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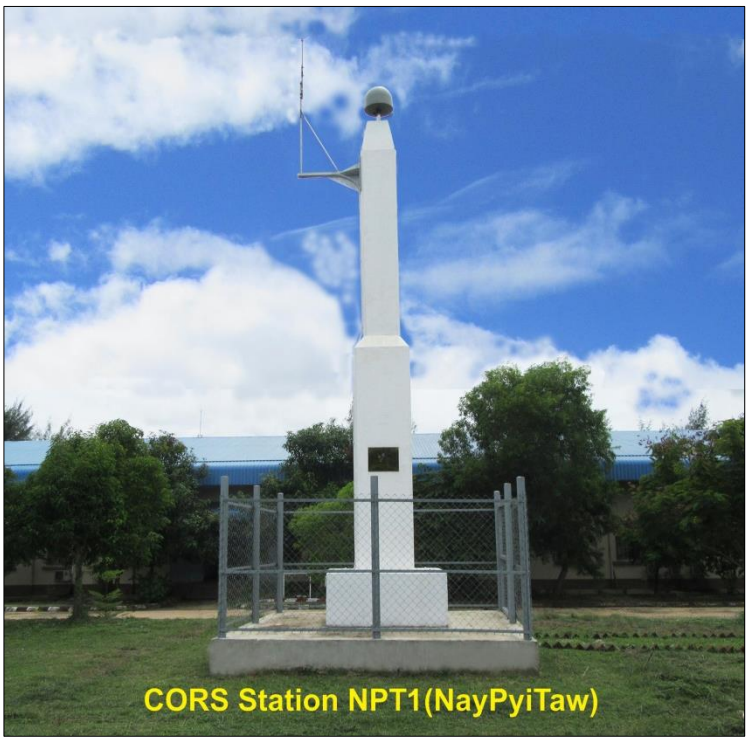
Global Network Computation of CORS in Myanmar



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Abstract

Global Navigation Satellite System (GNSS) technologies provide services and applications in a wide range of areas, including survey and mapping, transportation, agriculture, urban planning and other works related to GNSS applications. In order to improve GNSS technologies in Myanmar, Survey Department (SD) implemented 5 CORS (Continuously Operating Reference Station) in 2019. The objective of this study is to compare the fixed coordinates and observed coordinates of CORS through GNSS processing, to determine the movement of CORS within the period of 2021 December 2022 December and 2023 November. Non discrete daily measurement data of 5 CORS stations were chosen during the period of 2021 December 2022 December and 2023 November for the estimation of the movement. The data of IGS (International GNSS Service) Station (10 to 30 numbers of station data) were used for data processing and the data processing was performed by Bernese GNSS version 5.2 software. Three-dimensional coordinates' accuracy and the movement of stations have been presented in this paper. The results indicated that all five stations experienced measurable movements over the observation period. These findings show that the CORS stations experienced greater movement in the X-axis while movements in the Y and Z axis remained relatively consistent. The consistent Y and Z-axis movements suggest that these components of movement are relatively stable, while the X-axis movement is more dynamic and requires further investigation. In this study, the fixed coordinate and the observed coordinate of CORS can be compared during the period of (2021 December 2022 December and 2023 November).

Key Words: CORS (Continuously Operating Reference Station), GNSS (Global Navigation Satellite System), IGS (International GNSS Service)

CORS မှတ်တိုင်များ၏ Three-Dimensional တည်နေရာရွေ့လျားမှုအား ဆုံးဖြတ်ခြင်း

ဇာနည်အောင်၊ ဦးစီးအရာရှိ
မြေတိုင်းဦးစီးဌာန

စာတမ်းအကျဉ်း

ဂြိုဟ်တုဖြင့်ချိတ်ဆက်တိုင်းတာခြင်း နည်းပညာများကို မြေတိုင်းတာခြင်းနှင့် မြေပုံ ရေးဆွဲခြင်း လုပ်ငန်းများ၊ သယ်ယူပို့ဆောင်ရေး၊ စိုက်ပျိုးရေး၊ မြို့ပြစီမံကိန်း၊ ခေတ်မီမြို့ပြ စီမံ ခန့်ခွဲမှုတို့ အပါအဝင် ကျယ်ပြန့်သောနယ်ပယ်များတွင်အသုံးချလျက်ရှိပါသည်။ မြန်မာနိုင်ငံတွင် ဂြိုလ်တုဖြင့် ချိတ်ဆက်တိုင်းတာသည့် နည်းပညာများဖွံ့ဖြိုးတိုးတက်လာစေရန်၊ မြေပုံ ထုတ်လုပ်ရေးလုပ်ငန်းများတွင် အထောက်အပံ့ ဖြစ်စေရန်၊ မြေတိုင်းလုပ်ငန်းများ၊ ဆောက်လုပ်ရေးလုပ်ငန်းများနှင့် သုတေသနလုပ်ငန်းများတွင် အထောက်အပံ့ ဖြစ်စေရန် စသည့် ရည်ရွယ်ချက် များဖြင့် မြေတိုင်းဦးစီးဌာနသည် စဉ်ဆက်မပြတ် တိုင်းတာလျက် ရှိသည့် မှတ်တိုင်(၅) တိုင်အား ၂၀၁၉ ခုနှစ်တွင် စတင်တည်ထောင်ခဲ့ပါသည်။ ၎င်းမြေပြင်ထိန်း မှတ်တိုင်များကို Primary Station (၉)လုံးနှင့် ချိတ်ဆက်တိုင်းတာ၍ တွက်ချက်ခြင်းများဆောင်ရွက်ခဲ့ပြီး ၂၀၂၀ ခုနှစ်တွင် fix coordinate စတင်သတ်မှတ်ခဲ့ပါသည်။ ကမ္ဘာ့မြေလွှာချပ်များသည် အချိန်နှင့်အမျှ ရွေ့လျားလျက် ရှိပါသဖြင့် မြေပြင်ထိန်းမှတ်တိုင်များ၏ တည်နေရာများအားပုံမှန် စစ်ဆေးတွက်ချက် သုတေသန ပြုခြင်းများ ဆောင်ရွက်ရန် လိုအပ်ပါသည်။ သို့မှသာ ၎င်းမှတ်တိုင်များအား ကိုးကားချိတ်ဆက် တိုင်းတာသည့်အခါတွင် မှန်ကန်သည့်အချက်အလက်များအားရရှိနိုင်မည်ဖြစ်ပါသည်။မှတ်တိုင်(၅)လုံး၏တည်နေရာများကို စစ်ဆေးတွက်ချက်ရန် အတွက် IGS Station (၁၀) လုံးနှင့် ချိတ်ဆက်တိုင်းတာပြီး၊ တွက်ချက်ရန်အတွက် Bernese GNSS Software အား အသုံးပြု တွက်ချက်ခြင်းများကို နှစ်စဉ်တွက်ချက် စစ်ဆေးခဲ့ပါ သည်။ ယခုစာတမ်းတွင် ၂၀၂၁ ခုနှစ်မှ ၂၀၂၃ ခုနှစ်အထိ မှတ်တိုင်များ၏ တည်နေရာ အရွေ့များအား တွက်ချက်ခဲ့ရာတွင် NPT1 မှတ်တိုင်သည် နှစ်စဉ်ပျမ်းမျှ အရှေ့မြောက်ဘက်သို့ ၃စင်တီမီတာ နှင့် အမြင့် ၂စင်တီမီတာခန့်လည်း ကောင်း၊ NPT2 မှတ်တိုင်သည် နှစ်စဉ်ပျမ်းမျှ အရှေ့မြောက်ဘက်သို့ ၃စင်တီမီတာနှင့် အမြင့် ၂စင်တီ မီတာခန့်လည်းကောင်း၊ NPT3 မှတ်တိုင်သည် နှစ်စဉ်ပျမ်းမျှ အရှေ့မြောက်ဘက်သို့ ၃ စင်တီမီတာ နှင့် အမြင့် ၂စင်တီ မီတာခန့်လည်းကောင်း၊ NPT4 မှတ်တိုင်သည် နှစ်စဉ် ပျမ်းမျှ အရှေ့မြောက် ဘက်သို့ ၃စင်တီမီတာနှင့် အမြင့် ၂ စင်တီ မီတာခန့်လည်းကောင်း၊ POL5 မှတ်တိုင်သည် နှစ်စဉ် ပျမ်းမျှ အရှေ့ မြောက်ဘက်သို့ ၃စင်တီမီတာနှင့် အမြင့် ၂စင်တီ မီတာခန့် လည်းကောင်း ရွေ့လျား လျက်ရှိသည်ကို တွေ့ရှိခဲ့ရပါသည်။

Global Network Computation of CORS in Myanmar

1. Introduction

1.1 Global Navigation Satellite System (GNSS)

Global navigation satellite system (GNSS) is a general term describing any satellite constellation that provides positioning, navigation, and timing (PNT) services on a global or regional basis. GNSS is a term that refers to the International Multi-Constellation Satellite System (Shri Rakesh Kashyap et al., 2022), which generally includes GPS, GLONASS, Baidu, Galileo, QZSS and any other constellation system. GNSS base stations supply GNSS observational data necessary for relative positioning as well as generation of satellite ephemerides and clock correction data, earth and atmospheric studies and monitoring of crustal motions. GNSS observations, such as those utilizing the Global Positioning System (GPS), are increasingly used for a wide range of applications, including geodesy, deformation monitoring, precision agriculture and cadastral surveying (Joel HAASDYK et al., 2010). In order to simplify the process of relative GNSS positioning, many international organizations, academic institutions and national mapping agencies have established Continuously Operating Reference Staitons (CORS) that are configured to continuously collect and record GNSS data (Thiong'o Peter Njuguna, 2019).

1.2 About CORS

A Continuously Operating Reference Station (CORS) is defined as a facility that has a control point installing with GNSS receiver to collect data continuously. It is an integration of a GNSS receiver, GNSS antenna, a permanent survey point (with a known position) and supporting equipment. CORS is also called "Reference Station". CORS can operate in post-processed mode and real-time mode. It continuously collects and records data (Anthony Olatunbosun Abiri, 2020). The collected raw satellite observations data send to Data Center. The user can download the data from Data Center and access it for the Real-Time Kinematic (RTK) survey. CORS is used as base station for the Real-Time Kinematic (RTK) survey to obtain the correction signal via the internet. CORS is available 24 hours per day, 7 days a week and 365 days a year. Its data and corrections are available online for convenient access. High-grade accuracy observations can be done within the CORS network. The innovated technology was introduced in the late 1980s. It can support real-time correction data for establishing regional or state-wide development (Snay and Solar, 2008).

1.3 CORS Network

CORS network is a system of GNSS receivers strategically distributed across a region to provide real-time, high-precision positioning data. A CORS network can serve as a Network Real Time Kinematic (NRTK) where corrections are broadcasted, available over the internet or through other medium for retrieval (Anthony Olatunbosun Abiri, 2020). The primary function of a CORS network is to provide Real-Time Kinematic (RTK) positioning, which provides highly accurate corrections to GNSS signals, thus reducing the errors caused by atmospheric conditions, satellite geometry, and other interference factors. If CORS network is utilized, the high-precision measurements can be obtained by the user. By integrating CORS data with GNSS technology, the users can achieve millimeter-level accuracy in their positioning tasks by using GNSS technology. In the meantime Survey Department (SD) have

been established 4 CORS in Nay Pyi Taw and 1 CORS in Pyin Oo Lwin Township all together 5 CORS. Basic function of CORS is shown in **Figure 1** and CORS Network in Myanmar is shown in **Figure 2**.

