WIDE-AREA AUGMENTATION SYSTEM PERFORMANCE ANALYSIS REPORT

Report #16

Reporting Period: January 1 to March 31, 2006

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FAA/William J. Hughes Technical Center
NSTB/WAAS T&E Team
Atlantic City International Airport, NJ 08405

Changes:

List of Figures
Figure 4-13 Daily WAAS LNAV/VNAV and LPV Coverage
Figure 5-1 SV Daily Alert Trends

Executive Summary

Since 1999 the WAAS Group at the William J. Hughes Technical Center has reported GPS performance as measured against the GPS Standard Positioning Service (SPS) Signal Specification. These quarterly reports are known as the PAN (Performance Analysis Network) Report. In addition to that report, the WAAS/NSTB Team reports on the performance of the Wide-Area Augmentation System (WAAS). This report is the sixteenth such WAAS quarterly report. This report covers WAAS performance during the period from January 1, 2006 to March 2006.

The following table shows observations for accuracy and availability made during the reporting period. See the body of the report for additional results in accuracy, availability, safety index, range accuracy, WAAS broadcast message rates and GEO ranging availability. Please note that the results in the below table are valid when the Localizer Approach with Vertical Guidance (LPV) service is available. LPV service is available when the calculated Horizontal Protection Level (HPL) is less than 40 meters and the Vertical Protection Level (VPL) is less than 50 meters.

Parameter	**Site/Maximum**	**Site/Minimum**
95% Horizontal Accuracy	Dallas 1.078 meters	Albuquerque 0.677meters
95% Vertical Accuracy	Miami 1.574 meters	Chicago 0.914 meters
LPV Availability (HPL < 40 meters & VPL < 50 meters)	Minneapolis 99.91%	Los Angeles 98.00%
95% HPL	Oakland 29.223meters	Atlanta 17.043 meters
95% VPL	Los Angeles 42.907 meters	Kansas City 26.939 meters

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX

1.0 INTRODUCTION

The FAA began monitoring GPS SPS performance in order to ensure the safe and effective use of the satellite navigation system in the National Airspace System (NAS). The Wide Area Augmentation System (WAAS) adds more timely integrity monitoring of GPS and improves position accuracy and availability of GPS within the WAAS coverage area.

Objectives of this report are:

a. To evaluate and monitor the ability of WAAS to augment GPS by characterizing important performance parameters.
b. To analyze the effects of GPS satellite operation and maintenance, and ionospheric activity on the WAAS performance.
c. To investigate any GPS and WAAS anomalies and determine their impact on potential users.
d. To archive performance of GPS and WAAS for future evaluations.

The WAAS data transmitted from GEO satellite PRN#122 (AORW) and PRN#134 (POR) were used in the evaluation. Table 1.1 and Table 1.2 list NSTB and WAAS reference station receivers used in Precision Approach (PA) and Non-Precision Approach (NPA) evaluation process, respectively. This report presents results from three months of data, collected from January 1, 2006 to March 31, 2006.

Table 1-1 PA Sites

	Number of Days Evaluated	Number of Samples
NSTB:		
Anderson	76	6552717
Atlantic City	92	7944873
Grand Forks	84	7221584
Greenwood	92	7915504
Prescott	91	7877570
WAAS:		
Albuquerque	92	7921771
Atlanta	92	7907596
Billings	92	7942025
Boston	92	7929997
Chicago	92	7920916
Cleveland	92	7913585
Dallas	92	7941198
Denver	92	7906819
Houston	92	7906473
Jacksonville	92	7932829
Kansas City	92	7940108
Los Angeles	92	7930524
Memphis	91	7901027
Miami	91	7903133
Minneapolis	90	7753542
New York	92	7923913
Oakland	92	7940139
Salt Lake City	92	7941364
Seattle	92	7940622
Washington DC	92	7942952

Table 1-2 NPA Sites

Location	Number of Days Evaluated	Number of Samples
Albuquerque	90	7756893
Anchorage	90	7753970
Atlanta	88	7610489
Billings	90	7757138
Boston	90	7756057
Cleveland	90	7757867
Cold Bay	89	7694596
Honolulu	89	7705189
Houston	89	7656977
Juneau	89	7720227
Kansas City	87	7484059
Los Angeles	87	7507756
Miami	89	7657134
Minneapolis	90	7747236
Oakland	90	7757536
Salt Lake City	90	7752344
San Juan	89	7702904
Seattle	90	7757756
Washington DC	88	7615191

The report is divided in the performance categories listed below. This report also includes WAAS LPV Service Availability at Selected Airports, and WAAS Deterministic Code Noise and Multipath (CNMP) Bounding Analysis.

1. WAAS Position Accuracy
2. WAAS Operational Service Availability
3. Coverage
4. Integrity
5. WAAS Range Domain Accuracy
6. GEO Ranging Performance

Table 1.3 lists the performance parameters evaluated for the WAAS in this report. Please note that these are the performance parameters associated with the WAAS IOC system. These requirements are extracted from the FAA Specification FAA-E-2892B Change 1. In future reports the performance parameters will be derived from FAA Specification FAA-E-2976, as applicable.

Table 1-3 WAAS Performance Parameters

Performance Parameter	Expected WAAS Performance
PA Accuracy Horizontal	≤ 7.6m error 95% of the time
PA Accuracy Vertical	≤ 7.6m error 95% of the time
NPA Accuracy Horizontal	≤ 100m error 95% of the time ≤ 556m error 99.999% of the time
Availability LPV*	Not Defined for Current WAAS phase
Availability LNAV/VNAV*	Not Defined for Current WAAS phase
LPV and LNAV/VNAV Outages and outage rate	Not Defined for Current WAAS phase
LNAV Outages and outage rates	Not Defined for Current WAAS phase
Coverage LPV	Not Defined for Current WAAS phase For this report - 95% availability of 75% of CONUS
Coverage LNAV/VNAV	95% availability of 75% of CONUS
Coverage NPA	99.9% availability of 75% of service volume
LPV Availability	≥ 95% of the time within the service volume
LNAV/VNAV Availability	≥ 95% of the time within the service volume
Integrity	≤ 4 X 10e-8 HMI's per approach

* Instantaneous availability (i.e. Availability is calculated every second.)

1.1 Event Summary

Table 1.4 lists test events that occurred during the reporting period that affected WAAS performance or the ability to determine the WAAS performance. These events include GPS or WAAS anomalies, relevant receiver malfunctions, and receiver maintenance conducted. The Discrepancy Reports (DR) that provide detailed analysis of particular events are available upon request.

Table -4 Test Events

GPS Week	Date	Sites	Events
1356 day 5 to 1356 day 6	1/6/06 to 1/7/06	Atlanta	Atlanta outage.
1359 day 1	1/23/06	All POR Non-Dual Sites	See DR# 24, "Multiple POR Geo Gaps After 2 POR GUS Switchovers."
1359 day 2	1/24/06	All AOR-W Sites	PRN Mask update. Removed AOR-W (PRN 122) from mask (due to upcoming AOR-W SV move).
1359 day 2	1/24/06	None	Release 3 O&M Build 1 software update.
1359 day 4	1/26/06	Dallas, KC, LA, Denver, Seattle, Oakland	Tested new communications circuits between ZLA & ZTL.
1359 day 4 to 1360 day 2	1/26/06 to 1/31/06	Dallas	Dallas outage.
1359 day 5	1/27/06	None	Release 3 GUS software upgrades (POR GUS's: STA-B, BRE).
1359 day 6	1/28/06	None	Release 3 GUS software upgrades (AOR-W GUS's: STA-A, CLK).
1359 day 6	1/28/06	All	PRN Mask update. Fell back to previous mask (using AOR-W) due to Garmin receiver problems.
1360 day 4	2/2/06	Several Central CONUS Sites	See DR# 29, "Localized Loss of Availability over Central CONUS."
1361 day 4	2/9/06	Most CONUS Sites	See DR# 30, "Loss of Availability due to Satellite Maintenance, SV 5 (NANU 2006013)."
1361 day 4	2/9/06	All AOR-W Non-Dual Sites	AOR-W GUS Switchover to STA-A to prepare for CLK resectoring.
1362 day 4	2/16/06	All POR Non-Dual Sites	POR GUS switchover to BRE to replace STA-B GUS Test Loop Translator.
1362 day 4	2/16/06	All AOR-W Non-Dual Sites	See DR# 26, "Near-Simultaneous GUS Failures Caused AOR-W SIS outage."
1363 day 3	2/22/06	All POR Non-Dual Sites	See DR# 25, "Extended POR Signal-in-Space Outage after Communication failure."
1363 day 6 to 1364 day 3	2/25/06 to 3/1/06	Chicago	Chicago outage.
1364 day 4	3/2/06	All AOR-W Sites	AOR-W GUS switchover to CLK to work on STA-A. Changed STA-A dish tracking frequency due to AOR-W SV move.
1364 day 5, 1365 day 0 to 1365 day 2	3/3/06, 3/5/06 to 3/7/06	None	See DR# 28, "GPS Clock Antenna Problem Caused ZDC C&V to Fault Repeatedly While ZLA was Selected C&V Source."
1365 day 1 to 1365 day 2	3/6/06 to 3/7/06	DC	DC outage. ZDC C&V was down. ZDC WRE Thread 2 PCU was borrowed in the process of troubleshooting the C&V, thus the outage.
1365 day 6	3/11/06	Western CONUS Sites	See DR# 31, "Loss of Availability due to Extended Satellite Maintenance on SV 30 (NANU 2006020)."
1366 day 2	3/14/06	All AOR-W Sites	SV 30 was set to "Do Not Use" (UDREi = 15) since 3/10/06. It was incorrectly set to initialization state by a Type 0 message following an AOR-W GUS switchover.
1366 day 2	3/14/06	All AOR-W Sites	CLK maintainer error caused AOR-W GUS switchover to STA-A.
1366 day 4	3/16/06	Central and Western CONUS Sites	Loss of Availability due to SV 4 outage. See NANU 2006022.

GPS Week	Date	Sites	Events
1367 day 0	3/19/06	All Sites	One-second GEO message gap (bad CRCs), AOR-W & POR. Selected C&V source for STA was changed from ZLA to ZDC.
1367 day 3	3/22/06	All	AOR-W and POR SIS outage, caused by Loss Maneuver Bug.
1369 day 0 to 1369 day 1	3/30/06 to 3/31/06	Greenwood	Greenwood outage.

1.2 Report Overview

Section 2 provides the vertical and horizontal position accuracies from data collected, on a daily basis, at one-second intervals. The 95% accuracy index and the maximum accuracy for the reporting period are tabulated. The daily 95% accuracy index is plotted graphically for each receiver. Histograms of the vertical and horizontal error distribution are provided for three receivers within the WAAS service area.

Section 3 summarizes the WAAS instantaneous availability performance, at each receiver, for three operational service levels during the reporting period. Daily availability is also plotted for each receiver evaluated. The number of outages and outage rate for each site is reported.

Section 4 provides the percent of coverage provided by WAAS on a daily basis. Monthly roll-up graphs presented indicate the portions of service volume covered, and the percentage of time that WAAS was available.

Section 5 summarizes the number of HMI's detected during the reporting period and presents a safety margin index for each receiver. The safety index reflects the amount of over bounding of position error by WAAS protection levels. This section also includes update rates of WAAS messages transmitted from AORW and POR.

Section 6 provides the UDRE and GIVE bounding percentage and the 95% index of the range and ionospheric accuracy for each satellite tracked by the WAAS receiver in Houston.

Section 7 provides the GEO ranging performance for AORW and POR.

Section 8 summarizes WAAS anomalies and problems identified during the reporting period, which adversely affect WAAS performance described in Table 1.3.

Section 9 provides WAAS LPV availability and outages at selected airports.

Section 10 provides the assessment of WAAS CNMP bounding for 75 WAAS receivers.

2.0 WAAS POSITION ACCURACY

Navigation error data, collected from WAAS and NSTB reference stations, was processed to determine position accuracy at each location. This was accomplished by utilizing the GPS/WAAS position solution tool to compute a MOPS-weighted least squares user navigation solution, and WAAS horizontal and vertical protection levels (HPL & VPL), once every second. The user position calculated for each receiver was compared to the surveyed position of the antenna to assess position error associated with the WAAS SIS over time. The position errors were analyzed and statistics were generated for two operational service levels: WAAS LPV, and WAAS LNAV/VNAV, as shown in Table 2.1. For this evaluation, the WAAS operational service level is considered available at a given time and location, if the computed WAAS HPL and VPL are within the horizontal and vertical alarm limits (HAL & VAL) specified in Table 2.1.

Table 2-1 Operational Service Levels

WAAS Operational Service Levels	Horizontal Alert Limit HAL (meters)	Vertical Alert Limit VAL (meters)
LPV (LOC/VNAV)	40	50
LNAV/VNAV	556	50

Table 2.2 shows PA horizontal and vertical position accuracy maintained for 95% of the time at LPV and LNAV/VNAV operational service levels for the quarter. The table also includes 95% SPS accuracy for certain locations. Figures 2.1 to 2.4 show the daily horizontal and vertical 95% accuracy for LNAV/VNAV operational service level for the period. Note that WAAS accuracy statistics presented are compiled only when all WAAS corrections (fast, long term, and ionospheric) for at least 4 satellites are available. This is referred to as PA navigation mode. The percentage of time that PA navigation mode was supported by WAAS at each receiver is also shown in Table 2.2. A user is considered to be in NPA navigation mode if only WAAS fast and long term corrections are available to a user (i.e. no ionospheric corrections). Table 2.3 shows NPA horizontal position accuracy for 95% and 99.999% of the time. This table also shows the maximum NPA horizontal position error for the quarter. Figures 2.5 shows the daily horizontal 95% accuracy for NPA.

During the evaluated period, the 95% horizontal and vertical accuracy at all evaluated sites were less than 2 meters for both WAAS operational service levels. The maximum 95% horizontal and vertical LPV errors are 1.078 meters at Dallas and 1.574 Miami. The minimum 95% horizontal and vertical LPV errors are 0.677 meters at Albuquerque and 0.914 meters at Chicago. The maximum 95% and 99.999% NPA horizontal errors are 3.054 meters at Honolulu and 7.154 at Honolulu. The minimum 95% and 99.999% horizontal errors are 1.033 meters at Juneau and 2.803 meters at Seattle, respectively.

Table 2.4 shows the maximum horizontal and vertical position errors while the calculated HPL and VPL met the LPV service levels. The column marked 'Horizontal (or Vertical) Error/HPL (or VPL)' is the ratio of position error to protection level at the time the maximum error occurred. The column marked 'Horizontal (or Vertical) Maximum Ratio' is the maximum position error to protection level ratio for the quarter.

Figures 2.6 to 2.15 show the distributions of the vertical and horizontal errors in triangle charts and 2-D histogram plots for the quarter at three locations, Kansas City, Washington DC and Seattle. The triangle charts show the distributions of vertical position errors (VPE) versus vertical protection levels (VPL) and horizontal position errors (HPE) versus horizontal protection levels (HPL). The horizontal axis is the position error and the vertical axis is the WAAS protection levels. Lower protection levels equate to better availability. The diagonal line shows the point where error equals protection level. Above and to the left of the diagonal line in the chart, errors are bounded (WAAS is providing integrity in the position domain); below and to the right, errors are not bounded (HMI could be present). The horizontal lines at various protection levels represent the various operational service levels as defined in Table 2.1. The 2-D histogram plots contain four histograms showing the distributions of vertical and horizontal position errors and normalized position errors. The left top and bottom histograms show the distributions of the actual vertical and horizontal errors. The horizontal axis is the position errors and the vertical axis is the total count of data samples (log scale) in each 0.1-meter bin. The right top and bottom histograms show the distributions of the actual vertical and horizontal errors normalized by one-sigma value of the protection level; vertical - (VPL/5.33) and horizontal - (HPL/6.0). The horizontal axis is the standard units and vertical axis is the observed distribution of normalized errors data samples in each 0.1-sigma bin. Narrowness of the normalized error distributions shows very good observed safety performance.

Table 2-2 PA 95% Horizontal and Vertical Accuracy

Location	Horizontal GLS/APV2/LPV (HAL=40m) (Meters)	Horizontal APV-1(LNAV) (HAL=556m) (Meters)	Vertical LPV/VNAV (VAL=50m) (Meters)	Percentage in PA mode (%)	SPS Accuracy	
					95% Horizontal (Meters)	95% Vertical (Meters)
Atlantic City	0.797	0.799	1.091	99.92923	*	*
Grand Forks	0.808	0.811	1.313	99.91642	*	*
Greenwood	0.770	0.772	1.109	99.92986	*	*
Albuquerque	0.677	0.679	0.934	99.92670	2.486	4.467
Atlanta	0.763	0.765	1.259	99.92474	2.723	4.796
Billings	0.771	0.772	1.035	99.92751	2.524	4.542
Boston	0.781	0.783	1.032	99.92371	2.735	4.458
Chicago	0.728	0.729	0.914	99.92211	*	*
Cleveland	0.751	0.754	0.994	99.92675	2.792	4.562
Dallas	1.078	1.080	1.296	99.93056	*	*
Denver	0.705	0.708	1.142	99.92439	*	*
Houston	0.765	0.767	1.355	99.92635	2.490	4.831
Jacksonville	0.955	0.957	1.312	99.92621	*	*
Kansas City	0.747	0.749	0.986	99.92612	2.694	4.815
Los Angeles	0.890	0.893	1.298	99.96796	2.415	4.978
Memphis	0.727	0.728	1.048	99.92577	*	*
Miami	0.981	0.983	1.574	99.92597	2.619	4.868
Minneapolis	1.067	1.070	1.157	99.92645	2.703	4.727
New York	0.878	0.881	0.969	99.92357	*	*
Oakland	0.840	0.843	1.341	99.96797	2.284	4.982
Salt Lake City	0.703	0.704	1.039	99.96838	2.483	4.649
Seattle	0.885	0.885	0.942	99.97305	2.418	4.952
Washington DC	1.043	1.046	1.135	99.92480	2.738	4.716

* SPS accuracy not computed for this location.

Table 2-3 NPA 95% and 99.999% Horizontal Accuracy

Location	95% Horizontal (meters)	99.999% Horizontal (meters)	Percentage in NPA mode (%)	Maximum Horizontal Error
Albuquerque	1..163	4.069	99.92	4.882
Anchorage	1.213	3.848	99.95	5.819
Atlanta	1.475	3.578	99.92	3.917
Billings	1.345	4.127	99.92	4.633
Boston	1.508	2.851	99.92	5.730
Cleveland	1.447	2.925	99.92	5.198
Cold Bay	1.488	4.082	99.95	6.213
Honolulu	3.054	7.154	99.95	12.933
Houston	1.226	4.628	99.92	5.304
Juneau	1.033	5.065	99.95	9.870
Kansas City	1.555	3.364	99.92	4.915
Los Angeles	1.298	4.026	99.97	4.244
Miami	1.351	4.603	99.93	4.955
Minneapolis	2.073	4.656	99.93	6.536
Oakland	1.197	4.153	99.97	4.644
Salt Lake City	1.221	4.275	99.97	4.480
San Juan	1.552	7.103	99.93	7.342
Seattle	1.330	2.803	99.97	4.040
Washington DC	2.218	4.511	99.93	5.162

Table 2-4 Maximum Position Errors and Position Error/Protection Level Ratio

Location	**Horizontal Error (m)**	**Horizontal Error/HPL**	**Horizontal Maximum Ratio**	**Vertical Error (m)**	**Vertical Error/VPL**	**Vertical Maximum Ratio**
Atlantic City	1.760	0.112	0.112	4.753	0.153	0.154
Grand Forks	4.985	0.179	0.179	6.697	0.290	0.290
Greenwood	2.321	0.095	0.149	4.948	0.118	0.140
Albuquerque	3.057	0.125	0.171	8.195	0.338	0.338
Atlanta	2.741	0.122	0.154	3.538	0.100	0.162
Billings	2.421	0.088	0.163	5.861	0.161	0.184
Boston	2.730	0.099	0.132	3.712	0.099	0.120
Chicago	2.831	0.193	0.193	4.899	0.225	0.225
Cleveland	2.366	0.107	0.159	4.581	0.145	0.145
Dallas	5.090	0.155	0.224	7.344	0.262	0.262
Denver	2.846	0.152	0.168	5.237	0.151	0.192
Houston	2.326	0.061	0.141	4.179	0.148	0.167
Jacksonville	3.209	0.142	0.188	3.786	0.105	0.143
Kansas City	2.534	0.095	0.169	4.962	0.190	0.190
Los Angeles	3.026	0.126	0.130	5.371	0.110	0.169
Memphis	3.223	0.125	0.199	4.464	0.108	0.157
Miami	2.857	0.208	0.208	5.462	0.311	0.311
Minneapolis	3.797	0.203	0.284	8.002	0.255	0.298
New York	3.138	0.150	0.195	3.512	0.103	0.109
Oakland	2.818	0.093	0.133	6.342	0.135	0.166
Salt Lake City	2.720	0.093	0.128	5.079	0.152	0.159
Seattle	2.252	0.138	0.138	4.439	0.165	0.165
Washington DC	3.189	0.121	0.206	4.457	0.170	0.170

