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ANALYSIS OF THE ACCURACIES OF CSRS-PPP AND AUSPOS ONLINE POST-PROCESSING SERVICES

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Abstract:

The static mode of point positioning requires post-processing, which can be done automatically using some of the free online post-processing services. It is, therefore, important to evaluate the accuracy of coordinate solutions provided by these services, determine the optimal observation duration to achieve specific accuracy levels, identify when longer observation durations yield less accuracy improvement, and compare the overall accuracy performance of online post-processing services. In this study, the accuracies of two free online post-processing services (CSRS-PPP and AUSPOS) were tested using data acquired at three Continuously Operating Reference Stations (CORS) located at Asaba, Benin and Warri, all located in Southern Nigeria. The acquired 8 hours Global Navigation Satellite System (GNSS) observation data recorded in RINEX (Receiver Independent Exchange) format version 3.05 were decimated into shorter sessions of (15 minutes, 30 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, and 6 hours). The findings show that both services produced centimetre-level horizontal accuracy. However, CSRS-PPP achieved 10 cm accuracy within 15 minutes compared to 1 hour with AUSPOS, but the rate of accuracy improvement with both services decreased significantly after 2-3 hours. Also, from 14 performance evaluation criteria at each of the three stations totaling 42 total comparisons used in the study, CSRS-PPP won 29 out of 42 (69%). This study provides important practical information for geospatial professionals on which service offers better accuracy and which works faster.

Keywords: Global Navigation Satellite System (GNSS), Precise Point Positioning (PPP), Online Precise Point Positioning, Continuously Operating Reference Stations (CORS), AUSPOS, CSRS-PPP

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1.0 INTRODUCTION

Global Navigation Satellite Systems (GNSS) determine positions by measuring signal travel times from satellites orbiting about thousands of kilometres above the Earth. The most common GNSS systems are Global Positioning System (GPS) from the United States, GLONASS from Russia, Galileo from Europe, and BeiDou from China [15]. Basic GNSS positioning achieves 5 to 10 metres accuracy, which is inadequate for critical surveying applications [4]. In order to achieve centimetre-level precision, professionals use differential techniques where multiple receivers work together, with at least one positioned at a known location. This allows common error sources affecting all receivers to be eliminated or significantly reduced [10].

Real-Time Kinematic (RTK) positioning has become the most widely used GNSS method in modern surveying [6]. RTK uses a base receiver at a known point and a rover at the point being surveyed, with corrections transmitted in real time. This provides centimetre-level accuracy within seconds to minutes [12]. However, RTK requires the rover to stay within 10 to 20 kilometres of the base station and needs additional equipment for setup. Other differential methods include static positioning, which achieves millimetre accuracy but requires hours of observation [14], and Post-Processed Kinematic, which stores data for later processing. A major limitation of these traditional approaches is that they all require at least two receivers, meaning the user must either own a second receiver or have access to a nearby reference station.

The availability of online GNSS post-processing services plays a key role in addressing this limitation by allowing users to collect satellite observation data with just a single receiver and then submit the recorded data to a web-based platform for processing. Once the observation file is uploaded, the service processes the data automatically and sends back the coordinate solutions, usually within minutes to hours. Two of the most widely used online post-processing services are the Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP), operated by Natural Resources Canada, and the Australian Online GPS Processing Service (AUSPOS), operated by Geoscience Australia.

Several studies have shown that these online services can deliver professional-quality results. In [3], three online GNSS post-processing services: AUSPOS, GAPS, and magicGNSS were compared across five permanent GNSS stations in Nigeria using observation sessions of 1, 2, 6, 12, and 24 hours. The study found that magicGNSS and GAPS consistently returned horizontal RMSE values below 0.3 m in both the east and north components, while AUSPOS produced larger horizontal errors exceeding 0.3 m across all observation durations. A study by [8] tested four online PPP services and found that daily static solutions achieved millimetre-level precision in horizontal components and 1-2 cm in height, while shorter observation periods of around two hours yielded horizontal accuracy of 2-3 cm and height accuracy of 3-5 cm. Another study by [16] evaluated ten open-source software packages and five online PPP services using 45 IGS stations worldwide and found that the top-performing online services, APPS and CSRS-PPP, achieved RMSE values below 12 mm in all three coordinate components, with all five online services performing below 13 mm.

Despite extensive research on the use of online GNSS post-processing services, users lack clear guidelines on how long to observe for specific accuracy requirements. While existing literature confirms that accuracy improves with observation duration and typically requires 30 to 60 minutes for centimetre-level results, systematic data showing hour-by-hour accuracy evolution across operationally relevant time windows is lacking. Most studies have been done in America, Europe, and Australia. Very few studies have tested how these services work in Africa. The concept of diminishing returns in static mode observations has not been systematically quantified for online post-processing services. This refers to the point at which continuing observation provides only minimal accuracy improvement, which may not justify additional observation time. Several studies have evaluated individual services [1]; [2]; [5]; [11]. While individual services have been evaluated in isolation, comprehensive side-by-side comparisons of CSRS-PPP and AUPOS using simultaneous GNSS observations from geographically separated stations remains limited.

The main goal of this study is to evaluate the achievable accuracies of CSRS-PPP and AUSPOS post-processing services across multiple observation durations and stations, utilising data from multiple Continuously Operating Reference Stations (CORS) located in Asaba, Benin, and Warri in the Niger Delta Region of Nigeria. The study attempts to answer three key questions: First, how long would it take to observe and to reach specific accuracy levels like 10 cm, 5 cm, or 2 cm? Second, at what point does observing longer stop making a real difference? And third, which service performs better overall?

