WIDE-AREA AUGMENTATION SYSTEM PERFORMANCE ANALYSIS REPORT

Report #22

Reporting Period: July 1 to September 30, 2007

October 2007

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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 twenty-second such WAAS quarterly report. This report covers WAAS performance during the period from July 1, 2007 to September 30, 2007.

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	CONUS Site/Maximum	CONUS Site/Minimum	All Sites Site/Maximum	All Sites Site/Minimum
95% Horizontal Accuracy	Seattle 0.774 meters	Washington DC 0.522 meters	Seattle 0.774 meters	Bethel 0.492
95% Vertical Accuracy	Denver 1.281 meters	Seattle 0.900 meters	Barrow 1.822 meters	Seattle 0.900 meters
LPV Availability (HPL < 40 meters & VPL < 50 meters)	Billings 99.968%	Boston 98.265%	Billings 99.968%	Barrow 70.944%
95% HPL	Boston 28.639 meters	Kansas City 16.905 meters	Barrow 49.243 meters	Kansas City 16.905 meters
95% VPL	Boston 42.141 meters	Kansas City 25.662 meters	Barrow 82.709 meters	Kansas City 25.662 meters

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1.0 INTRODUCTION

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

Objectives of this report are:

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

The WAAS data transmitted from GEO satellite PRN#122 (AORW), PRN#134 (POR), PRN#135 (CRW), and PRN#138 (CRE) as of July 13, 2007 were used in the evaluation. Currently the CRW GEO provides only the data link capability, NPA ranging service is available from this GEO as of September 13, 2007.

Table 1.1 and Table 1.2 list WAAS reference station receivers used in Precision Approach (PA) and Non-Precision Approach (NPA) evaluation process, respectively. (There are no NSTB receivers this quarter as replacements are being installed.) This report presents results from three months of data, collected from July 1, 2007 to September 30, 2007.

Table 1-1 PA Sites

	Number of Days Evaluated	Number of Samples
WAAS:		
Albuquerque	91	7890447
Anchorage	91	7895846
Atlanta	91	7894280
Barrow	91	7870421
Bethel	91	7896681
Billings	91	7897691
Boston	91	7892718
Chicago	91	7897111
Cleveland	91	7903055
Cold Bay	91	7855666
Dallas	86	7436349
Denver	91	7882209
Fairbanks	91	7885985
Houston	91	7853738
Jacksonville	91	7897614
Juneau	88	7579337
Kansas City	89	7716278
Kotzebue	91	7884136
Los Angeles	91	7894976
Memphis	91	7885746
Miami	91	7890886
Minneapolis	89	7719939
New York	91	7896277
Oakland	91	7887963
Salt Lake City	91	7884510
Seattle	90	7810427
Washington DC	91	7885468

Table 1-2 NPA Sites

Location	Number of Days Evaluated	Number of Samples
Albuquerque	91.37	7893945
Anchorage	91.33	7891009
Atlanta	91.42	7898708
Bethel	91.15	7875153
Billings	91.44	7900635
Boston	91.40	7897112
Cleveland	91.51	7906740
Cold Bay	89.18	7704756
Fairbanks	91.14	7874334
Honolulu	91.22	7881351
Houston	91.32	7890450
Juneau	90.97	7859963
Kansas City	90.20	7793470
Kotzebue	90.07	7782450
Los Angeles	91.43	7899482
Miami	91.40	7897365
Minneapolis	89.72	7751396
Oakland	88.56	7651749
Salt Lake City	91.30	7888403
San Juan	91.16	7876019
Seattle	89.81	7759229
Washington DC	91.31	7888899

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 1and FAA Specification FAA-E-2976, as applicable.

Table 1-3 WAAS Performance Parameters

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

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

1.1 Event Summary

Table 1.4 lists test events that occurred during the reporting period that affected WAAS performance or the ability to determine the WAAS performance. These events include GPS or WAAS anomalies, relevant receiver malfunctions, and receiver maintenance conducted. Detailed analyses of particular events are documented in the Discrepancy Reports (DR). The DRs are posted on the website http://www.nstb.tc.faa.gov under 'WAAS Technical Reports' and can also be accessed via hyperlink from Table 1.4 below.

Table 1-4 Test Events

GPS Week	Date	Sites	Events
1434 day 1	7/2/07	All WAAS Sites	WEI outage.
1434 day 3	7/4/07	All WAAS Sites	WEI outage.
1434 day 4	7/5/07	All WAAS Sites	WEI outage.
1435 day 2	7/10/07	All Sites	C&V Tri-Fault logic caused ZLA C&V Fault. GEO's broadcast initialization messages.
1435 day 3	7/11/07	Central CONUS Sites	Several IGP's set to Do Not Use, caused loss of PA availability in Central CONUS. Caused by an IGP Mask update which triggered a WMS software bug while AOR-W GEO was being removed from WAAS.
1435 day 4	7/12/07	All	ZLA C&V Fault caused selected C&V source switch, and GEO initialization.

GPS Week	Date	Sites	Events
1435 day 5	7/13/07	All CRE Sites	CRE GEO set to Normal mode.
1436 day 1	7/16/07	Barrow	Ionospheric scintillation at Barrow.
1436 day 2	7/17/07	Barrow	Ionospheric scintillation at Barrow.
1436 day 6	7/21/07	All	User Position Monitor (UPM) Trip caused LPV service outage at some sites.
1437 day 1	7/23/07	All	3x C&V faults, each followed by GEO initialization, caused loss of WAAS coverage.
1437 day 1	7/23/07	None	POR SIS outage.
1437 day 2	7/24/07	Seattle	Seattle WRS receiver upgrade.
1437 day 3	7/25/07	Anchorage	Anchorage WRS receiver upgrade.
1438 day 1	7/30/07	Several CONUS Sites	WAAS set several IGP's to Do Not Use, resulting in loss of LPV availability.
1438 day 1	7/30/07	None	AOR-W & POR GEO's SIS deactivated.
1438 day 1 to 1439 day 2	7/30/07 to 8/7/07	Dallas, Houston	GEO cross-correlation caused apparent WAAS service outages.
1438 day 2	7/31/07	All Sites	See DR #63, "WAAS Set All Satellites and IGPs to Not Monitored."
1438 day 2	7/31/07	Cold Bay	Cold Bay WRS receiver upgrade.
1439 day 2	8/7/07	Kotzebue	Ionospheric scintillation at Kotzebue.
1439 day 3	8/8/07	San Juan	San Juan WRS receiver upgrade.
1440 day 0	8/12/07	Barrow	Ionospheric scintillation at Barrow.
1440 day 3	8/15/07	Houston	Houston WRS antenna upgrade.
1440 day 4	8/16/07	Dallas	Dallas WRS receiver upgrade.
1440 day 5	8/17/07	All WAAS Sites	3 WEI outages.
1441 day 1	8/20/07	SLC	SLC WRS receiver upgrade.
1441 day 2 to 1441 day 4	8/21/07 to 8/23/07	Minneapolis	Minneapolis WRS receiver upgrade.
1441 day 6	8/25/07	Barrow	Ionospheric scintillation at Barrow.
1442 day 2	8/28/07	Fairbanks	Ionospheric scintillation at Fairbanks.
1442 day 6	9/1/07	Oakland	Oakland WRS receiver upgrade.
1443 day 3	9/5/07	KC	KC WRS receiver upgrade.
1444 day 3	9/12/07	All WAAS Sites	Partial WEI outage.
1445 day 1	9/17/07	Alaska Sites	Release 6/7 IGP mask update improved Alaska PA coverage.
1445 day 2	9/18/07	All WAAS Sites	WEI 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, POR, CRW and CRE.

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

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

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 three operational service levels: WAAS LPV, WAAS LPV200 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
LPV200	40	35

Table 2.2 shows PA horizontal and vertical position accuracy maintained for 95% of the time at LPV, LPV200 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 0.774 meters at Seattle and 1.822 at Barrow, respectively. The minimum 95% horizontal and vertical LPV errors are 0.492 meters at Bethel and 0.900 meters at Seattle, respectively. The maximum 95% and 99.999% NPA horizontal errors are 2.201 meters and 6.564 meters at Honolulu, respectively. The minimum 95% and 99.999% horizontal errors are 0.866 meters and 1.983 meters at Albuquerque, respectively.

The AOR-W and POR GEO satellites were decommissioned during this quarter. A new GEO satellite, CRE, was commissioned into service. This leaves two GEO satellites for WAAS, CRW and CRE. Both of these satellites provide a ranging capability for enroute through NPA service, but not for PA service.

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.

During this evaluated period, the unusual high vertical and horizontal errors, observed at Fairbanks, Kotzebue and Barrow are due to ionospheric scintillation.

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)
Albuquerque	0.555	0.555	1.207	99.97446	2.171	4.114
Anchorage	0.511	0.511	1.218	99.97323	*	*
Atlanta	0.529	0.529	1.196	99.97470	2.390	4.809
Barrow	0.644	0.747	1.822	99.90179	*	*
Bethel	0.488	0.492	1.042	99.97401	2.079	3.971
Billings	0.670	0.670	1.009	99.97519	2.132	4.003
Boston	0.623	0.623	1.191	99.97810	2.375	4.549
Chicago	0.582	0.582	1.269	99.97571	*	*
Cleveland	0.631	0.631	1.221	99.97498	2.409	4.677
Cold Bay	0.747	0.764	0.970	99.97562	*	*
Dallas	0.604	0.606	1.189	99.88440	*	*
Denver	0.601	0.602	1.281	99.97424	*	*
Fairbanks	0.545	0.546	1.118	99.97328	1.985	4.113
Houston	0.651	0.651	1.201	99.97158	2.392	4.439
Jacksonville	0.532	0.532	1.166	99.97462	*	*
Juneau	0.542	0.542	1.307	99.98727	*	*
Kansas City	0.628	0.628	1.253	99.96722	2.286	4.411
Kotzebue	0.650	0.655	1.286	99.92236	2.009	4.180
Los Angeles	0.670	0.670	1.055	99.97508	2.309	4.325
Memphis	0.523	0.523	1.243	99.97572	*	*
Miami	0.612	0.612	1.208	99.97421	2.561	4.842
Minneapolis	0.616	0.616	1.278	99.97614	2.235	4.266
New York	0.603	0.603	1.117	99.97816	*	*
Oakland	0.676	0.677	1.043	99.97636	2.212	4.677
Salt Lake City	0.592	0.592	0.998	99.97601	2.171	4.537
Seattle	0.773	0.774	0.900	99.97628	2.226	4.289
Washington DC	0.522	0.522	1.125	99.97457	2.422	4.914

* SPS accuracy not computed for this location.

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

Location	95% Horizontal (meters)	99.999% Horizontal (meters)	Percentage in NPA mode (%)	Maximum Horizontal Error
Albuquerque	0.866	1.983	99.9859	7.631
Anchorage	0.961	3.085	99.9801	3.551
Atlanta	0.914	5.159	99.9851	5.403
Bethel	1.207	2.598	99.9869	9.071
Billings	1.240	2.556	99.9855	3.938
Boston	1.036	2.571	99.9852	5.182
Cleveland	1.092	2.949	99.9854	7.703
Cold Bay	1.211	2.389	99.9848	4.754
Fairbanks	0.783	2.639	99.9878	4.711
Honolulu	2.201	6.564	99.9868	7.241
Houston	1.043	2.445	99.9851	2.730
Juneau	0.873	2.557	99.9878	3.770
Kansas City	1.045	1.815	99.9843	3.546
Kotzebue	0.850	2.831	99.9686	6.971
Los Angeles	1.030	2.495	99.9880	3.238
Miami	1.083	2.835	99.9850	11.401
Minneapolis	1.082	3.967	99.9851	9.301
Oakland	1.102	2.258	99.9875	2.431
Salt Lake City	1.042	2.124	99.9885	3.397
San Juan	1.382	3.982	99.9812	4.178
Seattle	1.200	2.669	99.9799	2.946
Washington DC	0.950	2.341	99.9852	3.847

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
Albuquerque	2.010	0.093	0.111	3.163	0.090	0.128
Anchorage	3.115	0.127	0.127	3.261	0.074	0.136
Atlanta	1.694	0.131	0.131	3.364	0.111	0.159
Barrow	37.487	0.988	0.988	6.783	0.146	0.227
Bethel	1.540	0.048	0.090	2.968	0.060	0.087
Billings	1.823	0.077	0.132	3.552	0.194	0.194
Boston	2.627	0.114	0.114	3.443	0.128	0.128
Chicago	1.792	0.087	0.106	3.272	0.066	0.149
Cleveland	2.125	0.155	0.155	3.456	0.093	0.134
Cold Bay	2.030	0.052	0.102	4.060	0.100	0.105
Dallas	1.781	0.089	0.131	3.180	0.095	0.120
Denver	2.257	0.101	0.115	3.975	0.114	0.157
Fairbanks	2.723	0.189	0.189	9.255	0.266	0.266
Houston	2.151	0.068	0.135	3.367	0.077	0.131
Jacksonville	1.811	0.137	0.137	2.807	0.067	0.131
Juneau	1.985	0.111	0.150	4.258	0.188	0.188
Kansas City	1.670	0.073	0.113	2.877	0.093	0.152
Kotzebue	7.901	0.274	0.274	4.921	0.130	0.130
Los Angeles	2.206	0.077	0.112	3.099	0.092	0.125
Memphis	1.614	0.076	0.116	3.400	0.098	0.158
Miami	1.920	0.136	0.136	3.942	0.132	0.149
Minneapolis	2.868	0.185	0.185	3.415	0.086	0.141
New York	1.713	0.070	0.106	3.071	0.101	0.109
Oakland	2.389	0.123	0.123	4.119	0.133	0.141
Salt Lake City	1.672	0.070	0.141	3.456	0.136	0.179
Seattle	1.935	0.139	0.142	3.522	0.155	0.155
Washington DC	1.748	0.127	0.127	3.161	0.096	0.125

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

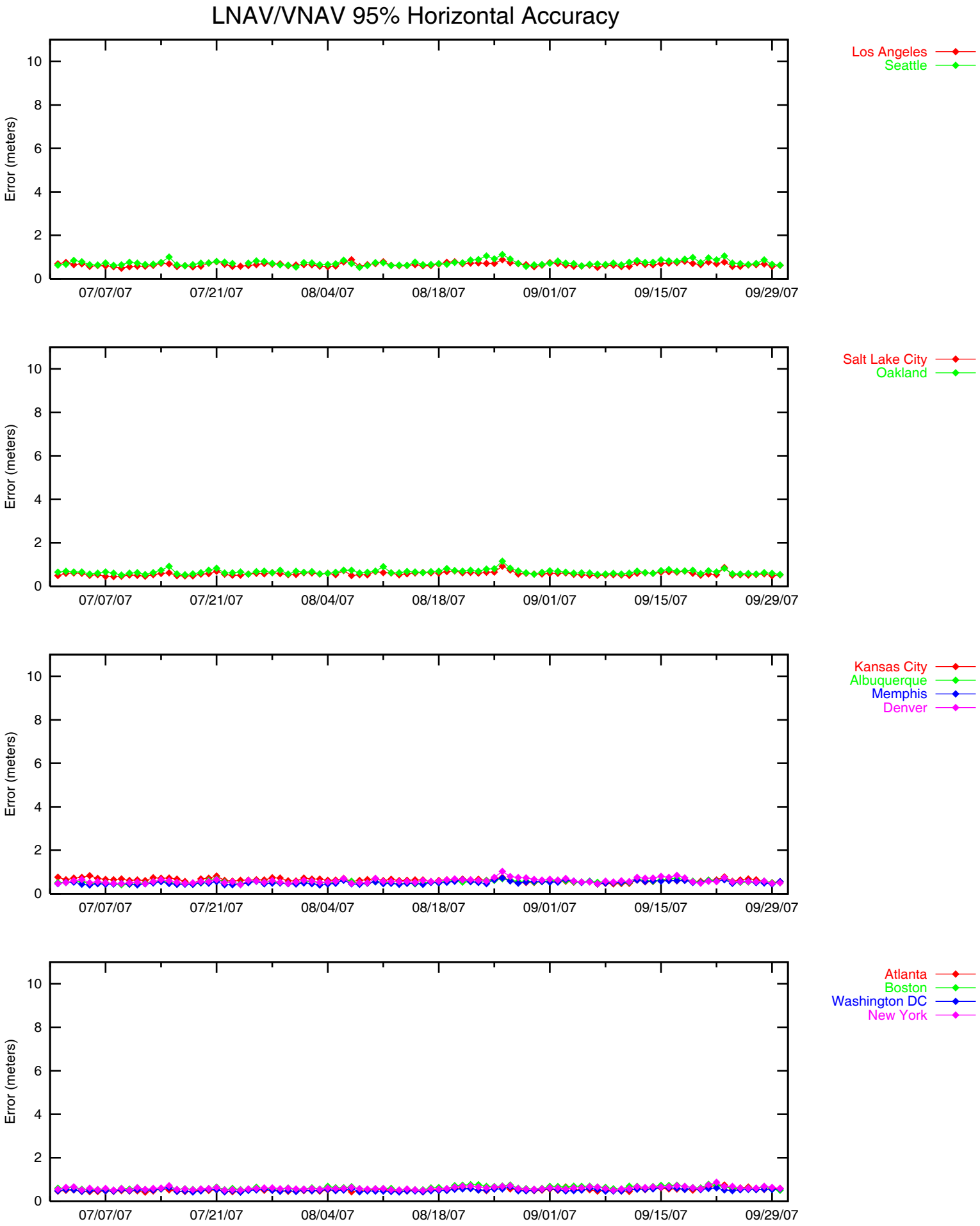


Figure 2-2 95% Horizontal Accuracy at LNAV/VNAV

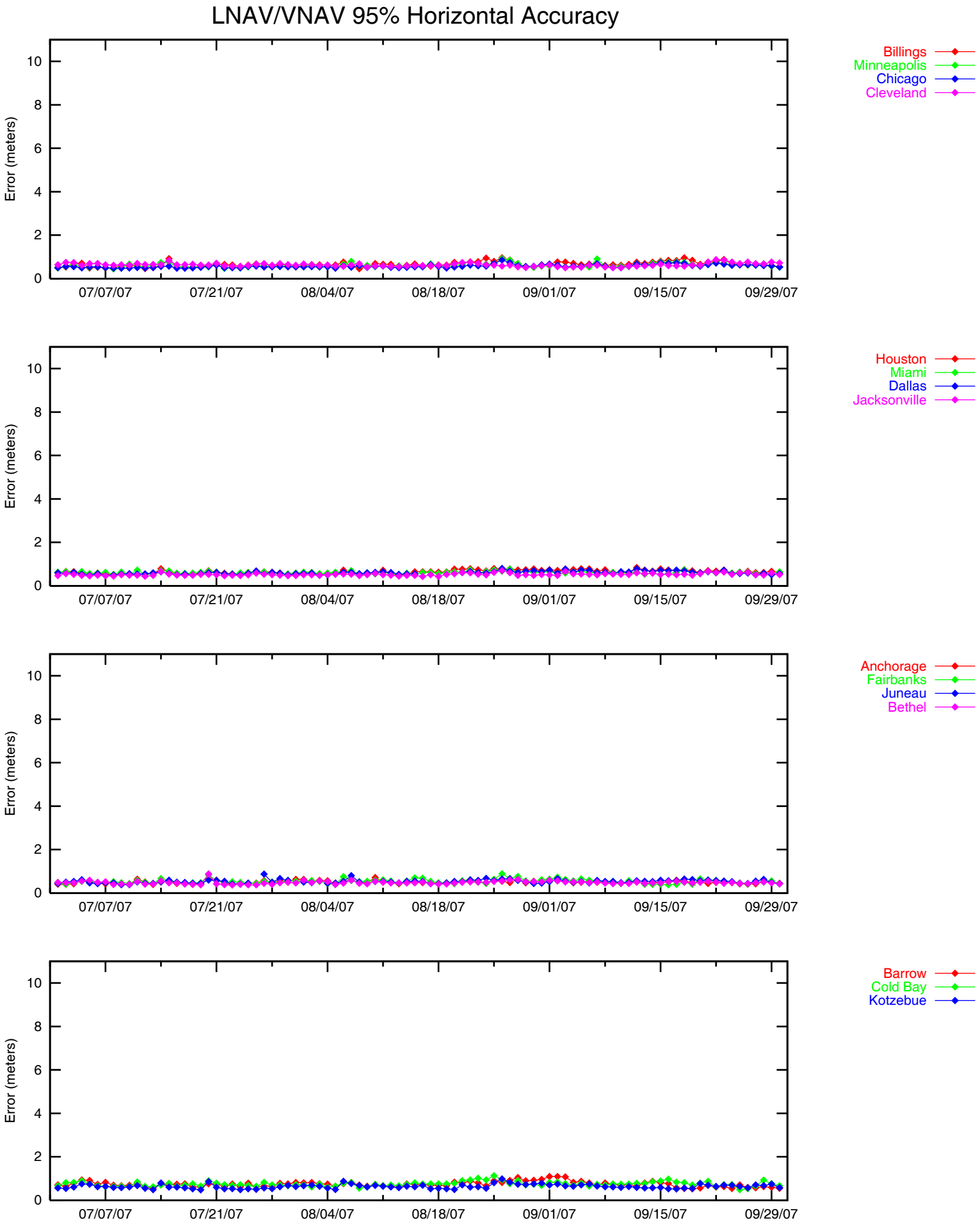


Figure 2-3 95% Vertical Accuracy at LNAV/VNAV

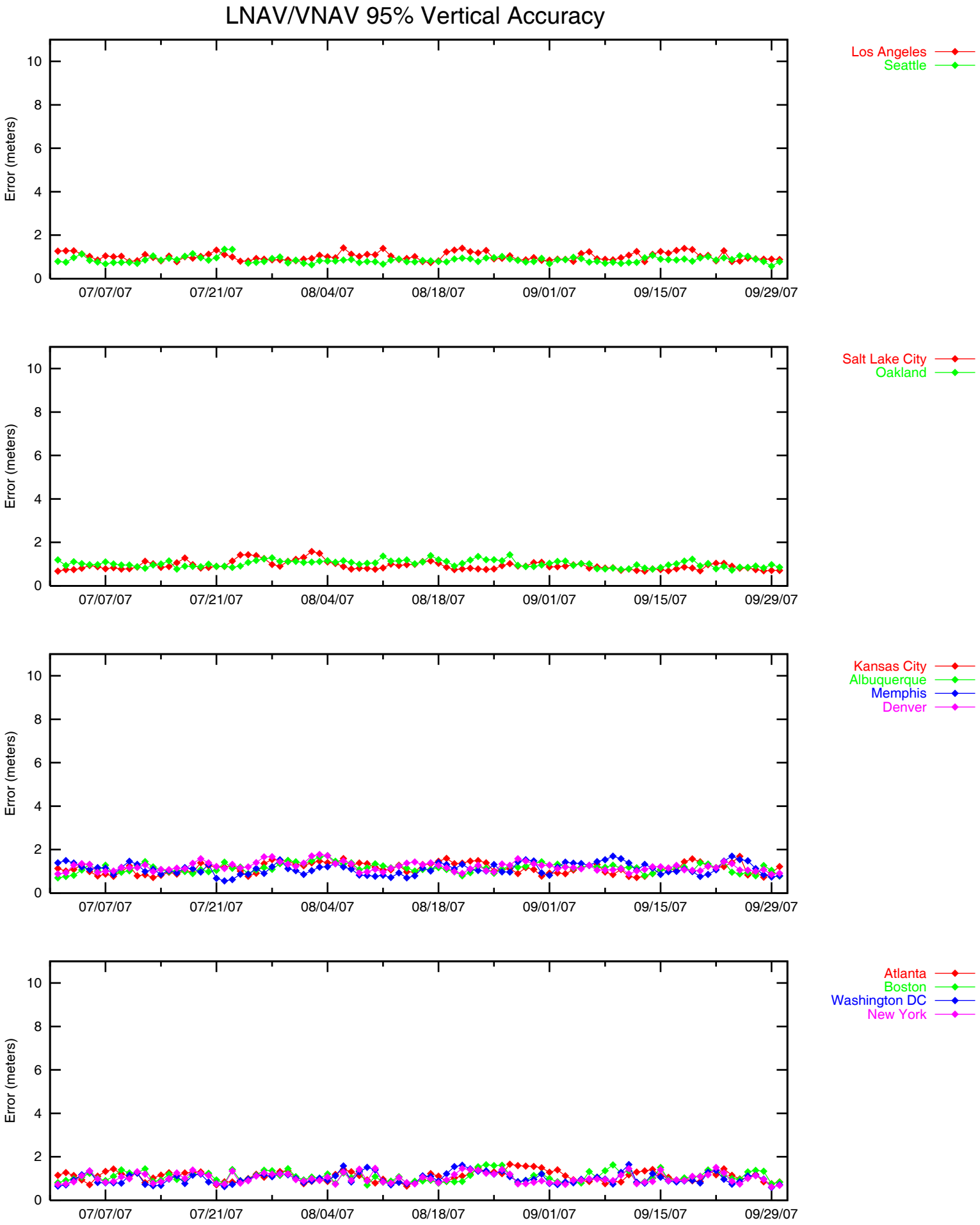


Figure 2-4 95% Vertical Accuracy at LNAV/VNAV

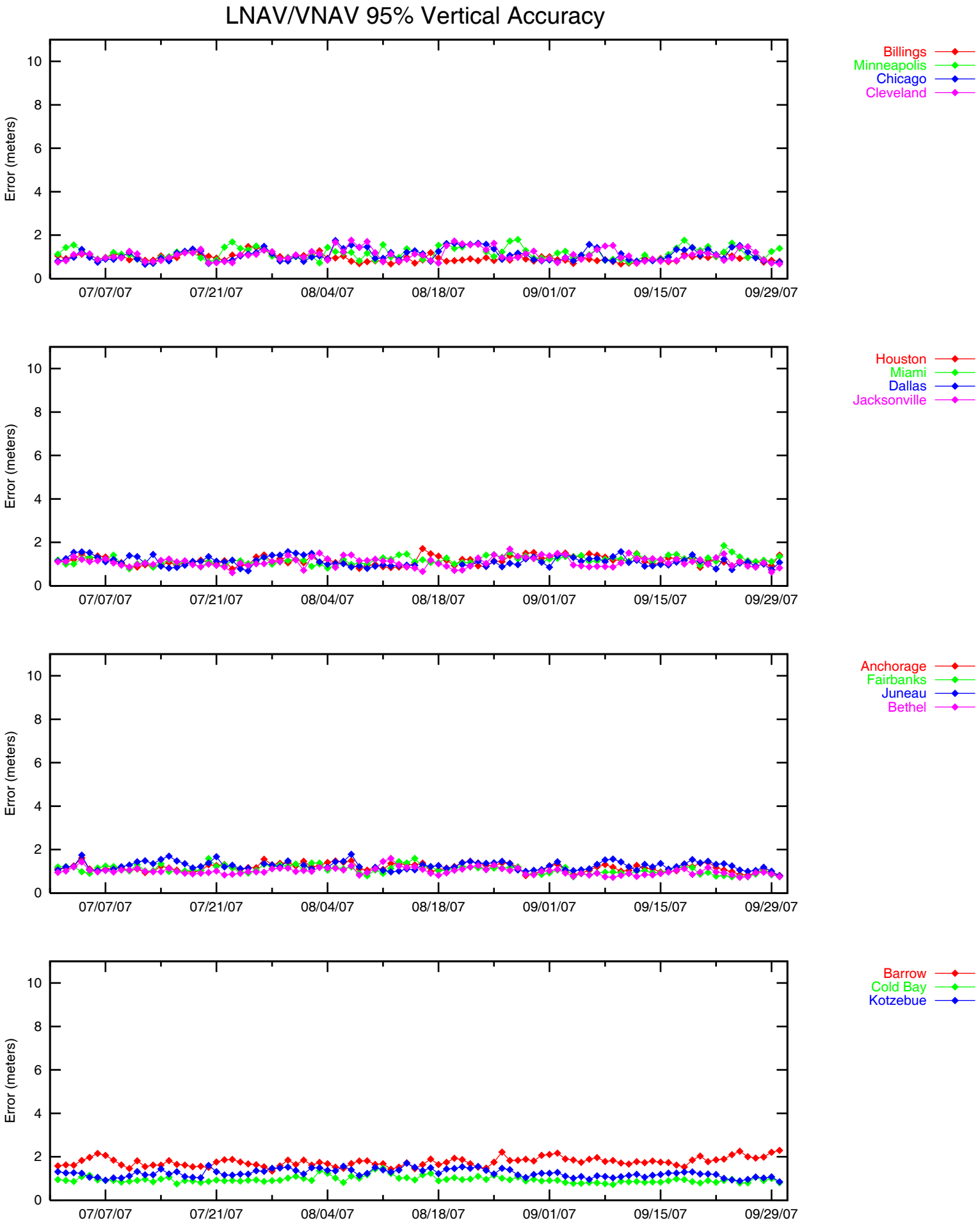


Figure 2-5 NPA 95% Horizontal Accuracy

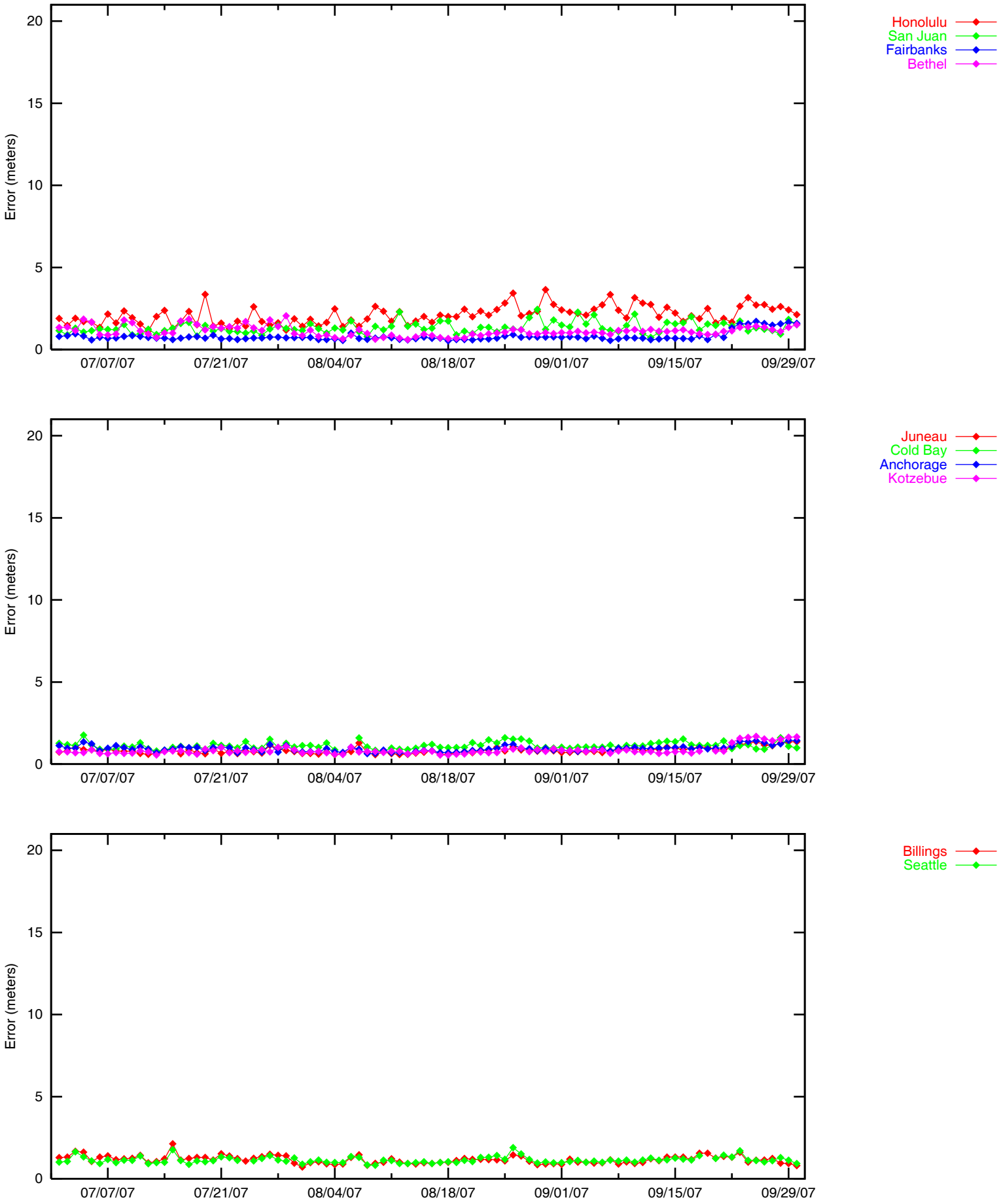


Figure 2-6 NPA 95% Horizontal Accuracy

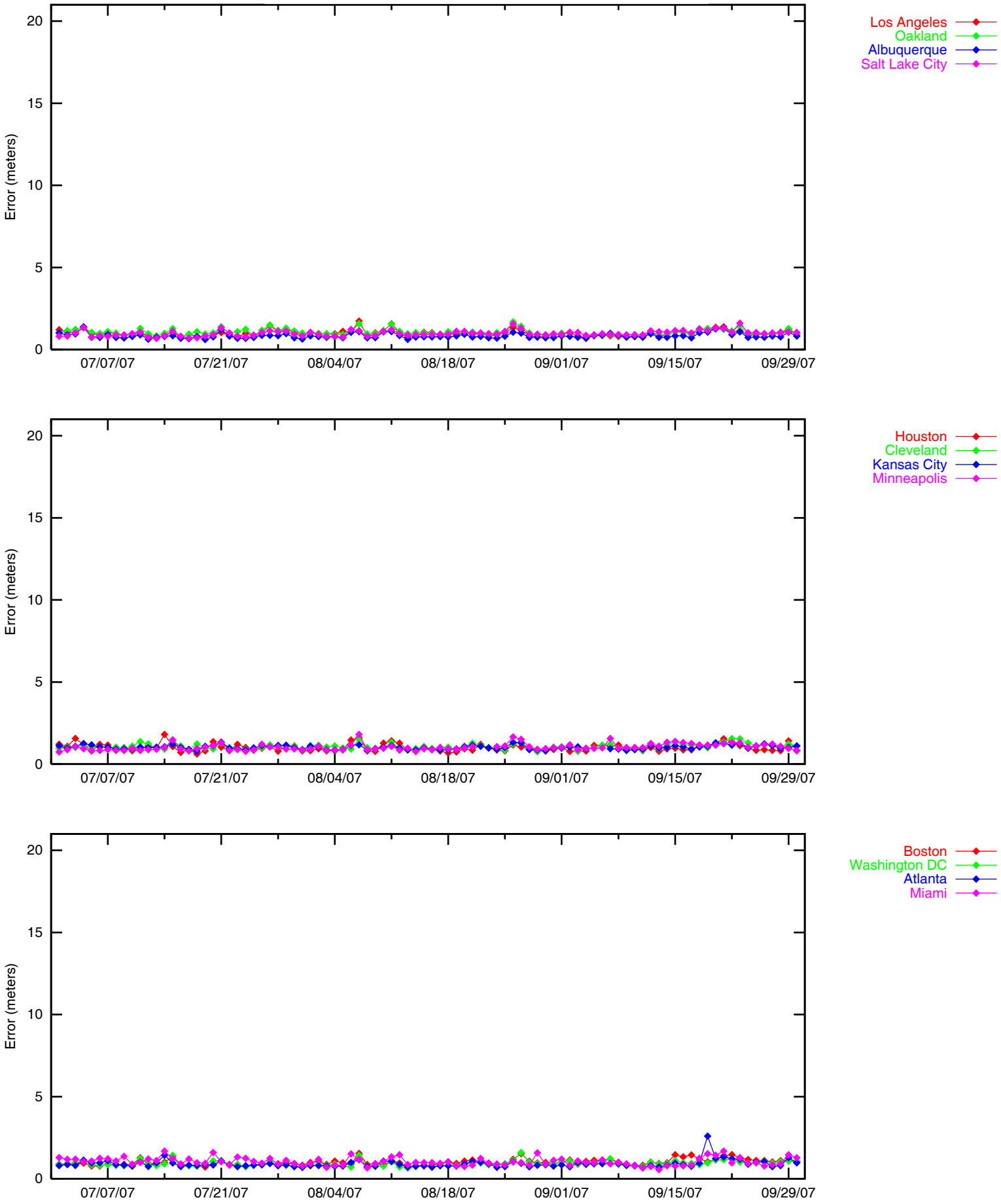
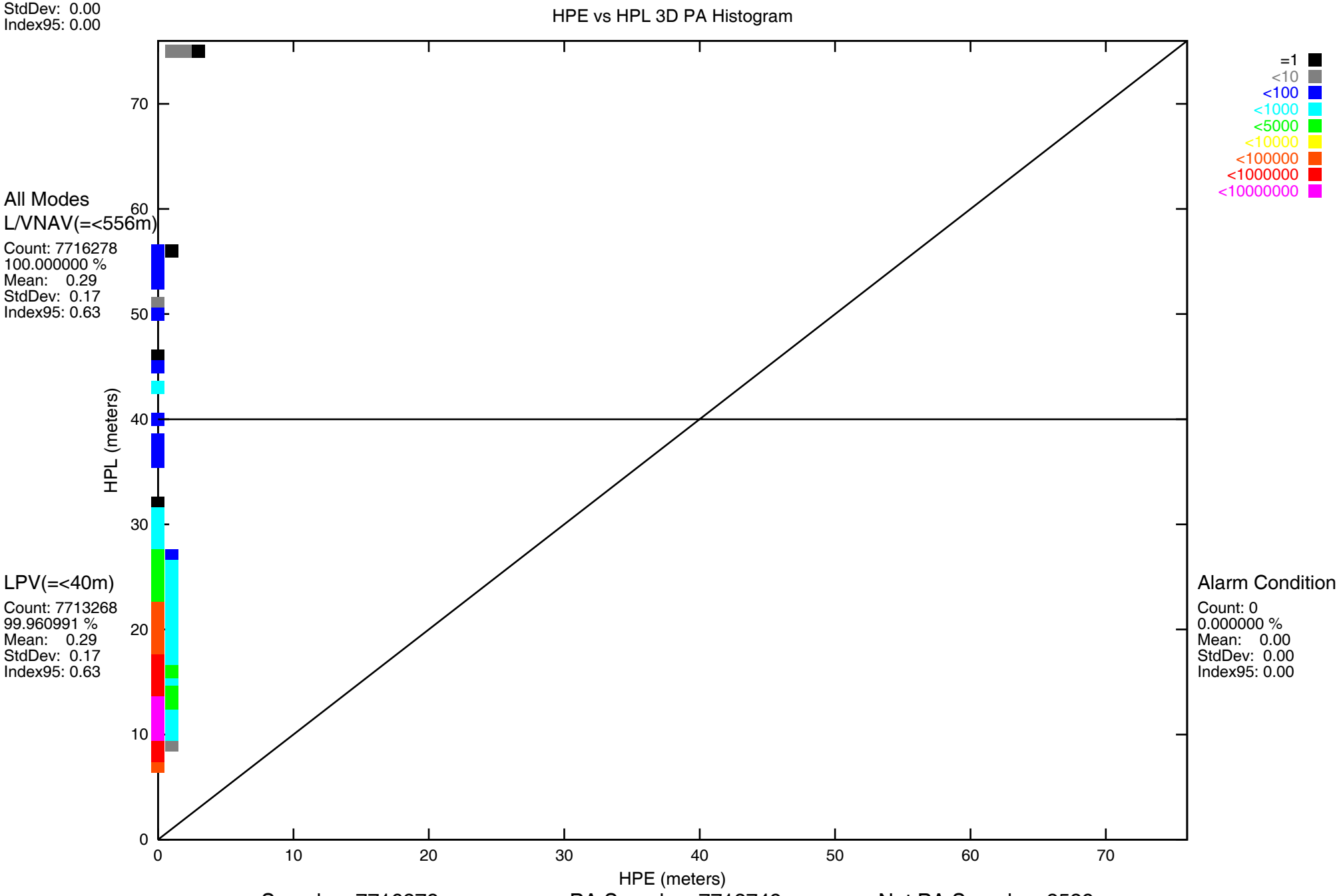


