



# Future Monitoring Systems



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# *Part 1: Future Monitoring Options*



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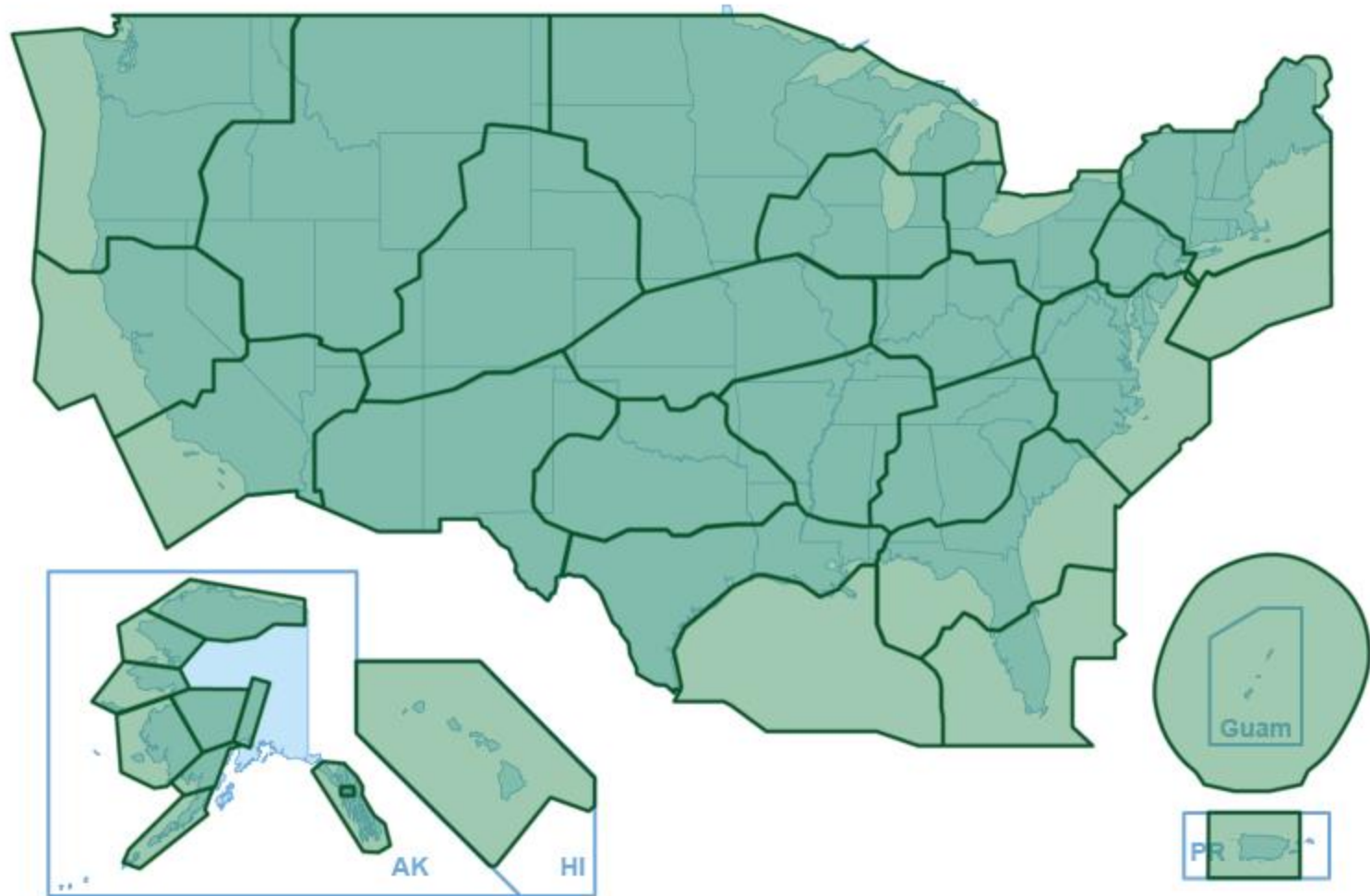
# Contents

- ☐ ADS-B Service Volume and Stations
- ☐ USA Coverage Map
- ☐ Raw Data
- ☐ ASE Processing Interface
  - ☐ ADS-B Extract
  - ☐ ASE Processing
- ☐ Quality Control
- ☐ Data Processed

# Service Volume and Stations

•	Service Volume	Station	•	Service Volume	Station
•	0	Boston Washington New York	•	7	Albuquerque Fort Worth Huston Golf of Mexico
•	1	Memphis Atlanta	•	10	Denver Salt Lake City Seattle
•	2	Jacksonville Miami San Juan	•	11	Los Angeles Oakland
•	5	Indianapolis Cleveland	•	15	Alaska Juneau
•	6	Chicago Kansas City Minneapolis	•	16	Honolulu
			•	17	Guam

