Satellite Navigation Branch, ANG-E66
NSTB/WAAS T&E Team

GLOBAL POSITIONING SYSTEM STANDARD POSITIONING SERVICE PERFORMANCE ANALYSIS REPORT

October 2025

Report #131
Reporting Period: July 1 to September 30, 2025
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FAA William J. Hughes Technical Center
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1.0	Final Report	10/31/2025

Executive Summary

The Satellite Navigation Office (AJM-32) has tasked the Satellite Navigation Branch (ANG-E66) at the William J. Hughes Technical Center to document the GPS Standard Positioning Service (SPS) performance in quarterly GPS SPS Performance Analysis (PAN) Reports. The reports contain the analysis performed on data collected at 28 Wide Area Augmentation System (WAAS) Reference Stations. This analysis verifies the GPS SPS performance as compared to the performance parameters stated in the GPS SPS Performance Standard (5^{th} Edition, dated April 2020).

This GPS SPS Performance Analysis Report #131 includes data collected from July 1 through September 30, 2025 reporting period. The next quarterly report will be issued January 31, 2026.

Analysis of this data represents the standards specified in the GPS SPS Standard and have been categorized as: Position Dilution of Precision (PDOP) Availability, "Notice Advisory to Navstar Users" (NANU) Summary and Evaluation, Service Availability, Position and Range Accuracy, Solar Storms, International GNSS Service (IGS) Data Performance, and Receiver Autonomous Integrity Monitoring (RAIM) Performance.

PDOP Availability Standard. This global availability is based on PDOP. Using the weekly almanac posted on the U.S. Coast Guard navigation website, the coverage data for every 2° grid point between 180W to 180E and 74S and 74N was calculated for every minute over a 24-hour period for each of the weeks covered in the reporting period. For this reporting period, the global availability based on PDOP less than six for CONUS was 99.9995%.

NANU Summary and Evaluation. This evaluation was achieved by reviewing the NANU reports issued between July 1 and September 30, 2025. Using this data, a set of statistics were computed that give a relative idea of constellation health for both the current and combined history of past quarters. For this quarter, seven outages were reported in the NANUs. Five outages were scheduled ahead of time, and two unscheduled NANUs occurred.

Service Availability Standard. The quarterly service availability standard was verified using 24-hour position accuracy values computed from data collected at 1-second intervals. All the sites achieved a 100% availability, which exceeds the SPS "average location" value of 99% and the "worst-case location" value of 90%.

Accuracy Standard. Calculating the 24-hour 95% horizontal and vertical position error values verified the accuracy standards. The User Range Error standard was verified for each satellite from 24-hour accuracy values computed using data collected at the following six sites: Boston, Honolulu, Los Angeles, Miami, Merida, and Juneau. This data was also collected in 1-second samples. All sites achieved 100% reliability, meeting the SPS Standard. The maximum range error recorded was 29.200 meters on PRN8. The SPS Standard states that the range error should never exceed 30 meters for less than 99.79% of the day for a worst-case point and 99.94% globally. The maximum Root Mean Square (RMS) range error value of 2.120 meters was recorded on PRN7.

SPS Standard states that RMS User Range Error (URE) cannot exceed 6 meters in any 24-hour interval.

Solar Storms. Geomagnetic storms had little to no effect on GPS performance this quarter. All sites met all GPS SPS Standards on those days with the most significant solar activity.

IGS Data Performance. The IGS is a voluntary federation of many worldwide agencies that pool resources and permanent Global Navigation Satellite System (GNSS) station data to generate precise GNSS products. IGS data processing has not been completed, and it will be added to this report when available.

RAIM Performance. RAIM is a technology developed to assess the integrity of GPS signals in a GPS receiver system. During the evaluation period, the minimum percentage of time in RNP 0.1 mode was 99.947% at Minneapolis. The minimum percent of time spent in RNP 0.3 mode was 100% at all locations evaluated. The maximum 99% HPL value was 131.179 meters at Gander.

From the analysis performed on data collected between July 1 and September 30, 2025, the GPS performance met all SPS requirements that were evaluated.

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1. INTRODUCTION

1.1 Objective of GPS SPS Performance Analysis Report

In 1993, the FAA began monitoring and analyzing Global Positioning System (GPS) Standard Positioning Service (SPS) performance data. To ensure the safe and effective use of GPS and its augmentation systems within the NAS, it is critical that characteristics of GPS performance as well as specific causes for service outages be monitored and understood. To accomplish this objective, GPS SPS performance data is documented in a quarterly GPS Analysis report. This report contains data collected at the following 28 WAAS reference station locations:

- Bethel, AK
- Billings, MT
- Fairbanks, AK
- Cold Bay, AK
- Kotzebue, AK
- Juneau, AK
- Albuquerque, NM
- Anchorage, AK
- Boston, MA
- Washington, DC
- Honolulu, HI
- Houston, TX
- Kansas City, KS
- Los Angeles, CA
- Salt Lake City, UT
- Miami, FL
- Minneapolis, MI
- Oakland, CA
- Cleveland, OH
- Seattle, WA
- San Juan, PR
- Atlanta, GA
- Barrow, AK
- Merida, Mexico
- Gander, Canada
- Tapachula, Mexico
- San Jose Del Cabo, Mexico
- Iqaluit, Canada

The analysis of the data is divided to include the performance categories stated in the SPS Performance Standard (5th Edition, April 2020) as well as additional performance categories and are presented as follows:

1. PDOP Availability Standard
2. Service Availability Standard
3. Service Reliability Standard
4. Positioning, Ranging and Timing Accuracy Standard
5. Solar Storms
6. IGS Data
7. RAIM Performance
8. GPS Test NOTAMs Summary
9. GPS Broadcast Orbit vs. NGA Precise Orbits and URA (IAURA) Bounding Analysis

For the performance categories found in the SPS Performance Standard, the results of these analyses have been compared to the performance parameters stated in the SPS Performance Standard. Analyses of events that merit more detailed investigations are documented in the Discrepancy Reports (DRs). The DRs are available at http://www.nstb.tc.faa.gov under "WAAS Technical Reports."

1.2 Report Overview

Section 2 summarizes the results obtained from the coverage calculation program developed by the WAAS test team at the William J. Hughes Technical Center. The SPS coverage area program uses the GPS satellite almanacs to compute each satellite position as a function of time for a selected day of the week. This program establishes a 2-degree grid between 180-degrees east and 180-degrees west, and from 74-degrees north and 74-degrees south. The program then computes the PDOP at each grid point (13,500 total grid points) every minute for the entire day and stores the results. After the PDOP's have been saved, the 99.99% index of 1-minute PDOP at each grid point is determined and plotted as contour lines (see Figure 2-1). The program also saves the number of satellites used in PDOP calculation at each grid point for analysis.

Section 3 summarizes the GPS constellation performance using NANU messages to calculate the total time of forecasted and actual satellite outages. This section also evaluates the Service Availability Standard using 24-hour 95% horizontal and vertical position accuracy values.

Section 4 summarizes service reliability performance. Although the Standard calls for yearly evaluations, this SPS requirement will be reported at quarterly intervals.

Section 5 provides the position accuracies based on data collected daily at 1-second intervals. This section also provides statistics on the range error, range error rate, and range acceleration error for each satellite. The overall average, maximum, minimum and standard deviations of the range rates and accelerations are tabulated for each satellite.

Section 6 provides the data collected during solar storms, which is analyzed to determine the effects, if any, of GPS SPS performance.

Section 7 provides an analysis of GPS-SPS accuracy performance from a selection of high-rate IGS stations around the world.

Section 8 provides a summary of RAIM performance.

Section 9 provides the GPS broadcast orbit versus NGA precise orbits and URA (IAURA) bounding analyses.

Appendix A provides a summary of all the results as compared to the SPS Standard.

Appendix B provides the geomagnetic data used for Section 6.

Appendix C provides a glossary of terms used in this PAN report. This glossary was obtained directly from the GPS SPS Standard document (April 2020).

1.3 Summary of Performance Requirements and Metrics

Table 1-1 lists the performance parameters from the SPS for the L1 (1575.42 MHz) Coarse/Acquisition (C/A) signal and identifies those parameters verified in this report. The L2C (1227.60 MHz) and L5 (1176.45 MHz) signals are pre-operational, and their use is at the users' own risk. No commitment of signal availability for L2C or L5 will be made until the signals are declared fully operational by the DoD and available for users.

Table 1-1 SPS SIS Performance Requirements Standards Evaluated in This Report

Parameter	Conditions and Constraints
Per-Satellite Coverage Terrestrial Service Volume: 100% Coverage Space Service Volume: No Coverage Performance Specified	For any healthy or marginal SPS SIS.
Constellation Coverage Terrestrial Service Volume: 100% Coverage Space Service Volume: No Performance Specified	For any healthy or marginal SPS SIS.

Parameter	Conditions and Constraints
User Range Error Accuracy Single-Frequency C/A-Code • ≤7.0 m 95% Global Average URE during normal operations over All Age of Data (AOD) • ≤3.8 m 95% Global Average URE during operations at Zero AOD • ≤9.7 m 95% Global Average URE during normal operations at Any AOD	For any healthy or marginal SPS SIS. Neglecting single-frequency ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Including inter-signal bias (P(Y)-code to C/A-code) errors at L1. Including Inter-Signal Correction (ISC) errors.
User Range Error Accuracy Single-Frequency C/A-Code: • ≤30 m 99.94% Global Average URE during normal operations • ≤30 m 99.79% Worst Case single point average during normal operations	For any healthy or marginal SPS SIS. Neglecting single-frequency ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Including inter-signal bias (P(Y)-code to C/A-code) errors at L1. Including ISC errors. Standard based on measurement interval of one year; average of daily values within service volume. Standard based on 3 service failures per year, lasting no more than 6 hours each.
User Range Error Accuracy Single-Frequency C/A-Code: ≤388 m 95% Global Statistic URE during Extended Operations after 14 Days without Upload	For any healthy or marginal SPS SIS.

Parameter	Conditions and Constraints
User Range Error Accuracy Single-Frequency C/A-Code: ≤2.0 m 95% Global Statistic URE during Normal Operations over all AODs for the ensemble of constellation slots	Across all healthy or marginal SPS SIS from satellites occupying constellation slots. Neglecting SF ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Including inter-signal bias (P(Y)-code to C/A-code) errors at L1. Including ISC errors.
User Range Rate Error Accuracy Single-Frequency C/A Code: ≤6 mm/sec 95% Global Average URRE over any 3-second interval during normal operations at Any AOD	For any healthy SPS SIS. Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers. Neglecting single-frequency ionospheric delay model errors.
User Range Acceleration Error Accuracy Single-Frequency C/A Code: ≤2 mm/sec^2 95% Global Average URAE over any 3-second interval during normal operations at Any AOD	For any healthy SPS SIS. Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers. Neglecting single-frequency ionospheric delay model errors.
Coordinated Universal Time Offset Error Accuracy ≤30 nanoseconds 95% Global average UTCOE during normal operations at Any AOD	For any healthy SPS SIS.

Parameter	Conditions and Constraints
Instantaneous URE Integrity Single-Frequency C/A-Code: $\leq 1x10^{-5}$ Probability over any hour of the SPS SIS Instantaneous URE exceeding the NTE tolerance without a timely alert during normal operations	For any healthy SPS SIS. SPS SIS URE NTE tolerance defined to be ±4.42 times the upper bound on the URA value corresponding to the URA index "N" currently broadcast by the satellite. Given that the maximum SPS SIS instantaneous URE did not exceed the NTE tolerance at the start of the hour. UMSI occurs if no timely alert issued after SPS SIS URE NTE tolerance exceeded. Worst case for delayed alert is 6 hour. Neglecting single-frequency ionospheric delay model errors.
Instantaneous UTCOE Integrity Single-Frequency C/A-Code: $\leq 1x10^{-5}$ Probability over any hour of the SPS SIS Instantaneous UTCOE exceeding the NTE tolerance without a timely alert during normal operations	For any healthy SPS SIS. SPS SIS UTCOE NTE tolerance defined to be ±120 ns. Given that the maximum SPS SIS instantaneous URE did not exceed the NTE tolerance at the start of the hour. Worst case for delayed alert is 6 hours.
Unscheduled Failure Interruption Continuity Unscheduled Failure Interruptions: ≥0.9998 Probability over any hour of not losing the SPS SIS availability from a slot due to unscheduled interruption	Calculated as an average over all slots in the 24-slot constellation, normalized annually. Given that the SPS SIS is available from the slot at the start of the hour.
Status and Problem Reporting Scheduled event affecting service Appropriate NANU issued to the U.S. Coast Guard and the FAA at least 48 hours prior to the event for 95% of the events	For any SPS SIS.

Parameter	Conditions and Constraints
Status and Problem Reporting Unscheduled outage or problem affecting service Appropriate NANU issued to the Coast Guard and the FAA as soon as possible after the event	For any SPS SIS.
Per-Slot Availability ≥0.957 Probability that a slot in the baseline 24-slot configuration will be occupied by a satellite broadcasting a healthy SPS SIS ≥0.957 Probability that a slot in the expanded configuration will be occupied by a pair of satellites each broadcasting a healthy SPS SIS	Calculated as an average over all slots in the 24-slot constellation, normalized annually. Applies to satellites broadcasting a healthy SPS SIS that also satisfy the other performance standards in the SPS performance standard.
Constellation Availability ≥0.98 Probability that at least 21 slots out of the 24 will be occupied either by a satellite broadcasting a healthy SPS SIS in the baseline 24-slot configuration or by a pair of satellites each broadcasting a healthy SPS SIS in the expanded slot configuration ≥0.99999 Probability that at least 20 slots out of the 24 will be occupied either by a satellite broadcasting a healthy SPS SIS in the baseline 24-slot configuration or by a pair of satellites each broadcasting a healthy SPS SIS in the expanded slot configuration	Calculated as an average over all slots in the 24-slot constellation, normalized annually. Applied to satellites broadcasting a healthy SPS SIS that also satisfies the other performance standards in the SPS performance standard.

Parameter	Conditions and Constraints
Operational Satellite Count ≥0.95 Probability that the constellation will have at least 24 operational satellites regardless of whether those operational satellites are located in slots or not	Applies to the total number of operational satellites in the constellation (averaged over any day); where any satellite which appears in the transmitted navigation message almanac is defined to be an operational satellite regardless of whether that satellite is currently broadcasting a healthy SPS SIS or not and regardless of whether the broadcast SPS SIS also satisfies the other performance standards in the SPS performance standard or not.
PDOP Availability ≥98% global PDOP of 6 or less ≥88% worst site PDOP of 6 or less	Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
Service Availability ≥99% Horizontal Service Availability, average location ≥99% Vertical Service Availability, average location	15 m Horizontal (SIS only) 95% threshold. 33 m Vertical (SIS only) 95% threshold. Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
Service Availability ≥90% Horizontal Service Availability, worst-case location ≥90% Vertical Service Availability, worst-case location	15 m Horizontal (SIS only) 95% threshold. 33 m Vertical (SIS only) 95% threshold. Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
Position/Time Accuracy Global Average Position Domain Accuracy: • ≤8 m 95% Horizontal Error • ≤13 m 95 % Vertical Error	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.

Parameter	Conditions and Constraints
Position/Time Accuracy Worst Site Position Domain Accuracy: • ≤15 m 95% Horizontal Error • ≤33 m 95% Vertical Error	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.
Position/Time Accuracy Time Transfer Domain Accuracy: ≤30 nanoseconds time transfer error 95% of time (SIS only)	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.

2. PDOP AVAILABILITY STANDARD

PDOP Availability is defined as the percentage of time over any 24-hour interval that the PDOP value is less than or equal to its threshold for any point within the service volume. Dilution of Precision (DOP) is defined as the magnifying effect on GPS position error induced by mapping GPS range errors into position within the specified coordinate system through the geometry of the position solution. The DOP varies as a function of satellite positions relative to user position. The DOP may be represented in any user local coordinate desired. Examples are HDOP for local horizontal, VDOP for local vertical, PDOP for all three coordinates, and TDOP for time.

Table 2-1 shows the PDOP Availability Standard parameters.

Table 2-1 PDOP Availability Standard Parameters

PDOP Availability Standard	Conditions and Constraints
≥98% global PDOP of 6 or less ≥88% worst site PDOP of 6 or less	Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.

Almanacs for GPS weeks used for this coverage portion of the report were obtained from the U.S. Coast Guard web site (https://www.navcen.uscg.gov/). In addition, real-time broadcast satellite ephemeris and summary NANUs were utilized to incorporate satellite maintenance start and stop times. Using this data, an SPS coverage area program developed by the WAAS Test Team was used to calculate the PDOP at every 2-degree point between longitudes of 180W to 180E and 74S and 74N at 1-minute intervals. This gives 1440 samples for each of the 13,500 grid points in the coverage area. Table 2-2 provides the global averages and worst-case availability over a 24-hour period for each week. Table 2-2 also gives the global 99.9% PDOP value for each of the 13 GPS Weeks. The PDOP was 2.979 or better 99.9% of the time for each of the 24-hour intervals.

Figure 2-1 is a contour plot of PDOP values over the entire globe. Inside each contour area, the PDOP value is greater than or equal to the contour value shown in the legend for that color line. That area's value is also less than the next higher contour value, unless another contour line lies within the current area. A single "DOP hole" where the PDOP value is greater than 6 was evaluated for satellite visibility for one 24-hour interval from the week shaded in Table 2-2. The histogram in Figure 2-2 shows the satellite visibility at the DOP hole position for the 24-hour interval in question. The GPS coverage performance evaluated met the specifications stated in the SPS.

Table 2-2 PDOP Availability Statistics

Date Range of Week	Global 99.9% PDOP Value	Global Average Availability (Spec: ≥98%)	Worst-Case Point Availability (Spec: ≥88%)
06/29/2025–07/05/2025	2.7218	100	100
07/06/2025–07/12/2025	2.7559	100	100
07/13/2025–07/19/2025	2.7274	100	100
07/20/2025–07/26/2025	2.7292	100	100
07/27/2025–08/02/2025	2.7544	100	100
08/03/2025–08/09/2025	2.7883	100	100
08/10/2025–08/16/2025	2.8245	100	100
08/17/2025–08/23/2025	2.9788	99.9995	99.6031
08/24/2025–08/30/2025	2.8441	100	100
08/31/2025–09/06/2025	2.8748	99.9999	99.9801
09/07/2025–09/13/2025	2.85	100	100
09/14/2025–09/20/2025	2.8506	100	100
09/21/2025–09/27/2025	2.8513	100	100
09/28/2025–10/04/2025	2.8565	100	100

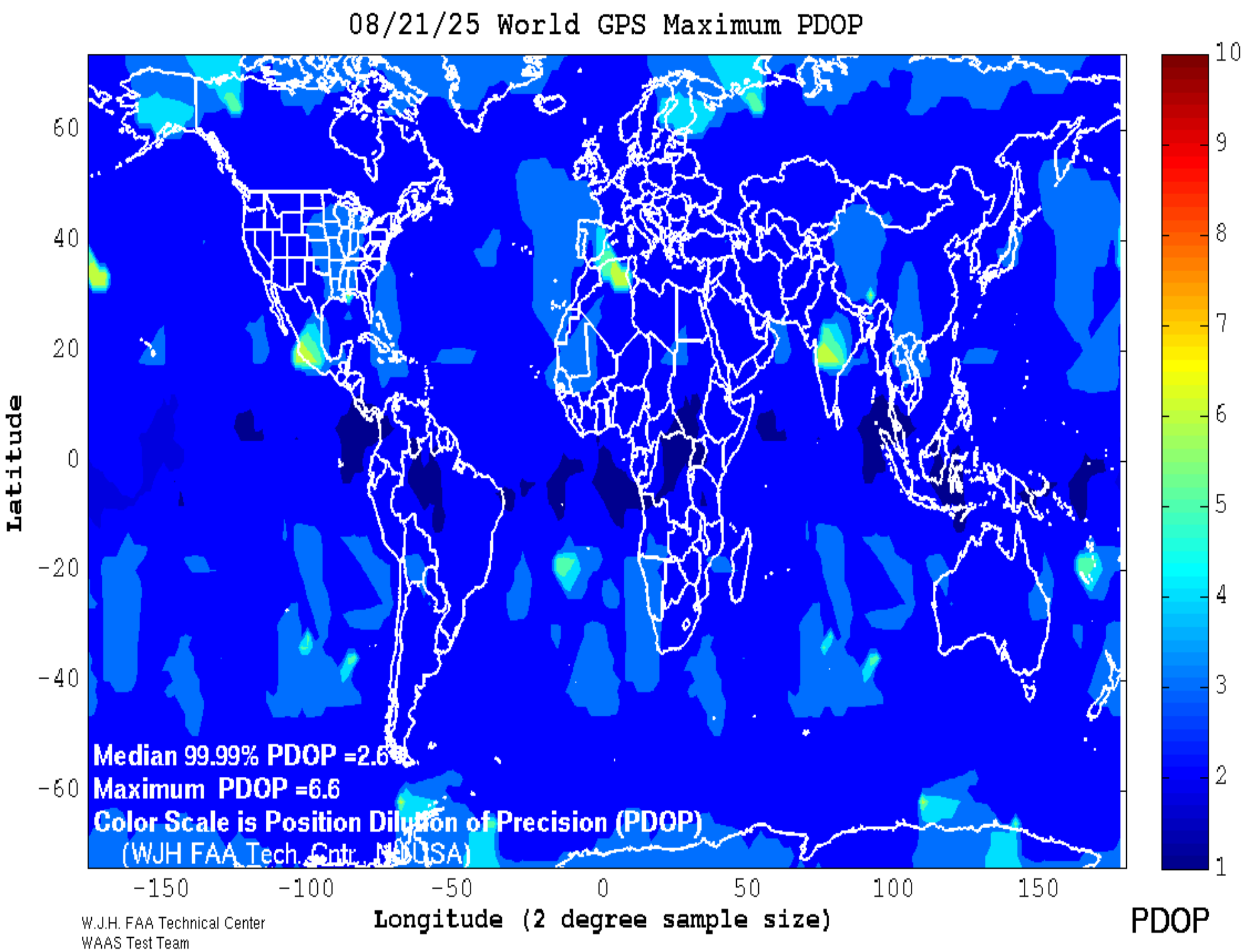

Figure 2-1 World GPS Maximum PDOP

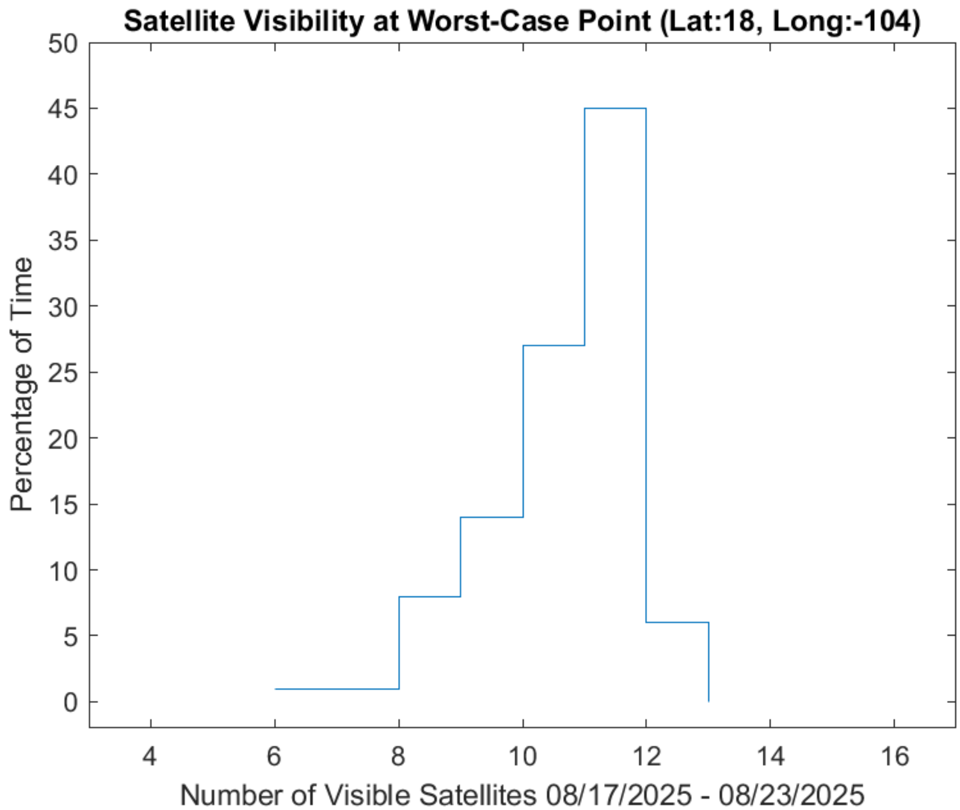

Figure 2-2 Satellite Visibility Profile for Worst-Case Point

3. NANU SUMMARY AND ELEVATION

A Notice Advisory to NAVSTAR Users (NANU) is a periodic bulletin alerting users to changes in the satellite system performance. Table 3-1 shows the parameters for issuing NANUs.

Table 3-1 Parameters for Issuing NANUs

Status and Problem Reporting	Conditions and Constraints
Scheduled event affecting service: Appropriate NANU issued to the U.S. Coast Guard and the FAA at least 48 hours prior to the event for 95% of the events	For any SPS SIS.
Unscheduled outage or problem affecting service: Appropriate NANU issued to the U.S. Coast Guard and the FAA as soon as possible after the event	For any SPS SIS.

3.1 Satellite Outages from NANU Reports

Satellite availability performance was analyzed based on published NANUs. During this reporting period, July 1 through September 30, 2025, there were seven reported outages. Five outages were maintenance activities and were reported in advance, and two were unscheduled outages. A complete list of outage NANUs for the reporting period is provided in Table 3-2. A complete list of the forecasted outage NANUs for the reporting period can be found in Table 3-3. Canceled outage NANUs (if any) are provided in Table 3-4. The minimum duration a scheduled outage was forecasted ahead of time was 4.6 hours. The maximum response time following an unscheduled outage was 0.467 hours. Therefore, the probability of continuity not being affected due to an unscheduled failure interruption was 100%, which met the specification requirement for the 24-slot GPS constellation. A complete list of the GPS constellation plane and slot designations is provided in Table 9-2. Figure 9-6 shows a graphical representation of the September 30, 2025 GPS constellation.

Table 3-2 NANUs Affecting Satellite Availability

NANU	PRN	TYPE	Start Date	Start Time (UTC)	End Date	End Time (UTC)	Total Unscheduled (hours)	Total Scheduled (hours)	Total (hours)
2025048	20	FCSTSUMM	July 03, 2025	19:44	July 04, 2025	01:38	0	5.9	5.9
2025050	27	FCSTSUMM	July 10, 2025	04:24	July 10, 2025	09:16	0	4.87	4.87
2025052	17	UNUSABLE	July 11, 2025	11:20	July 11, 2025	16:54	5.57	0	5.57
2025054	14	FCSTSUMM	July 31, 2025	08:30	July 31, 2025	13:22	0	4.87	4.87
2025058	4	UNUSABLE	August 16, 2025	10:59	August 22, 2025	19:18	152.32	0	152.32
2025065	1	FCSTSUMM	September 03, 2025	19:40	September 04, 2025	03:04	0	7.4	7.4
2025066	16	FCSTSUMM	September 04, 2025	21:29	September 05, 2025	03:15	0	5.77	5.77
Totals of Unscheduled, Scheduled, and Total Downtime							157.89	28.81	186.7

Table 3-3 NANUs Forecasted to Affect Satellite Availability

NANU	PRN	TYPE	Start Date	Start Time (UTC)	End Date	End Time (UTC)	Total (hours)	Comments
2025047	20	FCSTDV	Jul 03, 2025	19:15	Jul 04, 2025	07:15	12	2025048
2025049	27	FCSTDV	Jul 10, 2025	04:15	Jul 10, 2025	16:15	12	2025050
2025051	17	UNUSUFN	Jul 11, 2025	11:20				2025052
2025053	14	FCSTDV	Jul 31, 2025	08:00	Jul 31, 2025	20:00	12	2025054
2025057	4	UNUSUFN	Aug 16, 2025	10:59				2025058
2025059	1	FCSTDV	Aug 27, 2025	19:45	Aug 28, 2025	07:45	0	2025060
2025061	1	FCSTDV	Sep 02, 2025	19:30	Sep 03, 2025	07:30	0	2025063
2025062	16	FCSTDV	Sep 04, 2025	21:00	Sep 05, 2025	09:00	12	2025066
2025064	1	FCSTDV	Sep 03, 2025	19:30	Sep 04, 2025	07:30	12	2025065
Total Forecasted Downtime							60	

Table 3-4 Canceled NANUs

NANU	PRN	TYPE	Start Date	Start Time (UTC)	Comments
2025060	1	FCSTCANC	Aug 27, 2025	19:45	2025059
2025063	1	FCSTCANC	Sep 02, 2025	19:30	2025061

Table 3-5 GPS Satellite Maintenance Statistics

Satellite Reliability/Maintainability/Availability (RMA) Parameter	07/01/2025 to 09/30/2025	01/01/2000 to 09/30/2025
Total Forecasted Downtime (hrs)	60	17587.99
Total Actual Downtime (hrs)	186.7	46086.46

Satellite Reliability/Maintainability/Availability (RMA) Parameter	07/01/2025 to 09/30/2025	01/01/2000 to 09/30/2025
Total Actual Scheduled Downtime (hrs)	28.81	9847.3
Total Actual Unscheduled Downtime(hrs)	157.89	36239.16
Total Satellite Observed MTTR (hrs)	26.67	35.62
Scheduled Satellite Observed (hrs)	5.76	10.13
Unscheduled Satellite Observed (hrs)	78.94	112.54
Total Satellite Outages (number)	7	1294
Scheduled Satellite Outages (number)	5	972
Unscheduled Satellite Outages (number)	2	322
Percent Operational—Scheduled Downtime (%)	99.96	99.86
Percent Operational—All Downtime (%)	99.73	99.34

Satellite Reliability, Maintainability, and Availability (RMA) data is collected based on published NANUs. This data has been summarized in Table 3-5. The "Total Satellite Observed MTTR" was calculated by taking the average downtime of all satellite outage occurrences. Scheduled downtime was forecasted in advance via NANUs. All other downtime reported via NANU was considered unscheduled. The Percent Operational was calculated based on the ratio of total actual operating hours to total available operating hours for every satellite.

3.2 Service Availability Standard

Service Availability is the percentage of time over any 24-hour interval that the predicted 95% position error is less than the threshold at any given point within the service volume. Horizontal Service Availability and Vertical Service Availability are the percentage of time over any 24-hour interval that the predicted 95% horizontal error or vertical error is less than its threshold for any point within the service volume, respectively. Table 3-6 shows the Service Availability Standard.

Table 3-6 Service Availability Standard

Service Availability Standard	Conditions and Constraints
≥99% Horizontal Service Availability, average location ≥99% Vertical Service Availability, average location	15 m Horizontal (SIS only) 95% threshold. 33 m Vertical (SIS only) 95% threshold. Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
≥90% Horizontal Service Availability, worst-case location	15 m Horizontal (SIS only) 95% threshold. 33 m Vertical (SIS only) 95% threshold.

Service Availability Standard	Conditions and Constraints
≥90% Vertical Service Availability, worst-case location	Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.

To verify availability, the data collected from receivers at the 28 WAAS sites was reduced to calculate 24-hour accuracy information and reported in Table 3-7. The data was collected at 1-second intervals between July 1 and September 30, 2025.

Table 3-7 Accuracies Exceeding Threshold Statistics

Site	Total Number of Seconds of SPS Monitoring	Instances of 24-hour Threshold Failures	July 2025–September 2025 Service Availability (%)
Albuquerque	7935502	0	100
Anchorage	7935433	0	100
Atlanta	7935537	0	100
Barrow	7298827	0	100
Bethel	7935604	0	100
Billings	7932877	0	100
Boston	7936115	0	100
Cleveland	7936064	0	100
Cold Bay	7934261	0	100
Fairbanks	7935029	0	100
Gander	7935506	0	100
Honolulu	7935550	0	100
Houston	7925985	0	100
Iqaluit	7808420	0	100
Juneau	7935432	0	100
Kansas City	7935532	0	100
Kotzebue	7933534	0	100
Los Angeles	6961071	0	100
Merida	7690597	0	100
Miami	7924901	0	100
Minneapolis	7936139	0	100

Site	Total Number of Seconds of SPS Monitoring	Instances of 24-hour Threshold Failures	July 2025–September 2025 Service Availability (%)
Oakland	7933639	0	100
Salt Lake City	7935475	0	100
San Jose Del Cabo	7693896	0	100
San Juan	7935533	0	100
Seattle	7935980	0	100
Washington, DC	7929289	0	100

4. SERVICE RELIABILITY STANDARD

Service Reliability is the percentage of time over a specific time interval that the instantaneous SIS SPS URE is maintained within a specified reliability threshold at any given point within the service volume, for all healthy GPS satellites. Table 4-1 shows the User Range Error Accuracy parameters.

Table 4-1 User Range Error Accuracy Parameters

User Range Error Accuracy	Conditions and Constraints
Single Frequency C/A-Code: • ≤30 m 99.94% Global Average URE during normal operations • ≤30 m 99.79% Worst-Case single point average during normal operations	For any healthy SPS SIS. Neglecting single-frequency ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Including inter-signal bias (P(Y)-code to C/A-code) errors at L1. Standard based on measurement interval of one year; average of daily values within service volume. Standard based on 3 service failures per year, lasting no more than 6 hours each.

Table 4-2 shows a comparison to the service reliability standard for range data collected at a set of six receivers across North America. Although the specification calls for yearly evaluations, we will be evaluating this SPS requirement at quarterly intervals. Additional range analysis results can be found in Table 5-3. The maximum User Range Error recorded this quarter was 29.200 meters on satellite PRN8.

Table 4-2 User Range Error Accuracy

Date Range of Data Collection	Site	Number of Samples This Quarter	Number of Samples Where SPS URE >30 m NTE	Percentage (%)
July 1–September 30, 2025	Boston	67913275	0	100
July 1–September 30, 2025	Honolulu	70307999	0	100
July 1–September 30, 2025	Juneau	71026639	0	100
July 1–September 30, 2025	Los Angeles	61243281	0	100
July 1–July 22, 2025	Merida	63524	0	100
July 1–September 30, 2025	Miami	69000044	0	100
July 1–September 30, 2025	Global	339554762	0	100

5. ACCURACY STANDARD

Positioning Accuracy is the statistical difference, at a 95% probability, between position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval. Horizontal Positioning Accuracy and Vertical Positioning Accuracy are the statistical difference, at a 95% probability, between horizontal or vertical position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval, respectively.

Table 5-1 shows the Accuracy Standard parameters.

Table 5-1 Accuracy Standard Parameters

Position/Time Accuracy	Conditions and Constraints
Position/Time Accuracy Global Average Position Domain Accuracy: • ≤8 m 95% Horizontal Error • ≤13 m 95 % Vertical Error	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.
Position/Time Accuracy Worst Site Position Domain Accuracy: • ≤15 m 95% Horizontal Error • ≤33 m 95% Vertical Error	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.

Position/Time Accuracy	Conditions and Constraints
Position/Time Accuracy Time Transfer Domain Accuracy: ≤30 nanoseconds time transfer error 95% of time (SIS only)	Defined for a time transfer solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.
User Range Error Accuracy Single-Frequency C/A-Code • ≤7.0 m 95% Global Average URE during normal operations over All AODs • ≤3.8 m 95% Global Average URE during operations at Zero AOD • ≤9.7 m 95% Global Average URE during normal operations at Any AOD	For any healthy SPS SIS. Neglecting single-frequency ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Including inter-signal bias (P(Y)-code to C/A-code) errors at L1. Including Inter-Signal Correction (ISC) errors.
User Range Rate Error Accuracy Single-Frequency C/A Code: ≤6 mm/sec 95% Global Average URRE over any 3-second interval during normal operations at Any AOD	For any healthy SPS SIS. Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers. Neglecting single-frequency ionospheric delay model errors.
User Range Acceleration Error Accuracy Single-Frequency C/A Code: ≤2 mm/sec^2 95% Global Average URAE over any 3-second interval during normal operations at Any AOD	For any healthy SPS SIS. Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers. Neglecting single-frequency ionospheric delay model errors.
Coordinated Universal Time Offset Error Accuracy ≤30 nanoseconds 95% Global average UTCOE during normal operations at Any AOD	For any healthy SPS SIS.

5.1 Position Accuracy

The data used for this section was collected for every second from July 1 through September 30, 2025 at the selected WAAS locations. Table 5-2 provides the 95% and 99.99% horizontal and vertical error accuracies for the quarter. Every 24-hour analysis period this quarter passed both the worst-case and global average position accuracy requirements set forth by the SPS specification.

Table 5-2 Horizontal and Vertical Accuracy Statistics for the Quarter

Site	95% Vertical (m)	95% Horizontal (m)	99.99% Vertical (m)	99.99% Horizontal (m)
Albuquerque	3.30	2.88	10.1	5.22
Anchorage	3.34	2.75	11.84	5.94
Atlanta	3.27	2.56	8.95	6.26
Barrow	3.62	2.98	12.15	5.60
Bethel	4.07	2.67	11.96	5.90
Billings	3.14	1.68	9.88	4.96
Boston	3.10	1.99	10.89	4.91
Cleveland	3.09	1.76	9.43	4.48
Cold Bay	4.06	1.91	11.79	4.41
Fairbanks	3.15	3.06	10.98	5.99
Gander	2.65	2.41	9.06	8.63
Honolulu	5.24	7.93	11.86	17.77
Houston	3.48	3.38	9.39	6.43
Juneau	3.07	2.62	10.39	4.86
Kansas City	3.16	1.99	10.41	6.56
Kotzebue	3.60	3.19	12.37	5.86
Los Angeles	3.89	3.46	11.1	6.68
Merida	5.88	4.73	16.53	9.94
Miami	4.37	3.68	11.59	7.99
Minneapolis	3.17	1.64	11.25	6.17
Oakland	4.38	3.12	10.79	5.88
Salt Lake City	3.51	2.10	9.79	5.97
San Jose Del Cabo	5.25	5.60	13.87	14.01
San Juan	6.70	4.07	19.75	15.83
Seattle	3.67	1.7	9.80	4.13
Washington, DC	3.19	1.98	9.40	4.27

Figure 5-1 and Figure 5-2 are the combined histograms of the vertical and horizontal errors for all 28 WAAS sites from July 1 to September 30, 2025.

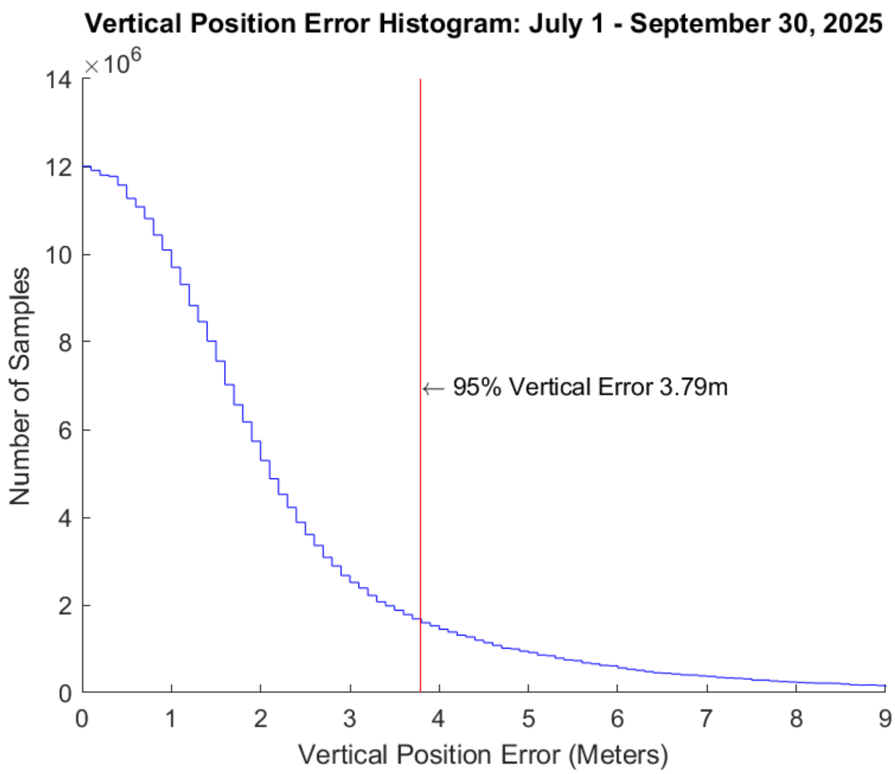

Figure 5-1 Global Vertical Error Histogram

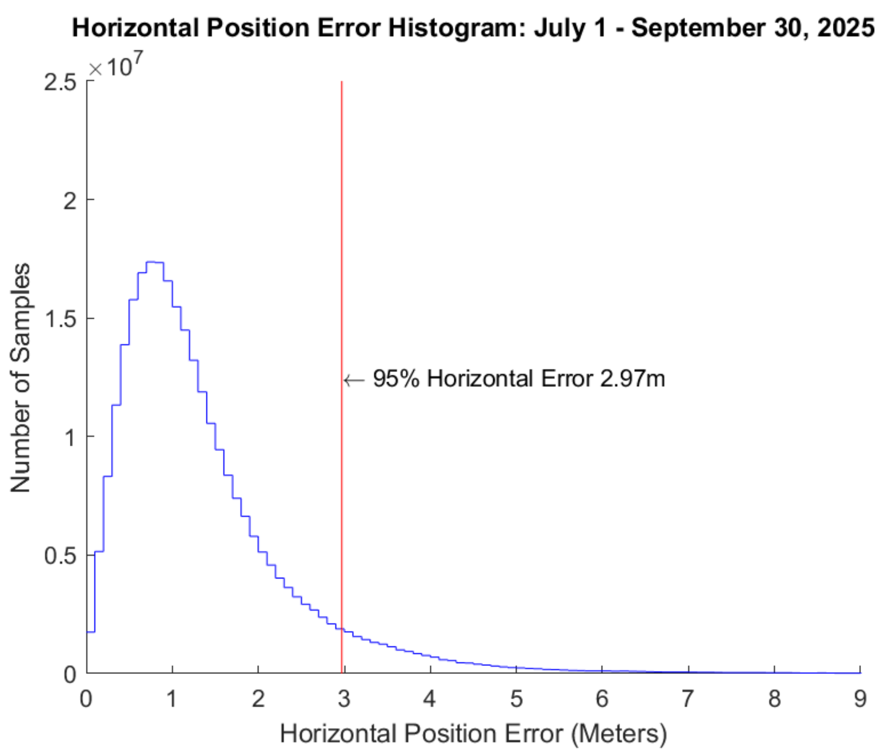

Figure 5-2 Global Horizontal Error Histogram

5.2 Time Transfer Accuracy

The GPS time error data between July 1 and September 30, 2025 was not available from the USNO website at the time of publication. After USNO provides this information, the FAA will publish a modified report. The USNO data file contains the time difference between the USNO master clock and GPS system time for each GPS satellite during the time period. Over 10,000 samples of GPS time error are contained in the USNO data file. To evaluate the GPS time transfer error, the data file was used to create a histogram (Figure 5-3) to represent the distribution of GPS time error. The histogram is created by taking the absolute value of time difference between the USNO master clock and GPS system time, then creating data bins with 1 nanosecond precision. The number of samples in each bin is then plotted to form the histogram in Figure 5-3. The maximum instantaneous UTC offset error (UTCOE) for the quarter will be processed when data is available. The mean, standard deviation, and 95% index of Time Transfer Error, and the maximum UTCOE are all expected to be within the requirements of GPS SPS time error.

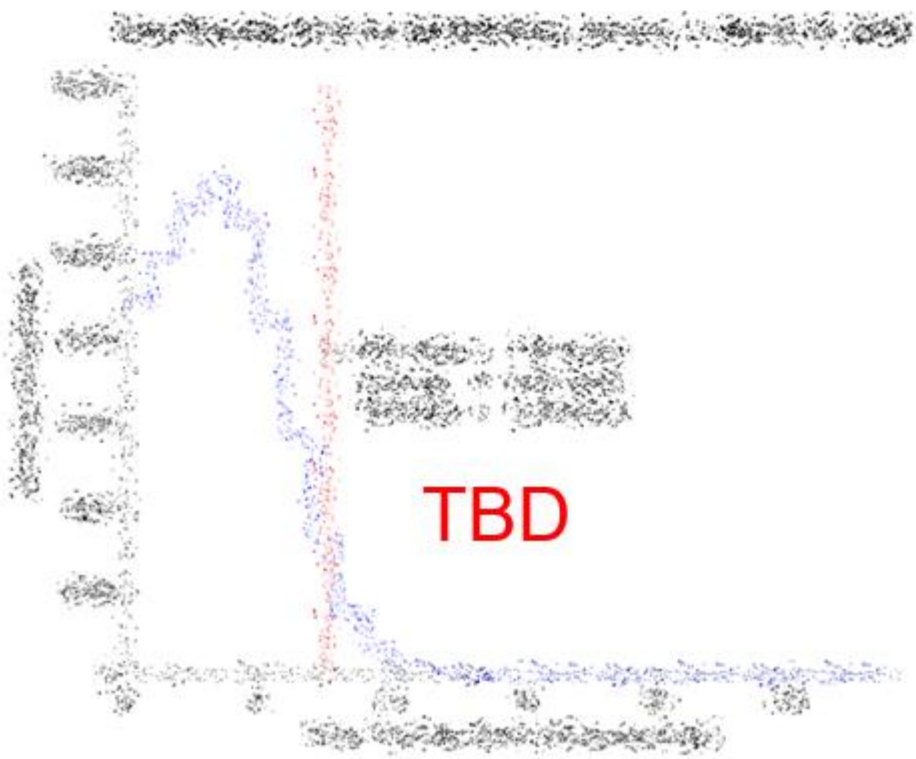

Figure 5-3 Time Transfer Error

5.3 Range Domain Accuracy

Table 5-3 through Table 5-5 provide the statistical data for the range error, range rate error, and the range acceleration error for each satellite. This data was collected between July 1 and September 30, 2025. A weighted average filter was used for the calculation of the range rate error and the range acceleration error. All Range Domain SPS specifications were met.

Table 5-3 Range Error Statistics

PRN	RMS Range Error (<6 m) (m)	Range Error Mean (m)	1σ Range Error (m)	95% Range Error (m)	Max Range Error (SPS Spec. <30 m) (m)	Samples (Number)
1	1.70	-0.48	1.46	3.30	15.47	10936151
2	1.72	0.4	1.49	3.36	16.37	11613249
3	1.93	-0.51	1.67	3.68	16.09	11557875
4	1.94	-0.46	1.57	3.58	11.72	9900827
5	1.88	0.18	1.7	3.68	21.24	11199754
6	1.91	-0.41	1.75	3.74	20.92	11346657
7	2.12	-0.58	1.57	3.84	13.86	10199604
8	1.69	0.28	1.45	3.2	29.2	10370616
9	1.88	-0.4	1.58	3.5	15.02	11360828
10	1.56	-0.09	1.22	2.93	20.34	10385535
11	1.88	0.24	1.73	3.9	26.53	11461238
12	1.8	0.05	1.64	3.74	28.46	11354592
13	2.08	-0.17	1.8	3.96	24.25	10667658
14	2.07	-0.34	1.73	3.75	19.41	10235905
15	1.89	-0.21	1.6	3.68	22.98	10155434
16	1.81	0.49	1.53	3.52	19.69	10641795
17	1.89	0.05	1.68	3.65	19.06	11605647
18	1.7	0.03	1.48	3.4	25.6	10230307
19	2.12	0.95	1.68	4.02	20.36	11291019

PRN	RMS Range Error (<6 m) (m)	Range Error Mean (m)	1σ Range Error (m)	95% Range Error (m)	Max Range Error (SPS Spec. <30 m) (m)	Samples (Number)
20	1.76	0.74	1.35	3.16	11.14	3938878
21	1.81	-0.21	1.63	3.47	23.37	10434301
22	2.05	0.27	1.67	3.66	17.96	10386196
23	1.54	-0.07	1.25	3.06	21.37	10412545
24	1.96	-0.55	1.71	3.67	21.77	10712808
25	1.67	0.2	1.49	3.19	19.04	11084215
26	1.67	0.23	1.43	3.28	15.05	10441663
27	1.7	0.21	1.52	3.31	21.34	10343103
28	1.78	-0.03	1.55	3.38	14.07	11352780
29	1.68	0.39	1.44	3.5	24.69	10457591
30	1.92	-0.38	1.49	3.45	13.03	10571428
31	1.84	0.07	1.6	3.49	14.38	11371474
32	1.74	-0.21	1.47	3.37	27.31	11533089

Table 5-4 Range Rate Error Statistics

PRN	Range Rate Error RMS (mm/s)	95% Range Rate Error (mm/s)	Max Range Rate Error (mm/s)	Samples (Number)
1	2.22	4.33	91.09	10936151
2	2.25	4.37	96.99	11613249
3	2.34	4.44	105.74	11557875
4	2.11	4.07	94.18	9900827
5	2.5	4.89	80.07	11199754
6	2.3	4.47	115.9	11346657
7	2.3	4.44	126.35	10199604
8	2.06	3.99	104.08	10370616
9	2.27	4.43	118.64	11360828
10	2.15	4.2	56.87	10385535
11	2.37	4.62	150.93	11461238
12	2.39	4.69	66.48	11354592
13	2.36	4.54	147.87	10667658
14	2.24	4.33	111.0	10235905
15	2.28	4.44	75.33	10155434
16	2.25	4.31	119.68	10641795
17	2.43	4.77	59.42	11605647
18	2.14	4.12	162.65	10230307
19	2.41	4.7	134.64	11291019
20	2.26	4.4	70.96	3938878
21	2.21	4.28	109.22	10434301
22	2.32	4.49	90.79	10386196
23	2.25	4.34	256.63	10412545
24	2.21	4.3	54.95	10712808
25	2.27	4.44	68.87	11084215
26	2.09	4.03	120.88	10441663
27	2.0	3.86	83.89	10343103
28	2.18	4.22	110.17	11352780
29	2.18	4.28	88.67	10457591
30	2.1	4.03	139.36	10571428
31	2.29	4.43	159.72	11371474
32	2.28	4.47	76.36	11533089

Table 5-5 Range Acceleration Error Statistics

PRN	Rate Acceleration Error RMS (um/s^2)	95% Range Acceleration Error (um/s^2)	Max Range Acceleration Error (um/s^2)	Samples (Number)
1	17.91	34.58	900	10936151
2	18.67	36.75	960	11613249
3	18.94	35.38	1070	11557875
4	16.8	31.96	940	9900827
5	20.62	39.28	810	11199754
6	18.15	35.41	1180	11346657
7	18.52	36.38	1260	10199604
8	16.58	32.88	1050	10370616
9	17.66	34.53	1150	11360828
10	17.86	34.1	570	10385535
11	19.1	36.29	1520	11461238
12	19.15	37.67	590	11354592
13	19.37	36.47	1390	10667658
14	18.12	34.87	1100	10235905
15	19.17	36.46	730	10155434
16	18.75	36.39	1200	10641795
17	19.45	38.22	630	11605647
18	17.1	32.74	1470	10230307
19	19.56	38.3	1320	11291019
20	19.83	37.84	660	3938878
21	17.49	34.09	1100	10434301
22	19.13	37.43	900	10386196
23	18.63	35.9	2280	10412545
24	17.65	34.62	550	10712808
25	18.35	36.05	740	11084215
26	17.09	33.28	1220	10441663
27	16.39	31.7	850	10343103
28	17.69	34.53	1120	11352780
29	17.64	34.5	880	10457591
30	16.27	31.88	1400	10571428
31	19.01	37.42	1610	11371474
32	18.72	35.79	740	11533089

Figure 5-4 through Figure 5-6 are graphical representations of the distributions of the maximum range error, range rate error, and range acceleration error for all satellites. As shown in Table 5-3, the highest maximum range error occurred on satellite PRN8 with an error of 29.20 meters. Satellite PRN20 had the lowest maximum range error of 11.14 meters. Figure 5-7 is histogram of satellite range error for all satellites over the entire quarter. Figure 5-8 through Figure 5-10 show the individual maximums per satellite for range error, range rate error, and range acceleration error, respectively.

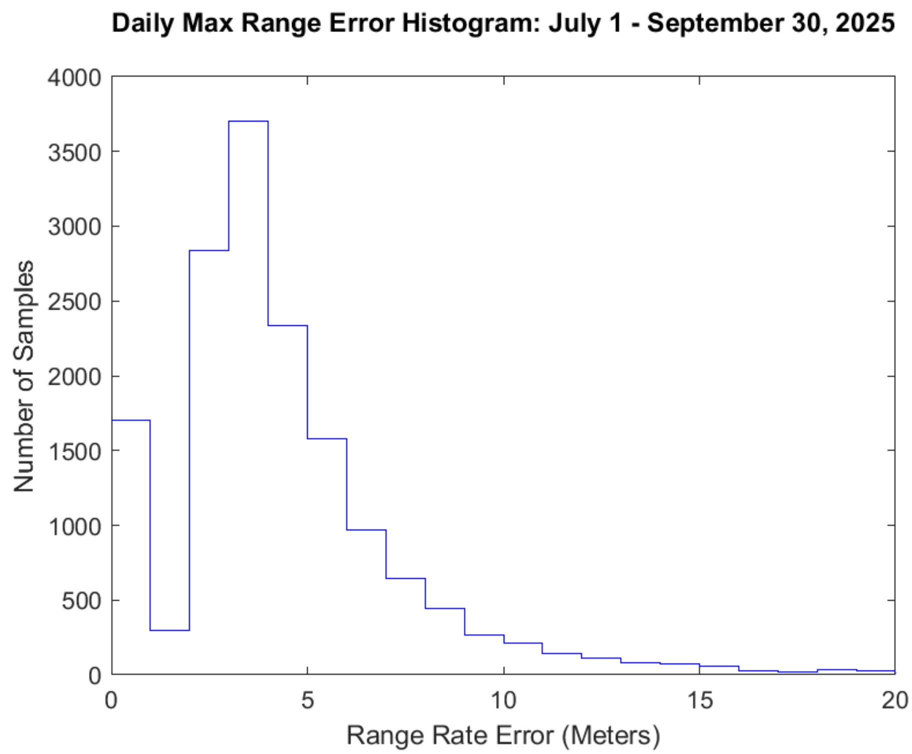

Figure 5-4 Distribution of Daily Max Range Errors

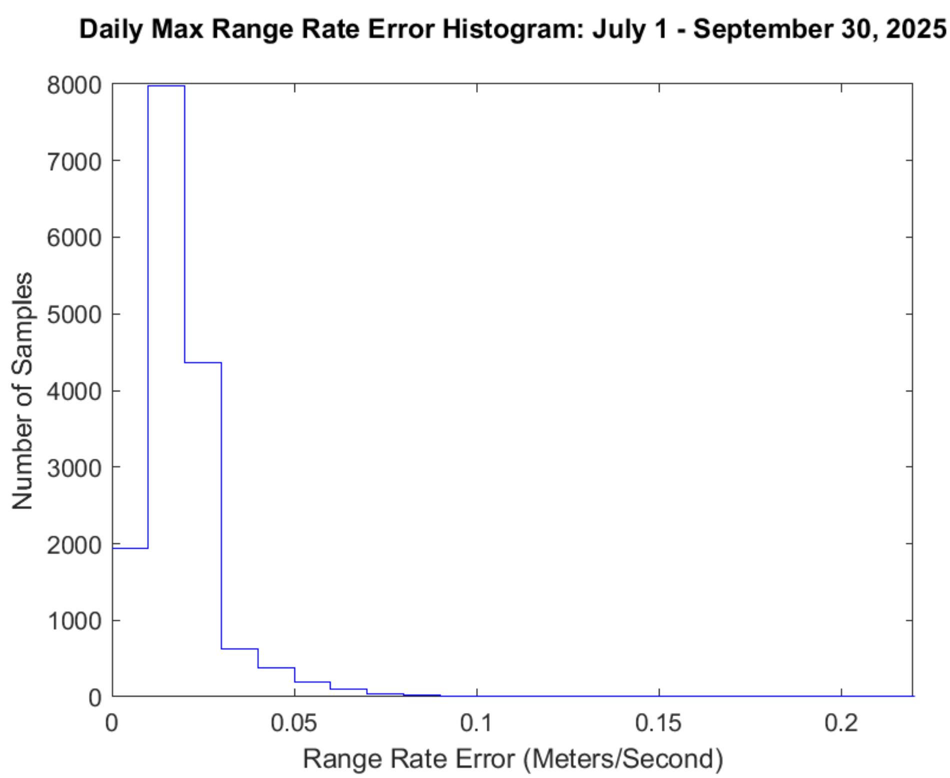

Figure 5-5 Distribution of Daily Max Range Rate Errors

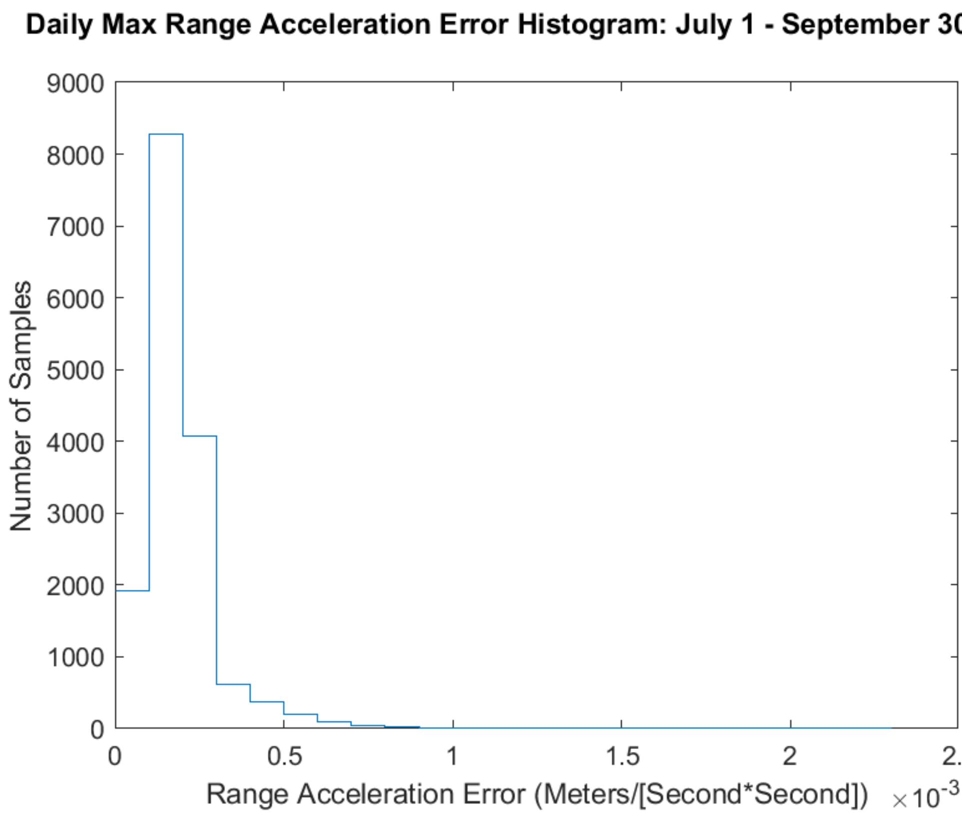

Figure 5-6 Distribution of Daily Max Range Acceleration Errors

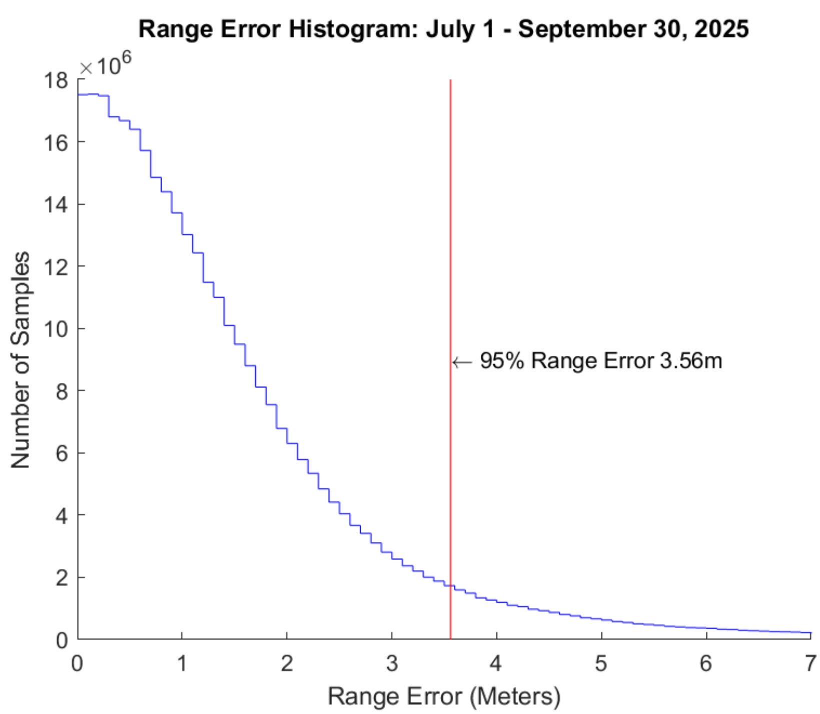

Figure 5-7 Range Error Histogram

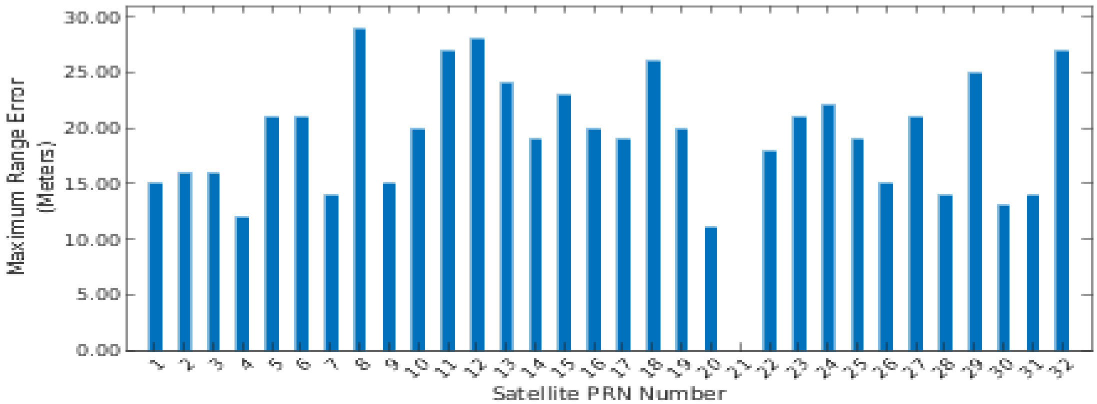

Figure 5-8 Maximum Range Error Per Satellite

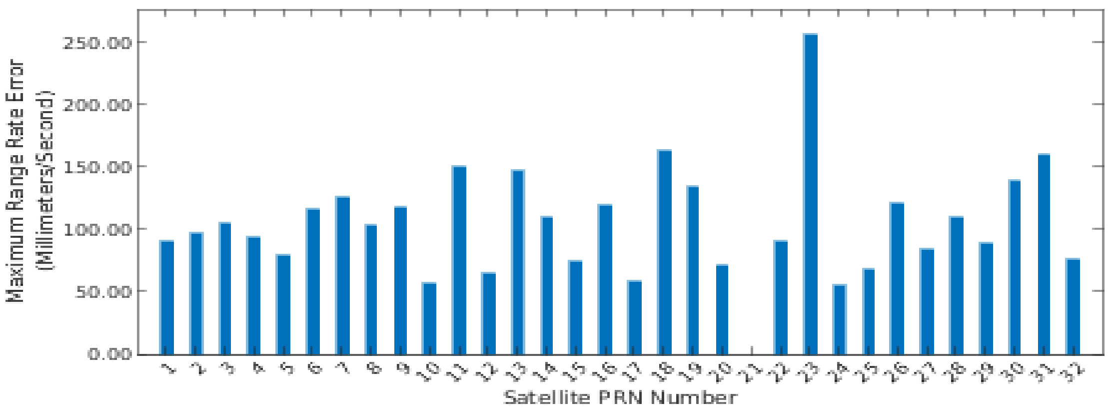

Figure 5-9 Maximum Range Rate Error Per Satellite

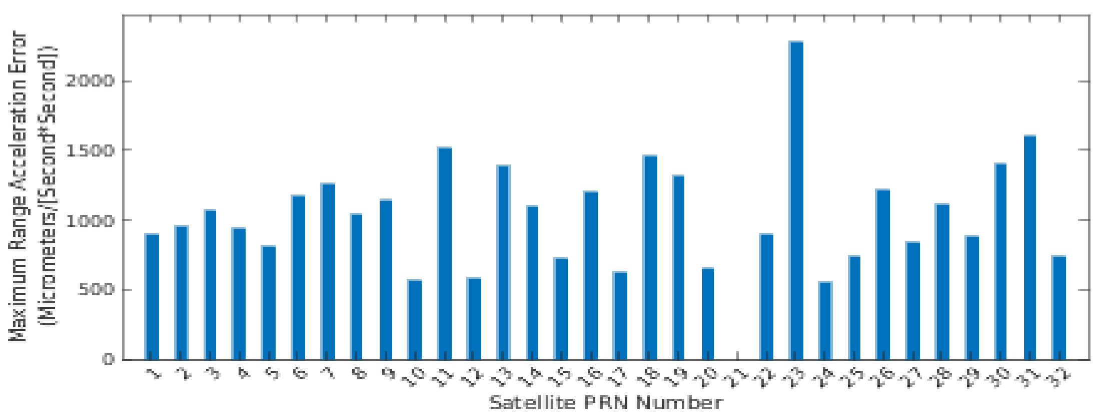

Figure 5-10 Maximum Range Acceleration Error Per Satellite

6. SOLAR STORMS

Solar storm activity is being monitored to assess the possible impact on GPS SPS performance. Solar activity is reported by the Space Weather Prediction Center (SWPC), a division of the National Oceanic and Atmospheric Administration (NOAA). When storm activity is indicated, ionospheric delays of the GPS signal, satellite outages, position accuracy and availability will be analyzed.

The following article was taken from the SEC website http://swpc.noaa.gov. It briefly explains some of the ideas behind the association of the aurora with geomagnetic activity and a bit about how the ‘K-index’ or ‘K-factor’ works.

The aurora is caused by the interaction of high-energy particles (usually electrons) with neutral atoms in the earth's upper atmosphere. These high-energy particles can ‘excite’ (by collisions) valence electrons that are bound to the neutral atom. The ‘excited’ electron can then ‘de-excite’ and return back to its initial, lower energy state, but in the process it releases a photon (a light particle). The combined effect of many photons being released from many atoms results in the aurora display that you see.

The details of how high energy particles are generated during geomagnetic storms constitute an entire discipline of space science in its own right. The basic idea, however, is that the Earth’s magnetic field (let us say the ‘geomagnetic field’) is responding to an outwardly propagating disturbance from the Sun. As the geomagnetic field adjusts to this disturbance, various components of the Earth’s field change form, releasing magnetic energy and thereby accelerating charged particles to high energies. These particles, being charged, are forced to stream along the geomagnetic field lines. Some end up in the upper part of the earth’s neutral atmosphere and the auroral mechanism begins.

An instrument called a magnetometer may also measure the disturbance of the geomagnetic field. At NOAA’s operations center magnetometer data is received from dozens of observatories in one-minute intervals. The data is received at or near to ‘real-time’ and allows NOAA to keep track of the current state of the geomagnetic conditions. In order to reduce the amount of data NOAA converts the magnetometer data into three-hourly indices, which give a quantitative, but less detailed measure of the level of geomagnetic activity. The K-index scale has a range from 0 to 9 and is directly related to the maximum amount of fluctuation (relative to a quiet day) in the geomagnetic field over a three-hour interval.

The K-index is therefore updated every three hours. The K-index is also necessarily tied to a specific geomagnetic observatory. For locations where there are no observatories, one can only estimate what the local K-index would be by looking at data from the nearest observatory, but this would be subject to some errors from time to time because geomagnetic activity is not always spatially homogenous.

Another item of interest is that the location of the aurora usually changes geomagnetic latitude as the intensity of the geomagnetic storm changes. The location of the aurora often takes on an ‘oval-like’ shape and is appropriately called the auroral oval.

Figure 6-1 through Figure 6-3 show the K-index for three time periods with significant solar activity. Although there were other days with increased solar activity, these time periods were selected as examples. (See Appendix B for the actual geomagnetic data for this reporting period).

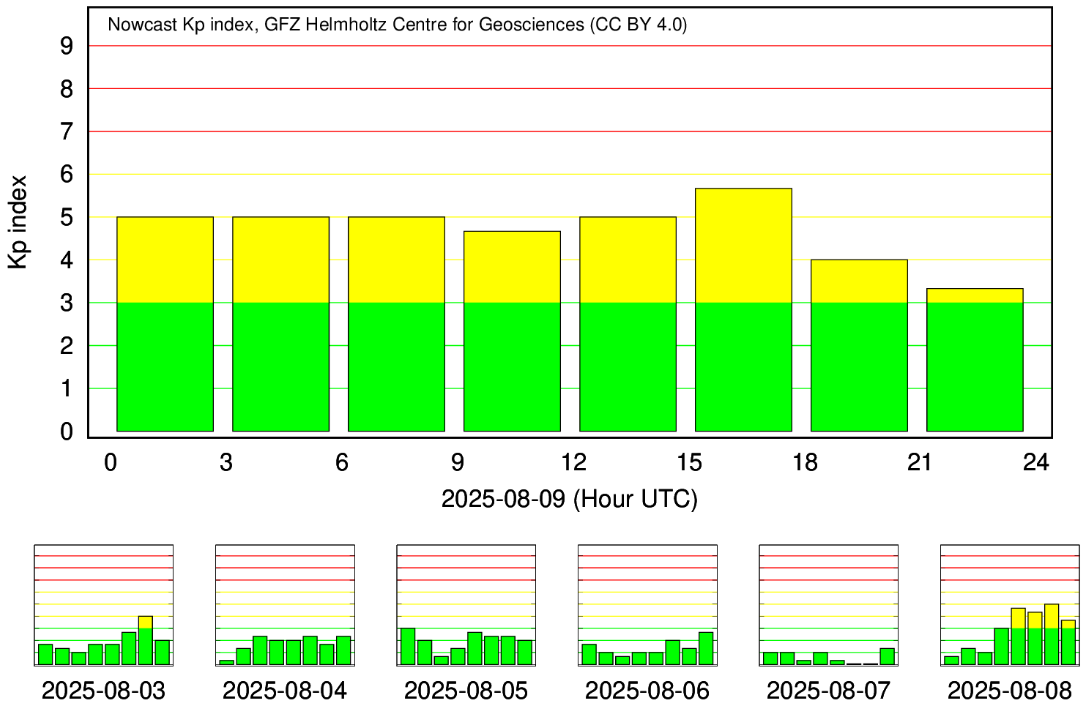

Figure 6-1 K-Index for August 9, 2025

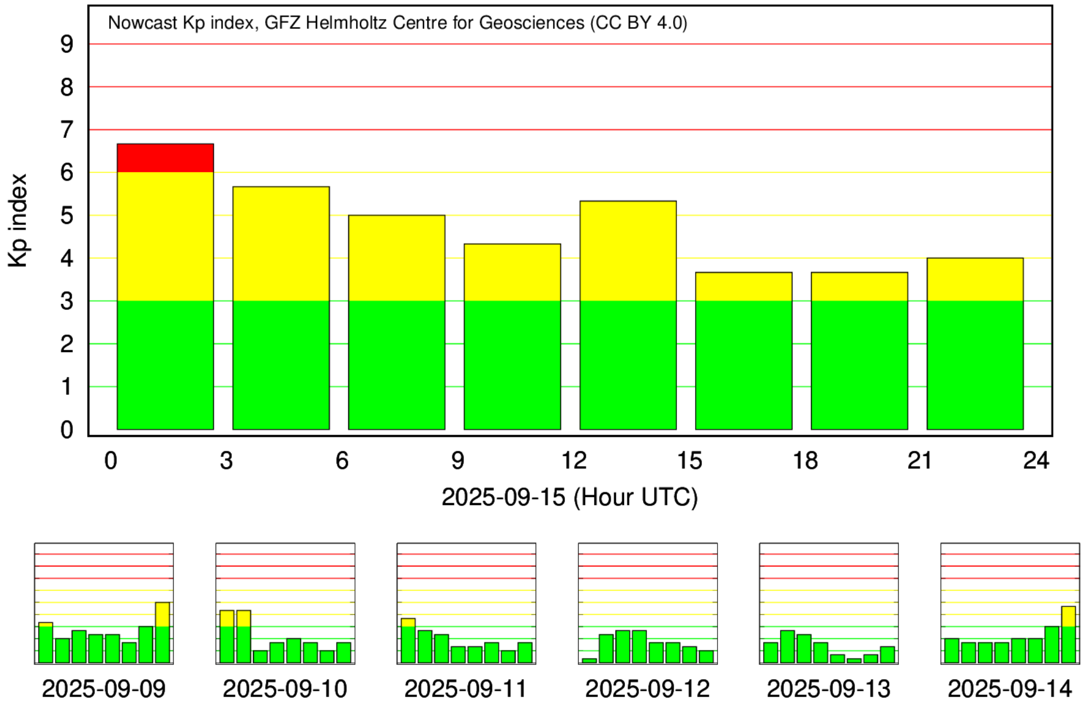

Figure 6-2 K-Index for September 15, 2025

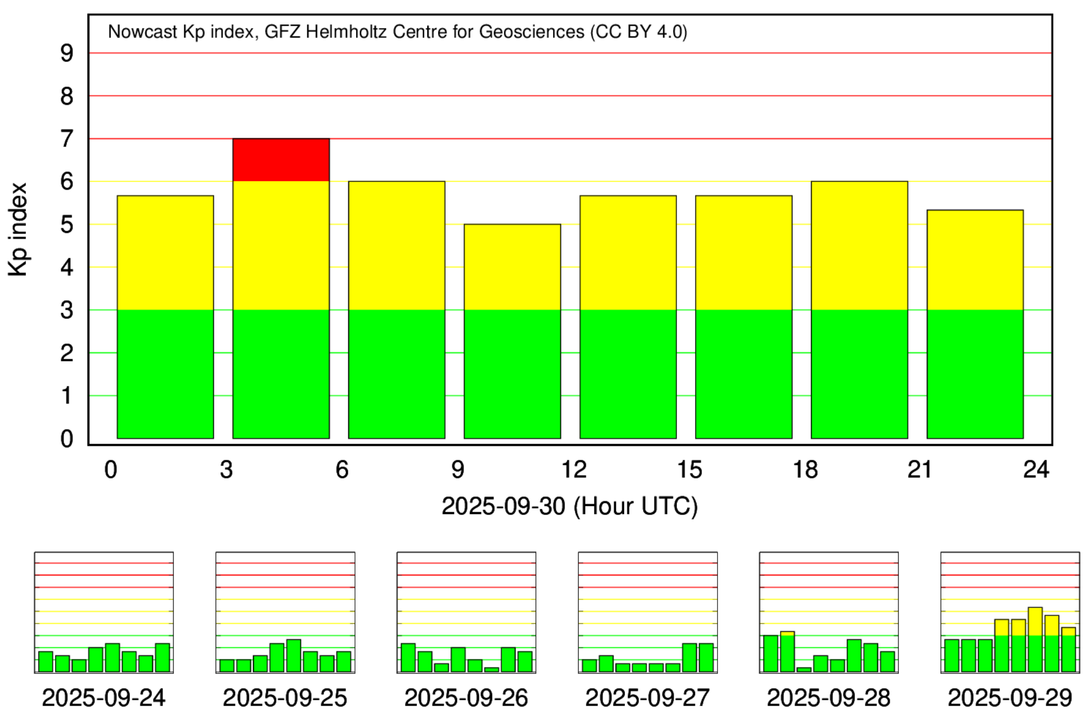

Figure 6-3 K-Index for September 30, 2025

Table 6-1 shows the position accuracy information for the quarter's worst-case storm day, September 30, 2025 (see Figure 6-3). The GPS SPS performance met all requirements during all storms that occurred during this quarter.

Table 6-1 Horizontal and Vertical Accuracy Statistics for September 30, 2025

Site	95% Horizontal (m)	95% Vertical (m)	Max Horizontal (m)	Max Vertical (m)
Albuquerque	4.31	8.905	5.556	10.31
Anchorage	3.756	10.308	5.449	12.147
Atlanta	5.639	7.135	6.325	9.37
Barrow	3.555	11.003	4.509	12.921
Bethel	3.868	10.877	5.7	12.429
Billings	3.65	8.984	4.693	10.255
Boston	2.239	8.675	3.012	11.013
Cleveland	3.978	8.846	4.696	9.723
Cold Bay	2.517	10.391	4.048	12.008
Fairbanks	3.688	9.88	6.131	12.239
Gander	2.405	8.696	4.098	9.71
Honolulu	14.09	7.307	18.771	12.506
Houston	3.452	8.479	4.308	9.761
Iqaluit	3.027	6.636	3.807	7.768
Juneau	3.815	9.519	5.237	12.038
Kansas City	5.546	8.745	6.71	11.203
Kotzebue	3.952	10.703	5.009	13.266
Los Angeles	4.497	10.456	5.812	11.247
Merida	5.895	6.999	9.456	9.491
Miami	4.338	6.88	5.146	8.011
Minneapolis	4.811	9.798	6.486	11.786
Oakland	5.41	10.442	6.103	11.006
Salt Lake City	5.42	9.424	6.258	10.317
San Jose Del Cabo	8.288	6.874	11.087	9.455
San Juan	6.509	6.885	8.934	9.465
Seattle	2.652	9.29	3.323	10.021
Washington, DC	3.771	8.597	4.899	9.674

7. IGS DATA

GPS SPS accuracy performance was evaluated at a selection of high-rate IGS stations[1]. The IGS is a voluntary federation of many worldwide agencies that pool resources and permanent GNSS station data to generate precise GNSS products.

Sites with high data rate (1 Hz) with good availability that are outside of the WAAS service area and that also provide a good geographic distribution have been selected. To facilitate differentiating between GPS accuracy issues and receiver tracking problems, an automatic data screening function excluded errors greater than 500 meters and or times when VDOP or HDOP were greater than 10. The remaining receiver tracking issues are still included in the processing and are forced into the 50.1-meter histogram bin. These issues cause the outliers seen in the 99.99% statistics and are visible in the 95% accuracy trend plots.

High-quality broadcast navigation data and Klobuchar model data are created by voting across all available IGS high-rate RINEX navigation data. Some manual review may be necessary to recover missing navigation data where the number of IGS sites reporting navigation data was below the voting threshold (i.e., 4).