Figure 2-7 Horizontal Triangle Chart for Kansas City

Site: Kansas_City Date: 7/1/07-9/30/07



Samples: 7716278

Mean: 0.29
StdDev: 0.17
Index95: 0.63

PA Samples: 7713749

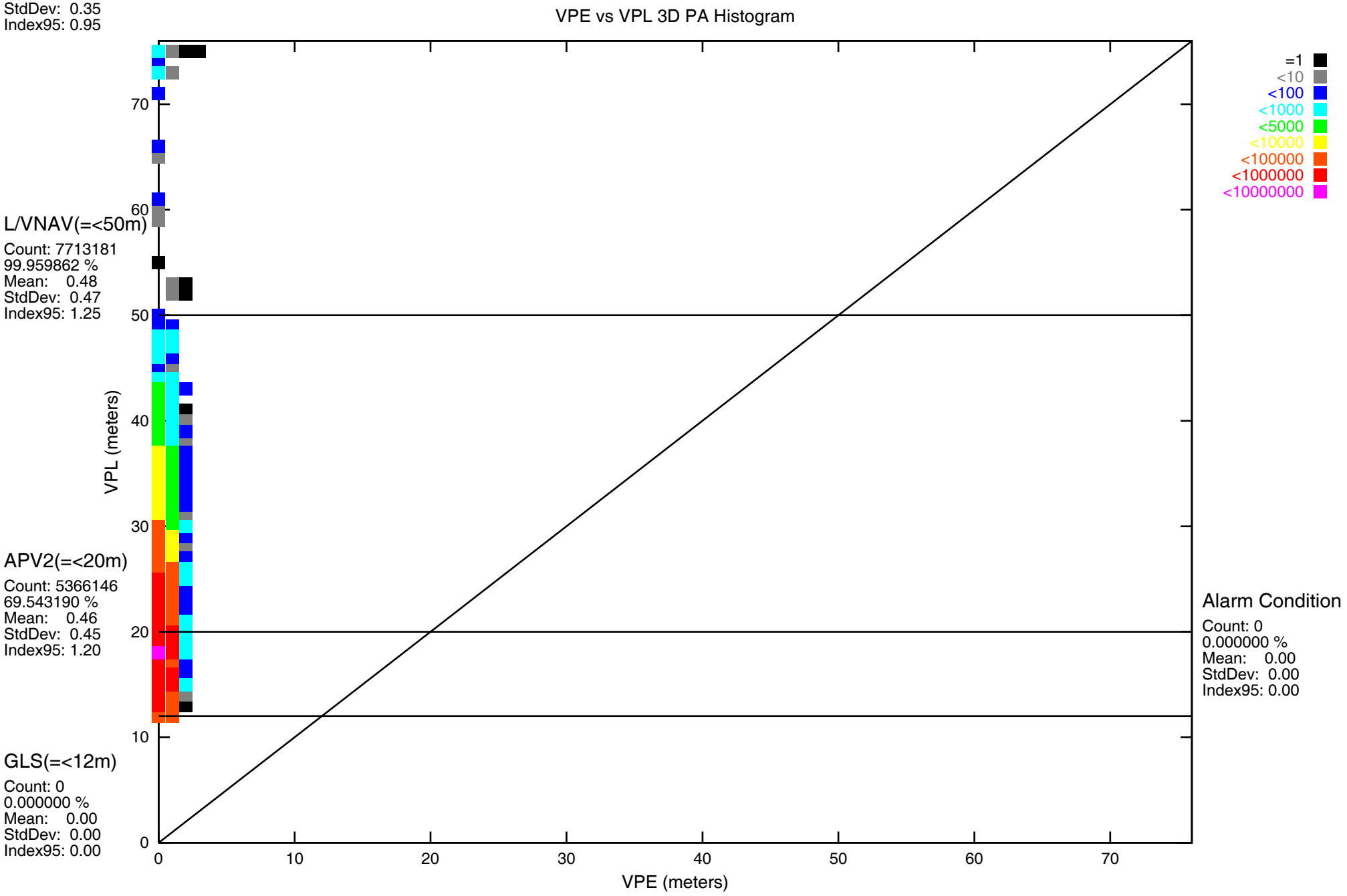
Mean: 0.29
StdDev: 0.17
Index95: 0.63

Not PA Samples: 2529

Mean: 0.36
StdDev: 0.32
Index95: 0.89

Figure 2-8 Vertical Triangle Chart for Kansas City

Site: Kansas_City Date: 7/1/07-9/30/07



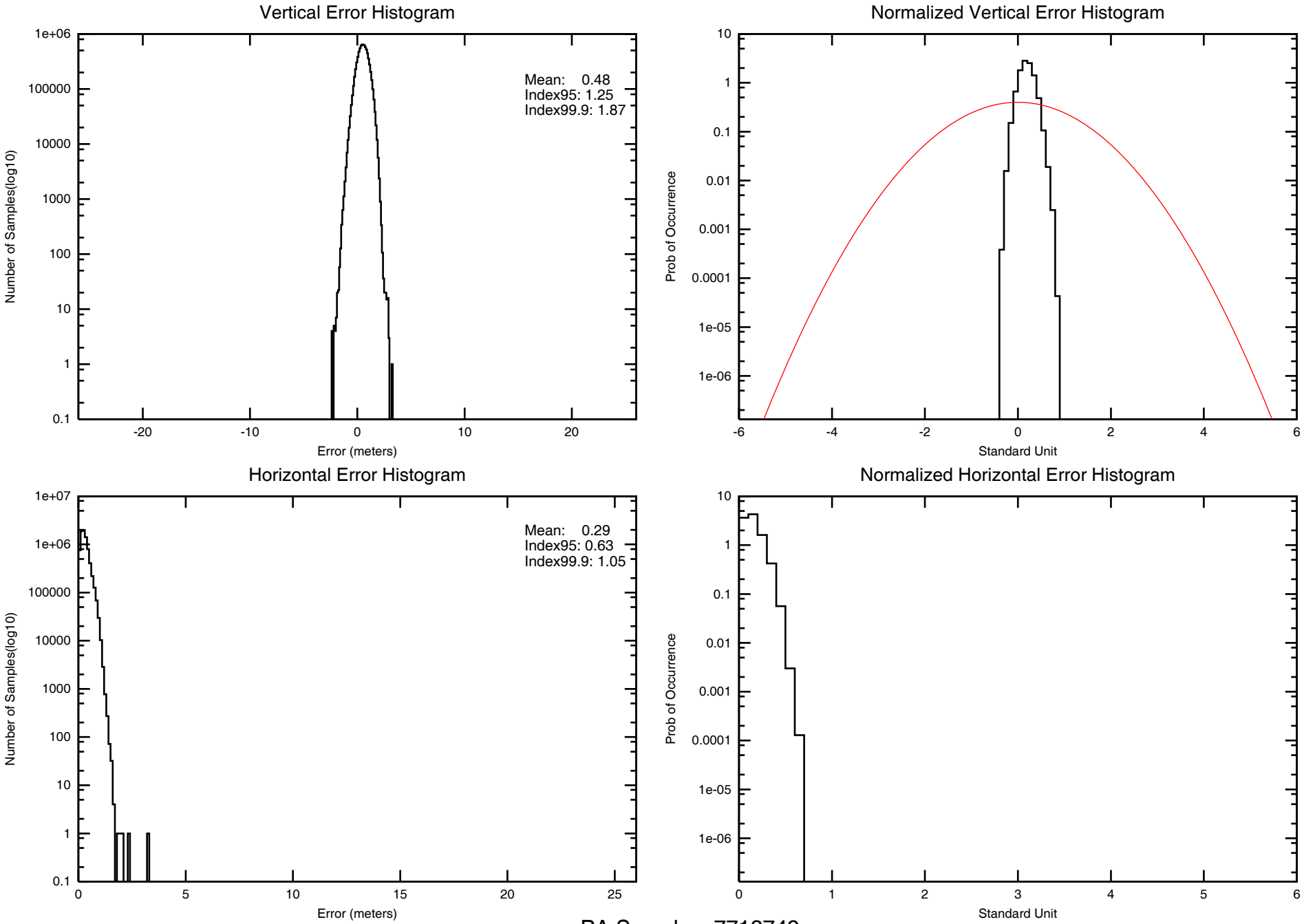
Samples: 7716278
Mean: 0.48
StdDev: 0.47
Index95: 1.25

PA Samples: 7713749
Mean: 0.48
StdDev: 0.47
Index95: 1.25

Not PA Samples: 2529
Mean: -0.27
StdDev: 0.64
Index95: 1.67

Figure 2-9 2-D Histogram for Kansas City

Site: Kansas_City Date: 7/1/07-9/30/07



PA Samples: 7713749

Figure 2-10 Horizontal Triangle Chart for Washington, DC

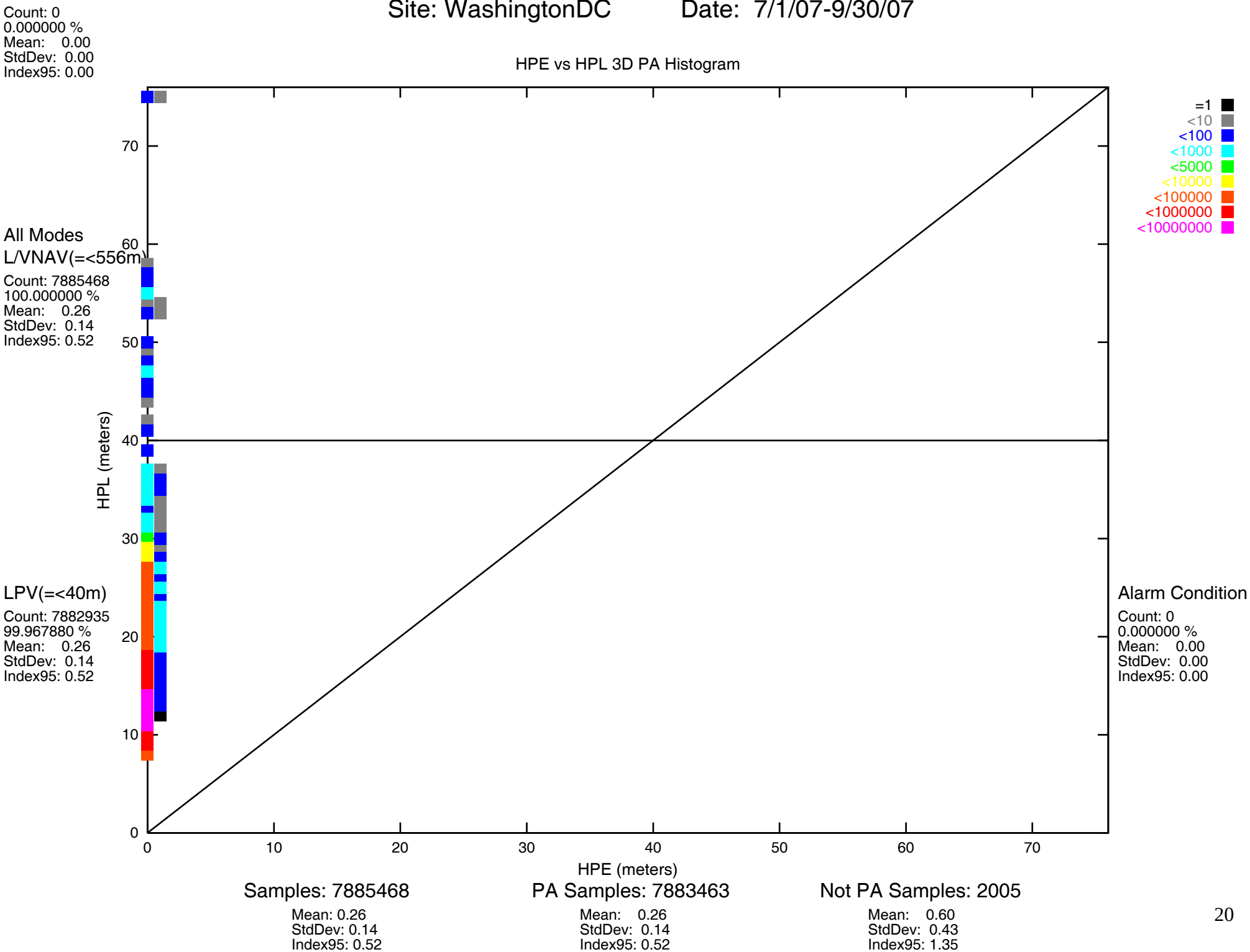
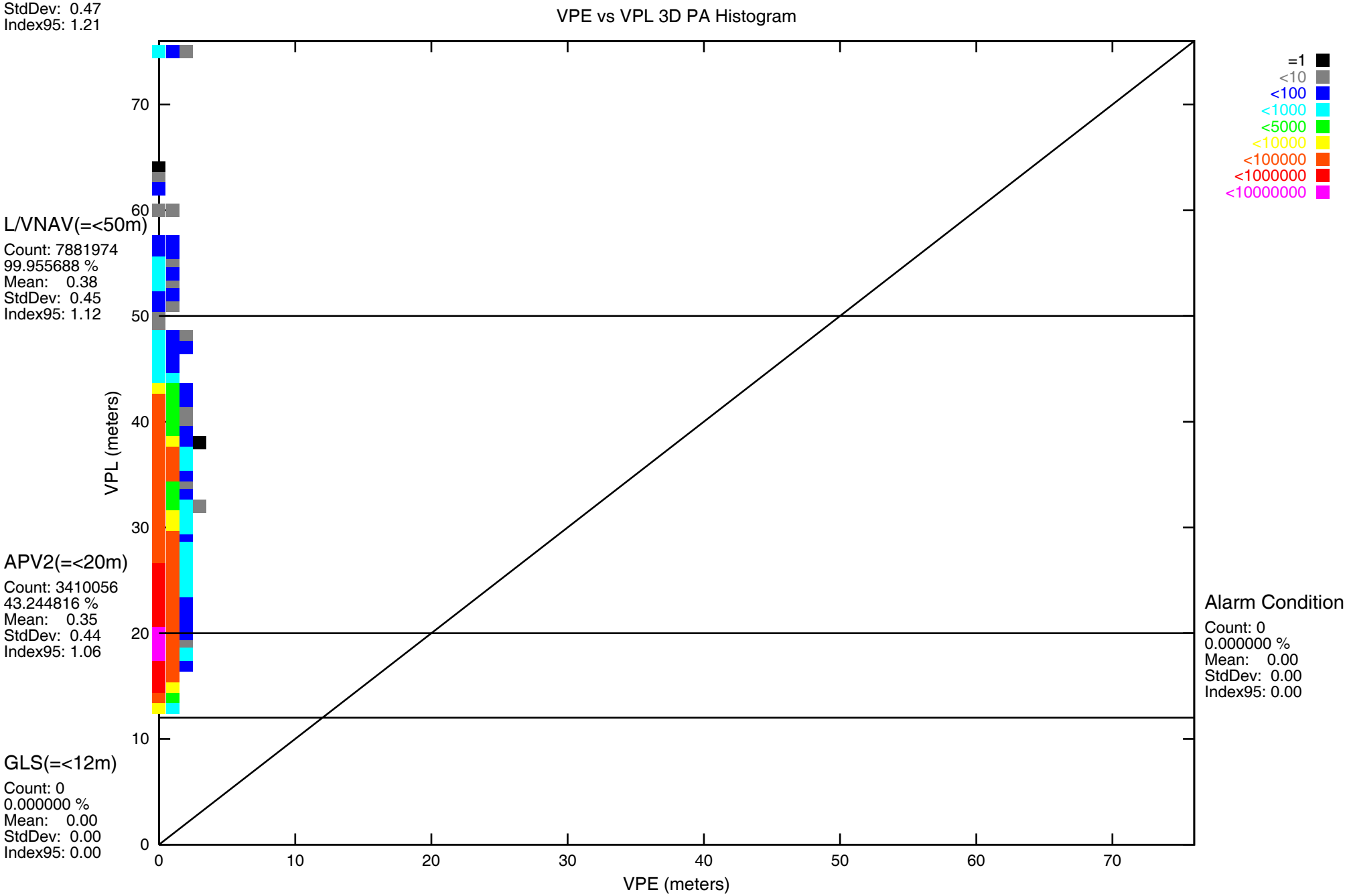


Figure 2-11 Vertical Triangle Chart for Washington, DC

Site: WashingtonDC Date: 7/1/07-9/30/07



Samples: 7885468
Mean: 0.38
StdDev: 0.45
Index95: 1.12

PA Samples: 7883463
Mean: 0.38
StdDev: 0.45
Index95: 1.12

Not PA Samples: 2005
Mean: -0.34
StdDev: 0.92
Index95: 1.98

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

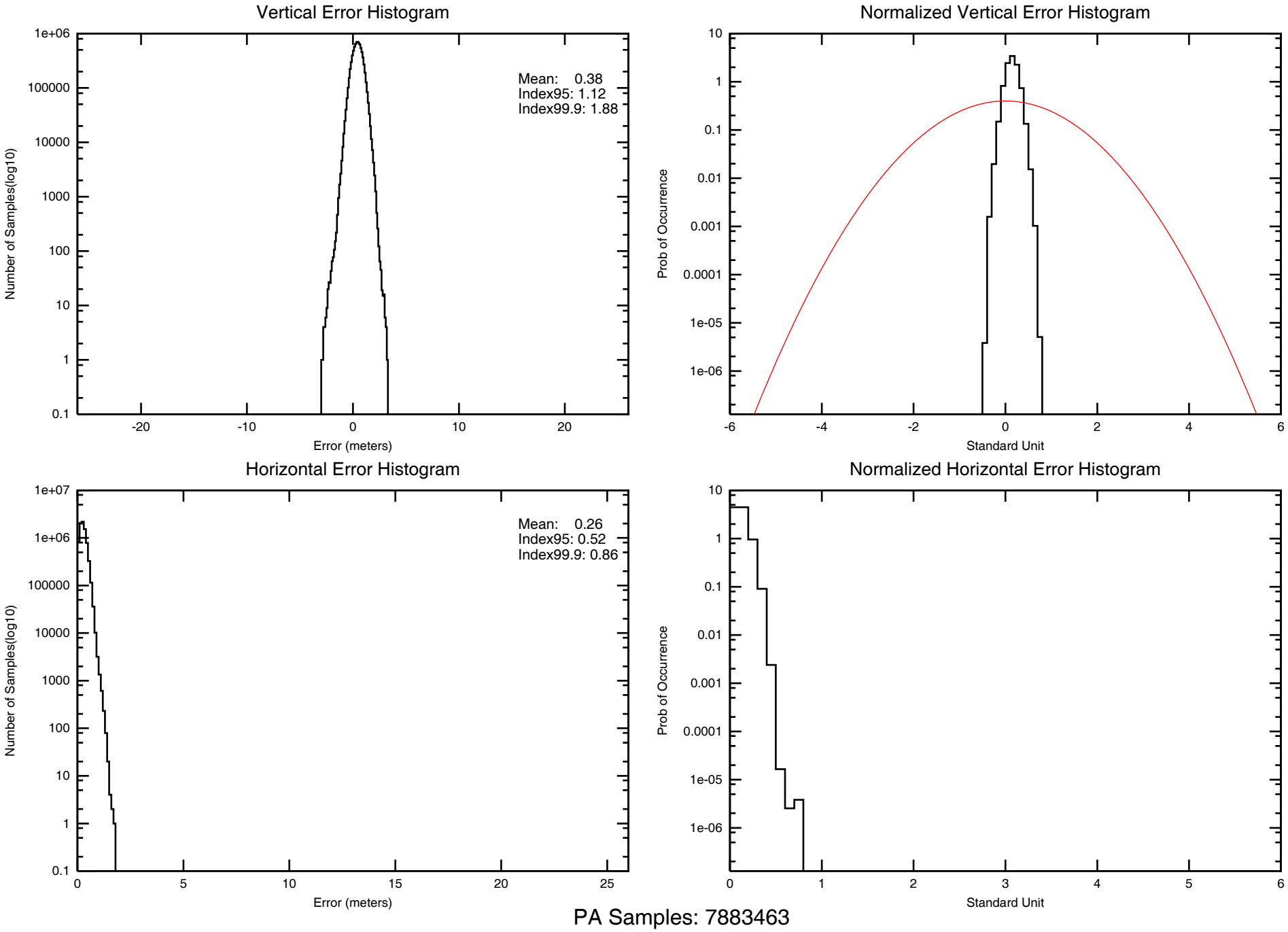


Figure 2-13 Horizontal Triangle Chart for Seattle

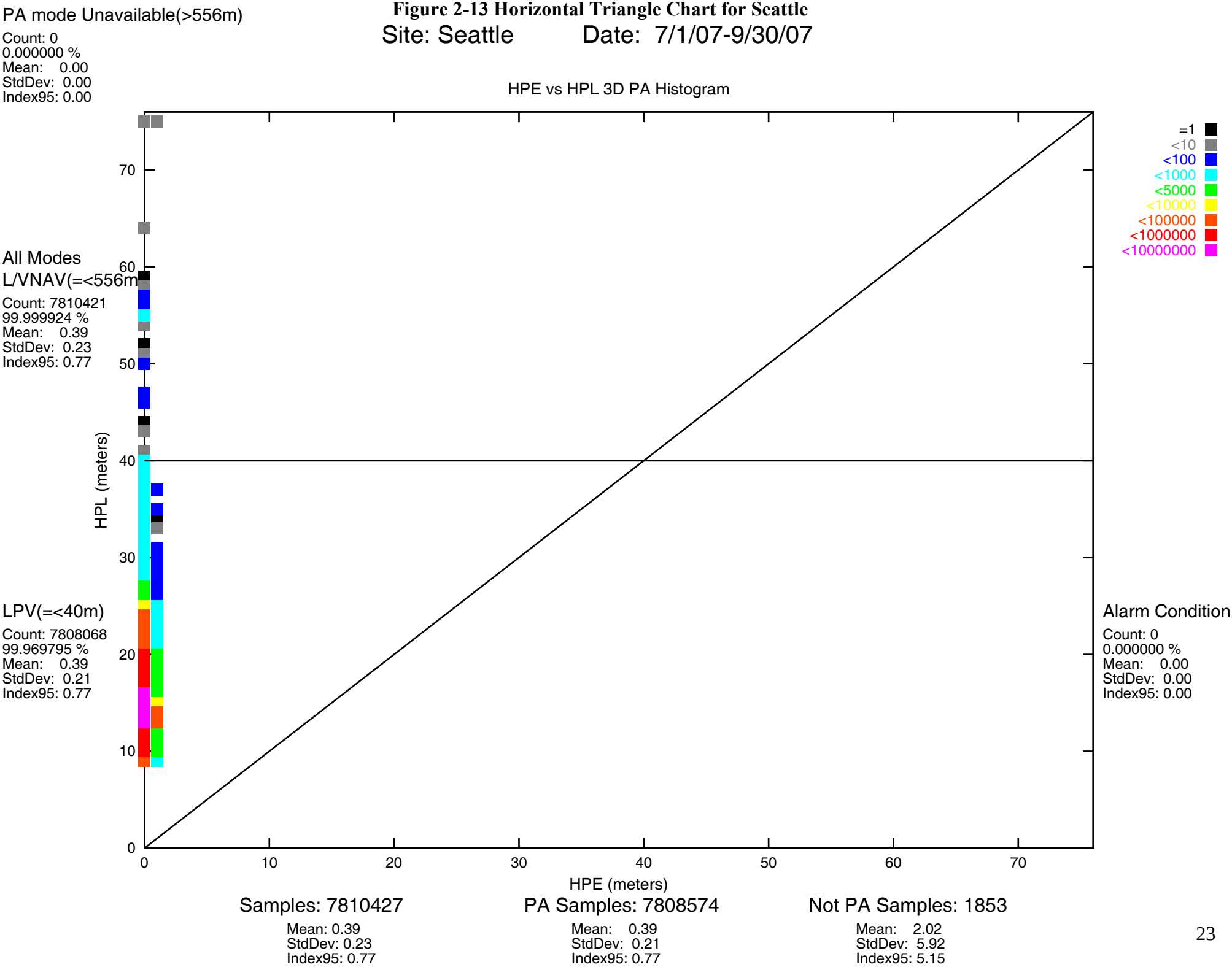
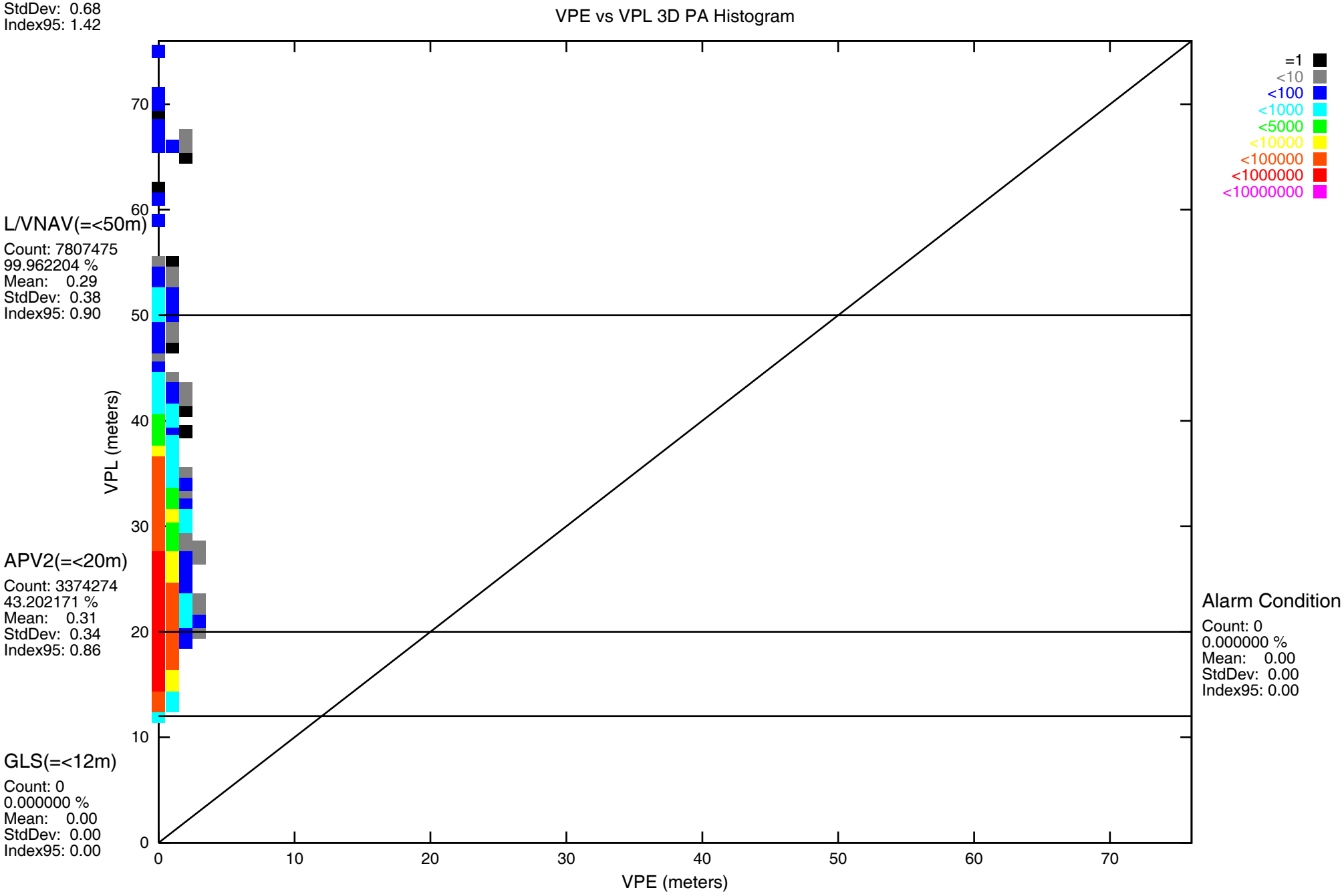


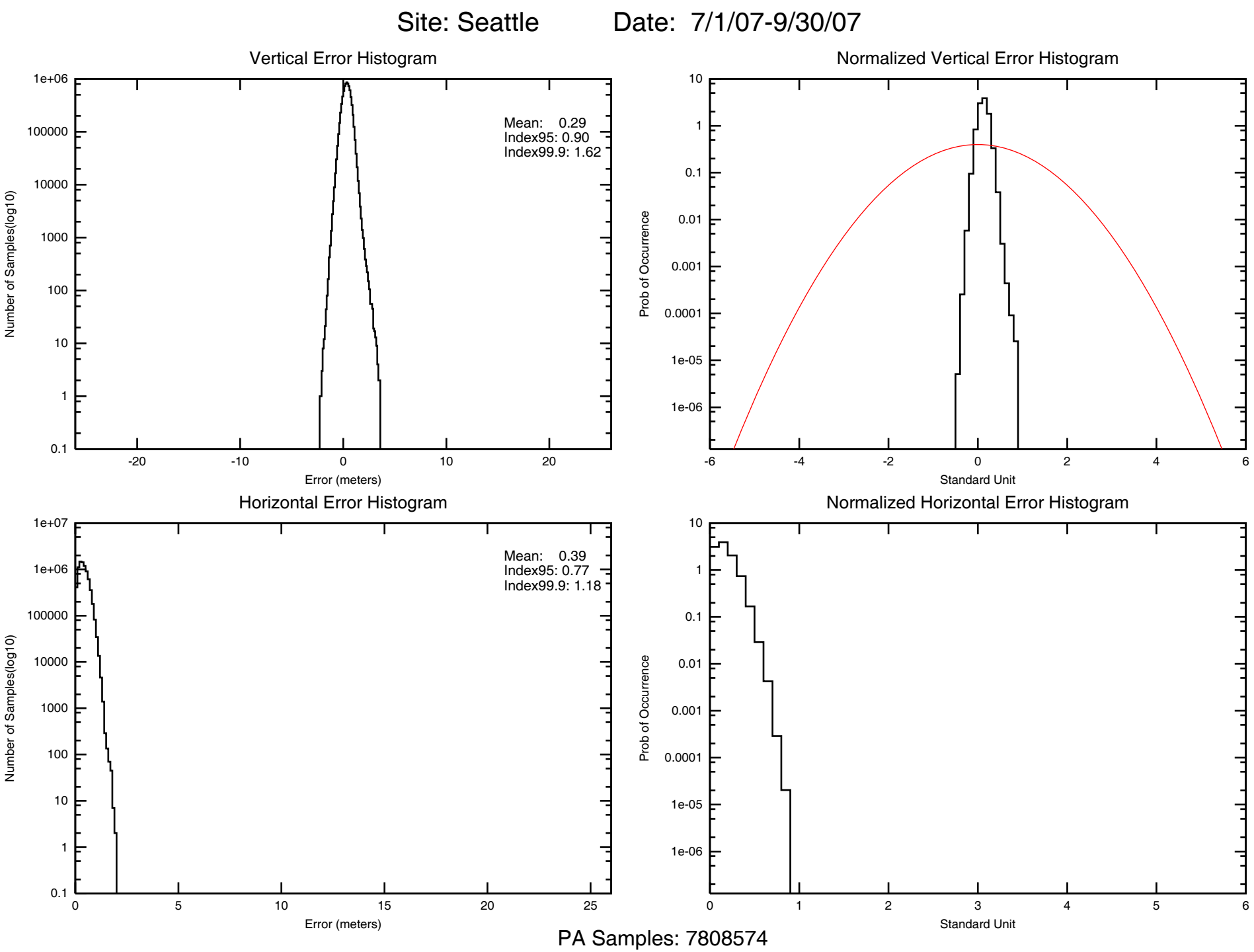
Figure 2-14 Vertical Triangle Chart for Seattle

Site: Seattle Date: 7/1/07-9/30/07



Samples: 7810427	PA Samples: 7808574	Not PA Samples: 1853
Mean: 0.29	Mean: 0.29	Mean: -0.92
StdDev: 0.38	StdDev: 0.38	StdDev: 1.53
Index95: 0.90	Index95: 0.90	Index95: 5.70

Figure 2-15 2-D Histogram for Seattle



3.0 AVAILABILITY

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

Availability of LPV and LNVA/VNAV service is evaluated by monitoring the WAAS protection levels at receiver locations throughout the test period. If both the vertical and horizontal protection levels are not greater than their respective alert limits (VAL and HAL) then the service is available. If either of the protection levels exceeds the required alert level then the operational service at that location is considered unavailable and an outage in service is recorded with its duration. The operational service is not considered available again until the protection levels are both within the alert limits for at least 15 minutes. Although this will reduce operational service availability minimally, it substantially reduces the number of service outages and prevents excessive switching in and out of service availability. The percent of time that LPV, LPV200 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.

The following table shows the maximum and minimum 95% HPL and VPL observed for this evaluated period.

Parameter	CONUS Site/Maximum	CONUS Site/Minimum	All Sites Site/Maximum	All Sites Site/Minimum
95% HPL	Boston 28.639 meters	Kansas City 16.905 meters	Barrow 49.243 meters	Kansas City 16.905 meters
95% VPL	Boston 42.141 meters	Kansas City 25.662 meters	Barrow 82.709 meters	Kansas City 25.662 meters

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 this 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.

During this evaluated period, there were three short SIS outages that caused a lower NPA availability for all sites. Two events due to C&V faults and one event due to AOR SIS outage.

Table 3-1 95% Protection Level

Location	95% HPL (meters)	95% VPL (meters)	Percentage in PA mode
Albuquerque	19.013	30.231	99.974464
Anchorage	21.022	34.846	99.973228
Atlanta	17.776	27.656	99.974701
Barrow	49.243	82.709	99.901787
Bethel	25.584	44.131	99.974014
Billings	18.571	27.159	99.975189
Boston	28.639	42.141	99.978104
Chicago	17.564	26.245	99.975708
Cleveland	18.978	28.547	99.974983
Cold Bay	40.825	55.873	99.975624
Dallas	19.340	29.347	99.884399
Denver	17.681	26.723	99.974236
Fairbanks	21.284	39.271	99.973282
Houston	23.213	34.053	99.971581
Jacksonville	19.284	31.476	99.974617
Juneau	21.052	31.786	99.987267
Kansas City	16.905	25.662	99.967224
Kotzebue	29.622	56.970	99.922363
Los Angeles	25.260	39.678	99.975075
Memphis	17.492	26.393	99.975716
Miami	23.578	38.041	99.974213
Minneapolis	20.006	27.476	99.976143
New York	25.404	38.189	99.978157
Oakland	26.092	40.742	99.976357
Salt Lake City	17.625	27.557	99.976013
Seattle	19.856	28.923	99.976280
Washington DC	20.707	30.633	99.974571

Table 3-2 Quarterly Availability Statistics

Location	LPV *Average Availability Percentage of time*	LNAV/VNAV *Average Availability Percentage of time*	LPV 200 WAAS *With 15 minute window*	LPV WAAS *With 15 minute window*	LNAV/VNAV *With 15 minute window*
Albuquerque	0.99929094	0.99929738	0.98678918	0.99929350	0.99929857
Anchorage	0.99881381	0.99885648	0.93900871	0.99854079	0.99857271
Atlanta	0.99963200	0.99963427	0.98336802	0.99962031	0.99962259
Barrow	0.70944387	0.73151553	0.28993399	0.67924562	0.69692251
Bethel	0.97903854	0.97980642	0.77825247	0.97649753	0.97767504
Billings	0.99968624	0.99970132	0.99510108	0.99968558	0.99970117
Boston	0.98265541	0.98270065	0.85146080	0.97509955	0.97519958
Chicago	0.99965167	0.99965167	0.99186791	0.99965060	0.99965060
Cleveland	0.99967253	0.99967253	0.97189285	0.99967314	0.99967314
Cold Bay	0.88081646	0.89855921	0.39833300	0.84754154	0.86746705
Dallas	0.99864316	0.99866521	0.98955309	0.99945090	0.99951407
Denver	0.99960351	0.99962145	0.99132132	0.99960699	0.99962515
Fairbanks	0.99232095	0.99237114	0.88893072	0.99045807	0.99050716
Houston	0.99723989	0.99734753	0.95203345	0.99688380	0.99701297
Jacksonville	0.99963278	0.99963278	0.96084604	0.99959237	0.99959237
Juneau	0.99956381	0.99956459	0.97324599	0.99947349	0.99947428
Kansas City	0.99959862	0.99959862	0.99291595	0.99960221	0.99960221
Kotzebue	0.90201807	0.90315562	0.58468623	0.88341687	0.88711622
Los Angeles	0.99876159	0.99893486	0.82425995	0.99839202	0.99855499
Memphis	0.99720341	0.99720341	0.98854882	0.99708525	0.99708525
Miami	0.99908680	0.99908692	0.90624151	0.99877775	0.99877787
Minneapolis	0.99963355	0.99963689	0.98568504	0.99962392	0.99962729
New York	0.99867684	0.99868852	0.91847082	0.99790743	0.99792048
Oakland	0.99572045	0.99578750	0.81911000	0.99434733	0.99441544
Salt Lake City	0.99968332	0.99968356	0.99537661	0.99968379	0.99968404
Seattle	0.99959606	0.99962205	0.99065583	0.99956637	0.99959583
Washington DC	0.99955690	0.99955690	0.96095239	0.99954782	0.99954782

Table 3-3 NPA Availability

Location	NPA Availability (Excluding RAIM/FDE)
Albuquerque	0.99985110
Anchorage	0.99984255
Atlanta	0.99984448
Bethel	0.99987671
Billings	0.99984693
Boston	0.99984686
Cleveland	0.99984743
Cold Bay	0.99983871
Fairbanks	0.99987963
Honolulu	0.99986842
Houston	0.99984382
Juneau	0.99987850
Kansas City	0.99983853
Kotzebue	0.99969551
Los Angeles	0.99988019
Miami	0.99984544
Minneapolis	0.99984372
Oakland	0.99987502
Puerto Rico	0.99980707
Salt Lake City	0.99988536
Seattle	0.99987661
Washington DC	0.99984506

Table 3-4 LPV and LNAV/VNAV Outage Rate

Location	LPV 200 Outages	LPV 200 Outage Rates	LPV Outages	LPV Outage Rates	LNAV/VNAV Outages	LNAV/VNAV Outage Rates
Albuquerque	74	0.001426	27	0.000514	27	0.000514
Anchorage	492	0.009956	36	0.000685	35	0.000666
Atlanta	194	0.003750	7	0.000133	7	0.000133
Barrow	883	0.058510	975	0.027577	966	0.026593
Bethel	870	0.021249	263	0.005120	261	0.005075
Billings	43	0.000821	9	0.000171	8	0.000152
Boston	817	0.018247	247	0.004817	245	0.004778
Chicago	60	0.001150	7	0.000133	7	0.000133
Cleveland	212	0.004142	7	0.000133	7	0.000133
Cold Bay	1096	0.052577	907	0.020449	699	0.015397
Dallas	111	0.002266	13	0.000263	11	0.000222
Denver	108	0.002076	11	0.000210	11	0.000210
Fairbanks	756	0.016183	262	0.005033	259	0.004975
Houston	301	0.006041	49	0.000939	48	0.000920
Jacksonville	223	0.004410	8	0.000152	8	0.000152
Juneau	323	0.006572	16	0.000317	15	0.000297
Kansas City	55	0.001077	8	0.000156	8	0.000156
Kotzebue	1213	0.039517	789	0.017012	771	0.016555
Los Angeles	638	0.014713	28	0.000533	26	0.000495
Memphis	62	0.001194	34	0.000649	34	0.000649
Miami	483	0.010136	35	0.000666	34	0.000647
Minneapolis	121	0.002386	13	0.000253	12	0.000233
New York	413	0.008334	72	0.001371	71	0.001352
Oakland	823	0.019116	159	0.003042	155	0.002965
Salt Lake City	73	0.001396	7	0.000133	7	0.000133
Seattle	115	0.002230	10	0.000192	8	0.000154
Washington DC	266	0.005268	16	0.000305	16	0.000305

Table 3-5 NPA Outage Rates

Location	NPA Outages	NPA Outage Rate
Albuquerque	5	0.00009505
Anchorage	6	0.00011411
Atlanta	5	0.00009500
Bethel	4	0.00007627
Billings	6	0.00011397
Boston	6	0.00011402
Cleveland	5	0.00009490
Cold Bay	6	0.00011709
Fairbanks	4	0.00007628
Honolulu	5	0.00009527
Houston	5	0.00009510
Juneau	3	0.00005732
Kansas City	5	0.00009628
Kotzebue	23	0.00044414
Los Angeles	3	0.00005700
Miami	5	0.00009503
Minneapolis	5	0.00009681
Oakland	3	0.00005884
Puerto Rico	7	0.00013339
Salt Lake City	3	0.00005707
Seattle	3	0.00005803
Washington DC	5	0.00009511

