

18th September 2019

MPFR Factual Report

Accident

LOS ANGELES FIRE DEPARTMENT

AW139, S/N 41528, R/M N304FD

Tujunga, CA – USA

2nd September 2017

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1. *Analysis*

1.1 *Data Recovery*

The data and audio tracks were successfully recovered from the MPFR on the day after the event.

1.2 *MPFR Data Analysis*

The MPFR data analysis allowed the full reconstruction of the flights of N304FD. The following chapters include a detailed presentation of the outcome of such analysis.

1.2.1 *Flight Path reconstruction*

Through the recorded GPS data it was possible to plot the Flight Path of N304FD, from the Take-off at Van Nuys up to the tree strike and the emergency landing position. A total of 11 different flight segments (i.e. ground-air-ground cycles) have been identified.

A dedicated plot for the final 3 flights is also provided: as these flights were aimed at dropping water roughly in the same spot a comparison can be made to highlight differences and commonalities in the piloting technique and in the A/C's response to said inputs, to identify possible abnormalities which may have arisen between the 2nd and 3rd water drops and could have contributed to the perceived loss of control by the Crew and/or to the tree strike.



Figure 1 – Full Flight Path of N304FD (all flights of 2nd of September 2017)

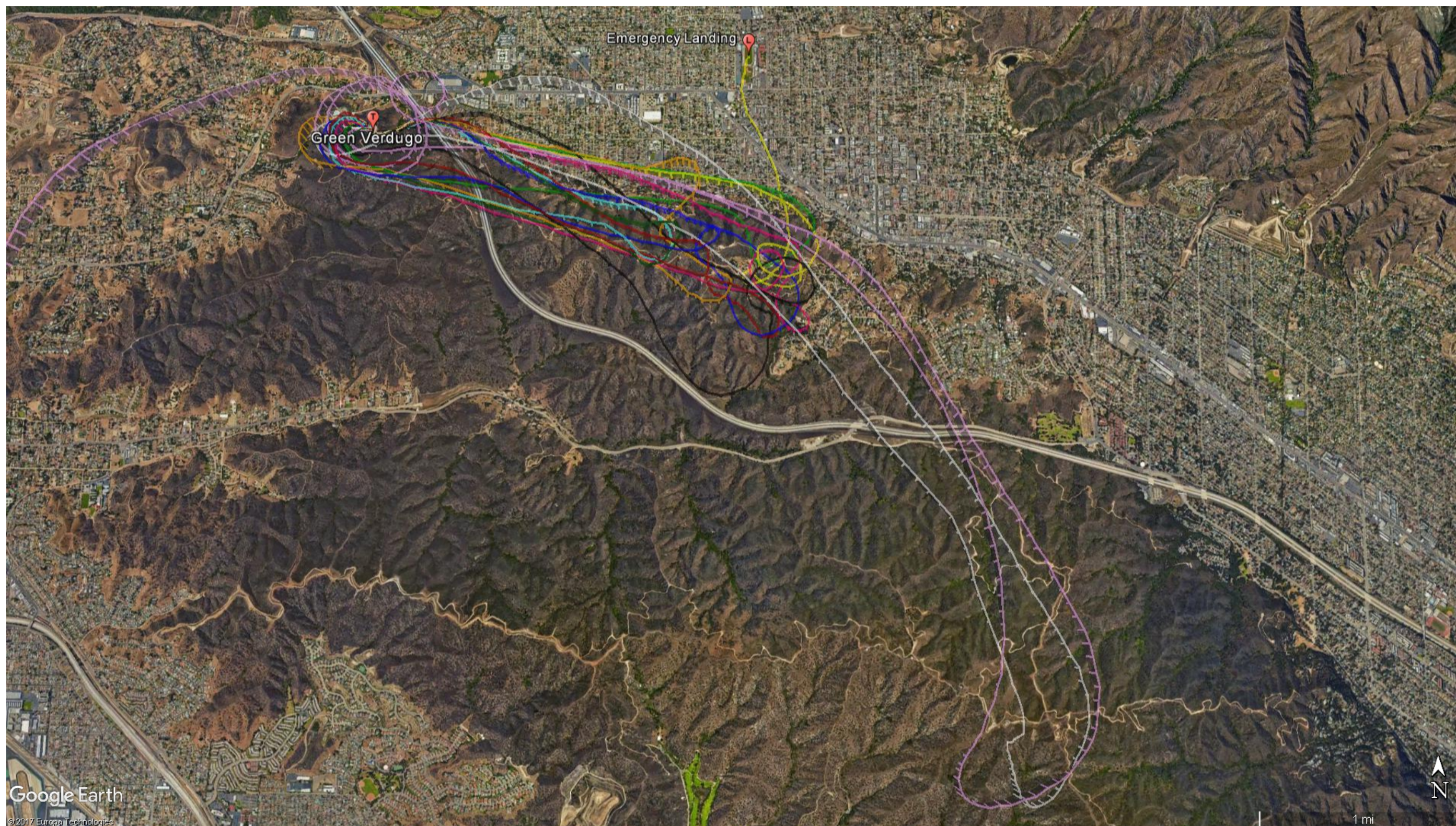


Figure 2 – Flight Path of N304FD (detail of the mountain area S of Tujunga)



Figure 3 – Flight Path of N304FD (last 3 flights of the recordings: **Yellow**: Last Flight; **Green**: 2nd to last Flight; **Magenta**: 3rd to last Flight)

1.2.2 Data Analysis

The 2 flights before the tree strike are considered uneventful, as the only anomalous readings recorded in the MPFR are the activation of the **COCKPIT DOOR** and **ATT OFF** Cautions: both messages were present for the entire duration of the recordings of the 2nd of September, and also in the days prior to the event.

The first of the two messages is triggered by the partial or complete opening of one or both the Cockpit Doors in flight and on ground.

The “Cockpit Door” CAS can be triggered additionally by a faulty or misaligned micro switch. According to LAFD, the caution “Cockpit Door” had been adjusted several times since delivery three months earlier with intermittent success. Ultimately it was deferred per FAA approved AW139 MMEL program (5270-01) until such time that Part 145 Maintenance department could dig into the problem deeper. 5270-01 requires that the crew verify that the door is closed and latched before flight which the crew had done.

The second of the two messages is related to the de-activation of the AFCS Attitude Hold mode, in favour of the operation with only the Stability Augmentation System (SAS) mode active. This message is active for the majority of the hours recorded in the MPFR although no other Autopilot-related caution is recorded (besides transient cautions at system power on, which are normal on AW139). The Caution is also displayed if the Crew intentionally deactivates ATT mode by using the dedicated pushbutton on the Autopilot Control Panel to fly always hands-on. MPFR data highlighted the absence of any activation of the FTR or Detent switches on the Cyclic Stick indicating that the Pilot was flying the A/C with the Pitch and Roll Trim motors permanently de-clutched from the control chain by possibly using the dedicated switch on the Miscellaneous Control Panel (FORCE TRIM on OFF position).

It is to be noted that, the de-activation of ATT mode has the following effects:

- The Autotrim function is suspended on all the 4 axis, therefore the Trim Motors are unable to continuously re-center the Linear AFCS actuators diminishing the effectiveness of the SAS in case of saturation of one or more of said linear actuators due to either large external disturbances and/or large attitude / rates variations
- The artificial force feel function provided by the Trim Motors is no longer available, and the control chain becomes looser than with ATT ON as the only feedback is provided by the natural friction of the joints

1.2.2.1 Accident Flight Analysis

After a period of approximately 5m30s on the ground at Verdugo Green, the H/C took off for its final flight at 16:44:55 UTC (09.44am LT) and headed toward the assigned water drop area, which was reached at about 16:46:50 UTC (09.46am LT) after a brief cruise flight above the southern outskirts of Tujunga.

The A/C performed a first 360° orbit above the wildfire area, which was the same as the two previous flights (ref. Figure 22) and then began the manoeuvre to approach the drop point from ESE.

During this approach the A/C slowly turned N, and progressively reduced altitude and IAS. After reaching a RoD peak of approximately 960ft/min (with 42 KIAS and 52kt GS) at 16:47:33 UTC (09.47am LT) the Pilot Flying began to increase the A/C pitch and the required TQ by further pulling the Cyclic Stick aft and the Collective Stick up.

This manoeuvre further reduced the A/C speed, which reached 18-20 KIAS at 16:47:45 UTC when the A/C was flying at 100ft AGL and was positioned approximately 50 meters (165ft) SSE from a nearby house.

As the Collective movement caused the TQ provided by the Engines to increase (up to 110% of AEO MCP), the Pilot progressively moved the Pedal command towards LH, to counteract for the CW momentum applied to the A/C by the CCW Main Rotor and to maintain the desired heading. As shown in Figure 24 below, 100% of the Pedal command was recorded at approximately 16:47:47 UTC. The 100% Pedal command was accompanied by a commanded peak in the A/C pitch angle, which reached 33° nose up and 16:47:48 UTC.

