International Civil Aviation Organization

The 17th Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/17)

Bangkok, Thailand, 28 – 31 August 2012

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

AAMA's EVALUATION OF ALTIMETRY SYSTEM ERROR USING ADS-B

(Presented by Australia/AAMA)

SUMMARY

This paper presents an update on Altimetry System Error calculations using ADS-B data collected and processed by the Australian Airspace Monitoring Agency (AAMA). We focus on the possibility of analysing international operators and aircraft using this data. Data was collected from January 2010 through to July 2012.

This paper relates to –

Strategic Objectives:
A: ***Safety*** *– Enhance global civil aviation safety*

Global Plan Initiatives:
GPI-2 Reduced vertical separation minima

1. INTRODUCTION

1.1 This paper deals with the AAMA's analysis of Altimetry System Error (ASE) using ADS-B. Previous papers have dealt with details of the method and analysis, in particular the need for care in determining the geoid height reference of the aircraft. This is the height assumption of the GNSS system as Height Above Mean Sea Level (HAMSL) or Height Above Ellipsoid (HAE). The difference between HAE and HAMSL varies over the Earth's surface by +/- 200 ft.

1.2 This paper focuses on the international aircraft and operators that have been seen in the AAMA's data and the possibility of providing height monitoring for these aircraft. A paper presented by MAAR at this meeting looks at the benefits for regional cooperation in using ADS-B to analyse ASE, in particular the improved determination of the geoid reference by having access to a data from a wide range of geographical regions.

1.3 The Australian Airspace Monitoring Agency (AAMA) gained ICAO endorsement to use Automatic Dependent Surveillance-Broadcast Data (ADS-B) for monitoring Aircraft Altimetry System Error (ASE) in 2011. This followed a period of collaborative research with the US FAA as described in a series of ICAO papers which demonstrated the feasibility of the method.

1.4 This study involves data collected by the AAMA from the network of ADS-B ground stations. Additional ADS-B data on 1045 of these aircraft was provided by MAAR from an ADSB receiver in Bangkok. This data sharing enabled us to better determine the geoid reference for some aircraft. The study involves 1883 aircraft, from 1 January 2010 to 1 August 2012, with 112 operators and 2,046,497,203 separate data points.

1.5 As discussed in the paper by MAAR, regional cooperation and data sharing allows for data to be obtained from different geographical regions. This enables the geoid height reference to be found and gives an improved estimation of the ASE. Australia has a large geoid range allowing easy determination of the geoid assumption as HAMSL or HAE for aircraft that regularly cross our country. International aircraft that fly only into Sydney or Brisbane from the USA, or into Perth from Asia or South Africa often do not cross enough geoid regions to easily determine the geoid height assumption. The addition of data from other regions by cooperation gives the required geographical range and hence allows the geoid height assumption to be calculated.

1.6 Calculation of ASE from ADS-B benefits from large data sets with the averaging procedure greatly improving the accuracy of the ASE measurement. A large contribution to the ASE estimation error comes from the finite discretisation of the meteorological data both in time and space. Obtaining a wide range of data from different time and spatial regions greatly enhances the ASE accuracy.

2. DISCUSSION

2.1 The following statistics summarise the ASE results collected from 1 January 2010 to 1 August 2012:

- 1883 aircraft were seen in the AAMA data set
- 1045 of these aircraft were also seen in the MAAR data
- 1230 aircraft used the HAMSL geometric height reference
- 290 aircraft used the HAE geometric height reference
- 11 aircraft used variable height references
- 8 had an undetermined height reference but had sufficient data near the regions where HAMSL=HAE to determine ASE
- 344 had unknown height reference and we were unable to determine an ASE value – although in many of these the ASE using either HAMSL or HAE were both still within the 250 ft limit and hence the aircraft could be considered successfully monitored
- 112 operators were seen
- 327 aircraft had Australian State of Registry (Y)
- 169 aircraft had USA State of Registry (K).

2.2 The following table (**Attachment 1**) considers summaries of fleet characteristics seen in the data sample. Note that this table records all aircraft in our sample. Some aircraft will have insufficient data or geoid reference to enable accurate ASE measurement.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

Attachment 1: Fleet Characteristics

Code	Operator	N	A320	A330	A340	A346	A380	B737NX	B744-10	B744-5	B767	B772	B773	BE20	BE30	MD11	PC12	Other
AAR	Asiana Airlines	8		2								6						
ACA	Air Canada	8										6	2					
ACI	Air Caledonia	4	1	2							1							
AFL	AeroFlot	4		3														1
AGC	StrategicAirlin	1		1														
CPA	Cathay Pacific	98		25					30	14		4	18					7
AIQ	Thai Air Asia	22	22															
AMSA	Australian Mari	1																1
ANG	Air Nuigini	2						1			1							
ANO	Air North	1																1
ANZ	Air New Zealand	36	13						4	3	3	8	5					
ARES	Aerorescue	1																1
ARG	Aerolineas	4			4													
AVN	Air Vanuatu	1						1										
AWQ	Indonesia Air A	18	18															
AXM	Air Asia	58	58															
BAW	British Airways	56							33	14		9						
BOE	Boeing	2																2
BOM	Bombardier	1																1
BTV	Metro Batavia A	4	2	2														
CAL	China Airlines	26		20	6													
CCA	Air China	24		23					1									
CES	China Eastern A	30		24	5	1												
CHH	Hainan Airlines	3		3														
CLX	Cargolux	14							13									1
CRK	Hong Kong Airli	8		5				3										
CSH	Shanghai Airlin	2									2							
CSN	China Southern	24		22								2						
DAL	Delta Airlines	10										10						
DAW	Dubai Air Wing	1							1									