[1] J.M. Dow, R.E. Neilan, G. Gendt, "The International GPS Service (IGS): Celebrating the 10th Anniversary and Looking to the Next Decade," Adv. Space Res. 36 vol. 36, no. 3, pp. 320-326, 2005. doi: 10.1016/j.asr.2005.05.125

Table 7-1 and

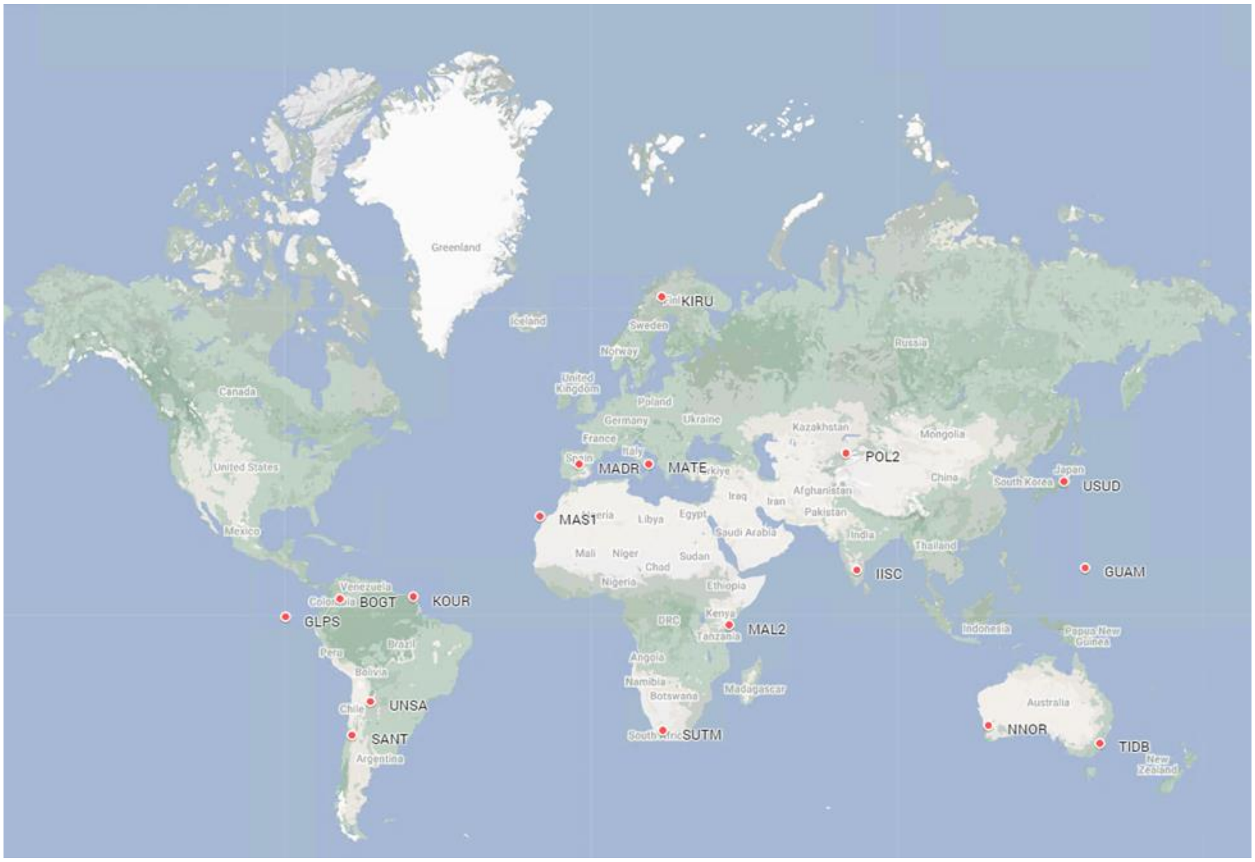

Figure 7-1 show the IGS site information and locations. IGS data processing between April 1 and June 30, 2025 was not available at the time of publication. After data processing is completed, the FAA will publish a modified report.

Table 7-1 Selected IGS Sites Information

ID	City	Country
BOGT	Bogota	Colombia
GLPS	Puerto Ayora	Ecuador
GUAM	Dededo	Guam
IISC	Bangalore	India
KIRU	Kiruna	Sweden
KOUR	Kourou	French Guyana
MADR	Robledo	Spain
MAL2	Malindi	Kenya
MAS1	Maspalomas	Spain
MATE	Matera	Italy
NNOR	New Norcia	Australia
POL2	Bishkek	Kyrgyzstan

ID	City	Country
SUTM	Sutherland	South Africa
TIDB	Tidbinbilla	Australia
UNSA	Salta	Argentina
USUD	Usuda	Japan

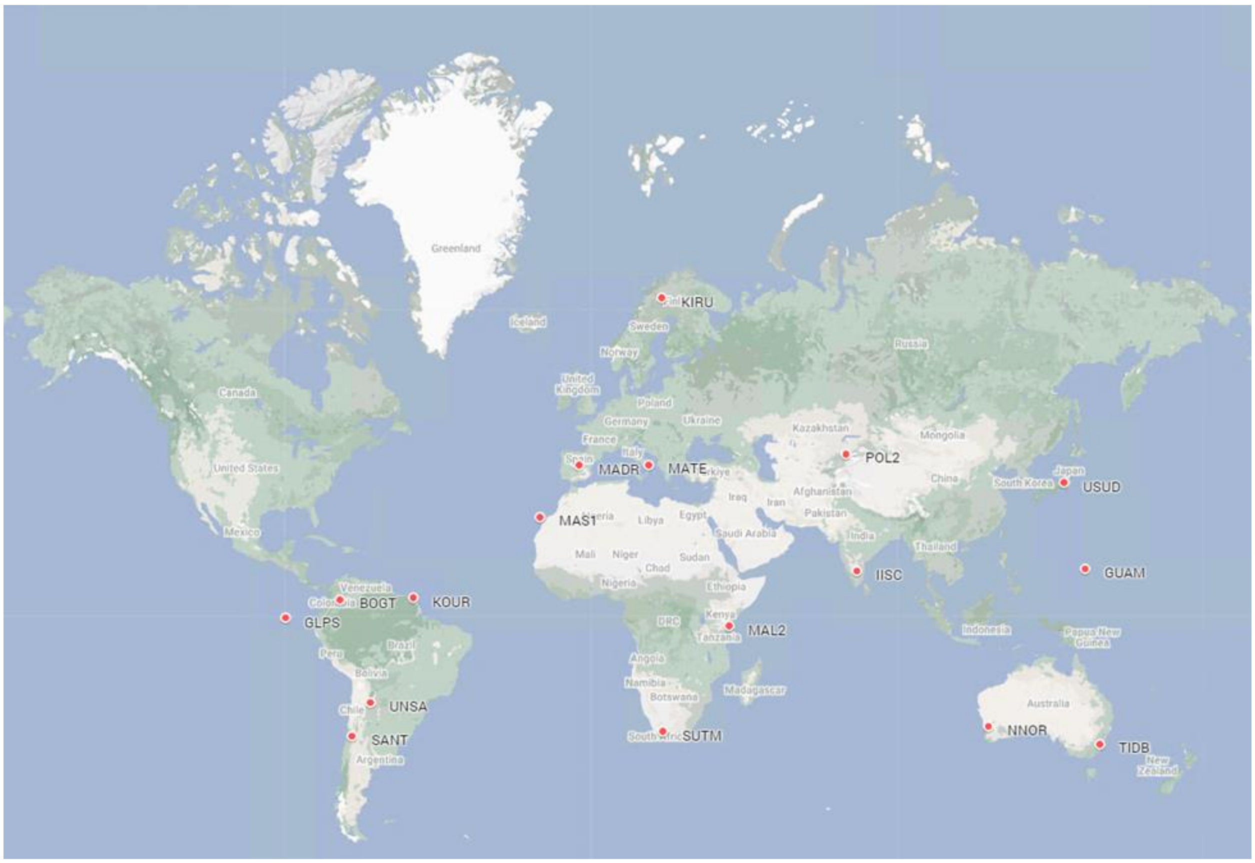

Figure 7-1 Selected IGS Site Locations

8. RAIM PERFORMANCE

Receiver autonomous integrity monitoring (RAIM) is a technology developed to assess the integrity of GPS signals in a GPS receiver system. It is especially important in safety critical GPS applications, such as aviation. For a GPS receiver to perform RAIM or fault detection (FD) function, a minimum of five visible satellites with satisfactory geometry must be visible. RAIM has various kinds of implementations; one of them performs consistency checks between all position solutions obtained with various subsets of the visible satellites. The receiver provides an alert to the pilot if the consistency checks fail.

Availability is a performance indicator of the RAIM algorithm. Availability is a function of the geometry of the constellation in view and of other environmental conditions. All the analysis performed here is utilizing the “Fault-Detection with no baro-aiding and SA off” RAIM implementation. Additional modes will be assessed at a future date. The test statistic used is a function of the pseudorange measurement residual (the difference between the expected measurement and the observed measurement) and the amount of redundancy. The test statistic is compared with a threshold value, and it is determined based on the requirements for the probability of false alarm (Pfa), the probability of missed detection (Pmd), and the expected measurement noise. In aviation systems, the Pfa is fixed at 1/15,000.

The horizontal protection limit (HPL) is a figure that represents the radius of a circle in the horizontal plane, centered on the GPS position solution, and is guaranteed to contain the true position of the receiver to within the specifications of the RAIM scheme (i.e., meets the Pfa and Pmd). The HPL is calculated as a function of the RAIM threshold and the satellite geometry at the time of the measurement. The HPL is compared with the horizontal alarm limit (HAL) to determine if RAIM is available. The RNP values shown here are measured in nautical miles, the computed HPL must be less than the RNP value for the service to be available.

8.1 Site Performance

Table 8-1 shows the RAIM performance for the 28 sites evaluated. For all sites collected, the minimum percent of time in RNP 0.1 mode was 99.947% at Minneapolis. The minimum percent of time spent in RNP 0.3 mode was 100 at all locations evaluated. The maximum 99% HPL value was 131.179 meters at Gander.

Table 8-1 RAIM Site Statistics

City	99% HPL (m)	RNP 0.1 (%)	RNP 0.3 (%)
Albuquerque	91.159	99.9911	100
Anchorage	115.408	99.97749	100
Atlanta	89.398	99.99875	100
Barrow	111.327	100	100
Bethel	122.177	100	100

City	99% HPL (m)	RNP 0.1 (%)	RNP 0.3 (%)
Billings	106.381	99.97885	100
Boston	110.341	100	100
Cleveland	104.679	99.9983	100
Cold Bay	106.968	100	100
Fairbanks	126.368	99.97201	100
Gander	131.179	100	100
Honolulu	95.882	100	100
Houston	81.116	99.98934	100
Iqaluit	127.182	99.99284	100
Juneau	114.454	100	100
Kansas City	126.055	99.98958	100
Kotzebue	111.119	100	100
Los Angeles	81.738	99.99964	100
Merida	72.658	100	100
Miami	78.181	99.96491	100
Minneapolis	121.095	99.94681	100
Oakland	80.296	100	100
Salt Lake City	99.022	100	100
San Jose Del Cabo	71.753	100	100
San Juan	78.373	100	100
Seattle	100.949	99.99723	100
Tapachula	76.501	99.98929	100
Washington, DC	100.399	100	100

8.2 RAIM Coverage

Figure 8-1 and Figure 8-2 show the worldwide RAIM coverage for both RNP 0.1 and RNP 0.3, respectively. Figure 8-3 and Figure 8-4 show the daily RAIM coverage trends between July 1 and September 30, 2025.

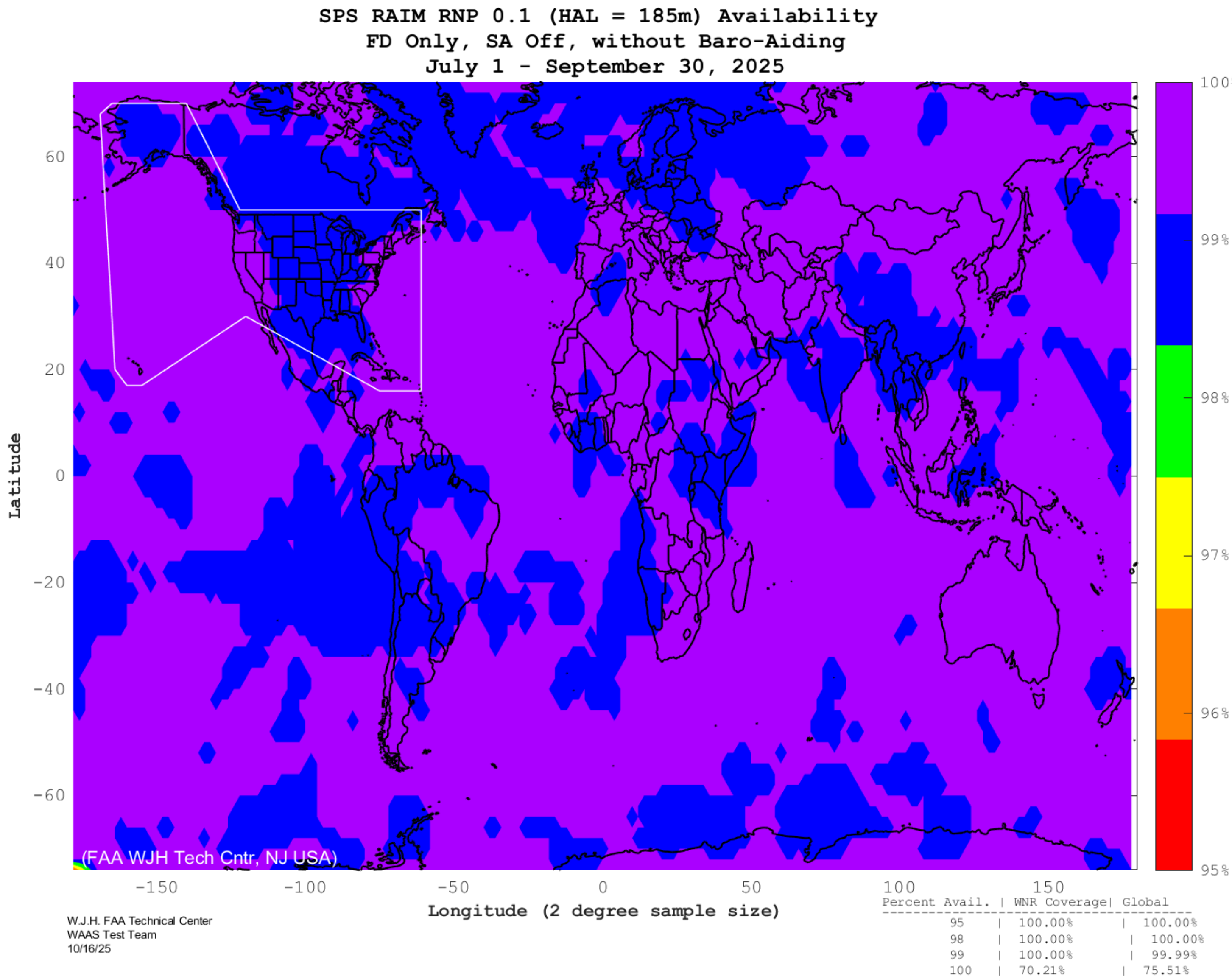

Figure 8-1 RAIM RNP 0.1 Coverage

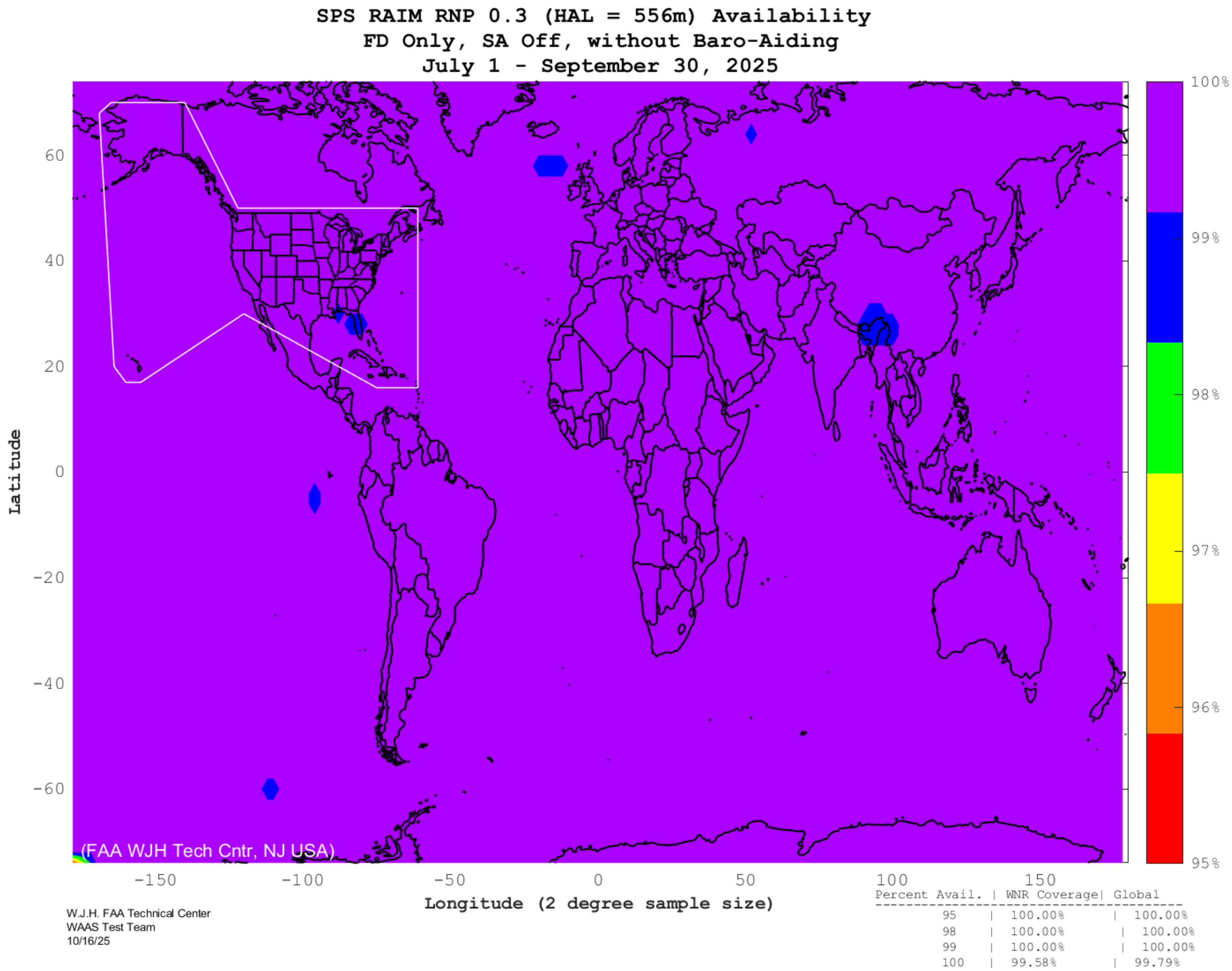

Figure 8-2 RAIM RNP 0.3 Coverage

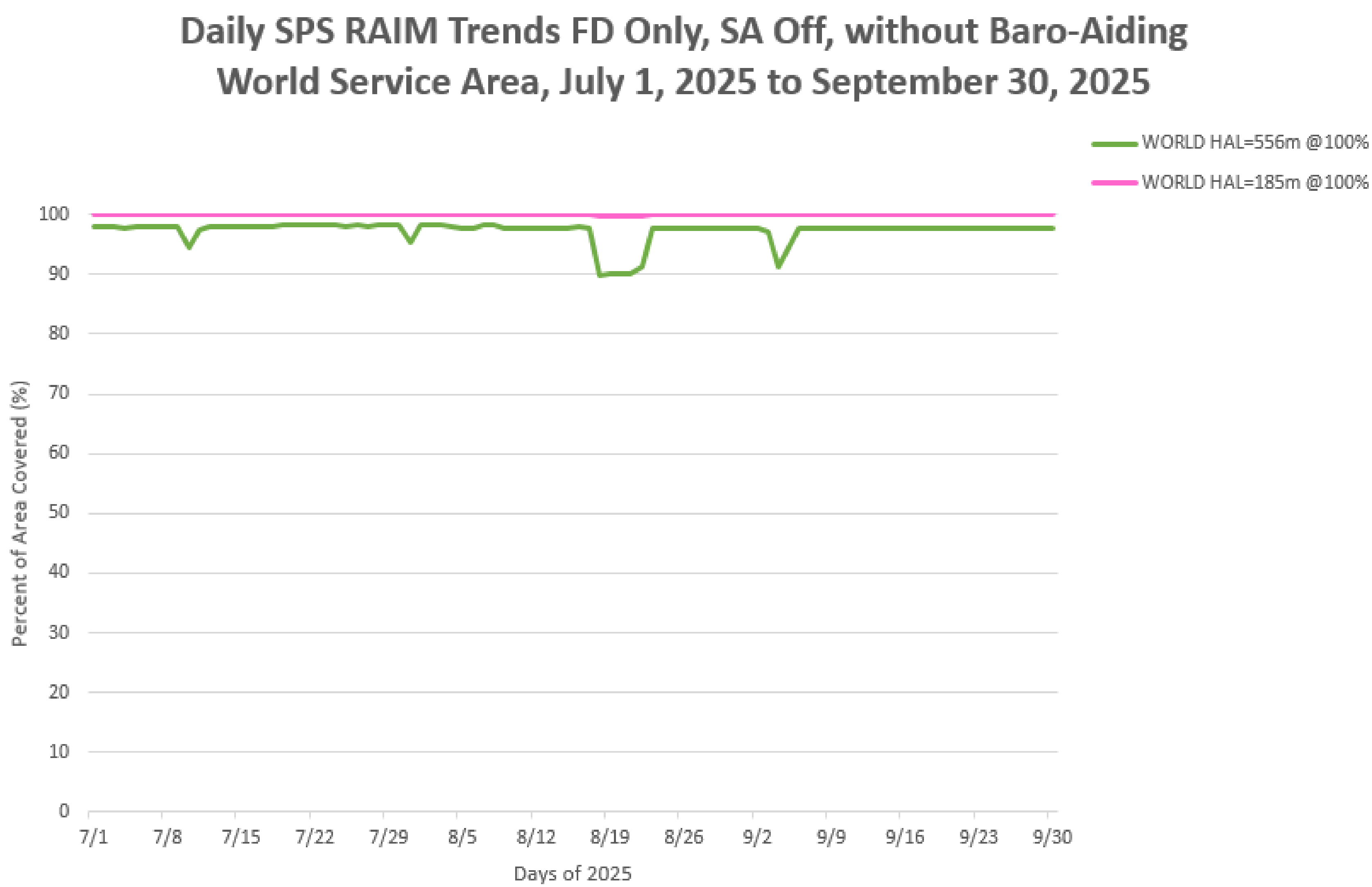

Figure 8-3 RAIM Worldwide Coverage Trend

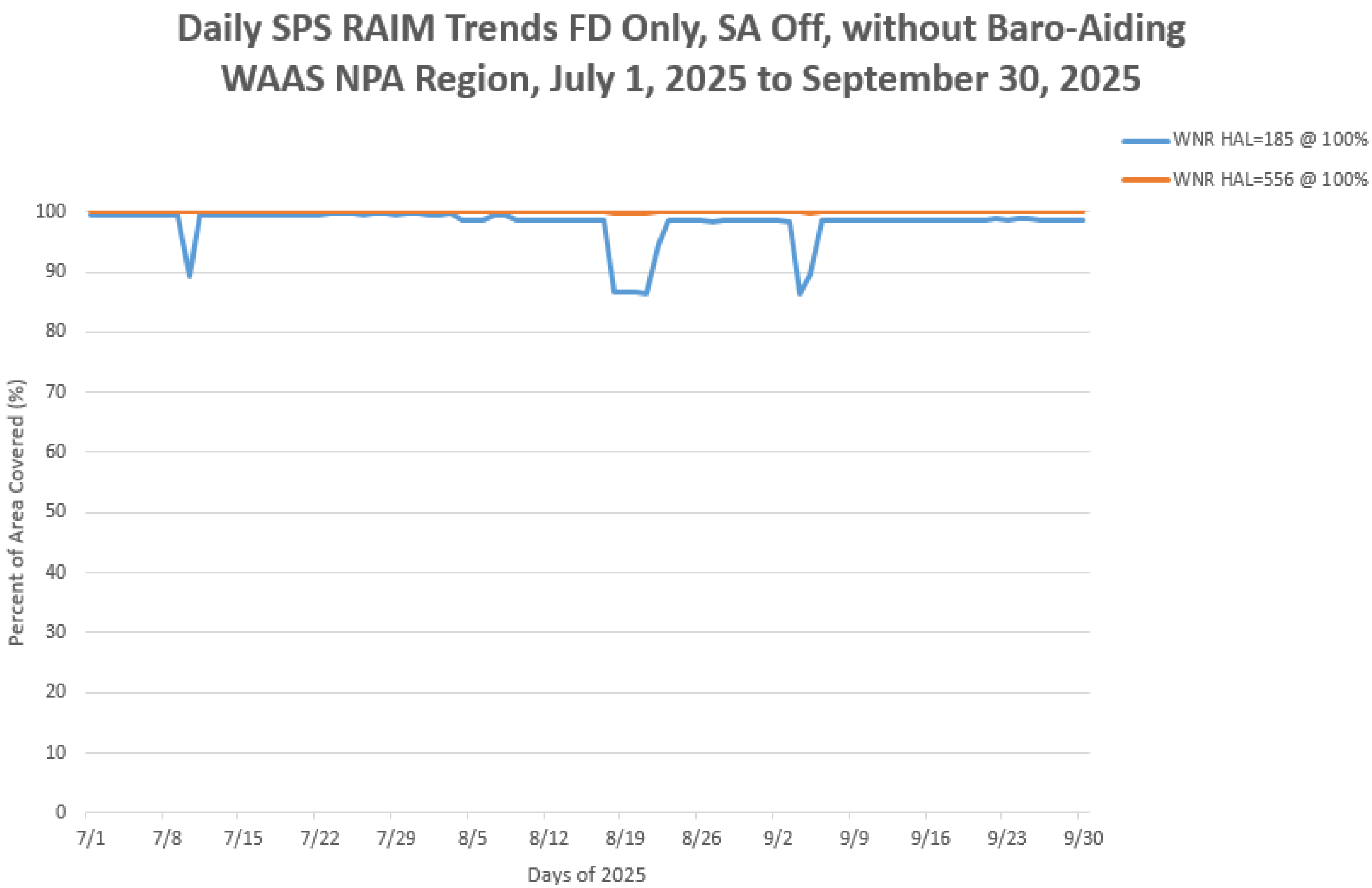

Figure 8-4 RAIM RNP Coverage Trend for WAAS NPA Service Area

8.3 RAIM Airport Analysis

Figure 8-5 and Figure 8-6 show RAIM RNP 0.1 and RNP 0.3 availability at all U.S. and Canadian airports that have an RNAV (GPS) published approach or better.

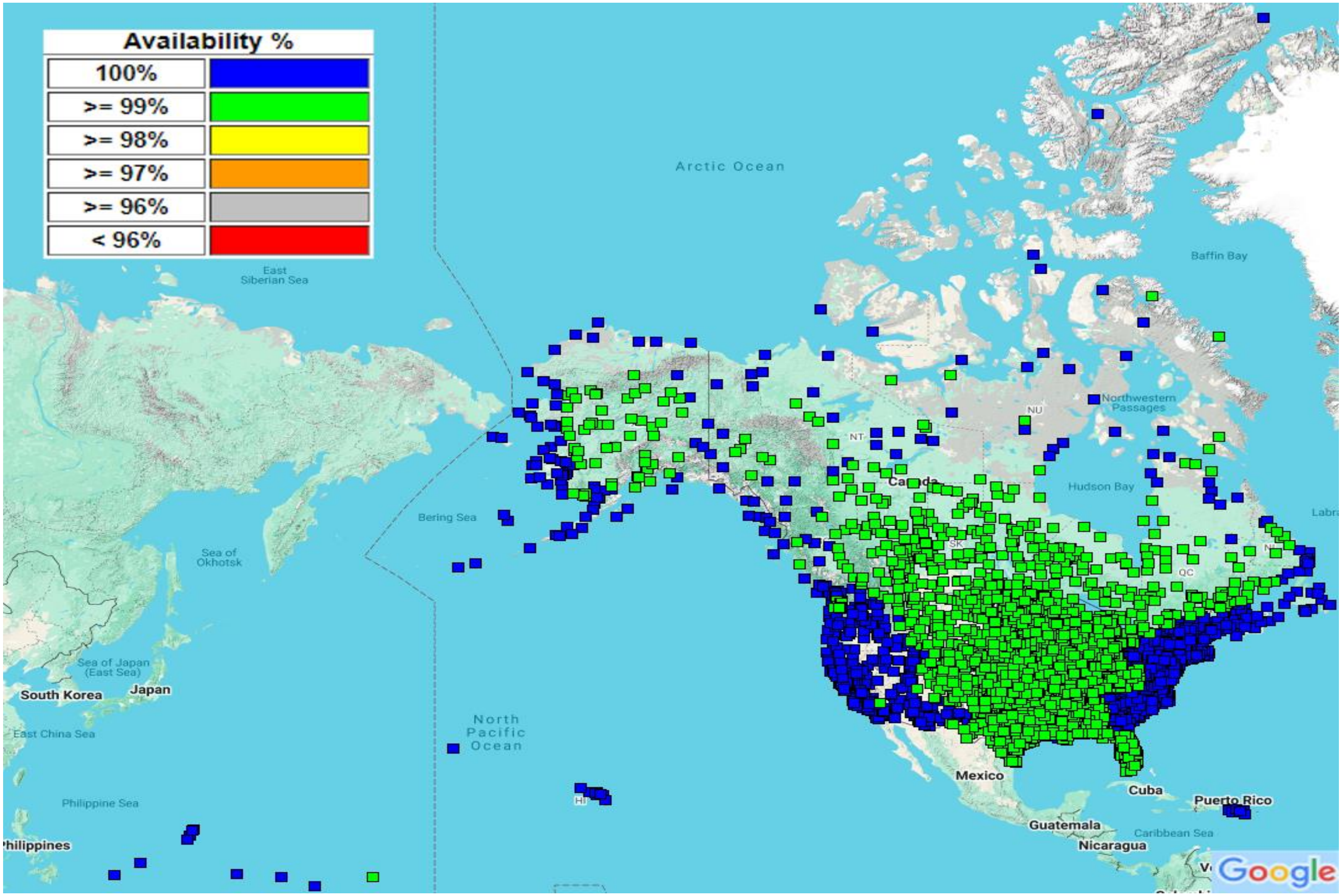

Figure 8-5 RAIM RNP 0.1 Airport Availability

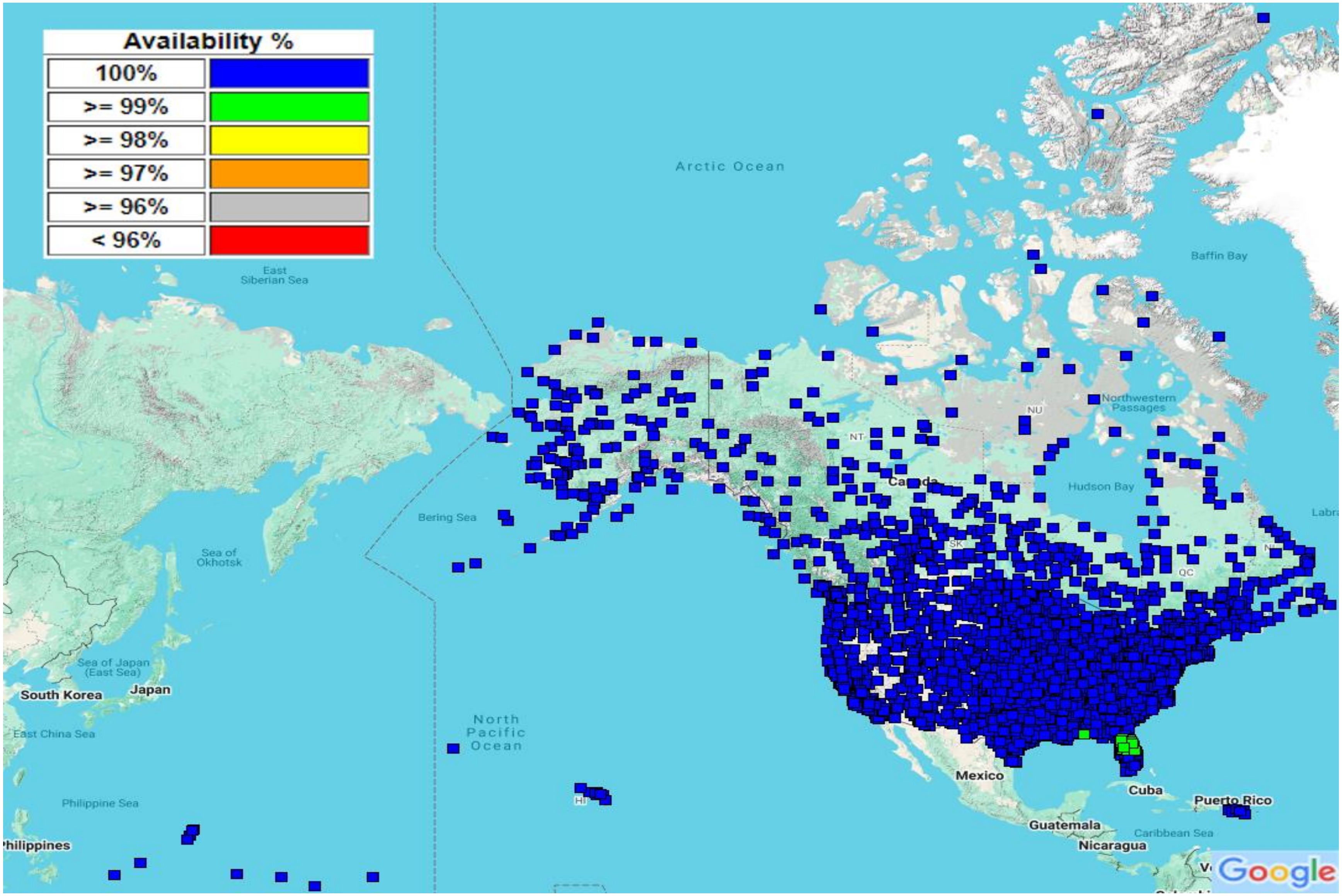

Figure 8-6 RAIM RNP 0.3 Airport Availability

Figure 8-7 and Figure 8-8 respectively show the number of RAIM RNP 0.1 and RAIM RNP 0.3 outages for every airport in the U.S. and Canada that have a RNAV (GPS) published approach or better.

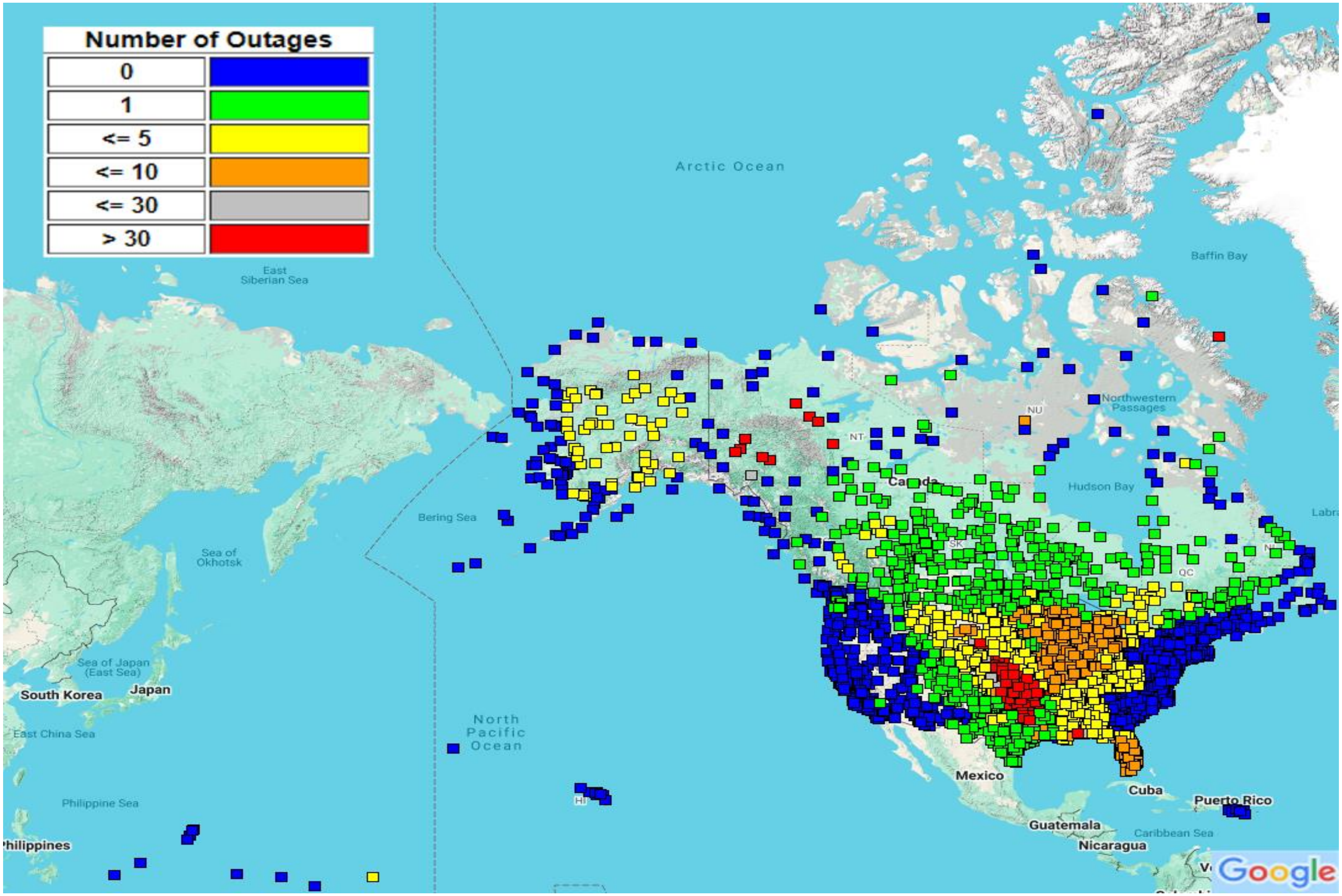

Figure 8-7 RAIM RNP 0.1 Airport Outages

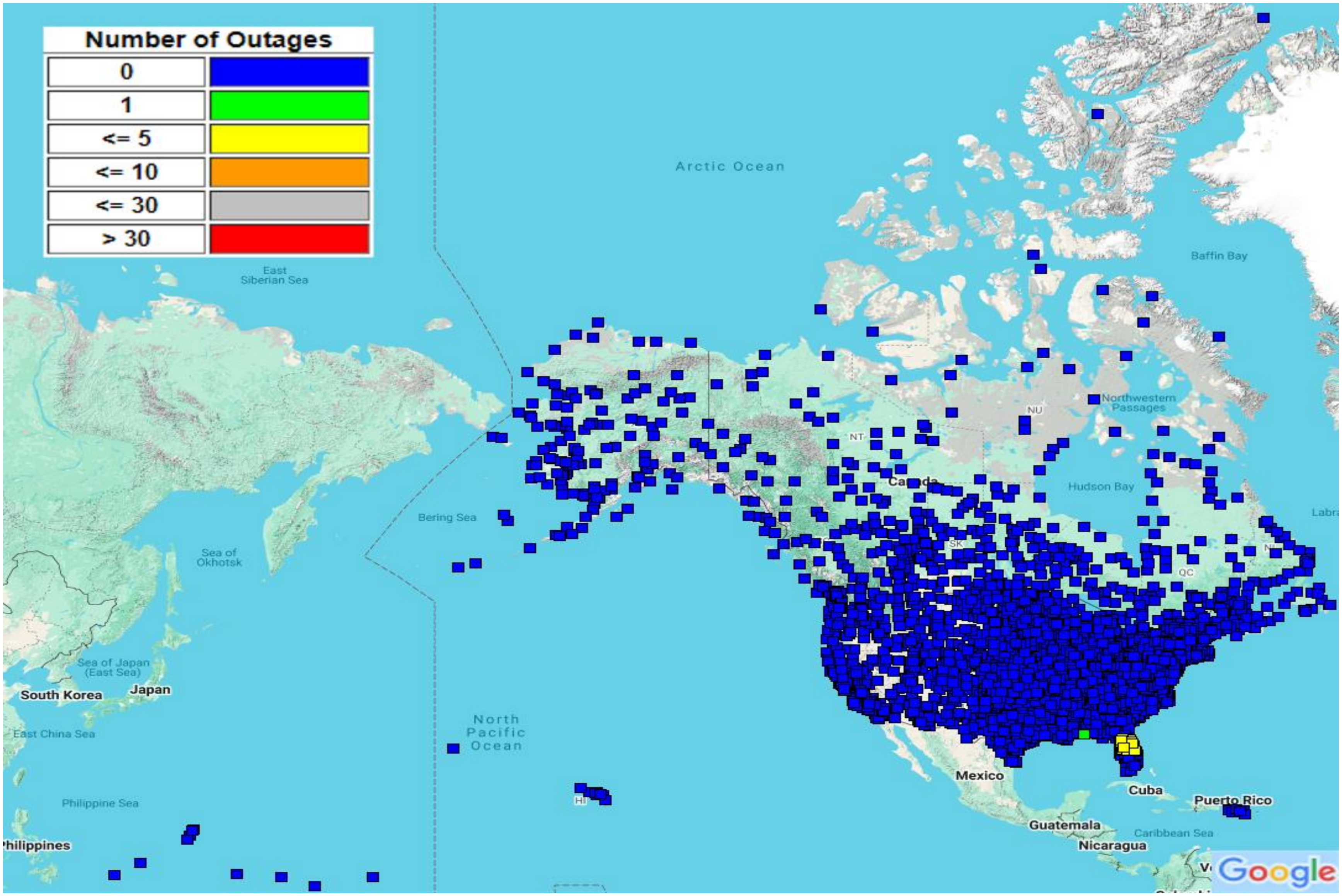

Figure 8-8 RAIM RNP 0.3 Airport Outages

9. GPS BROADCAST ORBIT VERSUS NGA PRECISE ORBITS AND URA (IAURA) BOUNDING ANALYSIS

As part of the WAAS off-line monitoring process, the accuracy of the GPS broadcast ephemeris is periodically compared to the NGA precise orbit information to monitor the validity of an a priori assumption concerning the accuracy of the GPS broadcast ephemeris information. That a priori assumption is part of a brute force computer simulation analysis utilized as part of the safety proof of the WAAS MT-28 functionality. That brute force analysis searches a simulated error sphere around a GPS satellite for a worst-case projection of post-correction ephemeris error to any user. A pessimistic extrapolation of historical data was used as an a priori to limit the radius of the searched sphere to a finite distance. This periodic offline monitoring verifies that the original logic of the a priori assumption remains sound.

The assumptions being validated are:

- Height Error: +/-15 meters (standard deviation <2.8 m),
- Along Track Error: +/-65 meters (standard deviation <12.2 m)
- Cross Track Error: +/-30 meters (standard deviation <5.6 m)

C/A Nav data URA bounding and L2C CNAV IAURA bounding performance are also evaluated.

For C/A Nav data, all IGS high-rate 15-minute broadcast navigation data RINEX format files are downloaded and merged into 24-hour broadcast navigation data files which are then added to RINEX nav data files from all WAAS peripheral reference stations. A majority voting algorithm is used to screen the navigation data after a LSB recovery algorithm is applied. NGA APC precise ephemeris referenced to the GPS satellite antenna phase center is downloaded from the NGA site. GPS satellite positions are computed every 15 minutes and differenced with the precise orbits. The resulting error information is then segregated into the Height, Along Track, and Cross Track (HAC) error data. The standard deviation of those errors is then computed for each dimension for each satellite. Figure 9-1 through Figure 9-4 show the standard deviation results.

The assumption is valid if a 5.33 scaling of the standard deviation across all satellites is within the a priori. Three months of data from July 1 to September 30, 2025 is presented. Only data points in which GPS is healthy and valid precise data is available are considered. There was maintenance on PRN20 on 07/03/25 to 07/04/25, PRN27 on 07/10/25, PRN14 on 07/31/25, PRN1 on 09/03/25 to 09/04/25, and PRN16 on 09/04/25 to 09/05/25. PRN17 was unusable 07/11/25 and PRN4 was unusable 08/16/25 to 08/22/25. Figure 9-5 shows the availability of C/A Nav data. There were no points where GPS was healthy and the NGA data was missing. There are no points where GPS C/A GPS Nav data is unavailable other than during NANUs.

For L2C CNAV data, raw 300-bit L2C and L5 CNAV message data is obtained from the WAAS G3 test receivers located at the NSTB ACY reference station. Those receivers are located at the William J. Hughes Technical Center in Atlantic City, NJ. CNAV data was only available while the satellites were in view of ACY G3 test receivers. This is the reason for the sparseness in the CNAV data. Because of the sparseness of the data, CNAV data from rising and setting satellites was used for the entire 3-hour fit interval, even though on rising and setting satellites there would have normally been an ephemeris set update at the 2-hour points. Those missing updates may or may not have provided improvement to the accuracy. L2C is used because there are more L2C capable satellites than L5 capable satellites. Table 9-1 shows the satellites that are capable of broadcasting L2C, L5 and L1C. In the September 30, 2025 GPS constellation (see Figure 9-6), SVN81 (PRN21) is the most recent satellite, which was added to the constellation on June 25, 2025.

Table 9-1 Signal Capability per Satellite Vehicle

PRN	SV	Block Type	L2C	L5	L1C
1	80	III	Yes	Yes	Yes
2	61	IIR	N/A	N/A	N/A
3	69	IIF	Yes	Yes	N/A
4	74	III	Yes	Yes	Yes
5	50	IIR-M	Yes	N/A	N/A
6	67	IIF	Yes	Yes	N/A
7	48	IIR-M	Yes	N/A	N/A
8	72	IIF	Yes	Yes	N/A
9	68	IIF	Yes	Yes	N/A
10	73	IIF	Yes	Yes	N/A
11	78	III	Yes	Yes	Yes
12	58	IIR-M	Yes	N/A	N/A
13	43	IIR	N/A	N/A	N/A
14	77	III	Yes	Yes	Yes
15	55	IIR-M	Yes	N/A	N/A
16	56	IIR	N/A	N/A	N/A
17	53	IIR-M	Yes	N/A	N/A
18	75	III	Yes	Yes	Yes
19	59	IIR	N/A	N/A	N/A
20	51	IIR	N/A	N/A	N/A
21	81	III	Yes	Yes	Yes
22	44	IIR	N/A	N/A	N/A
23	76	III	Yes	Yes	Yes
24	65	IIF	Yes	Yes	N/A
25	62	IIF	Yes	Yes	N/A
26	71	IIF	Yes	Yes	N/A
27	66	IIF	Yes	Yes	N/A
28	79	III	Yes	Yes	Yes

PRN	SV	Block Type	L2C	L5	L1C
29	57	IIR-M	Yes	N/A	N/A
30	64	IIF	Yes	Yes	N/A
31	52	IIR-M	Yes	N/A	N/A
32	70	IIF	Yes	Yes	N/A

The sign convention for this analysis is error = broadcast ECEF - precise ECEF. Along track is positive in the direction of the velocity vector. Cross track completes a right-hand system with height and along track.

Figure 9-7 and Figure 9-8 are URA (IAURA) overbounding plots. URA bounding using C/A Nav data used the maximum of the range indicated by the broadcast URA index. IAURA bounding using CNAV data used the algorithm from IS-GPS-200/IS-GPS-705. The error used in the analysis is at the location of maximum error in the footprint (usually edge of coverage). Review of the bounding plots, the QQ plots, and the histograms indicate that CNAV data is not as conservative as using the max URA from the C/A Nav data. The CNAV overbounding plot does not pass. Sparseness of data may have contributed to the failure to overbound. (i.e., using the full 3-hour fit interval at the beginning and end of tracks).

Figure 9-9 through Figure 9-67 are plots of the height, along track, and cross track error relative to NGA precise orbits by PRN number. These plots do not include clock error.

Figure 9-68 through Figure 9-82 are QQ plots of the URA (IAURA) normalized total range error (height, along track, cross track, and clock) projected onto the surface of the earth. The surface of the earth is approximated using +/-13.9-degrees from the bore sight of the satellite. The max URA of the broadcast URA index range is used for the C/A Nav data, and IAURA is used for the CNAV data. The range of the QQ plot axis has been fixed at +/-5. Annotations are provided for any instances beyond that range.

Errors larger than 3 times URA (IAURA) for C/A and 4 times URA (IURA) for CNAV were investigated.

Figure 9-83 through Figure 9-140 are histograms of the height error, along track error, cross track error, and URA (IAURA) normalized range error.

Figure 9-141 through Figure 9-198 are the timelines of the URA (IAURA) normalized range error. Missing data points are in red and are NANUs for the C/A data. The large number of red points in the CNAV data are the points where the satellites are out of view of ACY.

9.1 GPS Broadcast Orbit Accuracy Standard Deviation Plots

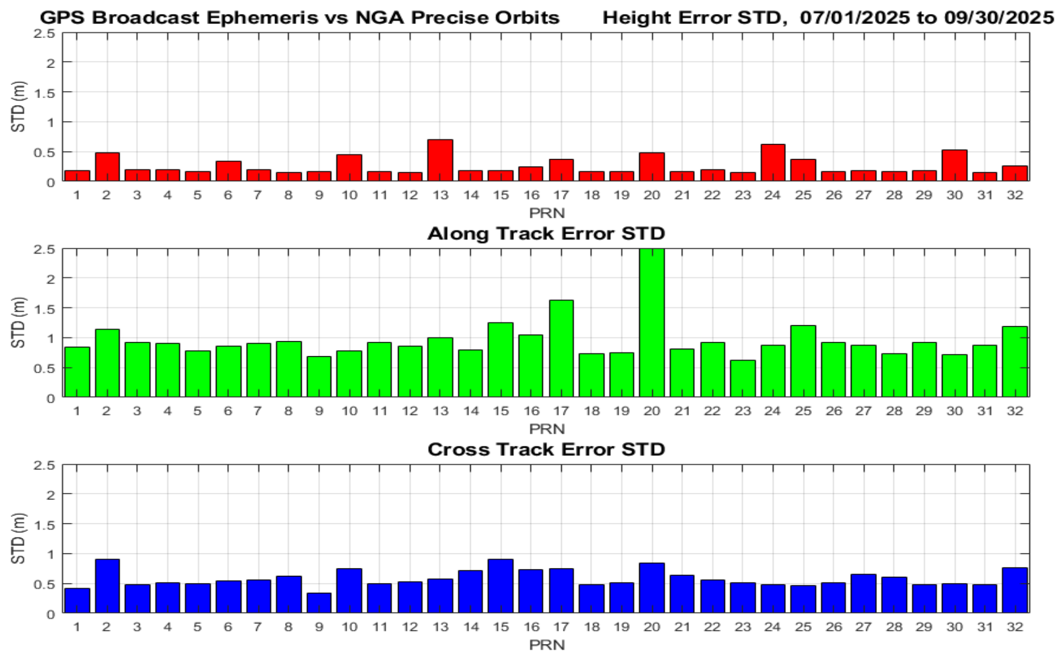

Figure 9-1 GPS Broadcast Orbit Accuracy Standard Deviations Using C/A Nav Data

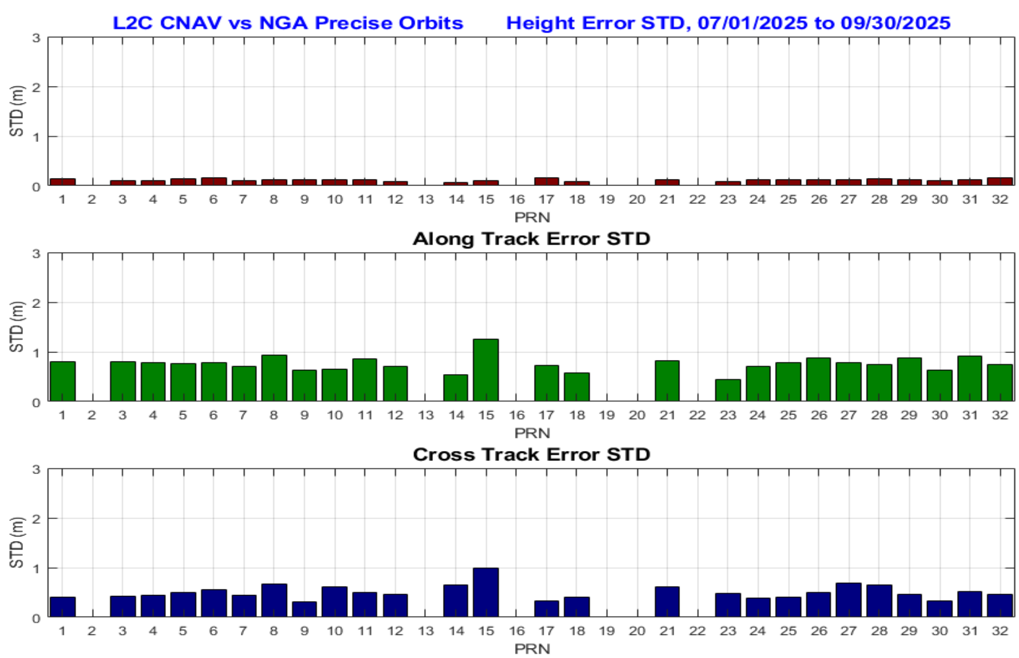

Figure 9-2 GPS Broadcast Orbit Accuracy Standard Deviations Using L2C CNAV Data

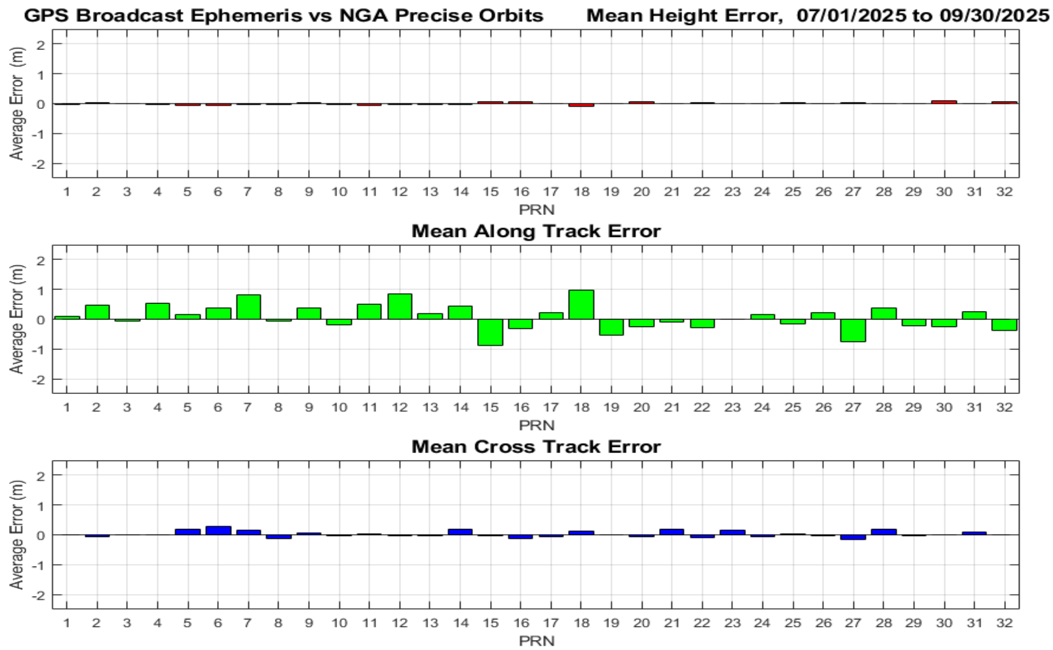

Figure 9-3 GPS Broadcast Orbit Error Means Using C/A Nav Data

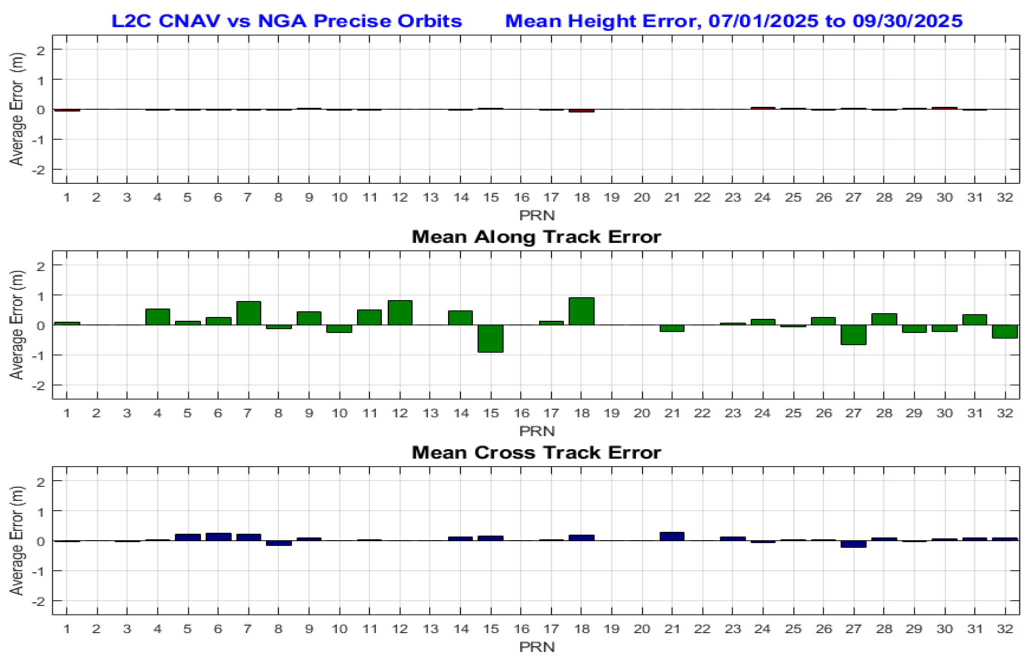

Figure 9-4 GPS Broadcast Orbit Error Means Using L2C CNAV Data

9.2 Broadcast Ephemeris vs. NGA Precise Data Availability Plots

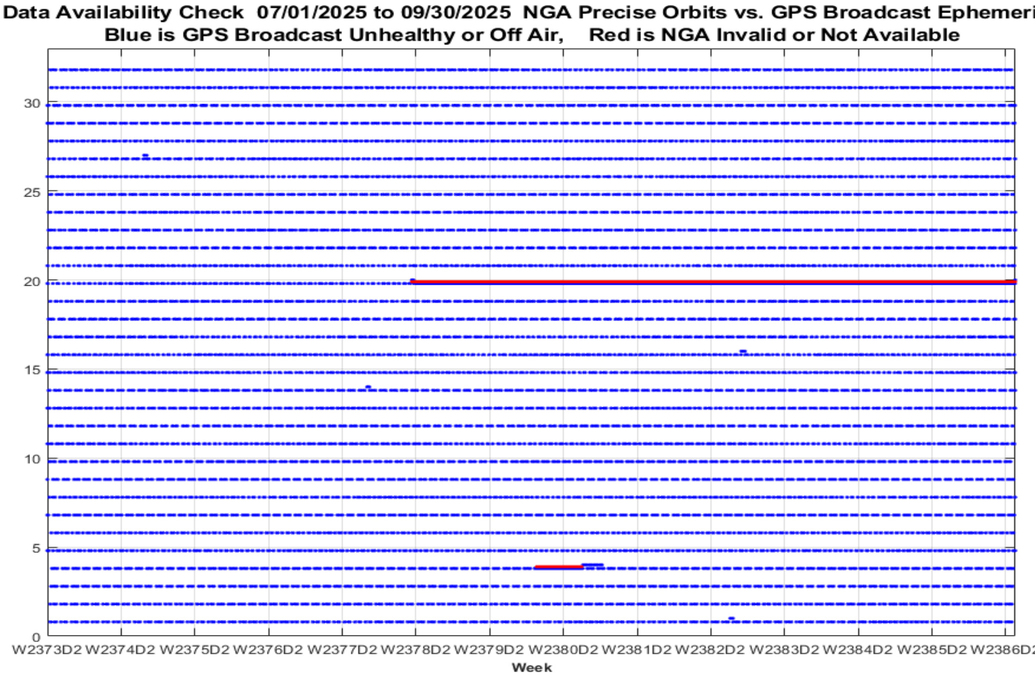

Figure 9-5 Broadcast Ephemeris vs. NGA Precise Data Availability Plots

9.3 Current GPS Constellation

Table 9-2 is a list of the current GPS constellation plane and slot designations provided by the United States Coast Guard (USCG) Navigation Center (NavCen) as depicted by their GPS Satellite Locations Slant Chart. Table 9-2 reflects actual orbital configuration and may not match the current GPS Constellation Operational Advisory (AO) status published by the USCG NavCen, which depicts the control station configuration. GPS constellation slots designated with an asterisk refer to the expandable slots. Expandable slots are divided into a fore (F) and an aft (A) slot. Figure 9-6 is a graphical representation of the September 30, 2025 GPS constellation during the reporting period.

Table 9-2 GPS Constellation Plane/Slot per SVN

Plane	Slot	SVN	PRN	Block Type
A	1	65	24	IIF
A	2	*	*	*
A	2F	79	28	III
A	2A	52	31	IIR-M
A	3	64	30	IIF
A	4	48	7	IIR-M

Plane	Slot	SVN	PRN	Block Type
B	1	*	*	*
B	1F	71	26	IIF
B	1A	56	16	IIR
B	2	62	25	IIF
B	3	77	14	III
B	4	58	12	IIR-M
B	*	44	22	IIR
C	1	57	29	IIR-M
C	2	66	27	IIF
C	3	72	8	IIF
C	4	*	*	*
C	4F	53	17	IIR-M
C	4A	59	19	IIR
D	1	78	11	IIR
D	2	*	*	*
D	2F	61	2	IIF
D	2A	80	1	III
D	3	75	18	IIR
D	4	67	6	IIF
E	1	69	3	IIF
E	2	73	10	IIF
E	3	*	*	*
E	3F	51	20	IIR
E	3A	50	5	IIR-M
E	4	76	23	III
E		81	21	III
F	1	70	32	IIF
F	2	*	*	*
F	2F	43	13	IIR
F	2A	55	15	IIR-M
F	3	68	9	IIF
F	4	74	4	III

