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

# GLOBAL POSITIONING SYSTEM STANDARD POSITIONING SERVICE PERFORMANCE ANALYSIS REPORT

## April 2025

**Report #129**
**Reporting Period: January 1 to March 31, 2025**
**http://www.nstb.tc.faa.gov/**

**FAA William J. Hughes Technical Center**
**Atlantic City International Airport, NJ 08405**

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**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 #129 includes data collected from the January 1 through March 31, 2025 reporting period. The next quarterly report will be issued July 31, 2025.

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, Receiver Autonomous Integrity Monitoring (RAIM) Performance, and GPS Test Notices to Airmen (NOTAMs) Summary.

**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 6 for CONUS was 99.9999%.

**NANU Summary and Evaluation.** This evaluation was achieved by reviewing the NANU reports issued between January 1 and March 31, 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 (URE) 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 38.320 meters on PRN25. 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 3.070 meters was recorded on satellite PRN19. SPS Standard states that RMS User Range Error (URE) cannot exceed 6 meters in any 24-hour interval.

**Solar Storms.** Strong geomagnetic storms affected GPS performance this quarter. However, 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 was not processed for this evaluation period.

**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 99.858% at Bethel. The minimum percent of time spent in RNP 0.3 mode was 99.999% at Gander. The maximum 99% HPL value was 130.635 meters at Juneau.

From the analysis performed on data collected between January 1 and March 31, 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 (5$^{th}$ 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 PDOPs 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 by providing the "Notice: Advisory to Navstar Users" (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 on a daily basis at 1-second intervals. This section also provides the 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 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**: Performance Summary provides a summary of all the results as compared to the SPS Standard.

**Appendix B**: Geomagnetic Data provides the geomagnetic data used for Section 6.

**Appendix C**: Key Terms 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**<br>Terrestrial Service Volume:<br>100% Coverage<br><br>Space Service Volume:<br>No Coverage Performance Specified | For any healthy or marginal SPS SIS. |
| **Constellation Coverage**<br>Terrestrial Service Volume:<br>100% Coverage<br><br>Space Service Volume:<br>No Performance Specified | For any healthy or marginal SPS SIS. |

| Parameter | Conditions and Constraints |
|---|---|
| **User Range Error Accuracy**<br>Single-Frequency C/A-Code<br>• ≤7.0 m 95% Global Average URE during normal operations over All Age of Data (AOD)<br>• ≤3.8 m 95% Global Average URE during operations at Zero AOD<br>• ≤9.7 m 95% Global Average URE during normal operations at Any AOD | For any healthy or marginal SPS SIS.<br><br>Neglecting single-frequency ionospheric delay model errors.<br><br>Including group delay time correction ($T_{GD}$) errors at L1.<br><br>Including inter-signal bias (P(Y)-code to C/A-code) errors at L1.<br><br>Including Inter-Signal Correction (ISC) errors. |
| **User Range Error Accuracy**<br><br>Single-Frequency C/A-Code:<br><br>• ≤30 m 99.94% Global Average URE during normal operations<br>• ≤30 m 99.79% Worst Case single point average during normal operations | For any healthy or marginal SPS SIS.<br><br>Neglecting single-frequency ionospheric delay model errors.<br><br>Including group delay time correction ($T_{GD}$) errors at L1.<br><br>Including inter-signal bias (P(Y)-code to C/A-code) errors at L1.<br><br>Including ISC errors.<br><br>Standard based on measurement interval of one year; average of daily values within service volume.<br><br>Standard based on 3 service failures per year, lasting no more than 6 hours each. |
| **User Range Error Accuracy**<br><br>Single-Frequency C/A-Code:<br><br>≤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**<br><br>Single-Frequency C/A-Code:<br><br>≤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.<br><br>Neglecting SF ionospheric delay model errors.<br><br>Including group delay time correction ($T_{GD}$) errors at L1.<br><br>Including inter-signal bias (P(Y)-code to C/A-code) errors at L1.<br><br>Including ISC errors. |
| **User Range Rate Error Accuracy**<br>Single-Frequency C/A Code:<br><br>≤6 mm/sec 95% Global Average URRE over any 3-second interval during normal operations at Any AOD | For any healthy SPS SIS.<br><br>Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers.<br><br>Neglecting single-frequency ionospheric delay model errors. |
| **User Range Acceleration Error Accuracy**<br><br>Single-Frequency C/A Code:<br><br>≤2 mm/sec$^2$ 95% Global Average URAE over any 3-second interval during normal operations at Any AOD | For any healthy SPS SIS.<br><br>Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers.<br><br>Neglecting single-frequency ionospheric delay model errors. |
| **Coordinated Universal Time Offset Error Accuracy**<br><br>≤30 nanoseconds 95% Global average UTCOE during normal operations at Any AOD | For any healthy SPS SIS. |

| Parameter | Conditions and Constraints |
|---|---|
| **Instantaneous URE Integrity**<br><br>Single-Frequency C/A-Code:<br><br>≤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.<br><br>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.<br><br>Given that the maximum SPS SIS instantaneous URE did not exceed the NTE tolerance at the start of the hour.<br><br>UMSI occurs if no timely alert issued after SPS SIS URE NTE tolerance exceeded.<br><br>Worst case for delayed alert is 6 hour.<br><br>Neglecting single-frequency ionospheric delay model errors. |
| **Instantaneous UTCOE Integrity**<br><br>Single-Frequency C/A-Code:<br><br>≤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.<br><br>SPS SIS UTCOE NTE tolerance defined to be ±120 ns.<br><br>Given that the maximum SPS SIS instantaneous URE did not exceed the NTE tolerance at the start of the hour.<br><br>Worst case for delayed alert is 6 hours. |
| **Unscheduled Failure Interruption Continuity**<br><br>Unscheduled Failure Interruptions:<br><br>≥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.<br><br>Given that the SPS SIS is available from the slot at the start of the hour. |
| **Status and Problem Reporting**<br>Scheduled event affecting service<br><br>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**<br>Unscheduled outage or problem affecting service<br>Appropriate NANU issued to the U.S. Coast Guard and the FAA as soon as possible after the event | For any SPS SIS. |
| **Per-Slot Availability**<br>≥0.957 Probability that a slot in the baseline 24-slot configuration will be occupied by a satellite broadcasting a healthy SPS SIS<br><br>≥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.<br><br>Applies to satellites broadcasting a healthy SPS SIS that also satisfy the other performance standards in the SPS performance standard. |
| **Constellation Availability**<br>≥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<br><br>≥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.<br><br>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**<br><br>≥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**<br><br>≥98% global PDOP of 6 or less<br><br>≥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**<br><br>≥99% Horizontal Service Availability, average location<br><br>≥99% Vertical Service Availability, average location | 15 m Horizontal (SIS only) 95% threshold.<br><br>33 m Vertical (SIS only) 95% threshold.<br><br>Defined for a position/time solution meeting the representative user conditions and operating within the service volume over any 24-hour interval. |
| **Service Availability**<br>≥90% Horizontal Service Availability, worst-case location<br><br>≥90% Vertical Service Availability, worst-case location | 15 m Horizontal (SIS only) 95% threshold.<br><br>33 m Vertical (SIS only) 95% threshold.<br><br>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**<br><br>Global Average Position Domain Accuracy:<br><br>• ≤8 m 95% Horizontal Error<br>• ≤13 m 95 % Vertical Error | Defined for a position/time solution meeting the representative user conditions.<br><br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |

| Parameter | Conditions and Constraints |
|---|---|
| **Position/Time Accuracy**<br>Worst Site Position Domain Accuracy:<br>• ≤15 m 95% Horizontal Error<br>• ≤33 m 95% Vertical Error | Defined for a position/time solution meeting the representative user conditions.<br><br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |
| **Position/Time Accuracy**<br>Time Transfer Domain Accuracy:<br><br>≤30 nanoseconds time transfer error 95% of time<br><br>(SIS only) | Defined for a position/time solution meeting the representative user conditions.<br><br>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<br><br>≥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 3.087 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%) |
|---|---|---|---|
| 12/29/2024 - 01/04/2025 | 3.0167 | 100 | 100 |
| 01/05/2025 - 01/11/2025 | 3.0633 | 100 | 100 |
| 01/12/2025 - 01/18/2025 | 3.0143 | 100 | 100 |
| 01/19/2025 - 01/25/2025 | 2.9151 | 100 | 100 |
| 01/26/2025 - 02/01/2025 | 2.8588 | 99.9999 | 99.9801 |
| 02/02/2025 - 02/08/2025 | 2.9088 | 99.9999 | 99.9107 |
| 02/09/2025 - 02/15/2025 | 2.8764 | 99.9999 | 99.8214 |
| 02/16/2025 - 02/22/2025 | 2.8416 | 99.9999 | 99.8115 |
| 02/23/2025 - 03/01/2025 | 2.8213 | 99.9999 | 99.9007 |
| 03/02/2025 - 03/08/2025 | 3.0867 | 99.9999 | 99.8511 |
| 03/09/2025 - 03/15/2025 | 3.0089 | 99.9999 | 99.9007 |
| 03/16/2025 - 03/22/2025 | 2.7853 | 99.9999 | 99.9305 |
| 03/23/2025 - 03/29/2025 | 2.7773 | 99.9999 | 99.9702 |
| 03/30/2025 - 04/05/2025 | 2.7745 | 100 | 100 |

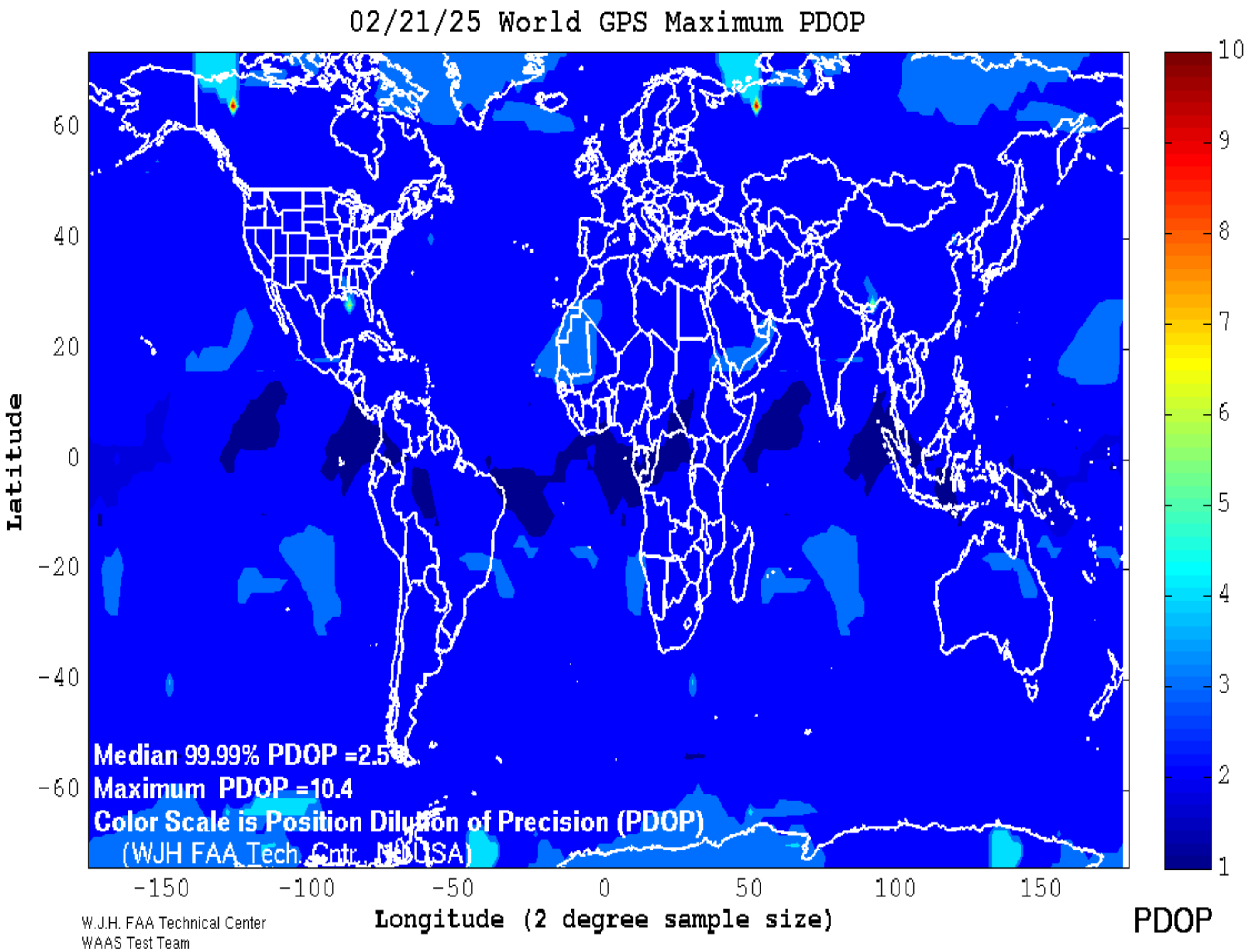



**Figure 2-1 World GPS Maximum PDOP**

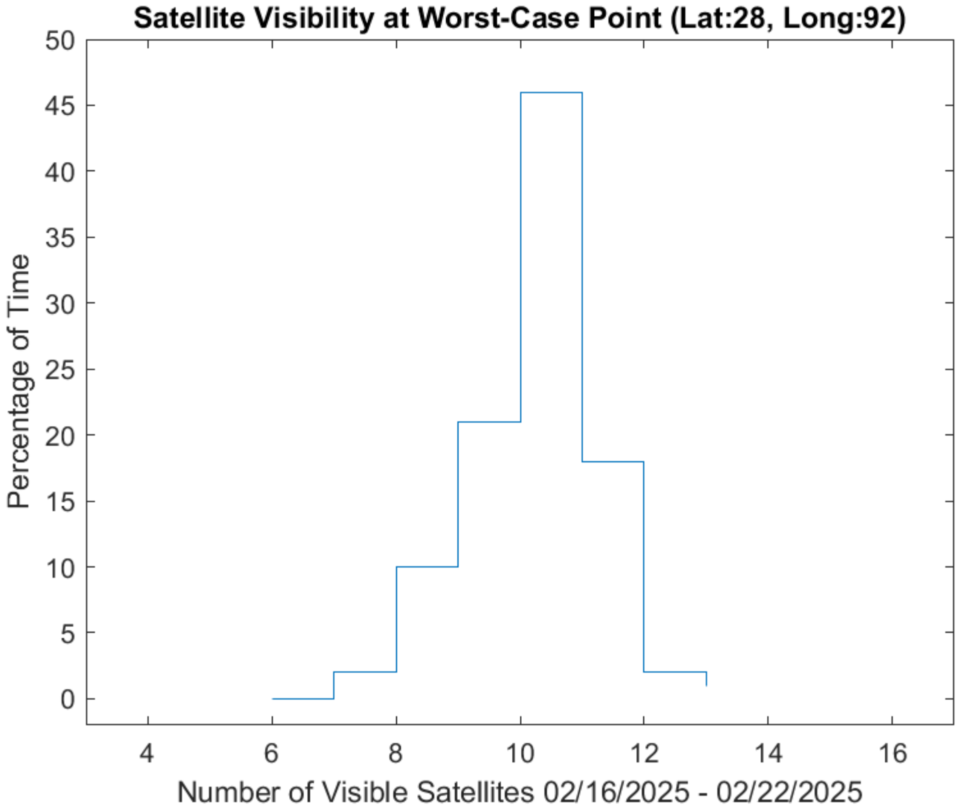



**Figure 2-2 Satellite Visibility Profile for Worst-Case Point**

# 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:<br>Appropriate NANU issued to the U.S. Coast Guard and the FAA at least 48 hours prior to the event | For any SPS SIS. |
| Unscheduled outage or problem affecting service:<br>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, January 1 through March 31, 2025, there were seven reported outages. Five outages were maintenance activities and were reported in advance, and two were unscheduled outages. A complete listing of outage NANUs for the reporting period is provided in Table 3-2. A complete listing 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 62.5 hours. The maximum response time following an unscheduled outage was 0.183 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 listing of the GPS constellation plane and slot designations is provided in Table 9-2. Figure 9-6 shows a graphical representation of the March 31, 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) |
|---|---|---|---|---|---|---|---|---|---|
| 2025002 | 10 | FCSTSUMM | Jan 09, 2025 | 10:04 | Jan 09. 2025 | 16:09 | 0 | 6.08 | 6.08 |
| 2025013 | 28 | FCSTSUMM | Feb 05, 2025 | 00:54 | Feb 05, 2025 | 08:31 | 0 | 7.62 | 7.62 |
| 2025014 | 2 | FCSTSUMM | Feb 07, 2025 | 02:24 | Feb 07, 2025 | 09:58 | 0 | 7.57 | 7.57 |
| 2025016 | 32 | FCSTSUMM | Feb 12, 2025 | 14:38 | Feb 12, 2025 | 20:57 | 0 | 6.32 | 6.32 |
| 2025020 | 8 | UNUSABLE | Mar 03, 2025 | 14:16 | Mar 03, 2025 | 16:09 | 1.88 | 0 | 1.88 |
| 2025023 | 8 | UNUSABLE | Mar 05, 2025 | 00:20 | Mar 11, 2025 | 22:39 | 166.32 | 0 | 166.32 |
| 2025024 | 6 | FCSTSUMM | Mar 11, 2025 | 19:52 | Mar 12, 2025 | 00:44 | 0 | 4.87 | 4.87 |
| Totals of Unscheduled, Scheduled, and Total Downtime | | | | | | | 168.2 | 32.46 | 200.66 |

**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 |
|---|---|---|---|---|---|---|---|---|
| 2025001 | 10 | FCSTDV | Jan 09, 2025 | 09:45 | Jan 09, 2025 | 21:45 | 12 | 2025002 |
| 2025009 | 28 | FCSTDV | Jan 31, 2025 | 00:45 | Jan 31, 2025 | 12:45 | 0 | 2025011 |
| 2025011 | 28 | FCSTRESCD | Feb 05, 2025 | 00:15 | Feb 05, 2025 | 12:15 | 12 | 2025013 |
| 2025012 | 2 | FCSTDV | Feb 07, 2025 | 02:15 | Feb 08, 2025 | 02:15 | 24 | 2025014 |
| 2025015 | 32 | FCSTDV | Feb 12, 2025 | 14:15 | Feb 13, 2025 | 02:15 | 12 | 2025016 |
| 2025018 | 6 | FCSTDV | Mar 06, 2025 | 19:45 | Mar 07, 2025 | 07:45 | 0 | 2025022 |
| 2025019 | 8 | UNUSUFN | Mar 03, 2025 | 14:16 | - | - | - | 2025020 |
| 2025021 | 8 | UNUSUFN | Mar 05, 2025 | 00:20 | - | - | - | 2025023 |
| 2025022 | 6 | FCSTRESCD | Mar 11, 2025 | 19:45 | Mar 12, 2025 | 07:45 | 12 | 2025024 |
| Total Forecasted Downtime | | | | | | | 72 | |

**Table 3-4 Canceled NANUs**

| NANU | PRN | TYPE | Start Date | Start Time (UTC) | Comments |
|---|---|---|---|---|---|
| 2025007 | 21 | FCSTCANC | Jan 23, 2025 | 19:00 | 2025004 |

**Table 3-5 GPS Satellite Maintenance Statistics**

| Satellite Reliability/Maintainability/Availability (RMA) Parameter | 01/01/2025 to 03/31/2025 | 01/01/2000 to 03/31/2025 |
|---|---|---|
| Total Forecasted Downtime (hrs) | 72 | 17095.9899 |
| Total Actual Downtime (hrs) | 200.66 | 45534.86 |
| Total Actual Scheduled Downtime (hrs) | 32.46 | 9469.04 |
| Total Actual Unscheduled Downtime(hrs) | 168.2 | 36065.82 |
| Total Satellite Observed MTTR (hrs) | 28.67 | 35.63 |
| Scheduled Satellite Observed (hrs) | 6.49 | 9.87 |
| Unscheduled Satellite Observed (hrs) | 84.1 | 113.06 |
| Total Satellite Outages (number) | 7 | 1278 |
| Scheduled Satellite Outages (number) | 5 | 959 |
| Unscheduled Satellite Outages (number) | 2 | 319 |
| Percent Operational—Scheduled Downtime (%) | 99.95 | 99.86 |
| Percent Operational—All Downtime (%) | 99.7 | 99.34 |

Satellite Reliability, Maintainability, and Availability (RMA) data is being 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<br><br>≥99% Vertical Service Availability, average location | 15 m Horizontal (SIS only) 95% threshold.<br>33 m Vertical (SIS only) 95% threshold.<br>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<br><br>≥90% Vertical Service Availability, worst-case location | 15 m Horizontal (SIS only) 95% threshold.<br>33 m Vertical (SIS only) 95% threshold.<br>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 January 1 and March 31, 2025.

**Table 3-7 Accuracies Exceeding Threshold Statistics**

| Site | Total Number of Seconds of SPS Monitoring | Instances of 24-hour Threshold Failures | January 2025–March 2025 Service Availability (%) |
|---|---|---|---|
| Billings | 7775165 | 0 | 100 |
| Albuquerque | 7775924 | 0 | 100 |
| Anchorage | 7771164 | 0 | 100 |
| Boston | 7775905 | 0 | 100 |
| Washington, DC | 7775943 | 0 | 100 |
| Honolulu | 7775915 | 0 | 100 |
| Honolulu | 7775915 | 0 | 100 |
| Houston | 7775945 | 0 | 100 |
| Kansas City | 7773445 | 0 | 100 |

| Site | Total Number of Seconds of SPS Monitoring | Instances of 24-hour Threshold Failures | January 2025–March 2025 Service Availability (%) |
|---|---|---|---|
| Los Angeles | 7775940 | 0 | 100 |
| Salt Lake City | 7775928 | 0 | 100 |
| Miami | 7775940 | 0 | 100 |
| Minneapolis | 7775941 | 0 | 100 |
| Oakland | 7775941 | 0 | 100 |
| Cleveland | 7775904 | 0 | 100 |
| Seattle | 7775942 | 0 | 100 |
| San Juan | 7739579 | 0 | 100 |
| Atlanta | 7775941 | 0 | 100 |
| Juneau | 7773380 | 0 | 100 |
| Cold Bay | 7721526 | 0 | 100 |
| Fairbanks | 7775521 | 0 | 100 |
| Bethel | 7775525 | 0 | 100 |
| Kotzebue | 7769220 | 0 | 100 |
| Barrow | 7775145 | 0 | 100 |
| Barrow | 7775145 | 0 | 100 |
| Gander | 7775497 | 0 | 100 |
| Tapachula | 6696972 | 0 | 100 |
| San Jose Del Cabo | 6055462 | 0 | 100 |
| Iqaluit | 7688275 | 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:<br>• ≤30 m 99.94% Global Average URE during normal operations<br>• ≤30 m 99.79% Worst Case single point average during normal operations | For any healthy SPS SIS.<br>Neglecting single-frequency ionospheric delay model errors.<br>Including group delay time correction ($T_{GD}$) errors at L1.<br>Including inter-signal bias (P(Y)-code to C/A-code) errors at L1.<br>Standard based on measurement interval of one year; average of daily values within service volume.<br>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 38.320 meters on satellite PRN25.

**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 (%) |
|---|---|---|---|---|
| January 1–March 31, 2025 | Boston | 64844734 | 0 | 100% |
| January 2–March 31, 2025 | Honolulu | 65384272 | 184149 | 99.72% |
| January 1–March 31, 2025 | Juneau | 67795778 | 0 | 100% |
| January 1–March 31, 2025 | Los Angeles | 65672855 | 0 | 100% |
| February 6–March 31, 2025 | Merida | 38369764 | 139630 | 99.64% |
| January 1–March 31, 2025 | Miami | 66246713 | 0 | 100% |
| January 1–March 31, 2025 | Global | 368314116 | 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**<br>Global Average Position Domain Accuracy:<br>• ≤8 m 95% Horizontal Error<br>• ≤13 m 95 % Vertical Error | Defined for a position/time solution meeting the representative user conditions.<br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |
| **Position/Time Accuracy**<br>Worst Site Position Domain Accuracy:<br>• ≤15 m 95% Horizontal Error<br>• ≤33 m 95% Vertical Error | Defined for a position/time solution meeting the representative user conditions.<br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |
| **Position/Time Accuracy**<br>Time Transfer Domain Accuracy:<br>≤30 nanoseconds time transfer error 95% of time (SIS only) | Defined for a time transfer solution meeting the representative user conditions.<br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |
| **User Range Error Accuracy**<br>Single-Frequency C/A-Code<br>• ≤7.0 m 95% Global Average URE during normal operations over All AODs<br>• ≤3.8 m 95% Global Average URE during operations at Zero AOD<br>• ≤9.7 m 95% Global Average URE during normal operations at Any AOD | For any healthy SPS SIS.<br>Neglecting single-frequency ionospheric delay model errors.<br>Including group delay time correction ($T_{GD}$) errors at L1.<br>Including inter-signal bias (P(Y)-code to C/A-code) errors at L1.<br>Including Inter-Signal Correction (ISC) errors. |

| Position/Time Accuracy | Conditions and Constraints |
| --- | --- |
| **User Range Rate Error Accuracy**<br>Single-Frequency C/A Code:<br><br>≤6 mm/sec 95% Global Average URRE over any 3-second interval during normal operations at Any AOD | For any healthy SPS SIS.<br>Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers.<br>Neglecting single-frequency ionospheric delay model errors. |
| **User Range Acceleration Error Accuracy**<br>Single-Frequency C/A Code:<br><br>≤2 mm/sec$^2$ 95% Global Average URAE over any 3-second interval during normal operations at Any AOD | For any healthy SPS SIS.<br>Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers.<br>Neglecting single-frequency ionospheric delay model errors. |
| **Coordinated Universal Time Offset Error Accuracy**<br><br>≤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 January 1 through March 31, 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 | 5.14 | 2.68 | 10.29 | 14.38 |
| Anchorage | 7.11 | 3.01 | 13.84 | 6.28 |
| Atlanta | 4.97 | 2.59 | 10.12 | 8.92 |
| Barrow | 9.08 | 3.37 | 20.26 | 6.89 |
| Bethel | 7.72 | 2.74 | 14.35 | 6.38 |
| Billings | 5.03 | 2.5 | 10.33 | 6.15 |
| Boston | 5.02 | 2.79 | 16.91 | 13.4 |

| | | | | |
|---|---|---|---|---|
| Cleveland | 4.51 | 2.57 | 17.73 | 9.51 |
| Cold Bay | 7.12 | 2.51 | 12.91 | 7.26 |
| Fairbanks | 7.73 | 3.28 | 16.98 | 6.67 |
| Gander | 5.46 | 2.88 | 11.02 | 20.37 |
| Honolulu | 7.73 | 12 | 16.5 | 17.39 |
| Houston | 5.26 | 2.95 | 10.87 | 9.05 |
| Iqaluit | 6.01 | 4.24 | 17.51 | 10.50 |
| Juneau | 5.92 | 2.96 | 12.02 | 7.31 |
| Kansas City | 4.55 | 2.55 | 9.47 | 10.14 |
| Kotzebue | 8.55 | 3.20 | 16.75 | 6.60 |
| Los Angeles | 5.96 | 3.12 | 12.03 | 14.83 |
| Merida | 8.37 | 5.49 | 28.75 | 16.26 |
| Miami | 5.90 | 3.72 | 17.33 | 8.97 |
| Minneapolis | 4.45 | 2.56 | 10.21 | 7.17 |
| Oakland | 6.07 | 3 | 11.91 | 14.41 |
| Salt Lake City | 5.52 | 2.58 | 11.79 | 9.70 |
| San Jose Del Cabo | 7.24 | 5.79 | 24.09 | 15.55 |
| San Juan | 12.14 | 8.44 | 34.72 | 23.47 |
| Seattle | 5.74 | 2.32 | 11.20 | 7.20 |
| Tapachula | 9.54 | 7.95 | 28.5 | 18.87 |
| Washington, DC | 4.73 | 2.62 | 8.85 | 12.59 |

Figure 5-1 and Figure 5-2 are the combined histograms of the vertical and horizontal errors for all 28 WAAS sites from January 1 to March 31, 2025.

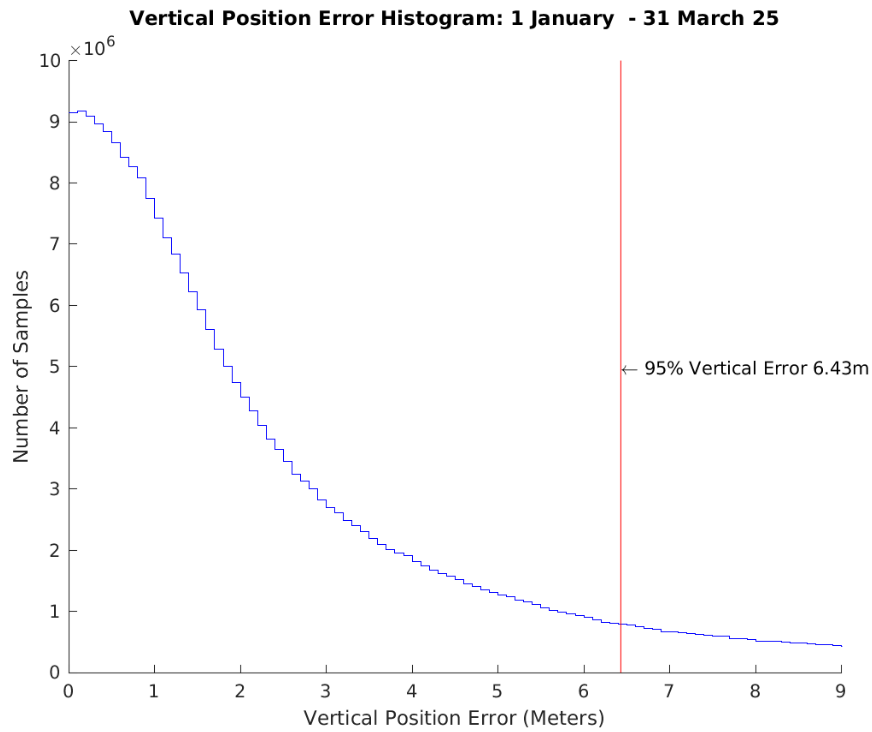



**Figure 5-1 Global Vertical Error Histogram**

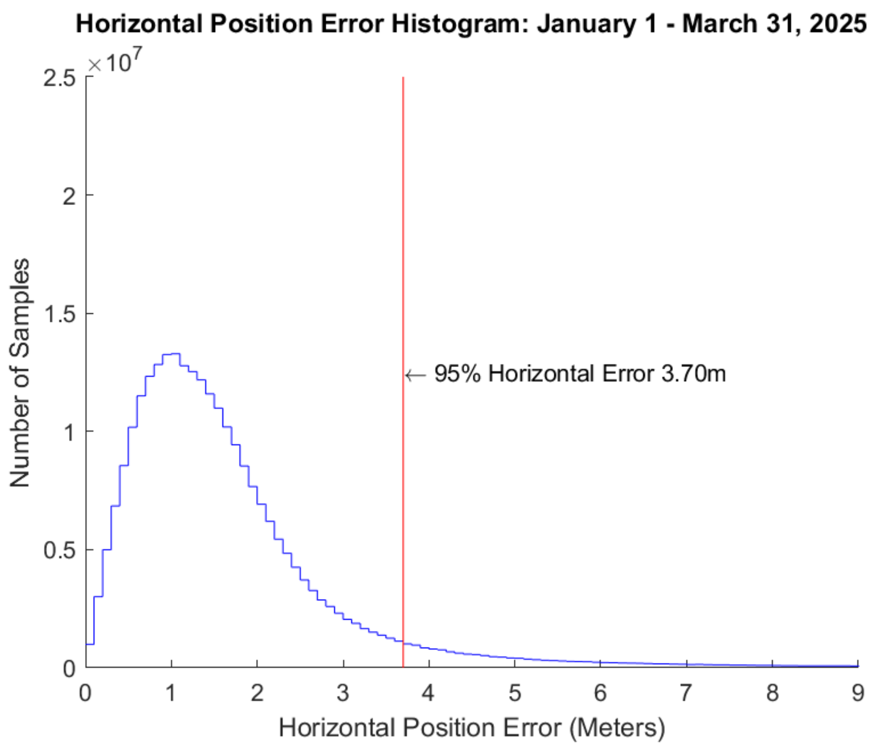



**Figure 5-2 Global Horizontal Error Histogram**

## 5.2 Time Transfer Accuracy

The GPS time error data between January 1 and March 31, 2025 was downloaded from the USNO website. 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 was 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 was then plotted to form the histogram in Figure 5-3. The maximum instantaneous UTC offset error (UTCOE) for the quarter was 12.1 nanoseconds. The mean, standard deviation, and 95% index of Time Transfer Error, and the maximum UTCOE are all within the requirements of GPS SPS time error.

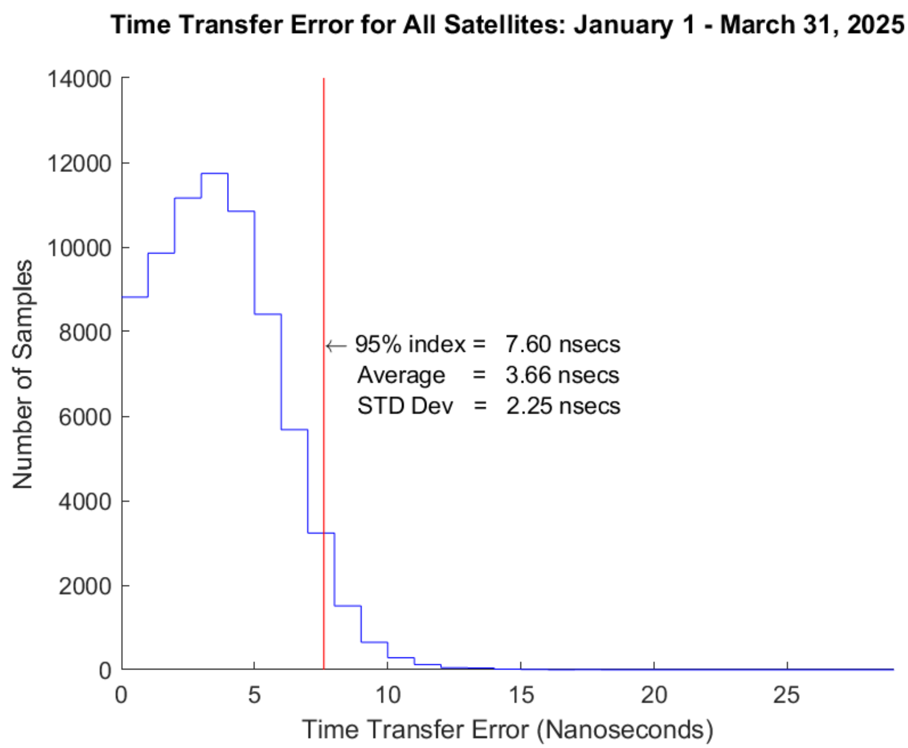



**Figure 5-3 Time Transfer Error**

## 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 January 1 and March 31, 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 | 3.27 | -2.3 | 2.04 | 5.94 | 19.95 | 9733994 |
| 2 | 2.44 | 0.33 | 2.0 | 4.64 | 22.65 | 12559044 |
| 3 | 2.26 | -0.36 | 2.04 | 4.53 | 26.18 | 12638747 |
| 4 | 2.12 | 0.4 | 1.82 | 4.36 | 30.82 | 11513745 |
| 5 | 2.81 | 0.5 | 2.44 | 5.61 | 29.31 | 12419514 |
| 6 | 2.81 | -0.01 | 2.25 | 5.23 | 20.69 | 12435554 |
| 7 | 2.17 | 0.12 | 1.58 | 4.03 | 27.24 | 11335255 |
| 8 | 2.44 | 0.21 | 2.05 | 4.49 | 30.07 | 10570992 |
| 9 | 2.23 | 0.39 | 1.92 | 4.66 | 33.06 | 12072020 |
| 10 | 2.79 | -0.06 | 2.28 | 5.33 | 25.27 | 11626893 |
| 11 | 3.04 | 0.41 | 2.42 | 5.85 | 23.8 | 12758514 |
| 12 | 2.74 | 0.14 | 2.22 | 4.89 | 29.81 | 12427041 |
| 13 | 2.21 | 0.26 | 1.89 | 4.37 | 22.39 | 12034282 |
| 14 | 2.51 | 0.03 | 1.71 | 4.37 | 23.54 | 11610677 |
| 15 | 2.17 | 0.28 | 1.86 | 4.15 | 31.52 | 11342045 |
| 16 | 2.49 | 0.98 | 2.05 | 4.55 | 25.14 | 11351010 |
| 17 | 2.8 | -0.03 | 2.08 | 5.08 | 22.29 | 12919562 |
| 18 | 2.83 | -0.41 | 2.08 | 5.14 | 24.34 | 11436370 |
| 19 | 3.07 | 1.08 | 2.11 | 5.42 | 20.66 | 12603035 |
| 20 | 2.81 | 1.22 | 2.14 | 5.33 | 25.67 | 12177734 |
| 21 | 2.33 | 1.21 | 1.78 | 4.38 | 18.06 | 3382606 |
| 22 | 2.56 | 0.22 | 1.72 | 4.41 | 18.57 | 9053499 |
| 23 | 2.61 | -0.23 | 2.08 | 4.93 | 25.16 | 11841018 |
| 24 | 2.63 | -0.21 | 2.33 | 5.12 | 27.71 | 12175060 |
| 25 | 2.89 | 0.33 | 2.47 | 5.44 | 38.32 | 12479157 |
| 26 | 2.61 | 0.84 | 2.23 | 4.92 | 27.76 | 11387204 |
| 27 | 2.62 | 0.08 | 2.37 | 5.14 | 30.31 | 11827621 |
| 28 | 2.44 | 0.21 | 2.2 | 4.85 | 24.3 | 12365821 |
| 29 | 2.75 | 0.03 | 2.09 | 5.07 | 21.6 | 11721138 |

| 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) |
|---|---|---|---|---|---|---|
| 30 | 2.25 | 0.41 | 1.67 | 4.03 | 26.36 | 11539232 |
| 31 | 2.43 | 0.55 | 2.14 | 4.83 | 28.76 | 12463348 |
| 32 | 2.58 | 0.03 | 2.32 | 5.09 | 31.86 | 12779473 |

**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 | 2.25 | 4.37 | 102.9 | 9733994 |
| 2 | 2.3 | 4.45 | 92.55 | 12559044 |
| 3 | 2.39 | 4.77 | 120.28 | 12638747 |
| 4 | 2.12 | 4.16 | 121.91 | 11513745 |
| 5 | 2.82 | 5.45 | 202.58 | 12419514 |
| 6 | 2.36 | 4.63 | 135.11 | 12435554 |
| 7 | 2.28 | 4.43 | 115.57 | 11335255 |
| 8 | 2.26 | 4.41 | 82.4 | 10570992 |
| 9 | 2.28 | 4.58 | 96.94 | 12072020 |
| 10 | 2.36 | 4.59 | 119.49 | 11626893 |
| 11 | 2.47 | 4.78 | 150.92 | 12758514 |
| 12 | 2.59 | 4.97 | 221.08 | 12427041 |
| 13 | 2.48 | 4.85 | 127.57 | 12034282 |
| 14 | 2.19 | 4.33 | 53.89 | 11610677 |
| 15 | 2.45 | 4.75 | 130.02 | 11342045 |
| 16 | 2.35 | 4.53 | 168.63 | 11351010 |
| 17 | 2.39 | 4.7 | 96.63 | 12919562 |
| 18 | 2.41 | 4.57 | 282.1 | 11436370 |
| 19 | 2.45 | 4.78 | 168.06 | 12603035 |
| 20 | 2.49 | 4.79 | 178.76 | 12177734 |
| 21 | 2.49 | 4.8 | 72.46 | 3382606 |
| 22 | 2.25 | 4.4 | 106.84 | 9053499 |
| 23 | 2.45 | 4.72 | 242.87 | 11841018 |

| PRN | Range Rate Error RMS (mm/s) | 95% Range Rate Error (mm/s) | Max Range Rate Error (mm/s) | Samples (Number) |
|---|---|---|---|---|
| 24 | 2.42 | 4.77 | 138.48 | 12175060 |
| 25 | 2.55 | 4.92 | 132.9 | 12479157 |
| 26 | 2.34 | 4.43 | 265.38 | 11387204 |
| 27 | 2.26 | 4.45 | 125.92 | 11827621 |
| 28 | 2.41 | 4.52 | 283.86 | 12365821 |
| 29 | 2.47 | 4.68 | 132.59 | 11721138 |
| 30 | 2.13 | 4.26 | 65.15 | 11539232 |
| 31 | 2.47 | 4.72 | 214.75 | 12463348 |
| 32 | 2.42 | 4.71 | 173.75 | 12779473 |

**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 | 17.3 | 33.41 | 1020 | 9733994 |
| 2 | 18.68 | 34.56 | 920 | 12559044 |
| 3 | 17.48 | 34.23 | 1210 | 12638747 |
| 4 | 15.72 | 32.07 | 1210 | 11513745 |
| 5 | 22.78 | 41.23 | 2020 | 12419514 |
| 6 | 17.72 | 33.7 | 1340 | 12435554 |
| 7 | 18.35 | 34.4 | 1140 | 11335255 |
| 8 | 16.48 | 33.93 | 820 | 10570992 |
| 9 | 16.75 | 32.79 | 950 | 12072020 |
| 10 | 17.27 | 34.62 | 1180 | 11626893 |
| 11 | 18.74 | 34.3 | 1500 | 12758514 |
| 12 | 19.96 | 35.88 | 2190 | 12427041 |
| 13 | 19.91 | 36.18 | 1280 | 12034282 |
| 14 | 16.92 | 33.45 | 540 | 11610677 |
| 15 | 20.19 | 35.3 | 1310 | 11342045 |
| 16 | 19.75 | 35.17 | 1660 | 11351010 |
| 17 | 19.24 | 35.82 | 970 | 12919562 |

| PRN | Rate Acceleration Error RMS (um/s^2) | 95% Range Acceleration Error (um/s^2) | Max Range Acceleration Error (um/s^2) | Samples (Number) |
|---|---|---|---|---|
| 18 | 18.18 | 34.04 | 2820 | 11436370 |
| 19 | 19.35 | 35.81 | 1530 | 12603035 |
| 20 | 19.86 | 35.23 | 1800 | 12177734 |
| 21 | 21.4 | 38.11 | 730 | 3382606 |
| 22 | 18.0 | 34.1 | 1070 | 9053499 |
| 23 | 18.79 | 35.52 | 2370 | 11841018 |
| 24 | 17.61 | 33.99 | 1320 | 12175060 |
| 25 | 18.8 | 34.88 | 1320 | 12479157 |
| 26 | 17.87 | 34.44 | 2640 | 11387204 |
| 27 | 16.6 | 33.31 | 1220 | 11827621 |
| 28 | 18.23 | 34.8 | 2840 | 12365821 |
| 29 | 19.2 | 34.07 | 1340 | 11721138 |
| 30 | 15.37 | 31.47 | 650 | 11539232 |
| 31 | 19.44 | 35.55 | 2150 | 12463348 |
| 32 | 17.54 | 35.16 | 1690 | 12779473 |

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 PRN25 with an error of 38.320 meters. PRN23 had the lowest maximum range error of 18.060 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.

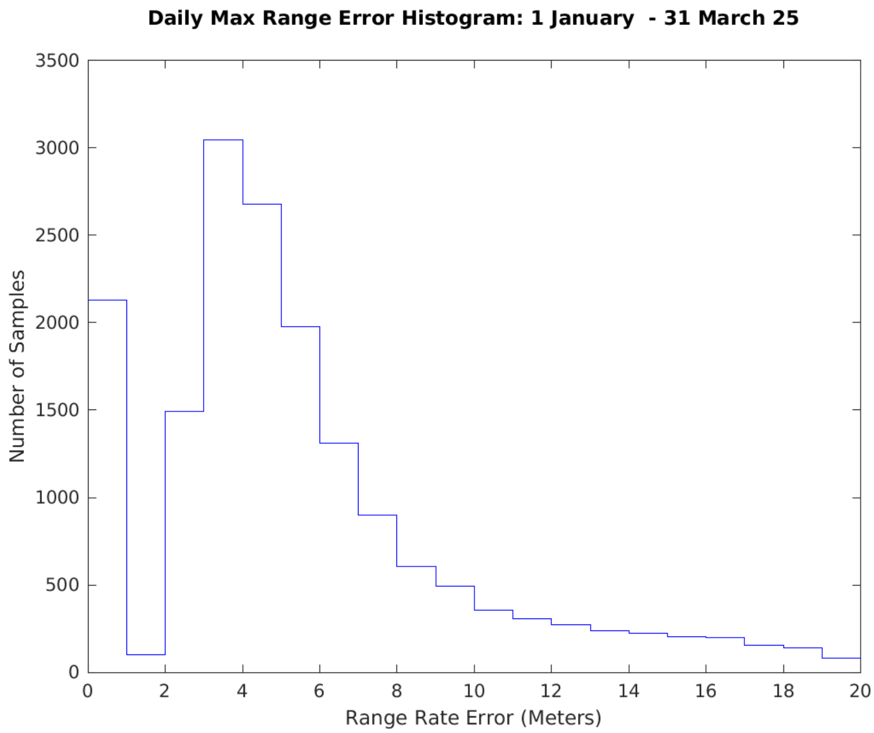



**Figure 5-4 Distribution of Daily Max Range Errors**

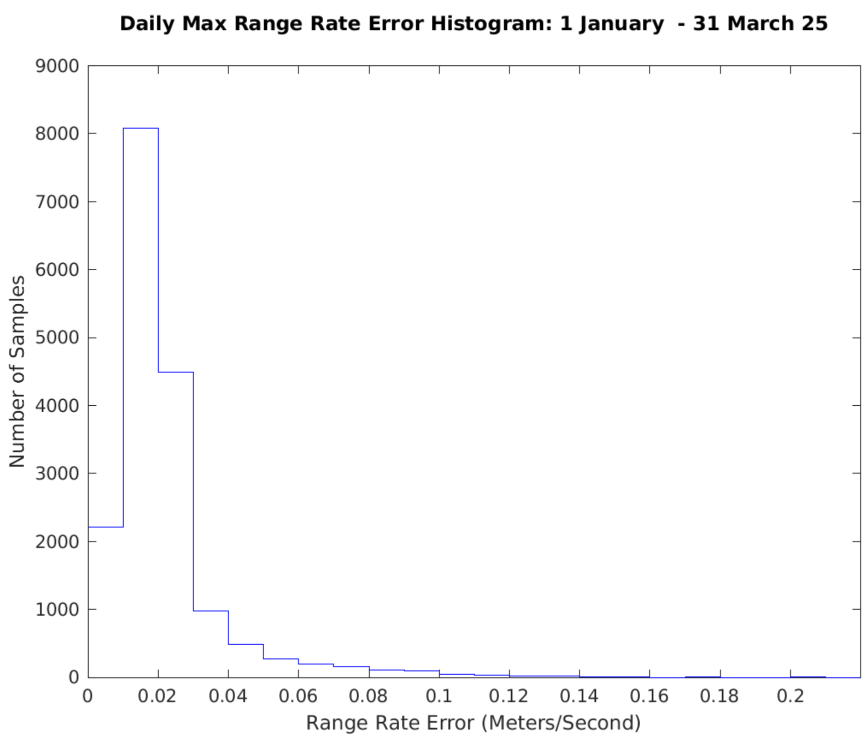



**Figure 5-5 Distribution of Daily Max Range Rate Errors**

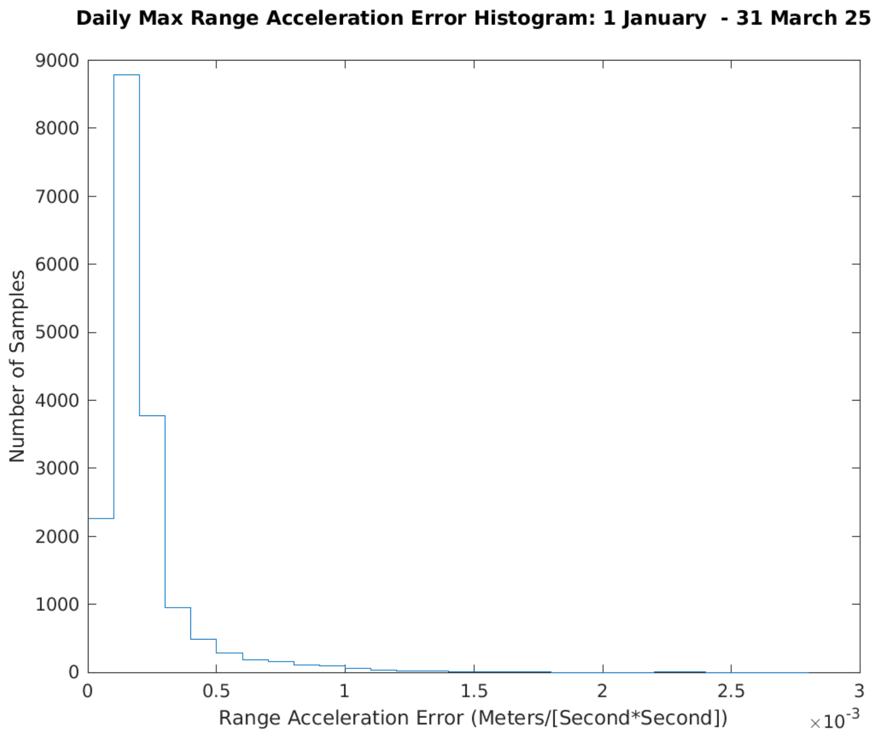



**Figure 5-6 Distribution of Daily Max Range Acceleration Errors**

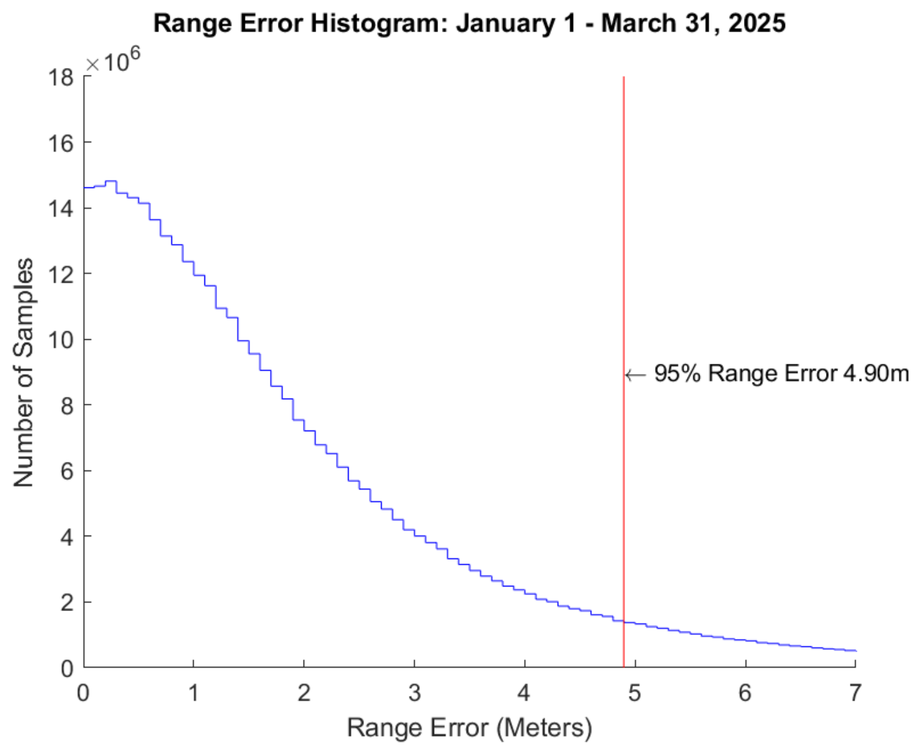



**Figure 5-7 Range Error Histogram**

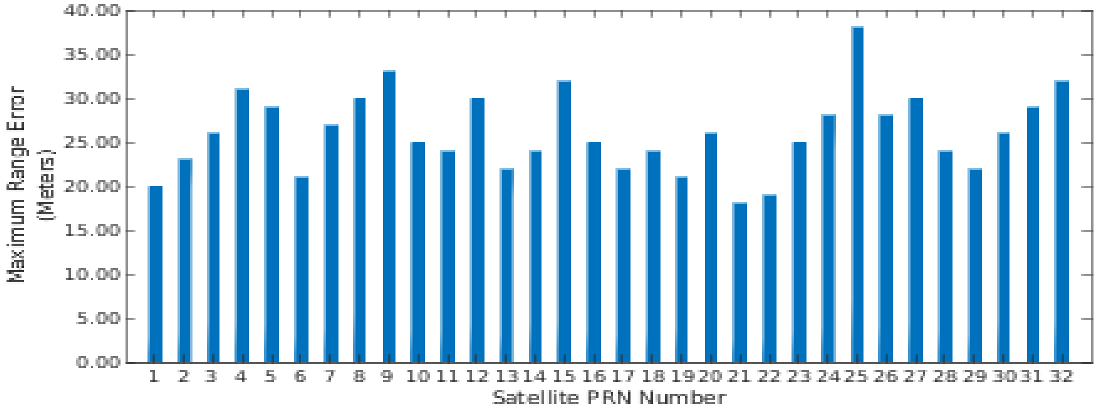



**Figure 5-8 Maximum Range Error Per Satellite**

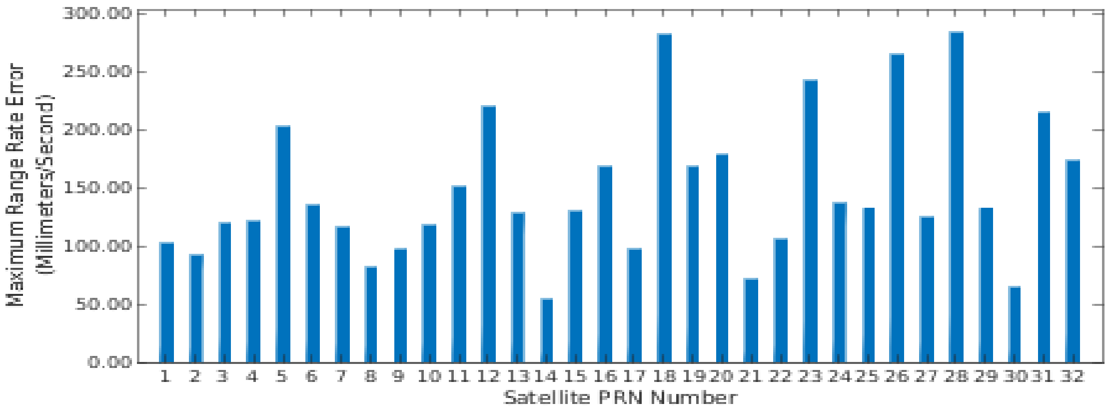



**Figure 5-9 Maximum Range Rate Error Per Satellite**

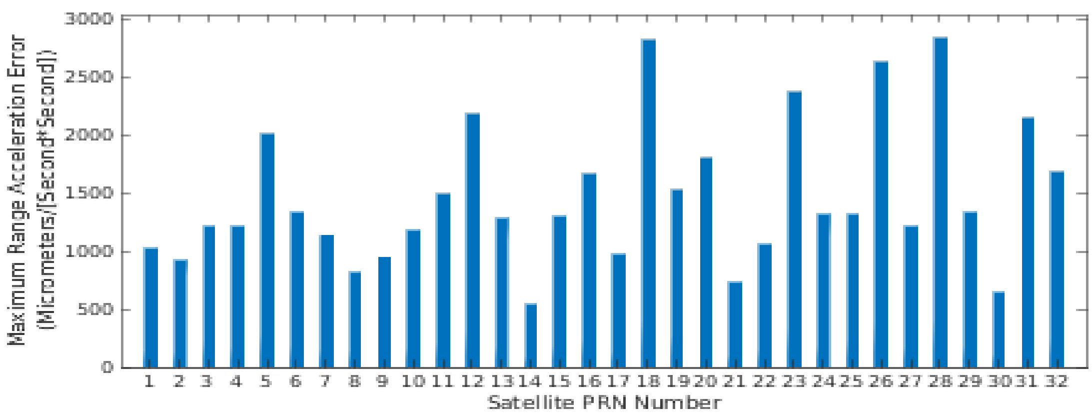



**Figure 5-10 Maximum Range Acceleration Error Per Satellite**

# 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: Geomagnetic Data for the actual geomagnetic data for this reporting period.)

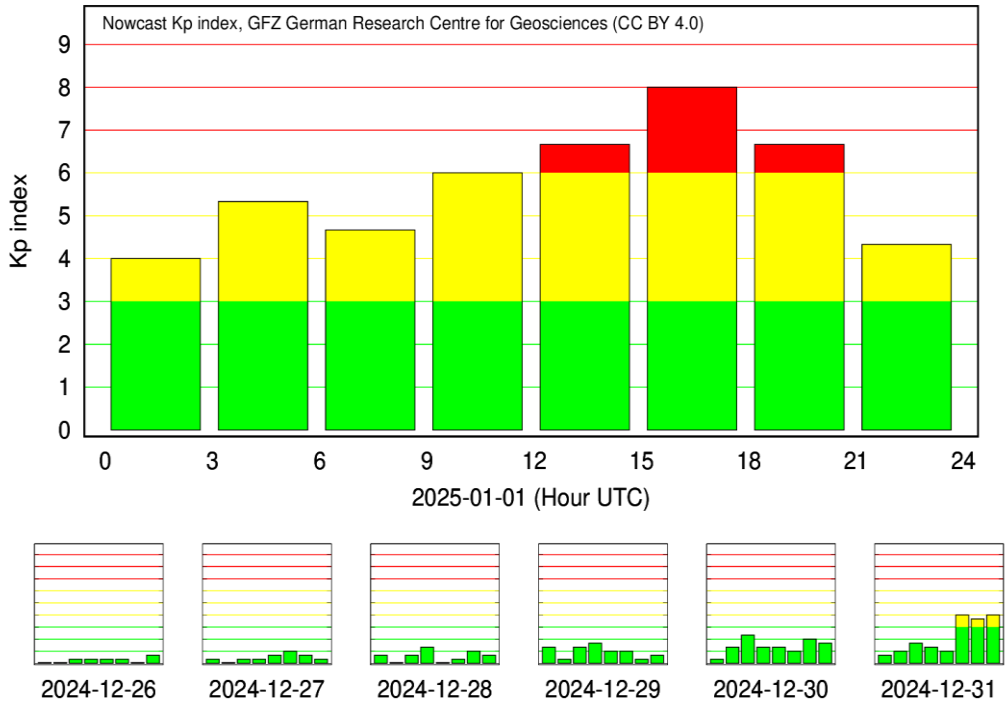



**Figure 6-1 K-Index for January 1, 2025**

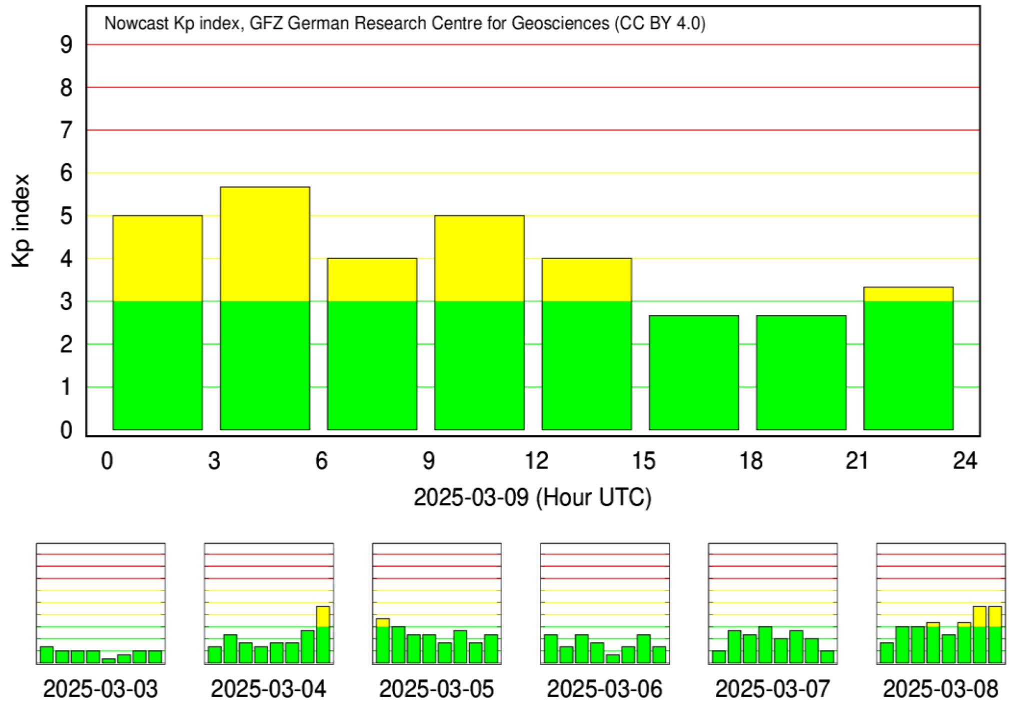



**Figure 6-2 K-Index for March 9, 2025**

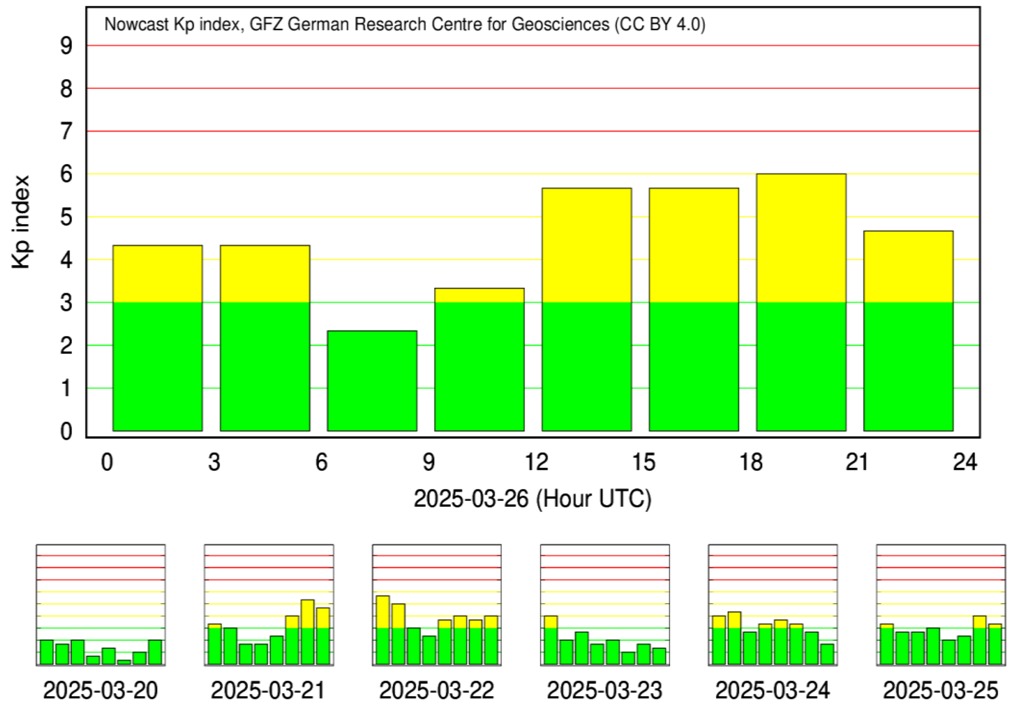



**Figure 6-3 K-Index for March 26, 2025**

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

**Table 6-1 Horizontal and Vertical Accuracy Statistics for January 1, 2025**

| Site | 95% Horizontal (m) | 95% Vertical (m) | Max Horizontal (m) | Max Vertical (m) |
|---|---|---|---|---|
| Albuquerque | 1.795 | 5.292 | 2.068 | 6.773 |
| Anchorage | 2.086 | 5.986 | 2.902 | 7.13 |
| Atlanta | 2.619 | 3.579 | 3.009 | 6.083 |
| Barrow | 2.391 | 7.245 | 3.251 | 9.156 |
| Bethel | 1.771 | 6.872 | 2.616 | 8.036 |
| Billings | 1.87 | 4.533 | 2.425 | 5.742 |
| Boston | 2.815 | 3.226 | 3.192 | 4.598 |
| Cleveland | 2.427 | 4.365 | 2.692 | 6.168 |
| Cold Bay | 1.764 | 6.614 | 2.693 | 7.772 |
| Fairbanks | 2.063 | 6.534 | 2.859 | 7.722 |
| Gander | 2.901 | 1.978 | 3.802 | 3.28 |
| Honolulu | 11.281 | 5.174 | 13.286 | 9.221 |
| Houston | 2.602 | 5.249 | 3.603 | 7.327 |
| Iqaluit | 6.641 | 5.189 | 7.723 | 7.437 |
| Juneau | 3.104 | 5.386 | 4.846 | 6.336 |
| Kansas City | 1.846 | 4.71 | 2.239 | 7.353 |
| Kotzebue | 2.171 | 6.954 | 2.47 | 8.109 |
| Los Angeles | 1.994 | 4.804 | 2.355 | 6.203 |
| Merida | 4.152 | 6.942 | 6.598 | 12.265 |
| Miami | 2.611 | 4.109 | 4.024 | 5.628 |
| Minneapolis | 1.919 | 4.532 | 2.199 | 5.797 |
| Oakland | 1.915 | 4.844 | 2.257 | 5.86 |
| Salt Lake City | 1.719 | 4.539 | 2.012 | 5.799 |
| San Jose Del Cabo | 5.005 | 8.448 | 7.331 | 21.261 |
| San Juan | 7.944 | 11.976 | 9.867 | 17.684 |
| Seattle | 1.478 | 4.647 | 2.044 | 5.865 |
| Tapachula | 6.388 | 9.476 | 9.552 | 12.296 |
| Washington, DC | 2.725 | 4.233 | 3.205 | 6.105 |

## 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 is 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).

Table 7-1 and Figure 7-1 show the IGS site information and locations. IGS data was not processed for this evaluation period.

**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 |
| SUTM | Sutherland | South Africa |

[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

| ID | City | Country |
|---|---|---|
| TIDB | Tidbinbilla | Australia |
| UNSA | Salta | Argentina |
| USUD | Usuda | Japan |

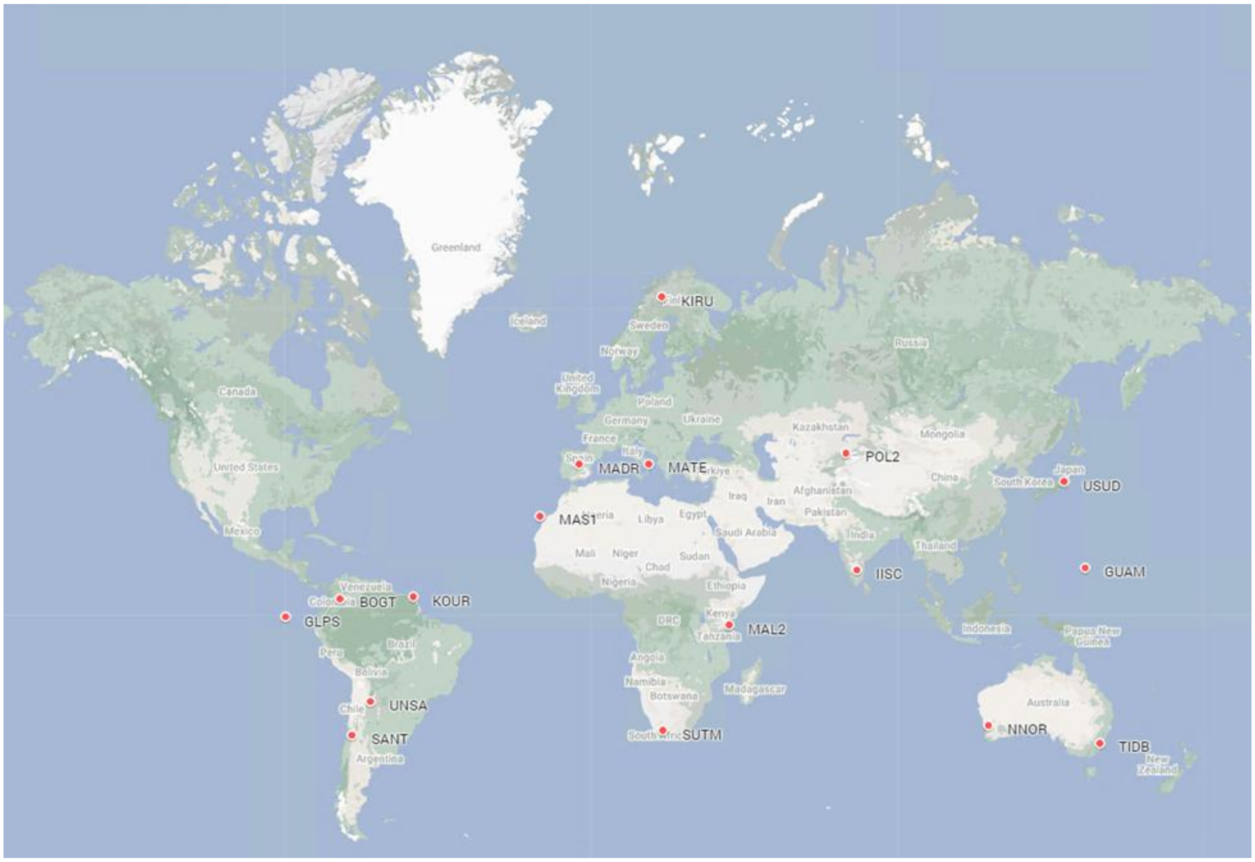



**Figure 7-1 Selected IGS Site Locations**

# 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 99.858% at Bethel. The minimum percent of time spent in RNP 0.3 mode was 99.999 at Gander. The maximum 99% HPL value was 130.635 meters at Juneau.

