



International Civil Aviation Organization

**The Nineteenth Meeting of the Regional Airspace Safety Monitoring
Advisory Group (RASMAG/19)**

Pattaya, Thailand, 27-30 May 2014

Agenda Item 5: Airspace Safety Monitoring Activities/Requirements in the Asia/Pacific Region

CHINA RMA ADS-B HEIGHT MONITORING REPORT

(Presented by China RMA)
(Prepared by Yang Xue, and Jin Kaiyan)

SUMMARY

This paper presents an introduction of the AHMS monitoring report prepared by China RMA to airlines for ADS-B monitoring status and results.

1. INTRODUCTION

1.1 China RMA has started to provide height monitoring service using ADS-B data from the beginning of 2014, and in order to let the responsible airlines to understand the ADS-B monitoring status and monitoring result conveniently, China RMA prepared a common monitoring report template by Latex. Formal monitoring reports will be created automatically by the AHMS Analysis and Management System under development.

1.2 The contents of this monitoring report template was prepared by reference to the Altimetry System Error (ASE) Analysis report of AAMA and MAAR. Some of the Latex implementation method was provided by the AAMA's Latex template. China RMA would like to express her appreciation and gratitude to AAMA and MAAR for providing these materials.

1.3 An example of China RMA's common monitoring report was presented in the Attachment 1 of this information paper.

2. DISCUSSION

2.1 All of the content of this monitoring report is organized by Chinese-English bilingual. There are five sections in the report: Background, Monitoring Result, Overall Statistics, ASE Analysis of Individual Aircraft and Contacts of China RMA.

2.2 In the first section the background of the Height Monitoring and the China RMA's ADS-B monitoring process was introduced.

2.3 Section two of the report introduced the China RMA's AHMS monitoring result of the target airlines. There are two separate tables in this section. **Table 1**, Fleet ADS-B Monitoring process, shows the number of aircraft (the compliant, aberrant and non-compliant number), and all the count values are demonstrated by monitoring group and ICAO type designator. **Table 2**, Monitoring Information, introduced the ASE results of each individual aircraft monitored by China RMA's AHMS system. In these two tables non-compliant aircraft will be highlighted in red and aberrant aircraft will be highlighted in yellow for caution to the operators.

2.4 Section three presents the overall statistics of monitoring result for the target operator. **Table 3** and **Table 4** of the report demonstrate the overall count and percentage for the successful monitoring. **Figure 1** presents the Daily Monitoring number, **Figure 2** presents the ASE distribution of the target operator; **Figure 3** and **Figure 4** present the ASE box-plot of the aircraft group by the ICAO Type and Monitoring Group respectively. In the example report, all the analysis plots are based on the monitoring data of Air China.

2.5 Section four is ASE analysis of Individual Aircraft. All the AHMS Comprehensive Analysis Plots of the aircraft which presented in **Table 2** of are presented in this section. After the report was produced automatically by the system, all the plots in this section will be reviewed by our engineers one by one to find the misjudgment result by the software and correct them.

2.6 This monitoring report template will be applied to produce reports for all responsible airlines on a quarterly basis. For the further work China RMA will redact a special report template for the Large ASE aircraft.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the information contained in this paper.

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基于ADS-B的测高学系统误差监控报告

Altimetry System Error Monitoring Report Using ADS-B Data

发布季度/ The Target Quarter

[编号/Report Number: ASEMR-example]

提供给/*Prepared for*

航空公司名称

Name of the Airline



中国地区监控组织

CHINA REGIONAL MONITORING AGENCY

20XX年XX月XX日

Month Day, 20XX

任务 / Role	人员 / Name	签字 / Signature	日期 / Date
创建人 / Prepared by			
审查人 / Reviewed by			
批准人 / Approved by			



中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

主送：航空公司名称

To: Name of the Airline

抄送：民航局飞标司，地区管理局，安全监督管理局

Copy to: Flight Standards Department of CAAC, Responsible CAAC Regional Administration, Responsible Local Civil Aviation Safety Supervision and Management Bureau

1 背景介绍

航空器在RVSM空域内运行，需要严格遵守RVSM空域的运行要求。对RVSM空域内运行的航空器开展有效的高度保持性能监控是保障RVSM空域飞行安全的重要手段。

航空器的高度保持性能反映了航空器对所指定飞行的高度层的符合性能力，通过总垂直偏差（Total Vertical Error，简称TVE）、测高学系统误差（Altimetry System Error，简称ASE）和指定高度偏差（Assigned Attitude Deviation，简称AAD）来描述。其中，ASE是由于机载测高学系统问题引起的，是RVSM空域运行安全的重大隐患，对它的检验至关重要。