From 16:47:49 UTC onwards a sudden reduction of the commanded Collective and TQ delivery is recorded. NOTE: As the Simplex water tank installed on N304FD is an STC no recording is available in the MPFR regarding its manual activation and therefore a more accurate assessment cannot be made.

From 16:47:49 UTC onwards the Longitudinal and Lateral Cyclic tracks show large and uncoordinated inputs for at least 10-12 seconds, while the A/C was flying above the mentioned residential complex with backwards ground speed between 8 and 26kts (the direction of the A/C flight path is deduced by combining heading, GPS track, drift and ground speed data).

The reduction in TQ demand allowed also a reduction of the Pedal command; at (16:47:53 UTC) the Pilot was again able to properly control the A/C heading and started banking away from the houses.

During this phase, between approximately 16:47:54-55 UTC a moderate spike in the lateral, longitudinal and vertical accelerations is recorded by the dedicated sensor in the Baggage Compartment (referred to as Tri-Axial Accelerometer in the below graphs), together with minor NR oscillations (down to 97%). Maximum values were 0.5-0.6g on all three axes, but as the sampling rate for these signals is limited to 4-8Hz higher instantaneous values could have been reached.

The A/C was still flying above the residential complex, at approximately 20ft AGL (note that the Radar Altitude value cannot be fully relied upon in presence of multiple ground obstacles) and yawing towards RH with a commanded ~40°/s rate. This event may be compatible with the reported impact of the Tail and Rear Fuselage with trees.

After 16:48:01 UTC the large Cyclic inputs ceased and controlled flight was resumed on all axis; from this point onwards the A/C flight path was clear from the residential complex, and the remaining of the recordings show a uneventful flight, up to the emergency landing at 16:49:24 UTC (09.49am LT). MFPR data do not highlight any further abnormal A/C behaviour induced by the damage in the last portion of flight.

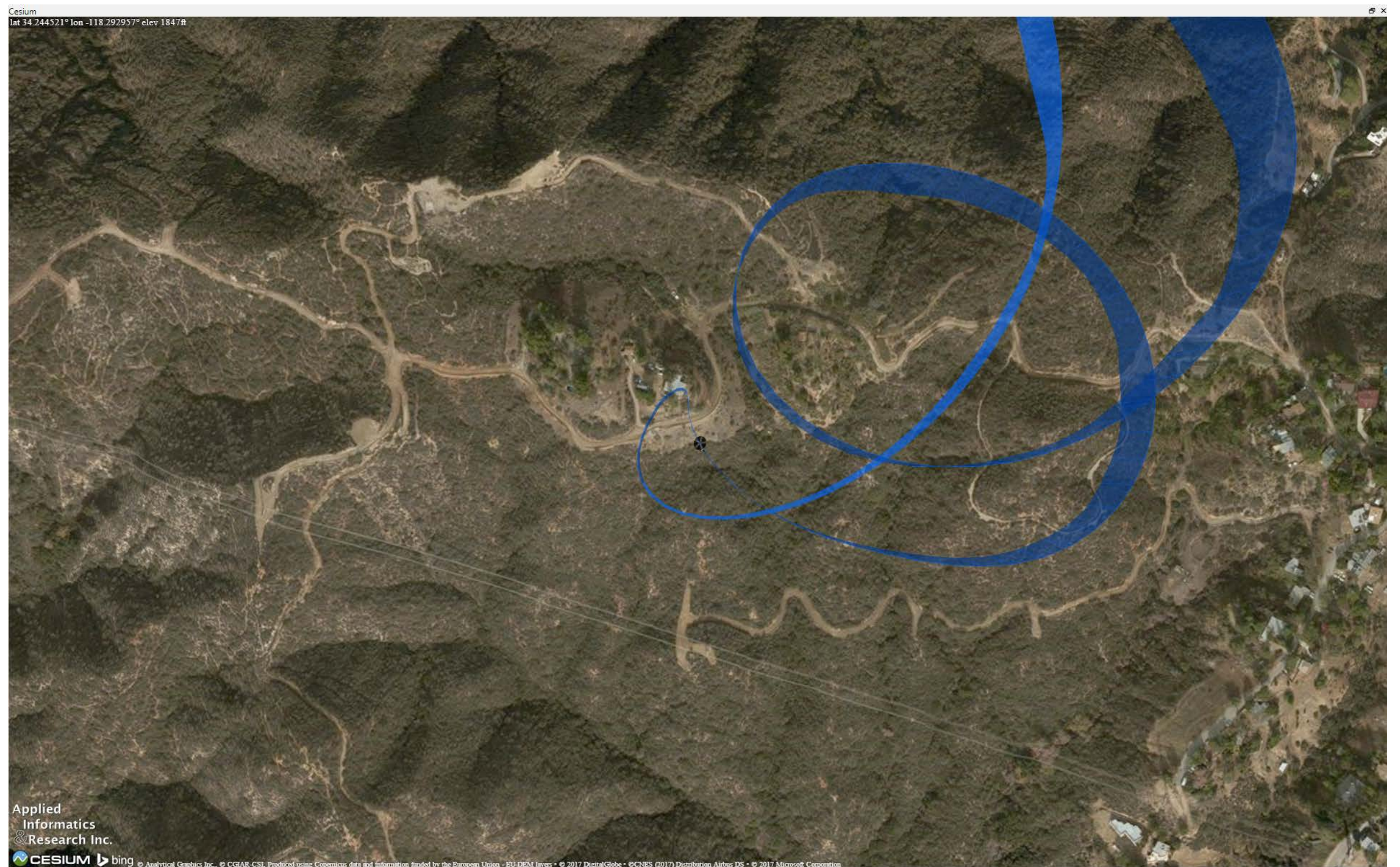


Figure 4 – 3D close-up detail of the flight path near the tree strike event

AW139 - S/N 41528 - R/M N304FD

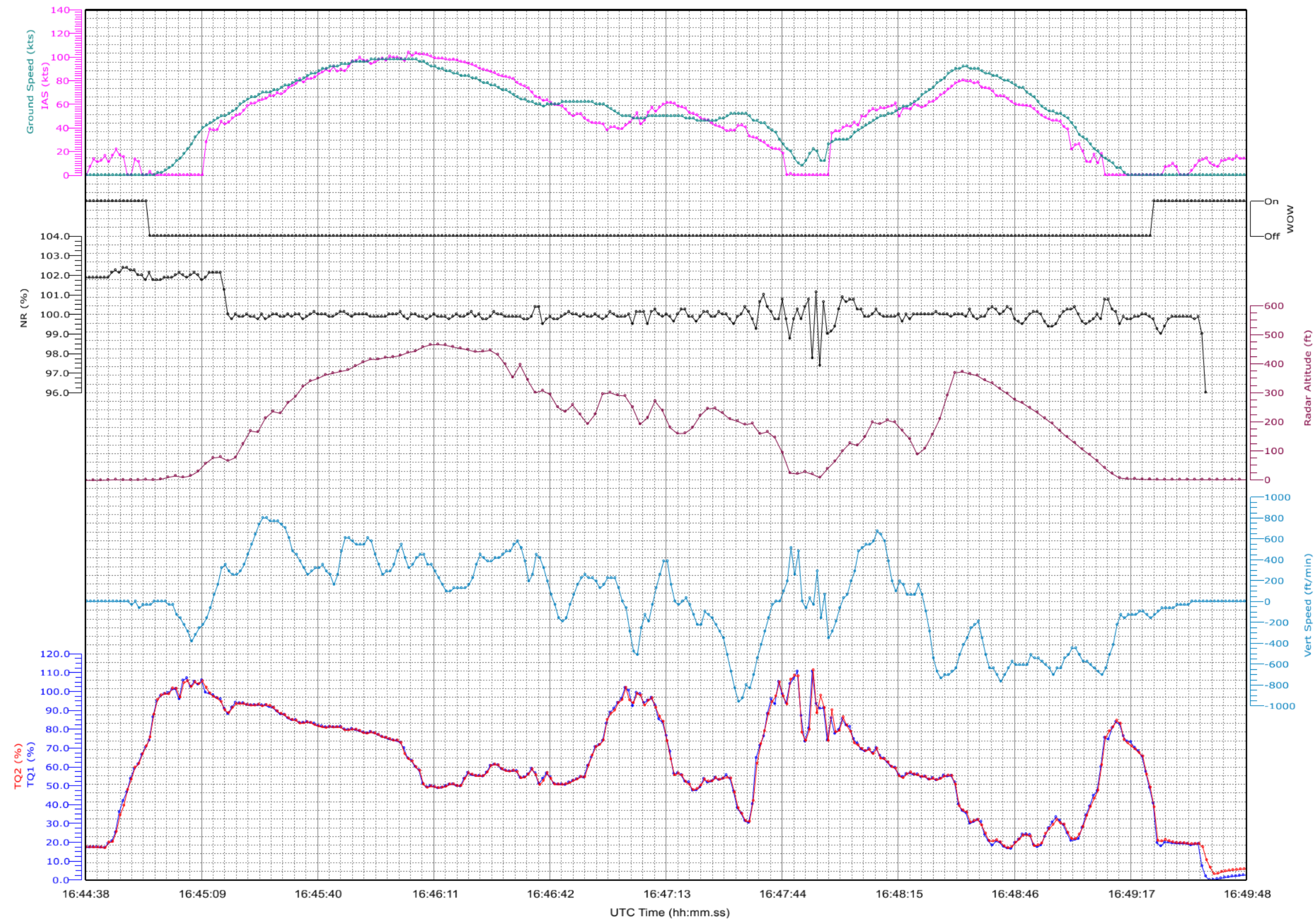


Figure 5 – Time Histories of the A/C main parameters for the accident flight (1/4)

