WIDE-AREA AUGMENTATION SYSTEM PERFORMANCE ANALYSIS REPORT

Report #19

Reporting Period: October 1 to December 31, 2006

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Changes:

List of Figures
Figure 4-22 LPV 200 Coverage – Quarter (changes to Figure title only)

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 nineteenth such WAAS quarterly report. This report covers WAAS performance during the period from October 1, 2006 to December 31 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	Miami 1.055 meters	Bethel 0.546 meters
95% Vertical Accuracy	Miami 1.657 meters	Washington DC 0.866 meters
LPV Availability (HPL < 40 meters & VPL < 50 meters)	Denver 99.983%	Barrow 63.31%
95% HPL	Barrow 49.133 meters	Atlanta 16.948 meters
95% VPL	Barrow 90.347 meters	Atlanta 27.928 meters

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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), PRN#134 (POR), and PRN#135 (CRW) were used in the evaluation. GEO CRW was added to the WAAS system and was placed operational on November 9, 2006. CRW currently only have data link capabilities.

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 October 1, 2006 to December 31, 2006.

Table 1-1 PA Sites

	Number of Days Evaluated	Number of Samples
NSTB:		
Atlantic City	92	7916127
Greenwood	92	7921587
San Angelo	87	7490437
WAAS:		
Albuquerque	92	7909204
Anchorage	91	7897657
Atlanta	91	7829832
Barrow	87	7488919
Bethel	87	7484446
Billings	71	6111399
Boston	92	7918575
Chicago	92	7920850
Cleveland	91	7845515
Cold Bay	88	7622829
Dallas	91	7900120
Denver	92	7910412
Fairbanks	90	7775110
Houston	92	7914720
Jacksonville	92	7919928
Juneau	83	7156718
Kansas City	90	7745863
Kotzebue	90	7765124
Los Angeles	91	7902425
Memphis	92	7909494
Miami	88	7562117
Minneapolis	84	7232757
New York	92	7912656
Oakland	92	7919215
Salt Lake City	90	7793141
Seattle	92	7923788
Washington DC	92	7922708

Table 1-2 NPA Sites

Location	Number of Days Evaluated	Number of Samples
Albuquerque	92	7933886
Anchorage	92	7924553
Atlanta	91	7894541
Bethel	87	7500626
Billings	73	6321829
Boston	88	7624856
Cleveland	80	6881610
Cold Bay	91	7905432
Fairbanks	90	7785422
Honolulu	88	7568947
Houston	92	7938034
Juneau	83	7170769
Kansas City	66	5713697
Kotzebue	90	7777706
Los Angeles	76	6596012
Miami	85	7367797
Minneapolis	85	7303321
Oakland	92	7939889
Salt Lake City	91	7877428
San Juan	91	7853767
Seattle	92	7938370
Washington DC	92	7941090

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. Detailed analyses of particular events are documented in the Discrepancy Reports (DR). The DRs are posted on the website under 'WAAS Technical Reports' and can be accessed via hyperlink from the Table 1.4.

Table 1-4 Test Events

GPS Week	Date	Sites	Events
1395 day 2 to 1397 day 3	10/3/06 to 10/18/06	Billings	Billings outage.
1396 day 1	10/9/06	All AOR-W Non-dual GEO sites	See DR #39, "Abnormal AOR-W Switchover and Extended SIS Outage."
1396 day 2	10/10/06	All WAAS Sites	WEI outages.
1396 day 3	10/11/06	All WAAS Sites	WEI outages.
1396 day 3	10/11/06	POR Sites	POR tracking anomalies. Apparent POR gaps and SIS outages occurred during WEI outages.
1396 day 3 to 1396 day 5	10/11/06 to 10/13/06	Minneapolis	Minneapolis outage.

GPS Week	Date	Sites	Events
1396 day 4	10/12/06	All Sites	SVN 52 (PRN 31) usable as of 2253 UTC. See NANU 2206112.
1397 day 2	10/17/06	Sites connected to ZLA, ZTL, & ZAU TCS Comm Nodes	TCS Communications Nodes outages.
1397 day 3	10/18/06	All WAAS Sites	WEI outages.
1398 day 1	10/23/06	All WAAS Sites	WEI outage.
1398 day 2	10/24/06	All WAAS Sites	WEI / TCS Communications Nodes outages.
1398 day 2	10/24/06	Sites connected to ZLA TCS Comm Node	ZLA TCS Communications Node outage.
1398 day 3	10/25/06	None	Type 3 Alert broadcast from AOR-W only. No UDREi's were changed by the alert.
1398 day 4	10/26/06	All Sites	WAAS Release 5.1 deployed.
1398 day 4	10/26/06	Central, Mid-West, & Eastern CONUS Sites	See DR# 41, "WAAS Ionospheric Grid Points (IGP) Set to 'Do Not Use'."
1398 day 5	10/27/06	None	Type 3 Alert broadcast from POR only. No UDREi's were changed by the alert.
1399 day 0	10/29/06	Fairbanks	See DR# 47, "Ionospheric Scintillation Caused Loss of Satellite Tracking at Fairbanks."
1399 day 0 to 1399 day 4	10/29/06 to 11/2/06	Juneau	Juneau outage.
1400 day 0	11/5/06	All sites	See DR# 40, "Type 0 Messages After C&V Faults."
1400 day 2 to 1401 day 1	11/7/06 to 11/13/06	Various sites	See DR# 42, "Loss of Availability due to Extended Satellite Maintenance on SV 5 (NANU 2006145)."
1400 day 2 to 1400 day 4	11/7/06 to 11/9/06	Bethel	Bethel outage.
1400 day 4	11/9/06	All Sites	CRW (CONUS Region West) GEO operational, beginning at 0800 UTC.
1400 day 6 to 1401 day 3	11/11/06 to 11/15/06	Minneapolis	Minneapolis outage.
1401 day 5	11/17/06	All Sites	SVN 15 (PRN 15) decommissioned. See NANU 2006148.
1402 day 6 to 1404 day 4	11/25/06 to 12/7/06	LA	LA outage. (Missing Range & Iono data only.)
1403 day 3	11/29/06	CRW single-GEO Sites	See DR# 43, "Switchover followed by Signal-in-Space (SIS) outage in CRW."
1403 day 5	12/1/06	None	See DR# 45, "Abnormal AOR-W Switchover and Extended SIS (Signal in Space) Outage."
1403 day 5 to 1404 day 1	12/1/06 to 12/4/06	Billings	Billings outage.
1404 day 0	12/3/06	CRW single-GEO sites	See DR# 44, "Signal-in-Space (SIS) outage in CRW."
1404 day 1	12/4/06	All Sites	See DR# 46, "Four Second Initialization in All Three GEOs."
1405 day 1 to 1405 day 4	12/11/06 to 12/14/06	Miami	Miami outage.
1405 day 3 to present	12/13/06 to present	All Sites	Per NANU 2006161, SVN 58 (PRN 12) usable for SPS as of Week 1405 day 3, 0307 UTC. However, it is not yet in the WAAS mask.

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, POR and CRW.

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, POR and CRW.

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.

Section 11 compares GPS broadcast orbits verse IGS precise orbits.

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 1.055 meters at Miami and 1.95 at Barrow, respectively. The minimum 95% horizontal and vertical LPV errors are 0.546 meters at Bethel and 0.866 meters at Washington DC, respectively. The maximum 95% and 99.999% NPA horizontal errors are 3.323 meters and 9.812 meters both at Honolulu, respectively. The minimum 95% and 99.999% horizontal errors are 1.046 meters at Fairbanks and 2.678 meters at Atlanta, respectively.

The AOR-W GEO is no longer available for PA ranging. CRW currently only have data link capabilities.

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	0.814	0.815	1.108	99.98351	*	*
Greenwood	0.714	0.714	1.112	99.98467	*	*
San Angelo	0.704	0.705	1.158	99.98118	*	*
Albuquerque	0.688	0.689	0.923	99.98930	2.328	4.383
Anchorage	0.612	0.612	1.074	99.99326	*	*
Atlanta	0.738	0.739	1.047	99.98395	2.506	5.074
Barrow	0.748	0.838	1.950	99.56836	*	*
Bethel	0.545	0.546	0.999	99.96971	2.072	5.033
Billings	0.791	0.792	0.961	99.99027	2.363	4.219
Boston	0.830	0.831	1.133	99.98348	2.576	4.607
Chicago	0.758	0.758	0.958	99.98446	*	*
Cleveland	0.788	0.789	0.973	99.98415	2.590	4.616
Cold Bay	0.800	0.823	1.033	99.97061	*	*
Dallas	0.881	0.881	1.281	99.98390	*	*
Denver	0.677	0.677	1.002	99.98861	*	*
Fairbanks	0.548	0.548	1.080	99.99367	2.017	5.114
Houston	0.739	0.740	1.225	99.98380	2.345	5.215
Jacksonville	0.785	0.786	1.150	99.98429	*	*
Juneau	0.704	0.704	1.125	99.99688	*	*
Kansas City	0.742	0.742	0.960	99.98232	2.477	5.000
Kotzebue	0.695	0.704	1.229	99.88482	2.015	5.329
Los Angeles	0.742	0.743	1.047	99.99596	2.228	4.904
Memphis	0.651	0.651	0.912	99.98451	*	*
Miami	1.054	1.055	1.657	99.98350	2.377	5.513
Minneapolis	0.773	0.774	1.041	99.98106	2.503	4.589
New York	0.786	0.787	0.938	99.98348	*	*
Oakland	0.752	0.753	1.035	99.99595	2.305	4.875
Salt Lake City	0.715	0.715	0.925	99.99574	2.332	4.412
Seattle	0.985	0.985	0.883	99.99600	2.357	4.501
Washington DC	0.693	0.693	0.866	99.98393	2.612	4.776

* 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	1.196	4.045	99.99451	4.260
Anchorage	1.294	4.752	99.99791	12.763
Atlanta	1.385	2.678	99.99425	3.277
Bethel	1.397	4.267	99.99785	4.380
Billings	1.506	2.965	99.99589	5.817
Boston	1.545	2.976	99.99406	4.513
Cleveland	1.478	4.374	99.99507	3.756
Cold Bay	1.546	5.107	99.99778	5.244
Fairbanks	1.046	4.666	99.99797	6.591
Honolulu	3.323	9.812	99.99539	11.641
Houston	1.185	4.151	99.99436	4.267
Juneau	1.115	4.218	99.99771	4.470
Kansas City	1.375	7.078	99.99515	8.598
Kotzebue	1.173	5.118	99.99785	5.239
Los Angeles	1.188	3.567	99.99831	4.927
Miami	1.319	3.494	99.99412	3.672
Minneapolis	1.400	3.404	99.99383	3.875
Oakland	1.257	3.037	99.99794	3.681
Salt Lake City	1.330	2.932	99.99793	5.271
San Juan	2.134	7.390	57.32604	16.201
Seattle	1.366	3.026	99.99803	3.711
Washington DC	1.427	2.794	99.99426	3.601

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

1.2.1 Location	Horizontal Error (m)	Horizontal Error/HPL	Horizontal Maximum Ratio	Vertical Error (m)	Vertical Error/VPL	Vertical Maximum Ratio
Atlantic City	2.305	0.130	0.136	3.921	0.102	0.133
Greenwood	2.496	0.084	0.123	5.054	0.140	0.186
San Angelo	2.412	0.103	0.124	4.374	0.137	0.137
Albuquerque	2.339	0.167	0.167	3.773	0.122	0.122
Anchorage	2.286	0.107	0.117	4.930	0.122	0.136
Atlanta	2.848	0.144	0.144	3.982	0.130	0.130
Barrow	8.852	0.396	0.396	6.211	0.162	0.162
Bethel	2.493	0.105	0.111	4.425	0.090	0.106
Billings	2.187	0.063	0.122	4.040	0.162	0.162
Boston	2.839	0.138	0.138	3.956	0.100	0.139
Chicago	2.336	0.069	0.115	3.016	0.097	0.124
Cleveland	3.569	0.202	0.202	5.727	0.215	0.216
Cold Bay	3.815	0.145	0.153	5.599	0.148	0.150
Dallas	3.061	0.184	0.186	6.879	0.196	0.218
Denver	1.822	0.107	0.126	4.609	0.169	0.169
Fairbanks	6.425	0.353	0.353	7.395	0.182	0.246
Houston	1.917	0.095	0.114	3.477	0.101	0.134
Jacksonville	1.864	0.152	0.154	3.694	0.096	0.129
Juneau	2.571	0.103	0.113	4.472	0.126	0.128
Kansas City	2.828	0.113	0.122	4.610	0.152	0.154
Kotzebue	3.645	0.185	0.185	4.595	0.098	0.137
Los Angeles	2.095	0.063	0.118	3.485	0.088	0.116
Memphis	1.955	0.078	0.114	3.013	0.070	0.116
Miami	3.036	0.092	0.161	6.913	0.149	0.149
Minneapolis	3.007	0.097	0.156	3.795	0.105	0.140
New York	1.857	0.066	0.098	2.709	0.062	0.093
Oakland	2.254	0.061	0.119	5.195	0.114	0.169
Salt Lake City	2.896	0.109	0.109	3.999	0.122	0.131
Seattle	2.608	0.096	0.138	3.790	0.146	0.146
Washington DC	1.955	0.095	0.121	2.841	0.077	0.115

