Analysis of the 7 march 2014 raw ATC radar data

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0. Executive Summary

An in-depth analysis of the Malaysian ATC radar recordings (referred to as ATC-Caption-2025) during the night of 8 March 2014 (i.e. on 7 March UTC) was carried out based on the raw data itself. These recordings contain the data coming from all Malaysian civilian ATC radars, along with ADS-B data from two sources, some ADS-C position reports and additional information on some of the flights.

Everything indicates that the data is genuine and was not altered after the recording. Furthermore, the accuracy of target reports timestamps and rotation speeds were analyzed and no anomaly was found.

The now available Genting ADS-B data makes the trajectory of MH370 perfectly known from the apron to IGARI. The ADS-B and SSR data received from the aircraft indicates a completely nominal flight up to IGARI followed by a shutdown (switch to standby) of its transponder, most probably manually perpetrated in the cockpit.

Some additional data was found in the Kota Bharu radar PSR tracks of MH370.

Later, the crossing of the Cone of silence of Kota Bharu radar by MH370 indicates the plane was most probably flying somewhere between FL340 and FL390 at that point and descending.

An issue with Butterworth azimuth angle measurement was discovered. When this was accounted for, the trajectories of MH370 from Butterworth radar and from the Geoscience dataset closely match.

No target report attributable to MH370 could be found in Langkawi radar data.

The ADS-B and SSR data allowed for an analysis of the traffic surrounding flight MH370.

Previous ATC derived datasets each appear to raise at least some issues. Therefore, the new ATC-Caption-2025 datasets extracted from the raw data are more precise, more complete and provide a more accurate representation of the trajectory of MH370 up to the Malacca strait. They also include complementary information on surrounding traffic never released before.

It is therefore recommended to base any new analysis work on these datasets coming from the ATC-Caption-2025 and provided on our web site (www.mh370-caption.net). It is also recommended to redo all analyses based on previously published data.

The reader is encouraged to contact the authors by email if he or she has a specific idea about a particular and relevant use of the raw data.

1. Introduction

The ATC-Caption-2025 data comes from several radar sensors and processing systems. The original radar data uses the ASTERIX format, with some additional data using other formats. The recording starts at 15:38 UTC, and ends at 21:38 UTC. The data is in the form of .cap files, which is a type of network capture format.

The "last modified" date indicates that the files were indeed created while the aircraft was still in flight. The files' structure itself and their temporal consistency show that they were not subsequently modified or edited. Given the way the files were created, a modification to the data, even if intentionally hidden, would likely reveal inconsistencies upon examination.

In the data, no "SIM" bit was found to be true, and "TST" bits were only true for points that manifestly correspond to fix transponders (in Langkawi, KB and Genting for example).

Therefore, the data in the recordings is authentic and original.

1.1. Malaysian ATC radars and receivers

ATC-Caption-2025 Raw original Malaysian ATC radar data of MH370 was made available early last year from a trusted source.

At the time of flight MH370, the Malaysian ATC used 9 different radar heads at 8 different sites:

Name	*Coordinates (°)*	*Altitude (ft)*	*Type*
Genting	3.441029,101.783303	5804	SSR Mode A/C
Kota Bharu (KB)	6.163639,102.293778	70	PSR+SSR Mode A/C/S
Senai	1.638919,103.663571	168	PSR+SSR Mode A/C/S
Subang	3.135911,101.534860	309	PSR+SSR Mode A/C
Kuala Lumpur North (KL N)	2.774631,101.689773	156	PSR+SSR Mode A/C
Kuala Lumpur South (KL S)	2.724614,101.725975	181	PSR+SSR Mode A/C
Langkawi	6.337545,99.745843	439	PSR+SSR Mode A/C
Butterworth (BW)*	5.472131,100.394659	56	PSR+SSR Mode A/C/2
*Kuantan**	3.775827,103.212203	79	PSR+SSR Mode A/C

*: Air force base

The maximum slant range value of each SSR and PSR was retrieved as shown in the following table:

Range(NM)	*PSR*	*Mode A/C*	*Mode S*
Genting	N/A	198.0	N/A
Kota Bharu (KB)	61.8	206.1	152.6
Senai	61.9	206.2	153.6
Subang	74.6	204.1	N/A
Kuala Lumpur North (KL N)	78.7	208.5	N/A
Kuala Lumpur South (KL S)	79.8	198	N/A
Langkawi	60.7	198.1	N/A
Butterworth (BW)*	97.3	169.6	N/A
*Kuantan**	79.7	191.4	N/A

This data, combined with horizons calculated thanks to HeyWhatsThat.com (using a 15% refraction), can be used to draw a maximal range plot for each radar:

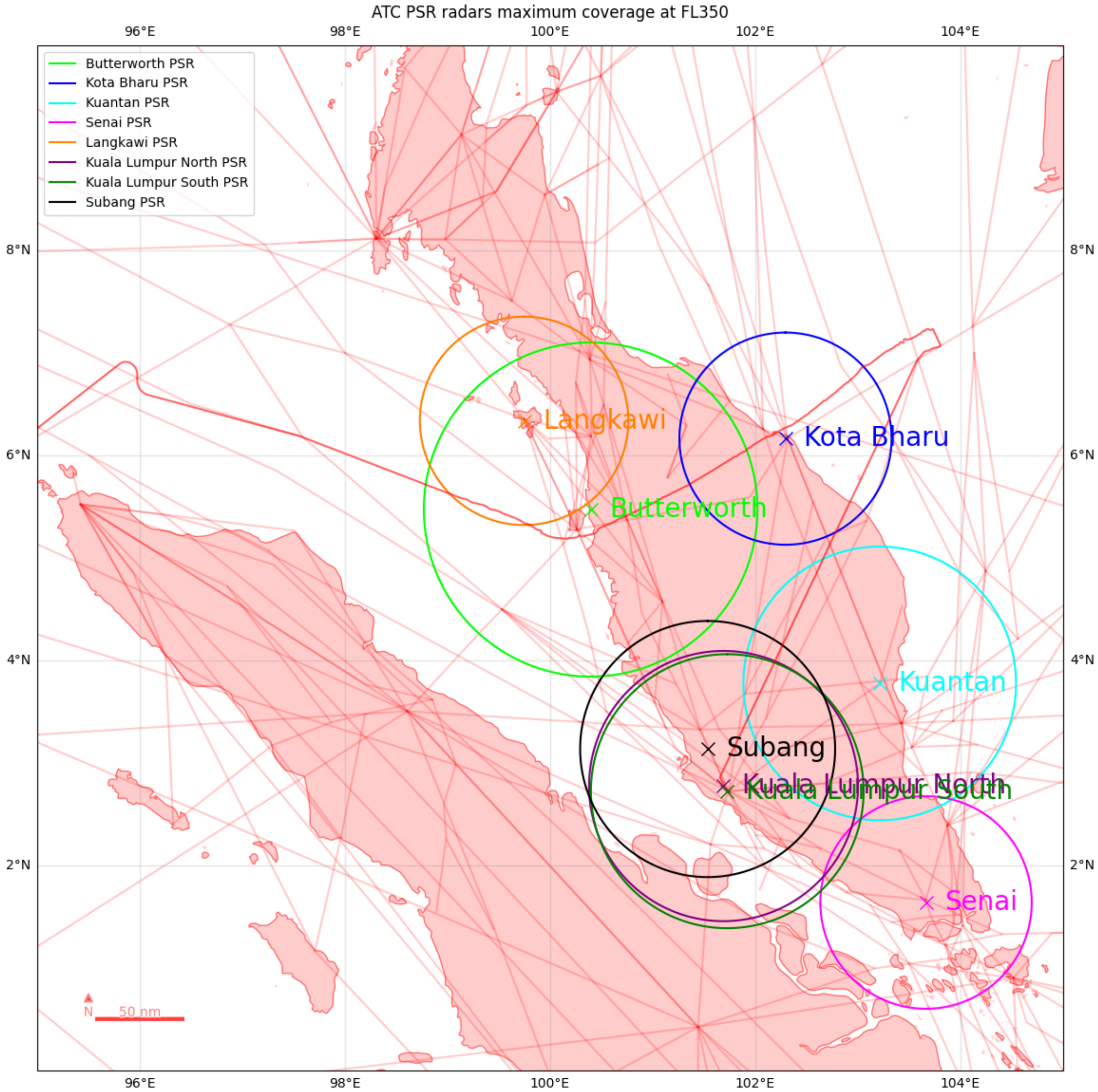


Figure 1 Maximum range for each ATC PSR radar.

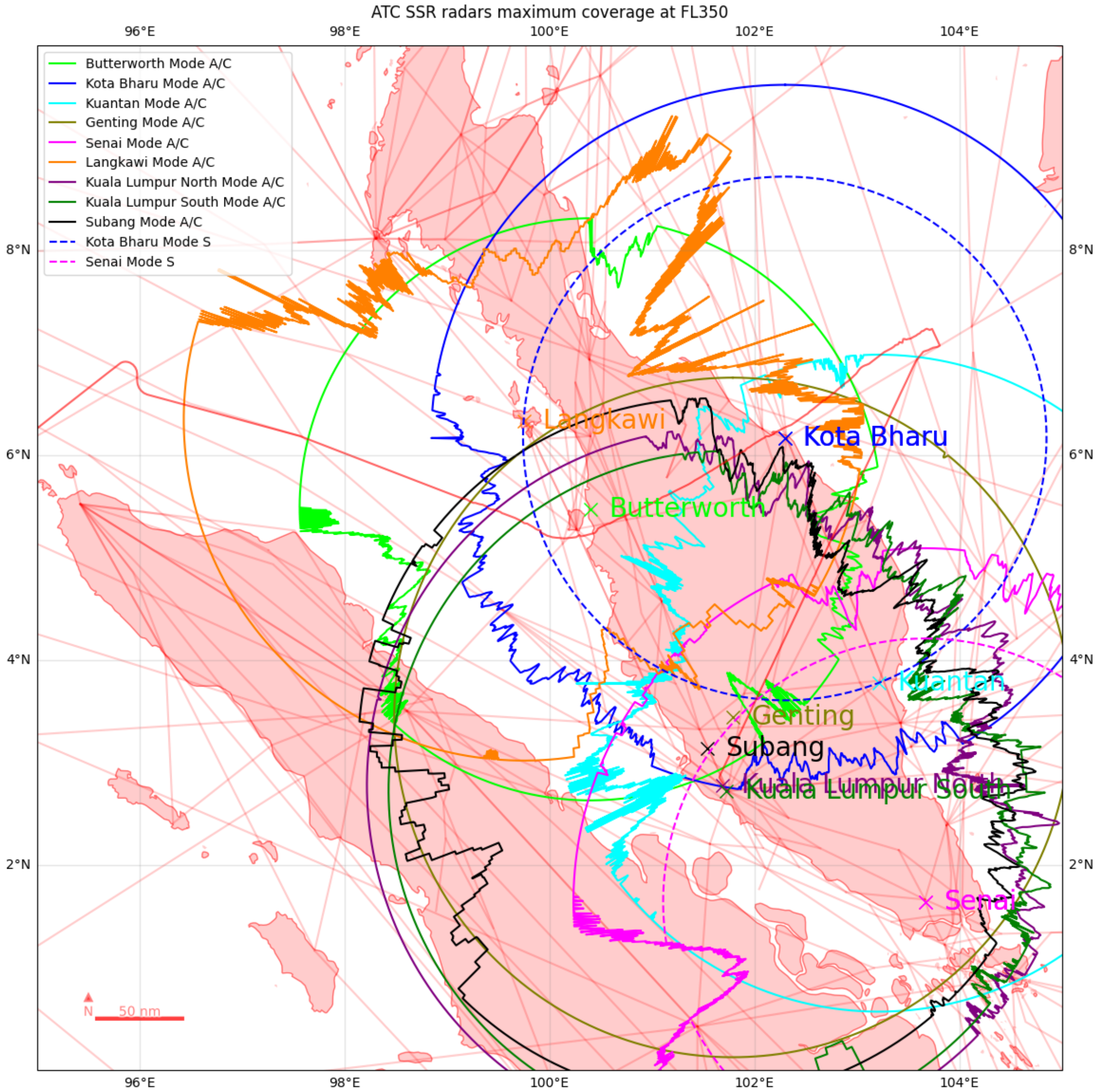


Figure 2 Maximum range for each ATC SSR radar.

The ATC-Caption-2025 raw data also contains 2 ADS-B sources, one from the Kuala Terengganu (KT) network (4 receivers in the KT airport, 4 receivers on top of mountains along the east coast), and another one from Genting presumably.

Name	*Coordinates (°)*	*Altitude (ft)*	*Type*
Kuala Terengganu	5.381389, 103.104722	21	ADS-B
>Airport (x4 receivers)	5.381389, 103.104722	21+	ADS-B
>Bukit Bintang	5.630401, 102.647971	1886	ADS-B
>Bukit Durian	4.998652, 103.106116	1886	ADS-B
>Bukit Besar	5.306820, 103.134484	597	ADS-B
>Bukit Kesing	5.295315, 102.860490	1916	ADS-B
Genting	3.434445, 101.784219	5837	ADS-B

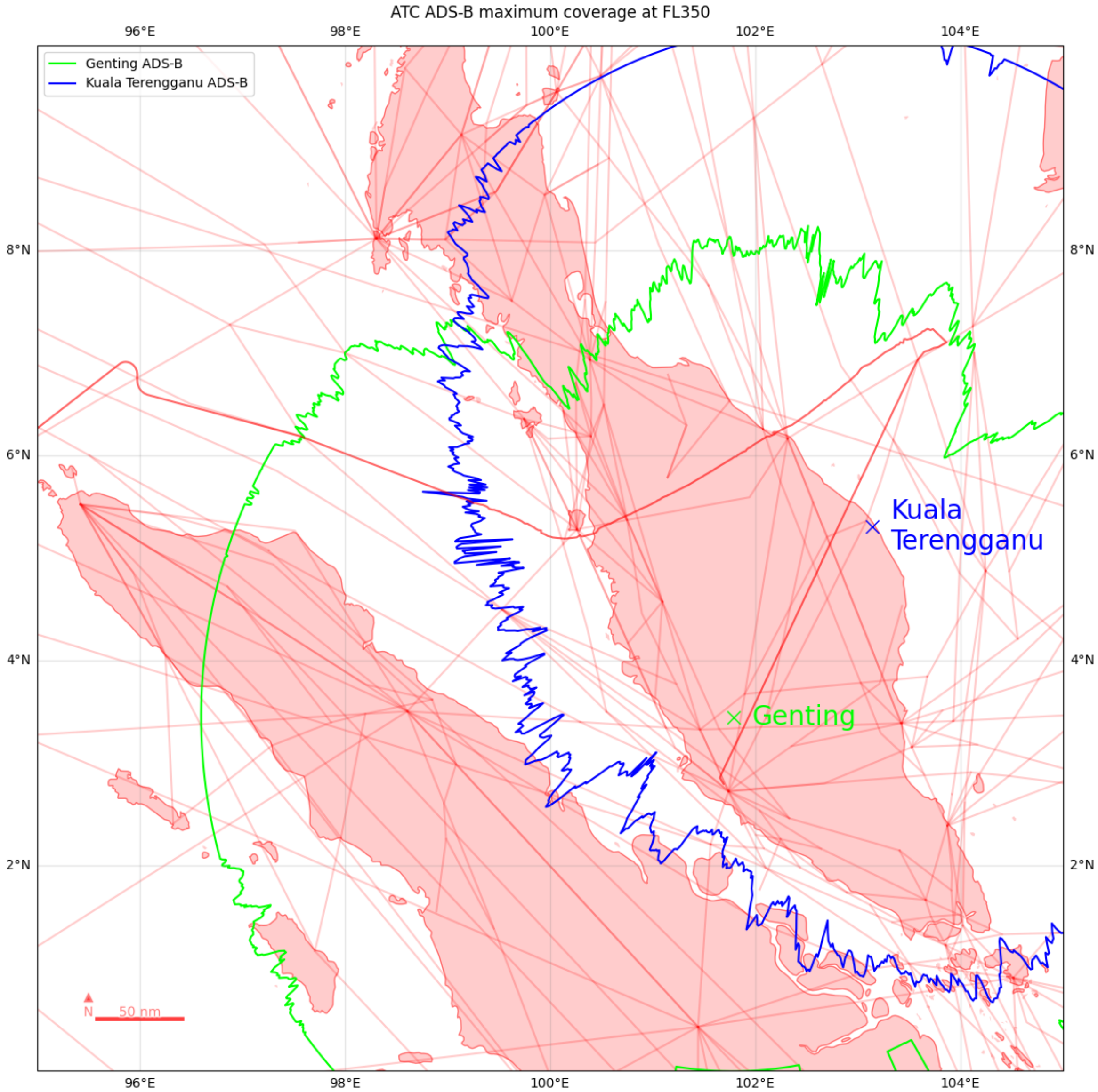


Figure 3 Theoretical maximum range of ADS-B receivers (for KT, the range was based on the combined range of the different receivers)

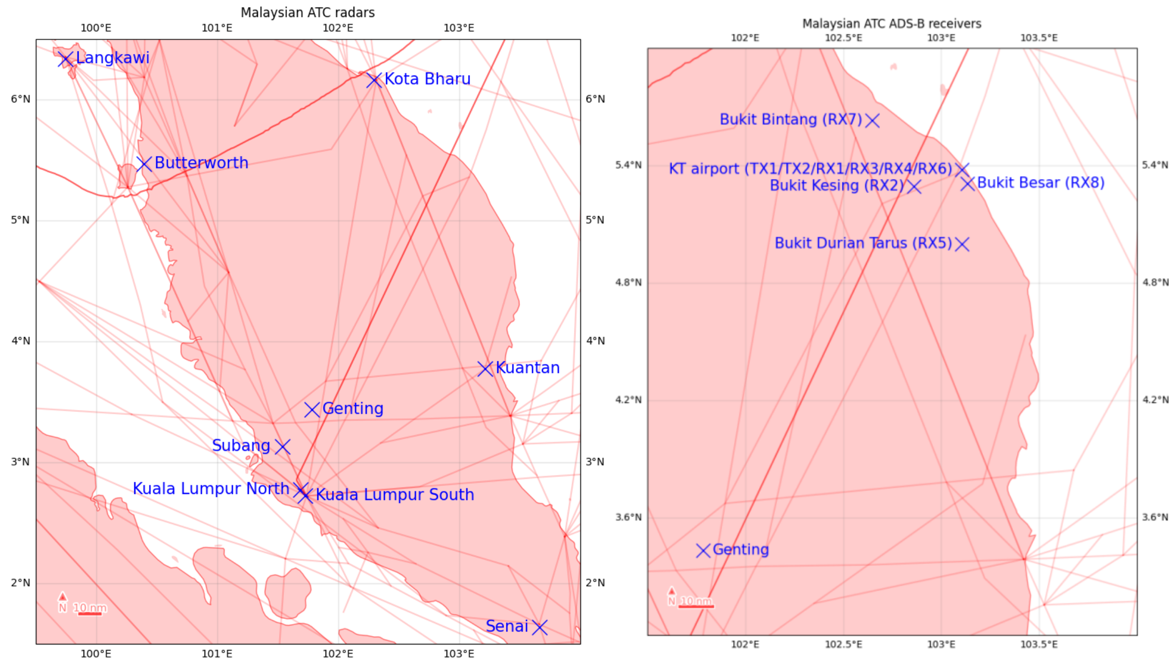


Figure 4 Locations of the 9 ATC radars (left) and the 9 ADS-B receivers (right)

Additionally, ADS-C was used to track air traffic towards the northwest of the FIR. This data was retrieved and gives a partial image of the traffic in the south of the Andaman Sea, as only the position of some flights is available.

1.2. Parsing of the data

The parsing of the ASTERIX data was carried out in Python language directly from the ATC-Caption-2025 files. First, the ASTERIX parser from Croatia Control [1] was used, but a byte by byte analysis showed that the data does not seem to fully comply with the official format (issue with Special Field Purpose length) leading to the loss of some of the target reports. It also showed that a rather unusual version of CAT021 in ADS-B data has been used when formatting the data (version 0.26 from 2005). Due to these facts, a custom Python ASTERIX parser adapted to match these characteristics was developed. Thanks to this homemade parser, a more complete and more representative reading of the data was achieved, due to a better understanding of its format and its parsing process.

Radar sources were identified based on prior knowledge of the positions of the radar heads, and geographic comparison of the position of the different flights.

1.3. ASTERIX data

Four types of ASTERIX messages are used in the data:

Table 1: ASTERIX categories identified in the raw data

CAT001/CAT048	MonoRadar target reports: SSR and/or PSR echoes with distance and angle, and possibly received altitude and squawk, tracking data, Mode S data…
CAT002/CAT034	MonoRadar service messages: information on the radar, position of the antenna, rotational speed…
CAT008	Radar weather messages: PSR derived weather data (radar reflection on rain)
CAT021	ADS-B target reports: GNSS[1] position, altitude, speed and other, derived from broadcasted data by the transponder

The first three categories are found in radar conversations (in both combinations CAT001 + CAT002 + CAT008, or CAT048 + CAT034 + CAT008), the last one (CAT021) is found in ADS-B/ADS-C conversations.

Note: CAT001 + CAT002 + CAT008 and CAT048 + CAT034 + CAT008 combinations are equivalent as, in the ASTERIX standard specifications, CAT048 and CAT034 replaced the former categories CAT001 and CAT002 respectively.

The only radars using the CAT048 + CAT034 + CAT008 combination are the two Mode S capable radars at KB and at Senai. The other radars only use the CAT001 + CAT002 + CAT008 combination.

Only Senai, KB, Langkawi and Subang data contains weather messages (CAT008). But KB data only contains 3 of these messages in the ATC-Caption-2025 recording, and Langkawi weather messages seem to concern Langkawi Island relief only. As a result, no PSR derived weather data relevant to MH370 can be found in the recording.

[1] GNSS: global navigation satellite system (GPS, Galileo, GLONASS…)

2. Radar data analysis

2.1. Antennas rotation speed stability

There are 4 ways to calculate the rotation speed of the radar antennas from the raw Data:

a) Using the rotation speed item in service messages directly (in ASTERIX CAT002/041[2] and CAT034/041)
b) Calculating the difference between the "Time of Day" (ToD) recorded in the successive north crossing service messages (CAT002/030 and CAT034/030)
c) Calculating the difference between the timestamps of the recording (network capture timestamps) in the successive north crossing service messages
d) Using the time of detection of known flights followed by SSR radar in order to calculate the evolution of theta angle with time

Here are the average rotation speeds of each antenna calculated with method (a) (CAT002/041 and CAT034/041):

Name	*Seconds per rotation*	*Rotations per minute*
Genting	3.8122	15.7389
Kota Bharu (KB)	3.8162	15.7224
Senai	3.8155	15.7253
Subang	3.6897	16.2615
Kuala Lumpur North (KL N)	3.8139	15.7319
Kuala Lumpur South (KL S)	3.8095	15.7501
Langkawi	3.8231	15.6941
Butterworth (BW)	4.0047	14.9824
Kuantan	3.9965	15.0131

Using the timestamps described in (c) is very noisy as the latency is relatively random, and requires some low pass filtering.

KB and BW antenna rotation speeds are particularly important for flight MH370.

For BW, it is impossible to use known flights (d) to calculate the speed of rotation as BW CAT001 (target reports) messages do not contain the Time of Day (it is calculated a posteriori thanks to the Time of Day and Rotation Speed in CAT002 messages, with the theta angle of the target).

All considered radar antennas have a rotation speed between 3.809s and 3.823s except Subang radar at 3.690s and also the two air force base radars, BW at 4.005s and Kuantan at 3.997s.

[2] CAT002/041 refers to field numbered 041 in a CAT002 message

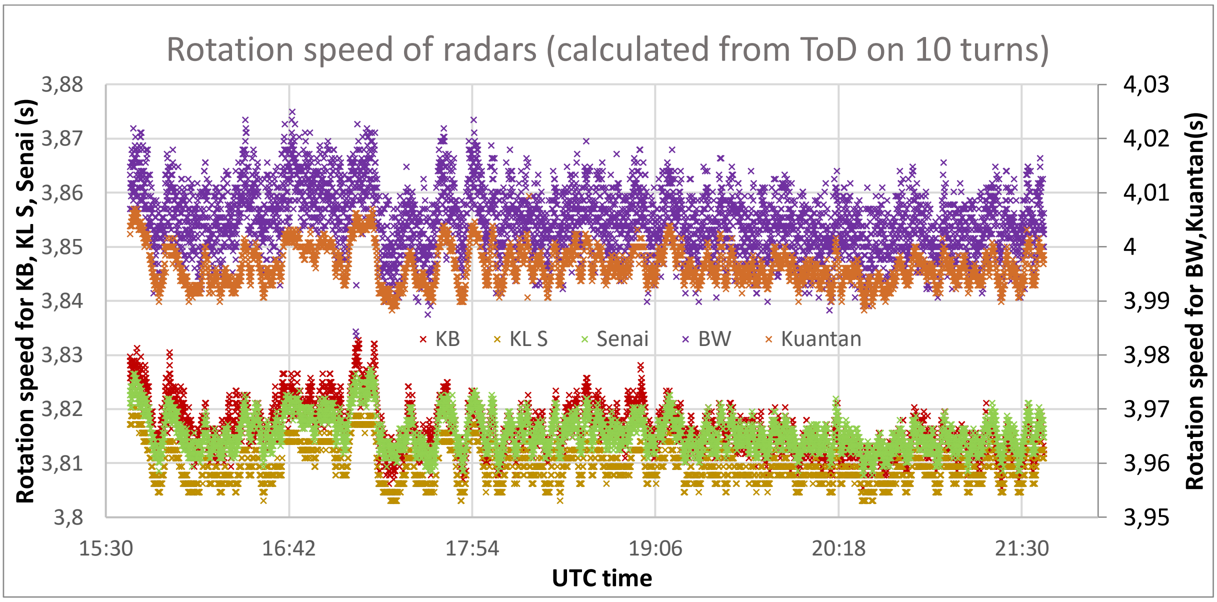


Figure 5 Antenna Rotation speed of KB, KL S, Senai, BW and Kuantan (on different scales), calculated from Time of day of North crossing (b), 10 turns average

The radars seem to have a stable rotation speed, varying within an interval of 20ms. Interestingly, it seems that the speed evolution is very similar for all radars, so it may be that these variations are more linked to time measurement or recording process than rotation speed itself. It could also be the result of fluctuations in a common synchronization signal used by radars.

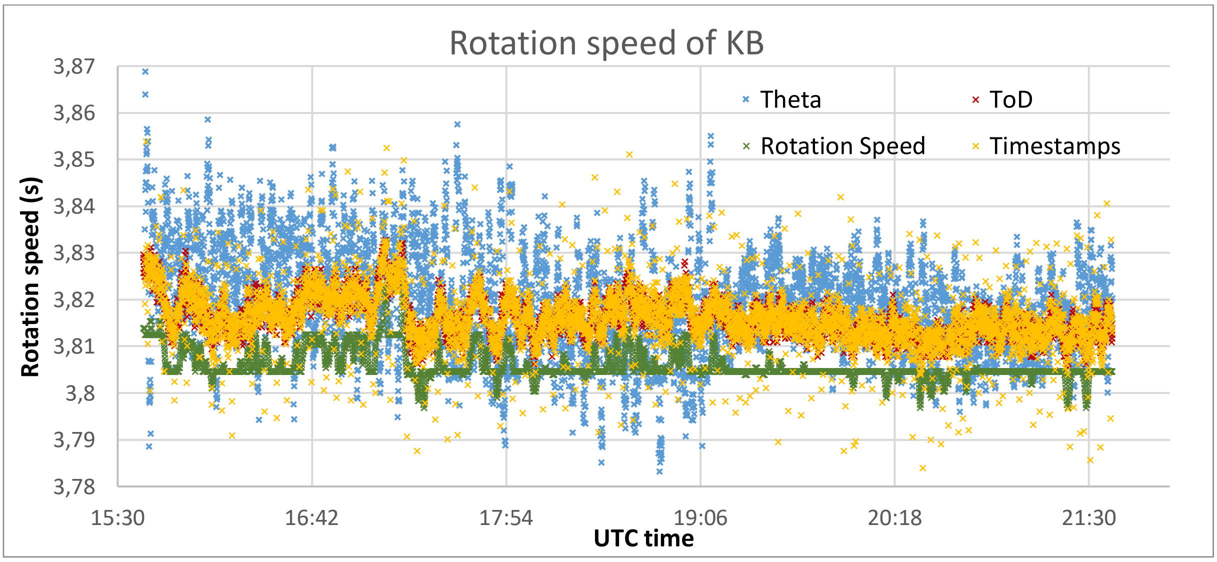


Figure 6 Rotation speed of KB using 4 different methods

KB rotation speeds calculated from the 4 methods are quite close, only the rotation speed magnitude contained in the service messages (CAT034/030) seems a bit smaller by about 10ms per rotation (green plots in Figure 6). The rotation speed in the service messages appears to have been rounded to 0.05s before being encoded in the 1/128s precision ASTERIX field.

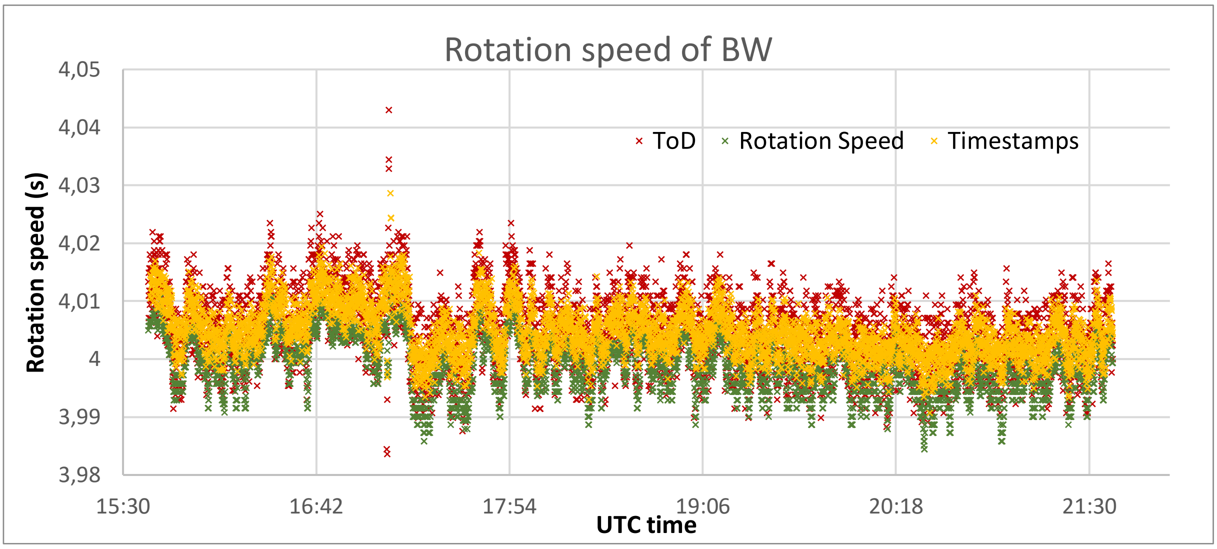


Figure 7 Rotation speed of BW using 3 different methods

For BW, only 3 methods are applicable i.e. (a), (b) and (c). The evolution of theta with time (d) is not possible as BW position reports do not contain the field "Time of Day".

As for KB, the rotation speed magnitude in service messages (CAT002/030) is slightly smaller, by about 5ms per rotation (cf Figure 7).

No real issue or incoherence between the different calculation methods was found in KB and BW data. It does not mean that there could not be a time shift between the different radars, but each radar antenna rotation appears very stable, and the rotation speeds are coherent with the period measured with each north crossing in the radar clock (ASTERIX ToD), with the recording timestamps and, for KB, are coherent with the times of the (mostly SSR) target reports for each target (theta evolution).

2.2. Kota Bharu radar

2.2.1. PSR Precision

Target reports in ASTERIX formatted data only contain one measurement for each target position. If an aircraft is tracked by a co-mounted PSR and SSR radar simultaneously, then only the SSR measured coordinates will be recorded in the data. As every aircraft should have its transponder in operation, the recorded PSR measurements should only be ghost tracks (erroneous targets due to relief, weather phenomena, bird flocks…) and aircraft with their transponder switched off. The PSR data from Kota Bharu radar contains some ghost tracks, two tracks corresponding to the MH370 flight ("KB in" and "KB out") and 11 PSR target reports of SSR tracked flights. For some reason, these positions correspond to rotations when the flights in question were followed by the PSR but no SSR reply was received. These 11 points are useful because thanks to the SSR tracking of these flights, the position of the aircraft when the PSR measurement was made can be precisely calculated. This limited sample makes it roughly possible to estimate the precision of Kota Bharu PSR as shown in Table 2.

Table 2: Kota Bharu target reports with PSR measurements under SSR tracking

Flight	*UTC Time*	*PSR Range (NM)*	*Calc. Range (NM)*	*PSR Angle (°)*	*Calc. Angle (°)*
SLK937	19:11:54	33.34	33.35	156.15	156.14
SIA345	21:05:05	40.37	40.30	334.06	334.33
SIA345	21:15:32	42.02	42.03	156.16	156.55
AIQ2932	15:51:27	57.52	57.55	354.29	354.51
AIQ2932	15:51:31	58.02	58.03	354.29	354.51
AIQ2932	15:51:34	58.48	58.51	354.31	354.51
AIQ2932	15:51:38	58.98	58.99	354.32	354.50
AIQ2932	15:51:42	59.47	59.48	354.31	354.50
MAS52	16:34:48	59.28	59.20	147.90	148.07
MAS52	16:42:18	56.51	56.47	87.55	87.89
SIA352	16:51:13	3.07	33.35	117.26	156.14

The last point shows a measured slant range of 3.07 NM, or 18655ft. SSR data shows that SIA352 was flying at FL320, which is incoherent. This demonstrates that the tracker can occasionally include a PSR plot to a track even if the received PSR echo cannot physically come from the aircraft in question. Presumably the PSR added a non-related echo (possibly of an obstacle on the ground) to the track because the target was supposed to be in the area. This leaves ten useful points only.

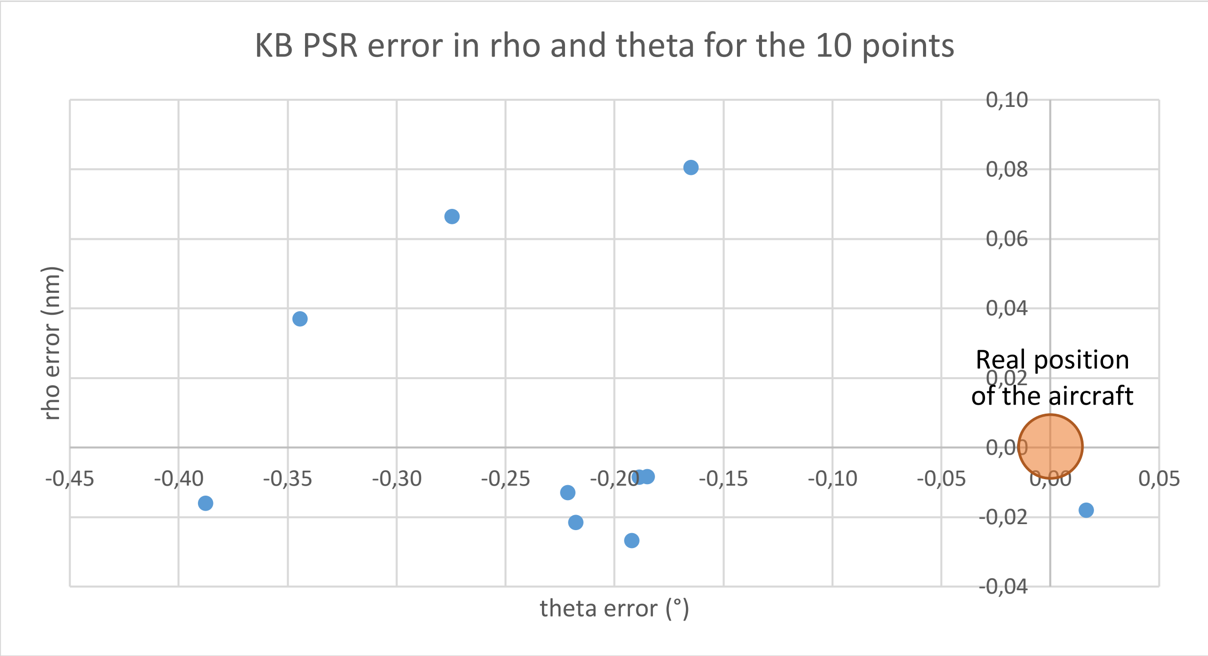


Figure 8 Error in rho and theta for KB PSR for the 10 points

It appears that the radar is very precise in range (-0.03 to 0.1 NM), but the angle precision is not as good, and shows a bias toward an early detection (-0.4° to 0°).

2.2.2. Cone of silence

An aircraft flying above or close to a radar will enter the “Cone of silence” of the radar due to the antenna elevation limitation. The cone of silence of Kota Bharu PSR is relevant as MH370 entered it after its transponder shutdown, and as it may help to estimate the altitude of the plane in that area.

In the recording, 19 flights tracked by SSR entered the cone of silence. The last PSR measured position of each flight before entering it can be plotted to estimate the cone characteristics.

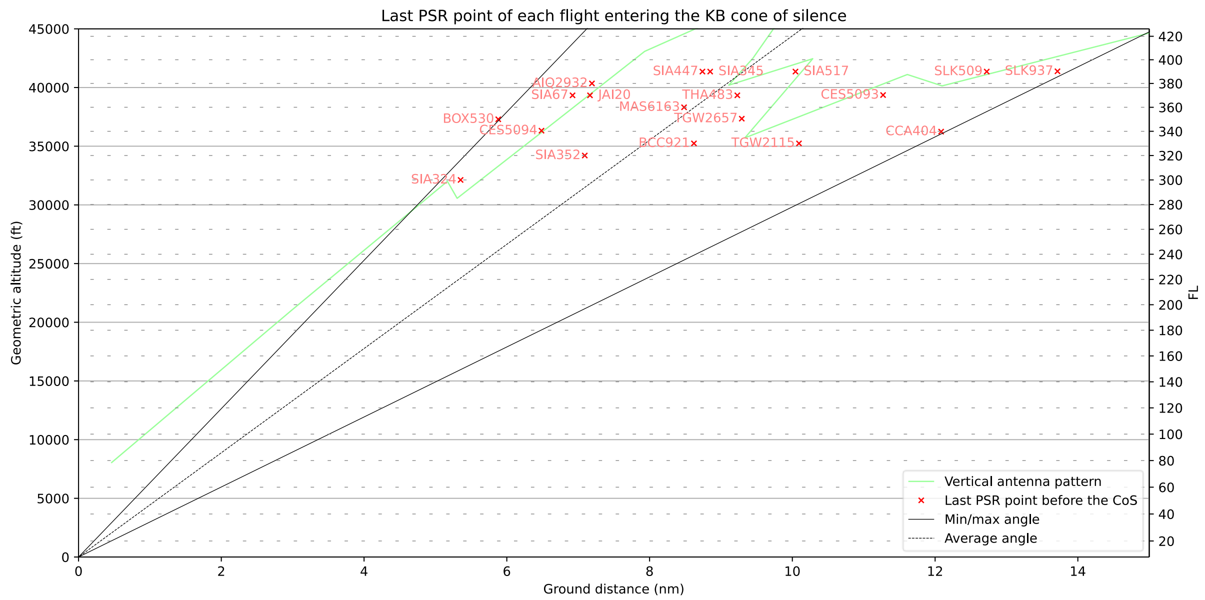


Figure 9 Plot of the last PSR measured position of each flight entering the cone of silence of Kota Bharu PSR. The distance from the origin is the slant range, the vertical axis is the geometric altitude (Flight level on the right), the horizontal axis is the calculated ground distance. Vertical and horizontal axis have the same scale in different units. The green curve is the vertical antenna pattern of the ATCR-33S radar, exported from the datasheet [2] (70% of the distance for a probability of detection of 80% for a RCS of 2m²).

The maximum angle of the last PSR points is 46.0°, the minimum angle is 26.1°, the average is 36.1°.

2.2.3. Special Purpose Field in MH370 PSR data

The ASTERIX format offers the capability to carry specific user defined data that does not fit with predefined items of the format. This data can be embedded at the end of every ASTERIX message in a field called "Special Purpose Field" (SPF), which contains non-standardised binary data (up to 255 bytes). This tailored field can be used by the system to share additional specific data. In the case of KB, two 2-byte values are systematically present in this field in every PSR and/or SSR position report. These values seem to be more or less proportional to the inverse of the square of the range (or $1/_{rho^2}$, which appears to be approximately proportional to the power of the signal received by the radar from the transponder). In particular, these values are available for the MH370 PSR tracks ("KB in" and "KB out"). The meaning of these values was not definitely determined, but it could either be linked to the radar gain control, or more likely to filtering parameters (power or time threshold for example).

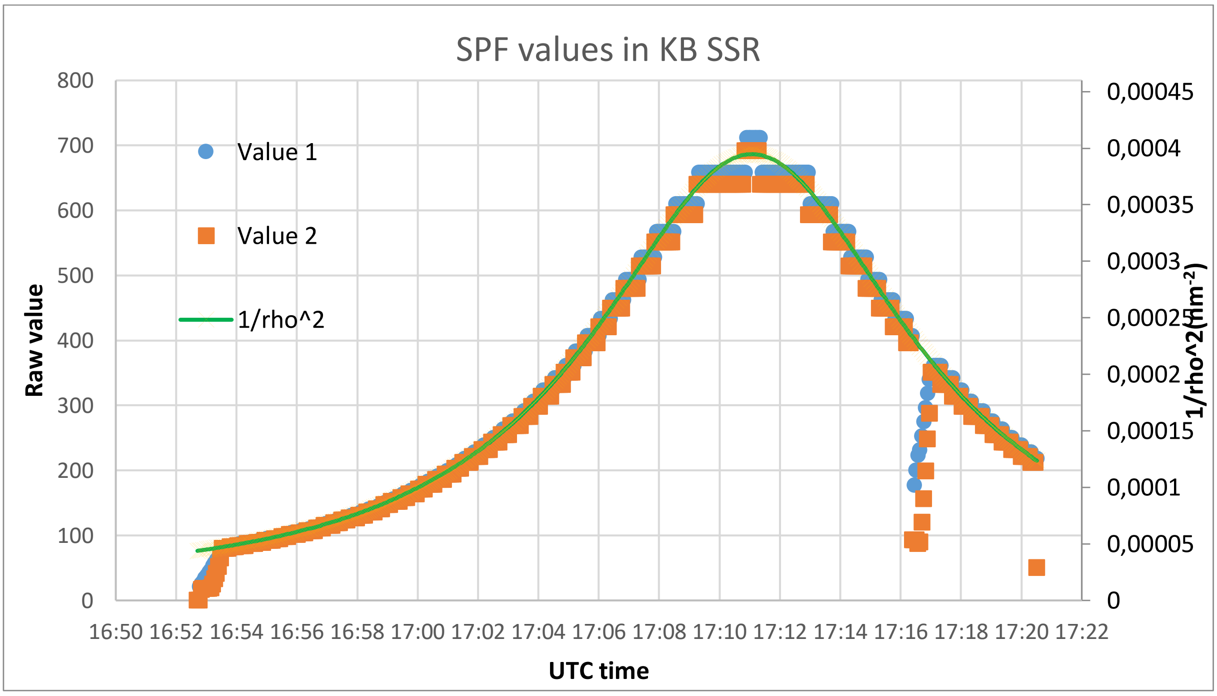


Figure 10 The two values in KB Special Purpose Field for KB SSR (MH370 SSR track before IGARI) compared to the inverse of the square of the slant range

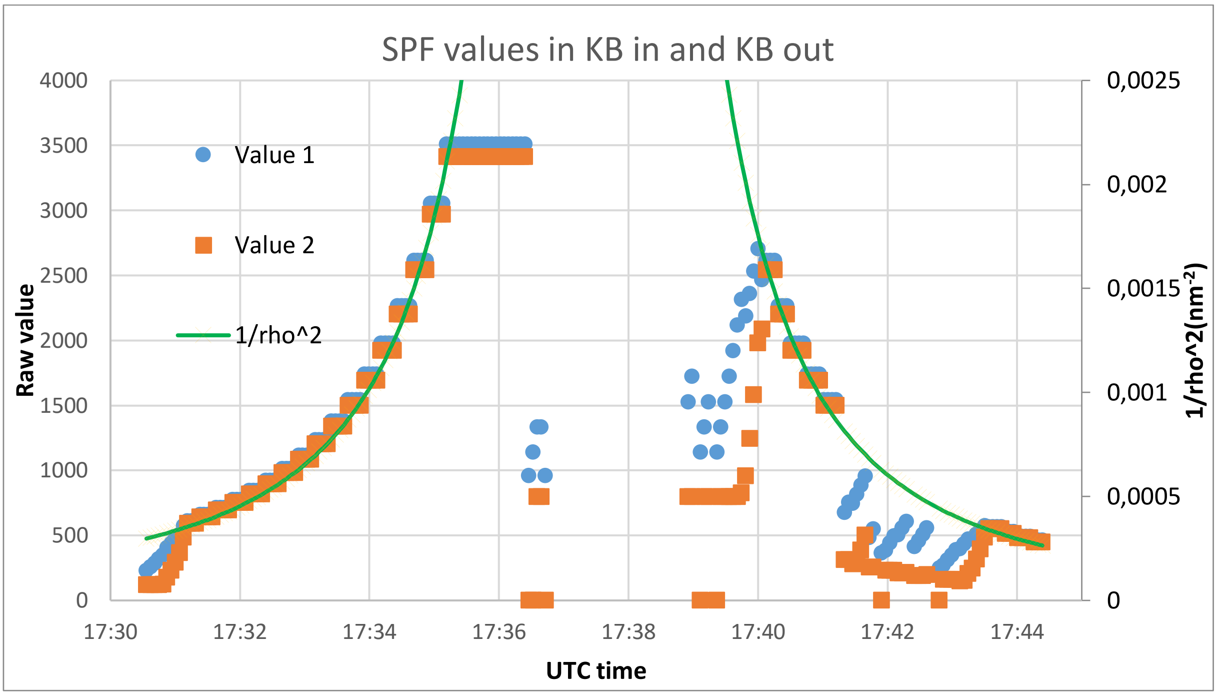
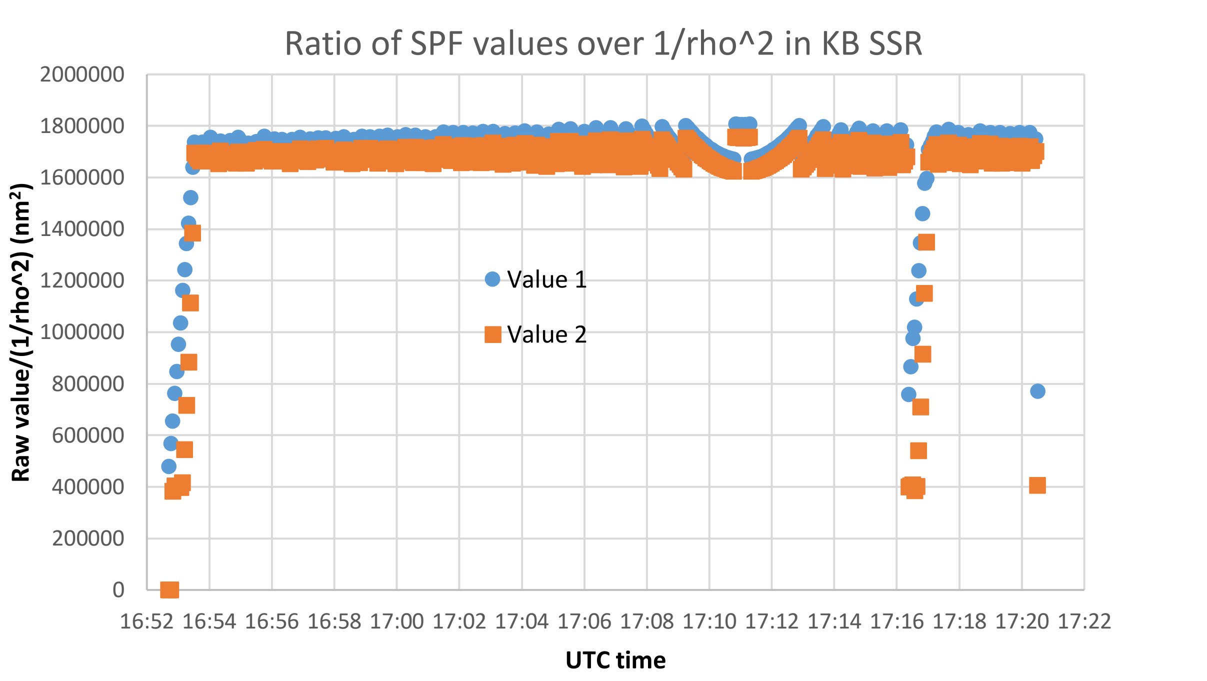


Figure 11 The two values in KB Special Purpose Field for "KB in" and "KB out" (MH370 PSR tracks) compared to the inverse of the square of the slant range

The values seem to reset when the aircraft is not detected during an antenna rotation, and then progressively increase back to $^1/_{rho^2}$.

In Figure 10, the values in the last reply of MH370 transponder are lower, it is probably because the radar detected a change of direction before IGARI (Horizontal manoeuvre sensed, MAH in field CAT048/170). The drop at 17:16:23 seems to be linked with a missed detection.



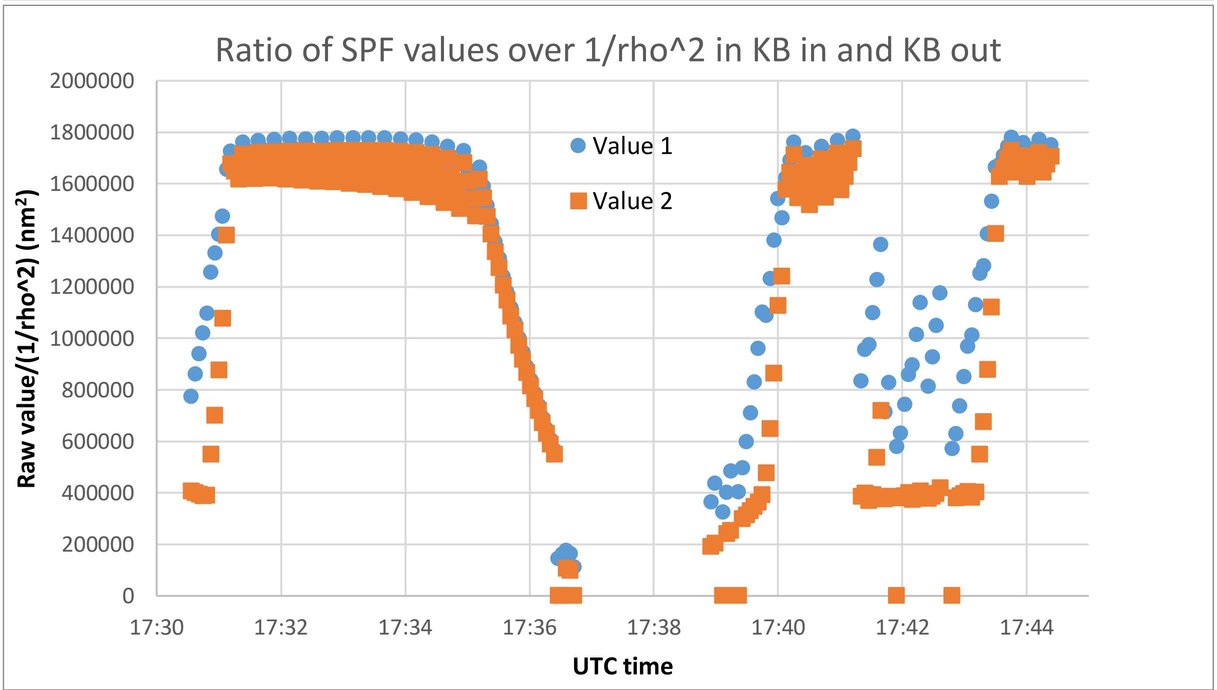


Figure 12 Ratio of the values over 1/rho^2 for "KB in" and "KB out", and KB SSR

The ratio of the values over $^{1}/_{rho^2}$ tends to around 1700000 if the target is detected for every rotation and if no change of direction is detected.

The evolution of these two values points to a filtering parameter used by the tracker.

2.3. Butterworth radar

2.3.1. PSR precision

There are 315 PSR-only position reports in the ATC-Caption-2025 data, 90 of which are attributable to the “PSR only” MH370 trajectory. The other 225 positions were each linked to other flights tracked by SSR. As for KB data, these PSR-only positions were reported when the SSR radar could not get a reply from the transponder of an aircraft, but a PSR echo could still be received from the aircraft. These positions can be used to estimate the accuracy of BW PSR.

As will be presented subsequently, BW SSR data has some shortcomings that may increase the relative error between the PSR positions and the estimated SSR positions. The standard deviations may therefore be somewhat exaggerated.