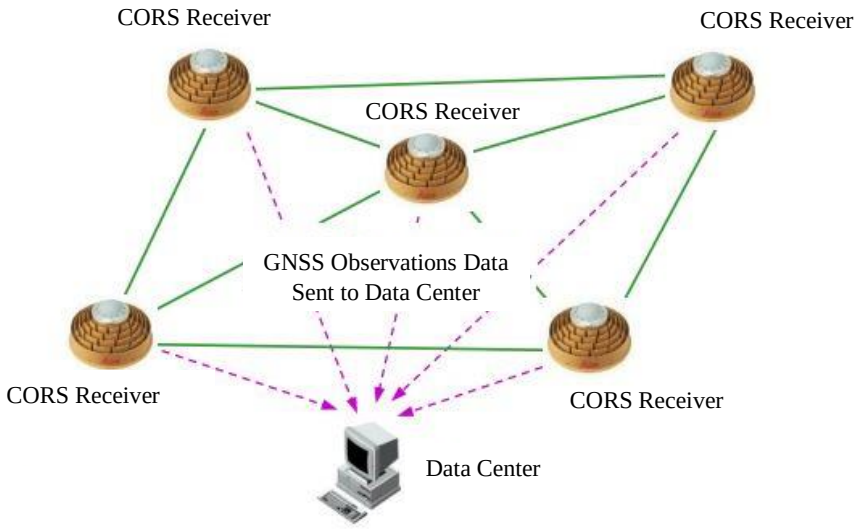


Figure 1: Basic Function of CORS

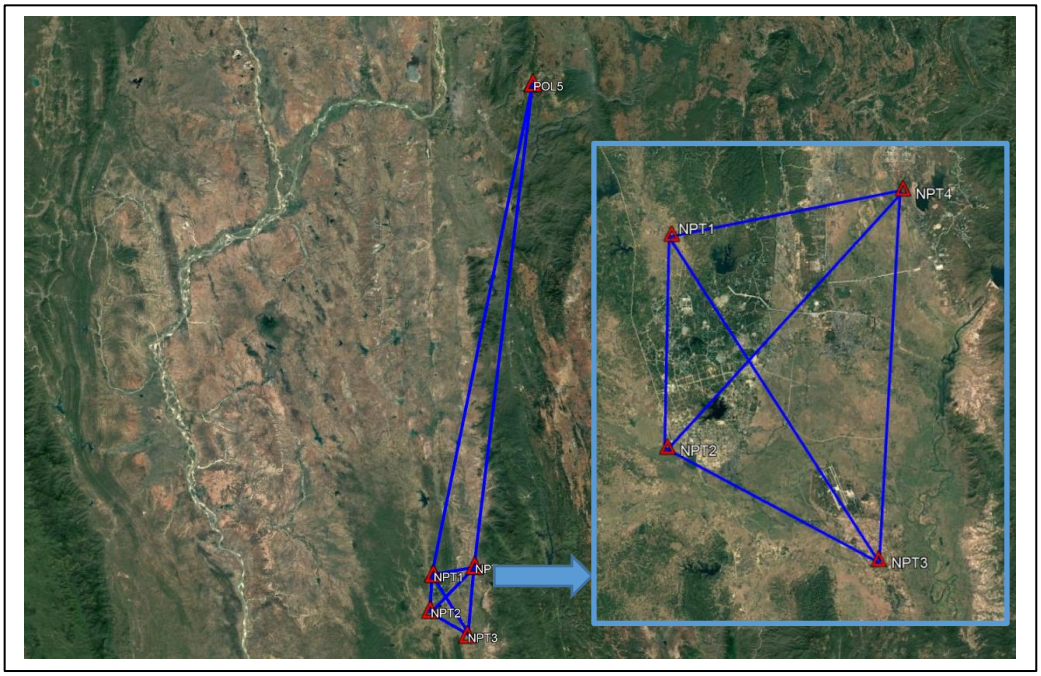


Figure 2: CORS Network in Myanmar

2. Objectives

The objectives of this study are:

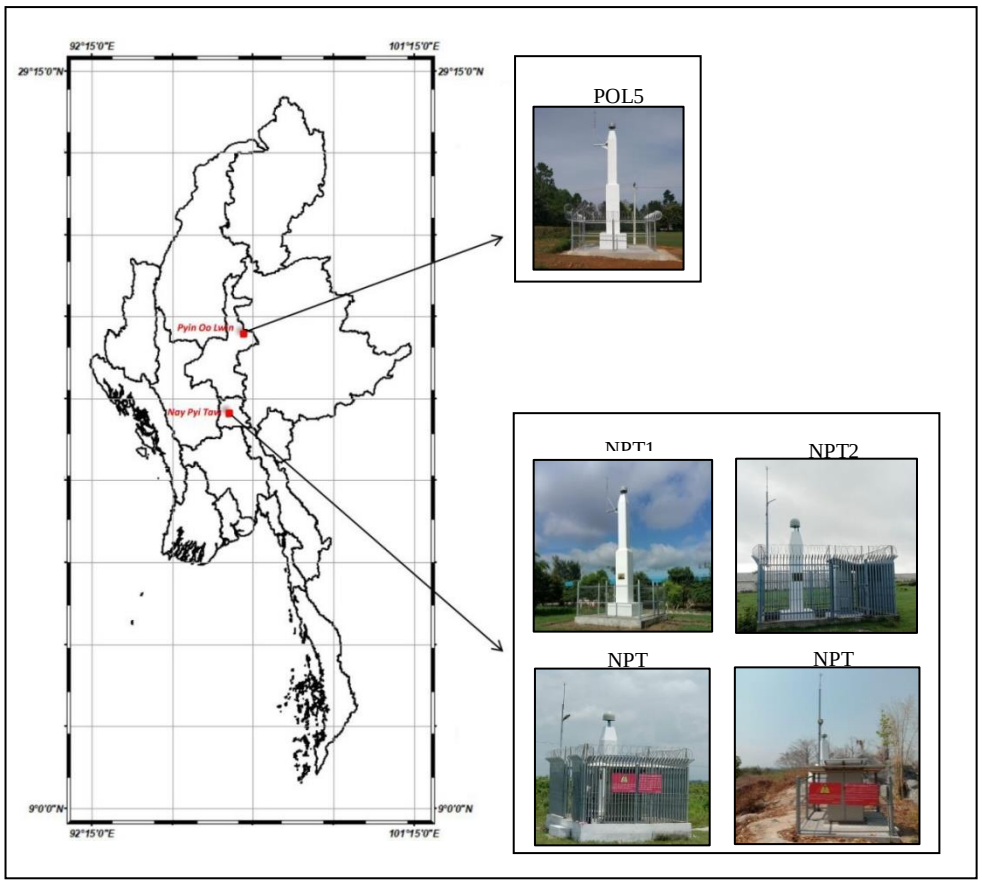
1. To compare between the fixed coordinates and observed coordinates through GNSS processing
2. To determine the movement of CORS in the period of 2021 December, 2022 December and 2023 November

This study will provide the significance of regional geodynamics and its impact on geodetic infrastructure, providing a foundation for further research into the underlying causes of these movements.

3. Materials and Methods

3.1 Locations of Study Area

Five CORS (NPT1, NPT2, NPT3, NPT4 and POL5) are selected to make the observation for exploration the movement of CORS. NPT1, NPT2, NPT3 and NPT4 are at Nay Pyi Taw and POL5 is at Pyin Oo Lwin. The location of CORS is shown in **Figure 3**.



- **NPT1**

Location:

- Lat: 19˚ 49′ 39.8″
- Long: 96˚ 03′ 50.6″
- Near the Flag Post,
- Survey Department Compound
- Ottarathiri Township,
- Nay Pyi Taw

- **NPT2**

Location:

- Lat: 19˚ 39′ 58.9″
- Long: 96˚ 03′ 17.3″
- Near the Toll Gate,
- Yangon-Mandalay Express Road,
- Dekkhina Thiri Township,
- Nay Pyi Taw

- **NPT3**

Location:

- Lat: 19˚ 33′ 38.1″
- Long: 96˚ 14′ 01.1″
- North corner of Panntin Brick Factory,
- Lewe Township,
- Nay Pyi Taw

- **NPT4**

Location:

- Lat: 19˚ 52′ 11.7″
- Long: 96˚ 15′ 34.3″
- On the top of Hill in front of Planetarium Entrance,
- Safari Zoological Garden,
- Nay Pyi Taw

- **POL5**

Location:

- Lat: 22˚ 01′ 29.0″
- Long: 96˚ 28′ 21.4″
- In the Compound of Survey Department Training School,
- Pyin Oo Lwin

Figure 3: Location of CORS

3.2 Data Sources and Study Period

This study utilized the data from 5 CORS established in Myanmar and IGS (International GNSS Service) station to enhance processing accuracy and ensure consistent geodetic reference frame. These data were collected in the period of 2021 December, 2022 December and 2023 November for 3 years interval. Additionally, observational data from IGS stations are incorporated to enhance processing accuracy and ensure consistent geodetic benchmarks. Only GNSS observations have been considered. 30 second RINEX data of 5 CORS download over the internet from CORS Data Center. Post-processed precise satellite orbits, earth orientation data, and satellite clock offset information were obtained from the International GNSS Service (via ftp from ftp://igscb.jpl.nasa.gov/ igscb/product). Post-processed data were provided in SP3, ERP and CLK file format and which were renamed with extensions PRE, IEP and CLK respectively to match Bernese requirements. Further post-processed files such as atmospheric modeling and differential code bias files were obtained from the University of Bern (via ftp from ftp://ftp.unibe.ch/aiub/CODE) as daily ION files and monthly P1P2.DCB and P1C1.DCB files (Joel HAASDYK et al., 2010). SD implemented 5 CORS in 2019. And then GNSS data processing were done to set a fix coordinate. In 2020, Survey Department set fixed coordinates for 5 CORS station. Fixed coordinates of 5 CORS were used to compare between the fixed coordinate and observed coordinate of 5 CORS for studying the movement of CORS. The fixed coordinates of 5 CORS were shown in **Table 1**.

Table 1.Fixed coordinates of 5 CORS

CORS	Fixed Coordinates of CORS (ITRF2014)		
	X (m)	Y (m)	Z (m)
NPT1	-634100.26672	5968838.27126	2149801.02021
NPT2	-633769.20114	5974921.40262	2132979.5053
NPT3	-652840.20783	5976802.14375	2121942.17082
NPT4	-654286.97051	5965074.92383	2154198.92104
POL5	-666949.23989	5878706.11735	2377340.77566

3.3 Methodology Overview

The study follows these steps:

1. **File Preparation:** Necessary folders and files are created for processing with Bernese GNSS Processing Software.
2. **Data Collection:** Sample CORS data and IGS reference station datasets are collected for the specified timeframe.
3. **Data Preprocessing:** Raw GNSS 30sec daily data are filtered and prepared for processing in Bernese software.
4. **Coordinate Computation:** Observed coordinates are derived from GNSS data processing with Bernese GNSS Processing Software.
5. **Comparative Analysis:** Fixed coordinates are compared against observed coordinates using Microsoft Excel.

For this study, observation were made by using CORS daily data in the period of 2021 December, 2022 December and 2023 November. First , all the real time data Rinex (30s) data were collected from CORS data center and the data of IGS Station (10 to 30 nos. of station data) were downloaded from IGS site. IGS final orbits and clock products were used in the data processing. Necessary calculations and analysis were done using Bernese GNSS software, Command Prompt and Microsoft Excel.

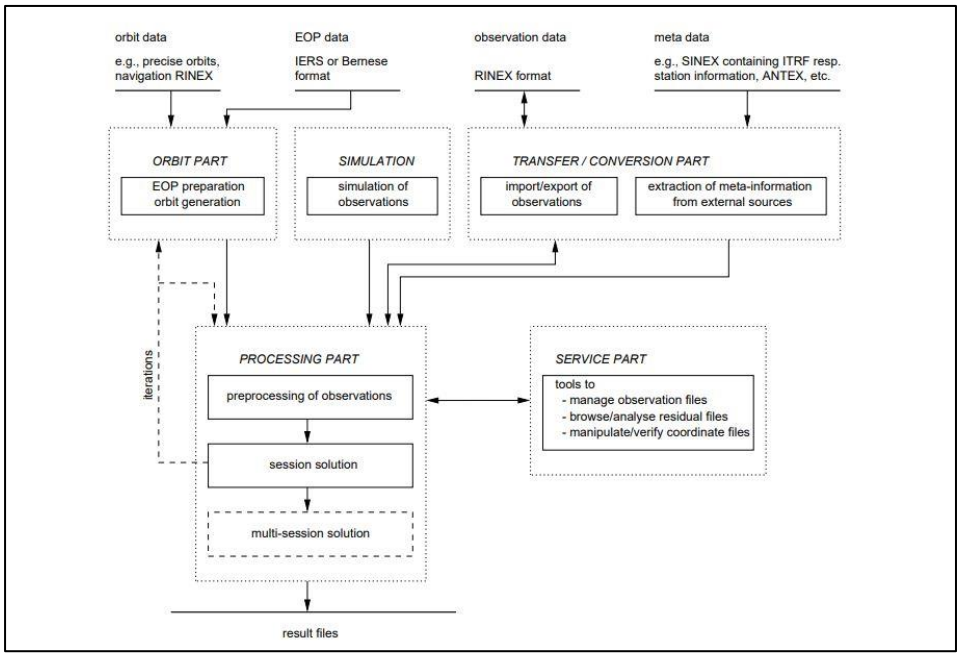
3.4 Application of Bernese GNSS Processing Software

The Bernese GNSS Software is a scientific software package meeting highest quality standards for geodetic and further applications based on Global Navigation Satellite Systems (GNSS). Both of the currently fully operational GNSS are supported: the American Global Positioning System (GPS) and the Russian Global Navigation Satellite System (GLONASS). The analysis of dual–frequency data for the upcoming new systems, like European Galileo, Chinese BeiDou, or Japanese Quasi-Zenith Satellite System (QZSS), is prepared but not yet fully developed for an operational processing (Rolf Dach et al.,2015). Bernese is a high performance, precise, and highly flexible processing software. Mainly users are researchers, academic institutions, national survey agencies responsible for high-accuracy GNSS surveys (e.g. first order networks), and organizations responsible for managing CORS networks. The Bernese software is particularly well suited for automatic processing of permanent networks, whether large or small, and it can combine various receiver types. It is capable of handling extremely long baselines. The Bernese Software is very flexible that is utilized for processing CORS data and monitoring movement of CORS. The processing workflow involves importing raw GNSS data, applying necessary corrections (e.g., atmospheric and satellite orbit corrections), and computing station coordinates in a consistent geodetic reference frame. Baselines between CORS and IGS reference stations are processed to determine coordinate variations. The results are analyzed to identify the movement of stations every time and that ensure reliable geodetic measurements through quality control and network adjustments. The flowchart of Bernese GNSS Processing Software is shown in **Figure 4**.