AW139 - S/N 41528 - R/M N304FD

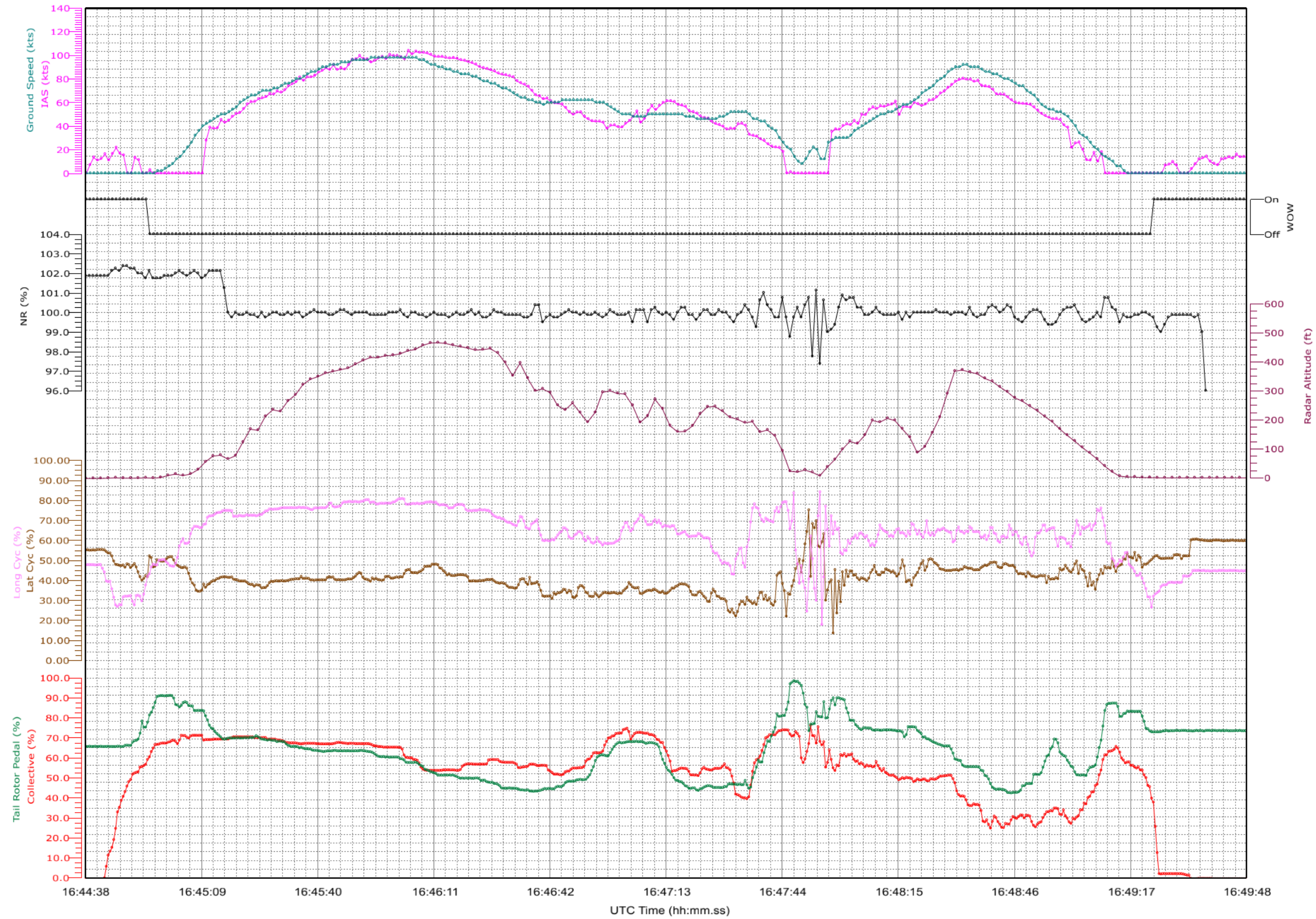


Figure 6 – Time Histories of the A/C main parameters for the accident flight (2/4)

AW139 - S/N 41528 - R/M N304FD

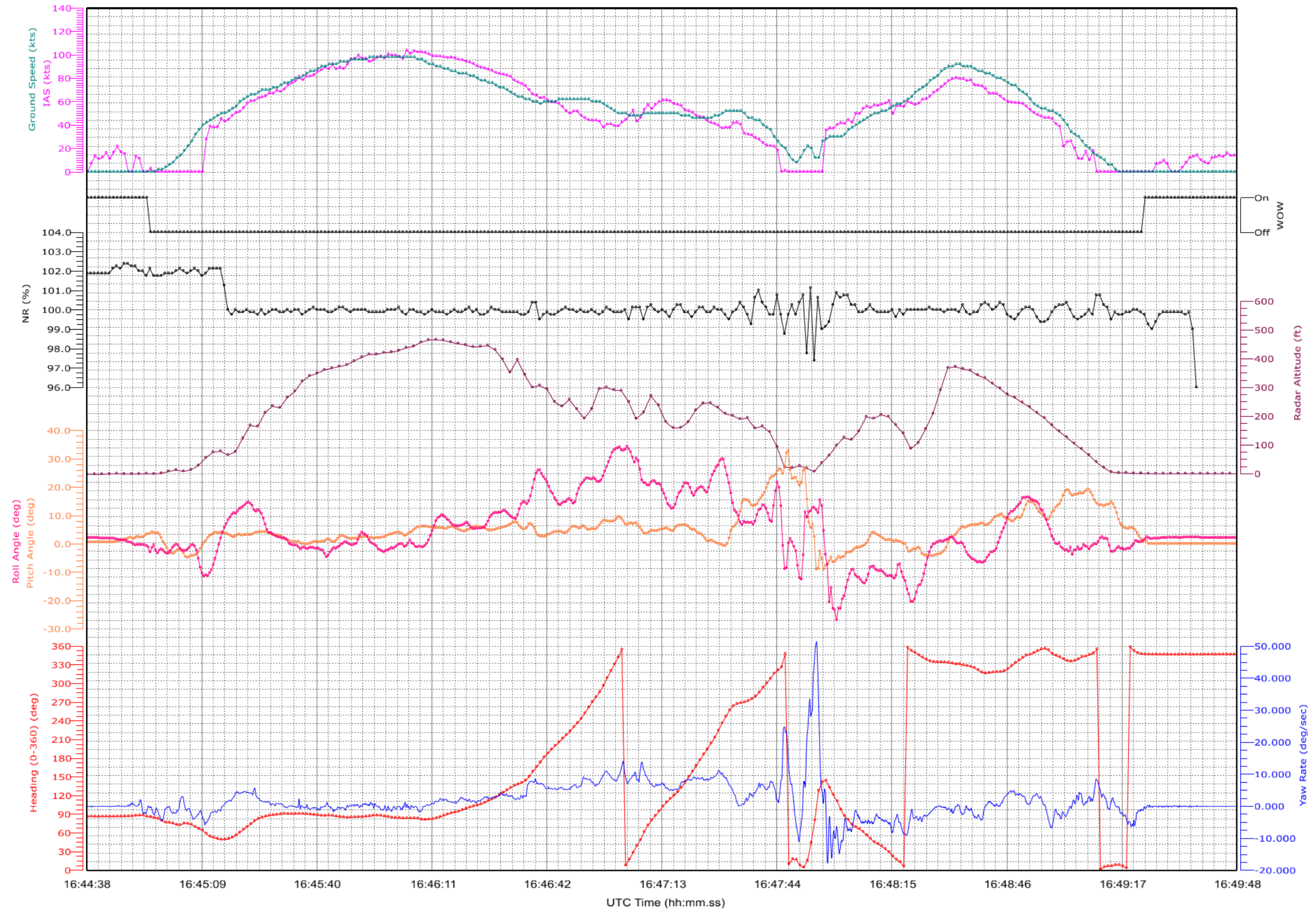


Figure 7 – Time Histories of the A/C main parameters for the accident flight (3/4)