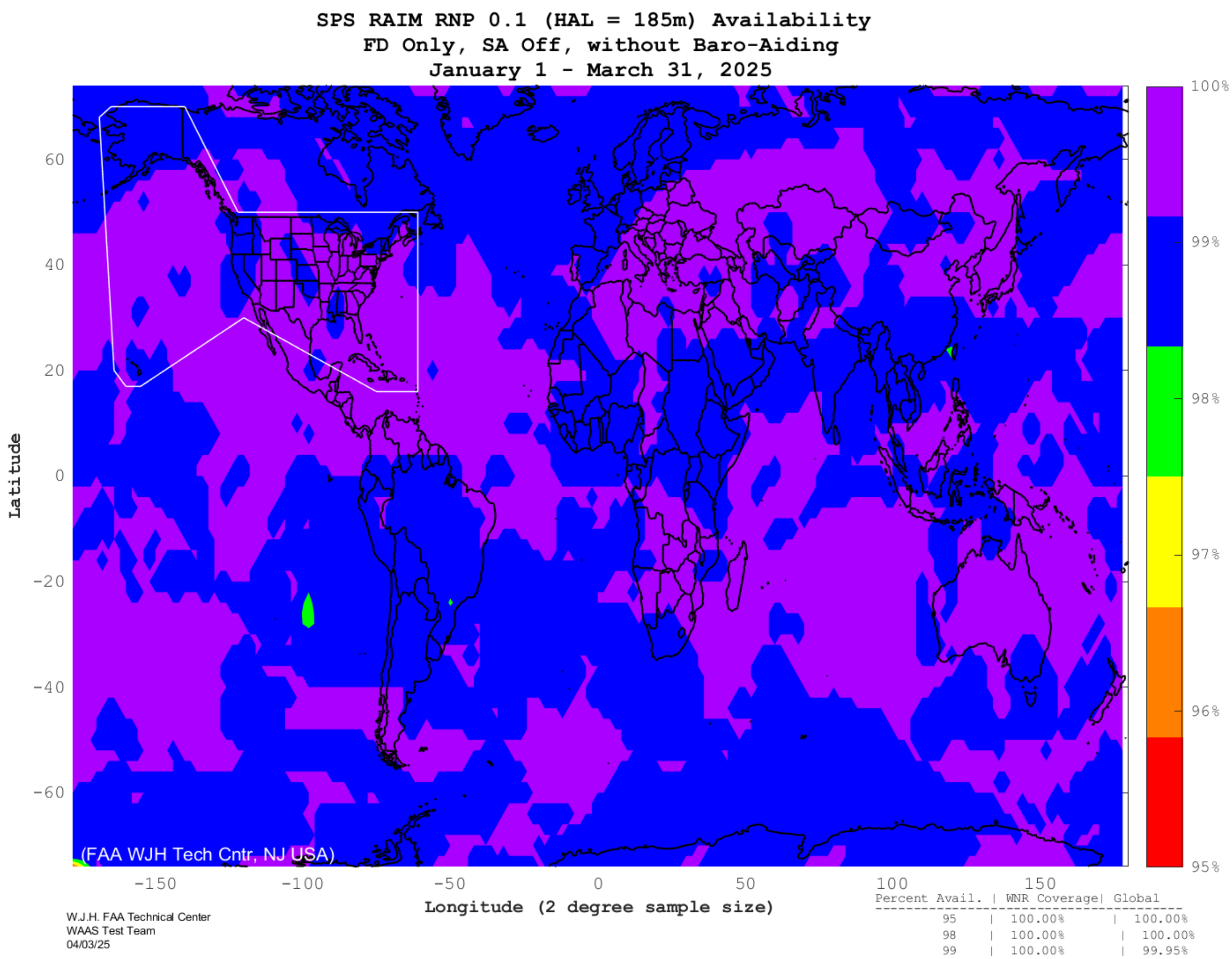
**Table 8-1 RAIM Site Statistics**

| City | 99% HPL (m) | RNP 0.1 (%) | RNP 0.3 (%) |
|---|---|---|---|
| Albuquerque | 87.695 | 100 | 100 |
| Anchorage | 123.686 | 99.92631 | 100 |
| Atlanta | 97.709 | 100 | 100 |
| Barrow | 119.293 | 99.90649 | 100 |
| Bethel | 129.037 | 99.85834 | 100 |

| City | 99% HPL (m) | RNP 0.1 (%) | RNP 0.3 (%) |
|---|---|---|---|
| Billings | 106.09 | 100 | 100 |
| Boston | 115.646 | 100 | 100 |
| Cleveland | 109.715 | 99.99937 | 100 |
| Cold Bay | 104.192 | 99.95684 | 100 |
| Fairbanks | 127.806 | 99.8752 | 100 |
| Gander | 125.221 | 99.99048 | 99.99887 |
| Honolulu | 104.783 | 99.9961 | 100 |
| Houston | 76.83 | 100 | 100 |
| Iqaluit | 127.353 | 99.91799 | 100 |
| Juneau | 130.635 | 99.99471 | 100 |
| Kansas City | 117.05 | 100 | 100 |
| Kotzebue | 123.924 | 99.88329 | 100 |
| Los Angeles | 90.896 | 100 | 100 |
| Merida | 80.785 | 100 | 100 |
| Miami | 77.273 | 100 | 100 |
| Minneapolis | 114.954 | 100 | 100 |
| Oakland | 88.19 | 99.99519 | 100 |
| Salt Lake City | 96.888 | 100 | 100 |
| San Jose Del Cabo | 76.723 | 100 | 100 |
| San Juan | 85.462 | 99.9993 | 100 |
| Seattle | 110.943 | 99.95405 | 100 |
| Tapachula | 85.463 | 100 | 100 |
| Washington, DC | 100.165 | 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 January 1 and March 31, 2025.




| Percent Avail. | WNR Coverage | Global |
|---|---|---|
| 95 | 100.00% | 100.00% |
| 98 | 100.00% | 100.00% |
| 99 | 100.00% | 99.95% |
| 100 | 74.42% | 49.14% |

**Figure 8-1 RAIM RNP 0.1 Coverage**

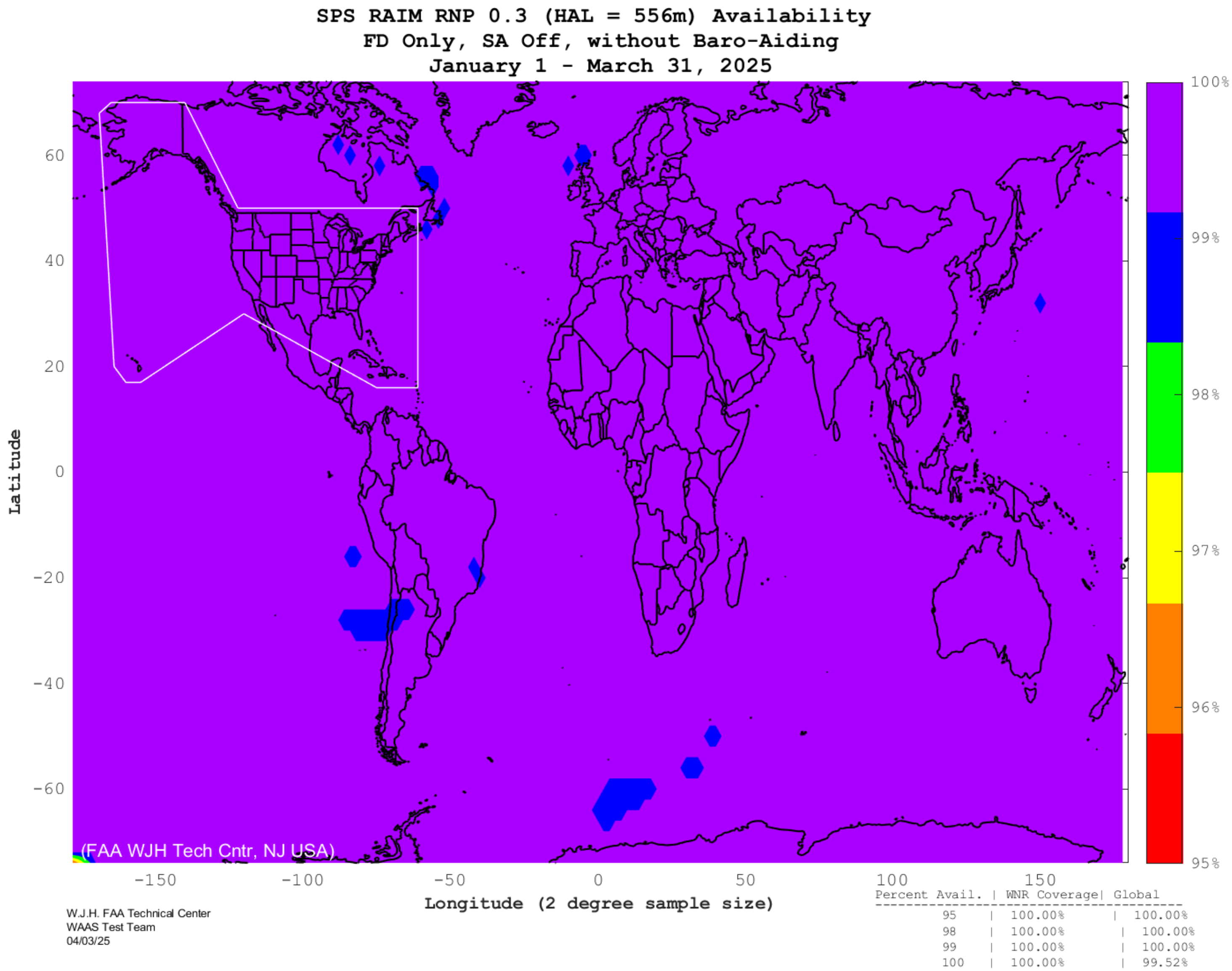



**Figure 8-2 RAIM RNP 0.3 Coverage**

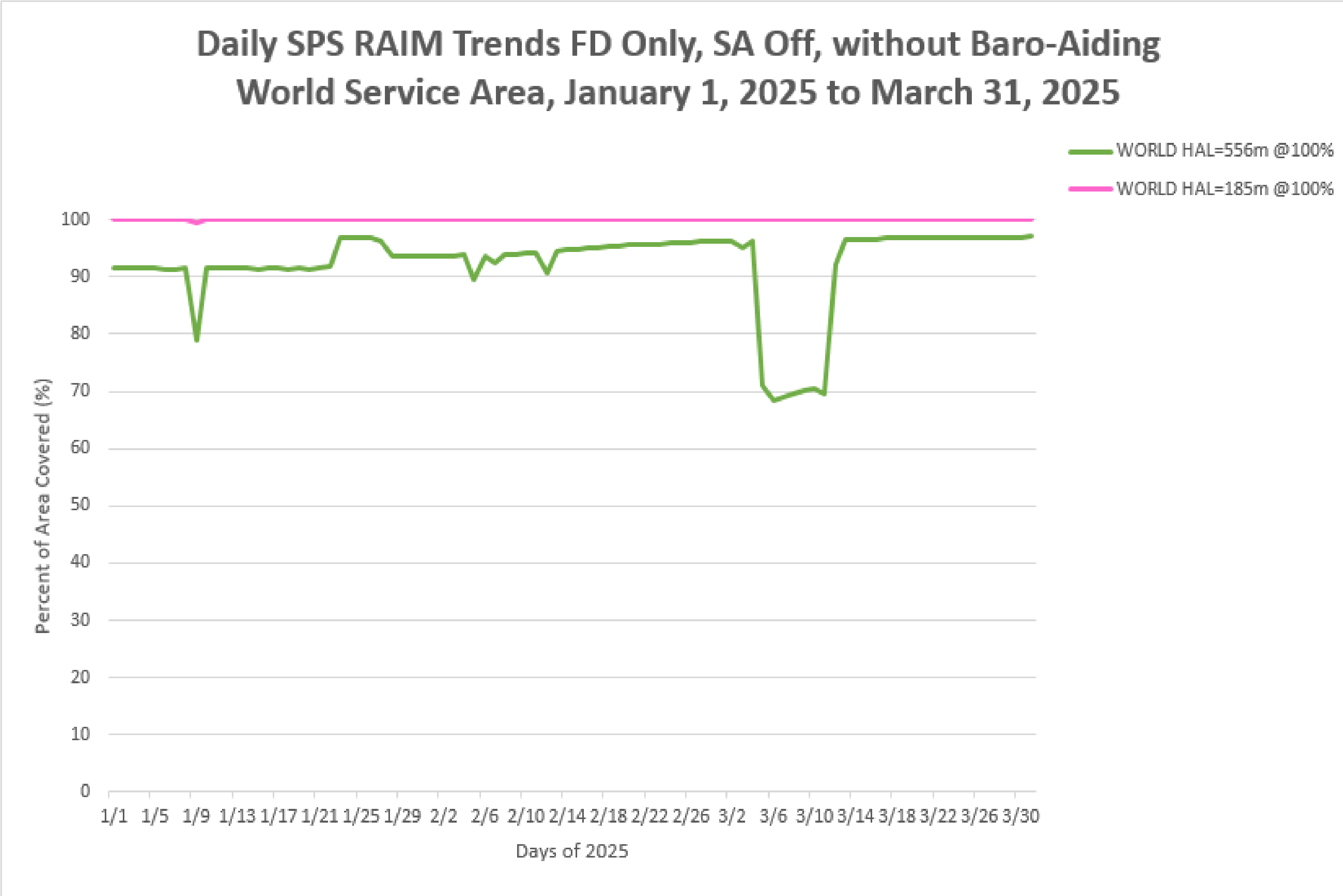



**Figure 8-3 RAIM Worldwide Coverage Trend**

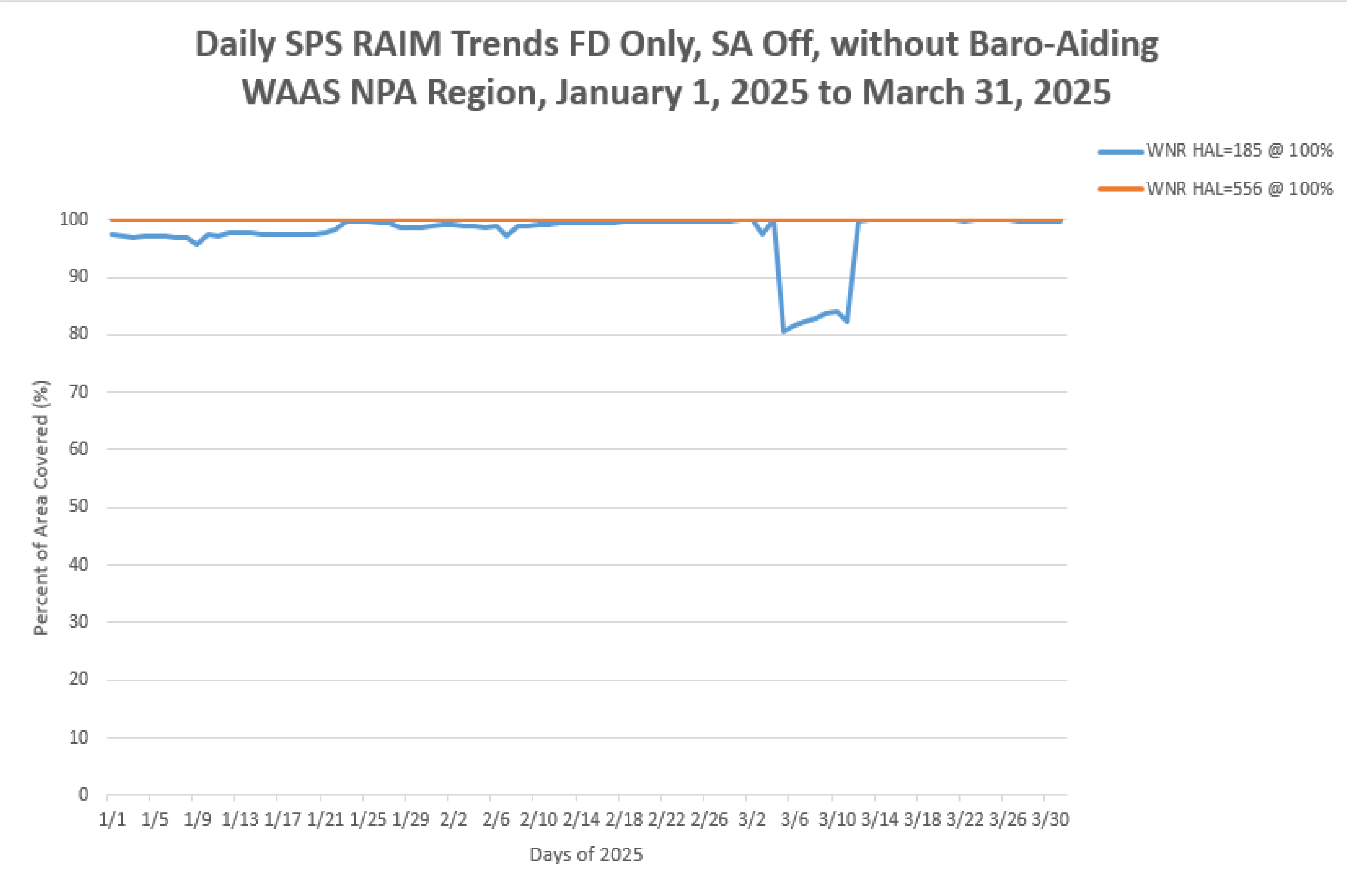



**Figure 8-4 RAIM RNP Coverage Trend for WAAS NPA Service Area**

### 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.

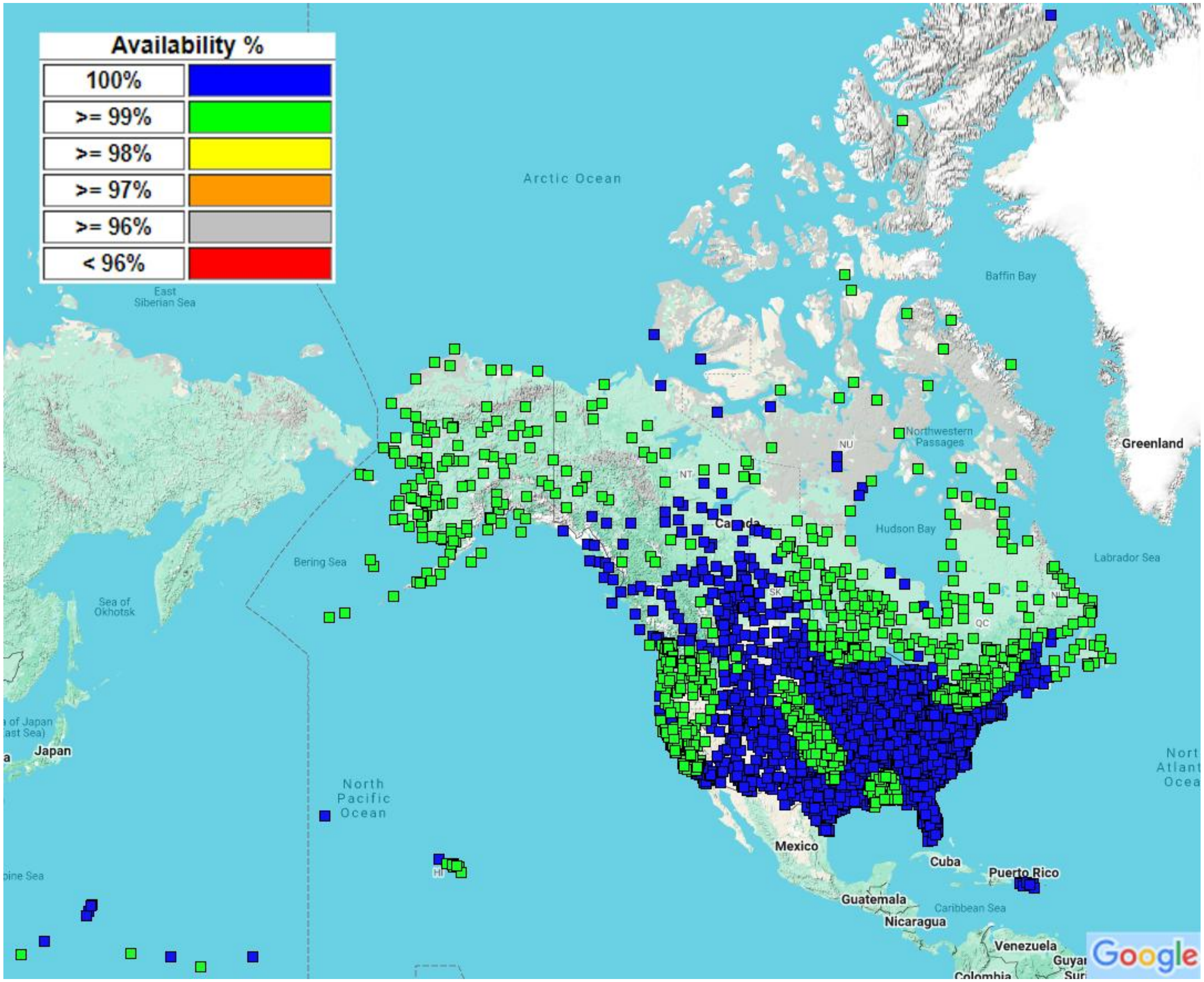



**Figure 8-5 RAIM RNP 0.1 Airport Availability**

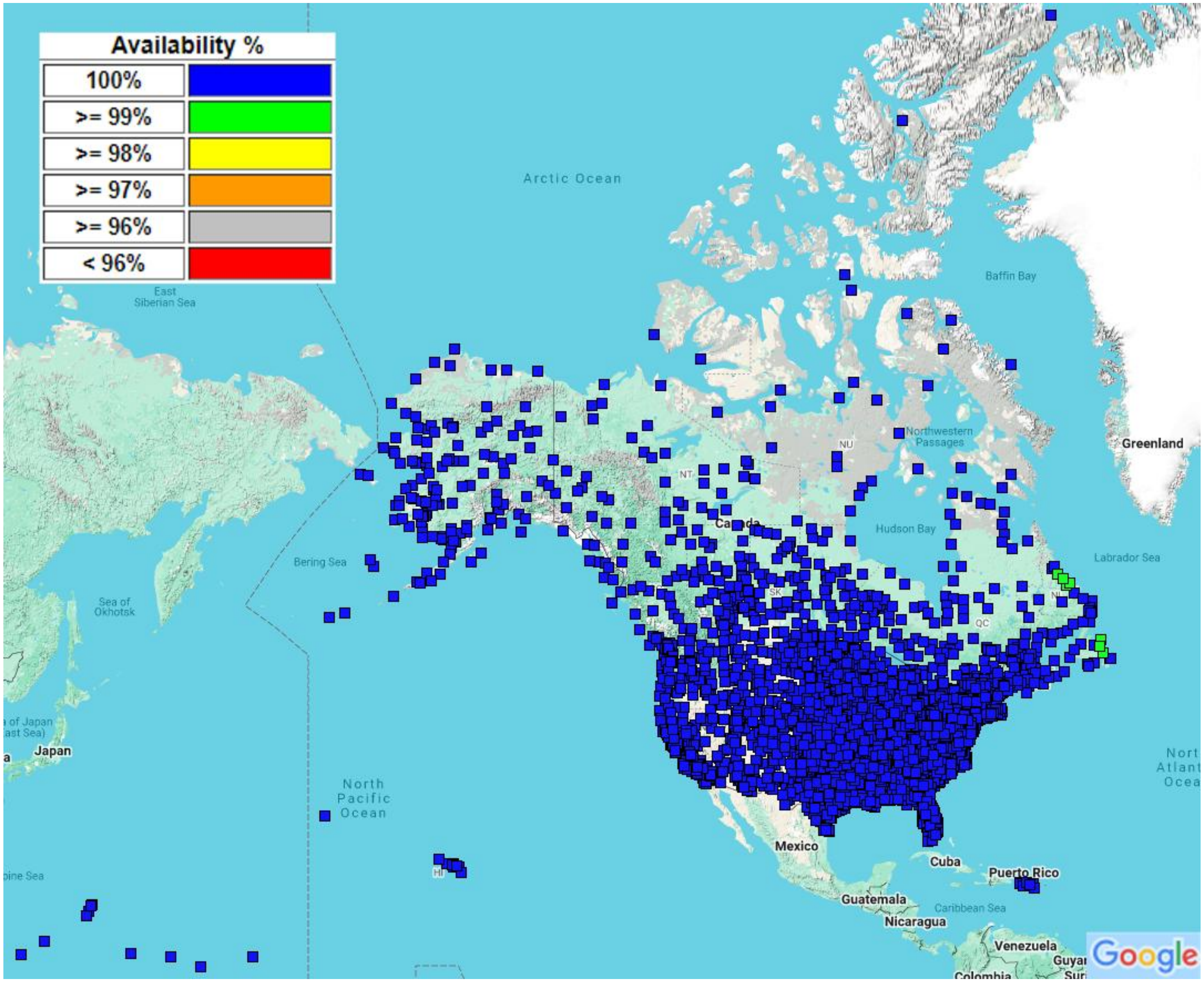



**Figure 8-6 RAIM RNP 0.3 Airport Availability**

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.

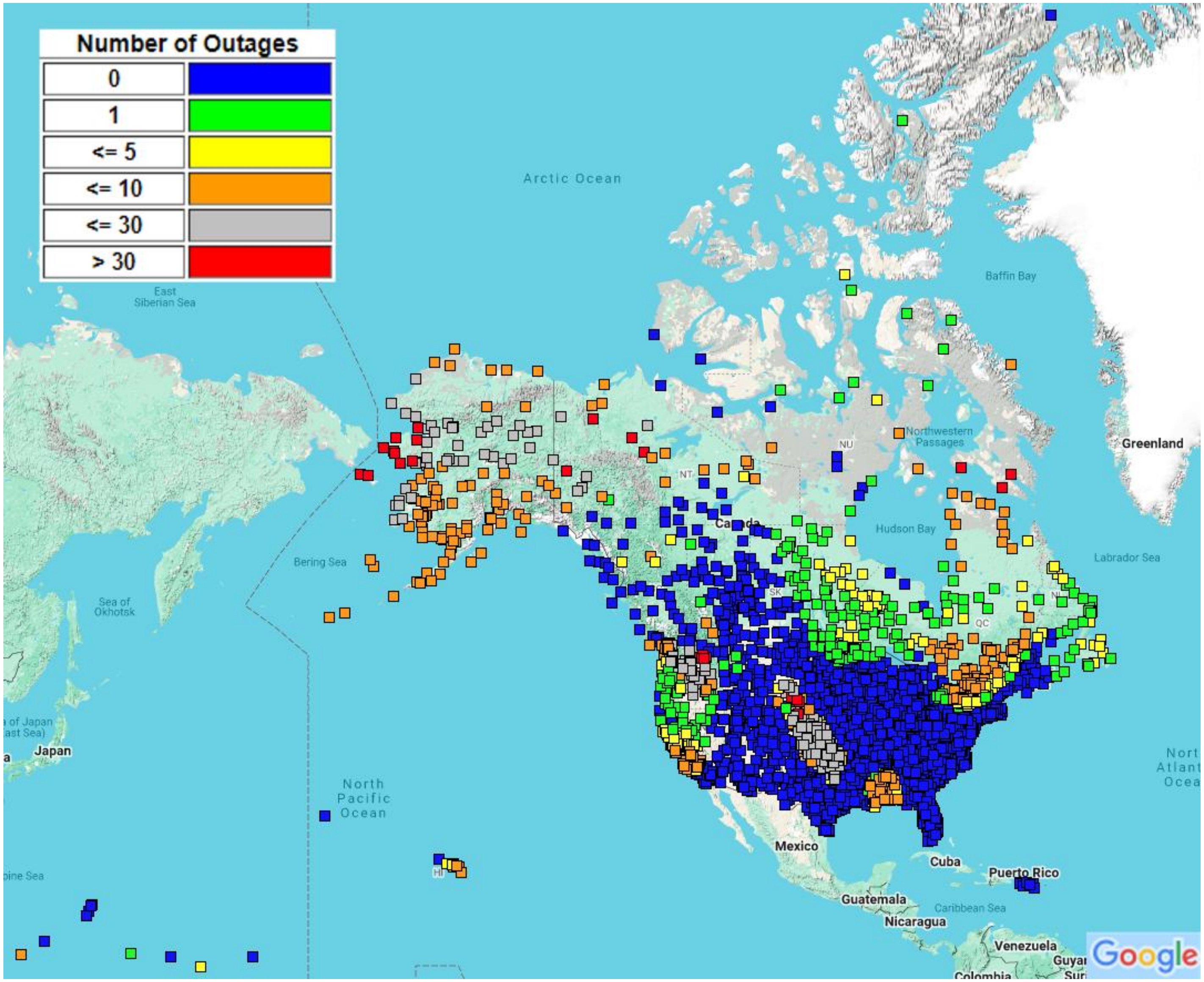



**Figure 8-7 RAIM RNP 0.1 Airport Outages**

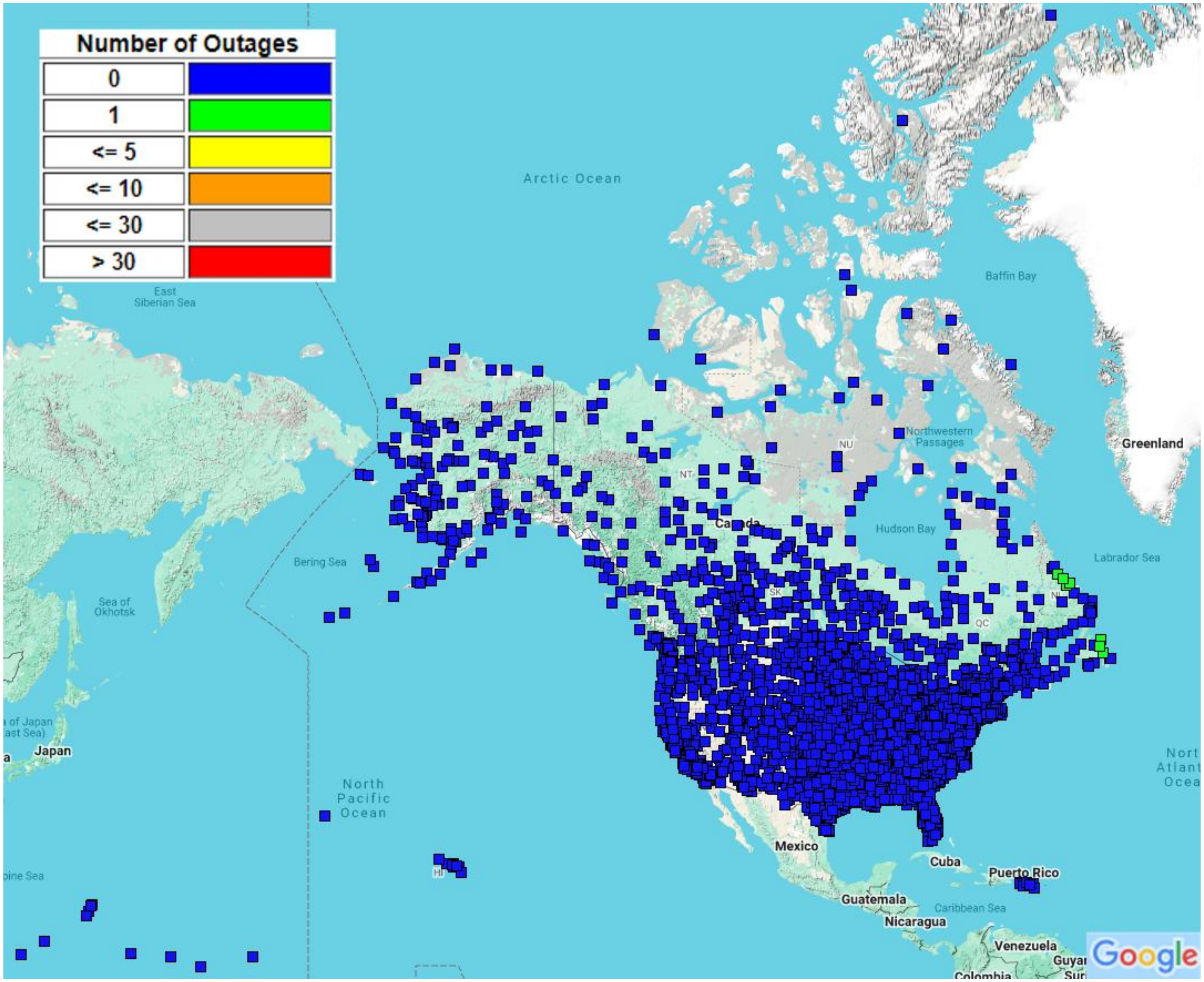



**Figure 8-8 RAIM RNP 0.3 Airport Outages**

# 9. GPS BROADCAST ORBIT VS. 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 January 1 to March 31, 2025 are presented. Only data points in which GPS is healthy and valid precise data is available are considered. There was maintenance on PRN28 on 01/09/25, PRN28 on 02/05/25, PRN2 on 02/07/25, PRN32 on 02/12/25, PRN8 on 03/03/25, PRN8 from 03/05/25 to 03/11/25, and PRN6 on 03/11/25 and 03/12/25. 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 March 31, 2025 GPS constellation (see Figure 9-6), PRN21 is not in use as SVN45 was set to Unusable and decommissioned on January 27, 2025. SVN80 (PRN1) is the most recent satellite, which was added to the constellation on January 22, 2025.

**Table 9-1 Signal Capability per Satellite Vehicle**

| PRN | SVN | 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 | 45 | IIR | | | |
| 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 | SVN | 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 through Figure 9-10 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 9-11 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 9-139 are histograms of the height error, along track error, cross track error, and URA (IAURA) normalized range error.

Figure 9-140 through Figure 9-196 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

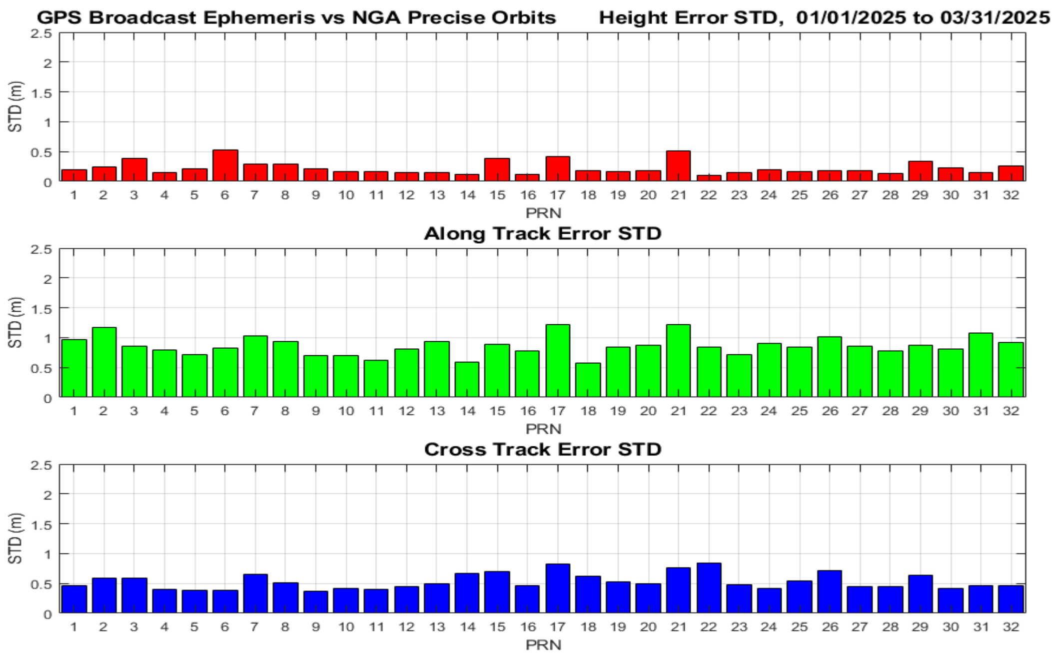



**Figure 9-1 GPS Broadcast Orbit Accuracy Standard Deviations Using C/A Nav Data**

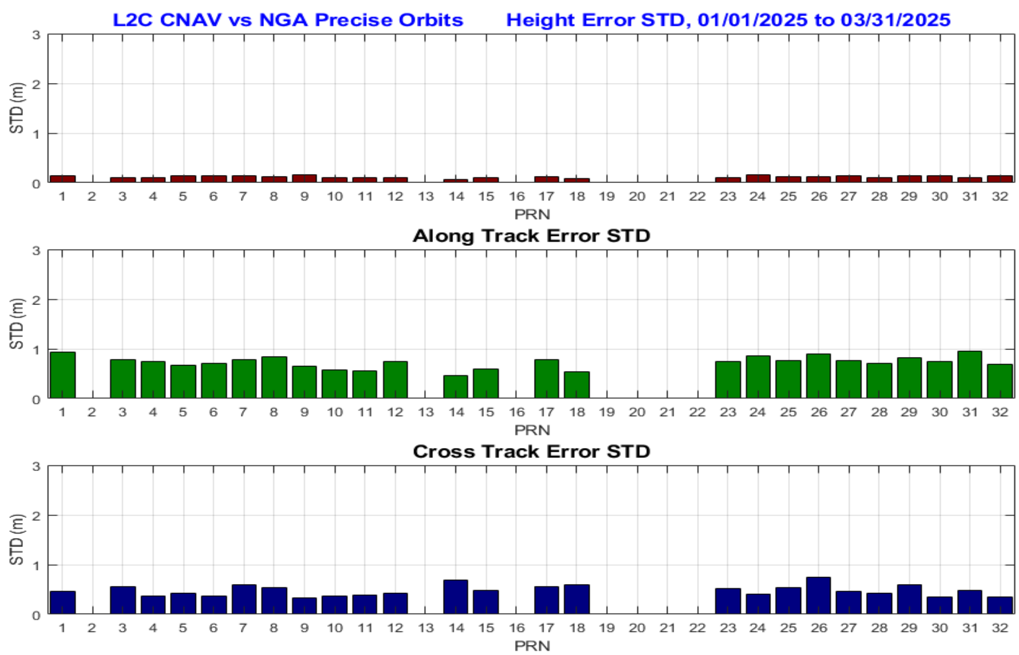



**Figure 9-2 GPS Broadcast Orbit Accuracy Standard Deviations Using L2C CNAV Data**

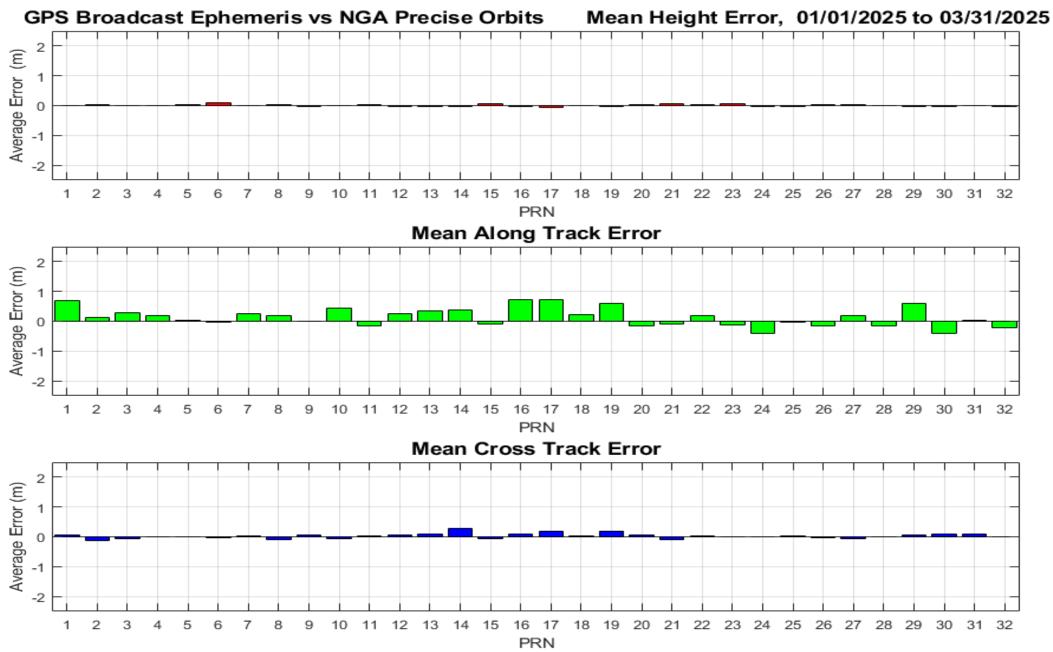



**Figure 9-3 GPS Broadcast Orbit Error Means Using C/A Nav Data**

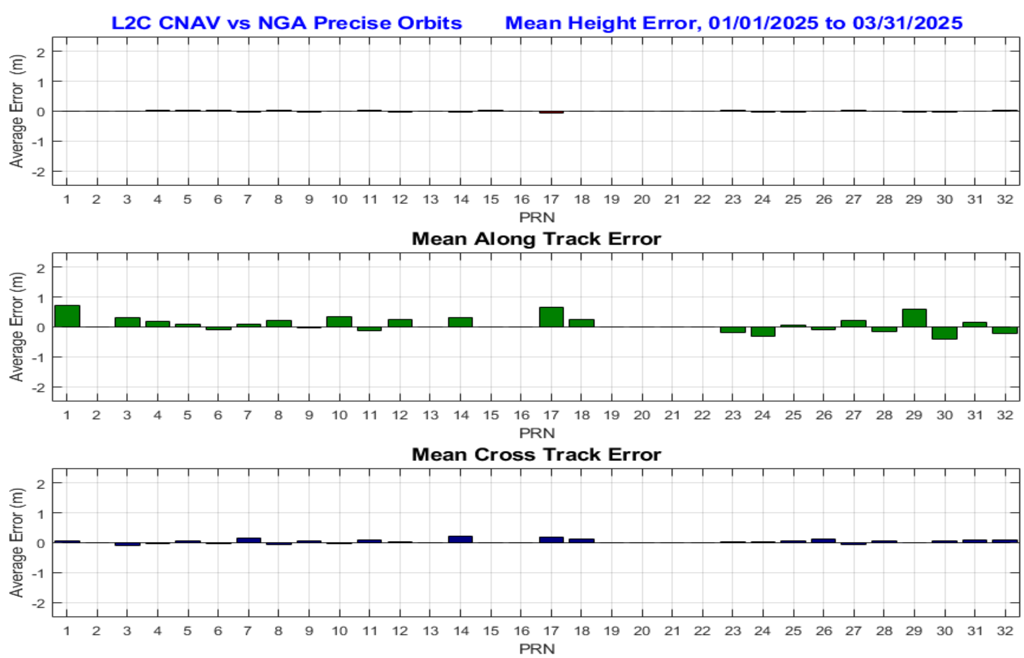



**Figure 9-4 GPS Broadcast Orbit Error Means Using L2C CNAV Data**

## 9.2 Broadcast Ephemeris vs. NGA Precise Data Availability Plots

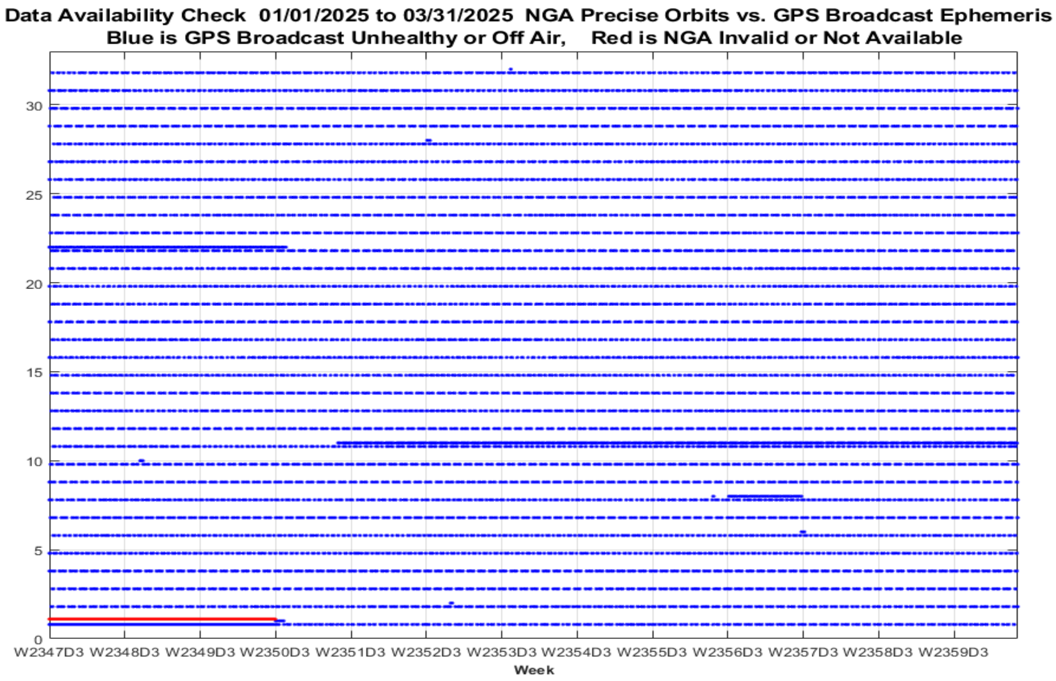



**Figure 9-5 Broadcast Ephemeris vs. NGA Precise Data Availability Plots**

## 9.3 Current GPS Constellation

Table 9-2 is a listing 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 March 31, 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 |
| | | 45 | 21 | 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 |
| | | | | |
| | | | | |
| 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 |
| | | | | |

