WIDE-AREA AUGMENTATION SYSTEM PERFORMANCE ANALYSIS REPORT

Report #15

Reporting Period: October 1 to December 31, 2005

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

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 fifteenth such WAAS quarterly report. This report covers WAAS performance during the period from October 1, 2005 to December 31, 2005.

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	Washington DC 1.694 meters	Greenwood 0.788 meters
95% Vertical Accuracy	Oakland 2.037meters	Greenwood and Chicago 1.116 meters
LPV Availability (HPL < 40 meters & VPL < 50 meters)	Washington DC 99.996%	Los Angeles 96.51%
95% HPL	Grand Forks 28.122 meters	Atlanta 16.042 meters
95% VPL	Prescott 43.192 meters	Denver 26.302 meters

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX

1.0 INTRODUCTION

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

Objectives of this report are:

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

The WAAS data transmitted from GEO satellite PRN#122 (AORW) and PRN#134 (POR) were used in the evaluation. Table 1.1 and Table 1.2 list NSTB and WAAS reference station receivers used in Precision Approach (PA) and Non-Precision Approach (NPA) evaluation process, respectively. This report presents results from three months of data, collected from October 1, 2005 to December 31, 2005.

Table 1-1 PA Sites

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

Table 1-2 NPA Sites

Location	Number of Days Evaluated	Number of Samples
Bangor	70	6084541
Kotzebue	83	7236264
Albuquerque	85	7419917
Anchorage	85	7425501
Atlanta	85	7402967
Billings	85	7426119
Boston	85	7425578
Cleveland	85	7425521
Cold Bay	85	7375749
Honolulu	80	6943192
Houston	85	7419859
Juneau	85	7384401
Kansas City	85	7425791
Los Angeles	85	7425359
Miami	85	7420285
Minneapolis	85	7384325
Oakland	85	7424515
Salt Lake City	85	7425562
San Juan	85	7354622
Seattle	85	7424484
Washington DC	85	7426586

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.

Table 1-4 Test Events

GPS Week	Date	Sites	Events
1347 day 6 to 1348 day 1	11/5/05 to 11/7/05	Grand Forks	Grand Forks outage.
1349 day 0	11/13/05	All AORW Non-dual Sites	AORW SIS outages.
1349 day 3	11/16/05	WAAS sites connected to ZTL TCS	ZTL BCN1 PCU firmware upgrade. Affected Albuquerque, Houston, Miami, Minneapolis, NY, Atlanta.
1349 day 4 to 1350 day 1	11/17/05 to 11/21/05	Grand Forks	Grand Forks outage.
1350 day 3	11/23/05	WAAS sites connected to ZTL TCS	One common network outage: 515 sec, beginning @ 310925. Affected Albuquerque, Houston, Miami, Minneapolis, NY, Atlanta.
1351 day 4	12/1/05	None	High number (57) of SV Alerts on AOR-W and POR GEOs.
1351 day 6	12/3/05	POR Non-dual Sites	POR message gaps caused TTA monitor trip & loss of PA & NPA service.
1353 day 3 to 1355 day 4	12/14/05 to 12/29/05	Anderson	Anderson outage.

1.2 Report Overview

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

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

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

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

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

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

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

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

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

2.0 WAAS POSITION ACCURACY

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

Table 2-1 Operational Service Levels

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

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

During the evaluated period, the 95% horizontal and vertical accuracy at all evaluated sites were less than 2 meters for both WAAS operational service levels. The maximum 95% horizontal and vertical LPV errors are 1.694 meters at Washington DC and 2.037 Oakland. The minimum 95% horizontal and vertical LPV errors are 0.788 meters at Greenwood and 1.116 meters at both Greenwood and Chicago. The maximum 95% and 99.999% NPA horizontal errors are 3.748 meters and 9.651 meters, both at Honolulu, respectively. The minimum 95% and 99.999% horizontal errors are 1.133 meters at Juneau and 2.902 meters at Houston, respectively.

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

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

Table 2-2 PA 95% Horizontal and Vertical Accuracy

Location	Horizontal GLS/APV2/LPV (HAL=40m) (Meters)	Horizontal APV-1(LNAV) (HAL=556m) (Meters)	Vertical LPV/VNAV (VAL=50m) (Meters)	Percentage in PA mode (%)	SPS Accuracy	
					95% Horizontal (Meters)	95% Vertical (Meters)
Anderson	0.914	0.914	1.173	99.99660	*	*
Atlantic City	0.805	0.805	1.149	99.99432	*	*
Grand Forks	0.872	0.872	1.396	99.99631	*	*
Greenwood	0.788	0.788	1.116	99.99792	*	*
Prescott	1.018	1.019	1.225	99.99863	*	*
Albuquerque	0.923	0.923	1.486	99.99543	2.437	4.508
Atlanta	1.050	1.050	1.227	99.99702	2.706	4.700
Billings	1.035	1.035	1.508	99.99529	2.639	4.408
Boston	1.062	1.062	1.250	99.99709	2.746	4.390
Chicago	0.982	0.982	1.116	99.99483	*	*
Cleveland	0.901	0.901	1.144	99.99699	2.802	4.280
Dallas	1.452	1.452	1.469	99.99514	*	*
Denver	0.968	0.968	1.465	99.99503	*	*
Houston	0.884	0.884	1.474	99.99511	2.376	5.014
Jacksonville	1.311	1.311	1.232	99.99703	*	*
Kansas City	0.970	0.970	1.119	99.99483	2.684	4.537
Los Angeles	1.081	1.088	1.733	99.99720	2.395	4.988
Memphis	1.003	1.003	1.148	99.99478	*	*
Miami	1.066	1.066	1.615	99.99700	2.516	4.864
Minneapolis	1.626	1.626	1.956	99.99471	2.693	4.401
New York	1.306	1.306	1.286	99.99709	*	*
Oakland	1.206	1.223	2.037	99.99722	2.444	5.086
Salt Lake City	0.856	0.856	1.546	99.99703	2.607	4.516
Seattle	0.994	0.994	1.301	99.99721	2.599	4.502
Washington DC	1.694	1.694	1.432	99.99703	2.775	4.342

* 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
Bangor	2.563	7.599	99.9985	6.251
Kotzebue	2.285	4.327	99.9951	5.665
Albuquerque	1.393	3.435	99.9987	3.651
Anchorage	1.310	3.360	99.9937	3.561
Atlanta	1.921	4.081	99.9987	6.959
Billings	1.633	3.368	99.9988	3.712
Boston	1.811	3.430	99.9987	7.300
Cleveland	1.720	3.405	99.9987	3.703
Cold Bay	1.612	4.539	99.9949	8.246
Honolulu	3.748	9.651	99.9949	10.133
Houston	1.331	2.902	99.9986	3.080
Juneau	1.133	3.294	99.9953	4.366
Kansas City	1.761	3.199	99.9987	3.870
Los Angeles	1.369	3.559	99.9999	3.811
Miami	1.483	3.259	99.9987	3.494
Minneapolis	2.609	4.871	99.9987	5.132
Oakland	1.506	3.364	99.9999	3.620
Salt Lake City	1.529	3.680	99.9999	3.939
San Juan	1.707	4.050	99.9986	6.128
Seattle	1.544	4.843	99.9999	5.093
Washington DC	2.983	5.140	99.9987	5.514

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

Location	Horizontal Error (m)	Horizontal Error/HPL	Horizontal Maximum Ratio	Vertical Error (m)	Vertical Error/VPL	Vertical Maximum Ratio
Anderson	2.197	0.138	0.156	3.576	0.107	0.132
Atlantic City	1.792	0.062	0.114	3.056	0.096	0.156
Grand Forks	4.692	0.166	0.166	4.660	0.161	0.186
Greenwood	1.953	0.108	0.125	4.454	0.116	0.133
Prescott	2.873	0.077	0.125	4.245	0.118	0.118
Albuquerque	3.346	0.154	0.180	5.220	0.130	0.192
Atlanta	3.399	0.205	0.205	5.278	0.146	0.148
Billings	3.153	0.197	0.199	6.617	0.217	0.217
Boston	3.750	0.209	0.218	6.799	0.159	0.176
Chicago	2.686	0.186	0.186	3.941	0.146	0.165
Cleveland	3.423	0.200	0.200	4.516	0.155	0.228
Dallas	5.471	0.164	0.267	6.719	0.273	0.273
Denver	3.372	0.182	0.182	4.419	0.191	0.191
Houston	2.645	0.086	0.149	4.546	0.138	0.151
Jacksonville	3.955	0.168	0.234	4.325	0.110	0.140
Kansas City	3.704	0.183	0.184	6.705	0.183	0.183
Los Angeles	4.077	0.174	0.174	6.266	0.178	0.178
Memphis	3.204	0.202	0.221	5.152	0.177	0.182
Miami	3.677	0.161	0.184	6.553	0.258	0.258
Minneapolis	4.387	0.331	0.333	7.439	0.259	0.278
New York	4.339	0.256	0.258	5.730	0.227	0.227
Oakland	5.235	0.137	0.185	7.123	0.192	0.192
Salt Lake City	3.360	0.178	0.199	6.515	0.244	0.244
Seattle	3.230	0.096	0.129	4.322	0.153	0.153
Washington DC	4.048	0.108	0.235	5.338	0.151	0.168

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

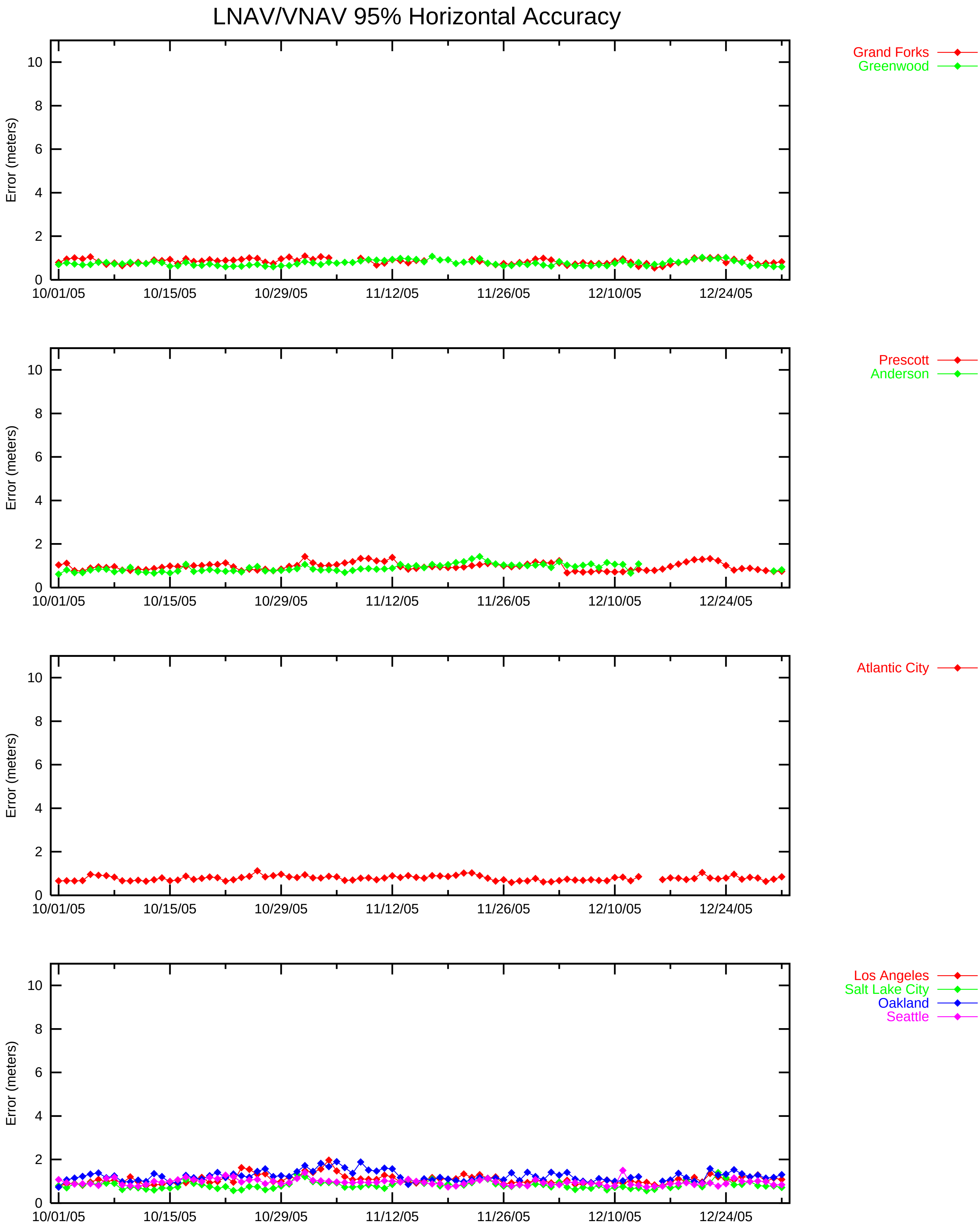


Figure 2-2 95% Horizontal Accuracy at LNAV/VNAV

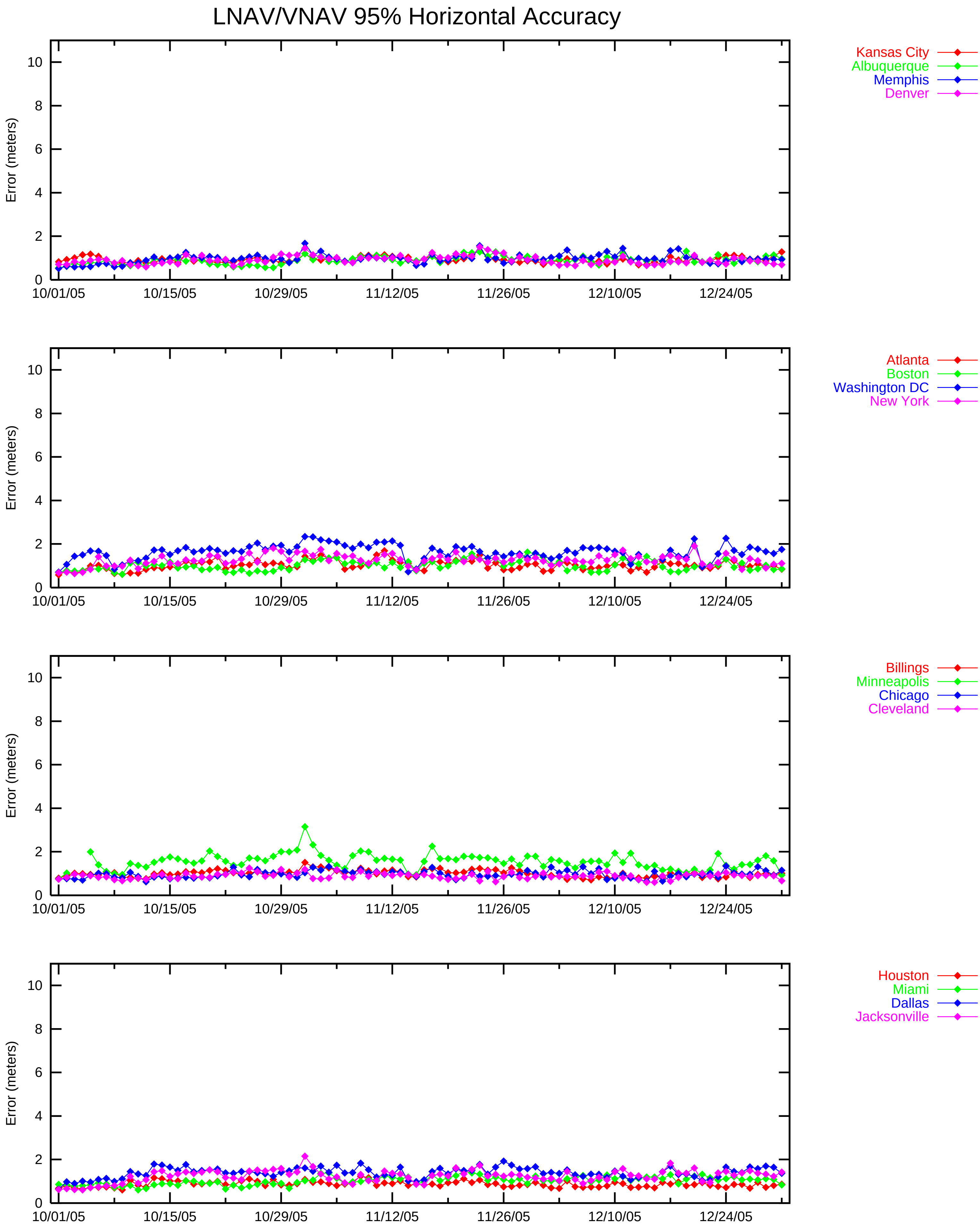


Figure 2-3 95% Vertical Accuracy at LNAV/VNAV

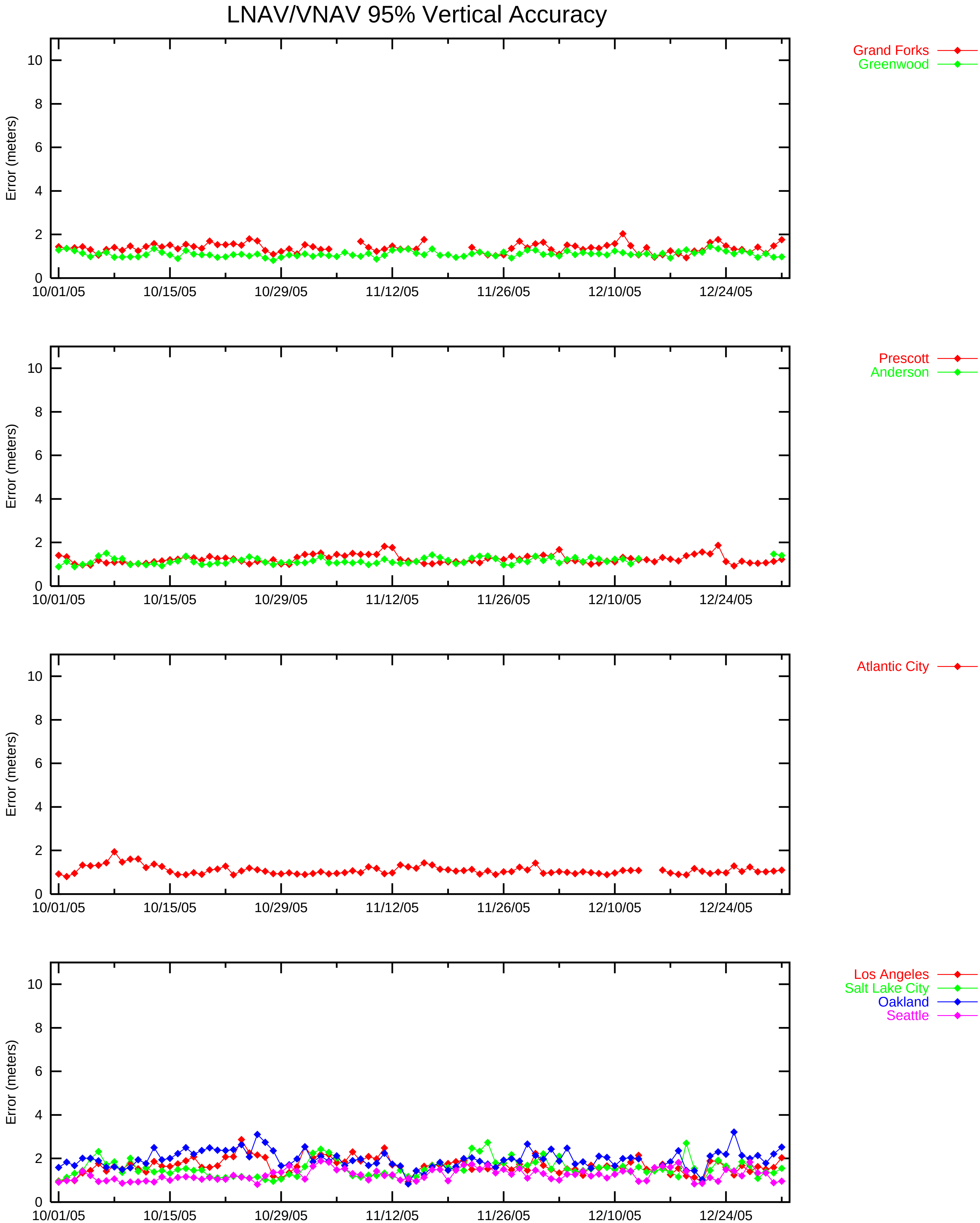


Figure 2-4 95% Vertical Accuracy at LNAV/VNAV

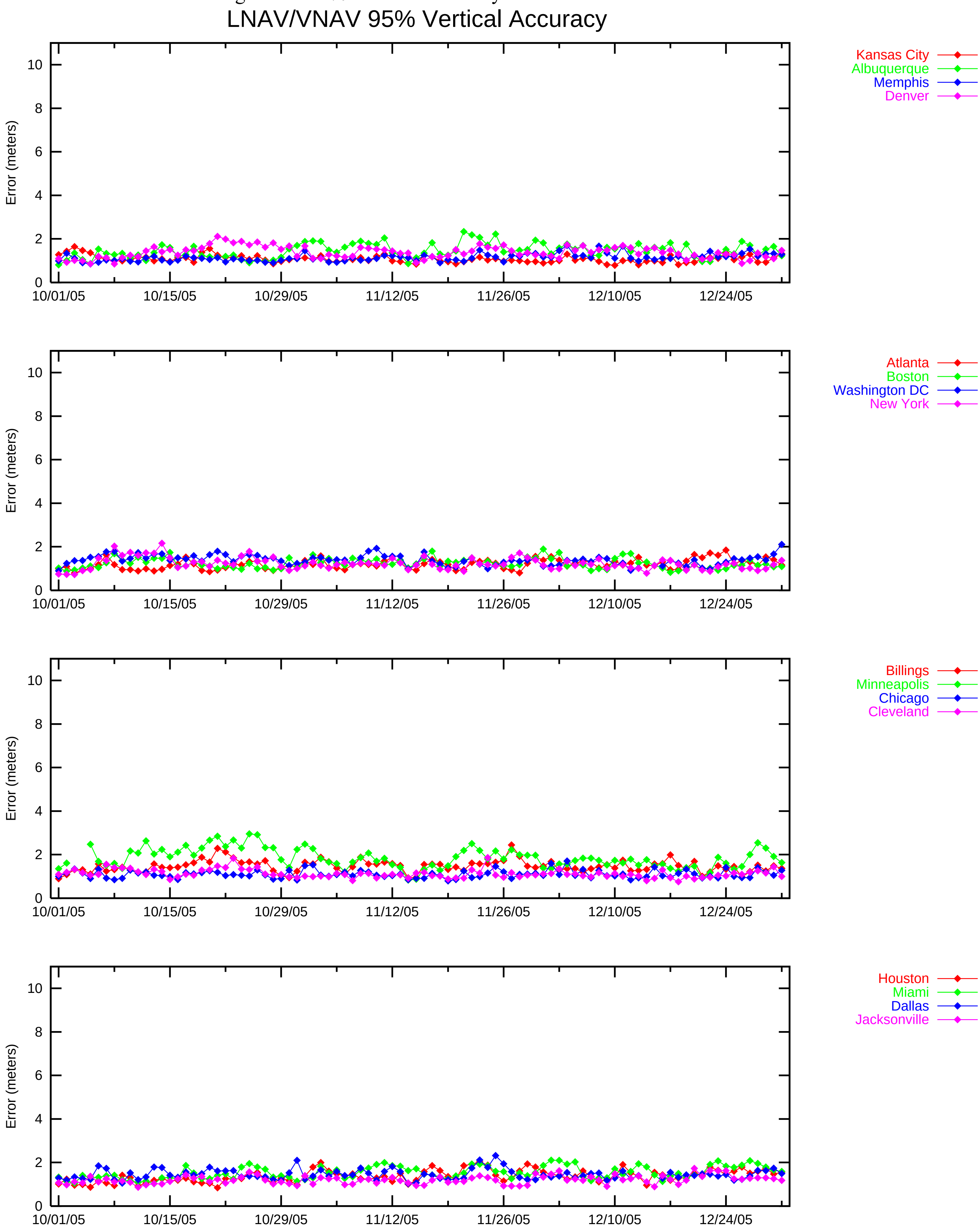
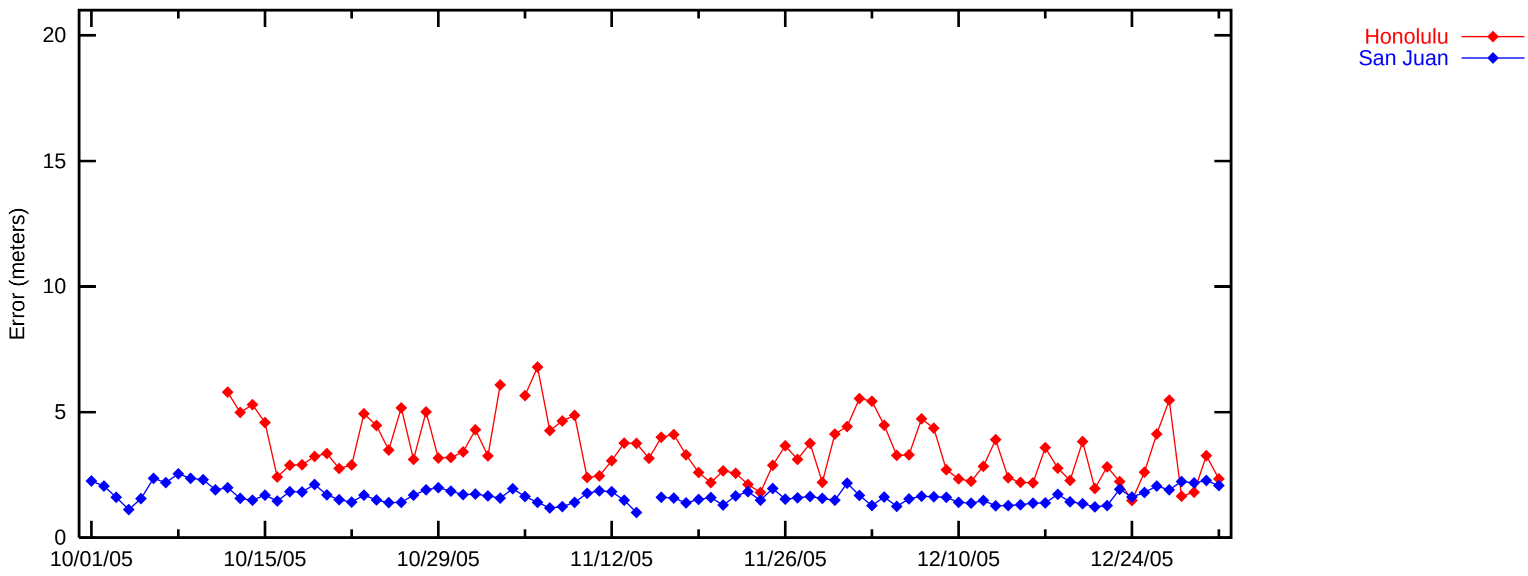
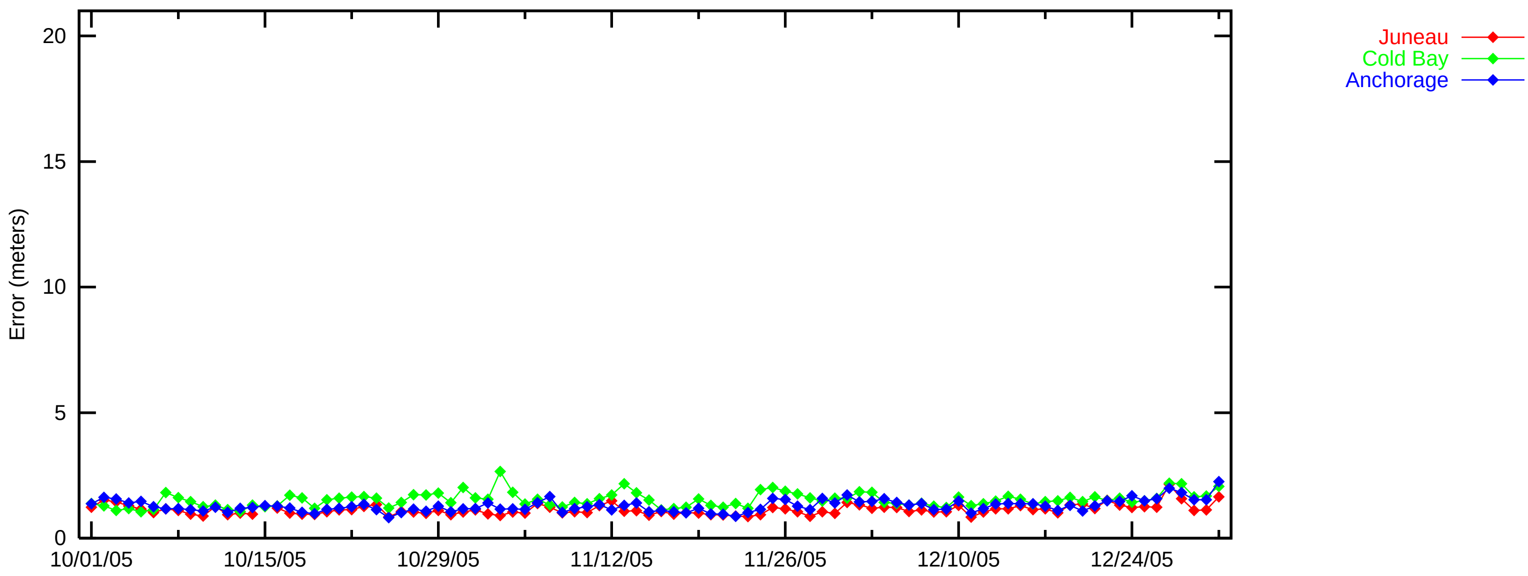


