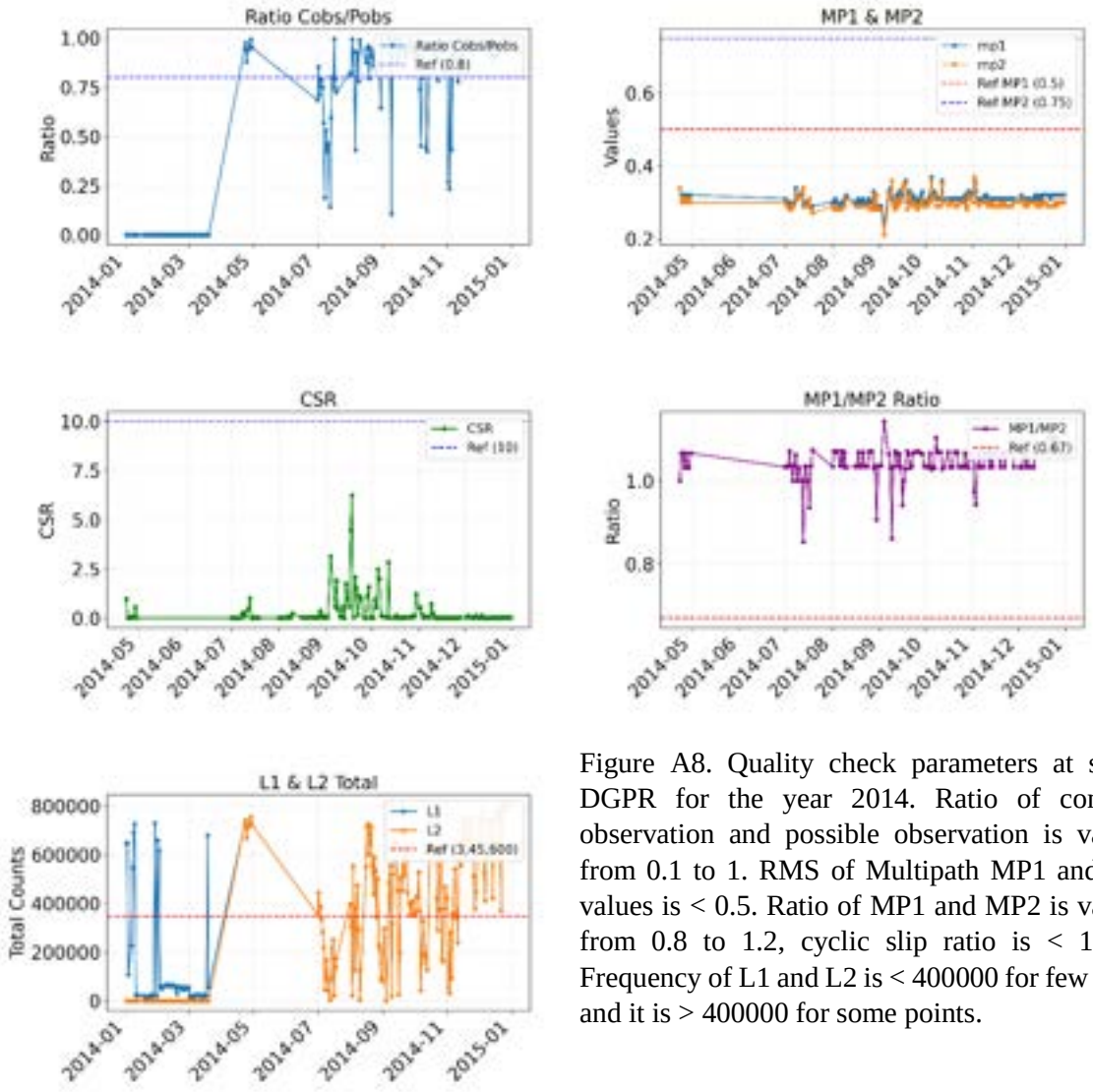


Figure A8. Quality check parameters at station DGPR for the year 2014. Ratio of complete observation and possible observation is varying from 0.1 to 1. RMS of Multipath MP1 and MP2 values is < 0.5. Ratio of MP1 and MP2 is varying from 0.8 to 1.2, cyclic slip ratio is < 10 and Frequency of L1 and L2 is < 400000 for few points and it is > 400000 for some points.

3. HAVE

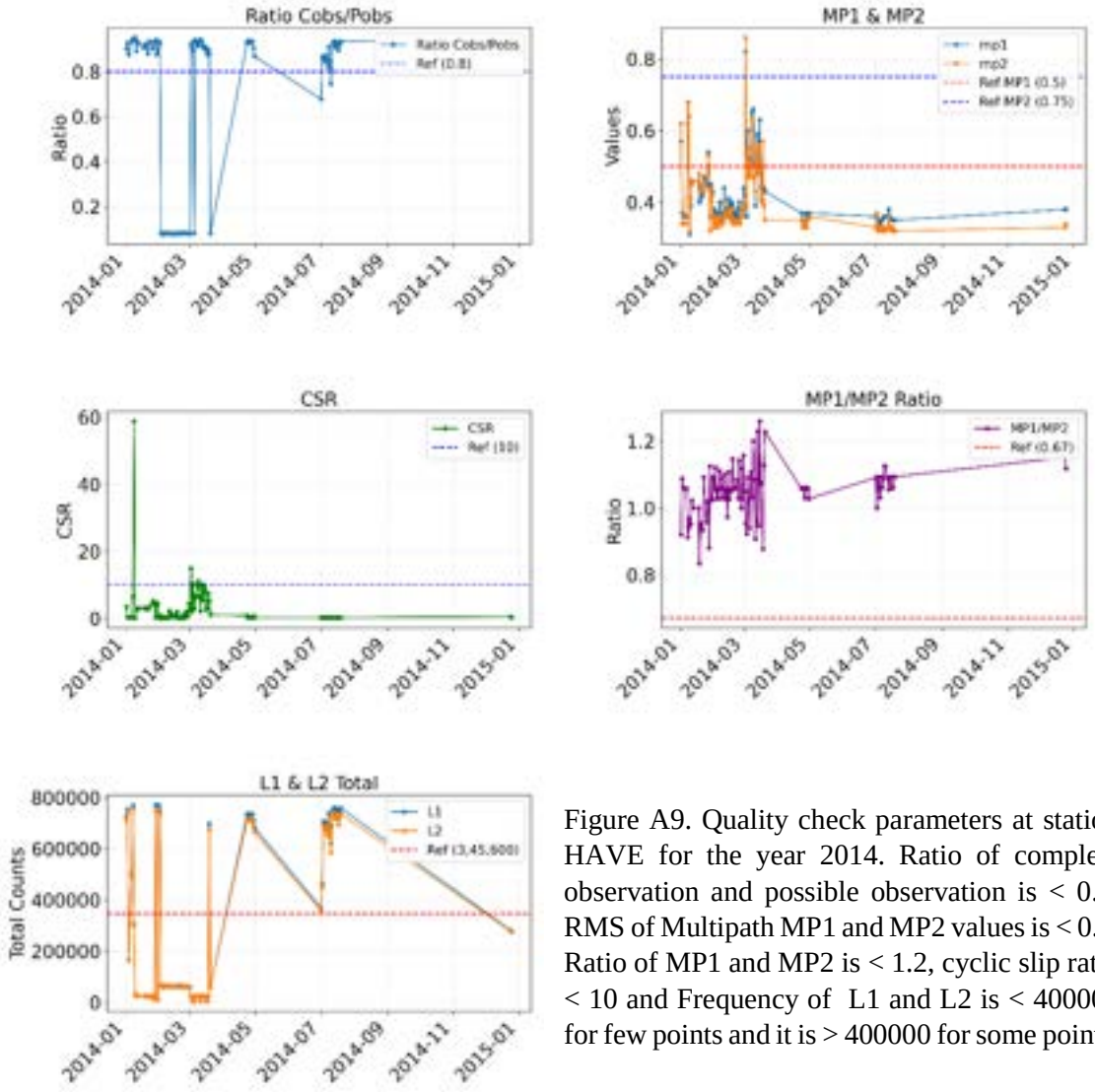


Figure A9. Quality check parameters at station HAVE for the year 2014. Ratio of complete observation and possible observation is < 0.8, RMS of Multipath MP1 and MP2 values is < 0.8, Ratio of MP1 and MP2 is < 1.2, cyclic slip ratio < 10 and Frequency of L1 and L2 is < 400000 for few points and it is > 400000 for some points.

4. HUTB

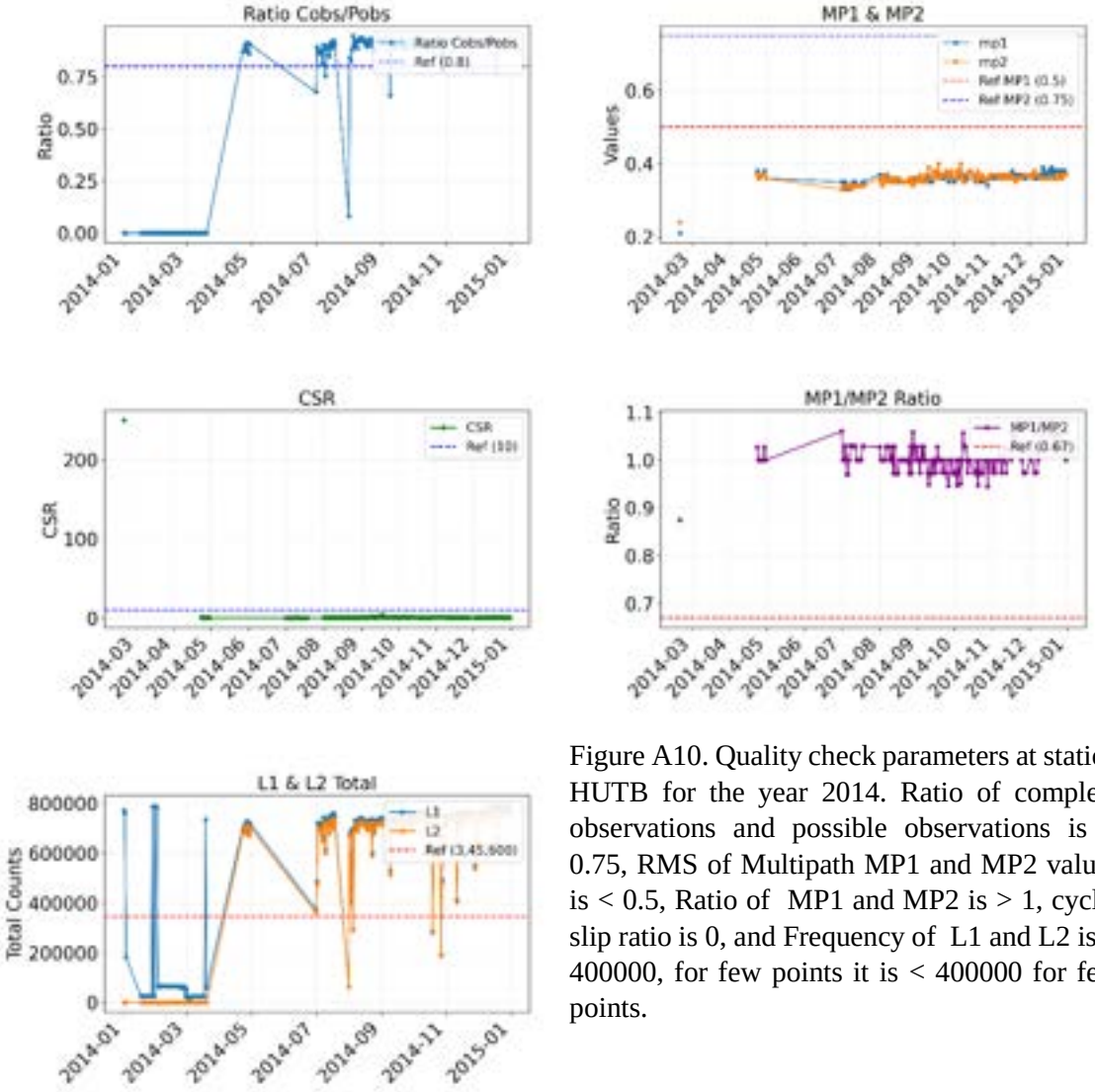


Figure A10. Quality check parameters at station HUTB for the year 2014. Ratio of complete observations and possible observations is < 0.75, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is > 1, cyclic slip ratio is 0, and Frequency of L1 and L2 is > 400000, for few points it is < 400000 for few points.

5. MBDR

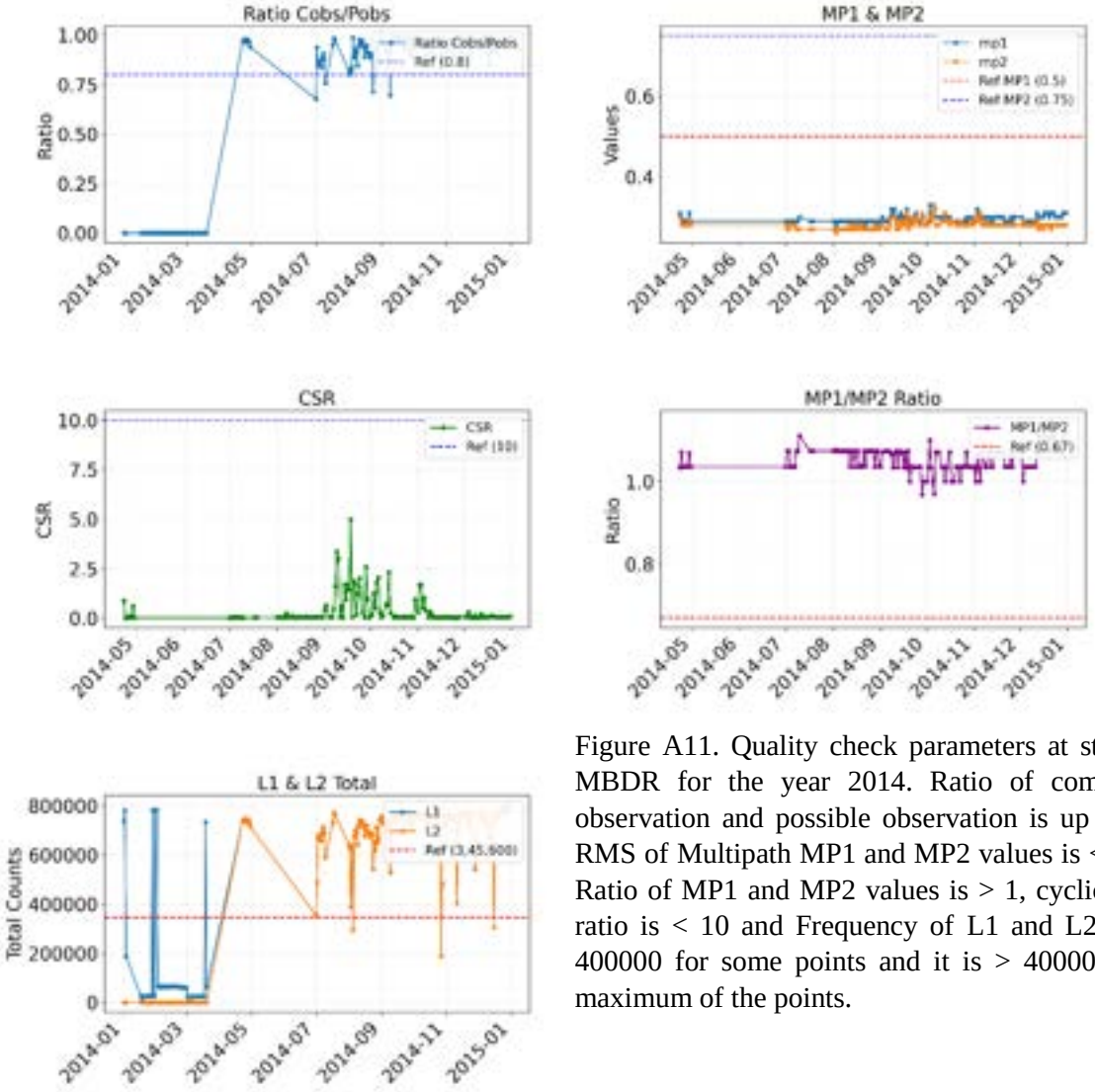


Figure A11. Quality check parameters at station MBDR for the year 2014. Ratio of complete observation and possible observation is up to 1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 values is > 1, cyclic slip ratio is < 10 and Frequency of L1 and L2 is < 400000 for some points and it is > 400000 for maximum of the points.

6. PORT

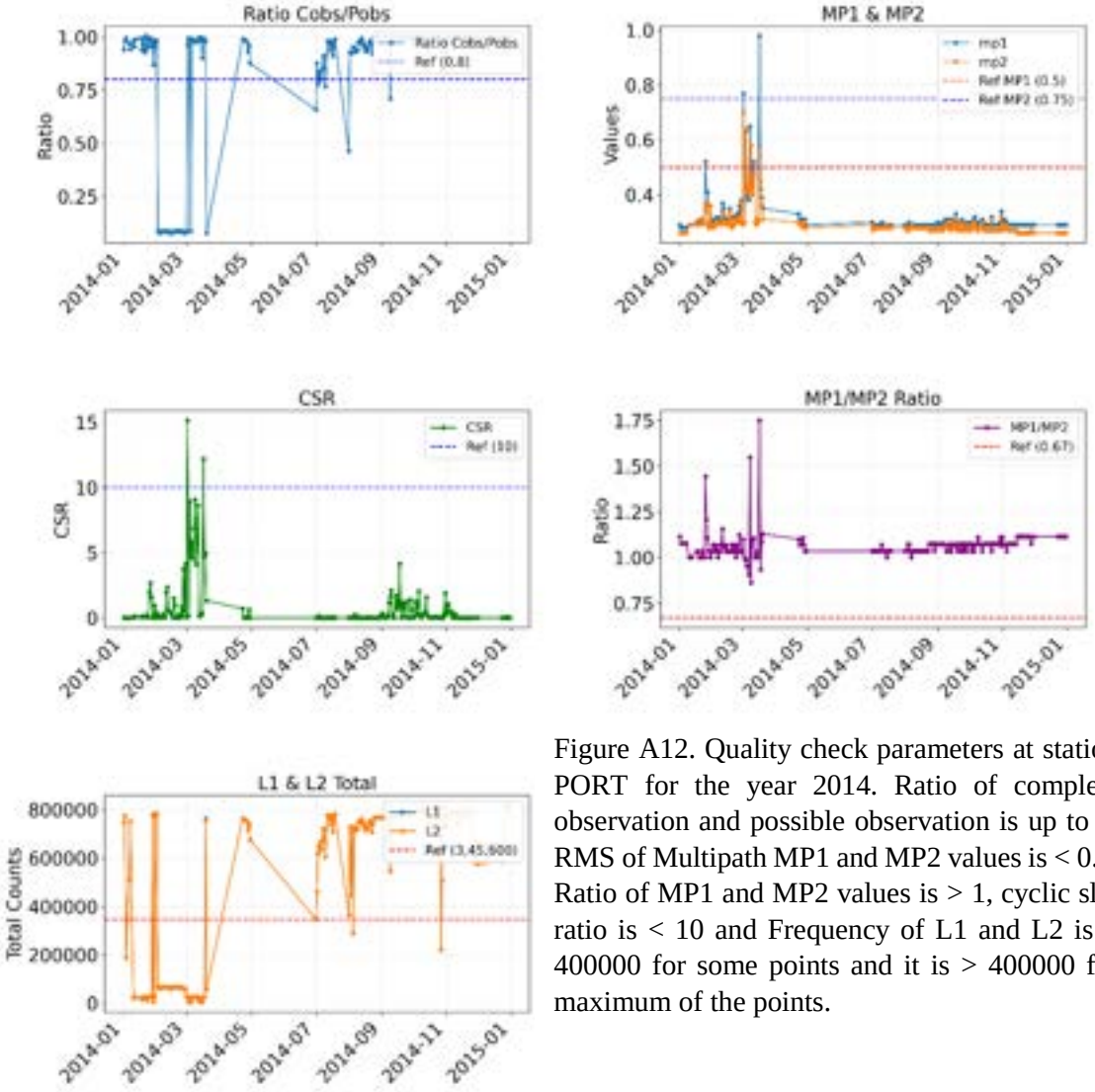


Figure A12. Quality check parameters at station PORT for the year 2014. Ratio of complete observation and possible observation is up to 1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 values is > 1, cyclic slip ratio is < 10 and Frequency of L1 and L2 is < 400000 for some points and it is > 400000 for maximum of the points.

YEAR 2015

1. CARN

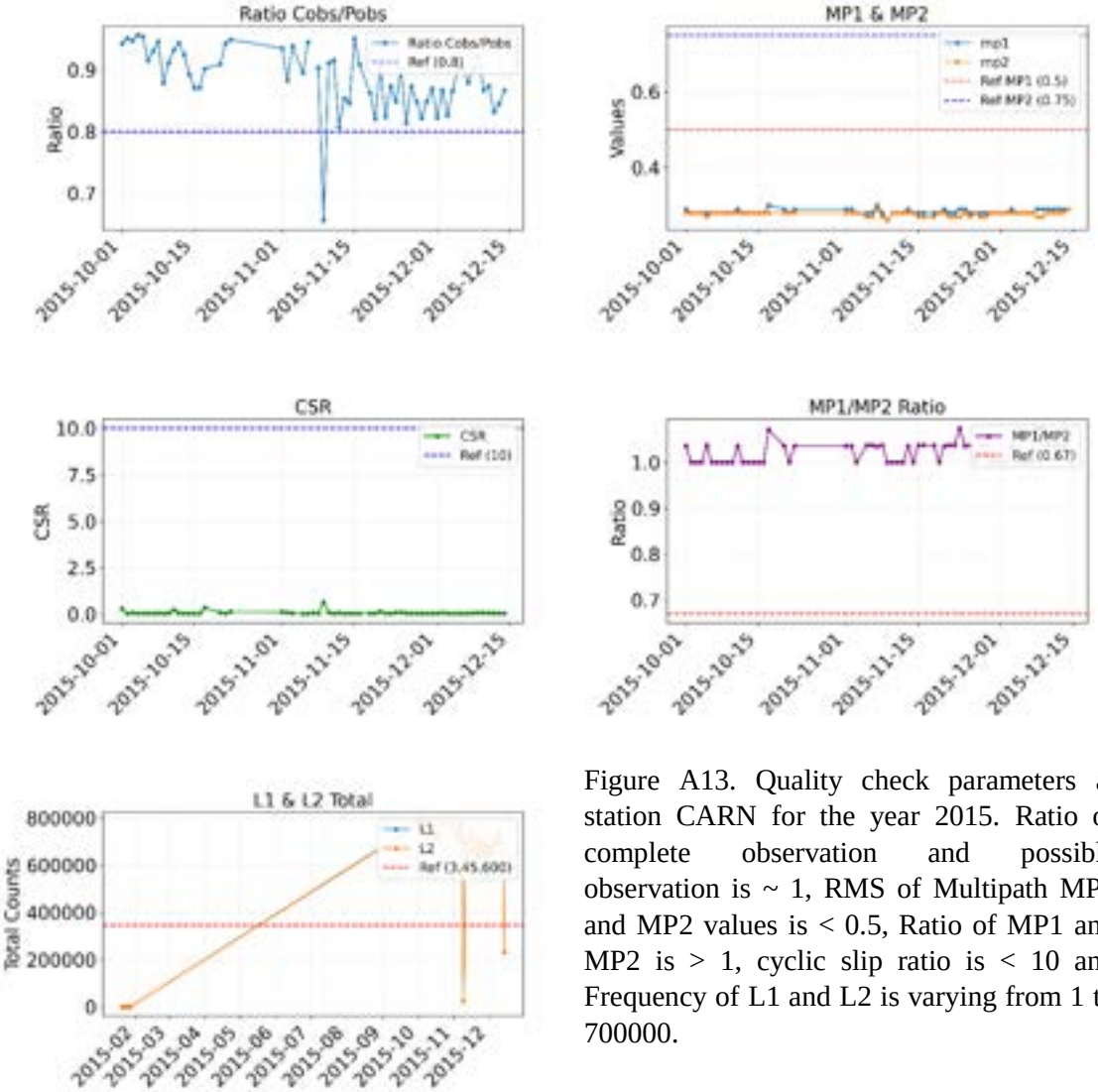


Figure A13. Quality check parameters at station CARN for the year 2015. Ratio of complete observation and possible observation is ~ 1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is > 1, cyclic slip ratio is < 10 and Frequency of L1 and L2 is varying from 1 to 700000.

2. DGPR

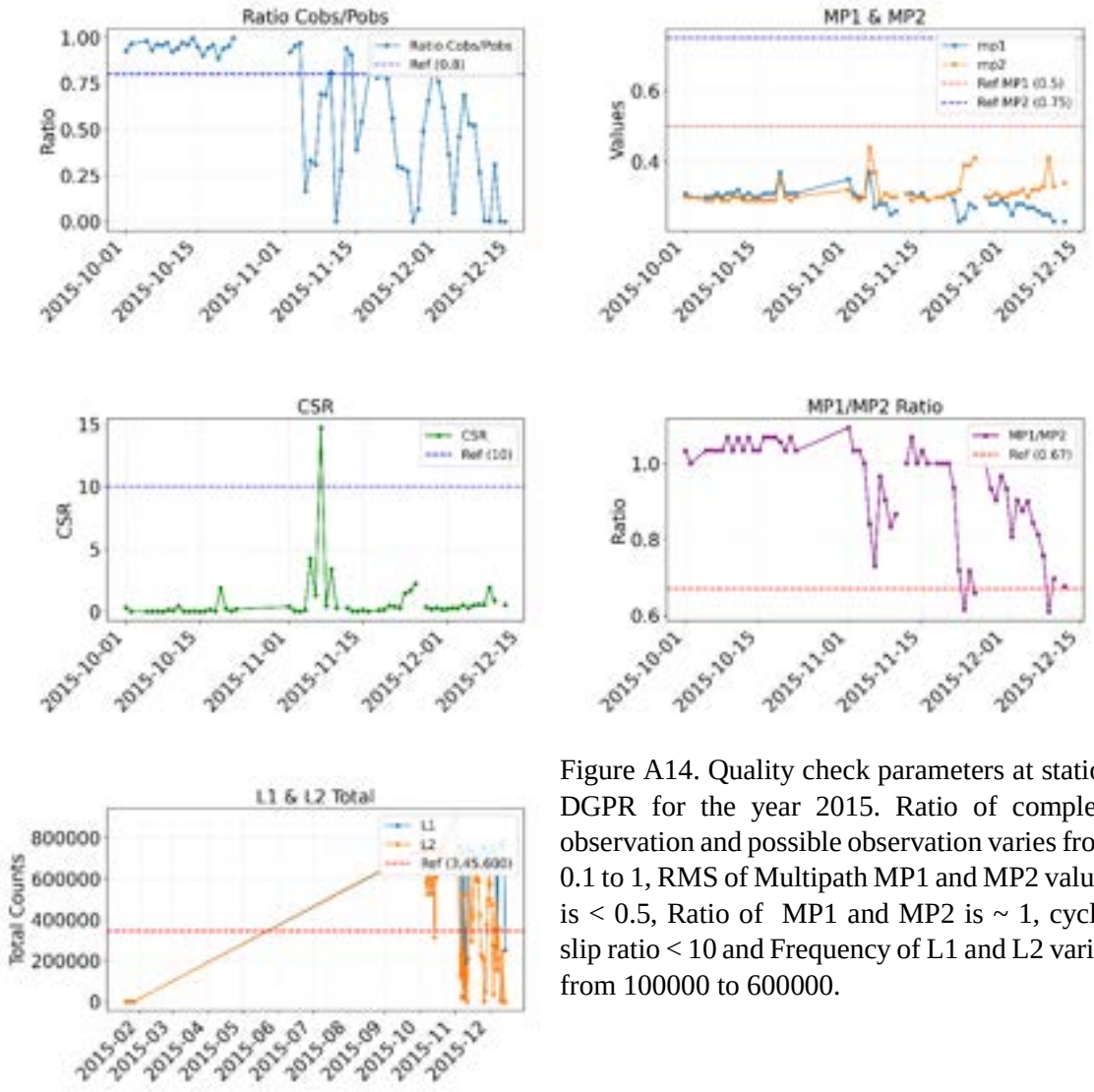


Figure A14. Quality check parameters at station DGPR for the year 2015. Ratio of complete observation and possible observation varies from 0.1 to 1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~ 1, cyclic slip ratio < 10 and Frequency of L1 and L2 varies from 100000 to 600000.

3. MBDR

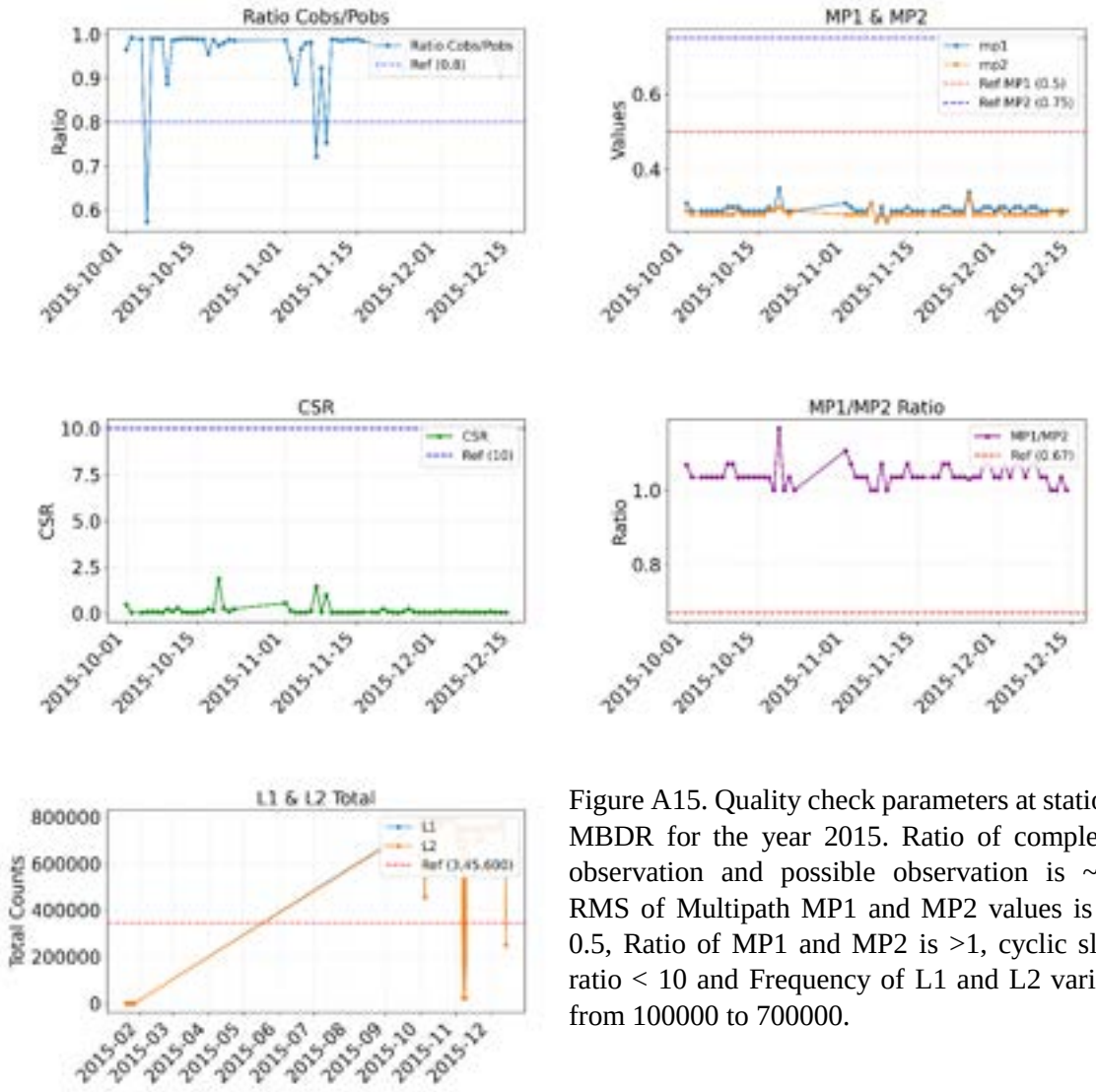


Figure A15. Quality check parameters at station MBDR for the year 2015. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is >1, cyclic slip ratio < 10 and Frequency of L1 and L2 varies from 100000 to 700000.

4. PORT

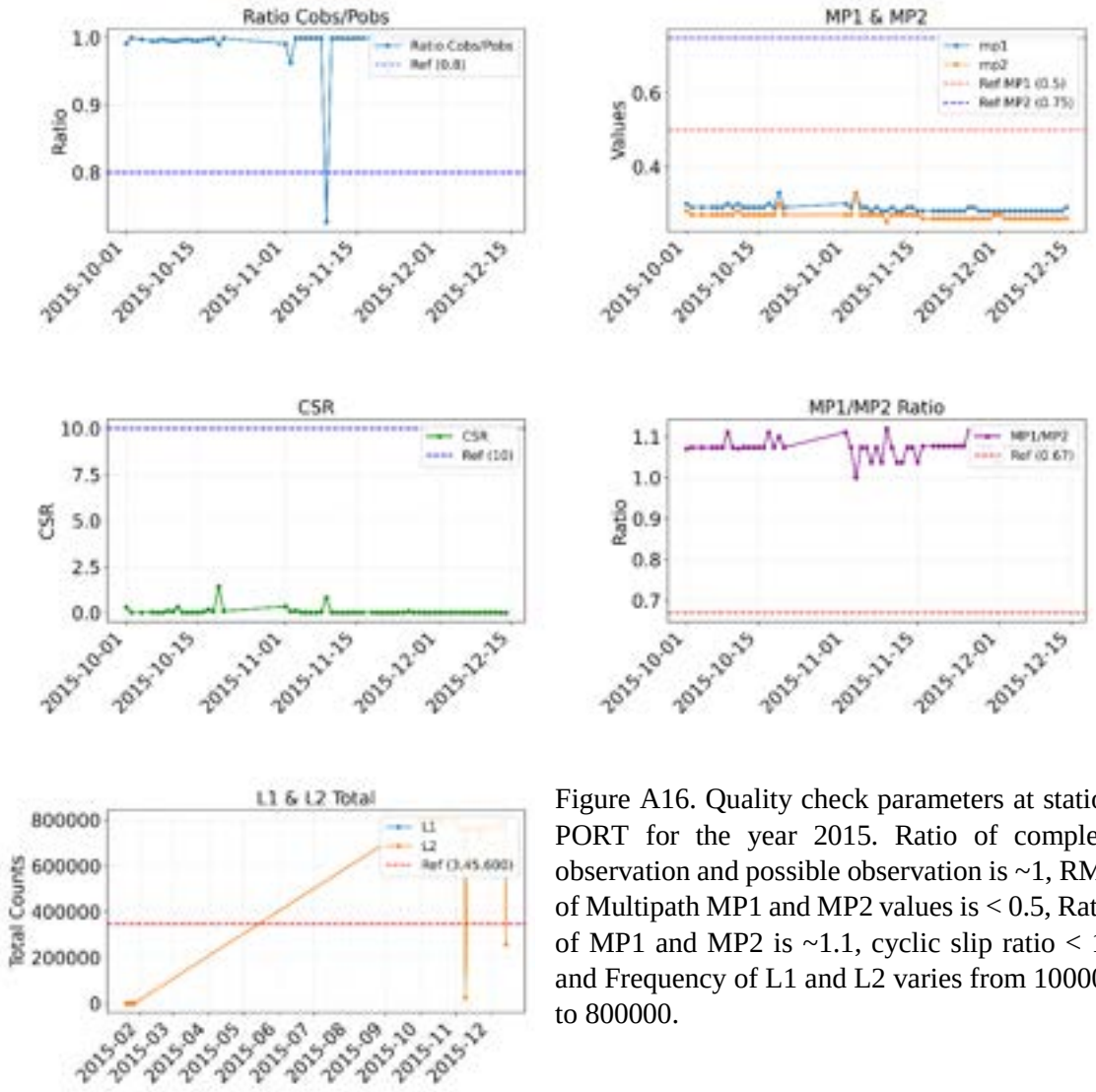


Figure A16. Quality check parameters at station PORT for the year 2015. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~1.1, cyclic slip ratio < 10 and Frequency of L1 and L2 varies from 100000 to 800000.

5. HUTB

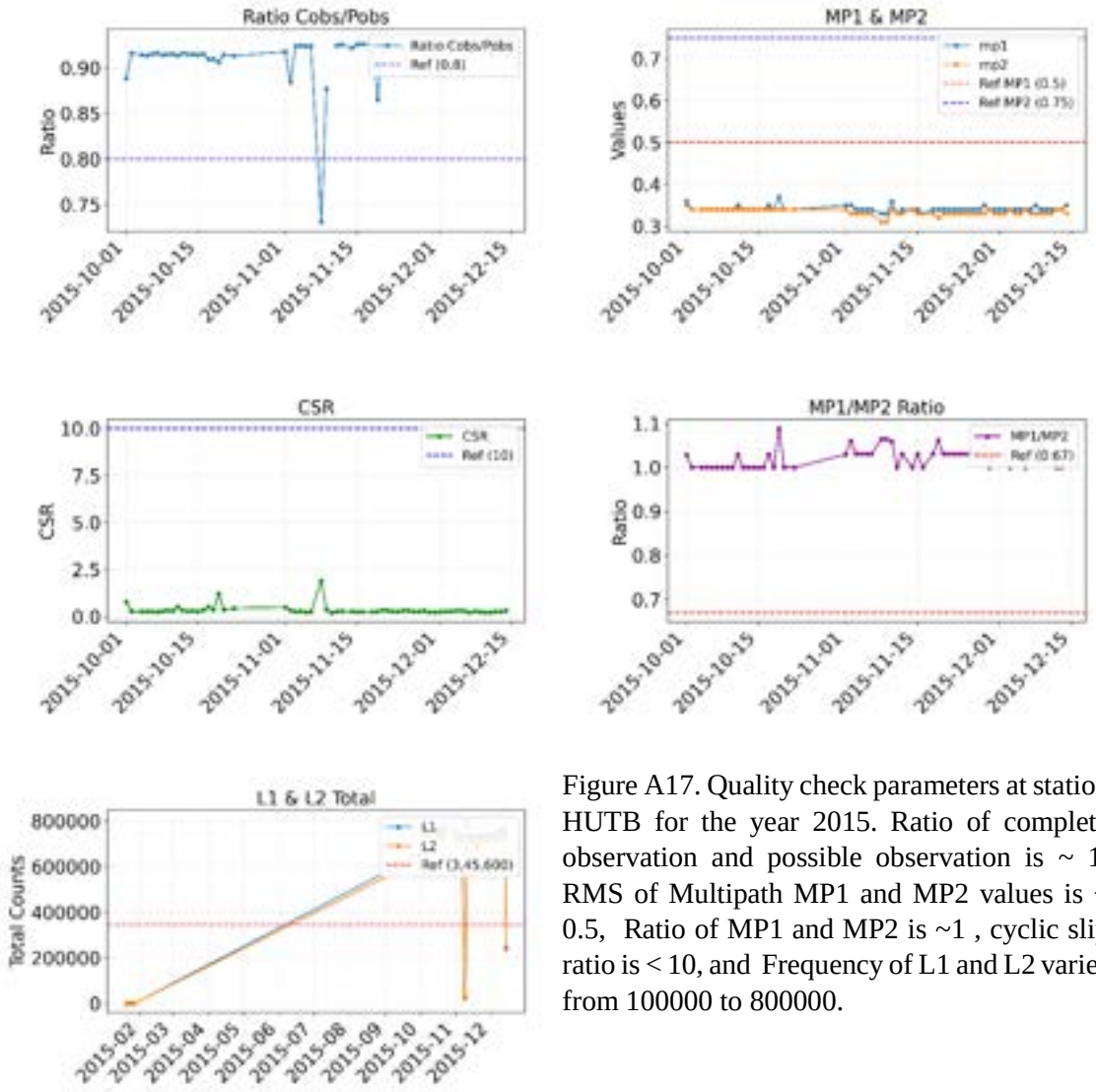


Figure A17. Quality check parameters at station HUTB for the year 2015. Ratio of complete observation and possible observation is ~ 1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~1 , cyclic slip ratio is < 10, and Frequency of L1 and L2 varies from 100000 to 800000.

YEAR 2016

1. CARN

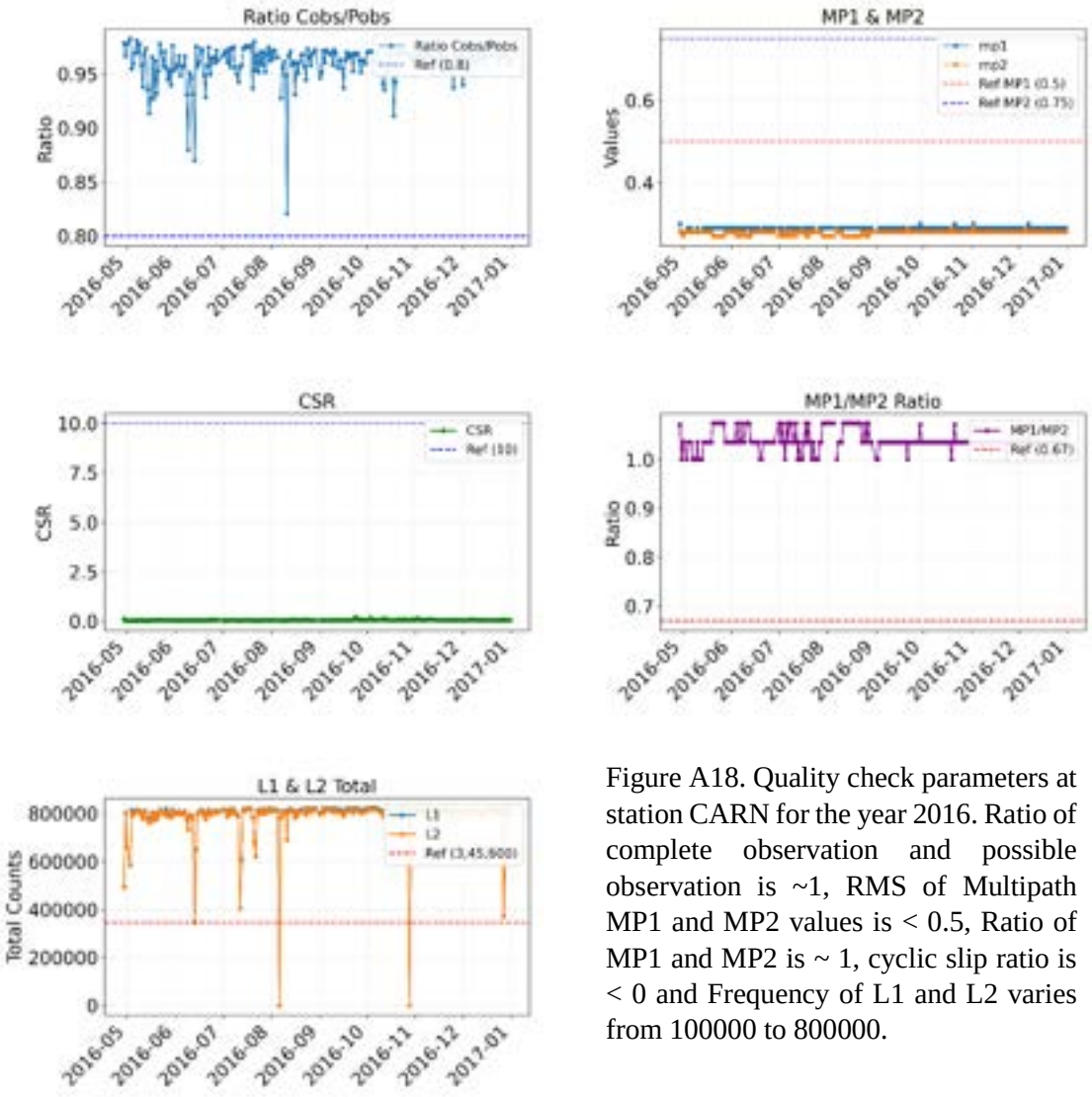


Figure A18. Quality check parameters at station CARN for the year 2016. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~ 1, cyclic slip ratio is < 0 and Frequency of L1 and L2 varies from 100000 to 800000.

2. DGPR

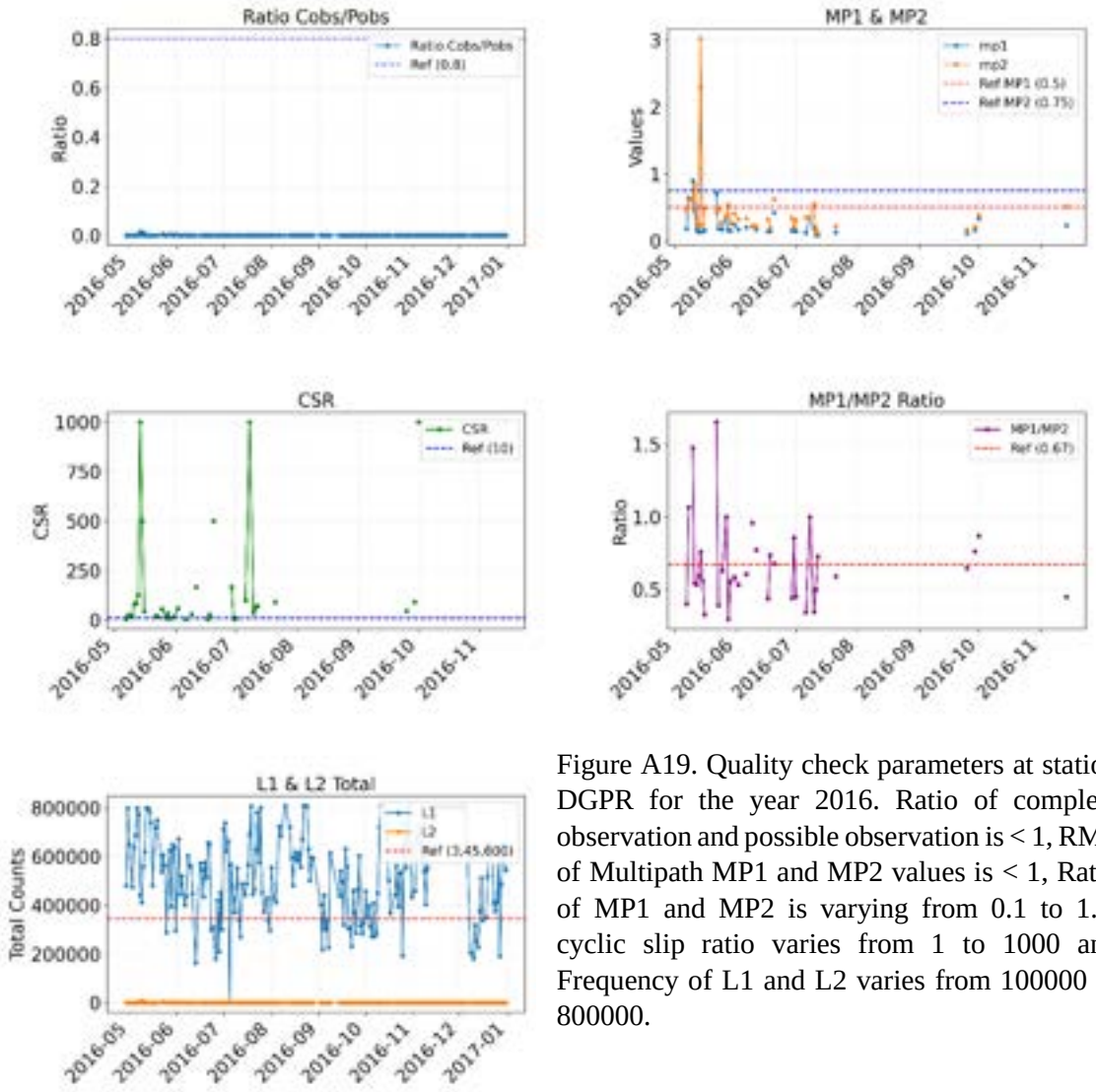


Figure A19. Quality check parameters at station DGPR for the year 2016. Ratio of complete observation and possible observation is < 1, RMS of Multipath MP1 and MP2 values is < 1, Ratio of MP1 and MP2 is varying from 0.1 to 1.5, cyclic slip ratio varies from 1 to 1000 and Frequency of L1 and L2 varies from 100000 to 800000.

3. HUTB

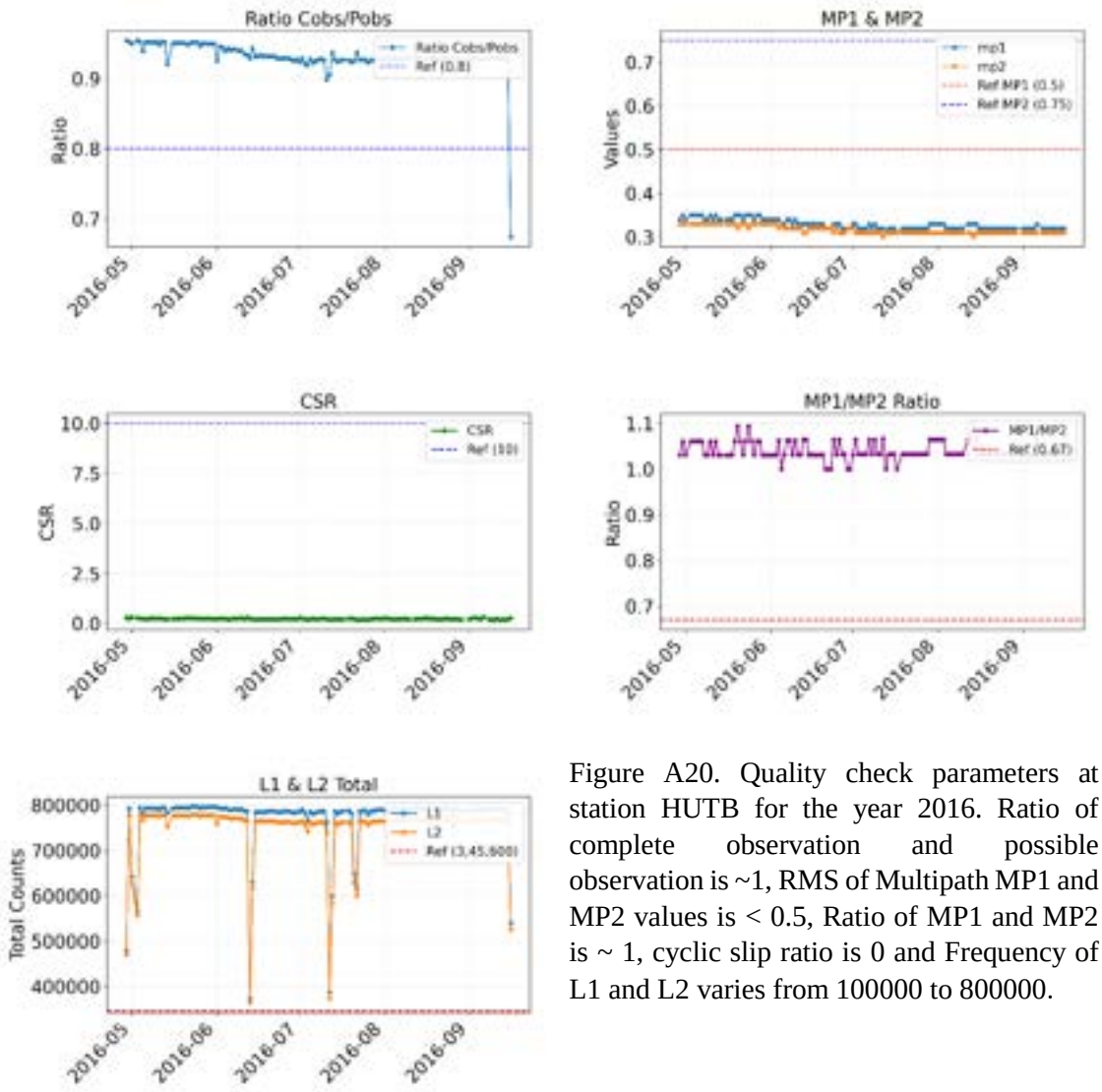


Figure A20. Quality check parameters at station HUTB for the year 2016. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~ 1, cyclic slip ratio is 0 and Frequency of L1 and L2 varies from 100000 to 800000.

4. MBDR

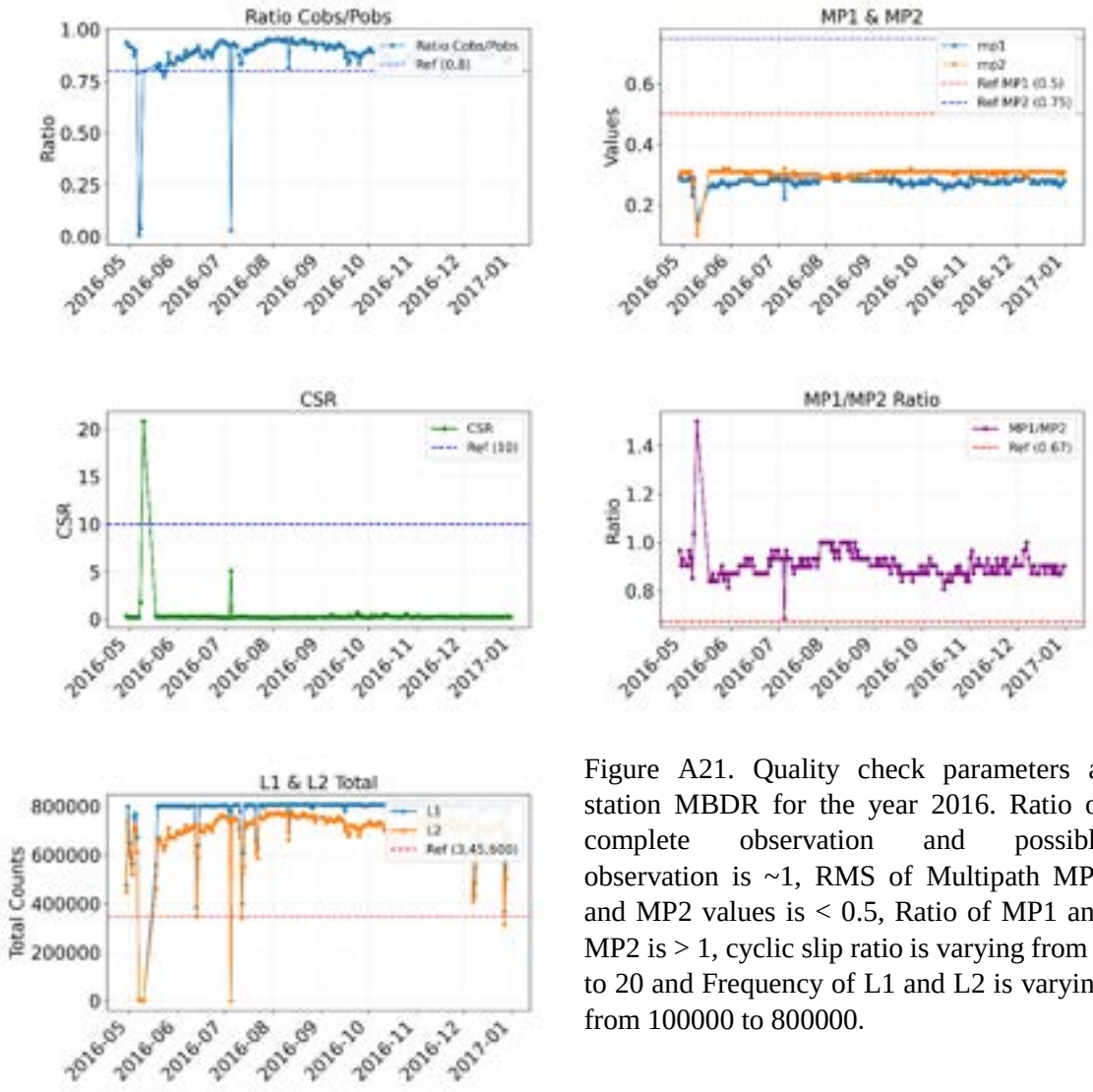


Figure A21. Quality check parameters at station MBDR for the year 2016. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is > 1, cyclic slip ratio is varying from 1 to 20 and Frequency of L1 and L2 is varying from 100000 to 800000.

5. PORT

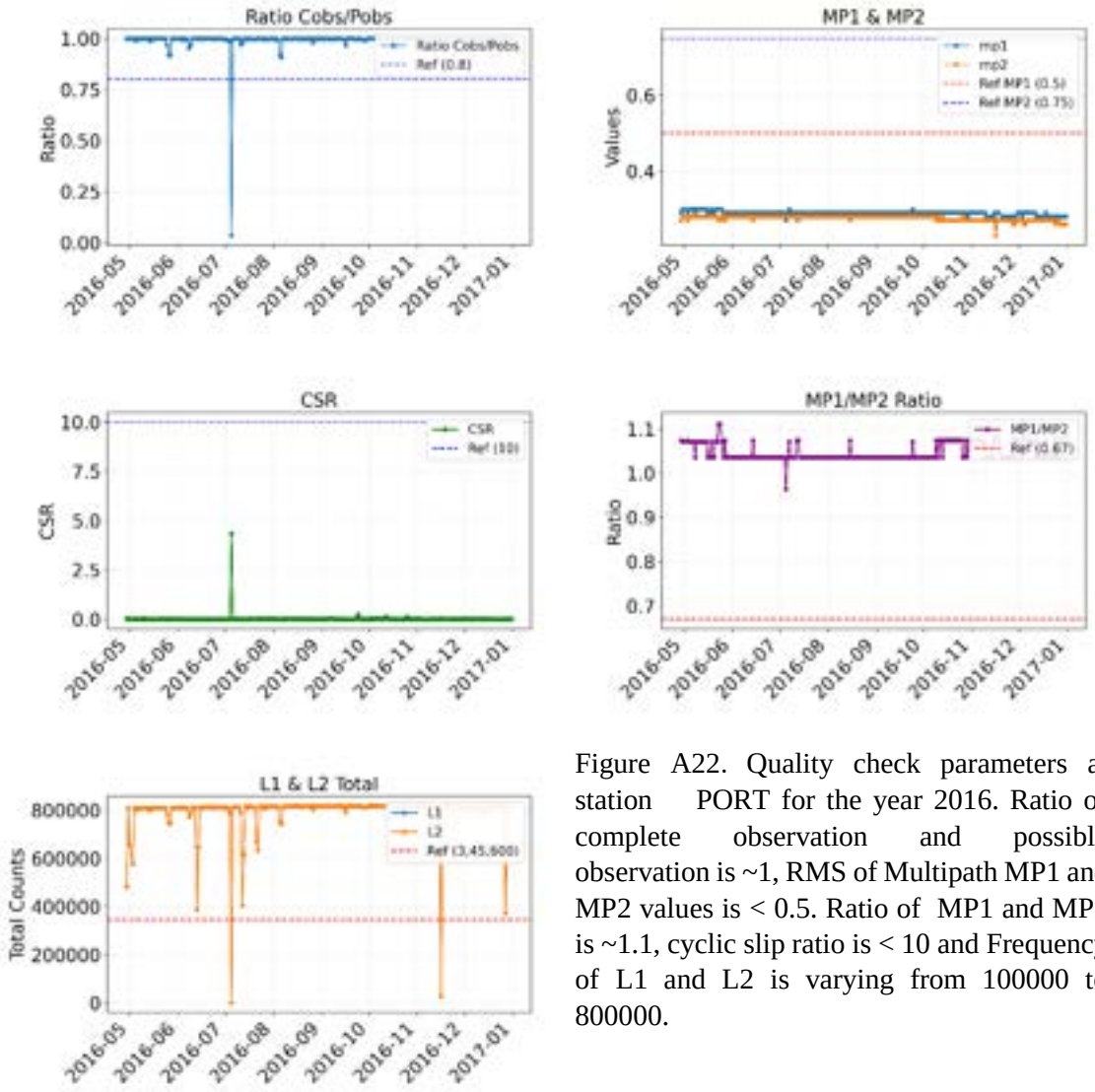


Figure A22. Quality check parameters at station PORT for the year 2016. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5. Ratio of MP1 and MP2 is ~1.1, cyclic slip ratio is < 10 and Frequency of L1 and L2 is varying from 100000 to 800000.

YEAR 2017

1. CARN

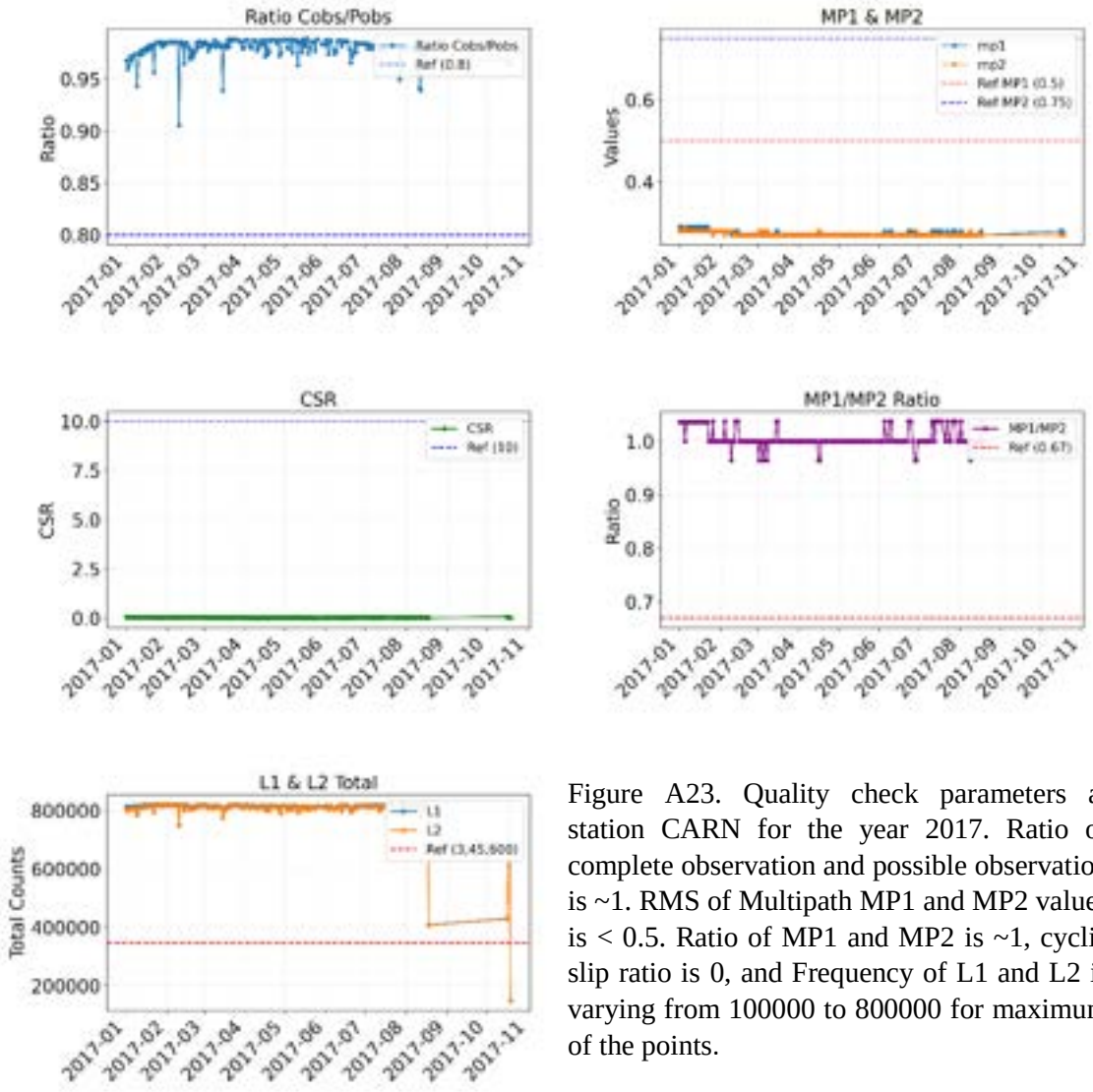


Figure A23. Quality check parameters at station CARN for the year 2017. Ratio of complete observation and possible observation is ~1. RMS of Multipath MP1 and MP2 values is < 0.5. Ratio of MP1 and MP2 is ~1, cyclic slip ratio is 0, and Frequency of L1 and L2 is varying from 100000 to 800000 for maximum of the points.

2. DGPR

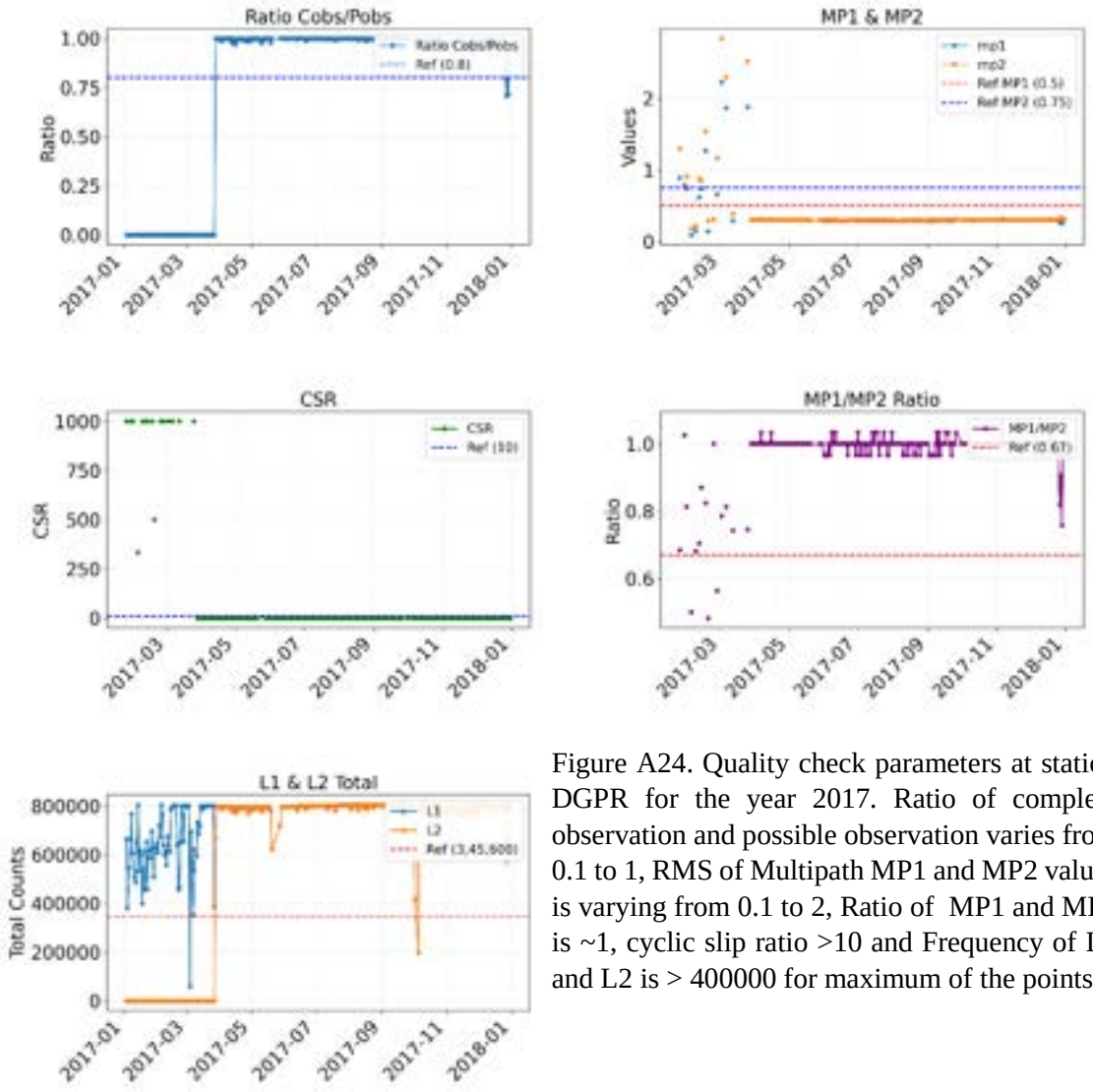


Figure A24. Quality check parameters at station DGPR for the year 2017. Ratio of complete observation and possible observation varies from 0.1 to 1, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 2, Ratio of MP1 and MP2 is ~1, cyclic slip ratio >10 and Frequency of L1 and L2 is > 400000 for maximum of the points.