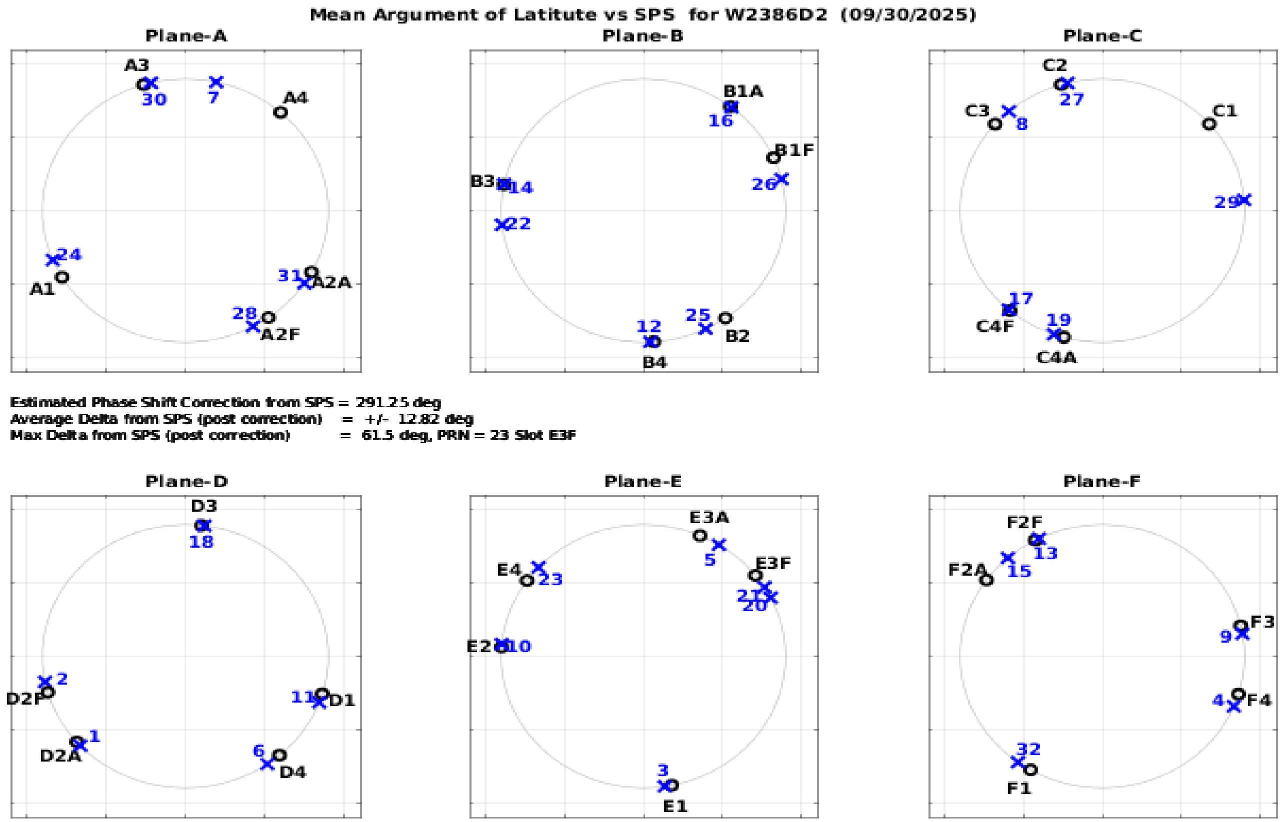

Figure 9-6 September 30, 2025 GPS Constellation

9.4 URA Overbounding Plots

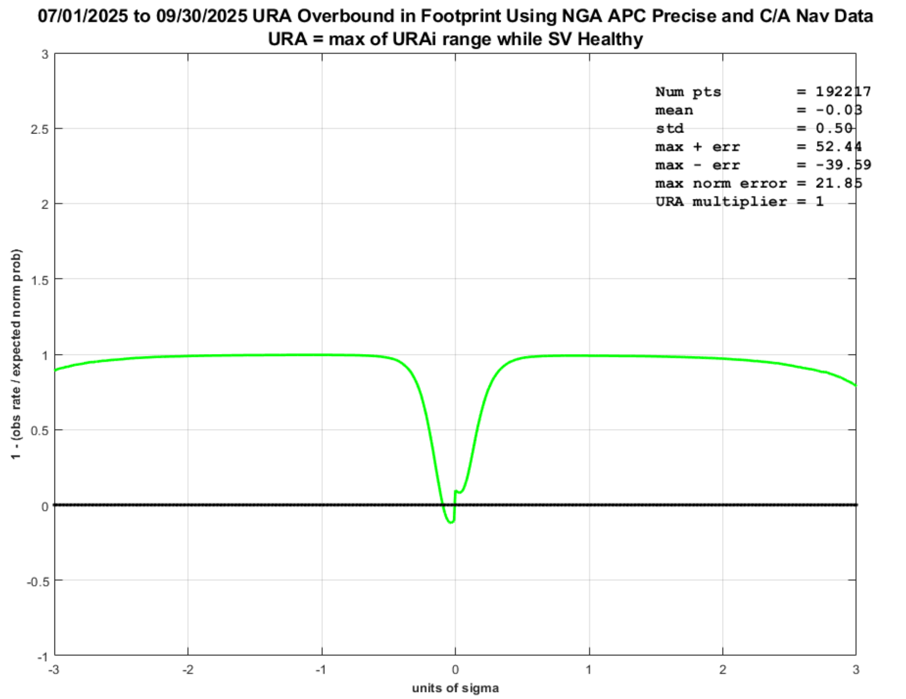

Figure 9-7 URA Overbounding Using C/A Nav Data

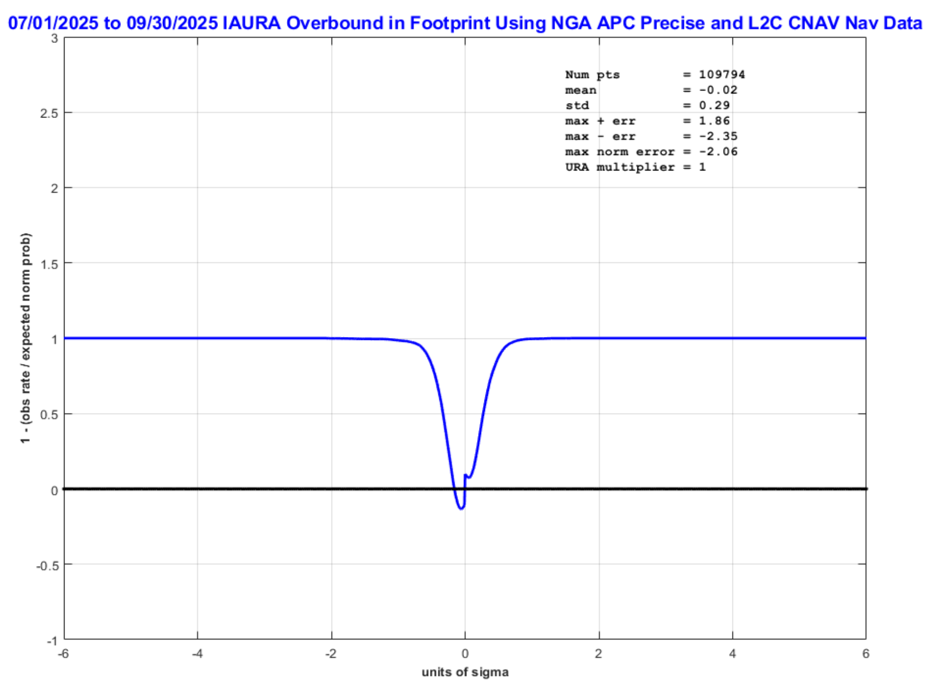

Figure 9-8 IAURA Overbounding Using L2C CNAV Data

9.5 Orbit Error Plots for All Satellites

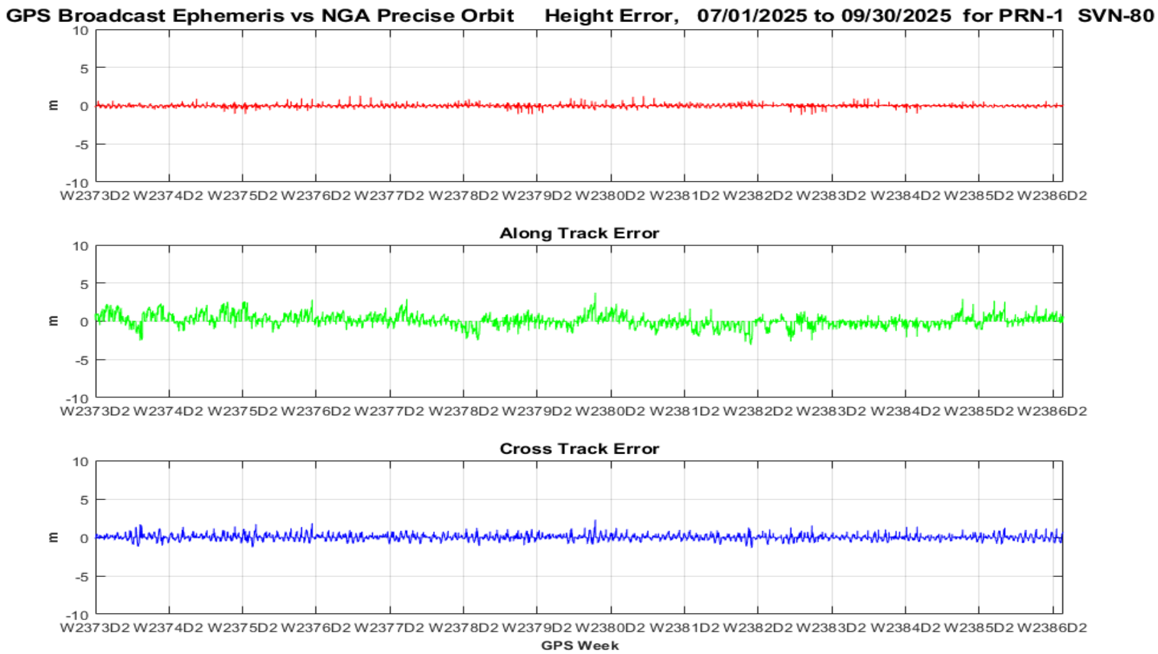

Figure 9-9 Orbit Error PRN1 (SVN80) Using C/A Nav Data

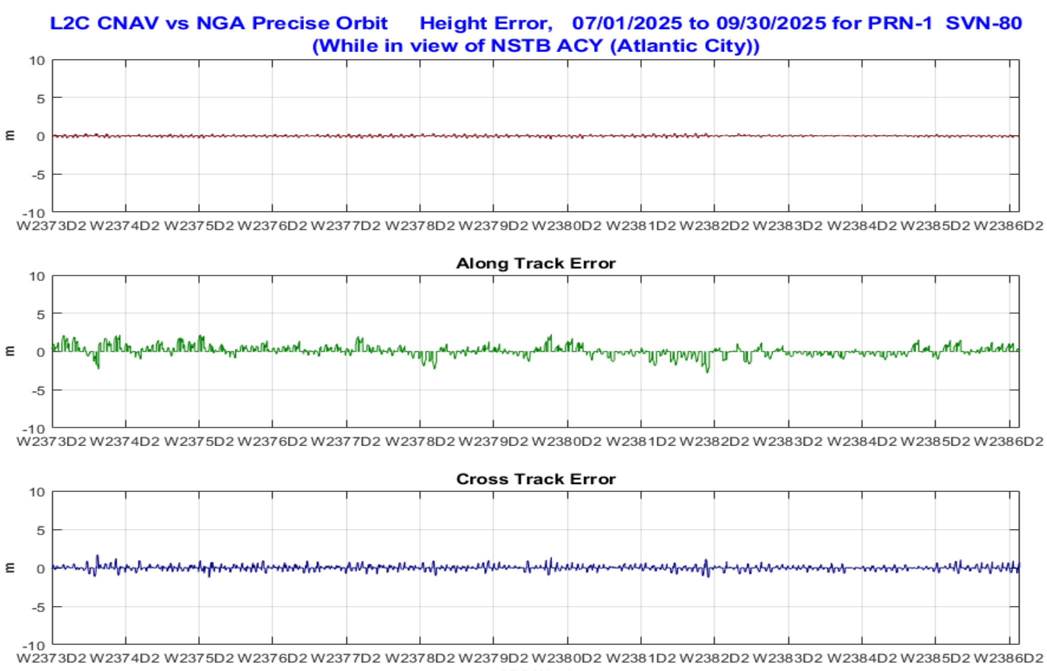

Figure 9-10 Orbit Error PRN1 (SVN80) Using L2C CNAV Data

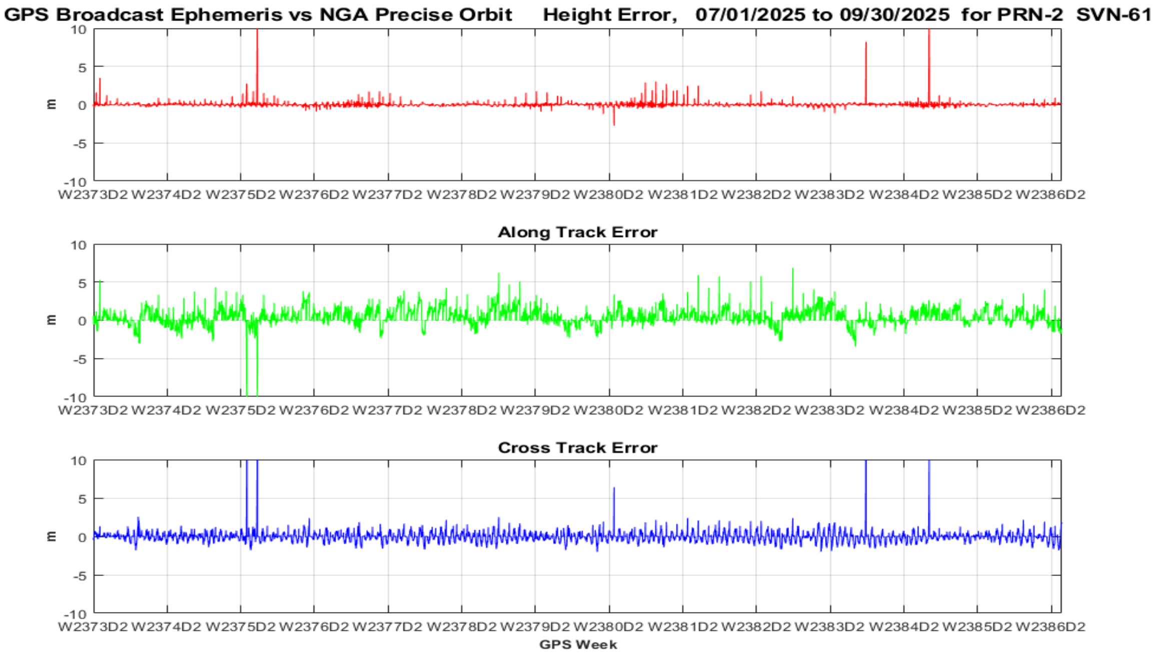

Figure 9-11 Orbit Error PRN2 (SVN61) Using C/A Nav Data

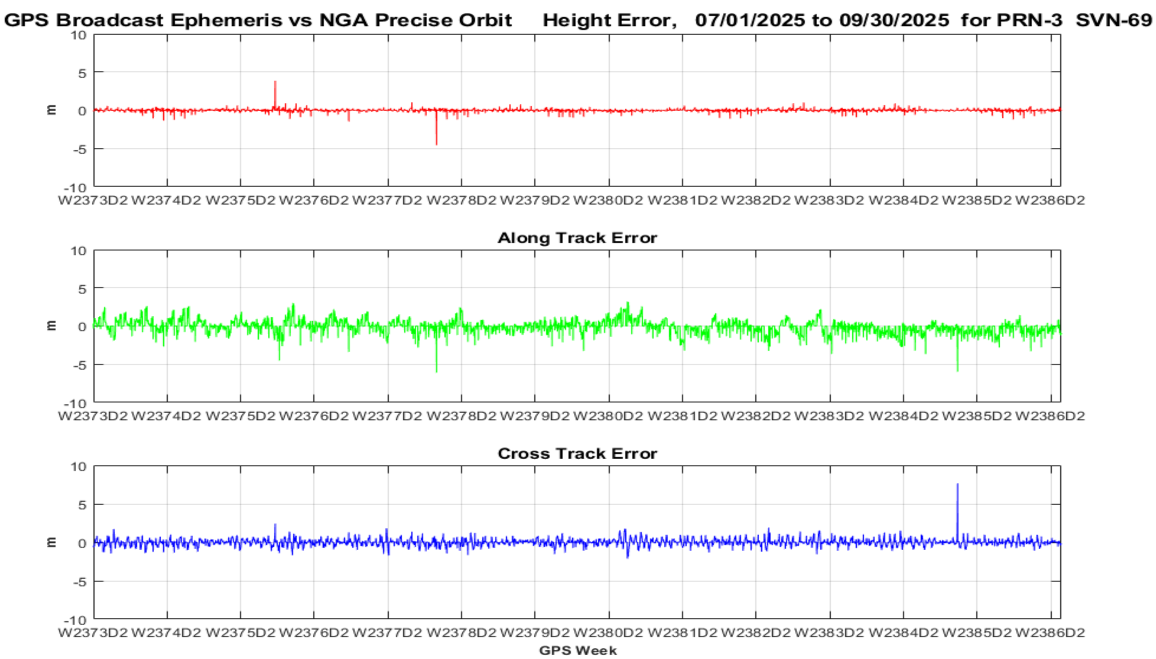

Figure 9-12 Orbit Error PRN3 (SVN69) Using C/A Nav Data

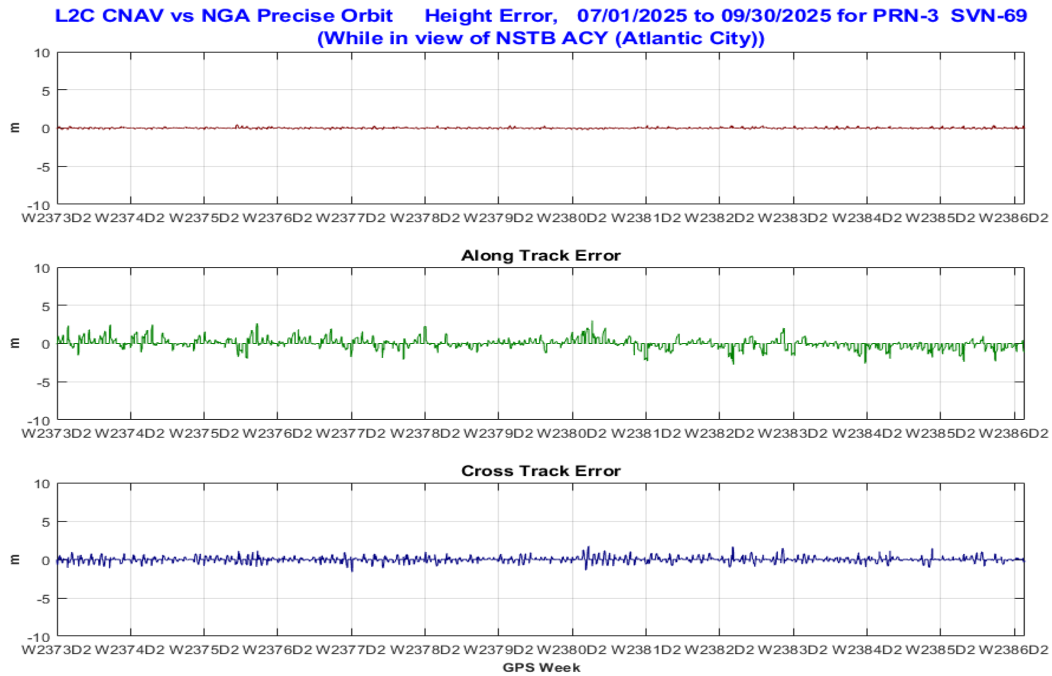

Figure 9-13 Orbit Error PRN3 (SVN69) Using L2C CNAV Data

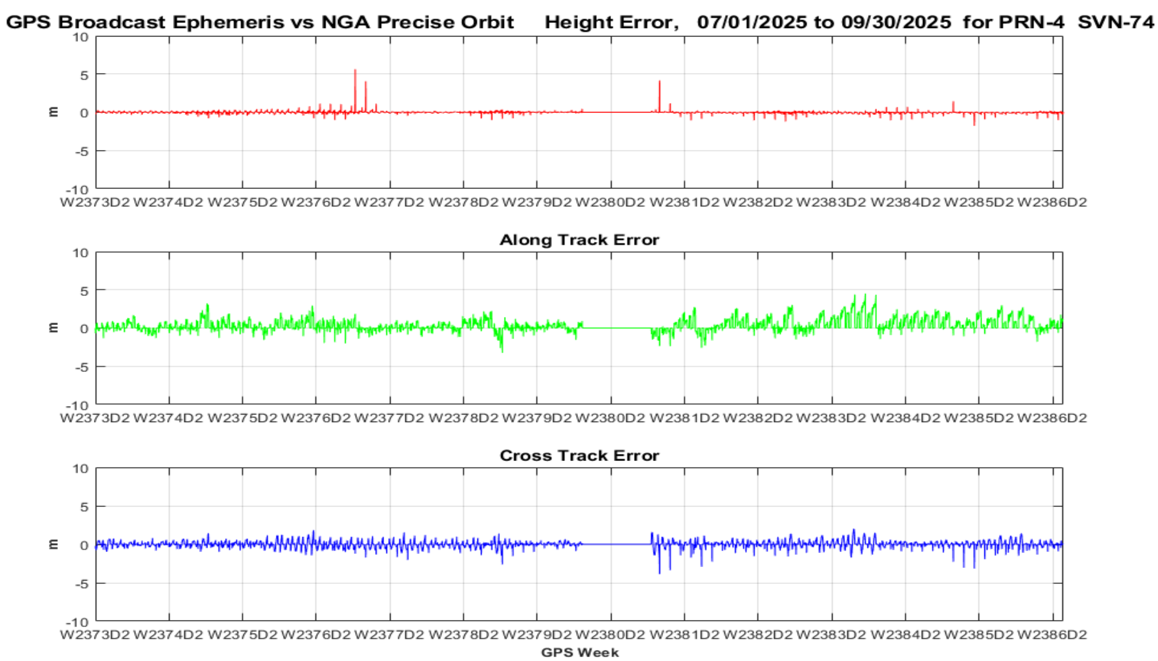

Figure 9-14 Orbit Error PRN4 (SVN74) Using C/A Nav Data

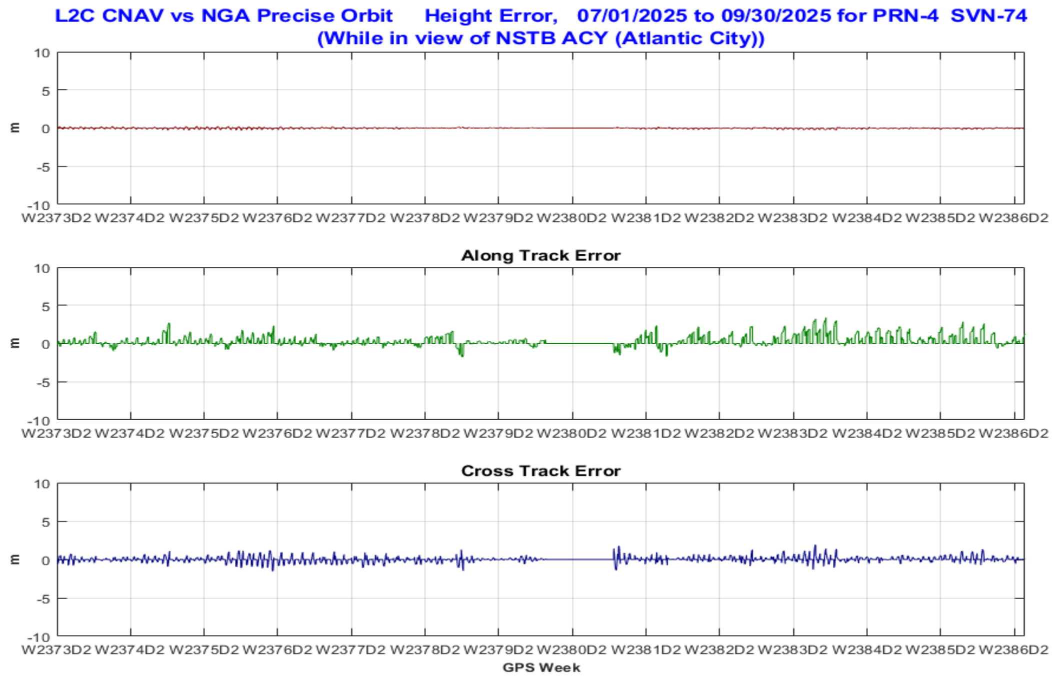

Figure 9-15 Orbit Error PRN4 (SVN74) Using L2C CNAV Data

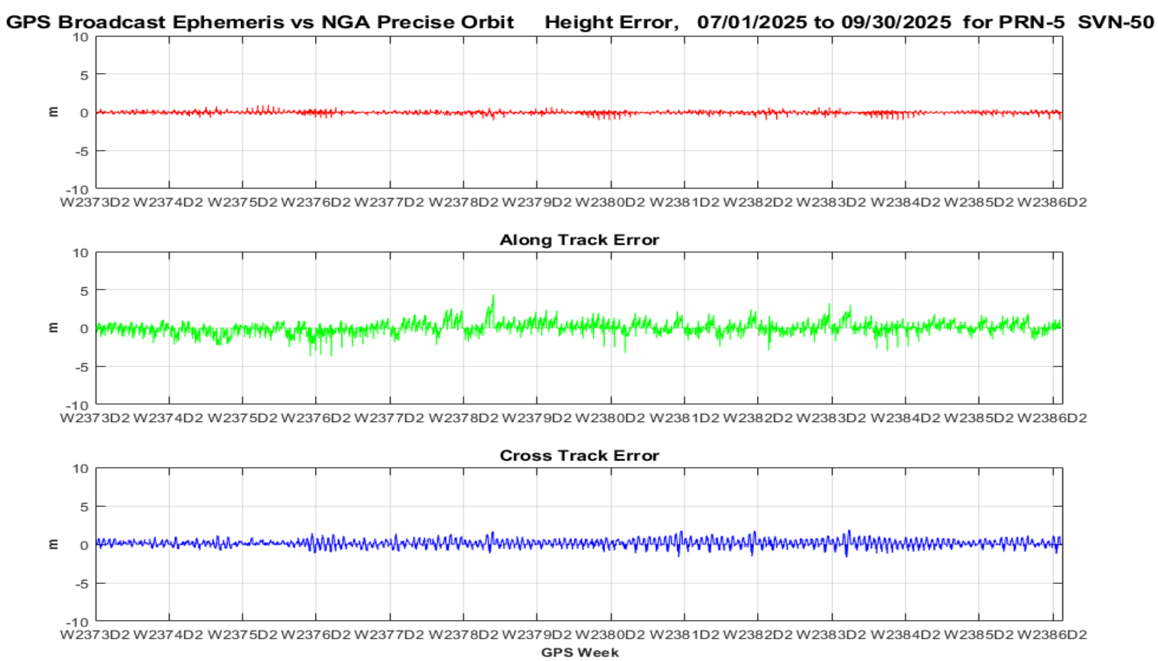

Figure 9-16 Orbit Error PRN5 (SVN50) Using C/A Nav Data

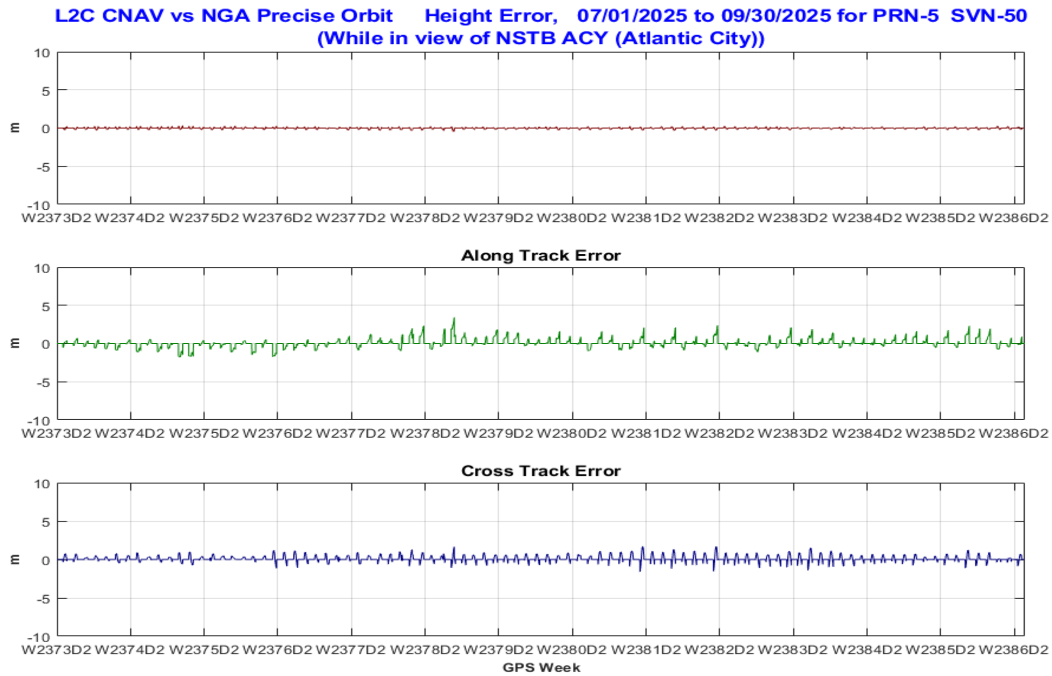

Figure 9-17 Orbit Error PRN5 (SVN50) Using L2C CNAV Data

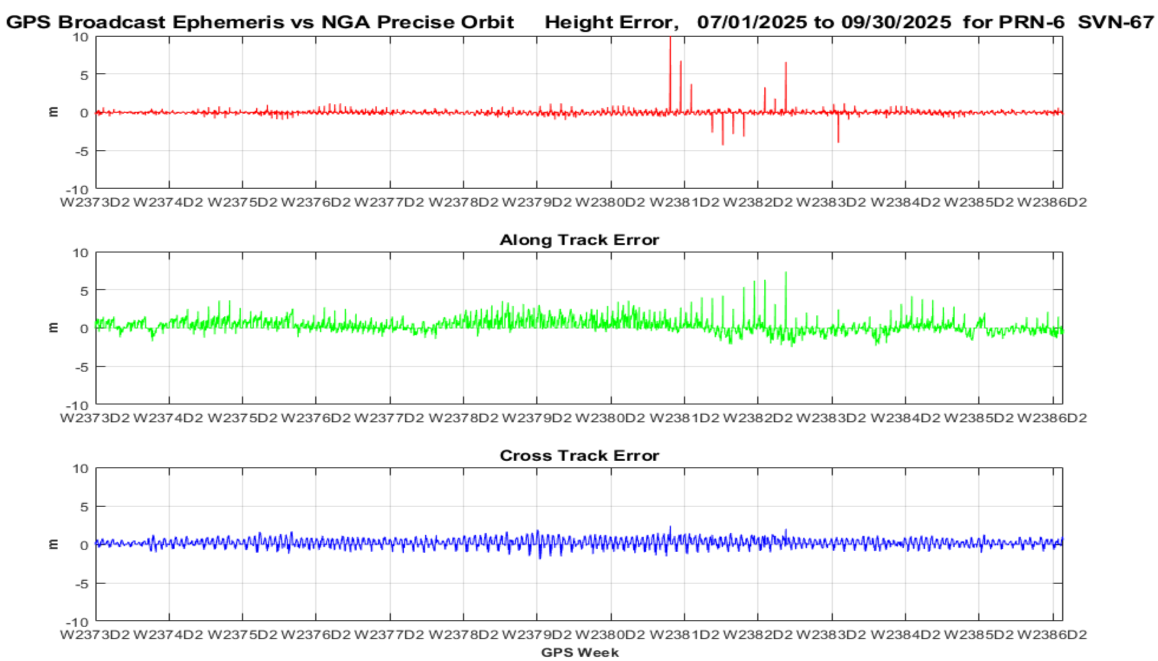

Figure 9-18 Orbit Error PRN6 (SVN67) Using C/A Nav Data

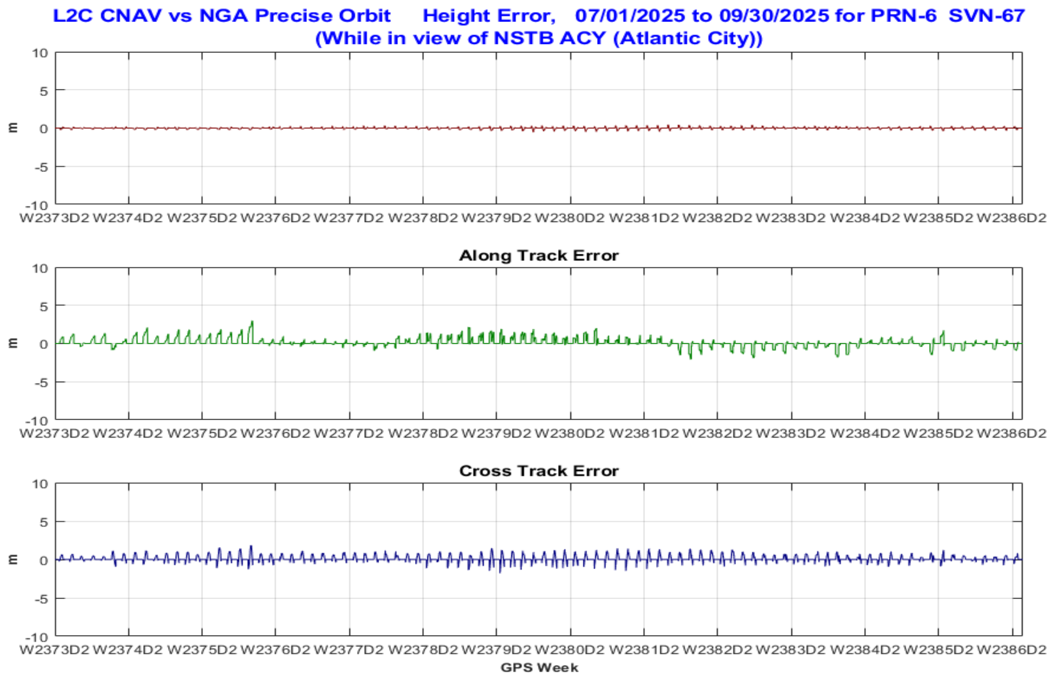

Figure 9-19 Orbit Error PRN6 (SVN67) Using L2C CNAV Data

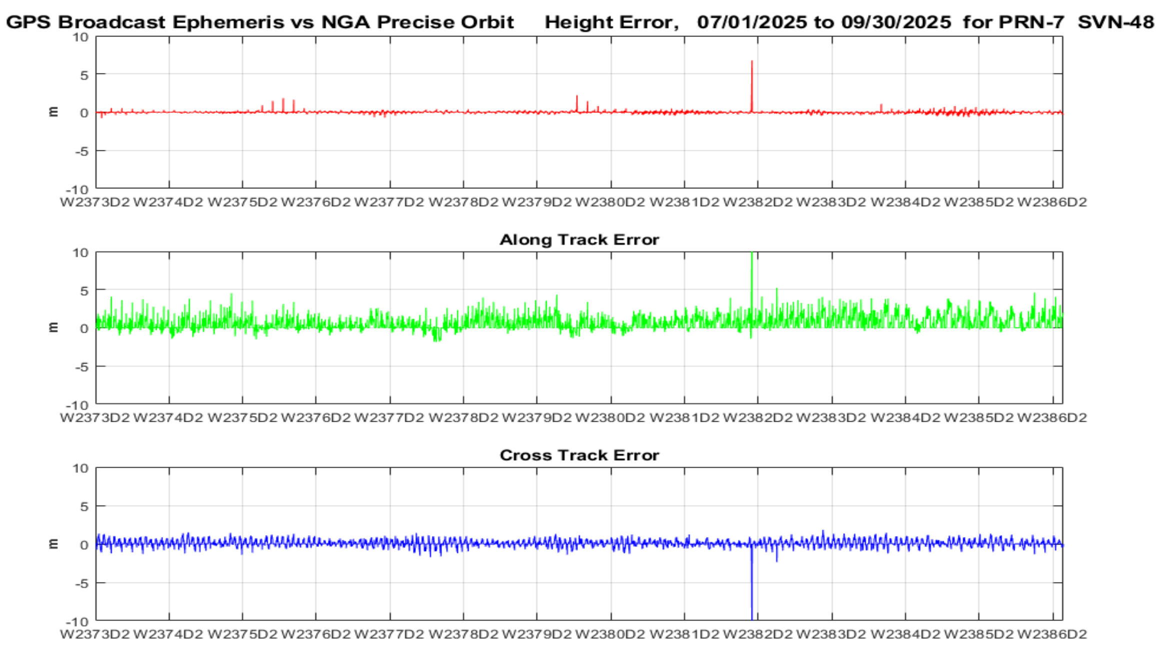

Figure 9-20 Orbit Error PRN7 (SVN48) Using C/A Nav Data

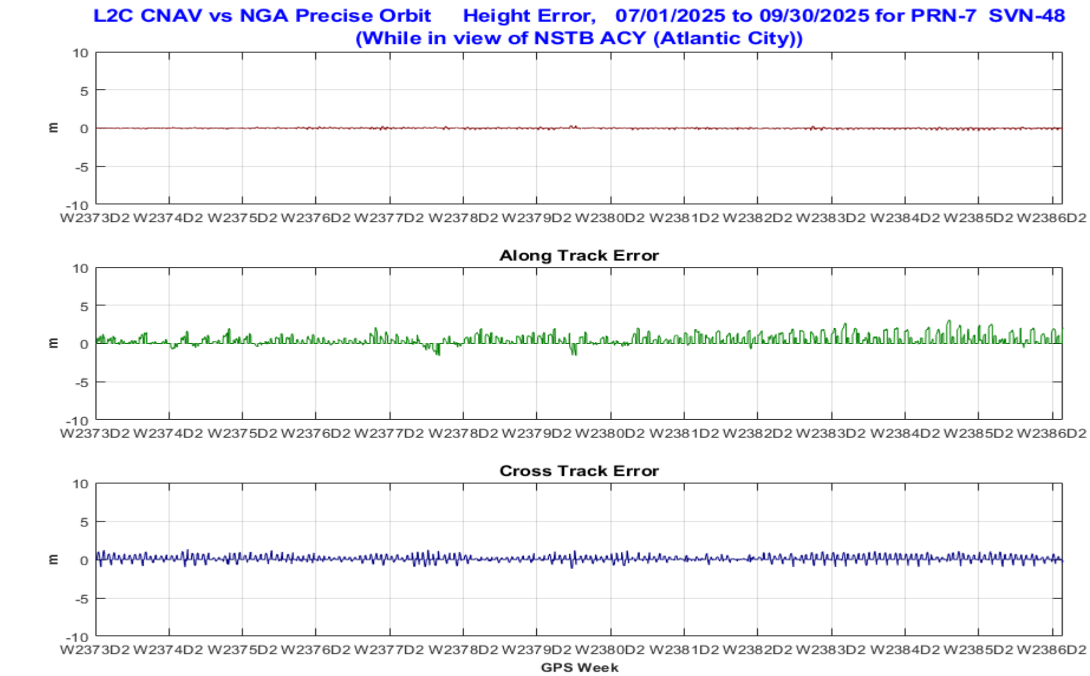

Figure 9-21 Orbit Error PRN7 (SVN48) Using L2C CNAV Data

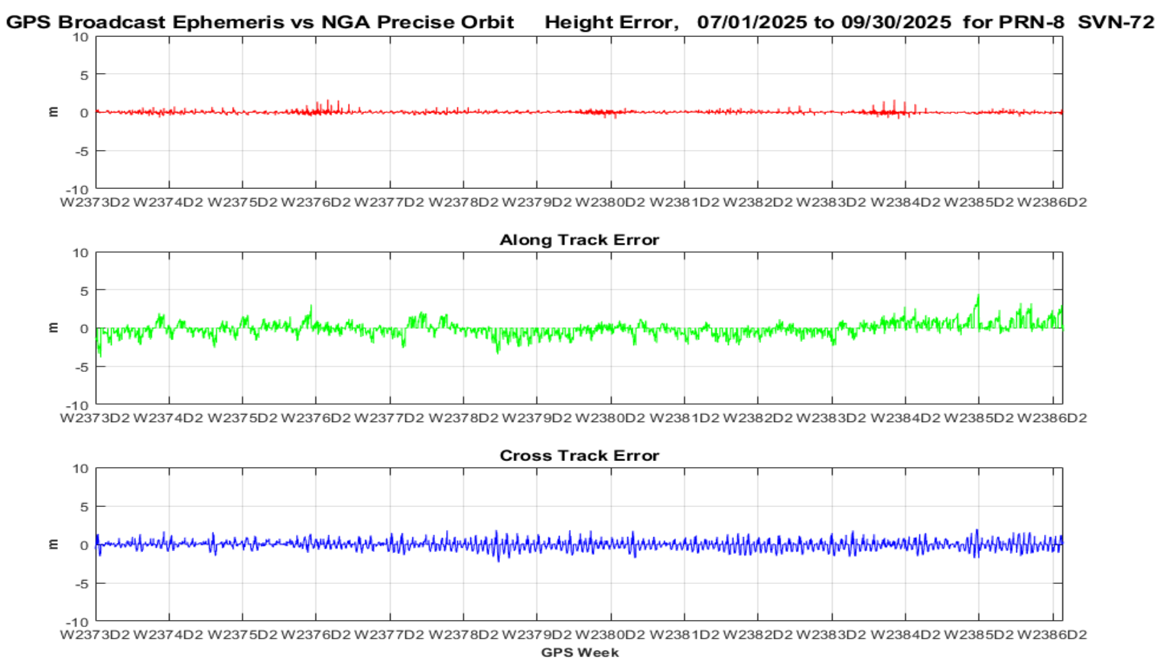

Figure 9-22 Orbit Error PRN8 (SVN72) Using C/A Nav Data

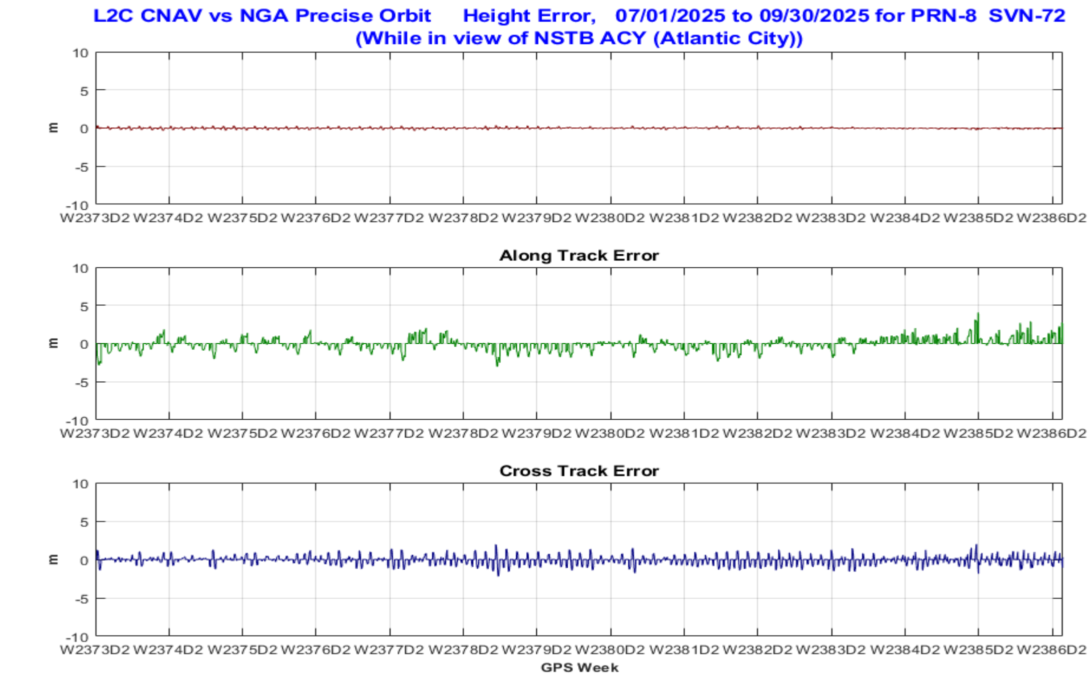

Figure 9-23 Orbit Error PRN8 (SVN72) Using L2C CNAV Data

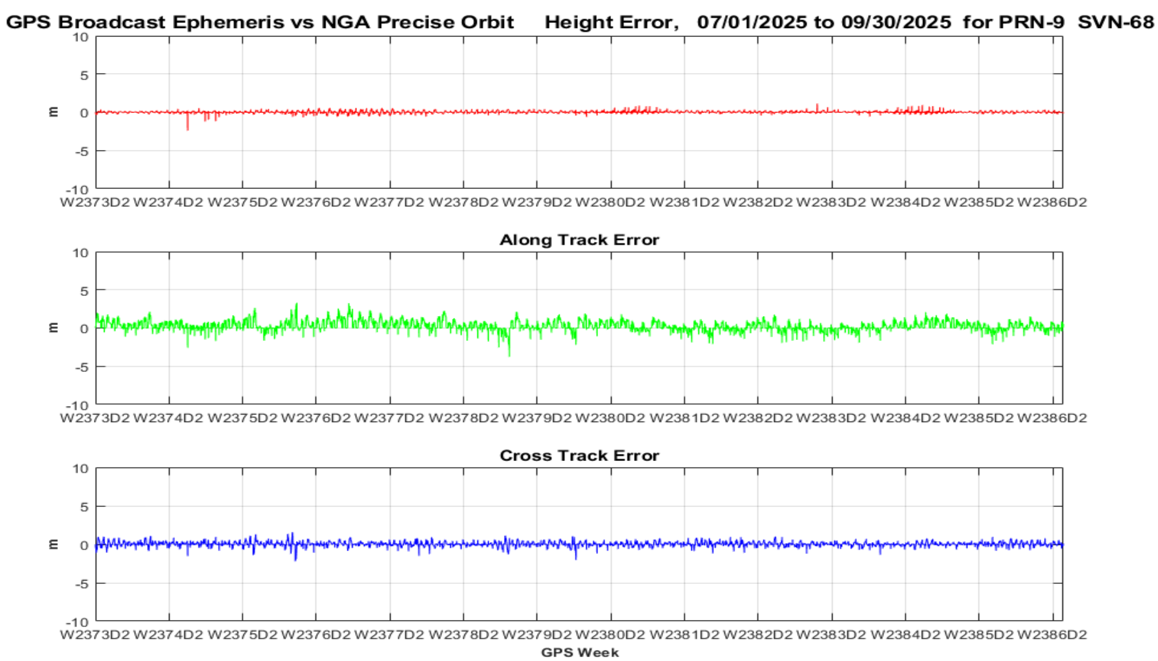

Figure 9-24 Orbit Error PRN9 (SVN68) Using C/A Nav Data

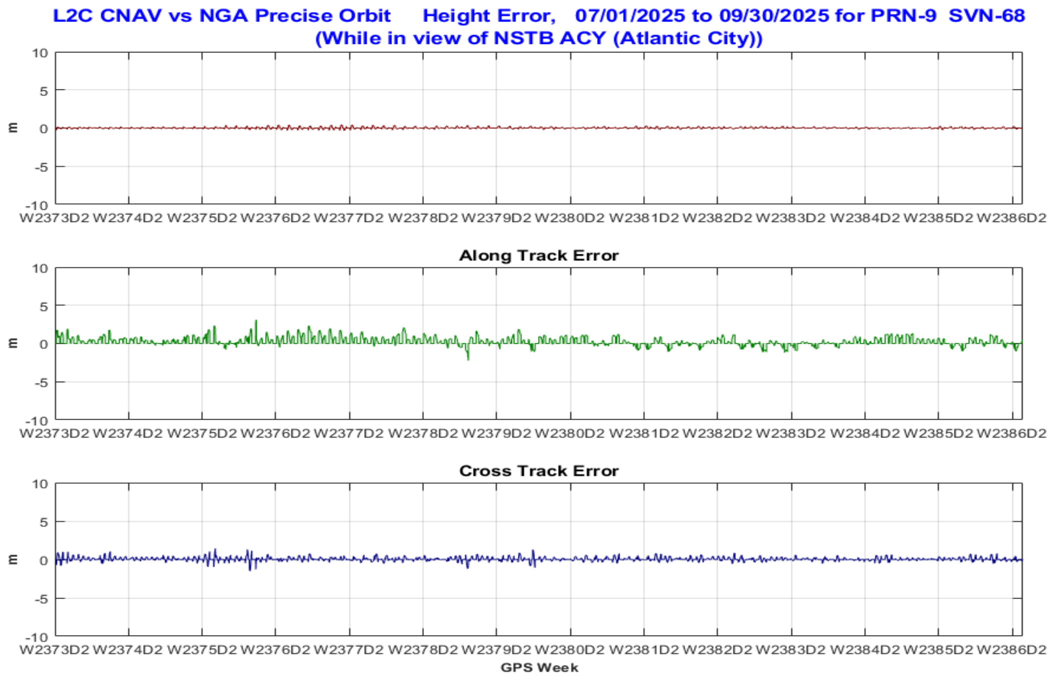

Figure 9-25 Orbit Error PRN9 (SVN68) Using L2C CNAV Data

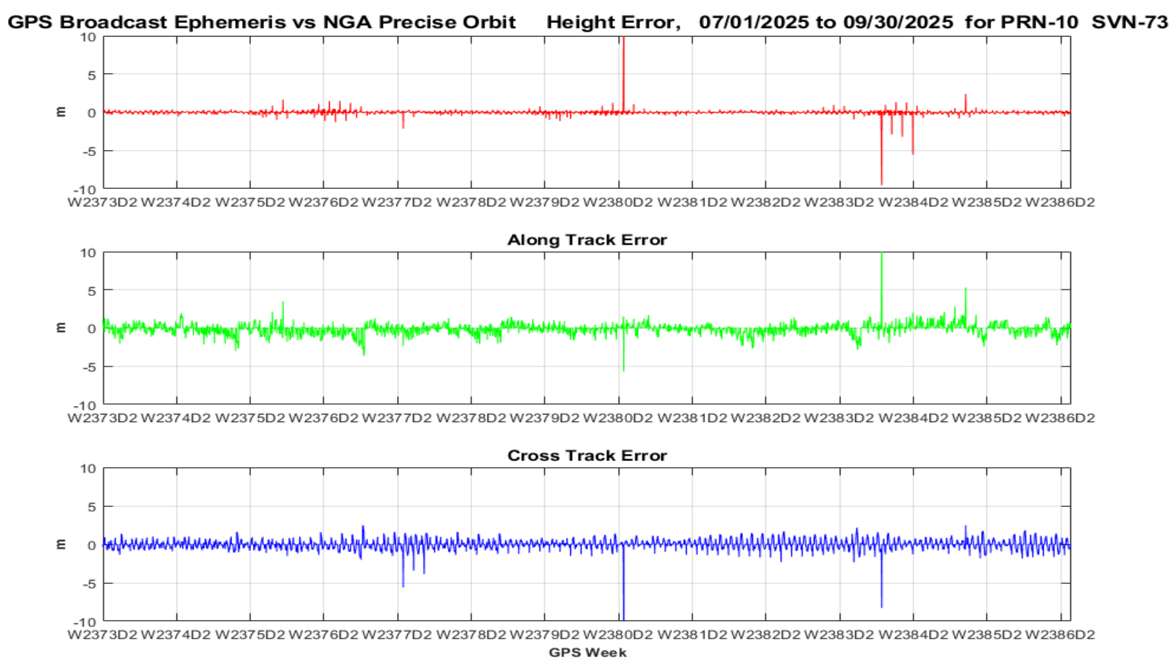

Figure 9-26 Orbit Error PRN10 (SVN73) Using C/A Nav Data

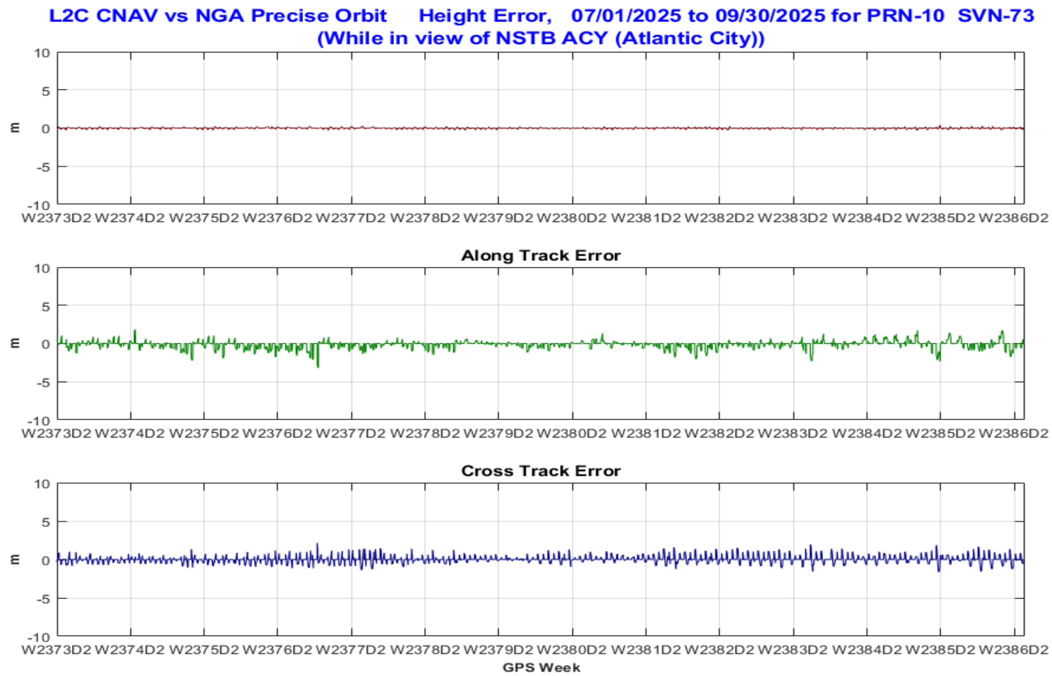

Figure 9-27 Orbit Error PRN10 (SVN73) Using L2C CNAV Data

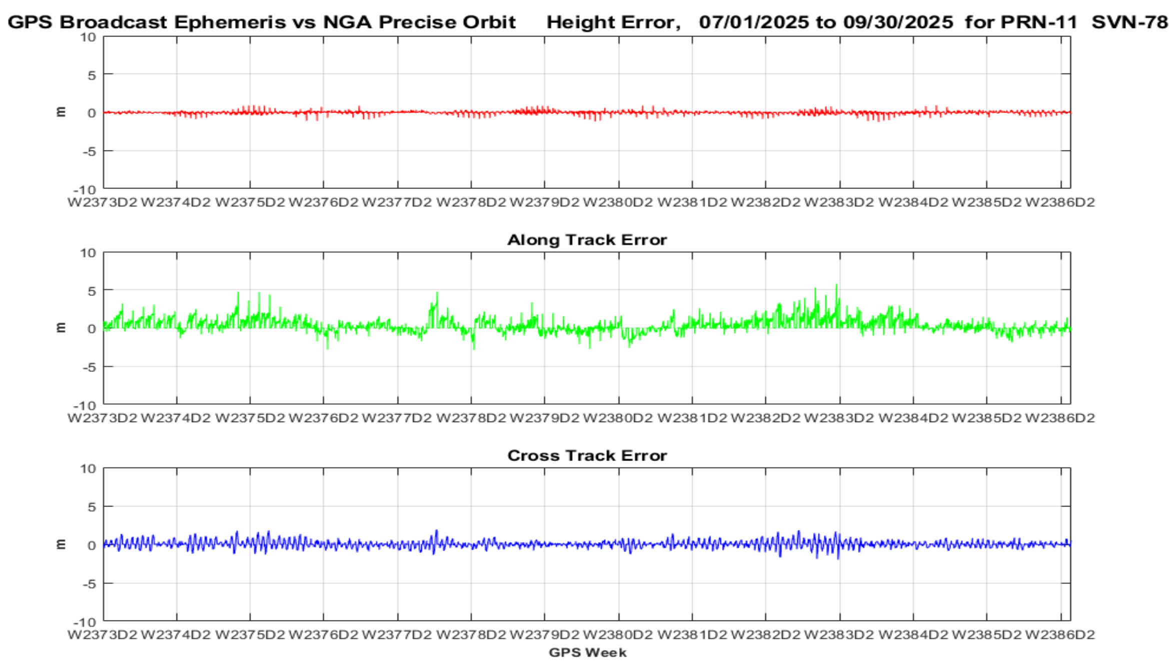

Figure 9-28 Orbit Error PRN11 (SVN78) Using C/A Nav Data

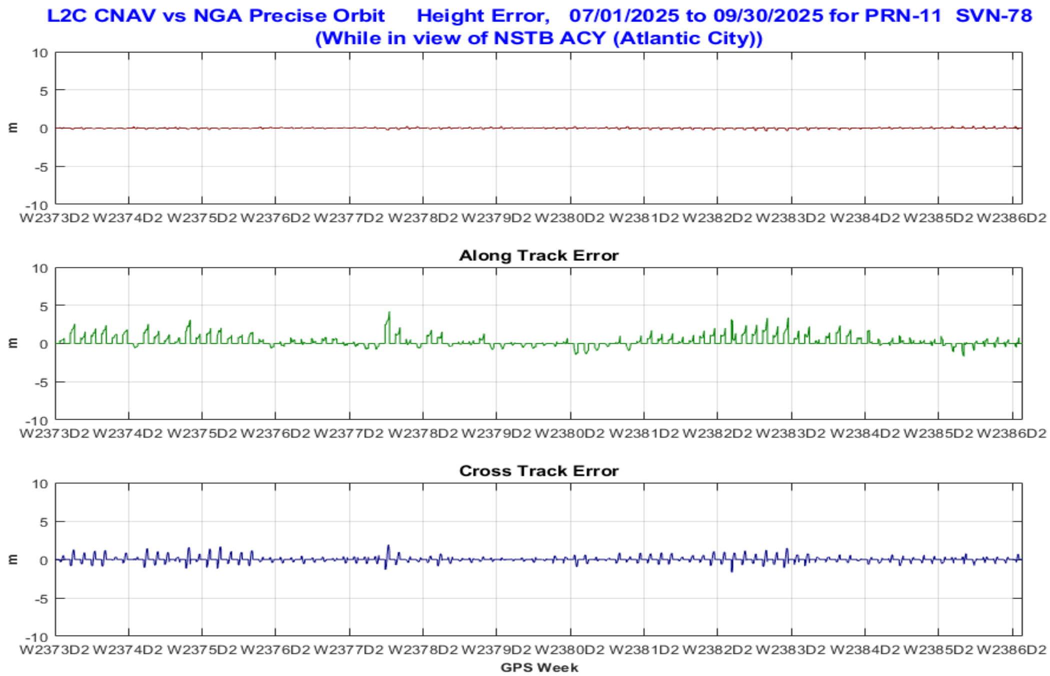

Figure 9-29 Orbit Error PRN11 (SVN78) Using L2C CNAV Data

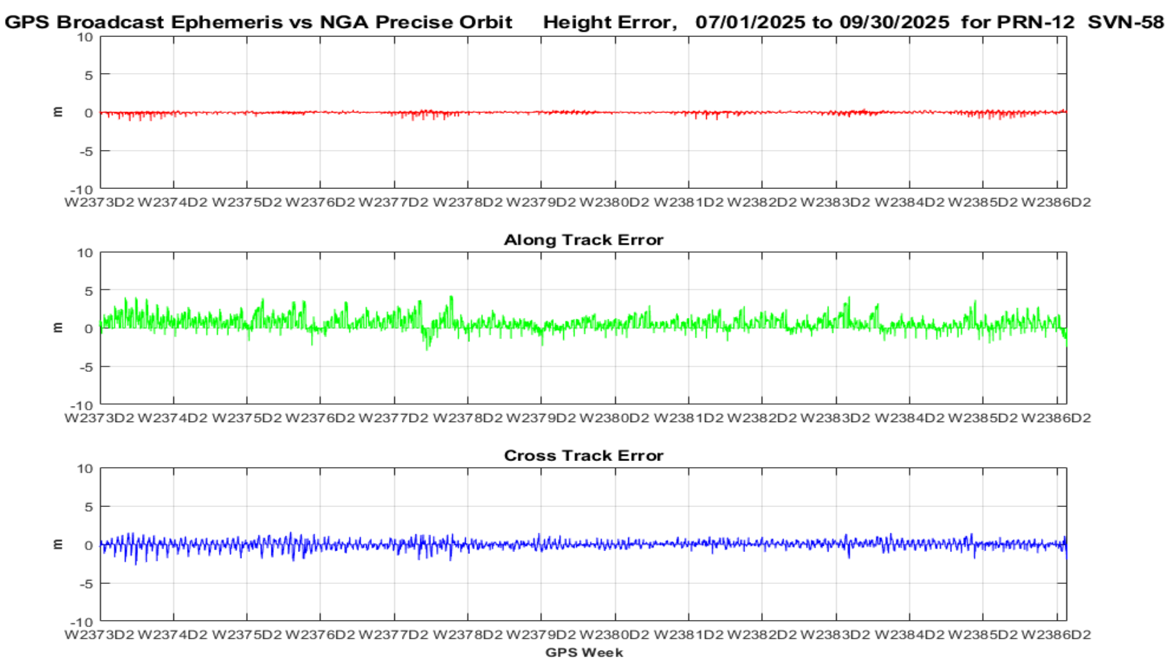

Figure 9-30 Orbit Error PRN12 (SVN58) Using C/A Nav Data

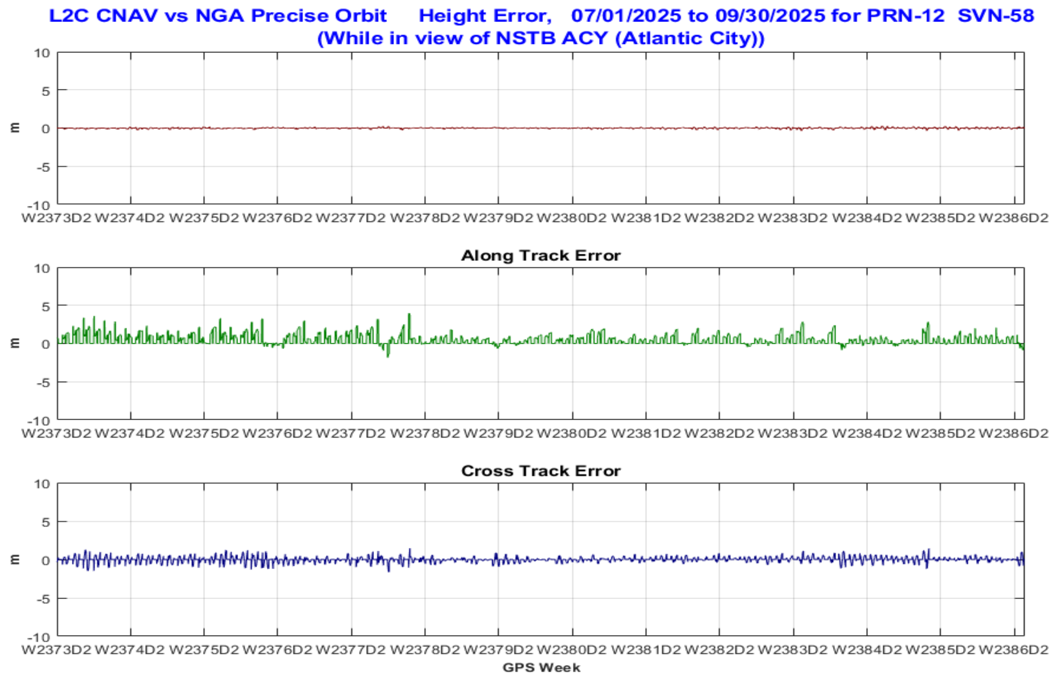

Figure 9-31 Orbit Error PRN12 (SVN58) Using L2C CNAV Data

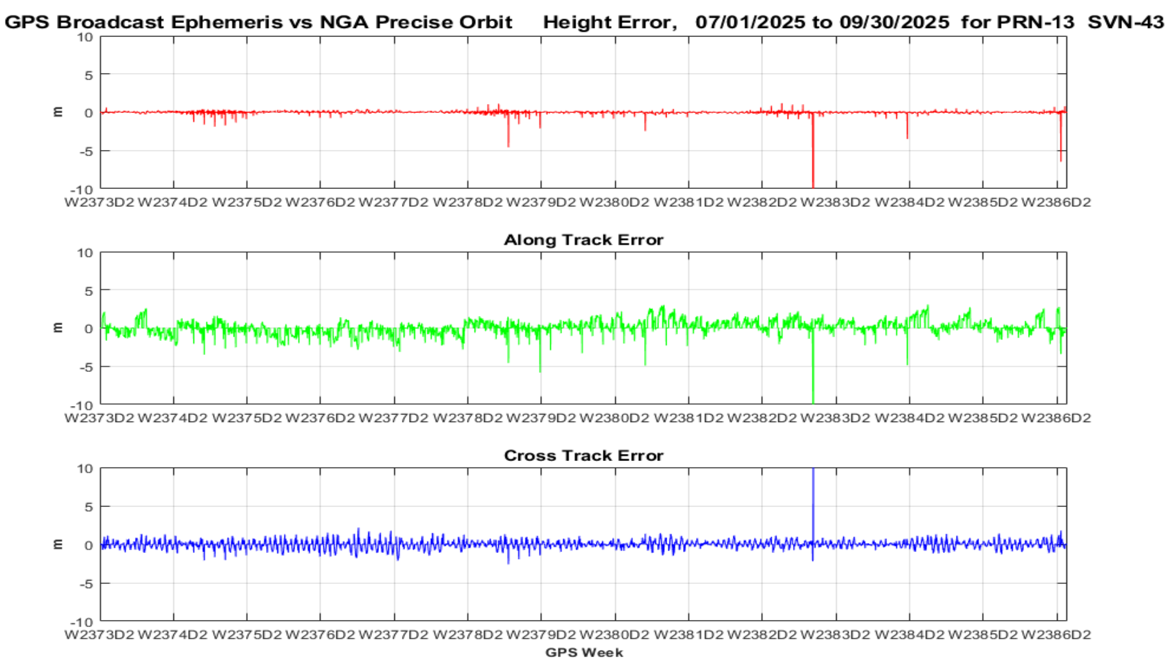

Figure 9-32 Orbit Error PRN13 (SVN43) Using C/A Nav Data

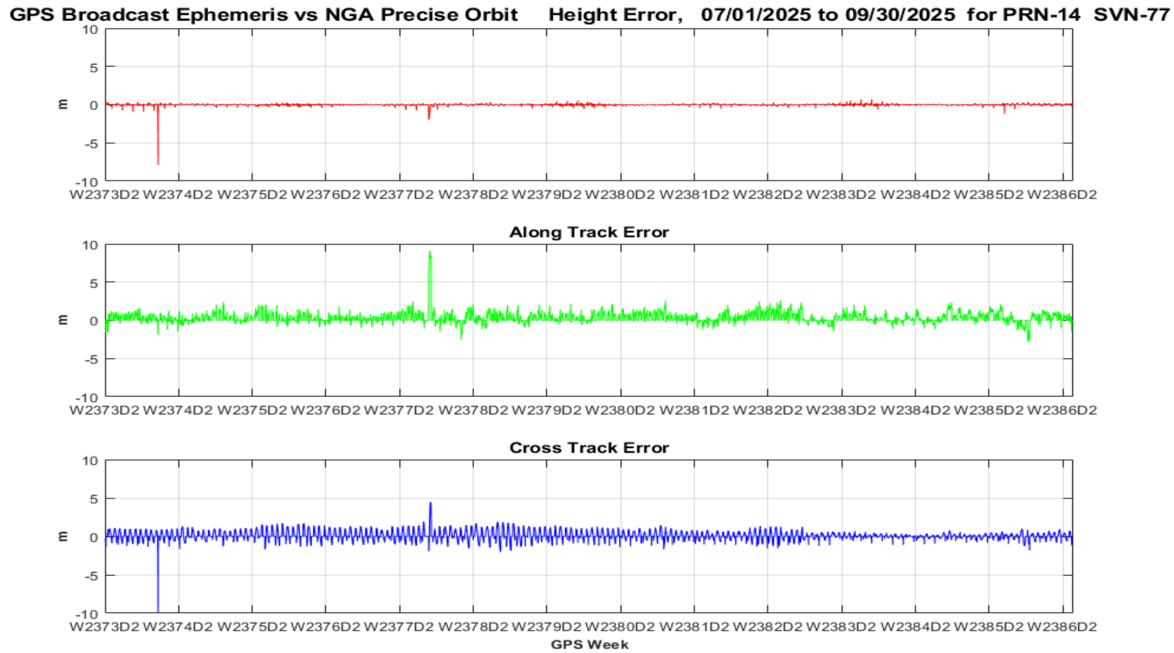

Figure 9-33 Orbit Error PRN14 (SVN77) Using C/A Nav Data

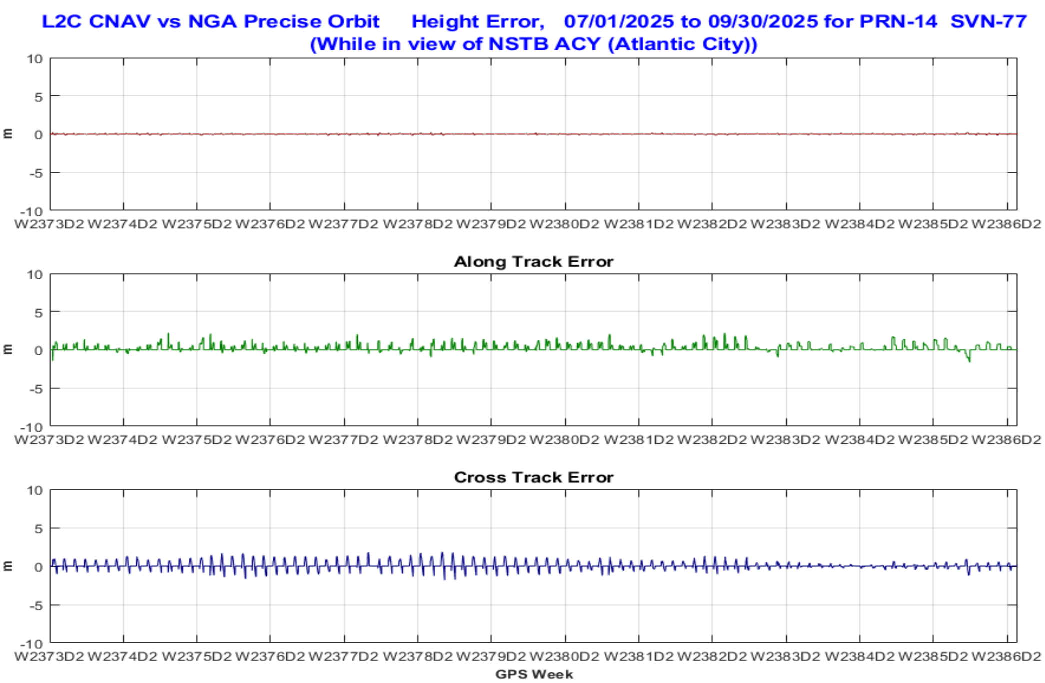

Figure 9-34 Orbit Error PRN14 (SVN77) Using L2C CNAV Data

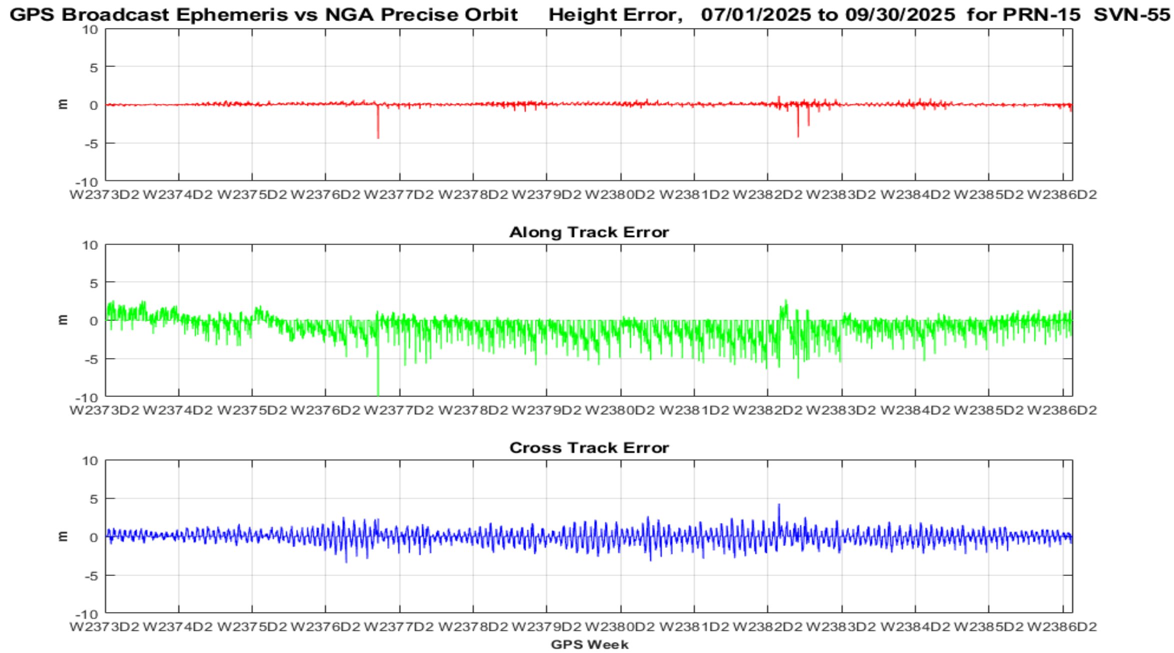

Figure 9-35 Orbit Error PRN15 (SVN55) Using C/A Nav Data

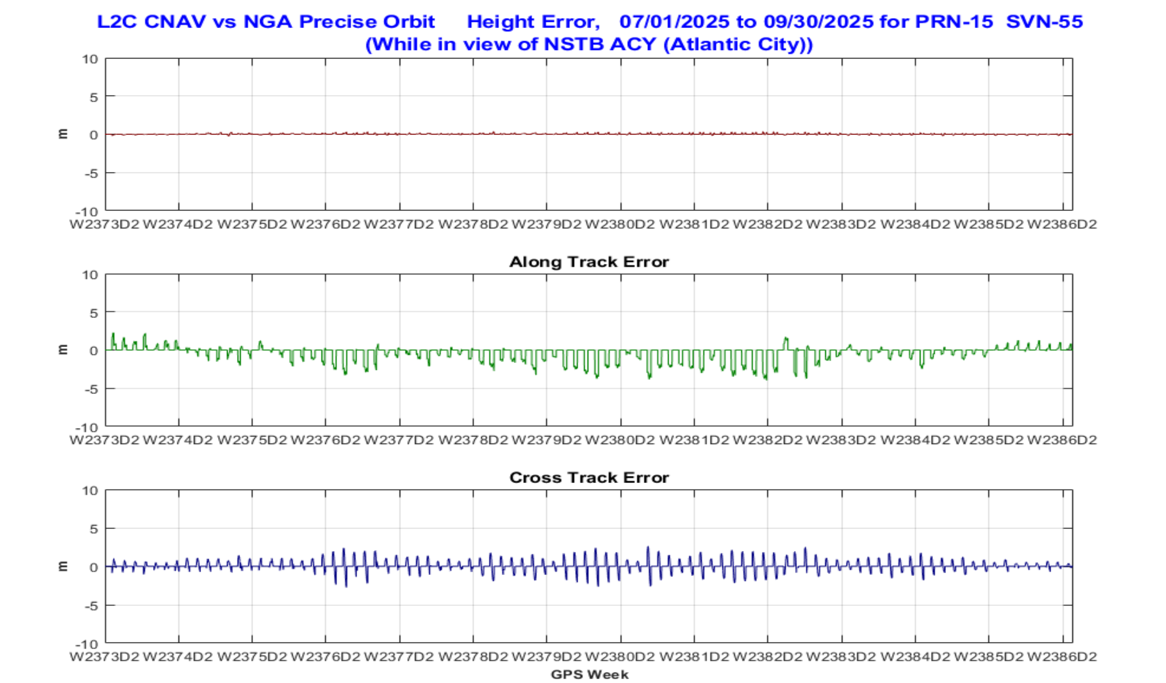

Figure 9-36 Orbit Error PRN15 (SVN55) Using L2C CNAV Data

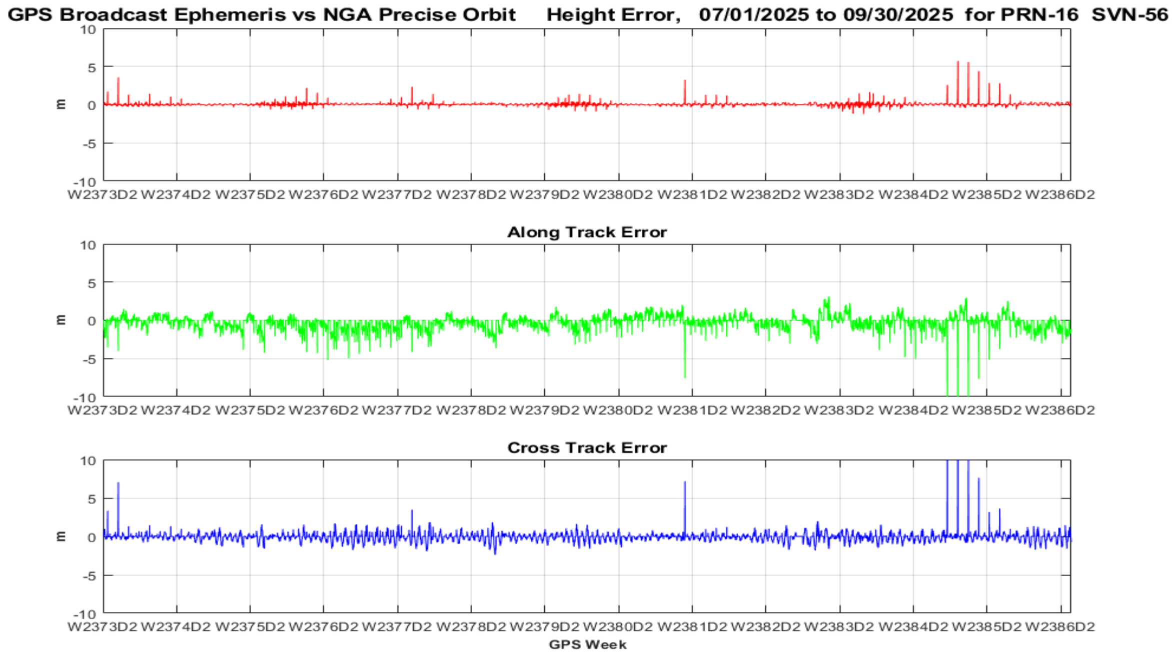

Figure 9-37 Orbit Error PRN16 (SVN56) Using C/A Nav Data

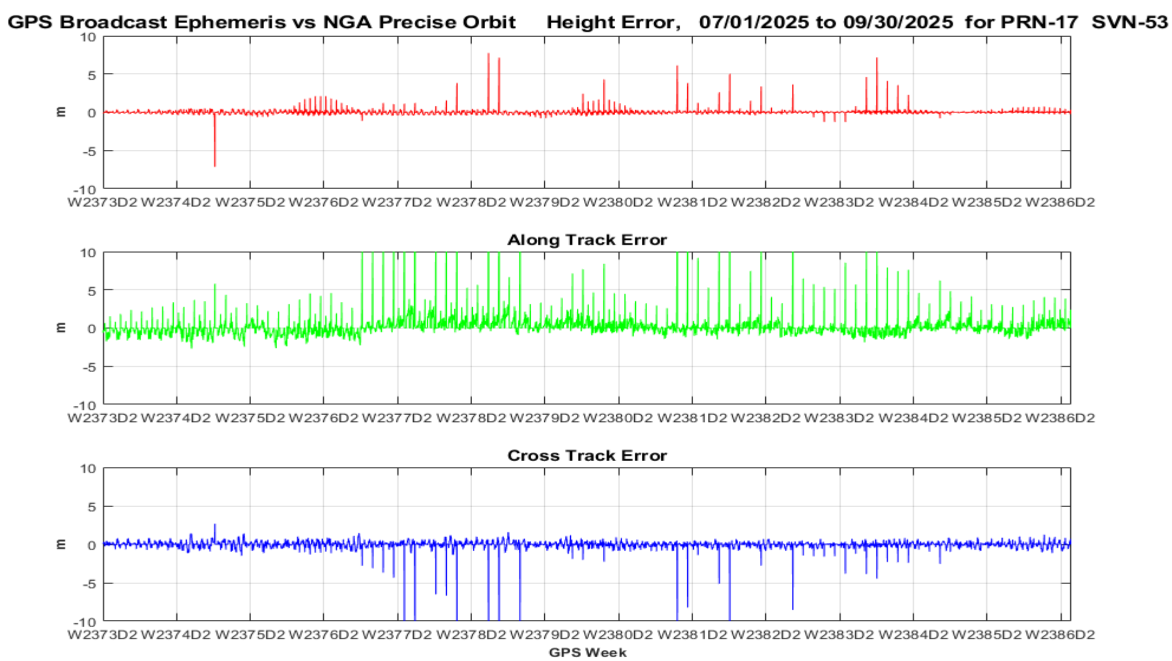

Figure 9-38 Orbit Error PRN17 (SVN53) Using C/A Nav Data

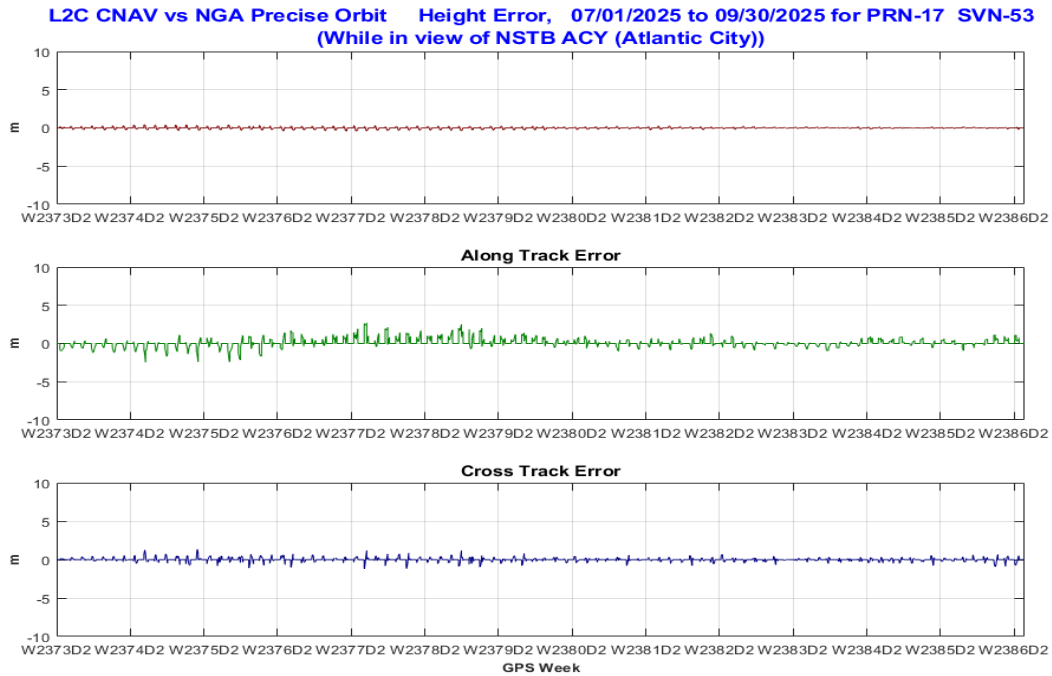

Figure 9-39 Orbit Error PRN17 (SVN53) Using L2C CNAV Data

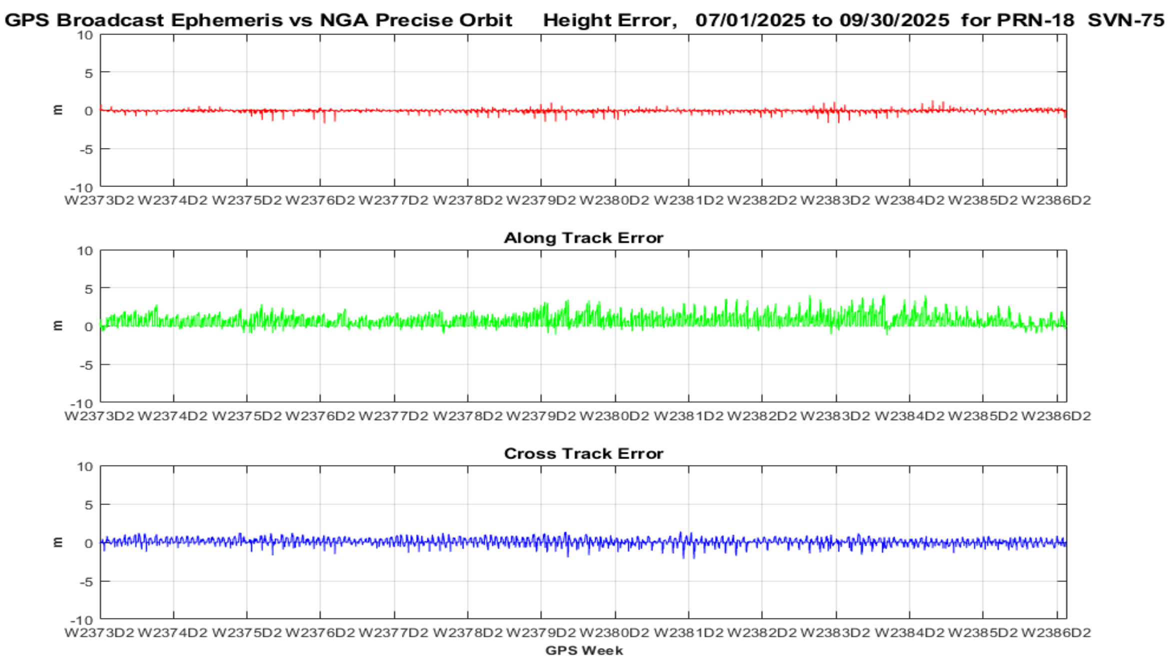

Figure 9-40 Orbit Error PRN18 (SVN75) Using C/A Nav Data

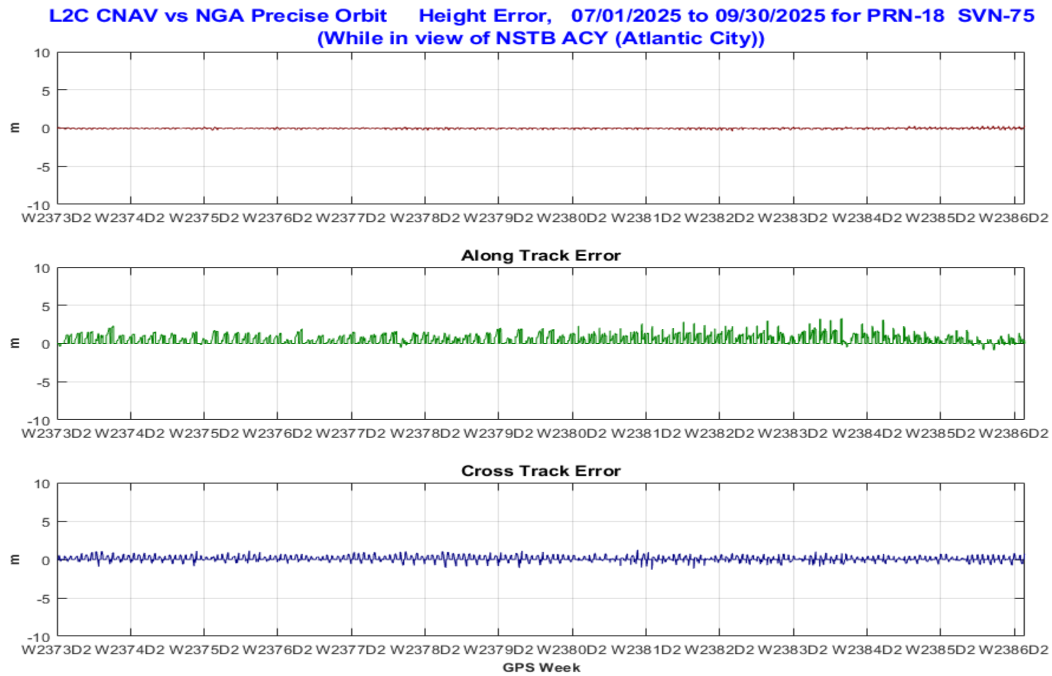

Figure 9-41 Orbit Error PRN18 (SVN75) Using L2C CNAV Data

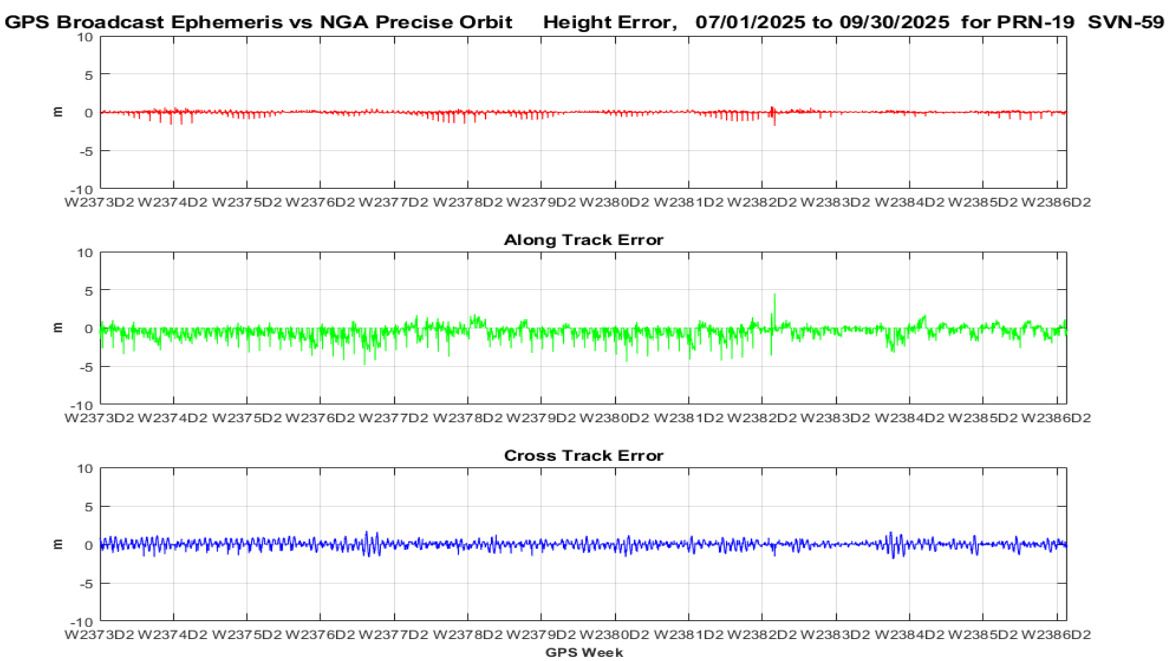

Figure 9-42 Orbit Error PRN19 (SVN59) Using C/A Nav Data

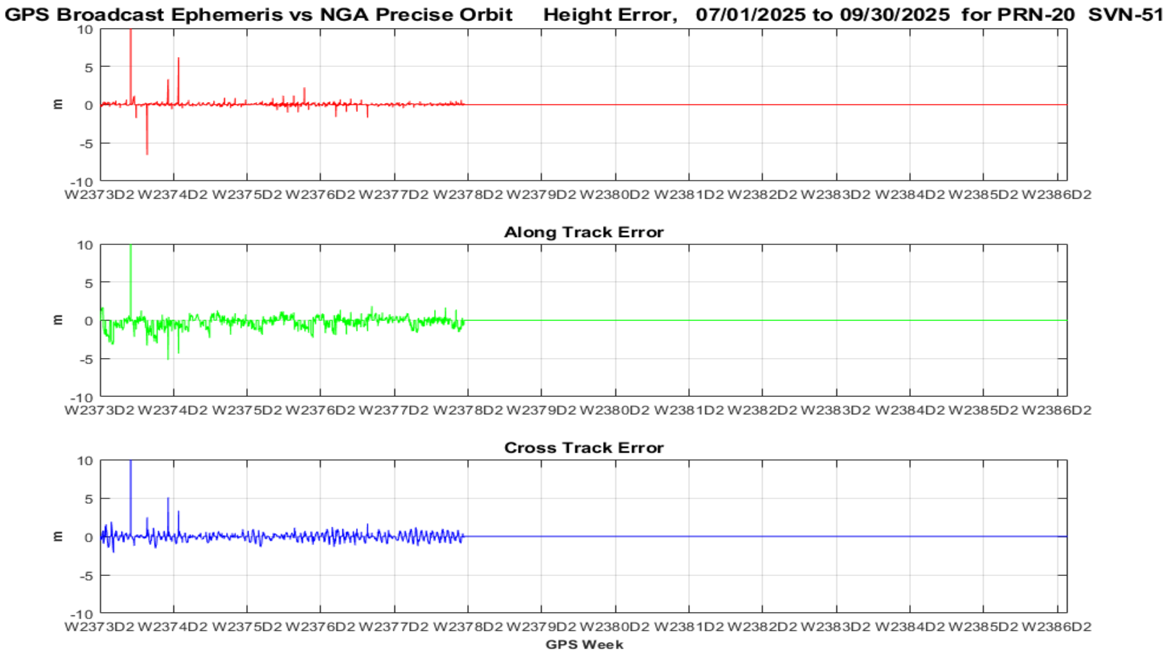

Figure 9-43 Orbit Error PRN20 (SVN51) Using C/A Nav Data

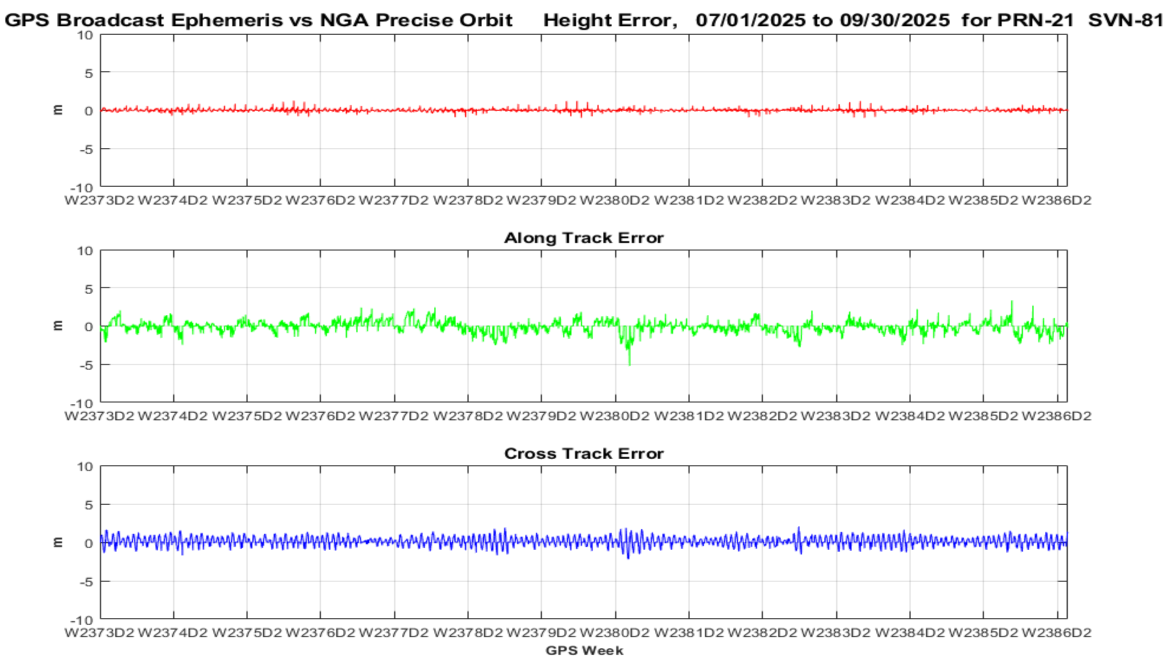

Figure 9-44 Orbit Error PRN21 (SVN81) Using C/A Nav Data

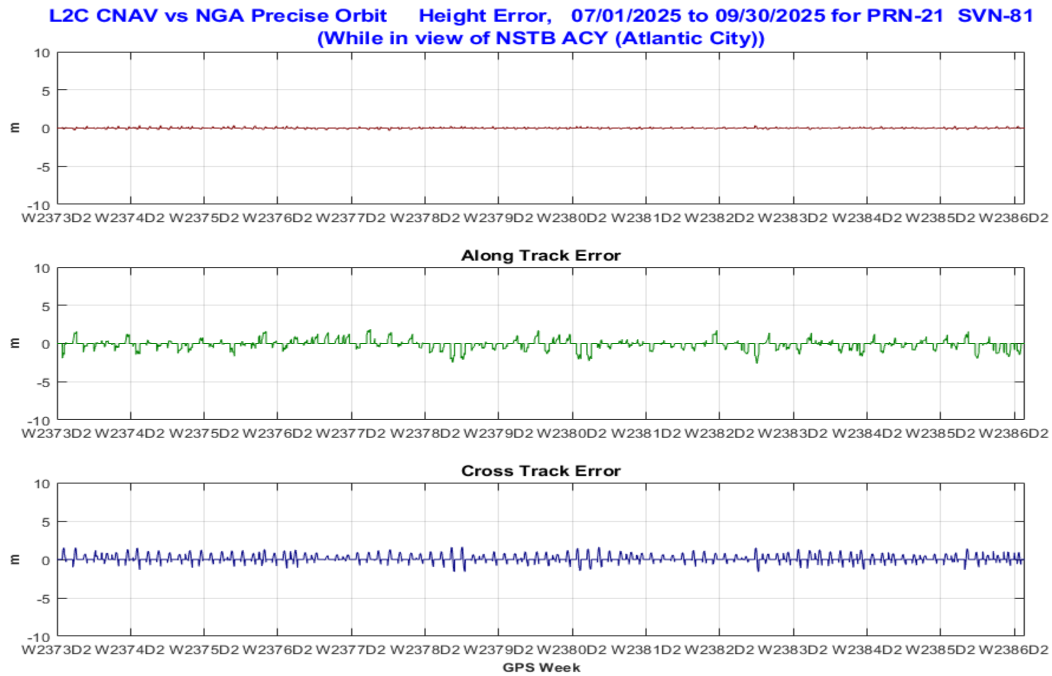