Figure 2-1 95% Horizontal Accuracy at LNAV/VNAV

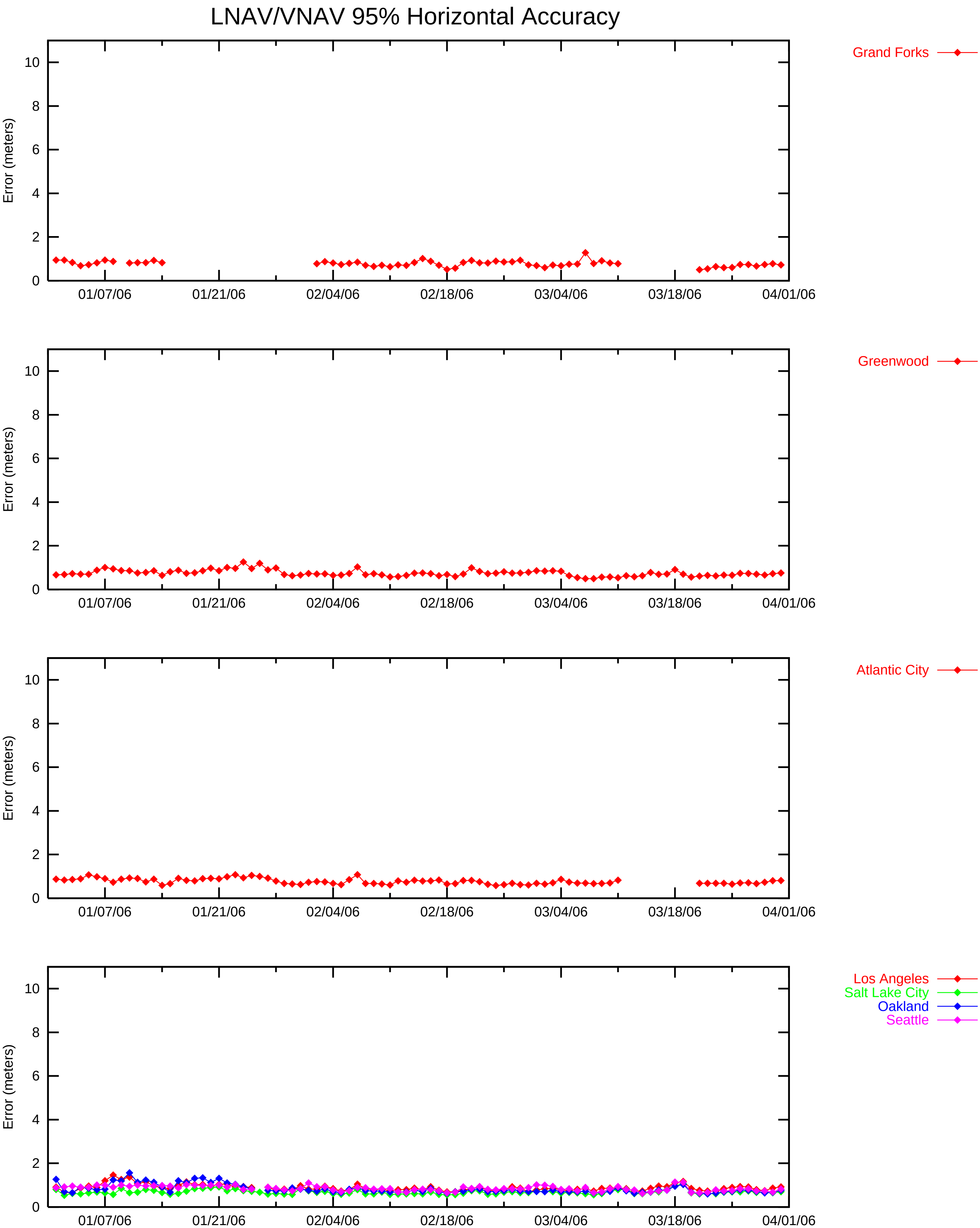


Figure 2-2 95% Horizontal Accuracy at LNAV/VNAV

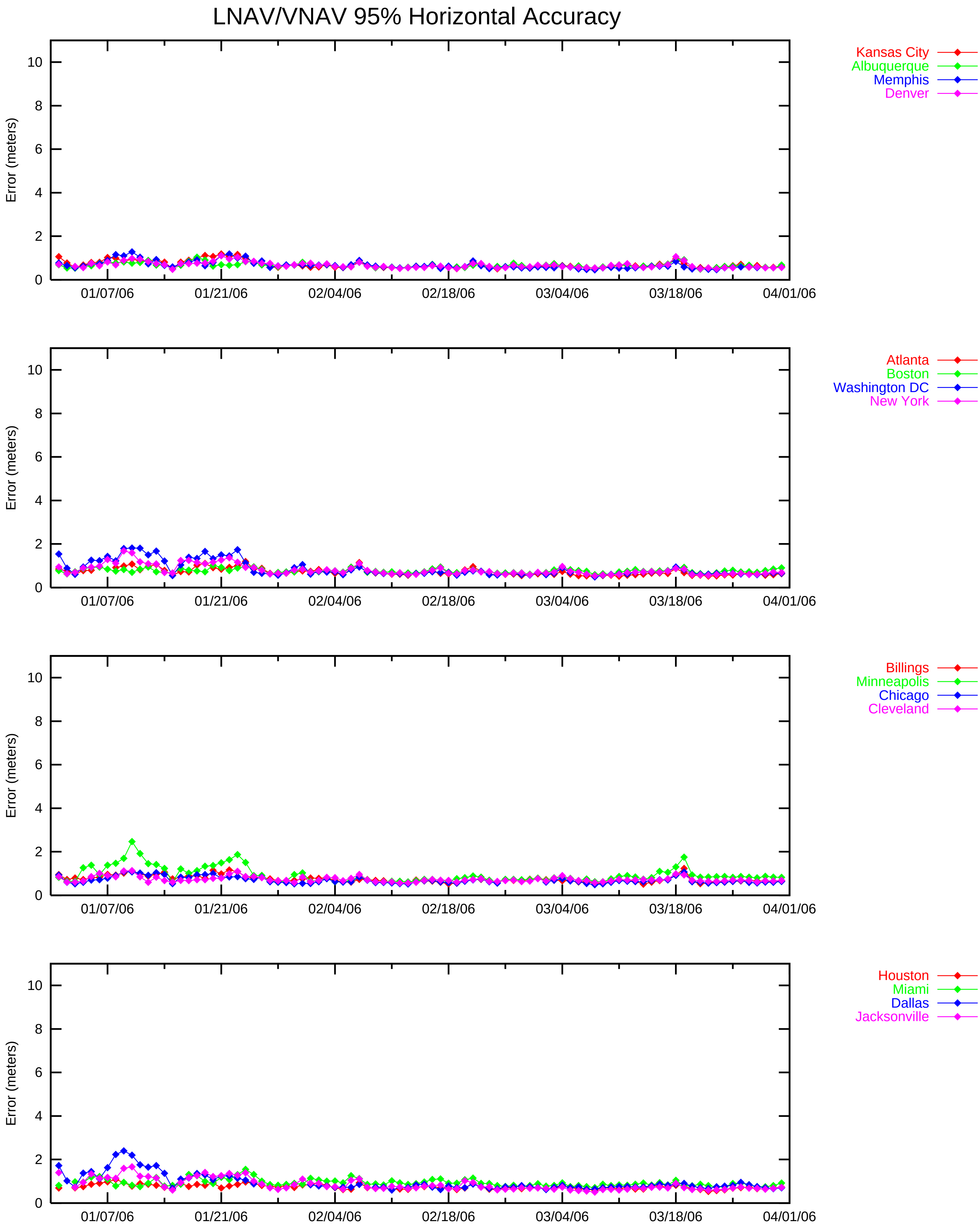


Figure 2-3 95% Vertical Accuracy at LNAV/VNAV

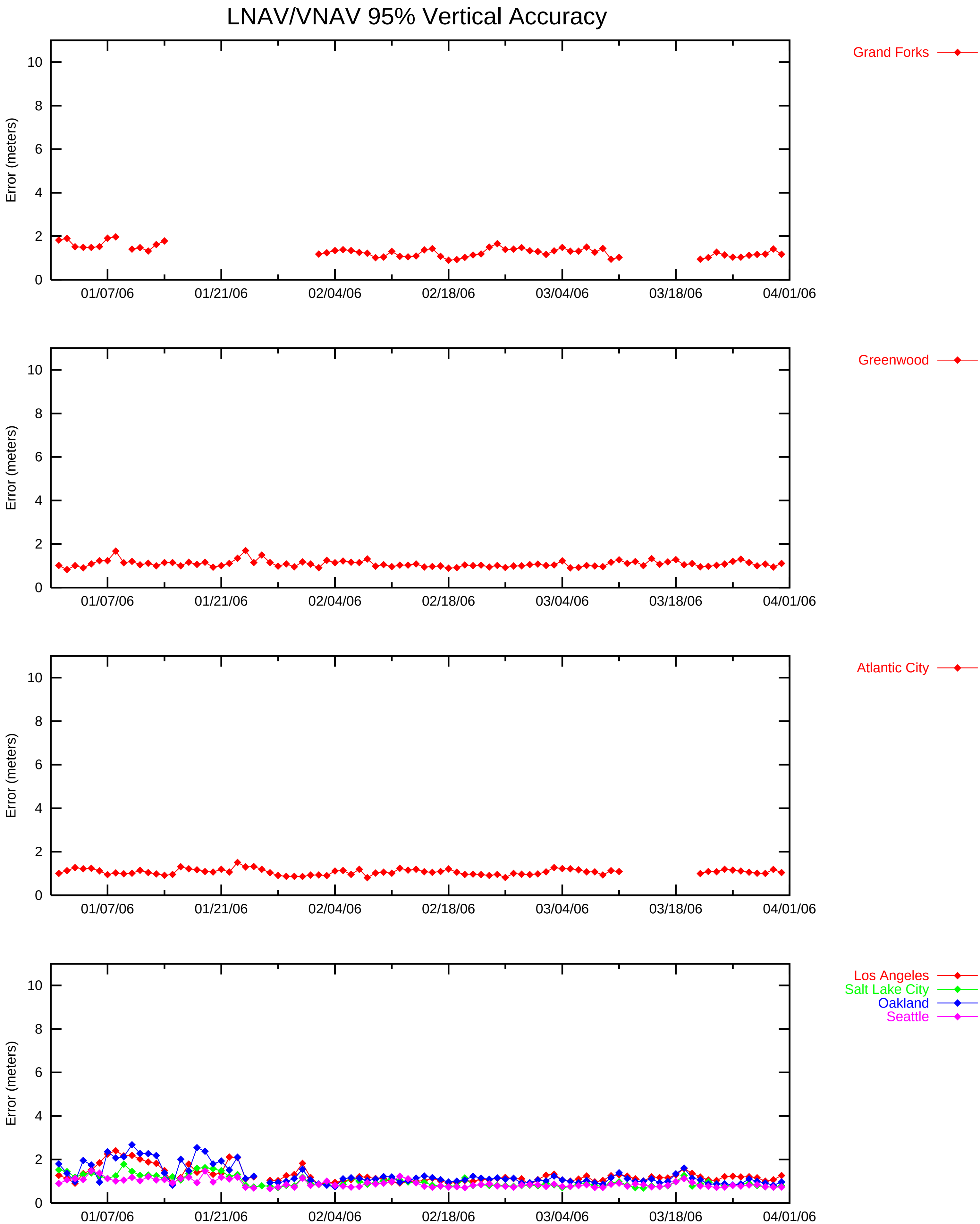


Figure 2-4 95% Vertical Accuracy at LNAV/VNAV

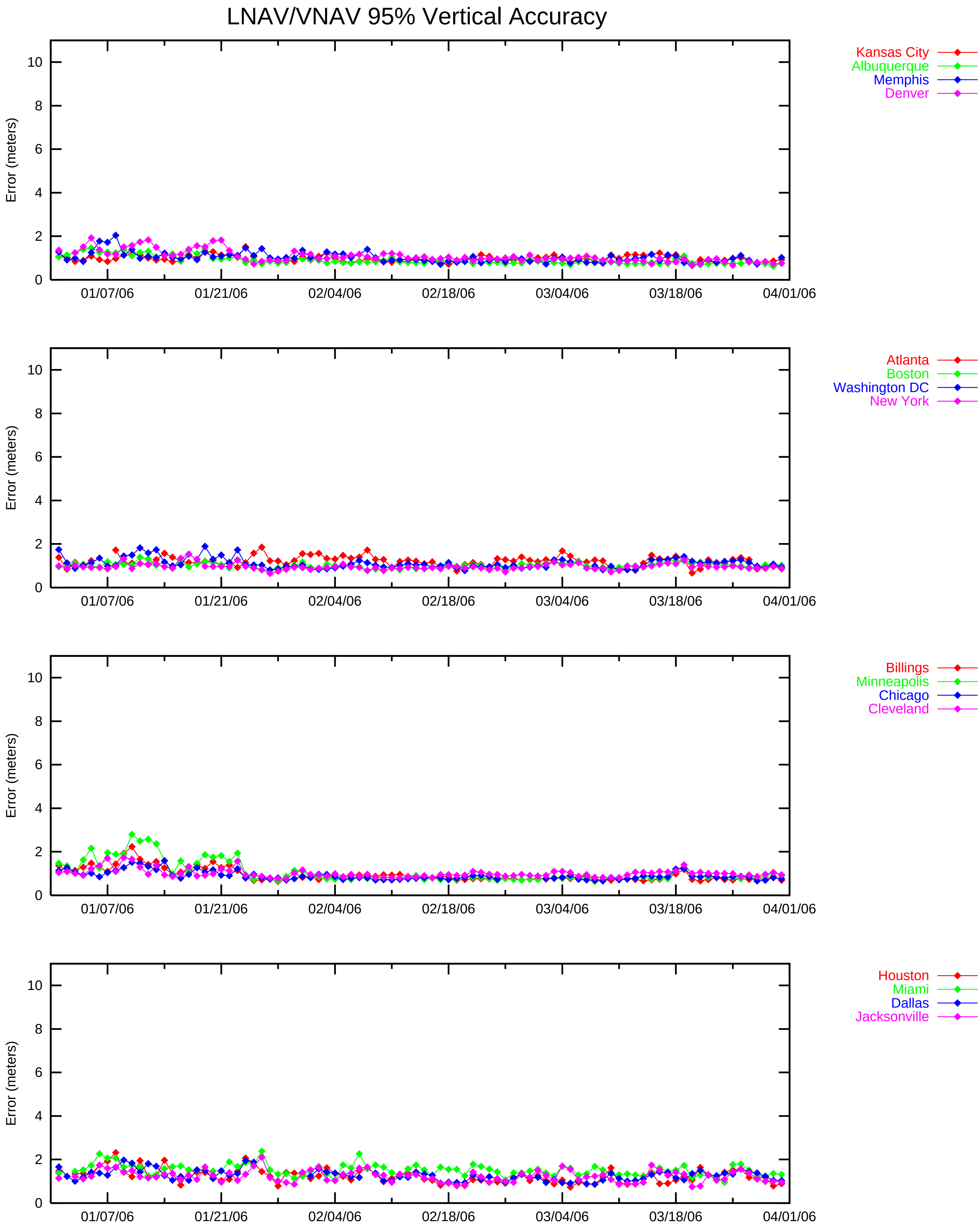


Figure 2-5 NPA 95% Horizontal Accuracy

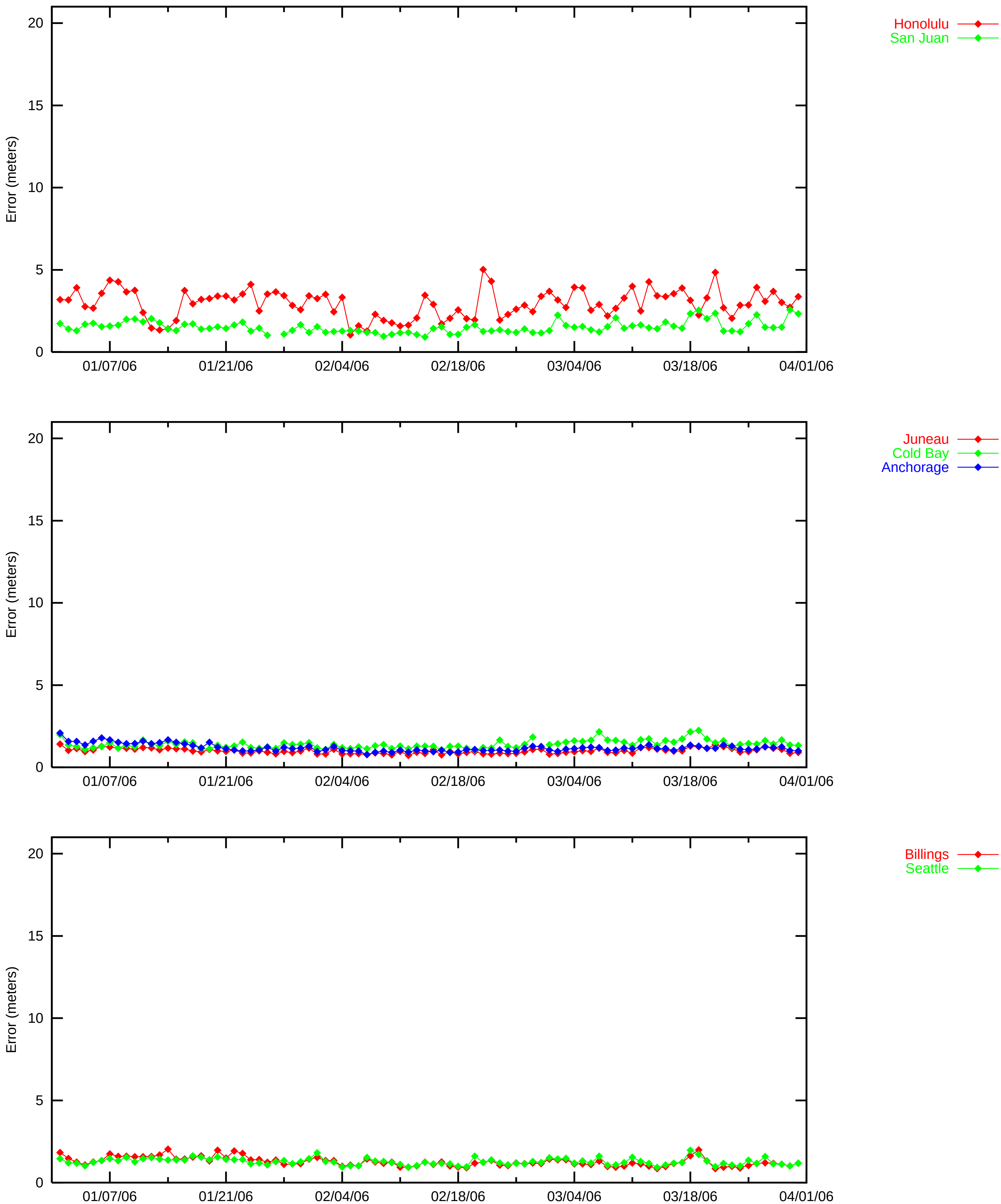
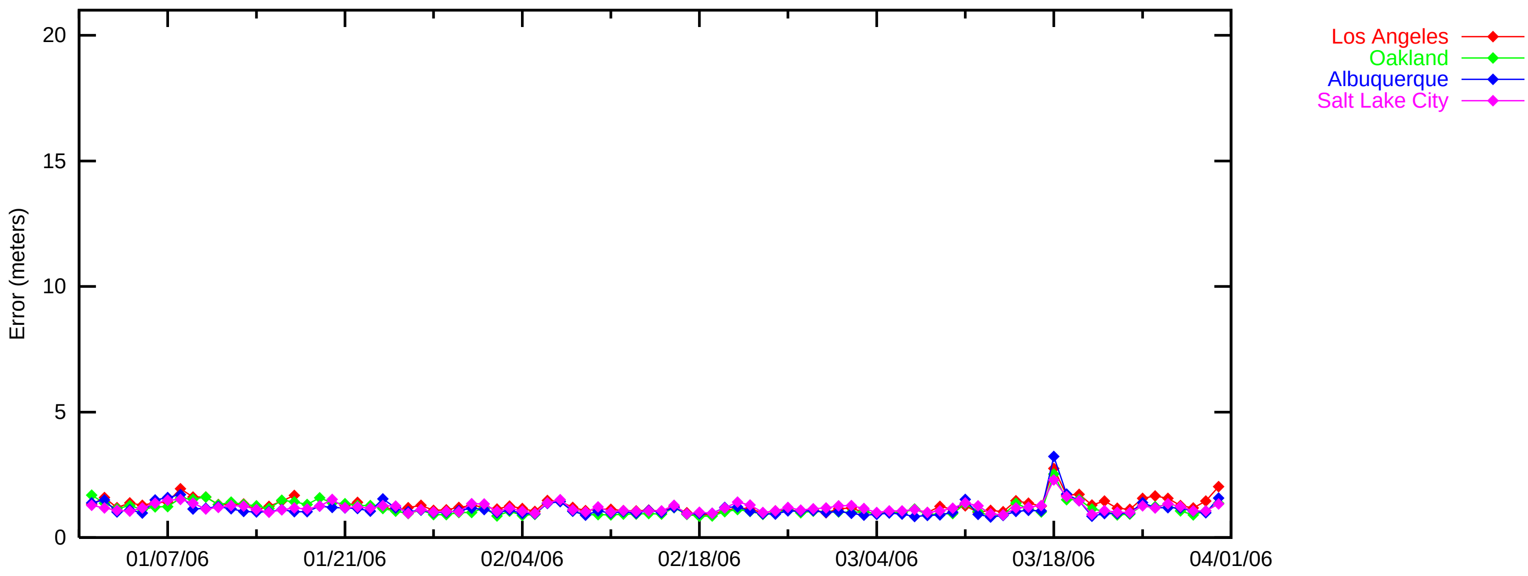
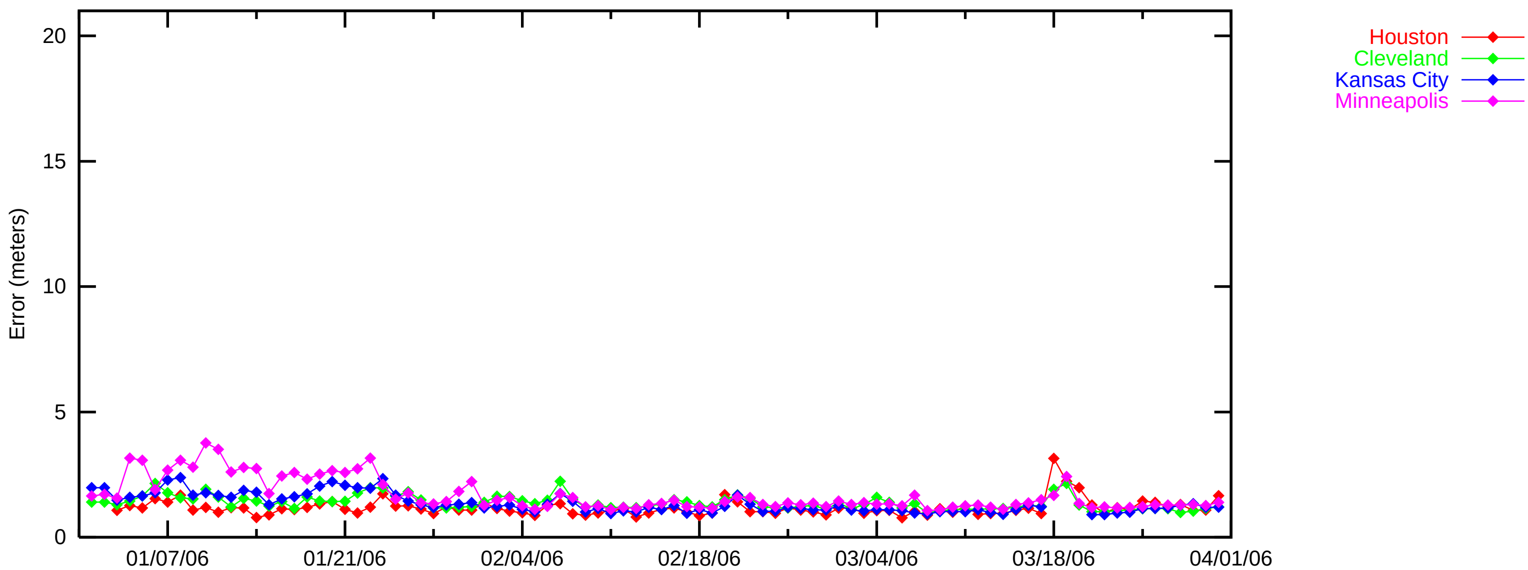