Figure 3-1 LPV Instantaneous Availability

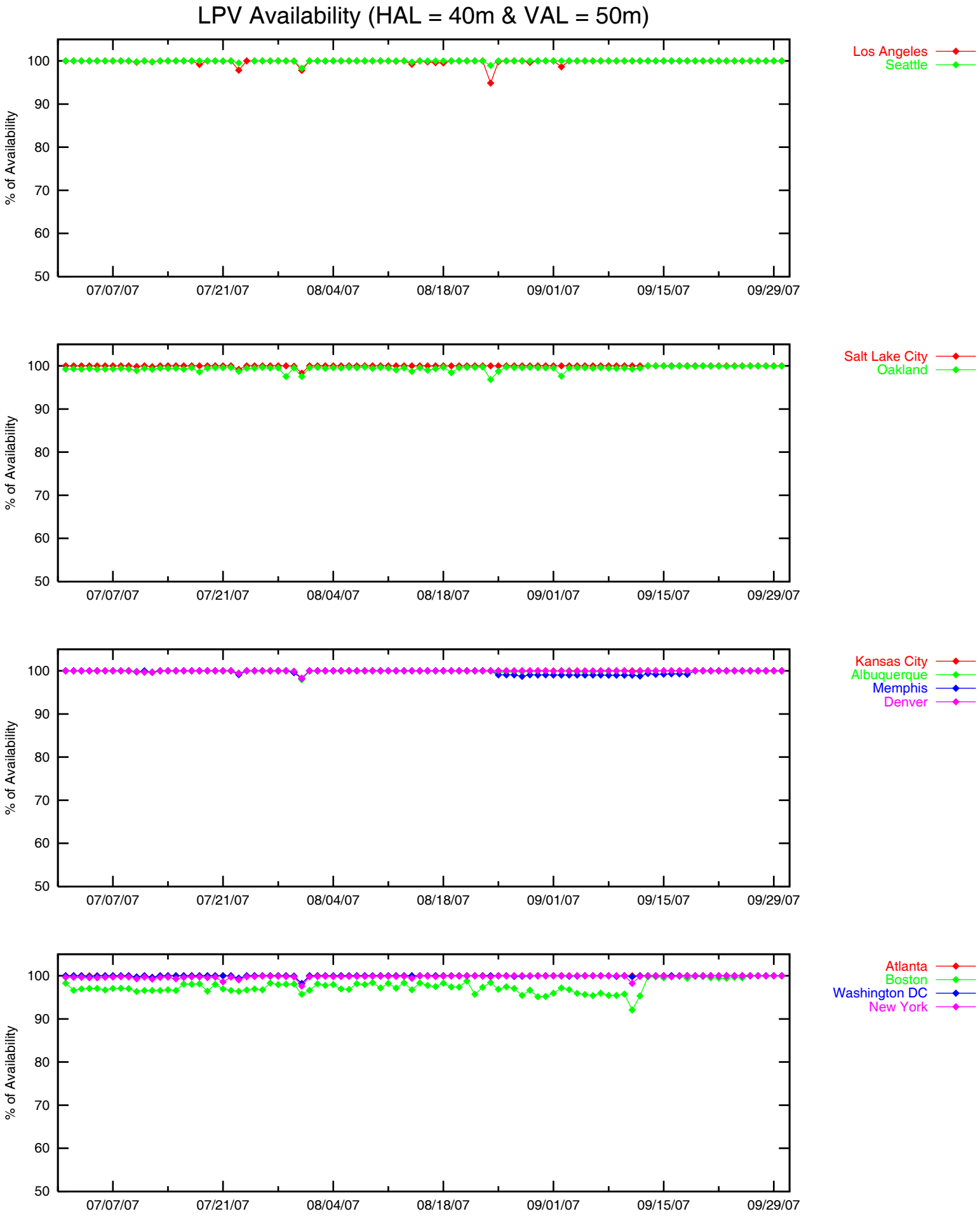


Figure 3-2 LPV Instantaneous Availability

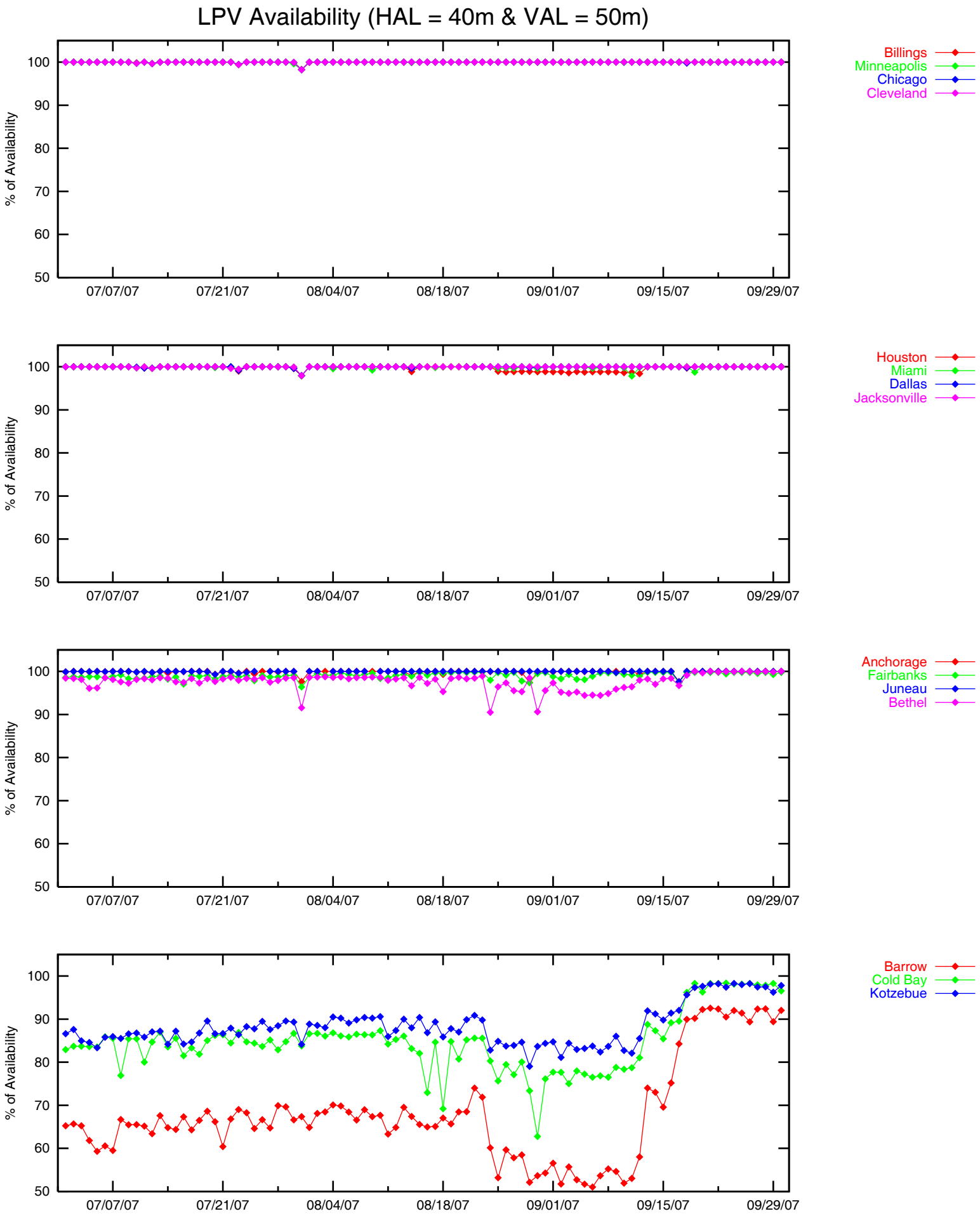


Figure 3-3 LNAV/VNAV Instantaneous Availability

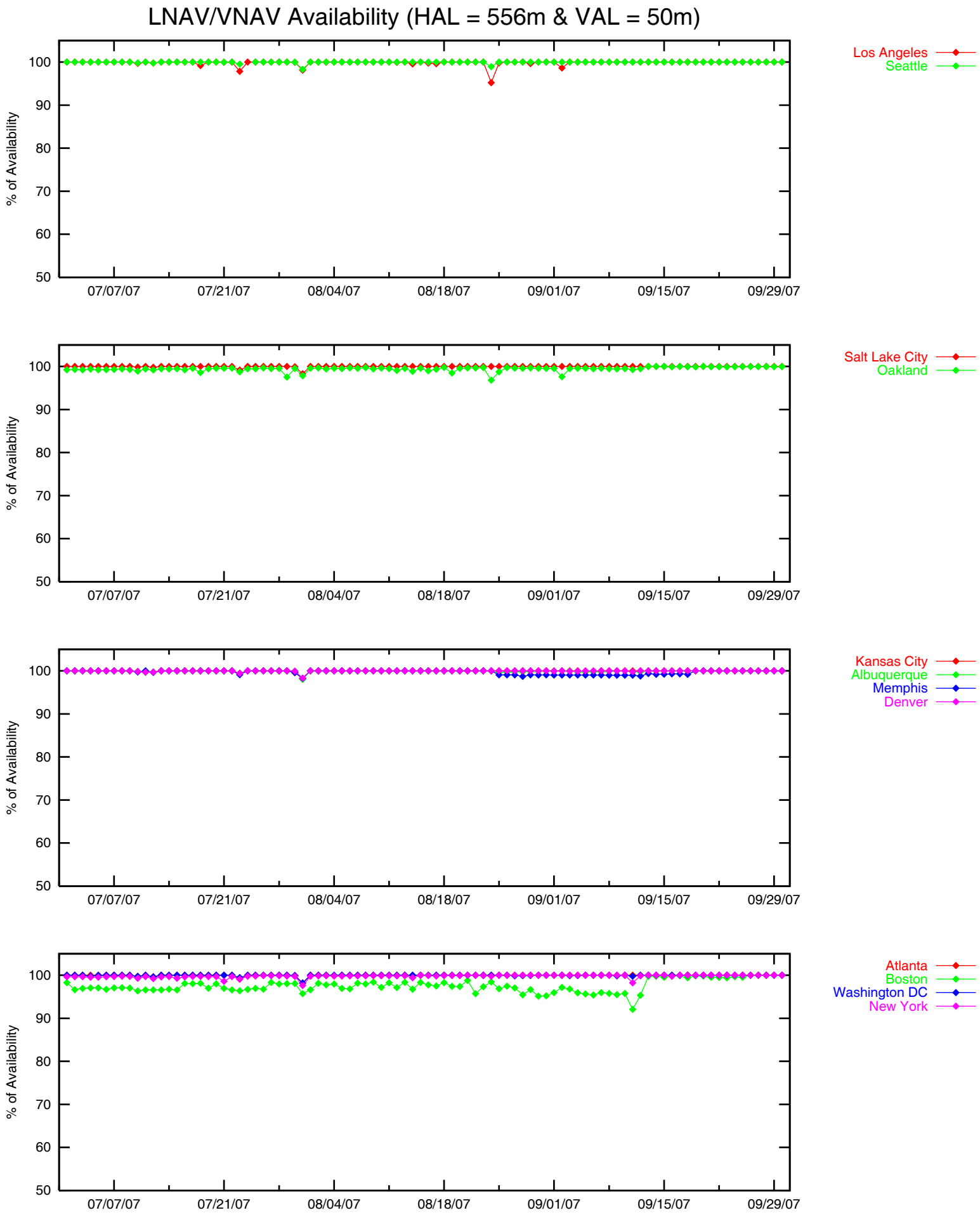


Figure 3-4 LNAV/VNAV Instantaneous Availability

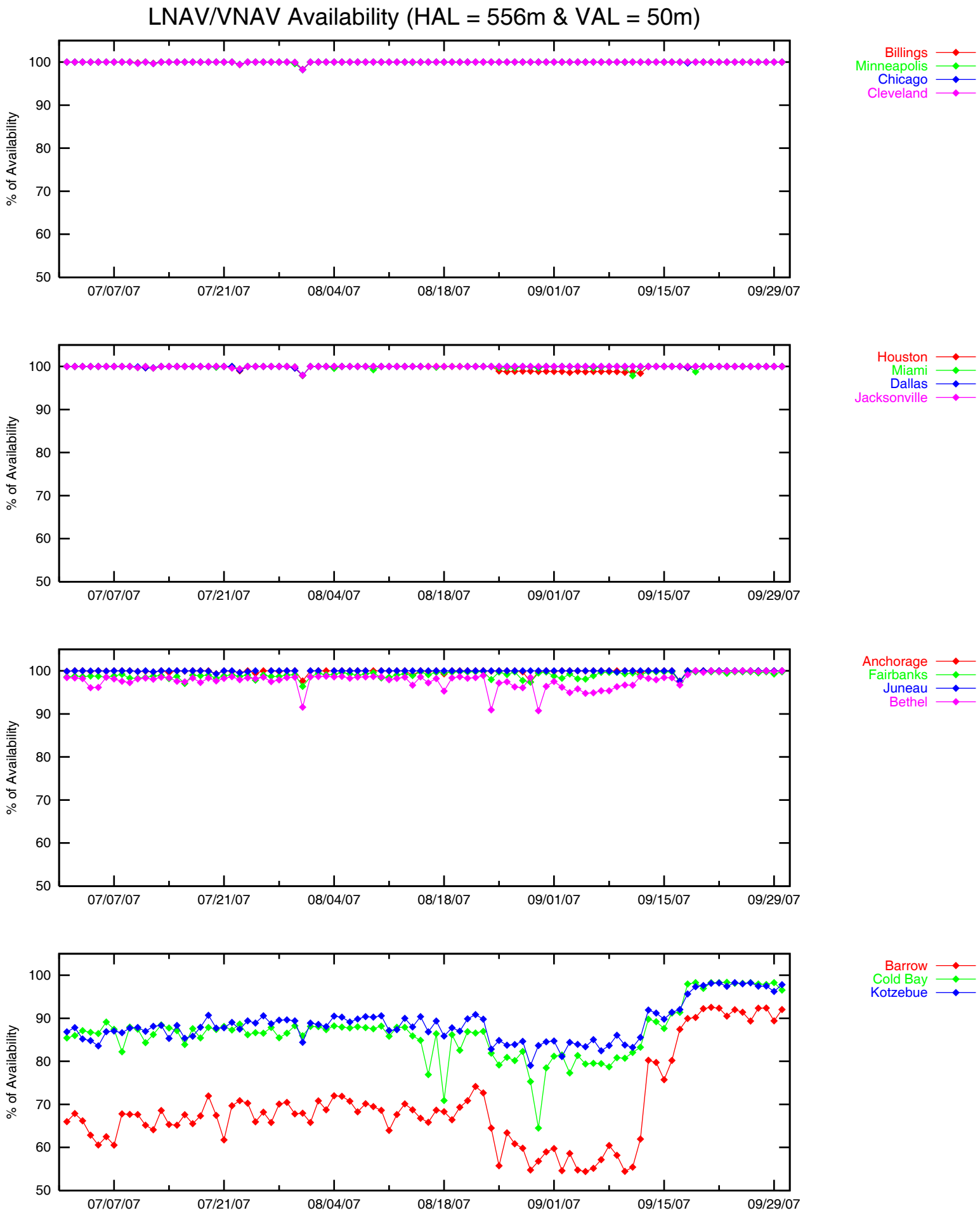


Figure 3-5 LPV Outages

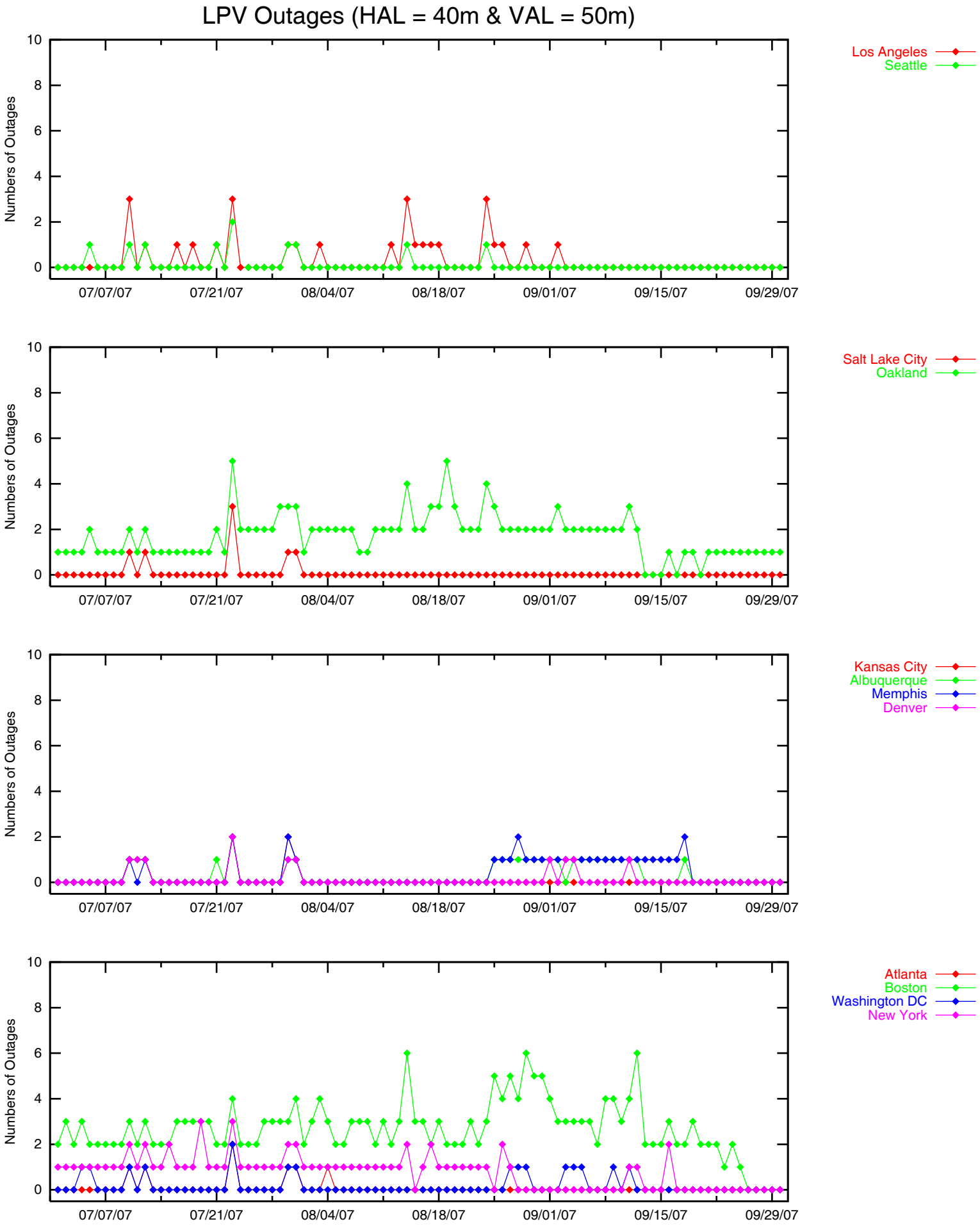


Figure 3-6 LPV Outages

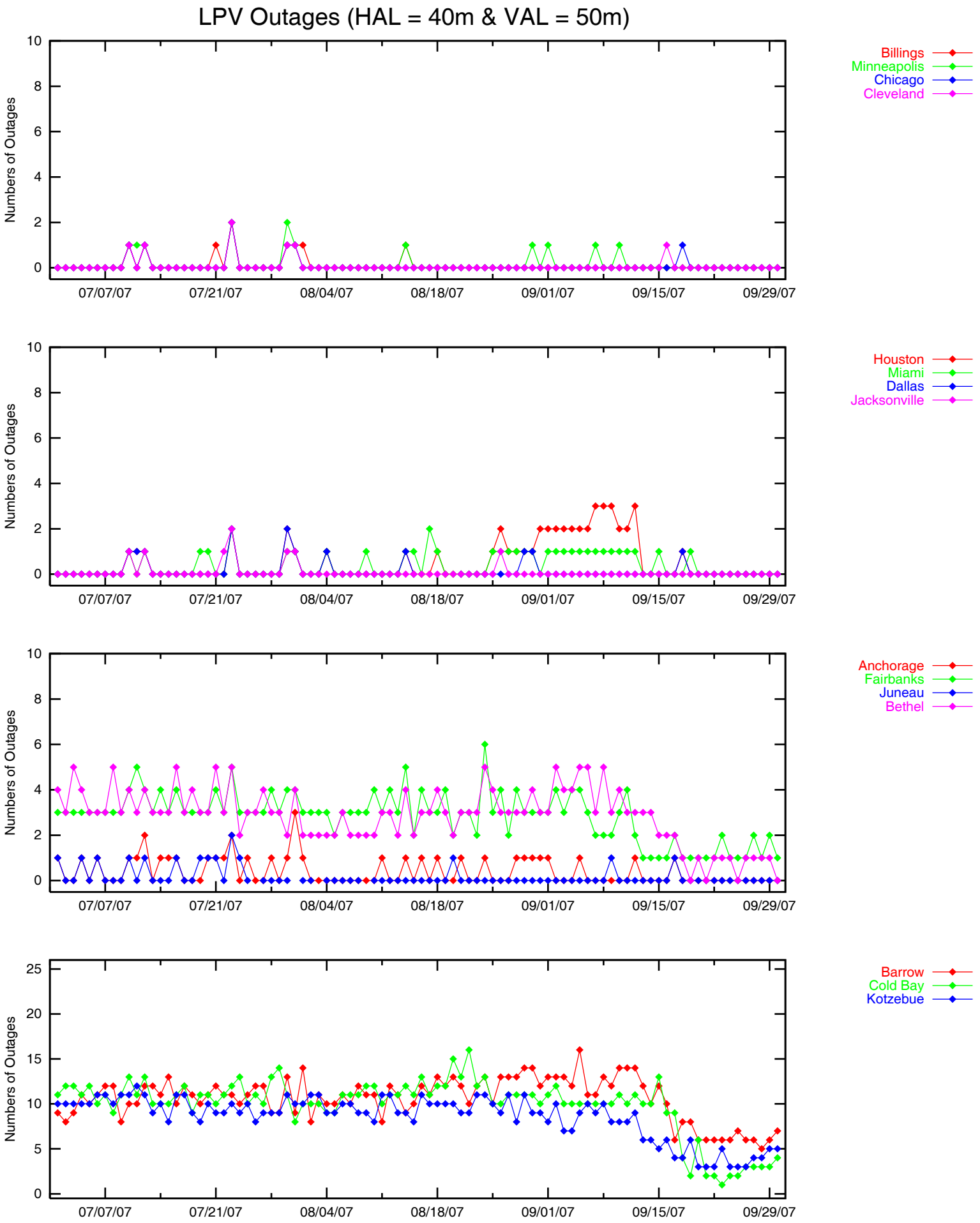


Figure 3-7 LNAV/VNAV Outages

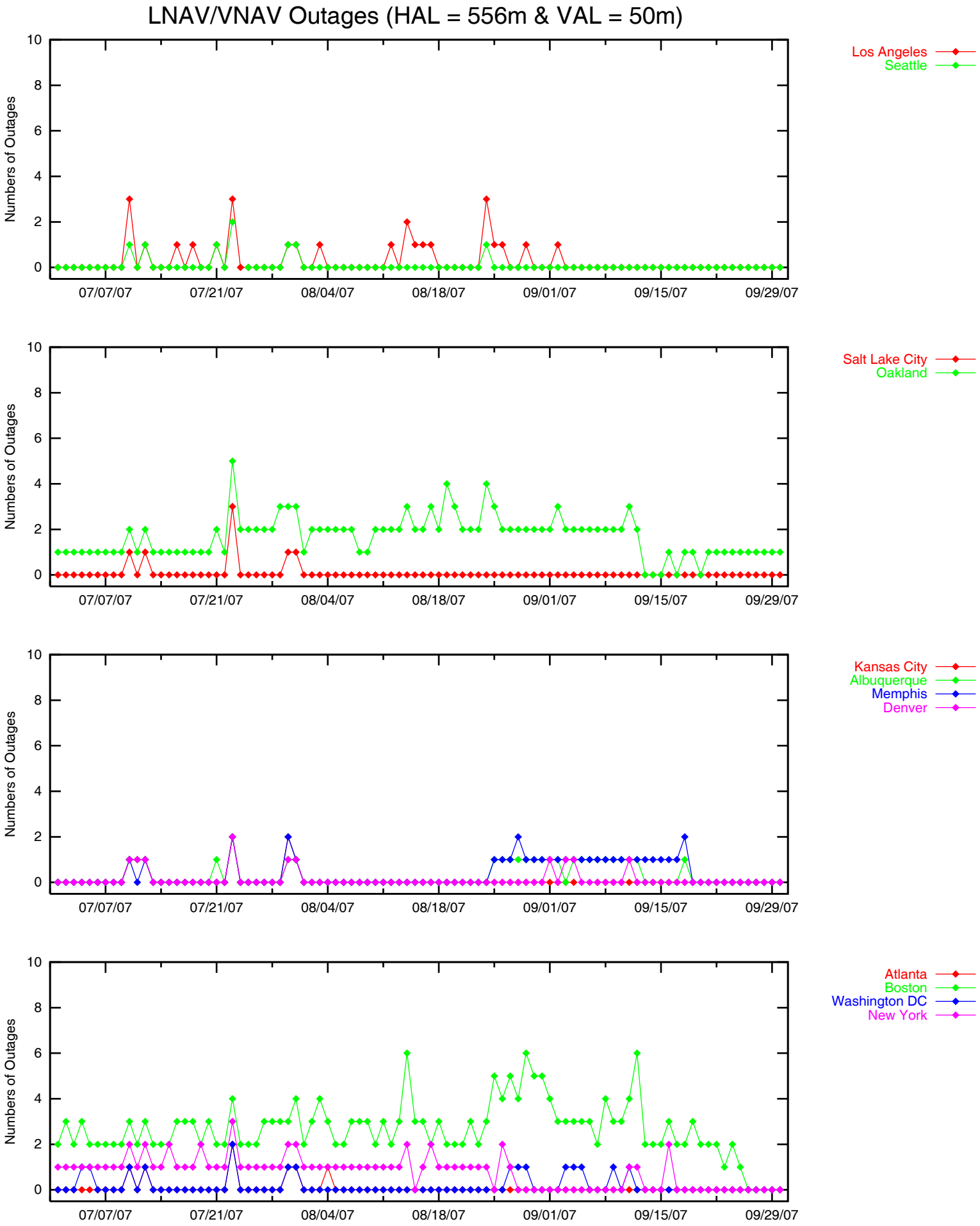
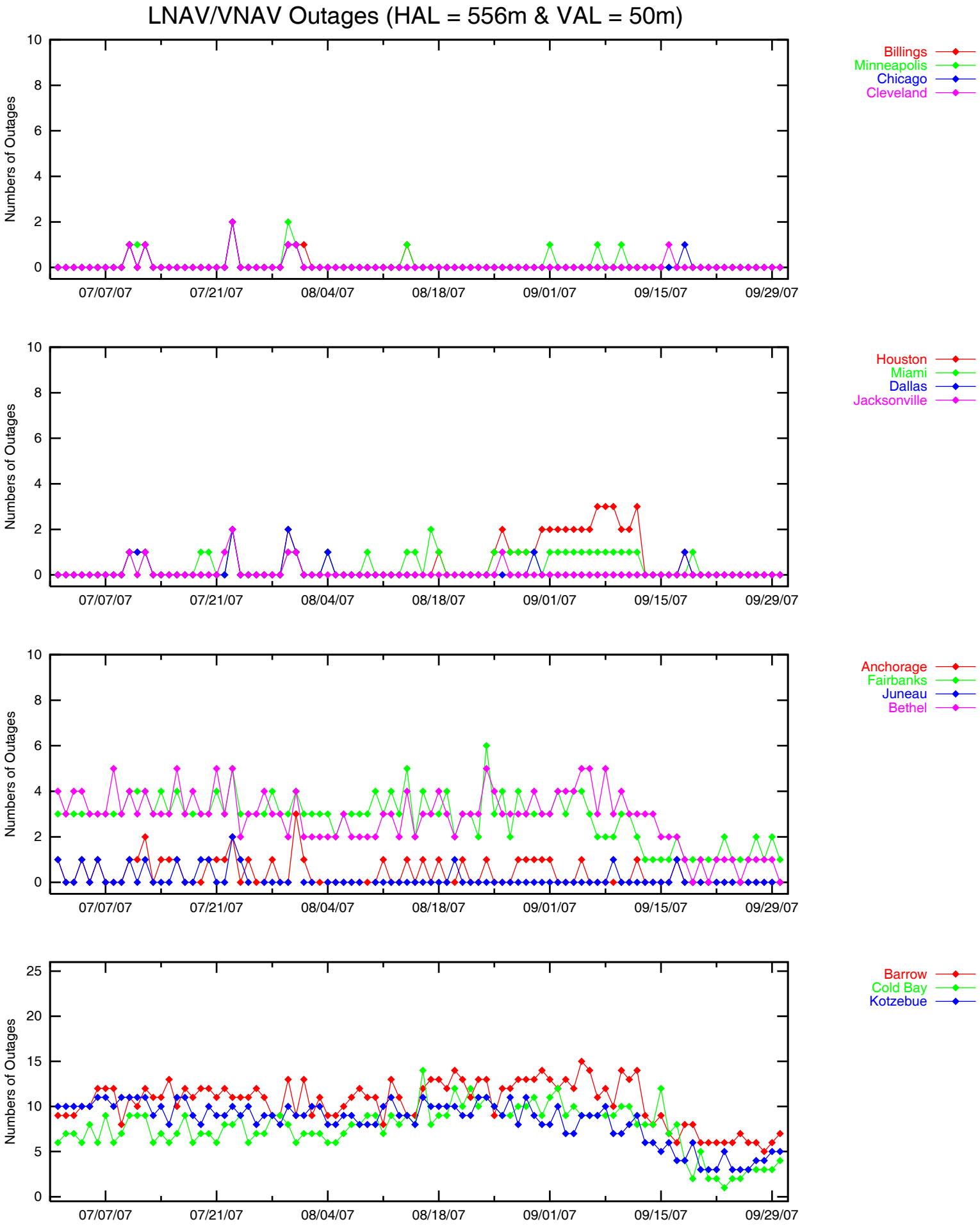


Figure 3-8 LNAV/VNAV Outages



4.0 COVERAGE

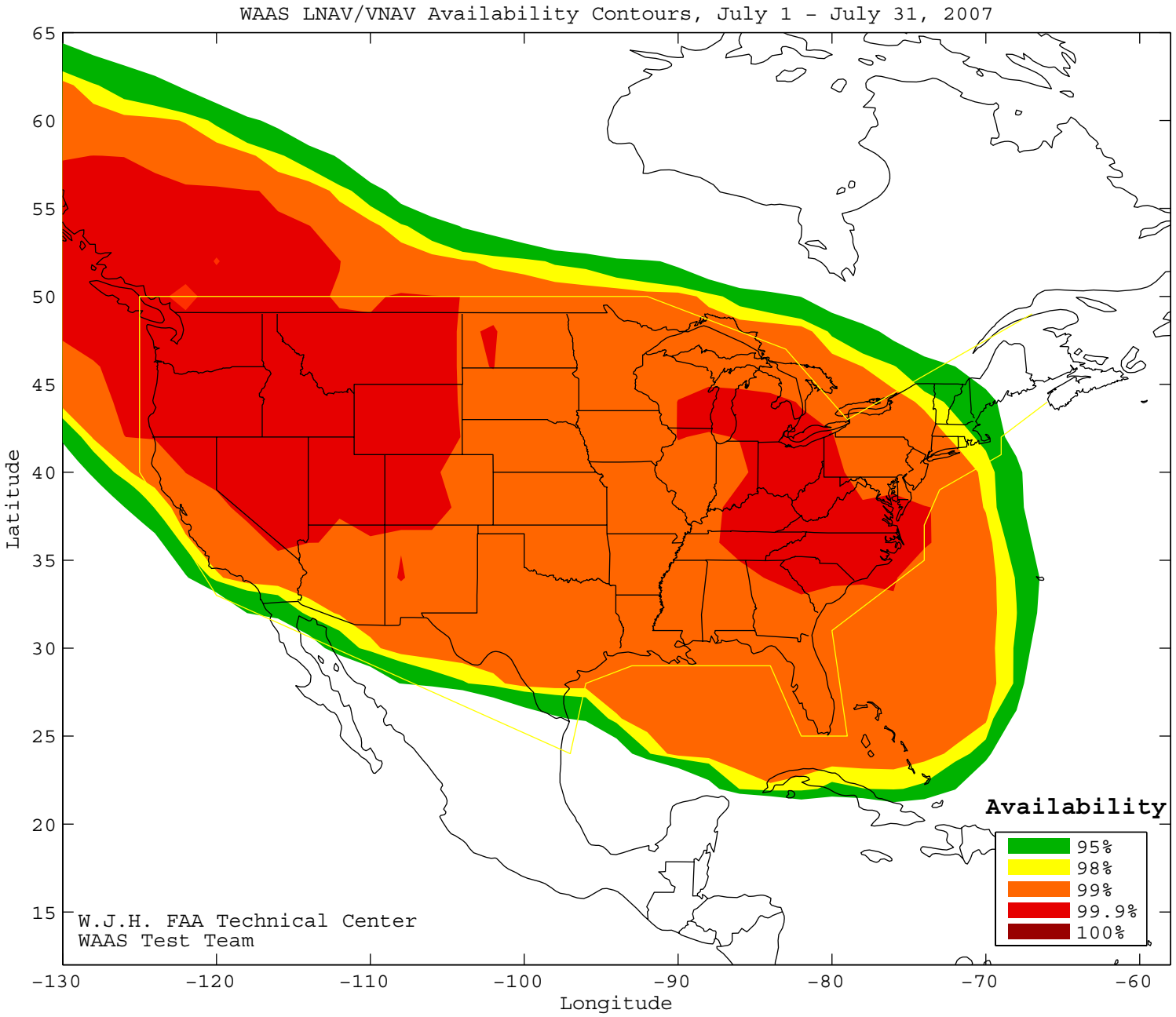
WAAS coverage area evaluation estimates the percent of service volume where WAAS is providing LPV, LPV200, LNAV/VNAV and NPA services. The WAAS message and the GPS/GEO satellite status are used to determine WAAS availability across North America. For PA coverage, protection levels were calculated at 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 LPV, LPV200, and LNAV/VNAV service levels. The coverage plots provide 100, 99.9, 99, 98 and 95% availability contours. Figures 4.1 to 4.3 show the LNAV/VNAV CONUS coverage, Figure 4.5 to 4.7 show the LPV CONUS coverage, Figure 4.9 to 4.11 show the LPV200 CONUS coverage, and Figure 4.23 to 4.25 show the LPV Alaska coverage for each month for this quarter. Figure 4.4, 4.8, and 4.12 show the rollup LNAV/VNAV, LPV, and LPV200 for the quarter. Figure 4.17 shows the daily LNAV/VNAV and LPV CONUS coverage, and Figure 4.27 shows the daily LPV Alaska coverage at 99% availability and ionosphere KP index values for this quarter.

Daily analysis for NPA was based on a 99.9% availability requirement. The NPA coverage plots provide 100, 99.9 and 99% availability contours. Figure 4.13 to 4.15 show the NPA coverage area of each month and Figure 4.16 shows the rollup NPA coverage for the quarter. Figure 4.18 shows the daily NPA coverage at 99.9% availability and ionosphere Kp index values for this quarter.

Figures 4.19 to 4.21 show the rollup of LNAV/VNAV, LPV and NPA CONUS coverage since WAAS commissioning (July 2003). Figure 4.22 shows the rollup of LPV 200 CONUS, and Figure 4.28 shows the rollup of LPV Alaska coverage since added to the WAAS (Oct 2006).