为保证RVSM空域的长期安全运行，ICAO在附件6中要求各个缔约国建立航空器高度保持性能的长期监控机制。

ICAO对于不合格航空器制定的标准为：

- $|TVE| \geq 90 \text{ m (300 ft)}$ ，
- $|ASE| \geq 75 \text{ m (245 ft)}$ ，以及
- $|AAD| \geq 90 \text{ m (300 ft)}$ ；

同时授权各地区监控组织根据自身实际情况确定异常（需关注）航空器的标准，目前，根据各地区监控组织的一贯标准，中国地区监控组织（China Regional Monitoring Agency，简称China RMA）采用 $|ASE| \geq 180 \text{ ft}$ 作为异常航空器的判定标准。

1 Background

To be approved for operation in RVSM airspace, states must ensure that aircraft comply with technical requirements that enable the actual height cleared by ATC to be accurately maintained.

Monitoring of aircraft height-keeping performance (HKP) is a demanding enterprise, as regards estimation of Aircraft Altimetry System Error (ASE), Total Vertical Error (TVE), and Assigned Attitude Deviation (AAD). ASE is defined as the difference between the altitude indicated by the altimeter display assuming a correct altimeter barometric setting and the pressure altitude corresponding to the undisturbed ambient pressure. Large ASE will bring risks to the safety of airspace.

To achieve continuous safe operation of RVSM, ICAO Annex 6 requires that the State of the Operator shall establish a long-term height monitoring program to ensure each RVSM approved aircraft type grouping have their HKP monitored.

The criteria for non-compliant aircraft to be applied by an RMA are:

- $|TVE| \geq 90 \text{ m (300 ft)}$;
- $|ASE| \geq 75 \text{ m (245 ft)}$; and
- $|AAD| \geq 90 \text{ m (300 ft)}$;

Aberrant aircraft are those aircraft which exhibit measured height-keeping performance that is significantly different from the core HKP measured for the whole population. Trigger levels for aberrant aircraft set by the China Regional Monitoring Agency (China RMA) is $|ASE| \geq 180 \text{ ft}$.

为保证对RVSM空域内运行的航空器进行长期持续有效的监控，China RMA利用ADS-B数据进行航空器的高度保持性能解算，对航空器的高度保持性能情况进行了分析。

China RMA所使用的ADS-B原始数据来自民航局认可的ADS-B地面站，原始数据格式采用国际标准的ASTERIX CAT 021 V0.26格式，利用ADS-B数据开展高度保持性能解算的算法得到了国际民航组织授权。

本报告是在对航空器高度保持性能进行长期监控后，按季度给出的该航空公司所有符合ADS-B监控要求的航空器的高度保持性能情况，并对其中结果异常和不合格的航空器进行了标注。本报告仅提供中国RMA的基于ADS-B数据的监控结果，如需查询机载监控或其他监控组织的监控结果，请参考中国地区监控组织数据交互平台 (<http://www.chinarma.cn/CRMA>)。

2 监控结果

满足如下要求的航空器在一般情况下可以通过China RMA的高度保持性能解算程序计算出ASE值：

1. 该航空器具有ADS-B Out能力；
2. 该航空器在ADS-B台站覆盖范围内保持一定时间的直平飞。

China RMA对RVSM空域内运行的航空器开

To meet the long-term height monitoring requirements, the China RMA has established ADS-B ground-based monitoring system to conduct analyses of aircraft/aircraft group performance, and evaluate stability of altimetry system error.

The ADS-B raw data that the China RMA implemented to conduct HKP analysis are transferred from the ADS-B stations approved by Civil Aviation Administration of China, and the data format is the ASTERIX CAT 021 V0.26. The methodology of HKP analysis that the China RMA implemented is authorized by ICAO.

This report, produced on a quarterly basis, provides detailed information of HKP for an operator whose fleet could meet ADS-B monitoring requirements after a period of time. The aircraft with aberrant or non-compliant performance is highlighted. As for request of China RMA's on-board monitoring or monitoring records from other R-MAs, Chinese operator and CAA users could visit the 'China RMA Data Exchange Platform' website (<http://www.chinarma.cn/CRMA>) to review.