3.5 IGS Station data

The International GNSS Service (IGS), established by International Association of Geodesy (IAG) in June 1994, was initially known as International GPS Service (Kutubuddin Ansari et al., 2017). The International GNSS Service (IGS) provides precise orbit and clock

solutions for GNSS satellites that support a wide range of science and engineering applications with numerous benefits for society at large. All IGS data and products are made freely available to the scientific community and the general public (O. Montenbruck, 2017). The International GNSS Service (IGS) operates a global network of CORS that provide high-quality GNSS data to support precise positioning, navigation, and timing applications. These stations are managed by various organizations and follow to IGS standards to ensure data consistency and reliability. Integrating IGS stations into CORS data processing can improve the accuracy and strength of processing results. The IGS offers instructions for incorporating CORS into their network, which can be beneficial both research project and researchers. The IGS network consists of stations worldwide, offering flexibility in selecting suitable reference points. A comprehensive analysis of coordinate discrepancies, leading to more accurate and reliable geodetic measurements can be achieved by utilizing data from both local CORS and selected IGS stations. In this study, 10 to 30 IGS stations were selected for this processing. The selected IGS stations and local CORS network is shown in **Figure 5** and selected IGS stations list is shown in **Table 2**.



Sources : Bernese GNSS Software Version 5.2 Manual

Figure 4: Flowchart of Bernese GNSS Processing Software

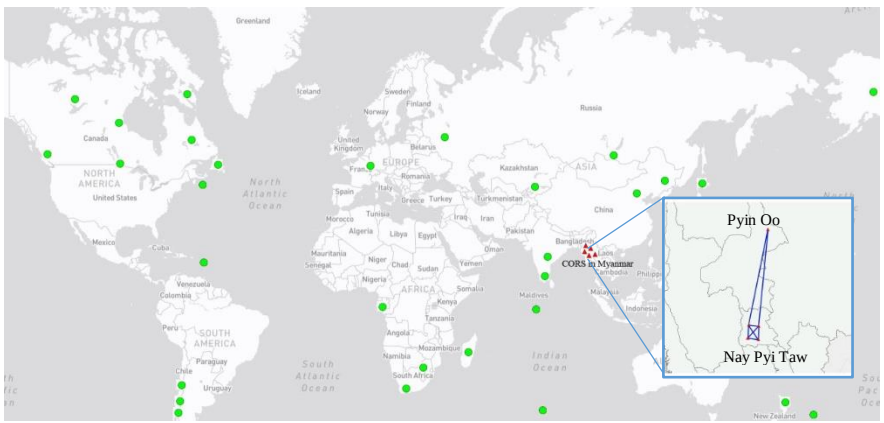


Figure 5: Selected IGS stations and Local CORS Network

Table 2.Selected IGS Station List

No	IGS Station	Fixed Coordinates of CORS (ITRF2014)	
		Latitude	Longitude
1.	ABMF	16.262˚	-61.528˚
2.	ABPO	-19.018˚	47.229˚
3.	AUCK	-36.603˚	174.834˚
4.	BJFS	39.609˚	115.892˚
5.	CHAN	43.791˚	125.443˚
6.	CHTI	-43.735˚	-176.617˚
7.	CHUM	42.999˚	74.751˚
8.	CHUR	58.759˚	-94.089˚
9.	DGAR	-7.270˚	72.370˚
10.	DUBO	50.259˚	-95.866˚
11.	HLFX	44.684˚	-63.611˚
12.	HOLB	50.640˚	-128.135˚
13.	HRAO	-25.890˚	27.687˚
14.	HYDE	17.417˚	78.551˚
15.	IISC	13.021˚	77.570˚
16.	IQAL	63.756˚	-68.510˚
17.	IRKJ	52.219˚	104.316˚
18.	KERG	-49.351˚	70.256˚
19.	MCM4	-77.838˚	166.669˚
20.	MDVJ	56.021˚	37.215˚
21.	NKLG	0.354˚	9.672˚
22.	SCH2	54.832˚	-66.833˚
23.	SANT	-33.450˚	-70.681˚
24.	STJO	47.595˚	-52.678˚
25.	SUTH	-32.380˚	20.810˚
26.	YELL	62.481˚	-114.481˚
27.	YSSK	47.030˚	142.717˚
28.	ZIMM	46.877˚	7.465˚
29.	FAIR	64.978˚	-147.499˚
30.	GUAM	13.589˚	144.868˚

4. Results

4.1 Comparison between Fixed Coordinates and Observed Coordinates

The raw data sets of 5 CORS were collected to obtain its' coordinate. The daily observed raw data were collected in the period of 2021 December, 2022 December and 2023 November. The complete set of raw data could not be obtained in 2023 December because of power failure. Furthermore, the IGS stations' raw data sets for the specified time frame were also collected to use as the reference stations. GNSS raw data and IGS station data were import to Bernese GNSS software. 10 to 30 IGS stations were used as known stations. The adjusted coordinate of 5 CORS were obtained by processing with IGS known reference stations. The adjustment and processing tasks were done for each day. Therefore, the adjustment coordinates were obtained for NPT1, NPT2, NPT3, NPT4 and POL5. The daily observed coordinates and

movements of 5 CORS were shown in **Table 3** to **Table 17**. The movement graph of NPT1, NPT2, NPT3, NPT4 and POL5 were shown in **Figure 6** to **Figure 20**.

Table 3.Daily Observed Coordinates and Movements of NPT1 in 2021 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2021	1	-634100.32375	0.05703	5968838.25392	0.01734	2149801.02252	-0.00231
2021	2	-634100.32596	0.05924	5968838.24068	0.03058	2149801.01580	0.00441
2021	3	-634100.32843	0.06171	5968838.25124	0.02002	2149801.01781	0.00240
2021	4	-634100.33186	0.06514	5968838.24189	0.02937	2149801.01976	0.00045
2021	5	-634100.32787	0.06115	5968838.25001	0.02125	2149801.02437	-0.00416
2021	6	-634100.32394	0.05722	5968838.25295	0.01831	2149801.03189	-0.01168
2021	7	-634100.32719	0.06047	5968838.24424	0.02702	2149801.01570	0.00451
2021	8	-634100.32515	0.05843	5968838.27165	-0.00039	2149801.02711	-0.00690
2021	9	-634100.33013	0.06341	5968838.24942	0.02184	2149801.01915	0.00106
2021	10	-634100.33345	0.06673	5968838.25899	0.01227	2149801.02389	-0.00368
2021	11	-634100.32932	0.06260	5968838.25625	0.01501	2149801.02082	-0.00061
2021	12	-634100.33338	0.06666	5968838.26316	0.00810	2149801.02326	-0.00305
2021	13	-634100.32334	0.05662	5968838.25217	0.01909	2149801.02032	-0.00011
2021	14	-634100.32590	0.05918	5968838.25039	0.02087	2149801.02108	-0.00087
2021	15	-634100.33136	0.06464	5968838.24905	0.02221	2149801.02808	-0.00787
2021	16	-634100.32339	0.05667	5968838.25369	0.01757	2149801.02237	-0.00216
2021	17	-634100.32442	0.05770	5968838.25379	0.01747	2149801.03327	-0.01306
2021	18	-634100.32411	0.05739	5968838.26037	0.01089	2149801.03622	-0.01601
2021	19	-634100.31976	0.05304	5968838.26159	0.00967	2149801.02472	-0.00451
2021	20	-634100.32916	0.06244	5968838.26030	0.01096	2149801.02422	-0.00401
2021	21	-634100.33033	0.06361	5968838.25979	0.01147	2149801.02739	-0.00718
2021	22	-634100.33528	0.06856	5968838.25698	0.01428	2149801.02253	-0.00232
2021	23	-634100.32410	0.05738	5968838.25158	0.01968	2149801.02704	-0.00683
2021	24	-634100.32571	0.05899	5968838.25623	0.01503	2149801.02769	-0.00748
2021	25	-634100.32796	0.06124	5968838.26055	0.01071	2149801.03103	-0.01082
2021	26	-634100.32493	0.05821	5968838.25336	0.01790	2149801.03185	-0.01164
2021	27	-634100.32738	0.06066	5968838.25756	0.01370	2149801.02974	-0.00953
2021	28	-634100.32297	0.05625	5968838.25309	0.01817	2149801.03052	-0.01031
2021	29	-634100.31984	0.05312	5968838.24949	0.02177	2149801.02898	-0.00877
2021	30	-634100.33055	0.06383	5968838.25512	0.01614	2149801.02568	-0.00547
2021	31	-634100.32805	0.06133	5968838.25212	0.01914	2149801.02769	-0.00748

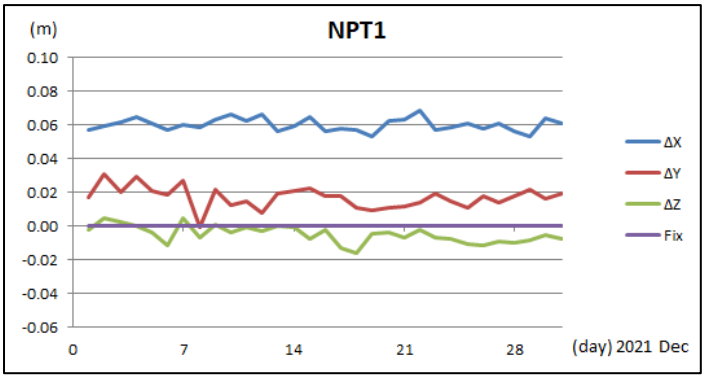


Figure 6: Daily Movements of NPT1 in 2021 December

Table 4.Daily Observed Coordinates and Movements of NPT2 in 2021 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2021	1	-633769.26054	0.05940	5974921.37828	0.02434	2132979.51063	-0.00533
2021	2	-633769.26257	0.06143	5974921.36979	0.03283	2132979.50410	0.00120
2021	3	-633769.26347	0.06233	5974921.38354	0.01908	2132979.50771	-0.00241
2021	4	-633769.27292	0.07178	5974921.37542	0.02720	2132979.50727	-0.00197
2021	5	-633769.26983	0.06869	5974921.38431	0.01831	2132979.51126	-0.00596
2021	6	-633769.26419	0.06305	5974921.38245	0.02017	2132979.52084	-0.01554
2021	7	-633769.26718	0.06604	5974921.38163	0.02099	2132979.50866	-0.00336
2021	8	-633769.25599	0.05485	5974921.39551	0.00711	2132979.51331	-0.00801
2021	9	-633769.26811	0.06697	5974921.37480	0.02782	2132979.50643	-0.00113
2021	10	-633769.27463	0.07349	5974921.38518	0.01744	2132979.51097	-0.00567
2021	11	-633769.26611	0.06497	5974921.38689	0.01573	2132979.51011	-0.00481
2021	12	-633769.27153	0.07039	5974921.39218	0.01044	2132979.51237	-0.00707
2021	13	-633769.25989	0.05875	5974921.38822	0.01440	2132979.51175	-0.00645
2021	14	-633769.26338	0.06224	5974921.38179	0.02083	2132979.51157	-0.00627
2021	15	-633769.26807	0.06693	5974921.37594	0.02668	2132979.51653	-0.01123
2021	16	-633769.25972	0.05858	5974921.38569	0.01693	2132979.51135	-0.00605
2021	17	-633769.26288	0.06174	5974921.38327	0.01935	2132979.52198	-0.01668
2021	18	-633769.26131	0.06017	5974921.38808	0.01454	2132979.52456	-0.01926
2021	19	-633769.26149	0.06035	5974921.39594	0.00668	2132979.51735	-0.01205
2021	20	-633769.26371	0.06257	5974921.39243	0.01019	2132979.51307	-0.00777
2021	21	-633769.26645	0.06531	5974921.39271	0.00991	2132979.51810	-0.01280
2021	22	-633769.27169	0.07055	5974921.39409	0.00853	2132979.51510	-0.00980
2021	23	-633769.26115	0.06001	5974921.38587	0.01675	2132979.51842	-0.01312
2021	24	-633769.26461	0.06347	5974921.39689	0.00573	2132979.52128	-0.01598
2021	25	-633769.26882	0.06768	5974921.39238	0.01024	2132979.51947	-0.01417
2021	26	-633769.26242	0.06128	5974921.38324	0.01938	2132979.52117	-0.01587
2021	27	-633769.26305	0.06191	5974921.38753	0.01509	2132979.51982	-0.01452
2021	28	-633769.25863	0.05749	5974921.38571	0.01691	2132979.51938	-0.01408
2021	29	-633769.25766	0.05652	5974921.37990	0.02272	2132979.51761	-0.01231
2021	30	-633769.26805	0.06691	5974921.39026	0.01236	2132979.51672	-0.01142
2021	31	-633769.26790	0.06676	5974921.38529	0.01733	2132979.51836	-0.01306