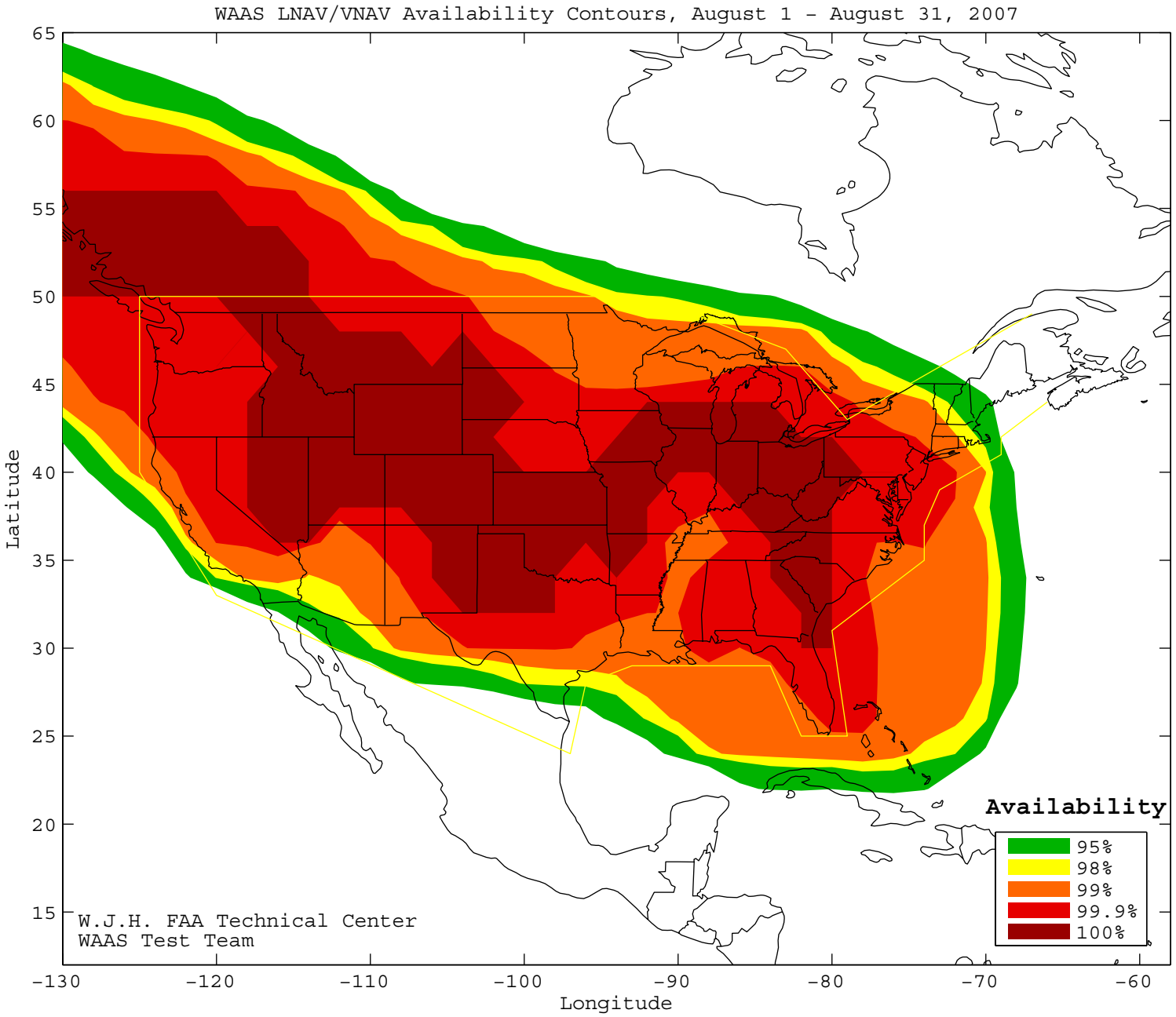
Figure 4-1 WAAS LNAV/VNAV Coverage - July



CONUS Coverage at 95% Availability = 97.17%
CONUS Coverage at 99% Availability = 91.09%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

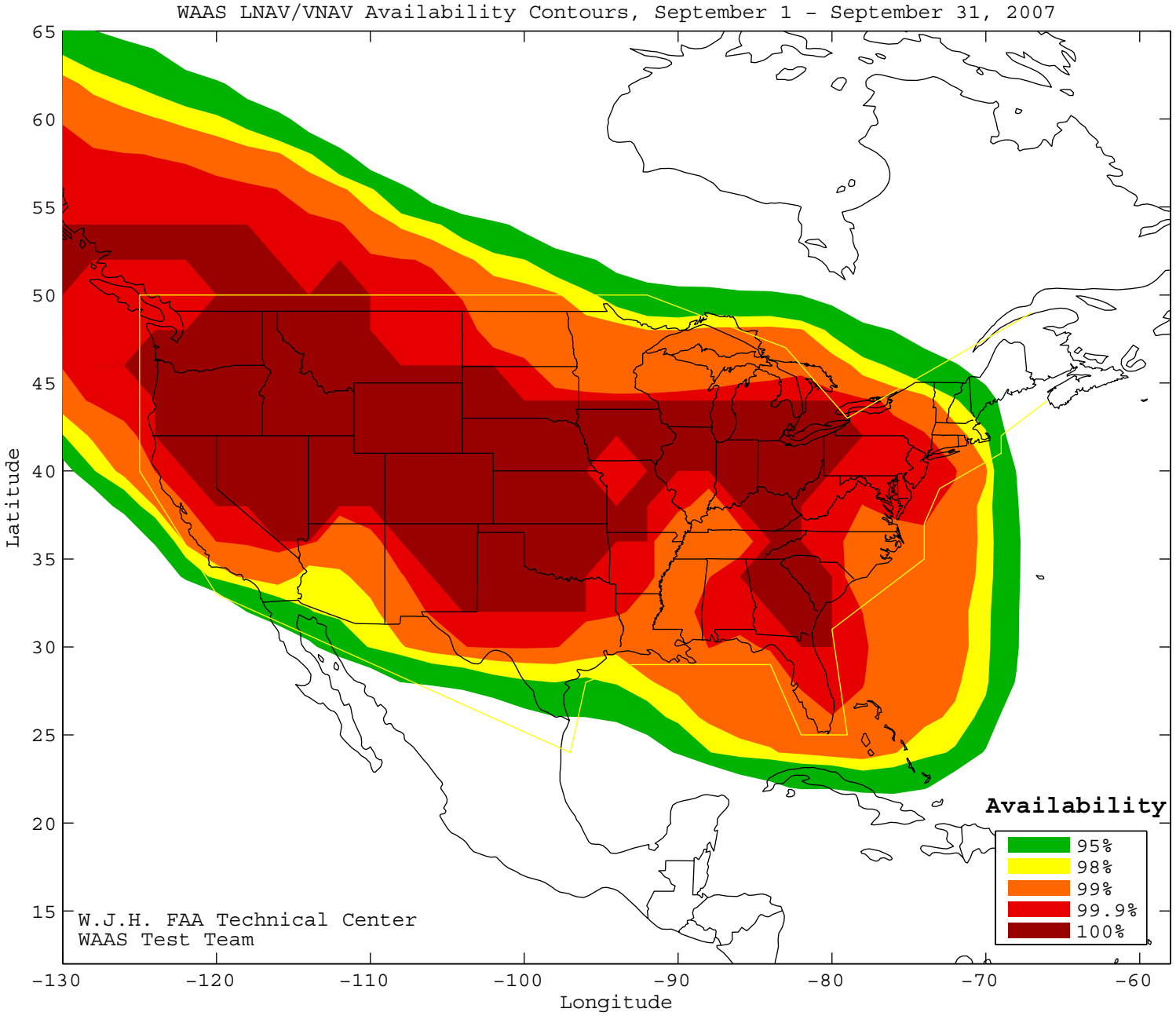
Figure 4-2 WAAS LNAV/VNAV Coverage - August



CONUS Coverage at 95% Availability = 96.36%
CONUS Coverage at 99% Availability = 89.88%
CONUS Coverage at 100% Availability = 48.18%

SL = LNAV/VNAV

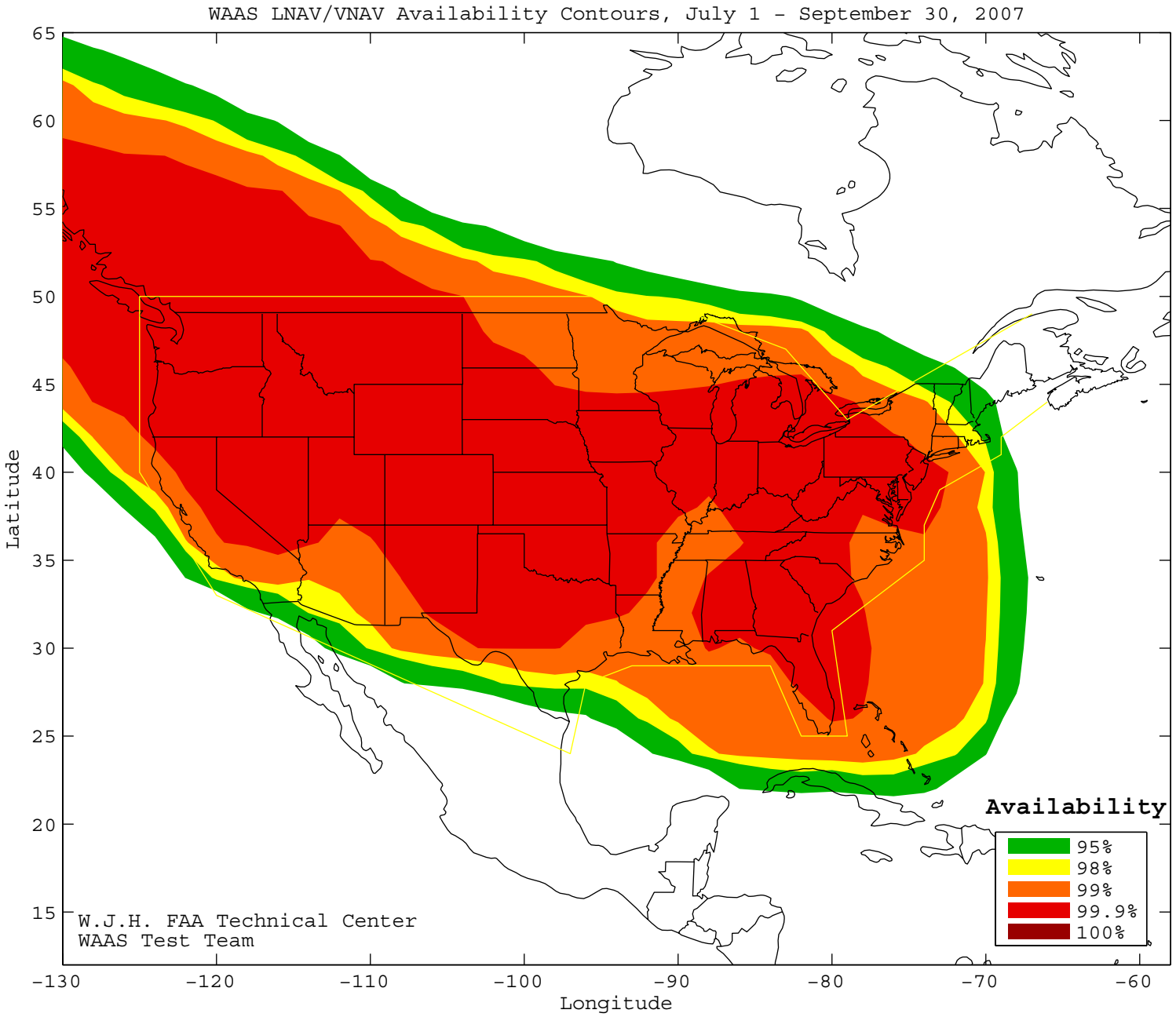
Figure 4-3 WAAS LNAV/VNAV Coverage - September



CONUS Coverage at 95% Availability = 97.17%
CONUS Coverage at 99% Availability = 89.07%
CONUS Coverage at 100% Availability = 56.68%

SL = LNAV/VNAV

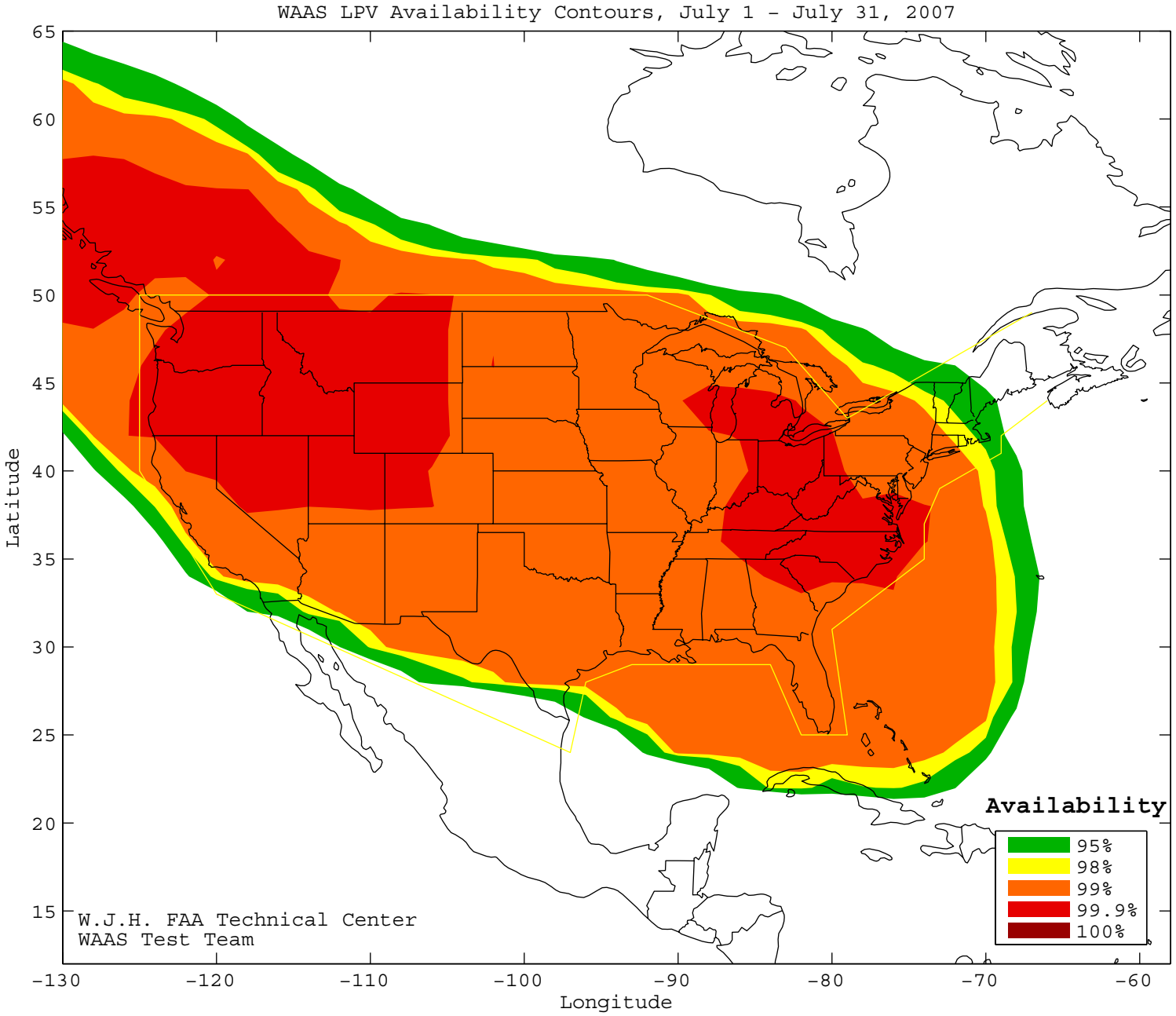
Figure 4-4 WAAS LNAV/VNAV Coverage for the Quarter



CONUS Coverage at 95% Availability = 96.76%
CONUS Coverage at 99% Availability = 90.28%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

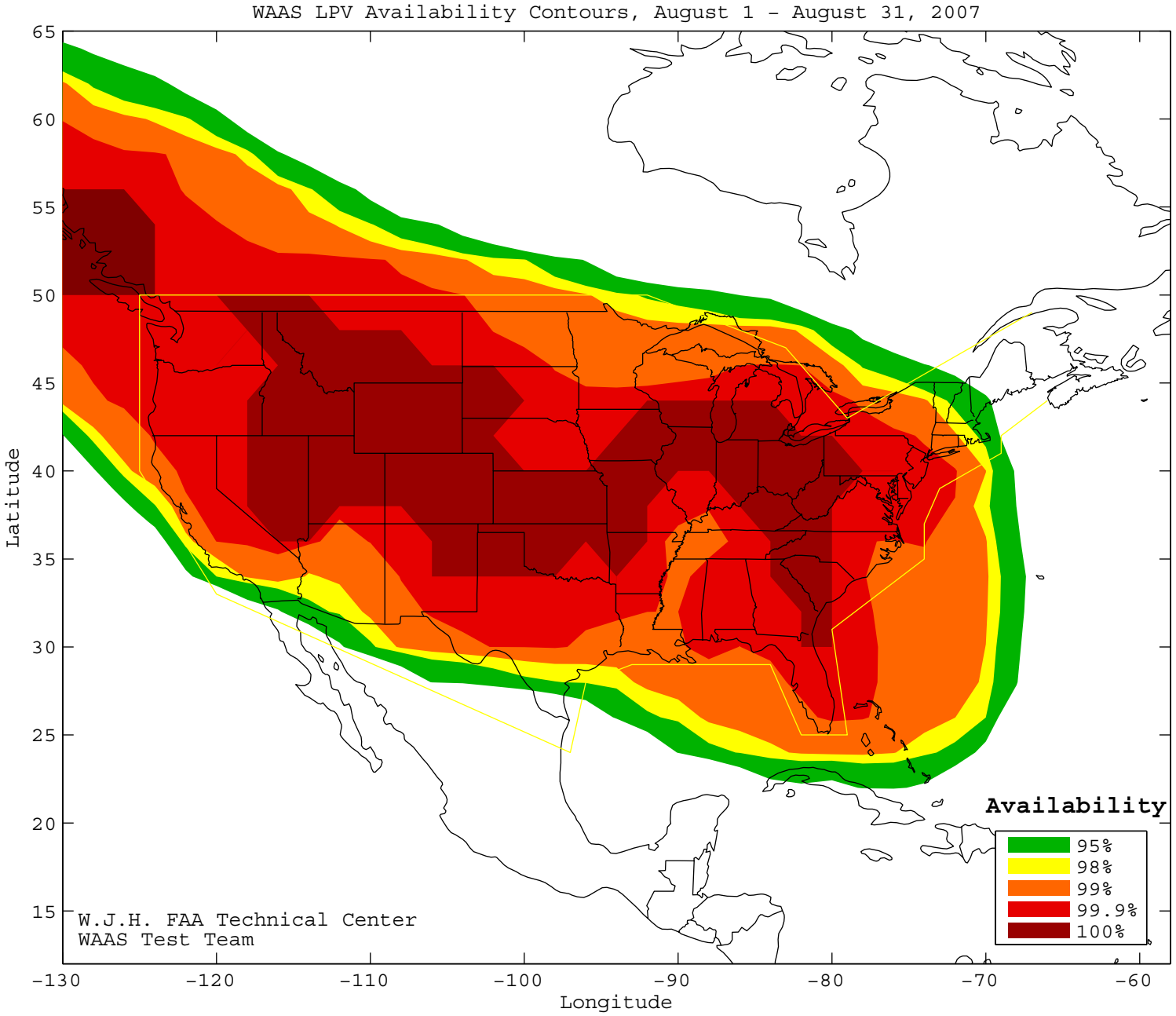
Figure 4-5 WAAS LPV Coverage - July



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

SL = LPV

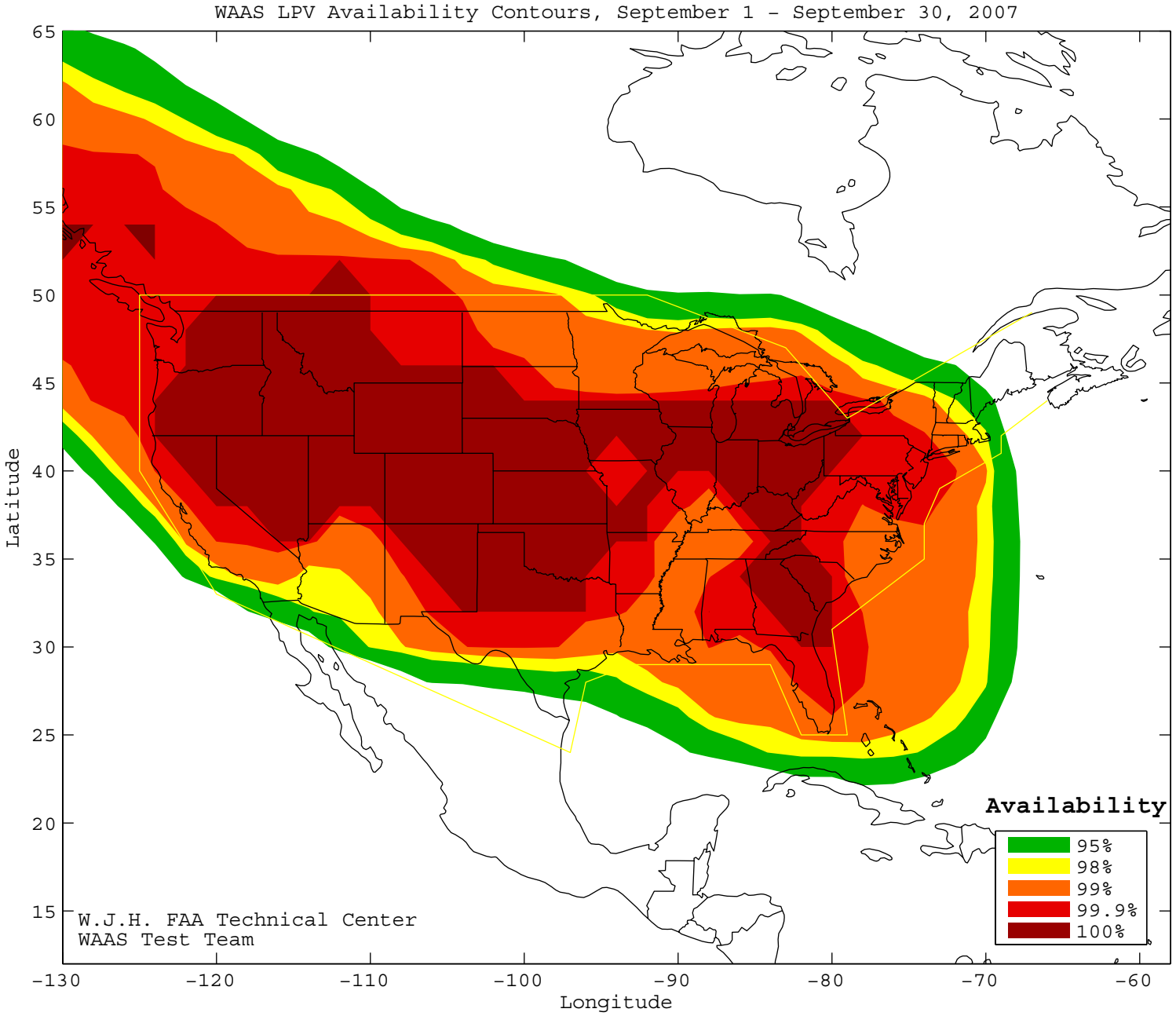
Figure 4-6 WAAS LPV Coverage - August



CONUS Coverage at 95% Availability = 95.95%
CONUS Coverage at 99% Availability = 89.88%
CONUS Coverage at 100% Availability = 46.15%

SL = LPV

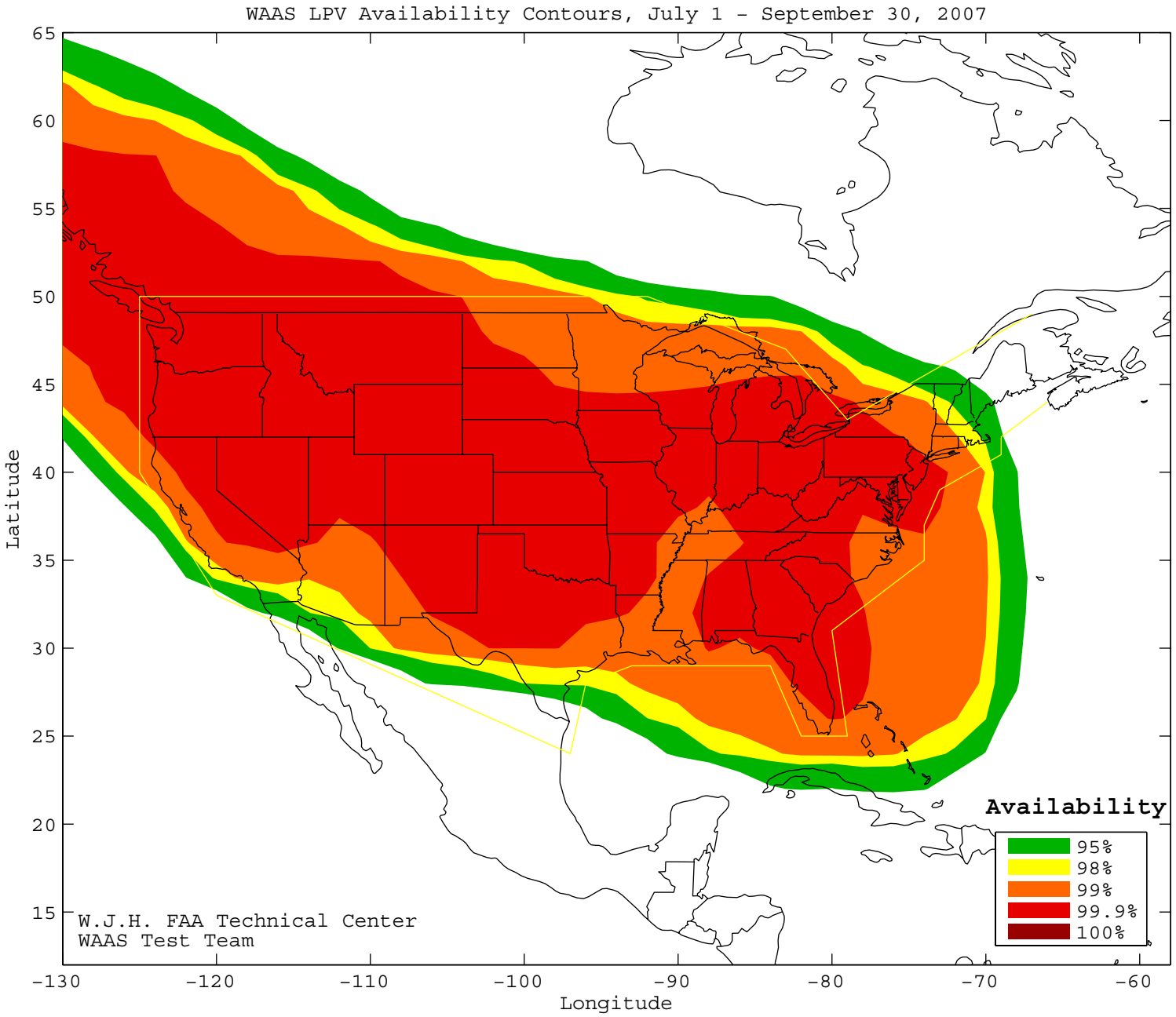
Figure 4-7 WAAS LPV Coverage - September



CONUS Coverage at 95% Availability = 97.17%
CONUS Coverage at 99% Availability = 88.66%
CONUS Coverage at 100% Availability = 55.87%

SL = LPV

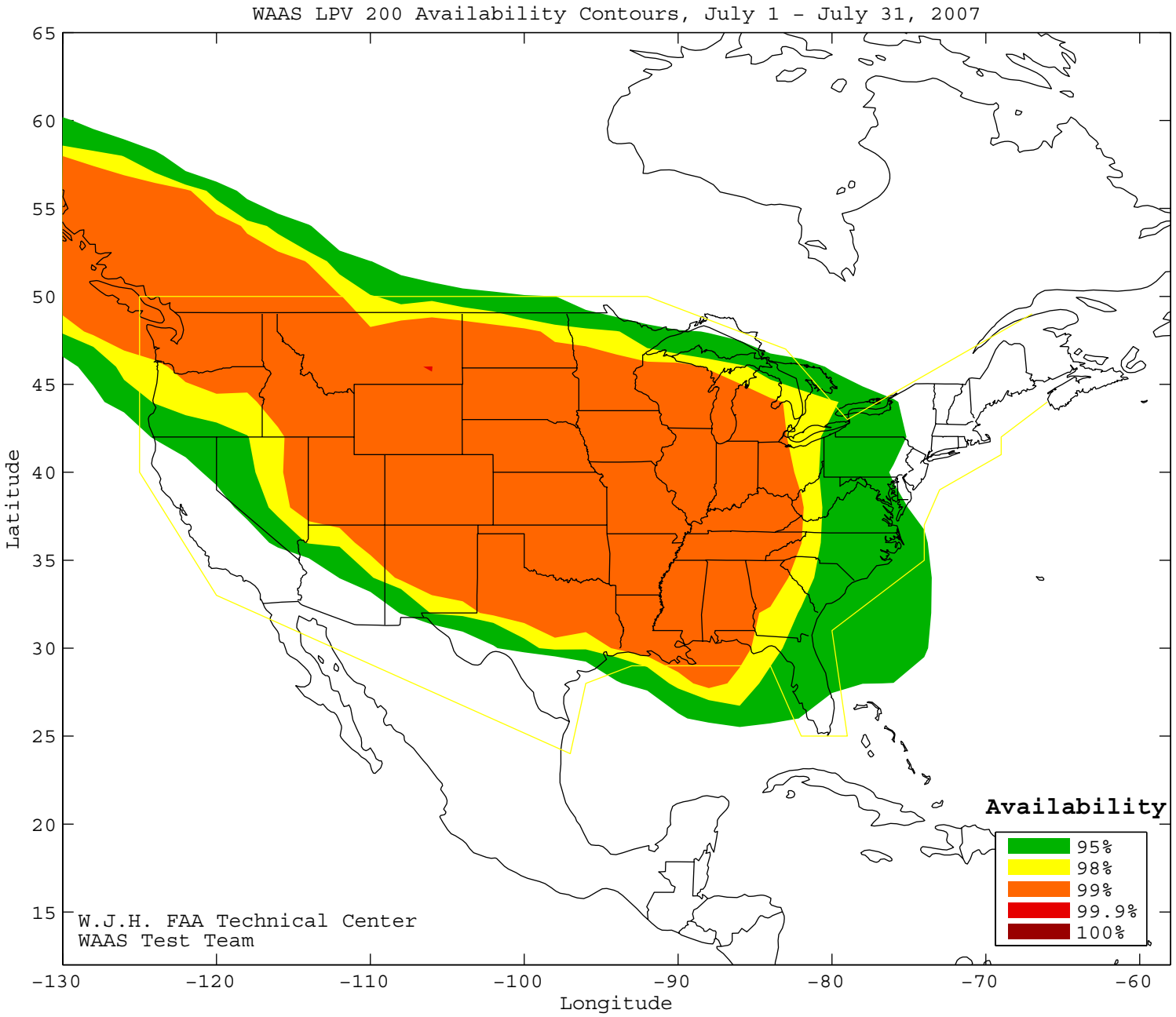
Figure 4-8 WAAS LPV Coverage for the Quarter



CONUS Coverage at 95% Availability = 96.76%
CONUS Coverage at 99% Availability = 90.28%
CONUS Coverage at 100% Availability = 0%

SL = LPV

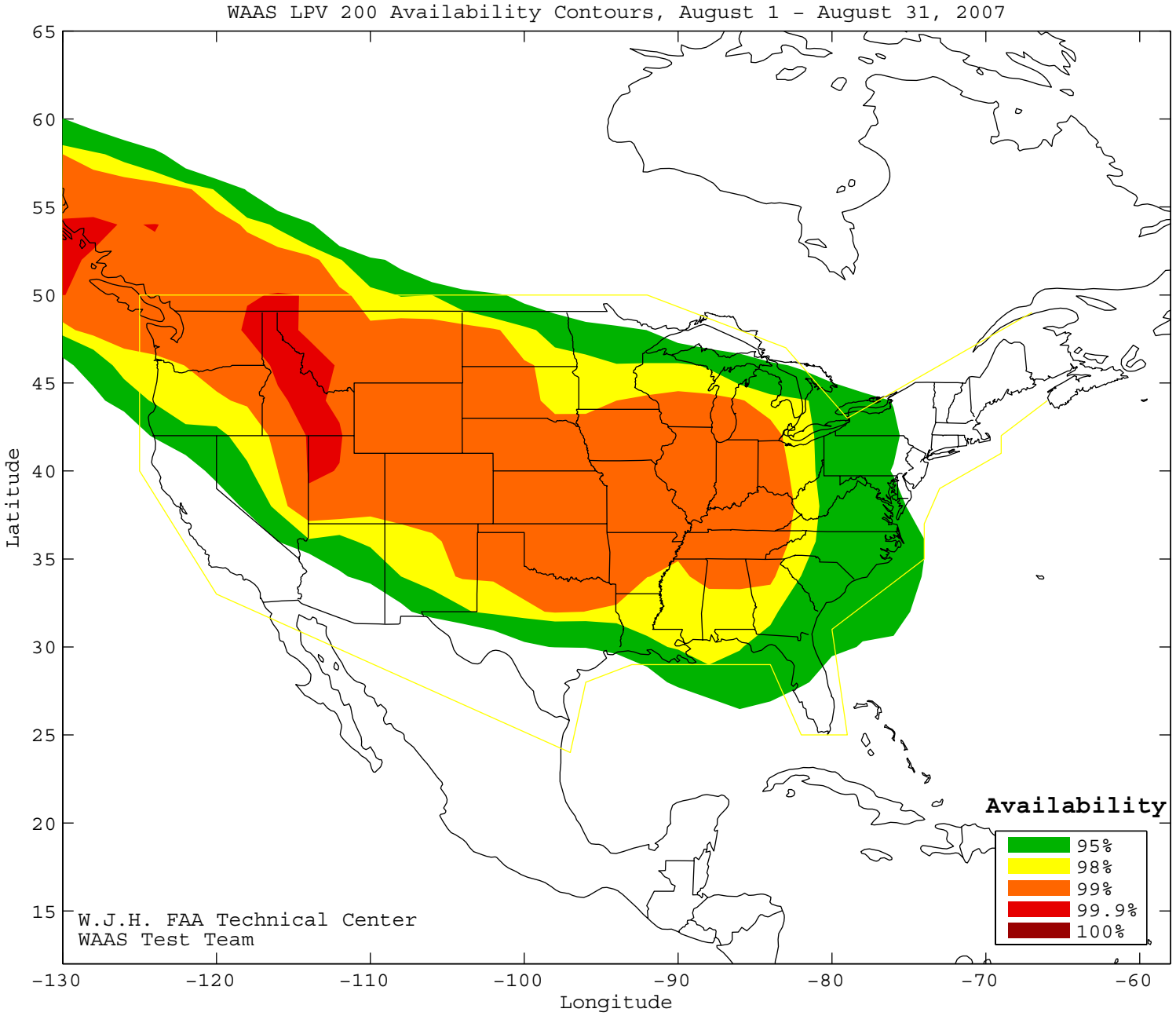
Figure 4-9 WAAS LPV 200 CONUS Coverage - July



CONUS Coverage at 95% Availability = 80.57%
CONUS Coverage at 99% Availability = 55.87%
CONUS Coverage at 100% Availability = 0%

SL = LPV 200

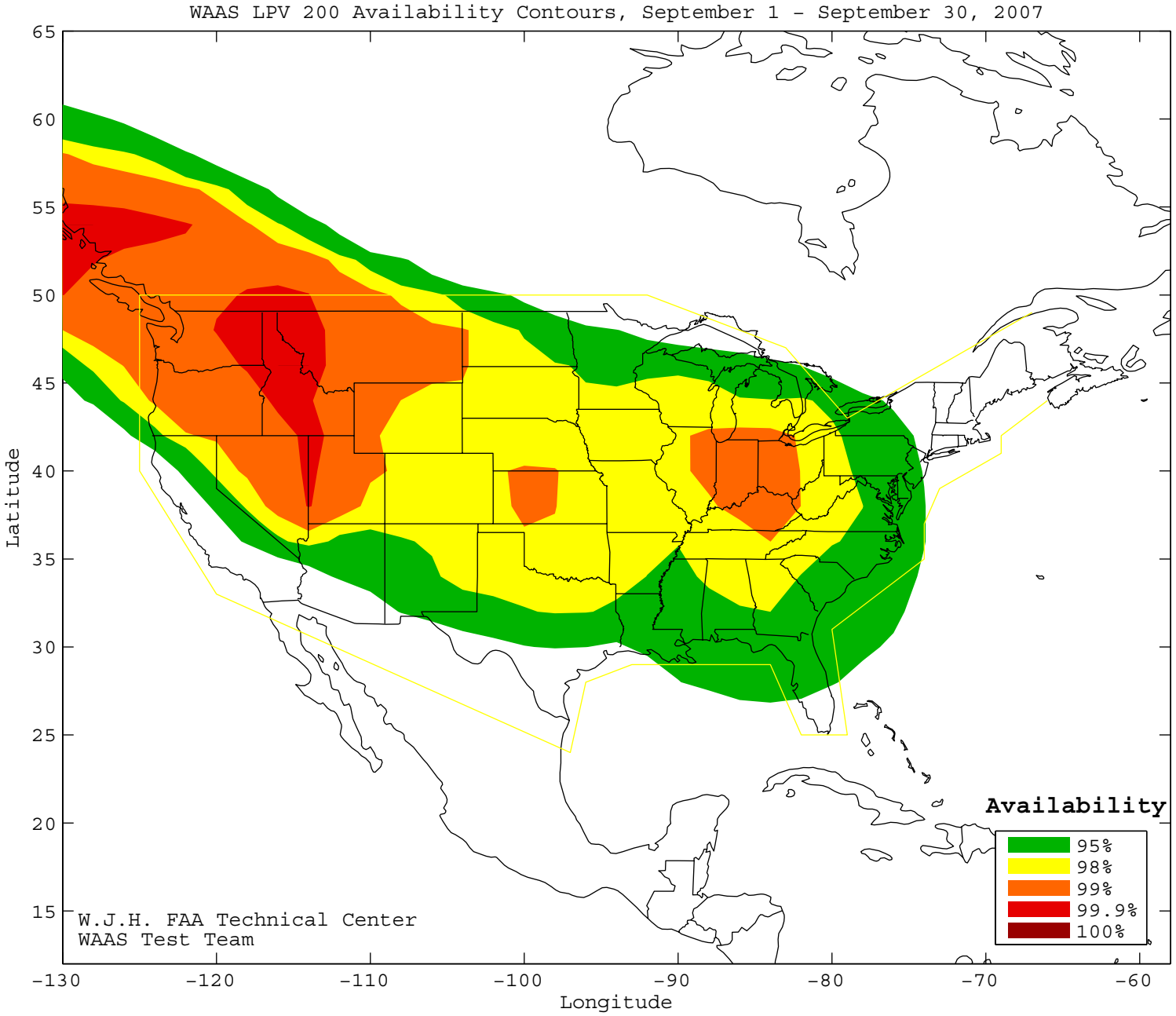
Figure 4-10 WAAS LPV 200 CONUS Coverage - August



CONUS Coverage at 95% Availability = 77.73%
CONUS Coverage at 99% Availability = 44.53%
CONUS Coverage at 100% Availability = 0%

SL = LPV 200

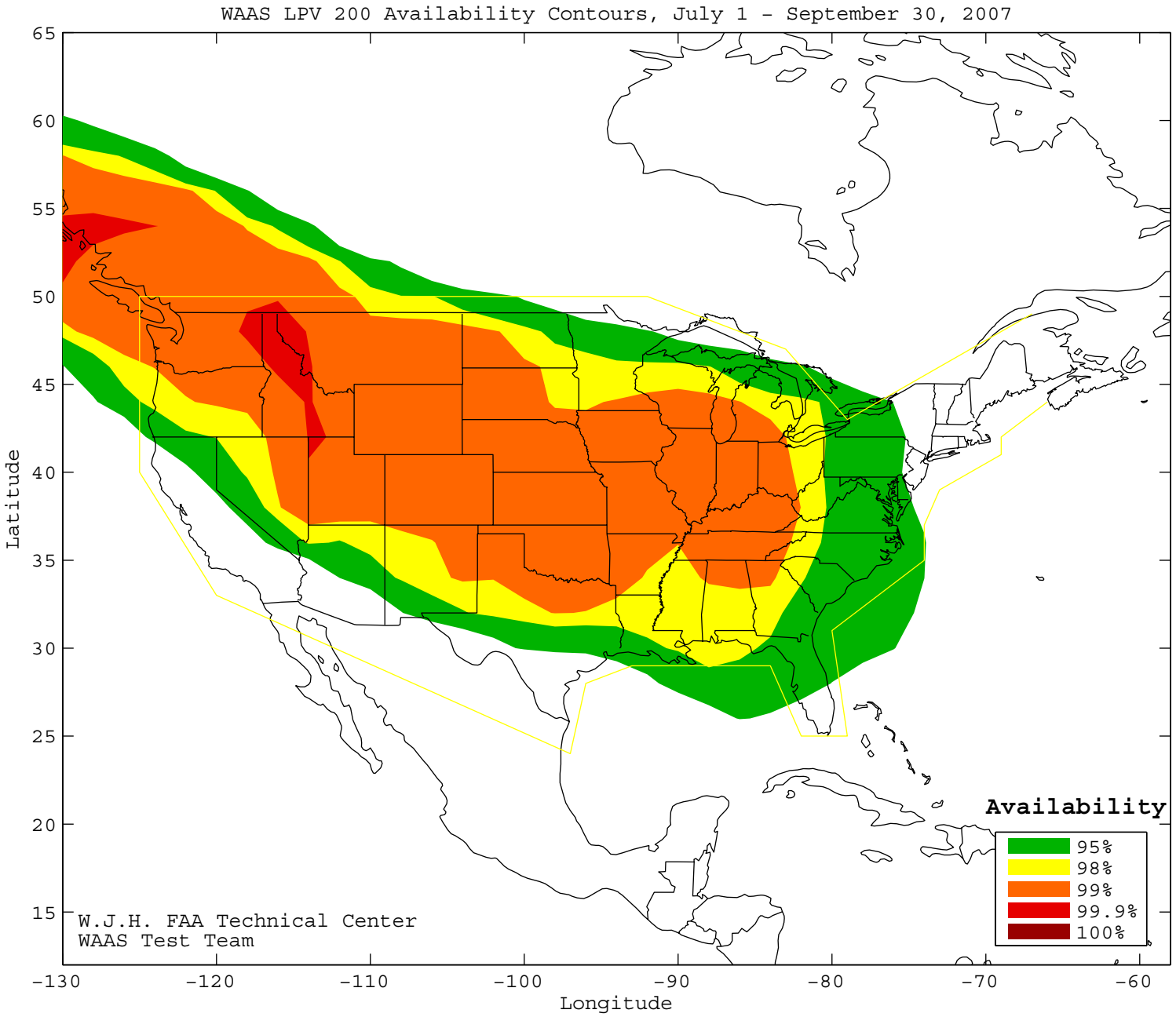
Figure 4-11 WAAS LPV 200 CONUS Coverage - September



CONUS Coverage at 95% Availability = 80.57%
CONUS Coverage at 99% Availability = 23.08%
CONUS Coverage at 100% Availability = 1.215%