Figure 2-5 NPA 95% Horizontal Accuracy





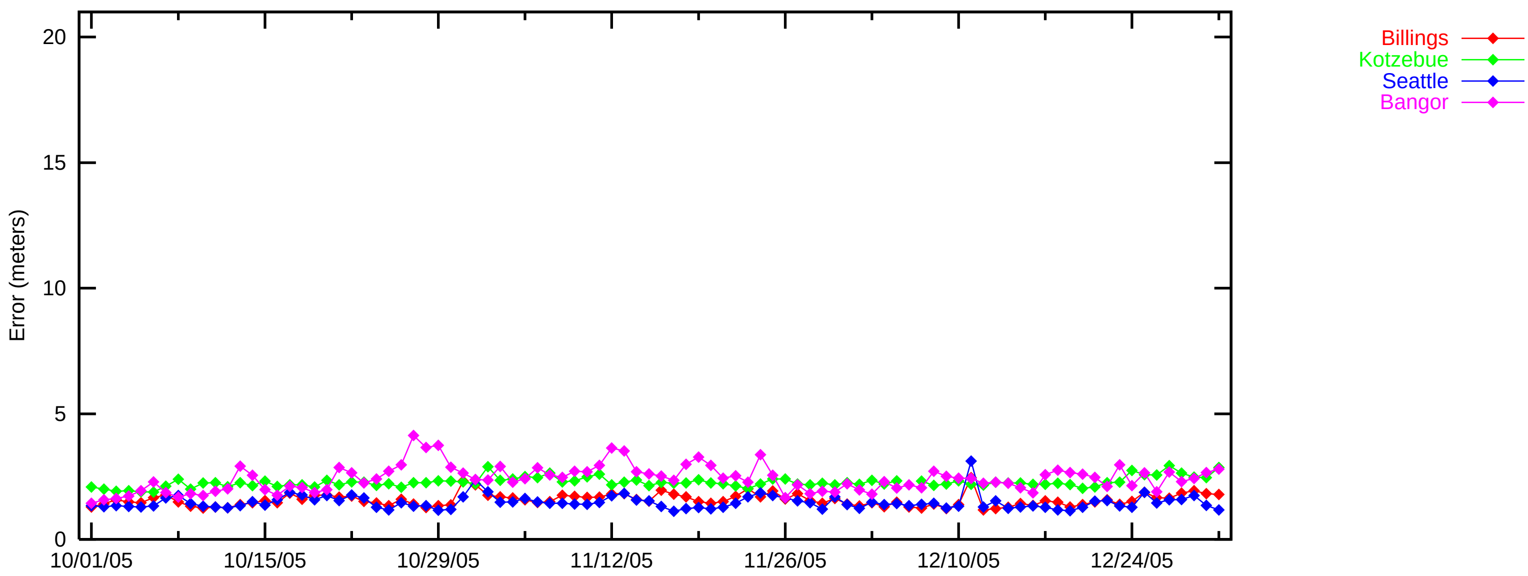


Figure 2-6 NPA 95% Horizontal Accuracy

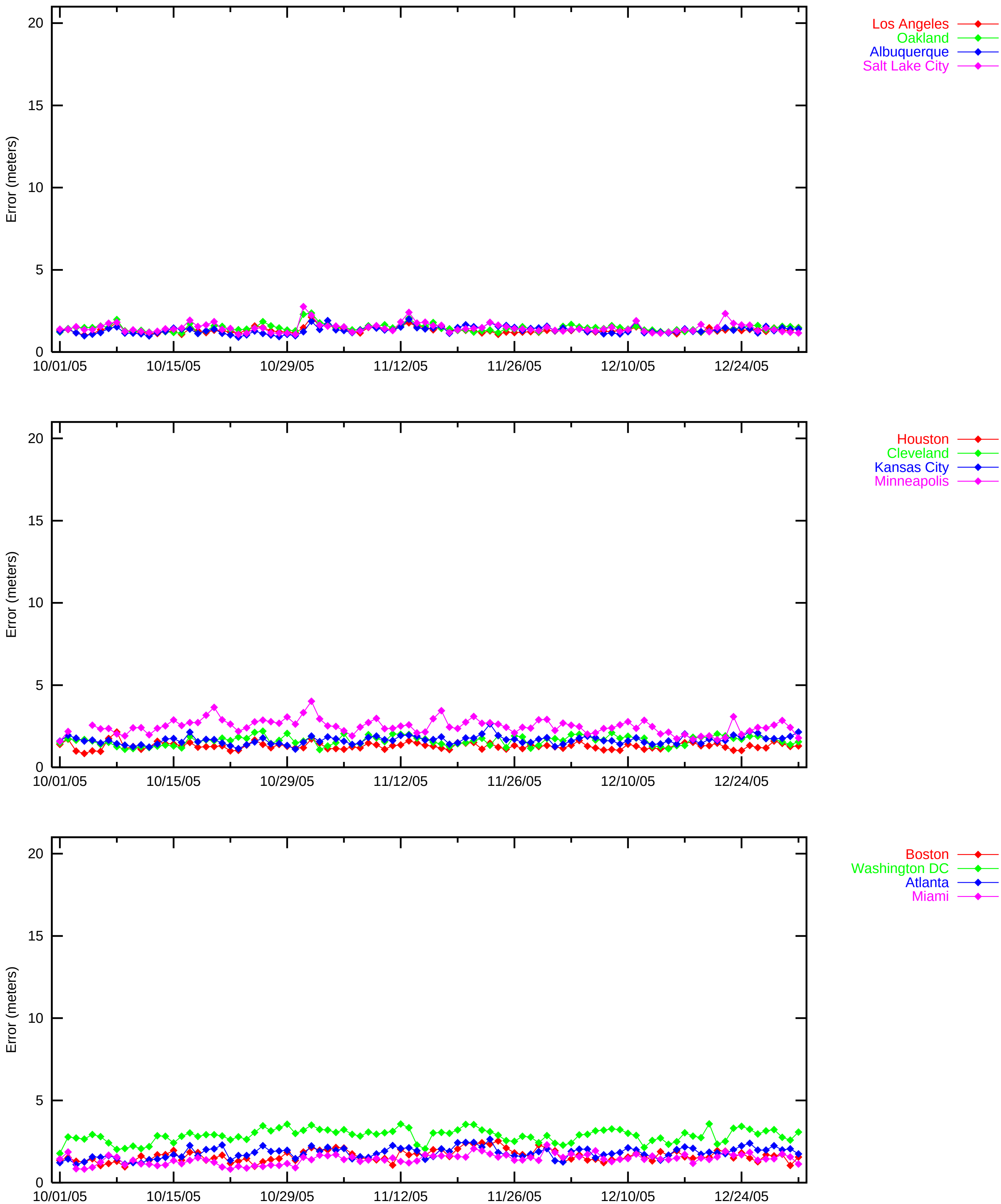


Figure 2-7 Horizontal Triangle Chart forKansas City

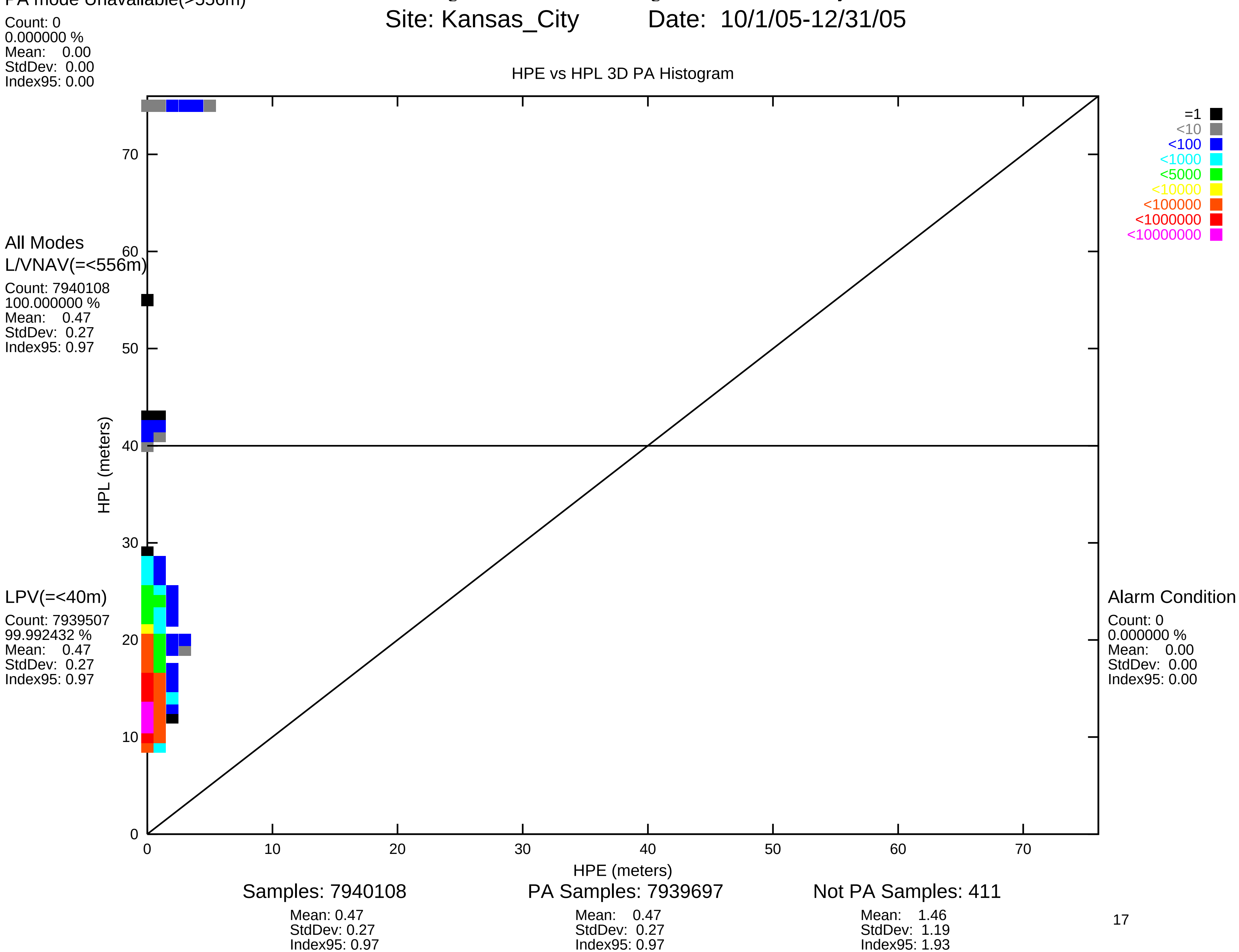


Figure 2-8 Vertical Triangle Chart for Kansas City

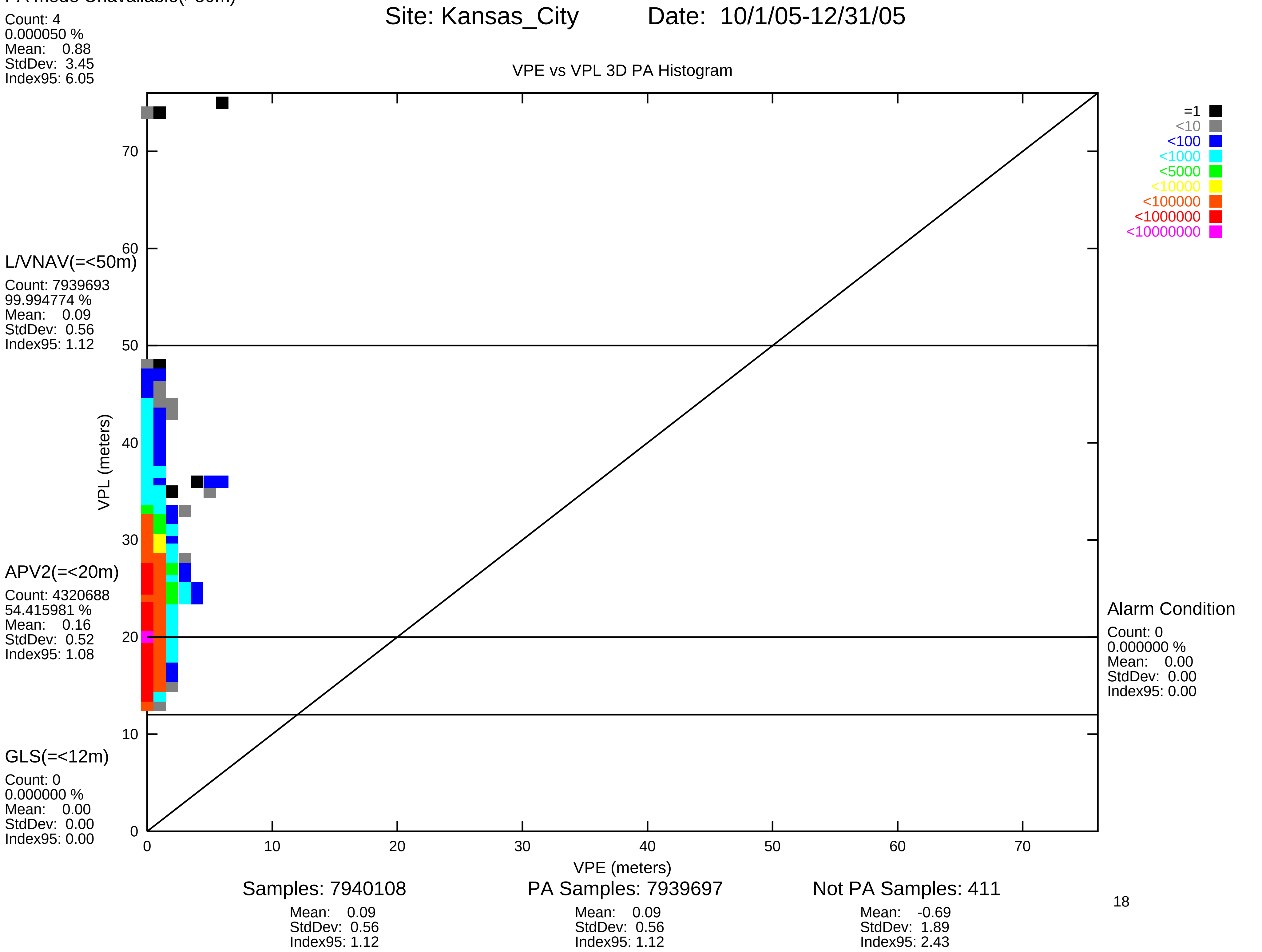


Figure 2-9 2-D Histogram for Kansas City

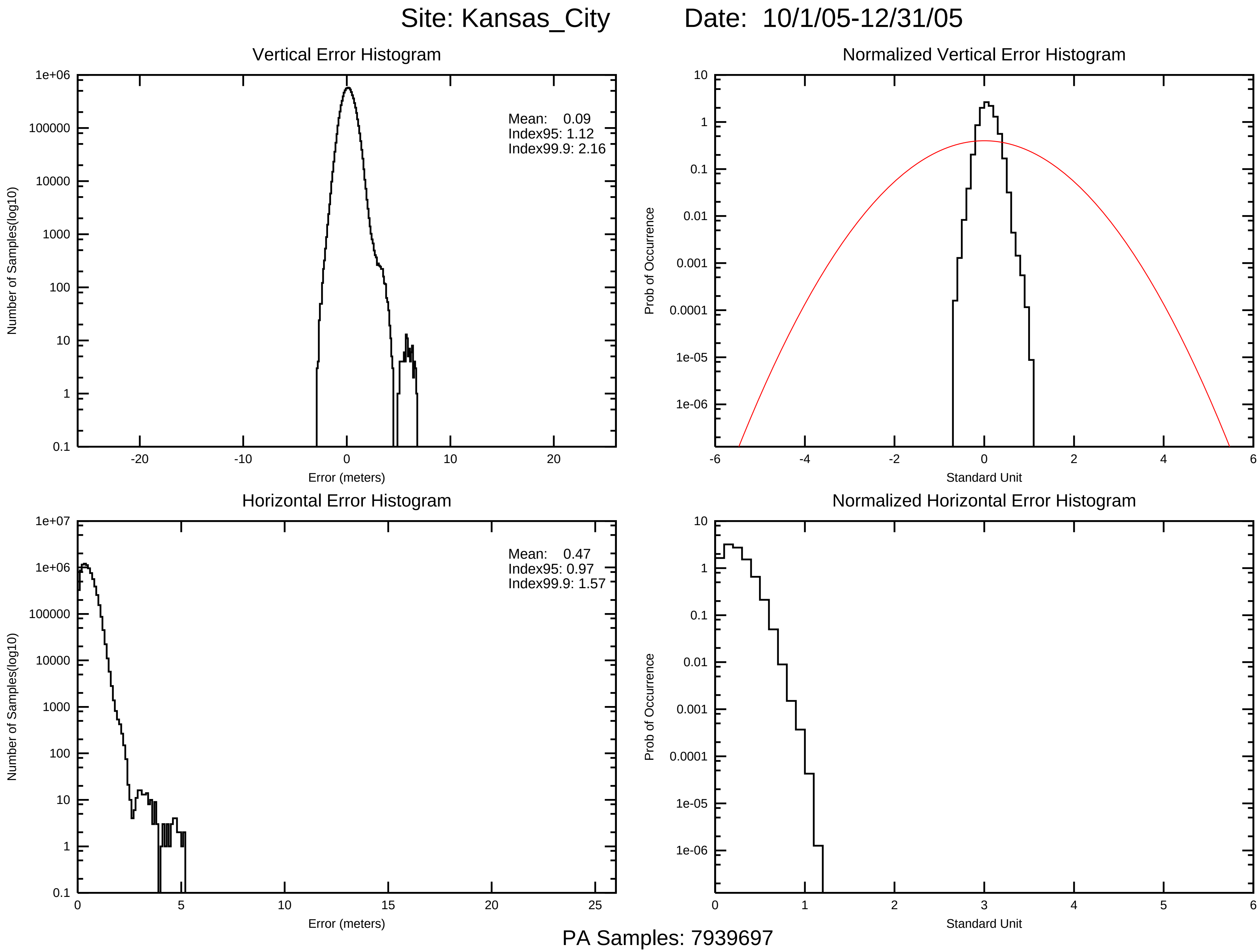


Figure 2-10 Horizontal Triangle Chart for Washington, DC

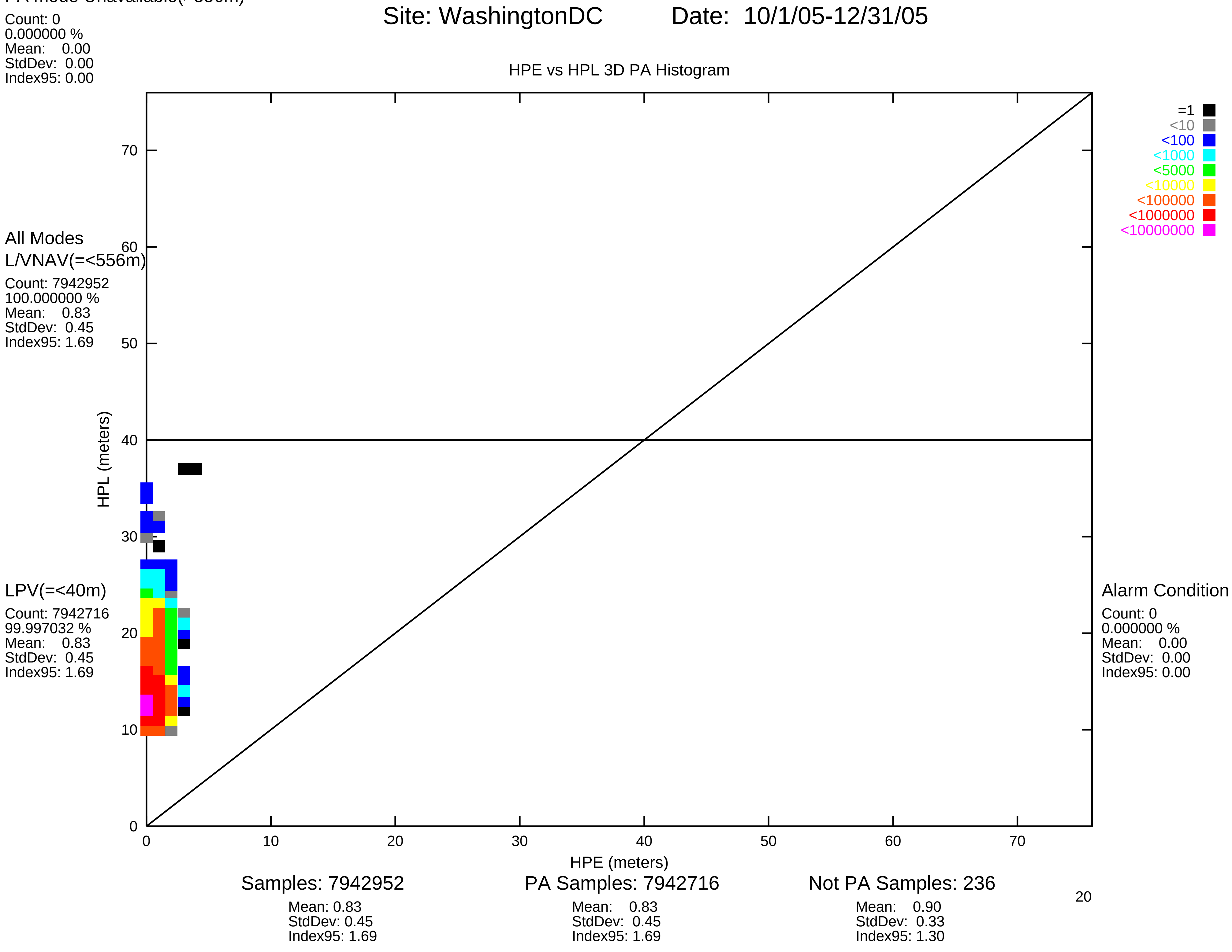


Figure 2-11 Vertical Triangle Chart for Washington, DC

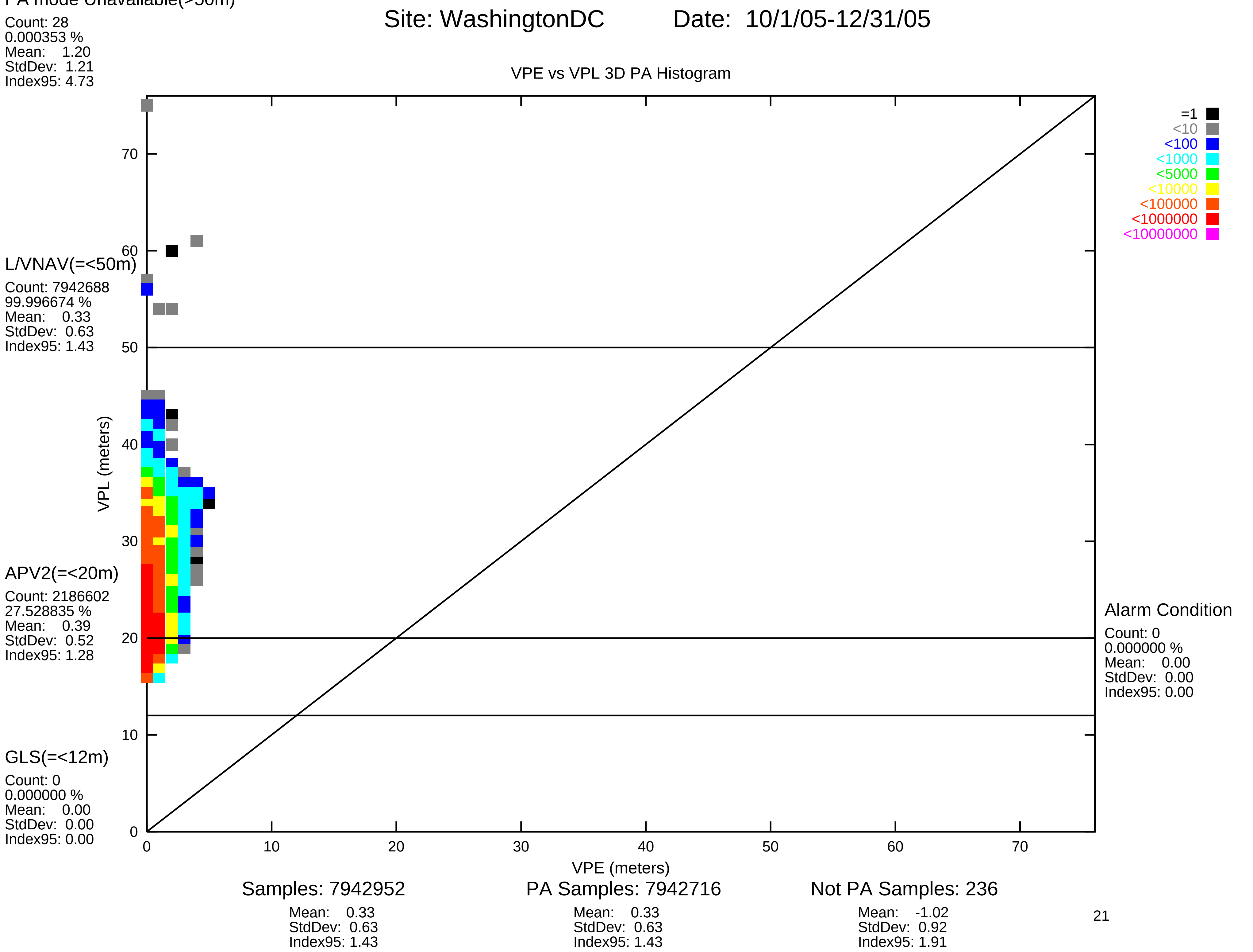
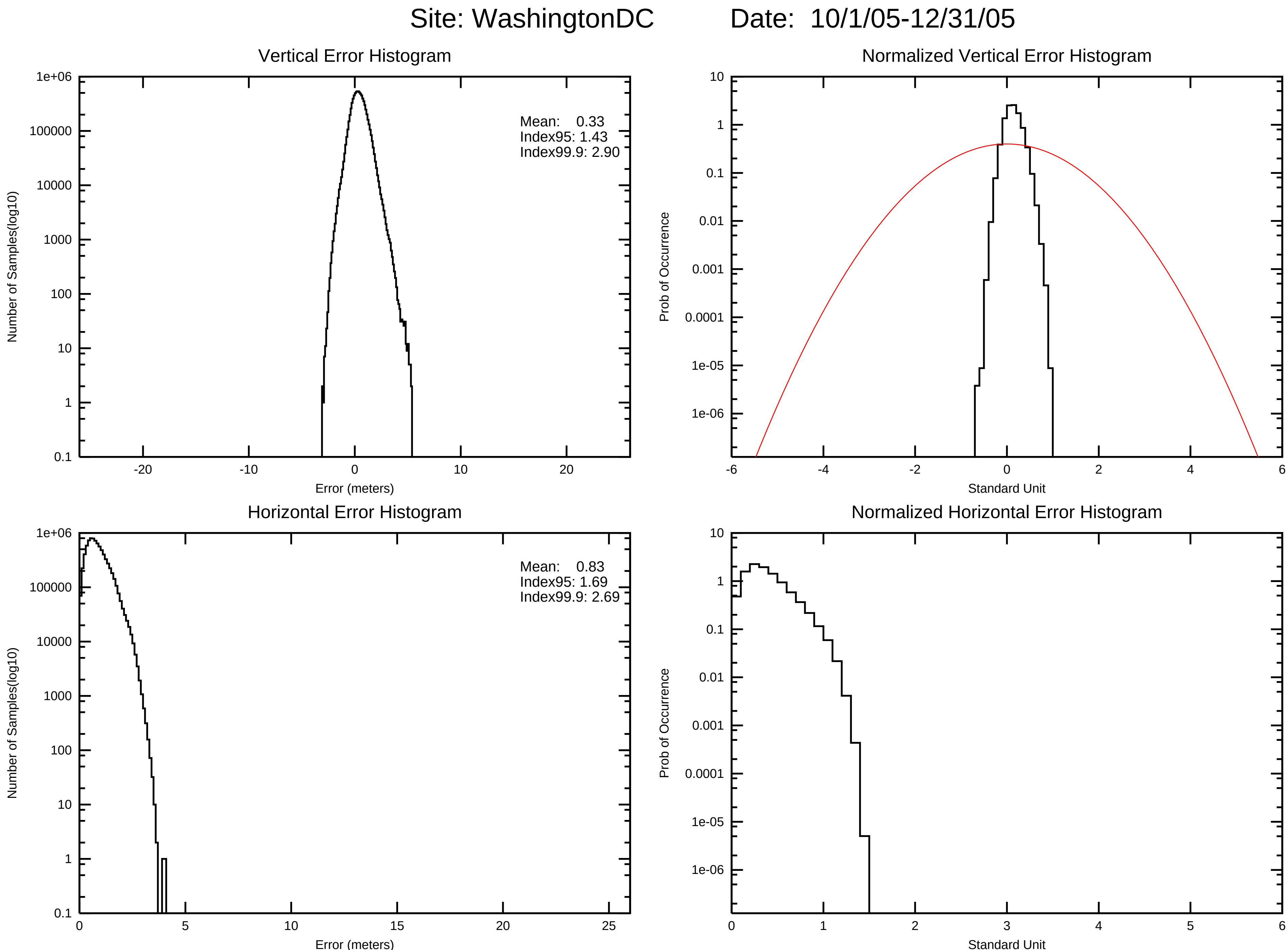


Figure 2-12 2-D Histogram for Washington, DC



PA Samples: 7942716

Figure 2-13 Horizontal Triangle Chart for Seattle

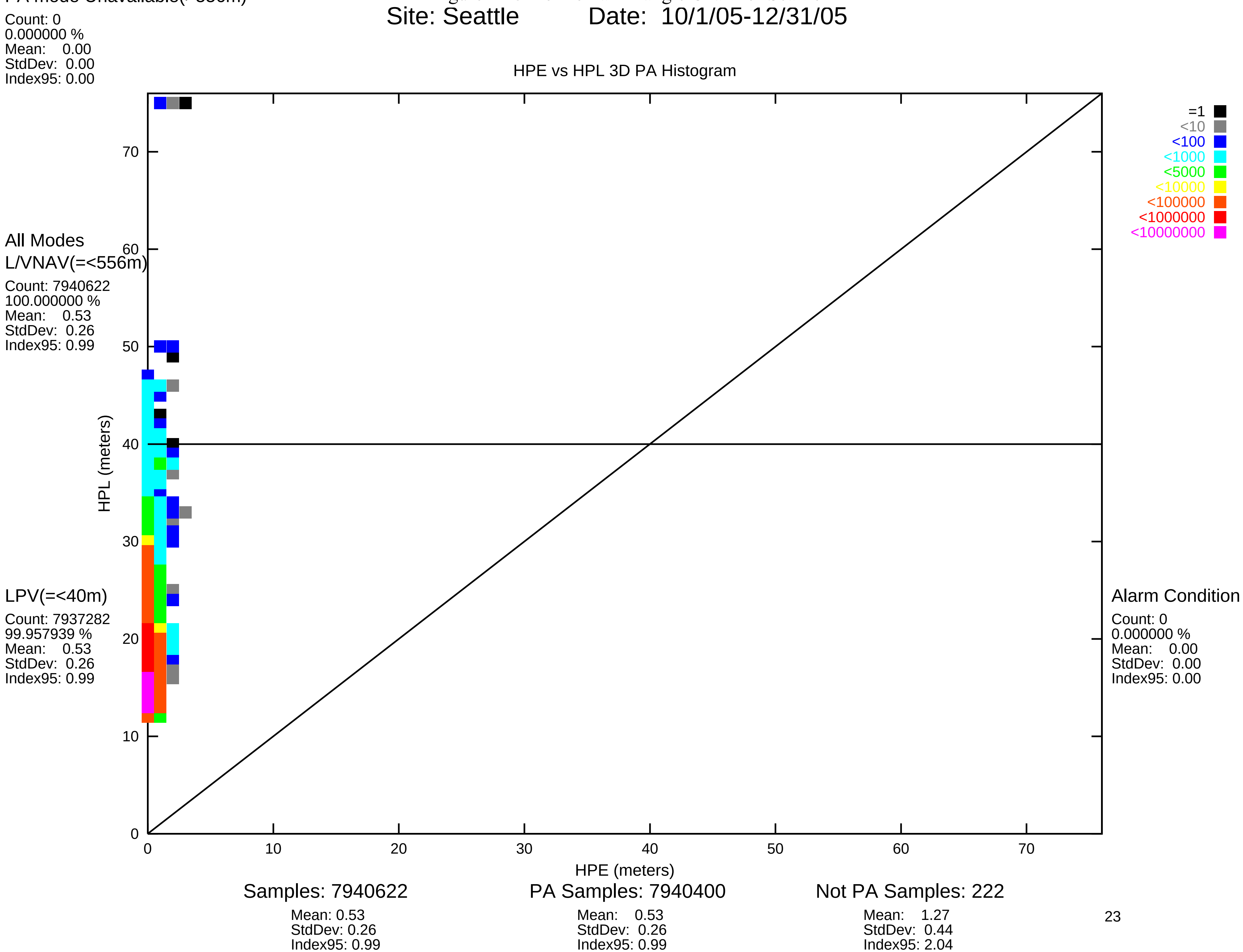


Figure 2-14 Vertical Triangle Chart for Seattle

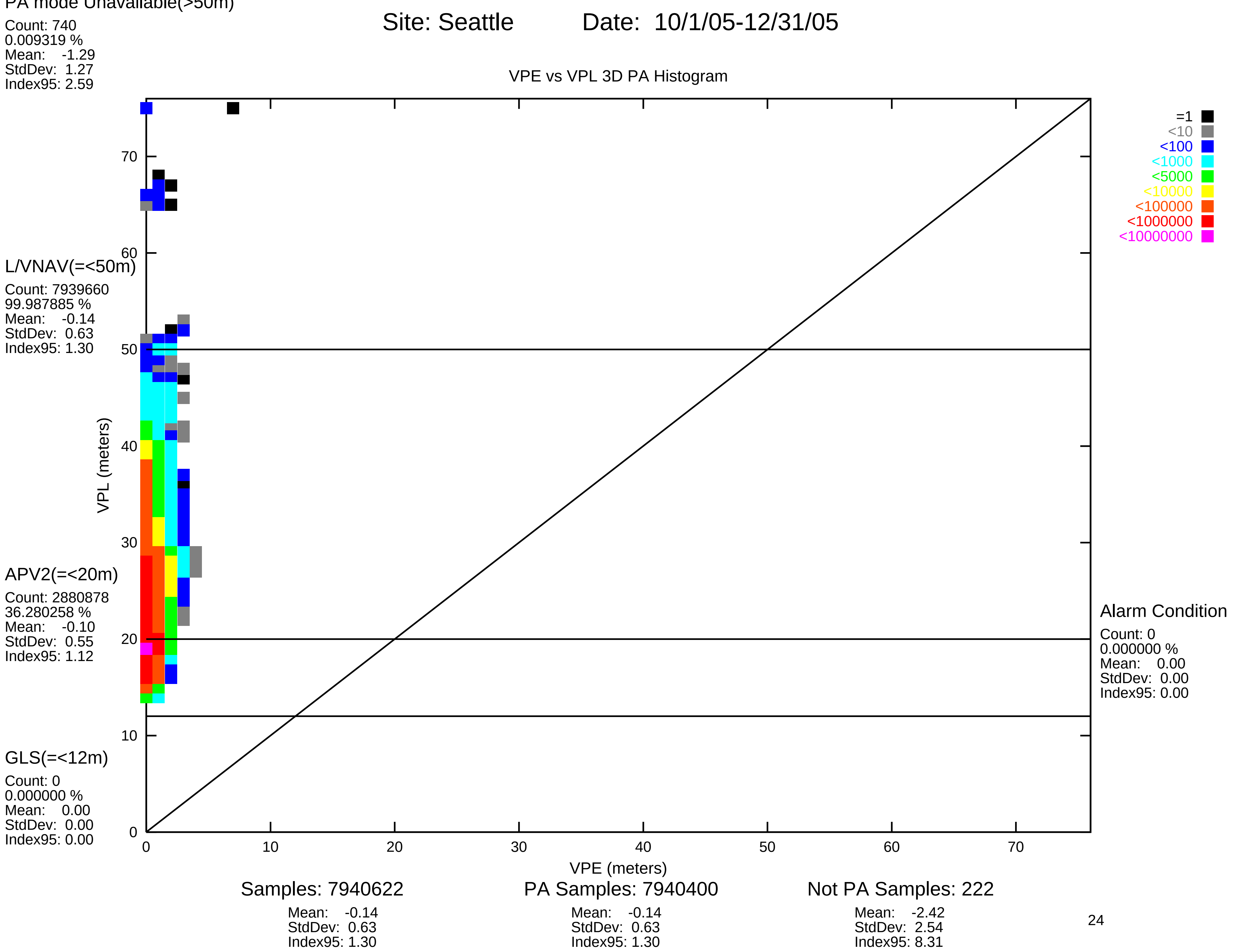
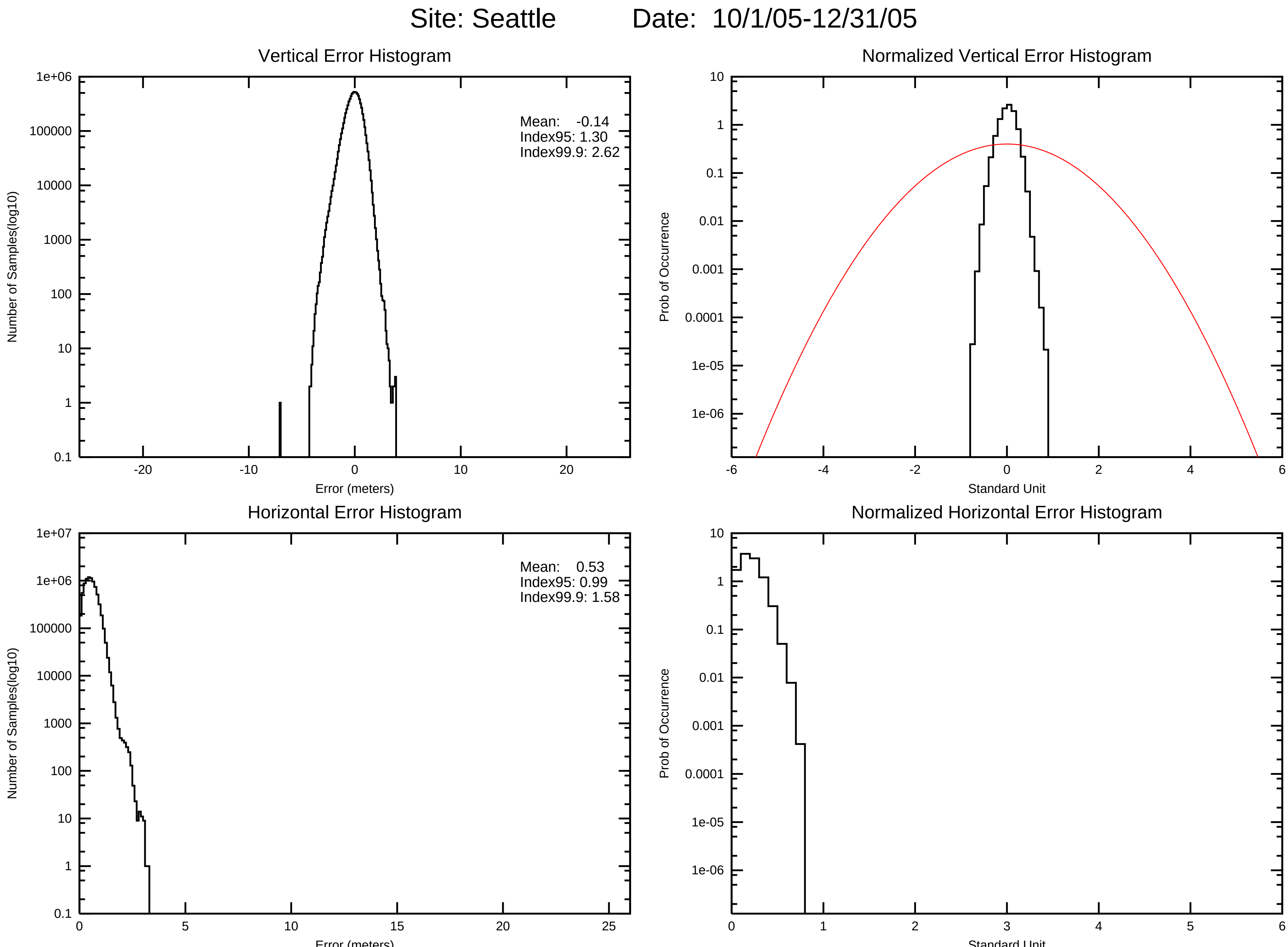


Figure 2-15 2-D Histogram for Seattle



PA Samples: 7940400

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 28.122 meters at Grand Forks and 43.192 meters at Prescott. The minimum 95% HPL and VPL are 16.042 meters at Atlanta and 26.302 meters at Denver.