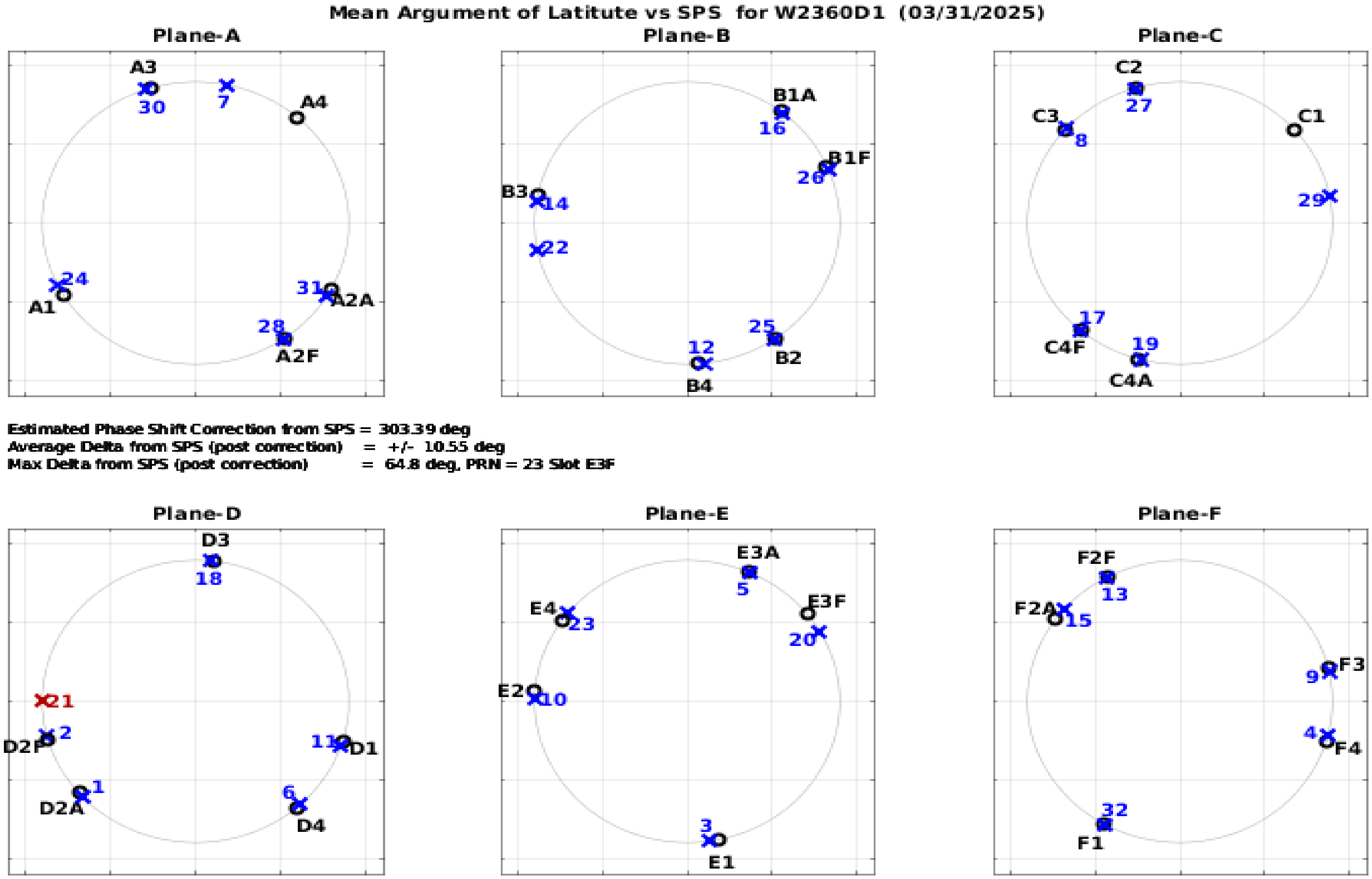



**Figure 9-6 March 31, 2025 GPS Constellation**

## 9.4 URA Overbounding Plots

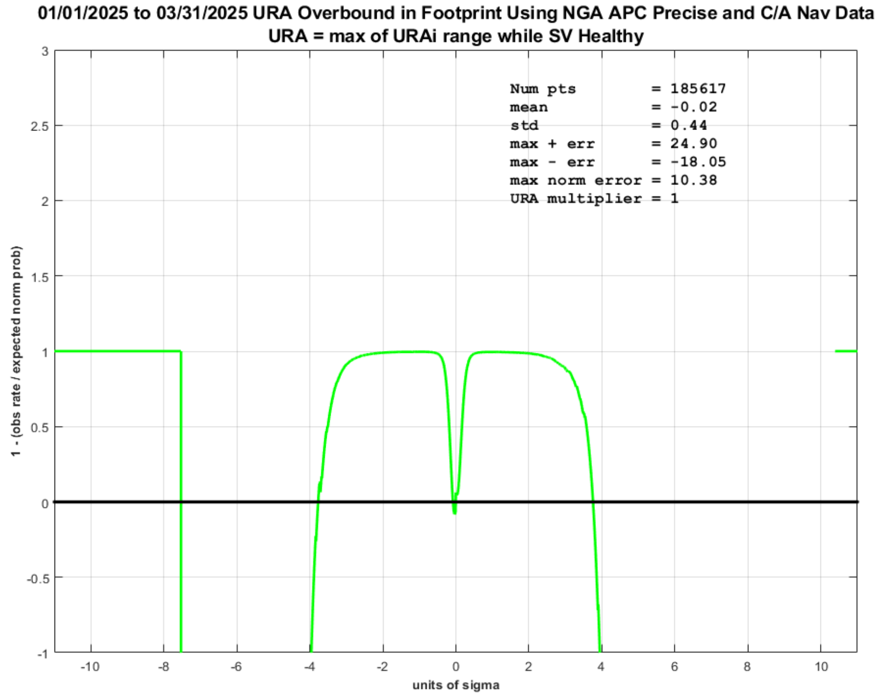



**Figure 9-7 URA Overbounding Using C/A Nav Data**

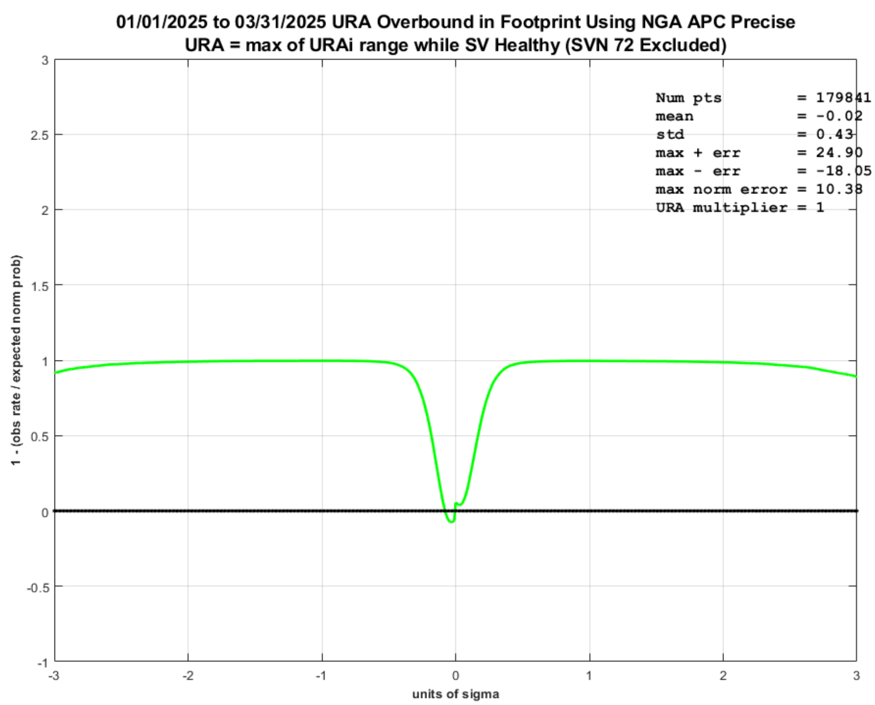



**Figure 9-8 URA Overbounding SV Excluded Using C/A Nav Data**

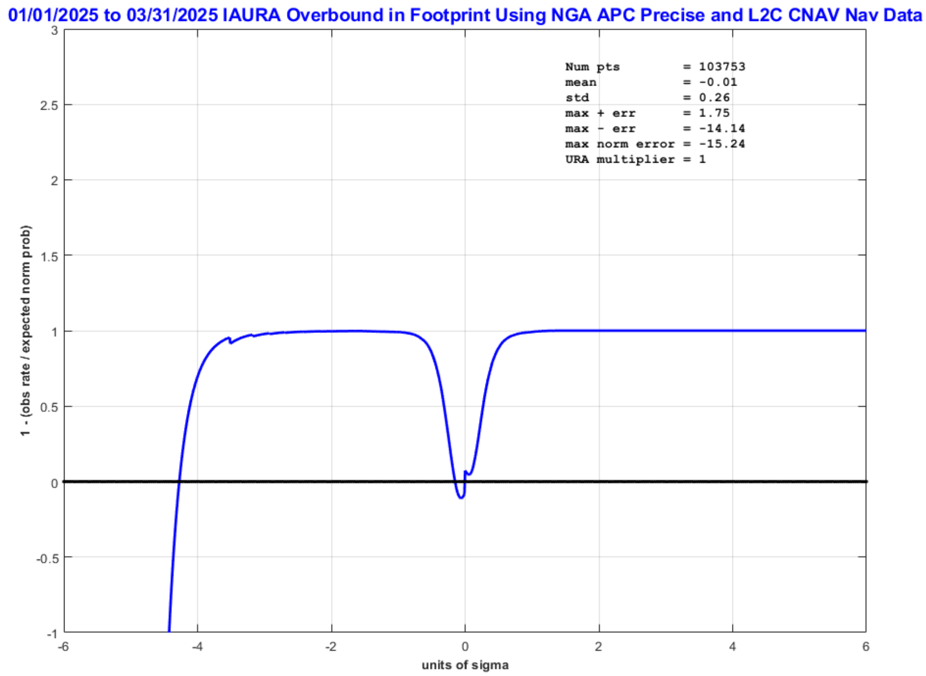



**Figure 9-9 IAURA Overbounding Using L2C CNAV Data**

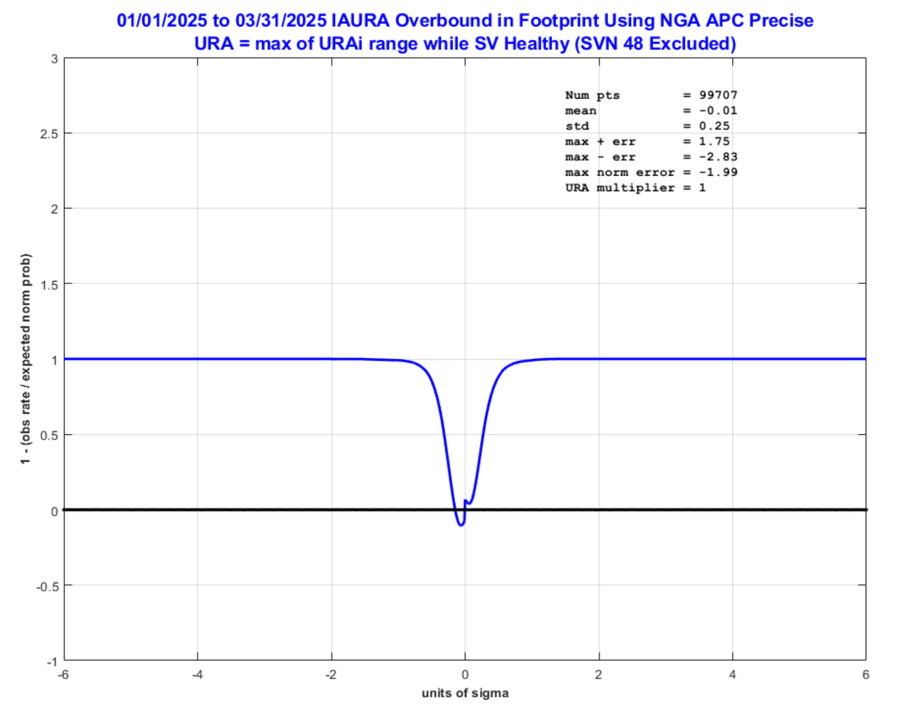



**Figure 9-10 IAURA Overbounding SV Excluded Using L2C CNAV Data**

## 9.5 Orbit Error Plots for All Satellites

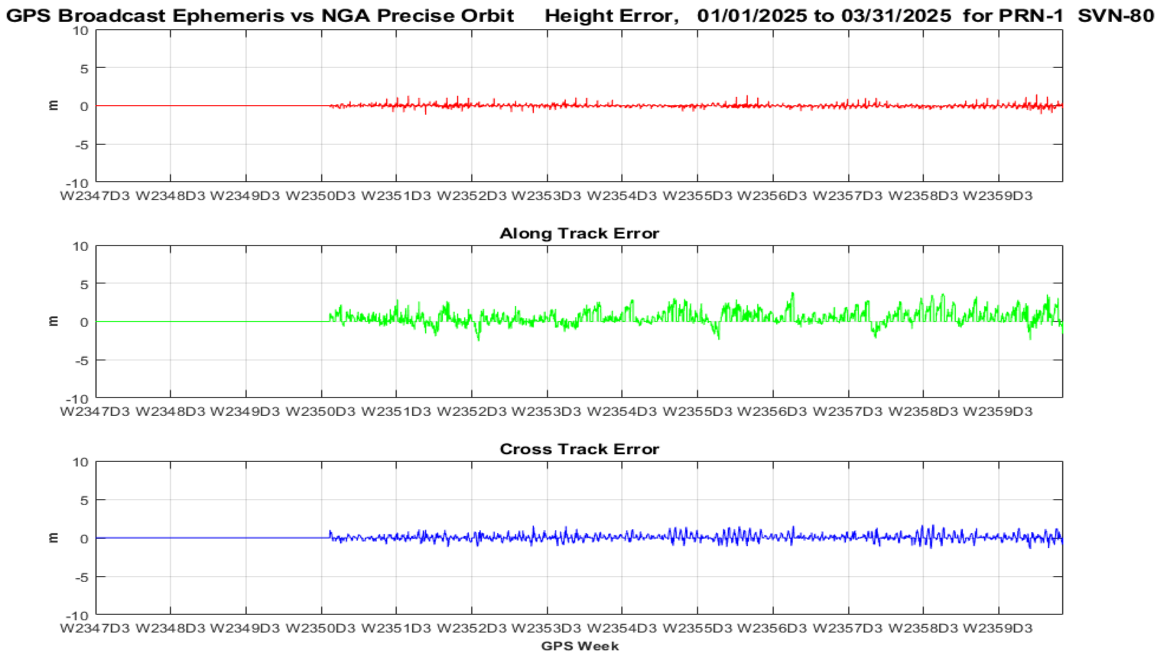



**Figure 9-11 Orbit Error PRN1 (SVN80) Using C/A Nav Data**

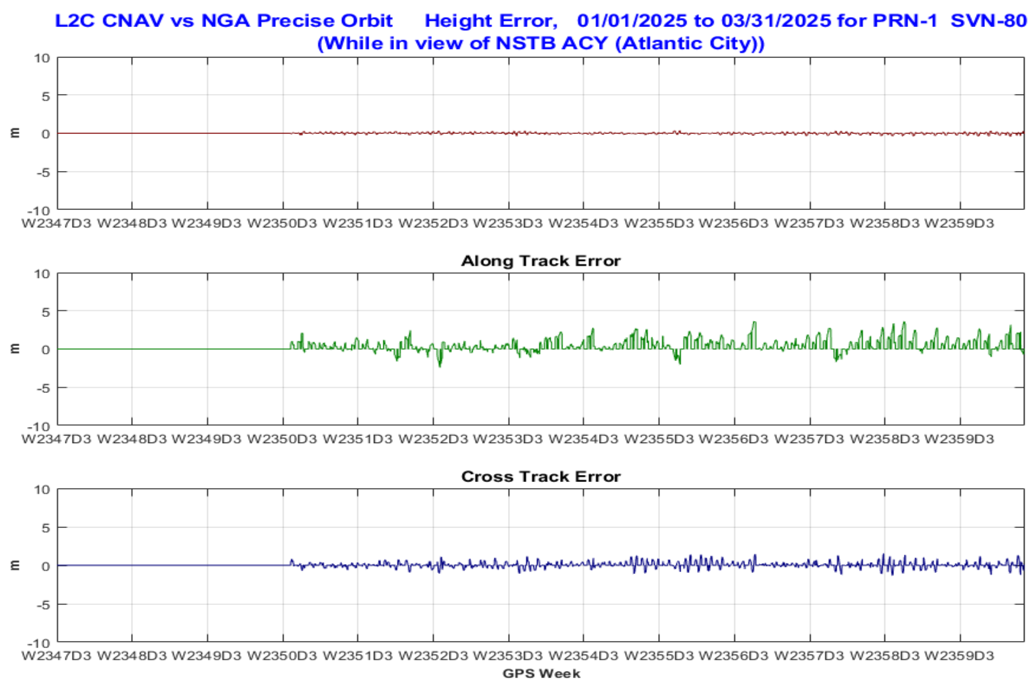



**Figure 9-12 Orbit Error PRN1 (SVN80) Using L2C CNAV Data**

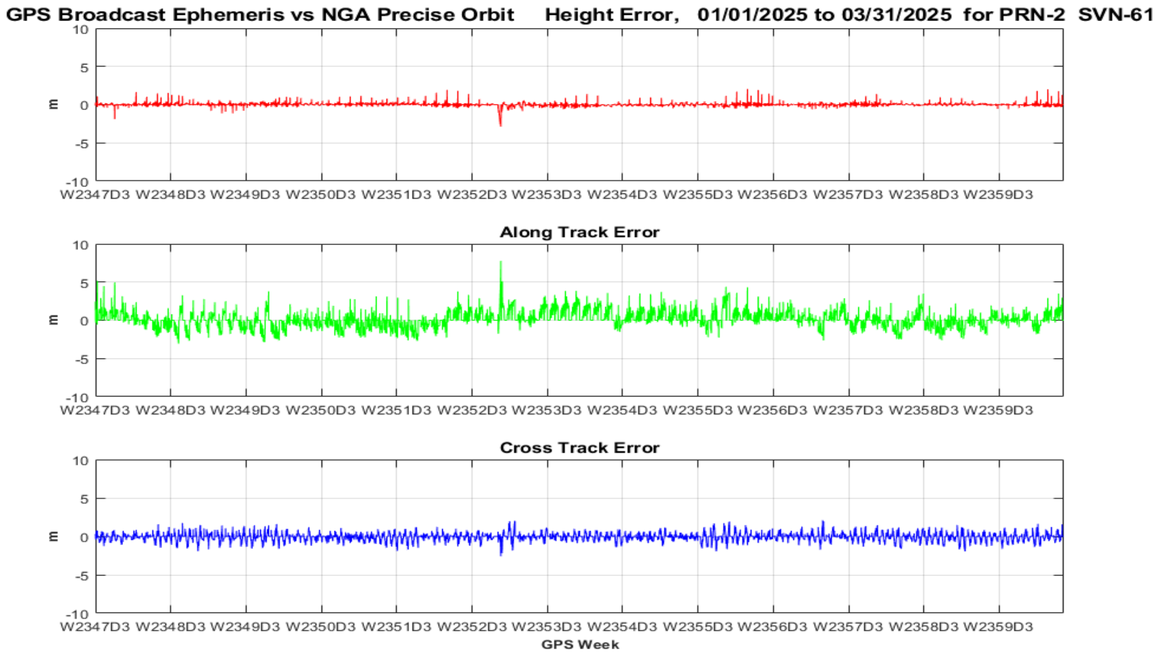



**Figure 9-13 Orbit Error PRN2 (SVN61) Using C/A Nav Data**

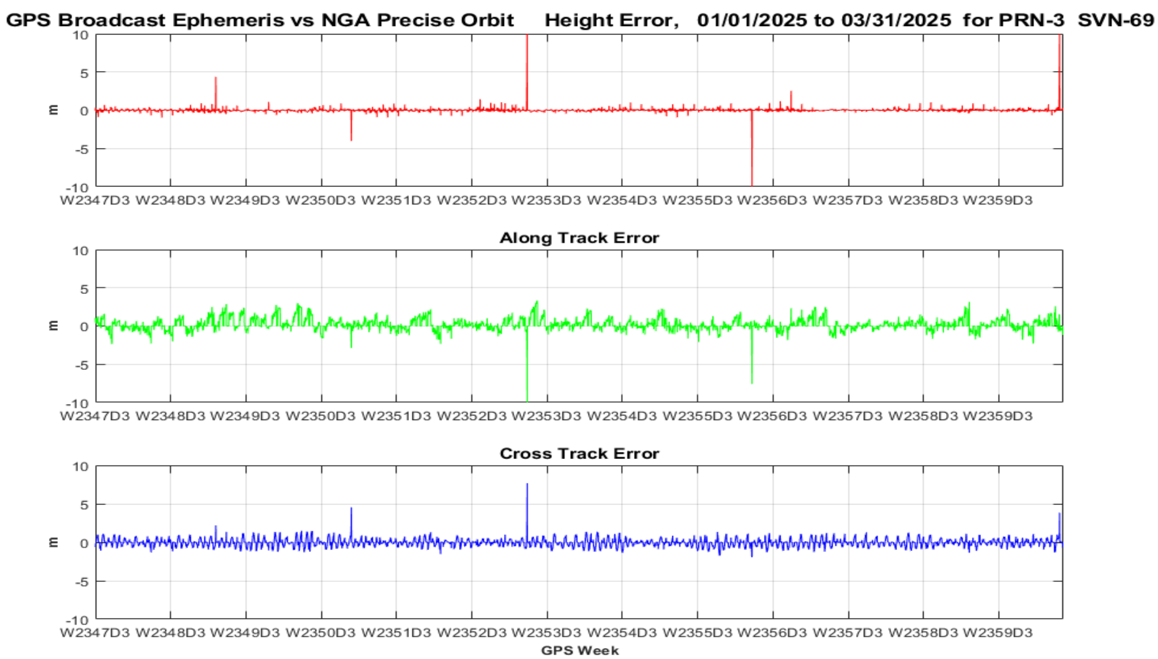



**Figure 9-14 Orbit Error PRN3 (SVN69) Using C/A Nav Data**

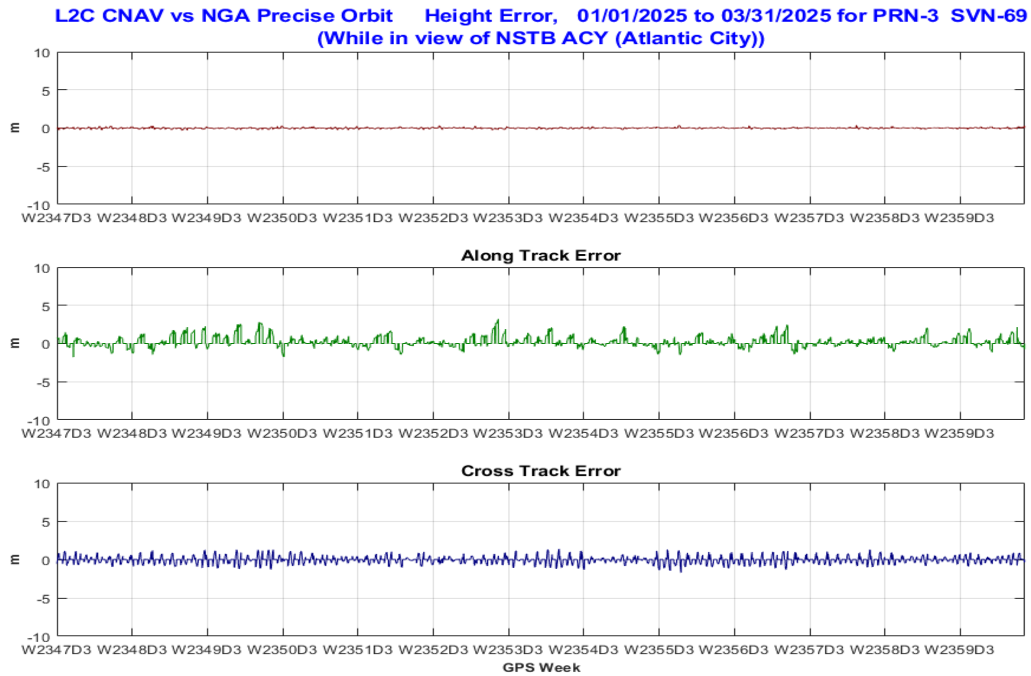



**Figure 9-15 Orbit Error PRN3 (SVN69) Using L2C CNAV Data**

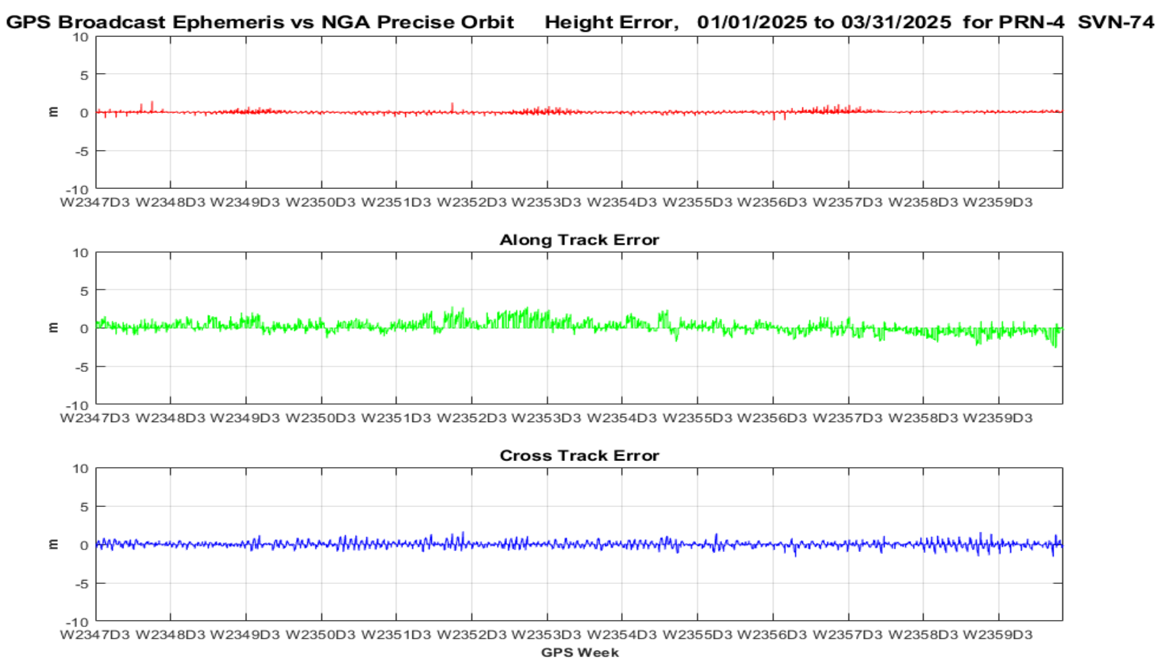



**Figure 9-16 Orbit Error PRN4 (SVN74) Using C/A Nav Data**

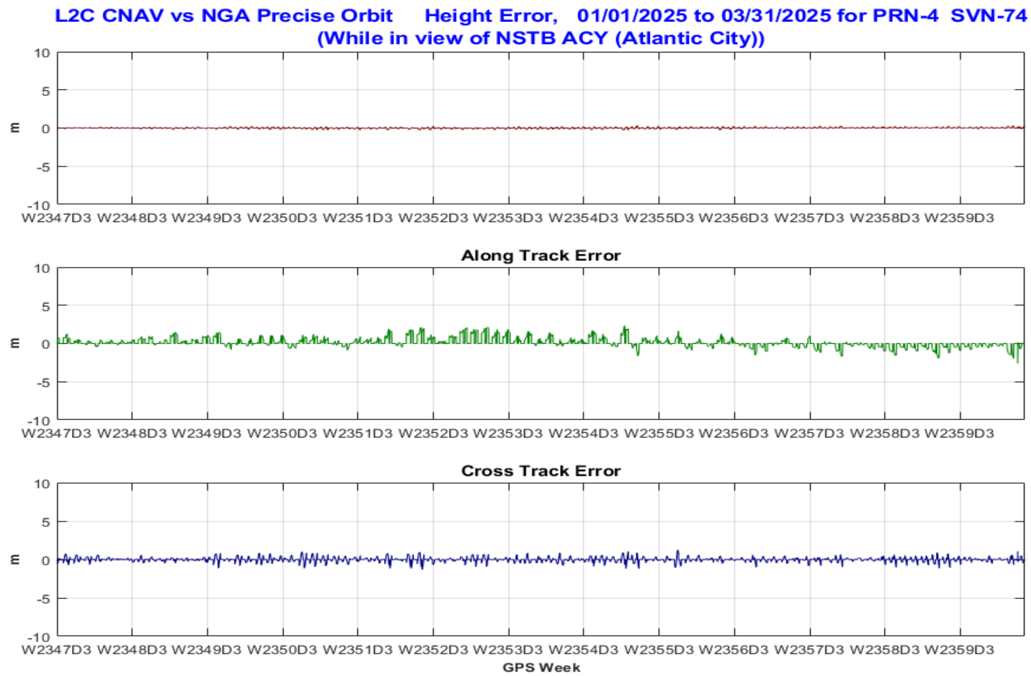



**Figure 9-17 Orbit Error PRN4 (SVN74) Using L2C CNAV Data**

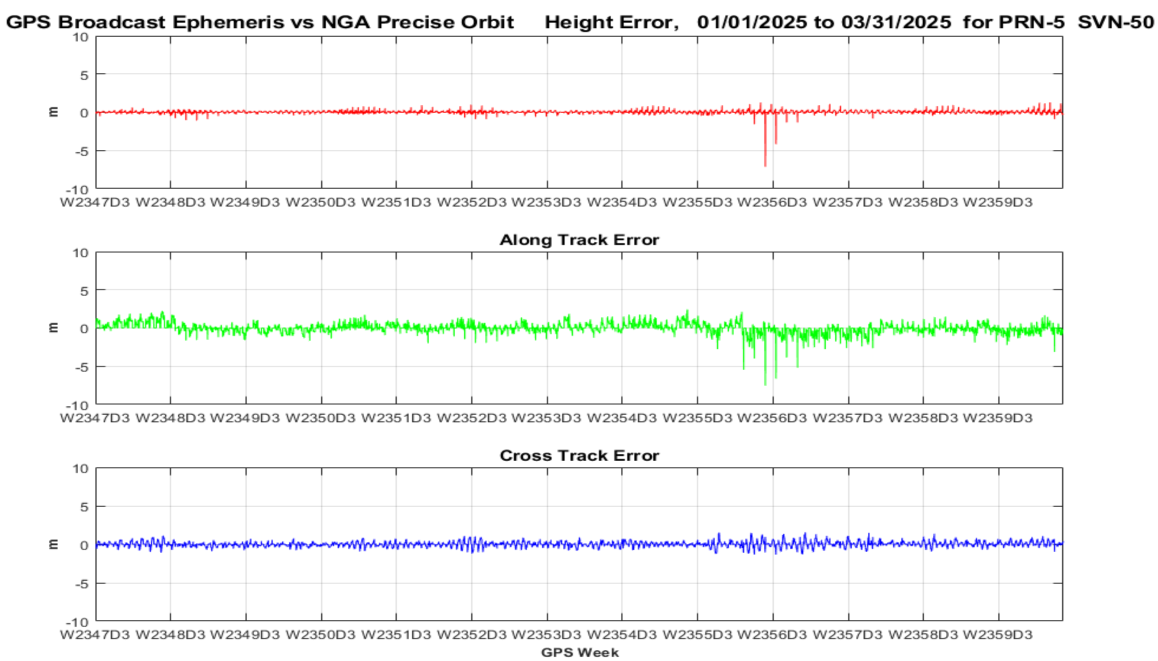



**Figure 9-18 Orbit Error PRN5 (SVN50) Using C/A Nav Data**

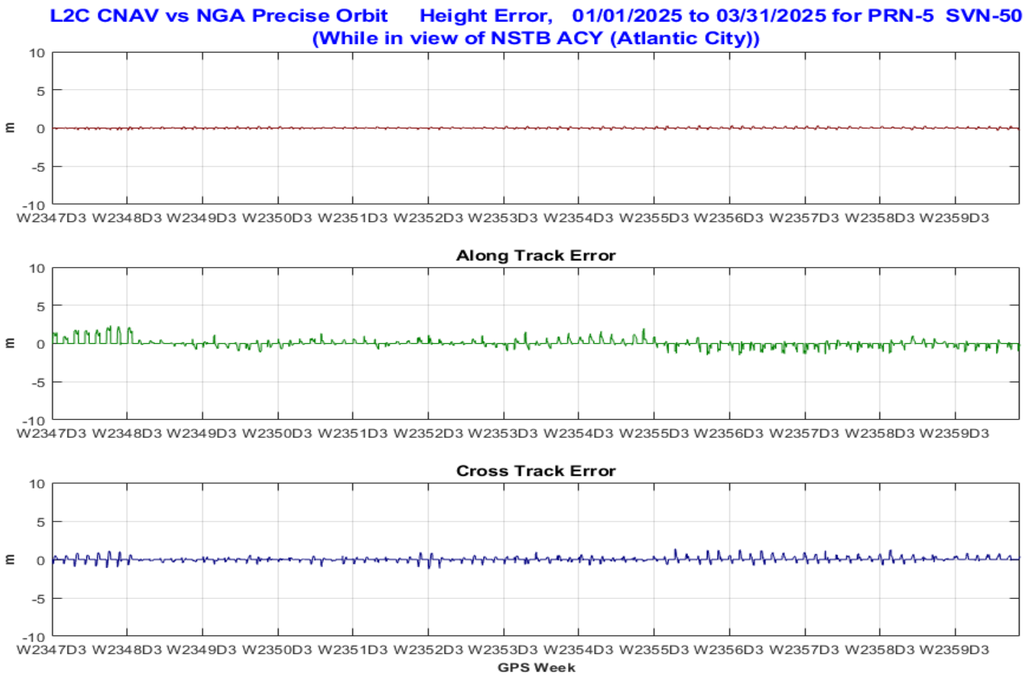



**Figure 9-19 Orbit Error PRN5 (SVN50) Using L2C CNAV Data**

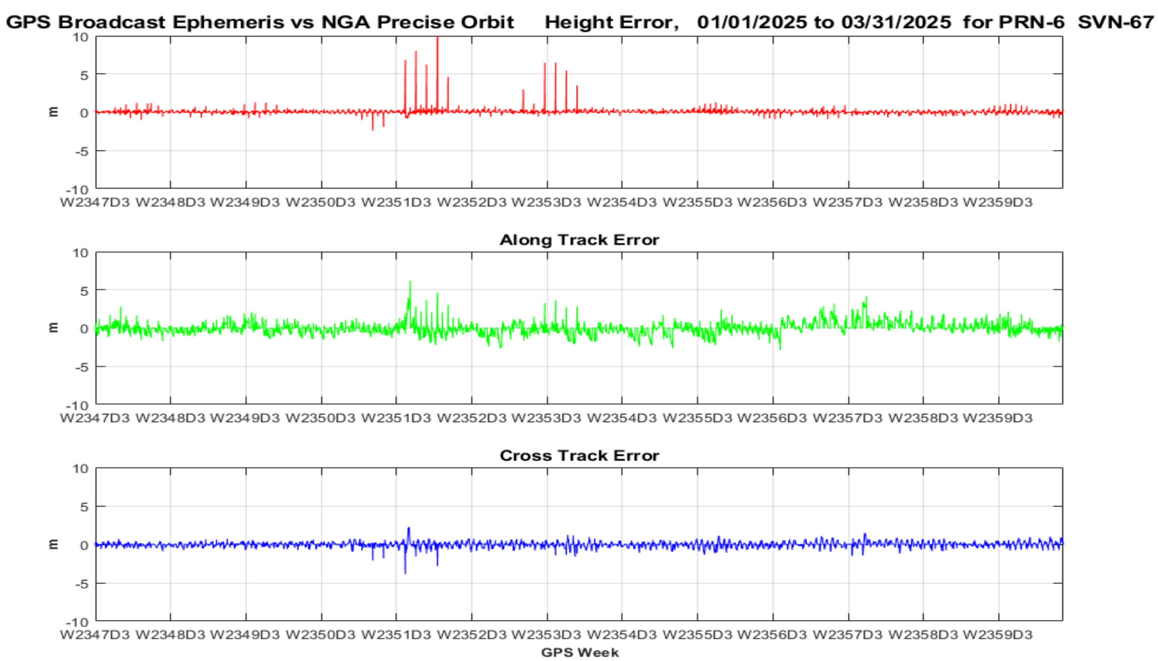



**Figure 9-20 Orbit Error PRN6 (SVN67) Using C/A Nav Data**

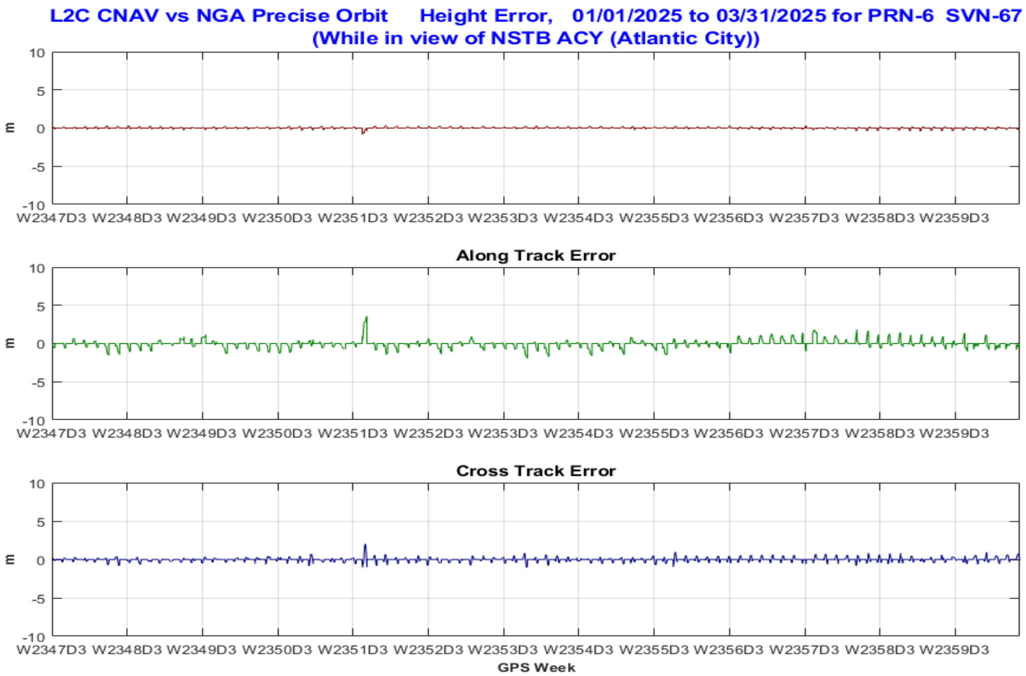



**Figure 9-21 Orbit Error PRN6 (SVN67) Using L2C CNAV Data**

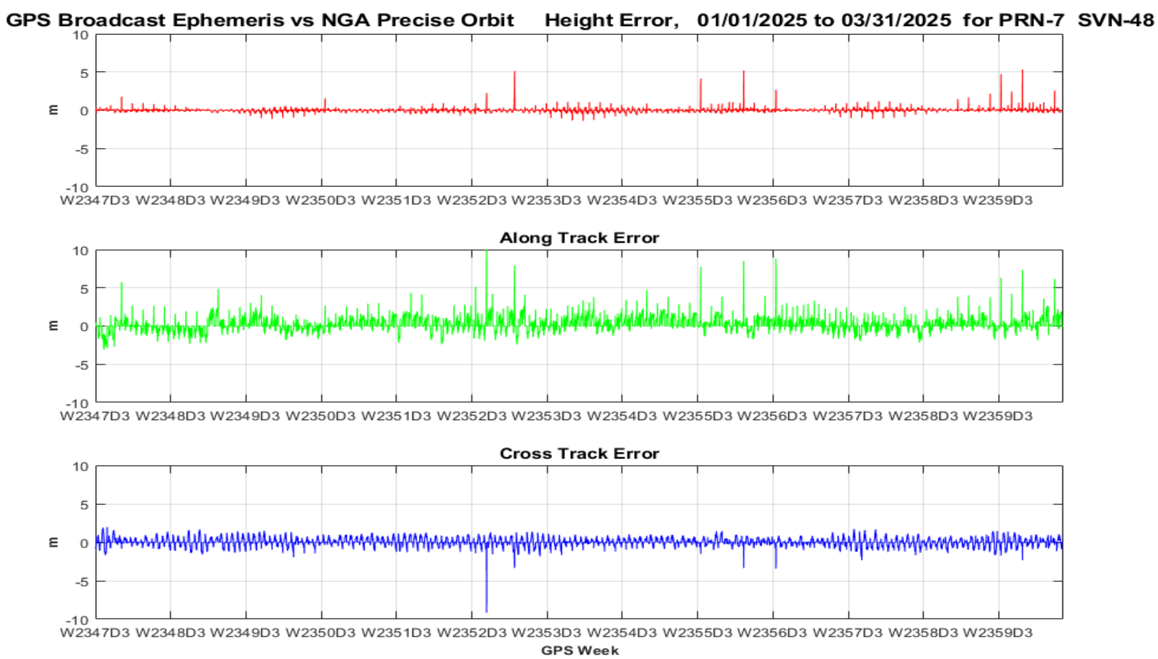



**Figure 9-22 Orbit Error PRN7 (SVN48) Using C/A Nav Data**

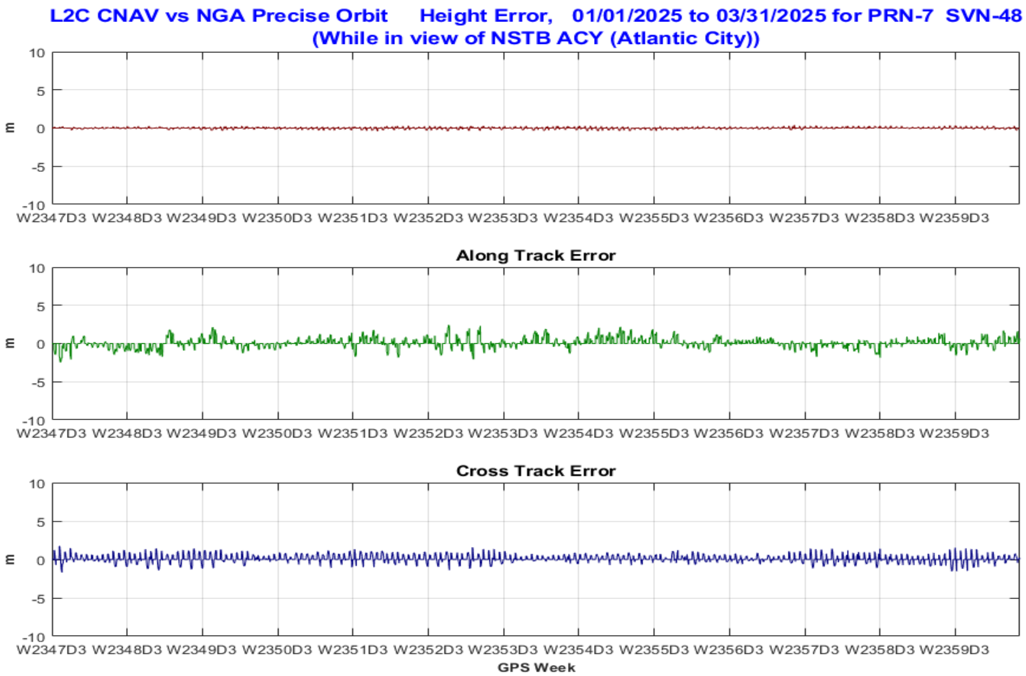



**Figure 9-23 Orbit Error PRN7 (SVN48) Using L2C CNAV Data**

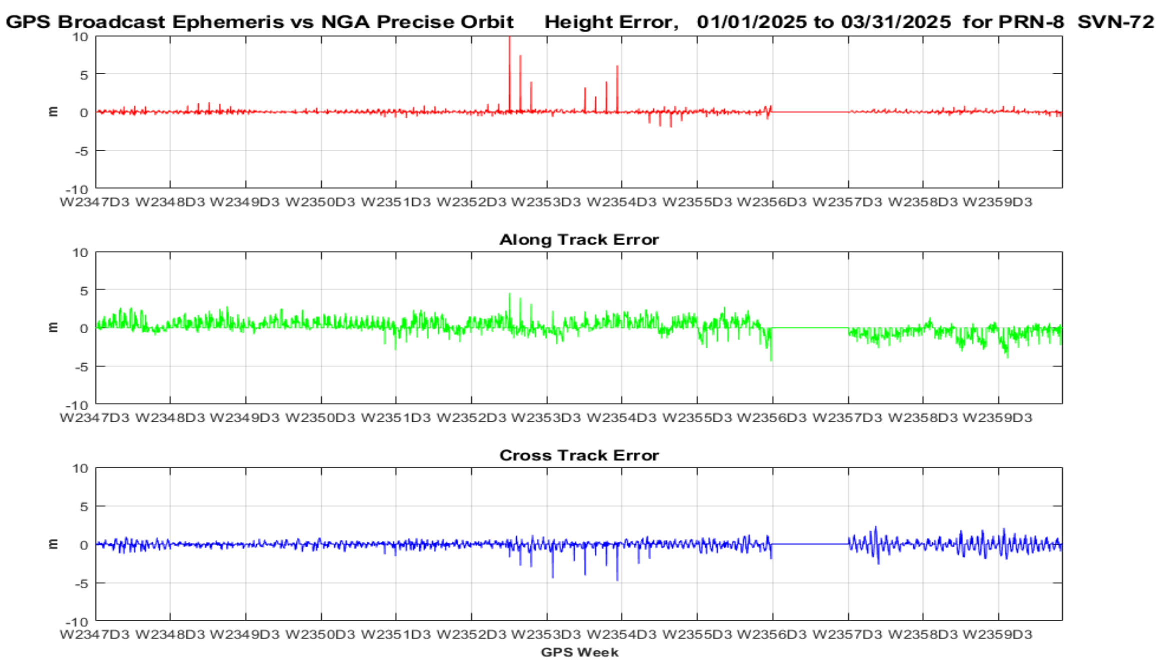



**Figure 9-24 Orbit Error PRN8 (SVN72) Using C/A Nav Data**

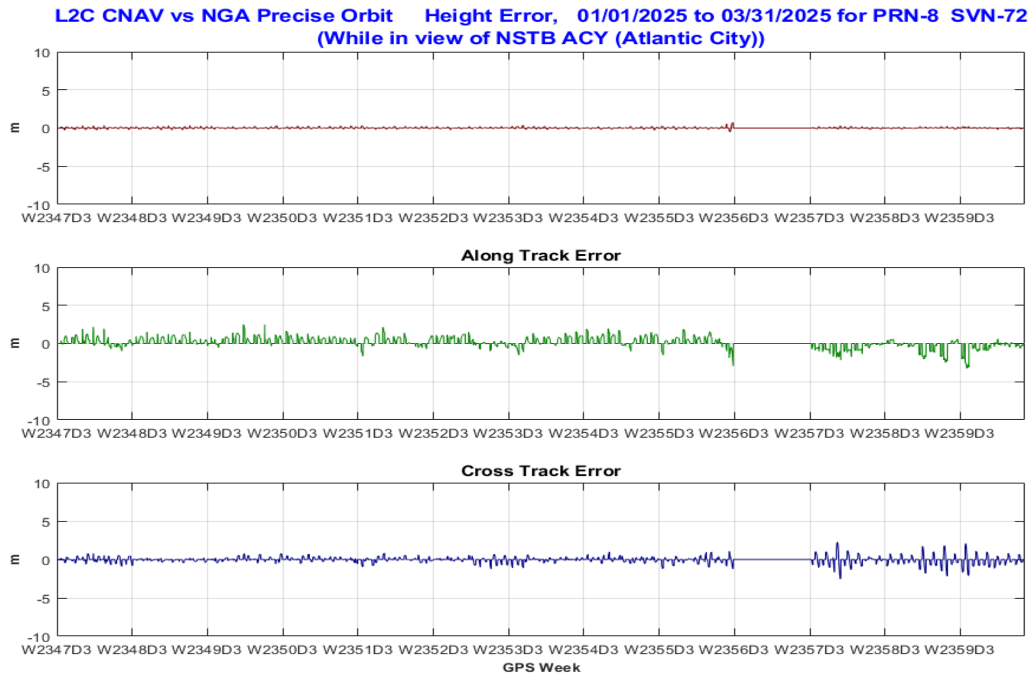



**Figure 9-25 Orbit Error PRN8 (SVN72) Using L2C CNAV Data**

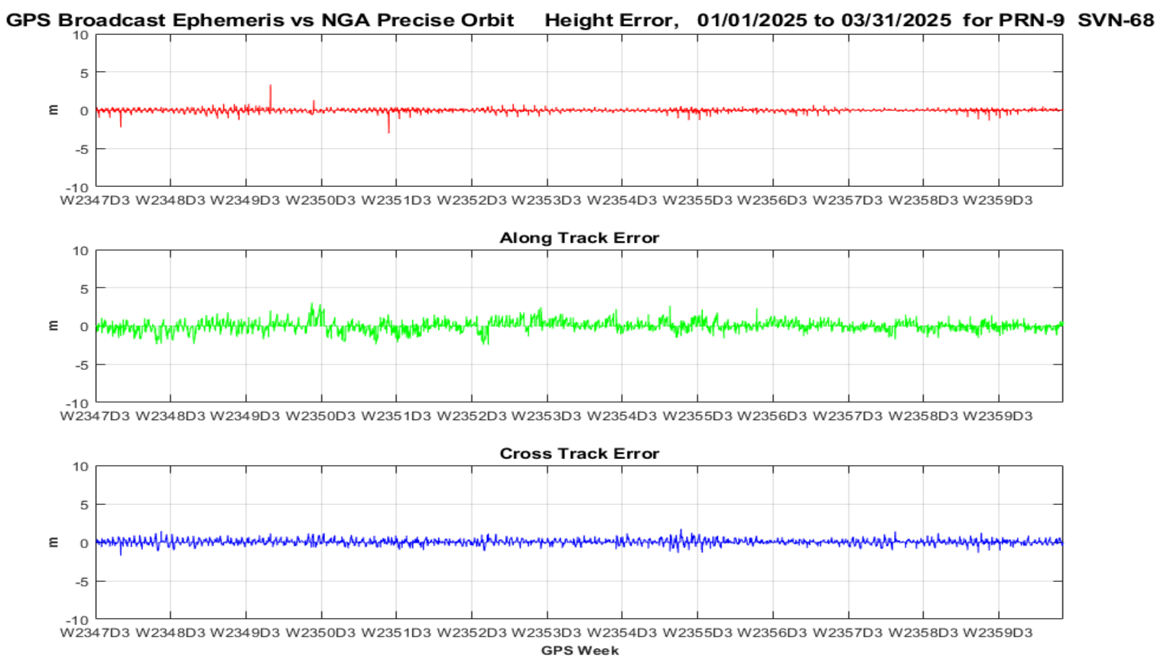



**Figure 9-26 Orbit Error PRN9 (SVN68) Using C/A Nav Data**

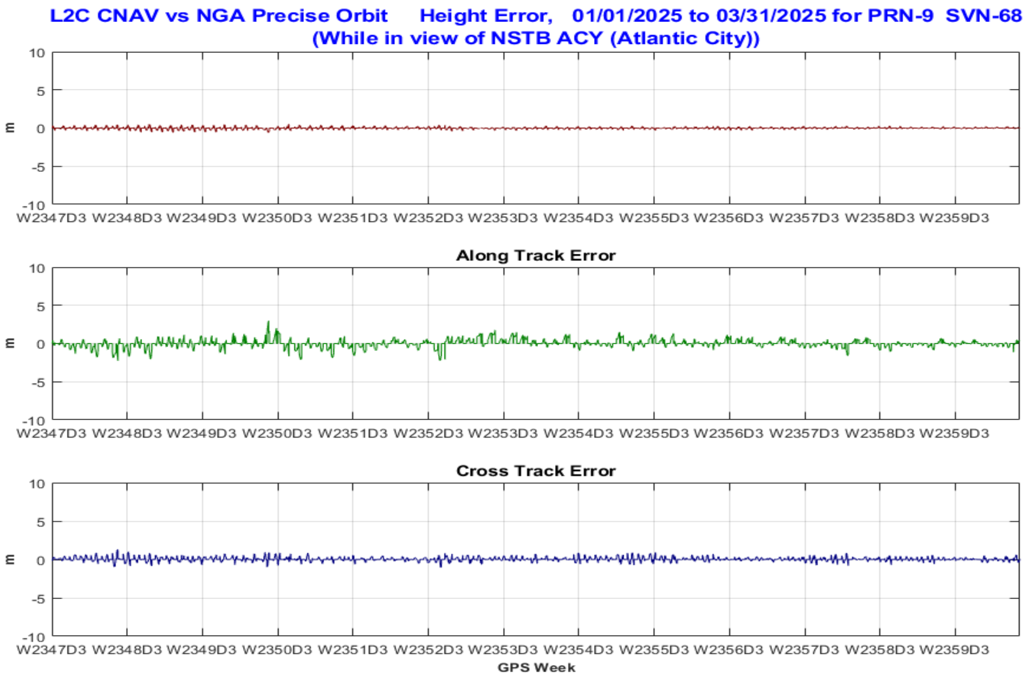



**Figure 9-27 Orbit Error PRN9 (SVN68) Using L2C CNAV Data**

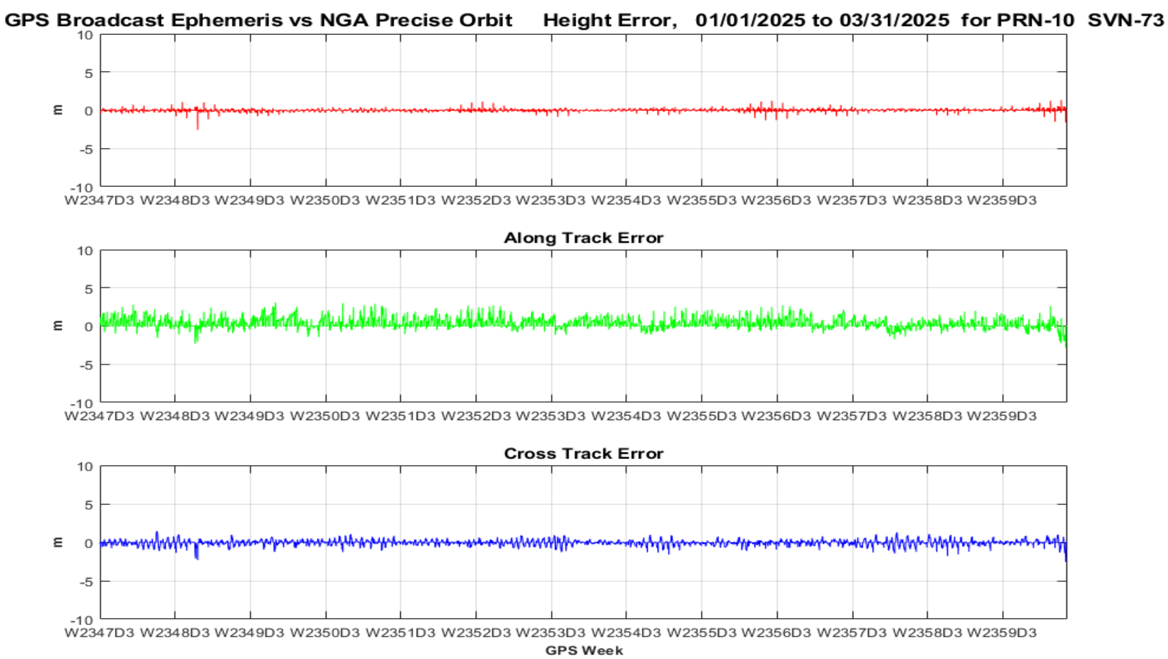



**Figure 9-28 Orbit Error PRN10 (SVN73) Using C/A Nav Data**

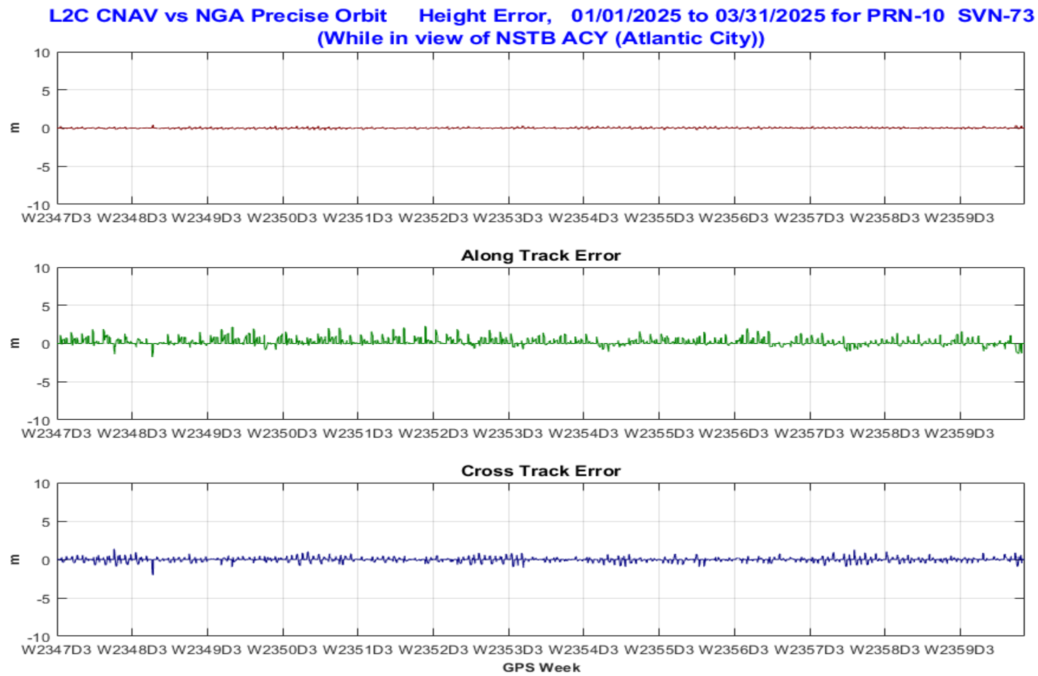



**Figure 9-29 Orbit Error PRN10 (SVN73) Using L2C CNAV Data**

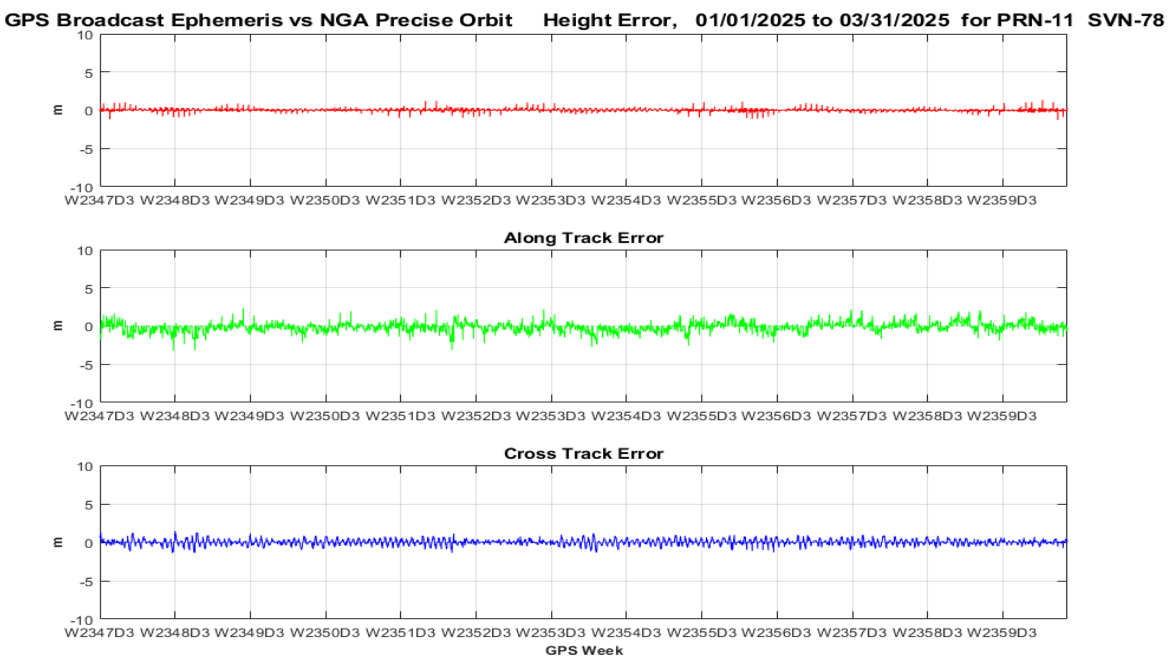



**Figure 9-30 Orbit Error PRN11 (SVN78) Using C/A Nav Data**

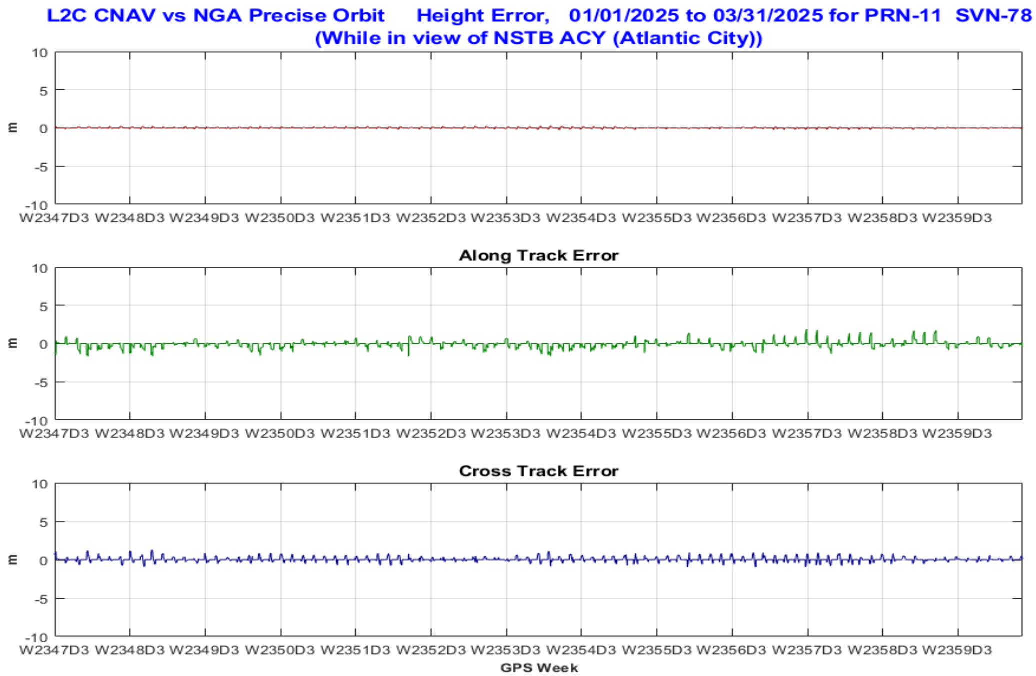



**Figure 9-31 Orbit Error PRN11 (SVN78) Using L2C CNAV Data**

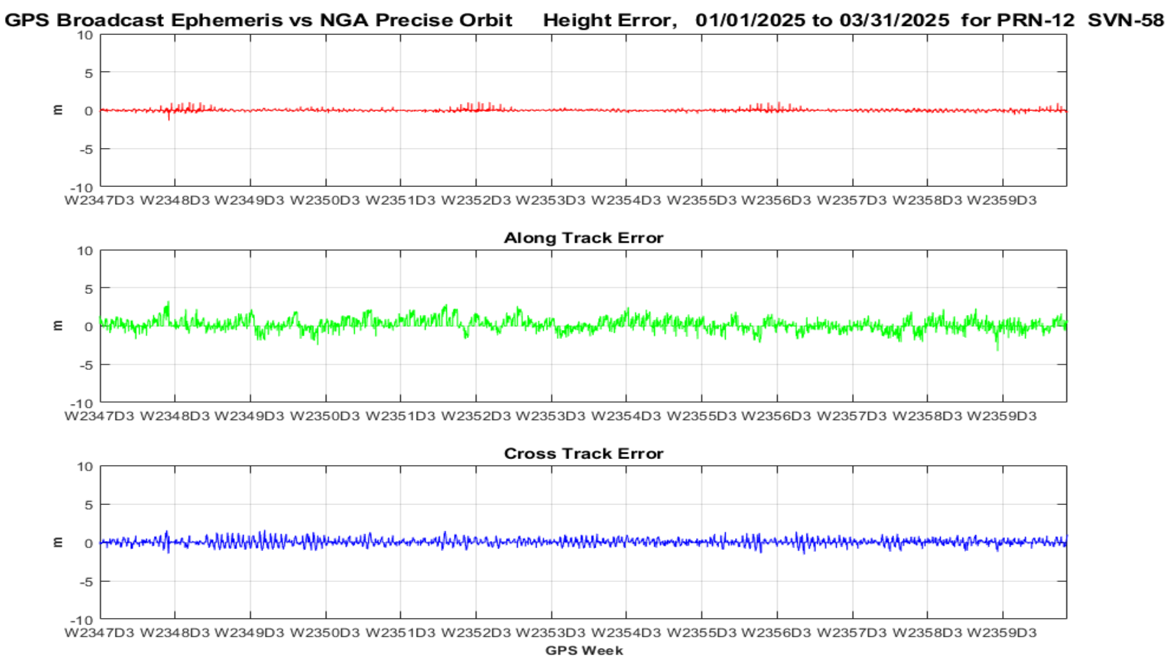



**Figure 9-32 Orbit Error PRN12 (SVN58) Using C/A Nav Data**

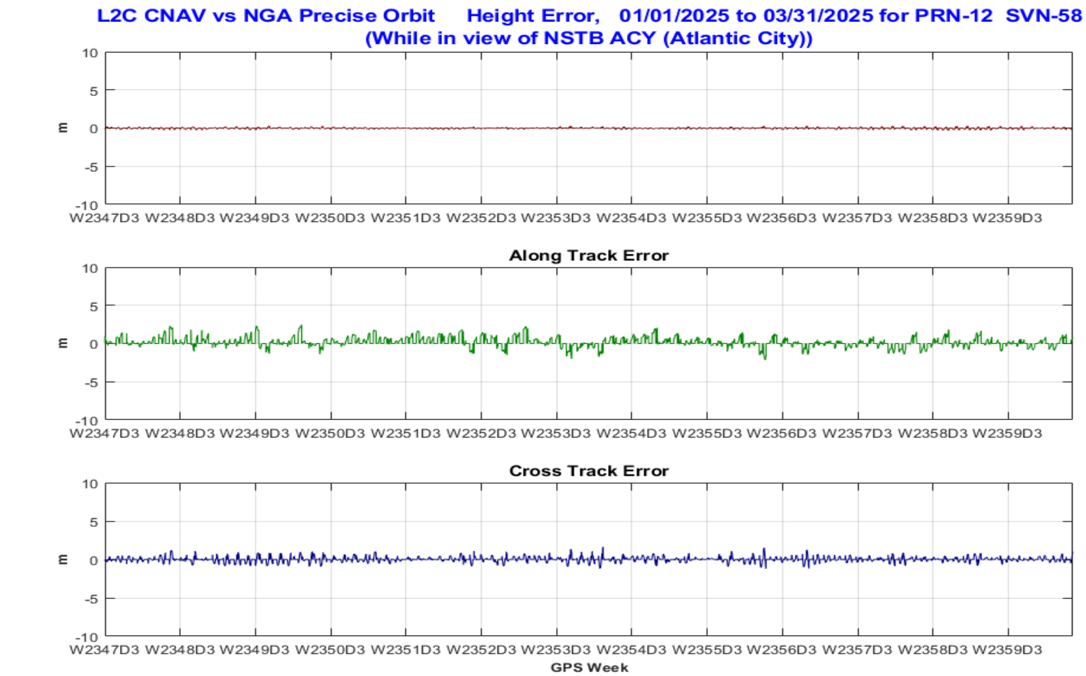



**Figure 9-33 Orbit Error PRN12 (SVN58) Using L2C CNAV Data**

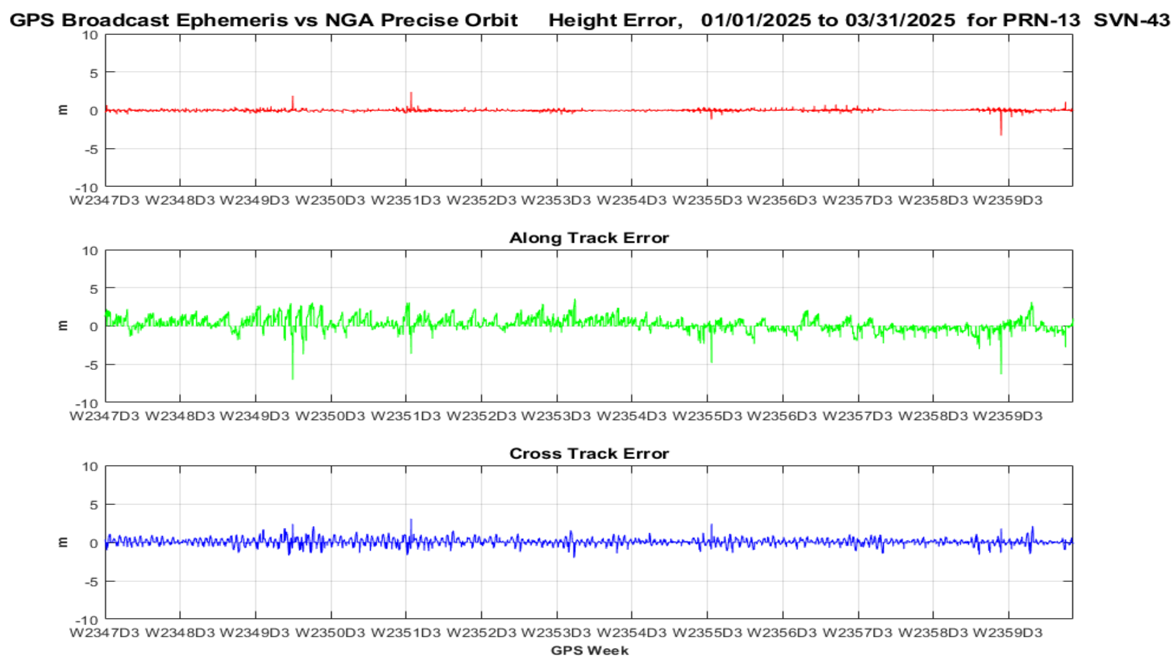



**Figure 9-34 Orbit Error PRN13 (SVN43) Using C/A Nav Data**

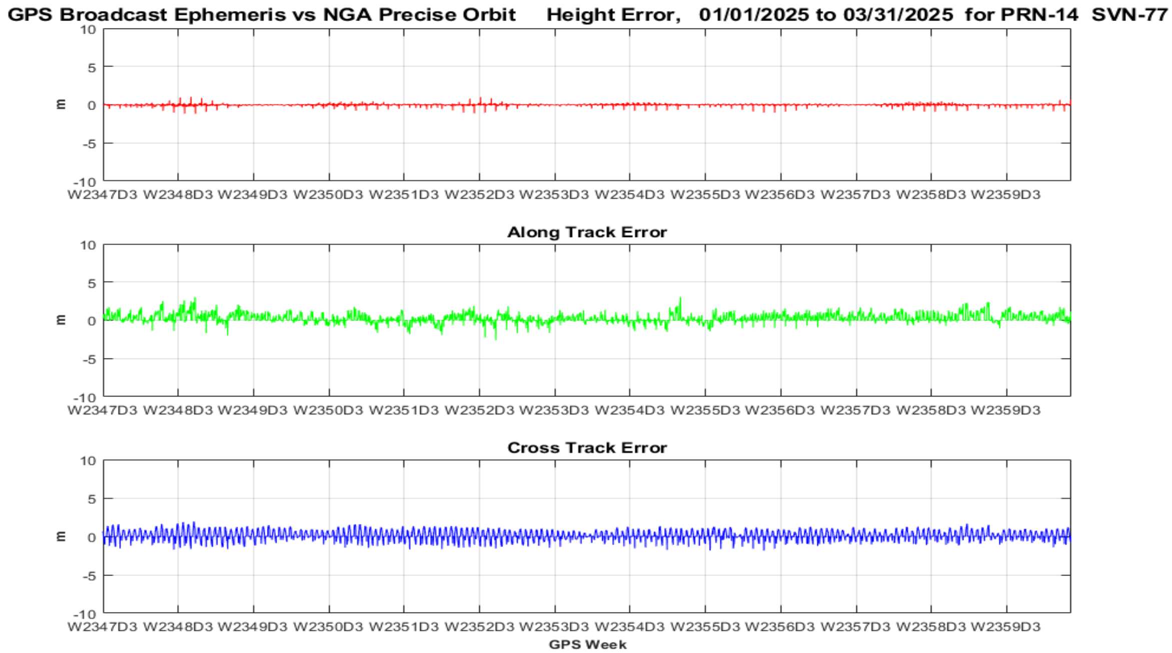



**Figure 9-35 Orbit Error PRN14 (SVN77) Using C/A Nav Data**

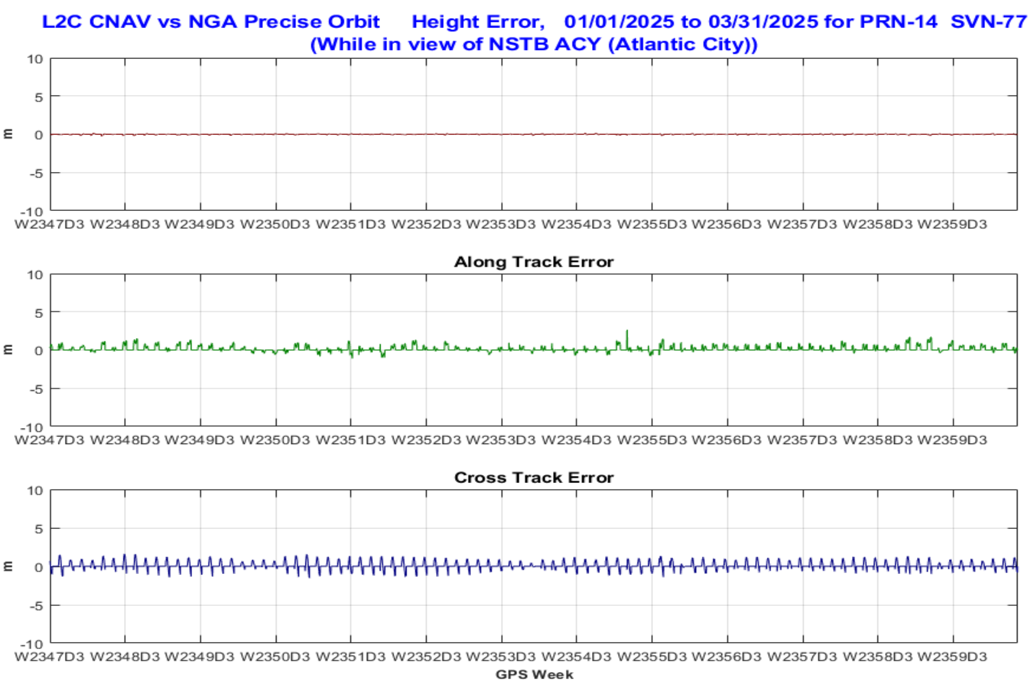



**Figure 9-36 Orbit Error PRN14 (SVN77) Using L2C CNAV Data**

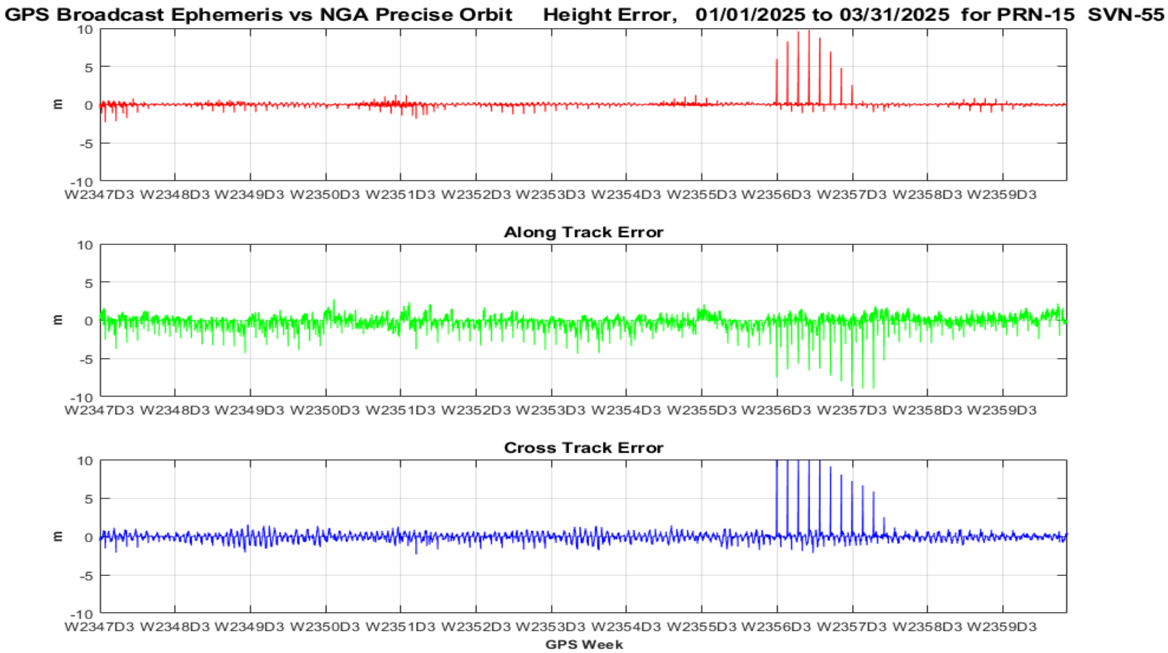



**Figure 9-37 Orbit Error PRN15 (SVN55) Using C/A Nav Data**

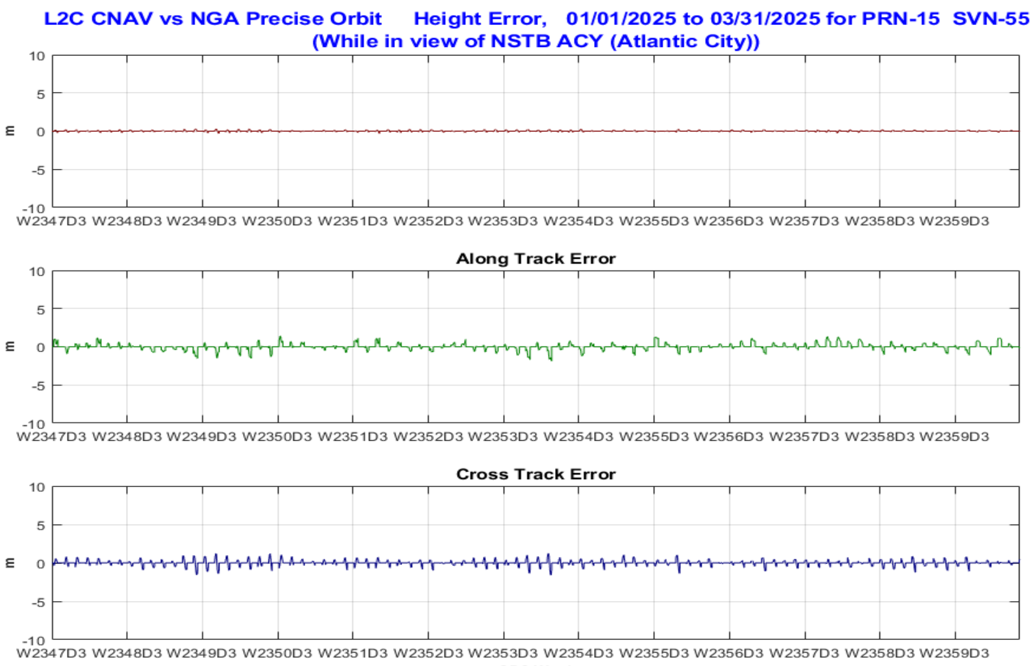



**Figure 9-38 Orbit Error PRN15 (SVN55) Using L2C CNAV Data**

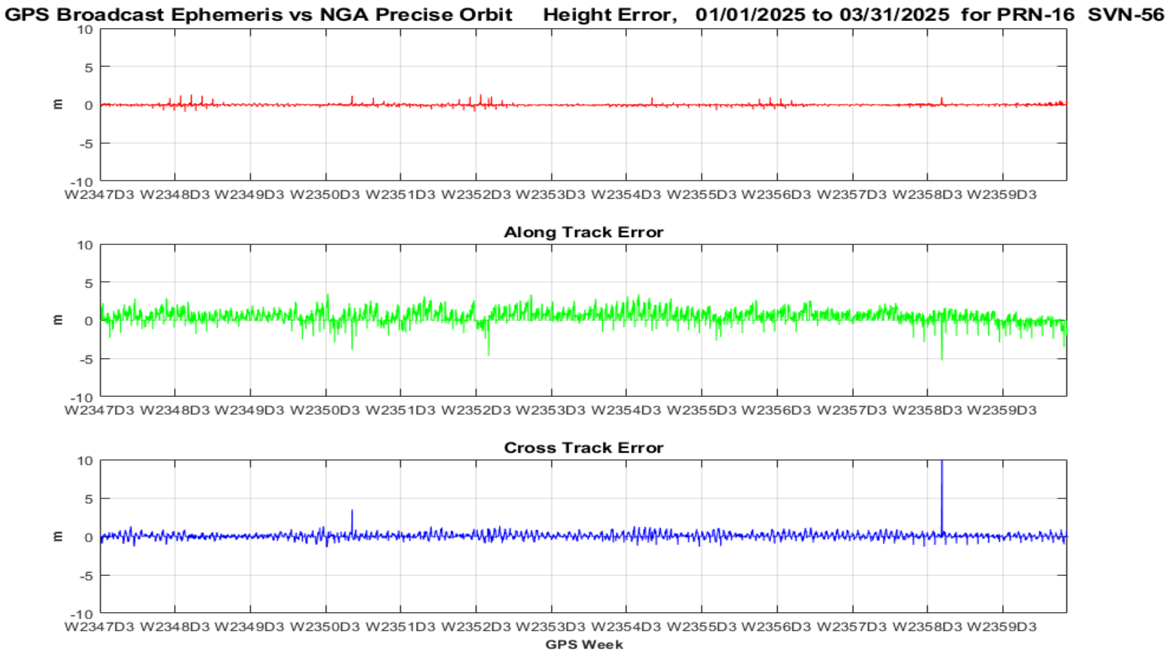



**Figure 9-39 Orbit Error PRN16 (SVN56) Using C/A Nav Data**

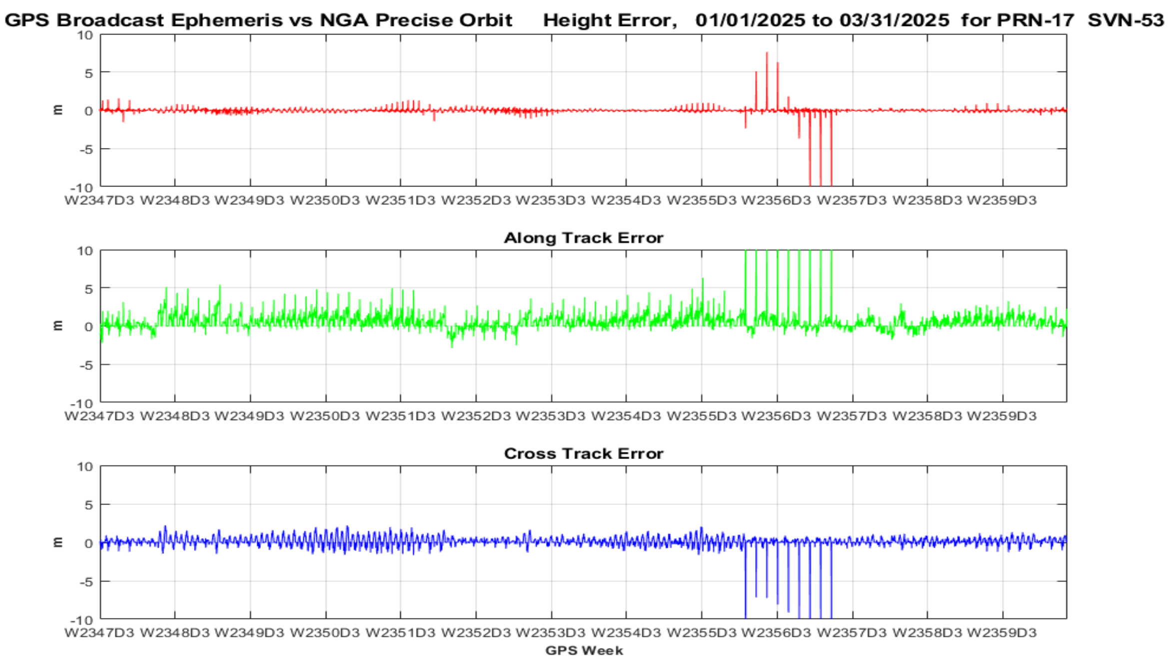



**Figure 9-40 Orbit Error PRN17 (SVN53) Using C/A Nav Data**

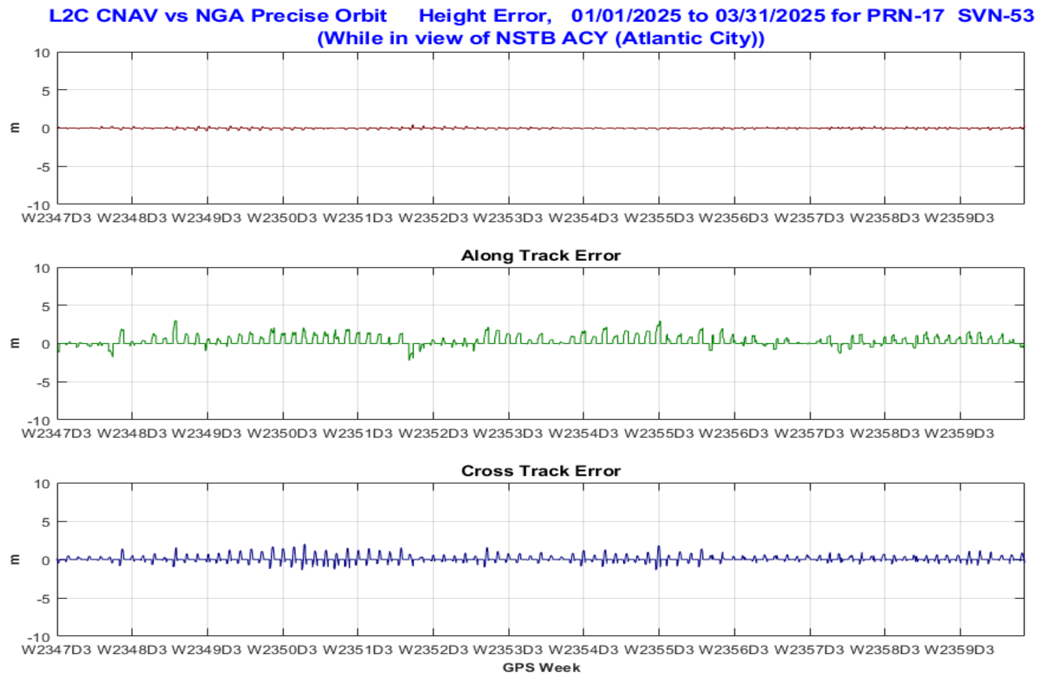



**Figure 9-41 Orbit Error PRN17 (SVN53) Using L2C CNAV Data**

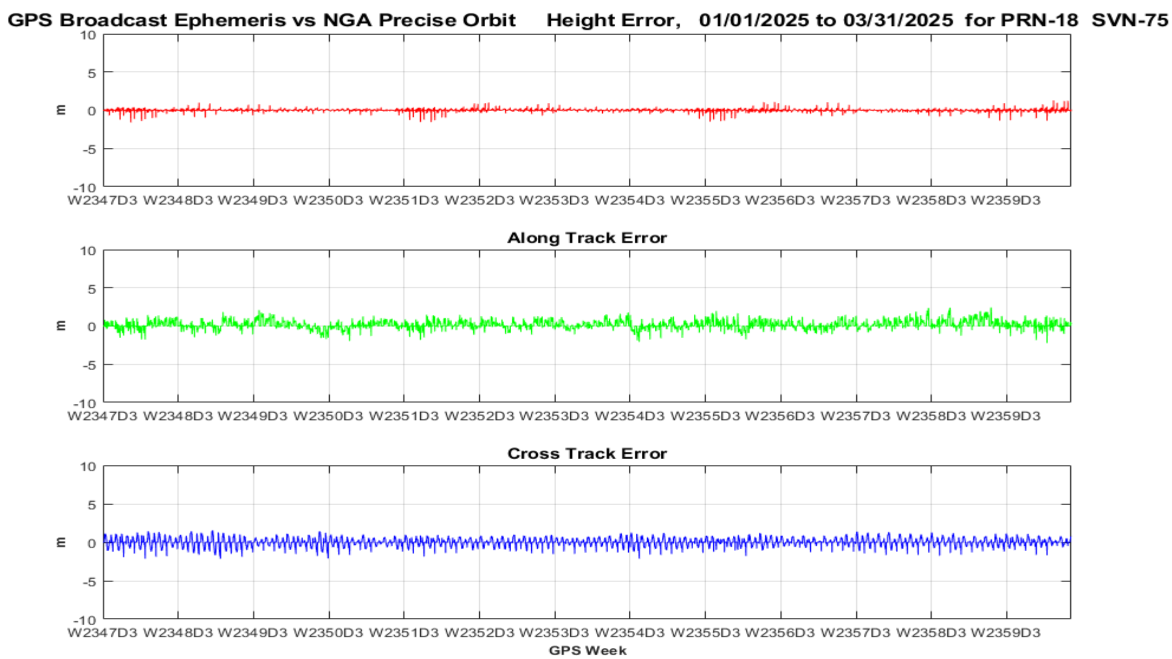



**Figure 9-42 Orbit Error PRN18 (SVN75) Using C/A Nav Data**

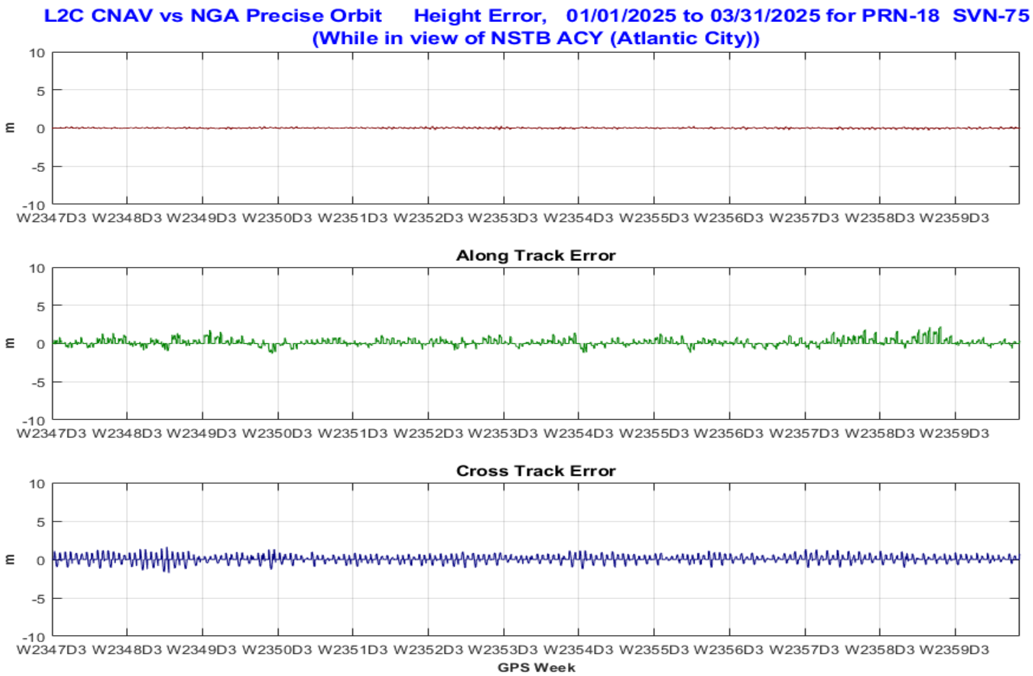



**Figure 9-43 Orbit Error PRN18 (SVN75) Using L2C CNAV Data**

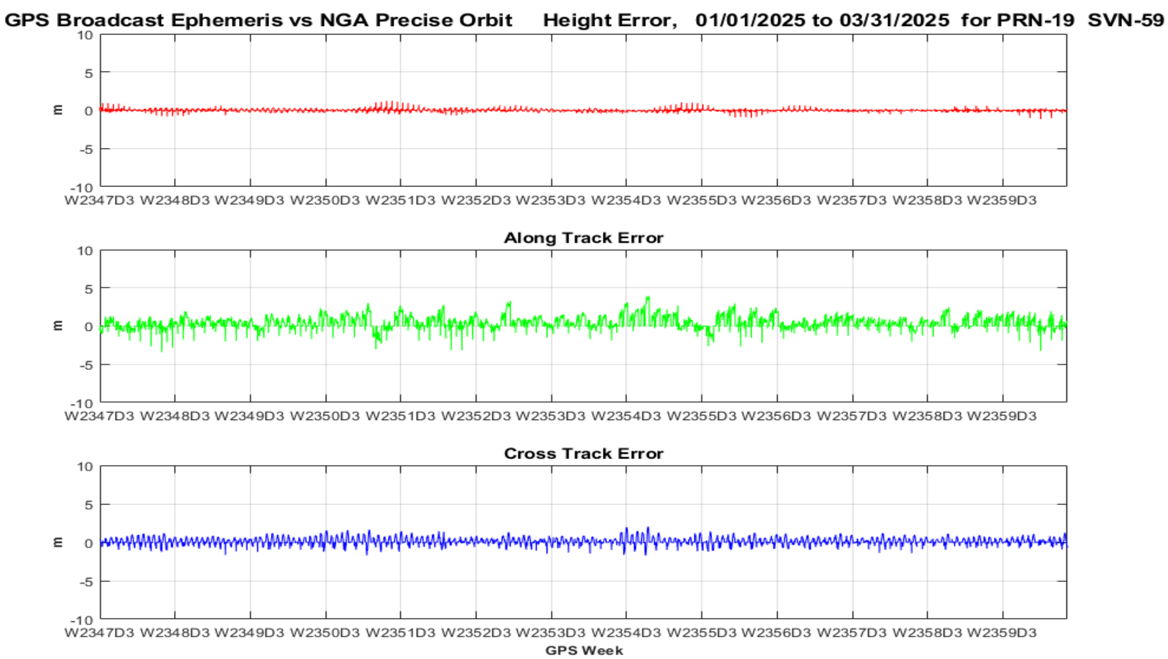



**Figure 9-44 Orbit Error PRN19 (SVN59) Using C/A Nav Data**

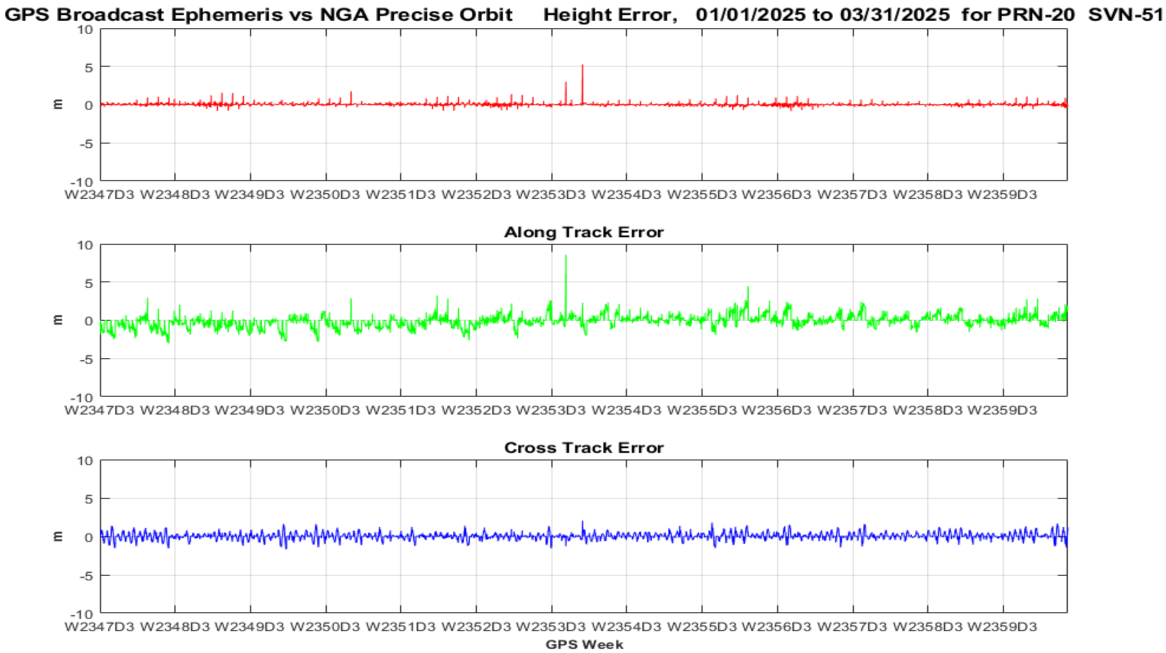



**Figure 9-45 Orbit Error PRN20 (SVN51) Using C/A Nav Data**

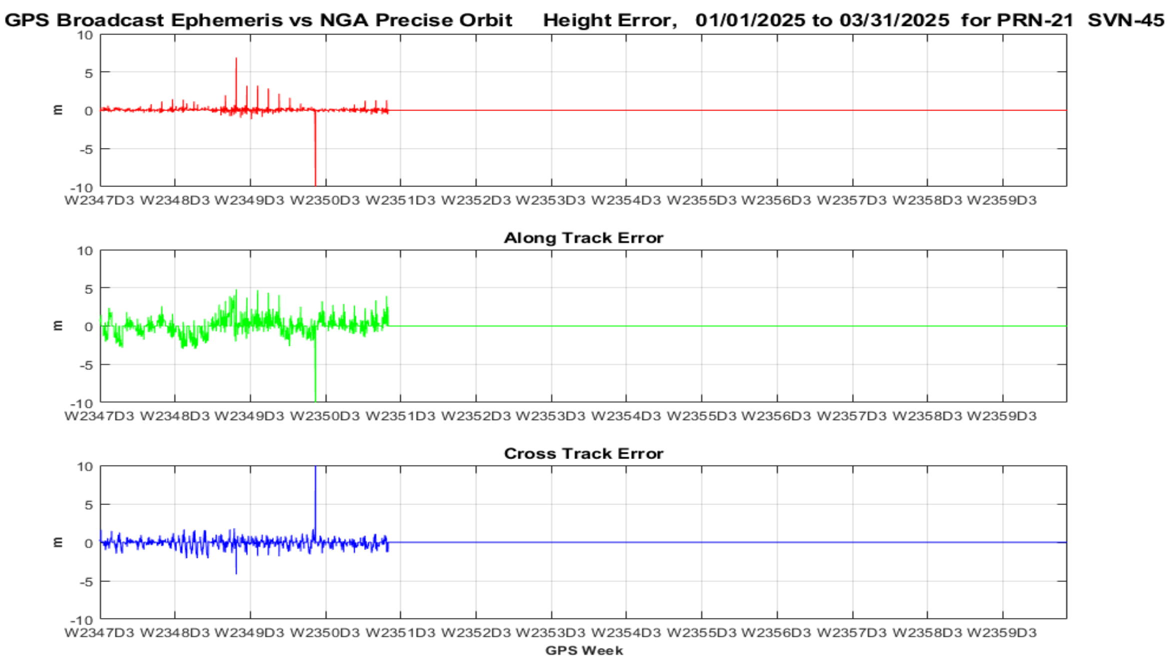



**Figure 9-46 Orbit Error PRN21 (SVN45) Using C/A Nav Data**

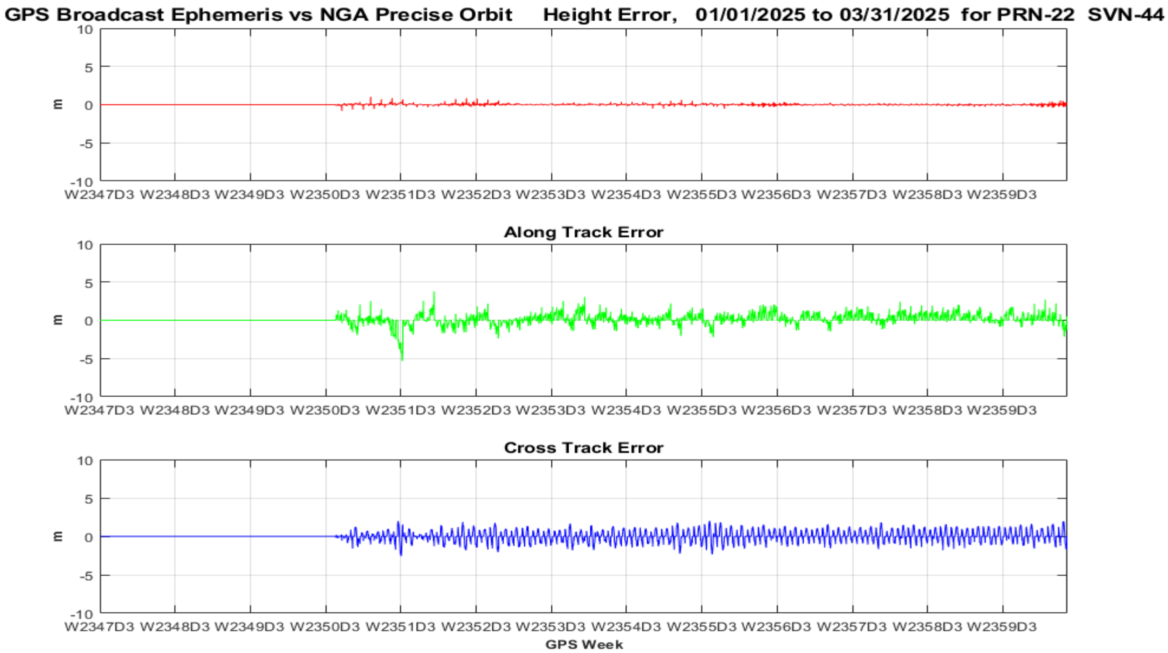



**Figure 9-47 Orbit Error PRN22 (SVN44) Using C/A Nav Data**

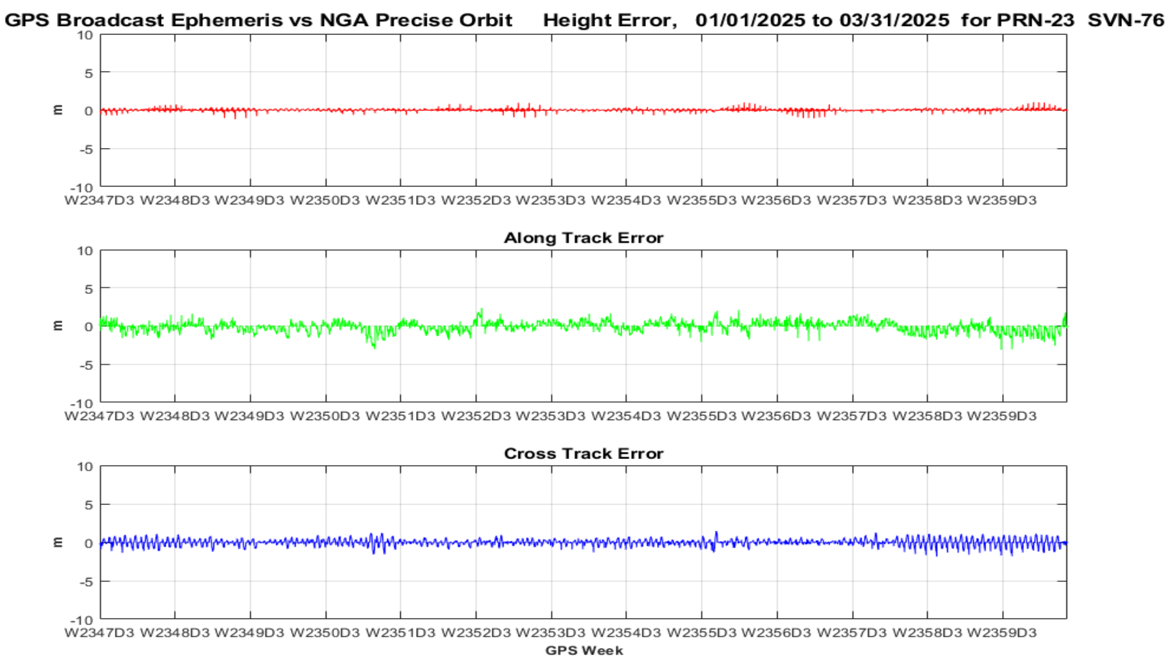



**Figure 9-48 Orbit Error PRN23 (SVN76) Using C/A Nav Data**

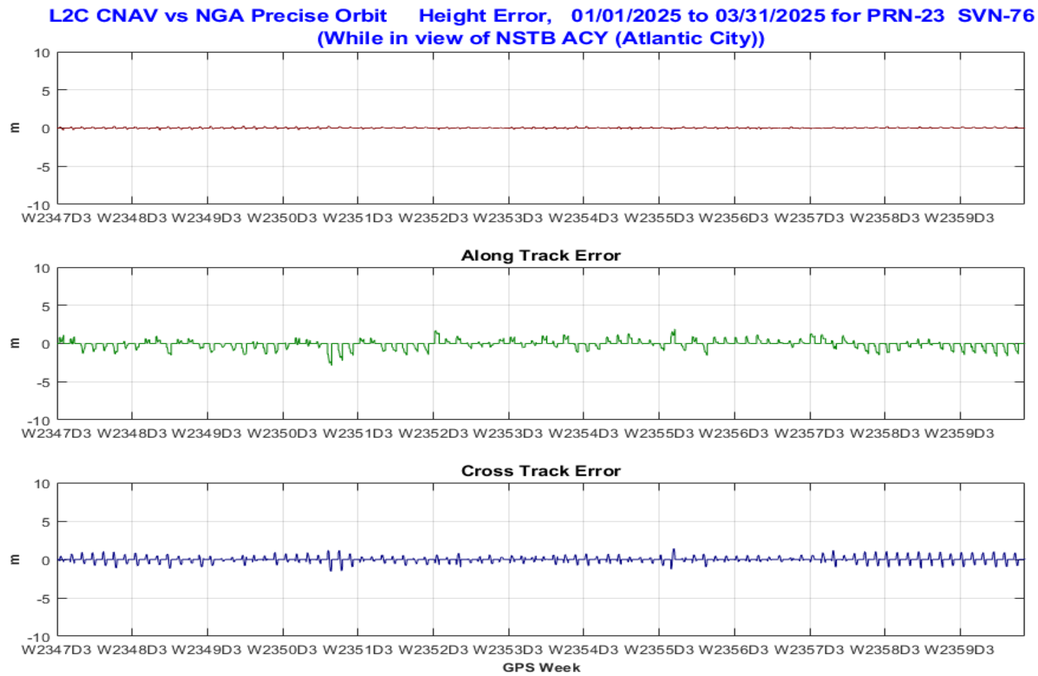



**Figure 9-49 Orbit Error PRN23 (SVN76) Using L2C CNAV Data**

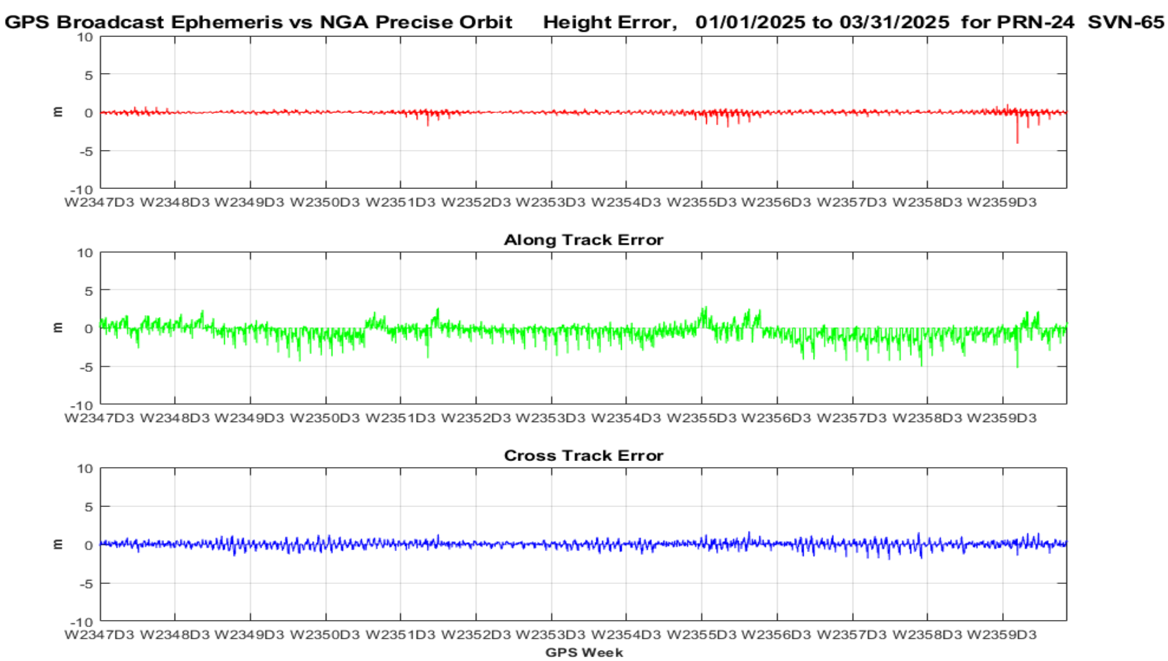



**Figure 9-50 Orbit Error PRN24 (SVN65) Using C/A Nav Data**

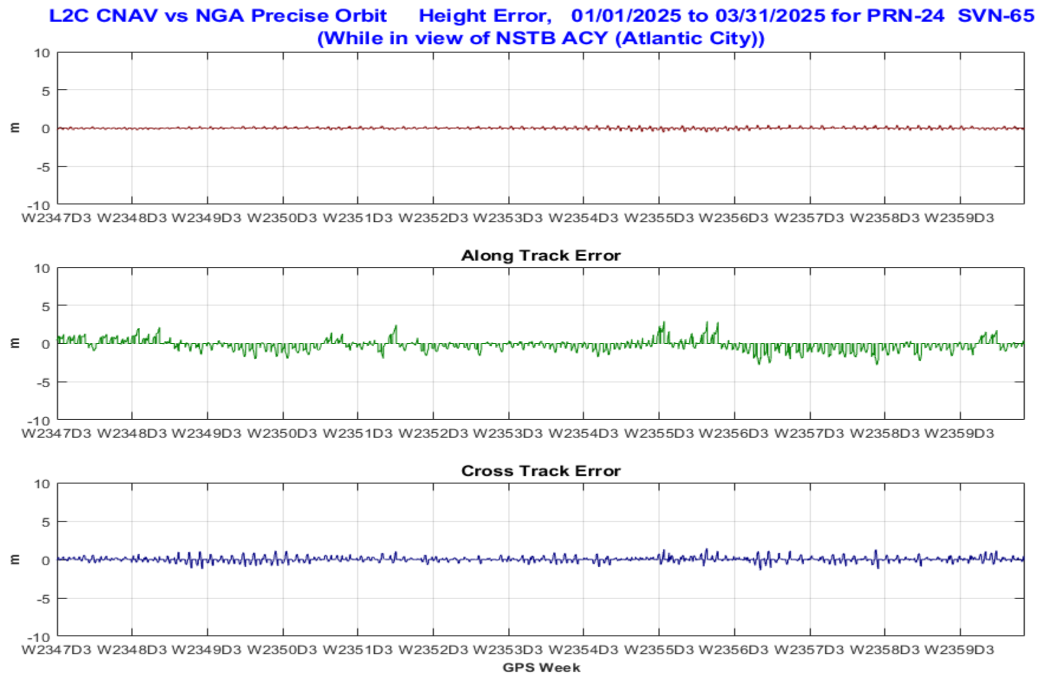



**Figure 9-51 Orbit Error PRN24 (SVN65) Using L2C CNAV Data**

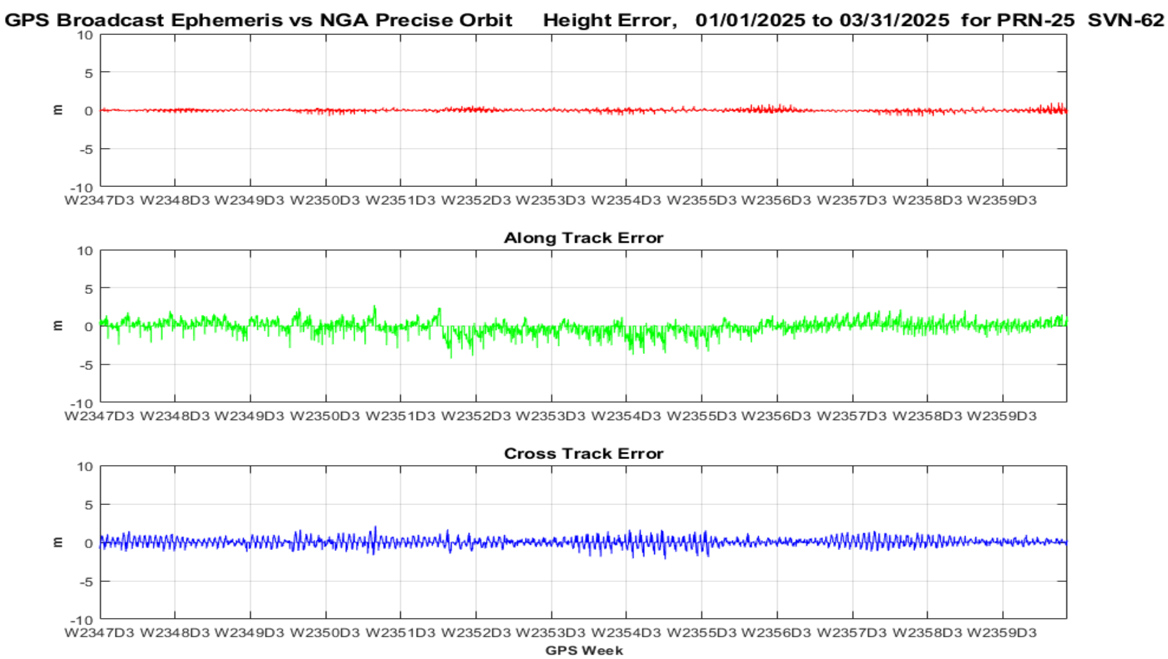



**Figure 9-52 Orbit Error PRN25 (SVN62) Using C/A Nav Data**

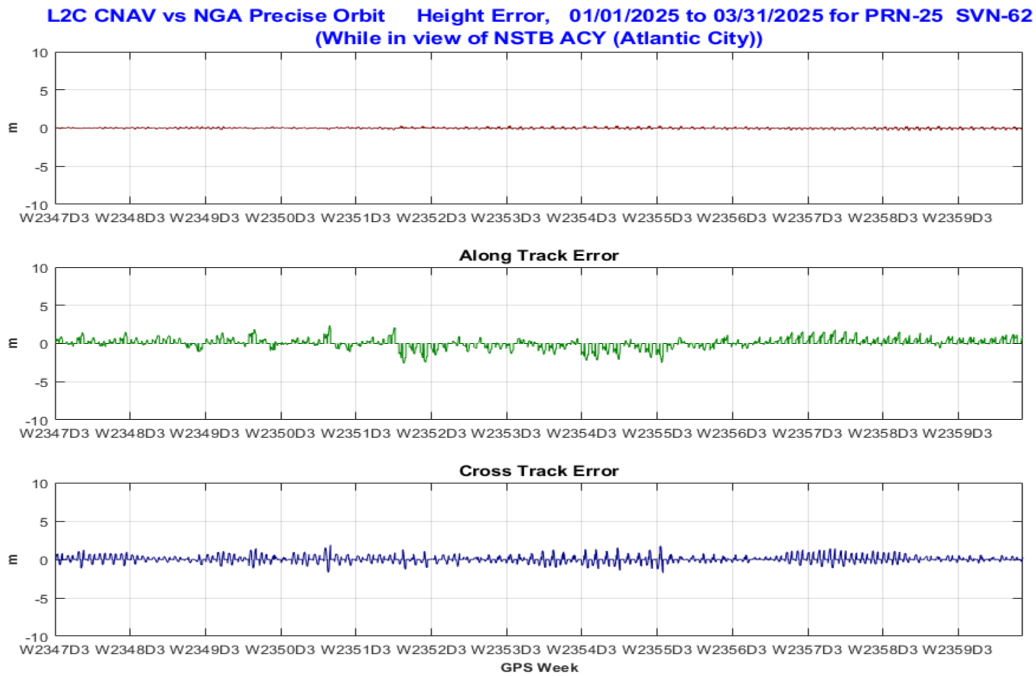



**Figure 9-53 Orbit Error PRN25 (SVN62) Using L2C CNAV Data**

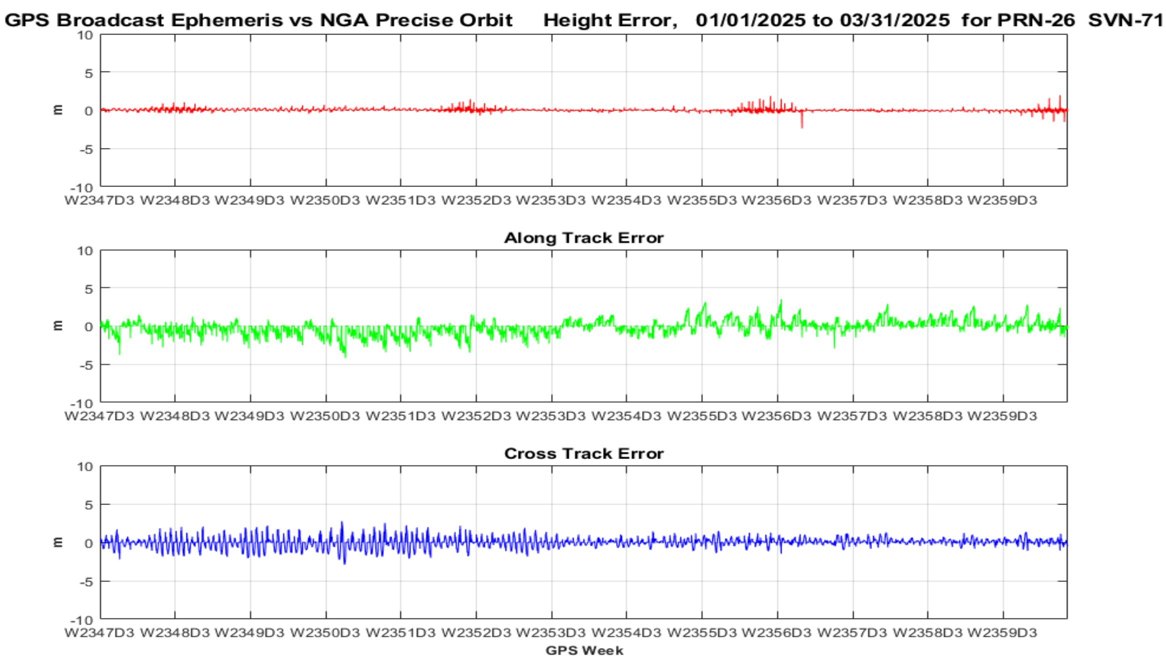



**Figure 9-54 Orbit Error PRN26 (SVN71) Using C/A Nav Data**

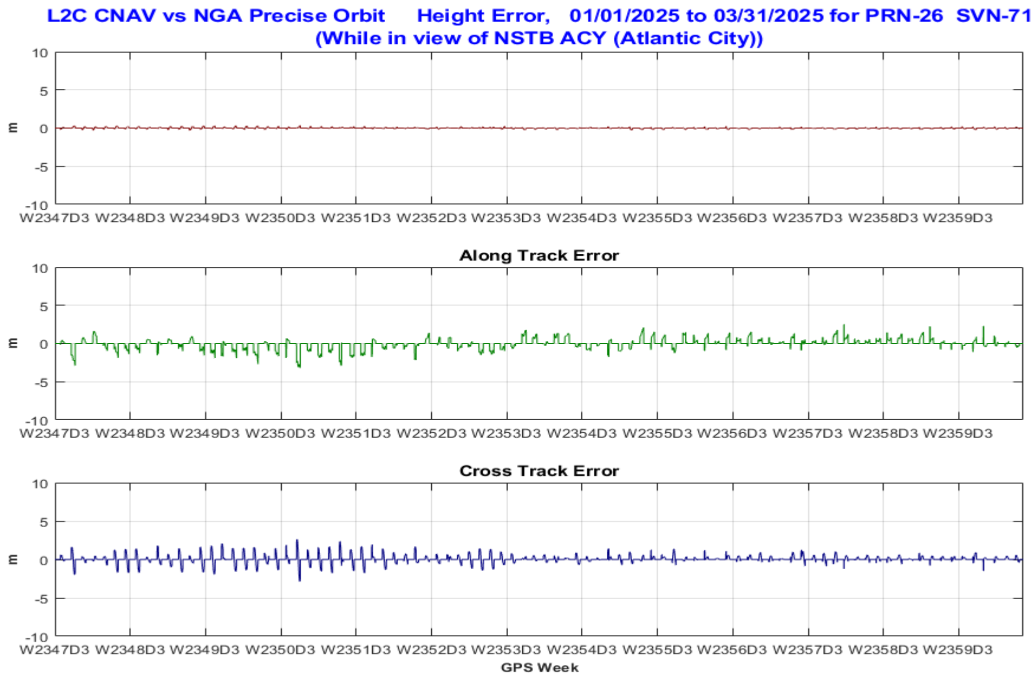



**Figure 9-55 Orbit Error PRN26 (SVN71) Using L2C CNAV Data**

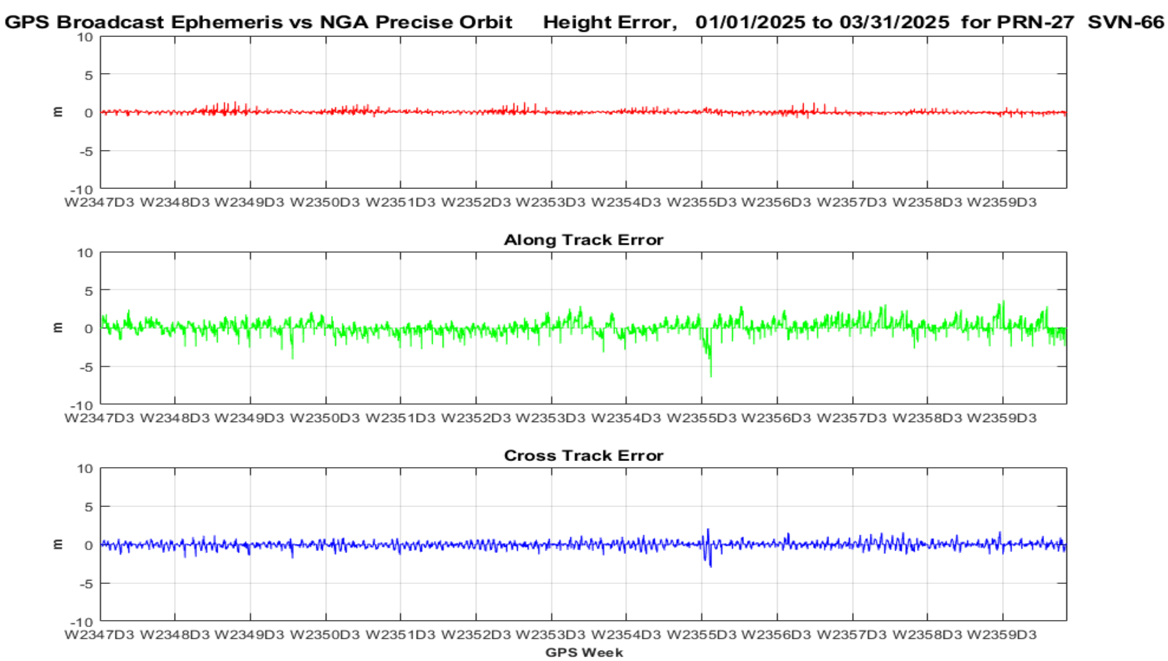



**Figure 9-56 Orbit Error PRN27 (SVN66) Using C/A Nav Data**

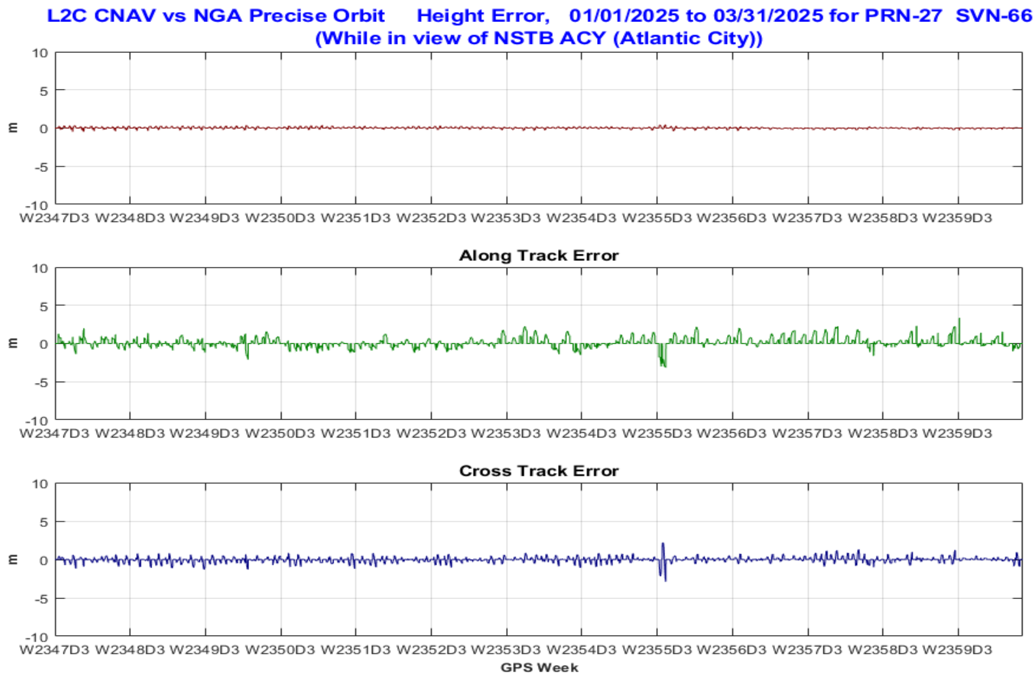



**Figure 9-57 Orbit Error PRN27 (SVN66) Using L2C CNAV Data**

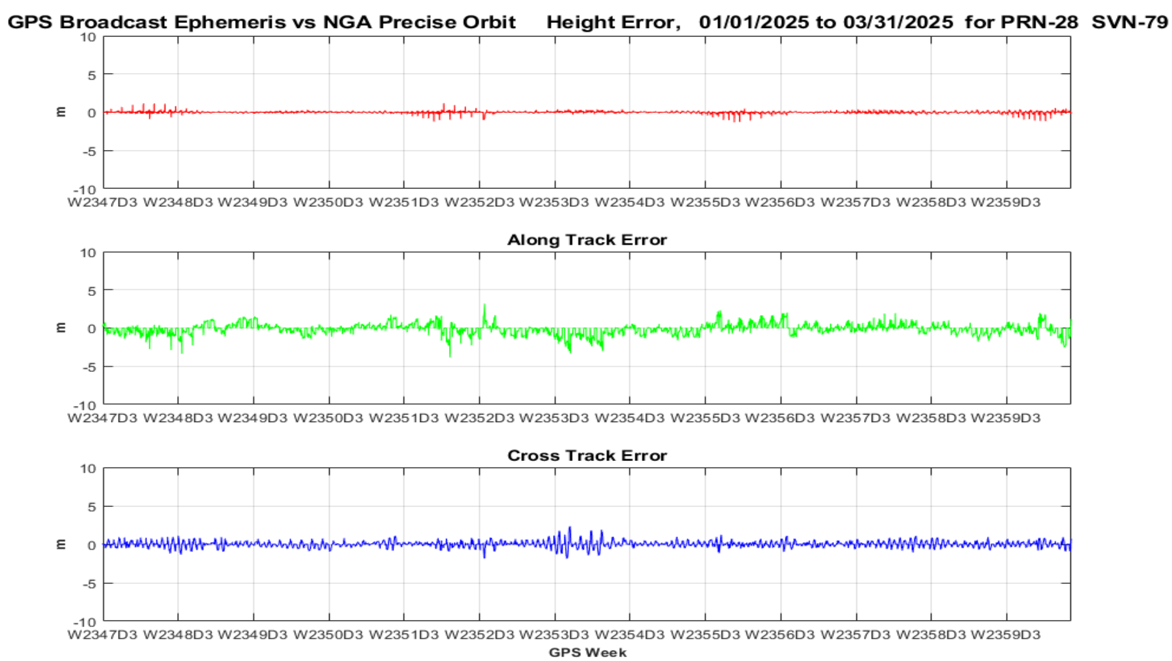



**Figure 9-58 Orbit Error PRN28 (SVN79) Using C/A Nav Data**

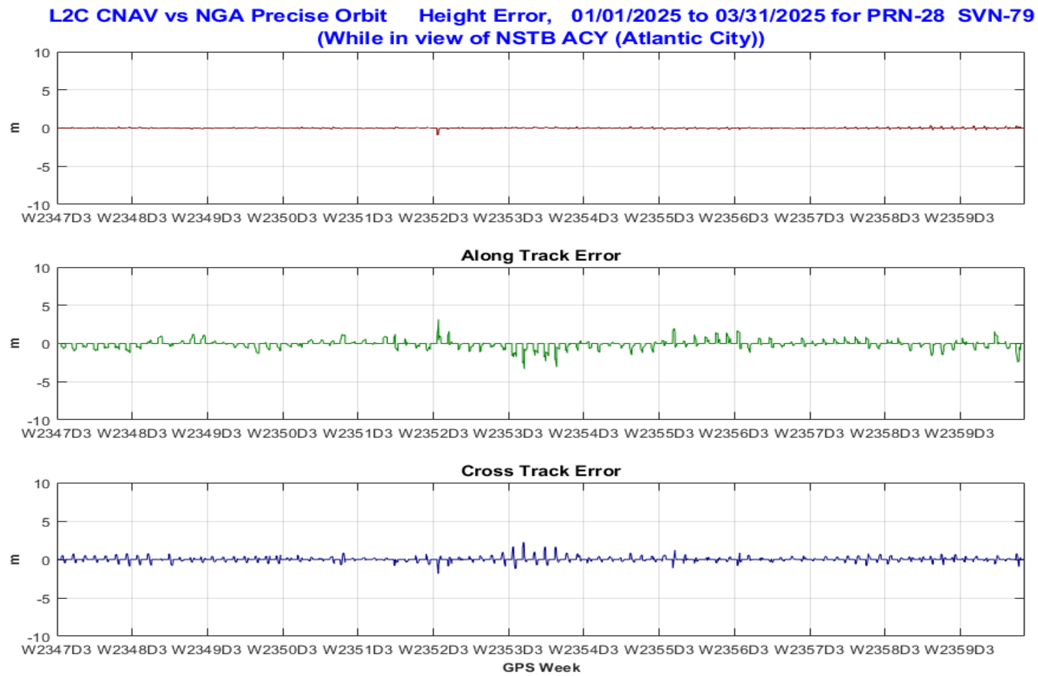



**Figure 9-59 Orbit Error PRN28 (SVN79) Using L2C CNAV Data**

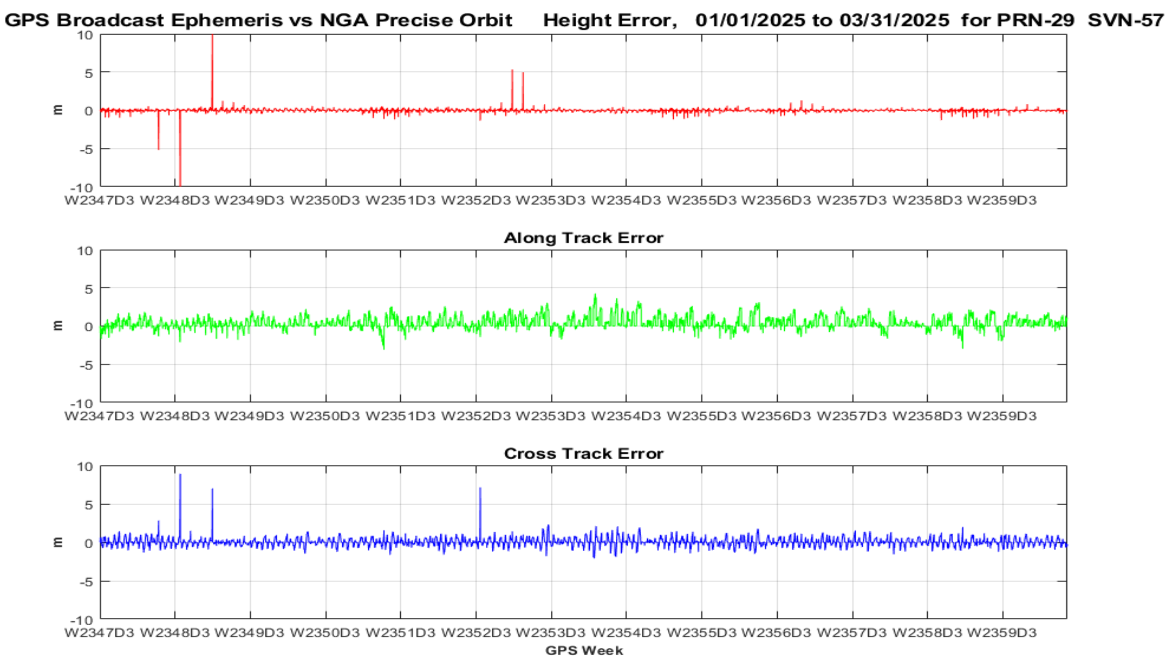



**Figure 9-60 Orbit Error PRN29 (SVN57) Using C/A Nav Data**

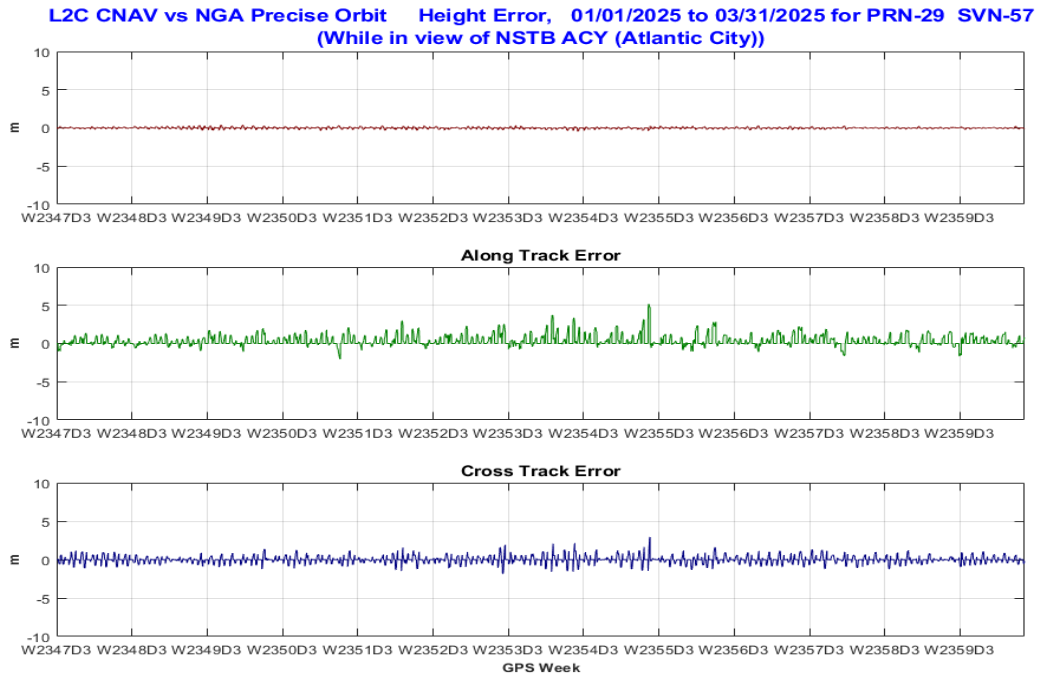



**Figure 9-61 Orbit Error PRN29 (SVN57) Using L2C CNAV Data**

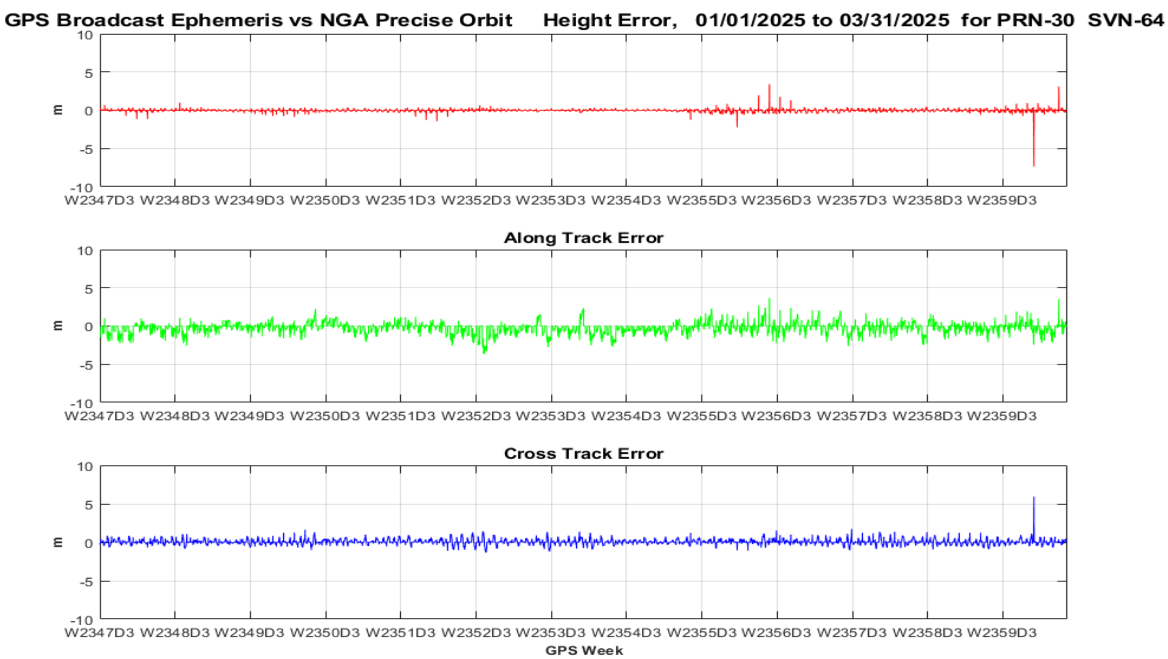



**Figure 9-62 Orbit Error PRN30 (SVN64) Using C/A Nav Data**

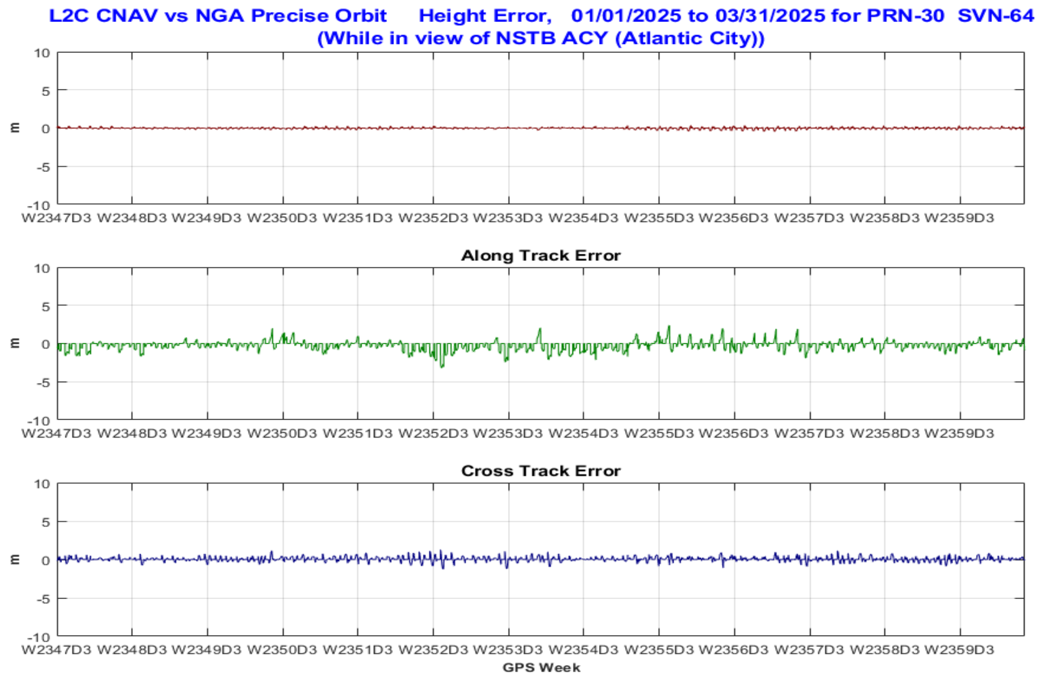



**Figure 9-63 Orbit Error PRN30 (SVN64) Using L2C CNAV Data**

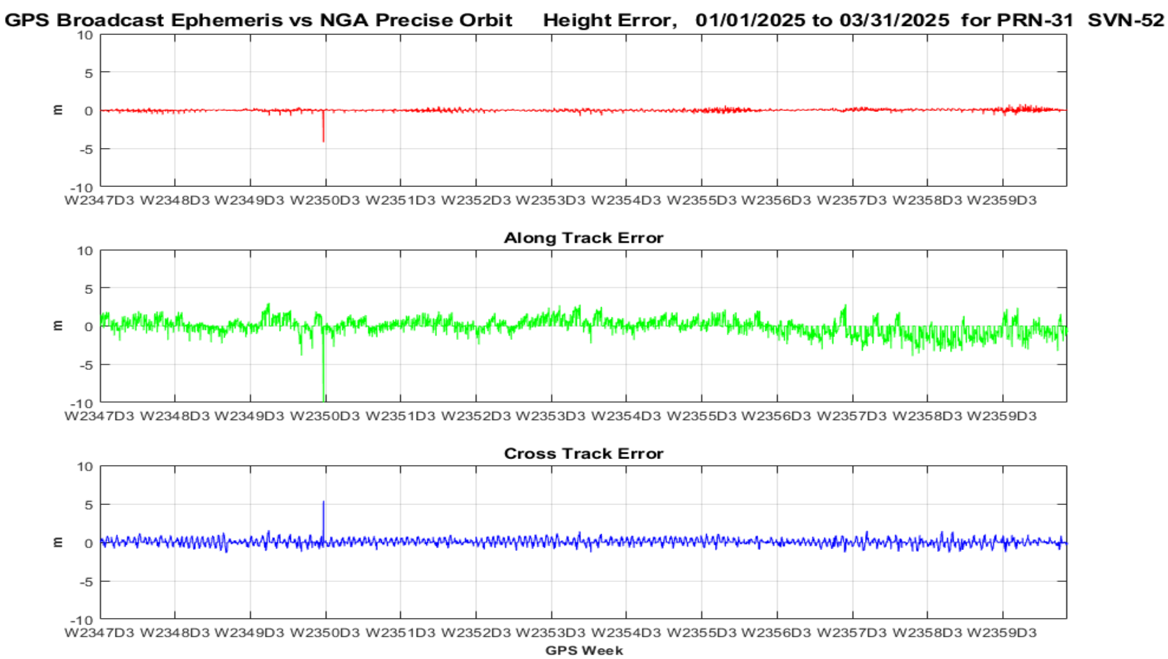



**Figure 9-64 Orbit Error PRN31 (SVN52) Using C/A Nav Data**

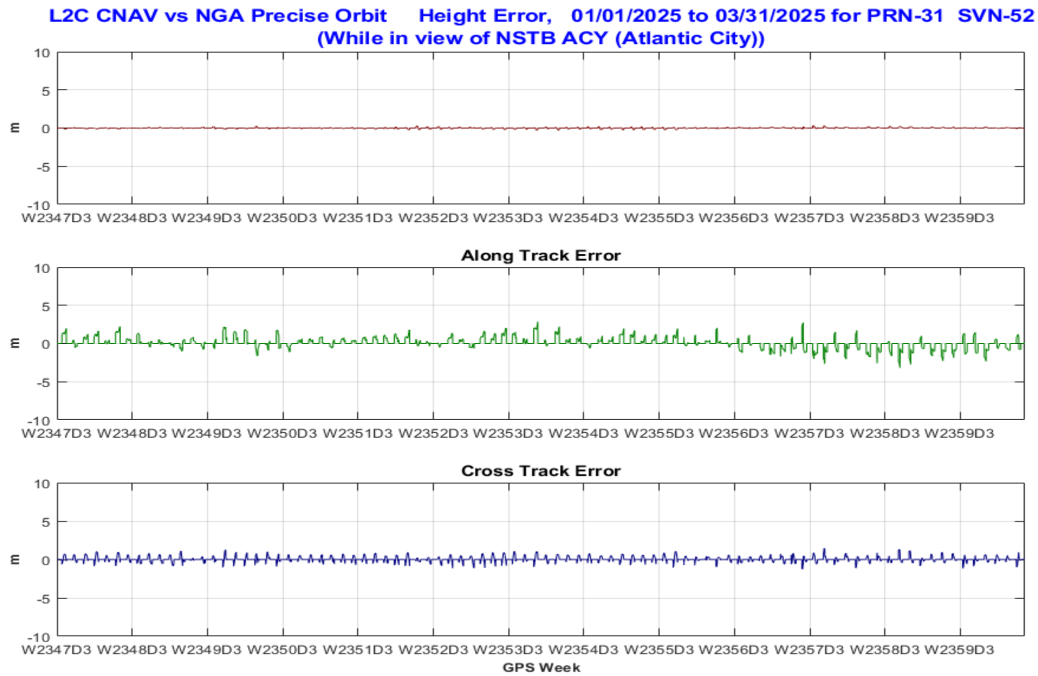



**Figure 9-65 Orbit Error PRN31 (SVN52) Using L2C CNAV Data**

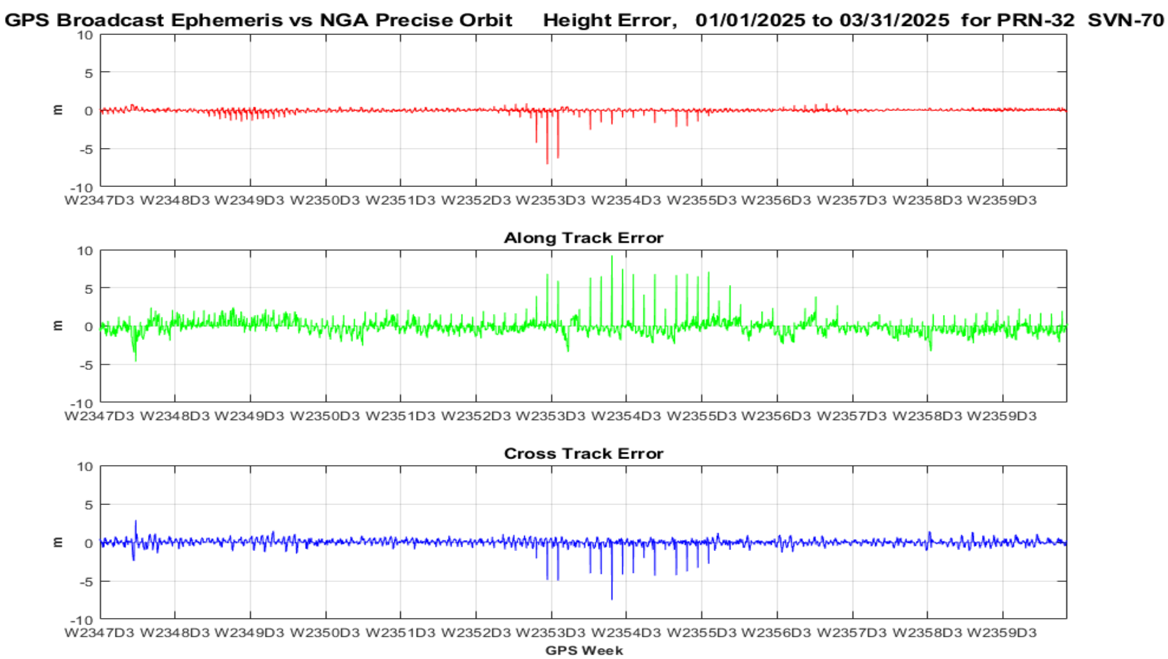



**Figure 9-66 Orbit Error PRN32 (SVN70) Using C/A Nav Data**

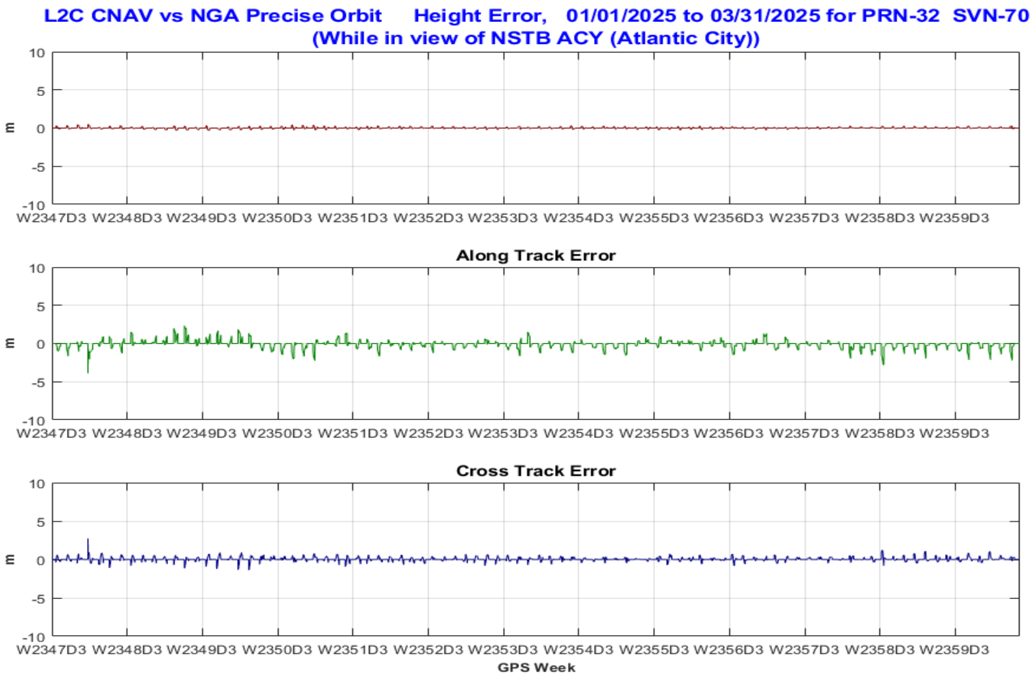



**Figure 9-67 Orbit Error PRN32 (SVN70) Using L2C CNAV Data**

## 9.6 QQ Plots of URA Normalized Error for All Satellites

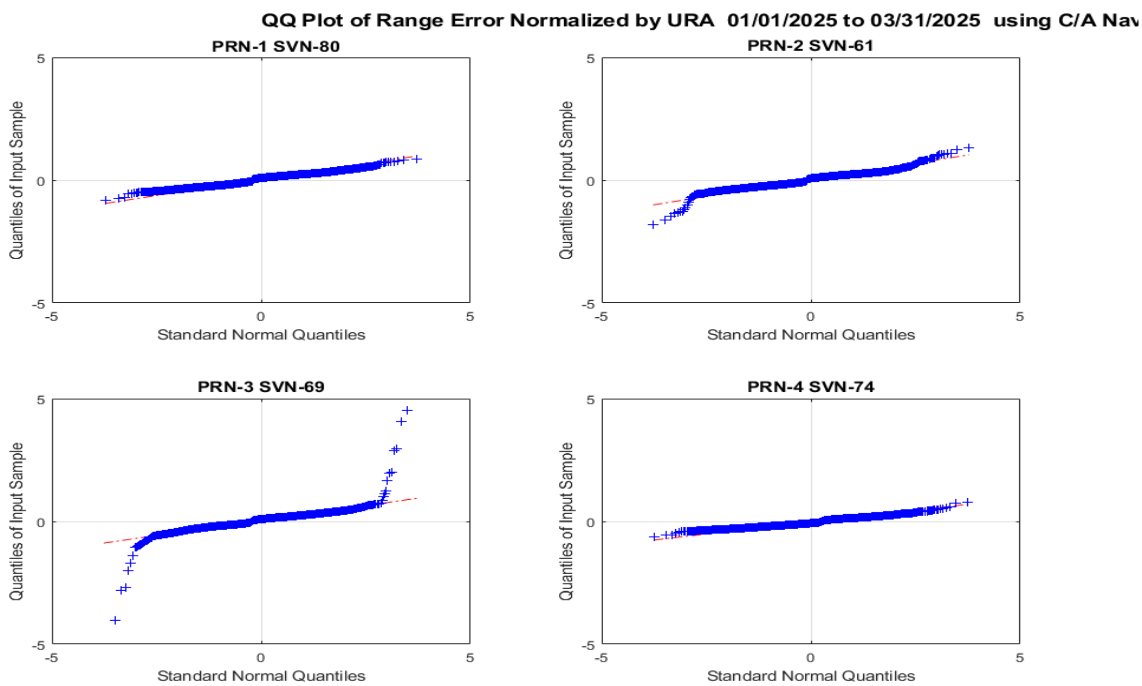



**Figure 9-68 QQ Plots of Range Error PRNs 1 to 4 Using C/A Nav Data**

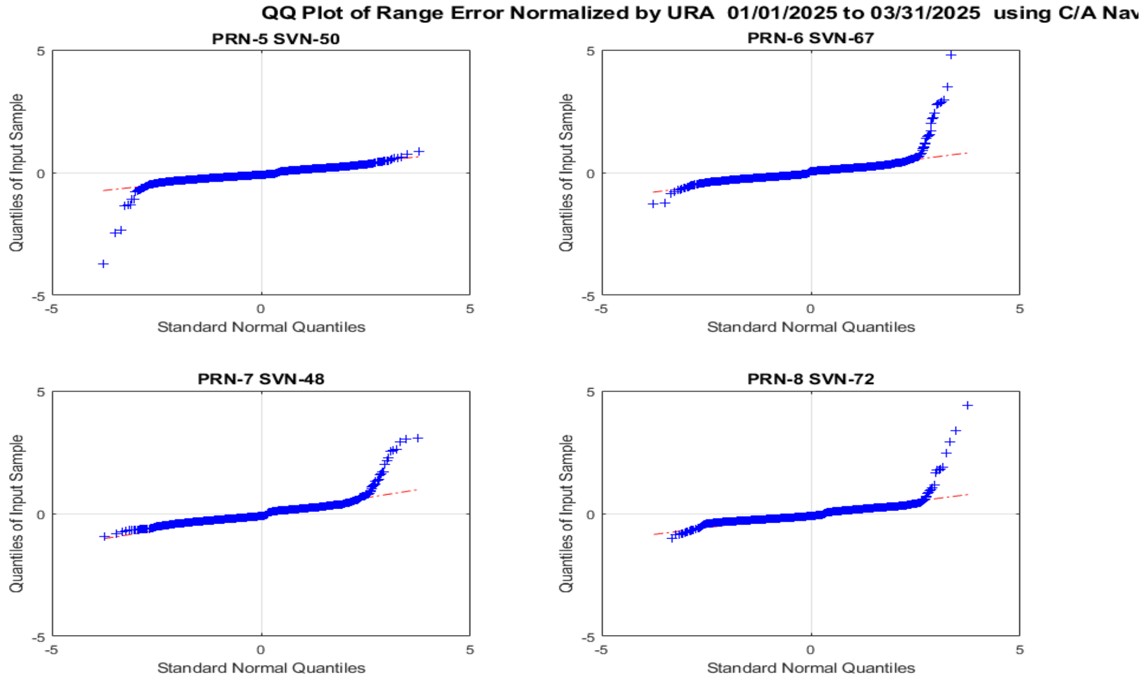



**Figure 9-69 QQ Plots of Range Error PRNs 5 to 8 Using C/A Nav Data**

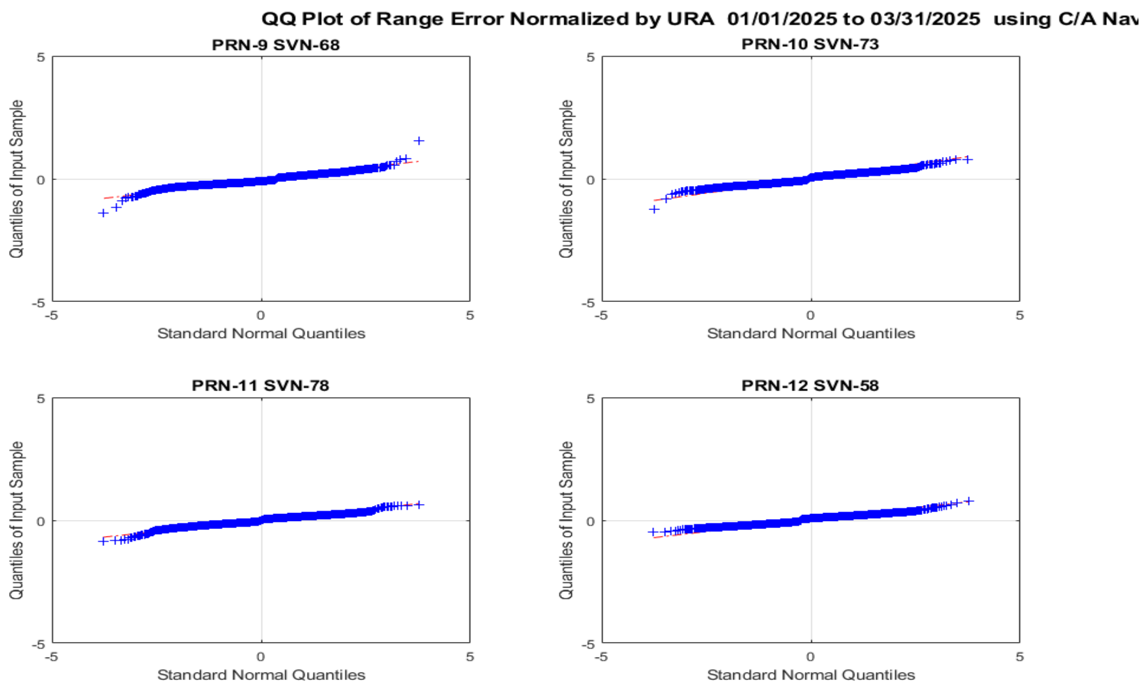



**Figure 9-70 QQ Plots of Range Error PRNs 9 to 12 Using C/A Nav Data**

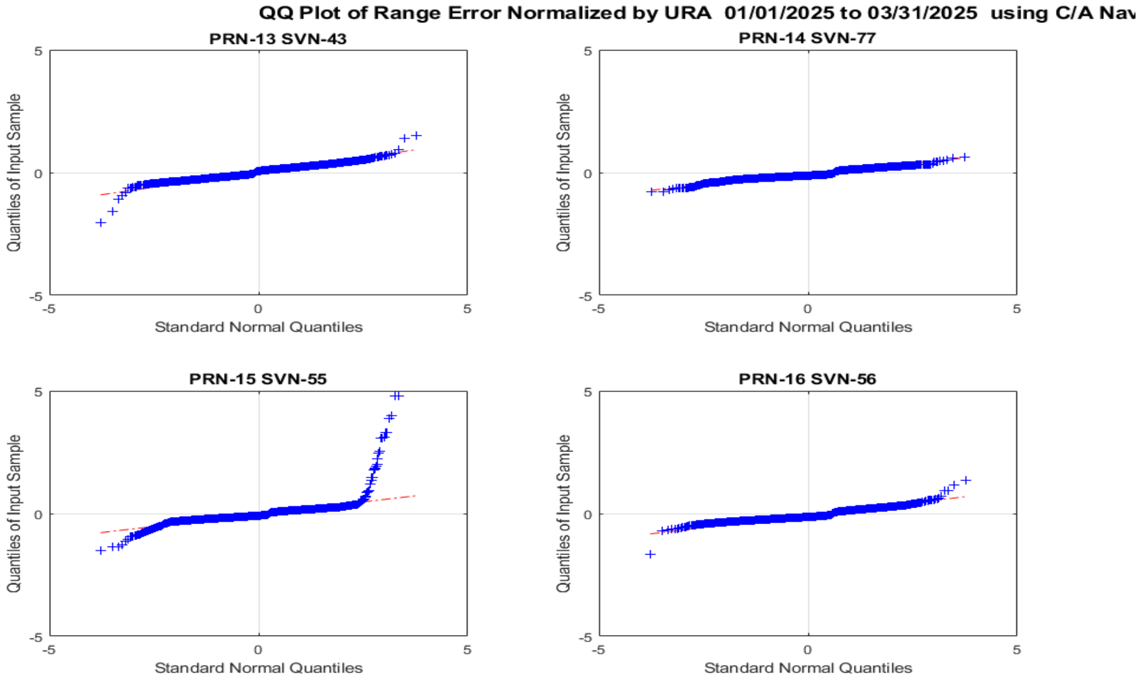



**Figure 9-71 QQ Plots of Range Error PRNs 13 to 16 Using C/A Nav Data**

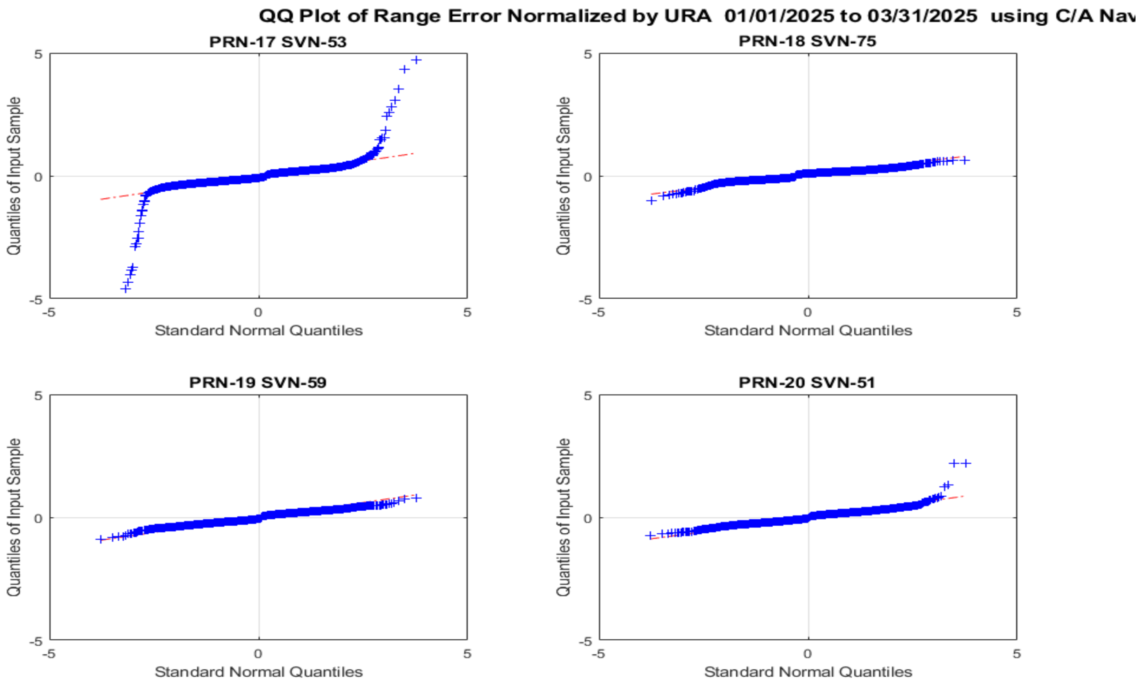