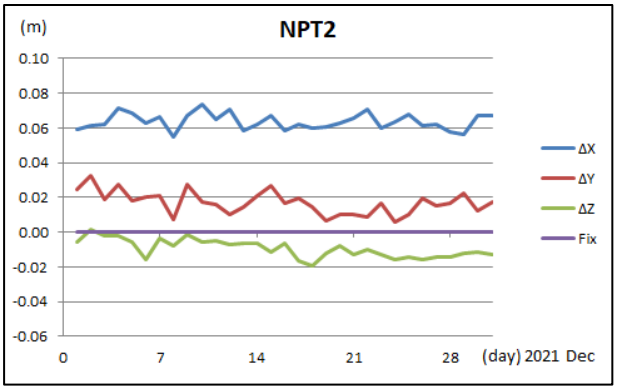


Figure 7: Daily Movements of NPT2 in 2021 December

Table 5.Daily Observed Coordinates and Movement of NPT3 in 2021 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2021	1	-652840.26707	0.05924	5976802.12723	0.01652	2121942.16099	0.00983
2021	2	-652840.26790	0.06007	5976802.11860	0.02515	2121942.15481	0.01601
2021	3	-652840.26783	0.06000	5976802.12630	0.01745	2121942.15717	0.01365
2021	4	-652840.27957	0.07174	5976802.12060	0.02315	2121942.15546	0.01536
2021	5	-652840.27586	0.06803	5976802.12704	0.01671	2121942.16065	0.01017
2021	6	-652840.27159	0.06376	5976802.13665	0.00710	2121942.17303	-0.00221
2021	7	-652840.27436	0.06653	5976802.13183	0.01192	2121942.15921	0.01161
2021	8	-652840.26112	0.05329	5976802.14531	-0.00156	2121942.16434	0.00648
2021	9	-652840.27415	0.06632	5976802.12024	0.02351	2121942.15607	0.01475
2021	10	-652840.27989	0.07206	5976802.13188	0.01187	2121942.16140	0.00942
2021	11	-652840.27176	0.06393	5976802.13202	0.01173	2121942.15770	0.01312
2021	12	-652840.27743	0.06960	5976802.14187	0.00188	2121942.16258	0.00824
2021	13	-652840.26857	0.06074	5976802.14315	0.00060	2121942.16214	0.00868
2021	14	-652840.26976	0.06193	5976802.12935	0.01440	2121942.15969	0.01113
2021	15	-652840.27471	0.06688	5976802.12702	0.01673	2121942.16769	0.00313
2021	16	-652840.26655	0.05872	5976802.13140	0.01235	2121942.16056	0.01026
2021	17	-652840.27010	0.06227	5976802.13352	0.01023	2121942.17183	-0.00101
2021	18	-652840.26808	0.06025	5976802.13369	0.01006	2121942.17303	-0.00221
2021	19	-652840.26638	0.05855	5976802.14315	0.00060	2121942.16599	0.00483
2021	20	-652840.26945	0.06162	5976802.14026	0.00349	2121942.16282	0.00800
2021	21	-652840.27223	0.06440	5976802.13629	0.00746	2121942.16606	0.00476
2021	22	-652840.27994	0.07211	5976802.13115	0.01260	2121942.15932	0.01150
2021	23	-652840.26720	0.05937	5976802.13202	0.01173	2121942.16834	0.00248
2021	24	-652840.26984	0.06201	5976802.14244	0.00131	2121942.16950	0.00132
2021	25	-652840.27446	0.06663	5976802.13706	0.00669	2121942.16826	0.00256
2021	26	-652840.26759	0.05976	5976802.12286	0.02089	2121942.16741	0.00341
2021	27	-652840.26841	0.06058	5976802.13631	0.00744	2121942.16994	0.00088
2021	28	-652840.26559	0.05776	5976802.13424	0.00951	2121942.16856	0.00226
2021	29	-652840.26448	0.05665	5976802.13033	0.01342	2121942.16851	0.00231
2021	30	-652840.27455	0.06672	5976802.13578	0.00797	2121942.16507	0.00575
2021	31	-652840.27555	0.06772	5976802.13813	0.00562	2121942.16910	0.00172

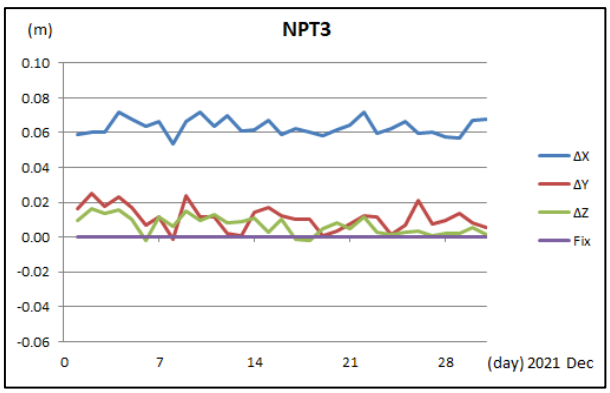


Figure 8: Daily Movements of NPT3 in 2021 December

Table 6.Daily Observed Coordinates and Movement of NPT4 in 2021 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2021	1	-654287.03197	0.06146	5965074.97015	-0.04632	2154198.93024	-0.00920
2021	2	-654287.03362	0.06311	5965074.95684	-0.03301	2154198.92199	-0.00095
2021	3	-654287.03540	0.06489	5965074.96555	-0.04172	2154198.92589	-0.00485
2021	4	-654287.03962	0.06911	5965074.95893	-0.03510	2154198.92550	-0.00446
2021	5	-654287.03713	0.06662	5965074.96916	-0.04533	2154198.93024	-0.00920
2021	6	-654287.03434	0.06383	5965074.97515	-0.05132	2154198.94034	-0.01930
2021	7	-654287.03883	0.06832	5965074.97142	-0.04759	2154198.92850	-0.00746
2021	8	-654287.03198	0.06147	5965074.98947	-0.06564	2154198.93396	-0.01292
2021	9	-654287.03759	0.06708	5965074.96633	-0.04250	2154198.92676	-0.00572
2021	10	-654287.04108	0.07057	5965074.97625	-0.05242	2154198.93001	-0.00897
2021	11	-654287.03797	0.06746	5965074.97636	-0.05253	2154198.92872	-0.00768
2021	12	-654287.04114	0.07063	5965074.98158	-0.05775	2154198.93194	-0.01090
2021	13	-654287.03114	0.06063	5965074.97271	-0.04888	2154198.92956	-0.00852
2021	14	-654287.03391	0.06340	5965074.96816	-0.04433	2154198.92970	-0.00866
2021	15	-654287.04003	0.06952	5965074.97069	-0.04686	2154198.93769	-0.01665
2021	16	-654287.03169	0.06118	5965074.97310	-0.04927	2154198.93112	-0.01008
2021	17	-654287.03226	0.06175	5965074.97571	-0.05188	2154198.94240	-0.02136
2021	18	-654287.03213	0.06162	5965074.97720	-0.05337	2154198.94318	-0.02214
2021	19	-654287.02774	0.05723	5965074.98283	-0.05900	2154198.93593	-0.01489
2021	20	-654287.03792	0.06741	5965074.97787	-0.05404	2154198.93233	-0.01129
2021	21	-654287.03779	0.06728	5965074.97532	-0.05149	2154198.93509	-0.01405
2021	22	-654287.04364	0.07313	5965074.97125	-0.04742	2154198.93000	-0.00896
2021	23	-654287.03319	0.06268	5965074.97365	-0.04982	2154198.93668	-0.01564
2021	24	-654287.03348	0.06297	5965074.98276	-0.05893	2154198.93917	-0.01813
2021	25	-654287.03714	0.06663	5965074.97361	-0.04978	2154198.93762	-0.01658
2021	26	-654287.03283	0.06232	5965074.96922	-0.04539	2154198.94021	-0.01917
2021	27	-654287.03470	0.06419	5965074.97474	-0.05091	2154198.94021	-0.01917
2021	28	-654287.03002	0.05951	5965074.97114	-0.04731	2154198.93890	-0.01786
2021	29	-654287.02773	0.05722	5965074.96803	-0.04420	2154198.93736	-0.01632
2021	30	-654287.03778	0.06727	5965074.97455	-0.05072	2154198.93487	-0.01383
2021	31	-654287.03623	0.06572	5965074.97719	-0.05336	2154198.93964	-0.01860

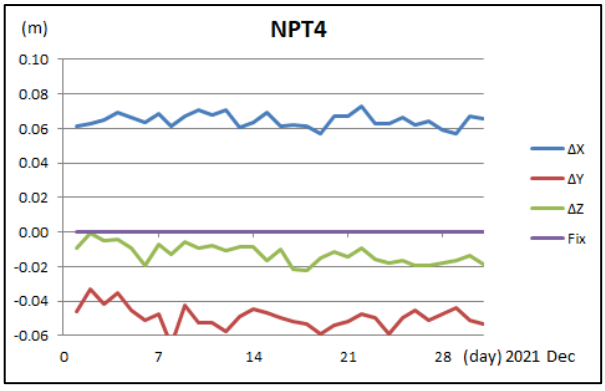


Figure 9: Daily Movements of NPT4 in 2021 December

Table 7.Daily Observed Coordinates and Movements of POL5 in 2021 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2021	1	-666949.29425	0.05436	5878706.10903	0.00832	2377340.76186	0.01380
2021	2	-666949.29719	0.05730	5878706.09838	0.01897	2377340.75493	0.02073
2021	3	-666949.29928	0.05939	5878706.10940	0.00795	2377340.76008	0.01558
2021	4	-666949.30291	0.06302	5878706.09878	0.01857	2377340.75689	0.01877
2021	5	-666949.29975	0.05986	5878706.10734	0.01001	2377340.75804	0.01762
2021	6	-666949.29557	0.05568	5878706.10639	0.01096	2377340.76733	0.00833
2021	7	-666949.30101	0.06112	5878706.10643	0.01092	2377340.75565	0.02001
2021	8	-666949.29290	0.05301	5878706.12313	-0.00578	2377340.76161	0.01405
2021	9	-666949.29885	0.05896	5878706.09949	0.01786	2377340.75428	0.02138
2021	10	-666949.30324	0.06335	5878706.11036	0.00699	2377340.75814	0.01752
2021	11	-666949.29939	0.05950	5878706.10746	0.00989	2377340.75494	0.02072
2021	12	-666949.30290	0.06301	5878706.11759	-0.00024	2377340.75972	0.01594
2021	13	-666949.29465	0.05476	5878706.10691	0.01044	2377340.75712	0.01854
2021	14	-666949.29597	0.05608	5878706.10236	0.01499	2377340.75786	0.01780
2021	15	-666949.30209	0.06220	5878706.10404	0.01331	2377340.76574	0.00992
2021	16	-666949.29295	0.05306	5878706.10561	0.01174	2377340.75807	0.01759
2021	17	-666949.29375	0.05386	5878706.11247	0.00488	2377340.77168	0.00398
2021	18	-666949.29387	0.05398	5878706.11385	0.00350	2377340.77197	0.00369
2021	19	-666949.29065	0.05076	5878706.11710	0.00025	2377340.76272	0.01294
2021	20	-666949.30112	0.06123	5878706.11643	0.00092	2377340.75987	0.01579
2021	21	-666949.29973	0.05984	5878706.11223	0.00512	2377340.76494	0.01072
2021	22	-666949.30442	0.06453	5878706.10823	0.00912	2377340.75766	0.01800
2021	23	-666949.29361	0.05372	5878706.10841	0.00894	2377340.76558	0.01008
2021	24	-666949.29484	0.05495	5878706.11638	0.00097	2377340.76703	0.00863
2021	25	-666949.29841	0.05852	5878706.10506	0.01229	2377340.76338	0.01228
2021	26	-666949.29465	0.05476	5878706.09827	0.01908	2377340.76577	0.00989
2021	27	-666949.29651	0.05662	5878706.10539	0.01196	2377340.76546	0.01020
2021	28	-666949.29241	0.05252	5878706.10560	0.01175	2377340.76588	0.00978
2021	29	-666949.28982	0.04993	5878706.10501	0.01234	2377340.76649	0.00917
2021	30	-666949.29923	0.05934	5878706.10697	0.01038	2377340.76051	0.01515
2021	31	-666949.29902	0.05913	5878706.10642	0.01093	2377340.76445	0.01121