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
Anderson	17.121	28.185	99.996597
Atlantic City	19.650	33.861	99.994316
Grand Forks	28.122	36.076	99.996307
Greenwood	17.894	29.483	99.997917
Prescott	27.989	43.192	99.998627
Albuquerque	19.749	30.638	99.995430
Atlanta	16.042	27.806	99.997017
Billings	20.246	28.323	99.995293
Boston	23.022	38.647	99.997086
Chicago	16.700	28.080	99.994827
Cleveland	16.751	27.889	99.996986
Dallas	18.241	29.777	99.995140
Denver	17.750	26.302	99.995026
Houston	21.052	33.115	99.995110
Jacksonville	16.794	29.530	99.997025
Kansas City	16.190	26.782	99.994827
Los Angeles	27.079	41.704	99.997200
Memphis	16.166	28.725	99.994781
Miami	20.958	35.988	99.997002
Minneapolis	20.245	28.217	99.994713
New York	19.573	34.566	99.997086
Oakland	26.727	37.236	99.997215
Salt Lake City	18.532	28.608	99.997025
Seattle	20.932	29.229	99.997208
Washington DC	16.126	27.733	99.997032

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*
Anderson	0.99980205	0.99980205	0.99980061	0.99980061
Atlantic City	0.99973923	0.99980569	0.99964158	0.99972903
Grand Forks	0.99696726	0.99698061	0.99542152	0.99568613
Greenwood	0.99993509	0.99993509	0.99993867	0.99993867
Prescott	0.96515942	0.96651012	0.96301082	0.96489849
Albuquerque	0.99976444	0.99976444	0.99975991	0.99975991
Atlanta	0.99994552	0.99996662	0.99996924	0.99996924
Billings	0.99972057	0.99972260	0.99968969	0.99969171
Boston	0.99961364	0.99961388	0.99954684	0.99954709
Chicago	0.99994713	0.99994713	0.99996983	0.99996983
Cleveland	0.99996638	0.99996638	0.99996914	0.99996914
Dallas	0.99995089	0.99995089	0.99997088	0.99997088
Denver	0.99994940	0.99994940	0.99997025	0.99997025
Houston	0.99985051	0.99985051	0.99975824	0.99975824
Jacksonville	0.99994439	0.99994439	0.99994700	0.99994700
Kansas City	0.99992394	0.99994773	0.99994768	0.99997151
Los Angeles	0.98432124	0.98647606	0.98231728	0.98457753
Memphis	0.99994737	0.99994737	0.99997124	0.99997124
Miami	0.99931026	0.99931294	0.99891605	0.99892226
Minneapolis	0.99994481	0.99994546	0.99996872	0.99996936
New York	0.99989957	0.99989957	0.99988252	0.99988252
Oakland	0.98847365	0.99177909	0.98608077	0.98962713
Salt Lake City	0.99995619	0.99995619	0.99996206	0.99996206
Seattle	0.99949890	0.99987882	0.99936035	0.99987583
Washington DC	0.99996674	0.99996674	0.99996870	0.99996870

Table 3-3 NPA Availability

Location	NPA Availability (Excluding RAIM/FDE)
Albuquerque	0.99997264
Atlanta	0.99997258
Bangor	0.99997028
Billings	0.99997267
Boston	0.99997265
Cleveland	0.99997259
Cold Bay	0.99980435
Honolulu	0.99994466
Houston	0.99997259
Juneau	0.99980945
Kansas City	0.99997266
Kotzebue	0.99980019
Los Angeles	0.99998715
Miami	0.99997245
Minneapolis	0.99997220
Oakland	0.99998715
Puerto Rico	0.99997240
Salt Lake City	0.99998791
Seattle	0.99998715
Washington DC	0.99997267

Table 3-4 LPV and LNAV/VNAV Outage Rate

Location	LPV Outages	LPV Outage Rates	LNAV/VNAV Outages	LNAV/VNAV Outage Rates
Anderson	6	0.000137	6	0.000137
Atlantic City	26	0.000502	22	0.000425
Grand Forks	72	0.001491	71	0.001469
Greenwood	6	0.000114	6	0.000114
Prescott	255	0.005054	245	0.004846
Albuquerque	10	0.000190	10	0.000190
Atlanta	3	0.000057	3	0.000057
Billings	4	0.000076	4	0.000076
Boston	22	0.000417	21	0.000398
Chicago	3	0.000057	3	0.000057
Cleveland	4	0.000076	4	0.000076
Dallas	3	0.000058	3	0.000058
Denver	3	0.000057	3	0.000057
Houston	9	0.000171	9	0.000171
Jacksonville	4	0.000076	4	0.000076
Kansas City	6	0.000113	3	0.000057
Los Angeles	141	0.002719	133	0.002558
Memphis	4	0.000076	4	0.000076
Miami	34	0.000647	33	0.000628
Minneapolis	5	0.000096	3	0.000058
New York	8	0.000152	8	0.000152
Oakland	90	0.001765	81	0.001583
Salt Lake City	2	0.000038	2	0.000038
Seattle	23	0.000435	7	0.000132
Washington DC	3	0.000058	3	0.000058

Table 3-5 NPA Outage Rates

Location	NPA Outages	NPA Outage Rate
Albuquerque	2	0.00003783
Atlanta	2	0.00003791
Bangor	2	0.00003811
Billings	2	0.00003779
Boston	2	0.00003781
Cleveland	2	0.00003790
Cold Bay	8	0.00015238
Honolulu	5	0.00010808
Houston	2	0.00003790
Juneau	8	0.00015227
Kansas City	2	0.00003780
Kotzebue	9	0.00017657
Los Angeles	2	0.00003780
Miami	3	0.00005688
Minneapolis	2	0.00003843
Oakland	2	0.00003780
Puerto Rico	2	0.00003815
Salt Lake City	1	0.00001890
Seattle	2	0.00003780
Washington DC	2	0.00003779

Figure 3-1 LPV Instantaneous Availability

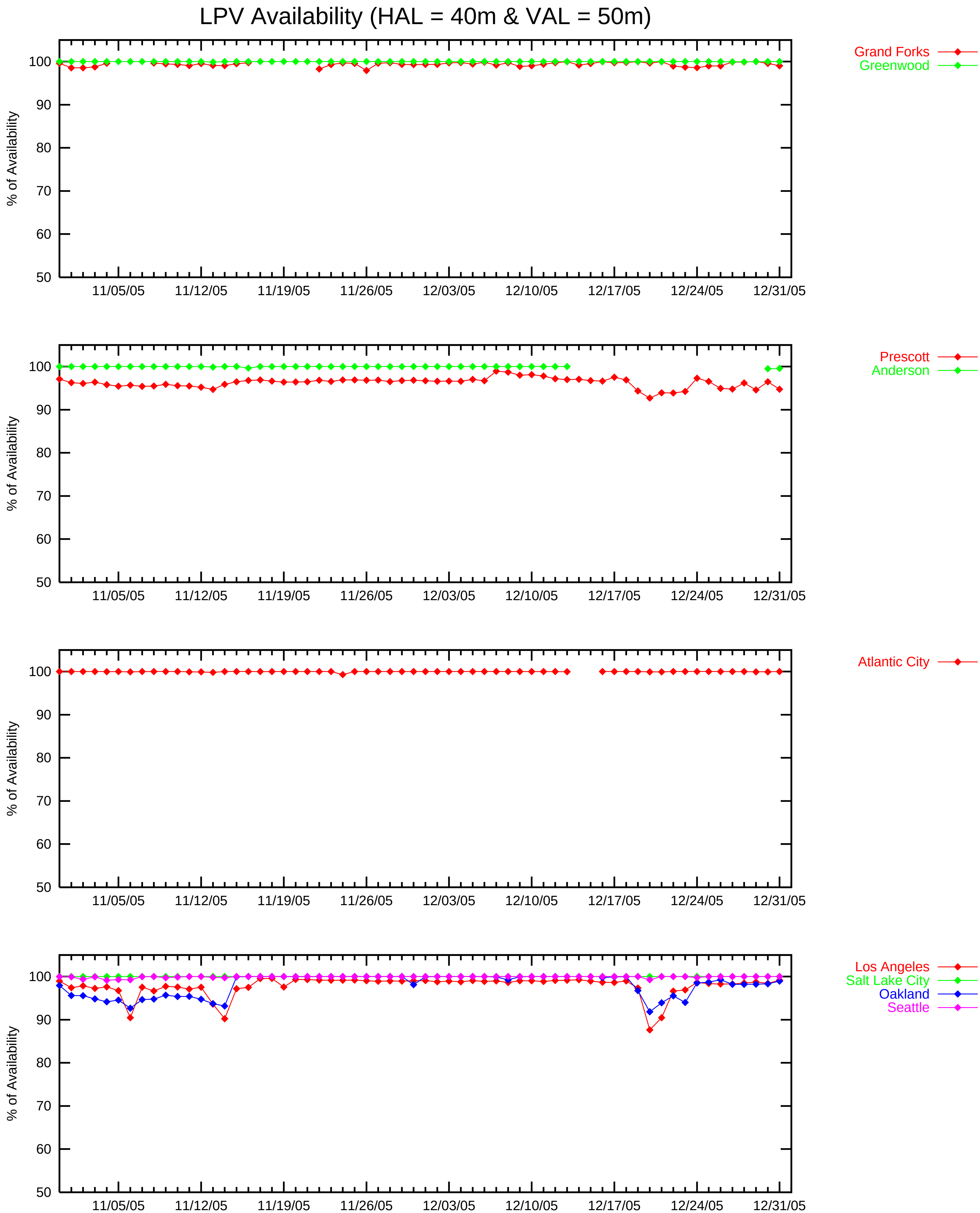


Figure 3-2 LPV Instantaneous Availability

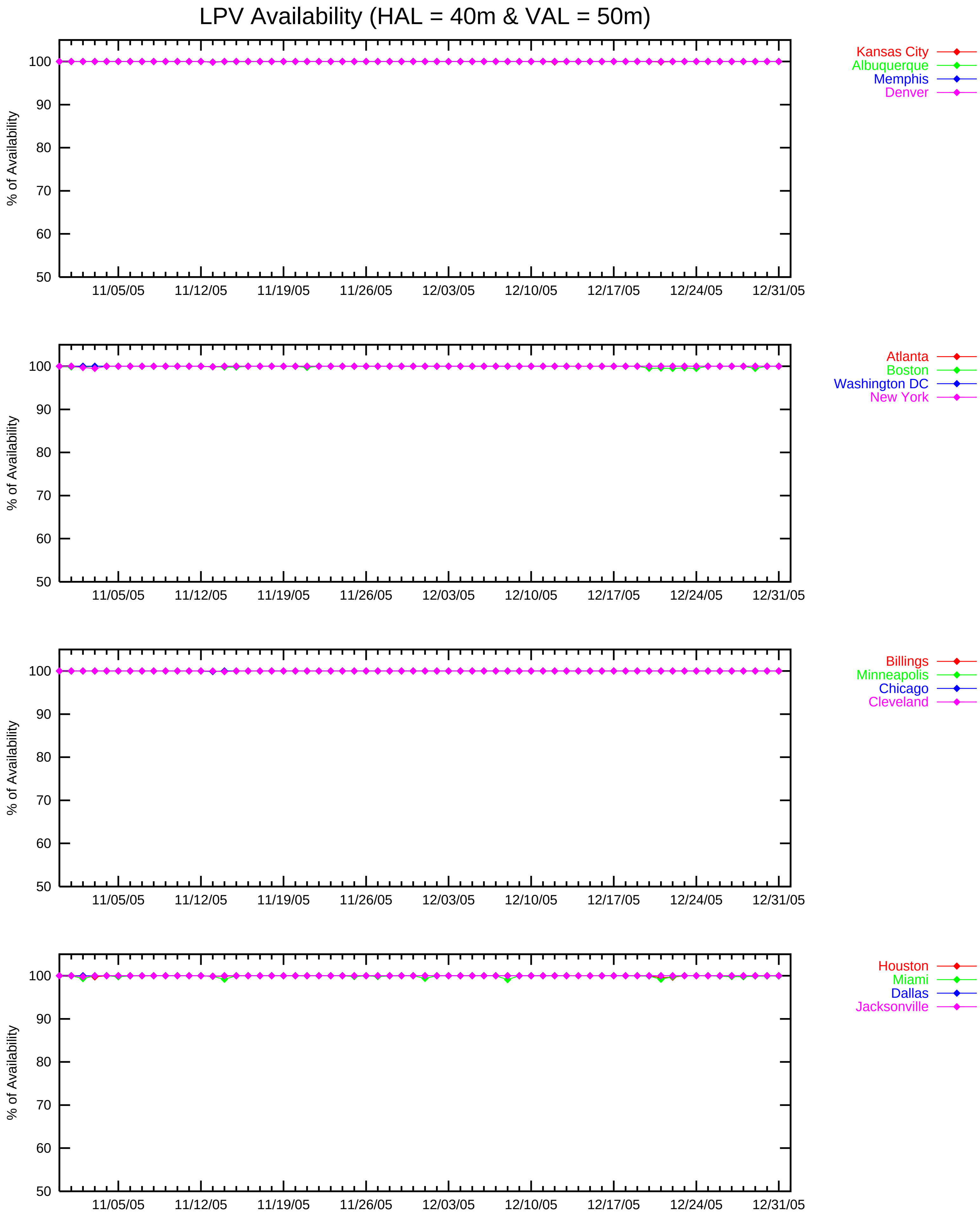
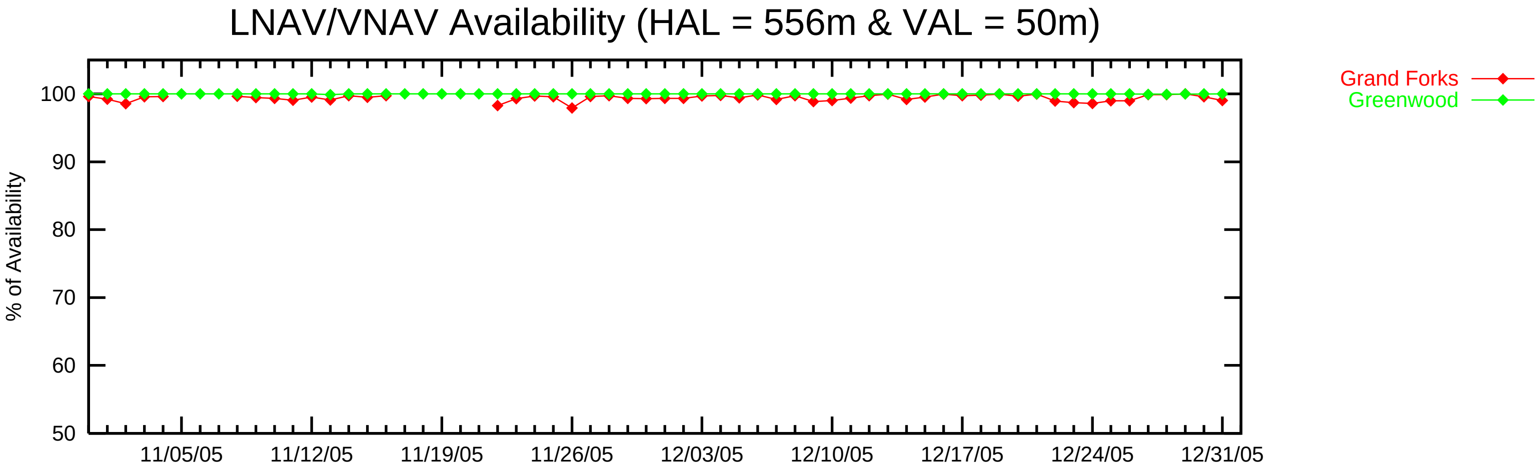


Figure 3-3 LNAV/VNAV Instantaneous Availability



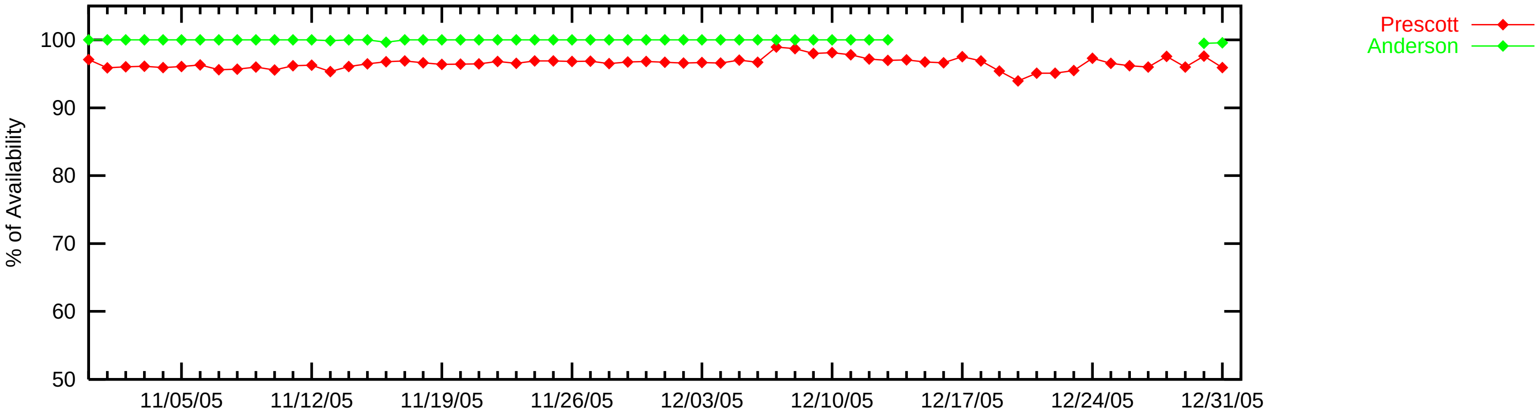
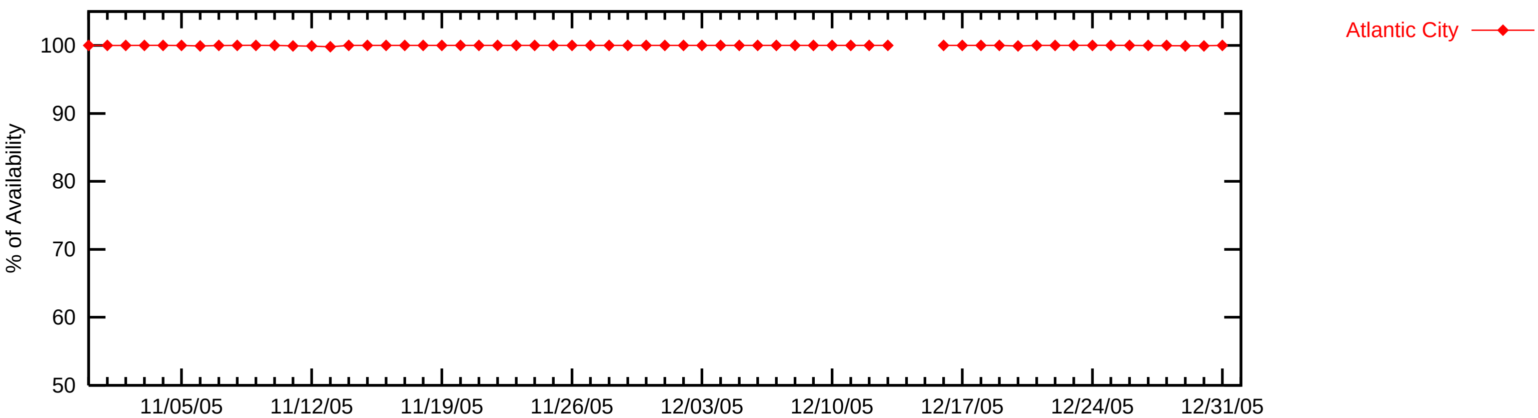