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

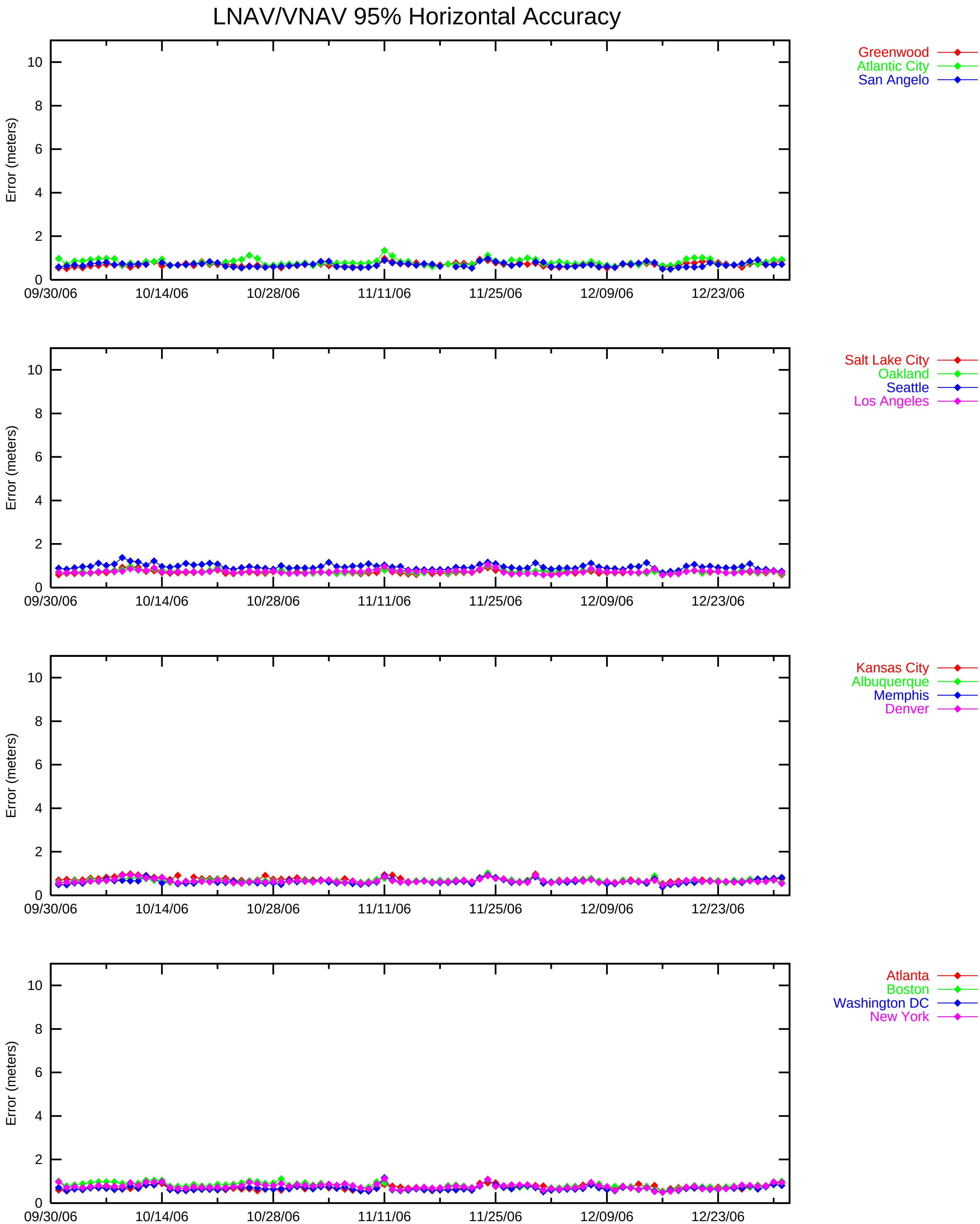


Figure 2-2 95% Horizontal Accuracy at LNAV/VNAV

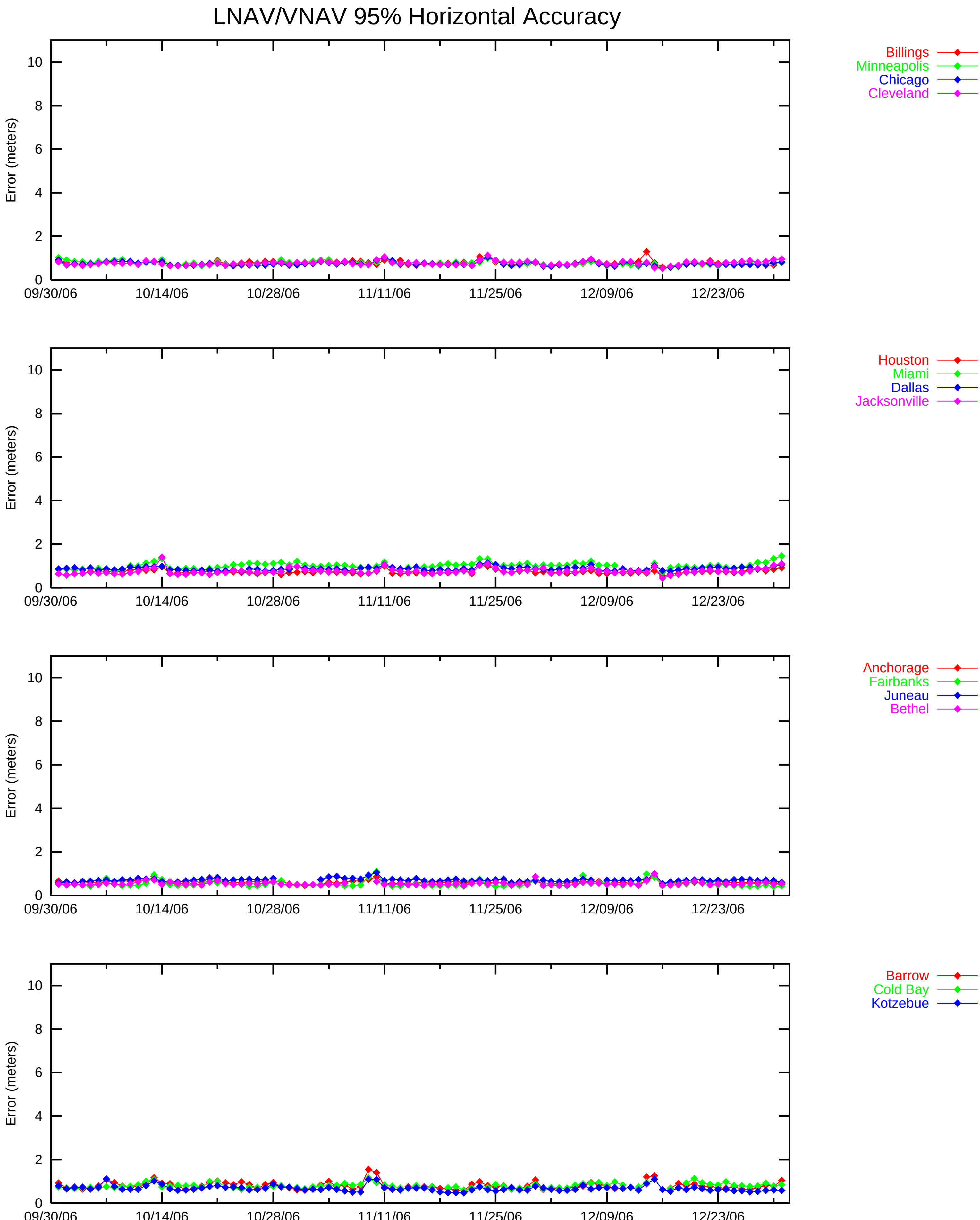


Figure 2-3 95% Vertical Accuracy at LNAV/VNAV

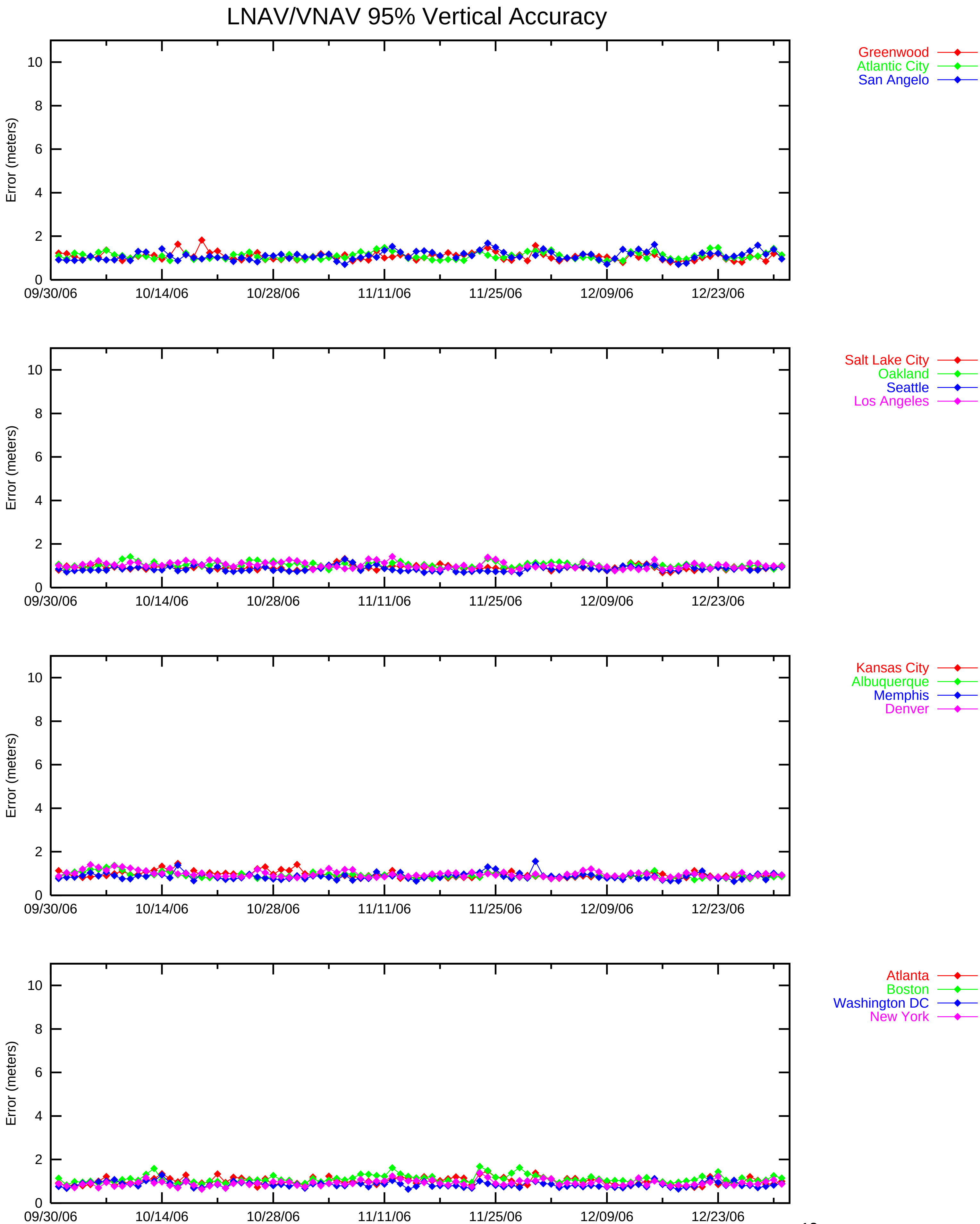


Figure 2-4 95% Vertical Accuracy at LNAV/VNAV

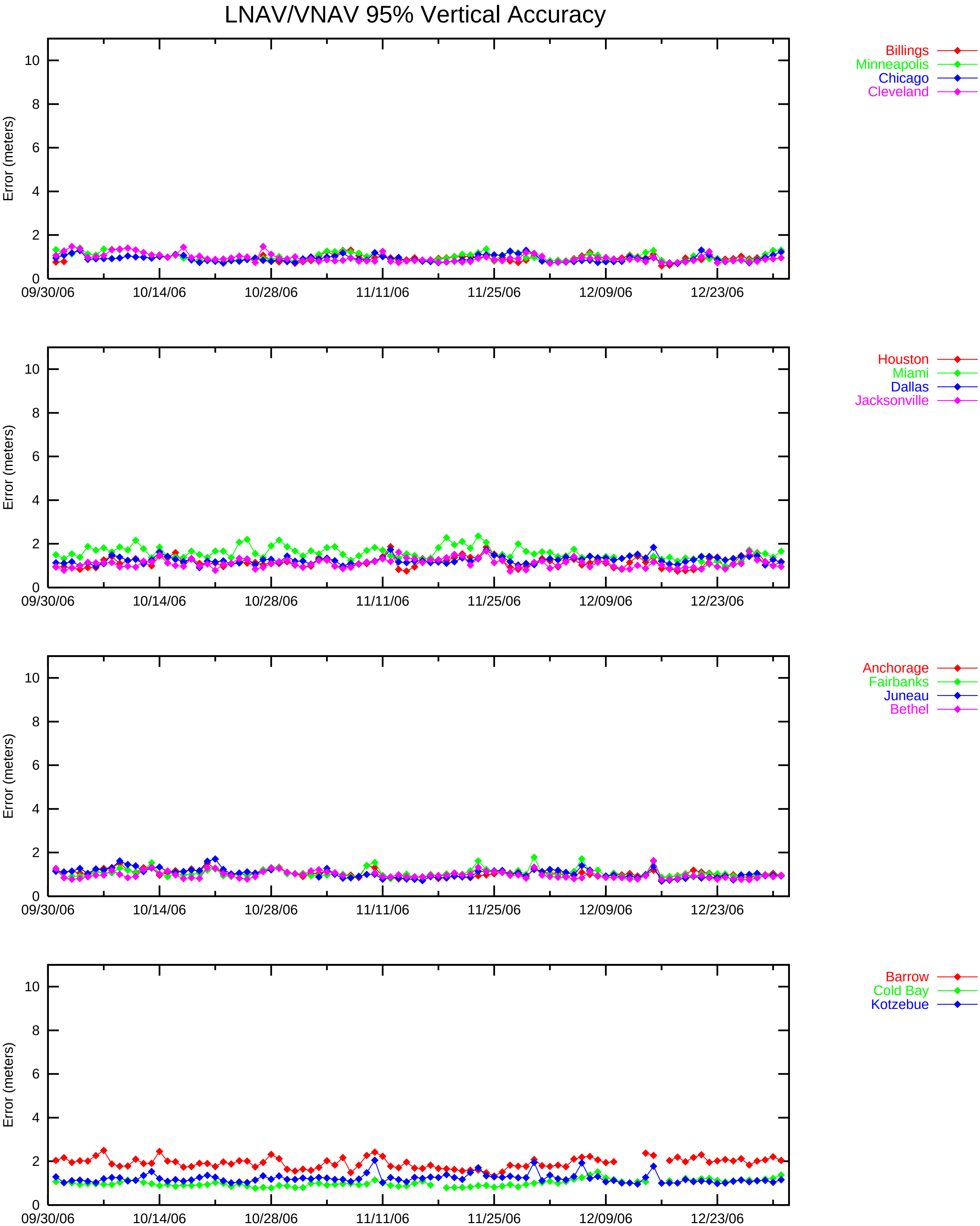


Figure 2-5 NPA 95% Horizontal Accuracy

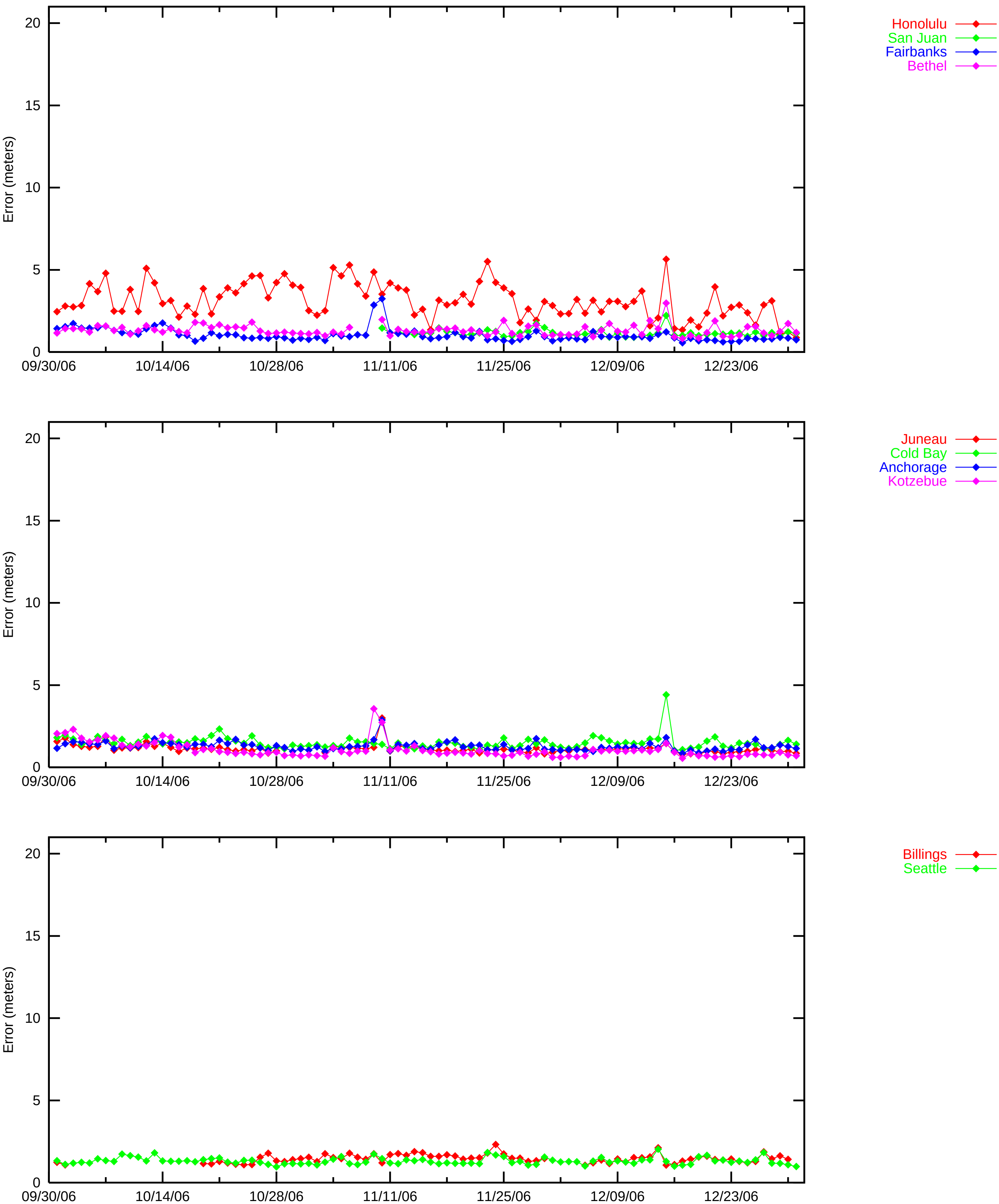


Figure 2-6 NPA 95% Horizontal Accuracy

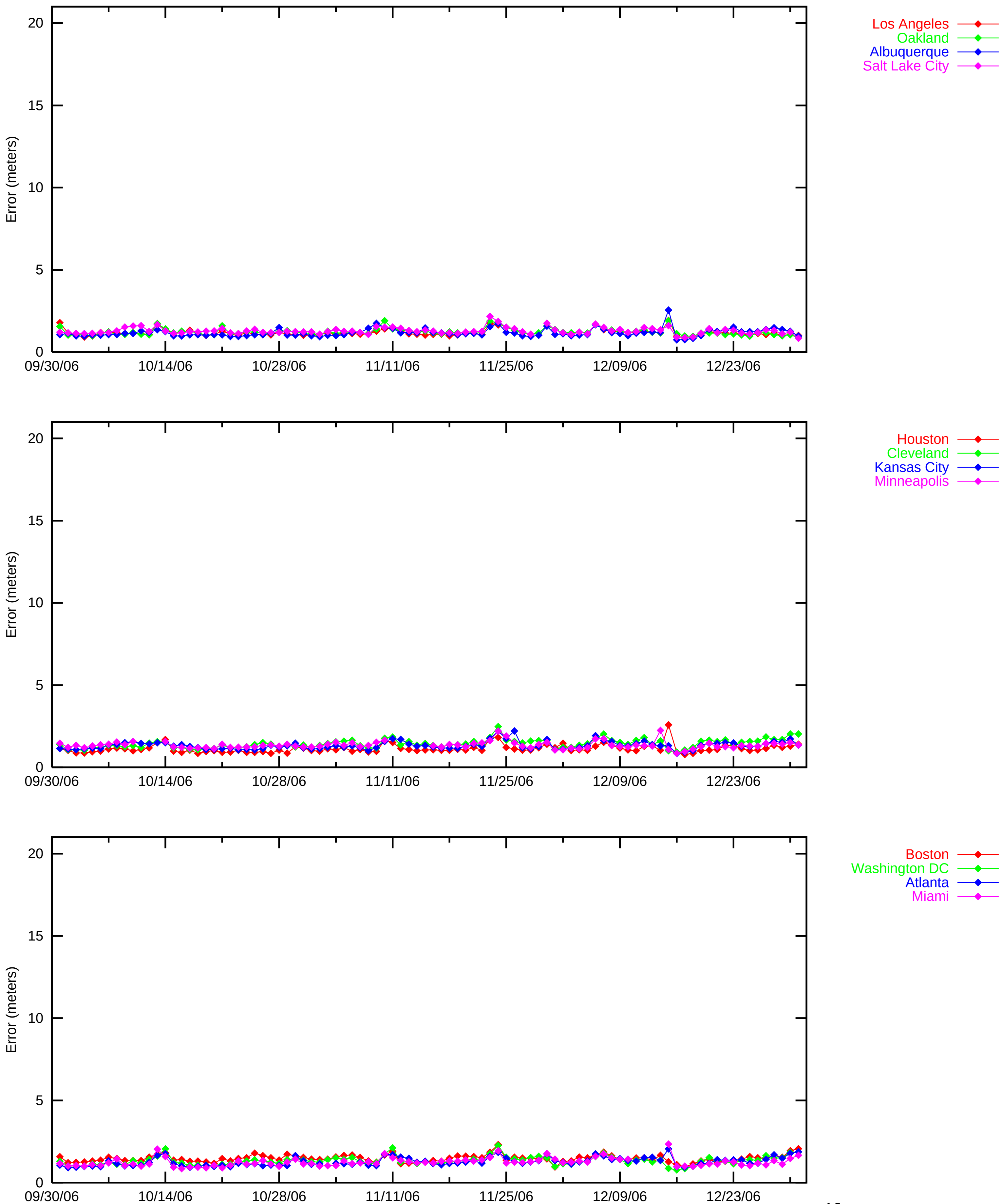


Figure 2-7 Horizontal Triangle Chart forKansas City

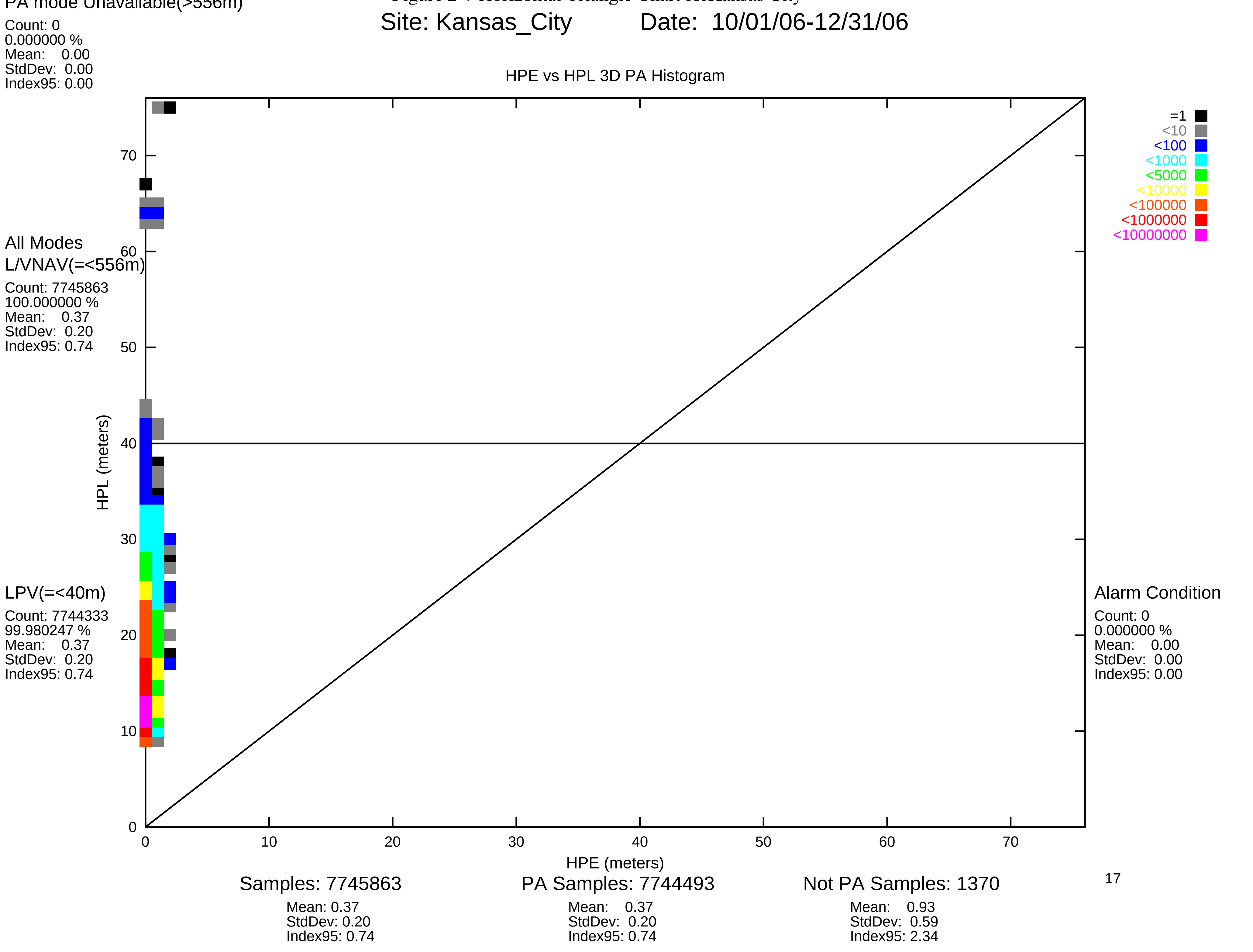


Figure 2-8 Vertical Triangle Chart for Kansas City

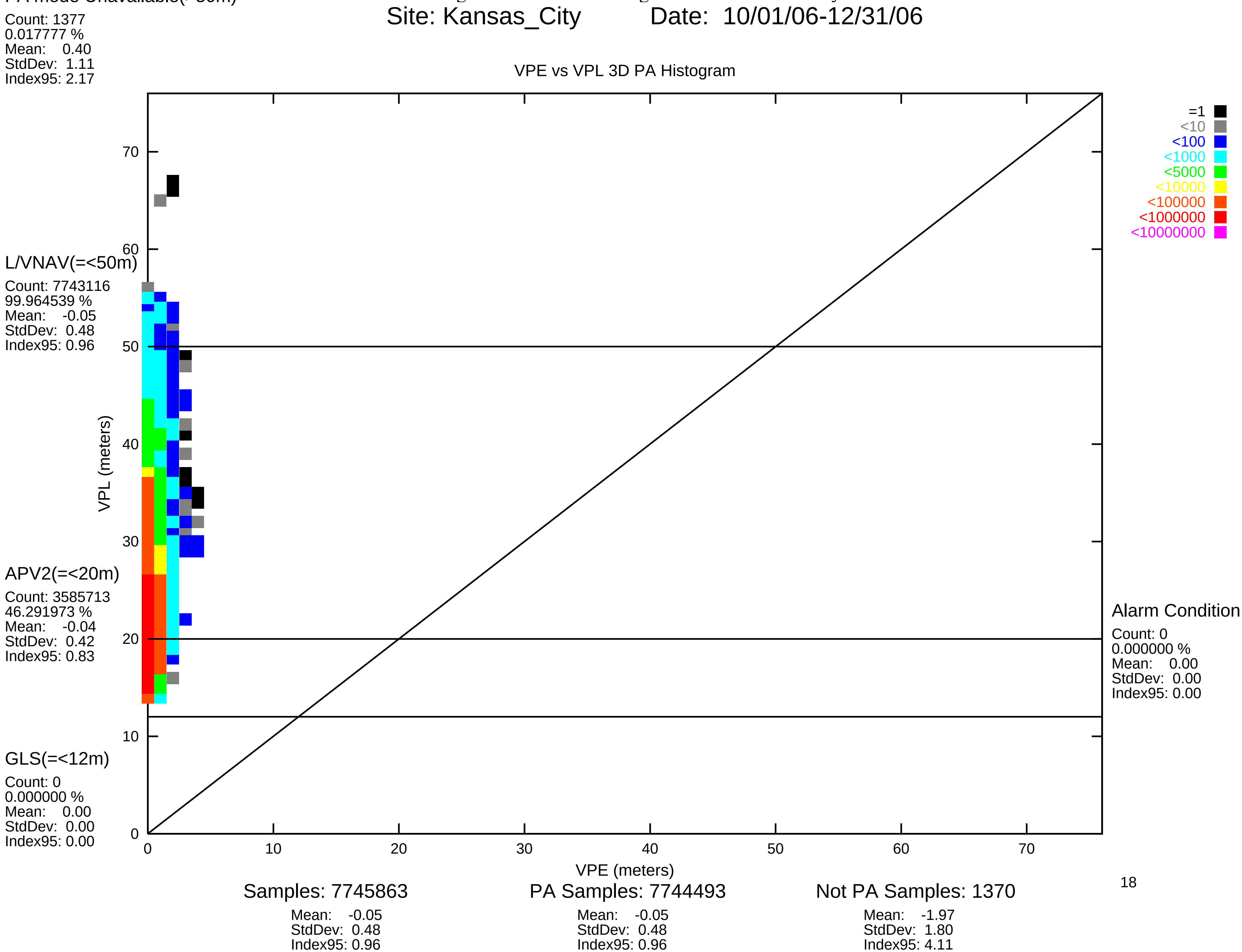


Figure 2-9 2-D Histogram for Kansas City

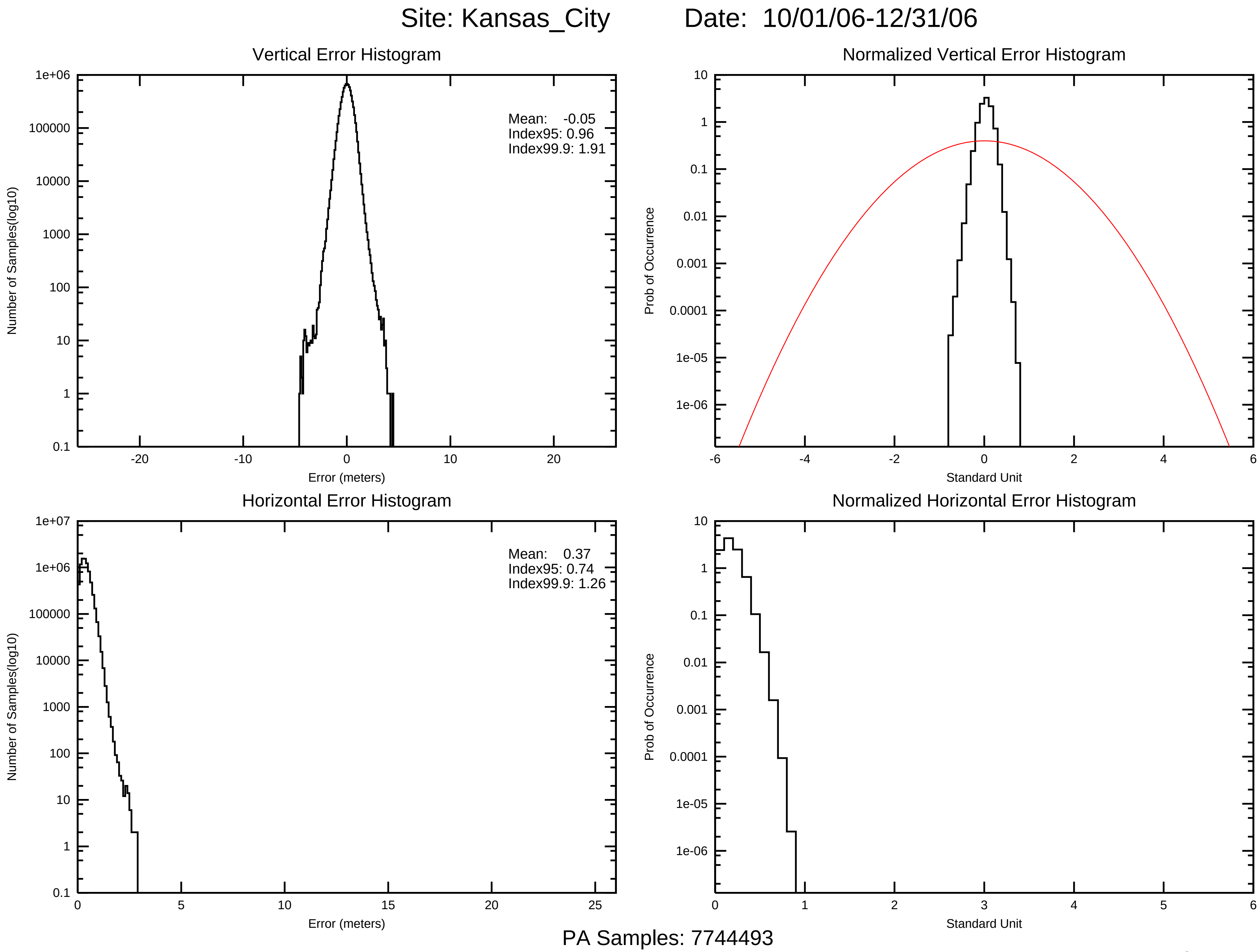


Figure 2-10 Horizontal Triangle Chart for Washington, DC

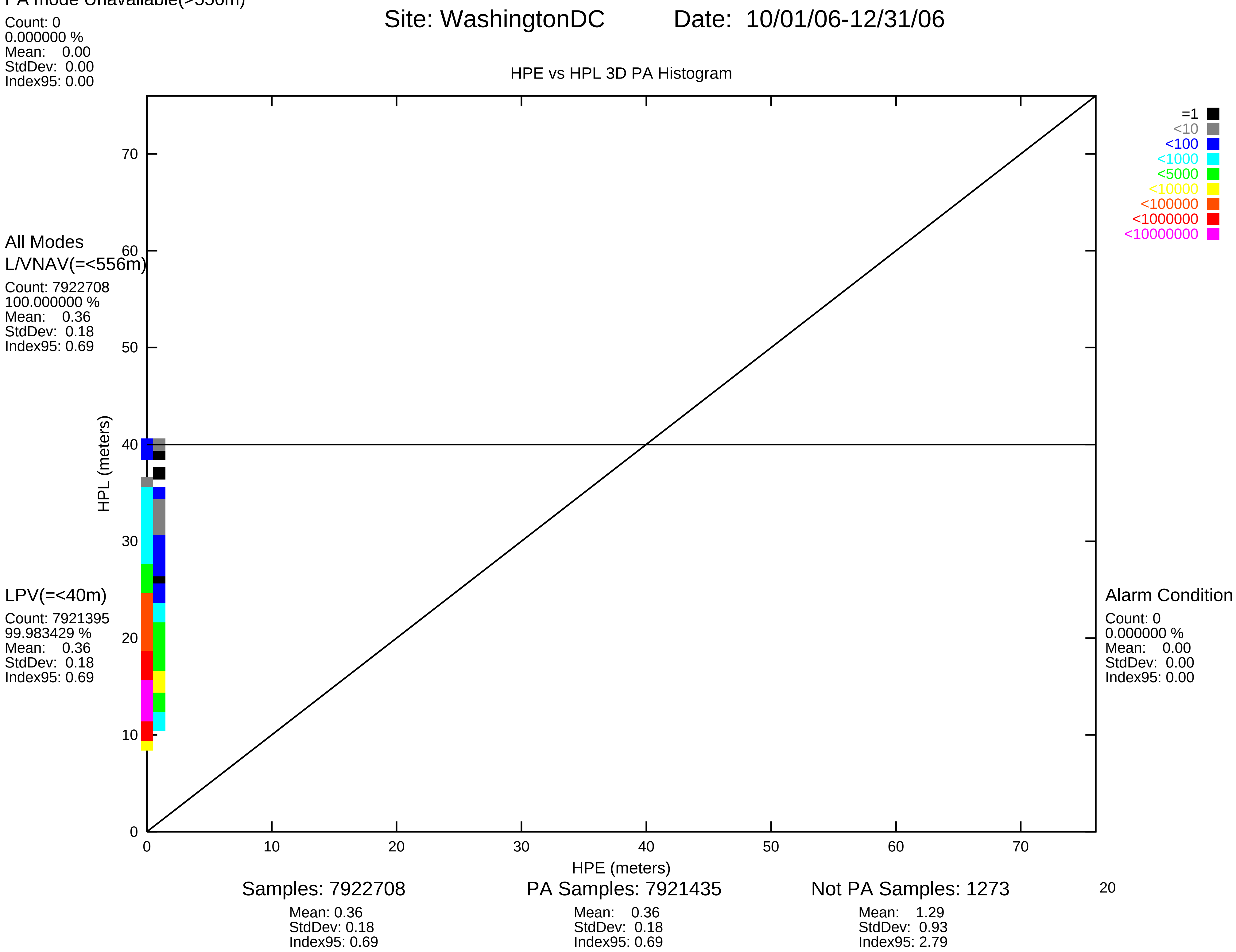


Figure 2-11 Vertical Triangle Chart for Washington, DC

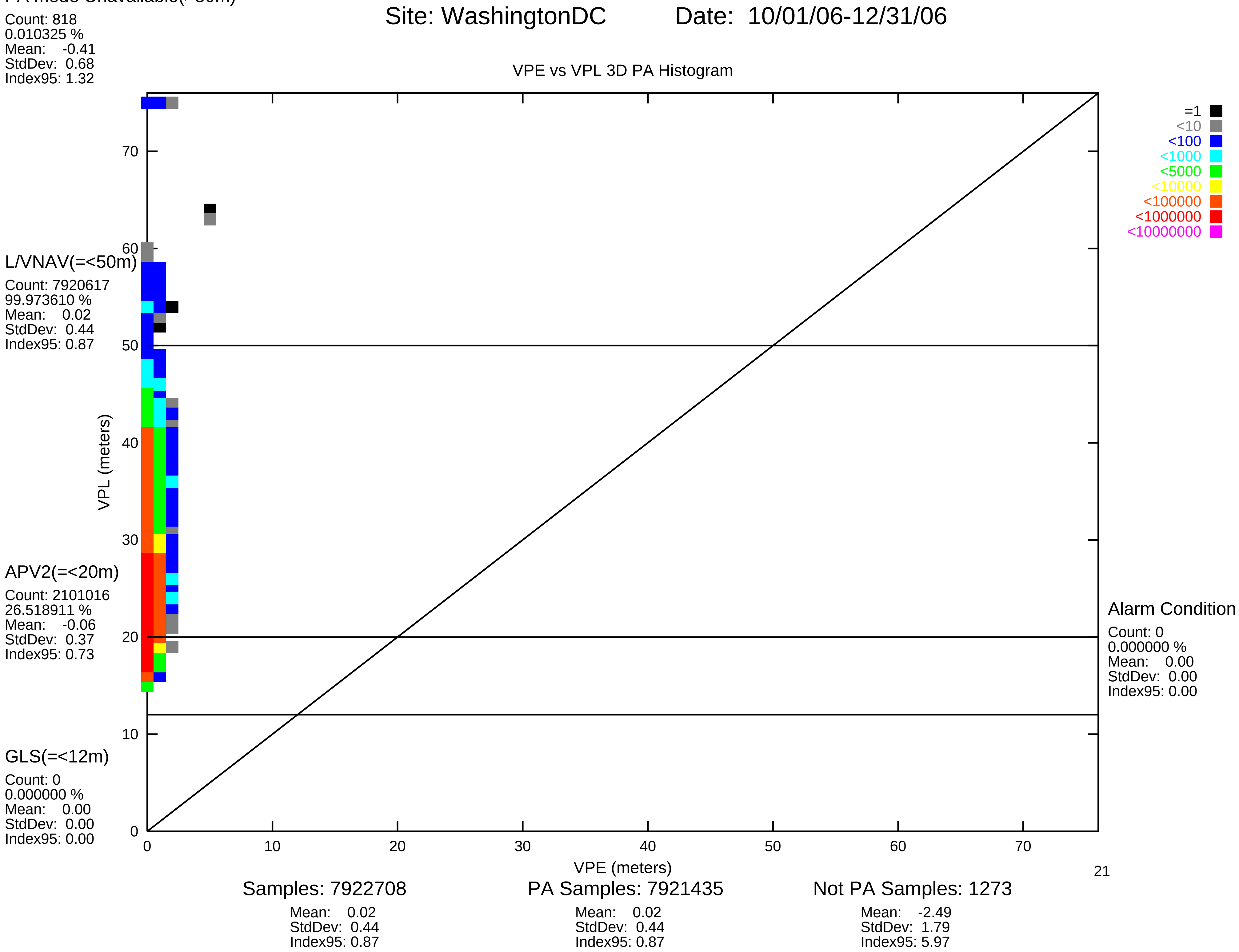


Figure 2-12 2-D Histogram for Washington, DC

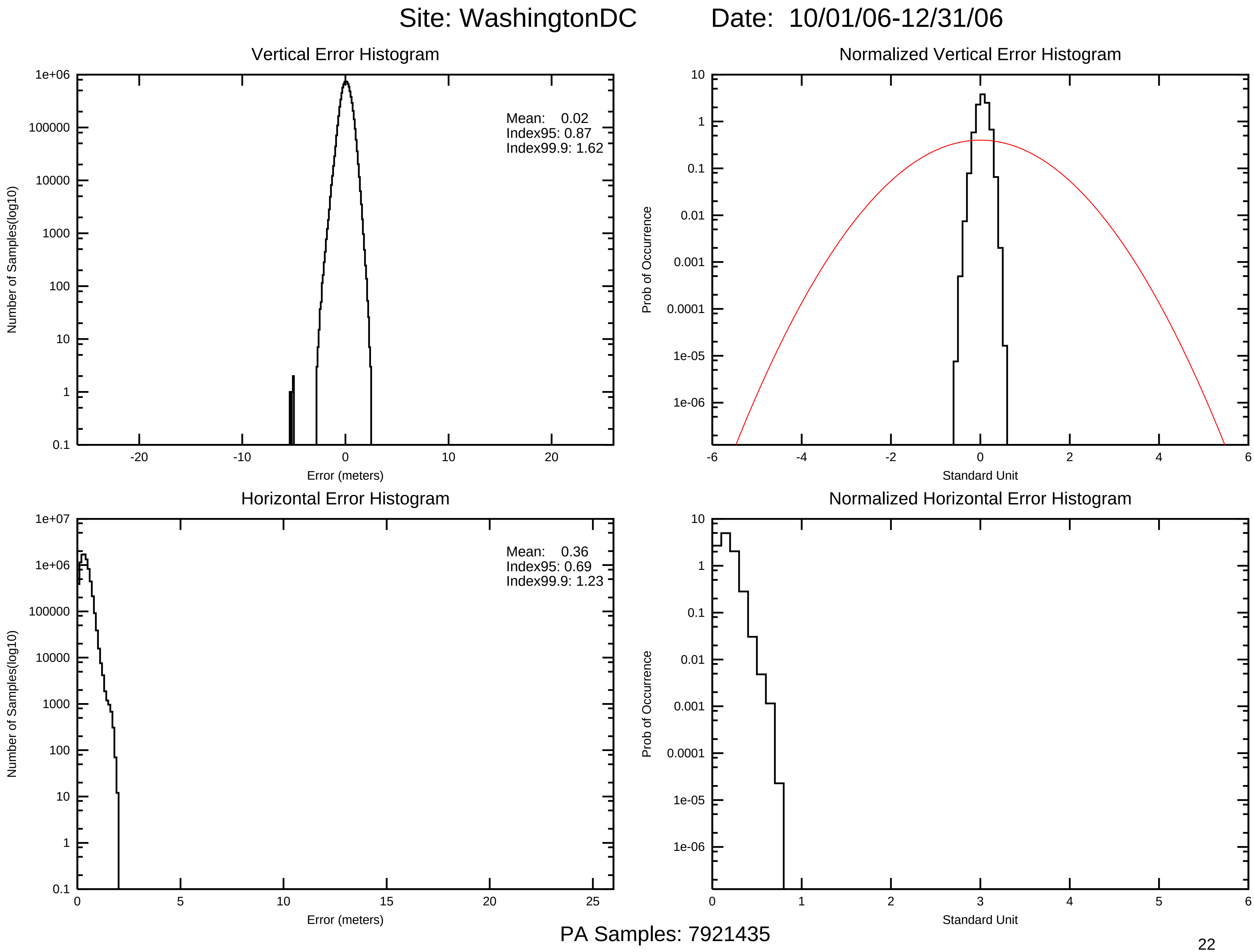


Figure 2-13 Horizontal Triangle Chart for Seattle

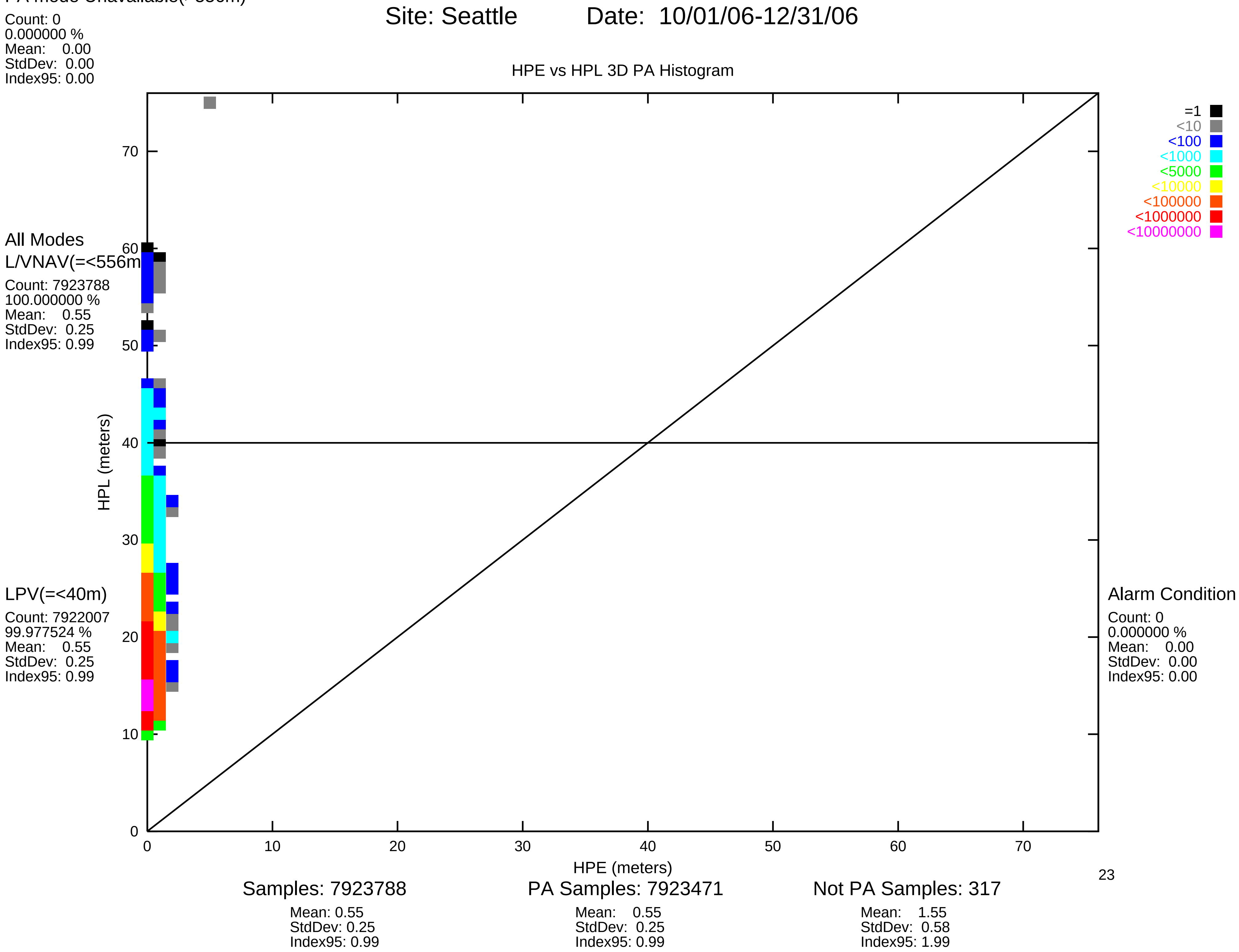


Figure 2-14 Vertical Triangle Chart for Seattle

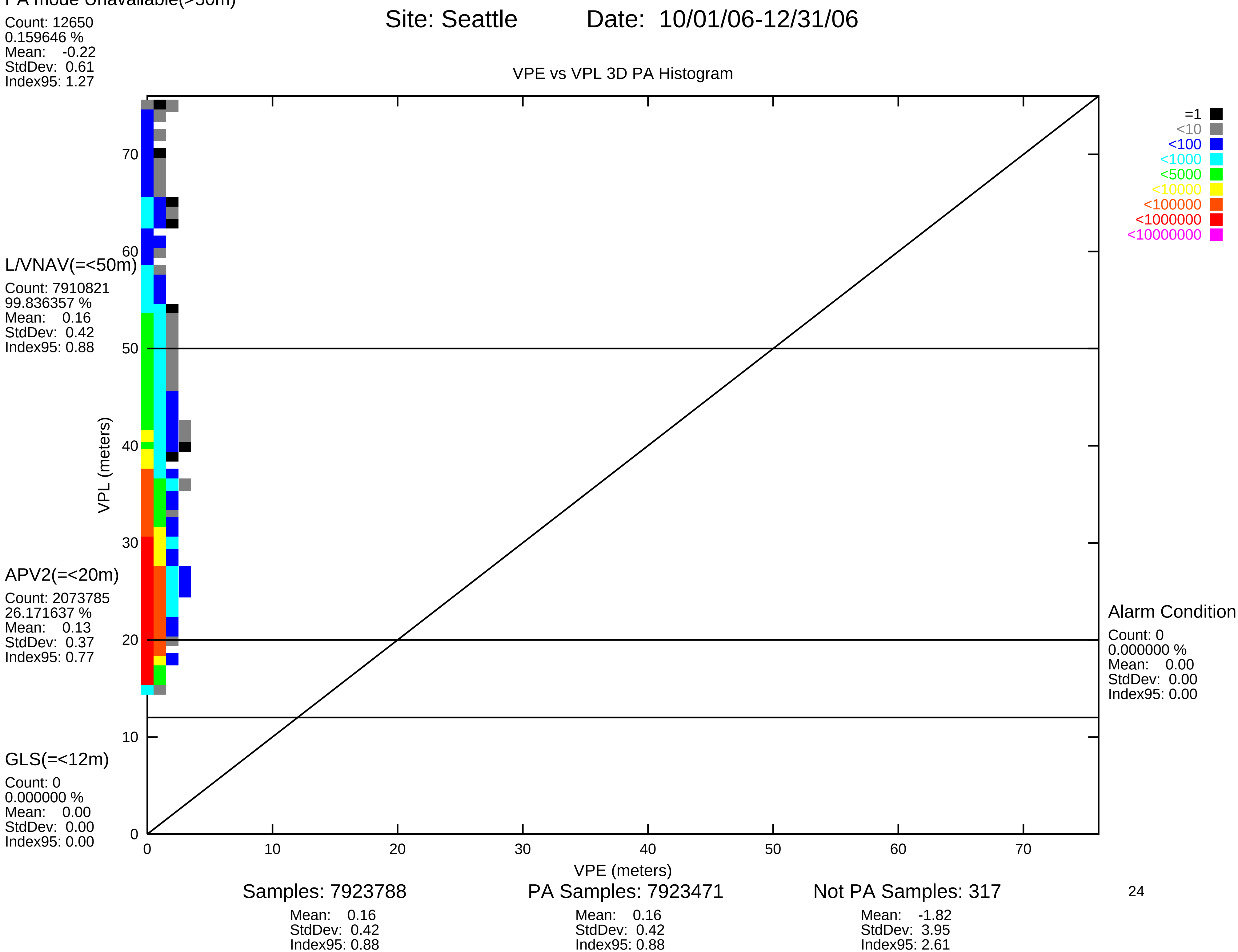
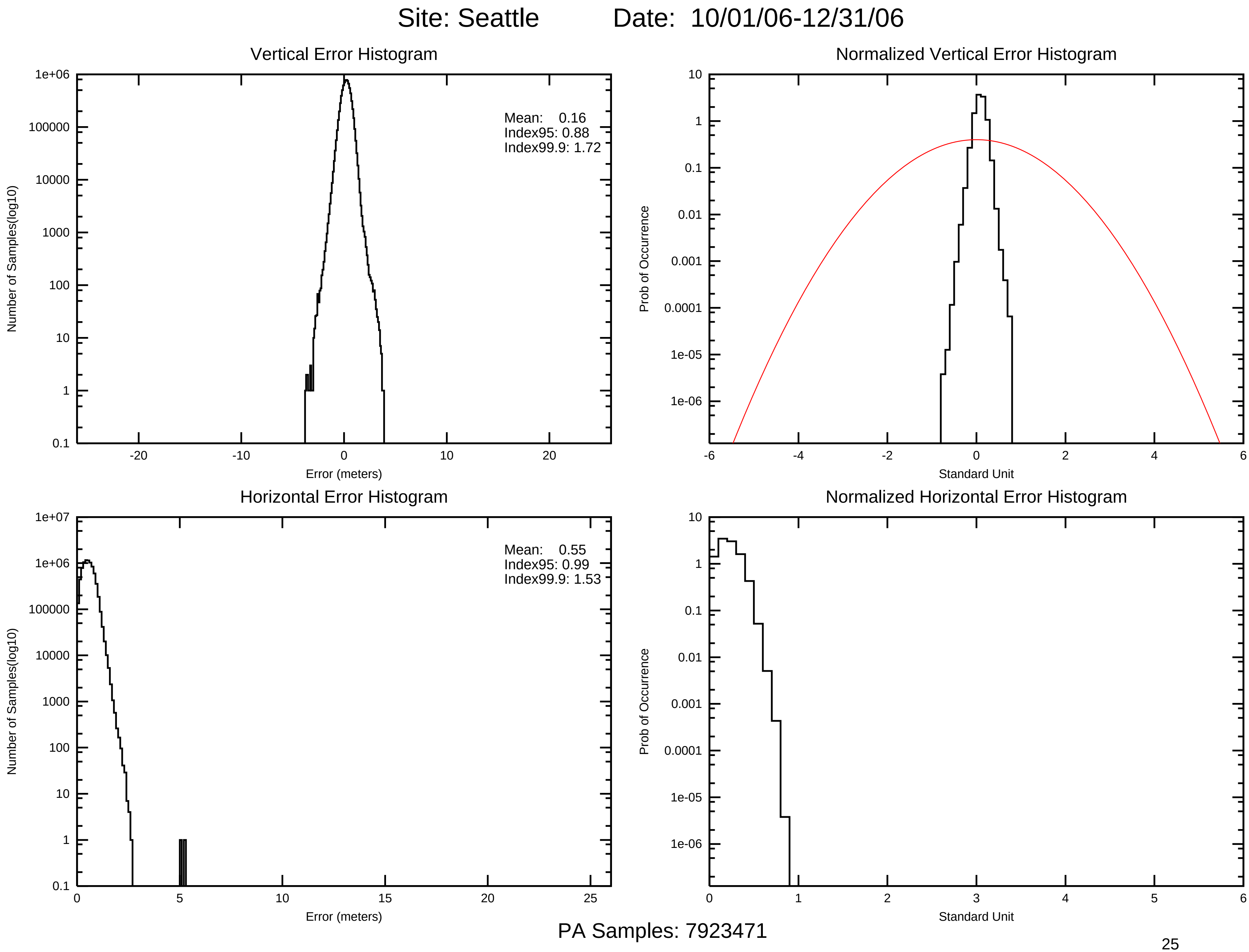


Figure 2-15 2-D Histogram for Seattle



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 49.133 meters and 90.347 meters both at Barrow, respectively. The minimum 95% HPL and VPL are 16.948 meters at Atlanta and 27.928 meters both at Atlanta.