**Figure 9-72 QQ Plots of Range Error PRNs 17 to 20 Using C/A Nav Data**

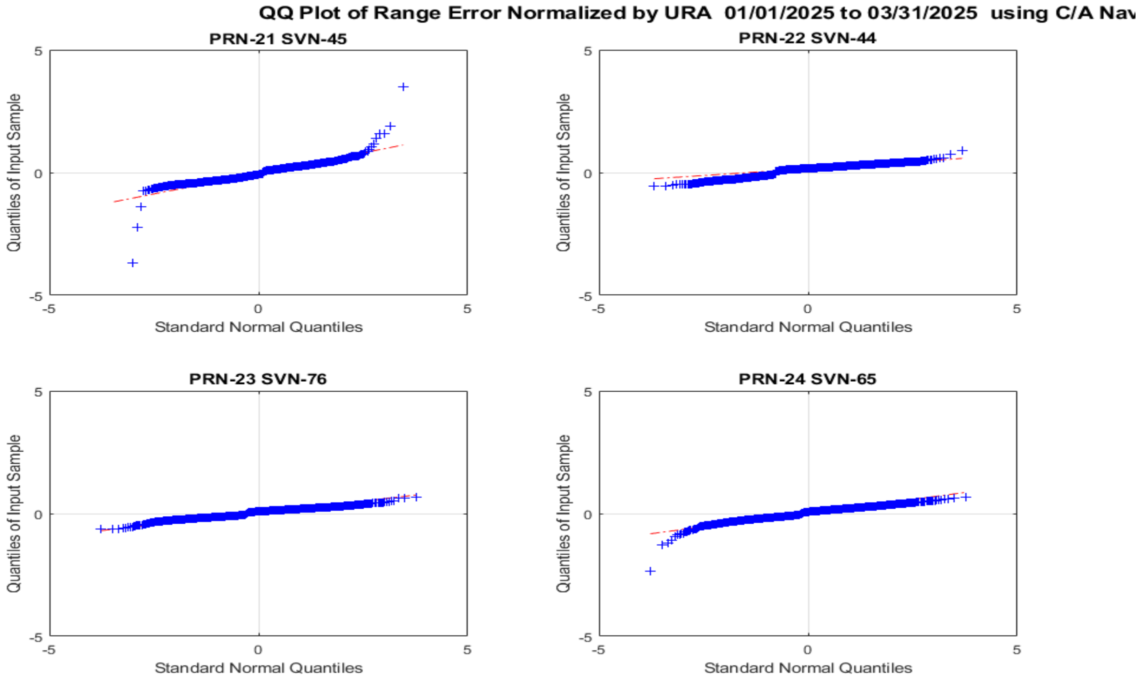



**Figure 9-73 QQ Plots of Range Error PRNs 21 to 24 Using C/A Nav Data**

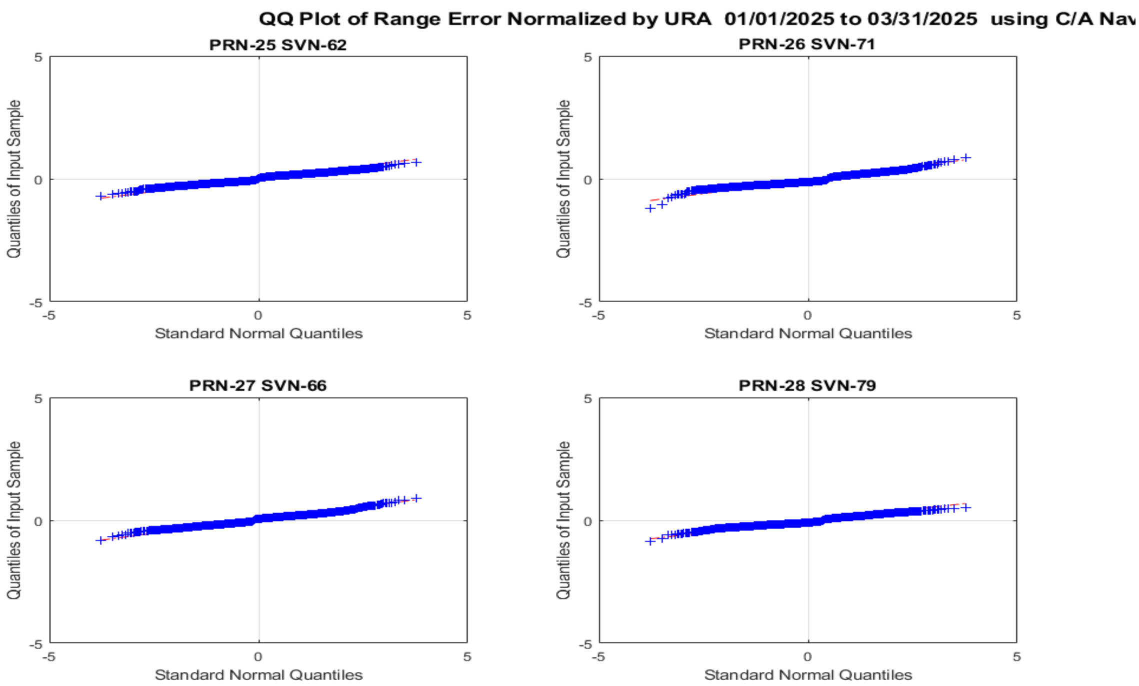



**Figure 9-74 QQ Plots of Range Error PRNs 25 to 28 Using C/A Nav Data**

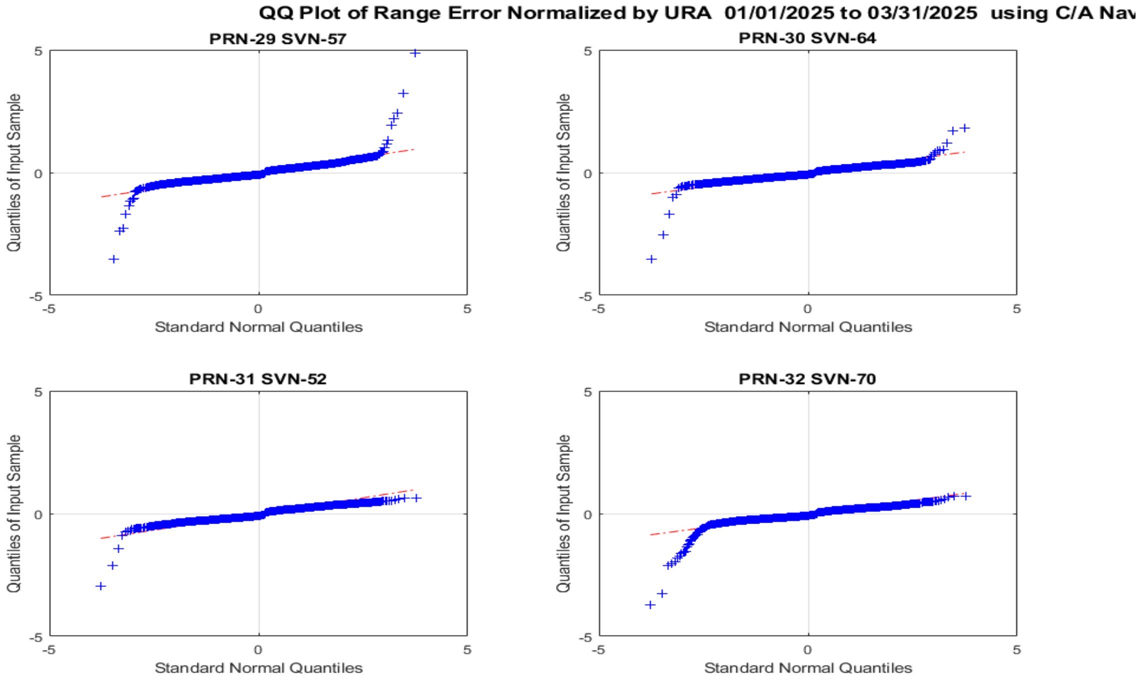



**Figure 9-75 QQ Plots of Range Error PRNs 29 to 32 Using C/A Nav Data**

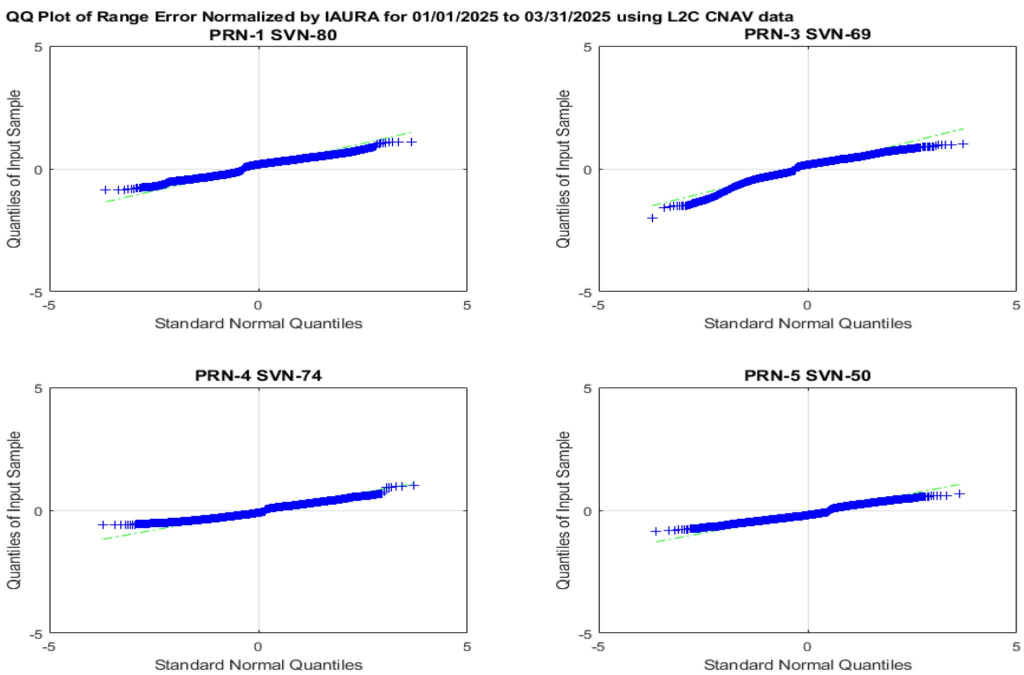



**Figure 9-76 QQ Plots of Range Error PRNs 1, 3, 4, and 5 Using L2C CNAV Data**

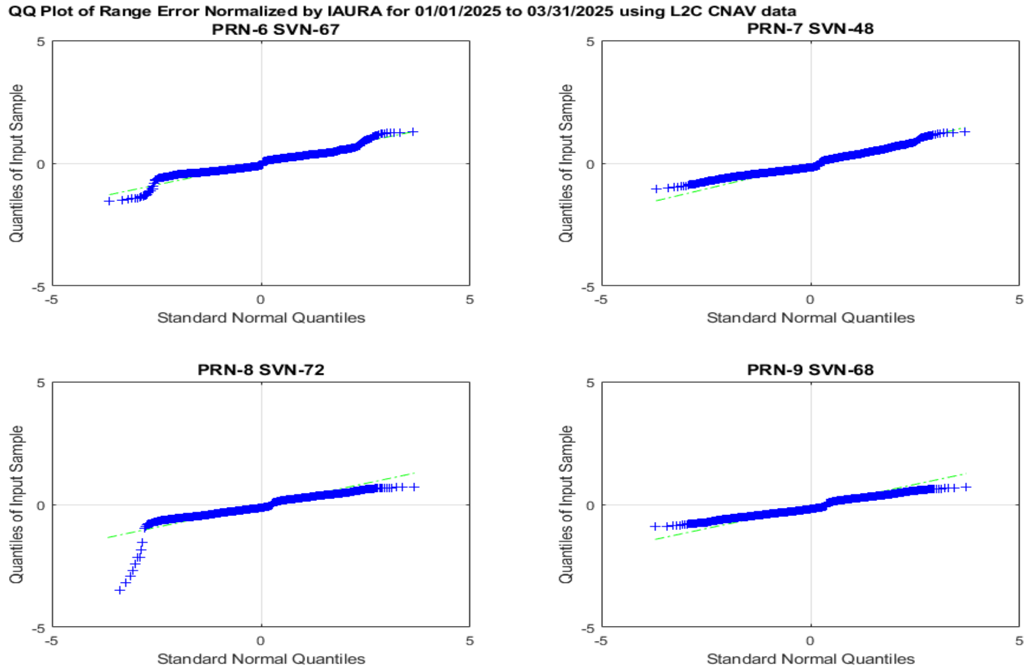



**Figure 9-77 QQ Plots of Range Error PRNs 6, 7, 8, and 9 Using L2C CNAV Data**

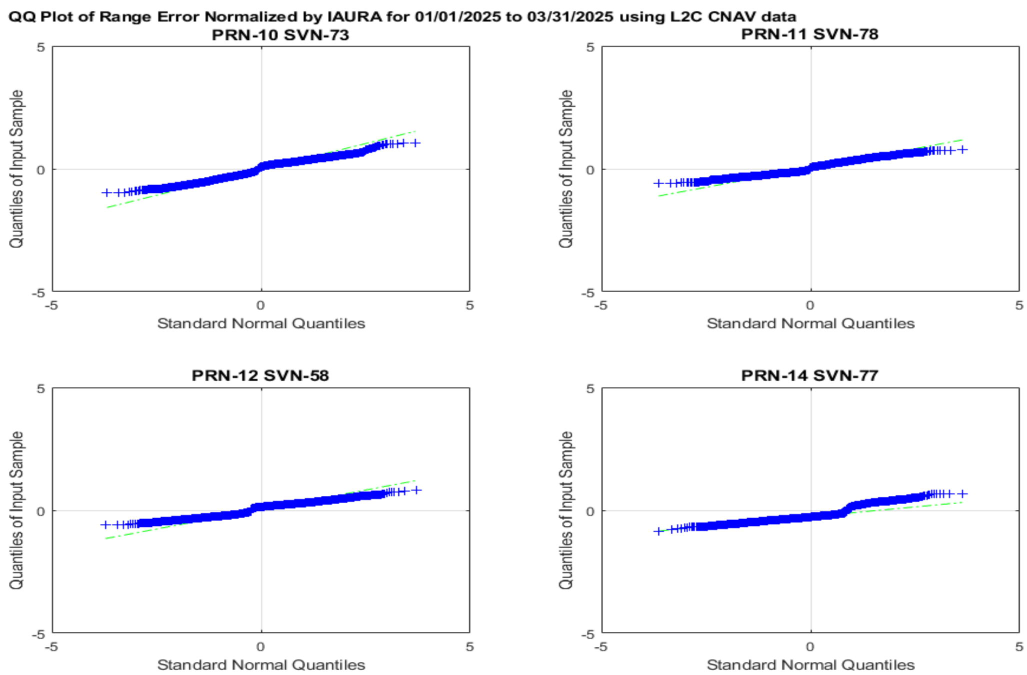



**Figure 9-78 QQ Plots of Range Error PRNs 10, 11, 12, and 14 Using L2C CNAV Data**

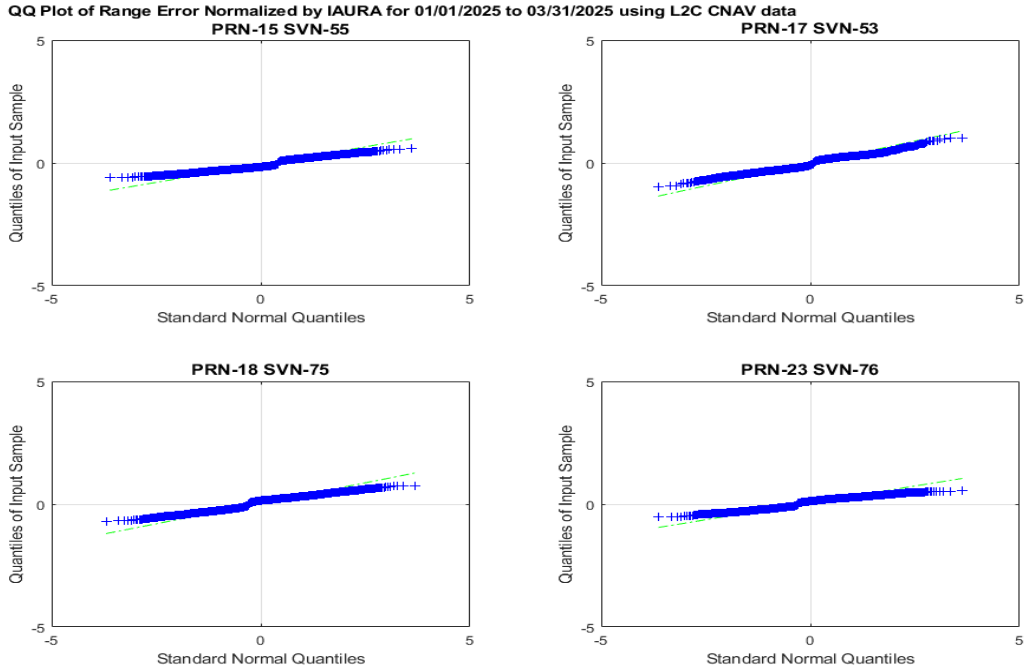



**Figure 9-79 QQ Plots of Range Error PRNs 15, 17, 18, and 23 Using L2C CNAV Data**

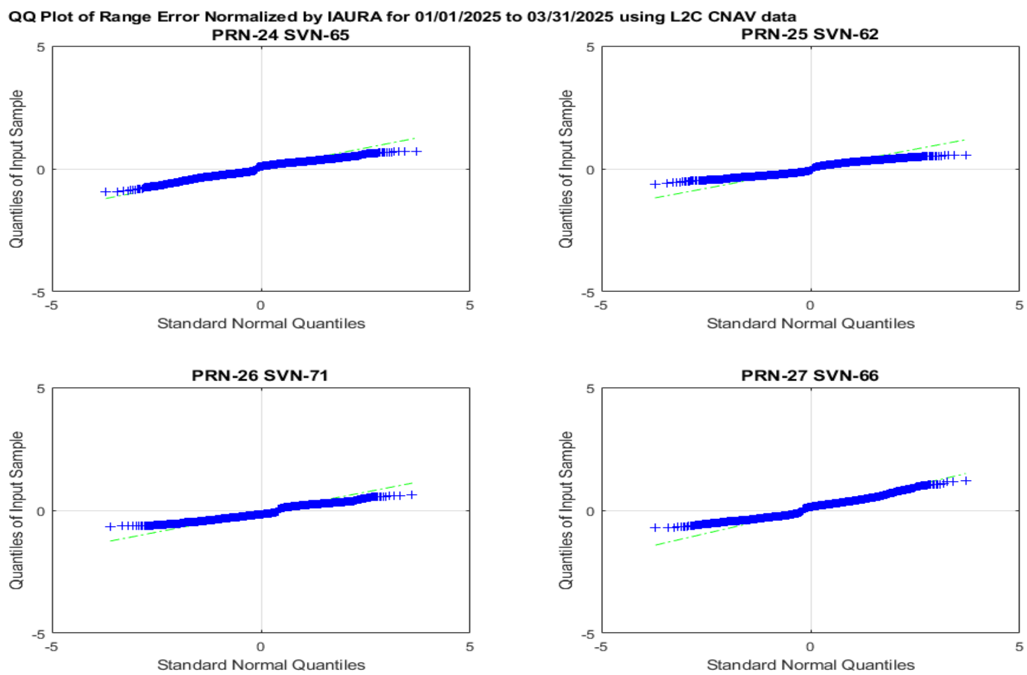



**Figure 9-80 QQ Plots of Range Error PRN 24, 25, 26, and 27 Using L2C CNAV Data**

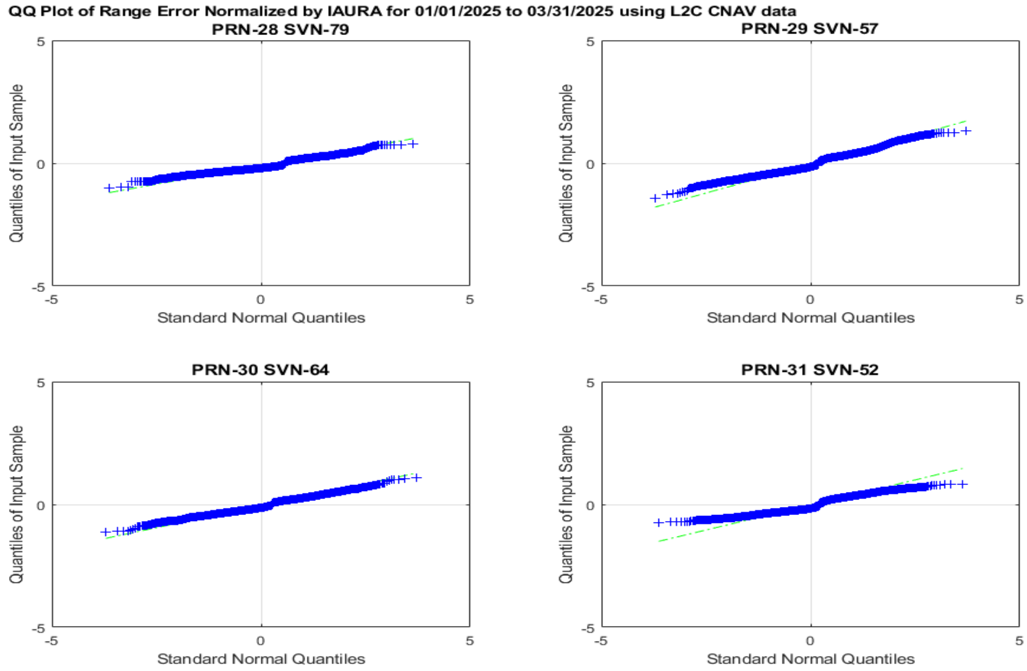



**Figure 9-81 QQ Plots of Range Error PRNs 28, 29, 30, and 31 Using L2C CNAV Data**

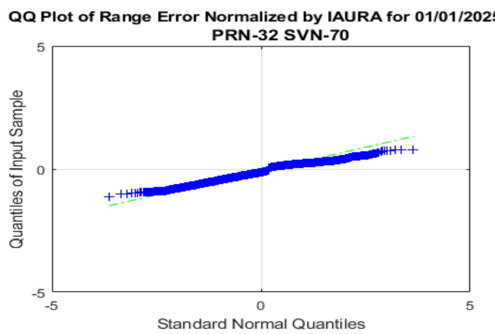



**Figure 9-82 QQ Plots of Range Error PRN 32 Using L2C CNAV Data**

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

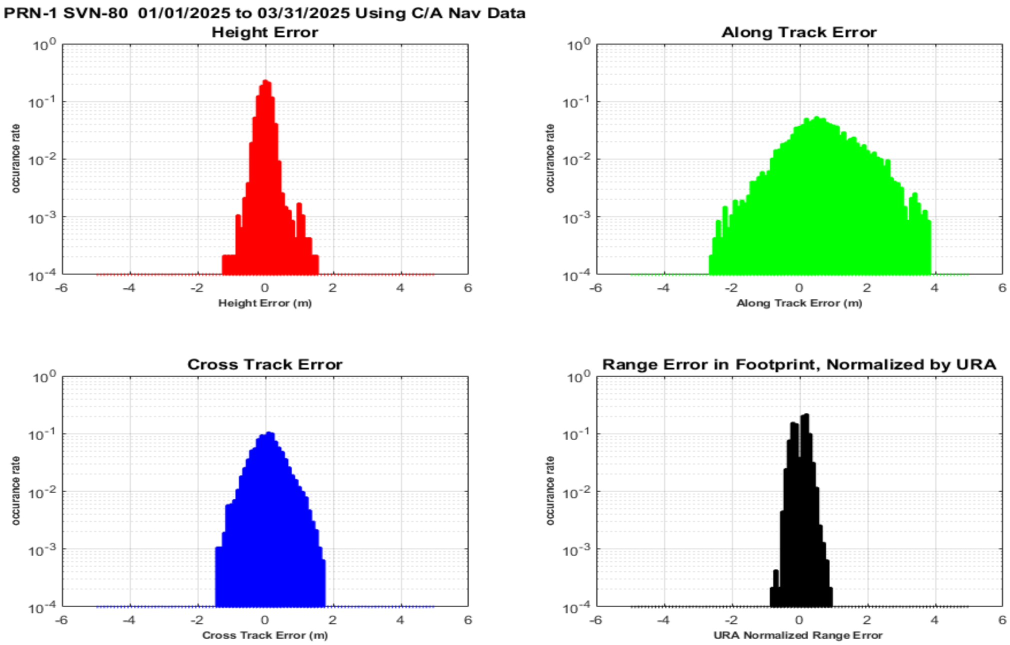



**Figure 9-83 Histograms of H, A, C, and Range Error PRN1 (SVN80) Using C/A Nav Data**

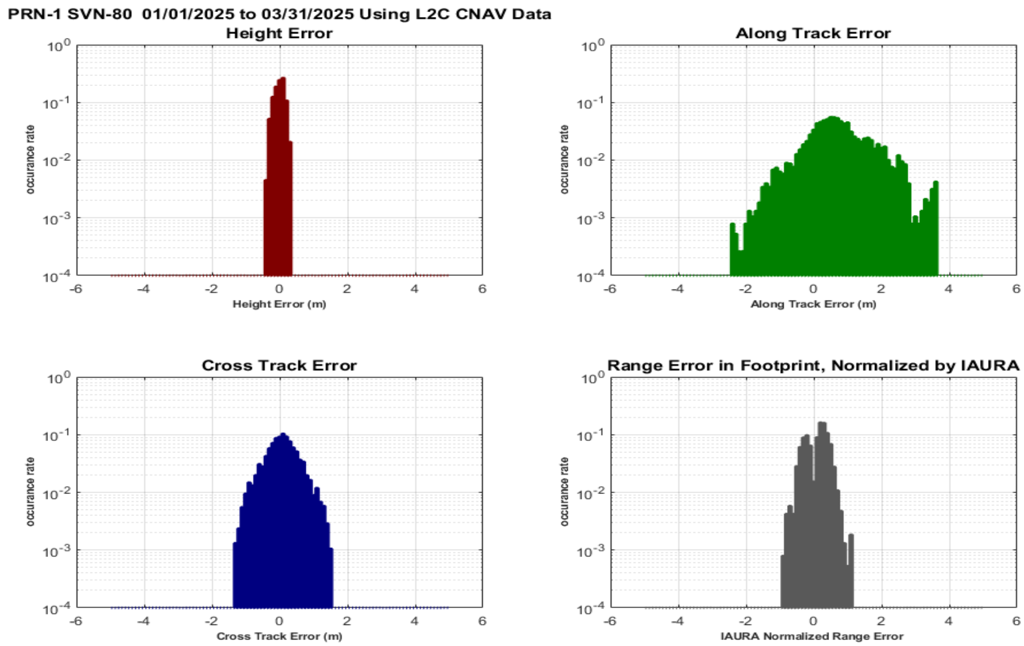



**Figure 9-84 Histograms of H, A, C, and Range Error PRN1 (SVN80) Using L2C CNAV Data**

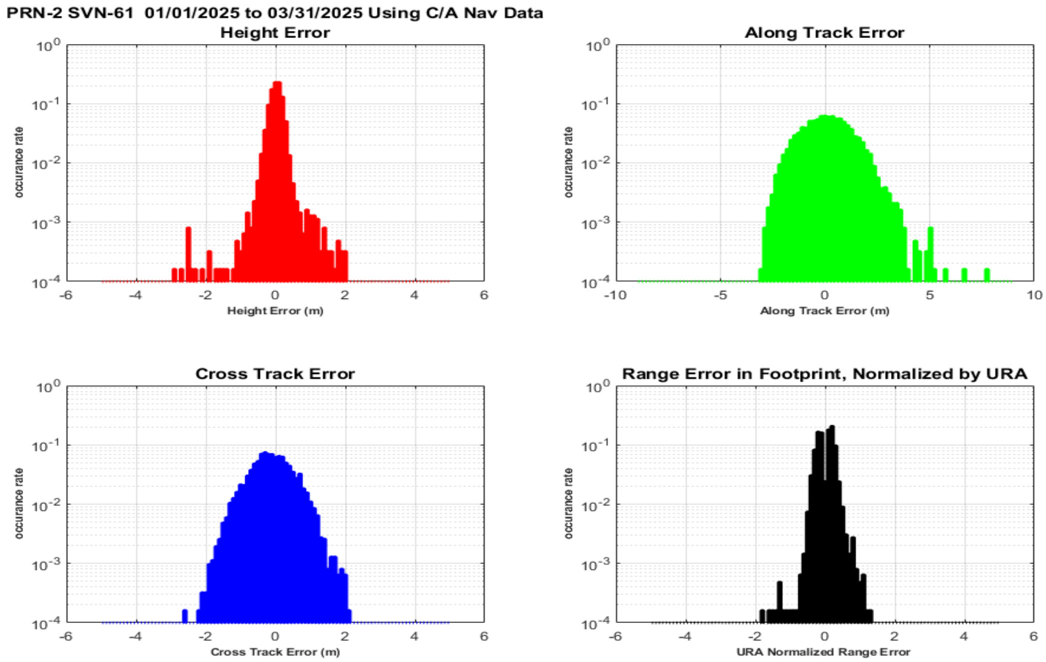



**Figure 9-85 Histograms of H, A, C, and Range Error PRN2 (SVN61) Using C/A Nav Data**

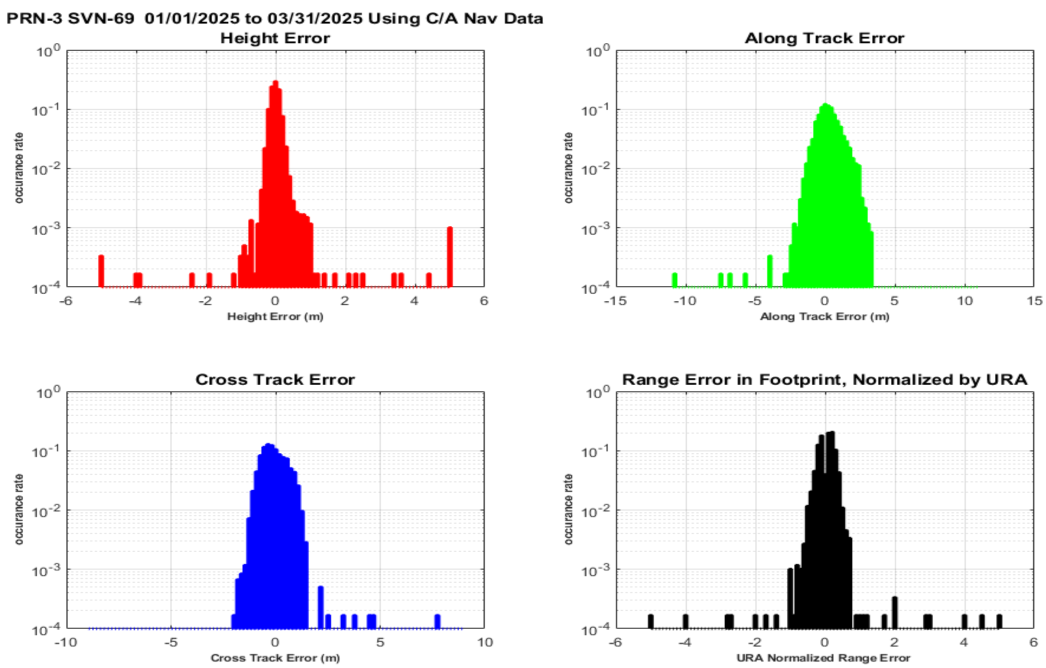



**Figure 9-86 Histograms of H, A, C, and Range Error PRN3 (SVN69) Using C/A Nav Data**

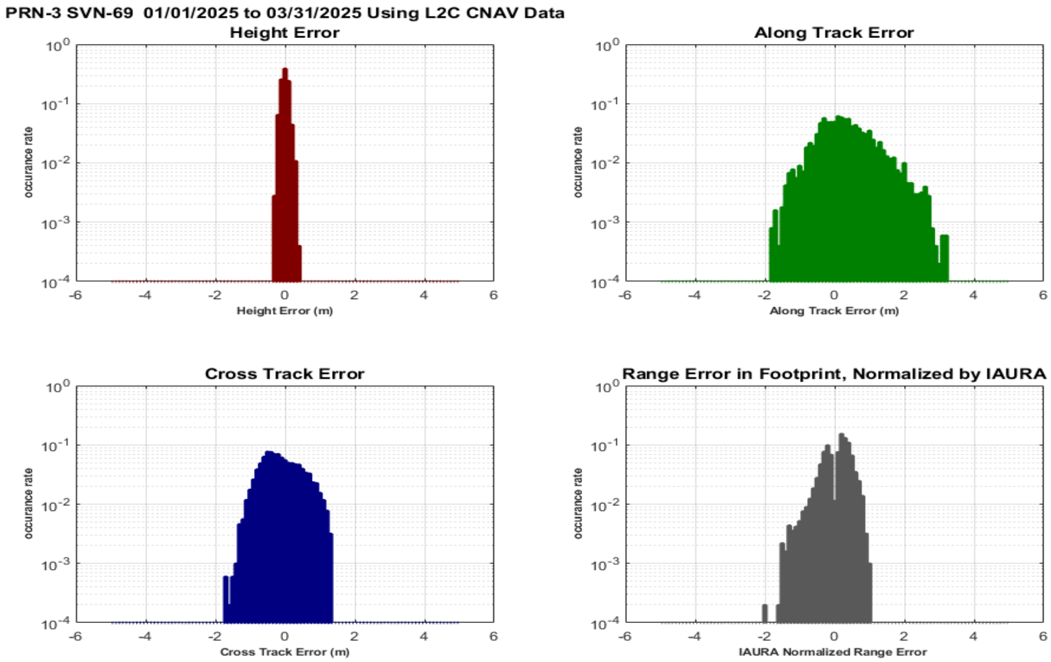



**Figure 9-87 Histograms of H, A, C, and Range Error PRN3 (SVN69) Using L2C CNAV Data**

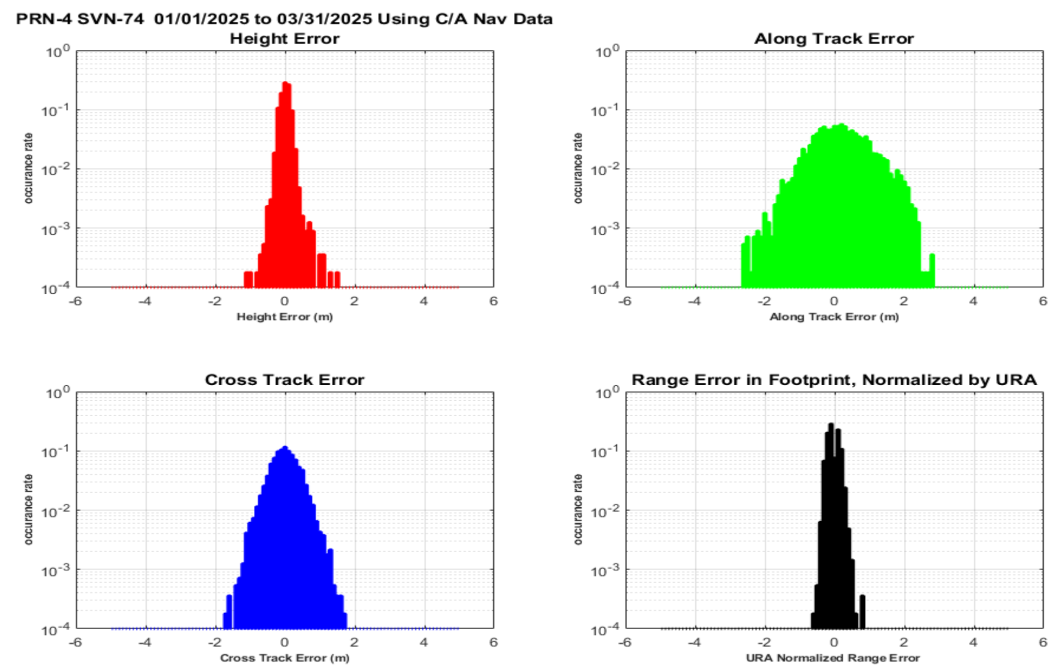



**Figure 9-88 Histograms of H, A, C, and Range Error PRN4 (SVN74) Using C/A Nav Data**

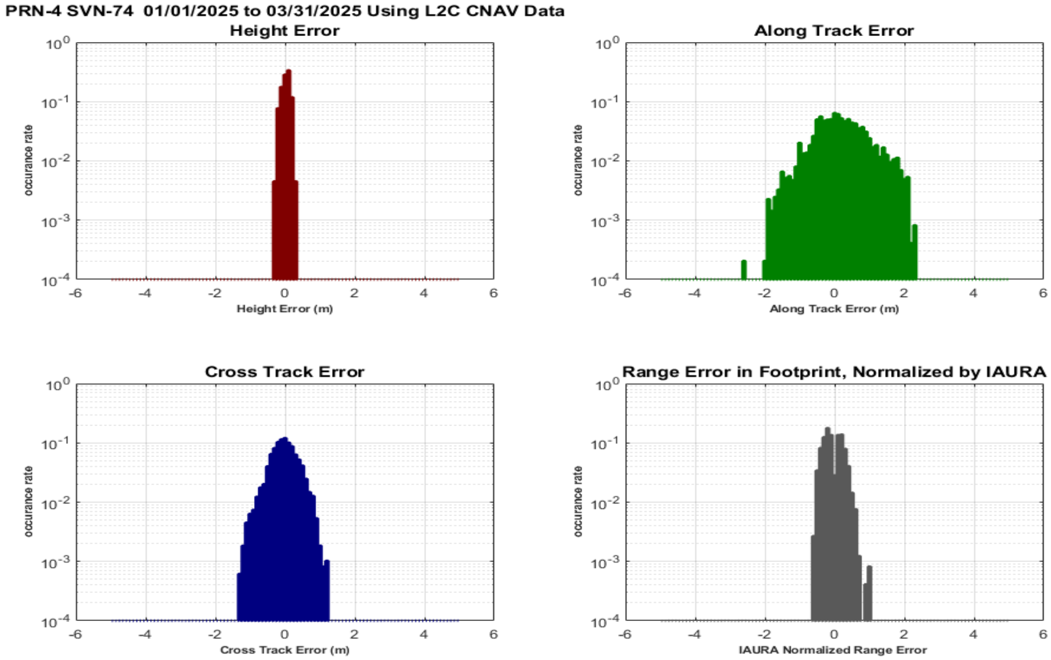



**Figure 9-89 Histograms of H, A, C, and Range Error PRN4 (SVN74) Using L2C CNAV Data**

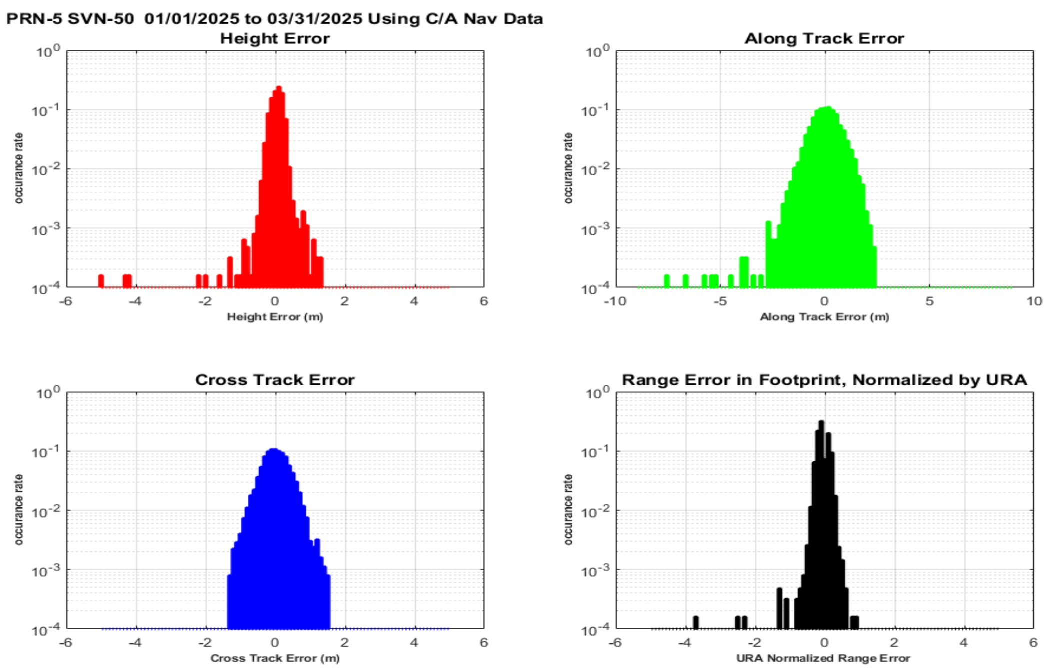



**Figure 9-90 Histograms of H, A, C, and Range Error PRN5 (SVN50) Using C/A Nav Data**

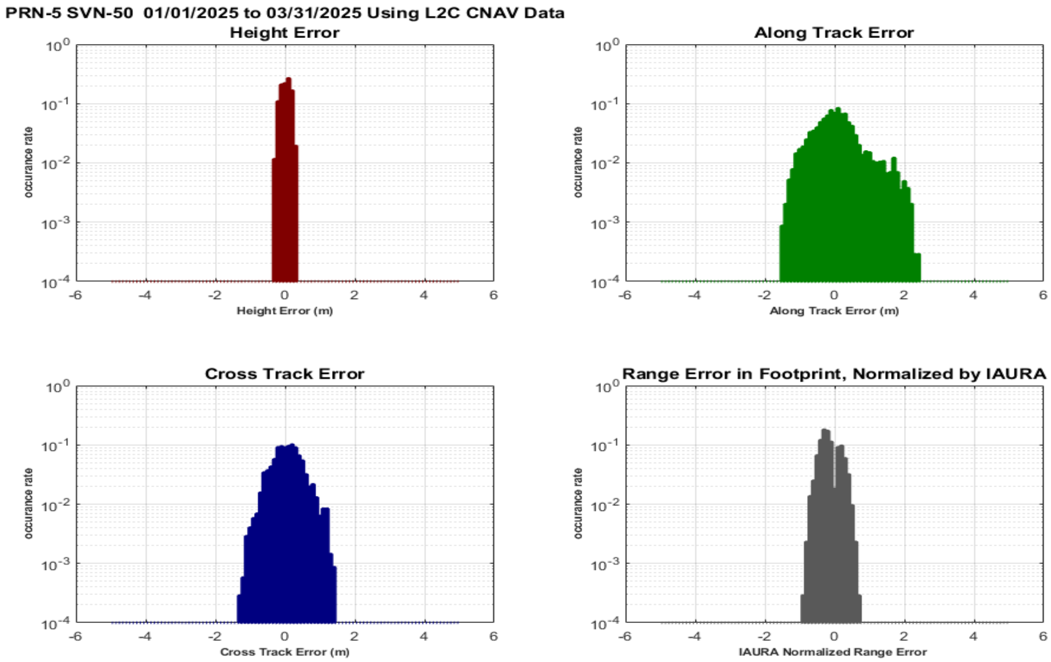



**Figure 9-91 Histograms of H, A, C, and Range Error PRN5 (SVN50) Using L2C CNAV Data**

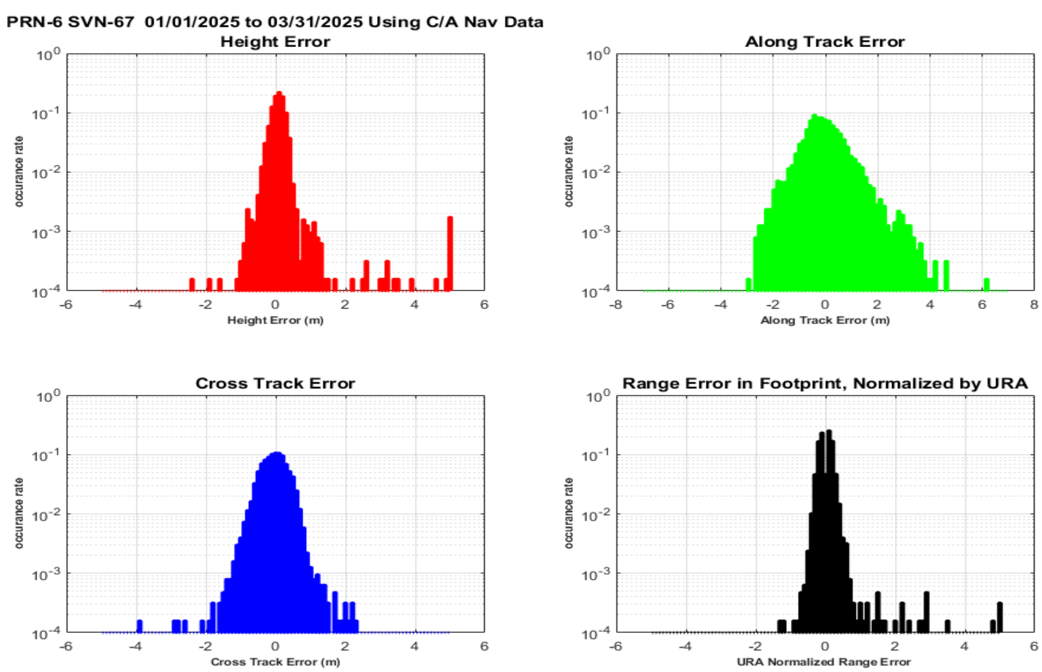



**Figure 9-92 Histograms of H, A, C, and Range Error PRN6 (SVN67) Using C/A Nav Data**

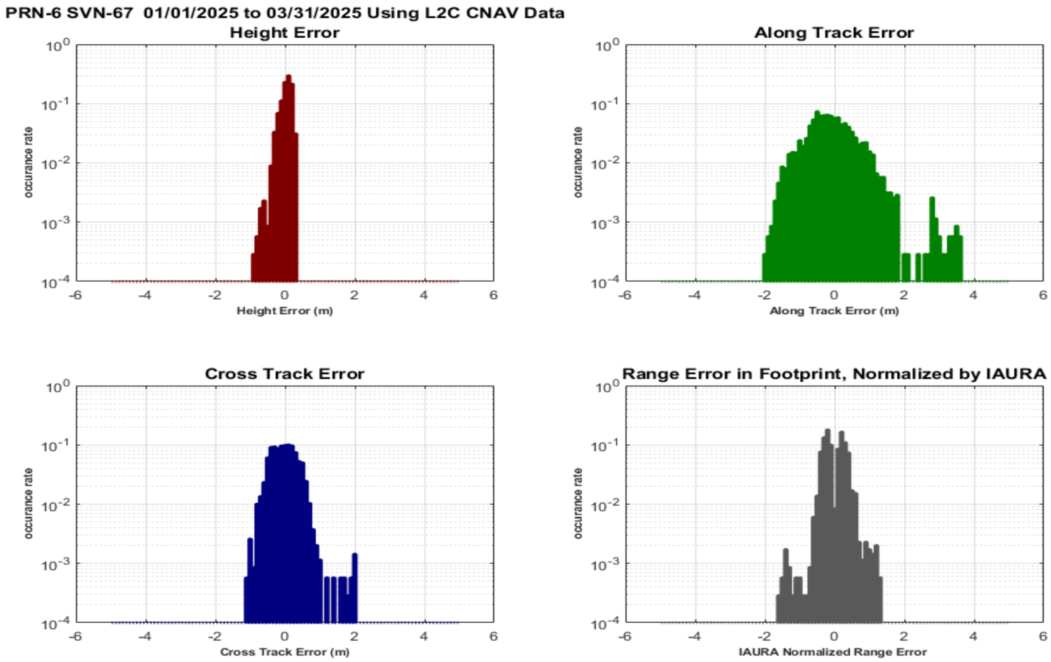



**Figure 9-93 Histograms of H, A, C, and Range Error PRN6 (SVN67) Using L2C CNAV Data**

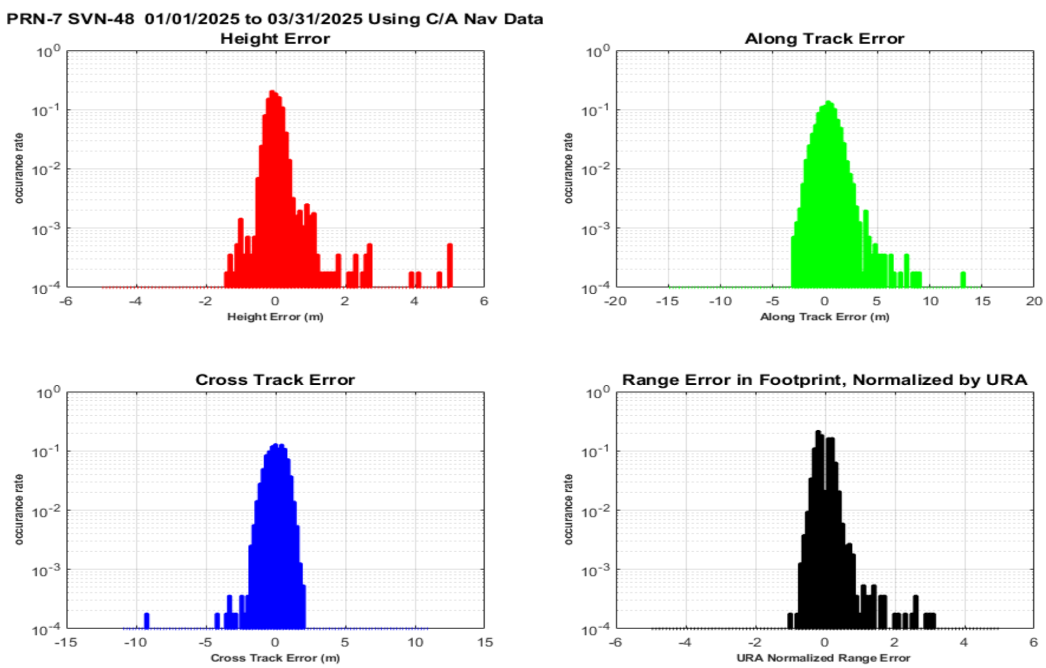



**Figure 9-94 Histograms of H, A, C, and Range Error PRN7 (SVN48) Using C/A Nav Data**

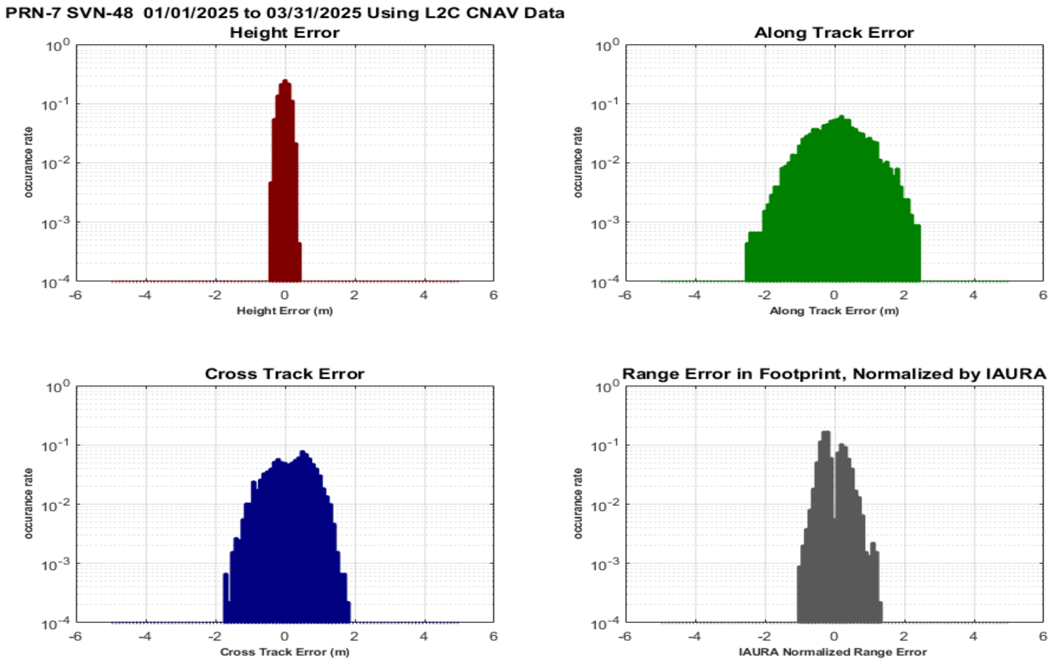



**Figure 9-95 Histograms of H, A, C, and Range Error PRN7 (SVN48) Using L2C CNAV Data**

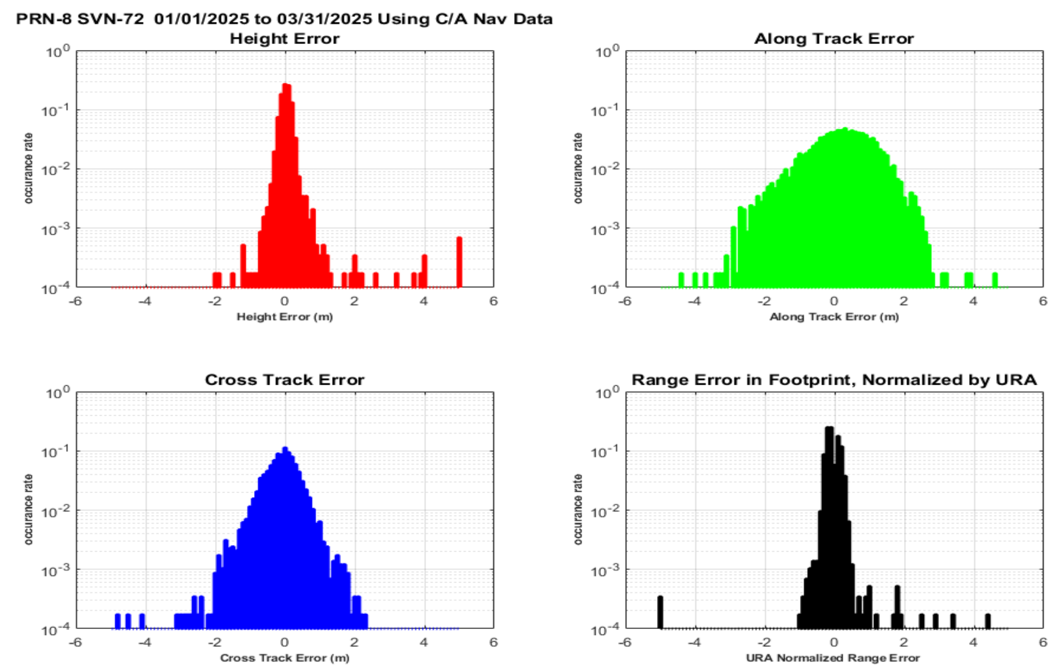



**Figure 9-96 Histograms of H, A, C, and Range Error PRN8 (SVN72) Using C/A Nav Data**

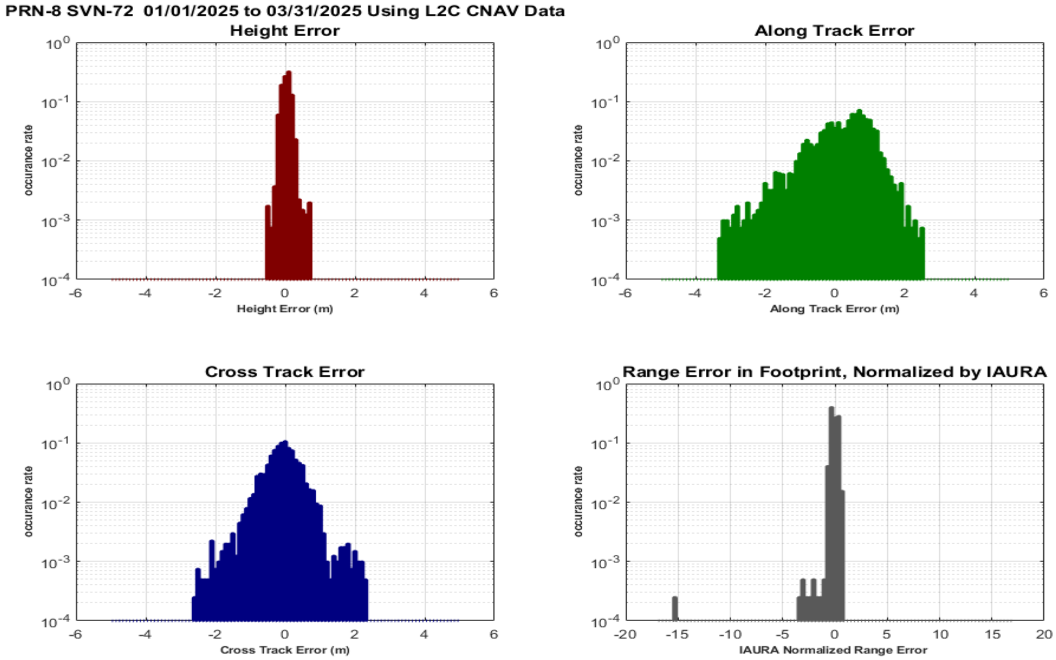



**Figure 9-97 Histograms of H, A, C, and Range Error PRN8 (SVN72) Using L2C CNAV Data**

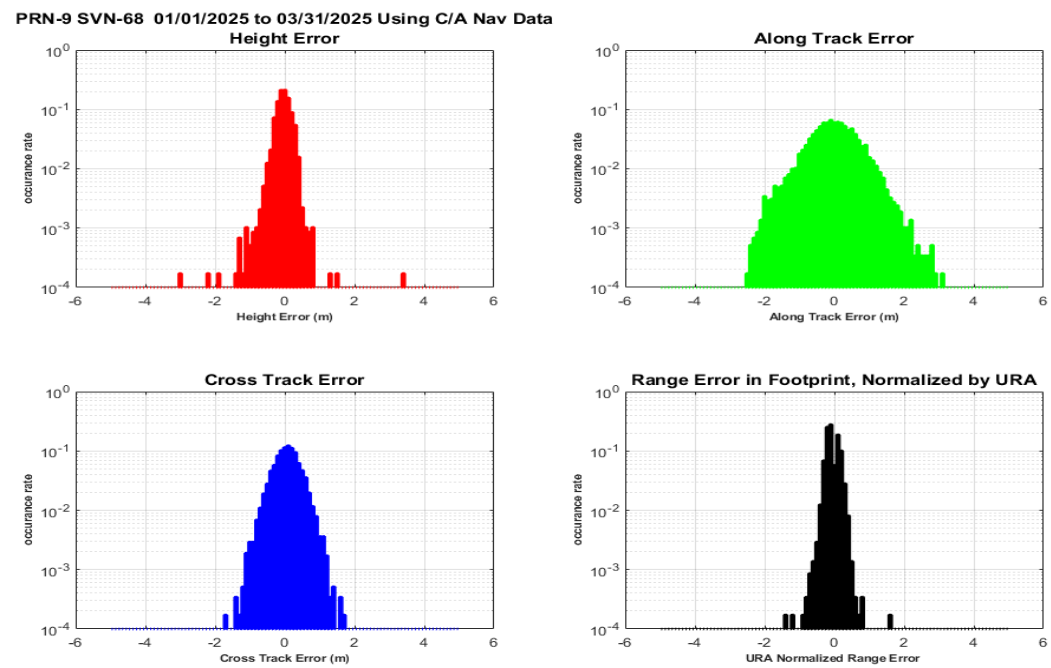



**Figure 9-98 Histograms of H, A, C, and Range Error PRN9 (SVN68) Using C/A Nav Data**

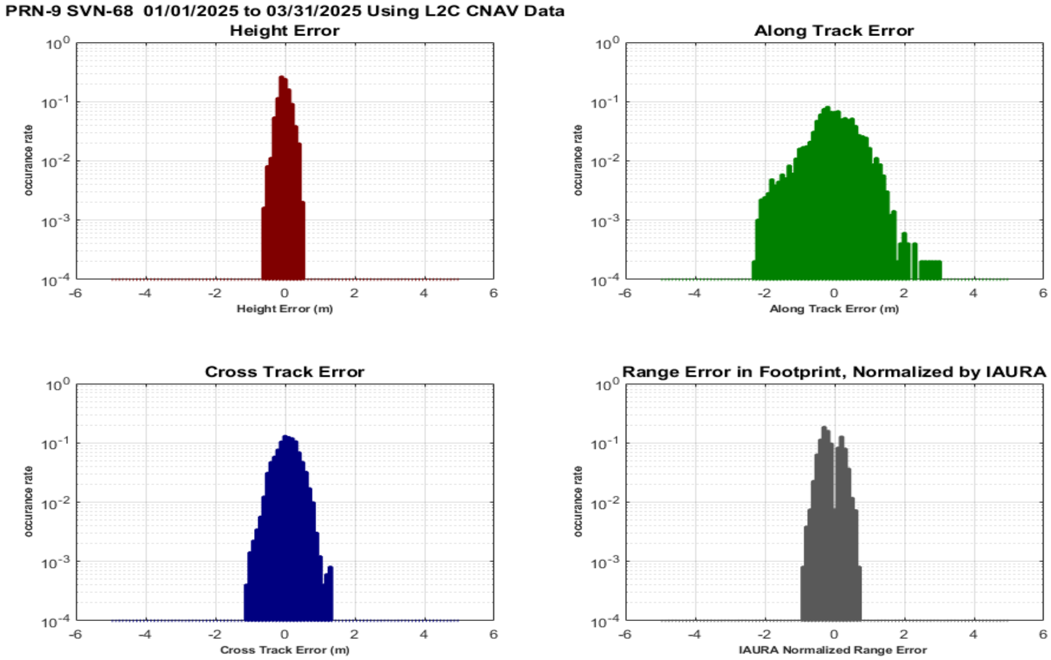



**Figure 9-99 Histograms of H, A, C, and Range Error PRN9 (SVN68) Using L2C CNAV Data**

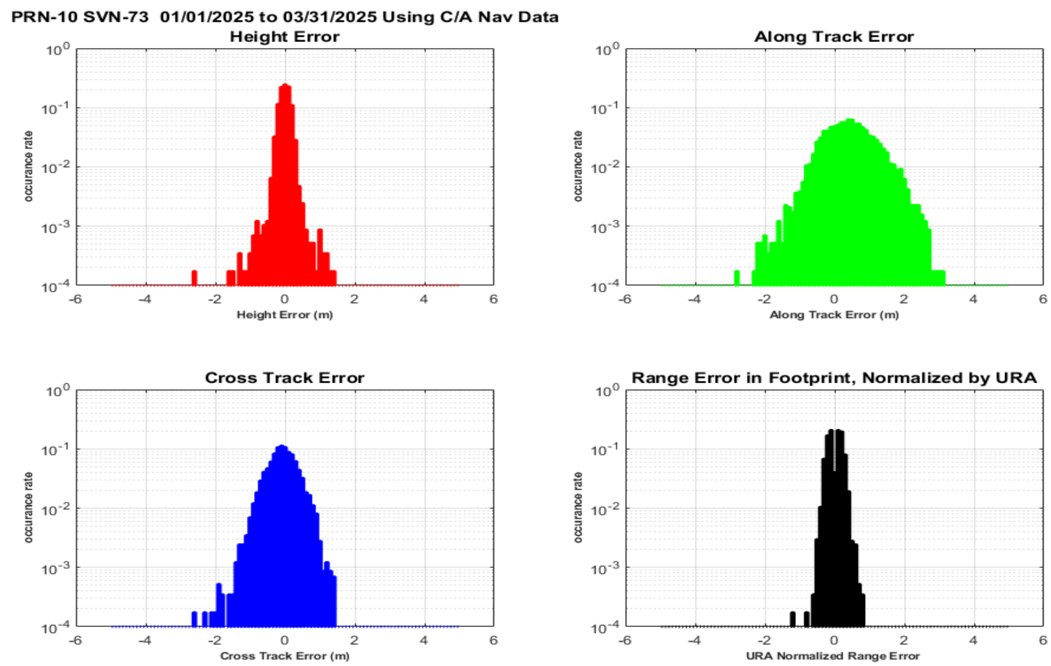



**Figure 9-100 Histograms of H, A, C, and Range Error PRN10 (SVN73) Using C/A Nav Data**

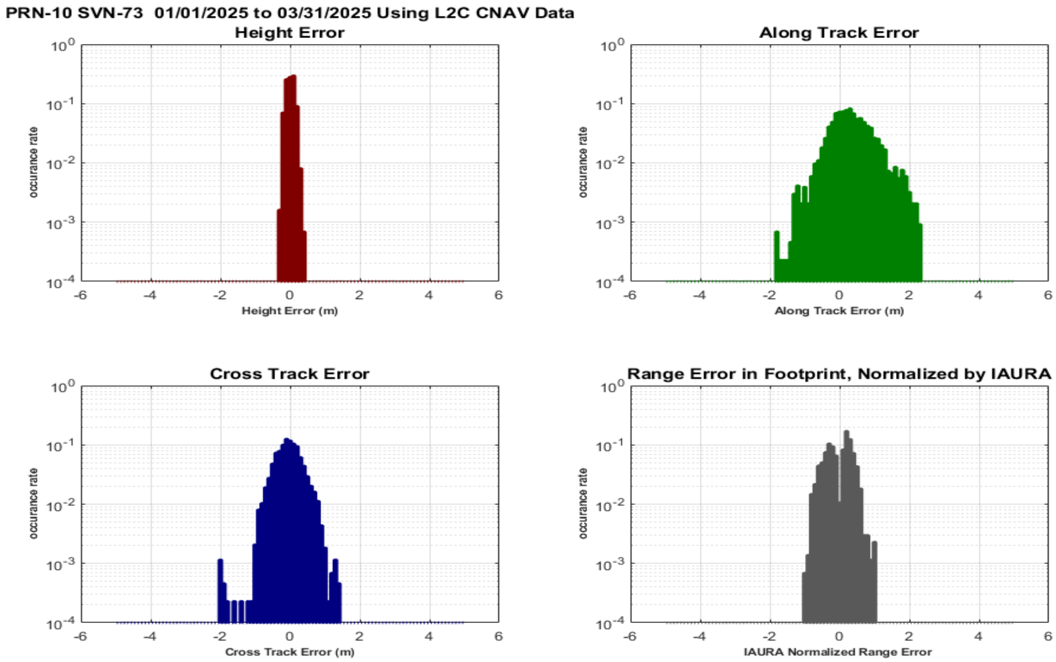



**Figure 9-101 Histograms of H, A, C, and Range Error PRN10 (SVN73) Using L2C CNAV Data**

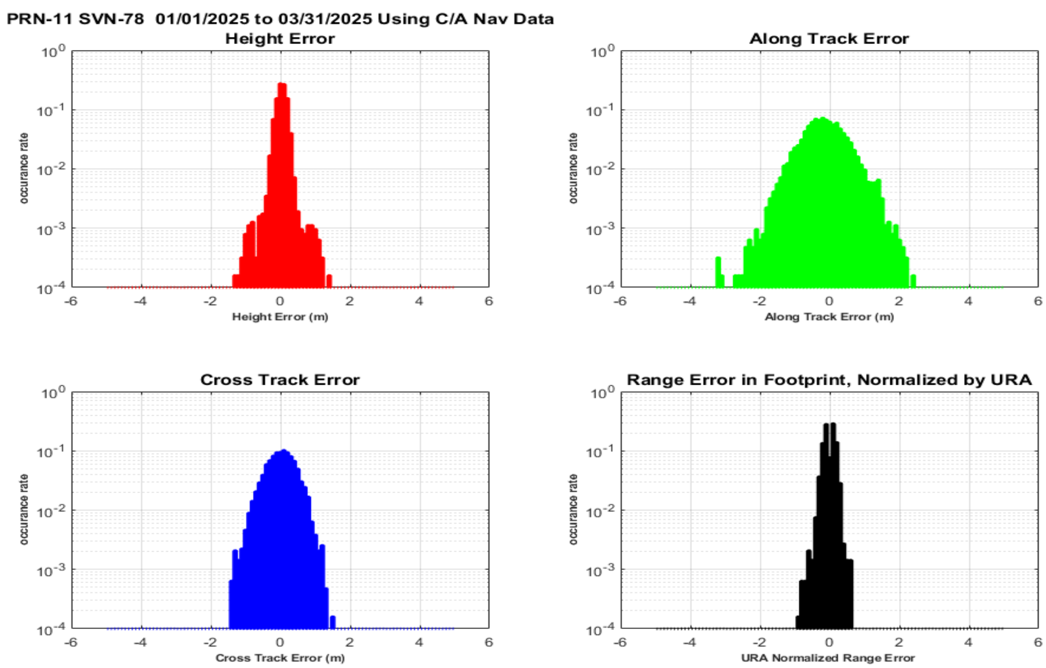



**Figure 9-102 Histograms of H, A, C, and Range Error PRN11 (SVN78) Using C/A Nav Data**

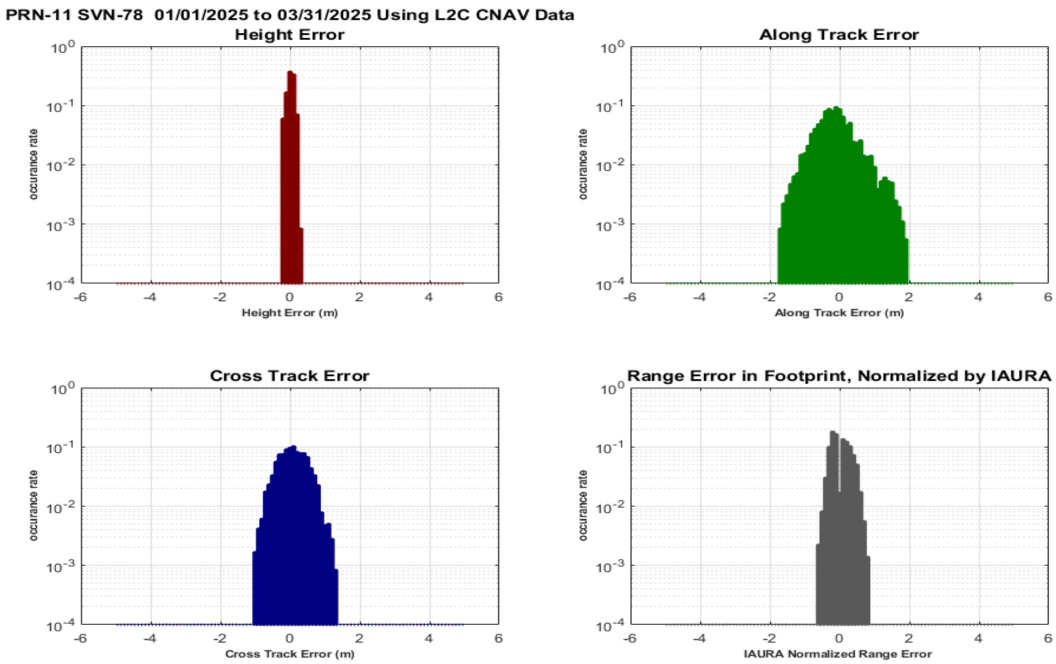



**Figure 9-103 Histograms of H, A, C, and Range Error PRN11 (SVN78) Using L2C CNAV Data**

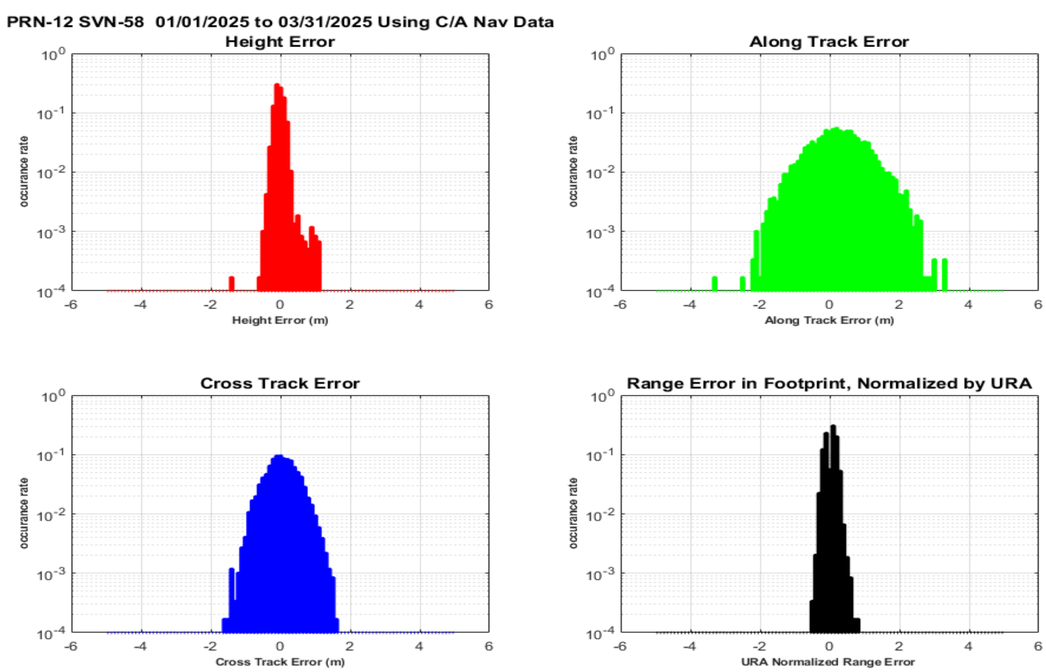



**Figure 9-104 Histograms of H, A, C, and Range Error PRN12 (SVN58) Using C/A Nav Data**

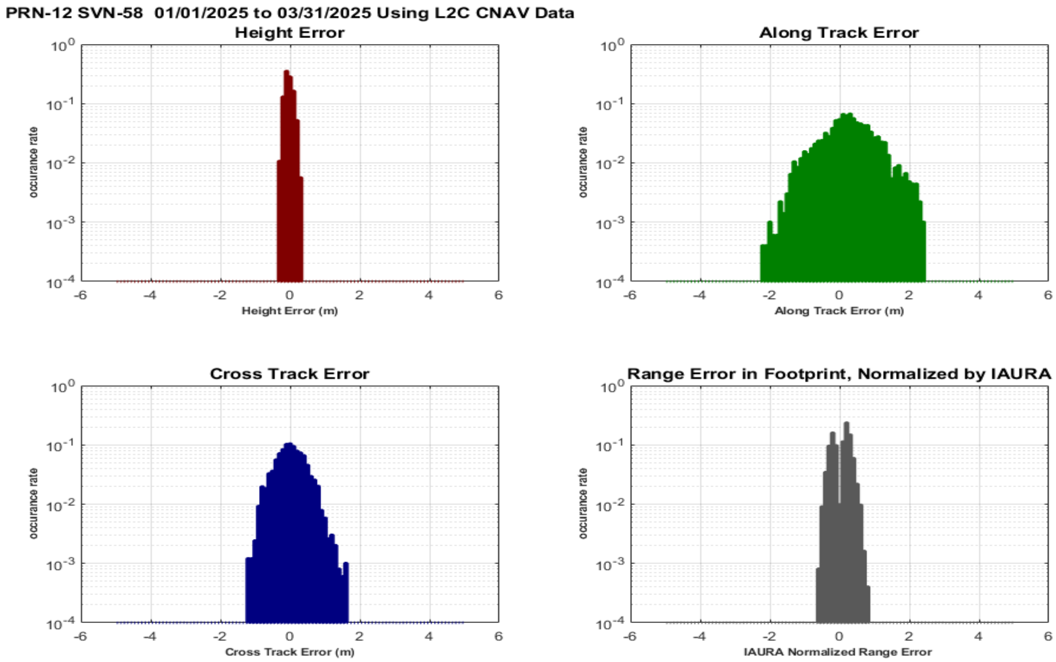



**Figure 9-105 Histograms of H, A, C, and Range Error PRN12 (SVN58) Using L2C CNAV Data**

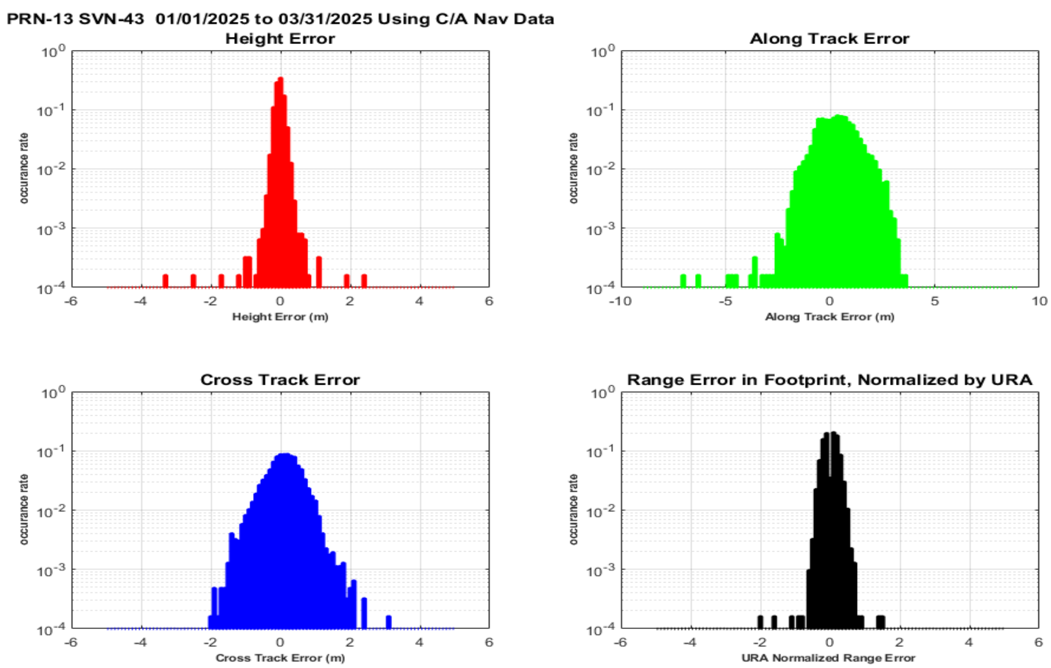



**Figure 9-106 Histograms of H, A, C, and Range Error PRN13 (SVN43) Using C/A Nav Data**

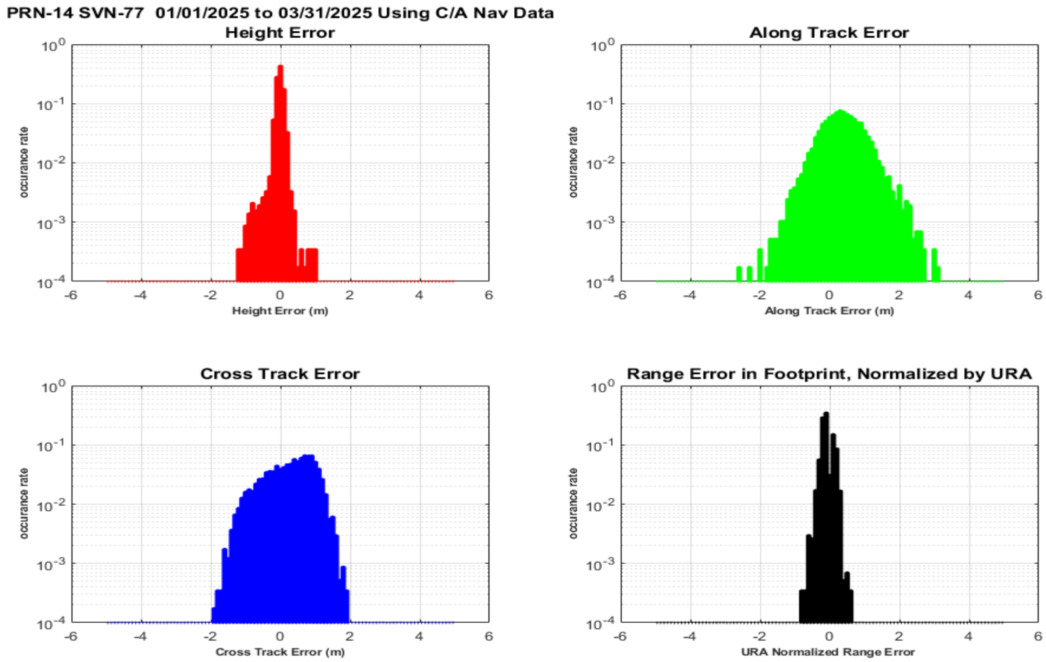



**Figure 9-107 Histograms of H, A, C, and Range Error PRN14 (SVN77) Using C/A Nav Data**

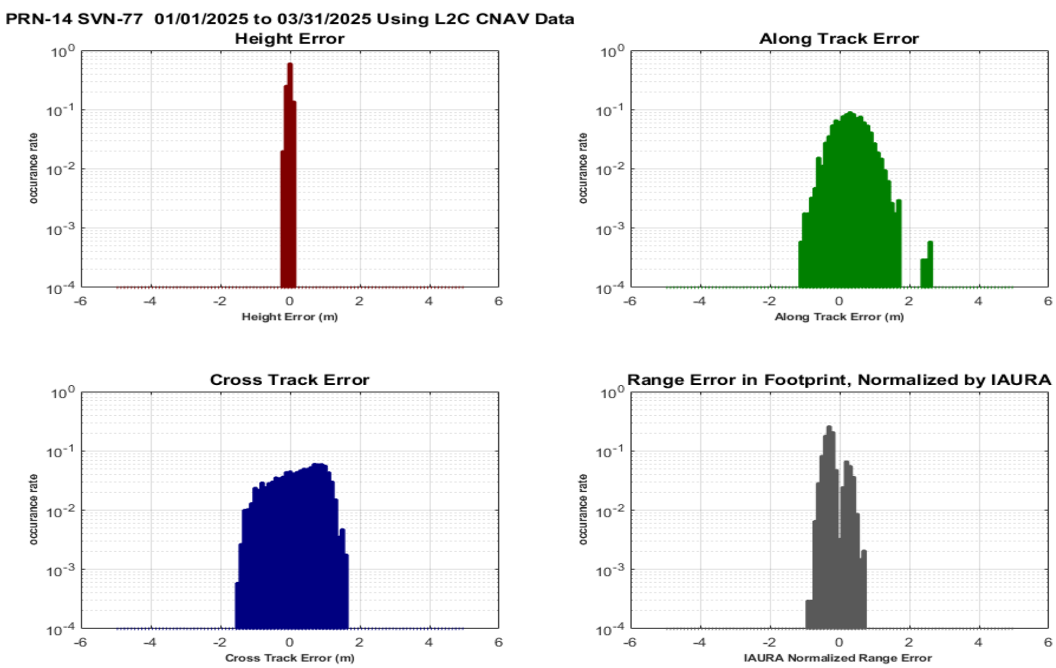



**Figure 9-108 Histograms of H, A, C, and Range Error PRN14 (SVN77) Using L2C CNAV Data**

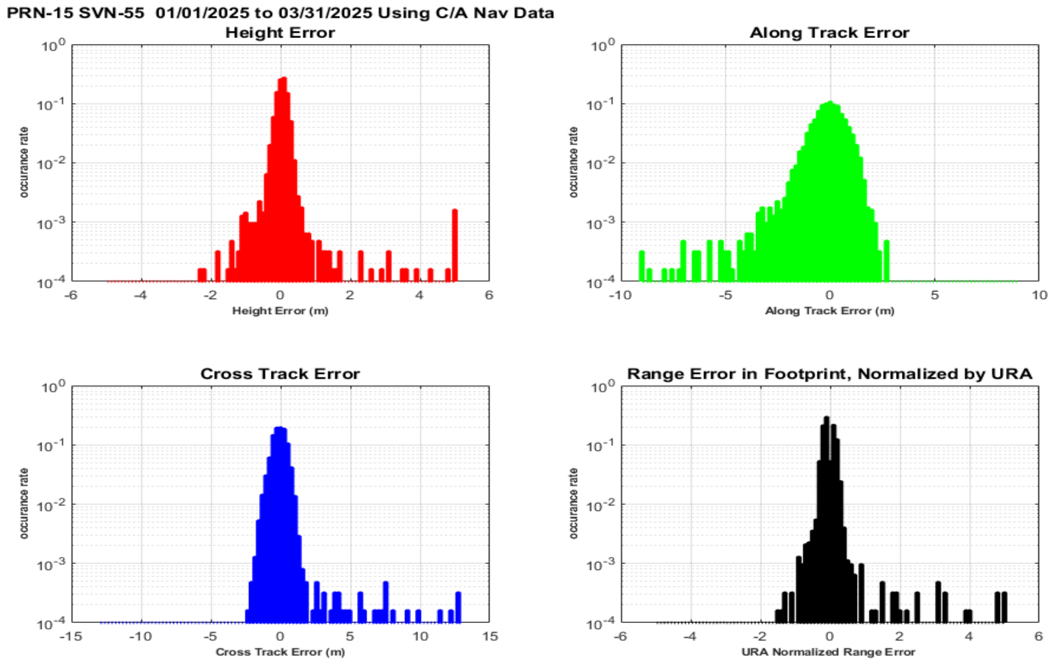



**Figure 9-109 Histograms of H, A, C, and Range Error PRN15 (SVN55) Using C/A Nav Data**

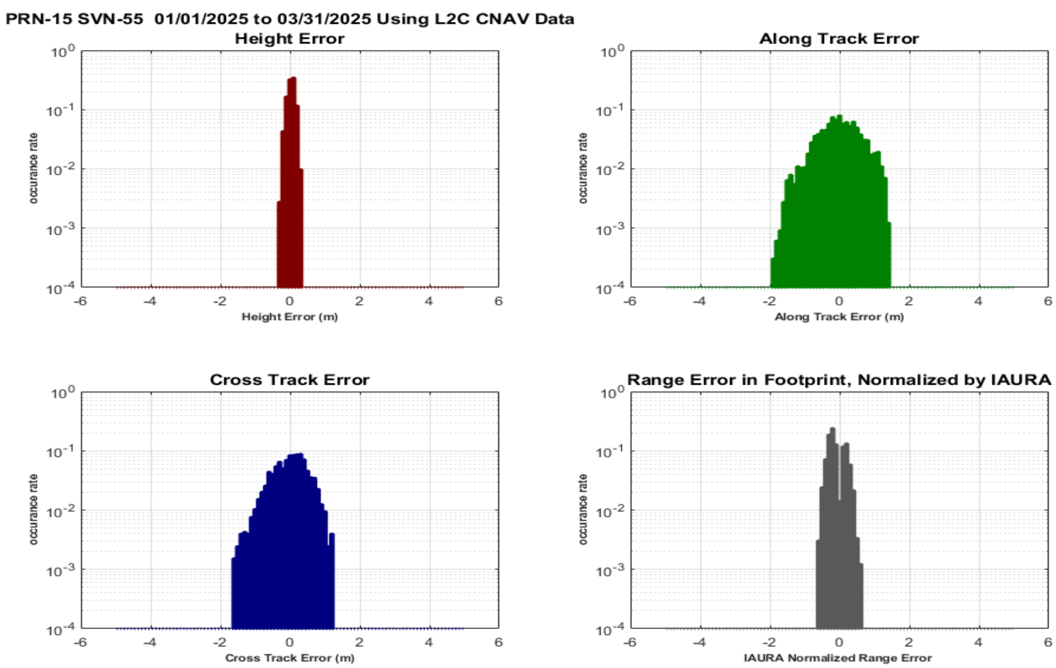



**Figure 9-110 Histograms of H, A, C, and Range Error PRN15 (SVN55) Using L2C CNAV Data**

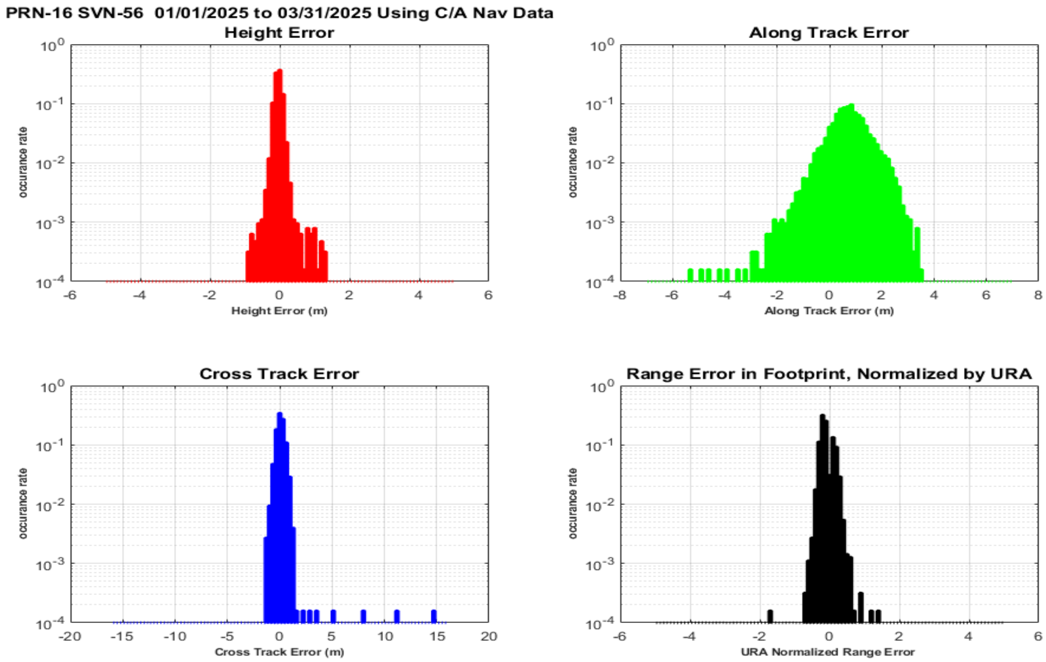



**Figure 9-111 Histograms of H, A, C, and Range Error PRN16 (SVN56) Using C/A Nav Data**

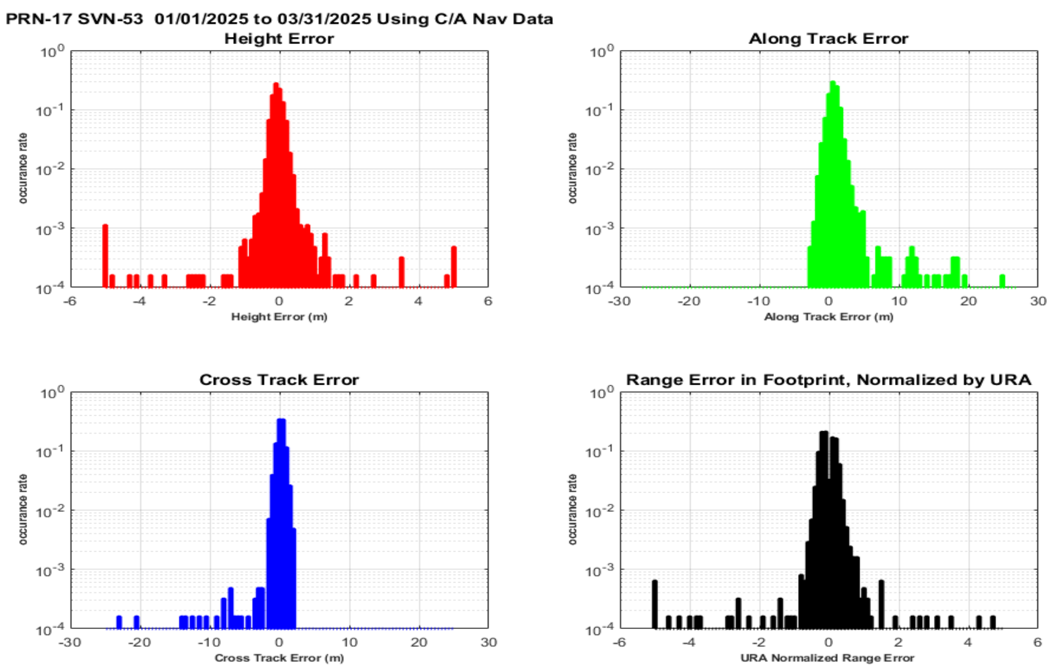



**Figure 9-112 Histograms of H, A, C, and Range Error PRN17 (SVN53) Using C/A Nav Data**

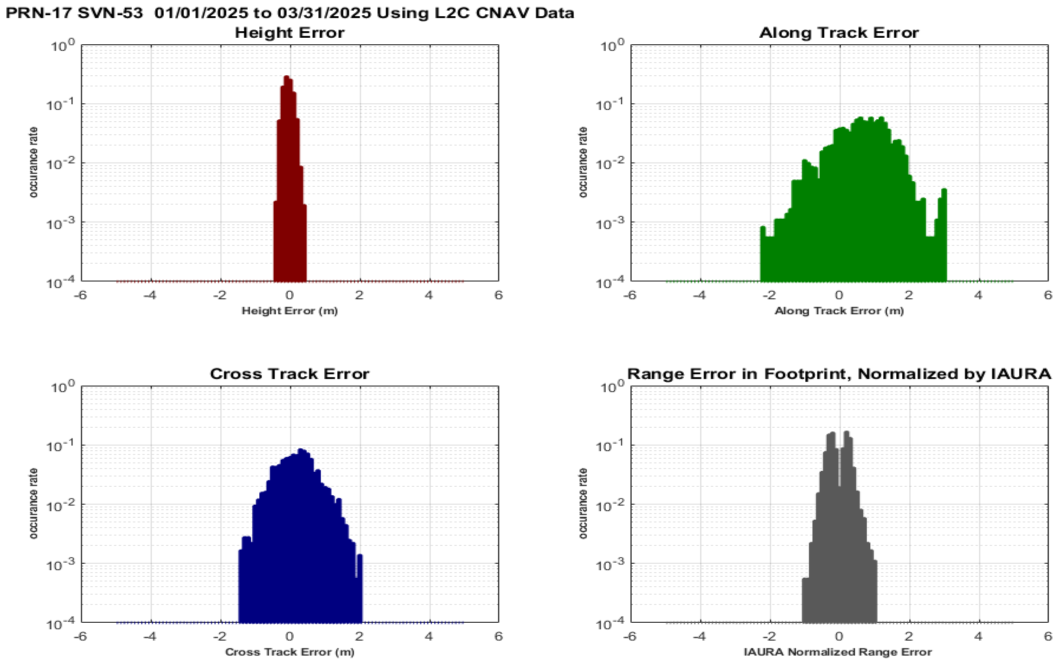



**Figure 9-113 Histograms of H, A, C, and Range Error PRN17 (SVN53) Using L2C CNAV Data**

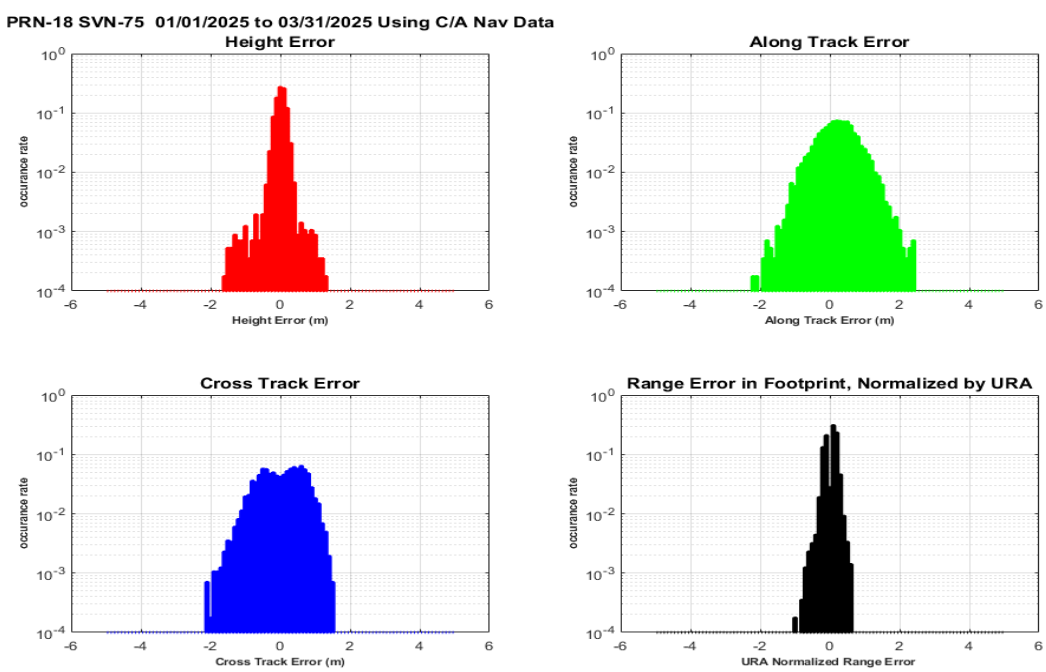



**Figure 9-114 Histograms of H, A, C, and Range Error PRN18 (SVN75) Using C/A Nav Data**

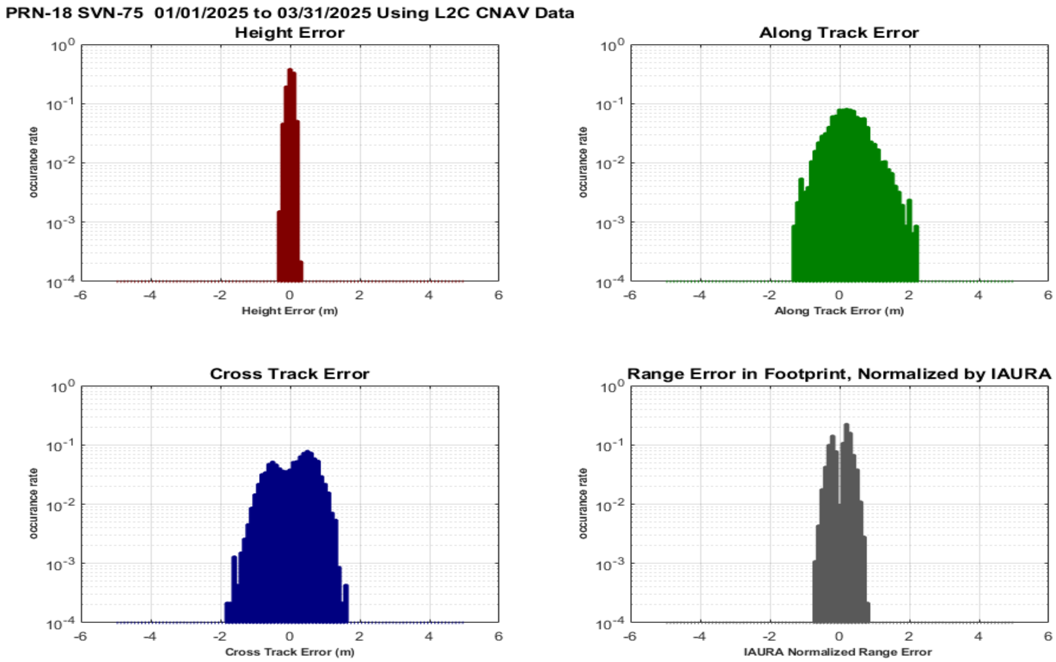



**Figure 9-115 Histograms of H, A, C, and Range Error PRN18 (SVN75) Using L2C CNAV Data**

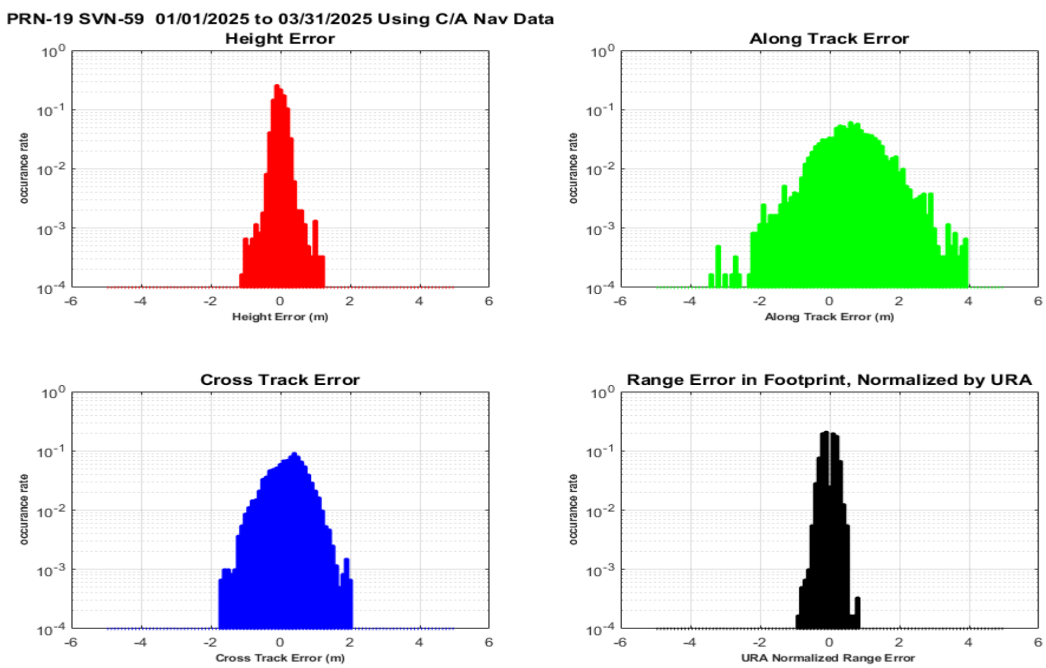



**Figure 9-116 Histograms of H, A, C, and Range Error PRN19 (SVN59) Using C/A Nav Data**

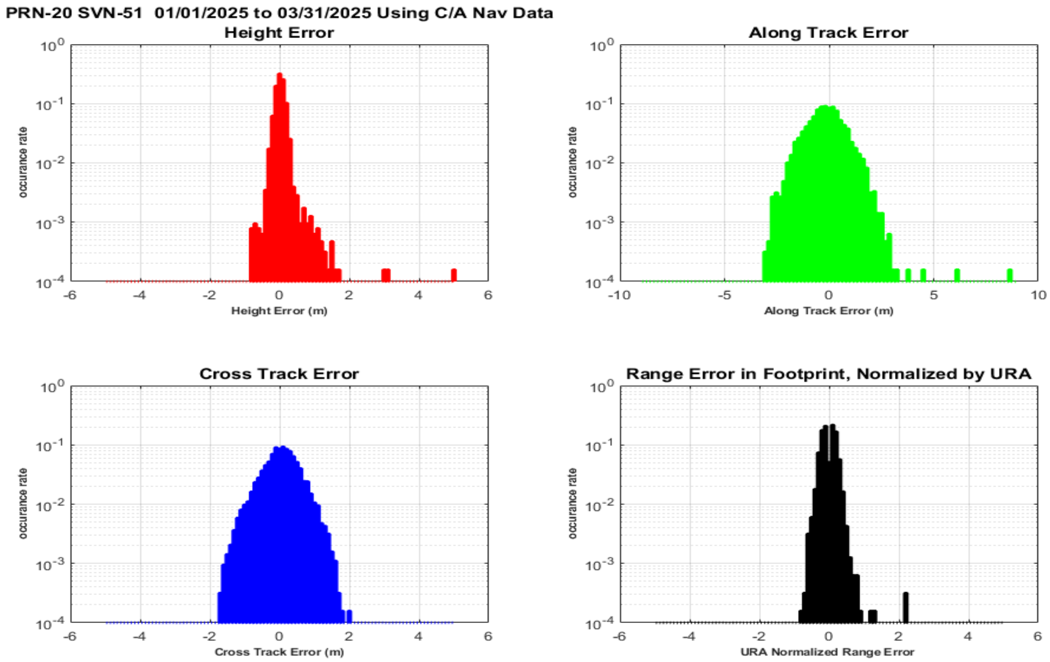



**Figure 9-117 Histograms of H, A, C, and Range Error PRN20 (SVN51) Using C/A Nav Data**

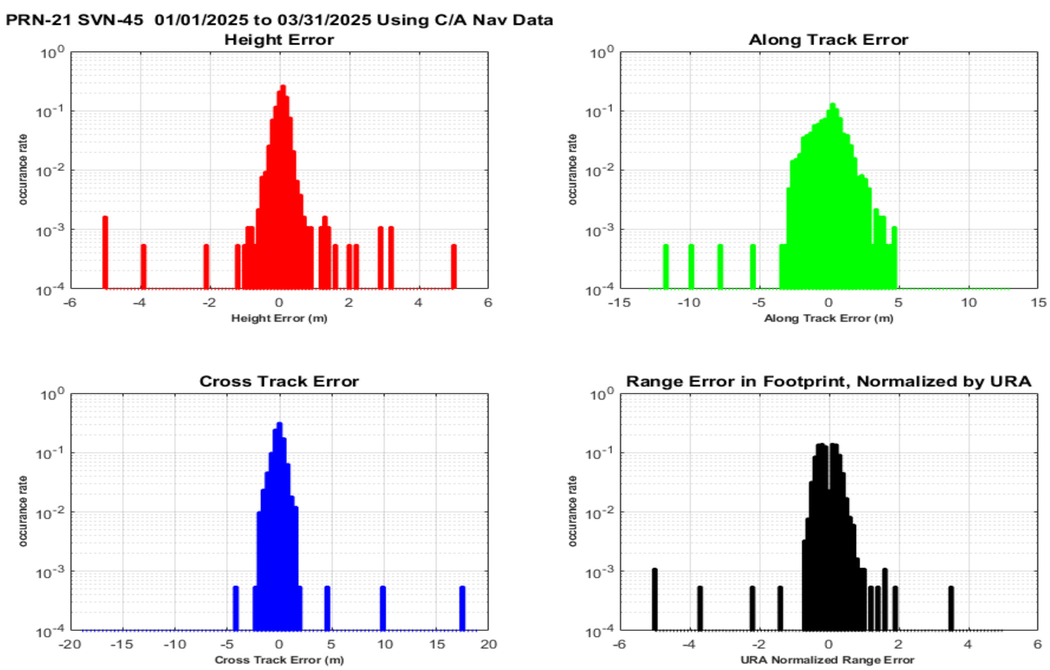



**Figure 9-118 Histograms of H, A, C, and Range Error PRN21 (SVN45) Using C/A Nav Data**

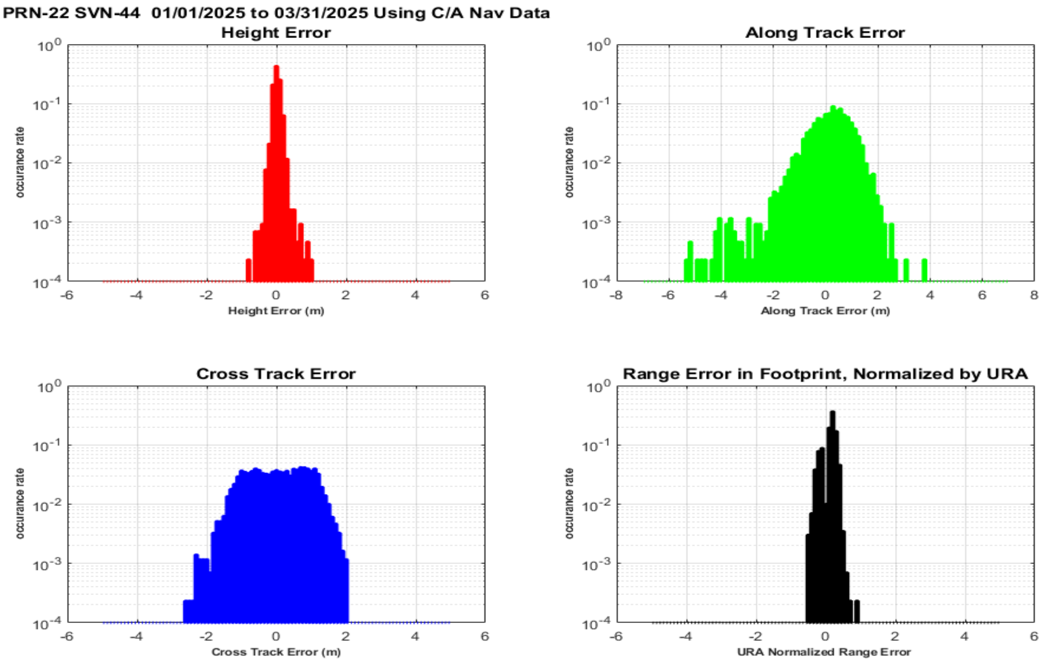



**Figure 9-119 Histograms of H, A, C, and Range Error PRN22 (SVN44) Using C/A Nav Data**

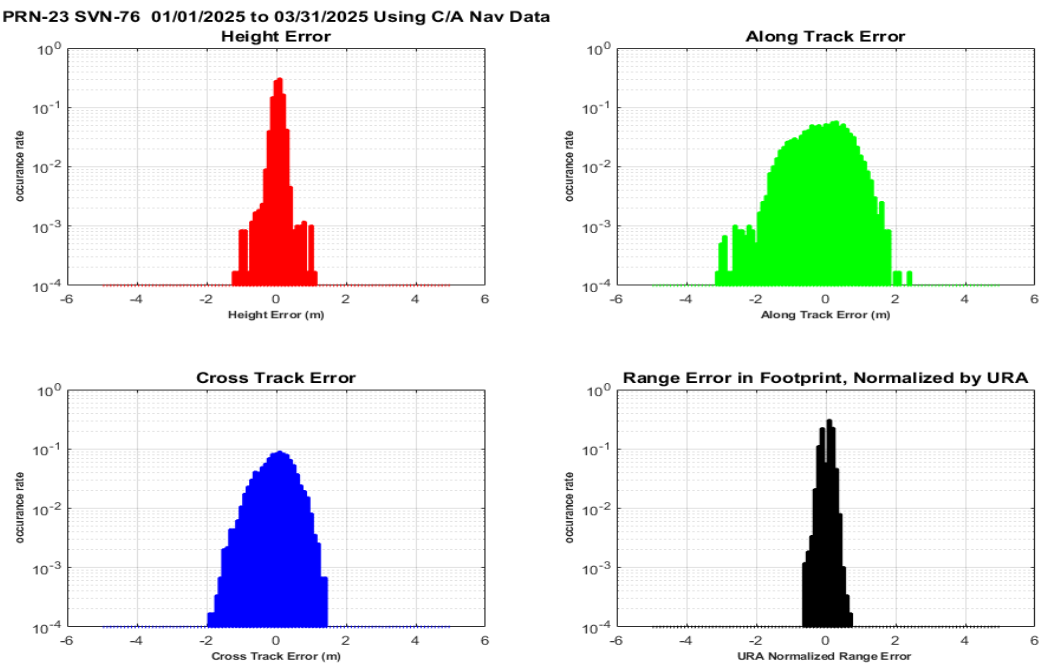



**Figure 9-120 Histograms of H, A, C, and Range Error PRN23 (SVN76) Using C/A Nav Data**

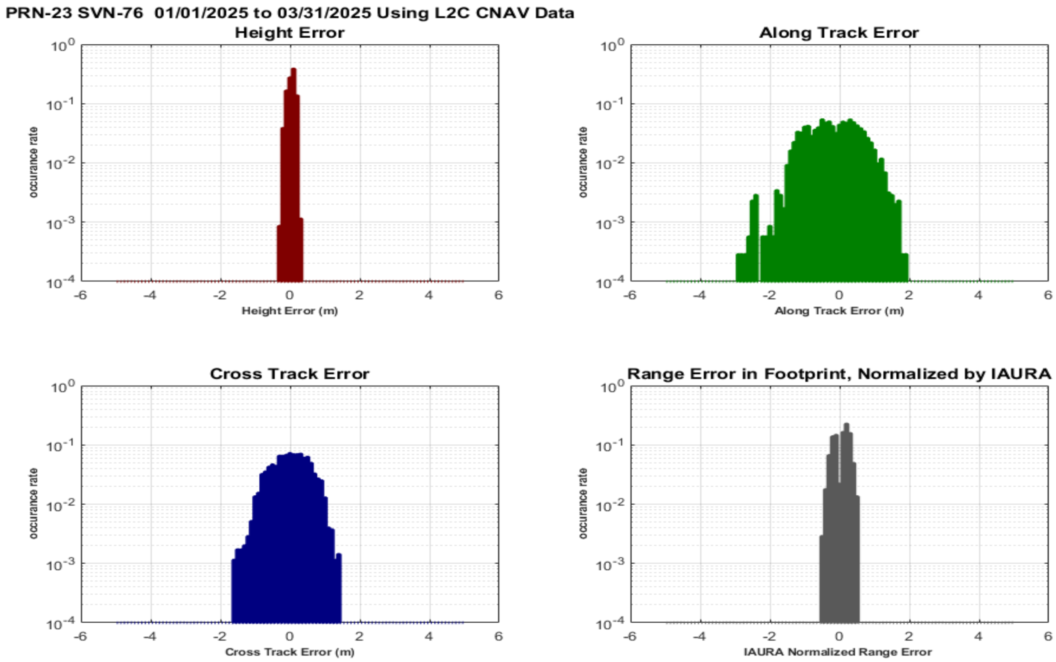



**Figure 9-121 Histograms of H, A, C, and Range Error PRN23 (SVN76) Using L2C CNAV Data**

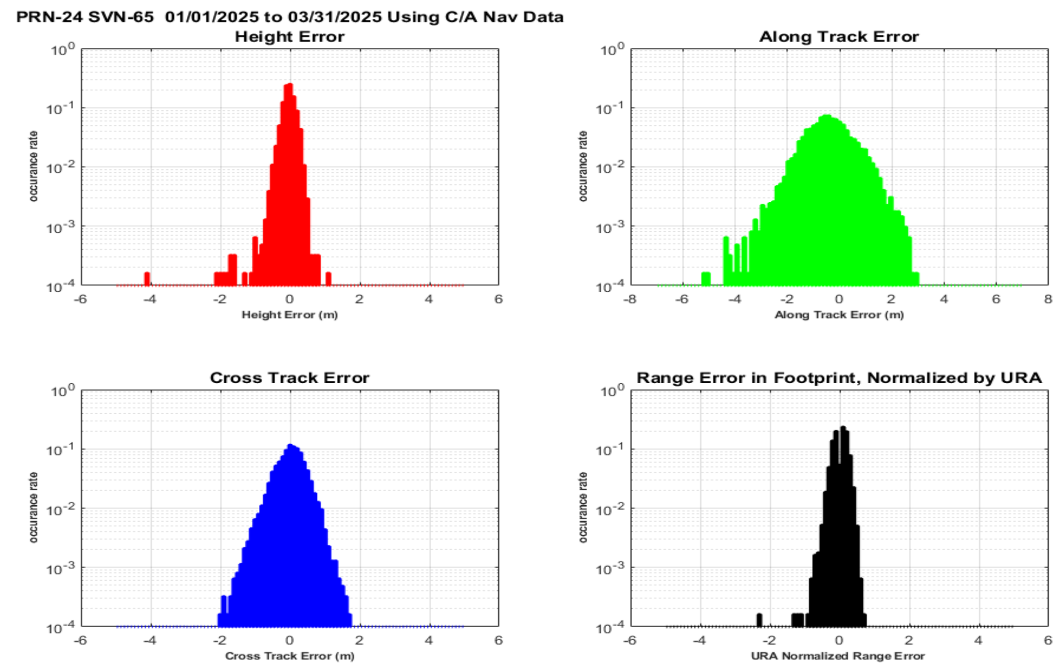



**Figure 9-122 Histograms of H, A, C, and Range Error PRN24 (SVN65) Using C/A Nav Data**

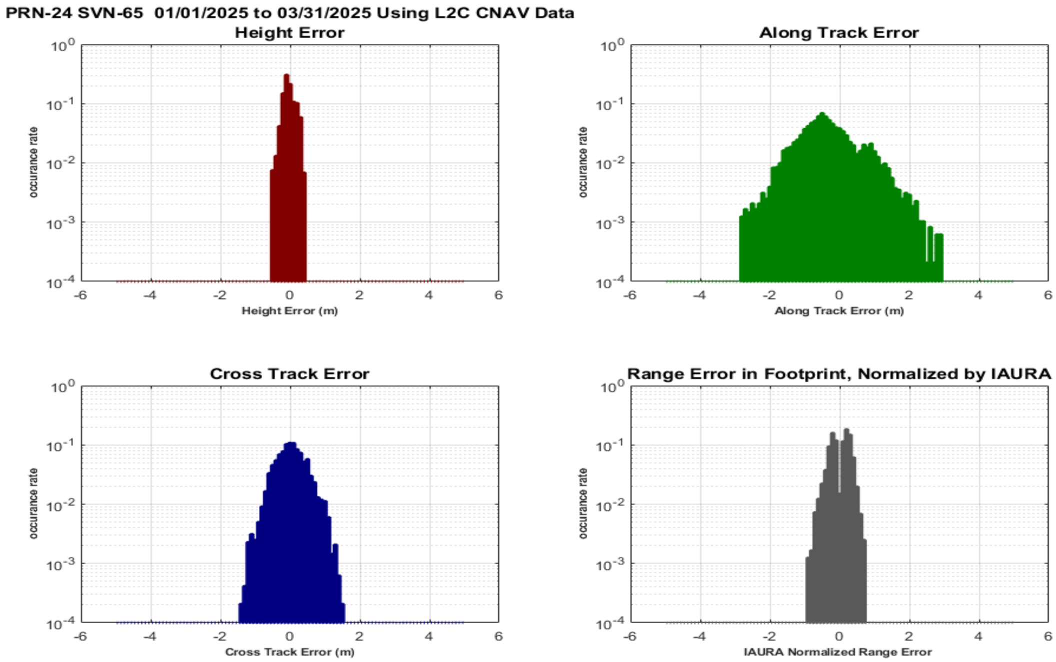



**Figure 9-123 Histograms of H, A, C, and Range Error PRN24 (SVN65) Using L2C CNAV Data**

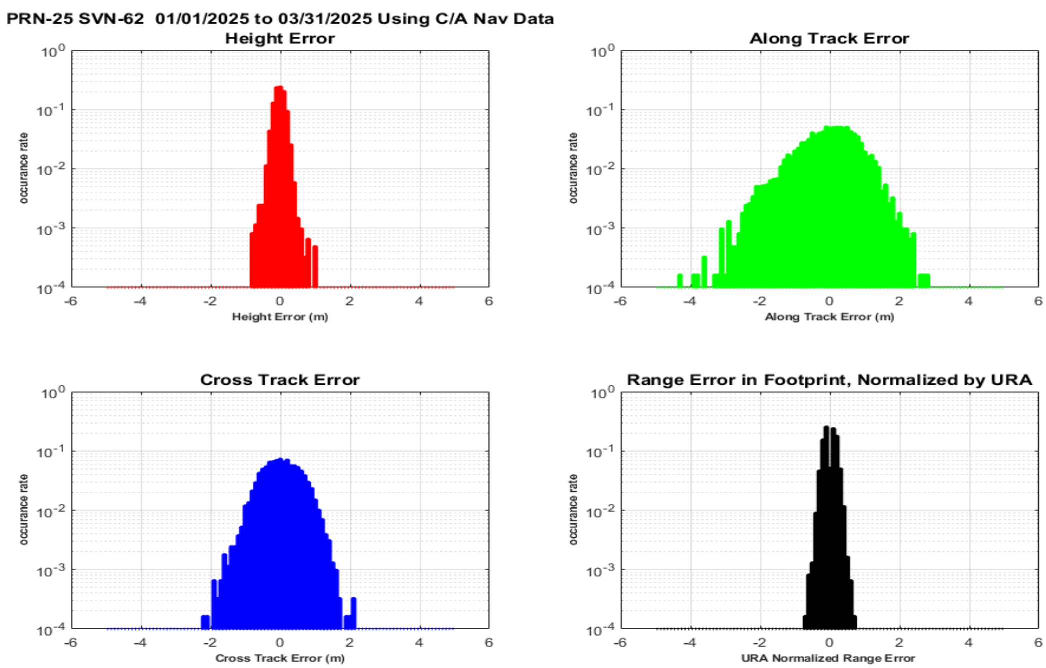



**Figure 9-124 Histograms of H, A, C, and Range Error PRN25 (SVN62) Using C/A Nav Data**

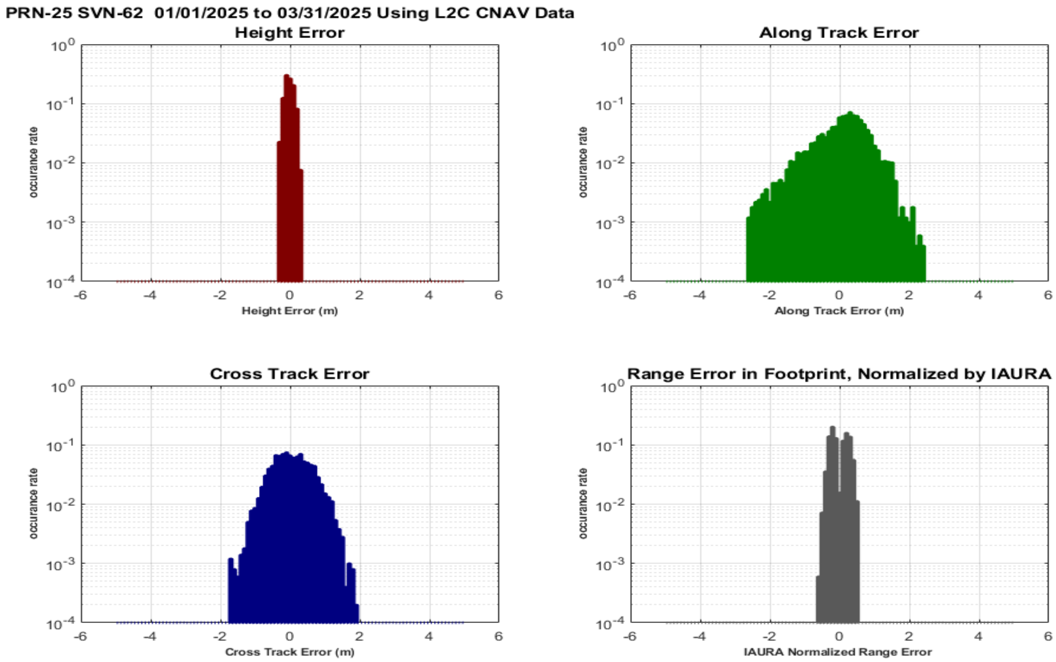



**Figure 9-125 Histograms of H, A, C, and Range Error PRN25 (SVN62) Using L2C CNAV Data**

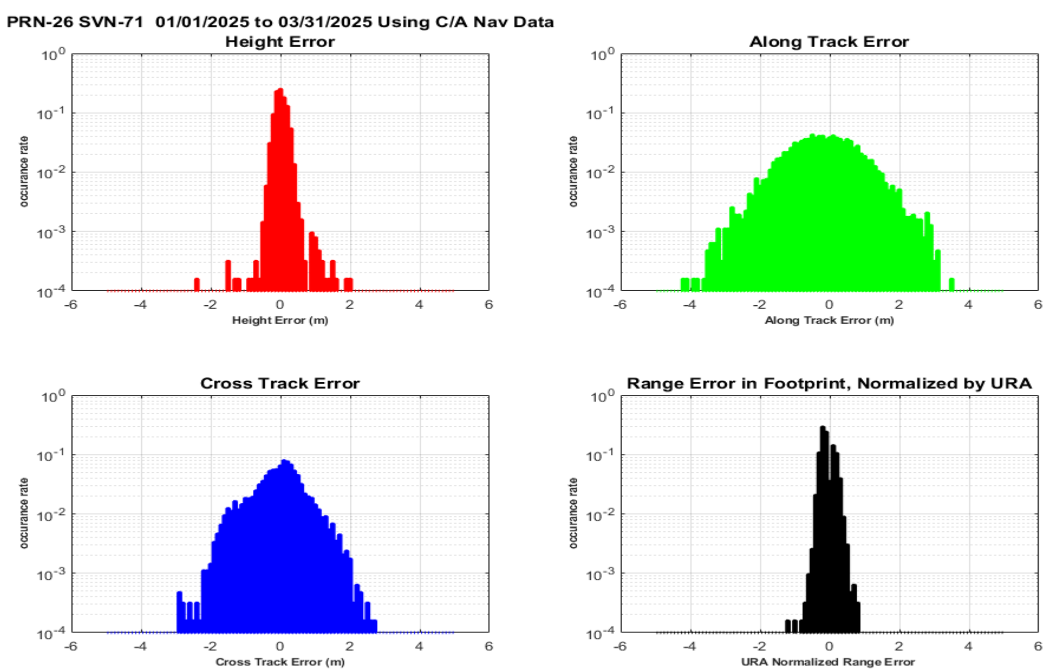