Figure 3-4 LNAV/VNAV Instantaneous Availability



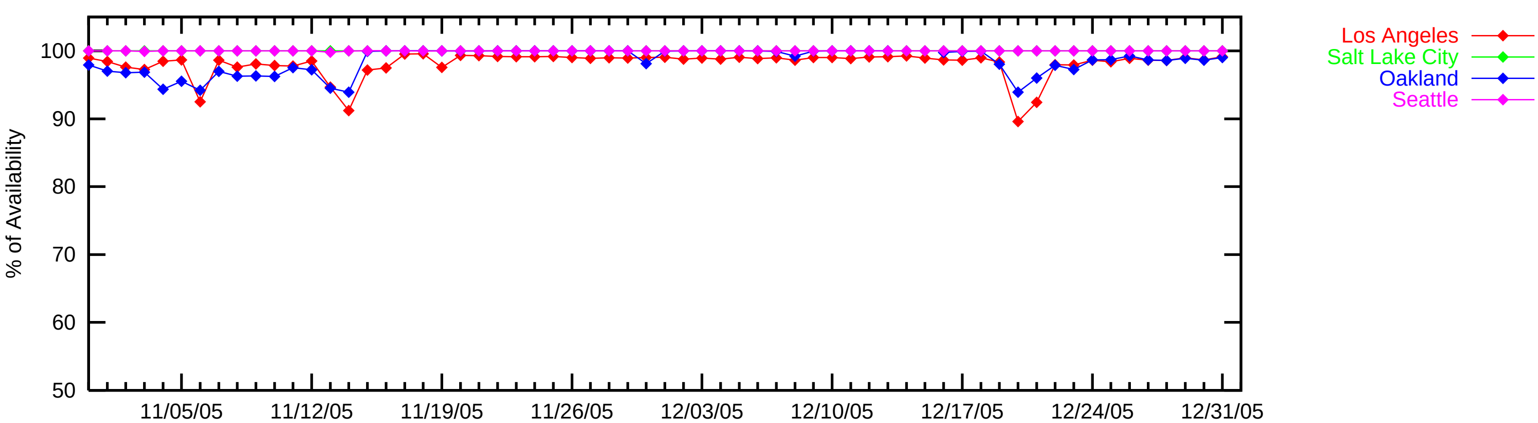


Figure 3-4 LNAV/VNAV Instantaneous Availability

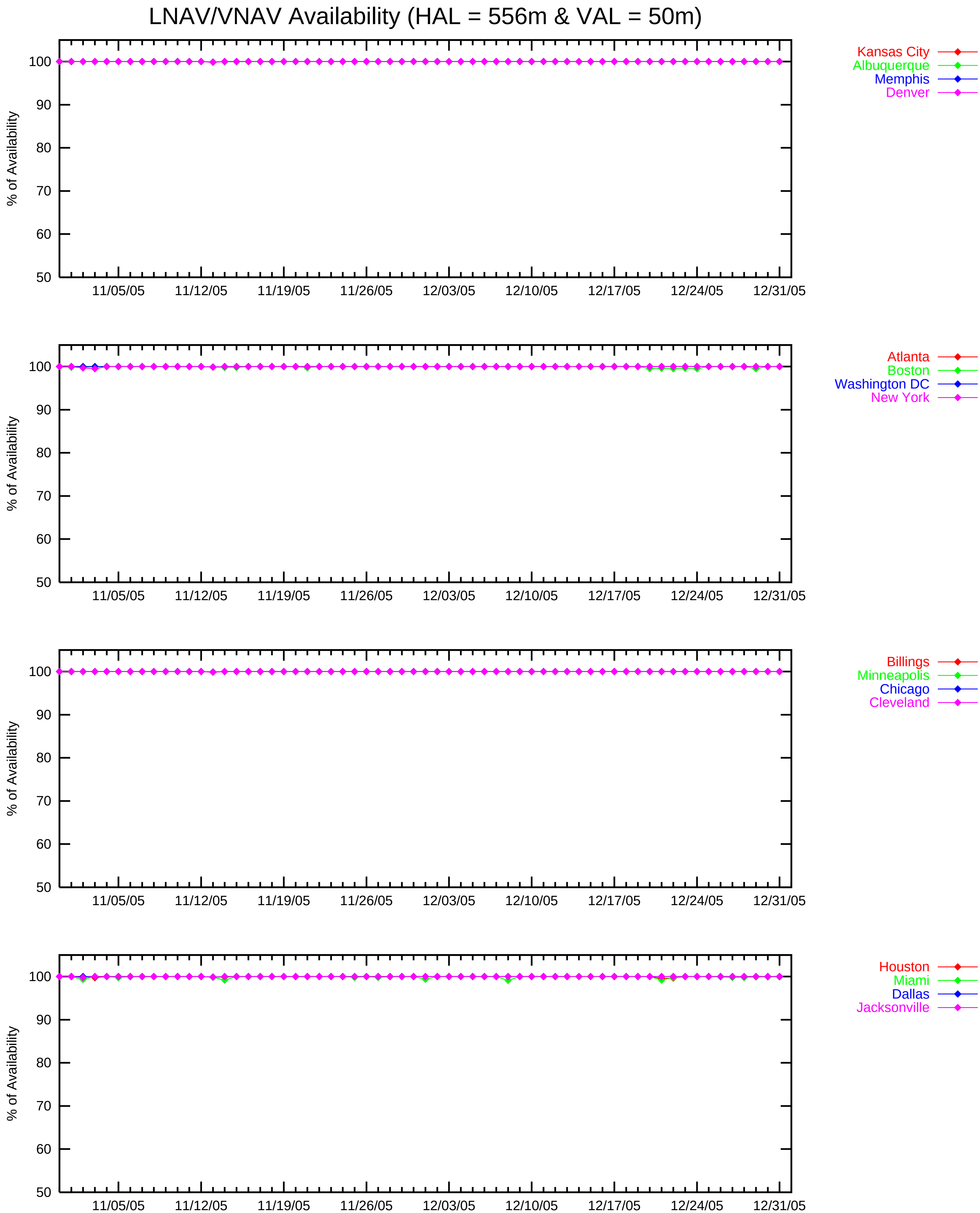


Figure 3-5 LPV Outages

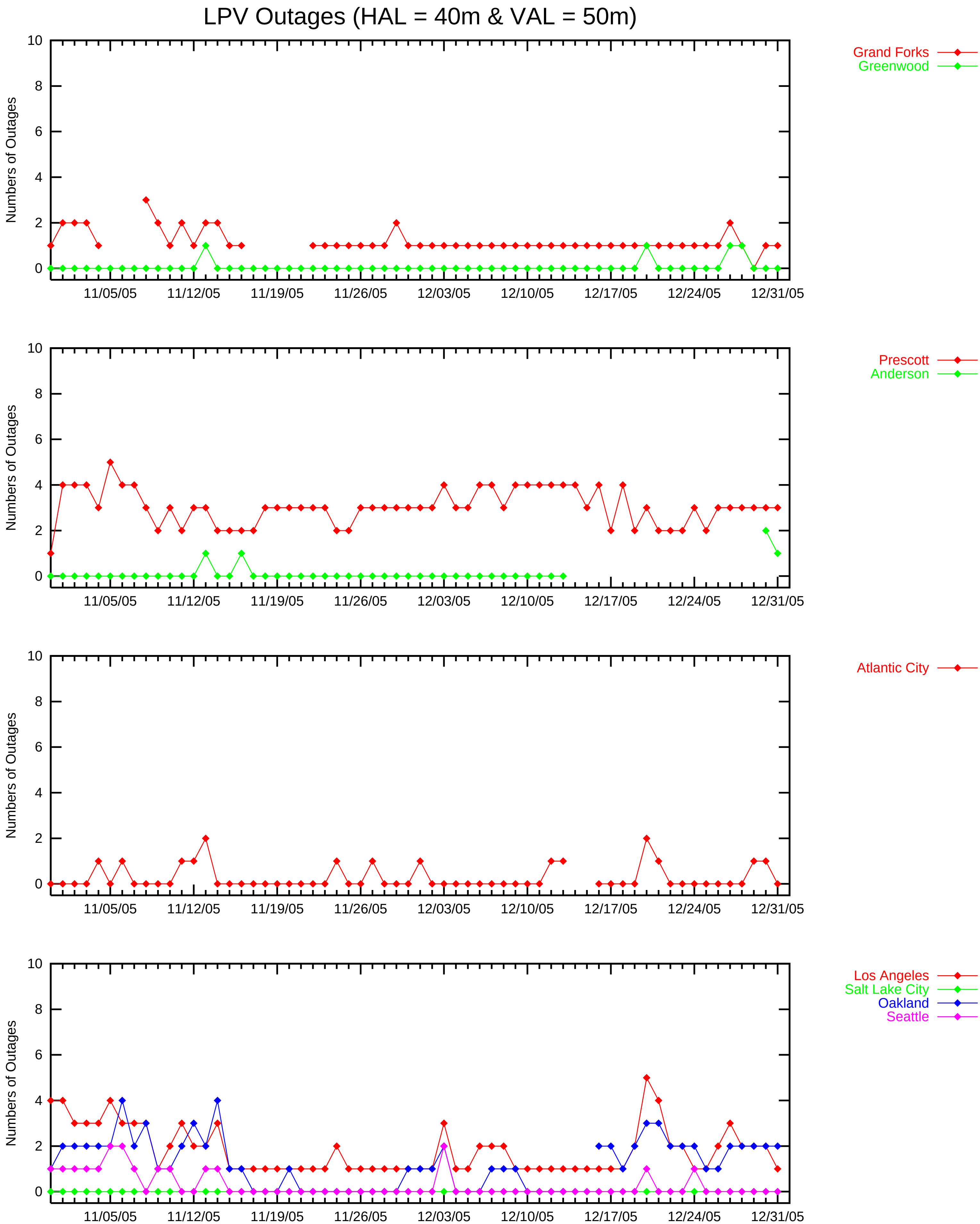


Figure 3-6 LPV Outages

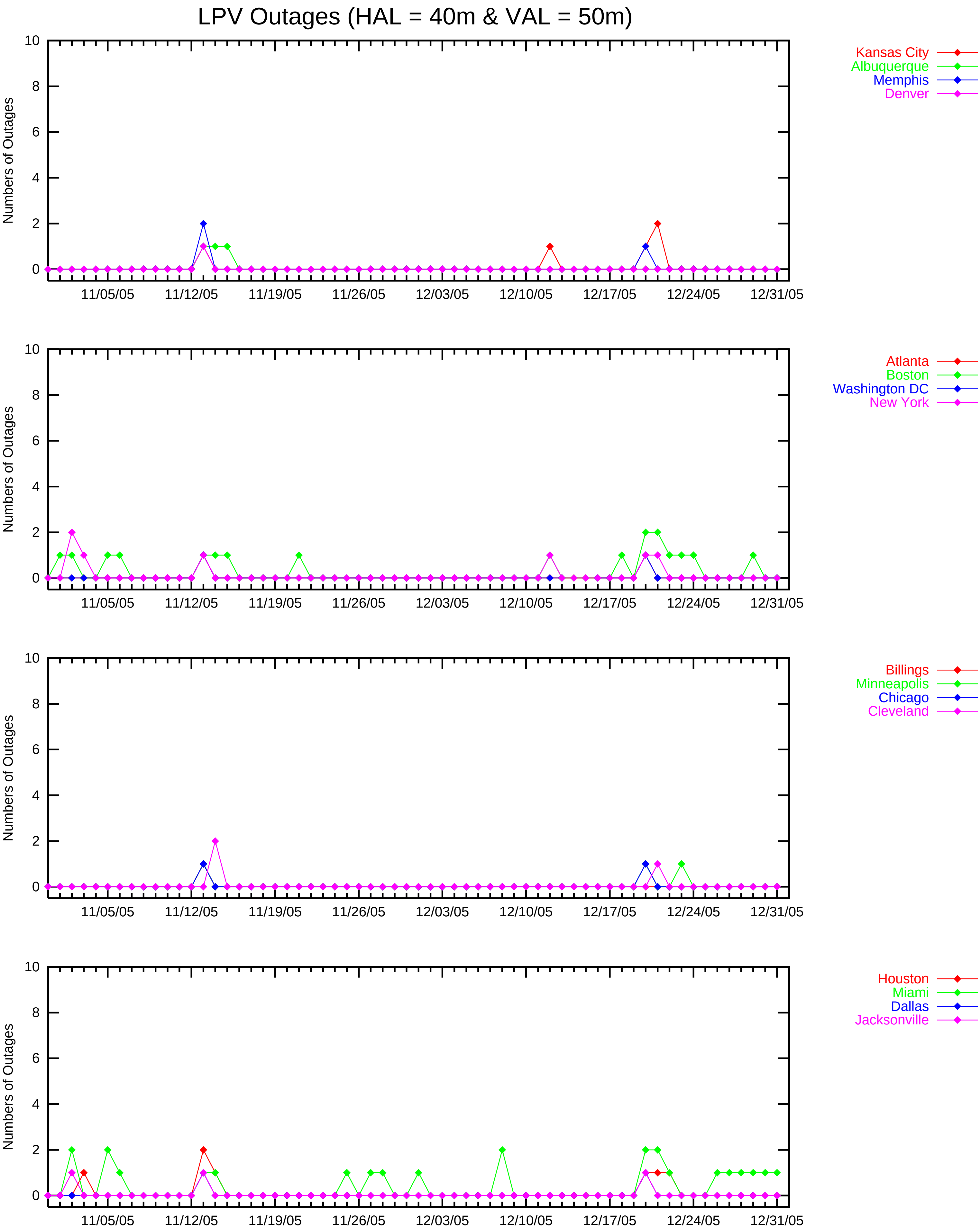


Figure 3-7 LNAV/VNAV Outages

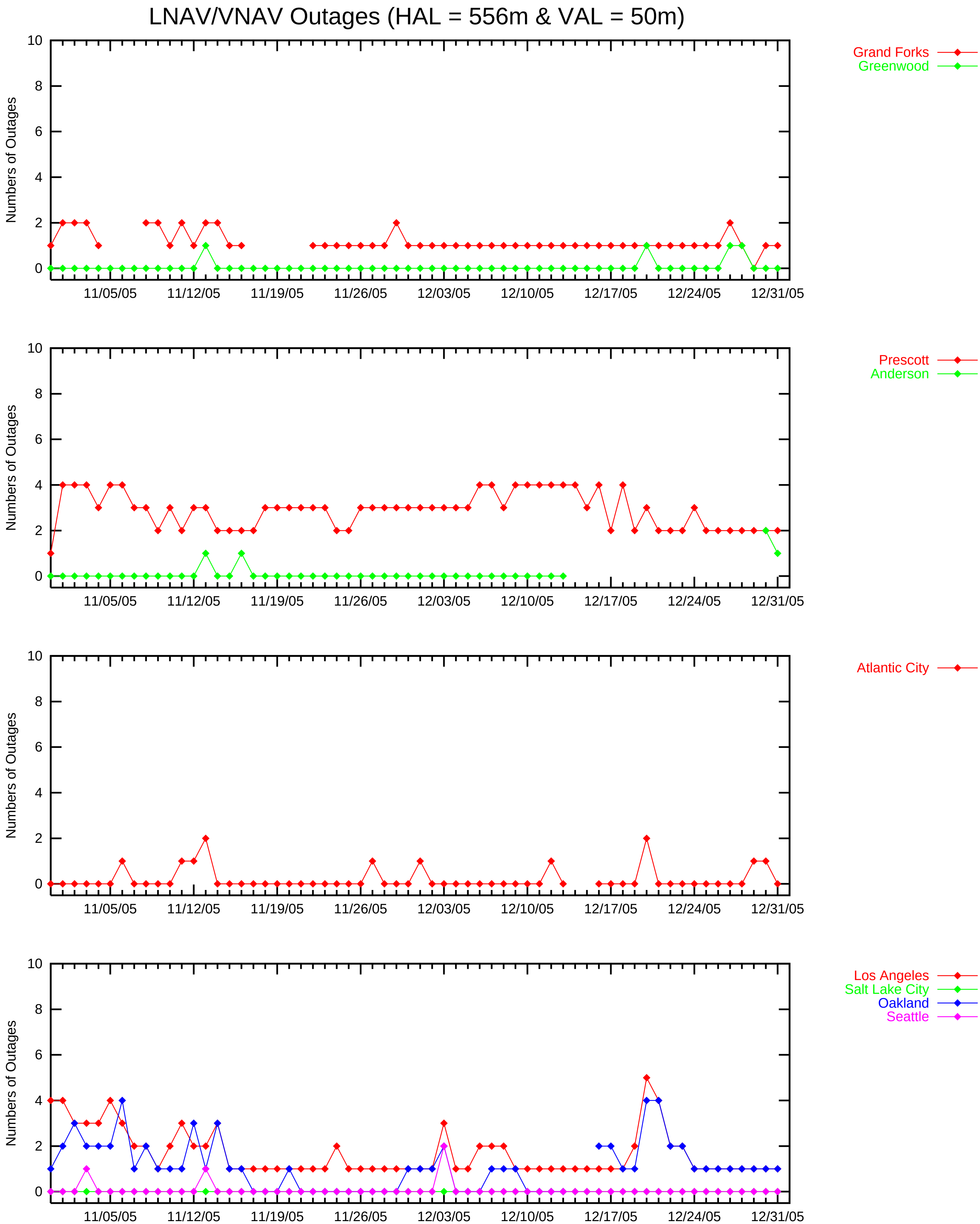
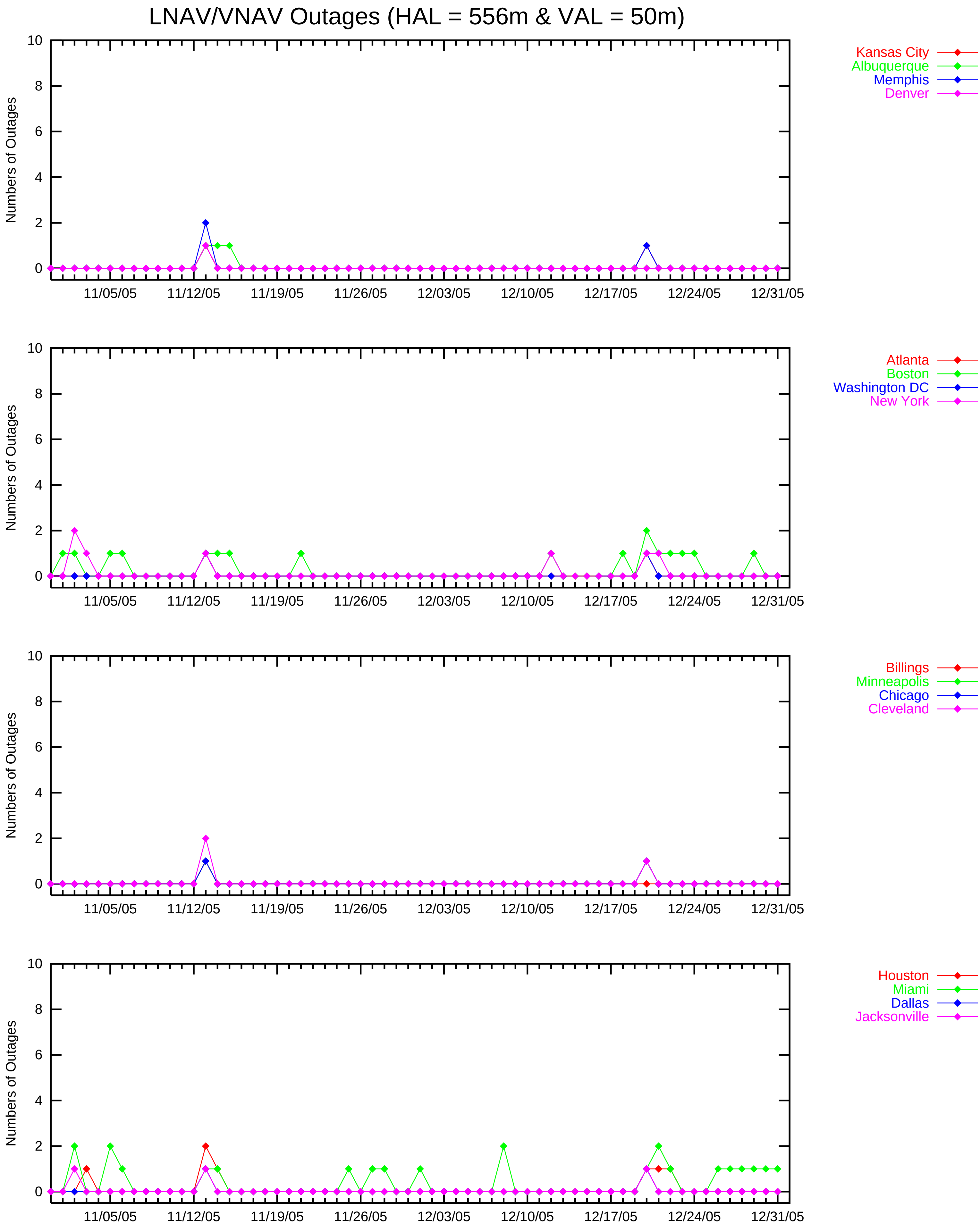


Figure 3-8 LNAV/VNAV Outages



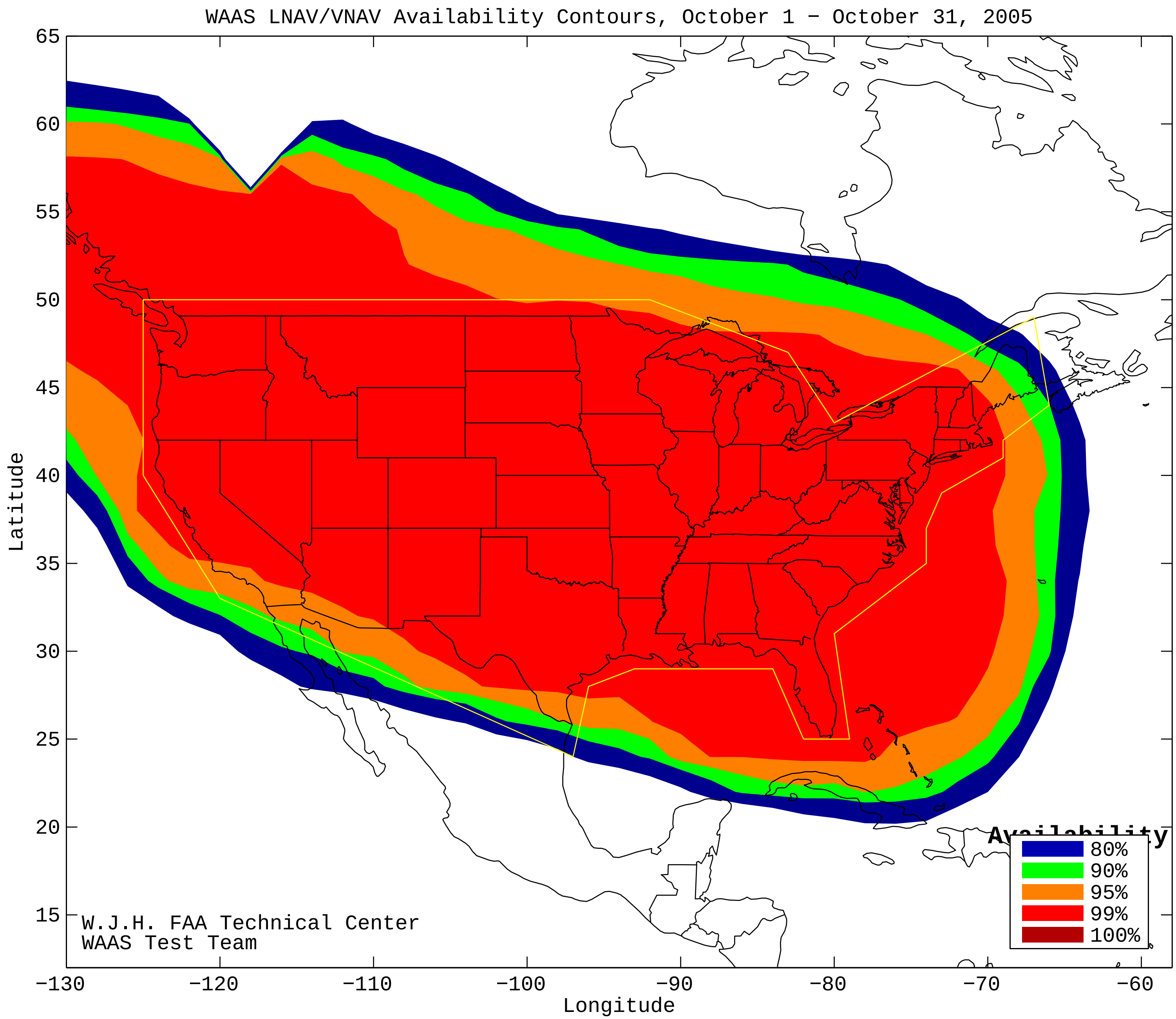
4.0 COVERAGE

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

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

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

Figure 4-1 WAAS LNAV/VNAV Coverage - October



CONUS Coverage at 95% Availability = 97.98
CONUS Coverage at 99% Availability = 93.12
CONUS Coverage at 100% Availability = 0

SL = LNAV/VNAV

Figure 4-2 WAAS LNAV/VNAV Coverage - November

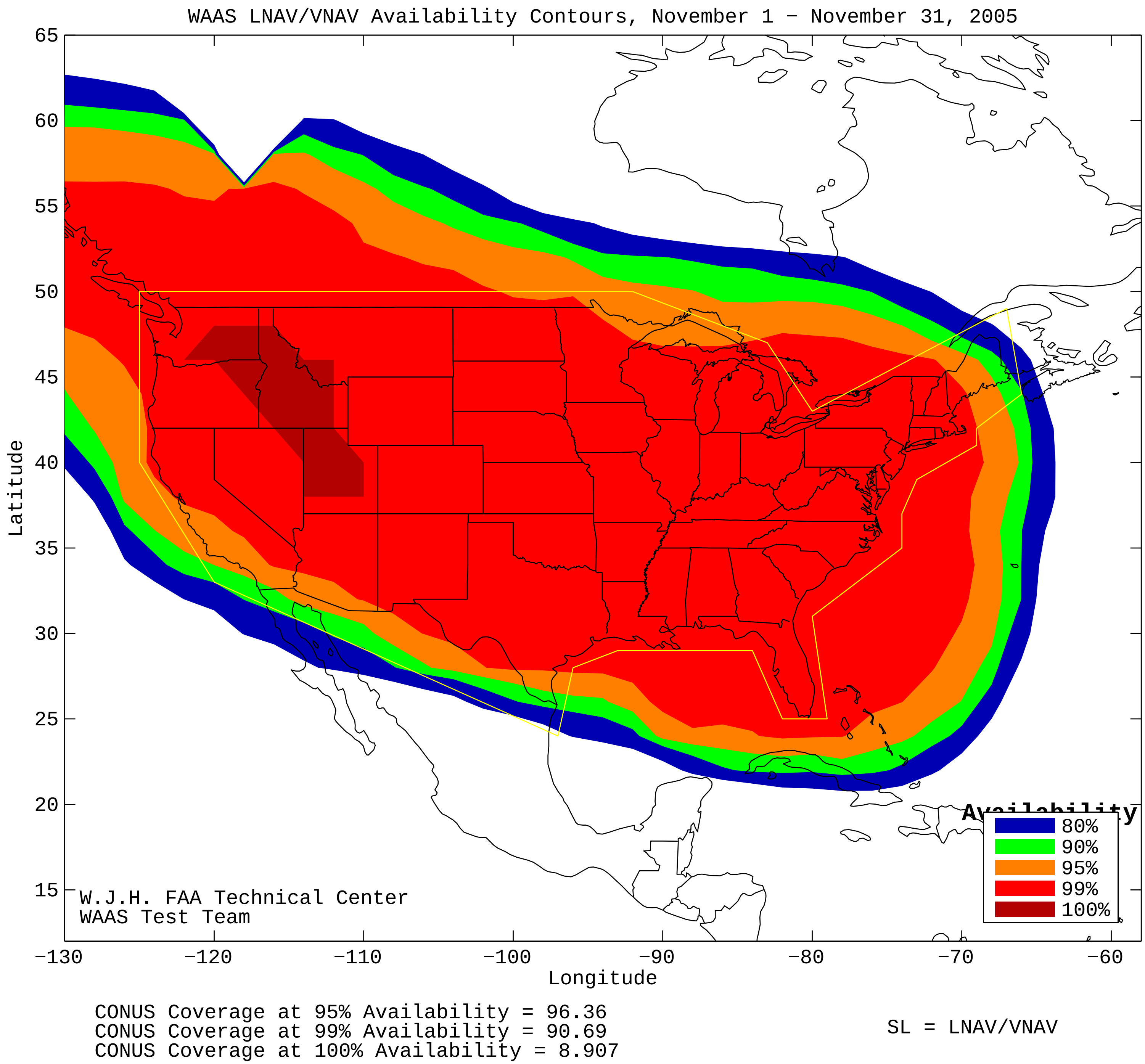
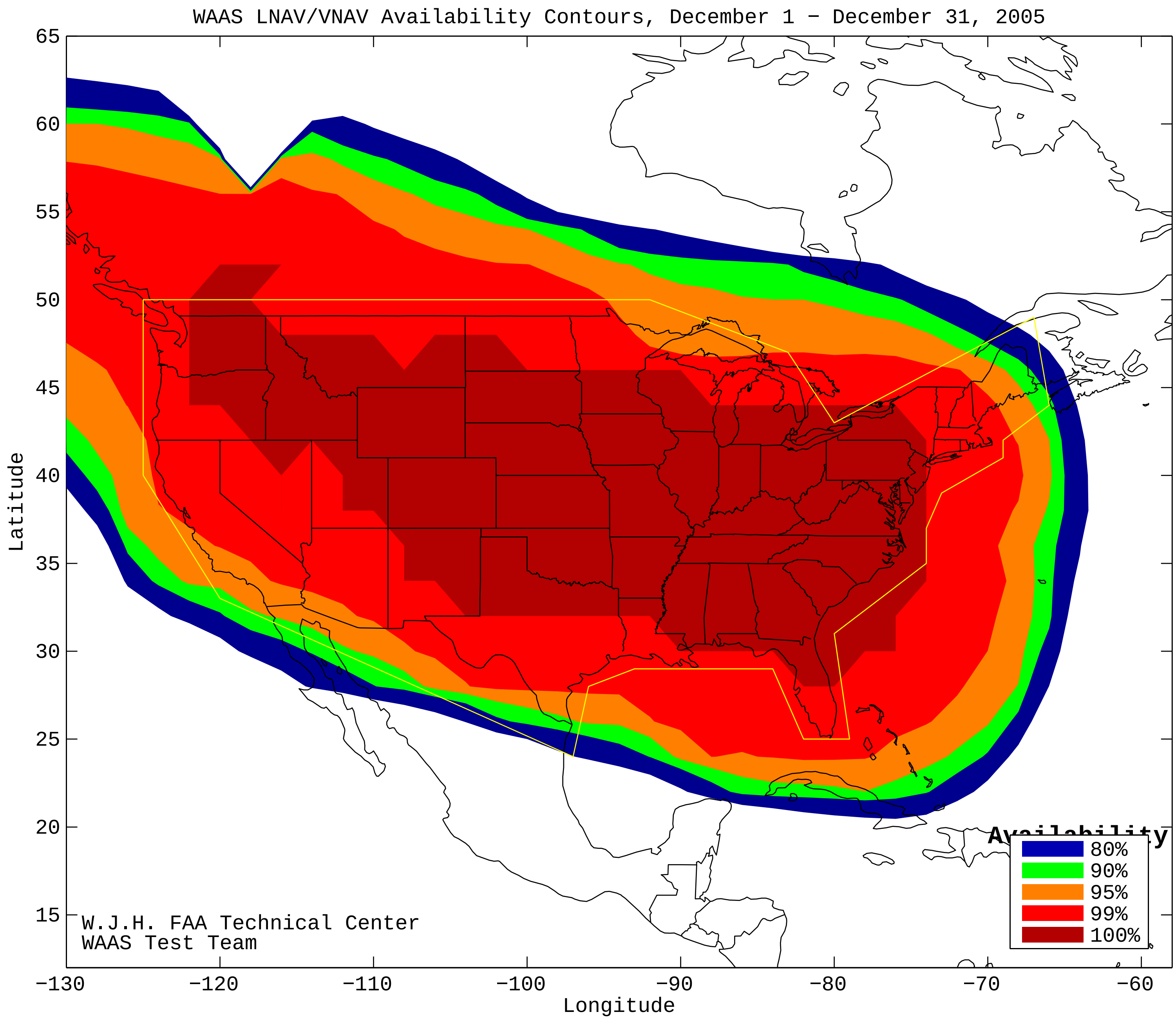


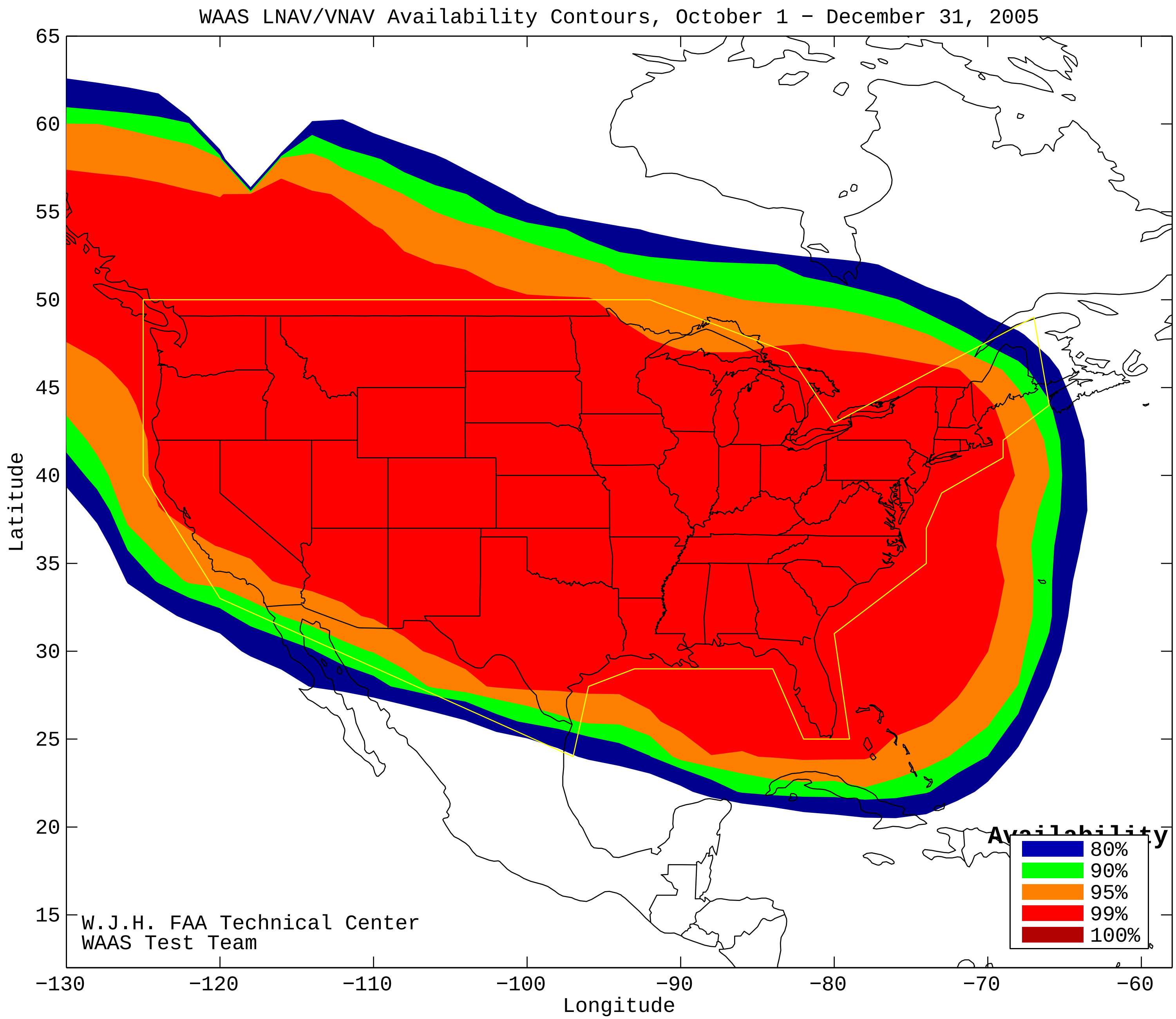
Figure 4-3 WAAS LNAV/VNAV Coverage - December



CONUS Coverage at 95% Availability = 97.57
CONUS Coverage at 99% Availability = 91.5
CONUS Coverage at 100% Availability = 68.42

SL = LNAV/VNAV

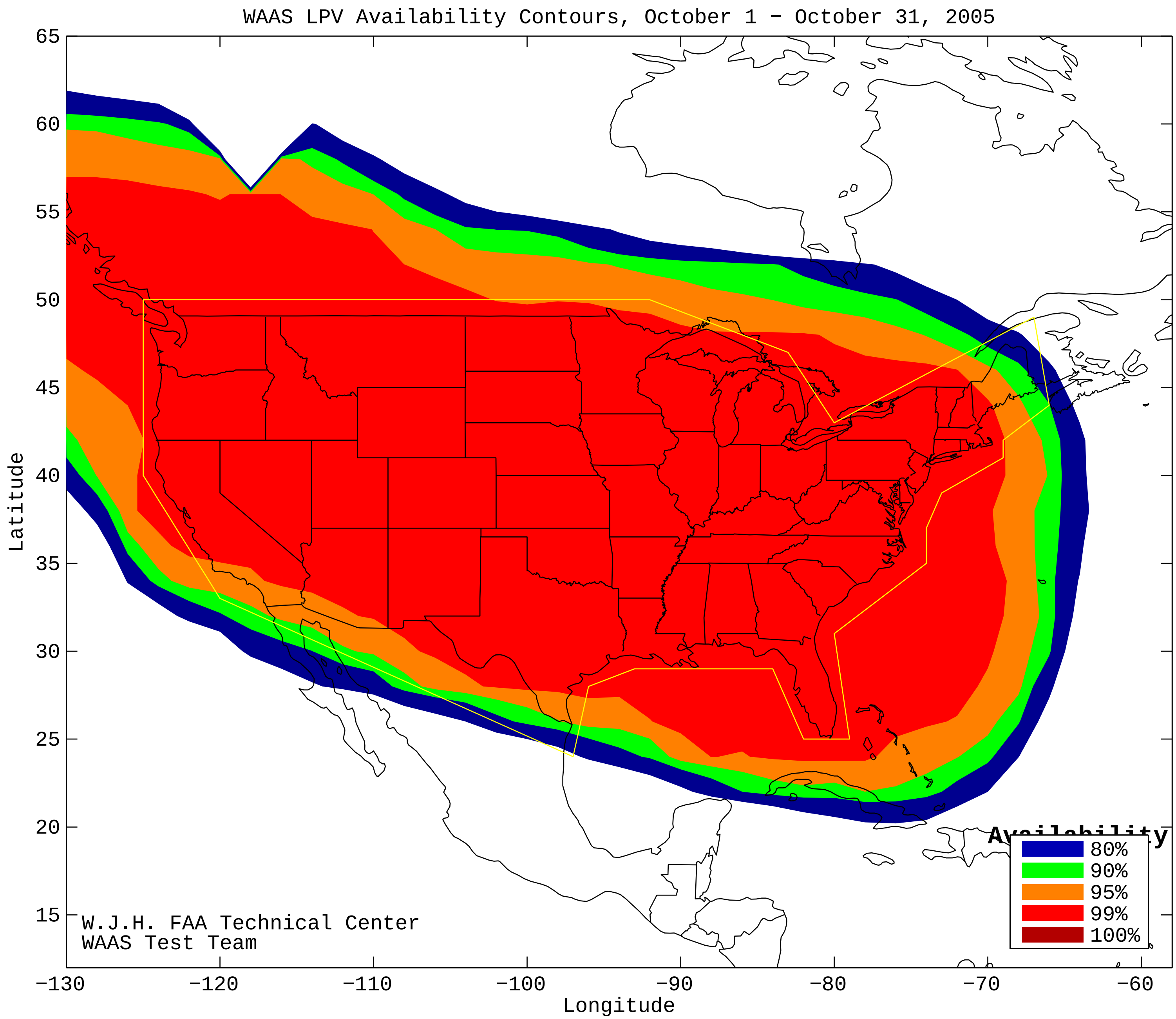
Figure 4-4 WAAS LNAV/VNAV Coverage for the Quarter



CONUS Coverage at 95% Availability = 97.17
CONUS Coverage at 99% Availability = 91.5
CONUS Coverage at 100% Availability = 0

SL = LNAV/VNAV

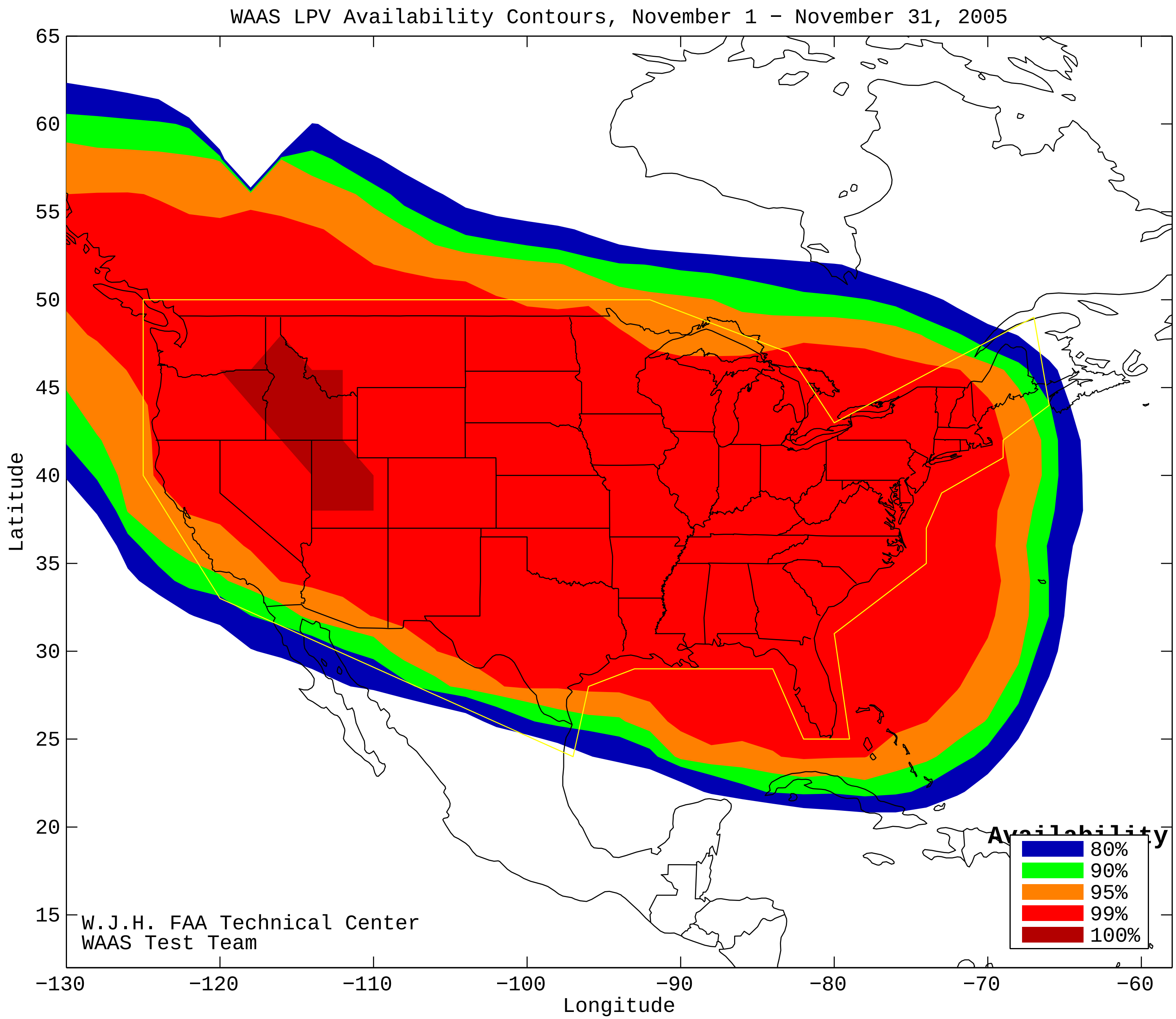
Figure 4-5 WAAS LPV Coverage - October



CONUS Coverage at 95% Availability = 97.57%
CONUS Coverage at 99% Availability = 93.12%
CONUS Coverage at 100% Availability = 0%