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2.0 THE STUDY AREA

The study areas (Figure 1) cover two neighbouring states in southern Nigeria - Delta State and Edo State. Three Continuously Operating Reference Stations (CORS) were selected for this study based on their geographic distribution and data availability. The first station (WARR) is located in Warri, Delta State, at coordinates Latitude 5° 34'N and Longitude 5° 48'E. Warri is a major oil producing city in Delta State and serves as an important commercial and industrial centre in the Niger Delta Region. The station is positioned in the southern part of the study area. The second station, designated as GEOS is located in Benin (Edo State) at coordinates Latitude 6° 20'N and Longitude 5° 38'E. This station represents the northern extent of the study area. The third station (ASAB) is situated in Asaba, the capital city of Delta State, at coordinates Latitude 6° 11'N and Longitude 6° 43'E. Asaba is located on the western bank of the River Niger.

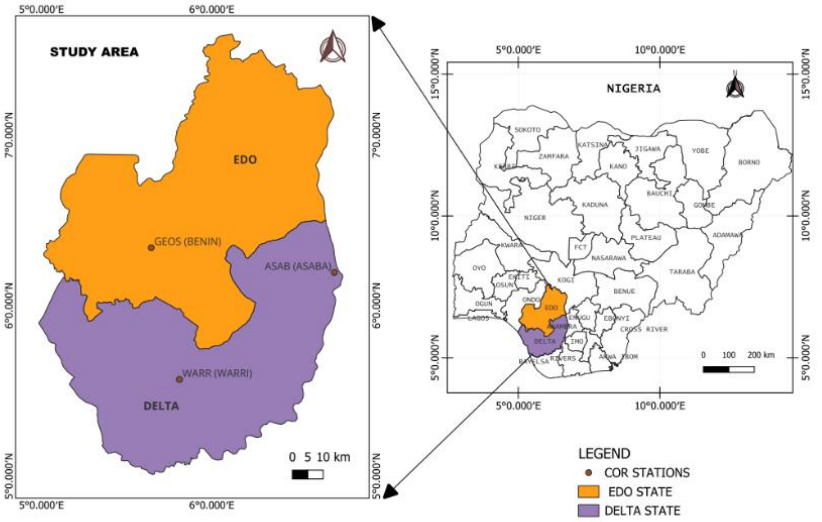

Figure 1: Map of Study Area

3.0 MATERIALS AND METHOD

The methodology comprises four core phases: station selection and data acquisition, data preparation and temporal extraction, online processing, and comprehensive accuracy assessment with statistical analysis. The flowchart of the methodology is given in Figure 2.

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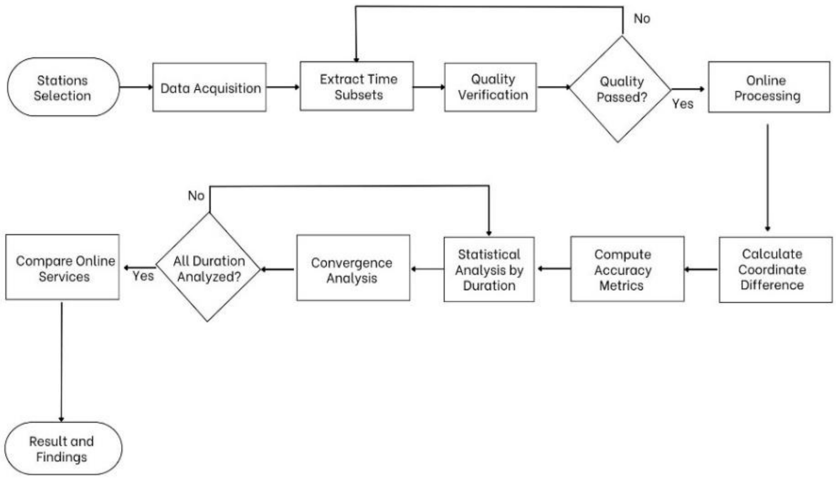

Figure 2: Flowchart of Methodology

3.1 Stations Selection

Three CORS stations were selected through a systematic evaluation process. The selected stations are operated by Sacredion CORS, a private Nigerian GNSS service provider maintaining a network of reference stations across the country. All three stations are equipped with identical dual-frequency GNSS receivers (Tersus David30) with ASAB and WARR having a matching antenna system (TRSAX3707-NONE), and GEO (TRSAX4E02-NONE). Each station has well-established reference coordinates determined through long-term observations. These coordinates were therefore considered sufficiently reliable for use as reference value in the accuracy evaluation of the study, while acknowledging the limitation that explicit uncertainty measures were not provided.

The reference coordinates for the three stations, as provided by Sacredion CORS, are given in Table 1.

Table 1: Reference Coordinates of CORS Stations

Station ID	Easting (m)	Northing (m)	Ellipsoidal Height (m)	UTM Zone
WARR	811342.037	616115.443	34.548	31N
ASAB	247605.928	685303.255	75.115	32N
GEOS	792565.951	701523.605	86.423	31N

3.2 Data Acquisition

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GNSS observation data were acquired on October 18, 2025, with uniform 8 hours observation from 06:00 to 14:00 local time across all three stations. Simultaneous observation across all stations eliminates temporal biases. The raw GNSS observations were recorded in RINEX (Receiver Independent Exchange) format version 3.05, which is the international standard for GNSS data exchange. The observation sampling rate was 30 seconds in static observation mode. The 30-second sampling rate provides the best balance between observation data volume and positioning accuracy and is compatible with both online processing services used in this study.