Figure 2-6 NPA 95% Horizontal Accuracy





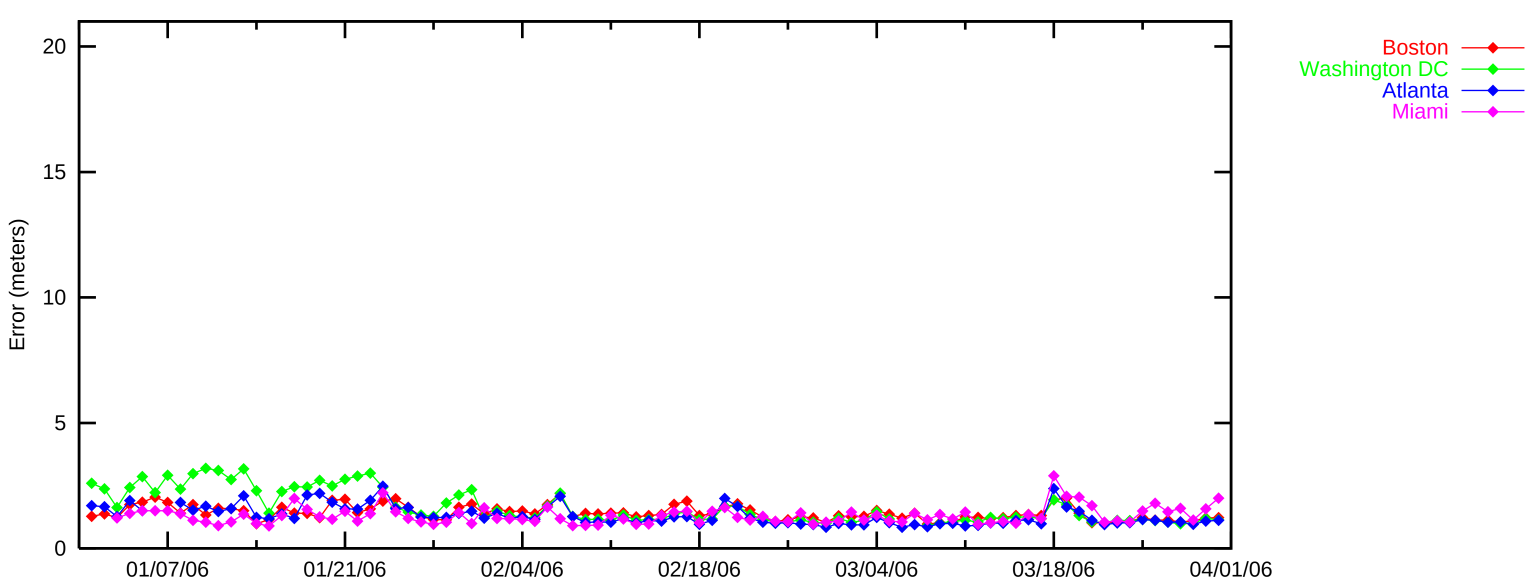


Figure 2-7 Horizontal Triangle Chart forKansas City

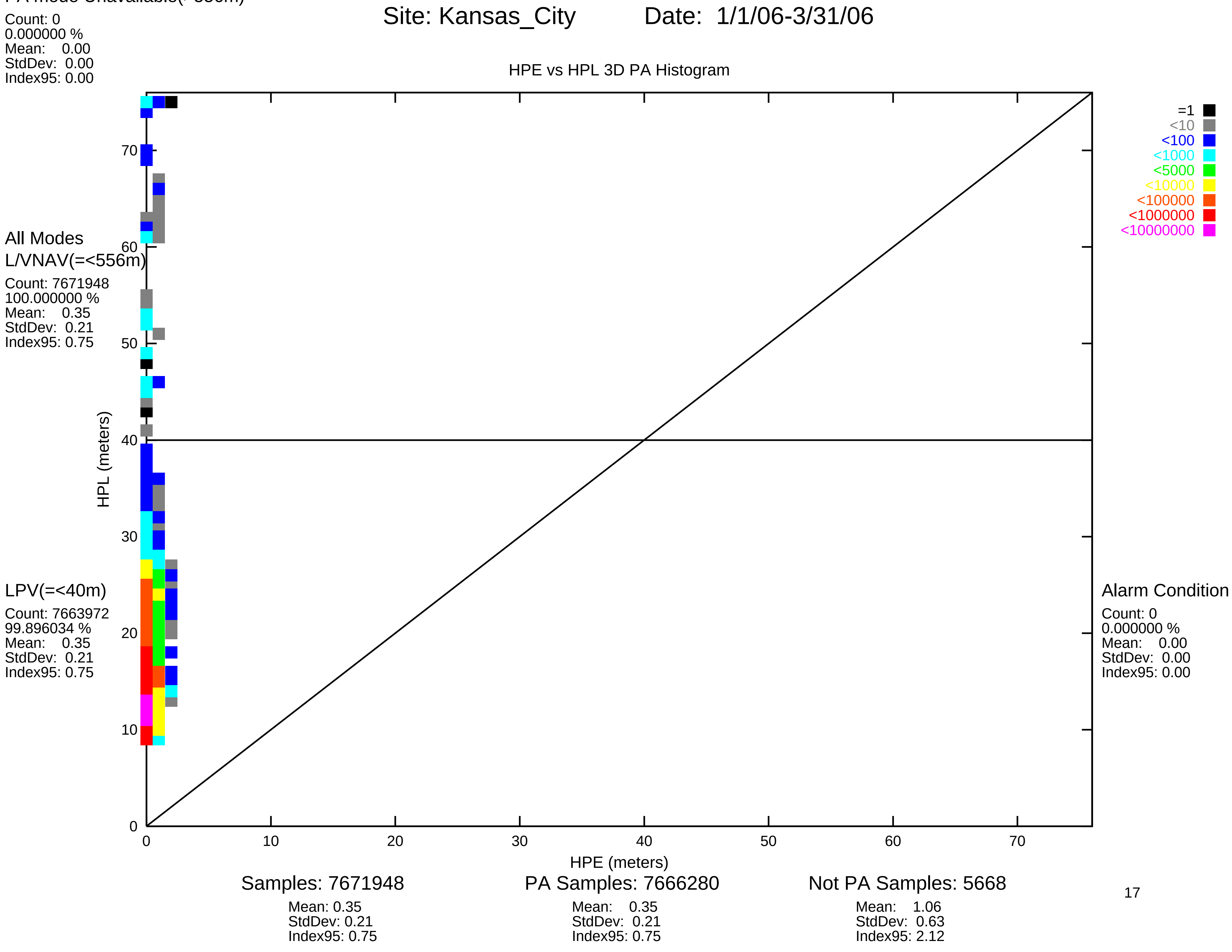


Figure 2-8 Vertical Triangle Chart for Kansas City

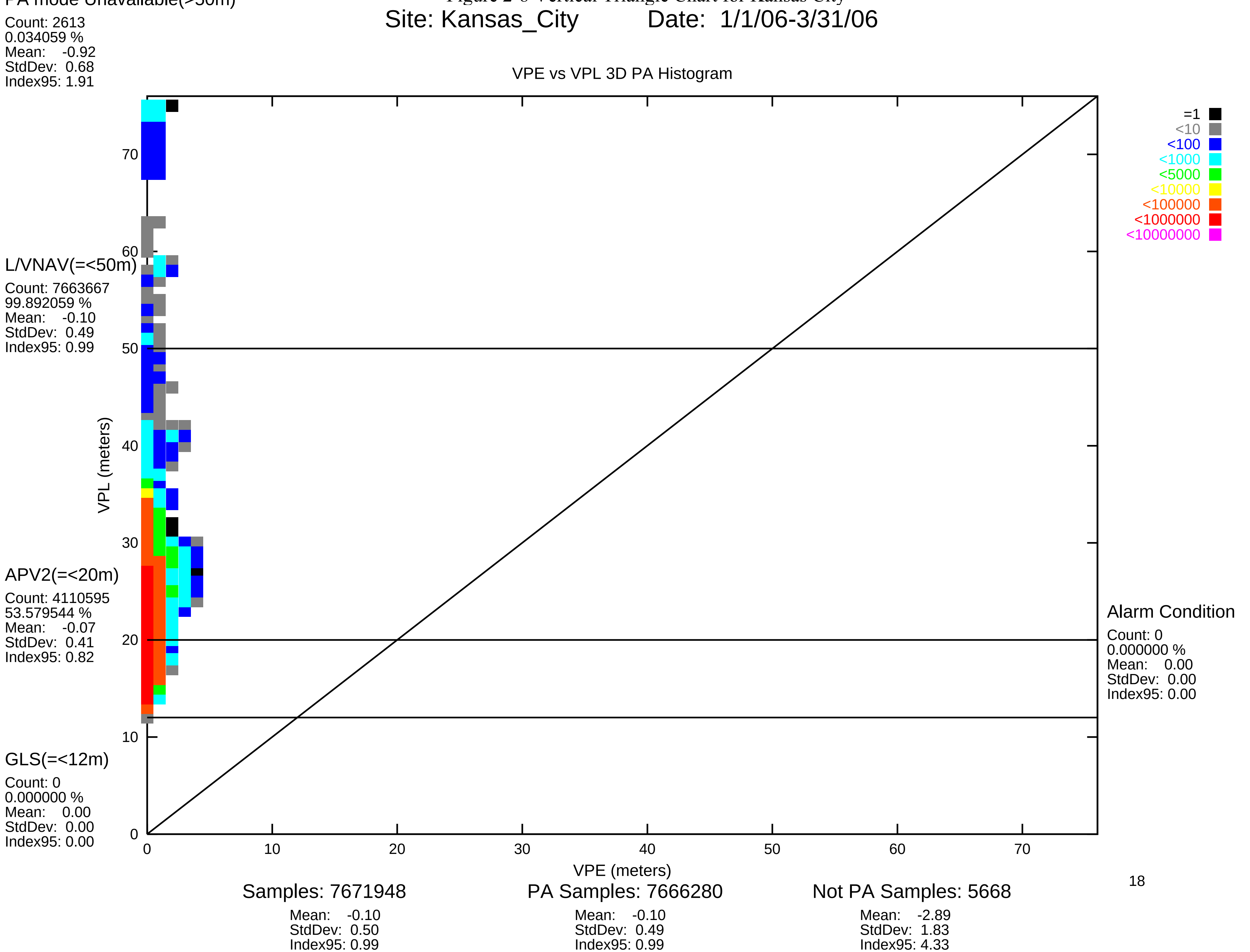


Figure 2-9 2-D Histogram for Kansas City

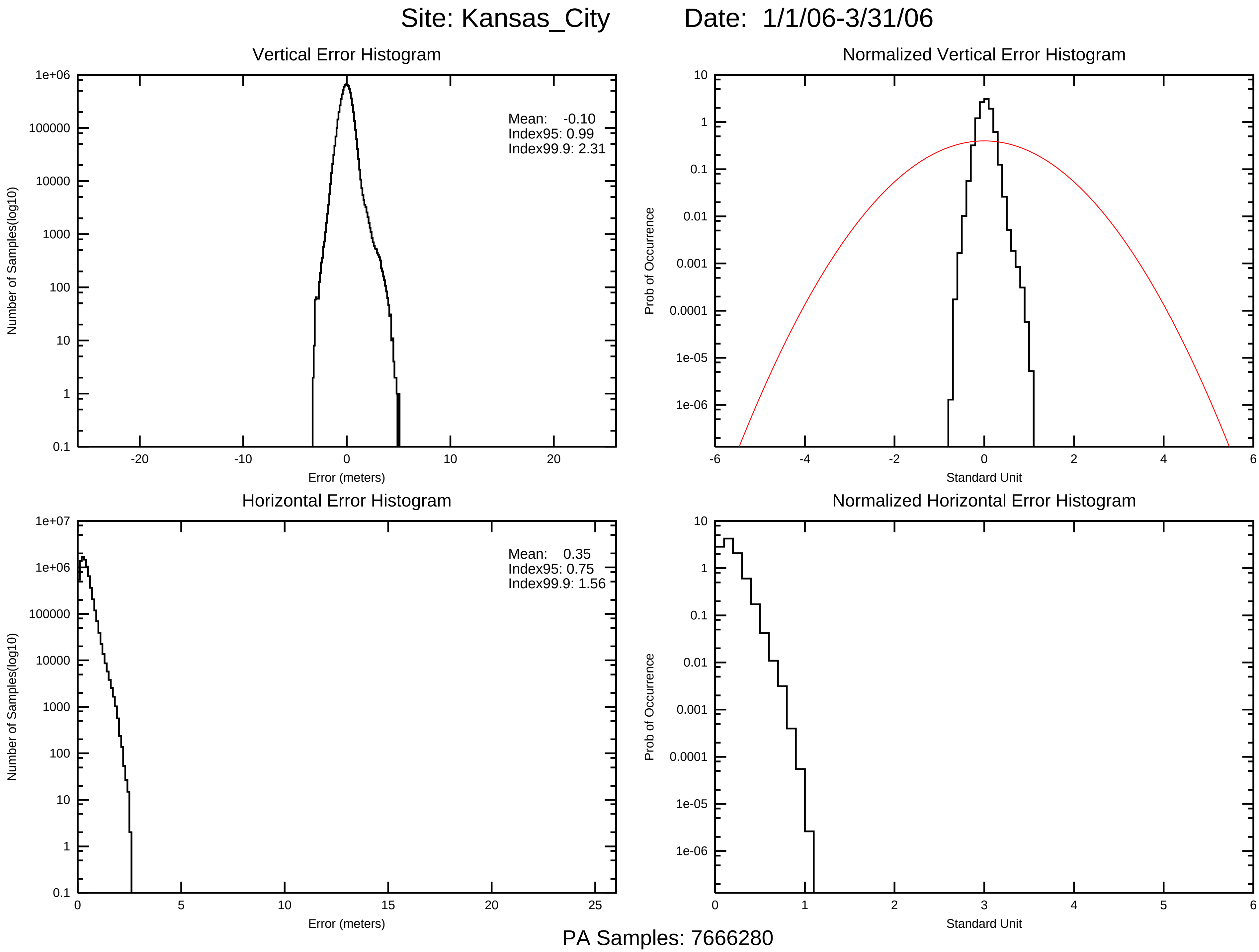


Figure 2-10 Horizontal Triangle Chart for Washington, DC

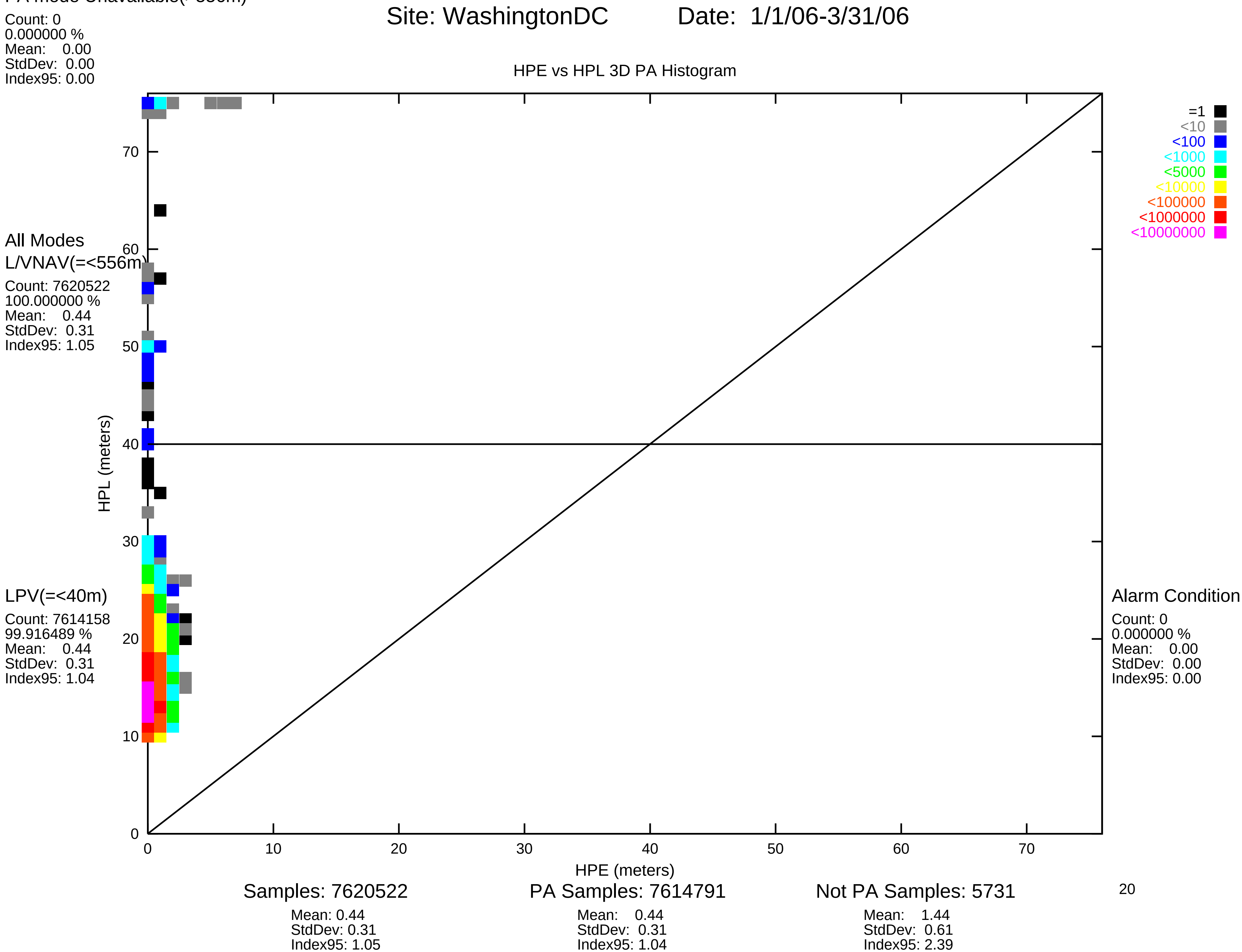


Figure 2-11 Vertical Triangle Chart for Washington, DC

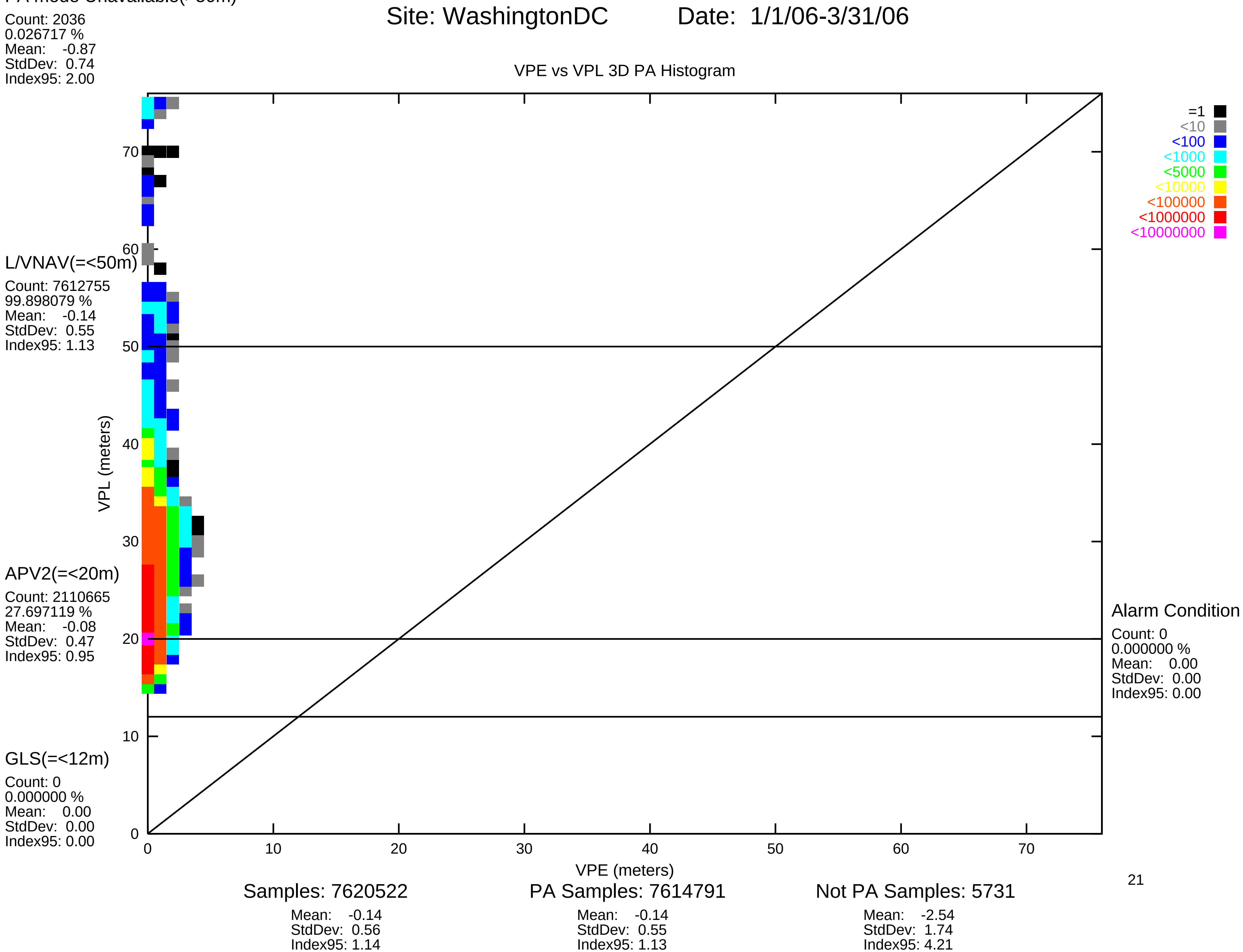


Figure 2-12 2-D Histogram for Washington, DC

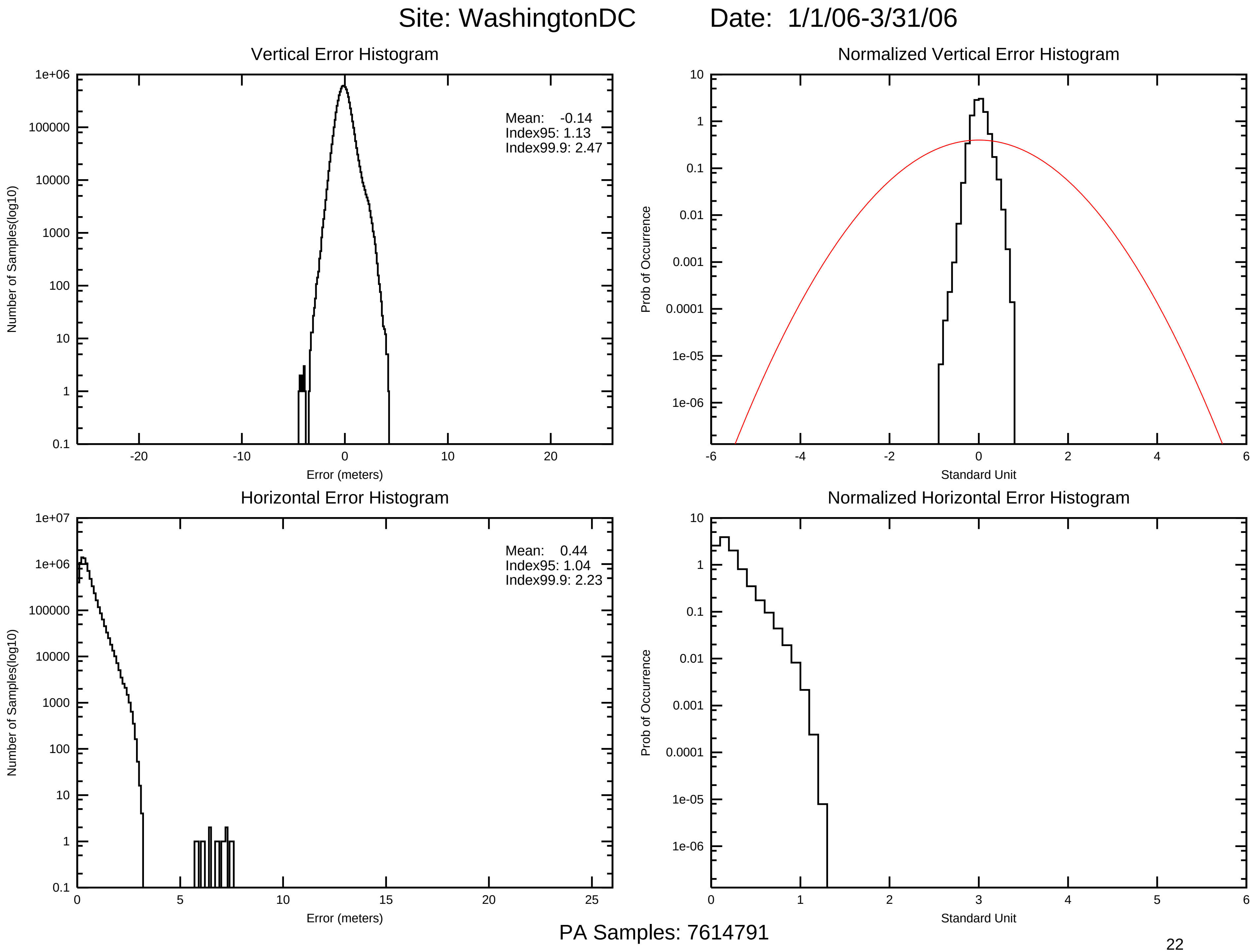


Figure 2-13 Horizontal Triangle Chart for Seattle

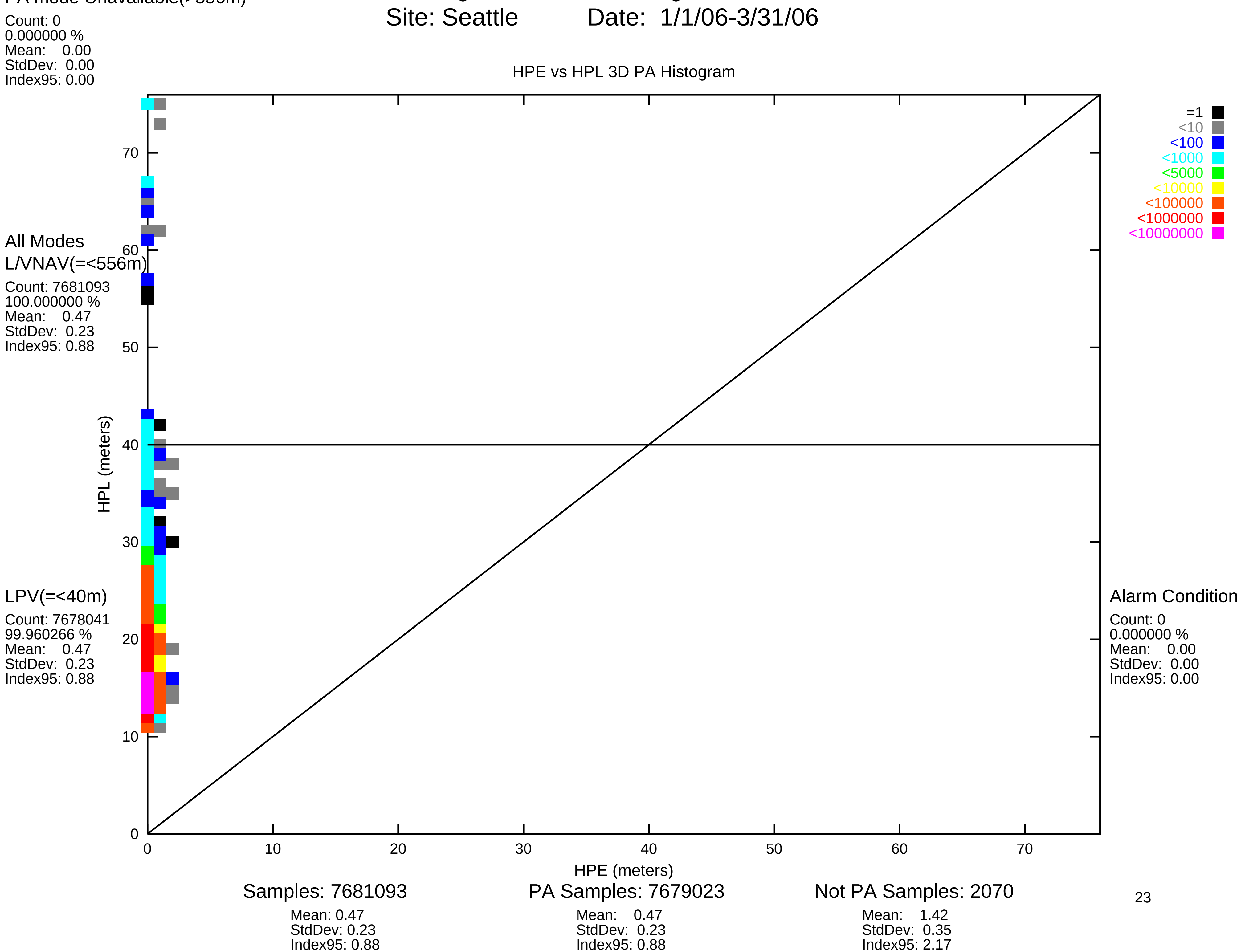


Figure 2-14 Vertical Triangle Chart for Seattle

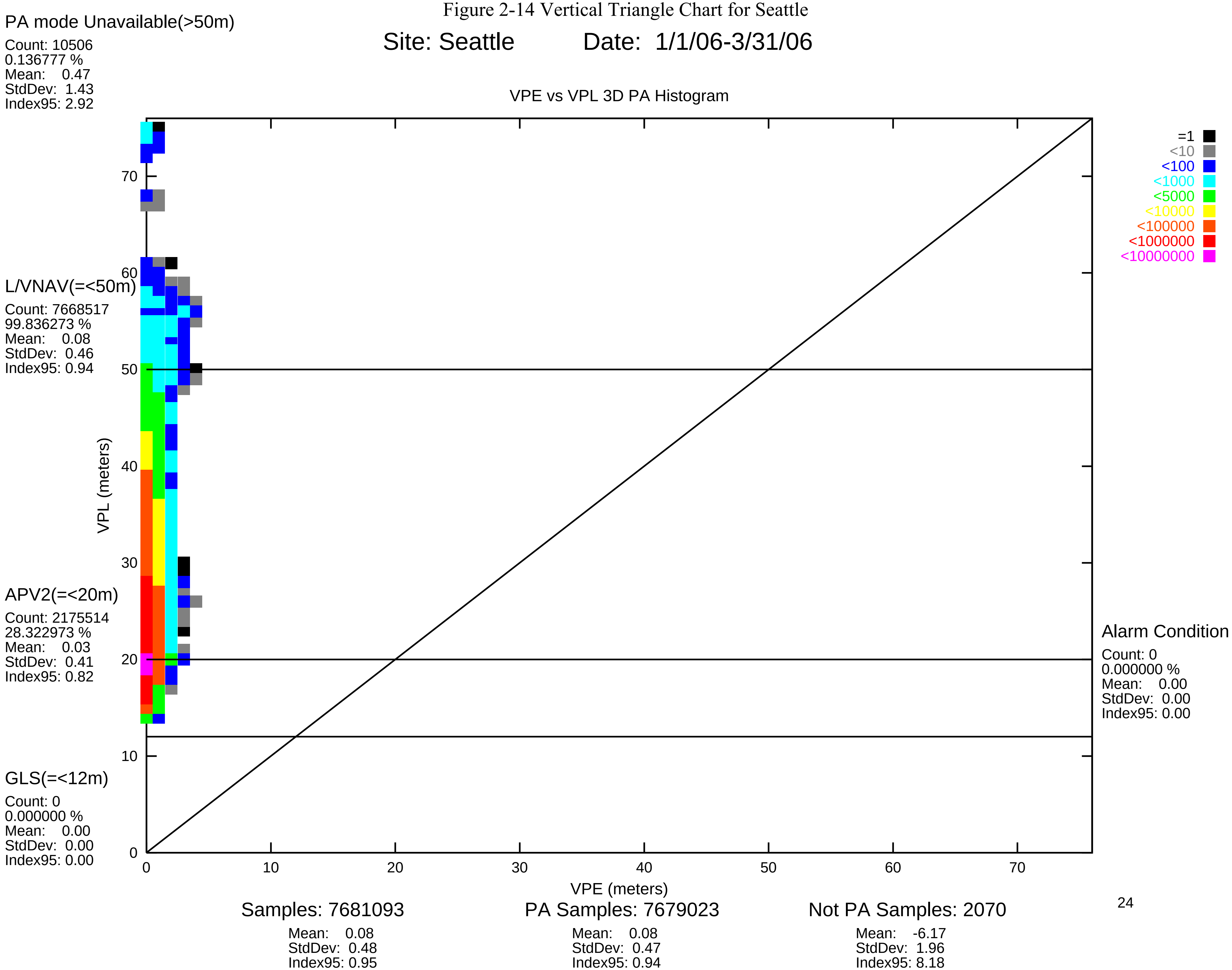
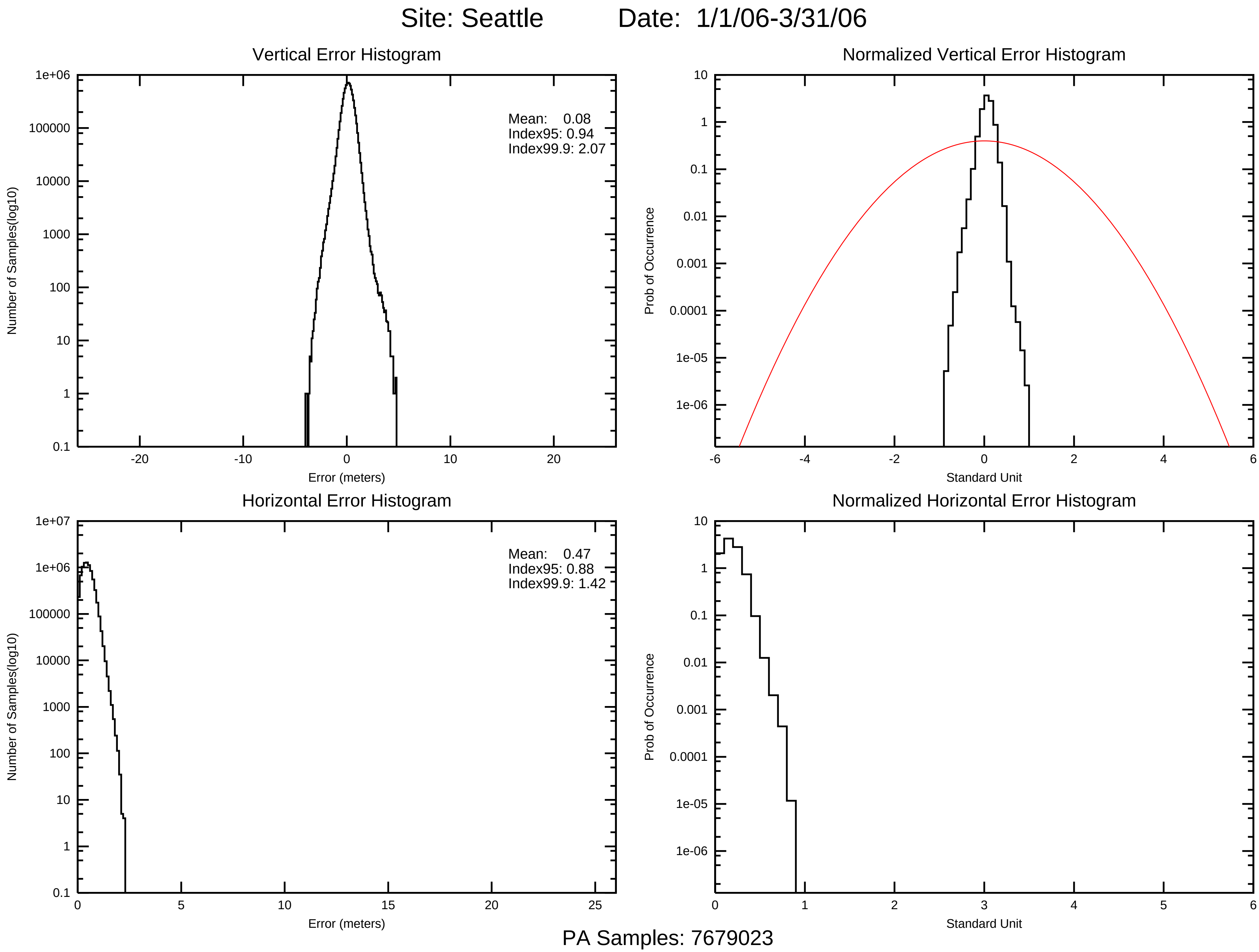


Figure 2-15 2-D Histogram for Seattle



3.0 AVAILABILITY

WAAS availability evaluation estimates the probability that the WAAS can provide service for the operational service levels (LPV and LNAV/VNAV) defined in Table 2.1. At each receiver, the WAAS message, along with the GPS/GEO satellites tracked, were used to produce WAAS protection levels in accordance with the WAAS MOPS. Table 3.1 shows the protection levels that were maintained for 95% of the time for each receiver location for the quarter. The table also included the percentage in PA mode as described in section 2.0. The first two columns of Table 3.2 presents the average portion of time that WAAS operational service levels are available at each receiver location.

Availability of LPV and LNVA/VNAV service is evaluated by monitoring the WAAS protection levels at receiver locations throughout the test period. If both the vertical and horizontal protection levels are not greater than their respective alert limits (VAL and HAL) then the service is available. If either of the protection levels exceeds the required alert level then the operational service at that location is considered unavailable and an outage in service is recorded with its duration. The operational service is not considered available again until the protection levels are both within the alert limits for at least 15 minutes. Although this will reduce operational service availability minimally, it substantially reduces the number of service outages and prevents excessive switching in and out of service availability. The percent of time that LPV and LNVA/VNAV service is available using the fifteen-minute window criteria is presented in the last two columns in Table 3.2. The LPV and LNVA/VNAV service outages and associated outage rate for the test period is presented in Table 3.4. The outage rate is the percent of approaches that theoretically would be interrupted by a loss of operational service once the approach had started. Figures 3.1 through 3.4 show the daily availability of LNAV/VNAV and LPV service levels for the evaluated period. Figures 3.5 through 3.8 show the daily interruptions of LNAV/VNAV and LPV service levels for the evaluated period.

During the evaluated period, the maximum 95% HPL and VPL are 29.223 meters at Oakland and 42.907 meters at Los Angeles. The minimum 95% HPL and VPL are 17.043 meters at Atlanta and 26.939 meters at Kansas City.

Availability of NPA service is evaluated by monitoring the WAAS horizontal protection level at receiver locations throughout the test period. If the horizontal protection level is not greater than the horizontal alert limit (HAL = 556m) then the service is available. If the horizontal protection level exceeds the required alert level or if WAAS navigation message is not received then the NPA service at that location is considered unavailable and an outage in service is recorded with its duration. The NPA service is not considered available again until the horizontal protection level is within the alert limit for at least 15 minutes. The percent of time that NPA service is available using the fifteen-minute window criteria is presented in Table 3.3. The NPA service outages and associated outage rate for the test period is presented in Table 3.5. The outage rate is the percent of NPA approaches that theoretically would be interrupted by a loss of operational service once the approach had started.

Table 3-1 95% Protection Level

Location	95% HPL (meters)	95% VPL (meters)	Percentage in PA mode
Atlantic City	19.520	34.523	99.929230
Grand Forks	24.997	35.002	99.916420
Greenwood	18.385	29.446	99.929855
Albuquerque	21.853	30.962	99.926697
Atlanta	17.043	27.185	99.924744
Billings	20.320	29.250	99.927505
Boston	23.894	39.385	99.923706
Chicago	18.209	28.290	99.922112
Cleveland	17.993	28.480	99.926750
Dallas	20.749	30.488	99.930557
Denver	19.256	27.864	99.924393
Houston	23.980	33.255	99.926353
Jacksonville	18.021	29.559	99.926208
Kansas City	17.844	26.939	99.926117
Los Angeles	29.074	42.907	99.967964
Memphis	17.544	28.420	99.925774
Miami	23.046	38.586	99.925972
Minneapolis	20.012	29.206	99.926453
New York	20.809	35.070	99.923569
Oakland	29.223	41.662	99.967972
Salt Lake City	19.853	29.384	99.968384
Seattle	20.955	31.929	99.973053
Washington DC	18.026	30.100	99.924797

Table 3-2 Quarterly Availability Statistics

Location	LPV *Average Availability Percentage of time*	LNAV/VNAV *Average Availability Percentage of time*	LPV WAAS *With 15 minute window*	LNAV/VNAV *With 15 minute window*
Atlantic City	0.99888283	0.99891901	0.99873870	0.99880948
Grand Forks	0.99566364	0.99641651	0.99624149	0.99643859
Greenwood	0.99873602	0.99887919	0.99872647	0.99887099
Albuquerque	0.99802083	0.99802393	0.99774760	0.99775070
Atlanta	0.99906391	0.99906588	0.99902704	0.99902901
Billings	0.99891704	0.99891871	0.99873271	0.99873438
Boston	0.99324650	0.99325693	0.99178912	0.99179840
Chicago	0.99870956	0.99871135	0.99870119	0.99870296
Cleveland	0.99894983	0.99902117	0.99894136	0.99901275
Dallas	0.99856484	0.99858844	0.99839484	0.99845162
Denver	0.99893343	0.99893636	0.99882263	0.99882549
Houston	0.99816650	0.99841595	0.99797394	0.99825685
Jacksonville	0.99908733	0.99908799	0.99907191	0.99907255
Kansas City	0.99891800	0.99892062	0.99892621	0.99892866
Los Angeles	0.98009598	0.98187095	0.97626926	0.97859716
Memphis	0.99883997	0.99893194	0.99880851	0.99881009
Miami	0.99595886	0.99608517	0.99511669	0.99524899
Minneapolis	0.99914116	0.99914360	0.99908030	0.99908300
New York	0.99785852	0.99785864	0.99766477	0.99766490
Oakland	0.98408037	0.98542124	0.98140395	0.98299923
Salt Lake City	0.99871504	0.99871606	0.99790967	0.99791070
Seattle	0.99830139	0.99836272	0.99777192	0.99784456
Washington DC	0.99897999	0.99898076	0.99893234	0.99893313

Table 3-3 NPA Availability

Location	NPA Availability (Excluding RAIM/FDE)
Albuquerque	0.99925265
Atlanta	0.99924158
Billings	0.99925560
Boston	0.99925909
Cleveland	0.99925687
Cold Bay	0.99932970
Honolulu	0.99937322
Houston	0.99925133
Juneau	0.99944639
Kansas City	0.99922734
Kotzebue	0.99967649
Los Angeles	0.99964548
Miami	0.99925756
Minneapolis	0.99925449
Oakland	0.99965733
Puerto Rico	0.99925354
Salt Lake City	0.99966950
Seattle	0.99965734

Table 3-4 LPV and LNAV/VNAV Outage Rate

Location	LPV Outages	LPV Outage Rates	LNAV/VNAV Outages	LNAV/VNAV Outage Rates
Atlantic City	22	0.000472	21	0.000451
Grand Forks	41	0.001137	39	0.001081
Greenwood	29	0.000561	27	0.000522
Albuquerque	37	0.000717	37	0.000717
Atlanta	19	0.000375	19	0.000375
Billings	23	0.000445	23	0.000445
Boston	140	0.002730	140	0.002730
Chicago	20	0.000407	20	0.000407
Cleveland	20	0.000387	19	0.000368
Dallas	25	0.000516	20	0.000413
Denver	32	0.000624	32	0.000624
Houston	47	0.000915	37	0.000720
Jacksonville	19	0.000369	19	0.000369
Kansas City	19	0.000368	19	0.000368
Los Angeles	226	0.004477	160	0.003162
Memphis	20	0.000396	20	0.000396
Miami	82	0.001600	80	0.001561
Minneapolis	22	0.000426	20	0.000387
New York	54	0.001047	54	0.001047
Oakland	149	0.002935	121	0.002379
Salt Lake City	21	0.000407	21	0.000407
Seattle	27	0.000523	25	0.000484
Washington DC	18	0.000354	18	0.000354

Table 3-5 NPA Outage Rates

Location	NPA Outages	NPA Outage Rate
Albuquerque	18	0.00036015
Atlanta	18	0.00036732
Billings	18	0.00036014
Boston	18	0.00036019
Cleveland	18	0.00036010
Cold Bay	15	0.00030268
Honolulu	14	0.00028190
Houston	17	0.00034474
Juneau	12	0.00024130
Kansas City	18	0.00037375
Kotzebue	5	0.00040452
Los Angeles	7	0.00014490
Miami	17	0.00034473
Minneapolis	18	0.00036061
Oakland	7	0.00014005
Puerto Rico	18	0.00036276
Salt Lake City	7	0.00014014
Seattle	7	0.00014004