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	21.725	39.351	99.983505
Greenwood	17.618	28.690	99.984673
San Angelo	22.145	34.685	99.981178
Albuquerque	20.290	33.782	99.989304
Anchorage	20.997	35.735	99.993263
Atlanta	16.948	27.928	99.983948
Barrow	49.133	90.347	99.568359
Bethel	25.104	46.266	99.969711
Billings	18.324	28.292	99.990265
Boston	28.841	46.780	99.983475
Chicago	17.114	27.936	99.984459
Cleveland	18.011	28.765	99.984146
Cold Bay	43.537	66.323	99.970612
Dallas	19.132	31.740	99.983902
Denver	17.415	28.659	99.988609
Fairbanks	20.752	39.340	99.993668
Houston	21.736	33.939	99.983803
Jacksonville	18.503	32.799	99.984291
Juneau	21.324	34.775	99.996880
Kansas City	17.054	28.131	99.982315
Kotzebue	29.303	58.146	99.884819
Los Angeles	28.311	44.317	99.995956
Memphis	16.600	26.769	99.984512
Miami	24.951	45.164	99.983498
Minneapolis	19.854	29.599	99.981056
New York	23.761	41.038	99.983482
Oakland	28.111	43.913	99.995949
Salt Lake City	18.705	30.677	99.995735
Seattle	20.869	30.576	99.996002
Washington DC	18.376	29.977	99.983932

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	0.99640733	0.99646509	0.99540887	0.99551400
Greenwood	0.99970776	0.99980873	0.99970086	0.99980188
San Angelo	0.99769986	0.99936372	0.99735196	0.99932029
Albuquerque	0.99618155	0.99664629	0.99608645	0.99659248
Anchorage	0.99297971	0.99301642	0.99146578	0.99182661
Atlanta	0.99982142	0.99983102	0.99980863	0.99982894
Barrow	0.63318324	0.67597342	0.57461704	0.63108076
Bethel	0.96325177	0.96329039	0.94910725	0.94919405
Billings	0.99980414	0.99984044	0.99978332	0.99981935
Boston	0.96998221	0.97015488	0.95404521	0.95428943
Chicago	0.99980962	0.99981427	0.99980911	0.99981303
Cleveland	0.99975270	0.99976856	0.99993799	0.99993799
Cold Bay	0.83986998	0.87165052	0.79354936	0.83342083
Dallas	0.99939293	0.99972671	0.99930565	0.99969841
Denver	0.99983871	0.99987966	0.99983876	0.99987973
Fairbanks	0.98847592	0.98850244	0.98660340	0.98698343
Houston	0.99743593	0.99836391	0.99712318	0.99786644
Jacksonville	0.99951339	0.99951577	0.99932342	0.99932583
Juneau	0.99612951	0.99621028	0.99582111	0.99595554
Kansas City	0.99962473	0.99964535	0.99981109	0.99981109
Kotzebue	0.90705764	0.90964353	0.87880694	0.88822248
Los Angeles	0.97630119	0.97834980	0.97148218	0.97354302
Memphis	0.99978167	0.99978662	0.99978158	0.99978651
Miami	0.96637779	0.96655303	0.96212753	0.96231529
Minneapolis	0.99968880	0.99973303	0.99971892	0.99979637
New York	0.99422902	0.99422926	0.99153155	0.99153149
Oakland	0.97708458	0.97957385	0.97010773	0.97313044
Salt Lake City	0.99938434	0.99939561	0.99902441	0.99904674
Seattle	0.99828768	0.99836355	0.99782078	0.99799498
Washington DC	0.99973100	0.99973607	0.99972528	0.99973601

Table 3-3 NPA Availability

Location	NPA Availability (Excluding RAIM/FDE)
Albuquerque	0.99994837
Anchorage	0.99998036
Atlanta	0.99994595
Bethel	0.99997981
Billings	0.99996124
Boston	0.99994416
Cleveland	0.99997093
Cold Bay	0.99997911
Fairbanks	0.99998088
Honolulu	0.99995708
Houston	0.99994696
Juneau	0.99997860
Kansas City	0.99989391
Kotzebue	0.99997976
Los Angeles	0.99998420
Miami	0.99994484
Minneapolis	0.99993932
Oakland	0.99998064
Puerto Rico	0.99720649
Salt Lake City	0.99998046
Seattle	0.99998148
Washington DC	0.99994626

Table 3-4 LPV and LNAV/VNAV Outage Rate

Location	LPV Outages	LPV Outage Rates	LNAV/VNAV Outages	LNAV/VNAV Outage Rates
Atlantic City	102	0.001942	99	0.001885
Greenwood	15	0.000284	8	0.000152
San Angelo	40	0.000830	26	0.000539
Albuquerque	69	0.001314	61	0.001161
Anchorage	144	0.002759	139	0.002662
Atlanta	8	0.000153	8	0.000153
Barrow	1328	0.046447	1345	0.042832
Bethel	574	0.012110	574	0.012109
Billings	8	0.000195	5	0.000122
Boston	376	0.007468	373	0.007406
Chicago	7	0.000133	8	0.000152
Cleveland	15	0.000849	9	0.000509
Cold Bay	1210	0.030142	1007	0.023877
Dallas	22	0.000418	14	0.000266
Denver	7	0.000133	5	0.000095
Fairbanks	300	0.005867	262	0.005122
Houston	50	0.000951	50	0.000950
Jacksonville	33	0.000626	33	0.000626
Juneau	71	0.001438	70	0.001417
Kansas City	16	0.000962	9	0.000541
Kotzebue	1201	0.026416	1137	0.024743
Los Angeles	320	0.006256	313	0.006107
Memphis	8	0.000152	7	0.000133
Miami	231	0.004764	226	0.004660
Minneapolis	13	0.000271	7	0.000146
New York	142	0.002716	143	0.002735
Oakland	290	0.005664	277	0.005393
Salt Lake City	25	0.000482	22	0.000424
Seattle	30	0.000569	28	0.000531
Washington DC	12	0.000227	11	0.000208

Table 3-5 NPA Outage Rates

Location	NPA Outages	NPA Outage Rate
Albuquerque	6	0.00010831
Anchorage	3	0.00005421
Atlanta	7	0.00012696
Bethel	2	0.00003810
Billings	3	0.00006840
Boston	6	0.00010832
Cleveland	2	0.00005591
Cold Bay	3	0.00005435
Fairbanks	2	0.00003678
Honolulu	6	0.00010913
Houston	6	0.00010826
Juneau	3	0.00005732
Kansas City	4	0.00022818
Kotzebue	4	0.00007361
Los Angeles	2	0.00004123
Miami	6	0.00011182
Minneapolis	6	0.00011978
Oakland	3	0.00005411
Puerto Rico	8	0.00025599
Salt Lake City	3	0.00005461
Seattle	3	0.00005412
Washington DC	6	0.00010822

Figure 3-1 LPV Instantaneous Availability

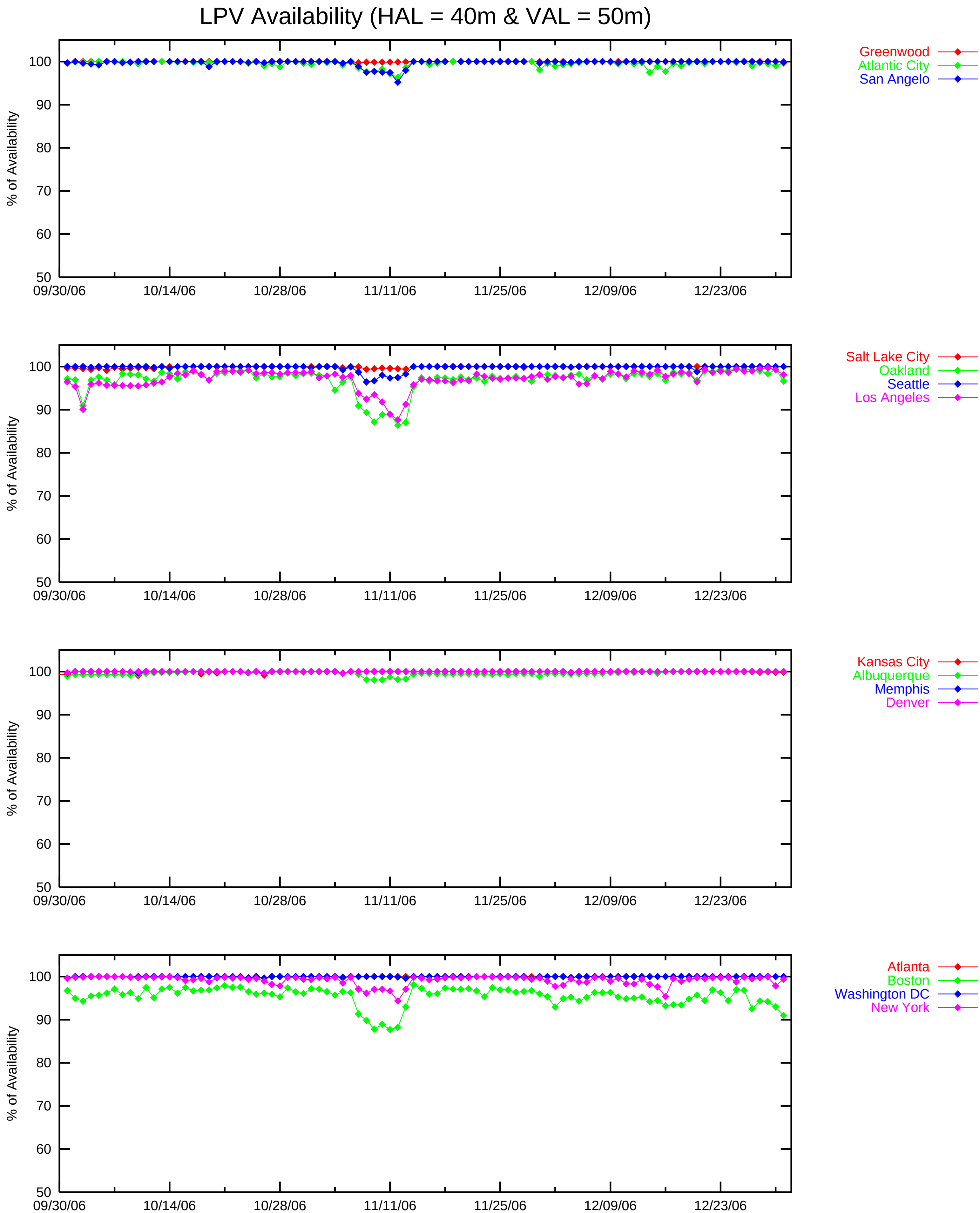


Figure 3-2 LPV Instantaneous Availability

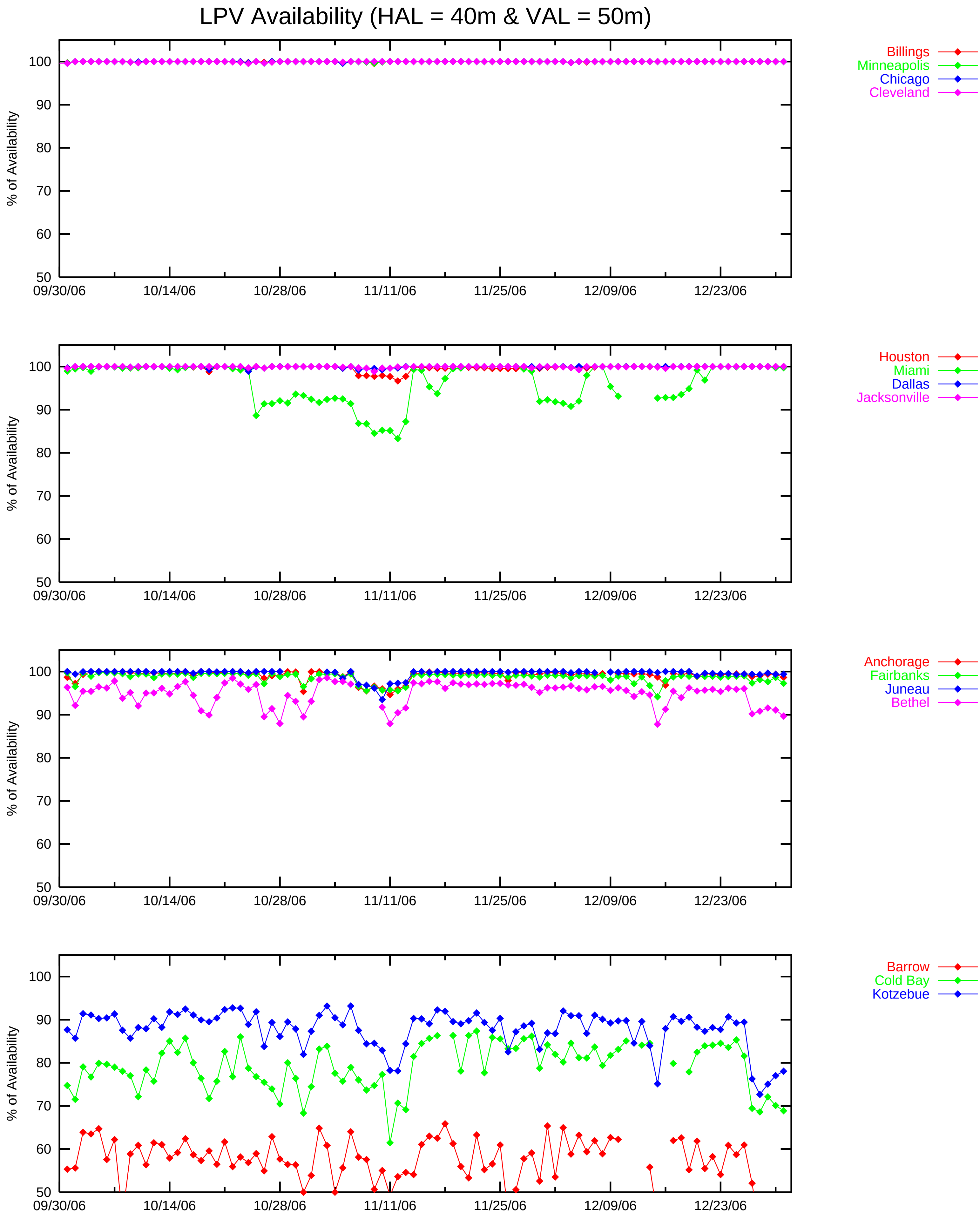


Figure 3-3 LNAV/VNAV Instantaneous Availability

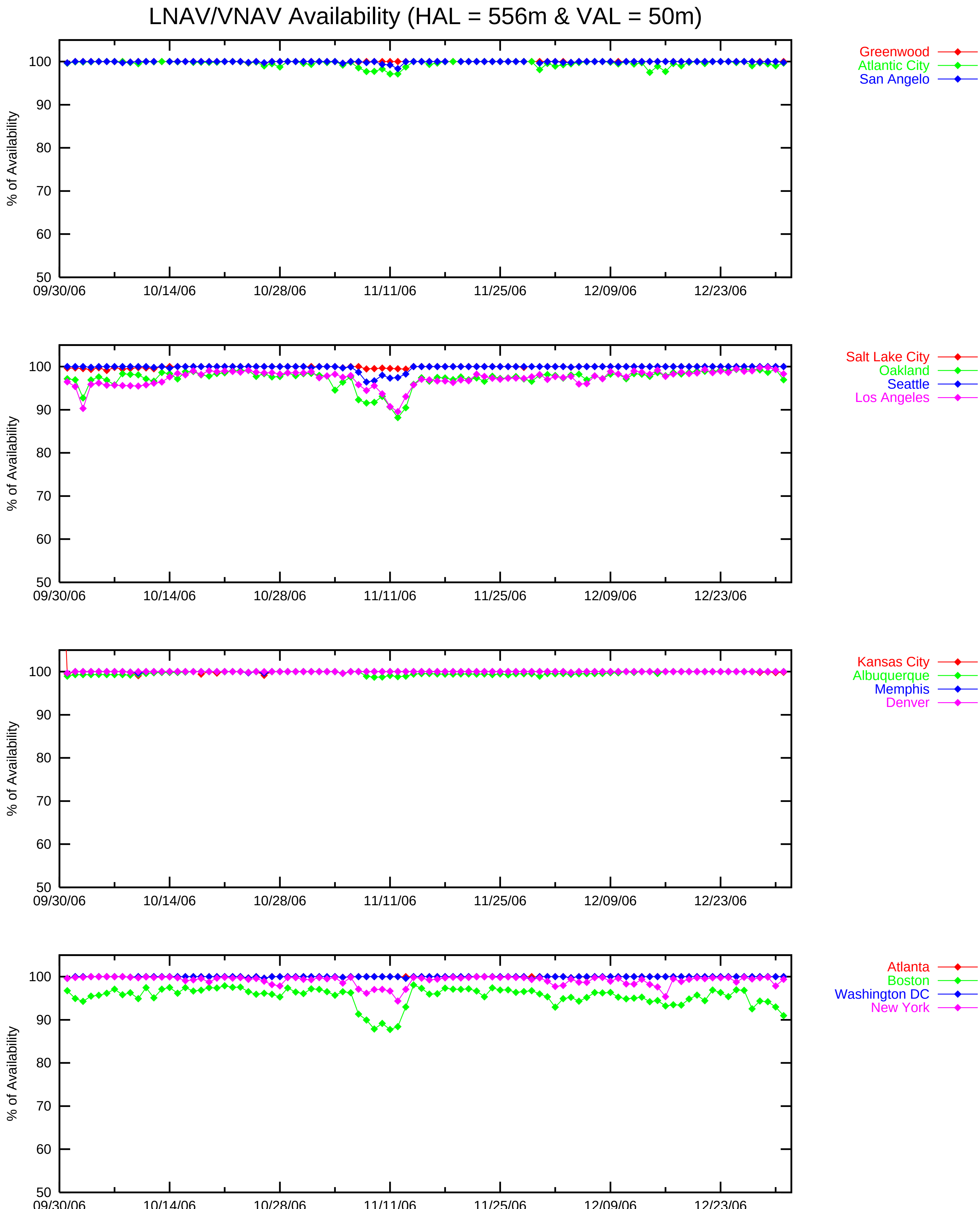


Figure 3-4 LNAV/VNAV Instantaneous Availability

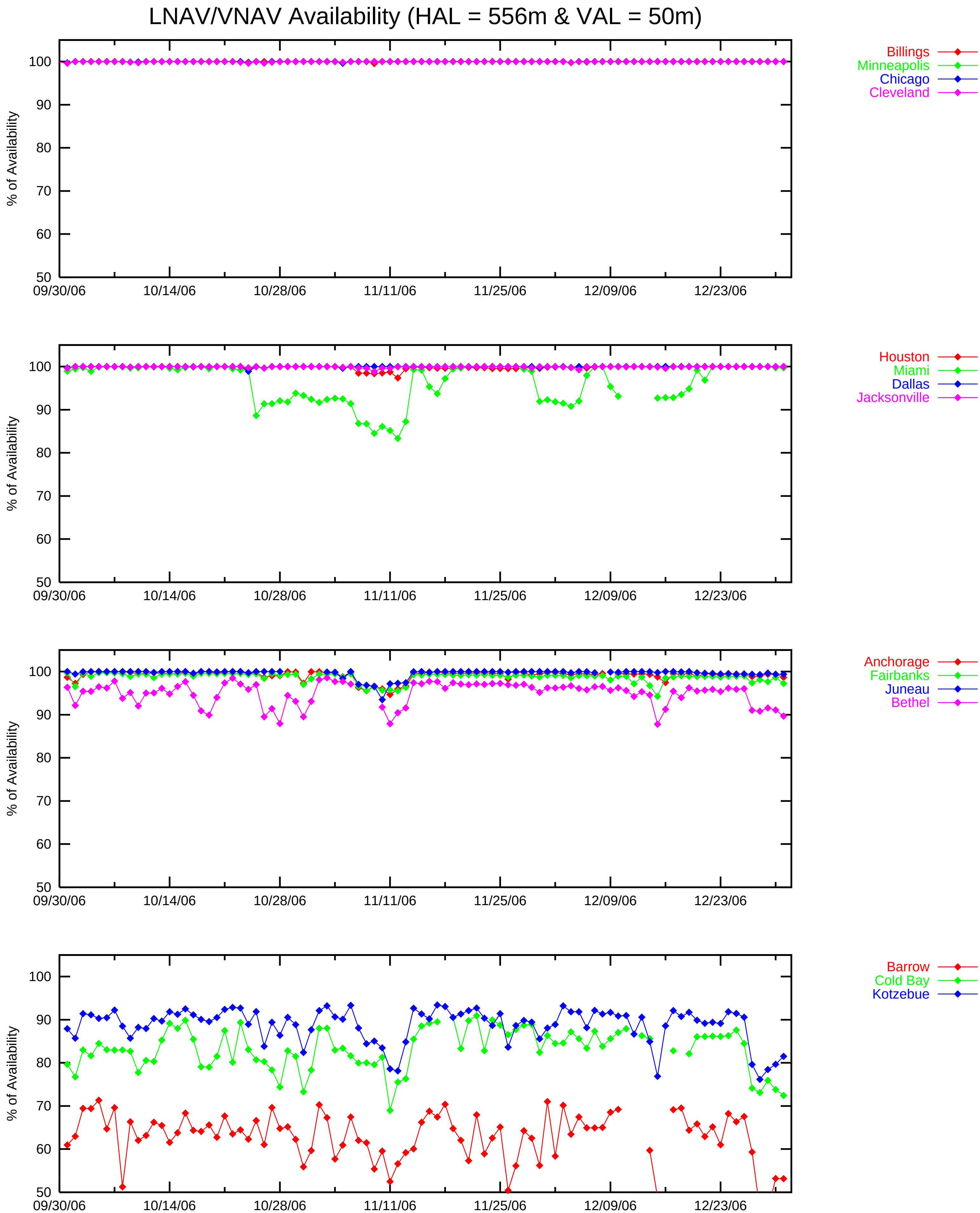


Figure 3-5 LPV Outages

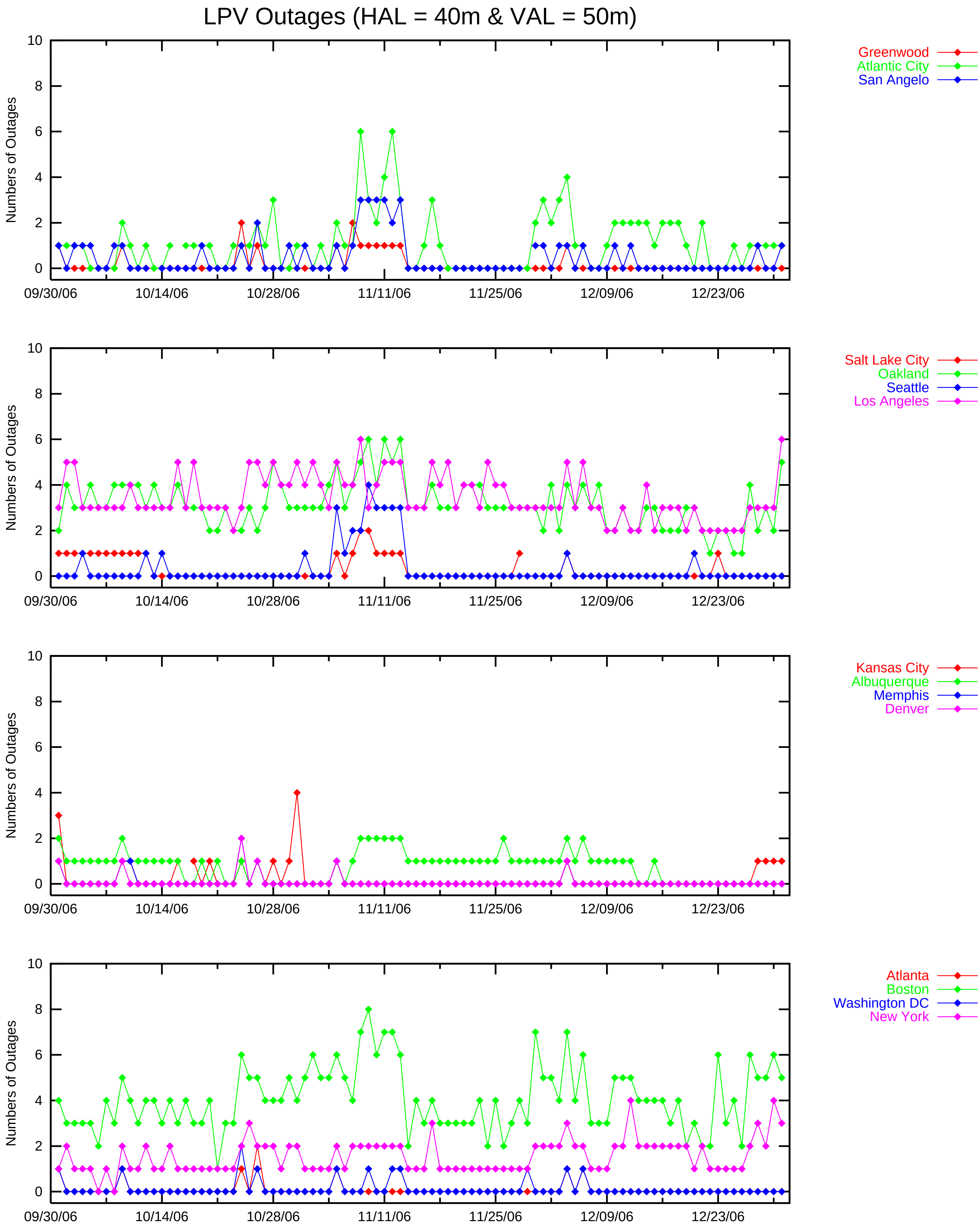


Figure 3-6 LPV Outages

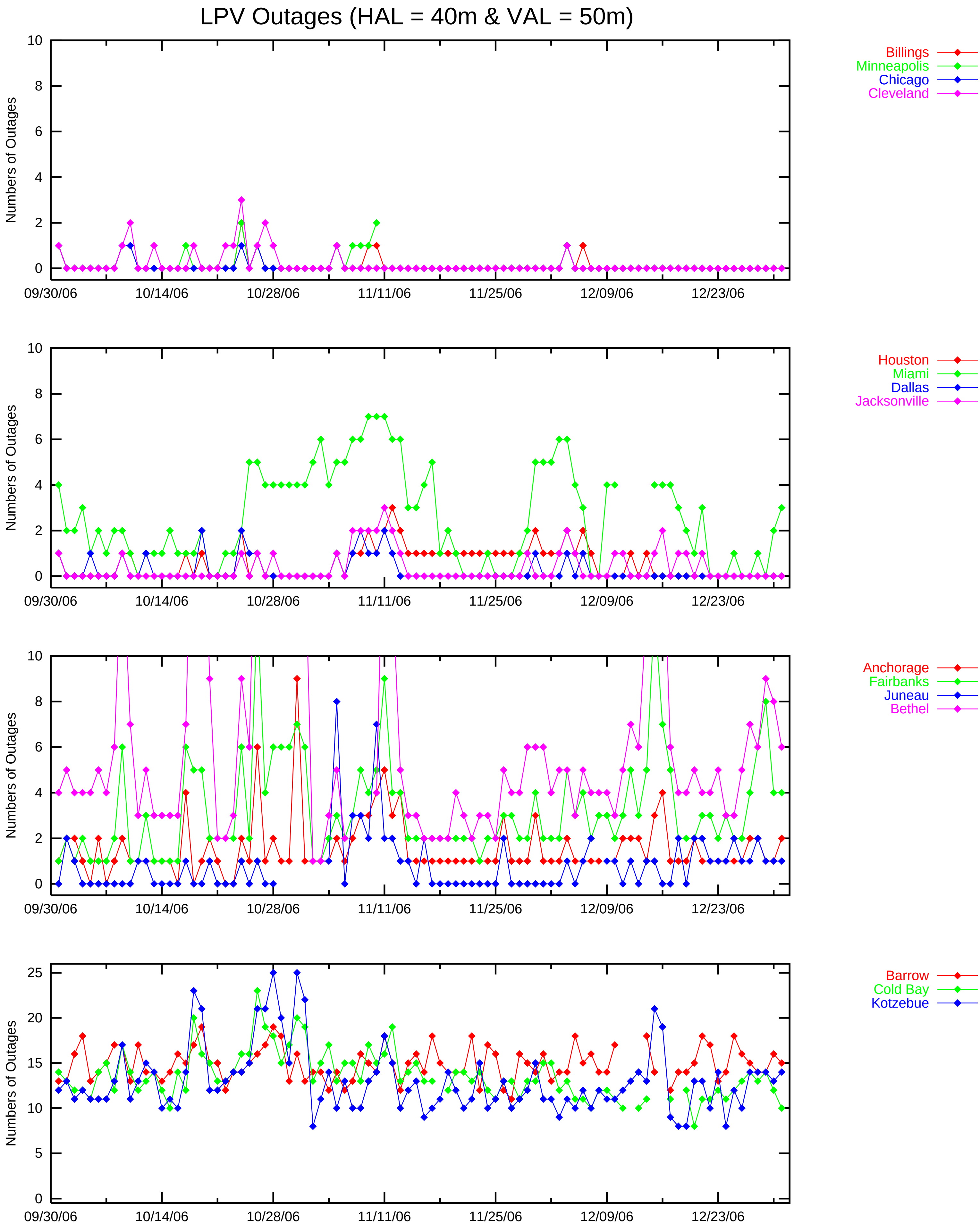


Figure 3-7 LNAV/VNAV Outages

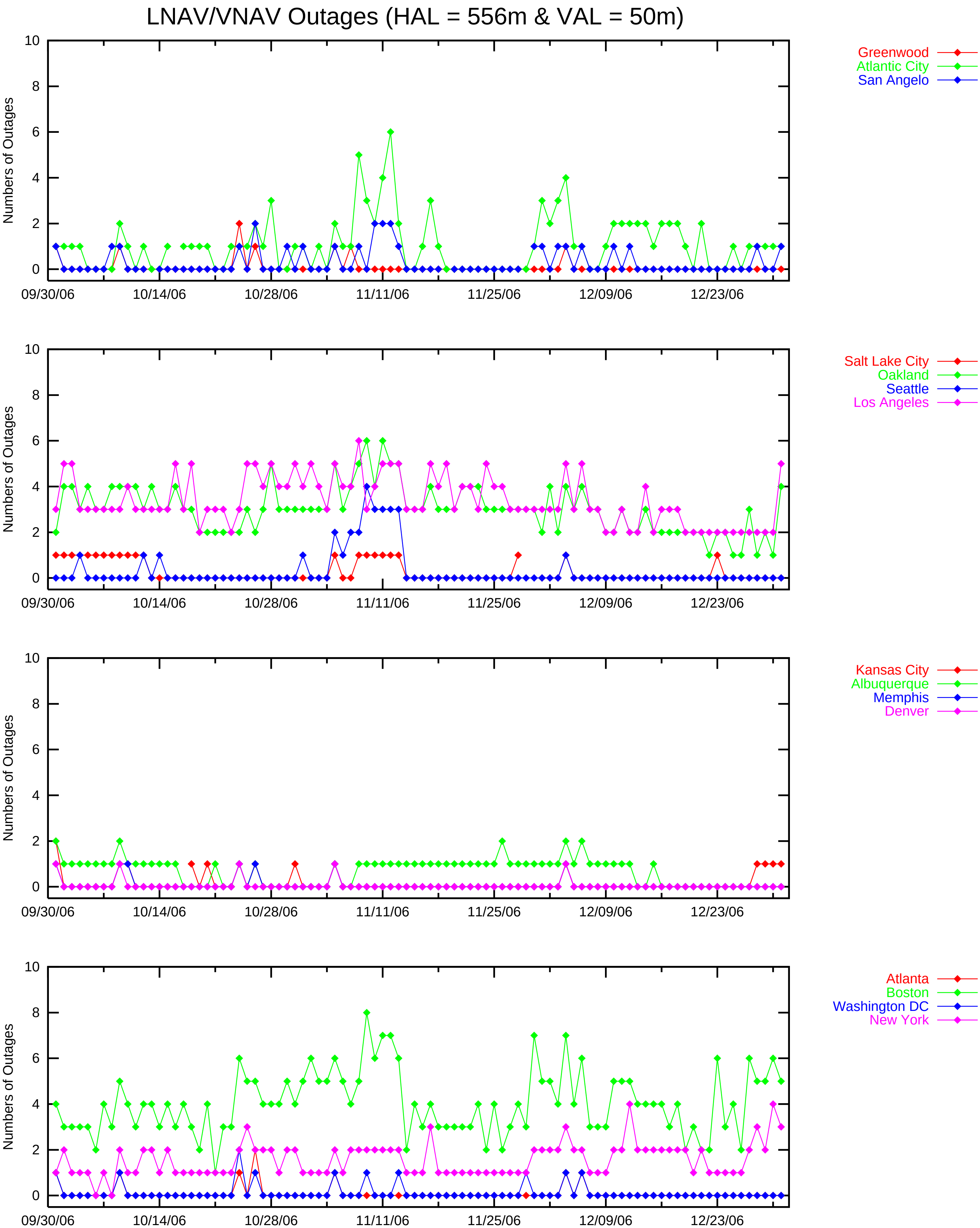
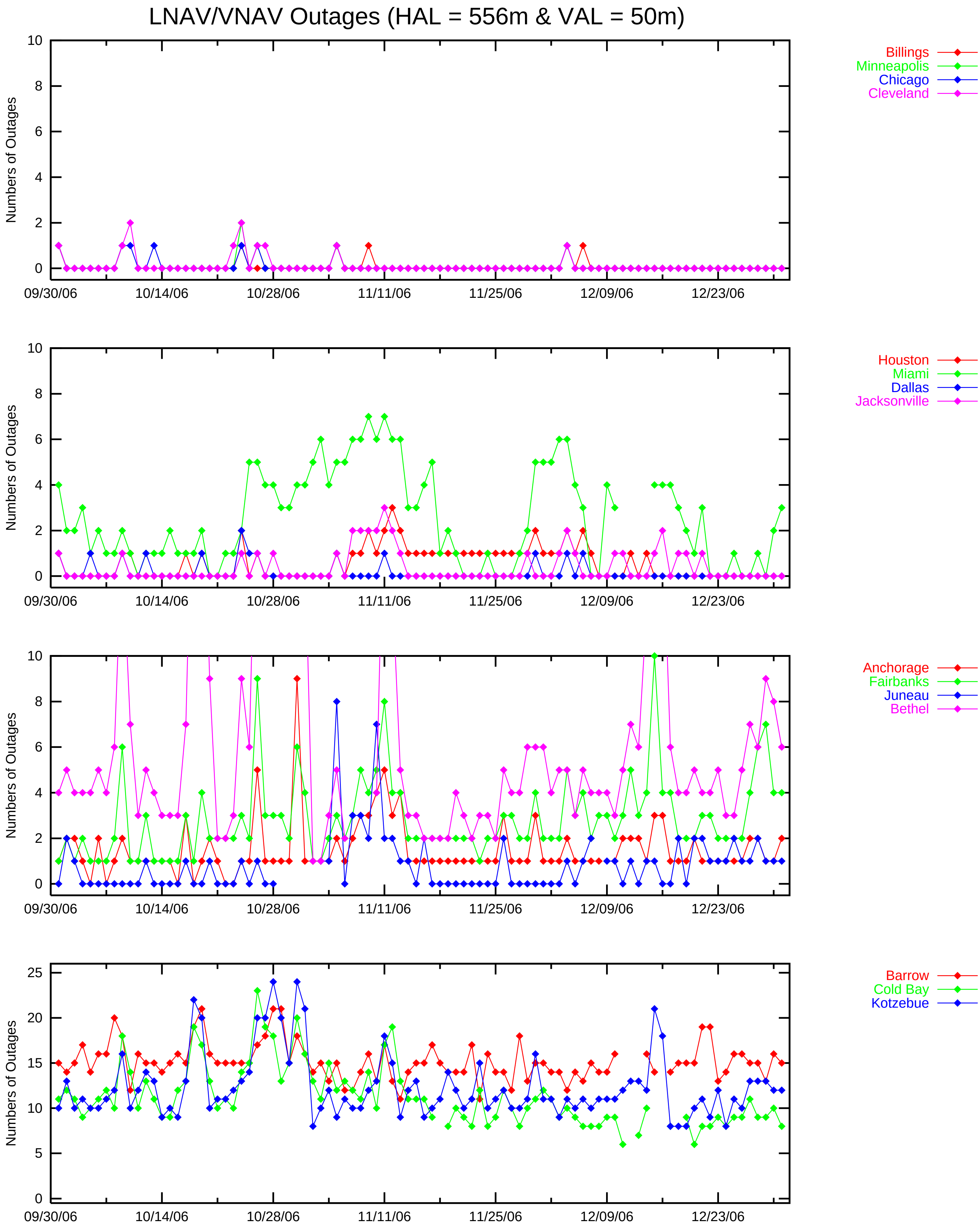


Figure 3-8 LNAV/VNAV Outages



4.0 COVERAGE

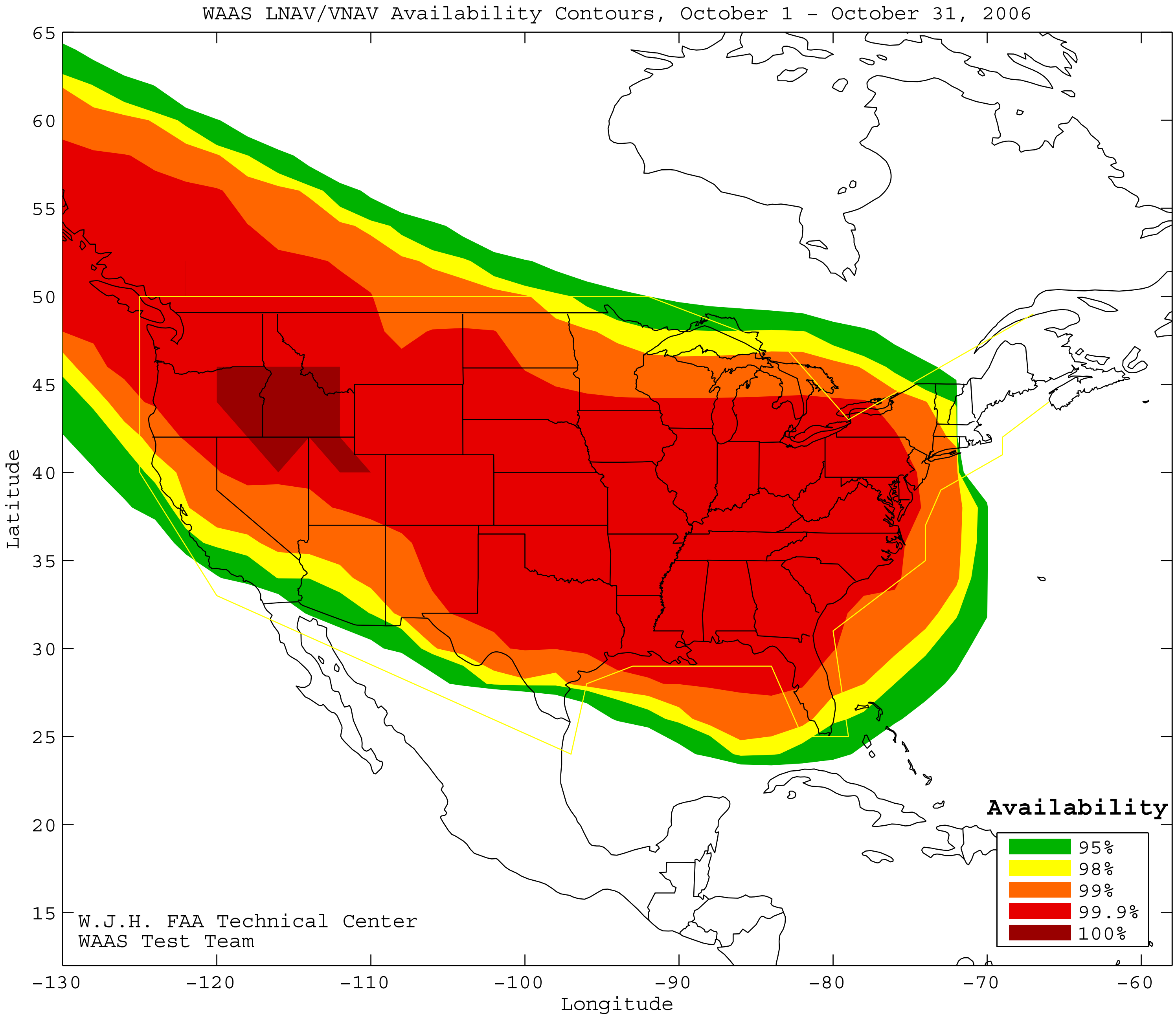
WAAS coverage area evaluation estimates the percent of service volume where WAAS is providing LPV, LNAV/VNAV and NPA services. The WAAS message and the GPS/GEO satellite status are used to determine WAAS availability across North America. For PA coverage, protection levels were calculated at two-minute 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. The coverage plots provide 100, 99, 95, 90 and 80% availability contours. Figures 4.1 to 4.3 and 4.5 to 4.7 show the LNAV/VNAV and LPV CONUS coverage area for each month for this quarter, respectively. Figures 4.18 to 4.20 show the LPV Alaska coverage area for each month for this quarter, respectively. Figures 4.4, 4.8 and 4.21 show the rollup LNAV/VNAV and LPV coverage for the quarter. Figure 4.13 shows the daily LNAV/VNAV and LPV coverage at 99% availability and ionosphere KP index values for this quarter. Figure 4.22 shows rollup LPV coverage at 200 meters for the quarter.