AW139 - S/N 41528 - R/M N304FD

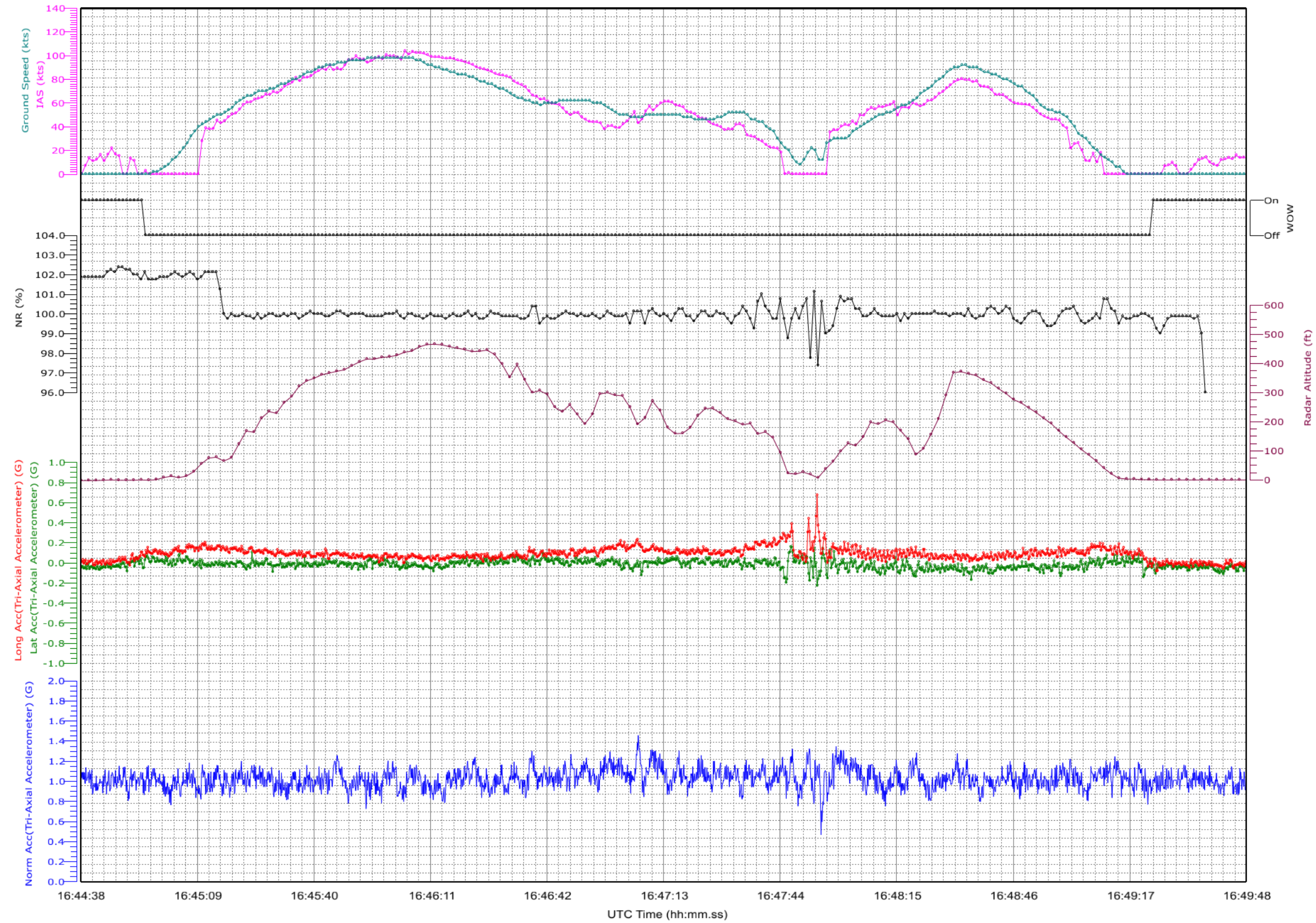


Figure 8 – Time Histories of the A/C main parameters for the accident flight (4/4)

1.2.3 *Comparison with previous Flights*

As mentioned in §1.2.1 the attitudes, rates, commands and main flight parameters' time histories for the last three flights have been compared in search for possible commonalities and/or differences w.r.t the accident one. The main findings are summarised below:

- When performing the two previous water drops (roughly at 16:26 and 16:37 UTC) the A/C did not reach peak commanded pitch attitude values similar to the final flight ($\sim 33^\circ$), remaining below 24° instead
- The A/C maintained higher IAS and Ground Speed, between 40 and 60 KIAS (compared to less than 20 KIAS), while passing over the area of the two previous water drops.
- Lower IAS during the approach translated into higher TQ (and Pedal command) demands during the deceleration phase in the final flight.
- The TQ required to take off from Verdugo is higher in the last two flights of the record by about 10%, compared to the third-to-last flight.
- No significant variation in the A/C behaviour w.r.t the Pilot's commands is recorded for all the flights of the 2nd of September

AW139 - S/N 41528 - R/M N304FD

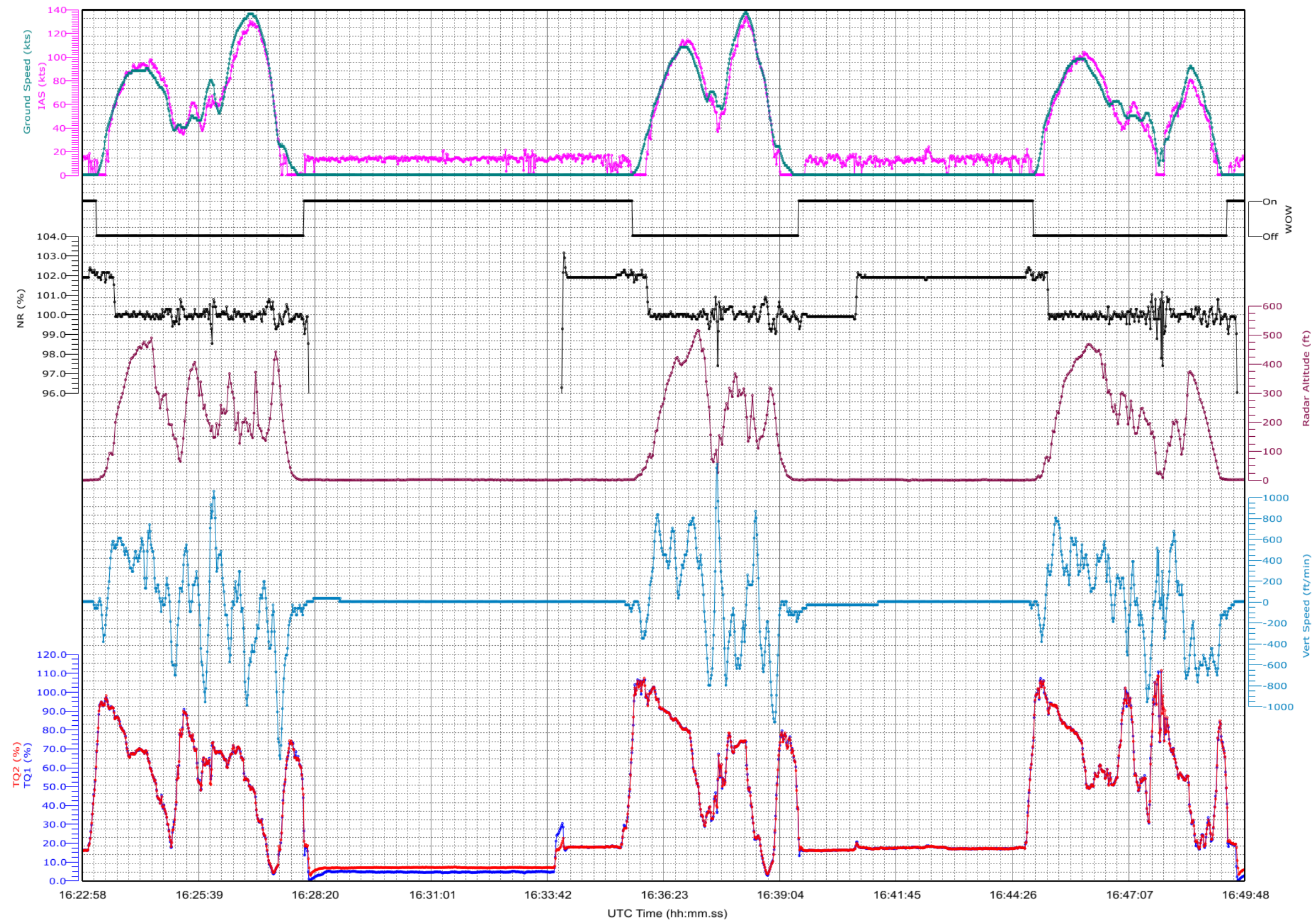


Figure 9 – Time Histories of the A/C main parameters for the last three flights (1/4)

AW139 - S/N 41528 - R/M N304FD



Figure 10 – Time Histories of the A/C main parameters for the last three flights (2/4)

AW139 - S/N 41528 - R/M N304FD



Figure 11 – Time Histories of the A/C main parameters for the last three flights (3/4)

AW139 - S/N 41528 - R/M N304FD



Figure 12 – Time Histories of the A/C main parameters for the last three flights (4/4)

