

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA23FA258

RECOVERABLE DATA MODULE

Specialist's Factual Report

March 6, 2024

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A. ACCIDENT

Location: Jamestown, New York
Date: June 6, 2023
Time: 1352 eastern daylight time (EDT)
1752 coordinate universal time (UTC)
Airplane: Cirrus SR22T, C-GNMT

B. RECOVERABLE DATA MODULE SPECIALIST

Specialist: W. Deven Chen
Electrical Engineer – Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A recorder group was not convened. The NTSB Vehicle Recorder Division received the following recoverable data module (RDM):

Device Manufacturer/Model:	Appareo RDM-300
Serial Number:	399

1.0 Device Description

The Appareo recoverable data module (RDM) is designed for Cirrus aircraft to record flight data in a crash and fire-resistant housing. The unit records flight, engine, and autopilot parameters. Depending on the recording software, over 75 parameters may be recorded. Data is logged up to five times per second and stored internally on four thin small outline package (TSOP) memory chips inside the crash-hardened enclosure. When the storage limit of the memory device is reached, the oldest recording is overwritten.

1.1 Device Condition and Data Recovery

The Appareo RDM-300 had sustained severe fire damage, as shown in Figure 1. Figure 2 shows an inside view of the device and its circuit board. Although the connector exhibited fire damage, the circuit board was in good condition. The manufacturer sent in a connector replacement as well as downloading tools. After the connector was replaced, the last two hours of raw data were downloaded normally using the manufacturer's procedure. The downloaded raw data were then decoded and converted into engineering unit data by a Cirrus Aircraft representative at NTSB headquarters.



Figure 1. Appareo RDM-300 as received.

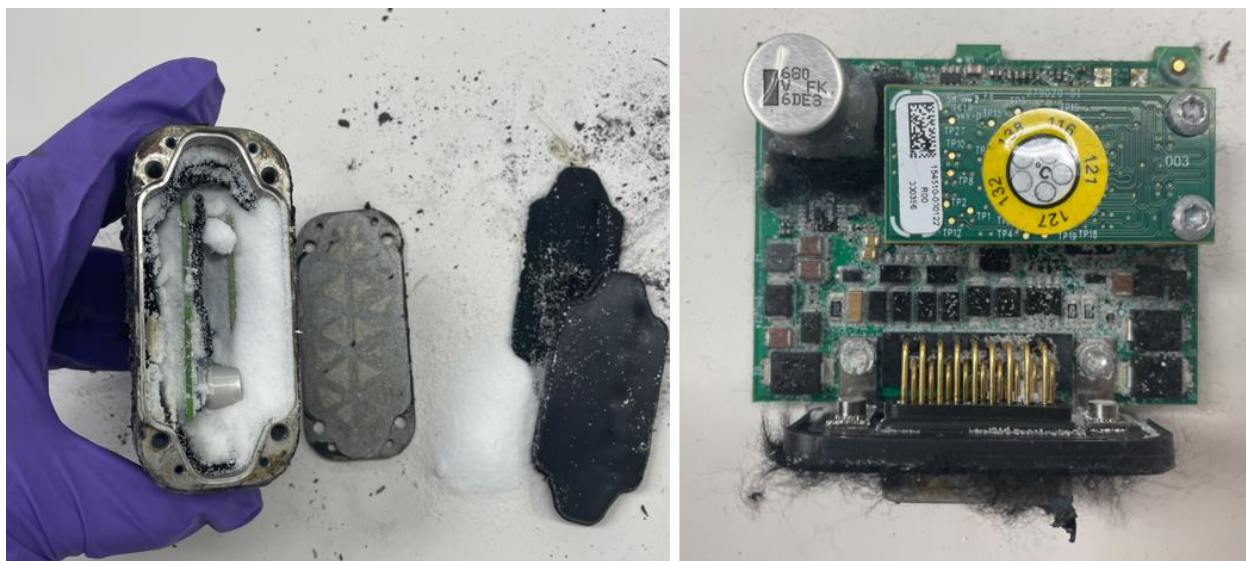


Figure 2. Inside view of the Appareo RDM-300 and its circuit board.