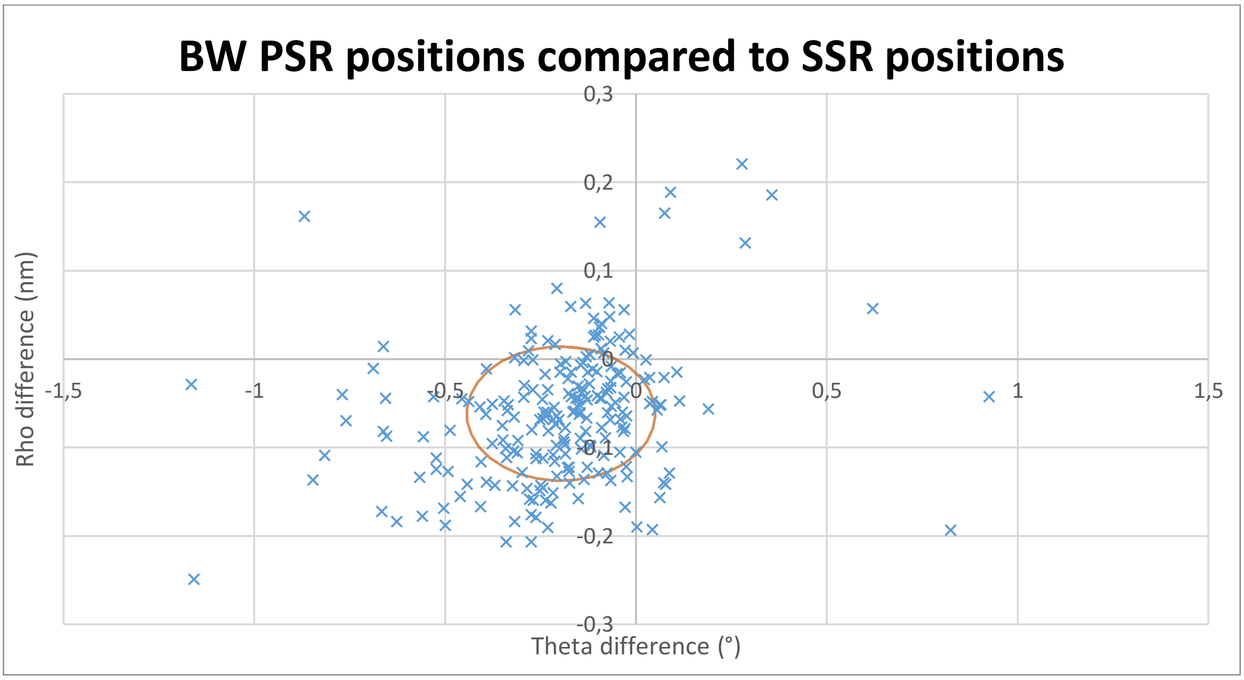


Figure 13 BW PSR positions compared to the corresponding estimated SSR positions. Standard deviation ellipse in orange.

PSR pos – est SSR pos	*Rho (NM)*	*Theta (°)*
Mean	-0.06	-0.20
Standard deviation	0.076	0.247

Figure 14 Mean and standard deviation of the differences for rho and theta

The mean and standard deviation are both small for rho, demonstrating a good precision of slant range. The azimuth seems to be slightly biased (the value of azimuth measured with the PSR is smaller than the value with the SSR, which corresponds to an earlier detection of the PSR) and the standard deviation is higher. This corresponds more or less to the KB PSR errors, but with a lower precision in the case of BW.

The fact that the standard deviation tends to be more significant for theta than for rho means that the noise in measured ground speed will be higher when the trajectory is radial to the radar head, than when it is axial to the radar head.

2.3.2. Azimuth issues

Trajectories recorded in the BW data seem irregular including small local oscillations, particularly for the flights following a radial path. This indicates some inaccuracies in the angle measurement reported in Butterworth's data.

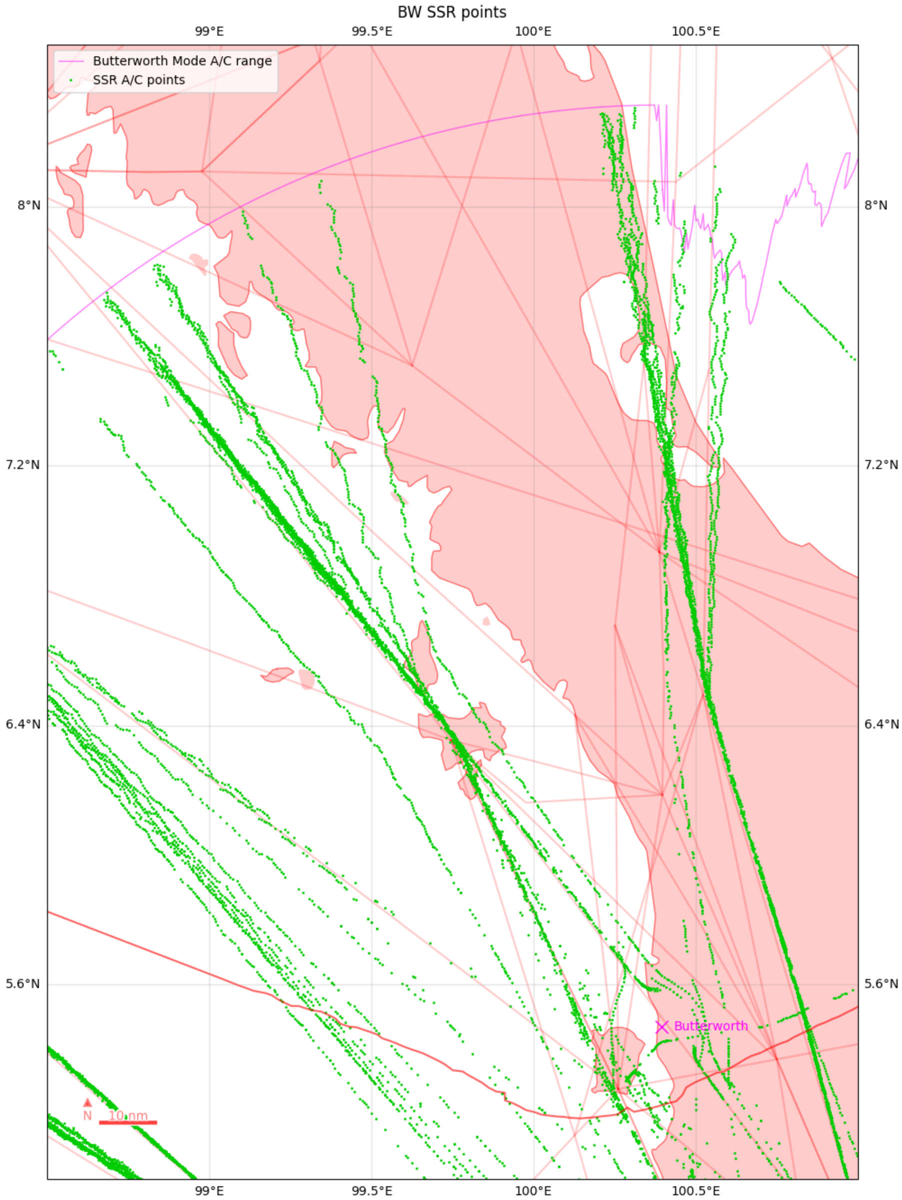


Figure 15 Zoom on the north of Butterworth in the BW data

A comparison between the angle measured by the Butterworth radar and the angle calculated with GNSS positions provided by Genting and KT ADS-B data shows the evolution of the angle error.

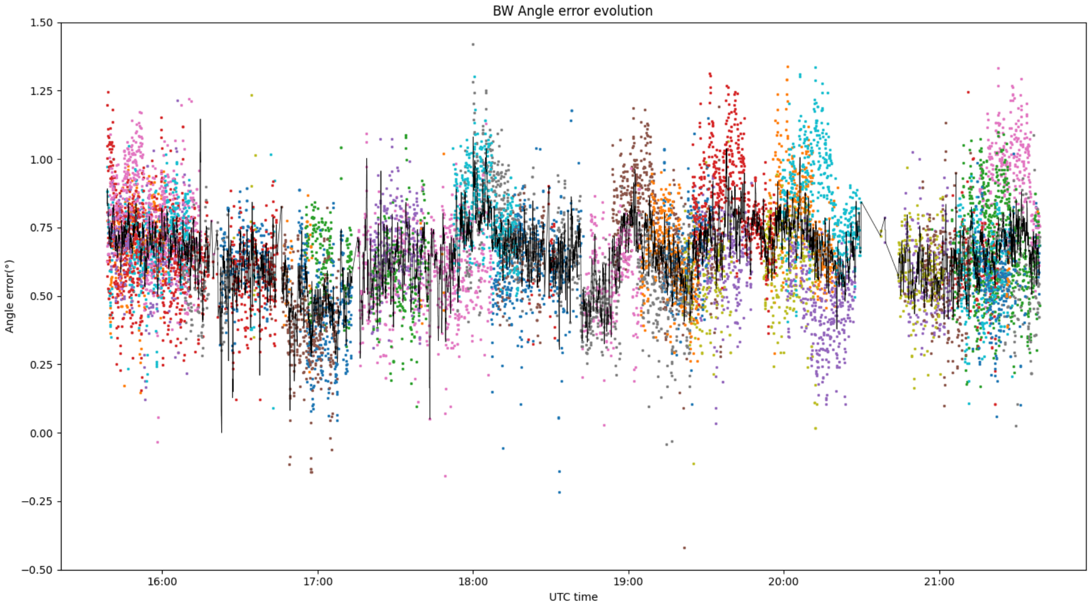


Figure 16 Angle error in BW data during the recording, colors indicate the different flights, the black line is the moving average over 16s (4 rotations)

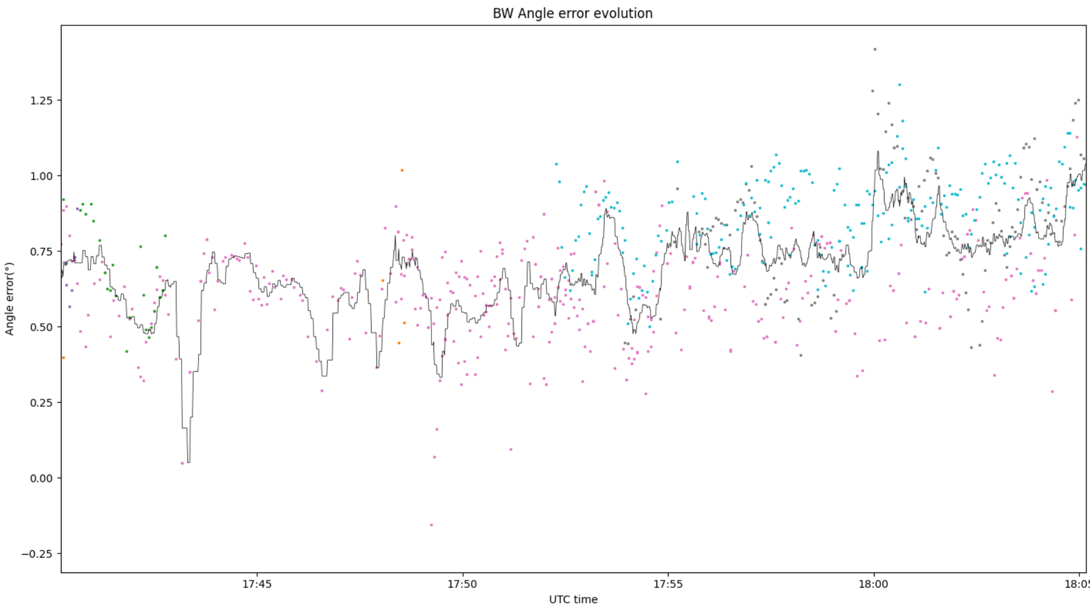


Figure 17 Zoom of the previous figure on the period when MH370 was tracked by BW

This data can then be used to obtain corrected BW angle measurements. As the PSR and the SSR are co-mounted, the PSR data are supposed to have the same angle error.

The error is on average 0.6° (each target is to be rotated 0.6° counter clockwise to correct this error).

2.3.3. Reflection

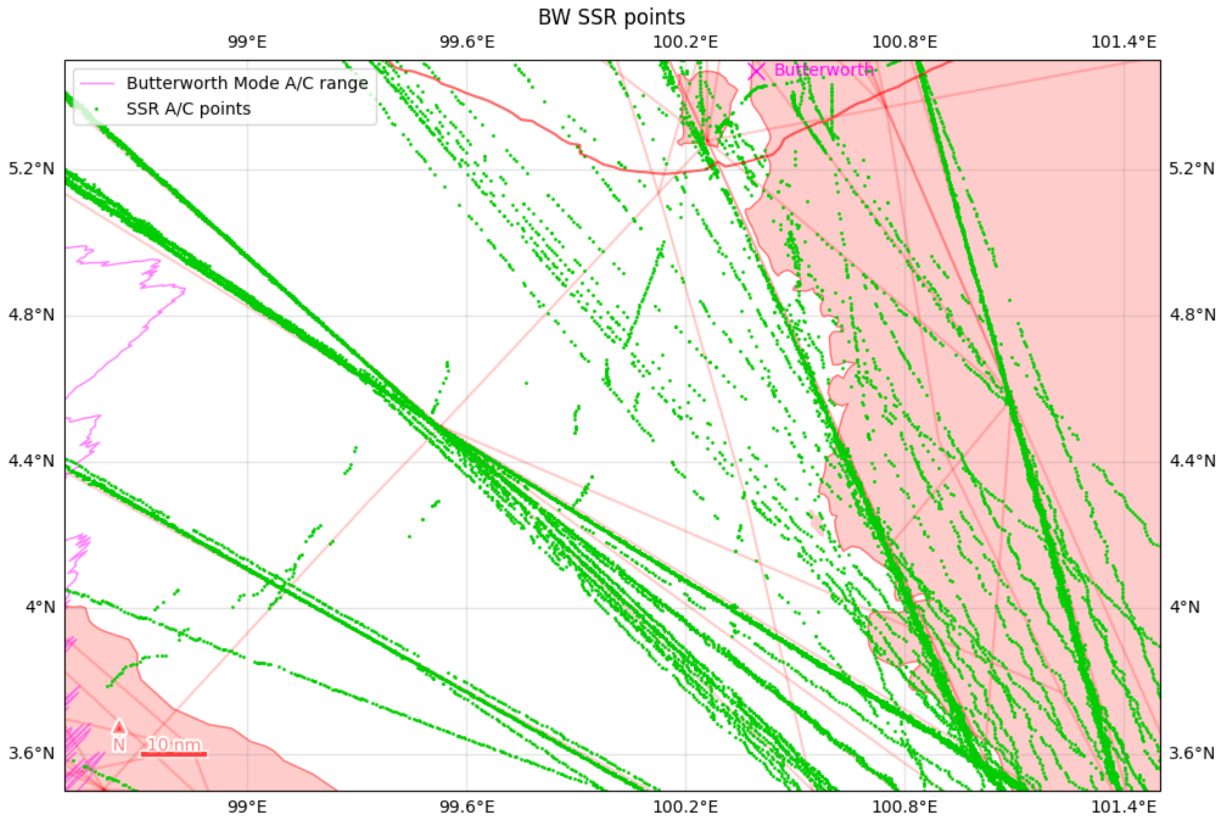


Figure 18 Zoom south west of Butterworth, BW data

In BW data, some ghost SSR tracks appear in the South West of Penang as visible in Figure 18. It seems that some SSR positions in the South Est are mirrored in the South West. A possible explanation is that the radio waves are reflected on hangars in the base in the South West of the radar head.

Figure 19 Butterworth hangars South West of the BW radar (Streetview)

When pointing to these hangars, the SSR seems to be able to interrogate transponders and receive replies, creating mirror targets in the South West. This probably cannot happen with PSR targets.

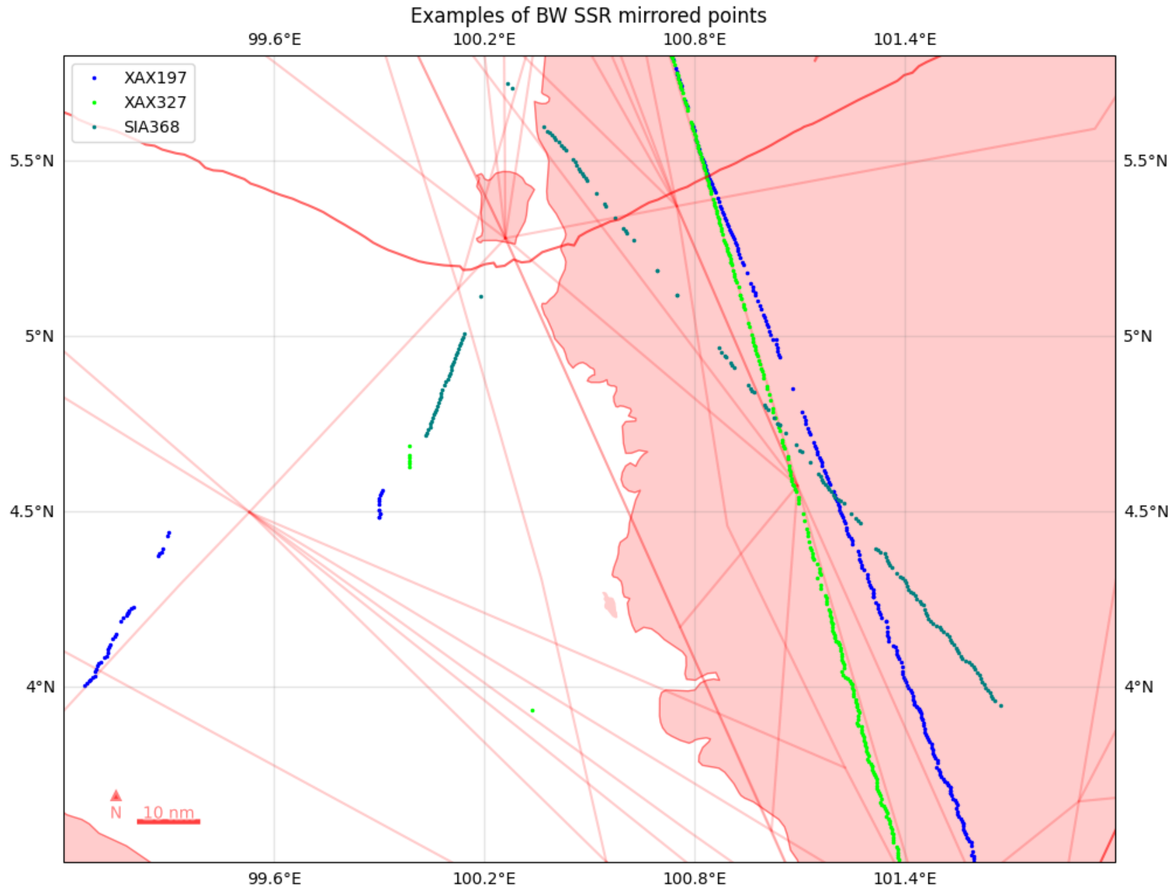


Figure 20 Three different flights with mirrored positions

2.4. Langkawi radar

2.4.1. Weather radar

The Langkawi data contains quasi constant weather data (ASTERIX CAT008). The intensity is 2 (in a scale from 0 to 7), and the location is 3 NM North East of the radar head, along a 2 NM line.

Figure 21 Representation of the constant Langkawi weather report in yellow, radar head in red

It probably corresponds to an error in calibration, as it aligns with the position of Gunung Raya mountain.

2.4.2. PSR performance

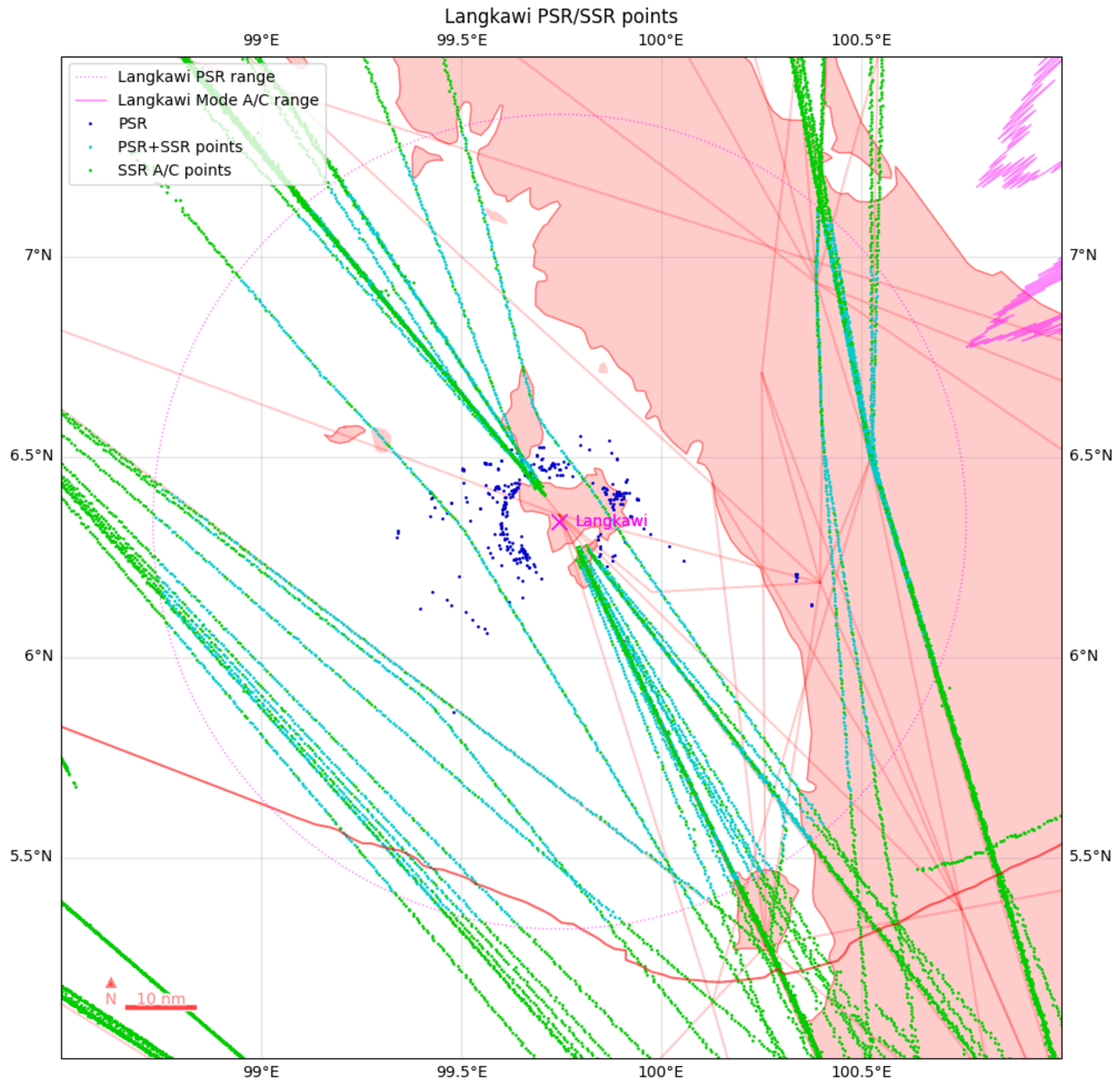


Figure 22 Zoom on Langkawi PSR and PSR+SSR reports

The Langkawi data indicates that PSR echoes were received for most of the target reports of the flights inside the PSR coverage (PSR+SSR position reports). However, it is unclear whether the PSR echoes could have been effectively reported for an aircraft with no transponder (SSR) reply. The data shows a high number of ghost PSR positions around the island. In the light of these facts, the radar may have had limited capabilities to track a "PSR only" aircraft.

2.5. ADS-B data

The ATC-Caption-2025 recording contains ADS-B data from both Genting and the Kuala Terengganu networks.

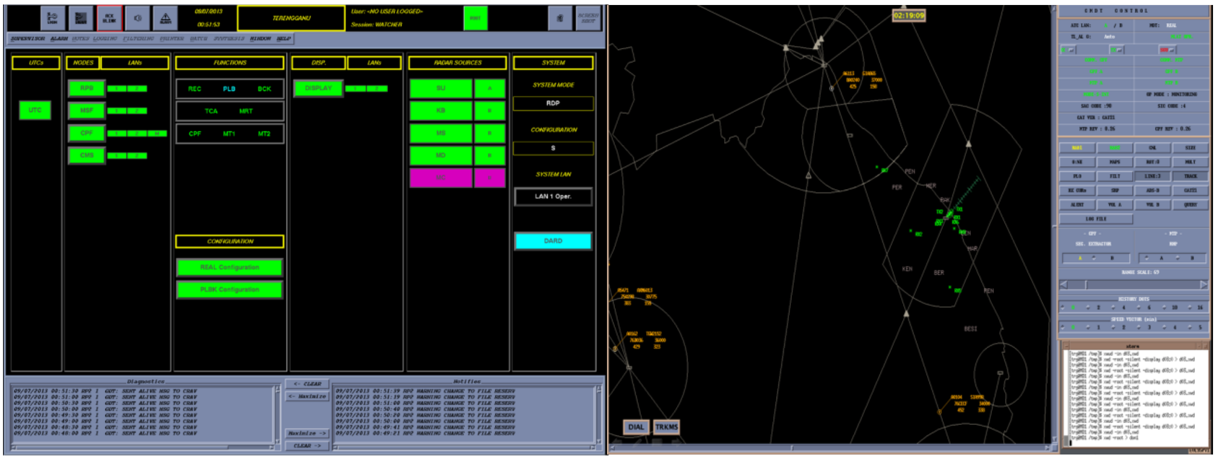


Figure 23 Screenshots of the Kuala Terengganu ADS-B system in 2013 [3]

While ADS-B is essentially a subset of Mode S, ADS-B is based on automatic broadcast of messages from the aircraft via their transponder, while a SSR interrogates aircraft and awaits for the replies. As ADS-B is not limited by the constraints of SSR radars (limitation of the time delay, reception of the interrogation, directional antenna…), the reception range of ADS-B stations is higher than that of an SSR.

The main Mode S messages downlink formats are:

Format	*Usage*
0	Short ACAS
4	Altitude
5	Ident (squawk)
11	All Call
16	Long ACAS
17	ADS-B
20	Altitude+Comm. B
21	Ident+Comm. B

Each “Downlink Format 17” message sent by a transponder is 112 bits long including an 8 bits header, a 24 bits “ICAO24” unique aircraft address, a 56 bits ADS-B message and 24 parity bits (to check the validity of the data). The 56 bits ADS-B message starts with a 5 bits “type code” indicating the content type of the message:

Type code	*Content*	*BDS*[3]
1 - 4	Aircraft identification	0,8
5 - 8	Surface position	0,6
9 - 18	Airborne position + Baro Altitude	0,5
19	Airborne velocities	0,9
20 - 22	Airborne position + GNSS Height	0,5
23 - 31	Reserved	

[3] BDS : Comm-B Data Selector is an hexadecimal code of the message structure

In flight, the most common types of ADS-B messages are airborne position + barometric altitude, and airborne velocity. Each message is usually sent twice a second on average. Aircraft identification messages are sent less frequently.

The ATC-Caption-2025 recordings do not contain any ADS-B message per se, instead Genting and KT data provide ASTERIX CAT021 messages. These messages can be seen as a close - but not an exact - transcription of the data from ADS-B format into ASTERIX format. For example, CAT021 messages don't have any type code. In the recording, most CAT021 messages contain both position and velocity data at the same time, which is not possible in ADS-B messages. Therefore, each CAT021 message can represent the fusion of data coming from multiple ADS-B messages and possibly other Mode S messages.

Content of the most common ADS-B messages:

- Aircraft identification:
    - ICAO24 address
    - Aircraft category (i.e. "Heavy", "Rotorcraft"…)
    - 8 characters aircraft ID (flight number)
- Airborne position + baro altitude:
    - ICAO24 address
    - Position accuracy
    - Surveillance status (emergency, "IDENT"…)
    - Altitude (25ft resolution)
    - Compressed GNSS coordinates
- Airborne velocities:
    - ICAO24 address
    - Intent change bit (change in autopilot)
    - Velocity accuracy
    - Ground Speed (Heading + speed or NS speed + EW speed)
    - Vertical rate (either barometric or GNSS)
    - Difference between GNSS altitude and barometric altitude (25ft resolution)

Content of each CAT021 (when the information is available):

- ICAO24 address
- Target Report Descriptor (multilateration, differential correction…)
- Figure of Merit (position accuracy, ACAS state…)
- Link Technology Indicator (ADS capabilities)
- Flight Level
- Vertical rate
- Aircraft ID (flight number)
- GNSS coordinates
- Geometric Altitude (GNSS)
- Signal Amplitude (strength of the received signal 0-255)
- Mode A Code (Squawk)
- Ground Vector (Ground speed + track angle)

Some of this data is possibly not provided by ADS-B data, but by other Mode S data.

2.6. ADS-C data

ADS-C means ADS Contract. It includes more detailed data on the intended flight plans in particular.

The ADS-C data is formatted in ASTERIX CAT021 format. In the ATC-Caption-2025 recording, ADS-C positions reports concern 34 flights for the duration of the recording, covering the North West of Kuala Lumpur FIR. The source of this data is probably a combination of VHF receivers (like the Langkawi ADS-C receiver on top of Gunung Raya mountain), SATLINK and inter-network. It is mainly used in the North West of the FIR, as radar coverage is very poor and stops well before the Kuala Lumpur FIR boundary. The reports frequency is variable. The time between two messages varies between 10s and 300s with a computed average of 90s.

Each ADS-C report can contain:

- Aircraft ID (flight number)
- Flight Level
- GNSS coordinates
- Ground Vector (Ground speed + track angle)

3. MH370 flight data analysis

3.1. ADS-B data

3.1.1. Coverage and trajectory

The ADS-B data of MH370 starts at 16:35:10 UTC by Genting station, when the plane is still on the ground at KLIA. At this moment, the plane is exiting the Satellite South apron and entering taxiway Hotel.

A10 is crossed at 16:39:57 to enter runway 32R as depicted in Figure 24.

The plane started accelerating at 16:40:52, and took off at 16:41:45 with a ground speed of 174 kts. It started a right turn at 16:43:20, and ended it at 16:43:55. At 16:46:20 the 10000ft altitude was crossed.

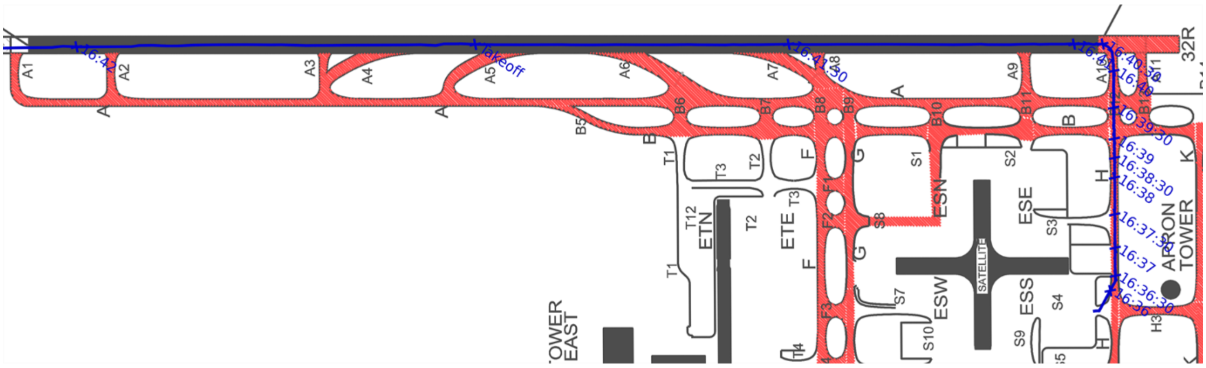


Figure 24 MH370 Genting ADS-B trajectory at KLIA

The first ADS-B message received by KT was at 16:49:37 UTC.

Genting received its last ADS-B message at 17:16:20 UTC.

The last SSR message received by Kuantan was at 17:20:32 UTC.

The last ADS-B message was received by KT at 17:20:34 UTC.

3.1.2. Other data

Figure 25, Figure 26 and Figure 27 present a fusion of Genting and KT ADS-B data.

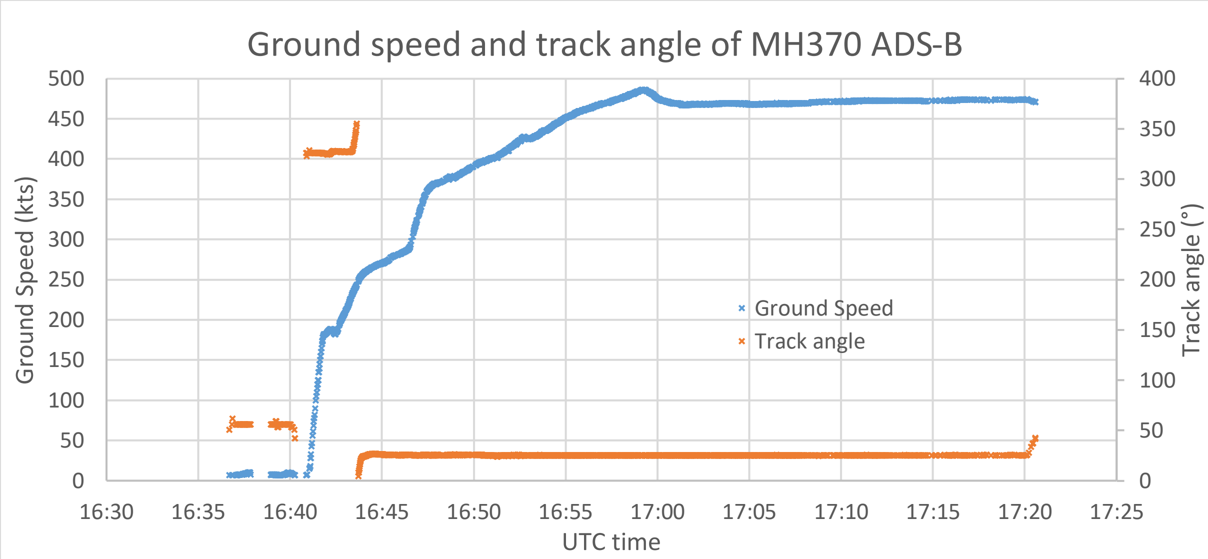


Figure 25 Ground speed and track angle of MH370 from taxiing to abeam IGARI, data fusion of Genting and KT ADS-B

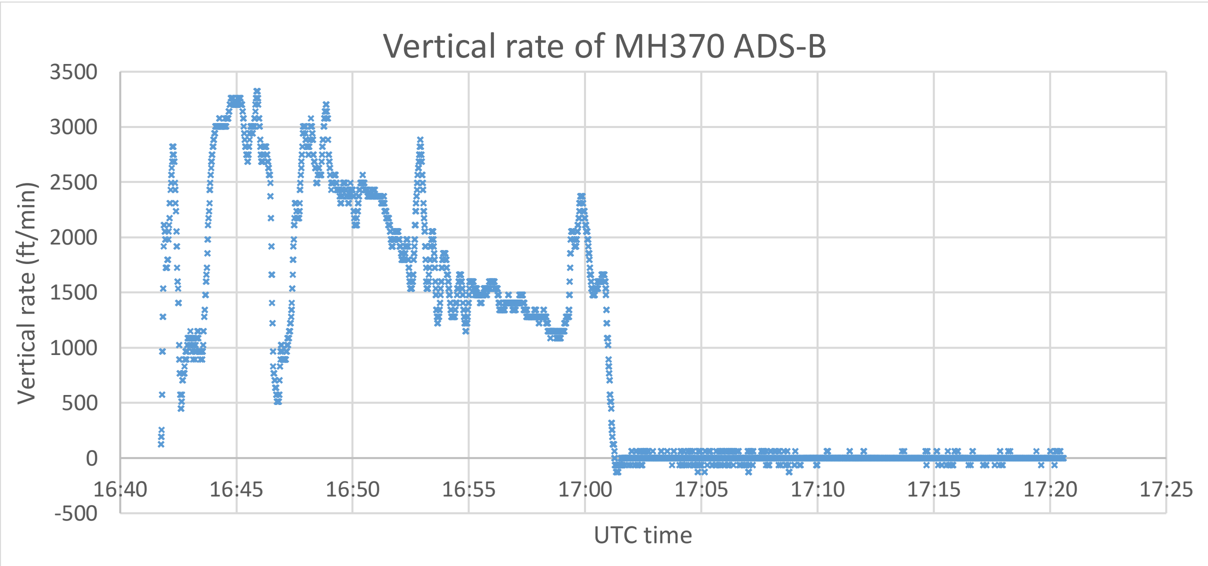


Figure 26 Vertical rate of MH370 from taxiing to abeam IGARI, data fusion of Genting and KT ADS-B

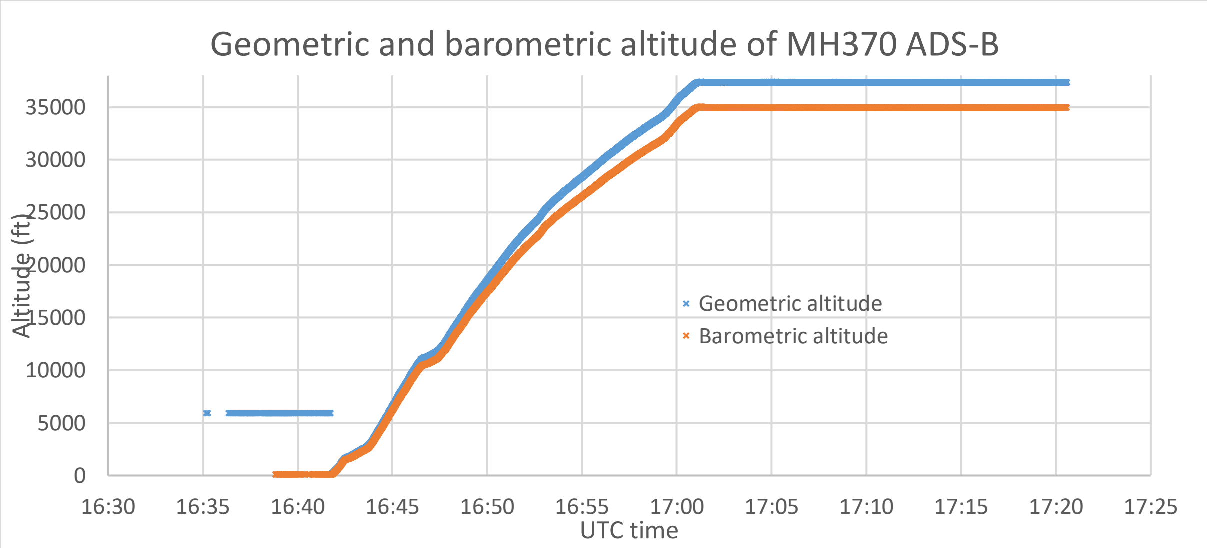


Figure 27 Geometric and barometric altitude of MH370 from taxiing to abeam IGARI, data fusion of Genting and KT ADS-B (the geometric altitude of the plane before the take-off is present in Genting data but is erroneous, it could be linked to a CAT021 transcription error)

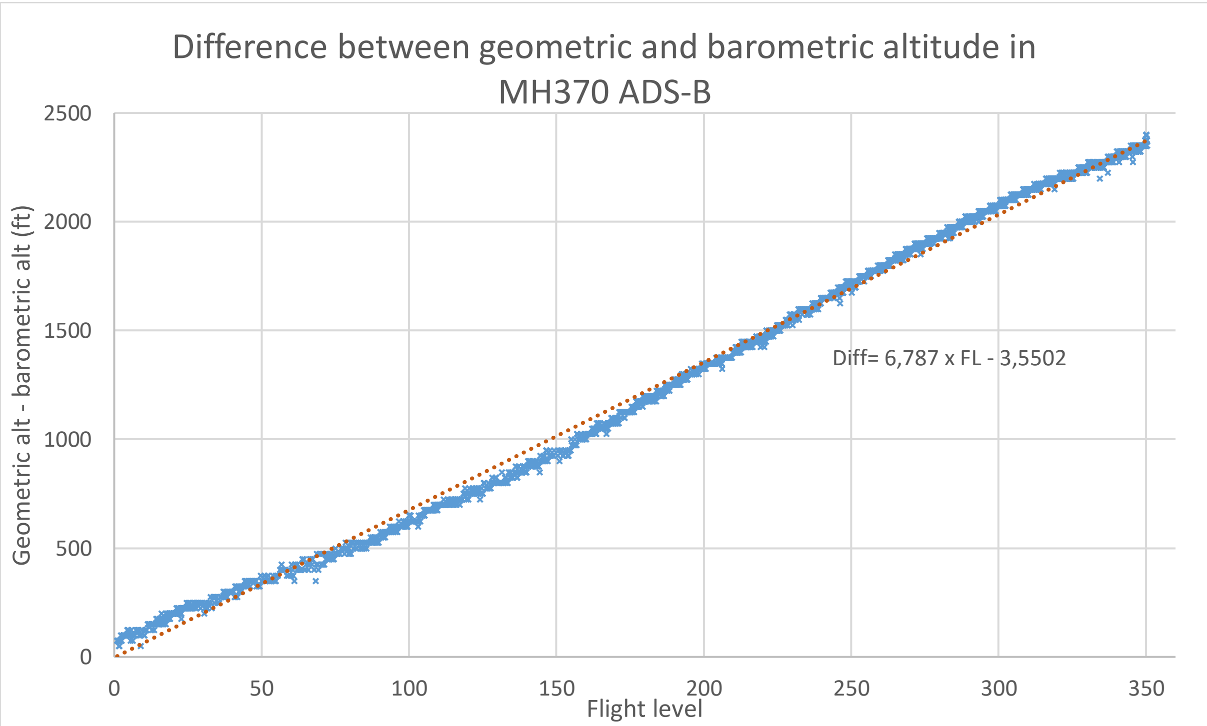


Figure 28 Difference between geometric and barometric altitude along the MH370 flight, data fusion of Genting and KT ADS-B

Last ADS-B data when abeam IGARI:

- Time: 17:20:34.555 UTC
- Mode A (squawk): 2157
- Latitude: 6.93192°
- Longitude: 103.59251°
- Flight level: FL350 (not present in the last 2 messages)
- Geometric altitude: 37350ft (GNSS source, height above the ellipsoid)
- Vertical rate: 0ft/min (precision 64ft/min)

- Ground speed: 471.3kts
- Track angle: 42.5°
- Signal: 44 (in a 0-255 range)
- Differential correction: No
- Navigational Uncertainty Categories – Position: 7 (containment radius < 0.05 NM, or 93m)

3.2. SSR data

3.2.1. Coverage

Table 3 presents the temporal coverage of MH370 SSR flight path by the different radars.

Table 3: Time intervals of MH370 radar coverage before IGARI in the ATC-Caption-2025 recording

Radar	*PSR*	*SSR Mode A/C*	*SSR Mode S*
KL S		16:39:44 - 17:05:32	
KL N	16:41:45 - 16:55:44	16:41:45 - 17:06:13	
Genting		16:41:47 - 17:14:39	
Subang	16:42:01 - 16:57:05	16:42:01 - 17:05:49	
Senai		16:46:32 - 17:02:42	16:46:36 - 16:51:11
Kuantan	16:56:23 - 17:03:43	16:48:34 - 17:20:32	
KB	17:06:31 - 17:15:37		16:52:42 - 17:20:30
BW		16:55:01 - 17:13:03	
Langkawi		17:01:33 - 17:10:01	

Mode S capable radars (Kota Bharu and Senai) can follow Mode S capable transponders either in Mode S or Mode A/C. In practice, these radars will use Mode S up to a distance of about 150 NM. Aircraft located further away will be interrogated via Mode A/C only.

Times in red mark loss of signal at the moment of the transponder shutdown.

3.2.2. Mode S data format

Mode S SSR "reply" data is able to provide the same information as Mode A/C, i.e. transmitting altitude and squawk. In addition, in this Mode, the "transponder registers" can be sent on demand as well. These 255 registers, which contain 56 bits each, designated by their Comm-B Data Selector or BDS, can contain permanent specific data of the flight, such as characteristics and capabilities of the aircraft, or variable data like the true airspeed or the magnetic heading. Only a few of these registers are sent by the transponder, some automatically with ADS-B (BDS 0,5 – 0,6 – 0,8 and 0,9) and others on request by interrogation from a Mode S SSR. In the ATC-Caption-2025 recording, 7 register types can be found:

BDS	*Name*	*Content*
1,0	Data link capability report	Mode S version and capabilities, ACAS capabilities
1,7	Common usage GICB capability report	List of common registers supported by the transponder
1,D	Mode S Specific Services Capability Report	List of less common registers supported by the transponder
2,0	Aircraft identification	8 characters identification or flight number
4,0	Selected vertical intention	MCP/FCU selected altitude, FMS selected altitude, barometric pressure setting, MCP/FCU Mode, target altitude source
5,0	Track and turn report	Roll angle, true track angle, ground speed, track angle rate, true airspeed
6,0	Heading and speed report	Magnetic heading, indicated airspeed, Mach, barometric altitude rate, inertial vertical velocity

In the ASTERIX formatted data, the BDS 2,0 register is directly provided in the form of the 8 characters identification, the other 6 BDS are recorded in raw binary format, as stored in the transponder and sent thereafter.

3.2.3. Transponder capabilities

BDS 1,0, BDS 1,7 and BDS 1,D are mainly equipment specifics and thus quasi-constant during the flight, the radar appears to ask for this data during the first interrogations only.

Here is the acquisition procedure from “European Mode S Station Functional Specification” [4] from EUROCONTROL:

1. Extract BDS 1,0
2. If bit 33 of BDS 1,0 is set then extract BDS 2,0
3. If bit 25 of BDS 1,0 is set then extract BDS 1,7 and BDS 1,D

In the case of MH370, BDS 1,7 and BDS 1,D were extracted once during the beginning of the coverage of each radar at 16:46:40 UTC for Senai and UTC 16:52:46 for Kota Bharu.

BDS 1,0 was extracted continuously by Senai, while Kota Bharu extracted it twice: once after acquisition at 16:52:42, and thereafter at 17:16:27 after a rotation without response.

All of these registers were constant during the flight:

BDS 1,0 value: 10010680F60000, decoded as:

Bits	*Value*	*Meaning*
16	1	ACAS operating
17-23	3	Mode S respecting Annex 10 version 2002
24	0	Level 2 to 4 transponder
25	1	At least one Mode S specific services capability is supported
26-28	0	No UELM Capability
29-32	0	No DELM Capability
33	1	Aircraft identification available
34	1	BDS 0,5 and BDS 0,6 have been updated in the last 10s
35	1	Surveillance identifier code capability
36	1	Common usage GICB capability report
37	0	ACAS Hybrid surveillance not operational
38	1	ACAS generating TAs and RAs
39-40	2	ACAS version RTCA/DO-185B & EUROCAE ED 143
41-56	0	No Data Terminal Equipment sub-address supported

Incidentally, this proves that at 17:16:27 the transponder switch was in the “TA/RA” position.

BDS 1,7 value: FA810100000000, decoded as:

- BDS supported: 0,5 / 0,6 / 0,7 / 0,8 / 0,9 / 2,0 / 4,0 / 5,0 / 6,0
- BDS not supported: 0,A / 2,1 / 4,1 / 4,2 / 4,3 / 4,4 / 4,5 / 4,8 / 5,1 / 5,2 / 5,3 / 5,4 / 5,5 / 5,6 / 5,F / E,1 / E,2 / F,1

(BDS 0,7 is “Extended squitter status”, it only contains the rate of ADS-B (high or low) and the altitude type (Barometric or GNSS). But it is not found in the data)

BDS 1,D value: 0

3.2.4. Speed data

The SSR Mode S different velocity resolutions are 2kts for TAS (True Air Speed), 2kts for GS (Ground Speed), 1kt for IAS (Indicated Air Speed), and 0.004 for Mach.

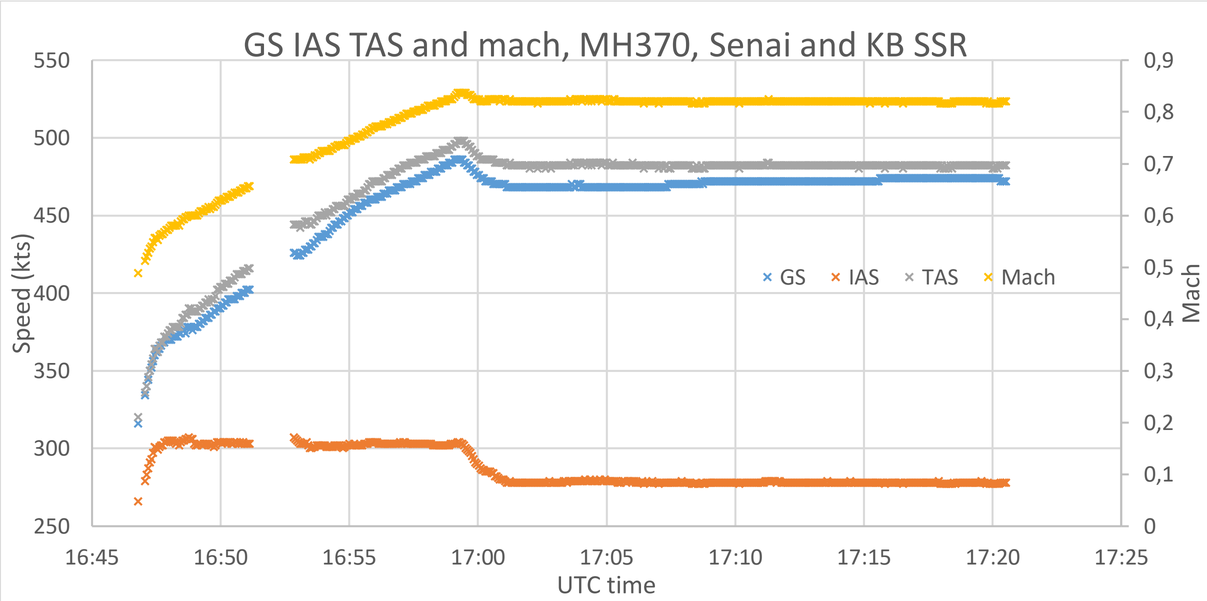


Figure 29 Different velocities of MH370 sent by the transponder with Mode S, in Senai and KB data

The resolution of SSR Mode S barometric altitude rate and inertial vertical velocity is of 32ft/min for both.

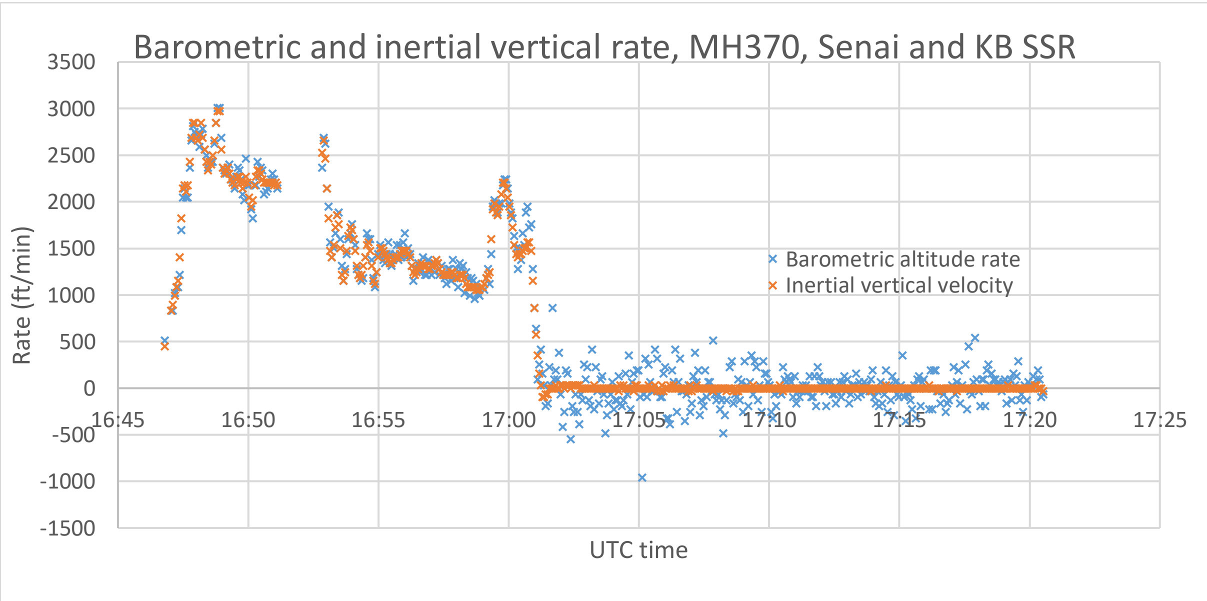


Figure 30 Different vertical rates of MH370 sent by the transponder with Mode S to Senai and KB

The barometric altitude rate is relatively erratic, which is a normal behavior. In [5] : « The Barometric Altitude Rate is usually very unsteady and may suffer from barometric instrument inertia. » and « The Inertial Vertical Velocity is also providing information on vertical movement of the aircraft but it comes from equipment (IRS, AHRS) using different sources used for navigation. The information is a more filtered and smoother parameter. »

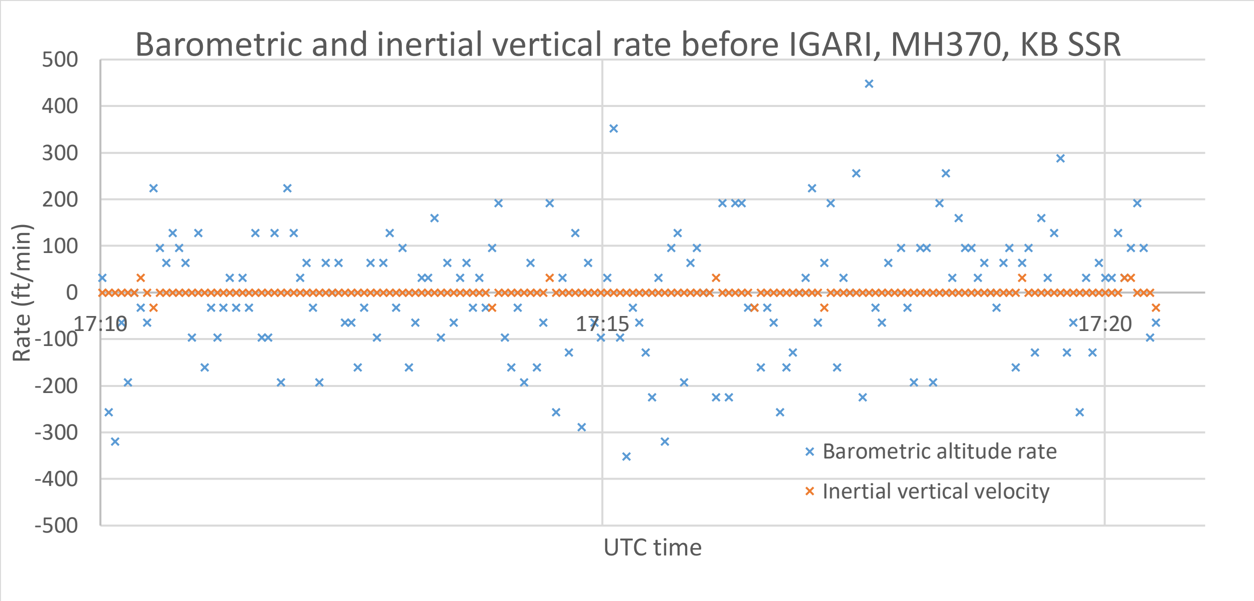


Figure 31 Vertical rates of MH370 sent by the transponder with Mode S before IGARI, in KB data

After 17:20 UTC, at the beginning of the turn the inertial vertical velocity increases slightly, and then decreases to reach -32ft/min, which may be due to the way the autopilot manages the turn towards BITOD, or alternatively to a small imprecision in the way the vertical velocity is calculated due to the banking.