3.3 Observation Data Decimation

From each 8-hour master observation file, eight temporal subsets were systematically extracted to create observation files of varying durations using GFZRNX software, an open-source toolbox developed by Thomas Nischan at the GFZ Helmholtz Centre Potsdam. The time windows are carefully designed to cover sufficient observation durations. The extraction employs a common start epoch approach, where all subsets begin at an identical time (08:00) but extend for different durations. The 08:00 start epoch was selected as the beginning of a standard professional working day in order to reflect realistic field conditions for practicing professionals during a typical survey operation. Table 2 summarizes the eight observation durations extracted from each station, along with their corresponding time windows.

Table 2: Decimated Time Scheme

Duration	Time Window	Decimal Hours
15 minutes	08:00 – 08:15	0.25
30 minutes	08:00 – 08:30	0.50
1 hour	08:00 – 09:00	1.00
2 hours	08:00 – 10:00	2.00
3 hours	08:00 – 11:00	3.00
4 hours	08:00 – 12:00	4.00
5 hours	08:00 – 13:00	5.00
6 hours	08:00 – 14:00	6.00

The common start epoch eliminates potential biases arising from different observation start times, enabling fair comparison of accuracy across different durations. The extraction process generated 24 observation files (8 durations × 3 stations), each requiring independent processing through both online processing services.

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3.4 Online Processing

Two established online processing services were selected for comparative evaluation: CSRS-PPP and AUSPOS. CSRS-PPP is developed and maintained by the Canadian Geodetic Survey (CGS) of Natural Resources Canada (NRCan). It employs the Precise Point Positioning (PPP) strategy, determining user positions by applying precise satellite orbits, clock corrections, and equipment delay bias estimates derived from a global network of GNSS receivers [13].

AUSPOS, on the other hand, is an online GPS data processing service provided by Geoscience Australia. It is important to note that AUSPOS does not directly employ the PPP computation strategy. Instead, it provides a network solution using a double-difference processing strategy, referencing the nearest 15 IGS and Asia-Pacific Reference Frame (APREF) stations to compute positions [7]. Like CSRS-PPP, it supports static mode processing. However, AUSPOS accepts only dual-frequency GPS RINEX data, making it a GPS-only service. These services were chosen based on their popularity in the geomatics field, proven reliability and free availability. All observations were processed using static mode on November 14, 2025 (27 days after observation). The 27-day processing delay ensures the availability of IGS final precise orbit and clock products, which offer the highest accuracy. Each of the 24 observation files was submitted to both CSRS-PPP and AUSPOS services, generating 48 independent coordinate solutions (24 files × 2 services). After submission, processed results were received via email in PDF and ZIP format containing the computed coordinates, quality indicators, and processing summaries. Table 3 shows the key characteristics of CSRS-PPP and AUSPOS online processing services.

Table 3: AUSPOS and CSRS-PPP key characteristics

Service	Organization	Software	Supported Constellations	Data Transfer Method	Minimum Duration	Processing Mode	Ambiguity Resolution
CSRS-PPP	Natural Resources Canada (NRCan)	NRCanPPP	GPS + GLONASS	Web service (file upload)	15 minutes	Static and Kinematic	Integer ambiguity resolution
AUSPOS	Geoscience Australia	Bernese GNSS Software	GPS only	Web service (file upload)	1 hour	Static only	Double-difference Network processing

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3.5 Accuracy Assessment and Statistical Analysis

The accuracy assessment was done by calculating coordinate differences between online post-processing services solutions and reference coordinates for each station.

$$\Delta E = \text{Online Processed Easting} - \text{Ref. Easting} \tag{3.1}$$

$$\Delta N = \text{Online Processed Northing} - \text{Ref. Northing} \tag{3.2}$$

$$\Delta H = \text{Online Processed Height} - \text{Ref. Height} \tag{3.3}$$

Where:

ΔE= Eastings coordinate difference,

ΔN= Northings coordinate difference,

ΔH= Ellipsoidal coordinate difference.

The two-dimensional horizontal positioning error combines Easting and Northing errors into a single metric representing the distance from the reference position:

$$\text{Horizontal E.} = \sqrt{(\Delta E^2 + \Delta N^2)} \tag{3.4}$$

The one-dimensional vertical positioning error represents the absolute deviation of the derived ellipsoidal height from the reference height value:

$$\text{Vertical E.(cm)} = |\Delta H| \times 100 \tag{3.5}$$

4.0 RESULTS AND DISCUSSION

The study produced several findings that address the study objectives as follows. Table 4 presents the computed horizontal and vertical error for each station.