3. HUTB

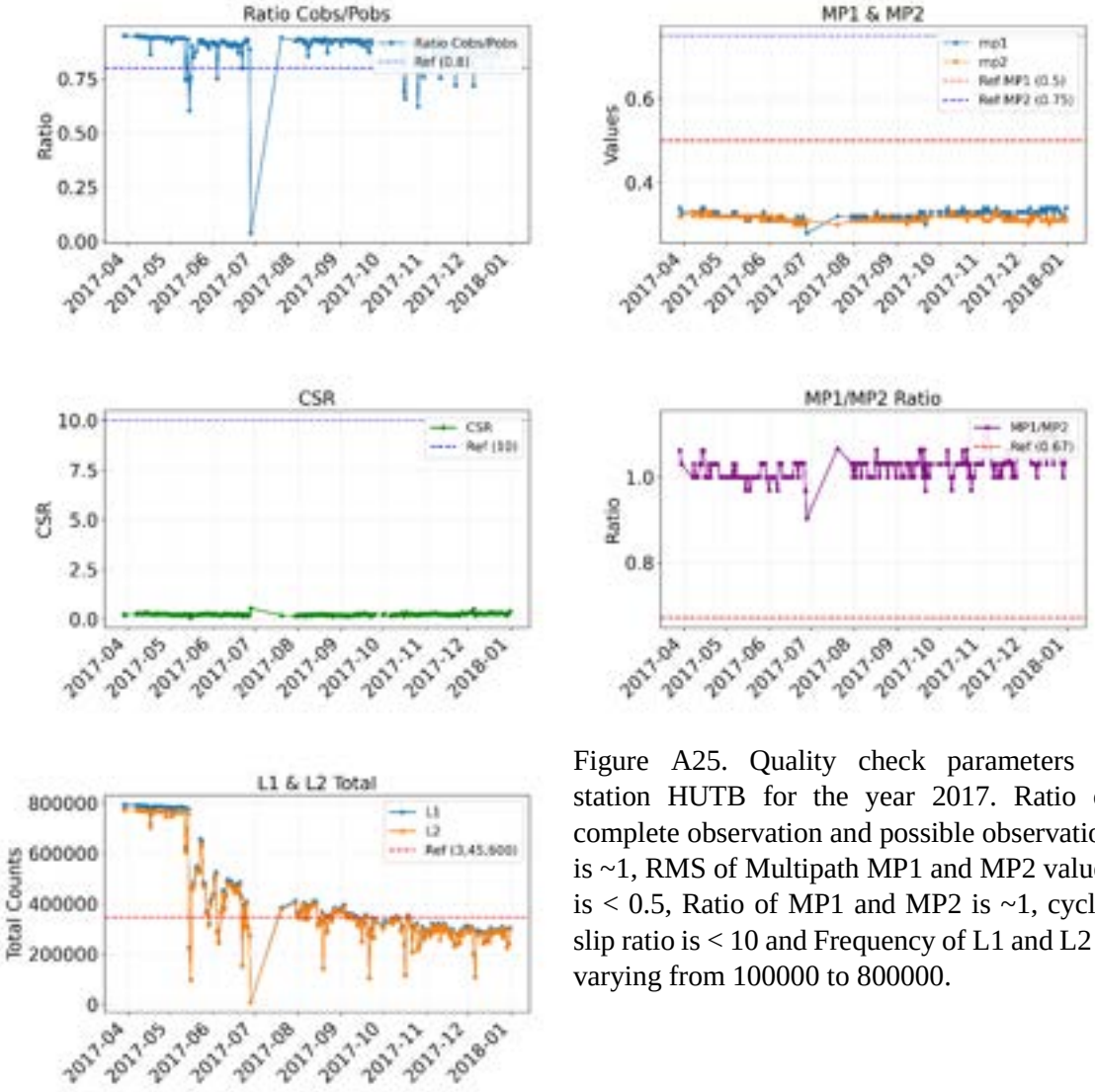


Figure A25. Quality check parameters at station HUTB for the year 2017. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~1, cyclic slip ratio is < 10 and Frequency of L1 and L2 is varying from 100000 to 800000.

4. PORT

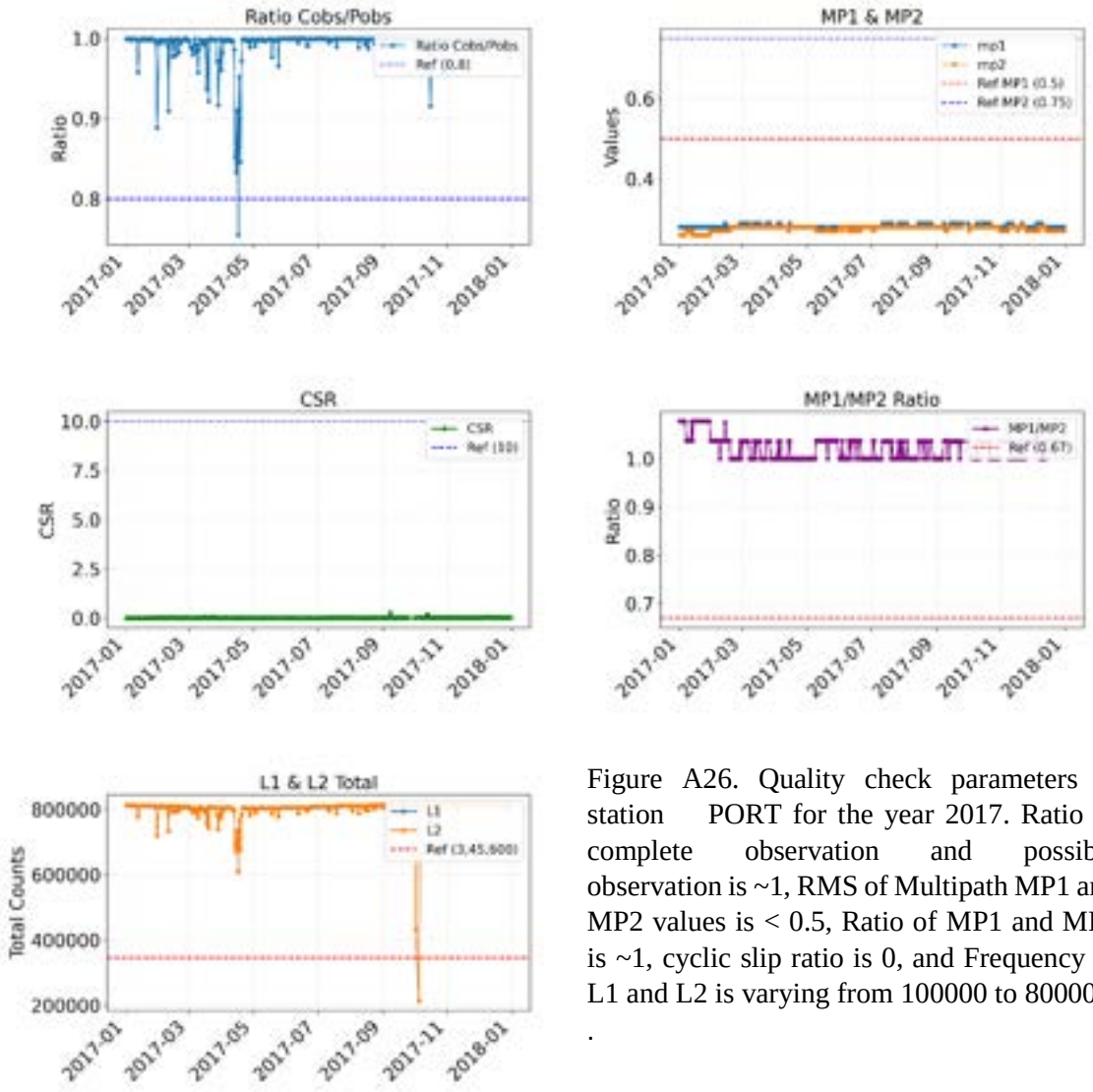


Figure A26. Quality check parameters at station PORT for the year 2017. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is ~1, cyclic slip ratio is 0, and Frequency of L1 and L2 is varying from 100000 to 800000.
.

5. MBDR

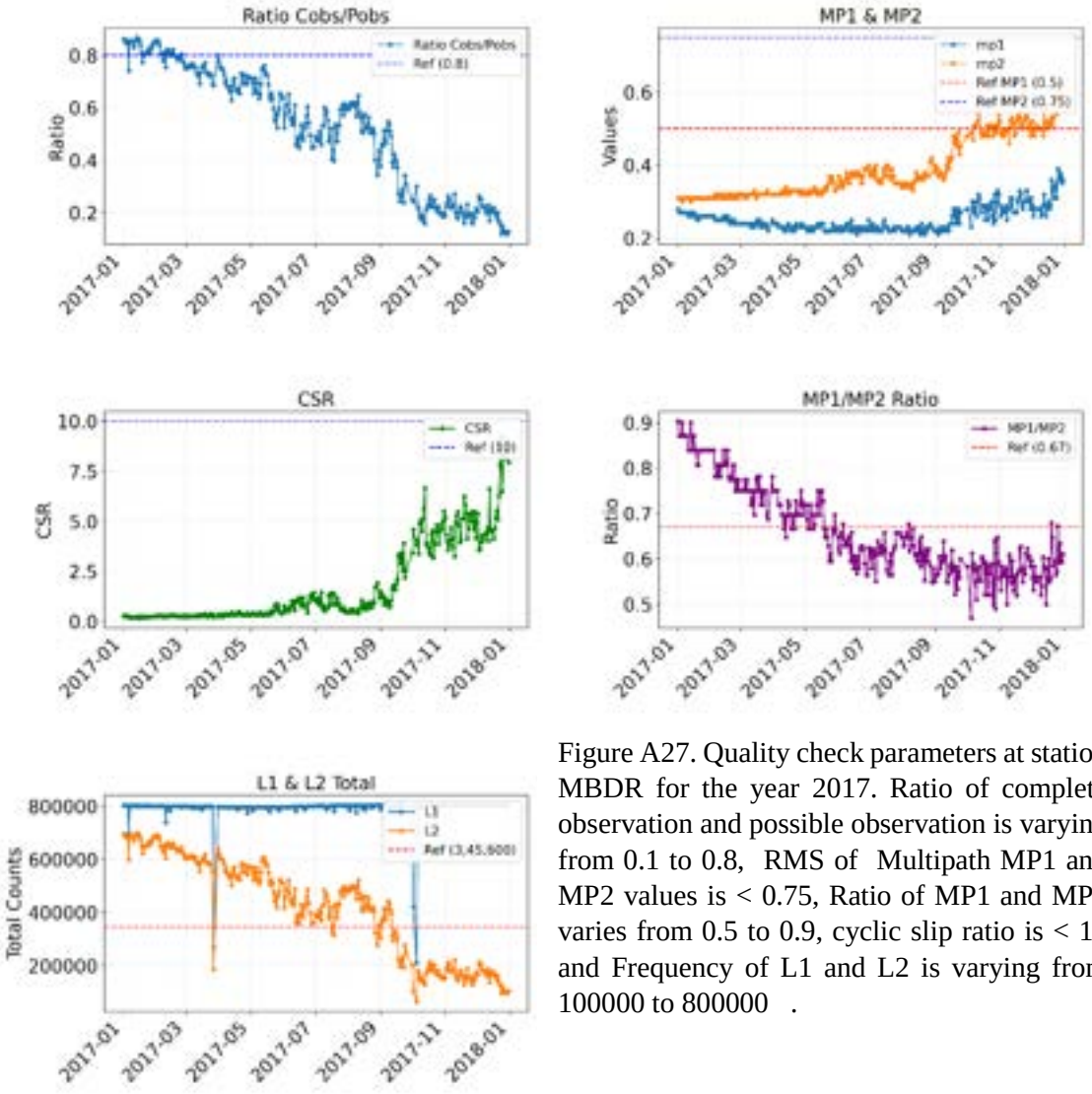


Figure A27. Quality check parameters at station MBDR for the year 2017. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is < 0.75, Ratio of MP1 and MP2 varies from 0.5 to 0.9, cyclic slip ratio is < 10 and Frequency of L1 and L2 is varying from 100000 to 800000 .

YEAR 2018

1. SHOA

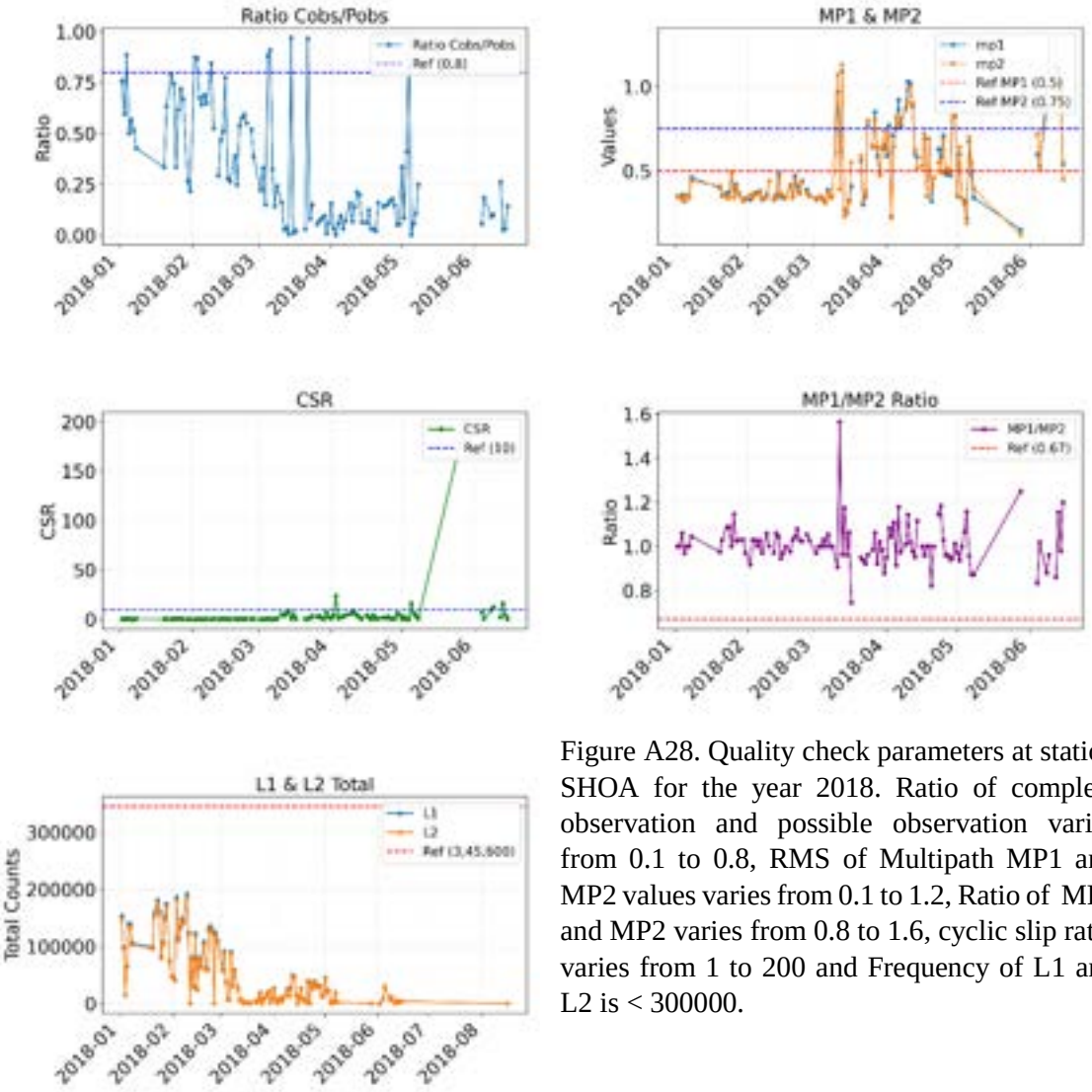


Figure A28. Quality check parameters at station SHOA for the year 2018. Ratio of complete observation and possible observation varies from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.1 to 1.2, Ratio of MP1 and MP2 varies from 0.8 to 1.6, cyclic slip ratio varies from 1 to 200 and Frequency of L1 and L2 is < 300000.

2. PORT

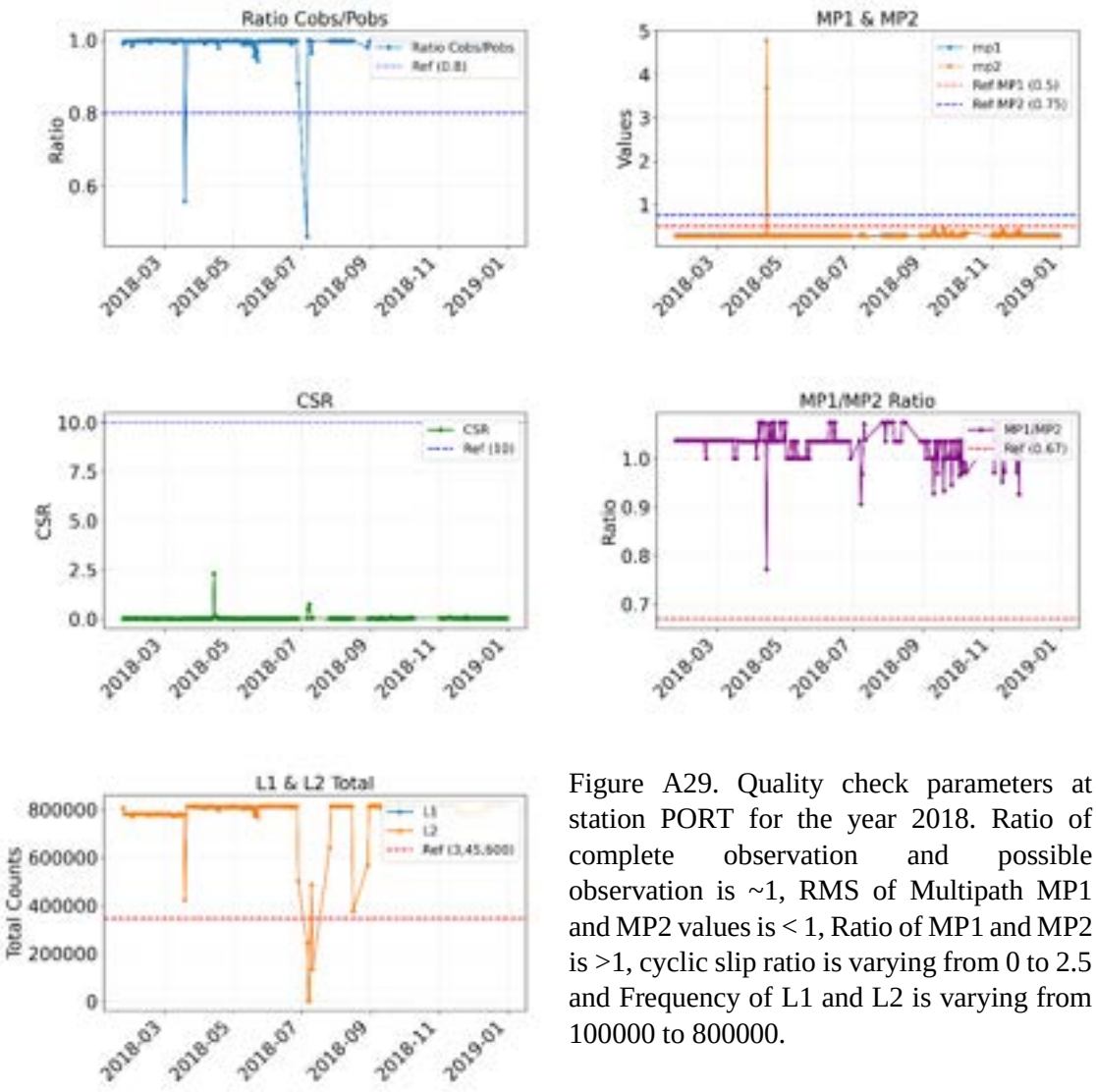


Figure A29. Quality check parameters at station PORT for the year 2018. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values is < 1, Ratio of MP1 and MP2 is >1, cyclic slip ratio is varying from 0 to 2.5 and Frequency of L1 and L2 is varying from 100000 to 800000.

2. RADA

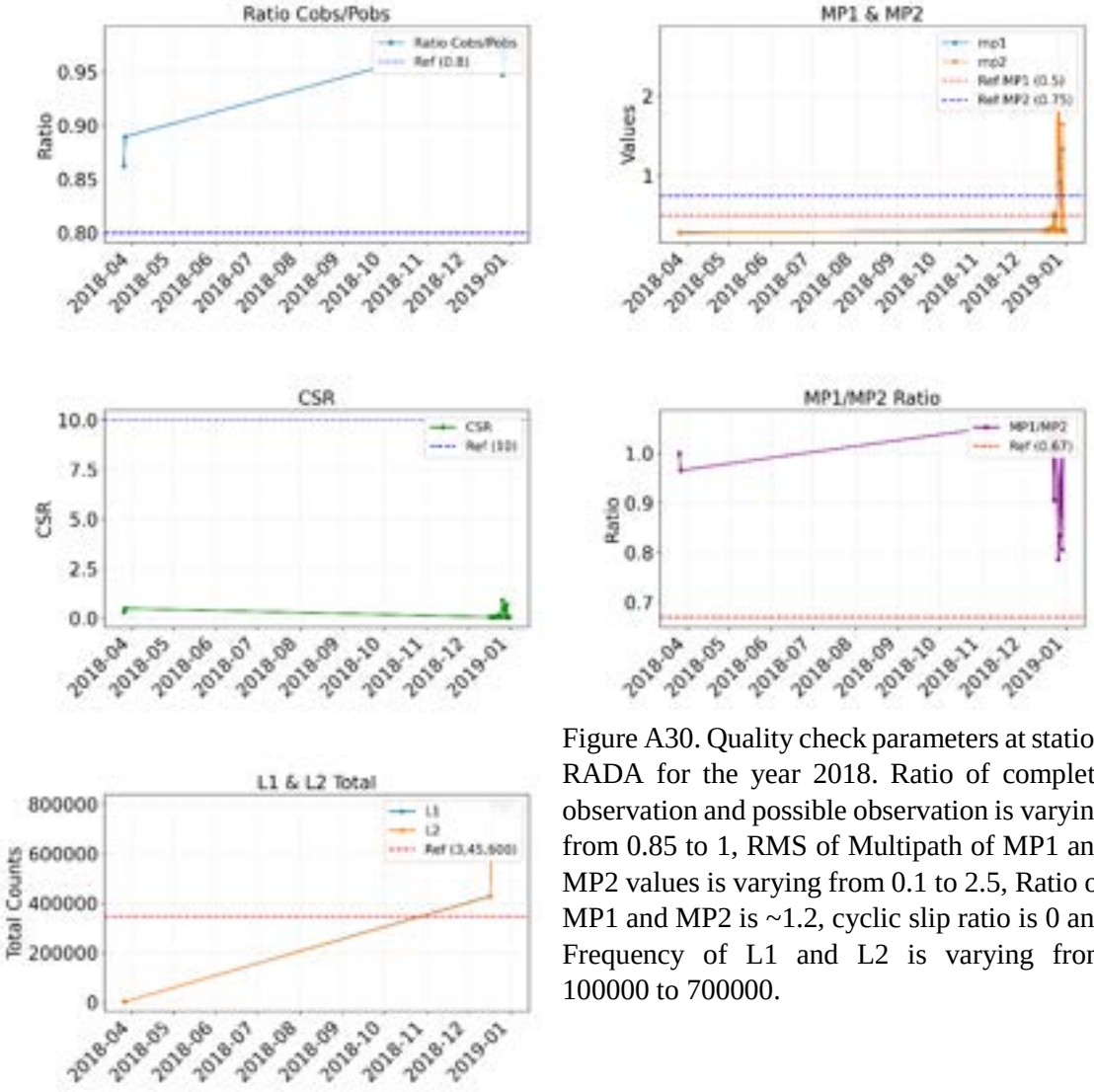


Figure A30. Quality check parameters at station RADA for the year 2018. Ratio of complete observation and possible observation is varying from 0.85 to 1, RMS of Multipath of MP1 and MP2 values is varying from 0.1 to 2.5, Ratio of MP1 and MP2 is ~1.2, cyclic slip ratio is 0 and Frequency of L1 and L2 is varying from 100000 to 700000.

6. RAMN

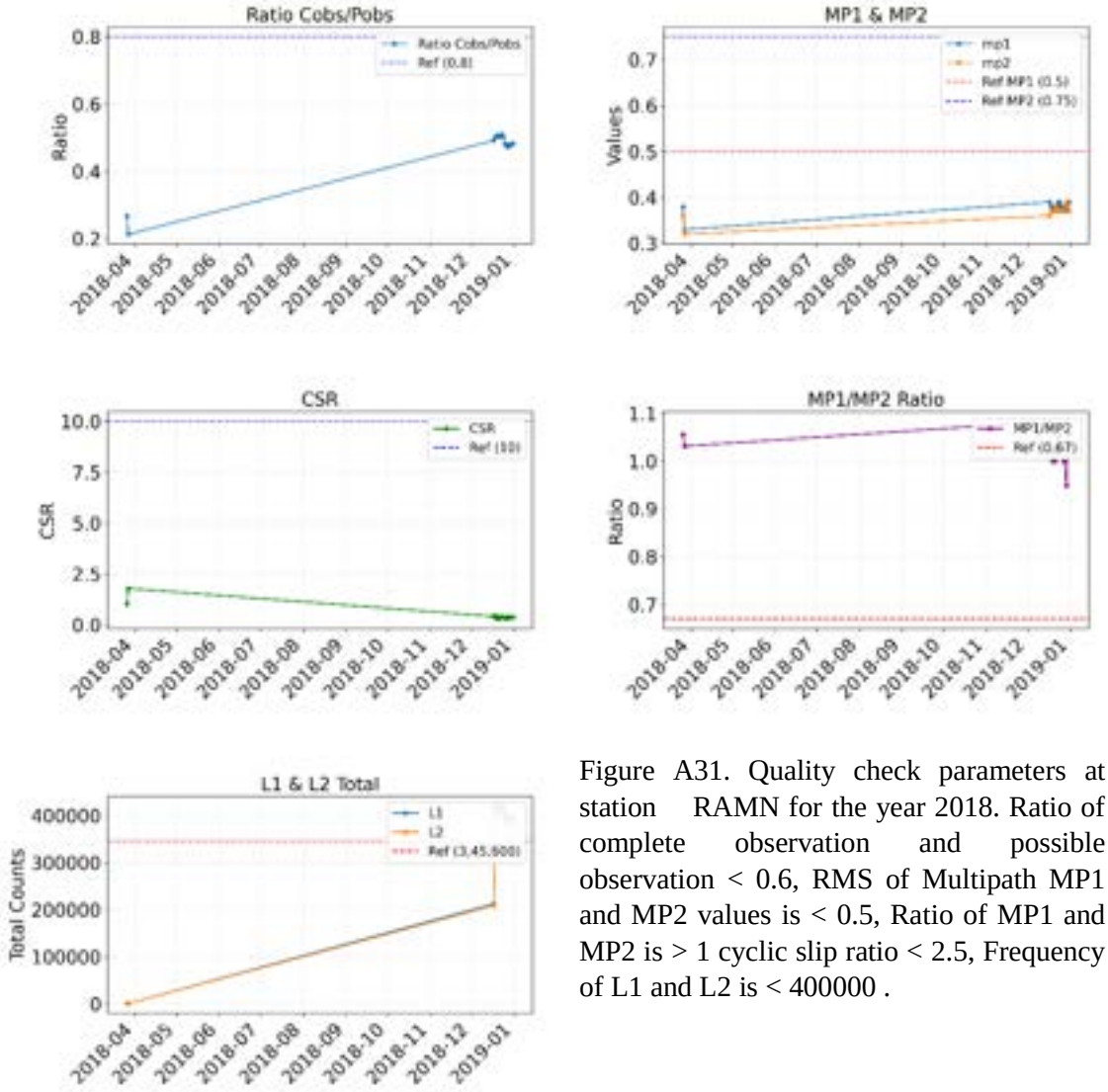


Figure A31. Quality check parameters at station RAMN for the year 2018. Ratio of complete observation and possible observation < 0.6, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is > 1 cyclic slip ratio < 2.5, Frequency of L1 and L2 is < 400000 .

7. SHAS

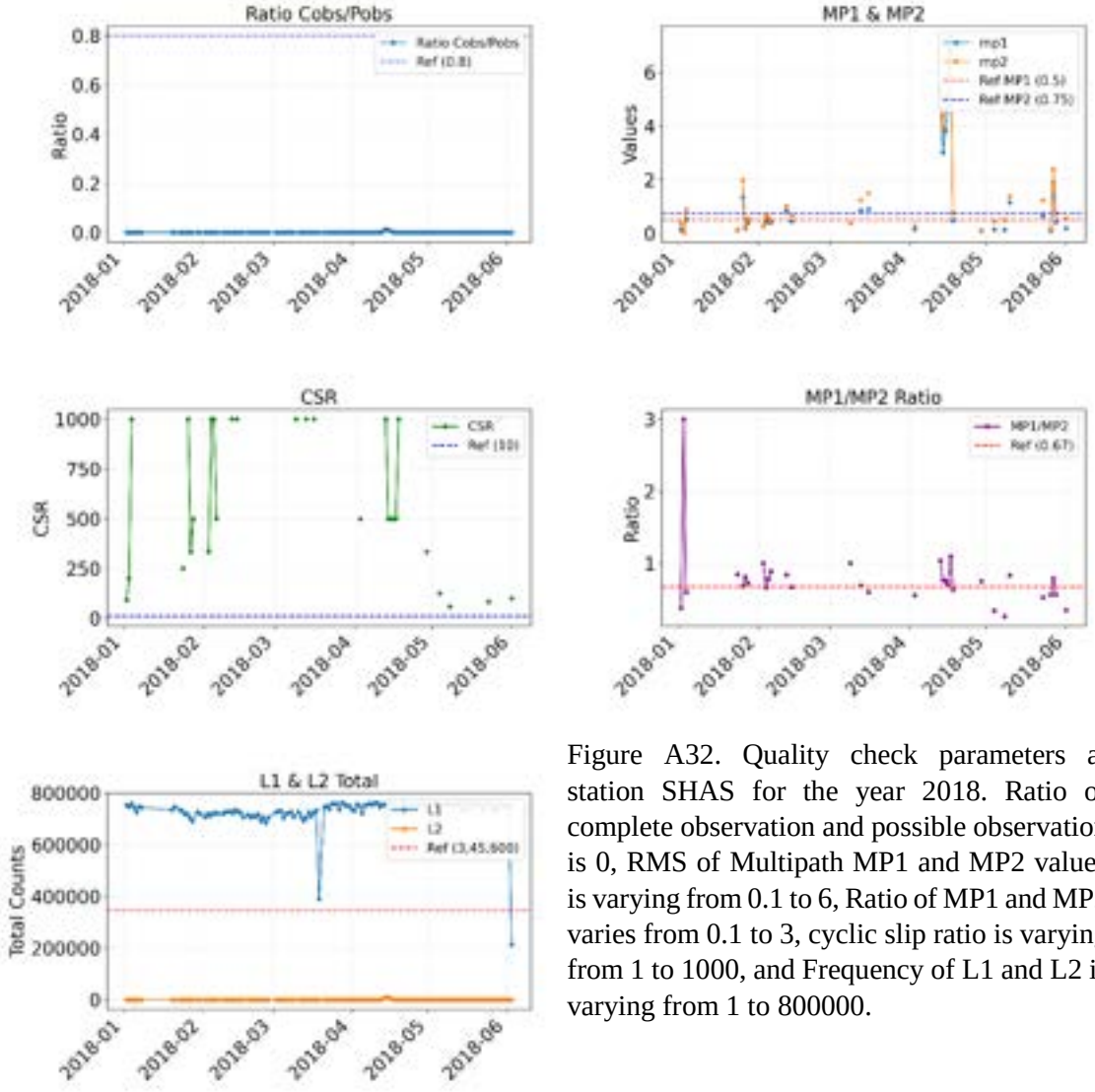


Figure A32. Quality check parameters at station SHAS for the year 2018. Ratio of complete observation and possible observation is 0, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 6, Ratio of MP1 and MP2 varies from 0.1 to 3, cyclic slip ratio is varying from 1 to 1000, and Frequency of L1 and L2 is varying from 1 to 800000.

8. TRIN

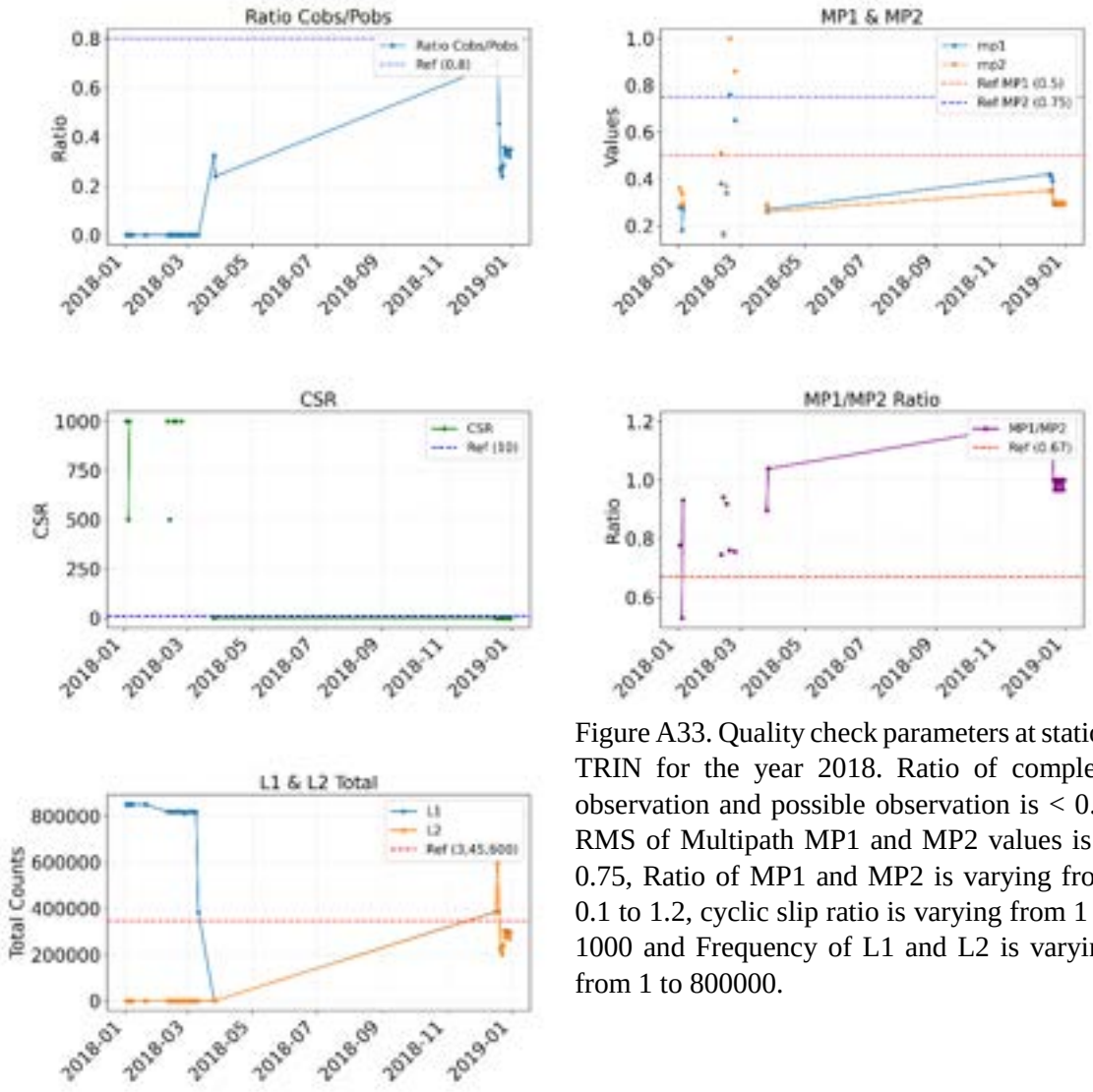


Figure A33. Quality check parameters at station TRIN for the year 2018. Ratio of complete observation and possible observation is < 0.8, RMS of Multipath MP1 and MP2 values is < 0.75, Ratio of MP1 and MP2 is varying from 0.1 to 1.2, cyclic slip ratio is varying from 1 to 1000 and Frequency of L1 and L2 is varying from 1 to 800000.

YEAR 2019

1. MBDR

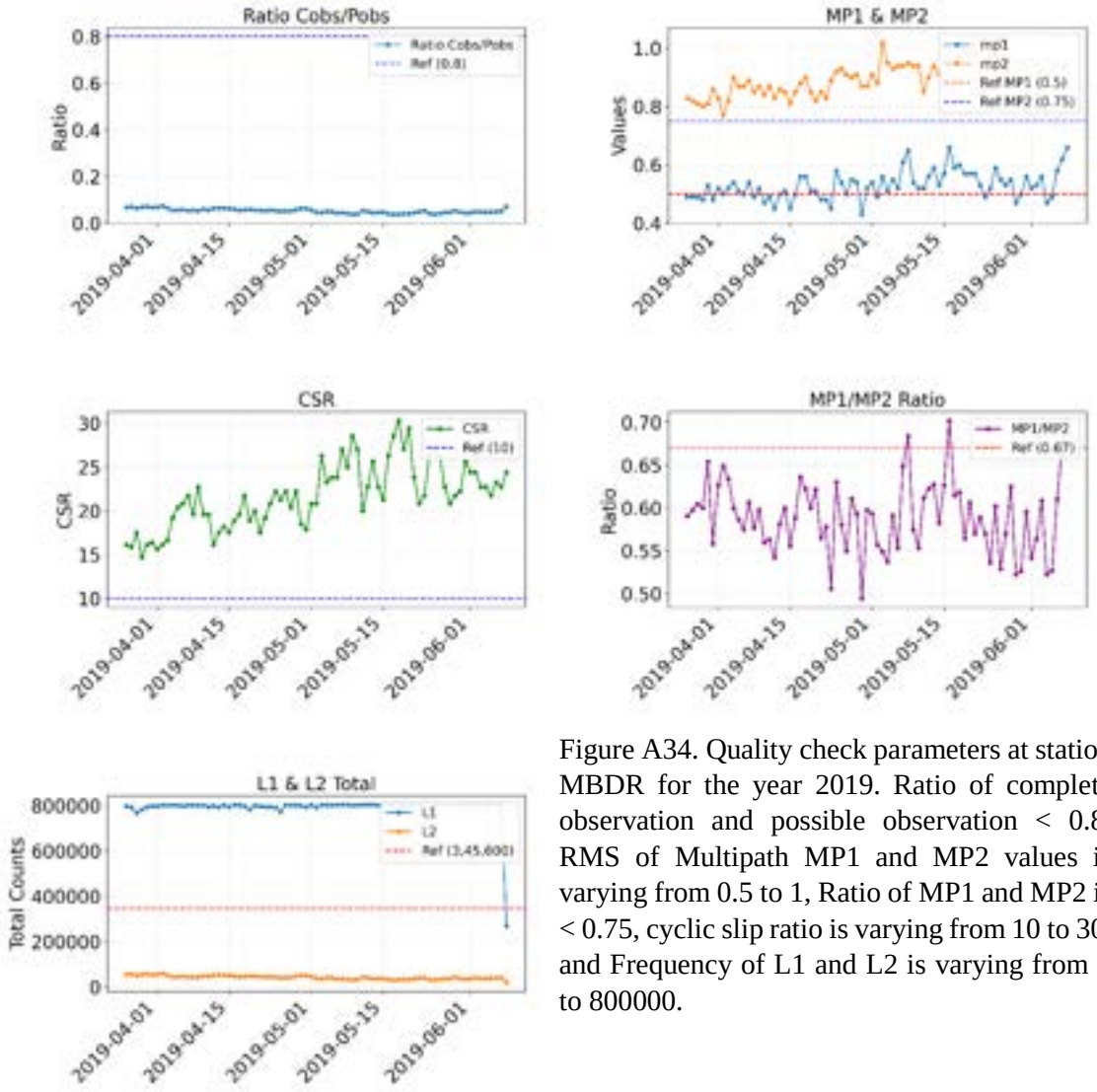


Figure A34. Quality check parameters at station MBDR for the year 2019. Ratio of complete observation and possible observation < 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 1, Ratio of MP1 and MP2 is < 0.75, cyclic slip ratio is varying from 10 to 30, and Frequency of L1 and L2 is varying from 1 to 800000.

2. LONS

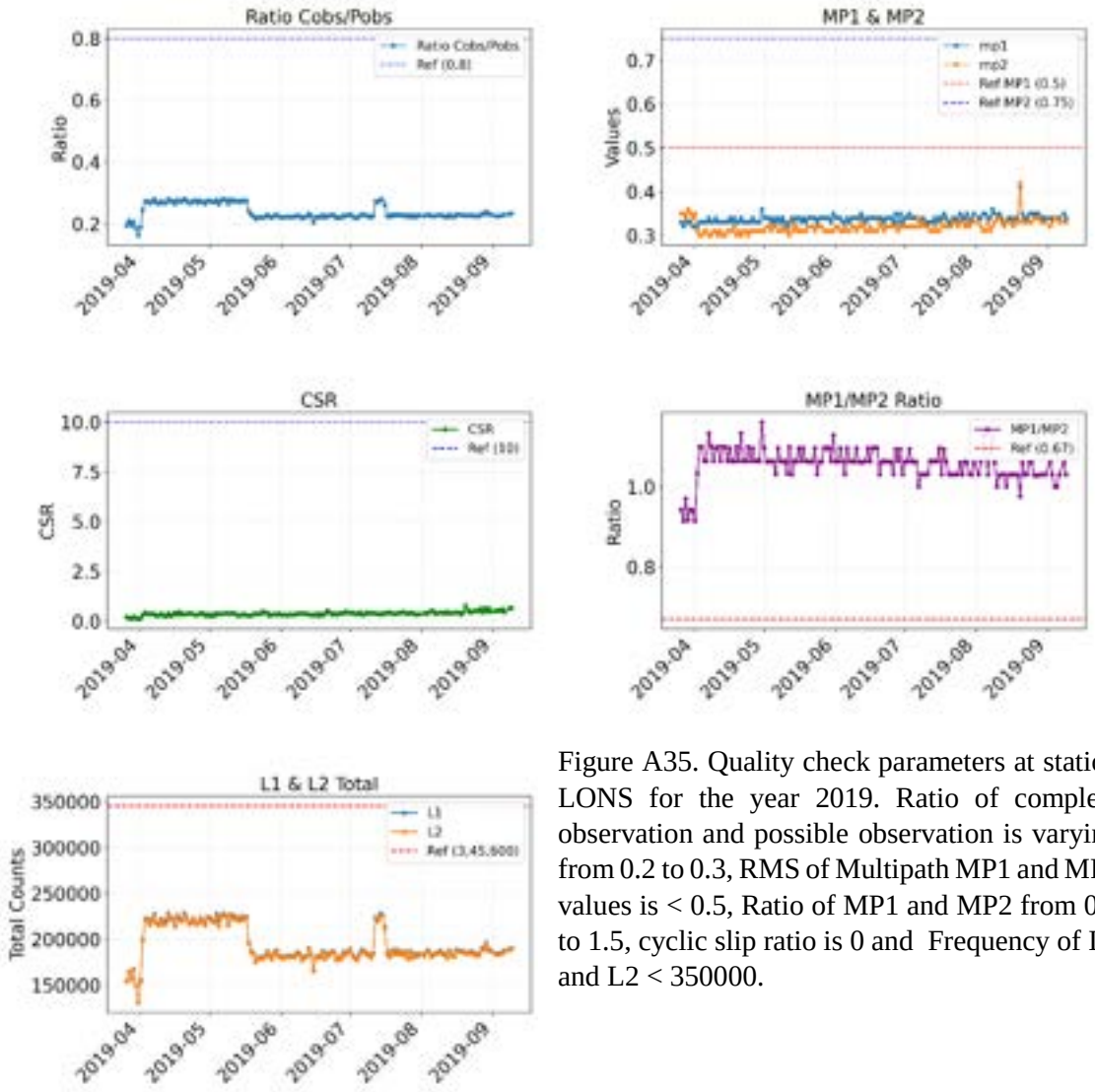


Figure A35. Quality check parameters at station LONS for the year 2019. Ratio of complete observation and possible observation is varying from 0.2 to 0.3, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 from 0.9 to 1.5, cyclic slip ratio is 0 and Frequency of L1 and L2 < 350000.

3.RAMN

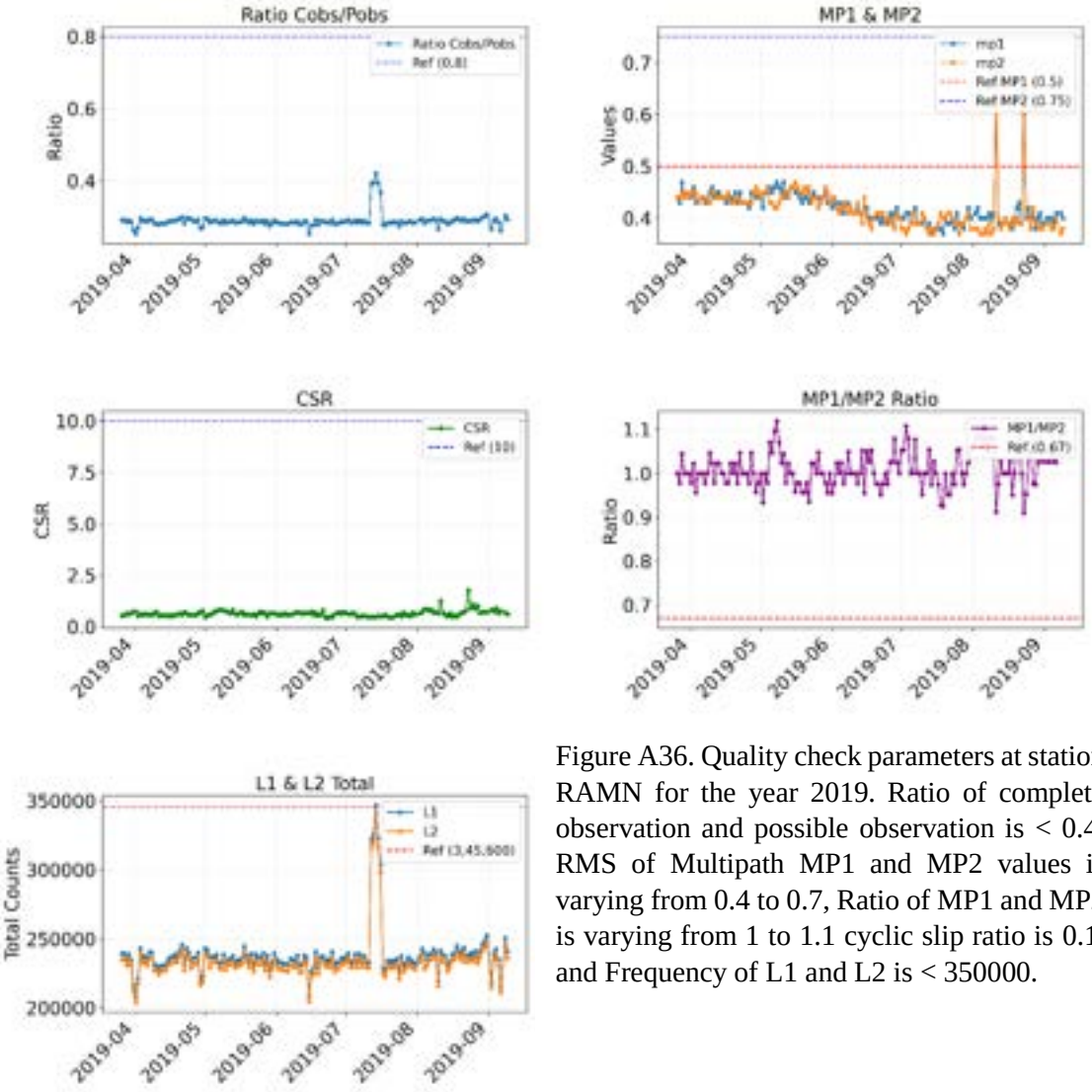


Figure A36. Quality check parameters at station RAMN for the year 2019. Ratio of complete observation and possible observation is < 0.4, RMS of Multipath MP1 and MP2 values is varying from 0.4 to 0.7, Ratio of MP1 and MP2 is varying from 1 to 1.1 cyclic slip ratio is 0.1, and Frequency of L1 and L2 is < 350000.

9. TRIN

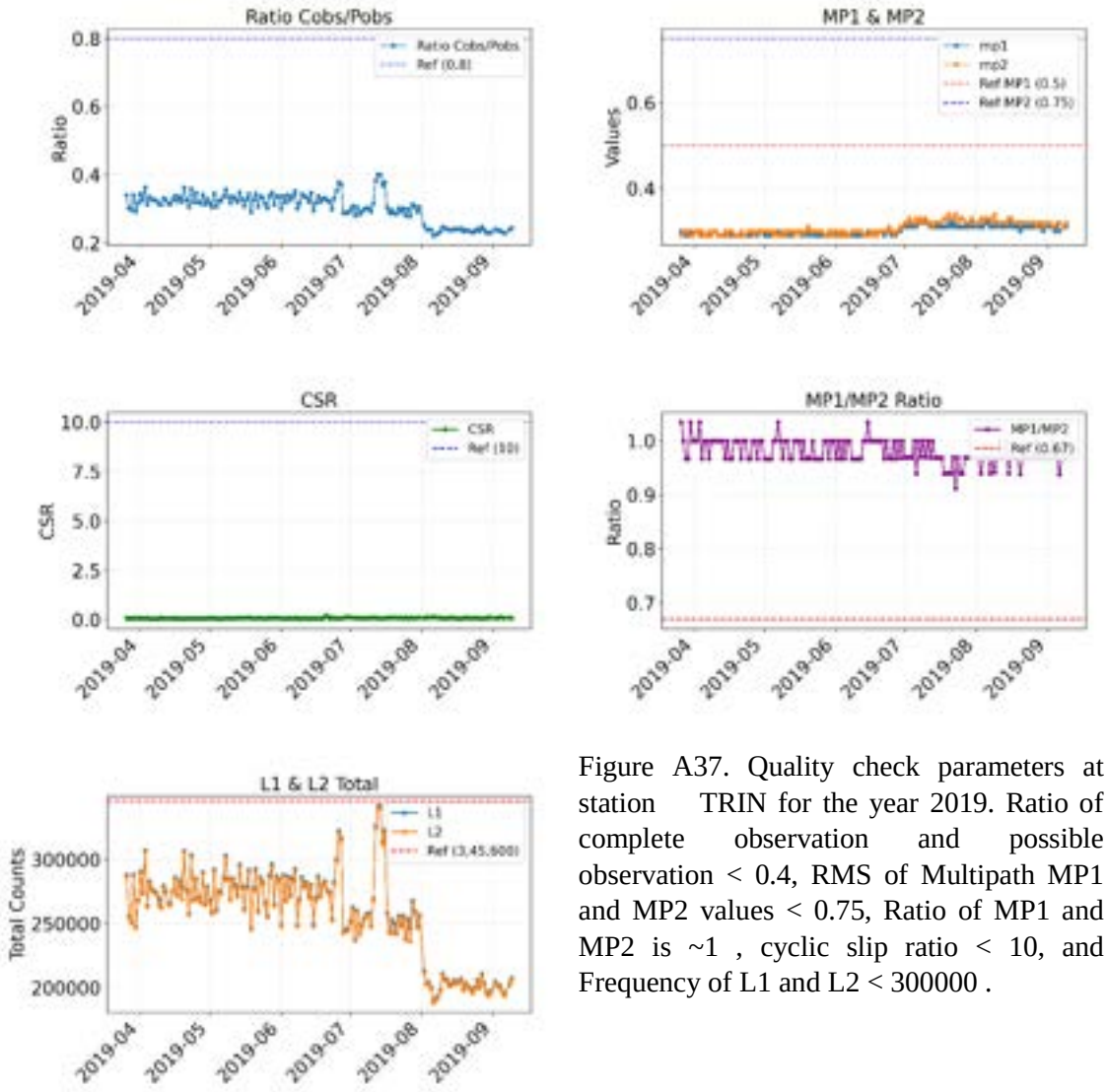


Figure A37. Quality check parameters at station TRIN for the year 2019. Ratio of complete observation and possible observation < 0.4, RMS of Multipath MP1 and MP2 values < 0.75, Ratio of MP1 and MP2 is ~1 , cyclic slip ratio < 10, and Frequency of L1 and L2 < 300000 .

10. ALUR

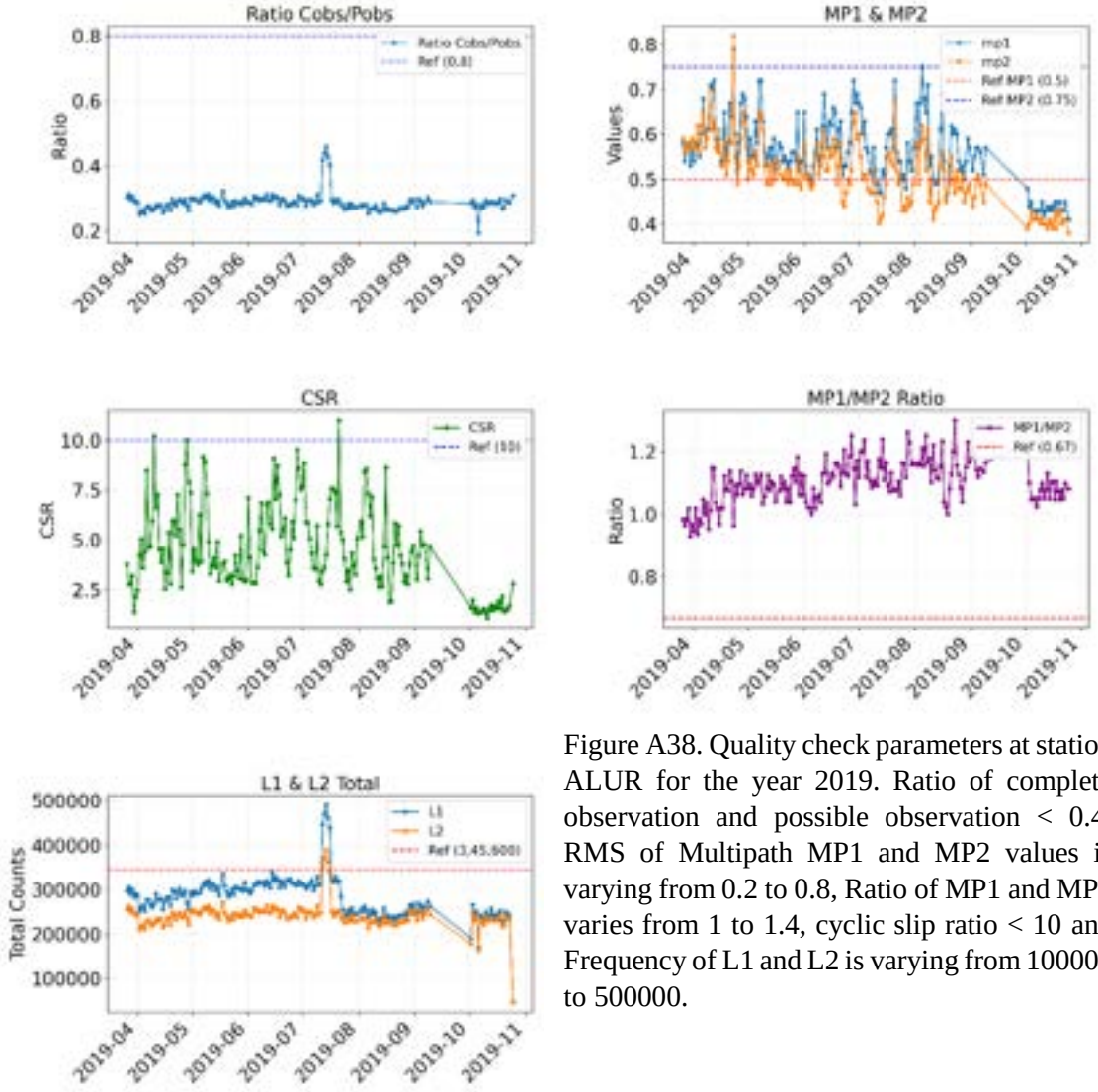


Figure A38. Quality check parameters at station ALUR for the year 2019. Ratio of complete observation and possible observation < 0.4, RMS of Multipath MP1 and MP2 values is varying from 0.2 to 0.8, Ratio of MP1 and MP2 varies from 1 to 1.4, cyclic slip ratio < 10 and Frequency of L1 and L2 is varying from 100000 to 500000.

11. CARN

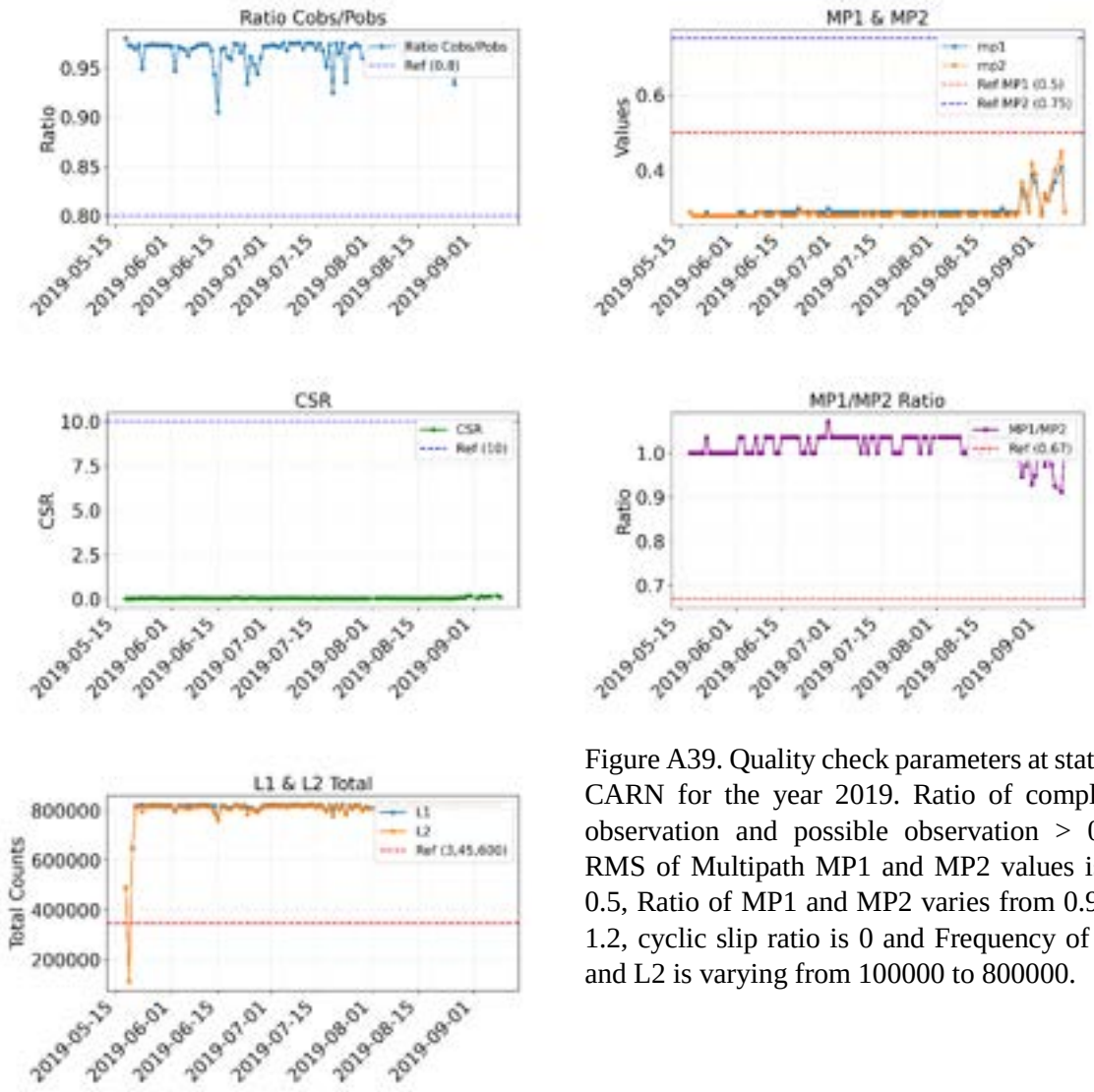


Figure A39. Quality check parameters at station CARN for the year 2019. Ratio of complete observation and possible observation > 0.9, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 varies from 0.9 to 1.2, cyclic slip ratio is 0 and Frequency of L1 and L2 is varying from 100000 to 800000.

12. CHID:

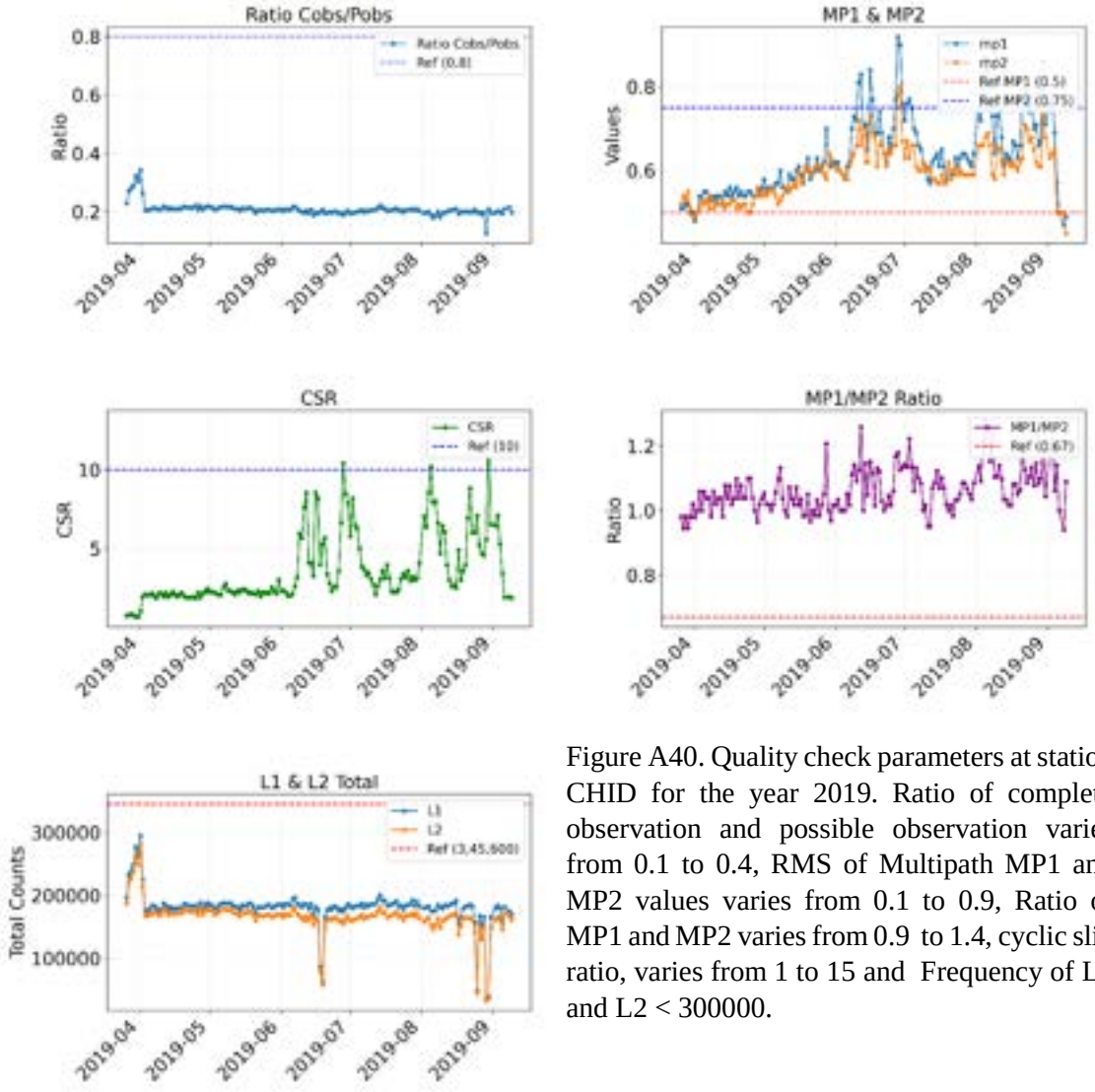


Figure A40. Quality check parameters at station CHID for the year 2019. Ratio of complete observation and possible observation varies from 0.1 to 0.4, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.9, Ratio of MP1 and MP2 varies from 0.9 to 1.4, cyclic slip ratio, varies from 1 to 15 and Frequency of L1 and L2 < 300000.

13. CHUK

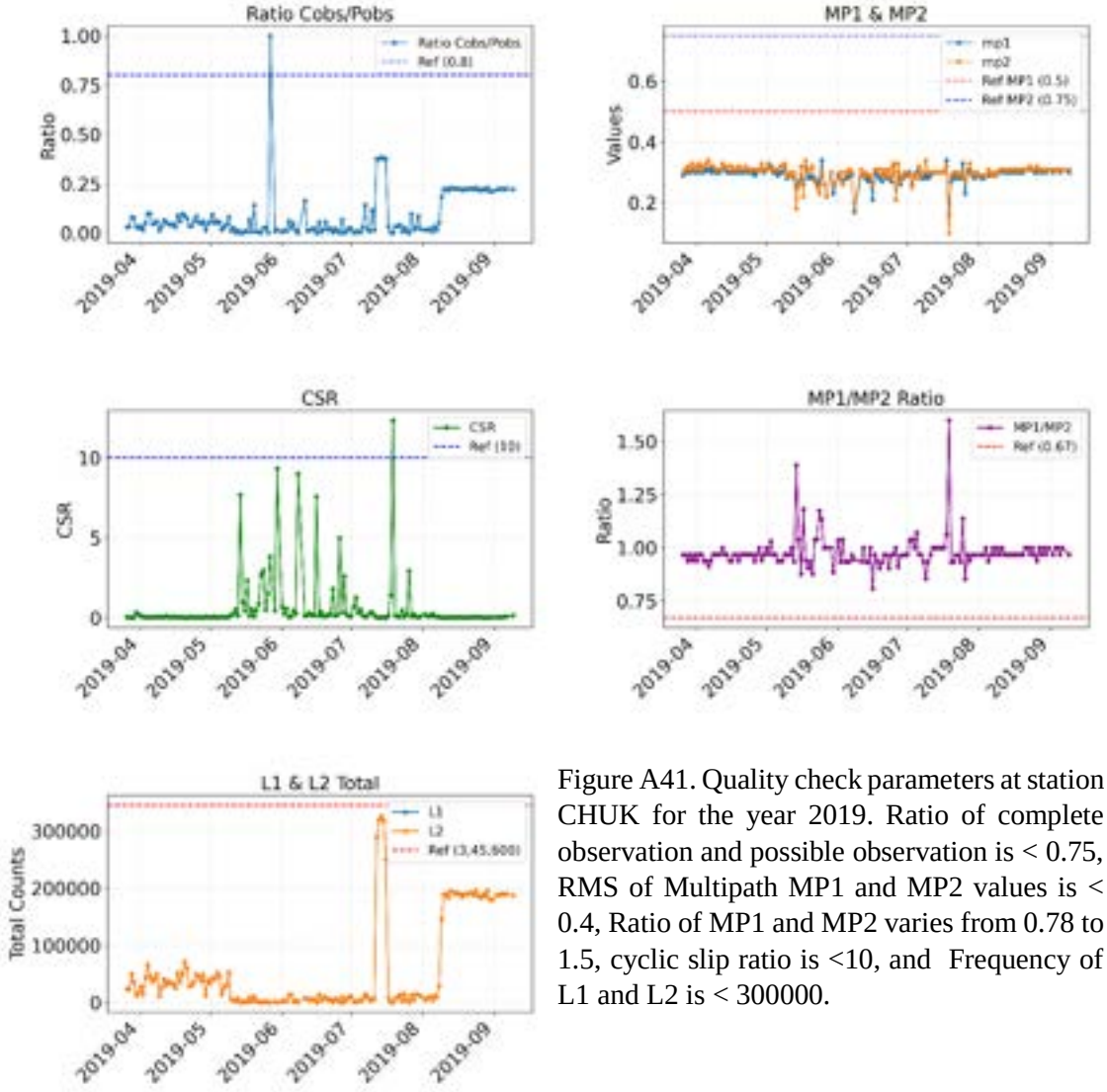


Figure A41. Quality check parameters at station CHUK for the year 2019. Ratio of complete observation and possible observation is < 0.75, RMS of Multipath MP1 and MP2 values is < 0.4, Ratio of MP1 and MP2 varies from 0.78 to 1.5, cyclic slip ratio is <10, and Frequency of L1 and L2 is < 300000.