It could also be due to the beginning of a manual piloting before the U-Turn.

3.2.5. Heading and roll data

The transponder did not send any track angle rate, but the magnetic heading, the track angle and the roll angle are all available. The resolution is 0.175° for all three.

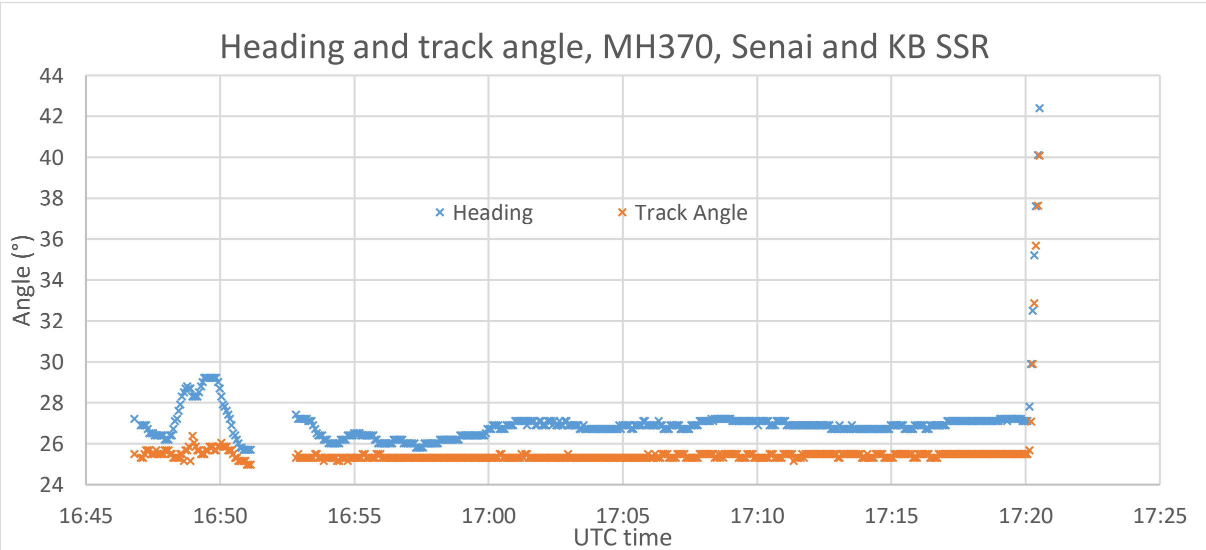


Figure 32 Heading and track angle of MH370 sent by the transponder with Mode S, in Senai and KB data

On the magnetic heading and track angle graph (cf Figure 32), the track angle seems relatively stable while the heading angle fluctuates before 16:53, this is coherent with the wind changes at different altitudes during the climb, with a compensated track angle by the autopilot.

The capacity of the auto-pilot to follow a perfect constant track should be noted. This will have to be taken in consideration on the leg returning to Malaysia after the U-Turn.

The raise of the angle curves indicates the beginning of the turn towards the next planned waypoint BITOD.

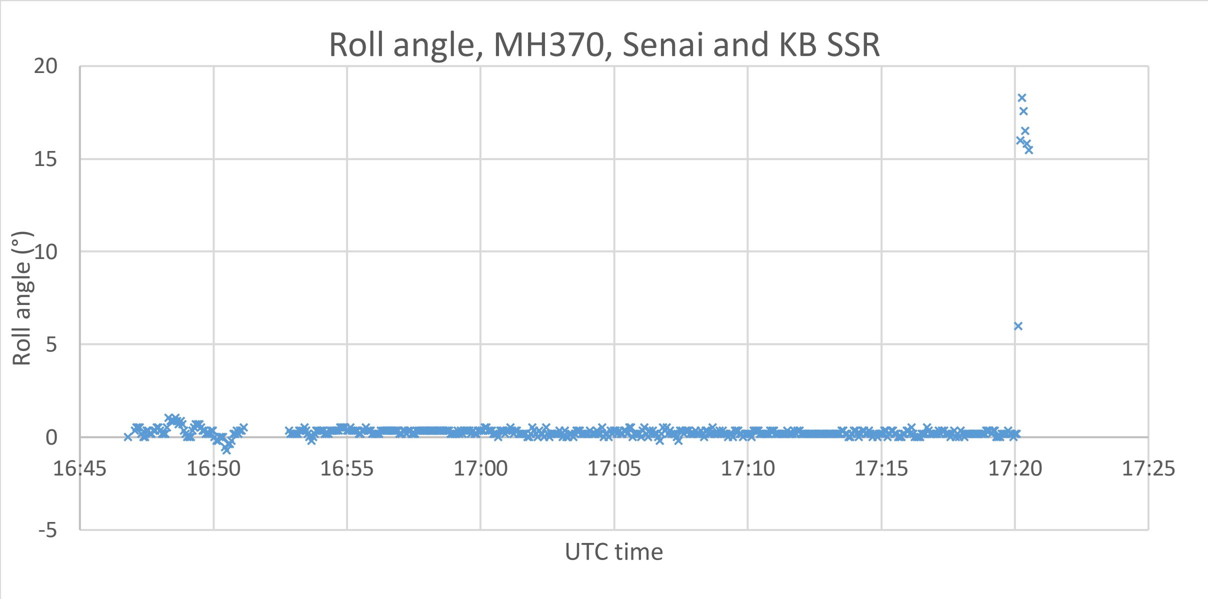


Figure 33 Roll angle of MH370 sent by the transponder with Mode S, in Senai and KB data

The roll angle is very steady, excepted maybe during the climb, when the autopilot has to compensate for the varying wind (cf Figure 33). Before the turn at IGARI, there is no noticeable variation and the roll angle stayed between +0.5 and -0.2° during the KB coverage. Added to the very stable vertical speed after 17:02, it shows that there was no input on the yoke before IGARI, which renders the scenario of a takeover of the plane by force less probable.

The roll angle data also confirms the turn at IGARI is at a banking angle of 15°. A slight roll overshoot can be seen at the start of the turn at 17:20:15 when the plane reaches a roll angle of 18,3° before stabilizing at around 15°.

The roll angle profile was compared with turns of other B777 in the ATC-Caption-2025 recordings and is depicted in Figure 34. The conclusion is that this overshoot is not unusual and does not indicate anything abnormal during the turn.

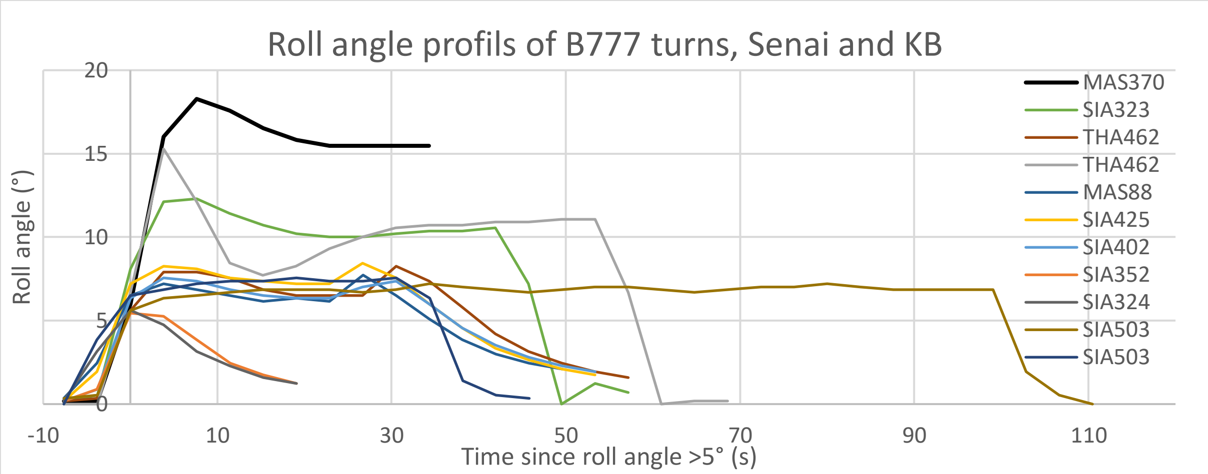


Figure 34 Roll angle of different B777 turns in the ATC-Caption-2025 recording compared to MH370 at IGARI, extracted from Mode S in Senai and KB data

3.2.6. MCP data

In the BDS 6,0 Mode S data, only the MCP/FCU (Main Control Panel/Flight Control Unit) selected altitude field is populated. The FMS selected altitude, the barometric pressure setting, the MCP/FCU mode and the target altitude source are not available for this transponder.

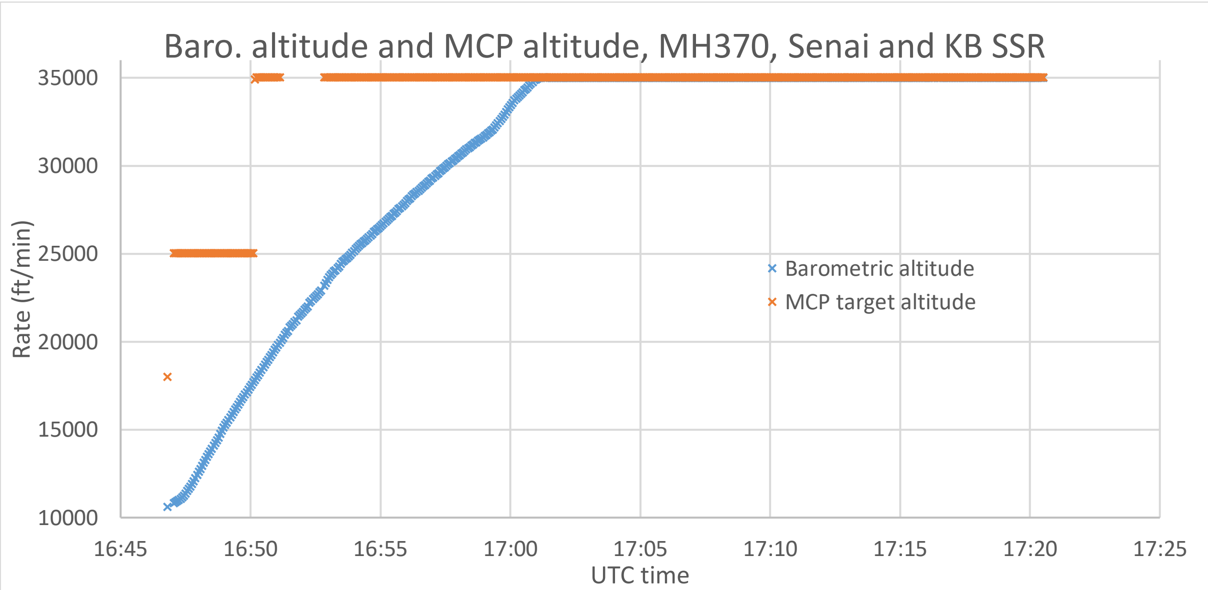


Figure 35 Barometric and MCP target altitude of MH370 sent by the transponder with Mode S, in Senai and KB data

The Main Control Panel target altitude is set at 18000ft during the first Senai replies (16:46:47), but is quickly changed to 25000ft at 16:47:03. At 16:50:10, the MCP altitude switches to 34900ft for one rotation, and then will reach and stay at 35000ft. It seems that the Senai SSR interrogated the transponder while the MCP altitude was being changed from 25000ft to 35000ft, hence the 34900ft value of 16:50:10. This is coherent with [6] and [7], which show that MH370 confirmed the ATC clearances of 18000ft at 16:43:01, 25000ft at 16:47:03 and 35000ft at 16:50:11.

3.3. Transponder data end

3.3.1. Last SSR data

The last replies to Malaysian SSR interrogations are received by Kota Bharu at 17:20:30.656 and Kuantan at 17:20:32.685. The first SSR interrogation without reply is at 17:20:34.508 when Kota Bharu interrogates the transponder without success. Kota Bharu and Kuantan were the only two Malaysian ATC radars to follow MH370 at the moment when the transponder was shut down. Kota Bharu includes a Mode A/C/S SSR and Kuantan a Mode A/C only SSR. The transponder stopped replying to these SSR radars at the same time. Note that the radar measurement occurs when the rotating radar antenna is pointing to the target, which will not happen at the same time for different radars. This explains the 2 seconds difference in the measurement of the absence of reply as they were not pointing to the aircraft simultaneously.

3.3.2. Last ADS-B data

The last ADS-B sourced data from MH370 is received at 17:20:34.555 by Kuala Terengganu. The last 2 CAT021 messages are interesting because they lack flight level data (ASTERIX CAT021/145).

CAT = 021	**LEN**	**FSPEC**	Items of the first record		**FSPEC**	Items of the last record

Figure 36 Illustration of an ASTERIX message, here a CAT021 message

Some analysts have stated in the past that the altitude value "went to 0" for the last 2 messages, but this is not true. The "Geometric Altitude" (CAT021/140) is present in all the messages, including the last two ones. The "Flight Level" is not null, it is simply lacking. Each ASTERIX message contains the data category number in the first byte (here 21) followed by the length of the message, then 1 to 4 bytes called FSPEC (for field specification) that list the type of data (items) included later in the message. Then the rest of the message contains the data itself. Each item defined in the ASTERIX standard can be either present or absent (except for some compulsory items). If an item is absent, it will just be indicated as absent in the FSPEC. This is the case in the last two messages: the "Flight Level" item (CAT021/145) is simply not contained in these messages. The same apply for most of the previous messages for the ground speed, or "Ground Vector" (CAT021/160), where the item is indicated as absent in the FSPEC.

Here is the content of the 7 last MH370 KT CAT021 messages:

UTC time (17:20:xx)	*31.664*	*32.195*	*32.602*	*33.102*	*33.609*	*34.148*	*34.555*
Time of Day (s)	62431.664	62432.195	62432.602	62433.102	62433.609	62434.148	62434.555
Mode 3	2157	2157	2157	2157	2157	2157	2157
Latitude (°)	6.9273	6.9280	6.9287	6.9297	6.9303	6.9313	6.9319
Longitude (°)	103.5884	103.5890	103.5896	103.5904	103.5910	103.5919	103.5925
GNSS alt. (ft)	37350	37350	37350	37350	37350	37350	37350
Flight Level	350	350	350	350	350	N/A	N/A
Vert. Rate (ft/min)	0	0	0	0	0	0	0
GS (kts)	N/A	N/A	N/A	N/A	470.87	N/A	471.31
Track Angle (°)	N/A	N/A	N/A	N/A	41.93	N/A	42.54
Identification	MAS370	MAS370	MAS370	MAS370	MAS370	MAS370	MAS370
Target Descriptor	40	40	40	40	40	40	40
Signal	35	28	32	41	43	44	44
F.O.M.	2055	2055	2055	2055	2055	2055	2055
Link Technology	8	8	8	8	8	8	8

Here the difference between ADS-B messages and ASTERIX CAT021 messages is important. As ADS-B messages cannot contain both position and speed data at the same time (two different types of ADS-B messages), it means that some of these CAT021 messages contain the data coming from at least 2 ADS-B messages. So, CAT021 messages and ADS-B messages do not necessarily correspond one to one. As both position and speed ADS-B messages are sent on average every 0.5s (in reality every 0.4 to 0.6s with a random distribution [8]), and all CAT021 messages contain position and are recorded every 0.5s, we can conclude that the receiver was probably sending a CAT021 on the ATC network every time a position ADS-B message (type code 9 – 18, BDS 0,5) is received. If a speed ADS-B message (type code 19, BDS 0,9) was received recently (probably less than 100ms before), then the ground speed data is included in this CAT021 message. This is why only 18% of the MH370 CAT021 messages in KT data contain ground speed data. Interestingly, the vertical rate data (which is sent along with the ground speed data) is present in every message, it seems that the receiver keeps this data in memory longer than the ground speed data.

So ASTERIX CAT021 messages in the ATC-Caption-2025 data correspond to the reception of position ADS-B messages. Thus, as the last message contains speed data, we know that a speed ADS-B message was received between the last two CAT021 messages. In fact, another speed ADS-B message could have been received after the last CAT021 message, but as it seems that the receiver sends a CAT021 only when it receives a position ADS-B message, it might have never sent this last data over the network.

The question is why the "Flight Level" data is absent from the last two CAT021 messages. In the KT data, only 5 CAT021 messages concerning aircraft in flight don't contain the "Flight Level" data:

- The last two messages of MH370
- Two messages of SIA800 at 17:50:39
- One message of THY67 at 17:20:09

The transponder (or some other onboard equipment) of SIA800 was clearly malfunctioning, some target reports in Senai data also indicate no FL for SIA800, and GNSS positions sent by the transponder are clearly incoherent. It is unclear why THY67 message is lacking the flight level. Thus, overall, among the 614613 CAT021 messages, only 3 messages corresponding to aircraft in flight without prior transponder issues can be found, and two of them are the last two MH370 CAT021 messages.

Flight Level data missing signaling the transponder shutdown

We can conclude that the hypothesis that the absence of the Flight Level data is linked to the shutdown of the transponder is extremely highly probable and that its absence in the CAT021 data is caused by the absence of this data in the BDS 0,5 position ADS-B message. The last two ADS-B messages couldn't have been corrupted (either at transmission or at reception) as the parity check of the ADS-B messages would have forced the KT receiver to ignore them, so this change in the last two messages cannot be caused by jamming, or by a decrease in the transponder signal strength. The absence of altitude in BDS 0,5 is indicated by an altitude binary field equal to 0. In [8]: "0 shall be transmitted in each of the 13 bits of the AC field if altitude information is not available or if the altitude has been determined invalid.". The field can contain altitude in meters or feet, between -1000ft and +50175ft and the value of this field corresponding to 0ft is 12. So, one can conclude that if the transponder had sent a 0ft altitude, the CAT021 messages would probably have contained a flight level of 0ft (i.e. value = 12), which is not the case. <u>The logical conclusion is that the altitude was reported as unavailable or invalid by the transponder.</u>

So what are the plausible causes to this missing data?

In the past, other analysts have presented one of the causes of missing data as originating from the transponder control unit switch on position "ALT OFF", which blocks the reply of barometric altitude in Mode C and Mode S in formats 4 and 20, and in BDS 0,5 in format 17 (ADS-B). In that case, the transponder reports the altitude as unavailable (e.g. for transponder KT 73: "The transmission of altitude information will be inhibited. [...] All ZEROs will be transmitted in the altitude field of the Mode S replies." [9]). The fact that the transponder sent two messages without the altitude data separated by 0.4s could be due to the passage through the "ALT OFF" position while turning the switch from TA/RA to Standby on the transponder control unit in the cockpit, which was polled at this very moment. The control unit in the cockpit and the transponder are communicating through an ARINC 429 bus which is quite old (1978) and slow as most of the data is transmitted at 12kbps. Thus, it is possible that the switch status is polled at relatively low frequency, and if it was polled at the very moment it passed the "ALT OFF" position, the transponder may have had the time to send two position messages without flight level before the next polling which would have been "Standby".

The other cause could be the unavailability of the barometric altitude to the transponder, which may correspond to an accident scenario. "If valid horizontal position information is available to the ADS-B Transmitting Subsystem, but valid barometric pressure-altitude information is not available, and valid geometric altitude information is available, the ADS-B Transmitting Subsystem shall set the TYPE subfield of Airborne Position Messages to a value in the range from 20 to 22" [5]. According to [5], the sources for barometric altitude in BDS 0,5 in decreasing priority are: ADS, IRS/FMS. The sources of GNSS coordinates in BDS 0,5 in decreasing priority are: FMC/GNSS, FMC/GEN, IRS/FMS. So if the transponder was not in "ALT OFF" mode and had lost barometric altitude, it should have sent GNSS altitude if it was available.

It is important to note that all the CAT021 messages contain a Figure of Merit (F.O.M.) that gives a Navigational Uncertainty Categories – Position (NUC_p). In the Genting and KT ADS-B data, the only NUC_p values sent by flying aircraft are either 0, 5, 6 or 7. For MH370, in some messages the NUC_p decreases to 6, but during most of the flight and more importantly in all the messages after 17:13:29, the NUC_p is 7. The NUC_p is encoded in every ADS-B message containing the aircraft's position.

NUC_p	Containment radius
7	Between 10m and 0.1NM
6	Between 0.05 and 0.1NM
5	Between 0.1 and 0.25NM
0	>10 NM

As stated above, if the transponder were to lose barometric altitude, the transponder would have to send GNSS altitude. But one other crucial detail is that the only possible NUC_p values with GNSS altitude are 0, 8 and 9. Since the NUC_p remained at 7 during the last messages, this could only mean that both GNSS and barometric altitude had been lost, or that the transponder was in "ALT OFF" mode.

There are only 4 flights in the ADS-B data (Genting and KT receivers combined) which contain 0 and non-0 NUC_p :

- CPA714, 3 successive messages with NUC_p=0 (during 1s), the rest is 6 or 7
- ETD413, 2 isolated messages with NUC_p=0 (separated by 30s), the rest is 6
- FIN82, 1 isolated message with NUC_p=0, the rest is 6 or 7
- SIA800, mostly NUC_p=0, with some 7 before 17:50:39, 6 or 7 after

SIA800 seems to have issues with its transponder, which end at 17:50:39, after one no altitude message. It is possible that the transponder was switched to standby then back to TA/RA to resolve the issues. But overall, the data shows isolated NUC_p=0 messages in several 6 or 7 messages and isolated NUC_p=7 messages in several 0 messages, demonstrating that the NUC_p value is extremely responsive to the GNSS precision.

As a result, if MH370 had lost its GNSS receiver, the last messages would have contained a NUC_p of 0. It was not the case, the last two messages have a NUC_p of 7.

The table below summarizes the coherence with the last messages of MH370 (FL unavailable and NUC_p =7) with the altitudes available to the transponder and the "ALT OFF" mode:

Altitudes available	*FL available*	*NUC_p*	*Coherent with the last messages*
GNSS and Baro	Yes	0 to 9	No
Barometric only	Yes	0 to 9	No
GNSS only	No	0, 8 or 9 [5]	No
None	No	0	No
"ALT OFF"	**No**	**0 to 9**	**Yes**

At this point, the fact that the NUC_p remained at 7 definitively demonstrated that the lack of flight level in the CAT021 messages could not have been caused by the lack of valid altitude available to the transponder.

Therefore, the only possible remaining cause of the last two messages is that the transponder was in "ALT OFF" mode before it stopped emitting. Consequently, the end of transponder data is necessarily due to a deactivation from the cockpit.

The GNSS altitude is not usually included in the ADS-B data as such. The GNSS altitude in CAT021 data is calculated with the flight level data in position ADS-B messages (barometric altitude) and the difference between the GNSS altitude and the barometric altitude in speed ADS-B messages. Therefore, the last two "Geometric Altitude" values are probably not updated values but values repeated from previous messages as the barometric altitude is not present anymore.

3.3.3. Transponder shutdown sequence

In order to compare timings in KT ADS-B and SSR data in KB and Kuantan, the time shift between the different sources was calculated using the variation of altitude of several flights. It was found that KT ADS-B clock was on average 0.19s earlier than KB clock. Even if it could not be measured, Kuantan is assumed to have no time shift with KB. Here are the last messages received from the transponder using the time of KT ADS-B at 17h20:

Seconds of 17:20 UTC	*Type*	*Source*	*Comment*
24.305	ADS-B	KT	
24.820	ADS-B	KT	
24.842	SSR A/C	Kuantan	
25.406	ADS-B	KT	
25.805	ADS-B	KT	
26.258	ADS-B	KT	
26.766	ADS-B	KT	
27.065	SSR S	KB	
27.273	ADS-B	KT	
27.680	ADS-B	KT	
28.234	ADS-B	KT	
28.703	ADS-B	KT	
28.819	SSR A/C	Kuantan	
29.188	ADS-B	KT	
29.695	ADS-B	KT	
30.195	ADS-B	KT	
30.664	ADS-B	KT	
30.846	SSR S	KB	Last KB reply
31.664	ADS-B	KT	
32.195	ADS-B	KT	
32.195	ADS-B	KT	
32.602	ADS-B	KT	
32.875	SSR A/C	Kuantan	Last Kuantan reply
33.102	ADS-B	KT	
33.609	ADS-B	KT	Last KT ADS-B with Alt
33.906	--	--	Closest to IGARI
34.148	ADS-B	KT	
34.555	ADS-B	KT	Last KT ADS-B
34.698	SSR S	KB	First KB lack of reply
35.155	ADS-B	KT	First KT lack of message
36.877	SSR A/C	Kuantan	First Kuantan lack of reply

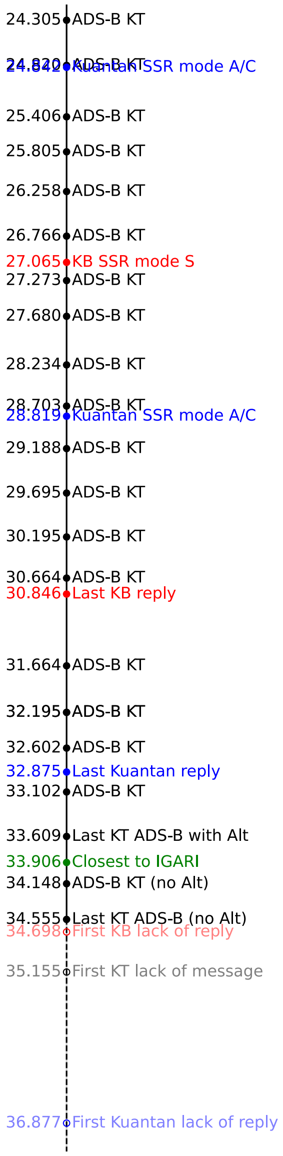


Figure 37 Timeline of the transponder shutdown sequence

As the receiver seems to send CAT021 messages (over the ground network) only when an ADS-B position message is received, and not after an ADS-B velocity message, there could have been another ADS-B velocity message between 34.555 and 35.155. But as the transponder did not reply to KB at 34.698, it seems that the state of the transponder switched from "ALT OFF" to "Standby" between 34.555 and 34.698 (KT clock). Thus, <u>there is a complete coherence between ADS-B, SSR Mode A/C and SSR Mode S on the time of the transponder shutdown.</u>

3.4. Atmospheric data

3.4.1. Geometric altitude

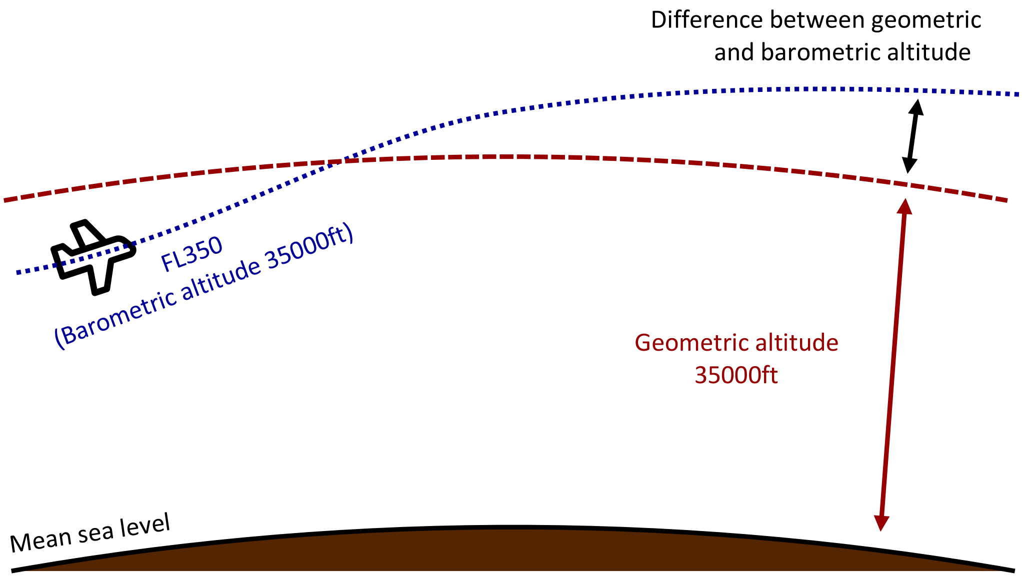


Figure 38 Diagram of the difference between barometric altitude and geometric altitude.

When an aircraft altimeter indicates 35000ft (or FL350), the aircraft is not necessarily flying 35000ft from mean sea level, but at an altitude where the atmospheric pressure corresponds to the ISA pressure for 35000ft (i.e. 238.42hPa). This is the barometric altitude. Depending on the atmospheric conditions, the geometric altitude, which is the altitude above the ellipsoid (or above mean sea level), may be above or below the barometric altitude (see Figure 38). As an analysis of the altitude of a target followed by PSR will involve the geometric altitude, and aircraft are flown using the barometric altitude, it is critical to know the relationship between the two.

ADS-B data transmitted by transponders of aircraft flying in the area contains the difference between the GNSS (Global Navigation Satellite System, e.g. GPS) altitude, which is the geometric altitude, and the barometric altitude. The ASTERIX CAT021 messages contain the barometric altitude (in FL format), and the calculated GNSS altitude. Using the data from KT and Genting ADS-B, it is possible to measure the relationship between the two altitudes. As the weather was calm during this night, the relationship is relatively consistent in time and space during the MH370 flight from Kuala Lumpur to the Malacca strait via IGARI. The plot of the geometric altitude as a function of the barometric altitude within 100 NM from IGARI is presented in Figure 39.

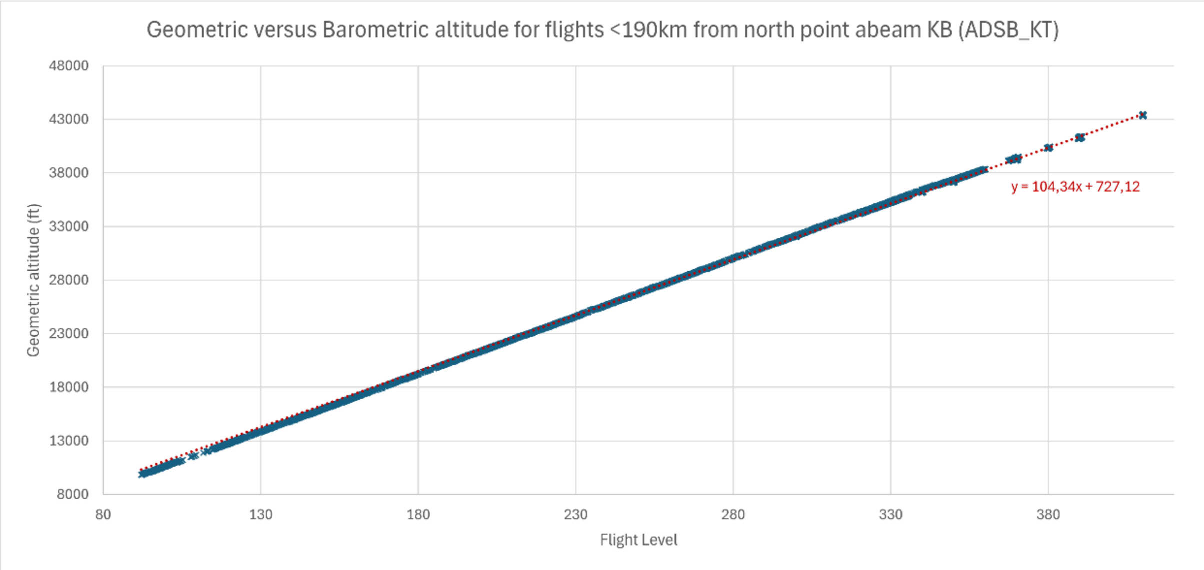


Figure 39 Relationship between barometric altitude and geometric altitude for different flights around "KB in" ADS-B data.

The results posted by the analysis of the Geoscience data correlated to the horizon of the radars [10], shows that the MH370 descended not much below approximately 30000ft between KB and MEKAR. Thus, it is necessary to go more in details and "zoom" the X-axis scale between FL300 and FL410.

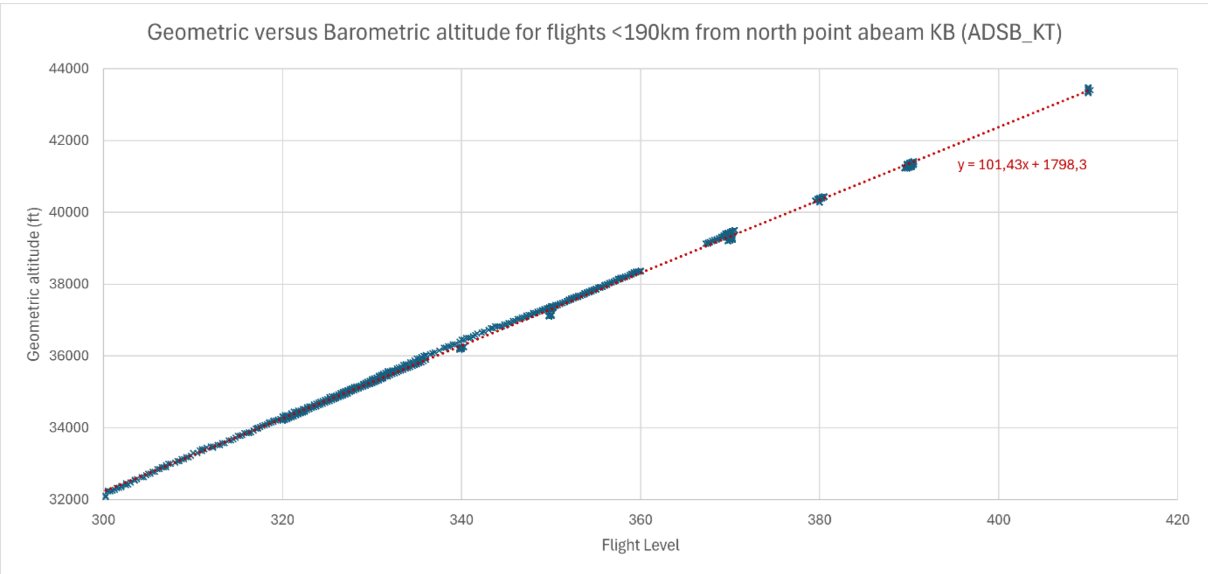


Figure 40 Relationship between barometric altitude and geometric altitude around "KB in" ADS-B data for flights above FL300.

Zooming in further and now considering the difference between geometric altitude and barometric altitude, the relationship takes a different shape:

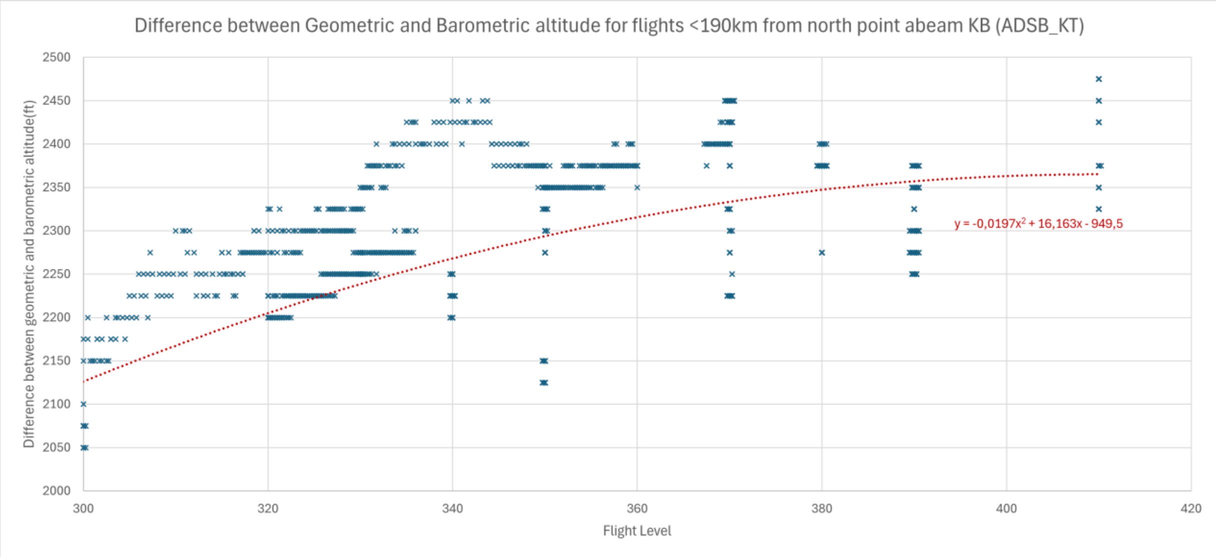


Figure 41 Difference between geometric and barometric altitude for flights above FL300

Using this data and a polynomial regression, it appears that the geometric altitude above FL300 can be approximated from the flight level by using the formula:

$$alt_{geometric} = -0.0197 \times FL^2 + 116.163 \times FL - 949.5$$

Its inverse formula is:

$$FL = 2948.3 \; - \; 0.02538 \times \sqrt{1.3419 \times 10^{10} \; - \; 78800 \times alt_{geometric}}$$

In the rest of this document, these formulas are used to calculate the geometric altitude based on the barometric altitude or the inverse.

3.4.2. Wind data

Wind estimation around an aircraft is possible by using ground speed, true air speed, true track angle and heading. This estimation was calculated for the KB SSR track, and for different flights that crossed the path of MH370, and compared to ERA5[4] [11] [12] calculated wind. Both GS and TAS have a resolution of 2kts, thus the estimation precision cannot be better than 4kts.

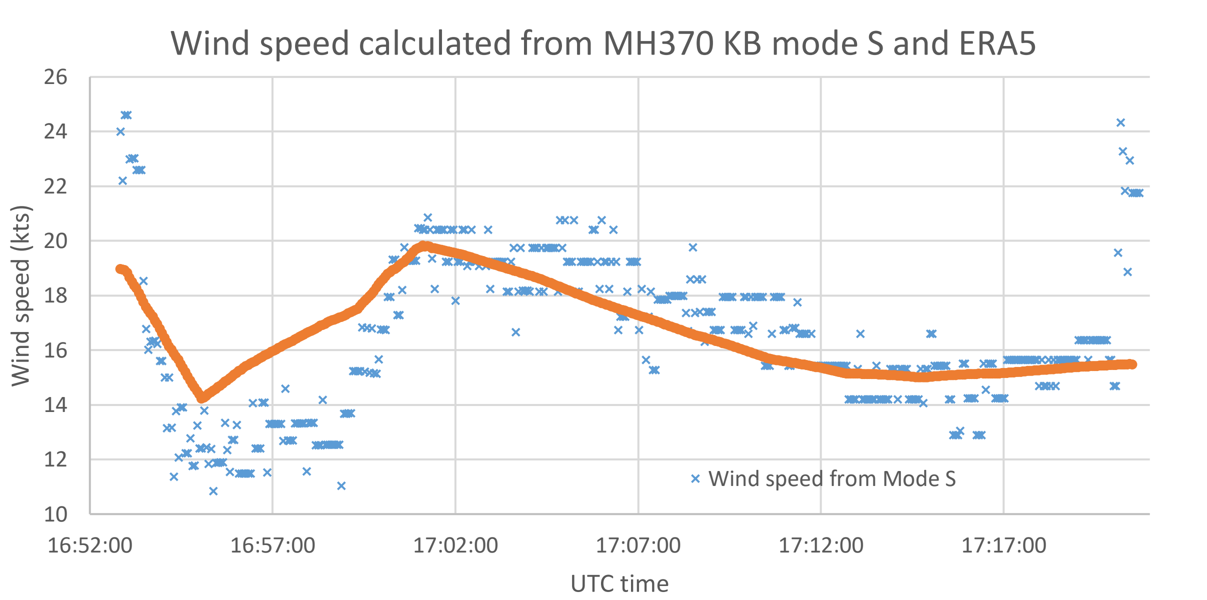


Figure 42 Comparison of Mode S calculated wind speed from KB data (blue), and ERA5 calculated wind speed (orange) along M370 flight toward IGARI

As illustrated in Figure 42, the wind calculated from Mode S data and ERA5 matches well except during the IGARI turn (the estimation of the wind from Mode S is only reliable if the aircraft is flying with a low banking angle). This confirms that ERA5 provides a reliable estimation of the surroundings of plane, and that the Mode S data can be used to estimate the local wind around flights tracked with Mode S.

As an example, before IGARI, ERA5 gives a wind of 15.4kts, coming from 86°, Mode S data from KB gives a wind of 15.9kts, coming from 87°.

[4] The results contain modified Copernicus Climate Change Service information 2020. Neither the European Commission nor ECMWF is responsible for any use that may be made of the Copernicus information or data it contains.

3.5. Kota Bharu PSR data

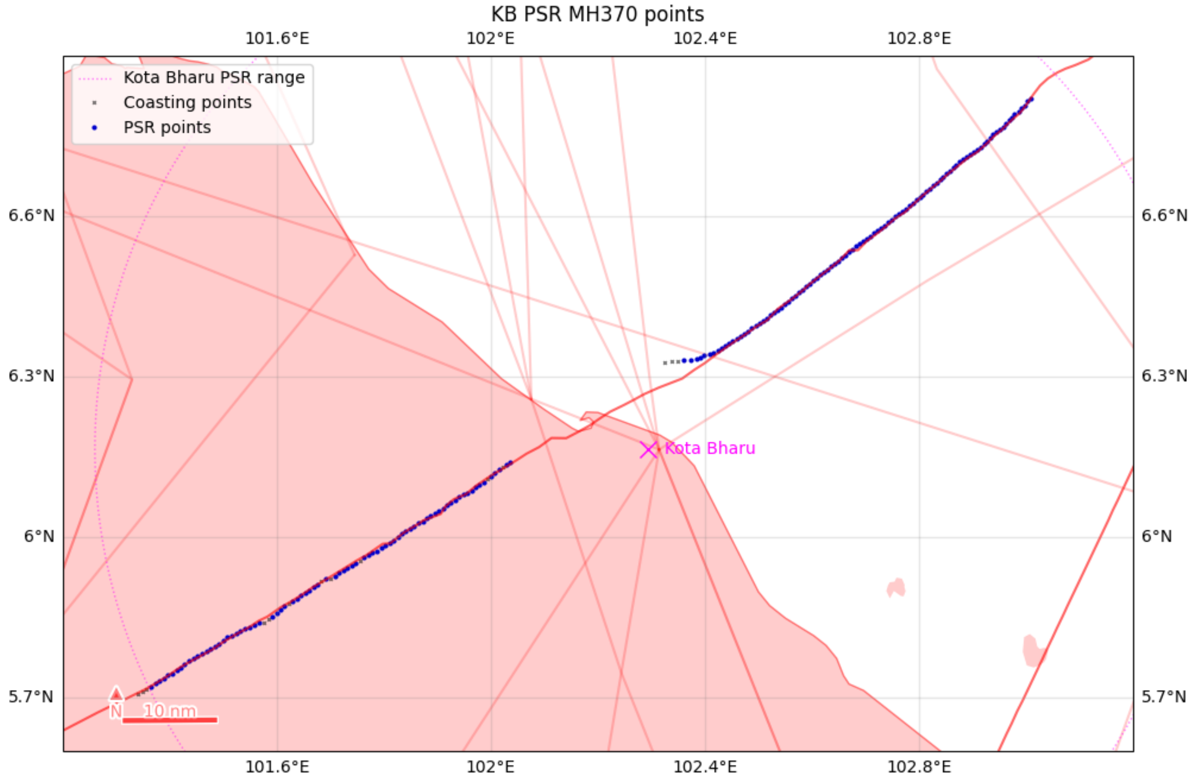


Figure 43 MH370 PSR tracks ("KB in"/1774 and "KB out"/1827, PSR points in blue, coasting points in grey)

3.5.1. Tracker speed (work in progress)

The Kota Bharu radar data in ATC-Caption-2025 contains tracker data; the raw positions had been filtered and processed and the result provides positions in Cartesian coordinates with the origin at the radar head for all target reports. A ground speed vector had been calculated by the radar for each report using multiple positions. This velocity vector consists of a ground speed value (CGS) and a track angle value. For the two MH370 PSR tracks ("KB in" and "KB out") the position and ground speed vectors seem to be calculated without slant range correction (i.e. coherent with a trajectory at the same altitude as the radar). Therefore, the calculated speed around the cone of silence is not representative as the plane was flying much higher. But further away from the head (at the beginning of "KB in" and the end of "KB out"), this speed should be more representative of the actual ground speed of the plane at these locations. Furthermore, a tracker-calculated ground speed value is already provided in the first target report of each track. As the tracker needs at least two rotations to calculate this speed, one can conclude that:

- As suspected, the first target report of "KB in" is not representing the first echo from the plane received by KB, one or more echoes were necessarily received beforehand without generating a report, as the track was still a tentative track at that time
- Even if those echoes cannot be "recreated" or calculated, the calculated tracker speed gives us information on the speed before the first known (or reported) position in the KB data.

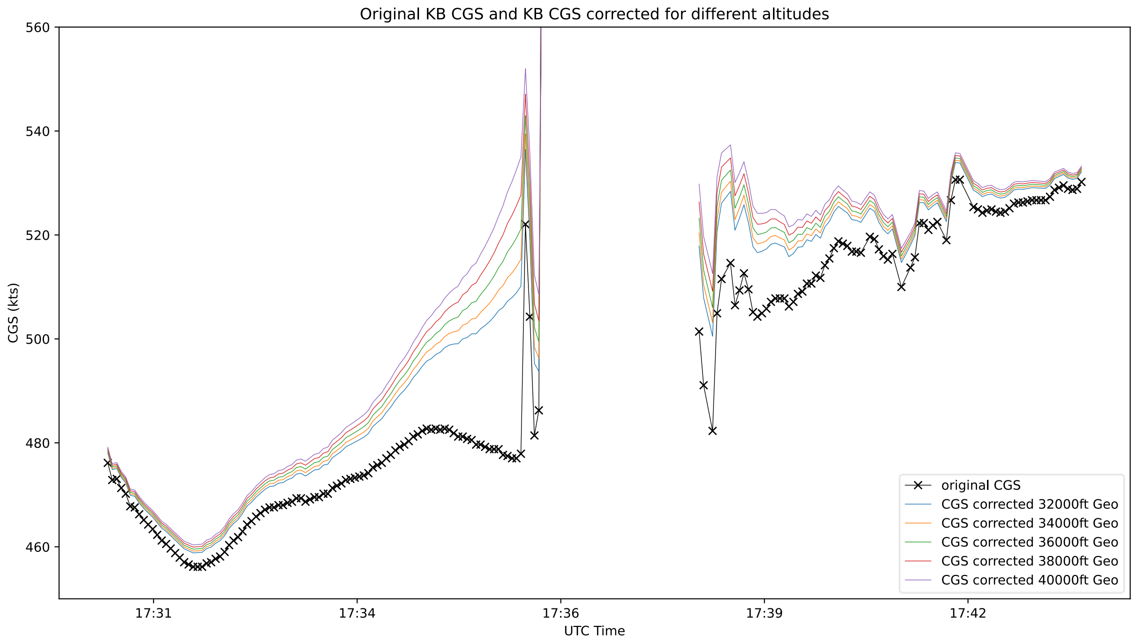


Figure 44 Ground Speed calculated without slant range correction (coherent with a target at the radar head height) by the KB tracker for MH370 PSR in track in black, corrected ground speed for different altitudes from the original CGS in colors

The data suggests that the ground speed during "KB in" decreased to reach a minimum of 460kt at 17:31:50. The filtering of the data by the tracker implies that this minimum was reach earlier (up to 30s earlier), and potentially that the speed at the first echo received by KB, calculated at 479kt, was higher.

The tracker calculated ground speed at the end of "KB out" is 531.5kts at 17:44:08 (average of the 10 last speeds)

3.5.2. Cone of silence (work in progress)

The MH370 KB PSR data around the cone of silence is important as it could give some evidence about the altitude in this area.

Firstly, as the last PSR point of several other flights entering the cone of silence of KB are known in ATC-Caption-2025, it is possible to compare them with the last PSR point of MH370 in "KB in" as shown in Figure 45.

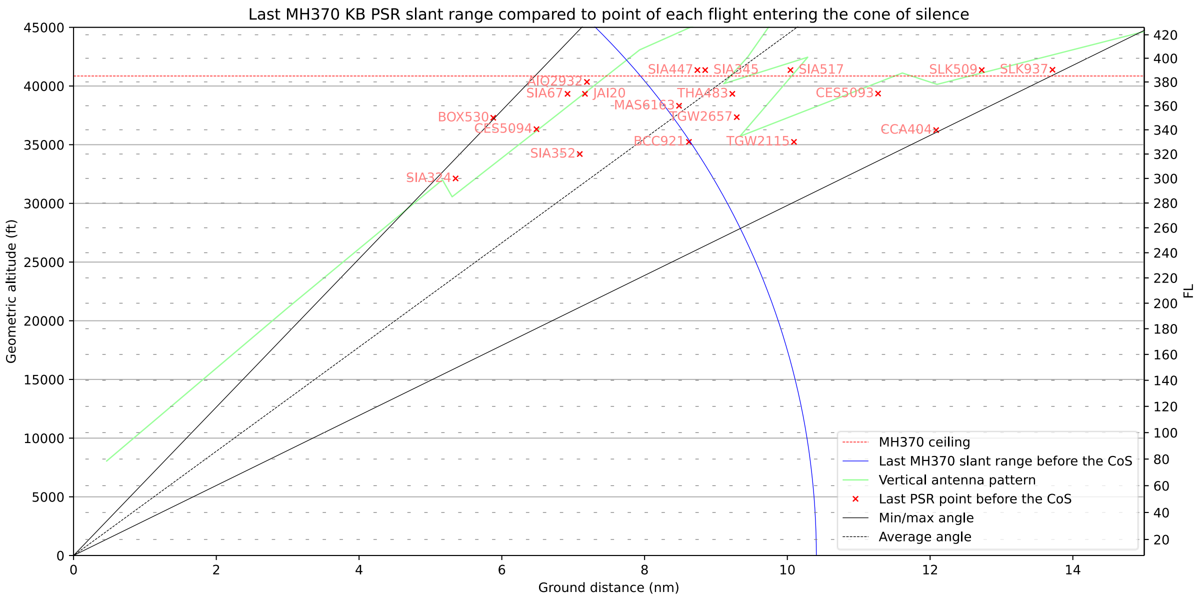


Figure 45 Last MH370 PSR slant range entering the KB cone of silence (blue arc) compared to the last PSR point of other flights. The distance from the origin is the slant range, the vertical axis is the geometric altitude (Flight level on the right), the horizontal axis is the ground distance. The red dashed line is the ceiling of MH370 in this phase of the flight.

Using the maximum, minimum and average angles of the last PSR points of other flights, the elevation “KB in” at the entry of the CoS (Cone of Silence) - that is at the last point of MH370 - was most probably between 26° and 46°, which corresponds to a flight level of maximum FL428, minimum FL261 and average FL350 (respectively geometric altitudes of 45200ft, 28000ft and 37300 ft). The certification ceiling of the MH370 aircraft is FL405, or 42900ft. However, in this phase of flight and with its current weight, the optimal flight was FL370, thus the margin for potential climbing was only at **maximum FL385** (which corresponds to 40850ft) due to the engines limited capabilities[5].