Table 4: Computed error from AUSPOS and CSRS-PPP

COMPUTED ERRORS - CSRS-PPP							
Station	Duration (hrs)	Delta Easting (m)	Delta Northing (m)	Delta Height(m)	Horizontal Error (m)	Horizontal Error(cm)	Vertical Error (cm)
WARR	0.25	-0.009	-0.004	0	0.009848858	0.984885775	0
WARR	0.5	0.003	0.014	-0.021	0.014317821	1.431782115	2.1
WARR	1	0.005	0.015	-0.022	0.015811388	1.581138832	2.2

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WARR	2	0.007	0.015	-0.029	0.016552945	1.655294536	2.9
WARR	3	0.007	0.015	-0.029	0.016552945	1.655294536	2.9
WARR	4	0.009	0.016	-0.02	0.01835756	1.835755979	2
WARR	5	0.009	0.016	-0.021	0.01835756	1.835755979	2.1
WARR	6	0.009	0.015	-0.02	0.017492856	1.749285568	2
ASAB	0.25	-0.016	0.02	-0.006	0.025612497	2.561249697	0.6
ASAB	0.5	0.003	0.009	-0.041	0.009486833	0.948683294	4.1
ASAB	1	0.001	0.012	-0.025	0.012041595	1.204159457	2.5
ASAB	2	0.009	0.011	-0.037	0.01421267	1.421267035	3.7
ASAB	3	0.011	0.012	-0.033	0.016278821	1.627882059	3.3
ASAB	4	0.013	0.012	-0.034	0.017691806	1.769180599	3.4
ASAB	5	0.011	0.012	-0.033	0.016278821	1.627882059	3.3
ASAB	6	0.009	0.011	-0.025	0.01421267	1.421267035	2.5
GEOS	0.25	0.044	0.058	-0.036	0.072801099	7.280109886	3.6
GEOS	0.5	0.049	0.027	-0.027	0.055946403	5.594640292	2.7
GEOS	1	0.025	0.017	-0.044	0.030232433	3.023243293	4.4
GEOS	2	0.021	0.013	-0.027	0.024698178	2.469817805	2.7
GEOS	3	0.02	0.01	-0.022	0.02236068	2.23606798	2.2
GEOS	4	0.021	0.012	-0.015	0.024186773	2.41867732	1.5
GEOS	5	0.022	0.012	-0.014	0.025059928	2.505992816	1.4
GEOS	6	0.021	0.013	-0.013	0.024698178	2.469817805	1.3
COMPUTED ERRORS - AUSPOS							
Station	Duration(hrs)	Delta East(m)	Delta North (m)	Delta Height (m)	Horizontal Error(m)	Horizontal Error (cm)	Vertical Error (cm)
WARR	0.25						
WARR	0.5						
WARR	1	0.011	0.015	-0.022	0.018601075	1.860107521	2.2
WARR	2	0.013	0.015	-0.022	0.019849433	1.984943328	2.2
WARR	3	0.014	0.013	-0.015	0.019104973	1.910497317	1.5
WARR	4	0.015	0.016	-0.015	0.021931712	2.193171225	1.5
WARR	5	0.016	0.015	-0.016	0.021931712	2.193171217	1.6
WARR	6	0.016	0.013	-0.016	0.020615528	2.061552811	1.6
ASAB	0.25						
ASAB	0.5						
ASAB	1	0.099	-0.05	-0.233	0.110909873	11.09098733	23.3
ASAB	2	0.004	0.011	-0.103	0.0117047	1.170469985	10.3
ASAB	3	0.014	0.011	-0.01	0.017804494	1.780449377	1
ASAB	4	0.017	0.012	-0.013	0.020808652	2.080865203	1.3

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ASAB	5	0.015	0.01	-0.026	0.018027756	1.802775637	2.6
ASAB	6	0.016	0.009	-0.02	0.01835756	1.835755971	2
GEOS	0.25						
GEOS	0.5						
GEOS	1	-0.019	0.041	-0.008	0.045188494	4.518849407	0.8
GEOS	2	0.026	0.017	-0.002	0.031064449	3.106444909	0.2
GEOS	3	0.027	0.012	0.001	0.029546573	2.95465734	0.1
GEOS	4	0.028	0.012	0.004	0.030463092	3.046309246	0.4
GEOS	5	0.026	0.013	0	0.029068884	2.906888368	0
GEOS	6	0.026	0.013	0.002	0.029068884	2.906888368	0.2

4.1 Optimal Observation Durations for Accuracy Thresholds

CSRS-PPP achieved 10 cm horizontal accuracy within just 15 minutes at all three stations, demonstrating exceptional performance for rapid positioning needs. For 5 cm accuracy, WARR and ASAB required only 15 minutes, whereas GEOS required 1 hour (see Figure 3). The 2 cm threshold was achieved in 15 minutes at WARR, 30 minutes at ASAB, but was not achieved at GEOS even after 6 hours (best result: 2.47 cm). AUSPOS required significantly longer observation times. For 10 cm accuracy, WARR and GEOS needed 1 hour while ASAB required 2 hours. The same pattern continued for 5 cm and 2 cm thresholds, with AUSPOS requiring 1-2 hours compared to CSRS-PPP's 15-30 minutes at good sites. Like CSRS-PPP, AUSPOS could not achieve 2 cm horizontal accuracy at GEOS within 6 hours (best result: 2.91 cm). This finding reveals that CSRS-PPP is 4-8 times faster than AUSPOS for achieving the same accuracy thresholds. However, both services face the same limitation at challenging sites, this means no amount of observation time can deliver 2 cm accuracy if site conditions do not support it.