Daily analysis for NPA was based on a 99.9% availability requirement. The NPA coverage plots provide 100, 99.9 and 99% availability contours. 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. Figure 4.14 shows the daily NPA coverage at 99.9% availability and ionosphere Kp index values for this quarter.

Figures 4.15 to 4.17 show LNAV/VNAV, LPV and NPA CONUS coverage since WAAS commissioning (July 2003).

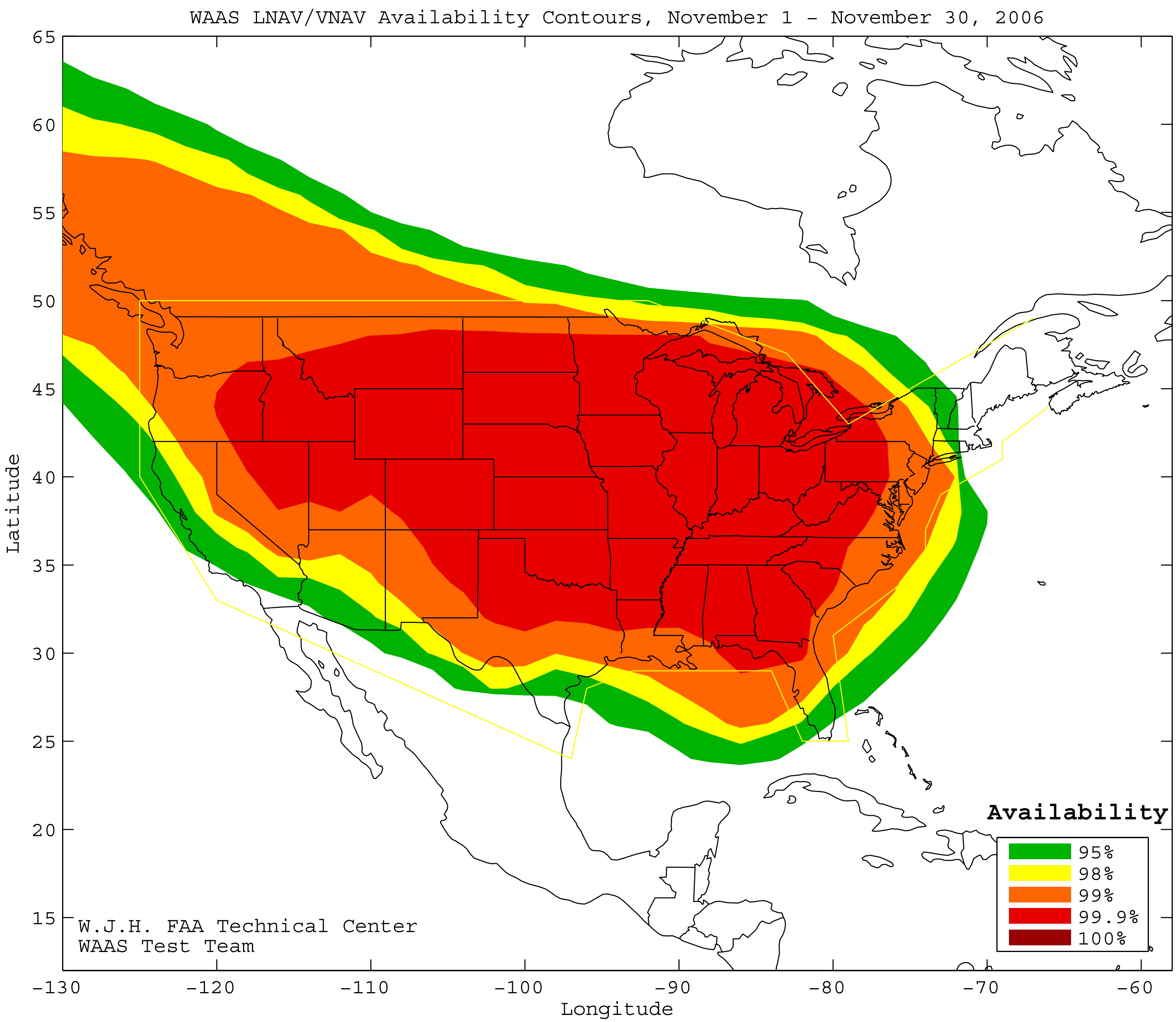
Figure 4-1 WAAS LNAV/VNAV Coverage - October



CONUS Coverage at 95% Availability = 93.93%
CONUS Coverage at 99% Availability = 83.81%
CONUS Coverage at 100% Availability = 6.883%

SL = LNAV/VNAV

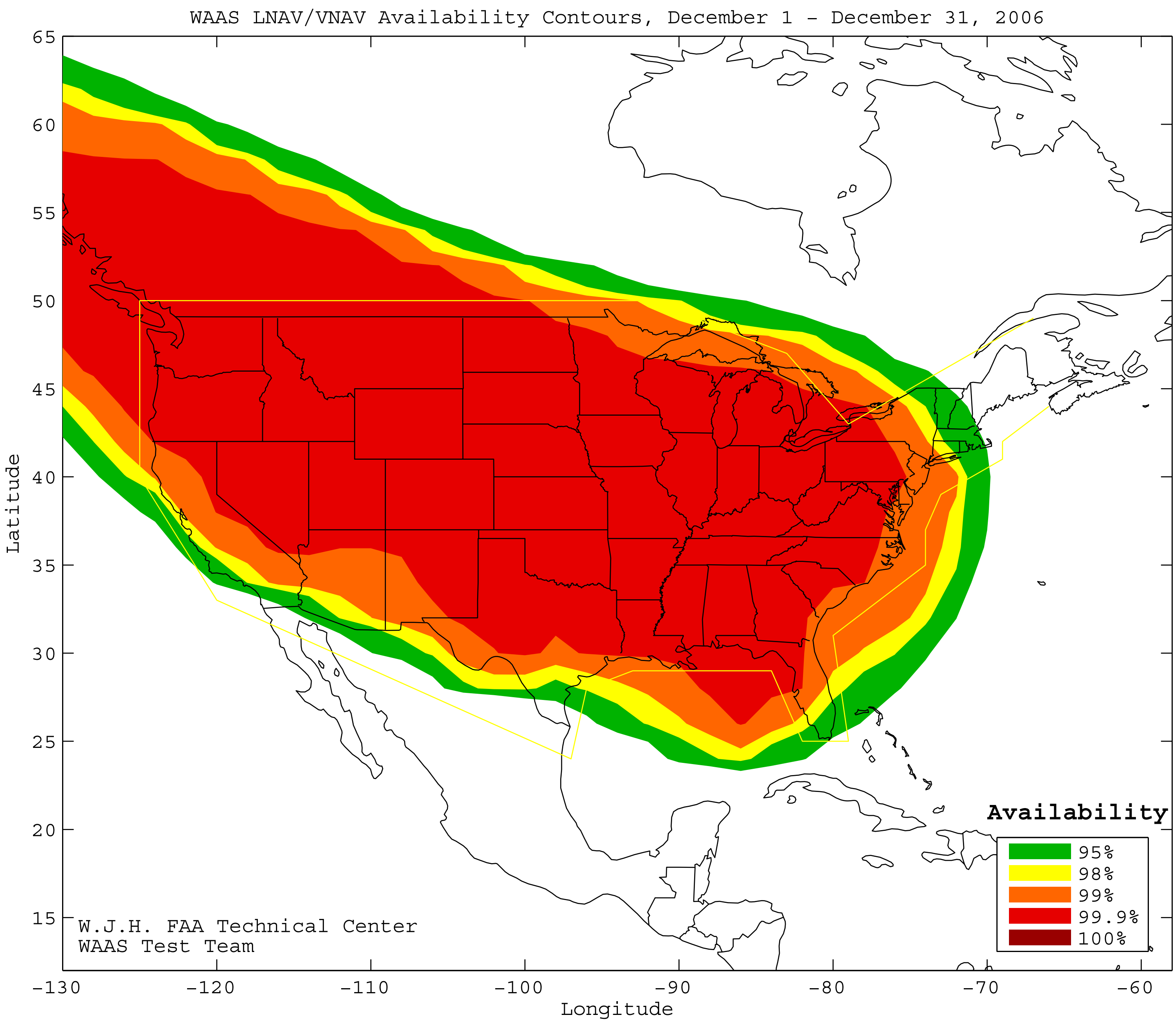
Figure 4-2 WAAS LNAV/VNAV Coverage - November



CONUS Coverage at 95% Availability = 93.12%
CONUS Coverage at 99% Availability = 81.78%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

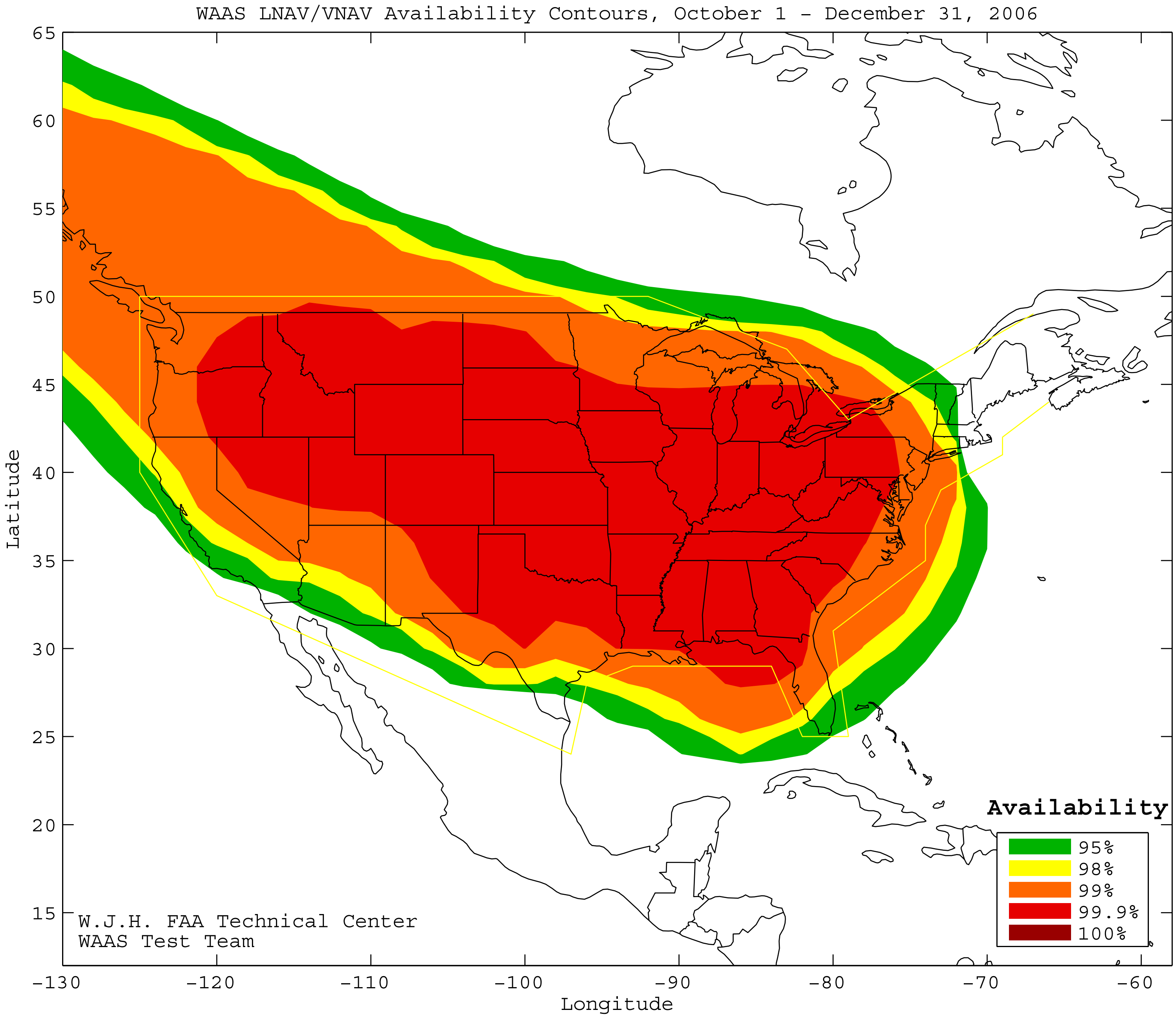
Figure 4-3 WAAS LNAV/VNAV Coverage - December



CONUS Coverage at 95% Availability = 94.33%
CONUS Coverage at 99% Availability = 86.64%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

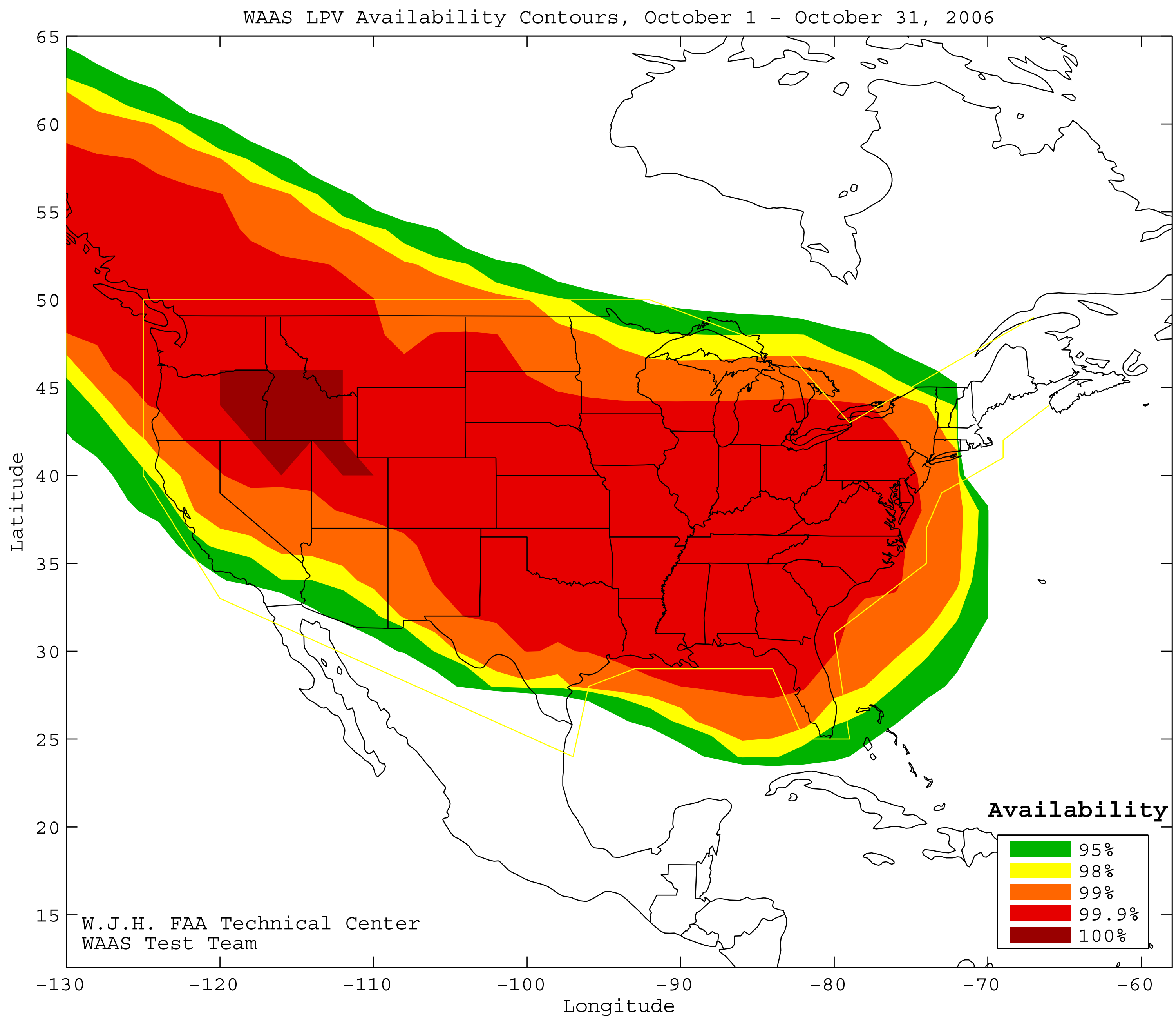
Figure 4-4 WAAS LNAV/VNAV Coverage for the Quarter



CONUS Coverage at 95% Availability = 93.52%
CONUS Coverage at 99% Availability = 83.81%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

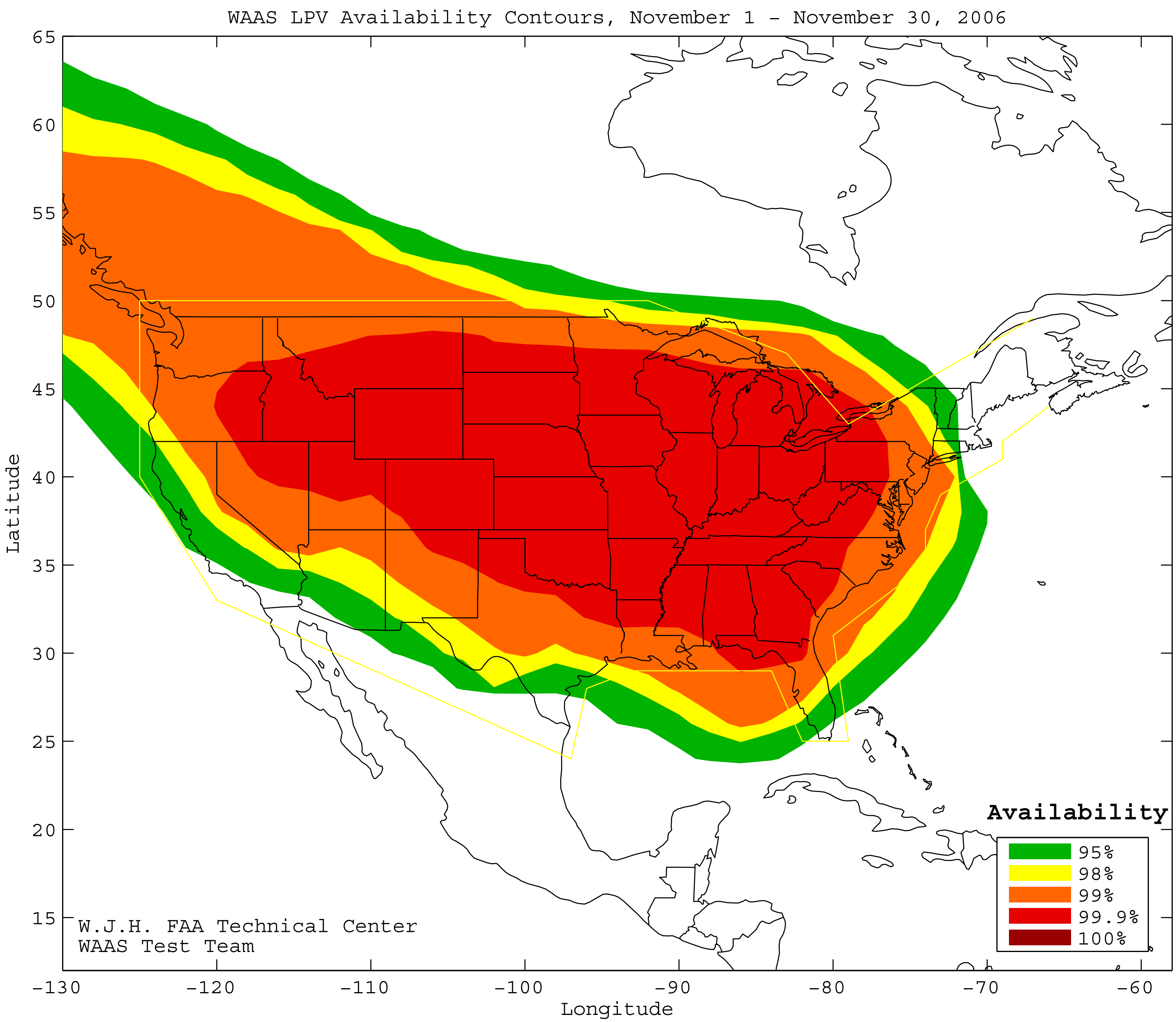
Figure 4-5 WAAS LPV Coverage - October



CONUS Coverage at 95% Availability = 93.52%
CONUS Coverage at 99% Availability = 83.81%
CONUS Coverage at 100% Availability = 6.883%

SL = LPV

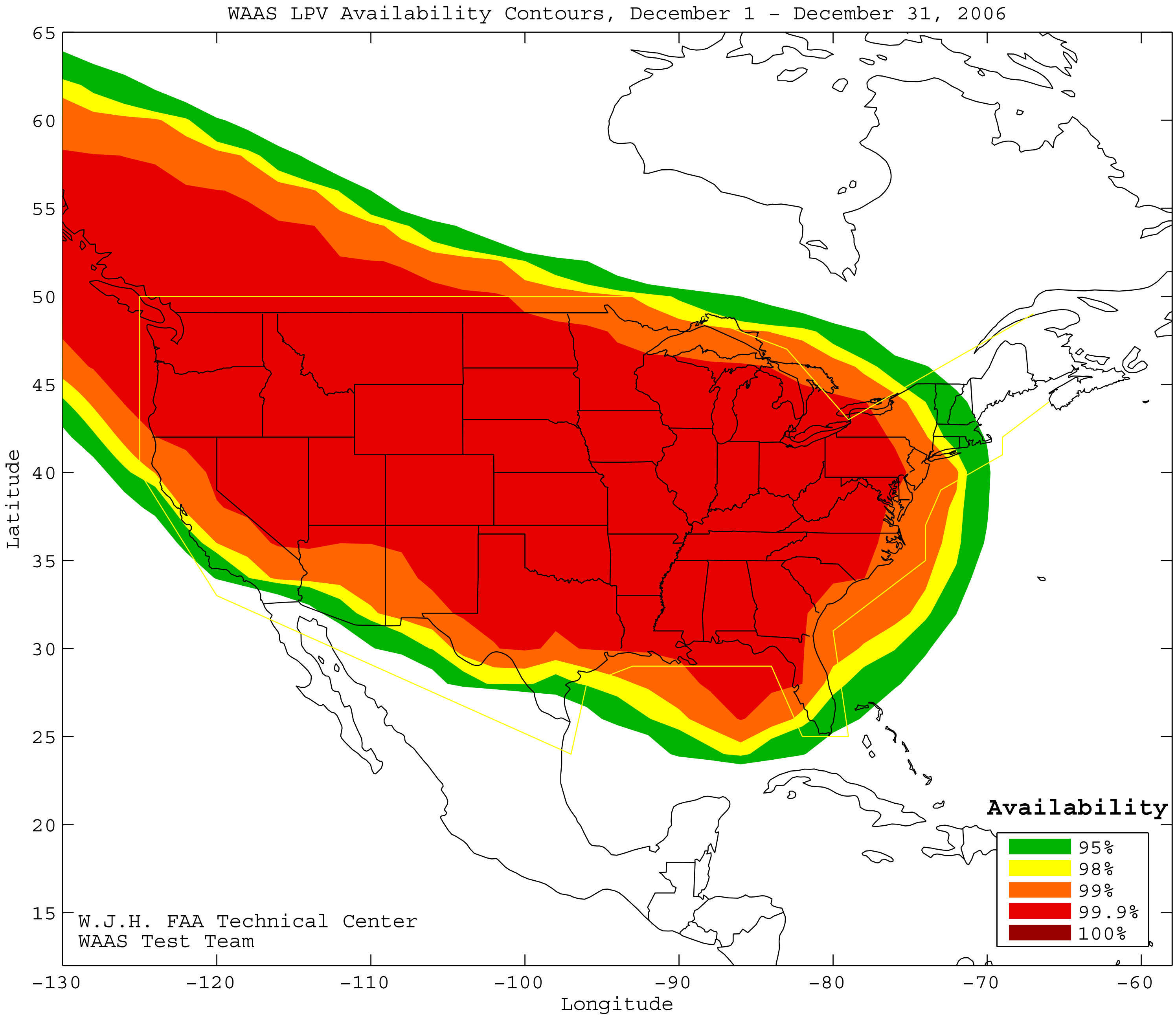
Figure 4-6 WAAS LPV Coverage - November



CONUS Coverage at 95% Availability = 92.71%
CONUS Coverage at 99% Availability = 79.35%
CONUS Coverage at 100% Availability = 0%

SL = LPV

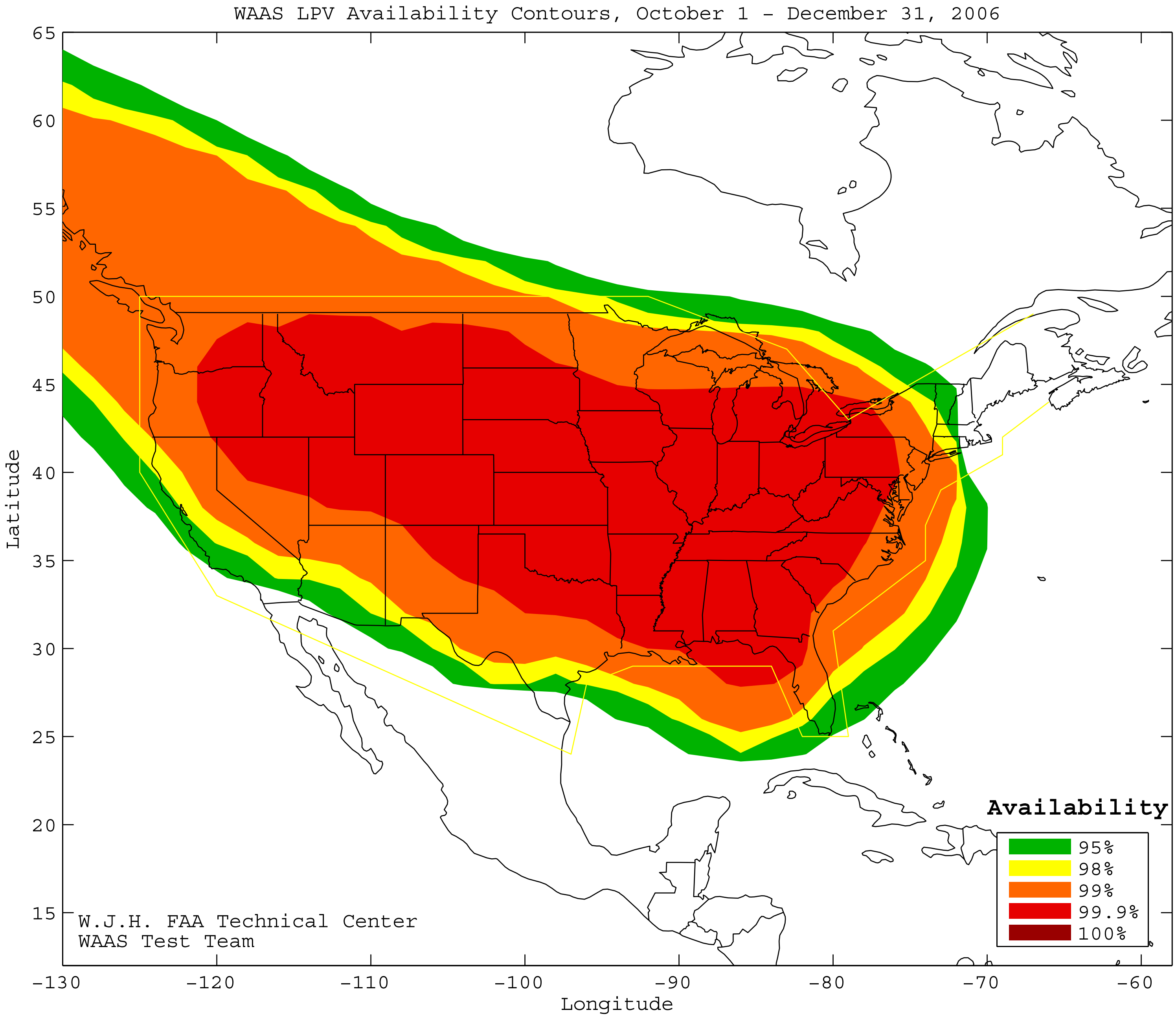
Figure 4-7 WAAS LPV Coverage - December



CONUS Coverage at 95% Availability = 93.93%
CONUS Coverage at 99% Availability = 86.64%
CONUS Coverage at 100% Availability = 0%

SL = LPV

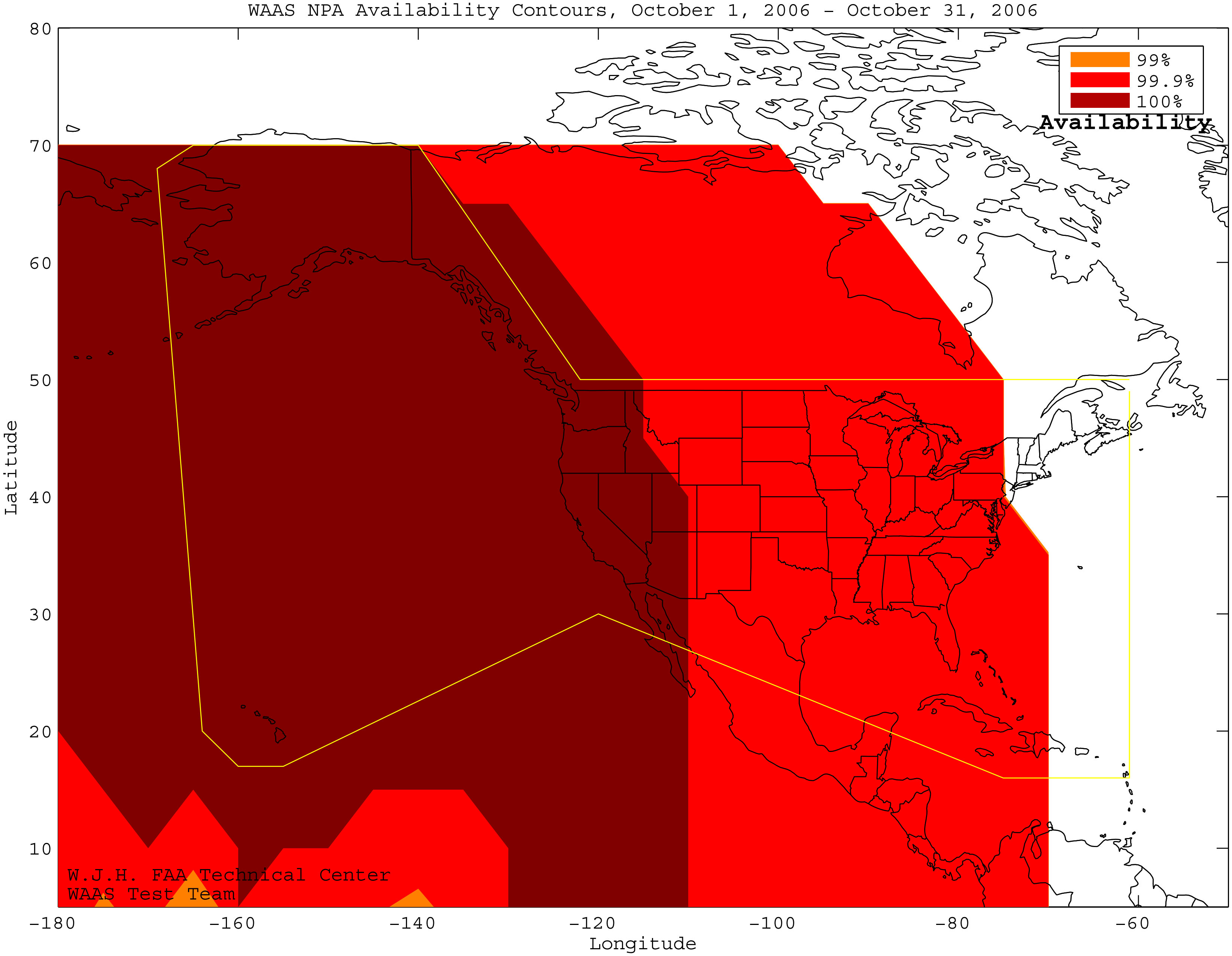
Figure 4-8 WAAS LPV Coverage for the Quarter



CONUS Coverage at 95% Availability = 93.52%
CONUS Coverage at 99% Availability = 83.4%
CONUS Coverage at 100% Availability = 0%

SL = LPV

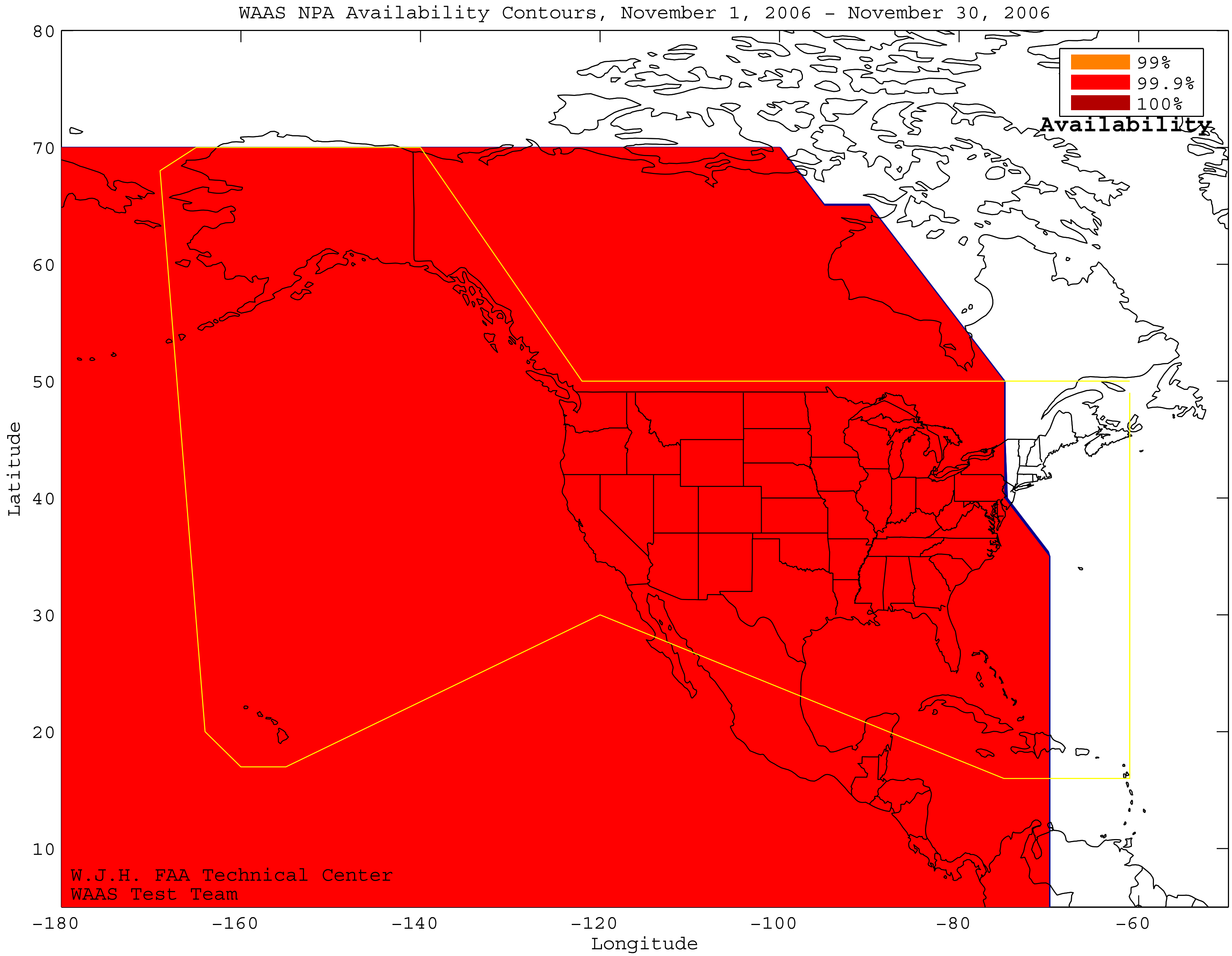
Figure 4-9 WAAS NPA Coverage - October



WAAS Coverage at 99% Availability = 94.12%
WAAS Coverage at 99.9% Availability = 94.12%
WAAS Coverage at 100% Availability = 63.24%