**Figure 9-126 Histograms of H, A, C, and Range Error PRN26 (SVN71) Using C/A Nav Data**

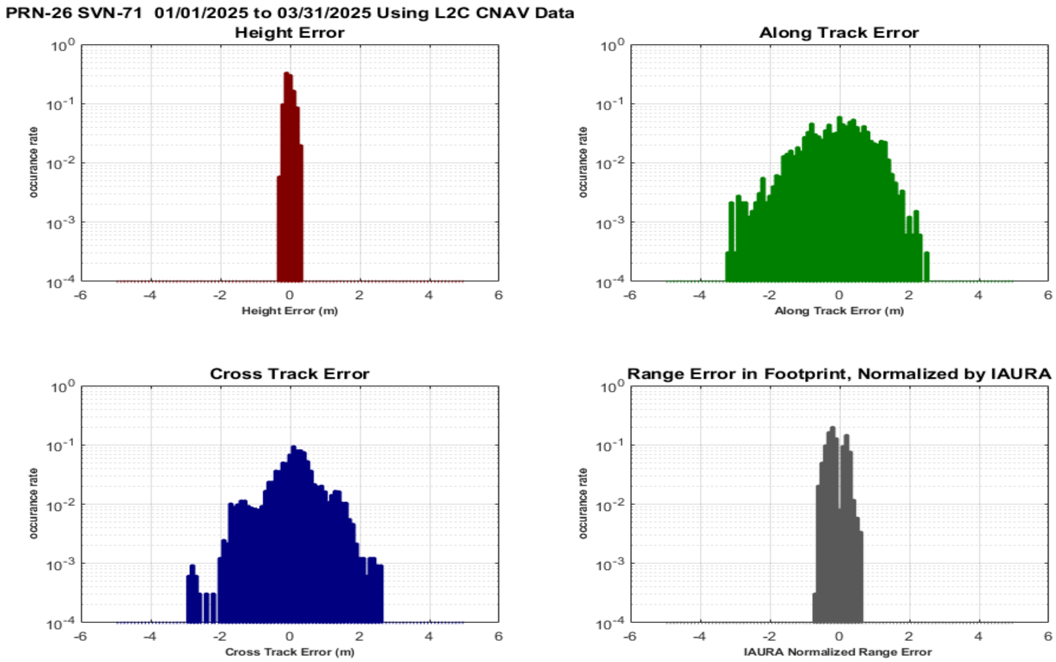



**Figure 9-127 Histograms of H, A, C, and Range Error PRN26 (SVN71) Using L2C CNAV Data**

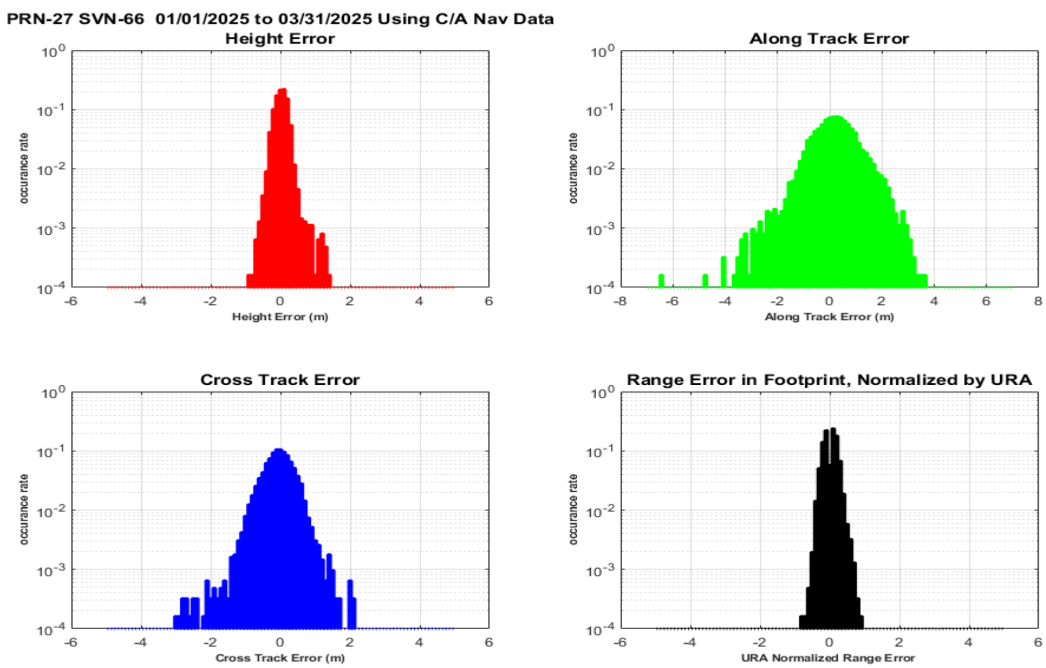



**Figure 9-128 Histograms of H, A, C, and Range Error PRN27 (SVN66) Using C/A Nav Data**

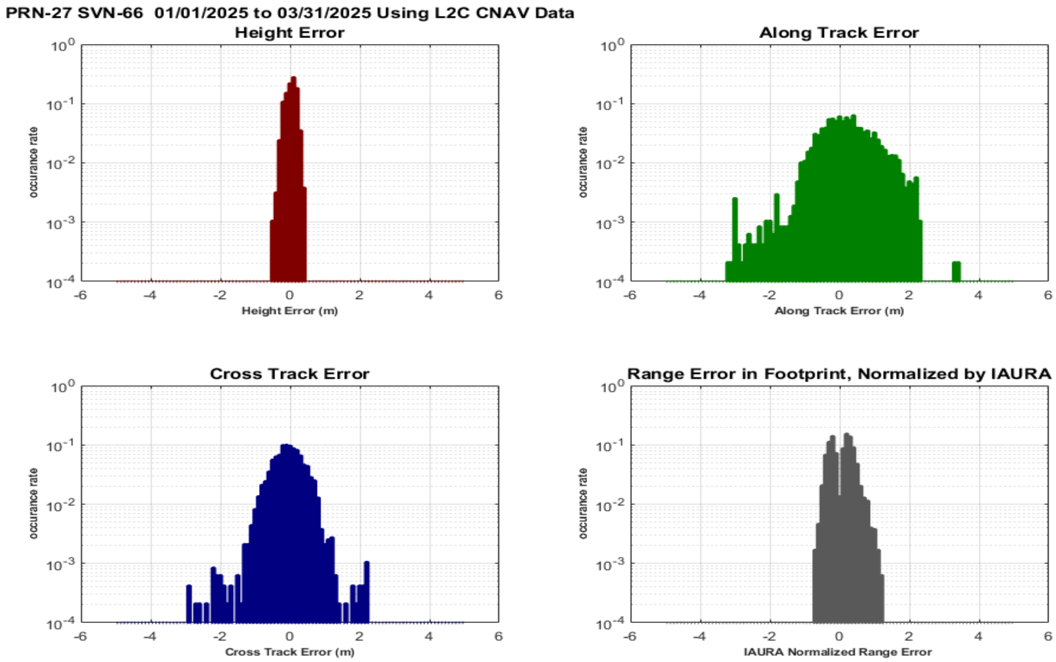



**Figure 9-129 Histograms of H, A, C, and Range Error PRN27 (SVN66) Using L2C CNAV Data**

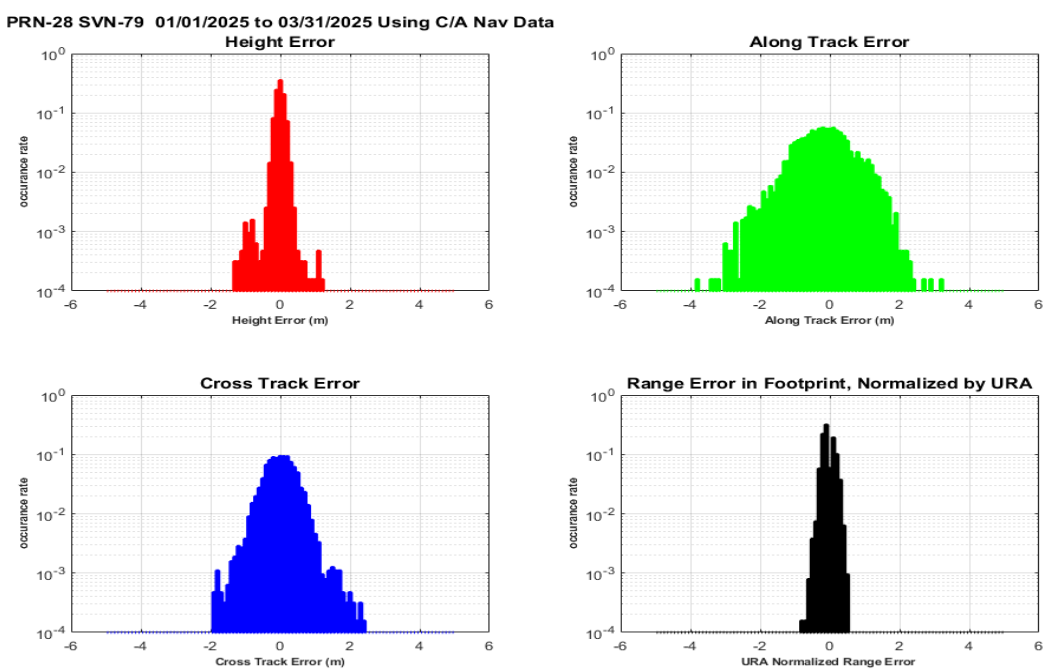



**Figure 9-130 Histograms of H, A, C, and Range Error PRN28 (SVN79) Using C/A Nav Data**

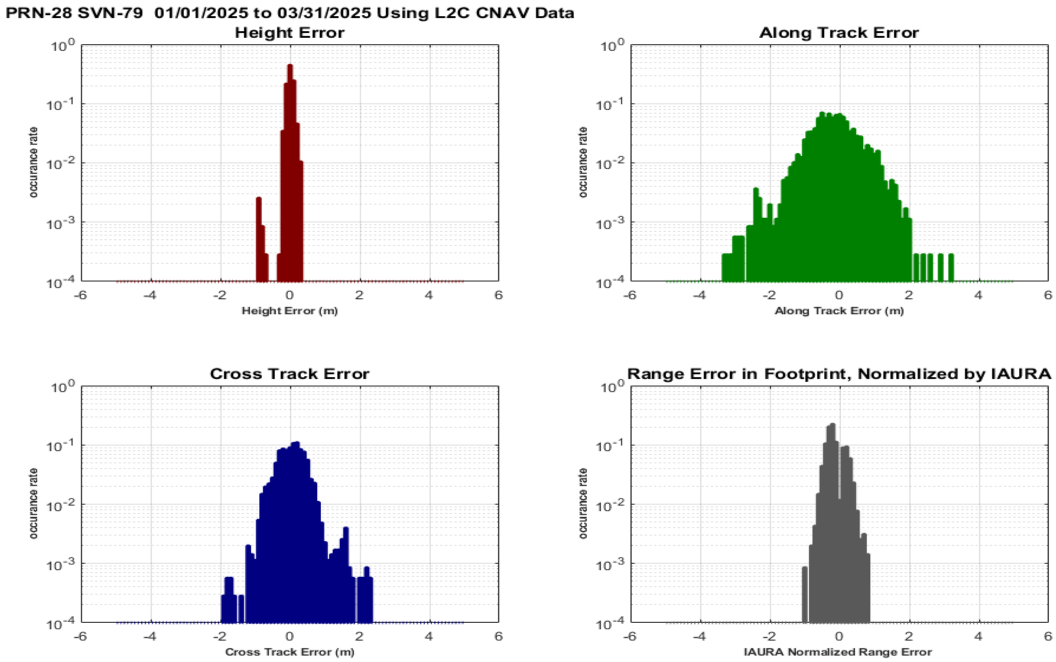



**Figure 9-131 Histograms of H, A, C, and Range Error PRN28 (SVN79) Using L2C CNAV Data**

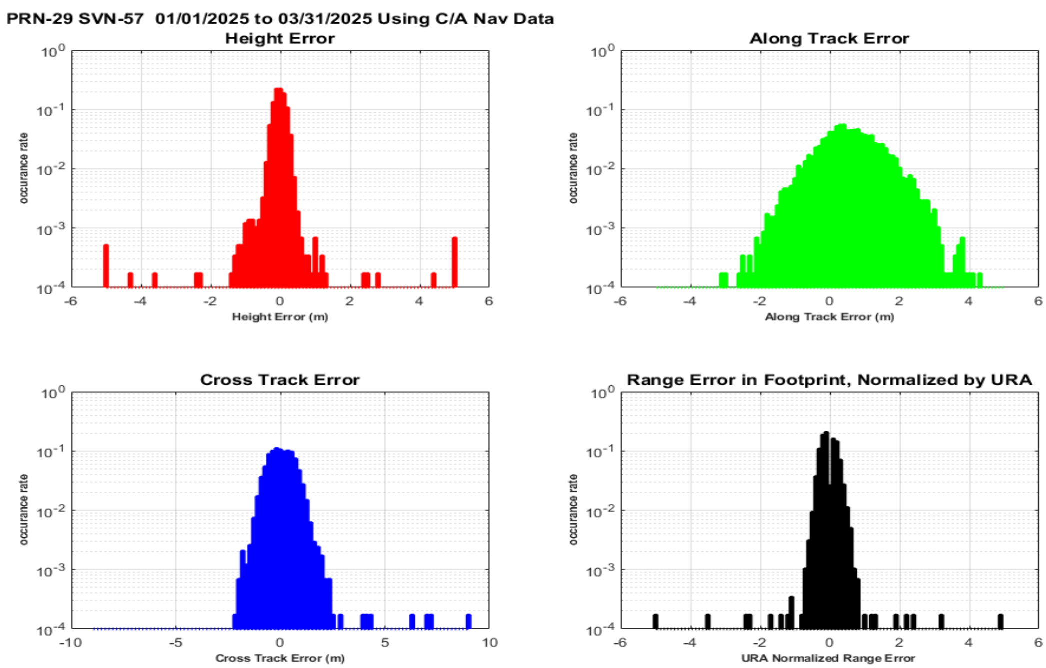



**Figure 9-132 Histograms of H, A, C, and Range Error PRN29 (SVN57) Using C/A Nav Data**

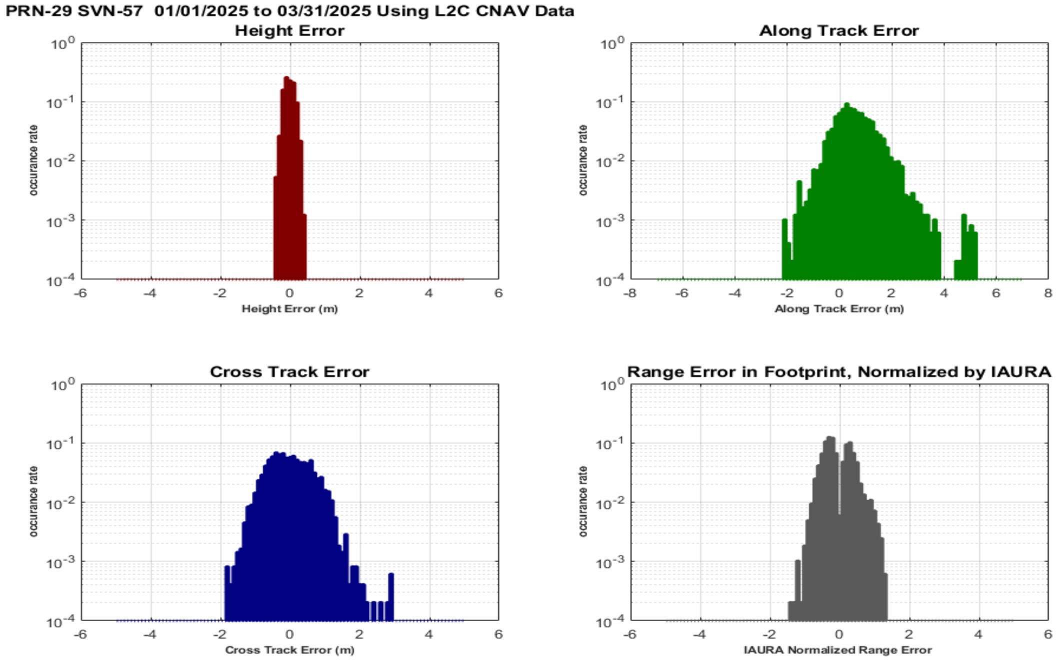



**Figure 9-133 Histograms of H, A, C, and Range Error PRN29 (SVN57) Using L2C CNAV Data**

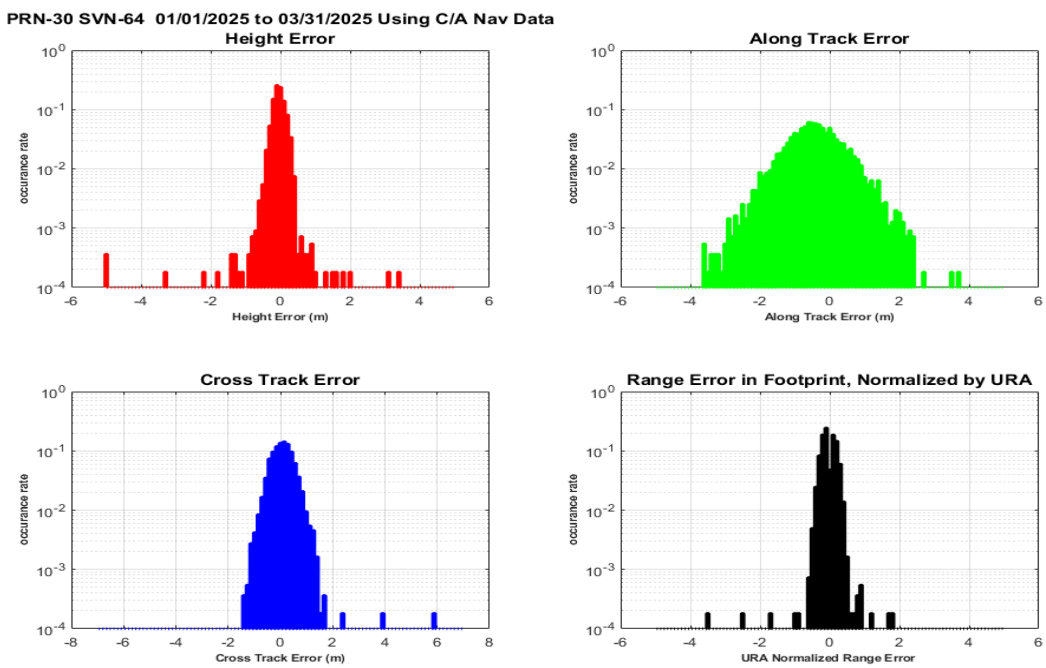



**Figure 9-134 Histograms of H, A, C, and Range Error PRN30 (SVN64) Using C/A Nav Data**

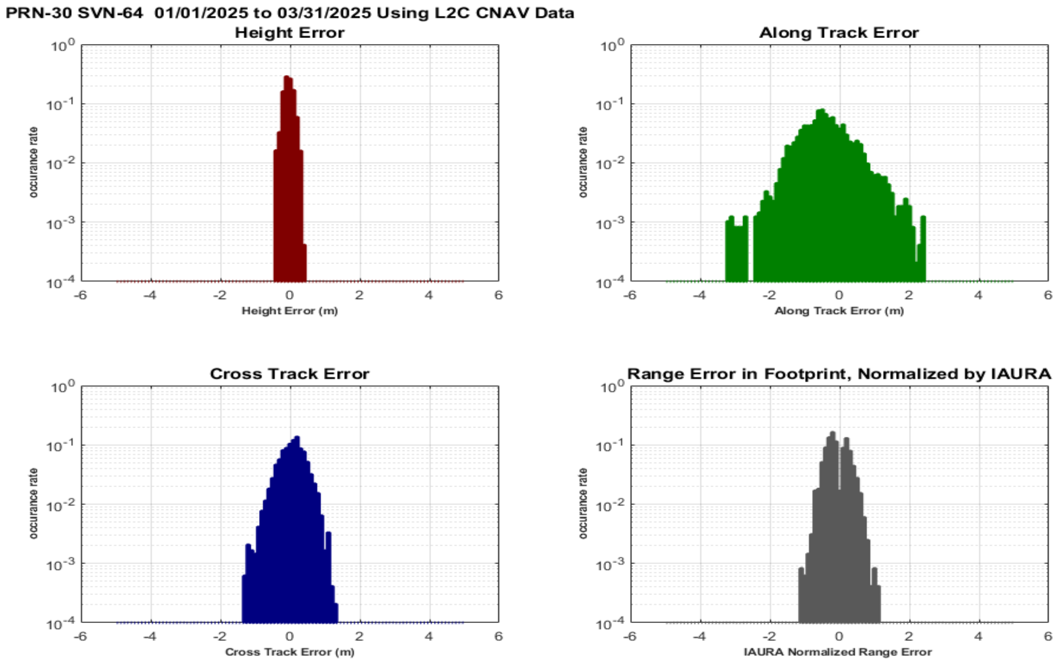



**Figure 9-135 Histograms of H, A, C, and Range Error PRN30 (SVN64) Using L2C CNAV Data**

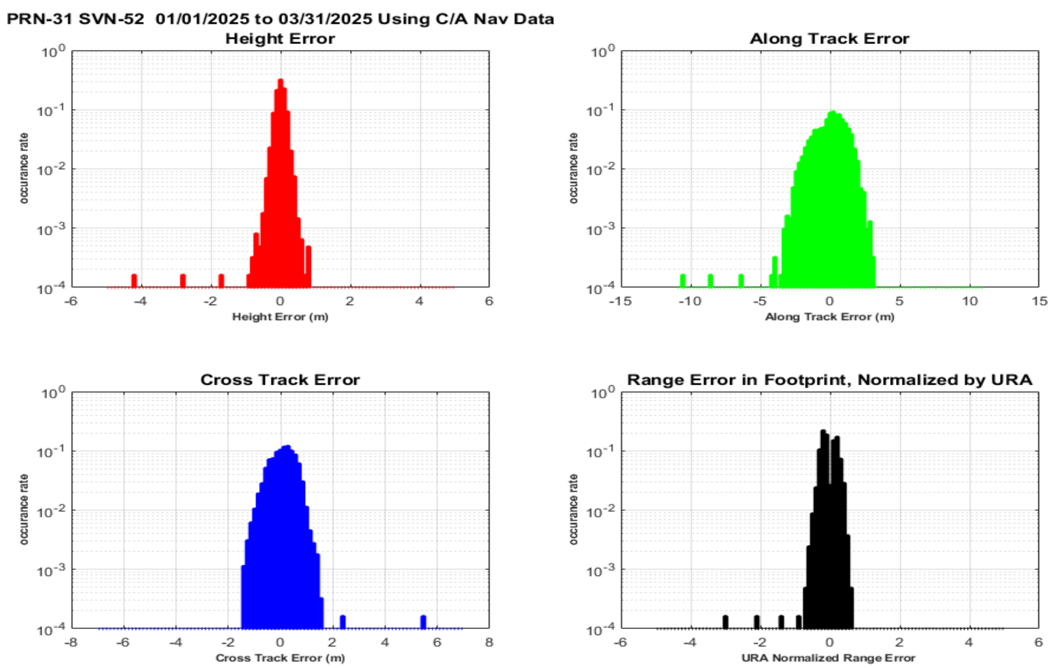



**Figure 9-136 Histograms of H, A, C, and Range Error PRN31 (SVN52) Using C/A Nav Data**

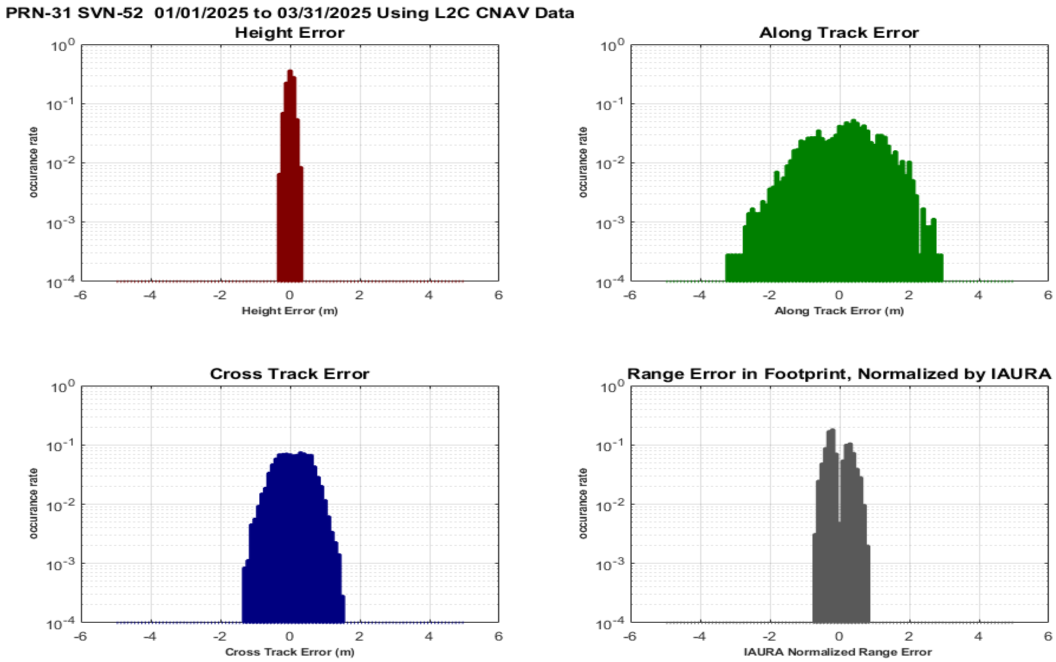



**Figure 9-137 Histograms of H, A, C, and Range Error PRN31 (SVN52) Using L2C CNAV Data**

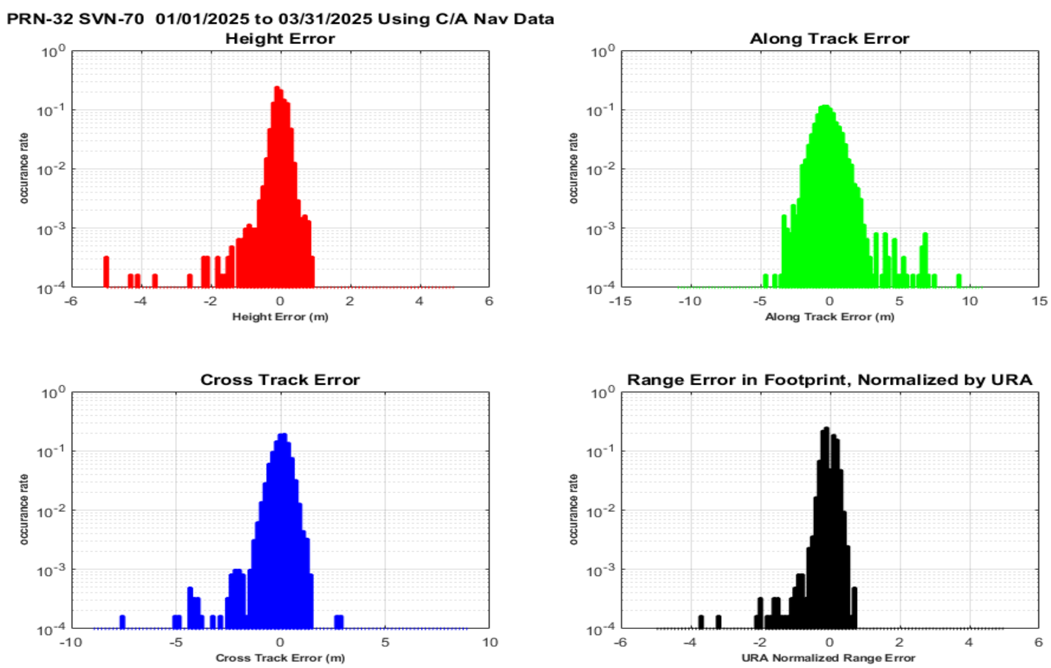



**Figure 9-138 Histograms of H, A, C, and Range Error PRN32 (SVN70) Using C/A Nav Data**

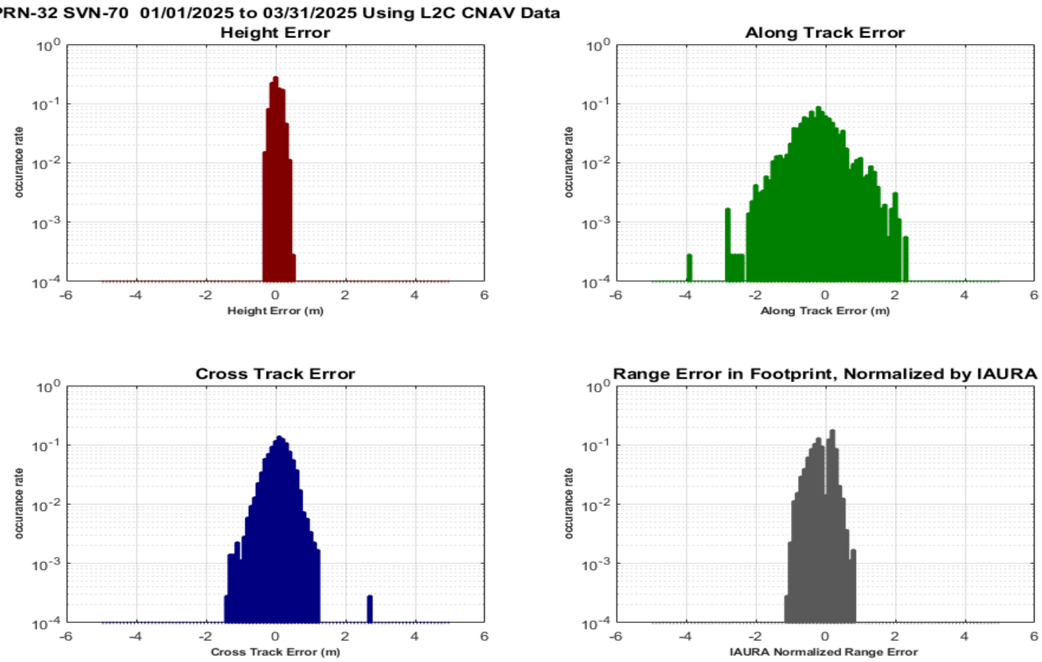



**Figure 9-139 Histograms of H, A, C, and Range Error PRN32 (SVN70) Using L2C CNAV Data**

## 9.8 Timeline of URA Normalized Range Error for All Satellites

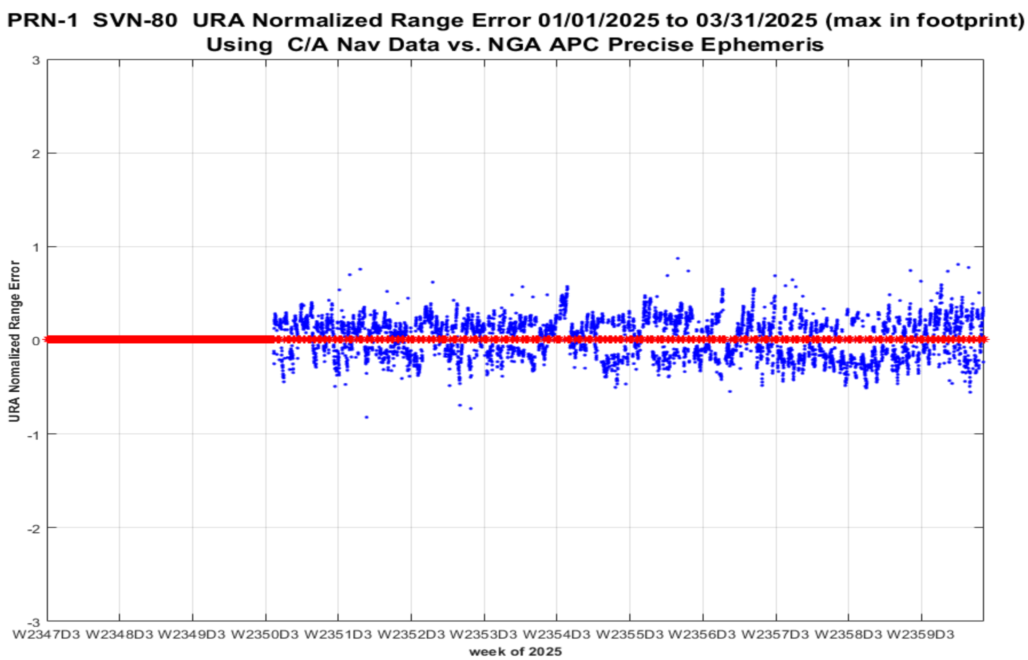



**Figure 9-140 Timeline of URA Normalized Range Error PRN1 (SVN80) Using C/A Nav Data**

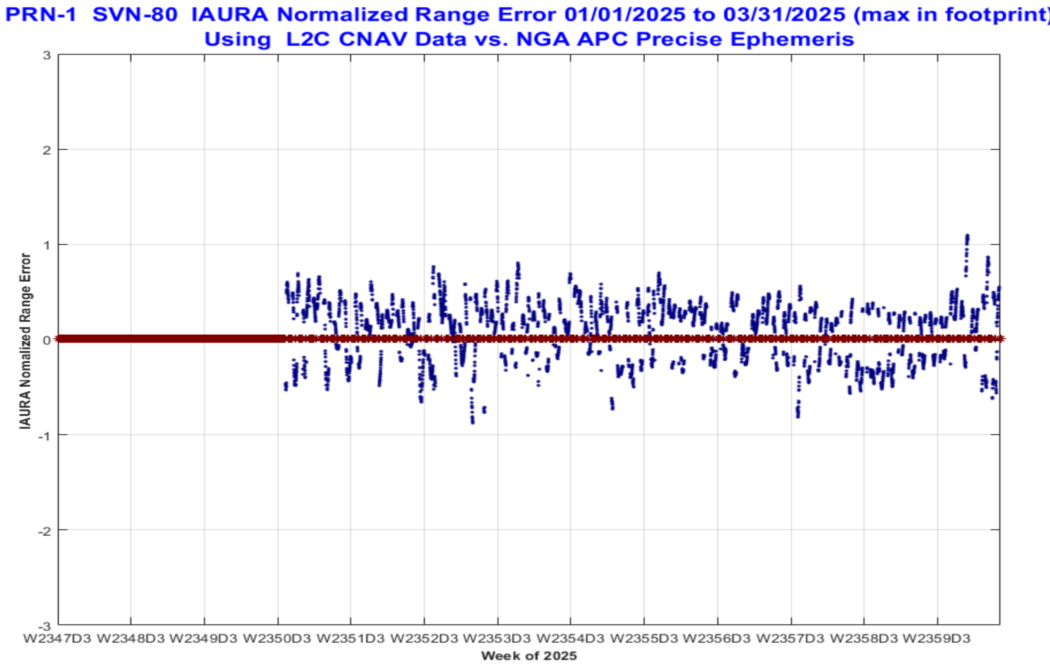



**Figure 9-141 Timeline of IAURA Normalized Range Error PRN1 (SVN80) Using L2C CNAV Data**

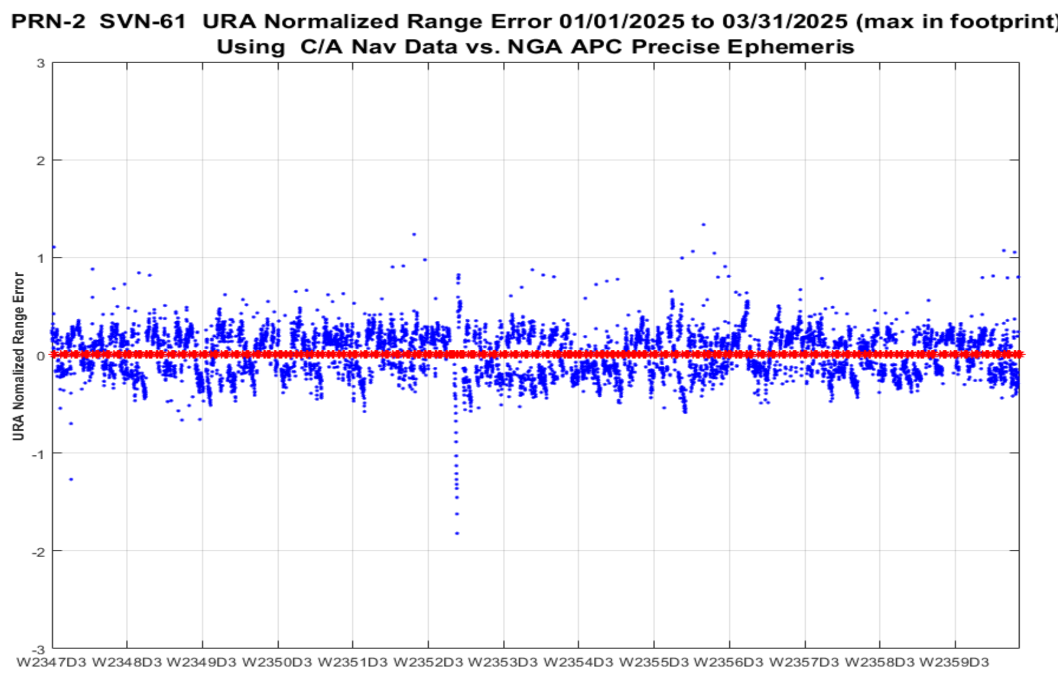



**Figure 9-142 Timeline of URA Normalized Range Error PRN2 (SVN61) Using C/A Nav Data**

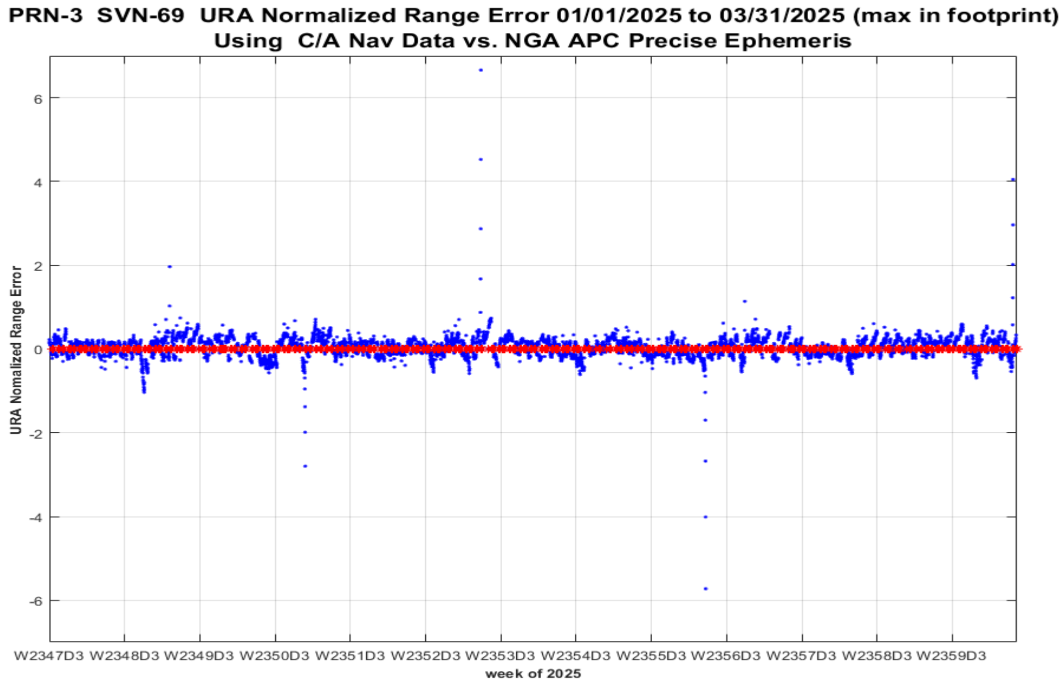



**Figure 9-143 Timeline of URA Normalized Range Error PRN3 (SVN69) Using C/A Nav Data**

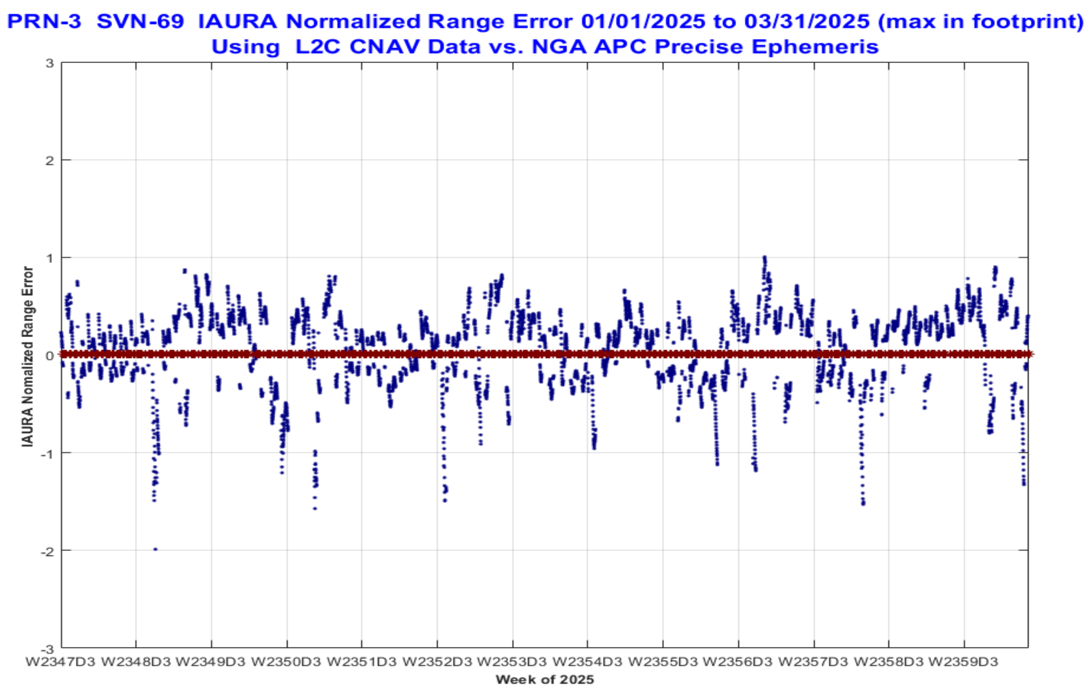



**Figure 9-144 Timeline of IAURA Normalized Range Error PRN3 (SVN69) Using L2C CNAV Data**

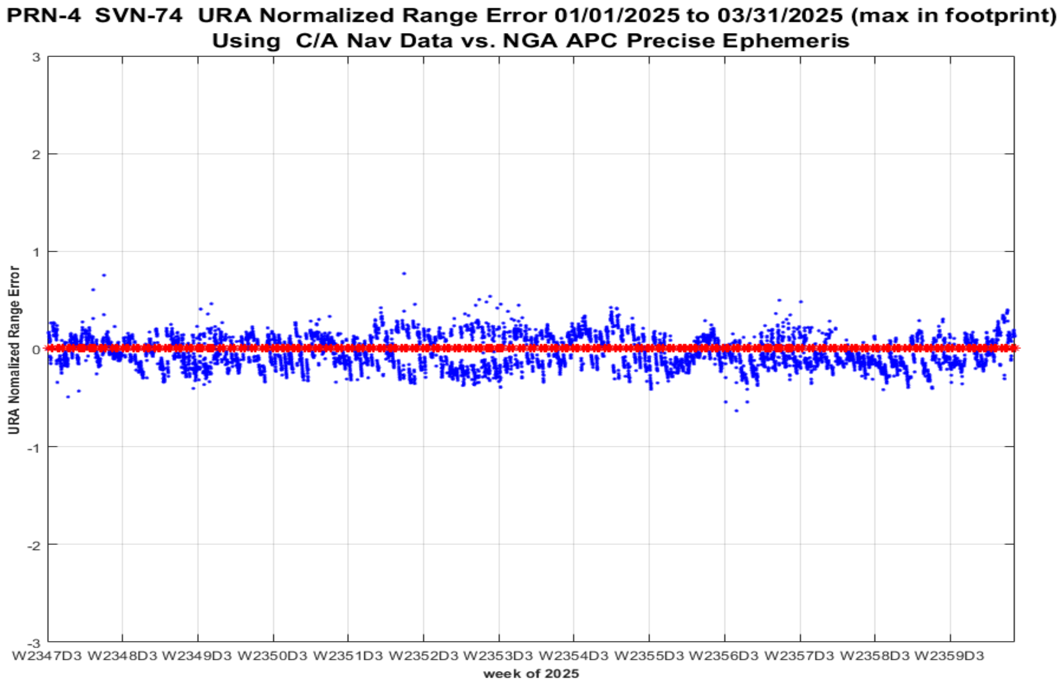



**Figure 9-145 Timeline of URA Normalized Range Error PRN4 (SVN74) Using C/A Nav Data**

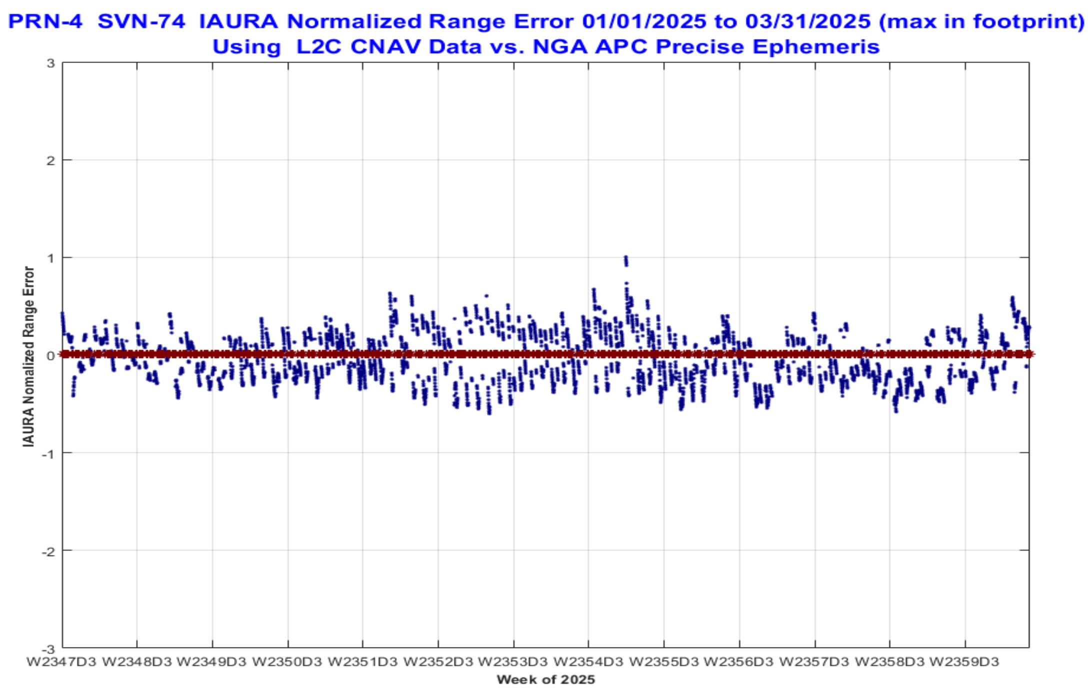



**Figure 9-146 Timeline of IAURA Normalized Range Error PRN4 (SVN74) Using L2C CNAV Data**

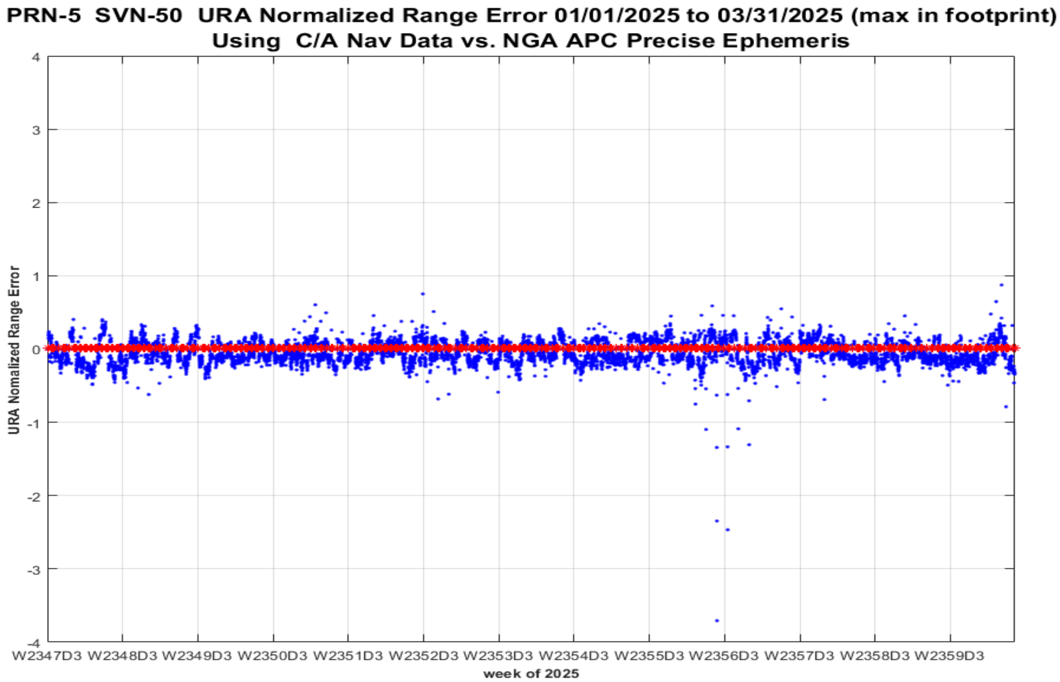



**Figure 9-147 Timeline of URA Normalized Range Error PRN5 (SVN50) Using C/A Nav Data**

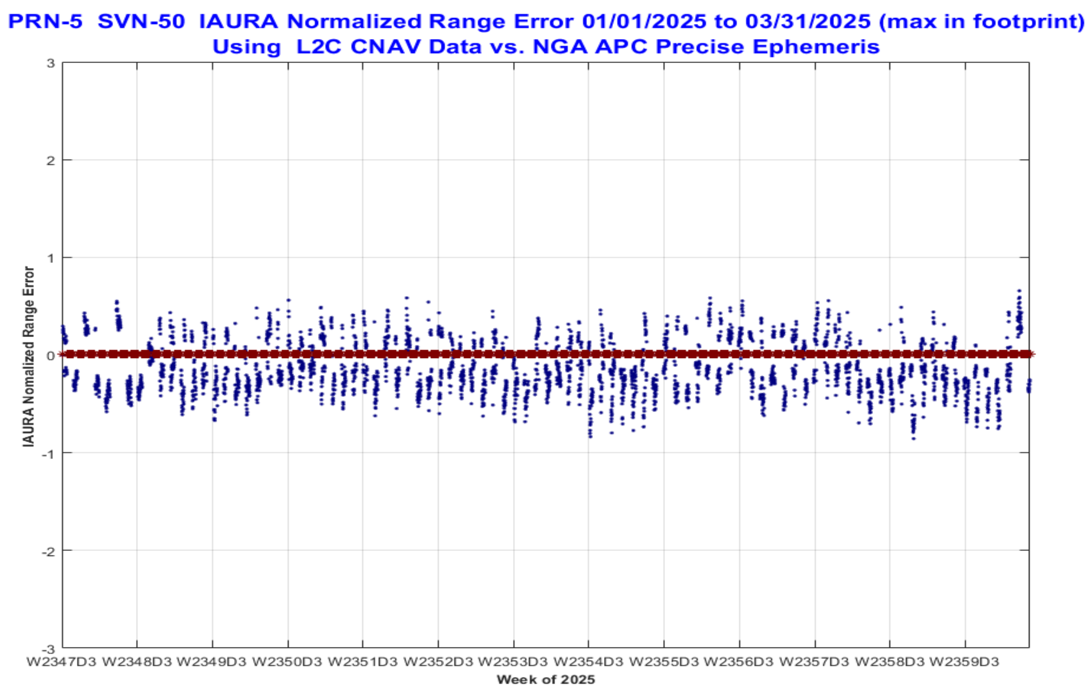



**Figure 9-148 Timeline of IAURA Normalized Range Error PRN5 (SVN50) Using L2C CNAV Data**

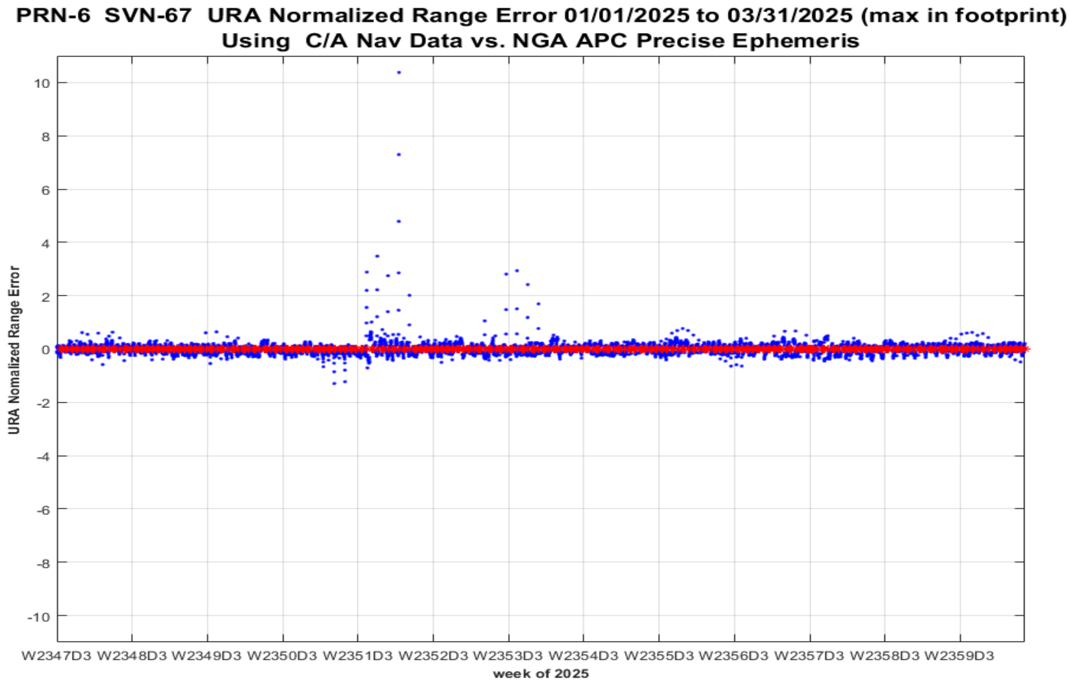



**Figure 9-149 Timeline of URA Normalized Range Error PRN6 (SVN67) Using C/A Nav Data**

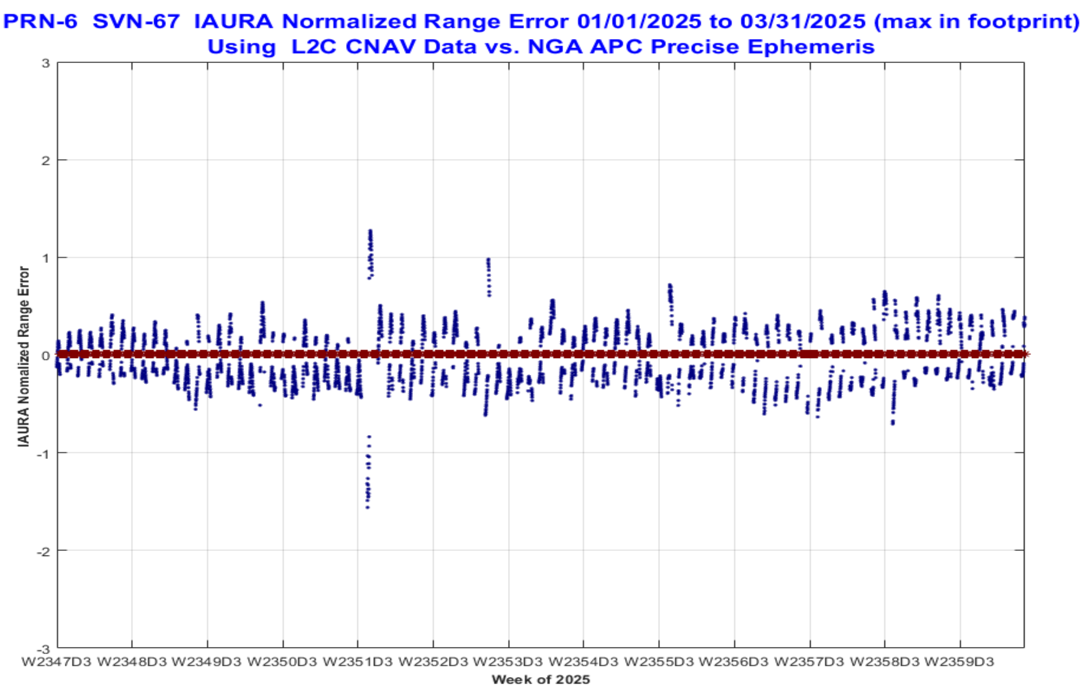



**Figure 9-150 Timeline of IAURA Normalized Range Error PRN6 (SVN67) Using L2C CNAV Data**

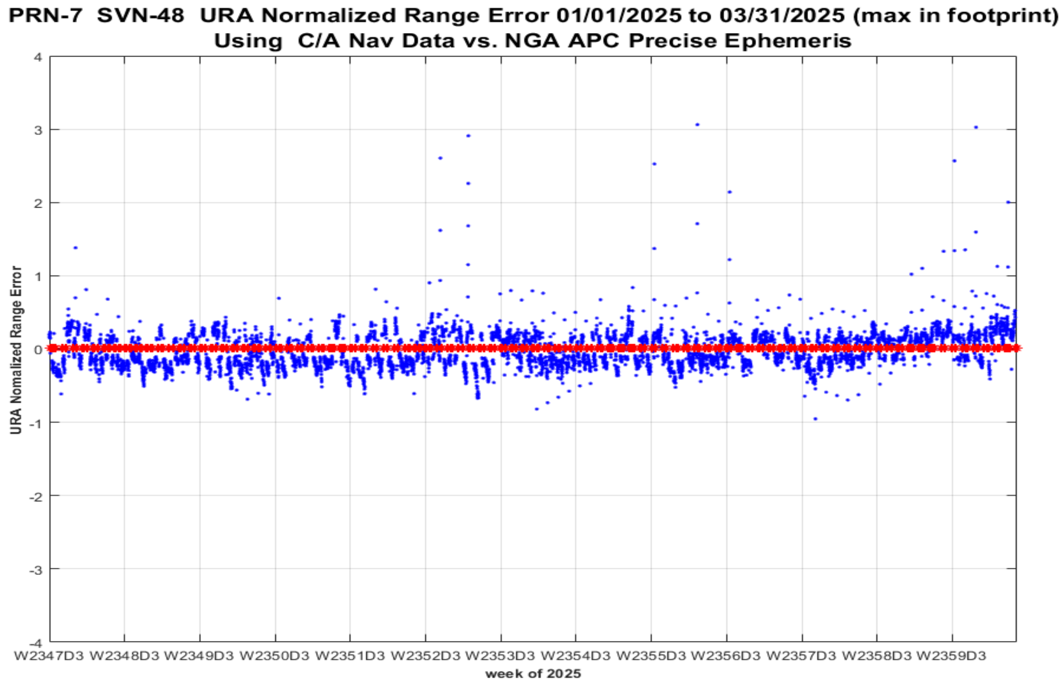



**Figure 9-151 Timeline of URA Normalized Range Error PRN7 (SVN48) Using C/A Nav Data**

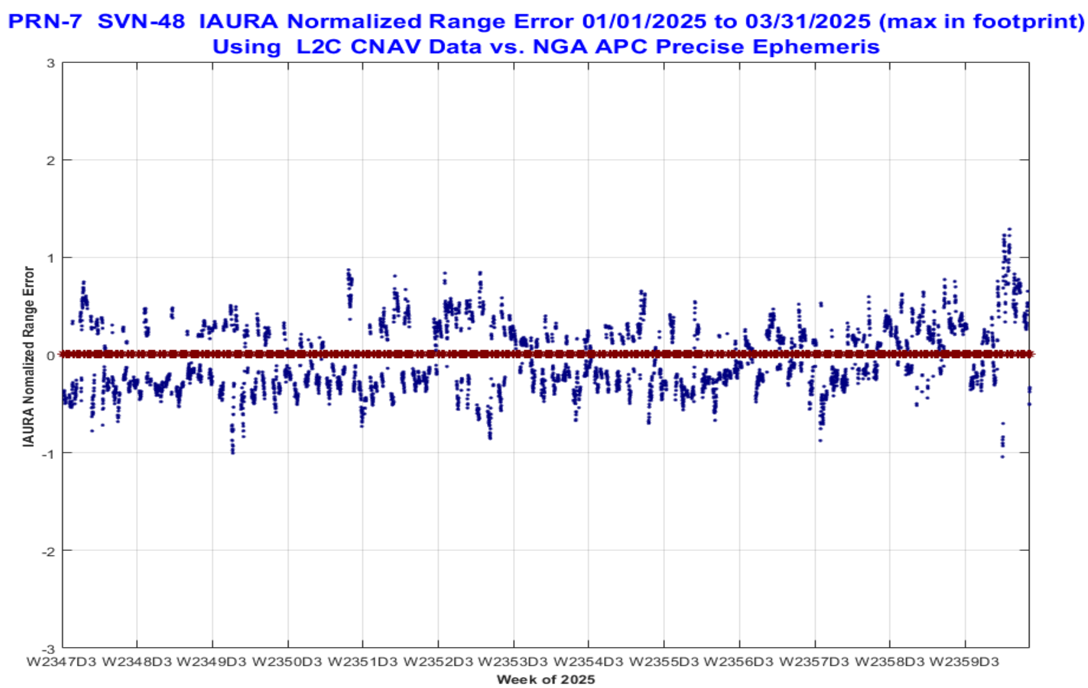



**Figure 9-152 Timeline of IAURA Normalized Range Error PRN7 (SVN48) Using L2C CNAV Data**

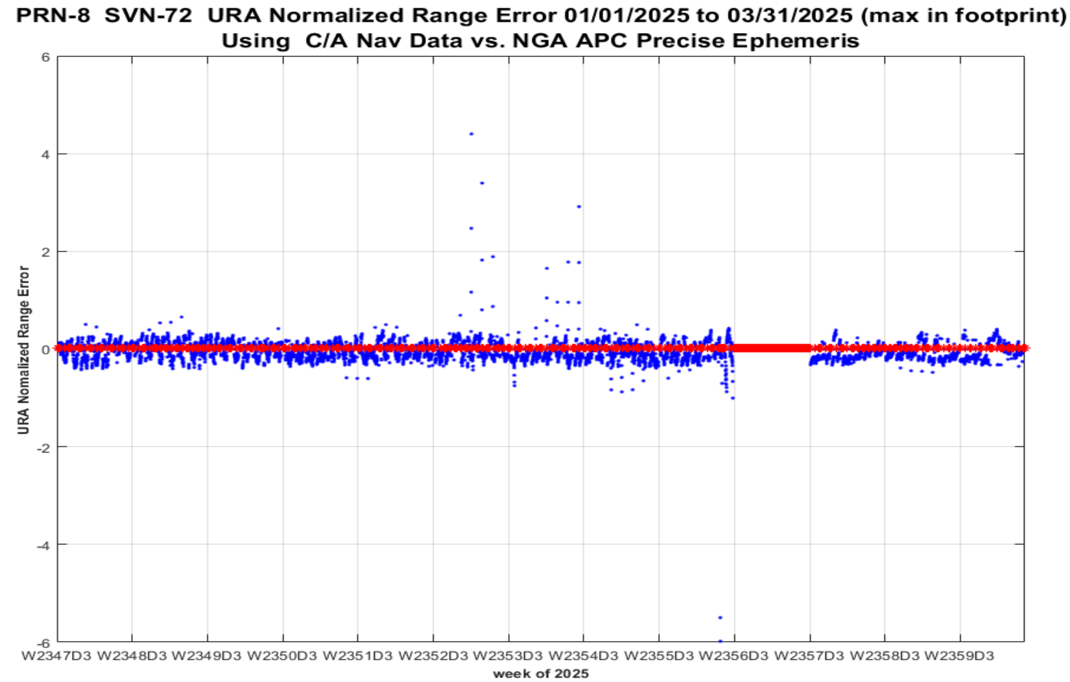



**Figure 9-153 Timeline of URA Normalized Range Error PRN8 (SVN72) Using C/A Nav Data**

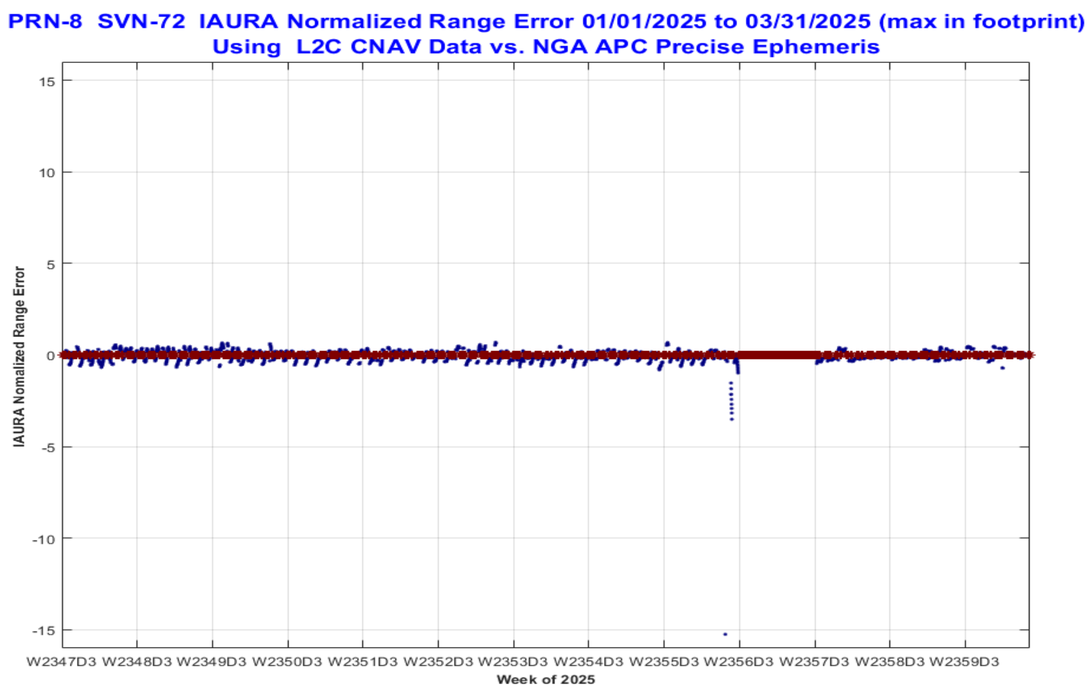



**Figure 9-154 Timeline of IAURA Normalized Range Error PRN8 (SVN72) Using L2C CNAV Data**

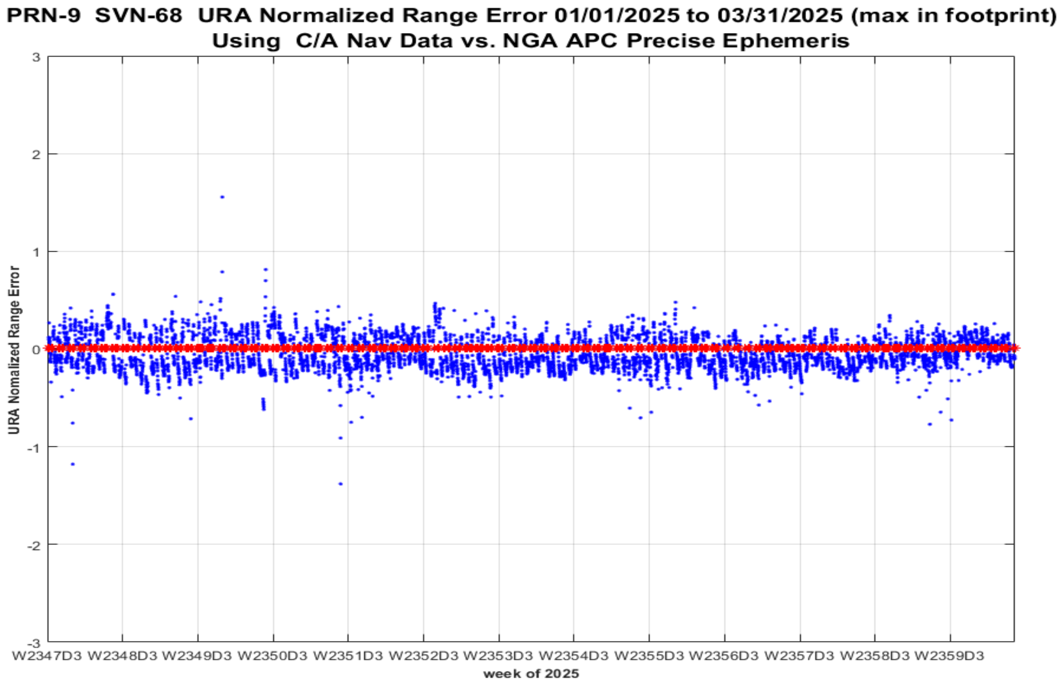



**Figure 9-155 Timeline of URA Normalized Range Error PRN9 (SVN68) Using C/A Nav Data**

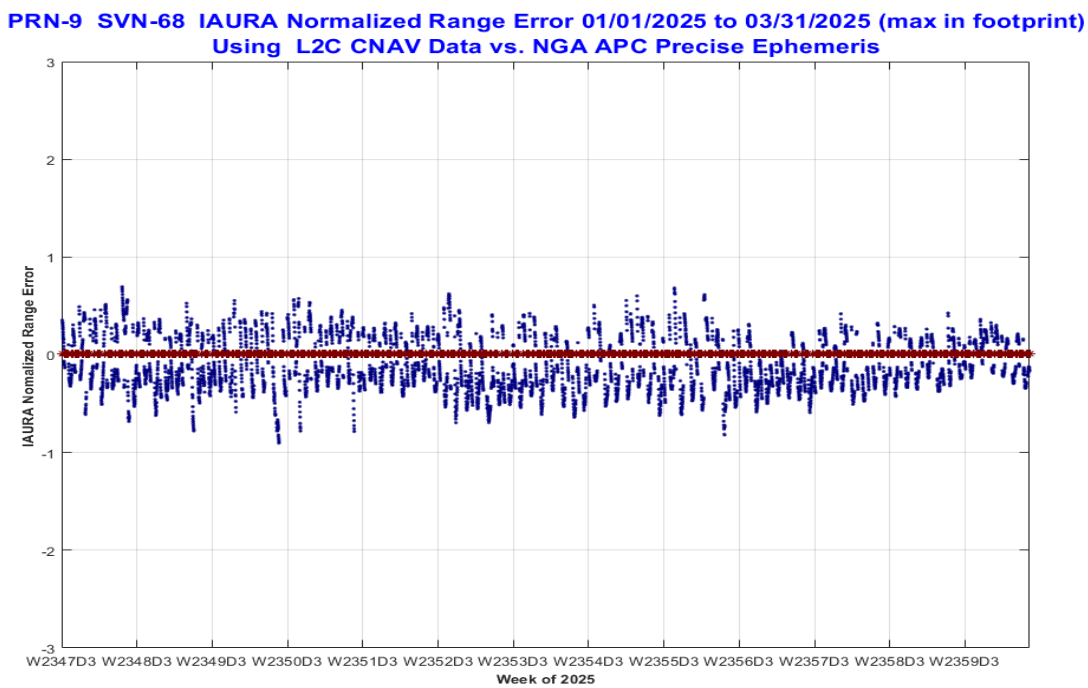



**Figure 9-156 Timeline of IAURA Normalized Range Error PRN9 (SVN68) Using L2C CNAV Data**

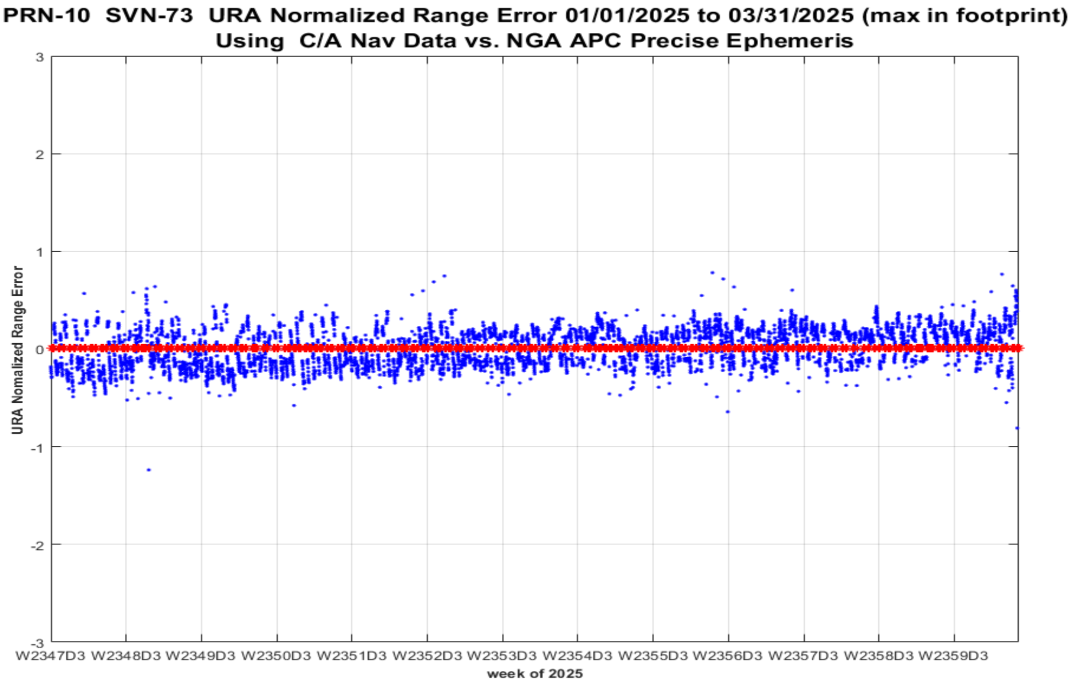



**Figure 9-157 Timeline of URA Normalized Range Error PRN10 (SVN73) Using C/A Nav Data**

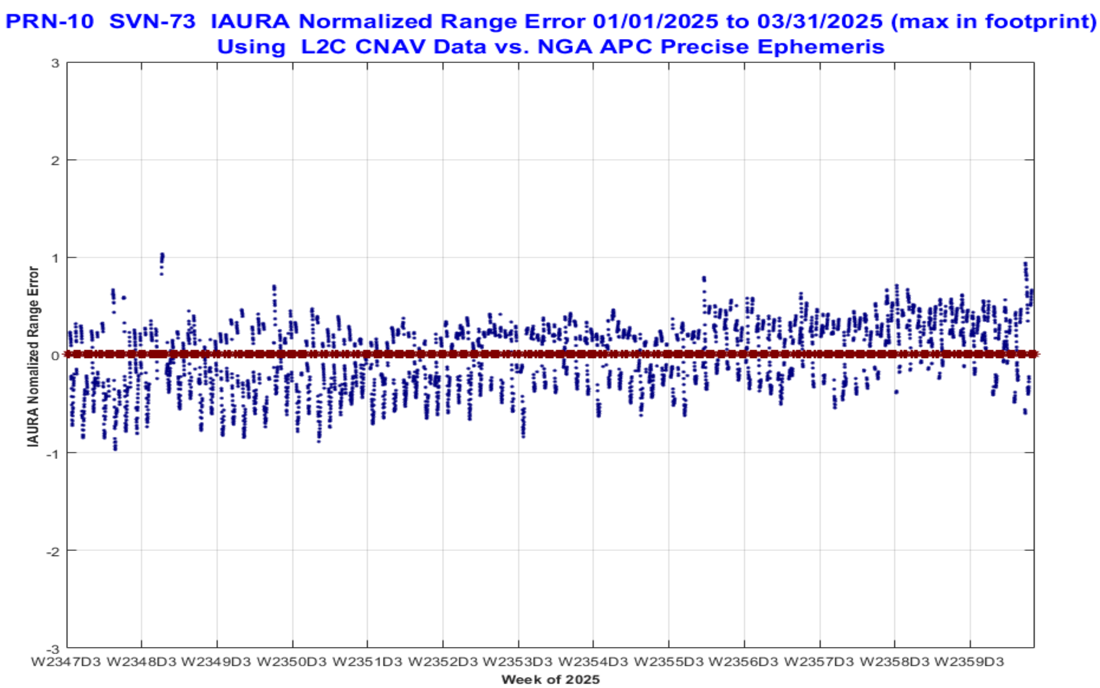



**Figure 9-158 Timeline of IAURA Normalized Range Error PRN10 (SVN73) Using L2C CNAV Data**

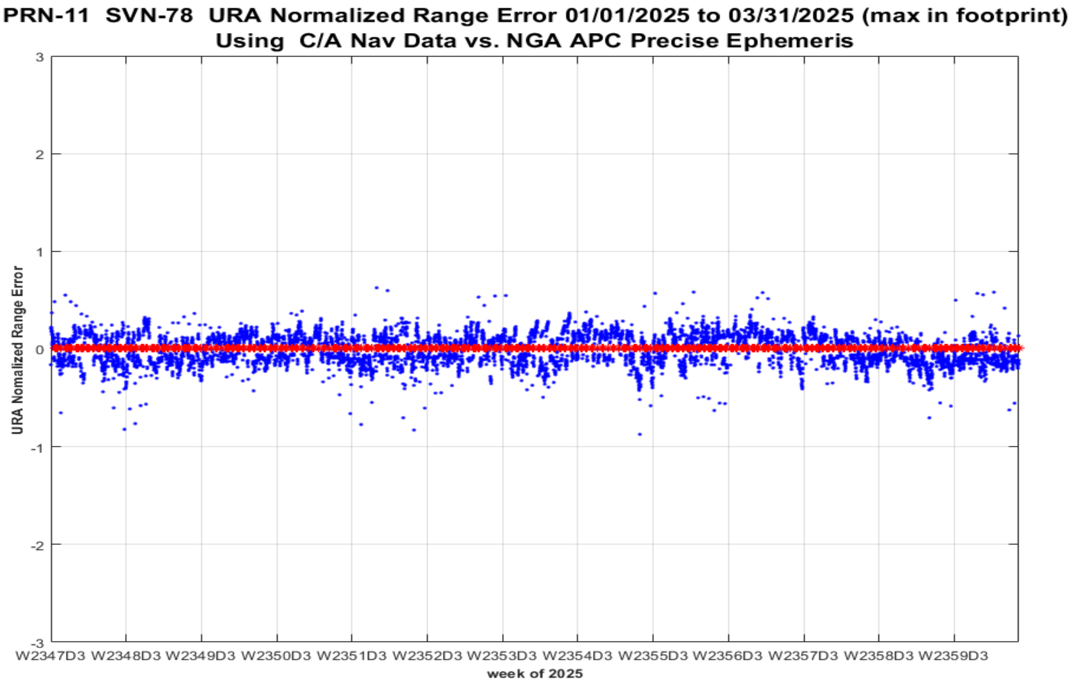



**Figure 9-159 Timeline of URA Normalized Range Error PRN11 (SVN78) Using C/A Nav Data**

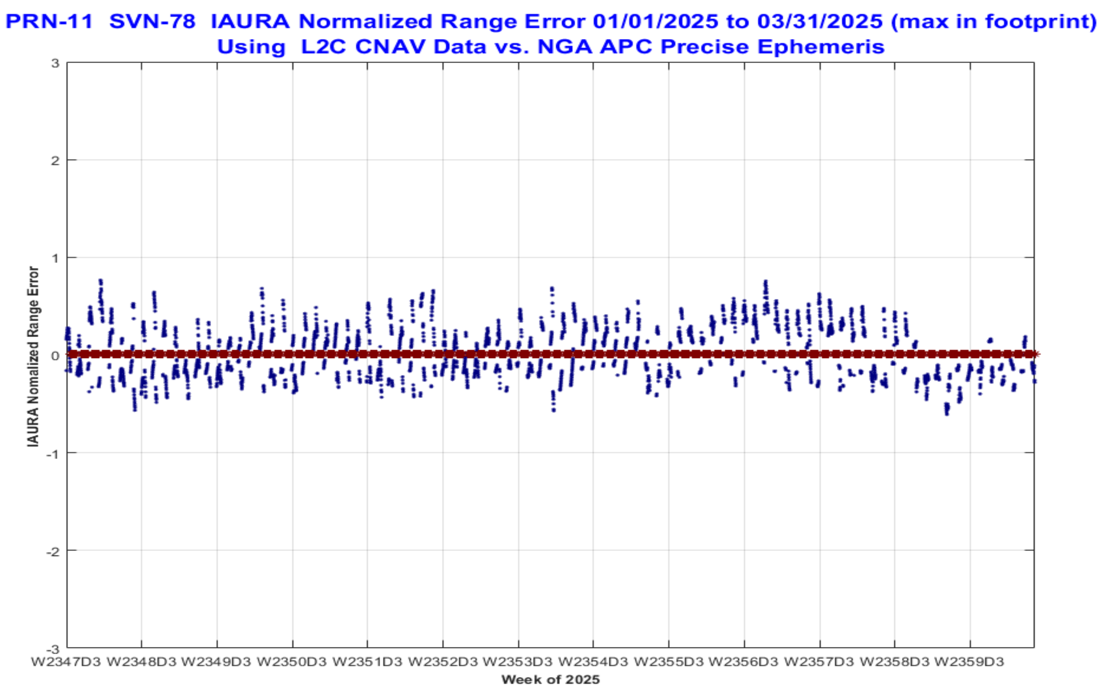



**Figure 9-160 Timeline of IAURA Normalized Range Error PRN11 (SVN78) Using L2C CNAV Data**

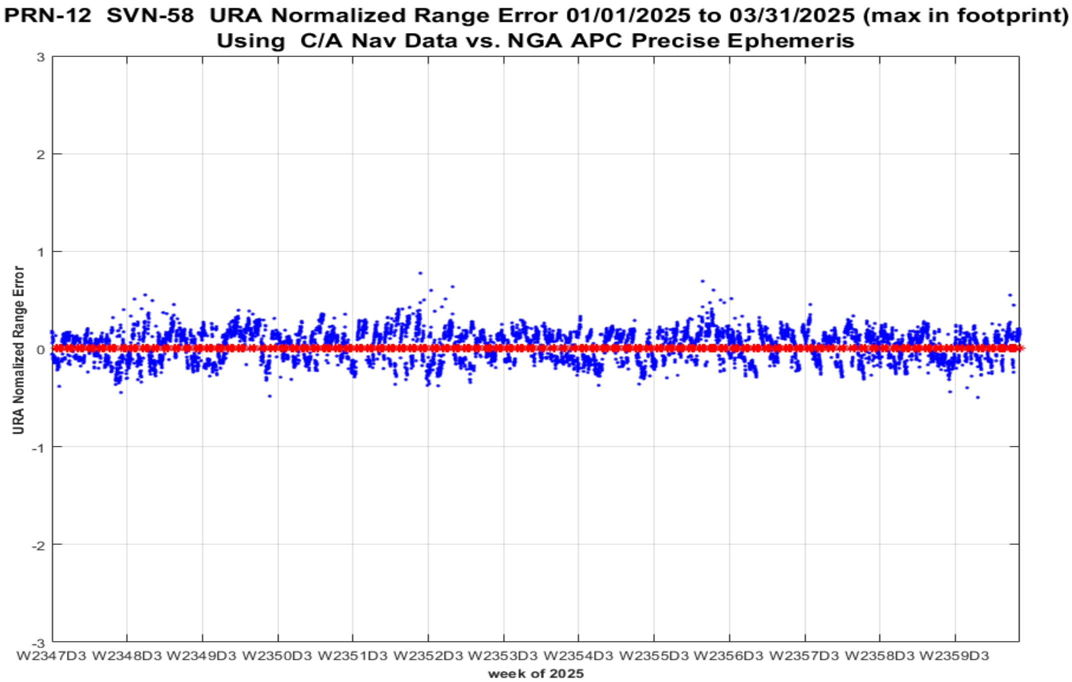



**Figure 9-161 Timeline of URA Normalized Range Error PRN12 (SVN58) Using C/A Nav Data**

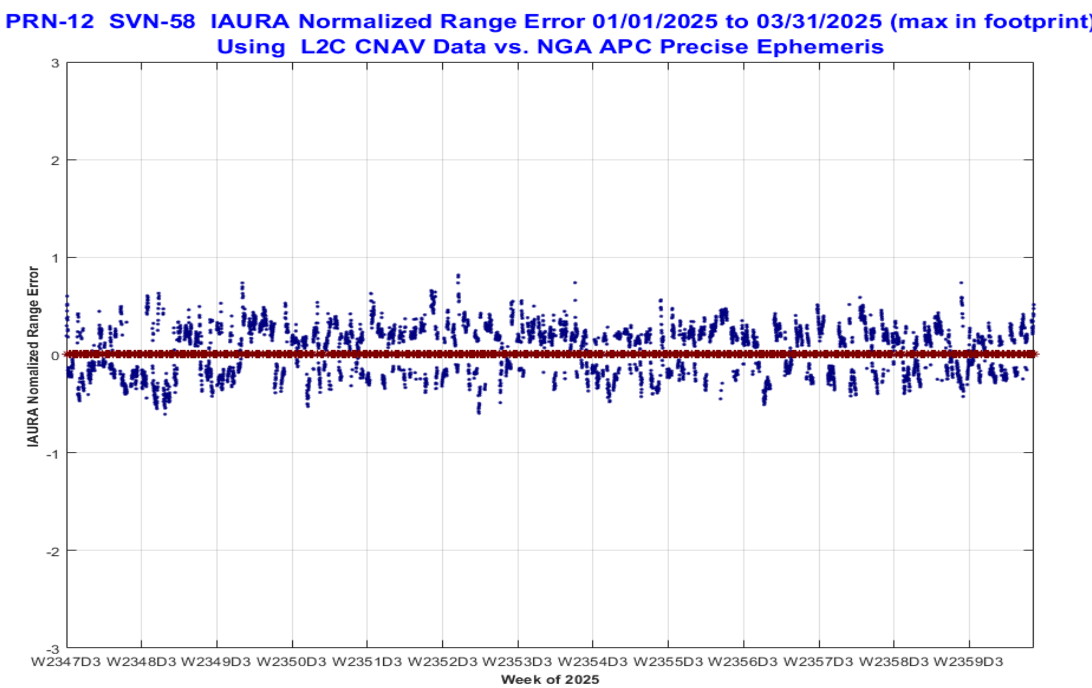



**Figure 9-162 Timeline of IAURA Normalized Range Error PRN12 (SVN58) Using L2C CNAV Data**

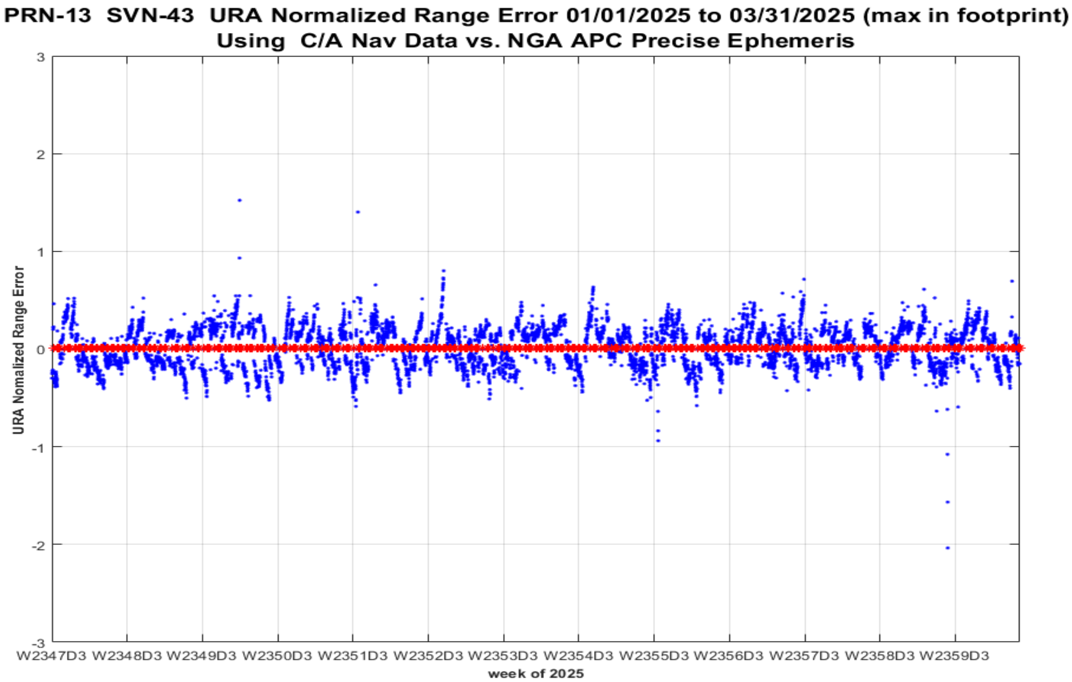



**Figure 9-163 Timeline of URA Normalized Range Error PRN13 (SVN43) Using C/A Nav Data**

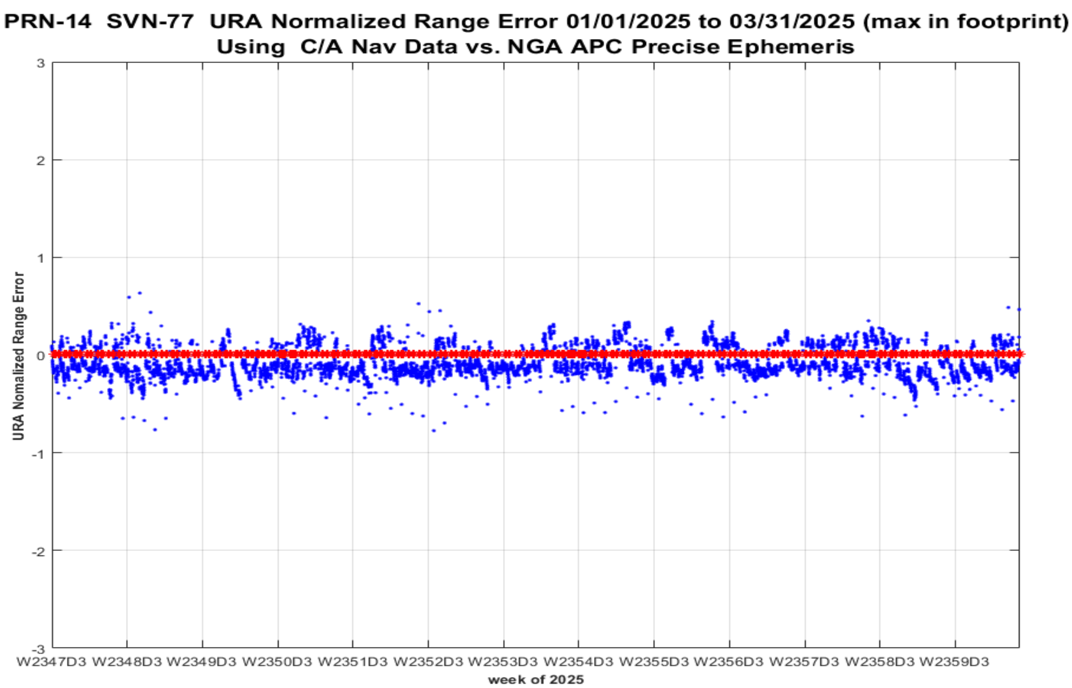



**Figure 9-164 Timeline of URA Normalized Range Error PRN14 (SVN77) Using C/A Nav Data**

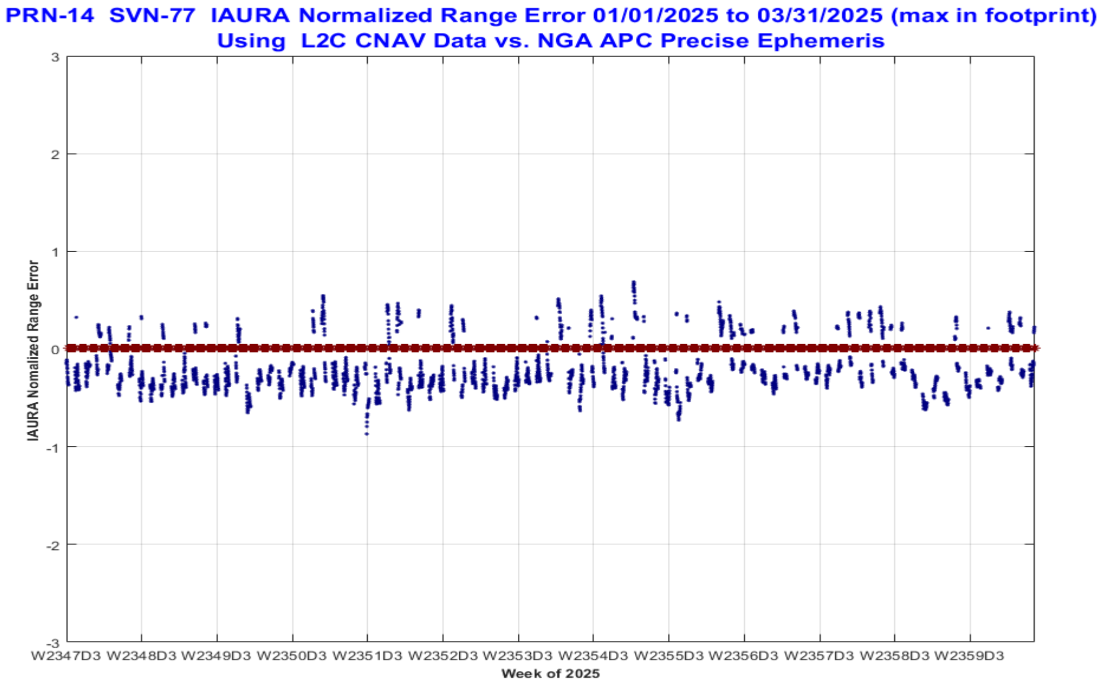



**Figure 9-165 Timeline of IAURA Normalized Range Error PRN14 (SVN77) Using L2C CNAV Data**

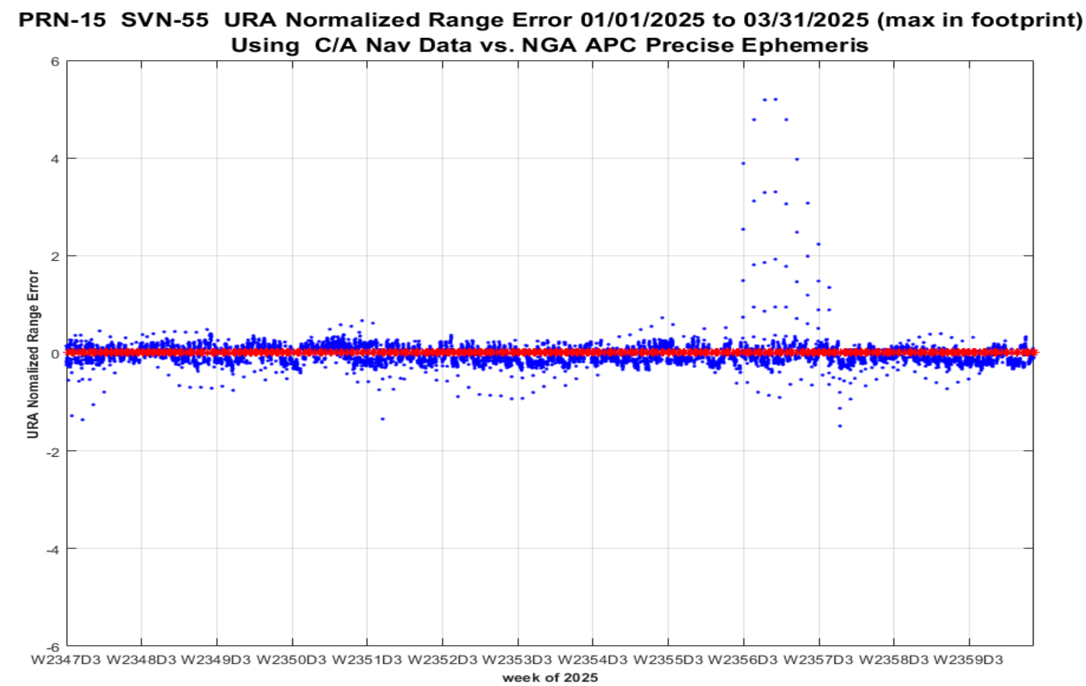



**Figure 9-166 Timeline of URA Normalized Range Error PRN15 (SVN55) Using C/A Nav Data**

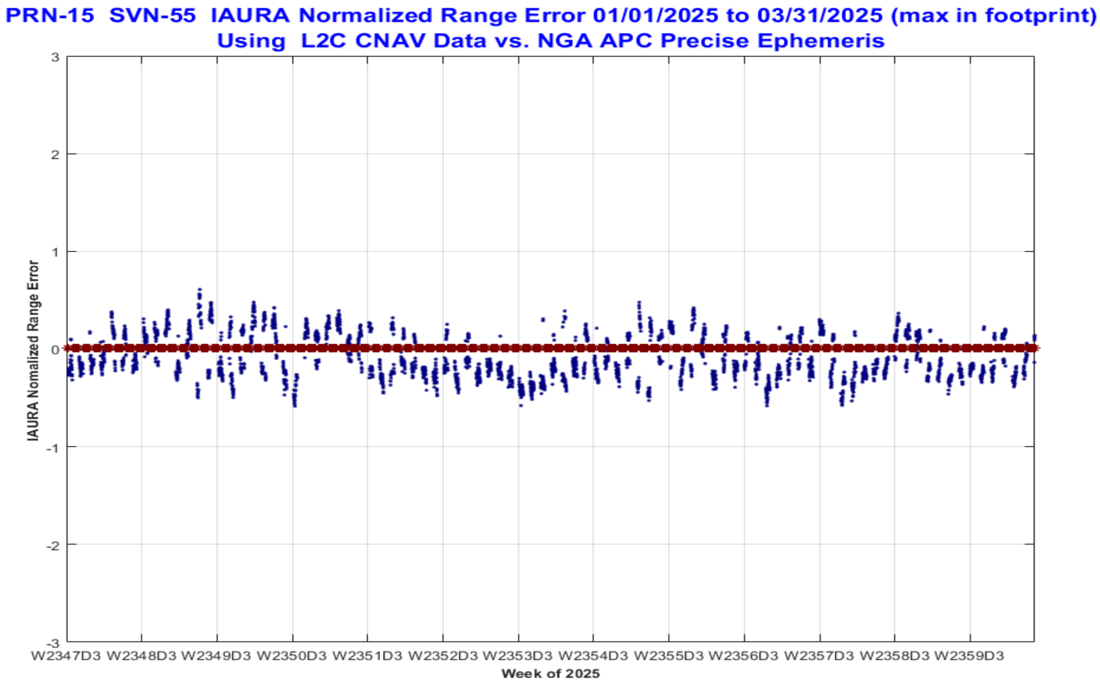



**Figure 9-167 Timeline of IAURA Normalized Range Error PRN15 (SVN55) Using L2C CNAV Data**

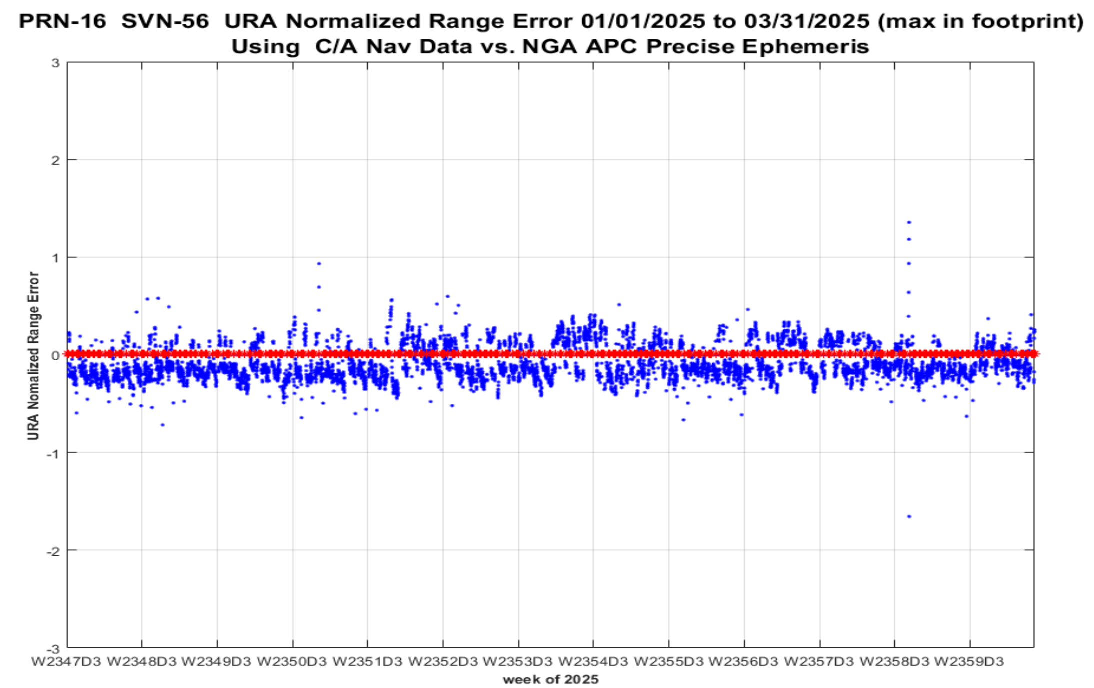



**Figure 9-168 Timeline of URA Normalized Range Error PRN16 (SVN56) Using C/A Nav Data**

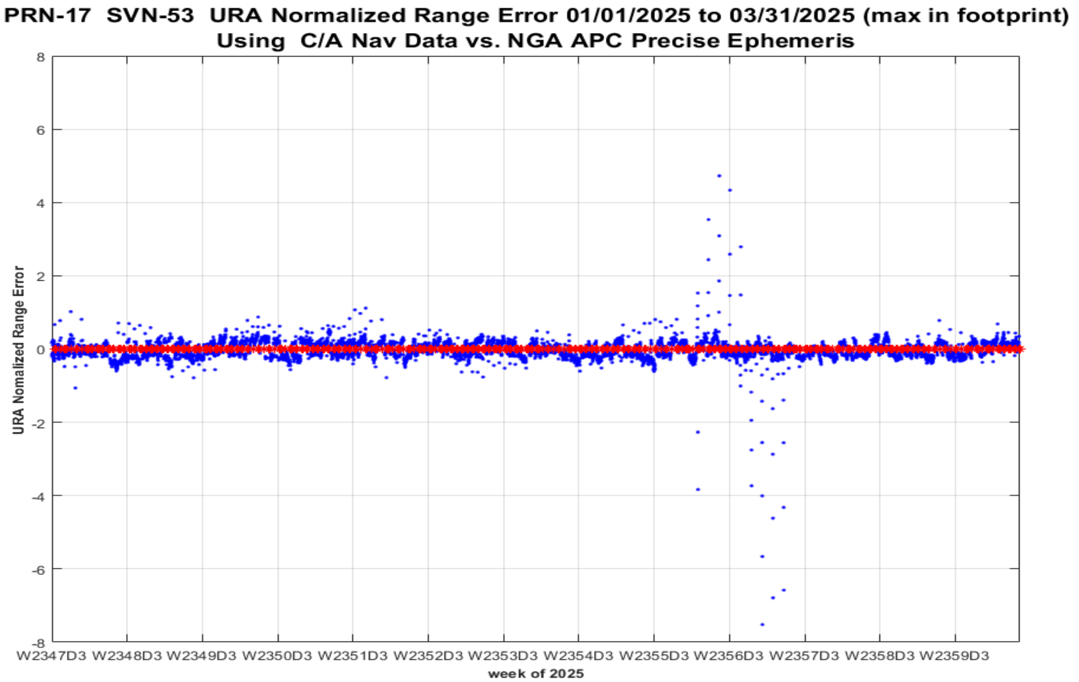



**Figure 9-169 Timeline of URA Normalized Range Error PRN17 (SVN53) Using C/A Nav Data**

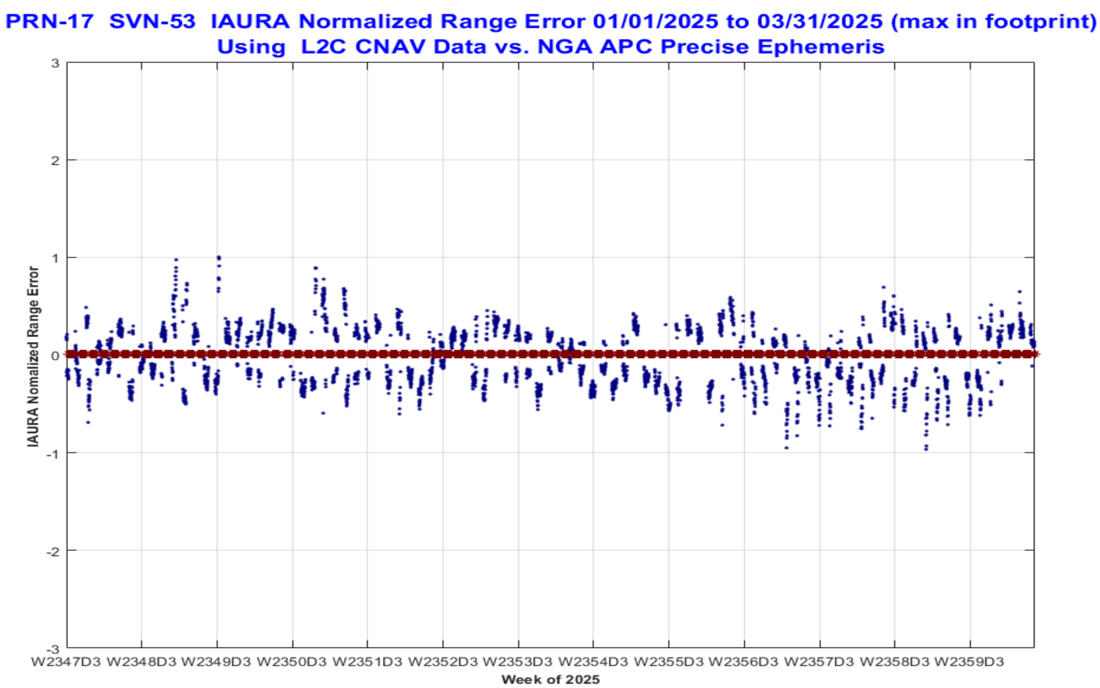



**Figure 9-170 Timeline of IAURA Normalized Range Error PRN17 (SVN53) Using L2C CNAV Data**

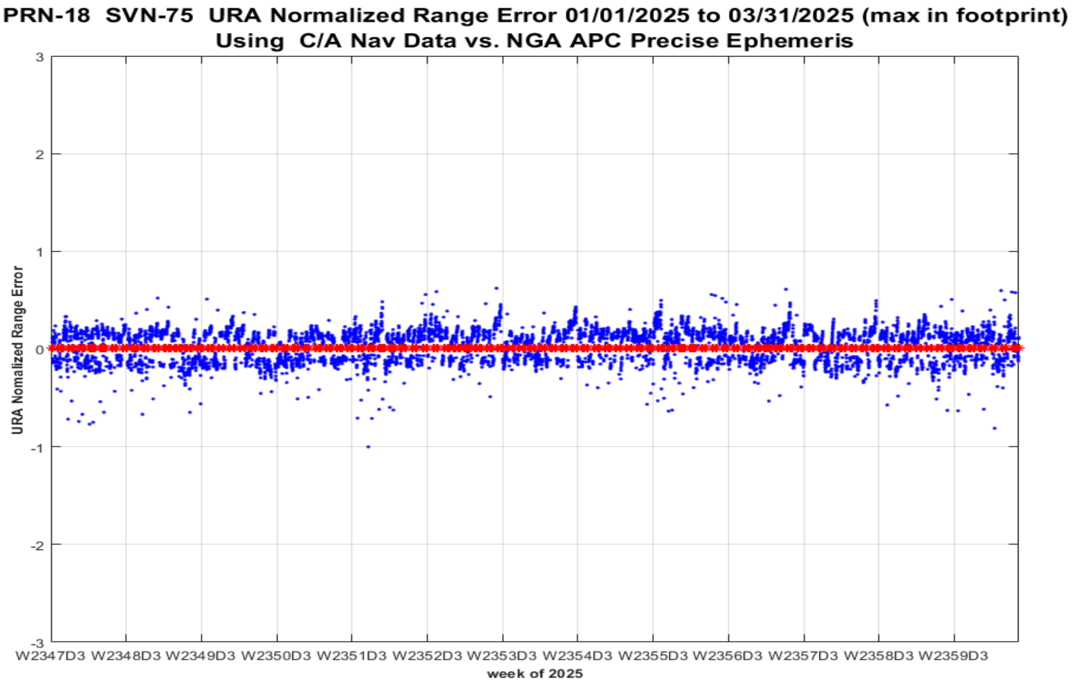



**Figure 9-171 Timeline of URA Normalized Range Error PRN18 (SVN75) Using C/A Nav Data**

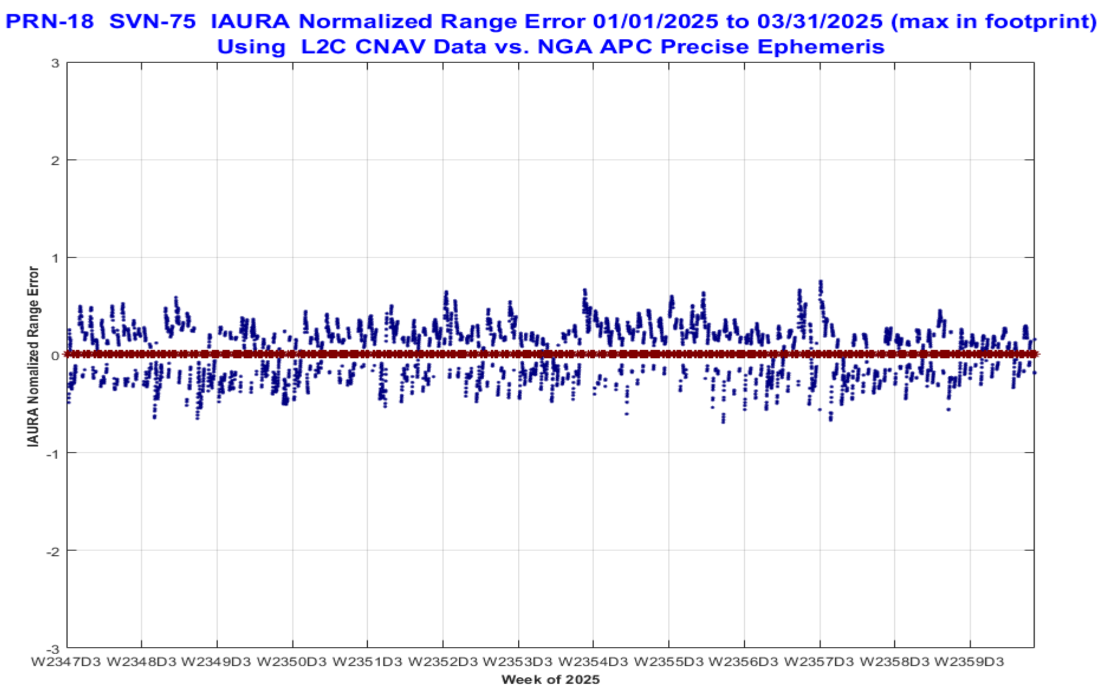



**Figure 9-172 Timeline of IAURA Normalized Range Error PRN18 (SVN75) Using L2C CNAV Data**

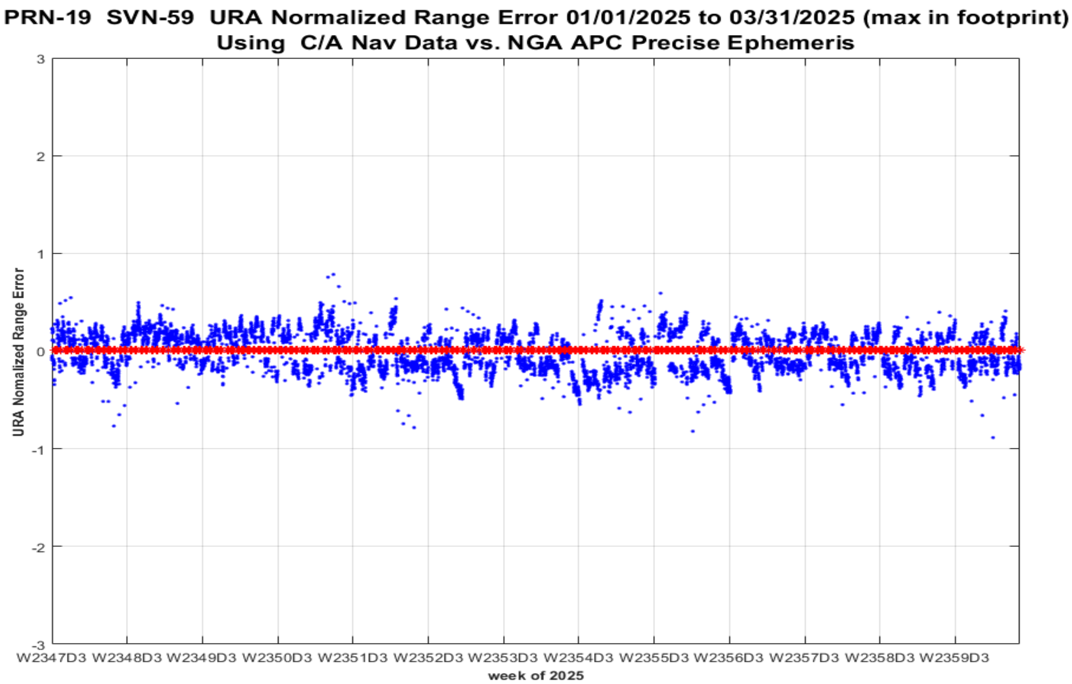



**Figure 9-173 Timeline of URA Normalized Range Error PRN19 (SVN59) Using C/A Nav Data**

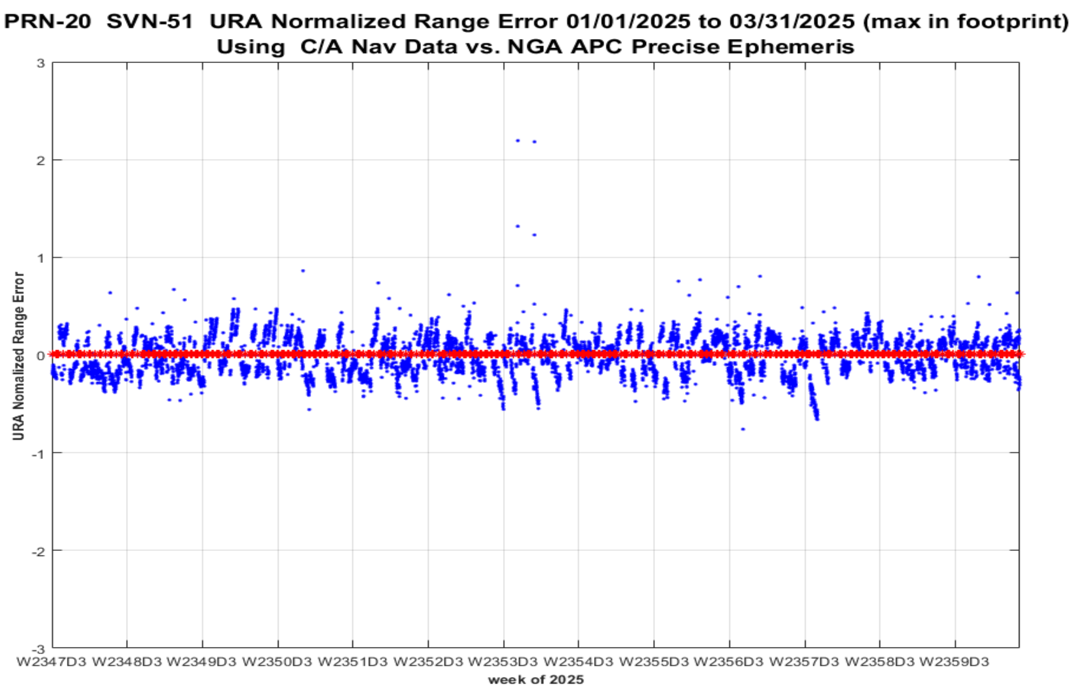



**Figure 9-174 Timeline of URA Normalized Range Error PRN20 (SVN51) Using C/A Nav Data**

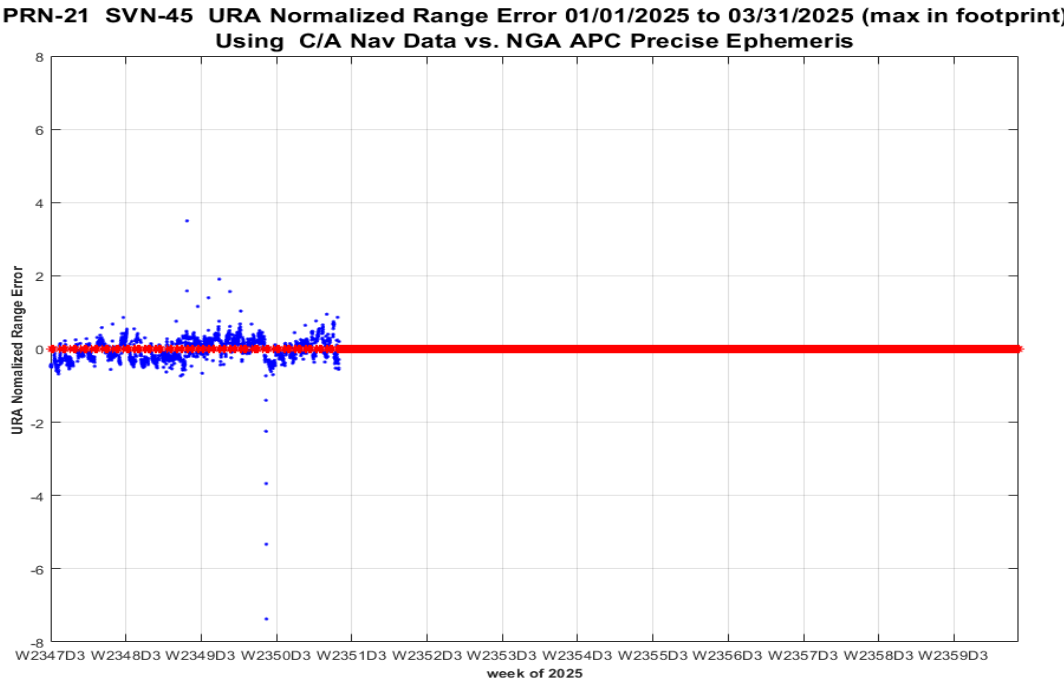



**Figure 9-175 Timeline of URA Normalized Range Error PRN21 (SVN45) Using C/A Nav Data**

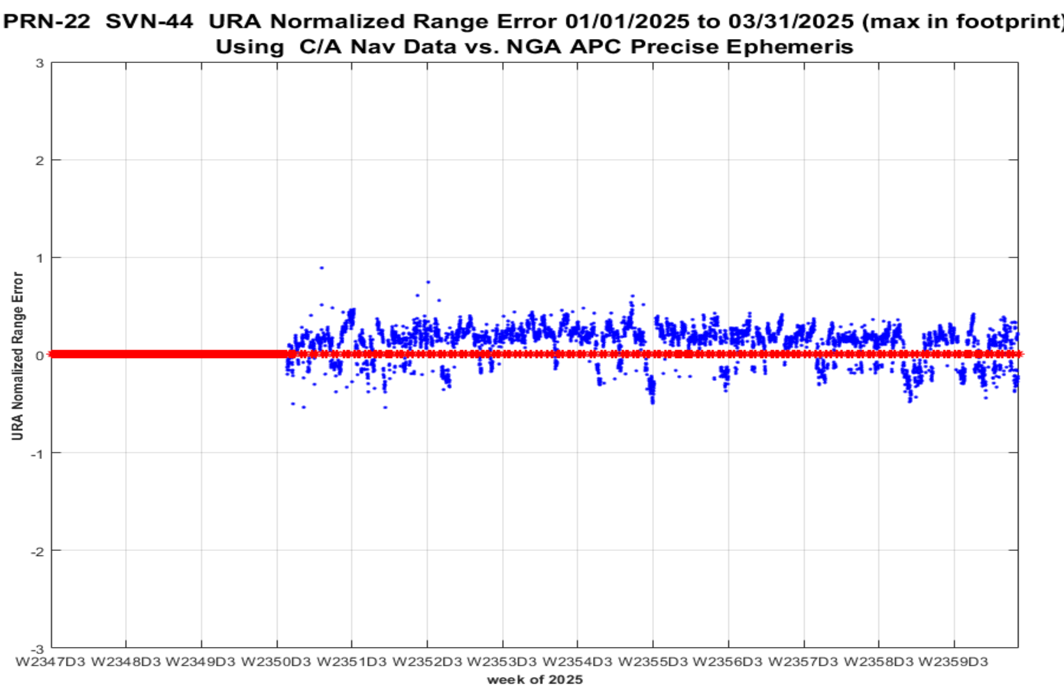



**Figure 9-176 Timeline of URA Normalized Range Error PRN22 (SVN44) Using C/A Nav Data**

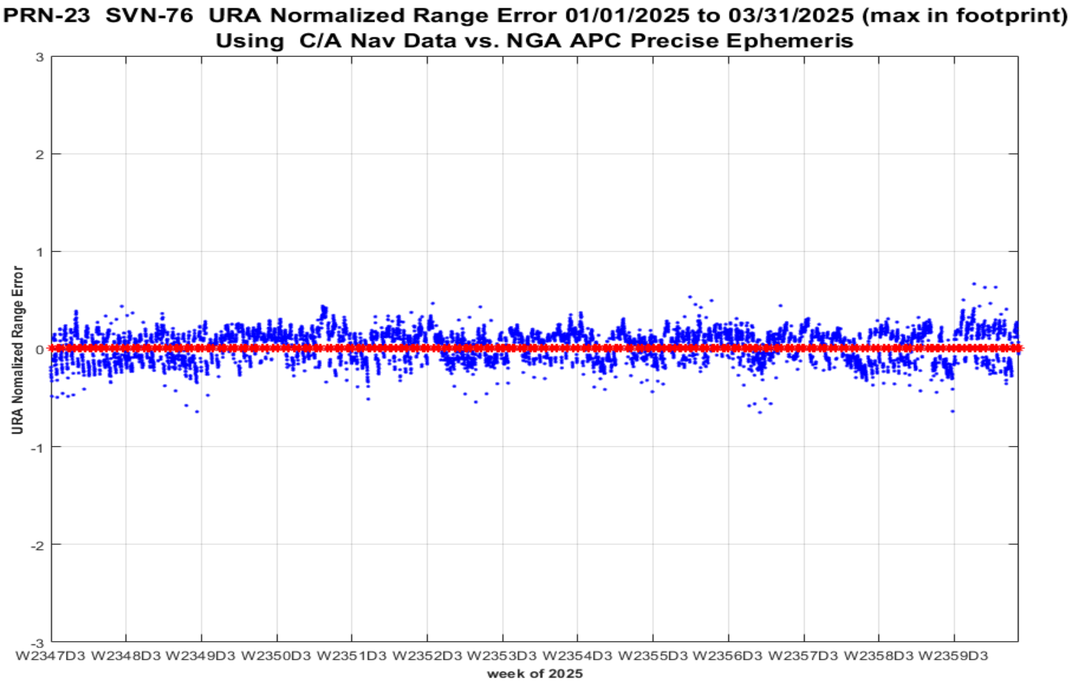



**Figure 9-177 Timeline of URA Normalized Range Error PRN23 (SVN76) Using C/A Nav Data**

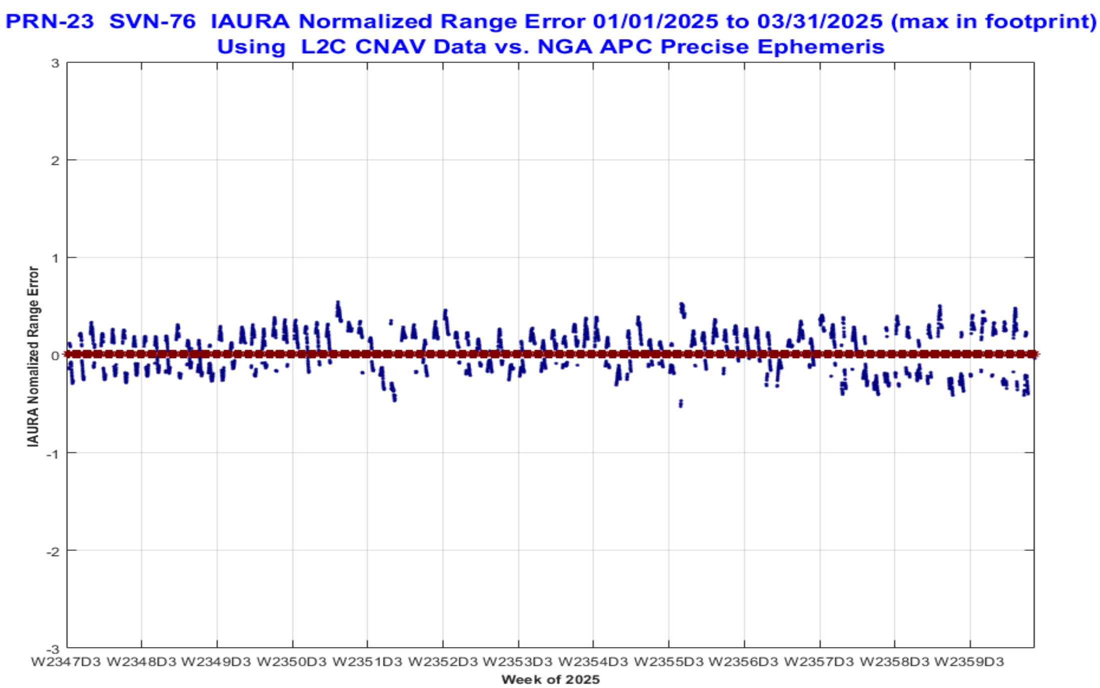



**Figure 9-178 Timeline of IAURA Normalized Range Error PRN23 (SVN76) Using L2C CNAV Data**

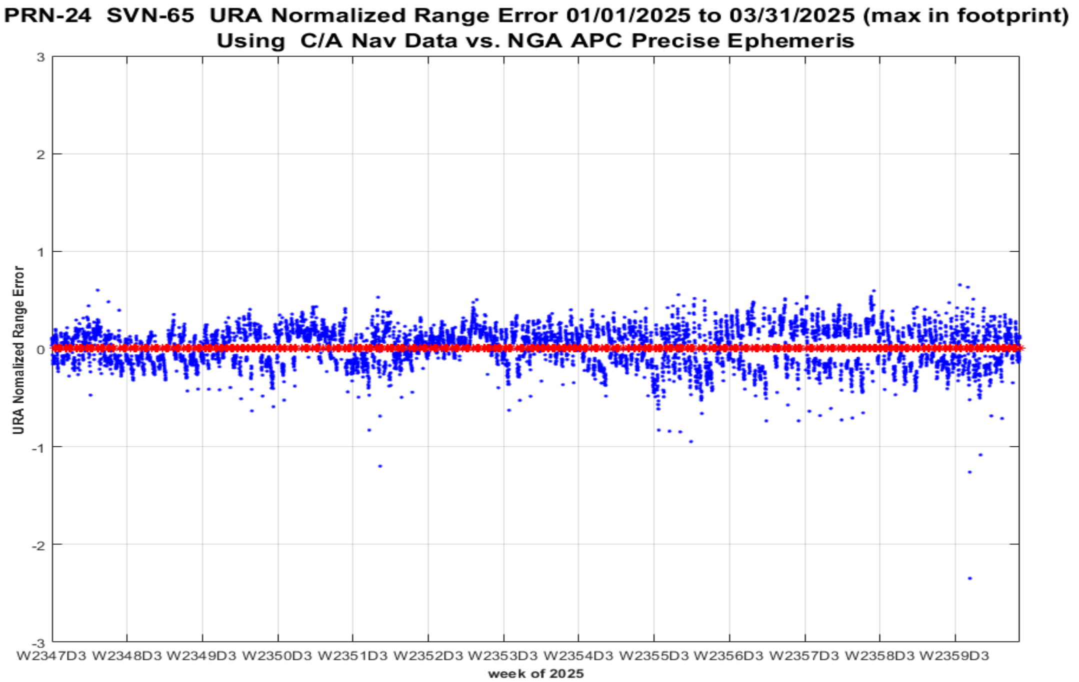