SL = LPV 200

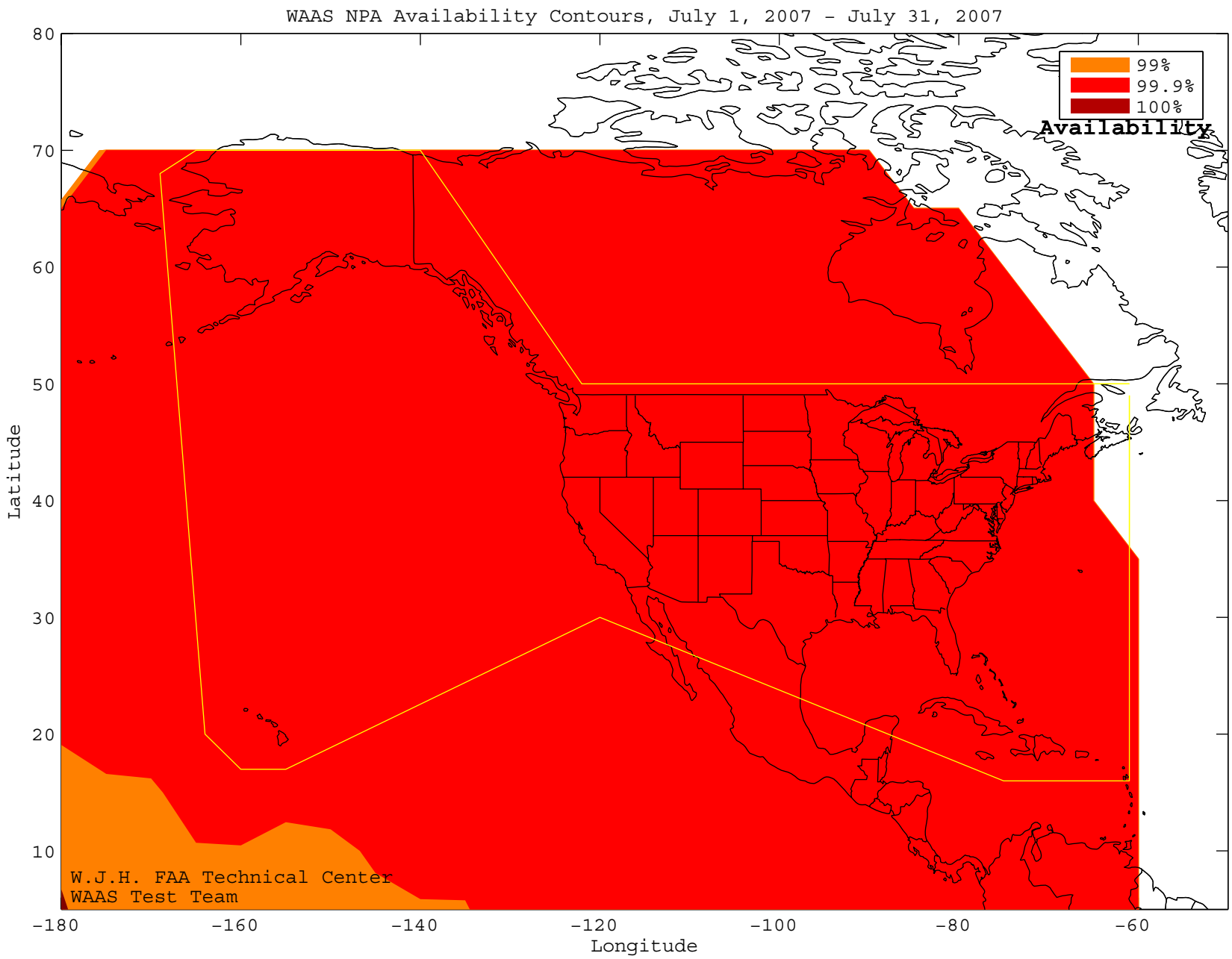
Figure 4-12 WAAS LPV 200 CONUS Coverage - Quarter



CONUS Coverage at 95% Availability = 79.35%
CONUS Coverage at 99% Availability = 45.34%
CONUS Coverage at 100% Availability = 0%

SL = LPV 200

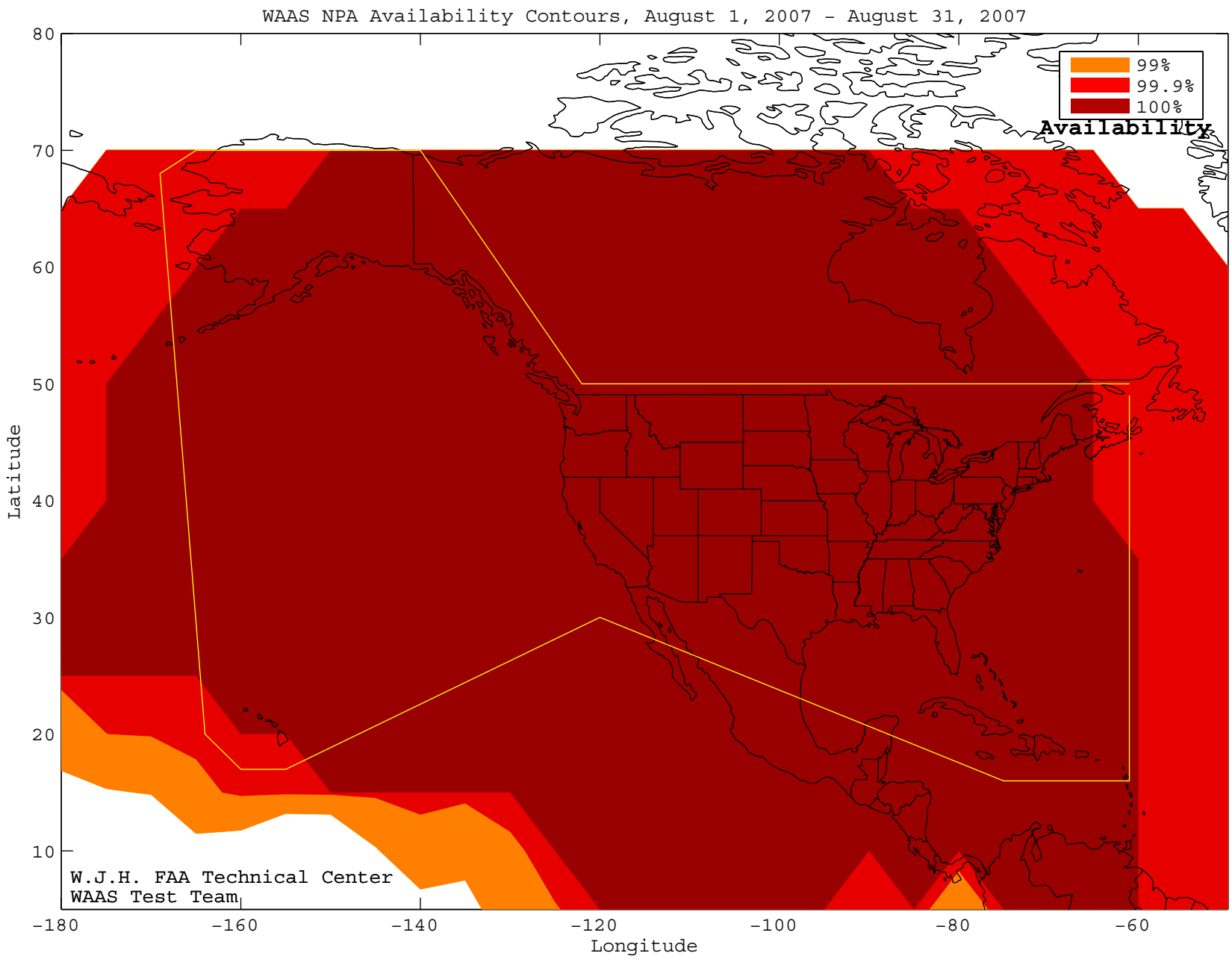
Figure 4-13 WAAS NPA Coverage - July



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

SL = NPA

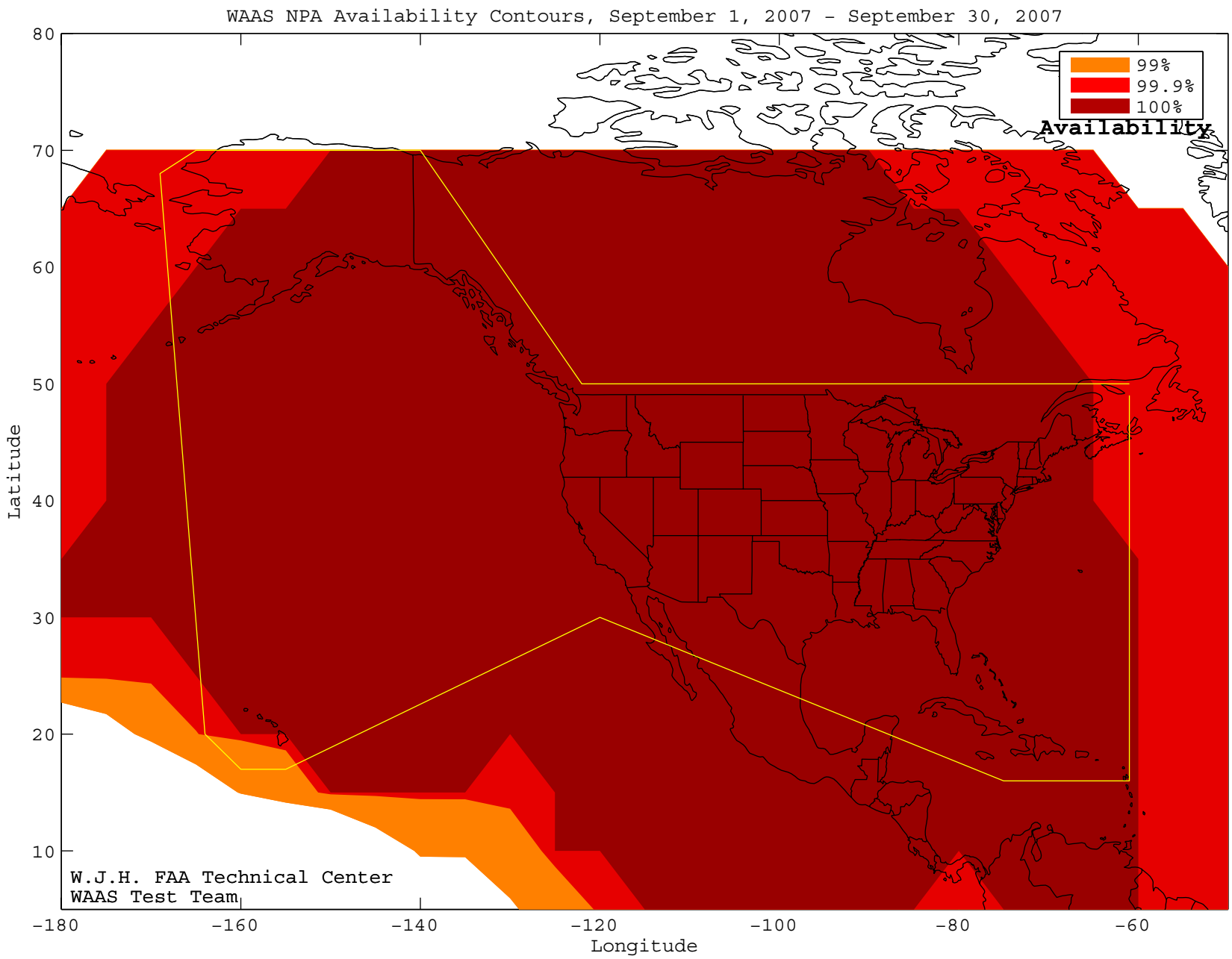
Figure 4-14 WAAS NPA Coverage - August



WAAS Coverage at 99% Availability = 100%
WAAS Coverage at 99.9% Availability = 100%
WAAS Coverage at 100% Availability = 99.26%

SL = NPA

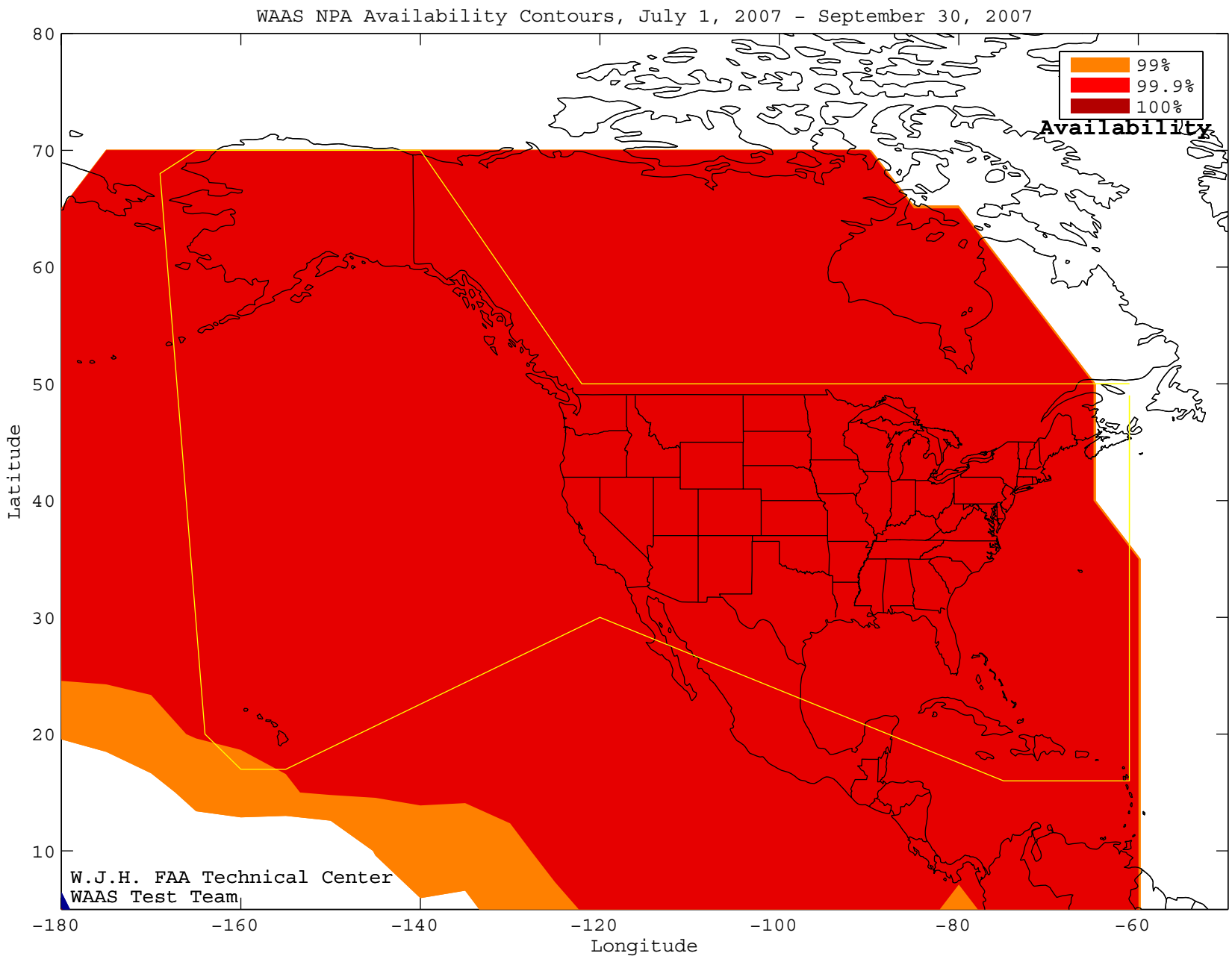
Figure 4-15 WAAS NPA Coverage - September



WAAS Coverage at 99% Availability = 100%
WAAS Coverage at 99.9% Availability = 100%
WAAS Coverage at 100% Availability = 99.26%

SL = NPA

Figure 4-16 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 4-17 Daily LNAV/VNAV and LPV Coverage

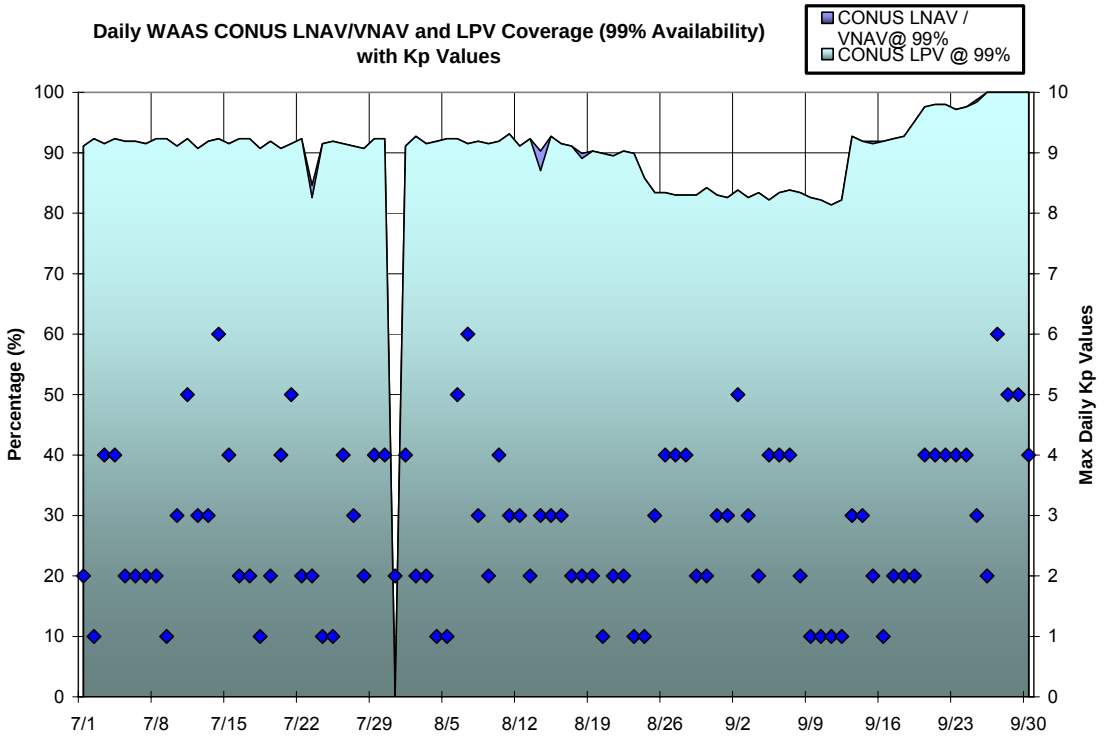


Figure 4-18 Daily NPA Coverage

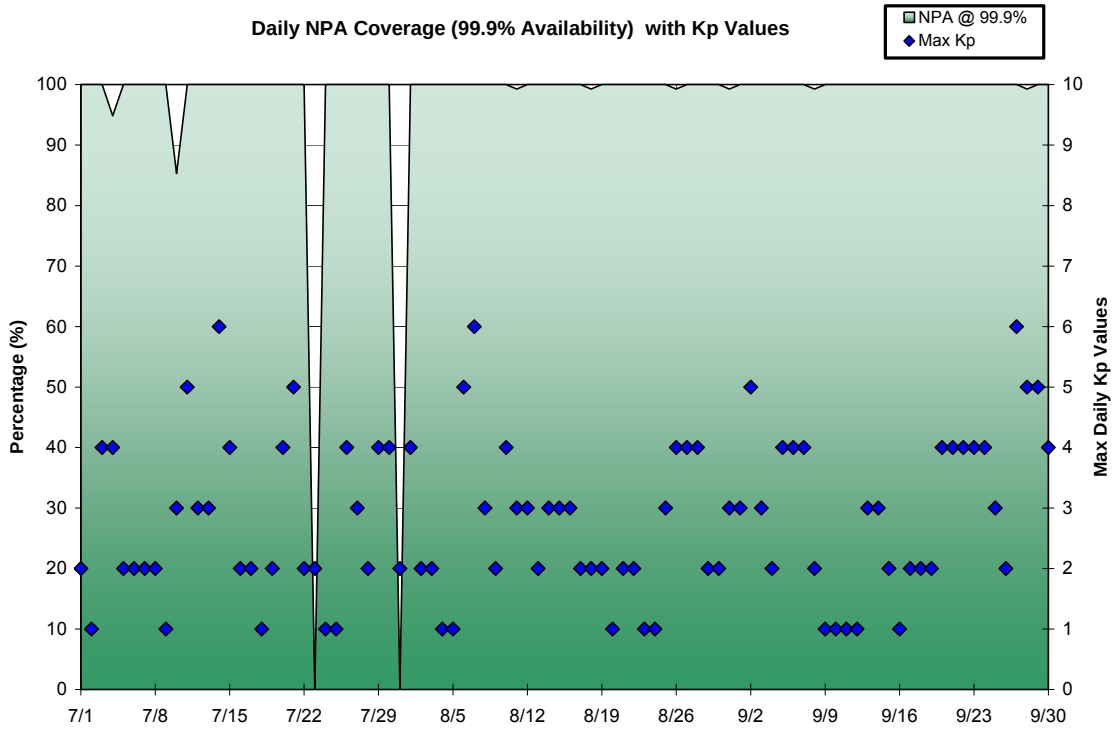
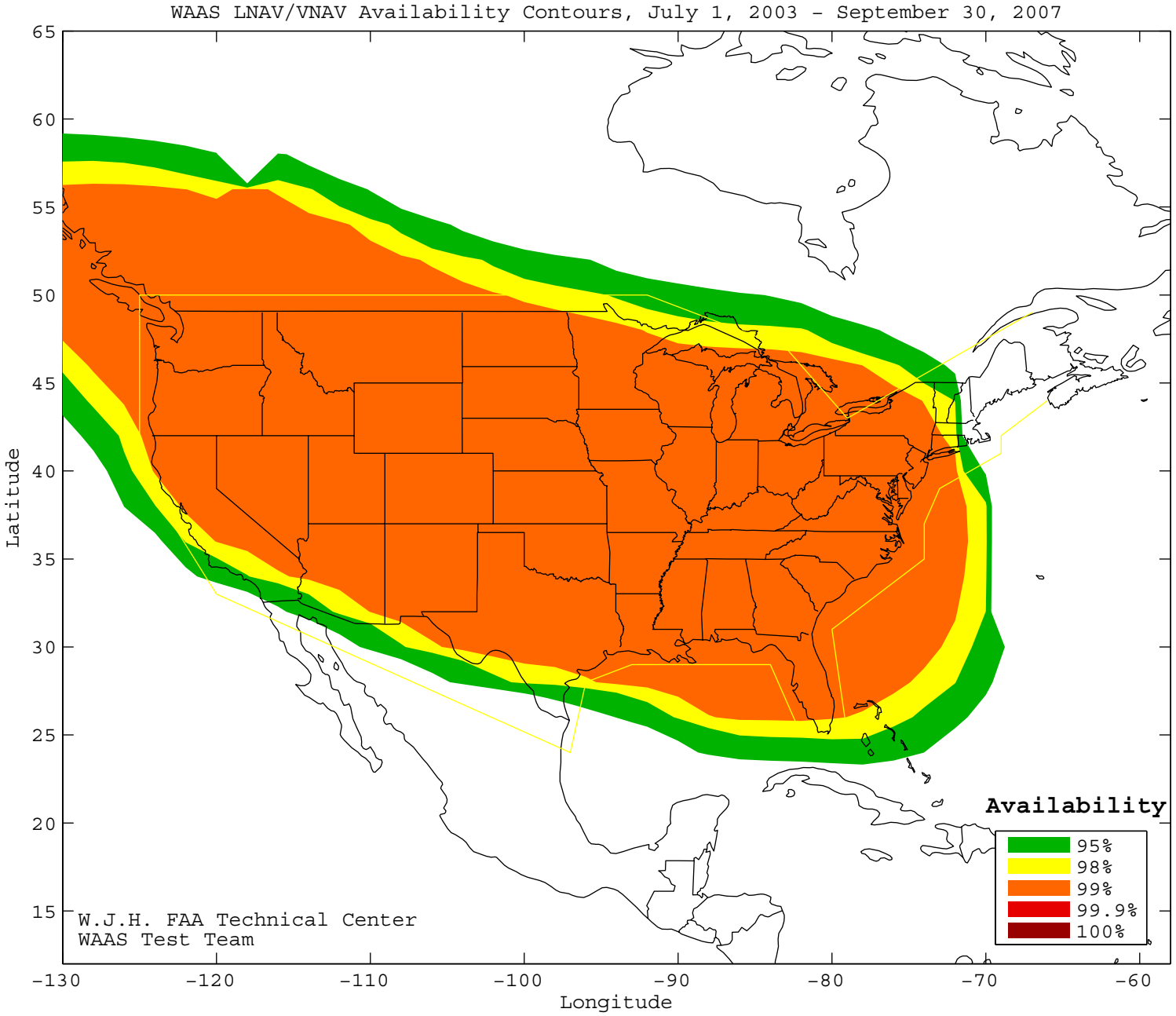


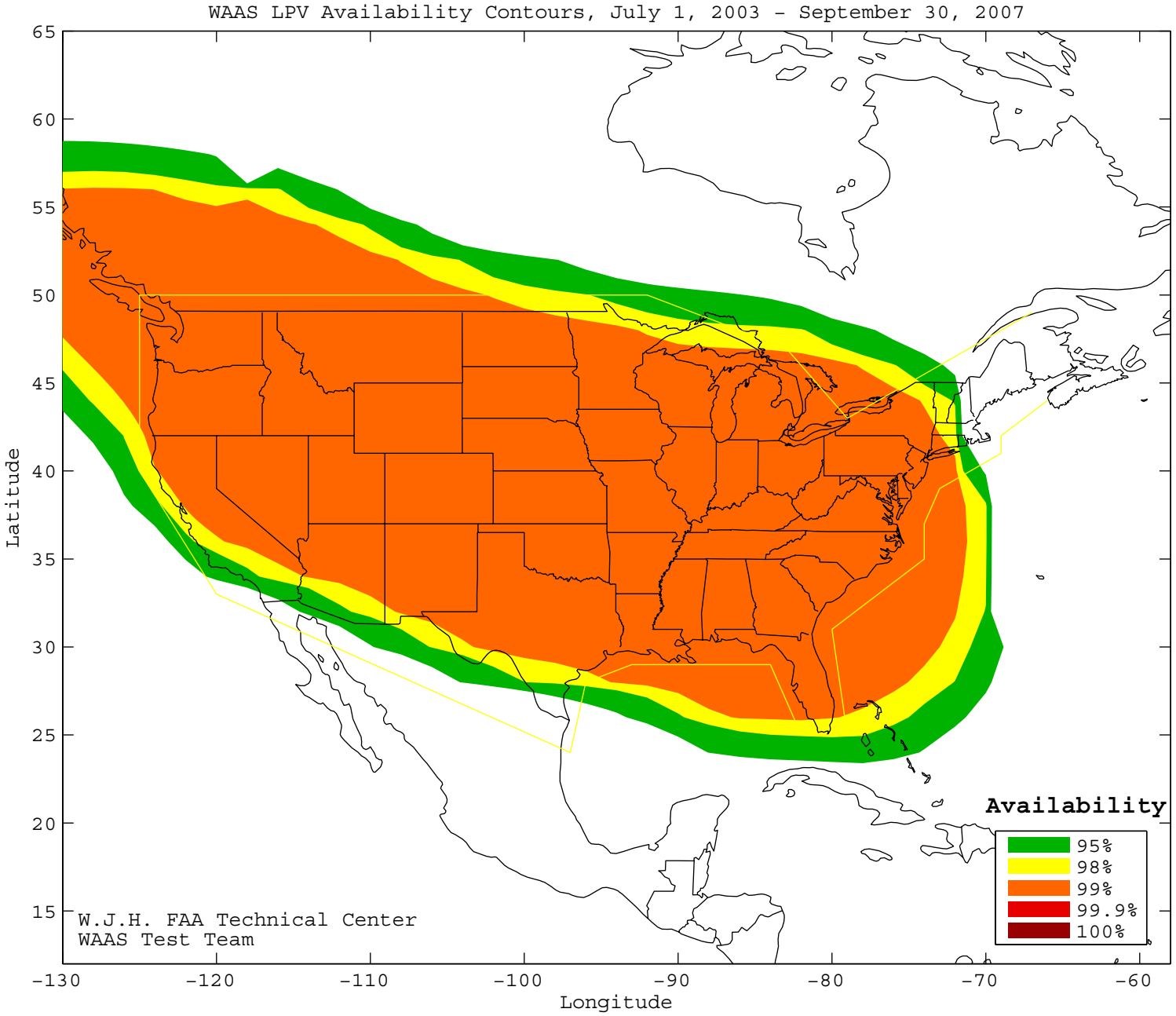
Figure 4-19 WAAS LNAV/VNAN CONUS Coverage Since Commissioning



CONUS Coverage at 95% Availability = 94.74%
CONUS Coverage at 99% Availability = 86.64%
CONUS Coverage at 100% Availability = 0%

SL = LNAV/VNAV

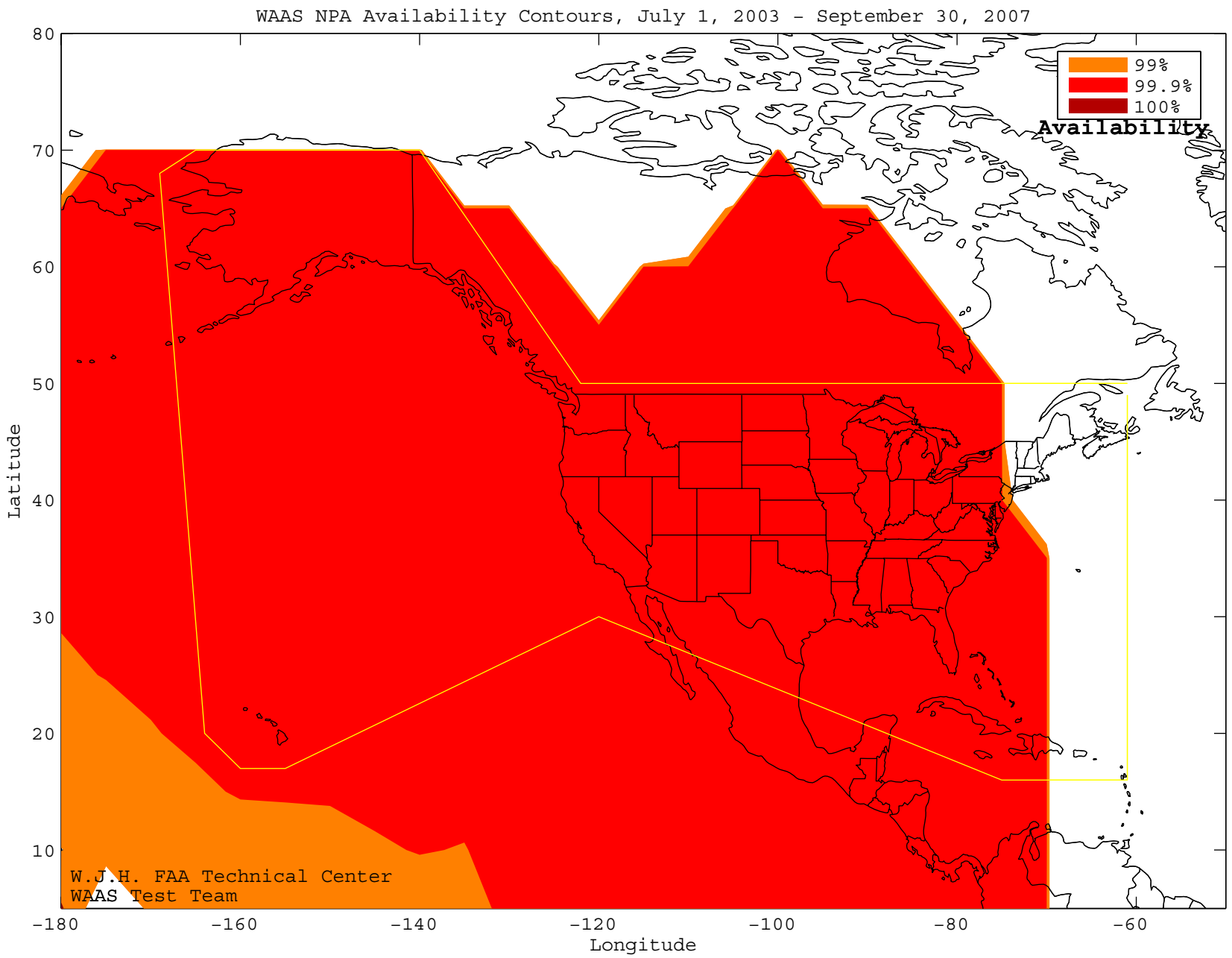
Figure 4-20 WAAS LPV CONUS Coverage Since Commissioning



CONUS Coverage at 95% Availability = 94.33%
CONUS Coverage at 99% Availability = 85.02%
CONUS Coverage at 100% Availability = 0%

SL = LPV

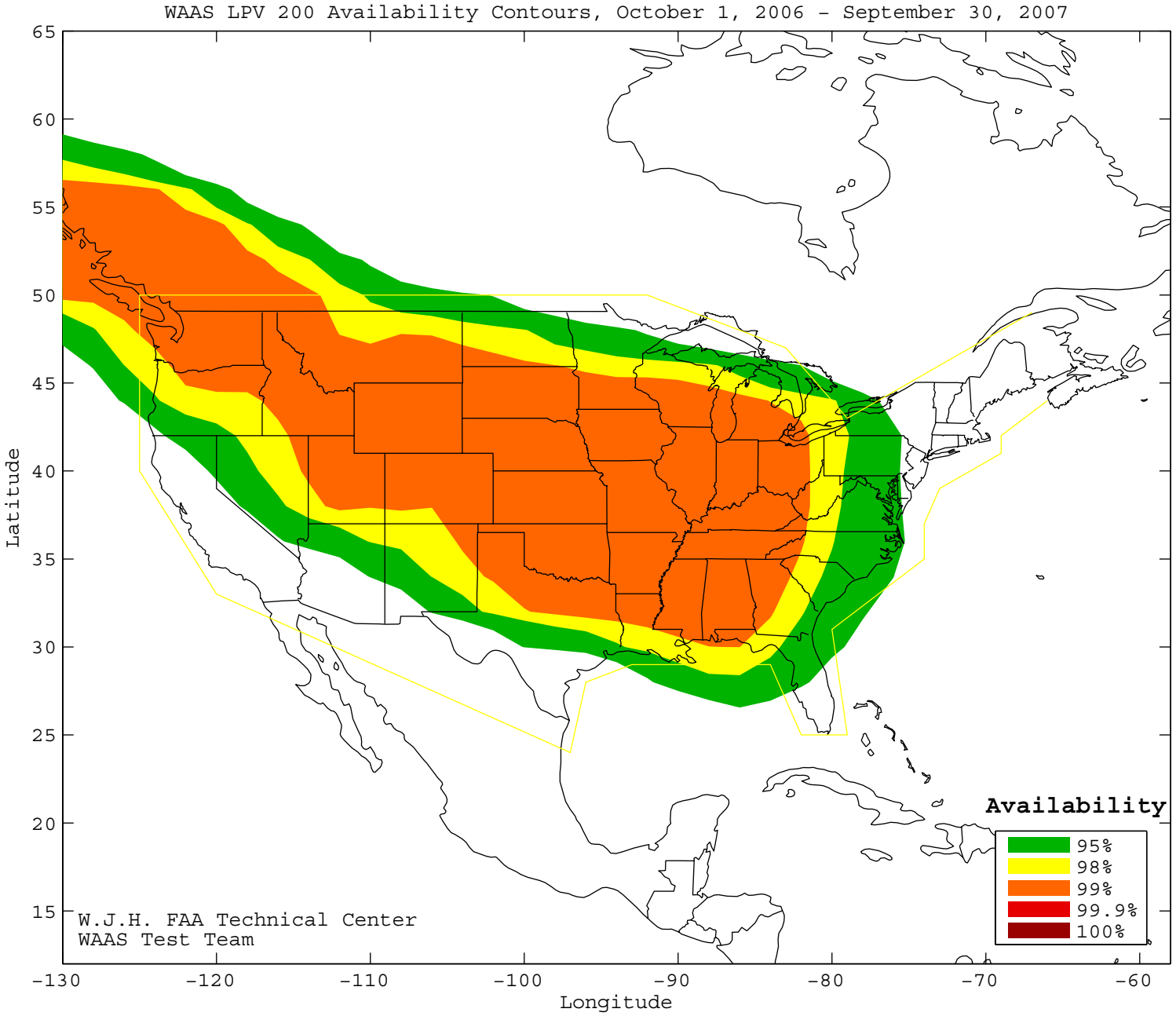
Figure 4-21 WAAS NPA CONUS Coverage Since Commissioning



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

SL = NPA

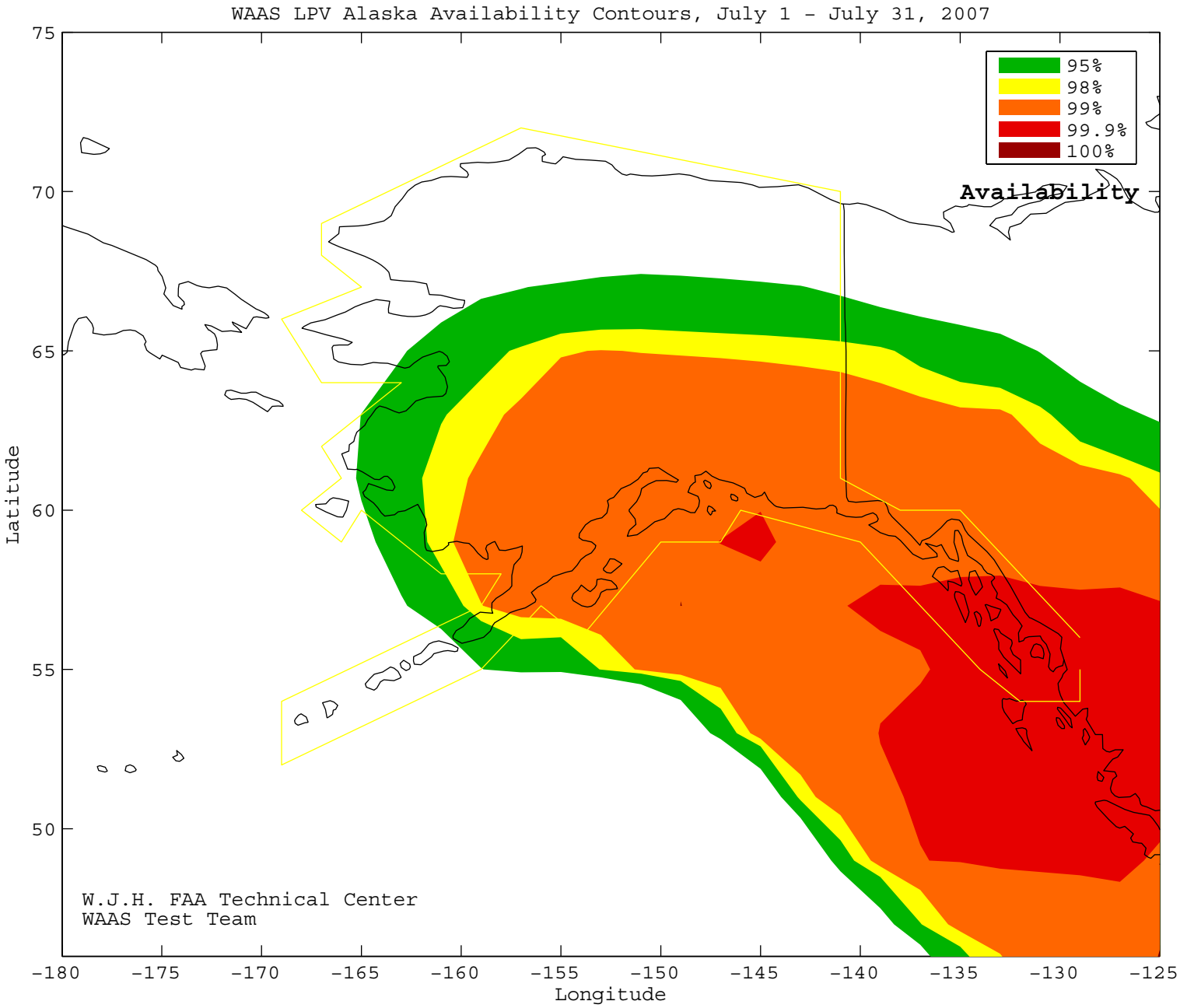
Figure 4-22 WAAS LPV 200 CONUS Coverage Since Commissioning



CONUS Coverage at 95% Availability = 77.73%
CONUS Coverage at 99% Availability = 46.96%
CONUS Coverage at 100% Availability = 0%