AW139 - S/N 41528 - R/M N304FD

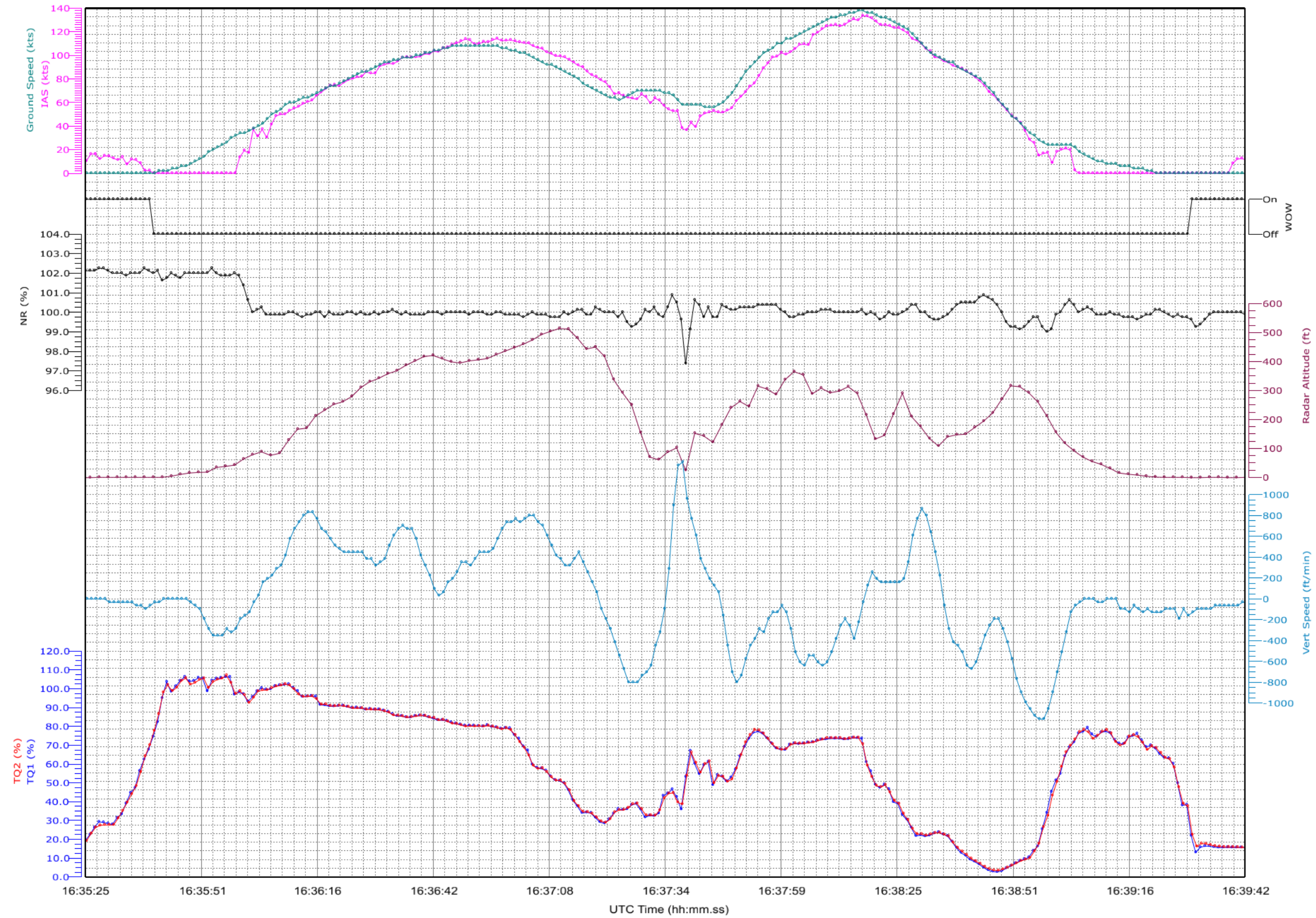


Figure 13 – Time Histories of the A/C main parameters for the 2nd-to-last flight (1/4)

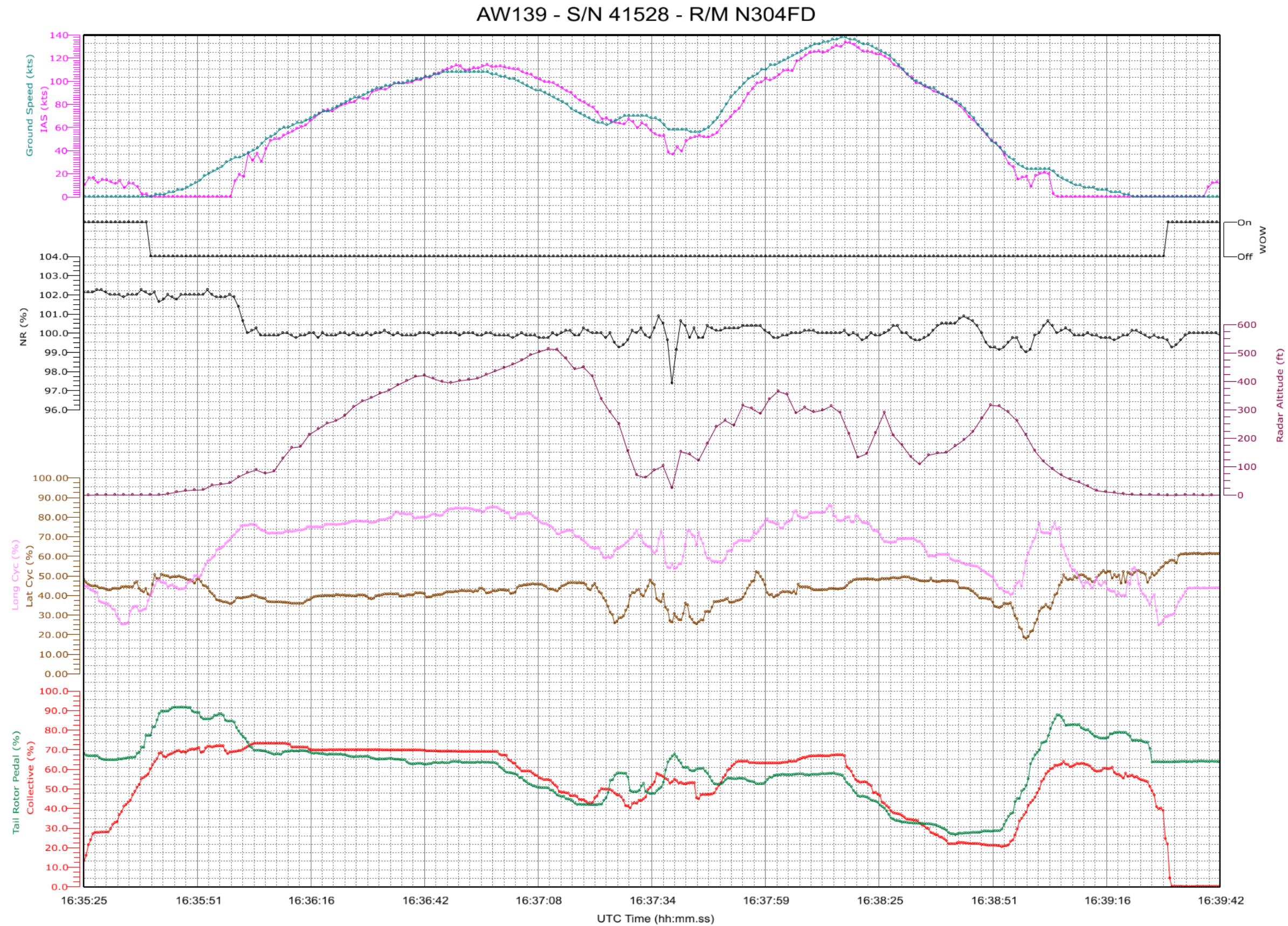


Figure 14 – Time Histories of the A/C main parameters for the 2nd-to-last flight (2/4)