Figure 9-45 Orbit Error PRN21 (SVN81) Using L2C CNAV Data

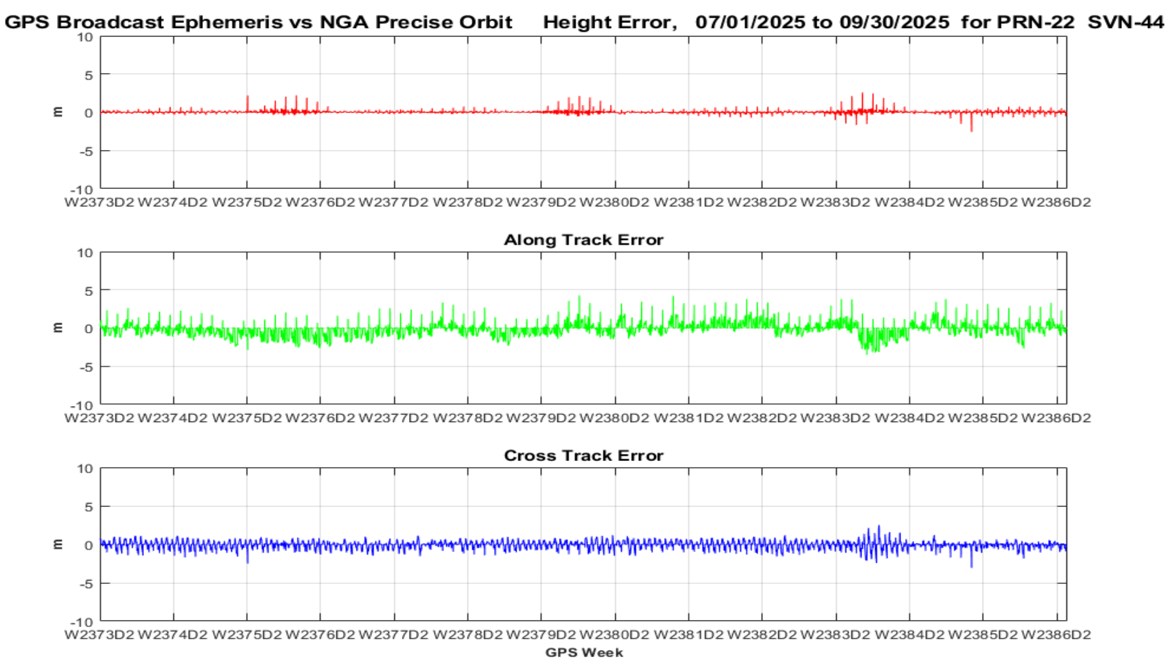

Figure 9-46 Orbit Error PRN22 (SVN44) Using C/A Nav Data

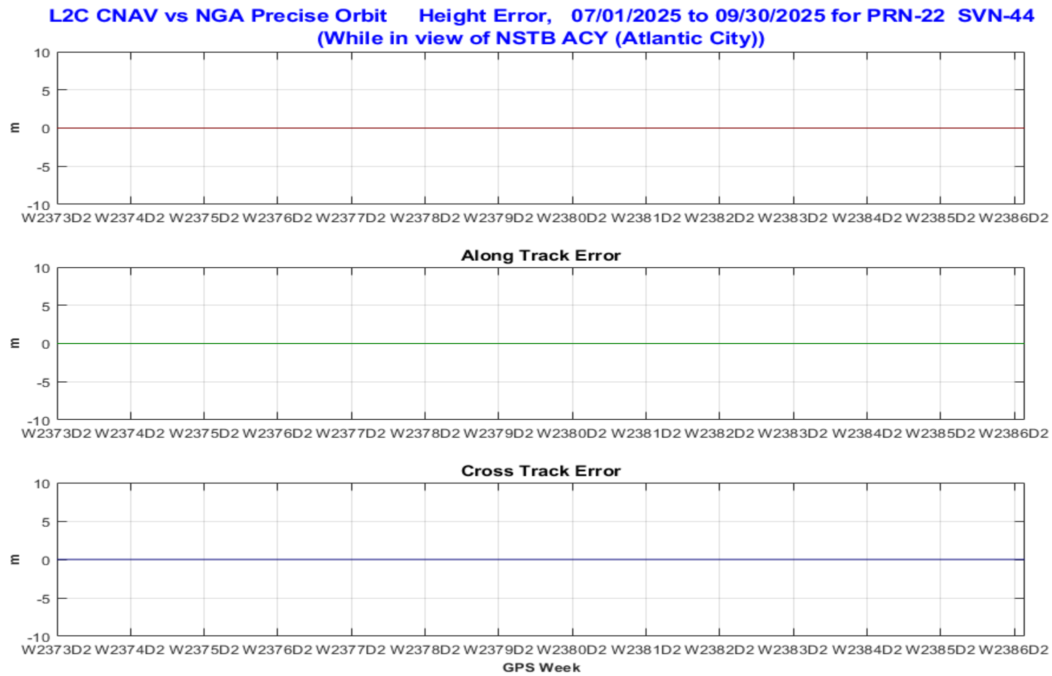

Figure 9-47 Orbit Error PRN22 (SVN44) Using L2C CNAV Data

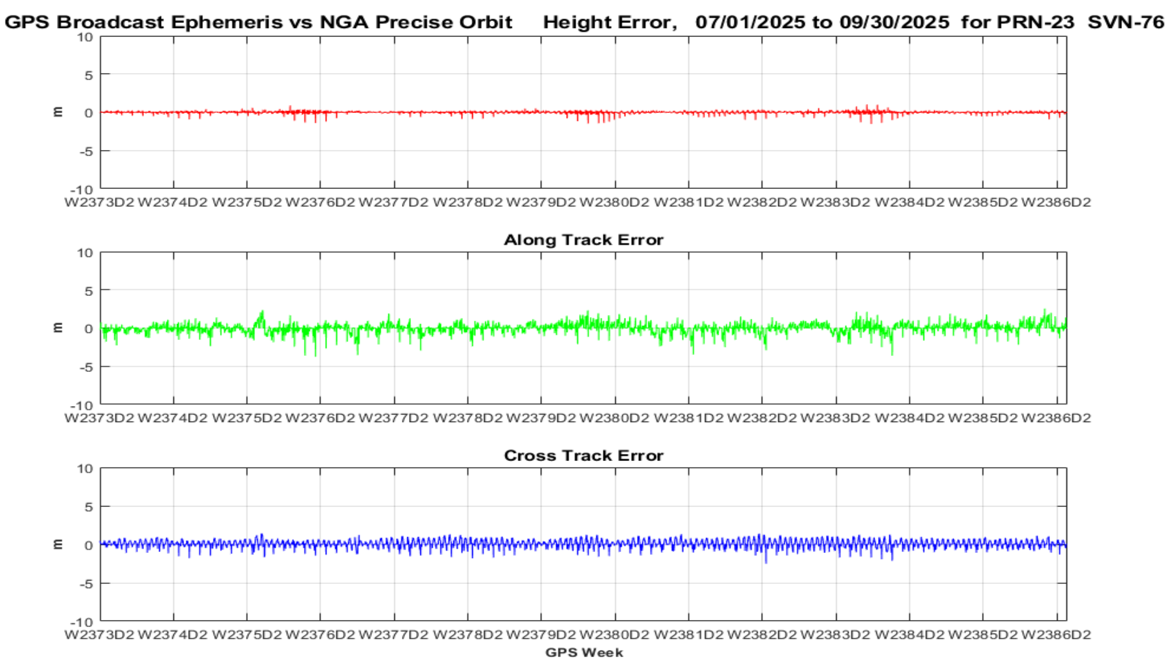

Figure 9-48 Orbit Error PRN23 (SVN76) Using C/A Nav Data

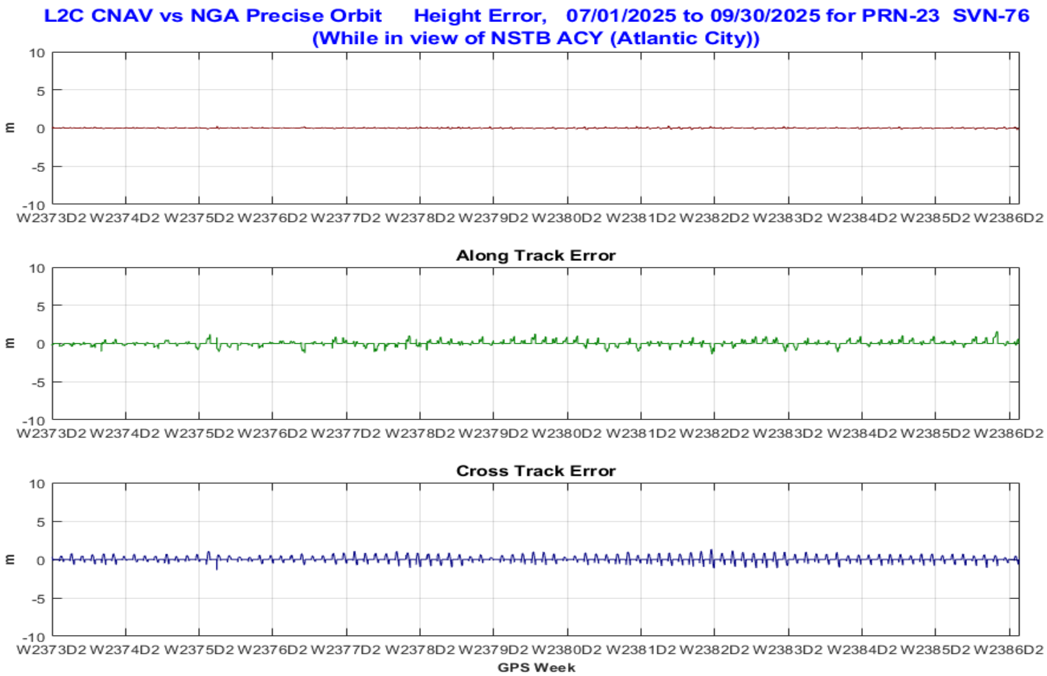

Figure 9-49 Orbit Error PRN23 (SVN76) Using L2C CNAV Data

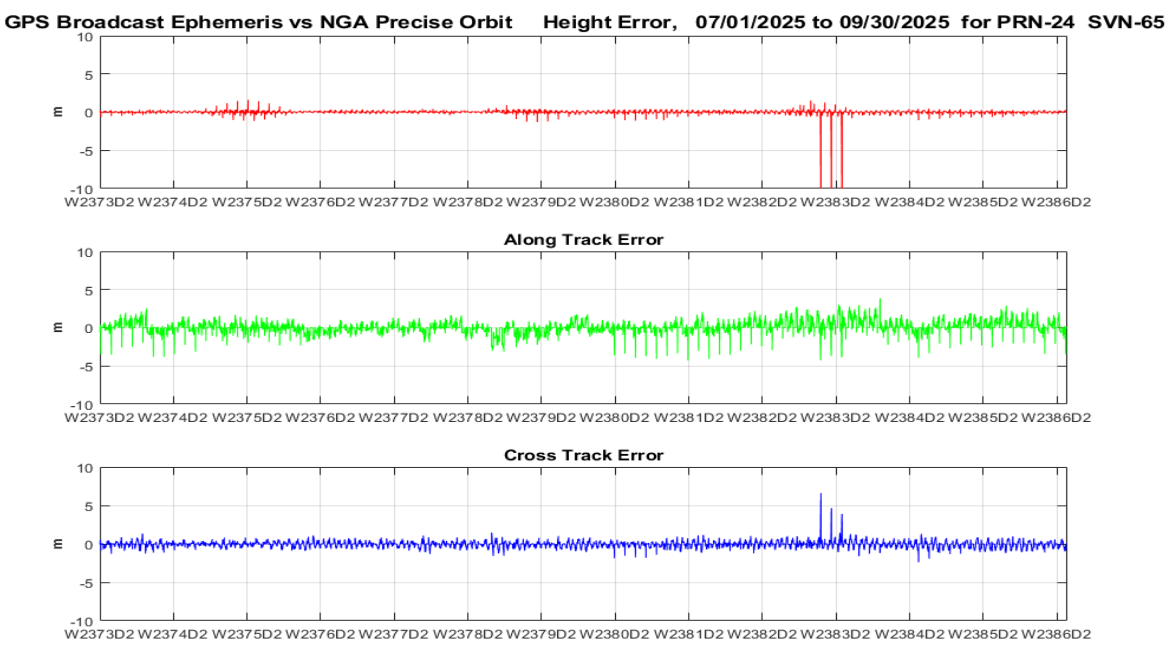

Figure 9-50 Orbit Error PRN24 (SVN65) Using C/A Nav Data

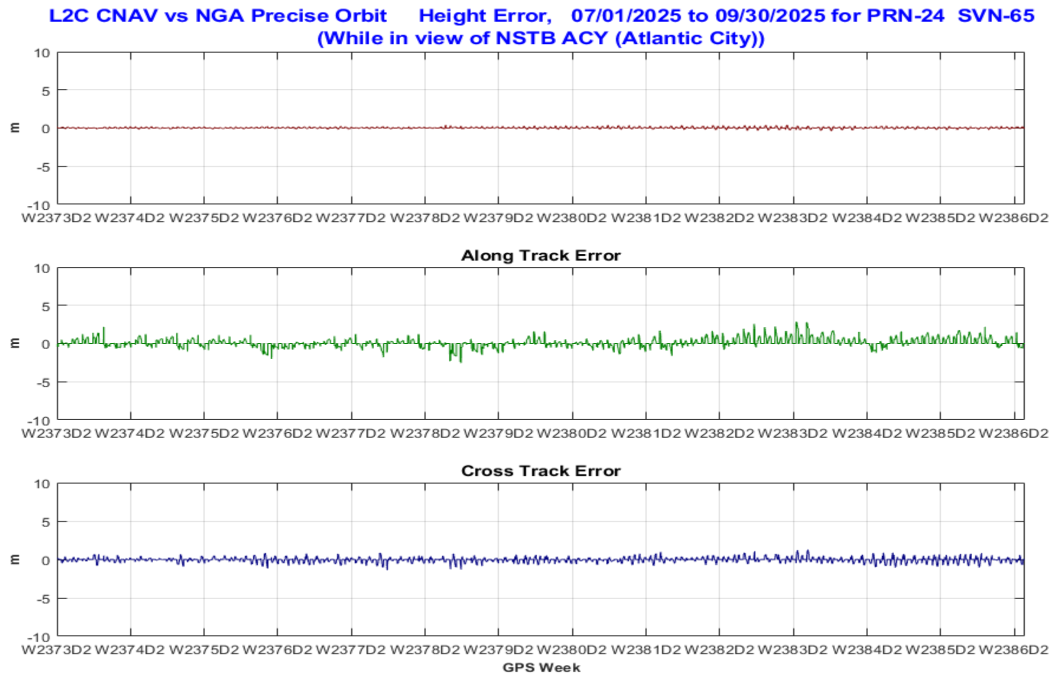

Figure 9-51 Orbit Error PRN24 (SVN65) Using L2C CNAV Data

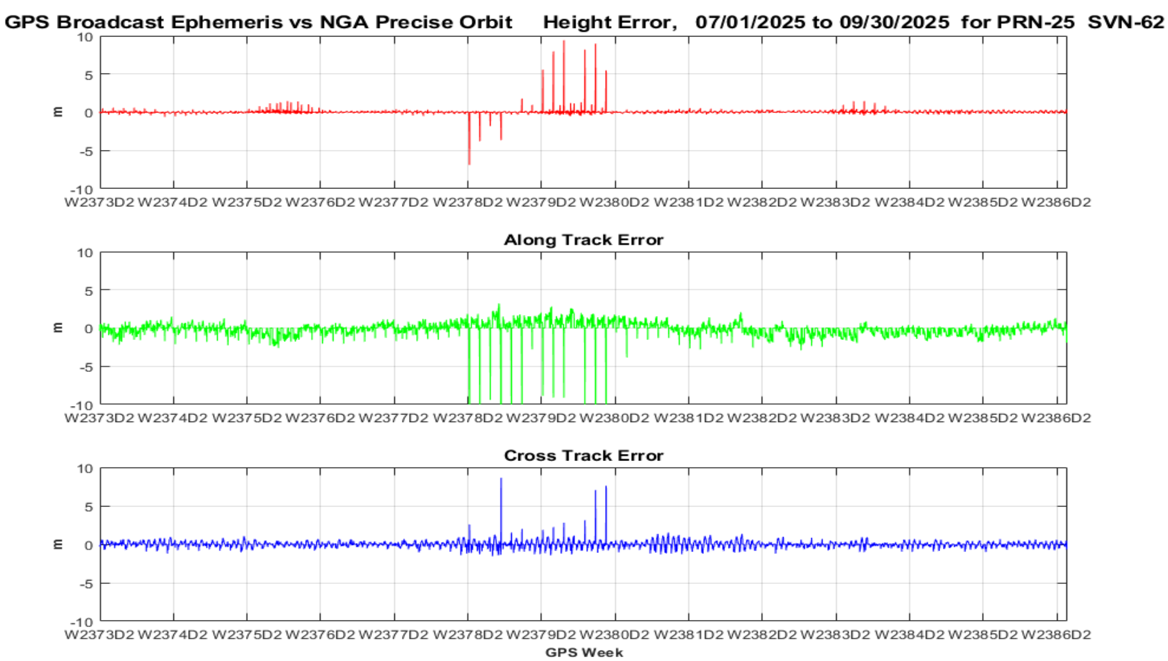

Figure 9-52 Orbit Error PRN25 (SVN62) Using C/A Nav Data

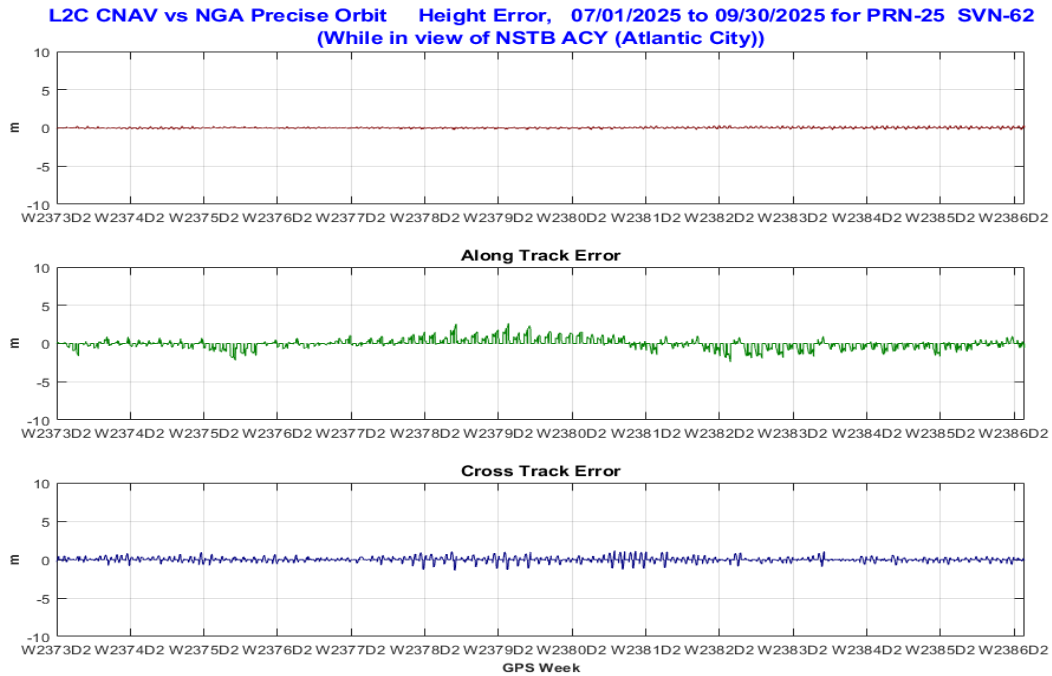

Figure 9-53 Orbit Error PRN25 (SVN62) Using L2C CNAV Data

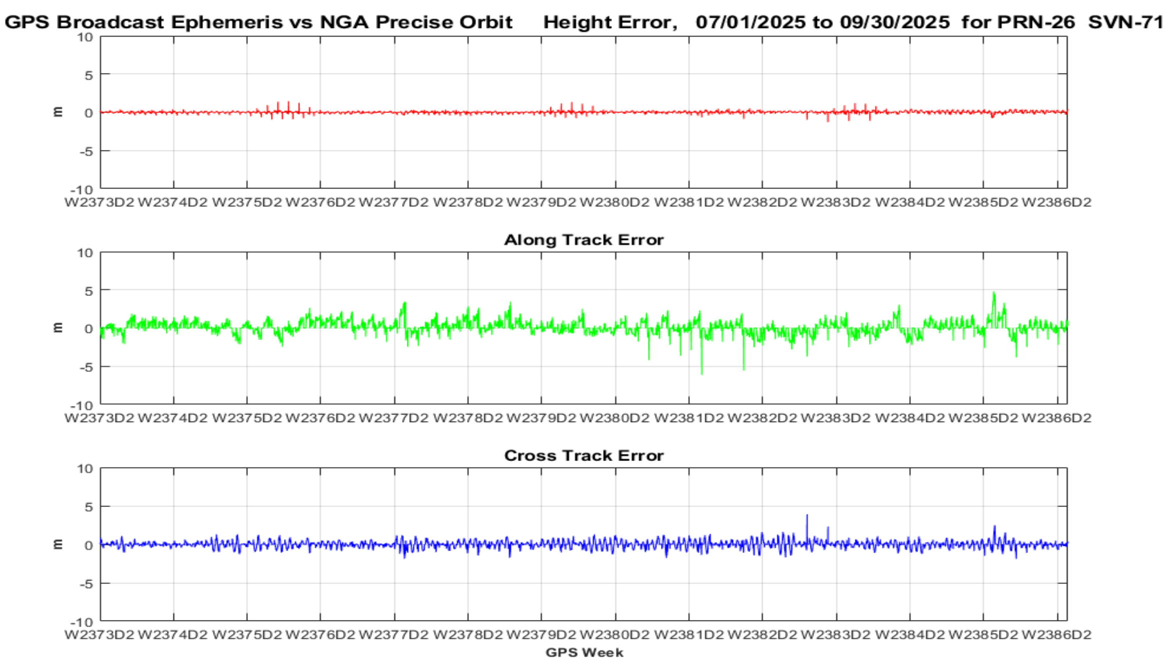

Figure 9-54 Orbit Error PRN26 (SVN71) Using C/A Nav Data

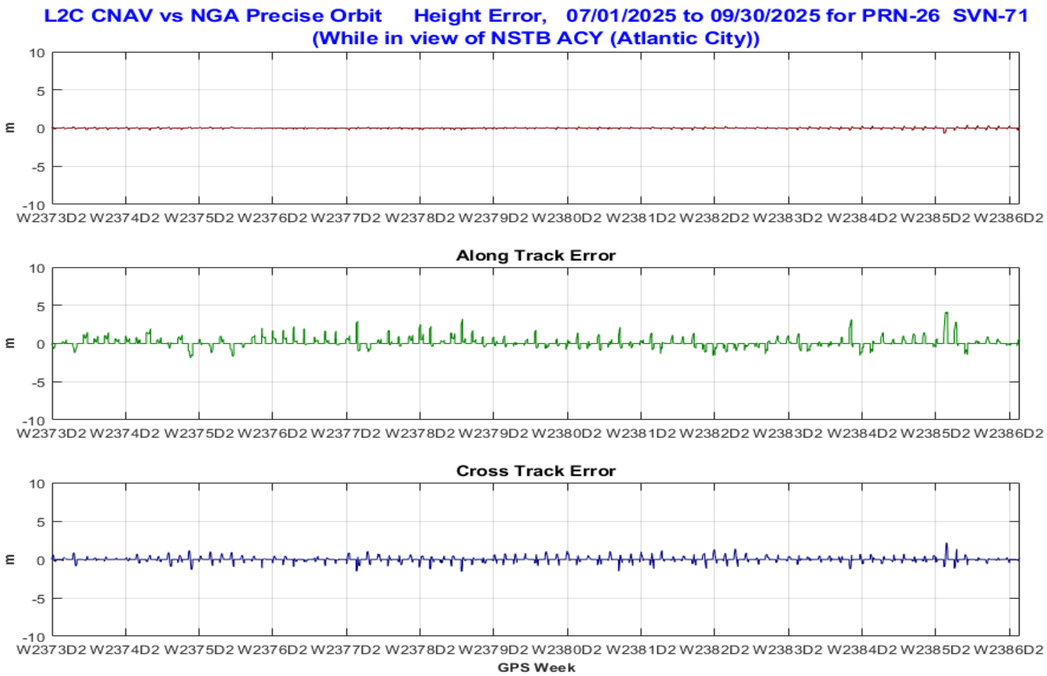

Figure 9-55 Orbit Error PRN26 (SVN71) Using L2C CNAV Data

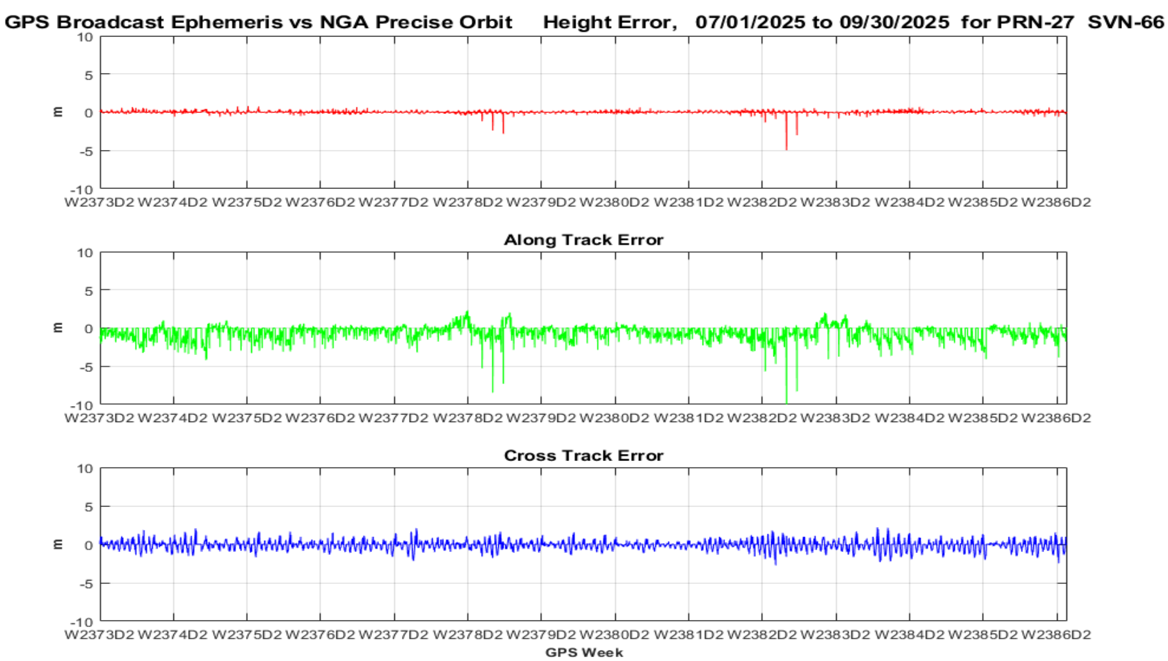

Figure 9-56 Orbit Error PRN27 (SVN66) Using C/A Nav Data

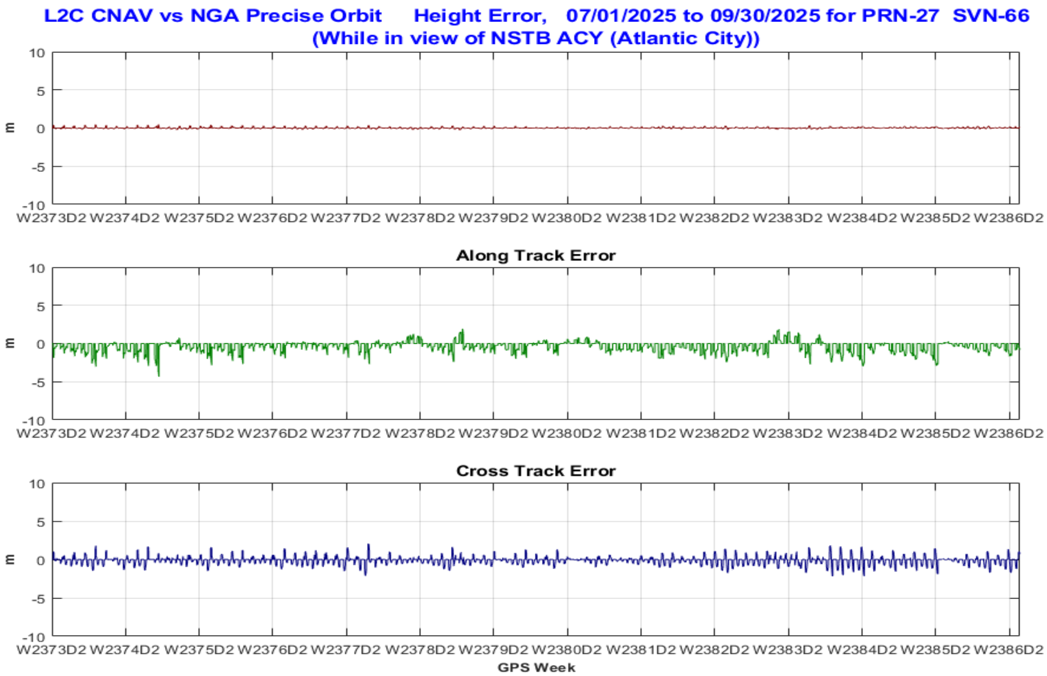

Figure 9-57 Orbit Error PRN27 (SVN66) Using L2C CNAV Data

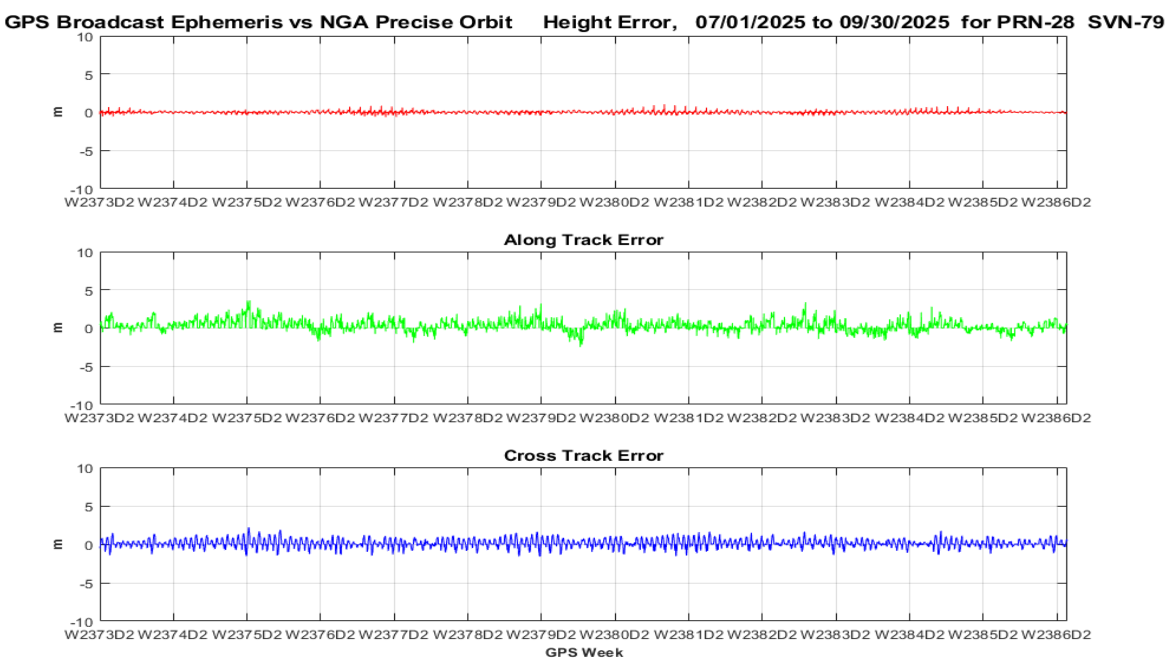

Figure 9-58 Orbit Error PRN28 (SVN79) Using C/A Nav Data

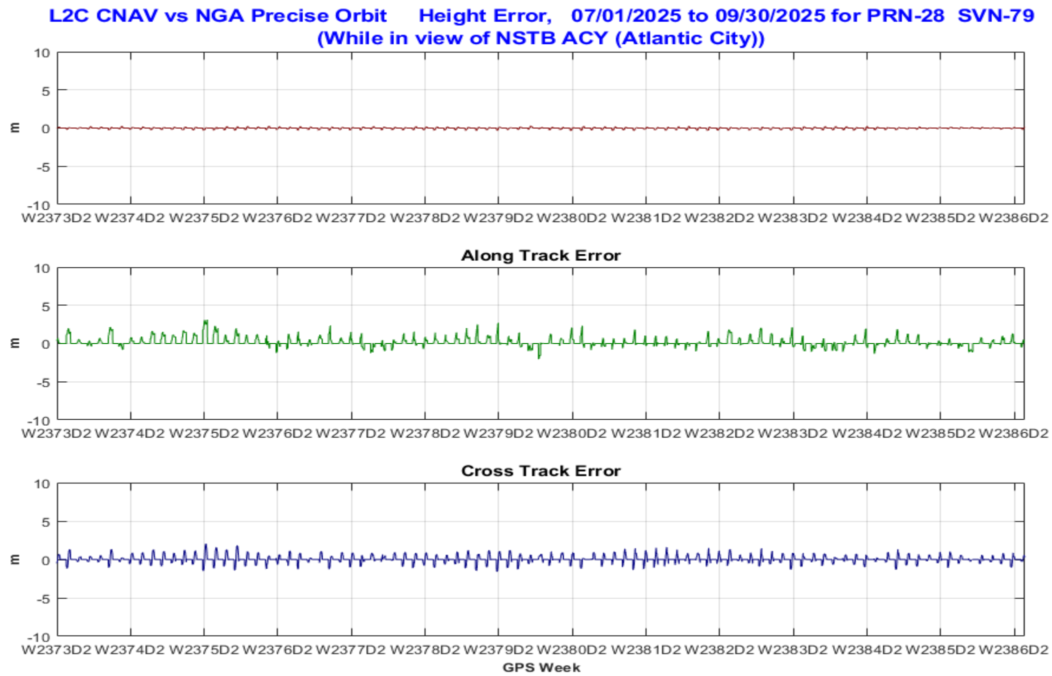

Figure 9-59 Orbit Error PRN28 (SVN79) Using L2C CNAV Data

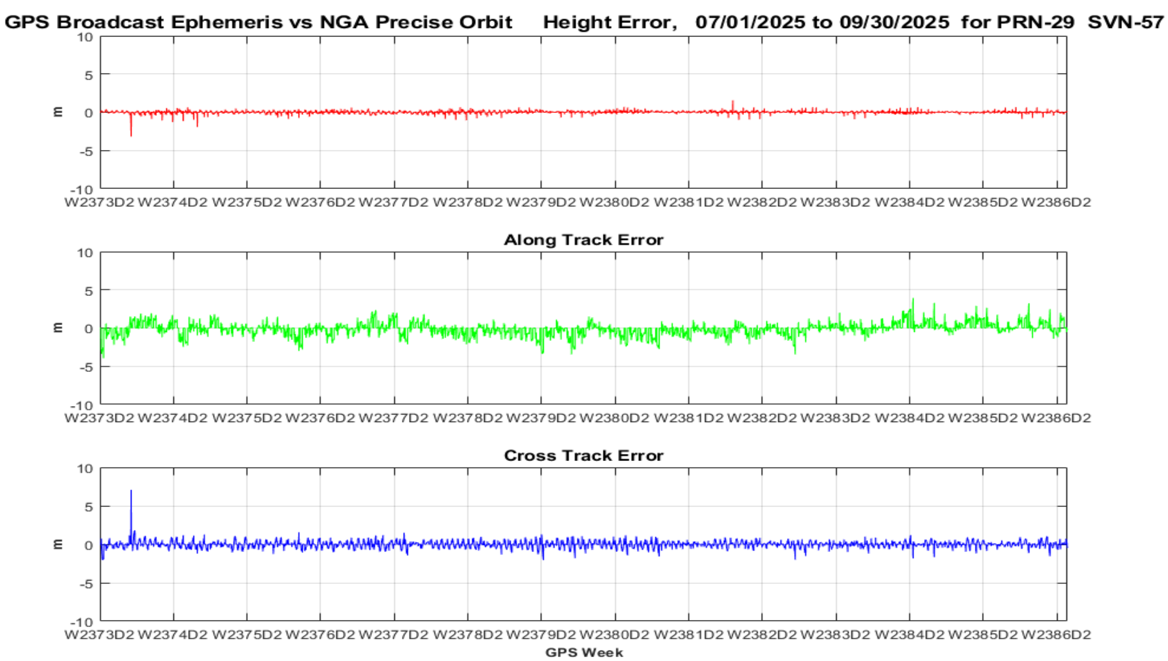

Figure 9-60 Orbit Error PRN29 (SVN57) Using C/A Nav Data

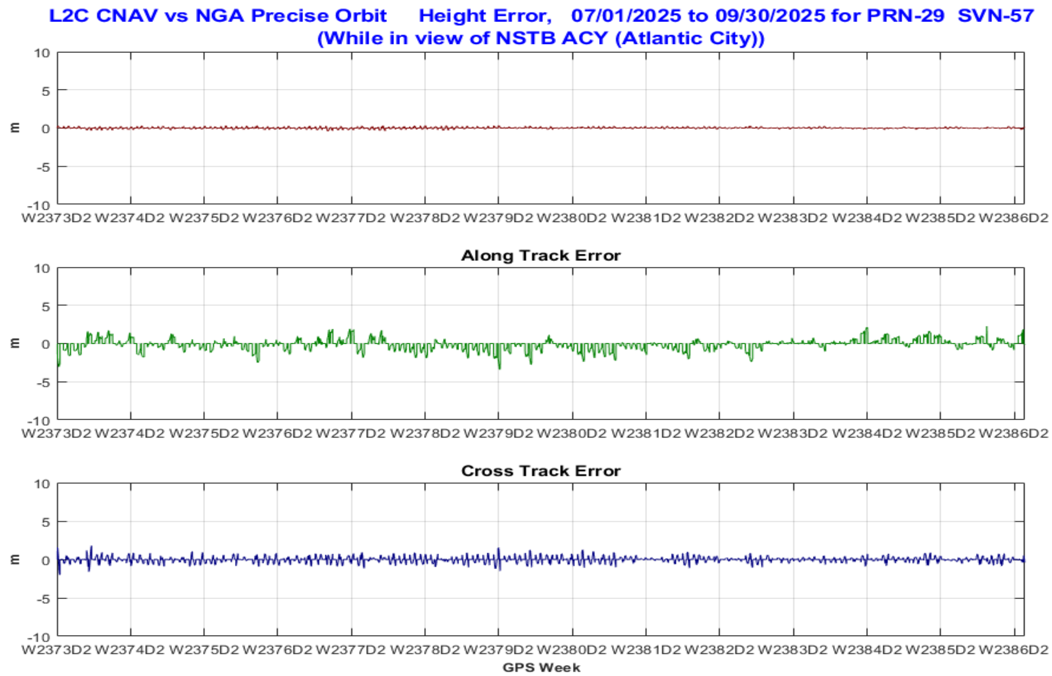

Figure 9-61 Orbit Error PRN29 (SVN57) Using L2C CNAV Data

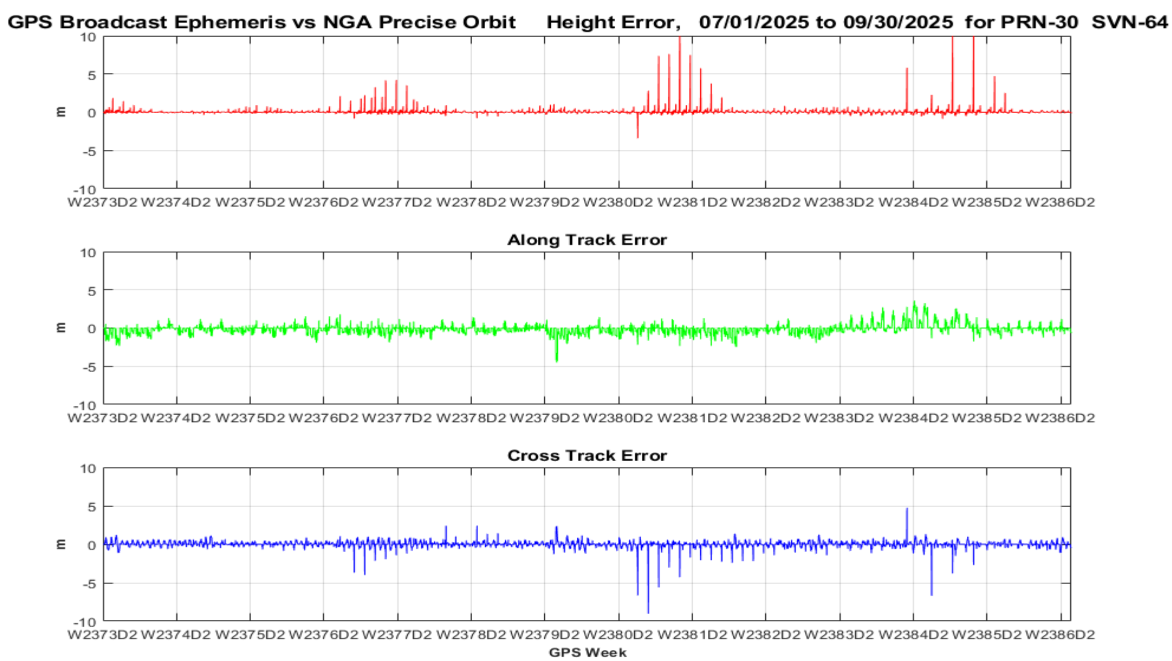

Figure 9-62 Orbit Error PRN30 (SVN64) Using C/A Nav Data

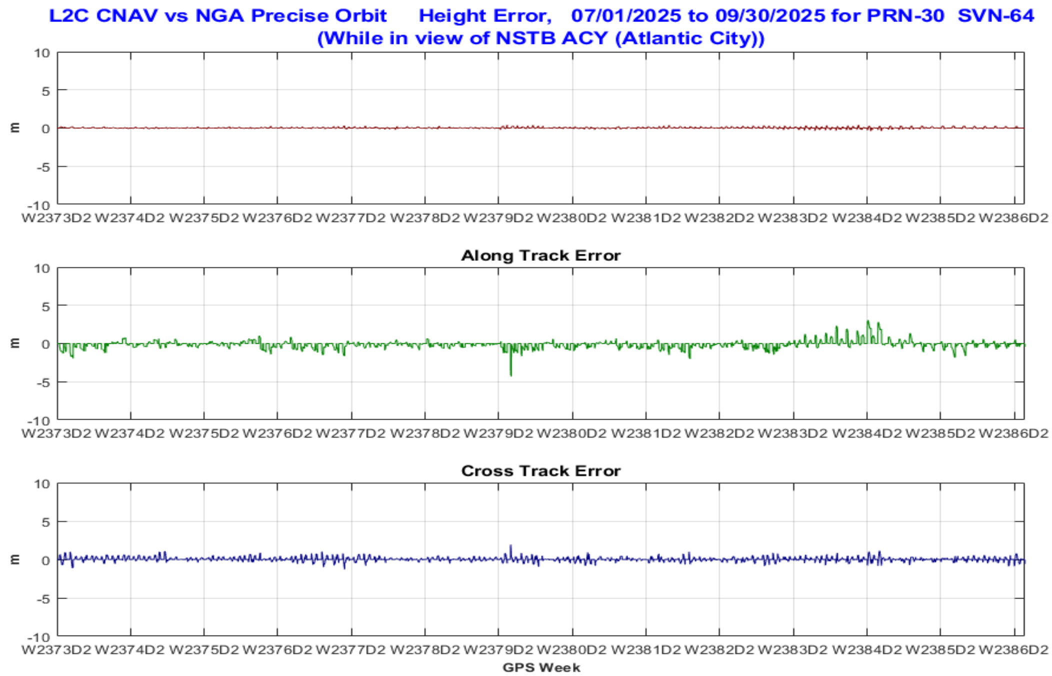

Figure 9-63 Orbit Error PRN30 (SVN64) Using L2C CNAV Data

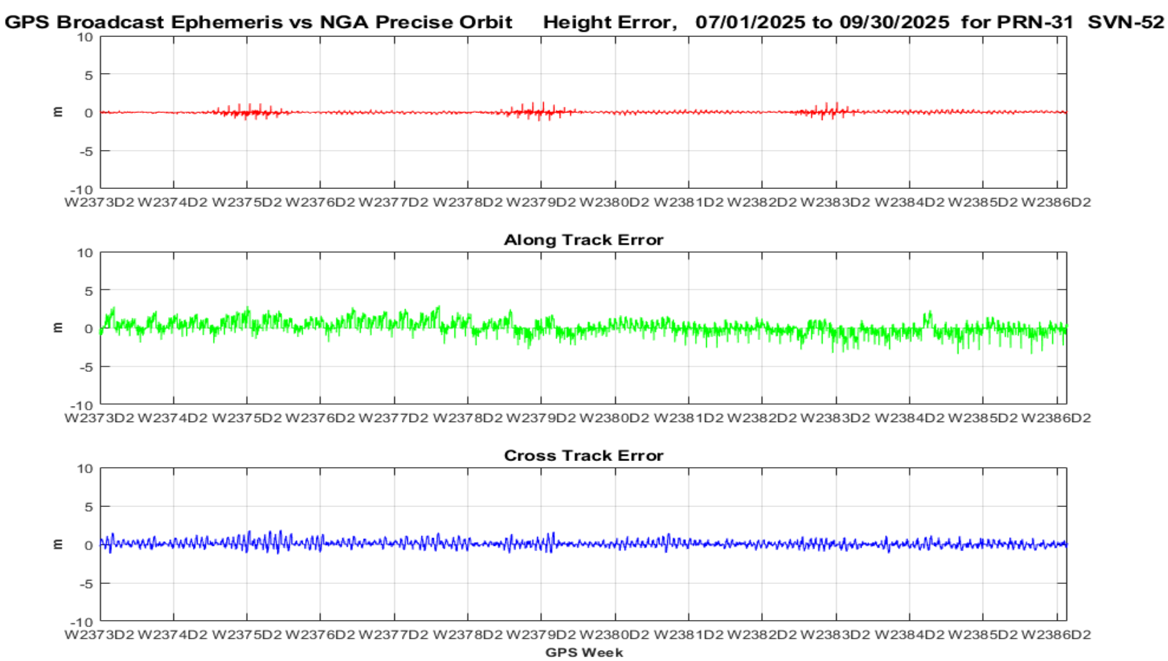

Figure 9-64 Orbit Error PRN31 (SVN52) Using C/A Nav Data

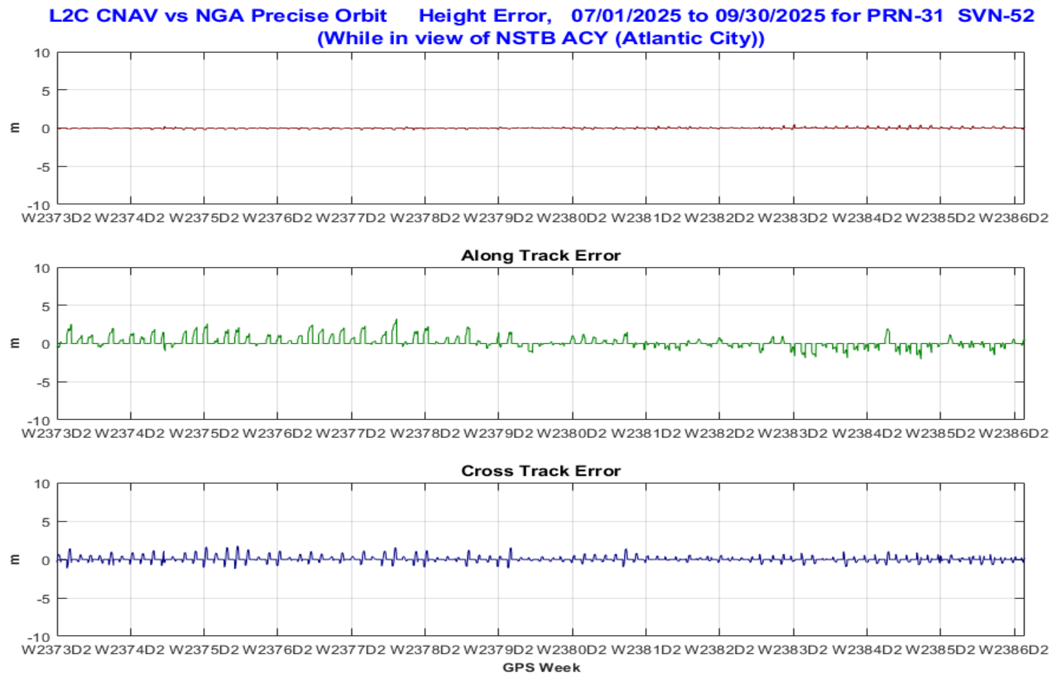

Figure 9-65 Orbit Error PRN31 (SVN52) Using L2C CNAV Data

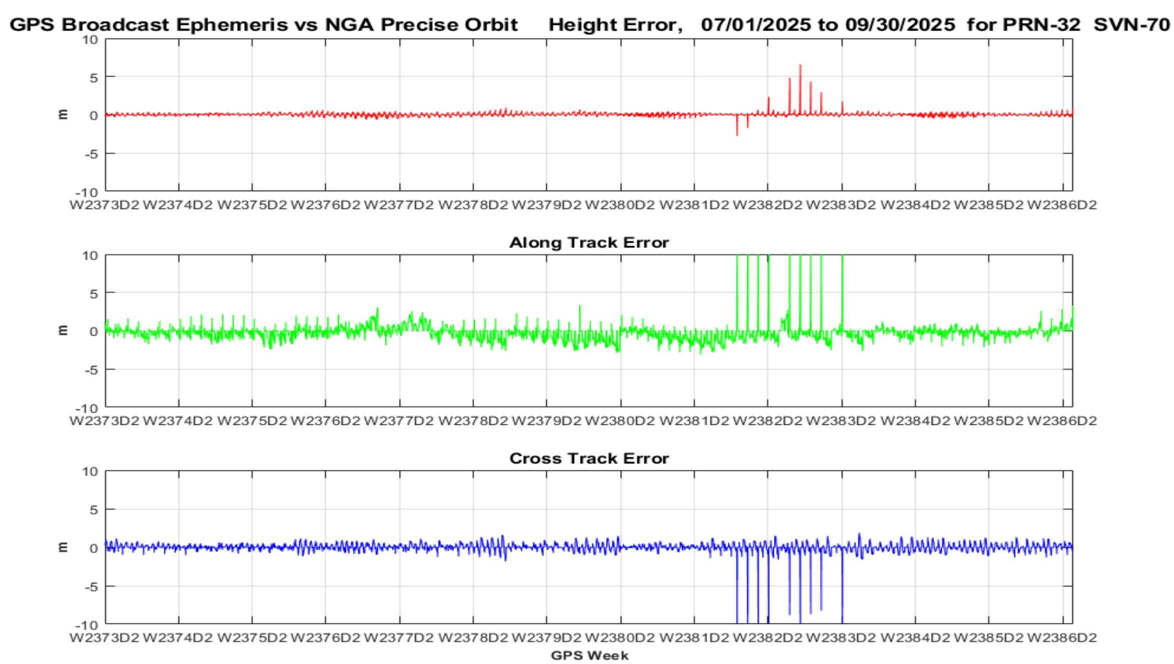

Figure 9-66 Orbit Error PRN32 (SVN70) Using C/A Nav Data

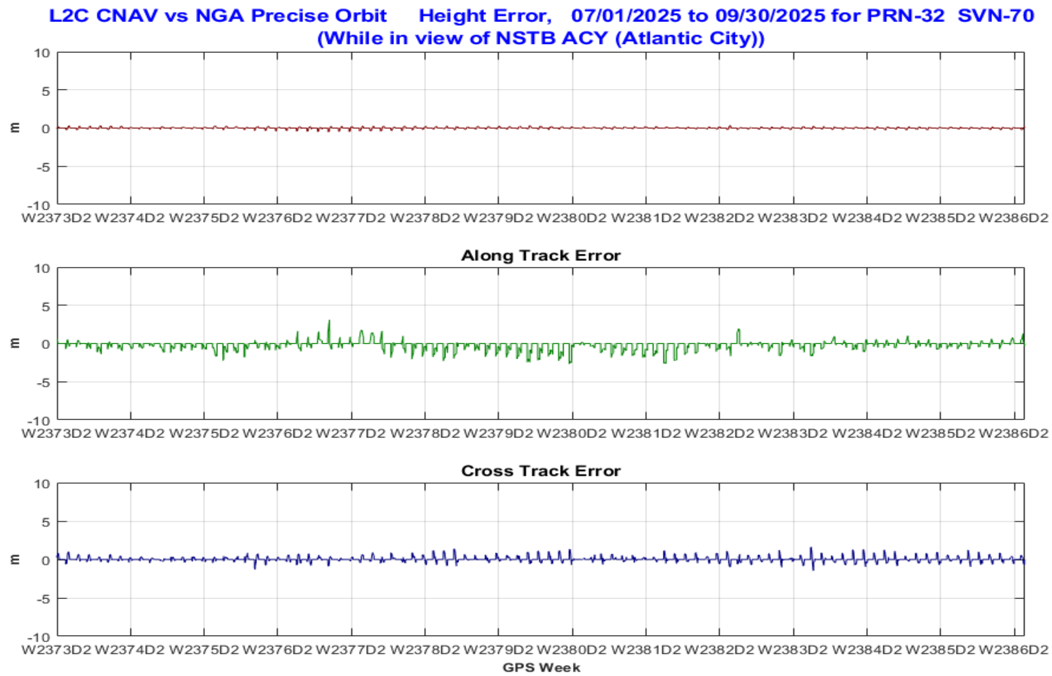

Figure 9-67 Orbit Error PRN32 (SVN70) Using L2C CNAV Data

9.6 QQ Plots of URA Normalized Error for All Satellites

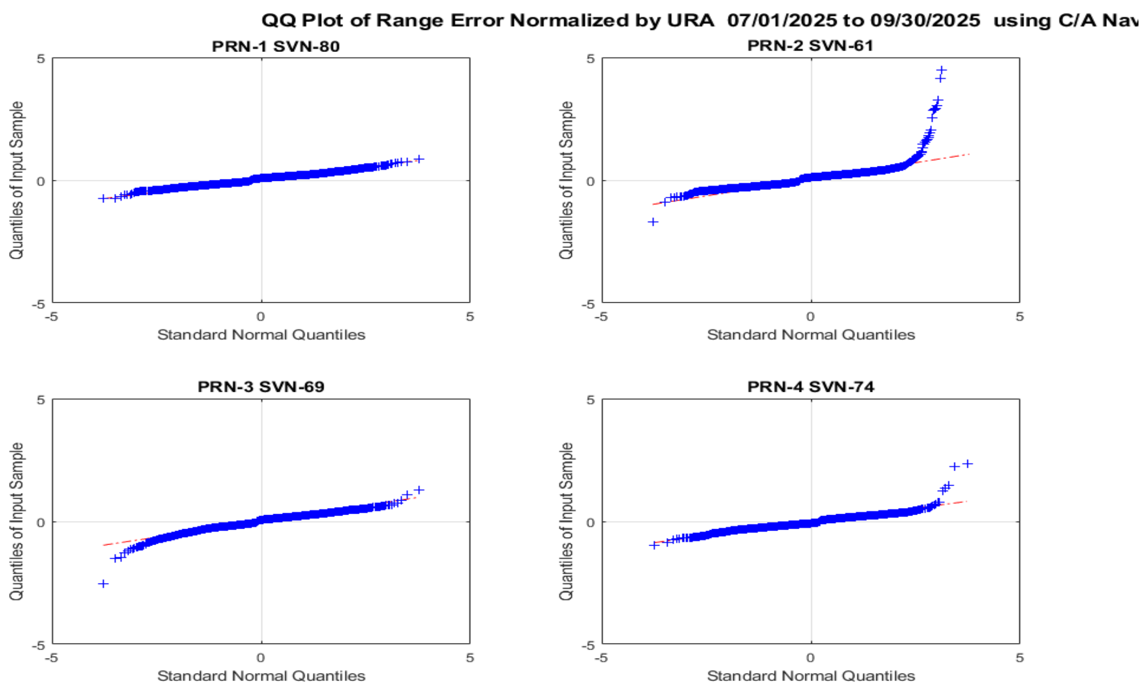

Figure 9-68 QQ Plots of Range Error PRNs 1 to 4 Using C/A Nav Data

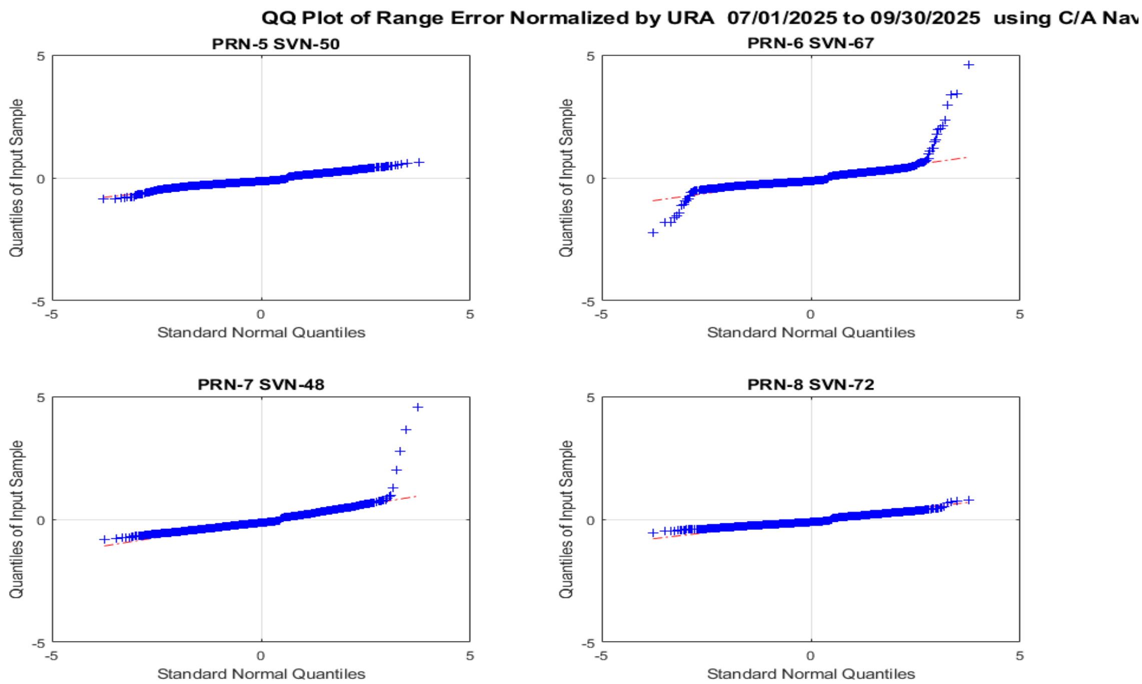

Figure 9-69 QQ Plots of Range Error PRNs 5 to 8 Using C/A Nav Data

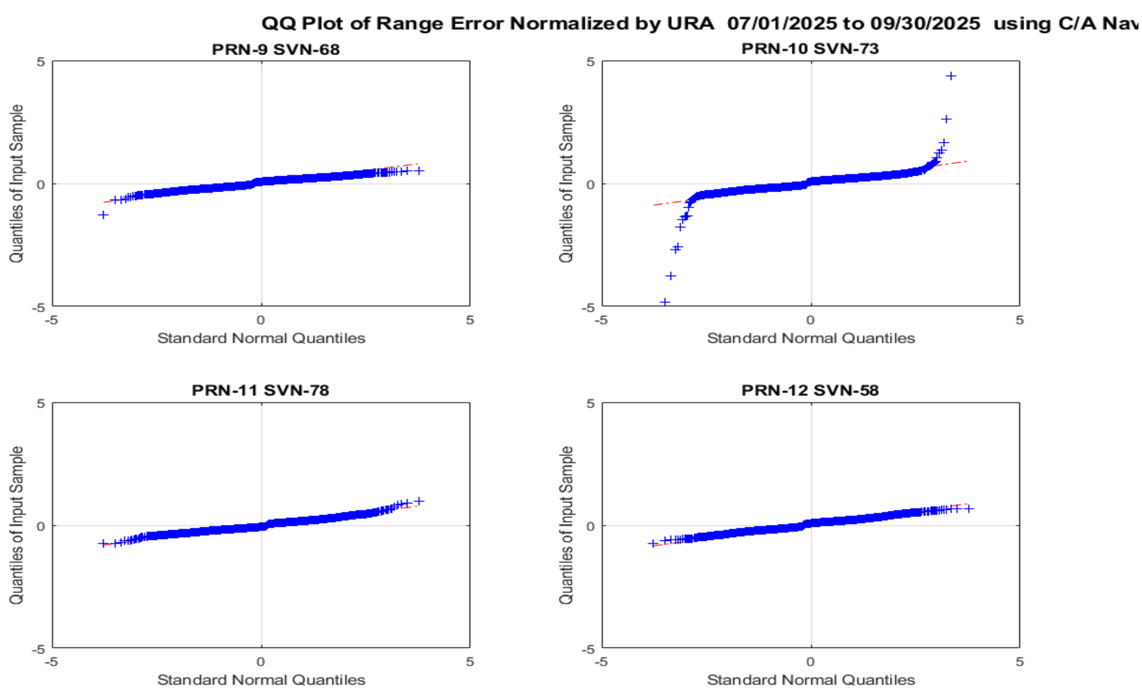

Figure 9-70 QQ Plots of Range Error PRNs 9 to 12 Using C/A Nav Data

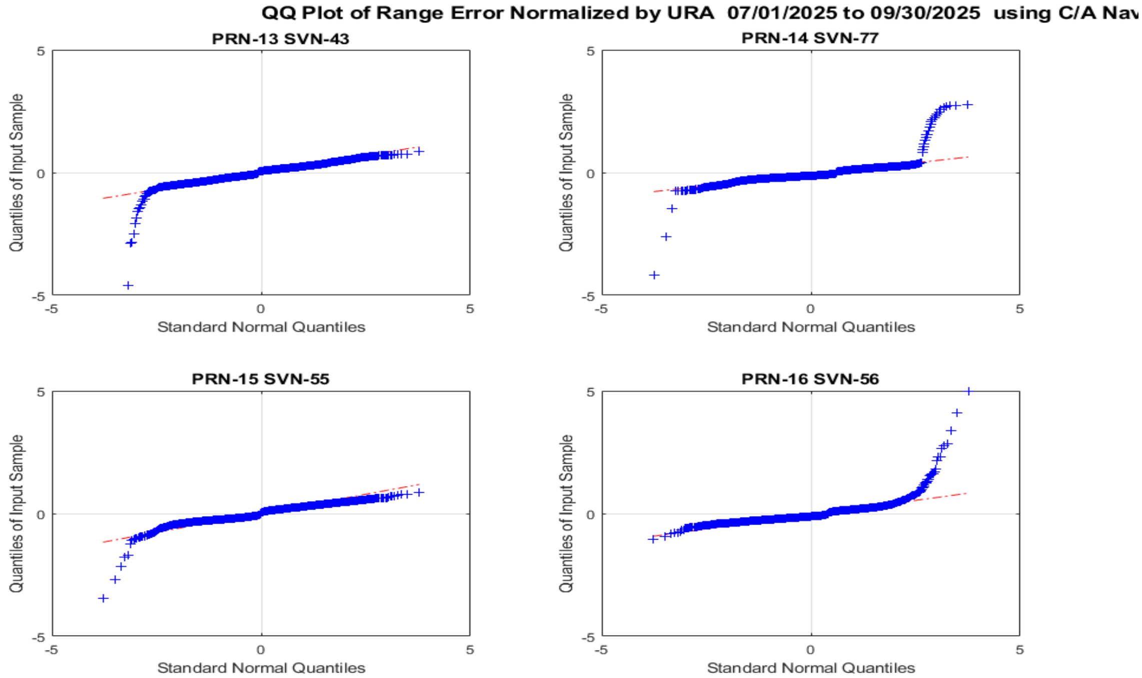

Figure 9-71 QQ Plots of Range Error PRNs 13 to 16 Using C/A Nav Data

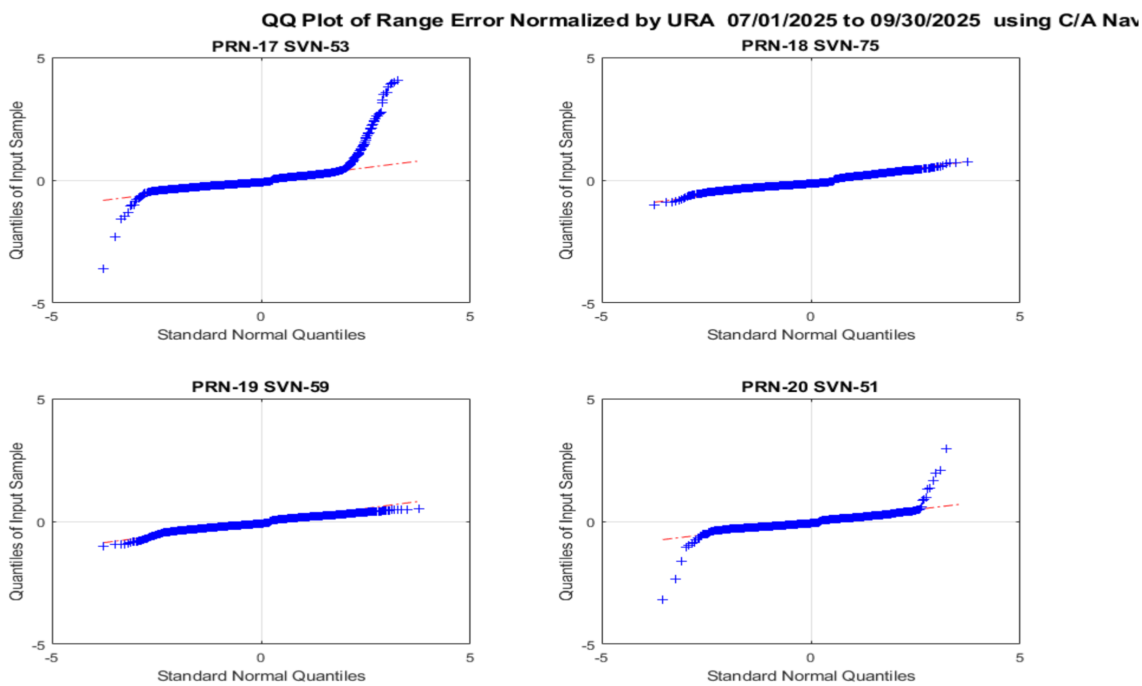

Figure 9-72 QQ Plots of Range Error PRNs 17 to 20 Using C/A Nav Data

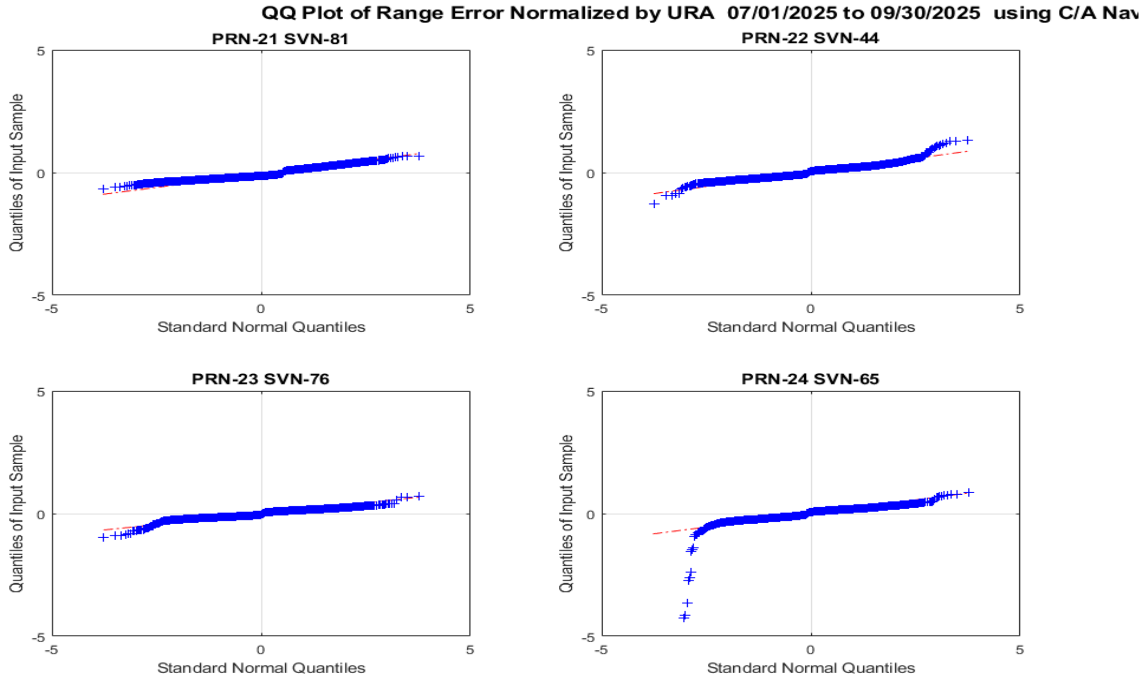

Figure 9-73 QQ Plots of Range Error PRNs 21 to 24 Using C/A Nav Data

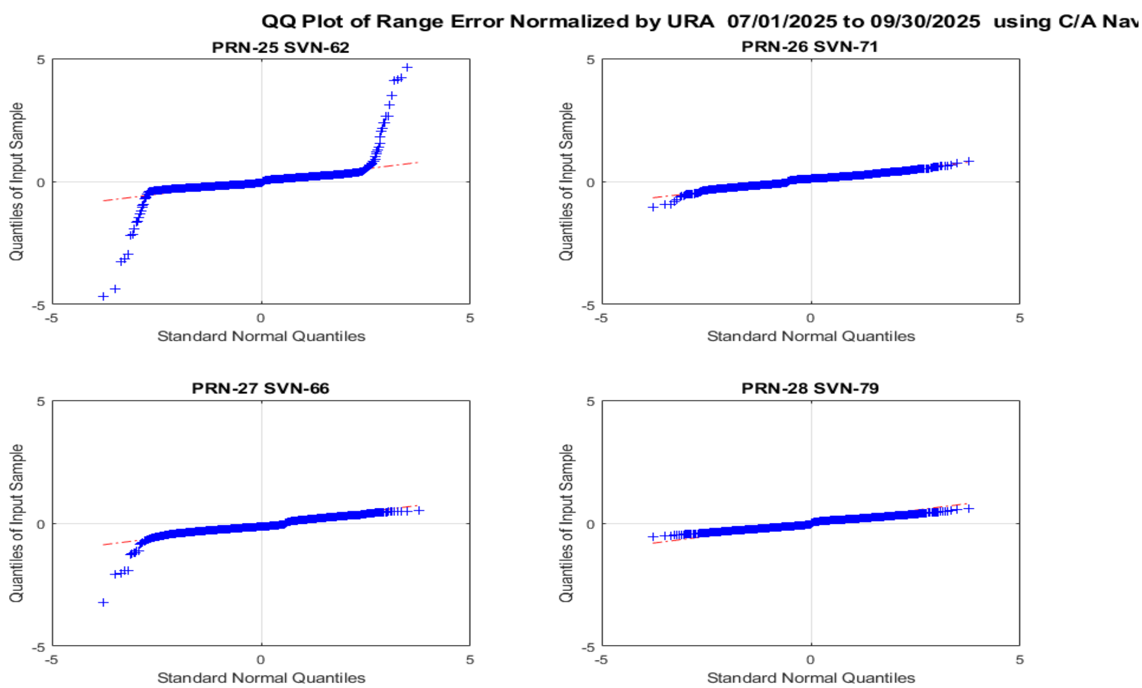

Figure 9-74 QQ Plots of Range Error PRNs 25 to 28 Using C/A Nav Data

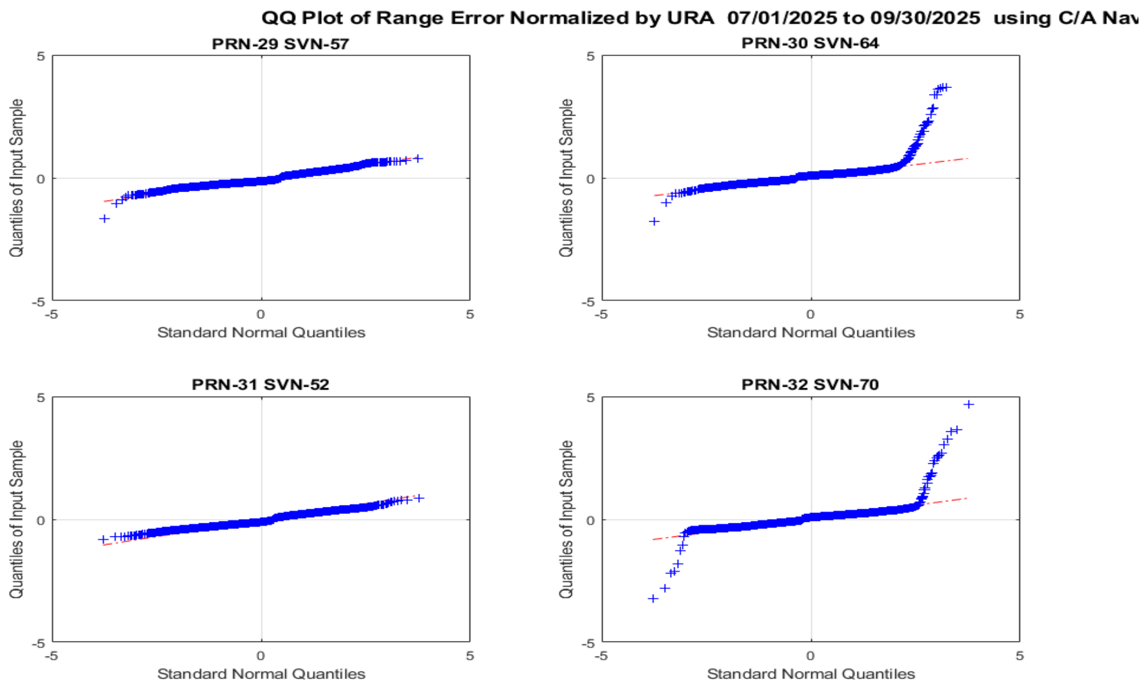

Figure 9-75 QQ Plots of Range Error PRNs 29 to 32 Using C/A Nav Data

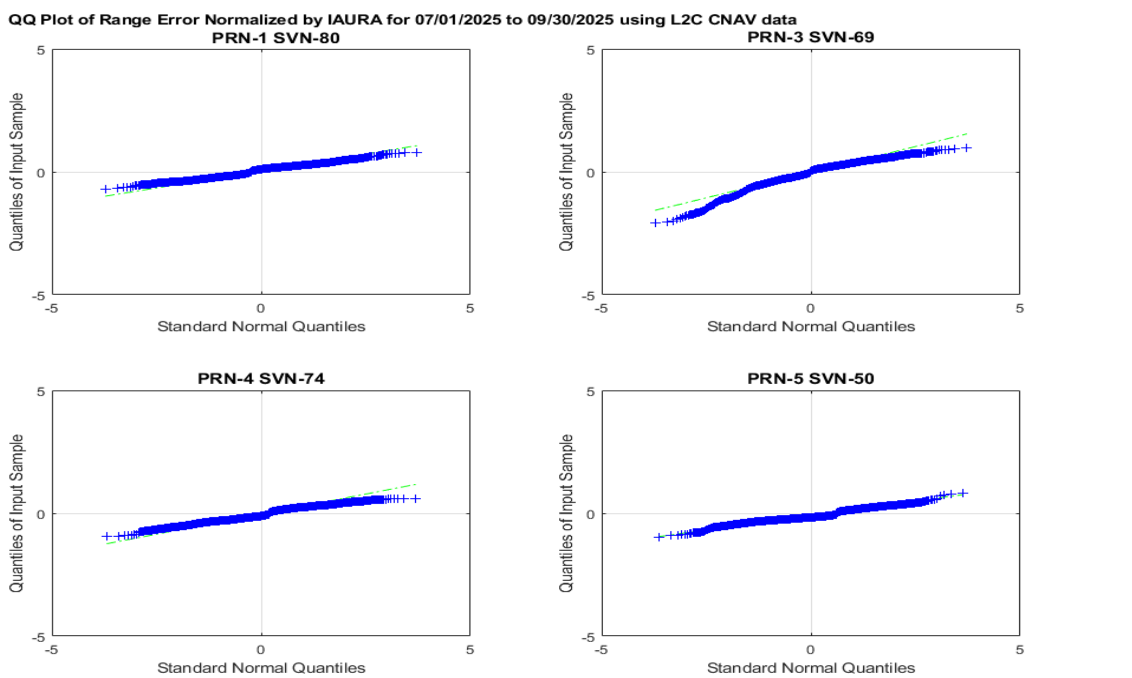

Figure 9-76 QQ Plots of Range Error PRNs 1, 3, 4, and 5 Using L2C CNAV Data

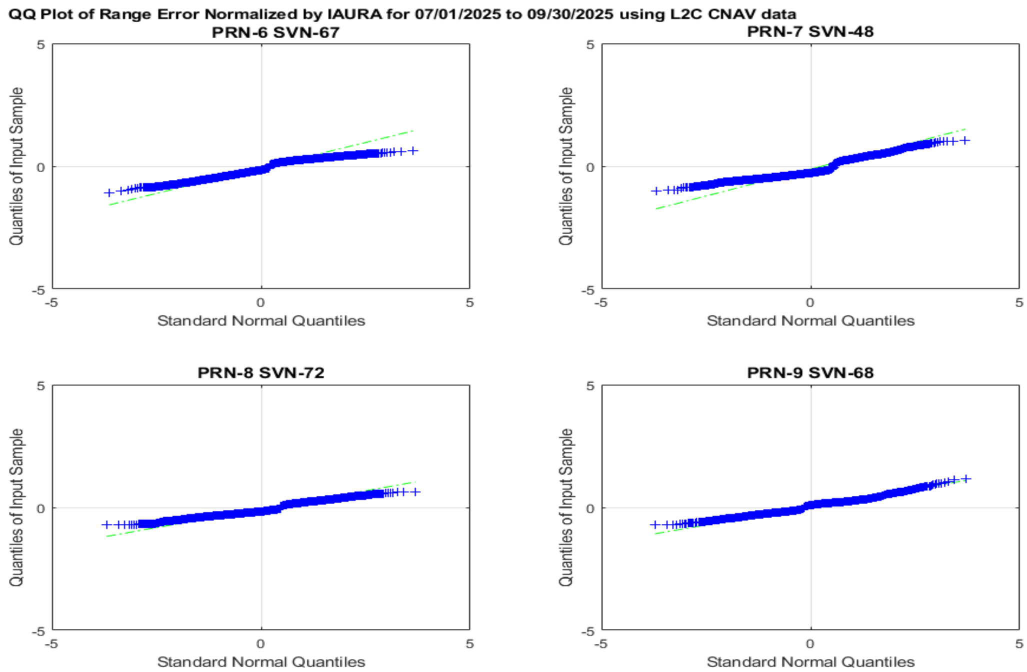

Figure 9-77 QQ Plots of Range Error PRNs 6, 7, 8, and 9 Using L2C CNAV Data

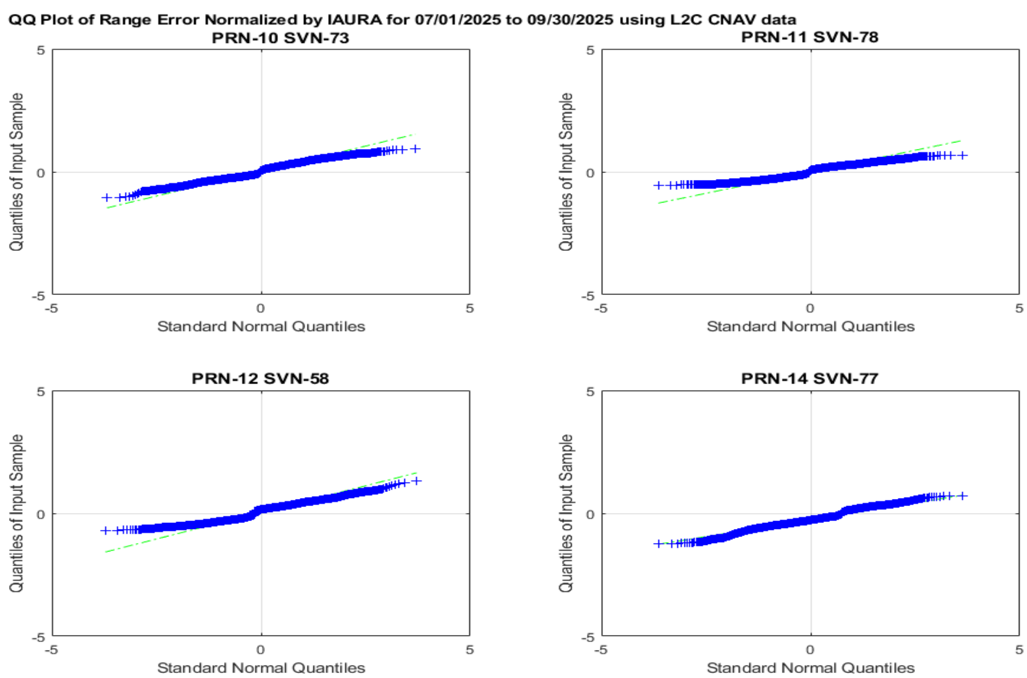

Figure 9-78 QQ Plots of Range Error PRNs 10, 11, 12, and 14 Using L2C CNAV Data

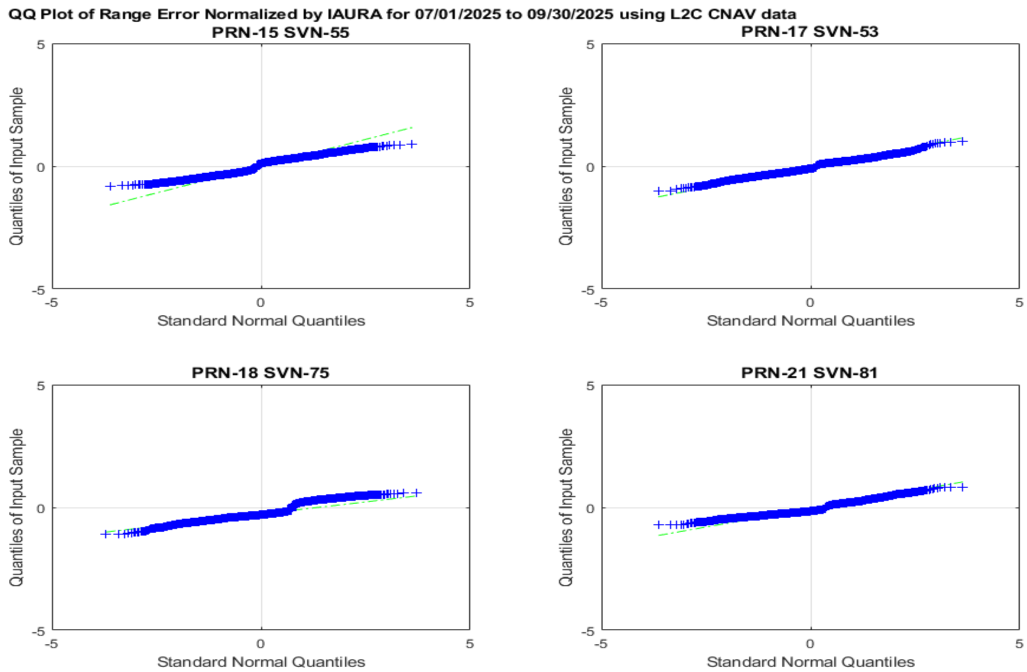

Figure 9-79 QQ Plots of Range Error PRNs 15, 17, 18, and 21 Using L2C CNAV Data

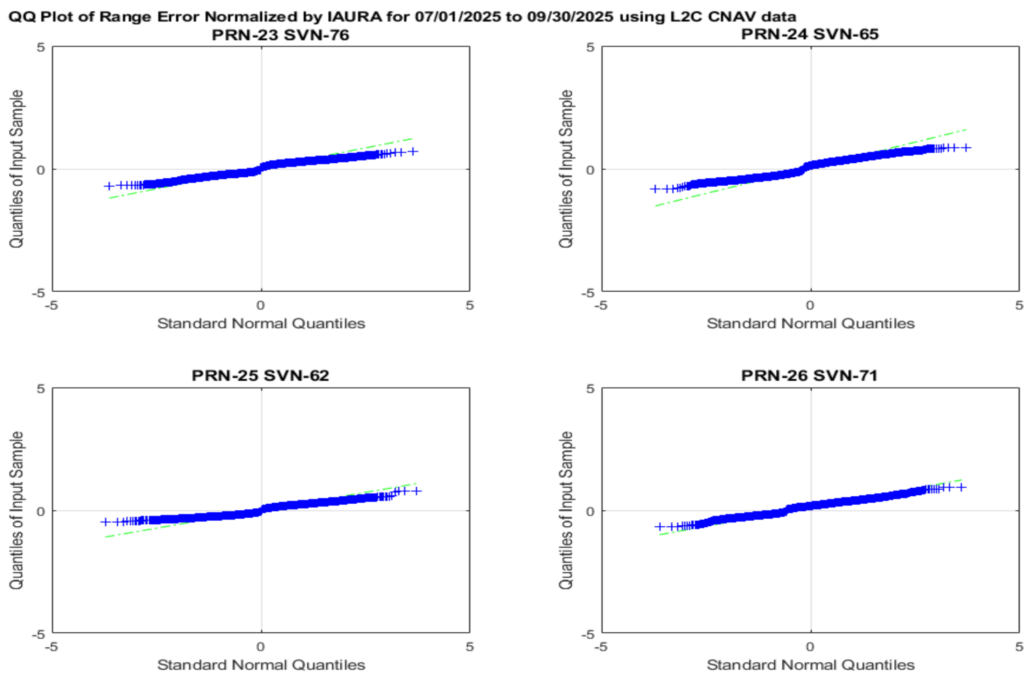

Figure 9-80 QQ Plots of Range Error PRN 23, 24, 25, and 26 Using L2C CNAV Data

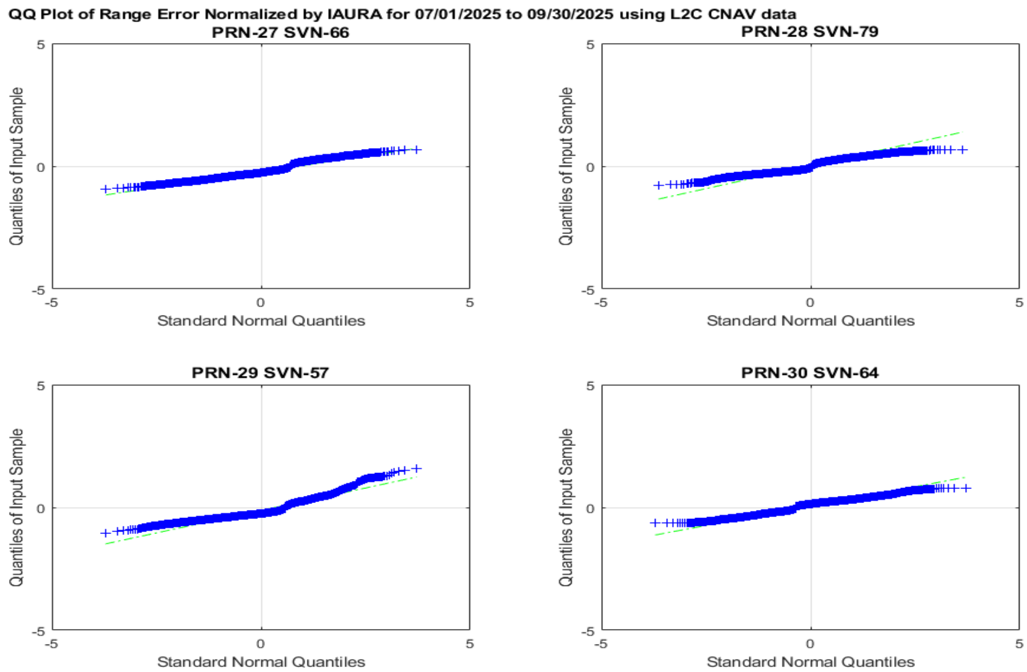

Figure 9-81 QQ Plots of Range Error PRNs 27, 28, 29, and 30 Using L2C CNAV Data

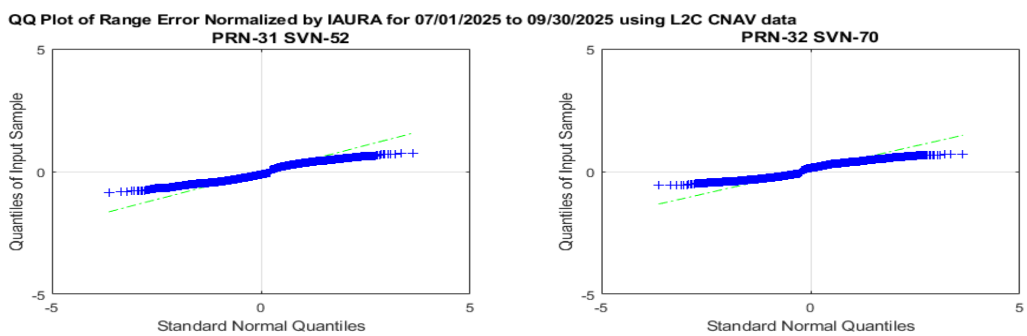