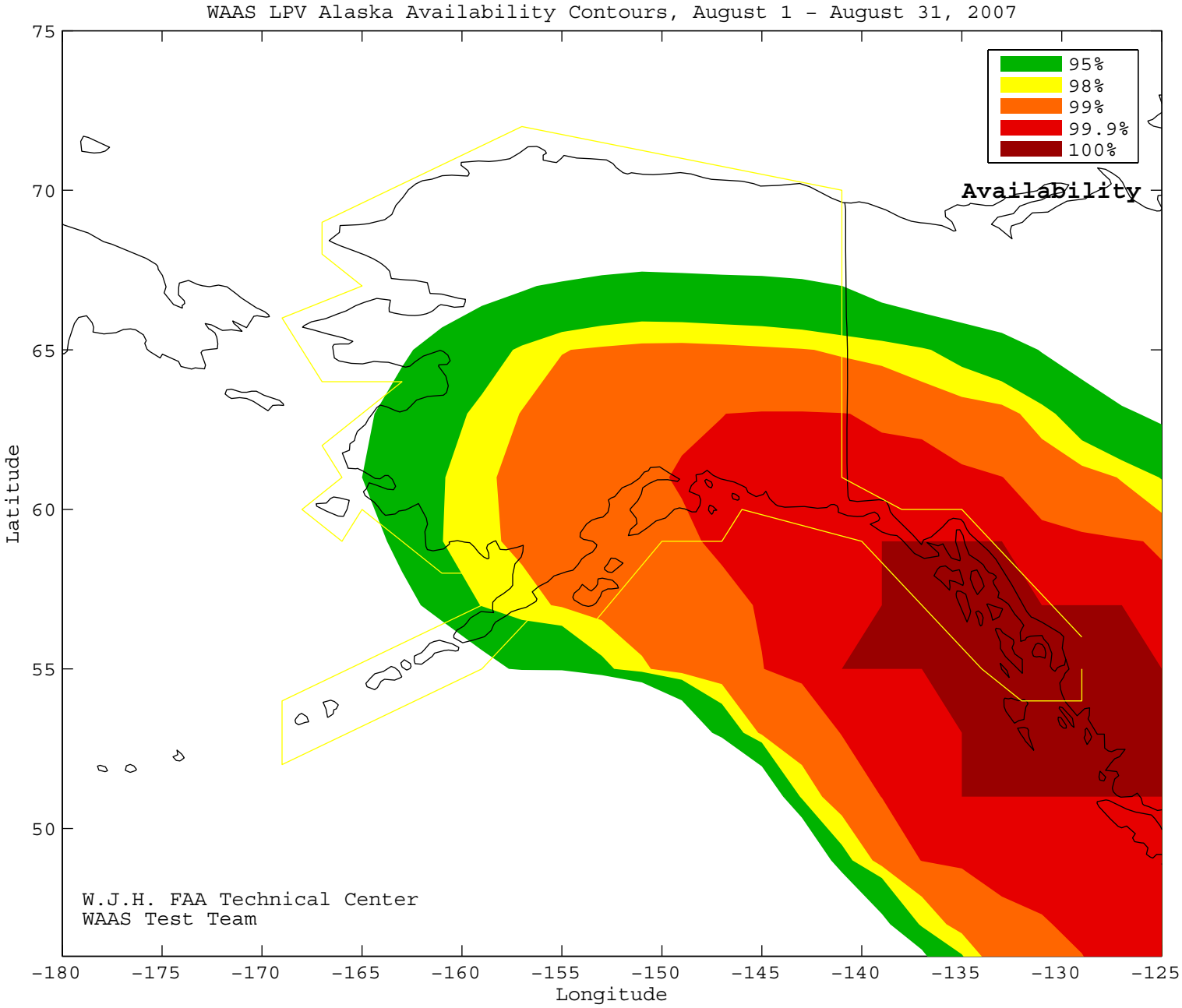
SL = LPV 200

Figure 4-23 LPV Alaska Coverage - July



Alaska Coverage at 95% Availability = 66.3%
Alaska Coverage at 99% Availability = 40.22%
Alaska Coverage at 100% Availability = 0%

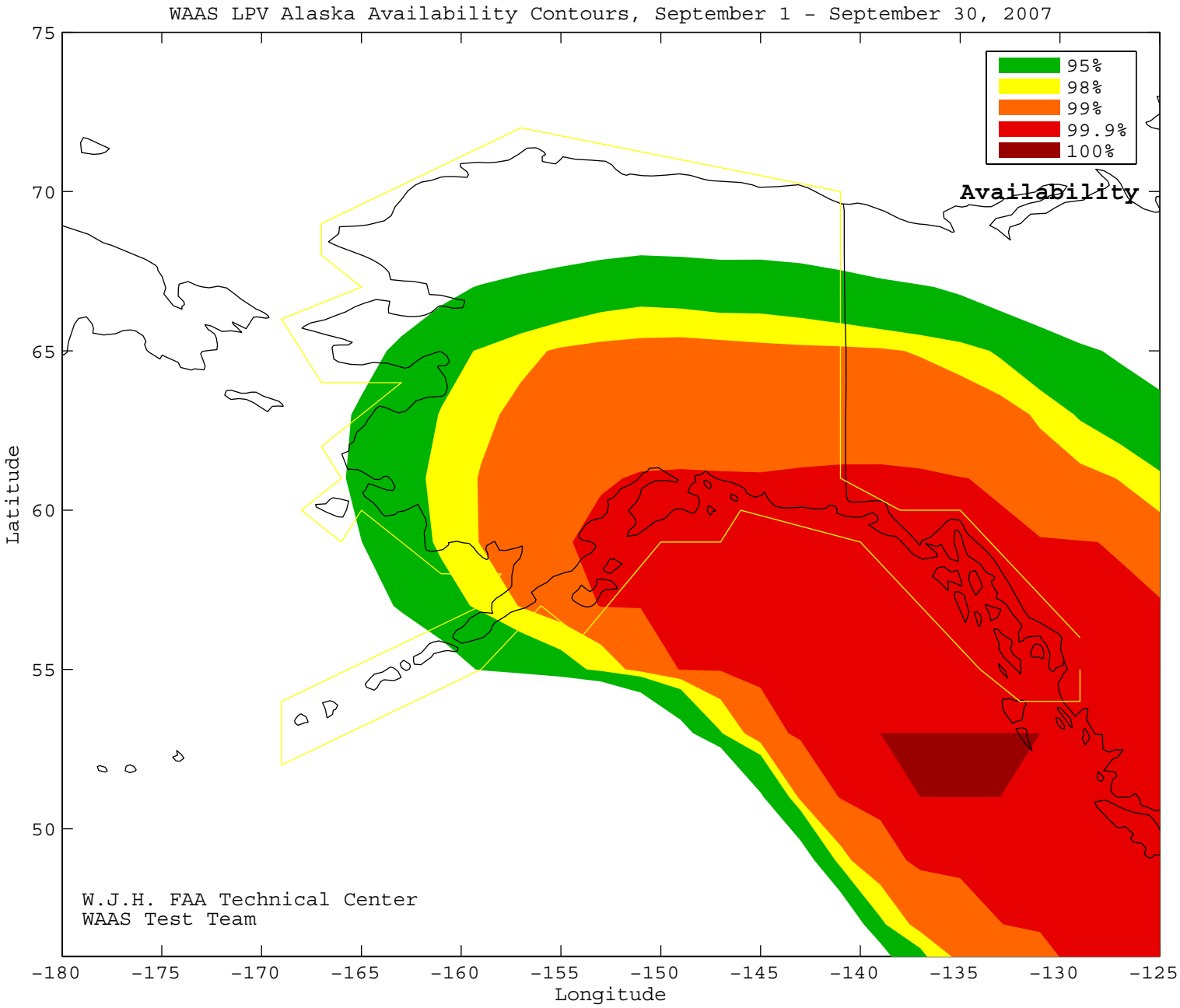
Figure 4-24 LPV Alaska Coverage - August



Alaska Coverage at 95% Availability = 66.3%
Alaska Coverage at 99% Availability = 42.39%
Alaska Coverage at 100% Availability = 9.783%

SL = LPV

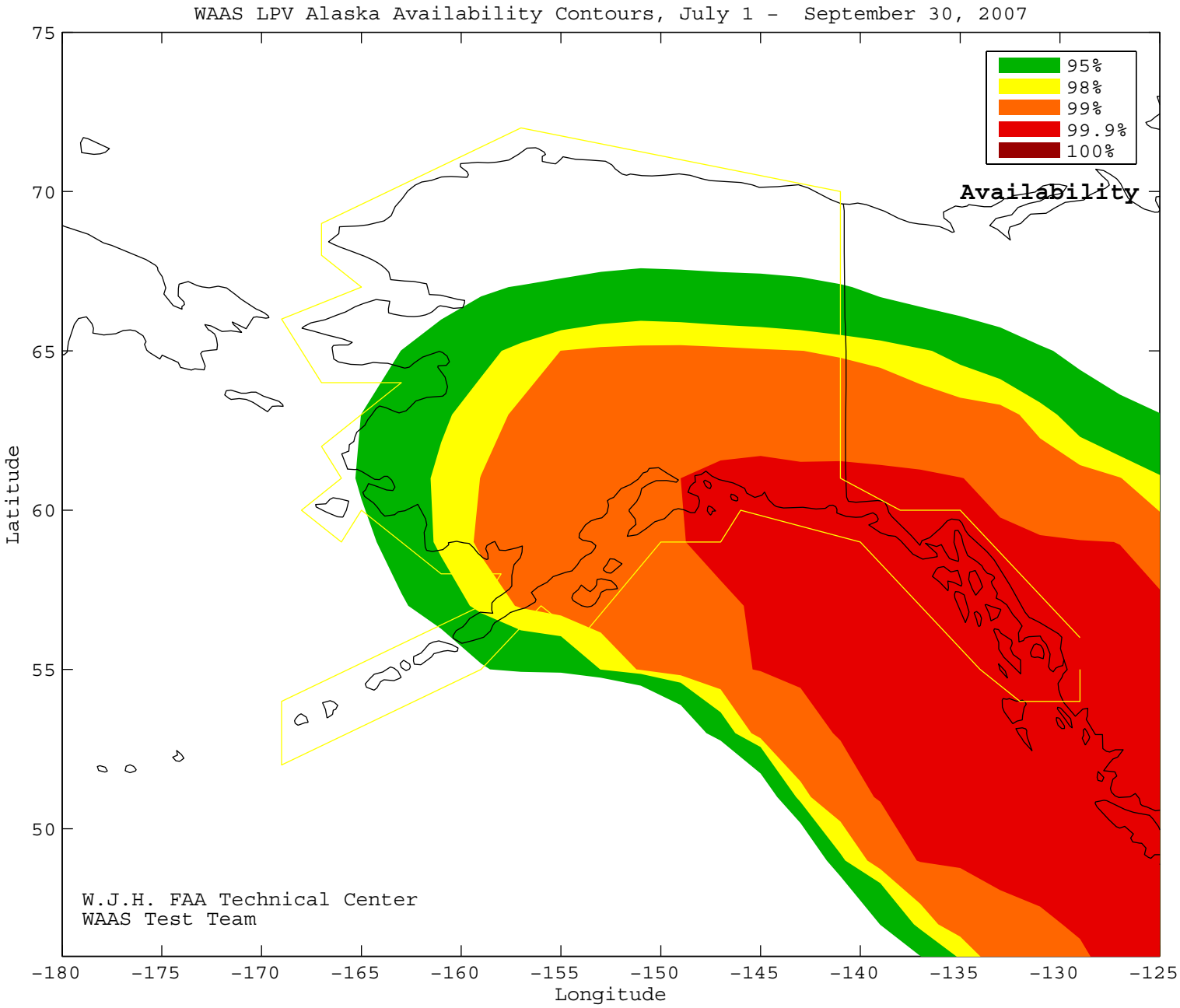
Figure 4-25 LPV Alaska Coverage - September



Alaska Coverage at 95% Availability = 70.65%
Alaska Coverage at 99% Availability = 46.74%
Alaska Coverage at 100% Availability = 0%

SL = LPV

Figure 4-26 LPV Alaska Coverage for the Quarter



Alaska Coverage at 95% Availability = 68.48%
Alaska Coverage at 99% Availability = 46.74%
Alaska Coverage at 100% Availability = 0%

SL = LPV

Figure 4-27 Daily LPV Alaska Coverage

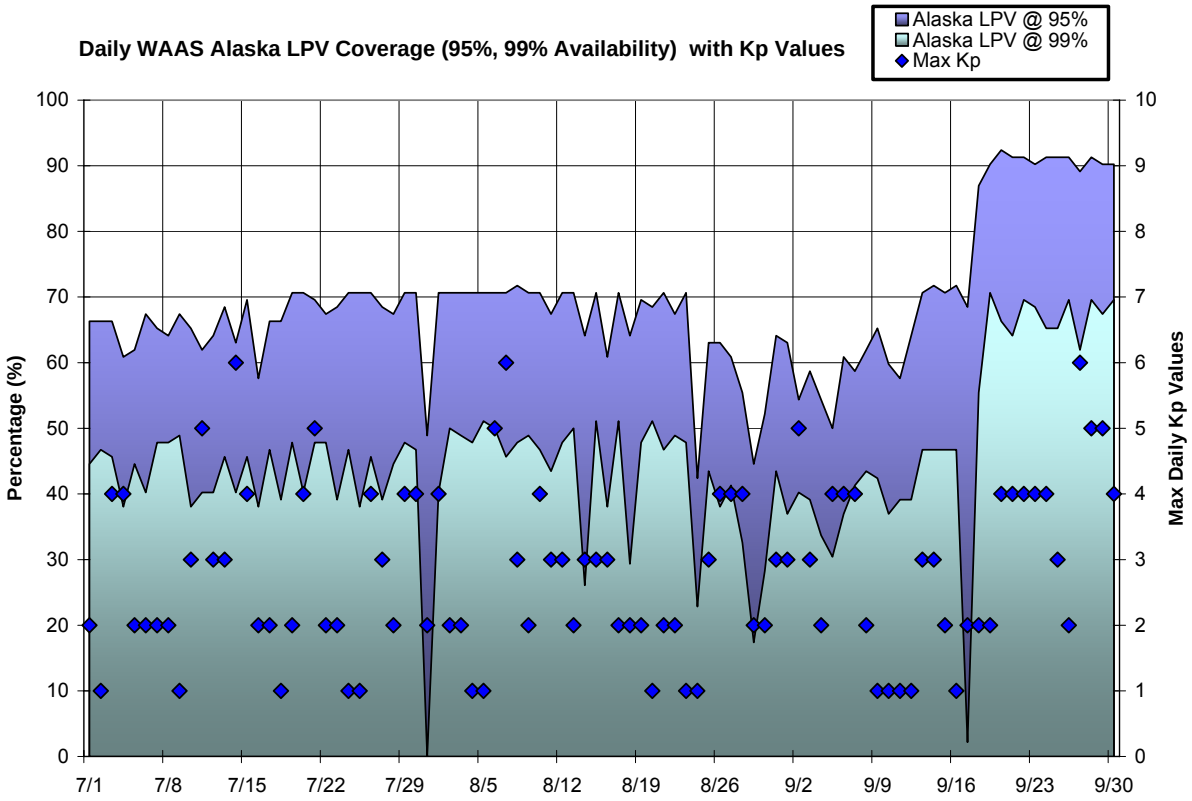
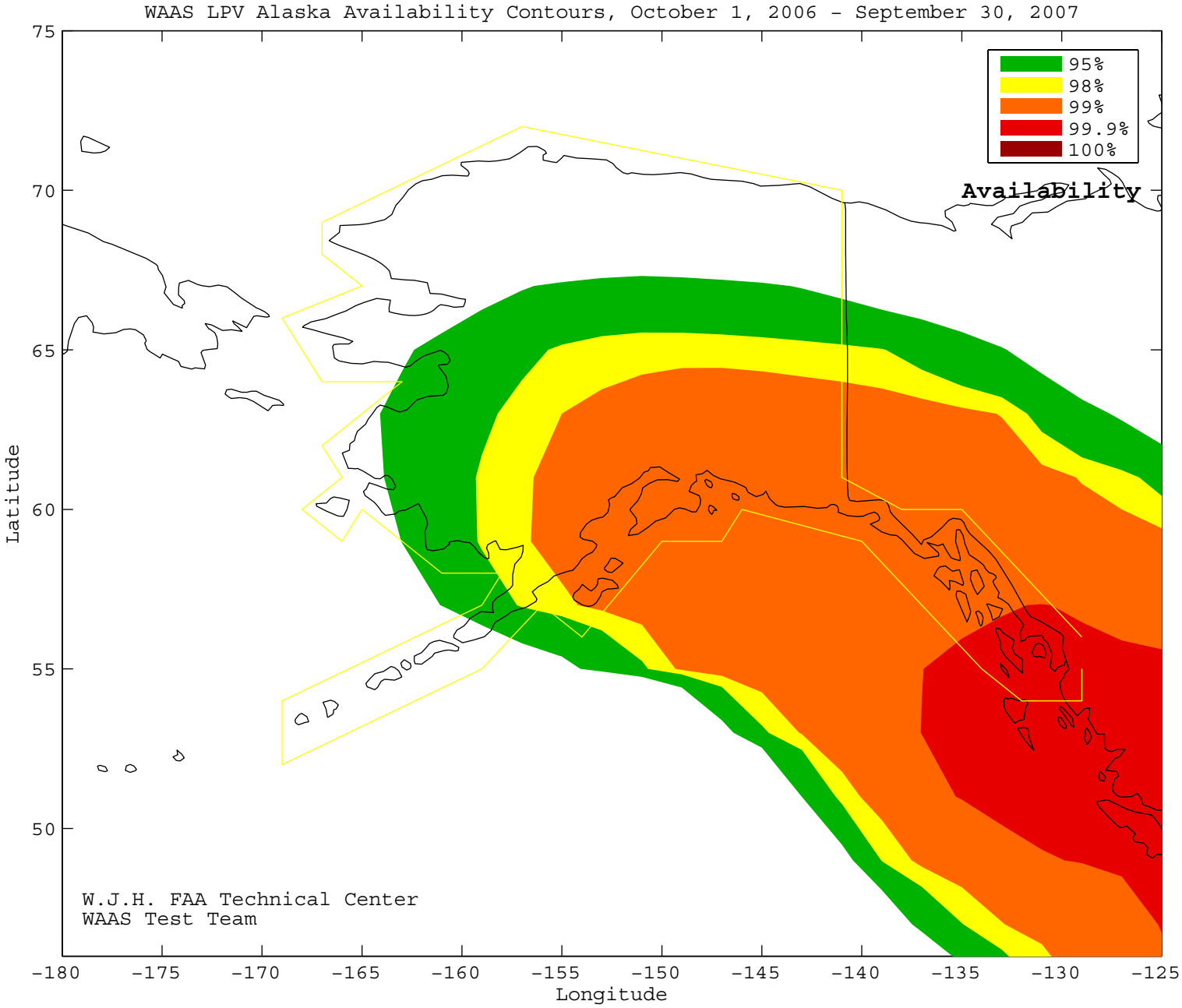


Figure 4-28 LPV Alaska Coverage Since Added to WAAS (Oct 2006)



Alaska Coverage at 95% Availability = 64.13%
Alaska Coverage at 99% Availability = 31.52%
Alaska Coverage at 100% Availability = 0%

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	
Albuquerque	10.00	7.61	0
Anchorage	8.57	7.61	0
Atlanta	8.57	6.66	0
Barrow	1.20	1.30	0
Bethel	12.00	10.66	0
Billings	8.57	5.33	0
Boston	10.00	7.61	0
Chicago	10.00	6.66	0
Cleveland	6.67	7.61	0
Cold Bay	10.00	8.88	0
Dallas	8.57	8.88	0
Denver	10.00	6.66	0
Fairbanks	5.45	3.81	0
Houston	7.50	7.61	0
Jacksonville	7.50	7.61	0
Juneau	7.50	5.33	0
Kansas City	10.00	6.66	0
Kotzebue	3.75	5.92	0
Los Angeles	10.00	7.61	0
Memphis	10.00	6.66	0
Miami	7.50	6.66	0
Minneapolis	5.45	6.66	0
New York	10.00	8.88	0
Oakland	8.57	6.66	0
Salt Lake City	7.50	5.33	0
Seattle	7.50	6.66	0
Washington DC	8.57	7.61	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. The lowest safety margin index is 1.20 at Barrow. High error caused by ionopsheric scinitilation was observed at Barrow which did not result in an alarm condition. Table 5.1 also shows the number of

HMIs that occurred during the quarter, of which there were none. An HMI occurs if the position error exceeds the protection level in the vertical or horizontal dimensions at any time and 6.2 seconds or more passes before this event is corrected by WAAS. Since WAAS was made available to the public in August 2000 there has not been an HMI event. Note that the FAA commissioned WAAS for safety of life services in July 2003.

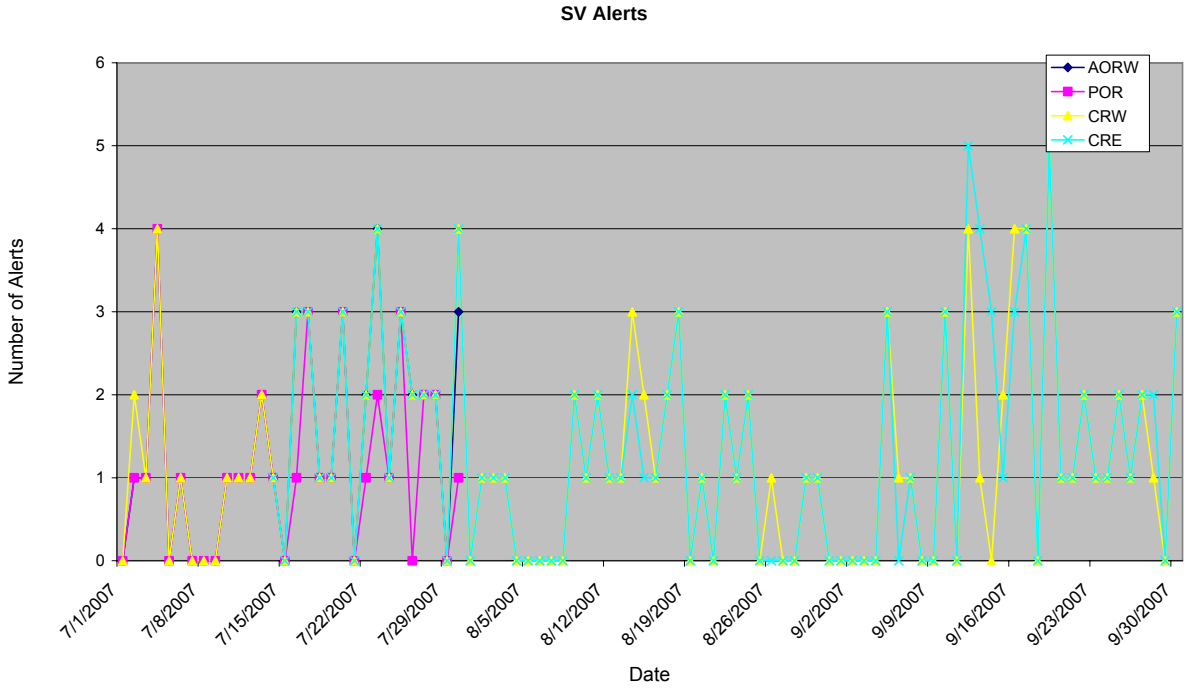
5.2 Broadcast Alerts

The WAAS transmits alert messages to protect the users from satellite degradation or severe ionospheric activity, both of which can cause unsafe conditions for a user. Space Vehicle (SV) alerts increase the User Differential Range Error (UDRE) of satellites, which can reduce the weighting of the satellite in the navigation solution, or completely exclude it from the navigation solution. An increase in UDRE's after an alert effectively increases the user protection levels (HPL and VPL), which affect the availability. Additionally, if an alert message sequence lasts for more than 12 seconds, WAAS fast corrections can time out, causing a loss of continuity. Table 5.2 shows the total number of alerts and the average number of alerts per day. Figure 5.1 shows the number of SV alerts that occurred daily during the reporting period. Often the number of alerts on one GEO is the same as the number of alerts on the other GEO. Therefore, lines tend to overlap in most points on this plot. Please note that the AOR-W and POR satellites were decommissioned from WAAS service during this quarter. The CRE GEO satellite was added to WAAS during this quarter. The number of alerts for each of these GEO satellites, therefore, are not for the full quarter.

Table 5-2 WAAS SV Alert

	Number of Alerts				Average Alerts Per Day			
Message Type	**AORW**	**POR**	**CRW**	**CRE**	**AORW**	**POR**	**CRW**	**CRE**
2	2	2	31	31	0.0217	0.0217	0.3369	0.3369
3	10	10	28	34	0.1086	0.1086	0.3043	0.3695
4	31	22	36	28	0.3369	0.2391	0.3913	0.3043
5	0	0	0	0	0	0	0	0
6	0	0	0	2	0	0	0	0.0217
24	0	0	23	21	0	0	0.25	0.2282
26	0	0	0	0	0	0	0	0
Total Alerts	43	34	118	116	0.4673	0.3695	1.2826	1.2608

Figure 5-1 SV Daily Alert Trends



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

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

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

All late messages statistics reported during the quarter were caused by GEO SIS outages, GUS switchovers and SV alerts except message type 7 and 10. Occasionally, message type 7 and 10 were late and they were not caused by GEO SIS outages, GUS switchovers or SV alerts. The lateness of type 7 and type 10 messages has little or no impact on user performance and safety.

Tables 5.4 to 5.8 show fast correction, long correction, ephemeris covariance, ionosphere correction, and ionospheric mask message rates statistics broadcasted on AORW. Table 5.9 to 5.13 show message rates statistics broadcasted on POR. Table 5.14 to 5.18 show messages rates statistics broadcasted on CRW.

Table 5-3 Update Rates for WAAS Messages

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

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

Message Type	**On Time**	**Late**	**Max Late Length (seconds)**
1	31843	3	131
2	419065	41	12
3	419095	35	12
4	419190	19	12
7	29312	7	139
9	29465	2	180
10	29359	3	142
17	16219	2	421

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

SV	On Time	Late	Max Late Length (seconds)
1	14976	1	162
2	15082	0	0
3	15532	0	0
4	15360	1	181
5	15483	3	169
6	15236	0	0
7	15452	0	0
8	14882	0	0
9	15363	0	0
10	15399	0	0
11	15869	0	0
12	15546	0	0
13	15204	1	155
14	15218	0	0
16	15566	0	0
17	15360	1	167
18	15150	0	0
19	15671	1	151
20	15602	3	169
21	14160	0	0
22	14570	0	0
23	15034	0	0
24	14761	0	0
25	14655	0	0
26	15128	0	0
27	14393	0	0
28	14945	1	155
29	15517	0	0
30	15520	0	0
31	15399	0	0

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

SV	On Time	Late	Max Late Length (seconds)
1	14011	1	125
2	14111	0	0
3	14524	0	0
4	14369	0	0
5	14462	1	185
6	14207	0	0
7	14428	1	140
8	13923	0	0
9	14377	1	126
10	14373	0	0
11	14852	0	0
12	14501	2	179
13	14154	1	153
14	14144	0	0
16	14407	1	149
17	14108	1	170
18	14085	2	151
19	14425	1	133
20	14074	0	0
21	12871	2	184
22	13090	3	162
23	13547	0	0
24	13224	0	0
25	13121	0	0
26	13543	0	0
27	12876	0	0
28	13375	2	168
29	13886	0	0
30	13922	0	0
31	13791	0	0
122	26358	3	155
134	26060	0	0
138	16026	1	136

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	8742	2	496
1	0	8733	4	453
1	1	8742	3	503
1	2	8732	4	445
1	3	8723	6	437
1	4	8721	7	479
2	0	8720	8	512
2	1	8733	8	522
2	2	8715	8	498
2	3	8732	6	442
2	4	8714	11	527
2	5	8741	5	520
3	0	8727	10	508

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

Band	On Time	Late	Max Late Length (seconds)
0	23500	0	0
1	23425	0	0
2	23434	0	0
3	23470	0	0

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

Message Type	On Time	Late	Max Late Length (seconds)
1	30777	5	180
2	417214	54	44
3	417255	42	53
4	417306	38	41
7	28429	7	211
9	29330	5	356
10	28427	7	224
17	16019	0	0

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

SV	On Time	Late	Max Late Length (seconds)
1	14877	1	170
2	15067	2	179
3	15513	2	238
4	15292	1	181
5	15363	3	186
6	15204	0	0
7	15416	2	181
8	14850	3	182
9	15293	2	168
10	15393	1	160
11	15745	2	256
12	15420	0	0
13	15174	3	173
14	15107	1	173
16	15507	1	256
17	15229	1	186
18	15052	1	186
19	15611	3	186
20	15482	2	168
21	14152	0	0
22	14444	3	181
23	14959	2	166
24	14750	1	168
25	14640	1	160
26	15101	3	256
27	14361	3	183
28	14902	2	160
29	15481	0	0
30	15417	0	0
31	15294	2	170

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

SV	On Time	Late	Max Late Length (seconds)
1	13908	3	192
2	14097	2	275
3	14507	3	190
4	14307	0	0
5	14349	3	189
6	14175	1	192
7	14393	2	188
8	13892	4	266
9	14311	3	184
10	14355	4	189
11	14722	4	264
12	14374	3	176
13	14122	3	194
14	14032	2	183
16	14351	2	288
17	13990	0	0
18	13998	1	185
19	14351	9	190
20	13954	3	193
21	12855	6	269
22	12982	2	197
23	13475	2	192
24	13207	3	190
25	13114	2	192
26	13521	1	184
27	12855	2	194
28	13325	2	288
29	13862	2	185
30	13823	3	192
31	13688	2	192
122	26231	8	286
134	26046	0	0
138	15929	3	195

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	8684	7	576
0	1	8701	9	602
0	2	8694	8	586
1	0	8692	7	581
1	1	8681	8	579
1	2	8683	11	576
1	3	8680	7	512
1	4	8682	8	522
2	0	8688	7	576
2	1	8681	9	590
2	2	8694	9	578
2	3	8699	8	617

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

Band	On Time	Late	Max Late Length (seconds)
0	22876	0	0
1	22877	0	0
2	22883	0	0

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

Message Type	On Time	Late	Max Late Length (seconds)
1	99721	9	160
2	1324691	106	30
3	1324691	104	25
4	615629	44	27
7	91539	18	146
9	93151	0	0
10	91562	11	155
17	37260	3	315

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

SV	On Time	Late	Max Late Length (seconds)
1	47909	0	0
2	48137	1	159
3	49433	1	186
4	48883	0	0
5	49594	1	159
6	48644	0	0
7	32035	2	188
8	47292	1	174
9	49042	0	0
10	35406	0	0
11	50604	0	0
12	49141	0	0
13	48049	2	166
14	48512	0	0
16	49557	1	166
17	48527	1	159
18	47979	1	186
19	49413	1	151
20	49834	2	176
21	45075	1	162
22	46240	2	165
23	47708	1	174
24	46842	0	0
25	46305	0	0
26	47651	0	0
27	46054	0	0
28	47224	1	162
29	49107	1	156
30	49712	1	178
31	48812	0	0

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

SV	On Time	Late	Max Late Length (seconds)
1	45040	1	127
2	45283	1	176
3	46456	0	0
4	45920	0	0
5	46431	1	133
6	45638	0	0
7	29934	0	0
8	44399	1	178
9	46015	1	127
10	33138	1	176
11	47418	2	178
12	45937	1	150
13	44924	2	185
14	44929	2	187
16	45805	0	0
17	44454	2	189
18	44539	1	183
19	45381	2	152
20	44780	2	189
21	40910	4	194
22	41481	3	162
23	42812	1	184
24	41933	0	0
25	41471	1	149
26	42664	1	137
27	41214	0	0
28	42247	1	165
29	43991	0	0
30	44518	0	0
31	43636	2	192
122	26354	4	157
134	26046	1	172
135	16540	0	0
138	72316	2	188

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

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	27648	15	576
0	1	27592	15	471
0	2	27598	21	543
0	3	4090	3	310
1	0	27589	20	534
1	1	27582	15	576
1	2	27600	9	455
1	3	27597	11	579
1	4	27597	14	444
2	0	27596	14	496
2	1	27588	14	485
2	2	27586	19	497
2	3	27597	18	495
2	4	27584	11	421
2	5	27597	14	451
3	0	27645	13	448
3	1	4091	1	301
3	2	4094	2	305
9	0	4088	4	305
9	1	4094	2	306
9	2	4090	2	302
9	3	4090	2	305
9	4	4095	1	304

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

Band	On Time	Late	Max Late Length (seconds)
0	73321	0	0
1	73238	0	0
2	73225	0	0
3	73276	0	0
9	12197	0	0

Table 5-199 WAAS Fast Correction and Degradation Message Rates – CRE

Message Type	On Time	Late	Max Late Length (seconds)
1	96555	4	138
2	1142539	85	30
3	1294771	82	27
4	455822	33	16
7	88334	10	153
9	91036	2	176
10	88324	16	140
17	36115	4	449
24	838999	47	23

Table 5-20 WAAS Long Correction Message Rates (Type 24 and 25) – CRE

SV	On Time	Late	Max Late Length (seconds)
1	46842	0	0
2	47073	1	159
3	48294	1	186
4	47756	0	0
5	48462	2	168
6	47589	1	176
7	30952	0	0
8	46114	1	175
9	47867	0	0
10	34289	1	179
11	49364	0	0
12	47963	0	0
13	46956	0	0
14	47437	0	0
16	48500	0	0
17	47291	1	159
18	46766	2	186
19	48231	2	173
20	48604	2	168
21	44086	0	0
22	45081	0	0
23	46629	1	169
24	45730	1	173
25	45187	2	185
26	46453	0	0
27	44917	0	0
28	45999	0	0
29	47879	1	167
30	48638	0	0
31	47747	1	159

Table 5-21 WAAS Ephemeris Covariance Message Rates (Type 28) – CRE

SV	On Time	Late	Max Late Length (seconds)
1	44035	0	0
2	44305	1	160
3	45402	1	160
4	44835	1	162
5	45346	0	0
6	44625	1	180
7	28858	0	0
8	43349	1	174
9	44957	0	0
10	32085	1	179
11	46256	1	178
12	44828	0	0
13	43827	0	0
14	43907	2	175
16	44783	1	192
17	43269	0	0
18	43358	0	0
19	44285	1	128
20	43679	1	191
21	40015	0	0
22	40430	1	161
23	41817	4	184
24	40912	0	0
25	40451	1	149
26	41571	1	135
27	40188	0	0
28	41155	0	0
29	42883	1	129
30	43502	2	193
31	42648	1	192
122	16198	1	144
134	16051	1	175
135	16536	0	0
138	80505	1	123

Table 5-22 WAAS Ionospheric Correction Message Rates (Type 26) – CRE

Band	Block	On Time	Late	Max Late Length (seconds)
0	0	26971	13	437
0	1	26991	12	577
0	2	26979	12	471
0	3	4088	5	308
1	0	26964	14	518
1	1	26970	9	540
1	2	26960	10	535
1	3	26969	9	521
1	4	26992	9	517
2	0	26979	9	507
2	1	26975	6	433
2	2	26958	11	576
2	3	26968	12	432
2	4	26962	12	419
2	5	26965	12	451
3	0	27089	11	448
3	1	4095	1	301
3	2	4094	2	305
9	0	4092	0	0
9	1	4088	4	306
9	2	4089	3	306
9	3	4091	5	306
9	4	4090	2	306

Table 5-23 WAAS Ionospheric Mask Message Rates (Type 18) - CRE

Band	On Time	Late	Max Late Length (seconds)
0	70814	0	0
1	70806	0	0
2	70890	0	0
3	70851	0	0
9	12185	0	0

6.0 SV RANGE ACCURACY

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

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

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

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

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

Site →	Billings		Albuquerque		Boston		Washington DC		Houston		Kansas City	
SV ↓	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding	95% Range Error	3.29 Sigma Bounding
1	1.520	100.00	1.694	100.00	1.495	100.00	1.286	100.00	1.482	100.00	1.486	100.00
2	0.933	100.00	1.507	100.00	1.194	100.00	1.074	100.00	2.385	100.00	1.536	100.00
3	1.370	100.00	1.114	100.00	1.265	100.00	1.585	100.00	1.547	100.00	1.522	100.00
4	1.893	100.00	1.661	100.00	1.663	100.00	1.643	100.00	1.767	100.00	1.753	100.00
5	1.355	100.00	1.677	100.00	1.148	100.00	1.144	100.00	1.110	100.00	1.207	100.00
6	2.640	100.00	1.567	100.00	2.267	100.00	1.615	100.00	1.445	100.00	2.035	100.00
7	1.401	100.00	0.865	100.00	1.099	100.00	1.535	100.00	0.929	100.00	1.593	100.00
8	1.725	100.00	1.037	100.00	1.350	100.00	1.363	100.00	1.272	100.00	1.368	100.00
9	1.485	100.00	1.607	100.00	1.452	100.00	1.490	100.00	1.445	100.00	1.400	100.00
10	0.783	100.00	1.063	100.00	0.864	100.00	0.929	100.00	1.489	100.00	2.406	100.00
11	0.786	100.00	1.070	100.00	1.061	100.00	0.948	100.00	1.389	100.00	1.067	100.00
12	1.453	100.00	1.458	100.00	1.488	100.00	1.239	100.00	1.433	100.00	1.765	100.00
13	1.688	100.00	1.351	100.00	1.428	100.00	1.156	100.00	1.751	100.00	1.573	100.00
14	1.593	100.00	1.056	100.00	1.008	100.00	0.850	100.00	1.502	100.00	0.984	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	0.886	100.00	1.240	100.00	0.870	100.00	0.760	100.00	1.662	100.00	1.443	100.00
17	2.629	100.00	1.268	100.00	1.752	100.00	1.561	100.00	2.358	100.00	1.362	100.00
18	0.668	100.00	1.012	100.00	0.966	100.00	1.383	100.00	1.602	100.00	1.177	100.00
19	1.916	100.00	2.239	100.00	1.960	100.00	1.760	100.00	2.716	100.00	1.609	100.00
20	1.123	100.00	1.352	100.00	1.508	100.00	1.032	100.00	1.634	100.00	1.237	100.00
21	0.816	100.00	1.238	100.00	1.088	100.00	1.129	100.00	2.191	100.00	1.013	100.00
22	0.853	100.00	1.002	100.00	1.366	100.00	1.238	100.00	1.560	100.00	1.019	100.00
23	1.085	100.00	1.616	100.00	1.687	100.00	1.849	100.00	2.325	100.00	1.729	100.00
24	1.712	100.00	1.866	100.00	2.189	100.00	2.010	100.00	1.580	100.00	1.943	100.00
25	2.015	100.00	1.317	100.00	1.705	100.00	1.291	100.00	1.629	100.00	1.692	100.00
26	1.675	100.00	1.640	100.00	1.720	100.00	1.816	100.00	1.548	100.00	1.655	100.00
27	1.329	100.00	1.128	100.00	1.321	100.00	1.232	100.00	1.496	100.00	1.636	100.00
28	0.851	100.00	0.963	100.00	0.947	100.00	0.773	100.00	2.014	100.00	0.881	100.00
29	1.830	100.00	1.444	100.00	1.319	100.00	1.750	100.00	1.807	100.00	1.794	100.00
30	1.957	100.00	1.785	100.00	1.596	100.00	1.791	100.00	2.012	100.00	1.660	100.00
31	2.381	100.00	1.661	100.00	1.317	100.00	1.354	100.00	1.828	100.00	1.686	100.00
135	-	-	-	-	-	-	-	-	-	-	-	-
138	-	-	-	-	-	-	-	-	-	-	-	-