**Figure 9-179 Timeline of URA Normalized Range Error PRN24 (SVN65) Using C/A Nav Data**

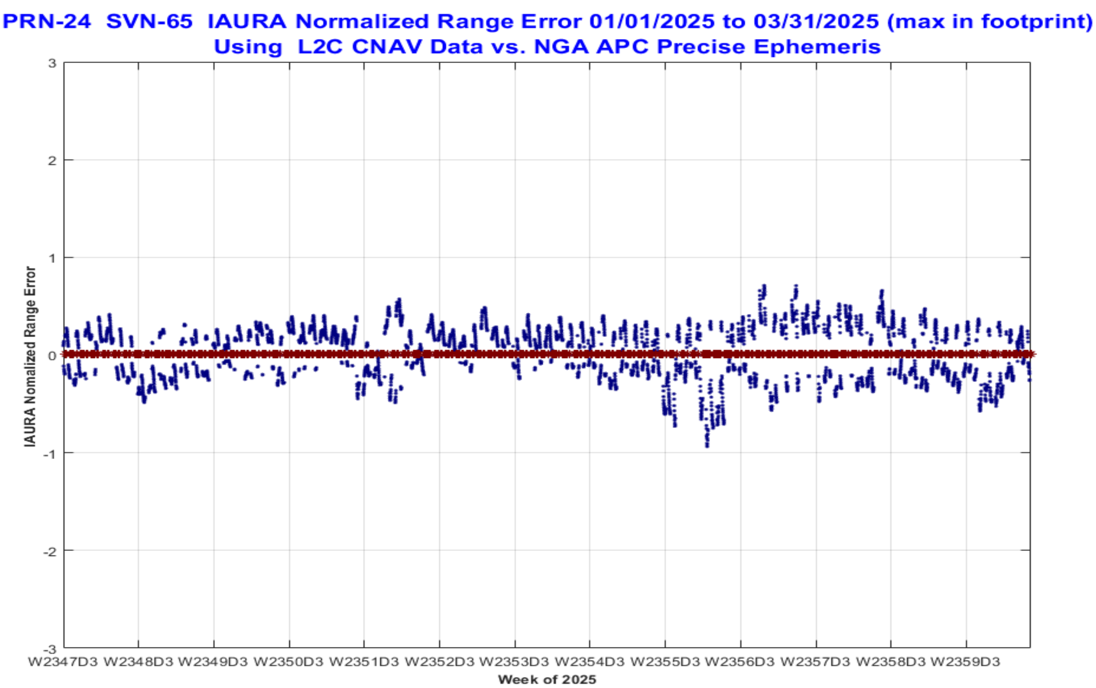



**Figure 9-180 Timeline of IAURA Normalized Range Error PRN24 (SVN65) Using L2C CNAV Data**

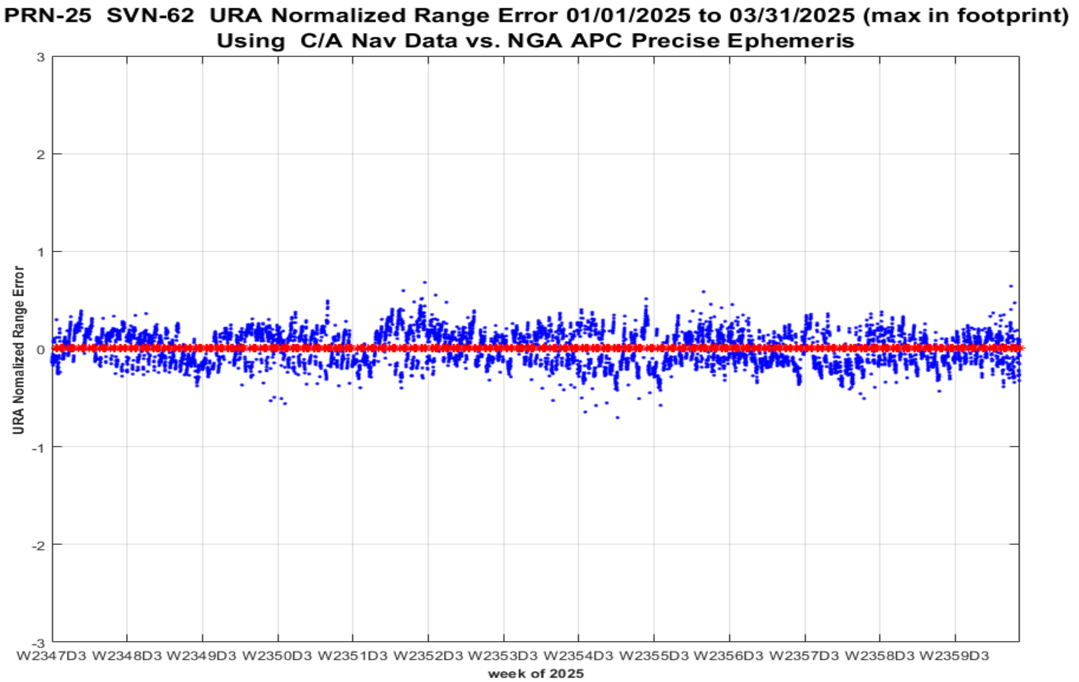



**Figure 9-181 Timeline of URA Normalized Range Error PRN25 (SVN62) Using C/A Nav Data**

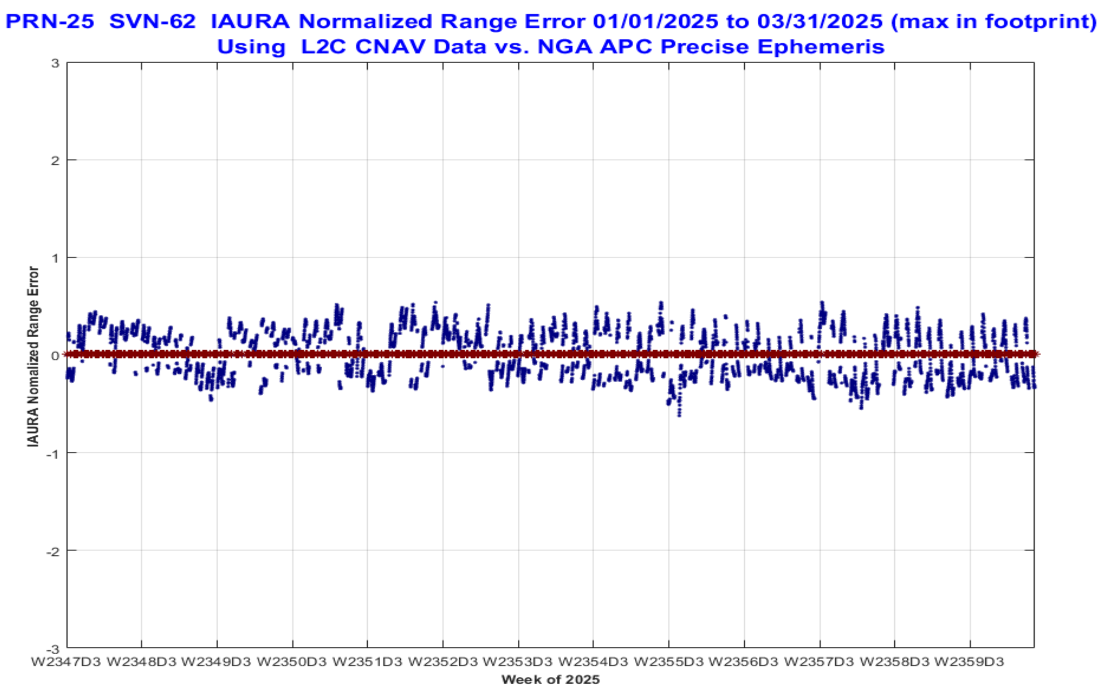



**Figure 9-182 Timeline of IAURA Normalized Range Error PRN25 (SVN62) Using L2C CNAV Data**

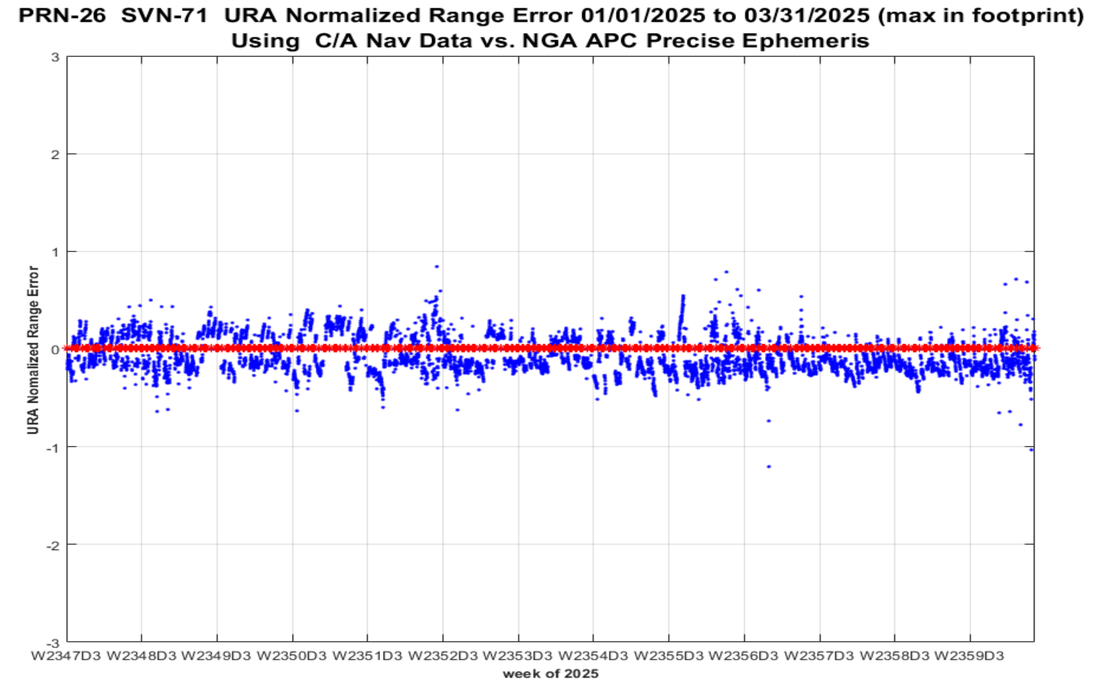



**Figure 9-183 Timeline of URA Normalized Range Error PRN26 (SVN71) Using C/A Nav Data**

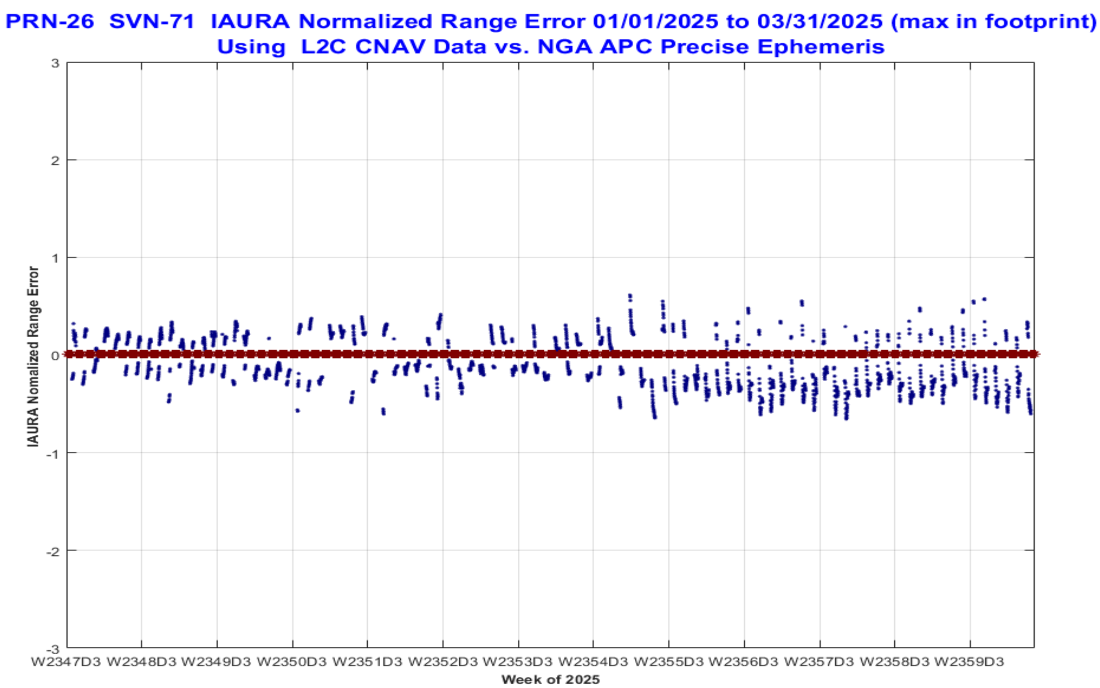



**Figure 9-184 Timeline of IAURA Normalized Range Error PRN26 (SVN71) Using L2C CNAV Data**

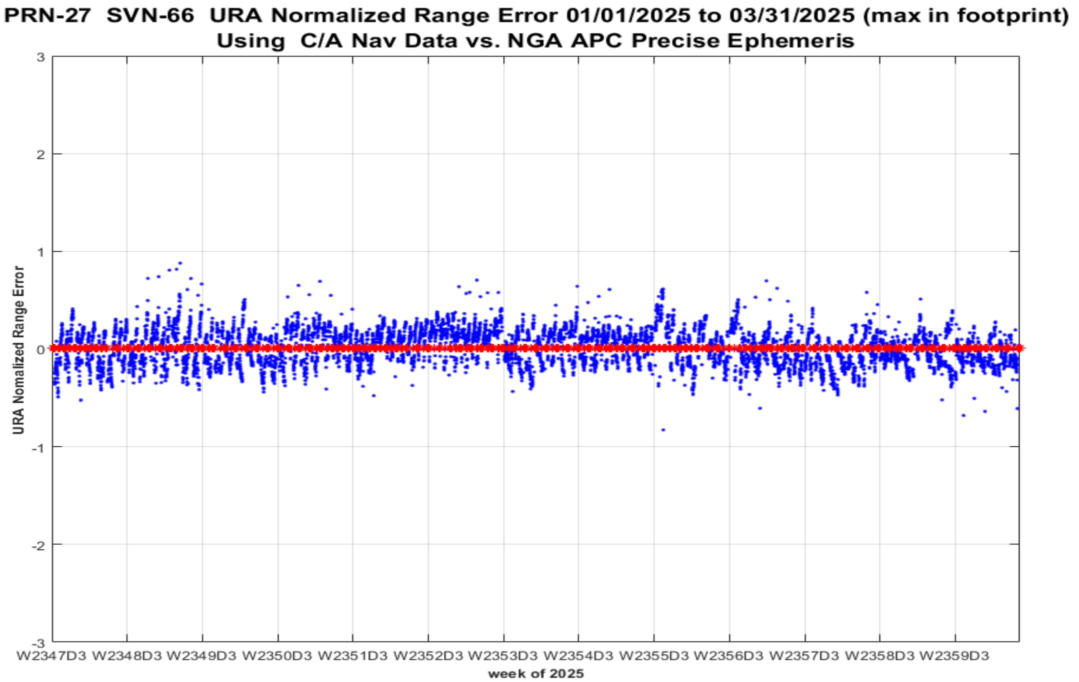



**Figure 9-185 Timeline of URA Normalized Range Error PRN27 (SVN66) Using C/A Nav Data**

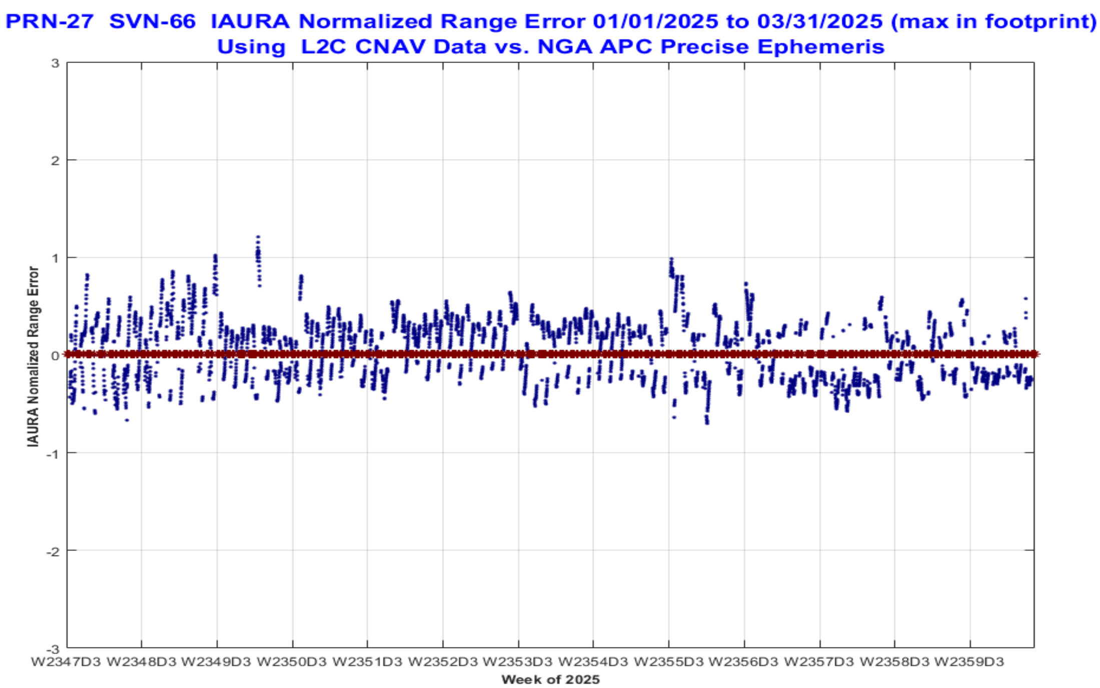



**Figure 9-186 Timeline of IAURA Normalized Range Error PRN27 (SVN66) Using L2C CNAV Data**

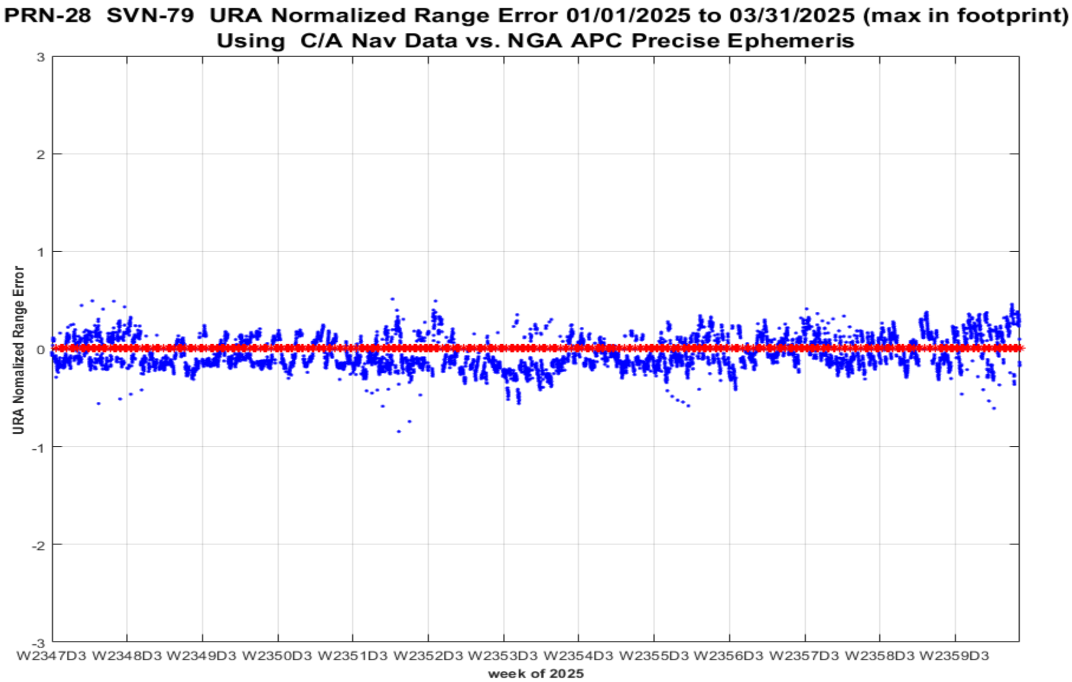



**Figure 9-187 Timeline of URA Normalized Range Error PRN28 (SVN79) Using C/A Nav Data**

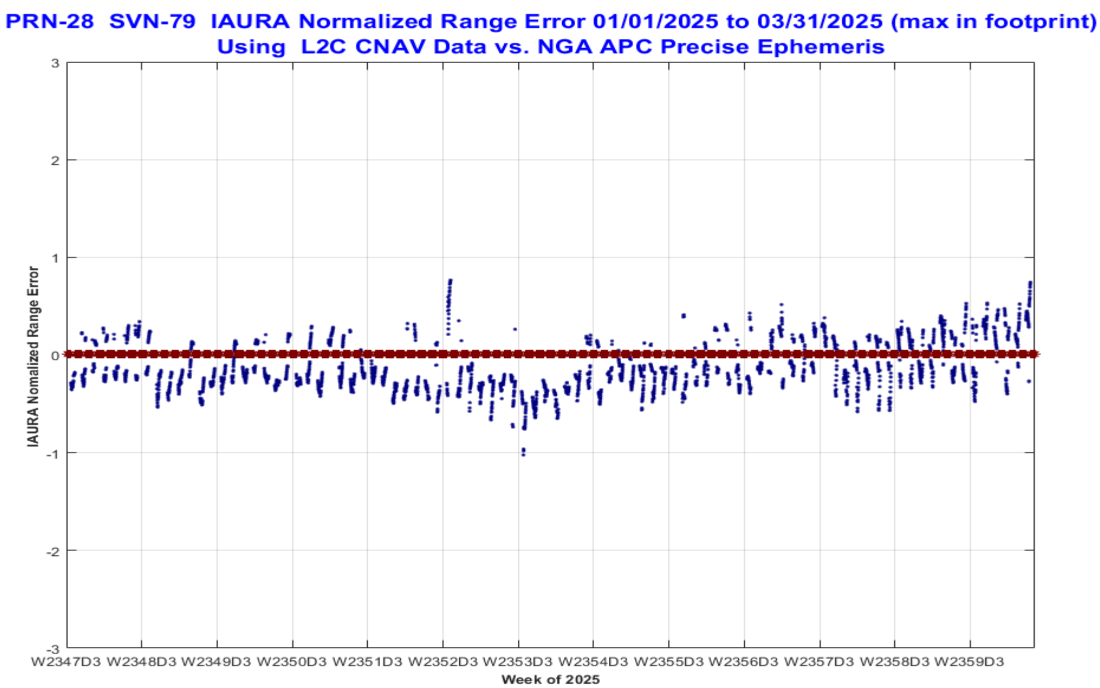



**Figure 9-188 Timeline of IAURA Normalized Range Error PRN28 (SVN79) Using L2C CNAV Data**

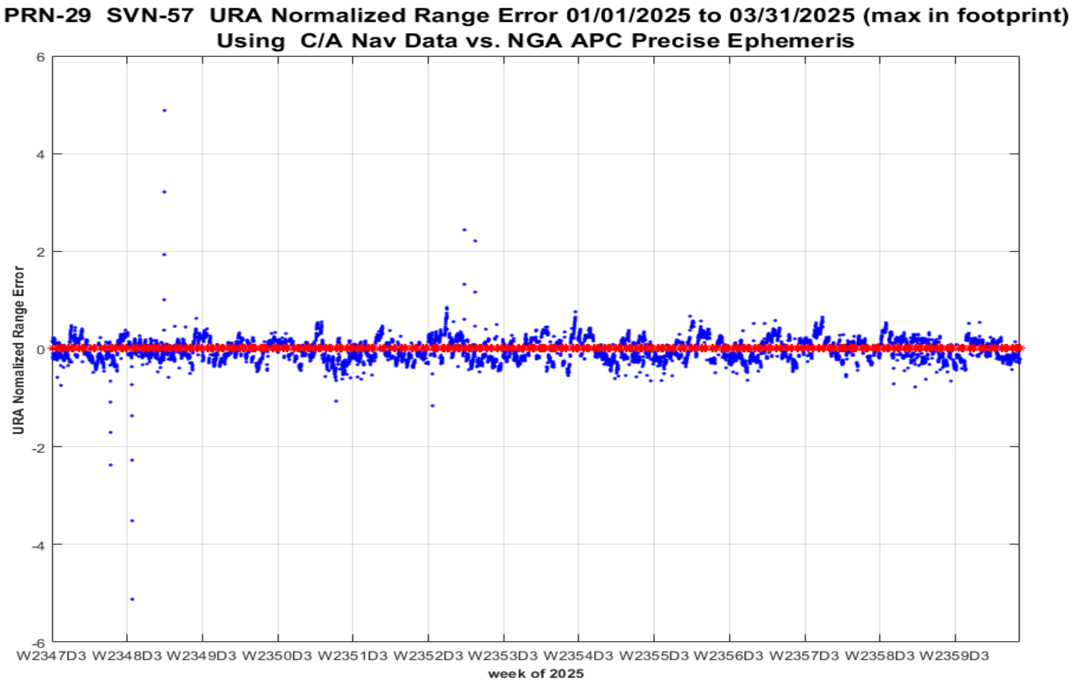



**Figure 9-189 Timeline of URA Normalized Range Error PRN29 (SVN57) Using C/A Nav Data**

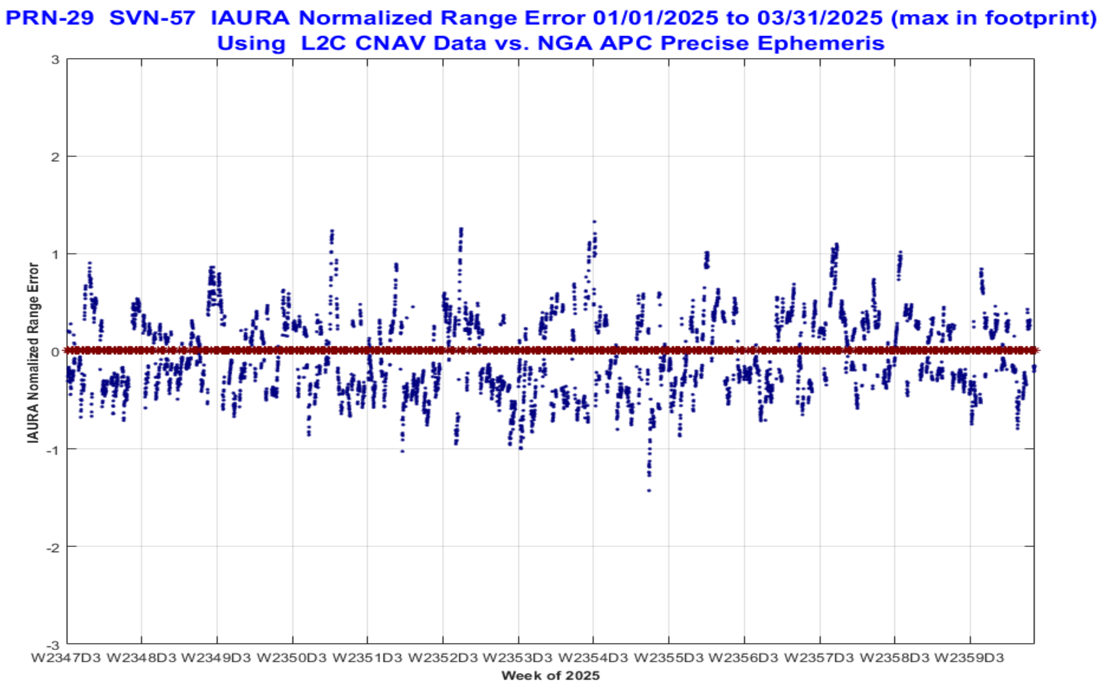



**Figure 9-190 Timeline of IAURA Normalized Range Error PRN29 (SVN57) Using L2C CNAV Data**

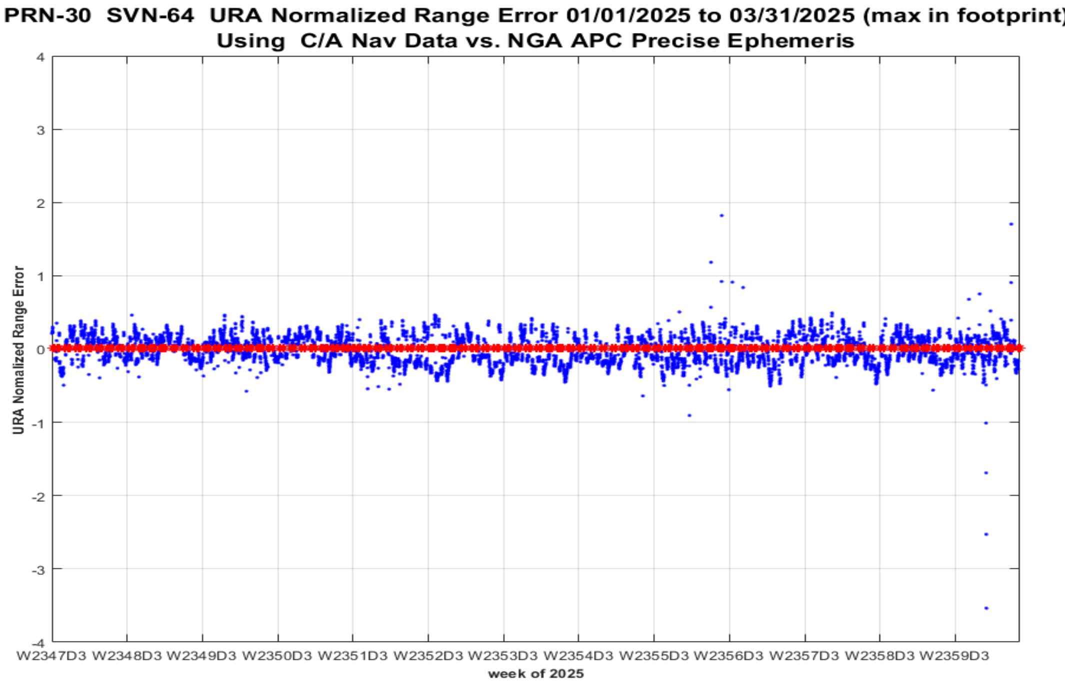



**Figure 9-191 Timeline of URA Normalized Range Error PRN30 (SVN64) Using C/A Nav Data**

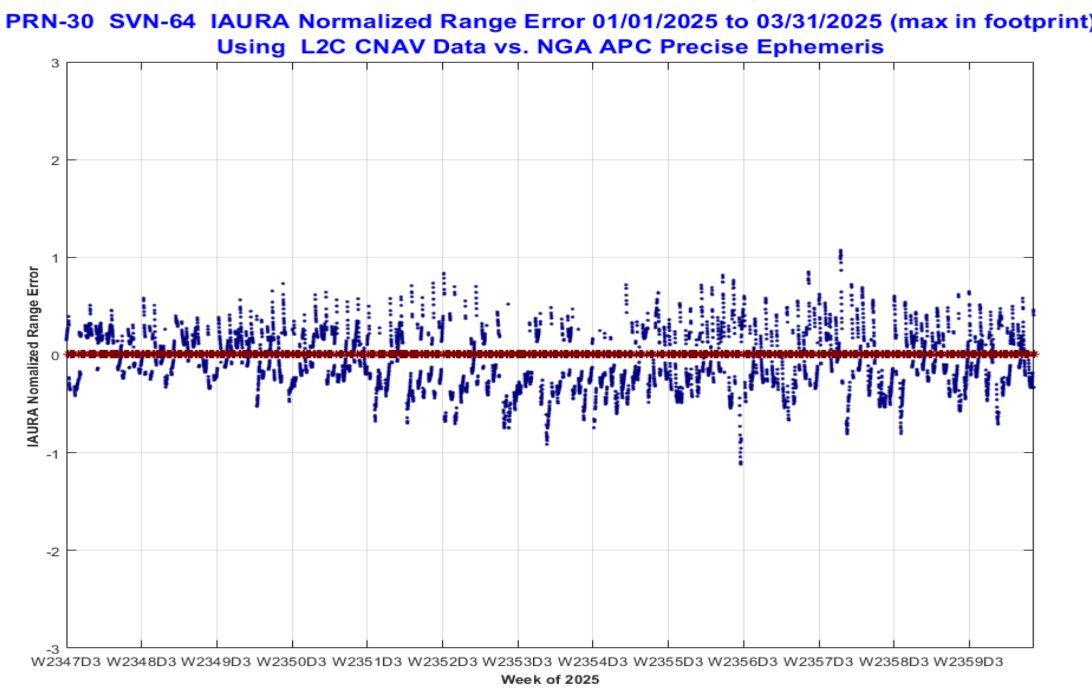



**Figure 9-192 Timeline of IAURA Normalized Range Error PRN30 (SVN64) Using L2C CNAV Data**

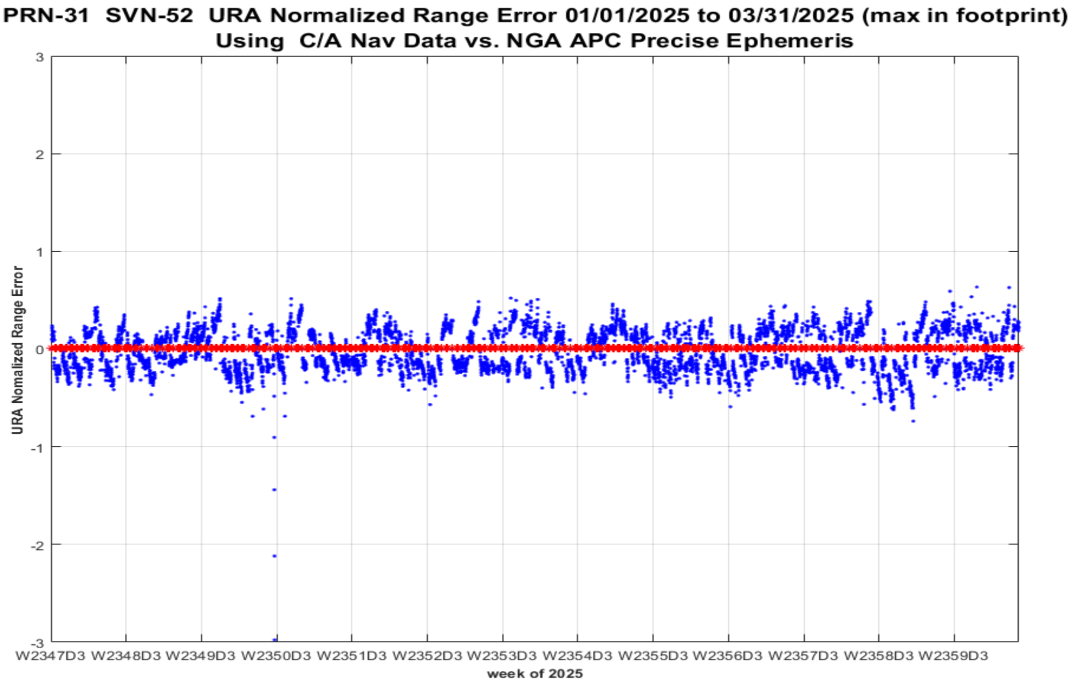



**Figure 9-193 Timeline of URA Normalized Range Error PRN31 (SVN52) Using C/A Nav Data**

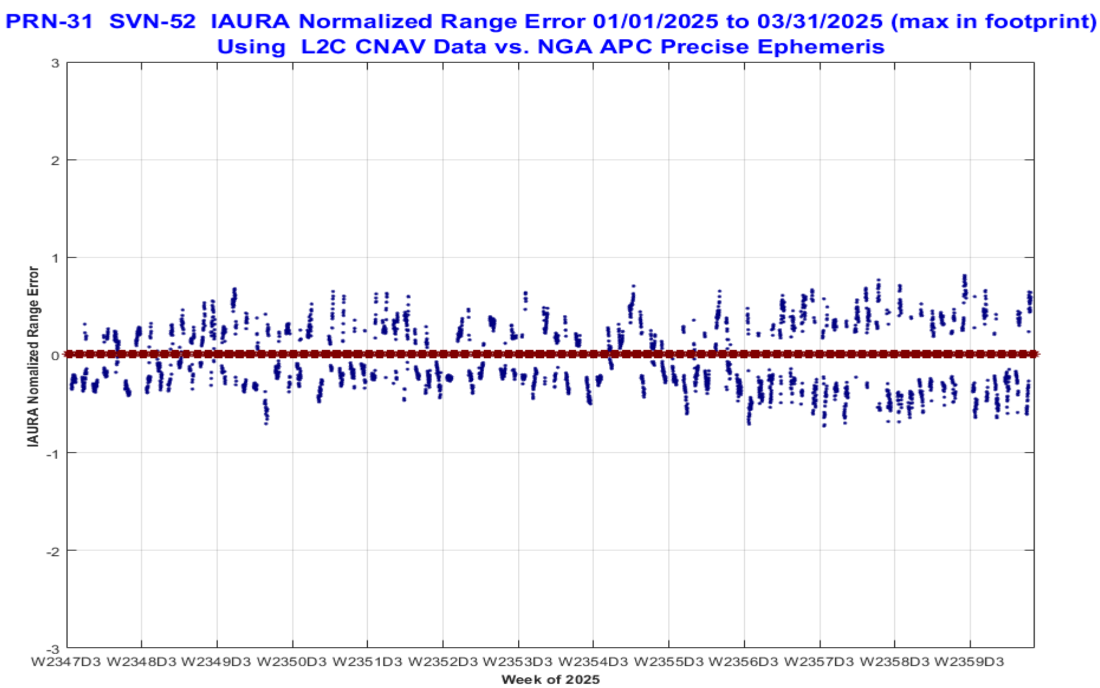



**Figure 9-194 Timeline of IAURA Normalized Range Error PRN31 (SVN52) Using L2C CNAV Data**

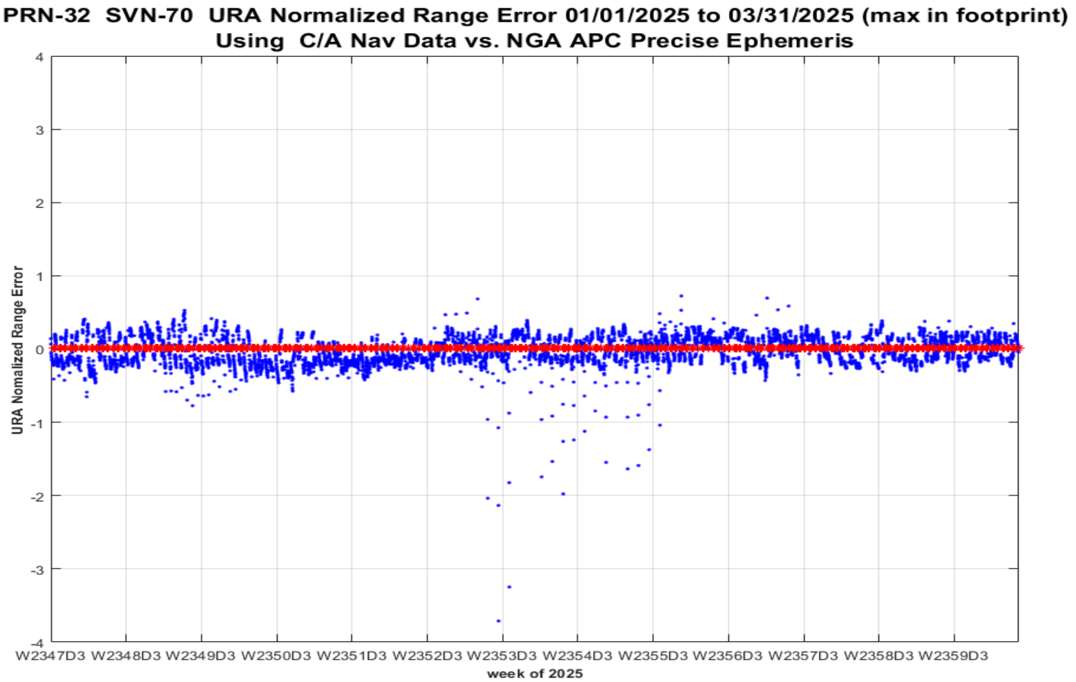



**Figure 9-195 Timeline of URA Normalized Range Error PRN32 (SVN70) Using C/A Nav Data**

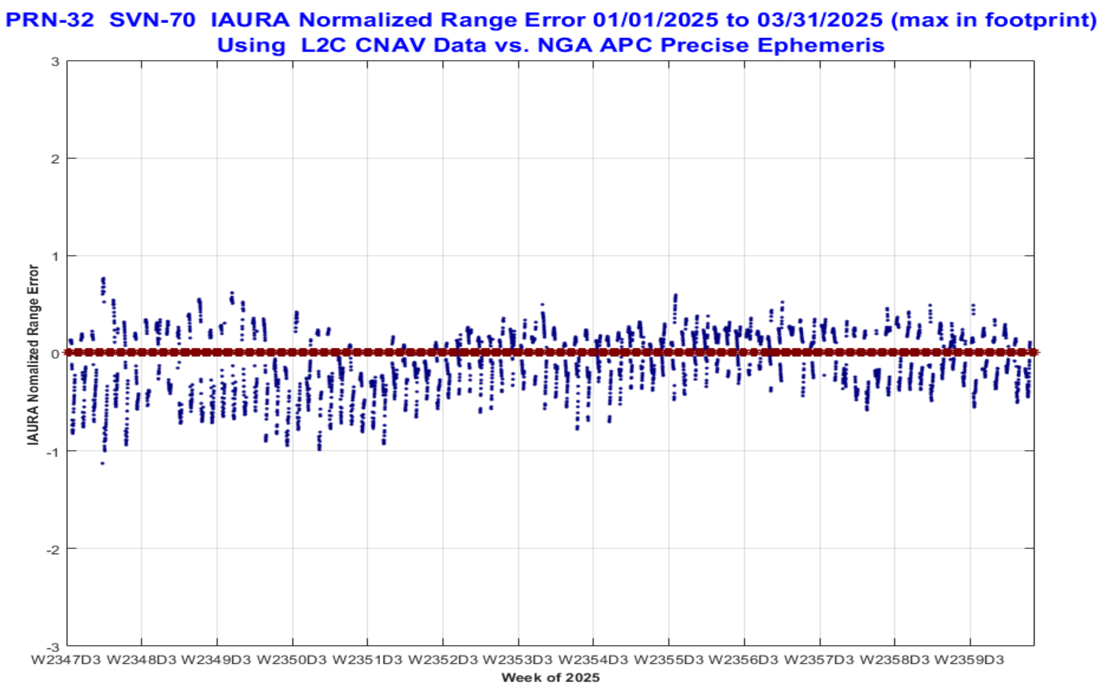



**Figure 9-196 Timeline of IAURA Normalized Range Error PRN32 (SVN70) Using L2C CNAV Data**

# APPENDIX A: PERFORMANCE SUMMARY

**Table A-1 Performance Summary**

| Parameter | Measured Performance | Conditions and Constraints |
|---|---|---|
| **User Range Error Accuracy**<br>Single-Frequency C/A-Code<br>1. ≤7.8 m 95% Global Average URE during normal operations over All AODs<br>2. ≤6.0 m 95% Global Average URE during operations at Zero AOD<br>3. ≤12.8 m 95% Global Average URE during normal operations at Any AOD | 1. ≤4.846 m<br>2. N/A<br>3. N/A | For any healthy SPS SIS.<br><br>Neglecting single-frequency ionospheric delay model errors.<br><br>Including group delay time correction ($T_{GD}$) errors at L1.<br><br>Including inter-signal bias (P(Y)-code to C/A-code) errors at L1. |
| **User Range Error Accuracy**<br>Single-Frequency C/A-Code<br>1. ≤0.03 mm 99.94% Global Average URE during normal operations<br>2. ≤0.03 mm 99.79% Worst Case single point average during normal operations | 1. 100% Global<br>2. 100% WCP | For any healthy SPS SIS.<br><br>Neglecting single-frequency ionospheric delay model errors.<br><br>Including group delay time correction ($T_{GD}$) errors at L1.<br><br>Standard based on measurement interval of one year; average of daily values within service volume.<br><br>Standard based on 3 service failures per year, lasting no more than 6 hours each. |
| **User Range Rate Error Accuracy**<br>Single-Frequency C/A Code:<br><br>≤6 mm/sec 95% Global Average URRE over any 3-second interval during normal operations at Any AOD | ≤4.642 mm/sec | For any healthy SPS SIS.<br><br>Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers.<br><br>Neglecting single-frequency ionospheric delay model errors. |

| Parameter | Measured Performance | Conditions and Constraints |
|---|---|---|
| **User Range Acceleration Error Accuracy**<br>Single-Frequency C/A Code:<br><br>≤2 mm/sec$^2$ 95% Global Average URAE over any 3-second interval during normal operations at Any AOD | ≤34.778 mm/s$^2$ | For any healthy SPS SIS.<br><br>Neglecting all perceived pseudorange rate errors attributable to pseudorange step changes caused by NAV message data cutovers.<br><br>Neglecting single-frequency ionospheric delay model errors. |
| **Per-Satellite Coverage**<br>Terrestrial Service Volume:<br>100% Coverage | 100% | For any healthy or marginal SPS SIS. |
| **Constellation Coverage**<br>Terrestrial Service Volume:<br>100% Coverage | 100% | For any healthy or marginal SPS SIS. |
| **Status and Problem Reporting**<br>Scheduled event affecting service<br>Appropriate NANU issued to the U.S. Coast Guard and the FAA at least 48 hours prior to the event | ≥62.5 hours<br><br>Prior to event | For any SPS SIS. |
| **Status and Problem Reporting**<br>Unscheduled outage or problem affecting service<br>Appropriate NANU issued to the U.S. Coast Guard and the FAA as soon as possible after the event | ≤0.183 hours | For any SPS SIS. |

| Parameter | Measured Performance | Conditions and Constraints |
|---|---|---|
| **Status and Problem Reporting**<br>Unscheduled Failure Interruption Continuity:<br><br>≥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.<br><br>Given that the SPS SIS is available from the slot at the start of the hour. |
| **Operational Satellite Count**<br>≥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**<br>1. ≥98% global PDOP of 6 or less<br><br>2. ≥88% worst site PDOP of 6 or less | 1. 100%<br>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**<br>1. ≥99% Horizontal Service Availability, average location<br><br>2. ≥99% Vertical Service Availability, average location | 1. 100% Horizontal<br>2. 100% Vertical | 15m Horizontal (SIS only) 95% threshold.<br><br>33m Vertical (SIS only) 95% threshold.<br><br>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**<br>1. ≥90% Horizontal Service Availability, worst-case location<br>2. ≥90% Vertical Service Availability, worst-case location | 1. 100% Horizontal<br>2. 100% Vertical | 15m Horizontal (SIS only) 95% threshold.<br><br>33m Vertical (SIS only) 95% threshold.<br><br>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**<br>Global Average Position Domain Accuracy:<br>1. ≤8 m 95% Horizontal Error<br>2. ≤13 m 95 % Vertical Error | 1. ≤4.010 m Horizontal<br>2. ≤6.590 m Vertical | Defined for a position/time solution meeting the representative user conditions.<br><br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |
| **Position/Time Accuracy**<br>Worst Site Position Domain Accuracy:<br>1. ≤15 m 95% Horizontal Error<br>2. ≤33 m 95% Vertical Error | 1. ≤12.000 m Horizontal<br>2. ≤12.140 m Vertical | Defined for a position/time solution meeting the representative user conditions.<br><br>Standard based on a measurement interval of 24 hours averaged over all points in the service volume. |