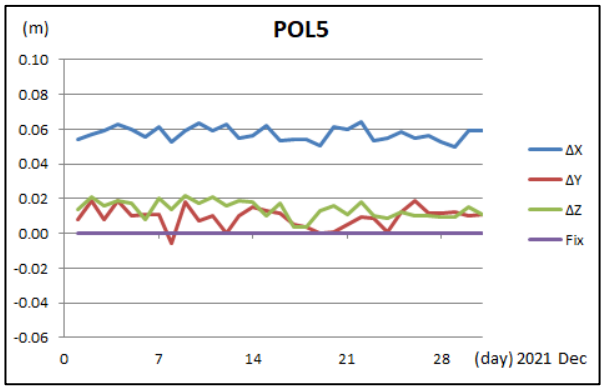


Figure 10: Daily Movements of POL5 in 2021 December

Table 8.Daily Observed Coordinates and Movements of NPT1 in 2022 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2022	1	-634100.35882	0.09210	5968838.24917	0.02209	2149801.03288	-0.01267
2022	2	-634100.35413	0.08741	5968838.24078	0.03048	2149801.02889	-0.00868
2022	3	-634100.35887	0.09215	5968838.24136	0.02990	2149801.03001	-0.00980
2022	4	-634100.34665	0.07993	5968838.24024	0.03102	2149801.02725	-0.00704
2022	5	-634100.34977	0.08305	5968838.24714	0.02412	2149801.03446	-0.01425
2022	6	-634100.35472	0.08800	5968838.25260	0.01866	2149801.03413	-0.01392
2022	7	-634100.35170	0.08498	5968838.24624	0.02502	2149801.03045	-0.01024
2022	8	-634100.35343	0.08671	5968838.24451	0.02675	2149801.02890	-0.00869
2022	9	-634100.35891	0.09219	5968838.24077	0.03049	2149801.03108	-0.01087
2022	10	-634100.34821	0.08149	5968838.24595	0.02531	2149801.03724	-0.01703
2022	11	-634100.34257	0.07585	5968838.23320	0.03806	2149801.03249	-0.01228
2022	12	-634100.34970	0.08298	5968838.24939	0.02187	2149801.03498	-0.01477
2022	13	-634100.33436	0.06764	5968838.24352	0.02774	2149801.03914	-0.01893
2022	14	-634100.34492	0.07820	5968838.24060	0.03066	2149801.02927	-0.00906
2022	15	-634100.33871	0.07199	5968838.24134	0.02992	2149801.03078	-0.01057
2022	16	-634100.34211	0.07539	5968838.24633	0.02493	2149801.04264	-0.02243
2022	17	-634100.34094	0.07422	5968838.25927	0.01199	2149801.04264	-0.02243
2022	18	-634100.34269	0.07597	5968838.24820	0.02306	2149801.03795	-0.01774
2022	19	-634100.34482	0.07810	5968838.23642	0.03484	2149801.03649	-0.01628
2022	20	-634100.34693	0.08021	5968838.24816	0.02310	2149801.04088	-0.02067
2022	21	-634100.34133	0.07461	5968838.25235	0.01891	2149801.04240	-0.02219
2022	22	-634100.35094	0.08422	5968838.24991	0.02135	2149801.04073	-0.02052
2022	23	-634100.35138	0.08466	5968838.25735	0.01391	2149801.03758	-0.01737
2022	24	-634100.35665	0.08993	5968838.24794	0.02332	2149801.03205	-0.01184
2022	25	-634100.35300	0.08628	5968838.25011	0.02115	2149801.03852	-0.01831
2022	26	-634100.34730	0.08058	5968838.24520	0.02606	2149801.03748	-0.01727
2022	27	-634100.34576	0.07904	5968838.24466	0.02660	2149801.03365	-0.01344
2022	28	-634100.33775	0.07103	5968838.24612	0.02514	2149801.03326	-0.01305
2022	29	-634100.34744	0.08072	5968838.25248	0.01878	2149801.03988	-0.01967
2022	30	-634100.34837	0.08165	5968838.25334	0.01792	2149801.03783	-0.01762
2022	31	-634100.36886	0.10214	5968838.25245	0.01881	2149801.01416	0.00605

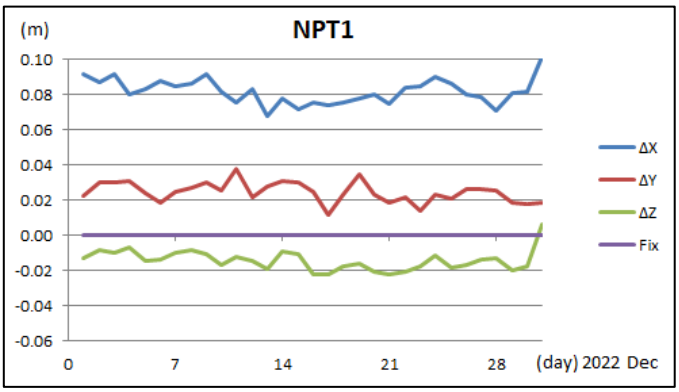


Figure 11: Daily Movements of NPT1 in 2022 December

Table 9.Daily Observed Coordinates and Movements of NPT2 in 2022 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2022	1	-633769.30096	0.09982	5974921.37853	0.02409	2132979.52344	-0.01814
2022	2	-633769.29672	0.09558	5974921.36979	0.03283	2132979.51672	-0.01142
2022	3	-633769.30037	0.09923	5974921.36670	0.03592	2132979.51932	-0.01402
2022	4	-633769.28835	0.08721	5974921.36328	0.03934	2132979.51737	-0.01207
2022	5	-633769.29249	0.09135	5974921.37171	0.03091	2132979.52443	-0.01913
2022	6	-633769.29339	0.09225	5974921.38210	0.02052	2132979.52526	-0.01996
2022	7	-633769.29598	0.09484	5974921.37883	0.02379	2132979.52382	-0.01852
2022	8	-633769.29761	0.09647	5974921.37397	0.02865	2132979.52095	-0.01565
2022	9	-633769.30135	0.10021	5974921.36684	0.03578	2132979.52142	-0.01612
2022	10	-633769.29357	0.09243	5974921.37397	0.02865	2132979.52864	-0.02334
2022	11	-633769.28262	0.08148	5974921.36410	0.03852	2132979.52399	-0.01869
2022	12	-633769.29534	0.09420	5974921.37439	0.02823	2132979.52513	-0.01983
2022	13	-633769.27479	0.07365	5974921.37207	0.03055	2132979.53016	-0.02486
2022	14	-633769.28348	0.08234	5974921.36819	0.03443	2132979.51978	-0.01448
2022	15	-633769.27970	0.07856	5974921.36194	0.04068	2132979.52081	-0.01551
2022	16	-633769.28591	0.08477	5974921.37578	0.02684	2132979.53436	-0.02906
2022	17	-633769.28163	0.08049	5974921.38895	0.01367	2132979.53477	-0.02947
2022	18	-633769.28772	0.08658	5974921.38125	0.02137	2132979.53230	-0.02700
2022	19	-633769.28744	0.08630	5974921.37149	0.03113	2132979.52683	-0.02153
2022	20	-633769.29108	0.08994	5974921.37443	0.02819	2132979.53201	-0.02671
2022	21	-633769.28283	0.08169	5974921.37787	0.02475	2132979.53194	-0.02664
2022	22	-633769.29293	0.09179	5974921.37306	0.02956	2132979.53132	-0.02602
2022	23	-633769.29521	0.09407	5974921.38050	0.02212	2132979.52776	-0.02246
2022	24	-633769.30165	0.10051	5974921.37794	0.02468	2132979.52520	-0.01990
2022	25	-633769.29410	0.09296	5974921.36762	0.03500	2132979.52908	-0.02378
2022	26	-633769.29095	0.08981	5974921.36889	0.03373	2132979.52650	-0.02120
2022	27	-633769.28769	0.08655	5974921.36675	0.03587	2132979.52291	-0.01761
2022	28	-633769.28070	0.07956	5974921.37043	0.03219	2132979.52369	-0.01839
2022	29	-633769.29175	0.09061	5974921.38131	0.02131	2132979.53057	-0.02527
2022	30	-633769.29155	0.09041	5974921.37688	0.02574	2132979.52767	-0.02237
2022	31	-633769.30926	0.10812	5974921.38456	0.01806	2132979.50857	-0.00327

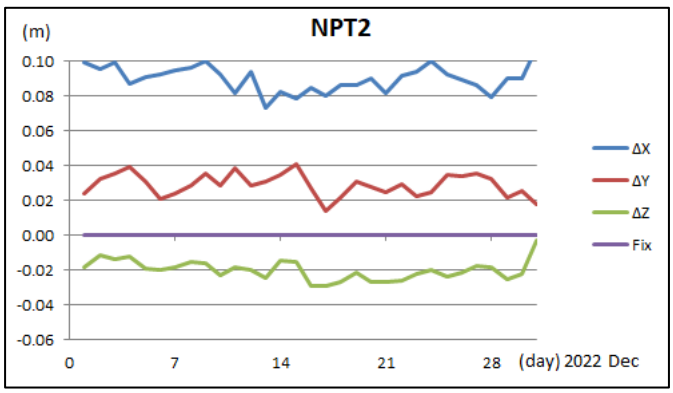


Figure 12: Daily Movements of NPT2 in 2022 December

Table 10.Daily Observed Coordinates and Movements of NPT3 in 2022 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2022	1	-652840.30466	0.09683	5976802.13067	0.01308	2121942.16363	0.00719
2022	2	-652840.30054	0.09271	5976802.12607	0.01768	2121942.16180	0.00902
2022	3	-652840.30278	0.09495	5976802.12379	0.01996	2121942.16116	0.00966
2022	4	-652840.28939	0.08156	5976802.11924	0.02451	2121942.15773	0.01309
2022	5	-652840.29502	0.08719	5976802.12663	0.01712	2121942.16687	0.00395
2022	6	-652840.29640	0.08857	5976802.13407	0.00968	2121942.16477	0.00605
2022	7	-652840.29838	0.09055	5976802.13378	0.00997	2121942.16599	0.00483
2022	8	-652840.30000	0.09217	5976802.12529	0.01846	2121942.16174	0.00908
2022	9	-652840.30473	0.09690	5976802.12719	0.01656	2121942.16501	0.00581
2022	10	-652840.29529	0.08746	5976802.12711	0.01664	2121942.16853	0.00229
2022	11	-652840.28528	0.07745	5976802.11761	0.02614	2121942.16591	0.00491
2022	12	-652840.29811	0.09028	5976802.12654	0.01721	2121942.16617	0.00465
2022	13	-652840.27888	0.07105	5976802.13150	0.01225	2121942.17237	-0.00155
2022	14	-652840.28505	0.07722	5976802.12538	0.01837	2121942.16226	0.00856
2022	15	-652840.28244	0.07461	5976802.11780	0.02595	2121942.16162	0.00920
2022	16	-652840.28712	0.07929	5976802.12604	0.01771	2121942.17449	-0.00367
2022	17	-652840.28272	0.07489	5976802.13964	0.00411	2121942.17390	-0.00308
2022	18	-652840.29048	0.08265	5976802.13561	0.00814	2121942.17284	-0.00202
2022	19	-652840.28950	0.08167	5976802.12376	0.01999	2121942.16789	0.00293
2022	20	-652840.29207	0.08424	5976802.12542	0.01833	2121942.17195	-0.00113
2022	21	-652840.28522	0.07739	5976802.13511	0.00864	2121942.17370	-0.00288
2022	22	-652840.29537	0.08754	5976802.13126	0.01249	2121942.17490	-0.00408
2022	23	-652840.29712	0.08929	5976802.13850	0.00525	2121942.16962	0.00120
2022	24	-652840.30434	0.09651	5976802.13114	0.01261	2121942.16470	0.00612
2022	25	-652840.29405	0.08622	5976802.12308	0.02067	2121942.16712	0.00370
2022	26	-652840.29466	0.08683	5976802.12834	0.01541	2121942.17188	-0.00106
2022	27	-652840.29163	0.08380	5976802.11998	0.02377	2121942.16488	0.00594
2022	28	-652840.28616	0.07833	5976802.13107	0.01268	2121942.16632	0.00450
2022	29	-652840.29434	0.08651	5976802.13330	0.01045	2121942.17075	0.00007
2022	30	-652840.29418	0.08635	5976802.13524	0.00851	2121942.16995	0.00087
2022	31	-652840.31147	0.10364	5976802.13188	0.01187	2121942.14569	0.02513