1.2 Recording Description

The decoded data contained six data files in comma-separated values (CSV) format. The file recorded on June 6, 2023, from 17:32:15 to 17:52:11 UTC, was determined to be related to the accident flight. The data were sampled at 1 Hz. A previous flight recorded on the same day, from 15:29:15 to 16:10:45 UTC, is also included in this report.

1.2.1 Parameters Provided

Table 1 lists the parameters verified and provided in this report. The recorded parameters include basic flight parameters, engine parameters, autopilot, ESP¹ (Electronic Stability and Protection) parameters, and some selected parameters.

Table 1. Appareo RDM-300 data parameters provided.

Parameter Name (unit)	Parameter Description
Amps (A)	Circuitry bus current (amperes)
AltMSL (ft)	Geometric altitude above Mean Sea Level (feet)
AltP (ft)	Pressure altitude (feet)
AOA ESP Engaged (BIN)	1 if AOA (angle of attack) exceeds AOA threshold and the system is activated to drive the pitch angle down. Otherwise, 0.
AP/FD (BIN)	Autopilot/Flight director status (1 = engaged and 0 = off)
CAPS handle pulled (BIN)	Cirrus Airframe Parachute System activation handle pulled (1 = yes and 0 = no)
CAPS rocket deployed (BIN)	Cirrus Airframe Parachute System deployed through rocket action (1 = yes and 0 = no)
CHT# (degF)	Cylinder # head temperature (degrees Fahrenheit)
EGT# (degF)	Cylinder # exhaust gas temperature (degrees Fahrenheit)
Elevator Mistrim Up/Down (BIN)	Elevator mistrim up/down status (1 = yes and 0 = no)
Engine RPM	Engine revolutions per minute
ESP Enabled (BIN)	1 if ESP is not failed (see ESP FAIL) AND ESP is enabled in configuration, AND the pilot has not inhibited it, AND the autopilot is not engaged. Otherwise, 0.
ESP Enabled by Pilot (BIN)	0 if the pilot has deactivated ESP in the System Settings menu. Otherwise, 1.
ESP Fail (BIN)	1 if autopilot is failed OR dual AHRS (attitude and heading reference system) are not available to the GIA (Garmin Integrated Avionics) OR dual ADCs (analog-to-digital converters) are not available to the GIA OR AFCS (Automated Flight Control System) Pre-Flight Test has not completed. Otherwise, 0.
FF (GPH)	Fuel flow rate (gallons per hour)
Flaps 0%/50%/100% (BIN)	Flap extension position at 0%/50%/100% (1 = yes and 0 = no)

¹ ESP - Electronic Stability and Protection is a flight auto-control system designed by Garmin, which monitors the aircraft's condition, functioning independently of the autopilot, and it applies a control force towards stable flight whenever pitch or roll deviations exceed recommended limits.