| **Position/Time Accuracy**<br>Time Transfer Domain Accuracy:<br><br>≤30 nanoseconds time transfer error 95% of time<br><br>(SIS only) | ≤7.6 nanoseconds | Defined for a time transfer solution meeting the representative user conditions.<br><br>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**<br>Instantaneous UTCOE Integrity:<br><br>NTE ±120 nanoseconds 99.999% of time without a timely alert.<br><br>(SIS only) | ≤12.1 nanoseconds | For any healthy SPS SIS.<br><br>Worst case for delayed alert is 6 hours. |
| **Per-Slot Availability**<br>1. ≥0.957 Probability that a slot in the baseline 24-slot configuration will be occupied by a satellite broadcasting a healthy SPS SIS<br>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%<br>2. 100% | Calculated as an average over all slots in the 24-slot constellation, normalized annually.<br><br>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**<br>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<br>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%<br>2. 100% | Calculated as an average over all slots in the 24-slot constellation, normalized annually.<br><br>Applied to satellites broadcasting a healthy SPS SIS that also satisfies the other performance standards in the SPS performance standard. |

## APPENDIX B: GEOMAGNETIC DATA

```
:Product: Daily Geomagnetic Data     quar_DGD.txt
:Issued: 1830 UT 02 Apr 2025
#
#  Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
#  Please send comment and suggestions to SWPC.Webmaster@noaa.gov
#
#              Current Quarter Daily Geomagnetic Data
#
#
#                 Middle Latitude        High Latitude                              Estimated
#              - Fredericksburg -     ---- College ----                          --- Planetary ---
#  Date        A     K-indices        A     K-indices        A                     K-indices
```

| Date | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2025 01 01 | 48 | 3 | 4 | 4 | 5 | 6 | 6 | 6 | 4 | 113 | 2 | 6 | 5 | 7 | 8 | 8 | 7 | 2 | 86 | 4.00 | 5.33 | 5.00 | 6.33 | 6.67 | 8.00 | 6.67 | 4.33 |
| 2025 01 02 | 14 | 3 | 3 | 2 | 4 | 3 | 3 | 2 | 2 | 51 | 3 | 1 | 4 | 7 | 6 | 6 | 5 | 3 | 22 | 3.67 | 2.67 | 3.33 | 4.67 | 4.00 | 4.00 | 3.33 | 3.00 |
| 2025 01 03 | 7 | 2 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 0 | 1 | 1 | 0 | 9 | 3.33 | 3.00 | 2.67 | 1.67 | 0.67 | 1.00 | 1.33 | 1.67 |
| 2025 01 04 | 21 | 2 | 4 | 4 | 4 | 4 | 4 | 3 | 2 | 62 | 1 | 5 | 7 | 6 | 5 | 6 | 6 | 3 | 32 | 2.67 | 4.67 | 5.00 | 4.33 | 3.33 | 4.67 | 5.00 | 3.67 |
| 2025 01 05 | 12 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 34 | 3 | 2 | 3 | 5 | 6 | 5 | 5 | 2 | 20 | 3.67 | 2.67 | 3.00 | 3.67 | 3.33 | 4.00 | 4.00 | 3.00 |
| 2025 01 06 | 13 | 3 | 4 | 3 | 2 | 3 | 2 | 2 | 2 | 20 | 2 | 2 | 3 | 5 | 5 | 4 | 2 | 1 | 15 | 3.33 | 4.00 | 3.00 | 2.67 | 2.67 | 3.00 | 2.33 | 2.33 |
| 2025 01 07 | 8 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 24 | 1 | 2 | 6 | 5 | 3 | 4 | 2 | 2 | 12 | 2.33 | 2.67 | 2.67 | 2.67 | 2.33 | 3.33 | 2.67 | 2.33 |
| 2025 01 08 | 6 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 6 | 2 | 1 | 1 | 0 | 4 | 2 | 1 | 0 | 8 | 3.67 | 2.33 | 1.67 | 0.67 | 1.67 | 2.33 | 1.33 | 1.00 |
| 2025 01 09 | 9 | 1 | 0 | 2 | 3 | 4 | 2 | 2 | 2 | 18 | 0 | 0 | 2 | 5 | 5 | 4 | 2 | 1 | 10 | 2.00 | 1.00 | 2.00 | 2.67 | 3.67 | 3.00 | 2.33 | 1.67 |
| 2025 01 10 | 11 | 2 | 3 | 1 | 3 | 3 | 2 | 2 | 3 | 18 | 0 | 3 | 2 | 5 | 5 | 3 | 2 | 2 | 12 | 1.33 | 3.33 | 1.67 | 3.00 | 3.00 | 1.67 | 2.67 | 3.67 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2025 01 11 | 5 | 2 0 0 1 2 3 2 1 | 7 | 2 0 0 3 3 3 2 0 | 7 | 2.67 | 0.67 | 1.00 | 1.67 | 1.67 | 3.00 | 2.00 | 0.67 |
| 2025 01 12 | 6 | 1 2 2 1 2 2 1 2 | 7 | 0 1 2 4 3 1 1 0 | 7 | 1.33 | 2.00 | 2.00 | 1.67 | 2.00 | 1.33 | 1.67 | 2.33 |
| 2025 01 13 | 9 | 3 2 2 2 2 3 2 1 | 10 | 2 1 2 4 2 3 2 2 | 11 | 4.00 | 2.33 | 1.67 | 2.33 | 2.00 | 2.33 | 2.67 | 2.00 |
| 2025 01 14 | 10 | 2 2 3 2 2 3 3 2 | 10 | 2 2 3 3 3 2 2 2 | 12 | 2.67 | 2.33 | 2.67 | 2.00 | 2.00 | 2.67 | 3.33 | 3.00 |
| 2025 01 15 | 11 | 3 2 3 2 3 3 2 1 | 25 | 2 4 5 3 5 5 2 1 | 16 | 3.67 | 3.67 | 3.33 | 2.67 | 3.00 | 3.33 | 2.67 | 2.00 |
| 2025 01 16 | 11 | 2 3 1 2 3 3 3 2 | 21 | 2 4 2 3 5 4 4 2 | 14 | 3.00 | 3.33 | 2.00 | 2.33 | 3.00 | 3.00 | 3.33 | 3.00 |
| 2025 01 17 | 14 | 3 3 3 3 3 2 3 3 | 29 | 3 3 3 5 5 5 3 4 | 21 | 3.33 | 3.67 | 3.67 | 3.00 | 3.33 | 3.33 | 4.00 | 4.00 |
| 2025 01 18 | 8 | 2 1 2 2 2 3 2 2 | 16 | 2 2 4 4 4 3 2 2 | 10 | 2.67 | 2.00 | 2.67 | 2.00 | 2.67 | 2.33 | 2.33 | 2.33 |
| 2025 01 19 | 9 | 1 1 3 3 3 2 2 2 | 23 | 1 2 4 5 4 4 4 3 | 15 | 1.33 | 2.33 | 3.67 | 3.00 | 3.33 | 2.67 | 3.00 | 3.67 |
| 2025 01 20 | 13 | 3 2 3 2 4 3 2 2 | 38 | 3 2 3 5 7 5 4 2 | 20 | 4.00 | 3.33 | 3.00 | 3.00 | 4.33 | 3.33 | 3.00 | 3.33 |
| 2025 01 21 | 6 | 1 2 1 1 2 2 2 2 | 13 | 2 2 1 4 3 4 2 2 | 11 | 2.33 | 3.33 | 2.00 | 1.67 | 1.33 | 2.67 | 3.00 | 2.67 |
| 2025 01 22 | 7 | 3 1 2 2 2 1 1 2 | 16 | 3 2 4 5 3 2 1 1 | 10 | 3.33 | 2.33 | 3.00 | 2.33 | 2.00 | 1.33 | 1.00 | 3.00 |
| 2025 01 23 | 7 | 2 1 0 2 2 3 2 2 | 9 | 2 1 1 2 3 3 3 2 | 10 | 3.00 | 1.33 | 0.67 | 1.33 | 1.67 | 3.33 | 3.33 | 2.33 |
| 2025 01 24 | 6 | 1 1 2 1 2 2 2 2 | 5 | 1 1 3 2 2 1 0 1 | 7 | 1.00 | 1.67 | 2.67 | 1.33 | 2.00 | 1.33 | 1.67 | 2.33 |
| 2025 01 25 | 2 | 0 0 0 1 2 1 1 1 | 1 | 0 0 0 1 0 1 0 0 | 3 | 0.67 | 0.33 | 1.00 | 0.67 | 0.67 | 1.33 | 0.67 | 0.67 |
| 2025 01 26 | 2 | 0 1 0 0 1 2 1 1 | 0 | 0 0 0 0 0 0 0 0 | 3 | 0.67 | 1.00 | 0.33 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 |
| 2025 01 27 | 6 | 0 1 1 2 2 2 2 3 | 12 | 0 0 1 3 4 5 1 1 | 8 | 0.33 | 0.33 | 1.67 | 2.33 | 2.00 | 3.00 | 2.00 | 2.67 |
| 2025 01 28 | 8 | 2 1 0 2 3 3 2 2 | 19 | 0 0 0 3 6 3 4 3 | 12 | 2.33 | 1.67 | 0.67 | 2.33 | 3.00 | 3.00 | 3.67 | 3.00 |
| 2025 01 29 | 6 | 2 1 1 2 2 1 2 2 | 12 | 1 2 1 4 4 4 1 0 | 7 | 2.67 | 1.00 | 1.00 | 2.33 | 2.33 | 1.67 | 1.33 | 1.67 |
| 2025 01 30 | 4 | 1 1 0 0 2 1 2 2 | 2 | 0 0 0 0 0 1 2 2 | 6 | 1.33 | 1.00 | 0.67 | 1.00 | 1.00 | 1.33 | 2.00 | 2.67 |
| 2025 01 31 | 5 | 1 1 0 1 2 2 2 2 | 9 | 1 0 0 4 4 2 1 1 | 8 | 1.67 | 1.00 | 1.33 | 1.67 | 2.33 | 2.00 | 2.33 | 3.00 |
| 2025 02 01 | 21 | 4 3 3 3 4 4 4 3 | 46 | 2 2 3 3 7 7 4 3 | 26 | 4.00 | 3.67 | 3.67 | 3.00 | 4.33 | 4.00 | 4.33 | 4.00 |
| 2025 02 02 | 18 | 2 4 3 3 4 4 3 2 | 40 | 2 2 5 6 6 6 2 2 | 21 | 3.67 | 4.00 | 3.67 | 3.33 | 4.00 | 4.33 | 2.67 | 2.00 |
| 2025 02 03 | 4 | 1 0 0 1 3 2 1 1 | 0 | 1 0 0 0 0 0 0 0 | 4 | 1.67 | 0.67 | 1.00 | 1.33 | 0.67 | 0.67 | 0.33 | 1.00 |
| 2025 02 04 | 4 | 1 1 1 1 2 2 2 0 | 5 | 0 0 1 4 1 0 0 1 | 5 | 1.00 | 1.00 | 1.67 | 1.67 | 0.67 | 1.00 | 1.33 | 1.00 |
| 2025 02 05 | 6 | 1 2 0 1 2 3 2 1 | 4 | 0 0 0 2 2 3 1 0 | 6 | 1.00 | 2.00 | 1.00 | 1.67 | 1.67 | 2.67 | 1.33 | 2.00 |
| 2025 02 06 | 9 | 2 3 2 0 3 3 2 2 | 11 | 1 1 1 3 5 2 1 1 | 9 | 2.33 | 3.00 | 2.33 | 1.33 | 2.67 | 2.33 | 1.67 | 1.33 |
| 2025 02 07 | 2 | 0 1 0 1 1 2 1 0 | 0 | 0 0 1 0 0 0 0 0 | 4 | 0.67 | 0.33 | 0.67 | 1.33 | 0.67 | 1.33 | 1.00 | 0.67 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2025 02 08 | 9 | 0 3 3 2 3 2 2 1 | 30 | 0 1 6 5 6 4 1 0 | 11 | 1.00 | 2.67 | 3.67 | 3.00 | 3.33 | 2.00 | 1.67 | 1.33 |
| 2025 02 09 | 14 | 1 2 2 2 3 3 4 4 | 28 | 1 1 3 3 5 6 5 3 | 18 | 1.33 | 2.00 | 2.00 | 2.33 | 3.00 | 4.00 | 4.67 | 4.33 |
| 2025 02 10 | 17 | 4 1 3 4 3 3 3 3 | 31 | 4 2 5 5 4 5 4 3 | 24 | 4.67 | 2.33 | 4.00 | 4.00 | 3.33 | 4.00 | 3.33 | 4.00 |