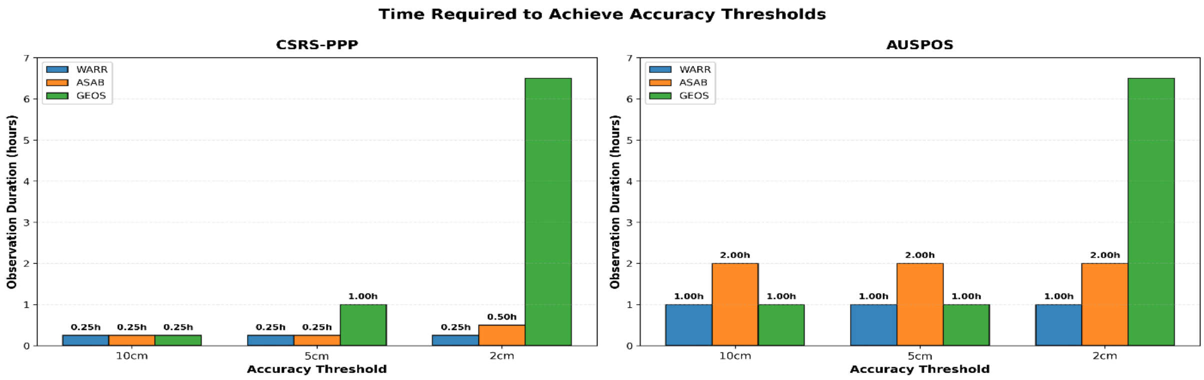

Figure 3: Horizontal accuracy thresholds timeframe

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4.2 Effect of Observation Duration on Accuracy

Observation duration has a substantial impact on accuracy, particularly in the first two hours of observation. For CSRS-PPP, horizontal positioning accuracy showed marked station-dependent behaviour. At 15 minutes, WARR achieved 0.98 cm, ASAB recorded 2.56 cm, and GEOS showed 7.28 cm. By 1 hour, the stations showed 1.58 cm, 1.20 cm, and 3.02 cm, respectively (see figures 4, 5 & 6). At 6 hours, all three stations had converged to similar levels (1.42-2.47 cm), demonstrating that longer observations help challenging stations achieve comparable accuracy. AUSPOS showed a similar but delayed pattern, because it required at least 1 hour to produce solutions. At 1 hour, WARR achieved 1.86 cm, GEOS recorded 4.52 cm, but ASAB struggled with 11.09 cm (the worst result in the study). However, ASAB showed dramatic recovery to 1.17 cm at 2 hours (89% improvement), while WARR and GEOS showed 1.98 cm and 3.11 cm respectively. By 6 hours, the stations ranged from 1.84 to 2.91 cm.

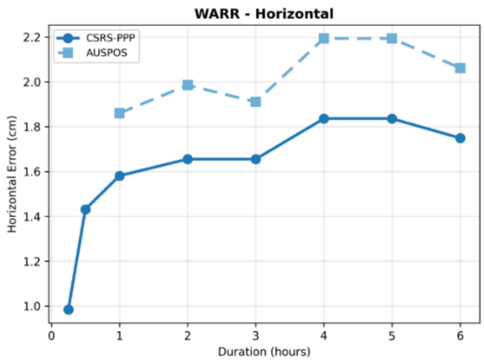

Figure 4: Horizontal accuracy for WARR station

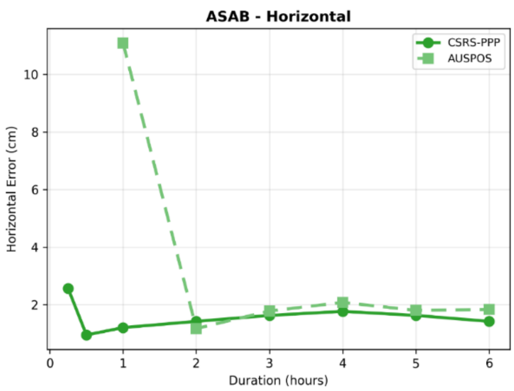

Figure 5: Horizontal accuracy for ASAB station

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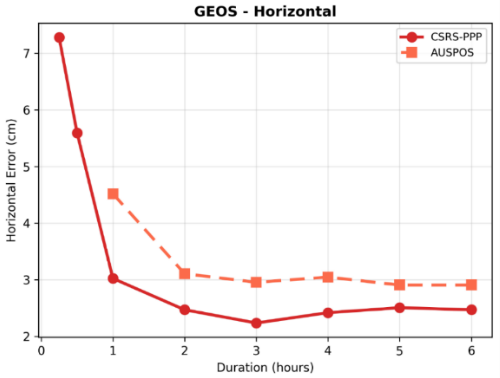

Figure 6: Horizontal accuracy for GEOS station

Vertical positioning showed similar patterns but generally had larger errors and greater variability than horizontal positioning. CSRS-PPP vertical accuracy ranged from 0 cm to 4.4 cm across stations and durations. AUSPOS vertical accuracy was excellent at GEOS (as low as 0.1 cm at 3 hours) but poor at ASAB (23.3 cm at 1 hour) (see figures 7, 8 & 9) demonstrating the same site-dependent convergence pattern observed horizontally.