2 Monitoring Result

Generally, the ADS-B monitoring system is able to produce ASE estimates for aircraft meeting the following requirements:

1. ADS-B out equipped;
2. Maintain straight and level flight under the coverage of ADS-B stations for a period of time.

Table 1 and Table 2 present the **20XX The Tar-**

展了长期的ADS-B监控，表1-表2给出了航空公司名称的航空器在20XX年发布季度的监控结果。其中，红色代表该航空器在监控周期内的监控结果不合格，黄色代表该航空器在监控周期内监控结果异常，未标记的航空器为性能符合要求。

get Quarter HKP analysis for Name of the Airline fleet based on the ADS-B observations for a period of time. Non-compliant aircraft are highlighted in red. Aberrant aircraft are highlighted in yellow. Records of aircraft without highlight are compliant.



中国地区监控组织
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表 1: 机队ADS-B监控信息列表

Table 1: Fleet ADS-B Monitoring Progress

监控组别 Group	机型 Type	航空器数 Num.	能得到监控结果的航空器 Successfully Monitored	监控合格航空器 Compliant	监控异常航空器 Aberrant	监控不合格航空器 Non-compliant
B752	B752	2	0	0	0	0
B772	B772	3	3	2	0	1
B772	B77L	3	3	3	0	0
MD11	MD11	1	0	0	0	0
B744-10	B744	5	4	3	1	0



中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

表 2: 监控信息列表

Table 2: Monitoring Information

注册号 Reg.	Mode S代码 Mode S	机型 Type	基准面* Geoid*	ASE均值 Mean	ASE范围 Range	样本点 Points	监控天数 Days	最后监控时间 Last Date	监控结果 Comment
监控组别/Monitoring Group: B744-10									
B0000	hxABC123	B744	HAE	-184.2	[-211.2,-157.2]	19780	215	2014-03-31	异常/Aberrant
B1111	hxABC124	B744	HAE	-65.2	[-92.6,-37.8]	23342	232	2014-03-31	合格/Compliant
B2222	hxABC125	B744	MSL	-56.4	[-86.2,-26.5]	21614	217	2014-03-29	合格/Compliant
B3333	hxABC126	B744	MSL	-56.6	[-80.7,-32.4]	18796	216	2014-03-30	合格/Compliant
监控组别/Monitoring Group: B772									
B4444	hxABC127	B772	HAE	-255.2	[-200.2,-300.2]	19780	215	2014-03-31	不合格/Non-compliant
B5555	hxABC128	B772	HAE	-9.2	[-31.9,13.4]	27604	367	2014-03-30	合格/Compliant
B6666	hxABC129	B772	HAE	14.2	[-9.1,37.5]	25299	348	2014-03-31	合格/Compliant

*航空器GPS高度基准面存在基于WGS-84椭球面（HAE）和平均海平面（MSL）两种情况，所以在获得航空器高度保持性能结果后需要通过数据分析进行基准面选择。

*The geoid reference used by an aircraft's avionics is either height above Mean Sea Level (MSL) or Height Above Ellipsoid (HAE), and it is necessary of ASE calculations to evaluate which geoid reference is being used by an aircraft through summary of data and statistics of ASE values.

3 监控信息统计

China RMA对本季度航空公司名称整体机队的监控情况作出如下统计分析。其中，表3是对航空公司所属的航空器被监控情况做出的统计，表4是对航空器获得的监控结果做出的统计，而图1-4给出了航空公司能得到监控结果的所有航空器高度保持性能数据的分析。

3 Overall Statistics

Table 3 and Table 4 demonstrate the overall statistics of ASE performance for **Name of the Airline**. Table 3 shows the total number of each fleet and the percentage of successfully monitored aircraft. Table 4 shows the monitoring results according to the status. Figure 1 to Figure 4 shows the detailed analysis of overall statistics.