# USA Coverage Map

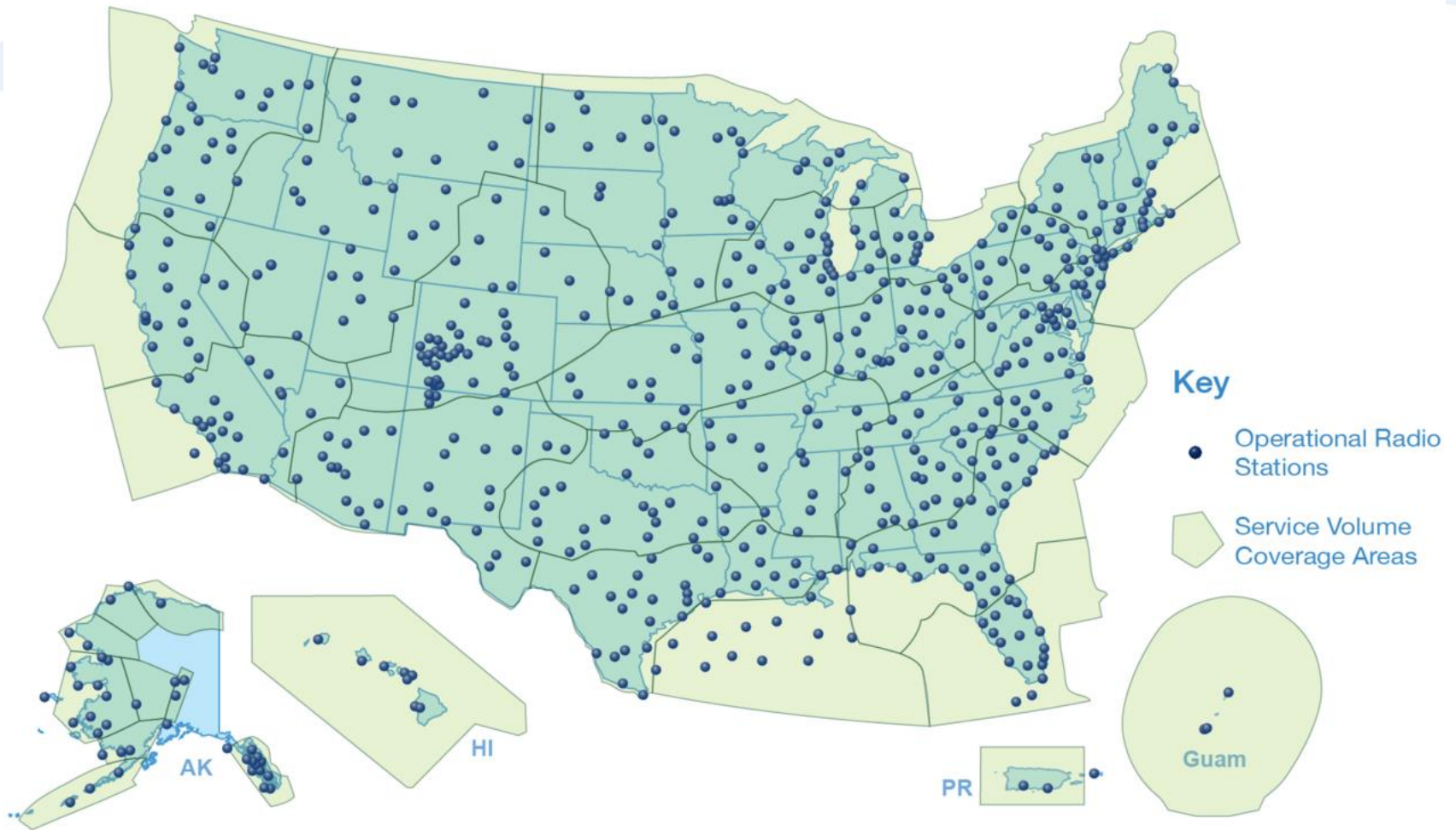


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# USA Operational Radio Stations



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# Raw Data

- ❑ Currently getting more than 1,000 individual Aircraft daily
- ❑ Around 1 GB of data
- ❑ Example of the Raw data

```
AA,6,3,N/A,82804335,82803935,A8F00E,1,2,7,0,invalid,n/a,0,40.74522257, -73.69804859,33000,GNSS,342.0,387.0,0,,  
AA,6,3,N/A,82804335,82803935,A8F00E,1,2,7,0,invalid,n/a,0,40.74522257, -73.69804859,33000,GNSS,342.0,387.0,0,,
```

- ❑ How the data look like after the first step of the ADS-B Processing

1	latitude	longitude	gps	modes	date	time	modes	sta	reg	NAC	link
2	(dec deg)	(dec deg)	hgt	alt		(Z)	addr	ATC			version
3		(ft) (ft)									
4	39.51264954,	-87.13537598,	28025,	28500,	2014-12-16,	17:59:53.578,	AD3353,	ZID,	N95LL,	10,	1090ES_260B
5	39.51237106,	-87.13707733,	28050,	28525,	2014-12-16,	17:59:54.460,	AD3353,	ZID,	N95LL,	10,	1090ES_260B
6	39.51173019,	-87.14044189,	28125,	28625,	2014-12-16,	17:59:56.390,	AD3353,	ZID,	N95LL,	10,	1090ES_260B
7	39.51173019,	-87.14044189,	28150,	28625,	2014-12-16,	17:59:56.390,	AD3353,	ZID,	N95LL,	10,	1090ES_260B
8	39.51140594,	-87.14235687,	28175,	28650,	2014-12-16,	17:59:57.367,	AD3353,	ZID,	N95LL,	10,	1090ES_260B

# ADS-B ASE Processing Interface

ADS-B ASE Processing Interface (Oracle)

Start Date: 11/11/2014 15  
Stop Date: 11/15/2014 15

Options Output

**ADS-B FTP Credentials:**  
Host: XXX.XXX.XXX.XXX  
Port: 22  
Username: XXXXX  
Password: XXXXX


**Filters:**  
Minimum NAC: 8  
Minimum Altit: 28500  
Maximum Altit: 41500  
☒ Overwrite Existing Files?

**ADS-B Versions:**  
☐ 1090 ES with DO-260A  
☒ 1090 ES with DO-260B  
☐ UAT with DO-260A  
☒ UAT with DO-260B  
☐ Other