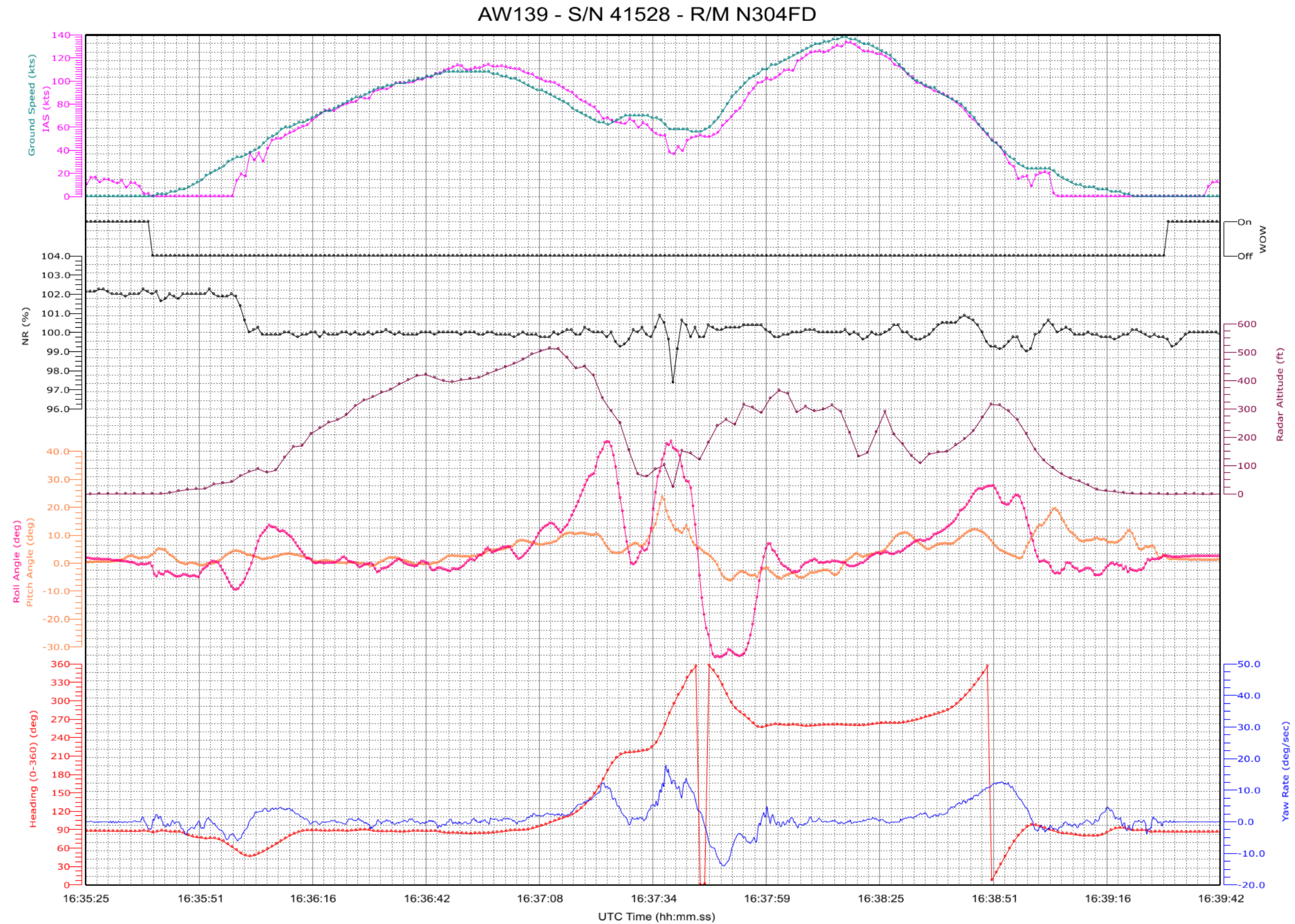


Figure 15 – Time Histories of the A/C main parameters for the 2nd-to-last flight (3/4)

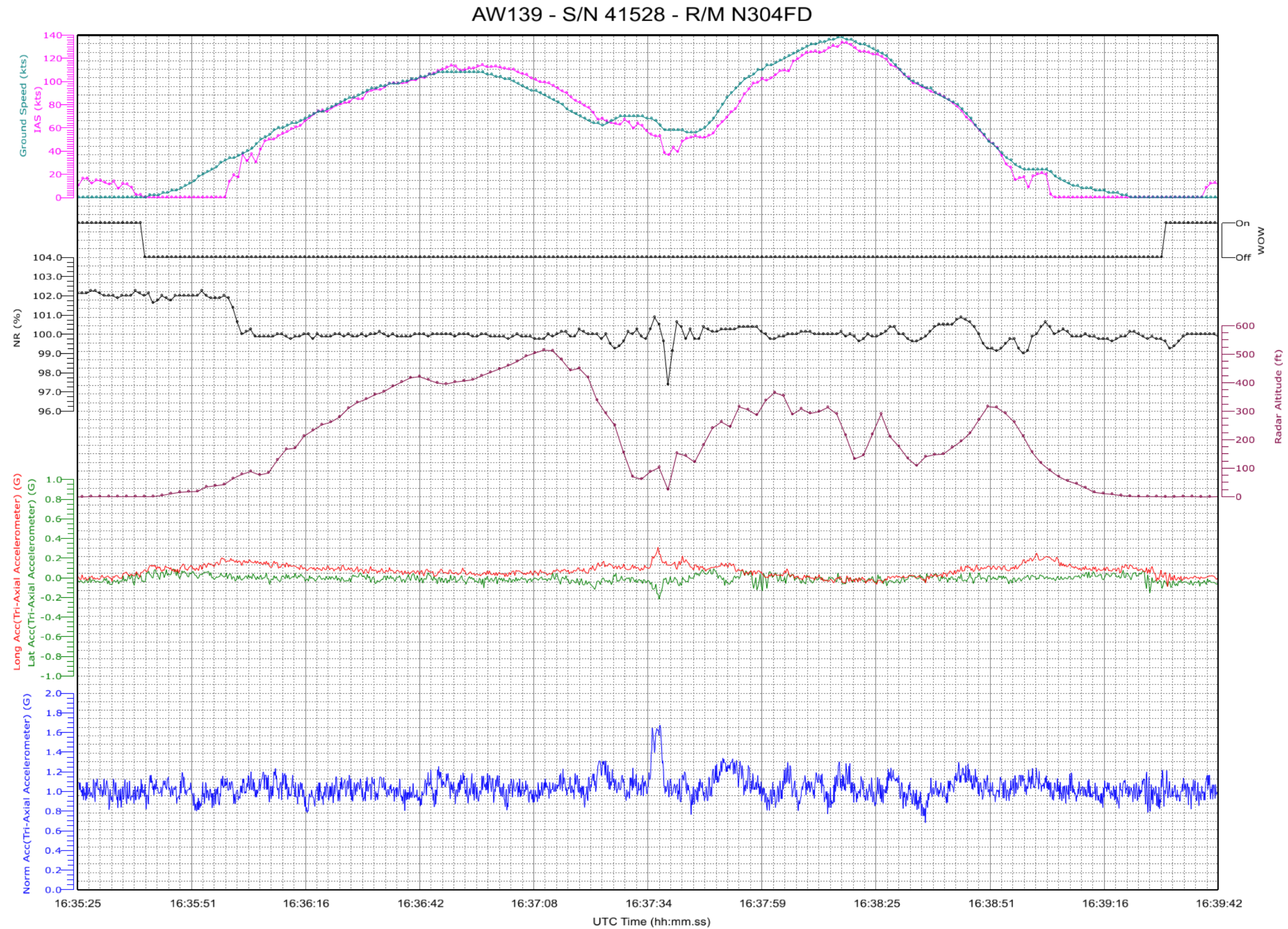


Figure 16 – Time Histories of the A/C main parameters for the 2nd-to-last flight (4/4)