A more precise way to estimate the altitude of the plane through the cone of silence is to measure the variation of the calculated speeds in respect to the altitude, due to the effect of the correction of the slant range.

Here is a geometric explanation of what the effect of the correction of the slant range is:

For a target with a trajectory passing close to the radar head, for the same horizontal trajectory, the higher the target altitude is, the greater the slant range at the closest point to the radar:

1. If the slant range is used as ground distance (no slant range correction) the trajectory close to the radar will seem to be stretched outward. The target positions close to the radar will seem to be further away than they really are.

[5] Internal memo from a major airline on the limitation of the B777-200 compared to the B777-300 (note to pilots)

2. If the slant range is corrected with an altitude that is lower than the real altitude, the points close to the radar will get closer to each other and the stretching will decrease, but both effects will still exist.
3. If the slant range is corrected with the correct altitude, then both effects will disappear and the trajectory will correspond to the real trajectory.
4. If the slant range is corrected with an altitude higher than the real one, then the effects will reverse, the trajectory will seem compressed toward the radar and the points close to the radar will be closer than they really are.

Obviously, this has an impact on the calculated ground speed. In case 1, the calculated ground speed will appear very high close to the radar (inside the cone of silence), but before entering it and after exiting from it, the speed going to and coming from the radar will be very slow. This effect will decrease in case 2, and disappear in case 3. In case 4 the effect will reverse and the speed will appear very low close to the radar, and high further away.

In Figure 44, the tracker speed seems to decrease after 17:35:20 and then to soar when close to the radar: the ground speed calculated by the tracker is effectively as described in case 1.

In our case, this will mean that there is a direct inverse link between the average speed in the cone of silence and the speed calculated close to the cone. The higher the altitude used for the correction of the slant range will be, the lower the average speed in the cone of silence will be and the higher the speed close to the cone will be.

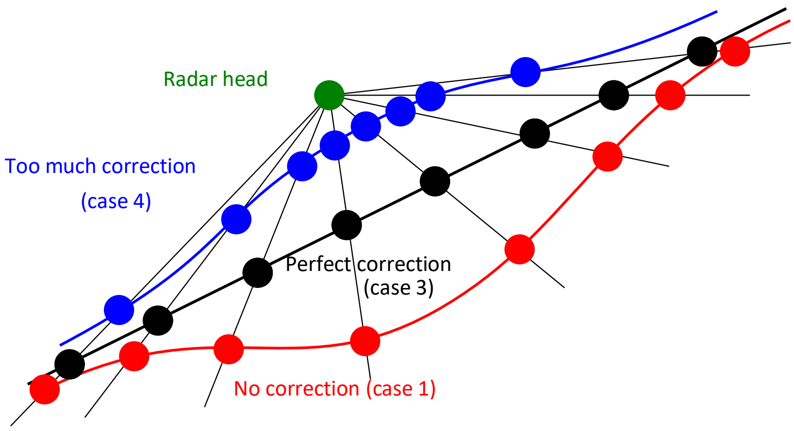


Figure 46 Illustration of the effect of the slant range correction on the apparent trajectory. The closer the points seem to be, the lower the calculated speed will be.

Obviously, this calculation is quite sensitive to the PSR precision close to the radar. As seen above the KB PSR seems very precise in rho (slant range), a bit less in theta (azimuth). The issue with theta is the width of the beam. It is possible that as the plane gets closer to the radar head, the echo gets stronger and the beam at high elevation gets wider. Thus, the target might be reported earlier than it should and as a result the theta value may be measured smaller than reality. It might be the case with the end of “KB in”, which might appear more North West than the actual trajectory.

Let us remember that the assumption made so far is that the flight level was kept constant in the CoS i.e. an horizontal trajectory. This is also the assumption made by the vast majority of the studies published in the past. This assumption may require to be challenged.

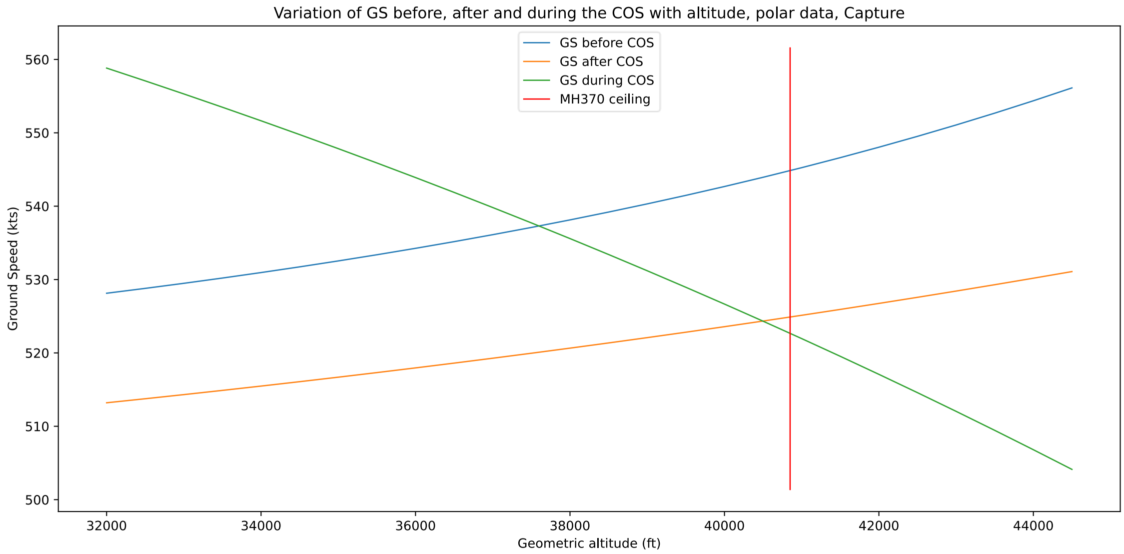


Figure 47 Graph of the calculated ground speed before, after and during the CoS at different geometric altitudes (based on the Cartesian points, last 10 points of "KB in", first 10 points of "KB out". MH370 ceiling in red is at FL385 i.e. 40850ft.

Keeping the hypothesis of a levelled trajectory, one can estimate the altitude around the CoS by using 4 points: two at the end of "KB in", and two at the beginning of "KB out". From these 4 points, 3 average ground speeds can be calculated: the ground speed before the CoS using the two points of "KB in", the ground speed during the CoS using the second point of "KB in" and the first point of "KB out", and the ground speed after the CoS using the two points of "KB out". These three ground speeds will depend on the considered geometric altitude, because of the effects of the slant range corrections. In Figure 47, the graph represents the variation of these three speeds with the geometric altitude, with the four points being:

- the point taken 10 rotations before the end of "KB in",
- the last point of "KB in",
- the first point of "KB out" and
- the 10th point of "KB out".

If the range and azimuth measured with the PSR are accurate enough and if the plane was flying at constant speed and altitude, then the three speed curves should intersect at a single point which would indicate the speed and altitude of the plane. However, as the PSR accuracy is low, the choice of points will have a significant impact on the results because each point suffers its own errors in rho and theta.

In order to analyse this, the two points of convergence of the ground speeds (GS pre-CoS with GS during CoS, and GS during CoS with GS post-CoS) were calculated for various sets of four points. Only those sets using two points of the last 15 points of "KB in" and two of the first 15 points of "KB out", with more than 20s between each other were selected. As a result, 2295 convergence altitudes (one per set) were calculated for both pre-CoS and post-CoS ground speed. Here are the steps for the calculation of the convergence altitudes:

1. Select the 4 points (two at the end of "KB in", two at the start of "KB out")
2. Calculate the positions of the 4 points (correction of the slant range) for different geometric altitudes (from 20000ft to 60000ft Geometric altitude, steps of 200ft)
3. Calculate the ground speeds between the 4 points for the different geometric altitudes. The pre-CoS speed is the speed between the first two points, the mean speed in the CoS is the

speed between points 2 and 3, and the post-CoS speed is the speed between the last two points.

4. Find the altitude of convergence, which is the altitude where the pre-CoS speed, the post-CoS speed, or the average of the two, is equal to the mean speed in the CoS.
5. Start again at 1) with another set of 4 points

The result is a distribution of convergence altitudes between the pre-CoS speed, the post-CoS speed, or the average of the two, and the mean speed in the CoS.

This result can be analysed by calculating statistical parameters (mean value, confidence interval…), or graphically by plotting an empirical cumulative distribution function (eCDF). The eCDF is a function which gives the fraction of observations which are less than or equal to the current value of the variable, i.e. the geometric altitude. For example, if the eCDF is at 0.7 at 40500ft, it means that 70% of the calculations gave a convergence altitude of 40500ft or less. If the eCDF graph is asymmetrical or presents unusual artefacts, it means that a number of sets of points may present a bias.

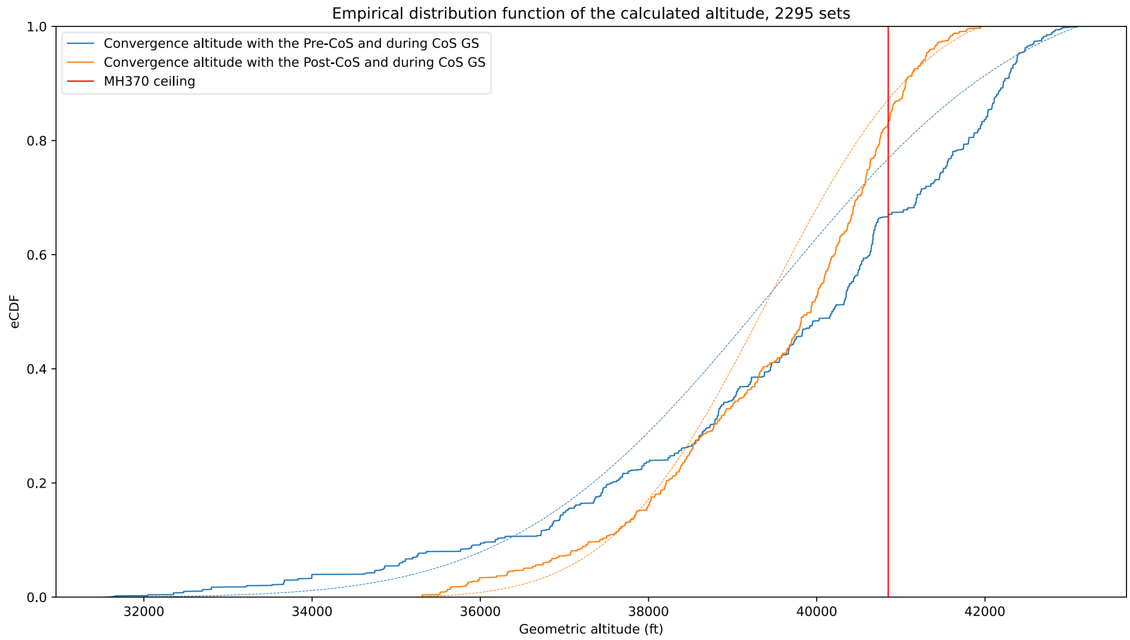


Figure 48 Empirical cumulative distribution function (eCDF) of the geometric altitudes obtained with the calculation of the convergence between the GS pre-CoS and during CoS (blue), and between the GS during CoS and post-CoS (orange), for the different sets of points. The graph shows that most of the convergence geometric altitudes are between 39000ft and 41000ft. MH370 ceiling in red.

The curve for the pre-CoS eCDF appears rather asymmetric, and biased towards lower altitudes. It may be related to the fact that the very last two points of "KB in" appear to be biased (at least in theta). Consequently, the same calculation was made excluding these points.

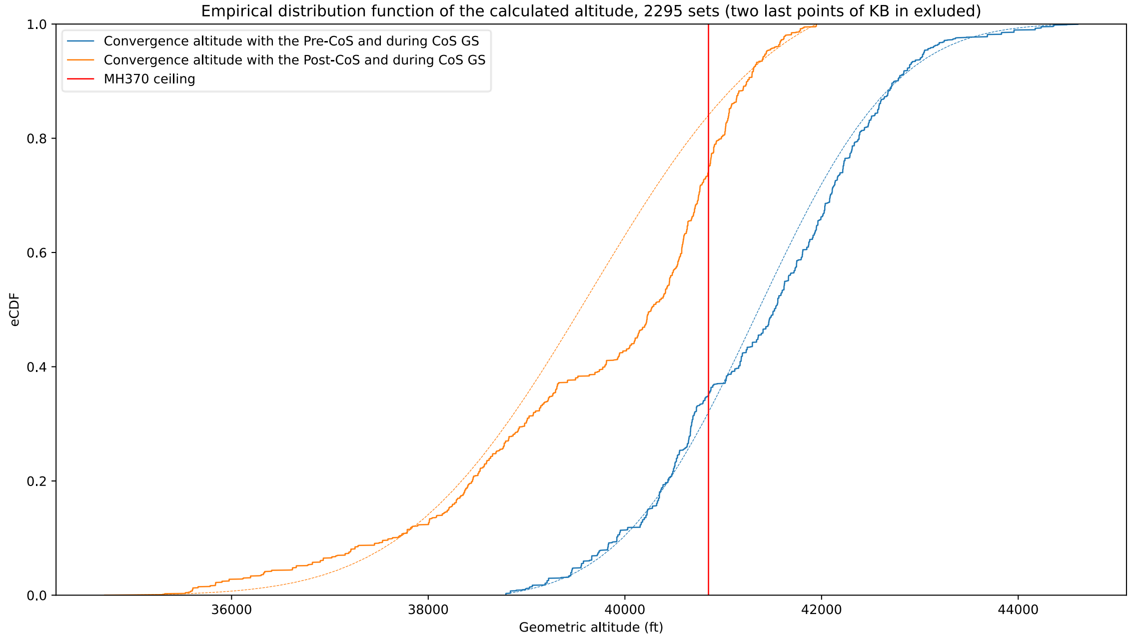


Figure 49 Empirical cumulative distribution function (eCDF) of the geometric altitudes obtained with the calculation of the convergence between the GS pre-CoS and during CoS (blue), and between the GS during CoS and post-CoS (orange), for the different sets of points, excluding the last two points of "KB in". MH370 ceiling in red.

This graph shows that the convergence altitude of the speeds is not the same for the pre-CoS and the post-CoS speed. **Therefore, the altitude and/or the ground speed were not constant during that period.** The altitude interval to consider depends on the type of profile of speed during the CoS. If the ground speed increased rapidly and reached its final speed value early within the CoS, then the post-CoS distribution is closer to the reality; if the ground speed increased slowly to stabilize only at the end of the CoS, then the pre-Cos distribution is closer to the reality.

The same calculation was made with the stringent hypothesis that the average speed during the CoS is equal to the mean value of the speeds before and after the CoS.

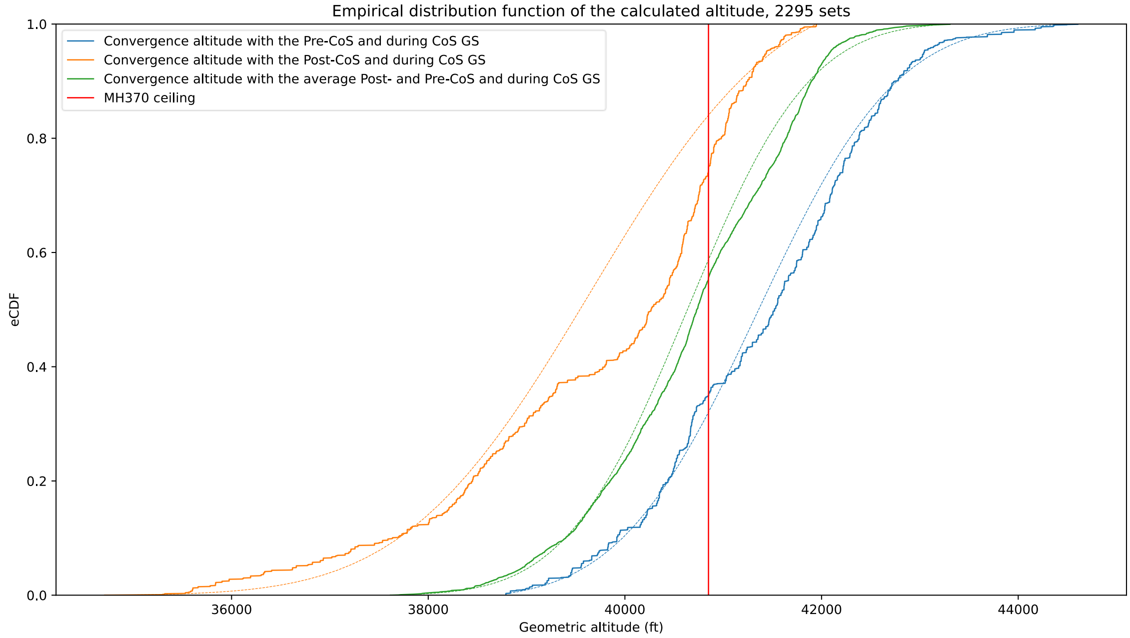


Figure 50 Empirical cumulative distribution function (eCDF) of the geometric altitudes obtained with the calculation of the convergence between the average of the pre-CoS and post-CoS GS with the average GS during CoS (in green), and the two eCDF of Figure 49 (blue and yellow), for the different sets of points, excluding the last two points of "KB in". MH370 ceiling in red.

The curve presented in Figure 50 is quite symmetrical, and does not contain irregularities. It seems coherent with a Gaussian distribution produced by the errors in theta and rho, and centred on a Geometric altitude of 40800ft.

Table 4 presents the results of these calculations (geometric altitude in feet and flight level) which encompasses the three methods described above: convergence PreCoS with AverageCoS, PostCoS with AverageCoS and Pre&PostCos with AverageCoS and their variants:

Table 4: Geometric altitude (and FL) computed via the 3 different methods

Type	*2 pts ignored*	*95% confidence interval*	*Median*	*Mean*
Pre	Yes	39209 (FL369) - 43361 (FL410)	41521 (FL392)	41411 (FL391)
Post	Yes	35975 (FL337) - 41617 (FL393)	40266 (FL379)	39732 (FL374)
Average	Yes	38647 (FL363) - 42285 (FL399)	40732 (FL384)	40697 (FL383)
Pre	No	33661 (FL315) - 42641 (FL403)	40180 (FL378)	39577 (FL372)
Post	No	35855 (FL336) - 41520 (FL392)	39925 (FL376)	39489 (FL372)
Average	No	36117 (FL339) - 41957 (FL396)	39783 (FL374)	39593 (FL373)

Depending on the hypothesis, the mean values of the calculated Flight Levels are between FL370 and FL390.

The calculation that seems to be the most realistic is the convergence of the CoS GS with the average of the pre- and post-CoS GS with the 2 biased points excluded. In that case, the geometric altitude around KB would be estimated between 38647ft (FL363) and 42285ft (FL399) with 95% confidence with an average of 40697ft (around FL383).

But altogether, considering the results posted in Table 4, the three flight maneuvering options should be kept in mind as possible: leveled flight, climbing or descending.

It is worth remembering that the MH370 maximum flight level was FL385 when considering its mass.

This analysis was made from a purely geometric perspective. Thus, to be more complete and more realistic, a detailed review of the IAS and Mach values is required to further refine the acceptable flight levels which must be within the flying capabilities of the aircraft. Figure 51 presents the geometrically derived Mach values for flight levels between FL350 and FL405 based on the most precise existing meteo data i.e. ERA5 verified with meteo data in the ATC-Caption-2025 recording. Table 5 presents the same values for the last point before the CoS, the average in the CoS and the first point after the CoS. The CoS crossing is between 17:36:35 and 17:38:55 UTC.

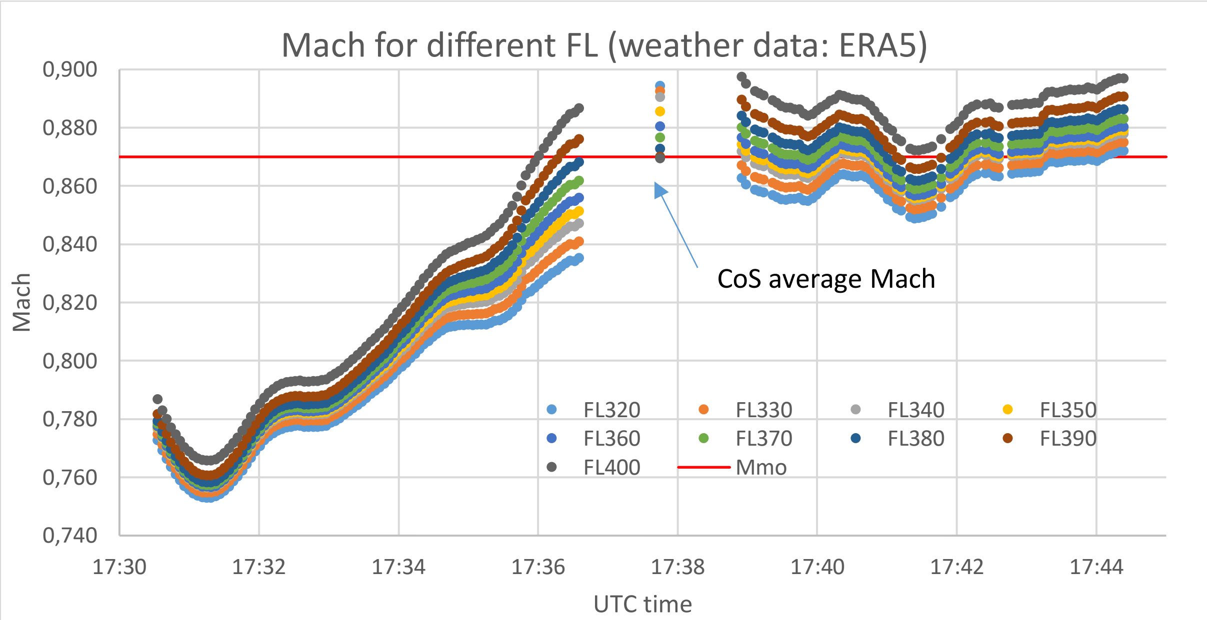


Figure 51 Mach evolution for flight levels between FL320 and FL400, based on ERA5 weather

Table 5 Mach just before, during and just after the CoS for constant flight levels between FL320 and FL400, based on ERA5 weather

		Flight level								
		320	330	340	350	360	370	380	390	400
Mach	Before CoS	0.835	0.841	0.847	0.851	0.856	0.862	0.868	0.876	0.887
	During CoS	0.894	0.892	0.890	0.886	0.880	0.876	0.873	0.870	0.869
	After CoS	0.863	0.867	0.872	0.874	0.877	0.880	0.884	0.889	0.897

Remembering that the B777 Mach limit is at 0.870, there is an opposite behavior of the calculated Mach based on the geometric method. For example, if we assume a constant flight level at FL380, while the Mach is marginally above the limit of 0.870 during the crossing, the post-Cos Mach is largely above at 0.884. But at FL360, the Mach is below the limit at the beginning but during the crossing it is above the limit at 0.880, thus longer in time but well below 0.884. Considering Table 5, we see that the hypothesis of a descent flight corresponds better to the speed constraints that a pilot would probably seek to respect as much as possible or to violate as little as possible.

Since the previous analysis [10], it is known that the aircraft was at FL350 when lost by radars at IGARI and may have slightly climbed to approximately FL360 maximum during the U-Turn at IGARI and that it descended at or below FL280/FL290 at around 17:29:30. Then it climbed until ~17:31:30. The final level is unknown which is the exact point of discussion above.

Mach values show that the most likely scenario is that the crossing of the Cone of Silence was not level but was globally in descent.

An additional study [13] is underway along with flight simulations investigating the flight profile and going deeper than the study documented in [10]. The preliminary results confirm that the aircraft descended after the U-turn at IGARI probably as low as FL260 before climbing until just before Kota Bharu at about FL370/FL375. Then it descended again and exited the CoS at about ~FL360 explaining the slight increase of its velocity. Up to now, the simulations recently performed show speed profiles which provide operational explanations to the calculated velocities from IGARI to Kota Bharu with a direct match.

From FL360, the aircraft descended to FL300 most likely non-stop at a constant vertical speed. Taking into account that flight BBC086 flying at FL370 crossed its projected route later at some ~40Nm ahead of it, the logical conclusion is that MH370 was most likely not at a flight level close to FL370 but was probably safely below it. This is coherent with the fact that few minutes later the first officer's mobile phone got connected to a GSM base station when passing in the South of Penang. This connection seems less likely at high flight level.

The above-mentioned additional study [13] will be reported in a separate document.

3.6. Butterworth PSR data

The MH370 BW PSR data was corrected in azimuth angle (theta) using error measurement on other flights as explained previously. The resulting locations are illustrated in Figure 52. The Geoscience track is also illustrated by the red line.

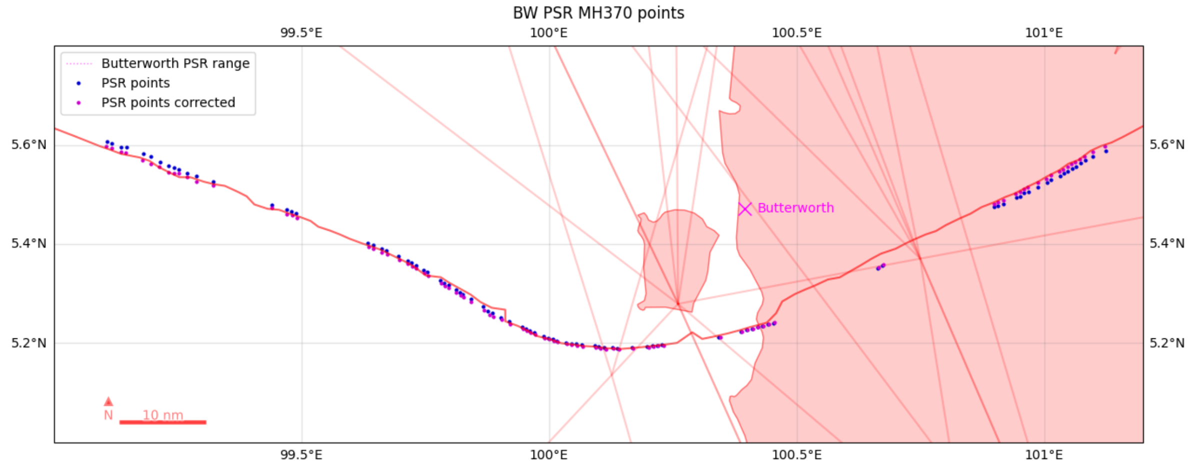


Figure 52 MH370 PSR target reports (raw values in blue dots, corrected angle in magenta dots)

Using the Vicenty formula, the track angle after 17:57:00 ([5.37°N; 99.68°E] in Figure 53) is 291.33° for BW data before theta correction, 290.68° for BW data after correction and 290.34° for Geoscience data.

The track angle was extrapolated up to VAMPI (cf Figure 53) for each dataset to calculate the minimum distance abeam VAMPI (cf Figure 54) if the plane kept that track angle:

	Track angle	Minimum distance to VAMPI
BW before correction	291.33°	0.71 NM North
BW after correction	290.68°	0.69 NM South
Geoscience	290.34°	1.39 NM South

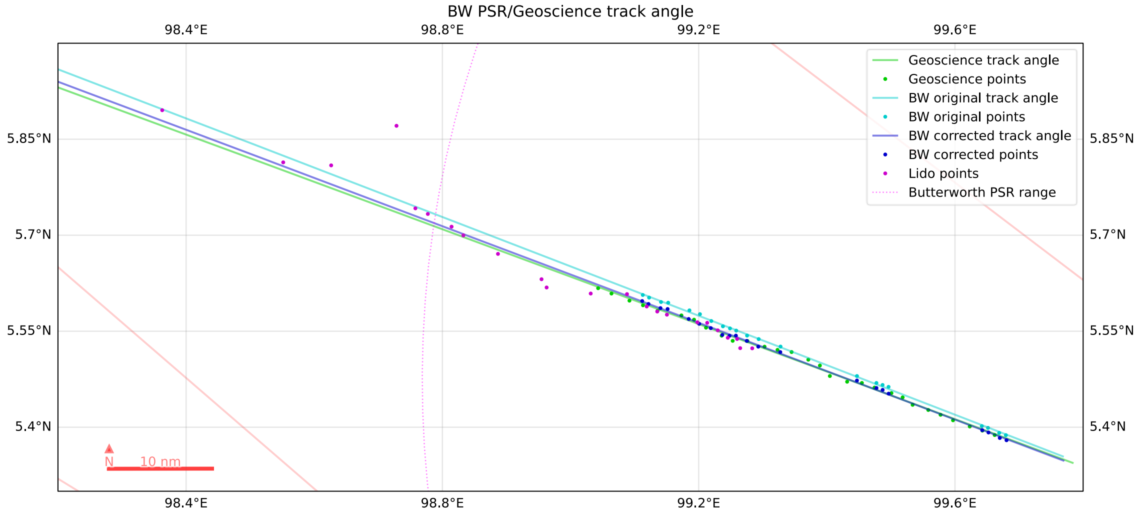


Figure 53 Trajectory of MH370 using BW data before correction (cyan), after correction (blue) and Geoscience data (green), with the track angle extrapolated from after 17:57:00 using the Vicenty formula. Digitalized Lido points in magenta

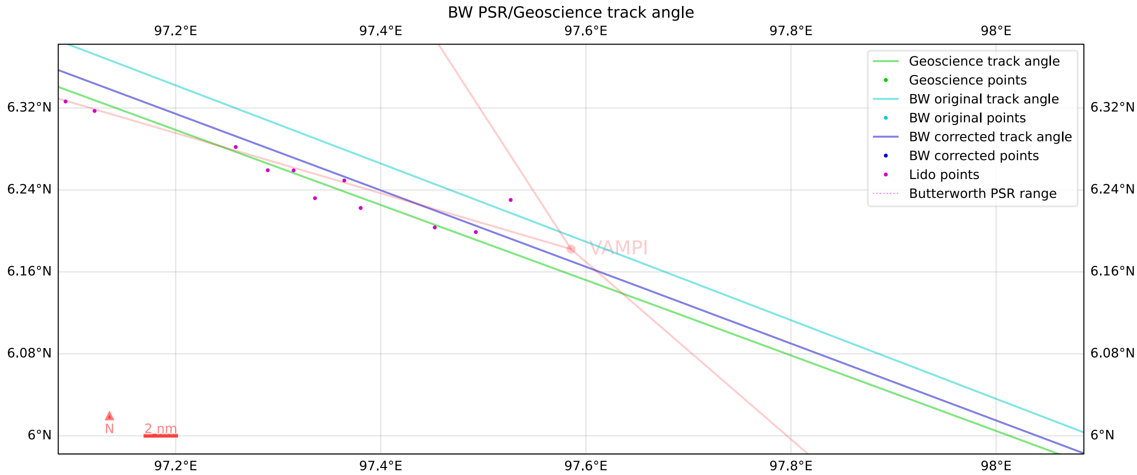


Figure 54 Trajectory of MH370 using BW data before correction (cyan), after correction (blue) and Geoscience data (green), with the track angle extrapolated from after 17:57:00 up to VAMPI using the Vicenty formula. Digitalized Lido points in magenta. (Zoomed on VAMPI)

The fact that the radar trajectories were not perfectly aligned with VAMPI could indicate that RNAV navigation was not operational, as the autopilot offers much higher accuracy. The inertial navigation system would have slightly drifted. However, a caveat should be placed as the angular accuracy of the PSR appears to be limited, and as track angle calculations based on positions 100 NM away from VAMPI could be the cause of this misalignment.

3.7. Langkawi: lack of PSR data

No PSR data compatible with MH370 trajectory was found in the Langkawi radar data. As the plane did not go deep inside this radar coverage, the PSR might have acquired too few echoes for the tracker to be able to build a usable track. As the flight was quasi-tangential to the PSR range, the Doppler filtering of the radar might have decreased the ability of tracking the aircraft.

Alternatively, the Langkawi PSR radar does not seem particularly sensitive, or at least well calibrated, which might also be a reason why no target report was generated.

3.8. Other PSR tracks

There are some other PSR tracks in the ATC-Caption-2025 recording data that cannot be linked to specific aircraft, in particular in KB data.

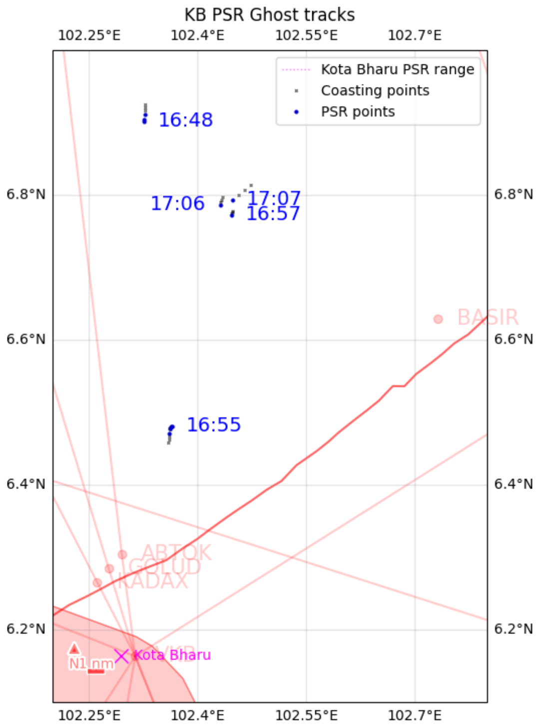


Figure 55 Short PSR tracks north of KB

Time	*CGS (kts)*	*CTA (°)*
16:48	254	3
16:55	50-240	186-227
16:57	109	16
17:06	203	11
17:07	613	51

CGS: Ground speed calculated by the tracker

CTA: Track angle calculated by the tracker

It seems that these short tracks are caused by radar clutter; it could come from some reflections on the sea, flocks of birds, or possibly fishing ships … This could also potentially be caused by weather balloons (one was launched from KB around 11:30 UTC), but this is relatively unlikely as most weather balloons stay aloft for less than 2 hours.

The corresponding calculated ground speed does not appear to be realistic; this may be caused by the low number of echoes available to the tracker.

3.9. Traffic around MH370

ATC-Caption-2025 recording reveals that few aircraft were in the vicinity of MH370 at various points in time. Figure 56 presents a synoptic view of the trajectories of these aircraft relative to the MH370 trajectory. Their closest point to MH370 trajectory with the corresponding time is indicated as well as the MH370 position at that specific time. This section provides the details and the analysis of each of these flights.

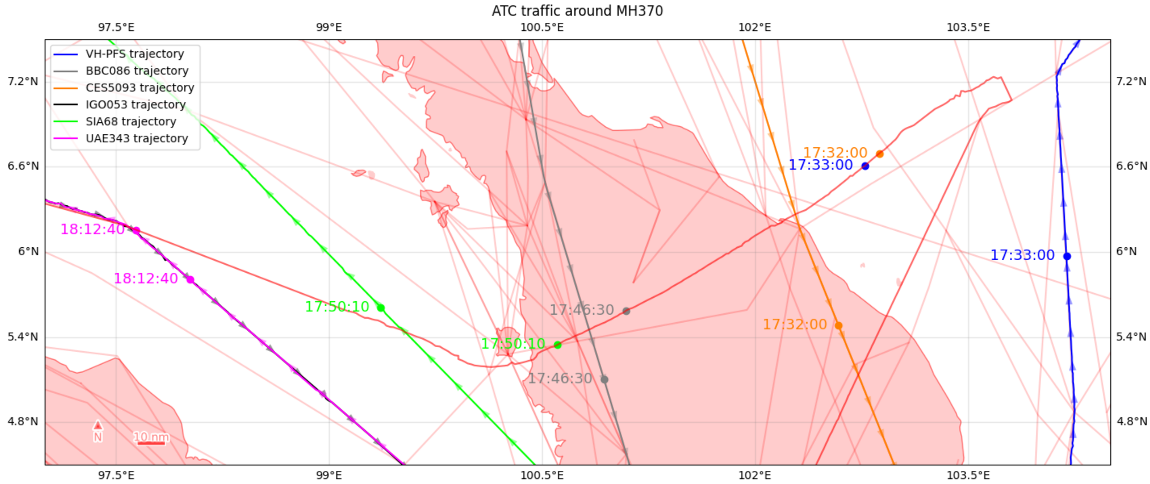


Figure 56 Positions of the various flights around MH370, closest positions with the flights are noted with two dots of the same color (the position of MH370 and of the other aircraft at that moment) except for IGO053

3.9.1. VH-PFS

Figure 57 Photo of VH-PFS at Bandung airport, Java, Indonesia, 28-09-2012 (Source jetphotos.com/Rinaldi Wibiyanto)

VH-PFS (ICAO24: 7C4CB6) is a Learjet 45XR, owned by Pacific Flight Services, a charter service subsidiary of ST Engineering. It is used for medical evacuation and sometimes executive charter. Even if no definitive information can be found, it seems it was flying from Jakarta, Indonesia, to Ho Chi Min City, Vietnam that night, with the squawk 2354.

Mode S data from KB and Senai only transmitted BDS 1,0 of its transponder, it seems it was quite limited. But importantly enough, the data indicates that VH-PFS was equipped with ACAS and each time BDS 1,0 was interrogated (16:37:36 and 17:21:29) TAs and RAs were activated. It was not broadcasting any ADS-B message; it is unclear if it was able to receive them.

VH-PFS was at FL430 until 17:17:21, when it began a descent to FL280, which was reached at 17:23:41.

At IGARI MH370 was 151 NM away from VH-PFS, at 17° to its left. VH-PFS was at its closest location to MH370 at 17:33:00, i.e. at 93 NM, while MH370 was at 63° to its left.

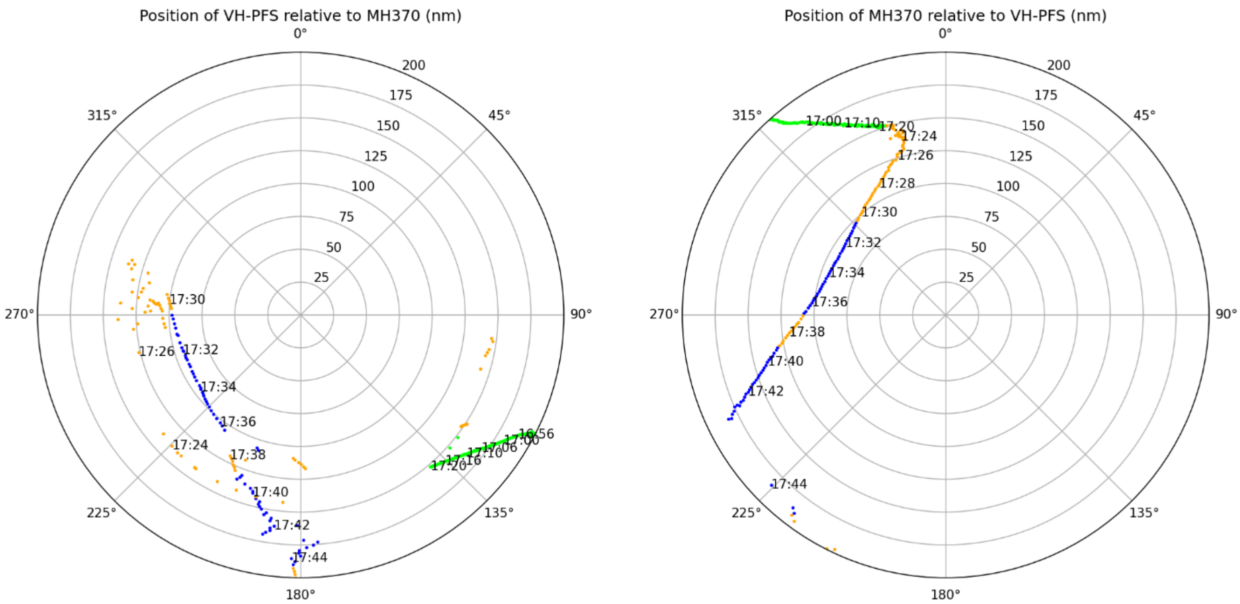


Figure 58 Left: Position of VH-PFS relative to MH370. Right: Position of MH370 relative to VH-PFS. 0° is in front of the reference plane. Distance in NM. MH370 position from ADS-B in green, from Geoscience in orange, from ATC PSR in blue

At 17:20:30 UTC, VH-PFS was on route to BITOD and was in a position to see MH370 would its strobe lights were on or if it exploded. But no report to ATC was made by VH-PFS crew on such an exceptional visible event which would have raised concerns about the safety on their own flight.

3.9.2. CES5093

Figure 59 Photo of B-6875 at Shanghai-Hongqiao airport, China, 09-07-2014 (Source jetphotos.com/zhangmx969)

CES5093 (squawk: 7401) is a flight from Kunming, China to Singapore, operated by China Eastern Airlines with an Airbus A320-200 (ICAO24: 780856, registration: B-6875). CES5093 flew above KB at 17:26. The plane stayed at FL370 within the radar coverage of KB. After MH370 U-turn, it was at 99 NM from MH370, approximately in line ahead of the aircraft. As CES5093 was flying south, it went to the left of MH370, and was at its closest at 17:32, i.e. at 75 NM, at 36° left of MH370.

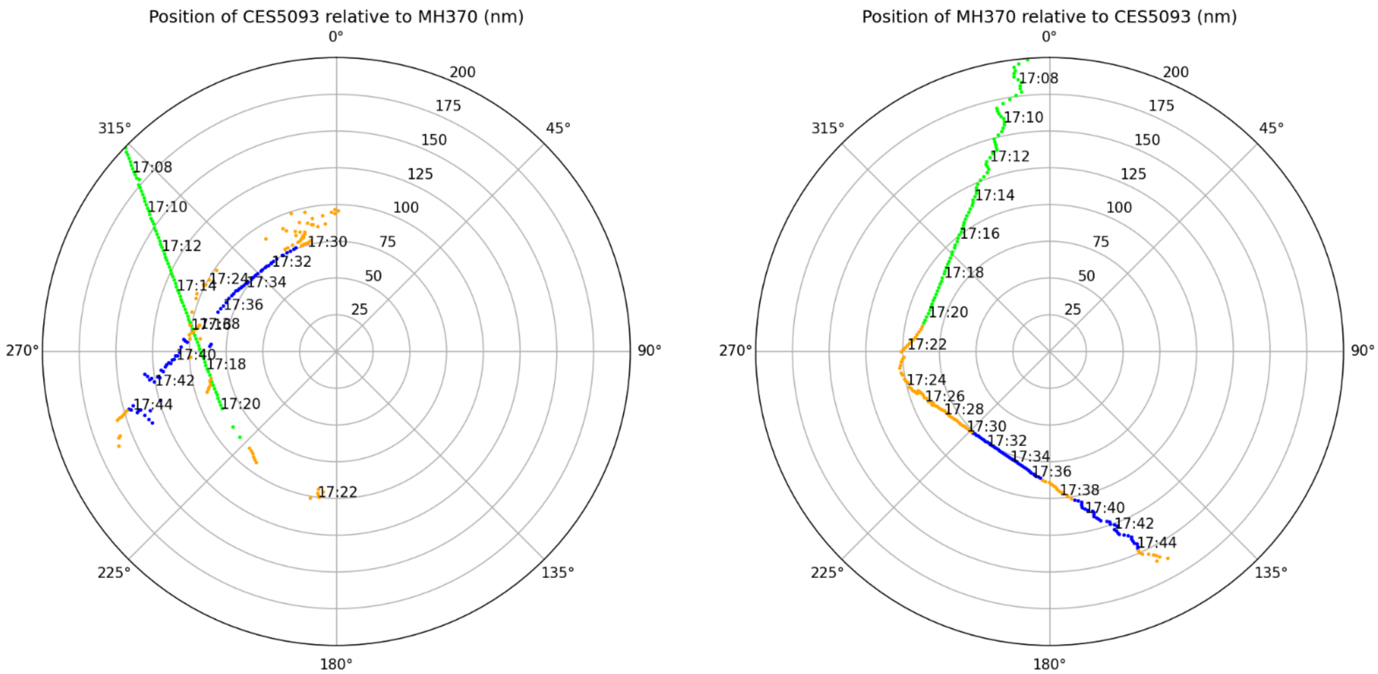


Figure 60 Position of CES5093 relative to MH370. Right: Position of MH370 relative to CES5093.

3.9.3. BBC086

Figure 61 Photo of S2-AFP at Dhaka Hazrat Shahjalal Int'l airport, Bangladesh, 21-03-2014 (Source jetphotos.com/Abdul Kawnain)

BBC086 (squawk: 4712) was a flight from Dhaka City, Bangladesh to Kuala Lumpur, Malaysia, operated by Biman Bangladesh with a Boeing 777-3E9ER (ICAO24: 70203F, registration: S2-AFP). BBC086 was flying South, and was at FL370 until 17:52. It was on the right of MH370 until 17:44 where it moved to its front at a distance of 38 NM. It is at the closest distance, i.e. 30 NM, at 17:46:30, while being at 38° on the left of MH370.

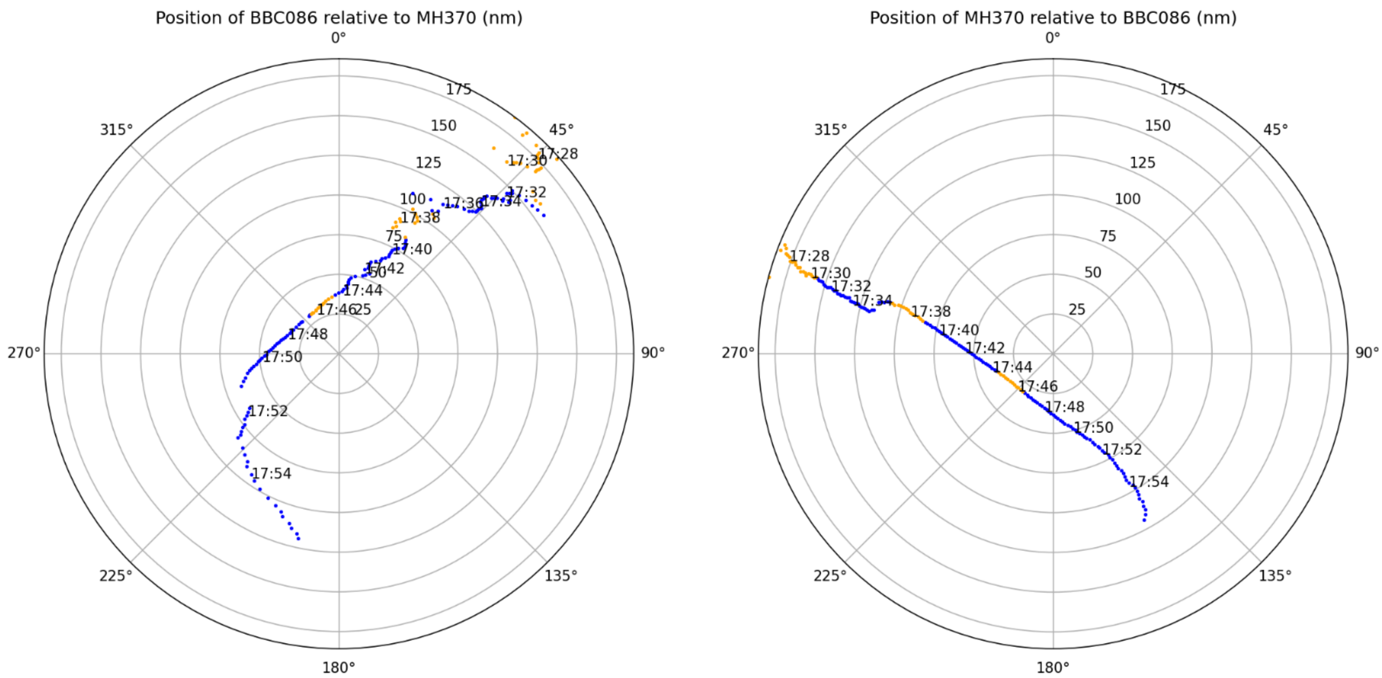


Figure 62 Position of BBC086 relative to MH370. Right: Position of MH370 relative to BBC086.

This aircraft was probably the most constraining flight vis-à-vis MH370 in midland between Kota Bharu and Penang Island. The closest distance in front was 38 NM and BBC086 was at FL370. This gives an indication that MH370 had to be well below or well above the flight level of the coming aircraft to avoid a hazardous encounter at night without TCAS. Thus at 17h44 and considering the copilot's GSM connection at 17h52 which implies a lower level, **the most logical conclusion is that MH370 was not higher than FL360 and most likely FL340 or below.**

3.9.4. SIA68

Figure 63 Photo of 9V-SWS at Manchester Ringway Int'l airport, UK, 05-03-2014 (Source jetphotos.com/Mark Jordan)

SIA68 (squawk: 2263) was a flight from Singapore to Barcelona, Spain, operated by Singapore Airlines with a Boeing 777-300ER (ICAO24: 76CEF3, registration: 9V-SWS). SIA68 was flying North West, along the East coast of Malaysia, at FL300 from 17:21. SIA68 was at the closest distance, i.e. 77 NM at 17:50:10, at 40° right of MH370.

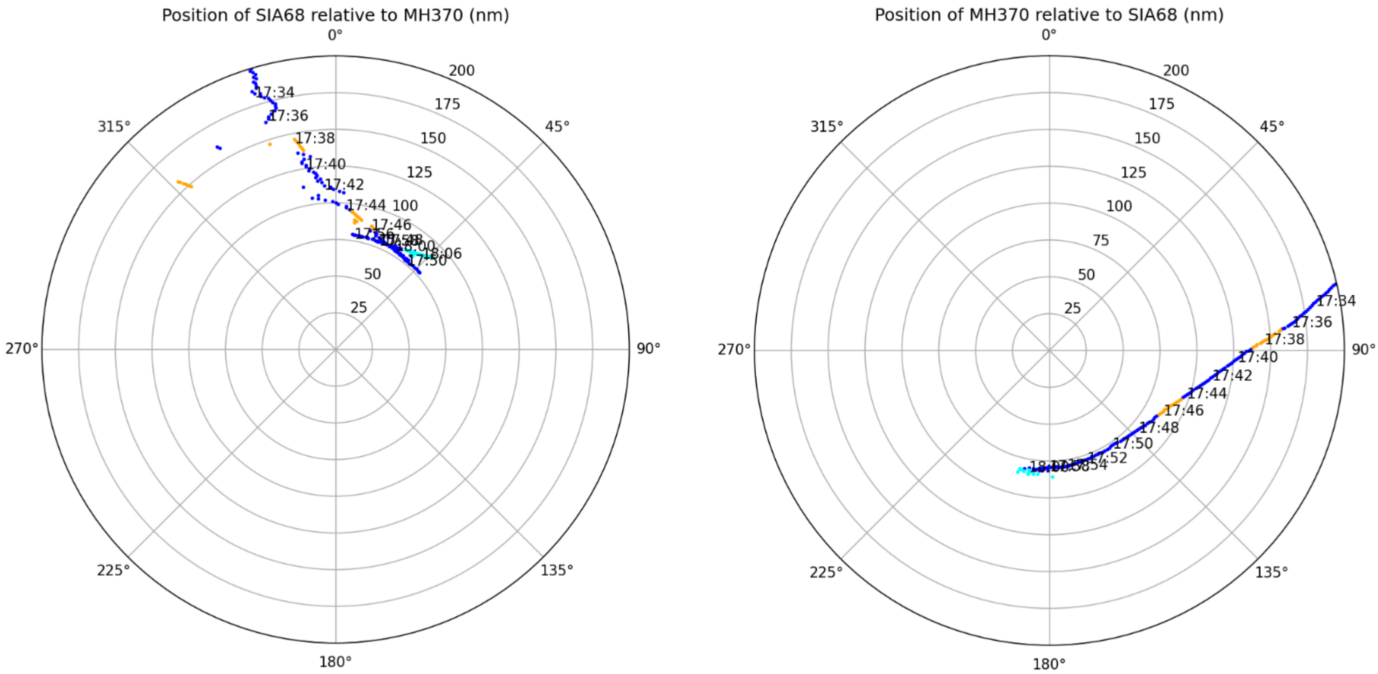


Figure 64 Position of SIA68 relative to MH370. Right: Position of MH370 relative to SIA68.

3.9.5. UAE343

Figure 65 Photo of A6-ECM at Bangkok Suvarnabhumi Int'l airport, Thailand, 31-10-2013 (Source jetphotos.com/Sudpoth Sirirattanasakul)

UAE343 (squawk: 2140) was a flight from Kuala Lumpur, Malaysia to Dubai, UAE, operated by Emirates with a Boeing 777-300ER (ICAO24: 896114, registration: A6-ECM). The last ADS-B point was at 18:13:08, the last SSR point is from Langkawi island at 18:25:38 after MEKAR and the last ADS-C point is at 18:43:45, 12 NM after IGOGU. UAE343 was visible from MH370 at 45-55° left until 17:51, when the distance was 84 NM, then MH370 started turning to the right. UAE343 was climbing and reached FL340 at 17:54:48. From the point of view of UAE343, MH370 comes from the right, was at 45° right from 18:00, when it was 53 NM away. And from 18:09 it was less than 20° in line of the plane, and less than 35 NM behind MH370. Before the end of radar coverage at 18:22, MH370 was at its closest distance, i.e. 31 NM ahead, at 18:13:20, and in line with UAE343. But UAE343 did not report any visual contact most probably because it could not see MH370 that must have had no strobe lights and that was in front and below its nose.