**ASEP:**  
Directory: d:\aghme\

**Service Volum Station**

<input checked="" type="checkbox"/> 0	<input checked="" type="checkbox"/> ZBW - Boston <input checked="" type="checkbox"/> ZDC - Washington <input checked="" type="checkbox"/> ZNY - New York
<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> ZME - Memphis <input checked="" type="checkbox"/> ZTL - Atlanta
<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> ZJX - Jacksonville <input checked="" type="checkbox"/> ZMA - Miami <input checked="" type="checkbox"/> ZSU - San Juan
<input checked="" type="checkbox"/> 5	<input checked="" type="checkbox"/> ZID - Indianapolis <input checked="" type="checkbox"/> ZOB - Cleveland
<input checked="" type="checkbox"/> 6	<input checked="" type="checkbox"/> ZAU - Chicago <input checked="" type="checkbox"/> ZKC - Kansas City <input checked="" type="checkbox"/> ZMP - Minneapolis
<input checked="" type="checkbox"/> 7	<input checked="" type="checkbox"/> ZAB - Albuquerque <input checked="" type="checkbox"/> ZFW - Fort Worth <input checked="" type="checkbox"/> ZHU - Houston <input checked="" type="checkbox"/> GOF - Gulf of Mexico
<input checked="" type="checkbox"/> 10	<input checked="" type="checkbox"/> ZDV - Denver <input checked="" type="checkbox"/> ZLC - Salt Lake City <input checked="" type="checkbox"/> ZSE - Seattle
<input checked="" type="checkbox"/> 11	<input checked="" type="checkbox"/> ZLA - Los Angeles <input checked="" type="checkbox"/> ZOA - Oakland
<input checked="" type="checkbox"/> 15	<input checked="" type="checkbox"/> ZAN - Alaska <input checked="" type="checkbox"/> JNU - Juneau
<input checked="" type="checkbox"/> 16	<input checked="" type="checkbox"/> ZHN - Honolulu
<input checked="" type="checkbox"/> 17	<input checked="" type="checkbox"/> ZUA - Guam