SL = NPA

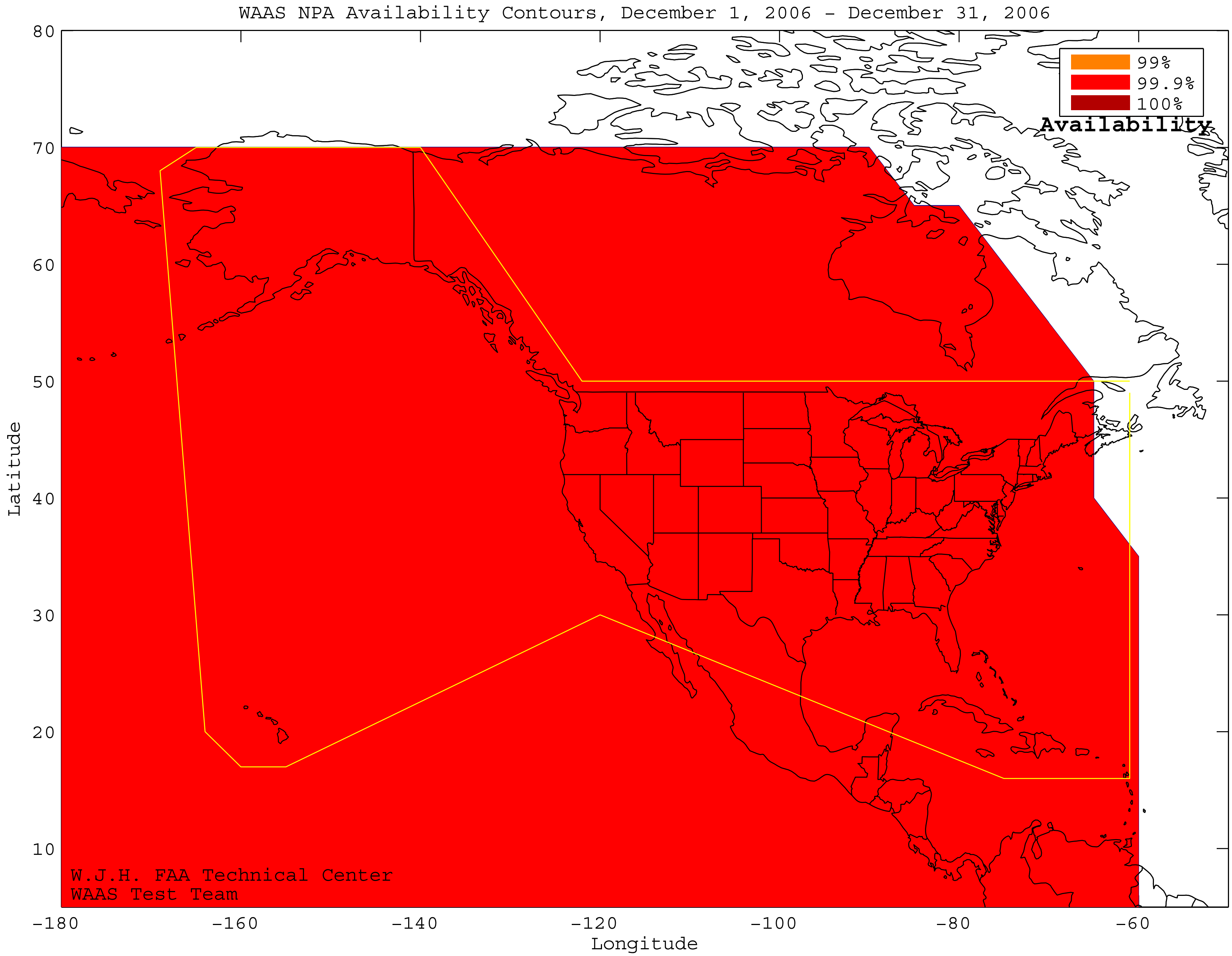
Figure 4-10 WAAS NPA Coverage - November



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

SL = NPA

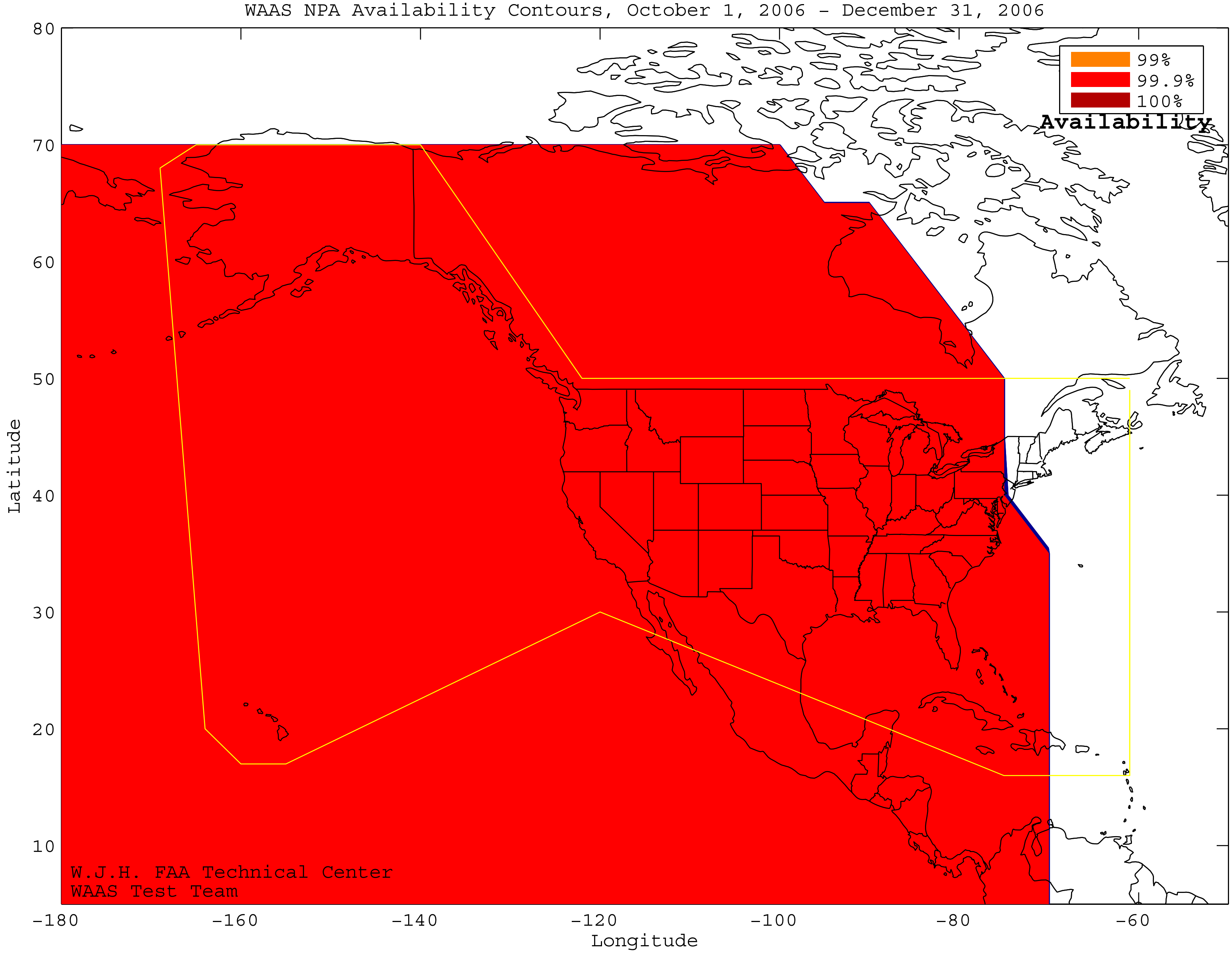
Figure 4-11 WAAS NPA Coverage - December



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

SL = NPA

Figure 4-12 WAAS NPA Coverage for the Quarter



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

SL = NPA

Figure 4-13 Daily LNAV/VNAV and LPV Coverage

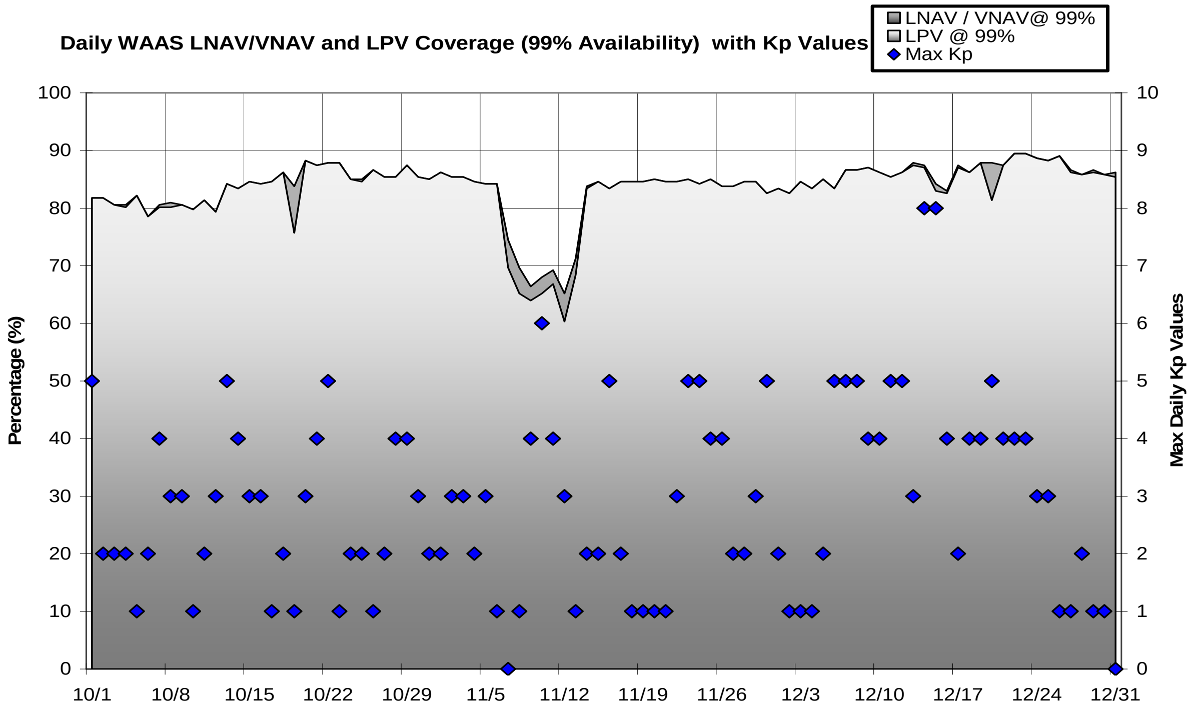


Figure 4-14 Daily NPA Coverage

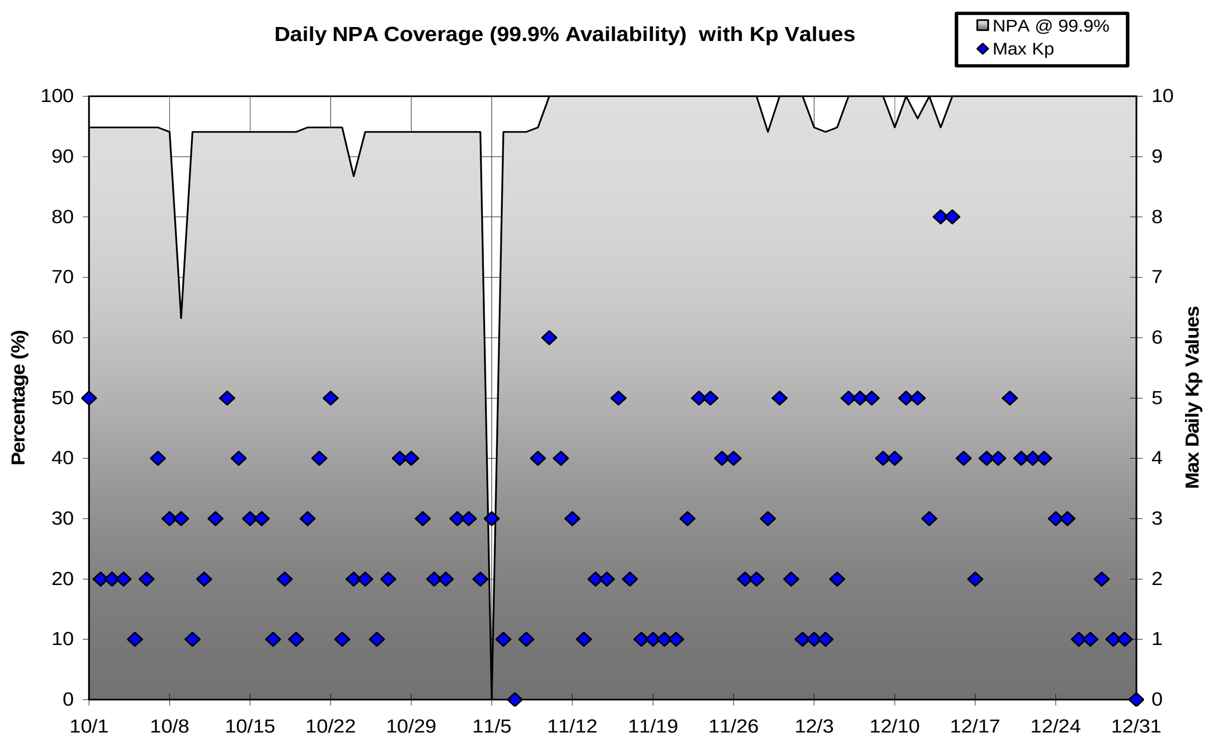
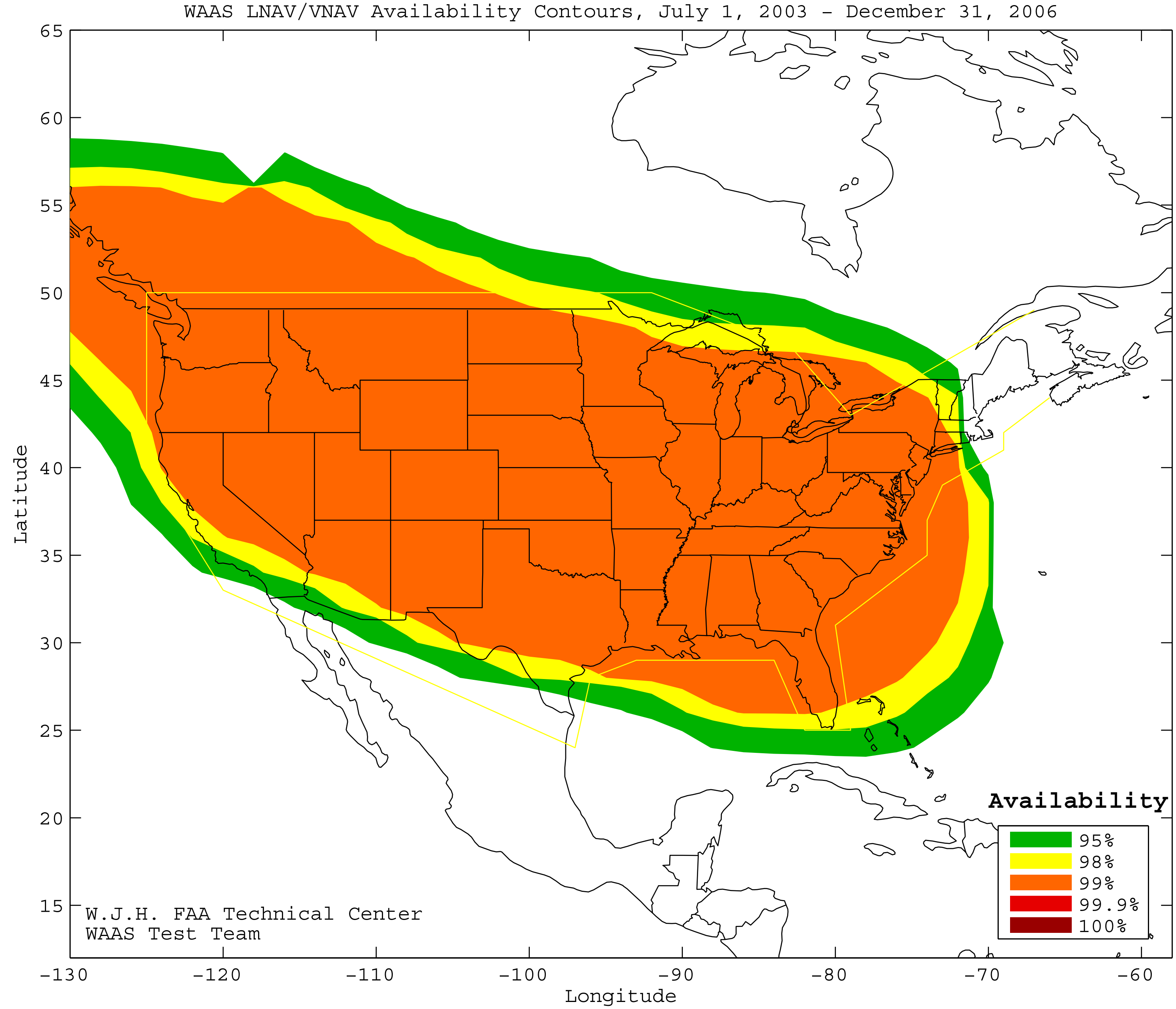


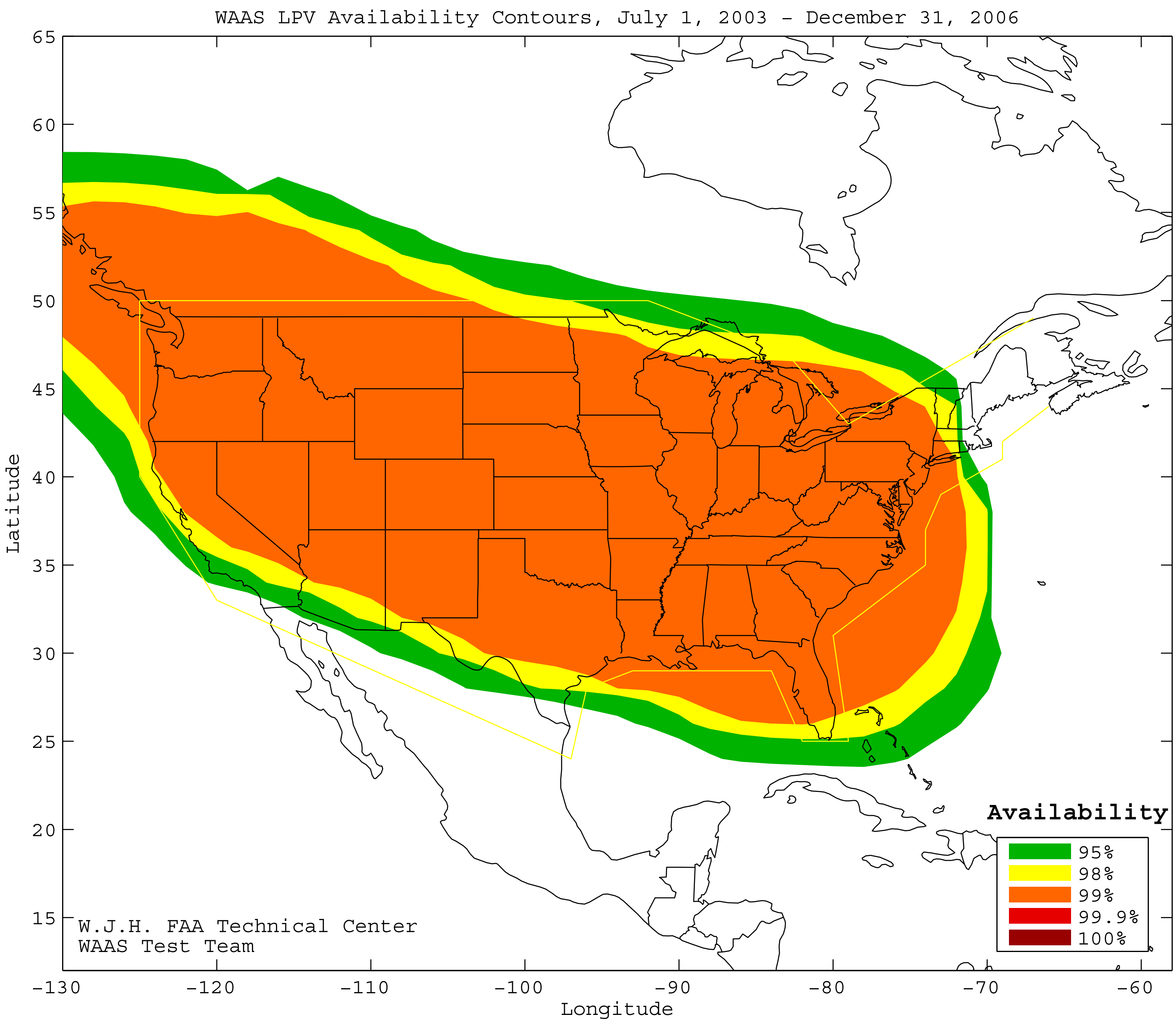
Figure 4-15 WAAS LNAV/VNAV Coverage Since Commissioning



CONUS Coverage at 95% Availability = 94.74%
CONUS Coverage at 99% Availability = 85.83%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

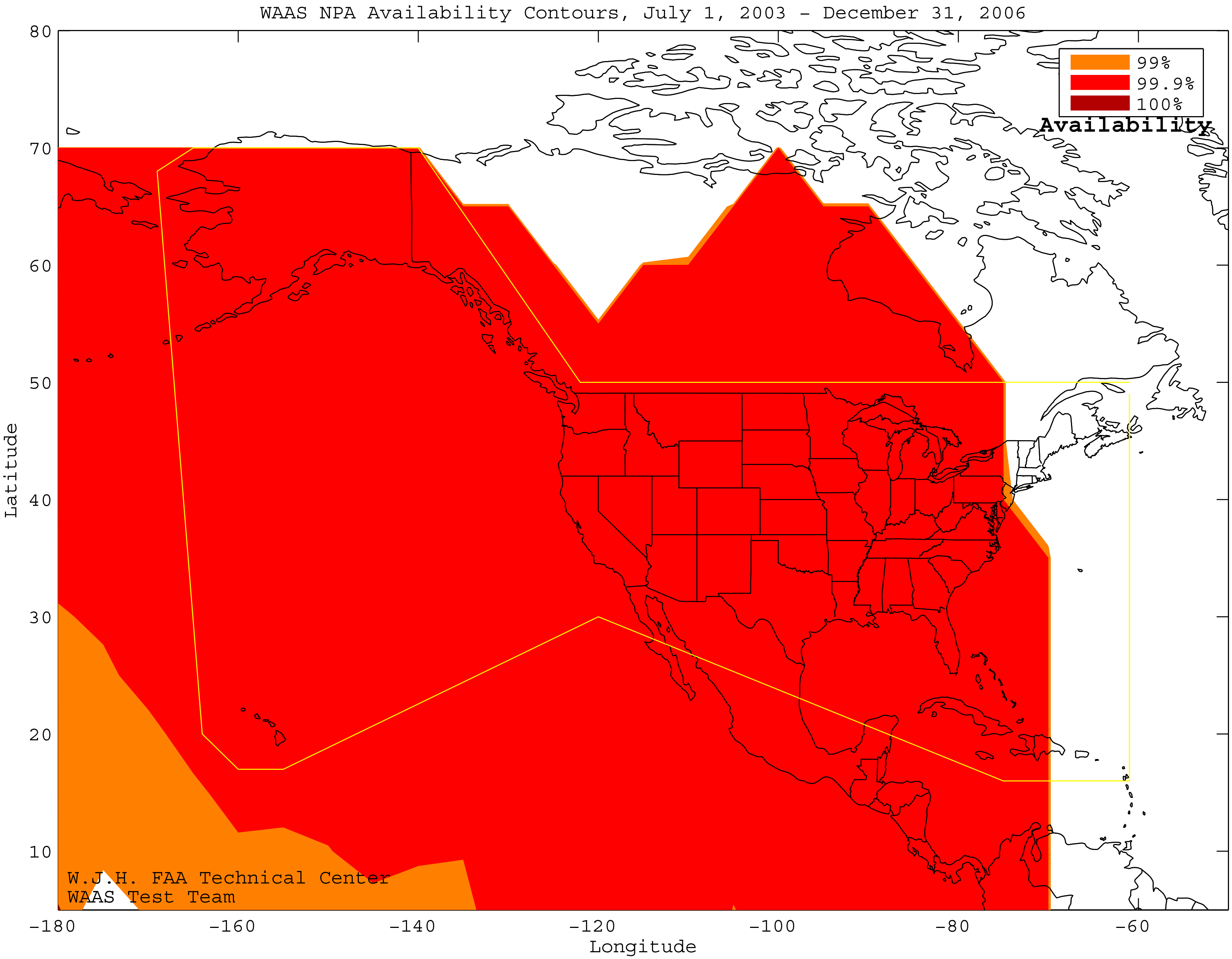
Figure 4-16 WAAS LPV Coverage Since Commissioning



CONUS Coverage at 95% Availability = 93.93%
CONUS Coverage at 99% Availability = 83.81%
CONUS Coverage at 100% Availability = 0%

SL = LPV

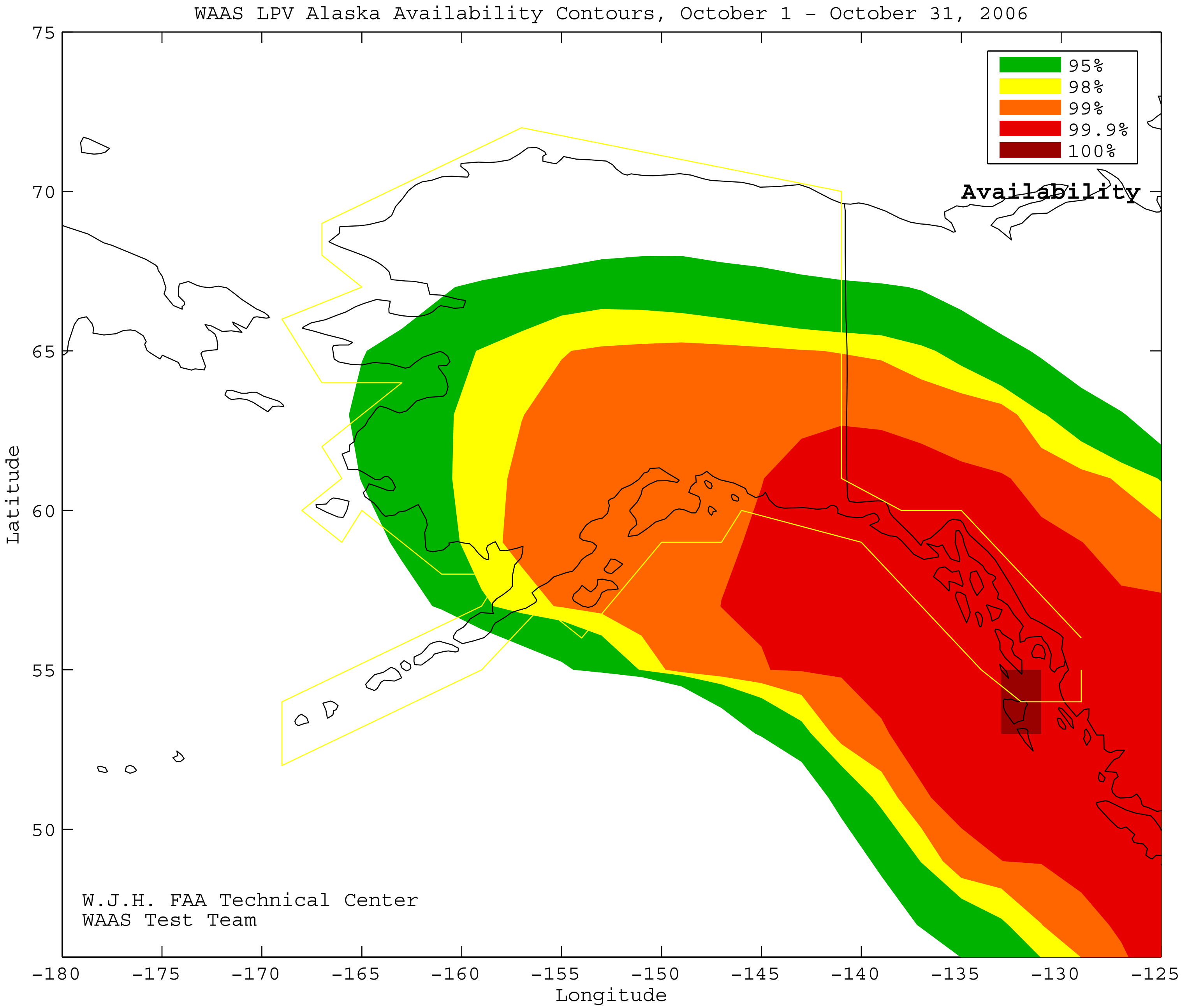
Figure 4-17 NPA Coverage Since Commissioning



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

SL = NPA

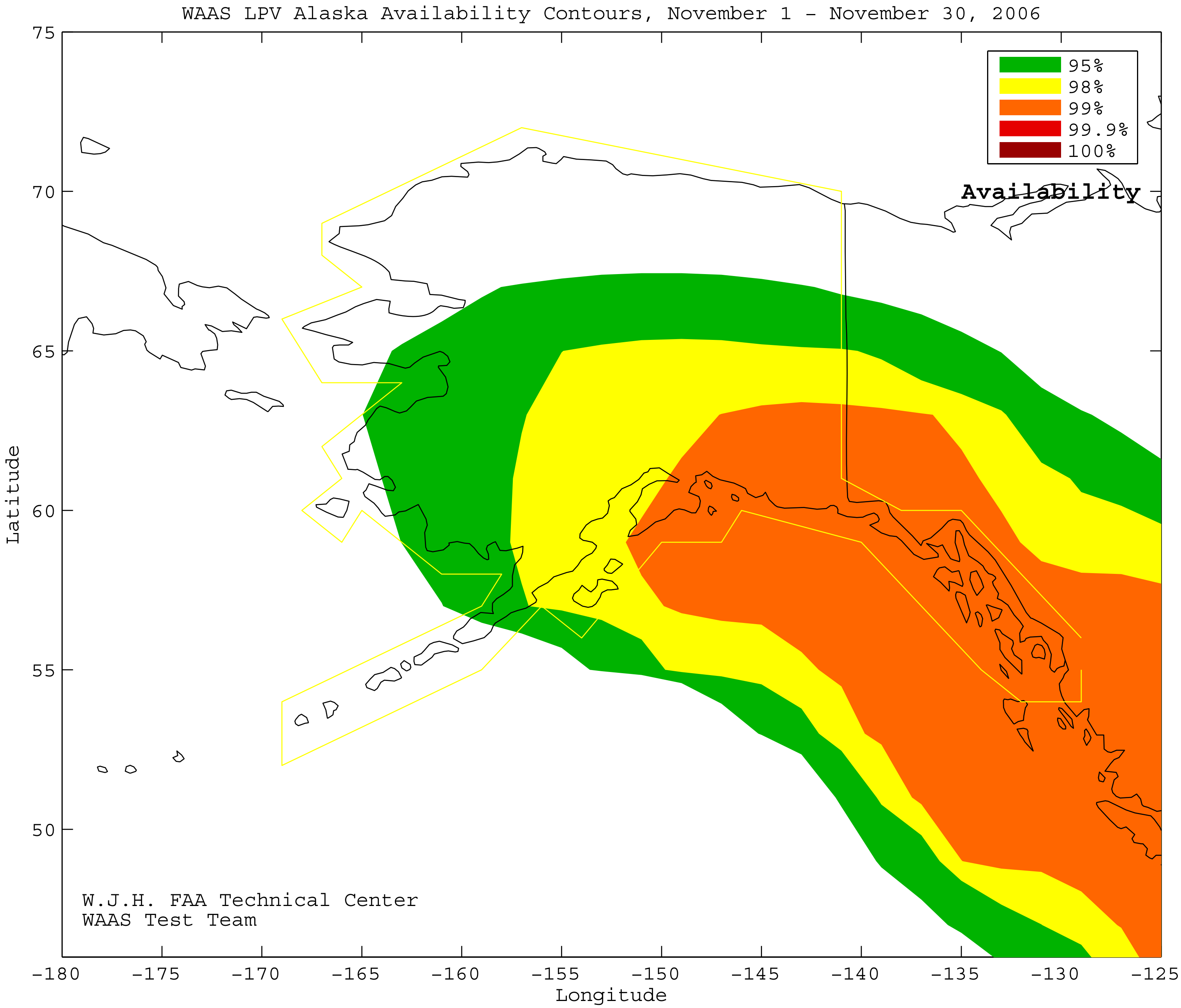
Figure 4-18 LPV Alaska Coverage - October



Alaska Coverage at 95% Availability = 69.57%
Alaska Coverage at 99% Availability = 41.3%
Alaska Coverage at 100% Availability = 2.174%

SL = LPV

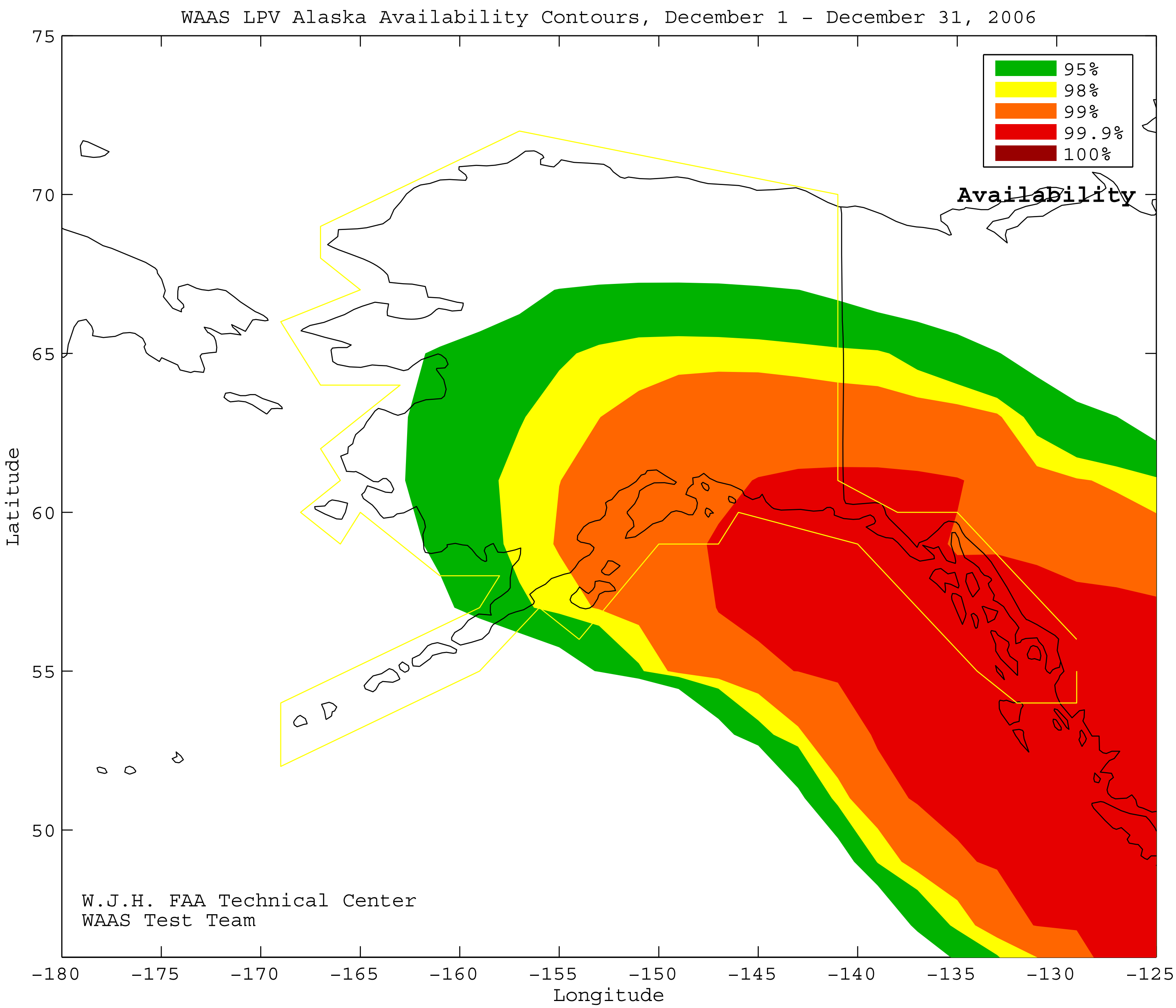
Figure 4-19 LPV Alaska Coverage - November