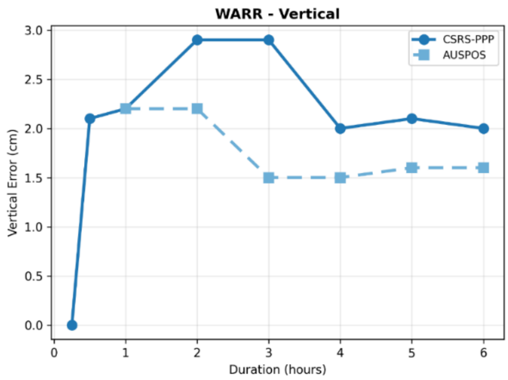

Figure 7: Vertical accuracy for WARR station

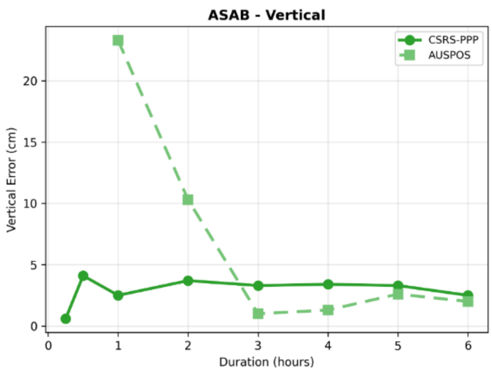

Figure 8: Vertical accuracy for ASAB station

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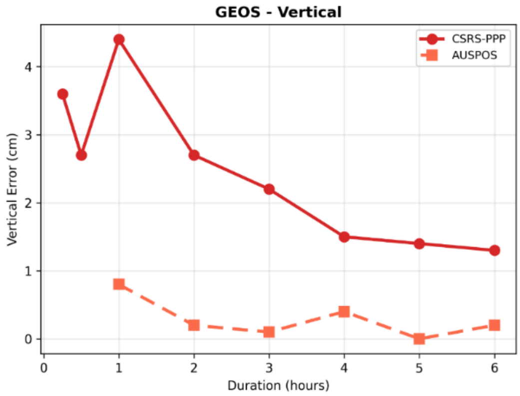

Figure 9: Vertical accuracy for GEOS station

4.3 Diminishing Returns in Accuracy Improvement

This study defined the diminishing returns point as when improvement rate drops below 10% per hour. The 10% per hour threshold was deliberately selected as a pragmatic benchmark representing the point at which additional observation time yields improvements that are no longer practically significant relative to the cost. A threshold of 10% was considered meaningful because improvements below this level, while statistically present, are unlikely to justify the additional field time.

CSRS-PPP reached diminishing returns at 2 hours (WARR), 4 hours (ASAB), and 3 hours (GEOS). AUSPOS reached it at 2 hours (WARR), 6 hours (ASAB), and 3 hours (GEOS) (see figure 10). The variation between stations reflects differences in site quality and initial convergence speed. For both services, most accuracy improvement occurred in the first 2-3 hours. Beyond this point, additional observation time yields progressively smaller gains in accuracy. After reaching the diminishing returns point, improvement rates typically fall below 5% per additional hour, suggesting limited value in extended observations for most applications. An important finding is that reaching the diminishing returns point does not guarantee excellent accuracy, it just means the rate of improvement has slowed. At excellent sites like WARR, diminishing returns occurred after achieving very good accuracy. At challenging sites like GEOS, it occurred while accuracy was still poor, indicating site limitations rather than processing limitations.

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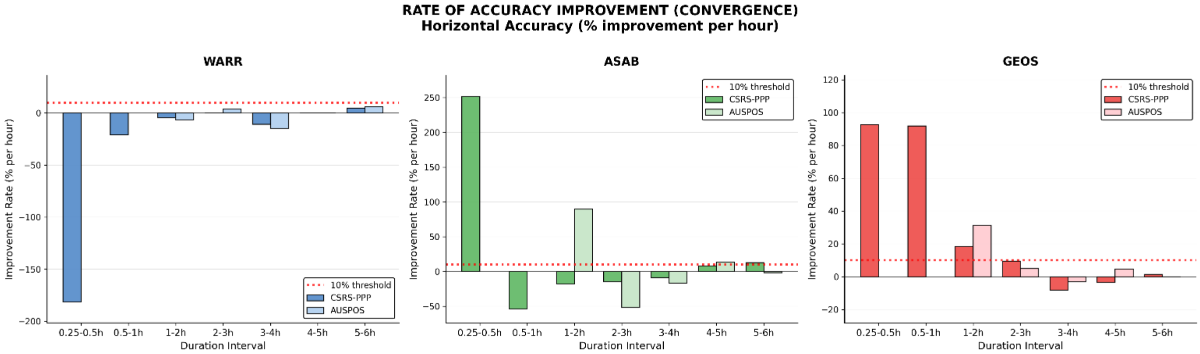

Figure 10: Diminishing returns point by station and service

4.4 Overall Service Performance Comparison

CSRS-PPP demonstrated superior overall performance across nearly all evaluation criteria as stated in [9]. Using 14 equally weighted performance measures at each of three stations (42 total comparisons), Figures 11,12 and 13 show CSRS-PPP won 69% of categories (29 out of 42). Table 5 show performance evaluation criteria with the best result at each of the three stations.

Table 5: Performance evaluation criteria and result

S/N	Evaluation Criteria	GEOS	WARR	ASAB
1.	Overall Reliability (lowest standard deviation)	1.51cm	0.27cm	1.04cm
2.	Horizontal/Vertical Ratio	1.41	0.69	0.49
3.	Diminishing Returns Point	3h	2h	4h
4.	Most Consistent (lowest std dev)	0.58cm	0.13cm	0.45cm
5.	Best Performance at 6 hours	2.47cm	1.75cm	1.42cm
6.	Best Performance at 4 hours	2.42cm	1.84cm	1.77cm
7.	Best Performance at 2 hours	2.47cm	1.66cm	1.17cm
8.	Best Performance at 1 hours	3.02cm	1.58cm	1.20cm
9.	Fastest Convergence to 2cm	6h+	0.25h	0.5h
10.	Fastest Convergence to 5cm	1hr	0.25h	0.25h
11.	Fastest Convergence to 10cm	0.25h	0.25h	0.25h.
12.	Best Average 3D Accuracy	3.26cm	2.63cm	3.46cm
13.	Best Average Vertical Accuracy	0.34cm	1.77cm	2.92cm
14.	Best Average Horizontal Accuracy	3.24cm	1.58cm	1.57cm