ADSB Extract  
Process ADSB Data  
Upload Results  
ETMS Match

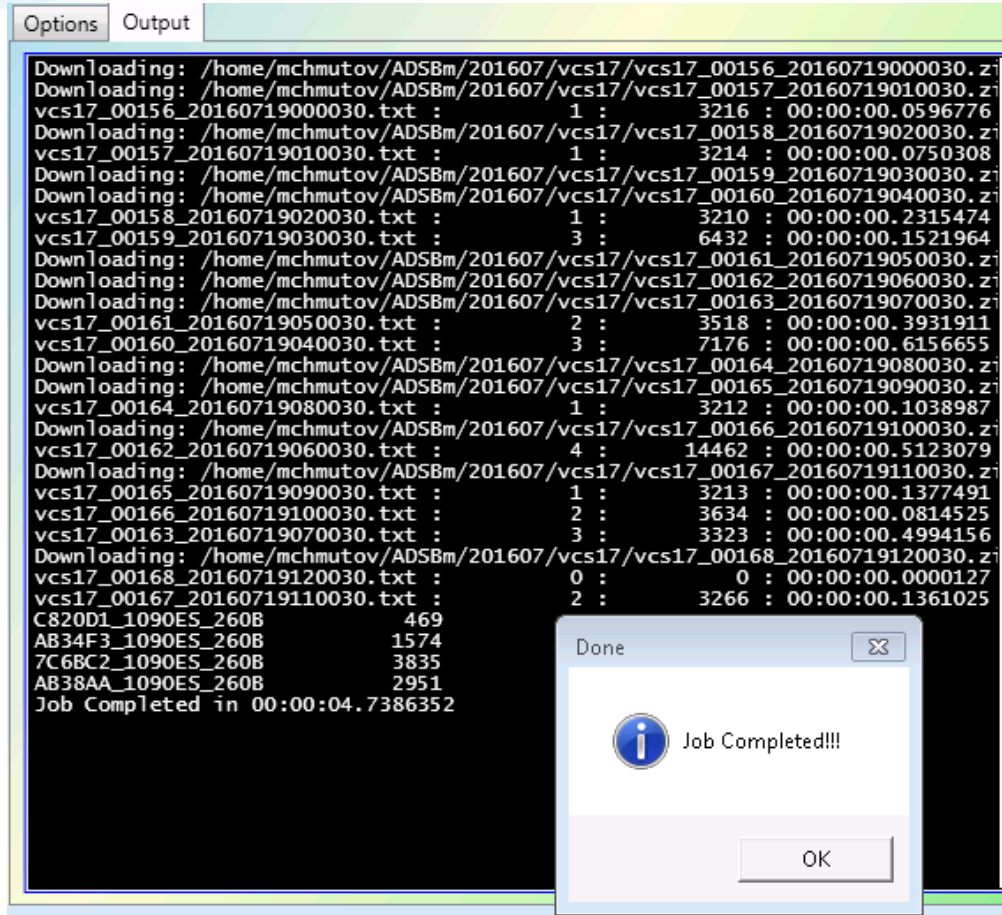


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# ADS-B Extract



The screenshot shows a software window titled 'Options' and 'Output'. The 'Output' tab is active, displaying a list of downloaded files. Each line represents a file download, showing the file path, file name, and a timestamp. The files are organized by date and time, with the most recent files at the top. A dialog box titled 'Done' is overlaid on the bottom right of the window, indicating that the job is completed. The dialog box contains an information icon and the text 'Job Completed!!!' with an 'OK' button.

```
Options Output
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00156_20160719000030.zi
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00157_20160719010030.zi
vcs17_00156_20160719000030.txt : 1 : 3216 : 00:00:00.0596776
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00158_20160719020030.zi
vcs17_00157_20160719010030.txt : 1 : 3214 : 00:00:00.0750308
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00159_20160719030030.zi
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00160_20160719040030.zi
vcs17_00158_20160719020030.txt : 1 : 3210 : 00:00:00.2315474
vcs17_00159_20160719030030.txt : 3 : 6432 : 00:00:00.1521964
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00161_20160719050030.zi
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00162_20160719060030.zi
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00163_20160719070030.zi
vcs17_00161_20160719050030.txt : 2 : 3518 : 00:00:00.3931911
vcs17_00160_20160719040030.txt : 3 : 7176 : 00:00:00.6156655
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00164_20160719080030.zi
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00165_20160719090030.zi
vcs17_00164_20160719080030.txt : 1 : 3212 : 00:00:00.1038987
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00166_20160719100030.zi
vcs17_00162_20160719060030.txt : 4 : 14462 : 00:00:00.5123079
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00167_20160719110030.zi
vcs17_00165_20160719090030.txt : 1 : 3213 : 00:00:00.1377491
vcs17_00166_20160719100030.txt : 2 : 3634 : 00:00:00.0814525
vcs17_00163_20160719070030.txt : 3 : 3323 : 00:00:00.4994156
Downloading: /home/mchmutov/ADSBm/201607/vcs17/vcs17_00168_20160719120030.zi
vcs17_00168_20160719120030.txt : 0 : 0 : 00:00:00.0000127
vcs17_00167_20160719110030.txt : 2 : 3266 : 00:00:00.1361025
C820D1_1090ES_260B 469
AB34F3_1090ES_260B 1574
7C6BC2_1090ES_260B 3835
AB38AA_1090ES_260B 2951
Job Completed in 00:00:04.7386352
```

Done

Job Completed!!!

OK

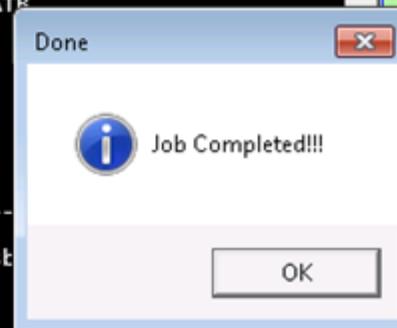


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# ASE Processing

```
AB34F3-ZUA-00001-23    -12.22    0.17    -12.39
D:\ADSB\20160719\AB38AA_1090ES_260B.adsb
American ADS-B ASE Processing System
Windows Based System
No Intermediate Output Files...
-----
Date      : 2016 - 7 - 19
Processing: D:\ADSB\20160719\AB38AA_1090ES_260B.adsb
Searching Start And Stop Times...
Estimating Flight Levels...
Estimating Straight Levels...
2016-07-19 ZUA      1  1 12088.00 13861.00   390 1460   19.23   15.35  145.0
2016-07-19 ZUA      1 14 24081.00 25044.00   370 790   15.82   17.91  144.9
2016-07-19 ZUA      1 15 25046.00 25496.00   370 78   17.92   18.88  145.0
Extracting Noaa Met Data from: noaa\2016\07191600.ATB
Extracting Noaa Met Data from: noaa\2016\07191612.ATB
Extracting Noaa Met Data from: noaa\2016\07201600.ATB
Applying Weckler-Ansley Regression...
AB38AA-ZUA-00001-01     77.59    -0.70    78.30
AB38AA-ZUA-00001-14     60.87    -0.89    61.76
AB38AA-ZUA-00001-15     50.13     0.00    50.13
D:\ADSB\20160719\C820D1_1090ES_260B.adsb
American ADS-B ASE Processing System
Windows Based System
No Intermediate Output Files...
-----
Date      : 2016 - 7 - 19
Processing: D:\ADSB\20160719\C820D1_1090ES_260B.adsb
Searching Start And Stop Times...
Estimating Flight Levels...
Estimating Straight Levels...
2016-07-19 ZUA      1  1 38958.00 39878.00   370 461   13.20   11.23  140.6
Extracting Noaa Met Data from: noaa\2016\07191600.ATB
Extracting Noaa Met Data from: noaa\2016\07191612.ATB
Extracting Noaa Met Data from: noaa\2016\07201600.ATB
Applying Weckler-Ansley Regression...
C820D1-ZUA-00001-01     35.15    -9.49    44.64
20160719\20160719_1090ES_260B_ASE.txt
```



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# Quality Control

- ❑ Altimetry System Error less than 200
- ❑ Standard Deviation less or equal to 45
- ❑ Straight Flight Levels between 290 and 410
- ❑ NAC value 8 or higher
- ❑ Developing quality control for ADS-B/MET alignment.
  - ❑ Localized areas of high MET gradients can cause incorrect high ASE values
- ❑ ADS-B Version B (1090 & UAT DO-260B)



# Data Processed

## ❑ Quarterly Report for 2016

### ❑ 1<sup>st</sup> Quarter (Jan, Feb, Mar)

- ❑ 2,601 Individual Segment with an ASE
- ❑ 82 Non-Compliant Due to High ASE
- ❑ 404 Not Successful Monitoring Due to High SD

### ❑ 2<sup>nd</sup> Quarter (Apr, May, Jun)

- ❑ 3,431 Individual Segment with an ASE
- ❑ 61 Non-Compliant Due to High ASE
- ❑ 323 Not Successful Monitoring Due to High SD



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## *Part 2: ADS-B Independent Sampling*