AW139 - S/N 41528 - R/M N304FD

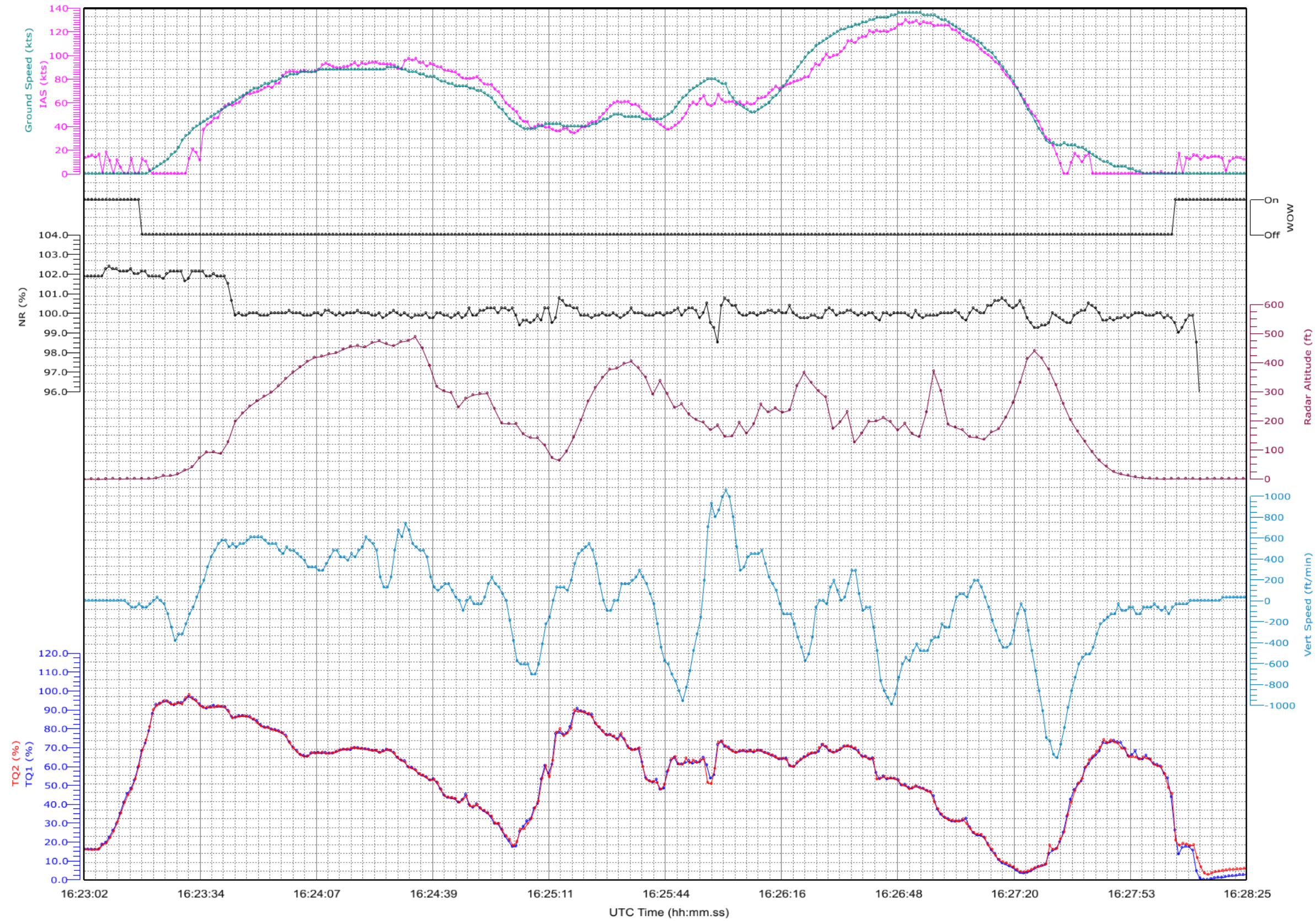


Figure 17 – Time Histories of the A/C main parameters for the 3rd-to-last flight (1/4)

AW139 - S/N 41528 - R/M N304FD

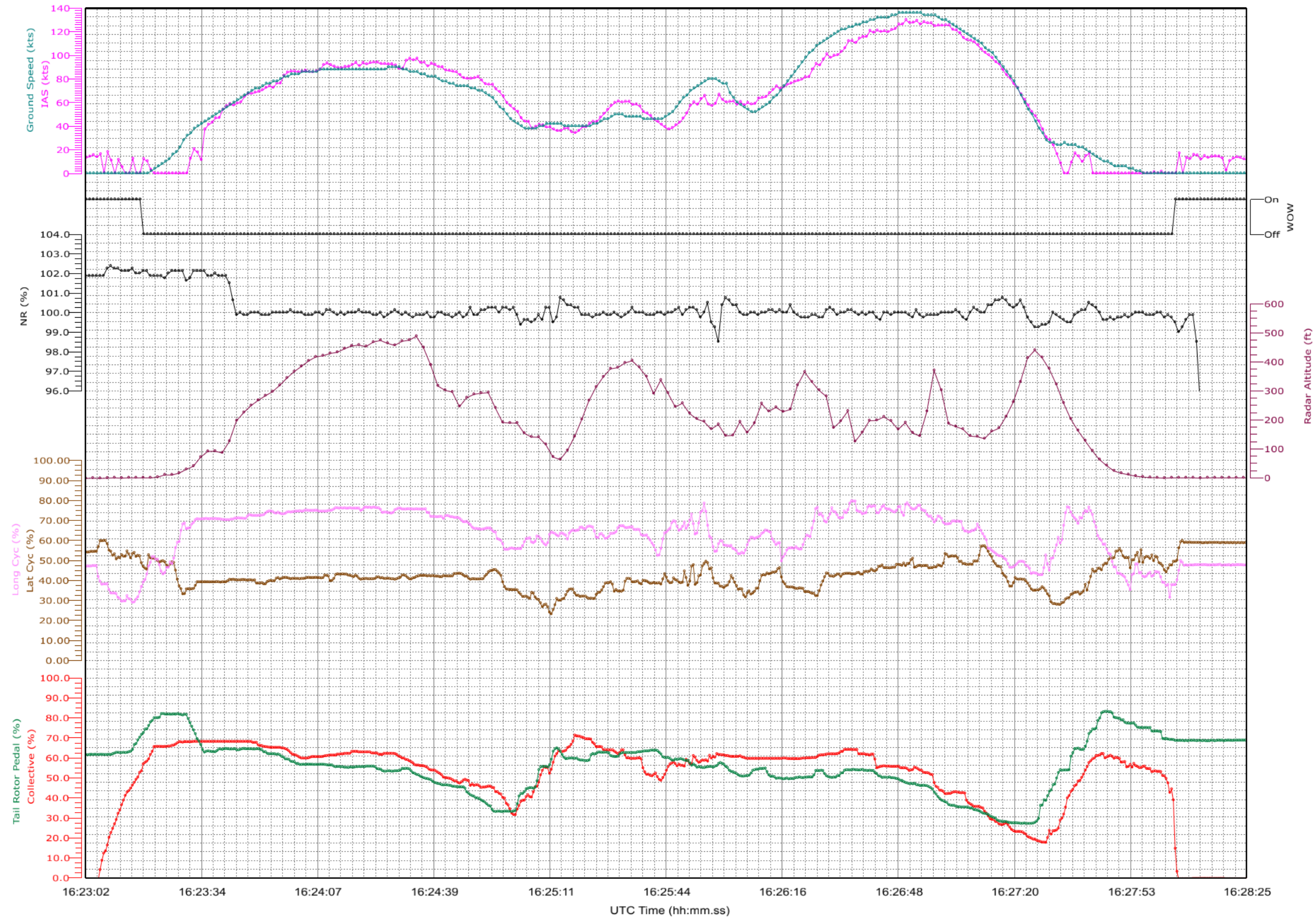


Figure 18 – Time Histories of the A/C main parameters for the 3rd-to-last flight (2/4)

AW139 - S/N 41528 - R/M N304FD

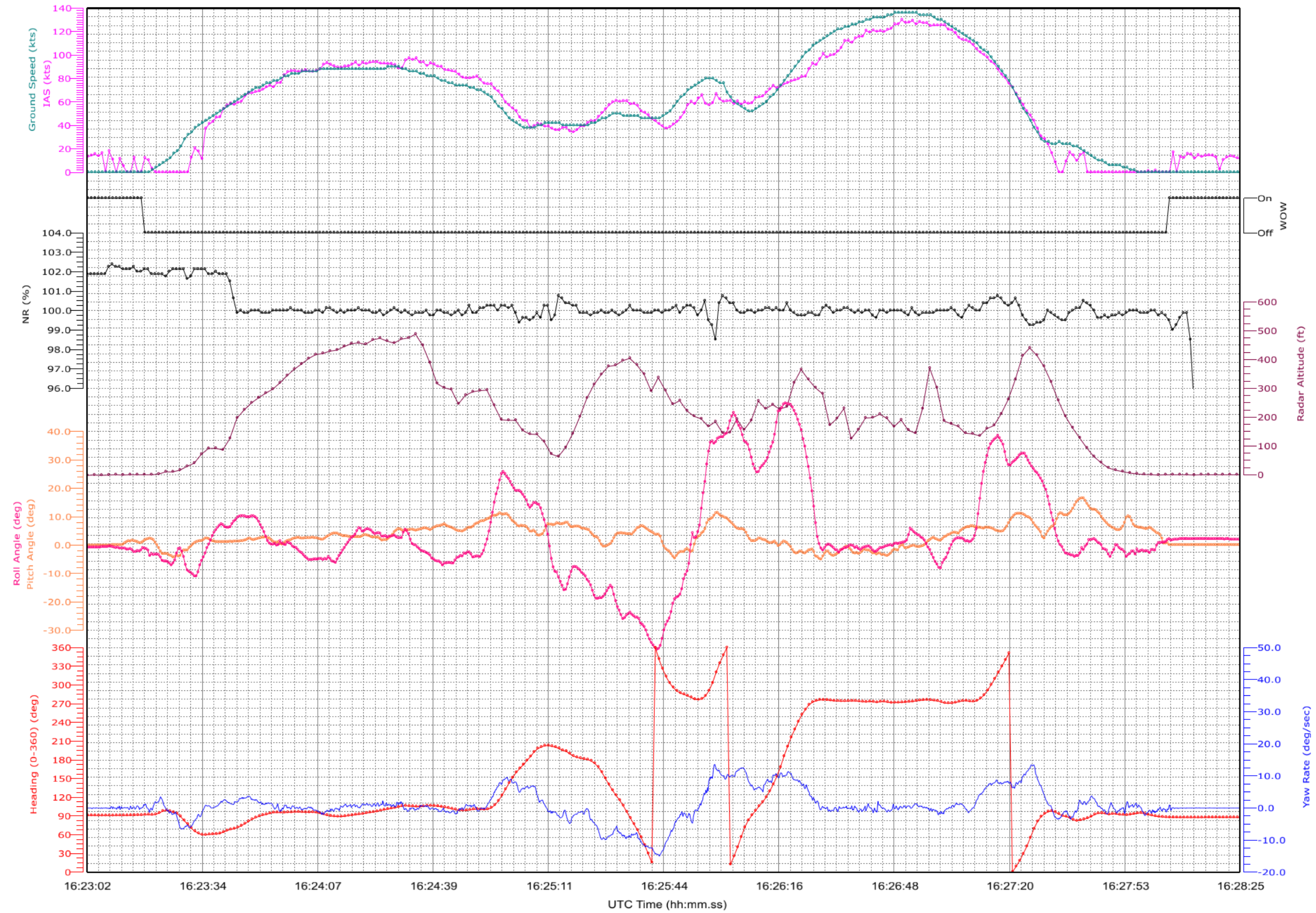


Figure 19 – Time Histories of the A/C main parameters for the 3rd-to-last flight (3/4)