Alaska Coverage at 95% Availability = 67.39%
Alaska Coverage at 99% Availability = 20.65%
Alaska Coverage at 100% Availability = 0%

SL = LPV

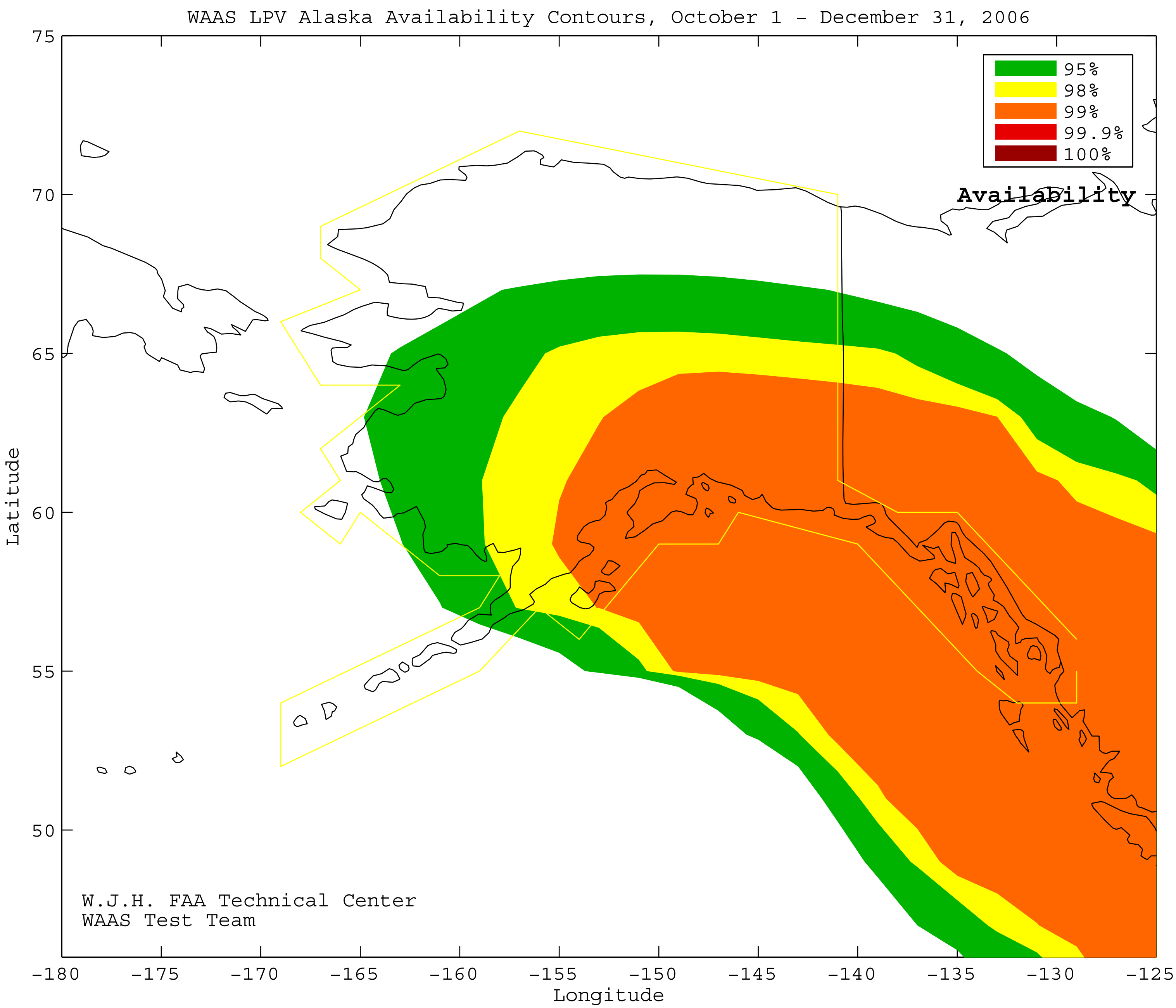
Figure 4-20 LPV Alaska Coverage - December



Alaska Coverage at 95% Availability = 61.96%
Alaska Coverage at 99% Availability = 28.26%
Alaska Coverage at 100% Availability = 0%

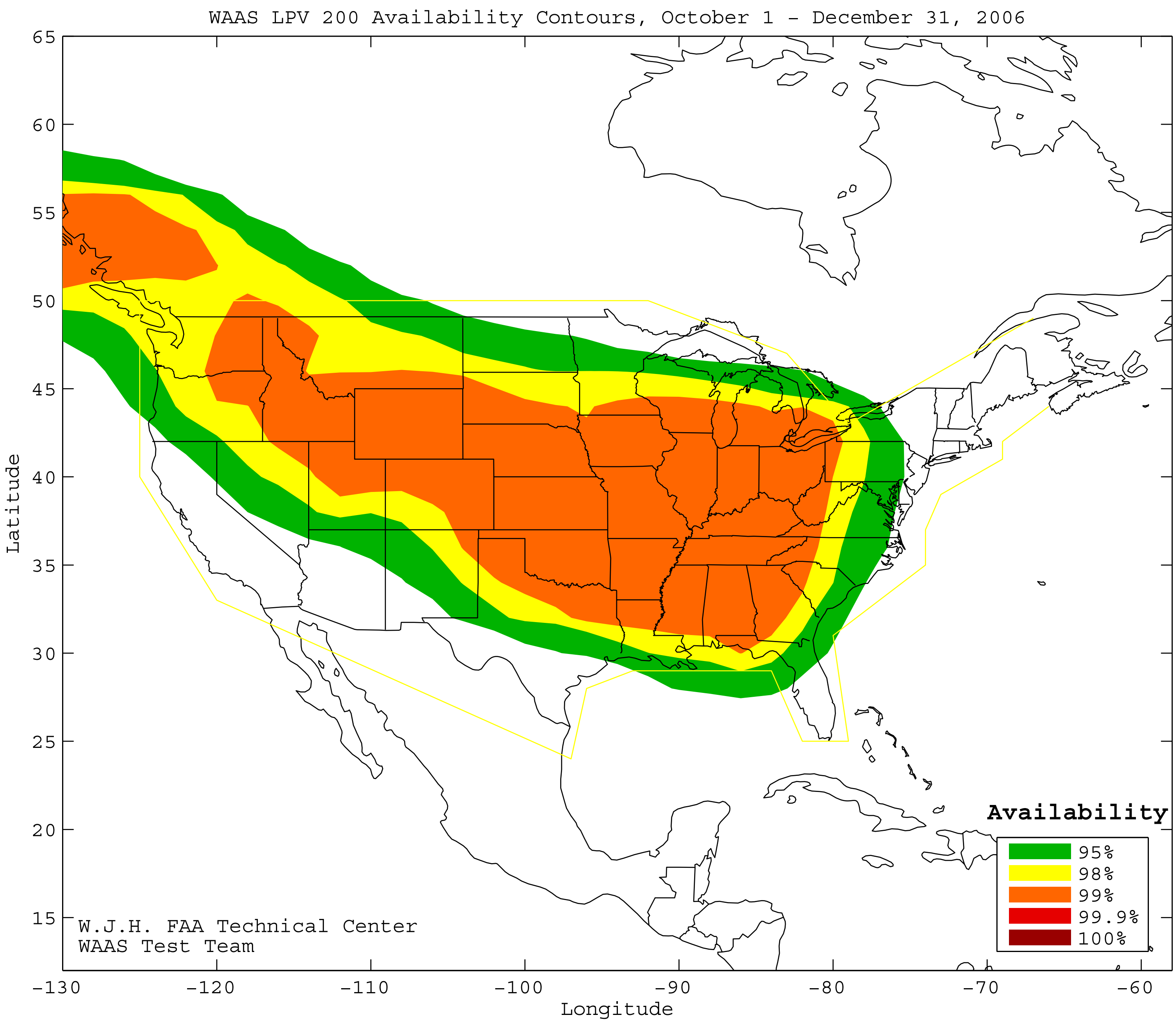
SL = LPV

Figure 4-21 LPV Alaska Coverage - Quarter



Alaska Coverage at 95% Availability = 24.7%
Alaska Coverage at 99% Availability = 10.53%
Alaska Coverage at 100% Availability = 0%

Figure 4-22 LPV 200 meter Coverage - Quarter



CONUS Coverage at 95% Availability = 72.06%
CONUS Coverage at 99% Availability = 40.49%
CONUS Coverage at 100% Availability = 0%

SL = LPV 200

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	7.50	7.61	0
Greenwood	8.57	5.33	0
San Angelo	8.57	7.61	0
Albuquerque	6.00	7.61	0
Anchorage	8.57	7.61	0
Atlanta	7.50	7.61	0
Barrow	2.61	1.52	0
Bethel	10.00	8.88	0
Billings	8.57	5.92	0
Boston	7.50	7.61	0
Chicago	10.00	7.61	0
Cleveland	8.57	5.92	0
Cold Bay	6.67	6.66	0
Dallas	5.45	4.44	0
Denver	8.57	5.92	0
Fairbanks	2.86	4.10	0
Houston	10.00	7.61	0
Jacksonville	6.67	7.61	0
Juneau	10.00	7.61	0
Kansas City	7.50	6.66	0
Kotzebue	5.45	6.66	0
Los Angeles	8.57	8.88	0
Memphis	10.00	8.88	0
Miami	6.67	6.66	0
Minneapolis	6.67	7.61	0
New York	12.00	10.66	0
Oakland	8.57	5.92	0
Salt Lake City	10.00	7.61	0
Seattle	7.50	6.66	0
Washington DC	8.57	8.88	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 2.61 at Barrow. Table 5.1 also 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.

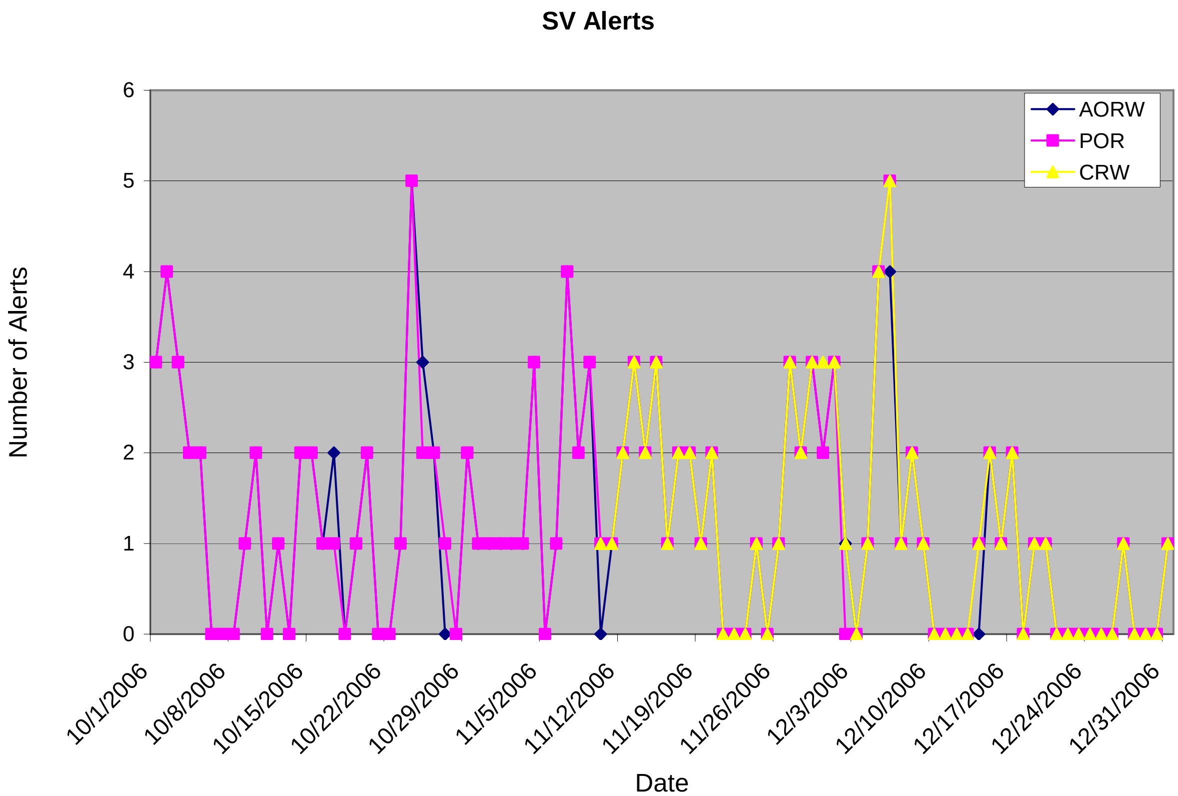
5.2 Broadcast Alerts

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**	**CRW**	**AORW**	**POR**	**CRW**
2	36	36	16	0.3913	0.3913	0.3076
3	51	50	31	0.5543	0.5434	0.5961
4	19	22	13	0.2065	0.2391	0.2500
5	0	0	0	0	0	0
6	1	1	1	0.0108	0.0108	0.0192
24	9	8	0	0.0978	0.0869	0
26	0	0	0	0	0	0
Total Alerts	116	117	61	1.2608	1.2717	1.1730

Figure 5-1 SV Daily Alert Trends



5.3 Availability of WAAS Messages (AOR-W, POR and CRW)

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. Table 5.9 to 5.13 show message rates statistics broadcasted on POR. Table 5.14 to 5.18 show messages rates statistics broadcasted on CRW.

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	109986	2	127
2	1324561	73	29
3	1324634	58	29
7	86345	29	138
9	93132	0	0
10	86313	29	219
17	30625	2	431
24	364451	23	23

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

SV	On Time	Late	Max Late Length (seconds)
1	47156	0	0
2	48066	1	177
3	45668	1	175
4	48797	0	0
5	45470	0	0
6	48293	0	0
7	49198	0	0
8	46947	0	0
9	47830	0	0
10	48620	0	0
11	48736	0	0
13	48008	1	161
14	47947	1	161
16	48334	0	0
17	48241	0	0
18	46990	0	0
19	48698	0	0
20	48877	0	0
21	44174	1	171
22	45784	1	171
23	47517	0	0
24	48891	0	0
25	49158	0	0
26	46759	0	0
27	45225	0	0
28	46029	1	173
29	48069	0	0
30	49418	0	0
31	42696	1	177

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

SV	On Time	Late	Max Late Length (seconds)
1	44388	1	131
2	44910	2	182
3	42773	1	179
4	45695	1	131
5	42790	0	0
6	45231	0	0
7	46033	2	216
8	43888	0	0
9	45015	0	0
10	45355	1	146
11	45975	0	0
13	44956	0	0
14	45068	0	0
16	44913	1	139
17	44638	0	0
18	43782	2	163
19	44580	0	0
20	44273	1	126
21	40040	3	168
22	41287	0	0
23	42734	0	0
24	44129	0	0
25	44404	1	121
26	42132	1	126
27	40649	0	0
28	41647	2	239
29	43384	3	260
30	44655	0	0
31	38559	0	0
122	60860	3	182
134	82592	1	151

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	27601	15	504
1	0	27630	9	514
1	1	27625	7	480
1	2	27610	10	455
1	3	27598	5	481
1	4	27591	8	480
2	0	27624	8	443
2	1	27597	6	442
2	2	27607	8	431
2	3	27606	9	408
2	4	27604	4	415
2	5	27602	6	410
3	0	27592	16	578

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

Band	On Time	Late	Max Late Length (seconds)
0	71558	0	0
1	71508	0	0
2	71565	0	0
3	71589	0	0

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

Message Type	On Time	Late	Max Late Length (seconds)
0	27	5	493710
1	107959	1	124
2	1324774	71	29
3	1324826	64	24
7	84650	37	168
9	93143	2	173
10	84598	42	197
17	30459	1	324
24	364432	27	25

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

SV	On Time	Late	Max Late Length (seconds)
1	47172	0	0
2	48046	1	172
3	45673	1	172
4	48810	1	150
5	45474	0	0
6	48292	0	0
7	49203	0	0
8	46953	1	176
9	47823	0	0
10	48618	1	177
11	48751	0	0
13	48008	4	178
14	47963	2	173
16	48352	1	166
17	48250	0	0
18	47002	0	0
19	48708	0	0
20	48872	0	0
21	44164	0	0
22	45807	0	0
23	47528	2	170
24	48871	2	175
25	49179	1	177
26	46763	0	0
27	45226	1	174
28	46033	1	172
29	48069	2	173
30	49453	0	0
31	42719	1	172

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

SV	On Time	Late	Max Late Length (seconds)
1	44400	1	131
2	44909	2	182
3	42772	2	179
4	45701	2	192
5	42806	0	0
6	45228	0	0
7	46025	3	217
8	43882	1	176
9	45018	0	0
10	45357	1	146
11	45983	0	0
13	44950	0	0
14	45081	0	0
16	44925	2	168
17	44654	0	0
18	43795	3	163
19	44584	0	0
20	44291	2	173
21	40042	4	168
22	41301	0	0
23	42743	0	0
24	44126	0	0
25	44416	0	0
26	42135	2	144
27	40642	2	192
28	41641	3	239
29	43386	2	260
30	44667	0	0
31	38580	0	0
122	60864	2	192
134	82607	2	192

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	27605	5	487
0	1	27643	6	499
0	2	27633	5	488
1	0	27614	8	488
1	1	27637	5	481
1	2	27640	9	496
1	3	27602	8	511
1	4	27600	7	481
2	0	27607	8	480
2	1	27606	5	384
2	2	27605	5	576
2	3	27616	12	576

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

Band	On Time	Late	Max Late Length (seconds)
0	70550	0	0
1	70576	0	0
2	70661	0	0

Table 5-14 WAAS Fast Correction and Degradation Message Rates – CRW

Message Type	On Time	Late	Max Late Length (seconds)
0	44	7	440147
1	56457	1	132
2	746751	40	29
3	746816	31	23
7	52085	4	138
9	52505	0	0
10	52057	4	145
17	17487	1	395

Table 5-15 WAAS Long Correction Message Rates (Type 24 and 25) – CRW

SV	On Time	Late	Max Late Length (seconds)
1	26525	0	0
2	27099	1	172
3	24611	0	0
4	27521	0	0
5	25549	1	171
6	27279	0	0
7	27938	0	0
8	26379	1	169
9	27139	0	0
10	27350	1	163
11	27361	0	0
13	27059	1	186
14	27037	0	0
16	27368	0	0
17	27178	0	0
18	26556	0	0
19	27354	0	0
20	27500	1	171
21	24826	0	0
22	25887	0	0
23	26734	1	169
24	27500	1	166
25	27709	1	163
26	26371	0	0
27	25422	1	167
28	25888	1	186
29	27236	0	0

30	27946	0	0
31	27693	1	172

Table 5-16 WAAS Ephemeris Covariance Message Rates (Type 28) – CRW

SV	On Time	Late	Max Late Length (seconds)
1	24820	1	192
2	25079	1	182
3	22989	1	179
4	25552	0	0
5	23994	0	0
6	25418	0	0
7	26128	1	174
8	24561	0	0
9	25429	0	0
10	25406	0	0
11	25831	2	184
13	25314	0	0
14	25331	0	0
16	25496	0	0
17	25109	0	0
18	24886	0	0
19	25140	0	0
20	24983	0	0
21	22625	0	0
22	23343	0	0
23	24029	0	0
24	24787	2	192
25	25051	0	0
26	23766	0	0
27	22891	2	125
28	23434	0	0
29	24605	0	0
30	25240	1	189
31	24998	0	0
122	47292	2	192
134	47111	1	151

Table 5-17 WAAS Ionospheric Correction Message Rates (Type 26) – CRW

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	15558	5	462
0	1	15580	5	324
0	2	15553	4	332
1	0	15550	3	336
1	1	15567	5	502
1	2	15551	5	527
1	3	15558	5	511
1	4	15560	4	526

2	0	15570	3	397
2	1	15568	7	418
2	2	15559	4	432
2	3	15568	3	456
2	4	15556	3	440
2	5	15556	7	446
3	0	15555	8	449

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

Band	On Time	Late	Max Late Length (seconds)
0	41813	0	0
1	41819	0	0
2	41744	0	0
3	41776	0	0

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	1.056	100.00	1.150	100.00	1.054	100.00	0.718	100.00	1.131	100.00	1.186	100.00
2	1.423	100.00	1.834	100.00	1.903	100.00	1.763	100.00	2.694	100.00	2.303	99.9642
3	1.816	100.00	0.934	100.00	1.807	100.00	1.011	100.00	1.483	100.00	1.406	100.00
4	2.188	100.00	1.302	100.00	1.499	100.00	1.188	100.00	1.512	100.00	1.342	99.9788
5	1.135	100.00	1.299	100.00	1.132	100.00	1.032	100.00	1.427	100.00	1.496	100.00
6	2.189	100.00	1.366	100.00	1.505	100.00	1.231	100.00	1.251	100.00	1.975	100.00
7	1.537	100.00	1.278	100.00	1.457	100.00	0.964	100.00	1.340	100.00	1.415	100.00
8	0.962	100.00	1.018	100.00	1.092	100.00	1.084	100.00	1.026	100.00	1.184	100.00
9	1.380	100.00	1.459	100.00	1.210	100.00	0.951	100.00	1.456	100.00	1.407	100.00
10	0.912	100.00	1.475	100.00	0.796	100.00	1.649	100.00	1.290	100.00	1.840	100.00
11	0.803	100.00	1.599	100.00	1.361	100.00	1.641	100.00	2.104	100.00	1.639	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.354	100.00	1.218	100.00	1.145	100.00	0.995	100.00	1.469	100.00	1.168	100.00
14	1.676	100.00	1.228	100.00	1.049	100.00	1.487	100.00	1.241	100.00	1.391	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	1.131	100.00	2.187	100.00	0.890	100.00	0.884	100.00	1.178	100.00	1.214	100.00
17	1.539	100.00	0.998	100.00	0.892	100.00	0.867	100.00	1.354	100.00	1.756	100.00
18	0.851	100.00	1.380	100.00	1.094	100.00	2.051	100.00	1.599	100.00	2.129	100.00
19	2.018	100.00	2.677	100.00	1.986	100.00	2.355	100.00	2.009	100.00	2.348	100.00
20	1.033	100.00	1.356	100.00	1.362	100.00	1.373	100.00	1.864	100.00	1.237	100.00
21	1.048	100.00	1.623	100.00	1.088	100.00	1.779	100.00	1.675	100.00	1.924	100.00
22	0.860	100.00	1.569	100.00	1.343	100.00	1.413	100.00	1.429	100.00	1.607	100.00
23	1.650	100.00	2.526	100.00	2.644	100.00	2.835	100.00	2.607	100.00	2.639	100.00
24	2.303	100.00	1.163	100.00	1.252	100.00	1.147	100.00	1.620	100.00	1.628	99.9157
25	2.120	100.00	1.051	100.00	1.125	100.00	0.902	100.00	1.762	100.00	1.371	100.00
26	1.442	100.00	1.684	100.00	1.817	100.00	1.370	100.00	1.850	100.00	1.510	100.00
27	1.228	100.00	1.076	100.00	1.497	100.00	0.980	100.00	0.981	100.00	0.954	100.00
28	0.970	100.00	1.784	100.00	1.207	100.00	1.317	100.00	1.469	100.00	1.663	100.00
29	1.660	100.00	1.433	100.00	1.625	100.00	1.237	100.00	1.286	100.00	1.430	100.00
30	2.151	100.00	1.468	100.00	1.767	100.00	1.107	100.00	1.736	100.00	1.510	100.00
31	2.184	100.00	1.032	100.00	1.043	100.00	0.704	100.00	1.422	100.00	1.269	100.00
122	-	-	-	-	-	-	-	-	-	-	-	-
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	1.480	100.00	1.520	100.00	1.406	100.00	1.047	100.00	0.824	100.00	1.289	100.00
2	1.890	100.00	1.966	100.00	2.666	100.00	1.644	100.00	1.785	100.00	1.460	100.00
3	1.492	100.00	1.690	100.00	1.308	100.00	2.108	100.00	1.101	100.00	1.213	100.00
4	1.910	100.00	2.216	100.00	1.928	100.00	1.635	100.00	1.101	100.00	1.384	100.00
5	1.316	100.00	1.351	100.00	1.491	100.00	1.006	100.00	1.160	100.00	0.868	100.00
6	1.729	100.00	2.030	100.00	1.634	100.00	2.005	100.00	1.227	100.00	1.670	100.00
7	1.551	100.00	1.668	100.00	1.724	100.00	1.458	100.00	0.966	100.00	1.180	100.00
8	1.326	100.00	1.478	100.00	1.055	100.00	1.457	100.00	0.929	100.00	1.245	100.00
9	1.746	100.00	1.884	100.00	1.319	100.00	1.462	100.00	0.938	100.00	1.124	100.00
10	1.230	100.00	1.226	100.00	1.633	100.00	1.003	100.00	1.122	100.00	0.824	100.00
11	1.306	100.00	1.338	100.00	2.716	100.00	1.226	100.00	1.129	100.00	1.018	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.571	100.00	1.400	100.00	1.815	100.00	1.326	100.00	1.251	100.00	1.272	100.00
14	1.111	100.00	1.261	100.00	1.451	100.00	1.292	100.00	1.332	100.00	0.868	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	1.394	100.00	1.277	100.00	1.230	100.00	1.057	100.00	1.050	100.00	0.822	100.00
17	1.564	100.00	1.347	100.00	1.291	100.00	1.115	100.00	0.988	100.00	0.906	100.00
18	1.223	100.00	1.682	100.00	1.264	100.00	1.543	100.00	1.472	100.00	1.140	100.00
19	2.383	100.00	2.231	100.00	2.547	100.00	2.072	100.00	2.175	100.00	2.019	100.00
20	1.751	100.00	1.616	100.00	1.431	100.00	1.193	100.00	1.165	100.00	0.904	100.00
21	1.467	100.00	1.262	100.00	1.404	100.00	1.068	100.00	1.332	100.00	0.979	100.00
22	1.490	100.00	1.261	100.00	2.750	100.00	1.326	100.00	1.476	100.00	1.015	100.00
23	2.226	100.00	2.337	100.00	2.229	100.00	2.633	100.00	2.016	100.00	1.916	100.00
24	1.765	100.00	2.198	100.00	1.497	100.00	1.640	100.00	1.029	100.00	1.523	100.00
25	1.651	100.00	1.743	100.00	1.986	100.00	1.586	100.00	0.944	100.00	1.406	100.00
26	1.386	100.00	2.005	100.00	1.838	100.00	1.909	100.00	1.512	100.00	1.633	100.00
27	1.822	100.00	1.574	100.00	1.212	100.00	1.328	100.00	1.043	100.00	1.344	100.00
28	1.198	100.00	1.234	100.00	1.864	100.00	1.298	100.00	1.215	100.00	1.034	100.00
29	1.249	100.00	1.779	100.00	1.387	100.00	1.494	100.00	1.157	100.00	1.377	100.00
30	1.962	100.00	1.704	100.00	1.876	100.00	1.363	100.00	1.326	100.00	1.692	100.00
31	1.709	100.00	1.687	100.00	1.588	100.00	1.050	100.00	0.940	100.00	1.106	100.00
122	-	-	-	-	-	-	-	-	-	-	-	-
134	-	-	-	-	-	-	-	-	-	-	-	-

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	0.587	100.00	0.552	100.00	0.495	100.00	0.325	100.00	0.589	100.00	0.708	100.00
2	0.916	100.00	1.344	100.00	1.158	100.00	1.266	100.00	1.392	100.00	1.487	100.00
3	0.813	100.00	0.432	100.00	0.617	100.00	0.427	100.00	0.786	100.00	0.657	100.00
4	1.306	100.00	0.750	100.00	0.970	100.00	0.758	100.00	1.227	100.00	0.965	100.00
5	0.489	100.00	0.574	100.00	0.501	100.00	0.461	100.00	0.577	100.00	0.628	100.00
6	1.063	100.00	0.554	100.00	0.689	100.00	0.587	100.00	0.762	100.00	0.998	100.00
7	0.514	100.00	0.513	100.00	0.636	100.00	0.436	100.00	0.511	100.00	0.598	100.00
8	0.419	100.00	0.611	100.00	0.495	100.00	0.566	100.00	0.516	100.00	0.682	100.00
9	0.639	100.00	0.551	100.00	0.497	100.00	0.463	100.00	0.533	100.00	0.825	100.00
10	0.483	100.00	0.824	100.00	0.382	100.00	1.043	100.00	0.647	100.00	1.011	100.00
11	0.483	100.00	0.889	100.00	0.515	100.00	0.775	100.00	1.074	100.00	0.805	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	0.747	100.00	0.438	100.00	0.542	100.00	0.406	100.00	0.685	100.00	0.554	100.00
14	1.065	100.00	0.874	100.00	0.489	100.00	0.883	100.00	0.686	100.00	0.855	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	0.644	100.00	1.308	100.00	0.353	100.00	0.659	100.00	0.613	100.00	0.560	100.00
17	0.984	100.00	0.549	100.00	0.474	100.00	0.350	100.00	0.864	100.00	0.863	100.00
18	0.680	100.00	1.078	100.00	0.772	100.00	1.258	100.00	0.947	100.00	1.375	100.00
19	1.491	100.00	1.966	100.00	1.423	100.00	1.877	100.00	1.539	100.00	1.651	100.00
20	0.428	100.00	0.949	100.00	0.781	100.00	0.719	100.00	0.838	100.00	0.611	100.00
21	0.779	100.00	1.189	100.00	0.723	100.00	1.200	100.00	1.032	100.00	1.225	100.00
22	0.616	100.00	1.176	100.00	0.799	100.00	0.967	100.00	0.915	100.00	1.101	100.00
23	1.486	100.00	2.096	100.00	1.986	100.00	2.266	100.00	1.760	100.00	2.022	100.00
24	1.448	100.00	0.647	100.00	0.857	100.00	0.781	100.00	1.170	100.00	1.107	100.00
25	0.757	100.00	0.534	100.00	0.560	100.00	0.412	100.00	0.986	100.00	0.830	100.00
26	0.746	100.00	0.886	100.00	0.974	100.00	0.776	100.00	1.443	100.00	0.862	100.00
27	0.709	100.00	0.594	100.00	0.587	100.00	0.451	100.00	0.456	100.00	0.580	100.00
28	0.541	100.00	1.219	100.00	0.616	100.00	0.705	100.00	0.760	100.00	1.039	100.00
29	0.834	100.00	0.565	100.00	0.688	100.00	0.668	100.00	0.734	100.00	0.746	100.00
30	0.953	100.00	0.619	100.00	0.954	100.00	0.585	100.00	0.730	100.00	0.764	100.00
31	1.596	100.00	0.595	100.00	0.385	100.00	0.375	100.00	0.836	100.00	0.697	100.00

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	0.995	100.00	1.006	100.00	0.910	100.00	0.507	100.00	0.529	100.00	0.654	100.00
2	0.874	100.00	1.412	100.00	1.121	100.00	1.066	100.00	0.968	100.00	1.108	100.00
3	0.709	100.00	0.944	100.00	0.697	100.00	0.898	100.00	0.492	100.00	0.545	100.00
4	1.241	100.00	1.409	100.00	1.074	100.00	0.978	100.00	0.768	100.00	0.749	100.00
5	0.502	100.00	0.809	100.00	0.650	100.00	0.399	100.00	0.438	100.00	0.408	100.00
6	1.087	100.00	1.196	100.00	0.989	100.00	1.014	100.00	0.694	100.00	0.793	100.00
7	0.722	100.00	0.715	100.00	0.745	100.00	0.513	100.00	0.494	100.00	0.433	100.00
8	0.621	100.00	0.989	100.00	0.669	100.00	0.623	100.00	0.440	100.00	0.534	100.00
9	0.643	100.00	0.883	100.00	0.674	100.00	0.620	100.00	0.566	100.00	0.571	100.00
10	0.502	100.00	0.661	100.00	0.412	100.00	0.445	100.00	0.412	100.00	0.592	100.00
11	0.482	100.00	0.591	100.00	1.091	100.00	0.478	100.00	0.502	100.00	0.572	100.00
12	-	-	-	-	-	-	-	-	-	-	-	-
13	0.824	100.00	0.887	100.00	0.940	100.00	0.652	100.00	0.478	100.00	0.583	100.00
14	0.406	100.00	0.831	100.00	0.631	100.00	0.751	100.00	0.558	100.00	0.667	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	0.676	100.00	0.666	100.00	0.582	100.00	0.478	100.00	0.488	100.00	0.612	100.00
17	0.905	100.00	0.820	100.00	0.714	100.00	0.456	100.00	0.438	100.00	0.457	100.00
18	0.553	100.00	1.182	100.00	0.700	100.00	1.029	100.00	0.828	100.00	0.868	100.00
19	1.267	100.00	1.401	100.00	1.352	100.00	1.494	100.00	1.476	100.00	1.585	100.00
20	0.716	100.00	0.658	100.00	0.659	100.00	0.657	100.00	0.576	100.00	0.660	100.00
21	0.698	100.00	1.012	100.00	1.158	100.00	0.908	100.00	0.785	100.00	0.804	100.00
22	0.657	100.00	0.925	100.00	1.833	100.00	0.996	100.00	0.881	100.00	0.776	100.00
23	1.526	100.00	1.905	100.00	1.713	100.00	2.041	100.00	1.595	100.00	1.533	100.00
24	0.986	100.00	1.351	100.00	1.021	100.00	0.962	100.00	0.747	100.00	0.834	100.00
25	1.142	100.00	1.081	100.00	1.040	100.00	0.808	100.00	0.564	100.00	0.656	100.00
26	0.705	100.00	1.152	100.00	1.043	100.00	1.027	100.00	0.886	100.00	0.754	100.00
27	0.872	100.00	1.071	100.00	0.753	100.00	0.606	100.00	0.499	100.00	0.687	100.00
28	0.499	100.00	0.873	100.00	0.967	100.00	0.713	100.00	0.593	100.00	0.722	100.00
29	0.556	100.00	0.965	100.00	0.906	100.00	0.714	100.00	0.627	100.00	0.567	100.00
30	1.038	100.00	1.018	100.00	0.977	100.00	0.694	100.00	0.720	100.00	0.820	100.00
31	0.926	100.00	0.921	100.00	0.788	100.00	0.523	100.00	0.441	100.00	0.477	100.00