14. CWRA

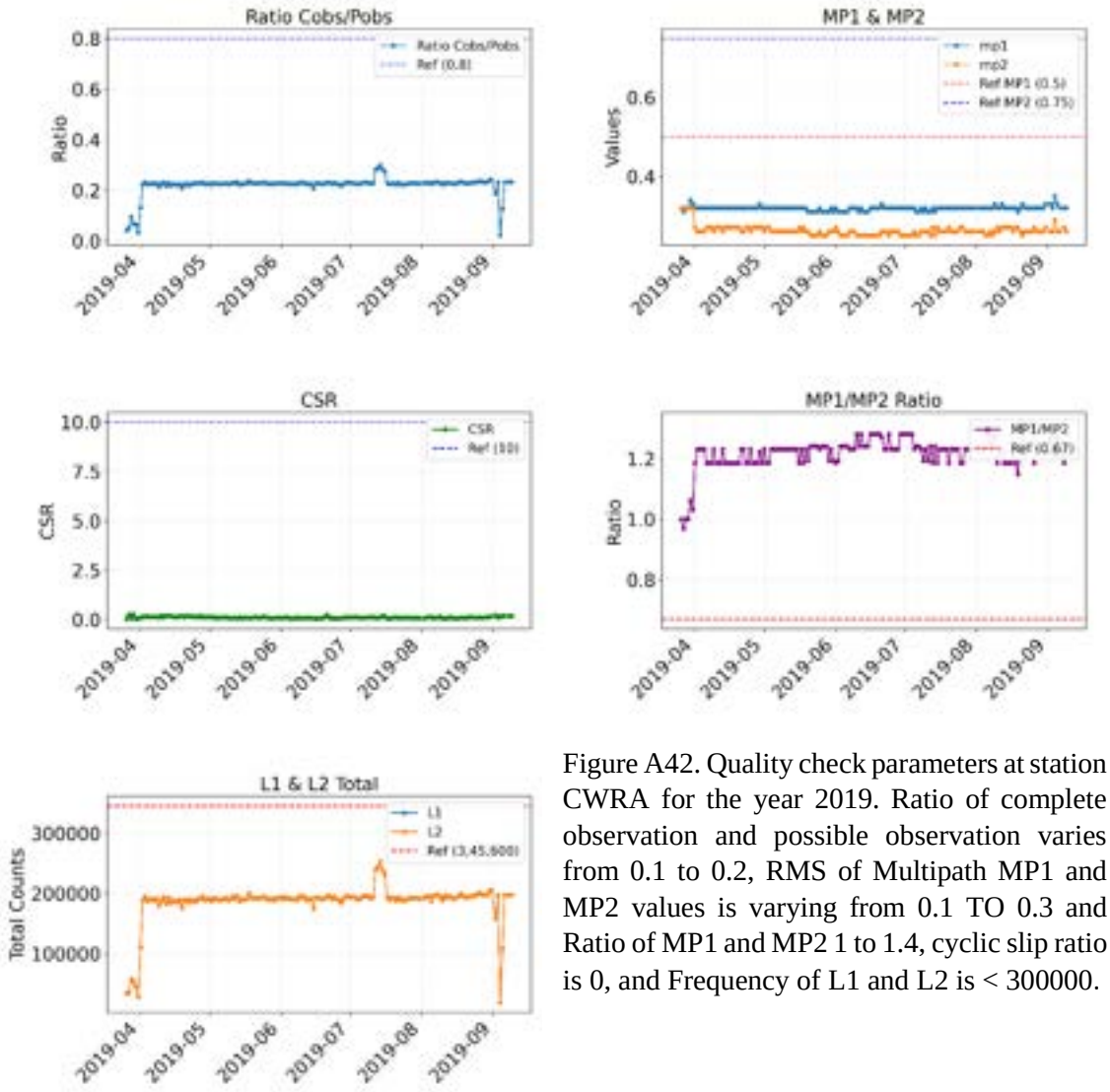


Figure A42. Quality check parameters at station CWRA for the year 2019. Ratio of complete observation and possible observation varies from 0.1 to 0.2, RMS of Multipath MP1 and MP2 values is varying from 0.1 TO 0.3 and Ratio of MP1 and MP2 1 to 1.4, cyclic slip ratio is 0, and Frequency of L1 and L2 is < 300000.

15. FERR

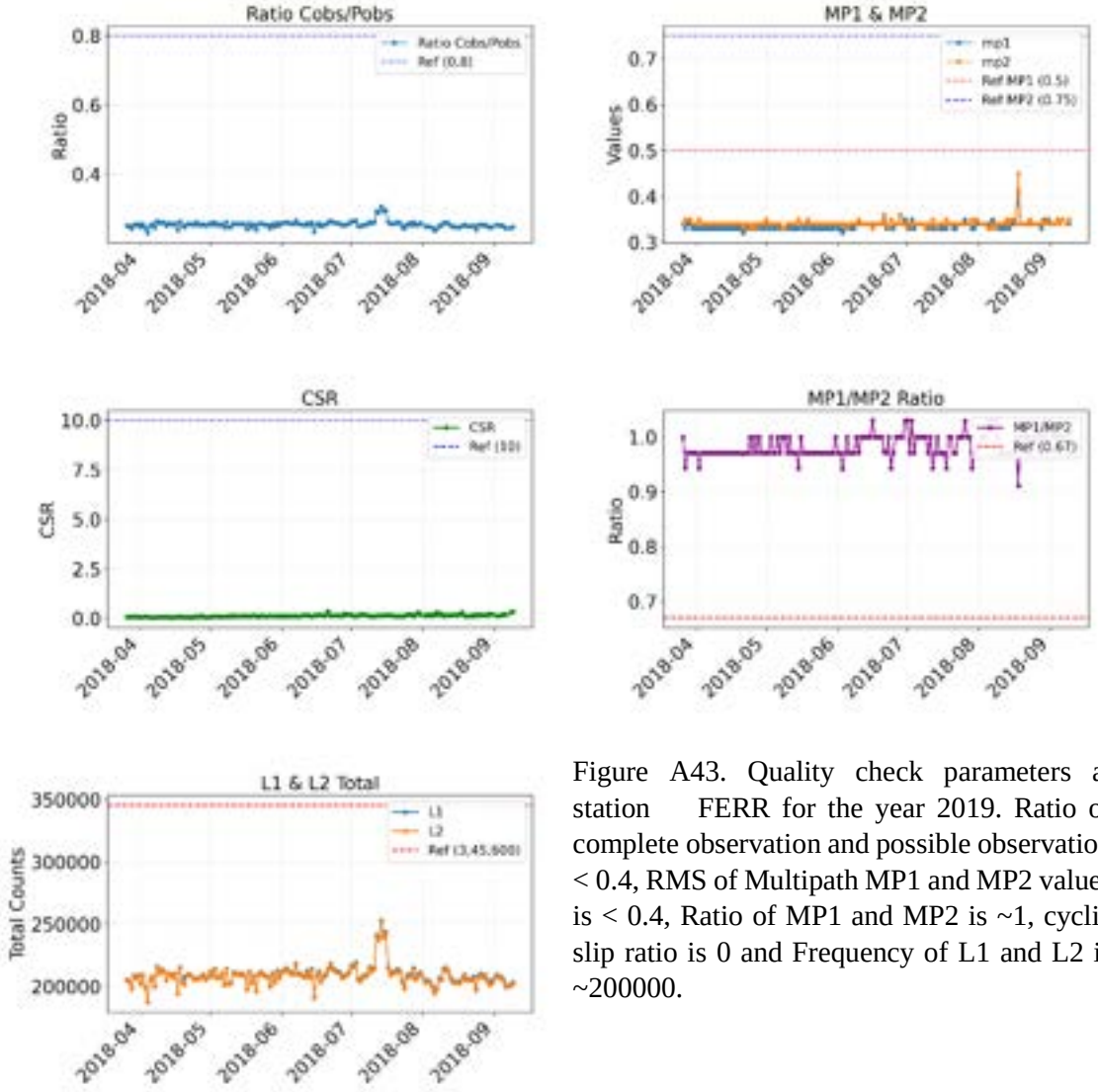


Figure A43. Quality check parameters at station FERR for the year 2019. Ratio of complete observation and possible observation < 0.4, RMS of Multipath MP1 and MP2 values is < 0.4, Ratio of MP1 and MP2 is ~1, cyclic slip ratio is 0 and Frequency of L1 and L2 is ~200000.

16. HAVE

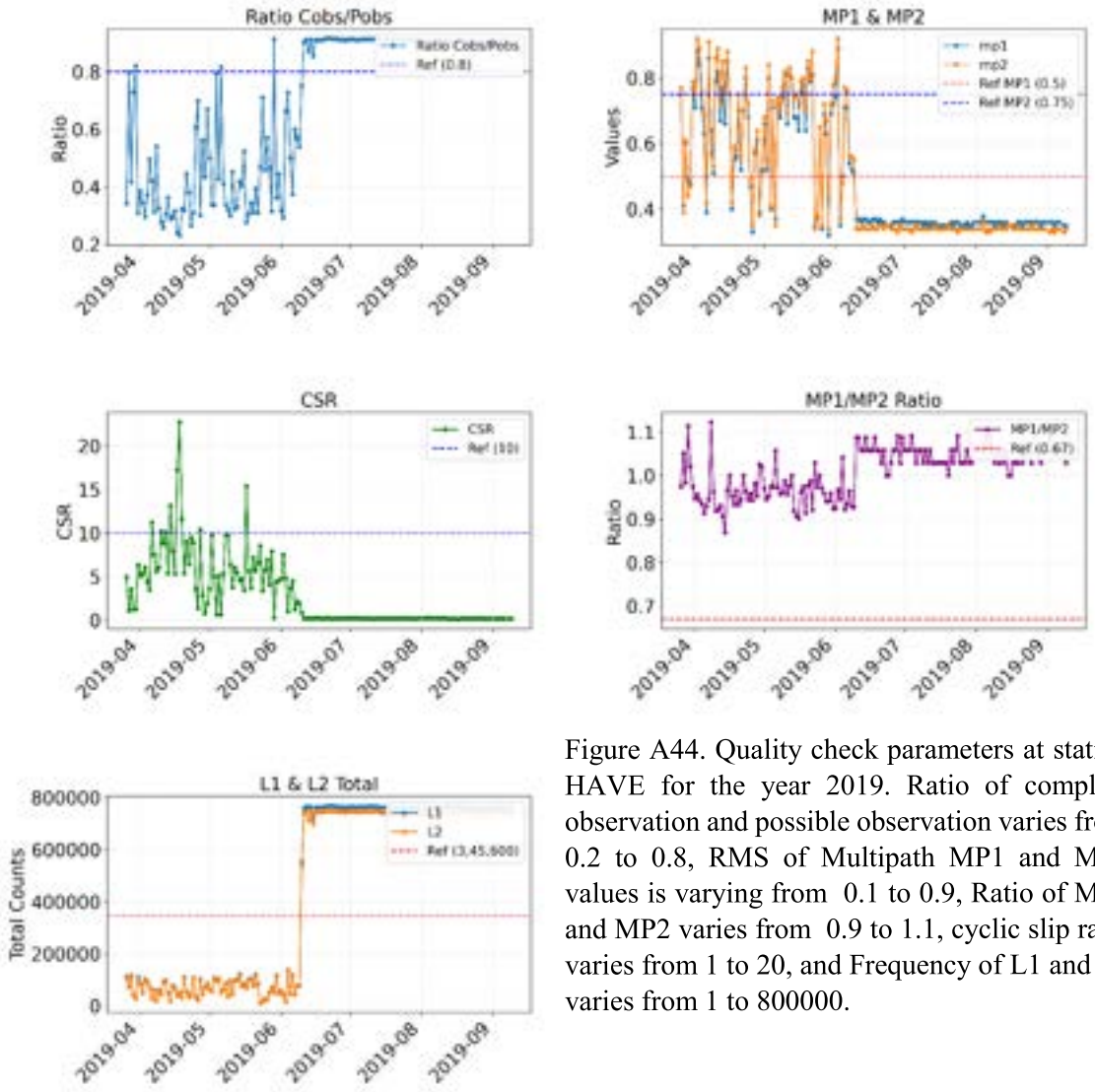


Figure A44. Quality check parameters at station HAVE for the year 2019. Ratio of complete observation and possible observation varies from 0.2 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.9, Ratio of MP1 and MP2 varies from 0.9 to 1.1, cyclic slip ratio varies from 1 to 20, and Frequency of L1 and L2 varies from 1 to 800000.

17. HUTB

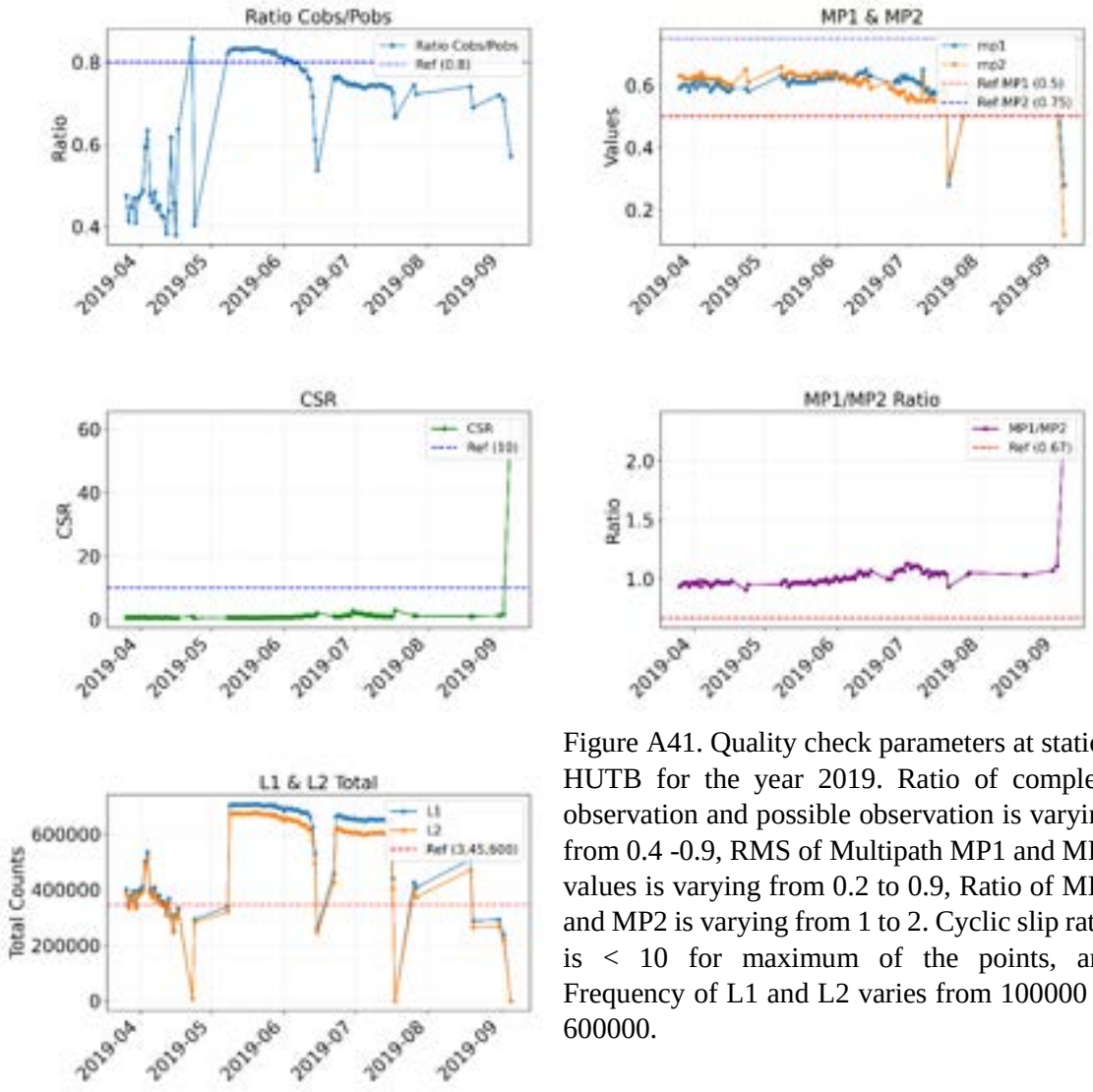


Figure A41. Quality check parameters at station HUTB for the year 2019. Ratio of complete observation and possible observation is varying from 0.4 -0.9, RMS of Multipath MP1 and MP2 values is varying from 0.2 to 0.9, Ratio of MP1 and MP2 is varying from 1 to 2. Cyclic slip ratio is < 10 for maximum of the points, and Frequency of L1 and L2 varies from 100000 to 600000.

18. MOHA

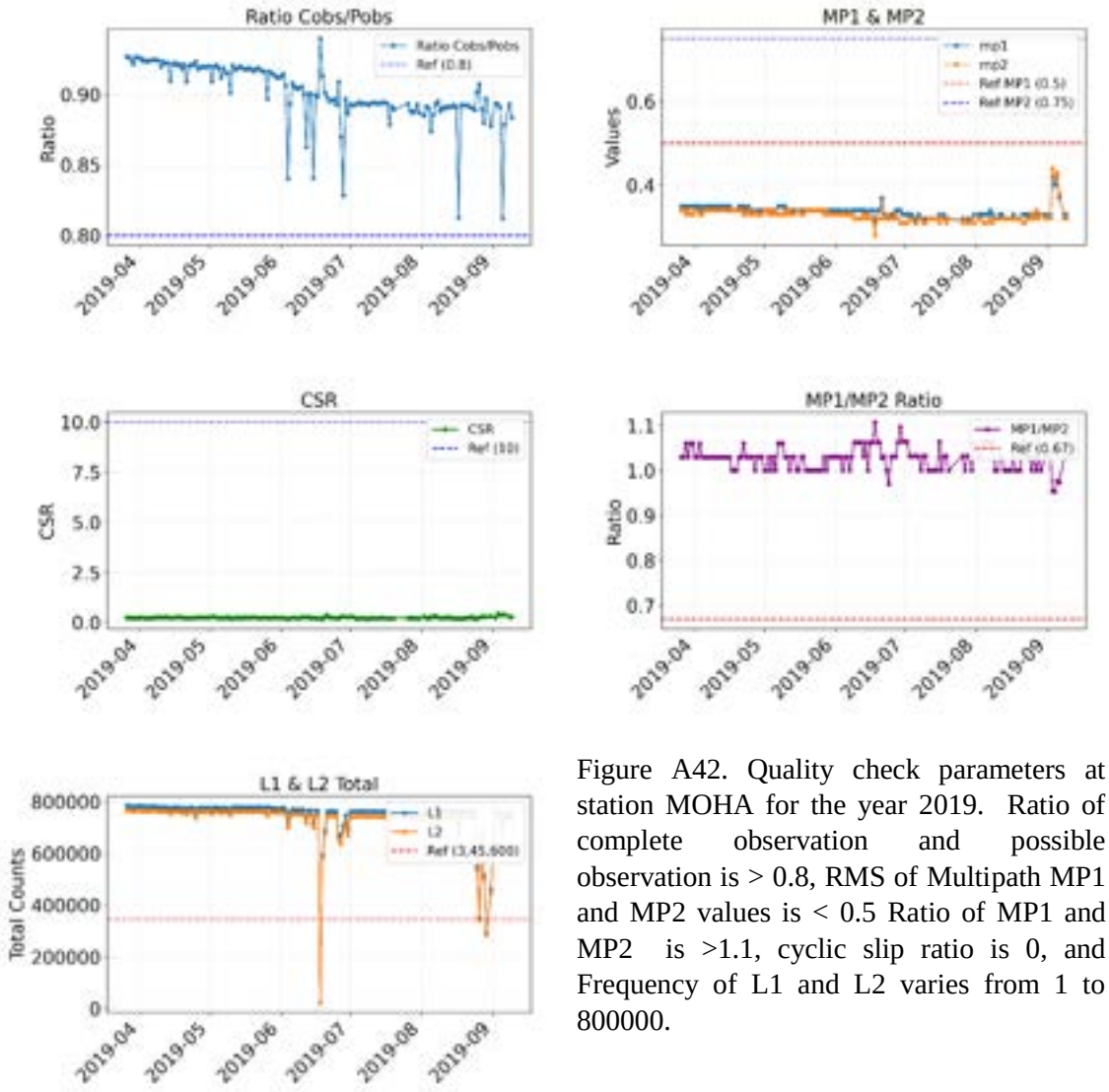


Figure A42. Quality check parameters at station MOHA for the year 2019. Ratio of complete observation and possible observation is > 0.8, RMS of Multipath MP1 and MP2 values is < 0.5 Ratio of MP1 and MP2 is >1.1, cyclic slip ratio is 0, and Frequency of L1 and L2 varies from 1 to 800000.

19. NAMU

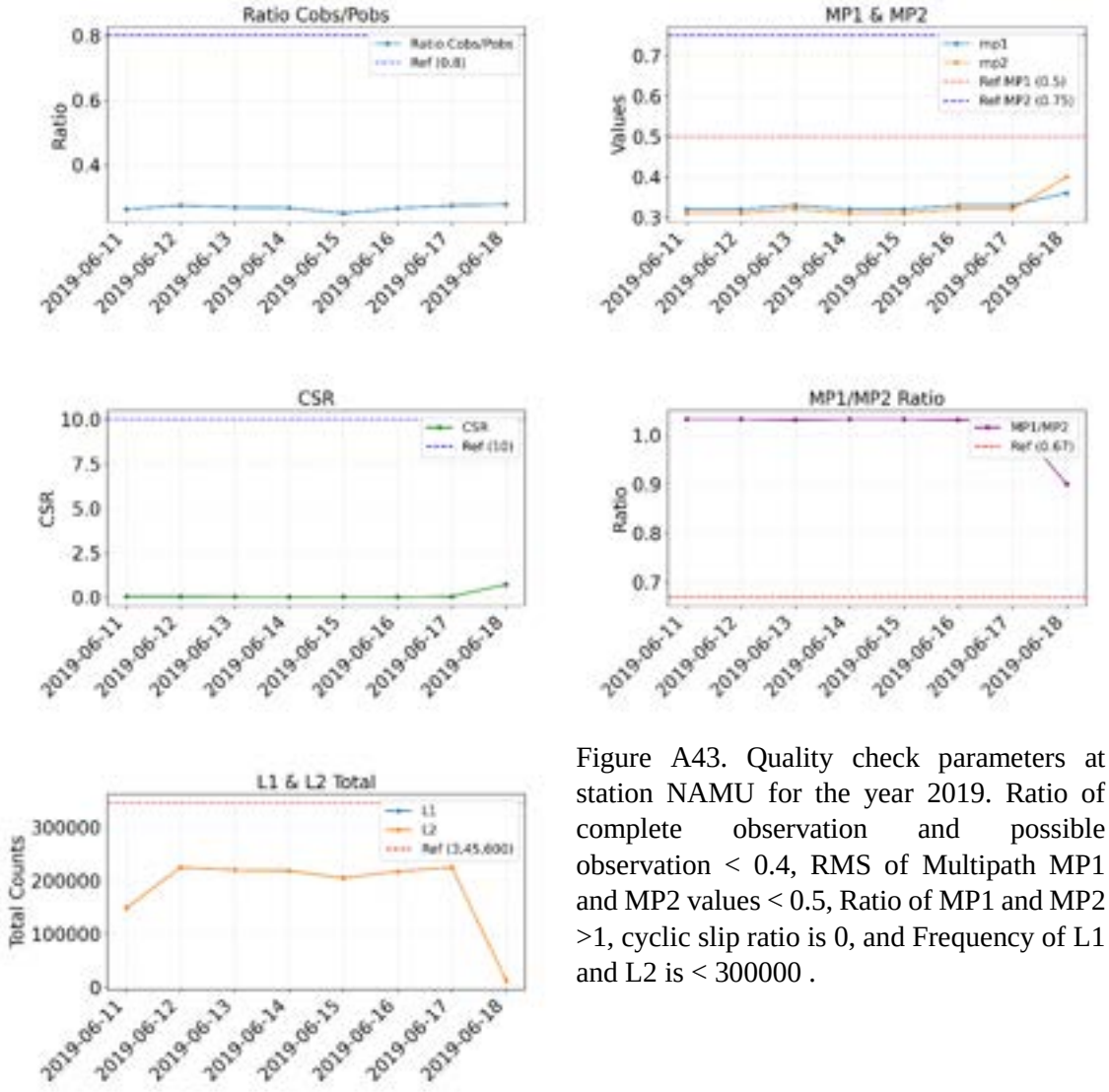


Figure A43. Quality check parameters at station NAMU for the year 2019. Ratio of complete observation and possible observation < 0.4, RMS of Multipath MP1 and MP2 values < 0.5, Ratio of MP1 and MP2 >1, cyclic slip ratio is 0, and Frequency of L1 and L2 is < 300000 .

20. PORT

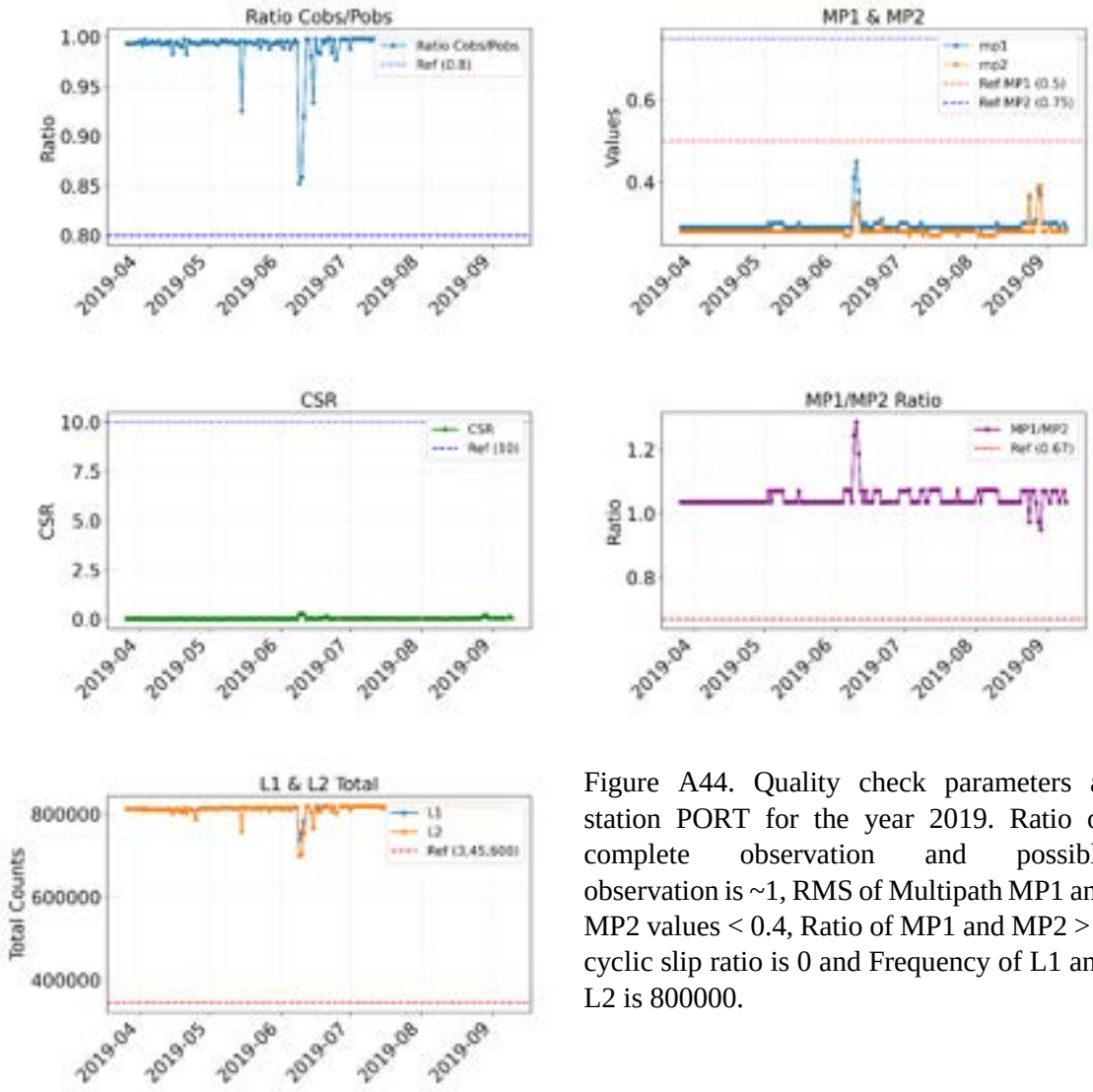


Figure A44. Quality check parameters at station PORT for the year 2019. Ratio of complete observation and possible observation is ~1, RMS of Multipath MP1 and MP2 values < 0.4, Ratio of MP1 and MP2 > 1 cyclic slip ratio is 0 and Frequency of L1 and L2 is 800000.

21. RADA

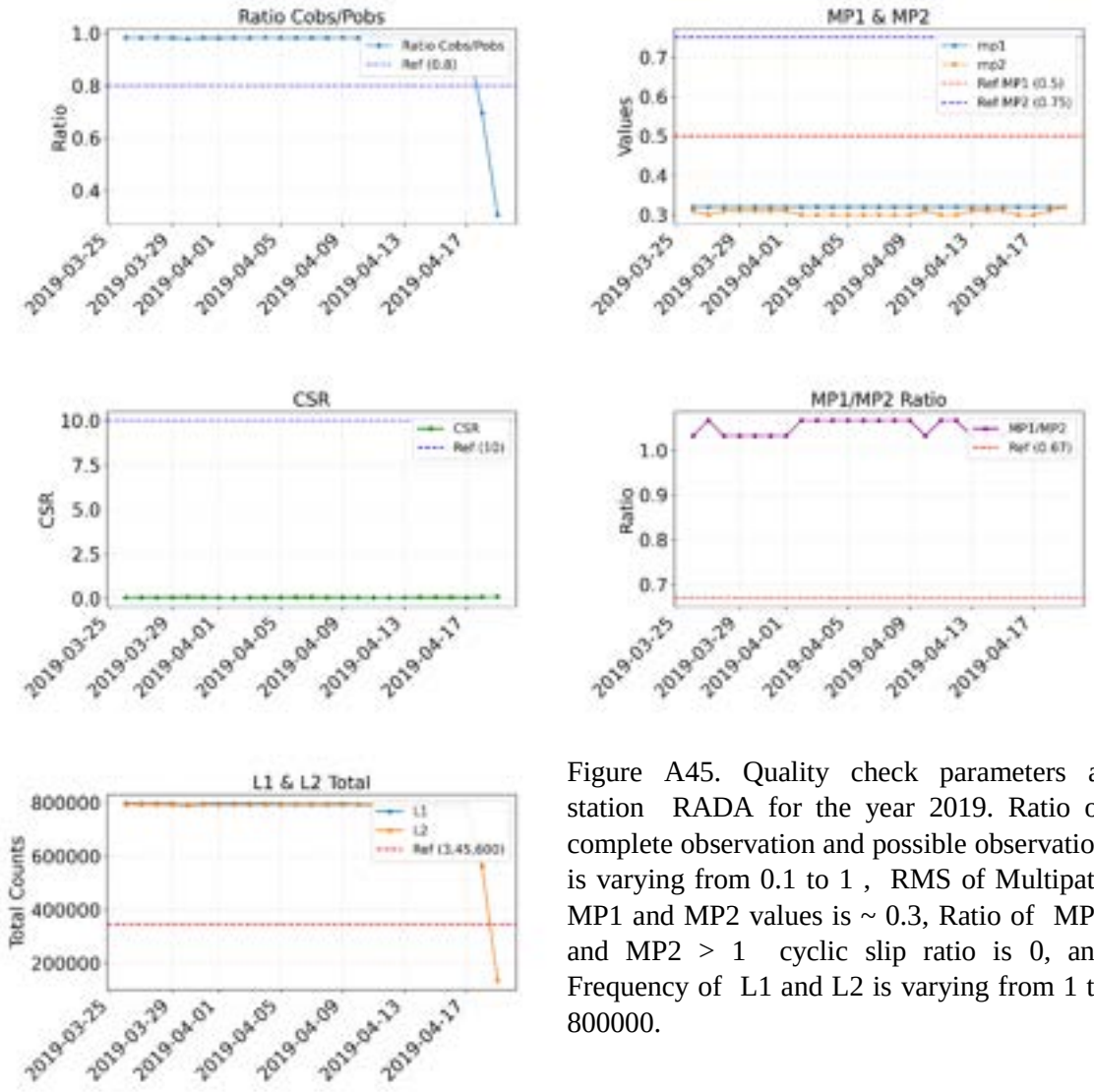


Figure A45. Quality check parameters at station RADA for the year 2019. Ratio of complete observation and possible observation is varying from 0.1 to 1 , RMS of Multipath MP1 and MP2 values is ~ 0.3, Ratio of MP1 and MP2 > 1 cyclic slip ratio is 0, and Frequency of L1 and L2 is varying from 1 to 800000.

22. RAMN

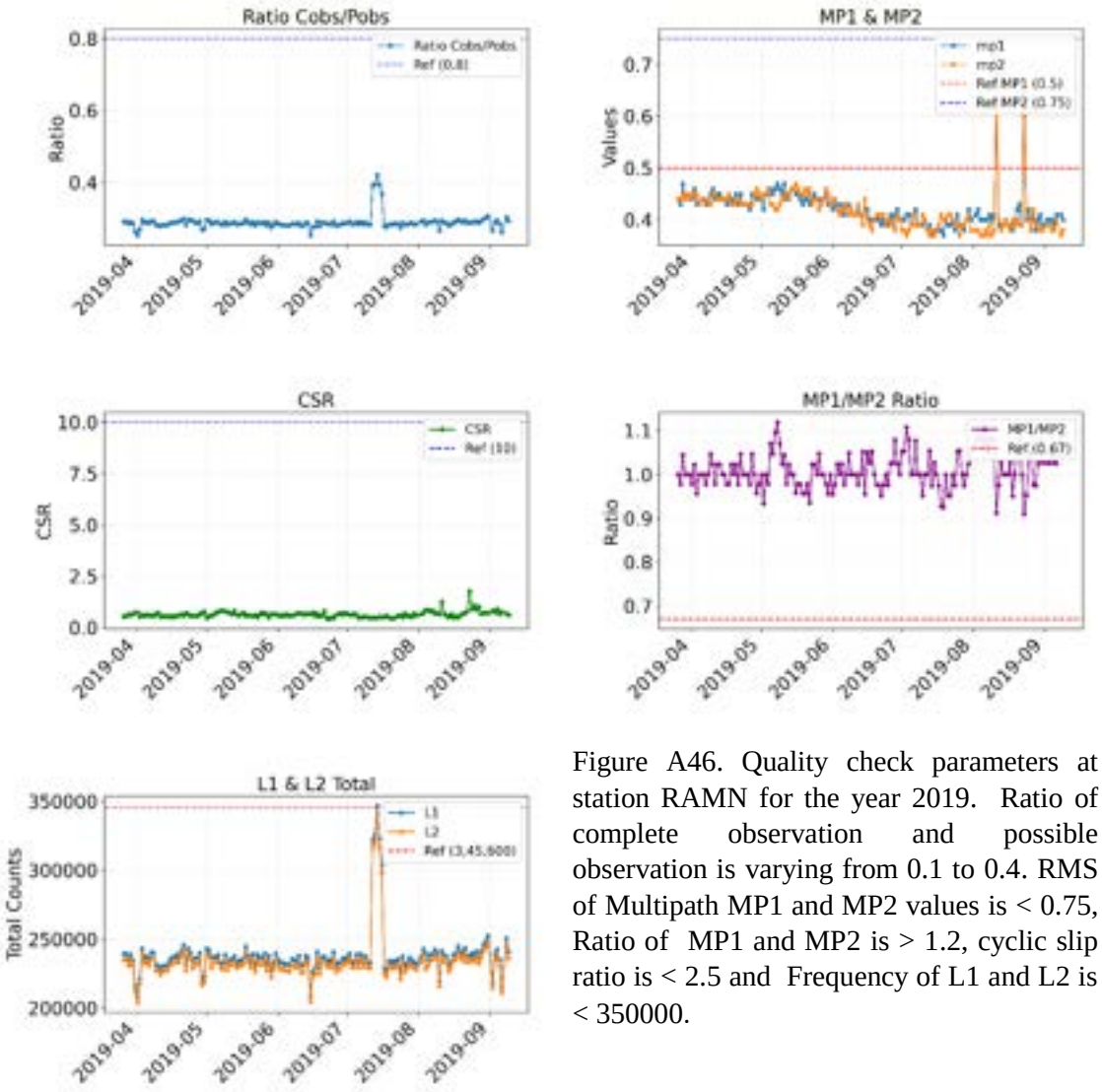


Figure A46. Quality check parameters at station RAMN for the year 2019. Ratio of complete observation and possible observation is varying from 0.1 to 0.4. RMS of Multipath MP1 and MP2 values is < 0.75, Ratio of MP1 and MP2 is > 1.2, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is < 350000.

23. SHAS

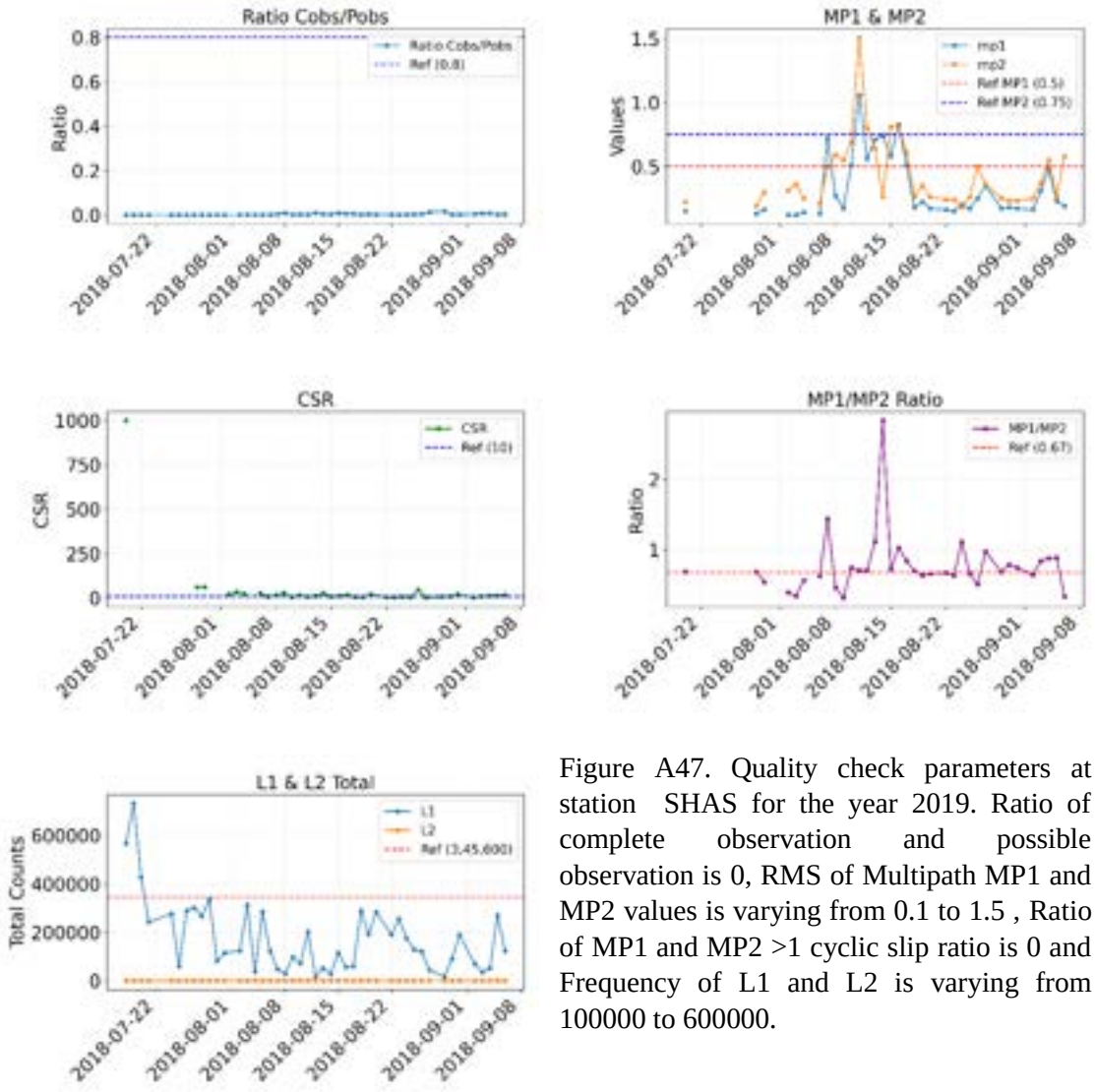


Figure A47. Quality check parameters at station SHAS for the year 2019. Ratio of complete observation and possible observation is 0, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 1.5 , Ratio of MP1 and MP2 >1 cyclic slip ratio is 0 and Frequency of L1 and L2 is varying from 100000 to 600000.

24. TRIN

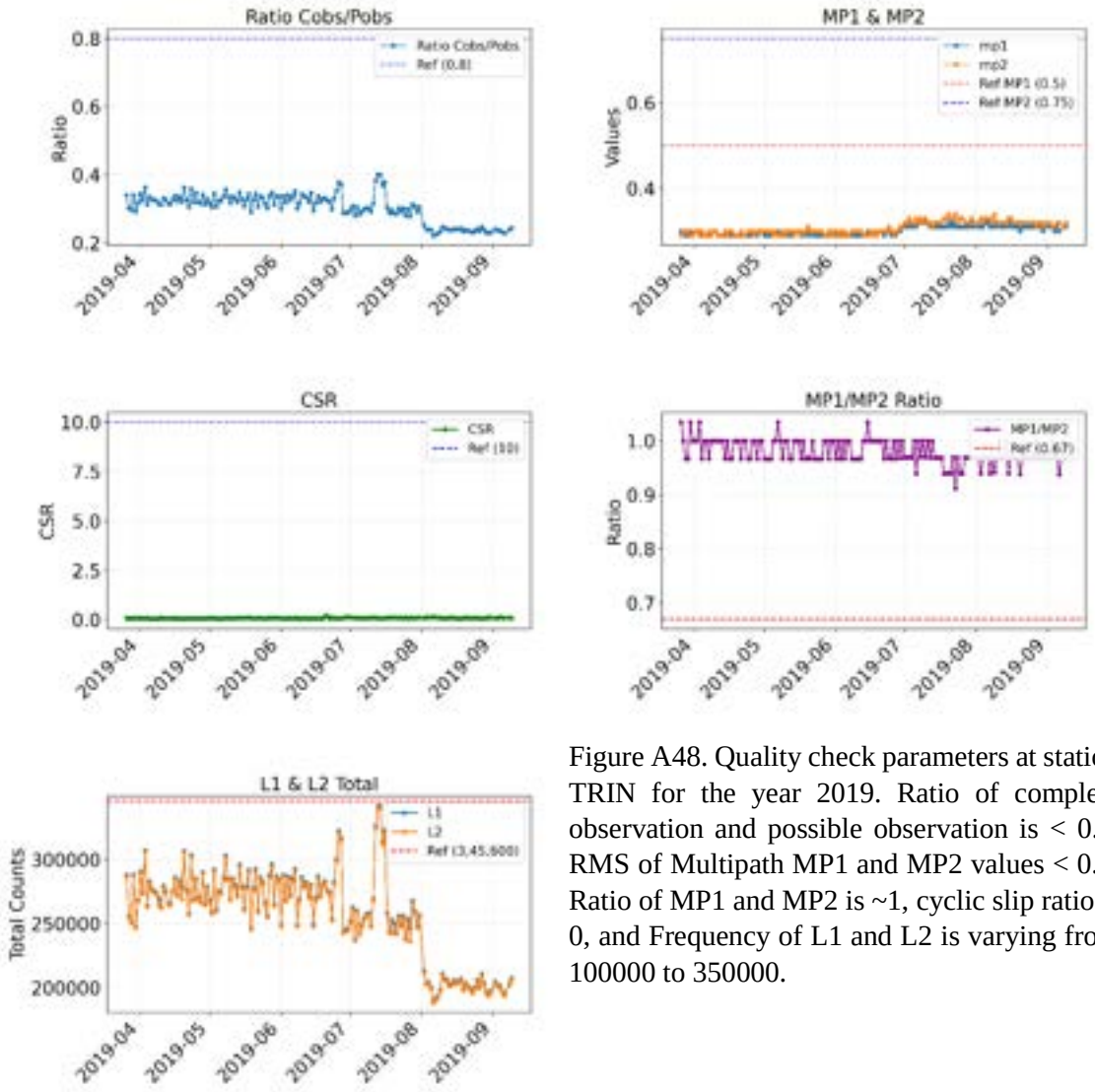


Figure A48. Quality check parameters at station TRIN for the year 2019. Ratio of complete observation and possible observation is < 0.4. RMS of Multipath MP1 and MP2 values < 0.4, Ratio of MP1 and MP2 is ~1, cyclic slip ratio is 0, and Frequency of L1 and L2 is varying from 100000 to 350000.

25. SHOA

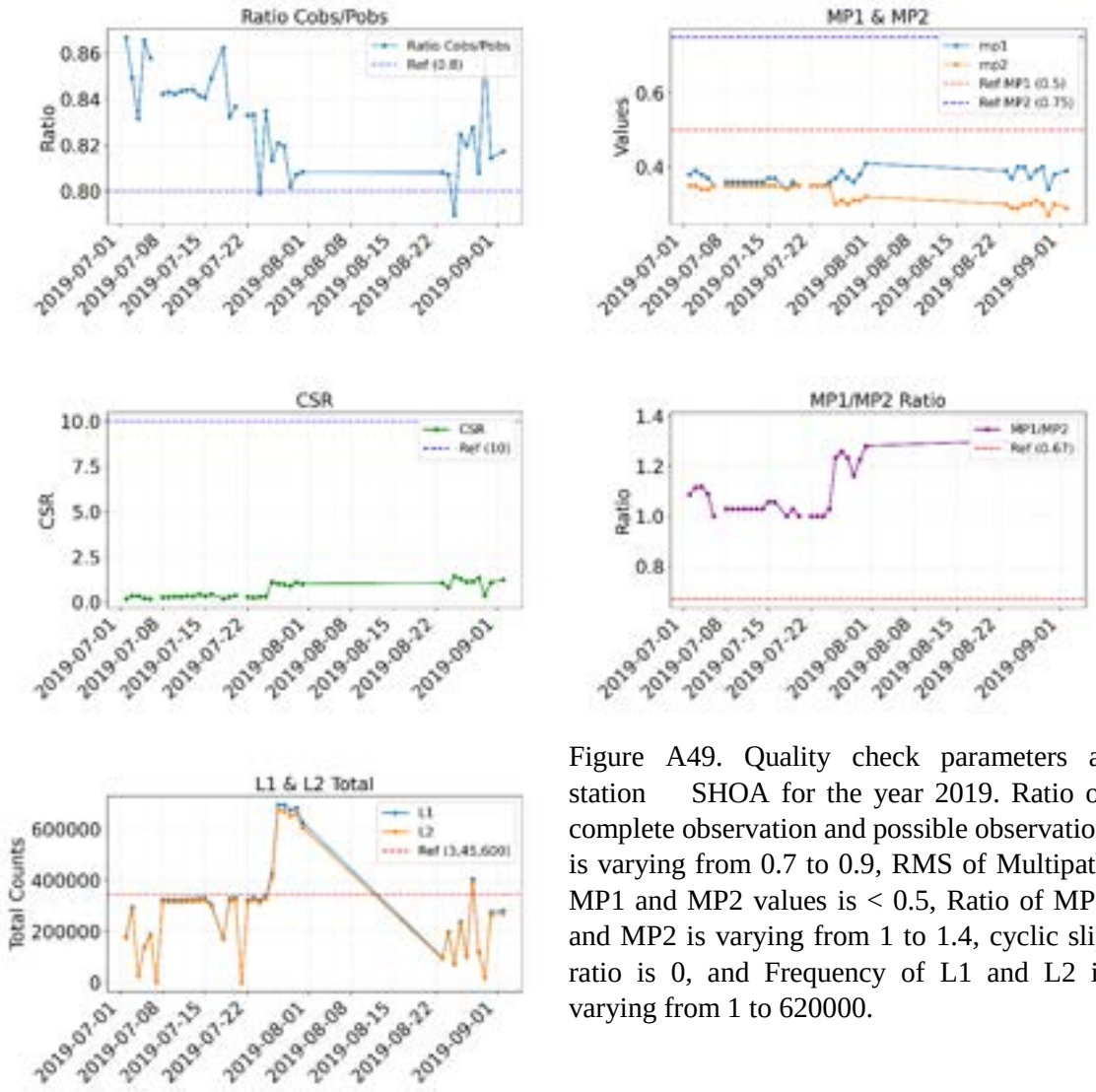


Figure A49. Quality check parameters at station SHOA for the year 2019. Ratio of complete observation and possible observation is varying from 0.7 to 0.9, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.4, cyclic slip ratio is 0, and Frequency of L1 and L2 is varying from 1 to 620000.

YEAR 2021:

1. ALUR:

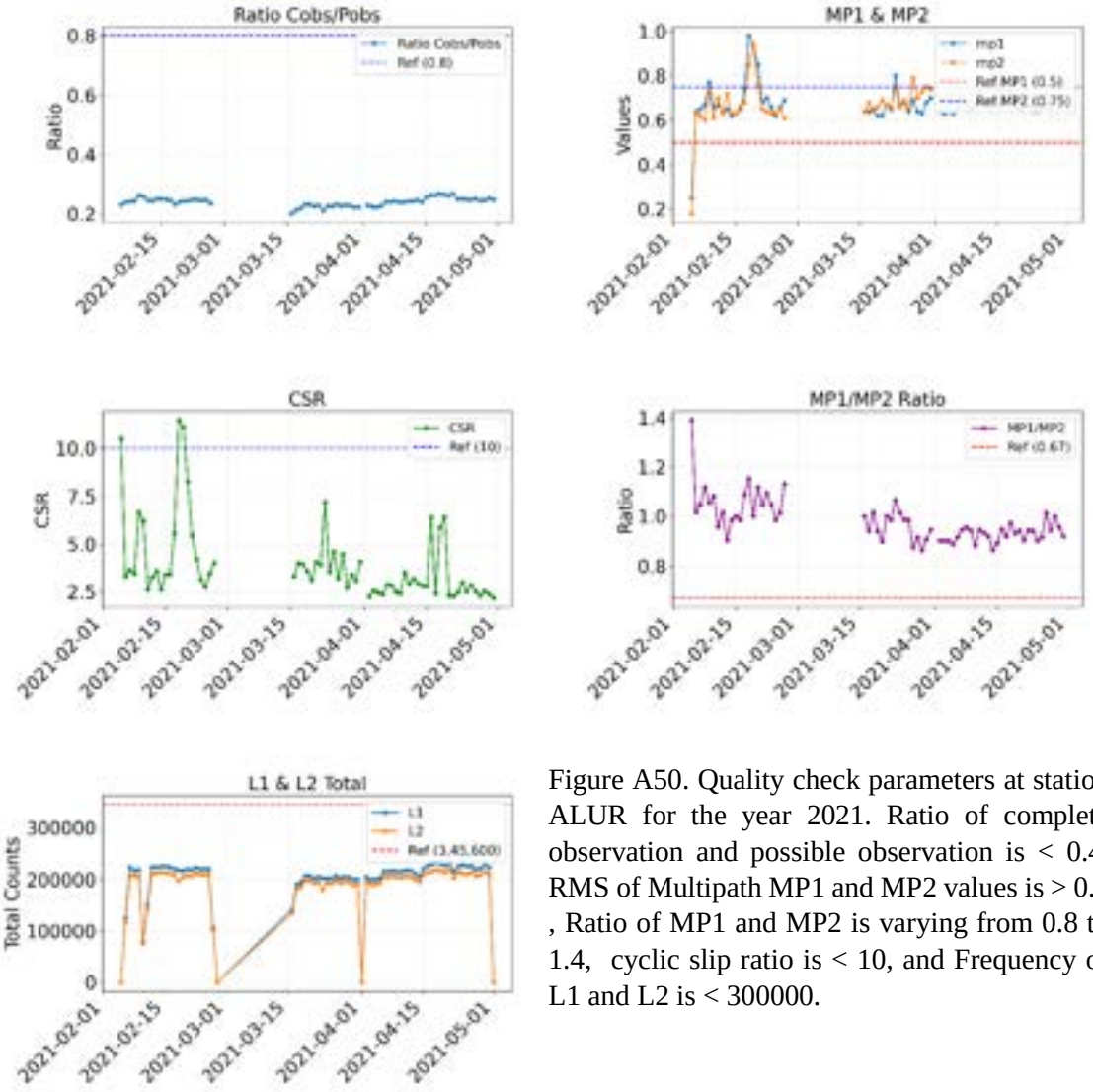


Figure A50. Quality check parameters at station ALUR for the year 2021. Ratio of complete observation and possible observation is < 0.4, RMS of Multipath MP1 and MP2 values is > 0.8 , Ratio of MP1 and MP2 is varying from 0.8 to 1.4, cyclic slip ratio is < 10, and Frequency of L1 and L2 is < 300000.

2. CARN

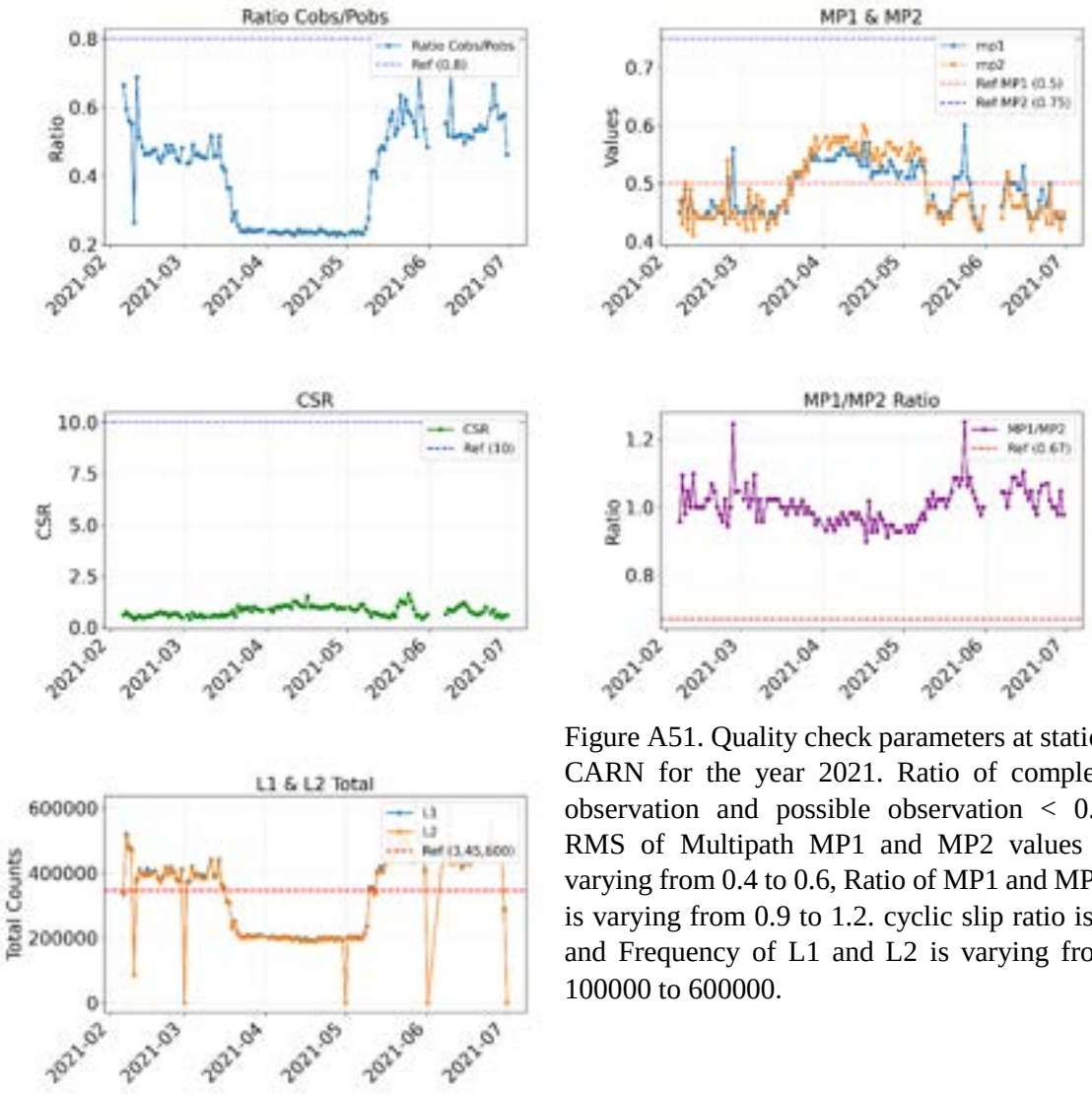


Figure A51. Quality check parameters at station CARN for the year 2021. Ratio of complete observation and possible observation < 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.4 to 0.6, Ratio of MP1 and MP2, is varying from 0.9 to 1.2. cyclic slip ratio is 0 and Frequency of L1 and L2 is varying from 100000 to 600000.

3. CHID

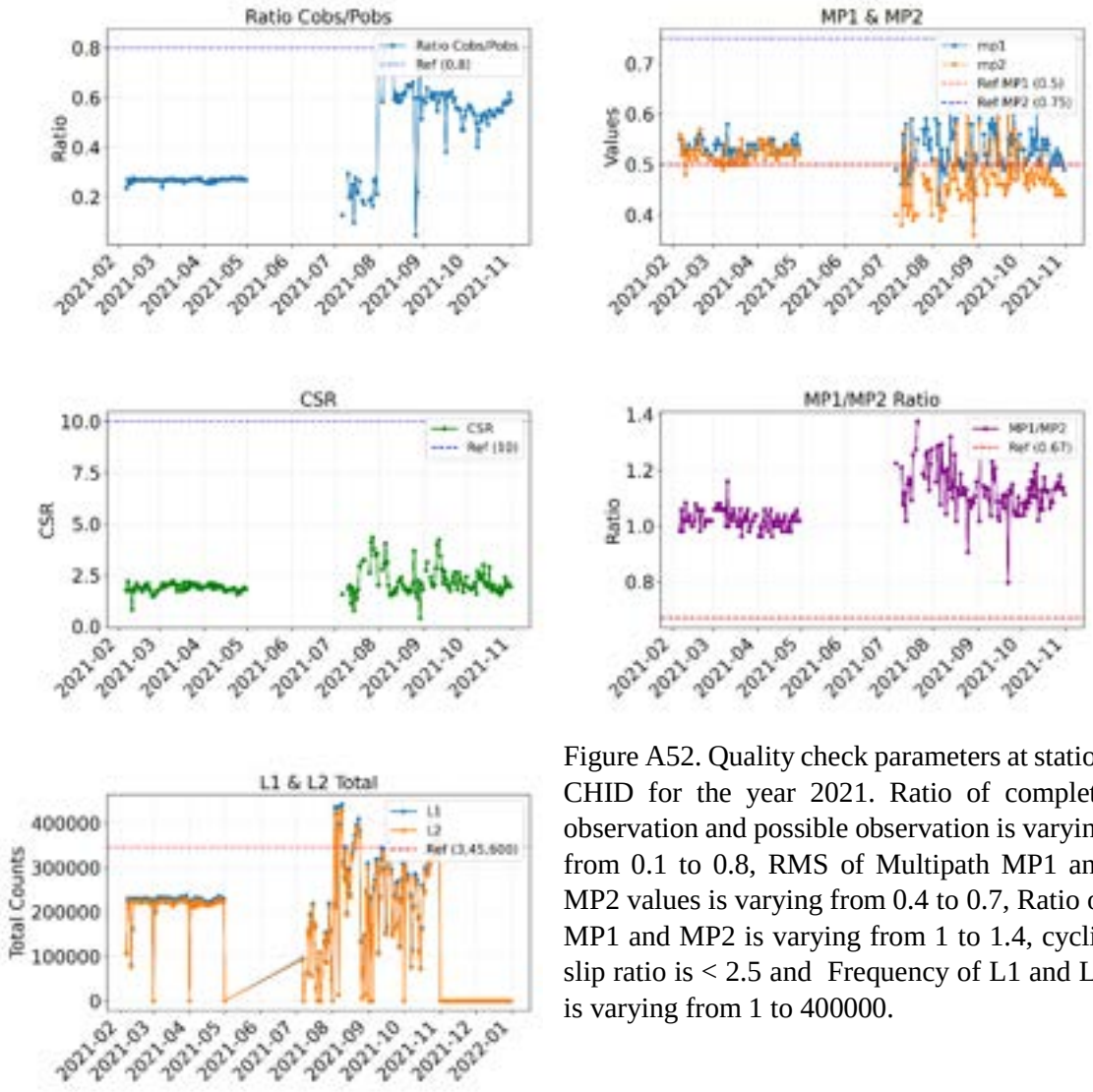


Figure A52. Quality check parameters at station CHID for the year 2021. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.4 to 0.7, Ratio of MP1 and MP2 is varying from 1 to 1.4, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is varying from 1 to 400000.

4. CWRA

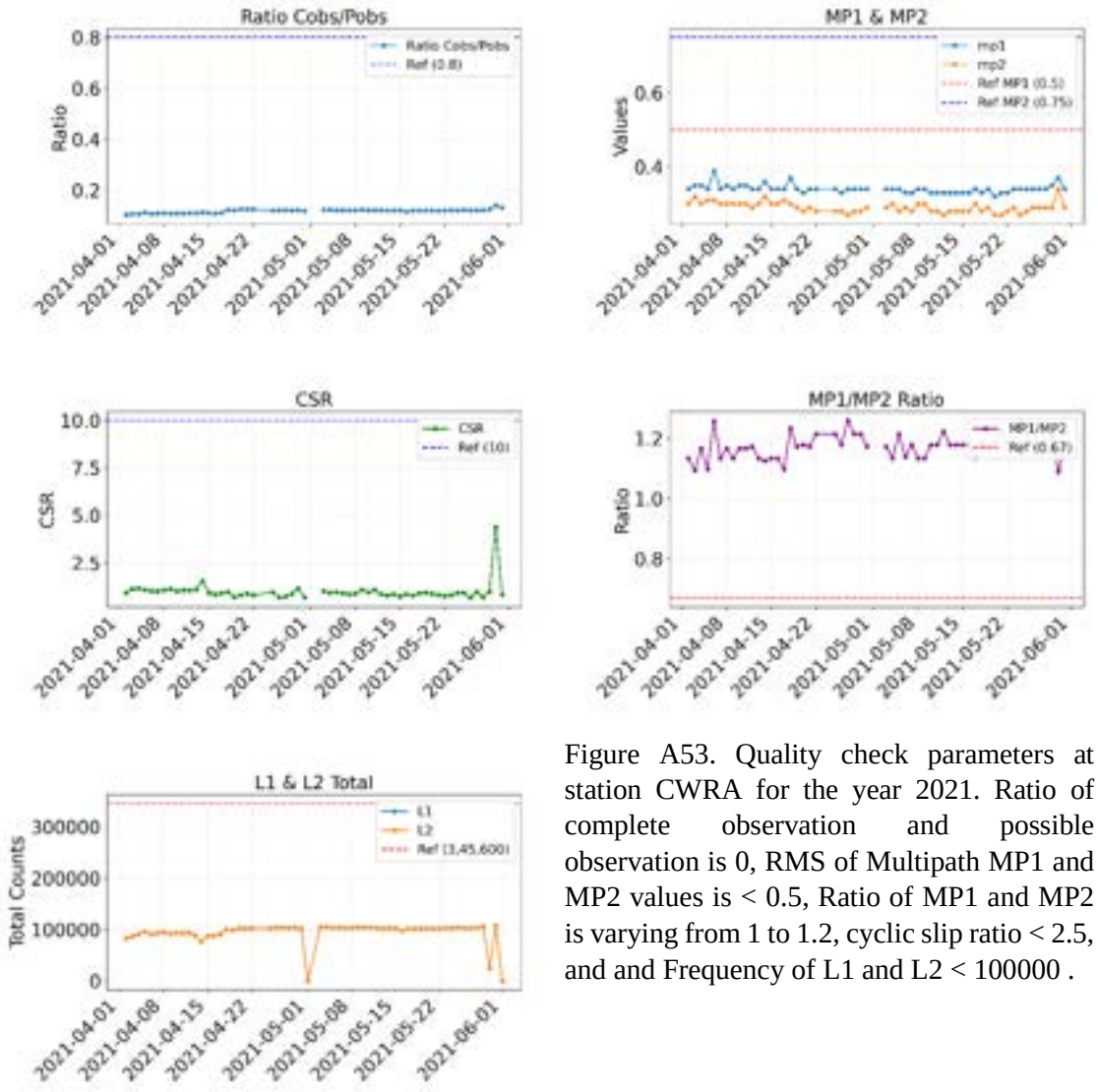


Figure A53. Quality check parameters at station CWRA for the year 2021. Ratio of complete observation and possible observation is 0, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.2, cyclic slip ratio < 2.5, and and Frequency of L1 and L2 < 100000 .

5. DARG

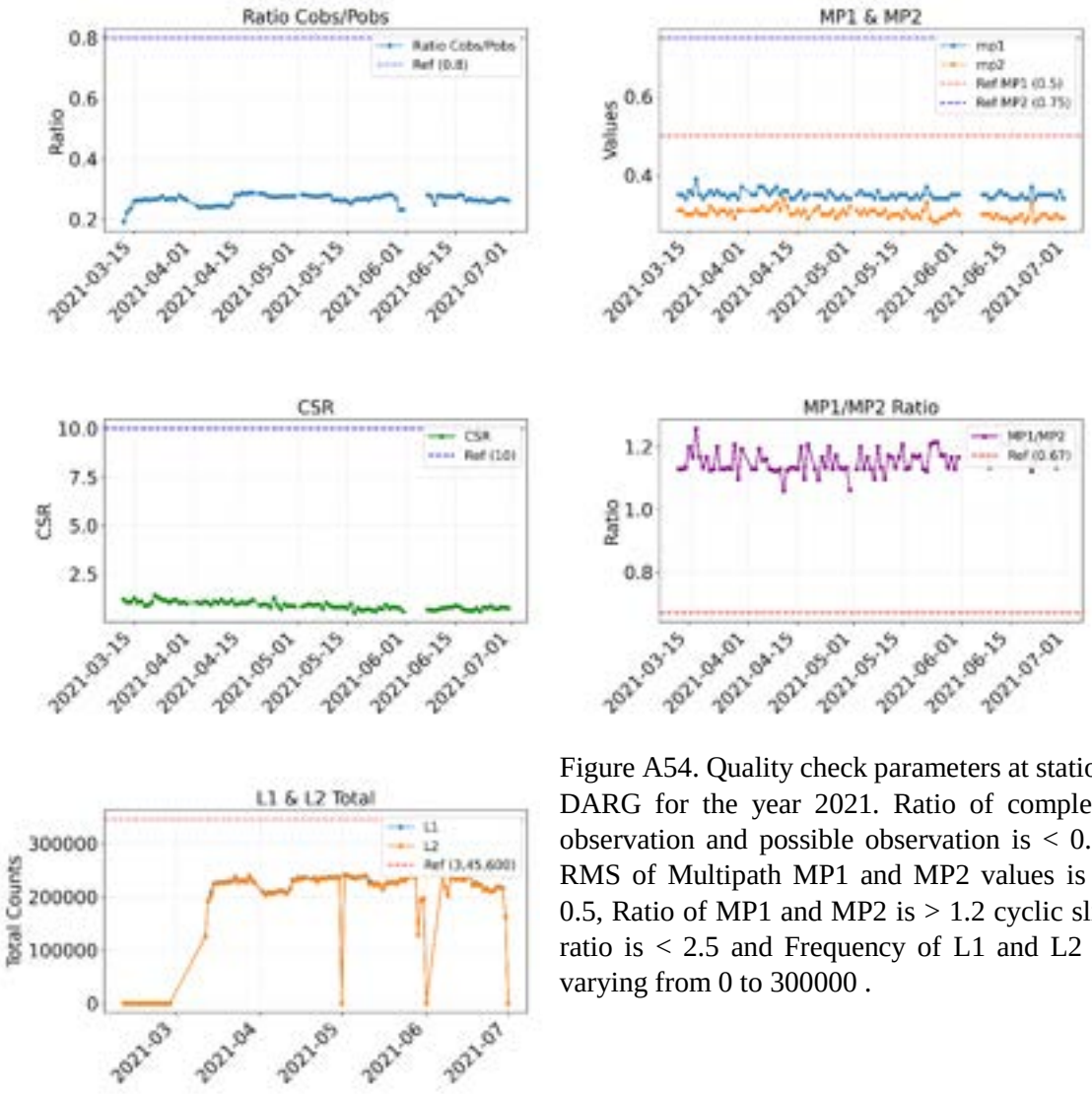


Figure A54. Quality check parameters at station DARG for the year 2021. Ratio of complete observation and possible observation is < 0.5, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is > 1.2 cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is varying from 0 to 300000 .