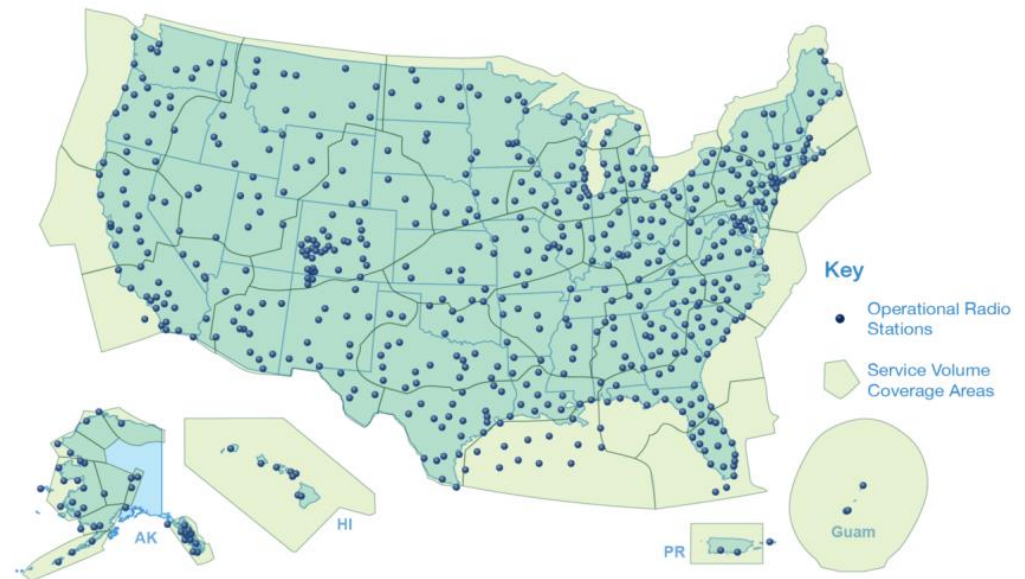
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# ADS-B Independent Sampling

- Calculating and monitoring ASE utilizing AGHMEs is restricted by geometry.
- Calculating ASE utilizing ADS-B is much less restrictive.



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**INEXL GEN**

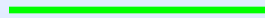


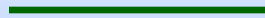


# ADS-B ASE

- Plotted ADS-B ASE position tracks for randomly selected GLF6 and GLF4 aircraft.
  - ✦ **GREEN LINE** Compliant average ASE values. Average ASE track value that is  $\leq 160$
  - ✦ **YELLOW LINE** Aberrant average ASE values. Average ASE track value that is  $> 160$  but  $\leq 199$
  - ✦ **RED LINE** Non-Compliant average ASE values. Average ASE track value  $\geq 200$

# Methodology

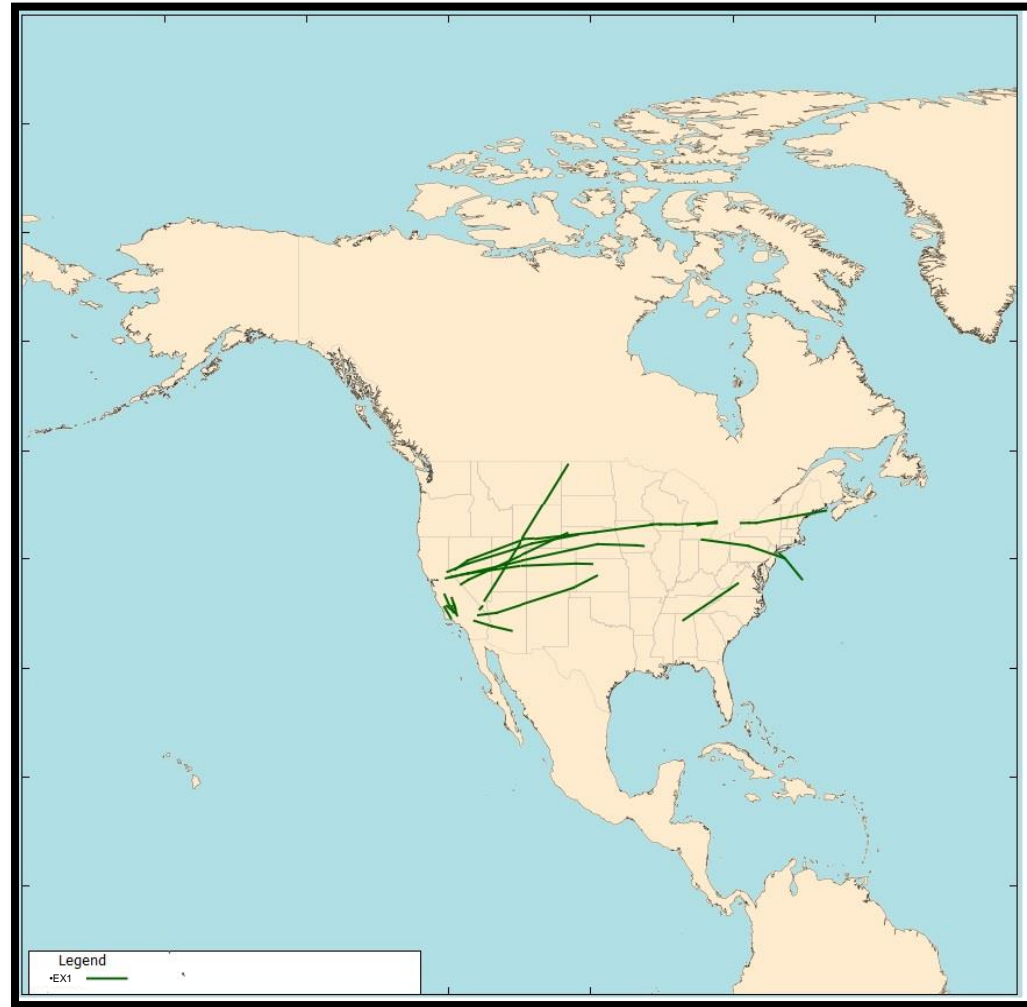
- Aircraft is selected and all ASE tracks are plotted
- The day with the largest number of observations is plotted over ALL ADS-B aircraft that flew on that day.
- Averaged ASE Position tracks use ADS-B filtered data
  - ✦ Version 2 (DO-260B)
  - ✦ Between FL290-FL410
  - ✦ 180 consecutive observations
    - Assuming 3 or more minutes of data

Map Key	
	All compliant ADS-B aircraft tracks
	All aberrant ADS-B aircraft tracks
	All non-compliant ADS-B aircraft
	New aircraft