Parameter Name (unit)	Parameter Description
FQtyL/R (gal)	Fuel quantity at left/right tank (gallons)
GndSpd (kt)	Groundspeed between current and previous data point (knots)
HDG (deg)	Heading (degrees)
IAS (kt)	Indicated airspeed (knots)
LatAcc (g)	Acceleration at lateral direction (g)
Latitude (deg)	Geometric latitude (degrees)
LonAcc (g)	Acceleration at longitudinal direction (g)
Longitude (deg)	Geometric longitude (degrees)
MAP (inHg)	Manifold pressure (inches of mercury)
MAP GT 36.5 (BIN)	1 if MAP exceeds 36.5 inHg for 300 seconds, and a silent caution is generated. Otherwise, 0. Only one caution/warning among the four and the one with the highest level will be asserted at any time. ²
MAP GT 37 (BIN)	1 if MAP exceeds 37 inHg for 120 seconds, and a silent caution is generated. Otherwise, 0. Only one caution/warning among the four and the one with the highest level will be asserted at any time.
MAP GT 37.5 (BIN)	1 if MAP exceeds 37.5 inHg instantly, and a silent warning is generated. Otherwise, 0. Only one caution/warning among the four and the one with the highest level will be asserted at any time.
MAP GT 38 (BIN)	1 if MAP exceeds 38 inHg for 30 seconds or exceeds 38.5 inHg instantly, and an aural warning is generated. Otherwise, 0. Only one caution/warning among the four and the one with the highest level will be asserted at any time.
MAT (degF)	Manifold air temperature (degrees Fahrenheit)
NormAcc (g)	Acceleration at normal direction (g)
Oil P (PSI)	Oil pressure (pounds per square inches)
Oil T (degC)	Oil temperature (degrees Celsius)
Percent Power (%)	Linearized engine power in percentage (%)
Pitch (deg)	Pitch angle (degrees)
PIT Torque (in-lb)	Pitch torque (inch-pounds)
Roll (deg)	Roll angle (degrees)
ROL Torque (in-lb)	Roll torque (inch-pounds)
Rudder Mistrim Left/Right (BIN)	Rudder mistrim left/right status (1 = yes and 0 = no)
STALL - TONE (BIN)	Stall tone status (1 = on and 0 = off)
Stall Warning ACTIVE (BIN)	Stall warning active status (1 = active and 0 = not active)
STALL WARN FAIL (BIN)	Stall warning fail status (1 = failed and 0 = not failed)
TAS (kt)	True airspeed (knots)
Volts (V)	Circuitry bus voltage (volts)

² MAP GT 36.5/37/37.5/38 (BIN) are four crew-alerting system (CAS) message parameters of Cirrus aircrafts, two cautions and two warnings, based on different thresholds. Only the highest level among these four CAS messages will be asserted at any time, so there will be only one active CAS at a time.

Parameter Name (unit)	Parameter Description
Vspd (fpm)	Vertical speed (feet per minute)

1.2.2 Time Correlation

The data were recorded in UTC and were kept in UTC for this report. EDT, the local time of the event is 4 hours behind UTC.

D. FIGURES AND TABULAR DATA

All parameters listed in Table 1 are plotted, except the manifold air temperature. Figure 3 to Figure 17 contain data recovered from the Appareo RDM-300 for the accident flight and a previous flight recorded on June 6, 2023.

Figure 3 and Figure 4 show plots of basic flight parameters of the accident flight with different time ranges: the entire flight and approximately the last 2 minutes.

Figure 5 and Figure 6 show plots of engine parameters of the accident flight with different time ranges: the entire flight and approximately the last 2 minutes. Note that a CAS aural warning was generated at around 17:51:45 UTC and lasted until around 17:51:55 UTC as the manifold pressure exceeded 38.5 inHg. Meanwhile, the fuel flow rate exceeded 42 GPH during this time.

Figure 7 and Figure 8 show plots of autopilot and ESP parameters of the accident flight with different time ranges: the entire flight and approximately the last 2 minutes.

Figure 9 and Figure 10 show plots selected parameters of the accident flight with different time ranges: the entire flight and approximately the last 2 minutes.

These plots are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns toward the top of the page, and nose-up attitudes toward the top of the page.

Figure 11 and Figure 12 are Google Earth overlays of the accident flight. Figure 11 is a Google Earth overlay of the entire accident flight. Figure 12 is a Google Earth overlay of the final portion of the accident flight. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 13 to Figure 16 are plots of the basic flight and engine parameters, autopilot and ESP, and selected parameters, respectively, of a previous flight recorded on the same day. Note that figure 14 indicates that there was a CAS silent

warning generated at around 15:36:30 UTC as the manifold pressure exceeded 37.5 inHg.

Figure 17 is a Google Earth overlay of this previous flight. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The corresponding tabular data used to create Figure 3 to Figure 17 are provided as attachments in CSV format to this report. Attachment 1 is the accident flight recording, and attachment 2 is the previous flight recording.