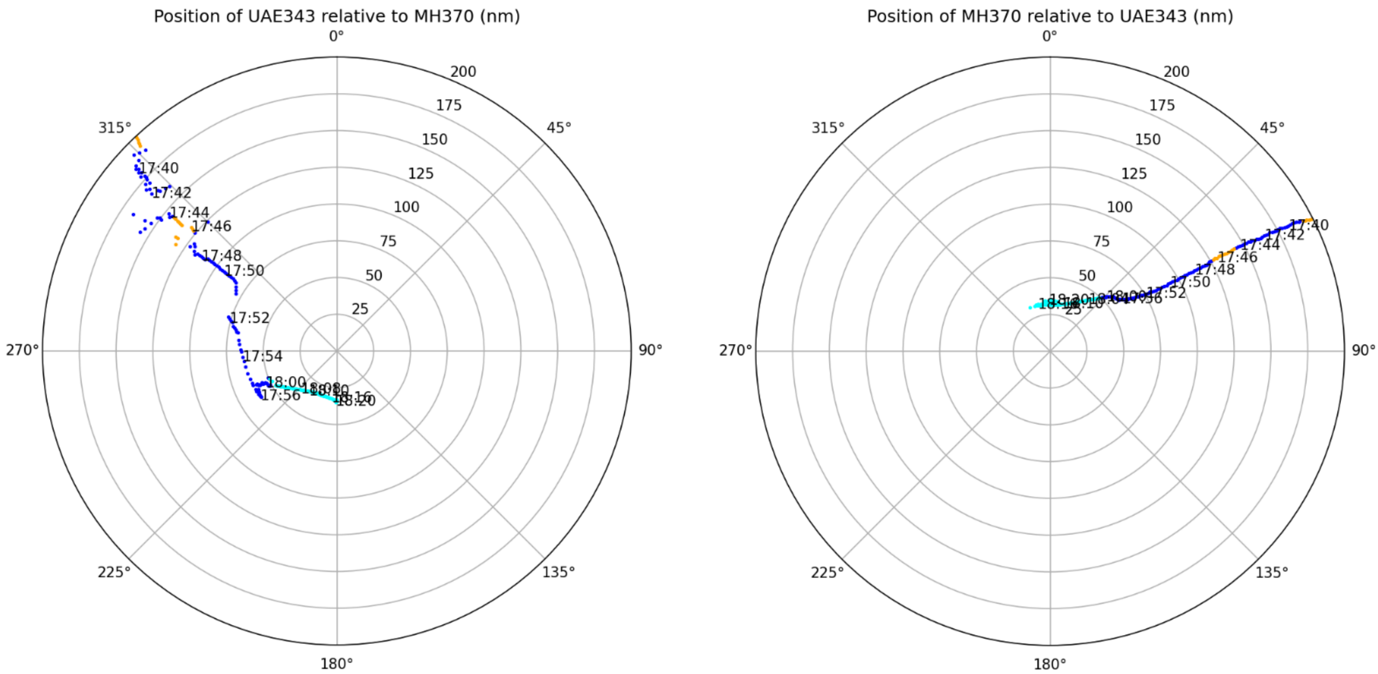


Figure 66 Position of UAE343 relative to MH370. Right: Position of MH370 relative to UAE343.

At 17:54:48 when UAE343 reached FL340, MH370 had just ended it turn into the Strait of Malacca. Being close at ~60 NM, it must have seen UAE343 on its left and climbing. Thus, before its turn and its maneuver to pass just in front of UAE343, MH370 had no reason to climb from its current level of FL300. **<u>The most logical conclusion is that MH370 was not higher than FL320 and most likely FL300 or below as reported later by the last radar target report (FL295).</u>**

3.9.6. IGO053

Figure 67 Photo of VT-IEK at Dubai Int'l airport, UAE, 18-01-2013 (Source jetphotos.com/PAUL LINK)

IGO053 (squawk: 0601) was a flight from Chennai, India to Singapore, operated by IndiGo with an Airbus A320-200 (ICAO24: 80064C, registration: VT-IEK). It first appears on Langkawi radar at 18:44 at MEKAR waypoint. This flight is not present in ADS-C data. Flight IGO053 was level at FL330 from its appearance on radar until 19:45 UTC. Based on the ATC-Caption-2025 recording data, IGO053 is estimated to have flown at Mach 0.78 (this is the Mach at 19:42 according to Senai Mode S data, and is coherent with the ADS-B ground speed from 18:57 to 19:42). An extrapolation in the past using the flight plan and the GDAS data was calculated. This extrapolation locates IGO053 at a distance of 34 NM before IGOGU at 18:22. IGOGU waypoint was overflown at 18:26.

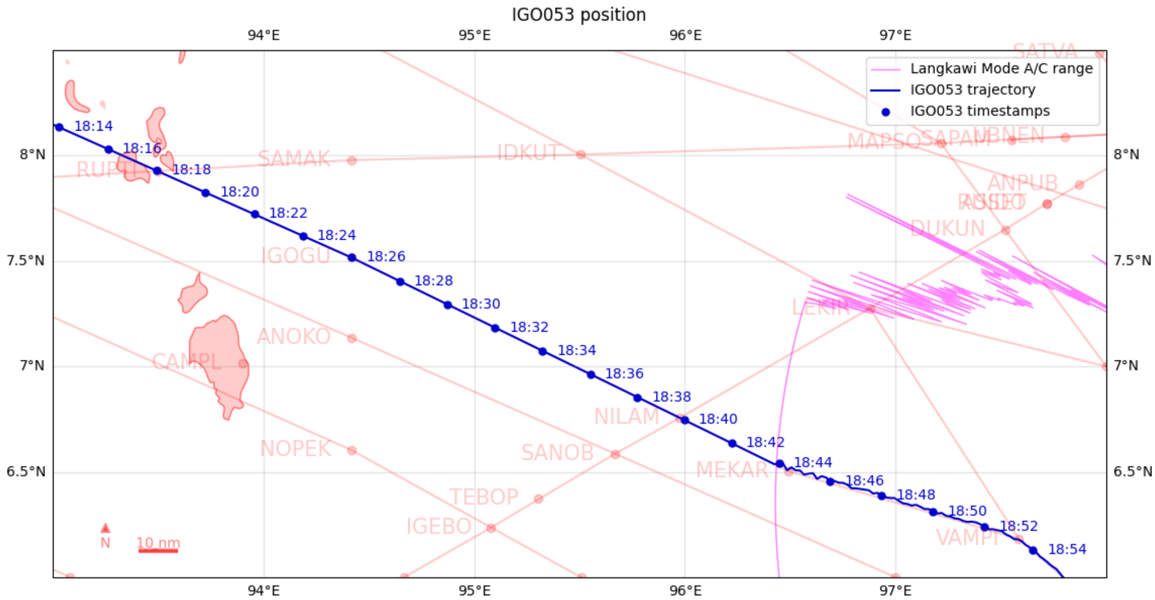


Figure 68 Extrapolation of the position of IGO53 based on Langkawi data and the flight plan

4. Comparison with previously published data

This section reviews previous datasets that have been made public by different groups or authorities.

The ATC-Caption-2025 data is demonstrated to supersede all of these previous datasets in terms of quality, precision and completeness. It is provided for the benefit of the community of MH370 searchers at www.mh370-caption.net. From now on, it is recommended to use it in the first place for any new analysis.

Subsequently, it is suggested that all analyses based on previous datasets be redone, especially those on velocity.

4.1. Independent group 2018 radar data [14]

The IG radar dataset published in 2018 on mh370.radiantphysics.com website comes from 3 different sources: Kuala Lumpur North SSR, Kota Bharu PSR and Butterworth PSR. To our knowledge coming from this analysis, the 2018 IG dataset was created using the very same data described in this document. But, there are several issues with the IG 2018 dataset:

- The KB data contains 8 additional coasting points, where no echoes were actually received
- The KB trajectory is smoothed and does not correspond to the genuine KB target reports
- Some BW points are missing
- The slant ranges seem to have been modified, particularly close to the KB and BW radar head, which appears to be a slant range correction of -18000ft

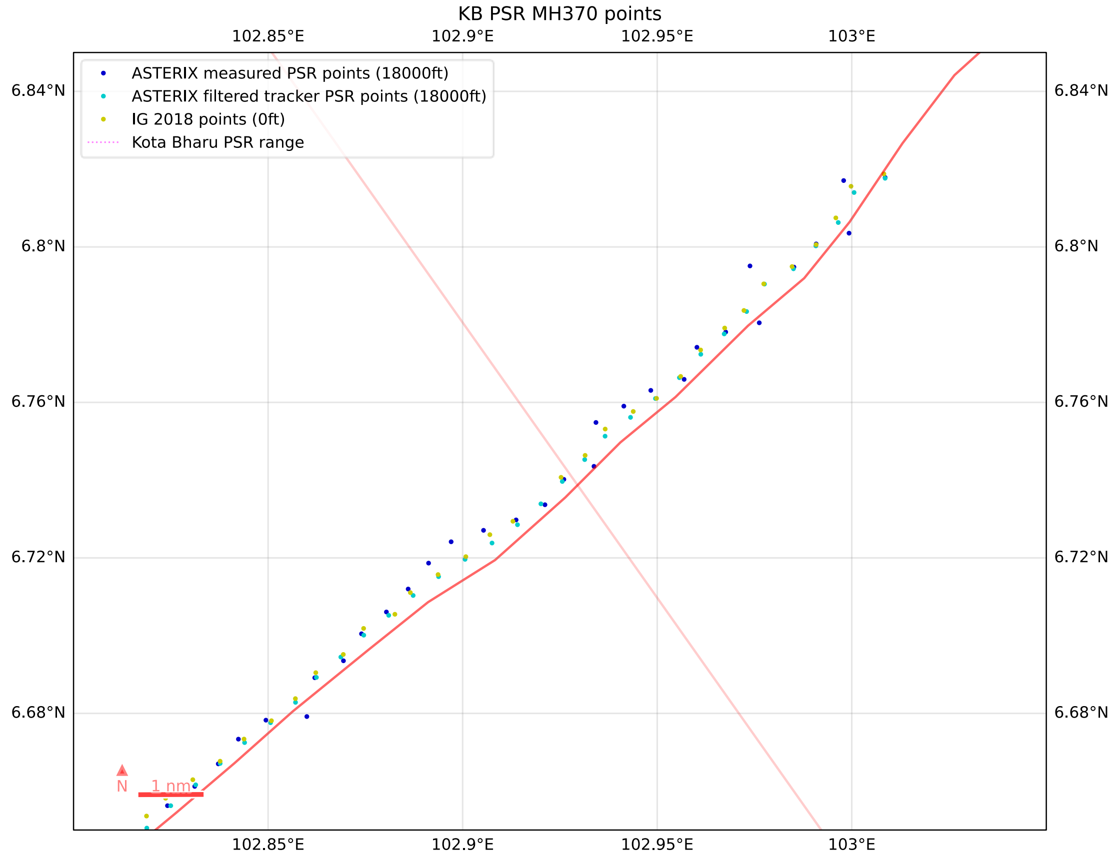


Figure 69 Comparison of ATC-Caption-2025 ASTERIX KB measured positions (blue) and filtered tracker positions (cyan), with IG 2018 positions (yellow). The measured positions are more erratic than the others.

It seems that the 2018 IG dataset was extracted with a partial understanding only of the parsing process. Polar coordinates (rho/theta), normally used to represent measured data, were in fact calculated from Cartesian coordinates. Thus, 2018 IG KB data provides filtered and processed positions, and not the measured ones. Also, the slant ranges seem to have been “corrected” as if to suppress a theoretical slant range correction of 18000ft in the original values (this can be seen in the points close to the KB and BW radar, where the range is longer than in the raw data and later in 2020 IG data). This may be due to a misunderstanding while using a third-party software (probably SASS-C). The raw radar data showed that KL N in 2018 IG dataset was extracted from cartesian coordinates and then converted to rho/theta coordinates; it is less clear for KB data which could come from ASTERIX Cartesian coordinates. For BW 2018 IG dataset, it was probably extracted from the measured rho/theta values.

The fact that KL N and KB in 2018 IG data were presented as measured rho/theta values, when it actually appears to be a calculation from cartesian information, could be seen as a way of presenting it as a direct radar measurement. But this seems more to correspond to an additional misunderstanding when using the software at that time.

These issues render the 2018 IG radar data unreliable.

4.2. Independent group 2020 radar data [15]

The 2020 IG radar dataset published in 2020 on mh370.radiantphysics.com website contained 3 different sources: Kota Bharu, Butterworth, and Langkawi, though the last one does not have data associated in the published 2020 IG file. This version is said to have been extracted from logs of the radar heads. In fact, it is much more similar to what the ASTERIX data contains. Some small discrepancies exist in rho and theta values, which seem to be linked with binary rounding errors (probably at the moment of the log/ASTERIX data creation). The main differences between the 2020 IG dataset and the ATC-Caption-2025 raw data are the time stamps. In both IG KB data (during the cone of silence) and IG BW data, a 2 seconds shift appears between successive points in each of these datasets. This is not possible as the time stamp of each echo is linked with the speed of rotation of the antenna and the azimuth of the target. This may be due to the way the logs are created. All in all, while the IG 2020 dataset is quite coherent with the ATC-Caption-2025 raw data (less than 4s shift on the time stamps), the timestamps of the IG 2020 dataset are somewhat imprecise. It seems that the ASTERIX data extracted from the ATC-Caption-2025 recording is more genuine in terms of time.

It is interesting to note that the ATC-Caption-2025 recording data provides the timestamps when the radar antennas crossed the North azimuth (t_N in seconds). As each antenna has a constant rotation speed noted $RotS$ (in seconds per revolution as defined in the ASTERIX format, which is technically a rotation period), each target report time t_T should be

$$t_T = t_N + RotS \times \frac{\theta}{360}$$

With θ being the measured angle of the target vector in degrees.

In the IG 2020 radar data, the timestamp of each point of KB is actually equal to:

$$t_{IG} = t_N + \frac{RotS}{2} \times \left(\frac{\theta}{360} + 1\right) \quad (1)$$

And the timestamp of each point of BW is:

$$t_{IG} = \begin{cases} t_N + \frac{RotS}{2} \times \left(\frac{\theta}{360} + 1\right) \; if \; \theta < 213° \\ t_N + \frac{RotS}{2} \times \left(\frac{\theta}{360} + 2\right) \; if \; \theta \geq 213° \end{cases} \tag{2}$$

We don't know whether the logs of the radar heads contain or not the timestamps of each target report (as in BW raw data). But the 2020 IG data timestamps were apparently calculated with the wrong formula when using the times of the North crossing and the theta values. Not only is the rotation speed used half of the real rotation speed of the radar antenna, but timestamps are shifted by half the rotation period.

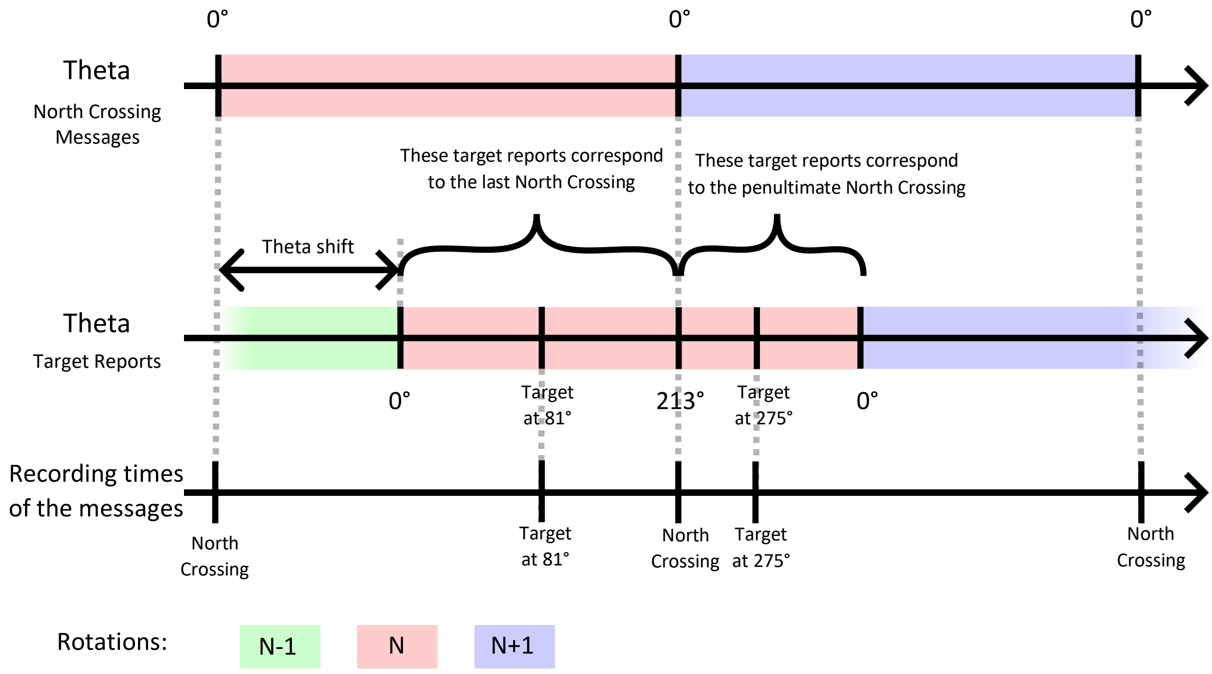


Figure 70 Illustration of the theta shift between the North crossing messages and the target reports in BW ASTERIX messages

In the case of BW timestamps, the 213° position coincides with the position where the north crossing service messages are sent by the radar. The target reports in BW are delayed compared to the service messages, and the north crossing service message is sent on the radar network at the same time a target report corresponding to an azimuth angle of 213° would be. In other words, the north crossing message for the next rotation is sent before the target reports with a theta of 213° or more. Therefore, for a target report with a theta value of more than 213°, the last north crossing time received is the time of the next rotation, and not the current one. If this delay is not taken into account, every target report received after 213° will have an erroneous timestamp (even if the correct rotation speed is used).

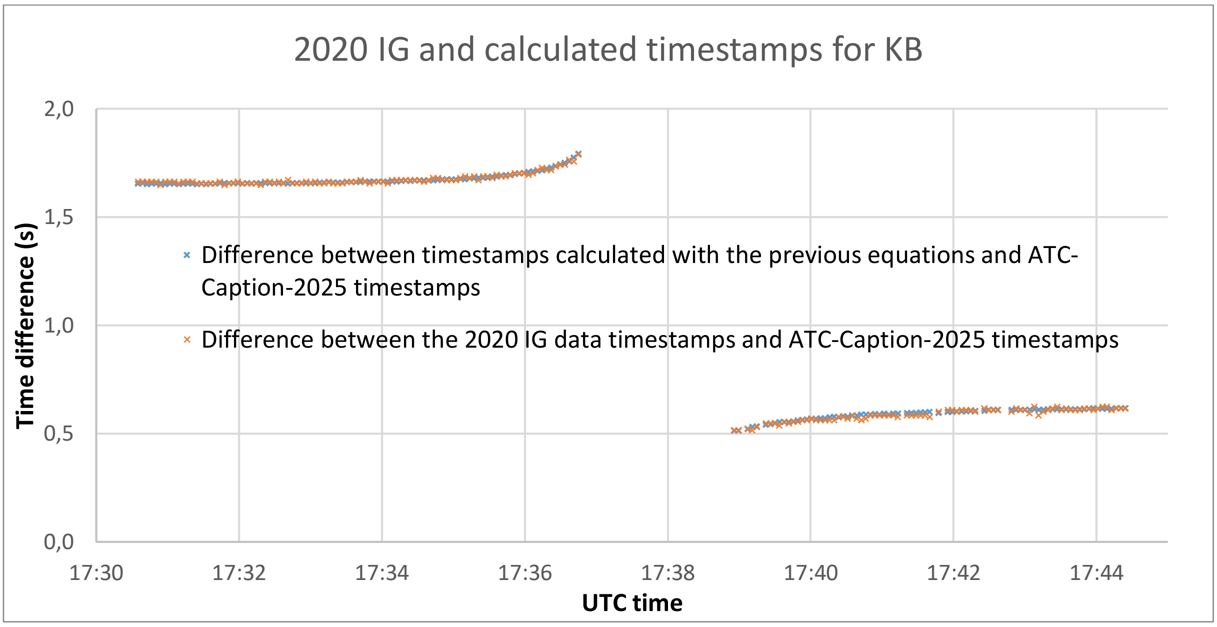


Figure 71 Comparison between the KB IG 2020 timestamps and the timestamps calculated from the North crossings and theta values using the formula (1)

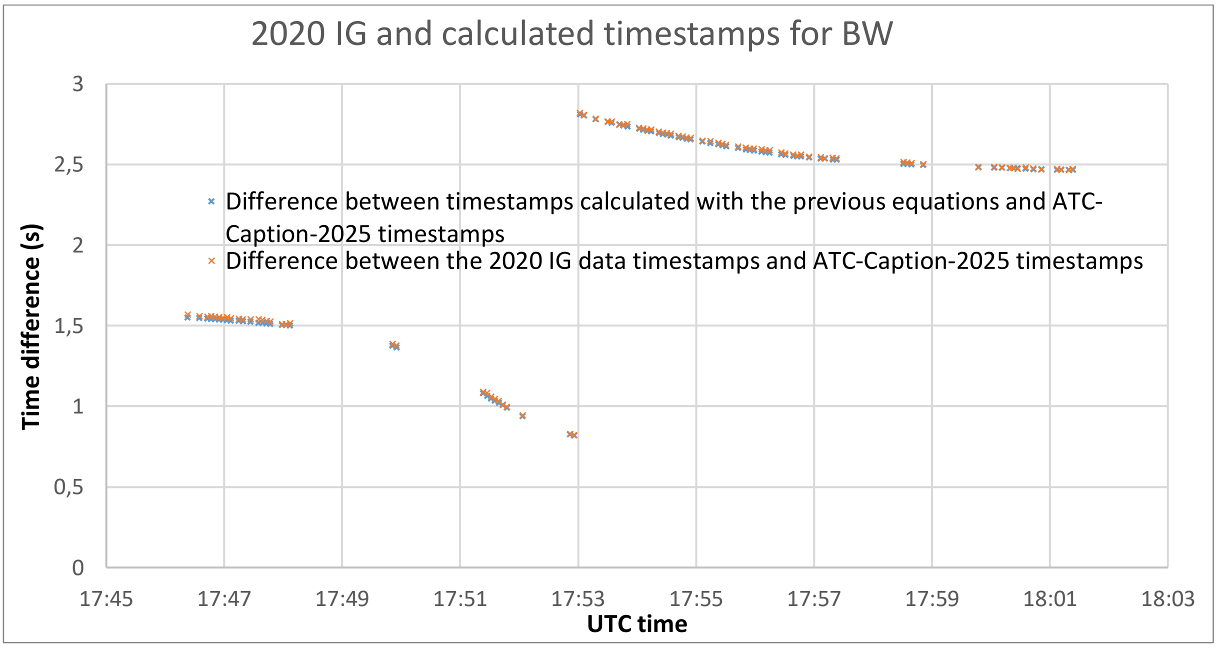


Figure 72 Comparison between the BW IG 2020 timestamps and the timestamps calculated from the North crossings and theta values using the formula (2)

4.3. Independent group 2019 ADS-B data [16]

In 2019 the Independent group published on mh370.radiantphysics.com website the ADS-B data from KT. It was clearly extracted from the ATC-Caption-2025 recording. While it is unclear why this dataset was not published earlier, the published data itself is very close to what is contained in the ATC-Caption-2025 recording raw data. The two first messages from MH370 were not included, probably because they don’t contain the flight identification. But values like the geometric altitude and the figure of merit were omitted, and the ground speed was converted from polar (speed and direction) to Cartesian coordinates (probably due to a “non-literal“ parsing process).

4.4. Godfrey 2024 radar [17] [18] and ADS-B data [18]

In April 2024, in response to our Geoscience data analysis paper [10], Richard Godfrey published a paper on his website with supporting data trying to defend the idea that the Geoscience data would in fact be based solely on ATC data. For this, SSR data containing Genting, KL N and KB SSR positions of MH370 were used. But, according to the timestamps, it is clear that Genting, KL N and KB datasets come from cartesian coordinates that were subsequently converted to rho/theta values (albeit with a constant 10ms time shift for Genting values). These coordinates are clearly incorrectly extracted. For example the first KB point is a PSR+SSR report with a rho of 200 NM which is impossible as KB PSR range is of 62 NM. The reason for this computation error appears to be that the rho and theta values were calculated from Cartesian coordinates that were supposed to be centered on Subang.

Thus, instead of subtracting the “Subang to KB” vector once from the coordinates, the calculation was done by subtracting that vector twice, resulting in rho/theta values coherent with a radar head in the middle of the South China Sea. This error might have been made while trying to translate coordinates from Subang to KB, but these coordinates had already been actually translated to KB. It is probable that this translation was done correctly in the 2018 IG radar dataset, basically confirming that the KL N positions in the 2018 data were calculated and not the genuine measurements.

In KB and BW PSR data, Mr Godfrey’s values are the same as in the 2018 IG dataset (including lacking points and unmarked coasting points), the only differences seem to be some typos (18:40:00 instead of 17:40:00 and 24,5 instead of 249,5), which could indicate that the values were manually typed in and not copied.

While Mr Godfrey’s KT ADS-B data contains all the points from ATC-Caption-2025 MH370 KT ADS-B (the IG’s 2019 ADS-B data was missing the first two), the first messages contain a wrong mode A code. These different IDs suggest that the parsing was redone. Furthermore, it seems to have been done in the exact same way with the same parser as for the 2020 IG dataset.

4.5. Official report diagrams [19]

The official report contains two radar diagrams based on ATC data, combining SSR data, KB PSR data and BW PSR data.

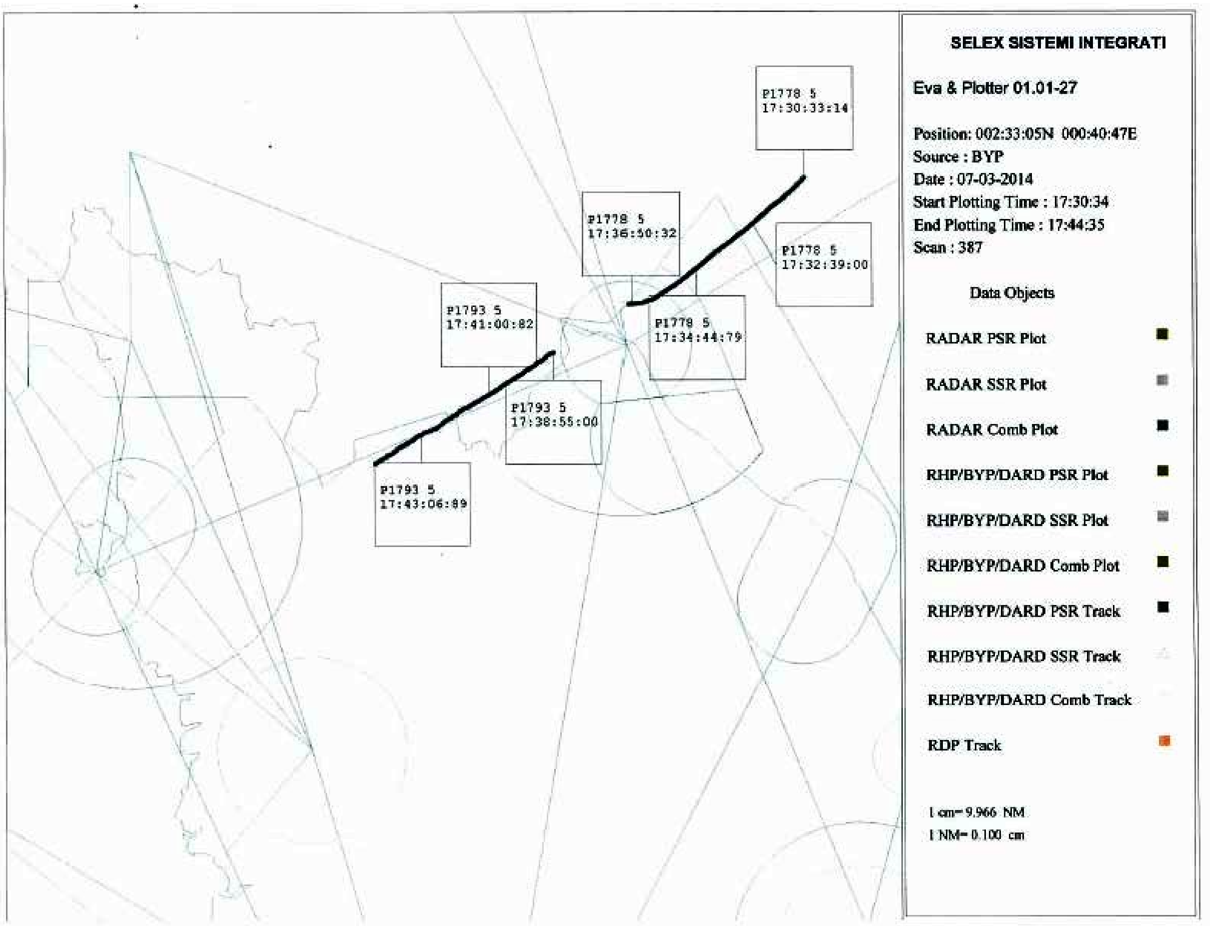


Figure 73 Figure 1.1F of the official report (increased contrast) – Kota Bharu

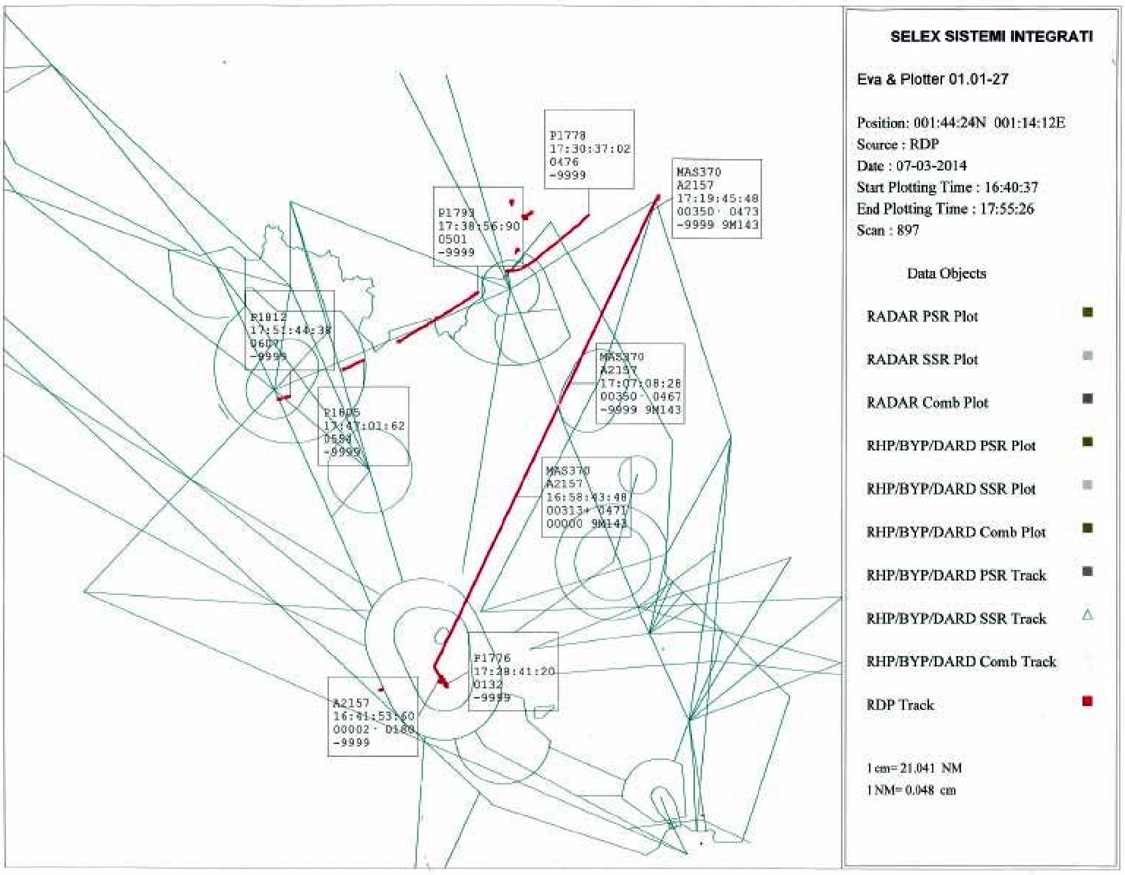


Figure 74 Figure 1.1G of the official report (increased contrast)

In the KB diagram (Figure 73), tracks P1778 and P1793 are coherent with tracks 1778 and 1793 in the KB data of ATC-Caption-2025 recording.

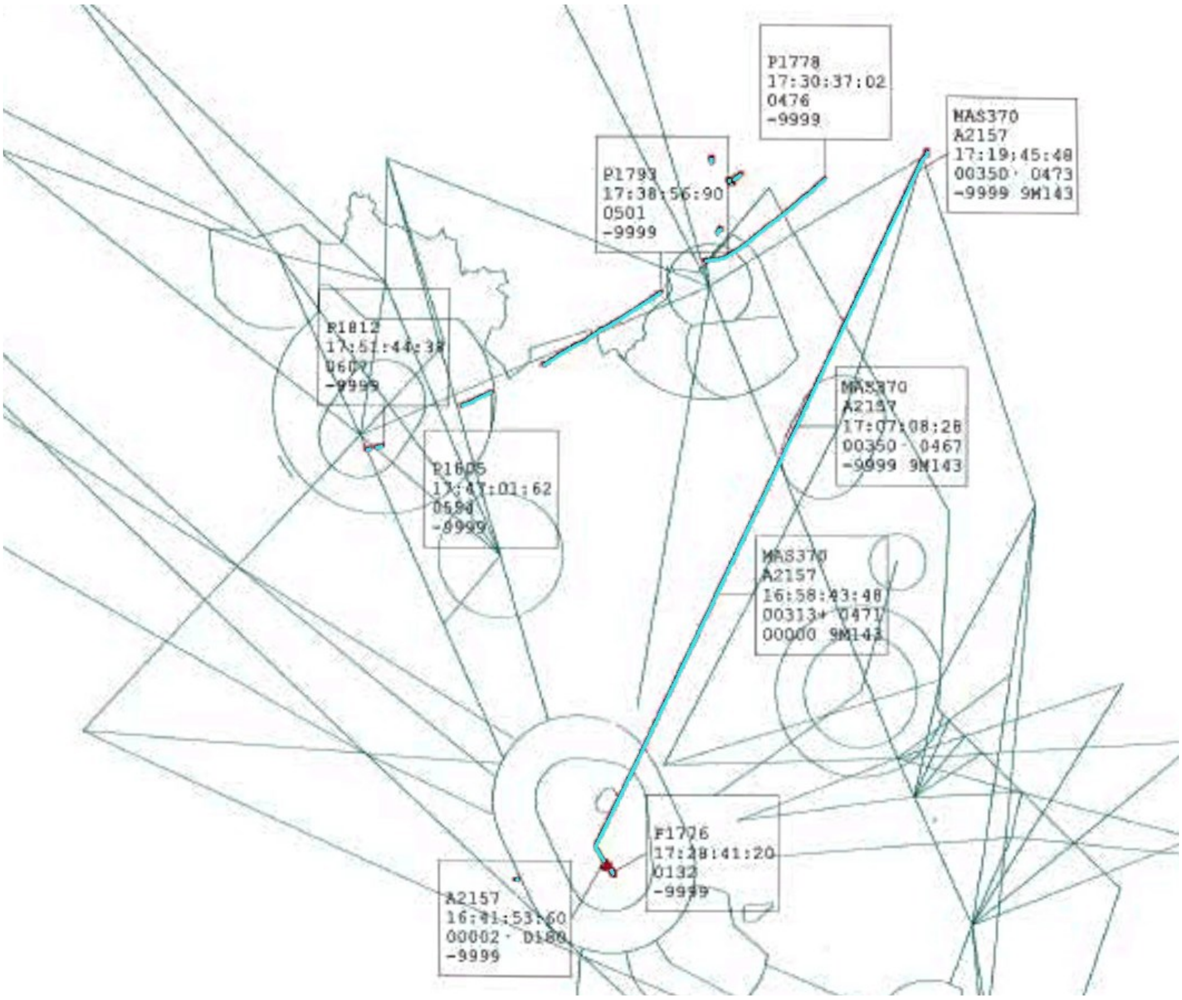


Figure 75 Figure 1.1G superimposed with corresponding tracks from ATC-Caption-2025

In the other diagram (Figure 75), all tracks can be found in the ATC-Caption-2025 data with perfectly corresponding timestamps.

Tracks in ATC-Caption-2025 data:

Number	*Time*	*Description*	*Source*
3165	16:41:54-17:20:56	SSR track (squawk 2157)	Multiple
1666	16:47:42-16:48:07	PSR track 42 NM N of KB,2 PSR points	KB
1679	16:54:56-16:55:31	PSR track 13 NM N of KB,7 PSR points	KB
1685	16:56:37-16:56:57	PSR track 35 NM N of KB,1 PSR point	KB
1716	17:05:47-17:06:08	PSR track 38 NM N of KB, 1 PSR point	KB
1717	17:06:38-17:06:58	PSR track 40 NM N of KB, 1 PSR point	KB
1720	17:07:39-17:08:09	PSR track 32 NM W of KLIA, 6 PSR points	KL S
1776	17:28:41-17:29:22	PSR track SE of KLIA, 5 PSR points	KL S
1778	17:30:37-17:37:06	KB in	KB
1779	17:30:47-17:31:23	PSR track SE of KLIA, 6 PSR points	KL S
1793	17:38:57-17:44:35	KB out	KB
1805	17:47:02-17:48:22	BW part 1, 12 PSR points	BW
1812	17:51:44-17:52:00	BW part 2A, 1 PSR point	BW
1813	17:51:44-17:52:00	BW part 2B, 2 PSR points	BW
1814	17:52:10-17:52:20	BW part 3, 1 PSR point	BW

It seems that the diagram was created by extracting all the PSR-only tracks of the RDP, and adding the known SSR track of MH370. This explains why the BW tracks are so short compared to the BW points: the tracker was not able to connect the intermittent echoes, and created only 4 tracks, with one being doubled. For the same reason, the official reports mention the disappearance of the PSR target at 17:52:35, whereas the ASTERIX data contains position reports up until 18:01.

4.6. Geoscience data [10]

In March 2024, the "Geoscience data" was released [10] by CAPTION. It is a series of points of the trajectory from Kuala Lumpur to Pulau Perak, with a pseudo 10s interval, based on civilian and military data. This data was extracted from a Geoscience Australia website aiming to publicize the efforts for the search of MH370 in the SIO. The dataset was found to coincide with data shared by Malaysia with Australia and Boeing. It was probably generated with KB and BW PSR data as a complement to Malaysian long-range military PSR. The data is quite close to ATC-Caption-2025 data, except at the beginning and the end of BW coverage if using the raw measurements. But after correcting for the BW angle error, the two tracks coincide. There are two possible explanations:

- The Geoscience track was created using other PSR sources in these areas than BW
- The tracker used to generate the Geoscience data indeed used BW data here, but was programmed to correct this angle error

In both cases, this confirms that the BW data needs to be corrected in azimuth angle to obtain realistic positions.

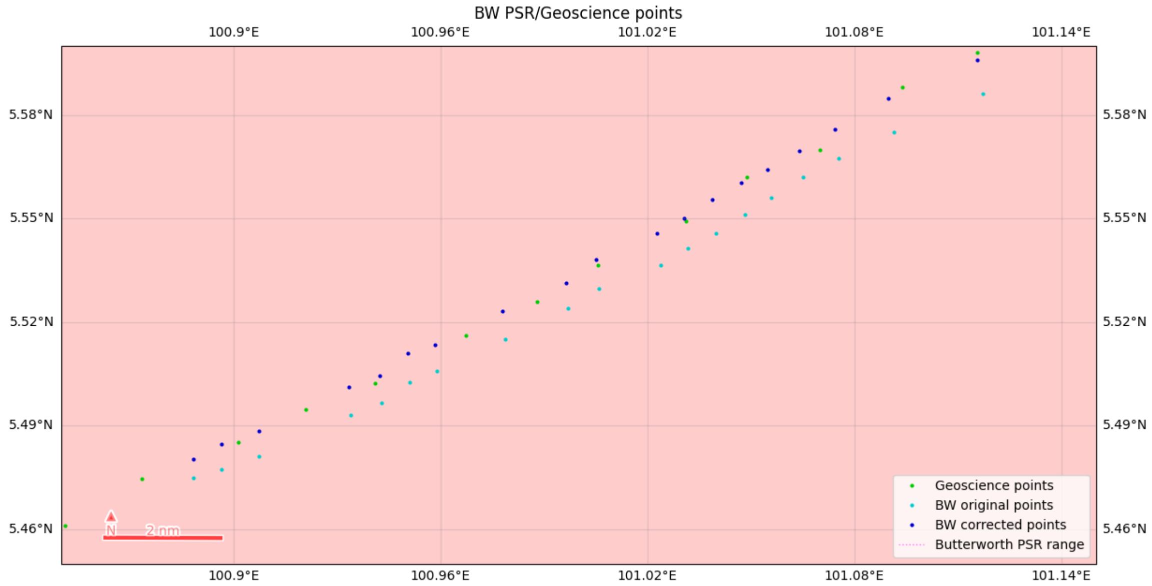


Figure 76 Comparison of Geoscience points (green), BW raw points (blue) and BW corrected points (cyan) at the beginning of BW coverage

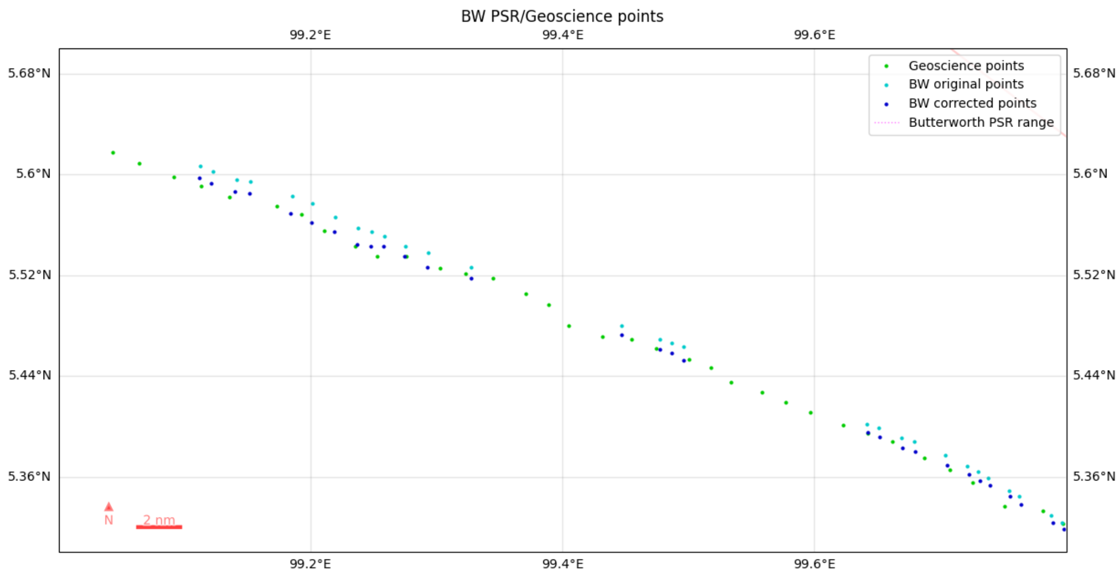


Figure 77 Comparison of Geoscience points (green), BW raw points (blue) and BW corrected points (cyan) at the end of BW coverage

4.7. Comparison with the Lido hotel photo

The Lido hotel photo is a photograph of a slide shown to the next of kin on 21 March 2014. It contains what looks like radar points from Penang to waypoint VAMPI, and from VAMPI to MEKAR. The last point timestamp is 022212, which corresponds to the MYT time of the last known radar point at 18:22:12 UTC.

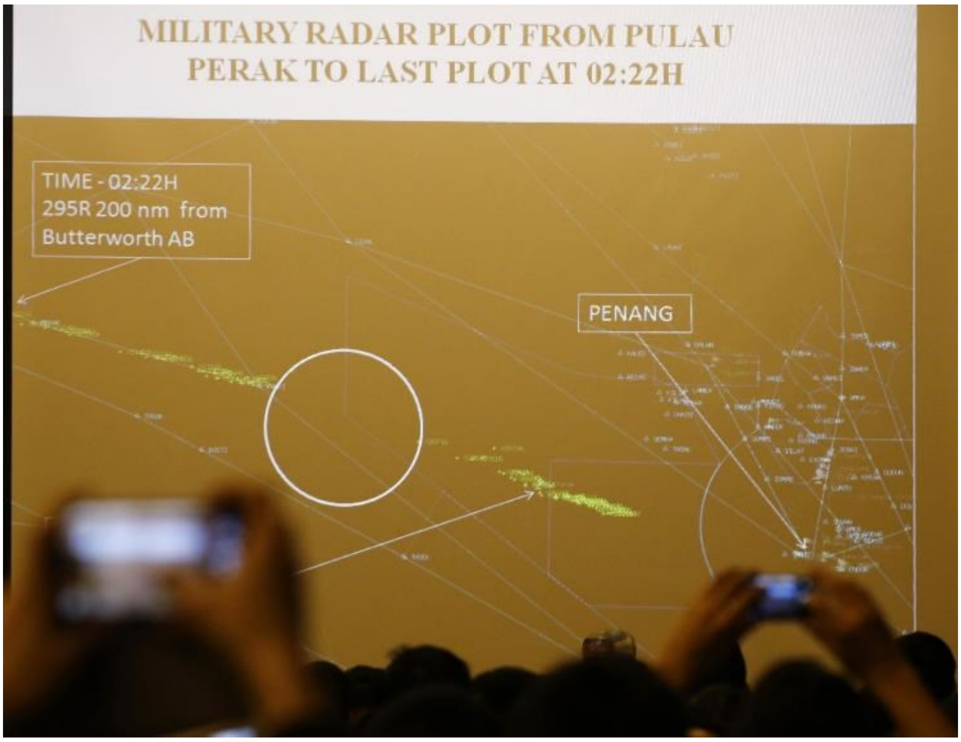


Figure 78 Lido photo (credit: Kim Kyung-Hoon; Reuters)

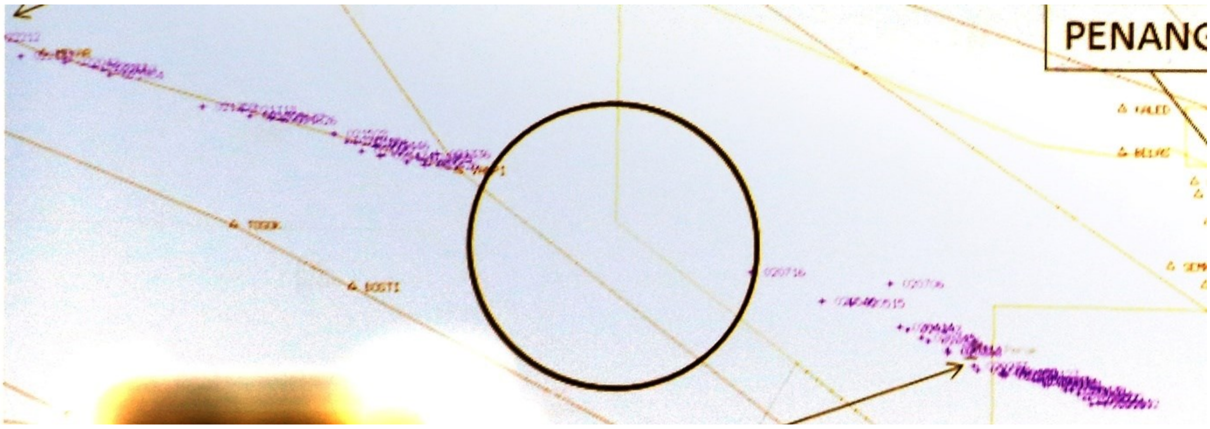


Figure 79 Zoom on the Lido hotel photo (inverted colors)

Some doubts have been raised regarding the veracity of these points, and some suggested that this could be points of another flight. Points 18:07:16, 18:16:35 and 18:22:12 are readable on the photo, they are compared with the ATC-Caption-2025 data at the same time in the next figures. While UAE343 is approximately 30 NM away from these points (which corresponds to a temporal separation of 4 minutes), it is too far away to correspond to the Lido target. As no PSR target could be found in BW (except the ones already associated with MH370) or Langkawi data, it seems unlikely that another aircraft without a transponder was flying there at that time.