# Example 1: GLF6

•LOA on 31-Mar-15

Date	Count of ASE Segments
21-Jul-15	1
27-Jul-15	3
4-Aug-15	12
17-Aug-15	2
12-Sep-15	1
13-Sep-15	2
16-Sep-15	2
24-Sep-15	2
25-Sep-15	2
26-Sep-15	4
29-Sep-15	2
1-Oct-15	3
2-Oct-15	3
Total	39



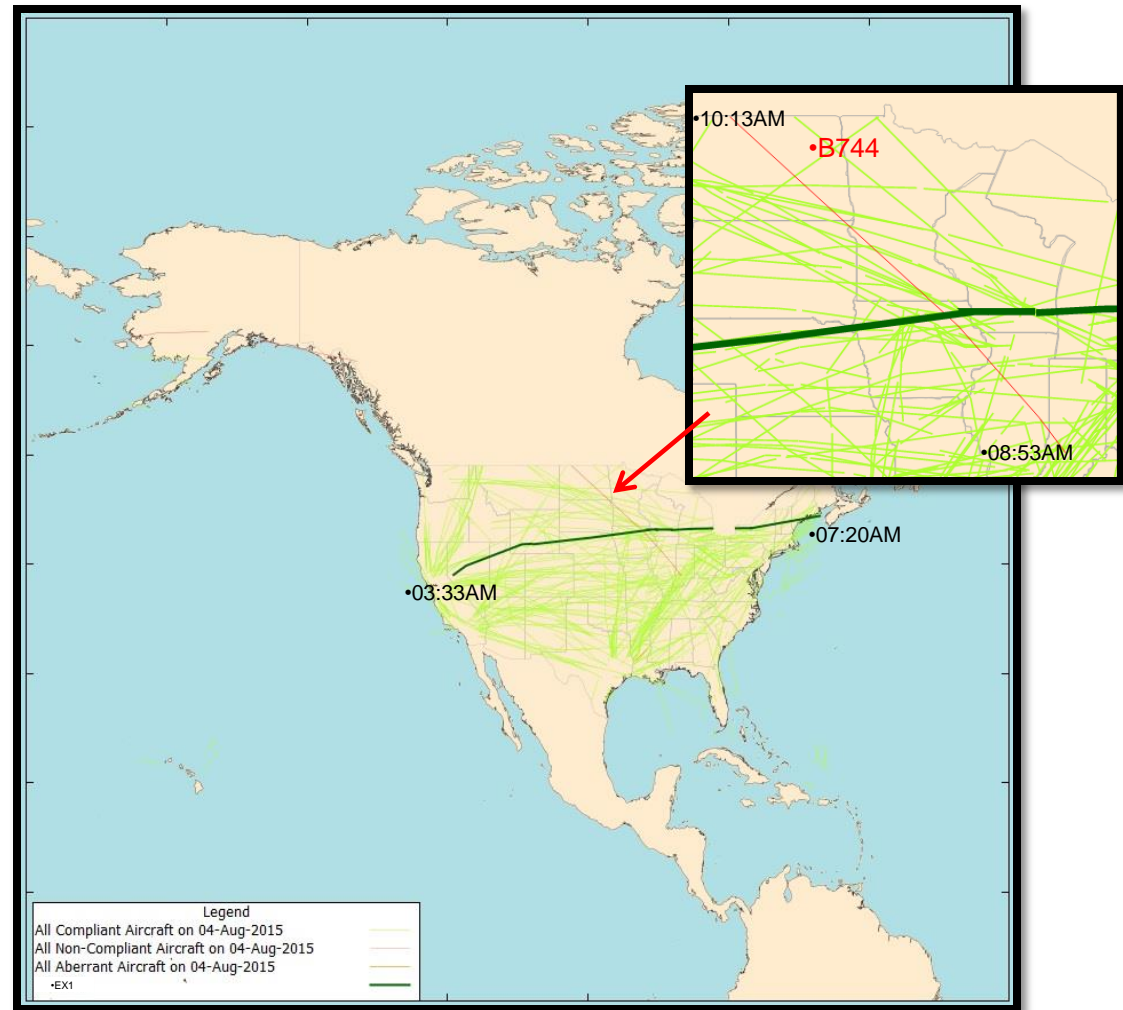


# Ex1 with all Aircraft on 4-Aug-15

•LOA on 31-Mar-15

Date	Count of ASE Segments
21-Jul-15	1
27-Jul-15	3
4-Aug-15	12
17-Aug-15	2
12-Sep-15	1
13-Sep-15	2
16-Sep-15	2
24-Sep-15	2
25-Sep-15	2
26-Sep-15	4
29-Sep-15	2
1-Oct-15	3
2-Oct-15	3
Total	39

•469 ADS-B Aircraft ON 04-AUG-15



# Ex2: GLF6

•LOA on 16-Jun-15

Date	Count of Segments
23-Jun-15	3
24-Jun-15	1
25-Jun-15	1
26-Jun-15	2
29-Jun-15	2
16-Jul-15	1
2-Aug-15	3
11-Aug-15	4
15-Aug-15	1
28-Aug-15	2
2-Sep-15	3
4-Sep-15	2
11-Sep-15	4
21-Sep-15	1
22-Sep-15	1
Total	31