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

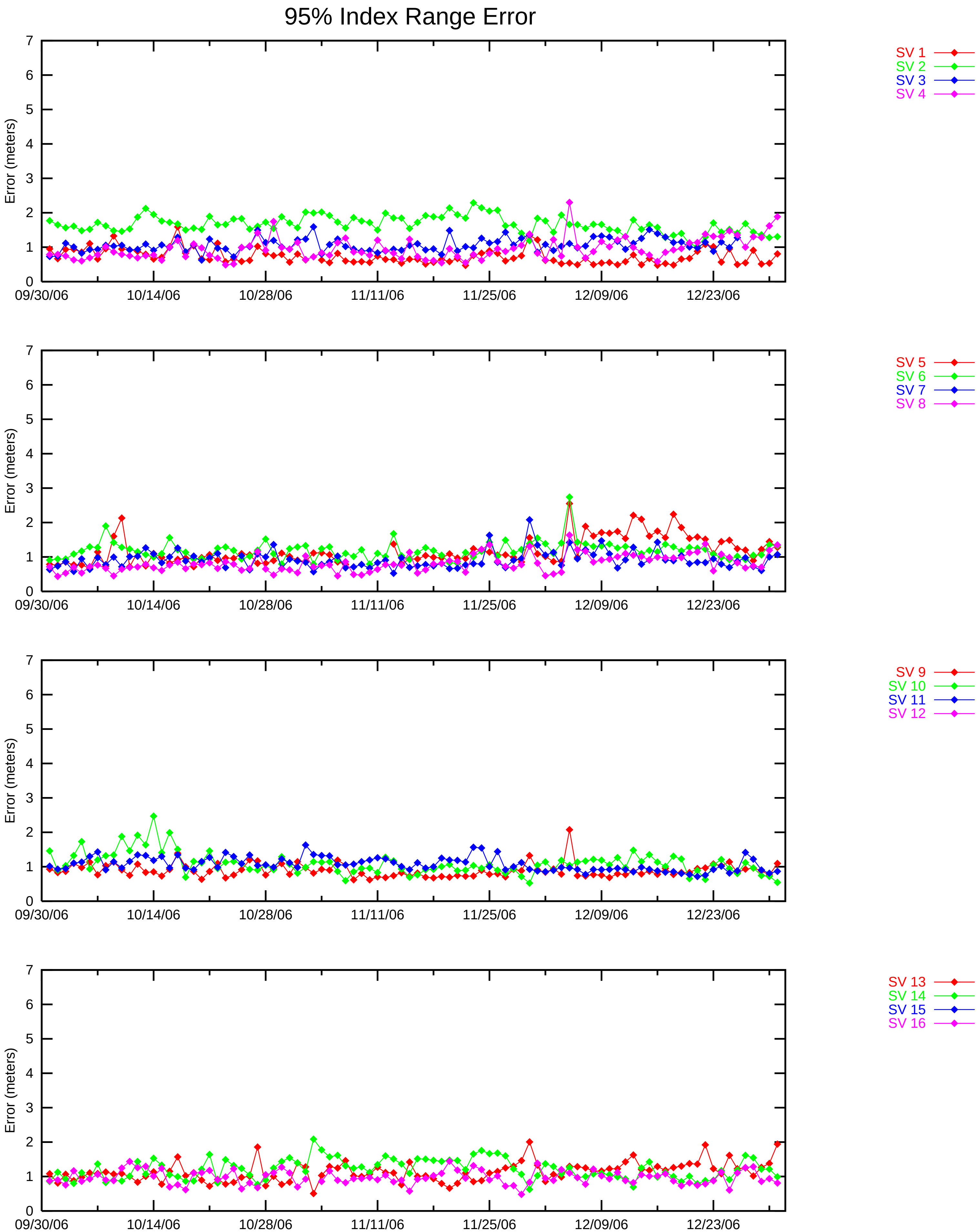


Figure 6-2 95% Range Error (SV 17 --SV 31 and SV 122) - Washington, DC

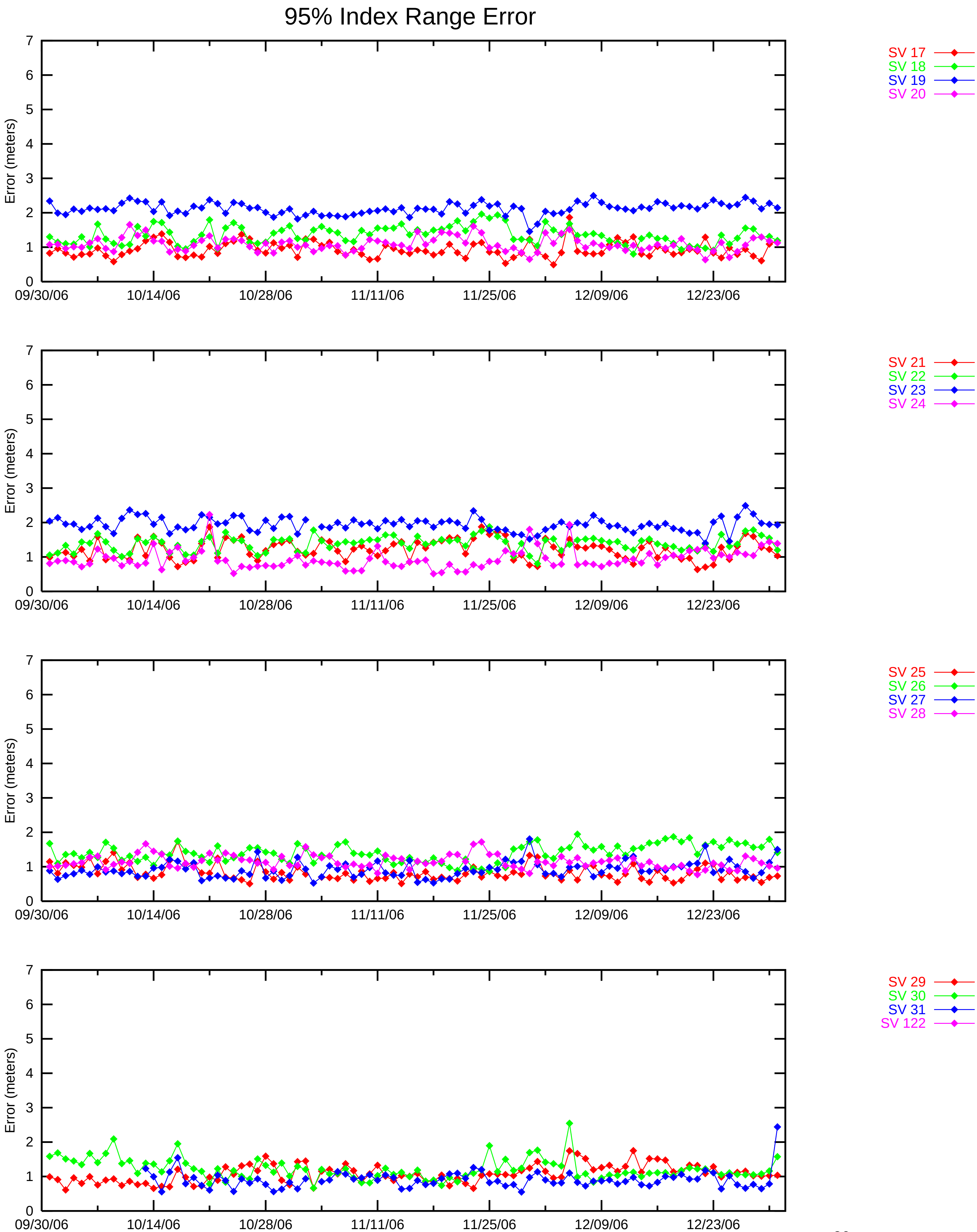


Figure 6-3 95% Ionospheric Error (SV 1 --SV 16) - Washington, DC

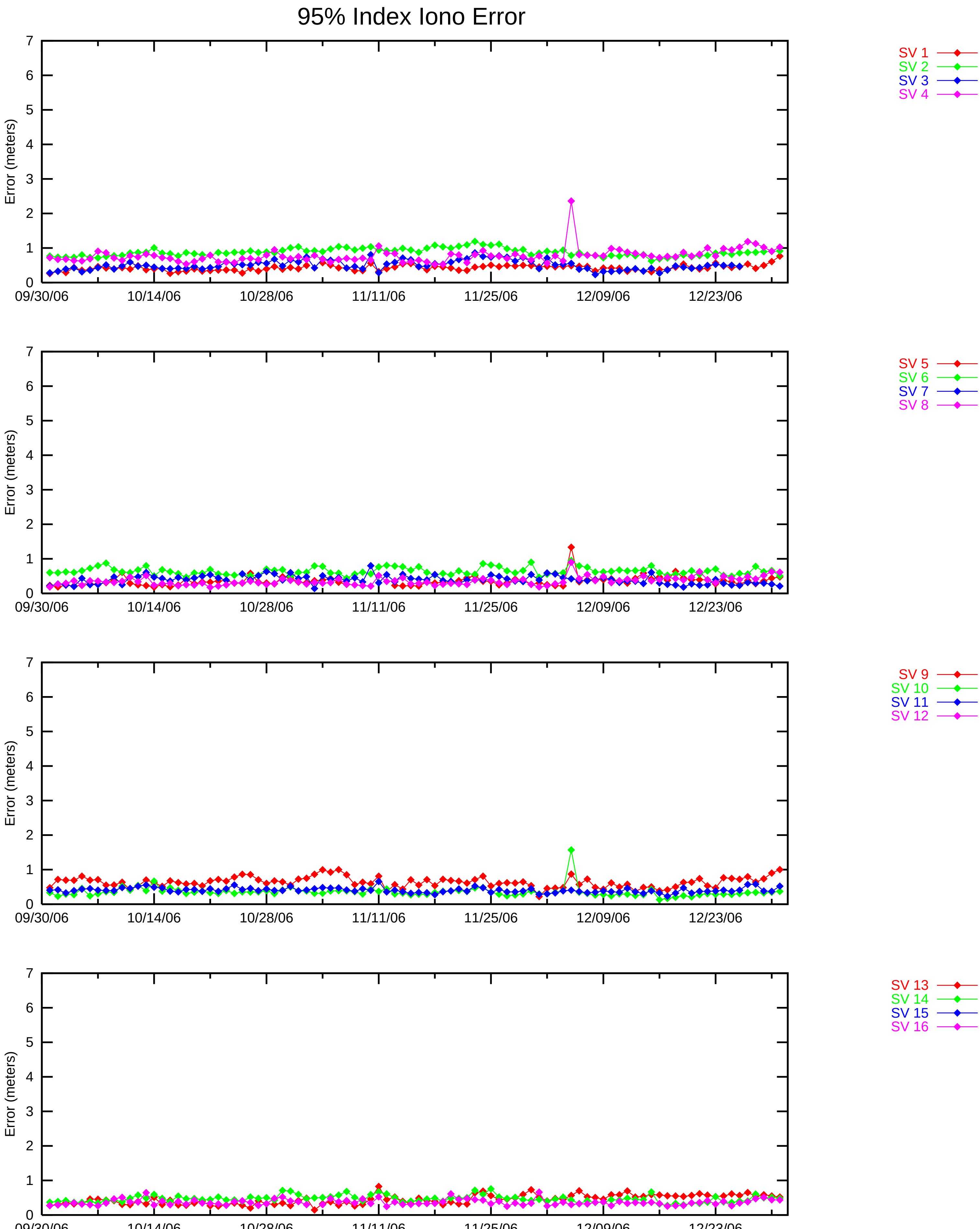
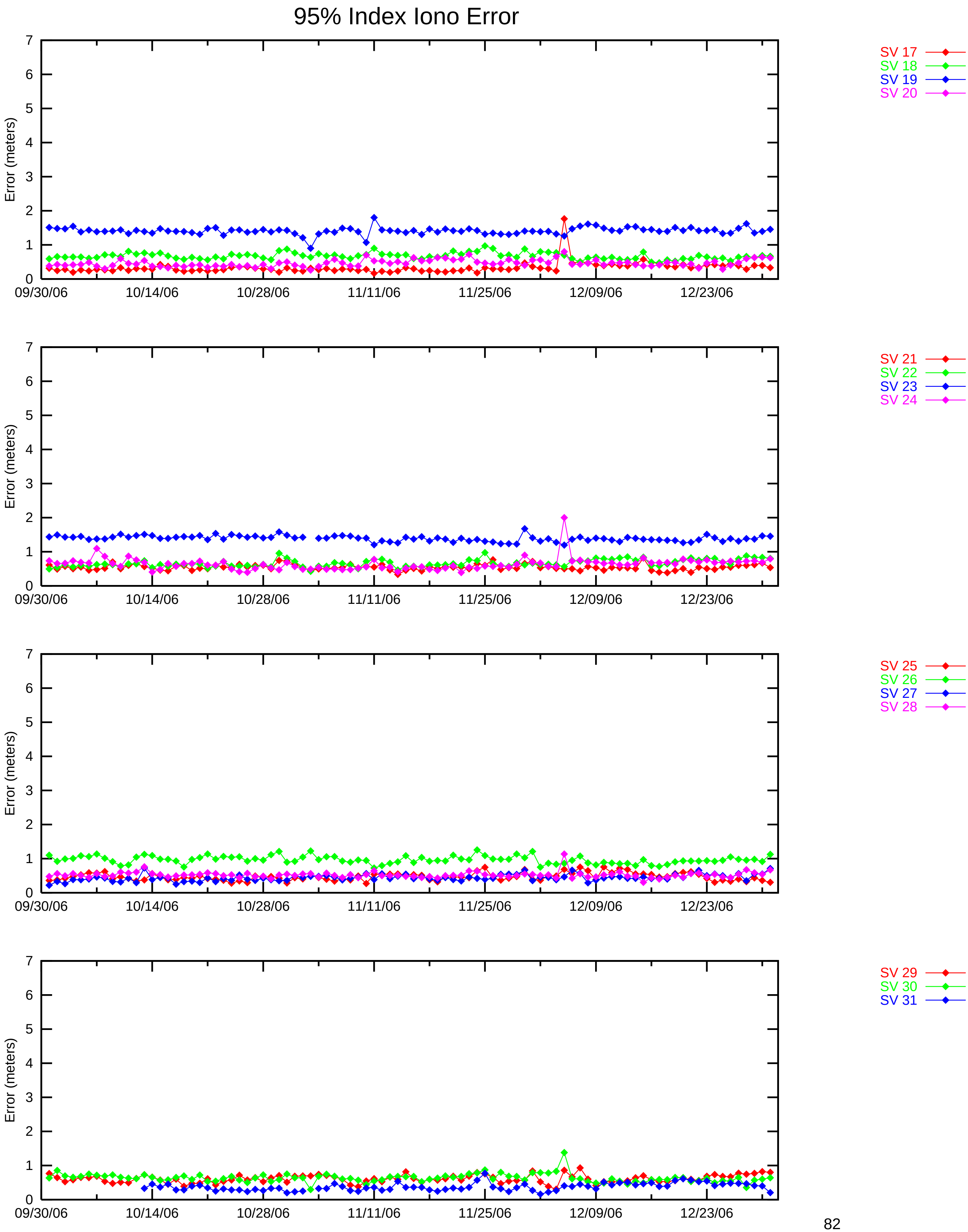


Figure 6-4 95% Ionospheric Error (SV 17 --SV 31) - Washington, DC



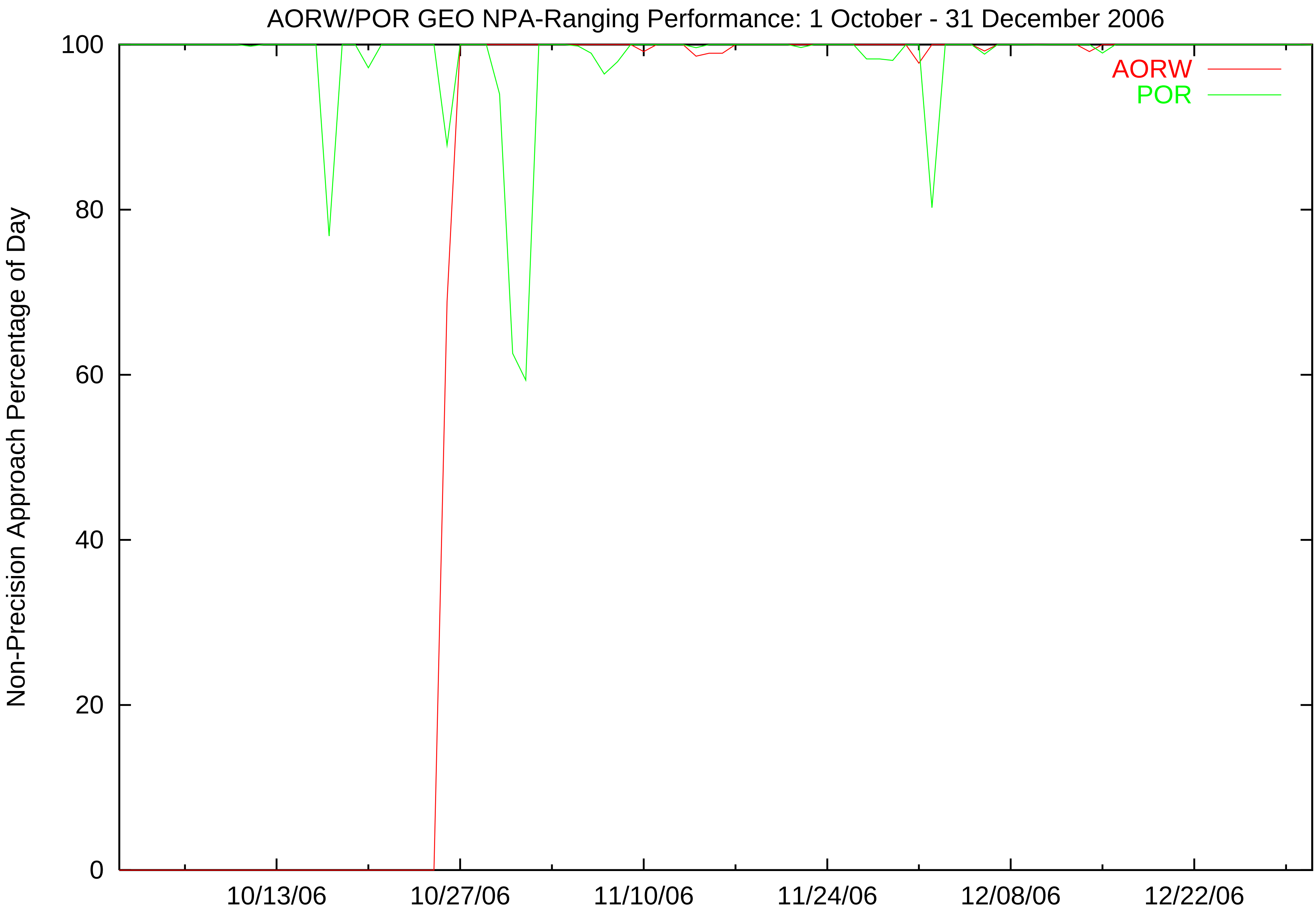
7.0 GEO RANGING PERFORMANCE

For the evaluated period, AOR-W GEO no longer provides PA ranging capability. CRW GEO has only data link capability and no ranging capability. As in the past, the POR satellite as a ranging source has very low PA availability. Table 7.1 shows the GEO-Ranging performance for AORW, POR, and CRW satellites throughout the evaluated period. Figure 7.1 shows the trend of NPA Ranging Availability for the AORW and POR satellite.

Table 7-1 GEO Ranging Availability

GEO	PA (%)	NPA (%)	Not Monitored (%)	Do Not Use (%)
AORW	0	72.398	27.285	0.299
POR	0	98.272	1.498	0.212
CRW	0	0	79.526	8.202

Figure 7-1 Daily NPA GEO Ranging Availability Trend



8.0 WAAS PROBLEM SUMMARY

During this evaluated period, there are several events that affected WAAS service. Details of each of the events are documented in the WAAS Discrepancy Report (DR). The DRs are posted on the website under 'WAAS Technical Reports' and can also be accessed via hyperlink below.

October 9, 2006 – SIS outage of approximately 110 seconds. See DR#39, "Abnormal AOR-W Switchover and Extended SIS Outage".

October 26, 2006 – The loss of LPV service in the central region of CONUS of about 300 seconds See DR#41, "Loss of availability due to WAAS Ionospheric Grid Points (IGP) Set to 'Do Not Use'".

October 29, 2006 – The loss of PA service at Fairbanks. See DR#47, "Ionospheric Scintillation Caused Loss of Satellite Tracking at Fairbanks".

November 5, 2006 – A brief loss of WAAS availability due to 4 second initialization on both AOR-W and POR. See DR#40, "Type 0 Messages After C&V Faults".

November 7, 2006 to November 13, 2006 – A drop of LPV service availability due to maintenance on SV 5. See DR#42, "Loss of Availability due to Extended Satellite Maintenance on SV 5".

November 20, 2006 – SIS outage of approximately 24 minutes on CRW GEO. See DR#43, "Switchover folled by Signal-in Space (SIS) outage in CRW".

December 1, 2006 – SIS outage of approximately 1244 seconds on AOR-W GEO. See DR#45, "Abnormal AOR-W Switchover and Extended SIS (Signal in Space) Outage".

December 3, 2006 – SIS outage of approximately 800 seconds on CRW GEO. See DR#44, "Signal-in-Space (SIS) outage in CRW".

December 4, 2006 – A brief loss of WAAS availability due to a 4 seconds initialization on all three GEOs. See DR#46, "4 seconds Initialization in AOR-W, POR, and CRW".

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 October 1, 2006 to December 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 INTERNATIONAL	EDMONTON	AB	61	0.994849
CGA	CRAIG	CRAIG	AK	13	0.997493
HYD	HKDER	HKDER	AK	14	0.997610
JNU	JUNEAU INTL AIRPORT	JUNEAU	AK	32	0.996478
KTN	KETCHIKAN AIRPORT	KETCHIKAN	AK	13	0.997583
PEC	PELICAN	PELICAN	AK	33	0.996612
PSG	PETERSBURG MUNICIPAL	PETERSBURG	AK	17	0.997184
SIT	SITKA AIRPORT	SITKA	AK	26	0.997053
SGY	SKAGWAY MUNICIPAL AIRPORT	SKAGWAY	AK	38	0.996126
79J	ANDALUSIA-OPP	ANDALUSIA/OP	AL	12	0.999588
KBHM	BIRMINGHAM INTL	BIRMINGHAM	AL	10	0.999622
KDHN	DOTHAN REGIONAL	DOTHAN	AL	9	0.999637
HSV	HUNTSVILLE INT'L- CARL T JONES FIELD	HUNTSVILLE	AL	11	0.999623
MOB	MOBILE REGIONAL	MOBILE	AL	18	0.999072
MGM	MONTGOMERY REGIONAL/DANNELLY FIELD	MONTGOMERY	AL	9	0.999638
MSL	MUSCLE SHOALS NORTWEST ALABAMA REG	SHEFFIELD	AL	10	0.999622
EET	SHELBY COUNTY	ALABASTER	AL	10	0.999638
M73	ALMYRA	UNKNOWN	AR	9	0.999659
LIT	ADAMS FIELD	LITTLE ROCK	AR	9	0.999659
KVBT	BENTONVILLE MUNI/LM THADDEN FLD	BENTONVILLE	AR	11	0.999635
BYH	BLYTHEVILLE	BLYTHEVILLE	AR	9	0.999654
HRO	BOONE COUNTY AIRPORT	HARRISON	AR	11	0.999635

KFSM	FORT SMITH RGNL	FORT SMITH	AR	10	0.999635
CDH	HARRELL FIELD	CAMDEN	AR	9	0.999663
KXNA	NORTHWEST ARKANSAS RGNL	FAYETTEVILLE/SPRINGDALE/ROGERS	AR	11	0.999635
SRC	SEARCY MUNICIPAL	SEARCY	AR	9	0.999660
ASG	SPRINGDALE MUNICIPAL	SPRINGDALE	AR	11	0.999635
KARG	WALNUT RIDGE REGIONAL	WALNUT RIDGE	AR	9	0.999646
KPRC	ERNEST A LOVE FIELD	PRESCOTT	AZ	83	0.988281
KGCN	GRAND CANYON NATL PARK	GRAND CANYON	AZ	63	0.992812
IFP	LAUGHLIN/BULLHEAD INTERNATIONAL	BULLHEAD CITY	AZ	74	0.991833
KPHX	PHOENIX SKY HARBOR INTL	PHOENIX	AZ	125	0.979038
KTUS	TUCSON INTL	TUCSON	AZ	154	0.971275
RQE	WINDOW ROCK	WINDOW ROCK	AZ	59	0.995417
BFL	BAKERSFIELD/MEADOWS FIELD	BAKERSFIELD	CA	1708	0.950403
KDAG	BARSTOW-DAGGETT	DAGGETT	CA	202	0.981165
O60	CLOVERDALE MUNICIPAL	CLOVERDALE	CA	214	0.972764
IYK	INYOKERN	INYOKERN	CA	210	0.982293
KLAX	LOS ANGELES INTL	LOS ANGELES	CA	350	0.948705
KCRQ	MC CLELLAN-PALOMAR	CARLSBAD	CA	358	0.931461
KOAK	METROPOLITAN OAKLAND INTL	OAKLAND	CA	242	0.971741
ONT	ONTARIO INTERNATIONAL	ONTARIO	CA	329	0.960729
KPMD	PALMDALE PROD FLT/TEST INSTLN	PALMDALE	CA	300	0.969196
KSMF	SACRAMENTO INTL	SACRAMENTO	CA	163	0.985369
KMHR	SACRAMENTO MATHER	SACRAMENTO	CA	159	0.986509
SAN	SAN DIEGO INTERNATIONAL-LINDBERGH FIELD	SAN DIEGO	CA	402	0.916504
KSFO	SAN FRANCISCO INTL	SAN FRANCISCO	CA	263	0.968627
SJC	SAN JOSE INTERNATIONAL	SAN JOSE	CA	251	0.971387
SVE	SUSANVILLE MUNICIPAL	SUSANVILLE	CA	102	0.993798
TNP	TWENTYNINE PALMS	TWENTYNINE PALMS	CA	239	0.978113
AKO	AKRON-COLORADO PLAINS REG'L	AKRON	CO	15	0.999589
COS	COLORADO SPRINGS	COLORADO SPRINGS	CO	13	0.999559

CEZ	CORTEZ MUNICIPAL	CORTEZ	CO	41	0.998398
KDEN	DENVER INTL	DENVER	CO	12	0.999619
LHX	LA JUNTA MUNICIPAL	LA JUNTA	CO	14	0.999568
LAA	LAMAR MUNICIPAL	LAMAR	CO	14	0.999604
EEO	MEEKER	MEEKER	CO	17	0.999596
TAD	PERRY STOKES	TRINIDAD	CO	14	0.999545
2V2	VANCE BRAND	LONGMONT	CO	11	0.999651
2V5	WRAY	WRAY	CO	13	0.999620
HDN	YAMPA VALLEY	HAYDEN	CO	18	0.999545
KBDL	BRADLEY INTL	WINDSOR LOCKS	CT	253	0.972885
KDCA	RONALD REAGAN WASHINGTON INTL	WASHINGTON	DC	17	0.999405
KIAD	WASHINGTON DULLES INTL	WASHINGTON	DC	10	0.999633
FXE	FORT LAUDERDALE EXECUTIVE AIRPORT	FORT LAUDERDALE	FL	218	0.960952
KFLL	FORT LAUDERDALE/HOLLYWOOD INTL	FORT LAUDERDALE	FL	229	0.958608
KGNV	GAINESVILLE RGNL	GAINESVILLE	FL	22	0.999179
KJAX	JACKSONVILLE INTL	JACKSONVILLE	FL	34	0.998543
KMIA	MIAMI INTL	MIAMI	FL	263	0.956942
KAPF	NAPLES MUNI	NAPLES	FL	185	0.979444
KOCF	OCALA INTL-JIM TAYLOR FLD	OCALA	FL	25	0.998723
KMCO	ORLANDO INTL	ORLANDO	FL	80	0.994617
KPBI	PALM BEACH INTL	WEST PALM BEACH	FL	188	0.969011
KPFN	PANAMA CITY-BAY COUNTY INTL	PANAMA CITY	FL	9	0.999653
KPNS	PENSACOLA REGIONAL	PENSACOLA	FL	18	0.999165
SRQ	SARASOTA/BRADENTON INTERNATIONAL	SARASOTA/BRADE NTON	FL	55	0.996416
KRSW	SOUTHWEST FLORIDA INTL	FORT MYERS	FL	142	0.984923
KPIE	ST PETERSBURG-CLEARWATER INTL	ST PETERSBURG-CLEARWATER	FL	29	0.997718
KTLH	TALLAHASSEE RGNL	TALLAHASSEE	FL	10	0.999638
TPA	TAMPA INTERNATIONAL	TAMPA	FL	28	0.997703
KVRB	VERO BEACH MUNI	VERO BEACH	FL	133	0.982650
KSAV	SAVANNAH INTL	SAVANNAH	GA	10	0.999621
KACJ	SOUTHER FIELD	AMERICUS	GA	8	0.999655
KTBR	STATESBORO-BULLOCH COUNTY	STATESBORO	GA	9	0.999672
KATL	WILLIAM B HARTSFIELD ATLANTA INTL	ATLANTA	GA	8	0.999654
KIKV	ANKENY RGNL	ANKENY	IA	13	0.999585
DSM	DES MOINES INTERNATIONAL	DES MOINES	IA	13	0.999604

KMXO	MONTICELLO RGNL	MONTICELLO	IA	11	0.999628
CID	THE EASTERN IOWA	CEDAR RAPIDS	IA	12	0.999613
KBOI	BOISE AIR TERMINAL/GOWEN FLD	BOISE	ID	5	0.999858
EUL	CALDWELL INDUSTRIAL	CALDWELL	ID	4	0.999876
SUN	FRIEDMAN MEMORIAL	HAILEY	ID	5	0.999831
PIH	POCATELLO REGIONAL	POCATELLO	ID	5	0.999837
SZT	SANDPOINT	SANDPOINT	ID	18	0.998506
KARR	AURORA MUNI	CHICAGO/AURORA	IL	10	0.999622
KENL	CENTRALIA MUNI	CENTRALIA	IL	10	0.999622
MDW	CHICAGO MIDWAY	CHICAGO	IL	10	0.999639
KORD	CHICAGO-O'HARE INTL	CHICAGO	IL	10	0.999639
KFOA	FLORA MUNI	FLORA	IL	11	0.999606
KPIA	GREATER PEORIA RGNL	PEORIA	IL	10	0.999639
KRFD	GREATER ROCKFORD	ROCKFORD	IL	12	0.999608
3CK	LAKE IN THE HILLS	UNKNOWN	IL	12	0.999590
KPPQ	PITTSFIELD PENSTONE MUNI	PITTSFIELD	IL	11	0.999629
MLI	QUAD-CITY	MOLINE	IL	11	0.999628
KTIP	RANTOUL NATL AVN CTR/FRANK ELLIOT FLD	RANTOUL	IL	9	0.999654
KSLO	SALEM-LECKRONE	SALEM	IL	10	0.999638
0I2	BRAZIL CLAY COUNTY	BRAZIL	IN	10	0.999639
FWA	FORT WAYNE INTERNATIONAL	FORT WAYNE	IN	9	0.999654
SER	FREEMAN MUNICIPAL	SEYMOUR	IN	9	0.999654
KIND	INDIANAPOLIS INTL	INDIANAPOLIS	IN	9	0.999638
CEV	METTEL FIELD	CONNERSVILLE	IN	9	0.999654
SBN	MICHIANA REG'L TRANSPORTATION CTR	SOUTH BEND	IN	9	0.999654
KBMG	MONROE COUNTY	BLOOMINGTON	IN	9	0.999638
KANQ	TRI-STATE STEUBEN COUNTY	ANGOLA	IN	9	0.999638
EHA	ELKHART-MORTON COUNTY	ELKHART	KS	15	0.999575
KHYS	HAYS RGNL	HAYS	KS	12	0.999606
KOJC	JOHNSON COUNTY EXECUTIVE	OLATHE	KS	12	0.999620
LWC	LAWRENCE MUNICIPAL	LAWRENCE	KS	12	0.999620
KMHK	MANHATTAN RGNL	MANHATTAN	KS	12	0.999620
TOP	PHILIP BILLARD MUNI	TOPEKA	KS	12	0.999620
GLD	RENNER FIELD/GOODLAND MUNICIPAL	GOODLAND	KS	13	0.999603
KCBK	SHALTZ FIELD	COLBY	KS	13	0.999603
KWLD	STROTHER FIELD	WINFIELD/ARKANS AS CITY	KS	13	0.999605
KULS	ULYSSES	ULYSSES	KS	13	0.999620
ICT	WICHITA MID-CONTINENT	WICHITA	KS	12	0.999620
KK22	BIG SANDY RGNL	PRESTONBURG	KY	9	0.999675
KLEX	BLUE GRASS	LEXINGTON	KY	9	0.999654
KCVG	CINCINNATI/NORTHERN KY INTL	COVINGTON/CINCI NNATI	KY	9	0.999638
LOZ	LONDON	LONDON	KY	9	0.999655
SDF	LOUISVILLE INTERNATIONAL-STANDIFORD FLD	LOUISVILLE	KY	9	0.999654
SME	SOMERSET/PULASKI	SOMERSET	KY	10	0.999639
KAEX	ALEXANDRIA INTL	ALEXANDRIA	LA	17	0.998916
DRI	DE RIDDER/BEAUREGARD	BEAUREGARD	LA	19	0.998422
LCH	LAKE CHARLES REGIONAL	LAKE CHARLES	LA	23	0.998016
L39	LEESVILLE	LEESVILLE	LA	18	0.998800

MSY	NEW ORLEANS INT'L/MOISANT FIELD	NEW ORLEANS	LA	20	0.998731
SHV	SHREVEPORT REGIONAL	SHREVEPORT	LA	10	0.999632
KBOS	GEN EDWARD LAWRENCE LOGAN INTL	BOSTON	MA	308	0.951010
OWD	NORWOOD MEMORIAL	NORWOOD	MA	290	0.955015
KPVC	PROVINCETOWN MUNI	PROVINCETOWN	MA	214	0.930745
MVY	VINEYARD HAVEN	MARTHA'S VINEYARD	MA	367	0.947968
YWG	WINNIPEG AIRPORT	WINNIPEG	MB	191	0.980991
KBWI	BALTIMORE-WASHINGTON INTL	BALTIMORE	MD	22	0.999215
DMW	CARROLL CNTY REG'L/JACK B. POAGE FLD	WESTMINSTER	MD	12	0.999597
FDK	FREDERICK MUNICIPAL	FREDERICK	MD	10	0.999654
W00	FREEWAY	MITCHELLVILLE	MD	19	0.999285
GAI	MONTGOMERY COUNTY AIRPARK	GAITHERSBURG	MD	12	0.999587
RJD	RIDGELY AIRPARK	RIDGELY	MD	35	0.998091
KPQI	N MAINE RGNL ARPT AT PRESQUE I	PRESQUE ISLE	ME	416	0.607650
PWM	PORTLAND INTERNATIONAL JETPORT	PORTLAND	ME	244	0.911708
AMN	ALMA/GRATIOT COMMUNITY	ALMA	MI	11	0.999614
KARB	ANN ARBOR MUNI	ANN ARBOR	MI	8	0.999679
KFNT	BISHOP INTL	FLINT	MI	10	0.999605
Y15	CHEBOYGAN COUNTY	CHEBOYGAN	MI	37	0.998558
CIU	CHIPPEWA COUNTY INTERNATIONAL	SAULT STE. MARIE	MI	59	0.995953
KDTW	DETROIT METROPOLITAN WAYNE CTY	DETROIT	MI	9	0.999661
KGRR	GERALD R FORD INTL	GRAND RAPIDS	MI	10	0.999613
KCMX	HOUGHTON COUNTY MEMORIAL	HANCOCK	MI	64	0.991592
KMBS	MBS INTL	SAGINAW	MI	12	0.999597
KMKG	MUSKEGON COUNTY	MUSKEGON	MI	10	0.999638
5D3	OWOSSO COMMUNITY	OWOSSO	MI	11	0.999607
HTL	ROSCOMMON COUNTY	HOUGHTON LAKE	MI	12	0.999607
HYX	SAGINAW CO H.W. BROWNE	UNKNOWN	MI	12	0.999593
HAI	THREE RIVERS MUNI DR. HAINES	UNKNOWN	MI	9	0.999638
BIV	TULIP CITY	HOLLAND	MI	10	0.999634
KBDE	BAUDETTE INTL	BAUDETTE	MN	99	0.989442
KBRD	BRAINERD-CROW WING CO RGNL	BRAINERD	MN	40	0.996293
KAXN	CHANDLER FIELD	ALEXANDRIA	MN	40	0.998259
KDLH	DULUTH INTL	DULUTH	MN	53	0.994308