Figure 9-82 QQ Plots of Range Error PRN 31 and 32 Using L2C CNAV Data

9.7 Histogram Plots of H, A, C, and Range Error for All Satellites

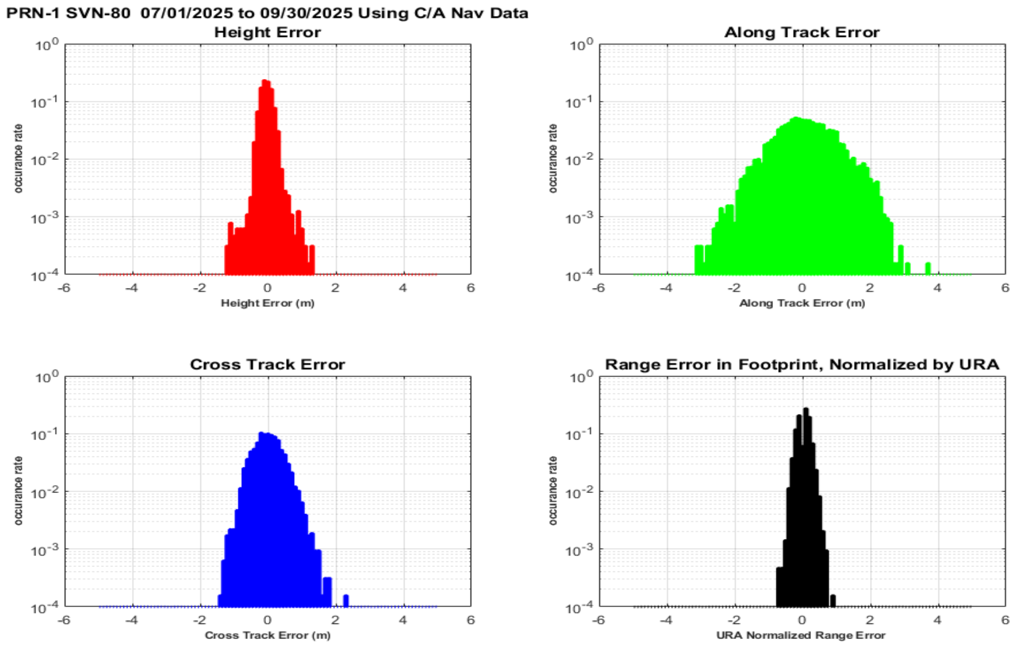

Figure 9-83 Histograms of H, A, C, and Range Error PRN1 (SVN80) Using C/A Nav Data

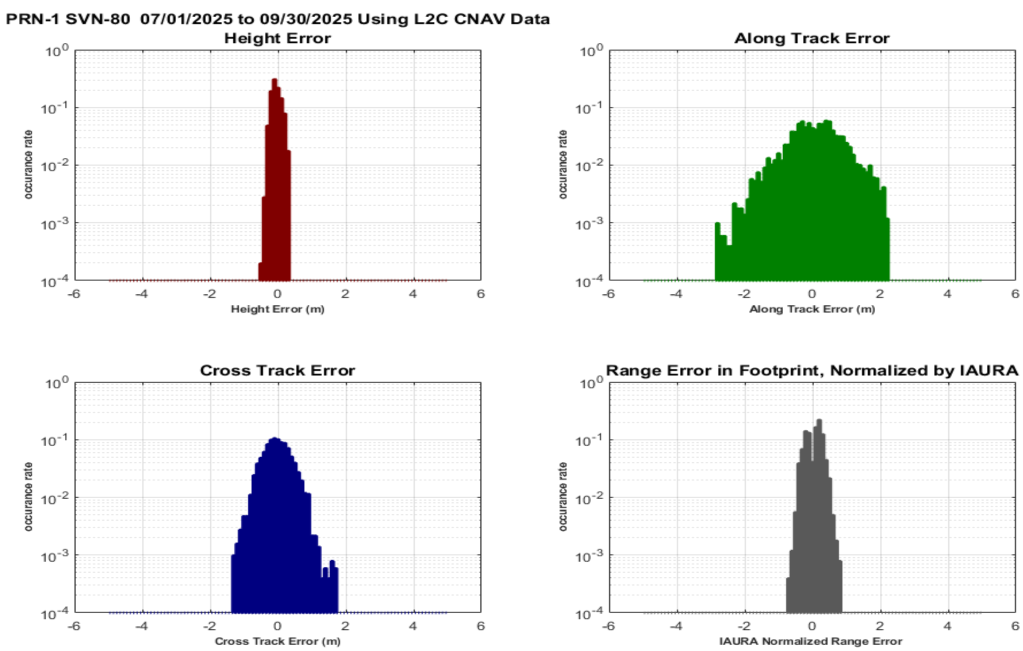

Figure 9-84 Histograms of H, A, C, and Range Error PRN1 (SVN80) Using L2C CNAV Data

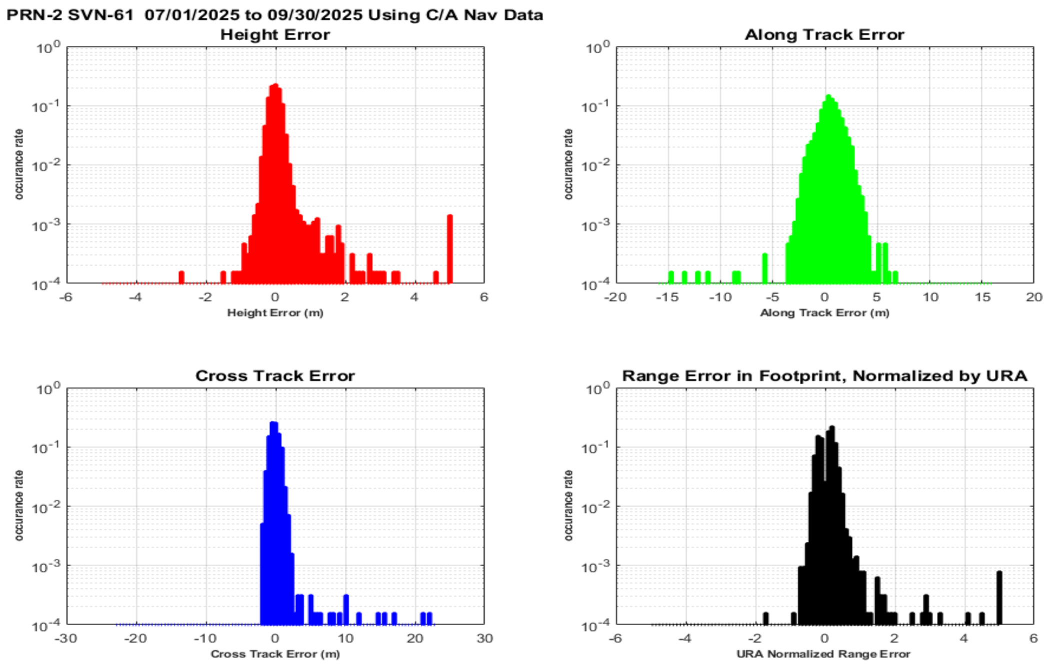

Figure 9-85 Histograms of H, A, C, and Range Error PRN2 (SVN61) Using C/A Nav Data

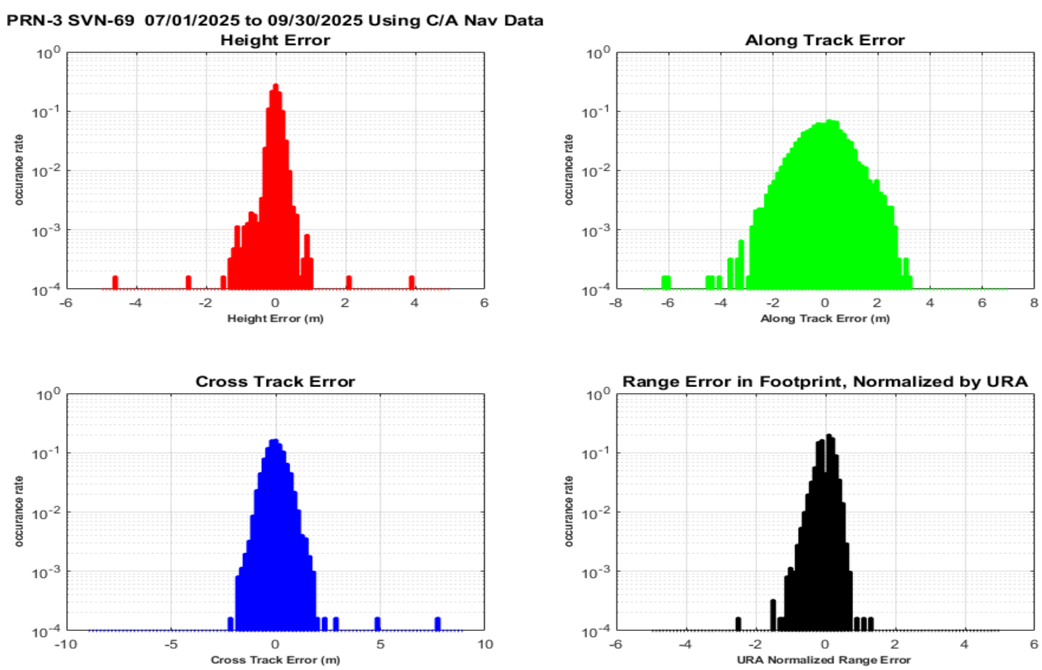

Figure 9-86 Histograms of H, A, C, and Range Error PRN3 (SVN69) Using C/A Nav Data

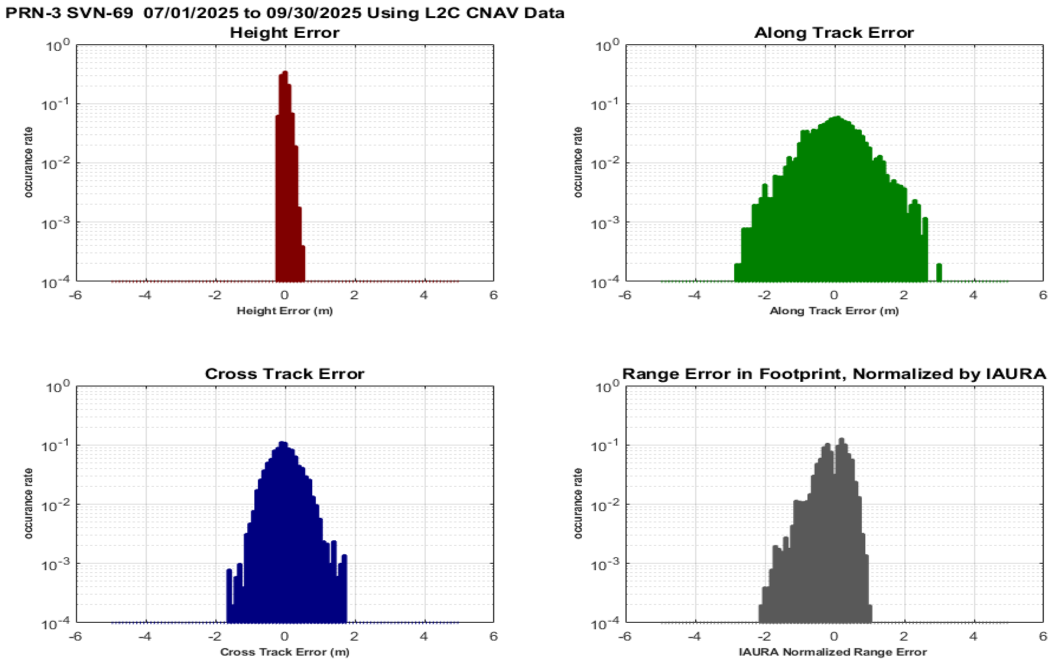

Figure 9-87 Histograms of H, A, C, and Range Error PRN3 (SVN69) Using L2C CNAV Data

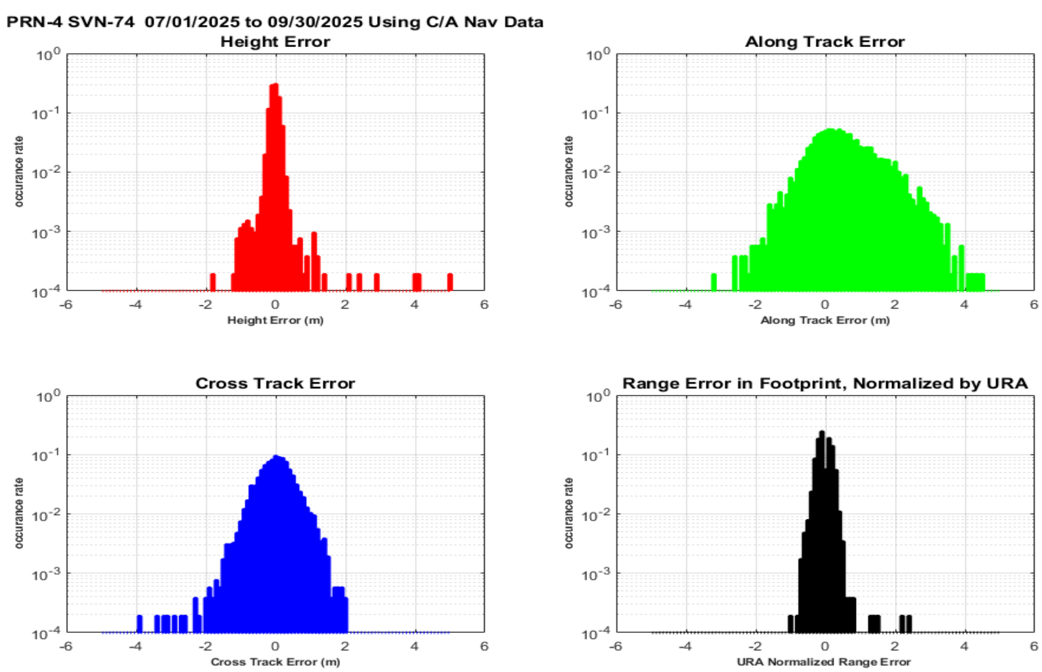

Figure 9-88 Histograms of H, A, C, and Range Error PRN4 (SVN74) Using C/A Nav Data

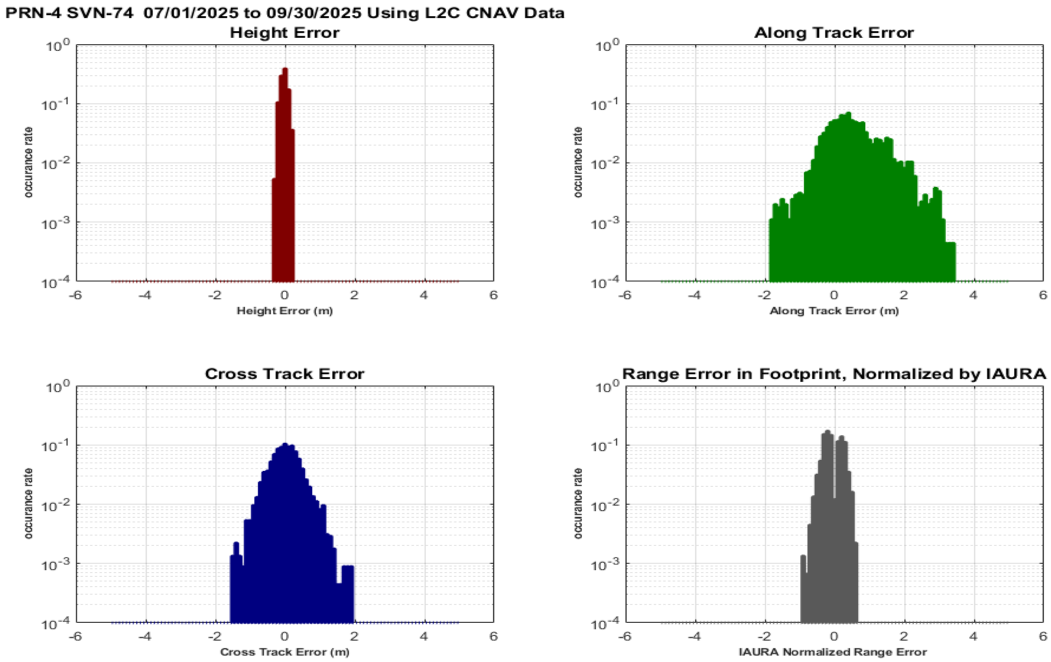

Figure 9-89 Histograms of H, A, C, and Range Error PRN4 (SVN74) Using L2C CNAV Data

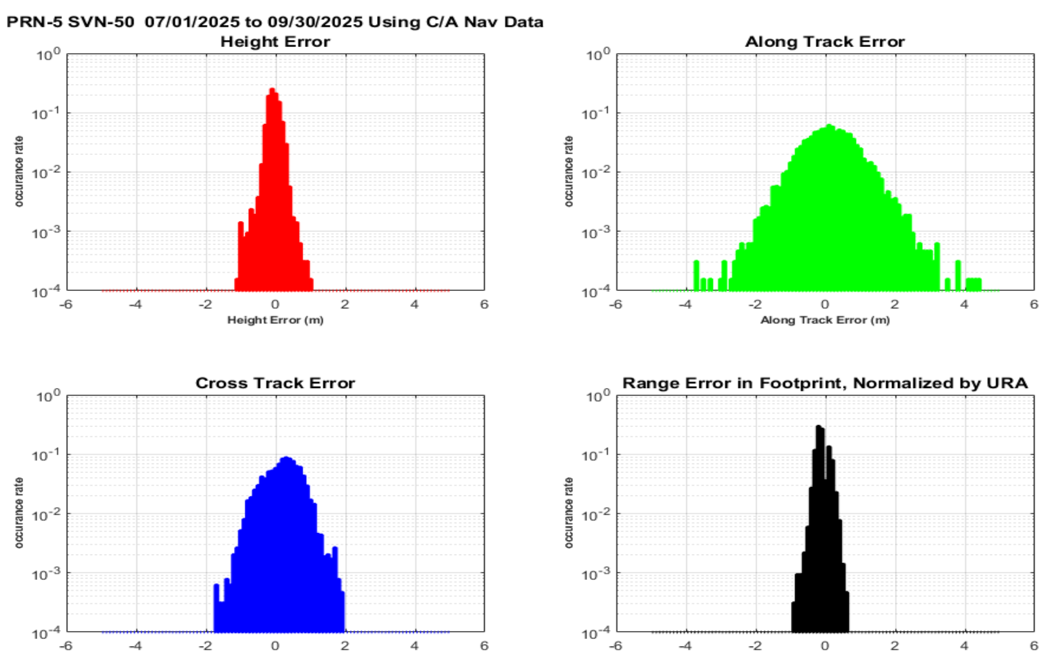

Figure 9-90 Histograms of H, A, C, and Range Error PRN5 (SVN50) Using C/A Nav Data

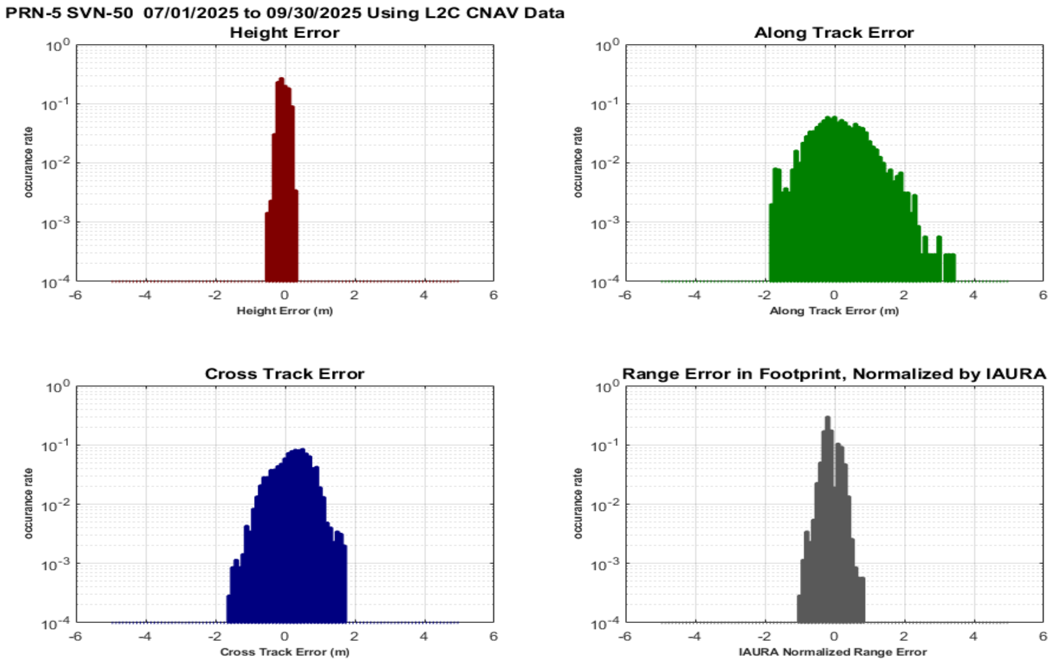

Figure 9-91 Histograms of H, A, C, and Range Error PRN5 (SVN50) Using L2C CNAV Data

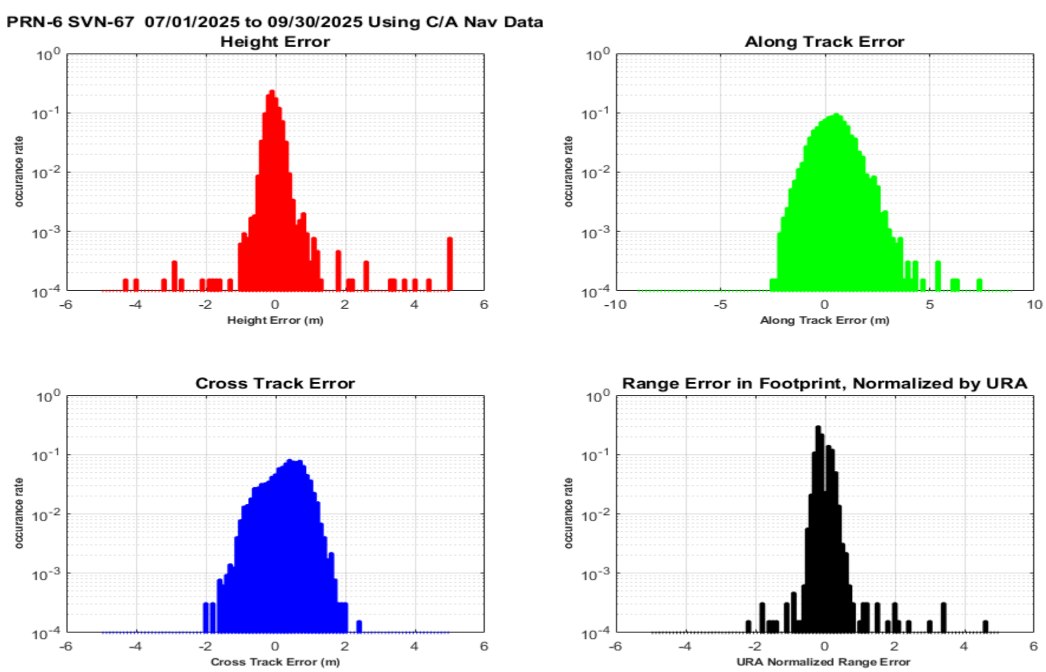

Figure 9-92 Histograms of H, A, C, and Range Error PRN6 (SVN67) Using C/A Nav Data

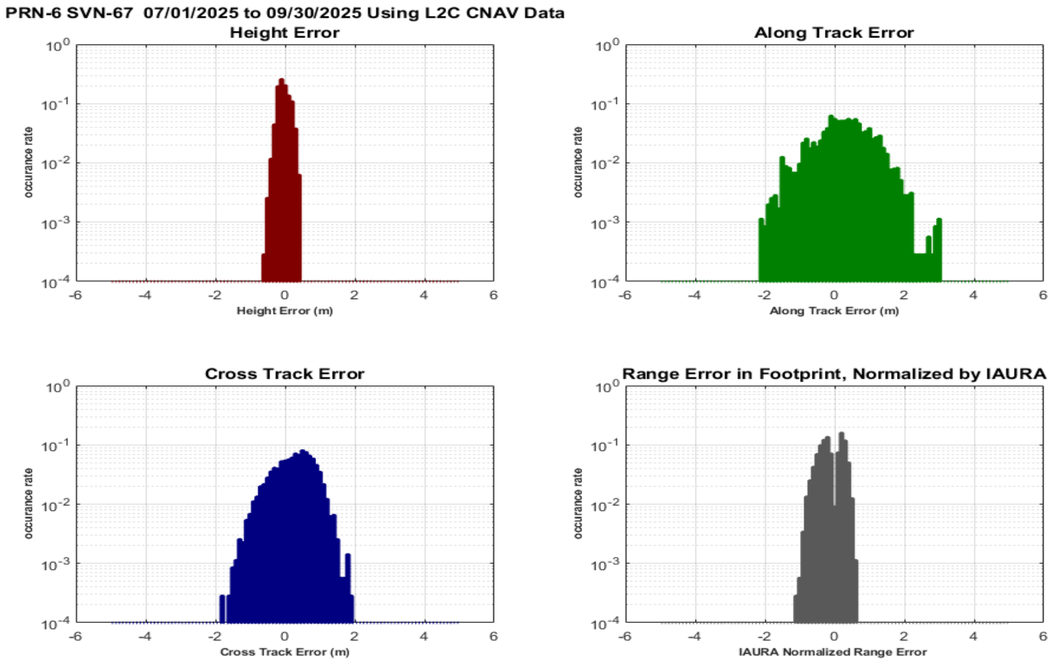

Figure 9-93 Histograms of H, A, C, and Range Error PRN6 (SVN67) Using L2C CNAV Data

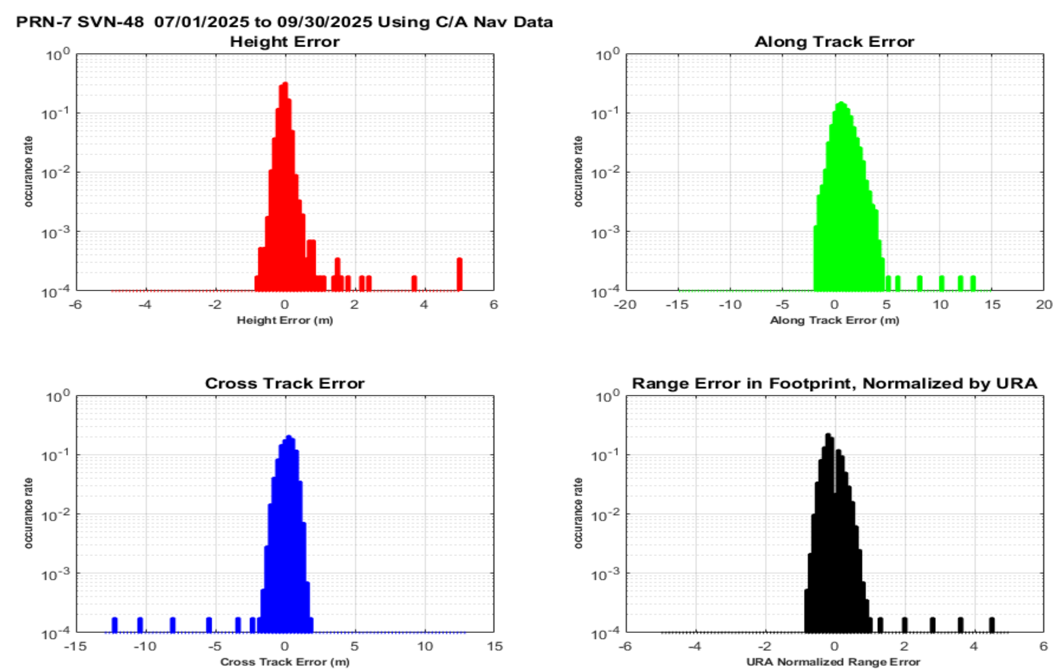

Figure 9-94 Histograms of H, A, C, and Range Error PRN7 (SVN48) Using C/A Nav Data

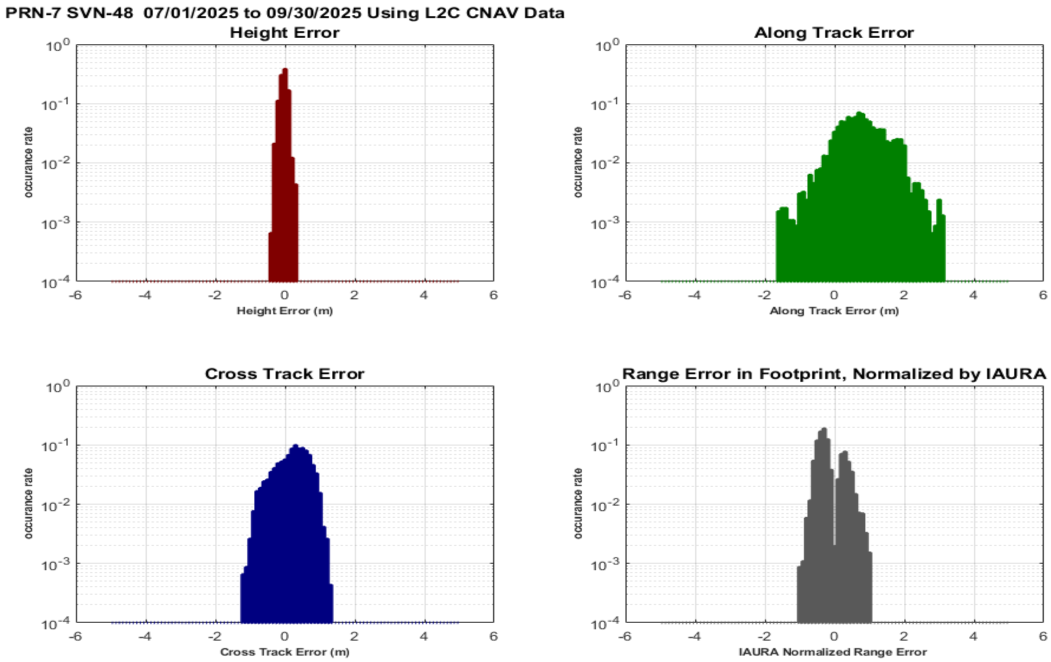

Figure 9-95 Histograms of H, A, C, and Range Error PRN7 (SVN48) Using L2C CNAV Data

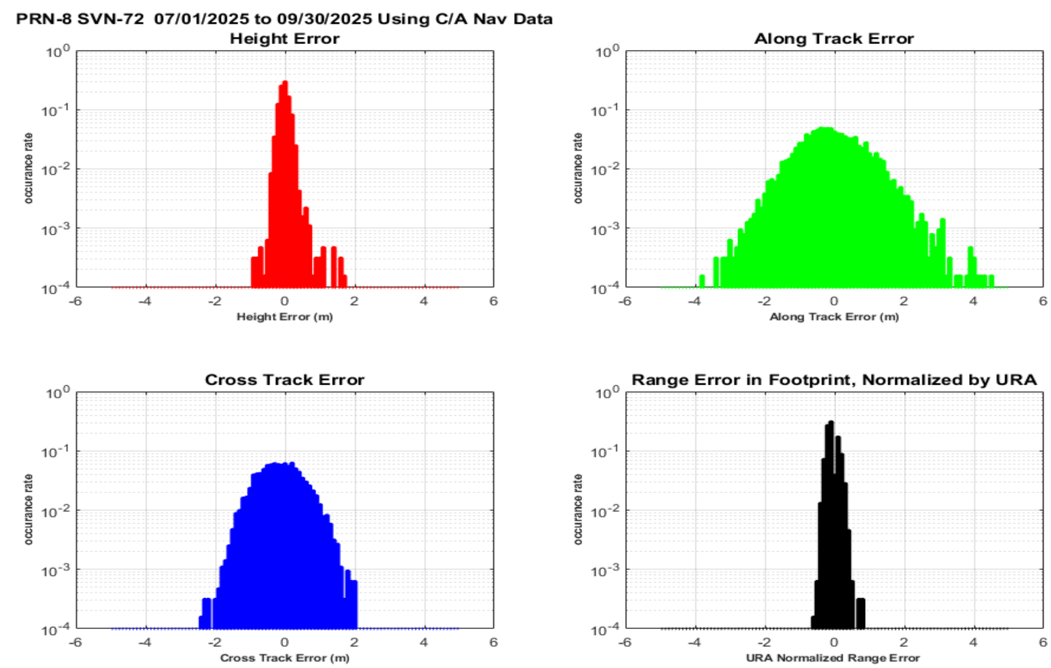

Figure 9-96 Histograms of H, A, C, and Range Error PRN8 (SVN72) Using C/A Nav Data

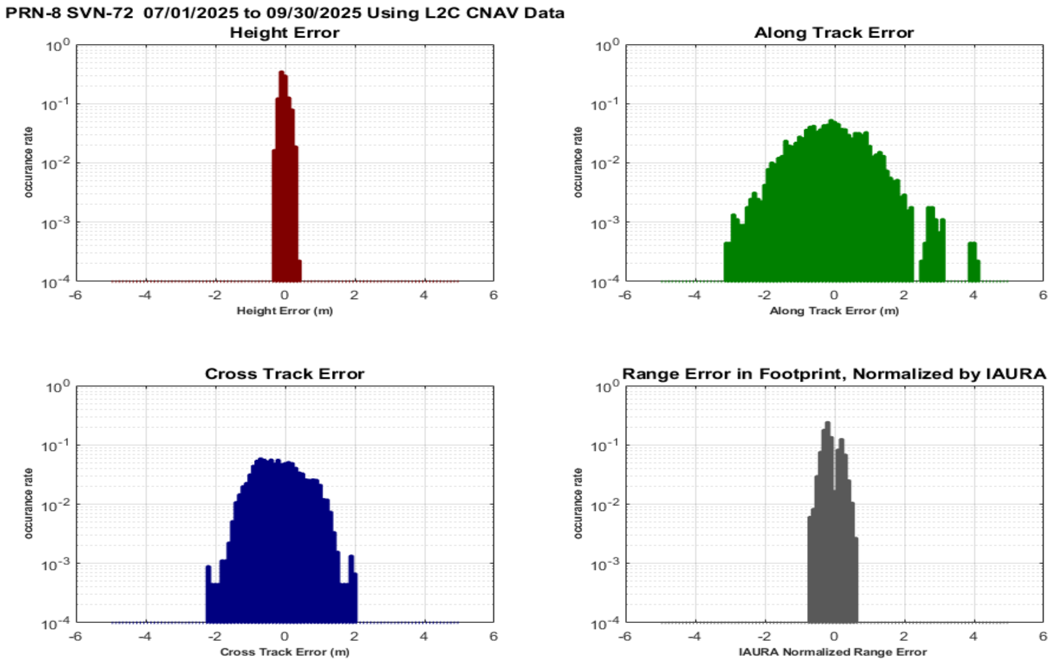

Figure 9-97 Histograms of H, A, C, and Range Error PRN8 (SVN72) Using L2C CNAV Data

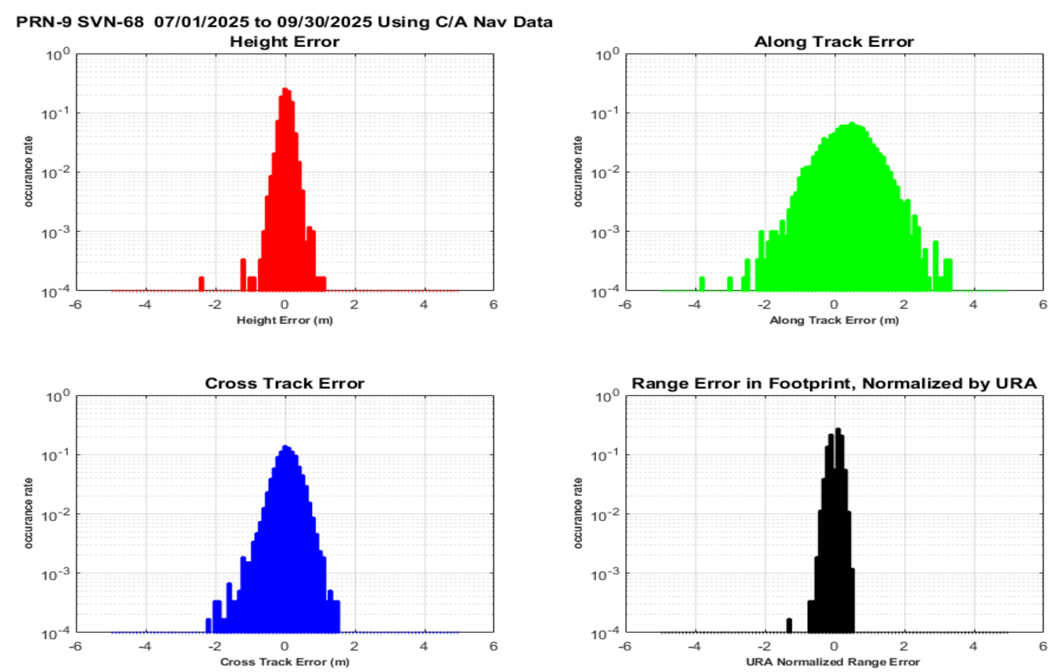

Figure 9-98 Histograms of H, A, C, and Range Error PRN9 (SVN68) Using C/A Nav Data

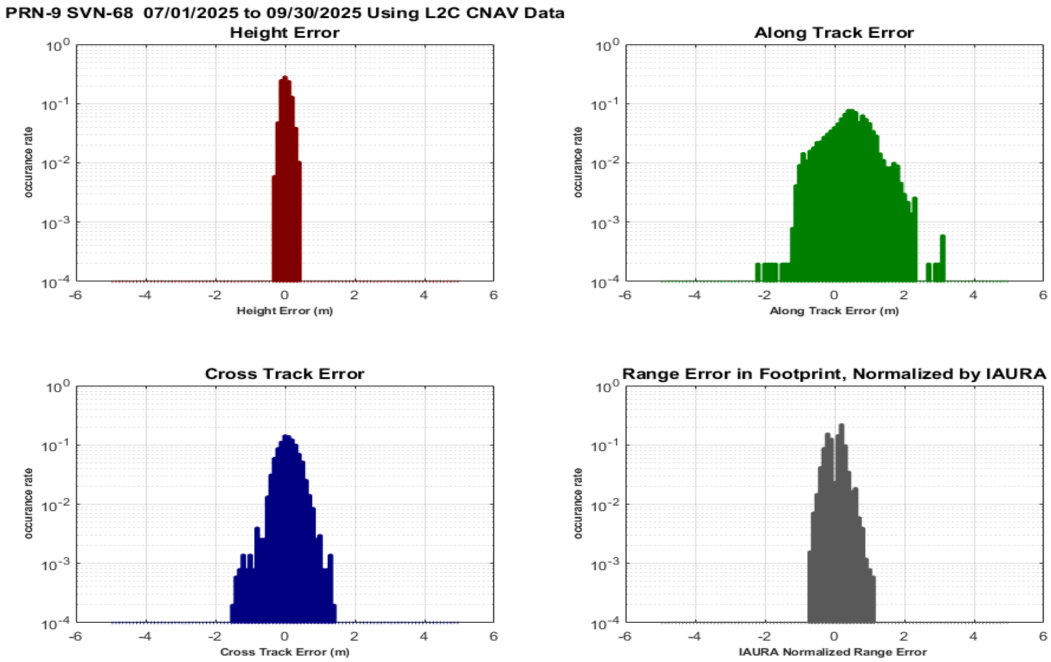

Figure 9-99 Histograms of H, A, C, and Range Error PRN9 (SVN68) Using L2C CNAV Data

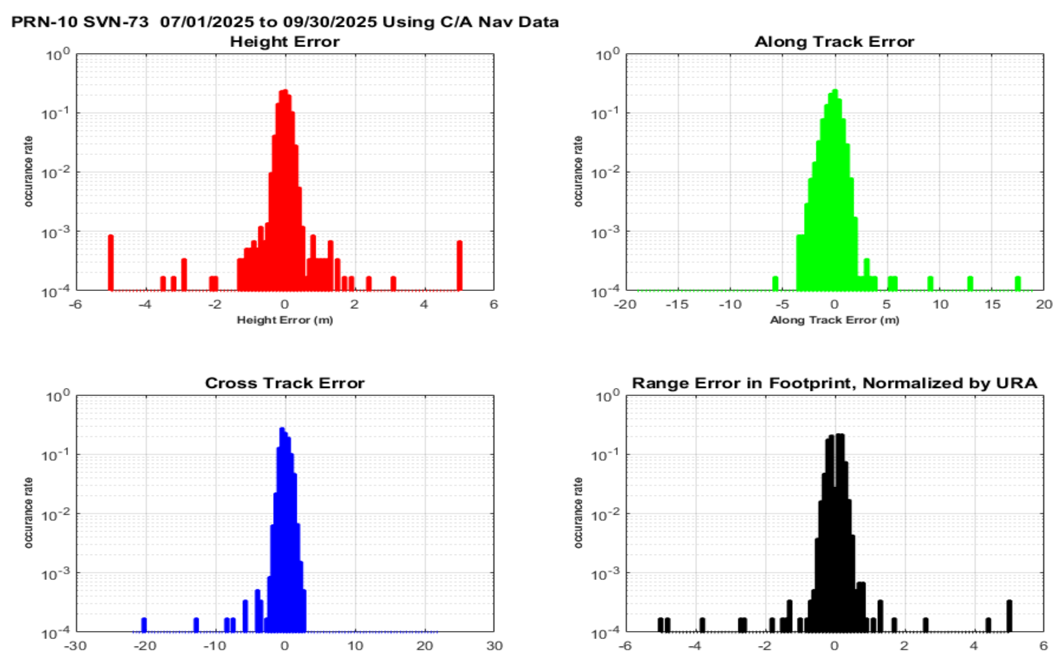

Figure 9-100 Histograms of H, A, C, and Range Error PRN10 (SVN73) Using C/A Nav Data

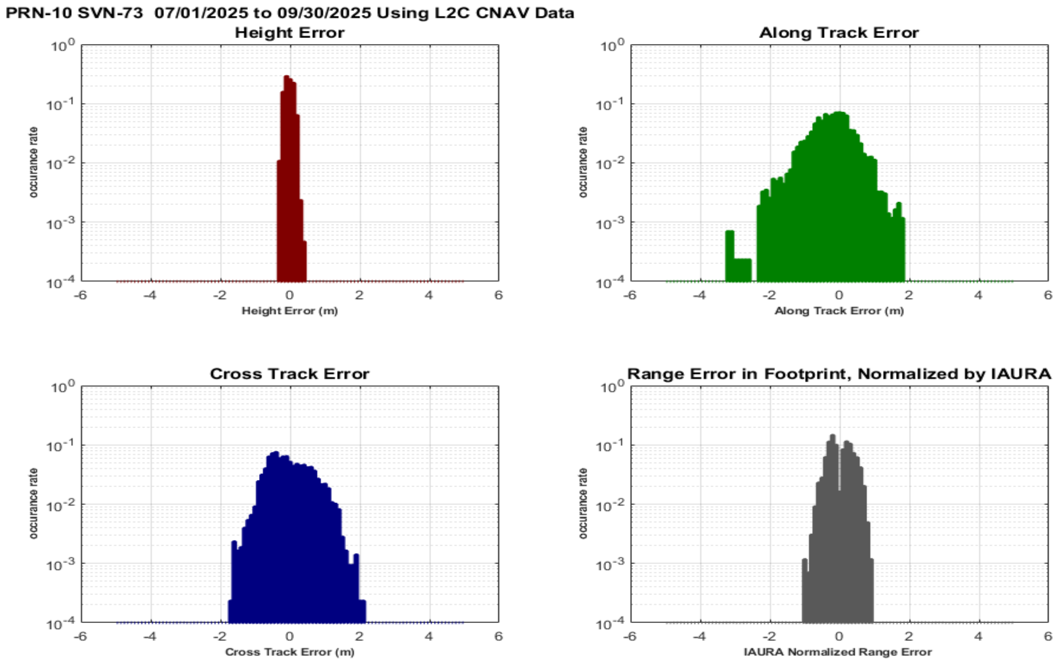

Figure 9-101 Histograms of H, A, C, and Range Error PRN10 (SVN73) Using L2C CNAV Data

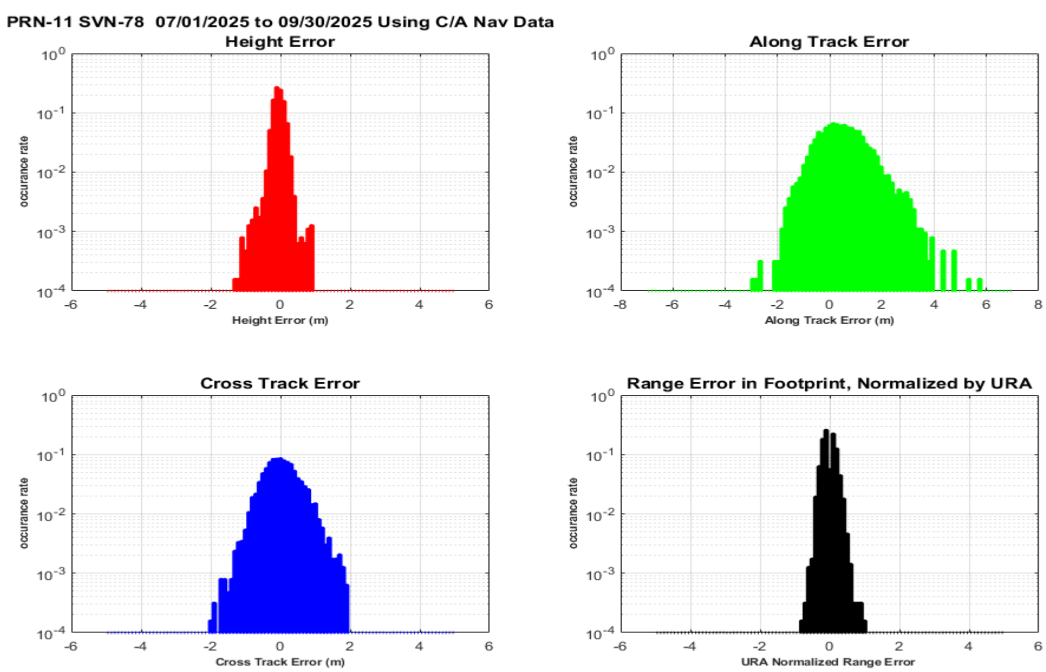

Figure 9-102 Histograms of H, A, C, and Range Error PRN11 (SVN78) Using C/A Nav Data

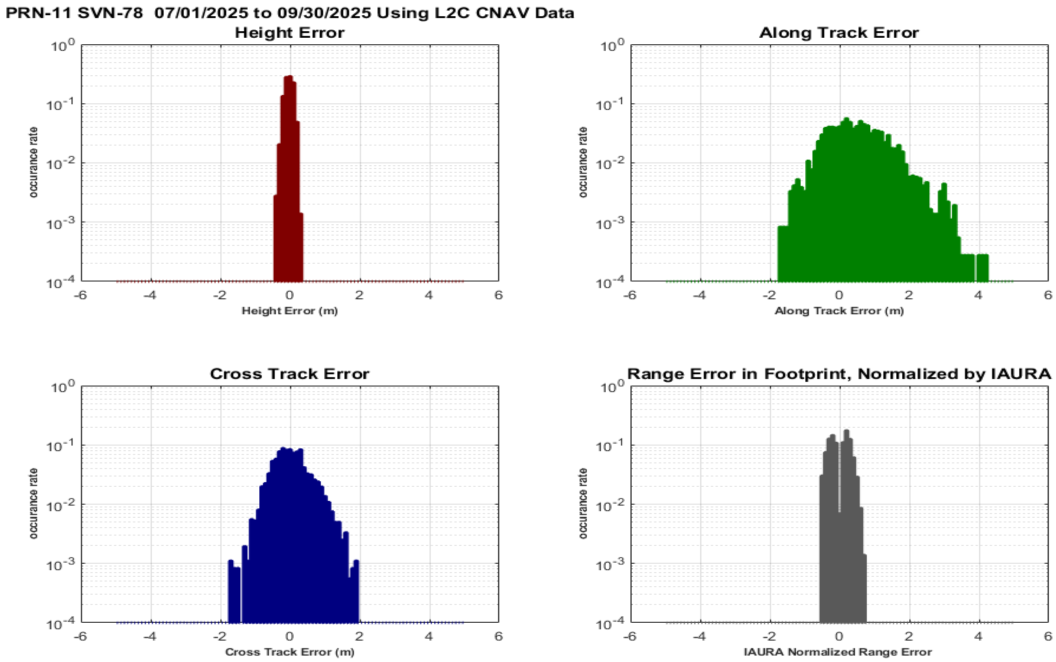

Figure 9-103 Histograms of H, A, C, and Range Error PRN11 (SVN78) Using L2C CNAV Data

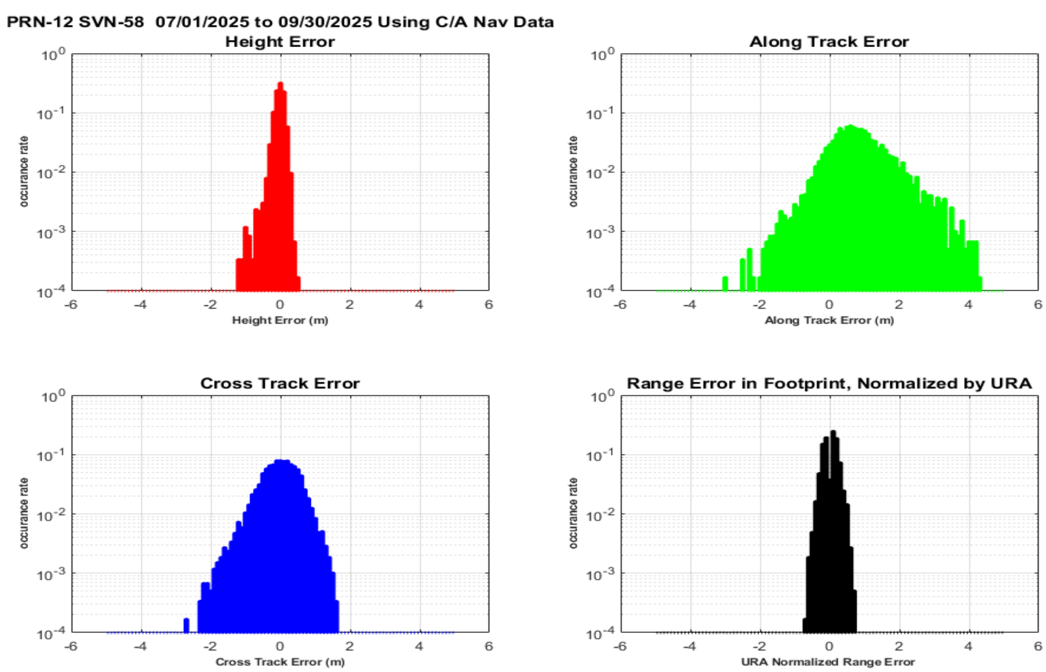

Figure 9-104 Histograms of H, A, C, and Range Error PRN12 (SVN58) Using C/A Nav Data

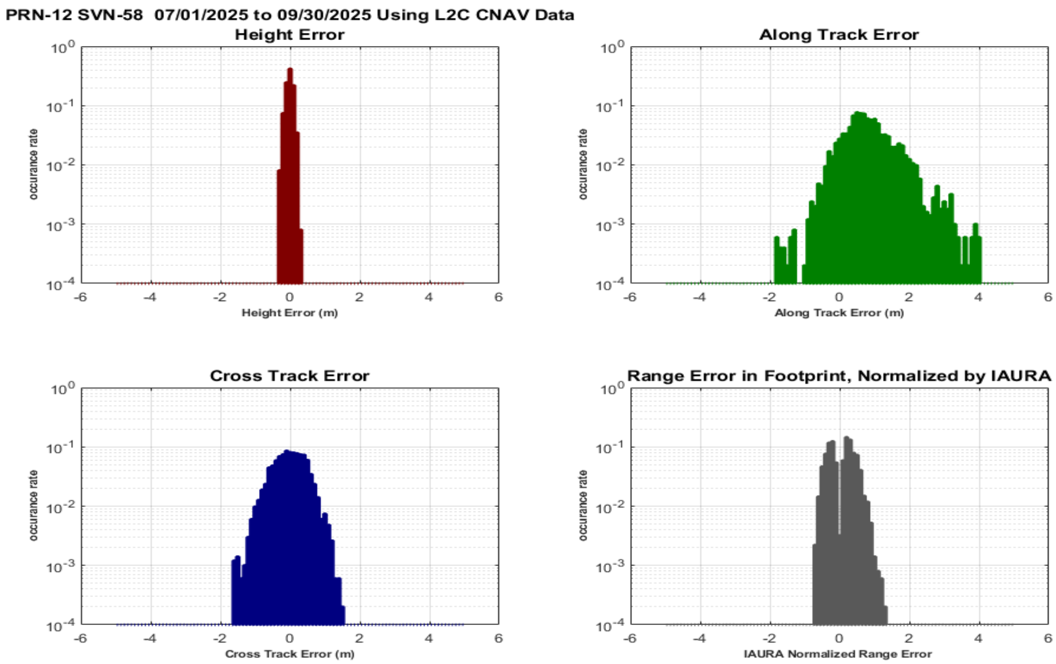

Figure 9-105 Histograms of H, A, C, and Range Error PRN12 (SVN58) Using L2C CNAV Data

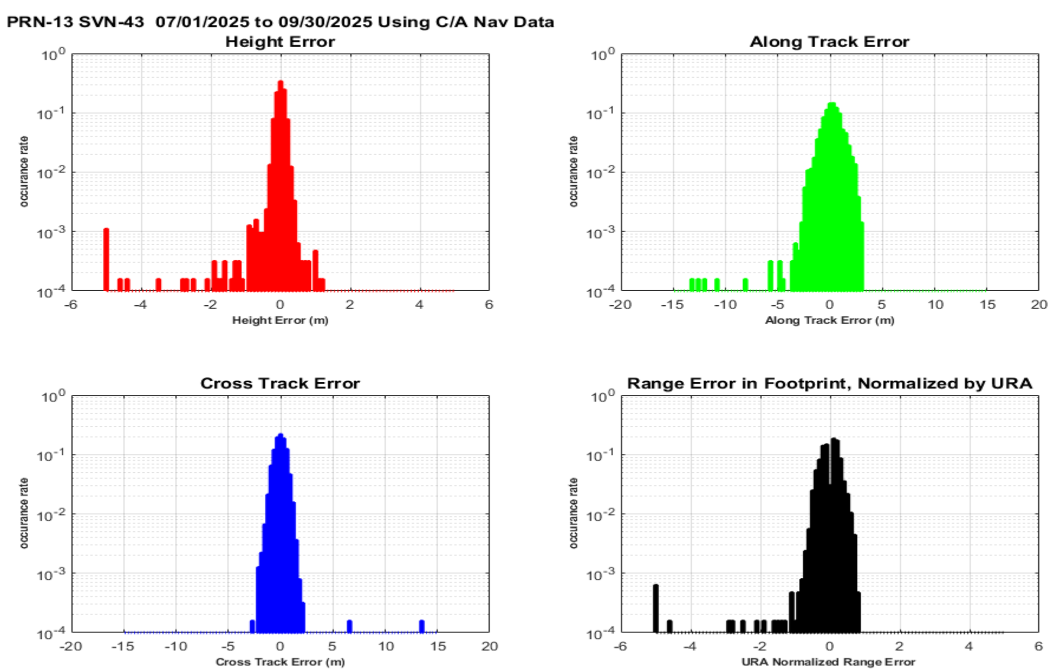

Figure 9-106 Histograms of H, A, C, and Range Error PRN13 (SVN43) Using C/A Nav Data

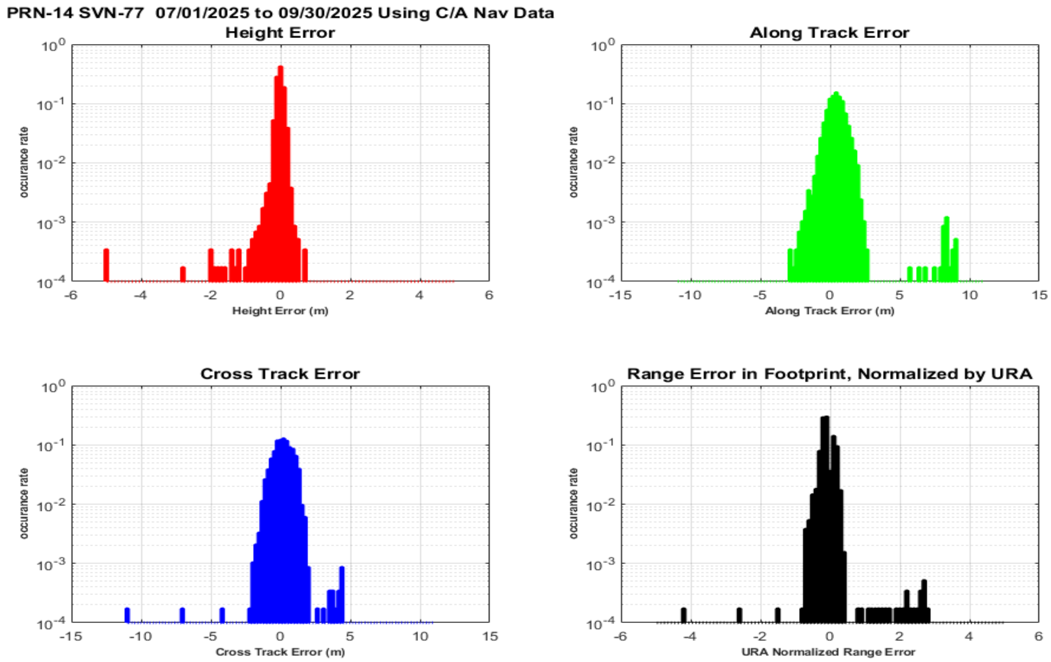

Figure 9-107 Histograms of H, A, C, and Range Error PRN14 (SVN77) Using C/A Nav Data

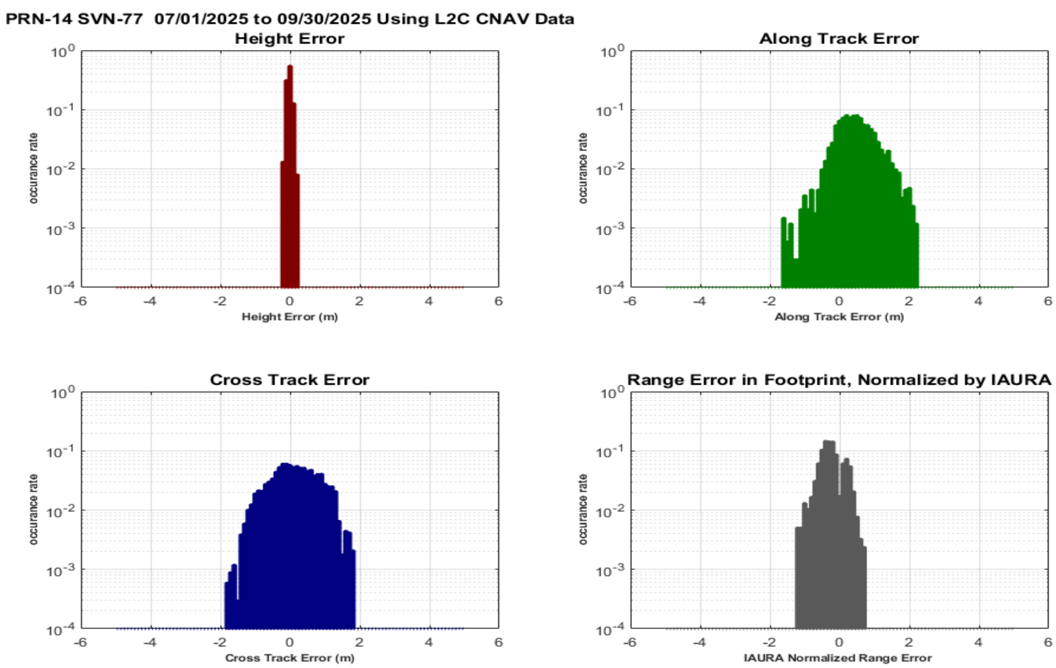

Figure 9-108 Histograms of H, A, C, and Range Error PRN14 (SVN77) Using L2C CNAV Data

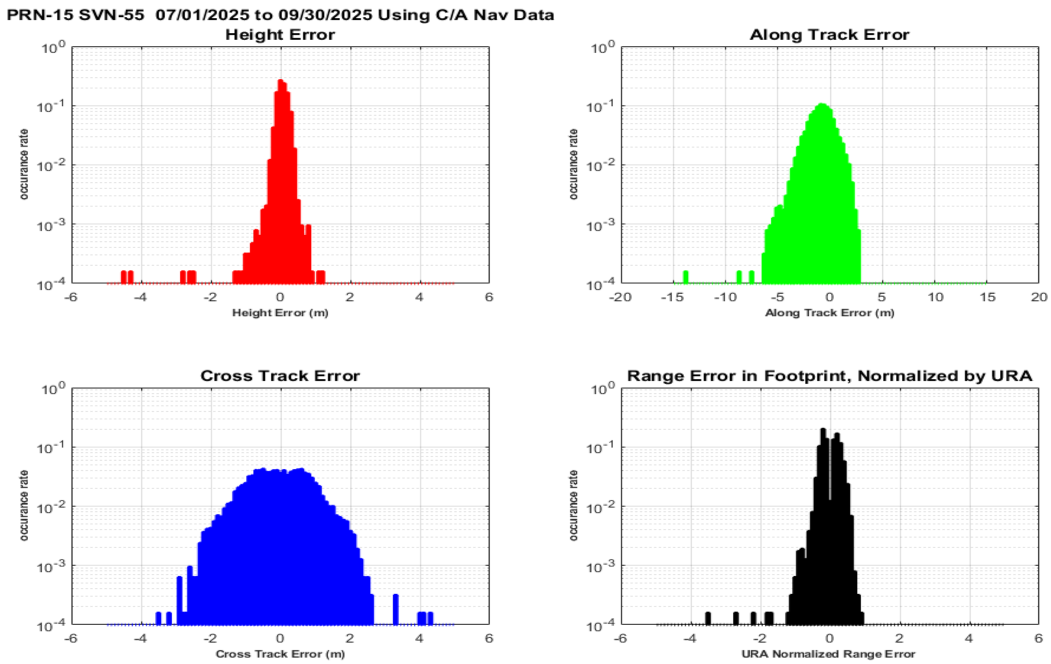

Figure 9-109 Histograms of H, A, C, and Range Error PRN15 (SVN55) Using C/A Nav Data

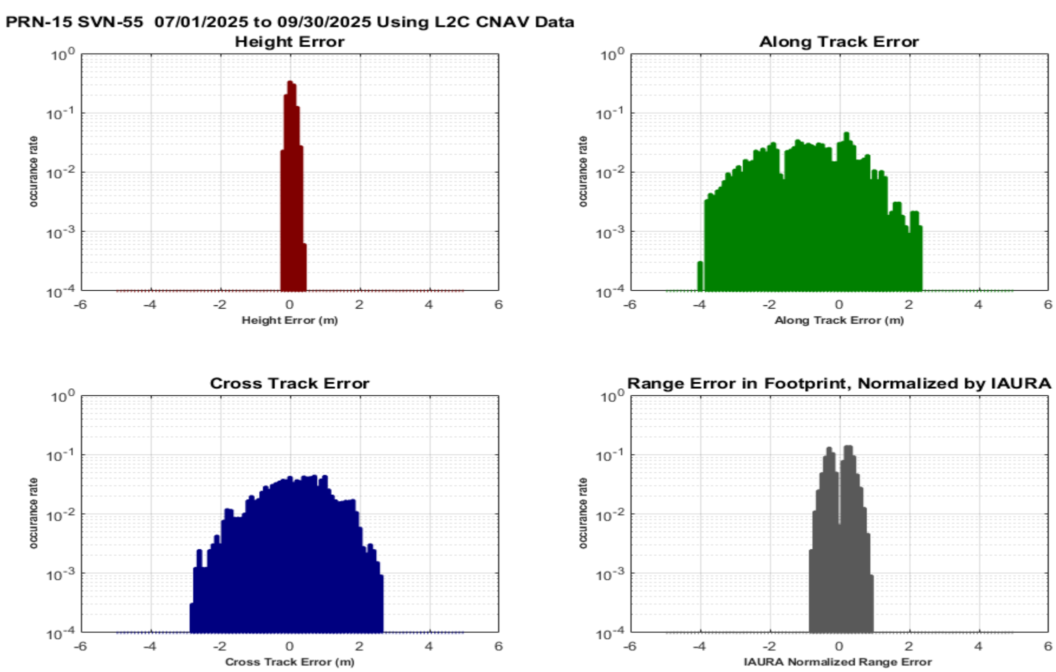

Figure 9-110 Histograms of H, A, C, and Range Error PRN15 (SVN55) Using L2C CNAV Data

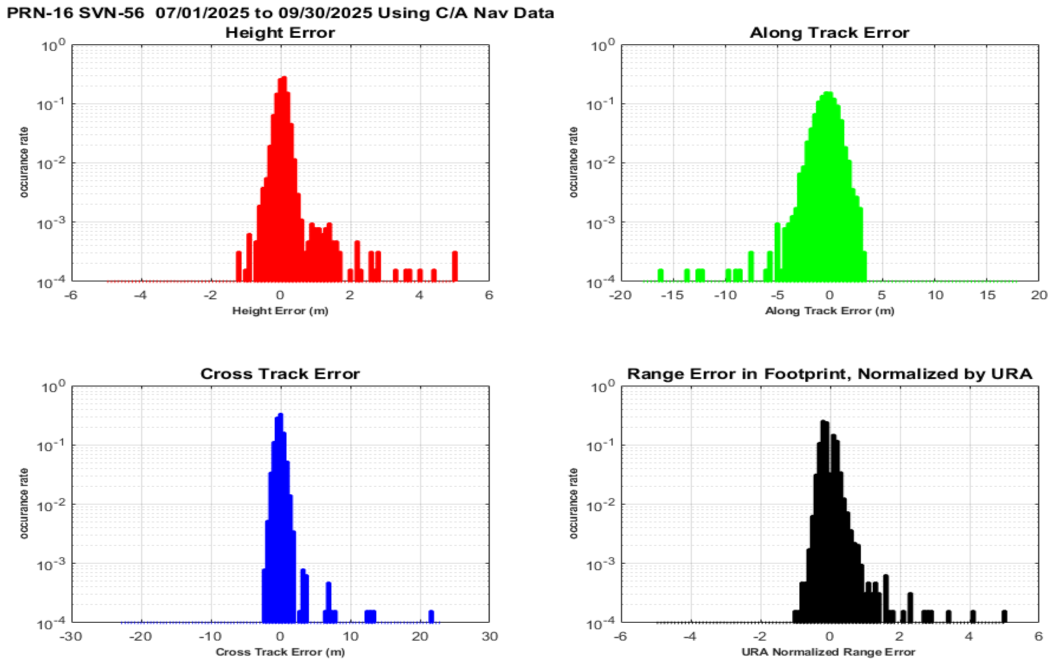

Figure 9-111 Histograms of H, A, C, and Range Error PRN16 (SVN56) Using C/A Nav Data

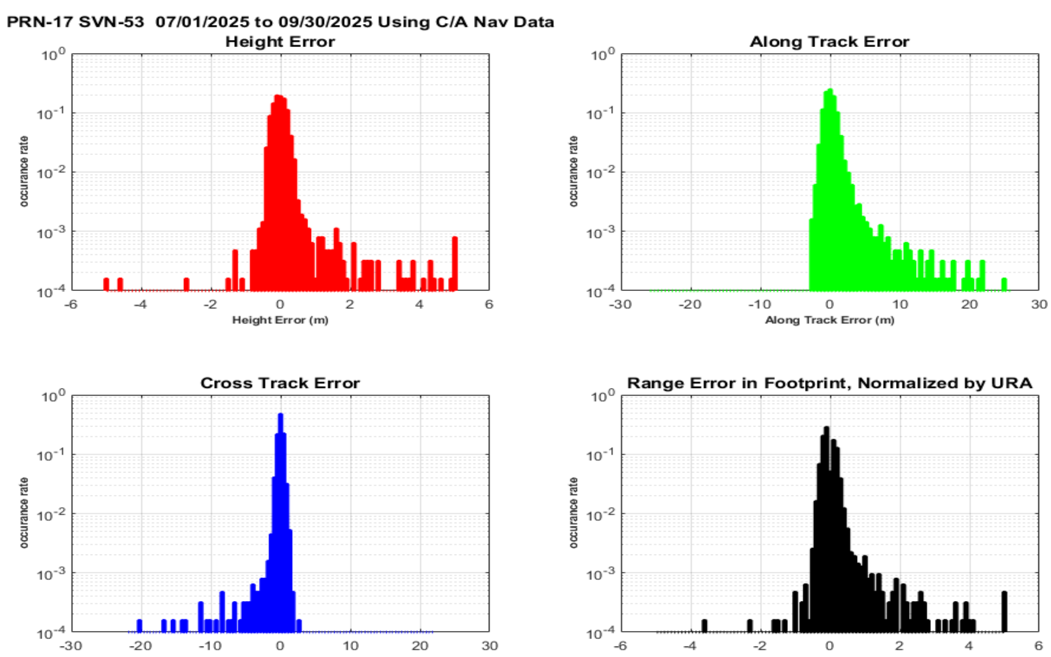

Figure 9-112 Histograms of H, A, C, and Range Error PRN17 (SVN53) Using C/A Nav Data