表 3: 监控情况统计表

Table 3: Monitoring Situation

总航空器数/Total Num.	14
能得到监控结果的航空器数/Successfully Monitored	10
有效监控率/Successfully Monitoring Rate	71.43%

表 4: 监控结果统计表

Table 4: Monitoring Result

能得到监控结果的航空器数/Successfully Monitored	10
合格航空器数/Num. of Compliant Aircraft	9
异常航空器数/Num. of Aberrant Aircraft	1
不合格航空器数/Num. of Non-compliant Aircraft	0

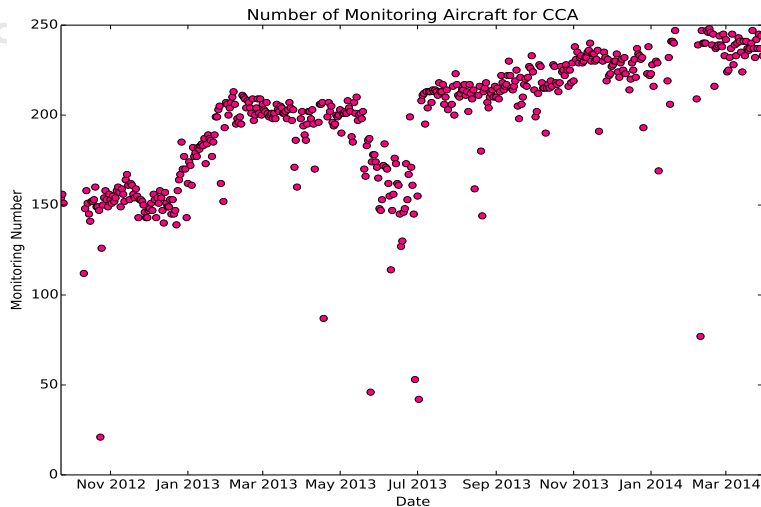


图 1: ADS-B日监控架次

Figure 1: Daily Monitoring Number

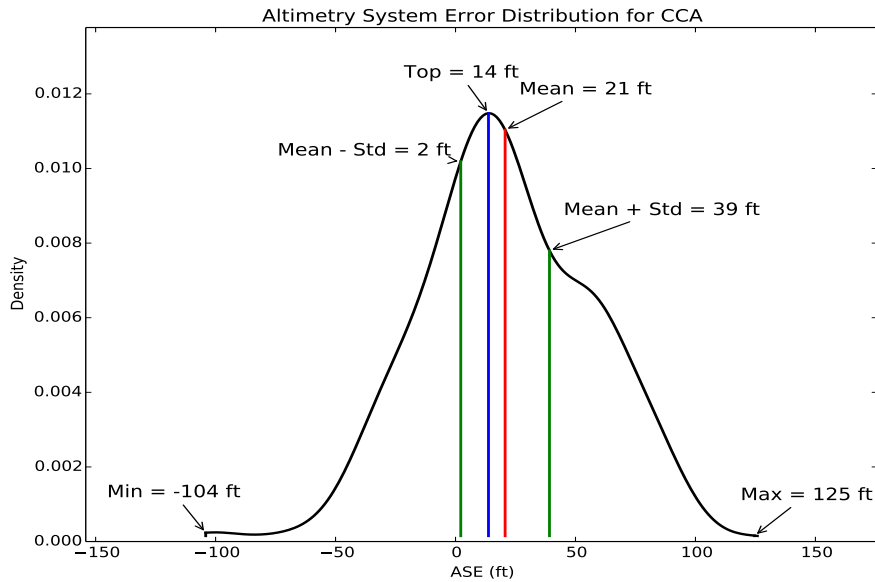


图 2: 航空器ASE概率密度曲线