6. DGPR

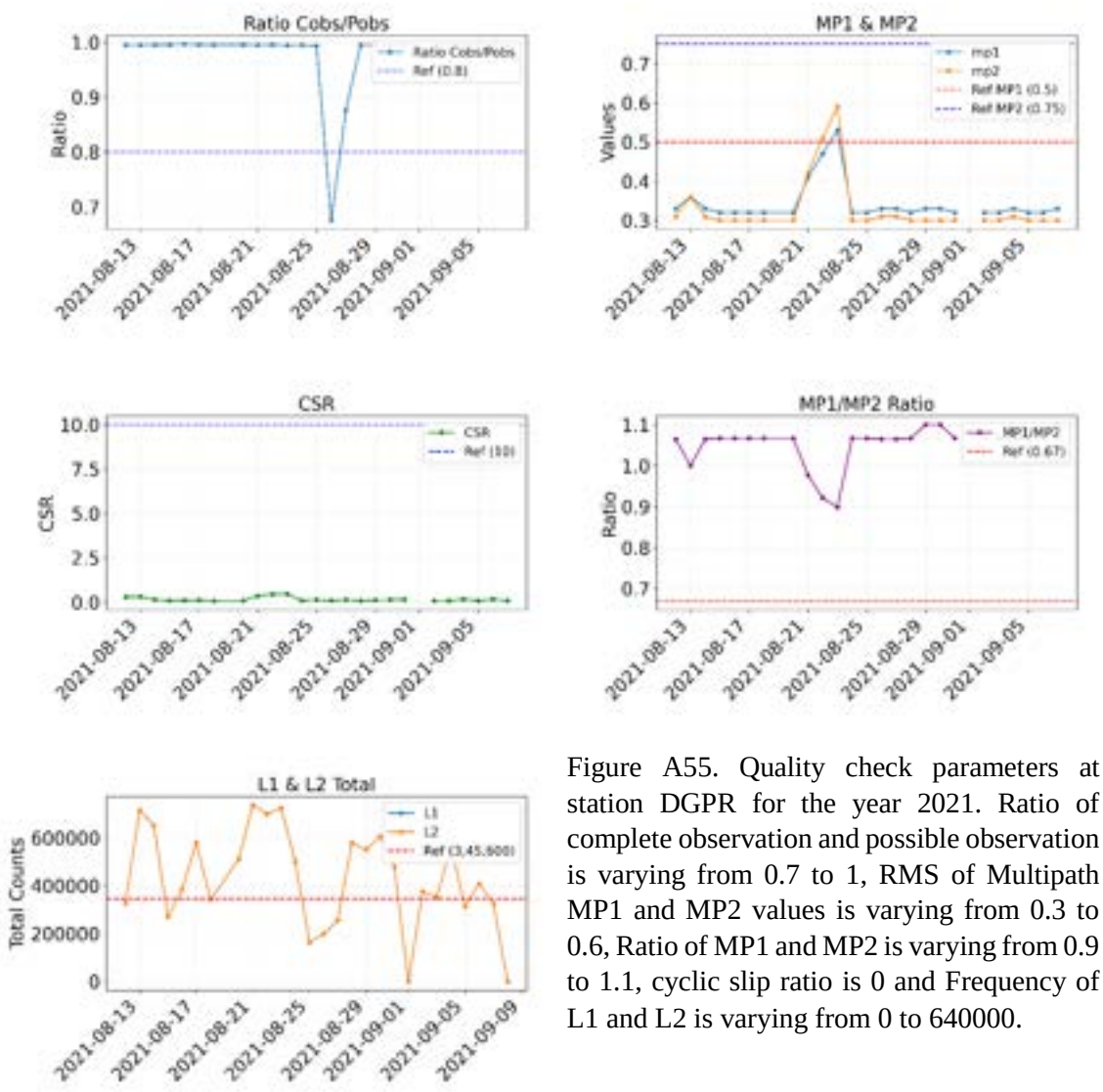


Figure A55. Quality check parameters at station DGPR for the year 2021. Ratio of complete observation and possible observation is varying from 0.7 to 1, RMS of Multipath MP1 and MP2 values is varying from 0.3 to 0.6, Ratio of MP1 and MP2 is varying from 0.9 to 1.1, cyclic slip ratio is 0 and Frequency of L1 and L2 is varying from 0 to 640000.

7. FERR

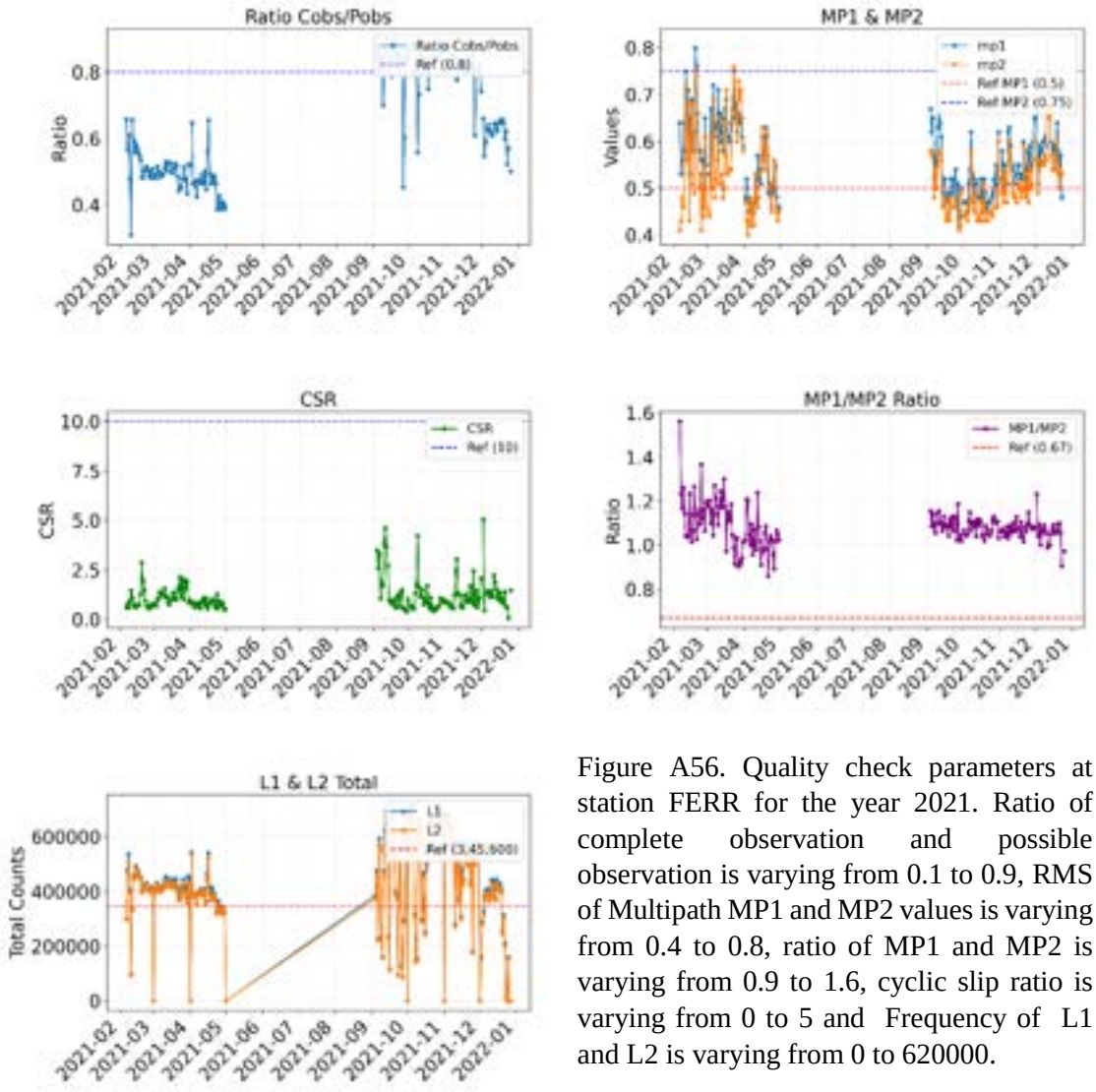


Figure A56. Quality check parameters at station FERR for the year 2021. Ratio of complete observation and possible observation is varying from 0.1 to 0.9, RMS of Multipath MP1 and MP2 values is varying from 0.4 to 0.8, ratio of MP1 and MP2 is varying from 0.9 to 1.6, cyclic slip ratio is varying from 0 to 5 and Frequency of L1 and L2 is varying from 0 to 620000.

8. KISH

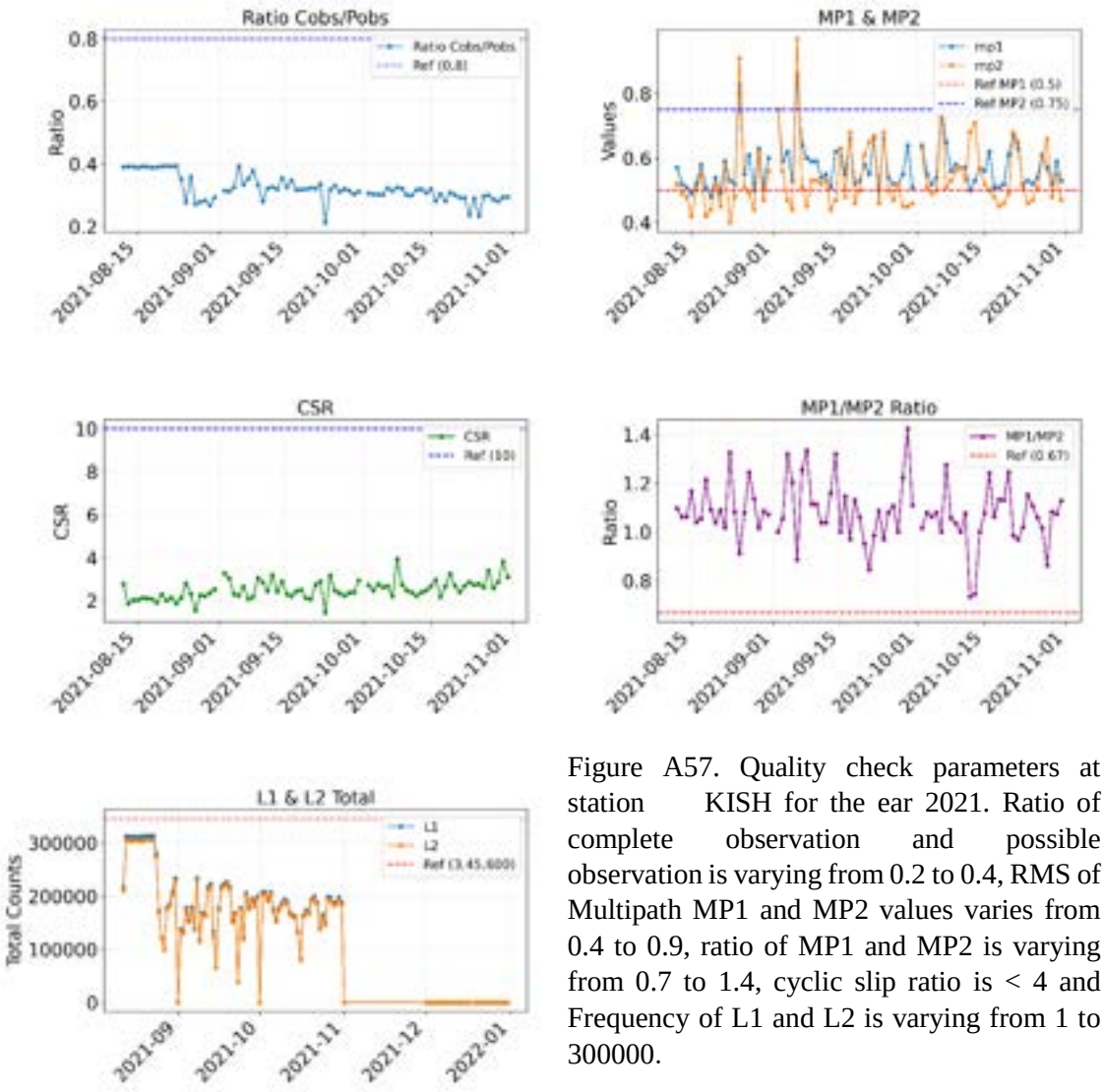


Figure A57. Quality check parameters at station KISH for the ear 2021. Ratio of complete observation and possible observation is varying from 0.2 to 0.4, RMS of Multipath MP1 and MP2 values varies from 0.4 to 0.9, ratio of MP1 and MP2 is varying from 0.7 to 1.4, cyclic slip ratio is < 4 and Frequency of L1 and L2 is varying from 1 to 300000.

9. LONS:

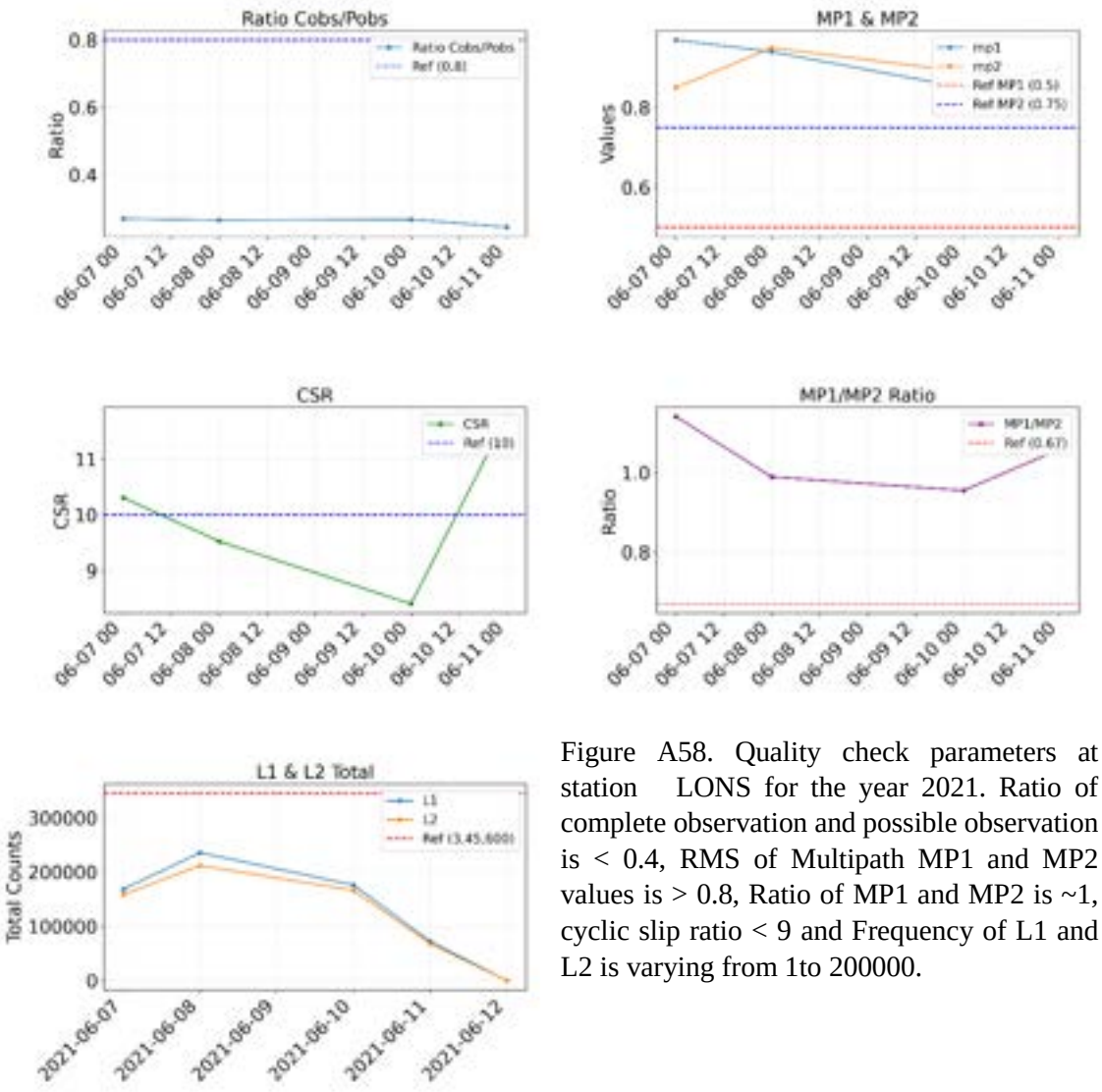


Figure A58. Quality check parameters at station LONS for the year 2021. Ratio of complete observation and possible observation is < 0.4, RMS of Multipath MP1 and MP2 values is > 0.8, Ratio of MP1 and MP2 is ~1, cyclic slip ratio < 9 and Frequency of L1 and L2 is varying from 1to 200000.

10. MAKA

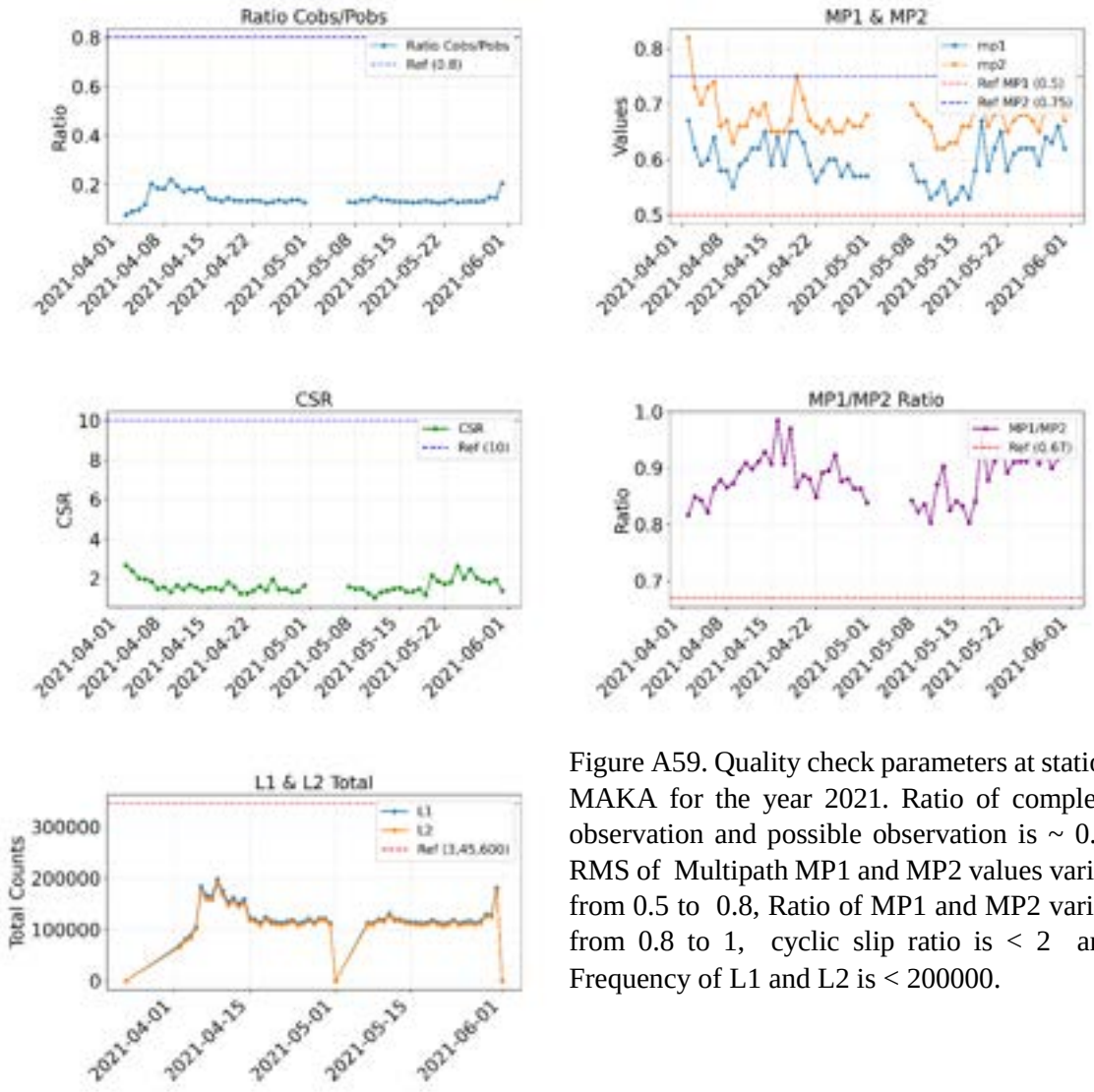


Figure A59. Quality check parameters at station MAKA for the year 2021. Ratio of complete observation and possible observation is ~ 0.2, RMS of Multipath MP1 and MP2 values varies from 0.5 to 0.8, Ratio of MP1 and MP2 varies from 0.8 to 1, cyclic slip ratio is < 2 and Frequency of L1 and L2 is < 200000.

11. MBDR

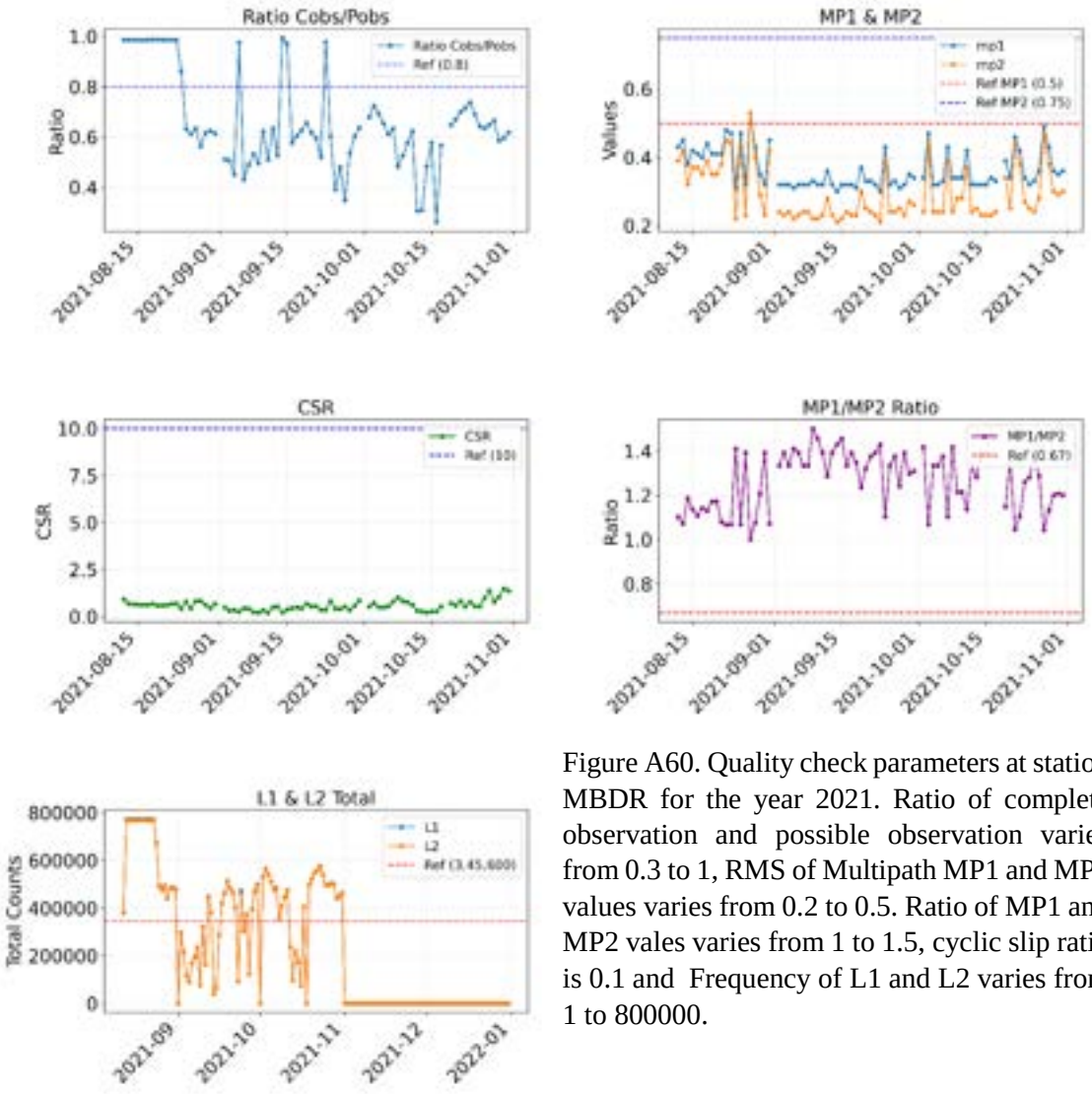


Figure A60. Quality check parameters at station MBDR for the year 2021. Ratio of complete observation and possible observation varies from 0.3 to 1, RMS of Multipath MP1 and MP2 values varies from 0.2 to 0.5. Ratio of MP1 and MP2 vales varies from 1 to 1.5, cyclic slip ratio is 0.1 and Frequency of L1 and L2 varies from 1 to 800000.

12. MOHA

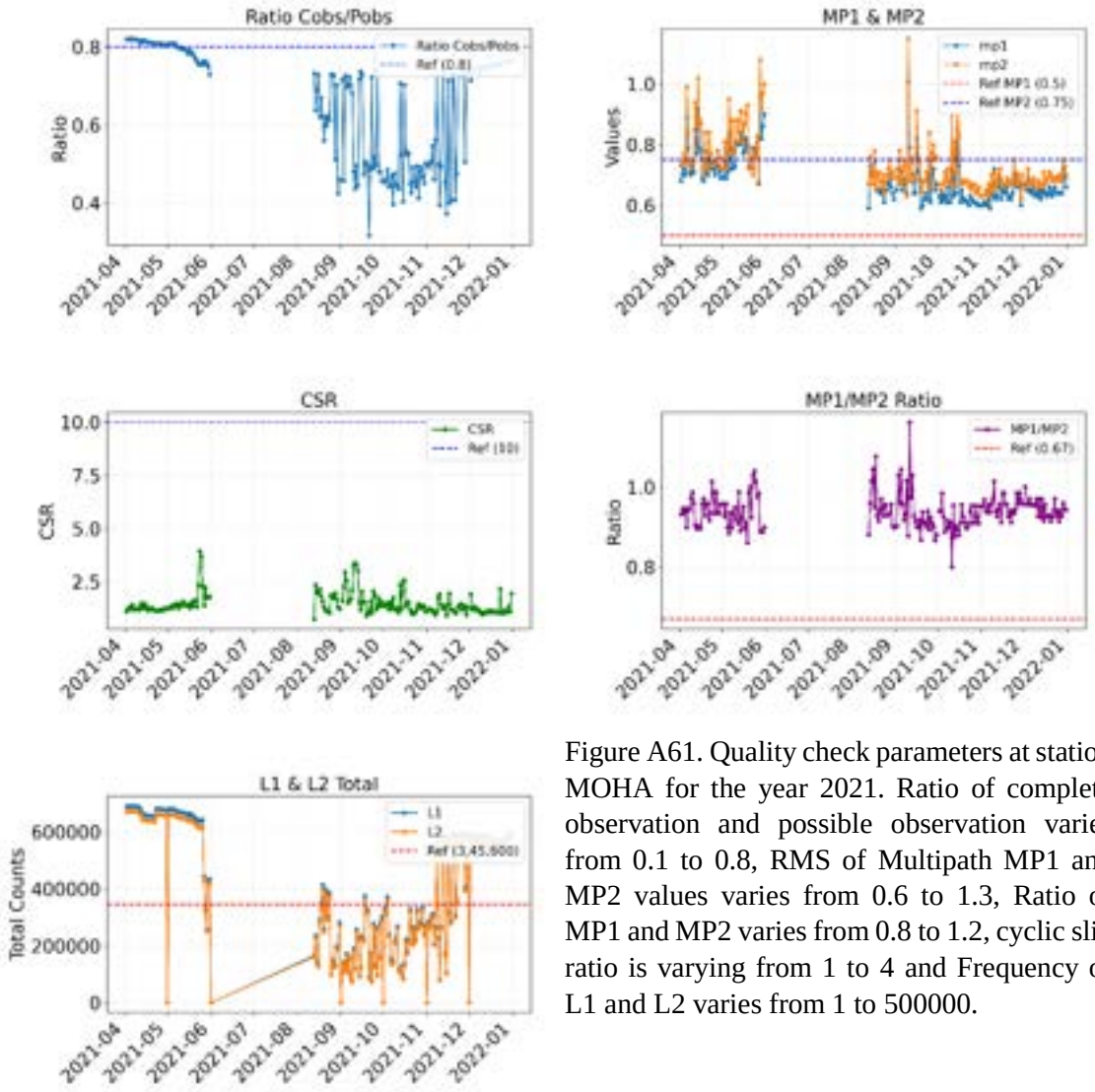


Figure A61. Quality check parameters at station MOHA for the year 2021. Ratio of complete observation and possible observation varies from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.6 to 1.3, Ratio of MP1 and MP2 varies from 0.8 to 1.2, cyclic slip ratio is varying from 1 to 4 and Frequency of L1 and L2 varies from 1 to 500000.

13. NIMB

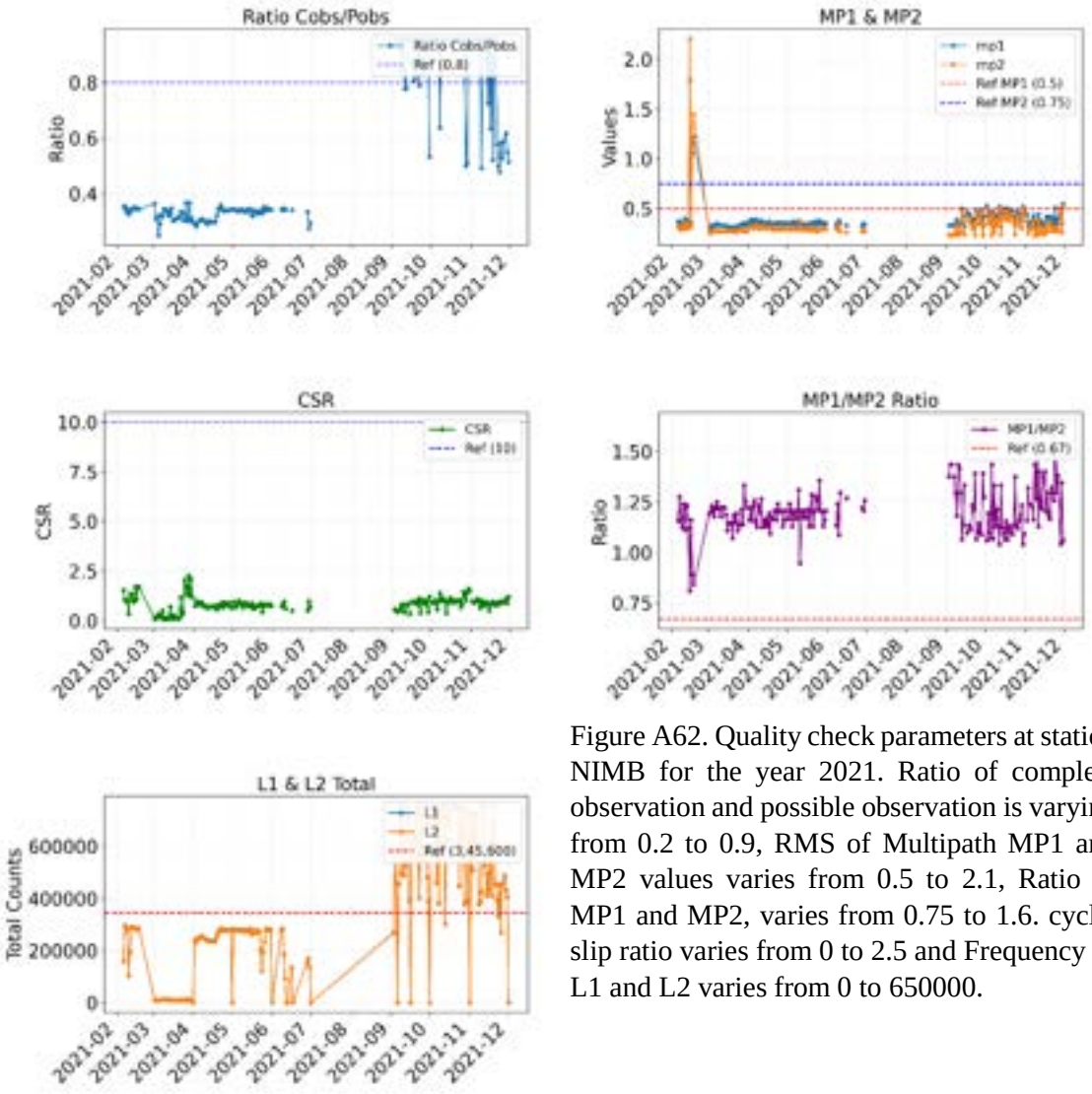


Figure A62. Quality check parameters at station NIMB for the year 2021. Ratio of complete observation and possible observation is varying from 0.2 to 0.9, RMS of Multipath MP1 and MP2 values varies from 0.5 to 2.1, Ratio of MP1 and MP2, varies from 0.75 to 1.6. cyclic slip ratio varies from 0 to 2.5 and Frequency of L1 and L2 varies from 0 to 650000.

14. RADA

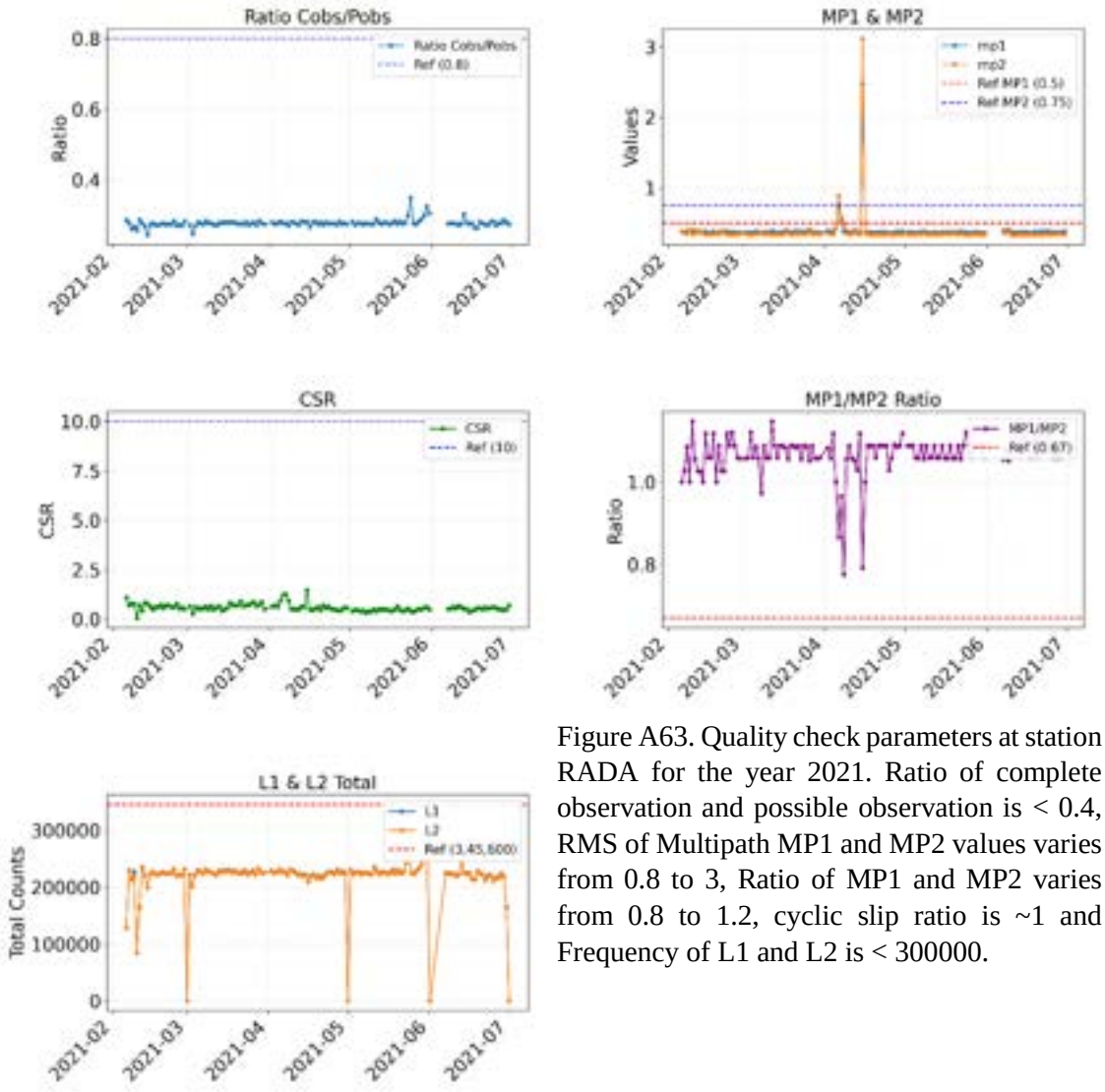


Figure A63. Quality check parameters at station RADA for the year 2021. Ratio of complete observation and possible observation is < 0.4, RMS of Multipath MP1 and MP2 values varies from 0.8 to 3, Ratio of MP1 and MP2 varies from 0.8 to 1.2, cyclic slip ratio is ~1 and Frequency of L1 and L2 is < 300000.

15. RAMN

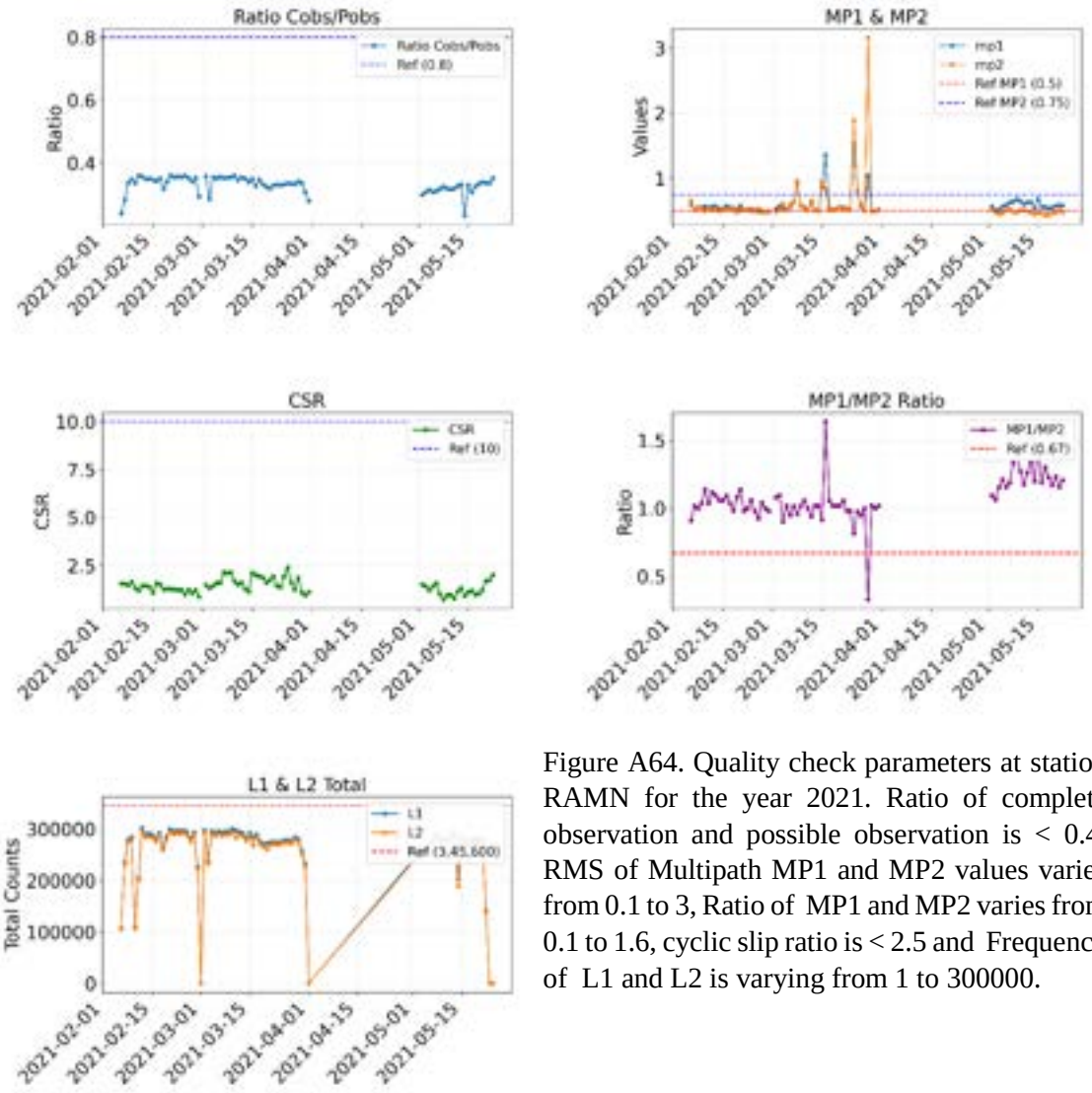


Figure A64. Quality check parameters at station RAMN for the year 2021. Ratio of complete observation and possible observation is < 0.4, RMS of Multipath MP1 and MP2 values varies from 0.1 to 3, Ratio of MP1 and MP2 varies from 0.1 to 1.6, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is varying from 1 to 300000.

16. RUTL

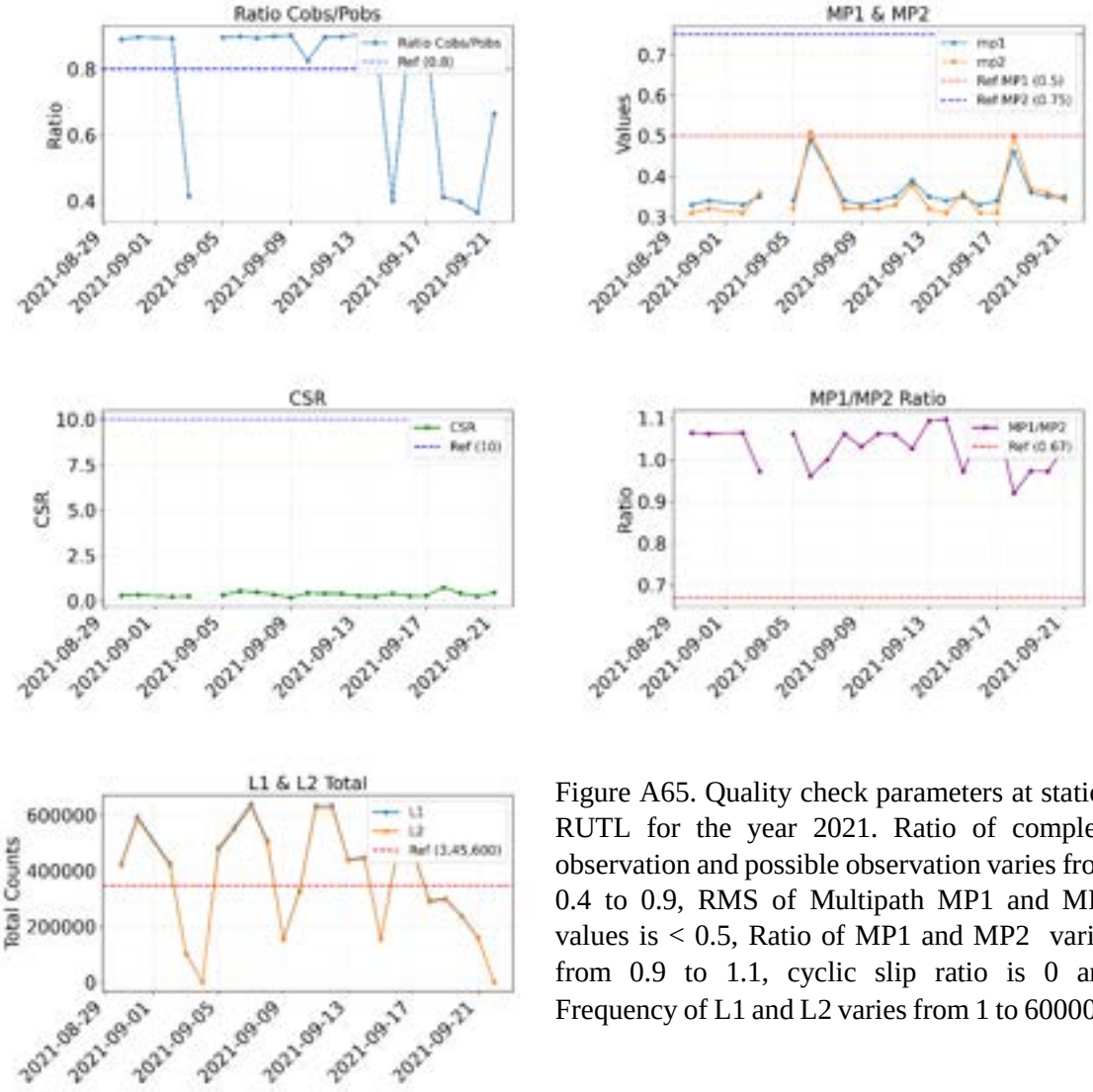


Figure A65. Quality check parameters at station RUTL for the year 2021. Ratio of complete observation and possible observation varies from 0.4 to 0.9, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 varies from 0.9 to 1.1, cyclic slip ratio is 0 and Frequency of L1 and L2 varies from 1 to 600000.

17. SLBY

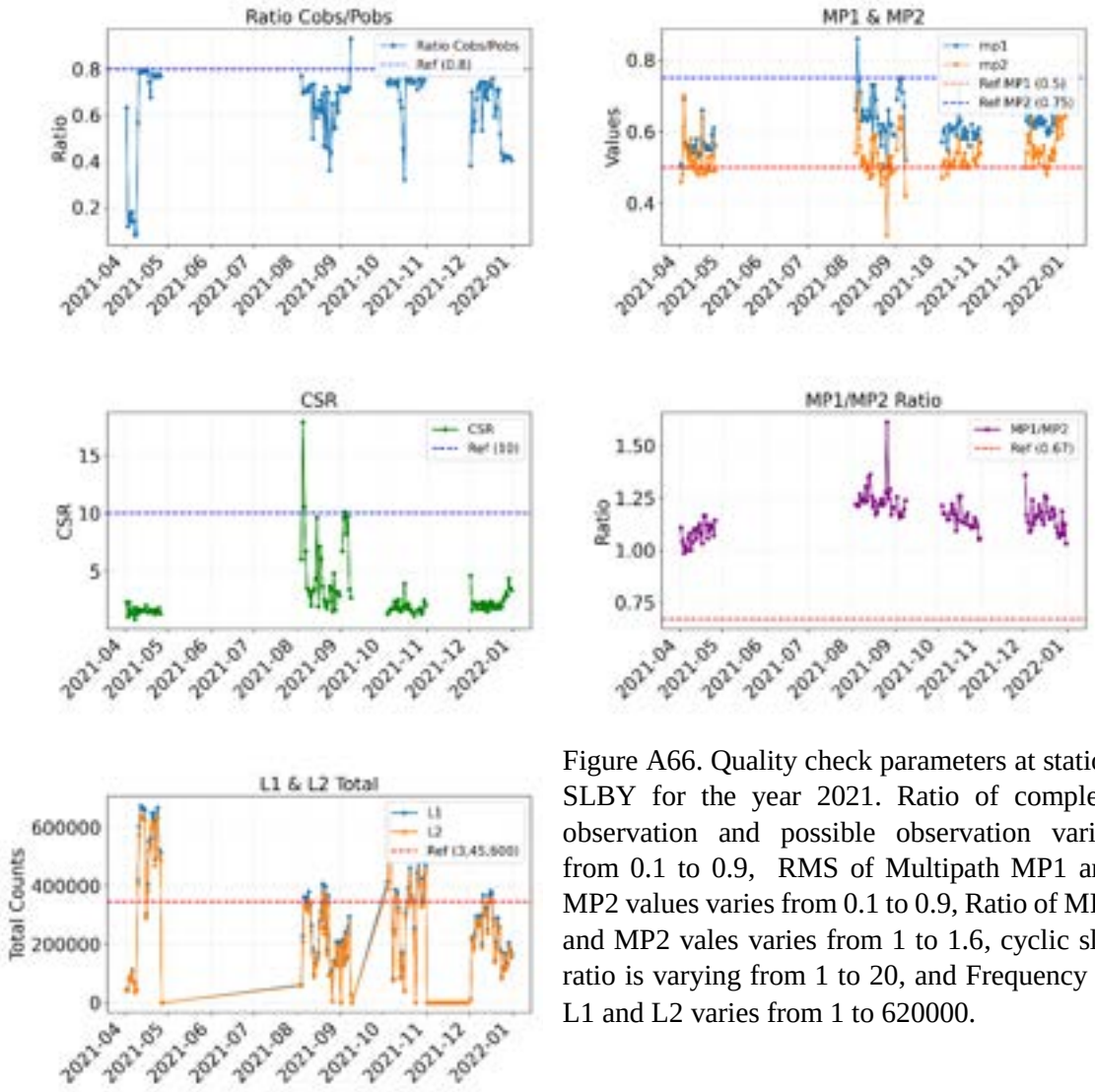


Figure A66. Quality check parameters at station SLBY for the year 2021. Ratio of complete observation and possible observation varies from 0.1 to 0.9, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.9, Ratio of MP1 and MP2 vales varies from 1 to 1.6, cyclic slip ratio is varying from 1 to 20, and Frequency of L1 and L2 varies from 1 to 620000.

18. TRIN

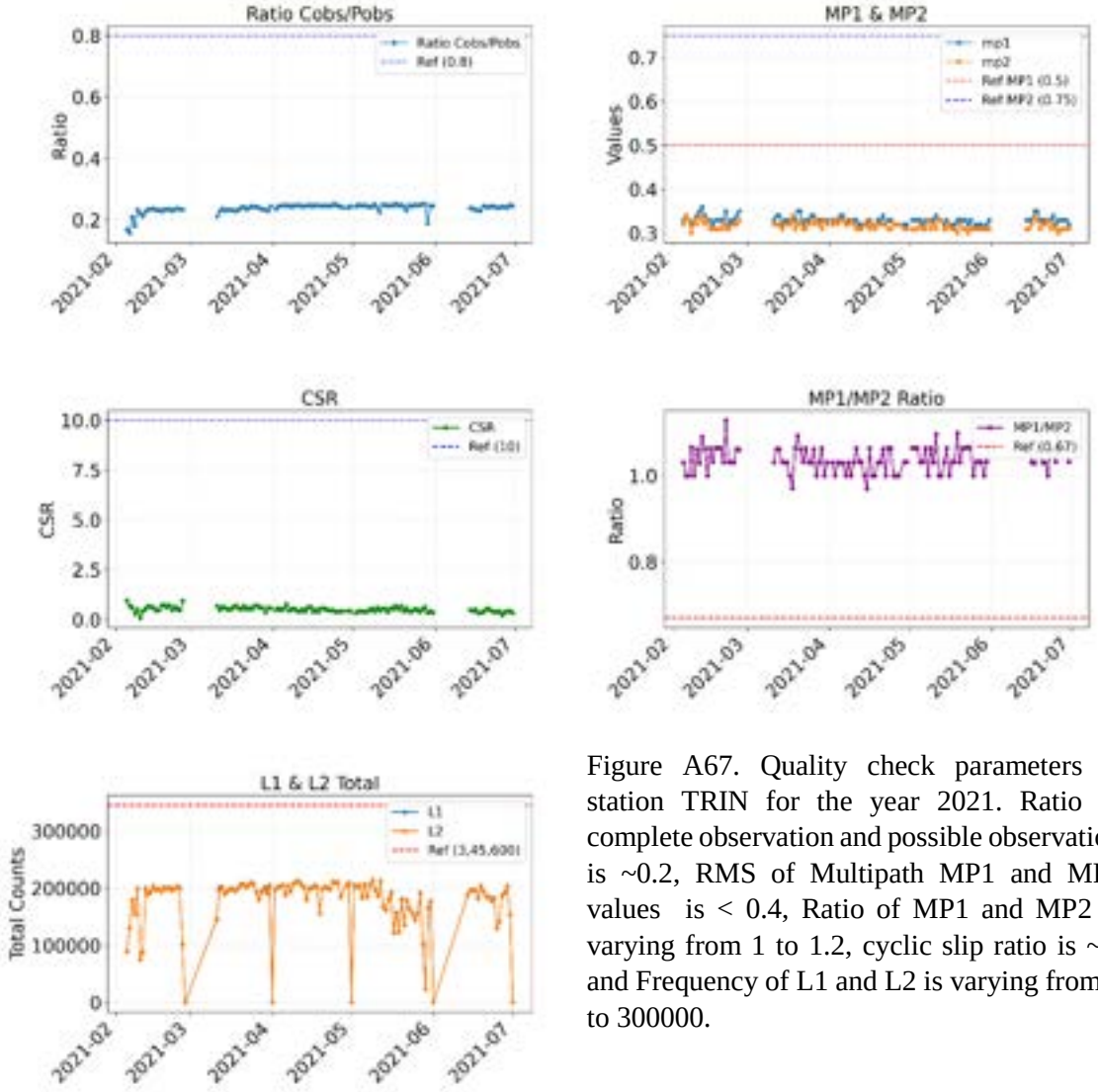


Figure A67. Quality check parameters at station TRIN for the year 2021. Ratio of complete observation and possible observation is ~0.2, RMS of Multipath MP1 and MP2 values is < 0.4, Ratio of MP1 and MP2 is varying from 1 to 1.2, cyclic slip ratio is ~0, and Frequency of L1 and L2 is varying from 0 to 300000.

19. UKAT

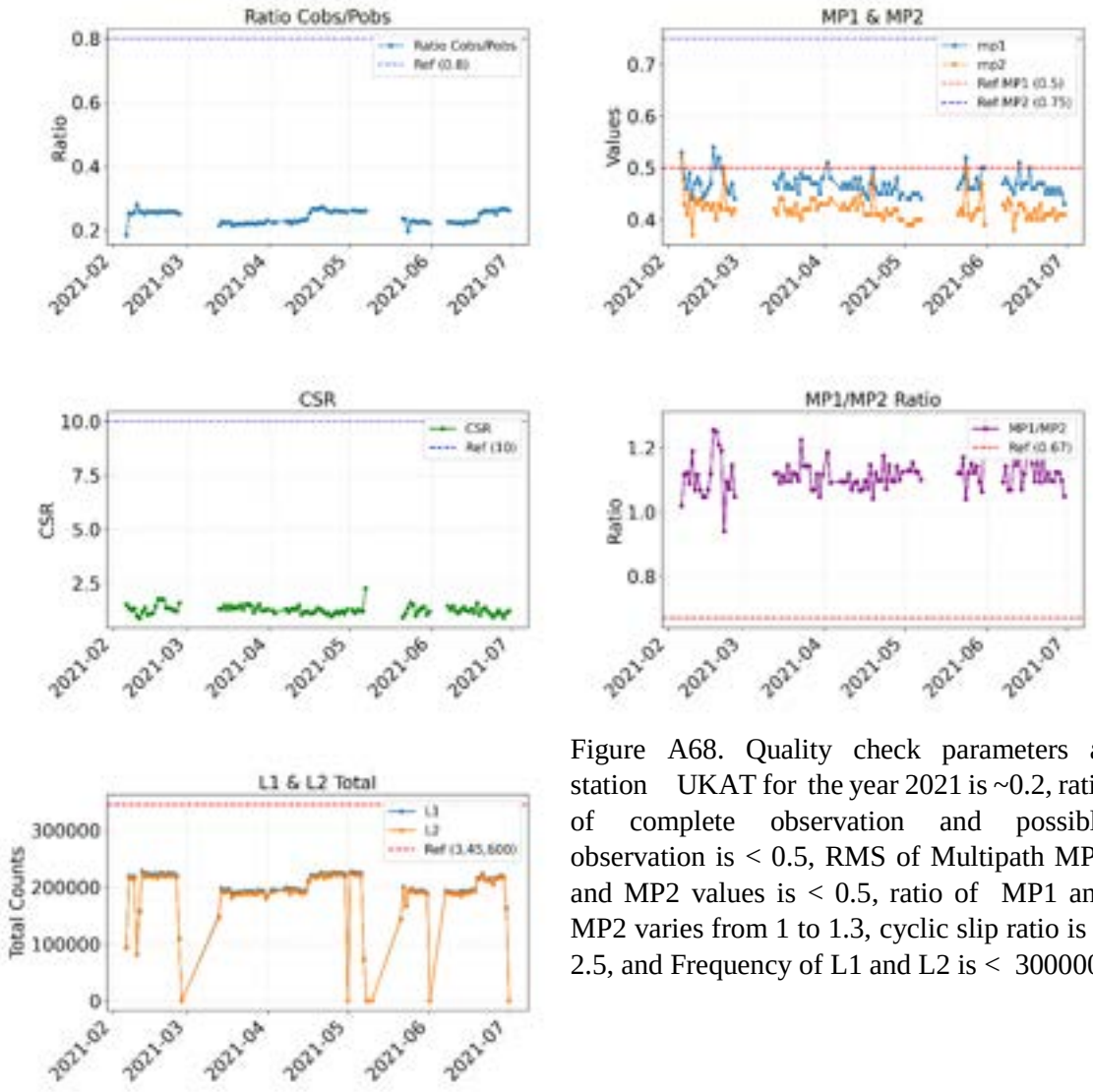


Figure A68. Quality check parameters at station UKAT for the year 2021 is ~0.2, ratio of complete observation and possible observation is < 0.5, RMS of Multipath MP1 and MP2 values is < 0.5, ratio of MP1 and MP2 varies from 1 to 1.3, cyclic slip ratio is < 2.5, and Frequency of L1 and L2 is < 300000.

YEAR 2022

1. BAKU

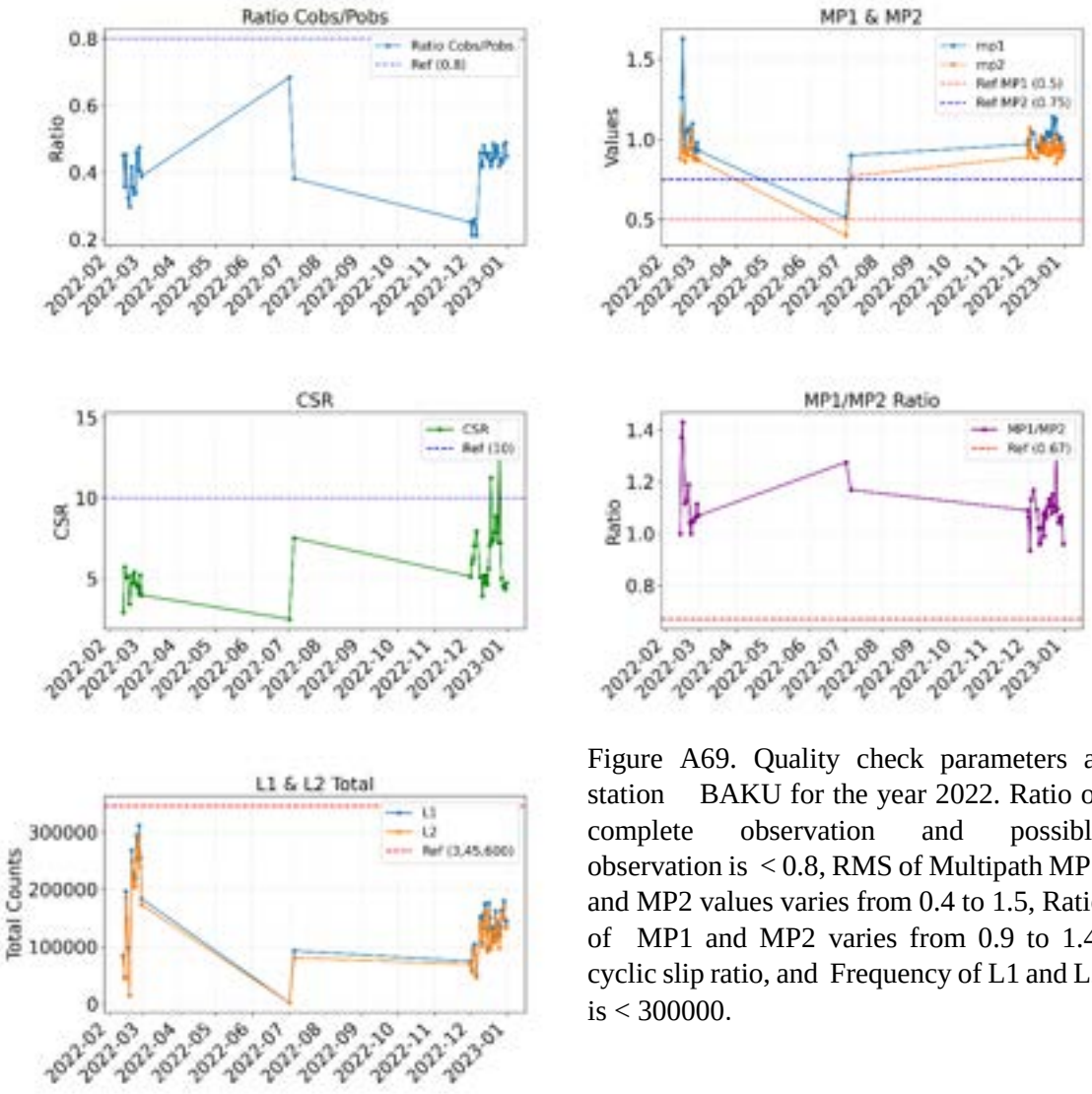


Figure A69. Quality check parameters at station BAKU for the year 2022. Ratio of complete observation and possible observation is < 0.8, RMS of Multipath MP1 and MP2 values varies from 0.4 to 1.5, Ratio of MP1 and MP2 varies from 0.9 to 1.4, cyclic slip ratio, and Frequency of L1 and L2 is < 300000.

2. ALUR

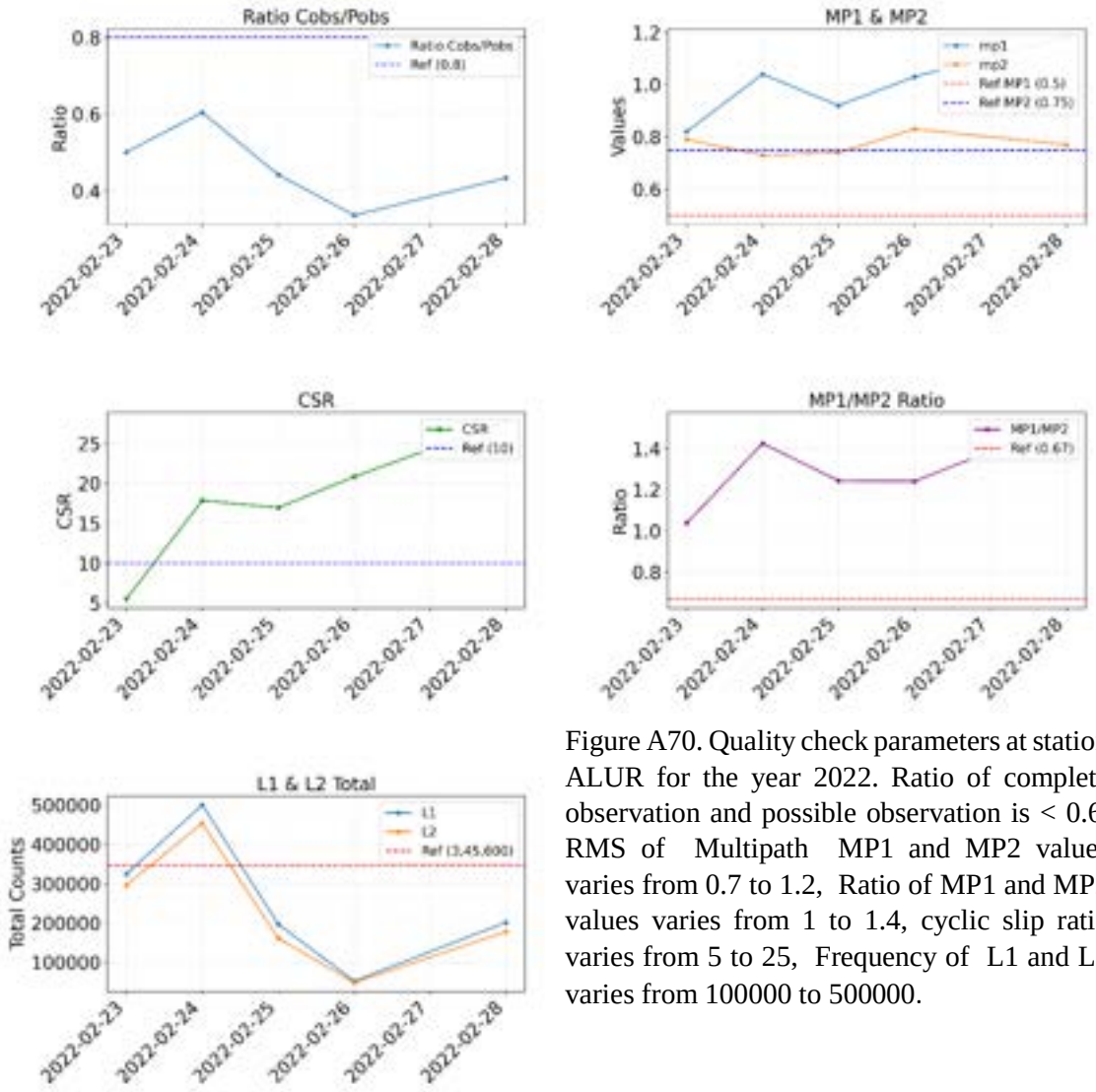


Figure A70. Quality check parameters at station ALUR for the year 2022. Ratio of complete observation and possible observation is < 0.6, RMS of Multipath MP1 and MP2 values varies from 0.7 to 1.2, Ratio of MP1 and MP2 values varies from 1 to 1.4, cyclic slip ratio varies from 5 to 25, Frequency of L1 and L2 varies from 100000 to 500000.