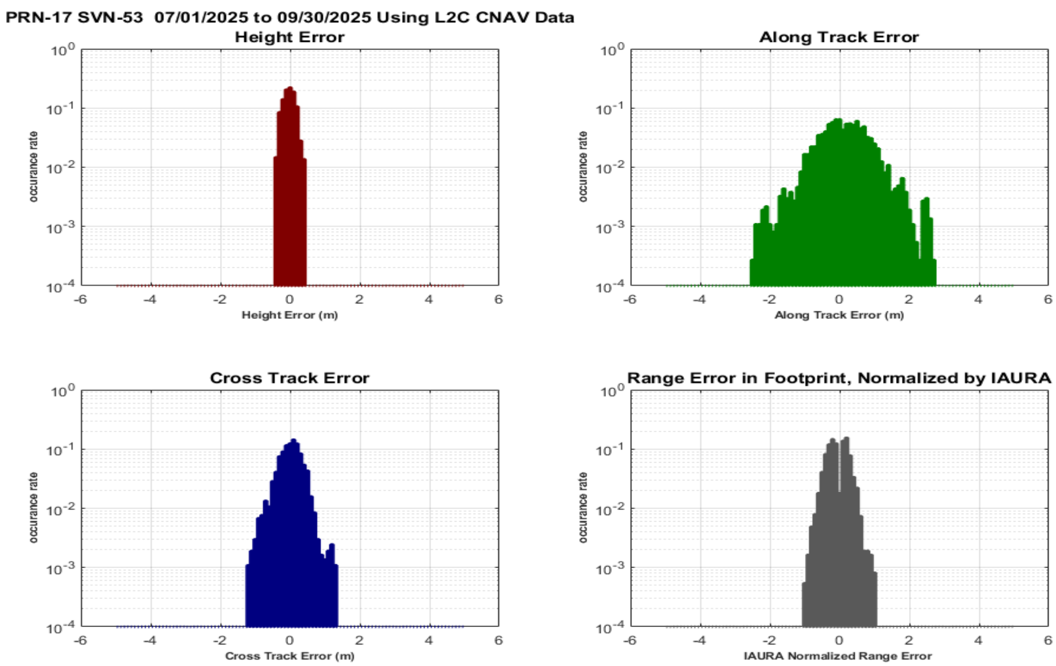

Figure 9-113 Histograms of H, A, C, and Range Error PRN17 (SVN53) Using L2C CNAV Data

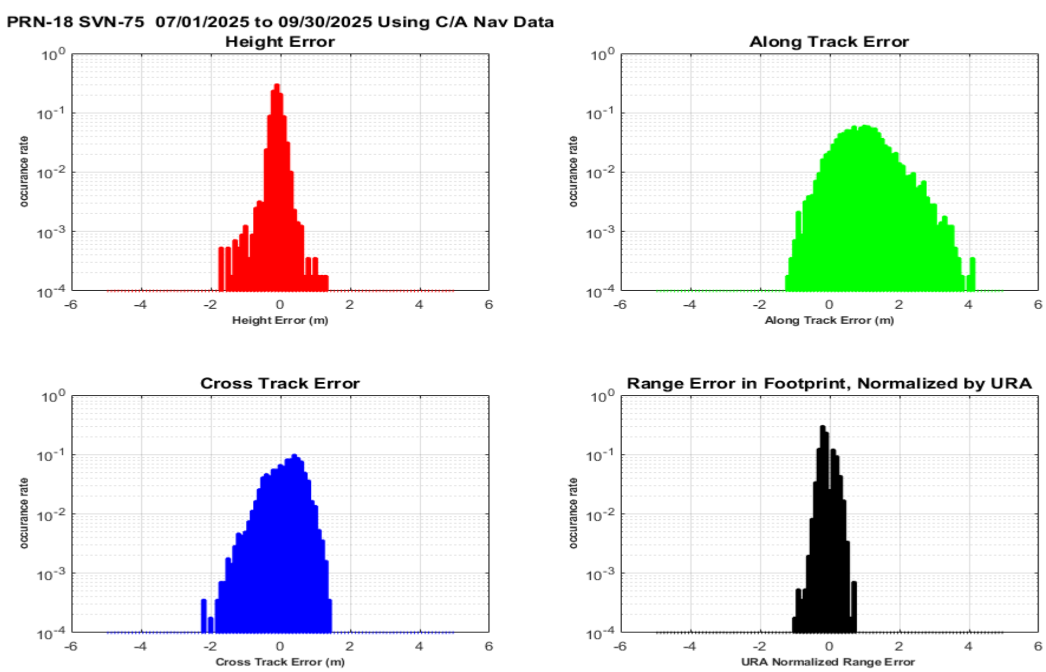

Figure 9-114 Histograms of H, A, C, and Range Error PRN18 (SVN75) Using C/A Nav Data

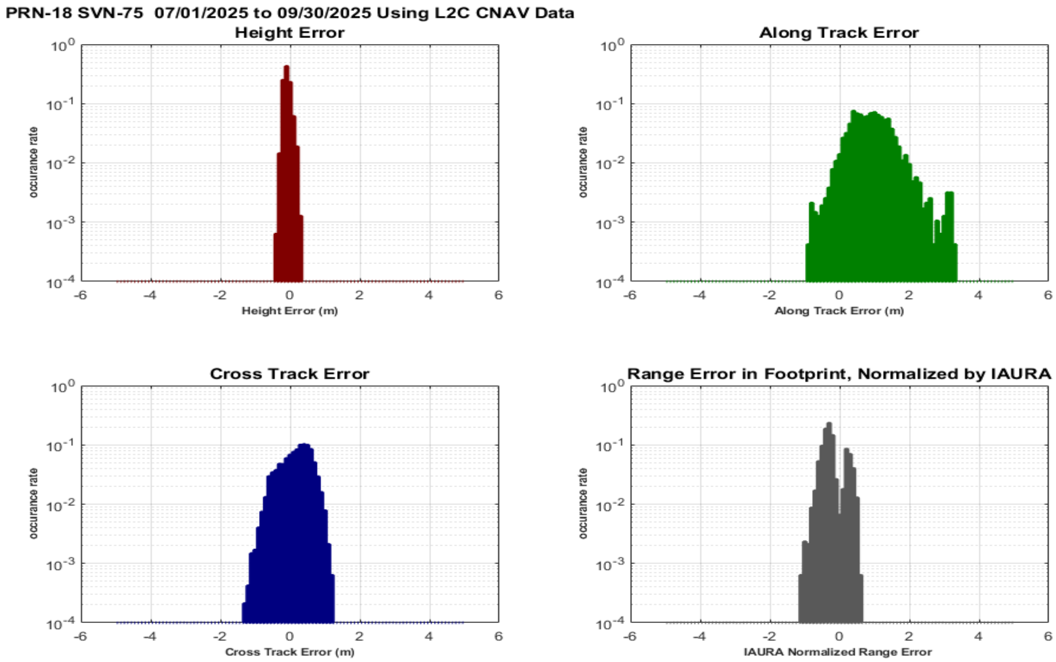

Figure 9-115 Histograms of H, A, C, and Range Error PRN18 (SVN75) Using L2C CNAV Data

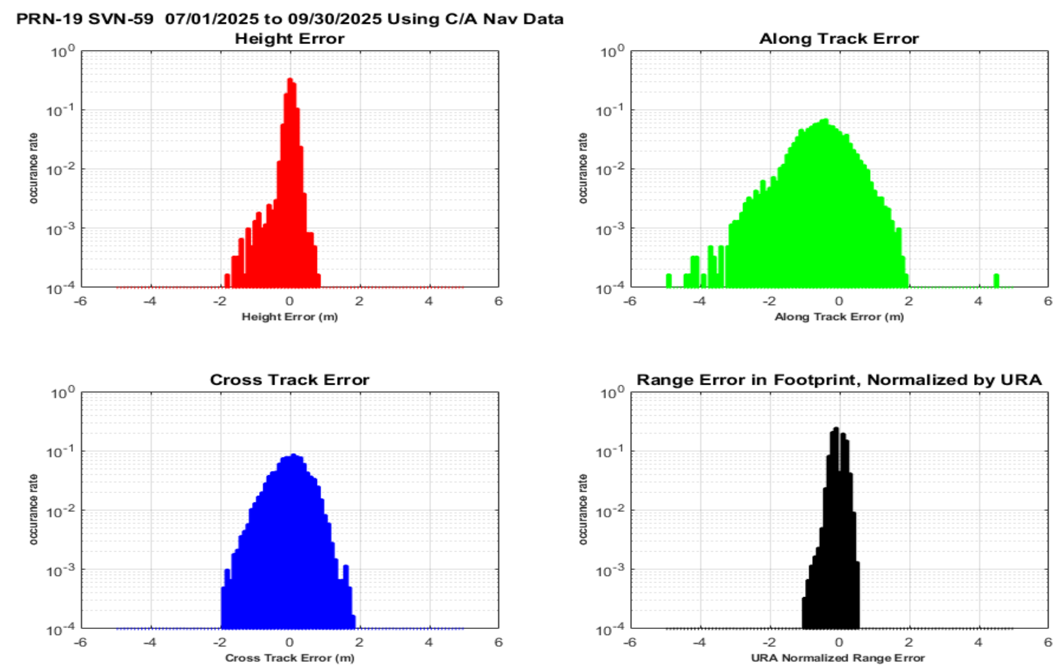

Figure 9-116 Histograms of H, A, C, and Range Error PRN19 (SVN59) Using C/A Nav Data

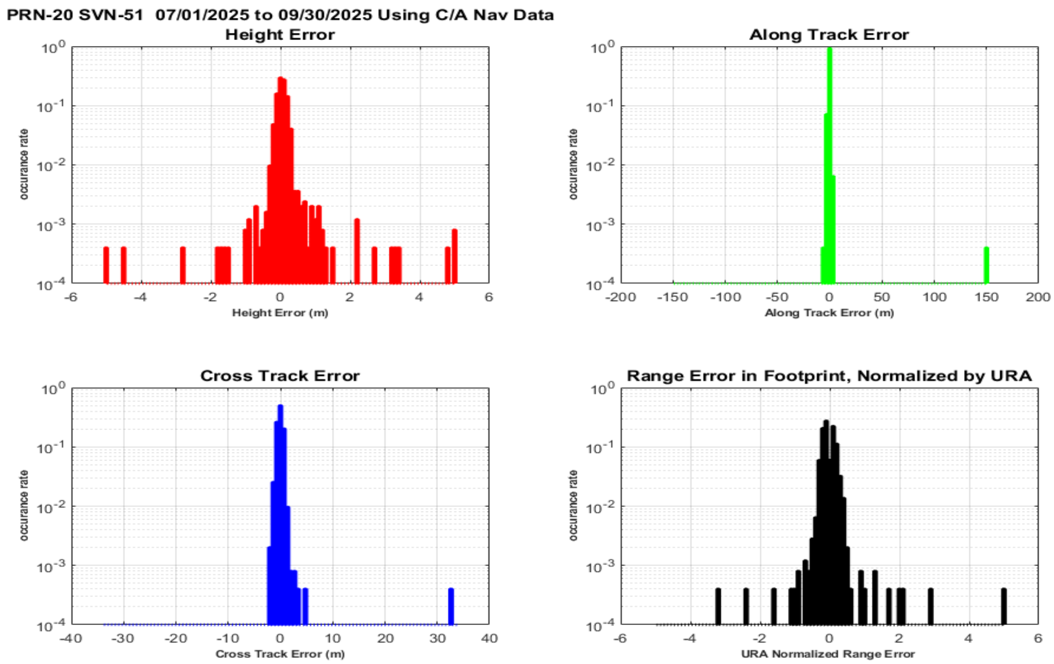

Figure 9-117 Histograms of H, A, C, and Range Error PRN20 (SVN51) Using C/A Nav Data

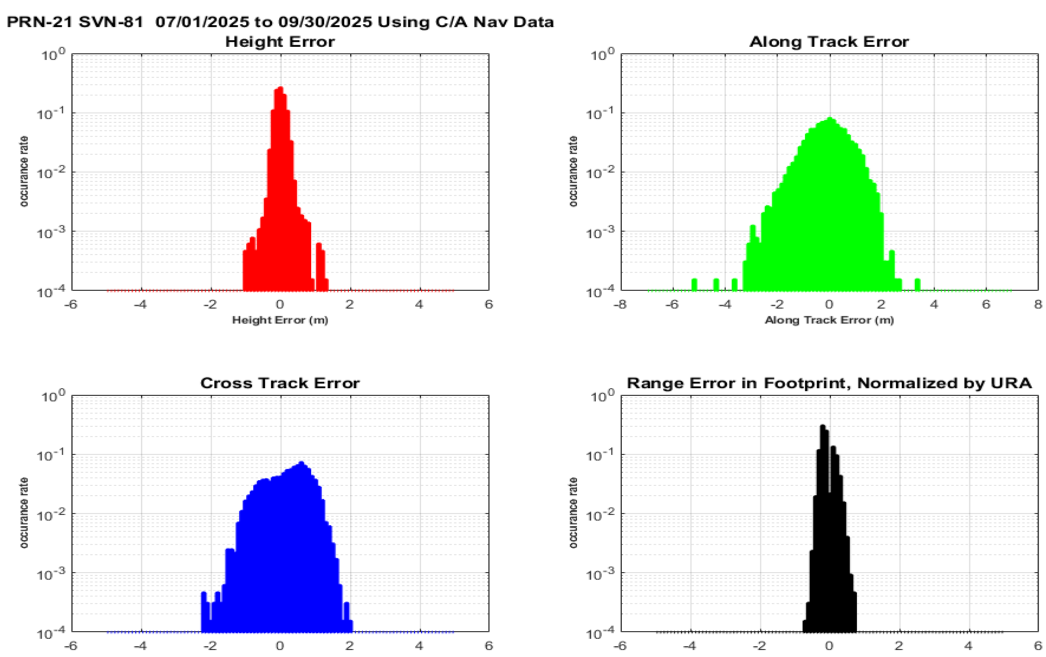

Figure 9-118 Histograms of H, A, C, and Range Error PRN21 (SVN81) Using C/A Nav Data

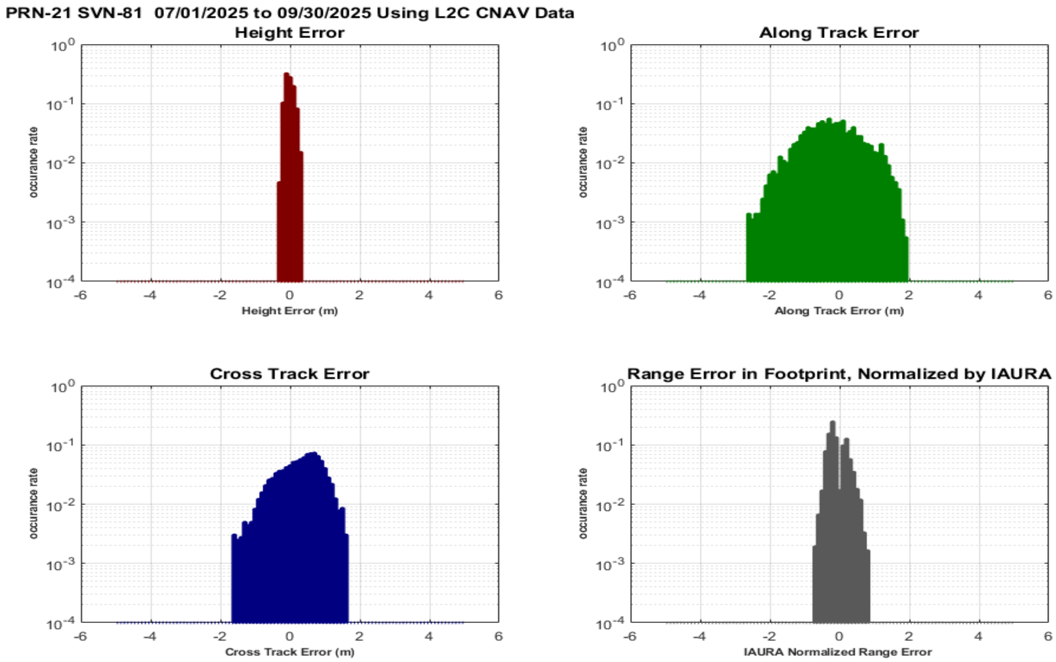

Figure 9-119 Histograms of H, A, C, and Range Error PRN21 (SVN81) Using L2C CNAV Data

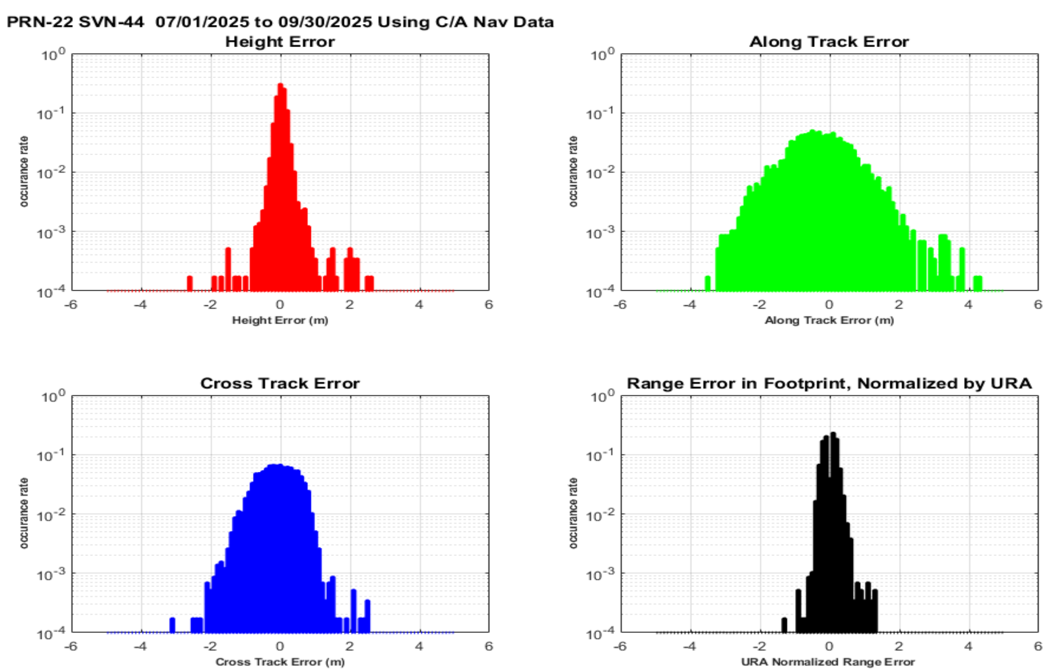

Figure 9-120 Histograms of H, A, C, and Range Error PRN22 (SVN44) Using C/A Nav Data

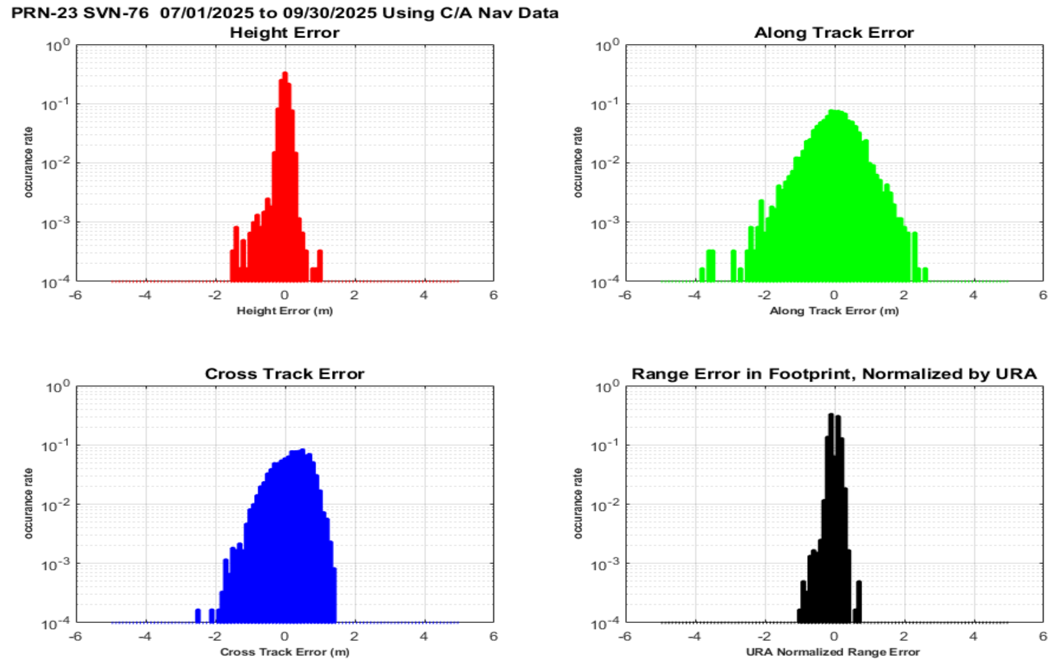

Figure 9-121 Histograms of H, A, C, and Range Error PRN23 (SVN76) Using C/A Nav Data

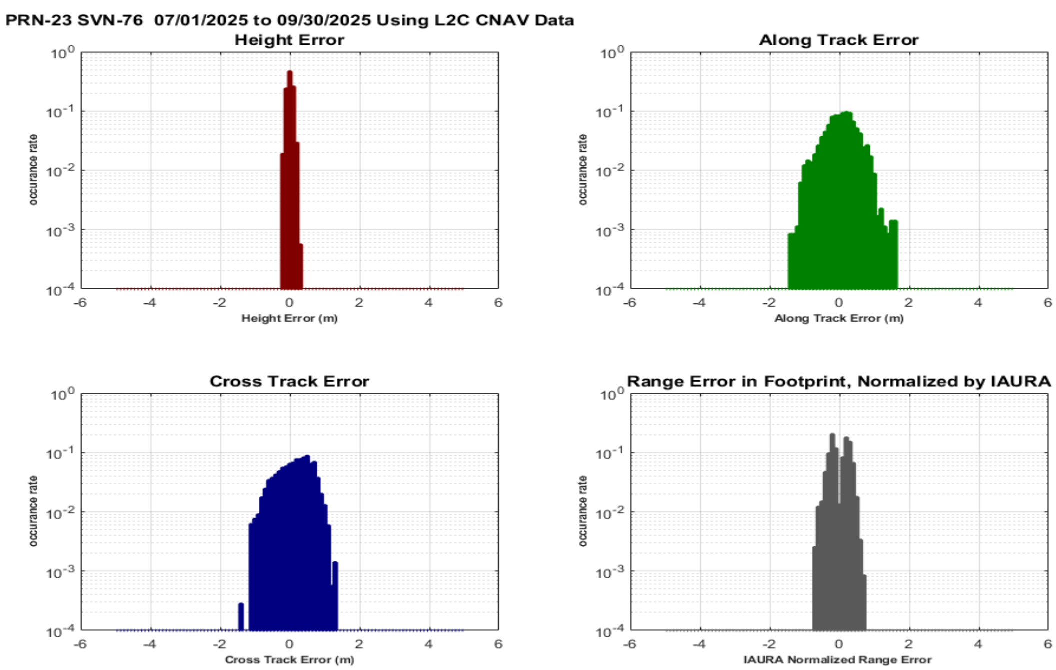

Figure 9-122 Histograms of H, A, C, and Range Error PRN23 (SVN76) Using L2C CNAV Data

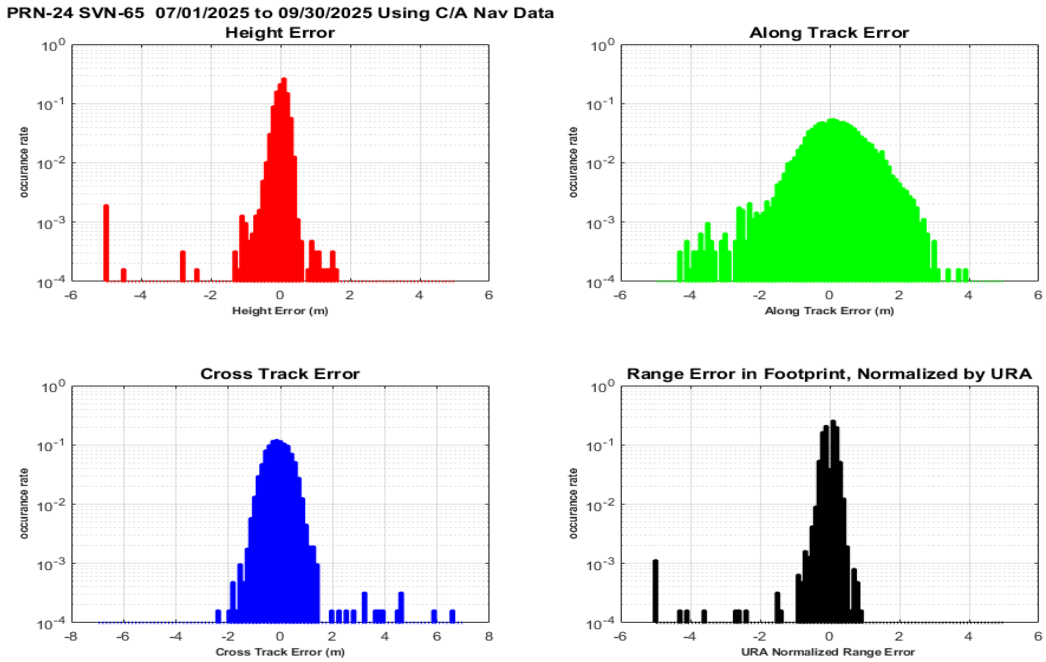

Figure 9-123 Histograms of H, A, C, and Range Error PRN24 (SVN65) Using C/A Nav Data

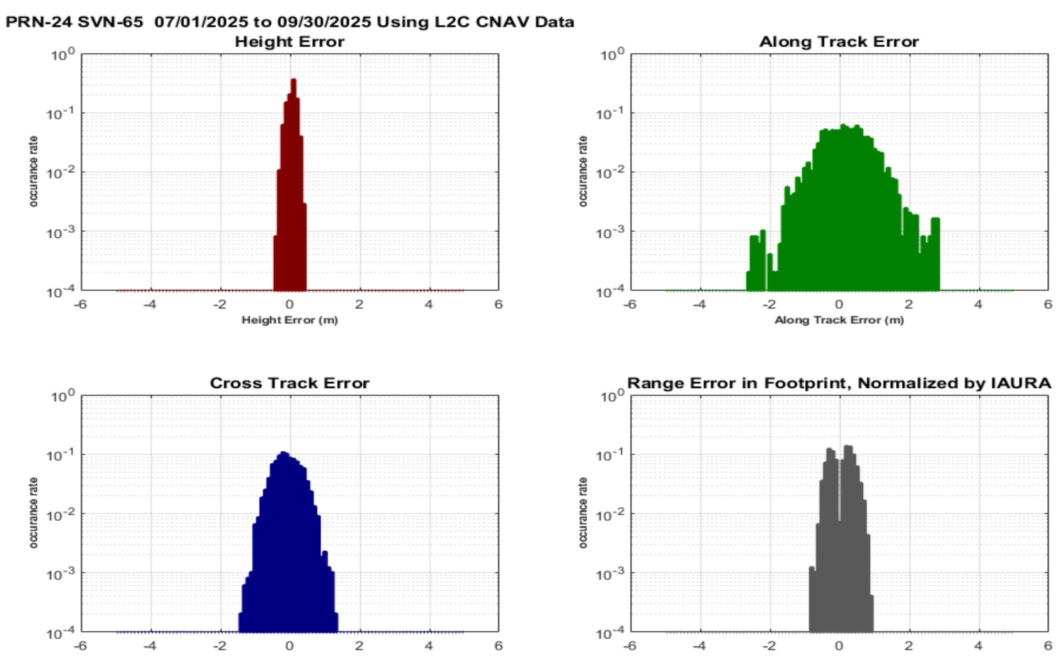

Figure 9-124 Histograms of H, A, C, and Range Error PRN24 (SVN65) Using L2C CNAV Data

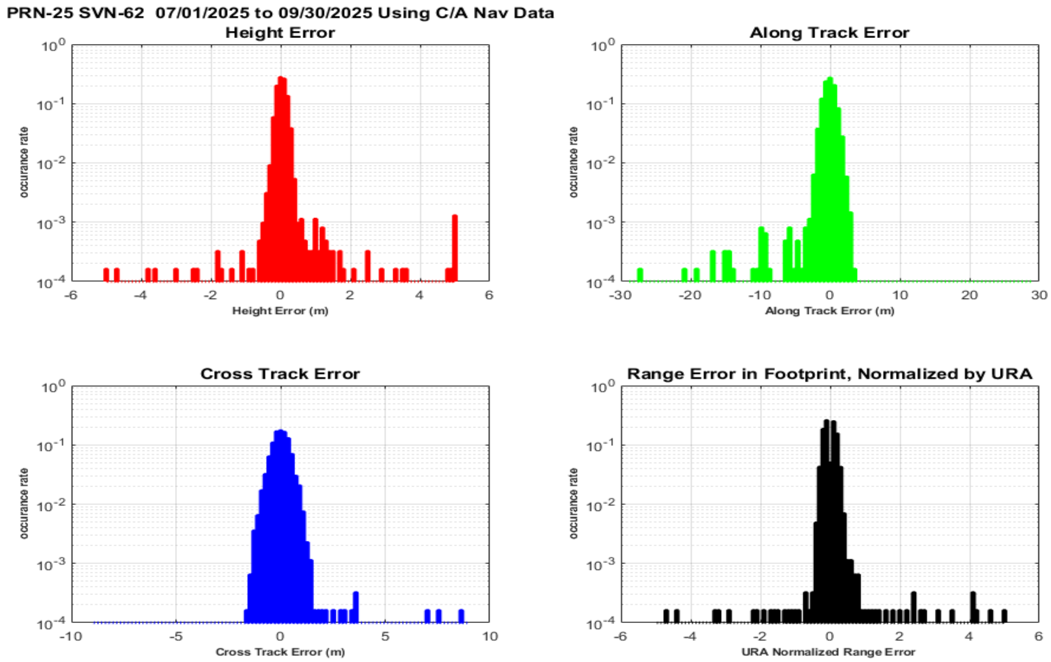

Figure 9-125 Histograms of H, A, C, and Range Error PRN25 (SVN62) Using C/A Nav Data

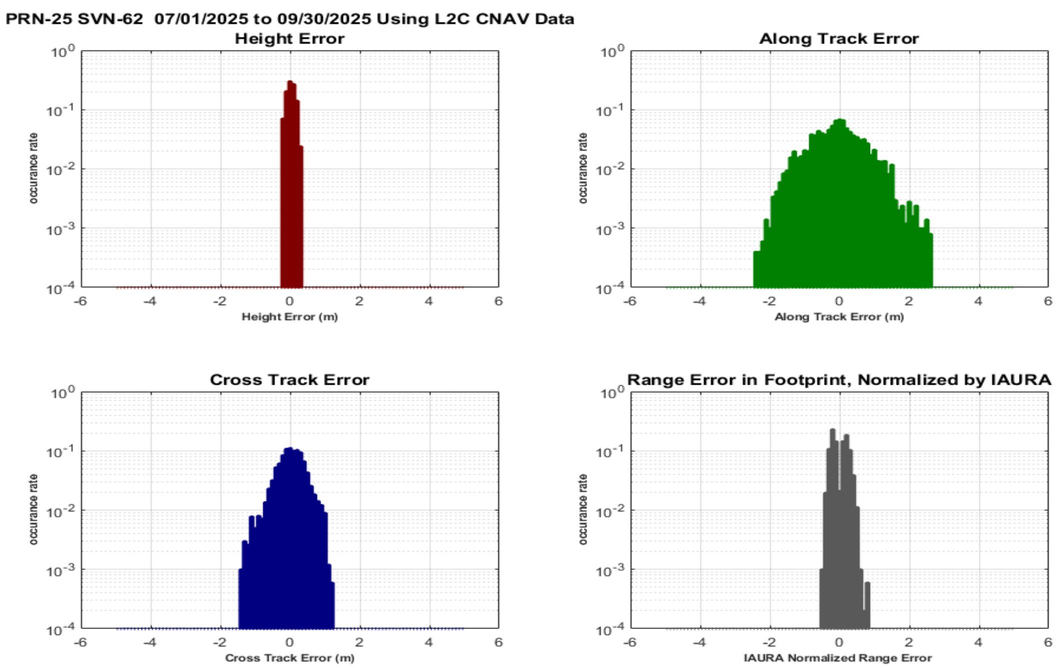

Figure 9-126 Histograms of H, A, C, and Range Error PRN25 (SVN62) Using L2C CNAV Data

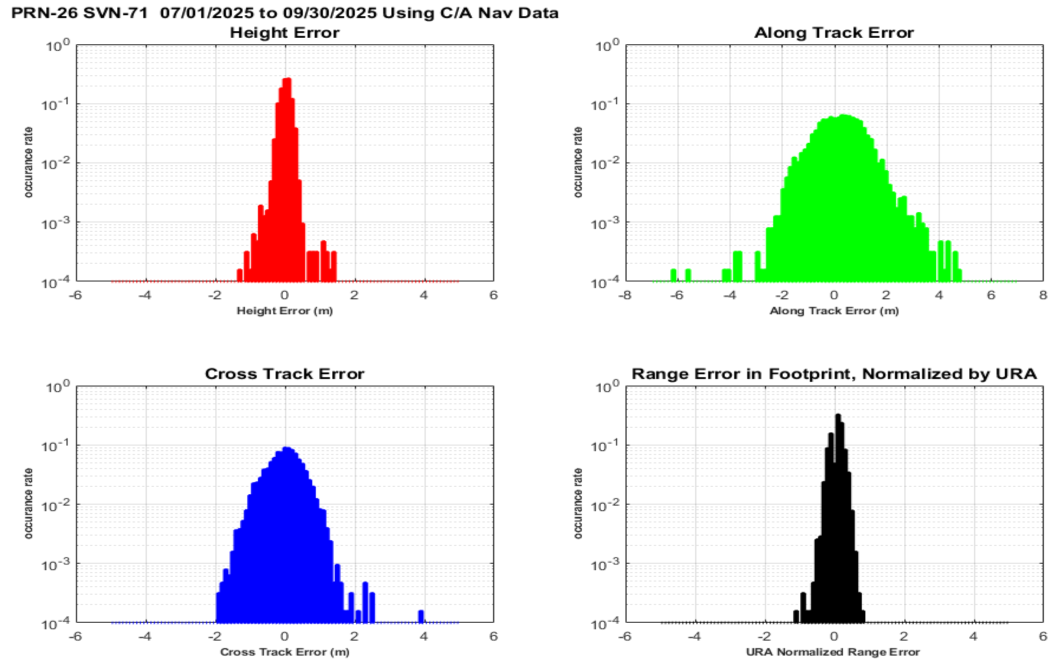

Figure 9-127 Histograms of H, A, C, and Range Error PRN26 (SVN71) Using C/A Nav Data

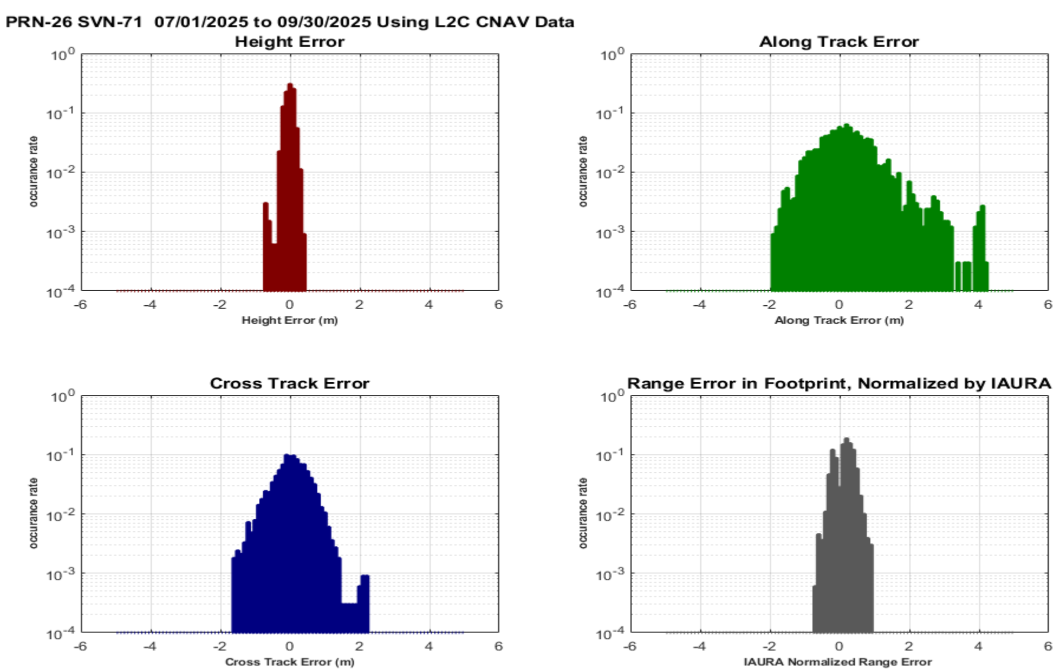

Figure 9-128 Histograms of H, A, C, and Range Error PRN26 (SVN71) Using L2C CNAV Data

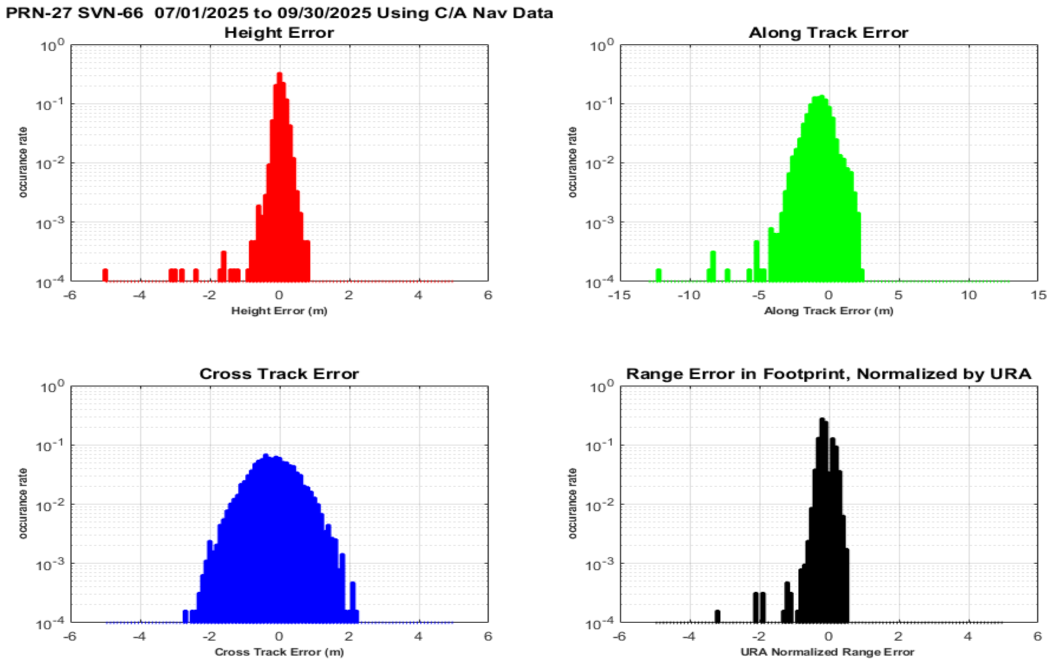

Figure 9-129 Histograms of H, A, C, and Range Error PRN27 (SVN66) Using C/A Nav Data

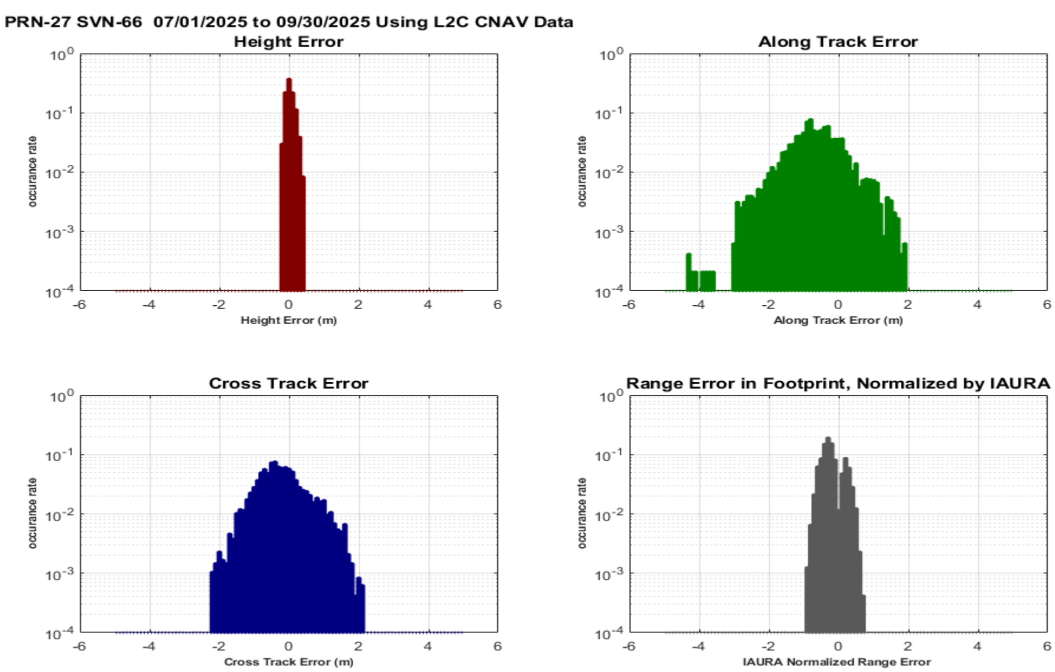

Figure 9-130 Histograms of H, A, C, and Range Error PRN27 (SVN66) Using L2C CNAV Data

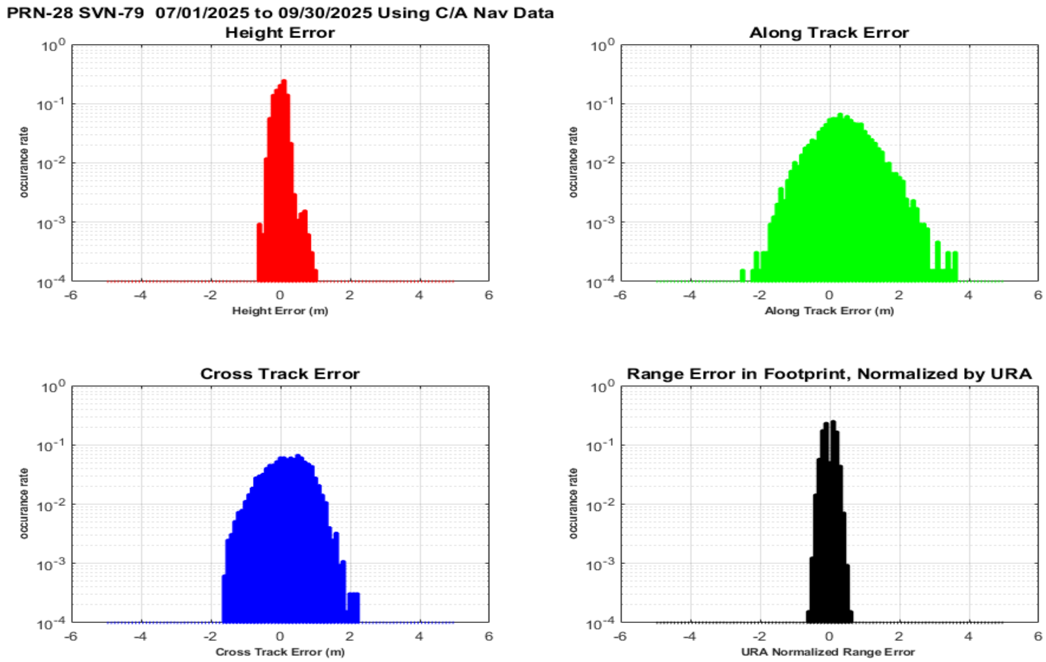

Figure 9-131 Histograms of H, A, C, and Range Error PRN28 (SVN79) Using C/A Nav Data

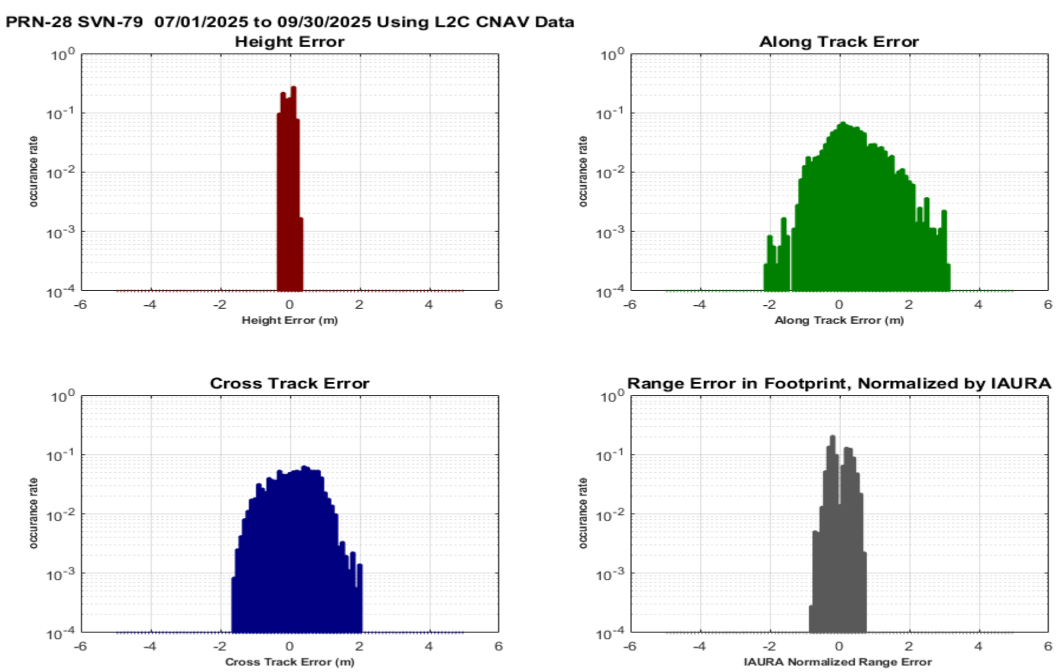

Figure 9-132 Histograms of H, A, C, and Range Error PRN28 (SVN79) Using L2C CNAV Data

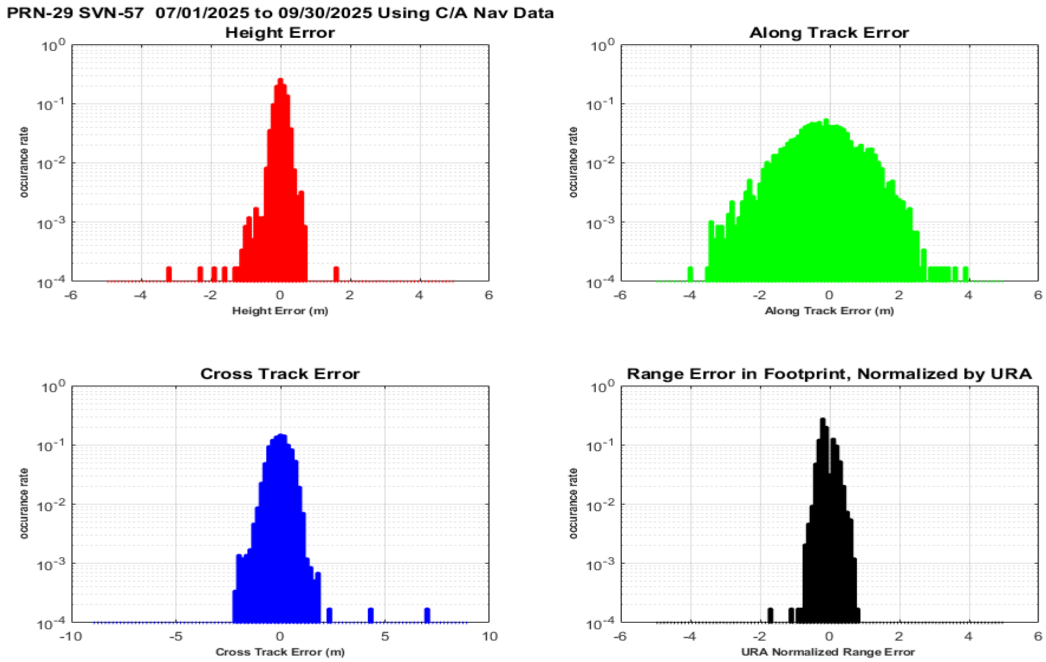

Figure 9-133 Histograms of H, A, C, and Range Error PRN29 (SVN57) Using C/A Nav Data

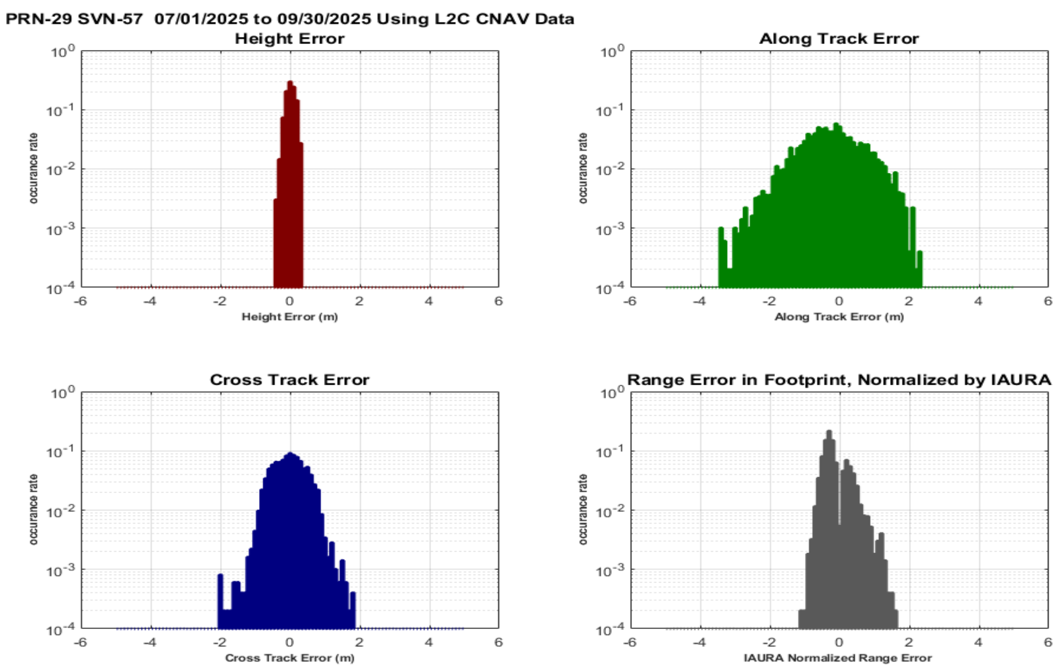

Figure 9-134 Histograms of H, A, C, and Range Error PRN29 (SVN57) Using L2C CNAV Data

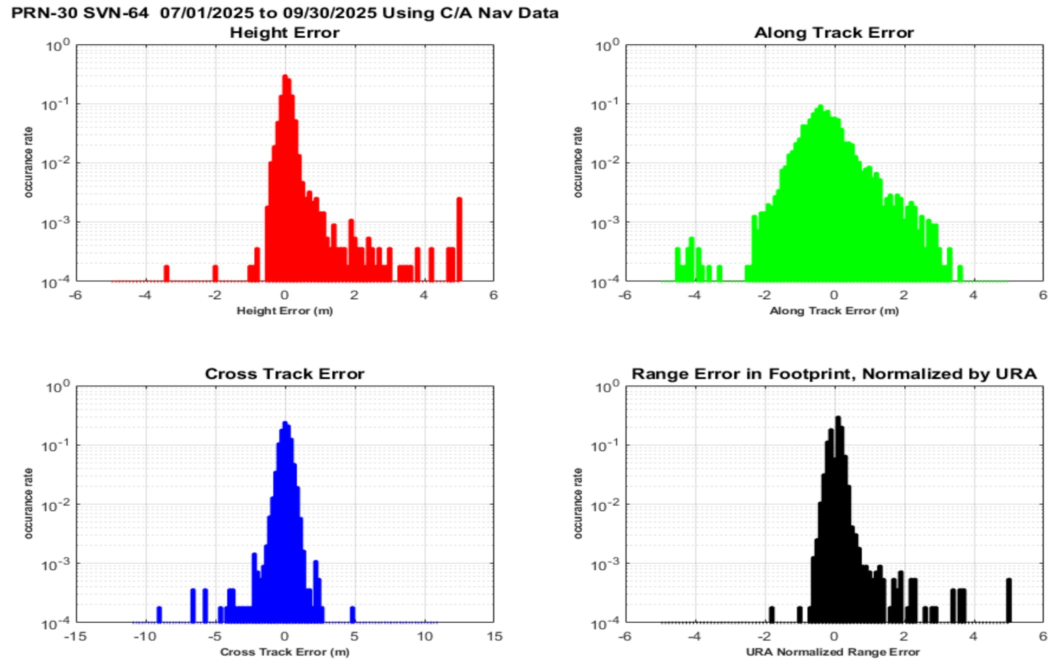

Figure 9-135 Histograms of H, A, C, and Range Error PRN30 (SVN64) Using C/A Nav Data

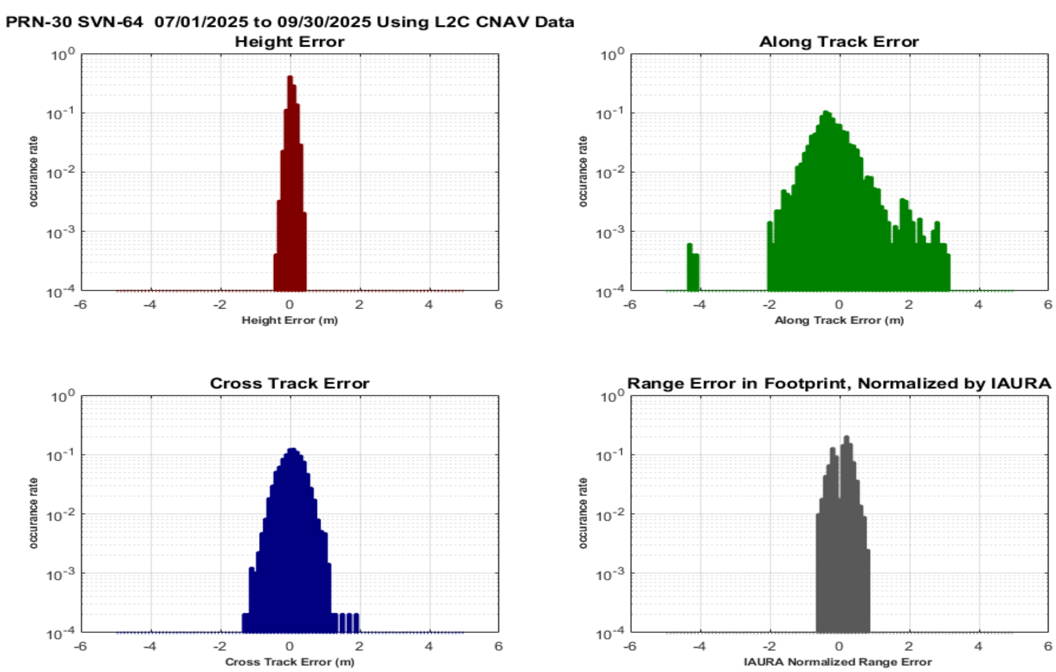

Figure 9-136 Histograms of H, A, C, and Range Error PRN30 (SVN64) Using L2C CNAV Data

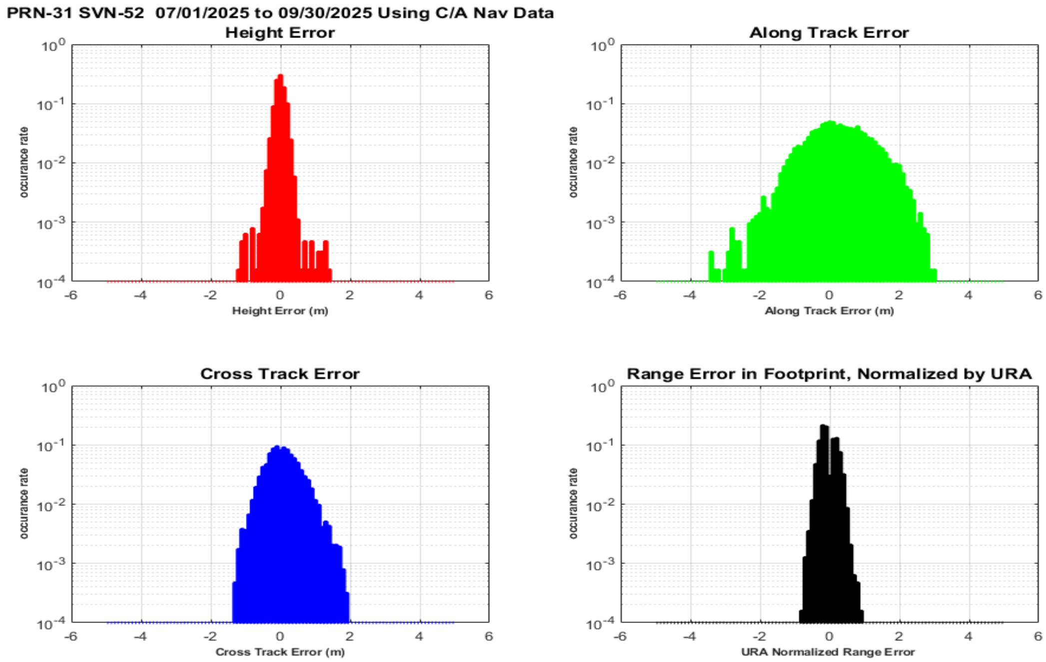

Figure 9-137 Histograms of H, A, C, and Range Error PRN31 (SVN52) Using C/A Nav Data

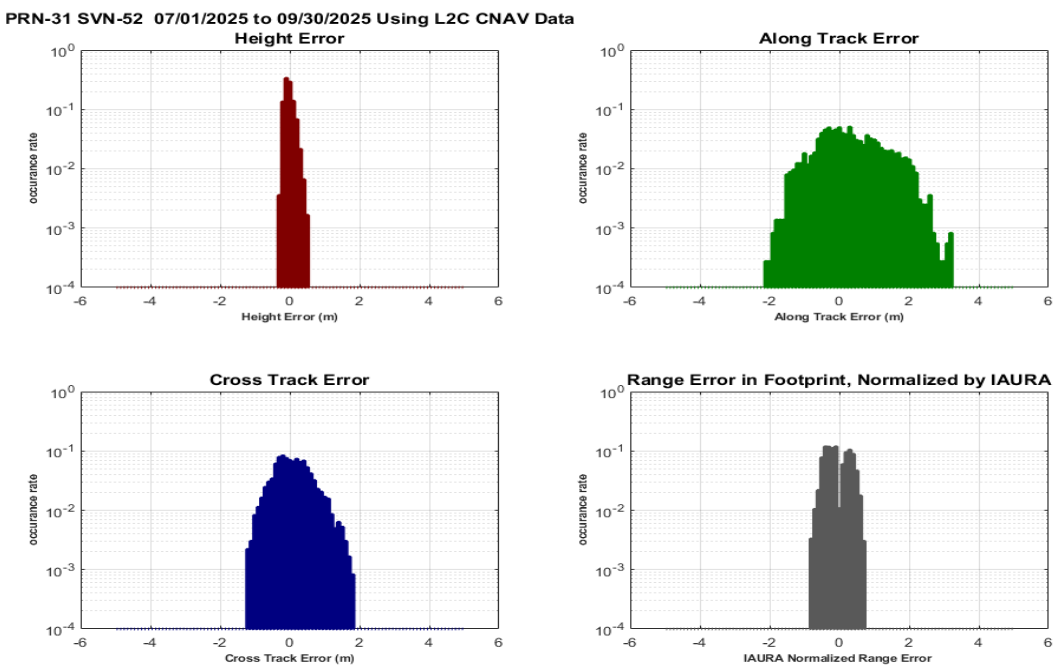

Figure 9-138 Histograms of H, A, C, and Range Error PRN31 (SVN52) Using L2C CNAV Data

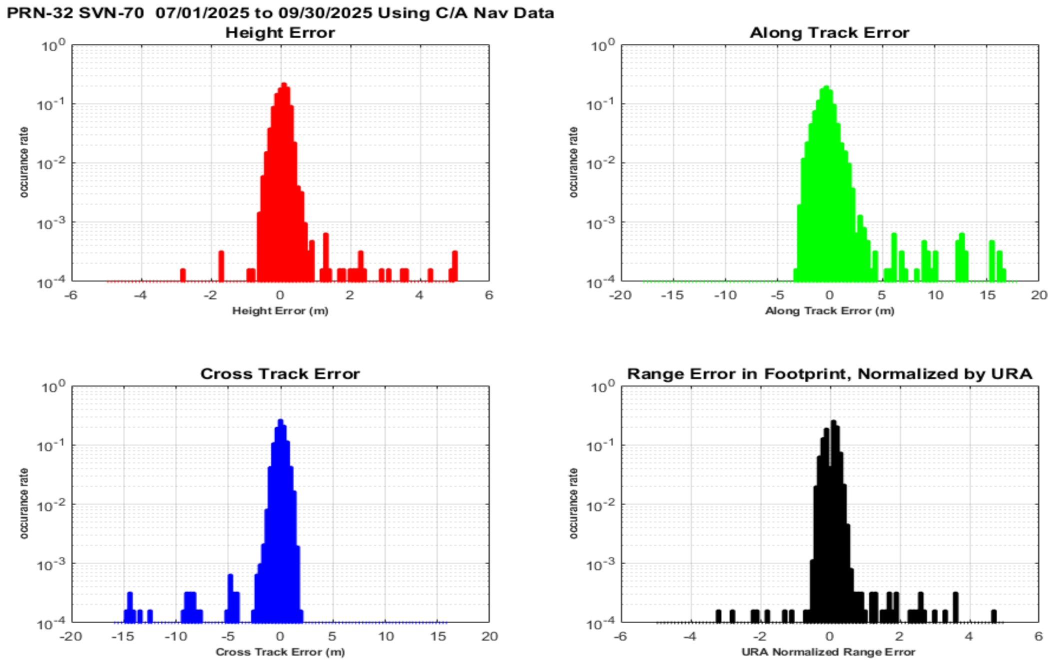

Figure 9-139 Histograms of H, A, C, and Range Error PRN32 (SVN70) Using C/A Nav Data

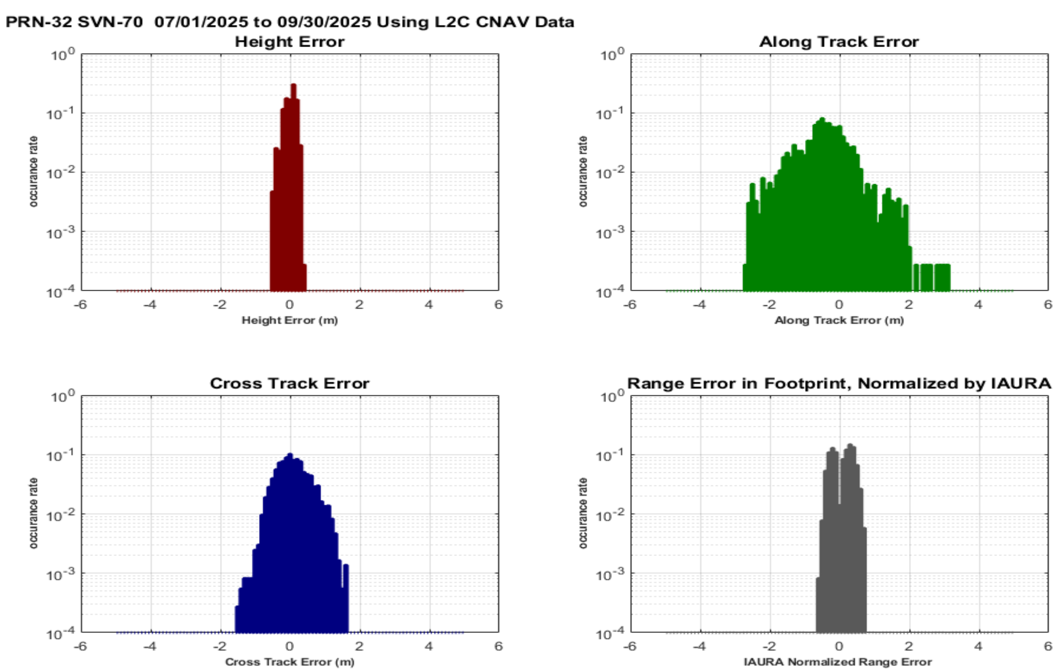

Figure 9-140 Histograms of H, A, C, and Range Error PRN32 (SVN70) Using L2C CNAV Data

9.8 Timeline of URA Normalized Range Error for All Satellites

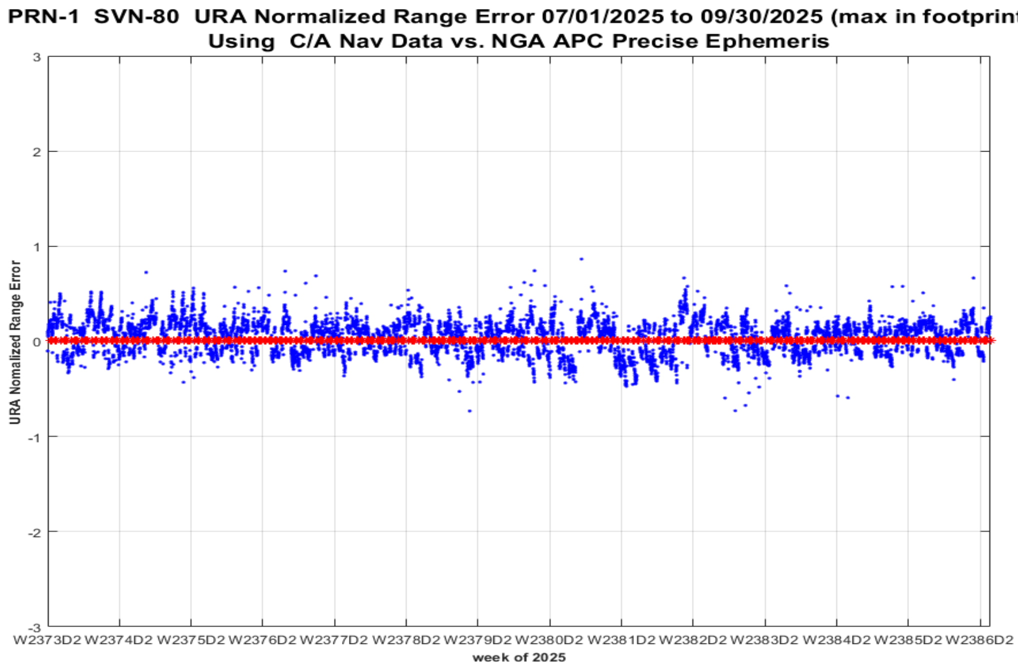

Figure 9-141 Timeline of URA Normalized Range Error PRN1 (SVN80) Using C/A Nav Data

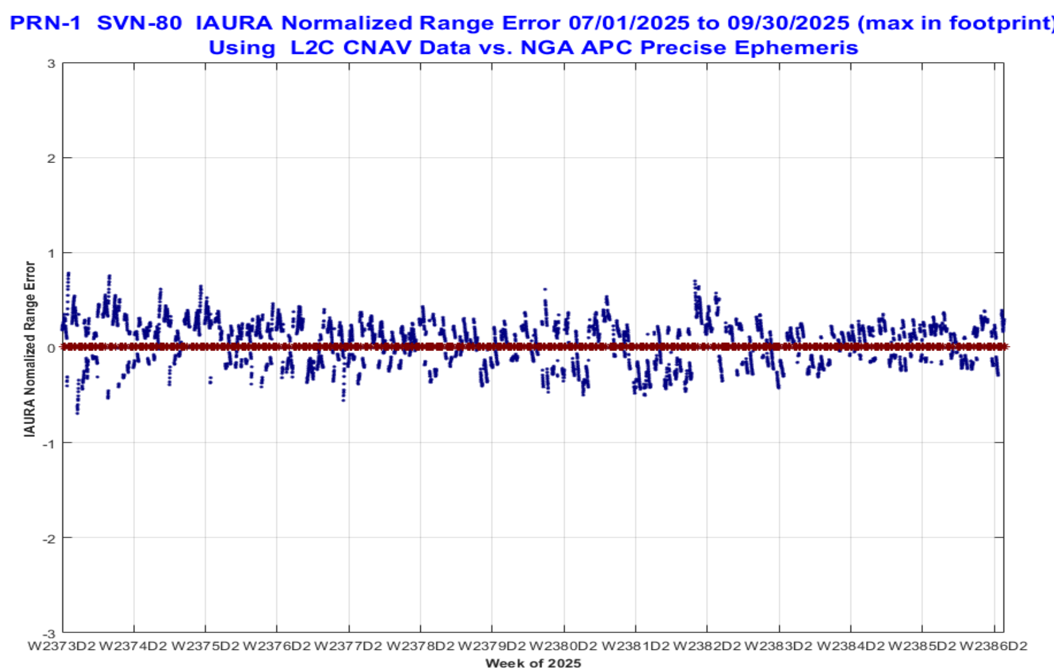

Figure 9-142 Timeline of IAURA Normalized Range Error PRN1 (SVN80) Using L2C CNAV Data

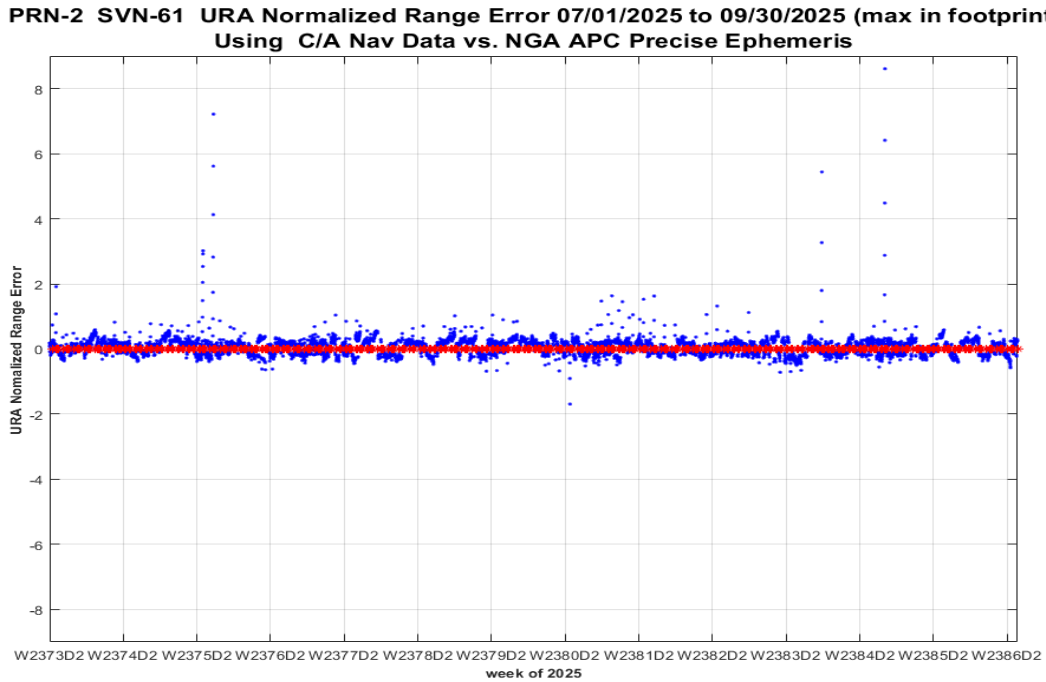

Figure 9-143 Timeline of URA Normalized Range Error PRN2 (SVN61) Using C/A Nav Data

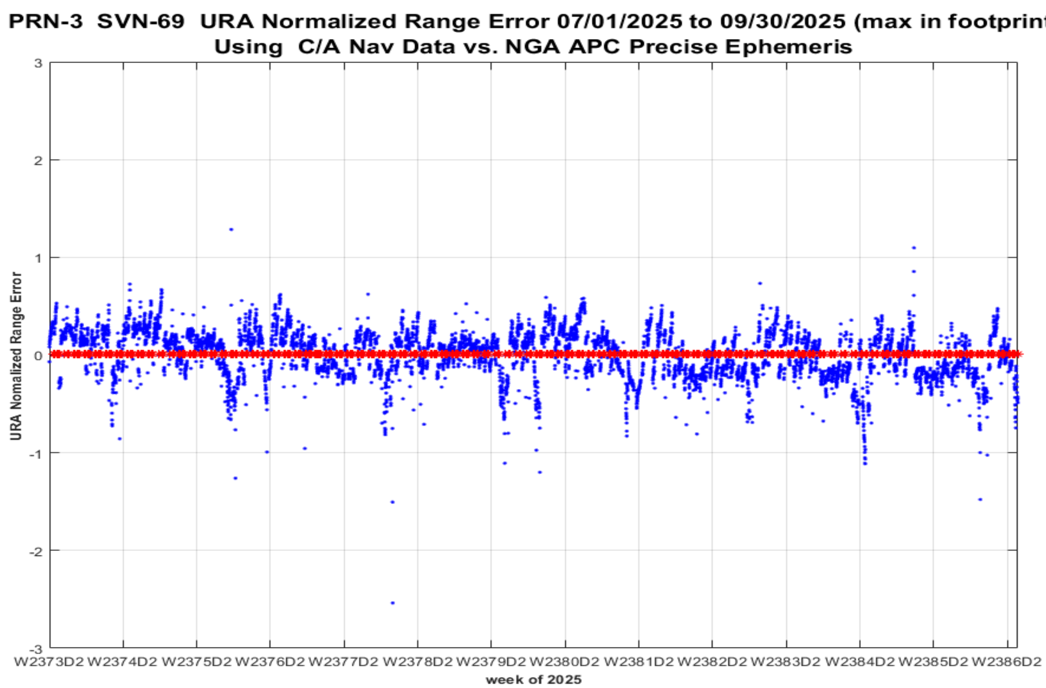

Figure 9-144 Timeline of URA Normalized Range Error PRN3 (SVN69) Using C/A Nav Data

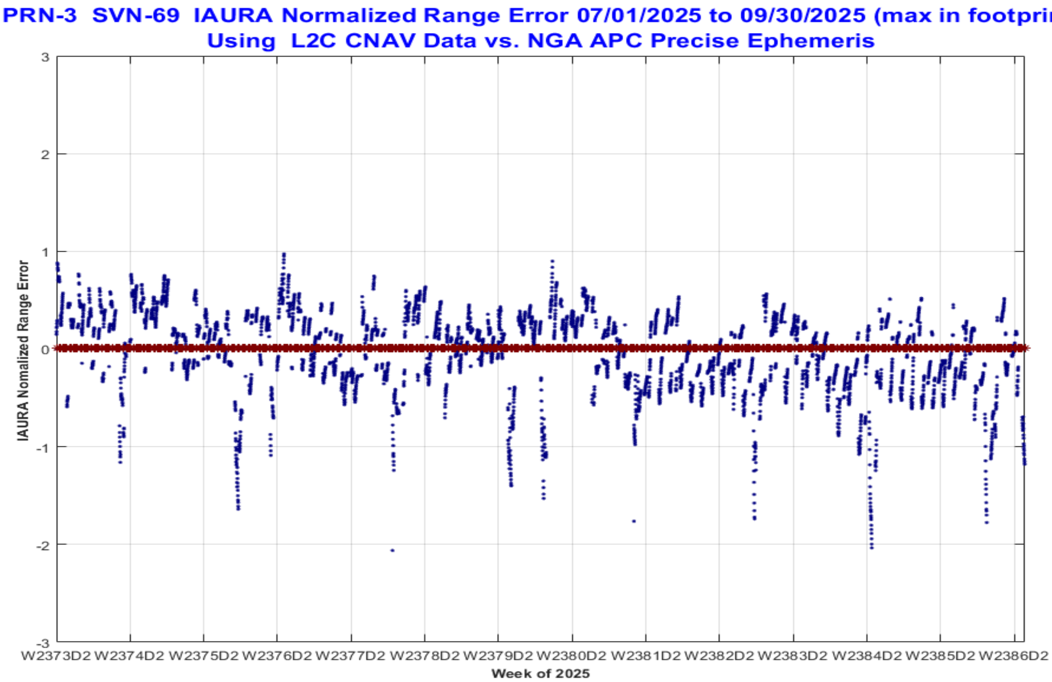

Figure 9-145 Timeline of IAURA Normalized Range Error PRN3 (SVN69) Using L2C CNAV Data

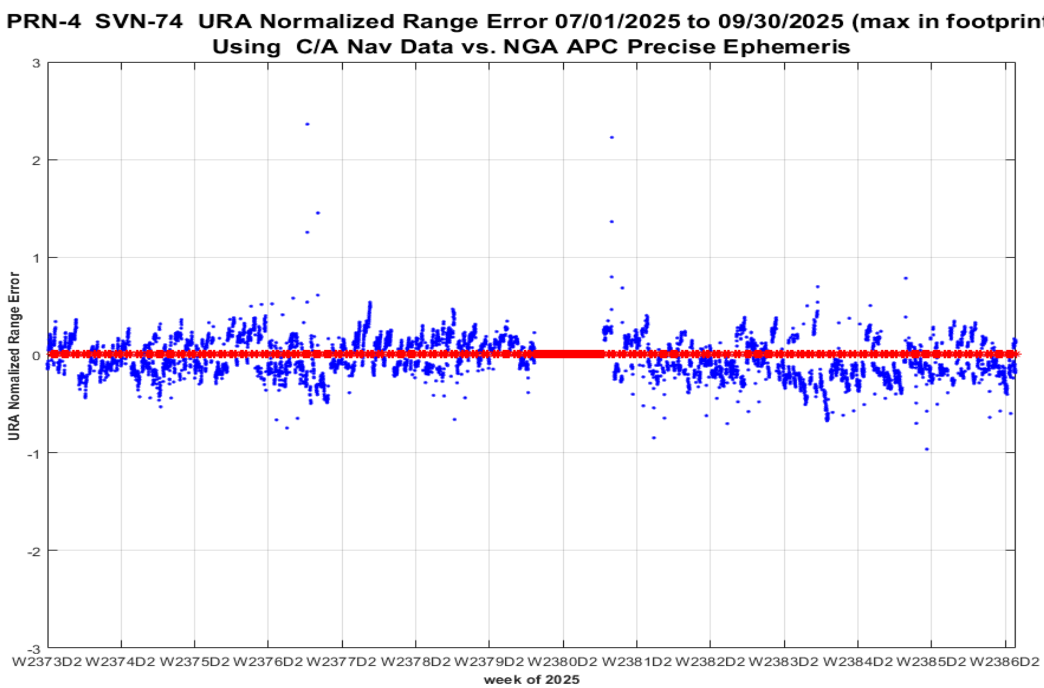

Figure 9-146 Timeline of URA Normalized Range Error PRN4 (SVN74) Using C/A Nav Data