SL = LPV

Figure 4-6 WAAS LPV Coverage - November



CONUS Coverage at 95% Availability = 95.95%
CONUS Coverage at 99% Availability = 90.28%
CONUS Coverage at 100% Availability = 7.692%

SL = LPV

Figure 4-7 WAAS LPV Coverage - December

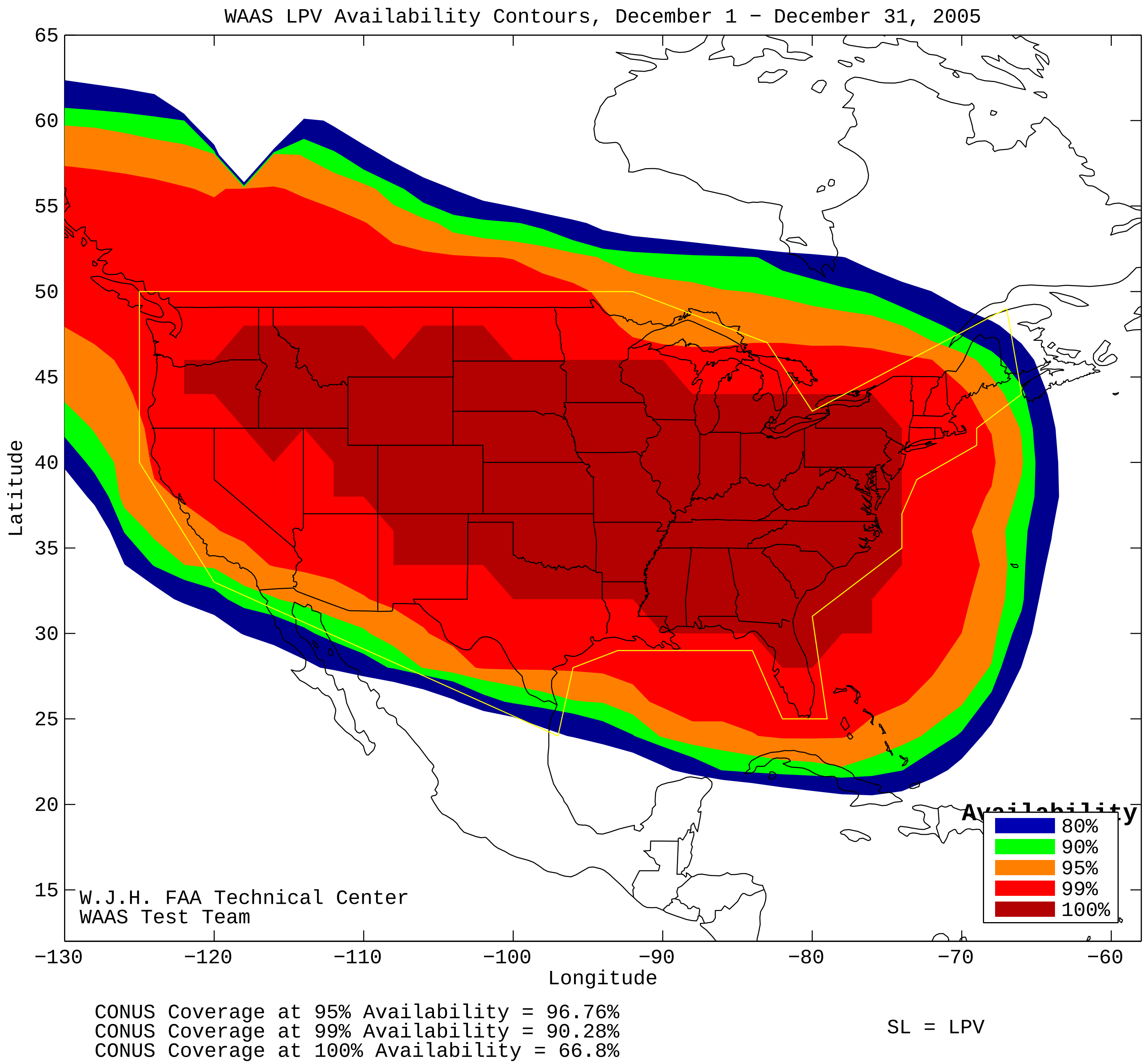
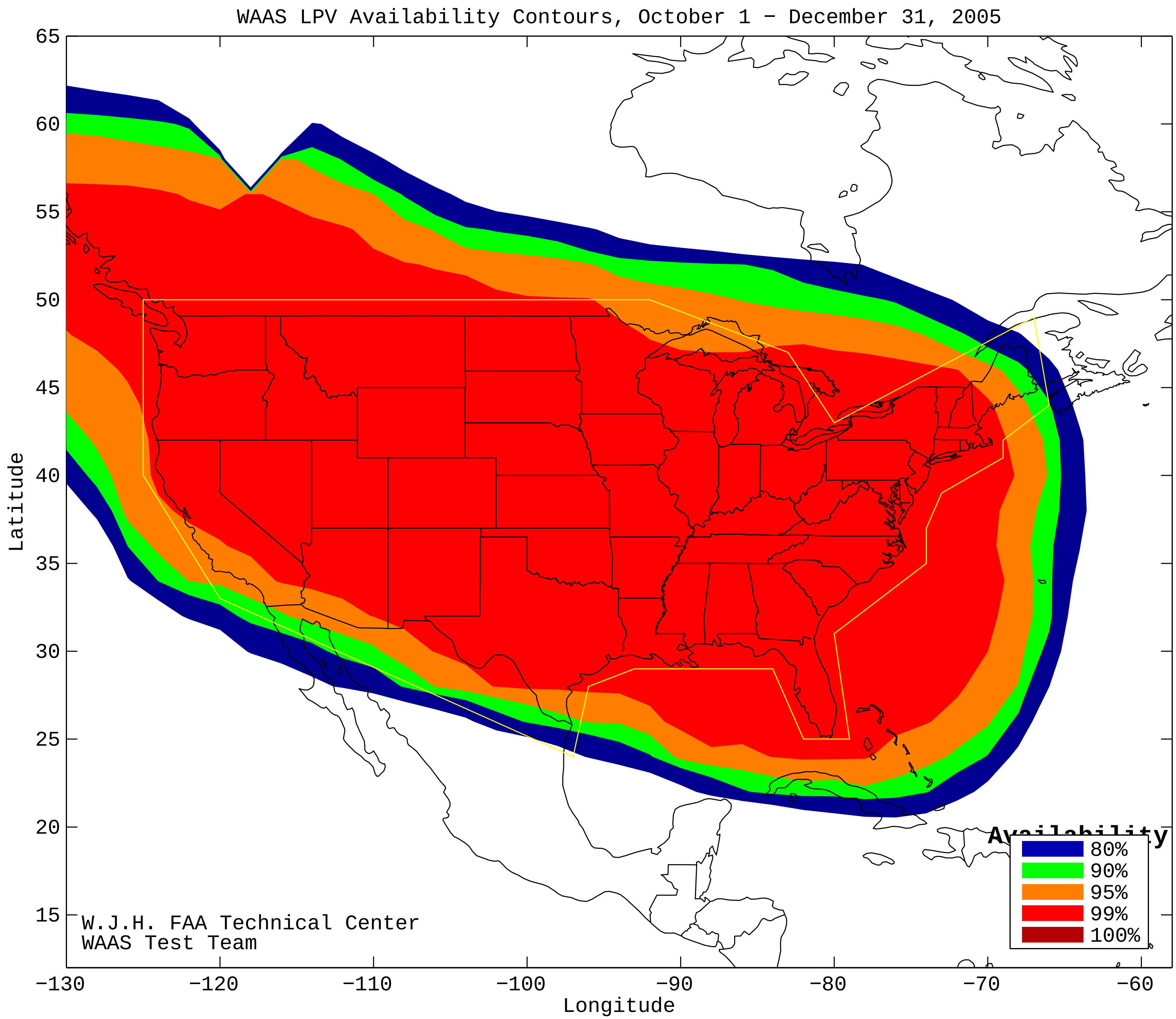


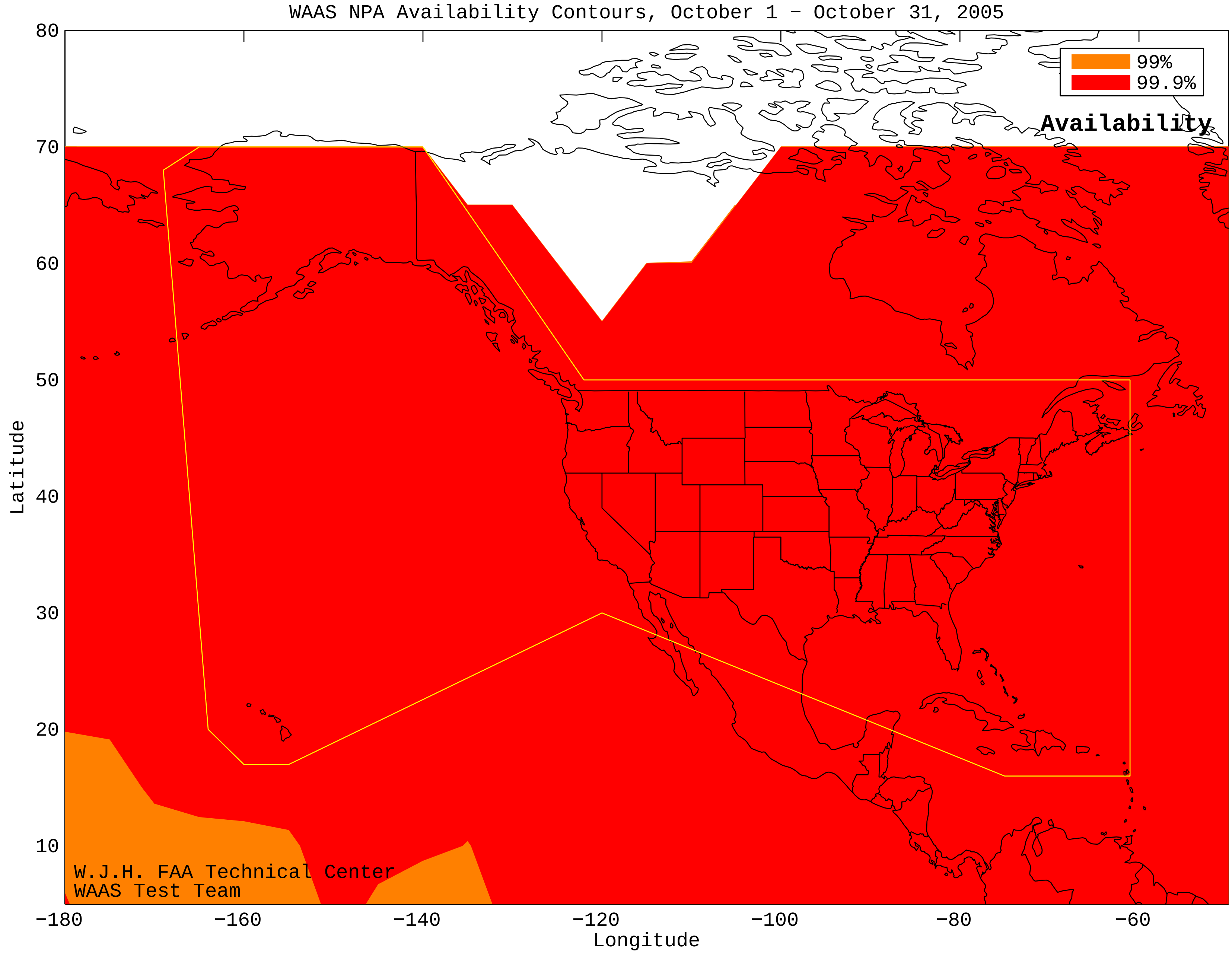
Figure 4-8 WAAS LPV Coverage for the Quarter



CONUS Coverage at 95% Availability = 96.76%
CONUS Coverage at 99% Availability = 91.09%
CONUS Coverage at 100% Availability = 0%

SL = LPV

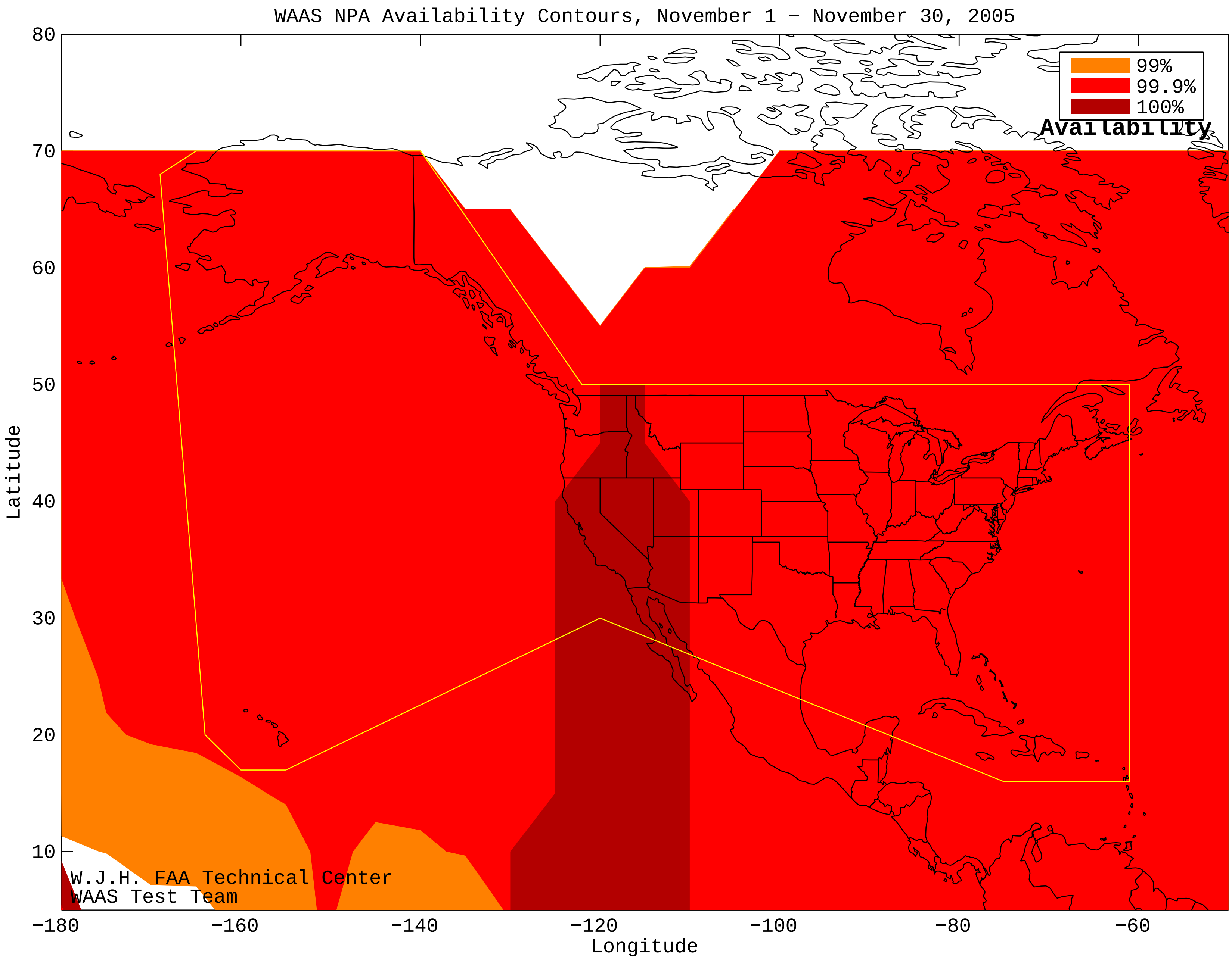
Figure 4-9 WAAS NPA Coverage - October



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

SL = NPA

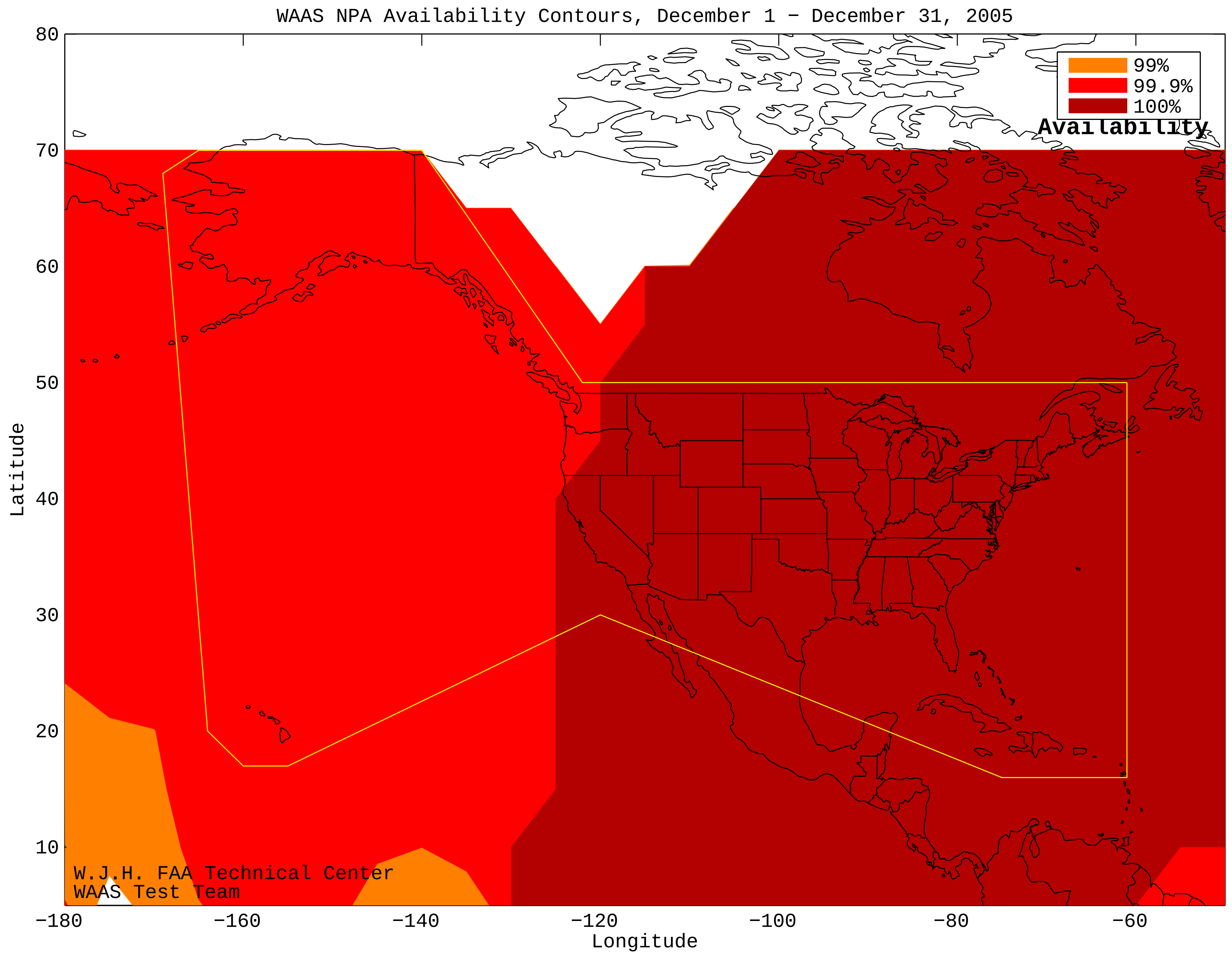
Figure 4-10 WAAS NPA Coverage - November



WAAS Coverage at 99% Availability = 100%
WAAS Coverage at 99.9% Availability = 100%
WAAS Coverage at 100% Availability = 10.29%

SL = NPA

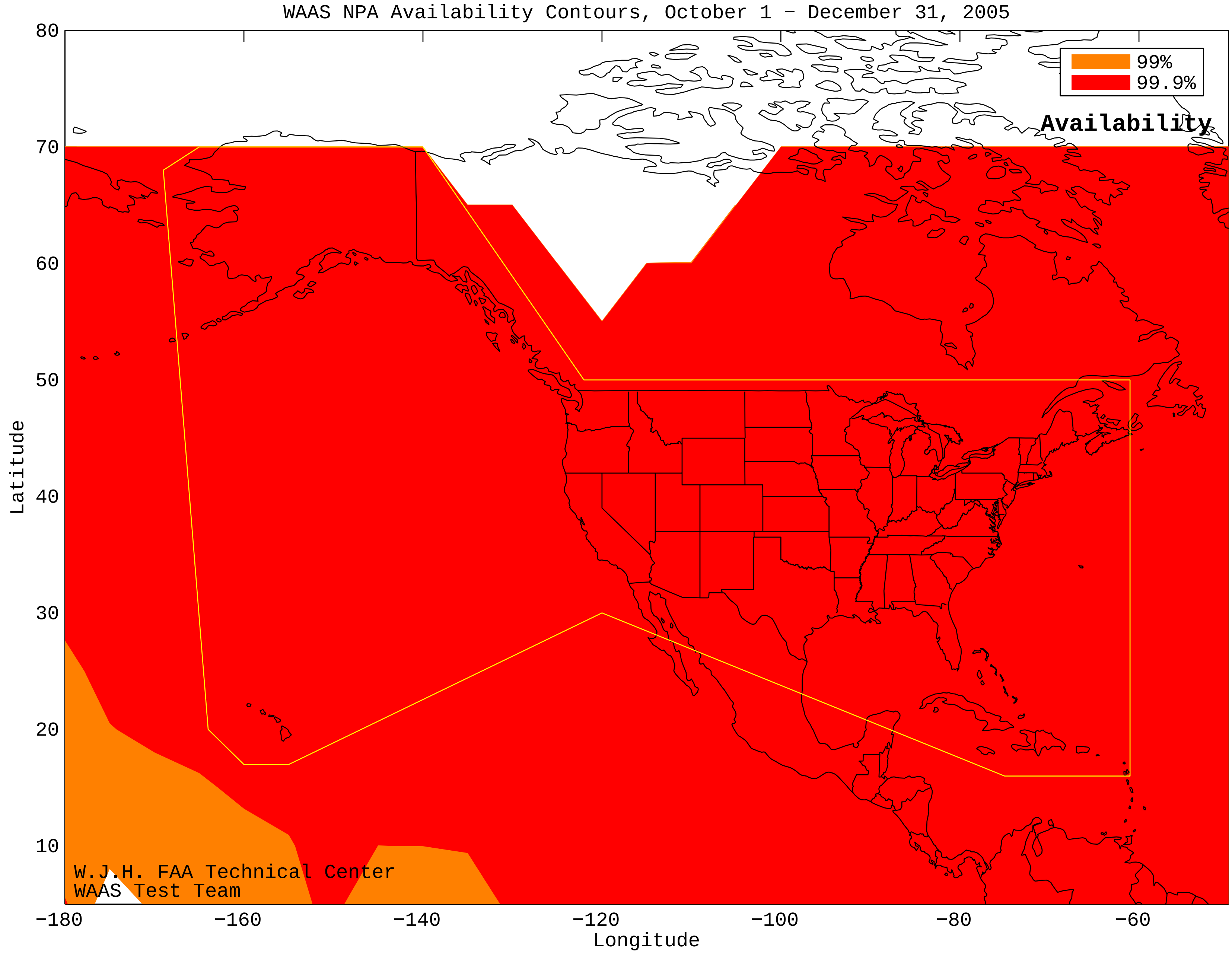
Figure 4-11 WAAS NPA Coverage - December



WAAS Coverage at 99% Availability = 100%
WAAS Coverage at 99.9% Availability = 100%
WAAS Coverage at 100% Availability = 47.06%

SL = NPA

Figure 4-12 WAAS NPA Coverage for the Quarter



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

SL = NPA

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

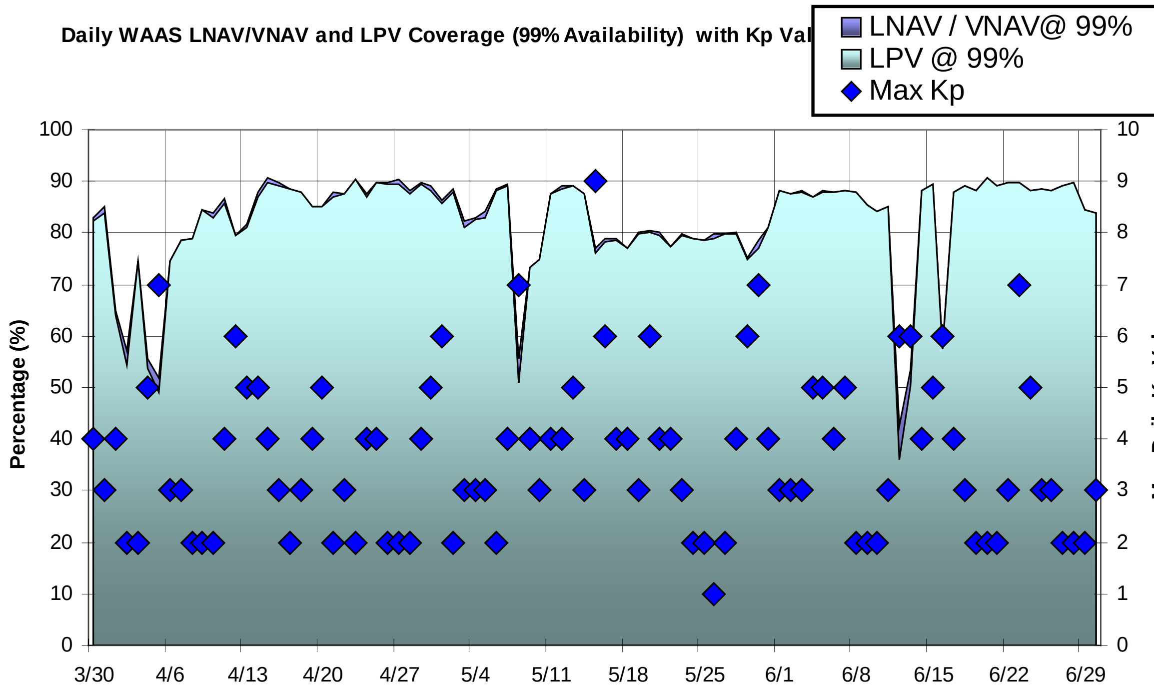


Figure 4-14 Daily NPA Coverage

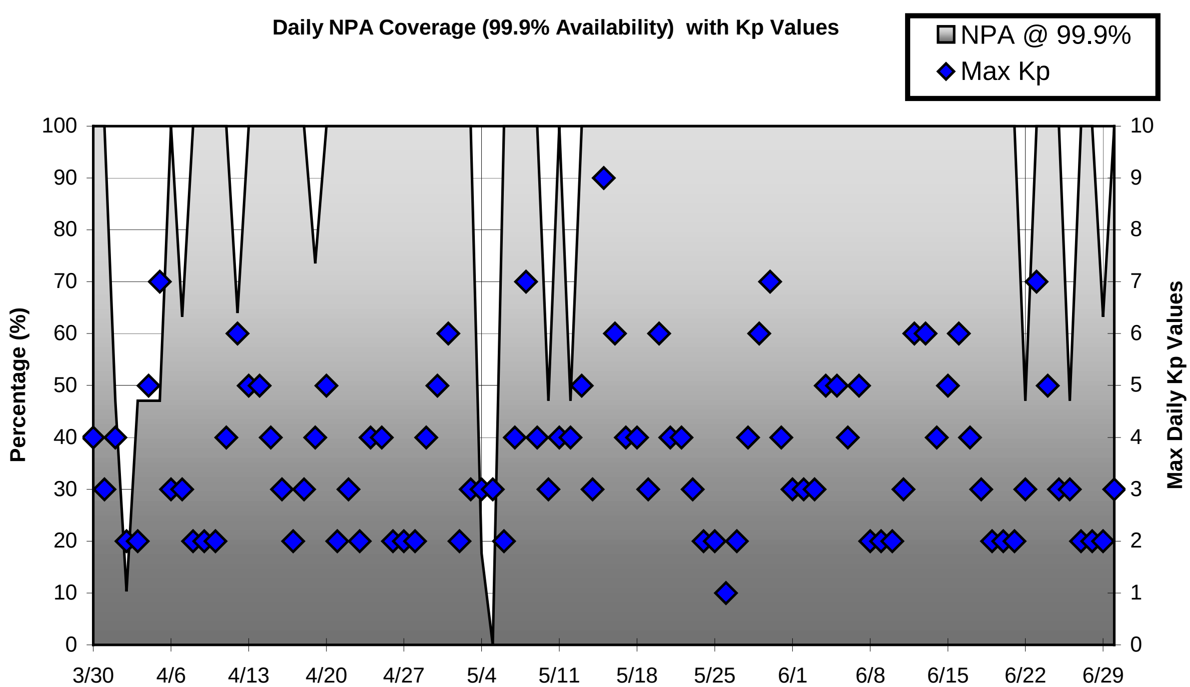


Figure 4-15 WAAS LNAV/VNAV Coverage Since Commissioning

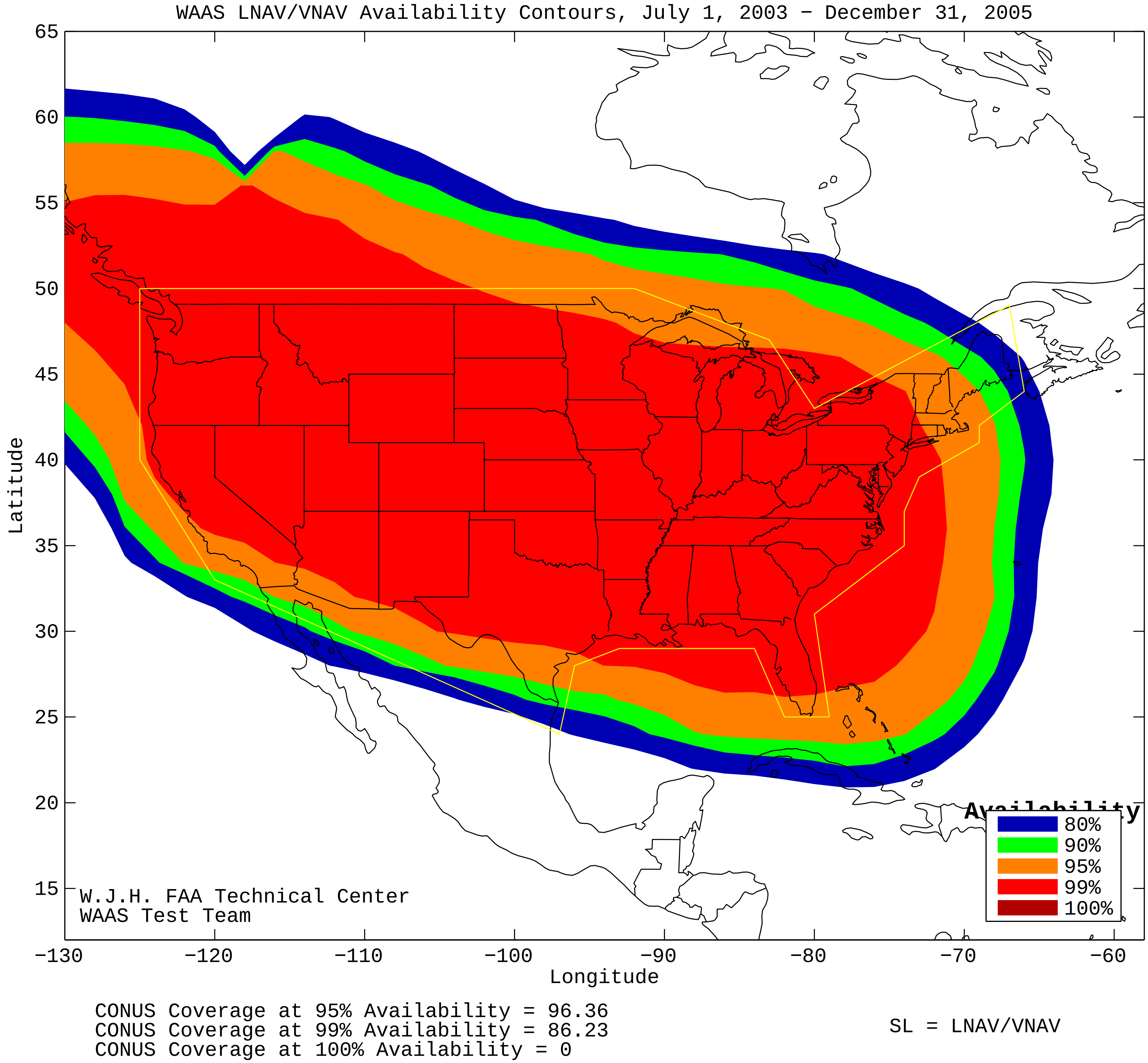
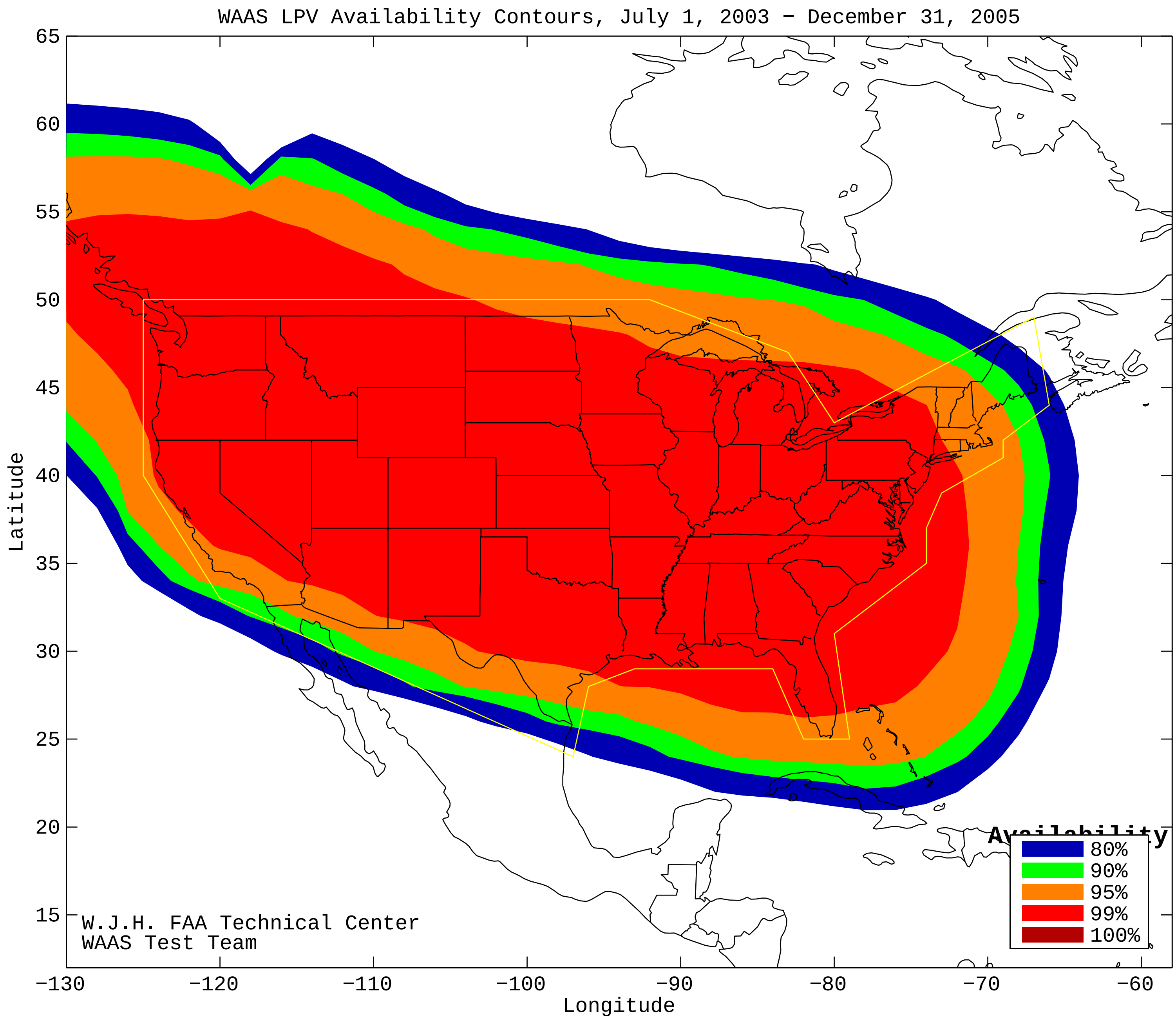