AW139 - S/N 41528 - R/M N304FD

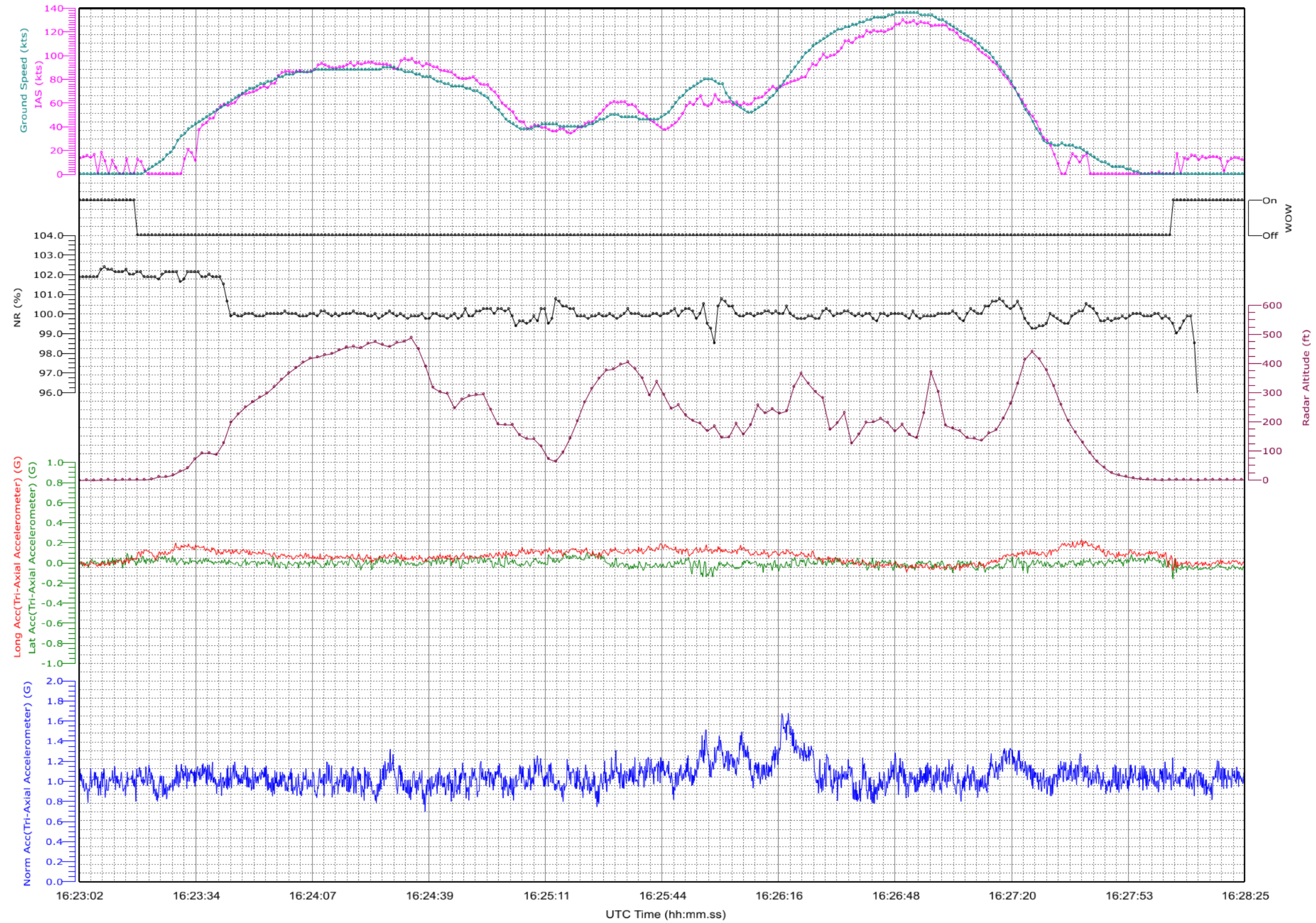


Figure 20 – Time Histories of the A/C main parameters for the 3rd-to-last flight (4/4)

2. Considerations

The analysis highlighted the following points:

1. MPFR analysis did not evidence any Airframe failure or System malfunction during the flight which led to the event or in any of the flights of the day of the event
2. The Wind calculation performed by the on-board FMS indicates a possible Wind direction of 115-120° with 7-8kts speed prior to the final approach to the wildfire. As the A/C progressively turned the nose towards 360° it is possible that it may have encountered wind blowing from one of the critical azimuths (see Figure 39) while flying at very low speed, reducing pedal margin
3. Comparison between the final water drop and the 2 previous ones highlighted some differences in the piloting technique and in the preparation for the manoeuvre.

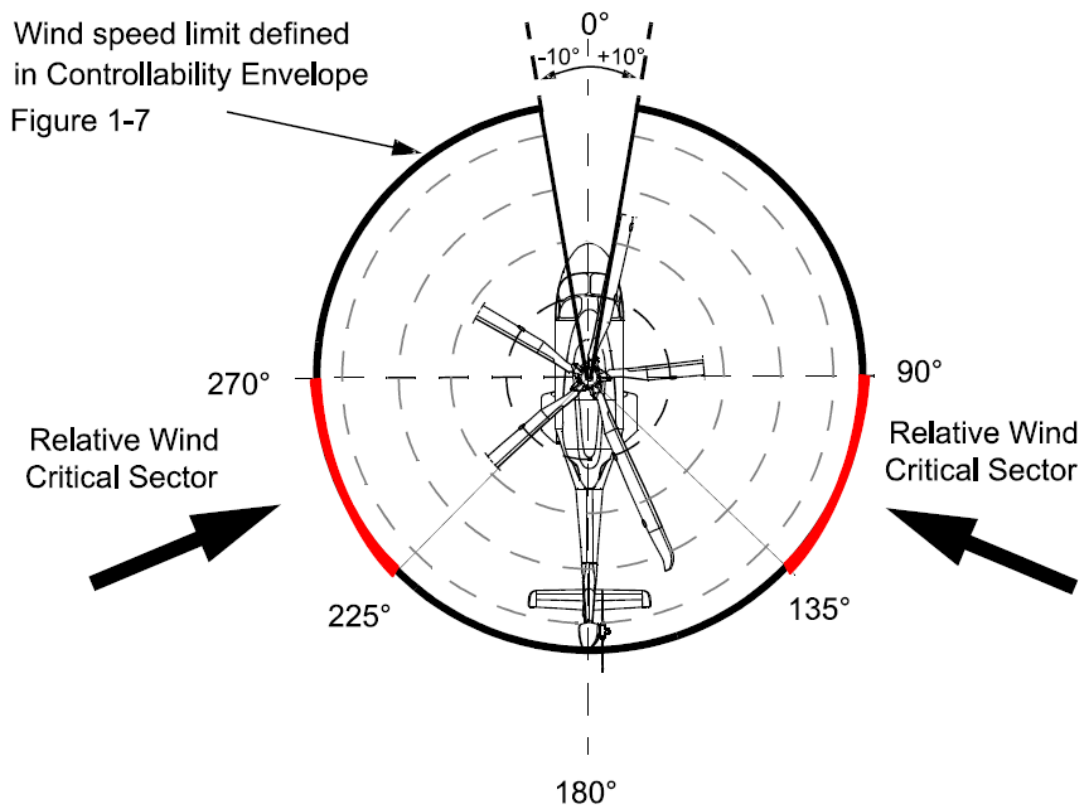


Figure 21 – Extract of AW139 RFM (Section 5 Supplement 90), Azimuth critical sectors

Appendix A – Glossary

A/C	Aircraft
AEO	All Engines Operative
AFCS	Automatic Flight Control System
AGL	Above Ground Level
FMS	Flight Management System
H/C	Helicopter
HOGE	Hover Out of Ground Effect
KIAS	Indicated Air Speed (Knots)
LH	Left Hand side
MCP	Maximum Continuous Power
MPFR	Multi-Purpose Flight Recorder
N _R	Rotor Speed
OAT	Outside Air Temperature
RH	Right Hand side
RFM	Rotorcraft Flight Manual
RoD	Rate of Descent
R/M	Registration Mark
S/N	Serial Number
STC	Supplement Type Certificate
TQ	Torque
UTC	Universal Time Coordinated