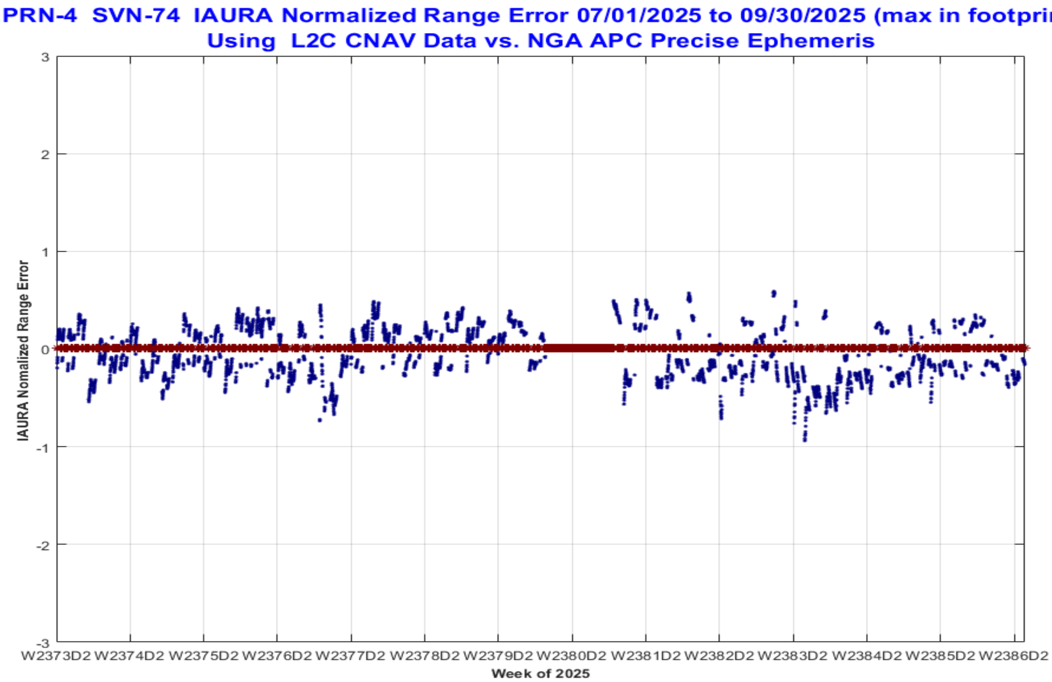

Figure 9-147 Timeline of IAURA Normalized Range Error PRN4 (SVN74) Using L2C CNAV Data

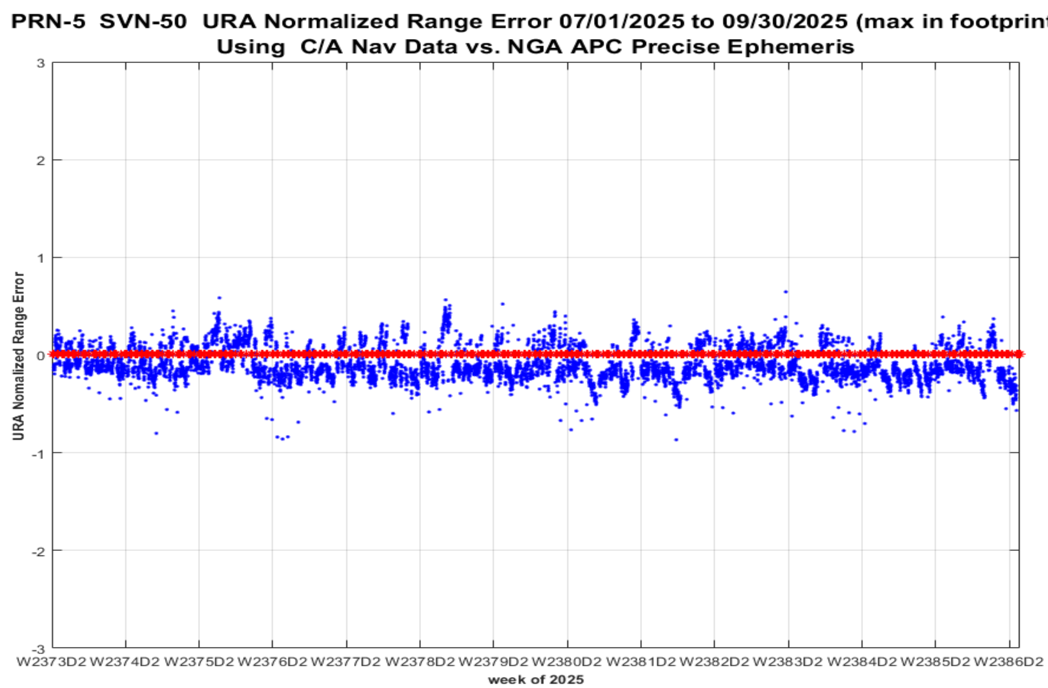

Figure 9-148 Timeline of URA Normalized Range Error PRN5 (SVN50) Using C/A Nav Data

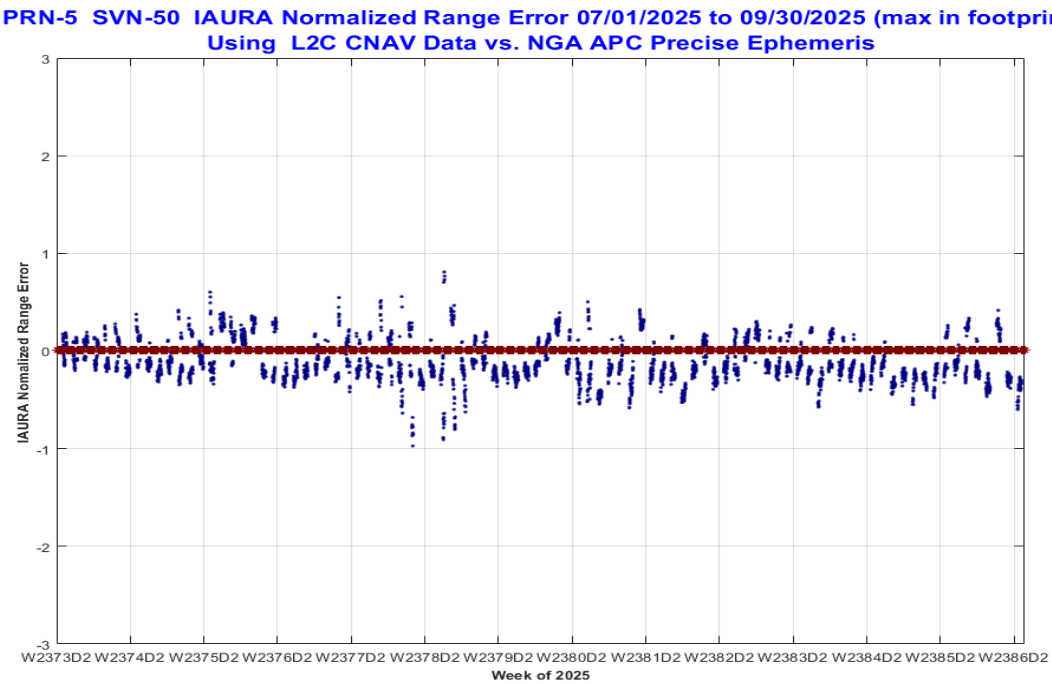

Figure 9-149 Timeline of IAURA Normalized Range Error PRN5 (SVN50) Using L2C CNAV Data

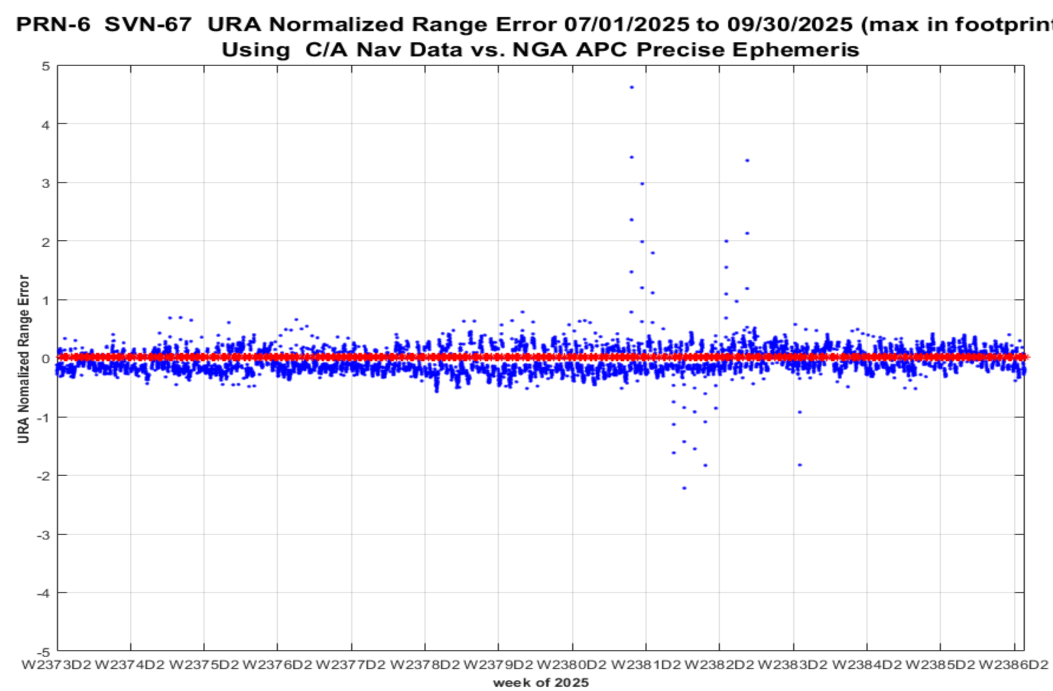

Figure 9-150 Timeline of URA Normalized Range Error PRN6 (SVN67) Using C/A Nav Data

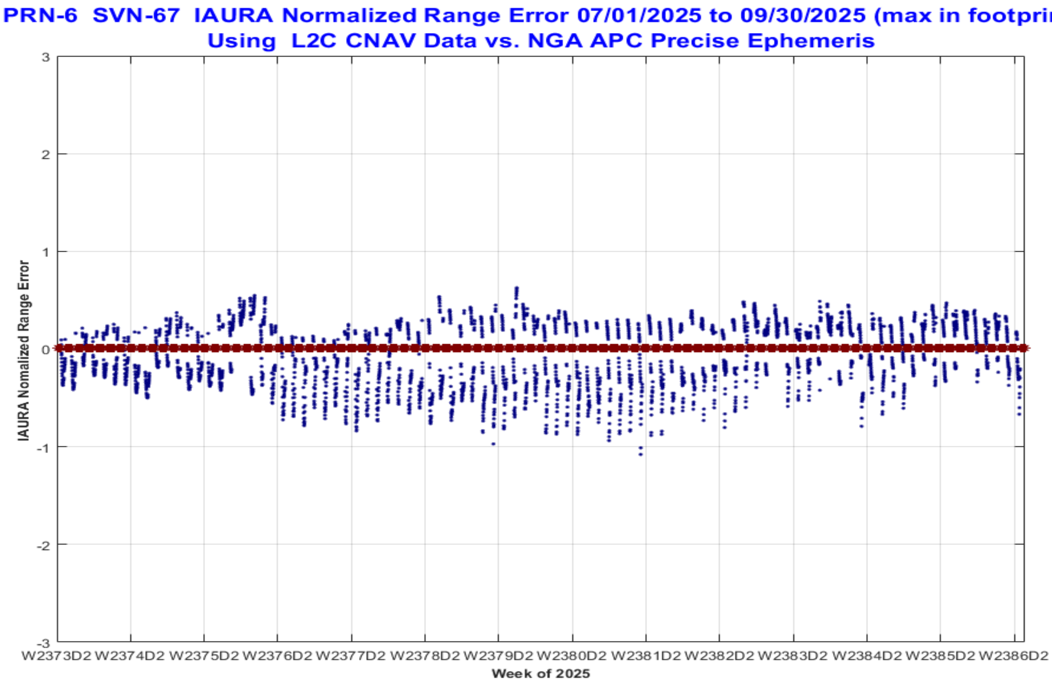

Figure 9-151 Timeline of IAURA Normalized Range Error PRN6 (SVN67) Using L2C CNAV Data

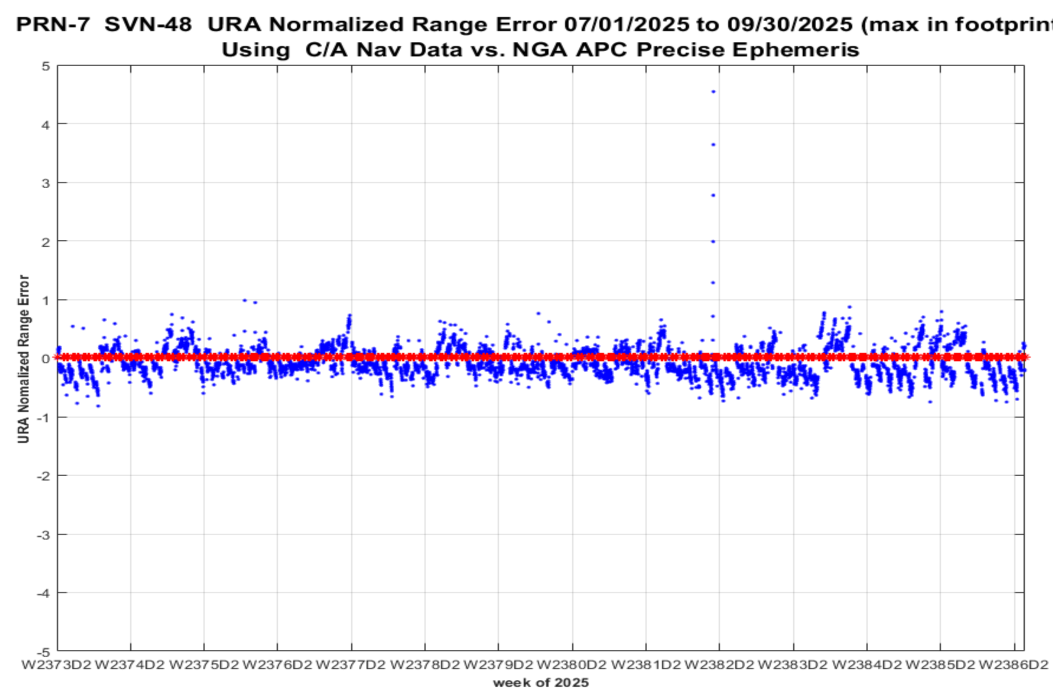

Figure 9-152 Timeline of URA Normalized Range Error PRN7 (SVN48) Using C/A Nav Data

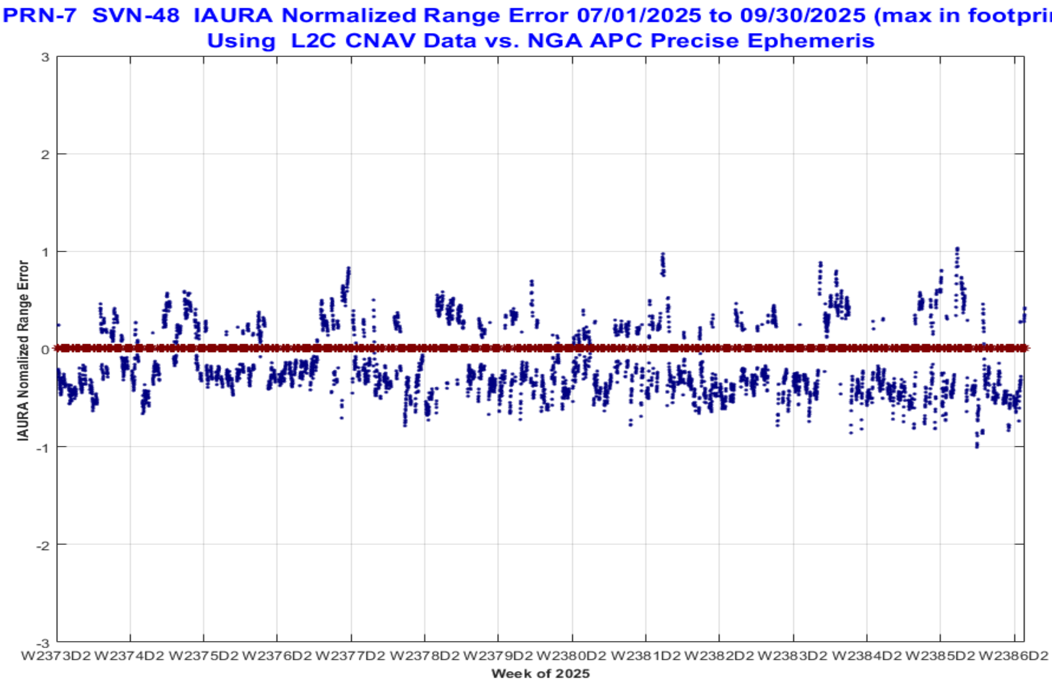

Figure 9-153 Timeline of IAURA Normalized Range Error PRN7 (SVN48) Using L2C CNAV Data

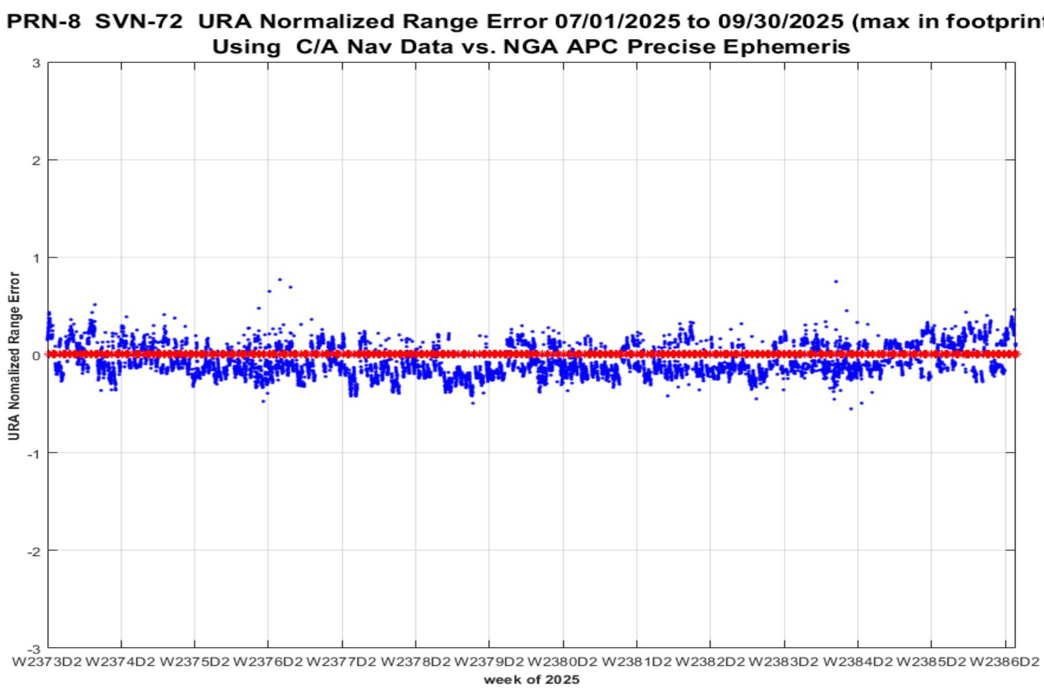

Figure 9-154 Timeline of URA Normalized Range Error PRN8 (SVN72) Using C/A Nav Data

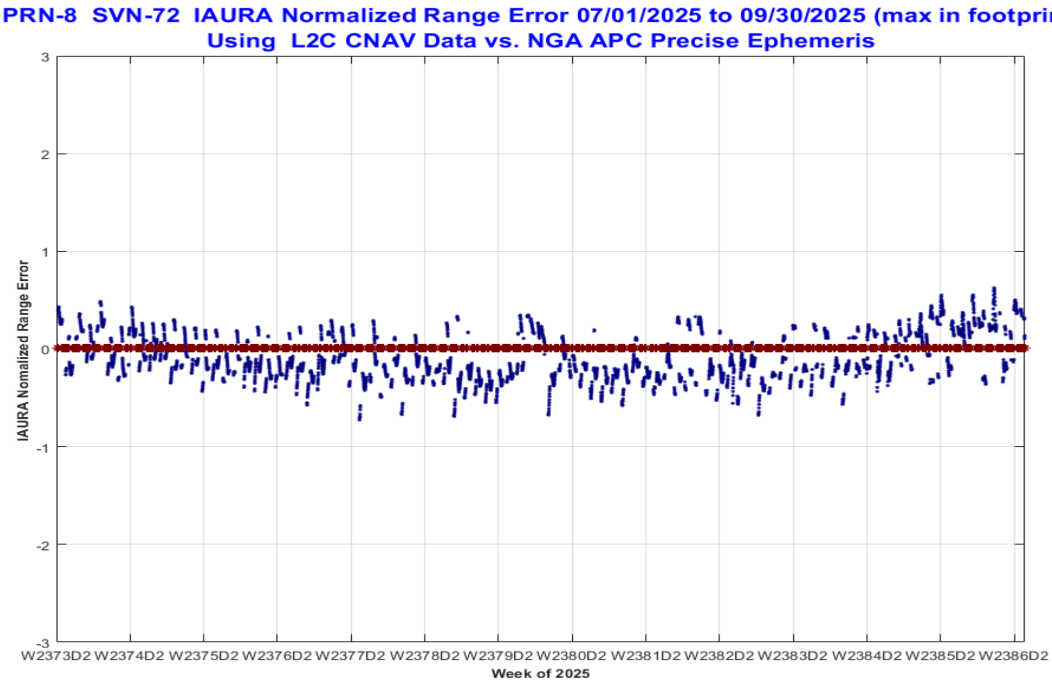

Figure 9-155 Timeline of IAURA Normalized Range Error PRN8 (SVN72) Using L2C CNAV Data

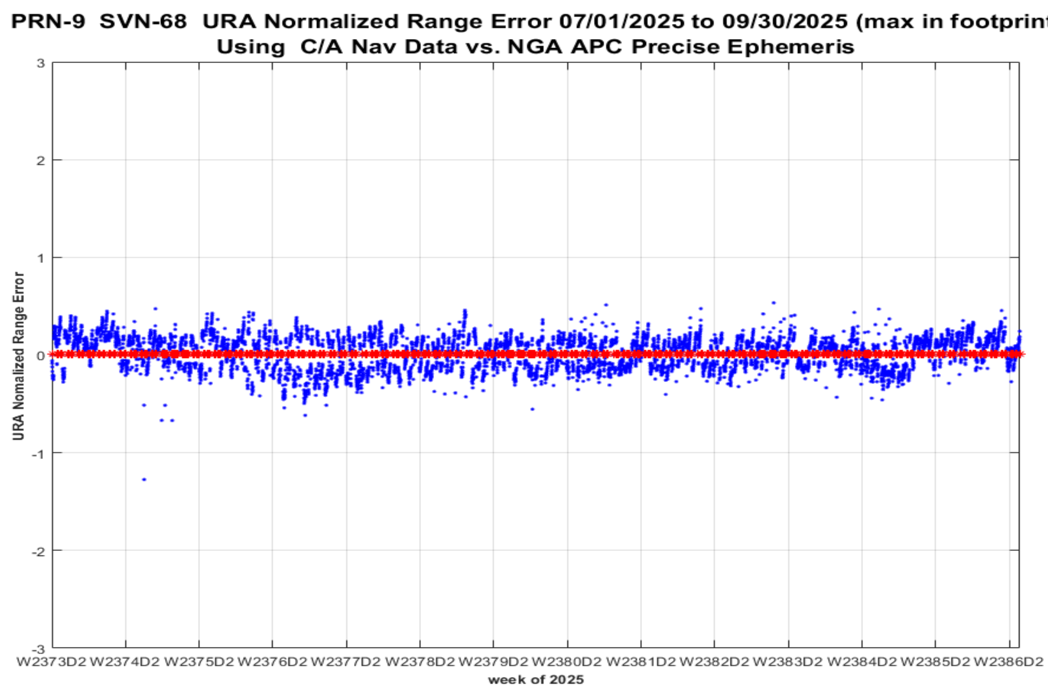

Figure 9-156 Timeline of URA Normalized Range Error PRN9 (SVN68) Using C/A Nav Data

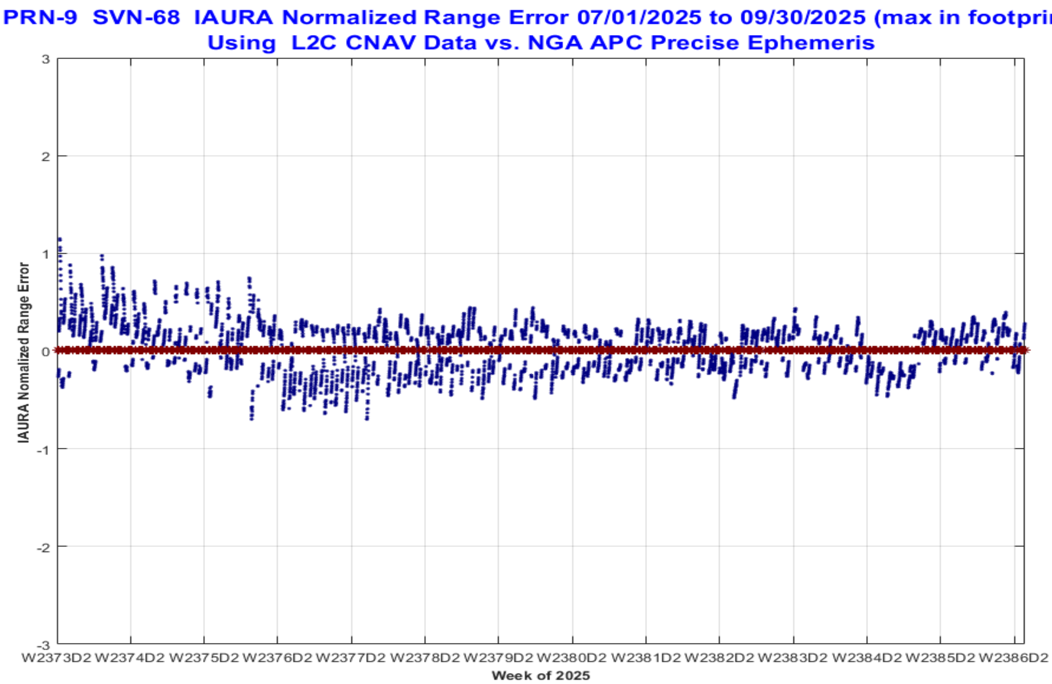

Figure 9-157 Timeline of IAURA Normalized Range Error PRN9 (SVN68) Using L2C CNAV Data

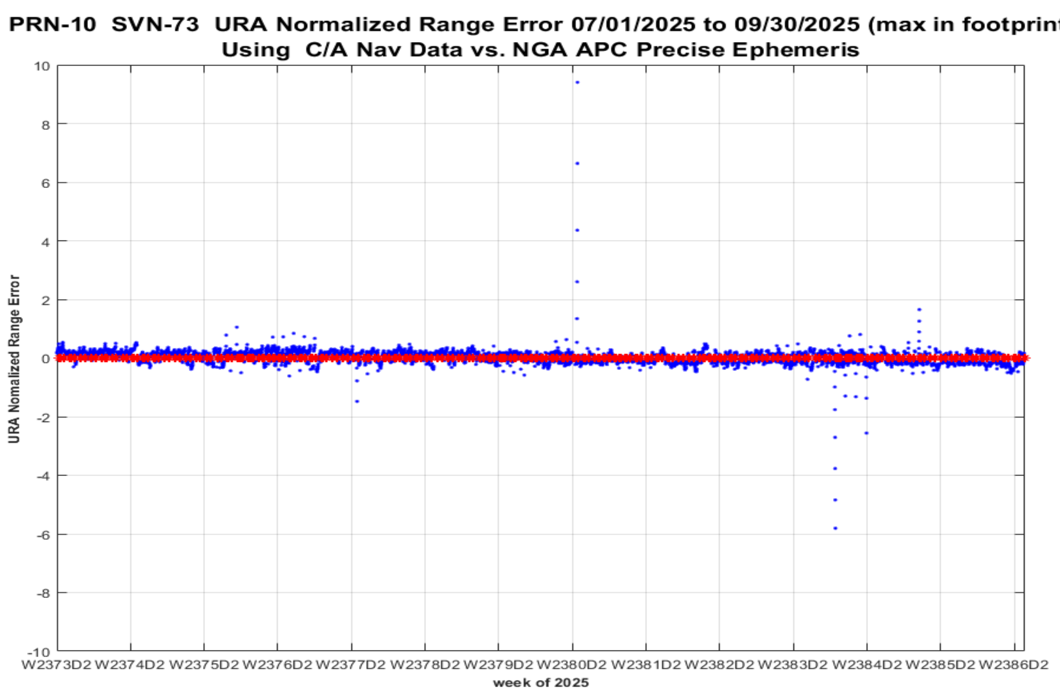

Figure 9-158 Timeline of URA Normalized Range Error PRN10 (SVN73) Using C/A Nav Data

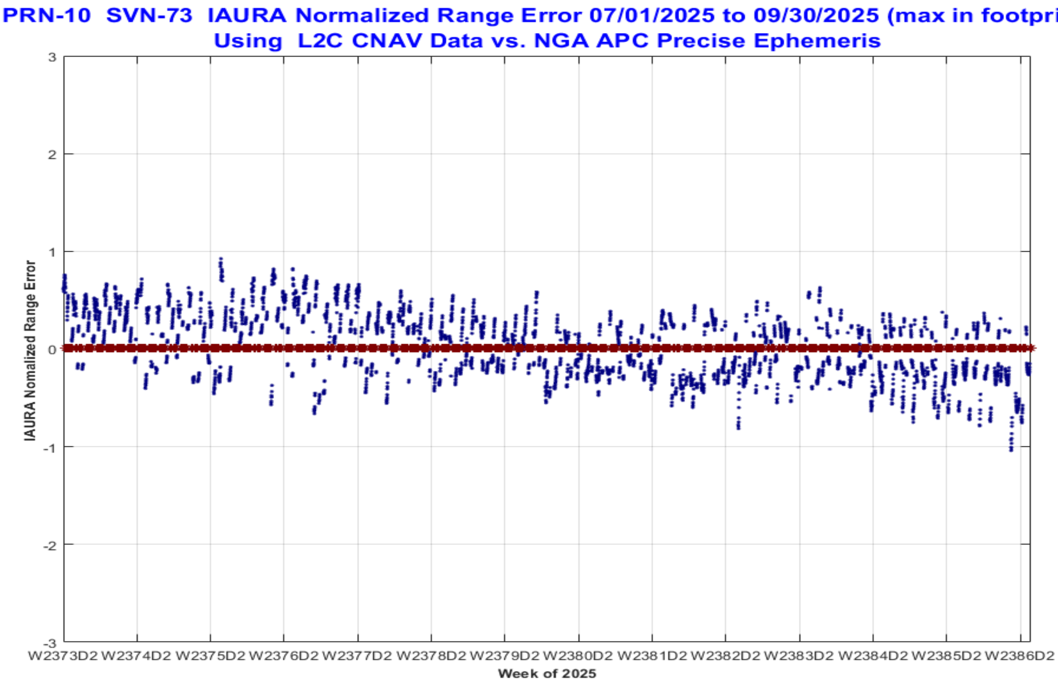

Figure 9-159 Timeline of IAURA Normalized Range Error PRN10 (SVN73) Using L2C CNAV Data

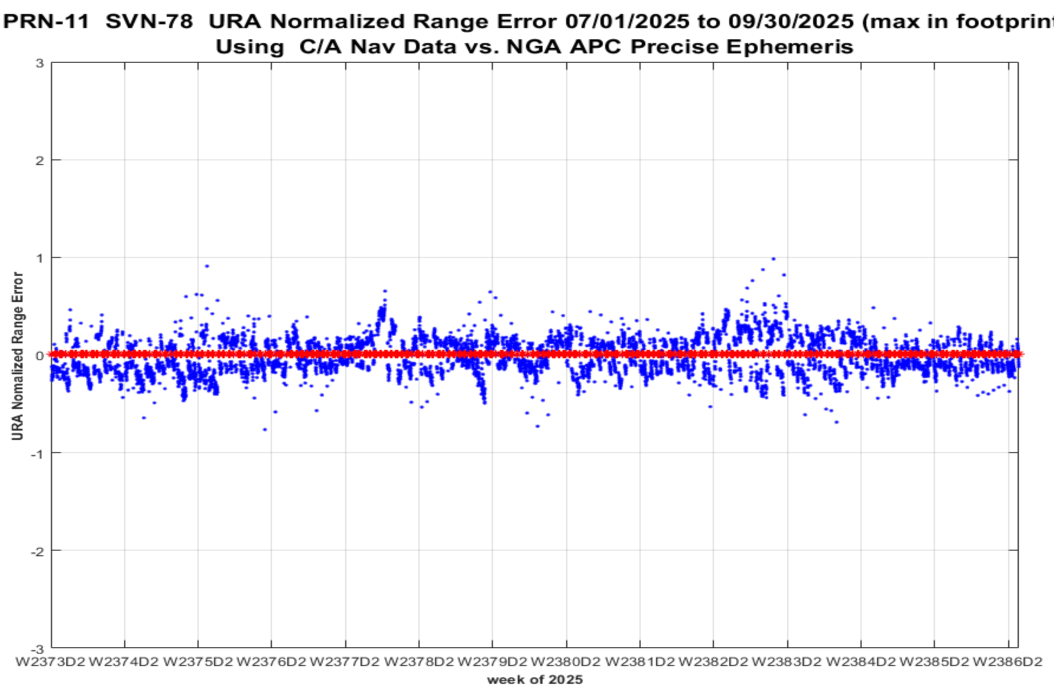

Figure 9-160 Timeline of URA Normalized Range Error PRN11 (SVN78) Using C/A Nav Data

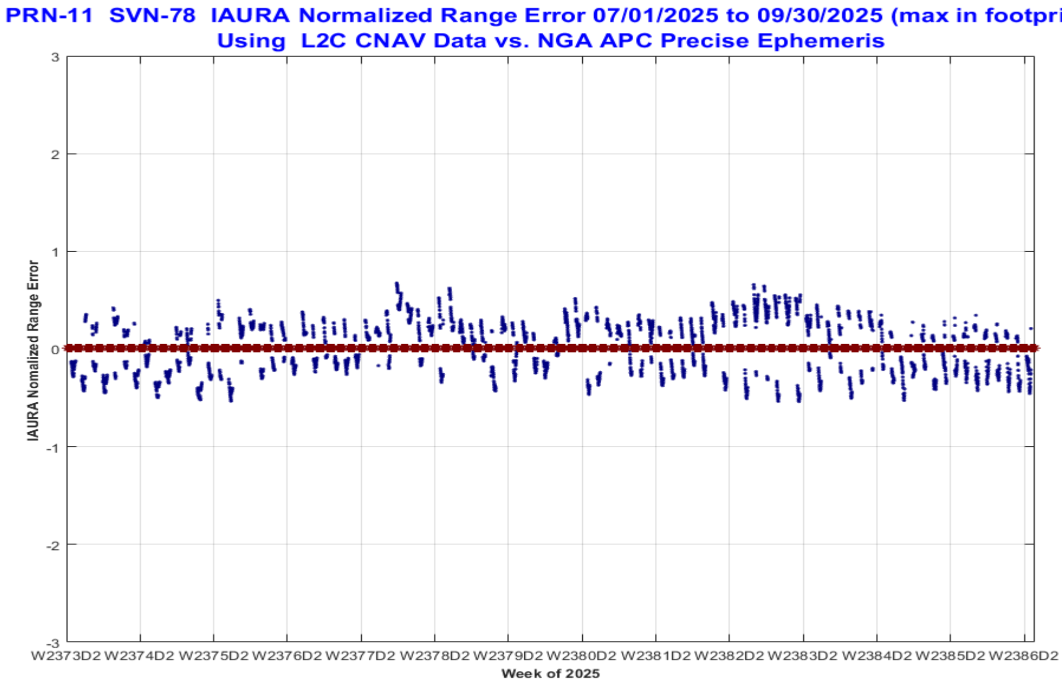

Figure 9-161 Timeline of IAURA Normalized Range Error PRN11 (SVN78) Using L2C CNAV Data

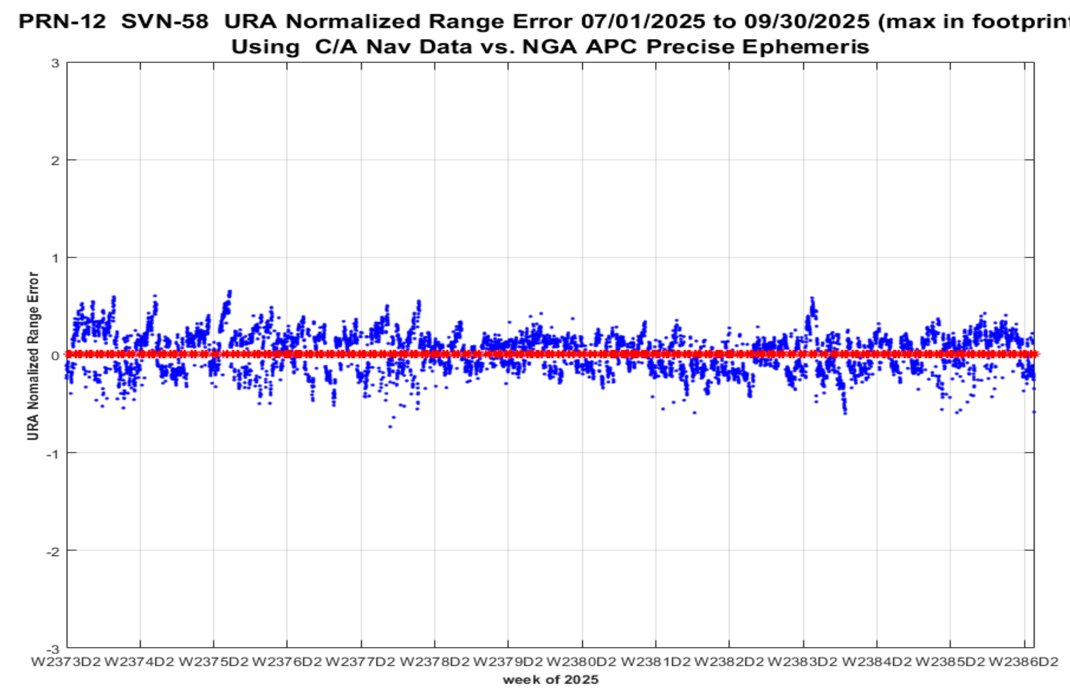

Figure 9-162 Timeline of URA Normalized Range Error PRN12 (SVN58) Using C/A Nav Data

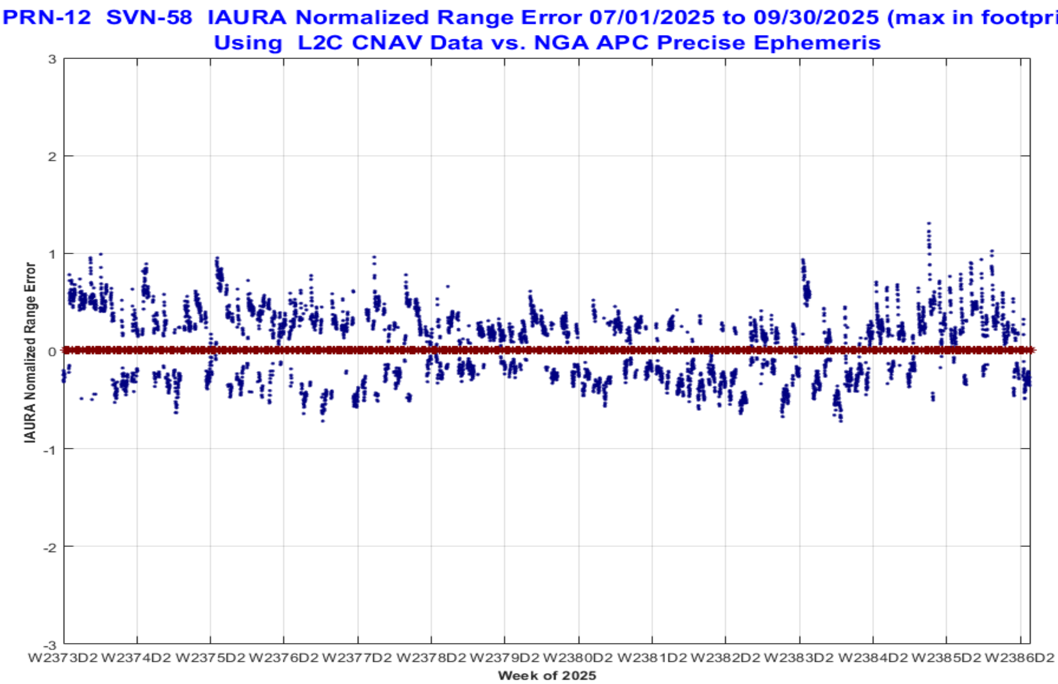

Figure 9-163 Timeline of IAURA Normalized Range Error PRN12 (SVN58) Using L2C CNAV Data

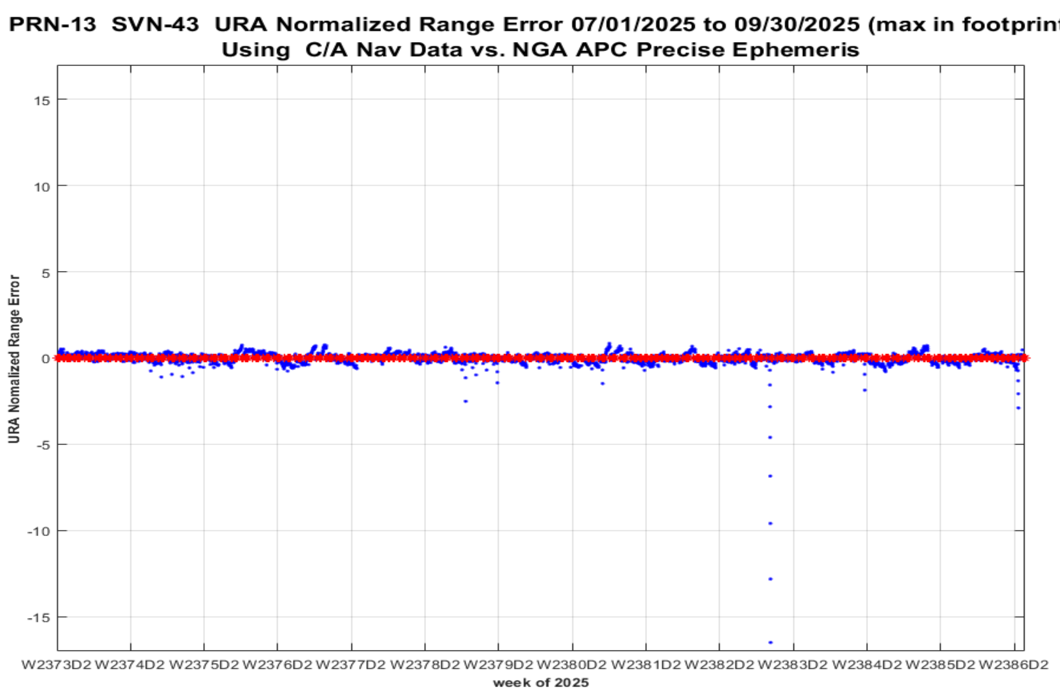

Figure 9-164 Timeline of URA Normalized Range Error PRN13 (SVN43) Using C/A Nav Data

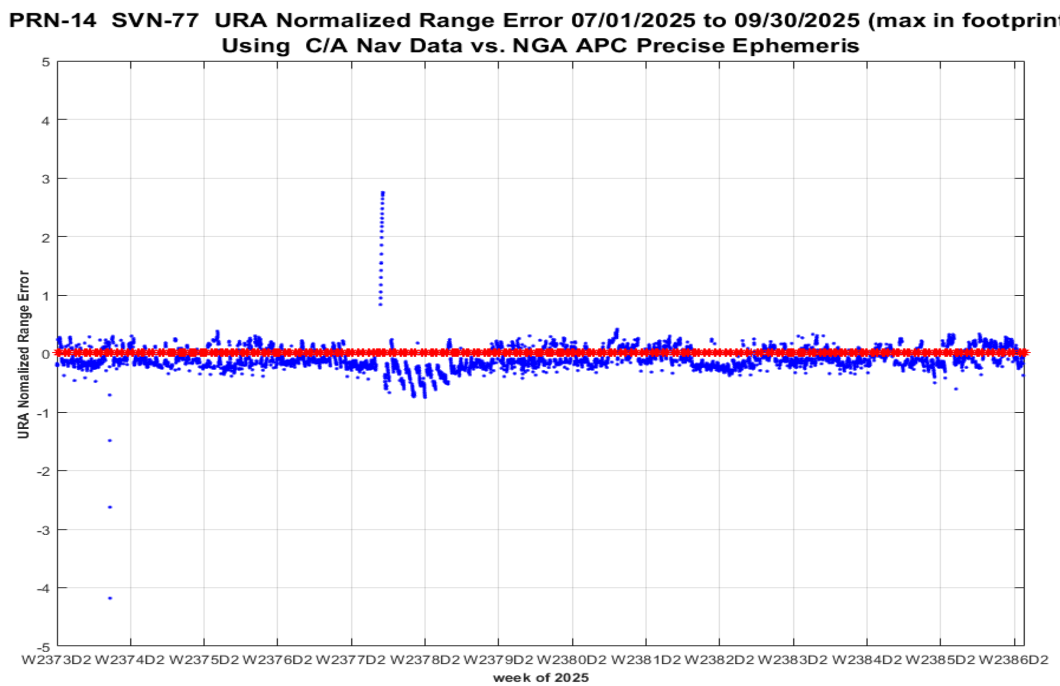

Figure 9-165 Timeline of URA Normalized Range Error PRN14 (SVN77) Using C/A Nav Data

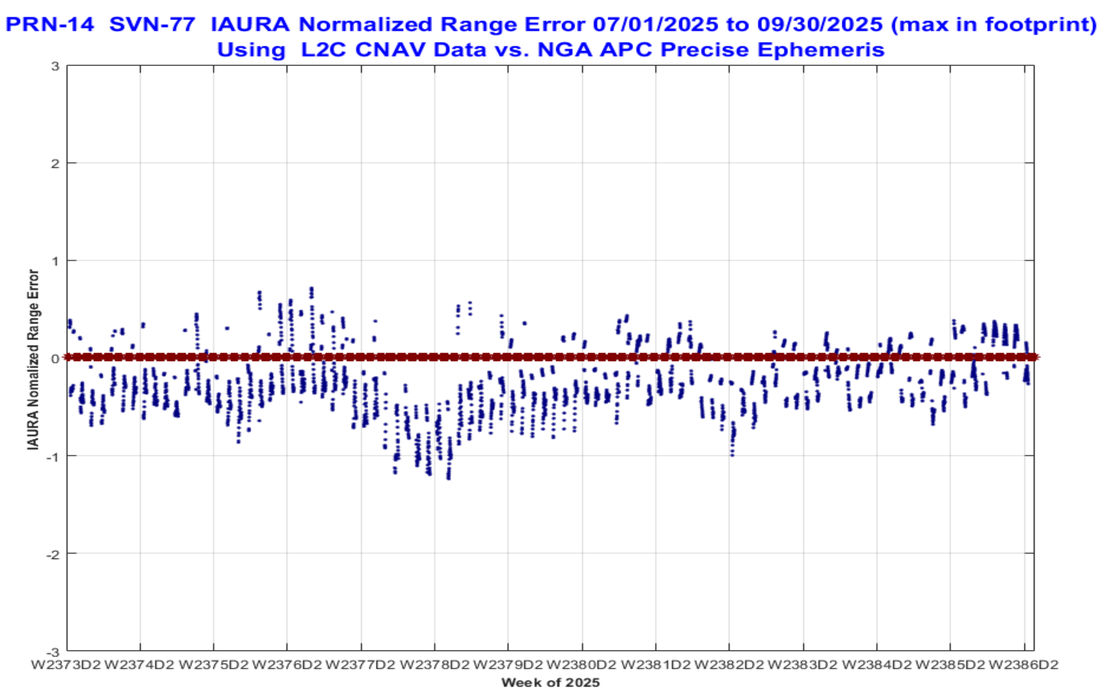

Figure 9-166 Timeline of IAURA Normalized Range Error PRN14 (SVN77) Using L2C CNAV Data

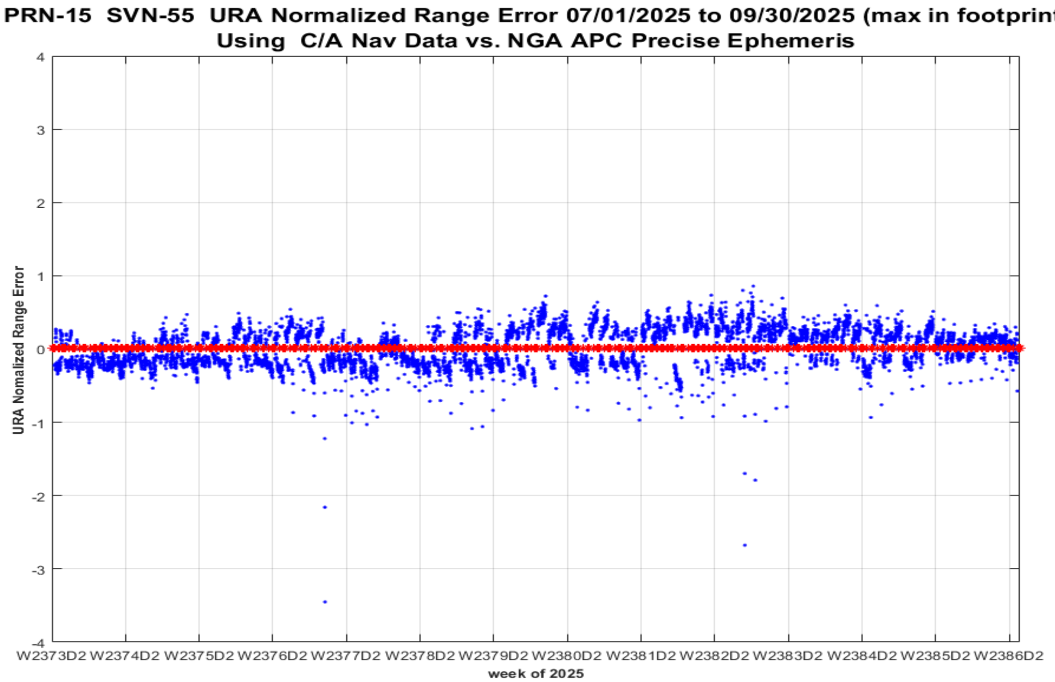

Figure 9-167 Timeline of URA Normalized Range Error PRN15 (SVN55) Using C/A Nav Data

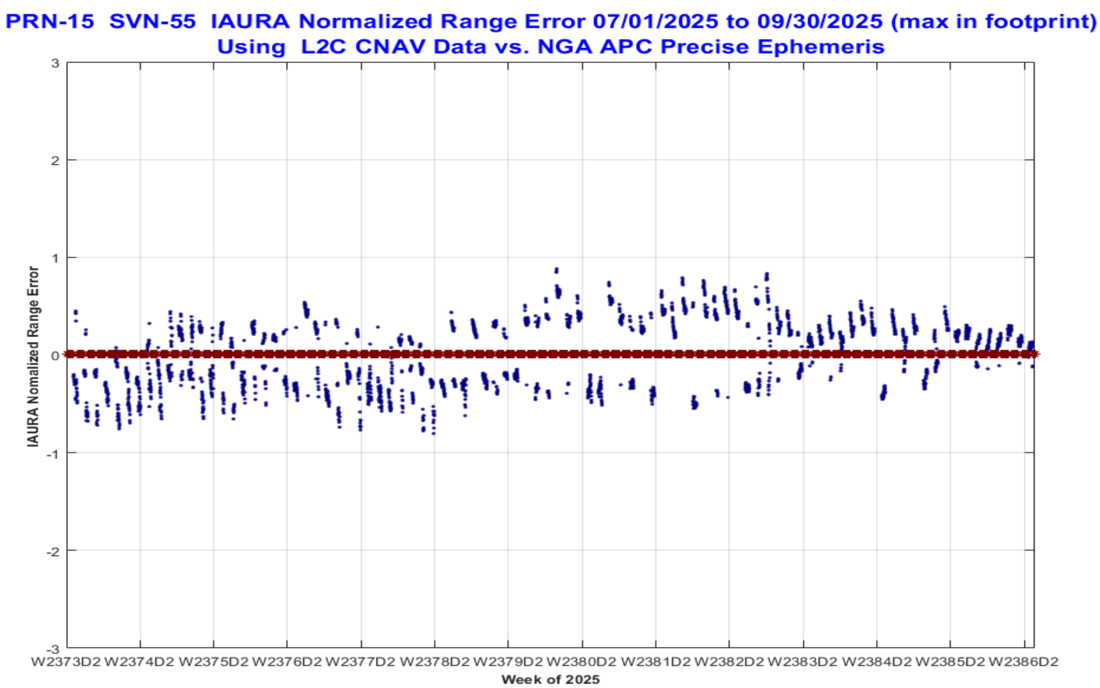

Figure 9-168 Timeline of IAURA Normalized Range Error PRN15 (SVN55) Using L2C CNAV Data

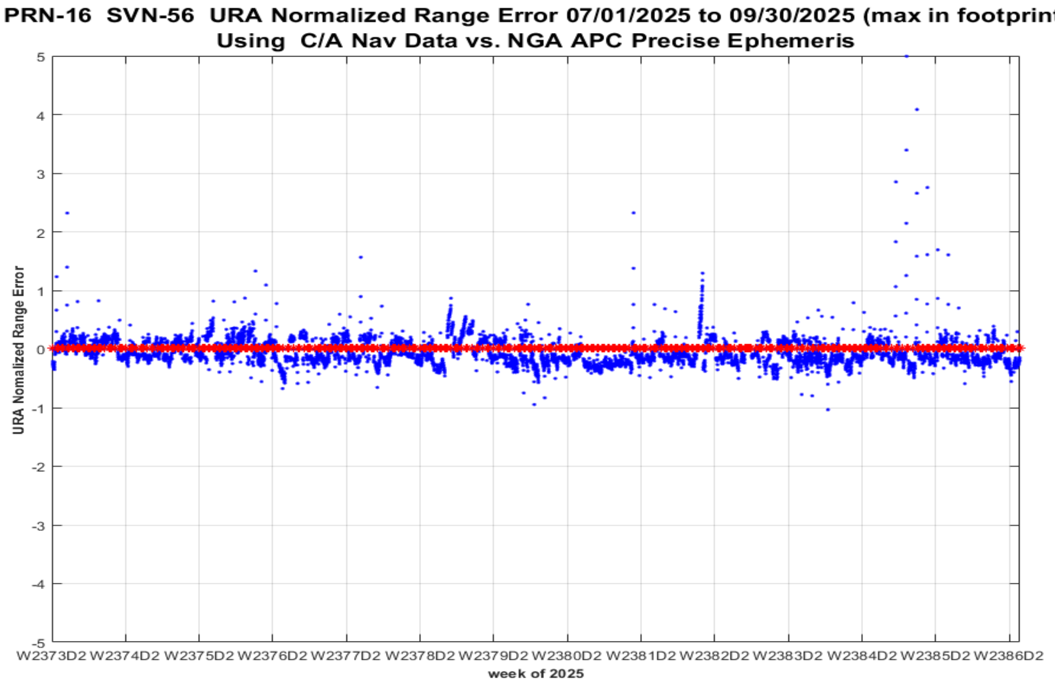

Figure 9-169 Timeline of URA Normalized Range Error PRN16 (SVN56) Using C/A Nav Data

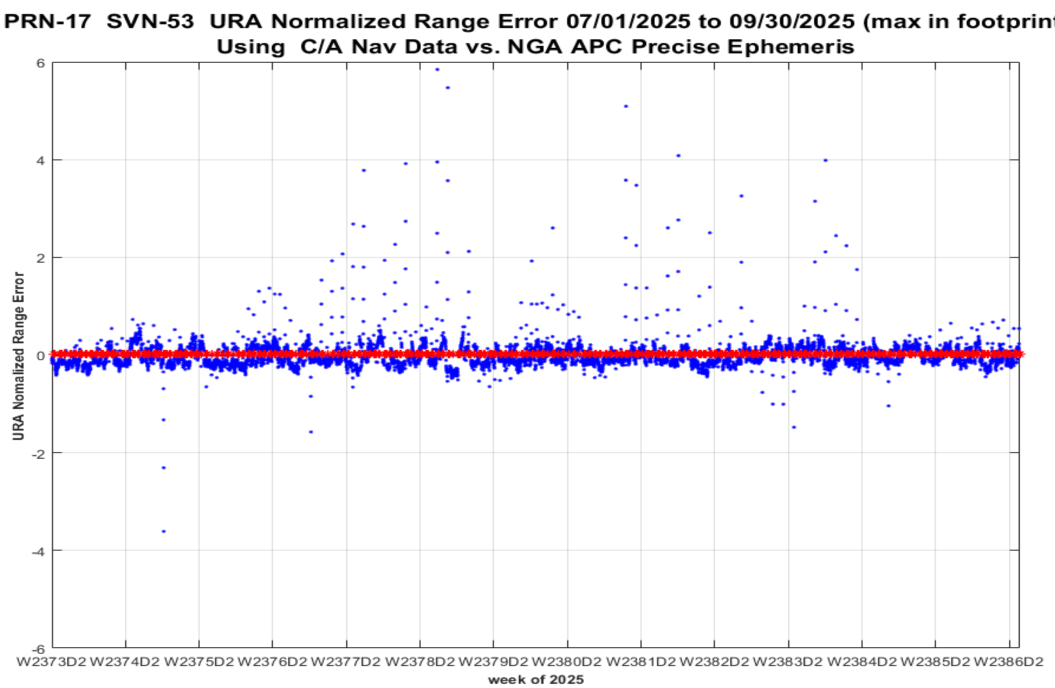

Figure 9-170 Timeline of URA Normalized Range Error PRN17 (SVN53) Using C/A Nav Data

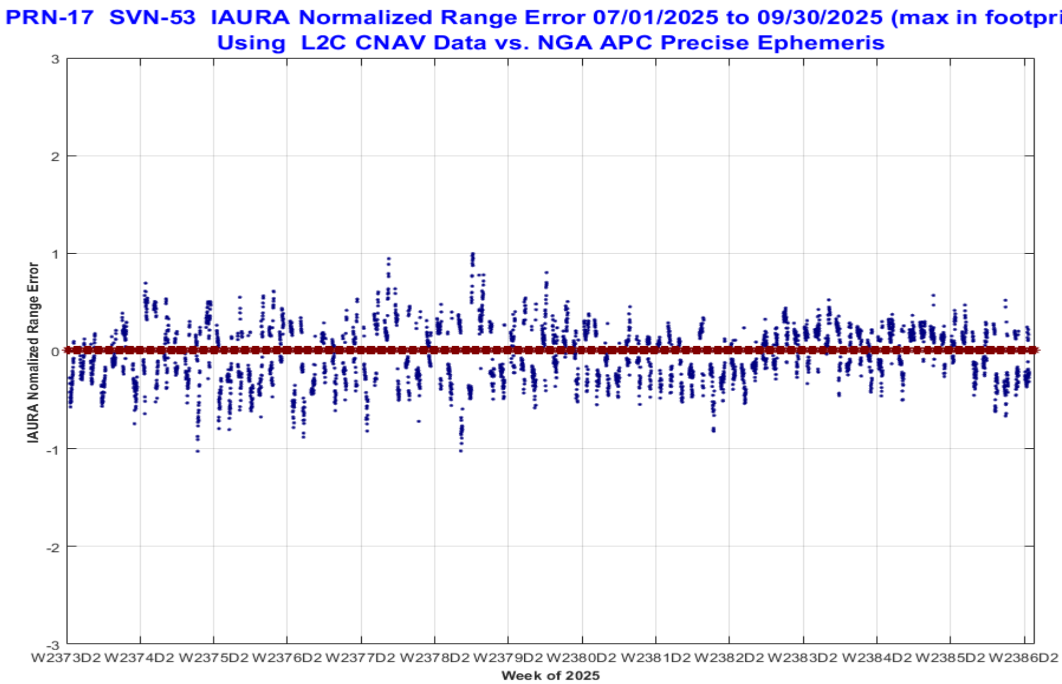

Figure 9-171 Timeline of IAURA Normalized Range Error PRN17 (SVN53) Using L2C CNAV Data

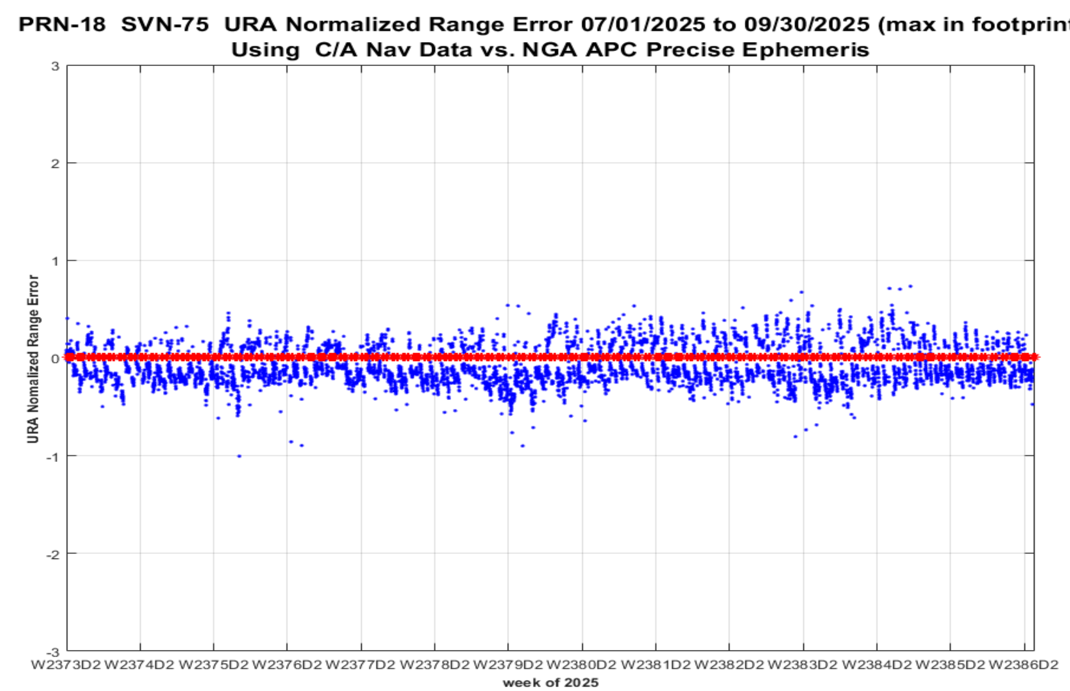

Figure 9-172 Timeline of URA Normalized Range Error PRN18 (SVN75) Using C/A Nav Data

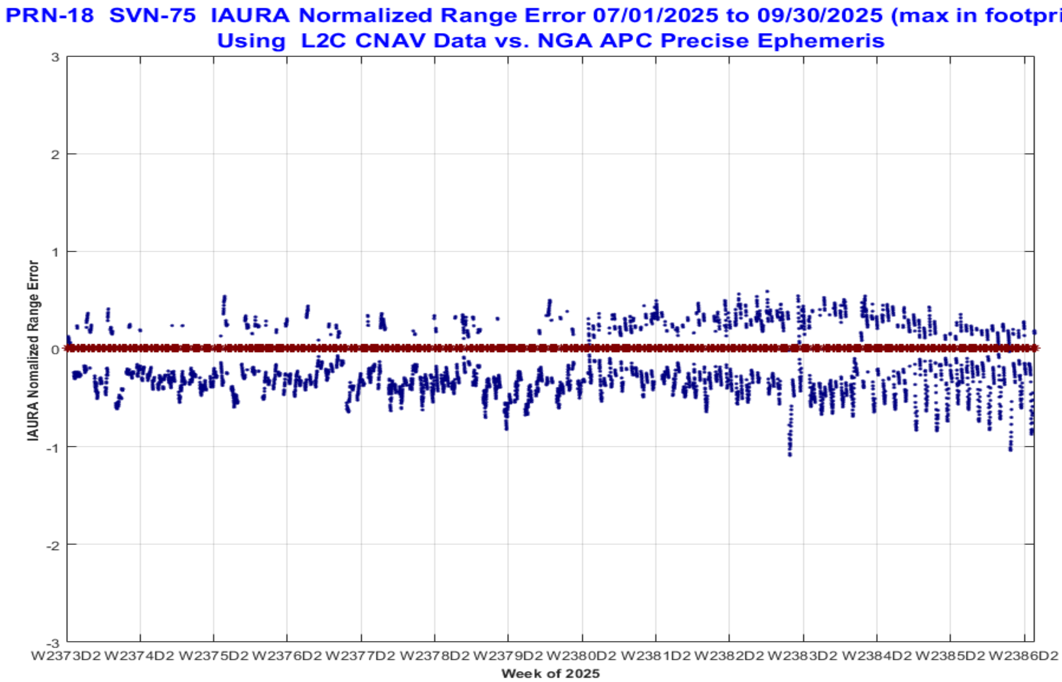

Figure 9-173 Timeline of IAURA Normalized Range Error PRN18 (SVN75) Using L2C CNAV Data

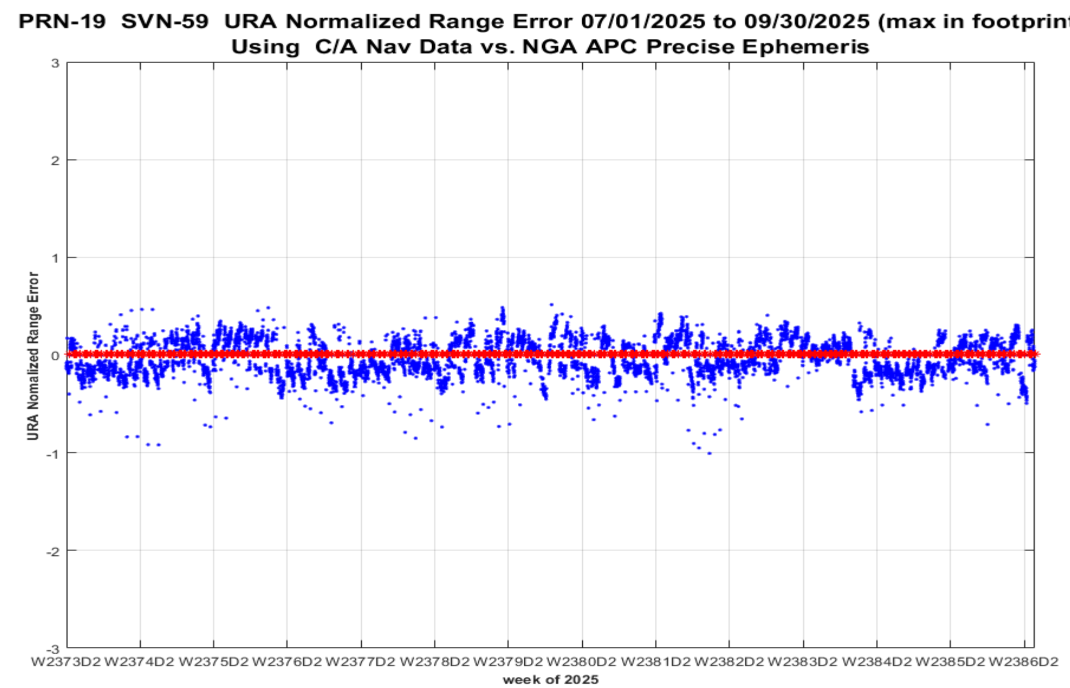

Figure 9-174 Timeline of URA Normalized Range Error PRN19 (SVN59) Using C/A Nav Data

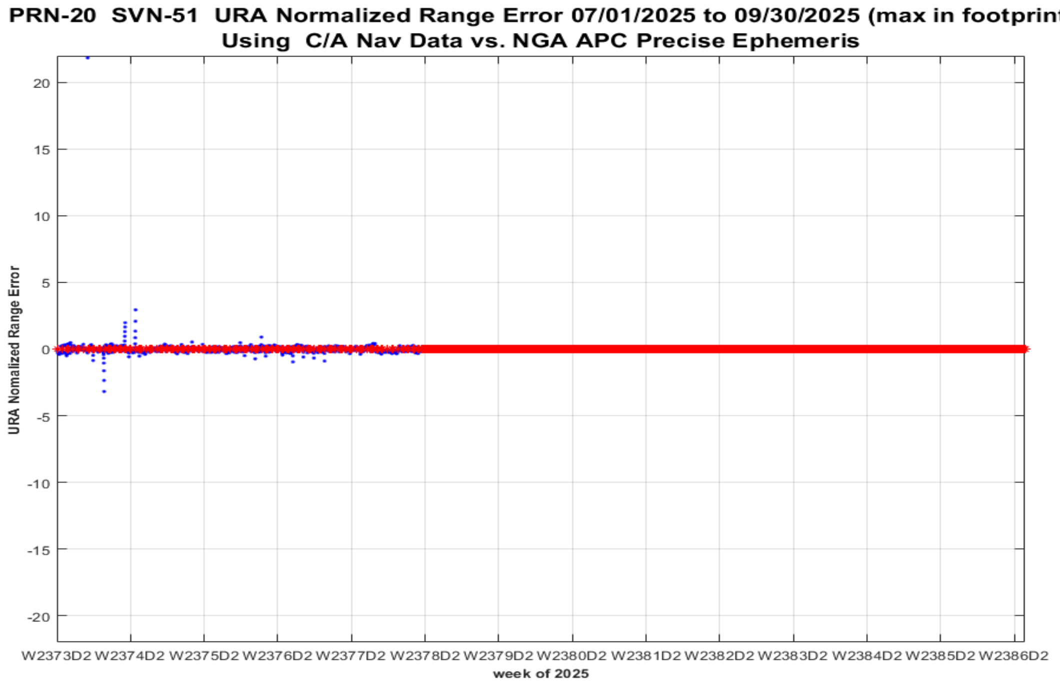

Figure 9-175 Timeline of URA Normalized Range Error PRN20 (SVN51) Using C/A Nav Data

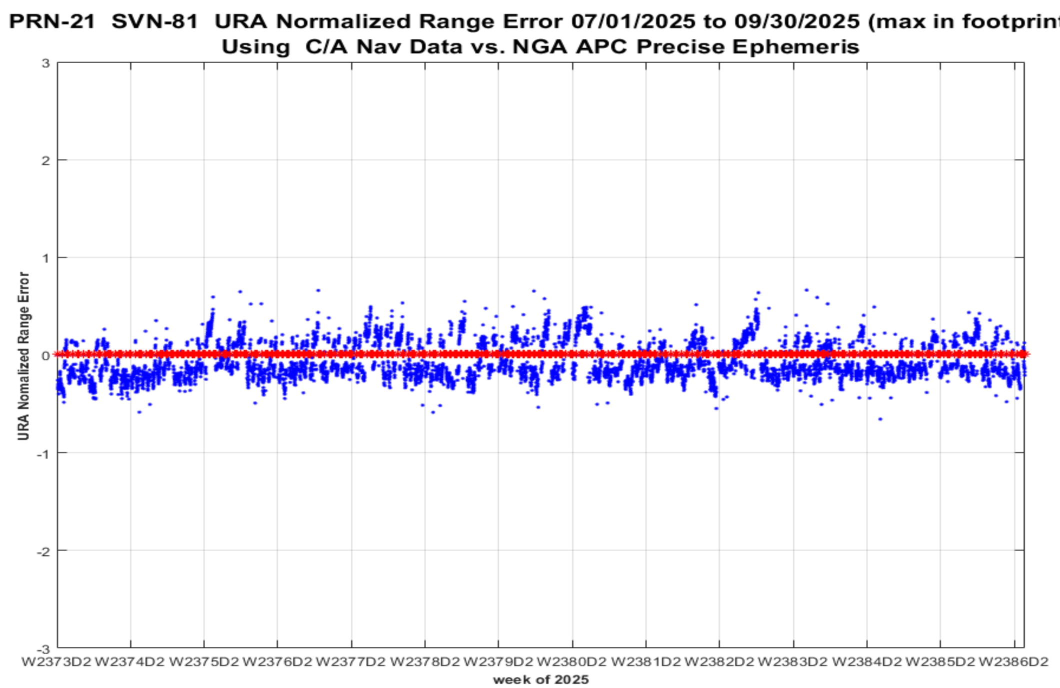

Figure 9-176 Timeline of URA Normalized Range Error PRN21 (SVN81) Using C/A Nav Data

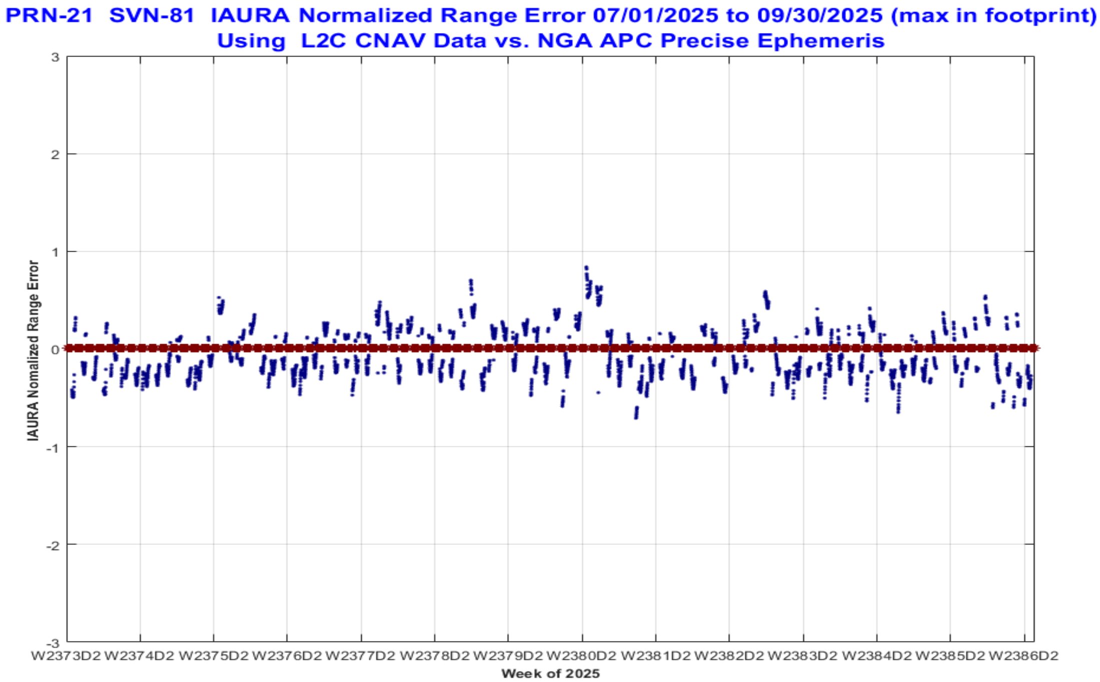

Figure 9-177 Timeline of IAURA Normalized Range Error PRN21 (SVN81) Using L2C CNAV Data

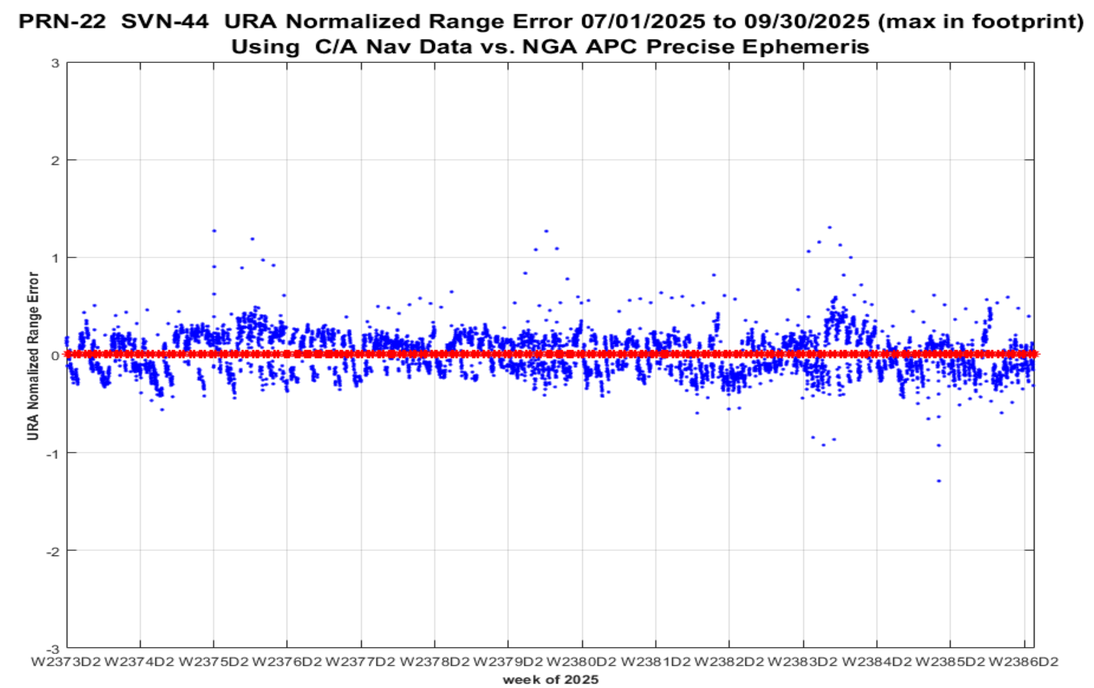

Figure 9-178 Timeline of URA Normalized Range Error PRN22 (SVN44) Using C/A Nav Data

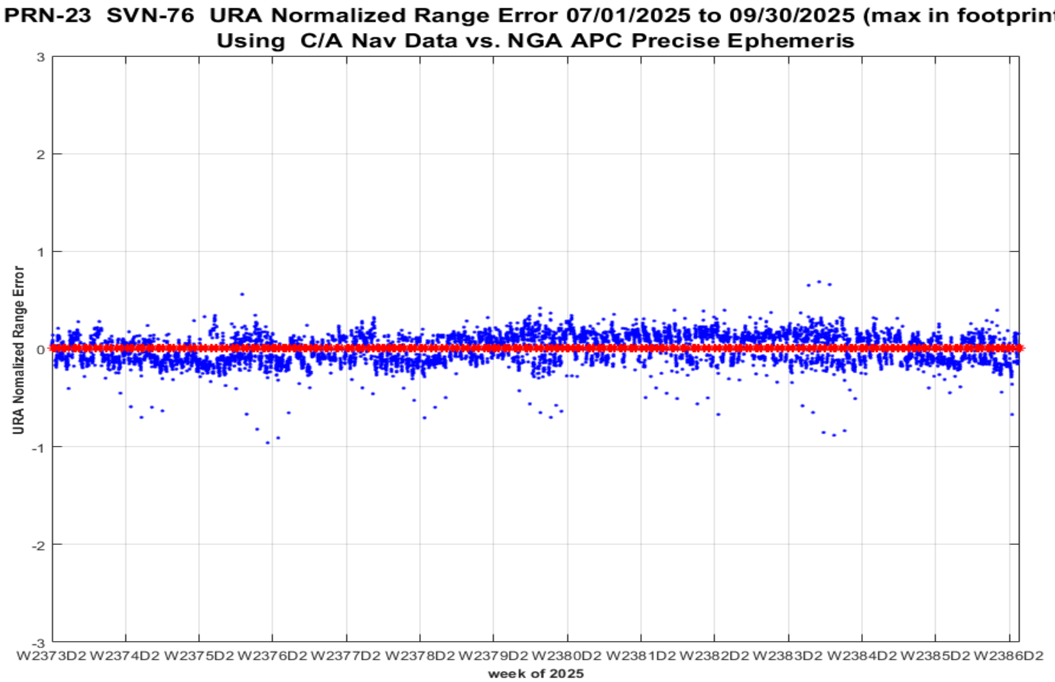

Figure 9-179 Timeline of URA Normalized Range Error PRN23 (SVN76) Using C/A Nav Data