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At WARR, CSRS-PPP won 64% of criteria (9 out of 14); at ASAB, 93% (13 out of 14); at GEOS, 50% (7 out of 14). The service achieved better horizontal accuracy across all observation durations, with differences ranging from nearly 3 times better at 1 hour (1.94 cm vs 5.82 cm) to 20% better at 6 hours (1.88 cm vs 2.27 cm). CSRS-PPP also showed faster convergence, greater consistency across stations (horizontal standard deviation 1.13 cm vs 1.34 cm), and the ability to process very short observations that AUSPOS could not handle. AUSPOS showed competitive performance at observation durations of 2 hours or longer, achieving horizontal accuracy of 2.1-2.3 cm. For applications where this accuracy is sufficient and 2-3 hours of observation time is acceptable, AUSPOS represents a viable option. Notably, AUSPOS achieved exceptional vertical accuracy at GEOS station (0.28 cm average, as low as 0.1 cm at some durations) and competitive vertical accuracy at WARR (1.77 cm average compared to CSRS-PPP's 2.02 cm), outperforming CSRS-PPP for vertical positioning at these sites.

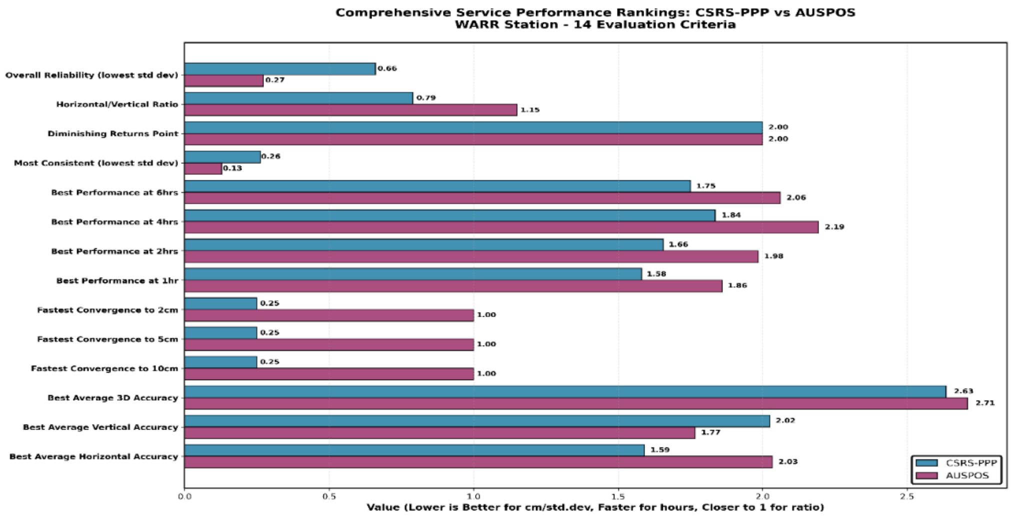

Figure 11: WARR station services performance ranking

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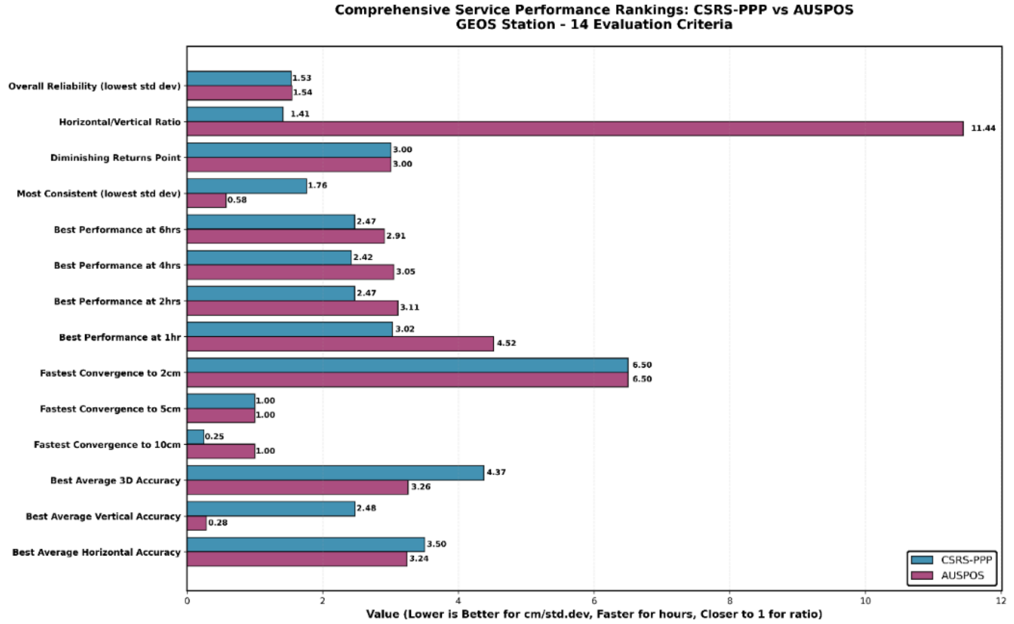