Figure 3-1 LPV Instantaneous Availability

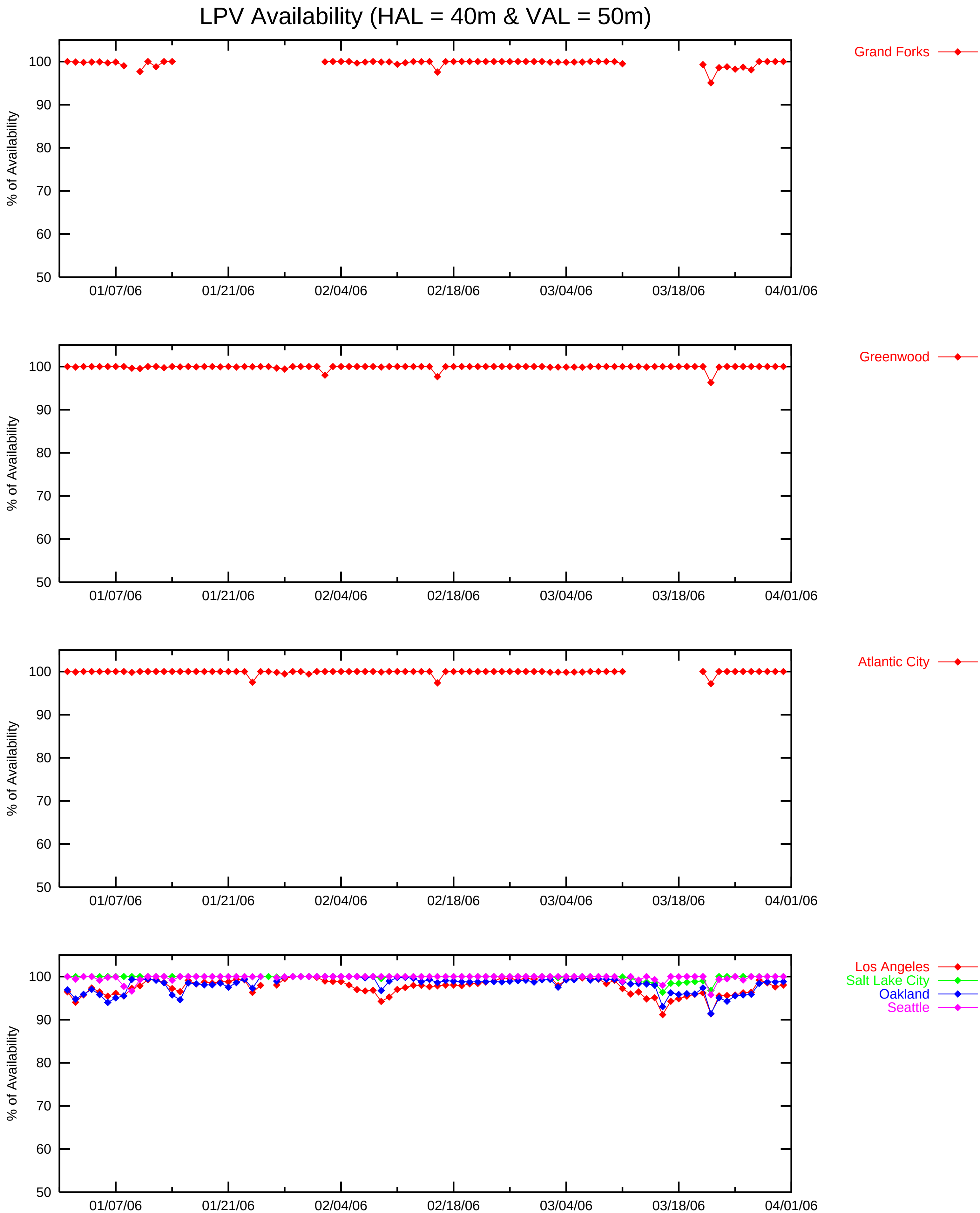


Figure 3-2 LPV Instantaneous Availability

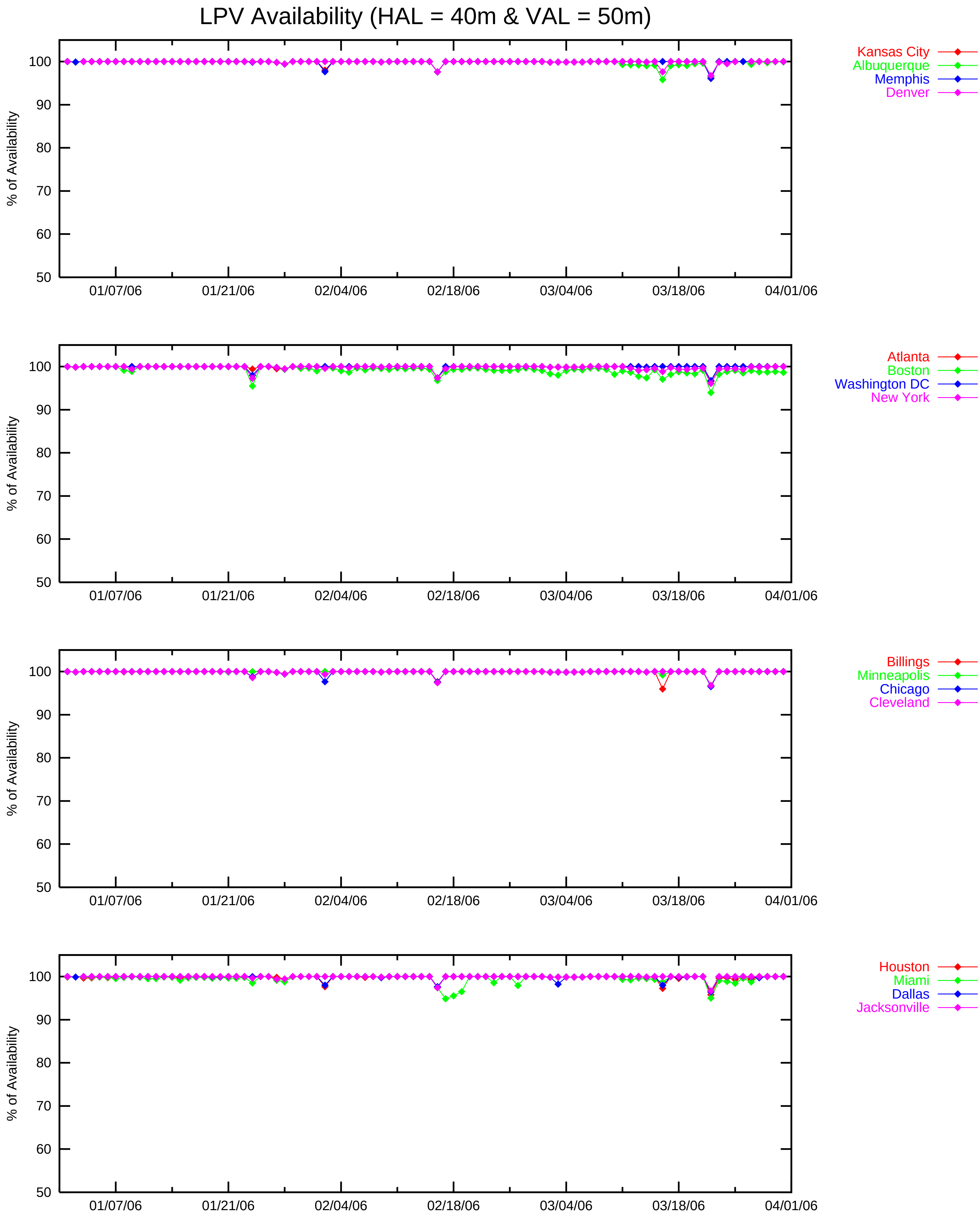


Figure 3-3 LNAV/VNAV Instantaneous Availability

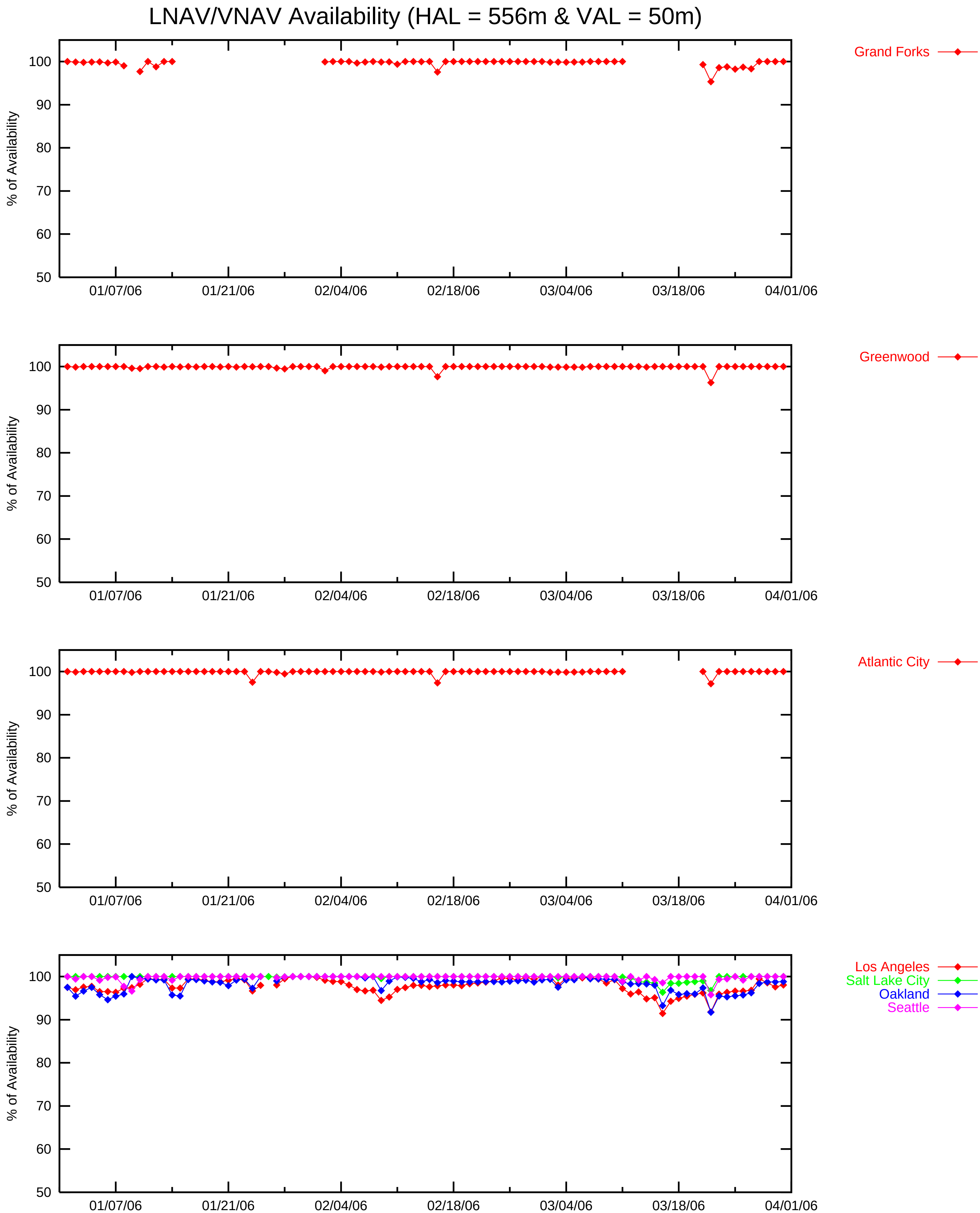


Figure 3-4 LNAV/VNAV Instantaneous Availability

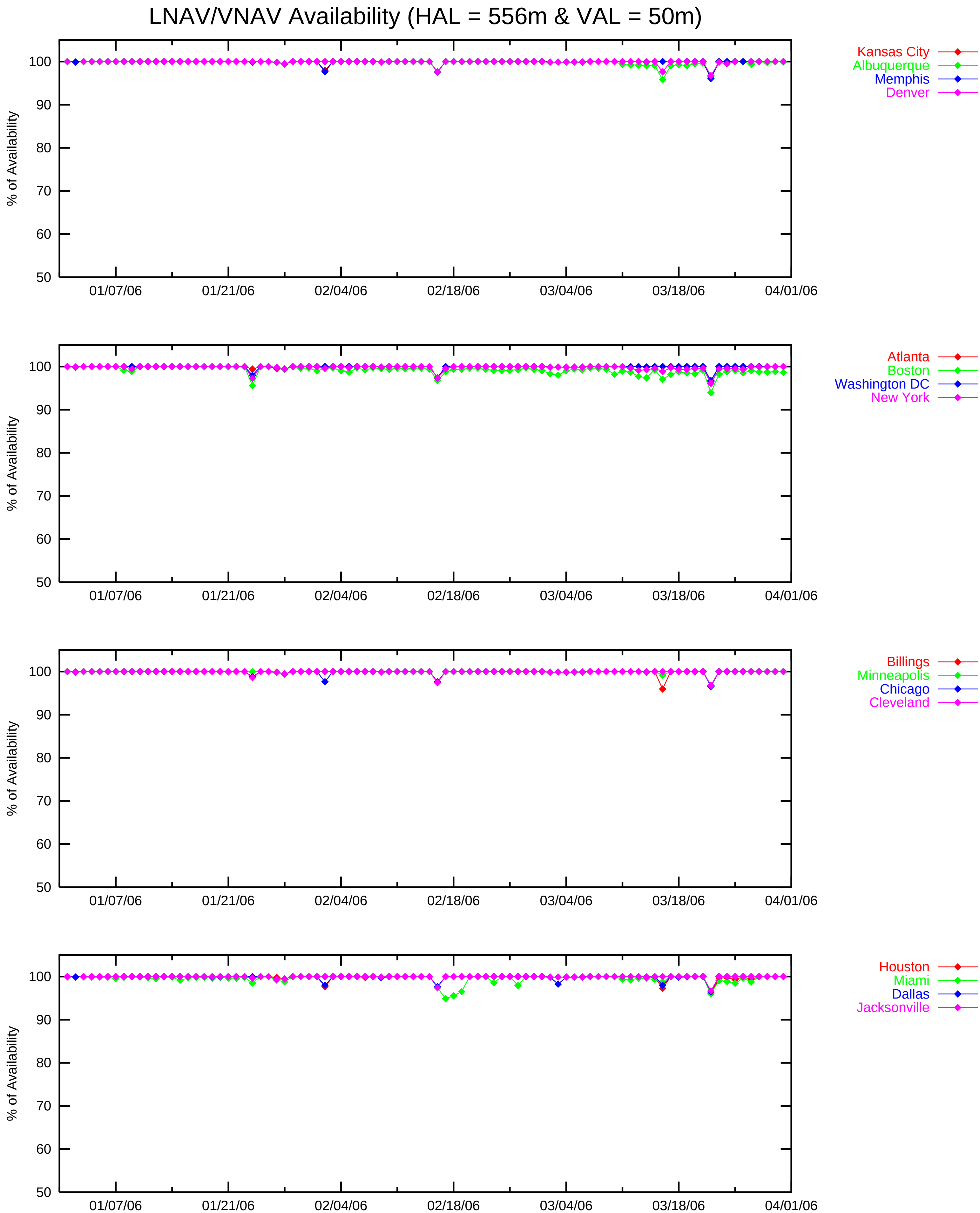


Figure 3-5 LPV Outages

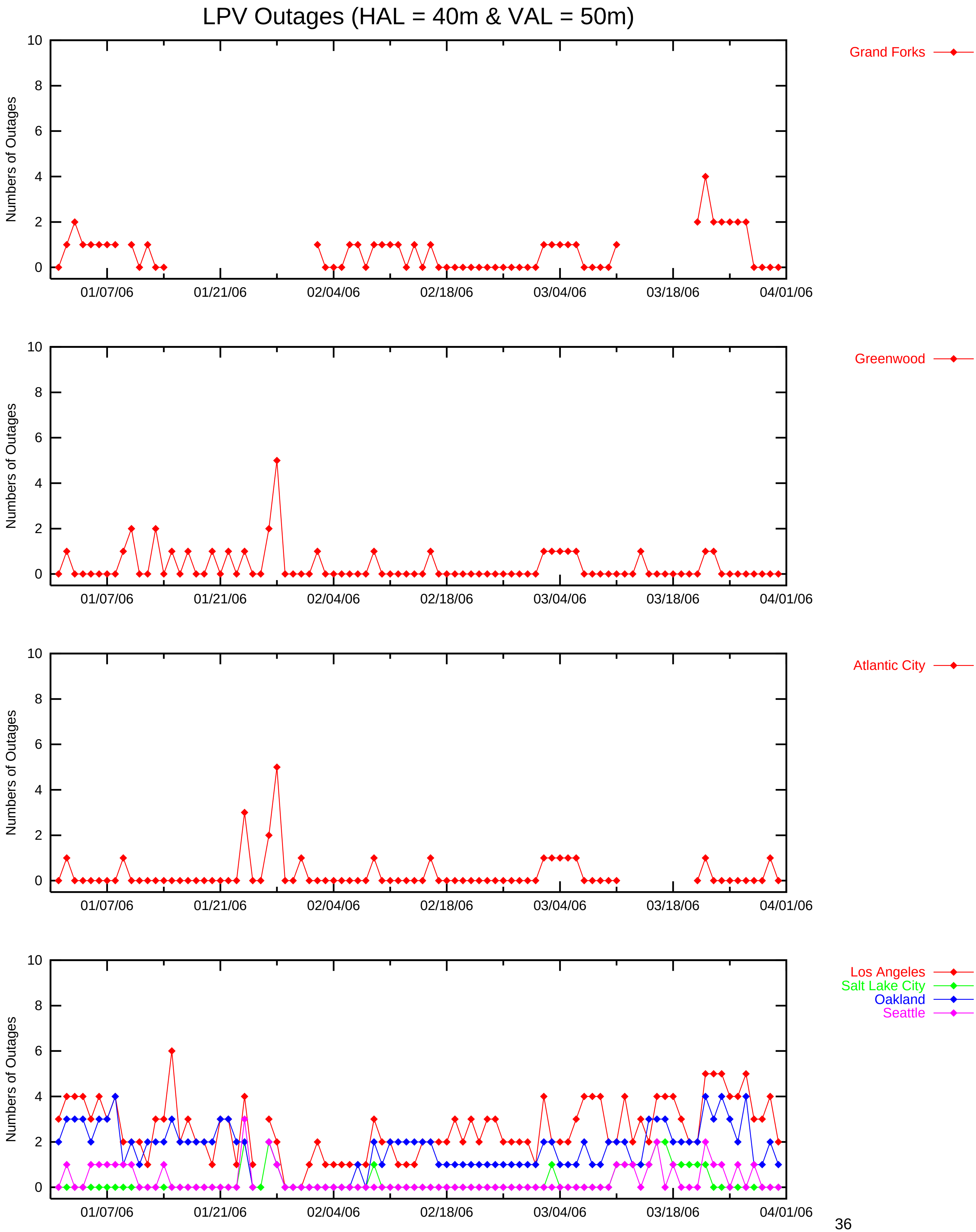


Figure 3-6 LPV Outages

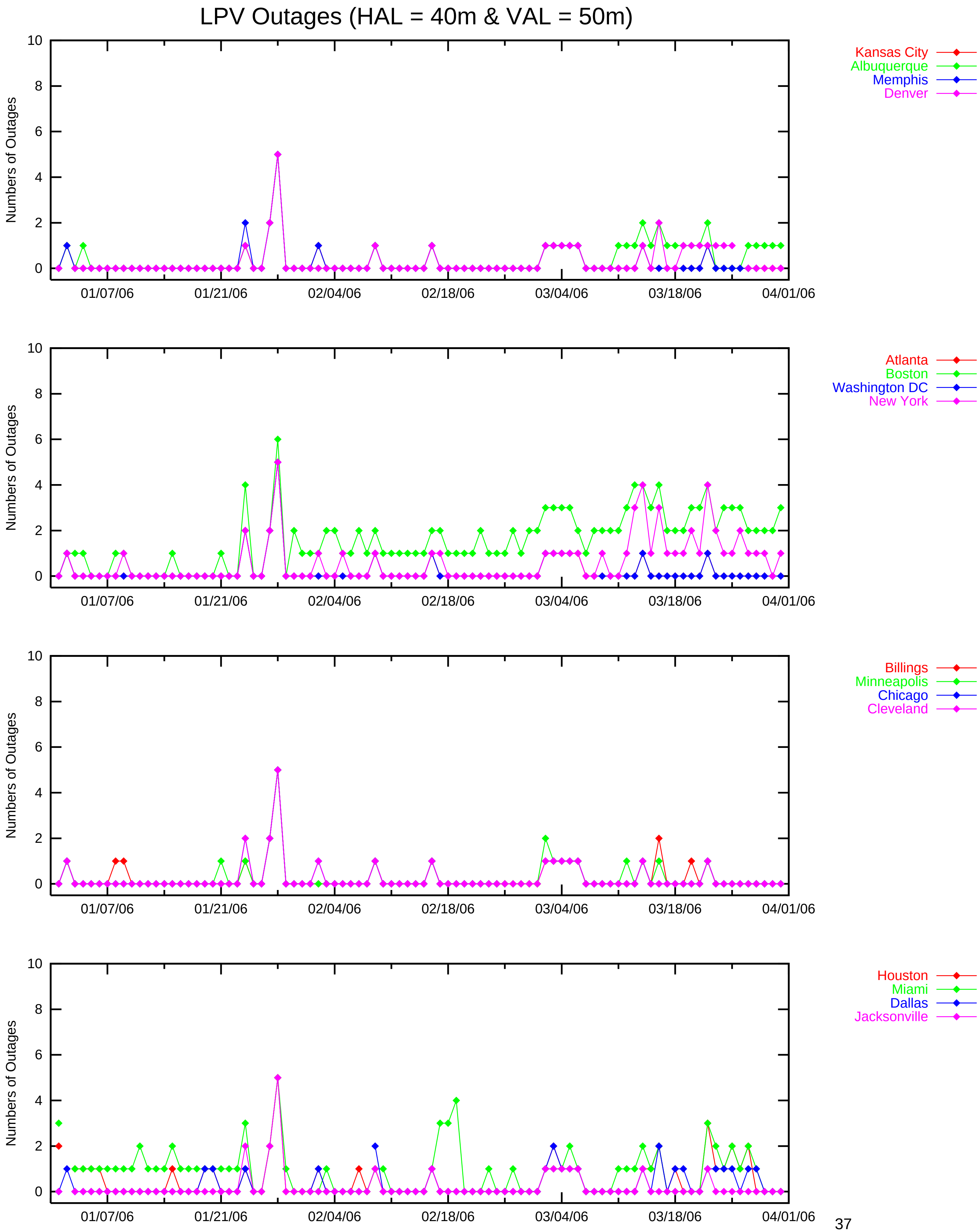


Figure 3-7 LNAV/VNAV Outages

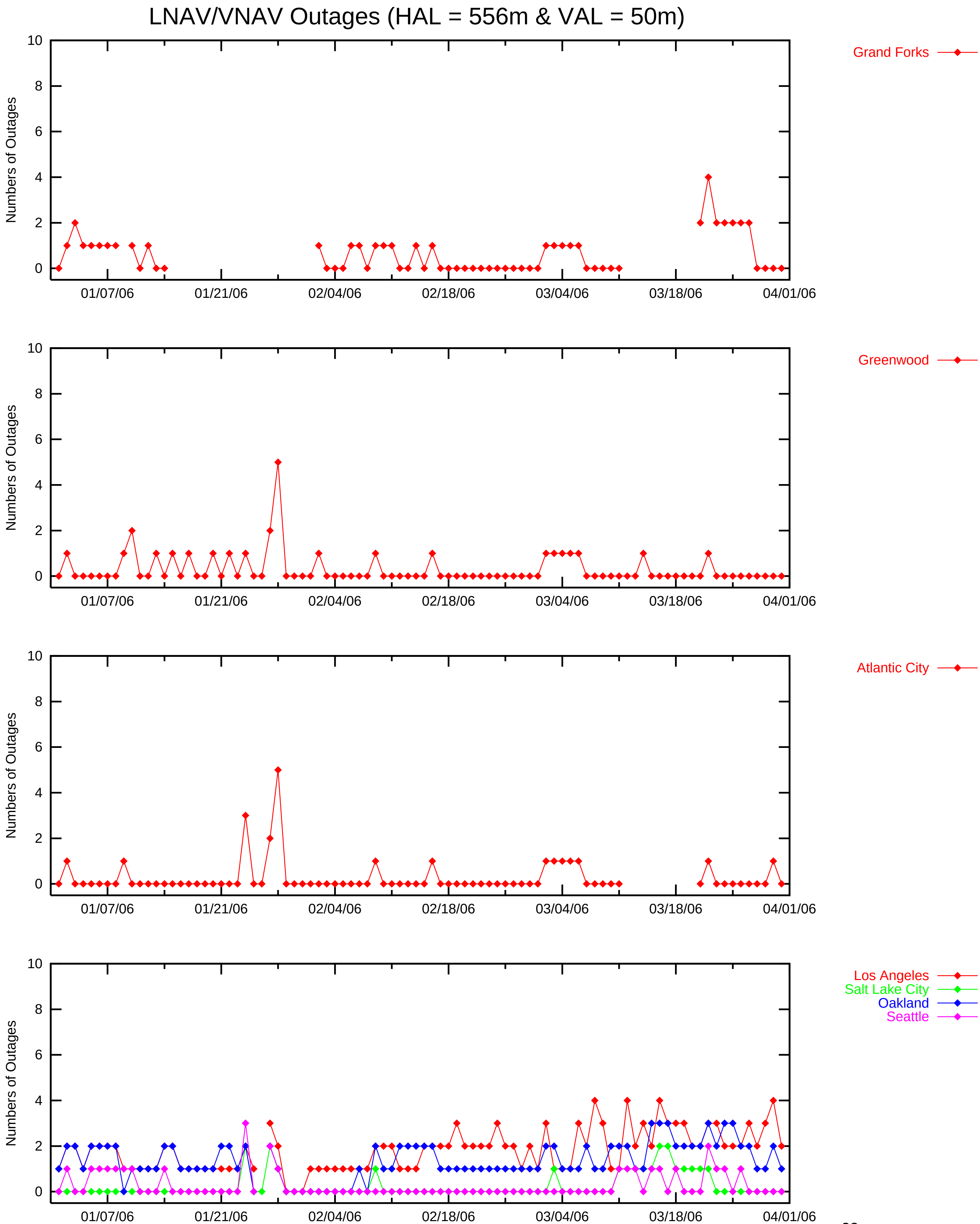
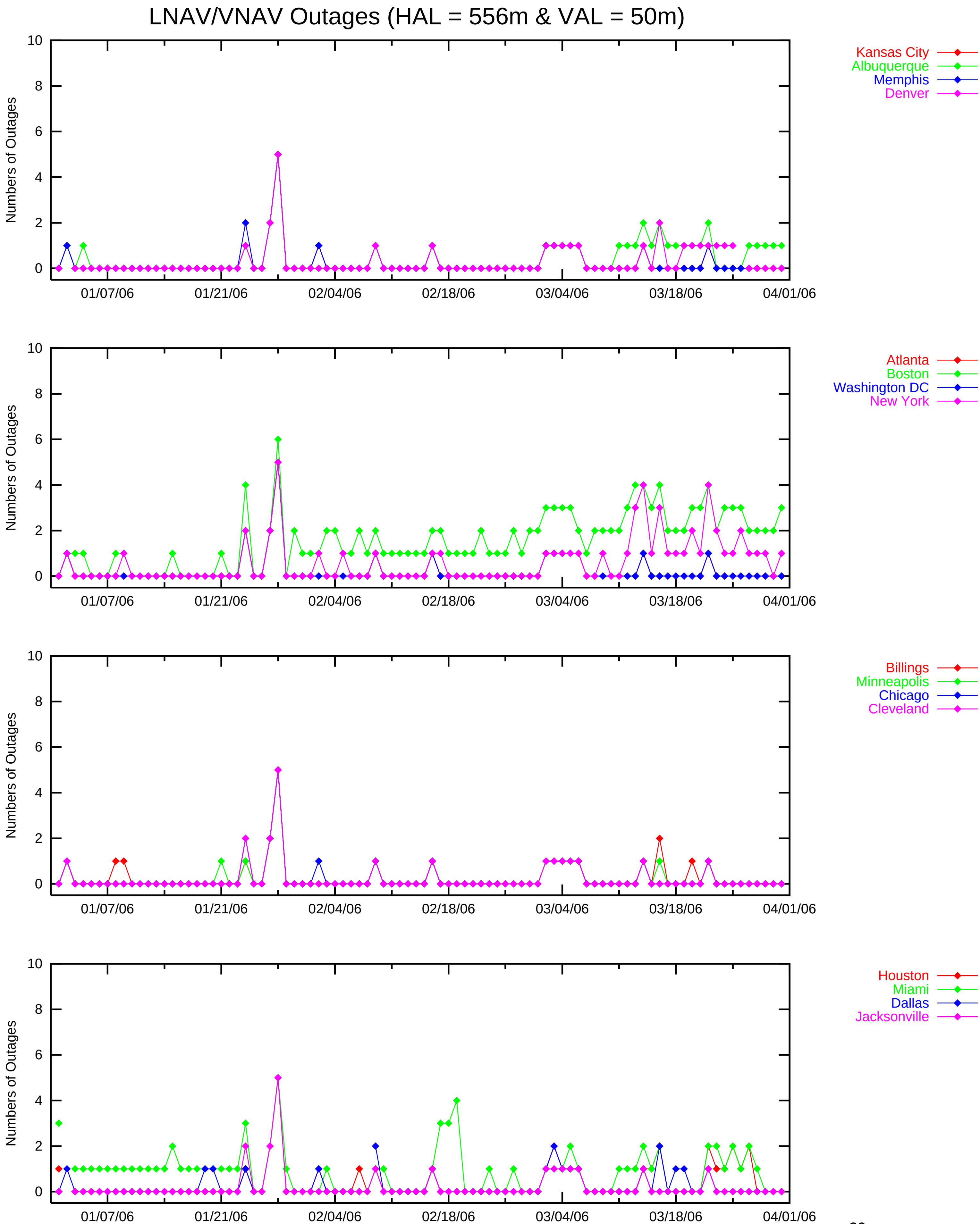


Figure 3-8 LNAV/VNAV Outages



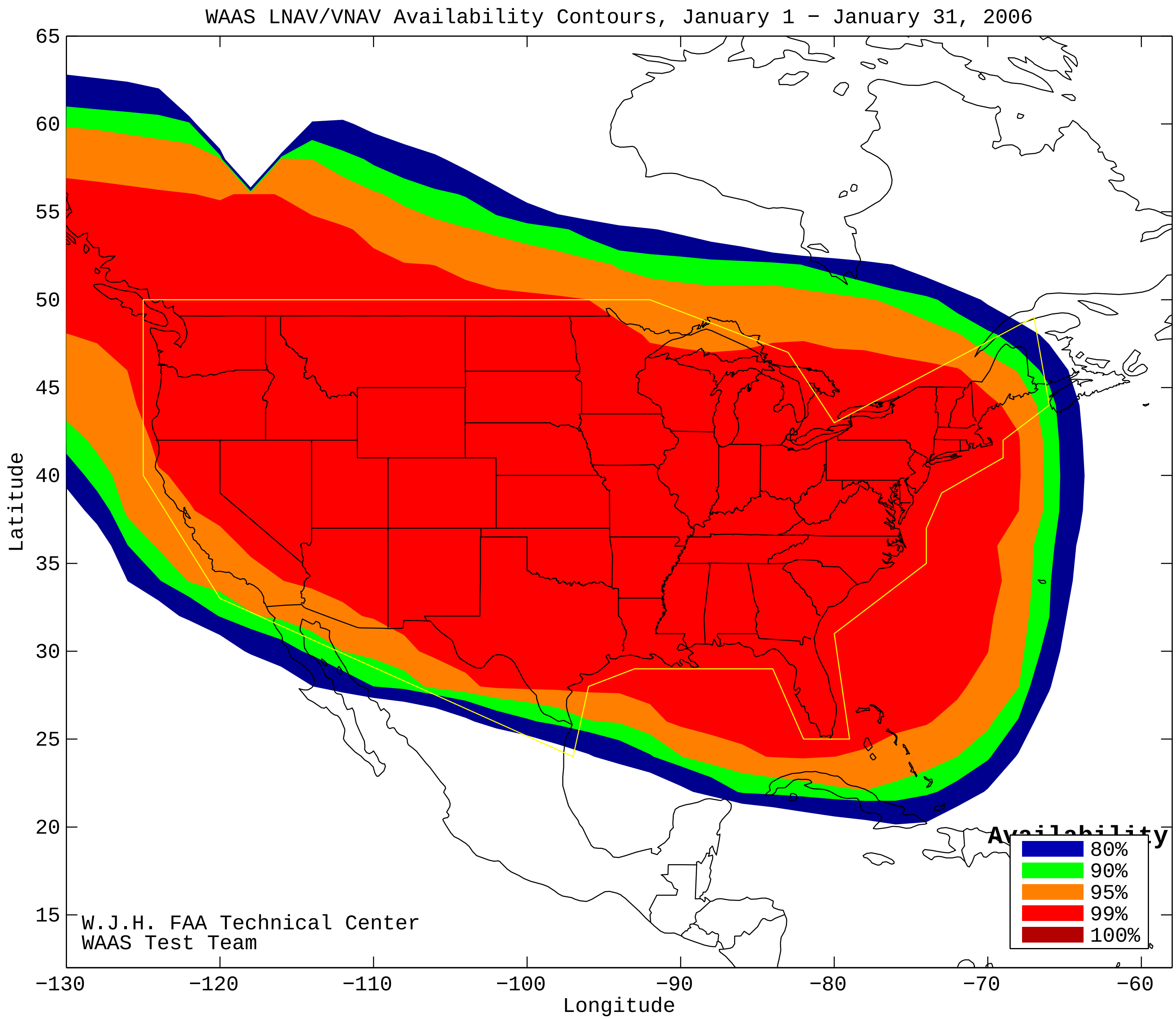
4.0 COVERAGE

WAAS coverage area evaluation estimates the percent of service volume where WAAS is providing LPV, LNAV/VNAV and NPA services. The WAAS message and the GPS/GEO satellite status are used to determine WAAS availability across North America. For PA coverage, protection levels were calculated at two-minute intervals and at two degree spacing over the PA service volume, while NPA coverage was calculated at two-minute intervals and five degree spacing over the NPA service volume.

Daily analysis for PA was conducted for both LPV and LNAV/VNAV service levels. Figures 4.1 to 4.3 and 4.5 to 4.7 show the WAAS LNAV/VNAV and LPV coverage area for each month for this quarter, respectively. Figures 4.4 and 4.8 show the rollup WAAS LNAV/VNAV and LPV coverage for the quarter. The coverage plots also provide 100, 99, 95, 90 and 80% availability contours. Figures 4.15 to 4.17 show WAAS LNAV/VNAV, LPV, and NPA coverage since WAAS commissioning (July 2003). Figure 4.13 shows the daily WAAS LNAV/VNAV and LPV coverage at 99% availability and ionosphere KP index values for this quarter.

Figure 4.9 to 4.11 show the NPA coverage area of each month and Figure 4.12 shows the rollup NPA coverage for the quarter. Daily analysis for NPA was based on a 99.9% availability requirement. The NPA coverage plots also provide 100, 99.9 and 99% availability contours. Figure 4.14 shows the daily NPA coverage at 99.9% availability and ionosphere Kp index values for this quarter.

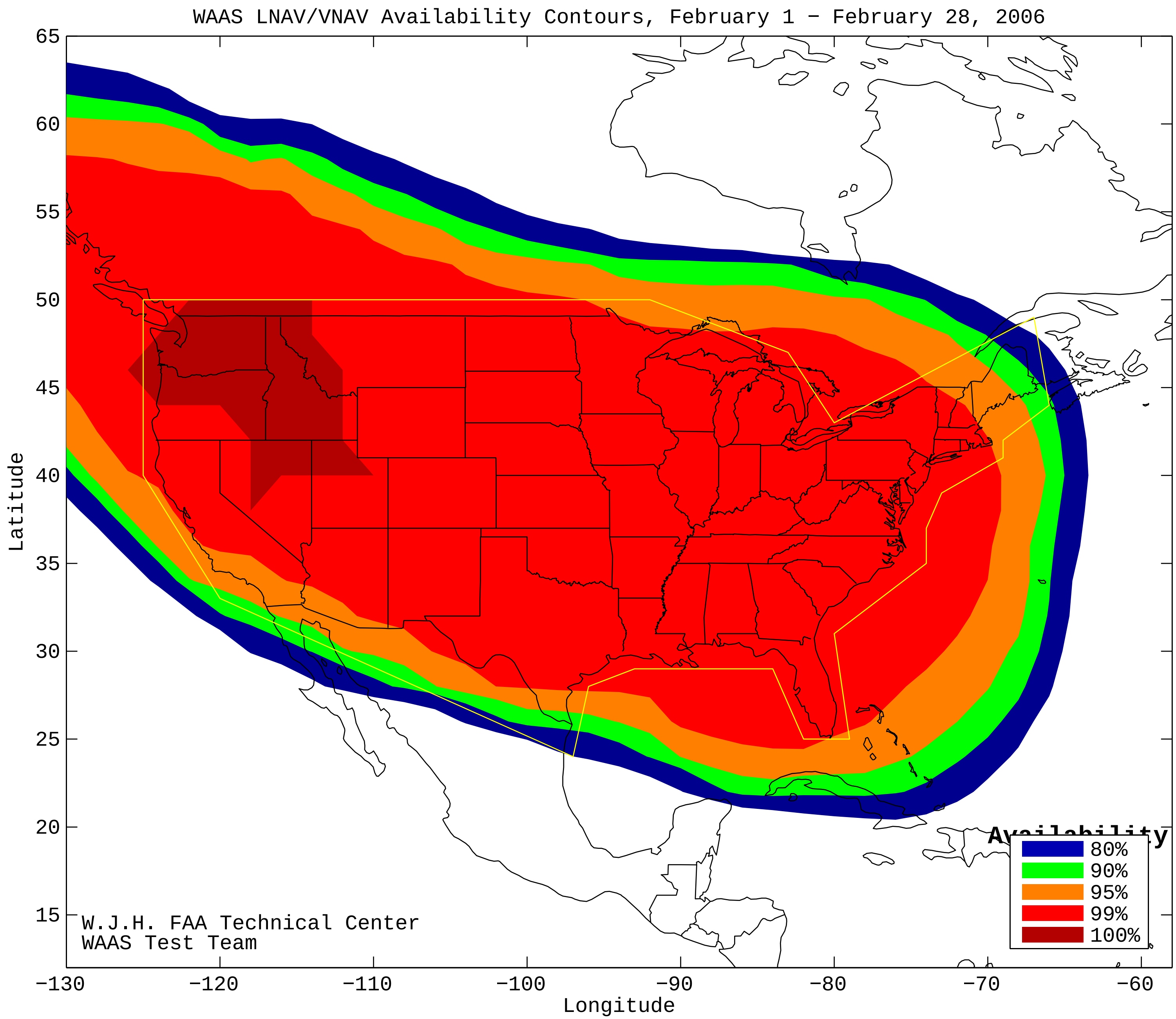
Figure 4-1 WAAS LNAV/VNAV Coverage - January



CONUS Coverage at 95% Availability = 97.98
CONUS Coverage at 99% Availability = 89.88
CONUS Coverage at 100% Availability = 0

SL = LNAV/VNAV

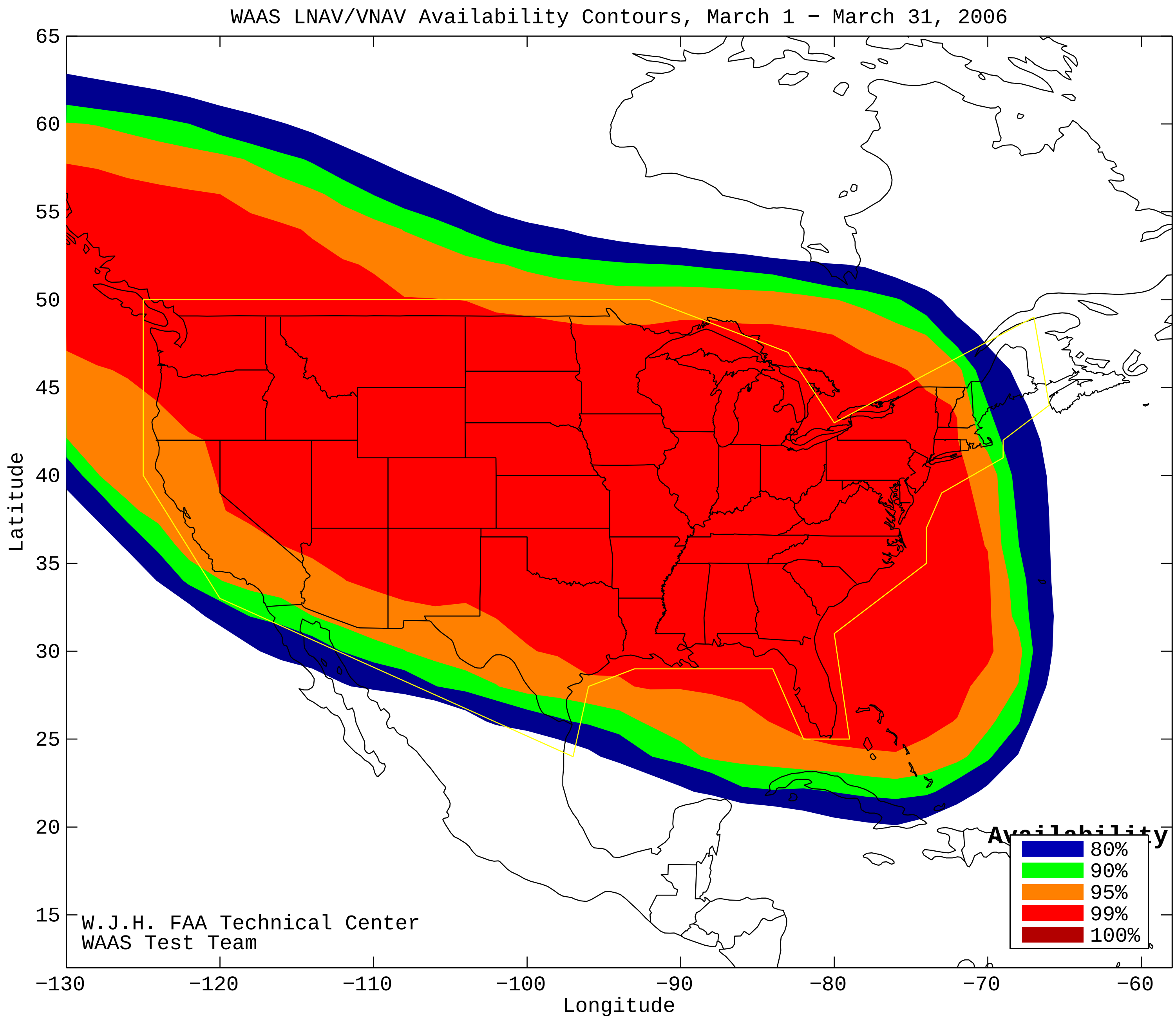
Figure 4-2 WAAS LNAV/VNAV Coverage - February



CONUS Coverage at 95% Availability = 97.17
CONUS Coverage at 99% Availability = 91.5
CONUS Coverage at 100% Availability = 12.15

SL = LNAV/VNAV

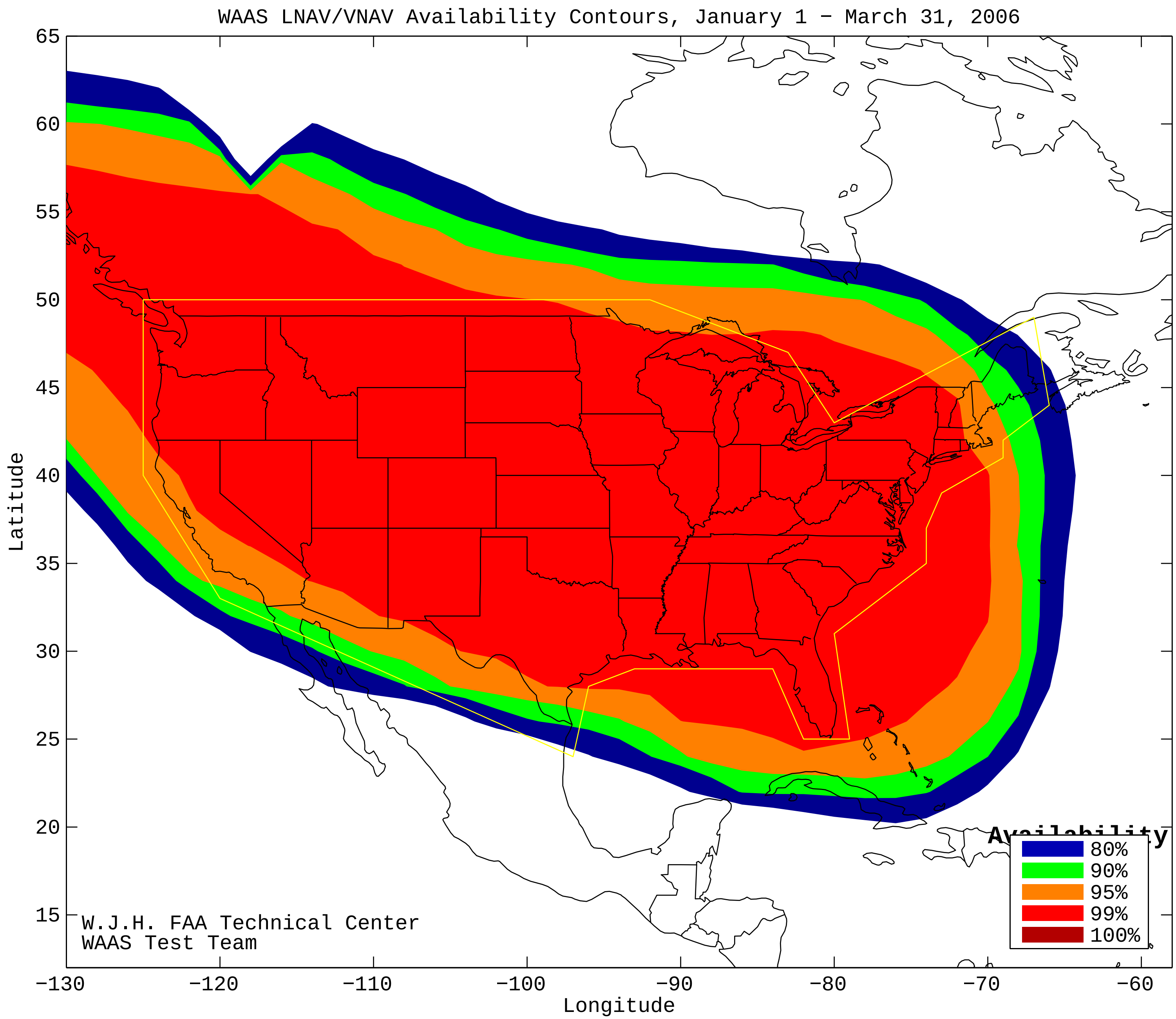
Figure 4-3 WAAS LNAV/VNAV Coverage - March



CONUS Coverage at 95% Availability = 92.71
CONUS Coverage at 99% Availability = 80.97
CONUS Coverage at 100% Availability = 0

SL = LNAV/VNAV

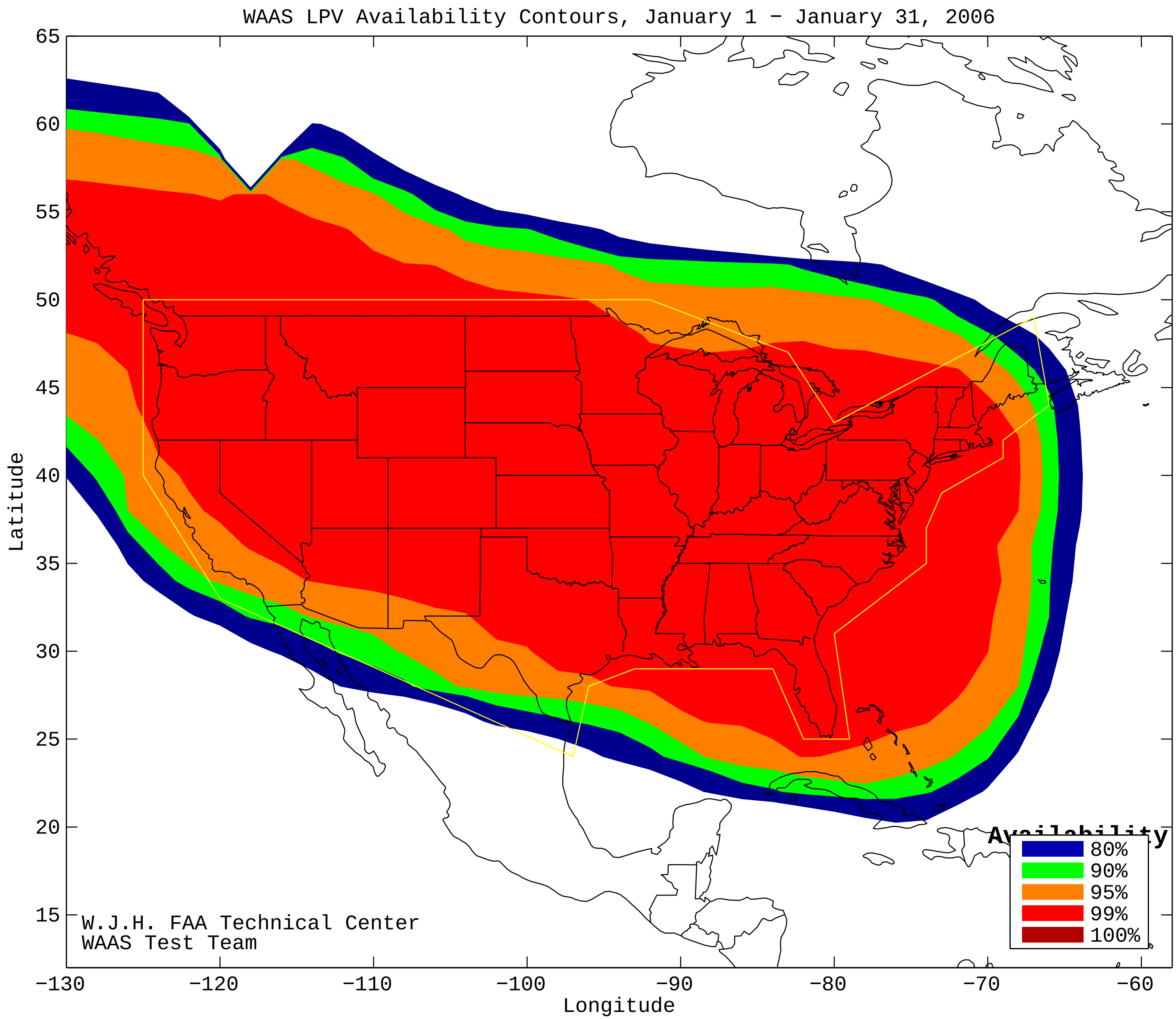
Figure 4-4 WAAS LNAV/VNAV Coverage for the Quarter



CONUS Coverage at 95% Availability = 95.95
CONUS Coverage at 99% Availability = 87.85
CONUS Coverage at 100% Availability = 0

SL = LNAV/VNAV

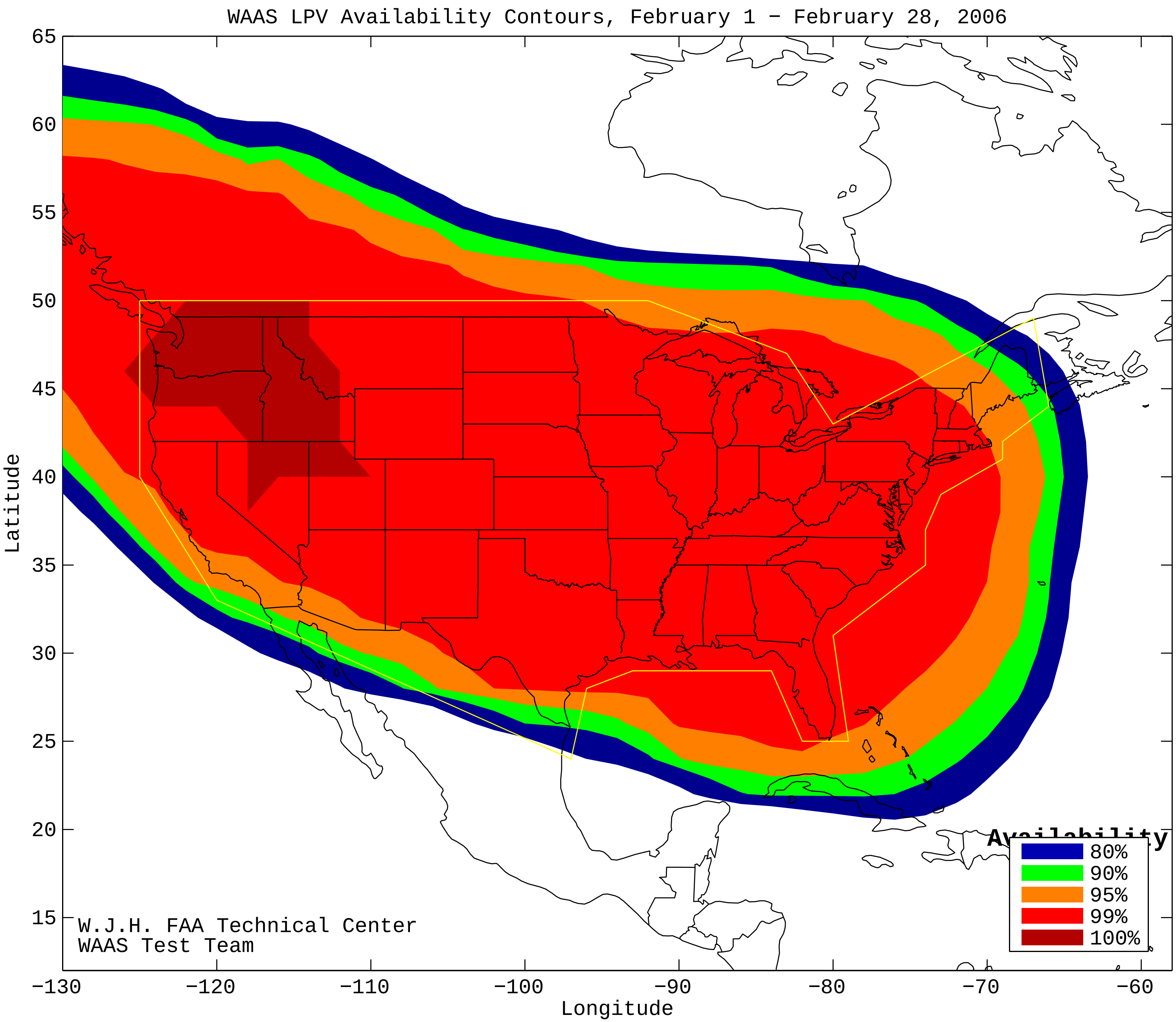
Figure 4-5 WAAS LPV Coverage - January



CONUS Coverage at 95% Availability = 96.36%
CONUS Coverage at 99% Availability = 85.02%
CONUS Coverage at 100% Availability = 0%

SL = LPV

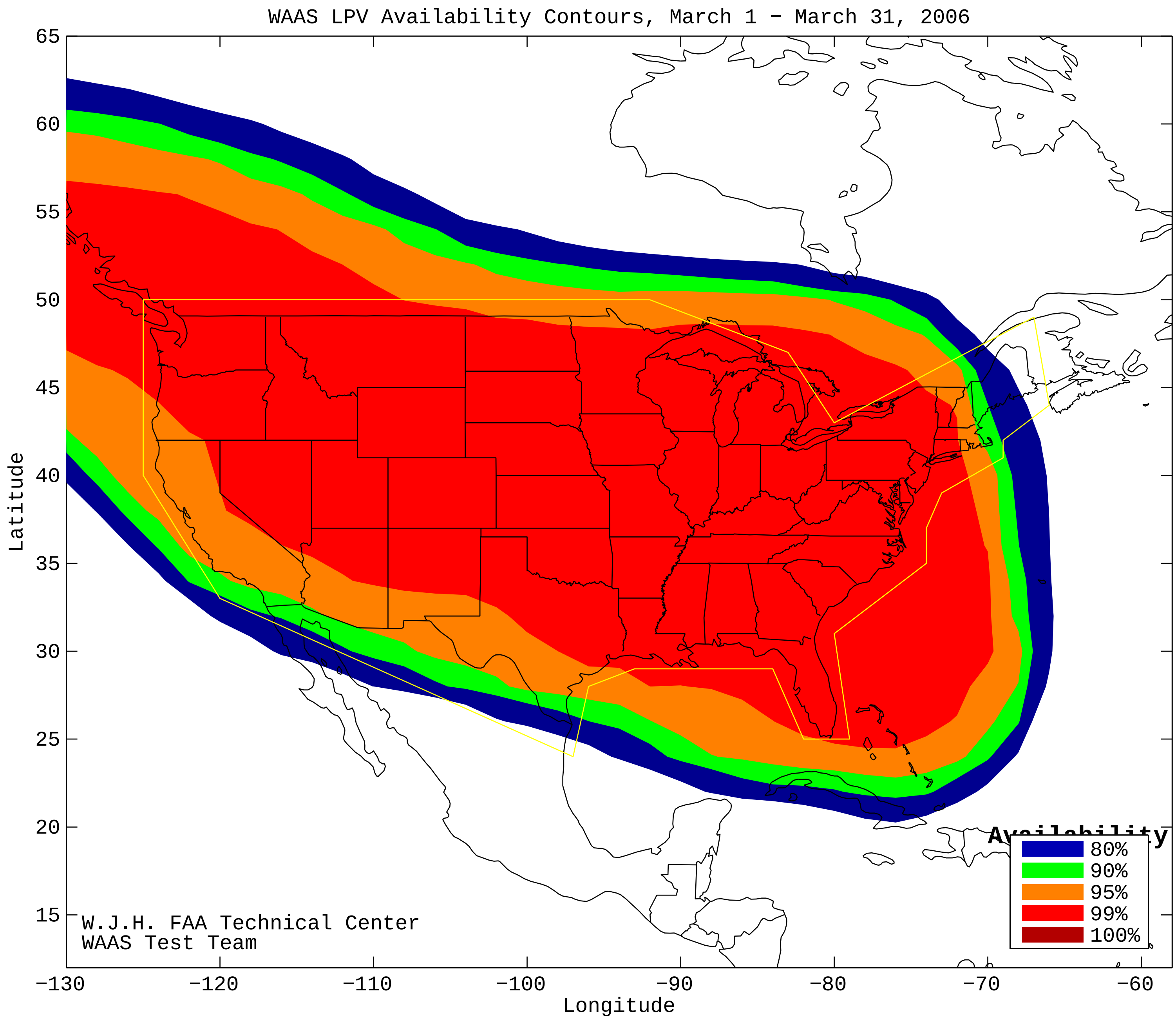
Figure 4-6 WAAS LPV Coverage - February



CONUS Coverage at 95% Availability = 96.76%
CONUS Coverage at 99% Availability = 91.09%
CONUS Coverage at 100% Availability = 12.15%