Figure 2: Probability Distribution of ASE of Fleet

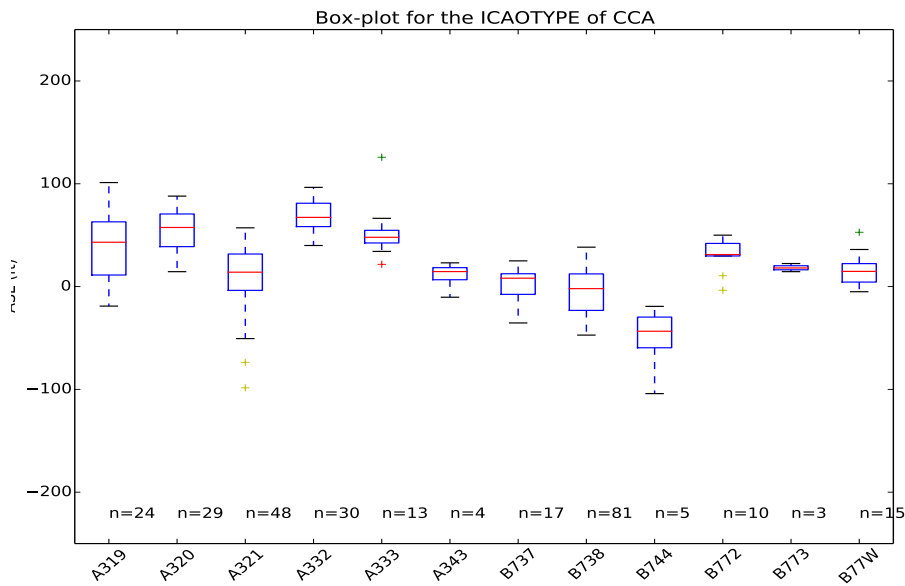


图 3: 不同机型ASE箱线图
Figure 3: Box-plot for ASE of Aircraft in Different Types

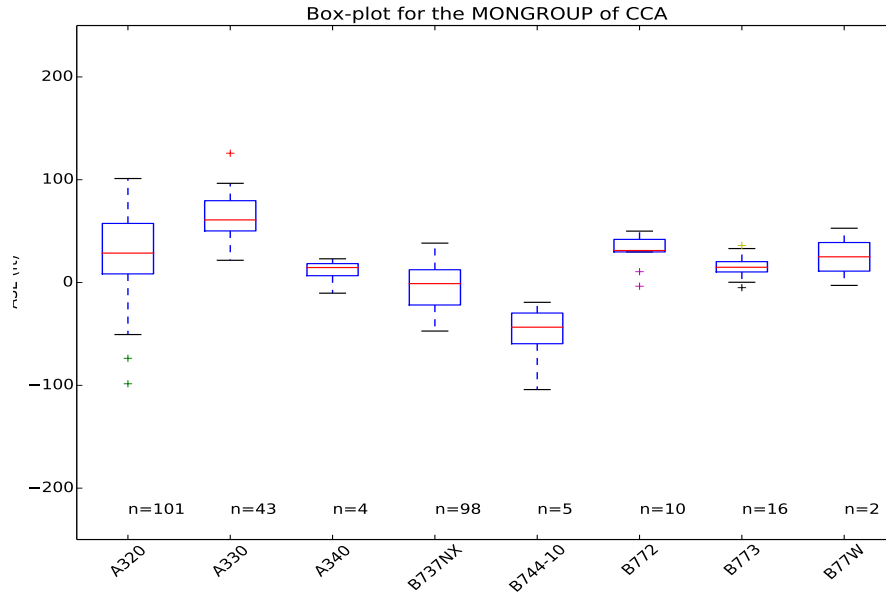


图 4: 不同监控组别ASE箱线图

Figure 4: Box-plot for ASE of Aircraft in Different Monitoring Groups

4 航空器ASE分析结果

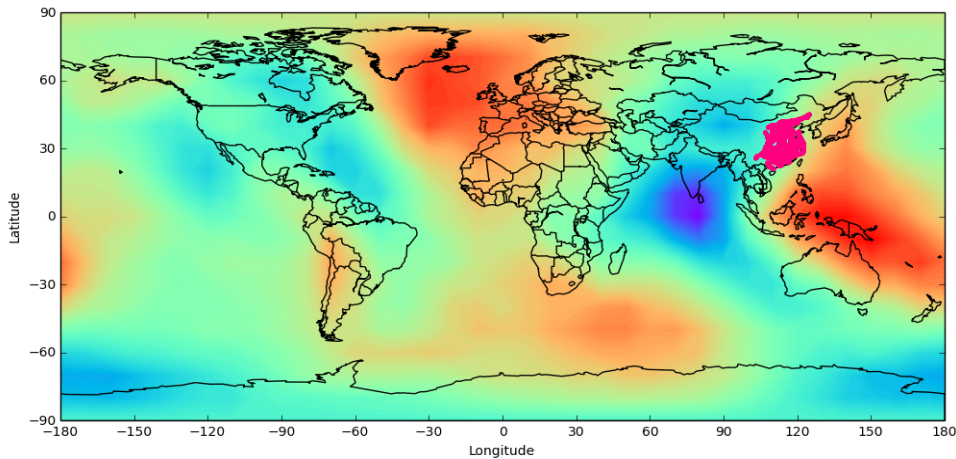
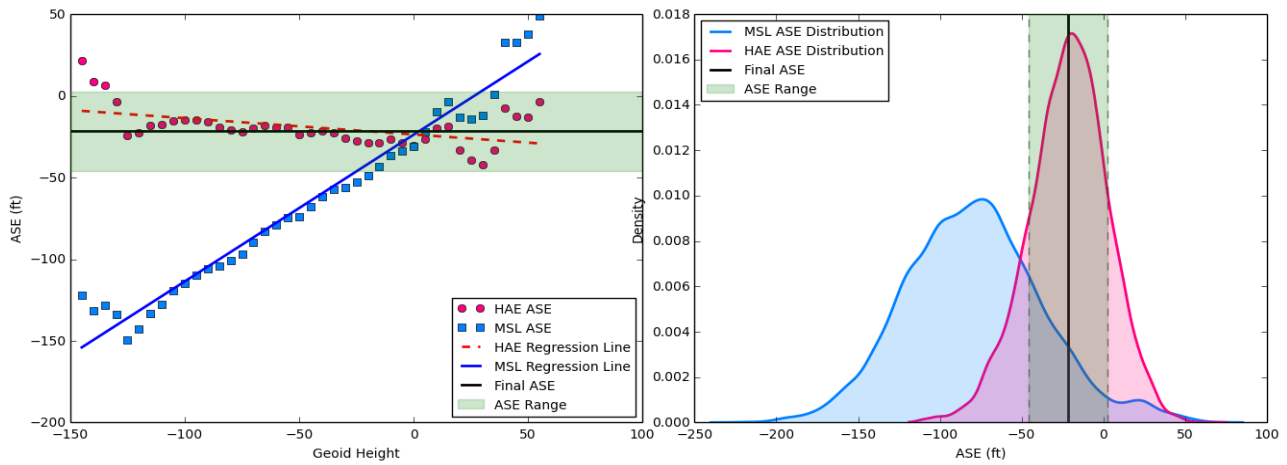
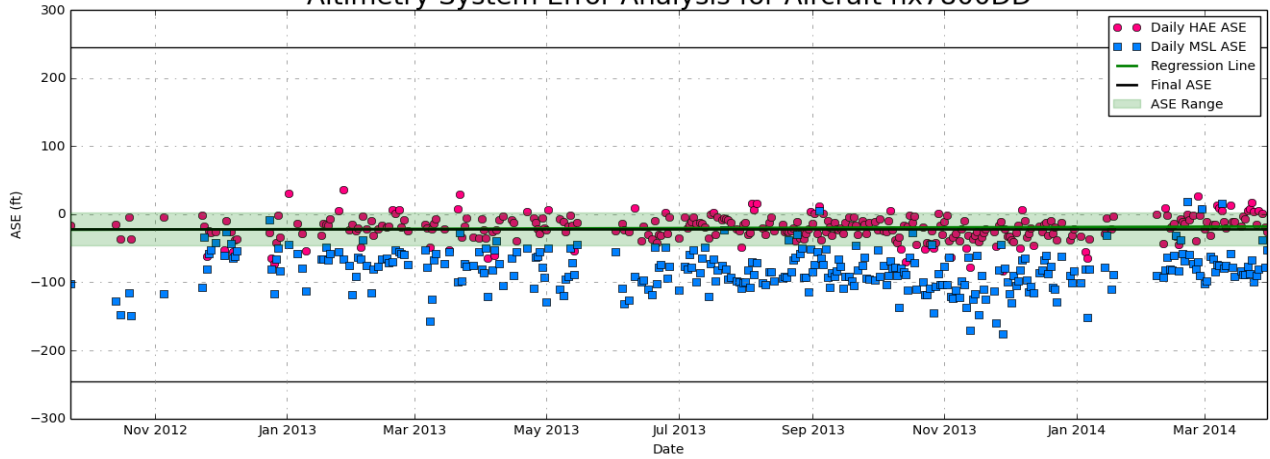
本章给出了单架航空器的ASE分析结果，包括ASE趋势性分析，基准面确定，分布拟合分析及航迹图。

4 ASE Analysis of Individual Aircraft

This section provides a comprehensive analysis of ASE for each airframe, including the ASE Trend Analysis, the Geoid Reference Analysis, Distribution Fitting of the ASE and the Flight Track Map.

监控航空器/Aircraft: B9999 ASE: 123.45 ft

Altimetry System Error Analysis for Aircraft hx7800DD



Aircraft: hx7800DD
 Geoid Reference: HAE
 Whole Daily Slope: 0.0087
 Data Comment: All ASE Point Used
 Final ASE: -21.5725 ft.
 ASE Range: [-45.9527, 2.8077]

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