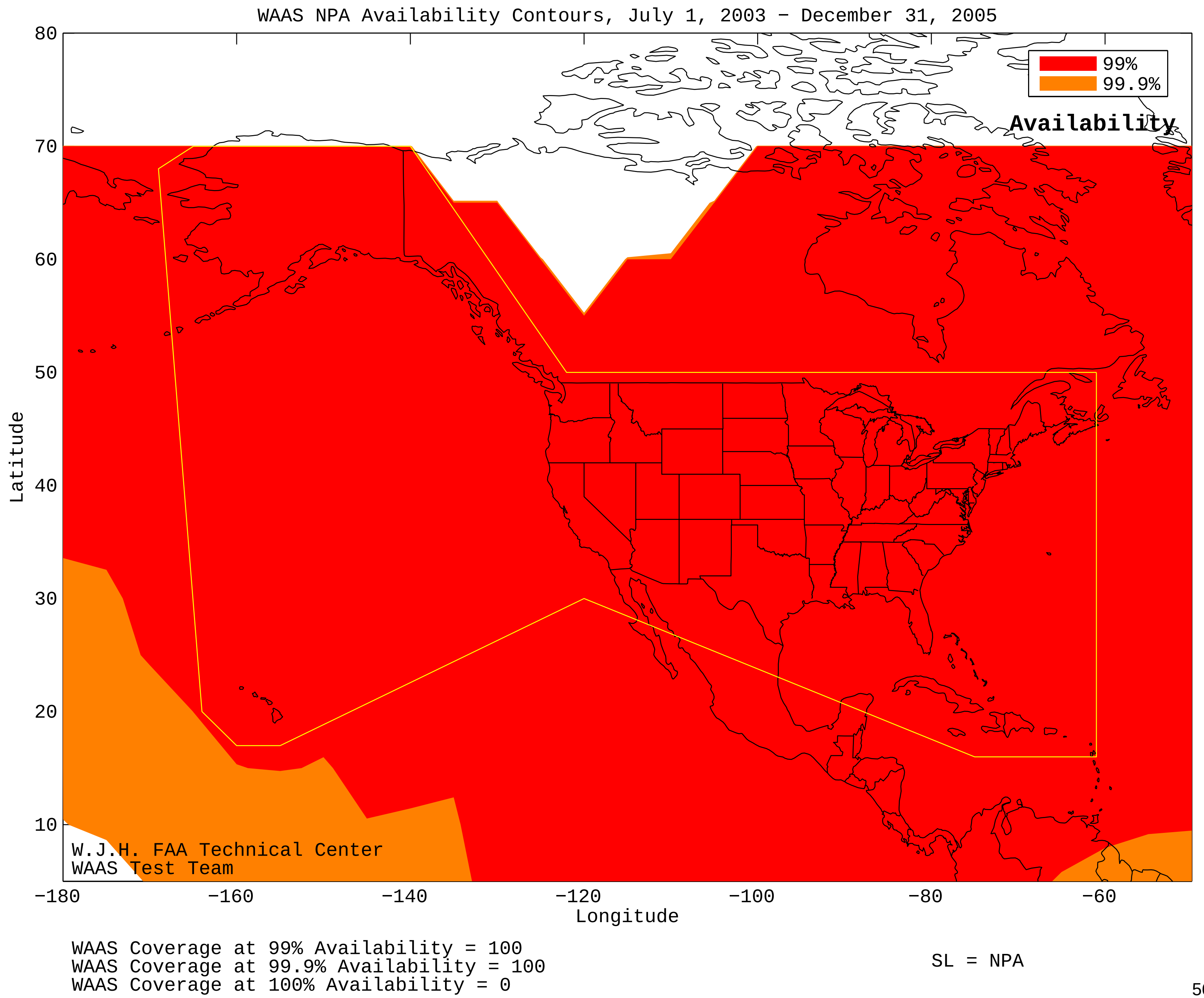
Figure 4-16 WAAS LPV Coverage Since Commissioning



CONUS Coverage at 95% Availability = 95.55%
CONUS Coverage at 99% Availability = 85.43%
CONUS Coverage at 100% Availability = 0%

SL = LPV

Figure 4-17 NPA Coverage Since Commissioning



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	
Anderson	6.67	6.66	0
Atlantic City	10.00	7.61	0
Grand Forks	6.67	5.33	0
Greenwood	8.57	7.61	0
Prescott	8.57	8.88	0
Albuquerque	6.00	5.33	0
Atlanta	5.00	6.66	0
Billings	5.45	4.44	0
Boston	1.76	1.97	0
Chicago	5.45	5.92	0
Cleveland	5.45	4.44	0
Dallas	3.75	3.55	0
Denver	5.45	5.33	0
Houston	7.50	6.66	0
Jacksonville	4.29	7.61	0
Kansas City	5.45	5.33	0
Los Angeles	6.00	5.33	0
Memphis	4.62	5.33	0
Miami	5.45	3.81	0
Minneapolis	3.16	3.55	0
New York	4.00	4.44	0
Oakland	5.45	5.33	0
Salt Lake City	5.45	4.10	0
Seattle	8.57	6.66	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 3.53 at Seattle. Also, Table 5.1 shows the number of HMIs that occurred during the quarter, of which there were none. An HMI occurs if the position error exceeds the protection level in the vertical or horizontal dimensions at any time and 6.2 seconds or more passes before this event is corrected by WAAS. Since WAAS was made available to the public in August 2000 there has not been an HMI event. Note that the FAA commissioned WAAS for safety of life services in July 2003.

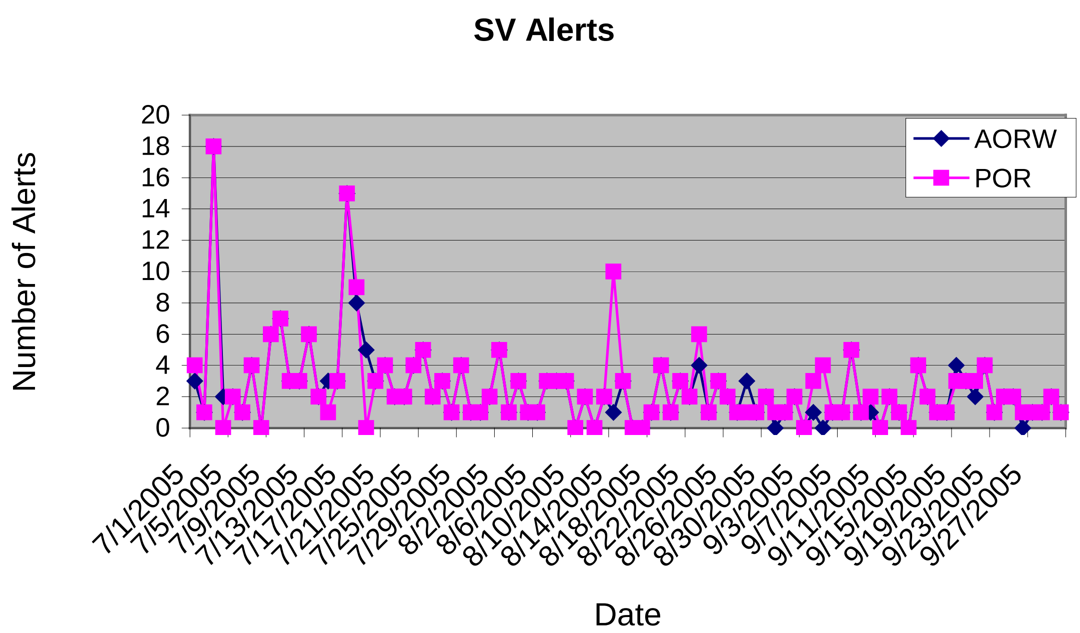
5.2 Broadcast Alerts

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

Table 5-2 WAAS SV Alert

Number of Alerts			Average Alerts Per Day	
Message Type	**AORW**	**POR**	**AORW**	**POR**
2	49	50	0.5326	0.5434
3	57	59	0.6195	0.6413
6	7	3	0.0760	0.0326
24	143	140	1.5543	1.5217
26	0	0	0	0
Total Alerts	256	252	2.7826	2.7391

Figure 5-1 SV Daily Alert Trends



5.3 Availability of WAAS Messages (AORW & POR)

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

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

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

Table 5-3 Update Rates for WAAS Messages

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

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

Message Type	On Time	Late	Max Late Length (seconds)
1	140801	0	0
2	1324688	151	30
3	1324734	142	27
7	75242	93	134
9	93145	2	179
10	75238	79	150
17	29999	1	308
24	1325029	83	27

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

SV	On Time	Late	Max Late Length (seconds)
1	42494	2	177
2	45355	0	0
3	45847	0	0
4	45514	0	0
5	47253	0	0
6	44663	0	0
7	45253	0	0
8	43279	0	0
9	36838	0	0
10	46095	0	0
11	47624	0	0
13	43986	1	174
14	44889	1	174
15	42257	1	166
16	46909	1	165
17	8100	0	0
18	44006	0	0
19	46312	1	175
20	46531	0	0
21	36263	0	0
22	39553	0	0
23	43433	0	0
24	47196	1	162
25	42713	0	0
26	44143	1	179
27	40379	1	171
28	39359	0	0
29	44713	0	0
30	47325	1	179

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

SV	On Time	Late	Max Late Length (seconds)
1	40784	0	0
2	43037	0	0
3	43494	0	0
4	43103	0	0
5	44714	0	0
6	42217	1	161
7	42900	0	0
8	40902	0	0
9	34747	0	0
10	43298	1	168
11	44973	0	0
13	41299	0	0
14	42231	1	176
15	39601	0	0
16	43376	0	0
17	7460	0	0
18	40867	0	0
19	42181	0	0
20	42155	0	0
21	33144	1	192
22	35847	1	270
23	39102	0	0
24	42593	0	0
25	38439	0	0
26	40084	1	192
27	36738	0	0
28	35970	0	0
29	40635	0	0
30	42776	0	0
122	83561	0	0
134	77126	0	0

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	27651	2	370
1	0	27604	3	576
1	1	27613	1	301
1	2	27611	2	306
1	3	27624	1	306
1	4	27628	1	304
2	0	27613	1	301
2	1	27615	0	0
2	2	27619	2	576
2	3	27613	1	301
2	4	27637	1	307
2	5	27593	3	576
3	0	27629	7	579

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

Band	On Time	Late	Max Late Length (seconds)
0	68064	0	0
1	68102	0	0
2	68064	0	0
3	68050	0	0

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

Message Type	On Time	Late	Max Late Length (seconds)
1	139471	0	0
2	1324679	153	30
3	1324720	148	29
7	74573	65	149
9	93148	1	179
10	74547	71	209
17	29898	4	535
24	1324985	96	31

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

SV	On Time	Late	Max Late Length (seconds)
1	42493	0	0
2	45353	0	0
3	45847	0	0
4	45518	0	0
5	47257	2	171
6	44663	1	171
7	45257	1	173
8	43286	0	0
9	36841	0	0
10	46093	1	181
11	47630	1	169
13	44000	1	175
14	44903	0	0
15	42258	0	0
16	46914	1	169
17	8100	0	0
18	44013	0	0
19	46313	0	0
20	46529	0	0
21	36258	1	165
22	39552	0	0
23	43413	0	0
24	47185	1	162
25	42703	0	0
26	44141	2	175
27	40372	1	170
28	39359	0	0
29	44710	0	0
30	47335	0	0

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

SV	On Time	Late	Max Late Length (seconds)
1	40774	1	175
2	43032	2	192
3	43491	0	0
4	43105	0	0
5	44709	2	185
6	42217	1	179
7	42899	0	0
8	40899	0	0
9	34744	1	181
10	43300	1	184
11	44973	0	0
13	41296	1	192
14	42230	1	168
15	39606	0	0
16	43365	3	194
17	7460	0	0
18	40861	2	192
19	42177	1	193
20	42159	0	0
21	33146	2	192
22	35851	0	0
23	39102	0	0
24	42592	0	0
25	38445	2	192
26	40085	0	0
27	36727	0	0
28	35972	0	0
29	40630	2	188
30	42773	2	194
122	83555	5	195
134	77123	1	192

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	27618	3	579
0	1	27627	6	507
0	2	27631	6	514
1	0	27608	5	580
1	1	27625	2	331
1	2	27639	3	347
1	3	27628	5	366
1	4	27613	4	360
2	0	27621	4	576
2	1	27612	5	576
2	2	27609	2	346
2	3	27607	3	339

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

Band	On Time	Late	Max Late Length (seconds)
0	67763	0	0
1	67686	0	0
2	67724	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	2.261	100	1.423	100	1.250	100	1.881	100	1.511	100	1.632	100
2	2.107	100	3.051	99.9715	1.778	100	1.147	100	2.461	100	1.951	100
3	2.318	100	1.417	100	1.426	100	2.420	100	1.816	100	1.713	100
4	3.103	99.7940	1.511	100	1.475	100	2.583	100	1.756	100	1.692	100
5	2.400	99.9303	2.067	99.9901	1.264	100	1.429	100	1.647	100	1.400	100
6	3.592	98.7495	1.416	100	1.702	100	2.809	100	1.604	100	2.407	100
7	2.343	99.9623	1.851	100	1.074	100	1.887	100	1.420	100	1.338	100
8	2.366	100	1.543	100	1.458	100	2.465	100	1.186	100	1.830	100
9	2.819	99.8954	1.582	100	1.365	100	2.281	100	1.652	100	1.816	100
10	2.002	100	2.189	100	1.303	100	1.261	100	1.316	100	1.487	100
11	1.895	100	1.883	100	1.943	100	2.049	100	2.608	100	1.193	100
12	-	-	-	-	-	-	-	-	-	-	-	-
13	2.095	100	1.179	100	1.108	100	2.053	100	1.673	100	1.629	100
14	2.068	100	1.808	100	1.341	100	1.392	100	1.259	100	1.435	100
15	2.687	99.7218	1.509	100	1.214	100	2.677	100	1.072	100	1.905	100
16	1.929	100	2.120	100	1.004	100	2.383	100	1.449	100	1.493	100
17	2.240	99.9518	2.541	100	1.635	100	2.142	100	1.713	100	2.146	100
18	2.035	99.9975	1.628	100	1.390	100	1.143	100	1.124	100	1.531	100
19	2.807	100	3.106	100	3.080	99.8839	1.839	100	2.382	100	2.558	100
20	1.885	100	1.690	100	1.671	100	1.390	100	1.553	100	1.293	100
21	2.289	99.8849	2.448	100	1.427	100	1.393	100	2.220	100	1.439	100
22	2.006	100	1.999	100	1.182	100	1.193	100	1.421	100	1.343	100
23	2.753	99.9952	2.893	100	2.916	100	1.907	100	2.246	100	2.431	99.9926
24	3.191	99.9196	1.551	100	1.357	100	2.454	100	2.060	100	2.422	100
25	2.467	99.9997	1.213	100	1.205	100	2.248	100	1.875	100	1.532	100
26	2.913	99.9722	1.645	100	1.573	100	3.032	100	1.910	100	1.997	100
27	2.385	99.9849	1.426	100	1.427	100	2.622	100	1.515	100	1.854	100
28	1.734	100	2.341	100	1.818	100	1.514	100	1.375	100	1.216	100
29	2.533	99.9924	1.339	100	1.425	100	2.613	100	1.517	100	1.514	100
30	2.980	99.8272	1.318	100	1.503	100	2.130	100	2.279	100	1.911	100
31	-	-	-	-	-	-	-	-	-	-	-	-
122	3.845	100	3.884	100	3.946	100	5.346	100	2.678	100	3.169	100
134	-	-	-	-	-	-	-	-	-	-	-	-

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

Site →	Los Angeles		Salt Lake City		Miami		Minneapolis		Atlanta		Juneau	
SV ↓	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding
1	2.195	100	1.823	100	1.609	100	1.602	100	1.090	100	1.435	100
2	1.992	100	3.086	99.9144	3.117	100	1.702	100	2.009	100	1.558	100
3	2.231	100	1.882	100	1.334	100	2.380	99.9939	1.232	100	1.152	100
4	2.973	100	2.474	100	2.048	100	2.345	100	1.097	100	1.551	100
5	1.857	99.9978	2.403	99.8528	1.329	100	1.712	100	1.021	100	1.058	100
6	2.673	99.9280	1.869	100	1.679	100	2.856	99.9590	1.535	100	1.534	100
7	2.376	100	1.906	100	1.399	100	1.847	100	0.998	100	1.080	100
8	2.031	100	1.693	100	1.132	99.9999	2.984	100	1.088	100	1.041	100
9	2.488	99.7604	2.017	100	1.464	100	2.401	100	1.316	100	1.570	100
10	1.774	100	2.241	100	1.367	100	1.900	100	1.156	100	0.860	100
11	2.183	100	1.847	100	2.543	100	1.400	100	1.211	100	0.995	100
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.835	100	1.633	100	1.432	100	2.249	99.9979	1.057	100	1.214	100
14	1.703	100	1.876	100	1.683	100	1.546	100	1.486	100	0.883	100
15	1.759	100	1.648	100	1.437	100	3.048	100	1.355	100	1.007	100
16	1.592	100	1.809	100	1.468	100	2.688	100	1.214	100	0.867	100
17	2.464	100	2.724	100	2.140	100	2.010	100	2.016	100	1.761	100
18	1.776	100	1.933	100	1.579	100	1.472	100	1.461	100	0.930	100
19	2.600	100	3.001	100	2.730	100	2.302	100	2.454	100	2.201	100
20	1.750	100	1.732	100	1.942	100	1.364	100	1.552	100	0.938	100
21	1.878	100	2.265	100	3.009	100	1.682	100	1.737	100	1.140	100
22	1.750	100	2.033	100	2.374	100	1.780	100	1.715	100	0.921	100
23	2.302	100	3.178	99.8650	2.624	100	2.243	100	2.376	100	2.024	100
24	2.559	100	2.262	100	1.459	100	3.180	99.9993	1.384	100	1.547	100
25	2.062	100	2.086	100	1.629	100	1.815	99.9670	1.089	100	1.284	100
26	2.342	99.9994	2.294	100	1.419	100	2.865	99.9711	1.538	100	1.664	100
27	2.155	100	2.194	100	1.304	100	2.275	99.9998	1.107	100	1.358	100
28	1.760	100	1.788	100	1.748	100	1.584	100	1.205	100	1.043	100
29	2.152	100	1.721	100	1.424	100	2.763	99.9942	1.075	100	1.247	100
30	2.547	99.8997	2.143	99.9146	1.777	100	2.448	100	1.469	100	1.858	100
31	-	-	-	-	-	-	-	-	-	-	-	-
122	3.650	100	4.123	100	3.320	100	5.654	100.0000	3.403	100	-	-
134	5.134	100	4.221	100	-	-	-	-	-	-	3.563	100

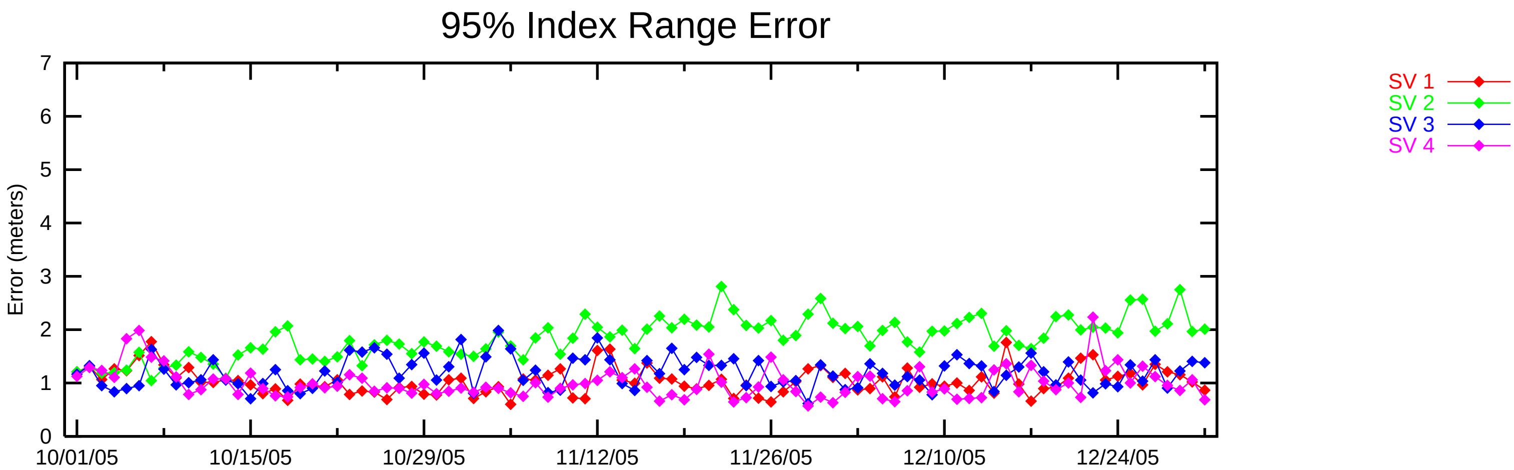
Table 6-3 Ionospheric Error 95% index and 3.29 Sigma Bounding

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	1.383	100	0.583	100	0.575	100	0.887	100	1.055	100	1.019	100
2	1.420	100	1.437	100	0.958	100	0.715	100	1.271	100	1.276	100
3	1.073	100	0.600	100	0.508	100	1.042	100	1.096	100	0.925	100
4	1.624	100	0.724	100	1.011	100	1.460	100	1.598	100	0.932	100
5	1.035	100	0.670	100	0.473	100	0.549	100	0.495	100	0.668	100
6	1.496	100	0.607	100	0.842	100	1.385	100	1.114	100	1.191	100
7	1.346	100	0.630	100	0.534	100	0.899	100	0.882	100	0.664	100
8	1.374	100	0.708	100	0.514	100	1.247	100	0.885	100	0.894	100
9	1.249	100	0.541	100	0.779	100	1.018	100	0.948	100	0.813	100
10	1.181	100	0.921	100	0.463	100	0.602	100	1.027	100	0.661	100
11	1.022	100	0.968	100	0.505	100	0.835	100	1.195	100	0.563	100
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.228	100	0.608	100	0.544	100	0.918	100	0.992	100	0.900	100
14	1.553	100	1.036	100	0.600	100	0.468	100	0.869	100	0.753	100
15	1.265	100	0.709	100	0.531	100	0.999	100	0.823	100	0.981	100
16	1.060	100	1.195	100	0.416	100	1.036	100	0.729	100	0.720	100
17	1.362	100	1.143	100	1.141	100	1.118	100	1.337	100	1.362	100
18	1.217	100	0.926	100	0.610	100	0.450	100	0.649	100	0.926	100
19	1.899	100	1.972	100	1.462	100	1.205	100	1.477	100	1.714	100
20	0.968	100	0.920	100	0.825	100	0.447	100	0.641	100	0.555	100
21	1.329	100	1.264	100	0.727	100	0.476	100	1.493	100	0.963	100
22	1.378	100	1.211	100	0.675	100	0.485	100	0.646	100	0.926	100
23	1.998	100	2.274	100	2.019	100	1.411	100	1.469	100	1.761	100
24	1.512	100	0.534	100	0.768	100	1.291	100	1.506	100	1.382	100
25	1.345	100	0.592	100	0.595	100	1.265	100	1.549	100	0.886	100
26	1.289	100	0.849	100	0.795	100	1.571	100	1.384	100	1.082	100
27	1.612	100	0.597	100	0.576	100	1.354	100	0.990	100	1.044	100
28	1.360	100	1.124	100	0.617	100	0.541	100	0.805	100	0.673	100
29	1.131	100	0.500	100	0.688	100	1.253	100	0.996	100	0.864	100
30	1.311	100	0.605	100	0.716	100	1.101	100	1.012	100	0.944	100
31	-	-	-	-	-	-	-	-	-	-	-	-

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

Site →	Los Angeles		Salt Lake City		Miami		Minneapolis		Atlanta		Juneau	
SV ↓	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding
1	1.289	100	1.061	100	1.092	100	0.646	100	0.571	100	0.703	100
2	0.836	100	1.595	100	1.298	100	1.072	100	1.045	100	1.185	100
3	0.898	100	0.953	100	0.873	100	0.747	100	0.519	100	0.605	100
4	1.656	100	1.527	100	1.012	100	1.129	100	0.820	100	0.782	100
5	0.562	100	1.052	100	0.544	100	0.505	100	0.437	100	0.473	100
6	1.356	100	1.208	100	1.065	100	1.322	100	0.823	100	0.745	100
7	1.172	100	1.149	100	0.628	100	0.797	100	0.346	100	0.473	100
8	0.974	100	1.159	100	0.752	100	1.059	100	0.424	100	0.543	100
9	0.876	100	1.005	100	1.017	100	0.928	100	0.747	100	0.828	100
10	0.589	100	0.914	100	0.488	100	0.716	100	0.386	100	0.492	100
11	0.683	100	0.834	100	1.185	100	0.605	100	0.536	100	0.641	100
12	-	-	-	-	-	-	-	-	-	-	-	-
13	1.067	100	1.096	100	0.830	100	0.801	100	0.453	100	0.589	100
14	0.683	100	1.069	100	0.711	100	0.544	100	0.526	100	0.725	100
15	0.800	100	1.031	100	0.861	100	0.869	100	0.445	100	0.361	100
16	0.652	100	0.907	100	0.635	100	0.701	100	0.579	100	0.585	100
17	1.169	100	1.705	100	1.088	100	0.988	100	0.926	100	1.007	100
18	0.711	100	1.031	100	0.678	100	0.796	100	0.452	100	0.578	100
19	1.248	100	1.745	100	1.363	100	1.564	100	1.560	100	1.597	100
20	0.543	100	0.867	100	0.801	100	0.623	100	0.779	100	0.694	100
21	0.676	100	1.240	100	2.070	100	0.845	100	0.947	100	0.834	100
22	0.539	100	1.242	100	1.546	100	0.663	100	0.859	100	0.749	100
23	1.300	100	2.145	100	1.907	100	1.687	100	1.691	100	1.616	100
24	1.175	100	1.230	100	0.998	100	1.414	100	0.828	100	0.752	100
25	1.203	100	1.077	100	1.094	100	0.884	100	0.539	100	0.555	100
26	0.959	100	1.288	100	0.929	100	1.154	100	0.868	100	0.800	100
27	1.127	100	1.533	100	0.936	100	0.865	100	0.642	100	0.780	100
28	0.538	100	1.036	100	0.991	100	0.673	100	0.627	100	0.579	100
29	0.839	100	0.886	100	0.887	100	0.924	100	0.551	100	0.595	100
30	1.226	100	1.036	100	1.062	100	1.061	100	0.879	100	0.883	100
31	-	-	-	-	-	-	-	-	-	-	-	-

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



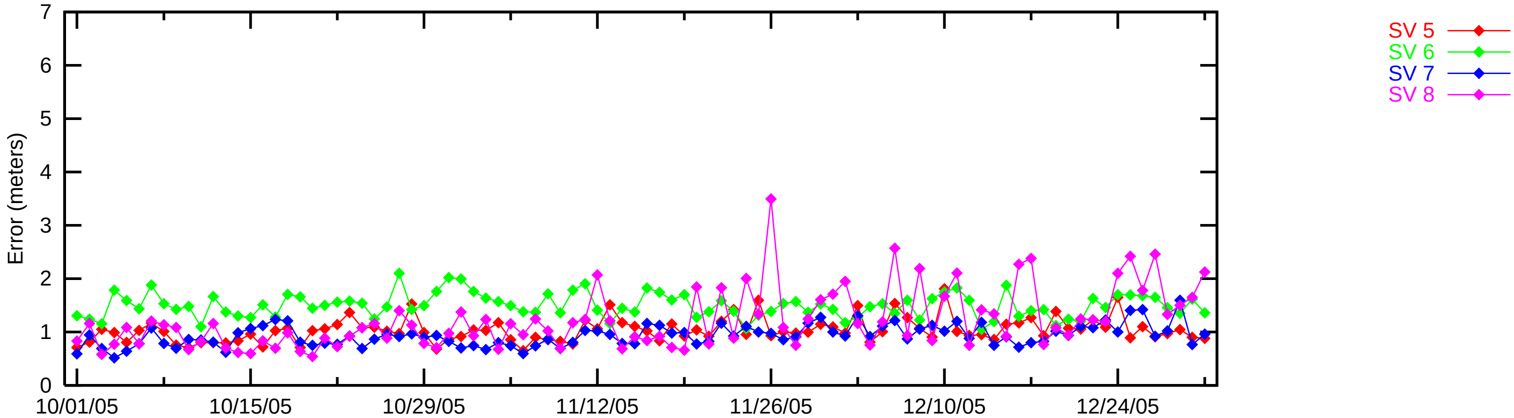
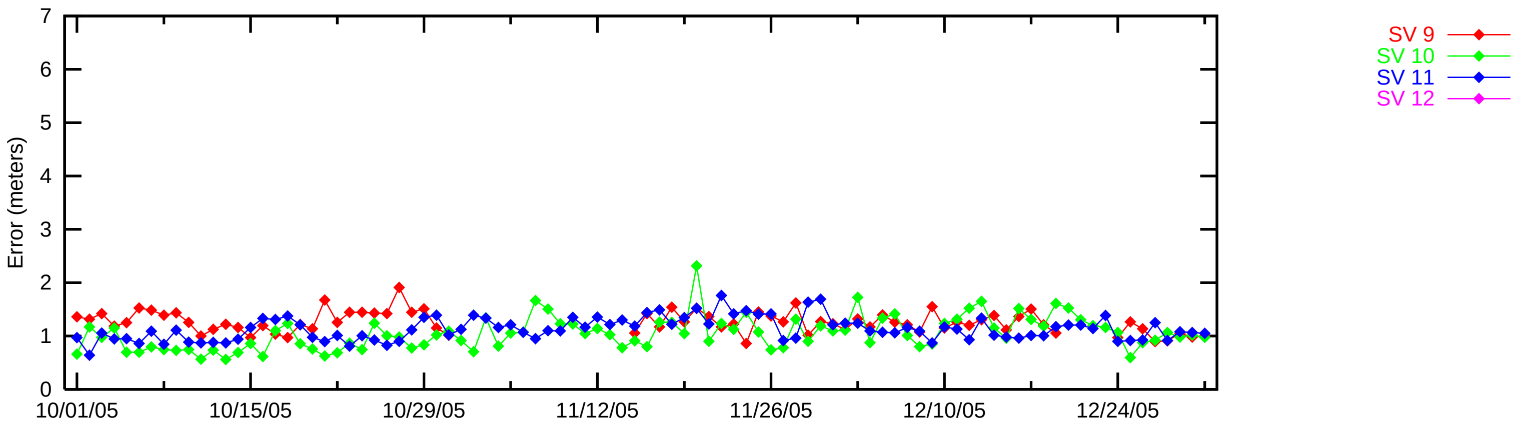