Figure 12: GEOS station services performance ranking

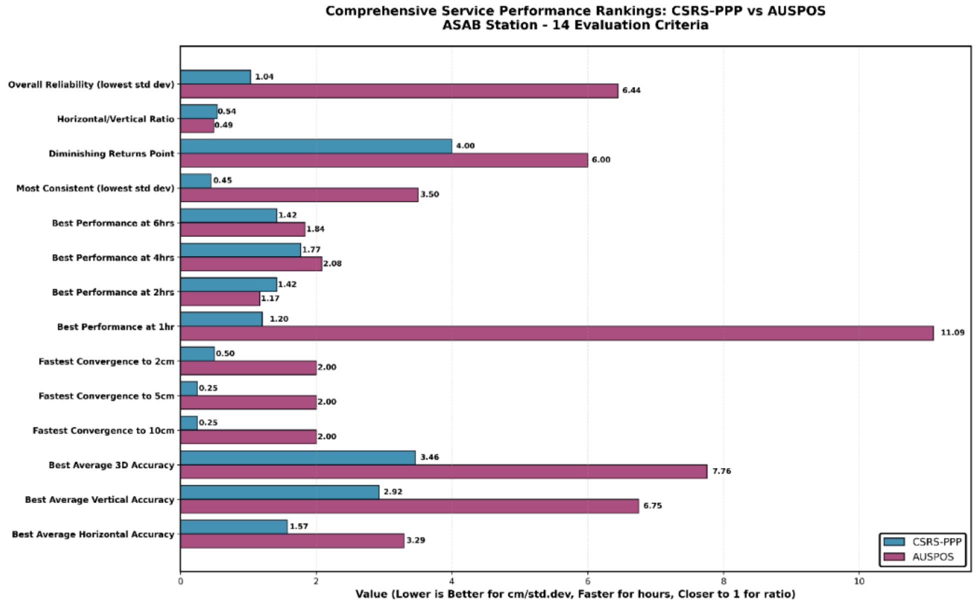

Figure 13: ASAB station services performance ranking

4.5 Station-Specific Performance Differences

WARR demonstrated exceptional performance, achieving sub-1 cm horizontal accuracy with CSRS-PPP at just 15 minutes (0.98 cm). ASAB showed moderate performance close to the overall average. GEOS presented more challenging conditions, requiring longer observation times and never achieving 2 cm accuracy with either service. This station-to-station variation of up to a factor of seven (WARR 0.98 cm vs GEOS 7.28 cm at 15 minutes) suggests that site quality factors such as multipath environment, sky obstruction, and local interference

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significantly influence accuracy. The best processing service cannot overcome poor site conditions. GEOS never achieved 2 cm accuracy even after 6 hours with either service, while WARR achieved it in just 15 minutes with CSRS-PPP. Interestingly, GEOS showed the best vertical accuracy with AUSPOS (0.1-0.8 cm) while having the poorest horizontal accuracy, suggesting that different site characteristics affect horizontal and vertical positioning differently. This finding indicates that site quality assessment should consider both components separately.

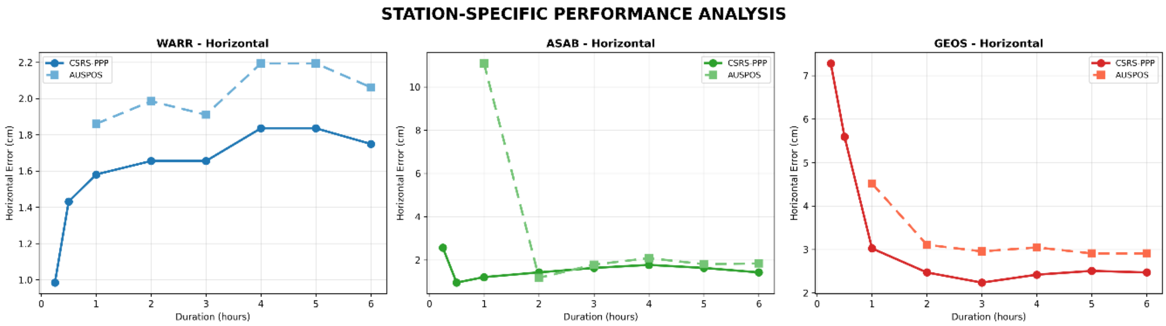

Figure 14: CORS stations side-by-side horizontal accuracy

5.0 CONCLUSION

This study successfully addressed its objectives of determining the accuracies of two online post-processing services - CSRS-PPP & AUSPOS, establishing optimal observation durations for specific accuracy levels, identifying diminishing returns points, and comparing the performance of two online processing services. The most important conclusion is that observation duration matters significantly, but with diminishing returns beyond 2-3 hours for most sites. CSRS-PPP emerges as the superior service for the study areas, offering faster convergence, better horizontal accuracy at all durations, and more reliable performance across different stations. The service achieved 10 cm accuracy in 15 minutes and 2 cm accuracy in 15-30 minutes at good sites. For applications requiring only 2-3 cm accuracy with 2-3 hours of observation time available, AUSPOS remains a viable free alternative. Additionally, AUSPOS demonstrates superior vertical accuracy at certain sites, making it worth considering for elevation-critical applications where 2-3 hour observations are acceptable. Site selection proves as important as observation duration and service choice. The large performance difference between WARR and GEOS (factor of seven at short durations) demonstrates that a poor site with 6 hours of observation cannot match a good site with 30 minutes of observation. However, applications requiring sub-centimetre accuracy, traditional network RTK or longer static observations processed with scientific software remain more appropriate. This study provides important practical information for geospatial professionals on which service offers better accuracy and which works faster.

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