| 2025 02 11 | 10 | 3 2 2 3 2 3 2 2 | 21 | 3 3 3 4 4 5 3 2 | 17 | 4.00 | 3.00 | 3.33 | 3.33 | 2.33 | 3.33 | 3.00 | 3.00 |
| 2025 02 12 | 12 | 3 3 2 3 3 2 3 2 | 23 | 3 3 3 5 4 5 2 2 | 17 | 3.33 | 4.00 | 3.00 | 3.33 | 2.67 | 3.00 | 3.00 | 2.67 |
| 2025 02 13 | 19 | 3 4 3 4 3 2 3 4 | 37 | 2 4 5 6 6 4 3 3 | 23 | 3.33 | 4.33 | 3.67 | 4.00 | 3.67 | 2.67 | 3.67 | 4.33 |
| 2025 02 14 | 20 | 4 4 3 3 4 3 3 3 | 44 | 4 5 5 3 6 6 4 4 | 27 | 4.67 | 4.33 | 3.67 | 3.00 | 4.67 | 3.33 | 3.67 | 4.00 |
| 2025 02 15 | 20 | 2 3 3 4 4 4 3 4 | 55 | 3 3 3 7 5 7 5 3 | 28 | 3.67 | 3.67 | 3.33 | 5.00 | 3.33 | 4.67 | 3.67 | 4.33 |
| 2025 02 16 | 14 | 2 3 3 3 3 2 2 4 | 28 | 2 3 5 6 3 4 3 3 | 18 | 3.00 | 3.67 | 3.33 | 3.33 | 3.00 | 2.67 | 3.33 | 4.00 |
| 2025 02 17 | 11 | 2 3 2 2 3 3 2 3 | 20 | 2 2 2 4 5 5 2 2 | 15 | 3.00 | 3.33 | 2.00 | 2.33 | 3.33 | 4.00 | 2.33 | 3.33 |
| 2025 02 18 | 10 | 3 2 1 1 1 3 1 4 | 12 | 3 4 2 0 1 3 3 3 | 14 | 3.67 | 3.33 | 2.00 | 1.00 | 1.00 | 2.67 | 1.33 | 4.67 |
| 2025 02 19 | 13 | 4 2 3 2 2 2 3 3 | 19 | 4 3 5 3 2 2 3 3 | 20 | 5.00 | 3.33 | 4.33 | 1.67 | 1.67 | 2.33 | 3.67 | 3.33 |
| 2025 02 20 | 5 | 3 2 1 0 2 1 0 1 | 4 | 3 2 1 1 0 0 0 0 | 7 | 3.67 | 2.67 | 1.33 | 0.67 | 1.00 | 0.33 | 0.33 | 0.67 |
| 2025 02 21 | 6 | 3 0 1 1 2 2 2 1 | 3 | 1 0 1 1 3 0 0 0 | 6 | 3.00 | 0.67 | 1.00 | 1.33 | 1.67 | 0.67 | 0.67 | 2.00 |
| 2025 02 22 | 3 | 2 0 0 0 2 2 1 1 | 5 | 2 0 1 3 3 0 1 0 | 7 | 3.00 | 0.67 | 0.67 | 1.33 | 2.00 | 1.33 | 1.33 | 2.33 |
| 2025 02 23 | 6 | 2 1 1 1 1 2 2 3 | 2 | 1 1 1 2 0 0 0 1 | 7 | 3.00 | 1.67 | 1.00 | 1.00 | 0.33 | 1.00 | 1.33 | 3.00 |
| 2025 02 24 | 10 | 3 1 2 2 3 2 3 2 | 17 | 1 0 0 5 4 3 4 3 | 14 | 3.33 | 1.33 | 1.33 | 3.00 | 3.00 | 2.00 | 4.33 | 2.67 |
| 2025 02 25 | 11 | -1-1-1-1-1-1 2 3 | 11 | -1-1-1-1-1-1 3 2 | 9 | 1.67 | 2.00 | 1.67 | 1.67 | 1.00 | 1.67 | 3.00 | 3.33 |
| 2025 02 26 | 13 | 2 3 2 2 4 3 3 2 | 33 | 1 4 3 6 4 5 5 3 | 16 | 3.00 | 3.67 | 3.00 | 2.67 | 3.00 | 3.33 | 3.33 | 2.33 |
| 2025 02 27 | 24 | 3 3 3 5 4 4 3 4 | 54 | 3 5 4 7 6 6 4 3 | 33 | 4.00 | 4.33 | 3.33 | 5.67 | 4.00 | 4.67 | 3.33 | 4.33 |
| 2025 02 28 | 21 | 4 3 3 3 5 4 3 2 | 51 | 4 4 5 6 6 6 5 3 | 32 | 5.00 | 4.00 | 4.33 | 3.67 | 4.67 | 4.67 | 4.33 | 3.00 |
| 2025 03 01 | 11 | 1 3 3 3 3 2 2 2 | 41 | 2 4 7 6 5 2 3 2 | 19 | 2.33 | 4.00 | 4.00 | 4.00 | 3.67 | 2.00 | 3.33 | 3.00 |
| 2025 03 02 | 5 | 1 1 2 1 2 2 2 1 | 5 | 2 1 2 3 2 0 0 0 | 6 | 2.00 | 1.67 | 2.33 | 1.67 | 1.67 | 0.67 | 1.00 | 0.67 |
| 2025 03 03 | 5 | 1 1 1 1 2 2 2 2 | 2 | 1 0 0 2 0 1 1 1 | 5 | 1.67 | 1.00 | 1.00 | 1.67 | 0.67 | 1.00 | 1.33 | 1.33 |
| 2025 03 04 | 7 | 1 2 2 1 2 2 2 3 | 7 | 0 1 0 2 2 1 2 4 | 11 | 1.67 | 2.33 | 1.67 | 1.33 | 2.00 | 2.00 | 3.00 | 4.33 |
| 2025 03 05 | 4 | -1-1-1-1-1-1 0 2 | 21 | 3 3 5 4 4 4 2 1 | 13 | 3.67 | 3.33 | 2.67 | 2.67 | 2.00 | 3.00 | 2.00 | 2.33 |
| 2025 03 06 | 6 | 2 1 2 2 1 2 2 1 | 5 | 2 1 2 2 0 1 2 1 | 7 | 2.33 | 1.67 | 2.67 | 2.00 | 0.33 | 1.33 | 2.33 | 1.67 |
| 2025 03 07 | 9 | 1 2 2 3 3 3 2 1 | 18 | 1 1 3 5 3 5 3 0 | 11 | 1.00 | 2.67 | 2.67 | 3.33 | 2.33 | 2.67 | 2.67 | 1.33 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2025 03 08 | 15 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 25 | 1 | 3 | 5 | 5 | 3 | 3 | 4 | 4 | 21 | 2.33 | 3.00 | 3.67 | 3.33 | 2.33 | 3.33 | 4.67 | 4.67 |
| 2025 03 09 | 24 | 4 | 4 | 3 | 5 | 4 | 3 | 3 | 3 | 49 | 4 | 5 | 4 | 7 | 6 | 5 | 2 | 3 | 35 | 4.67 | 5.67 | 4.00 | 5.67 | 4.33 | 3.00 | 2.67 | 3.33 |
| 2025 03 10 | 8 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 18 | 3 | 2 | 4 | 5 | 4 | 3 | 1 | 1 | 10 | 3.00 | 2.00 | 2.33 | 2.67 | 2.33 | 2.67 | 1.00 | 2.33 |
| 2025 03 11 | 9 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 13 | 1 | 2 | 3 | 4 | 4 | 3 | 1 | 1 | 10 | 2.33 | 2.33 | 2.33 | 2.67 | 3.00 | 1.67 | 1.67 | 2.67 |
| 2025 03 12 | 18 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 51 | 3 | 4 | 4 | 6 | 6 | 6 | 6 | 3 | 32 | 3.67 | 3.67 | 3.33 | 4.00 | 4.33 | 4.67 | 5.00 | 5.00 |
| 2025 03 13 | 26 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 44 | 4 | 4 | 6 | 5 | 6 | 4 | 5 | 3 | 42 | 5.00 | 5.00 | 5.00 | 4.67 | 5.00 | 3.67 | 5.00 | 4.33 |
| 2025 03 14 | 22 | 5 | 1 | -1 | -1 | -1 | 4 | 3 | 3 | 29 | 5 | 4 | 4 | 4 | 4 | 5 | 3 | 3 | 25 | 5.67 | 3.33 | 3.67 | 3.00 | 3.00 | 3.67 | 3.00 | 3.67 |
| 2025 03 15 | 14 | 3 | 3 | 3 | 3 | 4 | 3 | 2 | 1 | 29 | 3 | 2 | 5 | 6 | 4 | 5 | 1 | 1 | 18 | 4.00 | 3.67 | 3.33 | 3.67 | 3.67 | 3.33 | 1.67 | 1.33 |
| 2025 03 16 | 10 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 21 | 2 | 2 | 3 | 5 | 6 | 2 | 1 | 1 | 11 | 2.00 | 2.33 | 2.67 | 2.67 | 3.33 | 1.33 | 2.33 | 2.67 |
| 2025 03 17 | 14 | 3 | 3 | 3 | 2 | 4 | 2 | 3 | 2 | 23 | 3 | 3 | 4 | 3 | 5 | 5 | 2 | 2 | 16 | 3.33 | 3.33 | 3.00 | 2.00 | 3.33 | 2.67 | 3.67 | 3.00 |
| 2025 03 18 | 13 | 3 | 3 | 2 | 2 | 4 | 3 | 2 | 2 | 18 | 2 | 4 | 3 | 3 | 5 | 3 | 2 | 2 | 12 | 3.33 | 3.33 | 2.33 | 2.00 | 3.33 | 2.67 | 1.67 | 2.33 |
| 2025 03 19 | 19 | 2 | 4 | 4 | 3 | 4 | 4 | 3 | 2 | 42 | 2 | 4 | 7 | 4 | 4 | 5 | 5 | 3 | 23 | 2.33 | 4.33 | 4.33 | 3.00 | 3.00 | 3.67 | 4.67 | 3.33 |
| 2025 03 20 | 5 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 7 | 2 | 2 | 2 | 3 | 3 | 1 | 1 | 0 | 6 | 2.00 | 2.00 | 2.00 | 1.67 | 1.67 | 0.67 | 1.33 | 2.00 |
| 2025 03 21 | 16 | 3 | 3 | 2 | 2 | 3 | 3 | 4 | 4 | 16 | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 25 | 3.33 | 3.00 | 2.33 | 2.33 | 2.67 | 4.00 | 5.33 | 5.33 |
| 2025 03 22 | 20 | 4 | 4 | 2 | 3 | 4 | 3 | 3 | 4 | 33 | 4 | 3 | 3 | 3 | 6 | 6 | 3 | 3 | 33 | 5.67 | 5.00 | 3.00 | 3.00 | 4.00 | 4.33 | 3.33 | 4.67 |
| 2025 03 23 | 9 | 3 | 1 | 3 | 1 | 3 | 2 | 2 | 2 | 15 | 3 | 2 | 5 | 3 | 3 | 2 | 2 | 1 | 10 | 4.00 | 2.00 | 3.33 | 1.67 | 2.00 | 1.33 | 2.00 | 1.33 |
| 2025 03 24 | 18 | 4 | 4 | 2 | 3 | 5 | 2 | 2 | 1 | 29 | 2 | 4 | 4 | 6 | 5 | 4 | 2 | 2 | 19 | 4.33 | 4.33 | 2.67 | 3.67 | 4.00 | 3.00 | 2.00 | 1.67 |
| 2025 03 25 | 13 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 29 | 2 | 3 | 4 | 6 | 3 | 5 | 4 | 3 | 15 | 3.33 | 2.33 | 3.00 | 3.00 | 2.33 | 2.67 | 4.00 | 3.33 |
| 2025 03 26 | 26 | 4 | 3 | 2 | 2 | 5 | 4 | 5 | 4 | 43 | 4 | 4 | 2 | 4 | 6 | 6 | 5 | 5 | 46 | 4.67 | 4.33 | 2.33 | 3.33 | 5.67 | 5.67 | 6.33 | 4.67 |
| 2025 03 27 | 20 | 3 | 3 | 4 | 3 | 4 | 4 | 3 | 3 | 47 | 4 | 3 | 6 | 5 | 6 | 6 | 4 | 3 | 33 | 4.00 | 4.67 | 4.67 | 4.00 | 4.67 | 5.00 | 3.67 | 3.67 |
| 2025 03 28 | 13 | 2 | 3 | 3 | 2 | 3 | 4 | 2 | 2 | 18 | 3 | 2 | 4 | 4 | 4 | 3 | 2 | 3 | 16 | 2.67 | 3.33 | 3.33 | 2.33 | 3.00 | 3.33 | 2.67 | 3.67 |
| 2025 03 29 | 10 | 3 | 3 | 1 | 3 | 3 | 2 | 2 | 1 | 6 | 3 | 3 | 1 | 2 | 1 | 2 | 0 | 0 | 9 | 3.33 | 3.67 | 1.67 | 2.00 | 1.67 | 1.33 | 0.67 | 1.00 |
| 2025 03 30 | 8 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 5 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 7 | 2.00 | 2.33 | 2.67 | 1.67 | 1.33 | 1.00 | 1.33 | 1.00 |
| 2025 03 31 | 8 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 1 | 6 | 0 | 1 | 2 | 4 | 2 | 1 | 1 | 0 | 18 | 1.00 | 2.00 | 2.00 | 2.67 | 1.67 | 1.33 | 1.33 | 1.00 |

## 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 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 which 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 a 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.