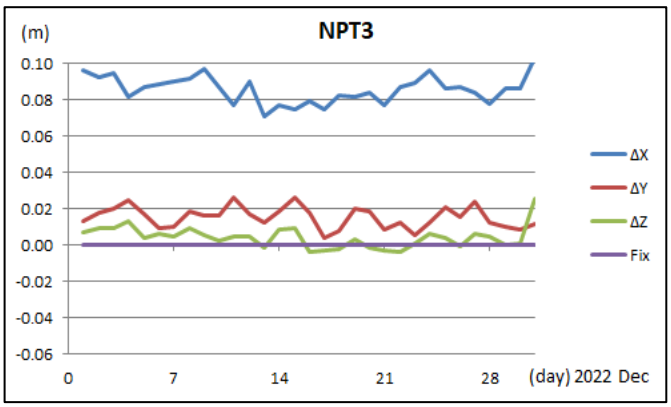


Figure 13: Daily Movements of NPT3 in 2022 December

Table 11.Daily Observed Coordinates and Movements of NPT4 in 2022 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2022	1	-654287.06887	0.09836	5965074.97145	-0.04762	2154198.93398	-0.01294
2022	2	-654287.06448	0.09397	5965074.96147	-0.03764	2154198.92836	-0.00732
2022	3	-654287.07120	0.10069	5965074.95829	-0.03446	2154198.93083	-0.00979
2022	4	-654287.05895	0.08844	5965074.96982	-0.04599	2154198.93216	-0.01112
2022	5	-654287.06031	0.08980	5965074.97012	-0.04629	2154198.93631	-0.01527
2022	6	-654287.06458	0.09407	5965074.97461	-0.05078	2154198.93480	-0.01376
2022	7	-654287.06320	0.09269	5965074.97285	-0.04902	2154198.93300	-0.01196
2022	8	-654287.06610	0.09559	5965074.97313	-0.04930	2154198.93428	-0.01324
2022	9	-654287.07015	0.09964	5965074.95685	-0.03302	2154198.93063	-0.00959
2022	10	-654287.05855	0.08804	5965074.96226	-0.03843	2154198.93804	-0.01700
2022	11	-654287.05461	0.08410	5965074.95202	-0.02819	2154198.93180	-0.01076
2022	12	-654287.06077	0.09026	5965074.97162	-0.04779	2154198.93707	-0.01603
2022	13	-654287.04708	0.07657	5965074.97403	-0.05020	2154198.94400	-0.02296
2022	14	-654287.05483	0.08432	5965074.96020	-0.03637	2154198.93038	-0.00934
2022	15	-654287.05030	0.07979	5965074.96358	-0.03975	2154198.93306	-0.01202
2022	16	-654287.05287	0.08236	5965074.96008	-0.03625	2154198.94240	-0.02136
2022	17	-654287.05035	0.07984	5965074.97955	-0.05572	2154198.94432	-0.02328
2022	18	-654287.05332	0.08281	5965074.96352	-0.03969	2154198.93802	-0.01698
2022	19	-654287.05279	0.08228	5965074.95739	-0.03356	2154198.93616	-0.01512
2022	20	-654287.05744	0.08693	5965074.96429	-0.04046	2154198.93988	-0.01884
2022	21	-654287.05125	0.08074	5965074.97258	-0.04875	2154198.94268	-0.02164
2022	22	-654287.06346	0.09295	5965074.97537	-0.05154	2154198.94457	-0.02353
2022	23	-654287.06247	0.09196	5965074.97323	-0.04940	2154198.93528	-0.01424
2022	24	-654287.06847	0.09796	5965074.97669	-0.05286	2154198.93712	-0.01608
2022	25	-654287.06080	0.09029	5965074.97366	-0.04983	2154198.94197	-0.02093
2022	26	-654287.05871	0.08820	5965074.96718	-0.04335	2154198.93953	-0.01849
2022	27	-654287.05675	0.08624	5965074.96744	-0.04361	2154198.93572	-0.01468
2022	28	-654287.04925	0.07874	5965074.96815	-0.04432	2154198.93593	-0.01489
2022	29	-654287.05689	0.08638	5965074.97277	-0.04894	2154198.94152	-0.02048
2022	30	-654287.05725	0.08674	5965074.96297	-0.03914	2154198.93676	-0.01572
2022	31	-654287.07831	0.10780	5965074.97580	-0.05197	2154198.91802	0.00302

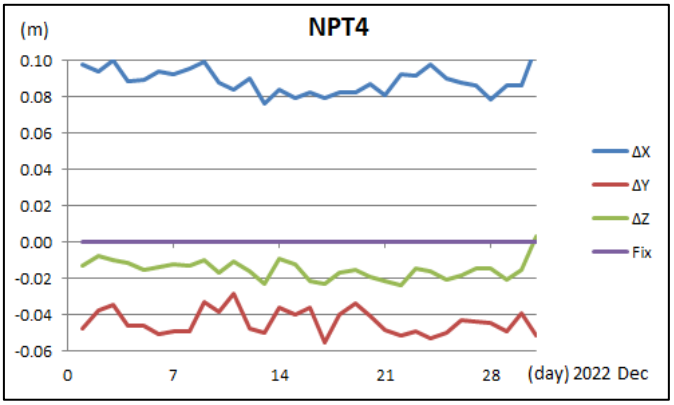


Figure 14: Daily Movements of NPT4 in 2022 December

Table 12.Daily Observed Coordinates and Movements of POL5 in 2022 December

Year	Day (Dec)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2022	1	-666949.33009	0.09020	5878706.11132	0.00603	2377340.75879	0.01687
2022	2	-666949.32629	0.08640	5878706.10237	0.01498	2377340.75417	0.02149
2022	3	-666949.33017	0.09028	5878706.10055	0.01680	2377340.75523	0.02043
2022	4	-666949.31568	0.07579	5878706.10455	0.01280	2377340.75519	0.02047
2022	5	-666949.32017	0.08028	5878706.10394	0.01341	2377340.75921	0.01645
2022	6	-666949.32359	0.08370	5878706.10884	0.00851	2377340.75783	0.01783
2022	7	-666949.32271	0.08282	5878706.11426	0.00309	2377340.75967	0.01599
2022	8	-666949.32428	0.08439	5878706.10626	0.01109	2377340.75704	0.01862
2022	9	-666949.32960	0.08971	5878706.10657	0.01078	2377340.76015	0.01551
2022	10	-666949.31971	0.07982	5878706.09763	0.01972	2377340.76043	0.01523
2022	11	-666949.31370	0.07381	5878706.08703	0.03032	2377340.75539	0.02027
2022	12	-666949.32088	0.08099	5878706.09707	0.02028	2377340.75854	0.01712
2022	13	-666949.30469	0.06480	5878706.09866	0.01869	2377340.76257	0.01309
2022	14	-666949.31275	0.07286	5878706.10338	0.01397	2377340.75593	0.01973
2022	15	-666949.30718	0.06729	5878706.09745	0.01990	2377340.75512	0.02054
2022	16	-666949.31207	0.07218	5878706.10283	0.01452	2377340.76757	0.00809
2022	17	-666949.30877	0.06888	5878706.11669	0.00066	2377340.76637	0.00929
2022	18	-666949.31395	0.07406	5878706.10885	0.00850	2377340.76415	0.01151
2022	19	-666949.31326	0.07337	5878706.09611	0.02124	2377340.75981	0.01585
2022	20	-666949.31784	0.07795	5878706.10278	0.01457	2377340.76397	0.01169
2022	21	-666949.31038	0.07049	5878706.10639	0.01096	2377340.76415	0.01151
2022	22	-666949.31850	0.07861	5878706.10420	0.01315	2377340.76588	0.00978
2022	23	-666949.31962	0.07973	5878706.10818	0.00917	2377340.75735	0.01831
2022	24	-666949.32820	0.08831	5878706.11533	0.00202	2377340.76195	0.01371
2022	25	-666949.32080	0.08091	5878706.10227	0.01508	2377340.76275	0.01291
2022	26	-666949.31768	0.07779	5878706.10141	0.01594	2377340.75915	0.01651
2022	27	-666949.31356	0.07367	5878706.09983	0.01752	2377340.75834	0.01732
2022	28	-666949.30706	0.06717	5878706.10446	0.01289	2377340.75981	0.01585
2022	29	-666949.31653	0.07664	5878706.10938	0.00797	2377340.76301	0.01265
2022	30	-666949.31651	0.07662	5878706.10438	0.01297	2377340.76045	0.01521
2022	31	-666949.33778	0.09789	5878706.11172	0.00563	2377340.74128	0.03438

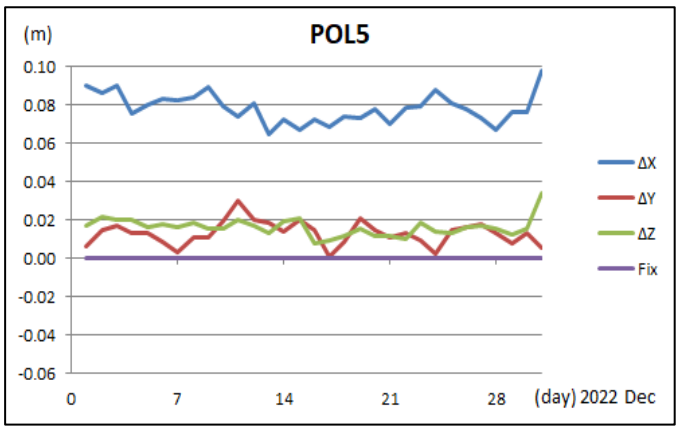


Figure 15: Daily Movements of POL5 in 2022 December

Table 13.Daily Observed Coordinates and Movements of NPT1 in 2023 November

Year	Day (Nov)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2023	1	-634100.35049	0.08377	5968838.24357	0.02769	2149801.02475	-0.00454
2023	2	-634100.34253	0.07581	5968838.24031	0.03095	2149801.02973	-0.00952
2023	3	-634100.34948	0.08276	5968838.24212	0.02914	2149801.03166	-0.01145
2023	4	-634100.34417	0.07745	5968838.25129	0.01997	2149801.03121	-0.01100
2023	5	-634100.34898	0.08226	5968838.25169	0.01957	2149801.02453	-0.00432
2023	6	-634100.34297	0.07625	5968838.25070	0.02056	2149801.02794	-0.00773
2023	7	-634100.34835	0.08163	5968838.24804	0.02322	2149801.04233	-0.02212
2023	8	-634100.34852	0.08180	5968838.24131	0.02995	2149801.03421	-0.01400
2023	9	-634100.35083	0.08411	5968838.24319	0.02807	2149801.03075	-0.01054
2023	10	-634100.34404	0.07732	5968838.23796	0.03330	2149801.02520	-0.00499
2023	11	-634100.33057	0.06385	5968838.25704	0.01422	2149801.03437	-0.01416
2023	12	-634100.34832	0.08160	5968838.24957	0.02169	2149801.04158	-0.02137
2023	13	-634100.35265	0.08593	5968838.24667	0.02459	2149801.02772	-0.00751
2023	14	-634100.34532	0.07860	5968838.25066	0.02060	2149801.02811	-0.00790
2023	15	-634100.35144	0.08472	5968838.23940	0.03186	2149801.03086	-0.01065
2023	16	-634100.34667	0.07995	5968838.23595	0.03531	2149801.03663	-0.01642
2023	17	-634100.34699	0.08027	5968838.23977	0.03149	2149801.03180	-0.01159
2023	18	-634100.34506	0.07834	5968838.23927	0.03199	2149801.03129	-0.01108
2023	19	-634100.33626	0.06954	5968838.24815	0.02311	2149801.03708	-0.01687
2023	20	-634100.34000	0.07328	5968838.24310	0.02816	2149801.03291	-0.01270
2023	21	-634100.35200	0.08528	5968838.24226	0.02900	2149801.02460	-0.00439
2023	22	-634100.35510	0.08838	5968838.24128	0.02998	2149801.02613	-0.00592
2023	23	-634100.35580	0.08908	5968838.23542	0.03584	2149801.02064	-0.00043
2023	24	-634100.35374	0.08702	5968838.24750	0.02376	2149801.02831	-0.00810
2023	25	-634100.35017	0.08345	5968838.23521	0.03605	2149801.02679	-0.00658
2023	26	-634100.34716	0.08044	5968838.25252	0.01874	2149801.03078	-0.01057
2023	27	-634100.34766	0.08094	5968838.25105	0.02021	2149801.03325	-0.01304
2023	28	-634100.34560	0.07888	5968838.24917	0.02209	2149801.03140	-0.01119
2023	29	-634100.35112	0.08440	5968838.24688	0.02438	2149801.02694	-0.00673
2023	30	-634100.35403	0.08731	5968838.25089	0.02037	2149801.03206	-0.01185