•481 ADS-B ACT ON 11-AUG-15

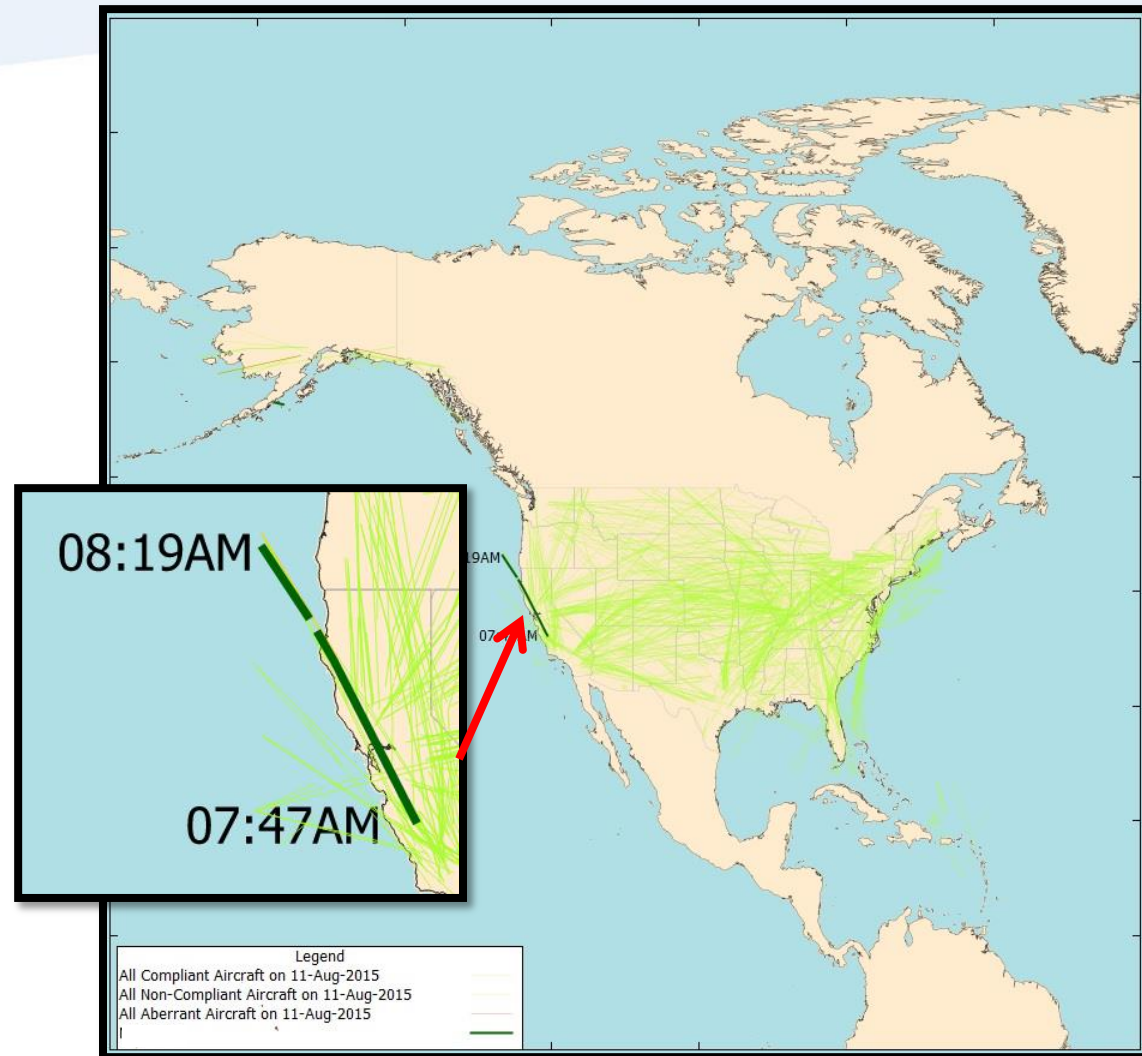


# Ex2: GLF6

•LOA on 16-Jun-15

Date	Count of Segments
23-Jun-15	3
24-Jun-15	1
25-Jun-15	1
26-Jun-15	2
29-Jun-15	2
16-Jul-15	1
2-Aug-15	3
11-Aug-15	4
15-Aug-15	1
28-Aug-15	2
2-Sep-15	3
4-Sep-15	2
11-Sep-15	4
21-Sep-15	1
22-Sep-15	1
Total	31