Figure 6-2 95% Range Error (SV 17 --SV 31 and SV 122) - Washington, DC



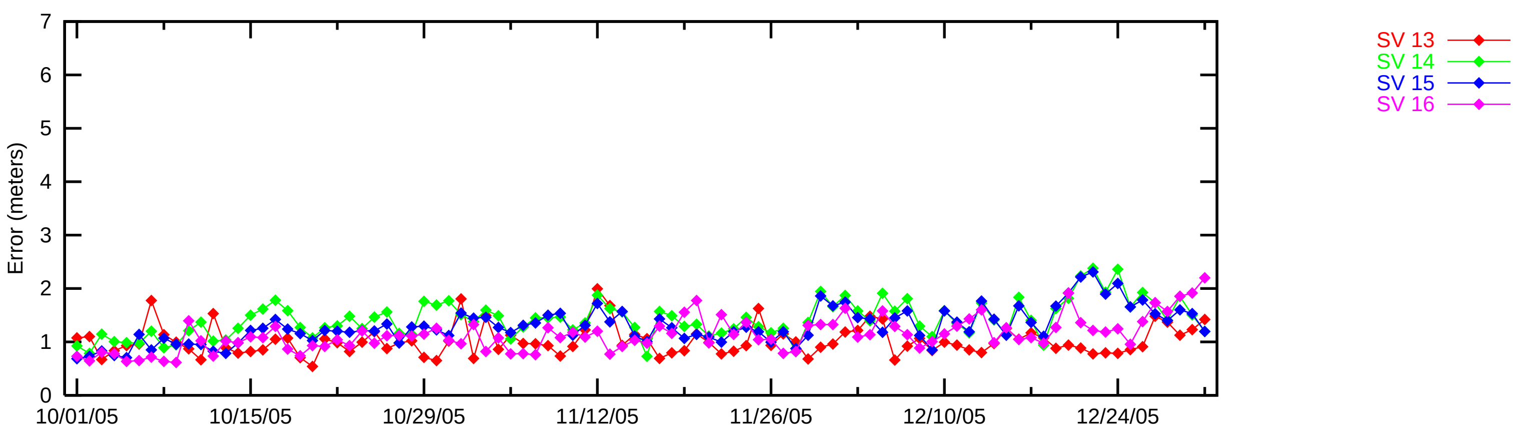


Figure 6-2 95% Range Error (SV 17 --SV 31 and SV 122) - Washington, DC

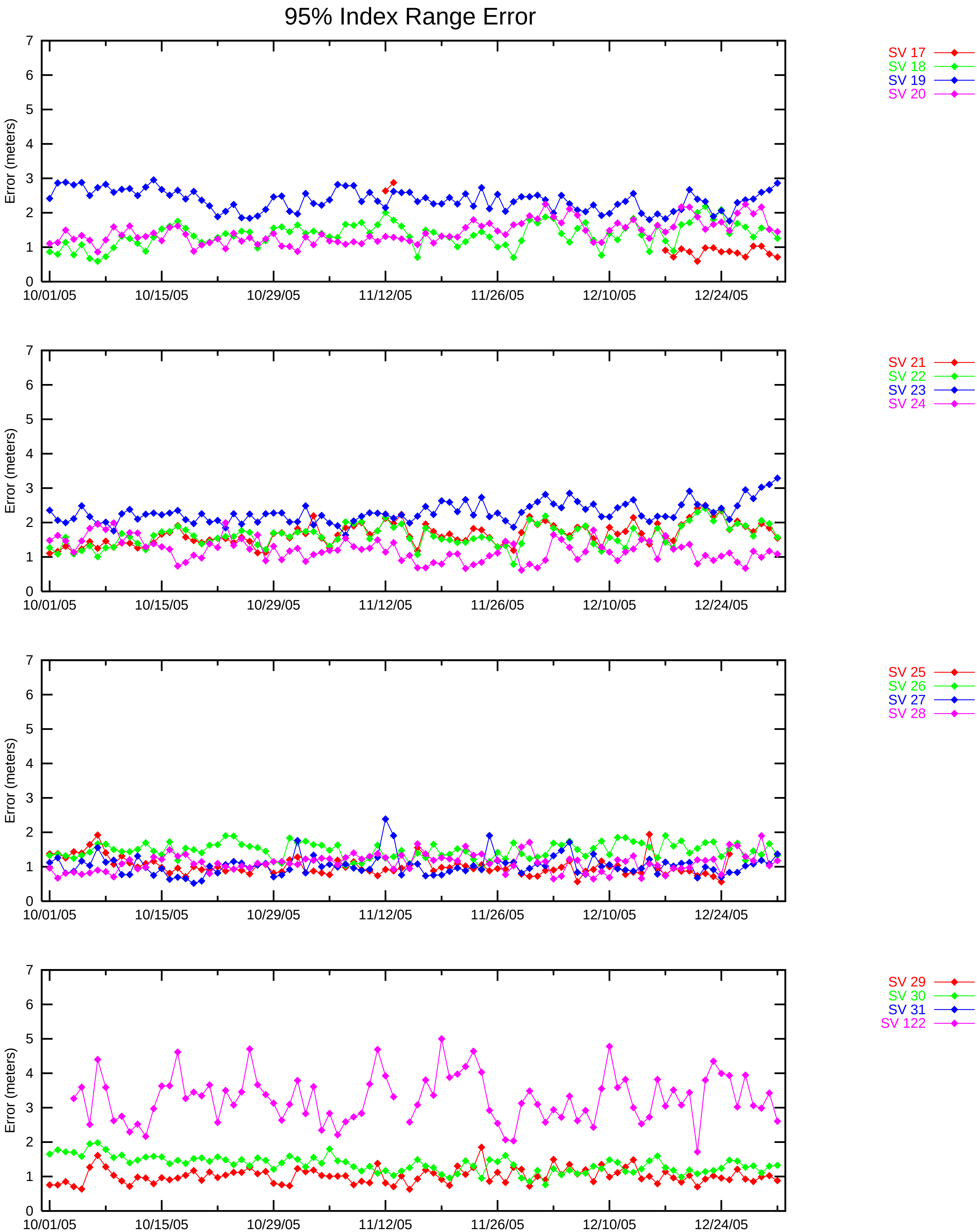


Figure 6-3 95% Ionospheric Error (SV 1 --SV 16) - Washington, DC

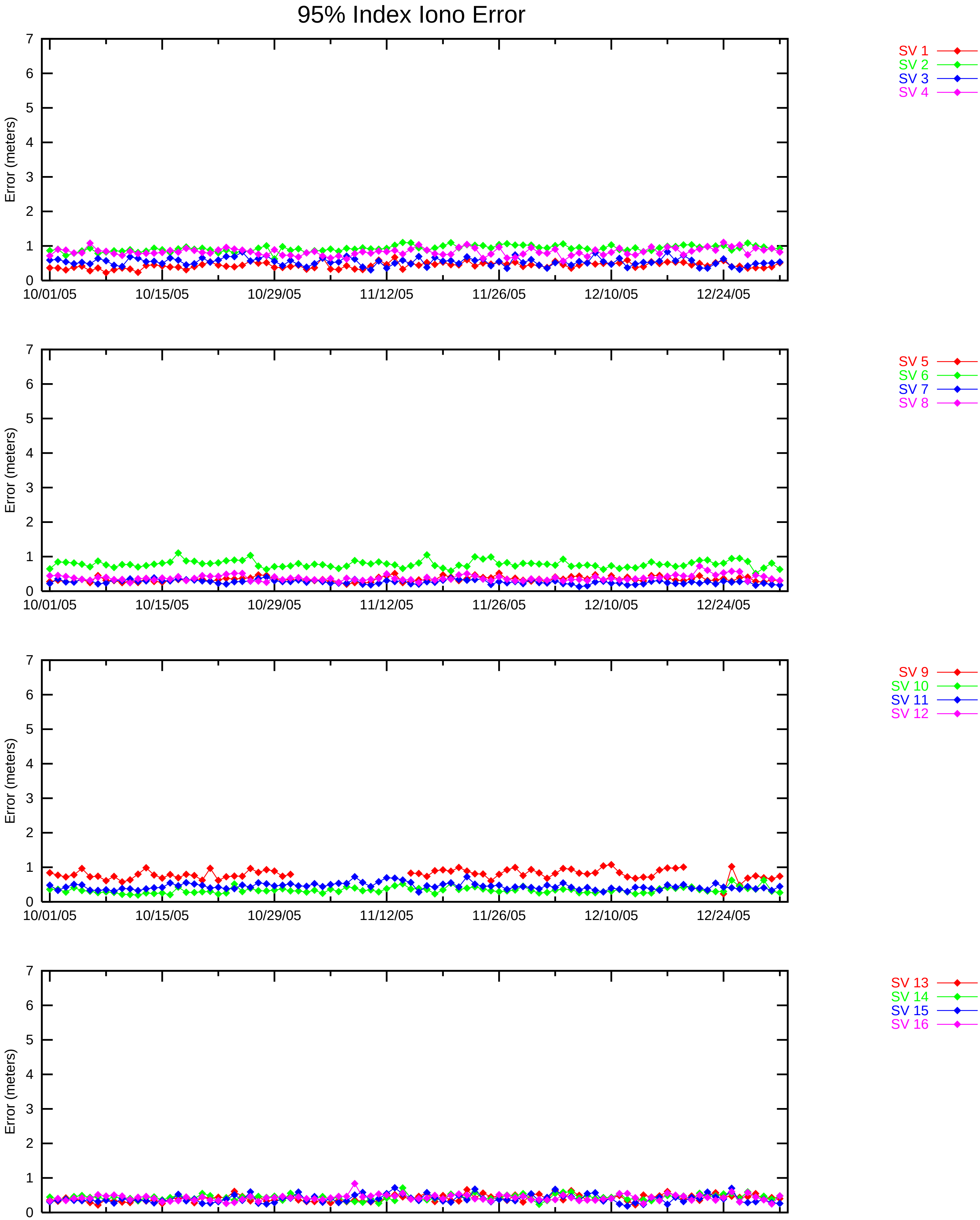
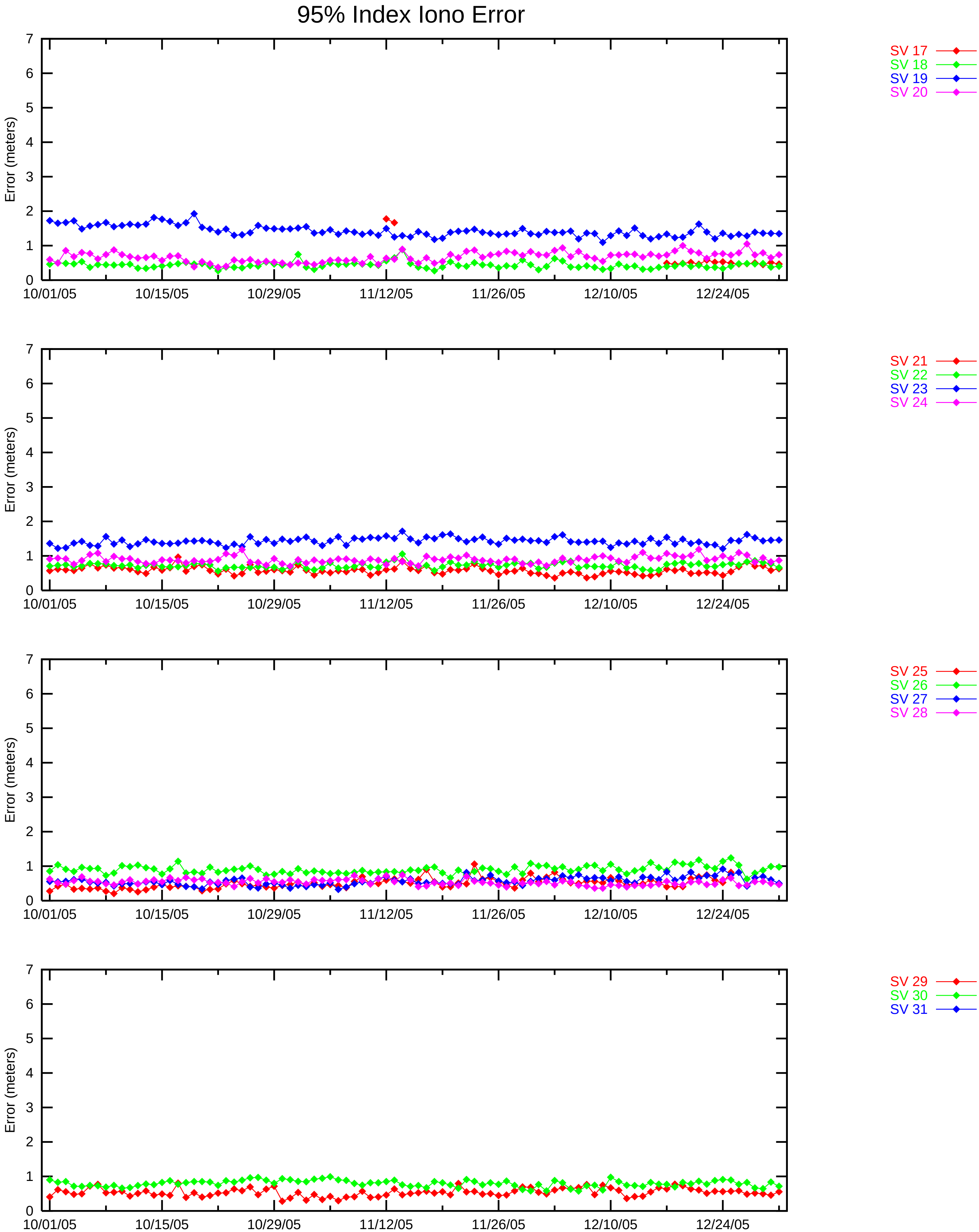


Figure 6-4 95% Ionospheric Error (SV 17 --SV 31) - Washington, DC



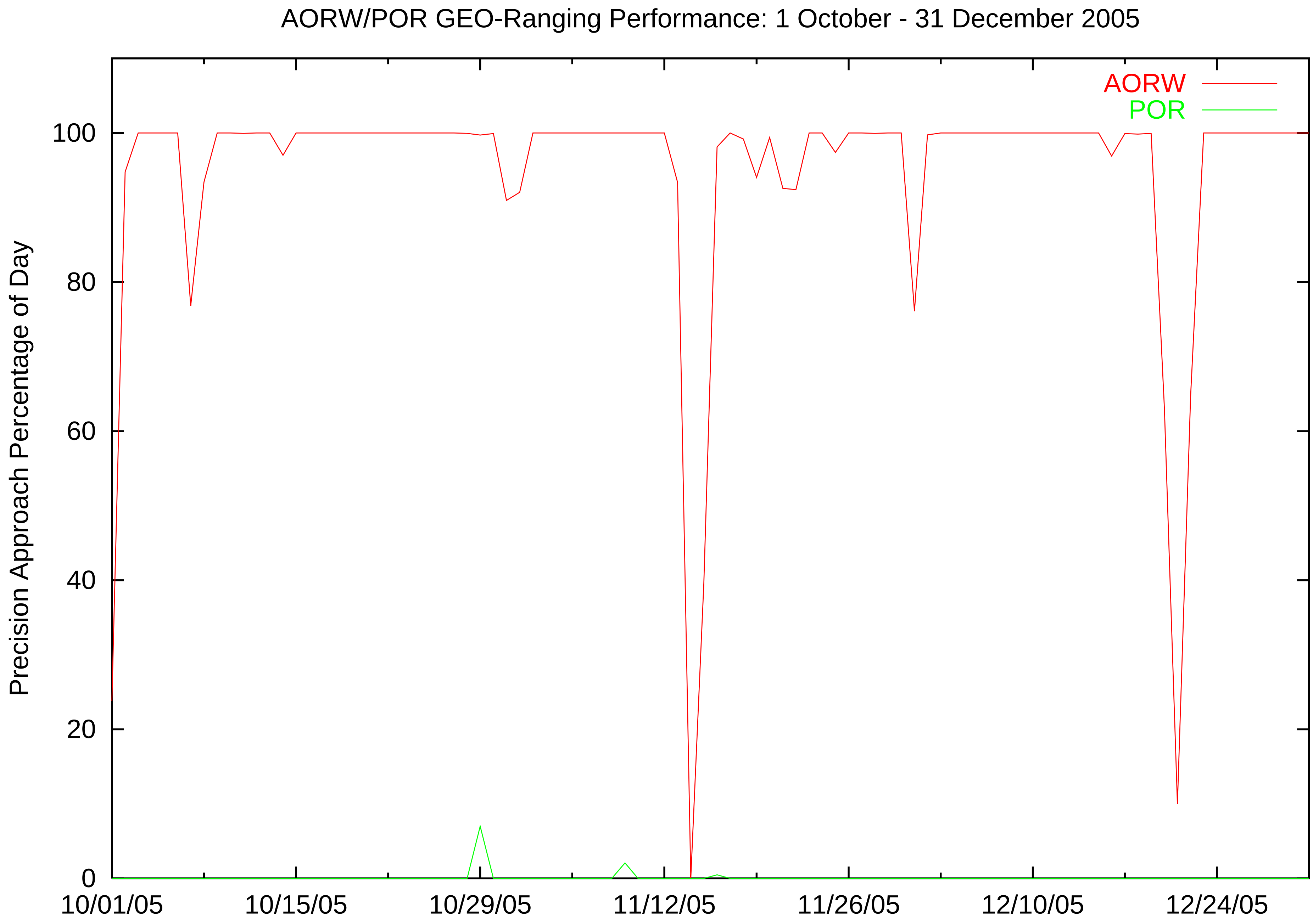
7.0 GEO RANGING PERFORMANCE

Table 7.1 shows the GEO-Ranging performance for AORW and POR satellites throughout the evaluated period. The percentage of PA ranging availability (i.e. the percentage of time a user receiver can use the GEO as a ranging source in a LNAV/VNAV or LPV position solution) for the AORW and POR is 85.670% and 0.779%, respectively. Figure 7.1 shows the trend of PA Ranging Availability for the AORW and POR satellite. The percentage of time the AOR-W GEO was available for PA ranging is lower this quarter than expected. The reason is thread switching by key WRSs and poor WRS receiver performance. The large drops in PA ranging availability for the AORW satellite is due to GUS switchovers. As in the past, the POR satellite as a ranging source has very low PA availability.

Table 7-1 GEO Ranging Availability

GEO	PA (%)	NPA (%)	Not Monitored (%)	Do Not Use (%)
AORW	94.395	4.857	0.357	0.389
POR	0.104	91.481	7.789	0.625

Figure 7-1 Daily PA GEO Ranging Availability Trend



8.0 WAAS PROBLEM SUMMARY

November 13, 2005 – There were some AORW SIS outages on this day.

December 1, 2005 – AORW and POR were having unusually high numbers of alerts. This anomaly had no effect on the WAAS SIS performance in either PA or NPA.

December 3, 2005 – The POR GEO had a series of short broadcast gaps. Brief losses of PA and NPA service availability occurred at WAAS sites that use POR as their primary GEO.

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 7/3/05 to 10/1/05 of WAAS operation is presented in Table 9.1. Figures 9.1 and 9.2 provide a graphical representation of WAAS LPV service availability and outage counts for the same period, respectively.

Table 9-1 WAAS LPV Outages and Availability

Airport Id	Airport Name	City	State	Outages	Availability
YEG	EDMONTON INTL	EDMONTON	AB	73	0.994501
CGA	CRAIG	CRAIG	AK	89	0.991867
HYD	HKDER	HKDER	AK	93	0.992112
JNU	JUNEAU INTL AIRPORT	JUNEAU	AK	377	0.960919
KTN	KETCHIKAN AIRPORT	KETCHIKAN	AK	77	0.993205
PEC	PELICAN	PELICAN	AK	352	0.963720
PSG	PETERSBURG MUNICIPAL	PETERSBURG	AK	190	0.984439
SIT	SITKA AIRPORT	SITKA	AK	273	0.978282
EET	SHELBY COUNTY	ALABASTER	AL	4	0.999907
79J	ANDALUSIA-OPP	ANDALUSIA/OP	AL	4	0.999907
KBHM	BIRMINGHAM INTL	BIRMINGHAM	AL	4	0.999907
KDHN	DOTHAN REGIONAL	DOTHAN	AL	4	0.999907
HSV	HUNTSVILLE INTL - CARL T JONES FIELD	HUNTSVILLE	AL	4	0.999909
MOB	MOBILE REGIONAL	MOBILE	AL	4	0.999907
MGM	MONTGOMERY REGIONAL/ DANNELLY FIELD	MONTGOMERY	AL	4	0.999907
MSL	MUSCLE SHOALS NORTWEST ALABAMA REGIONAL	SHEFFIELD	AL	4	0.999909
M73	ALMYRA	ALMYRA	AR	4	0.999909
KVBT	BENTONVILLE MUNICIPAL/ LM THADDEN FIELD	BENTONVILLE	AR	4	0.999909
BYH	BLYTHEVILLE	BLYTHEVILLE	AR	4	0.999909
CDH	HARRELL FIELD	CAMDEN	AR	4	0.999909
KXNA	NORTHWEST ARKANSAS REGIONAL	FAYETTEVILLE/ SPRINGDALE/ROGERS	AR	4	0.999909
KFSM	FORT SMITH REGIONAL	FORT SMITH	AR	4	0.999909
HRO	BOONE COUNTY AIRPORT	HARRISON	AR	4	0.999909
LIT	ADAMS FIELD	LITTLE ROCK	AR	4	0.999909
SRC	SEARCY MUNICIPAL	SEARCY	AR	4	0.999909
ASG	SPRINGDALE MUNICIPAL	SPRINGDALE	AR	4	0.999909

KARG	WALNUT RIDGE REGIONAL	WALNUT RIDGE	AR	4	0.999909
IFP	LAUGHLIN/BULLHEAD INTL	BULLHEAD CITY	AZ	24	0.997409
KGCN	GRAND CANYON NATL PARK	GRAND CANYON	AZ	14	0.998884
KPHX	PHOENIX SKY HARBOR INTL	PHOENIX	AZ	38	0.995814
KPRC	ERNEST A LOVE FIELD	PRESCOTT	AZ	24	0.997875
KTUS	TUCSON INTL	TUCSON	AZ	137	0.984823
RQE	WINDOW ROCK	WINDOW ROCK	AZ	12	0.999519
BFL	BAKERSFIELD/MEADOWS FIELD	BAKERSFIELD	CA	127	0.981640
KCRQ	MC CLELLAN-PALOMAR	CARLSBAD	CA	158	0.960631
O60	CLOVERDALE MUNICIPAL	CLOVERDALE	CA	40	0.995267
KDAG	BARSTOW-DAGGETT	DAGGETT	CA	87	0.993186
IYK	INYOKERN	INYOKERN	CA	94	0.991859
KLAX	LOS ANGELES INTL	LOS ANGELES	CA	152	0.966374
KOAK	METROPOLITAN OAKLAND INTL	OAKLAND	CA	50	0.987780
ONT	ONTARIO INTL	ONTARIO	CA	144	0.975877
KPMD	PALMDALE PROD FLT/ TEST INSTLN	PALMDALE	CA	118	0.981720
KMHR	SACRAMENTO MATHER	SACRAMENTO	CA	19	0.997138
KSMF	SACRAMENTO INTL	SACRAMENTO	CA	18	0.997152
SAN	SAN DIEGO INTL-LINDBERGH FIELD	SAN DIEGO	CA	194	0.945404
KSFO	SAN FRANCISCO INTL	SAN FRANCISCO	CA	53	0.985843
SJC	SAN JOSE INTL	SAN JOSE	CA	51	0.985730
SVE	SUSANVILLE MUNICIPAL	SUSANVILLE	CA	11	0.998643
TNP	TWENTYNINE PALMS	TWENTYNINE PALMS	CA	106	0.991129
AKO	AKRON-COLORADO PLAINS REGIONAL	AKRON	CO	5	0.999893
COS	COLORADO SPRINGS	COLORADO SPRINGS	CO	5	0.999893
CEZ	CORTEZ MUNICIPAL	CORTEZ	CO	5	0.999833
KDEN	DENVER INTL	DENVER	CO	5	0.999893
HDN	YAMPA VALLEY	HAYDEN	CO	5	0.999848
LHX	LA JUNTA MUNICIPAL	LA JUNTA	CO	5	0.999893
LAA	LAMAR MUNICIPAL	LAMAR	CO	5	0.999893
2V2	VANCE BRAND	LONGMONT	CO	5	0.999893
EEO	MEEKER	MEEKER	CO	5	0.999848
TAD	PERRY STOKES	TRINIDAD	CO	5	0.999812
2V5	WRAY	WRAY	CO	5	0.999893
KBDL	BRADLEY INTL	WINDSOR LOCKS	CT	9	0.999823
KDCA	RONALD REAGAN WASHINGTON INTL	WASHINGTON	DC	4	0.999907
KIAD	WASHINGTON DULLES INTL	WASHINGTON	DC	4	0.999907
KFLL	FORT LAUDERDALE/ HOLLYWOOD INTL	FORT LAUDERDALE	FL	21	0.999328
FXE	FORT LAUDERDALE EXECUTIVE AIRPORT	FORT LAUDERDALE	FL	17	0.999492
KRSW	SOUTHWEST FLORIDA INTL	FORT MYERS	FL	13	0.999665
KGNV	GAINESVILLE REGIONAL	GAINESVILLE	FL	4	0.999907
KJAX	JACKSONVILLE INTL	JACKSONVILLE	FL	4	0.999907
KMIA	MIAMI INTL	MIAMI	FL	26	0.999111
KAPF	NAPLES MUNICIPAL	NAPLES	FL	17	0.999426
KOCF	OCALA INTL-JIM TAYLOR FIELD	OCALA	FL	4	0.999907
KMCO	ORLANDO INTL	ORLANDO	FL	4	0.999907
KPFN	PANAMA CITY-BAY COUNTY INTL	PANAMA CITY	FL	4	0.999907
KPNS	PENSACOLA REGIONAL	PENSACOLA	FL	4	0.999907

SRQ	SARASOTA/BRADENTON INTL	SARASOTA/BRADENTON	FL	7	0.999800
KPIE	ST PETERSBURG-CLEARWATER INTL	ST PETERSBURG-CLEARWATER	FL	5	0.999870
KTLH	TALLAHASSEE REGIONAL	TALLAHASSEE	FL	4	0.999907
TPA	TAMPA INTL	TAMPA	FL	5	0.999870
KVRB	VERO BEACH MUNICIPAL	VERO BEACH	FL	4	0.999907
KPBI	PALM BEACH INTL	WEST PALM BEACH	FL	11	0.999651
KACJ	SOUTHER FIELD	AMERICUS	GA	4	0.999907
KATL	WILLIAM B HARTSFIELD ATLANTA INTL	ATLANTA	GA	4	0.999907
KSAV	SAVANNAH INTL	SAVANNAH	GA	4	0.999907
KTBR	STATESBORO-BULLOCH COUNTY	STATESBORO	GA	4	0.999907
KIKV	ANKENY REGIONAL	ANKENY	IA	4	0.999909
CID	THE EASTERN IOWA	CEDAR RAPIDS	IA	4	0.999909
DSM	DES MOINES INTL	DES MOINES	IA	4	0.999909
KMXO	MONTICELLO REGIONAL	MONTICELLO	IA	4	0.999909
KBOI	BOISE AIR TERMINAL/ GOWEN FIELD	BOISE	ID	4	0.999915
EUL	CALDWELL INDUSTRIAL	CALDWELL	ID	4	0.999921
SUN	FRIEDMAN MEMORIAL	HAILEY	ID	4	0.999901
PIH	POCATELLO REGIONAL	POCATELLO	ID	3	0.999916
SZT	SANDPOINT	SANDPOINT	ID	8	0.999615
KENL	CENTRALIA MUNICIPAL	CENTRALIA	IL	4	0.999909
KORD	CHICAGO-O'HARE INTL	CHICAGO	IL	4	0.999907
MDW	CHICAGO MIDWAY	CHICAGO	IL	4	0.999907
KARR	AURORA MUNICIPAL	CHICAGO/AURORA	IL	4	0.999909
KFOA	FLORA MUNICIPAL	FLORA	IL	4	0.999909
MLI	QUAD-CITY	MOLINE	IL	4	0.999909
KPIA	GREATER PEORIA REGIONAL	PEORIA	IL	4	0.999909
KPPQ	PITTSFIELD PENSTONE MUNICIPAL	PITTSFIELD	IL	4	0.999909
KTIP	RANTOUL NATL AVN CTR/ FRANK ELLIOT FIELD	RANTOUL	IL	4	0.999909
KRFD	GREATER ROCKFORD	ROCKFORD	IL	4	0.999909
KSLO	SALEM-LECKRONE	SALEM	IL	4	0.999909
3CK	LAKE IN THE HILLS	UNKNOWN	IL	4	0.999908
KANQ	TRI-STATE STEUBEN COUNTY	ANGOLA	IN	3	0.999923
KBMG	MONROE COUNTY	BLOOMINGTON	IN	4	0.999909
0I2	BRAZIL CLAY COUNTY	BRAZIL	IN	4	0.999909
CEV	METTEL FIELD	CONNERSVILLE	IN	3	0.999923
FWA	FORT WAYNE INTL	FORT WAYNE	IN	3	0.999923
KIND	INDIANAPOLIS INTL	INDIANAPOLIS	IN	4	0.999908
SER	FREEMAN MUNICIPAL	SEYMOUR	IN	4	0.999909
SBN	MICHIANA REGIONAL TRANSPORTATION CTR	SOUTH BEND	IN	4	0.999908
KCBK	SHALTZ FIELD	COLBY	KS	5	0.999893
EHA	ELKHART-MORTON COUNTY	ELKHART	KS	5	0.999893
GLD	RENNER FIELD/ GOODLAND MUNICIPAL	GOODLAND	KS	5	0.999893
KHYS	HAYS REGIONAL	HAYS	KS	4	0.999909
LWC	LAWRENCE MUNICIPAL	LAWRENCE	KS	4	0.999909
KMHK	MANHATTAN REGIONAL	MANHATTAN	KS	4	0.999909
KOJC	JOHNSON COUNTY EXECUTIVE	OLATHE	KS	4	0.999909
TOP	PHILIP BILLARD MUNICIPAL	TOPEKA	KS	4	0.999909

KULS	ULYSSES	ULYSSES	KS	5	0.999893
ICT	WICHITA MID-CONTINENT	WICHITA	KS	4	0.999909
KWLD	STROTHER FIELD	WINFIELD/ARKANSAS CITY	KS	4	0.999909
KCVG	CINCINNATI/NORTHERN KY INTL	COVINGTON/CINCINNATI	KY	3	0.999923
KLEX	BLUE GRASS	LEXINGTON	KY	3	0.999923
LOZ	LONDON	LONDON	KY	3	0.999923
SDF	LOUISVILLE INTL- STANDIFORD FIELD	LOUISVILLE	KY	3	0.999925
KK22	BIG SANDY REGIONAL	PRESTONBURG	KY	3	0.999923
SME	SOMERSET-PULASKI COUNTY	SOMERSET	KY	3	0.999923
KAEX	ALEXANDRIA INTL	ALEXANDRIA	LA	4	0.999907
DRI	DE RIDDER/ BEAUREGARD PAIRISH APT	BEAUREGARD	LA	5	0.999891
LCH	LAKE CHARLES REGIONAL	LAKE CHARLES	LA	7	0.999740
L39	LEESVILLE	LEESVILLE	LA	4	0.999907
MSY	NEW ORLEANS INTL/ MOISANT FIELD	NEW ORLEANS	LA	5	0.999891
SHV	SHREVEPORT REGIONAL	SHREVEPORT	LA	4	0.999907
KBOS	GEN EDWARD LAWRENCE LOGAN INTL	BOSTON	MA	24	0.999113
MVY	VINEYARD HAVEN	MARTHA'S VINEYARD	MA	31	0.998726
OWD	NORWOOD MEMORIAL	NORWOOD	MA	23	0.999204
KPVC	PROVINCETOWN MUNICIPAL	PROVINCETOWN	MA	38	0.997990
YWG	WINNIPEG AIRPORT	WINNIPEG	MB	149	0.985633
KBWI	BALTIMORE-WASHINGTON INTL	BALTIMORE	MD	4	0.999907
FDK	FREDERICK MUNICIPAL	FREDERICK	MD	4	0.999907
GAI	MONTGOMERY COUNTY AIRPARK	GAITHERSBURG	MD	4	0.999907
W00	FREEWAY	MITCHELLVILLE	MD	4	0.999907
RJD	RIDGELY AIRPARK	RIDGELY	MD	4	0.999907
DMW	CARROLL CNTY REGIONAL/ JACK B. POAGE FIELD	WESTMINSTER	MD	4	0.999907
PWM	PORTLAND INTL JETPORT	PORTLAND	ME	96	0.996087
KPQI	N MAINE RGNL ARPT AT PRESQUE I	PRESQUE ISLE	ME	634	0.843473
AMN	ALMA/GRATIOT COMMUNITY	ALMA	MI	3	0.999923
KARB	ANN ARBOR MUNICIPAL	ANN ARBOR	MI	3	0.999923
Y15	CHEBOYGAN COUNTY	CHEBOYGAN	MI	53	0.998563
KDTW	DETROIT METROPOLITAN WAYNE CTY	DETROIT	MI	3	0.999923
KFNT	BISHOP INTL	FLINT	MI	3	0.999923
KGRR	GERALD R FORD INTL	GRAND RAPIDS	MI	3	0.999923
KCMX	HOUGHTON COUNTY MEMORIAL	HANCOCK	MI	156	0.981833
BIV	TULIP CITY	HOLLAND	MI	3	0.999923
HTL	ROSCOMMON COUNTY	HOUGHTON LAKE	MI	4	0.999907
KMKG	MUSKEGON COUNTY	MUSKEGON	MI	4	0.999908
5D3	OWOSSO COMMUNITY	OWOSSO	MI	3	0.999923
KMBS	MBS INTL	SAGINAW	MI	3	0.999923
CIU	CHIPPEWA COUNTY INTL	SAULT STE. MARIE	MI	110	0.994161
HAI	THREE RIVERS MUNICIPAL DR. HAINES	UNKNOWN	MI	3	0.999923
HYX	SAGINAW CO H.W. BROWNE	UNKNOWN	MI	3	0.999923
KAXN	CHANDLER FIELD	ALEXANDRIA	MN	8	0.999815
KBDE	BAUDETTE INTL	BAUDETTE	MN	95	0.994204