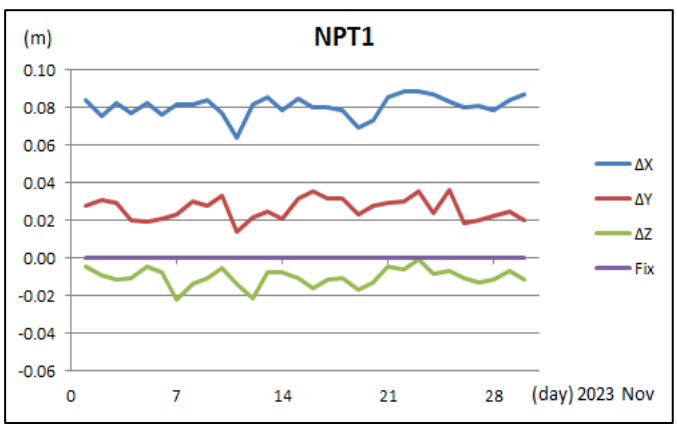


Figure 16: Daily Movements of NPT1 in 2023 November

Table 14.Daily Observed Coordinates and Movements of NPT2 in 2023 November

Year	Day (Nov)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2023	1	-633769.29322	0.09208	5974921.37190	0.03072	2132979.51664	-0.01134
2023	2	-633769.28586	0.08472	5974921.37176	0.03086	2132979.52331	-0.01801
2023	3	-633769.29217	0.09103	5974921.36600	0.03662	2132979.52154	-0.01624
2023	4	-633769.28747	0.08633	5974921.37657	0.02605	2132979.52131	-0.01601
2023	5	-633769.29360	0.09246	5974921.38104	0.02158	2132979.51789	-0.01259
2023	6	-633769.27964	0.07850	5974921.37499	0.02763	2132979.51617	-0.01087
2023	7	-633769.29120	0.09006	5974921.37897	0.02365	2132979.53330	-0.02800
2023	8	-633769.29212	0.09098	5974921.37350	0.02912	2132979.52745	-0.02215
2023	9	-633769.29522	0.09408	5974921.37475	0.02787	2132979.52330	-0.01800
2023	10	-633769.28222	0.08108	5974921.36656	0.03606	2132979.51668	-0.01138
2023	11	-633769.27000	0.06886	5974921.38574	0.01688	2132979.52625	-0.02095
2023	12	-633769.29305	0.09191	5974921.37659	0.02603	2132979.53333	-0.02803
2023	13	-633769.29846	0.09732	5974921.37560	0.02702	2132979.51977	-0.01447
2023	14	-633769.28882	0.08768	5974921.37886	0.02376	2132979.52110	-0.01580
2023	15	-633769.29476	0.09362	5974921.36664	0.03598	2132979.52263	-0.01733
2023	16	-633769.28584	0.08470	5974921.36464	0.03798	2132979.52739	-0.02209
2023	17	-633769.28754	0.08640	5974921.36639	0.03623	2132979.52296	-0.01766
2023	18	-633769.28777	0.08663	5974921.36920	0.03342	2132979.52278	-0.01748
2023	19	-633769.27501	0.07387	5974921.38112	0.02150	2132979.52873	-0.02343
2023	20	-633769.28194	0.08080	5974921.36815	0.03447	2132979.52211	-0.01681
2023	21	-633769.29489	0.09375	5974921.37355	0.02907	2132979.51677	-0.01147
2023	22	-633769.29843	0.09729	5974921.36959	0.03303	2132979.51612	-0.01082
2023	23	-633769.29875	0.09761	5974921.36153	0.04109	2132979.50966	-0.00436
2023	24	-633769.29315	0.09201	5974921.37133	0.03129	2132979.51770	-0.01240
2023	25	-633769.29231	0.09117	5974921.35838	0.04424	2132979.51742	-0.01212
2023	26	-633769.28801	0.08687	5974921.37677	0.02585	2132979.51992	-0.01462
2023	27	-633769.29054	0.08940	5974921.38208	0.02054	2132979.52481	-0.01951
2023	28	-633769.28881	0.08767	5974921.37984	0.02278	2132979.52325	-0.01795
2023	29	-633769.29221	0.09107	5974921.37243	0.03019	2132979.51624	-0.01094
2023	30	-633769.29464	0.09350	5974921.37496	0.02766	2132979.52243	-0.01713

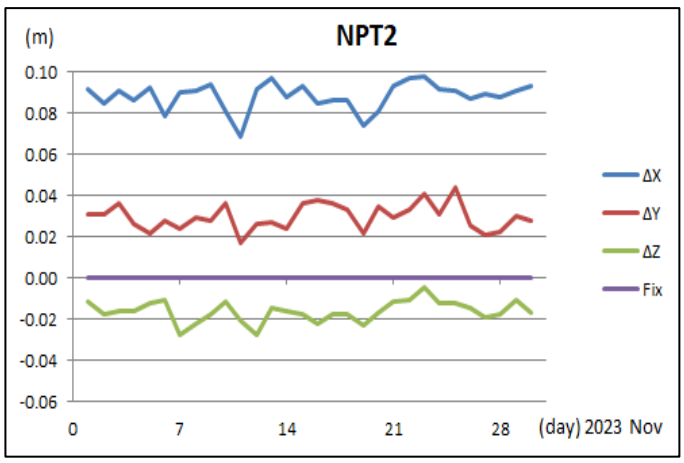


Figure 17: Daily Movements of NPT2 in 2023 November

Table 15.Daily Observed Coordinates and Movements of NPT3 in 2023 November

Year	Day (Nov)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2023	1	-652840.29513	0.08730	5976802.12560	0.01815	2121942.15943	0.01139
2023	2	-652840.28982	0.08199	5976802.12731	0.01644	2121942.16475	0.00607
2023	3	-652840.29599	0.08816	5976802.12214	0.02161	2121942.16374	0.00708
2023	4	-652840.29059	0.08276	5976802.13469	0.00906	2121942.16422	0.00660
2023	5	-652840.29451	0.08668	5976802.13523	0.00852	2121942.15896	0.01186
2023	6	-652840.28443	0.07660	5976802.13488	0.00887	2121942.16060	0.01022
2023	7	-652840.29421	0.08638	5976802.13365	0.01010	2121942.17497	-0.00415
2023	8	-652840.29440	0.08657	5976802.13004	0.01371	2121942.16920	0.00162
2023	9	-652840.29751	0.08968	5976802.12622	0.01753	2121942.16432	0.00650
2023	10	-652840.28607	0.07824	5976802.12048	0.02327	2121942.15837	0.01245
2023	11	-652840.27160	0.06377	5976802.13680	0.00695	2121942.16709	0.00373
2023	12	-652840.29714	0.08931	5976802.13538	0.00837	2121942.17585	-0.00503
2023	13	-652840.30175	0.09392	5976802.13771	0.00604	2121942.16141	0.00941
2023	14	-652840.28911	0.08128	5976802.13466	0.00909	2121942.16086	0.00996
2023	15	-652840.29727	0.08944	5976802.12243	0.02132	2121942.16263	0.00819
2023	16	-652840.28874	0.08091	5976802.12191	0.02184	2121942.17016	0.00066
2023	17	-652840.29100	0.08317	5976802.12414	0.01961	2121942.16547	0.00535
2023	18	-652840.28989	0.08206	5976802.12636	0.01739	2121942.16527	0.00555
2023	19	-652840.27801	0.07018	5976802.13091	0.01284	2121942.16923	0.00159
2023	20	-652840.28469	0.07686	5976802.11967	0.02408	2121942.16396	0.00686
2023	21	-652840.29781	0.08998	5976802.12354	0.02021	2121942.15606	0.01476
2023	22	-652840.29979	0.09196	5976802.12336	0.02039	2121942.15749	0.01333
2023	23	-652840.30135	0.09352	5976802.11952	0.02423	2121942.15240	0.01842
2023	24	-652840.29770	0.08987	5976802.12550	0.01825	2121942.15987	0.01095
2023	25	-652840.29621	0.08838	5976802.11780	0.02595	2121942.15911	0.01171
2023	26	-652840.28984	0.08201	5976802.13008	0.01367	2121942.16113	0.00969
2023	27	-652840.29342	0.08559	5976802.13519	0.00856	2121942.16622	0.00460
2023	28	-652840.29128	0.08345	5976802.13000	0.01375	2121942.16198	0.00884
2023	29	-652840.29467	0.08684	5976802.13181	0.01194	2121942.16047	0.01035
2023	30	-652840.29680	0.08897	5976802.13179	0.01196	2121942.16441	0.00641

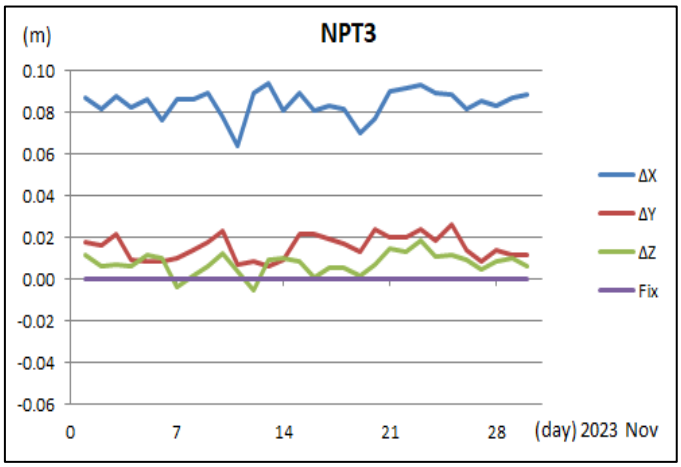


Figure 18: Daily Movements of NPT3 in 2023 November

Table 16.Daily Observed Coordinates and Movements of NPT4 in 2023 November

Year	Day (Nov)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2023	1	-654287.06229	0.09178	5965074.96465	-0.04082	2154198.92735	-0.00631
2023	2	-654287.05475	0.08424	5965074.96212	-0.03829	2154198.93261	-0.01157
2023	3	-654287.06143	0.09092	5965074.96214	-0.03831	2154198.93335	-0.01231
2023	4	-654287.05369	0.08318	5965074.97332	-0.04949	2154198.93499	-0.01395
2023	5	-654287.06293	0.09242	5965074.97539	-0.05156	2154198.92644	-0.00540
2023	6	-654287.05699	0.08648	5965074.97468	-0.05085	2154198.92910	-0.00806
2023	7	-654287.06176	0.09125	5965074.96964	-0.04581	2154198.94212	-0.02108
2023	8	-654287.05905	0.08854	5965074.96549	-0.04166	2154198.93710	-0.01606
2023	9	-654287.06068	0.09017	5965074.95886	-0.03503	2154198.93050	-0.00946
2023	10	-654287.05605	0.08554	5965074.96021	-0.03638	2154198.92769	-0.00665
2023	11	-654287.04261	0.07210	5965074.97926	-0.05543	2154198.93628	-0.01524
2023	12	-654287.05878	0.08827	5965074.96841	-0.04458	2154198.94198	-0.02094
2023	13	-654287.06340	0.09289	5965074.96615	-0.04232	2154198.92762	-0.00658
2023	14	-654287.05643	0.08592	5965074.97066	-0.04683	2154198.92934	-0.00830
2023	15	-654287.06360	0.09309	5965074.96218	-0.03835	2154198.93216	-0.01112
2023	16	-654287.05818	0.08767	5965074.95883	-0.03500	2154198.93823	-0.01719
2023	17	-654287.05739	0.08688	5965074.96185	-0.03802	2154198.93283	-0.01179
2023	18	-654287.05680	0.08629	5965074.96004	-0.03621	2154198.93119	-0.01015
2023	19	-654287.04744	0.07693	5965074.97024	-0.04641	2154198.93773	-0.01669
2023	20	-654287.05108	0.08057	5965074.96288	-0.03905	2154198.93322	-0.01218
2023	21	-654287.06321	0.09270	5965074.96833	-0.04450	2154198.92794	-0.00690
2023	22	-654287.06367	0.09316	5965074.95928	-0.03545	2154198.92690	-0.00586
2023	23	-654287.06687	0.09636	5965074.95601	-0.03218	2154198.92144	-0.00040
2023	24	-654287.06265	0.09214	5965074.96576	-0.04193	2154198.92850	-0.00746
2023	25	-654287.06078	0.09027	5965074.95475	-0.03092	2154198.92783	-0.00679
2023	26	-654287.05782	0.08731	5965074.97102	-0.04719	2154198.93083	-0.00979
2023	27	-654287.05954	0.08903	5965074.97119	-0.04736	2154198.93393	-0.01289
2023	28	-654287.05578	0.08527	5965074.96920	-0.04537	2154198.93045	-0.00941
2023	29	-654287.06166	0.09115	5965074.96390	-0.04007	2154198.92834	-0.00730
2023	30	-654287.06320	0.09269	5965074.96727	-0.04344	2154198.93220	-0.01116