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	0.825	100.00	1.562	100.00	1.685	100.00	1.480	100.00	1.448	100.00	1.741	100.00
2	2.227	100.00	2.030	100.00	1.852	100.00	1.535	100.00	1.114	100.00	0.978	100.00
3	0.899	100.00	1.557	100.00	1.214	100.00	1.607	100.00	1.412	100.00	1.402	100.00
4	1.030	100.00	1.962	100.00	1.532	100.00	1.803	100.00	1.726	100.00	1.788	100.00
5	1.370	100.00	1.286	100.00	1.161	100.00	1.769	100.00	1.242	100.00	1.692	100.00
6	0.767	100.00	1.756	100.00	2.096	100.00	1.963	100.00	1.794	100.00	2.100	100.00
7	1.025	100.00	1.495	100.00	1.294	100.00	1.368	100.00	1.255	100.00	1.600	100.00
8	0.840	100.00	1.784	100.00	1.260	100.00	1.473	100.00	1.298	100.00	1.737	100.00
9	1.344	100.00	2.195	100.00	1.107	100.00	1.628	100.00	1.531	100.00	1.759	100.00
10	1.256	100.00	1.177	100.00	1.064	100.00	0.944	100.00	0.943	100.00	1.003	100.00
11	1.191	100.00	1.438	100.00	1.897	100.00	1.032	100.00	0.774	100.00	1.093	100.00
12	1.111	100.00	1.572	100.00	1.197	100.00	1.449	100.00	1.813	100.00	1.780	100.00
13	0.745	100.00	1.768	100.00	1.536	100.00	1.565	100.00	1.857	100.00	1.750	100.00
14	1.065	100.00	1.039	100.00	1.485	100.00	1.347	100.00	1.026	100.00	0.873	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	1.573	100.00	1.163	100.00	1.432	100.00	1.110	100.00	0.802	100.00	0.963	100.00
17	1.128	100.00	1.736	100.00	1.413	100.00	1.152	100.00	1.283	100.00	1.573	100.00
18	1.661	100.00	1.620	100.00	1.322	100.00	1.044	100.00	0.847	100.00	0.658	100.00
19	3.327	100.00	2.106	100.00	2.152	100.00	1.945	100.00	1.841	100.00	1.381	100.00
20	1.425	100.00	1.695	100.00	1.233	100.00	1.060	100.00	0.988	100.00	0.819	100.00
21	1.841	100.00	1.349	100.00	2.642	100.00	1.263	100.00	0.912	100.00	0.817	100.00
22	1.512	100.00	1.304	100.00	1.677	100.00	0.999	100.00	1.093	100.00	0.748	100.00
23	2.124	100.00	1.742	100.00	2.158	100.00	2.033	100.00	1.436	100.00	1.007	100.00
24	1.032	100.00	2.352	100.00	1.424	100.00	2.159	100.00	1.606	100.00	2.070	100.00
25	0.741	100.00	1.799	100.00	2.715	100.00	1.563	100.00	1.484	100.00	2.027	100.00
26	0.884	100.00	1.972	100.00	2.006	100.00	1.813	100.00	1.848	100.00	1.970	100.00
27	0.705	100.00	1.768	100.00	1.311	100.00	1.662	100.00	1.363	100.00	1.757	100.00
28	1.456	100.00	1.194	100.00	1.986	100.00	0.946	100.00	0.802	100.00	1.182	100.00
29	1.042	100.00	1.487	100.00	1.665	100.00	1.763	100.00	1.432	100.00	1.638	100.00
30	1.069	100.00	1.431	100.00	1.916	100.00	1.800	100.00	1.868	100.00	2.143	100.00
31	1.115	100.00	1.655	100.00	1.577	100.00	1.244	100.00	1.415	100.00	1.673	100.00
135	-	-	-	-	-	-	-	-	-	-	-	-
138	-	-	-	-	-	-	-	-	-	-	-	-

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

Site →	Billings		Albuquerque		Boston		Washington DC		Houston		Kansas City	
SV ↓	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding
1	0.843	100.00	0.640	100.00	0.611	100.00	0.603	100.00	0.569	100.00	0.632	100.00
2	0.679	100.00	1.078	100.00	1.033	100.00	0.904	100.00	1.276	100.00	1.072	100.00
3	0.603	100.00	0.431	100.00	0.530	100.00	0.628	100.00	0.579	100.00	0.596	100.00
4	1.259	100.00	0.963	100.00	1.137	100.00	1.026	100.00	1.465	100.00	0.917	100.00
5	0.595	100.00	0.920	100.00	0.474	100.00	0.265	100.00	0.582	100.00	0.367	100.00
6	1.317	100.00	0.666	100.00	0.994	100.00	0.930	100.00	0.786	100.00	1.020	100.00
7	0.800	100.00	0.432	100.00	0.461	100.00	0.642	100.00	0.418	100.00	0.505	100.00
8	0.931	100.00	0.375	100.00	0.558	100.00	0.670	100.00	0.630	100.00	0.547	100.00
9	0.742	100.00	0.744	100.00	0.537	100.00	0.604	100.00	0.543	100.00	0.564	100.00
10	0.326	100.00	0.606	100.00	0.304	100.00	0.443	100.00	0.815	100.00	1.172	100.00
11	0.335	100.00	0.578	100.00	0.454	100.00	0.432	100.00	0.664	100.00	0.421	100.00
12	0.766	100.00	0.557	100.00	0.580	100.00	0.442	100.00	0.517	100.00	0.691	100.00
13	0.996	100.00	0.463	100.00	0.559	100.00	0.423	100.00	0.727	100.00	0.576	100.00
14	1.084	100.00	0.465	100.00	0.378	100.00	0.361	100.00	0.481	100.00	0.403	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	0.465	100.00	0.624	100.00	0.395	100.00	0.468	100.00	0.552	100.00	0.548	100.00
17	2.111	100.00	0.618	100.00	0.972	100.00	0.883	100.00	1.490	100.00	0.633	100.00
18	0.513	100.00	0.774	100.00	0.685	100.00	0.919	100.00	0.594	100.00	0.808	100.00
19	1.307	100.00	1.515	100.00	1.394	100.00	1.296	100.00	1.386	100.00	1.220	100.00
20	0.327	100.00	0.596	100.00	0.994	100.00	0.388	100.00	0.563	100.00	0.484	100.00
21	0.641	100.00	0.953	100.00	0.777	100.00	0.871	100.00	0.992	100.00	0.681	100.00
22	0.415	100.00	0.714	100.00	1.092	100.00	0.903	100.00	0.682	100.00	0.741	100.00
23	0.904	100.00	1.391	100.00	1.180	100.00	1.365	100.00	1.313	100.00	1.323	100.00
24	1.154	100.00	1.026	100.00	1.031	100.00	1.071	100.00	0.960	100.00	0.992	100.00
25	1.172	100.00	0.530	100.00	0.755	100.00	0.621	100.00	0.644	100.00	0.694	100.00
26	0.976	100.00	0.830	100.00	0.643	100.00	0.826	100.00	0.811	100.00	0.769	100.00
27	0.572	100.00	0.330	100.00	0.480	100.00	0.651	100.00	0.609	100.00	0.739	100.00
28	0.369	100.00	0.603	100.00	0.483	100.00	0.427	100.00	0.788	100.00	0.549	100.00
29	0.934	100.00	0.616	100.00	0.404	100.00	0.717	100.00	0.809	100.00	0.716	100.00
30	0.997	100.00	0.839	100.00	0.590	100.00	0.700	100.00	0.813	100.00	0.686	100.00
31	1.510	100.00	0.516	100.00	0.470	100.00	0.738	100.00	0.802	100.00	0.769	100.00

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

Site →	Los Angeles		Salt Lake City		Miami		Minneapolis		Atlanta		Juneau	
SV ↓	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding	95% Iono Error	3.29 Sigma Bounding
1	0.484	100.00	0.831	100.00	0.791	100.00	0.639	100.00	0.516	100.00	0.516	100.00
2	1.276	100.00	1.157	100.00	1.335	100.00	1.090	100.00	0.709	100.00	0.709	100.00
3	0.434	100.00	0.721	100.00	0.447	100.00	0.579	100.00	0.503	100.00	0.503	100.00
4	0.699	100.00	1.154	100.00	0.895	100.00	0.969	100.00	1.011	100.00	1.011	100.00
5	0.597	100.00	0.646	100.00	0.494	100.00	0.547	100.00	0.360	100.00	0.360	100.00
6	0.565	100.00	1.120	100.00	0.897	100.00	0.903	100.00	0.777	100.00	0.777	100.00
7	0.377	100.00	0.884	100.00	0.669	100.00	0.497	100.00	0.395	100.00	0.395	100.00
8	0.398	100.00	0.910	100.00	0.598	100.00	0.504	100.00	0.522	100.00	0.522	100.00
9	0.532	100.00	1.094	100.00	0.538	100.00	0.637	100.00	0.560	100.00	0.560	100.00
10	0.793	100.00	0.602	100.00	0.626	100.00	0.419	100.00	0.291	100.00	0.291	100.00
11	0.716	100.00	0.557	100.00	0.787	100.00	0.491	100.00	0.429	100.00	0.429	100.00
12	0.473	100.00	0.864	100.00	0.662	100.00	0.645	100.00	0.861	100.00	0.861	100.00
13	0.377	100.00	0.838	100.00	0.704	100.00	0.714	100.00	0.659	100.00	0.659	100.00
14	0.709	100.00	0.735	100.00	0.944	100.00	0.656	100.00	0.308	100.00	0.308	100.00
15	-	-	-	-	-	-	-	-	-	-	-	-
16	0.947	100.00	0.487	100.00	0.881	100.00	0.349	100.00	0.343	100.00	0.343	100.00
17	0.585	100.00	1.059	100.00	0.715	100.00	0.538	100.00	0.694	100.00	0.694	100.00
18	0.967	100.00	1.198	100.00	1.115	100.00	0.676	100.00	0.571	100.00	0.571	100.00
19	2.001	100.00	1.274	100.00	1.508	100.00	1.394	100.00	1.311	100.00	1.311	100.00
20	0.743	100.00	0.578	100.00	0.757	100.00	0.525	100.00	0.356	100.00	0.356	100.00
21	1.081	100.00	0.953	100.00	1.757	100.00	0.899	100.00	0.676	100.00	0.676	100.00
22	0.903	100.00	0.987	100.00	1.268	100.00	0.759	100.00	0.694	100.00	0.694	100.00
23	1.398	100.00	1.469	100.00	1.612	100.00	1.577	100.00	1.067	100.00	1.067	100.00
24	0.854	100.00	1.510	100.00	0.843	100.00	1.189	100.00	0.949	100.00	0.949	100.00
25	0.372	100.00	0.993	100.00	1.203	100.00	0.576	100.00	0.568	100.00	0.568	100.00
26	0.597	100.00	0.878	100.00	0.898	100.00	0.804	100.00	0.925	100.00	0.925	100.00
27	0.331	100.00	0.926	100.00	0.624	100.00	0.603	100.00	0.490	100.00	0.490	100.00
28	0.817	100.00	0.600	100.00	1.257	100.00	0.583	100.00	0.472	100.00	0.472	100.00
29	0.688	100.00	0.644	100.00	0.606	100.00	0.689	100.00	0.611	100.00	0.611	100.00
30	0.628	100.00	0.829	100.00	0.838	100.00	0.835	100.00	0.801	100.00	0.801	100.00
31	0.622	100.00	0.798	100.00	0.616	100.00	0.471	100.00	0.479	100.00	0.479	100.00

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

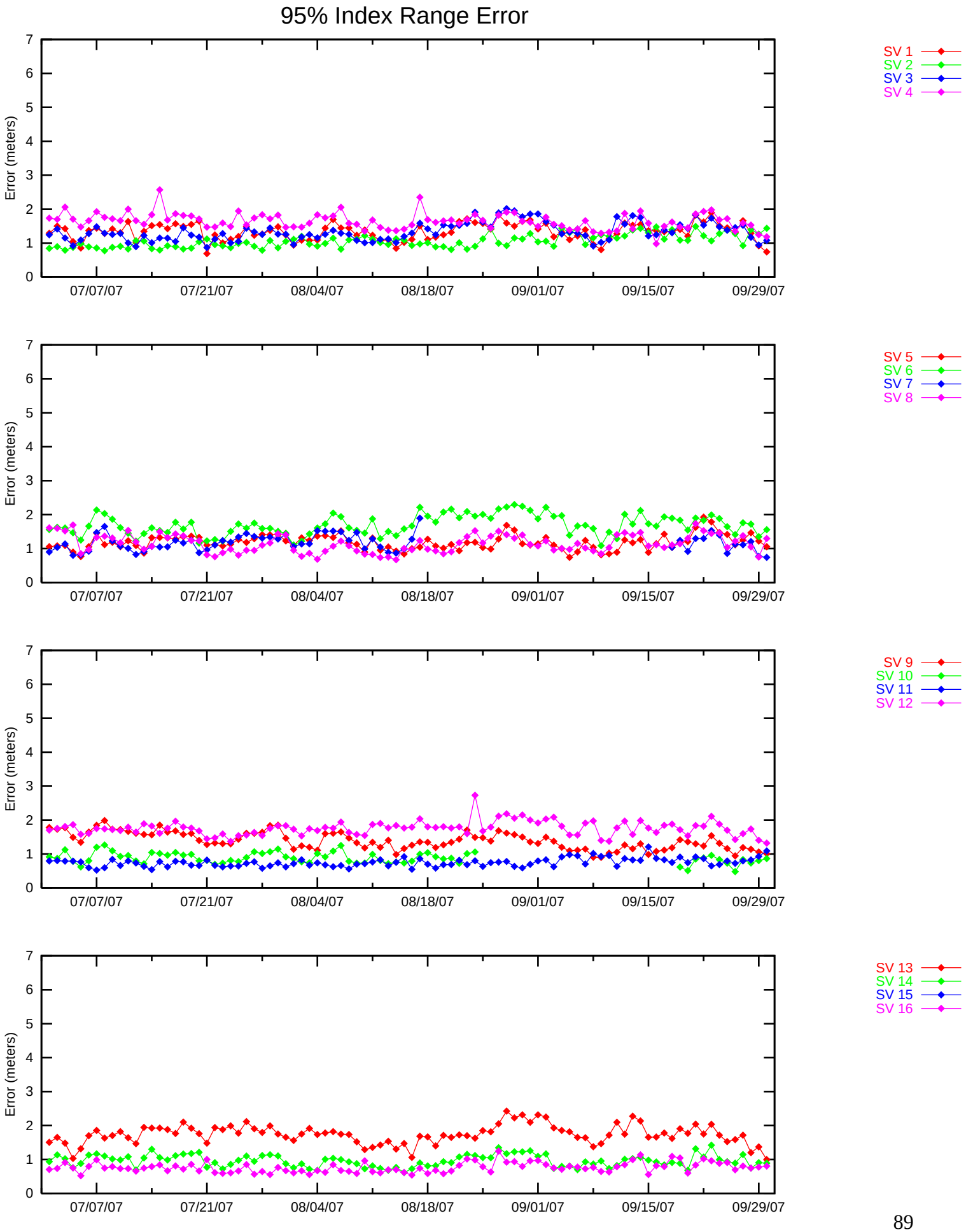


Figure 6-2 95% Range Error (SV 17 -- SV 31) - Washington, DC

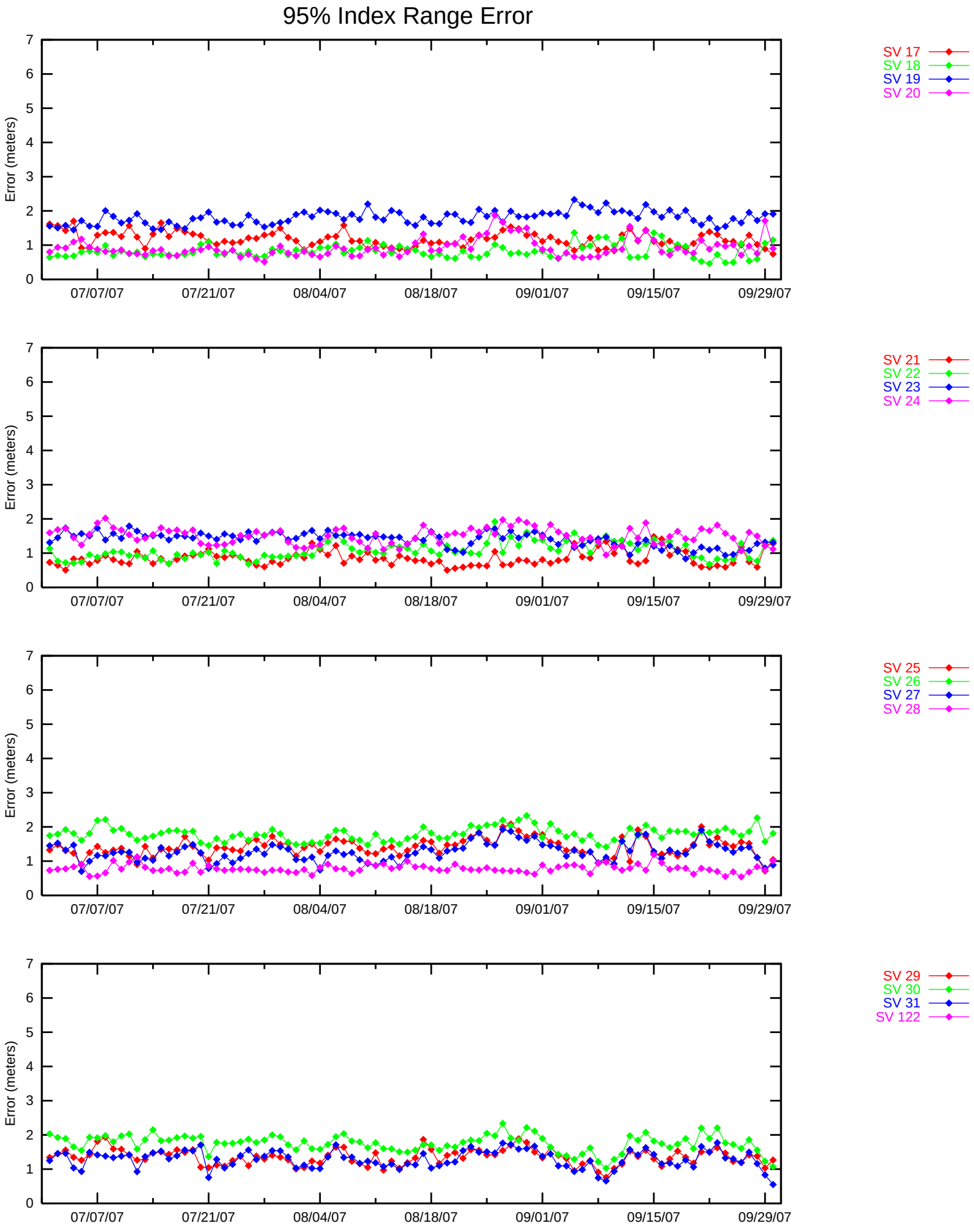


Figure 6-3 95% Ionospheric Error (SV 1 -- SV 16) - Washington, DC

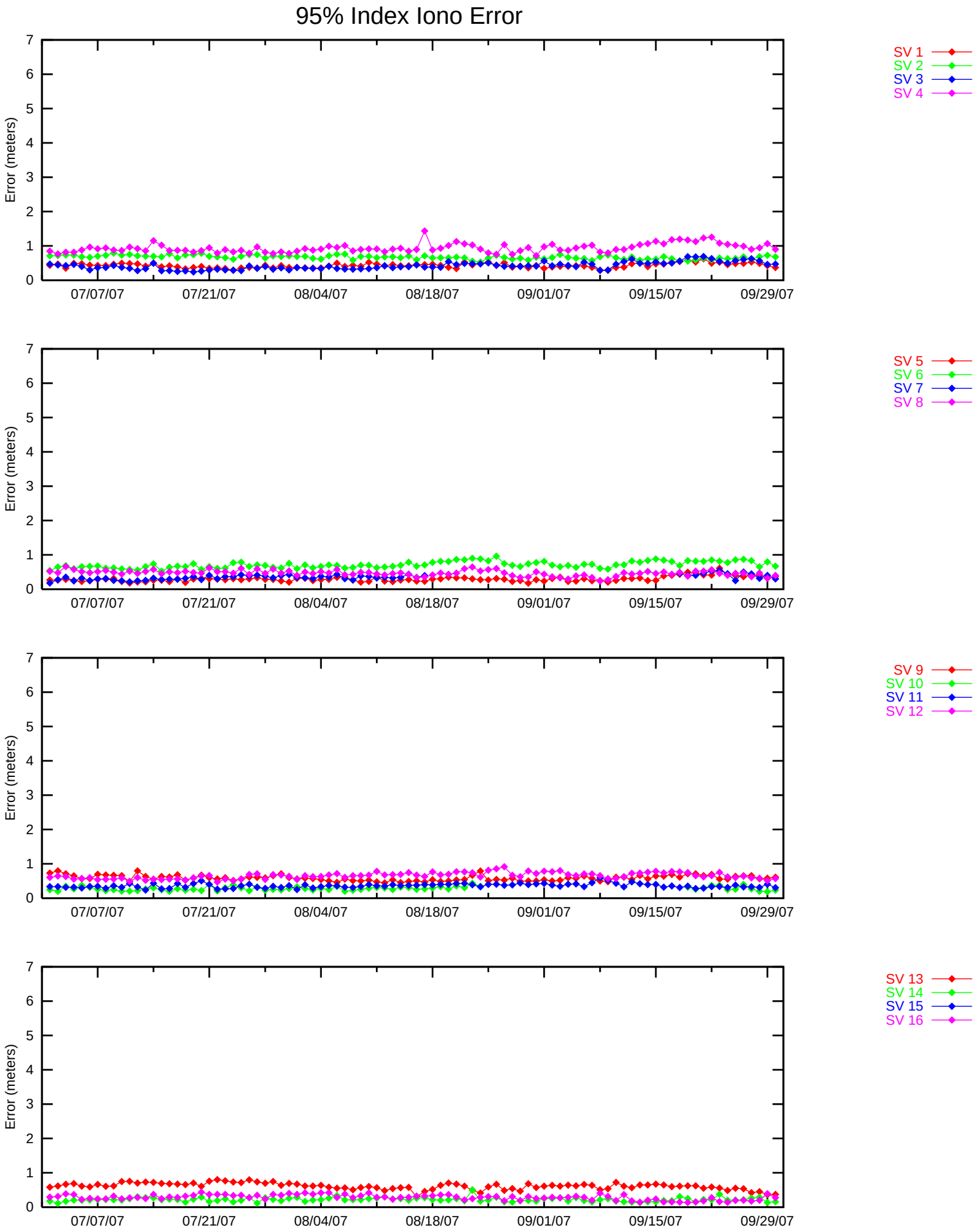
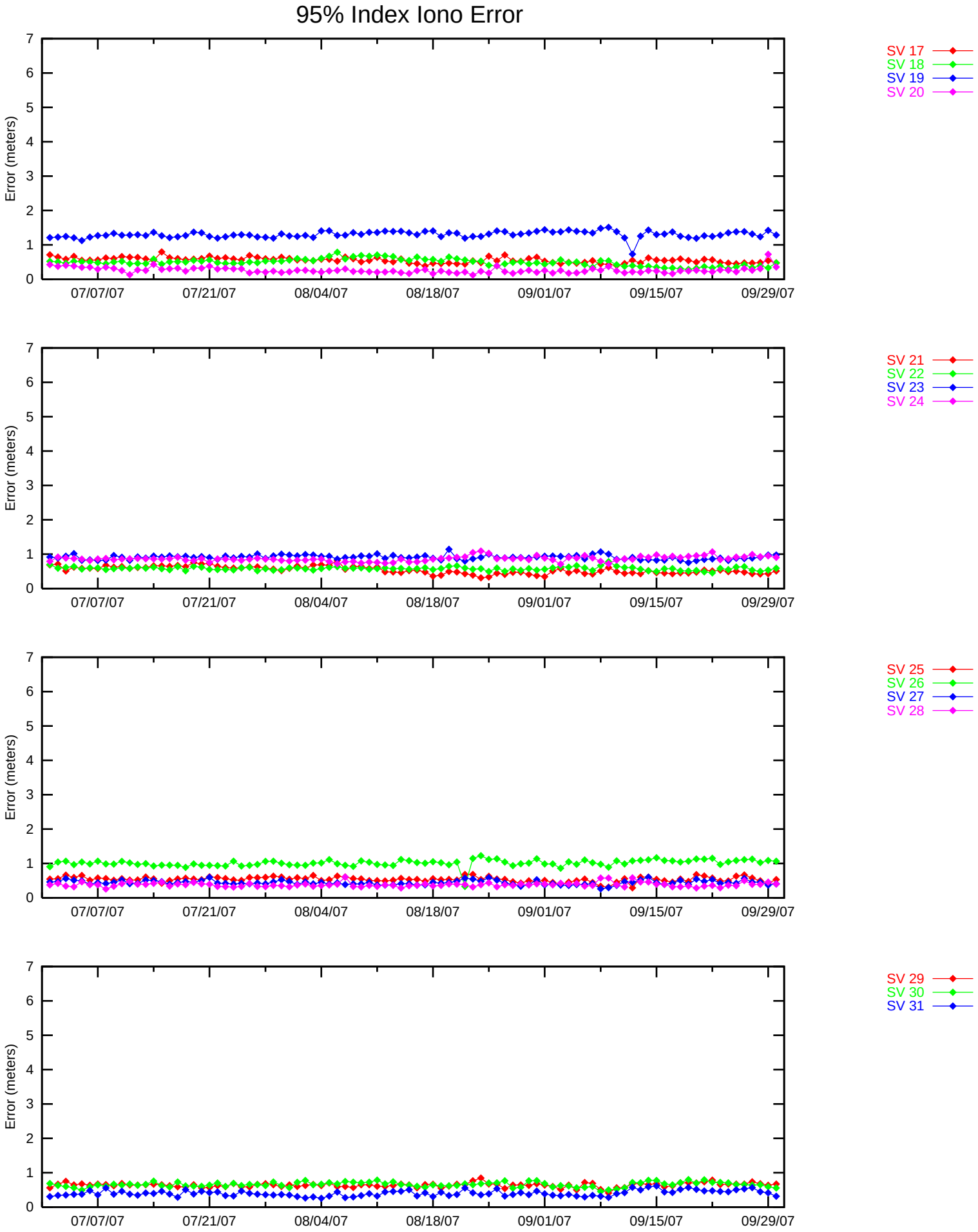


Figure 6-4 95% Ionospheric Error (SV 17 -- SV 31) - Washington, DC



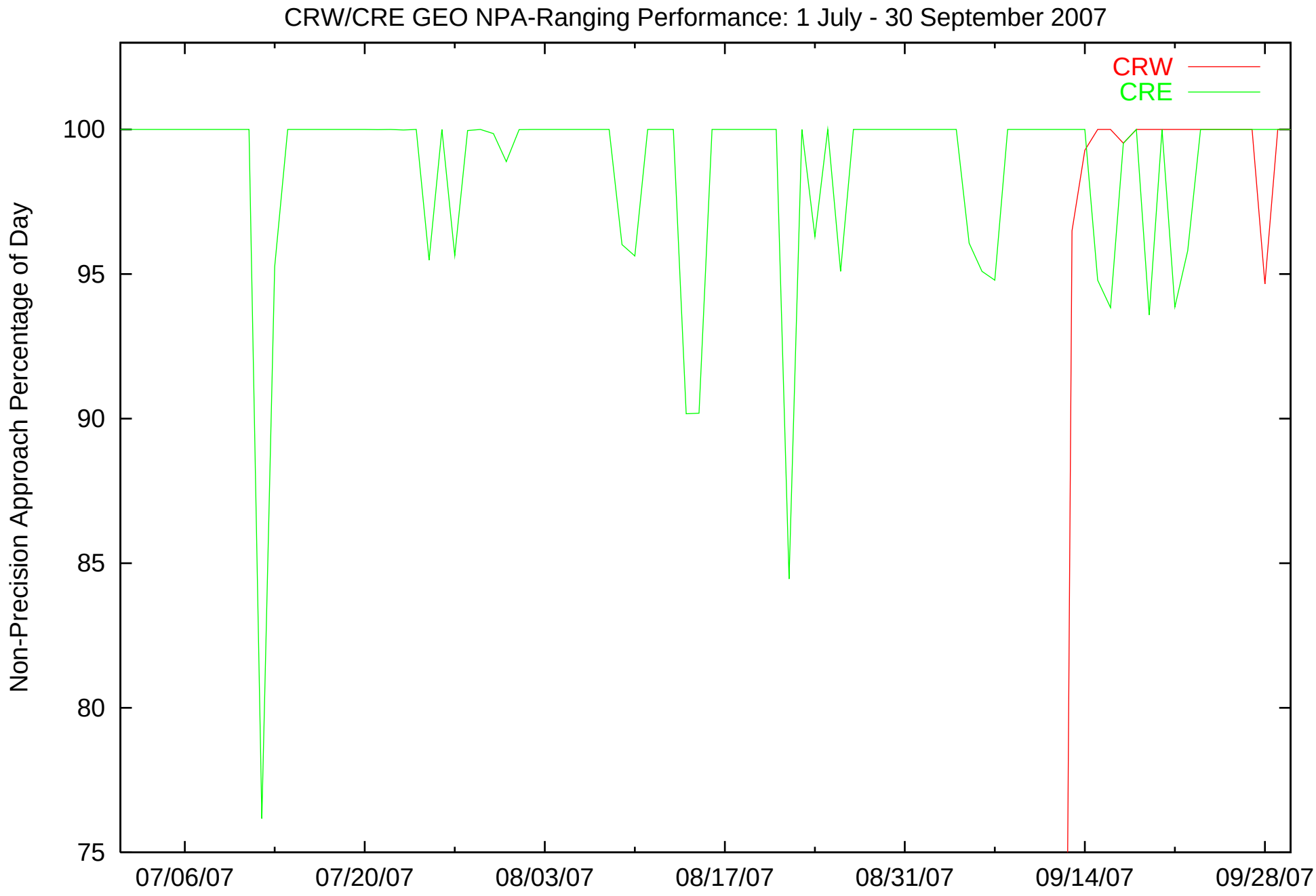
7.0 GEO RANGING PERFORMANCE

Please note that the AOR-W and POR satellites were decommissioned from WAAS service during this quarter. The CRE GEO satellite was added to WAAS during this quarter. The number of alerts for each of these GEO satellites, therefore, are not for the full quarter. As in the past, the POR satellite as a ranging source has very low PA availability. Table 7.1 shows the GEO-Ranging performance for AORW, POR, CRW and CRE satellites throughout the evaluated period. Figure 7.1 shows the trend of NPA Ranging Availability for the AORW and POR satellite.

Table 7-1 GEO Ranging Availability

GEO	PA (%)	NPA (%)	Not Monitored (%)	Do Not Use (%)
AORW	0	32.205	0.004	0.109
POR	0	31.867	0.408	0.043
CRW	0	19.812	79.791	0.392
CRE	0	86.507	0.636	3.061

Figure 7-1 Daily NPA GEO Ranging Availability Trend



8.0 WAAS PROBLEM SUMMARY

Events that adversely affected the WAAS service for this evaluated period are listed in Table 8.1. These events include any WAAS anomalies and problems that affected the WAAS performance. Details of each of the events are documented in the WAAS Discrepancy Report (DR). The DRs are available on the website http://www.nstb.tc.faa.gov under 'WAAS Technical Reports', and can also be accessed via hyperlink below.

Table 8-1 WAAS Problem Summary

Date	Events
7/31/07	See DR #63, "WAAS Set All Satellites and IGPs to Not Monitored."

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 all 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 this evaluated period 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	State	Outages	Availability
ANC	TED STEVENS ANCHORAGE INTL	AK	34	0.997833
79J	ANDALUSIA-OPP	AL	27	0.998692
EKY	BESSEMER	AL	9	0.999395
BHM	BIRMINGHAM INTL	AL	9	0.999396
DHN	DOTHAN RGNL	AL	27	0.998449
HSV	HUNTSVILLE INTL-CARL T JONES F	AL	32	0.998809
JKA	JACK EDWARDS	AL	40	0.998360
MDQ	MADISON COUNTY EXECUTIVE/TOM S	AL	33	0.998731
BFM	MOBILE DOWNTOWN	AL	36	0.998301
MOB	MOBILE RGNL	AL	33	0.998270
MGM	MONTGOMERY RGNL (DANNELLY FIELD)	AL	17	0.999179
MSL	NORTHWEST ALABAMA RGNL	AL	33	0.998108
DCU	PRYOR FIELD RGNL	AL	33	0.998657
LIT	ADAMS FIELD	AR	10	0.999303
M73	ALMYRA MUNICIPAL	AR	35	0.998371
BYH	ARKANSAS INTL	AR	34	0.996491
VBT	BENTONVILLE MUNICIPAL/LOUISE M THAD	AR	10	0.999348
HRO	BOONE COUNTY	AR	10	0.999348
FSM	FORT SMITH RGNL	AR	11	0.999322
PBF	GRIDER FIELD	AR	11	0.999283
XNA	NORTHWEST ARKANSAS RGNL	AR	10	0.999348
BPK	OZARK RGNL	AR	10	0.999351
ROG	ROGERS MUNI-CARTER FIELD	AR	10	0.999348
SRC	SEARCY MUNICIPAL	AR	10	0.999319
ELD	SOUTH ARKANSAS RGNL AT GOODWIN	AR	10	0.999278
ASG	SPRINGDALE MUNICIPAL	AR	10	0.999348
SGT	STUTTGART MUNICIPAL	AR	14	0.999232
ARG	WALNUT RIDGE RGNL	AR	9	0.999406

PRC	ERNEST A. LOVE FIELD	AZ	35	0.992850
GCN	GRAND CANYON NATIONAL PARK	AZ	35	0.996508
IFP	LAUGHLIN/BULLHEAD INTL	AZ	27	0.998601
DVT	PHOENIX DEER VALLEY	AZ	36	0.990820
PHX	PHOENIX SKY HARBOR INTL	AZ	40	0.990543
SJN	ST JOHNS INDUSTRIAL AIR PARK	AZ	29	0.997872
TUS	TUCSON INTL	AZ	66	0.989724
IWA	WILLIAMS GATEWAY	AZ	36	0.990707
APV	APPLE VALLEY	CA	21	0.998548
ACV	ARCATA	CA	42	0.998077
DAG	BARSTOW-DAGGETT	CA	16	0.998928
C83	BYRON	CA	62	0.997115
CMA	CAMARILLO	CA	162	0.987153
CNO	CHINO	CA	93	0.992325
FAT	FRESNO YOSEMITE INTL	CA	18	0.998944
WJF	GENERAL WM J FOX AIRFIELD	CA	26	0.998293
HAF	HALF MOON BAY	CA	165	0.987519
SNA	JOHN WAYNE AIRPORT-ORANGE COUNTY	CA	136	0.986728
LGB	LONG BEACH /DAUGHERTY FIELD	CA	133	0.987208
LAX	LOS ANGELES INTL	CA	140	0.987201
CRQ	MC CLELLAN-PALOMAR	CA	200	0.976144
BFL	MEADOWS FIELD	CA	36	0.998338
OAK	METROPOLITAN OAKLAND INTL	CA	141	0.992151
MRY	MONTEREY PENINSULA	CA	170	0.987772
APC	NAPA COUNTY	CA	93	0.995576
O02	NERVINO	CA	11	0.999428
SJC	NORMAN Y. MINETA SAN JOSE INTL	CA	145	0.991738
VCB	NUT TREE	CA	44	0.998023
ONT	ONTARIO INTL	CA	72	0.994355
OXR	OXNARD	CA	170	0.986310
PMD	PALMDALE RGNL/USAF PLANT 42	CA	26	0.998236
RDD	REDDING MUNICIPAL	CA	14	0.999163
RAL	RIVERSIDE MUNICIPAL	CA	77	0.993456
SMF	SACRAMENTO INTL	CA	15	0.998935
MHR	SACRAMENTO MATHER	CA	15	0.999122
SFO	SAN FRANCISCO INTL	CA	158	0.989544
TCY	TRACY MUNICIPAL	CA	58	0.997253
COS	CITY OF COLORADO SPRINGS MUNICIPAL	CO	9	0.999418
AKO	COLORADO PLAINS RGNL	CO	9	0.999409
CEZ	CORTEZ MUNICIPAL	CO	9	0.999470
DEN	DENVER INTL	CO	9	0.999410
GXY	GREELEY-WELD COUNTY	CO	9	0.999410
ITR	KIT CARSON COUNTY	CO	9	0.999408
LAA	LAMAR MUNICIPAL	CO	10	0.999392
PUB	PUEBLO MEMORIAL	CO	9	0.999418
ALS	SAN LUIS VALLEY RGNL/BERGMAN FIELD	CO	9	0.999422
HDN	YAMPA VALLEY	CO	9	0.999448
BDL	BRADLEY INTL	CT	157	0.988579
GON	GROTON-NEW LONDON	CT	149	0.990392
HVN	TWEED-NEW HAVEN	CT	96	0.994893
OXC	WATERBURY-OXFORD	CT	97	0.994793
DCA	RONALD REAGAN WASHINGTON NATIONAL	DC	18	0.999144
EVY	SUMMIT	DE	15	0.999233

GED	SUSSEX COUNTY	DE	18	0.999176
CEW	BOB SIKES	FL	27	0.998520
BCT	BOCA RATON	FL	16	0.998776
DAB	DAYTONA BEACH INTL	FL	12	0.999340
DED	DELAND MUNICIPAL-SIDNEY H TAYLOR FIELD	FL	12	0.999347
FXE	FORT LAUDERDALE EXECUTIVE	FL	25	0.998526
FLL	FORT LAUDERDALE/HOLLYWOOD INTL	FL	27	0.998481
GNV	GAINESVILLE RGNL	FL	11	0.999332
BKV	HERNANDO COUNTY	FL	28	0.998209
JAX	JACKSONVILLE INTL	FL	8	0.999436
TMB	KENDALL-TAMIAMI EXECUTIVE	FL	34	0.997726
EYW	KEY WEST INTL	FL	63	0.991337
ISM	KISSIMMEE GATEWAY	FL	14	0.999056
LEE	LEESBURG INTL	FL	11	0.999267
MLB	MELBOURNE INTL	FL	14	0.999046
COI	MERRITT ISLAND	FL	14	0.999091
MIA	MIAMI INTL	FL	32	0.998114
APF	NAPLES MUNICIPAL	FL	31	0.996941
EVB	NEW SMYRNA BEACH MUNICIPAL	FL	12	0.999322
OCF	OCALA INTL-JIM TAYLOR FIELD	FL	18	0.999141
MCO	ORLANDO INTL	FL	13	0.999091
PBI	PALM BEACH INTL	FL	15	0.998842
PFN	PANAMA CITY-BAY CO INTL	FL	27	0.997926
PNS	PENSACOLA RGNL	FL	27	0.998597
PMP	POMPANO BEACH AIRPARK	FL	22	0.998634
SRQ	SARASOTA/BRADENTON INTL	FL	28	0.997198
RSW	SOUTHWEST FLORIDA INTL	FL	31	0.997299
PIE	ST PETERSBURG-CLEARWATER INTL	FL	28	0.997695
TLH	TALLAHASSEE RGNL	FL	27	0.998039
TPA	TAMPA INTL	FL	28	0.997812
VDF	VANDENBERG	FL	28	0.997999
GIF	WINTER HAVEN'S GILBERT	FL	25	0.998751
AGS	AUGUSTA RGNL AT BUSH FIELD	GA	8	0.999470
BQK	BRUNSWICK GOLDEN ISLES	GA	8	0.999436
CSG	COLUMBUS METROPOLITAN	GA	26	0.998939
DNN	DALTON MUNICIPAL	GA	9	0.999397
ATL	HARTSFIELD - JACKSON ATLANTA	GA	8	0.999412
MCN	MIDDLE GEORGIA RGNL	GA	8	0.999403
MGR	MOULTRIE MUNICIPAL	GA	23	0.999019
CCO	NEWNAN COWETA COUNTY	GA	18	0.999218
SAV	SAVANNAH/HILTON HEAD INTL	GA	8	0.999434
ACJ	SOUTHER FIELD	GA	19	0.999128
ABY	SOUTHWEST GEORGIA RGNL	GA	25	0.998906
TBR	STATESBORO-BULLOCH COUNTY	GA	8	0.999448
VLD	VALDOSTA RGNL	GA	13	0.999255
AYS	WAYCROSS-WARE COUNTY	GA	8	0.999436
CTJ	WEST GEORGIA RGNL - O V GRAY FIELD	GA	18	0.999214
IKV	ANKENY RGNL	IA	11	0.999377
DVN	DAVENPORT MUNICIPAL	IA	9	0.999404
DSM	DES MOINES INTL	IA	12	0.999360
DBQ	DUBUQUE RGNL	IA	9	0.999406
FFL	FAIRFIELD MUNICIPAL	IA	9	0.999406
EOK	KEOKUK MUNICIPAL	IA	9	0.999405