SL = LPV

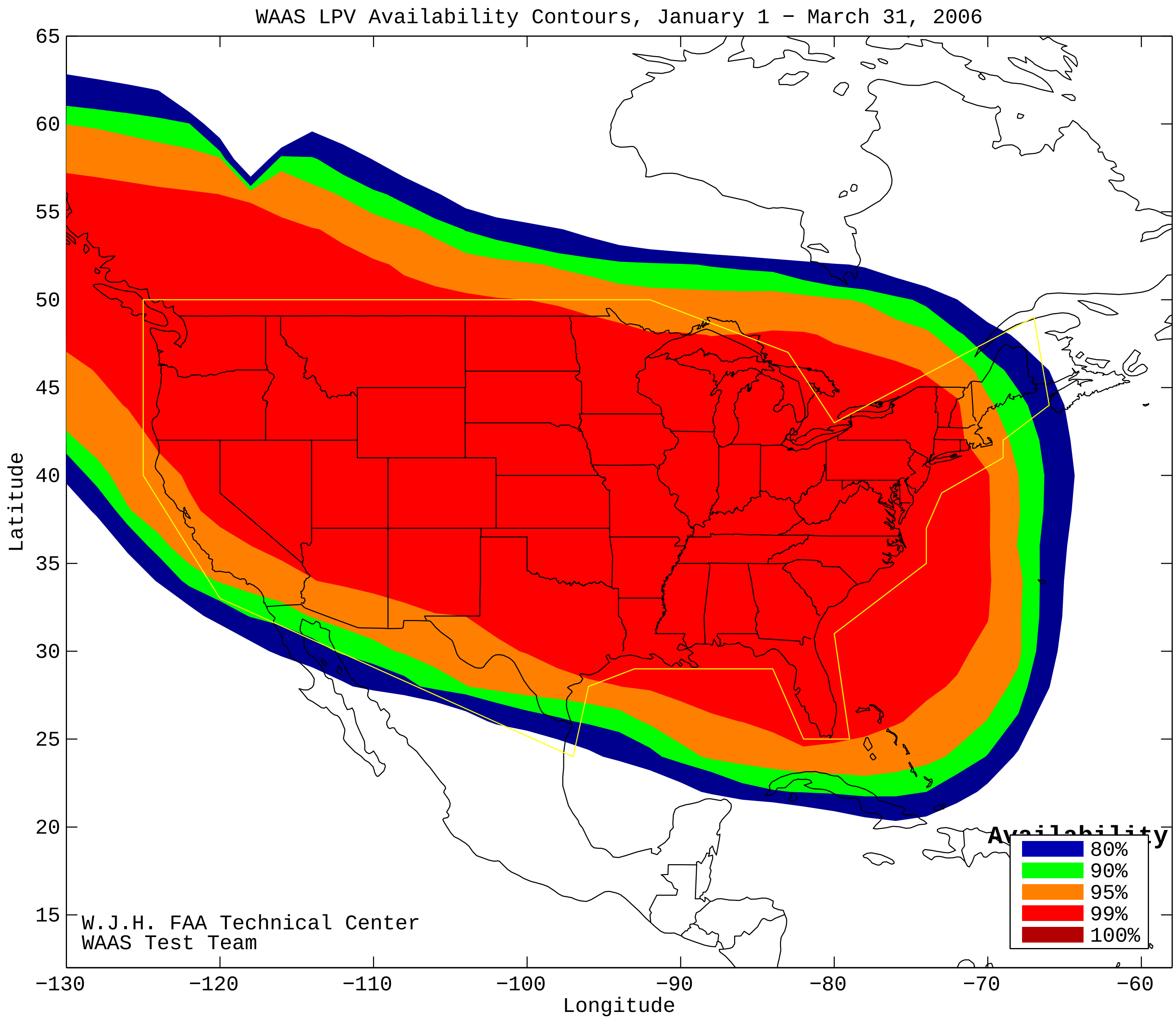
Figure 4-7 WAAS LPV Coverage - March



CONUS Coverage at 95% Availability = 92.71%
CONUS Coverage at 99% Availability = 80.16%
CONUS Coverage at 100% Availability = 0%

SL = LPV

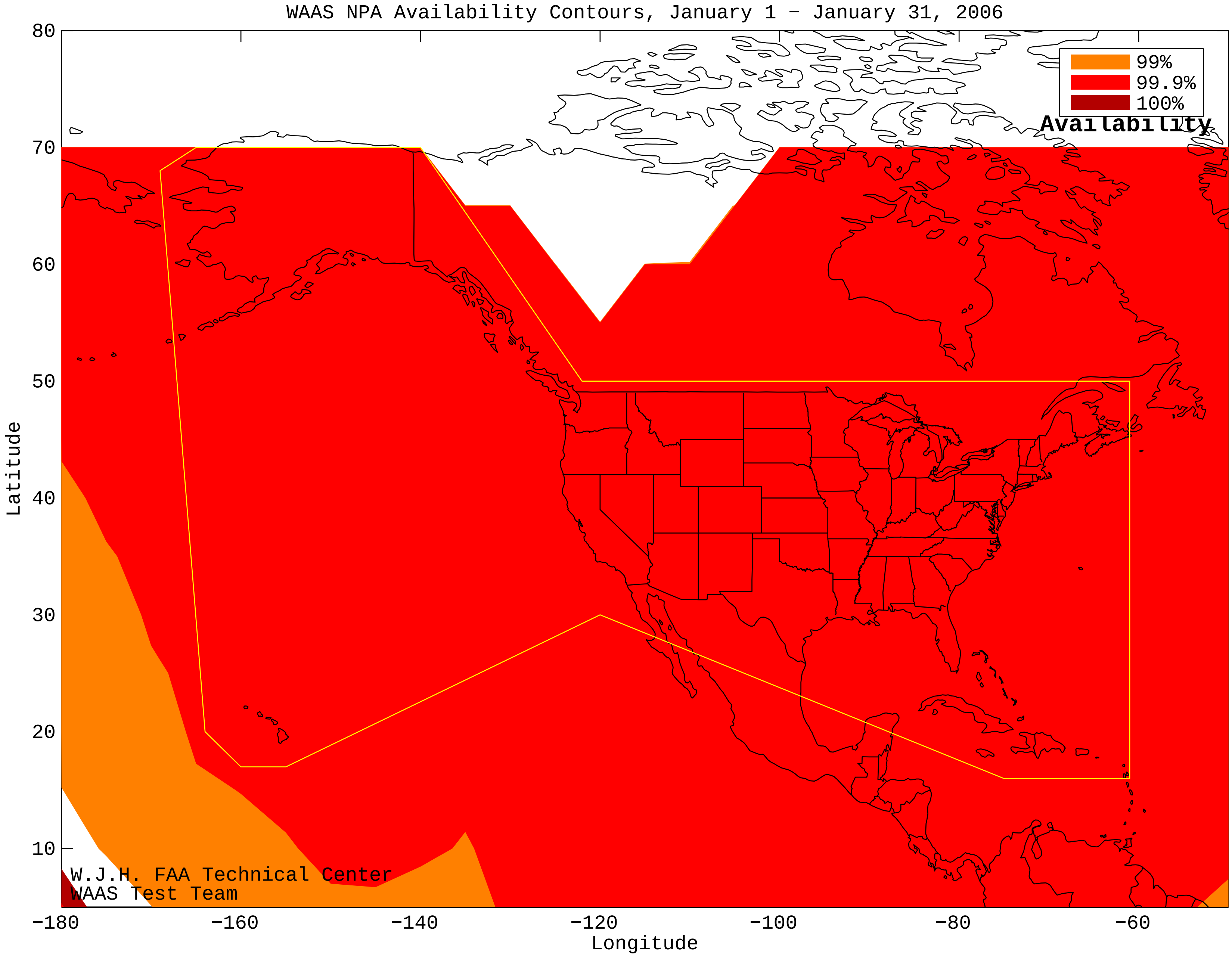
Figure 4-8 WAAS LPV Coverage for the Quarter



CONUS Coverage at 95% Availability = 95.14%
CONUS Coverage at 99% Availability = 84.62%
CONUS Coverage at 100% Availability = 0%

SL = LPV

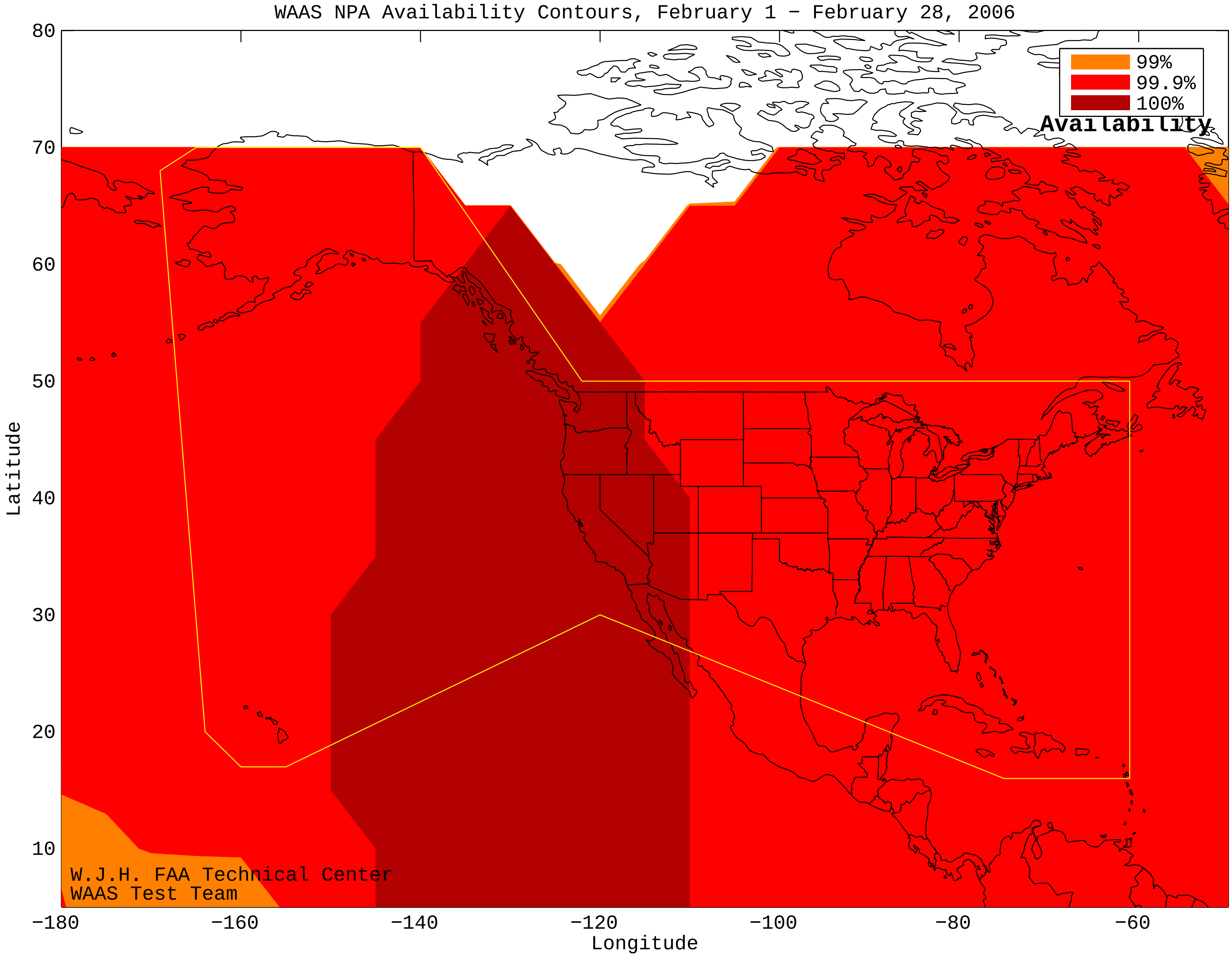
Figure 4-9 WAAS NPA Coverage - January



WAAS Coverage at 99% Availability = 100%
WAAS Coverage at 99.9% Availability = 100%
WAAS Coverage at 100% Availability = 0%

SL = NPA

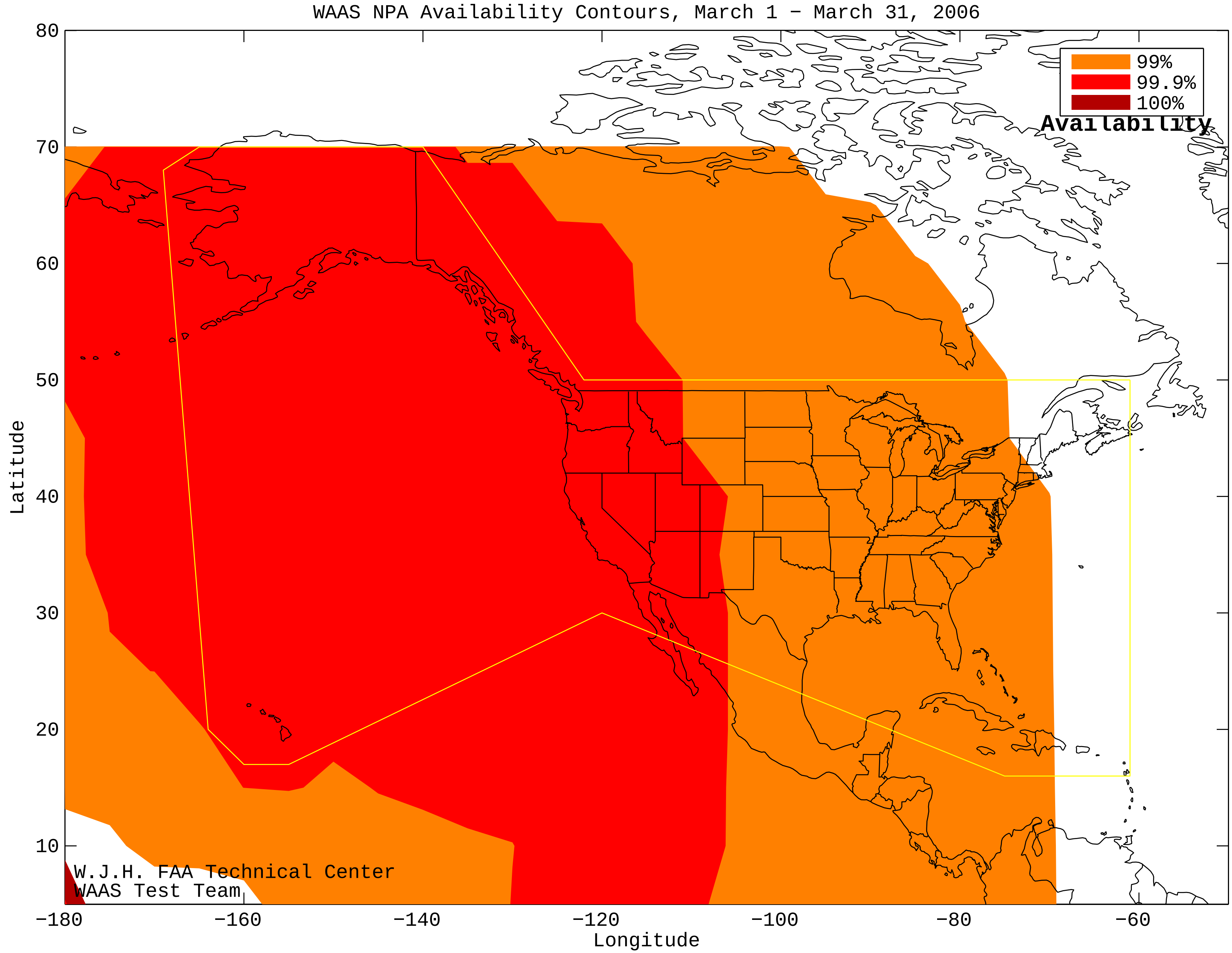
Figure 4-10 WAAS NPA Coverage - February



WAAS Coverage at 99% Availability = 100%
WAAS Coverage at 99.9% Availability = 100%
WAAS Coverage at 100% Availability = 33.09%

SL = NPA

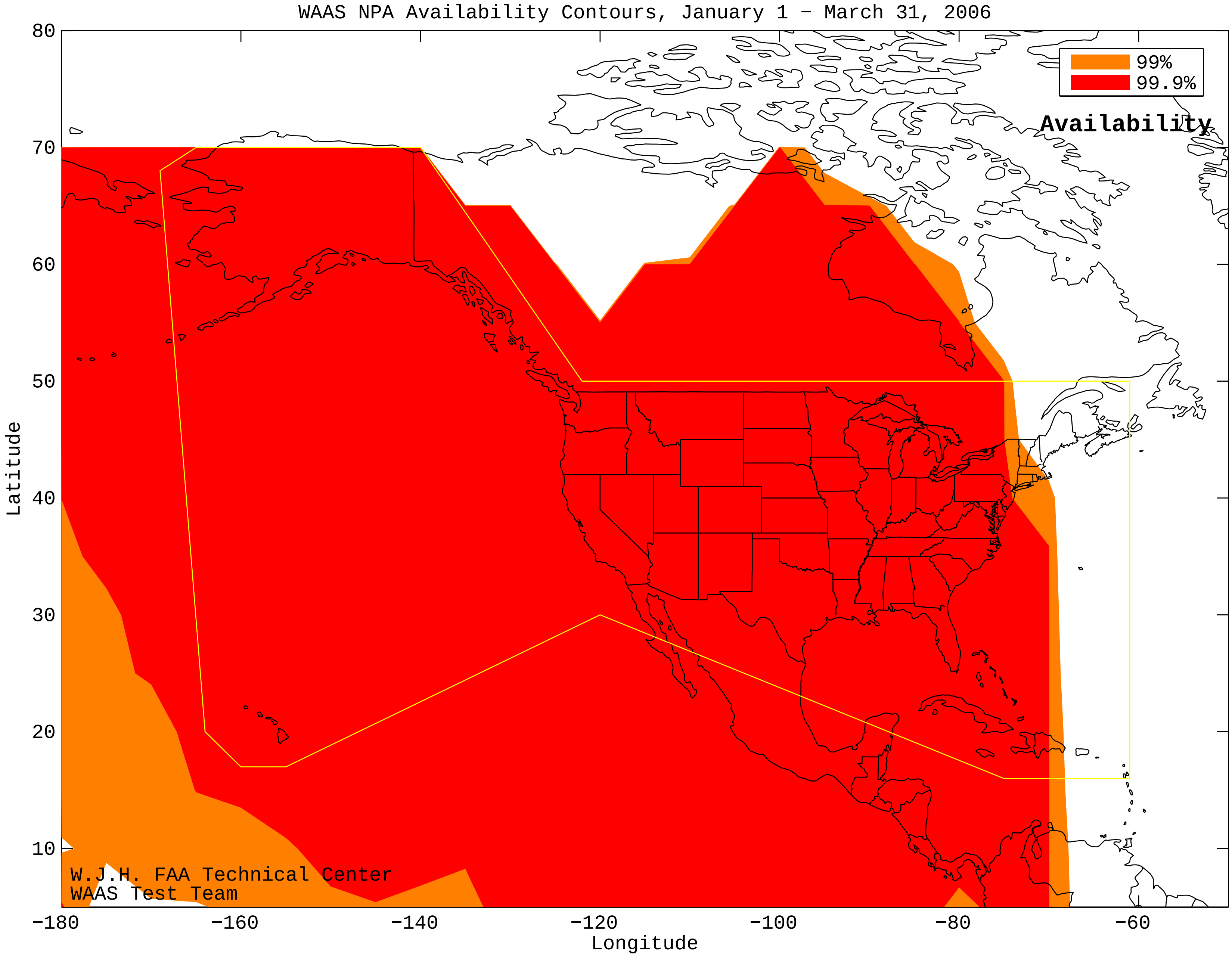
Figure 4-11 WAAS NPA Coverage - March



WAAS Coverage at 99% Availability = 94.85%
WAAS Coverage at 99.9% Availability = 63.24%
WAAS Coverage at 100% Availability = 0%

SL = NPA

Figure 4-12 WAAS NPA Coverage for the Quarter



WAAS Coverage at 99% Availability = 94.85%
WAAS Coverage at 99.9% Availability = 94.12%
WAAS Coverage at 100% Availability = 0%

SL = NPA

Figure 4-13 Daily WAAS LNAV/VNAV and LPV Coverage

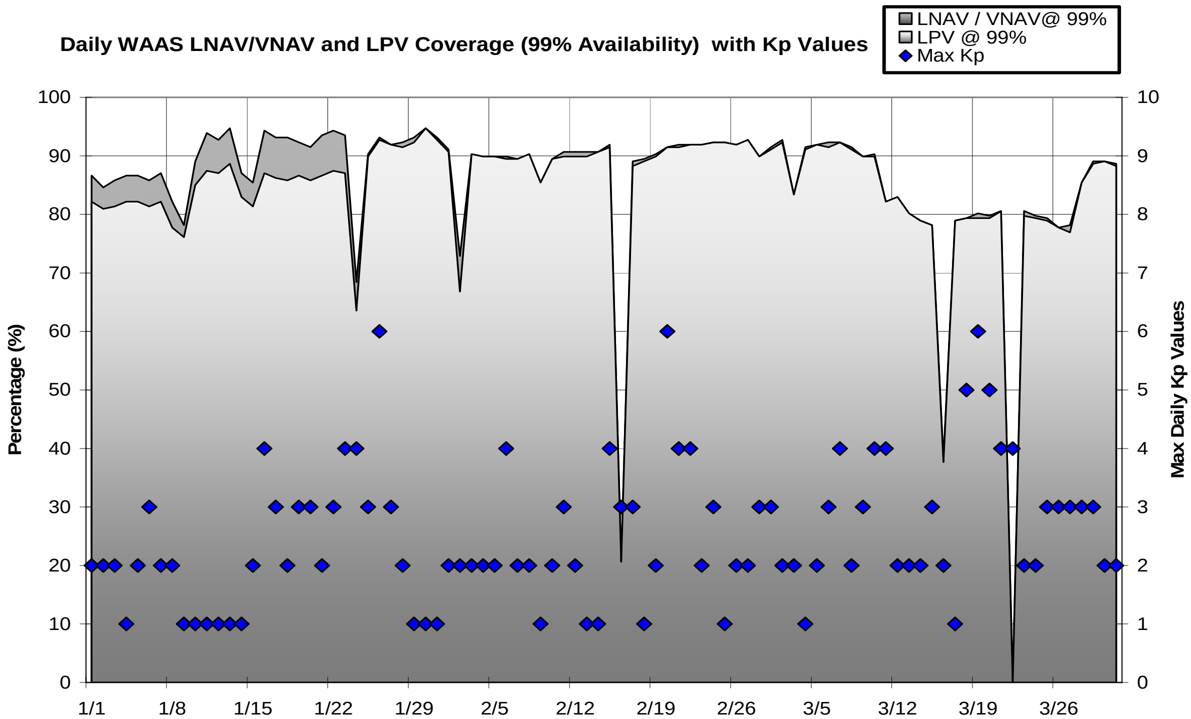


Figure 4-14 Daily NPA Coverage

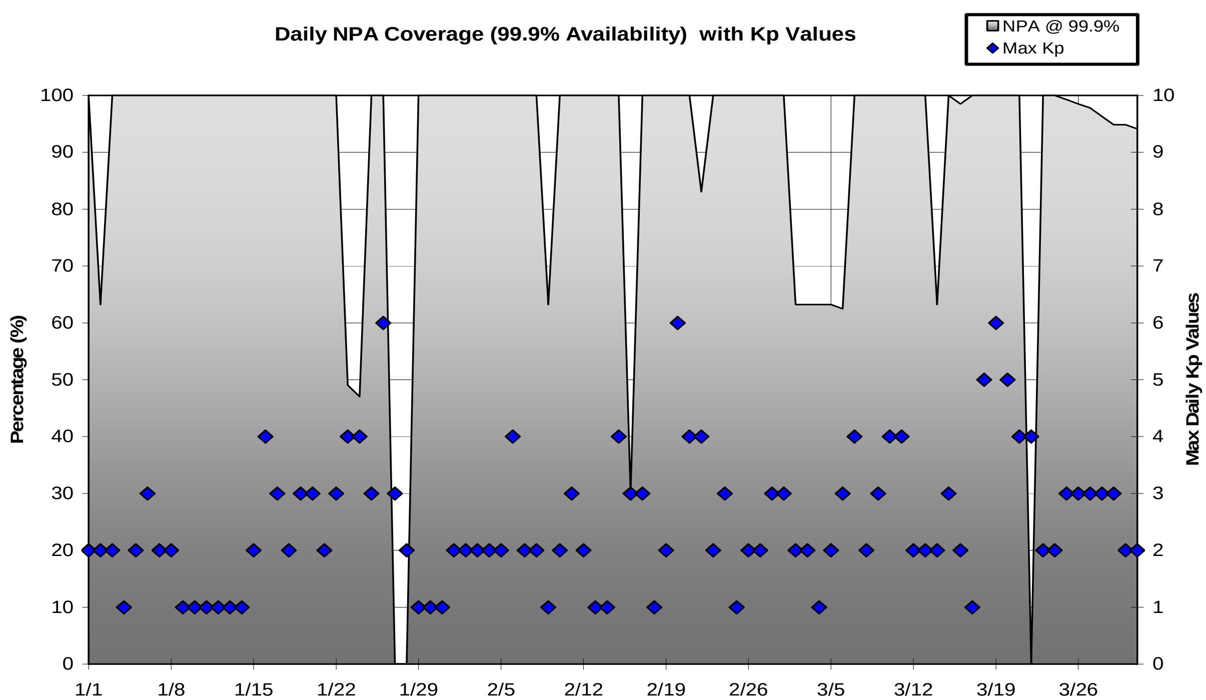


Figure 4-15 WAAS LNAV/VNAV Coverage Since Commissioning

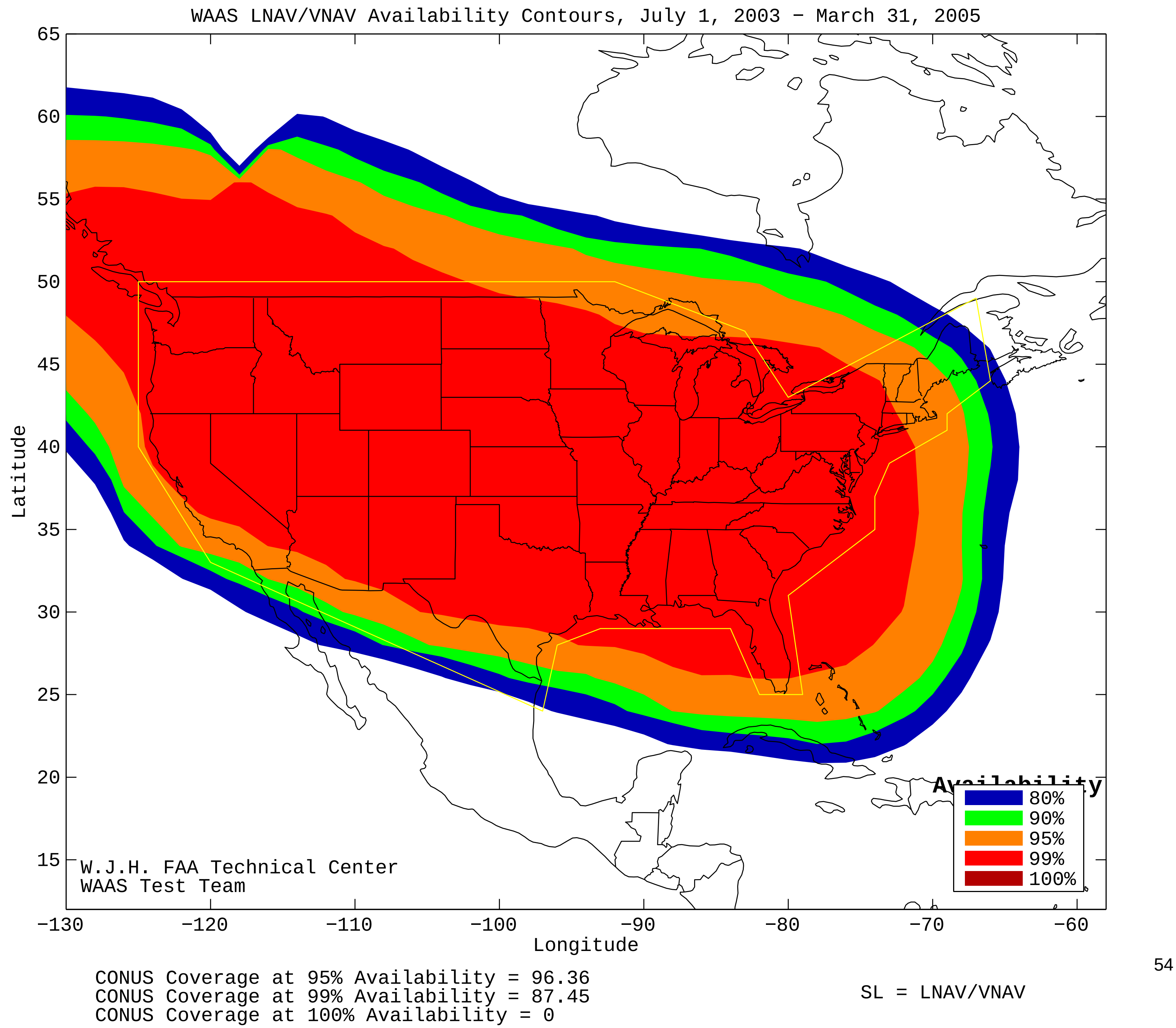


Figure 4-16 WAAS LPV Coverage Since Commissioning

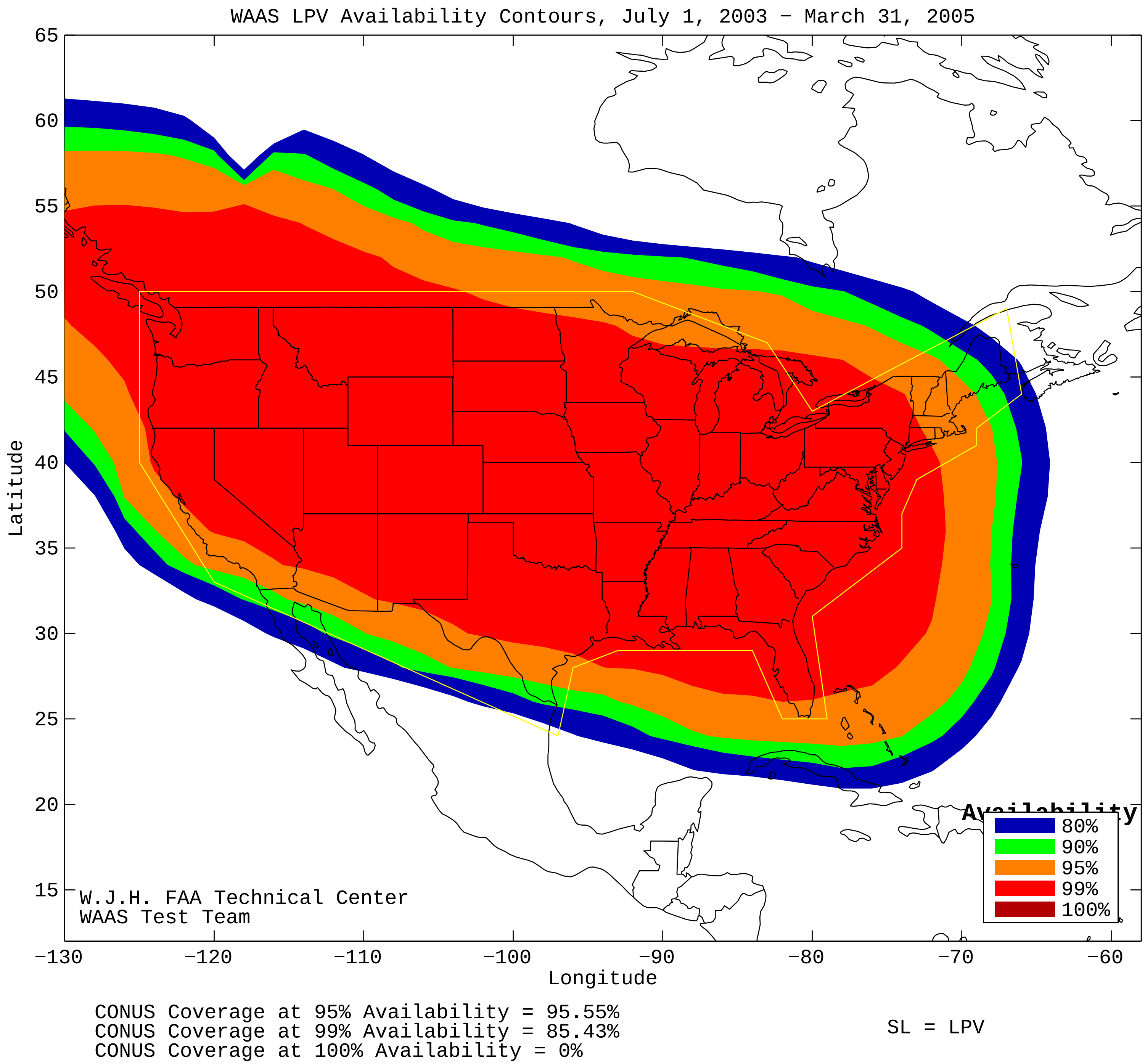
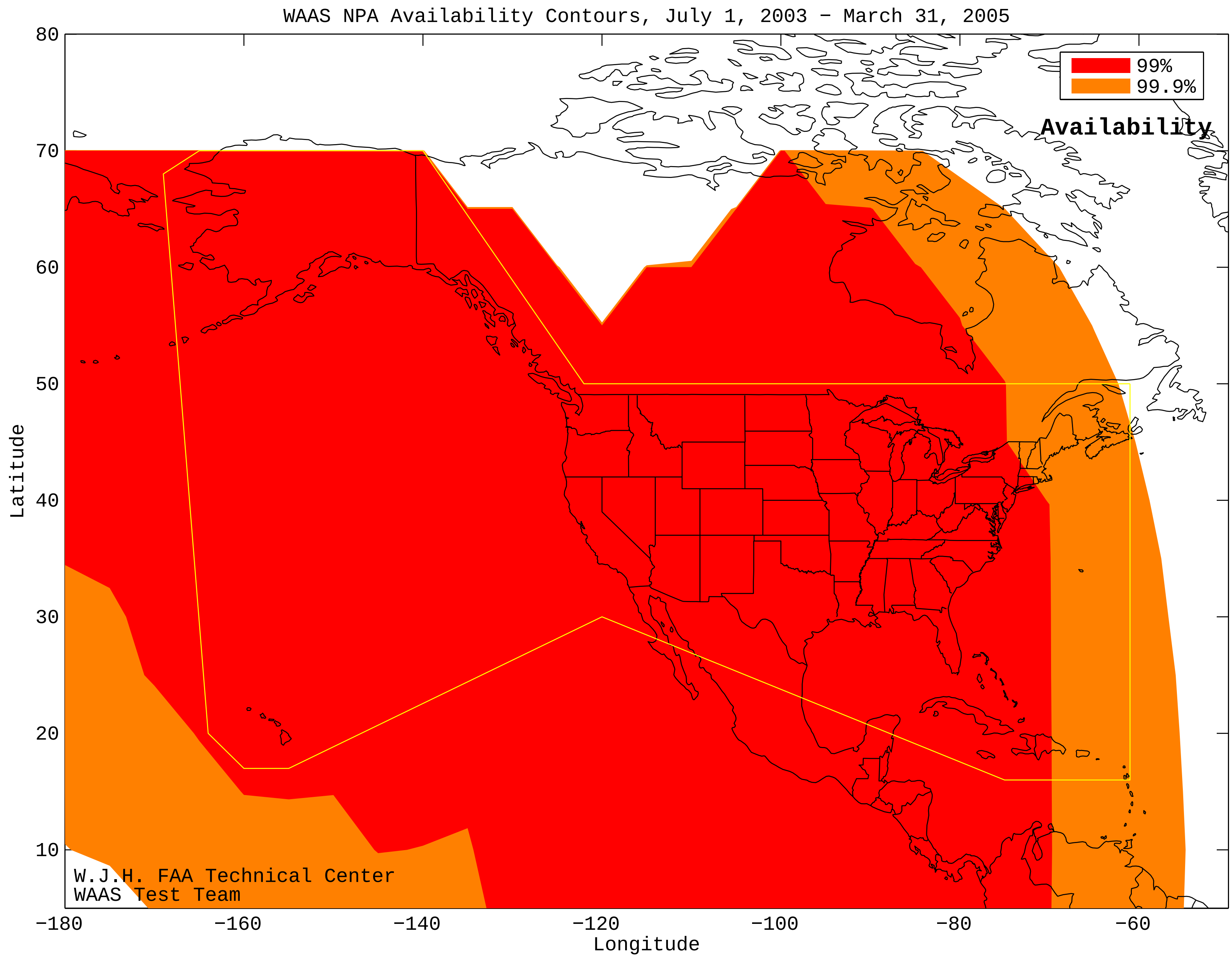


Figure 4-17 NPA Coverage Since Commissioning



WAAS Coverage at 99% Availability = 100
WAAS Coverage at 99.9% Availability = 94.12
WAAS Coverage at 100% Availability = 0

SL = NPA

5.0 INTEGRITY

5.1 HMI Analysis

Analysis of integrity includes the identification and evaluation of HMI (hazardously misleading information), as well as the generation of a safety index to illustrate the margin of safety that WAAS protection levels are providing. The safety margin index (shown in Table 5.1) is a metric that shows how well the protection levels are bounding the maximum observed error. The process for determining this index involves normalizing the largest error observed at a site. This is accomplished by dividing this maximum observed error by the WAAS estimated standard deviation of the error. The safety margin requirement, 5.33 standard units for vertical and 6 standard units for horizontal, is then divided by this maximum normalized error.