KMSP	MINNEAPOLIS-ST PAUL INTL/WOLD CHAMBERLAIN	MINNEAPOLIS	MN	21	0.999440
KRGK	RED WING RGNL	RED WING	MN	20	0.999451
KRST	ROCHESTER INTL	ROCHESTER	MN	19	0.999469
KJYG	ST JAMES MUNI	ST JAMES	MN	19	0.999504
STC	ST. CLOUD	SAINT CLOUD	MN	28	0.999240
M05	CARUTHERSVILLE MEMORIAL	CARUTHERSVILLE	MO	9	0.999654
KLBO	FLOYD W JONES LEBANON	LEBANON	MO	11	0.999632
KMCI	KANSAS CITY INTL	KANSAS CITY	MO	12	0.999620
KSTL	LAMBERT-ST LOUIS INTL	ST LOUIS	MO	10	0.999639
LXT	LEE'S SUMMIT MUNICIPAL	LEE'S SUMMIT	MO	11	0.999635
H41	MEXICO MEMORIAL	MEXICO	MO	11	0.999632
MYJ	MEXICO MEMORIAL	UNKNOWN	MO	11	0.999632
STJ	ROSECRANS MEMORIAL	UNKNOWN	MO	12	0.999620
KDMO	SEDALIA MEMORIAL	SEDALIA	MO	11	0.999619
SGF	SPRINGFIELD-BRANSON REGIONAL	SPRINGFIELD	MO	11	0.999635
KMO6	WASHINGTON MEMORIAL	WASHINGTON	MO	10	0.999647
GWO	GREENWOOD-LEFLORE	GREENWOOD	MS	9	0.999638
JAN	JACKSON INTERNATIONAL	JACKSON	MS	18	0.999446
0M6	PANOLA COUNTY	BATESVILLE	MS	9	0.999654
MPE	PHILADELPHIA MUNICIPAL	PHILADELPHIA	MS	11	0.999623
CRX	ROSCOE TURNER	UNKNOWN	MS	9	0.999654
KBIL	BILLINGS LOGAN INTL	BILLINGS	MT	14	0.999491
KMLS	FRANK WILEY FIELD	MILES CITY	MT	14	0.999517
KHLN	HELENA RGNL	HELENA	MT	15	0.999354
KLWT	LEWISTOWN MUNI	LEWISTOWN	MT	16	0.999313
6S5	RAVALLI COUNTY	HAMILTON	MT	10	0.999424
KHBI	ASHEBORO MUNI	ASHEBORO	NC	9	0.999536

KAVL	ASHEVILLE RGNL	ASHEVILLE	NC	8	0.999677
HSE	BILLY MITCHELL	HATTERAS	NC	62	0.994730
SUT	BRUNSWICK COUNTY	SOUTHPORT	NC	44	0.996642
KCLT	CHARLOTTE/DOUGLAS INTL	CHARLOTTE	NC	8	0.999674
ECG	ELIZABETH CITY CGAS	ELIZABETH CITY	NC	42	0.996642
KFAY	FAYETTEVILLE RGNL/GRANNIS FIELD	FAYETTEVILLE	NC	18	0.998623
HKY	HICKORY REGIONAL	HICKORY	NC	8	0.999689
KISO	KINSTON RGNL JETPORT AT STALLINGS FLD	KINSTON	NC	20	0.997676
MEB	LAURINBURG	MAXTON	NC	18	0.999029
MCZ	MARTIN COUNTY	WILLIAMSTON	NC	21	0.997754
MRH	MICHAEL J. SMITH FIELD	BEAUFORT	NC	47	0.996135
KEQY	MONROE	MONROE	NC	9	0.999543
GSO	PIEDMONT TRIAD INTERNATIONAL	GREENSBORO	NC	9	0.999669
PGV	PITT-GREENVILLE	GREENVILLE	NC	21	0.997763
KRDU	RALEIGH-DURHAM INTL	RALEIGH/DURHAM	NC	17	0.999194
RWI	ROCKY MOUNT-WILSON REGIONAL	ROCKY MOUNT	NC	18	0.998339
KRUQ	ROWAN COUNTY	SALISBURY	NC	8	0.999689
KTTA	SANFORD-LEE COUNTY RGNL	SANFORD	NC	17	0.999277
OCW	WARREN FIELD	WASHINGTON	NC	21	0.997698
KILM	WILMINGTON INTL	WILMINGTON	NC	30	0.997192
W03	WILSON INDUSTRIAL AIR CENTER	WILSON	NC	18	0.998380
KFAR	HECTOR INTL	FARGO	ND	39	0.996833
MOT	MINOT INTL AIRPORT	MINOT	ND	42	0.997371
KANW	AINSWORTH MUNI	AINSWORTH	NE	13	0.999598
AUH	AURORA MUNICIPAL	AURORA	NE	12	0.999620
BIE	BEATRICE MUNICIPAL	BEATRICE	NE	12	0.999620
CSB	CAMBRIDGE MUNICIPAL	CAMBRIDGE	NE	12	0.999631

CEK	CRETE MUNICIPAL	CRETE	NE	12	0.999620
OMA	EPPLEY AIRFIELD	OMAHA	NE	12	0.999620
OKS	GARDEN COUNTY	OSHKOSH	NE	14	0.999604
GRN	GORDON MUNICIPAL	GORDON	NE	14	0.999592
KEAR	KEARNEY MUNI	KEARNEY	NE	12	0.999603
VTN	MILLER FIELD	VALENTINE	NE	13	0.999615
KLBF	NORTH PLATTE RGNL LEE BIRD FLD	NORTH PLATTE	NE	12	0.999631
SCB	SCRIBNER STATE	SCRIBNER	NE	12	0.999620
SNY	SIDNEY MUNICIPAL	SIDNEY	NE	14	0.999604
MHT	MANCHESTER	MANCHESTER	NH	308	0.954112
KACY	ATLANTIC CITY INTL	ATLANTIC CITY	NJ	54	0.996413
K3NJ6	INDUCTOTHERM HELIPORT	RANCOCAS	NJ	45	0.996993
KMMU	MORRISTOWN MUNI	MORRISTOWN	NJ	69	0.995053
KEWR	NEWARK INTL	NEWARK	NJ	68	0.994634
7N7	SPITFIRE AERODROM	PEDRICTOWN	NJ	38	0.997616
KABQ	ALBUQUERQUE INTL SUNPORT	ALBUQUERQUE	NM	66	0.997423
KFMN	FOUR CORNERS RGNL	FARMINGTON	NM	52	0.997864
KLRU	LAS CRUCES INTL	LAS CRUCES	NM	89	0.991557
ELY	ELY AIRPORT/YELLAND FELD	ELY	NV	24	0.998761
KLAS	MC CARRAN INTL	LAS VEGAS	NV	60	0.994302
ALB	ALBANY INTERNATIONAL	ALBANY	NY	218	0.978638
BUF	BUFFALO NIAGARA INTERNATIONAL	BUFFALO	NY	13	0.999477
KJHW	CHAUTAUQUA COUNTY/JAMESTOWN	JAMESTOWN	NY	12	0.999621
KELM	ELMIRA/CORNING RGNL	ELMIRA	NY	22	0.998852
GFL	FLOYD BENNETT MEMORIAL	GLENS FALLS	NY	224	0.972789
ROC	GREATER ROCHESTER INTERNATIONAL	ROCHESTER	NY	26	0.998871
KJFK	JOHN F KENNEDY INTL	NEW YORK	NY	89	0.993700
LGA	LA GUARDIA	FLUSHING	NY	94	0.993431
LKP	LAKE PLACID	LAKE PLACID	NY	243	0.968430
PBG	PLATTSGURGH INTERNATIONAL	PLATTSGURGH	NY	273	0.959778

KSWF	STEWART INTL	NEWBURGH	NY	128	0.990919
KSYR	SYRACUSE HANCOCK INTL	SYRACUSE	NY	81	0.995723
FOK	THE FRANCIS S. GABRESKI	WESTHAMPTON BEACH	NY	158	0.987370
HPN	WESTCHESTER COUNTY	WHITE PLAINS	NY	123	0.991449
B16	WHITFORDS	WEEDSPORT	NY	55	0.997502
4F5	BELLEFONTAINE MUNICIPAL AIRPORT	UNKNOWN	OH	8	0.999693
KCLE	CLEVELAND-HOPKINS INTL	CLEVELAND	OH	9	0.999657
KDAY	JAMES M COX DAYTON INTL	DAYTON	OH	8	0.999655
I68	LEBANON-WARREN COUNTY	UNKNOWN	OH	8	0.999670
1G5	MEDINA MUNICIPAL	MEDINA	OH	9	0.999672
OSU	OHIO STATE UNIVERSITY	COLUMBUS	OH	8	0.999691
KCMH	PORT COLUMBUS INTL	COLUMBUS	OH	8	0.999677
KRZT	ROSS COUNTY	CHILLICOTHE	OH	8	0.999691
KTOL	TOLEDO EXPRESS	TOLEDO	OH	8	0.999693
KAVK	ALVA RGNL	ALVA	OK	12	0.999615
KCQB	CHANDLER MUNI	CHANDLER	OK	13	0.999592
CHK	CHICKASHA	CHICKASHA	OK	16	0.999519
GCM	CLAREMORE REGIONAL	UNKNOWN	OK	12	0.999620
1K4	DAVID J PERRY	UNKNOWN	OK	16	0.999514
KMKO	DAVIS FIELD	MUSKOGEE	OK	10	0.999651
DUA	EAKER FIELD AIRPORT	UNKNOWN	OK	14	0.999517
2O8	HINTON MUNICPAL	HINTON	OK	15	0.999559
KHBR	HOBART MUNI	HOBART	OK	15	0.999508
MIO	MIAMI	UNKNOWN	OK	11	0.999635
MDF	MORELAND MUNI	MORELAND	OK	12	0.999635
PVJ	PAULS VALLEY MUNICIPAL AIRPORT	UNKNOWN	OK	16	0.999472
PNC	PONCA CITY	PONCA CITY	OK	12	0.999623

K2K4	SCOTT FIELD	MANGUM	OK	17	0.999438
SNL	SHAWNEE	SHAWNEE	OK	16	0.999547
TQH	TAHLEQUAH	UNKNOWN	OK	11	0.999635
KTUL	TULSA INTL	TULSA	OK	12	0.999620
OKC	WILL ROGERS WORLD AIRPORT	OKLAHOMA CITY	OK	16	0.999537
YOW	OTTAWA AIRPORT	OTTAWA	ON	244	0.973877
S07	BEND MUNICIPAL	BEND	OR	17	0.998129
SLE	MCNARY FIELD	SALEM	OR	25	0.996482
KONP	NEWPORT MUNI	NEWPORT	OR	32	0.995842
PDX	PORTLAND INTERNATIONAL	PORTLAND	OR	22	0.997181
HIO	PORTLAND-HILLSBORO	HILLSBORO	OR	24	0.996957
S47	TILLAMOOK	TILLAMOOK	OR	27	0.996246
LGD	UNION COUNTY	LA GRANDE	OR	9	0.999641
KAGC	ALLEGHENY COUNTY	PITTSBURGH	PA	9	0.999658
KBFD	BRADFORD RGNL	BRADFORD	PA	12	0.999594
MDT	HARRISBURG INTERNATIONAL	HARRISBURG	PA	17	0.999451
KJST	JOHN MURTHA JOHNSTOWN-CAMBRIA COUNTY	JOHNSTOWN	PA	9	0.999673
LNS	LANCASTER	LANCASTER	PA	29	0.999013
ABE	LEHIGH VALLEY INTERNATIONAL	ALLENTOWN	PA	40	0.997653
PHL	PHILADELPHIA INTERNATIONAL	PHILADELPHIA	PA	42	0.997477
KPIT	PITTSBURGH INTL	PITTSBURGH	PA	8	0.999689
LHV	WILLIAM T. PIPER MEMORIAL	LOCK HAVEN	PA	12	0.999560
PVD	THEODORE FRANCIS GREEN STATE	PROVIDENCE	RI	288	0.960164
AND	ANDERSON REGIONAL	ANDERSON	SC	8	0.999690
KCHS	CHARLESTON AFB/INTL	CHARLESTON	SC	40	0.996299
KCAE	COLUMBIA METROPOLITAN	COLUMBIA	SC	9	0.999658
KGSP	GREENVILLE-SPARTANBURG INTL	GREER	SC	8	0.999676
KMYR	MYRTLE BEACH INTL	MYRTLE BEACH	SC	52	0.996444
KHON	HURON REGIONAL	HURON	SD	14	0.999557
FSD	JOE FOSS FIELD	SIOUX FALLS	SD	12	0.999620
1D1	MILBANK MUNICIPAL	MILBANK	SD	15	0.999520

KRAP	RAPID CITY REGIONAL	RAPID CITY	SD	15	0.999552
YXE	SASKATOON AIRPORT	SASKATOON	SK	152	0.987080
PHT	HENRY COUNTY	PARIS	TN	10	0.999638
CHA	LOVELL FIELD	CHATTANOOGA	TN	9	0.999654
TYS	MC GHEE TYSON	KNOXVILLE	TN	7	0.999685
KMEM	MEMPHIS INTL	MEMPHIS	TN	9	0.999654
KBNA	NASHVILLE INTL	NASHVILLE	TN	10	0.999622
TRI	TRI-CITIES REGIONAL TN/VA AIRPORT	UNKNOWN	TN	8	0.999691
KABI	ABILENE REGIONAL	ABILENE	TX	23	0.998646
ADS	ADDISON	DALLAS	TX	18	0.999306
ALI	ALICE	ALICE	TX	2798	0.924309
AMA	AMARILLO INTERNATIONAL	AMARILLO	TX	19	0.999426
AUS	AUSTIN-BERGSTROM INTERNATIONAL	AUSTIN	TX	74	0.994555
KLBX	BRAZORIA COUNTY	ANGLETON/LAKE JACKSON	TX	90	0.990480
7F9	COMANCHE	COMANCHE	TX	25	0.998603
CRP	CORPUS CHRISTI INTERNATIONAL	CORPUS CHRISTI	TX	2725	0.928203
KDAL	DALLAS LOVE FIELD	DALLAS	TX	18	0.999258
KDFW	DALLAS-FT WORTH INTL	DALLAS-FT WORTH	TX	18	0.999217
KDWH	DAVID WAYNE HOOKS MEMORIAL	HOUSTON	TX	57	0.996378
KDRT	DEL RIO INTL	DEL RIO	TX	62	0.992814
ELP	EL PASO INTERNATIONAL	EL PASO	TX	106	0.990064
KEFD	ELLINGTON FIELD	HOUSTON	TX	72	0.994021
KIAH	GEORGE BUSH INTERCONTINENTAL/HOUSTON	HOUSTON	TX	59	0.996088
KAXH	HOUSTON-SOUTHWEST	HOUSTON	TX	79	0.992826
KLBB	LUBBOCK INTL	LUBBOCK	TX	30	0.998800
MAF	MIDLAND INTERNATIONAL	MIDLAND	TX	32	0.997023
KCXO	MONTGOMERY COUNTY	CONROE	TX	28	0.997658
OSA	MOUNT PLEASANT MUNICIPAL	MOUNT PLEASANT	TX	10	0.999615
KSJT	SAN ANGELO RGNL/MATHIS FLD	SAN ANGELO	TX	33	0.997350
KSAT	SAN ANTONIO INTL	SAN ANTONIO	TX	98	0.990155
KSGR	SUGAR LAND MUNI/HULL FLD	HOUSTON	TX	77	0.993589
SGR	SUGARLAND MUNI/HULL FIELD	SUGAR LAND	TX	77	0.993589
KTYR	TYLER POUNDS RGNL	TYLER	TX	11	0.999574
KHRL	VALLEY INTL	HARLINGEN	TX	618	0.873477
KIWS	WEST HOUSTON	HOUSTON	TX	71	0.994485
KHOU	WILLIAM P HOBBY	HOUSTON	TX	72	0.994012
BMC	BRIGHAM CITY	BRIGHAM CITY	UT	4	0.999853
KCDC	CEDAR CITY RGNL	CEDAR CITY	UT	29	0.997837
KKNB	KANAB MUNI	KANAB	UT	30	0.997472
LGU	LOGAN-CACHE	LOGAN	UT	4	0.999853
SLC	SALT LAKE CITY INTERNATIONAL	SALT LAKE CITY	UT	4	0.999853
MTV	BLUE RIDGE	MARTINSVILLE	VA	8	0.999689
LVL	BRUNSWICK MUNICIPAL	LAWRENCEVILLE	VA	18	0.998916
KCHO	CHARLOTTESVILLE-ALBEMARLE	CHARLOTTESVILLE	VA	9	0.999656
FKN	FRANKLIN MUNICIPAL-JOHN BEVERLY ROSE	FRANKLIN	VA	28	0.997961
JYO	LEESBURG MUNICIPAL/GODFREY FIELD	LEESBURG	VA	9	0.999671

HEF	MANASSAS REGIONAL/HARRY P. DAVIS FIELD	MANASSAS	VA	10	0.999645
KPHF	NEWPORT NEWS/WILLIAMSBURG INTL	NEWPORT NEWS	VA	37	0.997545
KORF	NORFOLK INTL	NORFOLK	VA	41	0.996754
RIC	RICHMOND INTERNATIONAL	RICHMOND	VA	19	0.999069
AKQ	WAKEFIELD MUNICIPAL	WAKEFIELD	VA	21	0.998392
WAL	WALLOPS FLIGHT FACILITY	WALLOPS ISLAND	VA	51	0.996507
BTV	BURLINGTON INTERNATIONAL	BURLINGTON	VT	277	0.958523
BFI	BOEING FIELD/KING COUNTY INTERNATIONAL	SEATTLE	WA	24	0.997749
FHR	FRIDAY HARBOR	FRIDAY HARBOR	WA	25	0.997520
KMWH	GRANT COUNTY INTL	MOSES LAKE	WA	15	0.998808
KSEA	SEATTLE-TACOMA INTL	SEATTLE	WA	24	0.997709
KGEG	SPOKANE INTL	SPOKANE	WA	14	0.998937
KGRB	AUTIN STRAUBEL INTL	GREEN BAY	WI	20	0.999391
3T3	BOYCEVILLE MUNICIPAL	BOYCEVILLE	WI	21	0.999414
KCWA	CENTRAL WISCONSIN	MOSINEE	WI	19	0.999390
MSN	DANE COUNTY REGIONAL-TRUAX FIELD	MADISON	WI	11	0.999623
SUE	DOOR COUNTY CHERRYLAND	STURGEON BAY	WI	21	0.999344
FLD	FOND DU LAC COUNTY	FOND DU LAC	WI	13	0.999592
MKE	GENERAL MITCHELL INTERNATIONAL	MILWAUKEE	WI	12	0.999608
MTW	MANITOWOC COUNTY	MANITOWOC	WI	14	0.999566
KATW	OUTAGAMIE COUNTY RGNL	APPLETON	WI	16	0.999507
RHI	RHINELANDER-ONEIDA COUNTY	RHINELANDER	WI	29	0.999064
JVL	SOUTHERN WISCONSIN REGIONAL AIRPORT	JANESVILLE	WI	12	0.999590
RYV	WATERTOWN MUNICIPAL	WATERTOWN	WI	12	0.999608
ETB	WEST BEND MUNICIPAL	WEST BEND	WI	12	0.999608
OSH	WITTMAN REGIONAL	OSHKOSH	WI	13	0.999569
KMGW	MORGANTOWN MUNI-WLB HART FLD	MORGANTOWN	WV	9	0.999673
KPKB	WOOD CO-GILL ROBB WILSON FLD	PARKERSBURG	WV	9	0.999673
EVW	EVANSTON-UNITA CNTY-BURNS FLD	EVANSTON	WY	4	0.999851
KCPR	NATRONA COUNTY INTL	CASPER	WY	11	0.999603
SAA	SHIVELY FIELD	SARATOGA	WY	13	0.999633

Figure 9-1 WAAS LPV Availability

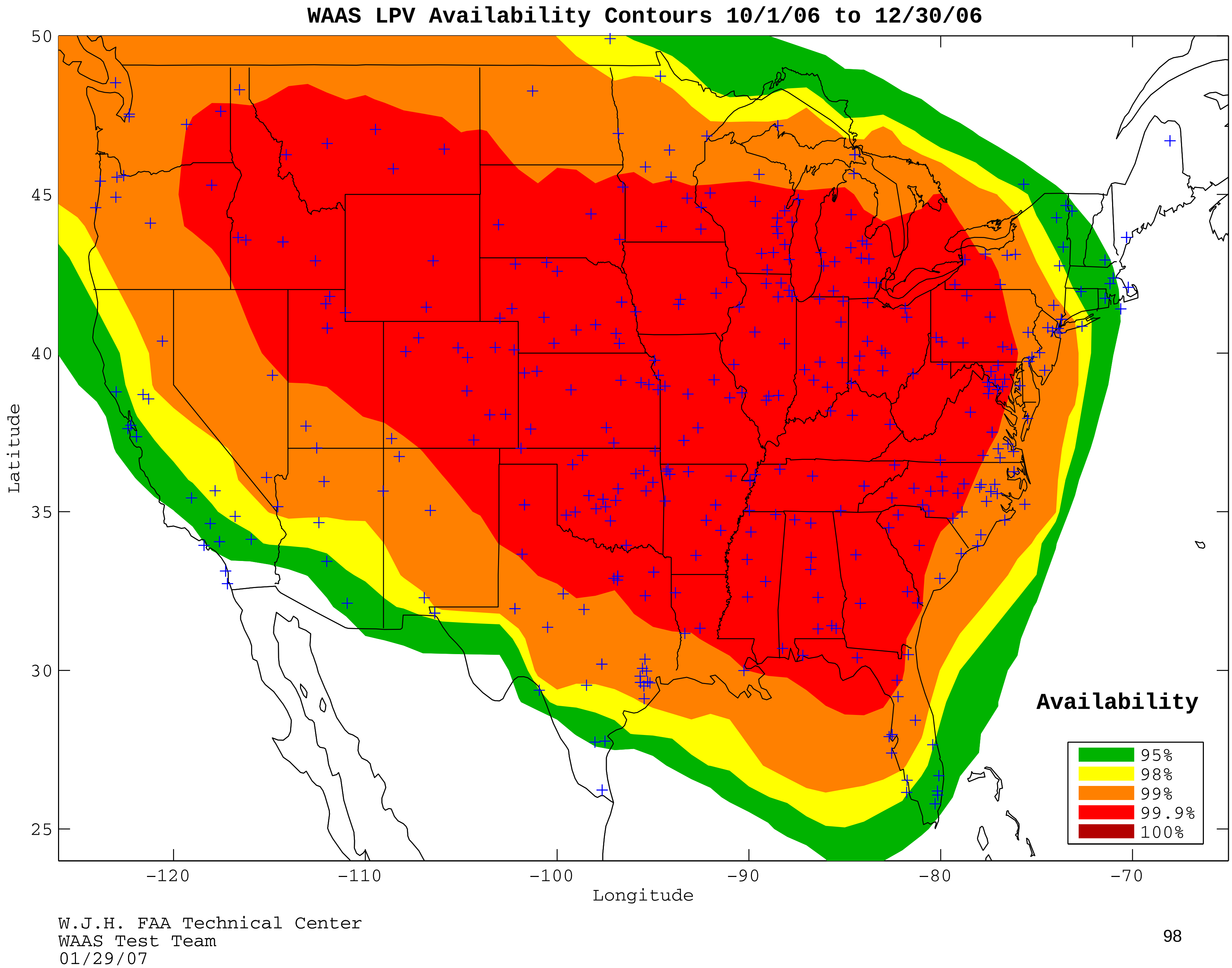
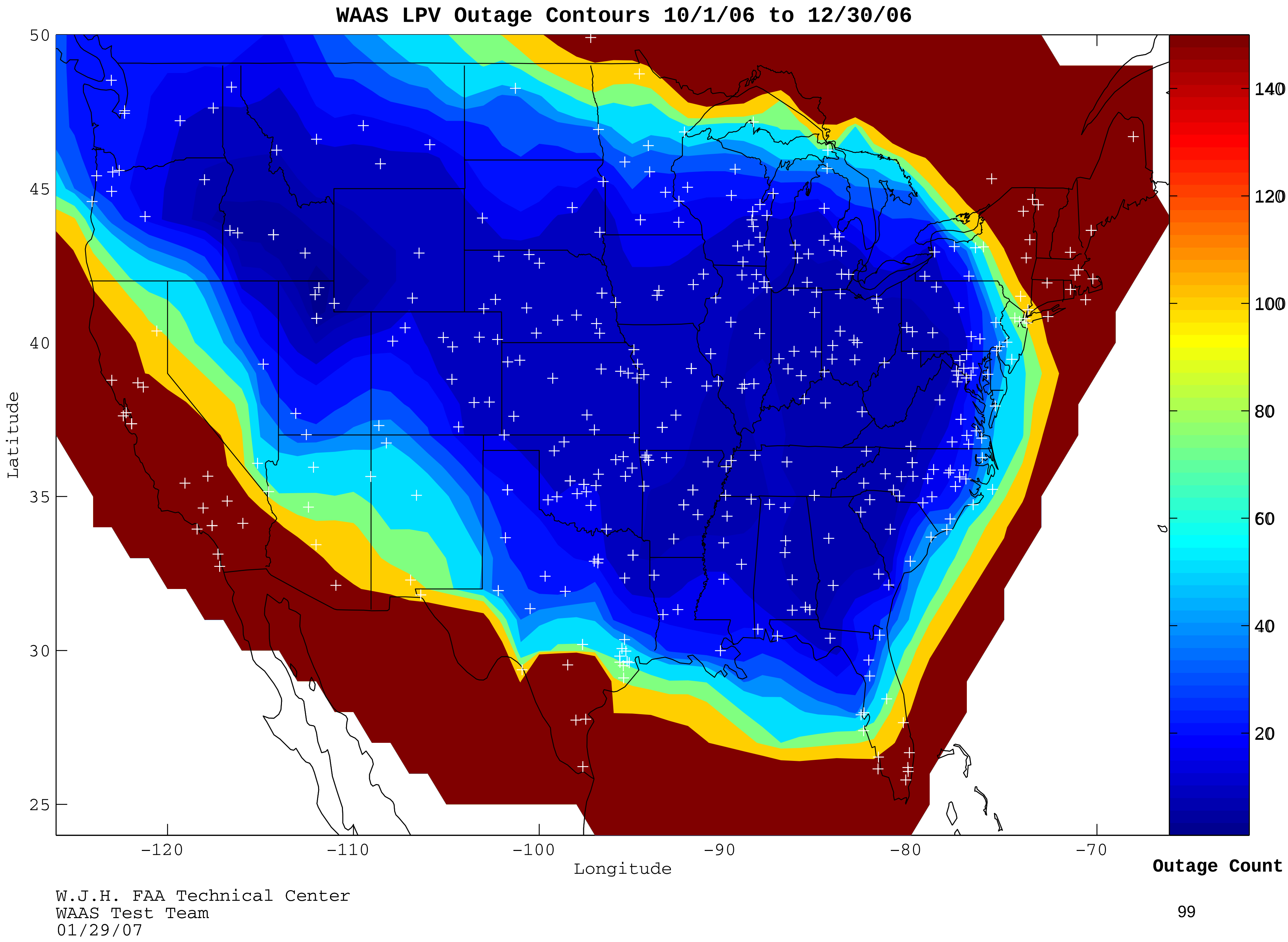


Figure 9-2 WAAS LPV Outage



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	Jan 06	Feb 06	Mar 06	Apr 06	May 06	Jun 06	Jul 06	Aug 06	Sep 06	Oct 06	Nov 06	Dec 06
Albuquerque	A	yellow	yellow	yellow	green	blue	green	red	green	yellow	blue	green	green
	B	blue	yellow	yellow	green	green	blue	red	green	blue	blue	green	blue
	C	green	yellow	green	yellow	blue	yellow	blue	yellow	red	blue	blue	blue
Anchorage	A	green	blue	blue	green	red	red	green	red	red	red	green	green
	B	green	yellow	green	green	yellow	yellow	red	red	red	yellow	red	red
	C	blue	blue	green	yellow	red	red	red	yellow	red	red	red	yellow
Atlanta	A	blue	blue	blue	blue	blue	yellow	yellow	blue	blue	green	green	blue
	B	green	yellow	blue	blue	blue	blue	yellow	blue	blue	yellow	blue	blue
	C	blue	green	yellow	blue	blue	green	green	yellow	blue	yellow	blue	blue
Billings	A	blue	blue	blue	blue	green	yellow	red	green	blue	blue	blue	blue
	B	blue	blue	blue	blue	yellow	green	yellow	green	blue	blue	blue	green
	C	yellow	blue	blue	blue	yellow	green	green	blue	blue	blue	blue	blue
Boston	A	blue	blue	green	blue	yellow	yellow	yellow	blue	blue	blue	blue	green
	B	red	yellow	yellow	green	yellow	blue	blue	blue	yellow	green	green	yellow
	C	blue	blue	blue	blue	blue	blue	blue	yellow	blue	blue	green	blue
Chicago	A	blue	red	blue	yellow	green	blue	green	yellow	blue	green	blue	blue
	B	green	blue	blue	green	green	green	blue	green	blue	blue	blue	yellow
	C	green	yellow	green	green	yellow	green	blue	blue	red	blue	green	blue
Cleveland	A	green	yellow	yellow	blue	blue	red	yellow	blue	blue	blue	green	yellow
	B	red	red	yellow	blue	yellow	green	blue	blue	green	green	blue	blue
	C	yellow	green	yellow	green	green	blue	blue	green	yellow	green	yellow	yellow
Cold Bay	A	green	yellow	green	green	red	yellow	yellow	yellow	red	red	yellow	green
	B	blue	blue	blue	blue	red	red	red	red	yellow	yellow	red	red
	C	blue	green	blue	blue	yellow	red	yellow	yellow	red	yellow	red	yellow
Dallas	A	blue	green	yellow	green	red	red	yellow	yellow	red	red	yellow	red
	B	green	yellow	yellow	yellow	red	red	red	red	red	red	red	red
	C	green	blue	green	green	red	yellow	red	red	red	yellow	red	red
Denver	A	green	yellow	red	yellow	green	blue	blue	blue	blue	yellow	green	blue
	B	blue	blue	blue	blue	green	blue	blue	blue	green	blue	blue	blue
	C	green	green	green	green	green	red	yellow	yellow	green	blue	blue	yellow
Honolulu	A	yellow	yellow	red	yellow	green	green	blue	blue	yellow	green	red	green
	B	blue	yellow	blue	blue	blue	blue	blue	blue	blue	blue	green	blue
	C	green	green	green	green	yellow	red	blue	blue	green	blue	red	green
Houston	A	yellow	red	red	red	red	red	green	green	yellow	yellow	red	green
	B	red	green	yellow	red	green	blue	yellow	green	green	yellow	yellow	yellow
	C	yellow	yellow	blue	blue	yellow	blue	blue	green	yellow	yellow	yellow	red
Jacksonville	A	yellow	blue	green	blue	green	blue	blue	yellow	blue	blue	green	blue
	B	blue	green	blue	green	blue	blue	blue	green	blue	green	blue	green
	C	blue	green	blue	yellow	yellow	yellow	blue	blue	blue	green	blue	blue
Juneau	A	yellow	yellow	yellow	blue	green	yellow	yellow	green	blue	red	green	green
	B	green	red	green	green	yellow	blue	blue	green	green	blue	blue	blue
	C	green	green	yellow	blue	yellow	blue	yellow	green	green	blue	green	blue
Kansas City	A	red	blue	blue	yellow	yellow	yellow	yellow	yellow	red	red	red	red
	B	blue	blue	green	yellow	red	red	red	red	red	red	yellow	green
	C	blue	blue	blue	green	red	yellow	green	green	blue	red	red	red
Los Angeles	A	yellow	yellow	blue	blue	blue	yellow	blue	green	yellow	green	blue	green
	B	blue	yellow	blue	blue	blue	blue	green	blue	blue	blue	blue	blue
	C	green	blue	blue	blue	blue	blue	yellow	blue	yellow	blue	blue	blue
Memphis	A	blue	yellow	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
	B	yellow	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
	C	green	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
Miami	A	green	green	yellow	yellow	yellow	yellow	green	green	yellow	yellow	red	yellow
	B	green	yellow	blue	blue	blue	blue	blue	blue	red	blue	blue	blue
	C	yellow	blue	blue	blue	yellow	blue	yellow	yellow	red	green	blue	blue
Minneapolis	A	blue	blue	blue	blue	green	red	red	red	red	red	red	red
	B	green	green	blue	blue	green	red	red	red	red	yellow	red	red
	C	yellow	green	blue	yellow	red	red	yellow	yellow	green	blue	yellow	yellow
New York	A	blue	blue	blue	blue	blue	blue	yellow	yellow	blue	blue	blue	green
	B	yellow	blue	blue	green	green	yellow	blue	blue	blue	blue	blue	yellow
	C	green	red	blue	green	blue	blue	red	red	green	blue	blue	red

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

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

Shaded receivers represent legacy receivers (non-G2). These receivers are predominantly the trouble receivers, with over 95% of their failures occurring on the L2 frequency.

11.0 GPS BROADCAST ORBIT VS. IGS PRECISE ORBITS ANALYSIS

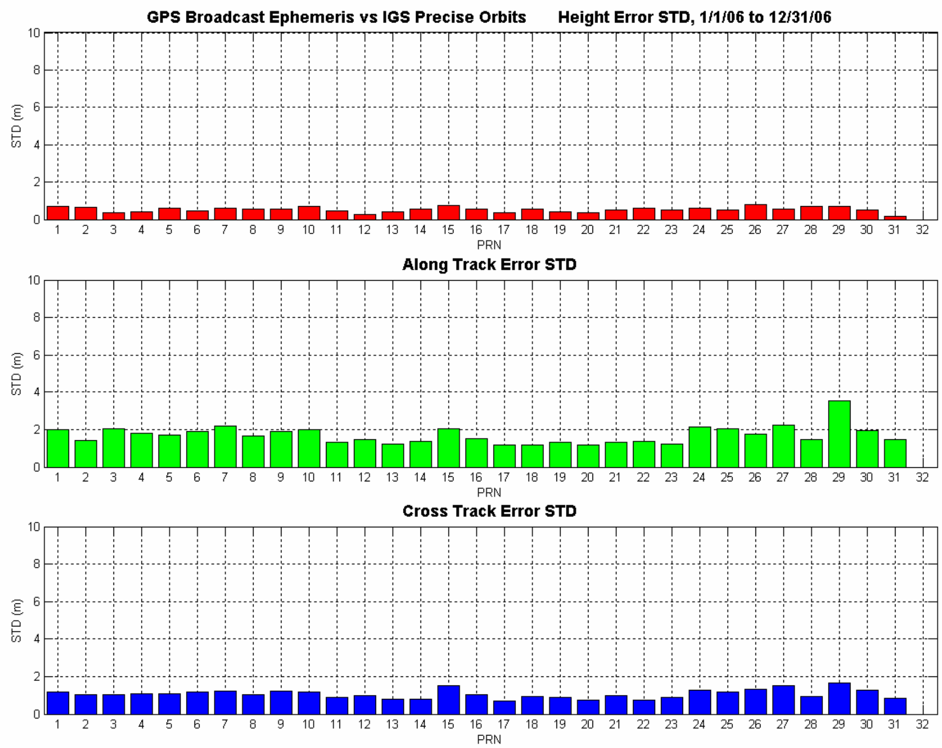
As part of the WAAS off-line monitoring process, the accuracy of the GPS broadcast ephemeris is periodically compared to the IGS precise orbit information to monitor the validity of an a priori assumption concerning the accuracy of the GPS broadcast ephemeris information that is part of a brute force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

Height Error:	+/- 15 meters,
Along Track Error:	+/- 65 meters,
Cross Track Error:	+/- 30 meters,

24 hour global GPB broadcast ephemeris information files and IGS precise orbit files are downloaded from the National Geodetic Survey (NGS). GPS satellite positions are computed every 15 minutes and differenced with the precise orbits. The resulting error information is then segregated into the Height, Along Track, Cross Track (HAC) error data. The standard deviation of the error is then computed for each dimension for each satellite. The assumption if valid if a 5.33 scaling of the standard deviation across all satellites is within the a priori. Only data points where GPS is healthy and valid IGS data is available are considered.

One year of data from 1/1/06 to 12/31/06 is presented. Figure 11-1 is a plot of the standard deviations. The worst case standard deviation meet the criteria (PRN 26 Height, PRN 29 Along Track, PRN 29 Cross Track), therefore the assumption is validated.

Figure 11-1 Standard Deviation for Height, Along Track, and Cross Track



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 slow error 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.