MCW	MASON CITY MUNICIPAL	IA	10	0.999366
MXO	MONTICELLO RGNL	IA	9	0.999407
MUT	MUSCATINE MUNICIPAL	IA	9	0.999404
TNU	NEWTON MUNICIPAL	IA	10	0.999399
OTM	OTTUMWA INDUSTRIAL	IA	10	0.999395
SDA	SHENANDOAH MUNICIPAL	IA	10	0.999370
SLB	STORM LAKE MUNICIPAL	IA	11	0.999345
CID	THE EASTERN IOWA	IA	9	0.999408
ALO	WATERLOO RGNL	IA	10	0.999399
BOI	BOISE AIR TERMINAL/GOWEN FIELD	ID	9	0.999498
IDA	IDAHO FALLS RGNL	ID	9	0.999492
LWS	LEWISTON-NEZ PERCE COUNTY	ID	9	0.999492
S67	NAMPA MUNICIPAL	ID	9	0.999498
PIH	POCATELLO RGNL	ID	9	0.999492
SPI	ABRAHAM LINCOLN CAPITAL	IL	9	0.999404
FEP	ALBERTUS	IL	9	0.999402
ARR	AURORA MUNICIPAL	IL	9	0.999402
BMI	CENTRAL IL REGL ARPT AT BLOOMI	IL	9	0.999404
ENL	CENTRALIA MUNICIPAL	IL	34	0.997406
MDW	CHICAGO MIDWAY INTL	IL	9	0.999402
ORD	CHICAGO O'HARE INTL	IL	9	0.999402
RFD	CHICAGO/ROCKFORD INTL	IL	9	0.999402
DEC	DECATUR	IL	9	0.999404
FOA	FLORA MUNICIPAL	IL	33	0.998755
IKK	GREATER KANKAKEE	IL	9	0.999402
PIA	GREATER PEORIA RGNL	IL	9	0.999404
3LF	LITCHFIELD MUNICIPAL	IL	31	0.998996
PPQ	PITTSFIELD PENSTONE MUNICIPAL	IL	9	0.999404
MLI	QUAD CITY INTL	IL	9	0.999404
TIP	RANTOUL NATL AVN CNTR-FRANK EL	IL	9	0.999402
SLO	SALEM-LECKRONE	IL	34	0.997929
ALN	ST LOUIS RGNL	IL	9	0.999404
UGN	WAUKEGAN RGNL	IL	9	0.999402
BAK	COLUMBUS MUNICIPAL	IN	9	0.999424
GWB	DE KALB COUNTY	IN	9	0.999423
MIE	DELAWARE COUNTY - JOHNSON FIELD	IN	9	0.999426
EKM	ELKHART MUNICIPAL	IN	9	0.999399
FWA	FORT WAYNE INTL	IN	9	0.999424
SER	FREEMAN MUNICIPAL	IN	9	0.999427
IND	INDIANAPOLIS INTL	IN	9	0.999410
MZZ	MARION MUNICIPAL	IN	9	0.999417
CEV	METTEL FIELD	IN	9	0.999437
BMG	MONROE COUNTY	IN	9	0.999409
LAF	PURDUE UNIVERSITY	IN	9	0.999402
GEZ	SHELBYVILLE MUNICIPAL	IN	9	0.999423
SBN	SOUTH BEND RGNL	IN	9	0.999399
ANQ	TRI-STATE STEUBEN COUNTY	IN	9	0.999419
PTS	ATKINSON MUNICIPAL	KS	10	0.999350
AAO	COLONEL JAMES JABARA	KS	10	0.999354
DDC	DODGE CITY RGNL	KS	10	0.999389
FOE	FORBES FIELD	KS	10	0.999353
HYS	HAYS RGNL	KS	10	0.999357
OJC	JOHNSON COUNTY EXECUTIVE	KS	10	0.999350

LWC	LAWRENCE MUNICIPAL	KS	10	0.999354
MHK	MANHATTAN RGNL	KS	10	0.999359
IXD	NEW CENTURY AIRCENTER	KS	10	0.999350
EWK	NEWTON-CITY-COUNTY	KS	10	0.999355
OEL	OAKLEY MUNICIPAL	KS	10	0.999352
TOP	PHILIP BILLARD MUNICIPAL	KS	10	0.999353
GLD	RENNER FLD /GOODLAND MUNICIPAL	KS	9	0.999408
SLN	SALINA MUNICIPAL	KS	10	0.999360
TQK	SCOTT CITY MUNICIPAL	KS	10	0.999387
CBK	SHALZ FIELD	KS	9	0.999408
WLD	STROTHER FIELD	KS	10	0.999350
ULS	ULYSSES	KS	10	0.999386
ICT	WICHITA MID-CONTINENT	KS	10	0.999356
EKX	ADDINGTON FIELD	KY	9	0.999438
PAH	BARKLEY RGNL	KY	34	0.995469
K22	BIG SANDY RGNL	KY	8	0.999456
LEX	BLUE GRASS	KY	8	0.999454
LOU	BOWMAN FIELD	KY	8	0.999455
CVG	CINCINNATI/NORTHERN KENTUCKY	KY	8	0.999454
LOZ	LONDON-CORBIN ARPT-MAGEE FIELD	KY	8	0.999454
SDF	LOUISVILLE INTL-STANDIFORD FIELD	KY	8	0.999455
OWB	OWENSBORO-DAVIESS COUNTY	KY	11	0.999370
W38	WILLIAMSBURG-WHITLEY COUNTY	KY	8	0.999454
ARA	ACADIANA RGNL	LA	52	0.994479
AEX	ALEXANDRIA INTL	LA	54	0.995834
BTR	BATON ROUGE METROPOLITAN` RYAN	LA	51	0.995665
DRI	BEAUREGARD RGNL	LA	53	0.994497
CWF	CHENNAULT INTL	LA	54	0.993948
ESF	ESLER RGNL	LA	54	0.996124
PTN	HARRY P WILLIAMS MEMORIAL	LA	53	0.994583
LFT	LAFAYETTE RGNL	LA	52	0.994577
LCH	LAKE CHARLES RGNL	LA	55	0.993813
NEW	LAKEFRONT	LA	53	0.996395
MSY	LOUIS ARMSTRONG NEW ORLEANS IN	LA	54	0.996069
DTN	SHREVEPORT DOWNTOWN	LA	11	0.999255
SHV	SHREVEPORT RGNL	LA	11	0.999253
TVR	VICKSBURG TALLULAH RGNL	LA	37	0.997299
HYA	BARNSTABLE MUNICIPAL-BOARDMAN/POLAN	MA	275	0.966912
BOS	GENERAL EDWARD LAWRENCE LOGAN	MA	268	0.968089
BED	LAURENCE G HANSCOM FIELD	MA	258	0.970795
MVY	MARTHAS VINEYARD	MA	223	0.976248
OWD	NORWOOD MEMORIAL	MA	253	0.972179
PVC	PROVINCETOWN MUNICIPAL	MA	293	0.960529
ORH	WORCESTER RGNL	MA	229	0.978923
BWI	BALTIMORE/WASHINGTON INTL	MD	16	0.999221
DMW	CARROLL COUNTY RGNL/JACK B POA	MD	13	0.999317
FDK	FREDERICK MUNICIPAL	MD	15	0.999257
GAI	MONTGOMERY COUNTY AIRPARK	MD	17	0.999194
2W6	ST. MARY'S COUNTY RGNL	MD	21	0.999016
LEW	AUBURN/LEWISTON MUNICIPAL	ME	316	0.943183
AUG	AUGUSTA STATE	ME	347	0.932517
BHB	HANCOCK COUNTY-BAR HARBOR	ME	640	0.867114
PQI	NORTHERN MAINE RGNL ARPT AT PR	ME	930	0.684495

PWM	PORTLAND INTL JETPORT	ME	307	0.947192
ARB	ANN ARBOR MUNICIPAL	MI	9	0.999436
ACB	ANTRIM COUNTY	MI	22	0.999097
FNT	BISHOP INTL	MI	9	0.999437
CIU	CHIPPEWA COUNTY INTL	MI	32	0.997638
DTW	DETROIT METROPOLITAN WAYNE COUNTY	MI	9	0.999440
GRR	GERALD R. FORD INTL	MI	9	0.999402
CMX	HOUGHTON COUNTY MEMORIAL	MI	38	0.994346
ADG	LENAWEE COUNTY	MI	8	0.999455
OZW	LIVINGSTON COUNTY SPENCER J. H	MI	9	0.999430
MBS	MBS INTL	MI	8	0.999453
MKG	MUSKEGON COUNTY	MI	9	0.999412
HYX	SAGINAW COUNTY H.W. BROWNE	MI	8	0.999453
BIV	TULIP CITY	MI	9	0.999426
YIP	WILLOW RUN	MI	9	0.999438
ANE	ANOKA COUNTY-BLAINE ARPT	MN	30	0.997585
BDE	BAUDETTE INTL	MN	65	0.993558
BRD	BRAINERD LAKES RGNL	MN	37	0.995959
AXN	CHANDLER FIELD	MN	30	0.996836
HIB	CHISHOLM-HIBBING	MN	53	0.994969
DLH	DULUTH INTL	MN	46	0.995176
MSP	MINNEAPOLIS-ST PAUL INTL	MN	29	0.998320
RGK	RED WING RGNL	MN	13	0.999305
RST	ROCHESTER INTL	MN	10	0.999372
STC	ST CLOUD RGNL	MN	30	0.996769
JYG	ST JAMES MUNICIPAL	MN	11	0.999333
STP	ST PAUL DOWNTOWN HOLMAN FIELD	MN	29	0.997993
BDH	WILLMAR MUNICIPAL	MN	26	0.998436
CGI	CAPE GIRARDEAU RGNL	MO	34	0.997212
MKC	CHARLES B. WHEELER DOWNTOWN	MO	10	0.999357
GPH	CLAY COUNTY RGNL	MO	10	0.999357
COU	COLUMBIA RGNL	MO	9	0.999416
LBO	FLOYD W. JONES LEBANON	MO	9	0.999415
HIG	HIGGINSVILLE INDUSTRIAL MUNICIPAL	MO	16	0.999286
VER	JESSE VIERTEL MEMORIAL	MO	10	0.999406
JLN	JOPLIN RGNL	MO	10	0.999350
MCI	KANSAS CITY INTL	MO	10	0.999357
TKX	KENNETT MEMORIAL	MO	34	0.997126
IRK	KIRKSVILLE RGNL	MO	10	0.999402
STL	LAMBERT-ST LOUIS INTL	MO	9	0.999408
AIZ	LEE C FINE MEMORIAL	MO	9	0.999423
6M6	LEWIS COUNTY RGNL	MO	9	0.999409
MYJ	MEXICO MEMORIAL	MO	9	0.999409
M58	MONETT MUNICIPAL	MO	10	0.999350
EOS	NEOSHO HUGH ROBINSON	MO	10	0.999350
STJ	ROSECRANS MEMORIAL	MO	10	0.999359
DMO	SEDALIA MEMORIAL	MO	13	0.999342
SIK	SIKESTON MEMORIAL MUNICIPAL	MO	34	0.996824
9K4	SKYHAVEN	MO	10	0.999398
SGF	SPRINGFIELD-BRANSON NATIONAL	MO	10	0.999350
TBN	WAYNESVILLE RGNL ARPT AT FORNE	MO	9	0.999416
UNO	WEST PLAINS MUNICIPAL	MO	9	0.999408
GTR	GOLDEN TRIANGLE RGNL	MS	34	0.998534

GWO	GREENWOOD-LEFLORE	MS	35	0.996887
GNF	GRENADA MUNICIPAL	MS	35	0.996948
GPT	GULFPORT-BILOXI INTL	MS	31	0.998378
HBG	HATTIESBURG BOBBY L CHAIN MUNICIPAL	MS	29	0.998133
PIB	HATTIESBURG-LAUREL RGNL	MS	29	0.998060
JAN	JACKSON-EVERS INTL	MS	35	0.997516
MEI	KEY FIELD	MS	28	0.998424
OLV	OLIVE BRANCH	MS	34	0.996388
CRX	ROSCOE TURNER	MS	34	0.997208
UTA	TUNICA MUNICIPAL	MS	35	0.996324
UOX	UNIVERSITY-OXFORD	MS	34	0.996983
BTM	BERT MOONEY	MT	9	0.999479
BIL	BILLINGS LOGAN INTL	MT	9	0.999463
MLS	FRANK WILEY FIELD	MT	10	0.999428
GPI	GLACIER PARK INTL	MT	9	0.999480
HLN	HELENA RGNL	MT	9	0.999474
LWT	LEWISTOWN MUNICIPAL	MT	9	0.999471
HBI	ASHEBORO RGNL	NC	10	0.999391
AVL	ASHEVILLE RGNL	NC	8	0.999456
CLT	CHARLOTTE/DOUGLAS INTL	NC	8	0.999456
JQF	CONCORD RGNL	NC	8	0.999453
EWN	CRAVEN COUNTY RGNL	NC	34	0.997048
ECG	ELIZABETH CITY CG AIR STATION	NC	35	0.997880
FAY	FAYETTEVILLE RGNL/GRANNIS FIELD	NC	31	0.998650
LHZ	FRANKLIN COUNTY	NC	34	0.997966
AKH	GASTONIA MUNICIPAL	NC	8	0.999458
GWW	GOLDSBORO-WAYNE MUNICIPAL	NC	34	0.997606
ISO	KINSTON RGNL JETPORT	NC	34	0.997287
EQY	MONROE RGNL	NC	8	0.999453
EDE	NORTHEASTERN RGNL	NC	34	0.997681
GSO	PIEDMONT TRIAD INTL	NC	10	0.999391
PGV	PITT-GREENVILLE	NC	34	0.997273
RDU	RALEIGH-DURHAM INTL	NC	32	0.998492
RWI	ROCKY MOUNT-WILSON RGNL	NC	34	0.997565
RUQ	ROWAN COUNTY	NC	8	0.999453
TTA	SANFORD-LEE COUNTY RGNL	NC	25	0.998885
SVH	STATESVILLE RGNL	NC	8	0.999458
ILM	WILMINGTON INTL	NC	34	0.997630
BIS	BISMARCK MUNICIPAL	ND	25	0.998630
DIK	DICKINSON - THEODORE ROOSEVELT	ND	10	0.999388
GFK	GRAND FORKS INTL	ND	45	0.995515
FAR	HECTOR INTL	ND	31	0.995990
MOT	MINOT INTL	ND	31	0.996612
ANW	AINSWORTH MUNICIPAL	NE	11	0.999326
AIA	ALLIANCE MUNICIPAL	NE	9	0.999406
BIE	BEATRICE MUNICIPAL	NE	10	0.999359
FNB	BRENNER FIELD	NE	10	0.999367
HDE	BREWSTER FIELD	NE	10	0.999354
GRI	CENTRAL NEBRASKA RGNL	NE	10	0.999360
CDR	CHADRON MUNICIPAL	NE	9	0.999405
OLU	COLUMBUS MUNICIPAL	NE	11	0.999341
OMA	EPPLEY AIRFIELD	NE	11	0.999353
FET	FREMONT MUNICIPAL	NE	11	0.999346

HSI	HASTINGS MUNICIPAL	NE	10	0.999366
LXN	JIM KELLY FIELD	NE	10	0.999357
OFK	KARL STEFAN MEMORIAL	NE	11	0.999339
EAR	KEARNEY RGNL	NE	10	0.999369
IBM	KIMBALL MUNICIPAL/ROBERT E ARRAJ FIIELD	NE	10	0.999390
LNK	LINCOLN	NE	10	0.999359
MCK	MC COOK RGNL	NE	10	0.999351
MLE	MILLARD	NE	10	0.999368
VTN	MILLER FIELD	NE	11	0.999318
LBF	NORTH PLATTE RGNL AIRPORT LEE	NE	10	0.999357
PMV	PLATTSMOUTH MUNICIPAL	NE	10	0.999368
SCB	SCRIBNER STATE	NE	11	0.999344
OGA	SEARLE FIELD	NE	9	0.999406
SNY	SIDNEY MUNICIPAL/LLOYD W. CARR FIELD	NE	9	0.999408
ONL	THE O'NEILL MUNICIPAL-JOHN L BAKER	NE	11	0.999334
LCG	WAYNE MUNICIPAL	NE	11	0.999333
BFF	WESTERN NEB. RGNL/WILLIAM B. H	NE	10	0.999377
JYR	YORK MUNICIPAL	NE	10	0.999360
ASH	BOIRE FIELD	NH	253	0.970781
CON	CONCORD MUNICIPAL	NH	267	0.968228
PSM	PORTSMOUTH INTL AT PEASE	NH	287	0.961073
ACY	ATLANTIC CITY INTL	NJ	17	0.999068
WWD	CAPE MAY COUNTY	NJ	17	0.999191
MIV	MILLVILLE MUNICIPAL	NJ	17	0.999186
EWR	NEWARK LIBERTY INTL	NJ	33	0.998622
ABQ	ALBUQUERQUE INTL SUNPORT	NM	9	0.999392
CVN	CLOVIS MUNICIPAL	NM	9	0.999396
AEG	DOUBLE EAGLE II	NM	9	0.999392
FMN	FOUR CORNERS RGNL	NM	10	0.999420
SVC	GRANT COUNTY	NM	30	0.997277
LRU	LAS CRUCES INTL	NM	30	0.998099
ROW	ROSWELL INTL AIR CENTER	NM	9	0.999371
LAS	MC CARRAN INTL	NV	9	0.999412
4SD	RENO/STEAD	NV	11	0.999423
WMC	WINNEMUCCA MUNCIPALI	NV	9	0.999491
9G3	AKRON	NY	29	0.998839
ALB	ALBANY INTL	NY	106	0.991901
HWV	BROOKHAVEN	NY	73	0.996493
BUF	BUFFALO NIAGARA INTL	NY	23	0.998999
OLE	CATTARAUGUS COUNTY-OLEAN	NY	19	0.999139
JHW	CHAUTAUQUA COUNTY/JAMESTOWN	NY	10	0.999390
ELM	ELMIRA/CORNING RGNL	NY	30	0.998705
FOK	FRANCIS S GABRESKI	NY	83	0.995841
BGM	GREATER BINGHAMTON/EDWIN A LIN	NY	48	0.998018
ROC	GREATER ROCHESTER INTL	NY	46	0.998122
JFK	JOHN F KENNEDY INTL	NY	42	0.998207
LGA	LA GUARDIA	NY	49	0.998050
MSS	MASSENA INTL-RICHARDS FIELD	NY	187	0.982345
PBG	PLATTSBURGH INTL	NY	259	0.968095
SWF	STEWART INTL	NY	83	0.996699
SYR	SYRACUSE HANCOCK INTL	NY	79	0.996312
ELZ	WELLSVILLE MUNICIPAL ARPT TARANTINE	NY	20	0.999101
HPN	WESTCHESTER COUNTY	NY	65	0.997310

CXY	CAPITAL CITY	OH	10	0.999390
LUK	CINCINNATI MUNICIPAL AIRPORT LUNKEN	OH	8	0.999454
CLE	CLEVELAND-HOPKINS INTL	OH	8	0.999455
MGY	DAYTON-WRIGHT BROTHERS	OH	8	0.999454
FDY	FINDLAY	OH	8	0.999454
I19	GREENE COUNTY-LEWIS A. JACKSON	OH	8	0.999454
DAY	JAMES M COX DAYTON INTL	OH	8	0.999454
1G3	KENT STATE UNIV	OH	8	0.999454
I68	LEBANON-WARREN COUNTY	OH	8	0.999454
OSU	OHIO STATE UNIVERSITY	OH	8	0.999457
UNI	OHIO UNIVERSITY SNYDER FIELD	OH	8	0.999456
CMH	PORT COLUMBUS INTL	OH	8	0.999457
RZT	ROSS COUNTY	OH	8	0.999456
TOL	TOLEDO EXPRESS	OH	8	0.999454
1G0	WOOD COUNTY	OH	8	0.999448
AVK	ALVA RGNL	OK	10	0.999403
CQB	CHANDLER RGNL	OK	11	0.999328
CHK	CHICKASHA MUNICIPAL	OK	9	0.999389
GCM	CLAREMORE RGNL	OK	10	0.999348
F29	CLARENCE E PAGE MUNICIPAL	OK	9	0.999389
1K4	DAVID JAY PERRY	OK	9	0.999388
MKO	DAVIS FIELD	OK	10	0.999341
DUA	EAKER FIELD	OK	10	0.999353
2O8	HINTON MUNICIPAL	OK	9	0.999396
HBR	HOBART MUNICIPAL	OK	10	0.999380
MLC	MC ALESTER RGNL	OK	10	0.999318
MIO	MIAMI MUNICIPAL	OK	10	0.999350
MDF	MOORELAND MUNICIPAL	OK	10	0.999405
OKM	OKMULGEE RGNL	OK	10	0.999343
PVJ	PAULS VALLEY MUNICIPAL	OK	10	0.999370
PNC	PONCA CITY RGNL	OK	10	0.999358
RVS	RICHARD LLOYD JONES JR	OK	10	0.999349
2K4	SCOTT FIELD	OK	10	0.999365
SNL	SHAWNEE RGNL	OK	11	0.999308
SWO	STILLWATER RGNL	OK	10	0.999357
TQH	TAHLEQUAH MUNICIPAL	OK	10	0.999348
TUL	TULSA INTL	OK	10	0.999349
OKC	WILL ROGERS WORLD	OK	9	0.999388
UAO	AURORA STATE	OR	12	0.999219
LMT	KLAMATH FALLS	OR	11	0.999384
LGD	LA GRANDE/UNION COUNTY	OR	9	0.999491
EUG	MAHLON SWEET FIELD	OR	11	0.999302
SLE	MCNARY FIELD	OR	12	0.999237
ONP	NEWPORT MUNICIPAL	OR	12	0.999270
PDX	PORTLAND INTL	OR	12	0.999292
AGC	ALLEGHENY COUNTY	PA	8	0.999449
AOO	ALTOONA-BLAIR COUNTY	PA	10	0.999374
BFD	BRADFORD RGNL	PA	14	0.999263
BTP	BUTLER COUNTY/K W SCHOLTER FIELD	PA	8	0.999449
9D4	DECK	PA	11	0.999339
HZL	HAZLETON MUNICIPAL	PA	15	0.999202
JST	JOHN MURTHA JOHNSTOWN-CAMBRIA	PA	10	0.999376
LNS	LANCASTER	PA	11	0.999344

ABE	LEHIGH VALLEY INTL	PA	16	0.999182
PNE	NORTHEAST PHILADELPHIA	PA	14	0.999252
PHL	PHILADELPHIA INTL	PA	15	0.999238
PIT	PITTSBURGH INTL	PA	8	0.999451
FWQ	ROSTRAVER	PA	9	0.999432
OYM	ST MARYS MUNICIPAL	PA	13	0.999317
UNV	UNIVERSITY PARK	PA	10	0.999388
FKL	VENANGO RGNL	PA	8	0.999448
BID	BLOCK ISLAND STATE	RI	162	0.987454
PVD	THEODORE FRANCIS GREEN STATE	RI	210	0.980760
AIK	AIKEN MUNICIPAL	SC	8	0.999468
AND	ANDERSON RGNL	SC	8	0.999472
CHS	CHARLESTON AFB/INTL	SC	10	0.999415
JZI	CHARLESTON EXECUTIVE	SC	10	0.999408
CAE	COLUMBIA METROPOLITAN	SC	8	0.999470
GYH	DONALDSON CENTER	SC	8	0.999457
GSP	GREENVILLE SPARTANBURG INTL	SC	8	0.999457
MYR	MYRTLE BEACH INTL	SC	19	0.999128
ABR	ABERDEEN RGNL	SD	10	0.999356
BKX	BROOKINGS RGNL	SD	11	0.999306
YKN	CHAN GURNEY MUNICIPAL	SD	11	0.999322
HON	HURON RGNL	SD	11	0.999291
FSD	JOE FOSS FIELD	SD	11	0.999316
MHE	MITCHELL MUNICIPAL	SD	11	0.999302
PIR	PIERRE RGNL	SD	10	0.999368
RAP	RAPID CITY RGNL	SD	10	0.999386
PVE	BEECH RIVER RGNL	TN	34	0.996915
UCY	EVERETT-STEWART	TN	34	0.995912
CHA	LOVELL FIELD	TN	9	0.999392
TYS	MC GHEE TYSON	TN	8	0.999454
MEM	MEMPHIS INTL	TN	34	0.996250
NQA	MILLINGTON RGNL JETPORT	TN	34	0.996156
BNA	NASHVILLE INTL	TN	33	0.997531
TRI	TRI-CITIES RGNL TN/VA	TN	8	0.999456
ABI	ABILENE RGNL	TX	11	0.999242
ADS	ADDISON	TX	10	0.999318
ALI	ALICE INTL	TX	149	0.974261
LFK	ANGELINA COUNTY	TX	29	0.997670
GKY	ARLINGTON MUNICIPAL	TX	11	0.999302
AUS	AUSTIN-BERGSTROM INTL	TX	31	0.997585
LBX	BRAZORIA COUNTY	TX	104	0.990144
BWD	BROWNWOOD RGNL	TX	11	0.999296
E30	BRUCE FIELD	TX	11	0.999177
TKI	COLLIN COUNTY RGNL AT MC KINNE	TX	10	0.999310
CRP	CORPUS CHRISTI INTL	TX	179	0.974380
PRX	COX FIELD	TX	10	0.999276
RBD	DALLAS EXECUTIVE	TX	10	0.999318
DAL	DALLAS LOVE FIELD	TX	10	0.999318
DFW	DALLAS/FORT WORTH INTL	TX	10	0.999321
DWH	DAVID WAYNE HOOKS MEMORIAL	TX	33	0.996335
DRT	DEL RIO INTL	TX	90	0.990892
TPL	DRAUGHON-MILLER CENTRAL TEXAS	TX	11	0.999191
CLL	EASTERWOOD FIELD	TX	30	0.997347

EBG	EDINBURG INTL	TX	555	0.908143
ELP	EL PASO INTL	TX	31	0.998134
AFW	FORT WORTH ALLIANCE	TX	10	0.999327
FWS	FORT WORTH SPINKS	TX	11	0.999265
IAH	GEORGE BUSH INTERCONTINENTAL	TX	46	0.995933
PVW	HALE COUNTY	TX	10	0.999375
AXH	HOUSTON-SOUTHWEST	TX	73	0.993772
ERV	KERRVILLE MUNI/LOUIS SCHREINER	TX	45	0.997555
LNC	LANCASTER	TX	10	0.999316
LRD	LAREDO INTL	TX	233	0.966183
CXO	LONE STAR EXECUTIVE	TX	30	0.996579
LBB	LUBBOCK PRESTON SMITH INTL	TX	10	0.999358
GVT	MAJORS	TX	10	0.999306
MFE	MC ALLEN MILLER INTL	TX	575	0.888527
HQZ	MESQUITE METRO	TX	10	0.999309
MAF	MIDLAND INTL	TX	10	0.999297
OSA	MOUNT PLEASANT RGNL	TX	17	0.999146
RAS	MUSTANG BEACH	TX	228	0.972595
BAZ	NEW BRAUNFELS MUNICIPAL	TX	49	0.994029
AMA	RICK HUSBAND AMARILLO INTL	TX	10	0.999384
GRK	ROBERT GRAY AAF	TX	11	0.999235
SJT	SAN ANGELO RGNL/MATHIS FIELD	TX	11	0.999210
SAT	SAN ANTONIO INTL	TX	72	0.992046
HYI	SAN MARCOS MUNICIPAL	TX	43	0.996725
GLS	SCHOLES INTL AT GALVESTON	TX	90	0.990548
SPS	SHEPPARD AFB/WICHITA FALLS MUNICIPAL	TX	9	0.999387
SGR	SUGAR LAND RGNL	TX	64	0.995127
T43	T P MC CAMPBELL	TX	198	0.975156
TRL	TERRELL MUNICIPAL	TX	10	0.999306
TYR	TYLER POUNDS RGNL	TX	18	0.999128
HRL	VALLEY INTL	TX	556	0.896706
IWS	WEST HOUSTON	TX	43	0.995941
HOU	WILLIAM P HOBBY	TX	70	0.994189
CDC	CEDAR CITY RGNL	UT	9	0.999489
KNB	KANAB MUNICIPAL	UT	9	0.999417
LGU	LOGAN-CACHE	UT	9	0.999494
OGD	OGDEN-HINCKLEY	UT	8	0.999510
PVU	PROVO MUNICIPAL	UT	8	0.999510
SLC	SALT LAKE CITY INTL	UT	8	0.999510
SGU	ST GEORGE MUNICIPAL	UT	9	0.999475
MTV	BLUE RIDGE	VA	10	0.999395
CHO	CHARLOTTESVILLE-ALBEMARLE	VA	30	0.998548
FCI	CHESTERFIELD COUNTY	VA	34	0.998208
JYO	LEESBURG EXECUTIVE	VA	19	0.999132
LNP	LONESOME PINE	VA	8	0.999456
HEF	MANASSAS RGNL	VA	21	0.999031
MKJ	MOUNTAIN EMPIRE	VA	8	0.999455
PSK	NEW RIVER VALLEY	VA	8	0.999451
PHF	NEWPORT NEWS/WILLIAMSBURG INTL	VA	34	0.998316
ORF	NORFOLK INTL	VA	35	0.998220
RIC	RICHMOND INTL	VA	34	0.998307
RMN	STAFFORD RGNL	VA	24	0.998887
BCB	VIRGINIATECH/MONTGOMERY EXECUTIVE	VA	9	0.999432

IAD	WASHINGTON DULLES INTL	VA	19	0.999109
BTV	BURLINGTON INTL	VT	261	0.968165
FSO	FRANKLIN COUNTY STATE	VT	279	0.957134
BLI	BELLINGHAM INTL	WA	15	0.999173
FHR	FRIDAY HARBOR	WA	14	0.999163
MWH	GRANT CO INTL	WA	9	0.999492
OLM	OLYMPIA	WA	14	0.999259
PUW	PULLMAN/MOSCOW RGNL	WA	9	0.999495
RLD	RICHLAND	WA	9	0.999482
SEA	SEATTLE-TACOMA INTL	WA	11	0.999339
BVS	SKAGIT RGNL	WA	14	0.999243
PAE	SNOHOMISH COUNTY (PAINE FLD)	WA	14	0.999266
GEG	SPOKANE INTL	WA	9	0.999495
ALW	WALLA WALLA RGNL	WA	9	0.999486
GRB	AUSTIN STRAUBEL INTL	WI	25	0.998970
CWA	CENTRAL WISCONSIN	WI	28	0.998298
MSN	DANE COUNTY RGNL-TRUAX FIELD	WI	9	0.999429
EGV	EAGLE RIVER UNION	WI	32	0.997067
FLD	FOND DU LAC COUNTY	WI	9	0.999406
MKE	GENERAL MITCHELL INTL	WI	9	0.999438
MTW	MANITOWOC COUNTY	WI	9	0.999401
MFI	MARSHFIELD MUNICIPAL	WI	25	0.998852
ATW	OUTAGAMIE COUNTY RGNL	WI	9	0.999401
RHI	RHINELANDER-ONEIDA COUNTY	WI	32	0.997203
RPD	RICE LAKE RGNL - CARL'S FIELD	WI	33	0.996889
HYR	SAWYER COUNTY	WI	35	0.996358
SBM	SHEBOYGAN COUNTY MEMORIAL	WI	9	0.999406
JVL	SOUTHERN WISCONSIN RGNL	WI	9	0.999402
OSH	WITTMAN RGNL	WI	9	0.999401
PKB	MID-OHIO VALLEY RGNL	WV	8	0.999453
HTS	TRI-STATE/MILTON J. FERGUSON F	WV	8	0.999456
CYS	CHEYENNE RGNL/JERRY OLSON FIELD	WY	10	0.999389
EVW	EVANSTON-UINTA COUNTY BURNS FIELD	WY	8	0.999497
GCC	GILLETTE-CAMPBELL COUNTY	WY	10	0.999425
JAC	JACKSON HOLE	WY	9	0.999472
LAR	LARAMIE RGNL	WY	10	0.999400
CPR	NATRONA COUNTY INTL	WY	9	0.999451
RIW	RIVERTON RGNL	WY	8	0.999486
RKS	ROCK SPRINGS-SWEETWATER COUNTY	WY	8	0.999494
SHR	SHERIDAN COUNTY	WY	9	0.999456
COD	YELLOWSTONE RGNL	WY	8	0.999486

Figure 9-1 WAAS LPV Availability

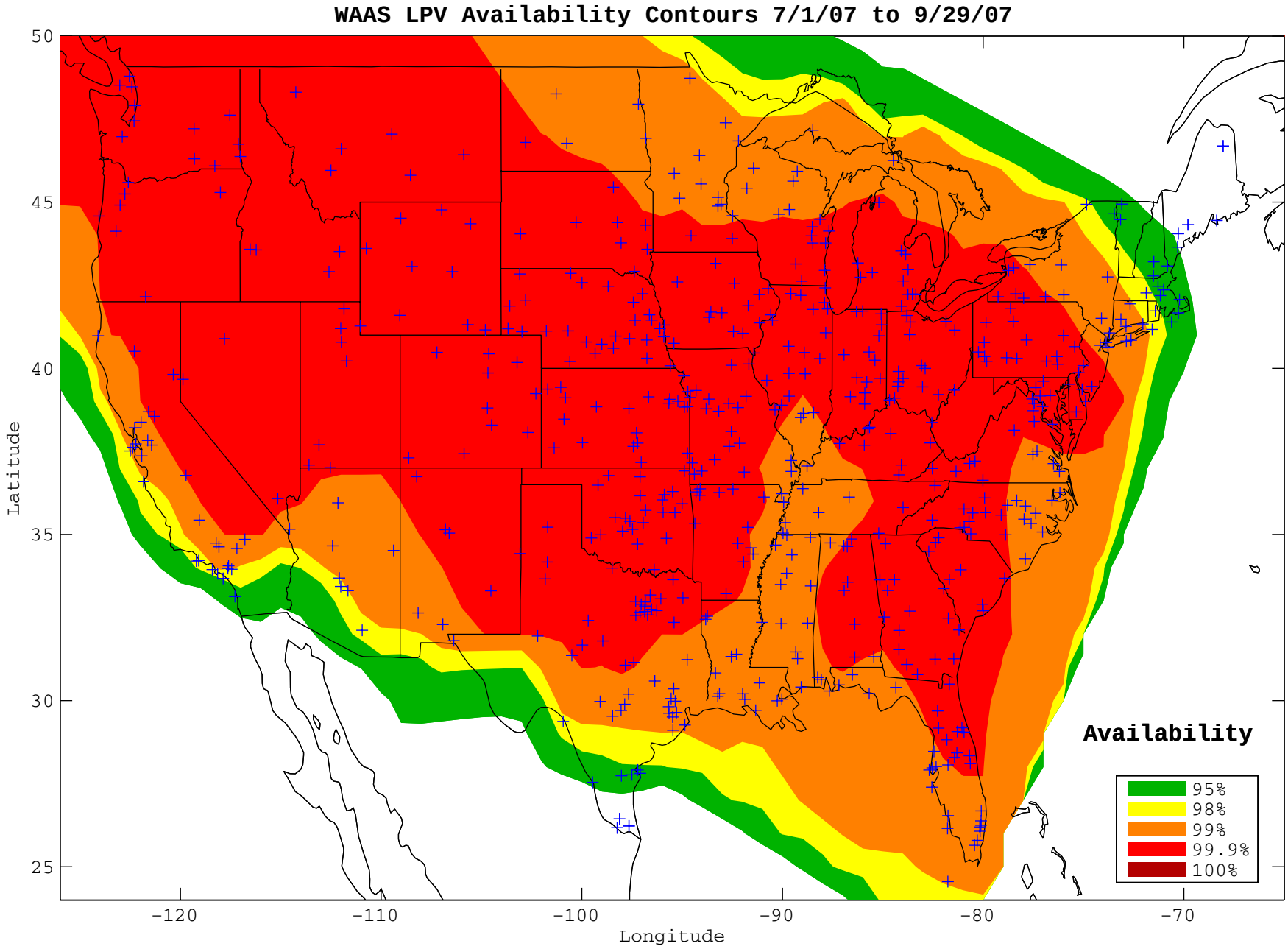
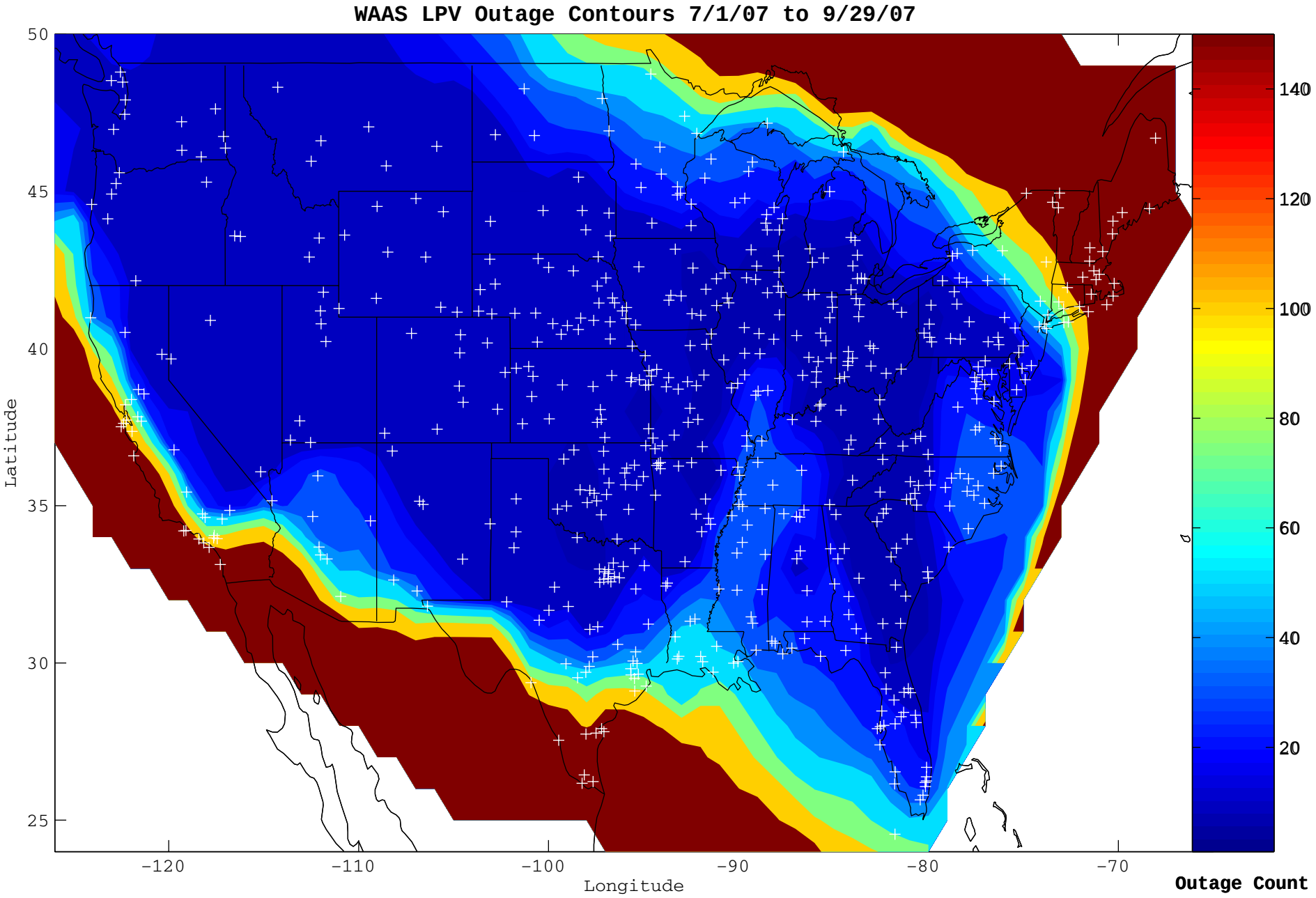


Figure 9-2 WAAS LPV Outage



10.0 WAAS DETERMINISTIC CODE NOISE AND MULTIPATH BOUNDING ANALYSIS

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

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

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

Table 10-1 CNMP Bounding Statistics

WAAS Site	WRE	Oct 06	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07	Sep 07
Albuquerque	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Anchorage	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Atlanta	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Billings	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Boston	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Chicago	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Cleveland	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Cold Bay	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Dallas	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Denver	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Honolulu	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Houston	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Jacksonville	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●

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

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

WAAS Site	WRE	Oct 06	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07	Sep 07
Juneau	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Kansas City	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Los Angeles	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Memphis	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Miami	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Minneapolis	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
New York	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Oakland	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Salt Lake City	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
San Juan	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Seattle	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Washington, DC	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●
Juneau	A	●	●	●	●	●	●	●	●	●	●	●	●
	B	●	●	●	●	●	●	●	●	●	●	●	●
	C	●	●	●	●	●	●	●	●	●	●	●	●

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

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

Appendix A: Glossary

General Terms and Definitions

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

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

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

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

CONUS. Continental United States.

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

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

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

DR. Discrepancy Report

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

GEO. Geostationary Satellite.

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

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

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

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

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

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

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

LNAV. Lateral Navigation.

MOPS. Minimum Operational Performance Standards.

Navigation Message. Message structure designed to carry navigation data.

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

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

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

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

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

SV. Satellite Vehicle.

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

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

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

VNAV. Vertical Navigation.

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