3. BETA

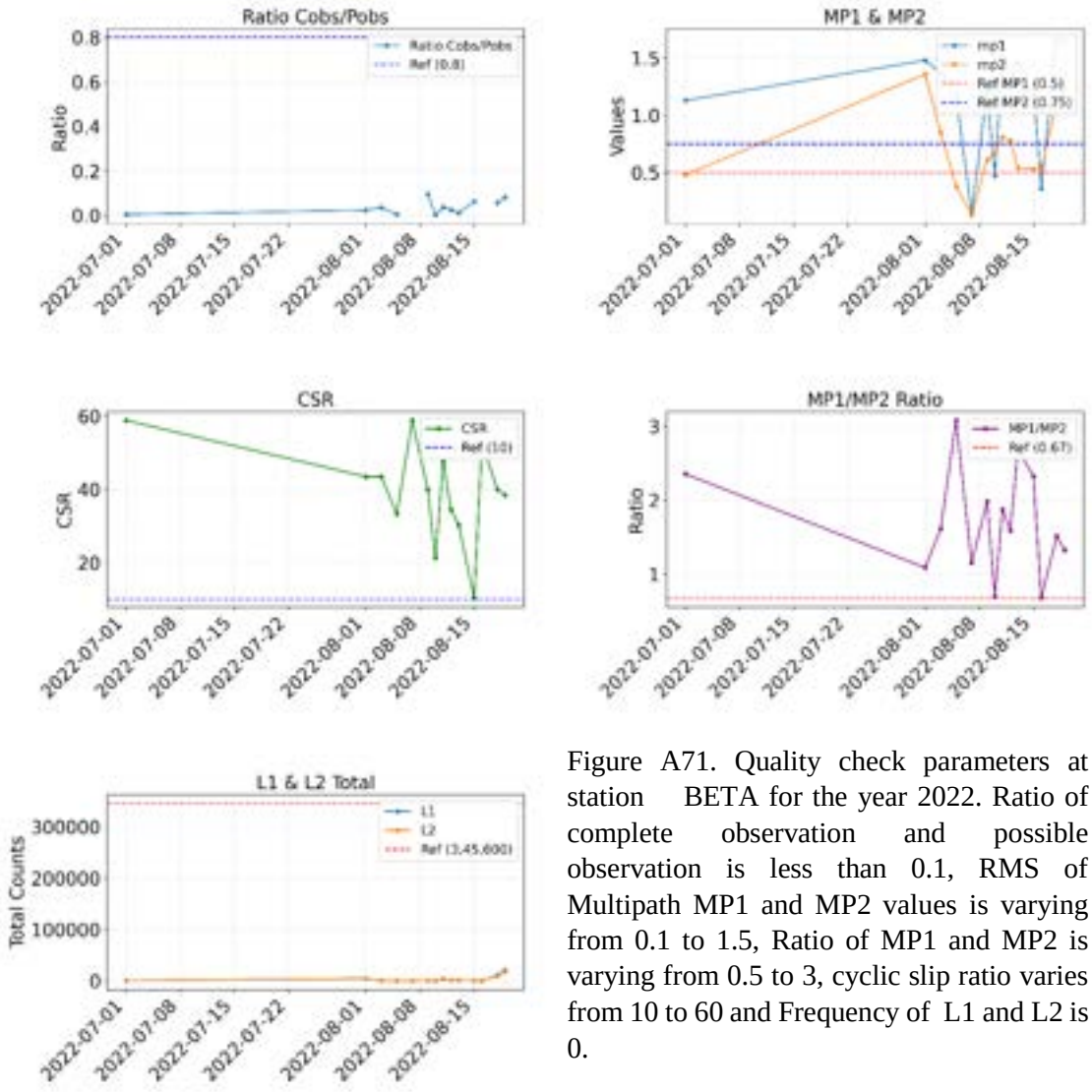


Figure A71. Quality check parameters at station BETA for the year 2022. Ratio of complete observation and possible observation is less than 0.1, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 1.5, Ratio of MP1 and MP2 is varying from 0.5 to 3, cyclic slip ratio varies from 10 to 60 and Frequency of L1 and L2 is 0.

4. CHID

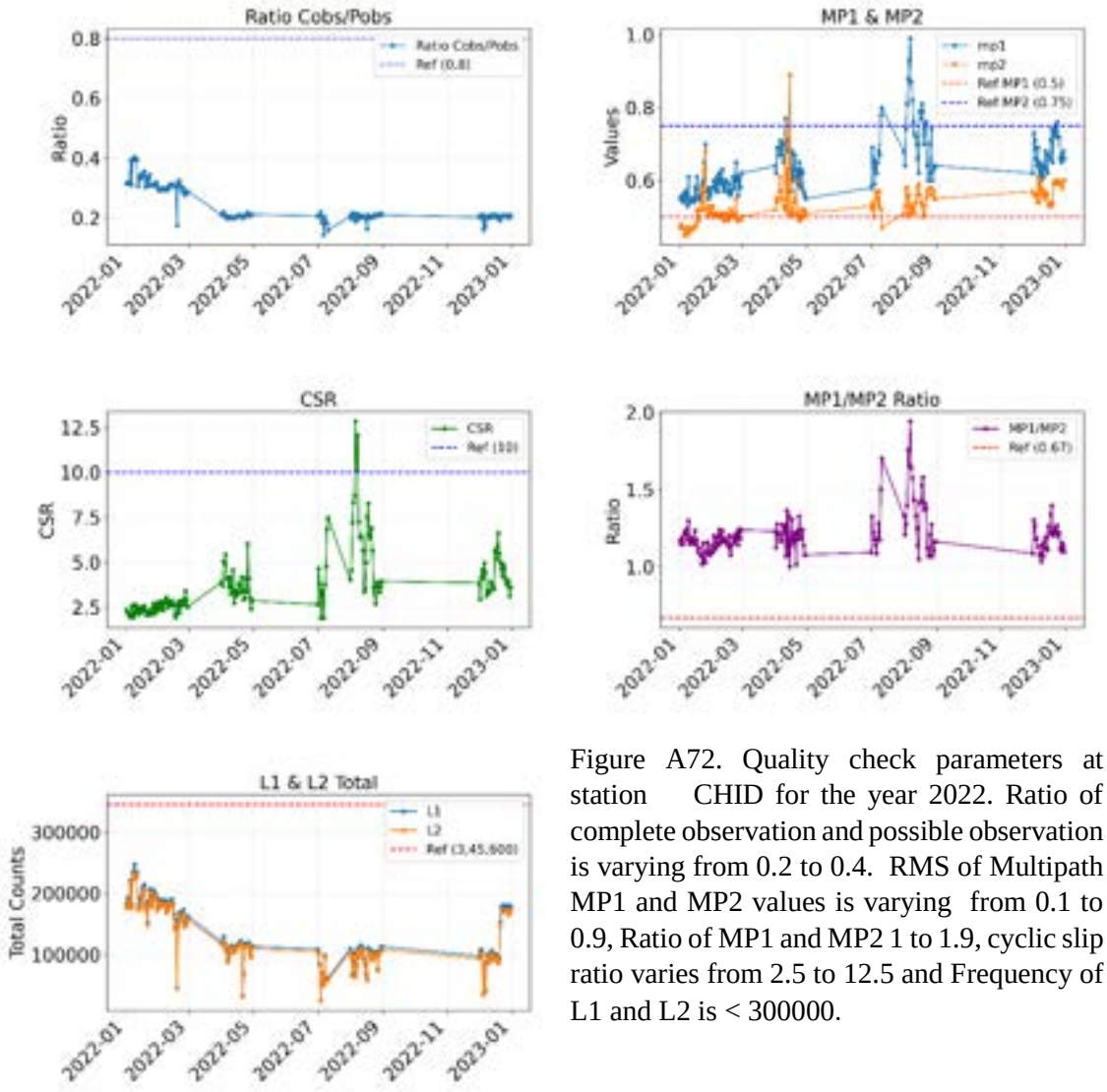


Figure A72. Quality check parameters at station CHID for the year 2022. Ratio of complete observation and possible observation is varying from 0.2 to 0.4. RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.9, Ratio of MP1 and MP2 1 to 1.9, cyclic slip ratio varies from 2.5 to 12.5 and Frequency of L1 and L2 is < 300000.

5. CWRA

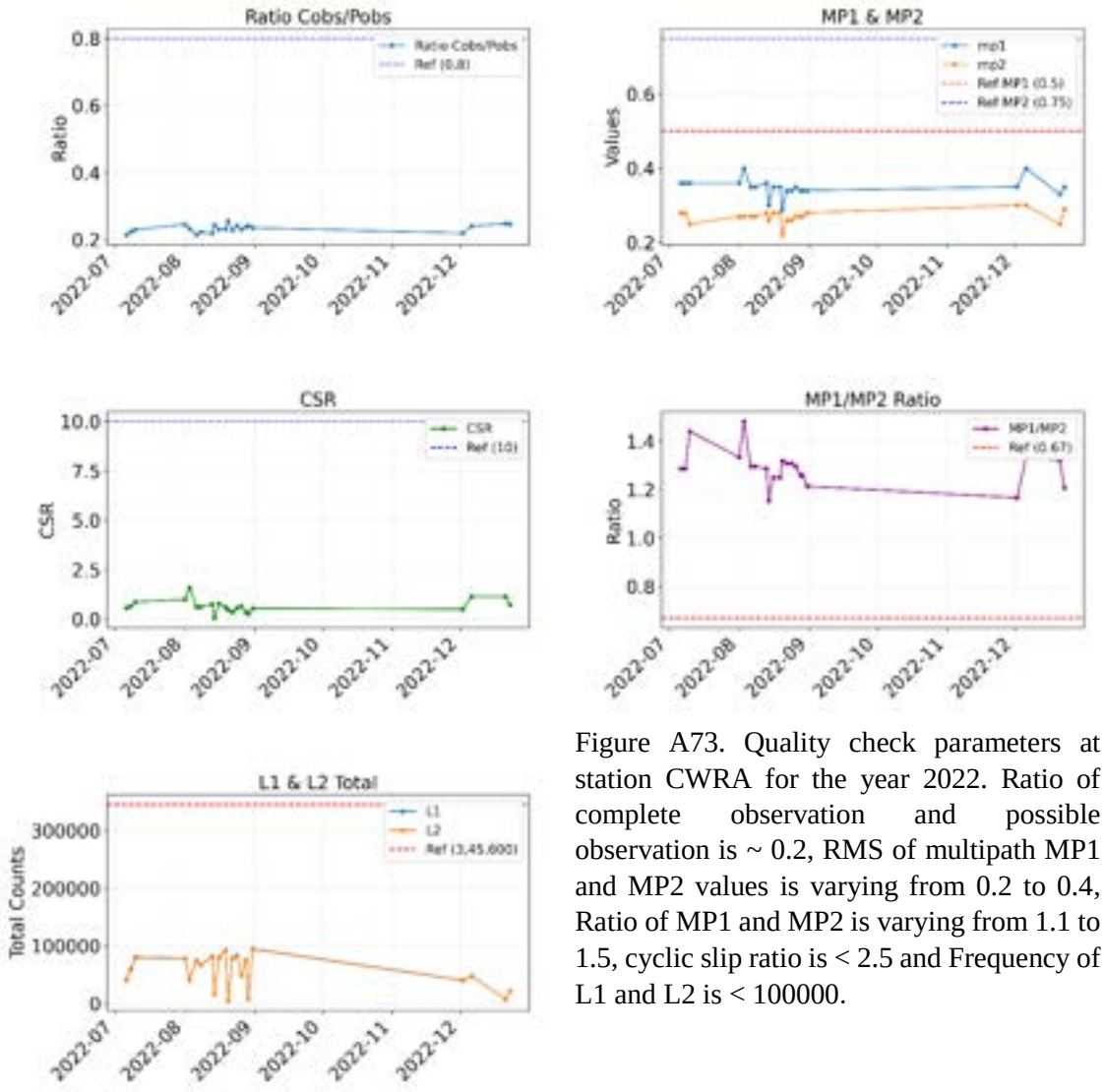


Figure A73. Quality check parameters at station CWRA for the year 2022. Ratio of complete observation and possible observation is ~ 0.2, RMS of multipath MP1 and MP2 values is varying from 0.2 to 0.4, Ratio of MP1 and MP2 is varying from 1.1 to 1.5, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is < 100000.

6. DGPR

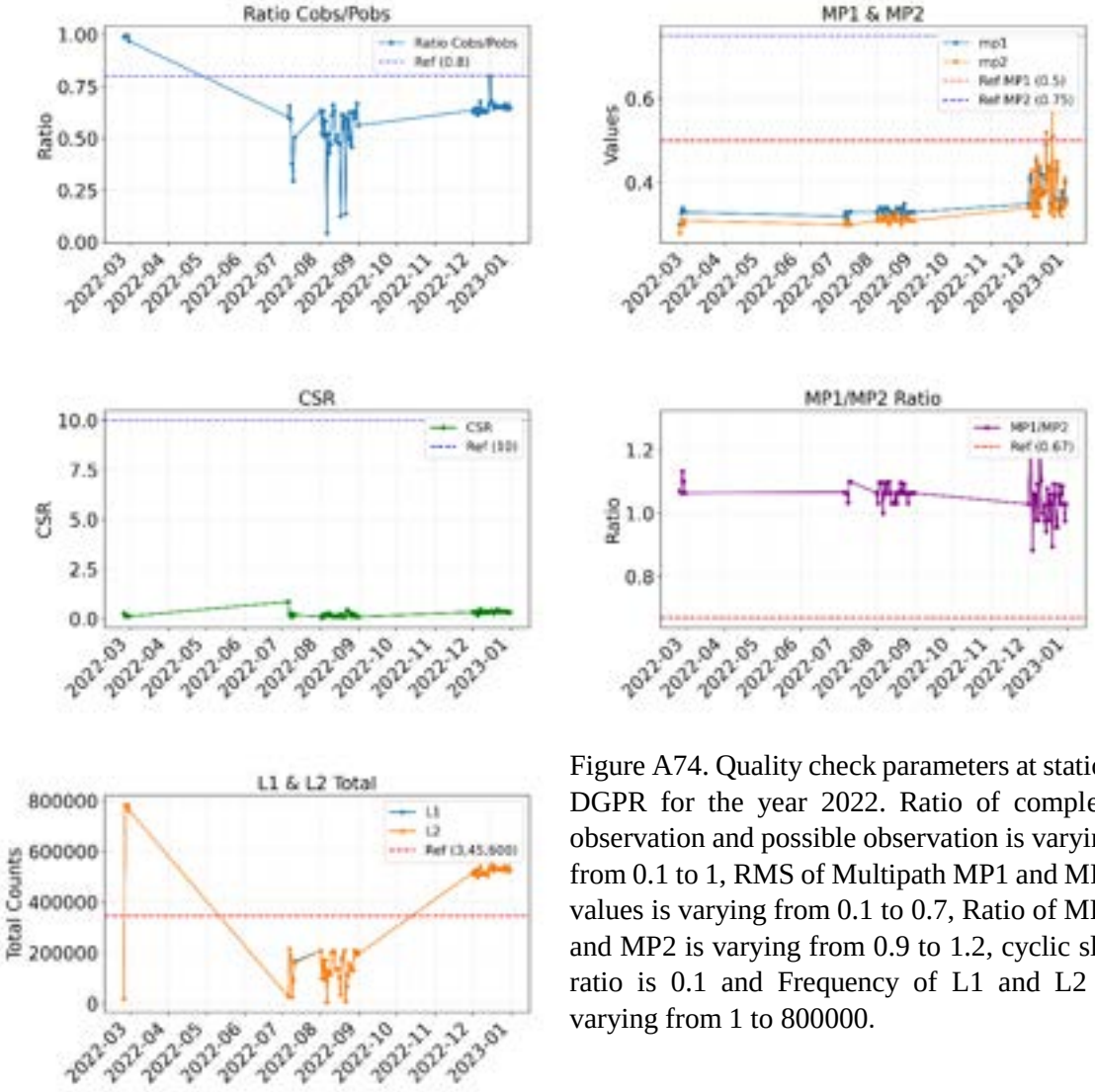


Figure A74. Quality check parameters at station DGPR for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 1, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.7, Ratio of MP1 and MP2 is varying from 0.9 to 1.2, cyclic slip ratio is 0.1 and Frequency of L1 and L2 is varying from 1 to 800000.

7. FERR

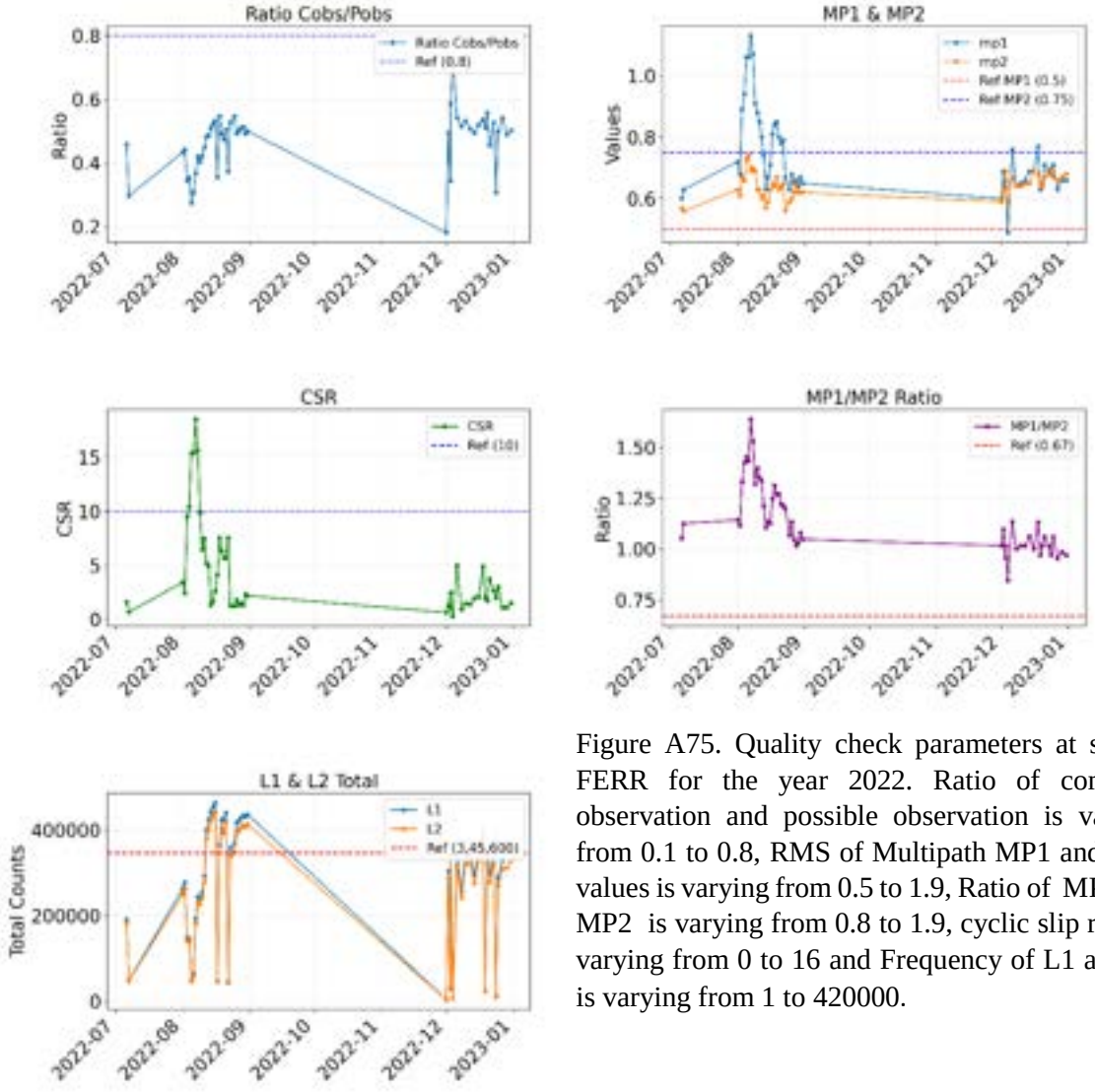


Figure A75. Quality check parameters at station FERR for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 1.9, Ratio of MP1 and MP2 is varying from 0.8 to 1.9, cyclic slip ratio is varying from 0 to 16 and Frequency of L1 and L2 is varying from 1 to 420000.

8. KISH

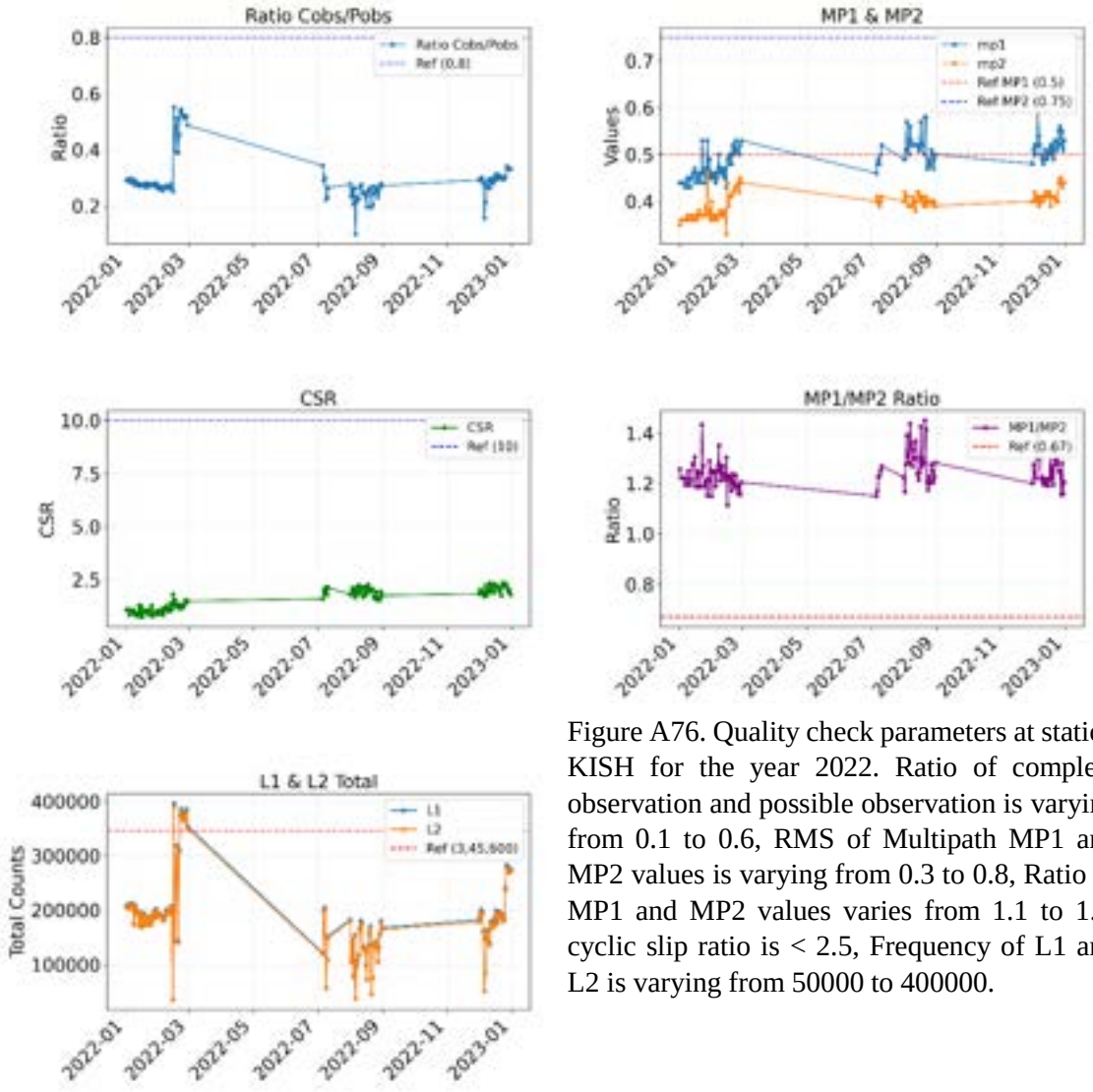


Figure A76. Quality check parameters at station KISH for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.6, RMS of Multipath MP1 and MP2 values is varying from 0.3 to 0.8, Ratio of MP1 and MP2 values varies from 1.1 to 1.5, cyclic slip ratio is < 2.5, Frequency of L1 and L2 is varying from 50000 to 400000.

9. KLPT

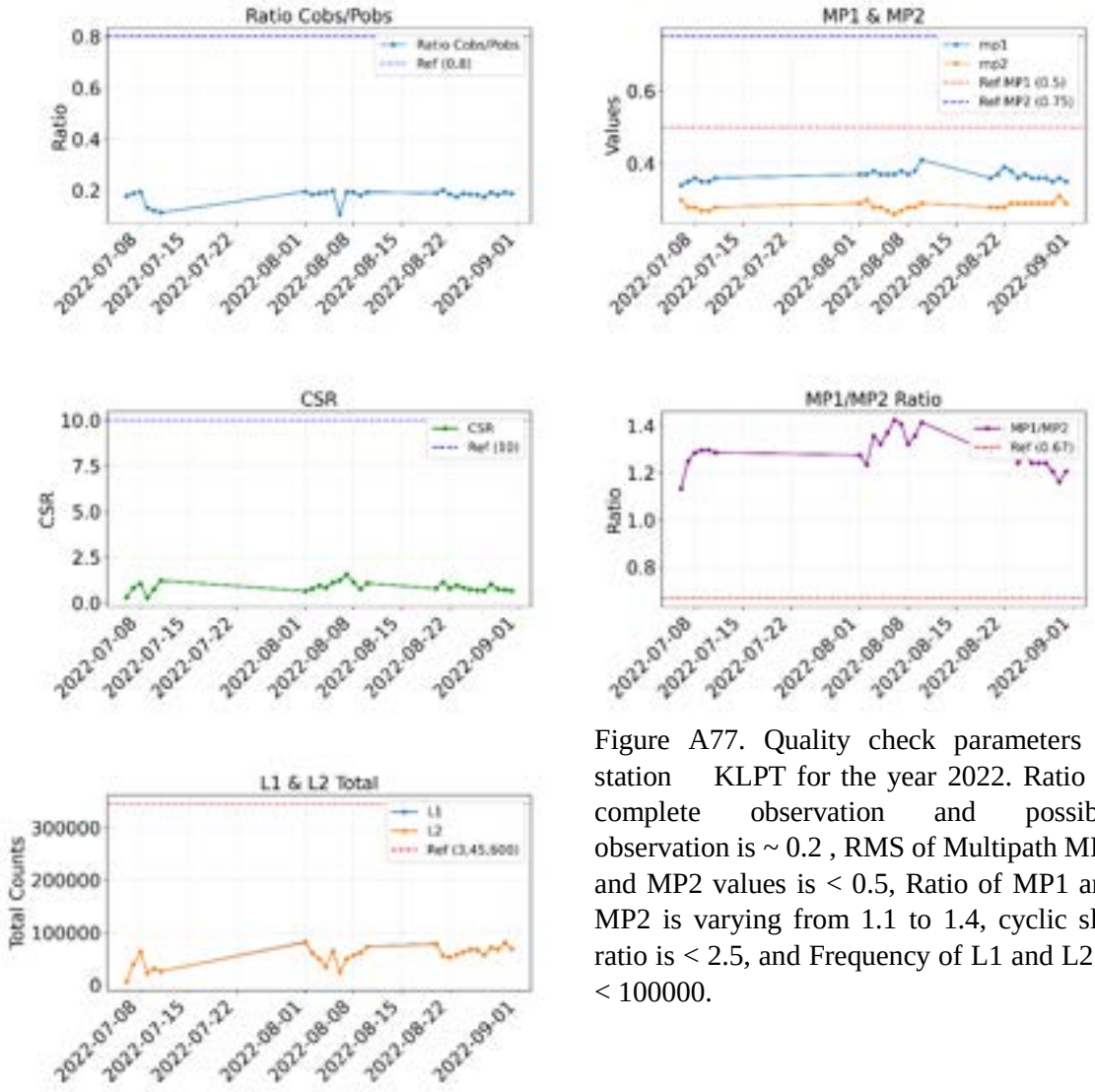


Figure A77. Quality check parameters at station KLPT for the year 2022. Ratio of complete observation and possible observation is ~ 0.2 , RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is varying from 1.1 to 1.4, cyclic slip ratio is < 2.5, and Frequency of L1 and L2 is < 100000.

10. MAKA

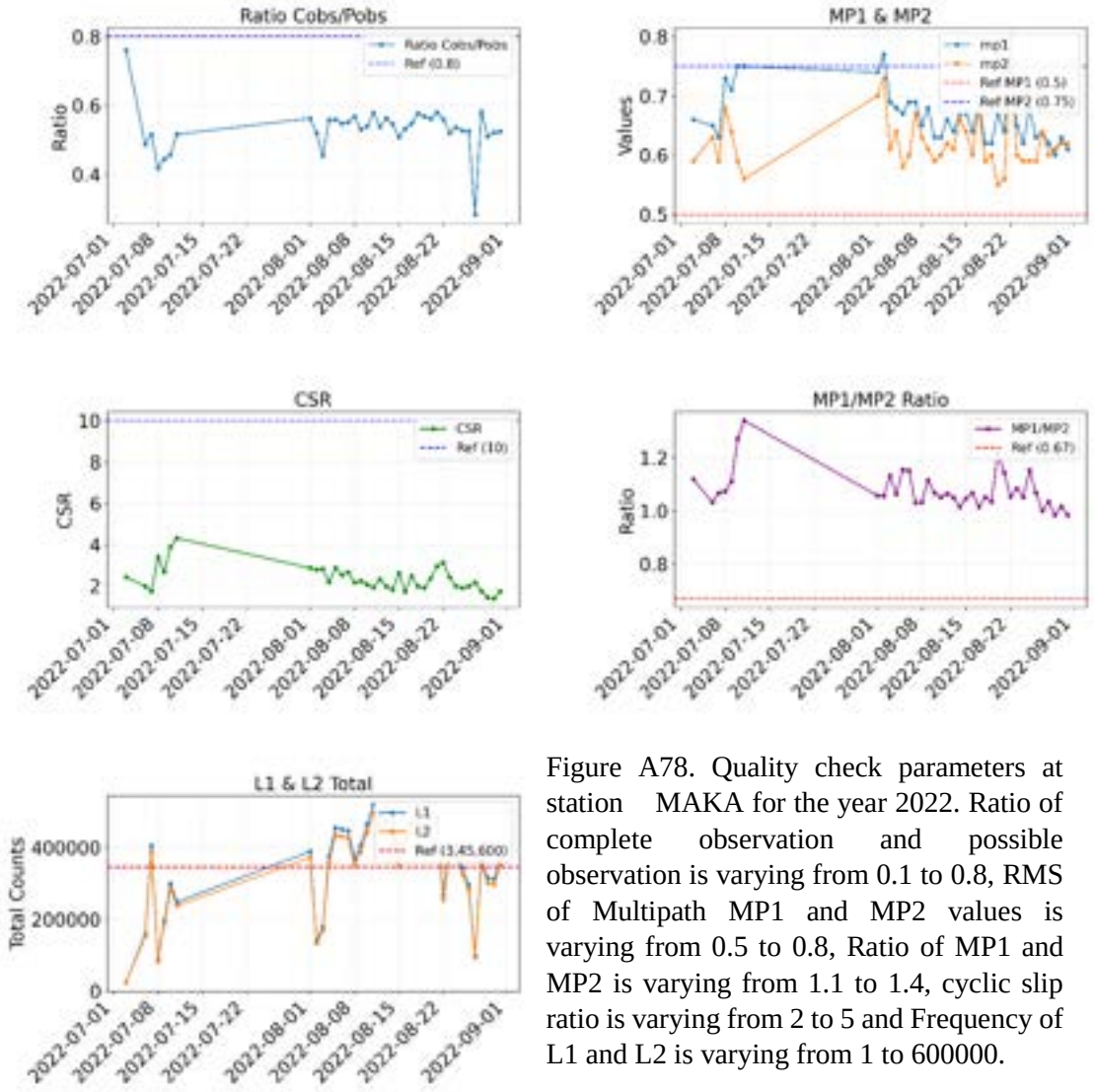


Figure A78. Quality check parameters at station MAKA for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 0.8, Ratio of MP1 and MP2 is varying from 1.1 to 1.4, cyclic slip ratio is varying from 2 to 5 and Frequency of L1 and L2 is varying from 1 to 600000.

11. MBDR

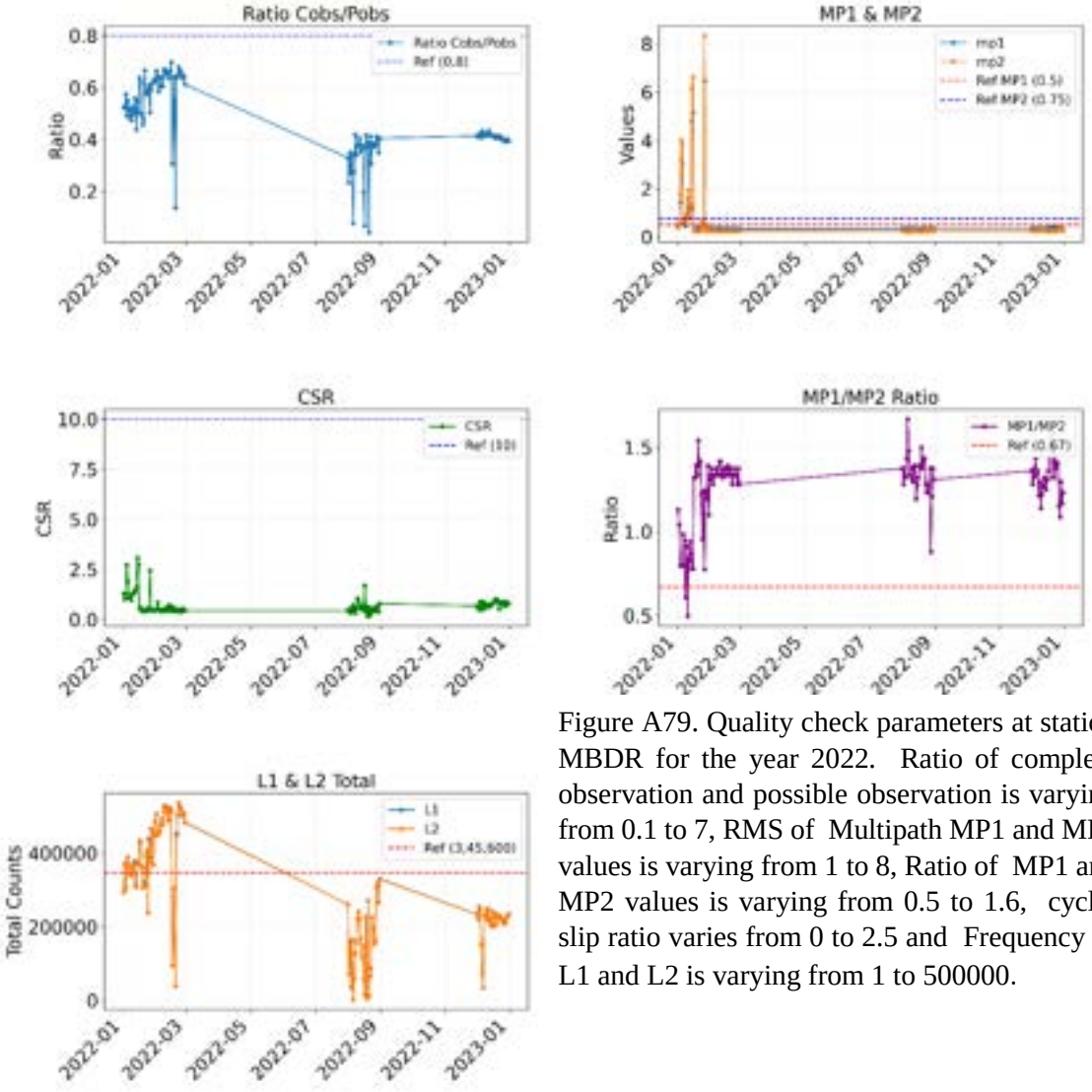


Figure A79. Quality check parameters at station MBDR for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 7, RMS of Multipath MP1 and MP2 values is varying from 1 to 8, Ratio of MP1 and MP2 values is varying from 0.5 to 1.6, cyclic slip ratio varies from 0 to 2.5 and Frequency of L1 and L2 is varying from 1 to 500000.

12. MOHA

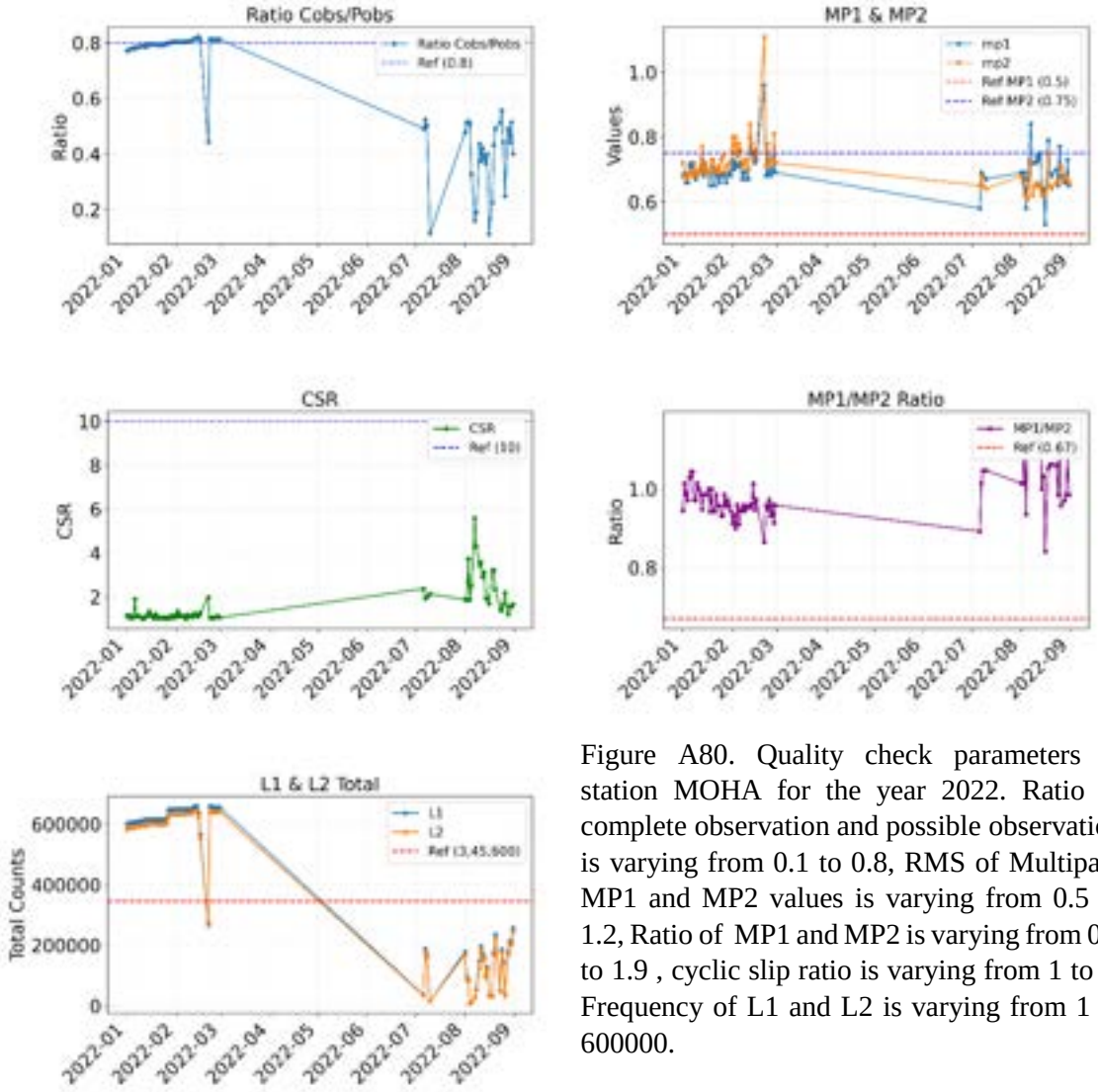


Figure A80. Quality check parameters at station MOHA for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 1.2, Ratio of MP1 and MP2 is varying from 0.9 to 1.9 , cyclic slip ratio is varying from 1 to 6, Frequency of L1 and L2 is varying from 1 to 600000.

13. NAMU

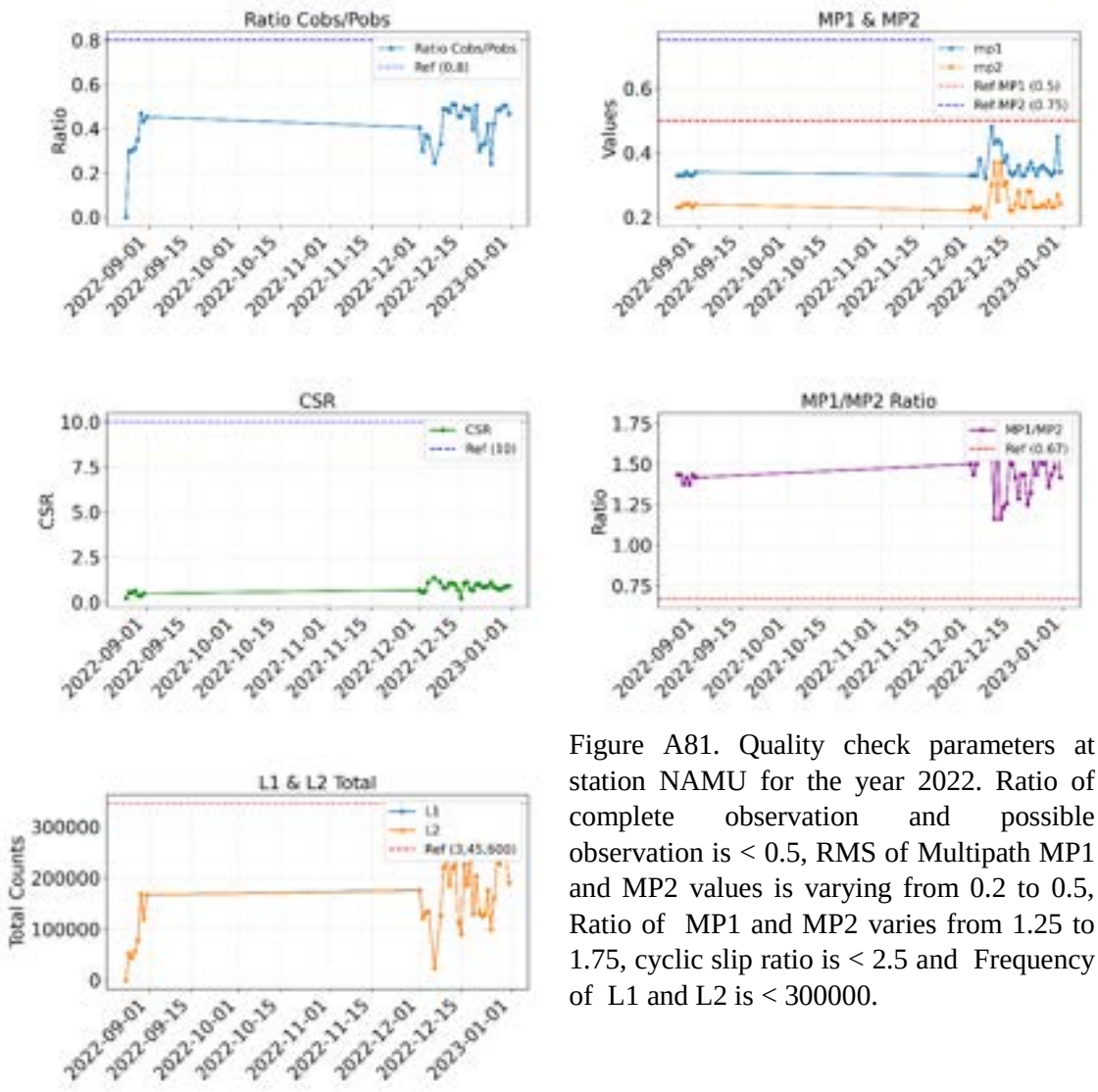


Figure A81. Quality check parameters at station NAMU for the year 2022. Ratio of complete observation and possible observation is < 0.5, RMS of Multipath MP1 and MP2 values is varying from 0.2 to 0.5, Ratio of MP1 and MP2 varies from 1.25 to 1.75, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is < 300000.

14. NIMB

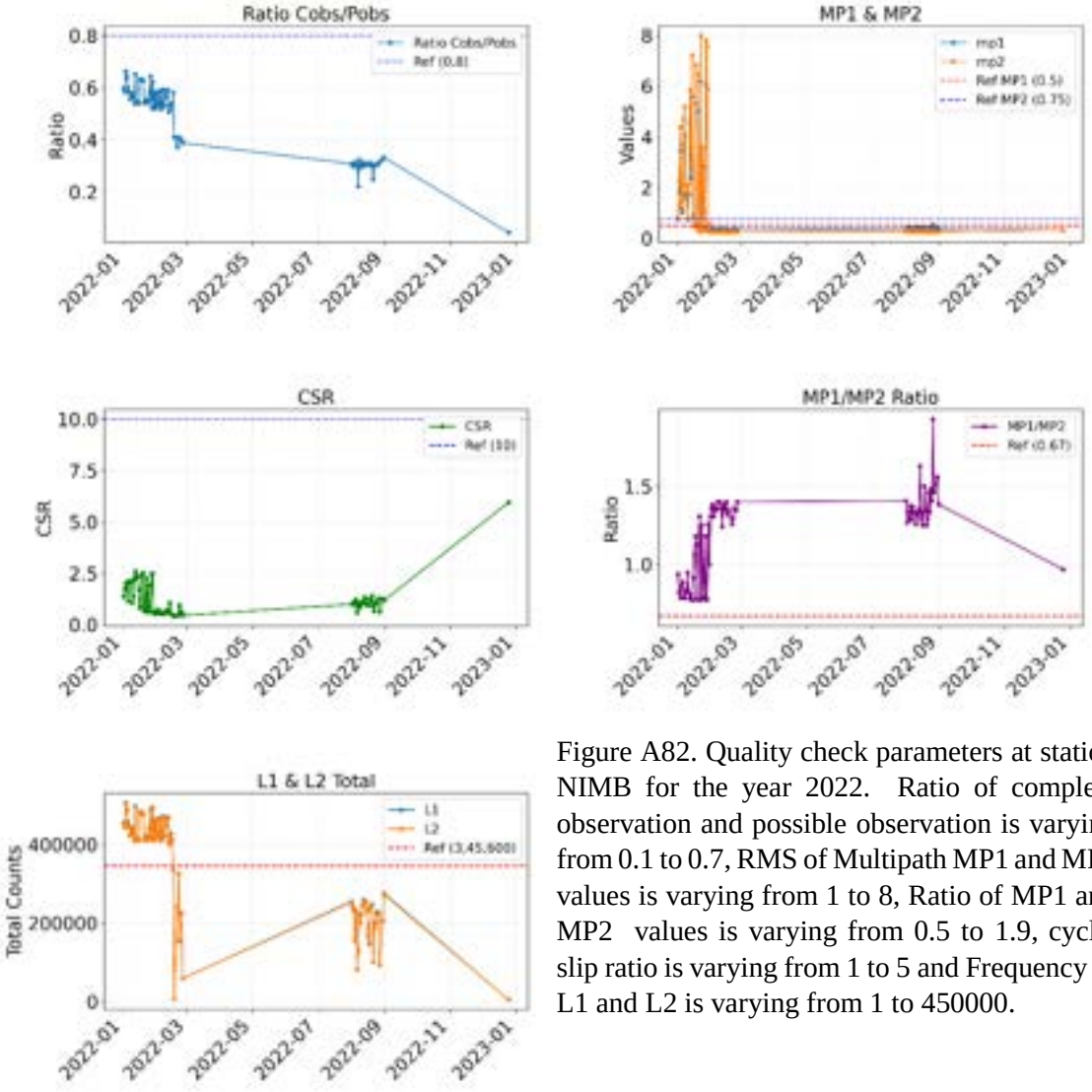
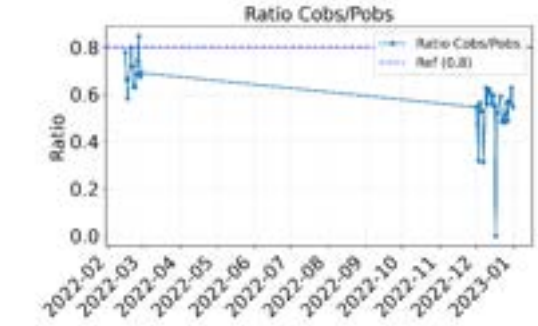
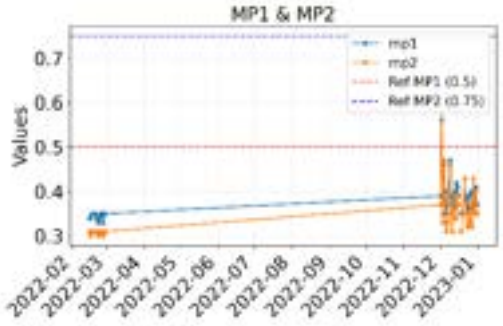
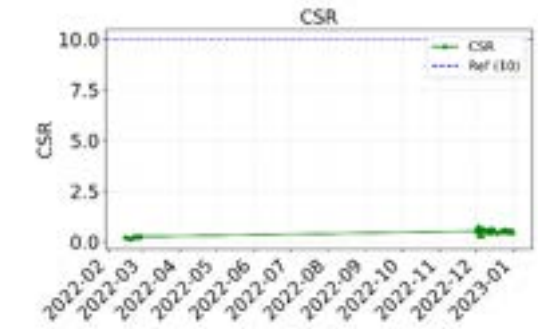


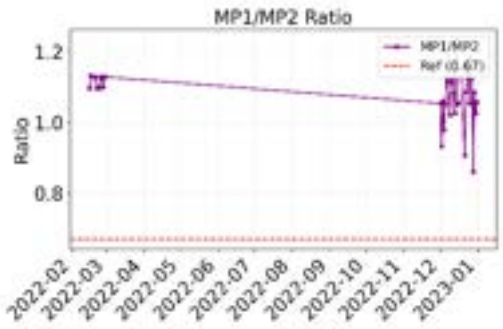
Figure A82. Quality check parameters at station NIMB for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.7, RMS of Multipath MP1 and MP2 values is varying from 1 to 8, Ratio of MP1 and MP2 values is varying from 0.5 to 1.9, cyclic slip ratio is varying from 1 to 5 and Frequency of L1 and L2 is varying from 1 to 450000.

15. RADA









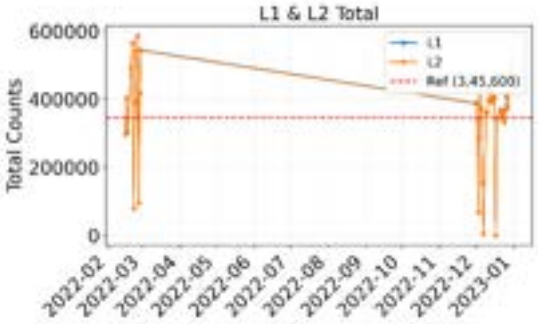


Figure A83. Quality check parameters at station RADA for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.3 to 0.6, Ratio of MP1 and MP2 is varying from 0.9 to 1.2, cyclic slip ratio is < 0.1, Frequency of L1 and L2 is varying from 1 to 600000.

16. RUTL

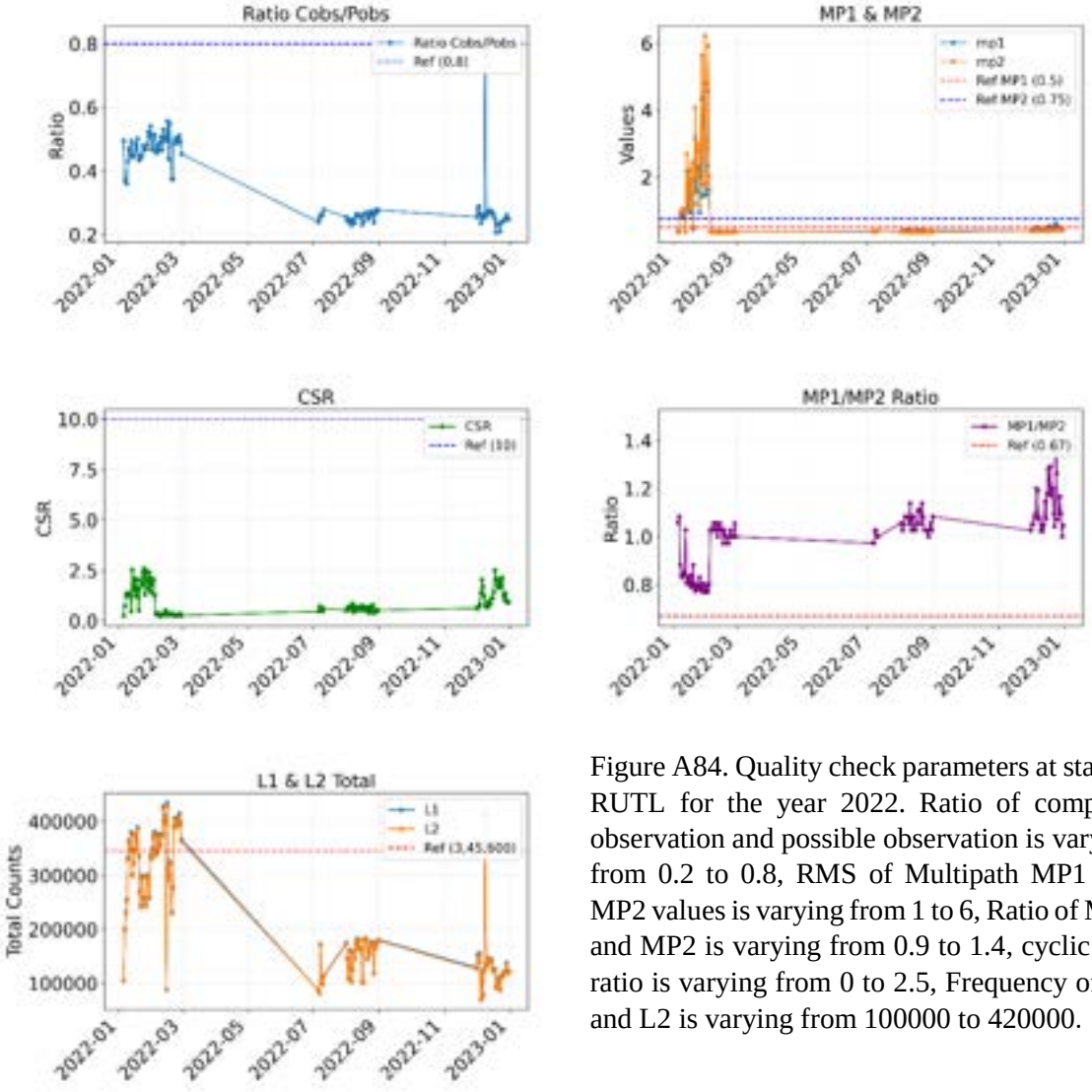


Figure A84. Quality check parameters at station RUTL for the year 2022. Ratio of complete observation and possible observation is varying from 0.2 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 1 to 6, Ratio of MP1 and MP2 is varying from 0.9 to 1.4, cyclic slip ratio is varying from 0 to 2.5, Frequency of L1 and L2 is varying from 100000 to 420000.

17. SHOA

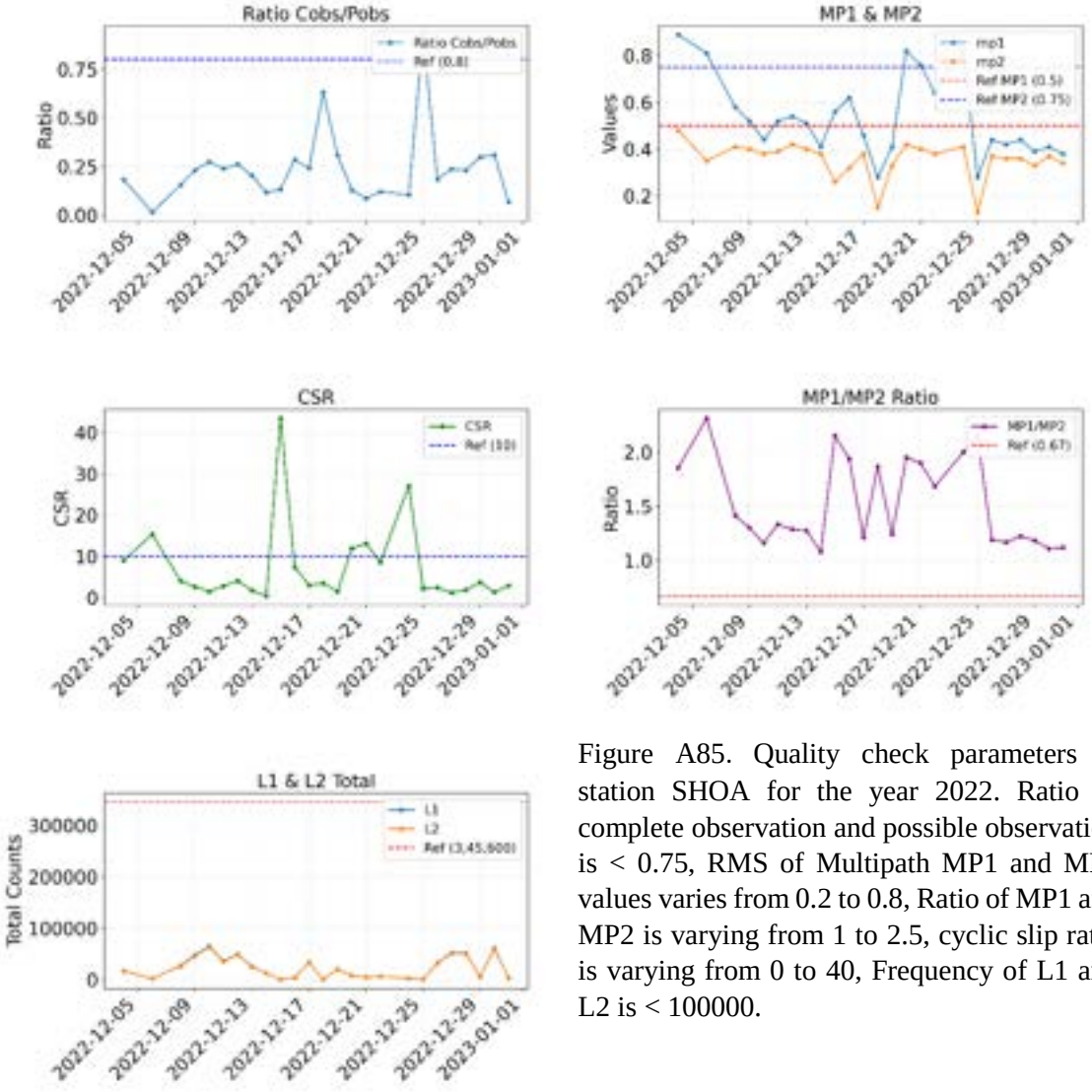


Figure A85. Quality check parameters at station SHOA for the year 2022. Ratio of complete observation and possible observation is < 0.75, RMS of Multipath MP1 and MP2 values varies from 0.2 to 0.8, Ratio of MP1 and MP2 is varying from 1 to 2.5, cyclic slip ratio is varying from 0 to 40, Frequency of L1 and L2 is < 100000.

18. SHAS

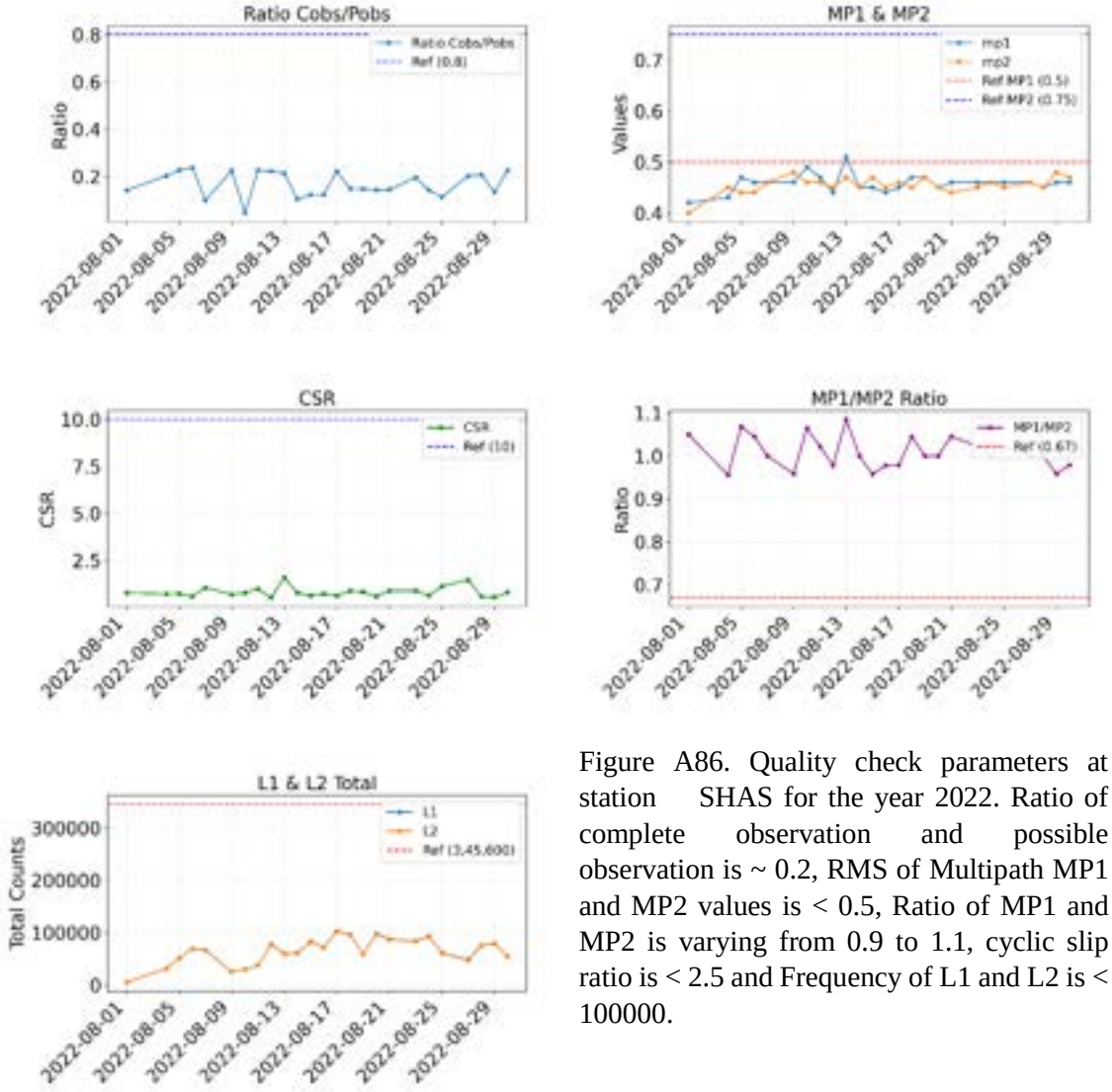


Figure A86. Quality check parameters at station SHAS for the year 2022. Ratio of complete observation and possible observation is ~ 0.2, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is varying from 0.9 to 1.1, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is < 100000.

19. SLBY

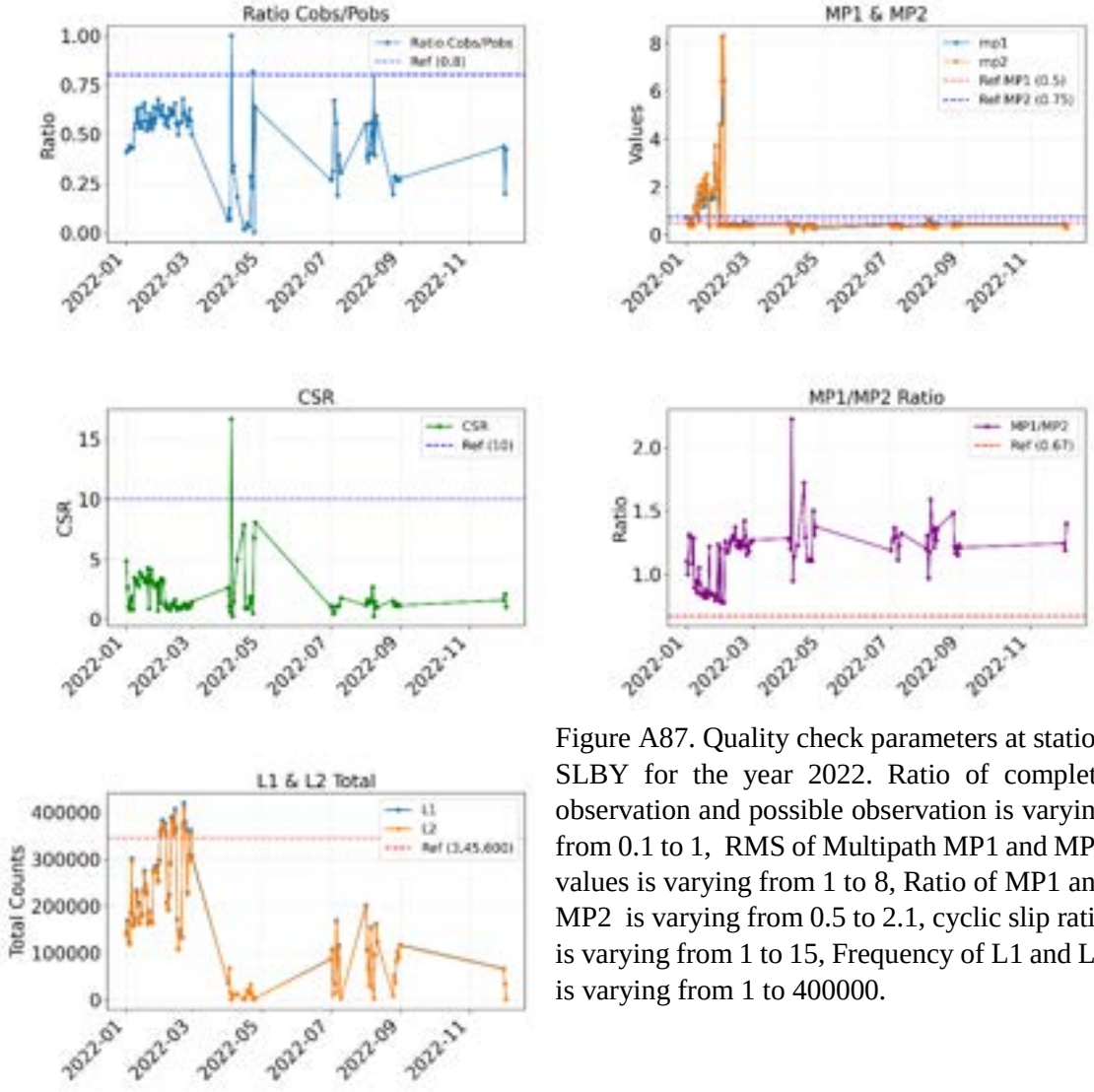


Figure A87. Quality check parameters at station SLBY for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 1, RMS of Multipath MP1 and MP2 values is varying from 1 to 8, Ratio of MP1 and MP2 is varying from 0.5 to 2.1, cyclic slip ratio is varying from 1 to 15, Frequency of L1 and L2 is varying from 1 to 400000.