•481 ADS-B ACT ON 11-AUG-15

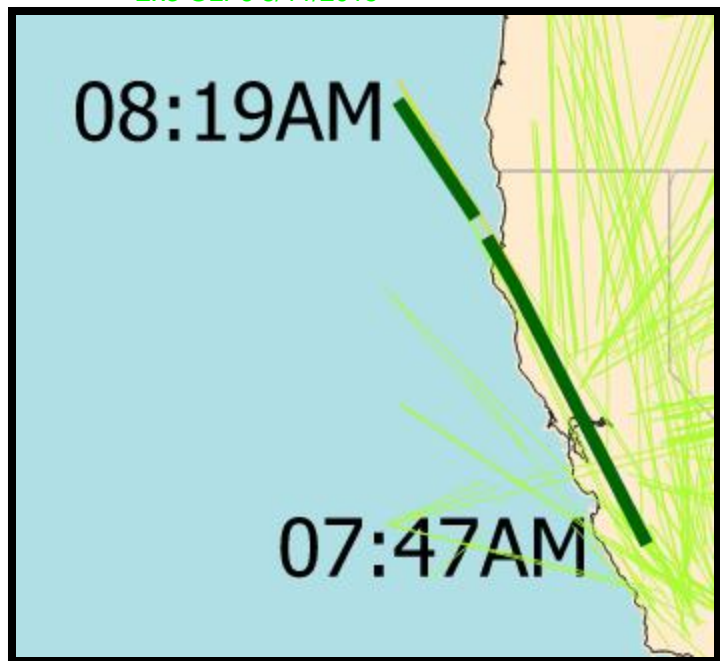




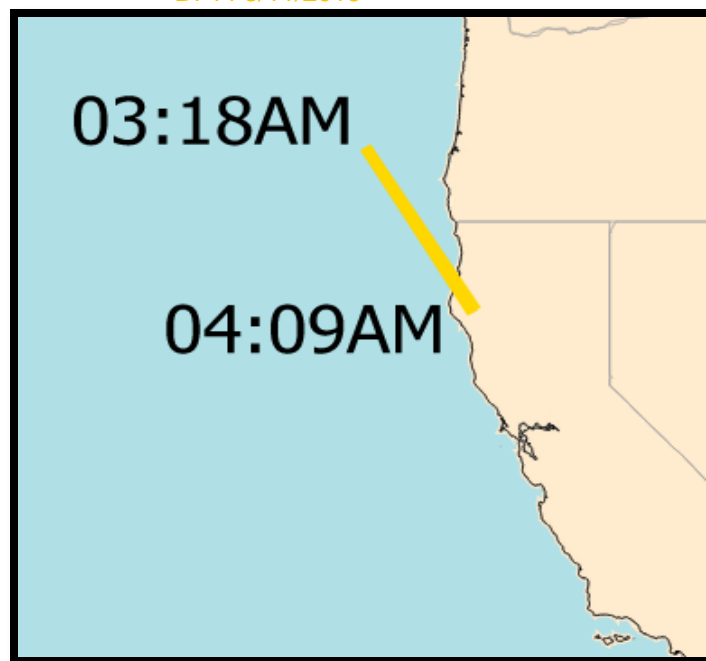
# Ex2 GLF6 on 11-Aug-15

LOA on 16-Jun-15

•Ex3 GLF6 8/11/2015



•B744 8/11/2015



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# Ex4:GLF6

- LOA on 16-Jan-15

Date	Count of ASE segments
3-Sep-15	2
9-Sep-15	1
14-Sep-15	5
17-Sep-15	1
22-Sep-15	23
24-Sep-15	1
Total	33



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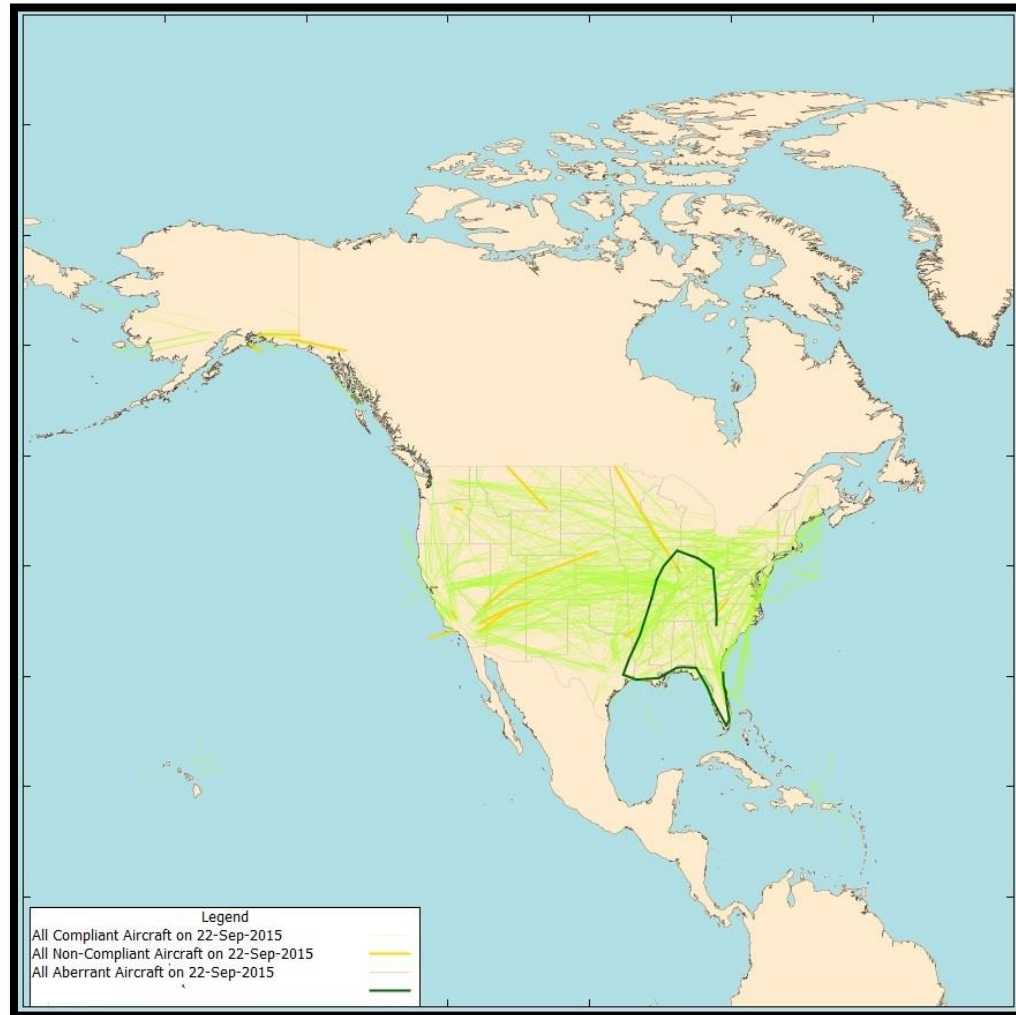
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# Ex3: GLF6 with all ADS-B On 22-Sep-15

- Gulfstream Aerospace Corporation (GXFJ)
- LOA on 16-Jan-15

Date	Count of ASE segments
3-Sep-15	2
9-Sep-15	1
14-Sep-15	5
17-Sep-15	1
22-Sep-15	23
24-Sep-15	1
Total	33

•518 ADS-B ACT ON 22-SEP-15



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# Conclusions

- With ADS-B we have a greater ability to observe ASE
- Still in the process of developing a procedure for ADS-B independent sampling
- By using ADS-B, we will be able to build an ASE profile as a function of speed and altitude and perhaps develop an error calibration curve into ASE calculation.