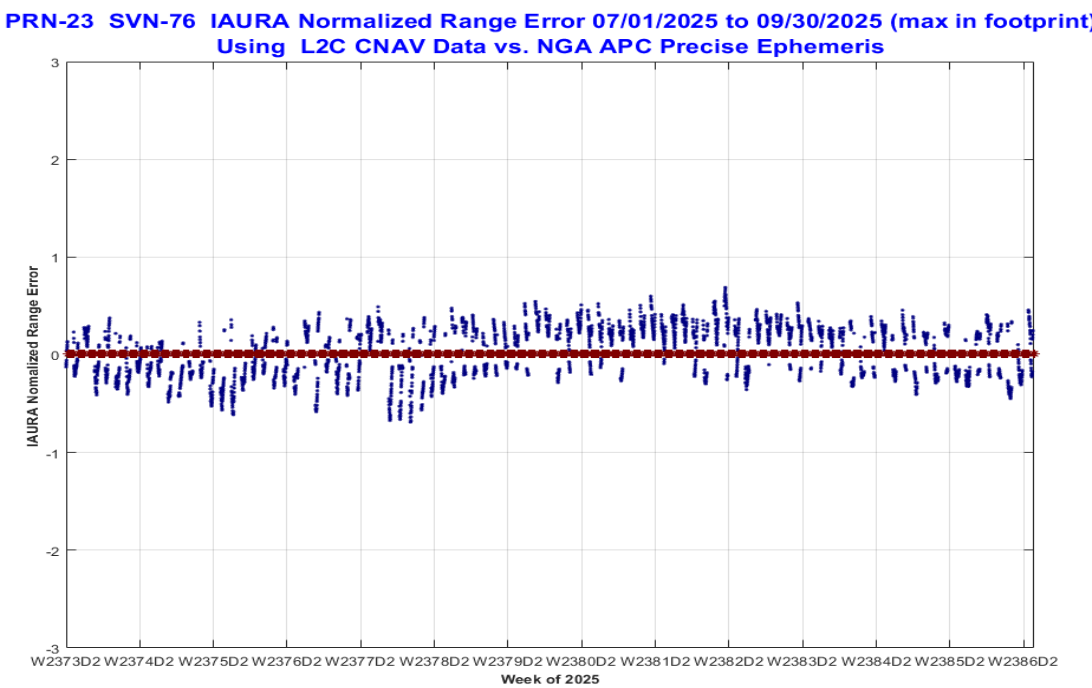

Figure 9-180 Timeline of IAURA Normalized Range Error PRN23 (SVN76) Using L2C CNAV Data

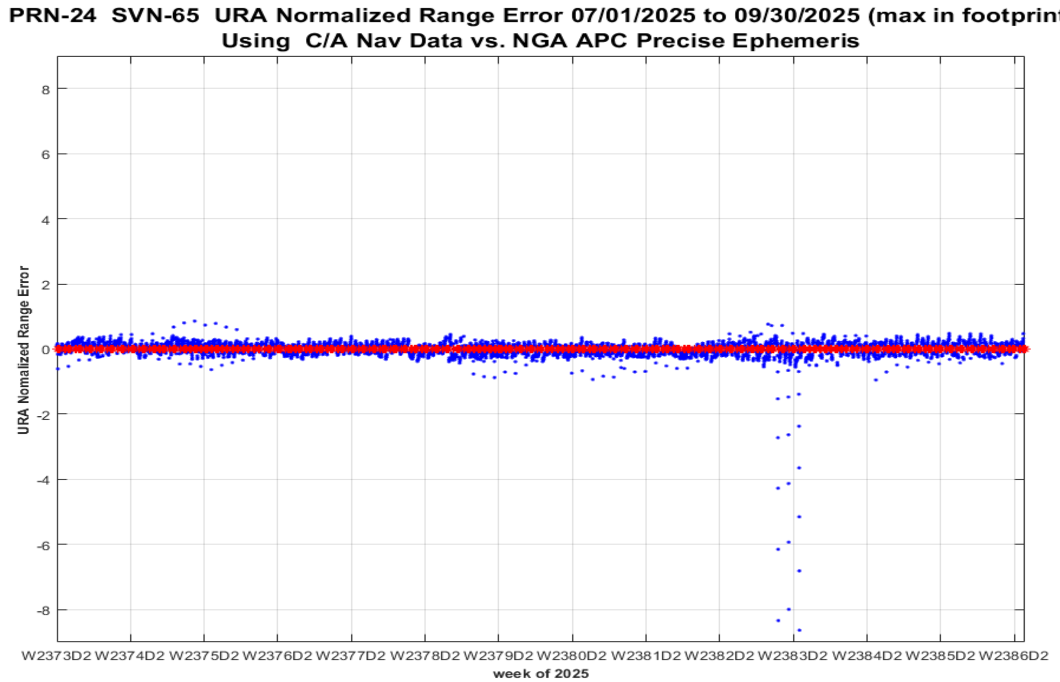

Figure 9-181 Timeline of URA Normalized Range Error PRN24 (SVN65) Using C/A Nav Data

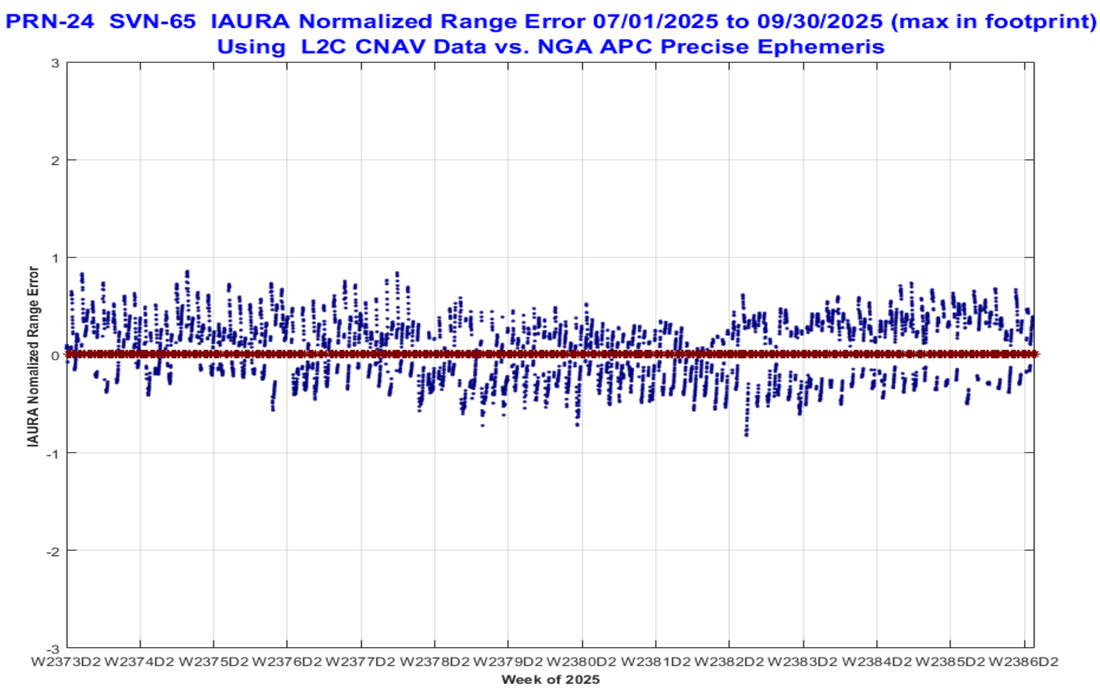

Figure 9-182 Timeline of IAURA Normalized Range Error PRN24 (SVN65) Using L2C CNAV Data

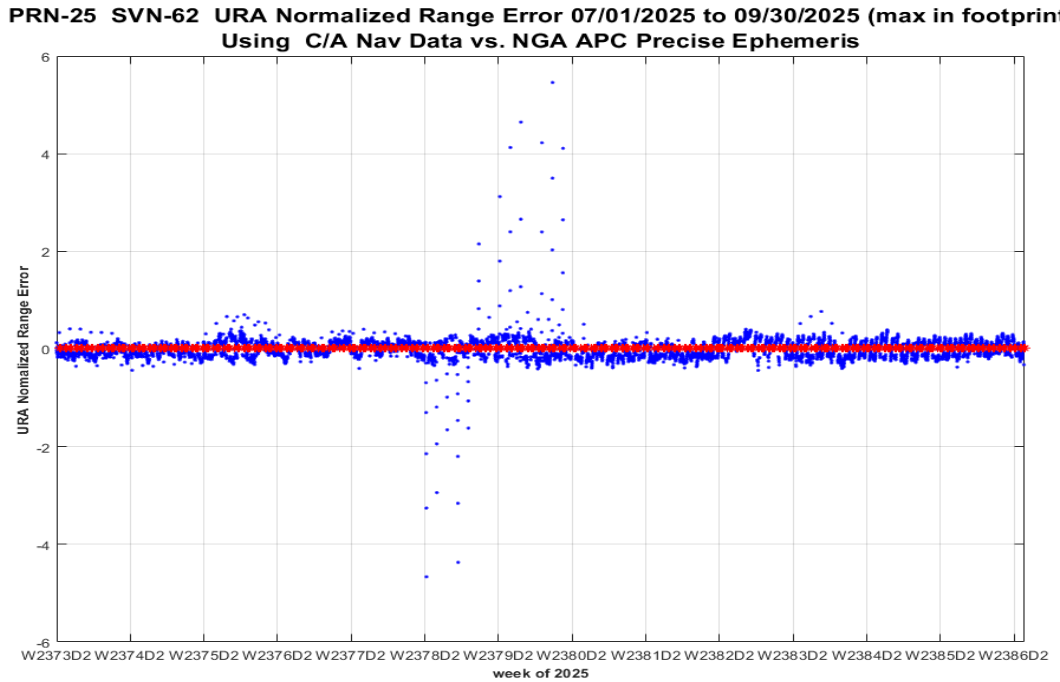

Figure 9-183 Timeline of URA Normalized Range Error PRN25 (SVN62) Using C/A Nav Data

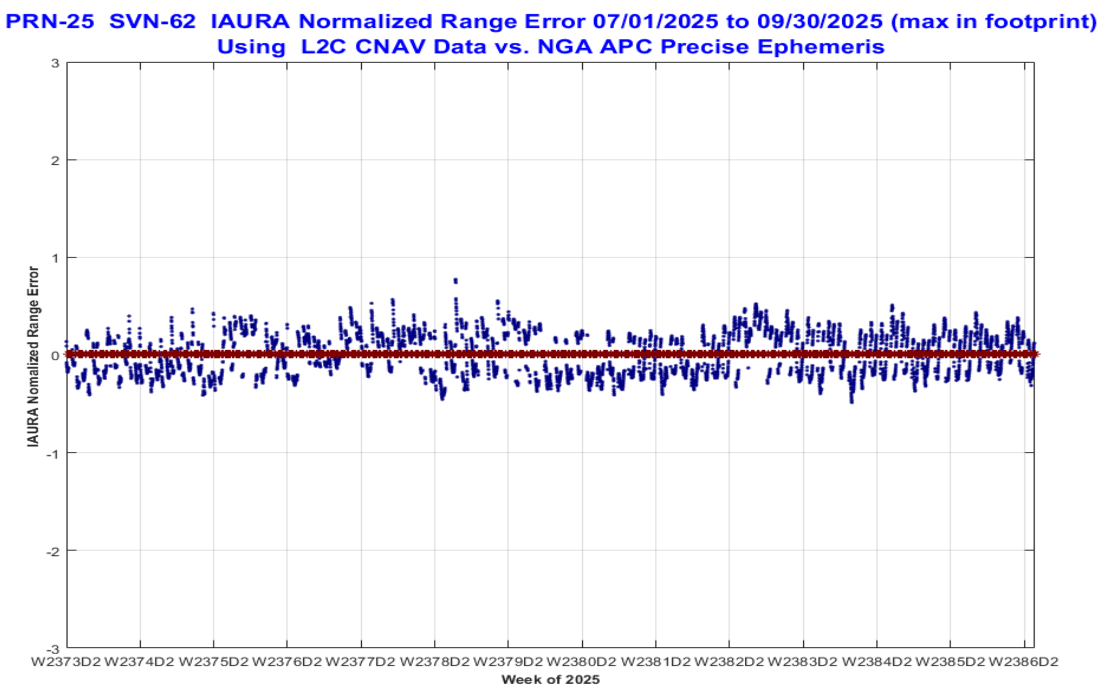

Figure 9-184 Timeline of IAURA Normalized Range Error PRN25 (SVN62) Using L2C CNAV Data

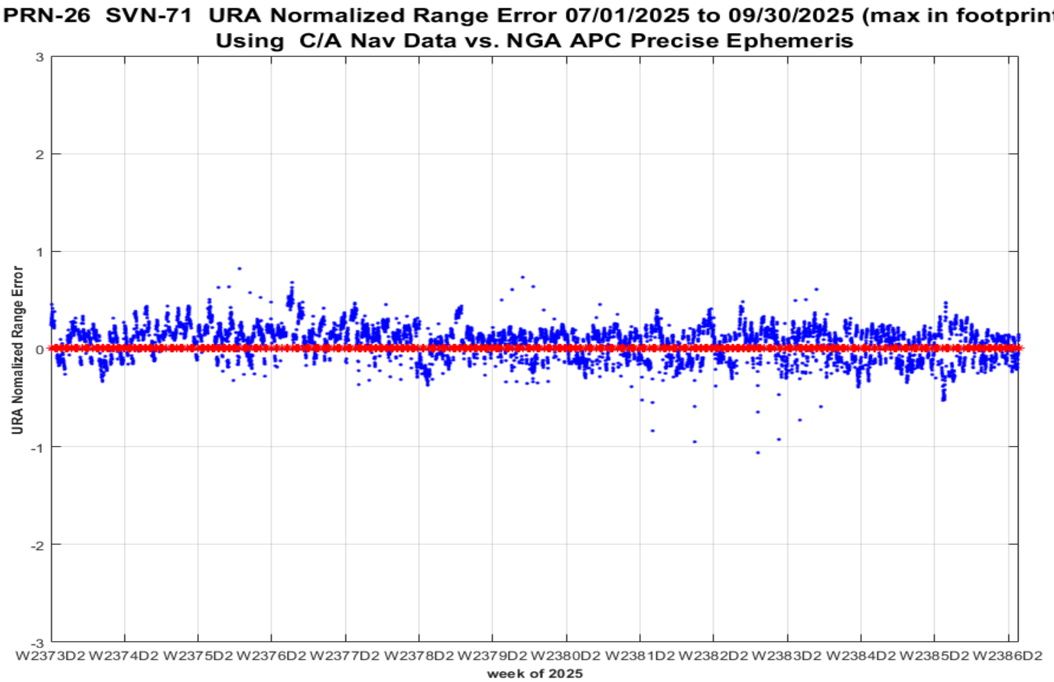

Figure 9-185 Timeline of URA Normalized Range Error PRN26 (SVN71) Using C/A Nav Data

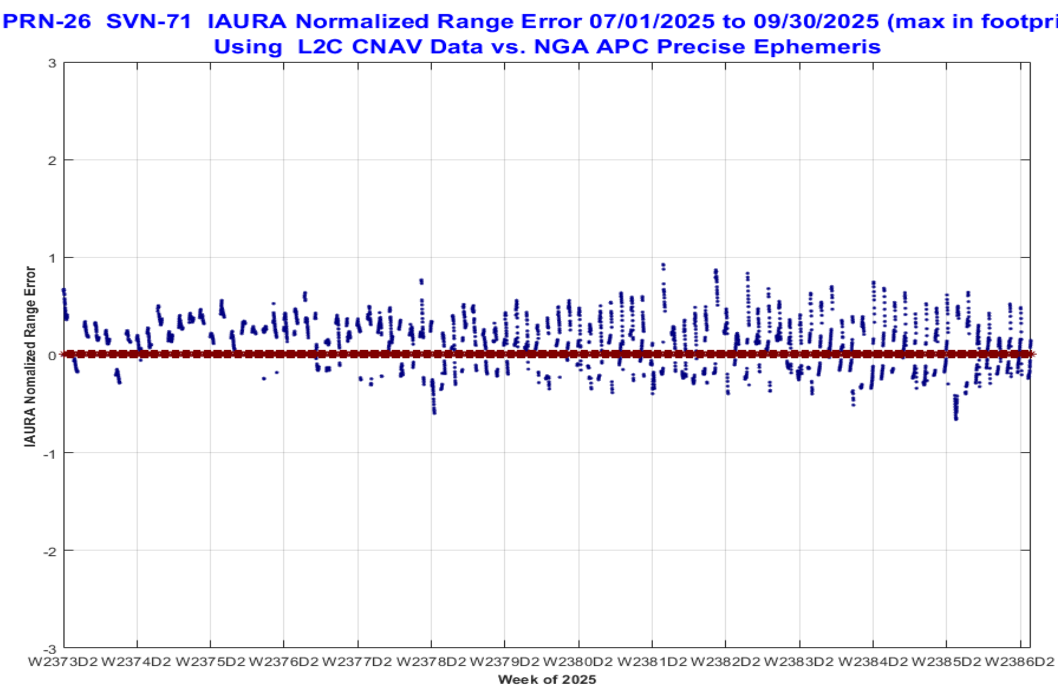

Figure 9-186 Timeline of IAURA Normalized Range Error PRN26 (SVN71) Using L2C CNAV Data

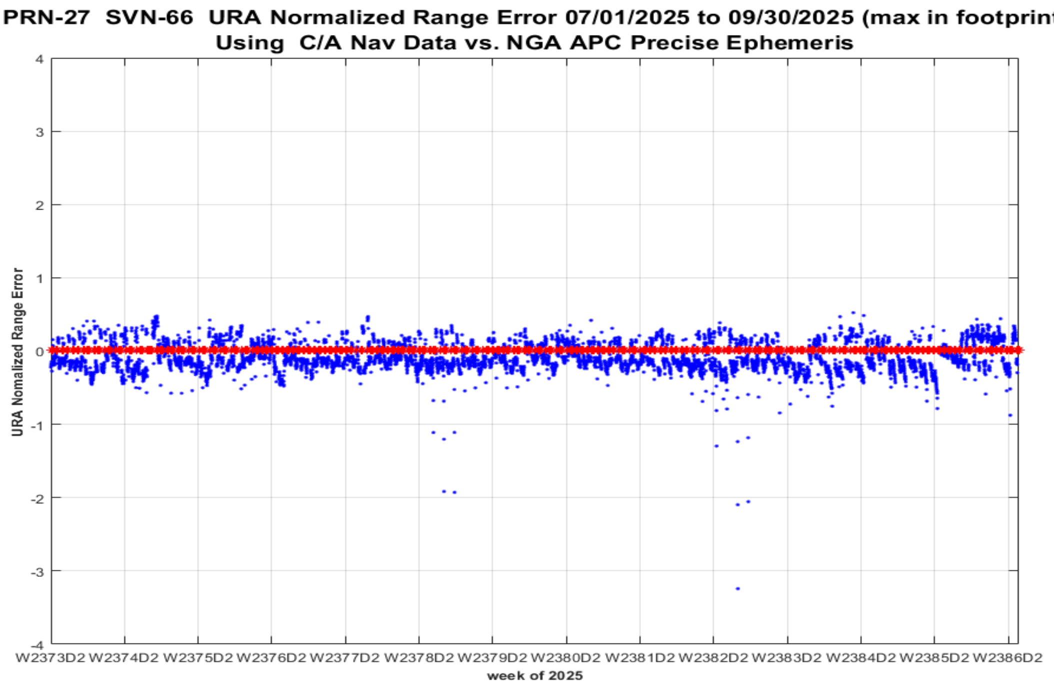

Figure 9-187 Timeline of URA Normalized Range Error PRN27 (SVN66) Using C/A Nav Data

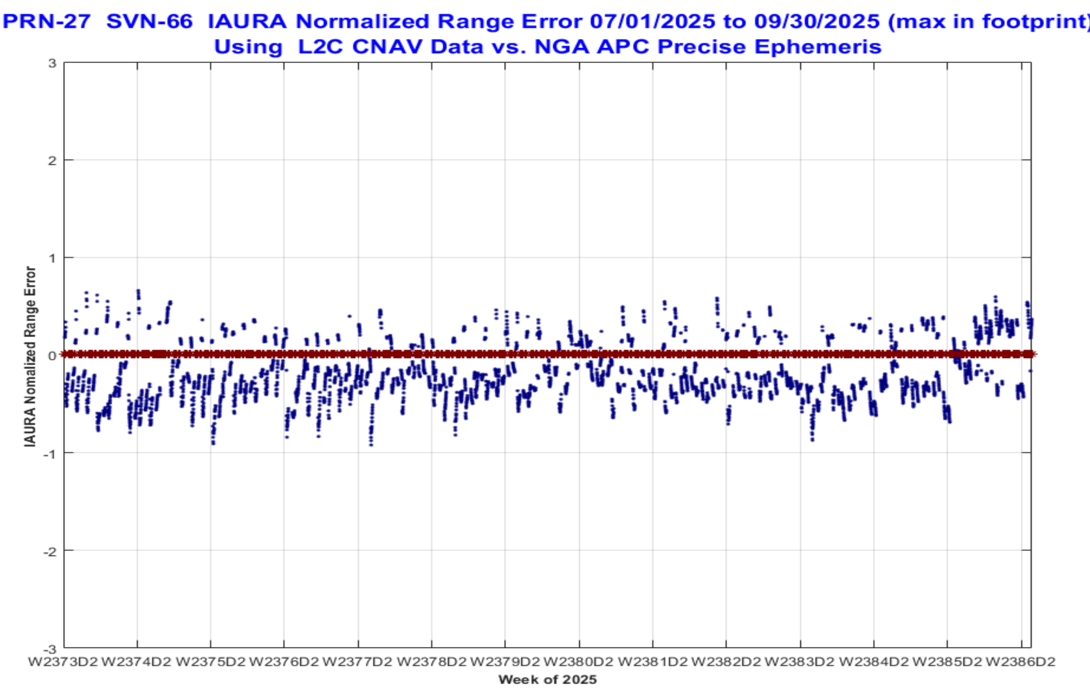

Figure 9-188 Timeline of IAURA Normalized Range Error PRN27 (SVN66) Using L2C CNAV Data

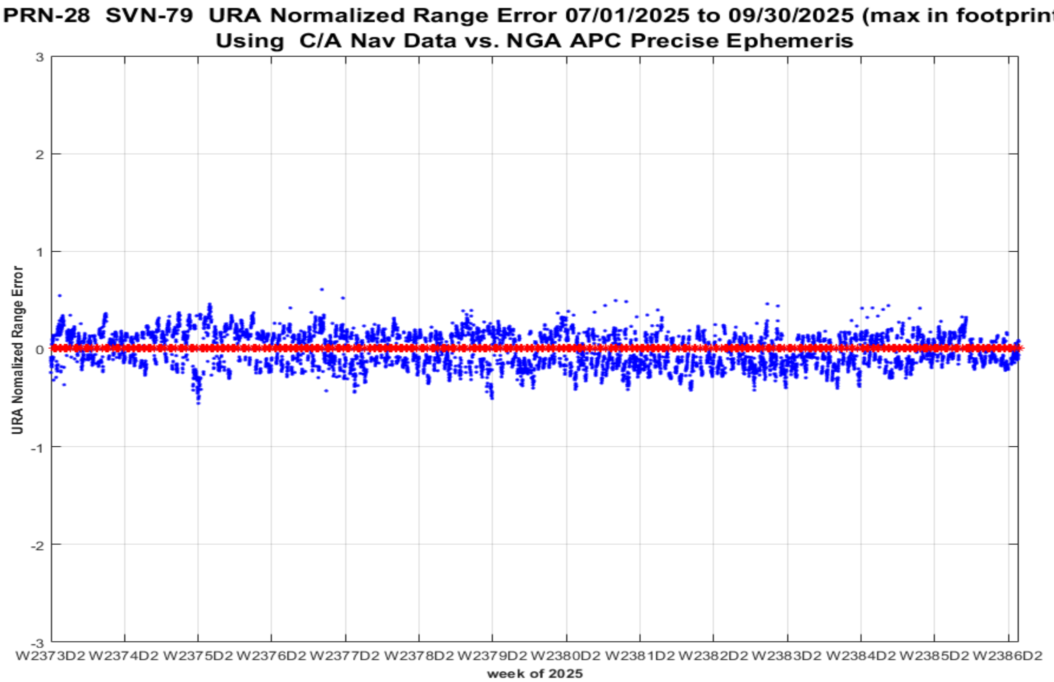

Figure 9-189 Timeline of URA Normalized Range Error PRN28 (SVN79) Using C/A Nav Data

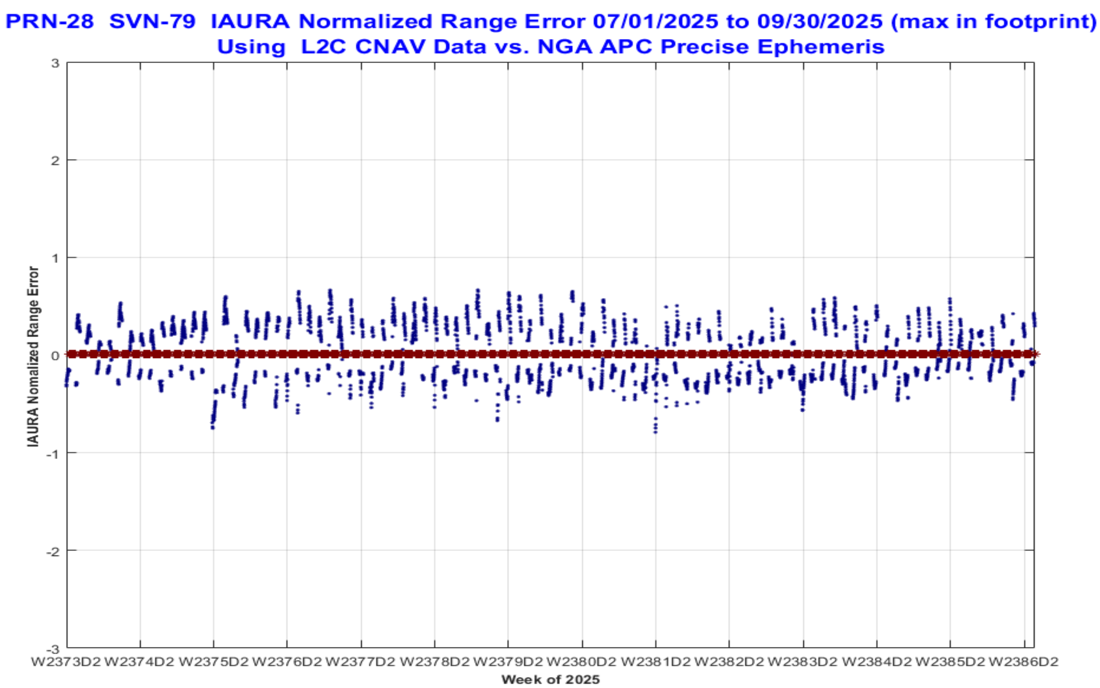

Figure 9-190 Timeline of IAURA Normalized Range Error PRN28 (SVN79) Using L2C CNAV Data

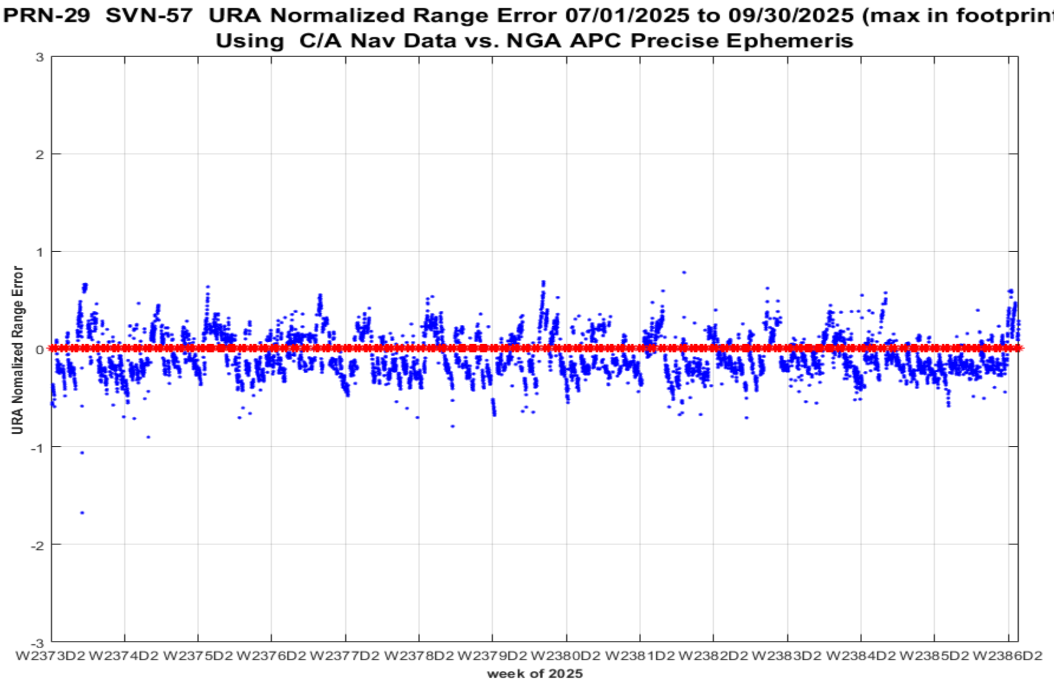

Figure 9-191 Timeline of URA Normalized Range Error PRN29 (SVN57) Using C/A Nav Data

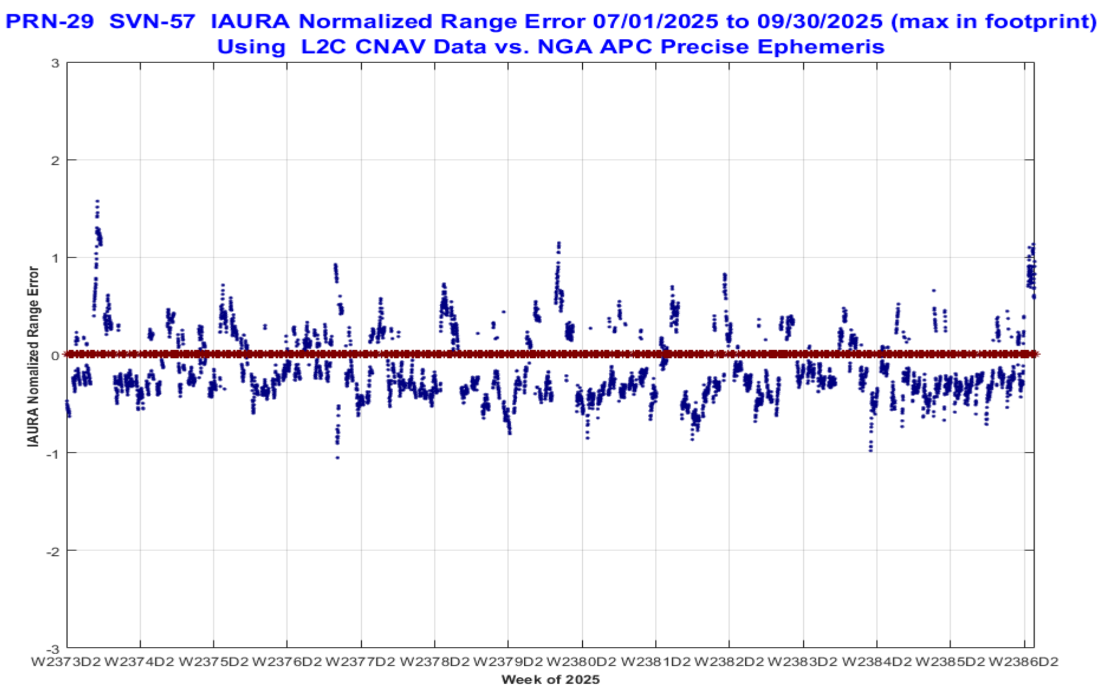

Figure 9-192 Timeline of IAURA Normalized Range Error PRN29 (SVN57) Using L2C CNAV Data

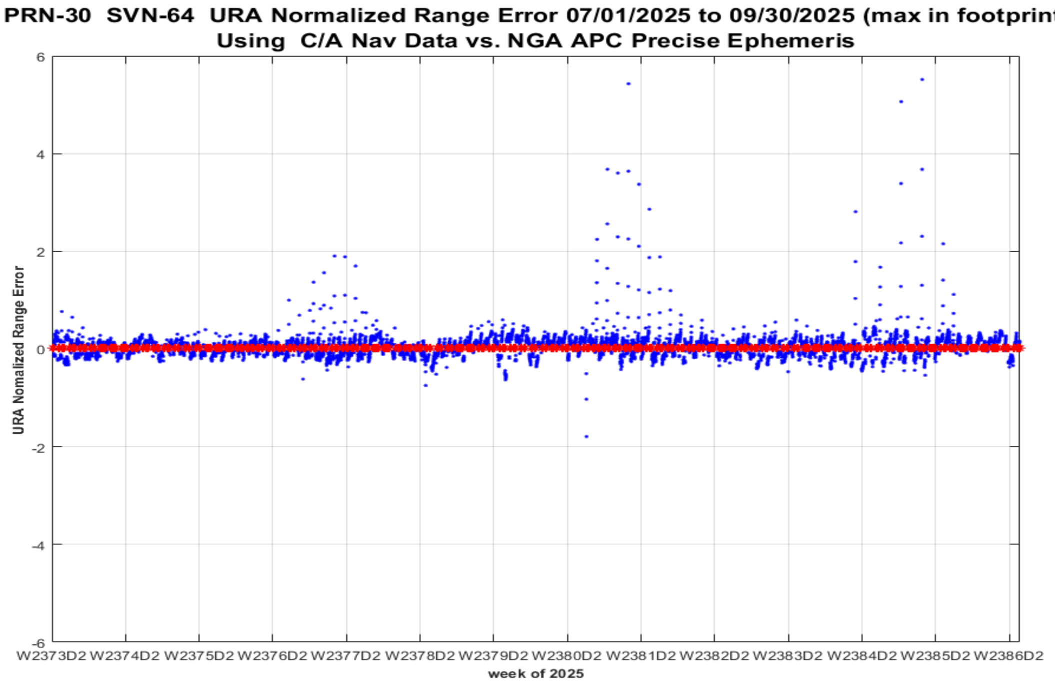

Figure 9-193 Timeline of URA Normalized Range Error PRN30 (SVN64) Using C/A Nav Data

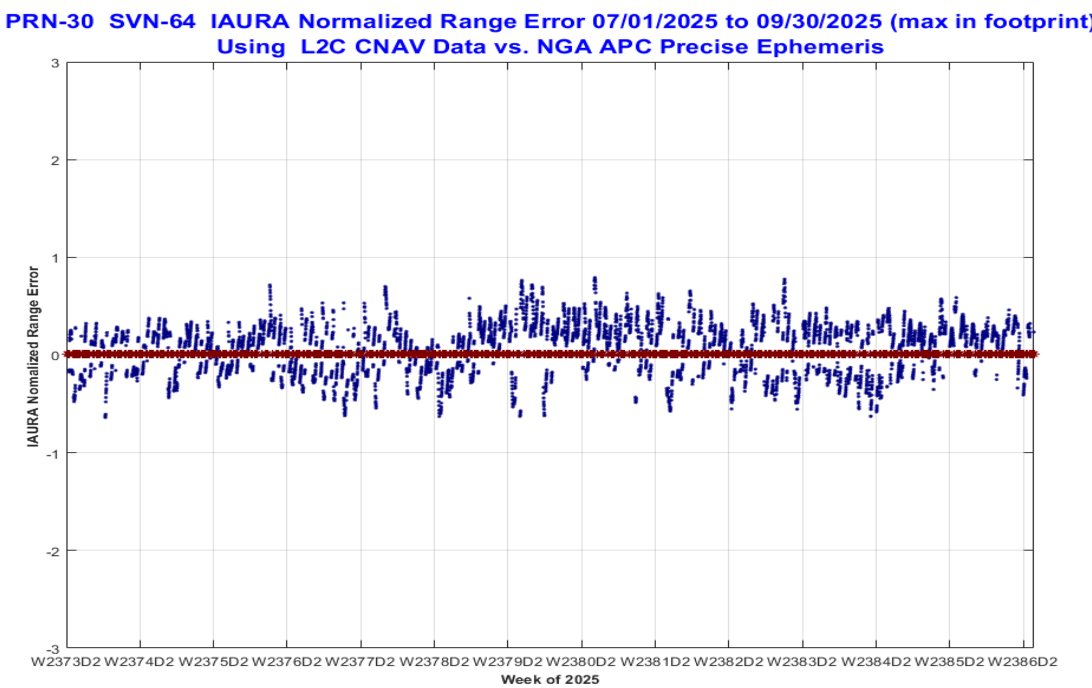

Figure 9-194 Timeline of IAURA Normalized Range Error PRN30 (SVN64) Using L2C CNAV Data

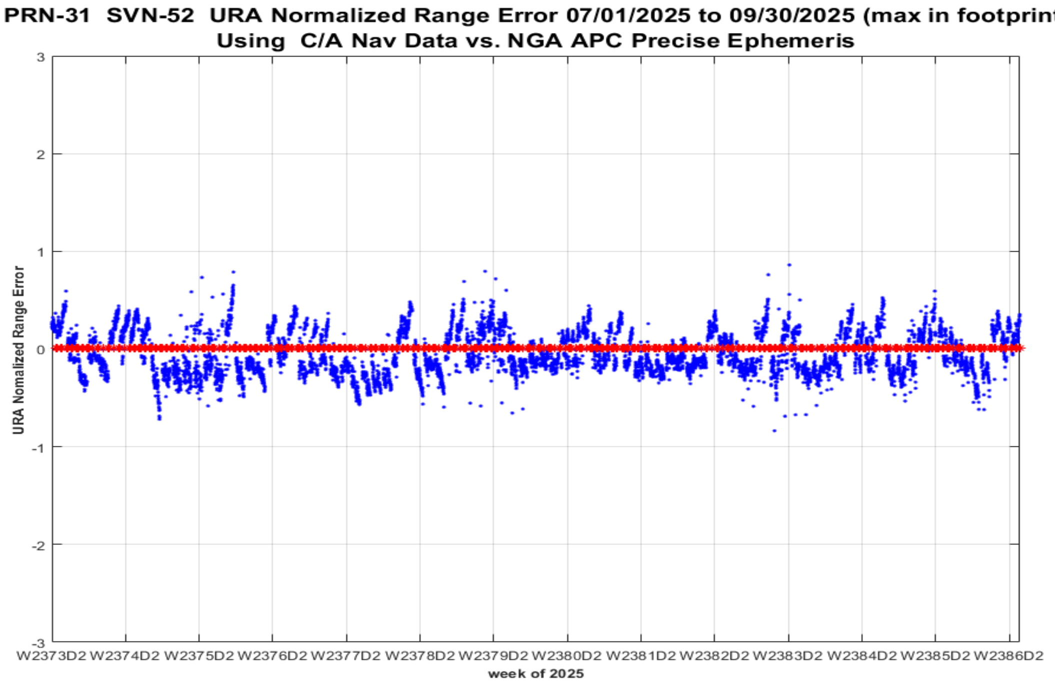

Figure 9-195 Timeline of URA Normalized Range Error PRN31 (SVN52) Using C/A Nav Data

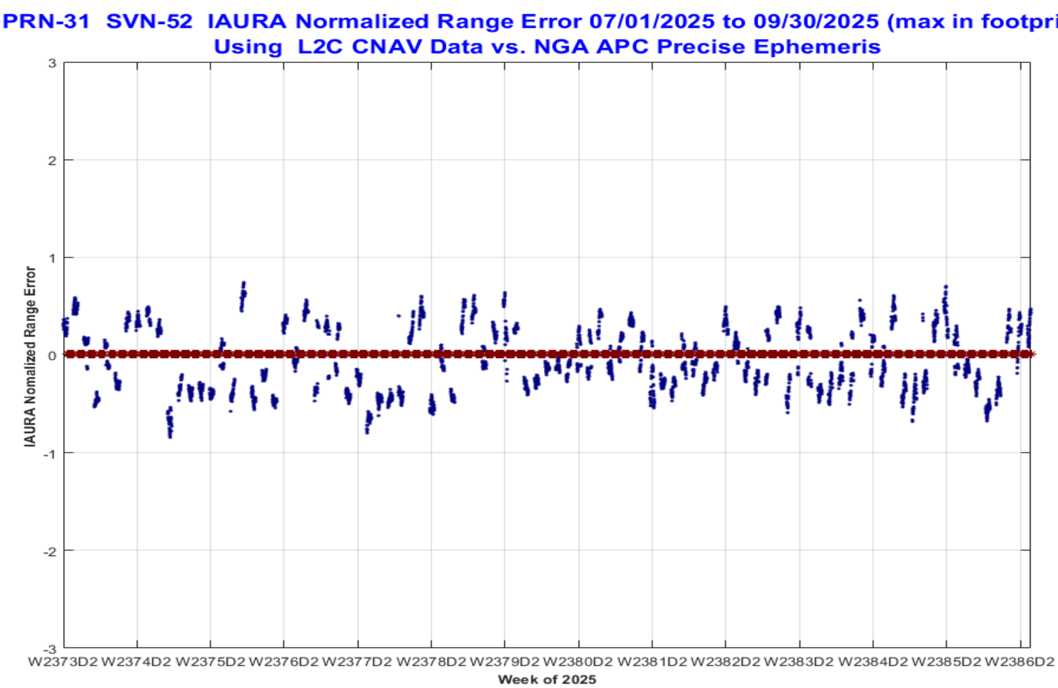

Figure 9-196 Timeline of IAURA Normalized Range Error PRN31 (SVN52) Using L2C CNAV Data

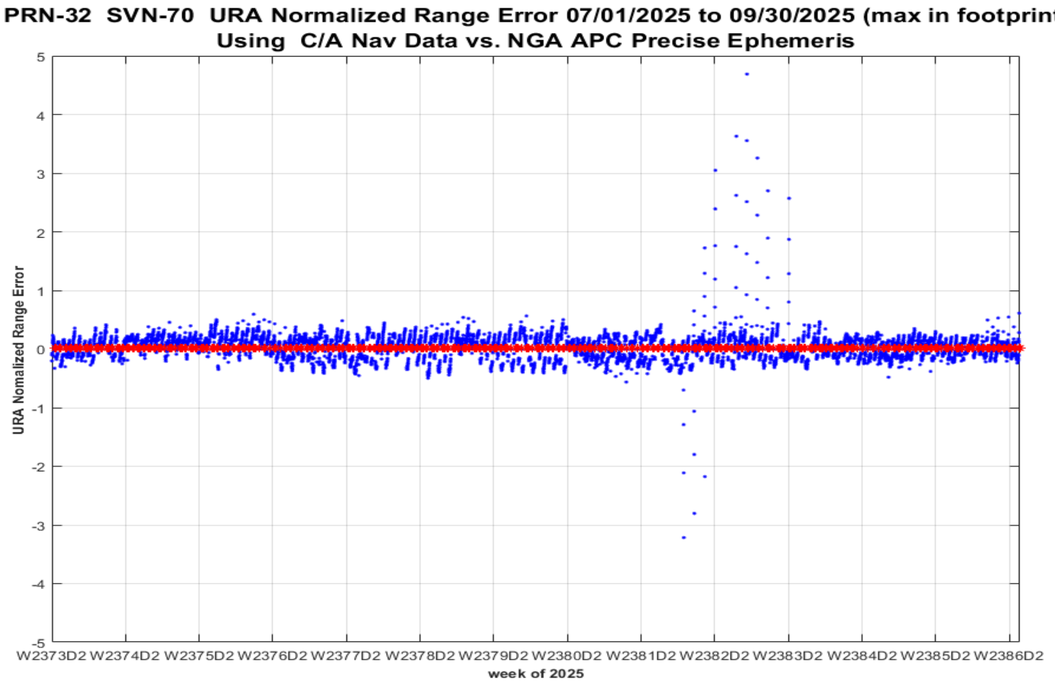

Figure 9-197 Timeline of URA Normalized Range Error PRN32 (SVN70) Using C/A Nav Data

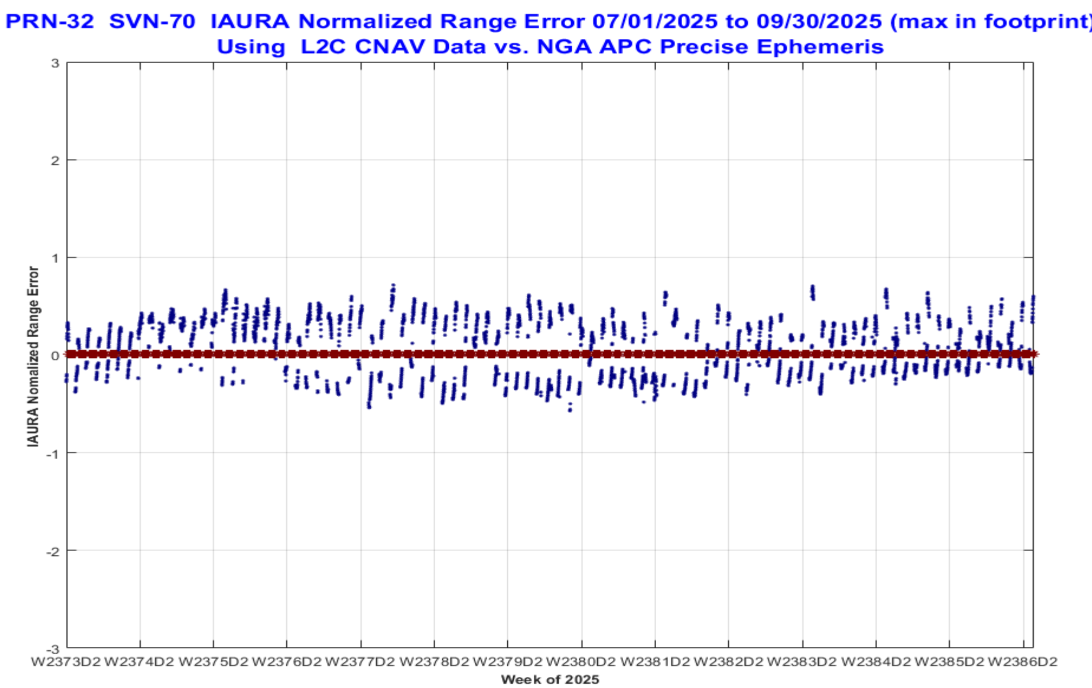

Figure 9-198 Timeline of IAURA Normalized Range Error PRN32 (SVN70) Using L2C CNAV Data

APPENDIX A: PERFORMANCE SUMMARY

Table A-1 Performance Summary

Parameter	Measured Performance	Conditions and Constraints
User Range Error Accuracy Single-Frequency C/A-Code 1. ≤7.8 m 95% Global Average URE during normal operations over All AODs 2. ≤6.0 m 95% Global Average URE during operations at Zero AOD 3. ≤12.8 m 95% Global Average URE during normal operations at Any AOD	1. ≤3.520 m 2. N/A 3. N/A	For any healthy SPS SIS. Neglecting single-frequency ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Including inter-signal bias (P(Y)-code to C/A-code) errors at L1.
User Range Error Accuracy Single-Frequency C/A-Code 1. ≤30 mm 99.94% Global Average URE during normal operations 2. ≤30 mm 99.79% Worst Case single point average during normal operations	1. 100% Global 2. 100% WCP	For any healthy SPS SIS. Neglecting single-frequency ionospheric delay model errors. Including group delay time correction (T_{GD}) errors at L1. Standard based on measurement interval of one year; average of daily values within service volume. Standard based on 3 service failures per year, lasting no more than 6 hours each.
User Range Rate Error Accuracy Single-Frequency C/A Code: ≤6 mm/sec 95% Global Average URRE over any 3-second interval during normal operations at Any AOD	≤4.367 mm/sec	For any healthy SPS SIS. Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers. Neglecting single-frequency ionospheric delay model errors.

Parameter	Measured Performance	Conditions and Constraints
User Range Acceleration Error Accuracy Single-Frequency C/A Code: ≤2 mm/sec^2 95% Global Average URAE over any 3-second interval during normal operations at Any AOD	≤35.455 mm/s^2	For any healthy SPS SIS. Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers. Neglecting single-frequency ionospheric delay model errors.
Per-Satellite Coverage Terrestrial Service Volume: 100% Coverage	100%	For any healthy or marginal SPS SIS.
Constellation Coverage Terrestrial Service Volume: 100% Coverage	100%	For any healthy or marginal SPS SIS.
Status and Problem Reporting Scheduled event affecting service Appropriate NANU issued to the U.S. Coast Guard and the FAA at least 48 hours prior to the event	≥4.6 hours Prior to event	For any SPS SIS.
Status and Problem Reporting Unscheduled outage or problem affecting service Appropriate NANU issued to the U.S. Coast Guard and the FAA as soon as possible after the event	≤0.467 hours	For any SPS SIS.

Parameter	Measured Performance	Conditions and Constraints
Status and Problem Reporting Unscheduled Failure Interruption Continuity: ≥0.9998 Probability over any hour of not losing the SPS SIS availability from a slot due to unscheduled interruption	100%	Calculated as an average over all slots in the 24-slot constellation, normalized annually. Given that the SPS SIS is available from the slot at the start of the hour.
Operational Satellite Count ≥0.95 Probability that the constellation will have at least 24 operational satellites regardless of whether those operational satellites are located in slots or not	100%	Applies to the total number of operational satellites in the constellation (averaged over any day); where any satellite which appears in the transmitted navigation message almanac is defined to be an operational satellite regardless of whether that satellite is currently broadcasting a healthy SPS SIS or not and regardless of whether the broadcast SPS SIS also satisfies the other performance standards in the SPS performance standard or not.
PDOP Availability 1. ≥98% global PDOP of 6 or less 2. ≥88% worst site PDOP of 6 or less	1. 100% 2. 100%	Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
Service Availability 1. ≥99% Horizontal Service Availability, average location 2. ≥99% Vertical Service Availability, average location	1. 100% Horizontal 2. 100% Vertical	15 m Horizontal (SIS only) 95% threshold. 33 m Vertical (SIS only) 95% threshold. Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.

Parameter	Measured Performance	Conditions and Constraints
Service Availability 1. ≥90% Horizontal Service Availability, worst-case location 2. ≥90% Vertical Service Availability, worst-case location	1. 100% Horizontal 2. 100% Vertical	15 m Horizontal (SIS only) 95% threshold. 33 m Vertical (SIS only) 95% threshold. Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
Position/Time Accuracy Global Average Position Domain Accuracy: 1. ≤8 m 95% Horizontal Error 2. ≤13 m 95 % Vertical Error	1. ≤3.128 m Horizontal 2. ≤3.808 m Vertical	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.
Position/Time Accuracy Worst Site Position Domain Accuracy: 1. ≤15 m 95% Horizontal Error 2. ≤33 m 95% Vertical Error	1. ≤7.930 m Horizontal 2. ≤6.700 m Vertical	Defined for a position/time solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.
Position/Time Accuracy Time Transfer Domain Accuracy: ≤30 nanoseconds time transfer error 95% of time (SIS only)	TBD	Defined for a time transfer solution meeting the representative user conditions. Standard based on a measurement interval of 24 hours averaged over all points in the service volume.

Parameter	Measured Performance	Conditions and Constraints
Position/Time Accuracy Instantaneous UTCOE Integrity: NTE ±120 nanoseconds 99.999% of time without a timely alert. (SIS only)	TBD	For any healthy SPS SIS. Worst case for delayed alert is 6 hours.
Per-Slot Availability 1. ≥0.957 Probability that a slot in the baseline 24-slot configuration will be occupied by a satellite broadcasting a healthy SPS SIS 2. ≥0.957 Probability that a slot in the expanded configuration will be occupied by a pair of satellites each broadcasting a healthy SPS SIS	1. 100% 2. 100%	Calculated as an average over all slots in the 24-slot constellation, normalized annually. Applies to satellites broadcasting a healthy SPS SIS that also satisfy the other performance standards in the SPS performance standard.

Parameter	Measured Performance	Conditions and Constraints
Constellation Availability 1. ≥0.98 Probability that at least 21 slots out of the 24 will be occupied either by a satellite broadcasting a healthy SPS SIS in the baseline 24-slot configuration or by a pair of satellites each broadcasting a healthy SPS SIS in the expanded slot configuration 2. ≥0.99999 Probability that at least 20 slots out of the 24 will be occupied either by a satellite broadcasting a healthy SPS SIS in the baseline 24-slot configuration or by a pair of satellites each broadcasting a healthy SPS SIS in the expanded slot configuration	1. 100% 2. 100%	Calculated as an average over all slots in the 24-slot constellation, normalized annually. Applied to satellites broadcasting a healthy SPS SIS that also satisfies the other performance standards in the SPS performance standard.

APPENDIX B: GEOMAGNETIC DATA

\# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

\# Current Quarter Daily Geomagnetic Data

#	Middle Latitude		High Latitude		Estimated								
#	- Fredericksburg -		---- College ----		--- Planetary ---								
# Date	A	K-indices	A	K-indices	A	K-indices							
2025 07 01	7	3 2 1 2 1 2 2 2	9	4 3 2 2 2 1 1 1	7	3.33	2.33	1.67	1.33	0.67	1.00	1.00	2.00
2025 07 02	8	1 2 3 1 3 2 2 2	11	0 1 3 4 4 2 2 1	7	1.33	1.67	2.33	1.67	2.33	1.67	2.00	2.00
2025 07 03	16	2 3 3 3 4 2 3 4	21	2 4 3 2 5 5 2 2	16	2.67	3.00	3.00	3.33	3.67	2.33	2.67	3.67
2025 07 04	11	2 2 3 2 2 1 3 4	16	3 4 5 2 2 2 2 2	10	2.67	2.33	2.67	1.67	1.33	1.33	2.67	3.67
2025 07 05	20	3 4 3 3 4 3 3 4	29	3 4 3 6 5 3 3 3	19	3.00	3.33	3.00	3.67	4.00	3.00	3.33	3.33
2025 07 06	20	3 4 3 4 3 2 2 5	37	5 5 4 6 5 2 2 4	26	4.33	5.00	3.00	3.67	3.33	1.67	2.67	5.33
2025 07 07	20	5 4 2 3 3 3 3 3	22	4 3 3 3 4 5 3 3	22	5.33	4.33	2.67	3.00	3.00	3.33	3.00	3.00
2025 07 08	13	3 3 3 3 3 3 2 2	19	3 4 3 4 2 5 2 2	13	3.00	3.67	3.00	2.67	2.00	2.67	1.67	2.67
2025 07 09	8	3 2 1 2 3 2 1 1	12	3 2 3 4 3 2 2 1	8	3.00	2.33	1.67	2.00	2.00	1.67	1.33	1.67
2025 07 10	6	1 1 1 2 3 2 2 0	2	1 1 1 1 0 1 1 0	4	1.00	1.33	1.00	1.33	0.67	1.00	1.00	0.67
2025 07 11	18	2 2 3 4 4 3 4 3	25	1 3 4 6 4 3 3 3	19	2.00	2.67	3.00	4.33	3.33	2.67	4.33	3.67
2025 07 12	10	2 2 3 3 3 2 2 2	29	3 4 4 6 5 3 2 3	13	2.67	2.67	3.00	3.00	3.00	2.00	2.33	3.00
2025 07 13	17	4 4 3 3 3 3 3 2	41	4 5 5 6 5 5 3 3	23	4.33	4.67	3.67	3.33	3.67	3.00	3.33	3.00
2025 07 14	16	2 2 3-1-1 3 4 4	16	2 3 3-1-1 4 3 3	16	2.00	2.67	3.00	1.67	2.67	3.00	4.67	3.67
2025 07 15	17	3 4 4 4 3 3 1 2	37	4 5 6 5 5 4 2 2	23	4.00	4.33	5.00	4.67	3.00	2.33	1.67	2.00
2025 07 16	14	2 3 3 4 2 1 2 4	24	4 4 4 6 2 1 2 3	17	3.00	3.00	2.67	3.67	1.67	1.33	3.00	5.00
2025 07 17	14	4 3 3 3-1-1-1 0	42	3 4 5 6 6 5 4 2	19	3.67	3.67	3.67	3.67	3.67	3.67	3.00	1.67
2025 07 18	9	2 1 2 2 4 2 1 2	18	2 2 2 5 5 3 2 2	11	2.00	1.00	2.00	2.67	4.00	3.00	1.67	2.00
2025 07 19	8	1 1 1 3 3 2 2 2	11	1 3 2 4 3 3 1 1	7	1.00	2.33	1.67	2.00	1.67	2.33	1.67	1.67
2025 07 20	7	1 1 1 2 3 2 2 2	9	1 1 1 3 4 3 1 1	5	1.33	1.33	0.67	1.67	2.00	1.67	0.67	1.33
2025 07 21	4	1 1 1 1 2 1 1 2	2	2 1 0 0 0 0 0 1	4	2.00	1.33	0.67	0.67	1.33	0.33	0.33	1.00
2025 07 22	17	1 3 2 3 3 2 4 5	9	1 2 1 1 2 2 3 4	17	1.00	2.00	1.33	2.00	2.00	3.00	4.67	5.00
2025 07 23	20	3 4 3 4 4 3 3 3	32	4 5 4 5 5 4 3 3	27	4.33	4.00	3.67	4.33	4.67	3.33	4.00	3.67
2025 07 24	16	3 3 3 4 3 3 2 3	29	4 4 5 5 5 3 3 2	15	3.67	2.67	3.00	3.67	3.33	3.00	2.33	2.33

2025 07 25	10	2 2 2 3 3 2 2 3	10	2 3 2 3 3 2 2 2	8	2.33 2.33 2.00 2.00 2.00 2.33 2.00 2.67
2025 07 26	11	2 1 2 3 3 3 3 2	19	3 2 1 3 6 4 1 1	12	2.00 1.67 1.67 3.00 3.00 4.00 2.67 2.00
2025 07 27	7	1 1 2 2 3 2 2 1	3	1 1 1 1 1 1 1 0	5	1.00 1.00 1.67 1.33 1.00 1.33 1.33 1.00
2025 07 28	8	0 1 1 2 3 3 2 3	6	1 2 1 0 3 2 1 2	7	1.00 1.33 1.33 1.67 1.67 1.67 2.33 3.00
2025 07 29	9	2 2 2 3 2 3 2 2	13	2 3 4 5 2 0 0 1	8	2.67 2.33 2.33 2.33 1.00 1.33 1.33 2.00
2025 07 30	9	2 1 2 3 3 2 3 1	7	2 2 1 1 3 2 2 1	8	2.67 1.67 1.33 2.00 2.33 2.67 2.33 1.33
2025 07 31	10	3 2 2 2 3 2 2 3	12	2 2 2 4 4 2 2 1	11	3.00 3.00 2.00 2.33 2.67 2.33 2.67 2.00
2025 08 01	13	3 3 2 3 3 2 3 3	19	3 3 2 3 6 2 2 2	13	2.67 2.67 2.67 2.67 3.33 1.67 2.67 3.33
2025 08 02	9	3 2 1 2 2 3 2 2	7	2 2 2 1 2 2 2 2	9	3.00 2.00 1.67 1.33 1.33 2.33 2.67 2.67
2025 08 03	9	2 2 1 2 2 3 3 2	6	2 2 1 0 2 2 3 1	9	2.00 1.67 1.33 1.67 1.33 2.67 3.67 2.00
2025 08 04	7	1 1 2 2 3 2 2 2	11	1 1 3 3 4 3 2 1	8	1.00 1.67 2.67 2.00 2.33 2.33 2.00 2.33
2025 08 05	10	3 2 1 2 3 2 3 2	11	2 3 0 2 4 3 2 2	10	3.00 2.67 1.00 1.33 2.33 2.33 3.00 2.33
2025 08 06	9	2 2 1 2 3 3 1 3	4	2 1 1 1 1 2 1 1	6	2.00 1.67 1.33 1.33 1.67 2.00 1.33 2.33
2025 08 07	6	1 2 1 3 2 2 1 1	3	2 2 1 1 0 0 0 0	4	1.33 1.33 1.33 1.33 1.00 0.33 0.33 1.33
2025 08 08	18	1 2 2 3 4 4 4 4	25	0 2 2 5 5 5 4 3	22	1.00 1.33 1.67 3.33 4.67 4.33 5.00 4.00
2025 08 09	27	5 4 4 4 4 4 3 3	55	5 5 7 5 5 6 3 3	47	5.33 5.00 5.00 4.67 5.33 6.00 4.33 3.00
2025 08 10	17	3 2 4 4 4 2 3 2	48	3 4 6 7 5 5 3 2	22	3.67 2.00 4.33 4.33 3.67 3.33 4.00 3.00
2025 08 11	17	4 3 2 3 4 4 2 2	44	4 3 6 6 6 5 3 2	17	4.33 2.33 3.33 3.00 3.33 3.67 2.67 2.67
2025 08 12	12	3 3 2 3 3 2 2 3	23	4 4 3 5 3 4 2 3	14	3.67 3.00 2.00 2.67 3.00 2.33 2.67 3.33
2025 08 13	17	3 3 3 4 4 2 3 3	37	3 3 5 6 6 4 3 3	15	2.67 3.00 2.67 3.00 3.00 2.67 3.00 3.67
2025 08 14	13	3 2 3 4 3 2 2 2	41	3 4 7 6 5 2 2 2	11	3.33 2.33 3.00 3.00 2.33 1.67 1.67 2.00
2025 08 15	10	3 3 3 3 2 1 2 1	13	3 3 4 4 1 2 1 1	7	2.67 2.33 2.33 2.00 1.33 1.33 2.00 1.33
2025 08 16	6	1 2 1 3 2 2 1 1	5	1 1 1 3 0 2 1 1	6	1.33 2.00 1.33 2.00 1.33 2.00 1.00 1.67
2025 08 17	7	0 2 3 3 3 1 1 0	6	1 2 2 2 4 0 0 0	5	1.33 1.33 2.00 1.67 2.00 1.00 0.33 0.33
2025 08 18	5	0 0 1 2 3 2 1 2	14	0 1 1 5 4 4 1 1	7	0.33 0.67 1.33 2.33 2.33 2.67 1.33 2.33
2025 08 19	16	3 2 2 3 4 3 4 3	25	3 2 3 5 5 4 4 3	19	3.00 2.00 2.00 2.67 4.00 3.67 4.67 3.67
2025 08 20	12	3 3 3 2 3 2 2 3	21	4 3 4 6 2 2 1 0	13	4.00 3.00 3.00 2.67 1.67 1.67 2.00 3.33
2025 08 21	8	3 2 1 2 3 1 2 2	4	3 2 1 0 0 0 1 1	7	2.67 2.00 1.00 1.00 1.33 1.33 2.33 2.00
2025 08 22	9	3 2 1 2 3 1 3 2	-1	-1-1-1 3 4 3 3-1	8	3.00 2.00 1.33 1.00 2.00 1.67 2.33 2.67
2025 08 23	7	2 2 1 2 3 1 2 1	6	2 3 2 2 2 0 1 1	7	2.67 2.33 1.67 1.67 1.67 0.67 1.00 2.00
2025 08 24	5	1 1 1 2 2 2 2 1	6	1 3 1 2 2 1 1 1	6	2.00 1.67 1.33 1.00 1.33 1.33 2.00 1.67
2025 08 25	7	0 1 1 2 4 2 2 1	12	0 1 1 2 5 4 1 1	8	1.00 1.33 1.33 1.33 3.33 2.67 1.67 1.67
2025 08 26	10	2 3 3 2 3 2 1 2	24	2 4 3 5 3 5 2 4	8	1.67 3.00 2.33 2.67 1.67 1.00 1.33 1.67
2025 08 27	9	2 1 1 3 3 2 3 2	12	2 1 1 2 3 3 3 4	8	1.33 1.33 1.00 2.67 3.00 1.67 2.00 2.33

2025 08 28	7	1	1	2	2	3	2	2	2	9	2	2	3	2	2	2	2	3	7	2.00	1.67	2.67	2.00	2.00	1.33	2.00	2.00
2025 08 29	6	2	1	1	2	2	2	2	1	6	2	2	1	1	1	2	2	2	6	2.33	2.00	1.33	1.33	1.33	1.67	2.00	1.67
2025 08 30	8	2	1	2	2	3	2	2	2	11	2	1	3	4	2	3	2	2	7	2.00	1.33	2.00	2.00	1.67	2.33	1.67	2.00
2025 08 31	9	2	2	1	3	3	2	2	2	6	2	1	1	3	1	2	2	1	8	2.33	2.00	1.33	2.67	2.00	2.00	2.00	1.67
2025 09 01	9	1	1	1	2	2	2	3	4	10	1	1	1	2	1	1	2	5	16	2.00	1.33	1.33	1.33	1.33	2.00	2.67	6.00
2025 09 02	25	5	4	4	3	3	4	4	3	27	4	4	4	3	5	3	4	4	34	5.33	4.33	4.33	3.67	3.00	4.33	5.00	4.33
2025 09 03	8	3	3	2	2	2	1	2	1	11	4	3	2	3	2	2	2	1	12	4.67	3.33	2.33	2.00	1.67	1.00	2.33	1.00
2025 09 04	10	2	1	2	3	3	3	2	2	19	1	1	3	5	4	5	1	2	10	2.00	1.33	2.33	3.00	2.00	2.67	2.33	2.67
2025 09 05	8	1	0	1	3	3	2	2	3	12	2	0	1	5	2	2	2	3	8	1.67	0.67	1.33	2.67	1.33	1.67	2.67	3.33
2025 09 06	17	3	3	3	3	4	4	3	1	51	3	5	6	6	5	6	5	2	26	4.00	3.67	4.00	3.33	4.00	5.00	4.33	1.33
2025 09 07	4	1	1	0	1	2	2	1	2	4	1	0	0	0	0	1	2	3	5	1.00	1.00	0.67	0.67	1.00	0.33	1.33	2.67
2025 09 08	10	3	3	2	3	2	2	2	2	24	3	3	5	5	4	4	2	2	13	3.33	3.67	2.67	2.67	2.33	2.33	2.67	1.67
2025 09 09	15	3	2	3	2	3	2	2	5	23	3	2	3	5	4	3	2	5	19	3.33	2.33	2.67	2.67	2.67	1.67	2.67	5.67
2025 09 10	12	4	4	1	2	3	2	1	2	18	5	5	2	3	2	3	1	1	13	4.33	4.33	1.33	2.00	2.00	2.00	1.33	1.67
2025 09 11	10	3	2	3	2	3	2	1	2	14	3	4	4	3	3	2	1	1	10	4.00	2.67	2.67	2.00	2.00	1.67	1.00	1.67
2025 09 12	9	1	3	3	3	2	2	2	1	21	0	2	4	6	4	3	2	1	9	1.00	2.67	2.67	3.00	2.00	2.00	2.00	1.00
2025 09 13	7	1	2	3	2	2	2	1	1	14	1	3	4	5	3	1	0	0	6	1.67	2.67	2.67	2.00	1.00	1.00	0.33	1.00
2025 09 14	12	2	2	2	3	2	2	3	4	12	1	1	3	4	3	2	2	3	14	2.00	2.00	2.67	2.33	2.00	2.00	3.00	5.00
2025 09 15	34	6	5	4	4	5	3	3	3	60	4	5	7	6	6	5	4	4	48	6.67	5.33	5.00	4.67	5.33	3.67	3.67	4.33
2025 09 16	17	5	3	3	3	3	2	2	3	38	4	3	6	5	6	4	3	3	21	5.00	3.67	3.67	3.67	3.67	2.33	2.33	3.00
2025 09 17	10	2	2	3	3	3	1	2	2	17	3	2	4	5	3	2	2	2	12	2.33	2.67	3.33	3.33	2.33	1.33	2.33	2.67
2025 09 18	6	1	2	1	1	3	2	2	1	10	2	1	3	4	3	2	0	1	6	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.33
2025 09 19	7	0	0	0	1	5	1	1	0	1	0	0	0	1	0	0	1	0	3	0.67	0.67	0.67	0.67	1.67	0.33	0.67	0.67
2025 09 20	5	1	2	2	2	2	1	1	1	4	1	0	3	2	0	0	0	1	5	1.67	2.00	2.00	1.33	0.67	0.33	0.33	1.33
2025 09 21	6	1	1	1	1	2	3	2	1	3	1	0	1	2	1	1	1	0	6	1.67	1.33	1.67	1.00	1.67	2.00	1.33	1.33
2025 09 22	12	3	2	2	3	3	3	2	3	14	3	2	2	3	5	2	2	2	13	2.67	2.33	2.00	3.00	3.00	3.33	2.67	3.33
2025 09 23	12	3	2	3	3	3	3	2	1	30	3	3	3	3	6	6	3	2	14	3.33	2.67	2.67	2.67	3.67	3.00	3.00	1.67
2025 09 24	6	1	1	1	2	2	2	2	2	6	1	1	1	2	3	2	1	1	8	2.00	1.67	1.33	2.33	2.33	2.00	1.67	2.67
2025 09 25	7	1	1	2	3	3	1	2	1	9	1	1	2	3	4	2	1	1	8	1.33	1.00	2.00	2.67	3.00	1.67	1.33	1.67
2025 09 26	6	2	2	1	2	2	1	2	1	4	2	1	0	0	3	0	1	1	7	2.33	2.33	1.00	2.33	1.67	1.00	2.33	1.67
2025 09 27	5	1	1	1	1	2	2	2	2	4	1	1	1	2	2	0	2	1	7	1.67	2.00	1.33	1.00	1.33	1.00	2.67	2.33
2025 09 28	9	3	3	0	2	2	3	2	2	5	2	1	1	1	1	2	2	1	10	3.00	3.00	1.33	2.00	1.67	3.00	2.67	2.00
2025 09 29	13	2	2	3	3	4	3	3	1	51	2	2	4	6	5	7	6	3	27	2.67	2.67	3.67	4.67	4.00	5.00	4.67	3.33
2025 09 30	43	5	6	5	5	5	4	3	4	70	4	6	6	5	7	6	6	4	15	5.33	7.33	6.00	5.33	5.67	5.67	5.33	5.67

APPENDIX C: KEY TERMS

The terms and definitions discussed below are taken from the Standard Positioning Service Performance Specification (April 2020). Understanding these terms and definitions is necessary to fully understand the Signal Specification.

General Terms and Definitions

Alarm: An indication requiring an immediate response (e.g., to preserve integrity).

Alert: Generic term encompassing both alarm and warning.

Alerted Misleading Signal-in-Space Information (AMSI: The pseudorange data set (e.g., pseudorange measurement and NAV data) provided by a SPS SIS provides alerted MSI (AMSI) when the instantaneous URE exceeds the SIS URE NTE tolerance, but a timely alert (alarm or warning) is provided.

AOD: Age of Data.

Almanac Longitude of the Ascending Node (.o): Equatorial angle from the Prime Meridian (Greenwich) at the weekly epoch to the ascending node at the ephemeris reference epoch.

Auxiliary Satellite: An operational satellite that is not occupying a defined orbital slot in the baseline 24-slot constellation or the expandable 24-slot constellation. Auxiliary satellites are typically either newly launched satellites waiting to take their place in the baseline/expandable 24-slot constellation, or they are older satellites that are nearing the end of their useful lives and have been shifted out of the baseline/expandable 24-slot constellation. The SPS SIS broadcast by an auxiliary satellite is not required to meet all the standards in Section 3.

Coarse/Acquisition (C/A) Code: A PRN code sequence used to modulate the GPS L1 carrier.

Corrected Longitude of Ascending Node (Ωk) and Geographic Longitude of the Ascending Node (GLAN): Equatorial angle from the Prime Meridian (Greenwich) to the ascending node, both at arbitrary time T_k.

Dilution of Precision (DOP): The magnifying effect on GPS position error induced by mapping GPS ranging errors into position within the specified coordinate system through the geometry of the position solution. The DOP varies as a function of satellite positions relative to user position. The DOP may be represented in any user local coordinate desired. Examples are HDOP for local horizontal, VDOP for local vertical, PDOP for all three coordinates, and TDOP for time.

Equatorial Angle: An angle along the equator in the direction of Earth's rotation.

Geometric Range: The difference between the estimated locations of a GPS satellite and an SPS receiver.

Ground Track Equatorial Crossing (GEC, λ, 2 SOPS GLAN): Equatorial angle from the Prime Meridian (Greenwich) to the location a ground track intersects the equator when crossing from the

Southern to the Northern hemisphere. GEC is equal to Ωk when the argument of latitude (Φ) is zero.

Instantaneous User Range Error (URE): The difference between the pseudo range measured at a given location and the expected pseudo range, as derived from the navigation message and the true user position, neglecting the bias in receiver clock relative to GPS time. A signal-in-space (SIS) URE includes residual orbit, satellite clock, and group delay errors. A system URE (sometimes known as a User Equivalent Range Error, or UERE) contains all line-of-sight error sources, to include SIS, single-frequency ionosphere model error, troposphere model error, multipath and receiver noise.

Longitude of Ascending Node (LAN): A general term for the location of the ascending node – the point that an orbit intersects the equator when crossing from the Southern to the Northern hemisphere.

Longitude of the Ground track Equatorial Crossing (GEC, λ, 2 SOPS GLAN): Equatorial angle from the Prime Meridian (Greenwich) to the location a ground track intersects the equator when crossing from the Southern to the Northern hemisphere. GEC is equal to Ωk when the argument of latitude (Φ) is zero.

Mean Down Time (MDT): A measure of time required to restore function after any downing event.

Mean Time Between Downing Events (MTBDE): A measure of time between any downing events.

Mean Time Between Failures (MTBF): A measure of time between unscheduled downing events.

Mean Time to Restore (MTTR): A measure of time required to restore function after an unscheduled downing event.

Navigation Message: Data contained in each satellite's ranging signal and consisting of the ranging signal time-of-transmission, the transmitting satellite's orbital elements, an almanac containing abbreviated orbital element information to support satellite selection, ranging measurement correction information, and status flags. The message structure is described in Section 2.1.2 of the SPS Performance Standard.

Operational Satellite: A GPS satellite that is capable of, but is not necessarily transmitting, a usable ranging signal.

PDOP Availability: Defined to be the percentage of time over any 24-hour interval that the PDOP value is less than or equal to its threshold for any point within the service volume.

Positioning Accuracy: Defined to be the statistical difference, at a 95% probability, between position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

• **Horizontal Positioning Accuracy:** Defined to be the statistical difference, at a 95% probability, between horizontal position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

• **Vertical Positioning Accuracy:** Defined to be the statistical difference, at a 95% probability, between vertical position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

Position Solution: An estimate of a user's location derived from ranging signal measurements and navigation data from GPS.

Position Solution Geometry: The set of direction cosines that define the instantaneous relationship of each satellite's ranging signal vector to each of the position solution coordinate axes.

Pseudo Random Noise (PRN): A binary sequence that appears to be random over a specified time interval unless the shift register configuration and initial conditions for generating the sequence are known. Each satellite generates a unique PRN sequence that is effectively uncorrelated (orthogonal) to any other satellite's code over the integration time constant of a receiver's code tracking loop.

Representative SPS Receiver: The minimum signal reception and processing assumptions employed by the U.S. Government to characterize SPS performance in accordance with performance standards defined in Section 3 of the SPS Performance Standard. Representative SPS receiver capability assumptions are identified in Section 2.2 of the SPS Performance Standard.

Right Ascension of Ascending Node (RAAN): Equatorial angle from the celestial principal direction to the ascending node.

Root Mean Square (RMS) SIS URE: A statistic that represents instantaneous SIS URE performance in an RMS sense over some sample interval. The statistic can be for an individual satellite or for the entire constellation. The sample interval for URE assessment used in the SPS Performance Standard is 24 hours.

Selective Availability: Protection technique formerly employed to deny full system accuracy to unauthorized users. SA was discontinued effective midnight May 1, 2000.

Service Availability: Defined to be the percentage of time over any 24-hour interval that the predicted 95% positioning error is less than its threshold for any given point within the service volume.

• **Horizontal Service Availability:** Defined to be the percentage of time over any 24-hour interval that the predicted 95% horizontal error is less than its threshold for any point within the service volume.

• **Vertical Service Availability:** Defined to be the percentage of time over any 24-hour interval that the predicted 95% vertical error is less than its threshold for any point within the service volume.

Service Degradation: A condition over a time interval during which one or more SPS performance standards are not supported.

Service Failure: A condition over a time interval during which a healthy GPS satellite's ranging signal exceeds the Not-to-Exceed (NTE) SPS SIS URE tolerance.

Service Reliability: The percentage of time over a specified time interval that the instantaneous SIS SPS URE is maintained within a specified reliability threshold at any given point within the service volume, for all healthy GPS satellites.

Service Volume: The spatial volume supported by SPS performance standards. Specifically, the SPS Performance Standard supports the terrestrial service volume. The terrestrial service volume covers from the surface of the earth up to an altitude of 3,000 kilometers.

SPS Performance Envelope: The range of nominal variation in specified aspects of SPS performance.

SPS Performance Standard: A quantifiable minimum level for a specified aspect of GPS SPS performance. SPS performance standards are defined in Section 3.

SPS Ranging Signal: An electromagnetic signal originating from an operational satellite. The SPS ranging signal consists of a Pseudo Random Noise (PRN) C/A code, a timing reference and sufficient data to support the position solution generation process. A description of the GPS SPS signal is provided in Section 2. The formal definition of the SPS ranging signal is provided in ICD IS-GPS-200G.

SPS Ranging Signal Measurement: The difference between the ranging signal time of reception (as determined by the receiver's clock) and the time of transmission derived from the navigation signal (as defined by the satellite's clock) multiplied by the speed of light. This is also known as the *pseudorange*.

SPS SIS User Range Error (URE) Statistic:

• A satellite SPS SIS URE statistic is defined to be the Root Mean Square (RMS) difference between SPS ranging signal measurements (neglecting user clock bias and errors due to propagation environment and receiver), and "true" ranges between the satellite and an SPS user at any point within the service volume over a specified time interval.

• A constellation SPS SIS URE statistic is defined to be the average of all satellite SPS SIS URE statistics over a specified time interval.

Time Transfer Accuracy Relative to UTC (USNO): The difference at a 95% probability between user UTC time estimates and UTC (USNO) at any point within the service volume over any 24-hour interval.

Transient Behavior: Short-term behavior not consistent with steady-state expectations.

Usable SPS Ranging Signal: An SPS ranging signal that can be received, processed, and used in a position solution by a receiver with representative SPS receiver capabilities.

User Navigation Error (UNE): Given a sufficiently stationary and ergodic satellite constellation ranging error behavior over a minimum sample interval, multiplication of the DOP and a constellation ranging error standard deviation value will yield an approximation of the RMS position error. This RMS approximation is known as the UNE (UHNE for horizontal, UVNE for vertical, and so on). The user is cautioned that any divergence away from the stationary and ergodic assumptions will cause the UNE to diverge from an RMS value based on actual measurements.

User Range Accuracy (URA): A conservative representation of each satellite's expected (1σ) SIS URE performance (excluding residual group delay) based on historical data. A URA value is provided that is representative over the curve fit interval of the navigation data from which the URA is read. The URA is a coarse representation of the URE statistic in that it is quantized to levels represented in ICD IS-GPS-200G.