20. TRIN

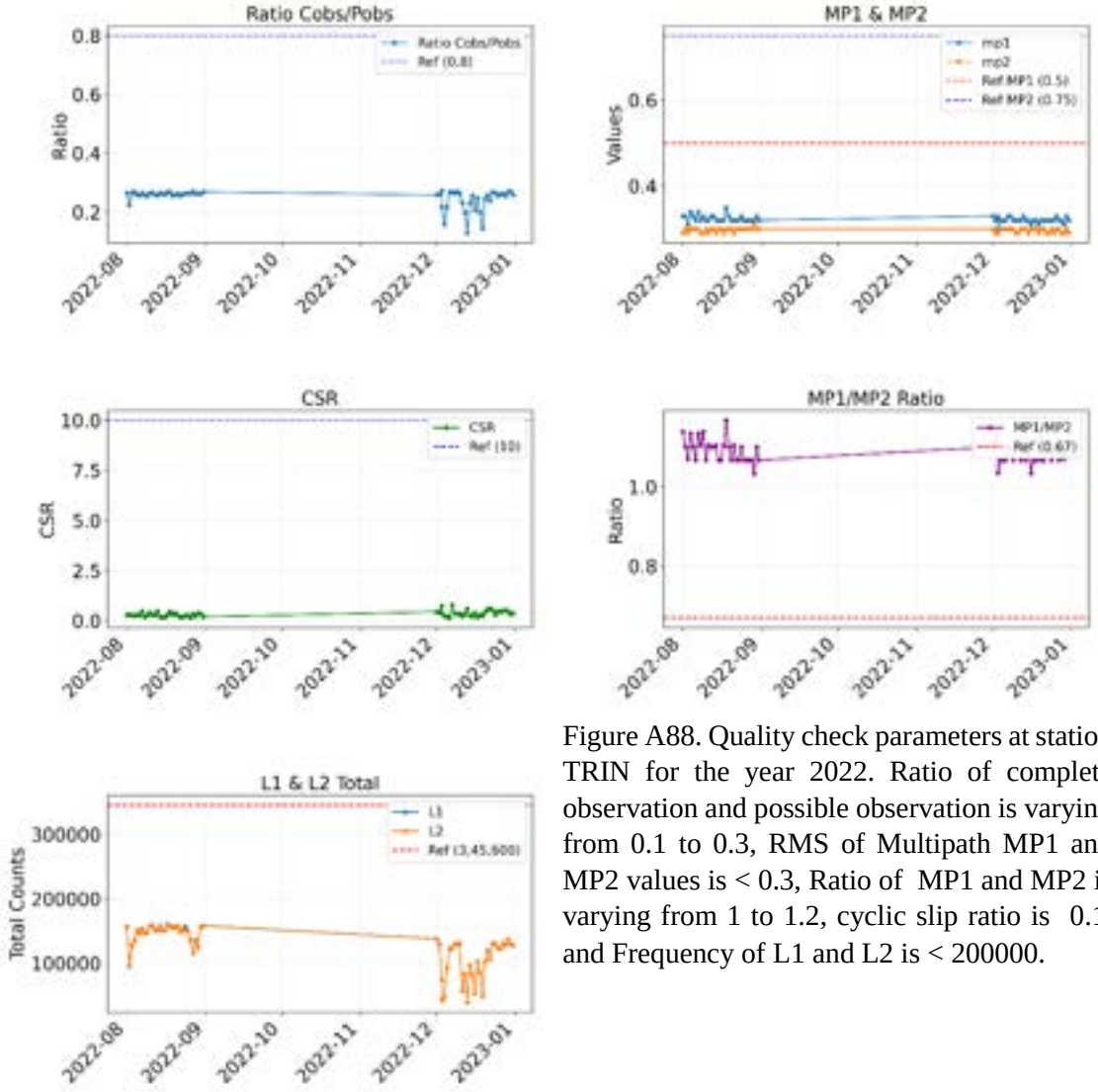


Figure A88. Quality check parameters at station TRIN for the year 2022. Ratio of complete observation and possible observation is varying from 0.1 to 0.3, RMS of Multipath MP1 and MP2 values is < 0.3, Ratio of MP1 and MP2 is varying from 1 to 1.2, cyclic slip ratio is 0.1, and Frequency of L1 and L2 is < 200000.

21. UKAT

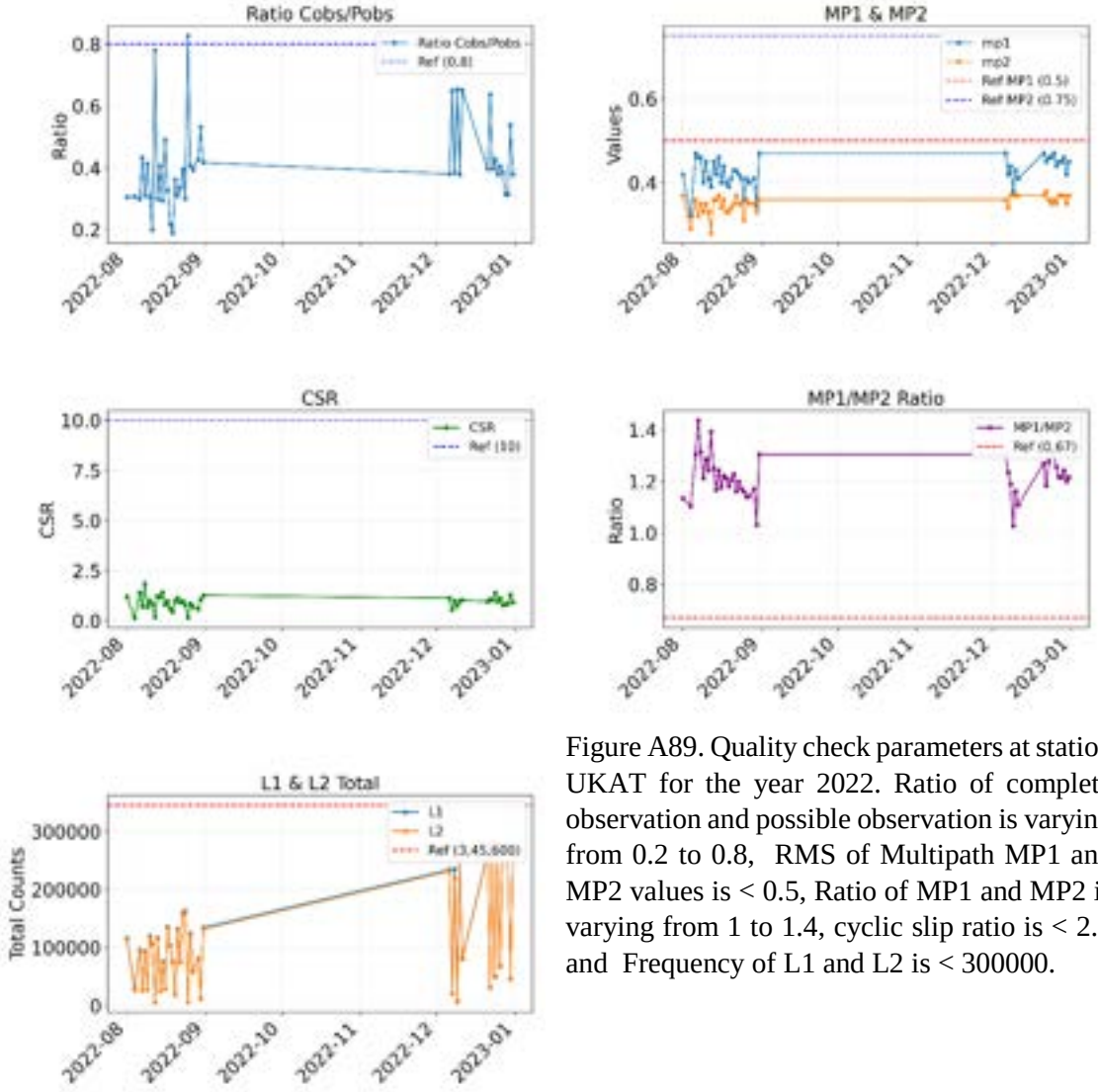


Figure A89. Quality check parameters at station UKAT for the year 2022. Ratio of complete observation and possible observation is varying from 0.2 to 0.8, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.4, cyclic slip ratio is < 2.5 and Frequency of L1 and L2 is < 300000.

YEAR 2024

1. ALUR

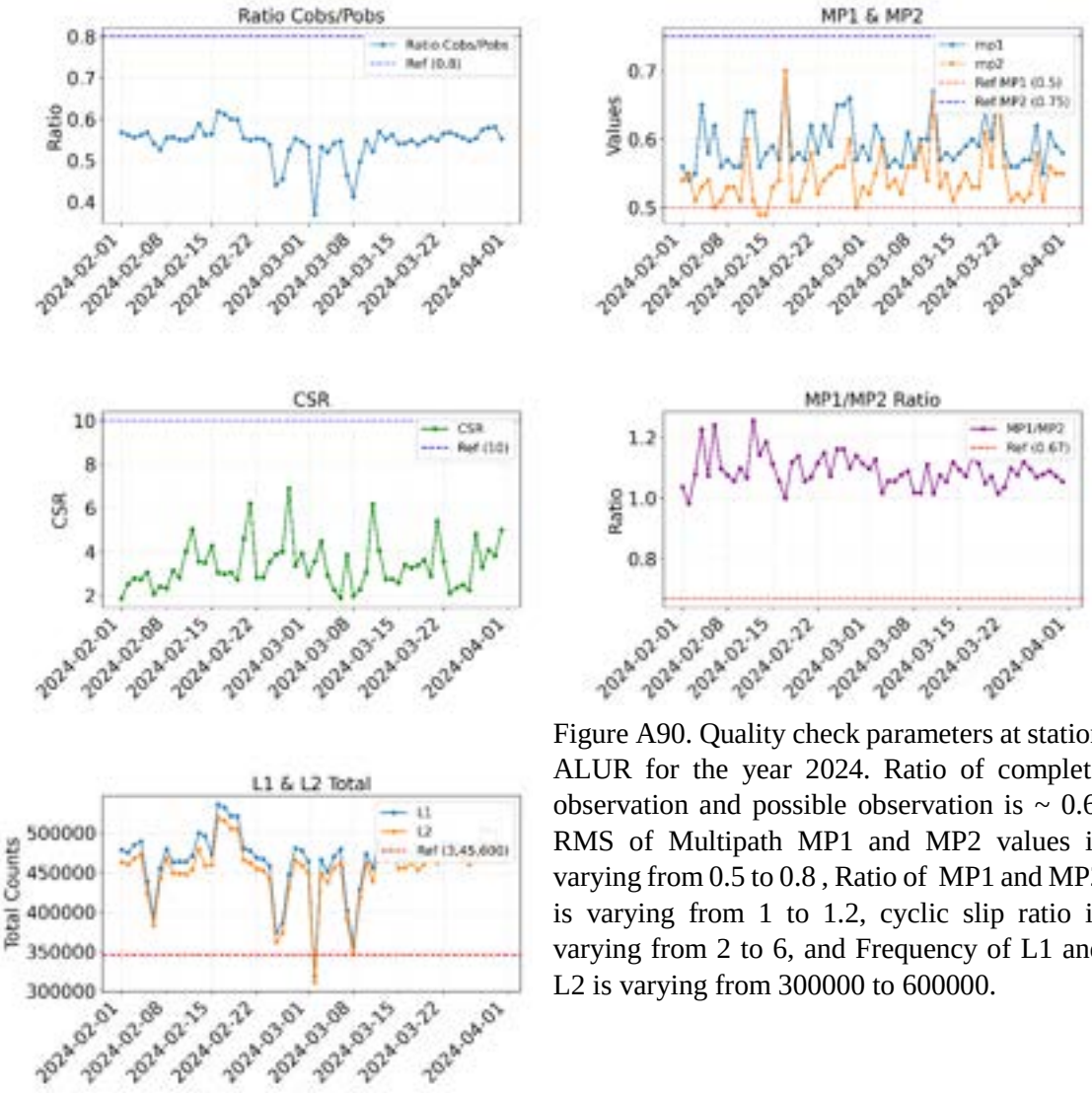


Figure A90. Quality check parameters at station ALUR for the year 2024. Ratio of complete observation and possible observation is ~ 0.6, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 0.8 , Ratio of MP1 and MP2 is varying from 1 to 1.2, cyclic slip ratio is varying from 2 to 6, and Frequency of L1 and L2 is varying from 300000 to 600000.

2. APRA

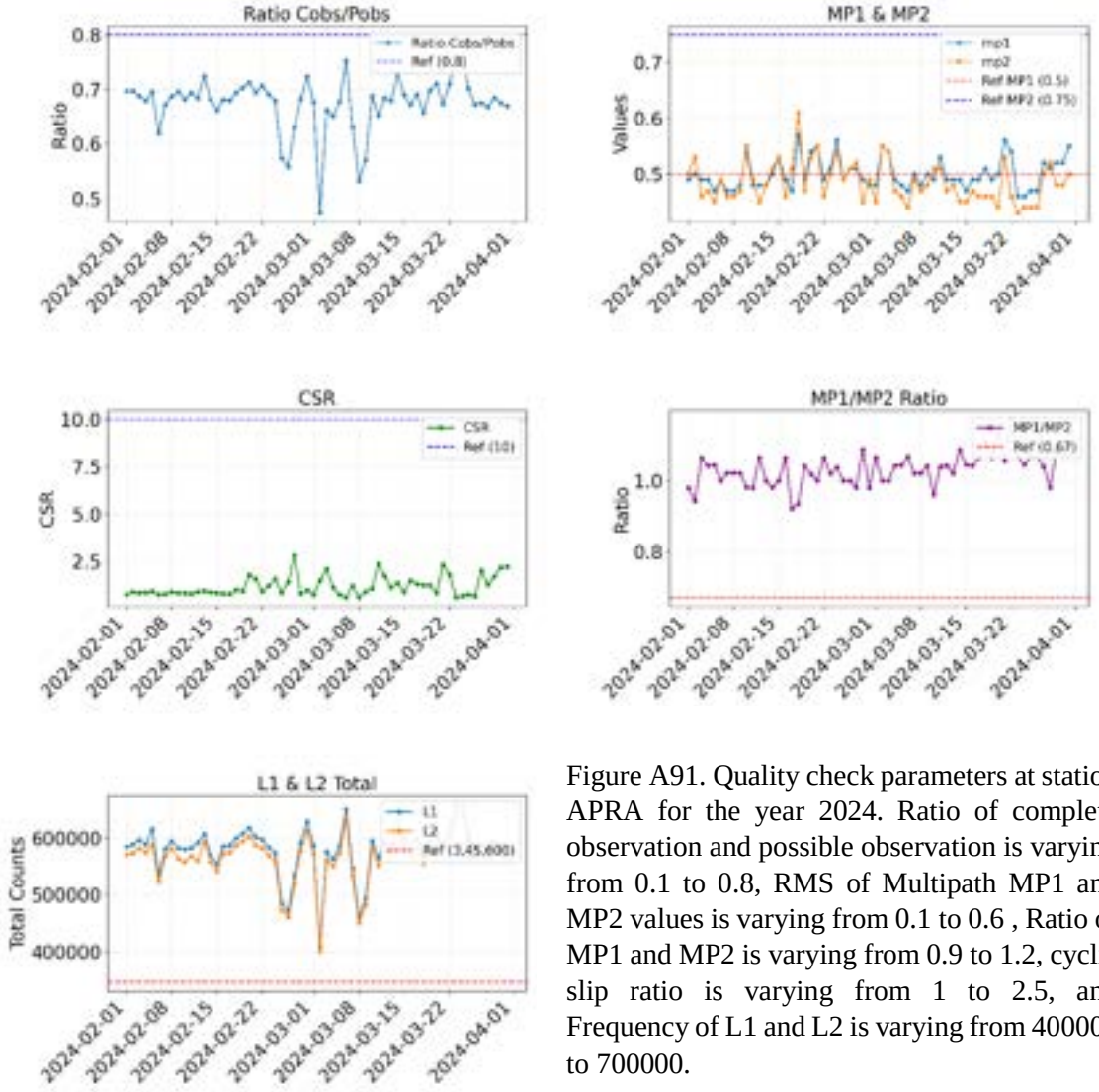


Figure A91. Quality check parameters at station APRA for the year 2024. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.6 , Ratio of MP1 and MP2 is varying from 0.9 to 1.2, cyclic slip ratio is varying from 1 to 2.5, and Frequency of L1 and L2 is varying from 400000 to 700000.

3. ARON

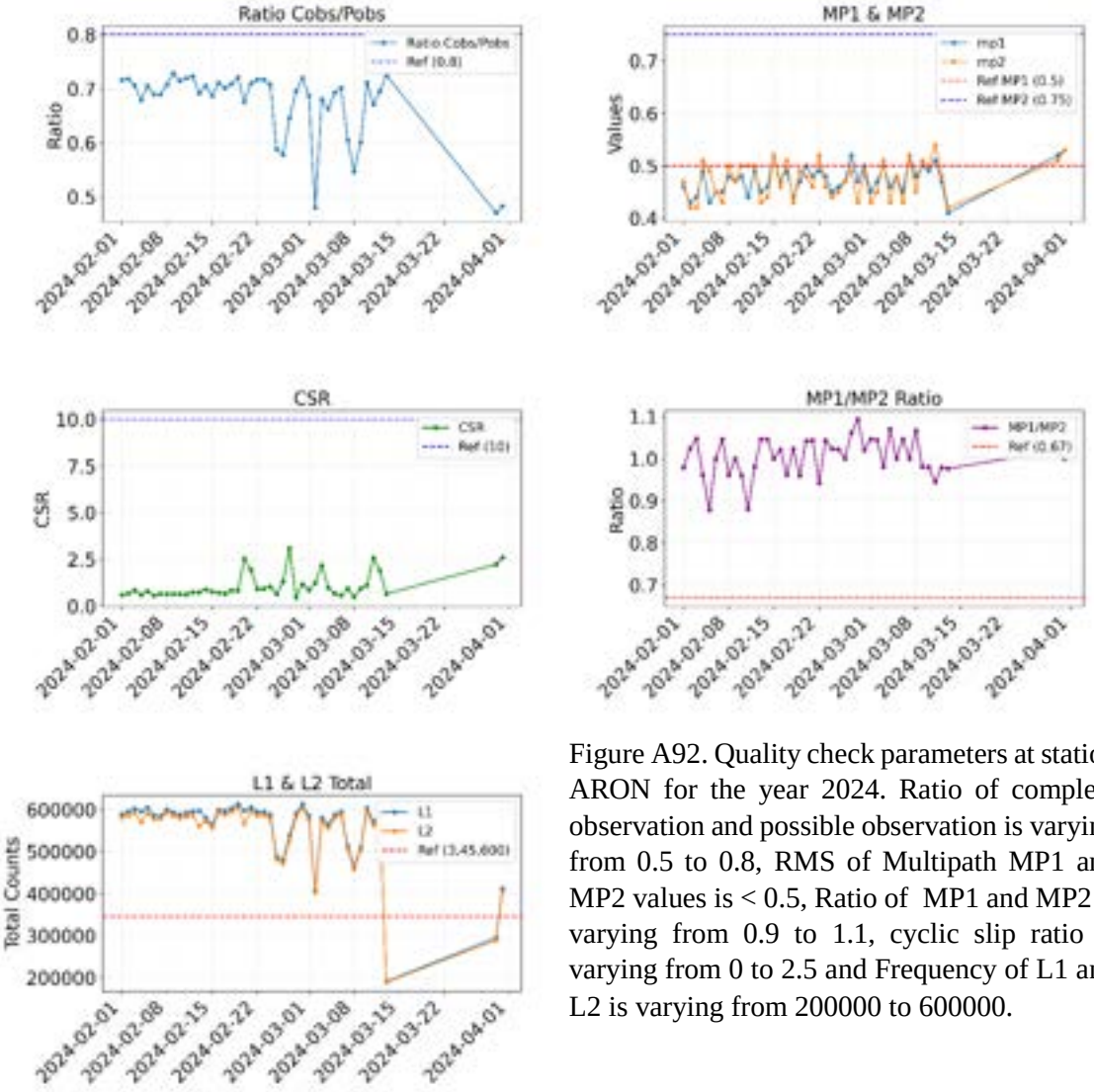


Figure A92. Quality check parameters at station ARON for the year 2024. Ratio of complete observation and possible observation is varying from 0.5 to 0.8, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 is varying from 0.9 to 1.1, cyclic slip ratio is varying from 0 to 2.5 and Frequency of L1 and L2 is varying from 200000 to 600000.

4. BAKU

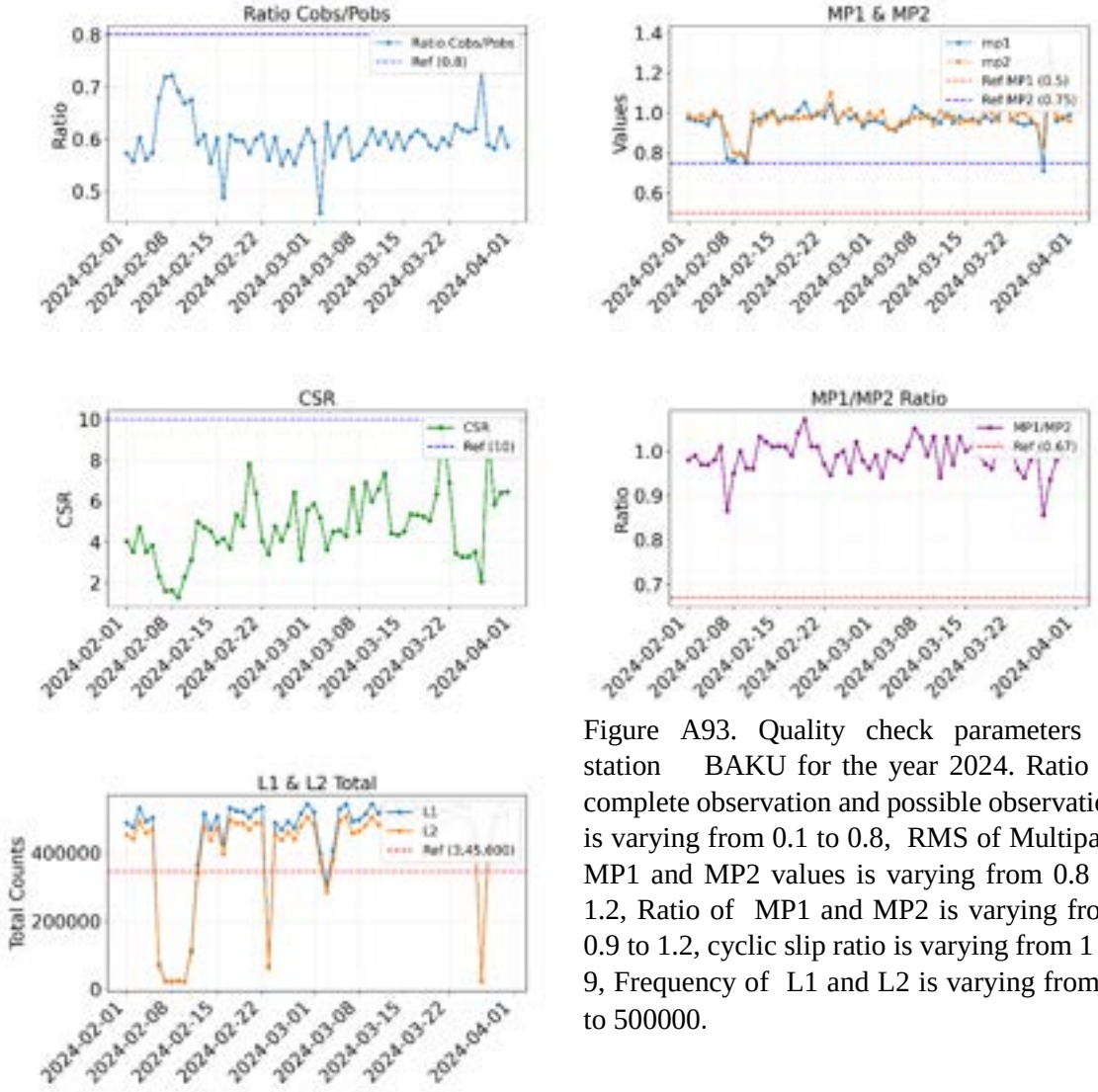


Figure A93. Quality check parameters at station BAKU for the year 2024. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.8 to 1.2, Ratio of MP1 and MP2 is varying from 0.9 to 1.2, cyclic slip ratio is varying from 1 to 9, Frequency of L1 and L2 is varying from 1 to 500000.

5. BARA

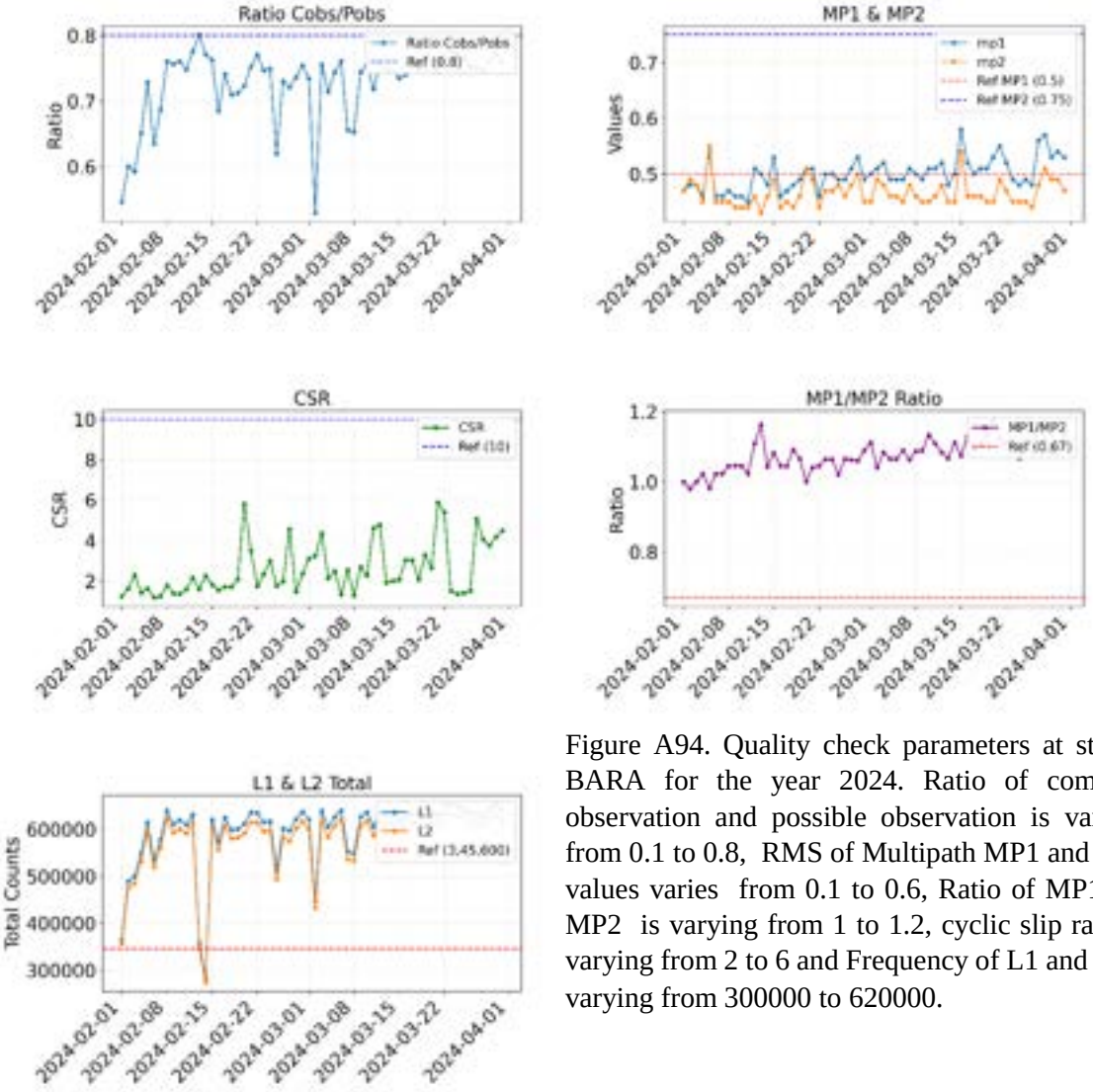


Figure A94. Quality check parameters at station BARA for the year 2024. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.6, Ratio of MP1 and MP2 is varying from 1 to 1.2, cyclic slip ratio is varying from 2 to 6 and Frequency of L1 and L2 is varying from 300000 to 620000.

6. CHID

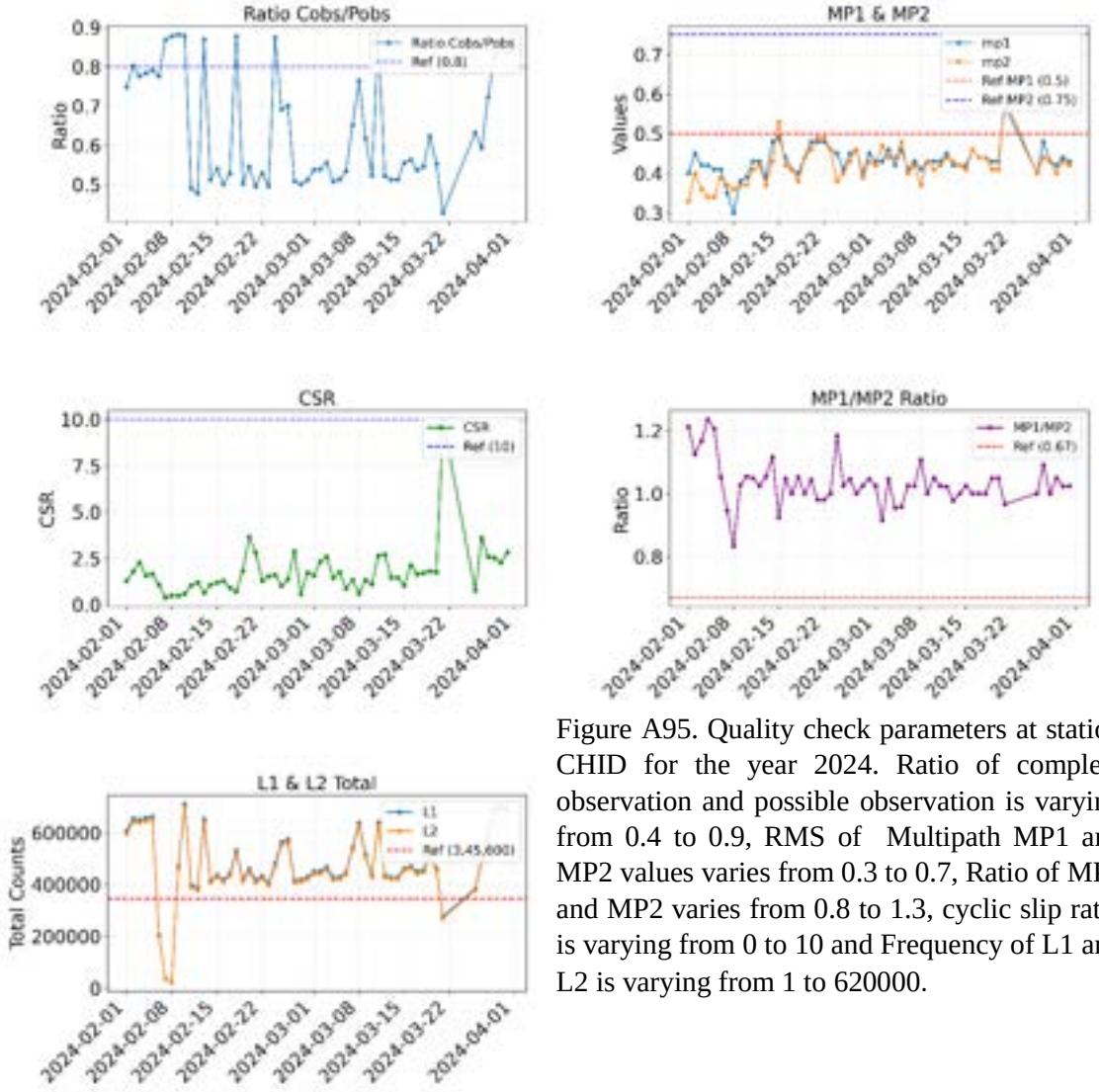


Figure A95. Quality check parameters at station CHID for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.9, RMS of Multipath MP1 and MP2 values varies from 0.3 to 0.7, Ratio of MP1 and MP2 varies from 0.8 to 1.3, cyclic slip ratio is varying from 0 to 10 and Frequency of L1 and L2 is varying from 1 to 620000.

7. CWRA

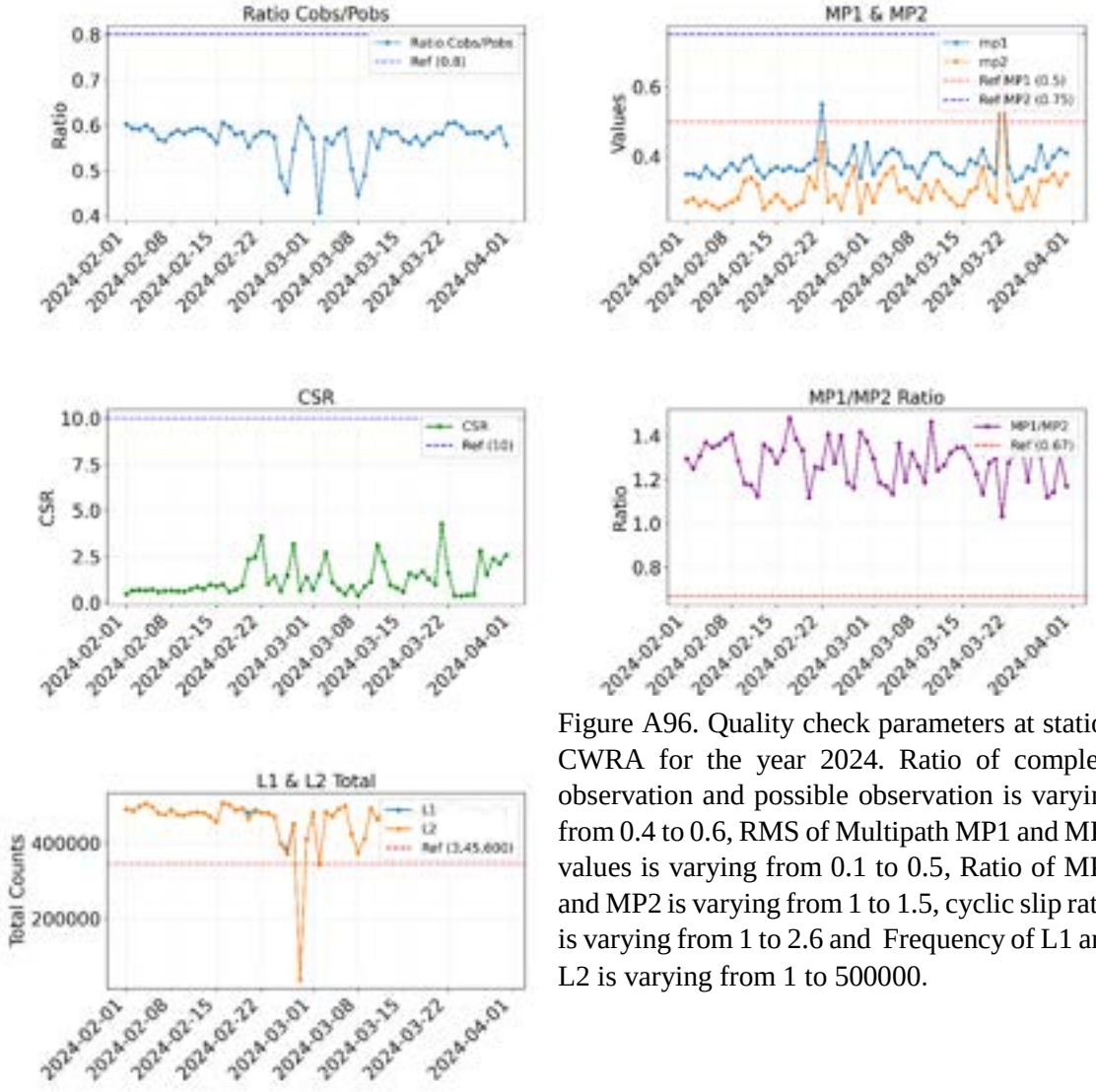


Figure A96. Quality check parameters at station CWRA for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.6, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.5, cyclic slip ratio is varying from 1 to 2.6 and Frequency of L1 and L2 is varying from 1 to 500000.

8. DARG

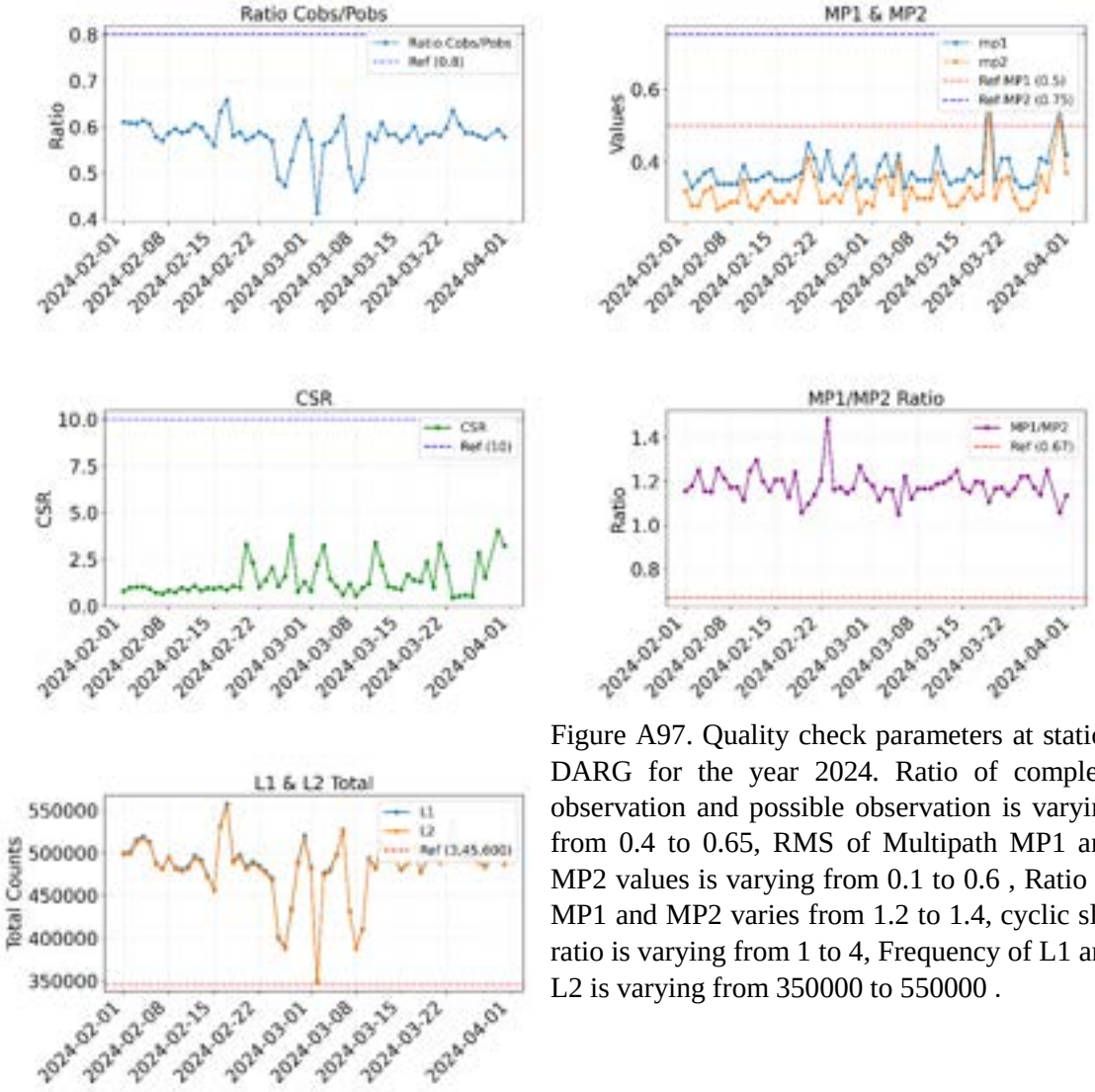


Figure A97. Quality check parameters at station DARG for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.65, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.6 , Ratio of MP1 and MP2 varies from 1.2 to 1.4, cyclic slip ratio is varying from 1 to 4, Frequency of L1 and L2 is varying from 350000 to 550000 .

9. DGPR

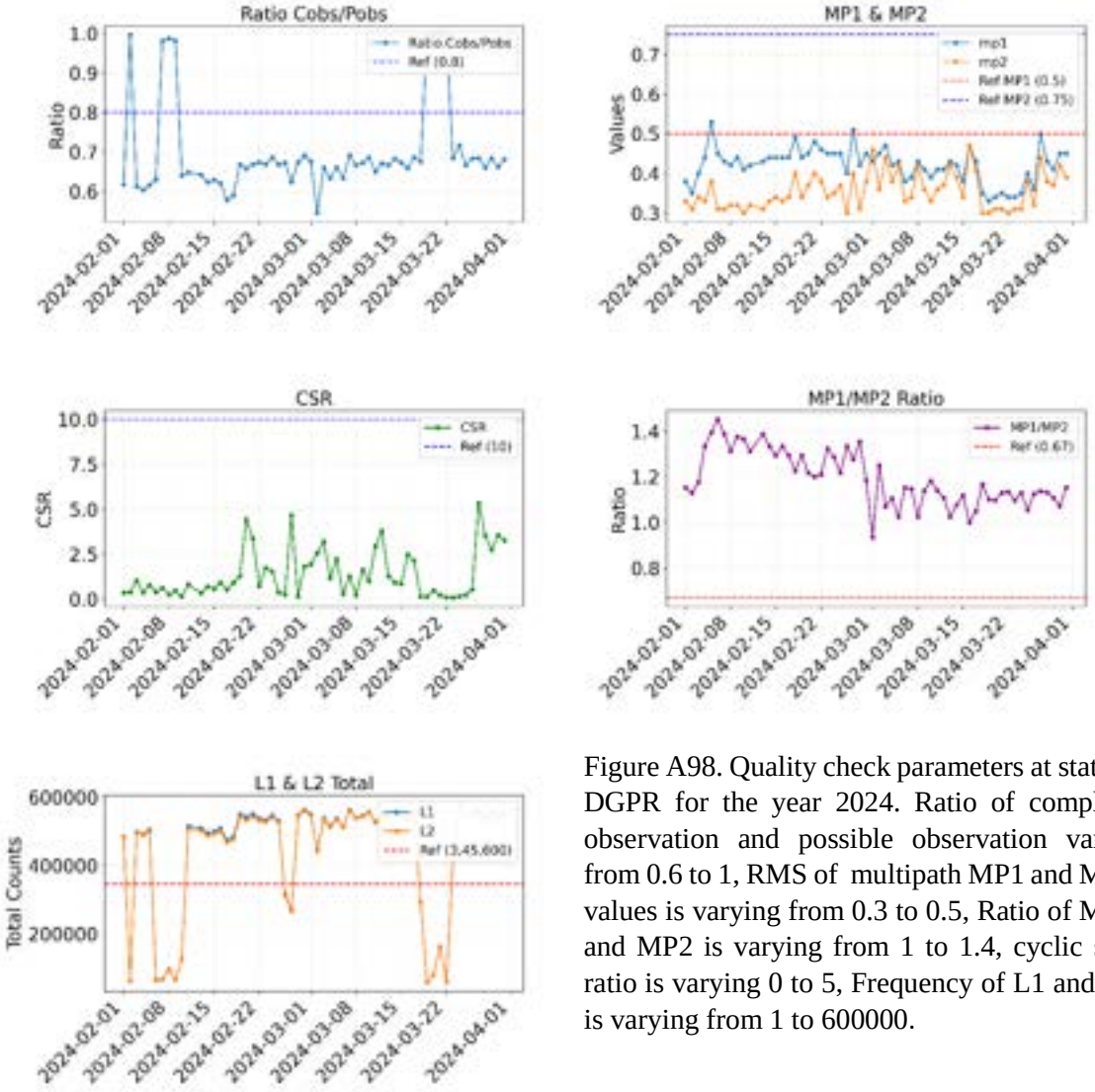


Figure A98. Quality check parameters at station DGPR for the year 2024. Ratio of complete observation and possible observation varies from 0.6 to 1, RMS of multipath MP1 and MP2 values is varying from 0.3 to 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.4, cyclic slip ratio is varying 0 to 5, Frequency of L1 and L2 is varying from 1 to 600000.

10. FERR

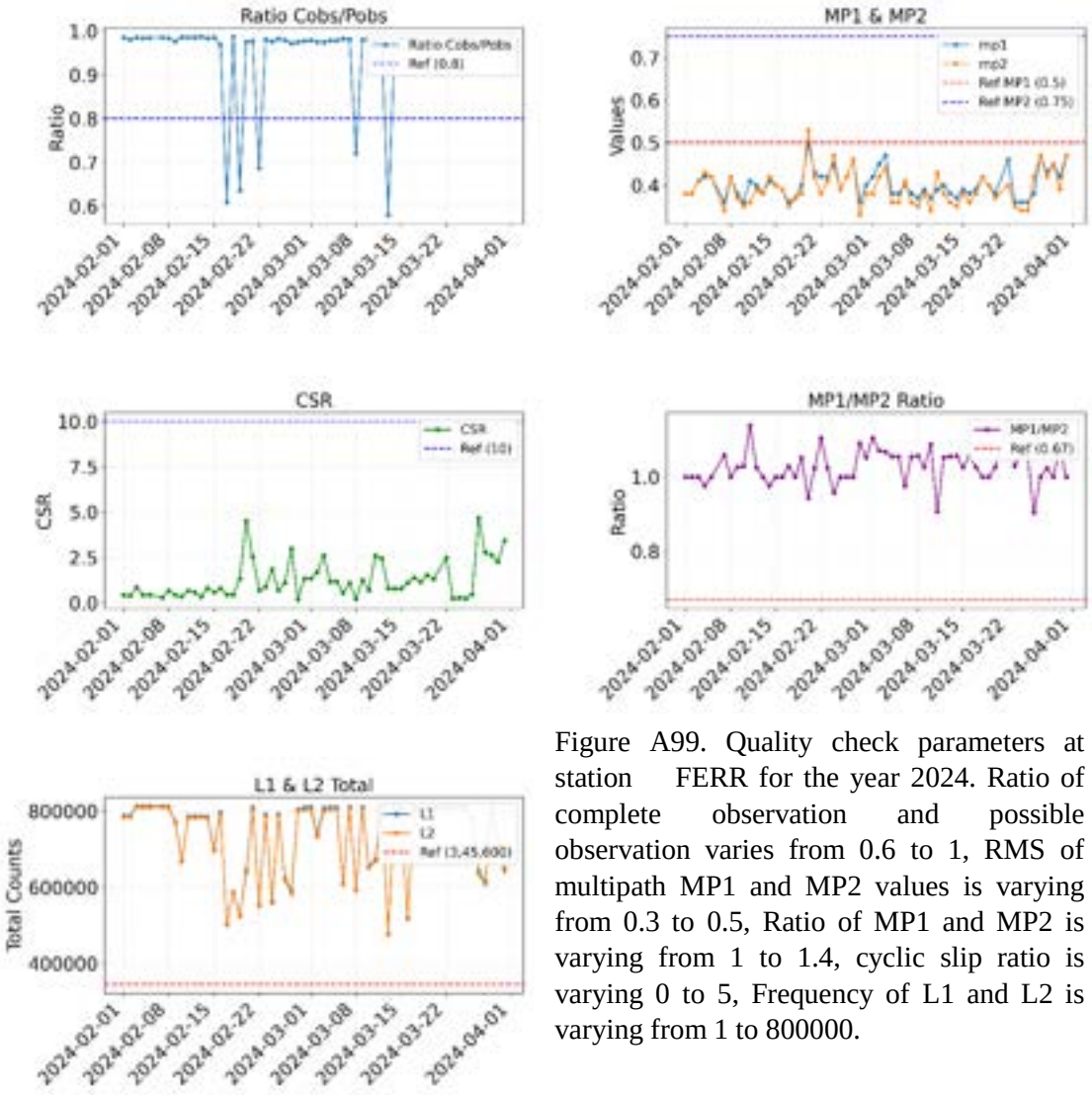


Figure A99. Quality check parameters at station FERR for the year 2024. Ratio of complete observation and possible observation varies from 0.6 to 1, RMS of multipath MP1 and MP2 values is varying from 0.3 to 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.4, cyclic slip ratio is varying 0 to 5, Frequency of L1 and L2 is varying from 1 to 800000.

11. KADA

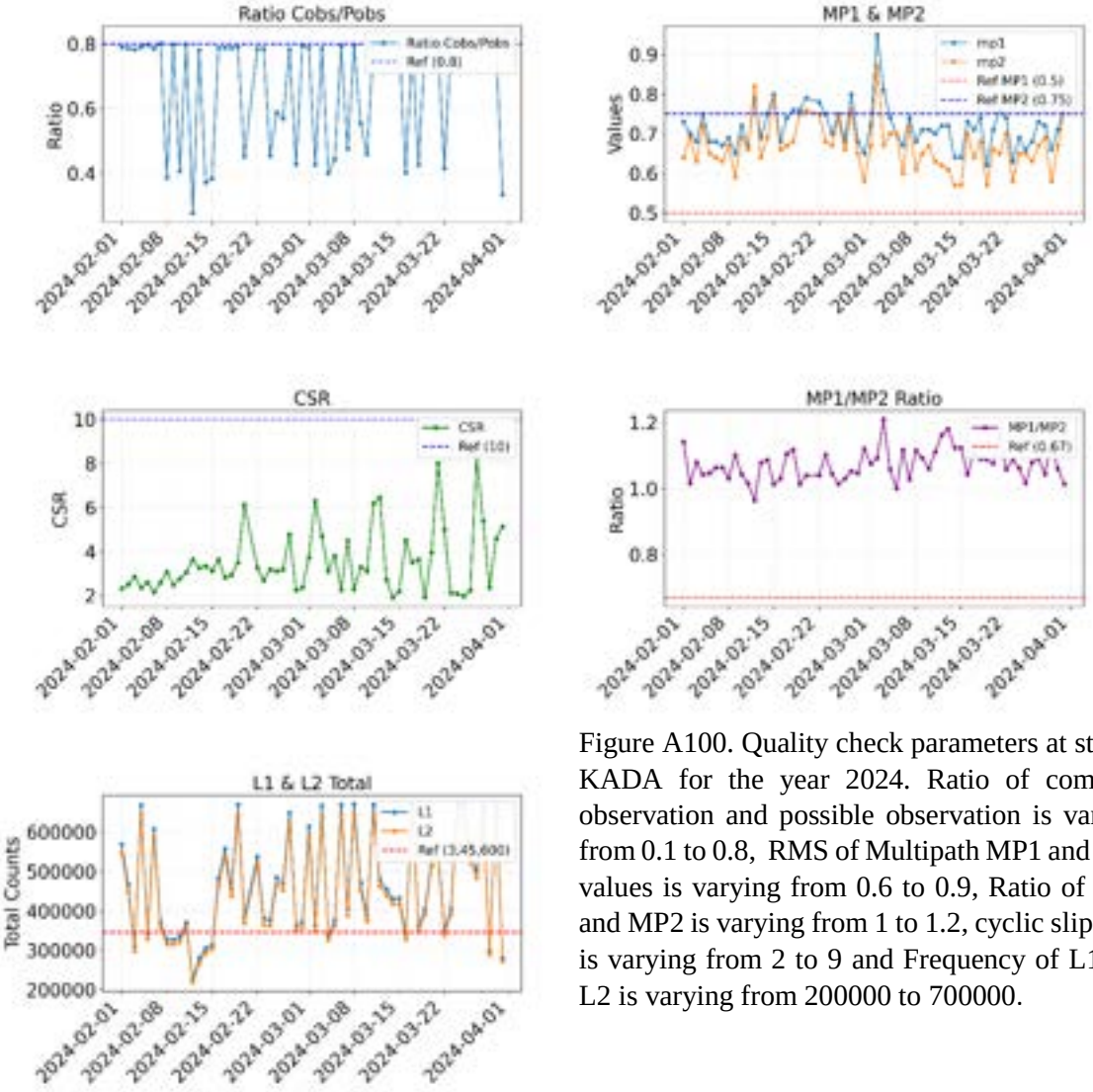


Figure A100. Quality check parameters at station KADA for the year 2024. Ratio of complete observation and possible observation is varying from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.6 to 0.9, Ratio of MP1 and MP2 is varying from 1 to 1.2, cyclic slip ratio is varying from 2 to 9 and Frequency of L1 and L2 is varying from 200000 to 700000.

12. KAKA

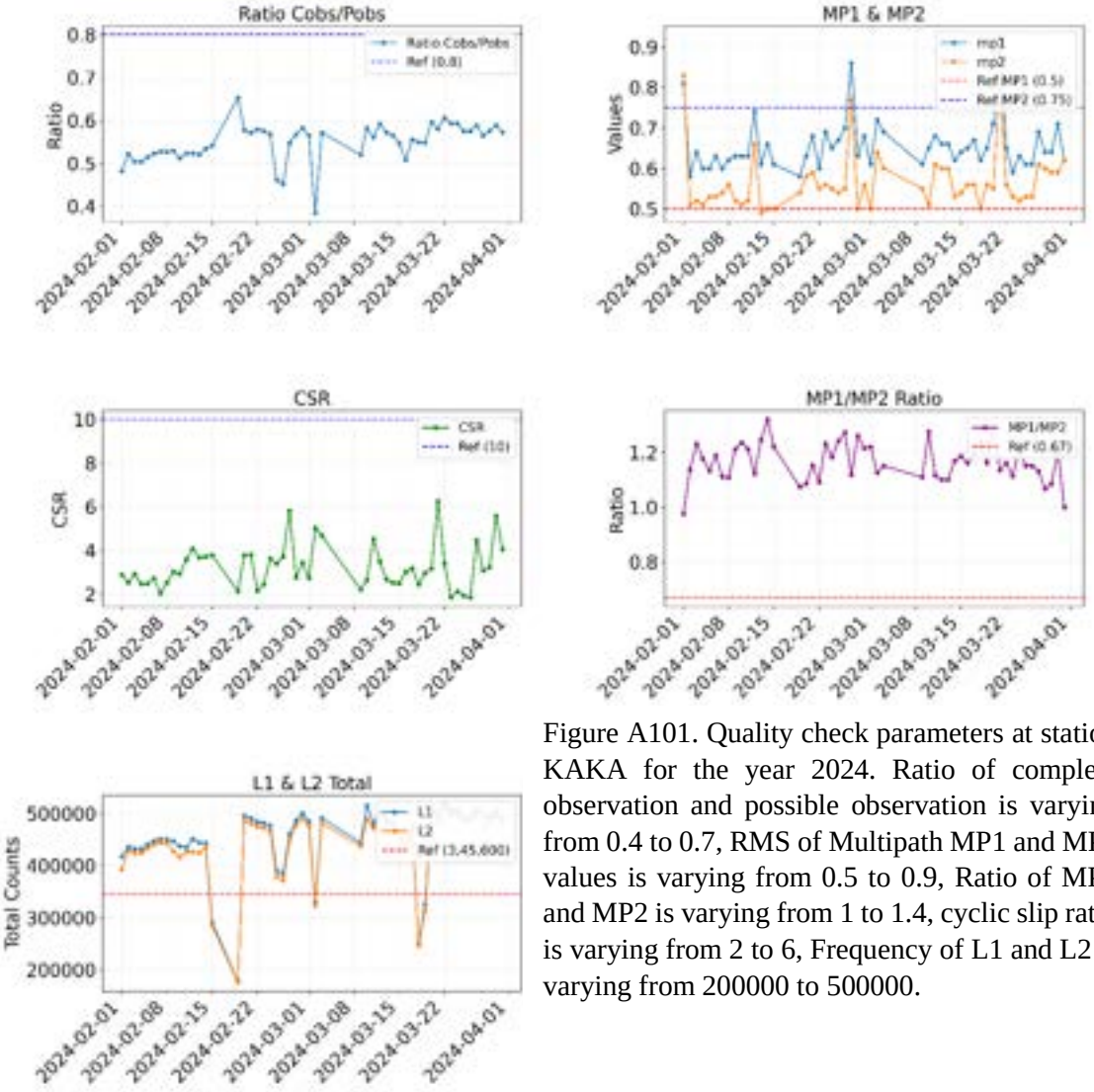


Figure A101. Quality check parameters at station KAKA for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.7, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 0.9, Ratio of MP1 and MP2 is varying from 1 to 1.4, cyclic slip ratio is varying from 2 to 6, Frequency of L1 and L2 is varying from 200000 to 500000.

13. KISH

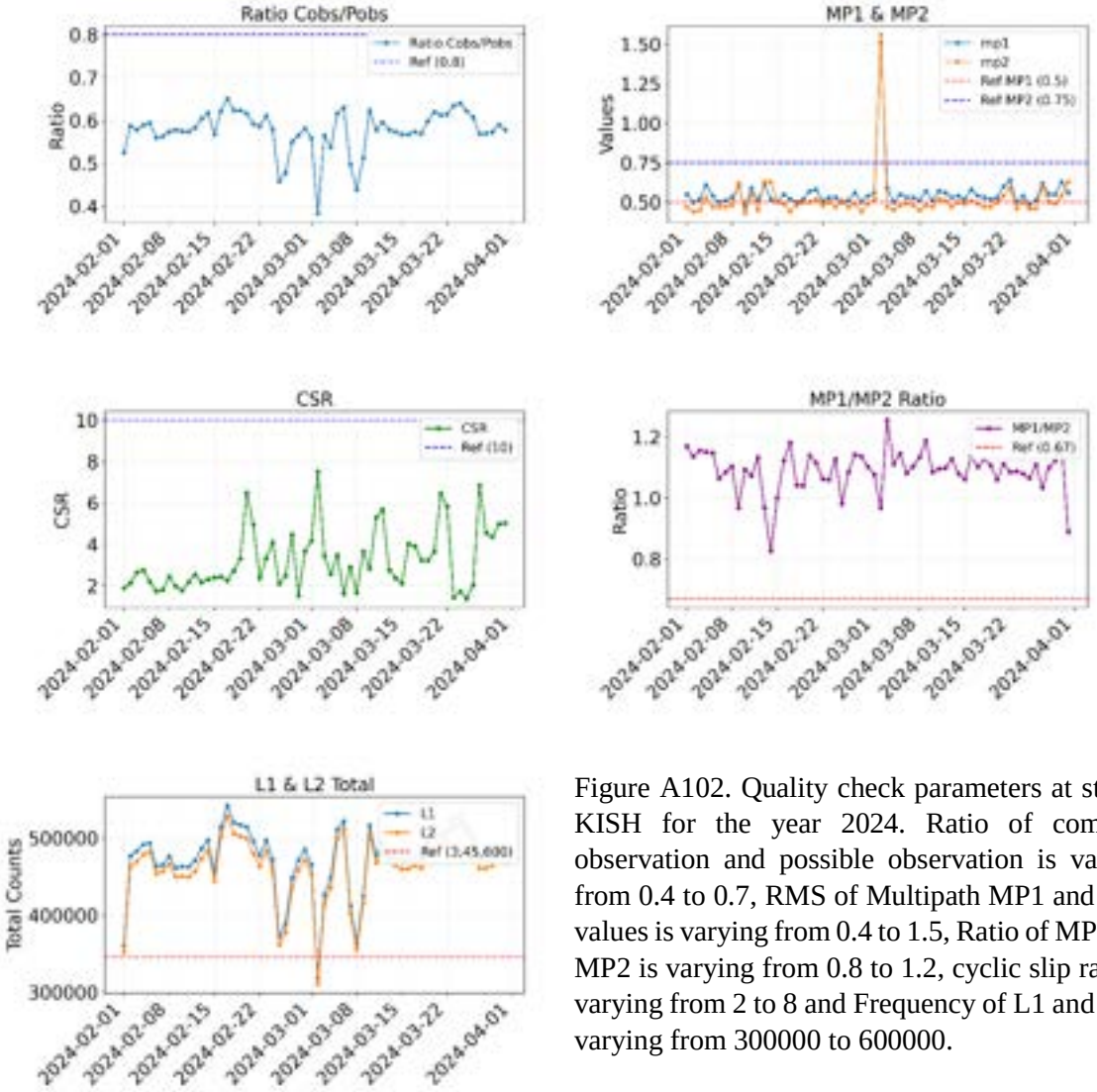


Figure A102. Quality check parameters at station KISH for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.7, RMS of Multipath MP1 and MP2 values is varying from 0.4 to 1.5, Ratio of MP1 and MP2 is varying from 0.8 to 1.2, cyclic slip ratio is varying from 2 to 8 and Frequency of L1 and L2 is varying from 300000 to 600000.

14. KLPT

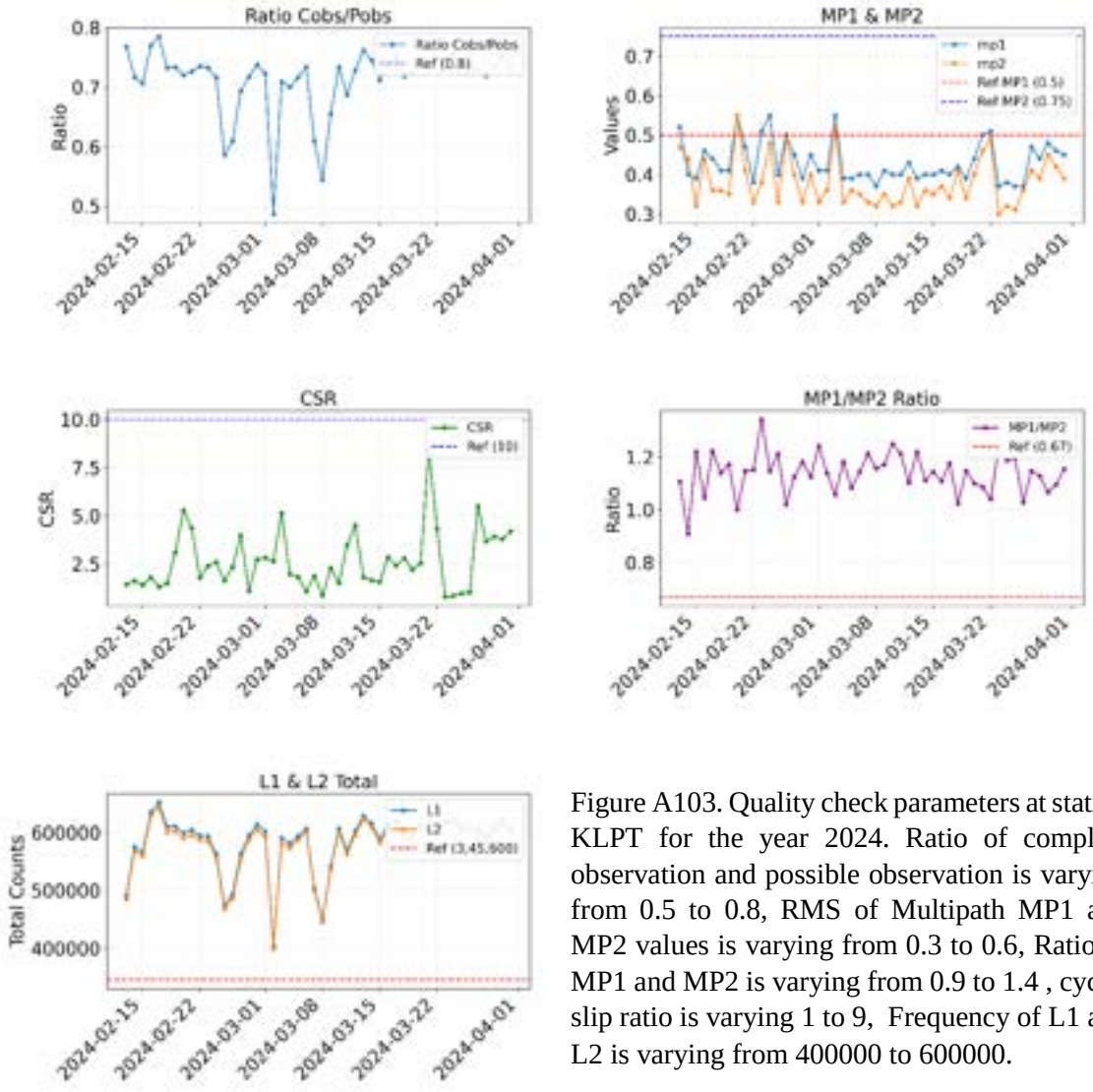


Figure A103. Quality check parameters at station KLPT for the year 2024. Ratio of complete observation and possible observation is varying from 0.5 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.3 to 0.6, Ratio of MP1 and MP2 is varying from 0.9 to 1.4 , cyclic slip ratio is varying 1 to 9, Frequency of L1 and L2 is varying from 400000 to 600000.

15. LONS

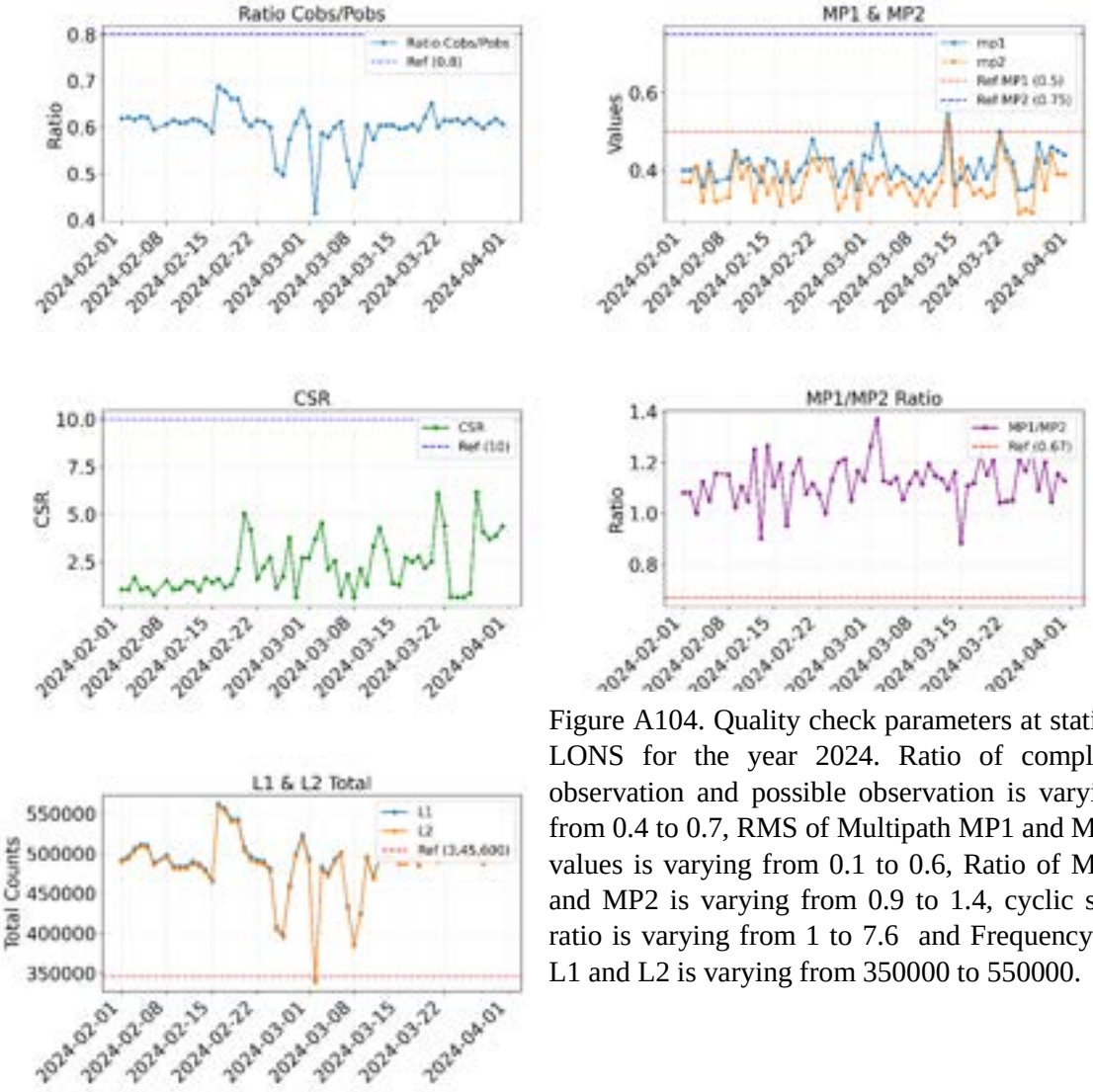


Figure A104. Quality check parameters at station LONS for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.7, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.6, Ratio of MP1 and MP2 is varying from 0.9 to 1.4, cyclic slip ratio is varying from 1 to 7.6 and Frequency of L1 and L2 is varying from 350000 to 550000.