Code	Operator	N	A320	A330	A340	A346	A380	B737NX	B744-10	B744-5	B767	B772	B773	BE20	BE30	MD11	PC12	Other
DHK	Airtours intern	1																1
ETD	Etihad Airways	37		16	9	3							9					
EVA	EVA Airways	11		11														
FDX	Federal Express	64														64		
FFM	Malaysia Airlin	1						1										
FJI	AirPacific	1						1										
GAP	AirPhil Express	4	4															
GIA	Garuda Indonesia	70	3	14				53										
GSS	Global Supply S	1																1
GTI	Atlas Air	11							8	3								
GZP	GAZPROMAVIA	1						1										
HAL	Hawiian Air	9		9														
HDA	Dragon Air Cargo	2							1	1								
HFY	HiFly	2			2													
HINT	Hinterland Avia	1												1				
HVN	Vietnam Airline	12		9								3						
ICE	Icelandair	1									1							
IGA	UNK	17	3					7	2		1							4
JAL	Japan Air Lines	10										6	4					
JSA	Jetstar Asia	14	14															
JST	Jetstar Airline	63	52	11														
KAL	Korean Airlines	78		20				1	37	4		14	2					
KKK	Saudi Arabian A	1		1														
KLM	Royal Dutch Air	18										13	5					
LAN	LAN Chile	5			5													
LNI	Lion Air	69						63		2								4
MAS	Malaysia Airlin	68		22				17	12			17						
MAU	Air Mauritiius	6		2	4													
MDL	Mandala Airline	1	1															
MEA	Middle East Air	1		1														
MLM	Comlux Malta	2	2															
MTJ	METROJET	1						1										

Code	Operator	N	A320	A330	A340	A346	A380	B737NX	B744-10	B744-5	B767	B772	B773	BE20	BE30	MD11	PC12	Other
NHN	Network Aviatio	2																2
NJC	National Jet	1																1
NWS	Nordwind Airlin	1									1							
OZW	Skywest Airline	3																3
PAC	Polar Air Cargo	1							1									
PAL	Philippine Airl	10	4	3									3					
PBI	Polynesian Blue	4						4										
PBN	Pacific Blue	6						6										
PEARL	Pearl Aviation	2													1			1
QAF	Qatar Amiri Fli	1			1													
QFA	QANTAS Airways	114		18			12	47	14	13	10							
QNZ	Qantas Jet Conn	8						8										
QTR	Qatar Airways	25										8	17					
QWA	Pel-Air Aviatio	1												1				
RBA	Royal Brunei Ai	6										6						
RES	Australian Mari	1																1
REU	Air Austral	4											4					
RFDS	RFDS	25												17	2		6	
RMF	Royal Malaysian	1						1										
ROJ	Royal Jet	1						1										
RON	Air Nauru	1																1
SAA	South African A	16			8	8												
SAS	Sunshine Air Se	1												1				
Scoot	Scoot	2										2						
SIA	Singapore Airli	117		19			17		9			41	31					
SLK	Silk Air	13	13															
SOO	Southern Air	1										1						
SQC	Singapore Airli	15							14	1								
SVA	Saudi Arabian A	1										1						
TGW	Tiger Airways S	34	34															
THA	Thai Airways	58		11	4	6			13	4		14	6					
TOM	ThomsonFly	1																1

Code	Operator	N	A320	A330	A340	A346	A380	B737NX	B744-10	B744-5	B767	B772	B773	BE20	BE30	MD11	PC12	Other
TSO	Transaero airli	1							1									
TVS	Travel Service	1						1										
UAE	Emirates	104			9		9					14	71					1
UAL	United Airlines	22							14	8								
UNK	UNK	61						2						2				57
UPS	United Parcel S	38														38		
UTY	Alliance Airlin	13																13
UZB	Uzbekistan Airw	1									1							
VAU	Virgin Blue Air	5											5					
VIR	Virgin Atlantic	19				19												
VJS	VistaJet	1																1
VOZ	Virgin Blue Air	61		5				44										12
WFBN	Wells Fargo Ban	1																1
XAX	AirAsiaX	8		8														
ZZZ2	Western Austral	1															1	
ZZZ3	SA Police	1															1	