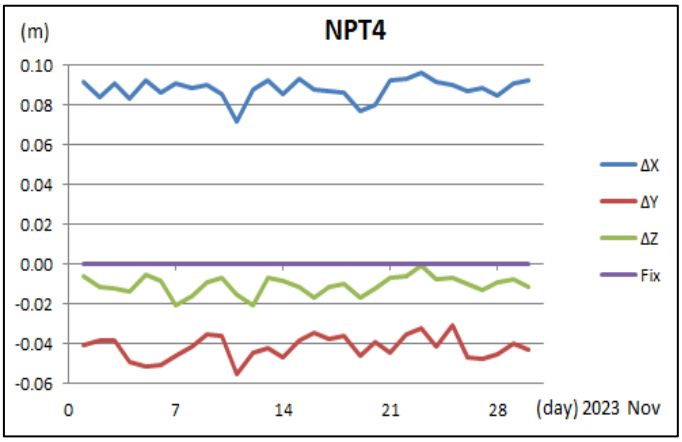


Figure 19: Daily Movements of NPT4 in 2023 November

Table 17.Daily Observed Coordinates and Movements of POL5 in 2023 November

Year	Day (Nov)	X (m)	ΔX	Y (m)	ΔY	Z (m)	ΔZ
2023	1	-666949.32027	0.08038	5878706.10172	0.01563	2377340.75154	0.02412
2023	2	-666949.31346	0.07357	5878706.10940	0.00795	2377340.76209	0.01357
2023	3	-666949.32131	0.08142	5878706.10910	0.00825	2377340.76202	0.01364
2023	4	-666949.31325	0.07336	5878706.11688	0.00047	2377340.76355	0.01211
2023	5	-666949.32051	0.08062	5878706.11018	0.00717	2377340.75143	0.02423
2023	6	-666949.31383	0.07394	5878706.11556	0.00179	2377340.75573	0.01993
2023	7	-666949.31951	0.07962	5878706.10208	0.01527	2377340.76622	0.00944
2023	8	-666949.31830	0.07841	5878706.10932	0.00803	2377340.76590	0.00976
2023	9	-666949.32072	0.08083	5878706.10258	0.01477	2377340.75802	0.01764
2023	10	-666949.31350	0.07361	5878706.10062	0.01673	2377340.75288	0.02278
2023	11	-666949.30021	0.06032	5878706.11775	-0.00040	2377340.76247	0.01319
2023	12	-666949.31847	0.07858	5878706.11407	0.00328	2377340.76954	0.00612
2023	13	-666949.32360	0.08371	5878706.10274	0.01461	2377340.75185	0.02381
2023	14	-666949.31448	0.07459	5878706.11236	0.00499	2377340.75624	0.01942
2023	15	-666949.32212	0.08223	5878706.09640	0.02095	2377340.75596	0.01970
2023	16	-666949.31997	0.08008	5878706.09996	0.01739	2377340.76329	0.01237
2023	17	-666949.31820	0.07831	5878706.10381	0.01354	2377340.75958	0.01608
2023	18	-666949.31303	0.07314	5878706.09891	0.01844	2377340.75824	0.01742
2023	19	-666949.30541	0.06552	5878706.10901	0.00834	2377340.76389	0.01177
2023	20	-666949.30974	0.06985	5878706.10460	0.01275	2377340.76021	0.01545
2023	21	-666949.32231	0.08242	5878706.10342	0.01393	2377340.75177	0.02389
2023	22	-666949.32314	0.08325	5878706.10354	0.01381	2377340.75377	0.02189
2023	23	-666949.32463	0.08474	5878706.10786	0.00949	2377340.75387	0.02179
2023	24	-666949.32370	0.08381	5878706.10527	0.01208	2377340.75274	0.02292
2023	25	-666949.31787	0.07798	5878706.09294	0.02441	2377340.75304	0.02262
2023	26	-666949.31629	0.07640	5878706.10821	0.00914	2377340.75604	0.01962
2023	27	-666949.31874	0.07885	5878706.10807	0.00928	2377340.75850	0.01716
2023	28	-666949.31558	0.07569	5878706.10829	0.00906	2377340.75599	0.01967
2023	29	-666949.32143	0.08154	5878706.10760	0.00975	2377340.75288	0.02278
2023	30	-666949.32206	0.08217	5878706.10510	0.01225	2377340.75688	0.01878

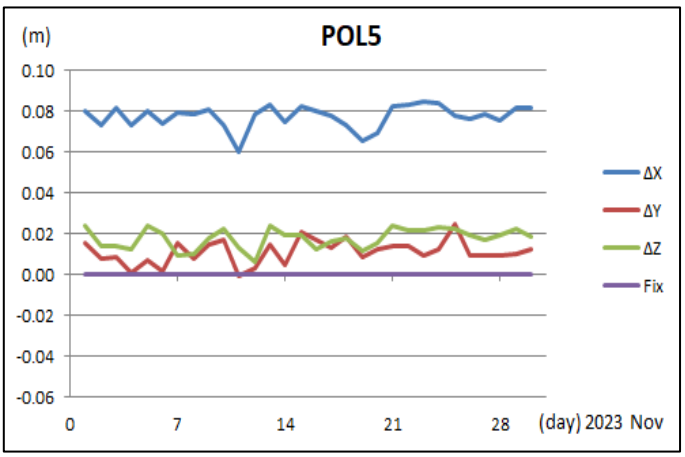


Figure 20: Daily Movements of POL5 in 2023 November

4.2 Determination of CORS Movement

By analyzing observed coordinates and movements above tables and graphs, the movements and directions of 5 CORS were found. The movements and directions of 5 CORS is shown in **Table 18**.

Table 18.Movements and Directions of 5 CORS

No.	2021 December			2022 December			2023 November		
	X	Y	Z	X	Y	Z	X	Y	Z
NPT1	53 mm to 68mm (To East)	8 mm to 30 mm (To North)	-1 mm to -16 mm (Down)	67 mm to 102 mm (To East)	11 mm to 38 mm (To North)	-7 mm to -22 mm (Down)	63 mm to 89 mm (To East)	14 mm to 36 mm (To North)	-1 mm to -22 mm (Down)
NPT2	54 mm to 73 mm (To East)	5 mm to 32 mm (To North)	-1 mm to -19 mm (Down)	73 mm to 108 mm (To East)	13 mm to 40 mm (To North)	3 mm to 29 mm (Down)	68 mm to 97 mm (To East)	16 mm to 44 mm (To North)	-4 mm to -28 mm (Down)
NPT3	53 mm to 72 mm (To East)	1 mm to 25 mm (To North)	1 mm to 16 mm (Up)	71 mm to 103 mm (To East)	4 mm to 26 mm (To North)	1 mm to 25 mm (Up)	63 mm to 93 mm (To East)	6 mm to 25 mm (To North)	1 mm to 18 mm (Up)
NPT4	57 mm to 73 mm (To East)	-33 mm to -65 mm (To South)	-1 mm to -22 mm (Down)	76 mm to 107 mm (To East)	-28 mm to -55 mm (To South)	7 mm to 23 mm (Down)	72 mm to 96 mm (To East)	-30 mm to -55 mm (To South)	-1 mm to -21 mm (Down)
POL5	49 mm to 64 mm (To East)	1 mm to 19 mm (To North)	3 mm to 21 mm (Up)	64 mm to 97 mm (To East)	1 mm to 30 mm (To North)	8 mm to 34 mm (Up)	60 mm to 84 mm (To East)	1 mm to 24 mm (To North)	6 mm to 24 mm (Up)

In this study, the movements of 5 CORS were analyzed by comparing their observed coordinates in the period of 2021 December, 2022 December, and 2023 November with their fixed coordinates established in 2020. The results indicated that all five stations experienced measurable movement over the observation period. These findings show that NPT1, NPT2, NPT3 and POL5 were moving to North-East direction but NPT 4 was moving to South-East direction. The analysis results indicate that the east side of the Sagaing Fault moves southeast at the average rate of approximately 32-40 mm/a, whereas the west side of the fault moves northeast at the rate of about 31-35 mm/a (Pyae Sone Aung et al. 2015). Therefore, from this study, NPT4 is located at East of Sagaing Fault. Moreover, 5 CORS stations experienced greater movement in the X-axis while movements in the Y and Z axis remained relatively consistent. The consistent Y and Z-axis movements suggest that these components of movement are relatively stable, while the X-axis movement is more dynamic and requires further investigation.

5. Discussion

The observed movements indicate that five CORS experienced significant movements in the observation periods, with the X-axis showing the most noticeable changes. This could be attributed to:

(1) **Tectonic Activity:** Myanmar is located in a tectonically active region, and the increasing X-axis movement may reflect ongoing crustal movements.

(2) **Local Geological Factors:** Local geological processes, such as subsidence or fault activity, may also contribute to the observed movements.

(3) **Seasonal and Environmental Effects:** Seasonal variations, such as changes in groundwater levels or heavy rainfall, could have minor influences on the Z-axis movements.

The observed movements underscore the importance of regularly updating CORS coordinates to maintain their accuracy as reference points for geodetic and geophysical technician. These findings also provide valuable insights into the crustal deformation patterns in Myanmar, those can contribute to better understanding seismic hazards and tectonic processes in the region. Future studies should incorporate several time series data to better understand the long-term trends and rates of movement. This study demonstrates that the CORS in Myanmar are subject to significant movements, primarily driven by tectonic activity. These findings highlight the dynamic nature of the Earth's crust in the region and emphasize the need for continuous monitoring and periodic updates to CORS coordinates to ensure their reliability for geodetic and geophysical applications.

CORS is necessary to check and analyze their movement regularly. Only then the correct data and strong precision quality will be available when CORS Network is used for land surveying and other related works by connecting CORS network. In Myanmar, there are currently 5 CORS established across the country. However, CORS Network should be implemented to cover the whole country because if compare to other countries, the number of CORS in Myanmar is very small. For instance, countries like the United States operate approximately 2,700 CORS, while China has over 2,160 stations. India is in the process of creating a nationwide network with plans for over 200 stations, and Bangladesh has begun expanding its network beyond the 6 initial stations established in 2011, with plans to expand the network by adding more stations for the future. There also have over 1,300 CORS in Japan and over 250 stations in Thailand for supporting advanced geospatial applications.

Given this disparity, it is evident that Myanmar's current CORS infrastructure is insufficient to meet the demands of modern GNSS applications such as precise navigation, land surveying, geospatial mapping. If the CORS Network could be expanded to cover the whole country, research and observation will be carried out more widely in the field of GNSS application. Expanding the CORS network is a critical step toward aligning Myanmar with international standards in the field of GNSS technology.

6. Conclusion

In conclusion, the results indicated that all 5 CORS experienced measurable movements over the observation period. These findings show that NPT1, NPT2, NPT3 and POL5 were moving to North-East direction but NPT 4 was moving to South-East direction. In addition, 5 CORS experienced greater movement in the X-axis while movements in the Y and Z axis remained relatively consistent. These movements are likely driven by the region's tectonic activity, particularly the convergence of the Indian and Eurasian Plates. Local geological factors and seasonal effects may also contribute to the observed movements. The findings underscore the importance of regularly updating CORS coordinates and provide valuable insights into crustal deformation patterns in Myanmar. Future research should focus on longer-term monitoring and investigating local environmental factors to better understand the underlying causes of these movements.

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