KBRD	BRAINERD-CROW WING CO REGIONAL	BRAINERD	MN	46	0.998047
KDLH	DULUTH INTL	DULUTH	MN	70	0.994453
KMSP	MINNEAPOLIS-ST PAUL INTL/ WOLD CHAMBERLAIN	MINNEAPOLIS	MN	4	0.999907
KRGK	RED WING REGIONAL	RED WING	MN	4	0.999908
KRST	ROCHESTER INTL	ROCHESTER	MN	4	0.999909
STC	ST. CLOUD	SAINT CLOUD	MN	4	0.999907
KJYG	ST JAMES MUNICIPAL	ST JAMES	MN	4	0.999909
M05	CARUTHERSVILLE MEMORIAL	CARUTHERSVILLE	MO	4	0.999909
KMCI	KANSAS CITY INTL	KANSAS CITY	MO	4	0.999909
KLBO	FLOYD W JONES LEBANON	LEBANON	MO	4	0.999909
LXT	LEE'S SUMMIT MUNICIPAL	LEE'S SUMMIT	MO	4	0.999909
H41	MEXICO MEMORIAL	MEXICO	MO	4	0.999909
MYJ	MEXICO MEMORIAL	MEXICO	MO	4	0.999909
STJ	ROSECRANS MEMORIAL	ROSECRANS	MO	4	0.999909
KDMO	SEDALIA MEMORIAL	SEDALIA	MO	4	0.999909
SGF	SPRINGFIELD-BRANSON REGIONAL	SPRINGFIELD	MO	4	0.999909
KSTL	LAMBERT-ST LOUIS INTL	ST LOUIS	MO	4	0.999909
KMO6	WASHINGTON MEMORIAL	WASHINGTON	MO	4	0.999909
0M6	PANOLA COUNTY	BATESVILLE	MS	4	0.999909
GWO	GREENWOOD-LEFLORE	GREENWOOD	MS	4	0.999909
JAN	JACKSON INTL	JACKSON	MS	4	0.999907
MPE	PHILADELPHIA MUNICIPAL	PHILADELPHIA	MS	4	0.999909
CRX	ROSCOE TURNER	UNKNOWN	MS	4	0.999909
KBIL	BILLINGS LOGAN INTL	BILLINGS	MT	5	0.999771
6S5	RAVALLI COUNTY	HAMILTON	MT	4	0.999760
KHLN	HELENA REGIONAL	HELENA	MT	4	0.999769
KLWT	LEWISTOWN MUNICIPAL	LEWISTOWN	MT	6	0.999515
KMLS	FRANK WILEY FIELD	MILES CITY	MT	6	0.999730
KHBI	ASHEBORO MUNICIPAL	ASHEBORO	NC	4	0.999907
KAVL	ASHEVILLE REGIONAL	ASHEVILLE	NC	4	0.999907
MRH	MICHAEL J. SMITH FIELD	BEAUFORT	NC	4	0.999906
KCLT	CHARLOTTE/DOUGLAS INTL	CHARLOTTE	NC	4	0.999907
ECG	ELIZABETH CITY CGAS	ELIZABETH CITY	NC	4	0.999906
KFAY	FAYETTEVILLE RGNL/ GRANNIS FIELD	FAYETTEVILLE	NC	4	0.999907
GSO	PIEDMONT TRIAD INTL	GREENSBORO	NC	4	0.999907
PGV	PITT-GREENVILLE	GREENVILLE	NC	4	0.999907
HSE	BILLY MITCHELL	HATTERAS	NC	4	0.999906
HKY	HICKORY REGIONAL	HICKORY	NC	4	0.999907
KISO	KINSTON REGIONAL JETPORT AT STALLINGS FIELD	KINSTON	NC	4	0.999907
MEB	LAURINBURG	MAXTON	NC	4	0.999907
KEQY	MONROE	MONROE	NC	4	0.999907
KRDU	RALEIGH-DURHAM INTL	RALEIGH/DURHAM	NC	4	0.999907
RWI	ROCKY MOUNT-WILSON REGIONAL	ROCKY MOUNT	NC	4	0.999907
KRUQ	ROWAN COUNTY	SALISBURY	NC	4	0.999907
KTTA	SANFORD-LEE COUNTY RGNL	SANFORD	NC	4	0.999907
SUT	BRUNSWICK COUNTY	SOUTHPORT	NC	4	0.999907
OCW	WARREN FIELD	WASHINGTON	NC	4	0.999907
MCZ	MARTIN COUNTY	WILLIAMSTON	NC	4	0.999907

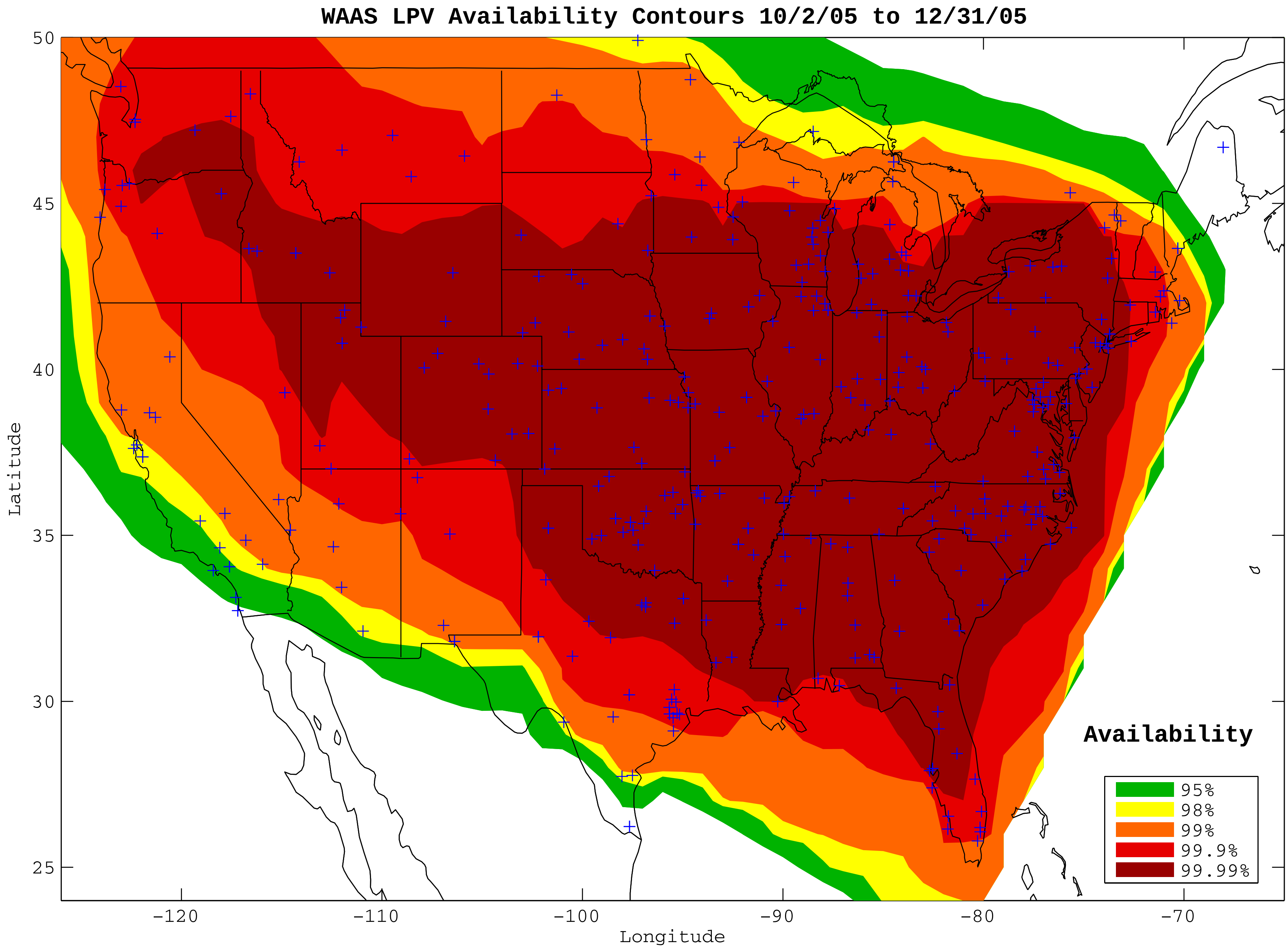
KILM	WILMINGTON INTL	WILMINGTON	NC	4	0.999907
W03	WILSON INDUSTRIAL AIR CTR	WILSON	NC	4	0.999907
KFAR	HECTOR INTL	FARGO	ND	41	0.998218
MOT	MINOT INTL AIRPORT	MINOT	ND	21	0.999060
KANW	AINSWORTH MUNICIPAL	AINSWORTH	NE	4	0.999909
AUH	AURORA MUNICIPAL	AURORA	NE	4	0.999909
BIE	BEATRICE MUNICIPAL	BEATRICE	NE	4	0.999909
CSB	CAMBRIDGE MUNICIPAL	CAMBRIDGE	NE	4	0.999909
CEK	CRETE MUNICIPAL	CRETE	NE	4	0.999909
GRN	GORDON MUNICIPAL	GORDON	NE	5	0.999893
KEAR	KEARNEY MUNICIPAL	KEARNEY	NE	4	0.999909
KLBF	NORTH PLATTE RGNL LEE BIRD FLD	NORTH PLATTE	NE	4	0.999909
OMA	EPPLEY AIRFIELD	OMAHA	NE	4	0.999909
OKS	GARDEN COUNTY	OSHKOSH	NE	5	0.999893
SCB	SCRIBNER STATE	SCRIBNER	NE	4	0.999909
SNY	SIDNEY MUNICIPAL	SIDNEY	NE	5	0.999893
VTN	MILLER FIELD	VALENTINE	NE	4	0.999909
MHT	MANCHESTER	MANCHESTER	NH	18	0.999302
KACY	ATLANTIC CITY INTL	ATLANTIC CITY	NJ	4	0.999906
KMMU	MORRISTOWN MUNICIPAL	MORRISTOWN	NJ	4	0.999906
KEWR	NEWARK INTL	NEWARK	NJ	4	0.999906
7N7	SPITFIRE AERODROM	PEDRICTOWN	NJ	4	0.999907
K3NJ6	INDUCTOTHERM HELIPORT	RANCOCAS	NJ	4	0.999906
KABQ	ALBUQUERQUE INTL SUNPORT	ALBUQUERQUE	NM	5	0.999778
KFMN	FOUR CORNERS RGNL	FARMINGTON	NM	7	0.999781
KLRU	LAS CRUCES INTL	LAS CRUCES	NM	22	0.997510
ELY	ELY AIRPORT/YELLAND FELD	ELY	NV	5	0.999833
KLAS	MC CARRAN INTL	LAS VEGAS	NV	17	0.998256
ALB	ALBANY INTL	ALBANY	NY	4	0.999896
BUF	BUFFALO NIAGARA INTL	BUFFALO	NY	3	0.999923
KELM	ELMIRA/CORNING RGNL	ELMIRA	NY	3	0.999923
LGA	LA GUARDIA	FLUSHING	NY	4	0.999906
GFL	FLOYD BENNETT MEMORIAL	GLENS FALLS	NY	9	0.999791
KJHW	CHAUTAUQUA COUNTY/ JAMESTOWN	JAMESTOWN	NY	3	0.999923
LKP	LAKE PLACID	LAKE PLACID	NY	5	0.999871
KJFK	JOHN F KENNEDY INTL	NEW YORK	NY	5	0.999890
KSWF	STEWART INTL	NEWBURGH	NY	4	0.999906
PBG	PLATTSGURGH INTL	PLATTSGURGH	NY	8	0.999730
ROC	GREATER ROCHESTER INTL	ROCHESTER	NY	3	0.999923
KSYR	SYRACUSE HANCOCK INTL	SYRACUSE	NY	3	0.999923
B16	WHITFORDS	WEEDSPORT	NY	3	0.999923
FOK	THE FRANCIS S. GABRESKI	WESTHAMPTON BEACH	NY	5	0.999890
HPN	WESTCHESTER COUNTY	WHITE PLAINS	NY	5	0.999890
4F5	BELLEFONTAINE MUNICIPAL AIRPORT	BELLEFONTAINE	OH	3	0.999923
KRZT	ROSS COUNTY	CHILLICOTHE	OH	3	0.999923
KCLE	CLEVELAND-HOPKINS INTL	CLEVELAND	OH	3	0.999923
KCMH	PORT COLUMBUS INTL	COLUMBUS	OH	3	0.999923
OSU	OHIO STATE UNIVERSITY	COLUMBUS	OH	3	0.999923
KDAY	JAMES M COX DAYTON INTL	DAYTON	OH	3	0.999923
1G5	MEDINA MUNICIPAL	MEDINA	OH	3	0.999923
KTOL	TOLEDO EXPRESS	TOLEDO	OH	3	0.999923

I68	LEBANON-WARREN COUNTY	UNKNOWN	OH	3	0.999923
KAVK	ALVA RGNL	ALVA	OK	4	0.999909
KCQB	CHANDLER MUNICIPAL	CHANDLER	OK	4	0.999909
CHK	CHICKASHA	CHICKASHA	OK	4	0.999909
GCM	CLAREMORE REGIONAL	CLAREMORE	OK	4	0.999909
DUA	EAKER FIELD AIRPORT	EAKER	OK	4	0.999909
2O8	HINTON MUNICPAL	HINTON	OK	4	0.999909
KHBR	HOBART MUNICIPAL	HOBART	OK	4	0.999909
K2K4	SCOTT FIELD	MANGUM	OK	5	0.999893
MIO	MIAMI	MIAMI	OK	4	0.999909
MDF	MORELAND MUNICIPAL	MORELAND	OK	4	0.999909
KMKO	DAVIS FIELD	MUSKOGEE	OK	4	0.999909
OKC	WILL ROGERS WORLD AIRPORT	OKLAHOMA CITY	OK	4	0.999909
PVJ	PAULS VALLEY MUNICIPAL AIRPORT	PAULS VALLEY	OK	4	0.999909
PNC	PONCA CITY	PONCA CITY	OK	4	0.999909
SNL	SHAWNEE	SHAWNEE	OK	4	0.999909
TQH	TAHLEQUAH	TAHLEQUAH	OK	4	0.999909
KTUL	TULSA INTL	TULSA	OK	4	0.999909
1K4	DAVID J PERRY	UNKNOWN	OK	4	0.999909
YOW	OTTAWA AIRPORT	OTTAWA	ON	10	0.999785
S07	BEND MUNICIPAL	BEND	OR	7	0.999697
HIO	PORTLAND-HILLSBORO	HILLSBORO	OR	8	0.999835
LGD	UNION COUNTY	LA GRANDE	OR	3	0.999923
KONP	NEWPORT MUNICIPAL	NEWPORT	OR	13	0.998314
PDX	PORTLAND INTL	PORTLAND	OR	5	0.999894
SLE	MCNARY FIELD	SALEM	OR	11	0.999653
S47	TILLAMOOK	TILLAMOOK	OR	14	0.999404
ABE	LEHIGH VALLEY INTL	ALLENTOWN	PA	4	0.999907
KBFD	BRADFORD RGNL	BRADFORD	PA	3	0.999923
MDT	HARRISBURG INTL	HARRISBURG	PA	4	0.999907
KJST	JOHN MURTHA JOHNSTOWN-CAMBRIA COUNTY	JOHNSTOWN	PA	3	0.999923
LNS	LANCASTER	LANCASTER	PA	4	0.999907
LHV	WILLIAM T. PIPER MEMORIAL	LOCK HAVEN	PA	3	0.999923
PHL	PHILADELPHIA INTL	PHILADELPHIA	PA	4	0.999907
KAGC	ALLEGHENY COUNTY	PITTSBURGH	PA	3	0.999923
KPIT	PITTSBURGH INTL	PITTSBURGH	PA	3	0.999923
PVD	THEODORE FRANCIS GREEN STATE	PROVIDENCE	RI	17	0.999404
AND	ANDERSON REGIONAL	ANDERSON	SC	4	0.999907
KCHS	CHARLESTON AFB/INTL	CHARLESTON	SC	4	0.999907
KCAE	COLUMBIA METROPOLITAN	COLUMBIA	SC	4	0.999907
KGSP	GREENVILLE-SPARTANBURG INTL	GREER	SC	4	0.999907
KMYR	MYRTLE BEACH INTL	MYRTLE BEACH	SC	4	0.999907
KHON	HURON REGIONAL	HURON	SD	4	0.999909
1D1	MILBANK MUNICIPAL	MILBANK	SD	4	0.999908
KRAP	RAPID CITY REGIONAL	RAPID CITY	SD	5	0.999889
FSD	JOE FOSS FIELD	SIOUX FALLS	SD	4	0.999909
YXE	SASKATOON AIRPORT	SASKATOON	SK	197	0.981756
CHA	LOVELL FIELD	CHATTANOOGA	TN	4	0.999907
TYS	MC GHEE TYSON	KNOXVILLE	TN	4	0.999907
KMEM	MEMPHIS INTL	MEMPHIS	TN	4	0.999909

KBNA	NASHVILLE INTL	NASHVILLE	TN	4	0.999909
PHT	HENRY COUNTY	PARIS	TN	4	0.999909
TRI	TRI-CITIES REGIONAL TN/ VA AIRPORT	UNKNOWN	TN	4	0.999907
KABI	ABILENE REGIONAL	ABILENE	TX	5	0.999833
ALI	ALICE	ALICE	TX	82	0.991488
AMA	AMARILLO INTL	AMARILLO	TX	5	0.999848
KLBX	BRAZORIA COUNTY	ANGLETON/LAKE JACKSON	TX	9	0.999226
AUS	AUSTIN-BERGSTROM INTL	AUSTIN	TX	8	0.999636
7F9	COMANCHE	COMANCHE	TX	5	0.999831
KCXO	MONTGOMERY COUNTY	CONROE	TX	8	0.999665
CRP	CORPUS CHRISTI INTL	CORPUS CHRISTI	TX	75	0.992207
KDAL	DALLAS LOVE FIELD	DALLAS	TX	4	0.999909
ADS	ADDISON	DALLAS	TX	4	0.999909
KDFW	DALLAS-FT WORTH INTL	DALLAS-FT WORTH	TX	4	0.999909
KDRT	DEL RIO INTL	DEL RIO	TX	30	0.997612
ELP	EL PASO INTL	EL PASO	TX	28	0.997275
KHRL	VALLEY INTL	HARLINGEN	TX	573	0.937251
KAXH	HOUSTON-SOUTHWEST	HOUSTON	TX	8	0.999513
KDWH	DAVID WAYNE HOOKS MEMORIAL	HOUSTON	TX	8	0.999598
KEFD	ELLINGTON FIELD	HOUSTON	TX	8	0.999511
KHOU	WILLIAM P HOBBY	HOUSTON	TX	8	0.999526
KIAH	GEORGE BUSH INTERCONTINENTAL/HOUSTON	HOUSTON	TX	8	0.999576
KIWS	WEST HOUSTON	HOUSTON	TX	8	0.999558
KSGR	SUGAR LAND MUNI/HULL FLD	HOUSTON	TX	8	0.999529
KLBB	LUBBOCK INTL	LUBBOCK	TX	5	0.999830
MAF	MIDLAND INTL	MIDLAND	TX	11	0.999065
OSA	MOUNT PLEASANT MUNICIPAL	MOUNT PLEASANT	TX	4	0.999909
KSJT	SAN ANGELO RGNL/MATHIS FLD	SAN ANGELO	TX	8	0.999709
KSAT	SAN ANTONIO INTL	SAN ANTONIO	TX	17	0.998973
SGR	SUGARLAND MUNI/HULL FIELD	SUGAR LAND	TX	8	0.999529
KTYR	TYLER POUNDS RGNL	TYLER	TX	4	0.999907
BMC	BRIGHAM CITY	BRIGHAM CITY	UT	3	0.999932
KCDC	CEDAR CITY RGNL	CEDAR CITY	UT	5	0.999844
KKNB	KANAB MUNICIPAL	KANAB	UT	13	0.999497
LGU	LOGAN-CACHE	LOGAN	UT	3	0.999930
SLC	SALT LAKE CITY INTL	SALT LAKE CITY	UT	3	0.999934
KCHO	CHARLOTTESVILLE-ALBEMARLE	CHARLOTTESVILLE	VA	4	0.999907
FKN	FRANKLIN MUNICIPAL- JOHN BEVERLY ROSE	FRANKLIN	VA	4	0.999907
LVL	BRUNSWICK MUNICIPAL	LAWRENCEVILLE	VA	4	0.999907
JYO	LEESBURG MUNICIPAL/ GODFREY FIELD	LEESBURG	VA	4	0.999907
HEF	MANASSAS REGIONAL/ HARRY P. DAVIS FIELD	MANASSAS	VA	4	0.999907
MTV	BLUE RIDGE	MARTINSVILLE	VA	4	0.999907
KPHF	NEWPORT NEWS/ WILLIAMSBURG INTL	NEWPORT NEWS	VA	4	0.999907
KORF	NORFOLK INTL	NORFOLK	VA	4	0.999906
RIC	RICHMOND INTL	RICHMOND	VA	4	0.999907
AKQ	WAKEFIELD MUNICIPAL	WAKEFIELD	VA	4	0.999907
WAL	WALLOPS FLIGHT FACILITY	WALLOPS ISLAND	VA	4	0.999906

BTV	BURLINGTON INTL	BURLINGTON	VT	9	0.999700
FHR	FRIDAY HARBOR	FRIDAY HARBOR	WA	19	0.998972
KMWH	GRANT COUNTY INTL	MOSES LAKE	WA	4	0.999897
KSEA	SEATTLE-TACOMA INTL	SEATTLE	WA	10	0.999628
BFI	BOEING FIELD/ KING COUNTY INTL	SEATTLE	WA	10	0.999618
KGEG	SPOKANE INTL	SPOKANE	WA	5	0.999863
KATW	OUTAGAMIE COUNTY RGNL	APPLETON	WI	4	0.999907
3T3	BOYCEVILLE MUNICIPAL	BOYCEVILLE	WI	4	0.999907
FLD	FOND DU LAC COUNTY	FOND DU LAC	WI	4	0.999907
KGRB	AUTIN STRAUBEL INTL	GREEN BAY	WI	4	0.999907
JVL	SOUTHERN WISCONSIN REGIONAL AIRPORT	JANESVILLE	WI	4	0.999908
MSN	DANE COUNTY REGIONAL-TRUAX FIELD	MADISON	WI	4	0.999908
MTW	MANITOWOC COUNTY	MANITOWOC	WI	4	0.999907
MKE	GENERAL MITCHELL INTL	MILWAUKEE	WI	4	0.999907
KCWA	CENTRAL WISCONSIN	MOSINEE	WI	4	0.999907
OSH	WITTMAN REGIONAL	OSHKOSH	WI	4	0.999907
RHI	RHINELANDER-ONEIDA COUNTY	RHINELANDER	WI	6	0.999870
SUE	DOOR COUNTY CHERRYLAND	STURGEON BAY	WI	5	0.999889
RYV	WATERTOWN MUNICIPAL	WATERTOWN	WI	4	0.999907
ETB	WEST BEND MUNICIPAL	WEST BEND	WI	4	0.999907
KMGW	MORGANTOWN MUNICIPAL-WLB HART FLD	MORGANTOWN	WV	3	0.999923
KPKB	WOOD CO-GILL ROBB WILSON FLD	PARKERSBURG	WV	3	0.999923
KCPR	NATRONA COUNTY INTL	CASPER	WY	5	0.999893
EVW	EVANSTON-UNITA CNTY-BURNS FLD	EVANSTON	WY	3	0.999924
SAA	SHIVELY FIELD	SARATOGA	WY	5	0.999893

Figure 9-1 WAAS LPV Availability



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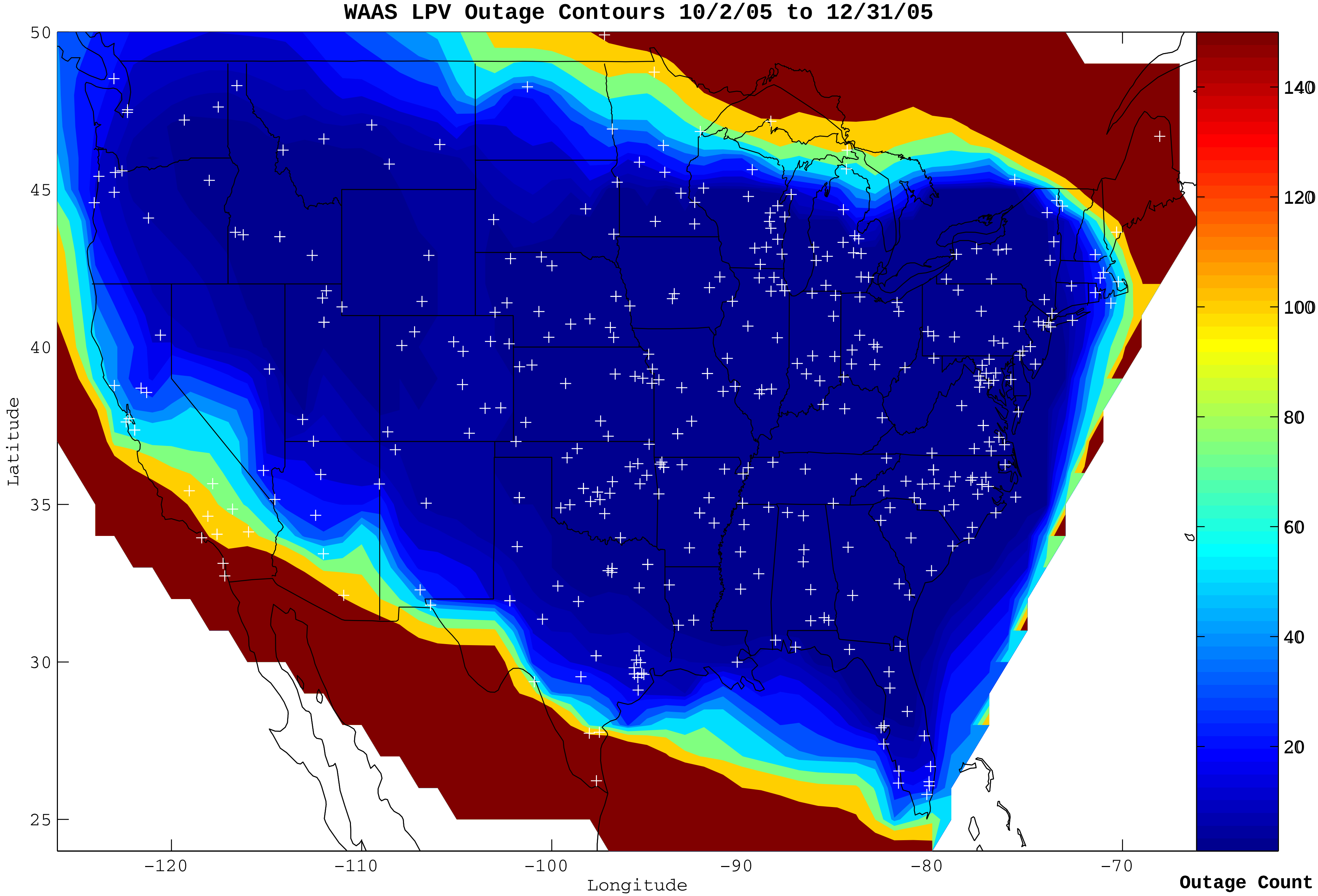
WAAS Test Team
02/14/06

Figure 9-2 WAAS LPV Outage



W.J.H. FAA Technical Center
WAAS Test Team
02/14/06

10.0 WAAS DETERMINISTIC CODE NOISE AND MULTIPATH BOUNDING ANALYSIS

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

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

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

Table 10-1 CNMP Bounding Statistics

WAAS Site	WRE	Jan 05	Feb 05	Mar 05	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05
Albuquerque	A	blue	yellow	green	yellow	blue	green	blue	blue	yellow	green	blue	yellow
	B	blue	blue	blue	blue	blue	blue	yellow	blue	yellow	blue	blue	blue
	C	blue	blue	blue	green	blue	blue	blue	green	green	green	yellow	green
Anchorage	A	green	blue	green	green	yellow	yellow	yellow	yellow	yellow	red	yellow	blue
	B	blue	blue	blue	blue	green	yellow	green	blue	blue	blue	green	blue
	C	yellow	blue	blue	yellow	green	green	blue	green	blue	red	green	blue
Atlanta	A	blue	blue	blue	blue	blue	blue	red	blue	green	blue	yellow	blue
	B	blue	blue	green	green	red	red	blue	green	green	green	green	yellow
	C	yellow	green	blue	blue	blue	blue	blue	blue	yellow	blue	green	yellow
Billings	A	blue	blue	blue	blue	blue	blue	blue	yellow	blue	blue	green	blue
	B	blue	blue	blue	blue	blue	blue	blue	green	blue	blue	blue	blue
	C	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
Boston	A	blue	blue	yellow	blue	blue	blue	blue	blue	red	green	green	blue
	B	blue	blue	blue	blue	blue	blue	green	green	green	green	blue	green
	C	blue	blue	blue	blue	blue	blue	blue	blue	blue	green	green	blue
Chicago	A	green	blue	blue	blue	blue	blue	blue	green	yellow	green	green	blue
	B	blue	blue	green	blue	blue	green	blue	blue	yellow	yellow	yellow	green
	C	blue	blue	yellow	green	blue	blue	yellow	blue	green	blue	green	blue
Cleveland	A	blue	green	blue	yellow	green	green	blue	red	green	green	green	yellow
	B	blue	yellow	blue	yellow	yellow	blue	blue	yellow	yellow	blue	green	green
	C	blue	blue	green	blue	blue	green	green	yellow	blue	yellow	yellow	green
Cold Bay	A	blue	blue	blue	blue	blue	yellow	blue	red	green	green	blue	blue
	B	blue	blue	blue	yellow	green	green	blue	green	green	green	green	green
	C	blue	blue	blue	yellow	green	green	blue	yellow	green	green	green	green
Dallas	A	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
	B	blue	blue	yellow	yellow	yellow	green	yellow	green	red	yellow	blue	yellow
	C	blue	green	blue	green	blue	green	blue	yellow	blue	yellow	green	green
Denver	A	blue	blue	blue	blue	blue	blue	green	green	yellow	red	red	yellow
	B	blue	green	blue	blue	green	blue	blue	blue	yellow	blue	blue	blue
	C	blue	blue	blue	green	green	green	blue	blue	green	green	green	red
Honolulu	A	green	yellow	yellow	blue	yellow	red	blue	red	green	red	green	yellow
	B	blue	blue	blue	blue	blue	blue	blue	green	yellow	blue	blue	green
	C	yellow	blue	blue	yellow	blue	blue	yellow	blue	yellow	green	blue	yellow
Houston	A	green	red	green	blue	green	blue	green	red	blue	yellow	green	yellow
	B	green	red	red	green	green	green	green	yellow	red	yellow	yellow	green
	C	yellow	yellow	yellow	yellow	yellow	green	yellow	yellow	green	yellow	red	green
Jacksonville	A	blue	blue	blue	blue	blue	blue	blue	blue	yellow	blue	blue	green
	B	green	yellow	blue	blue	blue	blue	blue	blue	yellow	blue	blue	blue
	C	green	blue	blue	blue	blue	blue	blue	blue	yellow	blue	blue	blue
Juneau	A	green	green	blue	green	blue	yellow	yellow	green	blue	red	green	green
	B	red	blue	blue	yellow	green	green	green	green	blue	blue	yellow	blue
	C	green	green	blue	red	yellow	blue	green	yellow	yellow	green	yellow	blue
Kansas City	A	blue	blue	blue	blue	blue	blue	blue	green	green	green	yellow	green
	B	blue	yellow	blue	blue	blue	blue	blue	blue	blue	blue	blue	green
	C	blue	blue	blue	blue	blue	yellow	blue	green	green	yellow	blue	blue
Los Angeles	A	blue	blue	blue	blue	blue	green	blue	yellow	green	blue	yellow	yellow
	B	blue	green	blue	blue	blue	blue	blue	blue	blue	blue	blue	yellow
	C	blue	yellow	blue	blue	blue	blue	blue	yellow	red	blue	red	green

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

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

Appendix A: Glossary

General Terms and Definitions

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

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

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

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

CONUS. Continental United States.

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

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

Dilution of Precision (DOP). The magnifying effect on GPS position error induced by mapping GPS ranging errors into position through the position solution. The DOP may be represented in any user local coordinate desired. Examples are HDOP for local horizontal, VDOP for local vertical, PDOP for all three coordinates, and TDOP for time.

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.