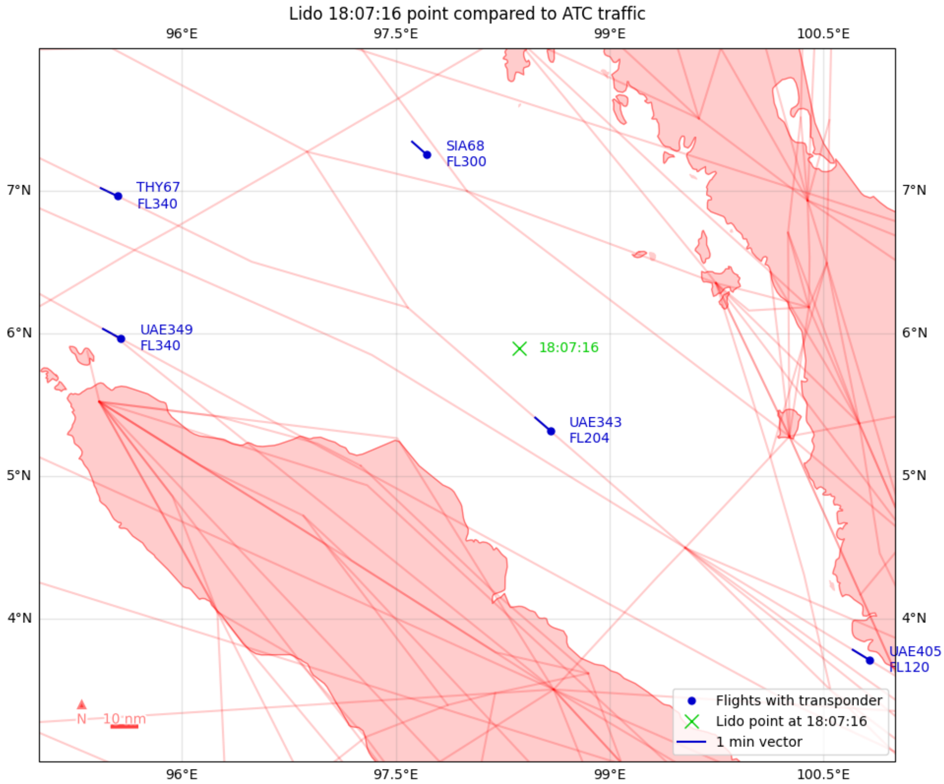


Figure 80 Lido 18:07:16 point compared to surrounding ATC traffic

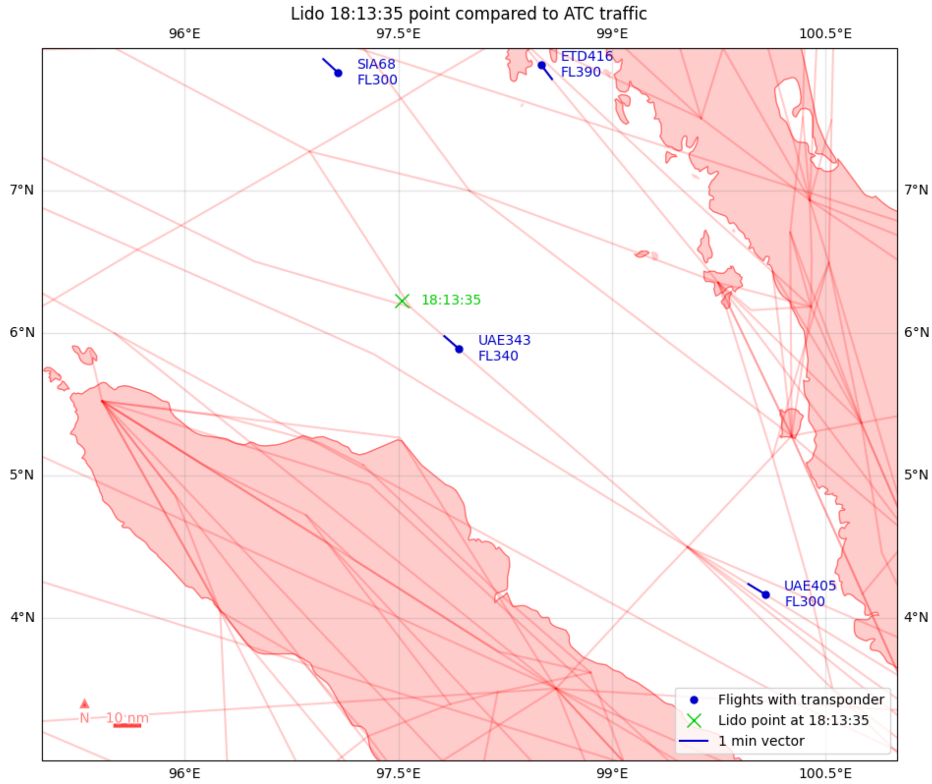


Figure 81 Lido 18:13:35 point compared to surrounding ATC traffic

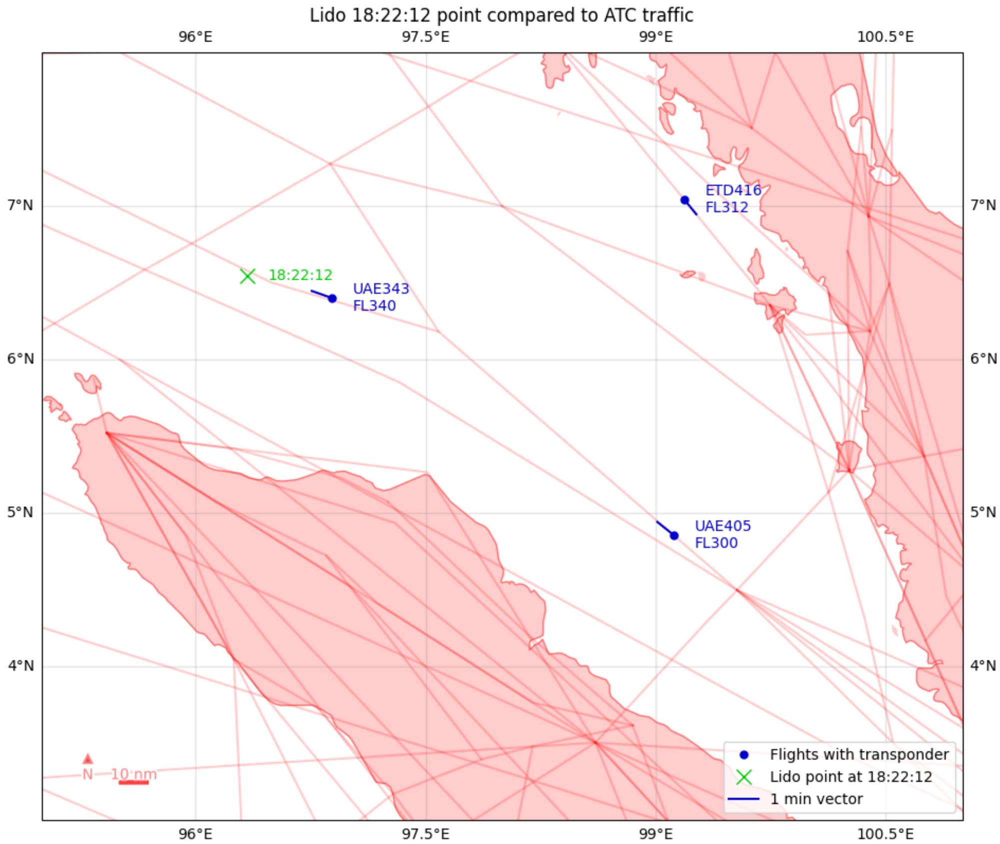


Figure 82 Lido 18:22:12 point compared to surrounding ATC traffic

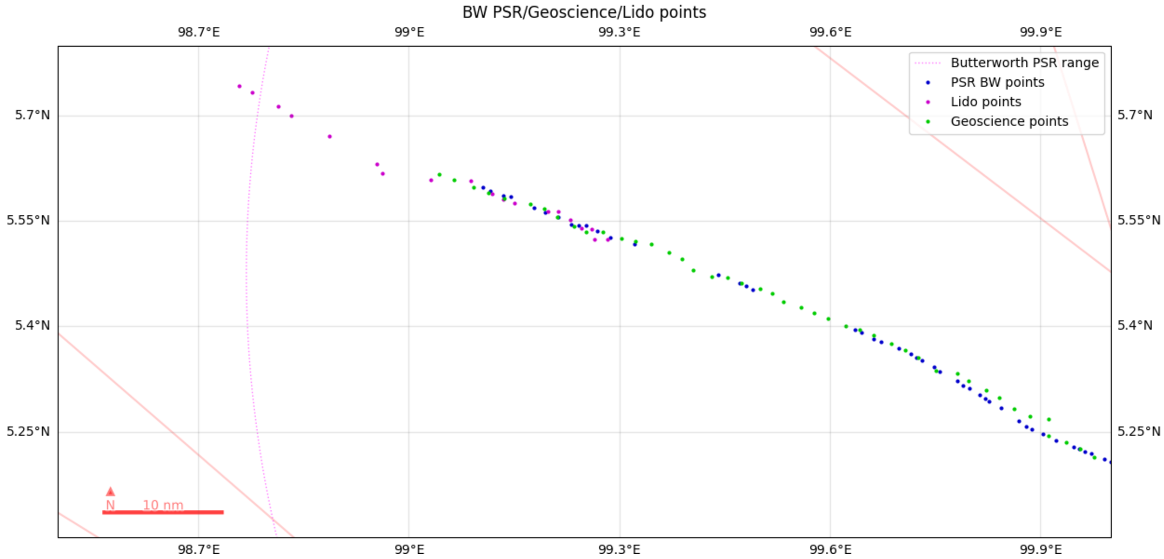


Figure 83 Comparison of BW PSR points, Geoscience points and Lido points

When geographically comparing the ATC-Caption-2025 BW PSR, Geoscience, and Lido photo points, we see a very good correspondence on a trajectory that does not appear to be a common route, which leads to the conclusion that the Lido photo points are genuine and correspond to the aircraft with a very high credibility.

5. Conclusion

An in-depth analysis of the Malaysian ATC radar recordings (referred to as ATC-Caption-2025) during the night of 8 March 2014 (i.e. on 7 March UTC) was carried out based on the raw data itself. These recordings contain the data coming from all Malaysian civilian ATC radars, along with ADS-B data from two sources, some ADS-C position reports and additional information on some of the flights.

Everything indicates that the data is genuine and was not altered after the recording. Furthermore, the accuracy of target reports timestamps and rotation speeds were analyzed and no anomaly was found.

The now available Genting ADS-B data makes the trajectory of MH370 perfectly known from the apron to IGARI. The ADS-B and SSR data received from the aircraft indicates a completely nominal flight up to IGARI followed by a shutdown (switch to standby) of its transponder, most probably manually perpetrated in the cockpit.

Some additional data was found in the Kota Bharu radar PSR tracks of MH370.

Later, the crossing of the Cone of silence of Kota Bharu radar by MH370 indicates the plane was most probably flying somewhere between FL340 and FL390 at that point and descending.

An issue with Butterworth azimuth angle measurement was discovered. When this was accounted for, the trajectories of MH370 from Butterworth radar and from the Geoscience dataset closely match.

No target report attributable to MH370 could be found in Langkawi radar data.

The ADS-B and SSR data allowed for an analysis of the traffic surrounding flight MH370.

Previous ATC derived datasets each appear to raise at least some issues. Therefore, the new ATC-Caption-2025 datasets extracted from the raw data are more precise, more complete and provide a more accurate representation of the trajectory of MH370 up to the Malacca strait. They also include complementary information on surrounding traffic never released before.

It is therefore recommended to base any new analysis work on these datasets coming from the ATC-Caption-2025 and provided on our web site (www.mh370-caption.net). It is also recommended to redo all analyses based on previously published data.

The reader is encouraged to contact the authors by email if he or she has a specific idea about a particular and relevant use of the raw data.

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7. Appendices

7.1. Comparison IG 2018 Dataset – ATC-Caption-2025

7.1.1. KB PSR

IG 2018			ATC-Caption-2025					Difference		
Time	Rho	Theta	Time	Rho	Theta	Time North	Diff TN	Time	Rho	Theta
63033.3	58.0	47.5	63033.313	57.977	47.554	63032.811		-0.002	0.023	-0.054
63037.0	57.5	47.3	63037.148	57.477	47.159	63036.651	3.840	-0.148	0.023	0.141
63040.0	57.0	47.5	63040.953	56.992	47.813	63040.448	3.798	-0.953	0.008	-0.313
63044.0	56.5	47.6	63044.773	56.508	47.593	63044.271	3.823	-0.773	-0.008	0.007
63048.0	56.0	47.6	63048.586	56.016	47.626	63048.083	3.812	-0.586	-0.016	-0.026
63052.0	55.5	47.5	63052.406	55.531	47.142	63051.909	3.825	-0.406	-0.031	0.358
63056.0	55.0	47.6	63056.227	55.047	47.911	63055.721	3.812	-0.227	-0.047	-0.311
63060.0	54.6	47.6	63060.039	54.570	47.659	63059.536	3.815	-0.039	0.030	-0.059
63064.0	54.1	47.6	63063.844	54.086	47.527	63063.342	3.806	0.156	0.014	0.073
63068.0	53.6	47.7	63067.656	53.609	47.774	63067.152	3.810	0.344	-0.009	-0.074
63071.0	53.1	47.7	63071.477	53.117	47.538	63070.975	3.823	-0.477	-0.017	0.162
63075.0	52.7	47.6	63075.289	52.648	47.428	63074.788	3.814	-0.289	0.052	0.172
63079.0	52.2	47.5	63079.109	52.164	47.313	63078.610	3.822	-0.109	0.036	0.187
63082.0	51.7	47.6	63082.906	51.688	47.840	63082.401	3.791	-0.906	0.013	-0.240
63086.0	51.2	47.6	63086.727	51.211	47.659	63086.223	3.822	-0.727	-0.011	-0.059
63092.0	50.2	47.6	63090.539	50.734	47.763	63090.035	3.811	1.461	-0.534	-0.163
			63094.344	50.250	47.620	63093.841	3.806			
63098.0	49.8	47.5	63098.156	49.773	47.368	63097.656	3.815	-0.156	0.027	0.132
63102.0	49.3	47.5	63102.000	49.289	47.126	63101.503	3.846	0.000	0.011	0.374
63106.0	48.8	47.4	63105.797	48.813	47.131	63105.299	3.797	0.203	-0.013	0.269
63110.0	48.3	47.3	63109.617	48.313	47.225	63109.119	3.819	0.383	-0.013	0.075
63113.0	47.9	47.4	63113.414	47.828	47.263	63112.915	3.796	-0.414	0.072	0.137
63117.0	47.4	47.2	63117.250	47.320	47.247	63116.751	3.836	-0.250	0.080	-0.047
63120.0	46.9	47.3	63121.055	46.836	47.390	63120.554	3.803	-1.055	0.064	-0.090
63124.0	46.4	47.2	63124.867	46.336	47.258	63124.368	3.814	-0.867	0.064	-0.058
63128.0	45.9	47.3	63128.680	45.844	47.703	63128.176	3.808	-0.680	0.056	-0.403
63132.0	45.4	47.3	63132.500	45.344	47.219	63132.002	3.825	-0.500	0.056	0.081
63136.0	44.9	47.2	63136.305	44.836	47.126	63135.807	3.806	-0.305	0.064	0.074
63140.0	44.4	47.2	63140.109	44.352	47.214	63139.611	3.804	-0.109	0.048	-0.014
63144.0	43.9	47.1	63143.930	43.852	47.225	63143.431	3.820	0.070	0.048	-0.125
63148.0	43.4	47.0	63147.727	43.344	47.137	63147.229	3.798	0.273	0.056	-0.137
63151.0	43.0	47.0	63151.547	42.836	47.280	63151.048	3.819	-0.547	0.164	-0.280
63155.0	42.5	47.0	63155.359	42.352	47.027	63154.863	3.815	-0.359	0.148	-0.027
63159.0	41.9	47.0	63159.164	41.844	47.329	63158.664	3.801	-0.164	0.056	-0.329
63163.0	41.5	47.0	63162.977	41.359	47.054	63162.480	3.815	0.023	0.141	-0.054
63167.0	41.0	47.0	63166.805	40.852	46.978	63166.309	3.829	0.195	0.148	0.022
63171.0	40.4	46.9	63170.609	40.375	46.835	63170.115	3.806	0.391	0.025	0.065
63174.0	39.9	46.9	63174.414	39.883	47.131	63173.917	3.802	-0.414	0.017	-0.231
63178.0	39.5	46.8	63178.219	39.375	46.917	63177.724	3.807	-0.219	0.125	-0.117
63182.0	39.0	46.8	63182.023	38.891	46.829	63181.529	3.806	-0.023	0.109	-0.029

63186.0	38.5	46.8	63185.867	38.391	46.588	63185.375	3.846	0.133	0.109	0.212
63189.0	38.0	46.6	63189.680	37.898	46.522	63189.189	3.813	-0.680	0.102	0.078
63193.0	37.6	46.6	63193.484	37.391	46.329	63192.995	3.807	-0.484	0.209	0.271
63197.0	37.0	46.5	63197.289	36.906	46.566	63196.798	3.802	-0.289	0.094	-0.066
63201.0	36.5	46.5	63201.117	36.422	46.780	63200.623	3.826	-0.117	0.078	-0.280
63205.0	35.9	46.4	63204.938	35.906	46.406	63204.448	3.824	0.063	-0.006	-0.006
63209.0	35.5	46.3	63208.734	35.406	46.324	63208.245	3.798	0.266	0.094	-0.024
63212.0	35.0	46.2	63212.539	34.922	46.137	63212.052	3.807	-0.539	0.078	0.063
63216.0	34.5	46.0	63216.359	34.414	45.901	63215.875	3.823	-0.359	0.086	0.099
63220.0	34.0	46.0	63220.164	33.922	46.269	63219.676	3.801	-0.164	0.078	-0.269
63224.0	33.6	45.8	63223.977	33.406	45.516	63223.496	3.820	0.023	0.194	0.284
63228.0	33.1	45.8	63227.789	32.922	45.643	63227.307	3.811	0.211	0.178	0.157
63231.0	32.5	45.5	63231.594	32.414	45.522	63231.113	3.806	-0.594	0.086	-0.022
63235.0	32.1	45.5	63235.414	31.906	45.555	63234.933	3.820	-0.414	0.194	-0.055
63239.0	31.5	45.3	63239.227	31.414	45.500	63238.746	3.813	-0.227	0.086	-0.200
63243.0	31.0	45.2	63243.039	30.906	45.483	63242.559	3.813	-0.039	0.094	-0.283
63246.0	30.5	45.2	63246.836	30.398	45.423	63246.356	3.798	-0.836	0.102	-0.223
63250.0	30.0	45.1	63250.664	29.898	45.494	63250.184	3.827	-0.664	0.102	-0.394
63254.0	29.5	45.0	63254.469	29.391	45.159	63253.992	3.808	-0.469	0.109	-0.159
63258.0	29.0	44.8	63258.273	28.883	44.791	63257.801	3.809	-0.273	0.117	0.009
63262.0	28.6	44.8	63262.086	28.367	45.104	63261.610	3.809	-0.086	0.233	-0.304
63265.0	28.0	44.7	63265.914	27.875	44.786	63265.441	3.831	-0.914	0.125	-0.086
63269.0	27.5	44.7	63269.727	27.359	44.610	63269.256	3.814	-0.727	0.141	0.090
63273.0	27.0	44.6	63273.539	26.844	44.665	63273.068	3.812	-0.539	0.156	-0.065
63277.0	26.5	44.4	63277.344	26.320	44.495	63276.874	3.806	-0.344	0.180	-0.095
63281.0	25.9	44.4	63281.164	25.820	44.484	63280.695	3.820	-0.164	0.080	-0.084
63285.0	25.5	43.9	63284.977	25.313	44.352	63284.508	3.814	0.023	0.188	-0.452
63289.0	24.9	44.0	63288.797	24.805	44.000	63288.332	3.824	0.203	0.095	0.000
63293.0	24.5	43.9	63292.609	24.289	43.874	63292.146	3.814	0.391	0.211	0.026
63296.0	24.0	43.8	63296.430	23.781	43.857	63295.967	3.820	-0.430	0.219	-0.057
63300.0	23.5	43.5	63300.250	23.266	43.638	63299.789	3.823	-0.250	0.234	-0.138
63304.0	22.9	43.4	63304.039	22.766	43.391	63303.581	3.792	-0.039	0.134	0.009
63308.0	22.5	43.1	63307.844	22.266	43.621	63307.383	3.802	0.156	0.234	-0.521
63312.0	21.9	43.0	63311.656	21.766	43.055	63311.202	3.818	0.344	0.134	-0.055
63315.0	21.5	42.5	63315.484	21.273	42.830	63315.032	3.831	-0.484	0.227	-0.330
63319.0	21.0	42.7	63319.289	20.766	42.413	63318.841	3.809	-0.289	0.234	0.287
63323.0	20.4	42.3	63323.086	20.281	42.204	63322.640	3.799	-0.086	0.119	0.096
63327.0	19.9	41.9	63326.883	19.781	42.198	63326.437	3.797	0.117	0.119	-0.298
63331.0	19.5	41.8	63330.719	19.305	41.660	63330.279	3.842	0.281	0.195	0.140
63334.0	19.0	41.4	63334.516	18.789	41.314	63334.080	3.801	-0.516	0.211	0.086
63338.0	18.5	41.1	63338.313	18.328	40.638	63337.884	3.804	-0.313	0.172	0.462
63342.0	18.0	40.5	63342.125	17.828	40.226	63341.700	3.817	-0.125	0.172	0.274
63346.0	17.6	39.9	63345.938	17.375	39.897	63345.516	3.816	0.063	0.225	0.003
63350.0	17.1	39.7	63349.734	16.867	39.161	63349.321	3.805	0.266	0.233	0.539
63354.0	16.6	39.0	63353.555	16.398	38.809	63353.145	3.824	0.445	0.202	0.191
63357.0	16.2	38.3	63357.344	15.914	38.293	63356.940	3.795	-0.344	0.286	0.007

63361.0	15.7	37.6	63361.180	15.438	37.370	63360.785	3.846	-0.180	0.262	0.230
63365.0	15.2	37.1	63364.969	14.969	36.711	63364.581	3.796	0.031	0.231	0.389
63368.0	14.7	36.6	63368.773	14.508	36.519	63368.388	3.807	-0.773	0.192	0.081
63373.0	14.3	35.5	63372.563	14.023	35.612	63372.187	3.799	0.438	0.277	-0.112
63376.0	13.9	34.6	63376.383	13.578	34.585	63376.018	3.831	-0.383	0.322	0.015
63380.0	13.4	34.0	63380.195	13.133	33.415	63379.843	3.825	-0.195	0.267	0.585
63384.0	13.1	32.8	63383.984	12.688	31.921	63383.647	3.805	0.016	0.413	0.879
63388.0	12.7	30.9	63387.789	12.227	30.652	63387.466	3.818	0.211	0.473	0.248
63391.0	12.2	29.3	63391.586	11.828	29.432	63391.275	3.810	-0.586	0.372	-0.132
63395.0	11.9	27.9	63395.398	11.492	28.092	63395.102	3.827	-0.398	0.408	-0.192
63399.0	11.5	25.8	63399.188	11.055	24.637	63398.927	3.826	-0.188	0.445	1.163
63403.0	11.2	21.7	63402.953	10.727	21.379	63402.727	3.800	0.047	0.473	0.321
63535.0	15.8	264.8	63535.164	15.445	264.260	63532.375	3.813	-0.164	0.355	0.540
63538.0	16.2	263.8	63538.984	15.898	264.260	63536.195	3.820	-0.984	0.302	-0.460
63546.0	17.1	262.5	63546.594	16.844	262.601	63543.822	3.813	-0.594	0.256	-0.101
63550.0	17.6	261.3	63550.398	17.320	260.947	63547.644	3.822	-0.398	0.280	0.353
63554.0	18.1	260.3	63554.195	17.797	260.178	63551.449	3.805	-0.195	0.303	0.122
63562.0	19.0	258.8	63561.813	18.773	258.805	63559.081	3.816	0.188	0.227	-0.005
63566.0	19.5	258.3	63565.633	19.281	258.547	63562.904	3.823	0.367	0.219	-0.247
63569.0	20.0	257.7	63569.438	19.773	257.646	63566.718	3.814	-0.438	0.227	0.054
63573.0	20.5	257.0	63573.250	20.273	256.888	63570.538	3.821	-0.250	0.227	0.112
63577.0	21.0	256.6	63577.063	20.766	256.668	63574.353	3.815	-0.062	0.234	-0.068
63581.0	21.5	256.2	63580.875	21.281	256.613	63578.166	3.813	0.125	0.219	-0.413
63585.0	22.0	255.8	63584.680	21.797	256.003	63581.977	3.811	0.320	0.203	-0.203
63588.0	22.5	255.4	63588.500	22.305	255.399	63585.804	3.827	-0.500	0.195	0.001
63592.0	23.0	254.9	63592.313	22.820	254.905	63589.622	3.818	-0.313	0.180	-0.005
63596.0	23.5	254.5	63596.125	23.336	254.344	63593.440	3.818	-0.125	0.164	0.156
63600.0	24.0	254.1	63599.930	23.852	253.987	63597.249	3.808	0.070	0.148	0.113
63603.0	24.5	253.7	63603.750	24.367	253.828	63601.071	3.822	-0.750	0.133	-0.128
63607.0	25.1	253.4	63607.578	24.891	253.559	63604.902	3.831	-0.578	0.209	-0.159
63611.0	25.6	253.1	63611.383	25.414	253.251	63608.710	3.808	-0.383	0.186	-0.151
63615.0	26.1	252.7	63615.219	25.938	252.675	63612.552	3.842	-0.219	0.163	0.025
63619.0	26.6	252.4	63619.016	26.469	252.103	63616.355	3.803	-0.016	0.131	0.297
63623.0	27.2	252.2	63622.828	27.000	252.675	63620.161	3.806	0.172	0.200	-0.475
63627.0	27.7	251.9	63626.656	27.539	251.620	63624.000	3.839	0.344	0.161	0.280
63630.0	28.2	251.6	63630.469	28.070	251.900	63627.810	3.810	-0.469	0.130	-0.300
63634.0	28.7	251.3	63634.273	28.609	251.147	63631.622	3.813	-0.273	0.091	0.153
63638.0	29.3	251.0	63638.109	29.141	251.032	63635.460	3.837	-0.109	0.159	-0.032
63642.0	29.8	250.7	63641.938	29.688	250.291	63639.296	3.836	0.063	0.113	0.409
63646.0	30.3	250.4	63645.750	30.219	250.274	63643.108	3.813	0.250	0.081	0.126
63649.0	30.9	250.2	63649.547	30.766	250.269	63646.905	3.797	-0.547	0.134	-0.069
63653.0	31.4	249.9	63653.367	31.297	249.675	63650.732	3.827	-0.367	0.103	0.225
63657.0	32.0	249.8	63657.195	31.844	250.148	63654.555	3.823	-0.195	0.156	-0.348
63661.0	32.5	249.5	63661.016	32.375	249.384	63658.383	3.828	-0.016	0.125	0.116
63665.0	33.0	249.4	63664.828	32.914	249.966	63662.190	3.806	0.172	0.086	-0.566
63669.0	33.6	249.3	63668.648	33.445	249.390	63666.016	3.826	0.352	0.155	-0.090

63673.0	34.1	249.1	63672.484	33.984	249.269	63669.853	3.837	0.516	0.116	-0.169
63681.0	35.2	248.7	63680.109	35.063	248.621	63677.485	3.816	0.891	0.138	0.079
63685.0	35.7	248.6	63683.930	35.602	248.626	63681.305	3.820	1.070	0.098	-0.026
63689.0	36.3	248.5	63687.750	36.133	248.610	63685.126	3.820	1.250	0.167	-0.110
63693.0	36.8	248.4	63691.586	36.664	248.423	63688.964	3.838	1.414	0.136	-0.023
63695.0	37.3	248.2	63695.398	37.203	248.313	63692.777	3.814	-0.398	0.097	-0.113
63699.0	37.9	248.0	63699.219	37.742	247.742	63696.604	3.826	-0.219	0.158	0.258
63707.0	38.9	248.1	63706.867	38.836	248.637	63704.243	3.819	0.133	0.064	-0.537
63714.0	40.0	247.8	63714.484	39.898	247.742	63711.869	3.813	-0.484	0.102	0.058
63718.0	40.5	247.7	63718.305	40.453	247.725	63715.690	3.820	-0.305	0.047	-0.025
63722.0	41.1	247.4	63722.148	40.992	247.269	63719.538	3.849	-0.148	0.108	0.131
63725.0	41.6	247.3	63725.953	41.547	247.352	63723.342	3.804	-0.953	0.053	-0.052
63728.0	42.2	247.2	63729.773	42.086	247.308	63727.163	3.821	-1.773	0.114	-0.108
63734.0	42.7	247.0	63733.594	42.625	246.967	63730.987	3.824	0.406	0.075	0.033
63737.0	43.3	246.9	63737.430	43.195	246.978	63734.823	3.836	-0.430	0.105	-0.078
63745.0	44.4	246.8	63745.055	44.273	246.984	63742.448	3.812	-0.055	0.127	-0.184
63749.0	44.9	246.4	63748.867	44.836	246.083	63746.270	3.822	0.133	0.064	0.317
63753.0	45.5	246.2	63752.695	45.398	246.088	63750.098	3.828	0.305	0.102	0.112
63756.0	46.0	246.1	63756.523	45.938	246.099	63753.926	3.828	-0.523	0.063	0.001
63768.0	47.7	246.0	63767.969	47.609	246.099	63765.371	3.815	0.031	0.091	-0.099
63772.0	48.2	245.9	63771.805	48.156	245.896	63769.209	3.838	0.195	0.044	0.004
63776.0	48.8	246.0	63775.633	48.711	246.088	63773.035	3.826	0.367	0.089	-0.088
63779.0	49.3	246.0	63779.453	49.273	246.088	63776.856	3.820	-0.453	0.027	-0.088
63783.0	49.9	246.1	63783.273	49.828	246.088	63780.676	3.820	-0.273	0.072	0.012
63787.0	50.5	245.9	63787.094	50.383	245.660	63784.501	3.825	-0.094	0.117	0.240
63791.0	51.0	246.0	63790.930	50.938	246.083	63788.332	3.831	0.070	0.063	-0.083
63795.0	51.6	246.0	63794.750	51.500	246.094	63792.152	3.820	0.250	0.100	-0.094
63799.0	52.1	245.8	63798.547	52.063	245.314	63795.957	3.805	0.453	0.038	0.486
63802.0	52.7	245.7	63802.383	52.625	245.336	63799.793	3.836	-0.383	0.075	0.364
63806.0	53.2	245.6	63806.203	53.180	245.533	63803.611	3.818	-0.203	0.020	0.067
63810.0	53.8	245.5	63810.023	53.719	245.336	63807.434	3.822	-0.023	0.081	0.164
63814.0	54.4	245.4	63813.844	54.289	245.336	63811.254	3.820	0.156	0.111	0.064
63818.0	54.9	245.4	63817.664	54.844	245.352	63815.074	3.820	0.336	0.056	0.048
63821.0	55.5	245.3	63821.500	55.406	245.336	63818.910	3.836	-0.500	0.094	-0.036
63825.0	56.0	245.3	63825.328	55.961	245.314	63822.739	3.828	-0.328	0.039	-0.014
63829.0	56.6	245.3	63829.133	56.523	245.308	63826.543	3.805	-0.133	0.077	-0.008
63833.0	57.1	245.2	63832.953	57.094	245.045	63830.367	3.823	0.047	0.006	0.155
63837.0	57.7	245.0	63836.766	57.641	244.418	63834.186	3.819	0.234	0.059	0.582
63840.0	58.3	244.9	63840.609	58.203	244.764	63838.026	3.840	-0.609	0.097	0.136
63844.0	58.8	244.8	63844.414	58.766	244.759	63841.830	3.805	-0.414	0.034	0.041
63848.0	59.4	244.8	63848.234	59.313	245.006	63845.648	3.818	-0.234	0.087	-0.206
63852.0	59.9	244.8	63852.055	59.867	244.836	63849.470	3.822	-0.055	0.033	-0.036
63856.0	60.5	244.7	63855.898	60.422	244.506	63853.318	3.847	0.102	0.078	0.194
63860.0	61.0	244.6	63859.703	60.984	244.567	63857.122	3.804	0.297	0.016	0.033
63864.0	61.6	244.6	63863.508	61.539	244.539	63860.927	3.805	0.492	0.061	0.061

Coasted points :

63542.0	16.7	263.2
63558.0	18.5	259.6
63677.0	34.6	248.9
63703.0	38.4	248.1
63711.0	39.5	248.0
63741.0	43.8	246.9
63760.0	46.6	246.0
63764.0	47.1	246.0

7.1.2. BW PSR

IG 2018			ATC-Caption-2025					Difference		
Time	Rho	Theta	Time	Rho	Theta	Time North	Diff TN	Time	Rho	Theta
			63980.963	44.234	81.046	63980.063				
63994.0	42.7	81.6	63993.018	42.617	81.612	63992.111	4.016	-0.982	-0.083	0.012
64002.0	41.7	82.1	64001.091	41.617	82.057	64000.180	4.034	-0.909	-0.083	-0.043
64006.0	41.1	82.5	64005.027	40.969	82.386	64004.111	3.931	-0.973	-0.131	-0.064
64010.0	40.5	82.8	64009.068	40.375	82.798	64008.148	4.037	-0.932	-0.125	-0.002
64014.0	40.0	83.1	64013.103	39.891	83.128	64012.180	4.031	-0.897	-0.109	0.028
64018.0	39.5	83.5	64017.076	39.359	83.502	64016.148	3.969	-0.924	-0.141	0.002
64022.0	39.0	83.8	64021.113	38.852	83.815	64020.182	4.033	-0.887	-0.148	0.015
64026.0	38.5	84.2	64025.086	38.352	84.177	64024.150	3.969	-0.914	-0.148	-0.023
64034.0	37.4	84.6	64033.128	37.266	84.644	64032.187	4.019	-0.872	-0.134	0.044
64038.0	36.8	85.1	64037.172	36.703	85.095	64036.227	4.039	-0.828	-0.097	-0.005
64046.0	35.7	85.8	64045.149	35.578	85.820	64044.195	3.984	-0.851	-0.122	0.020
64054.0	34.5	86.6	64053.181	34.375	86.600	64052.219	4.012	-0.819	-0.125	0.000
64058.0	34.0	86.9	64057.200	33.898	86.880	64056.234	4.016	-0.800	-0.102	-0.020
64062.0	33.5	87.5	64061.230	33.406	87.468	64060.258	4.023	-0.770	-0.094	-0.032
64066.0	33.0	87.8	64065.210	32.867	87.792	64064.234	3.977	-0.790	-0.133	-0.008
64078.0	31.4	89.0	64077.208	31.289	89.011	64076.219	3.995	-0.792	-0.111	0.011
64082.0	30.8	89.4	64081.208	30.641	89.401	64080.215	3.996	-0.792	-0.159	0.001
64086.0	30.3	89.7	64085.250	30.164	89.676	64084.254	4.039	-0.750	-0.136	-0.024
			64189.464	18.055	112.505	64188.214	3.998			
			64193.529	17.703	114.170	64192.261	4.047			
64283.0	14.6	165.7	64282.154	14.242	165.712	64280.312	4.002	-0.846	-0.358	0.012
64287.0	14.6	168.4	64286.152	14.281	168.360	64284.282	3.969	-0.848	-0.319	-0.040
64291.0	14.7	171.2	64290.231	14.359	171.271	64288.328	4.046	-0.769	-0.341	0.071
64295.0	14.8	173.8	64294.220	14.422	173.754	64292.289	3.961	-0.780	-0.378	-0.046
64299.0	14.9	176.4	64298.288	14.539	176.396	64296.328	4.039	-0.712	-0.361	-0.004
64303.0	15.0	178.8	64302.350	14.664	178.841	64300.363	4.035	-0.650	-0.336	0.041
64307.0	15.2	181.7	64306.308	14.852	181.719	64304.289	3.926	-0.692	-0.348	0.019
			64322.501	15.789	191.327	64320.375	4.021			
			64370.874	19.195	211.168	64368.528	4.013			
			64374.866	19.578	212.536	64372.505	3.977			
			64378.955	19.953	213.876	64376.578	4.074			
			64382.928	20.352	215.250	64380.536	3.958			
64398.0	21.8	219.0	64395.012	21.602	219.040	64392.578	4.014	-2.988	-0.198	0.040
64410.0	23.0	222.4	64407.077	22.781	222.374	64404.606	4.009	-2.923	-0.219	-0.026
64414.0	23.4	223.5	64411.132	23.141	223.522	64408.648	4.042	-2.868	-0.259	0.022
64422.0	24.0	225.4	64419.150	23.844	225.423	64416.646	3.999	-2.850	-0.156	0.023
64426.0	24.4	226.6	64423.221	24.219	226.609	64420.703	4.058	-2.779	-0.181	0.009
64430.0	24.8	227.5	64427.275	24.555	227.488	64424.747	4.044	-2.725	-0.245	-0.012
64442.0	25.9	230.1	64439.280	25.664	230.098	64436.724	3.992	-2.720	-0.236	-0.002
64446.0	26.3	231.2	64443.324	26.094	231.185	64440.755	4.031	-2.676	-0.206	-0.015
64450.0	26.7	232.1	64447.353	26.531	232.152	64444.773	4.018	-2.647	-0.169	0.052

64454.0	27.2	233.1	64451.392	26.984	233.108	64448.802	4.028	-2.608	-0.216	0.008
64462.0	27.9	234.9	64459.396	27.719	234.877	64456.786	3.992	-2.604	-0.181	-0.023
64466.0	28.2	235.7	64463.429	28.055	235.712	64460.810	4.023	-2.571	-0.145	0.012
64470.0	28.6	236.7	64467.486	28.422	236.673	64464.857	4.047	-2.514	-0.178	-0.027
64474.0	28.9	237.7	64471.568	28.773	237.728	64468.927	4.070	-2.432	-0.127	0.028
64482.0	29.6	239.5	64479.573	29.477	239.518	64476.911	3.992	-2.427	-0.123	0.018
64486.0	30.0	240.4	64483.637	29.859	240.414	64480.966	4.055	-2.363	-0.141	0.014
64490.0	30.3	241.2	64487.573	30.141	241.199	64484.893	3.927	-2.427	-0.159	-0.001
64494.0	30.6	242.1	64491.632	30.477	242.062	64488.943	4.049	-2.368	-0.123	-0.038
64506.0	31.7	244.4	64503.656	31.594	244.380	64500.940	3.999	-2.344	-0.106	-0.020
64514.0	32.4	246.0	64511.739	32.297	246.039	64509.005	4.033	-2.261	-0.103	0.039
64522.0	33.2	247.5	64519.826	33.016	247.560	64517.076	4.035	-2.174	-0.184	0.060
64526.0	33.5	248.3	64523.866	33.391	248.307	64521.107	4.031	-2.134	-0.109	0.007
64530.0	33.9	249.4	64527.816	33.789	249.467	64525.044	3.938	-2.184	-0.111	0.067
64542.0	35.0	251.7	64539.959	34.867	251.735	64537.162	4.039	-2.041	-0.133	0.035
64550.0	35.7	253.1	64547.927	35.602	253.059	64545.115	3.977	-2.073	-0.098	-0.041
64554.0	36.0	253.6	64551.995	35.891	253.603	64549.177	4.063	-2.005	-0.109	0.003
64558.0	36.4	254.2	64556.049	36.273	254.257	64553.224	4.047	-1.951	-0.127	0.057
64566.0	37.1	255.5	64564.039	36.969	255.460	64561.201	3.988	-1.961	-0.131	-0.040
64570.0	37.5	256.1	64568.070	37.367	256.075	64565.224	4.023	-1.930	-0.133	-0.025
64574.0	37.9	256.8	64572.031	37.797	256.783	64569.177	3.953	-1.969	-0.103	-0.017
64586.0	39.2	258.6	64584.106	39.078	258.607	64581.232	4.018	-1.894	-0.122	0.007
64590.0	39.6	259.1	64588.151	39.484	259.146	64585.271	4.039	-1.849	-0.116	0.046
64598.0	40.4	260.2	64596.189	40.336	260.255	64593.297	4.013	-1.811	-0.064	0.055
64602.0	40.9	260.8	64600.210	40.773	260.771	64597.313	4.016	-1.790	-0.127	-0.029
64606.0	41.3	261.3	64604.151	41.242	261.260	64601.248	3.935	-1.849	-0.058	-0.040
64614.0	42.3	262.2	64612.241	42.188	262.189	64609.328	4.040	-1.759	-0.112	-0.011
64626.0	43.7	263.3	64624.222	43.563	263.276	64621.297	3.990	-1.778	-0.138	-0.024
64630.0	44.2	263.6	64628.258	44.156	263.644	64625.328	4.031	-1.742	-0.044	0.044
64638.0	45.2	264.4	64636.334	45.141	264.391	64633.396	4.034	-1.666	-0.059	-0.009
64642.0	45.8	264.7	64640.298	45.695	264.672	64637.357	3.961	-1.702	-0.105	-0.028
			64708.478	54.172	269.423	64705.484	4.007			
			64712.519	54.727	269.615	64709.523	4.039			
			64716.451	55.297	269.813	64713.453	3.930			
			64728.513	57.109	270.472	64725.508	4.018			
64787.0	64.4	272.9	64784.516	64.305	272.884	64781.484	3.998	-2.484	-0.095	-0.016
64803.0	66.4	273.4	64800.514	66.375	273.400	64797.477	3.998	-2.486	-0.025	0.000
64811.0	67.5	273.6	64808.587	67.477	273.625	64805.547	4.035	-2.413	-0.023	0.025
64819.0	68.6	274.0	64816.607	68.516	273.961	64813.562	4.008	-2.393	-0.084	-0.039
64823.0	69.2	274.1	64820.546	69.109	274.098	64817.500	3.937	-2.454	-0.091	-0.002
64827.0	69.8	274.2	64824.597	69.781	274.219	64821.551	4.051	-2.403	-0.019	0.019
64835.0	70.9	274.5	64832.574	70.898	274.554	64829.523	3.986	-2.426	-0.002	0.054
64843.0	72.0	275.0	64840.618	72.008	274.999	64837.562	4.020	-2.382	0.008	-0.001
64851.0	73.0	275.2	64848.608	73.016	275.208	64845.551	3.994	-2.392	0.016	0.008
			64864.639	75.055	275.614	64861.576	4.006			
			64868.711	75.727	275.614	64865.648	4.072			

			64876.682	76.875	275.839	64873.617	3.984			
			64880.730	77.484	275.977	64877.664	4.047			

7.2. Comparison IG 2020 Dataset – ATC-Caption-2025

7.2.1. KB PSR

IG 2020					ATC-Caption-2025					Difference		
Time	Rho	Theta	Time North	Diff TN	Time	Rho	Theta	Time North	Diff TN	Time	Rho	Theta
17:30:33 : Start of KB in												
63034.977	57.969	47.549	63034.475		63033.313	57.977	47.554	63032.811		1.664	-0.0078	-0.005
63038.813	57.469	47.153	63038.315	3.840	63037.148	57.477	47.159	63036.651	3.840	1.664	-0.0078	-0.005
63042.617	56.984	47.813	63042.113	3.798	63040.953	56.992	47.813	63040.448	3.798	1.664	-0.0078	0.000
63046.438	56.500	47.593	63045.935	3.823	63044.773	56.508	47.593	63044.271	3.823	1.664	-0.0078	0.000
63050.250	56.016	47.626	63049.747	3.812	63048.586	56.016	47.626	63048.083	3.812	1.664	0.0000	0.000
63054.055	55.531	47.142	63053.557	3.810	63052.406	55.531	47.142	63051.909	3.825	1.648	0.0000	0.000
63057.891	55.047	47.911	63057.385	3.828	63056.227	55.047	47.911	63055.721	3.812	1.664	0.0000	0.000
63061.703	54.563	47.659	63061.200	3.815	63060.039	54.570	47.659	63059.536	3.815	1.664	-0.0078	0.000
63065.508	54.078	47.527	63065.006	3.806	63063.844	54.086	47.527	63063.342	3.806	1.664	-0.0078	0.000
63069.313	53.609	47.769	63068.808	3.802	63067.656	53.609	47.774	63067.152	3.810	1.656	0.0000	-0.005
63073.141	53.109	47.538	63072.639	3.831	63071.477	53.117	47.538	63070.975	3.823	1.664	-0.0078	0.000
63076.953	52.641	47.428	63076.452	3.814	63075.289	52.648	47.428	63074.788	3.814	1.664	-0.0078	0.000
63080.773	52.156	47.307	63080.274	3.822	63079.109	52.164	47.313	63078.610	3.822	1.664	-0.0078	-0.005
63084.563	51.688	47.834	63084.058	3.783	63082.906	51.688	47.840	63082.401	3.791	1.656	0.0000	-0.005
63088.383	51.203	47.659	63087.880	3.822	63086.727	51.211	47.659	63086.223	3.822	1.656	-0.0078	0.000
63092.195	50.734	47.758	63091.691	3.811	63090.539	50.734	47.763	63090.035	3.811	1.656	0.0000	-0.005
63096.000	50.250	47.615	63095.497	3.806	63094.344	50.250	47.620	63093.841	3.806	1.656	0.0000	-0.005
63099.813	49.766	47.362	63099.313	3.815	63098.156	49.773	47.368	63097.656	3.815	1.656	-0.0078	-0.005
63103.664	49.281	47.120	63103.167	3.854	63102.000	49.289	47.126	63101.503	3.846	1.664	-0.0078	-0.005
63107.445	48.813	47.131	63106.948	3.781	63105.797	48.813	47.131	63105.299	3.797	1.648	0.0000	0.000
63111.273	48.313	47.219	63110.775	3.827	63109.617	48.313	47.225	63109.119	3.819	1.656	0.0000	-0.005
63115.070	47.828	47.263	63114.571	3.796	63113.414	47.828	47.263	63112.915	3.796	1.656	0.0000	0.000
63118.914	47.313	47.241	63118.415	3.844	63117.250	47.320	47.247	63116.751	3.836	1.664	-0.0078	-0.005
63122.711	46.828	47.384	63122.211	3.795	63121.055	46.836	47.390	63120.554	3.803	1.656	-0.0078	-0.005
63126.523	46.328	47.252	63126.025	3.814	63124.867	46.336	47.258	63124.368	3.814	1.656	-0.0078	-0.005
63130.336	45.844	47.703	63129.832	3.808	63128.680	45.844	47.703	63128.176	3.808	1.656	0.0000	0.000
63134.156	45.344	47.219	63133.658	3.825	63132.500	45.344	47.219	63132.002	3.825	1.656	0.0000	0.000
63137.953	44.828	47.120	63137.456	3.798	63136.305	44.836	47.126	63135.807	3.806	1.648	-0.0078	-0.005
63141.773	44.344	47.208	63141.275	3.819	63140.109	44.352	47.214	63139.611	3.804	1.664	-0.0078	-0.005
63145.594	43.844	47.219	63145.095	3.820	63143.930	43.852	47.225	63143.431	3.820	1.664	-0.0078	-0.005
63149.383	43.344	47.131	63148.885	3.790	63147.727	43.344	47.137	63147.229	3.798	1.656	0.0000	-0.005
63153.211	42.828	47.274	63152.712	3.827	63151.547	42.836	47.280	63151.048	3.819	1.664	-0.0078	-0.005
63157.016	42.344	47.021	63156.519	3.807	63155.359	42.352	47.027	63154.863	3.815	1.656	-0.0078	-0.005
63160.836	41.844	47.329	63160.336	3.817	63159.164	41.844	47.329	63158.664	3.801	1.672	0.0000	0.000
63164.633	41.359	47.054	63164.136	3.800	63162.977	41.359	47.054	63162.480	3.815	1.656	0.0000	0.000
63168.461	40.844	46.978	63167.965	3.829	63166.805	40.852	46.978	63166.309	3.829	1.656	-0.0078	0.000
63172.266	40.375	46.835	63171.771	3.806	63170.609	40.375	46.835	63170.115	3.806	1.656	0.0000	0.000
63176.078	39.875	47.131	63175.581	3.809	63174.414	39.883	47.131	63173.917	3.802	1.664	-0.0078	0.000
63179.875	39.375	46.912	63179.380	3.799	63178.219	39.375	46.917	63177.724	3.807	1.656	0.0000	-0.005
63183.688	38.891	46.824	63183.193	3.813	63182.023	38.891	46.829	63181.529	3.806	1.664	0.0000	-0.005
63187.523	38.391	46.582	63187.032	3.838	63185.867	38.391	46.588	63185.375	3.846	1.656	0.0000	-0.005

63191.336	37.891	46.516	63190.845	3.813	63189.680	37.898	46.522	63189.189	3.813	1.656	-0.0078	-0.005
63195.148	37.391	46.329	63194.659	3.814	63193.484	37.391	46.329	63192.995	3.807	1.664	0.0000	0.000
63198.945	36.906	46.560	63198.454	3.794	63197.289	36.906	46.566	63196.798	3.802	1.656	0.0000	-0.005
63202.773	36.422	46.780	63202.280	3.826	63201.117	36.422	46.780	63200.623	3.826	1.656	0.0000	0.000
63206.594	35.906	46.406	63206.104	3.824	63204.938	35.906	46.406	63204.448	3.824	1.656	0.0000	0.000
63210.398	35.406	46.318	63209.910	3.806	63208.734	35.406	46.324	63208.245	3.798	1.664	0.0000	-0.005
63214.203	34.922	46.132	63213.716	3.807	63212.539	34.922	46.137	63212.052	3.807	1.664	0.0000	-0.005
63218.023	34.406	45.901	63217.539	3.823	63216.359	34.414	45.901	63215.875	3.823	1.664	-0.0078	0.000
63221.836	33.922	46.263	63221.348	3.809	63220.164	33.922	46.269	63219.676	3.801	1.672	0.0000	-0.005
63225.641	33.406	45.516	63225.160	3.813	63223.977	33.406	45.516	63223.496	3.820	1.664	0.0000	0.000
63229.445	32.922	45.637	63228.964	3.803	63227.789	32.922	45.643	63227.307	3.811	1.656	0.0000	-0.005
63233.258	32.406	45.516	63232.777	3.814	63231.594	32.414	45.522	63231.113	3.806	1.664	-0.0078	-0.005
63237.078	31.906	45.549	63236.597	3.820	63235.414	31.906	45.555	63234.933	3.820	1.664	0.0000	-0.005
63240.891	31.406	45.494	63240.410	3.813	63239.227	31.414	45.500	63238.746	3.813	1.664	-0.0078	-0.005
63244.695	30.906	45.483	63244.215	3.805	63243.039	30.906	45.483	63242.559	3.813	1.656	0.0000	0.000
63248.508	30.391	45.417	63248.028	3.813	63246.836	30.398	45.423	63246.356	3.798	1.672	-0.0078	-0.005
63252.336	29.891	45.494	63251.856	3.827	63250.664	29.898	45.494	63250.184	3.827	1.672	-0.0078	0.000
63256.141	29.391	45.154	63255.664	3.808	63254.469	29.391	45.159	63253.992	3.808	1.672	0.0000	-0.005
63259.945	28.875	44.791	63259.473	3.809	63258.273	28.883	44.791	63257.801	3.809	1.672	-0.0078	0.000
63263.758	28.359	45.099	63263.282	3.809	63262.086	28.367	45.104	63261.610	3.809	1.672	-0.0078	-0.005
63267.586	27.875	44.780	63267.113	3.831	63265.914	27.875	44.786	63265.441	3.831	1.672	0.0000	-0.005
63271.398	27.359	44.604	63270.928	3.814	63269.727	27.359	44.610	63269.256	3.814	1.672	0.0000	-0.005
63275.203	26.844	44.659	63274.732	3.804	63273.539	26.844	44.665	63273.068	3.812	1.664	0.0000	-0.005
63279.016	26.313	44.495	63278.546	3.814	63277.344	26.320	44.495	63276.874	3.806	1.672	-0.0078	0.000
63282.844	25.813	44.484	63282.374	3.828	63281.164	25.820	44.484	63280.695	3.820	1.680	-0.0078	0.000
63286.656	25.313	44.352	63286.188	3.814	63284.977	25.313	44.352	63284.508	3.814	1.680	0.0000	0.000
63290.469	24.797	44.000	63290.004	3.816	63288.797	24.805	44.000	63288.332	3.824	1.672	-0.0078	0.000
63294.281	24.281	43.868	63293.818	3.814	63292.609	24.289	43.874	63292.146	3.814	1.672	-0.0078	-0.005
63298.102	23.781	43.857	63297.639	3.820	63296.430	23.781	43.857	63295.967	3.820	1.672	0.0000	0.000
63301.922	23.266	43.638	63301.461	3.823	63300.250	23.266	43.638	63299.789	3.823	1.672	0.0000	0.000
63305.719	22.766	43.385	63305.261	3.800	63304.039	22.766	43.391	63303.581	3.792	1.680	0.0000	-0.005
63309.531	22.266	43.616	63309.071	3.810	63307.844	22.266	43.621	63307.383	3.802	1.688	0.0000	-0.005
63313.336	21.766	43.055	63312.881	3.811	63311.656	21.766	43.055	63311.202	3.818	1.680	0.0000	0.000
63317.172	21.266	42.825	63316.720	3.838	63315.484	21.273	42.830	63315.032	3.831	1.687	-0.0078	-0.005
63320.961	20.766	42.407	63320.513	3.793	63319.289	20.766	42.413	63318.841	3.809	1.672	0.0000	-0.005
63324.773	20.281	42.198	63324.328	3.815	63323.086	20.281	42.204	63322.640	3.799	1.688	0.0000	-0.005
63328.570	19.781	42.198	63328.125	3.797	63326.883	19.781	42.198	63326.437	3.797	1.688	0.0000	0.000
63332.398	19.297	41.660	63331.959	3.834	63330.719	19.305	41.660	63330.279	3.842	1.680	-0.0078	0.000
63336.211	18.781	41.309	63335.775	3.816	63334.516	18.789	41.314	63334.080	3.801	1.695	-0.0078	-0.005
63340.000	18.328	40.638	63339.571	3.796	63338.313	18.328	40.638	63337.884	3.804	1.688	0.0000	0.000
63343.813	17.828	40.221	63343.388	3.817	63342.125	17.828	40.226	63341.700	3.817	1.688	0.0000	-0.005
63347.633	17.375	39.891	63347.212	3.824	63345.938	17.375	39.897	63345.516	3.816	1.695	0.0000	-0.005
63351.438	16.859	39.155	63351.024	3.812	63349.734	16.867	39.161	63349.321	3.805	1.703	-0.0078	-0.005
63355.258	16.391	38.804	63354.848	3.824	63353.555	16.398	38.809	63353.145	3.824	1.703	-0.0078	-0.005
63359.047	15.906	38.287	63358.643	3.795	63357.344	15.914	38.293	63356.940	3.795	1.703	-0.0078	-0.005
63362.875	15.438	37.365	63362.481	3.838	63361.180	15.438	37.370	63360.785	3.846	1.695	0.0000	-0.005