16. MAKA

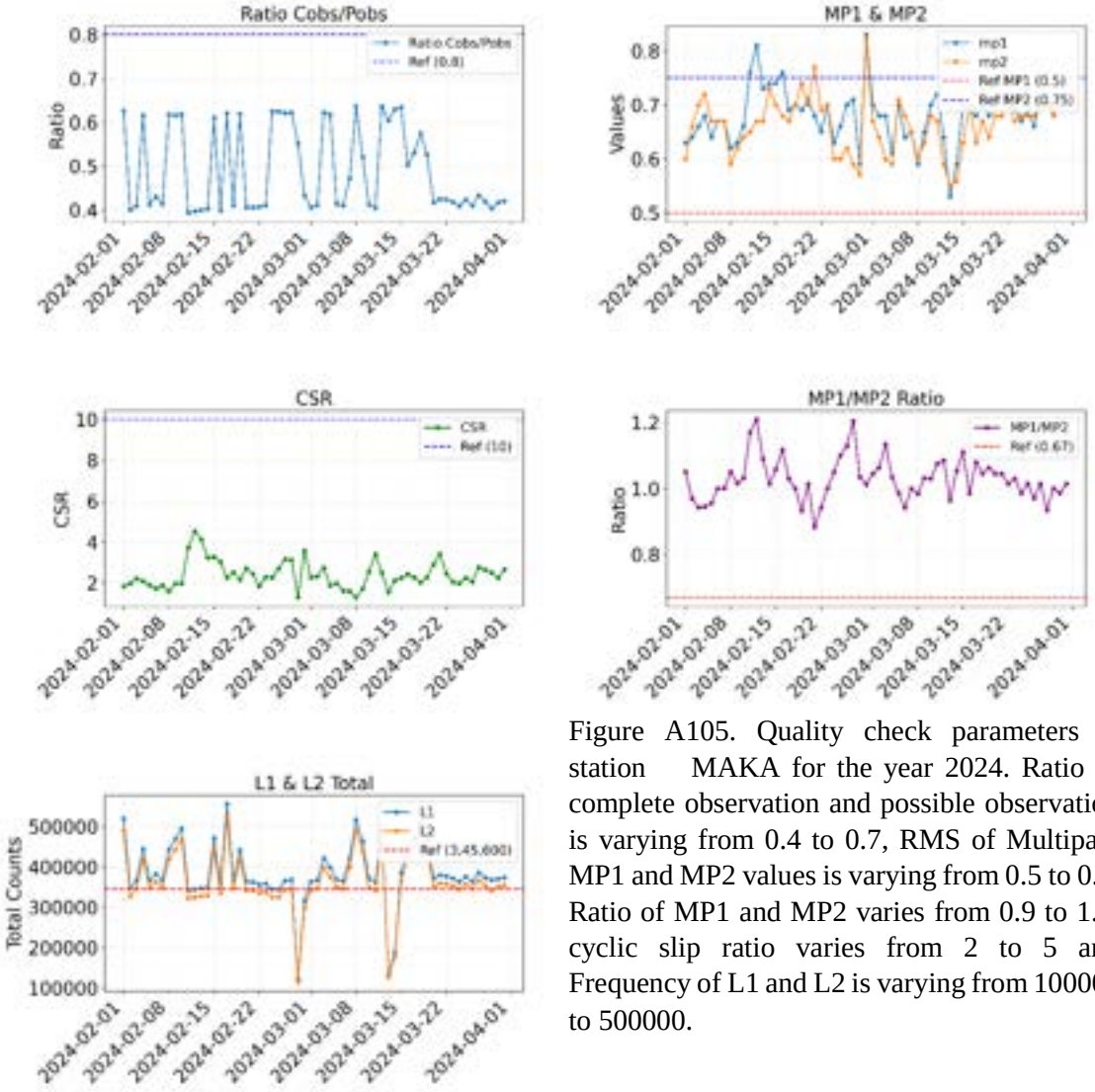


Figure A105. Quality check parameters at station MAKA for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.7, RMS of Multipath MP1 and MP2 values is varying from 0.5 to 0.8, Ratio of MP1 and MP2 varies from 0.9 to 1.2, cyclic slip ratio varies from 2 to 5 and Frequency of L1 and L2 is varying from 100000 to 500000.

17. MBDR

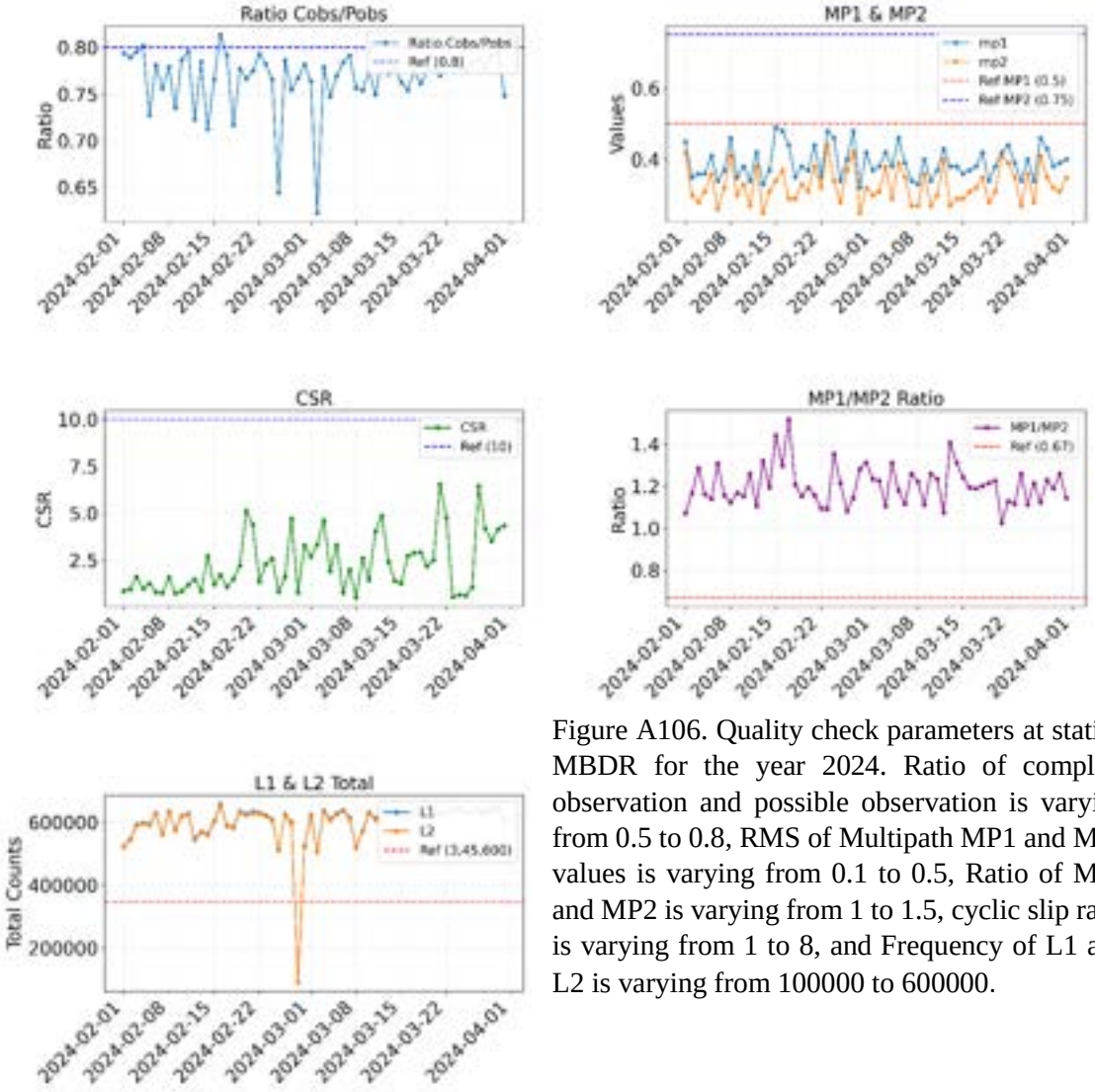


Figure A106. Quality check parameters at station MBDR for the year 2024. Ratio of complete observation and possible observation is varying from 0.5 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.1 to 0.5, Ratio of MP1 and MP2 is varying from 1 to 1.5, cyclic slip ratio is varying from 1 to 8, and Frequency of L1 and L2 is varying from 100000 to 600000.

18. MILD

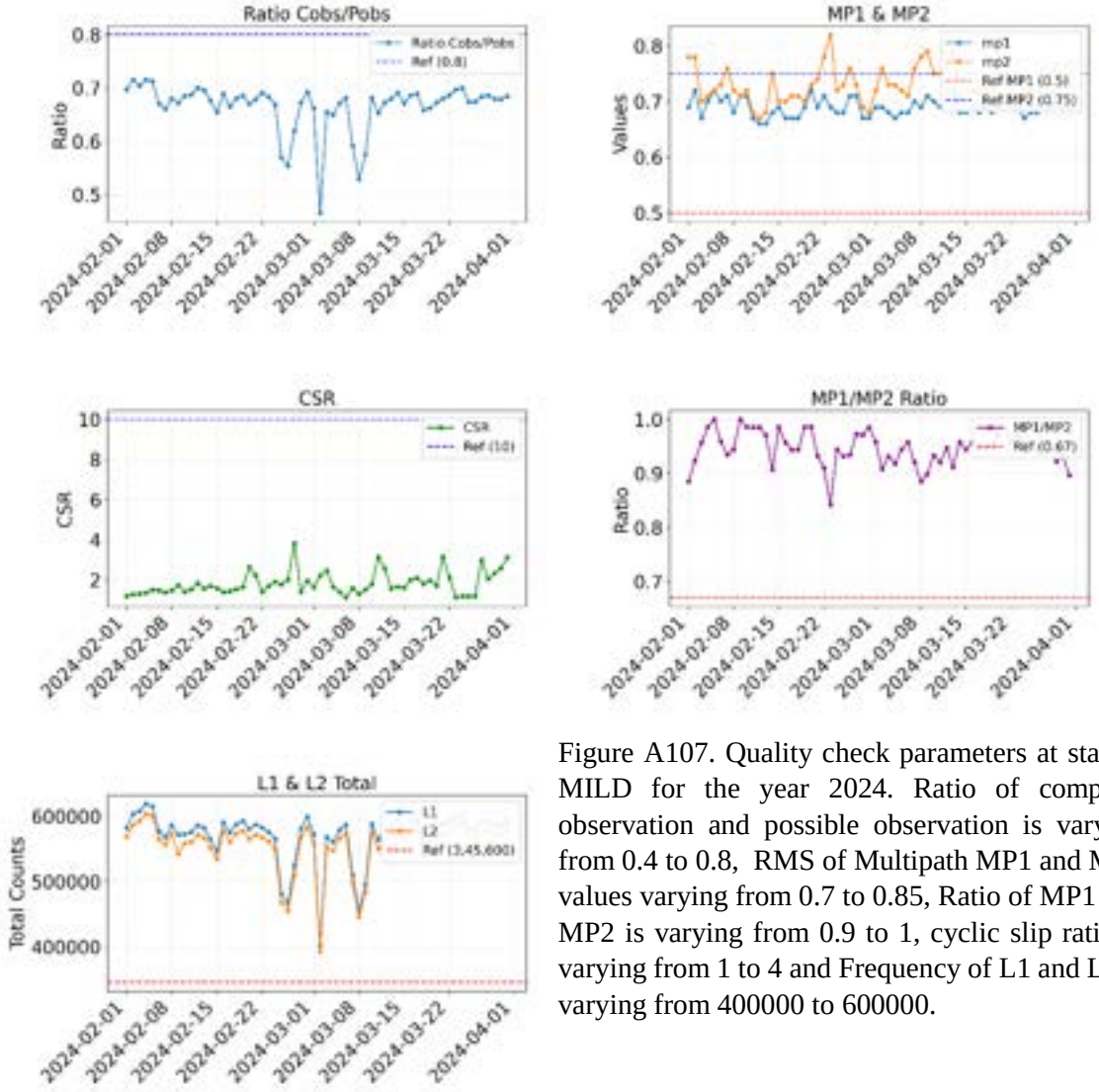


Figure A107. Quality check parameters at station MILD for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.8, RMS of Multipath MP1 and MP2 values varying from 0.7 to 0.85, Ratio of MP1 and MP2 is varying from 0.9 to 1, cyclic slip ratio is varying from 1 to 4 and Frequency of L1 and L2 is varying from 400000 to 600000.

19. MOHA

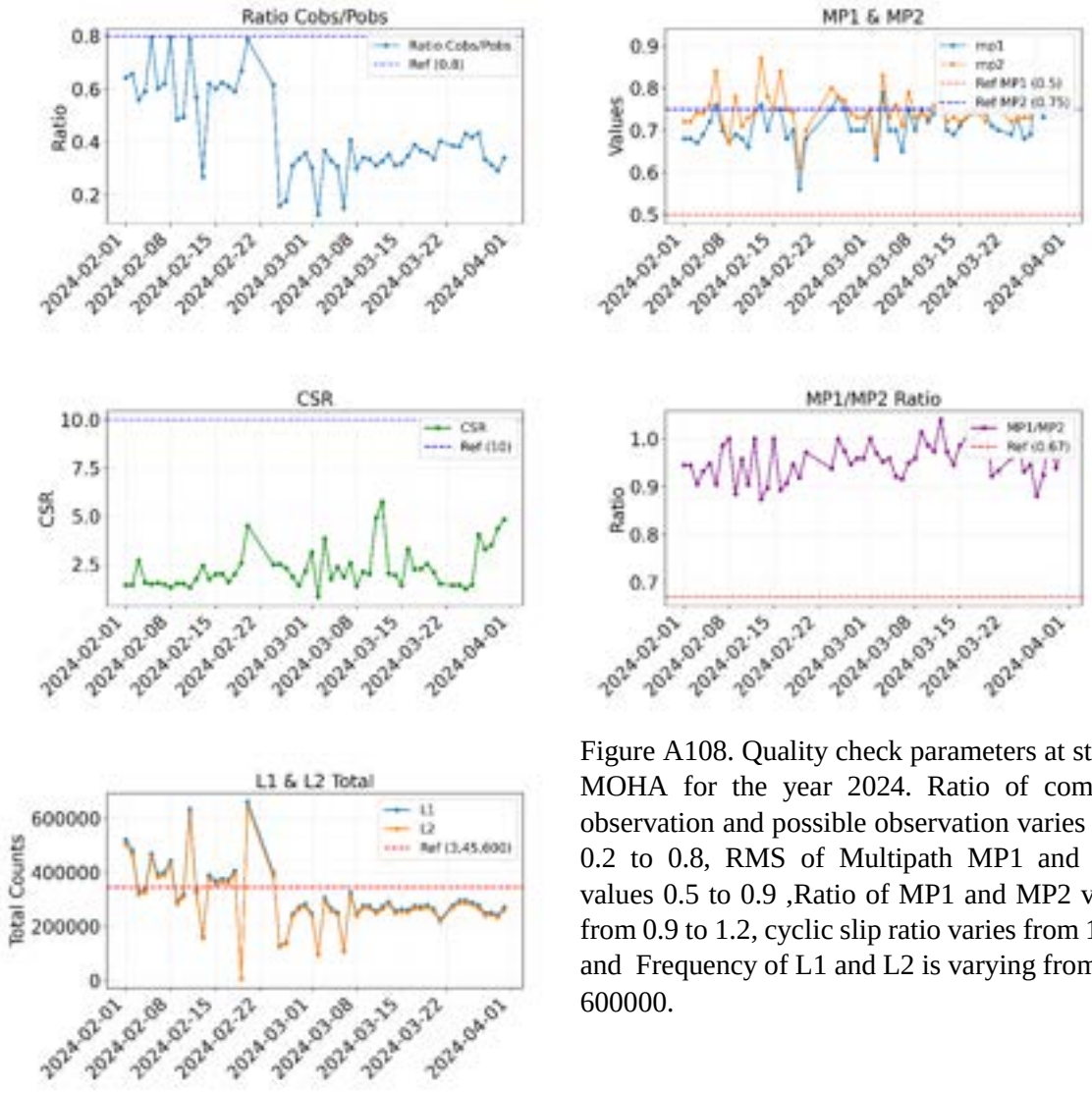


Figure A108. Quality check parameters at station MOHA for the year 2024. Ratio of complete observation and possible observation varies from 0.2 to 0.8, RMS of Multipath MP1 and MP2 values 0.5 to 0.9 ,Ratio of MP1 and MP2 varies from 0.9 to 1.2, cyclic slip ratio varies from 1 to 5 and Frequency of L1 and L2 is varying from 1 to 600000.

20. NAMU

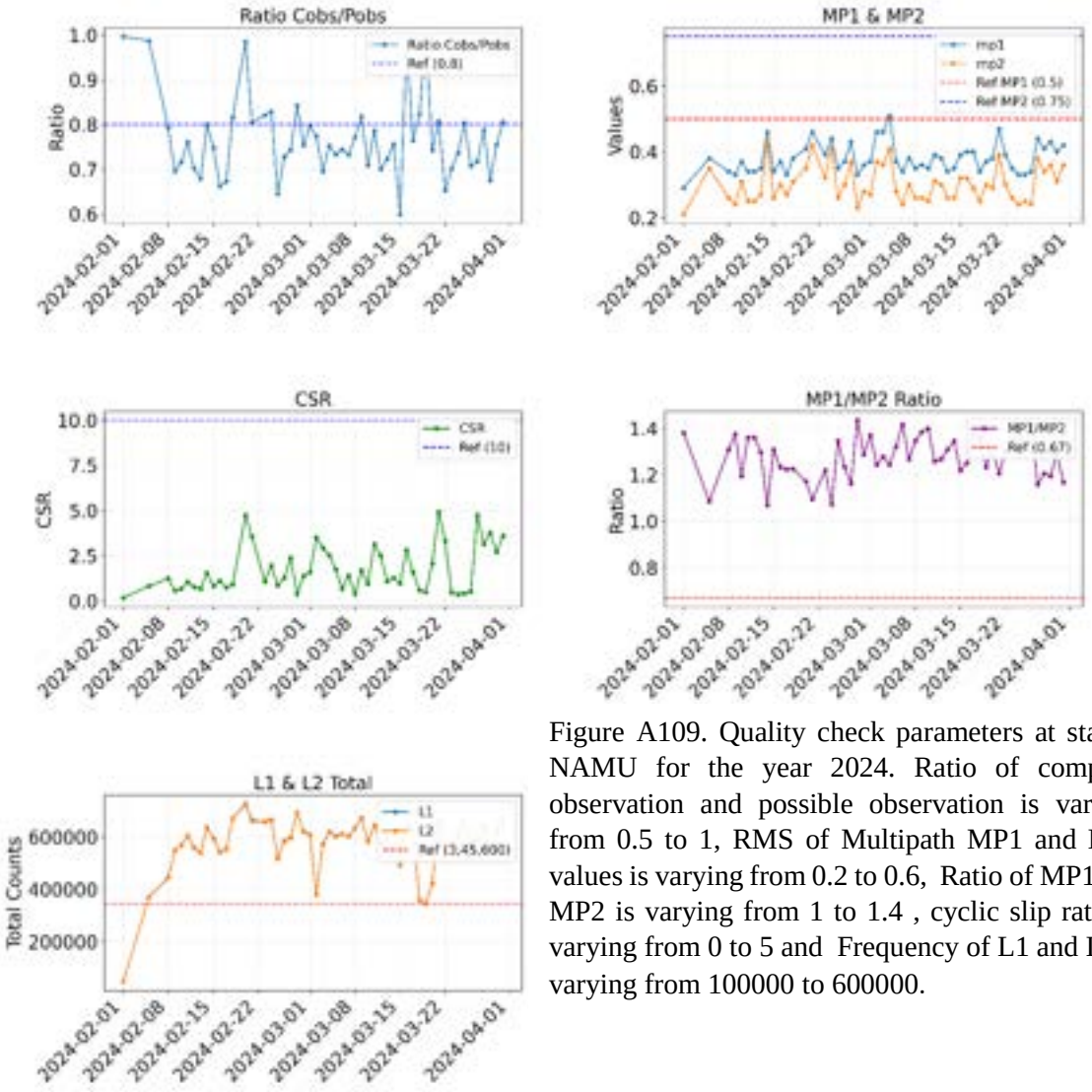


Figure A109. Quality check parameters at station NAMU for the year 2024. Ratio of complete observation and possible observation is varying from 0.5 to 1, RMS of Multipath MP1 and MP2 values is varying from 0.2 to 0.6, Ratio of MP1 and MP2 is varying from 1 to 1.4 , cyclic slip ratio is varying from 0 to 5 and Frequency of L1 and L2 is varying from 100000 to 600000.

21. NEIL

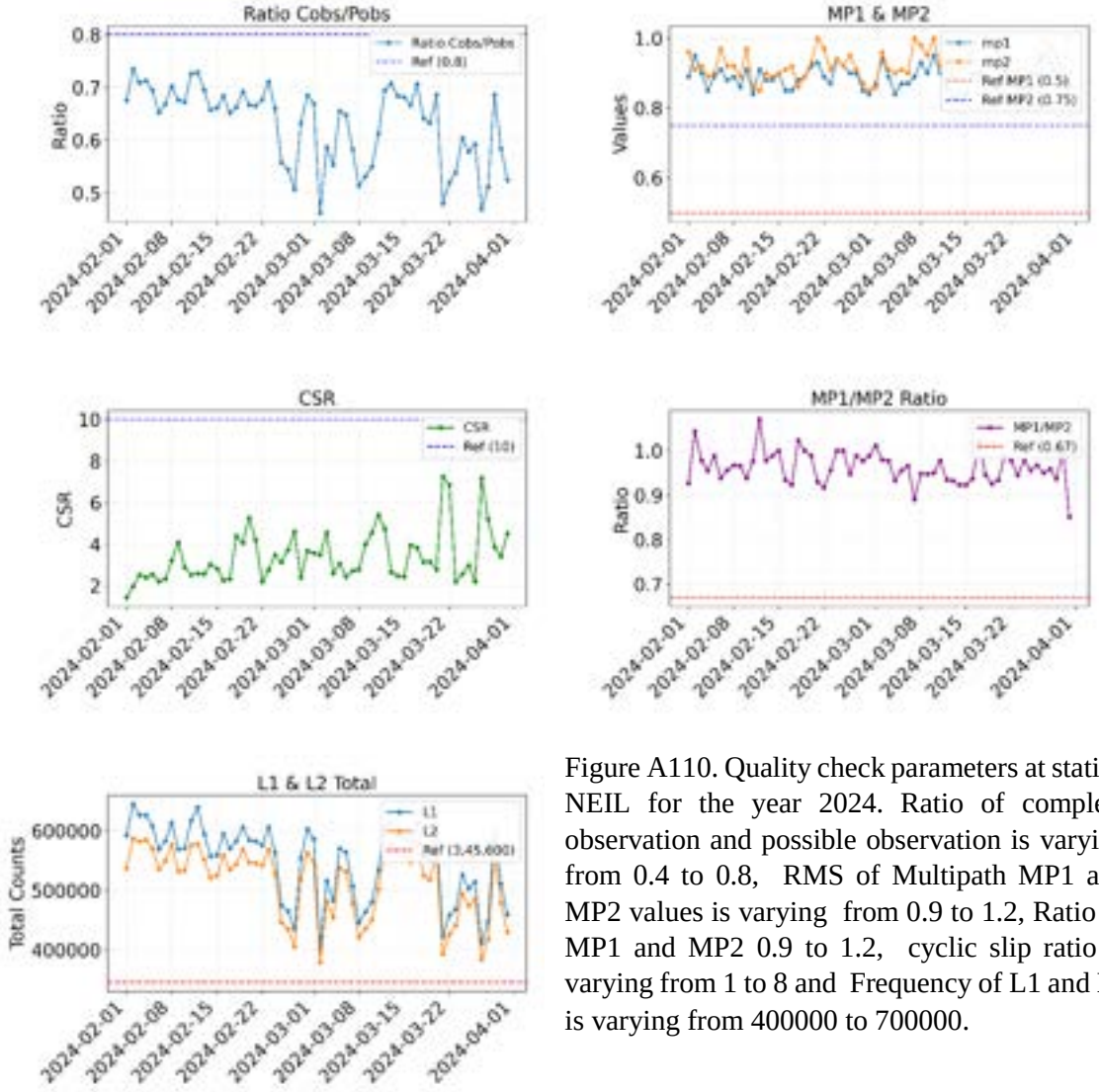


Figure A110. Quality check parameters at station NEIL for the year 2024. Ratio of complete observation and possible observation is varying from 0.4 to 0.8, RMS of Multipath MP1 and MP2 values is varying from 0.9 to 1.2, Ratio of MP1 and MP2 0.9 to 1.2, cyclic slip ratio is varying from 1 to 8 and Frequency of L1 and L2 is varying from 400000 to 700000.

22. NIMB

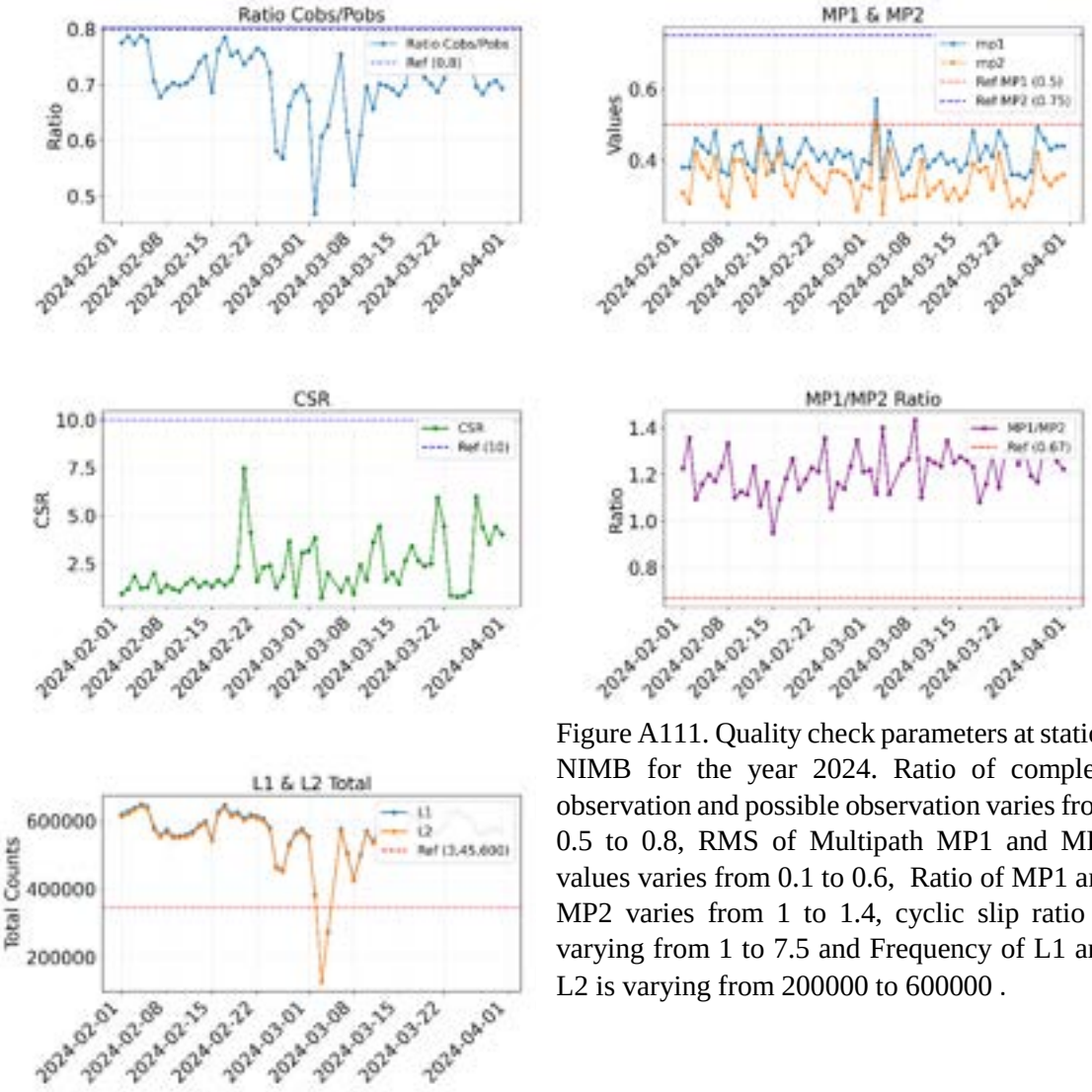


Figure A111. Quality check parameters at station NIMB for the year 2024. Ratio of complete observation and possible observation varies from 0.5 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.6, Ratio of MP1 and MP2 varies from 1 to 1.4, cyclic slip ratio is varying from 1 to 7.5 and Frequency of L1 and L2 is varying from 200000 to 600000 .

23. RADA

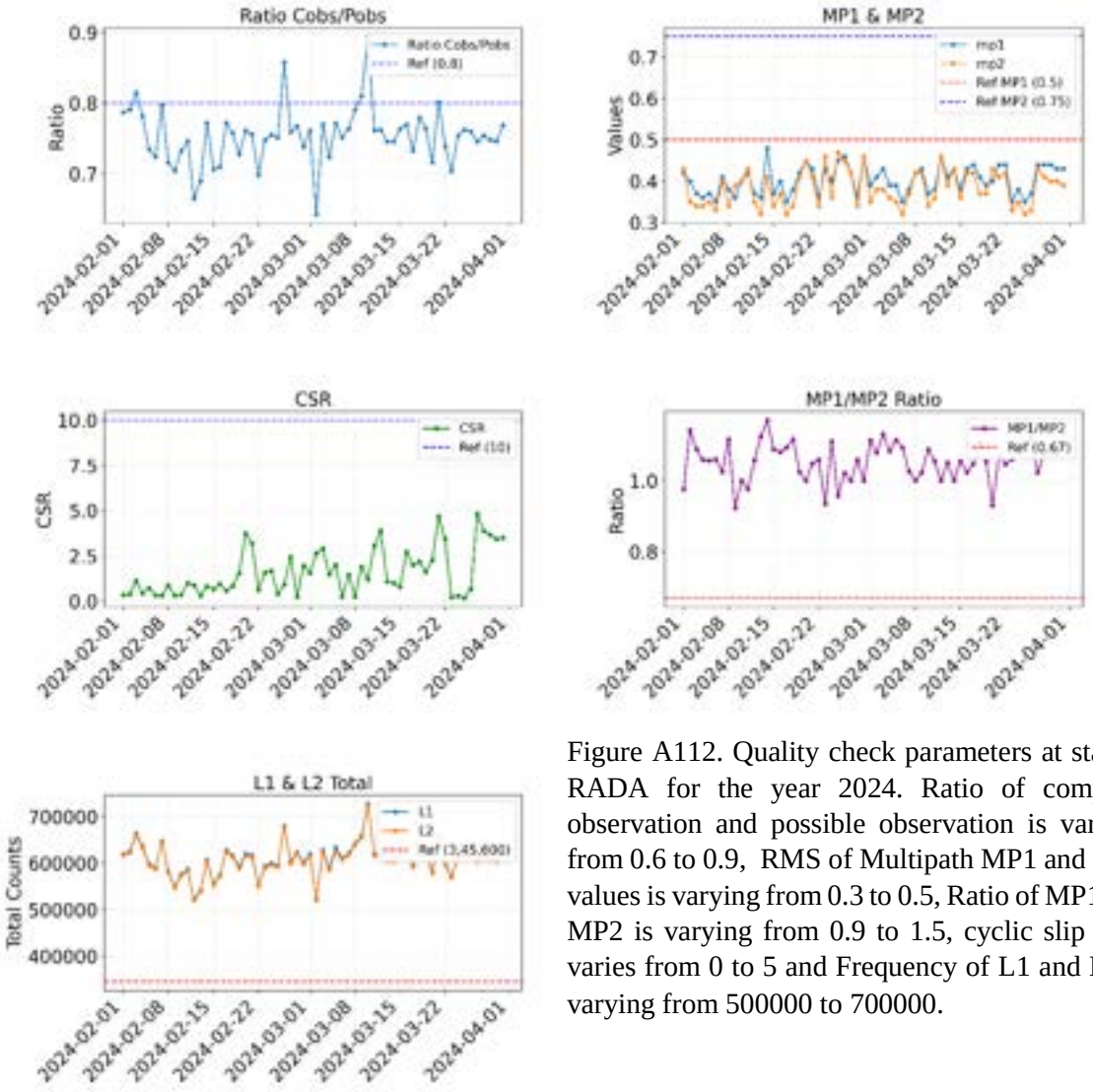


Figure A112. Quality check parameters at station RADA for the year 2024. Ratio of complete observation and possible observation is varying from 0.6 to 0.9, RMS of Multipath MP1 and MP2 values is varying from 0.3 to 0.5, Ratio of MP1 and MP2 is varying from 0.9 to 1.5, cyclic slip ratio varies from 0 to 5 and Frequency of L1 and L2 is varying from 500000 to 700000.

24. RUTL

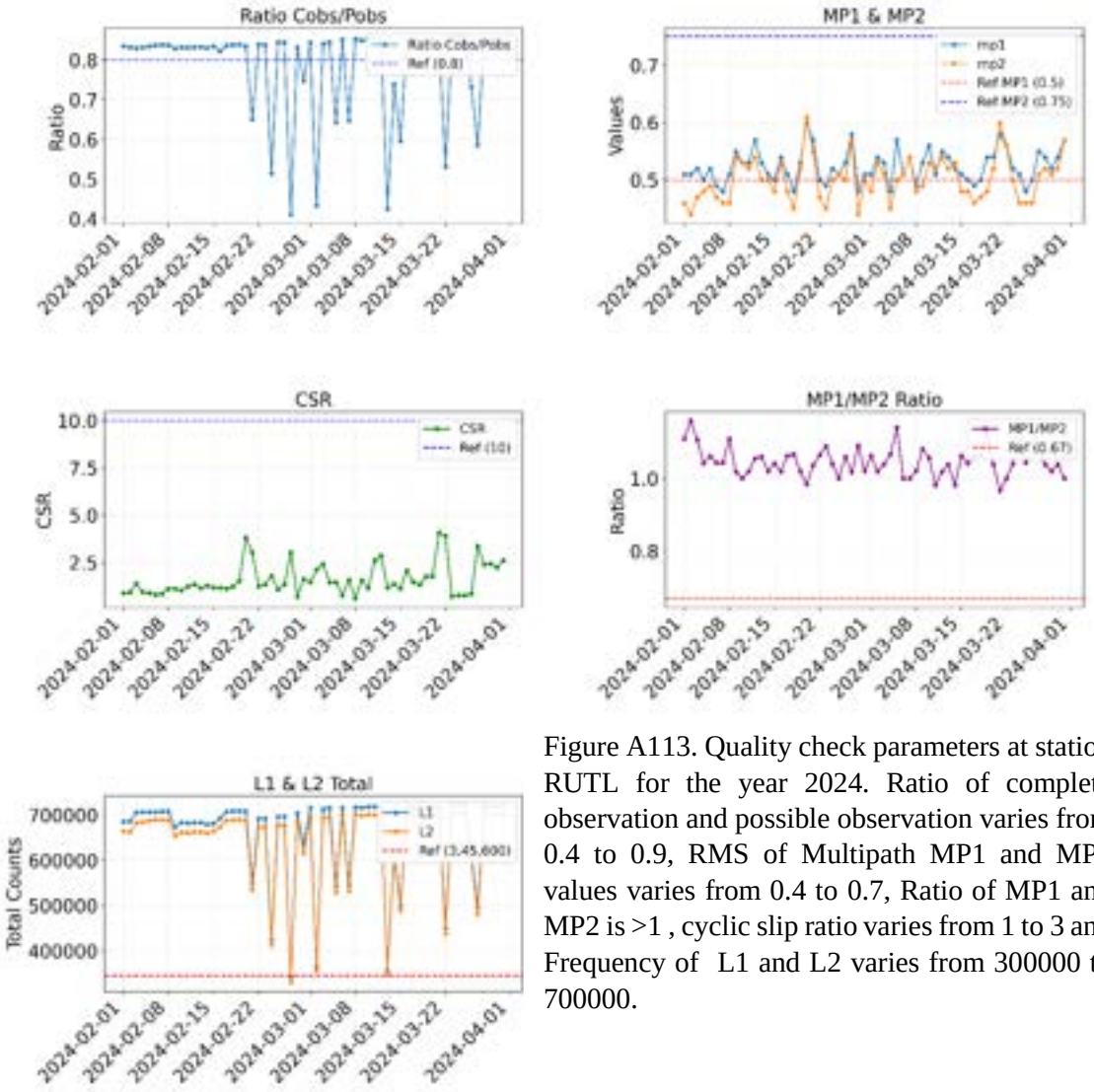


Figure A113. Quality check parameters at station RUTL for the year 2024. Ratio of complete observation and possible observation varies from 0.4 to 0.9, RMS of Multipath MP1 and MP2 values varies from 0.4 to 0.7, Ratio of MP1 and MP2 is >1 , cyclic slip ratio varies from 1 to 3 and Frequency of L1 and L2 varies from 300000 to 700000.

25. RAMN

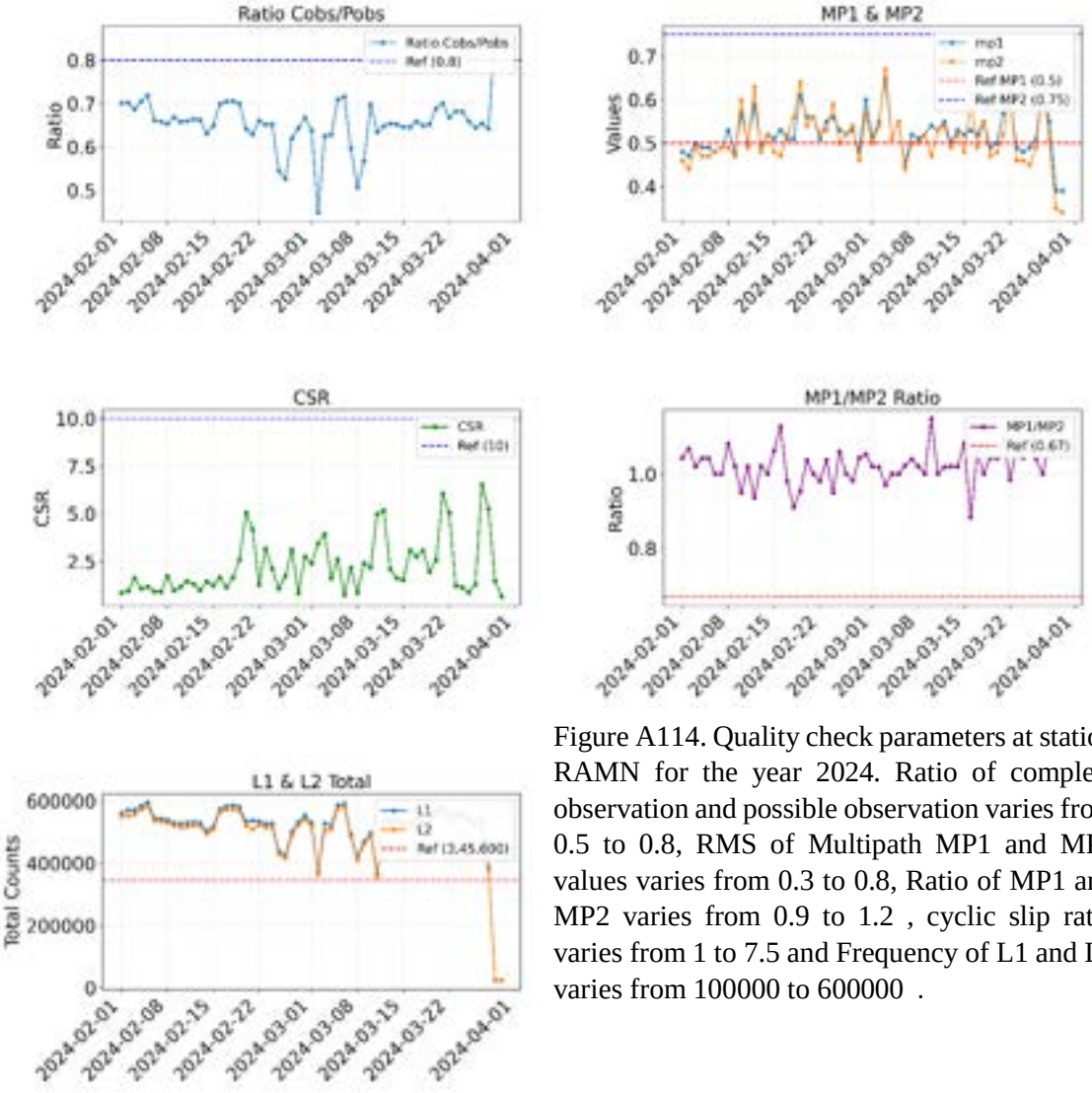


Figure A114. Quality check parameters at station RAMN for the year 2024. Ratio of complete observation and possible observation varies from 0.5 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.3 to 0.8, Ratio of MP1 and MP2 varies from 0.9 to 1.2 , cyclic slip ratio varies from 1 to 7.5 and Frequency of L1 and L2 varies from 100000 to 600000 .

26. SHAS

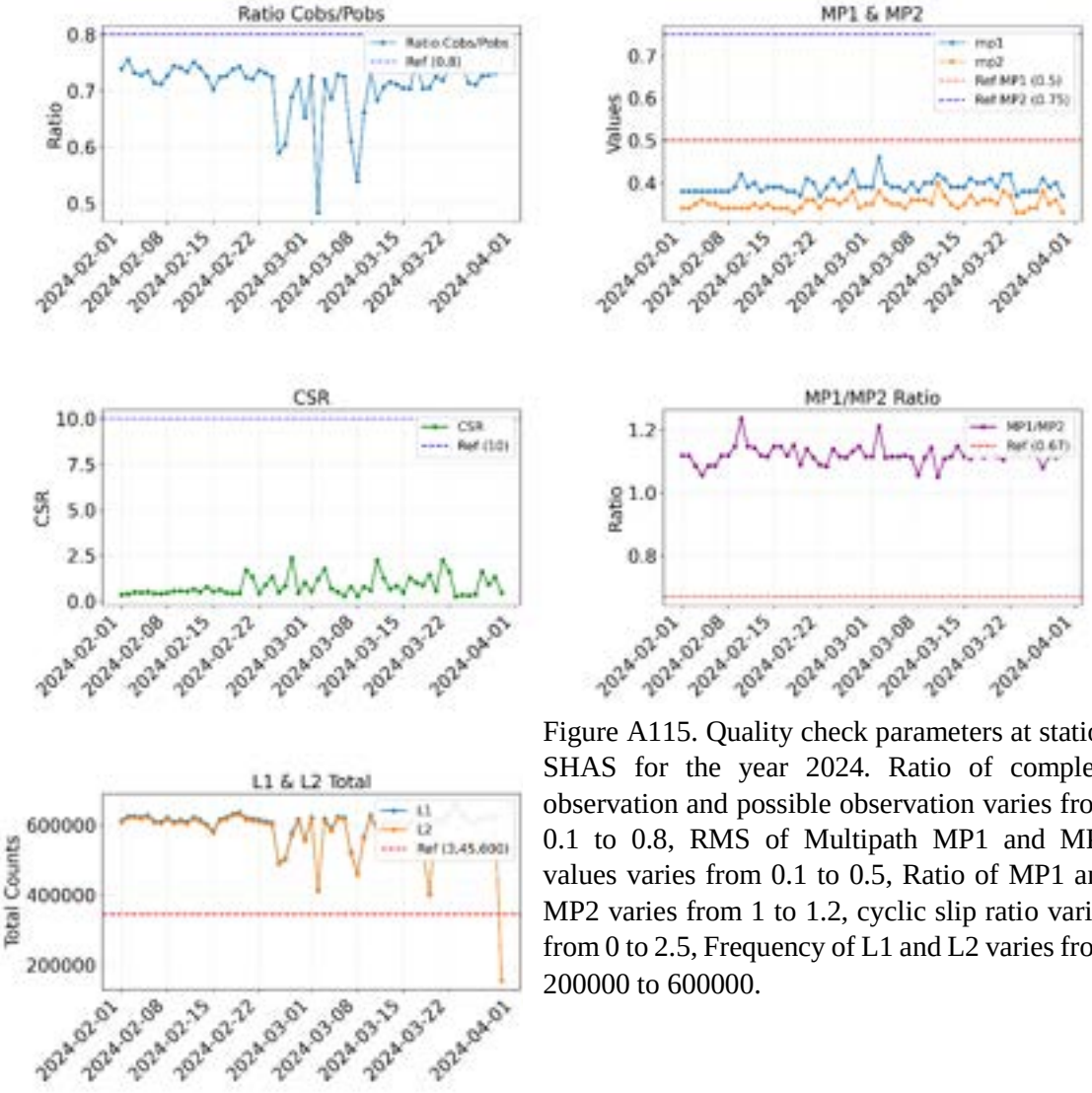


Figure A115. Quality check parameters at station SHAS for the year 2024. Ratio of complete observation and possible observation varies from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.5, Ratio of MP1 and MP2 varies from 1 to 1.2, cyclic slip ratio varies from 0 to 2.5, Frequency of L1 and L2 varies from 200000 to 600000.

27. SHOA

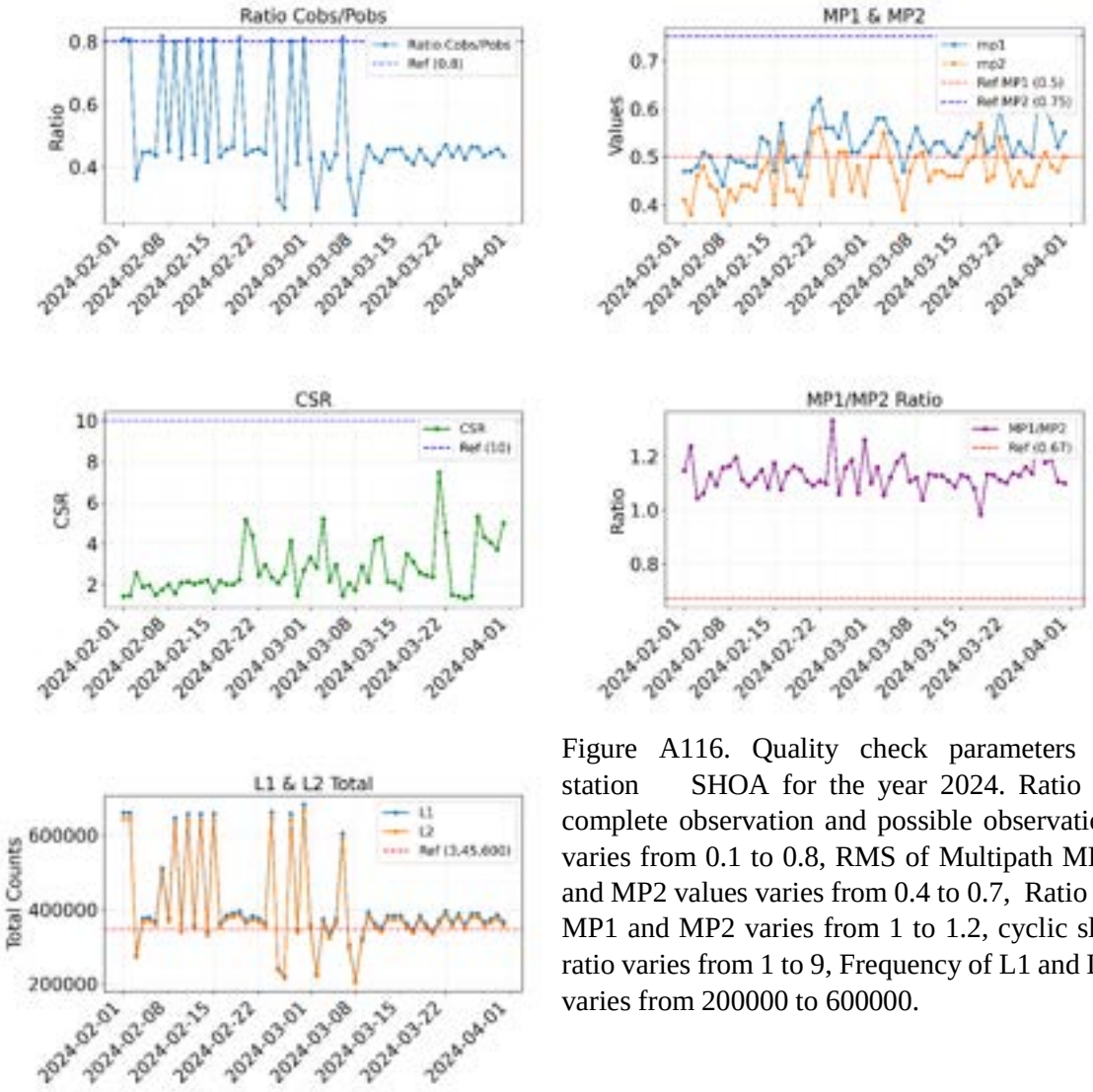


Figure A116. Quality check parameters at station SHOA for the year 2024. Ratio of complete observation and possible observation varies from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.4 to 0.7, Ratio of MP1 and MP2 varies from 1 to 1.2, cyclic slip ratio varies from 1 to 9, Frequency of L1 and L2 varies from 200000 to 600000.

28. TRIN

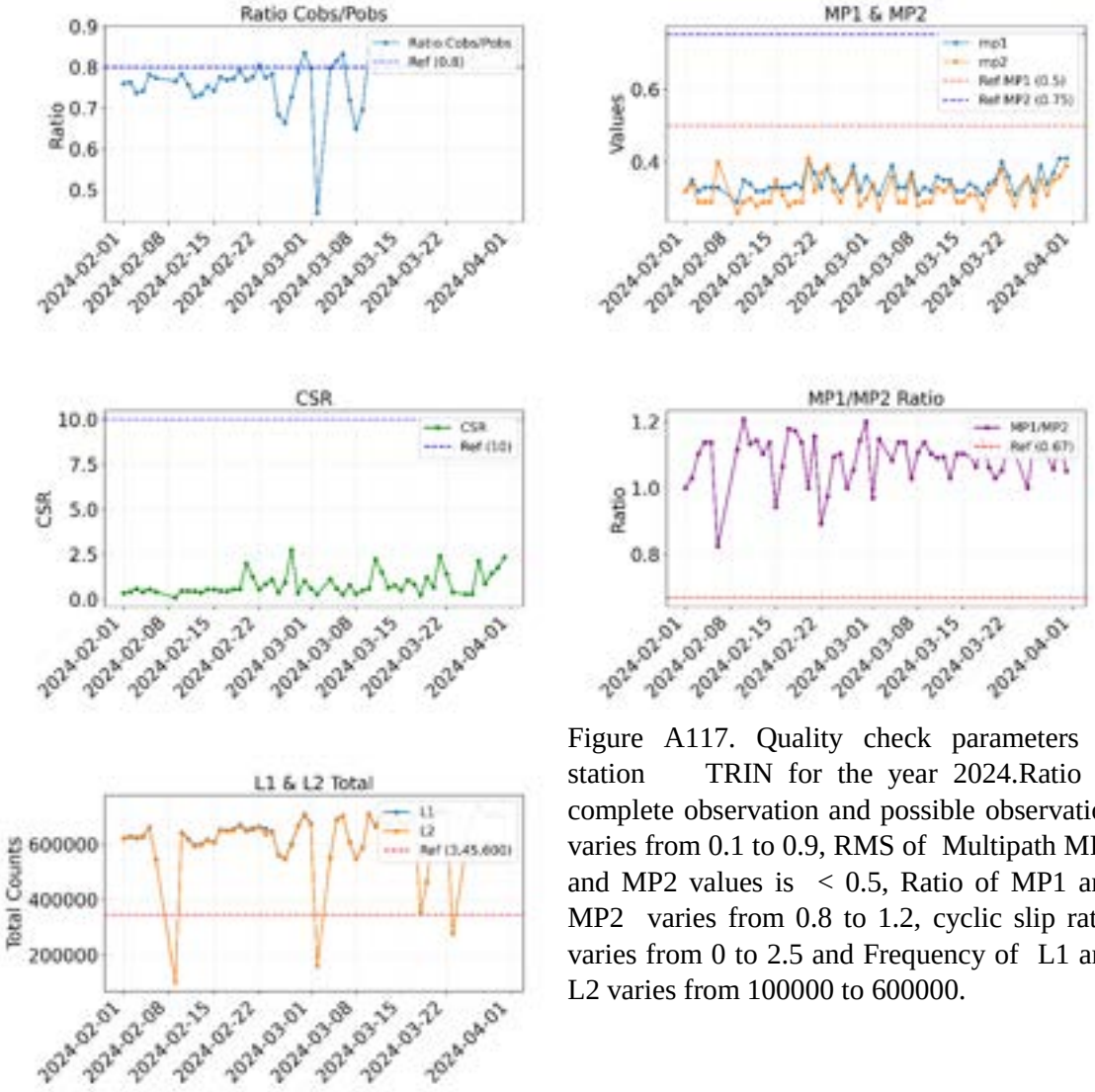


Figure A117. Quality check parameters at station TRIN for the year 2024.Ratio of complete observation and possible observation varies from 0.1 to 0.9, RMS of Multipath MP1 and MP2 values is < 0.5, Ratio of MP1 and MP2 varies from 0.8 to 1.2, cyclic slip ratio varies from 0 to 2.5 and Frequency of L1 and L2 varies from 100000 to 600000.

29. UKAT

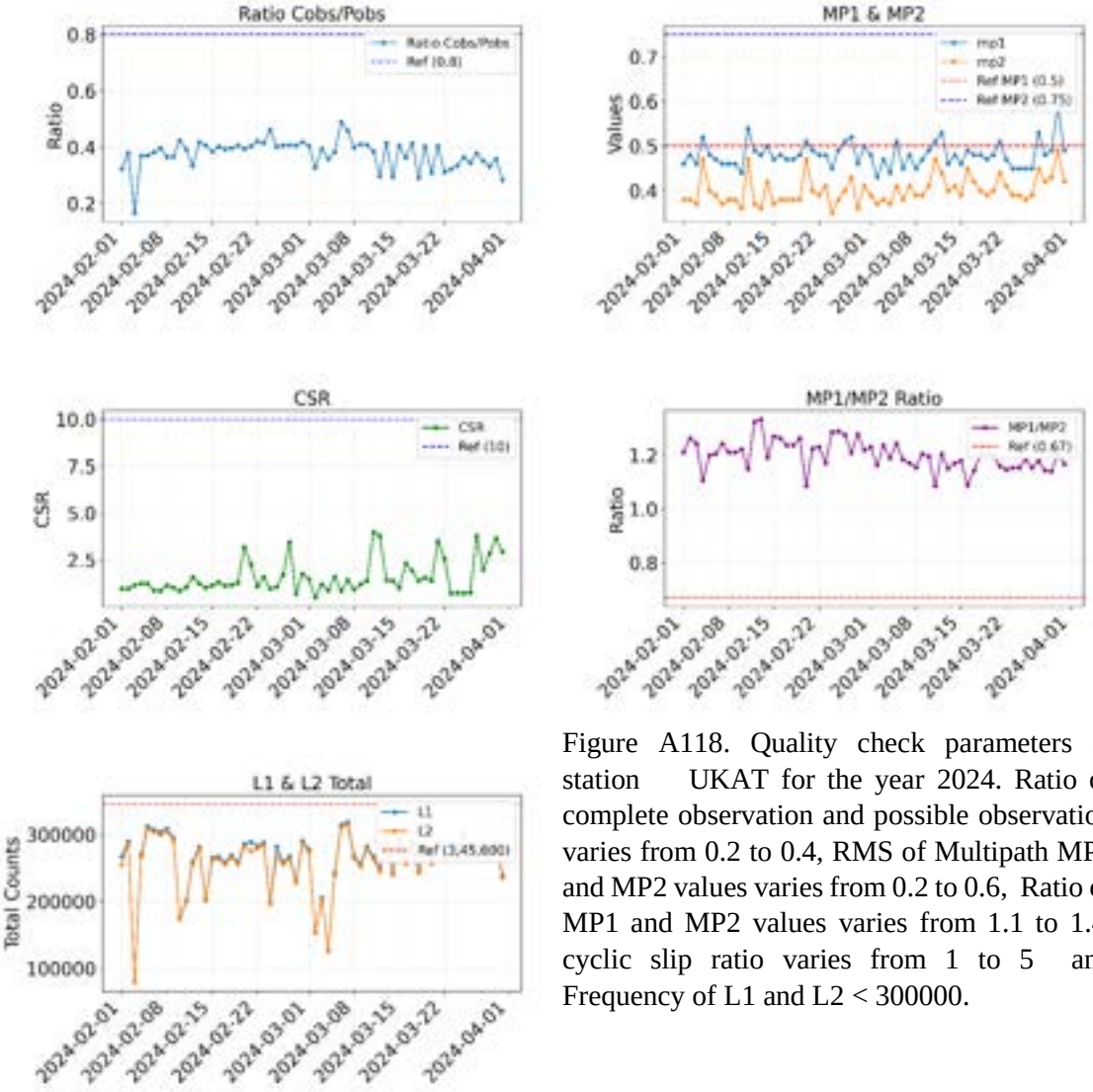


Figure A118. Quality check parameters at station UKAT for the year 2024. Ratio of complete observation and possible observation varies from 0.2 to 0.4, RMS of Multipath MP1 and MP2 values varies from 0.2 to 0.6, Ratio of MP1 and MP2 values varies from 1.1 to 1.4, cyclic slip ratio varies from 1 to 5 and Frequency of L1 and L2 < 300000.

30. WAND

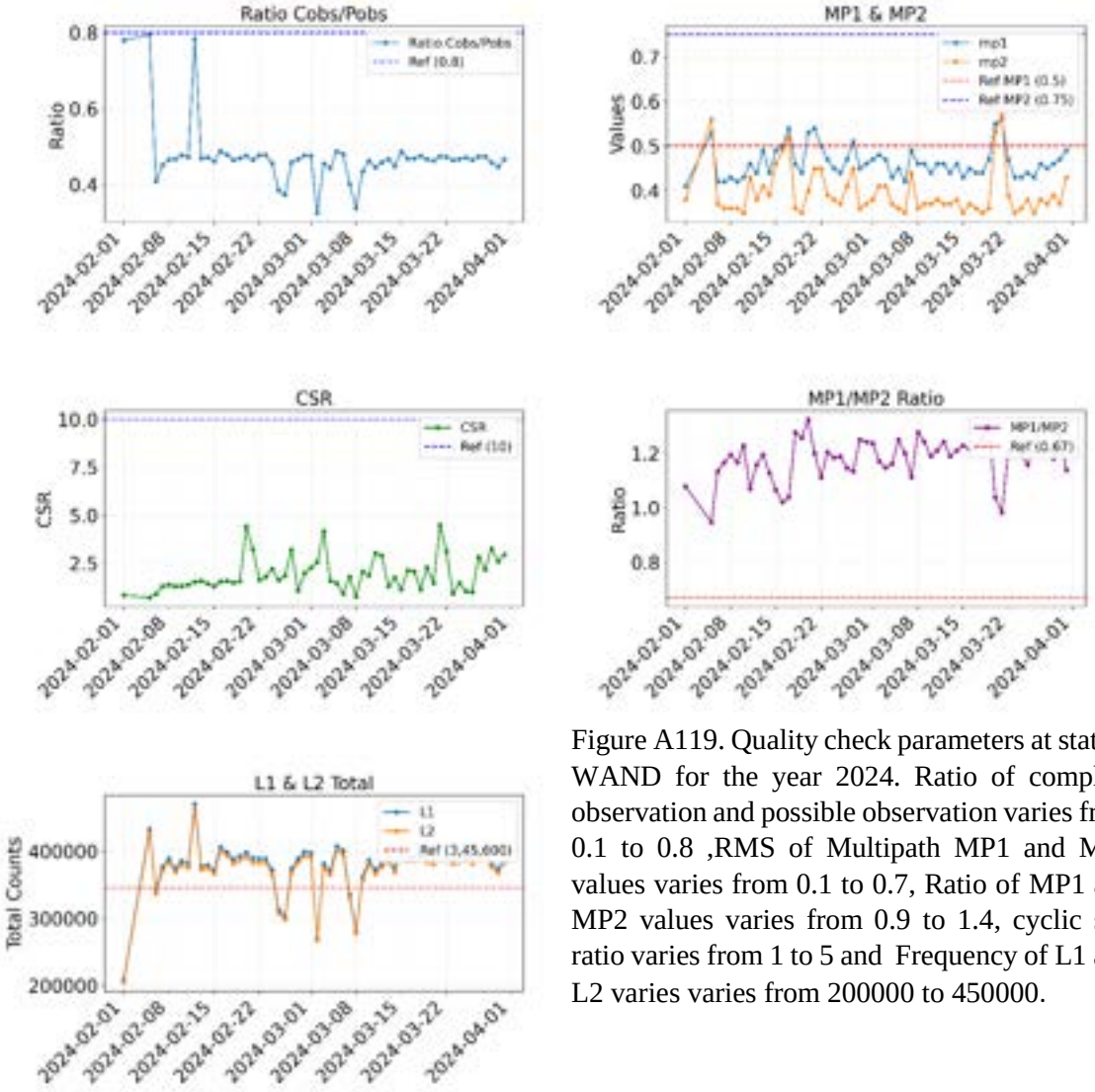


Figure A119. Quality check parameters at station WAND for the year 2024. Ratio of complete observation and possible observation varies from 0.1 to 0.8 ,RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.7, Ratio of MP1 and MP2 values varies from 0.9 to 1.4, cyclic slip ratio varies from 1 to 5 and Frequency of L1 and L2 varies varies from 200000 to 450000.

YEAR 2025

1. ALUR

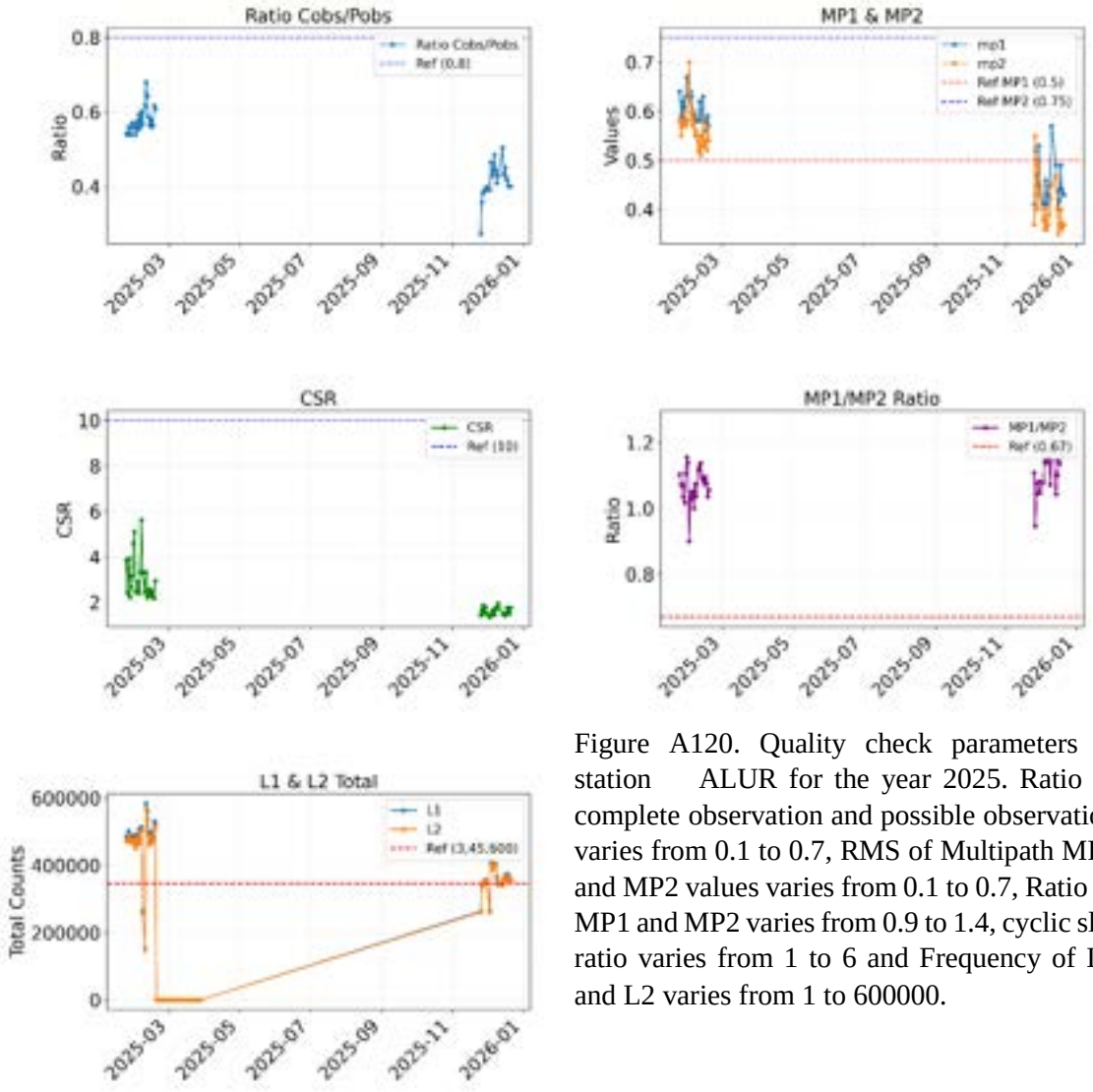


Figure A120. Quality check parameters at station ALUR for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.7, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.7, Ratio of MP1 and MP2 varies from 0.9 to 1.4, cyclic slip ratio varies from 1 to 6 and Frequency of L1 and L2 varies from 1 to 600000.

2. ARON

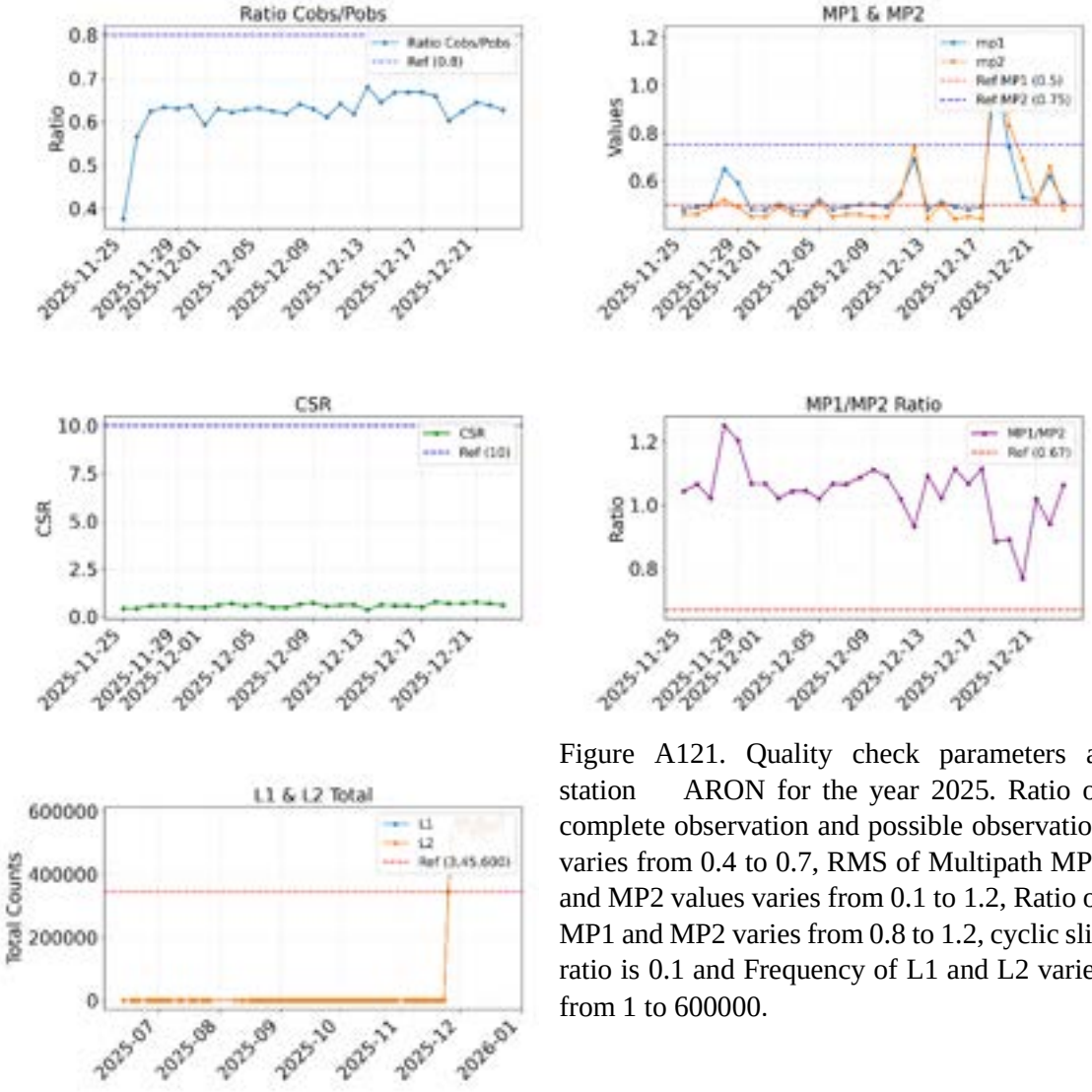


Figure A121. Quality check parameters at station ARON for the year 2025. Ratio of complete observation and possible observation varies from 0.4 to 0.7, RMS of Multipath MP1 and MP2 values varies from 0.1 to 1.2, Ratio of MP1 and MP2 varies from 0.8 to 1.2, cyclic slip ratio is 0.1 and Frequency of L1 and L2 varies from 1 to 600000.