Table 5-1 Safety Margin Index and HMI Statistics

Location	Safety Index		Number of HMIs
	Horizontal	Vertical	
Atlantic City	10.00	6.66	0
Grand Forks	6.00	3.55	0
Greenwood	7.50	7.61	0
Albuquerque	6.00	2.96	0
Atlanta	6.67	5.92	0
Billings	6.67	5.33	0
Boston	8.57	8.88	0
Chicago	5.45	4.44	0
Cleveland	6.67	6.66	0
Dallas	4.62	3.81	0
Denver	6.00	5.33	0
Houston	7.50	5.92	0
Jacksonville	5.45	6.66	0
Kansas City	6.00	5.33	0
Los Angeles	8.57	5.92	0
Memphis	5.45	6.66	0
Miami	5.00	3.14	0
Minneapolis	3.53	3.33	0
New York	5.45	8.88	0
Oakland	8.57	5.92	0
Salt Lake City	8.57	6.66	0
Seattle	7.50	5.92	0

An observed safety margin index of greater than one indicates safe bounding of the greatest observed error, less than one indicates that the maximum error was not bounded, and a result equal to one means that the error was equal to the protection level. As evidenced by the statistics in the above table, the lowest safety margin index is 2.96 at Albuquerque. Also, Table 5.1 shows the number of HMIs that occurred during the quarter, of which there were none. An HMI occurs if the position error exceeds the protection level in the vertical or horizontal dimensions at any time and 6.2 seconds or more passes before this event is corrected by WAAS. Since WAAS was made available to the public in August 2000 there has not been an HMI event. Note that the FAA commissioned WAAS for safety of life services in July 2003.

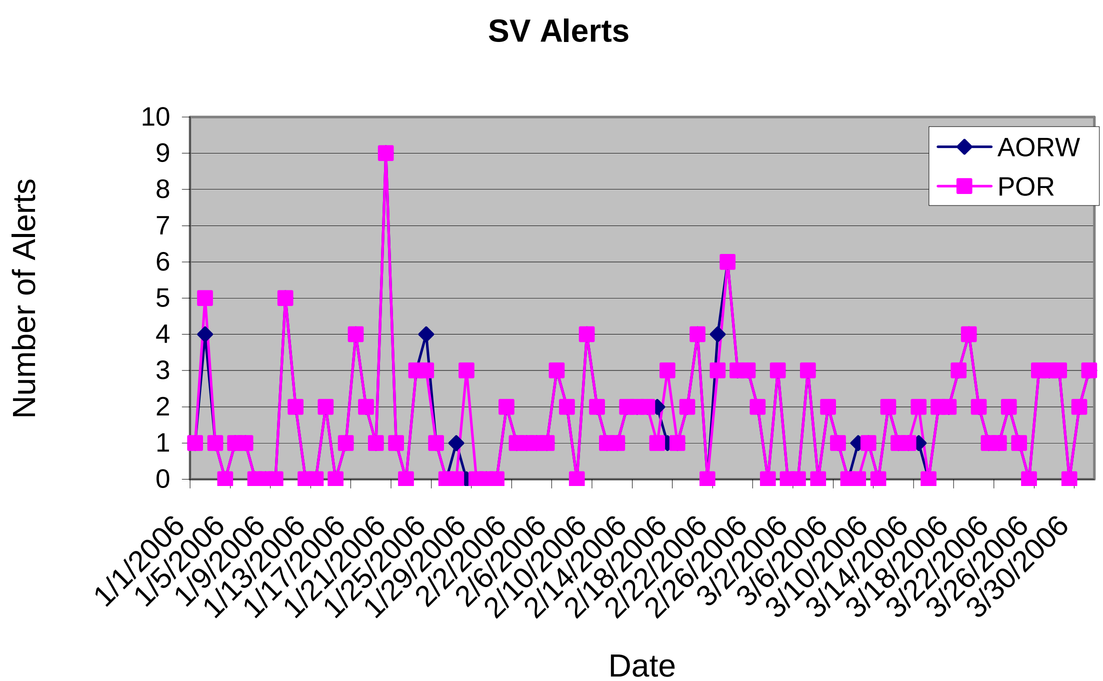
5.2 Broadcast Alerts

The WAAS transmits alert messages to protect the users from satellite degradation or severe ionospheric activity, both of which can cause unsafe conditions for a user. Space Vehicle (SV) alerts increase the User Differential Range Error (UDRE) of satellites, which can reduce the weighting of the satellite in the navigation solution, or completely exclude it from the navigation solution. An increase in UDRE's after an alert effectively increases the user protection levels (HPL and VPL), which affect the availability. Additionally, if an alert message sequence lasts for more than 12 seconds, WAAS fast corrections can time out, causing a loss of continuity. Table 5.2 shows the total number of alerts and the average number of alerts per day. Figure 5.1 shows the number of SV alerts that occurred daily during the reporting period. Often the number of alerts on one GEO is the same as the number of alerts on the other GEO. Therefore, lines tend to overlap in most points on this plot.

Table 5-2 WAAS SV Alert

Number of Alerts			Average Alerts Per Day	
Message Type	**AORW**	**POR**	**AORW**	**POR**
2	35	34	0.3888	0.3777
3	38	38	0.4222	0.4222
6	1	2	0.0111	0.0222
24	89	95	0.9888	1.0555
26	0	0	0	0
Total Alerts	163	169	1.8111	1.8777

Figure 5-1 SV Daily Alert Trends



5.3 Availability of WAAS Messages (AORW & POR)

For an accurate and current user position to be calculated, the content of the WAAS message must be broadcast and received within precise time specifications. This aspect of the WAAS is critical to maintaining integrity requirements. Each message type in the WAAS SIS has a specific amount of time for which it must be received anew. Although the content of every message is relevant to the functionality of the system, the importance of different messages varies along with the frequency with which they must be received. Table 5.3 lists the maximum intervals at which each message must broadcast to meet system requirements.

GUS switchovers or broadcast WAAS alerts can interrupt the normal broadcast message stream. If these events occur at a time when the maximum interval of a specific message is approaching, that message may be delayed, resulting in its late transmittal.

All late messages statistics reported during the quarter were caused by GEO SIS outages, GUS switchovers and SV alerts except message type 7 and 10. Occasionally, message type 7 and 10 were late and they were not caused by GEO SIS outages, GUS switchovers or SV alerts. The lateness of type 7 and type 10 messages has little or no impact on user performance and safety. Tables 5.4 to 5.8 show fast correction, long correction, ephemeris covariance, ionosphere correction, and ionospheric mask message rates statistics broadcasted on AORW. The message rates statistics for POR are shown in table 5.9 to 5.13.

Table 5-3 Update Rates for WAAS Messages

Data	Associated Message Types	Maximum Update Interval (seconds)	En Route, Terminal, NPA Timeout (seconds)	Precision Approach Timeout (seconds)
WAAS in Test Mode	0	6	N/A	N/A
PRN Mask	1	60	None	None
UDREI	2-6, 24	6	18	12
Fast Corrections	2-5, 24	See Table A-8 in RTCA DO-229C	See Table A-8 in RTCA DO-229C	See Table A-8 in RTCA DO-229C
Long Term Corrections	24, 25	120	360	240
GEO Nav. Data	9	120	360	240
Fast Correction Degradation	7	120	360	240
Weighting Factors	8	120	240	240
Degradation Parameters	10	120	360	240
Ionospheric Grid Mask	18	300	None	None
Ionospheric Corrections	26	300	600	600
UTC Timing Data	12	300	None	None
Almanac Data	17	300	None	None

Table 5-4 WAAS Fast Correction and Degradation Message Rates - AORW

Message Type	On Time	Late	Max Late Length (seconds)
1	138332	0	0
2	1295235	91	35
3	1295246	101	28
7	73905	98	157
9	91075	0	0
10	73823	128	215
17	29373	6	337
24	1295421	66	30

Table 5-5 WAAS Long Correction Message Rates (Type 24 and 25) - AORW

SV	On Time	Late	Max Late Length (seconds)
1	41629	0	0
2	44273	1	177
3	45026	1	169
4	44300	1	176
5	45783	0	0
6	43548	0	0
7	40795	0	0
8	42160	2	174
9	45942	1	165
10	44983	1	167
11	46454	2	176
13	42736	1	163
14	44043	1	171
15	42050	1	174
16	45835	0	0
17	44462	2	191
18	43278	0	0
19	45416	1	168
20	45012	0	0
21	35429	0	0
22	38803	0	0
23	42237	3	176
24	45956	0	0
25	29945	1	173
26	43478	0	0
27	39938	0	0
28	38540	0	0
29	43985	0	0
30	37176	0	0

Table 5-6 WAAS Ephemeris Covariance Message Rates (Type 28) - AORW

SV	On Time	Late	Max Late Length (seconds)
3	42732	2	127
4	41894	2	192
5	43309	2	185
6	41291	0	0
7	38528	2	240
8	39744	3	263
9	43578	1	127
10	42304	1	171
11	43934	0	0
13	40111	3	187
14	41468	3	181
15	39631	0	0
16	42424	3	169
17	41146	0	0
18	40056	3	209
19	41395	0	0
20	40809	1	166
21	32403	1	336
22	35209	5	241
23	38203	3	156
24	41536	1	191
25	27055	1	143
26	39618	0	0
27	36370	4	198
28	35191	0	0
29	40015	3	312
30	33562	0	0
122	22918	0	0
134	69079	2	185

Table 5-7 WAAS Ionospheric Correction Message Rates (Type 26) - AORW

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	27014	4	496
1	0	27012	6	536
1	1	26998	7	517
1	2	26997	5	540
1	3	27013	5	363
1	4	26995	3	344
2	0	26983	6	357
2	1	26994	3	351
2	2	26989	4	363
2	3	27014	3	361
2	4	26985	8	576
2	5	26995	7	525
3	0	26994	7	524

Table 5-8 WAAS Ionospheric Mask Message Rates (Type 18) - AORW

Band	On Time	Late	Max Late Length (seconds)
0	66789	0	0
1	66739	0	0
2	66782	0	0
3	66774	0	0

Table 5-9 WAAS Fast Correction and Degradation Message Rates - POR

Message Type	On Time	Late	Max Late Length (seconds)
1	136658	2	338
2	1295147	107	138
3	1295161	111	186
7	73100	97	348
9	91063	4	346
10	73076	87	448
17	29255	5	538
24	1295358	71	222

Table 5-10 WAAS Long Correction Message Rates (Type 24 and 25) - POR

SV	On Time	Late	Max Late Length (seconds)
1	41641	0	0
2	44270	0	0
3	45002	2	256
4	44312	0	0
5	45763	1	252
6	43537	1	343
7	40774	1	170
8	42159	1	256
9	45929	0	0
10	44979	1	169
11	46463	0	0
13	42746	0	0
14	44041	2	339
15	42059	1	345
16	45826	1	176
17	44469	0	0
18	43264	1	256
19	45416	0	0
20	45003	1	174
21	35411	1	337
22	38782	3	332
23	42235	0	0
24	45959	0	0
25	29971	1	256
26	43468	0	0
27	39945	0	0
28	38530	1	343
29	43973	1	176
30	37199	1	257

Table 5-11 WAAS Ephemeris Covariance Message Rates (Type 28) – POR

SV	On Time	Late	Max Late Length (seconds)
1	39729	2	134
2	41864	2	162
3	42725	1	194
4	41910	1	144
5	43289	1	139
6	41282	1	168
7	38517	1	217
8	39744	2	274
9	43582	3	322
10	42310	2	168
11	43940	2	340
13	40127	2	192
14	41481	2	334
15	39606	3	335
16	42422	2	147
17	41149	1	168
18	40032	3	245
19	41387	1	144
20	40792	3	192
21	32397	0	0
22	35191	2	286
23	38188	3	192
24	41535	1	180
25	27066	2	194
26	39602	2	384
27	36356	3	202
28	35161	1	359
29	40019	1	312
30	33580	1	304
122	22906	2	186
134	69062	1	136

Table 5-12 WAAS Ionospheric Correction Message Rates (Type 26) – POR

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	26987	12	598
0	1	27015	6	593
0	2	27001	7	579
1	0	26996	6	580
1	1	27004	9	872
1	2	26995	7	672
1	3	26988	5	952
1	4	26995	5	647
2	0	27009	4	656
2	1	26990	5	648
2	2	26999	5	640
2	3	27014	9	624

Table 5-13 WAAS Ionospheric Mask Message Rates (Type 18) - POR

Band	On Time	Late	Max Late Length (seconds)
0	66331	1	405
1	66360	2	388
2	66389	2	359

6.0 SV RANGE ACCURACY

Range accuracy evaluation computes the probability that the WAAS User Differential Range Error (UDRE) and Grid Ionospheric Vertical Error (GIVE) statistically bound 99.9% of the range residuals for each satellite tracked by the receiver. A UDRE is broadcast by the WAAS for each satellite that is monitored by the system and the 99.9% bound (3.29 sigma) of the residual error on a pseudorange after application of fast and long-term corrections is checked. The pseudorange residual error is determined by taking the difference between the raw pseudorange and a calculated reference range. The reference range is equal to the true range between the corrected satellite position and surveyed user antenna plus all corrections (WAAS Fast Clock, WAAS Long-Term Clock, WAAS Ionospheric delay, Tropospheric delay, Receiver Clock Bias, and Multipath). Since the true ionospheric delay and multipath error are not precisely known, the estimated variance in these error sources are added to the UDRE before the comparing it to the residual error.

GPS satellite range residual errors were calculated for twelve WAAS receivers during the quarter. Table 6.1 and 6.2 show the range error 95% index and 99.9% (3.29 sigma) bounding statistics for each SV at the selected locations. Figures 6.1 and 6.2 show the range error for each SV as measured by the WAAS receivers at the Washington DC reference station.

A GIVE is broadcast by the WAAS for each IGP that is monitored by the system and the 99.9% (3.29 sigma) bound of the ionospheric error is checked. The WAAS broadcasts the ionospheric model using IGP's at predefined geographic locations. Each IGP contains the vertical ionospheric delay and the error in that delay in the form of the GIVE. The ionospheric error is determined by taking the difference between the WAAS vertical ionospheric delay interpolated from the IGP's and GPS dual frequency measurement at that GPS satellite.

GPS satellite ionospheric errors were calculated for twelve WAAS receivers during the quarter. Table 6.3 and 6.4 show the ionospheric error 95% index and 99.9% (3.29 sigma) bounding statistics for each SV at the selected locations. Figures 6.3 and 6.4 show the ionospheric error for each SV as measured by the WAAS receiver at the Washington DC reference station.

Table 6-1 Range Error 95% index and 3.29 Sigma Bounding

Site →	Billings		Albuquerque		Boston		Washington DC		Houston		Kansas City	
SV ↓	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding
1	1.114	100.00	1.014	100.00	0.977	100.00	1.351	100.00	1.341	100.00	1.306	100.00
2	1.967	100.00	2.122	100.00	1.511	100.00	1.681	100.00	2.311	100.00	1.553	100.00
3	1.175	100.00	1.102	100.00	1.537	100.00	2.326	100.00	1.710	100.00	1.551	100.00
4	1.723	100.00	1.213	100.00	1.801	100.00	2.193	100.00	2.291	100.00	1.960	100.00
5	1.240	100.00	1.329	100.00	1.520	100.00	1.178	100.00	1.068	100.00	1.266	100.00
6	1.572	100.00	1.141	100.00	1.407	100.00	2.279	100.00	1.338	100.00	1.959	100.00
7	1.374	100.00	1.094	100.00	1.174	100.00	1.779	100.00	1.651	100.00	1.637	100.00
8	1.238	100.00	1.199	100.00	1.058	100.00	2.083	100.00	1.514	100.00	1.689	100.00
9	1.315	100.00	1.031	100.00	1.203	100.00	1.928	100.00	1.883	100.00	1.739	100.00
10	1.557	100.00	2.251	100.00	1.196	100.00	1.274	100.00	1.652	100.00	1.351	100.00
11	1.357	100.00	1.614	100.00	1.234	100.00	1.595	100.00	2.300	100.00	0.958	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.066	100.00	1.132	100.00	1.129	100.00	1.814	100.00	1.506	100.00	1.392	100.00
14	1.428	100.00	1.184	100.00	1.306	100.00	1.257	100.00	1.024	100.00	1.634	100.00
15	1.472	100.00	1.275	100.00	1.382	100.00	2.101	100.00	1.055	100.00	1.702	100.00
16	1.314	100.00	1.629	100.00	1.051	100.00	1.730	100.00	1.096	100.00	1.508	100.00
17	1.208	100.00	1.103	100.00	1.310	100.00	1.673	100.00	1.653	100.00	1.364	100.00
18	1.424	100.00	1.016	100.00	1.248	100.00	1.284	100.00	1.006	100.00	1.763	100.00
19	2.796	100.00	2.883	100.00	2.567	100.00	2.342	100.00	2.360	100.00	2.597	100.00
20	1.388	100.00	1.380	100.00	1.416	100.00	1.180	100.00	1.357	100.00	1.158	100.00
21	1.785	100.00	1.851	100.00	1.550	100.00	1.349	100.00	1.433	100.00	1.577	100.00
22	1.443	100.00	1.625	100.00	1.516	100.00	1.309	100.00	1.386	100.00	1.587	100.00
23	2.847	100.00	2.795	100.00	2.521	100.00	2.424	100.00	2.322	99.9917	2.661	100.00
24	1.853	100.00	1.238	100.00	1.347	100.00	2.641	100.00	2.262	100.00	2.437	100.00
25	1.404	100.00	1.126	100.00	1.238	100.00	1.852	100.00	1.874	100.00	1.445	100.00
26	1.428	100.00	1.153	100.00	1.307	100.00	2.296	100.00	1.612	100.00	1.908	100.00
27	1.169	100.00	1.203	100.00	1.204	100.00	2.338	100.00	1.549	100.00	1.644	100.00
28	1.377	100.00	1.566	100.00	1.045	100.00	1.140	100.00	0.929	100.00	1.268	100.00
29	1.199	100.00	1.248	100.00	1.480	100.00	2.052	100.00	1.703	100.00	1.313	100.00
30	1.607	100.00	1.391	100.00	1.531	100.00	1.831	100.00	1.891	100.00	1.677	100.00
31	-	-	-	-	-	-	-	-	-	-	-	-
122	3.745	100.00	3.762	100.00	3.140	100.00	4.986	100.00	2.721	100.00	3.900	100.00
134	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-2 Range Error 95% index and 3.29 Sigma Bounding

Site →	Los Angeles		Salt Lake City		Miami		Minneapolis		Atlanta		Juneau	
SV ↓	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding
1	2.009	100.00	1.947	100.00	1.240	100.00	1.455	100.00	1.004	100.00	1.277	100.00
2	1.219	100.00	1.559	100.00	1.518	100.00	1.791	100.00	1.608	100.00	1.353	100.00
3	2.087	100.00	1.953	100.00	1.302	100.00	1.788	100.00	1.012	100.00	1.187	100.00
4	2.620	100.00	2.970	100.00	1.710	100.00	2.082	100.00	1.265	100.00	1.650	100.00
5	1.691	99.9271	1.879	100.00	1.356	100.00	1.193	100.00	0.904	100.00	1.044	100.00
6	2.394	99.8999	2.267	100.00	1.613	100.00	2.140	99.8555	1.109	100.00	1.476	100.00
7	2.081	100.00	2.139	100.00	1.377	100.00	1.640	100.00	0.921	100.00	1.161	100.00
8	1.635	100.00	1.854	100.00	1.288	100.00	2.173	100.00	1.061	100.00	0.976	100.00
9	2.668	99.9806	2.455	100.00	1.475	100.00	2.042	100.00	1.102	100.00	1.387	100.00
10	1.536	100.00	1.506	100.00	1.294	100.00	1.974	99.9571	1.081	100.00	0.861	100.00
11	2.115	100.00	1.576	100.00	2.512	100.00	1.385	100.00	1.136	100.00	0.880	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.816	100.00	1.604	100.00	1.386	100.00	1.741	100.00	1.023	100.00	1.333	100.00
14	1.468	100.00	1.348	100.00	1.492	100.00	1.408	100.00	1.667	100.00	0.913	100.00
15	1.347	100.00	1.764	100.00	1.095	100.00	1.820	100.00	1.397	100.00	1.033	100.00
16	1.496	100.00	1.570	100.00	1.542	100.00	1.682	100.00	1.457	100.00	0.929	100.00
17	2.437	100.00	2.662	100.00	2.561	100.00	1.731	100.00	0.904	100.00	1.428	100.00
18	1.582	100.00	1.400	100.00	1.183	100.00	1.831	100.00	1.542	100.00	1.059	100.00
19	2.315	100.00	2.264	100.00	2.691	100.00	2.667	100.00	2.462	100.00	2.062	100.00
20	1.362	100.00	1.624	100.00	1.610	100.00	1.220	100.00	1.420	100.00	0.976	100.00
21	1.225	100.00	1.367	100.00	2.028	100.00	1.803	99.9906	1.813	100.00	1.415	100.00
22	1.251	100.00	1.259	100.00	2.498	100.00	1.509	100.00	1.796	100.00	1.121	100.00
23	1.923	100.00	2.224	100.00	2.625	100.00	2.509	100.00	2.546	100.00	1.911	100.00
24	2.512	100.00	2.810	100.00	1.673	100.00	2.594	100.00	1.244	100.00	1.666	100.00
25	2.097	100.00	2.047	100.00	1.598	100.00	1.150	100.00	0.973	100.00	1.312	100.00
26	2.198	100.00	2.656	100.00	1.337	100.00	2.526	99.9007	1.348	100.00	1.684	100.00
27	1.886	100.00	2.151	100.00	1.226	100.00	1.733	100.00	0.935	100.00	1.175	100.00
28	1.365	100.00	1.442	100.00	1.700	100.00	1.203	100.00	1.187	100.00	0.999	100.00
29	2.105	100.00	2.060	100.00	1.346	100.00	2.191	99.9034	1.078	100.00	1.275	100.00
30	2.694	99.7963	2.637	100.00	1.669	100.00	2.085	100.00	1.166	100.00	1.941	100.00
31	-	-	-	-	-	-	-	-	-	-	-	-
122	3.923	100.00	4.617	100.00	2.839	100.00	6.033	100.00	2.987	100.00	-	-
134	4.667	100.00	5.033	100.00	-	-	-	-	-	-	6.194	100.00

Table 6-3 Ionospheric Error 95% index and 3.29 Sigma Bounding

Site →	Billings		Albuquerque		Boston		Washington DC		Houston		Kansas City	
SV ↓	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding
1	0.678	100.00	0.385	100.00	0.625	100.00	0.827	100.00	1.036	100.00	0.841	100.00
2	1.555	100.00	1.601	100.00	0.944	100.00	0.949	100.00	1.249	100.00	1.133	100.00
3	0.578	100.00	0.501	100.00	0.488	100.00	1.246	100.00	1.231	100.00	0.879	100.00
4	1.030	100.00	0.615	100.00	1.143	100.00	1.479	100.00	1.913	100.00	1.406	100.00
5	0.580	100.00	0.638	100.00	0.579	100.00	0.557	100.00	0.402	100.00	0.552	100.00
6	0.843	100.00	0.531	100.00	0.720	100.00	1.257	100.00	1.011	100.00	0.999	100.00
7	0.784	100.00	0.607	100.00	0.555	100.00	1.085	100.00	1.016	100.00	0.935	100.00
8	0.695	100.00	0.628	100.00	0.457	100.00	1.134	100.00	1.169	100.00	1.074	100.00
9	0.545	100.00	0.447	100.00	0.721	100.00	0.953	100.00	0.982	100.00	0.816	100.00
10	1.037	100.00	1.135	100.00	0.536	100.00	0.757	100.00	1.060	100.00	0.755	100.00
11	0.771	100.00	0.913	100.00	0.451	100.00	0.739	100.00	1.122	100.00	0.480	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	0.676	100.00	0.521	100.00	0.586	100.00	1.026	100.00	1.274	100.00	0.858	100.00
14	1.137	100.00	0.796	100.00	0.560	100.00	0.470	100.00	0.662	100.00	0.918	100.00
15	0.729	100.00	0.587	100.00	0.554	100.00	0.932	100.00	0.705	100.00	0.806	100.00
16	0.844	100.00	1.006	100.00	0.389	100.00	0.745	100.00	0.697	100.00	0.783	100.00
17	0.728	100.00	0.561	100.00	0.897	100.00	1.096	100.00	1.254	100.00	0.840	100.00
18	1.063	100.00	0.641	100.00	0.531	100.00	0.502	100.00	0.543	100.00	1.067	100.00
19	1.940	100.00	1.952	100.00	1.474	100.00	1.359	100.00	1.543	100.00	1.763	100.00
20	0.835	100.00	0.761	100.00	0.793	100.00	0.545	100.00	0.549	100.00	0.578	100.00
21	1.300	100.00	1.183	100.00	0.692	100.00	0.498	100.00	0.896	100.00	1.078	100.00
22	1.097	100.00	1.112	100.00	0.703	100.00	0.598	100.00	0.751	100.00	1.123	100.00
23	2.057	100.00	2.099	100.00	1.927	100.00	1.615	100.00	1.540	100.00	1.801	100.00
24	0.967	100.00	0.501	100.00	0.688	100.00	1.673	100.00	1.606	100.00	1.468	100.00
25	0.893	100.00	0.553	100.00	0.830	100.00	1.395	100.00	1.690	100.00	0.960	100.00
26	0.704	100.00	0.506	100.00	0.574	100.00	1.303	100.00	1.293	100.00	1.086	100.00
27	0.829	100.00	0.602	100.00	0.612	100.00	1.313	100.00	1.247	100.00	1.064	100.00
28	1.055	100.00	1.046	100.00	0.609	100.00	0.512	100.00	0.700	100.00	0.664	100.00
29	0.610	100.00	0.561	100.00	0.595	100.00	1.145	100.00	1.049	100.00	0.732	100.00
30	0.754	100.00	0.597	100.00	0.831	100.00	1.124	100.00	0.926	100.00	0.868	100.00
31	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-4 Ionospheric Error 95% index and 3.29 Sigma Bounding

Site →	Los Angeles		Salt Lake City		Miami		Minneapolis		Atlanta		Juneau	
SV ↓	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding
1	1.246	100.00	1.339	100.00	1.123	100.00	0.702	100.00	0.549	100.00	0.576	100.00
2	0.414	100.00	0.878	100.00	0.803	100.00	1.244	100.00	0.976	100.00	1.046	100.00
3	1.010	100.00	1.157	100.00	1.000	100.00	0.650	100.00	0.485	100.00	0.650	100.00
4	1.559	100.00	1.868	100.00	1.267	100.00	1.056	100.00	0.794	100.00	0.892	100.00
5	0.720	100.00	0.922	100.00	0.662	100.00	0.468	100.00	0.473	100.00	0.497	100.00
6	1.401	100.00	1.439	100.00	1.149	100.00	1.010	100.00	0.639	100.00	0.730	100.00
7	1.213	100.00	1.250	100.00	0.900	100.00	0.741	100.00	0.475	100.00	0.558	100.00
8	1.179	100.00	1.295	100.00	1.164	100.00	0.921	100.00	0.480	100.00	0.402	100.00
9	1.143	100.00	1.198	100.00	1.089	100.00	0.832	100.00	0.762	100.00	0.671	100.00
10	0.584	100.00	0.871	100.00	0.507	100.00	0.837	100.00	0.438	100.00	0.497	100.00
11	0.797	100.00	0.698	100.00	1.132	100.00	0.699	100.00	0.601	100.00	0.557	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.322	100.00	1.150	100.00	1.314	100.00	0.855	100.00	0.658	100.00	0.771	100.00
14	0.837	100.00	0.766	100.00	0.694	100.00	0.650	100.00	0.683	100.00	0.653	100.00
15	0.766	100.00	1.203	100.00	0.799	100.00	0.643	100.00	0.411	100.00	0.410	100.00
16	0.630	100.00	0.844	100.00	0.569	100.00	0.677	100.00	0.633	100.00	0.625	100.00
17	1.622	100.00	1.530	100.00	1.622	100.00	0.955	100.00	0.630	100.00	0.663	100.00
18	0.748	100.00	0.748	100.00	0.639	100.00	0.955	100.00	0.618	100.00	0.631	100.00
19	1.054	100.00	1.348	100.00	1.205	100.00	1.723	100.00	1.468	100.00	1.529	100.00
20	0.583	100.00	0.840	100.00	0.686	100.00	0.539	100.00	0.627	100.00	0.616	100.00
21	0.393	100.00	0.784	100.00	1.457	100.00	1.172	100.00	1.023	100.00	0.876	100.00
22	0.394	100.00	0.704	100.00	1.559	100.00	0.802	100.00	0.968	100.00	0.759	100.00
23	0.981	100.00	1.509	100.00	1.950	100.00	1.758	100.00	1.789	100.00	1.618	100.00
24	1.387	100.00	1.544	100.00	1.307	100.00	1.222	100.00	0.772	100.00	0.863	100.00
25	1.448	100.00	1.459	100.00	1.375	100.00	0.714	100.00	0.702	100.00	0.655	100.00
26	1.080	100.00	1.459	100.00	0.946	100.00	1.123	100.00	0.800	100.00	0.746	100.00
27	1.390	100.00	1.629	100.00	1.297	100.00	0.788	100.00	0.605	100.00	0.580	100.00
28	0.671	100.00	0.829	100.00	0.931	100.00	0.747	100.00	0.593	100.00	0.752	100.00
29	1.066	100.00	1.084	100.00	0.981	100.00	0.861	100.00	0.570	100.00	0.570	100.00
30	1.392	100.00	1.448	100.00	1.270	100.00	1.041	100.00	0.809	100.00	0.867	100.00
31	-	-	-	-	-	-	-	-	-	-	-	-