63366.672	14.969	36.705	63366.284	3.804	63364.969	14.969	36.711	63364.581	3.796	1.703	0.0000	-0.005
63370.492	14.500	36.519	63370.107	3.822	63368.773	14.508	36.519	63368.388	3.807	1.719	-0.0078	0.000
63374.289	14.016	35.607	63373.913	3.807	63372.563	14.023	35.612	63372.187	3.799	1.727	-0.0078	-0.005
63378.102	13.578	34.585	63377.736	3.823	63376.383	13.578	34.585	63376.018	3.831	1.719	0.0000	0.000
63381.914	13.125	33.409	63381.561	3.825	63380.195	13.133	33.415	63379.843	3.825	1.719	-0.0078	-0.005
63385.719	12.688	31.915	63385.382	3.820	63383.984	12.688	31.921	63383.647	3.805	1.734	0.0000	-0.005
63389.531	12.219	30.652	63389.208	3.826	63387.789	12.227	30.652	63387.466	3.818	1.742	-0.0078	0.000
63393.328	11.828	29.432	63393.017	3.810	63391.586	11.828	29.432	63391.275	3.810	1.742	0.0000	0.000
63397.164	11.484	28.092	63396.868	3.850	63395.398	11.492	28.092	63395.102	3.827	1.766	-0.0078	0.000
63400.945	11.047	24.631	63400.685	3.818	63399.188	11.055	24.637	63398.927	3.826	1.758	-0.0078	-0.005
63404.742	10.719	21.379	63404.517	3.831	63402.953	10.727	21.379	63402.727	3.800	1.789	-0.0078	0.000
17:36:43 - 17:38:55 : Cone of silence. 132.214s. 34 (+0.67) rotations												
63535.680	15.438	264.254	63532.890	3.776	63535.164	15.445	264.260	63532.375	3.813	0.516	-0.0078	-0.005
63539.500	15.891	264.254	63536.711	3.820	63538.984	15.898	264.260	63536.195	3.820	0.516	-0.0078	-0.005
63547.117	16.844	262.595	63544.345	3.817	63546.594	16.844	262.601	63543.822	3.813	0.523	0.0000	-0.005
63550.914	17.313	260.947	63548.160	3.814	63550.398	17.320	260.947	63547.644	3.822	0.516	-0.0078	0.000
63554.727	17.797	260.178	63551.980	3.821	63554.195	17.797	260.178	63551.449	3.805	0.531	0.0000	0.000
63562.359	18.766	258.805	63559.628	3.824	63561.813	18.773	258.805	63559.081	3.816	0.547	-0.0078	0.000
63566.180	19.281	258.541	63563.451	3.823	63565.633	19.281	258.547	63562.904	3.823	0.547	0.0000	-0.005
63569.984	19.766	257.640	63567.265	3.814	63569.438	19.773	257.646	63566.718	3.814	0.547	-0.0078	-0.005
63573.789	20.266	256.882	63571.078	3.813	63573.250	20.273	256.888	63570.538	3.821	0.539	-0.0078	-0.005
63577.617	20.766	256.663	63574.908	3.830	63577.063	20.766	256.668	63574.353	3.815	0.555	0.0000	-0.005
63581.422	21.281	256.608	63578.713	3.805	63580.875	21.281	256.613	63578.166	3.813	0.547	0.0000	-0.005
63585.234	21.797	256.003	63582.532	3.819	63584.680	21.797	256.003	63581.977	3.811	0.555	0.0000	0.000
63589.055	22.297	255.399	63586.359	3.827	63588.500	22.305	255.399	63585.804	3.827	0.555	-0.0078	0.000
63592.875	22.813	254.905	63590.184	3.826	63592.313	22.820	254.905	63589.622	3.818	0.563	-0.0078	0.000
63596.688	23.328	254.344	63594.003	3.818	63596.125	23.336	254.344	63593.440	3.818	0.563	-0.0078	0.000
63600.500	23.844	253.982	63597.819	3.816	63599.930	23.852	253.987	63597.249	3.808	0.570	-0.0078	-0.005
63604.313	24.359	253.828	63601.633	3.814	63603.750	24.367	253.828	63601.071	3.822	0.563	-0.0078	0.000
63608.141	24.891	253.553	63605.464	3.831	63607.578	24.891	253.559	63604.902	3.831	0.562	0.0000	-0.005
63611.945	25.406	253.246	63609.272	3.808	63611.383	25.414	253.251	63608.710	3.808	0.563	-0.0078	-0.005
63615.781	25.938	252.675	63613.114	3.842	63615.219	25.938	252.675	63612.552	3.842	0.563	0.0000	0.000
63619.578	26.469	252.103	63616.917	3.803	63619.016	26.469	252.103	63616.355	3.803	0.563	0.0000	0.000
63623.406	27.000	252.675	63620.739	3.822	63622.828	27.000	252.675	63620.161	3.806	0.578	0.0000	0.000
63627.234	27.531	251.620	63624.578	3.839	63626.656	27.539	251.620	63624.000	3.839	0.578	-0.0078	0.000
63631.039	28.063	251.895	63628.380	3.802	63630.469	28.070	251.900	63627.810	3.810	0.570	-0.0078	-0.005
63634.859	28.609	251.147	63632.208	3.828	63634.273	28.609	251.147	63631.622	3.813	0.586	0.0000	0.000
63638.680	29.141	251.027	63636.030	3.822	63638.109	29.141	251.032	63635.460	3.837	0.570	0.0000	-0.005
63642.500	29.688	250.291	63639.858	3.828	63641.938	29.688	250.291	63639.296	3.836	0.563	0.0000	0.000
63646.320	30.219	250.269	63643.679	3.821	63645.750	30.219	250.274	63643.108	3.813	0.570	0.0000	-0.005
63650.133	30.766	250.269	63647.491	3.813	63649.547	30.766	250.269	63646.905	3.797	0.586	0.0000	0.000
63653.953	31.297	249.675	63651.318	3.827	63653.367	31.297	249.675	63650.732	3.827	0.586	0.0000	0.000
63657.781	31.844	250.148	63655.141	3.823	63657.195	31.844	250.148	63654.555	3.823	0.586	0.0000	0.000
63661.602	32.375	249.379	63658.969	3.828	63661.016	32.375	249.384	63658.383	3.828	0.586	0.0000	-0.005
63665.414	32.906	249.961	63662.776	3.806	63664.828	32.914	249.966	63662.190	3.806	0.586	-0.0078	-0.005
63669.234	33.438	249.390	63666.602	3.826	63668.648	33.445	249.390	63666.016	3.826	0.586	-0.0078	0.000

63673.063	33.984	249.269	63670.431	3.829	63672.484	33.984	249.269	63669.853	3.837	0.578	0.0000	0.000
63680.695	35.063	248.621	63678.071	3.820	63680.109	35.063	248.621	63677.485	3.816	0.586	0.0000	0.000
63684.516	35.594	248.621	63681.891	3.820	63683.930	35.602	248.626	63681.305	3.820	0.586	-0.0078	-0.005
63688.336	36.125	248.610	63685.712	3.820	63687.750	36.133	248.610	63685.126	3.820	0.586	-0.0078	0.000
63692.172	36.656	248.423	63689.550	3.838	63691.586	36.664	248.423	63688.964	3.838	0.586	-0.0078	0.000
63695.984	37.203	248.313	63693.363	3.814	63695.398	37.203	248.313	63692.777	3.814	0.586	0.0000	0.000
63699.797	37.734	247.742	63697.182	3.819	63699.219	37.742	247.742	63696.604	3.826	0.578	-0.0078	0.000
63707.469	38.828	248.632	63704.844	3.831	63706.867	38.836	248.637	63704.243	3.819	0.602	-0.0078	-0.005
63715.094	39.891	247.742	63712.479	3.817	63714.484	39.898	247.742	63711.869	3.813	0.609	-0.0078	0.000
63718.914	40.453	247.720	63716.299	3.821	63718.305	40.453	247.725	63715.690	3.820	0.609	0.0000	-0.005
63722.750	40.984	247.269	63720.140	3.841	63722.148	40.992	247.269	63719.538	3.849	0.602	-0.0078	0.000
63726.563	41.547	247.346	63723.952	3.812	63725.953	41.547	247.352	63723.342	3.804	0.609	0.0000	-0.005
63730.383	42.078	247.302	63727.772	3.821	63729.773	42.086	247.308	63727.163	3.821	0.609	-0.0078	-0.005
63734.203	42.625	246.962	63731.596	3.824	63733.594	42.625	246.967	63730.987	3.824	0.609	0.0000	-0.005
63738.031	43.188	246.973	63735.424	3.828	63737.430	43.195	246.978	63734.823	3.836	0.602	-0.0078	-0.005
63745.672	44.266	246.984	63743.065	3.820	63745.055	44.273	246.984	63742.448	3.812	0.617	-0.0078	0.000
63749.477	44.828	246.083	63746.879	3.814	63748.867	44.836	246.083	63746.270	3.822	0.609	-0.0078	0.000
63753.305	45.391	246.083	63750.707	3.828	63752.695	45.398	246.088	63750.098	3.828	0.609	-0.0078	-0.005
63757.133	45.938	246.094	63754.535	3.828	63756.523	45.938	246.099	63753.926	3.828	0.609	0.0000	-0.005
63768.570	47.609	246.094	63765.973	3.813	63767.969	47.609	246.099	63765.371	3.815	0.602	0.0000	-0.005
63772.422	48.156	245.896	63769.826	3.854	63771.805	48.156	245.896	63769.209	3.838	0.617	0.0000	0.000
63776.242	48.703	246.083	63773.645	3.818	63775.633	48.711	246.088	63773.035	3.826	0.609	-0.0078	-0.005
63780.063	49.266	246.083	63777.465	3.820	63779.453	49.273	246.088	63776.856	3.820	0.609	-0.0078	-0.005
63783.867	49.828	246.083	63781.270	3.805	63783.273	49.828	246.088	63780.676	3.820	0.594	0.0000	-0.005
63787.719	50.375	245.654	63785.126	3.856	63787.094	50.383	245.660	63784.501	3.825	0.625	-0.0078	-0.005
63791.516	50.938	246.083	63788.918	3.792	63790.930	50.938	246.083	63788.332	3.831	0.586	0.0000	0.000
63795.352	51.500	246.094	63792.754	3.836	63794.750	51.500	246.094	63792.152	3.820	0.602	0.0000	0.000
63799.156	52.063	245.314	63796.567	3.813	63798.547	52.063	245.314	63795.957	3.805	0.609	0.0000	0.000
63803.000	52.625	245.336	63800.410	3.844	63802.383	52.625	245.336	63799.793	3.836	0.617	0.0000	0.000
63806.828	53.172	245.533	63804.236	3.826	63806.203	53.180	245.533	63803.611	3.818	0.625	-0.0078	0.000
63810.633	53.719	245.336	63808.043	3.807	63810.023	53.719	245.336	63807.434	3.822	0.609	0.0000	0.000
63814.461	54.281	245.336	63811.871	3.828	63813.844	54.289	245.336	63811.254	3.820	0.617	-0.0078	0.000
63818.273	54.844	245.347	63815.684	3.812	63817.664	54.844	245.352	63815.074	3.820	0.609	0.0000	-0.005
63822.109	55.406	245.336	63819.520	3.836	63821.500	55.406	245.336	63818.910	3.836	0.609	0.0000	0.000
63825.938	55.953	245.314	63823.348	3.828	63825.328	55.961	245.314	63822.739	3.828	0.609	-0.0078	0.000
63829.750	56.516	245.303	63827.161	3.813	63829.133	56.523	245.308	63826.543	3.805	0.617	-0.0078	-0.005
63833.570	57.094	245.039	63830.984	3.823	63832.953	57.094	245.045	63830.367	3.823	0.617	0.0000	-0.005
63837.375	57.641	244.413	63834.795	3.811	63836.766	57.641	244.418	63834.186	3.819	0.609	0.0000	-0.005
63841.227	58.203	244.764	63838.643	3.848	63840.609	58.203	244.764	63838.026	3.840	0.617	0.0000	0.000
63845.039	58.766	244.753	63842.456	3.813	63844.414	58.766	244.759	63841.830	3.805	0.625	0.0000	-0.005
63848.859	59.313	245.006	63846.273	3.818	63848.234	59.313	245.006	63845.648	3.818	0.625	0.0000	0.000
63852.664	59.859	244.830	63850.080	3.807	63852.055	59.867	244.836	63849.470	3.822	0.609	-0.0078	-0.005
63856.516	60.422	244.501	63853.935	3.855	63855.898	60.422	244.506	63853.318	3.847	0.617	0.0000	-0.005
63860.320	60.984	244.567	63857.739	3.804	63859.703	60.984	244.567	63857.122	3.804	0.617	0.0000	0.000
63864.125	61.531	244.534	63861.544	3.805	63863.508	61.539	244.539	63860.927	3.805	0.617	-0.0078	-0.005

17:44:24 : End of KB out

7.2.2. BW PSR

IG 2020					ATC-Caption-2025					Difference		
Time	Rho	Theta	Time North	Diff TN	Time	Rho	Theta	Time North	Diff TN	Time	Rho	Theta
17:46:21 : Start of BW data												
63982.531	44.234	81.046	63981.631		63980.96	44.234	81.046	63980.063		1.568	0.000	0.000
63994.578	42.609	81.606	63993.671	4.014	63993.02	42.617	81.612	63992.111	4.016	1.560	-0.008	-0.005
64002.648	41.609	82.057	64001.737	4.033	64001.09	41.617	82.057	64000.180	4.034	1.557	-0.008	0.000
64006.586	40.969	82.386	64005.671	3.934	64005.03	40.969	82.386	64004.111	3.931	1.559	0.000	0.000
64010.625	40.375	82.793	64009.705	4.035	64009.07	40.375	82.798	64008.148	4.037	1.557	0.000	-0.005
64014.656	39.891	83.123	64013.733	4.028	64013.1	39.891	83.128	64012.180	4.031	1.553	0.000	-0.005
64018.625	39.359	83.496	64017.697	3.965	64017.08	39.359	83.502	64016.148	3.969	1.549	0.000	-0.005
64022.664	38.844	83.815	64021.733	4.036	64021.11	38.852	83.815	64020.182	4.033	1.551	-0.008	0.000
64026.633	38.344	84.177	64025.698	3.965	64025.09	38.352	84.177	64024.150	3.969	1.547	-0.008	0.000
64034.672	37.266	84.639	64033.731	4.017	64033.13	37.266	84.644	64032.187	4.019	1.544	0.000	-0.005
64038.711	36.703	85.089	64037.766	4.034	64037.17	36.703	85.095	64036.227	4.039	1.539	0.000	-0.005
64046.688	35.578	85.814	64045.734	3.984	64045.15	35.578	85.820	64044.195	3.984	1.539	0.000	-0.005
64054.719	34.375	86.594	64053.757	4.011	64053.18	34.375	86.600	64052.219	4.012	1.538	0.000	-0.005
64058.734	33.891	86.880	64057.769	4.012	64057.2	33.898	86.880	64056.234	4.016	1.535	-0.008	0.000
64062.758	33.406	87.462	64061.786	4.017	64061.23	33.406	87.468	64060.258	4.023	1.528	0.000	-0.005
64066.734	32.859	87.792	64065.759	3.973	64065.21	32.867	87.792	64064.234	3.977	1.525	-0.008	0.000
64078.719	31.281	89.011	64077.730	3.990	64077.21	31.289	89.011	64076.219	3.995	1.511	-0.008	0.000
64082.719	30.641	89.396	64081.725	3.996	64081.21	30.641	89.401	64080.215	3.996	1.511	0.000	-0.005
64086.766	30.156	89.670	64085.769	4.044	64085.25	30.164	89.676	64084.254	4.039	1.515	-0.008	-0.005
17:48:05 - 17:49:49 : 104.214s gap (26 rotations)												
64190.852	18.047	112.500	64189.602	3.994	64189.46	18.055	112.505	64188.214	3.998	1.388	-0.008	-0.005
64194.906	17.703	114.170	64193.638	4.036	64193.53	17.703	114.170	64192.261	4.047	1.377	0.000	0.000
17:49:54 - 17:51:22 : 88.625s gap (22 rotations)												
64283.242	14.234	165.707	64281.401	3.989	64282.15	14.242	165.712	64280.312	4.002	1.088	-0.008	-0.005
64287.234	14.281	168.354	64285.364	3.963	64286.15	14.281	168.360	64284.282	3.969	1.082	0.000	-0.005
64291.289	14.359	171.266	64289.386	4.022	64290.23	14.359	171.271	64288.328	4.046	1.058	0.000	-0.005
64295.266	14.422	173.749	64293.335	3.949	64294.22	14.422	173.754	64292.289	3.961	1.046	0.000	-0.005
64299.320	14.531	176.396	64297.360	4.025	64298.29	14.539	176.396	64296.328	4.039	1.032	-0.008	0.000
64303.359	14.656	178.835	64301.372	4.012	64302.35	14.664	178.841	64300.363	4.035	1.009	-0.008	-0.005
64307.305	14.844	181.714	64305.286	3.913	64306.31	14.852	181.719	64304.289	3.926	0.997	-0.008	-0.005
64323.445	15.781	191.327	64321.319	4.008	64322.5	15.789	191.327	64320.375	4.021	0.944	-0.008	0.000
17:52:02 - 17:52:51 : 48.373s gap (12 rotations)												
64371.703	19.188	211.168	64369.357	4.003	64370.87	19.195	211.168	64368.528	4.013	0.829	-0.008	0.000
64375.688	19.578	212.531	64373.326	3.969	64374.87	19.578	212.536	64372.505	3.977	**0.821**	0.000	-0.005
64381.773	19.953	213.871	64379.397	**3.036**	64378.95	19.953	213.876	64376.578	4.074	**2.819**	0.000	-0.005
64385.734	20.344	215.244	64383.343	3.946	64382.93	20.352	215.250	64380.536	3.958	2.807	-0.008	-0.005
64397.797	21.594	219.034	64395.363	4.007	64395.01	21.602	219.040	64392.578	4.014	2.785	-0.008	-0.005
64409.844	22.781	222.374	64407.373	4.003	64407.08	22.781	222.374	64404.606	4.009	2.767	0.000	0.000
64413.898	23.141	223.517	64411.415	4.042	64411.13	23.141	223.522	64408.648	4.042	2.766	0.000	-0.005
64421.898	23.844	225.417	64419.394	3.989	64419.15	23.844	225.423	64416.646	3.999	2.748	0.000	-0.005
64425.969	24.219	226.604	64423.451	4.057	64423.22	24.219	226.609	64420.703	4.058	2.748	0.000	-0.005

64430.023	24.547	227.483	64427.496	4.045	64427.27	24.555	227.488	64424.747	4.044	2.749	-0.008	-0.005
64442.008	25.656	230.098	64439.451	3.985	64439.28	25.664	230.098	64436.724	3.992	2.727	-0.008	0.000
64446.047	26.094	231.185	64443.478	4.027	64443.32	26.094	231.185	64440.755	4.031	2.723	0.000	0.000
64450.070	26.531	232.152	64447.491	4.013	64447.35	26.531	232.152	64444.773	4.018	2.717	0.000	0.000
64454.109	26.984	233.108	64451.519	4.028	64451.39	26.984	233.108	64448.802	4.028	2.717	0.000	0.000
64462.102	27.719	234.877	64459.492	3.986	64459.4	27.719	234.877	64456.786	3.992	2.705	0.000	0.000
64466.125	28.047	235.712	64463.506	4.014	64463.43	28.055	235.712	64460.810	4.023	2.696	-0.008	0.000
64470.180	28.422	236.667	64467.550	4.044	64467.49	28.422	236.673	64464.857	4.047	2.693	0.000	-0.005
64474.258	28.766	237.722	64471.616	4.066	64471.57	28.773	237.728	64468.927	4.070	2.689	-0.008	-0.005
64482.250	29.469	239.513	64479.589	3.986	64479.57	29.477	239.518	64476.911	3.992	2.677	-0.008	-0.005
64486.313	29.859	240.414	64483.641	4.052	64483.64	29.859	240.414	64480.966	4.055	2.675	0.000	0.000
64490.242	30.141	241.194	64487.562	3.921	64487.57	30.141	241.199	64484.893	3.927	2.669	0.000	-0.005
64494.297	30.469	242.062	64491.607	4.045	64491.63	30.477	242.062	64488.943	4.049	2.665	-0.008	0.000
64506.305	31.594	244.380	64503.589	3.994	64503.66	31.594	244.380	64500.940	3.999	2.649	0.000	0.000
64514.383	32.297	246.039	64511.649	4.030	64511.74	32.297	246.039	64509.005	4.033	2.644	0.000	0.000
64522.461	33.016	247.555	64519.710	4.031	64519.83	33.016	247.560	64517.076	4.035	2.635	0.000	-0.005
64526.492	33.391	248.302	64523.733	4.023	64523.87	33.391	248.307	64521.107	4.031	2.626	0.000	-0.005
64530.438	33.781	249.467	64527.666	3.932	64527.82	33.789	249.467	64525.044	3.938	2.621	-0.008	0.000
64542.570	34.859	251.730	64539.773	4.036	64539.96	34.867	251.735	64537.162	4.039	2.612	-0.008	-0.005
64550.531	35.594	253.059	64547.719	3.973	64547.93	35.602	253.059	64545.115	3.977	2.605	-0.008	0.000
64554.594	35.891	253.597	64551.776	4.057	64552	35.891	253.603	64549.177	4.063	2.599	0.000	-0.005
64558.648	36.266	254.257	64555.823	4.047	64556.05	36.273	254.257	64553.224	4.047	2.599	-0.008	0.000
64566.633	36.969	255.454	64563.794	3.986	64564.04	36.969	255.460	64561.201	3.988	2.594	0.000	-0.005
64570.656	37.359	256.069	64567.811	4.017	64568.07	37.367	256.075	64565.224	4.023	2.587	-0.008	-0.005
64574.617	37.797	256.783	64571.764	3.953	64572.03	37.797	256.783	64569.177	3.953	2.587	0.000	0.000
64586.680	39.078	258.607	64583.806	4.014	64584.11	39.078	258.607	64581.232	4.018	2.574	0.000	0.000
64590.719	39.484	259.146	64587.839	4.033	64588.15	39.484	259.146	64585.271	4.039	2.568	0.000	0.000
64598.750	40.328	260.255	64595.858	4.009	64596.19	40.336	260.255	64593.297	4.013	2.561	-0.008	0.000
64602.766	40.766	260.771	64599.868	4.010	64600.21	40.773	260.771	64597.313	4.016	2.556	-0.008	0.000
64606.711	41.234	261.255	64603.808	3.940	64604.15	41.242	261.260	64601.248	3.935	2.560	-0.008	-0.005
64614.789	42.188	262.189	64611.876	4.034	64612.24	42.188	262.189	64609.328	4.040	2.548	0.000	0.000
64626.766	43.563	263.276	64623.840	3.988	64624.22	43.563	263.276	64621.297	3.990	2.543	0.000	0.000
64630.797	44.156	263.639	64627.868	4.027	64628.26	44.156	263.644	64625.328	4.031	2.539	0.000	-0.005
64638.875	45.141	264.386	64635.937	4.035	64636.33	45.141	264.391	64633.396	4.034	2.541	0.000	-0.005
64642.836	45.688	264.672	64639.895	3.958	64640.3	45.695	264.672	64637.357	3.961	2.538	-0.008	0.000
17:57:24 - 17:58:32 : 68.172s gap (17 rotations)												
64710.992	54.172	269.418	64707.999	4.006	64708.48	54.172	269.423	64705.484	4.007	2.514	0.000	-0.005
64715.031	54.719	269.615	64712.036	4.037	64712.52	54.727	269.615	64709.523	4.039	2.512	-0.008	0.000
64718.961	55.297	269.813	64715.963	3.927	64716.45	55.297	269.813	64713.453	3.930	2.510	0.000	0.000
64731.016	57.109	270.472	64728.010	4.016	64728.51	57.109	270.472	64725.508	4.018	2.503	0.000	0.000
17:58:52 - 17:59:49 : 56.003s gap (14 rotations)												
64787.000	64.297	272.878	64783.968	3.997	64784.52	64.305	272.884	64781.484	3.998	2.484	-0.008	-0.005
64803.000	66.375	273.395	64799.962	3.999	64800.51	66.375	273.400	64797.477	3.998	2.486	0.000	-0.005
64811.070	67.469	273.625	64808.030	4.034	64808.59	67.477	273.625	64805.547	4.035	2.483	-0.008	0.000
64819.086	68.516	273.955	64816.042	4.006	64816.61	68.516	273.961	64813.562	4.008	2.479	0.000	-0.005
64823.023	69.109	274.098	64819.978	3.936	64820.55	69.109	274.098	64817.500	3.937	2.478	0.000	0.000

64827.070	69.781	274.219	64824.023	4.046	64824.6	69.781	274.219	64821.551	4.051	2.473	0.000	0.000
64835.055	70.891	274.548	64832.004	3.990	64832.57	70.898	274.554	64829.523	3.986	2.481	-0.008	-0.005
64843.094	72.000	274.999	64840.038	4.017	64840.62	72.008	274.999	64837.562	4.020	2.476	-0.008	0.000
64851.078	73.016	275.208	64848.020	3.991	64848.61	73.016	275.208	64845.551	3.994	2.470	0.000	0.000
64867.109	75.047	275.614	64864.047	4.007	64864.64	75.055	275.614	64861.576	4.006	2.471	-0.008	0.000
64871.180	75.719	275.614	64868.117	4.070	64868.71	75.727	275.614	64865.648	4.072	2.469	-0.008	0.000
64879.148	76.875	275.834	64876.084	3.983	64876.68	76.875	275.839	64873.617	3.984	2.466	0.000	-0.005
64883.203	77.484	275.977	64880.137	4.053	64880.73	77.484	275.977	64877.664	4.047	2.473	0.000	0.000
18:01:25 : End of BW data												

7.3. Aircraft and flights in ATC-Caption-2025

7.3.1. Aircraft

Some transponders can be ground vehicles. Some aircraft were used for more than one flight during the recording. Some flights have multiple squawks, ICAO24, squawks and identification come from ADS-B (KT and Genting) and Mode S (KB and Senai) (aircrafts equipped with none are not in that list). Details on each aircraft (registration, manufacturer, model owner) do not come from ATC-Caption-2025 but from online databases.

ICAO24	*Sq1*	*Ident1*	*Sq2*	*Ident2*	*Sq3*	*Ident3*	*Reg.*	*Manuf.*	*Model*	*Owner*
76D037	5342	TGW2069								
7C7AA0	6157	VOZ4148					VH-YIA	BOEING	737NG 8FE/W	Virgin Australia
750142	3147	AXM1089								
76CEC3	2250	SIA352					9V-SVC	BOEING	777 212ER	Singapore Airlines
76CD68	1455	SIA333	2443	SIA333	2403	SIA333	9V-SKH	AIRBUS	A380 841	Singapore Airlines
75008F	2157	MAS370								
461EB0	2277	FIN82					OH-LQE	AIRBUS	A340 313E	Finnair
750088	2106	MAS6								
76CECA	2227	SIA324					9V-SVJ	BOEING	777 212ER	Singapore Airlines
76CD66	2221	SIA334	2444	SIA334			9V-SKF	AIRBUS	A380 841	Singapore Airlines
3C65A5	2205	DLH779	2444	DLH779			D-AIME	AIRBUS	A380 841	Lufthansa
76CE8F	0425	SIA517					9V-STO	AIRBUS	A330 343E	Singapore Airlines
A1DCB4	5355	UAL895					N219UA	BOEING	777-222	United Airlines Inc
780856	7401	CES5093	2210	CES5094			B-6875	AIRBUS	A320 232	China Eastern Airlines
7C4CB6	2354						VH-PFS	LEARJET	45	St Engineering Aero.
70203F	4712	BBC086	2165	BBC087			S2-AFP	BOEING	777 3E9ER	Biman Banglad. Airlines
780B3A	5111	CES539	2176	CES540			B-9946	AIRBUS	A320 214SL	China Eastern Airlines
76CEF3	2263	SIA68					9V-SWS	BOEING	777 312ER	Singapore Airlines
76CF27	3021	SIA801								
885045	6114	THA483					HS-TBE	AIRBUS	A330 343E	Thai Airways Int.
76D02D	4704	TGW2657								
885155	6116	THA465					HS-TJU	BOEING	777 2D7ER	Thai Airways Int.
75025D	2131	MAS386					9M-MTJ	AIRBUS	A330 323E	Malaysia Airlines
76CCCD	5347	SQC7821					9V-SFM	BOEING	747 412F	Singapore Airlines Cargo
76CEE5	2223	SIA368					9V-SWE	BOEING	777 312ER	Singapore Airlines
780069	2217	CCA404	1511	CCA403			B-6047	AIRBUS	A319 115	Air China
750263	6345	MAS6163	5101	MAS6163			9M-MUA	AIRBUS	A330 223F	Malaysia Airlines
70204C	2107		4714				S2-AHC	BOEING	737NG 7V3/W	Regent Airways
89638B	1706	ETD416	2144	ETD413						
750320	2514	XAX197								
75027F	4750	MAS113					9M-MLL	BOEING	737NG 8FZ/W	Malaysia Airlines
76CC48	1513	SLK937					9V-SBH	AIRBUS	A319 133	Silkair
76D034	2427	TGW2953					9V-TAT	AIRBUS	A320 232	Scoot
3C4582	6117	BOX530					D-AALB	BOEING	777-FZN	Aerologic
7502C3	4754	MXD161					9M-LNG	BOEING	737NG	Malindo Air
76CD86	7402	SLK509								
76CEF1	2203	SIA62					9V-SWQ	BOEING	777 312ER	Singapore Airlines

7501E7	1512	XAX327	1000	XAX327			9M-XXC	AIRBUS	A330 343E	Airasia X
76CEF4	1214	SIA67					9V-SWT	BOEING	777 312ER	Singapore Airlines
76CE92	4751	SIA447					9V-STR	AIRBUS	A330 343E	Singapore Airlines
750205	3127	MAS381					9M-MXE	BOEING	737NG 8H6/W	Malaysia Airlines
7803BE	5053	CES543					B-6545	AIRBUS	A330 243	China Eastern Airlines
750082	7450	MAS197								
7801CC	5315	CPA659					B-HNP	BOEING	777 367	Cathay Pacific Airways
75015A	3130	AXM1019					9M-AHG	AIRBUS	A320 216	Airasia
76CE96	3110	SIA853					9V-STV	AIRBUS	A330 343E	Singapore Airlines
76CEC7	0141	SIA323					9V-SVG	BOEING	777 212ER	Singapore Airlines
76CEC2	2327	SIA391					9V-SVB	BOEING	777 212ER	Singapore Airlines
76CEED	2710	SIA61					9V-SWM	BOEING	777 312ER	Singapore Airlines
76AA6C	1314	JSA832					9V-JSL	AIRBUS	A320 232	Jetstar Asia Airways
76CD74	3006	SIA345	2446	SIA345			9V-SKT	AIRBUS	A380 841	Singapore Airlines
76CF28	0527	SIA403					9V-SYH	BOEING	777 312	Singapore Airlines
78090F	3075	CCA975					B-5906	AIRBUS	A330 343E	Air China
750236	2146	MAS798					9M-MLG	BOEING	737NG 8FZ/W	Malaysia Airlines
70A062	2547						9N-ACB	BOEING	757 2F8C	Nepal Airlines
885157	1320	THA462					HS-TJW	BOEING	777 2D7ER	Thai Airways Int.
76CD69	5047	SIA825	2452	SIA825			9V-SKI	AIRBUS	A380 841	Singapore Airlines
8005A2	0515	JAI20					VT-JBR	BOEING	737NG 85R/W	Jet Airways
88084A	2254	AIQ2932	1444	AIQ2932			HS-BBJ	AIRBUS	A320 216SL	Thai Airasia
76D039	6160	TGW2115								
76AA6D	6134	JSA514					9V-JSM	AIRBUS	A320 232	Jetstar Asia Airways
8A03EF	6136	MDL903								
040015	2114	ETH619					ET-ALO	BOEING	767 360ER/W	Ethiopian Airlines
75022B	0706	AXM1949					9M-AQA	AIRBUS	A320 216	Airasia
75025A	2116	MAS066					9M-MTG	AIRBUS	A330 323E	Malaysia Airlines
7501FD	5477	AXM6121					9M-AHZ	AIRBUS	A320 216	Airasia
7502CA	5350	AXM1655					9M-AQU	AIRBUS	A320 216SL	Airasia
40040F	2220	BAW12					G-BNLP	BOEING	747-436	British Airways
750087	2175	MAS88								
7502B0	5351	MAS433					9M-MLP	BOEING	737NG 8H6/W	Malaysia Airlines
394A18	2251	AFR257					F-GSQY	BOEING	777 328ER	Air France
76CEEA	2266	SIA328					9V-SWJ	BOEING	777 312ER	Singapore Airlines
750012	0371									
880927	6161	BCC921	2342	BCC920						
78006A	0170	CXA855					B-5633	BOEING	737NG 85C/W	Xiamen Airlines
3949E5	2105	AFR241					F-GSPF	BOEING	777 228ER	Air France
75025F	2154	MAS52					9M-MTL	AIRBUS	A330 323E	Malaysia Airlines
750202	2504	MAS115					9M-MXB	BOEING	737NG 8H6/W	Malaysia Airlines
780853	5020	CES5081	2207	MU5082			B-6871	AIRBUS	A320 214	China Eastern Airlines
750292	2173	MAS2	2444	MAS2			9M-MNE	AIRBUS	A380 841	Malaysia Airlines
750323	5676	AXM1017	1413	AXM1017			9M-AQY	AIRBUS	A320 216SL	Airasia
4065DE	2210	BAW16					G-STBF	BOEING	777-336ER	British Airways
78015F	5354	CPA791					B-HXE	AIRBUS	A340 313X	Cathay Pacific Airways

4B1907	2275	SWR179					HB-JML	AIRBUS	A340 313X	Swiss Int. Air Lines
76CE95	2230	SIA656					9V-STU	AIRBUS	A330 343E	Singapore Airlines
8A0194	2250	CAD8411	7102	CAD8411						
8960D8	2202	UAE405					A6-EBQ	BOEING	777 36NER	Emirates Airline
7501FB	2134	XAX222					9M-XXH	AIRBUS	A330 343E	Airasia X
8A0391	6206	MDL079	6206							
7C6CA6	2273	JST64		JST64			VH-VQW	AIRBUS	A320 232	Jetstar Airways
750070	4102	AXM1367								
76CECE	2264	SIA478	1310	SIA242			9V-SVN	BOEING	777 212ER	Singapore Airlines
44D103	2276	UAE4866								
76CE97	2262	SIA618					9V-STW	AIRBUS	A330 343E	Singapore Airlines
71BC49	4167	KAL385					HL7449	BOEING	747 4B5F	Korean Air
76CE8A	1360	SIA208								
ABE924	3742	DAL621	2277	DAL622	2277	DAL621	N867DA	BOEING	777-232	Delta Air Lines Inc
76AA74	2772	3K766								
76AA72	0763	JSA538					9V-JSR	AIRBUS	A320 232SL	Jetstar Asia Airways
76AA65	5346	JSA696					9V-JSE	AIRBUS	A320 232	Jetstar Asia Airways
76CEC8	5455	SIA365								
76CE4D	0344	SIA425					9V-SRM	BOEING	777 212ER	Singapore Airlines
7502CF	2636	XAX377								
76CCCB	2204	SQC7866					9V-SFK	BOEING	747 412F	Singapore Airlines Cargo
8960F1	1104	UAE435	2442	UAE435			A6-EDP	AIRBUS	A380 861	Emirates Airline
750210	2152	MAS867					9M-MSA	BOEING	737NG 8H6/W	Malaysia Airlines
48436A	2235	KLM836					PH-BQC	BOEING	777 206ER	Klm Royal Dutch Airlines
76AA6B	2251	JSA763					9V-JSK	AIRBUS	A320 232	Jetstar Asia Airways
7801B4	5343	CPA715	2206	CPA714			B-HLU	AIRBUS	A330 343X	Cathay Pacific Airways
7502CD	1461	XAX221	2443	XAX221	2403	XAX221				
76CE82	2271	SIA672					9V-STB	AIRBUS	A330 343E	Singapore Airlines
76AA70	7402	JSA588					9V-JSP	AIRBUS	A320 232SL	Jetstar Asia Airways
4BA9D4	2245	THY67					TC-JNT	AIRBUS	A330 303	Turkish Airlines
706016	7104	KAC416	2126	KAC416			N505CC		PW-5	Romano James J
86CED2	3253	ANA151					JA804A	BOEING	787 8	All Nippon Airways
750260	1064	MAS134					9M-MTM	AIRBUS	A330 323E	Malaysia Airlines
758270	2273	CEB808	2703	CEB807	1444	CEB808	RP-C3237	AIRBUS	A320 214	Cebu Pacific Air
758226	2711	CEB803C	2247	CEB804			RP-C3265	AIRBUS	A320 214	Cebu Pacific Air
896326	0341	ETD474A					A6-ETI	BOEING	777 3FXER	Etihad Airways
8A0418	0703	AWQ8123					PK-AZG	AIRBUS	A320 216SL	Indonesia Airasia
75031F	2130	XAX236								
76CEEE	1261	SIA218					9V-SWN	BOEING	777 312ER	Singapore Airlines
76CE2A	2257	SIA422					9V-SQJ	BOEING	777 212ER	Singapore Airlines
71BC62	4103	KAL363					HL7462	BOEING	747 4B5F	Korean Air
75829E	6541	CEB547	2232	CEB548	1444	CEB548	RP-C3271	AIRBUS	A320 214	Cebu Pacific Air
06A139	2214	QTR945	2443	QTR945			A7-BAW	BOEING	777 3DZER	Qatar Airways
76CE91	1025	SIA246					9V-STQ	AIRBUS	A330 343E	Singapore Airlines
76CE9A	7166	SIA603					9V-STZ	AIRBUS	A330 343E	Singapore Airlines
76AA73	5532	JSA552					9V-JSS	AIRBUS	A320 232SL	Jetstar Asia Airways

76BE86	2254	SCO088								
899050	2645	EVA6281					B-16337	AIRBUS	A330 302	Eva Air
7502D1	2060	3G305	2135	3G304			9M-GSB	BOEING	737 46QSF	Asia Cargo Express
76CD6C	3753	SIA11					9V-SKL	AIRBUS	A380 841	Singapore Airlines
76CE50	2212	SIA402					9V-SRP	BOEING	777 212ER	Singapore Airlines
89630A	2231	UAE349					A6-ENH	BOEING	777 31HER	Emirates Airline
7500C6	2040	--------								
76CE8E	2225	SIA255								
80064C	0601	IGO053					VT-IEK	AIRBUS	A320 232	Indigo Airlines
750262	1531	MAS140					9M-MTO	AIRBUS	A330 323E	Malaysia Airlines
8A02D2	0705	AWQ8321					PK-AXV	AIRBUS	A320 216	Indonesia Airasia
899111	2601	CAL5883					B-18706	BOEING	747-409F	China Airlines
75025E	1530	MAS128					9M-MTK	AIRBUS	A330 323E	Malaysia Airlines
896276	1722	ETD472					A6-ETF	BOEING	777 3FXER	Etihad Airways
750264	2162	MAS6075	7132	MAS6076			9M-MUB	AIRBUS	A330 223F	Malaysia Airlines
76CEE4	2255	SIA306	4176	SIA15			9V-SWD	BOEING	777 312ER	Singapore Airlines
8A03A5	7114	GIA894					PK-GIA	BOEING	777 3U3ER	Garuda Indonesia
76AA76	1270	JSA132					9V-JSV	AIRBUS	A320 232SL	Jetstar Asia Airways
7501F9	2132	XAX246					9M-XXF	AIRBUS	A330 343E	Airasia X
76CE29	2216	SIA826								
76CD67	2222		2444	SIA322			9V-SKG	AIRBUS	A380 841	Singapore Airlines
AAD012	3705	UAL803					N796UA	BOEING	777-222	United Airlines Inc
76D025	2256	TGW2728					9V-TAE	AIRBUS	A320 232	Scoot
76CE46	4135	SIA949								
750212	2137	MAS609					9M-MSC	BOEING	737NG 8H6/W	Malaysia Airlines
76CE89	3625	SIA615								
76AA69	2110	JSA690					9V-JSI	AIRBUS	A320 232	Jetstar Asia Airways
ADE16D	2043	GJE76					N9939T		G450	Prime Jet Llc
750083	2164	MAS149								
76D033	7011	TGW2259					9V-TAS	AIRBUS	A320 232	Scoot
76AA66	2302	VLU206					9V-JSF	AIRBUS	A320 232	Jetstar Asia Airways
76CCCF	2274	SQC7296	2274	SQC7395			9V-SFO	BOEING	747 412F	Singapore Airlines Cargo
76CD61	5101	SIA231	2444	SIA231			9V-SKA	AIRBUS	A380 841	Singapore Airlines
75025B	2170	MAS123					9M-MTH	AIRBUS	A330 323E	Malaysia Airlines
76BE82	2270		1416	SCO007						
7BE001	2253						B-2563	BOEING	767 36D	Shanghai Airlines
750334	2125	XAX506	2444	XAX506			9M-XXP	AIRBUS	A330 343E	Airasia X
758228	2776	CEB501	2143	CEB502	1444	CEB502	RP-C3267	AIRBUS	A320 214	Cebu Pacific Air
71BD73	4126	KAL641	2267	KAL642			HL7573	BOEING	777 3B5	Korean Air
75805E	2717	CEB255	2275	CEB256			RP-C3197	AIRBUS	A319 111	Cebu Pacific Air
89613E	2207	ETD473					A6-EYI	AIRBUS	A330 243	Etihad Airways
76BE83	2220	SCO220								
76BE84	2233	SCO202								
76CC43	0452	SLK447								
8417BB	3766	NCA283					JA06KZ	BOEING	747 4KZF	Nippon Cargo Airlines
758330	2163	EZD941					RP-C8970	AIRBUS	A320 216	Airasia Philippines

76CCD1	2227	SQC7366					9V-SFQ	BOEING	747 412F	Singapore Airlines Cargo
76D026	4145	TGW2289					9V-TAF	AIRBUS	A320 232	Scoot
71BF92	2224	AAR752					HL7792	AIRBUS	A330 323E	Asiana Airlines
7502C0	2122	3G306					9M-GSA	BOEING	737 4B7SF	Asia Cargo Express
861F44	2236	JAL710	3265	JAL711			JA617J	BOEING	767 346ER/W	Japan Airlines
76CE4E	0642	SIA503								
86CEB0	2244	ANA902	2444	ANA902			JA803A	BOEING	787 8	All Nippon Airways
76D038	1315	TGW2717								
76AA75	2622	JSA722					9V-JSU	AIRBUS	A320 232SL	Jetstar Asia Airways
76CF2B	2215	SIA237								
76CE2C	2200	SIA800					9V-SQL	BOEING	777 212ER	Singapore Airlines
7501E6	0645	AXM1204					9M-AHV	AIRBUS	A320 216	Airasia
76CD6D	2243	SIA346	2444	SIA346						
76CD6A	2261	SIA638	2444	SIA638			9V-SKJ	AIRBUS	A380 841	Singapore Airlines
76CD71	2252	SIA26	2444	SIA26			9V-SKQ	AIRBUS	A380 841	Singapore Airlines
71BF09	2141	KAL672					HL7709	AIRBUS	A330 323X	Korean Air
A2DEA7	1377	UPS35	2402	UPS35	2442	UPS35	N284UP	MCDONNELL DOUGLAS	MD-11F	United Parcel Service Co
76AA6A	2701	JSA764					9V-JSJ	AIRBUS	A320 232	Jetstar Asia Airways
780971	2211	CCA970					B-5916	AIRBUS	A330 343E	Air China
7C6BBB	1265	JST28	2442	JST28			VH-VKD	BOEING	787 8	Jetstar Airways
76CE8C	2246	SIA279								
76CE94	2226	SIA225					9V-STT	AIRBUS	A330 343E	Singapore Airlines
76CE81	2234	SIA608					9V-STA	AIRBUS	A330 343E	Singapore Airlines
76D032	2707	TGW2727					9V-TAR	AIRBUS	A320 232	Scoot
8960C6	2272	ETD470					A6-EYD	AIRBUS	A330 243	Etihad Airways
8A02FE	2316	GIA890					PK-GPP	AIRBUS	A330 243	Garuda Indonesia
76AA6F	2201	JSA723					9V-JSO	AIRBUS	A320 232	Jetstar Asia Airways
76AA68	2241	JSA133					9V-JSH	AIRBUS	A320 232	Jetstar Asia Airways
8A036F	2317	LNI286					PK-LJL	BOEING	737NG 9GPER/W	Lion Air
750277	2257	AXM1824					9M-AQC	AIRBUS	A320 216	Airasia
750186	1000									
7501A7	1000	CRASH2								
7502E5	1064									
75033B	1400	AXM6049					9M-AJC	AIRBUS	A320 216SL	Airasia
424609	1444	VQBNH								
7502E2	1531									
750201	2000						9M-MXA	BOEING	737NG 8H6/W	Malaysia Airlines
7502E1	2060									
7335D6	2102	IRM082					EP-MNV	AIRBUS	A310 304	Mahan Air
06A048	2104	QTR851					A7-ACJ	AIRBUS	A330 202	Qatar Airways
861F66	2111	JAL724					JA618J	BOEING	767 346ER/W	Japan Airlines
76D02F	2112	TGW2477					9V-TAO	AIRBUS	A320 232	Scoot
75008C	2113	MAS16								
040015	2114	ETH619					ET-ALO	BOEING	767 360ER/W	Ethiopian Airlines
7502E6	2122									

750261	2123	MAS139					9M-MTN	AIRBUS	A330 323E	Malaysia Airlines
896114	2140	UAE343					A6-ECM	BOEING	777 36NER	Emirates Airline
750146	2145	AXM1241					9M-AFT	AIRBUS	A320 216	Airasia
750293	2153	MAS20	2444	MAS20						
750109	2155	AXM1237					9M-AFD	AIRBUS	A320 214	Airasia
750266	2156	MAS6240					9M-MUD	AIRBUS	A330 223F	Malaysia Airlines
750181	2160									
750281	2160	MAS179					9M-MLN	BOEING	737NG 8H6/W	Malaysia Airlines
80044D	2161	AXB621								
750185	2164									
75008D	2171	MAS30								
75029E	2174	MAS145					9M-MXG	BOEING	737NG 8H6/W	Malaysia Airlines
484CBA	2177	KLM810					PH-BVF	BOEING	777 306ER	Klm Royal Dutch Airlines
76D247	2201	TGW2624								
44D102	2203	TAY001					OO-THB	BOEING	747 4HAERF	Asl Airlines Belgium
06A139	2214	QTR945					A7-BAW	BOEING	777 3DZER	Qatar Airways
76D152	2214	TGW2636					9V-TJR	AIRBUS	A320 232	Scoot
78013E	2217	AHK316								
76CE83	2256	SIA468					9V-STC	AIRBUS	A330 343E	Singapore Airlines
76D24D	2267	TGW2652					9V-TRM	AIRBUS	A320 232SL	Scoot
7502CC	2444	XAX214					9M-XXJ	AIRBUS	A330 343E	Airasia X
750179	2457	AGL10								
8A01CE	2575	LNI212					PK-LGM	BOEING	737NG 9GPER/W	Lion Air
75033D	0317	AXM6447	1440	AXM6447			9M-AJD	AIRBUS	A320 216SL	Airasia
750322	0357						9M-AQX	AIRBUS	A320 216SL	Airasia
750216	0373	MAS1426					9M-MSG	BOEING	737NG 8H6/W	Malaysia Airlines
7502DF	0374	OD1241								
750187	0415									
750307	0415	AXM5649					9M-AQV	AIRBUS	A320 216SL	Airasia
75002C	0473	AXM5123					9M-AHL	AIRBUS	A320 216	Airasia
7502E3	5101									
896212	0520	UAE368					A6-EGQ	BOEING	777 31HER	Emirates Airline
76D036	5476						9V-TAV	AIRBUS	A320 232	Scoot
7501F1	0603	AXM1258					9M-AHX	AIRBUS	A320 216	Airasia
76CE99	0611	SIA529					9V-STY	AIRBUS	A330 343E	Singapore Airlines
7501FC	0640	AXM1212					9M-AHY	AIRBUS	A320 216	Airasia
76CD88	0652	SLK467								
76D248	0662	TGW2669					9V-TRH	AIRBUS	A320 232SL	Scoot
750182	7450									
8A01BA	0761	AWQ8243					PK-AXF	AIRBUS	A320 216	Indonesia Airasia
75014C	0762	AXM1923					9M-AFZ	AIRBUS	A320 216	Airasia
49E729		SQB02ER								
75016D		AMCOP0								
75017B		AGL12								
750183										
750184										

75018B		OSCAR4								
75018C		OSCAR3								
7501A2		BACKUP								
7501A6		CRASH2								
7502DE		1218								
7502E0										
7502E4										
780935	1544						B-6951	AIRBUS	A320 232	China Eastern Airlines
A3BF1E	2445	UPS167					N340UP	BOEING	767-34AF	United Parcel Service Co
76CD73	2451	SIA25					9V-SKS	AIRBUS	A380 841	Singapore Airlines
88104B	3357	DD7117					HS-DBK	BOEING	737NG 86J/W	Nok Air
78084C	4002	CES7253					B-6877	AIRBUS	A320 232	China Eastern Airlines
750074		XAX523					9M-XXB	AIRBUS	A330 343E	Airasia X

7.3.2. Flights

These are flights present in air traffic management in ATC-Caption-2025.