3. BAKU

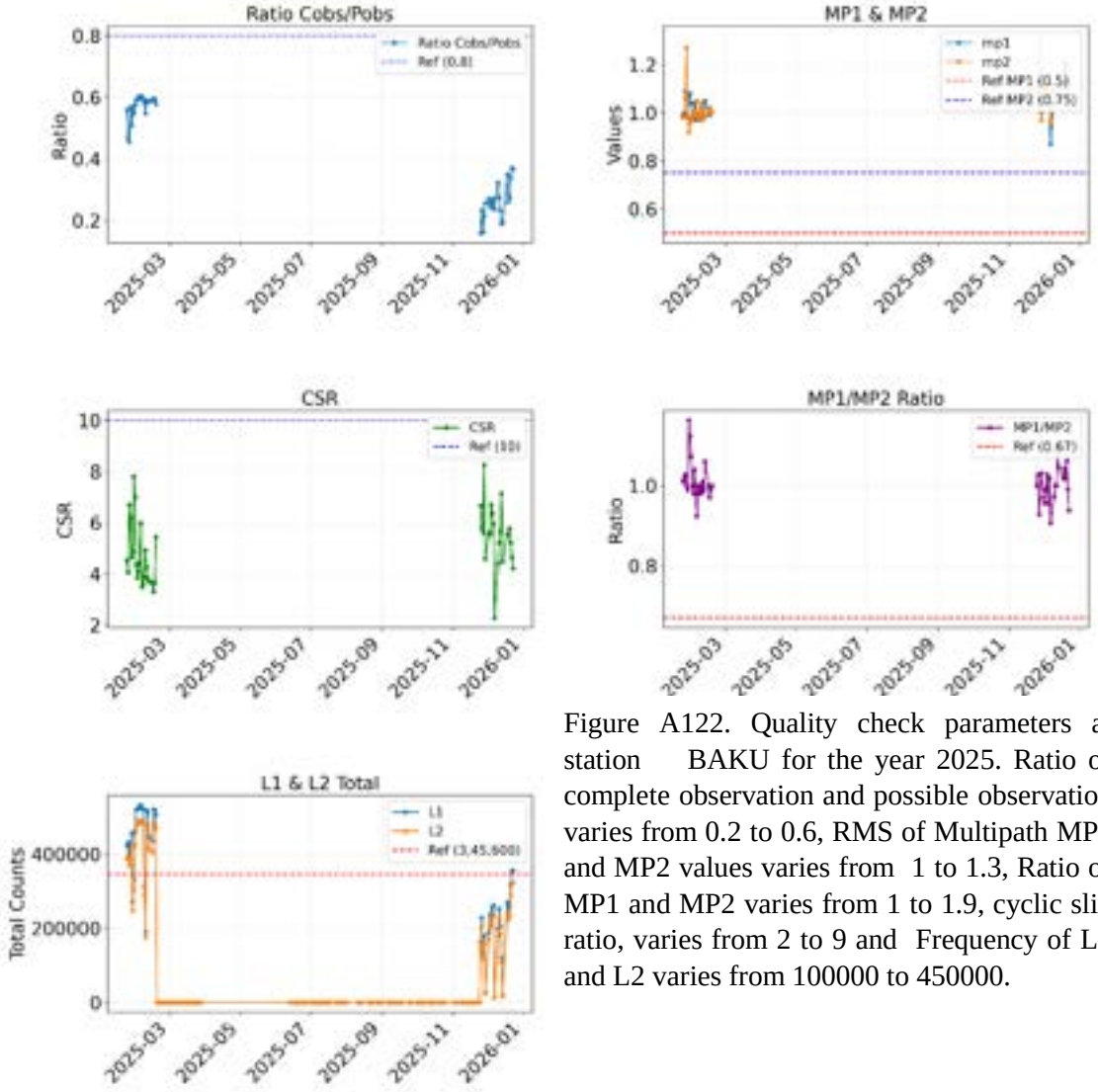


Figure A122. Quality check parameters at station BAKU for the year 2025. Ratio of complete observation and possible observation varies from 0.2 to 0.6, RMS of Multipath MP1 and MP2 values varies from 1 to 1.3, Ratio of MP1 and MP2 varies from 1 to 1.9, cyclic slip ratio, varies from 2 to 9 and Frequency of L1 and L2 varies from 100000 to 450000.

4. BARA

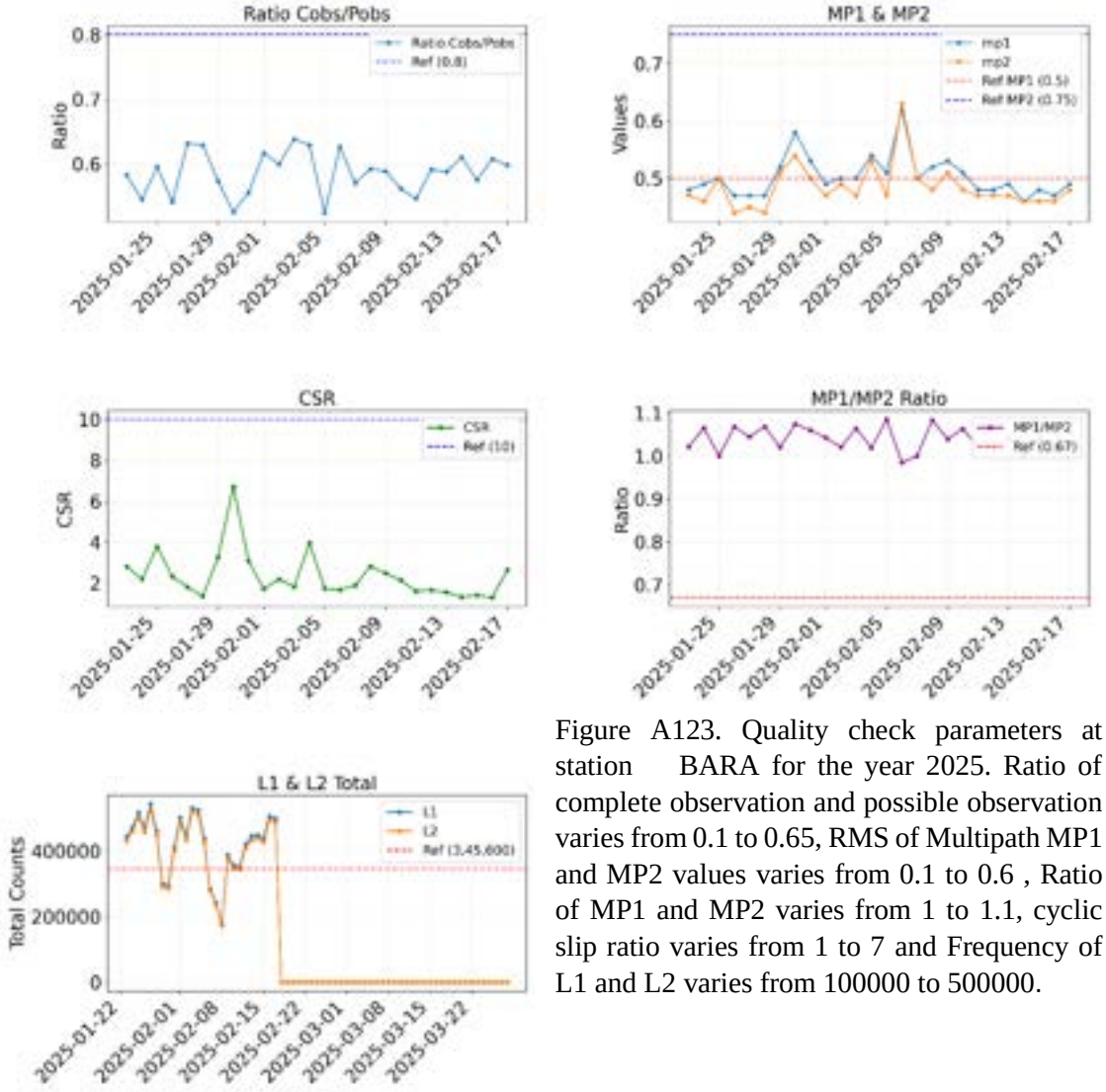


Figure A123. Quality check parameters at station BARA for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.65, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.6 , Ratio of MP1 and MP2 varies from 1 to 1.1, cyclic slip ratio varies from 1 to 7 and Frequency of L1 and L2 varies from 100000 to 500000.

5. CHID

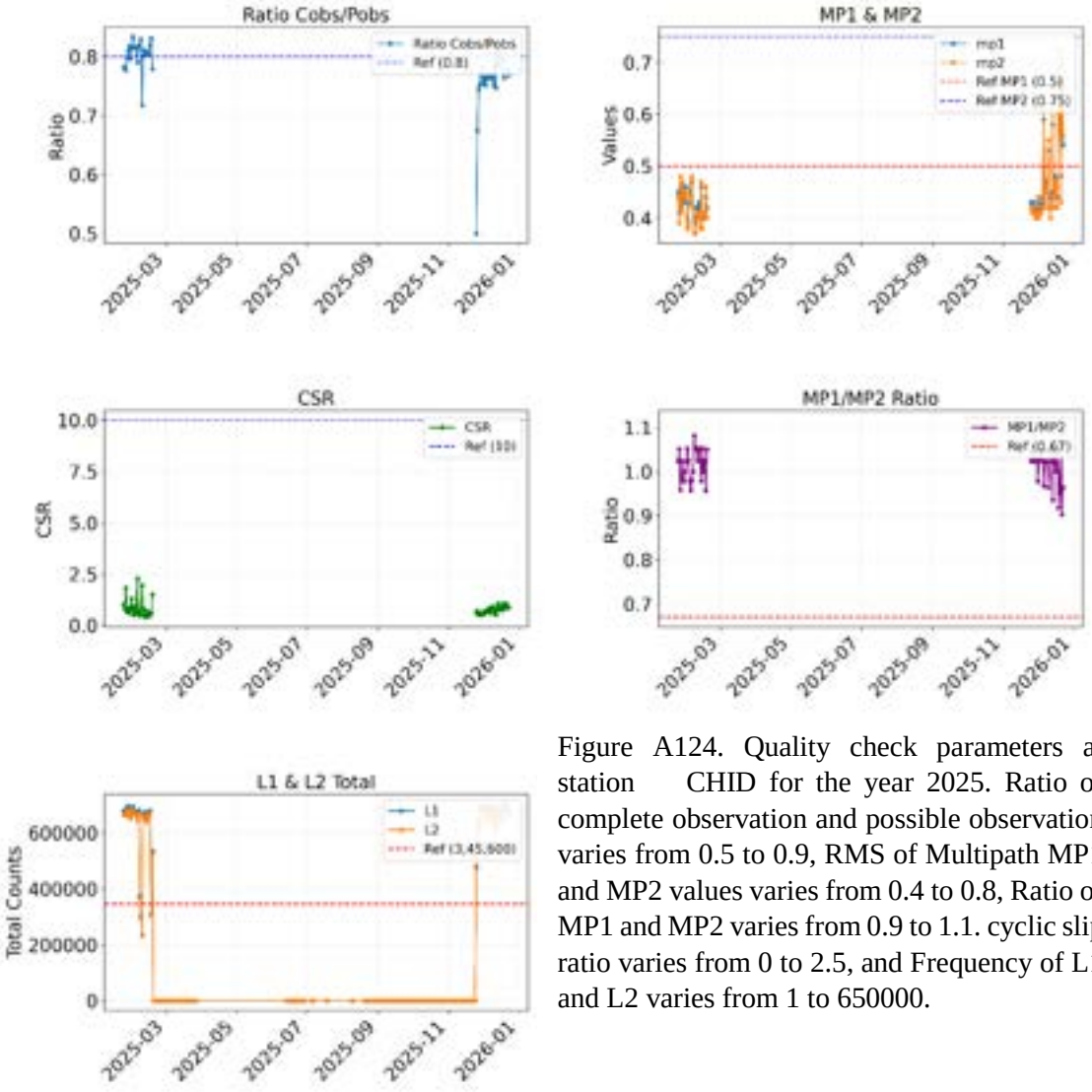


Figure A124. Quality check parameters at station CHID for the year 2025. Ratio of complete observation and possible observation varies from 0.5 to 0.9, RMS of Multipath MP1 and MP2 values varies from 0.4 to 0.8, Ratio of MP1 and MP2 varies from 0.9 to 1.1. cyclic slip ratio varies from 0 to 2.5, and Frequency of L1 and L2 varies from 1 to 650000.

26. CWRA

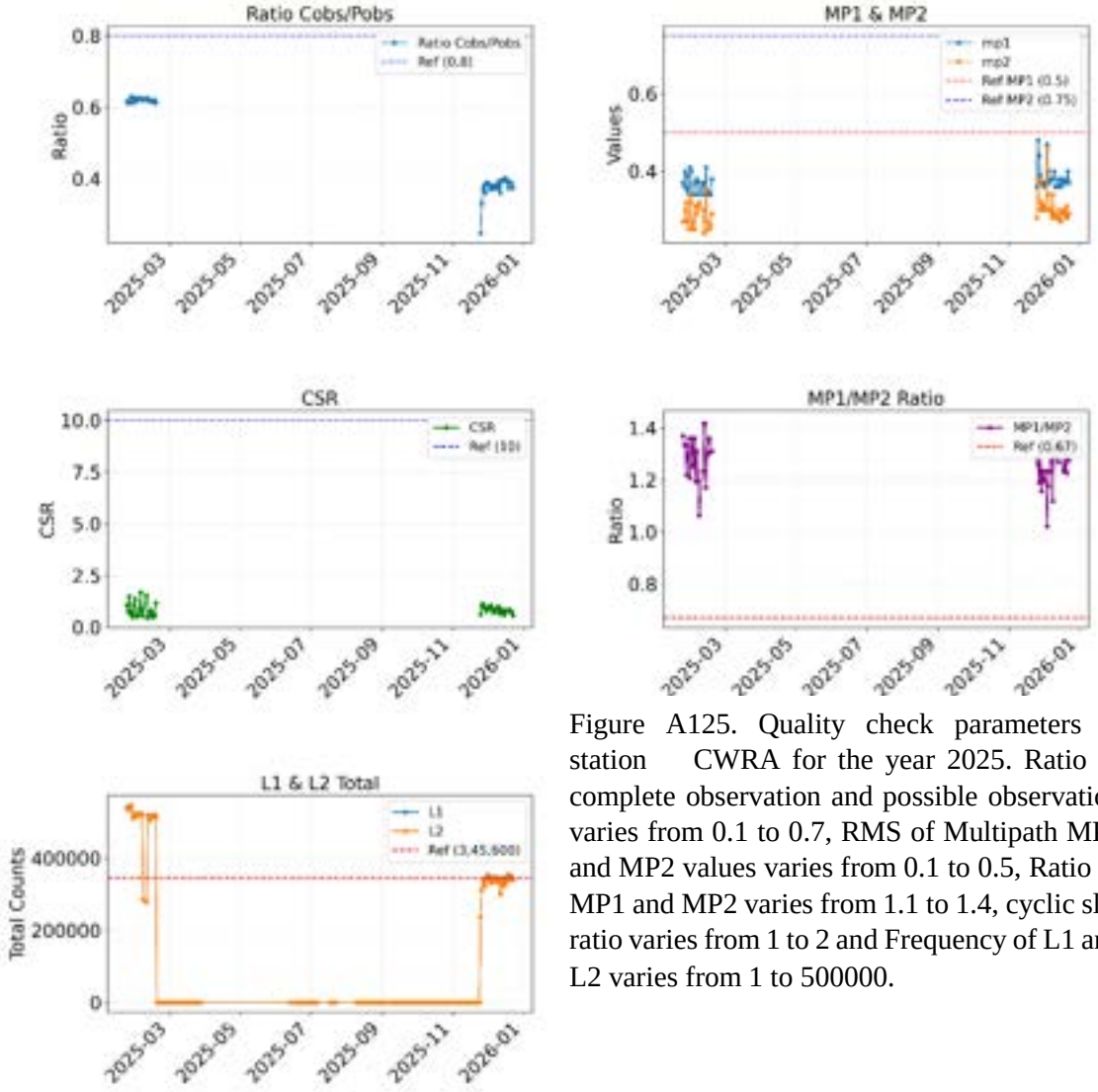


Figure A125. Quality check parameters at station CWRA for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.7, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.5, Ratio of MP1 and MP2 varies from 1.1 to 1.4, cyclic slip ratio varies from 1 to 2 and Frequency of L1 and L2 varies from 1 to 500000.

27. FERR

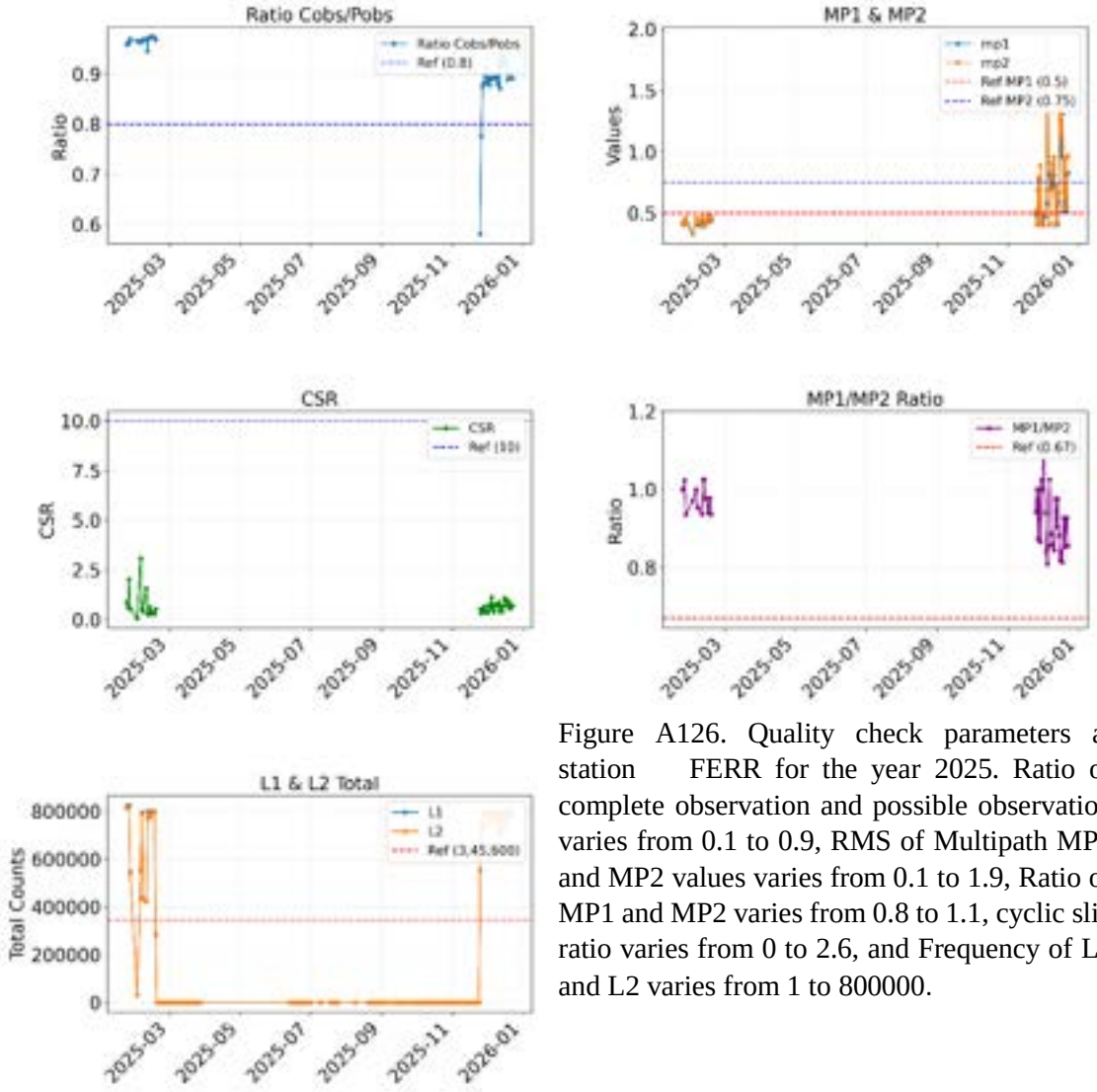


Figure A126. Quality check parameters at station FERR for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.9, RMS of Multipath MP1 and MP2 values varies from 0.1 to 1.9, Ratio of MP1 and MP2 varies from 0.8 to 1.1, cyclic slip ratio varies from 0 to 2.6, and Frequency of L1 and L2 varies from 1 to 800000.

28. KADA

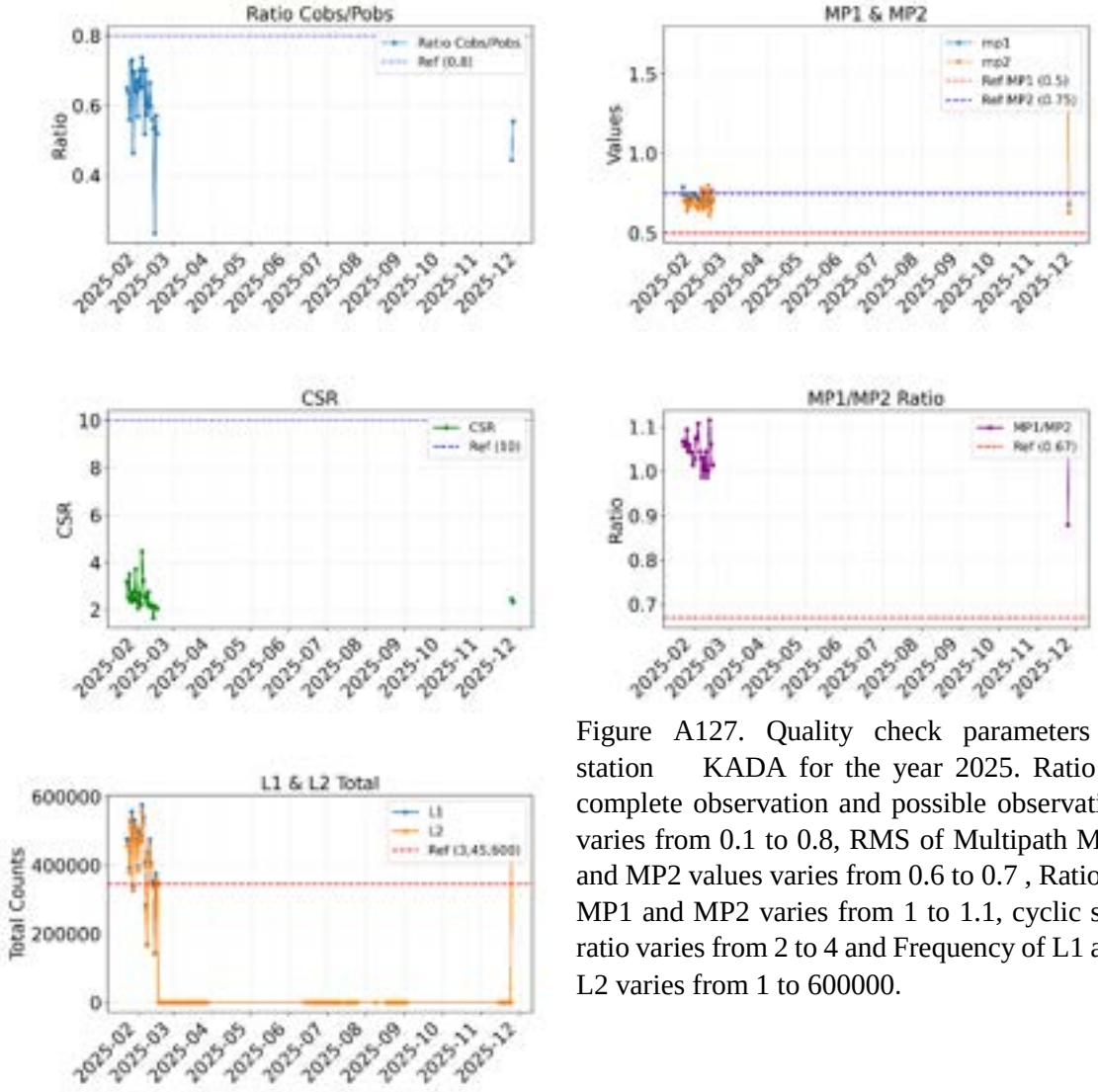


Figure A127. Quality check parameters at station KADA for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.6 to 0.7 , Ratio of MP1 and MP2 varies from 1 to 1.1, cyclic slip ratio varies from 2 to 4 and Frequency of L1 and L2 varies from 1 to 600000.

29. KAKA

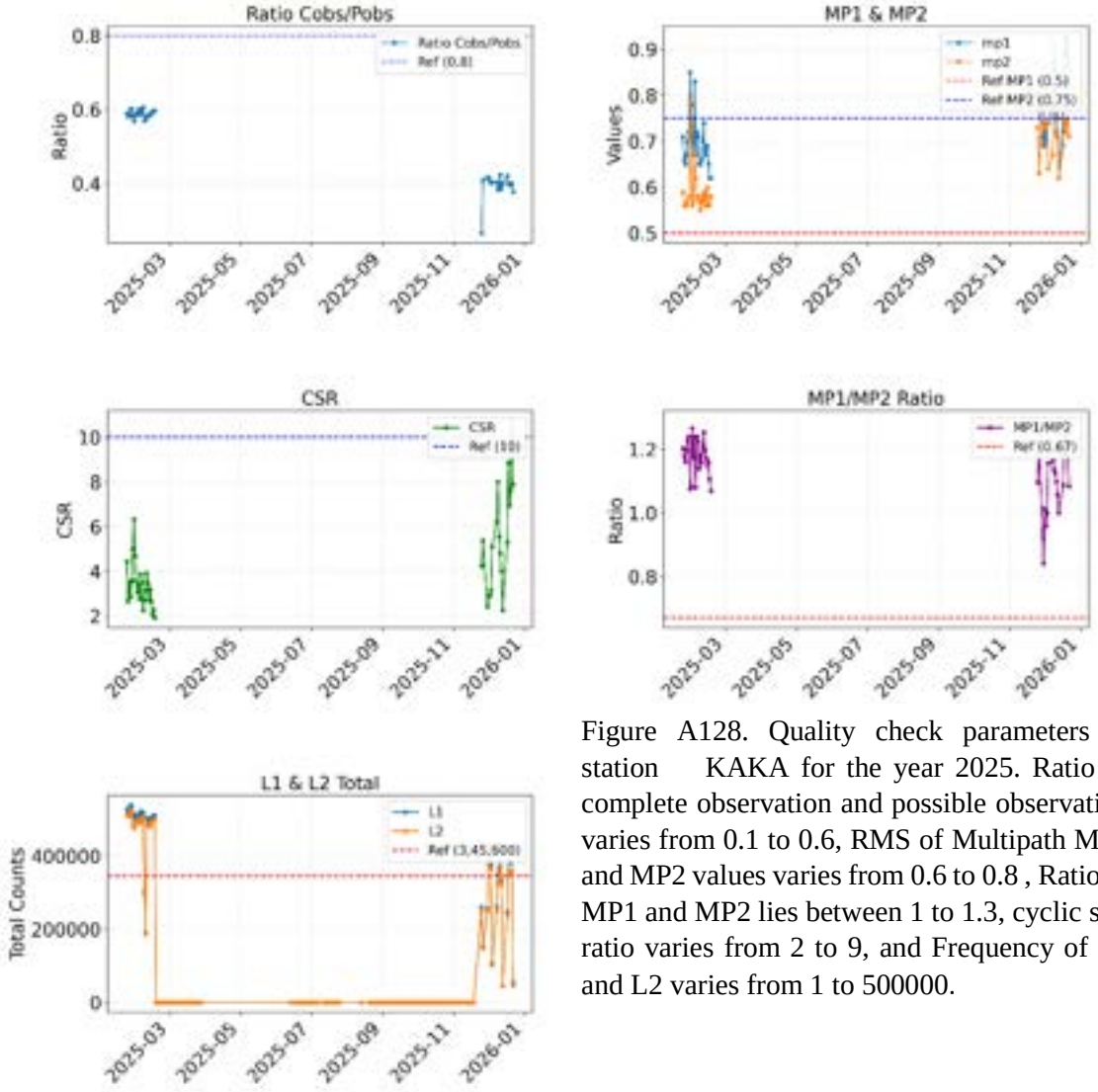


Figure A128. Quality check parameters at station KAKA for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.6, RMS of Multipath MP1 and MP2 values varies from 0.6 to 0.8 , Ratio of MP1 and MP2 lies between 1 to 1.3, cyclic slip ratio varies from 2 to 9, and Frequency of L1 and L2 varies from 1 to 500000.

30. KISH

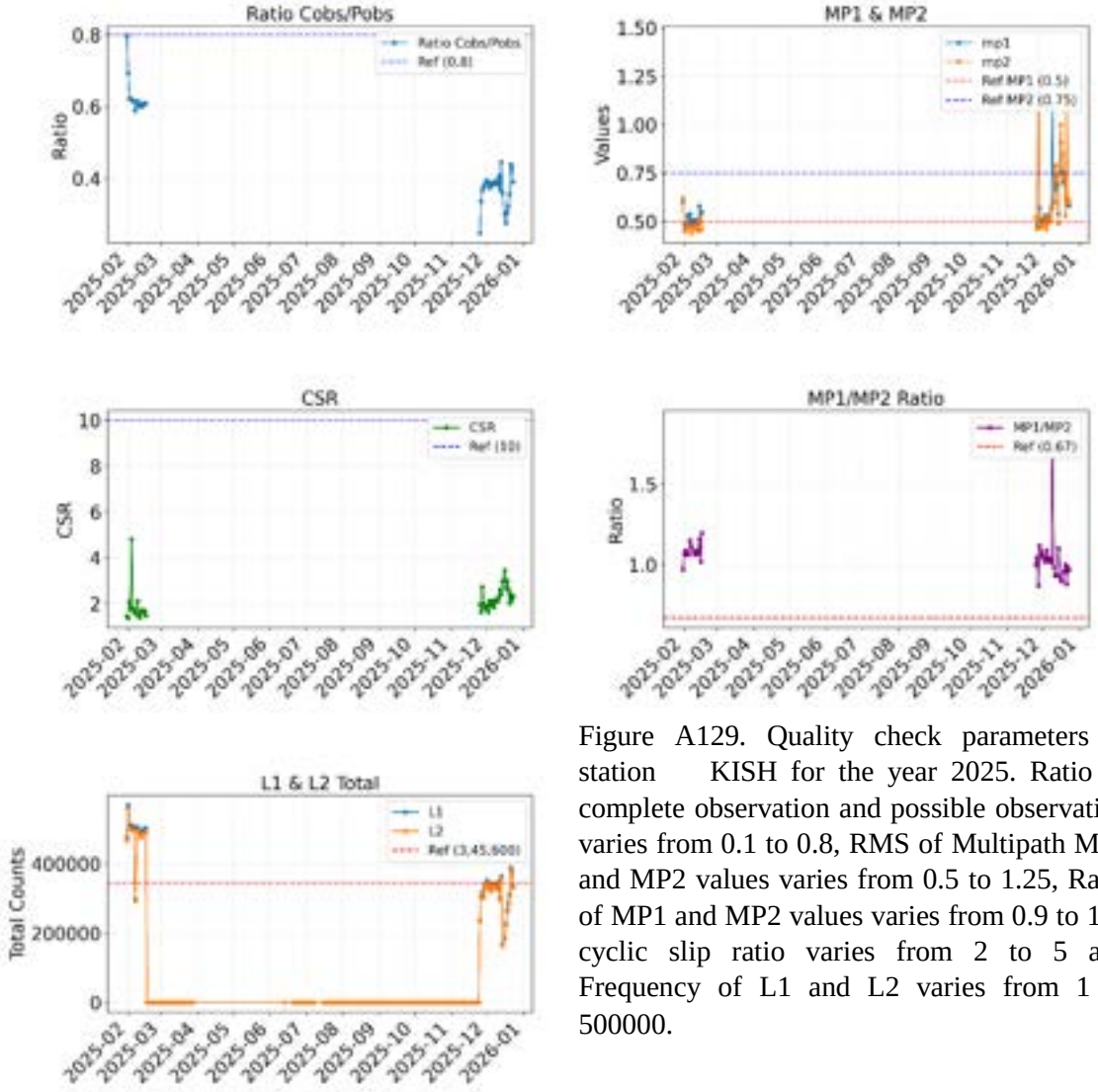


Figure A129. Quality check parameters at station KISH for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.5 to 1.25, Ratio of MP1 and MP2 values varies from 0.9 to 1.9, cyclic slip ratio varies from 2 to 5 and Frequency of L1 and L2 varies from 1 to 500000.

31. KLPT

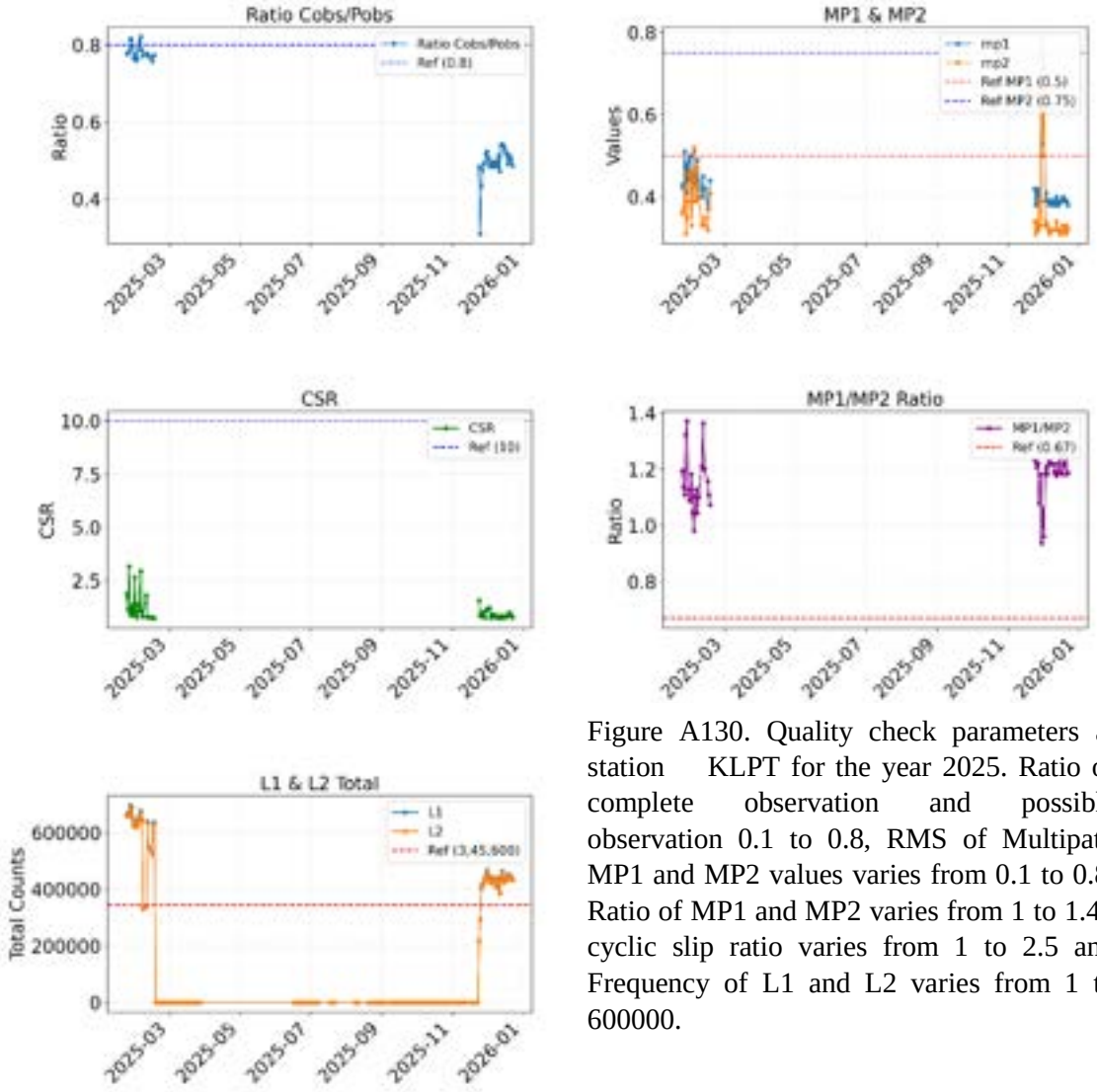


Figure A130. Quality check parameters at station KLPT for the year 2025. Ratio of complete observation and possible observation 0.1 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.8, Ratio of MP1 and MP2 varies from 1 to 1.4 , cyclic slip ratio varies from 1 to 2.5 and Frequency of L1 and L2 varies from 1 to 600000.

32. LONS

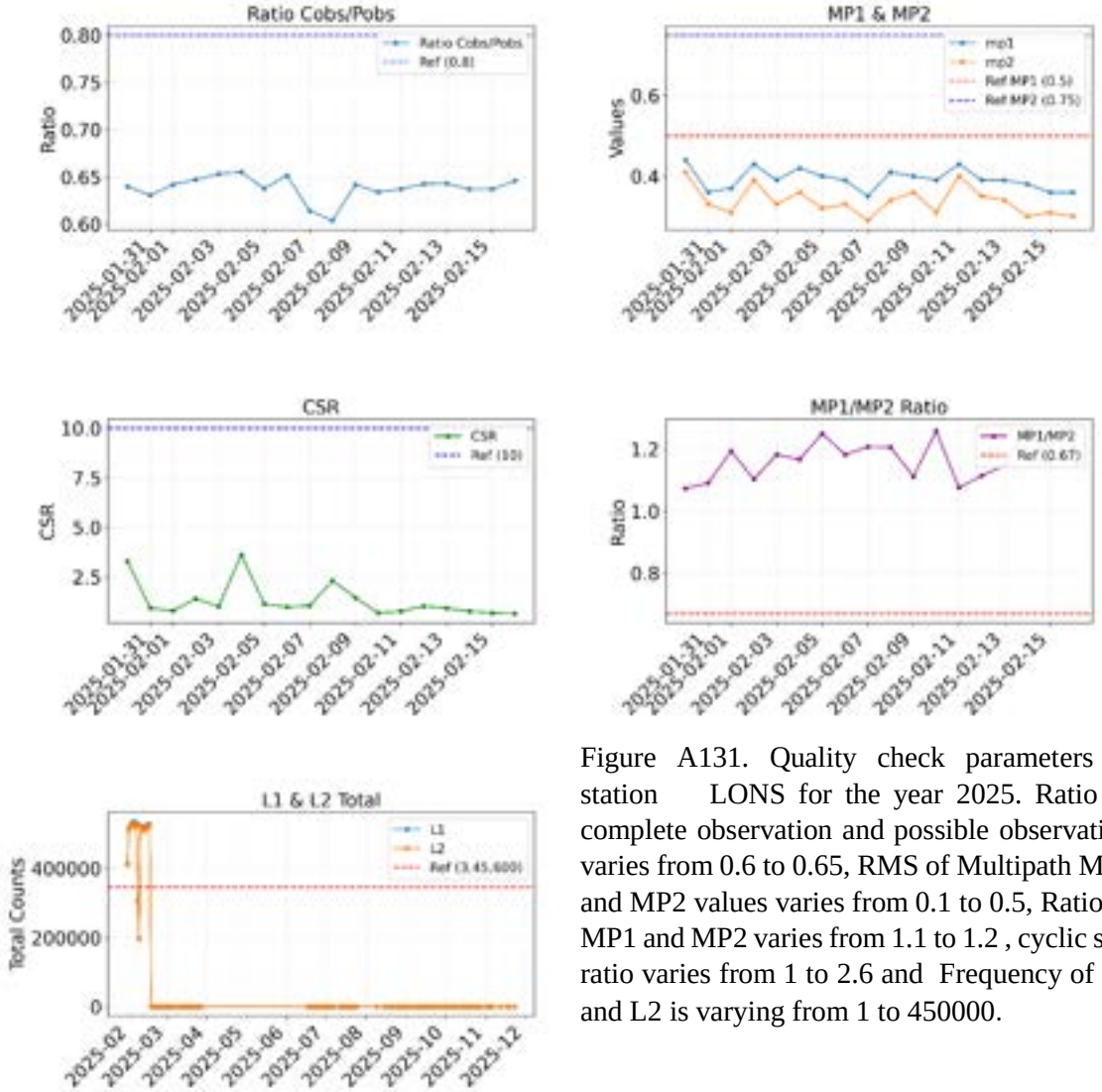


Figure A131. Quality check parameters at station LONS for the year 2025. Ratio of complete observation and possible observation varies from 0.6 to 0.65, RMS of Multipath MP1 and MP2 values varies from 0.1 to 0.5, Ratio of MP1 and MP2 varies from 1.1 to 1.2 , cyclic slip ratio varies from 1 to 2.6 and Frequency of L1 and L2 is varying from 1 to 450000.

33. MAKA

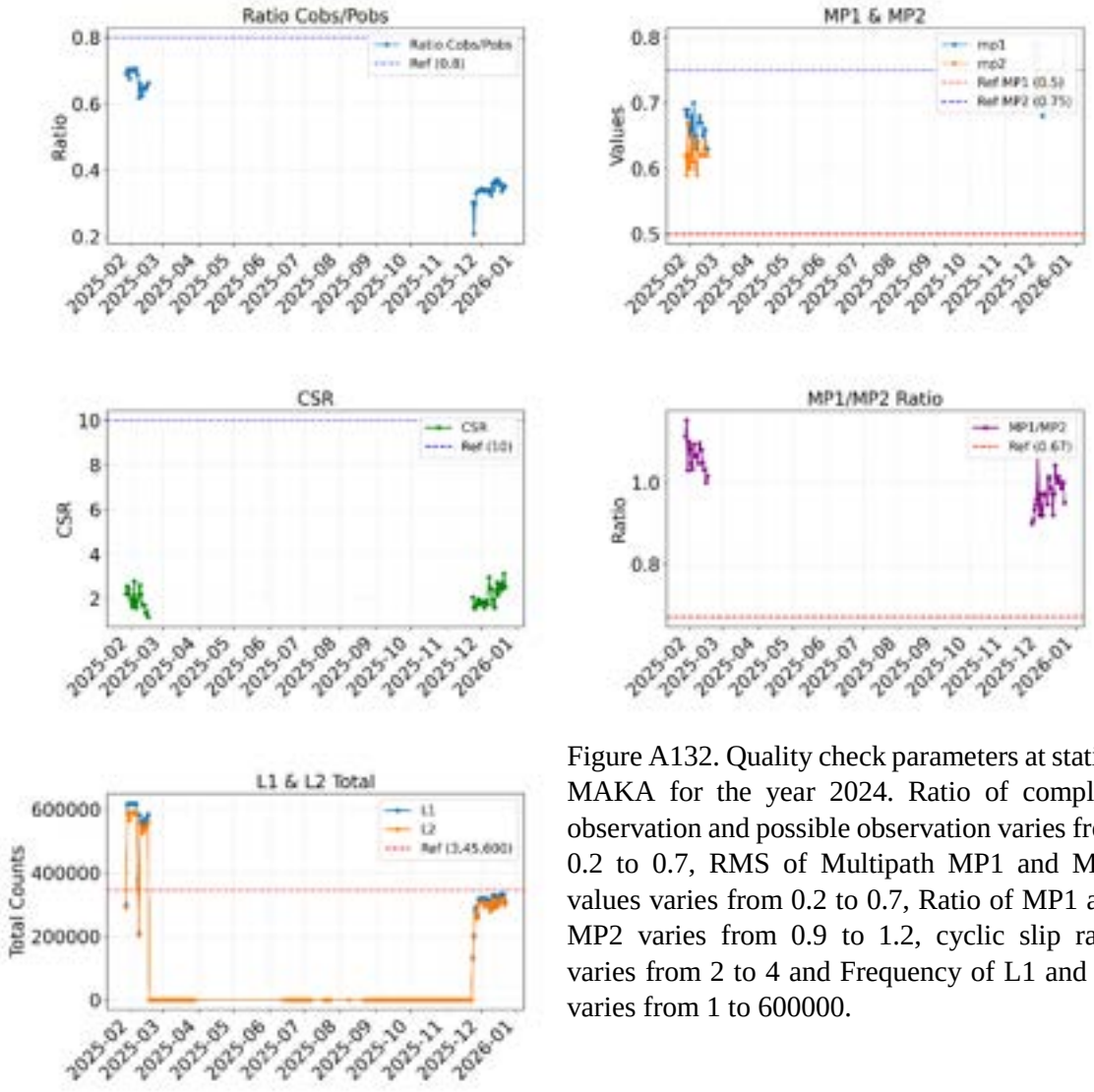


Figure A132. Quality check parameters at station MAKA for the year 2024. Ratio of complete observation and possible observation varies from 0.2 to 0.7, RMS of Multipath MP1 and MP2 values varies from 0.2 to 0.7, Ratio of MP1 and MP2 varies from 0.9 to 1.2, cyclic slip ratio varies from 2 to 4 and Frequency of L1 and L2 varies from 1 to 600000.

34. MILD

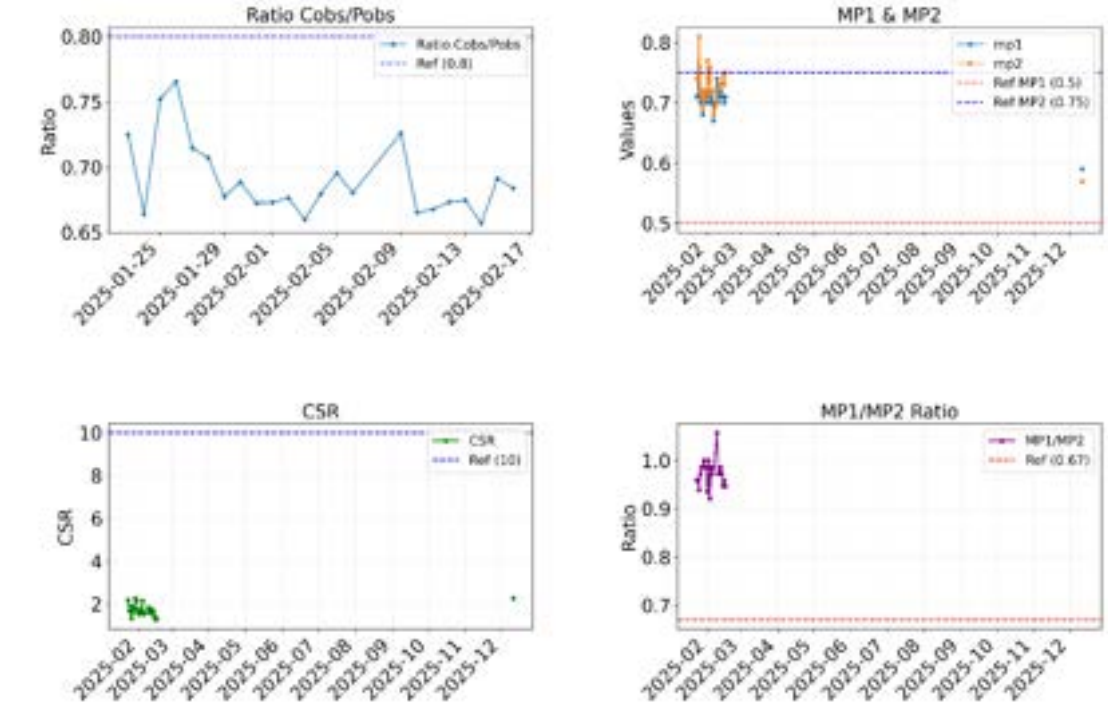


Figure A133. Quality check parameters at station MILD for the year 2025. Ratio of complete observation and possible observation varies from 0.65 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.7 to 0.8, Ratio of MP1 and MP2 varies from 0.9 to 1.2 , cyclic slip ratio is 2, and Frequency of L1 and L2 varies from 1 to 600000.

35. MOHA

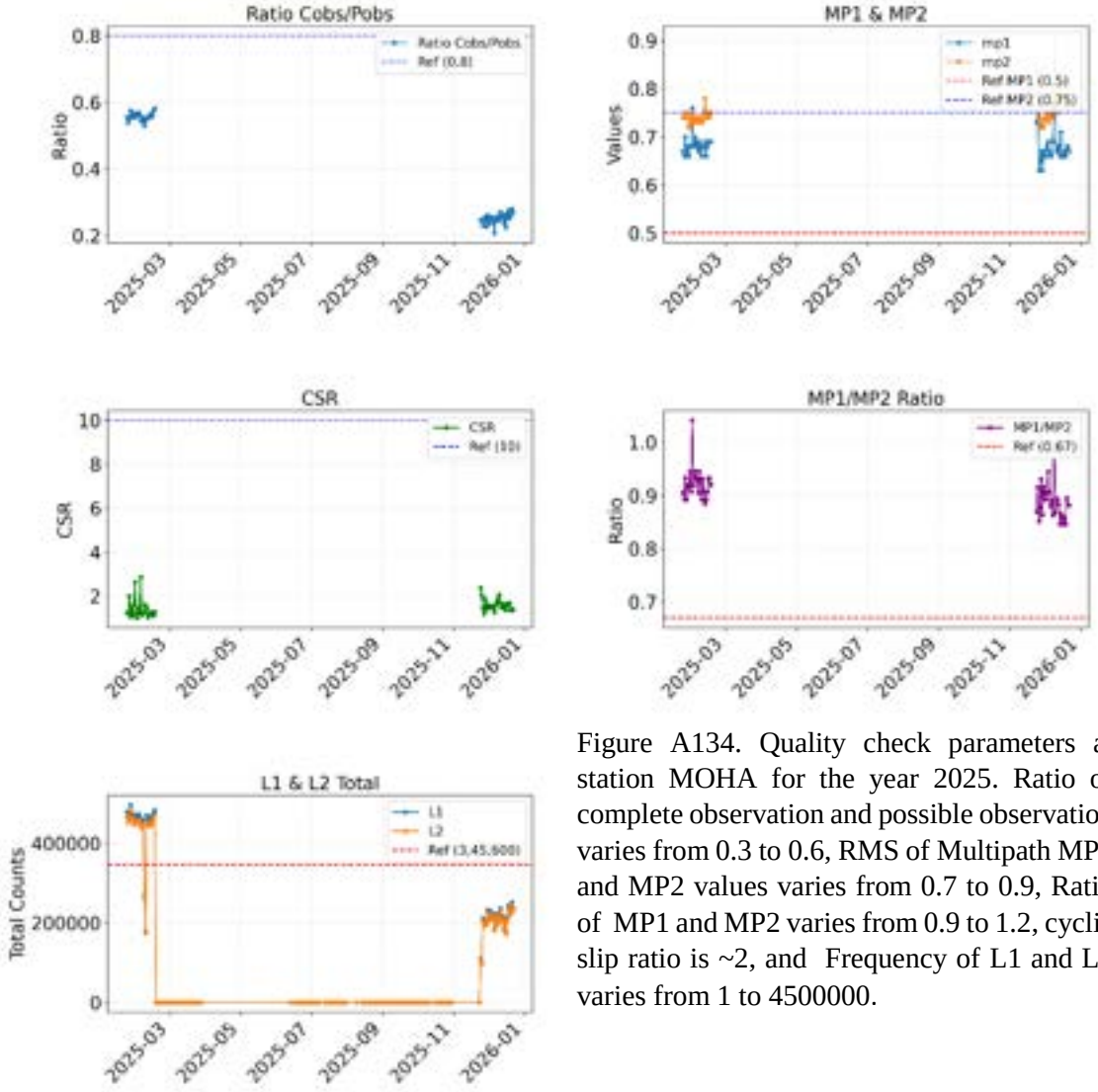


Figure A134. Quality check parameters at station MOHA for the year 2025. Ratio of complete observation and possible observation varies from 0.3 to 0.6, RMS of Multipath MP1 and MP2 values varies from 0.7 to 0.9, Ratio of MP1 and MP2 varies from 0.9 to 1.2, cyclic slip ratio is ~2, and Frequency of L1 and L2 varies from 1 to 4500000.

16. NAMU

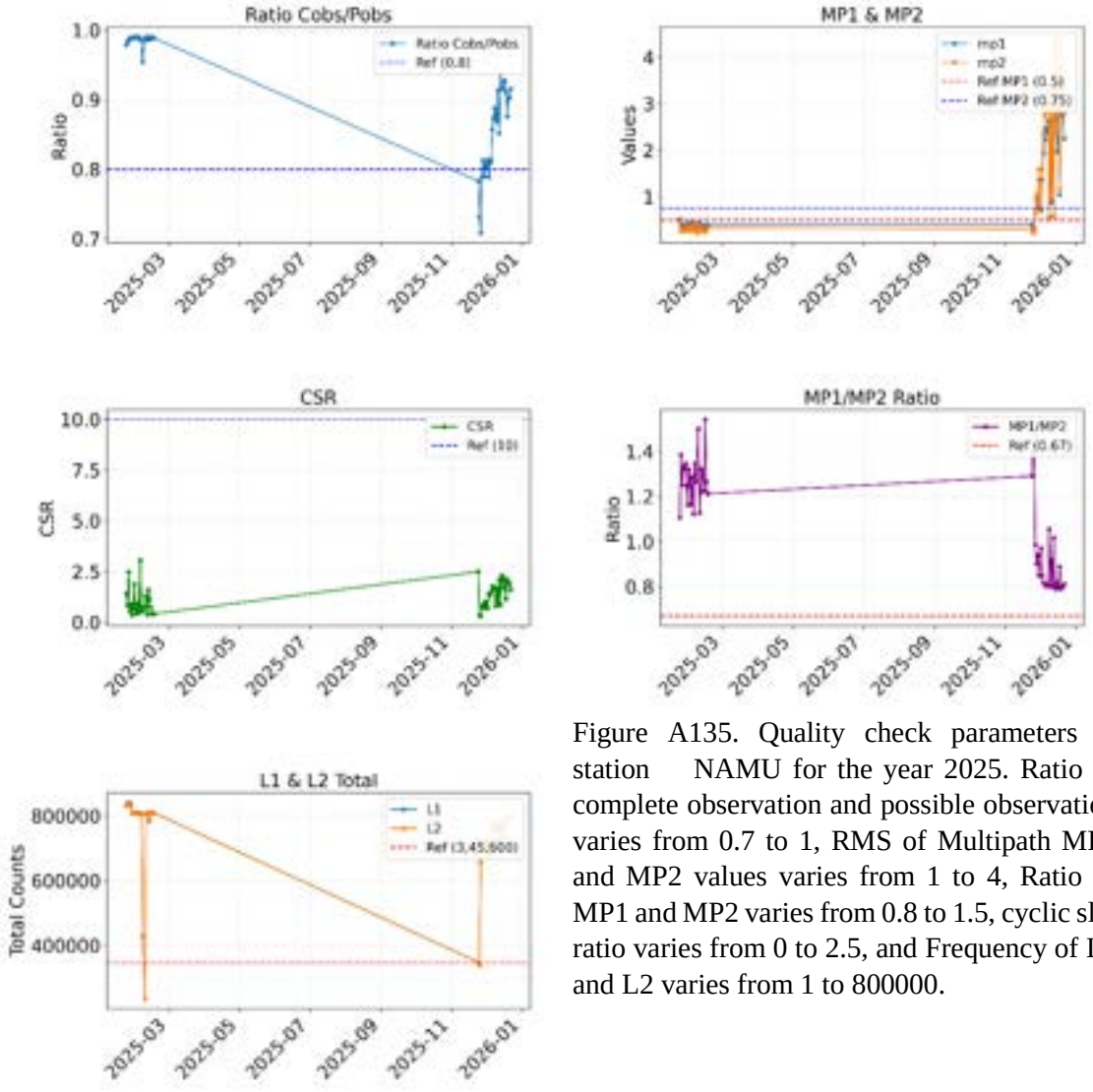


Figure A135. Quality check parameters at station NAMU for the year 2025. Ratio of complete observation and possible observation varies from 0.7 to 1, RMS of Multipath MP1 and MP2 values varies from 1 to 4, Ratio of MP1 and MP2 varies from 0.8 to 1.5, cyclic slip ratio varies from 0 to 2.5, and Frequency of L1 and L2 varies from 1 to 800000.

17. NEIL

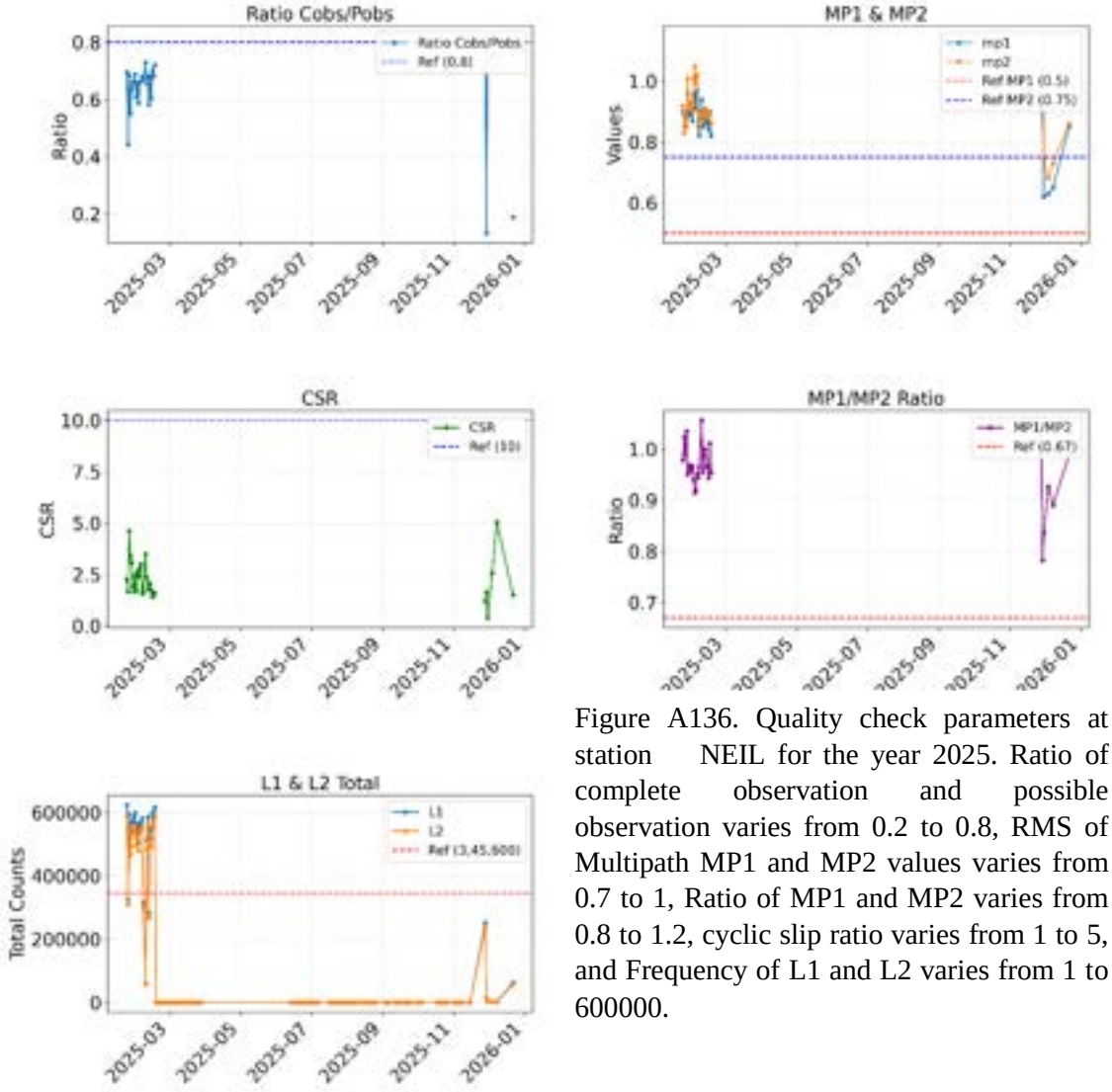


Figure A136. Quality check parameters at station NEIL for the year 2025. Ratio of complete observation and possible observation varies from 0.2 to 0.8, RMS of Multipath MP1 and MP2 values varies from 0.7 to 1, Ratio of MP1 and MP2 varies from 0.8 to 1.2, cyclic slip ratio varies from 1 to 5, and Frequency of L1 and L2 varies from 1 to 600000.

18. RADA

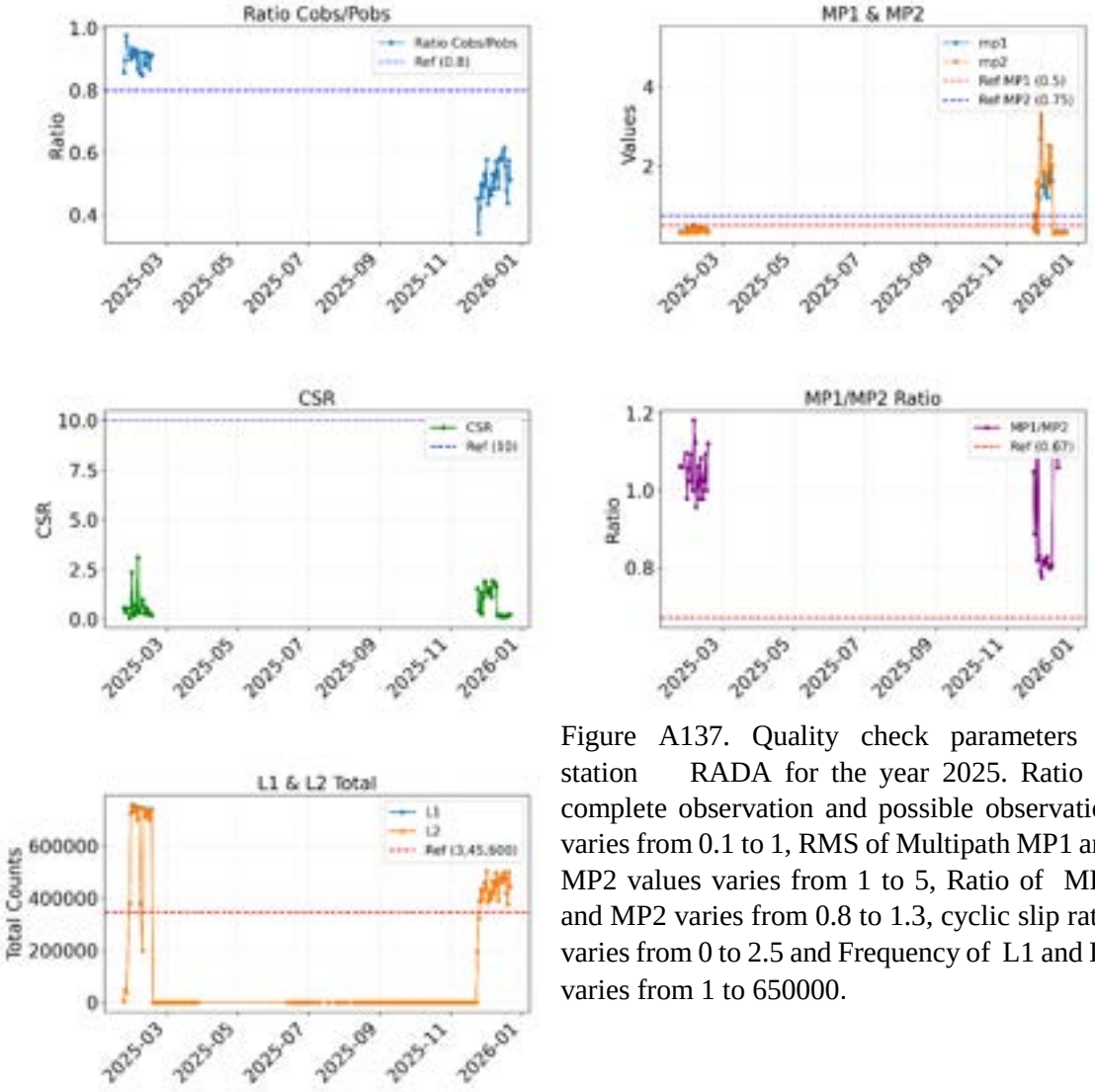


Figure A137. Quality check parameters at station RADA for the year 2025. Ratio of complete observation and possible observation varies from 0.1 to 1, RMS of Multipath MP1 and MP2 values varies from 1 to 5, Ratio of MP1 and MP2 varies from 0.8 to 1.3, cyclic slip ratio varies from 0 to 2.5 and Frequency of L1 and L2 varies from 1 to 650000.

19. RAMN

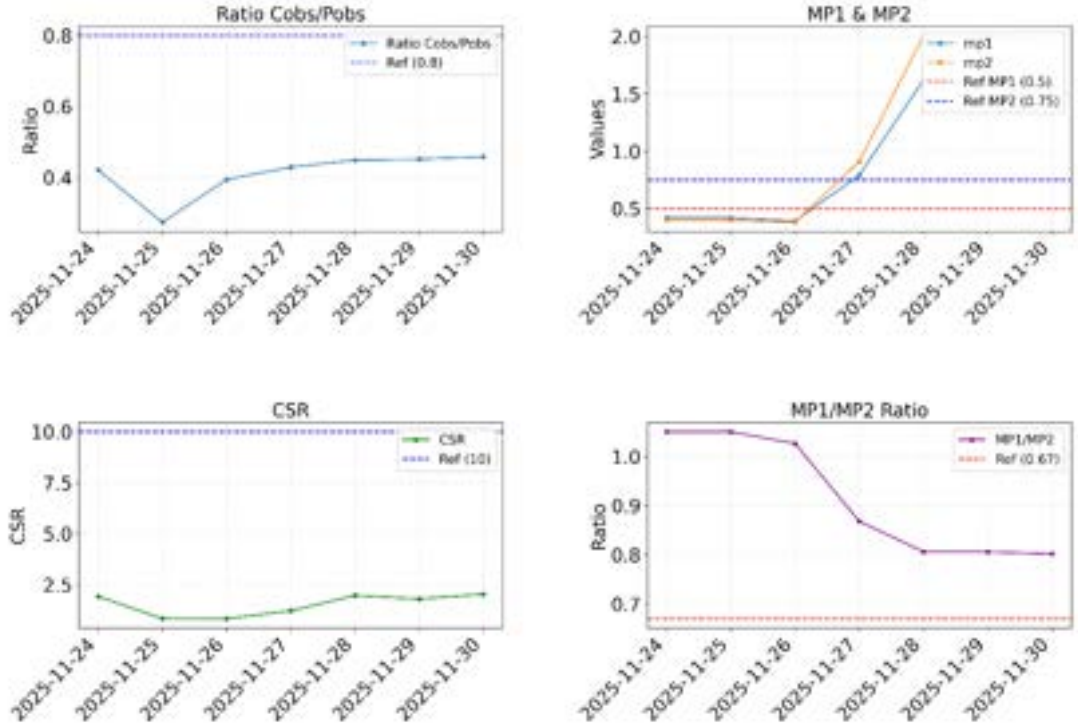


Figure A138. Quality check parameters at station RAMN for the year 2025. Ratio of complete observation and possible observation is varying from 0.1 to 0.5, RMS of Multipath MP1 and MP2 values varies from 0.4 to 2, Ratio of MP1 and MP2 varies from 0.8 to 1.2, cyclic slip ratio < 2.5, and Frequency of L1 and L2 varies from 1 to 400000 .