Figure 6-1 95% Range Error (SV 1 --SV 16) - Washington, DC

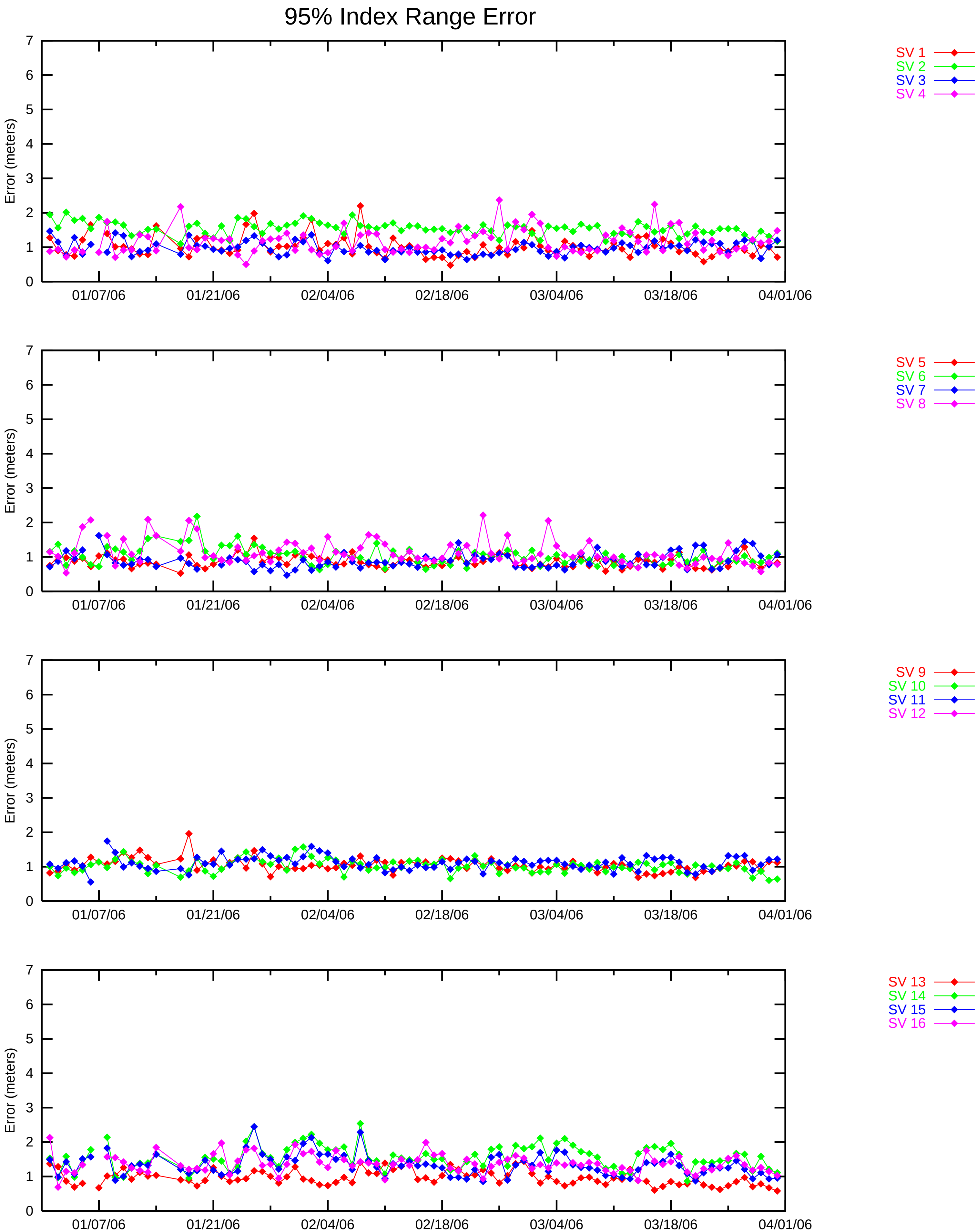


Figure 6-2 95% Range Error (SV 17 --SV 31 and SV 122) - Washington, DC

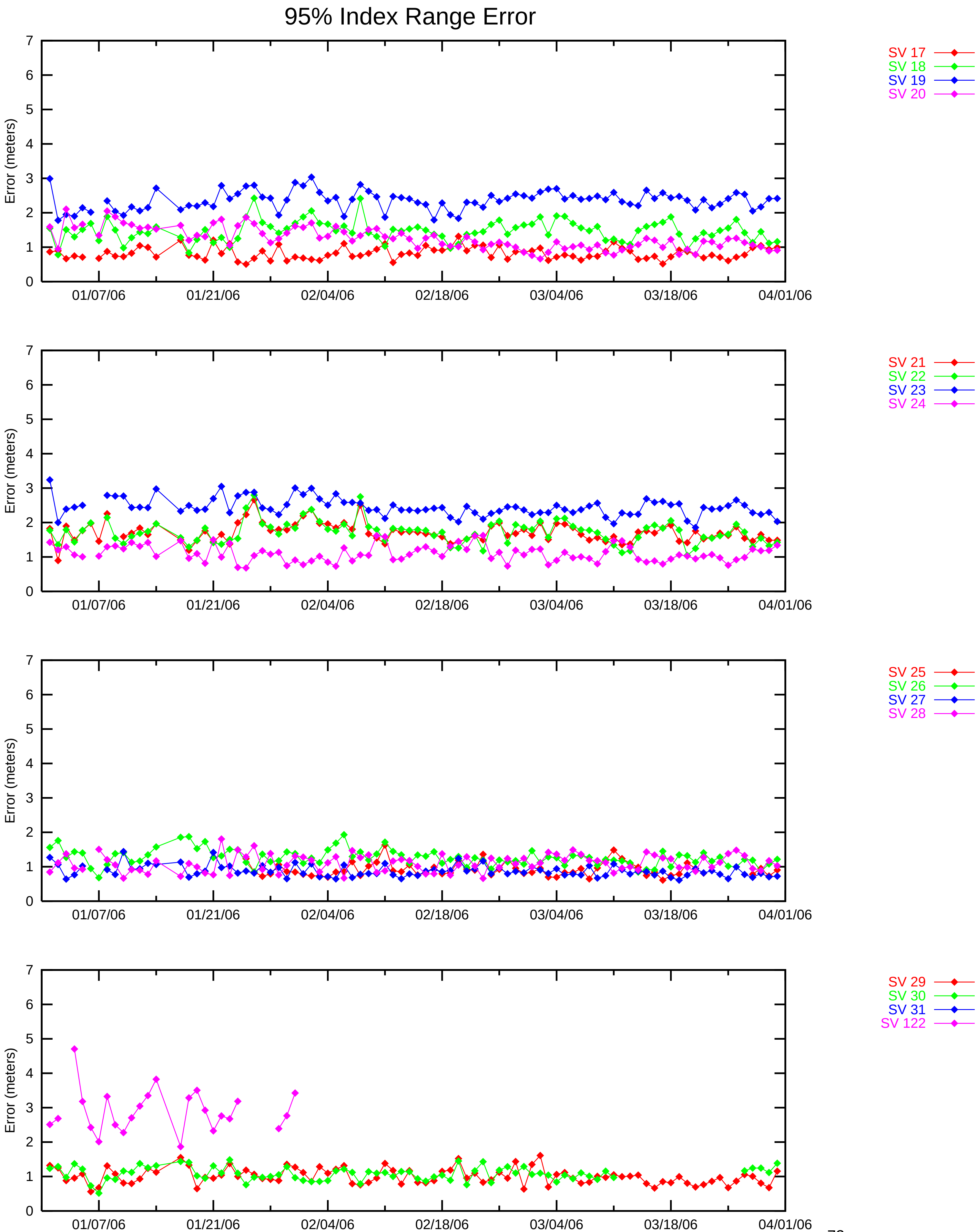


Figure 6-3 95% Ionospheric Error (SV 1 --SV 16) - Washington, DC

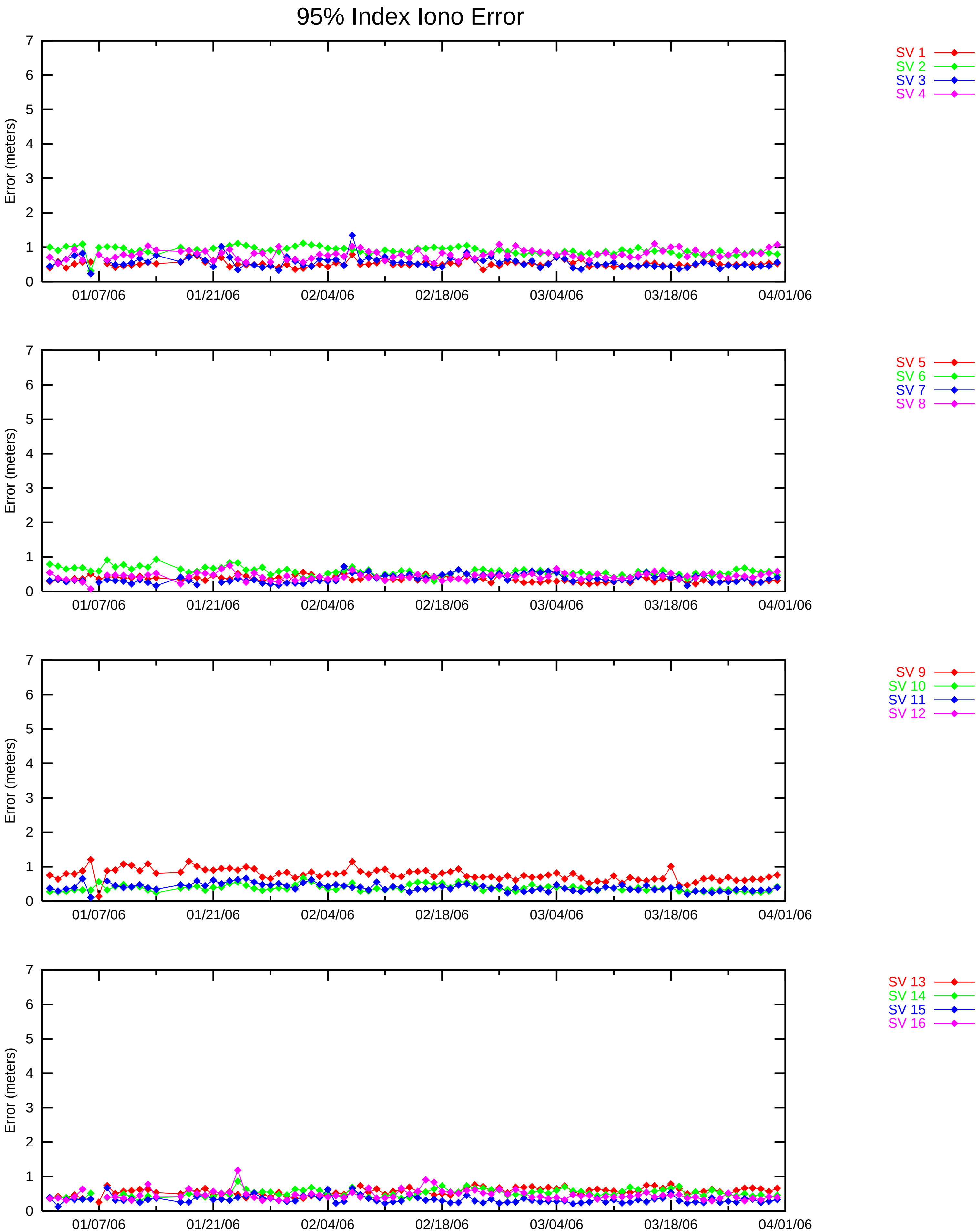
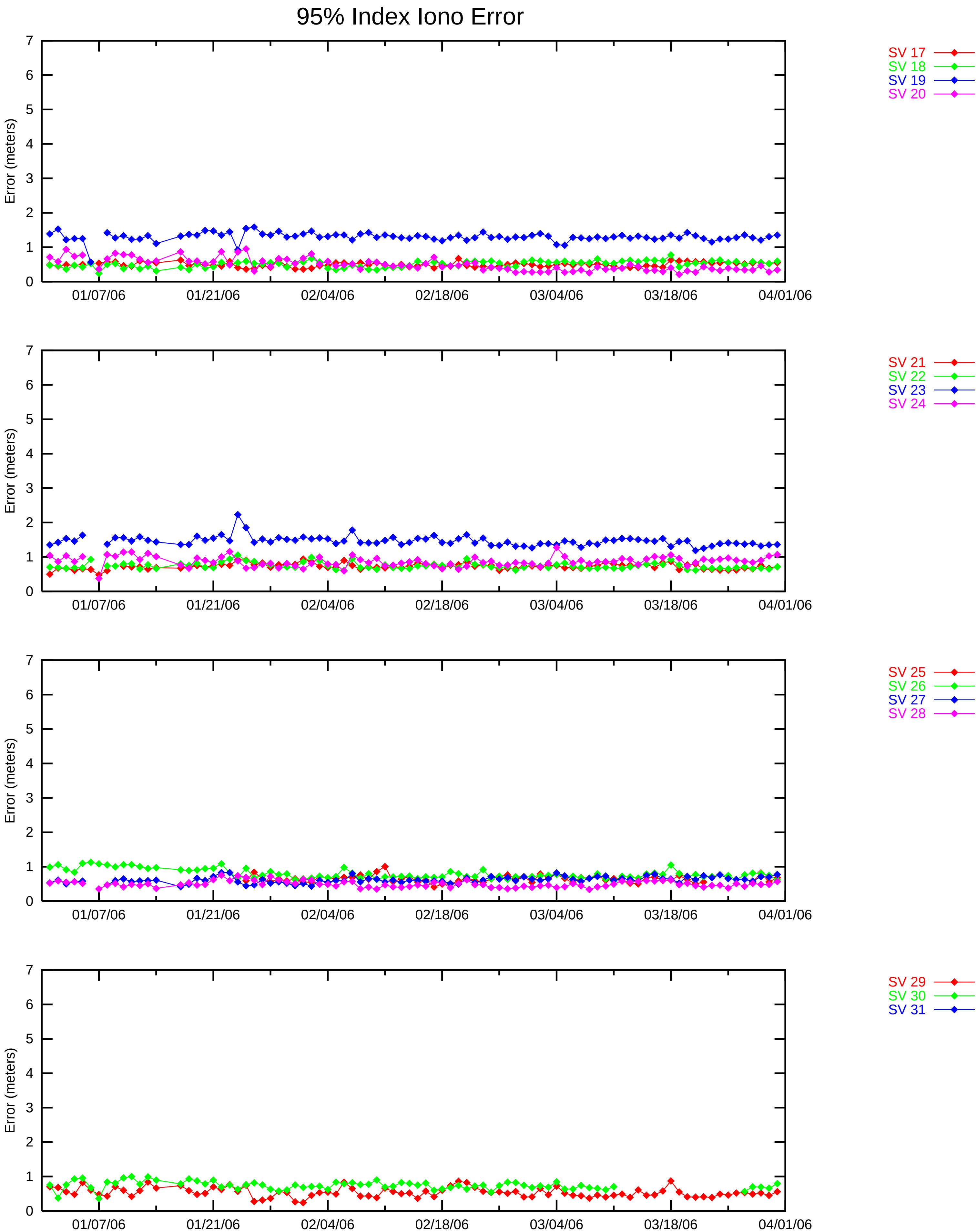


Figure 6-4 95% Ionospheric Error (SV 17 --SV 31) - Washington, DC



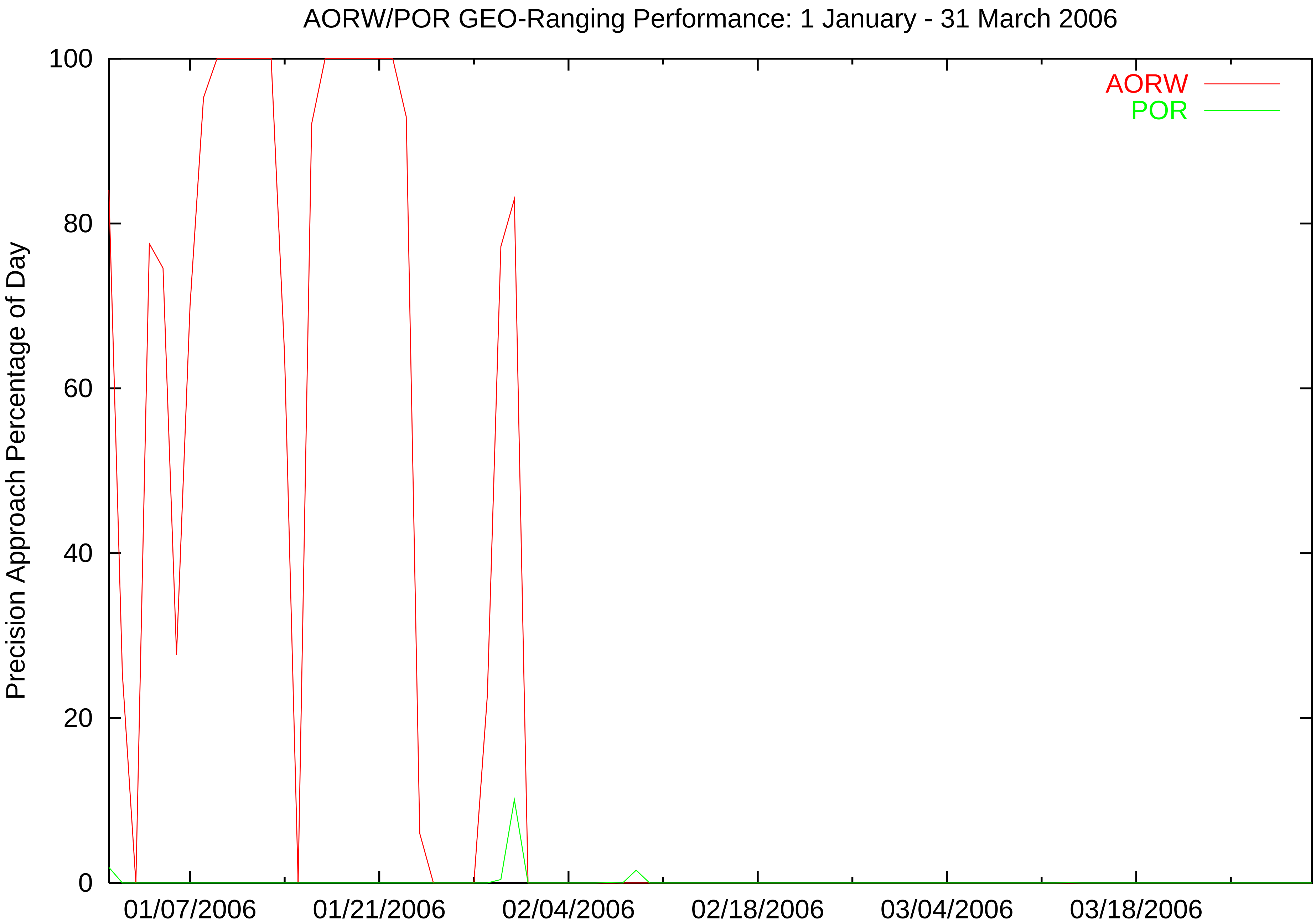
7.0 GEO RANGING PERFORMANCE

Table 7.1 shows the GEO-Ranging performance for AORW and POR satellites throughout the evaluated period. The percentage of PA ranging availability (i.e. the percentage of time a user receiver can use the GEO as a ranging source in a LNAV/VNAV or LPV position solution) for the AORW and POR is 22.138% and 0.156%, respectively. Figure 7.1 shows the trend of PA Ranging Availability for the AORW and POR satellite. The percentage of time the AOR-W GEO was available for PA ranging is lower this quarter as expected. The reason is the AOR-W GEO was being relocated to a different location and was not available during the transitional period. As in the past, the POR satellite as a ranging source has very low PA availability.

Table 7-1 GEO Ranging Availability

GEO	PA (%)	NPA (%)	Not Monitored (%)	Do Not Use (%)
AORW	22.138	5.702	66.607	5.498
POR	0.156	83.453	15.452	0.883

Figure 7-1 Daily PA GEO Ranging Availability Trend



8.0 WAAS PROBLEM SUMMARY

During this quarter there were several outages of the WAAS service. Some of these outages were related to satellite maintenance. Details of each of the outages were documented in WAAS Discrepancy Reports. This quarterly report lists each outage and a short description of why the outage occurred.

A common theme to several of the outages was related to satellite maintenance. The satellite absence as a PA ranging source is likely the cause of the loss of WAAS availability.

February 2, 2006 – The localized loss of LPV service over central CONUS was due to a response by the WAAS ionospheric storm detector that was apparently unrelated to any actual ionospheric activity. The outage lasted about 2040 second (from GPS Time 429300 to 431340).

February 9, 2006 – Loss of WAAS availability was observed over the CONUS service volume. SV 5 was down for maintenance and the loss of availability was due directly to the absence of SV 5 as a PA ranging source.

February 16, 2006 – An amplifier glitch at the Santa Paula-A GUS and a near-simultaneous failure at the Clarksburg GUS caused a 2002 second AOR-W signal in space outage.

February 22, 2006 – POR experienced a signal-in-space outage. The transponder offset at Santa Paula GUS caused a longer than expected switch from Brewster GUS that had a communication failure.

March 11, 2006 – Loss of LPV availability were most significant, namely in the Central Southwestern and Western regions of CONUS. SV 30 was down for maintenance and its absence as a ranging source is likely the cause of reduced availability over the CONUS service volume

March 16, 2006 – Loss of Availability was due to SV 4 outage.

March 22, 2006 – AOR-W and POR SIS outage were due to Loss Maneuver Bug.

9.0 WAAS AIRPORT AVAILABILITY

The WAAS airport availability evaluation determines the number and length LVP service outages at selected airports from the transmitted WAAS navigation message. The navigation messages transmitted from both AORW and POR GEO satellites are processed simultaneously, and WAAS protection levels (VPL and HPL) are computed at each airport once a second in accordance with the WAAS MOPS. Once the protection levels have been produced at each airport an LPV service evaluation is conducted to identify outages in service (i.e. when protection levels exceed alert limits). WAAS LPV service is available for a user when the vertical protection level (VPL) is less than or equal to vertical alert limit (VAL) of 50 meters and the horizontal protection level (HPL) is less than or equal to horizontal alert limit (HAL) of 40 meters. If both conditions are met at a specified airport location then WAAS LPV service is available at that airport. If either one of the conditions are not met at a specified airport location then WAAS LPV service at that airport is unavailable and an outage in LPV service is recorded with its duration. When the LPV service becomes unavailable it is not considered available again until protection levels are below or equal to alert limits for at least 15 minutes. Although this will reduce LPV service availability minimally, it substantially reduces the number of service outages and prevents excessive switching in and out of service availability. When computing LPV service availability an extra two minutes of outage time was prefixed to each outage. The number of WAAS LPV service outages and the availability at selected airports for the period from 1/1/2006 to 3/31/2006 of WAAS operation is presented in Table 9.1. Figures 9.1 and 9.2 provide a graphical representation of WAAS LPV service availability and outage counts for the same period, respectively.

Table 9-1 WAAS LPV Outages and Availability

Airport Id	Airport Name	City	State	Outages	Availability
YEG	EDMONTON INTL	EDMONTON	AB	121	0.988981
CGA	CRAIG	CRAIG	AK	94	0.992656
HYD	HKDER	HKDER	AK	97	0.992860
JNU	JUNEAU INTL AIRPORT	JUNEAU	AK	381	0.966654
KTN	KETCHIKAN AIRPORT	KETCHIKAN	AK	83	0.993180
PEC	PELICAN	PELICAN	AK	364	0.971026
PSG	PETERSBURG MUNICIPAL	PETERSBURG	AK	201	0.986741
SIT	SITKA AIRPORT	SITKA	AK	245	0.982085
EET	SHELBY COUNTY	ALABASTER	AL	18	0.999342
79J	ANDALUSIA-OPP	ANDALUSIA/OP	AL	17	0.999358
KBHM	BIRMINGHAM INTL	BIRMINGHAM	AL	18	0.999332
KDHN	DOTHAN REGIONAL	DOTHAN	AL	17	0.999393
HSV	HUNTSVILLE INTL – CARL T JONES FIELD	HUNTSVILLE	AL	18	0.999314
MOB	MOBILE REGIONAL	MOBILE	AL	17	0.999354
MGM	MONTGOMERY REGIONAL/ DANNELLY FIELD	MONTGOMERY	AL	18	0.999336
MSL	MUSCLE SHOALS NORTWEST ALABAMA REGIONAL	SHEFFIELD	AL	18	0.999331
M73	ALMYRA	ALMYRA	AR	17	0.999402
KVBT	BENTONVILLE MUNICIPAL/ LM THADDEN FIELD	BENTONVILLE	AR	17	0.999427
BYH	BLYTHEVILLE	BLYTHEVILLE	AR	18	0.999341
CDH	HARRELL FIELD	CAMDEN	AR	17	0.999425
KXNA	NORTHWEST ARKANSAS REGIONAL	FAYETTEVILLE/ SPRINGDALE/ROGERS	AR	17	0.999427
KFSM	FORT SMITH REGIONAL	FORT SMITH	AR	17	0.999426

HRO	BOONE COUNTY AIRPORT	HARRISON	AR	17	0.999425
LIT	ADAMS FIELD	LITTLE ROCK	AR	17	0.999421
SRC	SEARCY MUNICIPAL	SEARCY	AR	17	0.999415
ASG	SPRINGDALE MUNICIPAL	SPRINGDALE	AR	17	0.999427
KARG	WALNUT RIDGE REGIONAL	WALNUT RIDGE	AR	17	0.999406
IFP	LAUGHLIN/BULLHEAD INTL	BULLHEAD CITY	AZ	68	0.991049
KGCN	GRAND CANYON NATL PARK	GRAND CANYON	AZ	49	0.996388
KPHX	PHOENIX SKY HARBOR INTL	PHOENIX	AZ	118	0.986390
KPRC	ERNEST A LOVE FIELD	PRESCOTT	AZ	68	0.992908
KTUS	TUCSON INTL	TUCSON	AZ	213	0.969648
RQE	WINDOW ROCK	WINDOW ROCK	AZ	25	0.998098
BFL	BAKERSFIELD/MEADO WS FIELD	BAKERSFIELD	CA	190	0.979157
KCRQ	MC CLELLAN-PALOMAR	CARLSBAD	CA	335	0.942088
O60	CLOVERDALE MUNICIPAL	CLOVERDALE	CA	131	0.982078
KDAG	BARSTOW-DAGGETT	DAGGETT	CA	110	0.986342
IYK	INYOKERN	INYOKERN	CA	114	0.986850
KLAX	LOS ANGELES INTL	LOS ANGELES	CA	320	0.959466
KOAK	METROPOLITAN OAKLAND INTL	OAKLAND	CA	141	0.982109
ONT	ONTARIO INTL	ONTARIO	CA	252	0.969886
KPMD	PALMDALE PROD FLT/ TEST INSTLN	PALMDALE	CA	215	0.977555
KMHR	SACRAMENTO MATHER	SACRAMENTO	CA	102	0.989078
KSMF	SACRAMENTO INTL	SACRAMENTO	CA	101	0.988764
SAN	SAN DIEGO INTL – LINDBERGH FIELD	SAN DIEGO	CA	376	0.927110
KSFO	SAN FRANCISCO INTL	SAN FRANCISCO	CA	147	0.980809
SJC	SAN JOSE INTL	SAN JOSE	CA	144	0.981964
SVE	SUSANVILLE MUNICIPAL	SUSANVILLE	CA	67	0.993440
TNP	TWENTYNINE PALMS	TWENTYNINE PALMS	CA	161	0.983087
AKO	AKRON-COLORADO PLAINS REGIONAL	AKRON	CO	19	0.999333
COS	COLORADO SPRINGS	COLORADO SPRINGS	CO	25	0.998869
CEZ	CORTEZ MUNICIPAL	CORTEZ	CO	29	0.998434
KDEN	DENVER INTL	DENVER	CO	19	0.999167
HDN	YAMPA VALLEY	HAYDEN	CO	27	0.998560
LHX	LA JUNTA MUNICIPAL	LA JUNTA	CO	24	0.998965
LAA	LAMAR MUNICIPAL	LAMAR	CO	21	0.999105
2V2	VANCE BRAND	LONGMONT	CO	20	0.999162
EEO	MEEKER	MEEKER	CO	29	0.998490
TAD	PERRY STOKES	TRINIDAD	CO	26	0.998619
2V5	WRAY	WRAY	CO	18	0.999447
KBDL	BRADLEY INTL	WINDSOR LOCKS	CT	81	0.995677

KDCA	RONALD REAGAN WASHINGTON INTL	WASHINGTON	DC	18	0.999223
KIAD	WASHINGTON DULLES INTL	WASHINGTON	DC	18	0.999236
KFLL	FORT LAUDERDALE/ HOLLYWOOD INTL	FORT LAUDERDALE	FL	66	0.996733
FXE	FORT LAUDERDALE EXECUTIVE AIRPORT	FORT LAUDERDALE	FL	64	0.997025
KRSW	SOUTHWEST FLORIDA INTL	FORT MYERS	FL	56	0.997273
KGNV	GAINESVILLE REGIONAL	GAINESVILLE	FL	18	0.999384
KJAX	JACKSONVILLE INTL	JACKSONVILLE	FL	18	0.999369
KMIA	MIAMI INTL	MIAMI	FL	69	0.996179
KAPF	NAPLES MUNICIPAL	NAPLES	FL	58	0.996753
KOCF	OCALA INTL-JIM TAYLOR FIELD	OCALA	FL	21	0.999250
KMCO	ORLANDO INTL	ORLANDO	FL	24	0.999076
KPFN	PANAMA CITY-BAY COUNTY INTL	PANAMA CITY	FL	17	0.999383
KPNS	PENSACOLA REGIONAL	PENSACOLA	FL	17	0.999339
SRQ	SARASOTA/BRADENTO N INTL	SARASOTA/BRADENTO N	FL	38	0.998057
KPIE	ST PETERSBURG – CLEARWATER INTL	ST PETERSBURG-CLEARWATER	FL	35	0.998124
KTLH	TALLAHASSEE REGIONAL	TALLAHASSEE	FL	17	0.999392
TPA	TAMPA INTL	TAMPA	FL	28	0.998635
KVRB	VERO BEACH MUNICIPAL	VERO BEACH	FL	28	0.998735
KPBI	PALM BEACH INTL	WEST PALM BEACH	FL	50	0.997851
KACJ	SOUTHER FIELD	AMERICUS	GA	18	0.999357
KATL	WILLIAM B HARTSFIELD ATLANTA INTL	ATLANTA	GA	18	0.999323
KSAV	SAVANNAH INTL	SAVANNAH	GA	18	0.999341
KTBR	STATESBORO-BULLOCH COUNTY	STATESBORO	GA	18	0.999344
KIKV	ANKENY REGIONAL	ANKENY	IA	17	0.999453
CID	THE EASTERN IOWA	CEDAR RAPIDS	IA	17	0.999461
DSM	DES MOINES INTL	DES MOINES	IA	17	0.999453
KMXO	MONTICELLO REGIONAL	MONTICELLO	IA	18	0.999406
KBOI	BOISE AIR TERMINAL/ GOWEN FIELD	BOISE	ID	17	0.999291
EUL	CALDWELL INDUSTRIAL	CALDWELL	ID	17	0.999272
SUN	FRIEDMAN MEMORIAL	HAILEY	ID	9	0.999494
PIH	POCATELLO REGIONAL	POCATELLO	ID	10	0.999477
SZT	SANDPOINT	SANDPOINT	ID	21	0.998634
KENL	CENTRALIA MUNICIPAL	CENTRALIA	IL	18	0.999295
KORD	CHICAGO-O'HARE INTL	CHICAGO	IL	18	0.999296
MDW	CHICAGO MIDWAY	CHICAGO	IL	18	0.999296

KARR	AURORA MUNICIPAL	CHICAGO/AURORA	IL	18	0.999302
KFOA	FLORA MUNICIPAL	FLORA	IL	18	0.999279
MLI	QUAD-CITY	MOLINE	IL	18	0.999373
KPIA	GREATER PEORIA REGIONAL	PEORIA	IL	18	0.999348
KPPQ	PITTSFIELD PENSTONE MUNICIPAL	PITTSFIELD	IL	18	0.999411
KTIP	RANTOUL NATL AVN CTR FRANK ELLIOT FIELD	RANTOUL	IL	18	0.999316
KRFD	GREATER ROCKFORD	ROCKFORD	IL	18	0.999314
KSLO	SALEM-LECKRONE	SALEM	IL	18	0.999291
3CK	LAKE IN THE HILLS	UNKNOWN	IL	18	0.999299
KANQ	TRI-STATE STEUBEN COUNTY	ANGOLA	IN	19	0.999176
KBMG	MONROE COUNTY	BLOOMINGTON	IN	18	0.999299
0I2	BRAZIL CLAY COUNTY	BRAZIL	IN	18	0.999310
CEV	METTEL FIELD	CONNERSVILLE	IN	18	0.999280
FWA	FORT WAYNE INTL	FORT WAYNE	IN	18	0.999277
KIND	INDIANAPOLIS INTL	INDIANAPOLIS	IN	18	0.999296
SER	FREEMAN MUNICIPAL	SEYMOUR	IN	18	0.999289
SBN	MICHIANA REGIONAL TRANSPORTATION CTR	SOUTH BEND	IN	19	0.999204
KCBK	SHALTZ FIELD	COLBY	KS	18	0.999445
EHA	ELKHART-MORTON COUNTY	ELKHART	KS	21	0.999084
GLD	RENNER FIELD/ GOODLAND MUNICIPAL	GOODLAND	KS	18	0.999446
KHYS	HAYS REGIONAL	HAYS	KS	17	0.999446
LWC	LAWRENCE MUNICIPAL	LAWRENCE	KS	17	0.999426
KMHK	MANHATTAN REGIONAL	MANHATTAN	KS	17	0.999426
KOJC	JOHNSON COUNTY EXECUTIVE	OLATHE	KS	17	0.999428
TOP	PHILIP BILLARD MUNICIPAL	TOPEKA	KS	17	0.999426
KULS	ULYSSES	ULYSSES	KS	19	0.999265
ICT	WICHITA MID-CONTINENT	WICHITA	KS	17	0.999426
KWLD	STROTHER FIELD	WINFIELD/ARKANSAS CITY	KS	17	0.999426
KCVG	CINCINNATI/NORTHERN KY INTL	COVINGTON/CINCINNATI	KY	18	0.999276
KLEX	BLUE GRASS	LEXINGTON	KY	18	0.999282
LOZ	LONDON	LONDON	KY	18	0.999295
SDF	LOUISVILLE INTL – STANDIFORD FIELD	LOUISVILLE	KY	18	0.999294
KK22	BIG SANDY REGIONAL	PRESTONBURG	KY	18	0.999266
SME	SOMERSET-PULASKI COUNTY	SOMERSET	KY	18	0.999305
KAEX	ALEXANDRIA INTL	ALEXANDRIA	LA	17	0.999396

DRI	DE RIDDER/ BEAUREGARD PAIRISH APT	BEAUREGARD	LA	18	0.999327
LCH	LAKE CHARLES REGIONAL	LAKE CHARLES	LA	22	0.999047
L39	LEESVILLE	LEESVILLE	LA	18	0.999349
MSY	NEW ORLEANS INTL/ MOISANT FIELD	NEW ORLEANS	LA	20	0.999282
SHV	SHREVEPORT REGIONAL	SHREVEPORT	LA	18	0.999407
KBOS	GEN EDWARD LAWRENCE LOGAN INTL	BOSTON	MA	108	0.991569
MVY	VINEYARD HAVEN	MARTHA'S VINEYARD	MA	103	0.991720
OWD	NORWOOD MEMORIAL	NORWOOD	MA	105	0.992027
KPVC	PROVINCETOWN MUNICIPAL	PROVINCETOWN	MA	117	0.969390
YWG	WINNIPEG AIRPORT	WINNIPEG	MB	158	0.981834
KBWI	BALTIMORE-WASHINGTON INTL	BALTIMORE	MD	18	0.999220
FDK	FREDERICK MUNICIPAL	FREDERICK	MD	18	0.999226
GAI	MONTGOMERY COUNTY AIRPARK	GAITHERSBURG	MD	18	0.999225
W00	FREEWAY	MITCHELLVILLE	MD	18	0.999220
RJD	RIDGELY AIRPARK	RIDGELY	MD	18	0.999209
DMW	CARROLL CNTY REGIONAL/ JACK B. POAGE FIELD	WESTMINSTER	MD	18	0.999222
PWM	PORTLAND INTL JETPORT	PORTLAND	ME	147	0.961642
KPQI	N MAINE REGIONAL AIRPORT AT PRESQUE I	PRESQUE ISLE	ME	588	0.818954
AMN	ALMA/GRATIOT COMMUNITY	ALMA	MI	19	0.999127
KARB	ANN ARBOR MUNICIPAL	ANN ARBOR	MI	19	0.999163
Y15	CHEBOYGAN COUNTY	CHEBOYGAN	MI	45	0.998240
KDTW	DETROIT METROPOLITAN WAYNE CTY	DETROIT	MI	19	0.999178
KFNT	BISHOP INTL	FLINT	MI	19	0.999157
KGRR	GERALD R FORD INTL	GRAND RAPIDS	MI	19	0.999120
KCMX	HOUGHTON COUNTY MEMORIAL	HANCOCK	MI	99	0.992452
BIV	TULIP CITY	HOLLAND	MI	19	0.999114
HTL	ROSCOMMON COUNTY	HOUGHTON LAKE	MI	20	0.999072
KMKG	MUSKEGON COUNTY	MUSKEGON	MI	19	0.999109
5D3	OWOSSO COMMUNITY	OWOSSO	MI	19	0.999147
KMBS	MBS INTL	SAGINAW	MI	19	0.999133
CIU	CHIPPEWA COUNTY INTL	SAULT STE. MARIE	MI	53	0.996865

HAI	THREE RIVERS MUNICIPAL DR. HAINES	UNKNOWN	MI	19	0.999150
HYX	SAGINAW CO H.W. BROWNE	UNKNOWN	MI	19	0.999141
KAXN	CHANDLER FIELD	ALEXANDRIA	MN	25	0.998767
KBDE	BAUDETTE INTL	BAUDETTE	MN	82	0.995042
KBRD	BRAINERD-CROW WING CO REGIONAL	BRAINERD	MN	29	0.998643
KDLH	DULUTH INTL	DULUTH	MN	45	0.997641
KMSP	MINNEAPOLIS-ST PAUL INTL/ WOLD CHAMBERLAIN	MINNEAPOLIS	MN	19	0.999299
KRGK	RED WING REGIONAL	RED WING	MN	19	0.999422
KRST	ROCHESTER INTL	ROCHESTER	MN	18	0.999442
STC	ST. CLOUD	SAINT CLOUD	MN	23	0.998921
KJYG	ST JAMES MUNICIPAL	ST JAMES	MN	19	0.999373
M05	CARUTHERSVILLE MEMORIAL	CARUTHERSVILLE	MO	18	0.999333
KMCI	KANSAS CITY INTL	KANSAS CITY	MO	17	0.999425
KLBO	FLOYD W JONES LEBANON	LEBANON	MO	17	0.999426
LXT	LEE'S SUMMIT MUNICIPAL	LEE'S SUMMIT	MO	17	0.999425
H41	MEXICO MEMORIAL	MEXICO	MO	17	0.999425
MYJ	MEXICO MEMORIAL	MEXICO	MO	17	0.999425
STJ	ROSECRANS MEMORIAL	ROSECRANS	MO	17	0.999424
KDMO	SEDALIA MEMORIAL	SEDALIA	MO	17	0.999424
SGF	SPRINGFIELD – BRANSON REGIONAL	SPRINGFIELD	MO	17	0.999425
KSTL	LAMBERT-ST LOUIS INTL	ST LOUIS	MO	18	0.999361
KMO6	WASHINGTON MEMORIAL	WASHINGTON	MO	17	0.999424
0M6	PANOLA COUNTY	BATESVILLE	MS	17	0.999386
GWO	GREENWOOD-LEFLORE	GREENWOOD	MS	17	0.999386
JAN	JACKSON INTL	JACKSON	MS	17	0.999385
MPE	PHILADELPHIA MUNICIPAL	PHILADELPHIA	MS	17	0.999385
CRX	ROSCOE TURNER	UNKNOWN	MS	18	0.999346
KBIL	BILLINGS LOGAN INTL	BILLINGS	MT	21	0.999059
6S5	RAVALLI COUNTY	HAMILTON	MT	26	0.998463
KHLN	HELENA REGIONAL	HELENA	MT	31	0.998802
KLWT	LEWISTOWN MUNICIPAL	LEWISTOWN	MT	23	0.998683
KMLS	FRANK WILEY FIELD	MILES CITY	MT	23	0.998731
KHBI	ASHEBORO MUNICIPAL	ASHEBORO	NC	18	0.999310
KAVL	ASHEVILLE REGIONAL	ASHEVILLE	NC	18	0.999318
MRH	MICHAEL J. SMITH FIELD	BEAUFORT	NC	18	0.999287
KCLT	CHARLOTTE/DOUGLAS INTL	CHARLOTTE	NC	18	0.999306

ECG	ELIZABETH CITY CGAS	ELIZABETH CITY	NC	18	0.999259
KFAY	FAYETTEVILLE REGIONAL/ GRANNIS FIELD	FAYETTEVILLE	NC	18	0.999331
GSO	PIEDMONT TRIAD INTL	GREENSBORO	NC	18	0.999309
PGV	PITT-GREENVILLE	GREENVILLE	NC	18	0.999289
HSE	BILLY MITCHELL	HATTERAS	NC	18	0.999283
HKY	HICKORY REGIONAL	HICKORY	NC	18	0.999299
KISO	KINSTON RGNL JETPORT AT STALLINGS FIELD	KINSTON	NC	18	0.999299
MEB	LAURINBURG	MAXTON	NC	18	0.999330
KEQY	MONROE	MONROE	NC	18	0.999305
KRDU	RALEIGH-DURHAM INTL	RALEIGH/DURHAM	NC	18	0.999309
RWI	ROCKY MOUNT – WILSON REGIONAL	ROCKY MOUNT	NC	18	0.999292
KRUQ	ROWAN COUNTY	SALISBURY	NC	18	0.999288
KTTA	SANFORD – LEE COUNTY REGIONAL	SANFORD	NC	18	0.999322
SUT	BRUNSWICK COUNTY	SOUTHPORT	NC	18	0.999338
OCW	WARREN FIELD	WASHINGTON	NC	18	0.999283
MCZ	MARTIN COUNTY	WILLIAMSTON	NC	18	0.999279
KILM	WILMINGTON INTL	WILMINGTON	NC	18	0.999327
W03	WILSON INDUSTRIAL AIR CENTER	WILSON	NC	18	0.999296
KFAR	HECTOR INTL	FARGO	ND	37	0.997720
MOT	MINOT INTL AIRPORT	MINOT	ND	41	0.997480
KANW	AINSWORTH MUNICIPAL	AINSWORTH	NE	18	0.999277
AUH	AURORA MUNICIPAL	AURORA	NE	17	0.999439
BIE	BEATRICE MUNICIPAL	BEATRICE	NE	17	0.999449
CSB	CAMBRIDGE MUNICIPAL	CAMBRIDGE	NE	17	0.999458
CEK	CRETE MUNICIPAL	CRETE	NE	17	0.999439
GRN	GORDON MUNICIPAL	GORDON	NE	20	0.999217
KEAR	KEARNEY MUNICIPAL	KEARNEY	NE	17	0.999453
KLBF	NORTH PLATTE REGIONAL LEE BIRD FIELD	NORTH PLATTE	NE	18	0.999431
OMA	EPPLEY AIRFIELD	OMAHA	NE	17	0.999424
OKS	GARDEN COUNTY	OSHKOSH	NE	19	0.999334
SCB	SCRIBNER STATE	SCRIBNER	NE	17	0.999424
SNY	SIDNEY MUNICIPAL	SIDNEY	NE	19	0.999346
VTN	MILLER FIELD	VALENTINE	NE	18	0.999248
MHT	MANCHESTER	MANCHESTER	NH	104	0.991802
KACY	ATLANTIC CITY INTL	ATLANTIC CITY	NJ	20	0.999131
KMMU	MORRISTOWN MUNICIPAL	MORRISTOWN	NJ	34	0.998570
KEWR	NEWARK INTL	NEWARK	NJ	37	0.998412
7N7	SPITFIRE AERODROM	PEDRICTOWN	NJ	18	0.999207
K3NJ6	INDUCTOTHERM HELIPORT	RANCOCAS	NJ	20	0.999135