Identification	*Squawk*	*Model*	*Reg.*	*Origin*	*Destin.*
AFR241	2105	B772	FGSPF	WMKK	LFPG
AFR257	2251	B77W	FGSQY	WSSS	LFPG
AHK317		B744	BHUR	VHHH	WSSS
AIC342	613	A332	VTIWB	VOMM	WSSS
AIC380		A319	VTSCP	VIDP	WSSS
AIQ2932	2254	A320		WSSS	VTBD
ALK306		A320	4RABP	VCBI	WSSS
ALK318		A320	4RABM	VCBI	WMKK
ANA152		B788	JA801	WSSS	RJTT
ANA902		B788	JA803	WSSS	RJAA
AWQ8123	703	A320	PKAZG	VTBD	WARR
AWQ8310		A320		WMKP	WIII
AWQ8321	705	A320	PKAXV	VTBD	WIII
AWQ8389	7017	A320		WARR	WMKJ
AXB621	2161	B738		WMKK	VOMM
AXM1012	2150	A320	9MAFP	WMKK	ZGGG
AXM1017	5676	A320	9MAQY	ZGGG	WMKK
AXM1019	2040	A320	9MAHG	ZGGG	WMKK
AXM1034		A320	9MAQA	WMKK	ZGKL
AXM1058		A320	9MAQY	WMKK	VMMC
AXM1086		A320	9MAFI	WMKK	ZGSZ
AXM1089	3147	A320	9MAFS	ZGSZ	WMKK
AXM1204	645	A320	9MAHV	VOCI	WMKK
AXM1212	640	A320	9MAHY	VOBL	WMKK
AXM1236		A320	9MAHU	VOTR	WMKK
AXM1238	661	A320	9MAFD	VOTR	WMKK
AXM1240		A320	9MAFT	VECC	WMKK
AXM1253		A320	9MAHX	WMKK	VOMM
AXM1258	603	A320	9MAHX	VOMM	WMKK

AXM1367	4102	A320	9MAHO	WADD	WMKK
AXM1391		A320		WARR	WMKK
AXM1446		A320	9MAQX	WMKK	VVNB
AXM1655	5350	A320	9MAQU	VHHH	WMKK
AXM1656		A320	9MAQC	WMKK	VHHH
AXM1801		A320		WMKK	WSSS
AXM1824	2257	A320		WSSS	WMKK
AXM1923	762	A320		VTSP	WMKK
AXM1949	706	A320		VTBD	WMKK
AXM5121		A320		WBKK	WMKK
AXM5123	473	A320		WBKK	WMKK
AXM5192		A320		WMKK	WBKS
AXM5222		A320		WMKK	WBGG
AXM5235		A320		WBGG	WMKK
AXM5236		A320		WMKK	WBGG
AXM5269		A320		WBGR	WMKK
AXM5305	407	A320		WBKK	WMKJ
AXM5649	415	A320		WBGR	WMKK
AXM5743		A320		WBKW	WMKK
AXM5876		A320		WMKK	WBGS
AXM6049	366	A320		WMKJ	WMKK
AXM6121	5477	A320		WMKP	WMKK
AXM6321	357	A320		WMKL	WMKK
AXM6430		A320		WMKK	WMKC
AXM6443		A320		WMKC	WMKK
AXM6447	317	A320		WMKC	WMKK
BAW12	2220	B744	GBNLP	WSSS	EGLL
BAW16	2210	B77W	GSTBF	WSSS	EGLL
BBC086	4712	B77W	S2AFP	VGHS	WMKK
BBC087	2165	B77W	S2AFP	WMKK	VGHS
BCC920	2342	B763	HSBIG	WIII	VTBS
BCC921	6161	B763	HSBIG	VTBS	WIII
BOX530	6117	B77L	DAALB	VTBS	WSSS
CCA403	1511	A319	B6047	ZUUU	WSSS
CCA404	2217	A319	B6047	WSSS	ZUUU
CCA970		A333	B5916	WSSS	ZBAA
CCA975		A333	B5906	ZBAA	WSSS
CEB501	2776	A320	RPC32	RPLL	WMKK
CEB502	2143	A320	RPC32	WMKK	RPLL
CES5093	7401	A320	B6875	ZPPP	WSSS
CES5094	2210	A320	B6875	WSSS	ZPPP
CES539	5111	A320	B9946	ZSPD	WMKK
CES540	2176	A320	B9946	WMKK	ZSPD
CPA659		B773	BHNP	VHHH	WSSS
CPA791	5354	A343	BHXE	VHHH	WMKK
DAL622		B772	N867D	WSSS	RJAA

DLH778		A388	DAIMC	EDDF	WSSS
DLH779	2205	A388	DAIME	WSSS	EDDF
ETD413	2144	A332		WMKK	OMAA
ETD416		A332	A6EYA	OMAA	WMKK
ETD471		B77W	A6ETF	WIII	OMAA
ETD472	1722	B77W	A6ETF	OMAA	WIII
ETD473	2207	A332	A6EYI	WSSS	OMAA
ETD474A	341	B77W	A6ETI	OMAA	WIII
ETD475		B77W	A6ETI	WIII	OMAA
ETH619	2114	B763		WMKK	VTBS
EVA6281		B744	B1646	WSSS	WMKP
EZD941	2163	A320	RPC89	WMKK	RPLL
FDX5343		A306	N722F	ZGGG	WMKK
FFM2002		AT72		WMSA	WMKE
FIN82	2277	A343	OHLQE	WSSS	EFHK
GIA890		A332	PKGPP	WIII	ZBAA
GJE76	2043	GLF4		WBGB	WMSA
GSB304	2135	B734	9MGSB	WMKK	WBGR
GSB305	2060	B734	9MGSB	WBGG	WMKK
GSB306	2122	B734		WMKK	WBGG
HVN658		A321	VNA33	WSSS	VVTS
IGO053	601	A320	VTIEK	VOMM	WSSS
IGO054		A320	VTIEK	WSSS	VOMM
IRM082	2102	A310		WMKK	OIIE
JAI12	312	A332	VTJWP	VABB	WSSS
JAI16	603	B738	VTJBE	VOMM	WSSS
JAI20	515	B738	VTJBR	VIDP	WSSS
JAL724	2111	B763		WMKK	RJAA
JSA514	6134	A320		VTBS	WSSS
JSA518		A320		VTBS	WSSS
JSA538	763	A320		VTSP	WSSS
JSA588	7402	A320	9VJSP	VYYY	WSSS
JSA661		A320		WSSS	WMKK
JSA680		A320	9VJSA	WMKP	WSSS
JSA690	2110	A320		WMKK	WSSS
JSA691		A320	9VJSQ	WSSS	VHHH
JSA696		A320	9VJSE	VHHH	WSSS
JSA832		A320	9VJSL	ZSHC	WSSS
JST28	1265	B788	VHVKD	VTSP	YSSY
KAC416	2126	A343	9KAND	WMKK	OKBK
KAL363		B744		WSSS	WMKP
KAL385	4167	B744		RKSI	WMKK
KAL672	2141	A333		WMKK	RKSI
KLM810	2177	B77W		WMKK	EHAM
KLM835		B77W	PHBVI	EHAM	WSSS
KLM836	2235	B772	PHBQC	WSSS	EHAM

KZR935		B752	P4GAS	UAAA	WMKK
LNI286	2317	B739		WIII	WMKK
MAS066	2116	A333	9MMTG	WMKK	RKSI
MAS113	4750	B738	9MMLL	VGHS	WMKK
MAS115	2504	B738	9MMXB	VNKT	WMKK
MAS118	2124	B738		WMKK	VOCI
MAS119	651	B77W		VABB	WMKK
MAS1194	371	B734		WMKK	WMKP
MAS123	2170	A333		WMKK	YSSY
MAS128	1530	A333	9MMTK	YMML	WMKK
MAS134	1064	A333	9MMTM	YBBN	WMKK
MAS140	1531	A333	9MMTO	YSSY	WMKK
MAS1426	373	B738		WMKK	WMKC
MAS149	2164	B772		WMKK	YMML
MAS16	2113	B772		WMKK	EHAM
MAS163	517	A333	9MMTC	OMDB	WMKK
MAS176	7306	B738		VRMM	WMKK
MAS178	7354	B738	9MMLN	VCBI	WMKK
MAS179	2160	B738		WMKK	VCBI
MAS180	2166	B738		WMKK	VOMM
MAS181	604	B738		VOMM	WMKK
MAS191	511	A333	9MMTI	VIDP	WMKK
MAS193	643	B738	9MMLH	VOBL	WMKK
MAS195	345	B772	9MMRM	VABB	WMKK
MAS197	7450	B772		VGHS	WMKK
MAS198	2133	B738		WMKK	VOHS
MAS199	675	B738		VOHS	WMKK
MAS2	2173	A388		WMKK	EGLL
MAS20	2153	A388		WMKK	LFPG
MAS2524		B734		WMKK	WBGG
MAS2547		B738		WBGG	WMKK
MAS2623		B734		WBKK	WMKK
MAS2639		B734		WBKK	WMKK
MAS30	2171	B772		WMKK	LTBA
MAS361		A333	9MMTB	ZBAA	WMKK
MAS370	2157	B772		WMKK	ZBAA
MAS381	3127	B738	9MMXE	ZGGG	WMKK
MAS386	2131	A333	9MMTJ	WMKK	ZSPD
MAS433	5351	B738	9MMLP	VHHH	WMKK
MAS5	2140	B772		EDDF	WMKK
MAS52	2154	A333	9MMTL	WMKK	RJBB
MAS6	2106	B772		WMKK	EDDF
MAS6075	2162	A332	9MMUB	WMKK	WIII
MAS6076	7132	A332	9MMUB	WIII	WMKK
MAS609	2137	B738		WMKK	WSSS
MAS6163		A332	9MMUA	WMKP	WMKK

MAS6240	2156	A332		WMKK	VOMM
MAS726		B738		WIII	WMKK
MAS782	2154	B738		WMKK	VTBS
MAS798	2146	B738	9MMLG	WMKK	VTSP
MAS840		B738		WMKK	WIMM
MAS848		B738		WIII	WMKK
MAS866	4125	B738	9MMSA	WADD	WMKK
MAS867	2152	B738		WMKK	WADD
MAS88	2175	B772	9MMRC	WMKK	RJAA
MAU641	5132	A332	3BNBM	VHHH	FIMP
MAU646		A332	3BNBL	FIMP	WMKK
MAU689	5037	A343	3BNAU	ZSPD	FIMP
MDG010	2341	A343	5REAA	FMMI	VTBS
MDL903	6136	A320	PKRMV	VTBS	WIII
MPH095	524	B744		OMDW	WSSS
MXD1241	374	AT72		WMKC	WMSA
MXD161	4754	B739	9MLNG	VGHS	WMKK
MXD206	575	B739	9MLNK	VIDP	WMKK
MXD216	324	B739	9MLNJ	VABB	WMKK
MXD221		B739	9MLNL	WMKK	VOTR
QTR844		B77W	A7BAA	OTBD	WMKK
QTR847		A333		WMKK	OTBD
QTR851	2104	A332	A7ACJ	WMKK	OTBD
QTR945	2214	B77W	A7BAW	WSSS	OTBD
QTR955		B77W	A7BAK	WIII	OTBD
RBA97	2002	B788	V8DLA	WBSB	OMDB
RGE782	4714	B737	S2AHC	VGHS	WMKK
RGE783	2107	B737	S2AHC	WMKK	VGHS
RNA415	2547	B752	9NACB	VNKT	WMKK
SAA287	5121	A346	ZSSNB	VHHH	FAOR
SIA185		A333	9VSTA	VVTS	WSSS
SIA25	4513	A388		EDDF	WSSS
SIA26	2252	A388	9VSKQ	WSSS	EDDF
SIA306	2255	B77W	9VSWD	WSSS	EGLL
SIA317		A388	9VSKK	EGLL	WSSS
SIA321	3426	A388		EGLL	WSSS
SIA322	2222	A388	9VSKG	WSSS	EGLL
SIA323	141	B772		EHAM	WSSS
SIA324	2227	B772	9VSVJ	WSSS	EHAM
SIA325		B77W	9VSWO	EDDF	WSSS
SIA328	2266	B77W	9VSWJ	WSSS	EDDM
SIA333	1455	A388	9VSKH	LFPG	WSSS
SIA334	2221	A388	9VSKF	WSSS	LFPG
SIA345	3006	A388		LSZH	WSSS
SIA346		A388	9VSKM	WSSS	LSZH
SIA351	4653	B772		EKCH	WSSS

SIA352	2250	B772	9VSVC	WSSS	EKCH
SIA365	5455	B772		LIRF	WSSS
SIA368	2223	B77W	9VSWE	WSSS	LIMC
SIA391	2327	B772		LTBA	WSSS
SIA402	2212	B772	9VSRP	WSSS	VIDP
SIA403	527	B773	9VSYH	VIDP	WSSS
SIA407		B772	9VSRH	VIDP	WSSS
SIA422	2257	B772	9VSQJ	WSSS	VABB
SIA423	331	B77W	9VSWV	VABB	WSSS
SIA425	344	B772	9VSRM	VABB	WSSS
SIA447	4751	A333		VGHS	WSSS
SIA468	2256	A333	9VSTC	WSSS	VCBI
SIA495	572	B77W		OMDB	WSSS
SIA503	642	B772	9VSRN	VOBL	WSSS
SIA517	425	A333	9VSTO	VECC	WSSS
SIA529	611	A333	9VSTY	VOMM	WSSS
SIA61	2710	B77W	9VSWM	UUDD	WSSS
SIA62	2203	B77W	9VSWQ	WSSS	UUDD
SIA67	1214	B77W	9VSWT	LEBL	WSSS
SIA68	2263	B77W	9VSWS	WSSS	LEBL
SIA801		B773	9VSYG	ZBAA	WSSS
SIA803		A333	9VSTP	ZBAA	WSSS
SIA825		A388	9VSKI	ZSPD	WSSS
SIA853		A333	9VSTV	ZGGG	WSSS
SIT9999		B744	B7474	EGLL	WMKK
SLK447	452	A319	9VSBC	VOVZ	WSSS
SLK467	652	A320	9VSLH	VOCI	WSSS
SLK477	676	A320	9VSLB	VOHS	WSSS
SLK509	7402	A320	9VSLF	VYYY	WSSS
SLK937	1513	A319	9VSBH	ZUUU	WSSS
SQC7366	2227	B744	9VSFQ	WSSS	VOMM
SQC7821		B744	9VSFM	VHHH	WSSS
SQC7839		B744	9VSFN	VHHH	WSSS
SQC7889		B744	9VSFF	ZSPD	WSSS
SWR179	2275	A343	HBJML	WSSS	LSZH
TGW2069		A320	9VTAW	VHHH	WSSS
TGW2115	6160	A320	9VTAY	VTBS	WSSS
TGW2433	5476	A320	9VTAV	WMKP	WSSS
TGW2613	665	A320	9VTRI	VOTV	WSSS
TGW2624	2201	A320	9VTRG	WSSS	VOHS
TGW2625		A320	9VTRG	VOHS	WSSS
TGW2636	2214	A320	9VTJR	WSSS	VOMM
TGW2637		A320	9VTJR	VOMM	WSSS
TGW2638	2225	A320	9VTAP	WSSS	VOMM
TGW2639	601	A320	9VTAP	VOMM	WSSS
TGW2652	2267	A320	9VTRM	WSSS	VOBL

TGW2653		A320	9VTRM	VOBL	WSSS
TGW2657	4704	A320	9VTAM	VGHS	WSSS
TGW2669	662	A320	9VTRH	VOTR	WSSS
TGW2953		A320	9VTAT	ZGSZ	WSSS
TGW2989		A320	9VTAN	ZGGG	WSSS
THA419		A333		VTBS	WMKK
THA462	1320	B772		YMML	VTBS
THA465	7230	B773		VTBS	YMML
THA483	6114	A333	HSTBE	VTBS	YPPH
THY67	2245	A333	TCJNT	WSSS	LTBA
TSE315	2172	B722	9MTGN	WMSA	WBKK
TSE738	2040	B722	9MTGG	WBGG	WMSA
UAE343	2140	B77W		WMKK	OMDB
UAE344		B77W	A6ENG	OMDB	WMKK
UAE349	2231	B77W	A6ENH	WSSS	VCBI
UAE359		B77W	A6EBP	WIII	OMDB
UAE368	520	B77W	A6EGQ	OMDB	WIII
UAE379	760	B77W	A6ENJ	VTSP	OMDB
UAE405	2202	B77W	A6EBQ	WSSS	OMDB
UAE435	1104	A388	A6EDP	YBBN	OMDB
UPS167		B763	N340U	ZGSZ	WSSS
VOZ4148	6157	B738	VHYIA	VTSP	YPPH
VQBNH		F900	VQBNH	WSSL	VHHH
XAX197	2514	A333	9MXXO	VNKT	WMKK
XAX213	1431	A333	9MXXG	YMML	WMKK
XAX221	1461	A333	9MXXK	YSSY	WMKK
XAX222	2134	A333	9MXXH	WMKK	YSSY
XAX236	2130	A333	9MXXN	WMKK	YPPH
XAX246	2132	A333	9MXXF	WMKK	YPAD
XAX2997		A333	9MXXF	OEJN	WMKK
XAX327	1512	A333	9MXXC	ZUUU	WMKK
XAX331		A333	9MXAA	ZSPD	WMKK
XAX377	2636	A333	9MXXM	RCTP	WMKK
XAX506	2125	A333	9MXXP	WMKK	RKSI
XAX523	3651	A333	9MXXB	RJTT	WMKK

7.4. Flight plans

Some flight plans can be found in the data. Some flights are not included, probably because the flight plans are published earlier than the departure, if the flight departed earlier or soon after the beginning of the recording, the flights plans may have been published earlier than the start of the recording. The flight plans are in ICAO format.

BAW12:

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(FPL-BAW12-IS37-B744/H-SDE3FGHIJ3J5J6M1M2RWXYZ/LB1D109-WSSS151065-M084F300 AROSO Y339 GEMAS B466 SUKAT/N0511F300 A457 VPG/M084F30065 B579 PUT/N0511F300 L759 KKJ/N0494F320 L759 AGG L760 DPN/M084F32064 A589 ASARI A466 SAMAR/N0488F320 L509 LAJAK/N0486F320 L509 TAPIS65 M875 AMDAR/K0884F320 A466 GR/K0888F340 A466 EKPAK/K0896F360 A46660 TMD A66 ODIVA B824 URL/K0874F340 G3 FV R11 UK/K0857F320 R1166 OPOKA/N0465F320 M869 LEP/N0478F360 M864 KOLJA M611 CDA Z701 GOBOT30 UZ701 GORLO UL980 LOGAN LAM3A14-EGLL1315 EGSS59-PBN/A1B1D1O1S2 NAV/RNVD1E2A1 SUR/TCAS DOF/140307 REG/GBNLP67 EET/WMFC0001 VTBB0056 VYYF0129 VOMF0150 VYYF0211 VECF0214 VABF035563 VIDF0417 OPLR0523 OAKX0600 UTSD0636 UTTR0711 UAII0723 UATT075263 UWWW0902 UUWV0942 ULLL1036 EVRR1049 EYVL1129 ESAA1132 EKDK120066 EDVV1209 EHAA1231 EGTT1258 SEL/BPCM CODE/40040F OPR/BAW RALT/WSSS59 VIDP UBBB EDDB EGLL RVR/075 RMK/TCAS LAHSO NOT AUTHORISED)
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AFR241:

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(FPL-AFR241-IS38-B772/H-SDE2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WMKK154062-N0503F320 DCT AGOSA/M066F210 A457 VPG B579 PUT/N0497F340 L75961 TAVUN/M084F340 L759 MIPAK/N0497F340 L759 NISUN/M084F340 L75968 LIBDI/N0496F340 L759 KKJ L333 TIGER/N0482F350 DCT BI/N0484F340 G20166 ZB L750 ROSIE/N0482F340 L750 RANAH/K0886F360 B449 DUKAN/N0480F36064 L850 ADEKI/K0888F360 L850 DEDON/K0888F380 L850 BANUT A277 LAMET67 R230 OLENA P567 ODS L981 RETRO/N0480F380 L981 INROG/K0889F380 L98165 DIBED/N0478F380 L984 PADKA UL984 NOSPA DCT TOLVU/N0470F370 UN85732 RAPOR/N0472F360 UZ157 VEDUS DCT14-LFPG1300 LFPO60-PBN/A1B1C1D1S1L1 DOF/140307 REG/FGSPF EET/VTBB0038 VYYF011263 VOMF0132 VYYF0154 VECF0157 VABF0341 VIDF0405 OPKR0505 OPLR052263 OAKX0540 UTAV0633 UTAA0648 UTAK0734 UBBA0801 UGGG0834 URRV091963 UKFV0942 UKOV1007 LUUU1024 UKLV1041 EPWW1103 LKAA1125 EDMM115563 EDGG1204 EBUR1226 LFFF1231 SEL/FLDH OPR/AFR RMK/PAKISTAN HQCAA44 108838 AT NR TURKMENISTAN PERMIT GC 106 443095 060913)
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MAS2:

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(FPL-MAS2-IS30-A388/J-SDFGHIJ3J5M1RWXY/LB1D109-WMKK155559-N0490F340 DCT AGOSA A457 VPG B579 PUT L759 NISUN/N0490F36061 L759 KKJ L333 TIGER/N0480F380 DCT BI G201 ZB L750 RANAH B44949 MAMED A87 TIROM/N0480F380 A87 AZABI R122 UP A10264 NALEM/N0480F380 L32 LS A83 TAGAN L980 USTIL DCT GOVEN/N0470F40032 DCT POVEL DCT GORLO UL980 LOGAN19-EGLL1308 EGCC EHAM64-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9MMNE EET/VTBB0036 VYYF0111 64VOMF0131 VECF0157 VABF0341 VIDF0406 OPKR0507 OPLR0524 OAKX0542 64UTAV0636 UTAA0650 UTAK0735 UATT0802 URRV0832 UKDV0930 UKBV1003 63UKLV1035 EPWW1051 EDUU1137 EDVV1156 EDGG1207 EHAA1218 EGTT1242 29SEL/FKCP RMK/ACASII EQUIPPED)
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XAX506:

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(FPL-XAX506-IS28-A333/H-SDFGHIJ4J5ZRWY/LB1D109-WMKK170063-N0465F390 KIMATA KIMAT W533 ADNUT G582 VPK L629 DOLOX/M081F39062 M771 DUDIS/M081F400 M771 DAGAG/N0465F390 M765 MAPNO/N0461F41056 M765 ALDAS/M081F400 L625 ARESI L625 AKOTA/M081F410 L62559 AGVAR/N0461F410 M646 POTIB/N0462F410 M646 HCN/N0464F400 W450 TNN/N0463F410 W4 APU B576 ATOTI Y722 OLMEN OLME1N19-RKSI0603 RKSS RKPC65-PBN/A1B1C1D1 NAV/AUSEP DAT/SV DOF/140307 REG/9MXXP EET/WSJC0023 64VVTS0100 RPHI0217 ADIZ0248 RCAA0334 RJJJ0434 RKRR0448 SEL/BFGQ 63CODE/750334 OPR/AIRASIA X RMK/ACAS II EQUIPPED CALLSIGN XANADU)
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AFR257:

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(FPL-AFR257-IS38-B77W/H-SDE2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WSSS151556-M084F300 DCT AROSO Y339 GEMAS B466 SUKAT A457 VPG B579 60PUT/N0508F300 L759 TAVUN/M084F300 L759 MIPAK/N0507F300 L759 66NISUN/M084F300 L759 LIBDI/N0507F300 L759 LEMEX/N0501F320
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L759 KKJ 67L333 TIGER/N0491F310 DCT BI/N0489F320 G201 ZB L750 ROSIE/N0488F320 68L750 RANAH/K0893F340 B449 DUKAN/N0482F340 L850 ADEKI/K0893F340 L850 63DEDON/K0891F360 L850 BANUT A277 LAMET R230 OLENA P567 ODS N190 54TURSA/N0482F360 N190 DOBOK/K0892F360 UN190 BUKOV N190 67MALBE/N0481F360 UP27 MAKAL UL624 LABUK UY444 ELMEK UL726 OKG UL984 63NOSPA DCT TOLVU/N0478F350 UN857 RAPOR/N0481F340 UZ157 VEDUS DCT14-LFPG1305 LFPO60-PBN/A1B1C1D1S1L1 DOF/140307 REG/FGSQY EET/WMFC0001 VTBB005563 VYYF0129 VOMF0149 VYYF0210 VECF0213 VABF0354 VIDF0418 OPKR051863 OPLR0534 OAKX0552 UTAV0644 UTAA0659 UTAK0744 UBBA0811 UGGG084463 URRV0930 UKFV0952 UKOV1018 LUUU1031 LRBB1044 UKLV1053 LZBB111262 LKAA1132 EDMM1202 EDGG1211 EBUR1233 LFFF1237 SEL/HLFG OPR/AFR62RMK/PAKISTAN HQCAA 108838 AT NR TURKMENISTAN PERMIT GC 106 44301508 060913)

MAS6075:

(FPL-MAS6075-IS30-A332/H-SDFGHIJ3J5M1RWXY/LB1D109-WMKK170056-N0460F390 DCT MITOS M630 SUKRI/M080F390 M630 BOBAG P50137 ANITO/N0460F390 B470 BUNIK DCT NOKTA19-WIII0141 WSSS WBGG63-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9MMUB EET/WSJC0023 WIIF0041 46SEL/BGHK RMK/ACASII EQUIPPED FREIGHTER FLIGHT)

SIA328:

(FPL-SIA328-IS40-B77W/H-SDE1E2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WSSS152061-M083F300 AROSO Y339 GEMAS B466 SUKAT/N0503F300 A457 VPG Y33760 GIVAL/M083F300 P628 PPB/N0502F300 P628 KAGUL/N0497F320 P62863 AMJID/N0479F340 P628 ASLUM/N0478F340 P628 PAROD/N0477F340 P62860 CHARN G792 MSD G775 ORPAB/K0882F340 G775 ASB A87 MAMED B45066 MARAL/N0473F340 M23 BISNA/K0877F340 B491 MKL B494 OLGIN/K0868F34057 M991 DOTEL/K0876F360 M991 REPLI T254 TAKET M991 IVF M14157 LADOB/N0471F360 UM141 OKR UL856 MATIG Q113 NAPSA NAPSA1A14-EDDM1220 LOWW62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSWJ EET/WMFC0002 VOMF013963 VECF0232 VABF0347 VIDF0437 OPKR0521 OPLR0551 OAKX0604 OIIX065763 UTAA0725 UTAK0749 UBBA0821 URRV0837 UKDV0955 UKBV1020 UKLV104666 LZBB1112 LOVV1139 EDMM1202 SEL/BPGS CODE/76CEEA OPR/SIA RALT/VCBI68 OMDB LTBA RMK/IRAN PERMIT NUMBER YK 2S 28 3712 ALA ACASII EQUIPPED)

UAE343:

(FPL-UAE343-IS34-B77W/H-SDE2E3FGHIJ3J5M1RWXY/LB1D109-WMKK171064-N0493F340 AGOSAA AGOSA R467 GUNIP/M083F340 N571 LAGOG/N0493F34054 N571 GURAS/N0488F360 N571 VUSET A454 PASOV B540 BUBIN14-OMDB0700 OOMS64-PBN/A1B1C1D1L1O1S2T1 DOF/140307 REG/A6ECM EET/VOMF0108 VABF034766 OOMM0536 OMAE0635 SEL/JKAC CODE/896114 RALT/VTSP VOMM RMK/NRP HAR11 TCAS ADSB)

SWR179:

(FPL-SWR179-IS34-A343/H-SDE2E3FGHIJ4J5M1RWXY/LB1D109-WSSS153568-N0490F300 AROSO Y339 GEMAS B466 SUKAT/M081F300 A457 TEPUS/M081F32069A457 VPG/N0485F320 B579 PUT L759 KKJ L333 MEMID/N0473F340 L333 TIGER0068DCT BI G201 BASIR/N0463F360 G201 ZB L750 RANAH/K0861F360 B449 MAMED69A87 BALIG/K0864F380 A87 AZABI R122 UP A102 OBETI G364 RND B493 FASAD0069L984 BULIG/K0857F380 L984 NM M991 IVF M141 LADOB/N0461F380 UM141 OKR0032UL856 MAREG DCT SBG UL856 NEGRA14-LSZH1302 LFSB62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/HBJML EET/WMFC0001 VTBB010063 VYYF0134 VOMF0155 VECF0221 VABF0408 VIDF0432 OPKR0534 OPLR055163 OAKX0610 UTAV0706 UTAA0720 UTAK0807 UATT0835 URRV0906 UKDV101463 UKBV1044 UKLV1109 LZBB1136 LOVV1204 EDUU1225 LSAS1248 SEL/DKEQ56RMK/CALLSIGN SWISS ACAS II EQUIPPED ADSB ID LX179 RTE 2817 SEQ10006 RVR/75)

BAW16:

(FPL-BAW16-IS39-B77W/H-SDE1E3FGHIJ3J5J6M1M2RWXYZ/LB1D109-WSSS151565-M083F300 AROSO Y339 GEMAS B466 SUKAT/N0506F300 A457 VPG/M084F30065 B579 PUT/N0507F300 L759 KKJ/N0490F320 L759 AGG L760 DPN/M084F32064 A589 ASARI A466 SAMAR/N0485F320 L509 LAJAK/N0480F340 L509 TAPIS59 M875 AMDAR/K0882F340 A466 TMD A66 ODIVA B824 URL G3 FV R1163 UK/K0874F320 R11 OPOKA/N0474F320 M869 LEP/N0476F360 M864 KOLJA50 M611 CDA Z701 GOBOT UZ701 GORLO UL980 LOGAN LAM3A14-EGLL1316 EGSS59-PBN/A1B1D1O1S2 NAV/RNVD1E2A1 SUR/TCAS DOF/140307 REG/GSTBF67 EET/WMFC0001 VTBB0056 VYYF0129

VOMF0149 VYYF0211 VECF0214 VABF035663 VIDF0418 OPLR0523 OAKX0601 UTSD0638 UTTR0713 UAII0725 UATT075563 UWWW0907 UUWV0946 ULLL1039 EVRR1052 EYVL1131 ESAA1134 EKDK120364 EDVV1212 EHAA1233 EGTT1300 SEL/CHFP CODE/4065DE OPR/BAW RVR/07531 RMK/TCAS LAHSO NOT AUTHORISED)

SIA352:

(FPL-SIA352-IS40-B772/H-SDE1E2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WSSS154566-M083F320 VMR B469 VPK M751 GOLUD/N0491F340 M770 RAN/M083F340 M77061 BUBKO/N0491F340 M770 KAKID M875 BUTOP/N0474F360 M875 DI A46663 SAJAN/N0449F280 A466 SITAX/N0448F280 M875 AMDAR/K0812F280 A46659 HA/K0871F360 A466 TMD A66 ODIVA B824 URL G3 FV R11 UK B10263 ASKIL/K0854F360 L736 KOSAN/K0865F380 L736 PODIL/N0467F380 L73654 TIGNU/K0869F380 B65 LATMI/N0468F380 M865 ROE M743 ALM14-EKCH1234 EKBI62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSVC EET/WMFC0001 VTBB004463 VYYF0124 VECF0230 VABF0415 VIDF0419 OPLR0531 OAKX0608 UTSD064963 UTTR0726 UAII0737 UATT0807 UWWW0920 UUWV1000 UMMV1051 EYVL111265 UMKK1142 EPWW1151 ESAA1159 EKDK1230 SEL/LSGQ CODE/76CEC3 OPR/SIA36 RALT/OMDB LTAC RMK/ACASII EQUIPPED)

SIA334:

(FPL-SIA334-IS41-A388/J-SDE1E2E3GHIJ2J3J5J6M1M2RWXY/LB1D109-WSSS155566-M084F340 AROSO Y339 GEMAS B466 SUKAT/N0498F340 A457 VPG/M084F340 68B579 PUT/N0498F340 L759 BBS/N0493F360 L759 KKJ L333 TIGER DCT MURLI62DCT BI G201 BASIR/N0475F340 G201 ZB L750 ROSIE/N0474F340 L75069RANAH/K0871F340 A646 BELUG/K0882F360 A646 MAXAT/K0893F380 A646 ATASH0066A645 TIROM A87 AZABI R122 UP A102 NALEM/K0880F380 L32 LS W633 DON60L69 OSLAN L984 DIBED/N0471F380 L984 PADKA UL984 NOSPA UN85766IDOSA/N0452F360 UN857 TOLVU/N0451F350 UN857 RAPOR/N0435F300 UZ15713VEDUS VEDUS5E14-LFPG1312 LFPO62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSKF EET/WMFC0002 VTBB005663 VYYF0130 VOMF0151 VYYF0213 VECF0216 VABF0400 VIDF0425 OPKR052763 OPLR0543 OAKX0601 UTAV0655 UTAA0711 UTAK0751 UATT0821 URRV085163 UKDV0949 UKBV1026 UKLV1049 EPWW1113 LKAA1137 EDUU1207 EBUR123959 LFFF1244 SEL/KMDE CODE/76CD66 OPR/SIA RMK/ACASII EQUIPPED)

FIN82:

(FPL-FIN82-IS35-A343/H-SDE2E3FGHIJ4J5J6M1RWXYZ/HD109-WSSS155565-M081F320 AROSO Y339 GEMAS B466 SUKAT/N0485F320 A457 VPG/M081F32065 B579 PUT/N0486F320 L515 OBMOG/M081F320 M770 BUBKO/N0485F320 M77063 KAKID M875 IGONA/N0471F340 M875 BUTOP/M081F360 A589 ASARI A46653 SAMAR/N0463F360 L509 LAJAK/N0462F360 L509 TAPIS M87561 AMDAR/K0852F360 A466 TMD A66 ODIVA B824 URL G3 FV R11 TU R5826 NOTAR/K0840F360 L56 INTOR14-EFHK1150 EETN60-PBN/A1B1C1D1L1O1S2 DAT/SV DOF/140307 REG/OHLQE EET/WMFC000263 VTBB0102 VYYF0133 VECF0235 VABF0421 VIDF0424 OPLR0542 OAKX062263 UTSD0700 UTTR0737 UAII0749 UATT0820 UWWW0934 UUWV1015 ULLL111165 EETT1128 EFIN1148 SEL/LRAJ CODE/461EB0 OPR/FIN RVR/075 RMK/TCAS)

SIA334:

(FPL-SIA334-IS41-A388/J-SDE1E2E3GHIJ2J3J5J6M1M2RWXY/LB1D109-WSSS155566-M084F340 AROSO Y339 GEMAS B466 SUKAT/N0498F340 A457 VPG/M084F340 68B579 PUT/N0498F340 L759 BBS/N0493F360 L759 KKJ L333 TIGER DCT MURLI62DCT BI G201 BASIR/N0475F340 G201 ZB L750 ROSIE/N0474F340 L75069RANAH/K0871F340 A646 BELUG/K0882F360 A646 MAXAT/K0893F380 A646 ATASH0066A645 TIROM A87 AZABI R122 UP A102 NALEM/K0880F380 L32 LS W633 DON60L69 OSLAN L984 DIBED/N0471F380 L984 PADKA UL984 NOSPA UN85766IDOSA/N0452F360 UN857 TOLVU/N0451F350 UN857 RAPOR/N0435F300 UZ15713VEDUS VEDUS5E14-LFPG1312 LFPO62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSKF EET/WMFC0002 VTBB005663 VYYF0130 VOMF0151 VYYF0213 VECF0216 VABF0400 VIDF0425 OPKR052763 OPLR0543 OAKX0601 UTAV0655 UTAA0711 UTAK0751 UATT0821 URRV085163 UKDV0949 UKBV1026 UKLV1049 EPWW1113 LKAA1137 EDUU1207 EBUR123959 LFFF1244 SEL/KMDE CODE/76CD66 OPR/SIA RMK/ACASII EQUIPPED)

ETD474A:

(FPL-ETD474A-IS32-B77W/H-SDE2E3FGHIJ5M1RWXY/SB1D109-OMAA031553-N0485F310 KANIP N318 TOLDA/N0486F330 M628 PARAR N57162 VATMO/N0490F350 N571 LAGOG/M083F350 N571

GUNIP/N0488F350 M63045 BOBAG P501 ANITO/M083F350 B470 BUNIK BUNIK1B14-WIII0719 WARR64-PBN/A1B1C1D1L1O1S2T1 DOF/140307 REG/A6ETI EET/OMAE0007 OOMM001362 VABF0103 VOMF0229 WMFC0452 WSJC0612 WIIF0628 SEL/EGAC OPR/ETD44 RALT/VOMM VTSP TALT/OMDW RMK/TCAS EQUIPPED)

MAS16:

(FPL-MAS16-IS30-B772/H-SDFGHIJ3J5M1RWXY/LB1D109-WMKK160561-N0500F300 DCT AGOSA A457 VPG Y337 GIVAL P628 OPASA/N0490F32062 P628 BIDAN/N0480F340 P628 VIKIT/N0480F360 P628 CHARN G792 MSD52 G775 ASB A87 TIROM/N0480F380 A87 AZABI R122 UP A10264 NALEM/N0480F380 L32 LS A83 TAGAN L980 USTIL DCT GOVEN DCT POVEL33 UL986 DLE UL980 AMSAN T281 NORKU19-EHAM1242 EBBR EDDF64-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9MMRL EET/VOMF0122 VECF0215 64VABF0330 VIDF0420 OPKR0505 OPLR0536 OAKX0549 OIIX0641 UTAA0709 64UTAK0733 UATT0800 URRV0830 UKDV0929 UKBV1002 UKLV1033 EPWW1049 66EDUU1136 EDVV1155 EDGG1211 EHAA1217 SEL/QRCL RMK/ACASII EQUIPPED)

KAL672:

(FPL-KAL672-IS34-A333/H-SDE2E3FGHIJ3J5M1RWXY/LB1D109-WMKK155967-N0470F370 DCT KIMAT W533 ADNUT G582 VPK L629 DOLOX/M081F360 M771 63 DAGAG/N0471F370 M765 ALDAS/M080F360 L625 ARESI/M081F390 L625 61 AGVAR/N0468F390 M646 POTIB/N0468F390 M646 HCN/N0469F380 W4 14TNN/N0469F390 42 W4 ANLOT B1 APU B576 ATOTI Y722 OLMEN DCT14-RKSI0603 RKSS64-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/HL7709 EET/WSJC0025 VVTS0101 66RPHI0216 ADIZ0247 RCAA0332 RJJJ0432 RKRR0445 SEL/MPDH CODE/71BF09 18RMK/TCAS EQUIPPED)

SIA26:

(FPL-SIA26-IS41-A388/J-SDE1E2E3GHIJ2J3J5J6M1M2RWXY/LB1D109-WSSS155561-M084F340 AROSO Y339 GEMAS B466 SUKAT/N0497F340 A457 VPG Y33760 GIVAL/M084F340 P628 PPB/N0495F340 P628 KAGUL/N0492F360 P62863 ABDUL/N0472F340 P628 ASLUM/N0472F340 P628 PAROD/N0471F340 P62859 CHARN G792 MSD G775 ORPAB/K0865F340 G775 ASB/K0880F360 A8767 MAMED/K0892F380 A87 AZABI R122 UP A102 NALEM/K0878F380 L32 LS W63361 DON L69 OSLAN L984 DIBED/N0470F380 L984 PADKA DCT RAPET T17035 GAPLA/N0390F240 T173 KERAX KERAX1B14-EDDF1248 LSZH62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSKQ EET/WMFC0002 VOMF014063 VECF0233 VABF0349 VIDF0440 OPKR0525 OPLR0556 OAKX0609 OIIX070263 UTAA0731 UTAK0754 UATT0821 URRV0851 UKDV0949 UKBV1026 UKLV105065 EPWW1114 LKAA1137 EDUU1209 EDGG1223 SEL/GSJM CODE/76CD71 OPR/SIA58 RMK/IRAN PERMIT NUMBER YK 2S 28 3712 ALA ACASII EQUIPPED)

VOZ4148:

(FPL-VOZ4148-IS20-B738/M-SDGHIRWZ/LB109-VTSP155562-N0449F350 DCT PUT B579 DALAN/N0452F370 B579 VPL W531 VIH A46452 VKL Y341 MITOS M630 SUKRI DCT BOBAG P501 ANITO B47061 PKP/N0445F390 L764 LAMOB Y100 IDOKU/N0444F410 Y100 REVOP Q6707 PH DCT09-YPPH061744-PBN/A1B2C2D2O2S2 NAV/RNP2 GPSRNAV REG/VHYIA40 EET/WMFC0021 WSJC0112 WIIF0130 YMMM031648 SEL/LPAK CODE/7C7AA0 OPR/VIRGIN AUSTRALIA PER/C20 RALT/WIII WSSS YPLM48 RMK/PERMITS INDONESIA AU 008 18 5 DJPU DAU 201328 MALAYSIA DGCA AT 6115 10 1319 CALLSIGN VELOCITY)

MAS6:

(FPL-MAS6-IS30-B772/H-SDFGHIJ3J5M1RWXY/LB1D109-WMKK162059-N0500F280 DCT AGOSA A457 VPG B579 PUT L759 MIPAK/N0500F30054 L759 BBS/N0490F320 L759 KKJ L333 INTIL/N0480F340 L33357 TIGER/N0480F360 DCT BI G201 ZB L750 RANAH B449 MAMED A8759 TIROM/N0480F360 A87 INRED/N0480F380 A87 AZABI R122 UP A10264 NALEM/N0480F380 L32 LS A83 TAGAN L980 PEKIT A83 CH M70 LDZ L98054 INDIG T174 KORUP UQ318 TAMEB/N0420F240 T173 KERAX DCT19-EDDF1223 EDDK EBBR64-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9MMRH EET/VTBB0038 VYYF0112 64VOMF0133 VECF0158 VABF0340 VIDF0405 OPKR0505 OPLR0522 OAKX0540 64UTAV0634 UTAA0649 UTAK0733 UATT0801 URRV0831 UKDV0930 UKBV1002 66UKLV1034 EPWW1053 EDMM1137 EDGG1158 SEL/QREP RMK/ACASII EQUIPPED)

SIA322:

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(FPL-SIA322-IS41-A388/J-SDE1E2E3GHIJ2J3J5J6M1M2RWXY/LB1D109-WSSS154561-M084F340
AROSO Y339 GEMAS B466 SUKAT/N0498F340 A457 VPG Y33760 GIVAL/M084F340 P628
PPB/N0496F340 P628 KAGUL/N0494F360 P62863 ABDUL/N0474F340 P628 ASLUM/N0474F340 P628
PAROD/N0473F340 P62859 CHARN G792 MSD G775 ORPAB/K0869F340 G775 ASB/K0883F360 A8766
KEKAL/K0894F380 A87 AZABI R122 UP A102 NALEM/K0880F380 L32 LS A8363 TAGAN L980
USTIL/N0469F380 DCT GOVEN DCT POVEL DCT GORLO UL98012 LOGAN LAM3A14-EGLL1323
EGSS62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSKG EET/WMFC0002 VOMF014063 VECF0233
VABF0349 VIDF0440 OPKR0525 OPLR0555 OAKX0608 OIIX070163 UTAA0730 UTAK0753 UATT0820
URRV0850 UKDV0948 UKBV1020 UKLV105266 EPWW1107 EDUU1154 EDVV1213 EHAA1235 EGTT1259
SEL/AEHR CODE/76CD6766 OPR/SIA RMK/IRAN PERMIT NUMBER YK 2S 28 3712 ALA ACASII
EQUIPPED)
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THY67:

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(FPL-THY67-IS37-A333/H-DE1E2E3FGHIJ4J5M1RSWXYZ/B1D1L09-WSSS163063-M080F340
AROSO/N0470F340 Y339 GEMAS B466 GUNIP N571 LAGOG N87760ORARA/N0470F360 N877 PRA
A325 KE B210 NH N636 GASIR G452 ZDN60UL125 RADAL T210 RUS R661 SUTBU/N0460F380 R661
ZAJ UL124 EZS30UL614 GEM UT32 BUK UL615 ERKAL14-LTBA1136 LTFJ60-PBN/A1B1D1L1S1S2
NAV/RNP APCH S1 S2 RNP4 L1 RNAV10 RNP10 A160DOF/140307 REG/TCJNT EET/WMFC0007
VOMF0133 VABF0344 VIDF052459OPKR0531 OIIX0657 LTAA0931 LTBB1109 OPR/THY RMK/TCAS
RVR/7546SEL/ERJL RALT/VTSP VOMM TALT/WMKJ CODE/4BA9D4)
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DLH779:

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(FPL-DLH779-IS38-A388/J-SADE2E3FGHIJ3J4J5M1RWXYZ/LB1D109-WSSS155562-M084F340
AROSO Y339 GEMAS B466 SUKAT/N0499F340 A457 VPG Y337 60GIVAL/M084F340 P628
PPB/N0498F340 P628 KAGUL/N0495F360 P628 62ASLUM/N0479F380 P628 PAROD/N0479F380 P628
CHARN G792 MSD G775 68ORPAB/K0896F380 G775 ASB A87 AZABI R122 UP A102
NALEM/K0884F380  L3269LS W633 DON L69 OSLAN L984 DIBED/N0475F380 L984 PADKA DCT
RAPET T1700024GAPLA T173 KERAX KERAX1B14-EDDF1224 EDDK64-PBN/A1B1C1D1L1O1S1S2
NAV/RNVD1E2A1 DAT/SVM DOF/140307 REG/DAIME66EET/WMFC0002 VOMF0140 VECF0234
VABF0349 VIDF0440 OPKR0524 OPLR055563 OAKX0608 OIIX0700 UTAA0728 UTAK0751 UATT0817
URRV0847 UKDV094563 UKBV1022 UKLV1045 EPWW1109 LKAA1132 EDUU1203 EDGG1214
SEL/MRDL30OPR/DLH RMK/TCAS ADSB RVR/200)
MAS30:
(FPL-MAS30-IS30-B772/H-SDFGHIJ3J5M1RWXY/LB1D109-WMKK163057-N0490F340  DCT AGOSA
R467 GUNIP N571 IDASO/N0480F360 N57159 DORAM B466 BBB N519 EXOLU L505 NOBAT P518
PARET G208 KEBUD57 UL124 YZD UT211 RUS R661 ZAJ UL124 TOTBO/N0470F380 UL12457
TUDNU/N0480F400 UL124 EZS UL614 GEM UT32 BUK UL615 GAYEM19-LTBA1049 LTAI LTAC64-
PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9MMRM EET/VOMF0110 VABF0350  60OPKR0524 OIIX0607
LTAA0853 LTBB1025 SEL/QRCM RALT/VTSP VOMM 20RMK/ACASII EQUIPPED)
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CES540:

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(FPL-CES540-IS24-A320/M-SDE2E3FGHIRW/LB109-WMKK184056-N0453F350 DCT KIMAT W533
ADNUT G582 VPK L629 DOLOX M77162 DONDA/K0822S1070 M771 DOSUT/N0442F350 M771 DULOP
Q1 CARSO DCT54 RAMUS DCT SOUSA V1 DOTMI/K0810S1070 A470 LJG B221 SHZ14-ZSPD0456
ZSHC61-PBN/A1B2C1D1O2S2 DOF/140307 REG/B9946 EET/WSJC0024 VVTS0102 67ZJSA0215
VHHK0238 ZGZU0327 ZSHA0337 SEL/QRCJ CODE/780B3A OPR/CHINA 17EASTERN RMK/TCAS)
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CEB502:

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(FPL-CEB502-IS20-A320/M-SDFGHIRWYZ/H09-WMKK184063-N0438F330  KIMATB KIMAT W533
ADNUT G582 VPK M758 IDSEL/M073F33064 M758 LUSMO/M077F390 N884 LAXOR/N0440F390 N884
LEGED DCT LBG DCT08 MIA DCT14-RPLL0334 RPLC54-PBN/A1B1C1D1O1S2 NAV/GBAS SBAS
DOF/140307 REG/RPC326722 EET/WSJC0026 RPHI021634 SEL/CEFG PER/C RMK/TCAS EQUIPPED)
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UAE405:

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(FPL-UAE405-IS34-B77W/H-SDE2E3FGHIJ3J5M1RWXY/LB1D109-WSSS172066-M083F320   AROSO
Y339 GEMAS B466 GUNIP/M082F300 N571 MEKAR/M083F30063 N571 NILAM/M083F340 N571
LAGOG/N0493F340 N571 VUSET A454 PASOV11 B540 BUBIN14-OMDB0717 OOMS64-
PBN/A1B1C1D1L1O1S2T1 DOF/140307 REG/A6EBQ EET/WMFC0001 VOMF012863 VABF0407
OOMM0555 OMAE0652 SEL/BMCP CODE/8960D8 RALT/WMKP VCBI23 RMK/NRP HAR TCAS ADSB)
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SIA368:

(FPL-SIA368-IS40-B77W/H-SDE1E2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WSSS173566-M083F300 AROSO Y339 GEMAS B466 SUKAT/N0503F300 A457 VPG/M083F300 66B579 PUT/N0503F300 L759 KKJ/N0488F320 L333 TIGER DCT MURLI DCT BI 55G201 ZB L750 ROSIE/N0481F320 L750 RANAH/K0881F320 B449 66MAMED/K0880F340 B450 MARAL/N0474F340 M23 BISNA/K0881F360 B491 MKL 69B494 OLGIN/K0877F360 DCT KERTA L140 SURAP/N0475F360 L140 POGAV UL1400061NARKA UM174 PUSTA UY563 SUNIS DCT DETSA/N0468F350 UM984 LUSIL14-LIMC1240 LSZH62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSWK EET/WMFC0002 VTBB005663 VYYF0130 VOMF0150 VYYF0212 VECF0215 VABF0357 VIDF0421 OPKR052163 OPLR0537 OAKX0555 UTAV0647 UTAA0702 UTAK0747 UBBA0819 URRV083563 UKDV0954 UKFV1002 UKOV1019 LUUU1035 LRBB1043 LHCC1115 LOVV114259 LIMM1203 SEL/FPKQ CODE/76CEEB OPR/SIA RALT/LTBA RMK/ACASII10 EQUIPPED)

BBC087:

(FPL-BBC087-IS25-B77W/H-SDE1FGHIJ1M1RWY/L09-WMKK192060-N0496F340 DCT AGOSA A457 HTY A464 UPNEP M626 BGO G463 KANDI04 DCT14-VGHS0323 VECC67-PBN/A1B2D2S2O2 DOF/140307 REG/S2AFP EET/VTB0037 VYYF0116 VGFR0245 09SEL/BJAE)

QTR851:

(FPL-QTR851-IS32-A332/H-SDE1E3FGHIJ5M1RWXY/SB1D109-WMKK192559-M081F380 AGOSAA AGOSA R467 GUNIP N571 LAGOG/N0469F380 N57164 PARAR/N0468F400 N571 ATBOR P699 KISAG M430 ASKOP/N0382F220 M43016 TOSNA UM430 DOH14-OTBD0737 OEDF60-PBN/A1B1D1L1O1S1 DOF/140307 REG/A7ACJ EET/VOMF0110 VABF035666 OOMM0552 OMAE0654 OBBB0729 SEL/DSBK CODE/06A048 OPR/QTR RALT/VTSP15 VCBI RMK/TCAS)

SIA346:

(FPL-SIA346-IS41-A388/J-SDE1E2E3GHIJ2J3J5J6M1M2RWXY/LB1D109-WSSS173066-M084F340 AROSO Y339 GEMAS B466 SUKAT/N0496F340 A457 VPG/M084F340 68B579 PUT/N0496F340 L759 BBS/N0492F360 L759 KKJ L333 TIGER DCT MURLI62DCT BI G201 ZB L750 ROSIE/N0474F360 L750 RANAH/K0879F360 A64661MAXAT/K0891F380 A646 ATASH A645 TIROM A87 AZABI R122 UP A102 64NALEM/K0877F380 L32 LS W633 DON L69 OSLAN L984 NM M991 IVF M141 68LADOB/N0469F380 UM141 OKR UL856 SBG/N0455F360 UL856 TRAUN/N0446F34011UL856 NEGRA14-LSZH1238 EDDF62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSKM EET/WMFC0002 VTBB005663 VYYF0130 VOMF0151 VYYF0213 VECF0216 VABF0400 VIDF0425 OPKR052763 OPLR0543 OAKX0601 UTAV0654 UTAA0710 UTAK0750 UATT0820 URRV085063 UKDV0948 UKBV1025 UKLV1049 LZBB1115 LOVV1143 EDUU1204 EDMM121959 LSAS1225 SEL/JKEF CODE/76CD6D OPR/SIA RMK/ACASII EQUIPPED)

QTR945:

(FPL-QTR945-IS34-B77W/H-SDE1E3FGHIJ4J5M1RWXY/SB1D109-WSSS180066-N0499F320 AROSO Y339 GEMAS/M083F320 B466 VBA G582 PUGER/N0493F34067 P574 ANSAX/M083F340 P574 DUBTA/N0494F340 P574 GULAM/N0488F360 P57464 BOLIS/N0486F300 P574 TOTOX L555 TOLDA/N0492F320 M628 TULBU N56350 NOBTO Z994 VEBAT P899 MEKMA UP899 KUPSA UB415 DOH19-OTBD0728 OEDF OBBI62-PBN/A1B1D1L1O1S1T1 DOF/140307 REG/A7BAW EET/WMFC0002 WIIF003763 WMFC0116 VOMF0125 VABF0418 OOMM0556 OMAE0652 OBBB0719 SEL/PQEM40 CODE/06A139 OPR/QTR RALT/VCBI RMK/TCAS)

SIA422:

(FPL-SIA422-IS40-B772/H-SDE1E2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WSSS183063-M083F380 AROSO Y339 GEMAS B466 GUNIP N571 LAGOG/N0480F380 N57106 AGELA14-VABB0456 VAAH62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSQJ EET/WMFC0002 VOMF013064 VABF0411 SEL/MSCE CODE/76CE2A OPR/SIA RALT/WMKP VCBI RMK/ACASII10 EQUIPPED)

SIA62:

(FPL-SIA62-IS40-B77W/H-SDE1E2E3FGHIJ3J5J6M1M2RWXY/LB1D109-WSSS183066-M083F300 AROSO Y339 GEMAS B466 SUKAT/N0503F300 A457 VPG/M083F300 64B579 PUT/N0503F300 L515 OBMOG/M083F300 M770 LALAT/M083F320 M770 69BUBKO/N0497F320 M770 KAKID/M083F320 M770 JJS/N0495F320 P646 BBN R4600059LKN M890 SAMAR A466 DI/N0477F340 A466

SITAX/N0476F340 M875 62AMDAR/K0875F340 A466 TMD A66 ODIVA B824 URL G3 FE FE1D AO AO2A14-UUDD1034 EKCH62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/9VSWQ EET/WMFC0002 VTBB005663 VYYF0126 VECF0226 VIDF0408 OPLR0527 OAKX0606 UTSD0645 UTTR072165 UAII0732 UATT0802 UWWW0914 UUWV0954 SEL/ELCS CODE/76CEF1 OPR/SIA35RALT/UTTT LTAC RMK/ACASII EQUIPPED)

ETD416:

(FPL-ETD416-IS32-A332/H-SDFGHIJ1J5LORVWXY/SB1D1L09-OMAA112064-N0462F370 KANIP N318 TOLDA M628 LOXOP/N0468F390 M628 PARAR N57144 LAGOG/M081F390 N571 GUNIP R467 AGOSA SASRI214-WMKK0620 WMKJ63-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/A6EYA EET/OMAE0007 OOMM0014 68VABF0103 VOMF0233 WMFC0507 SEL/FGKP OPR/ETD RALT/VOMM VTSP RMK/TCAS 09EQUIPPED)

RGE783:

(FPL-RGE783-IS25-B737/M-SDE1FHIJ7LORWXY/S09-WMKK201555-N0454F380 AGOSAA AGOSA A457 VPG W525 VPL/M079F380 B57945 PUT/N0455F380 G331 DWI M626 BGO G463 DAC DCT14-VGHS0328 VECC67-PBN/C3 DAT/V/H DOF/140307 REG/S2AHC EET/VTBB0040 VYYF0111 VGFR030020 OPR/RGE RMK/TCAS 7)

ETD413:

(FPL-ETD413-IS31-A332/H-SDFGHIJ1J5LORVWXY/LB1D109-WMKK204055-N0470F380 AGOSAA AGOSA A457 VPG W525 VPL/M081F380 B57963 PUT/N0470F380 L759 BBS T1 BPL/M081F360 A791 PRA/N0465F360 A32539 PARET A454 VUSET R462 MIXAM P899 ROVOS14-OMAA0738 OMDW62-PBN/A1B1C1D1L1O1S2 DOF/140307 REG/A6EYA EET/VTBB0039 VYYF011463 VOMF0136 VYYF0159 VECF0202 VABF0346 VIDF0518 OPKR0525 OOMM064245 OMAE0730 SEL/FGKP OPR/ETD RMK/TCAS EQUIPPED)

BCC920:

(FPL-BCC920-IS18-B763/H-SFRGWYID/S09-WIII210066-N0474F340 DOLTA1D DOLTA A585 PLB G579 REPOV/M080F340 G579 SJ B46948 PU/N0474F340 B469 VPK M751 VKB M644 RYN DANNY1B14-VTBS0258 VTBD67-PBN/A1B3B4B5D4 DOF/140307 REG/HSBIG EET/WSJC0052 WMFC0106 VTBB014634 SEL/BQGK PER/D RMK/TCAS EQUIPPED)

AXM1658:

(FPL-AXM1658-IS22-A320/M-SDFGHIRWYZ/LB109-WMKK052059-N0426F290 PIBOSA PIBOS R208 GUNBO/M077F370 R208 IGARI M76563 BITOD/N0450F370 L637 TSN W1 DAN A1 IKELA P901 IDOSI V561 CANTO19-VHHH0327 VMMC ZGSZ54-PBN/A1B1C1D1O1 NAV/ABAS COM/AMDS DOF/140306 REG/9MAFI40 EET/WSJC0031 VVTS0042 ZJSA0218 VHHK024345 SEL/BRGS CODE/750110 PER/C RMK/TCAS EQUIPPED50 E/0435 P/TBN R/VE S/M J/LF A/RED AND WHITE C/TBN)

SIT9999:

(FPL-SIT9999-IN16-B744/H-SHIXYW/C09-EGLL100060-N0501F290 BPK6J BPK UQ295 CLN UL620 BASNO UL603 BESNI UL60560 MIQ/N0500F310 UL605 NEKUL UM747 NERDI/N0494F330 UM747 TALAM58 M747 SOBLO/K0915F330 B143 IDLER/N0492F330 M747 LUSAL N31964 ULDUS/N0492F330 UN319 DNZ/N0492F330 UN319 IMPAT/N0492F350 UN31963 ZDN G452 DERBO/N0493F350 G452 DPN R460 TEPAL/M085F350 R460 CEA62 L507 TEBOV/N0497F350 L507 BGO M626 DALER/N0498F370 M626 UPNEP16 A464 VBA SASRI209-WMKK121021-DOF/140307 REG/B747458 EET/EHAA0018 EDVV0036 EDUU0045 LOVV0117 LHCC0135 LRBB020063 UKFV0253 URRV0325 UGGG0345 UBBA0412 OIIX0450 OPKR0611 VIDF071755 VECF0827 VGFR0907 VECF0918 VYYF0929 VTBB1049 WMFC1128)