KABQ	ALBUQUERQUE INTL SUNPORT	ALBUQUERQUE	NM	36	0.997710
KFMN	FOUR CORNERS REGIONAL	FARMINGTON	NM	32	0.998318
KLRU	LAS CRUCES INTL	LAS CRUCES	NM	93	0.986982
ELY	ELY AIRPORT/YELLAND FELD	ELY	NV	18	0.998511
KLAS	MC CARRAN INTL	LAS VEGAS	NV	55	0.993504
ALB	ALBANY INTL	ALBANY	NY	55	0.996913
BUF	BUFFALO NIAGARA INTL	BUFFALO	NY	19	0.999114
KELM	ELMIRA/CORNING REGIONAL	ELMIRA	NY	19	0.999172
LGA	LA GUARDIA	FLUSHING	NY	41	0.998071
GFL	FLOYD BENNETT MEMORIAL	GLENS FALLS	NY	59	0.996561
KJHW	CHAUTAUQUA COUNTY/ JAMESTOWN	JAMESTOWN	NY	19	0.999211
LKP	LAKE PLACID	LAKE PLACID	NY	62	0.996292
KJFK	JOHN F KENNEDY INTL	NEW YORK	NY	40	0.998084
KSWF	STEWART INTL	NEWBURGH	NY	37	0.998109
PBG	PLATTSGURGH INTL	PLATTSGURGH	NY	68	0.995154
ROC	GREATER ROCHESTER INTL	ROCHESTER	NY	21	0.999026
KSYR	SYRACUSE HANCOCK INTL	SYRACUSE	NY	21	0.998973
B16	WHITFORDS	WEEDSPORT	NY	21	0.998992
FOK	THE FRANCIS S. GABRESKI	WESTHAMPTON BEACH	NY	61	0.996746
HPN	WESTCHESTER COUNTY	WHITE PLAINS	NY	42	0.997870
4F5	BELLEFONTAINE MUNICIPAL AIRPORT	BELLEFONTAINE	OH	18	0.999258
KRZT	ROSS COUNTY	CHILLICOTHE	OH	18	0.999258
KCLE	CLEVELAND-HOPKINS INTL	CLEVELAND	OH	19	0.999290
KCMH	PORT COLUMBUS INTL	COLUMBUS	OH	18	0.999259
OSU	OHIO STATE UNIVERSITY	COLUMBUS	OH	18	0.999255
KDAY	JAMES M COX DAYTON INTL	DAYTON	OH	18	0.999269
1G5	MEDINA MUNICIPAL	MEDINA	OH	18	0.999306
KTOL	TOLEDO EXPRESS	TOLEDO	OH	19	0.999182
I68	LEBANON-WARREN COUNTY	UNKNOWN	OH	18	0.999273
KAVK	ALVA REGIONAL	ALVA	OK	18	0.999410
KCQB	CHANDLER MUNICIPAL	CHANDLER	OK	17	0.999426
CHK	CHICKASHA	CHICKASHA	OK	18	0.999313
GCM	CLAREMORE REGIONAL	CLAREMORE	OK	17	0.999426
DUA	EAKER FIELD AIRPORT	EAKER	OK	18	0.999358
2O8	HINTON MUNICPAL	HINTON	OK	18	0.999303
KHBR	HOBART MUNICIPAL	HOBART	OK	18	0.999229

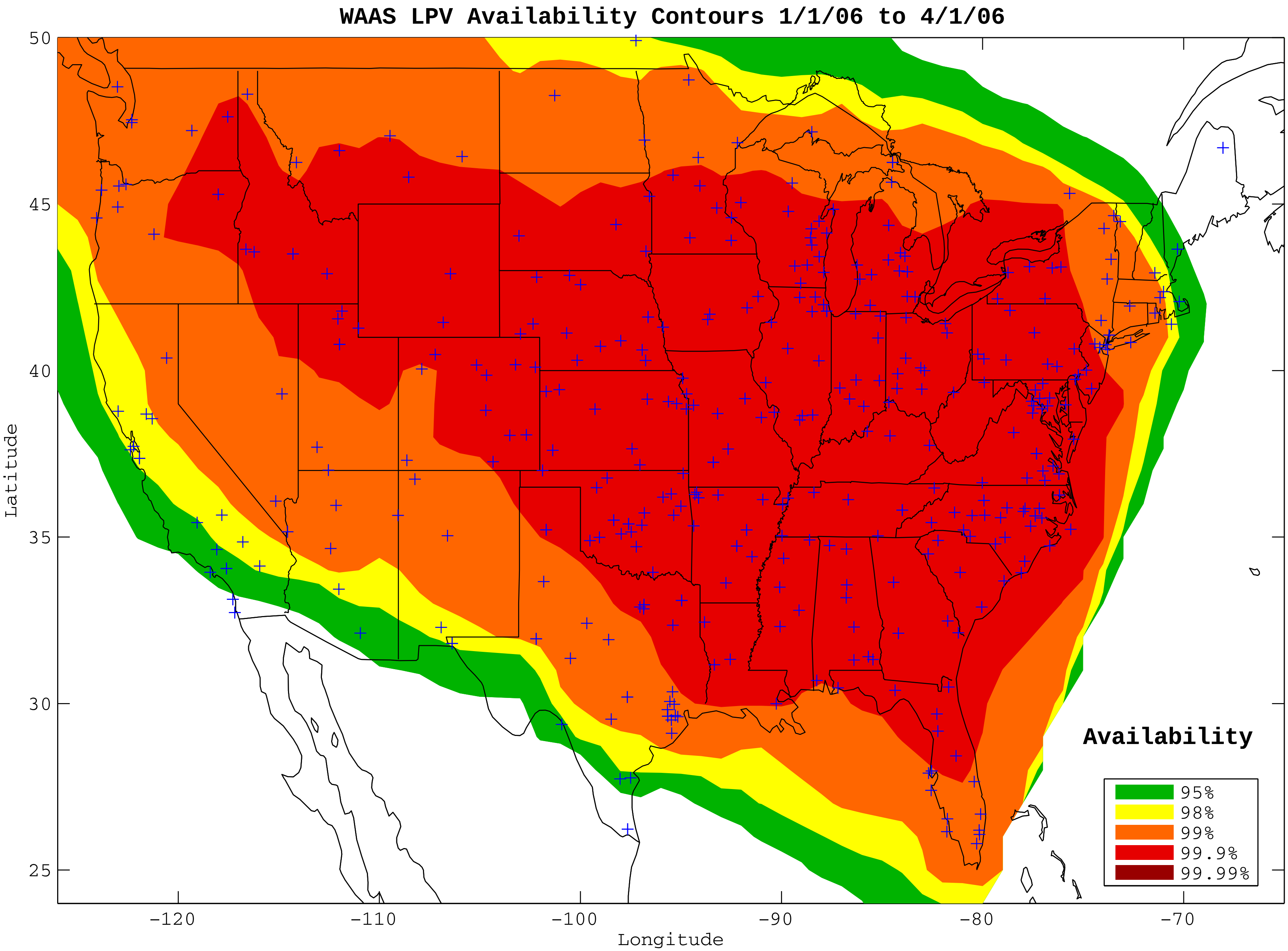
K2K4	SCOTT FIELD	MANGUM	OK	20	0.999035
MIO	MIAMI	MIAMI	OK	17	0.999427
MDF	MORELAND MUNICIPAL	MORELAND	OK	18	0.999325
KMKO	DAVIS FIELD	MUSKOGEE	OK	17	0.999426
OKC	WILL ROGERS WORLD AIRPORT	OKLAHOMA CITY	OK	18	0.999384
PVJ	PAULS VALLEY MUNICIPAL AIRPORT	PAULS VALLEY	OK	18	0.999327
PNC	PONCA CITY	PONCA CITY	OK	17	0.999426
SNL	SHAWNEE	SHAWNEE	OK	17	0.999425
TQH	TAHLEQUAH	TAHLEQUAH	OK	17	0.999427
KTUL	TULSA INTL	TULSA	OK	17	0.999426
1K4	DAVID J PERRY	UNKNOWN	OK	18	0.999375
YOW	OTTAWA AIRPORT	OTTAWA	ON	32	0.998208
S07	BEND MUNICIPAL	BEND	OR	18	0.998737
HIO	PORTLAND-HILLSBORO	HILLSBORO	OR	34	0.997714
LGD	UNION COUNTY	LA GRANDE	OR	13	0.999349
KONP	NEWPORT MUNICIPAL	NEWPORT	OR	47	0.994641
PDX	PORTLAND INTL	PORTLAND	OR	22	0.998104
SLE	MCNARY FIELD	SALEM	OR	42	0.996286
S47	TILLAMOOK	TILLAMOOK	OR	43	0.995712
ABE	LEHIGH VALLEY INTL	ALLENTOWN	PA	19	0.999178
KBFD	BRADFORD REGIONAL	BRADFORD	PA	18	0.999240
MDT	HARRISBURG INTL	HARRISBURG	PA	18	0.999216
KJST	JOHN MURTHA JOHNSTOWN-CAMBRIA COUNTY	JOHNSTOWN	PA	18	0.999266
LNS	LANCASTER	LANCASTER	PA	18	0.999211
LHV	WILLIAM T. PIPER MEMORIAL	LOCK HAVEN	PA	18	0.999223
PHL	PHILADELPHIA INTL	PHILADELPHIA	PA	19	0.999185
KAGC	ALLEGHENY COUNTY	PITTSBURGH	PA	18	0.999281
KPIT	PITTSBURGH INTL	PITTSBURGH	PA	18	0.999287
PVD	THEODORE FRANCIS GREEN STATE	PROVIDENCE	RI	101	0.993141
AND	ANDERSON REGIONAL	ANDERSON	SC	18	0.999344
KCHS	CHARLESTON AFB/INTL	CHARLESTON	SC	18	0.999343
KCAE	COLUMBIA METROPOLITAN	COLUMBIA	SC	18	0.999337
KGSP	GREENVILLE – SPARTANBURG INTL	GREER	SC	18	0.999329
KMYR	MYRTLE BEACH INTL	MYRTLE BEACH	SC	18	0.999346
KHON	HURON REGIONAL	HURON	SD	19	0.999209
1D1	MILBANK MUNICIPAL	MILBANK	SD	22	0.999017
KRAP	RAPID CITY REGIONAL	RAPID CITY	SD	20	0.999147
FSD	JOE FOSS FIELD	SIOUX FALLS	SD	18	0.999334
YXE	SASKATOON AIRPORT	SASKATOON	SK	227	0.973011
CHA	LOVELL FIELD	CHATTANOOGA	TN	18	0.999296
TYS	MC GHEE TYSON	KNOXVILLE	TN	18	0.999325
KMEM	MEMPHIS INTL	MEMPHIS	TN	18	0.999363
KBNA	NASHVILLE INTL	NASHVILLE	TN	18	0.999280
PHT	HENRY COUNTY	PARIS	TN	18	0.999312

TRI	TRI-CITIES REGIONAL TN/ VA AIRPORT	UNKNOWN	TN	18	0.999296
KABI	ABILENE REGIONAL	ABILENE	TX	37	0.997858
ALI	ALICE	ALICE	TX	172	0.976610
AMA	AMARILLO INTL	AMARILLO	TX	24	0.998798
KLBX	BRAZORIA COUNTY	ANGLETON/LAKE JACKSON	TX	67	0.995305
AUS	AUSTIN-BERGSTROM INTL	AUSTIN	TX	62	0.995229
7F9	COMANCHE	COMANCHE	TX	35	0.997913
KCXO	MONTGOMERY COUNTY	CONROE	TX	32	0.998567
CRP	CORPUS CHRISTI INTL	CORPUS CHRISTI	TX	165	0.977565
KDAL	DALLAS LOVE FIELD	DALLAS	TX	18	0.999230
ADS	ADDISON	DALLAS	TX	18	0.999245
KDFW	DALLAS-FT WORTH INTL	DALLAS-FT WORTH	TX	18	0.999207
KDRT	DEL RIO INTL	DEL RIO	TX	103	0.984742
ELP	EL PASO INTL	EL PASO	TX	108	0.984948
KHRL	VALLEY INTL	HARLINGEN	TX	630	0.899241
KAXH	HOUSTON-SOUTHWEST	HOUSTON	TX	54	0.997049
KDWH	DAVID WAYNE HOOKS MEMORIAL	HOUSTON	TX	39	0.998223
KEFD	ELLINGTON FIELD	HOUSTON	TX	49	0.997536
KHOU	WILLIAM P HOBBY	HOUSTON	TX	49	0.997538
KIAH	GEORGE BUSH INTERCONTINENTAL/HOUSTON	HOUSTON	TX	41	0.998150
KIWS	WEST HOUSTON	HOUSTON	TX	50	0.997642
KSGR	SUGAR LAND MUNICIPAL/ HULL FIELD	HOUSTON	TX	50	0.997318
KLBB	LUBBOCK INTL	LUBBOCK	TX	42	0.997698
MAF	MIDLAND INTL	MIDLAND	TX	68	0.991184
OSA	MOUNT PLEASANT MUNICIPAL	MOUNT PLEASANT	TX	18	0.999385
KSJT	SAN ANGELO REGIONAL/ MATHIS FIELD	SAN ANGELO	TX	67	0.993048
KSAT	SAN ANTONIO INTL	SAN ANTONIO	TX	85	0.991885
SGR	SUGARLAND MUNICIPAL/ HULL FIELD	SUGAR LAND	TX	50	0.997318
KTYR	TYLER POUNDS REGIONAL	TYLER	TX	18	0.999308
BMC	BRIGHAM CITY	BRIGHAM CITY	UT	19	0.998962
KCDC	CEDAR CITY REGIONAL	CEDAR CITY	UT	22	0.998431
KKNB	KANAB MUNICIPAL	KANAB	UT	36	0.997958
LGU	LOGAN-CACHE	LOGAN	UT	18	0.999204
SLC	SALT LAKE CITY INTL	SALT LAKE CITY	UT	20	0.998891
KCHO	CHARLOTTESVILLE-ALBEMARLE	CHARLOTTESVILLE	VA	18	0.999267

FKN	FRANKLIN MUNICIPAL – JOHN BEVERLY ROSE	FRANKLIN	VA	18	0.999255
LVL	BRUNSWICK MUNICIPAL	LAWRENCEVILLE	VA	18	0.999267
JYO	LEESBURG MUNICIPAL/ GODFREY FIELD	LEESBURG	VA	18	0.999239
HEF	MANASSAS REGIONAL/ HARRY P. DAVIS FIELD	MANASSAS	VA	18	0.999241
MTV	BLUE RIDGE	MARTINSVILLE	VA	18	0.999307
KPHF	NEWPORT NEWS/ WILLIAMSBURG INTL	NEWPORT NEWS	VA	18	0.999241
KORF	NORFOLK INTL	NORFOLK	VA	18	0.999239
RIC	RICHMOND INTL	RICHMOND	VA	18	0.999243
AKQ	WAKEFIELD MUNICIPAL	WAKEFIELD	VA	18	0.999249
WAL	WALLOPS FLIGHT FACILITY	WALLOPS ISLAND	VA	18	0.999219
BTV	BURLINGTON INTL	BURLINGTON	VT	75	0.994697
FHR	FRIDAY HARBOR	FRIDAY HARBOR	WA	30	0.997711
KMWH	GRANT COUNTY INTL	MOSES LAKE	WA	22	0.998488
KSEA	SEATTLE-TACOMA INTL	SEATTLE	WA	25	0.997970
BFI	BOEING FIELD/ KING COUNTY INTL	SEATTLE	WA	25	0.997962
KGEG	SPOKANE INTL	SPOKANE	WA	18	0.998971
KATW	OUTAGAMIE COUNTY REGIONAL	APPLETON	WI	19	0.999288
3T3	BOYCEVILLE MUNICIPAL	BOYCEVILLE	WI	20	0.999301
FLD	FOND DU LAC COUNTY	FOND DU LAC	WI	18	0.999305
KGRB	AUTIN STRAUBEL INTL	GREEN BAY	WI	19	0.999280
JVL	SOUTHERN WISCONSIN REGIONAL AIRPORT	JANESVILLE	WI	18	0.999312
MSN	DANE COUNTY REGIONAL-TRUAX FIELD	MADISON	WI	18	0.999322
MTW	MANITOWOC COUNTY	MANITOWOC	WI	19	0.999262
MKE	GENERAL MITCHELL INTL	MILWAUKEE	WI	18	0.999303
KCWA	CENTRAL WISCONSIN	MOSINEE	WI	24	0.999210
OSH	WITTMAN REGIONAL	OSHKOSH	WI	19	0.999286
RHI	RHINELANDER-ONEIDA COUNTY	RHINELANDER	WI	28	0.999040
SUE	DOOR COUNTY CHERRYLAND	STURGEON BAY	WI	20	0.999098
RYV	WATERTOWN MUNICIPAL	WATERTOWN	WI	18	0.999323
ETB	WEST BEND MUNICIPAL	WEST BEND	WI	18	0.999297
KMGW	MORGANTOWN MUNICIPAL – WLB HART FIELD	MORGANTOWN	WV	18	0.999285
KPKB	WOOD CO – GILL ROBB WILSON FIELD	PARKERSBURG	WV	18	0.999282

KCPR	NATRONA COUNTY INTL	CASPER	WY	20	0.999216
EVW	EVANSTON-UNITA CNTY – BURNS FIELD	EVANSTON	WY	18	0.998941
SAA	SHIVELY FIELD	SARATOGA	WY	20	0.999168

Figure 9-1 WAAS LPV Availability



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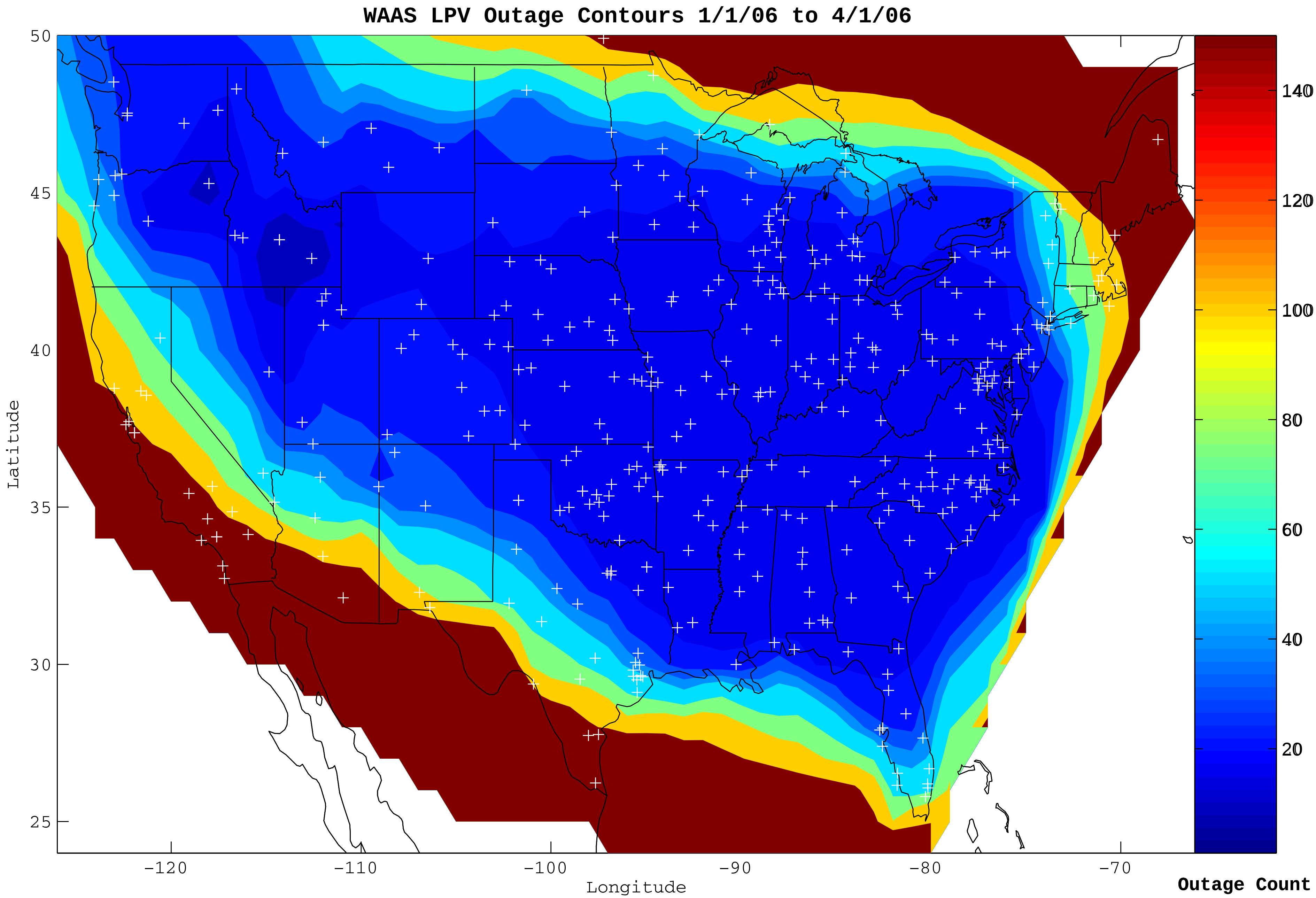
WAAS Test Team
05/01/06

Figure 9-2 WAAS LPV Outage



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WAAS Test Team
05/01/06

10.0 WAAS DETERMINISTIC CODE NOISE AND MULTIPATH BOUNDING ANALYSIS

WAAS utilizes a deterministic model to estimate the residual CNMP noise after the application of standard dual frequency carrier smoothing techniques to minimize the effects of multipath and code noise. This analysis performs an assessment of how well that deterministic model bounds the actual errors. This analysis is periodically performed as part of the WAAS Test Team's off-line monitoring to ensure that there are no drastic detrimental changes to the multipath environment at the WAAS Reference Stations (WRSs). This analysis also ensures that WAAS system is not indefinitely exposed to conspiring receiver failure symptoms that would invalidate the CNMP bounding estimate in a manner that would exceed the assumption that no more than one receiver is conspiring to deceive the WAAS monitors at any time by underestimating the residual measurement noise the safety monitors. Although some failures mechanisms that cause CNMP bounding issues are occasionally seen, no "conspiring" errors have ever been detected. That is, data has caused the safety monitors to trip unnecessarily versus missing a necessary trip.

The analysis post processes measurement data to estimate the pseudorange code to carrier ambiguity for each entire arc of measurements for each satellite pass. The ambiguity estimate is then used to level the carrier measurement. The leveled carrier is then used as a multipath free truth estimate. The WAAS real time deterministic CNMP smoothing algorithm is then applied to the original measurements. The difference between the smoothed measurements and the leveled truth measurements is compared to the deterministic noise estimates. Only arcs with continuous carrier phase greater in length than 7200 seconds are utilized for this analysis to minimize the impacts of non-zero mean multipath biasing the truth estimates. The WAAS dual frequency cycle slip detector algorithm is used to detect any discontinuities in the carrier phase.

Statistics are calculated on how well the 0.1 multiples of the deterministically estimated standard deviation bounds the difference between the leveled truth and the real time smoothed measurements. Those statistics are then compared to a theoretical gaussian distribution and an extensive set of plots are generated and manually reviewed. Table 10.1 recaps the results of that manual analysis.

Table 10-1 CNMP Bounding Statistics

WAAS Site	WRE	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05	Jan 06	Feb 06	Mar 06
Albuquerque	A	Yellow	Blue	Green	Blue	Blue	Yellow	Green	Blue	Yellow	Yellow	Yellow	Yellow
	B	Blue	Blue	Blue	Yellow	Blue	Yellow	Blue	Blue	Blue	Blue	Yellow	Yellow
	C	Green	Blue	Blue	Blue	Green	Green	Green	Yellow	Green	Green	Yellow	Green
Anchorage	A	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Red	Yellow	Blue	Green	Blue	Blue
	B	Blue	Green	Yellow	Green	Blue	Blue	Blue	Green	Blue	Green	Yellow	Green
	C	Yellow	Green	Green	Blue	Green	Blue	Red	Green	Blue	Blue	Blue	Green
Atlanta	A	Blue	Blue	Blue	Red	Blue	Green	Blue	Yellow	Blue	Blue	Blue	Blue
	B	Green	Red	Red	Blue	Green	Green	Green	Green	Yellow	Green	Yellow	Blue
	C	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Green	Yellow	Blue	Green	Yellow
Billings	A	Blue	Blue	Blue	Blue	Yellow	Blue	Blue	Green	Blue	Blue	Blue	Blue
	B	Blue	Blue	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	C	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Blue
Boston	A	Blue	Blue	Blue	Blue	Blue	Red	Green	Green	Blue	Blue	Blue	Green
	B	Blue	Blue	Blue	Green	Green	Green	Green	Blue	Green	Red	Yellow	Yellow
	C	Blue	Blue	Blue	Blue	Blue	Blue	Green	Green	Blue	Blue	Blue	Blue
Chicago	A	Blue	Blue	Blue	Blue	Green	Yellow	Green	Green	Blue	Blue	Red	Blue
	B	Blue	Blue	Green	Blue	Blue	Yellow	Yellow	Yellow	Green	Green	Blue	Blue
	C	Green	Blue	Blue	Yellow	Blue	Green	Blue	Green	Blue	Green	Yellow	Green
Cleveland	A	Yellow	Green	Green	Blue	Red	Green	Green	Green	Yellow	Green	Yellow	Yellow
	B	Yellow	Yellow	Blue	Blue	Yellow	Yellow	Blue	Green	Green	Red	Red	Yellow
	C	Blue	Blue	Green	Green	Yellow	Blue	Yellow	Yellow	Green	Yellow	Green	Yellow
Cold Bay	A	Blue	Blue	Yellow	Blue	Red	Green	Green	Blue	Blue	Green	Yellow	Green
	B	Yellow	Green	Green	Blue	Green	Green	Green	Green	Green	Blue	Blue	Blue
	C	Yellow	Green	Green	Blue	Yellow	Green	Green	Green	Green	Blue	Green	Blue
Dallas	A	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Green	Yellow
	B	Yellow	Yellow	Green	Yellow	Green	Red	Yellow	Blue	Yellow	Green	Yellow	Yellow
	C	Green	Blue	Green	Blue	Yellow	Blue	Yellow	Green	Green	Green	Blue	Green
Denver	A	Blue	Blue	Blue	Green	Green	Yellow	Red	Red	Yellow	Green	Yellow	Red
	B	Blue	Green	Blue	Blue	Blue	Yellow	Blue	Blue	Blue	Blue	Blue	Blue
	C	Green	Green	Green	Blue	Blue	Green	Green	Green	Red	Green	Green	Green
Honolulu	A	Blue	Yellow	Red	Blue	Red	Green	Red	Green	Yellow	Yellow	Yellow	Red
	B	Blue	Blue	Blue	Blue	Green	Yellow	Blue	Blue	Green	Blue	Yellow	Blue
	C	Yellow	Blue	Blue	Yellow	Blue	Yellow	Green	Blue	Yellow	Green	Green	Green
Houston	A	Blue	Green	Blue	Green	Red	Blue	Yellow	Green	Yellow	Yellow	Red	Red
	B	Green	Green	Green	Green	Yellow	Red	Yellow	Yellow	Green	Red	Green	Yellow
	C	Yellow	Yellow	Green	Yellow	Yellow	Green	Yellow	Red	Green	Yellow	Yellow	Blue
Jacksonville	A	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Blue	Green	Yellow	Blue	Green
	B	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Blue	Blue	Blue	Green	Blue
	C	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Blue	Blue	Blue	Green	Blue
Juneau	A	Green	Blue	Yellow	Yellow	Green	Blue	Red	Green	Green	Yellow	Yellow	Yellow
	B	Yellow	Green	Green	Green	Green	Blue	Blue	Yellow	Blue	Green	Red	Green
	C	Red	Yellow	Blue	Green	Yellow	Yellow	Green	Yellow	Blue	Green	Green	Yellow
Kansas City	A	Blue	Blue	Blue	Blue	Green	Green	Green	Yellow	Green	Red	Blue	Blue
	B	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue	Green
	C	Blue	Blue	Yellow	Blue	Green	Green	Yellow	Blue	Blue	Blue	Blue	Blue
Los Angeles	A	Blue	Blue	Green	Blue	Yellow	Green	Blue	Yellow	Yellow	Yellow	Yellow	Blue
	B	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Yellow	Blue
	C	Blue	Blue	Blue	Blue	Yellow	Red	Blue	Red	Green	Green	Blue	Blue
Memphis	A	Blue	Blue	Green	Blue	Yellow	Green	Blue	Green	Blue	Blue	Yellow	Blue
	B	Yellow	Blue	Blue	Blue	Yellow	Yellow	Green	Yellow	Blue	Yellow	Blue	Blue
	C	Blue	Blue	Blue	Blue	Yellow	Green	Blue	Green	Blue	Green	Blue	Blue
Miami	A	Blue	Blue	Blue	Blue	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Yellow
	B	Blue	Green	Green	Blue	Yellow	Green	Yellow	Yellow	Yellow	Green	Yellow	Blue
	C	Yellow	Yellow	Yellow	Yellow	Yellow	Blue	Blue	Red	Yellow	Yellow	Blue	Blue

Minneapolis	A	Blue	Blue	Blue	Green	Red	Blue	Green	Yellow	Red	Blue	Blue	Blue
	B	Blue	Yellow	Blue	Yellow	Green	Green	Blue	Green	Blue	Green	Green	Blue
	C	Green	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Yellow	Green	Blue
New York	A	Yellow	Blue	Blue	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	B	Blue	Blue	Blue	Blue	Yellow	Red	Green	Blue	Green	Yellow	Blue	Blue
	C	Green	Blue	Blue	Blue	Yellow	Yellow	Green	Blue	Blue	Green	Red	Blue
Oakland	A	Blue	Green	Blue	Blue	Yellow	Blue	Green	Blue	Green	Blue	Red	Green
	B	Green	Yellow	Green	Blue	Blue	Blue	Blue	Blue	Green	Yellow	Blue	Blue
	C	Blue	Blue	Yellow	Green	Red	Green	Yellow	Yellow	Yellow	Green	Red	Red
Salt Lake City	A	Blue	Blue	Blue	Green	Green	Blue	Green	Blue	Green	Green	Green	Blue
	B	Blue	Blue	Blue	Blue	Green	Blue	Yellow	Blue	Green	Blue	Blue	Blue
	C	Green	Blue	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Blue	Green
San Juan	A	Green	Yellow	Blue	Blue	Yellow	Green	Green	Green	Red	Yellow	Yellow	Yellow
	B	Blue	Blue	Blue	Green	Blue	Yellow	Green	Blue	Blue	Blue	Blue	Blue
	C	Green	Red	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Green	Green	Blue	Blue
Seattle	A	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue	Blue	Yellow	Blue	Blue
	B	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue
	C	Blue	Red	Blue	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Washington, DC	A	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Green	Blue	Yellow	Blue
	B	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Green	Green	Blue	Blue
	C	Blue	Blue	Blue	Blue	Blue	Yellow	Blue	Blue	Green	Blue	Blue	Blue

- (Blue) **Excellent** - 3.29σ bounded 100%
- (Green) **Good** - 4σ bounded 100%
- (Orange) **Fair** - 4σ bounded 100% with one worst satellite excluded (Requires manual review if symptoms repeat from month to month)
- (Red) **Poor** – Requires manual review

Appendix A: Glossary

General Terms and Definitions

Alert. An alert is an indication provided by the GPS/WAAS equipment to inform the user when the positioning performance achieved by the equipment does not meet the integrity requirements.

APV-ILNAV/VNAV. APV-I is a WAAS operational service level with an HAL equal to 556 meters and a VAL equal to 50 meters.

Availability. The availability of a navigation system is the ability of the system to provide the required function and performance at the initiation of the intended operation. Availability is an indication of the ability of the system to provide usable service within the specified coverage area.

AVP-II. APV-II is a WAAS operational service level with an HAL equal to 40 meters and a VAL equal to 20 meters.

CONUS. Continental United States.

Continuity. The continuity of a system is the ability of the total system (comprising all elements necessary to maintain aircraft position within the defined airspace) to perform its function without interruption during the intended operation. More specifically, continuity is the probability that the specified system performance will be maintained for the duration of a phase of operation, presuming that the system was available at the beginning of that phase of operation.

Coverage. The coverage provided by a radio navigation system is that surface area or space volume in which the signals are adequate to permit the user to determine position to a specified level of accuracy. Coverage is influenced by system geometry, signal power levels, receiver sensitivity, atmospheric noise conditions, and other factors that affect signal availability.

Dilution of Precision (DOP). The magnifying effect on GPS position error induced by mapping GPS ranging errors into position through the position solution. 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.

DR. Discrepancy Report

Fault Detection and Exclusion (FDE). Fault detection and exclusion is a receiver processing scheme that autonomously provides integrity monitoring for the position solution, using redundant range measurements. The FDE consists of two distinct parts: fault detection and fault exclusion. The fault detection part detects the presence of an unacceptably large position error for a given mode of flight. Upon the detection, fault exclusion follows and excludes the source of the unacceptably large position error, thereby allowing navigation to return to normal performance without an interruption in service.

GEO. Geostationary Satellite.

Global Positioning System (GPS). A space-based positioning, velocity, and time system composed of space, control, and user segments. The space segment, when fully operational, will be composed of 24 satellites in six orbital planes. The control segment consists of five monitor stations, three ground antennas, and a master control station. The user segment consists of antennas and receiver-processors that provide positioning, velocity, and precise timing to the user.

GLS. GLS is a WAAS operational service level with HAL equal to 40 meters and VAL equal to 12 meters.

Grid Ionospheric Vertical Error (GIVE). GIVEs indicate the accuracy of ionospheric vertical delay correction at a geographically defined ionospheric grid point (IGP). WAAS transmits one GIVE for each IGP in the mask.

Hazardous Misleading Information (HMI). Hazardous misleading information is any position data, that is output, that has an error larger than the current protection level (HPL/VPL), without any indication of the error (e.g., alert message sequence).

Horizontal Alert Limit (HAL). The Horizontal Alert Limit (HAL) is the radius of a circle in the horizontal plane (the local plane tangent to the WGS-84 ellipsoid), with its center being at the true position, which describes the region that is required to contain the indicated horizontal position with a probability of $1\text{-}10^{-7}$ per flight hour, for a particular navigation mode, assuming the probability of a GPS satellite integrity failure being included in the position solution is less than or equal to 10^{-4} per hour.

Horizontal Protection Level (HPL). The Horizontal Protection Level is the radius of a circle in the horizontal plane (the plane tangent to the WGS-84 ellipsoid), with its center being at the true position, which describes the region that is assured to contain the indicated horizontal position. It is based upon the error estimates provided by WAAS.

Ionospheric Grid Point (IGP). IGP is a geographically defined point for which the WAAS provides the vertical ionospheric delay.

LNAV. Lateral Navigation.

MOPS. Minimum Operational Performance Standards.

Navigation Message. Message structure designed to carry navigation data.

Non-Precision Approach (NPA) Navigation Mode. The Non-Precision Approach navigation mode refers to the navigation solution operating with a minimum of four satellites with fast and long term WAAS corrections (no WAAS ionospheric corrections) available.

Position Solution. The use of ranging signal measurements and navigation data from at least four satellites to solve for three position coordinates and a time offset.

Precision Approach (PA) Navigation Mode. The Precision Approach navigation mode refers to the navigation solution operating with a minimum of four satellites with all WAAS corrections (fast, long term, and ionospheric) available.

Selective Availability. Protection technique employed by the DOD to deny full system accuracy to unauthorized users.

Standard Positioning Service (SPS). Three-dimensional position and time determination capability provided to a user equipped with a minimum capability GPS SPS receiver in accordance with GPS national policy and the performance specifications.

SV. Satellite Vehicle.

User Differential Range Error (UDRE). UDRE's indicate the accuracy of combined fast and sl Report 16 corrections. WAAS transmits one UDRE for each satellite in the mask.

Vertical Alert Limit (VAL). The Vertical Alert Limit is half the length of a segment on the vertical axis (perpendicular to the horizontal plane of WGS-84 ellipsoid), with its center being at the true position, which describes the region that is required to contain the indicated vertical position with a probability of $1\text{-}10^{-7}$ per flight hour, for a particular navigation mode, assuming the probability of a GPS satellite integrity failure being included in the position solution is less than or equal to 10^{-4} per hour.

Vertical Protection Level (VPL). The Vertical Protection Level is half the length of a segment on the vertical axis (perpendicular to the horizontal plane of WGS-84 ellipsoid), with its center being at the true position, which describes the region that is assured to contain the indicated vertical position. It is based upon the error estimates provided by WAAS.

VNAV. Vertical Navigation.

Wide Area Augmentation System (WAAS). The WAAS is made up of an integrity reference monitoring network, processing facilities, geostationary satellites, and control facilities. Wide area reference stations and integrity monitors are widely dispersed data collection sites that contain GPS/WAAS ranging receivers that monitor all signals from the GPS, as well as the WAAS geostationary satellites. The reference stations collect measurements from the GPS and WAAS satellites so that differential corrections, ionospheric delay information, GPS/WAAS accuracy, WAAS network time, GPS time, and UTC can be determined. The wide area reference station and integrity monitor data are forwarded to the central data processing sites. These sites process the data in order to determine differential corrections, ionospheric delay information, and GPS/WAAS accuracy, as well as verify residual error bounds for each monitored satellite. The central data processing sites also generate navigation messages for the geostationary satellites and WAAS messages. This information is modulated on the GPS-like signal and broadcast to the users from geostationary satellites.