Submitted by:

W. Deven Chen
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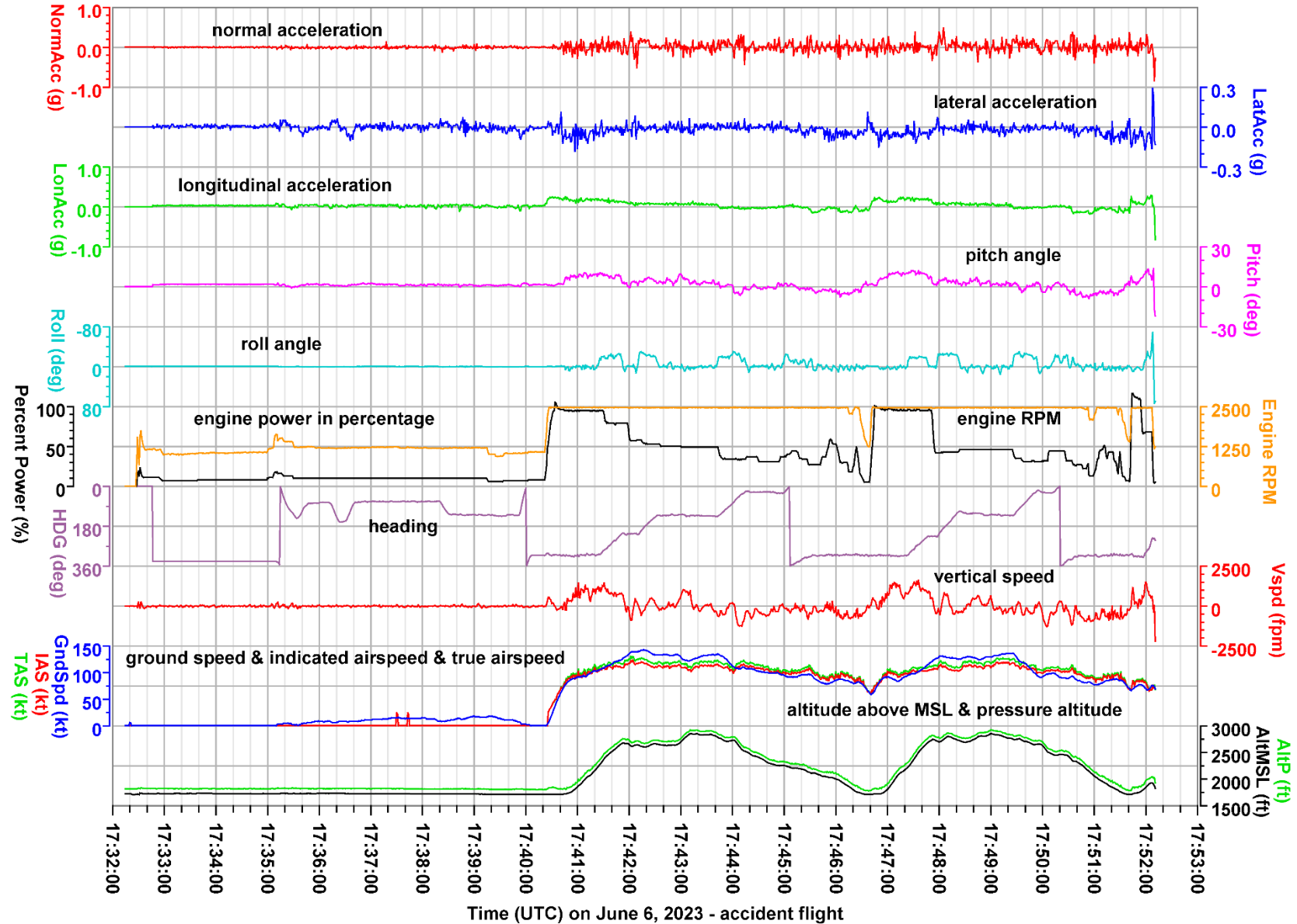


Figure 3. Plot of basic flight parameters of the entire accident flight recording.

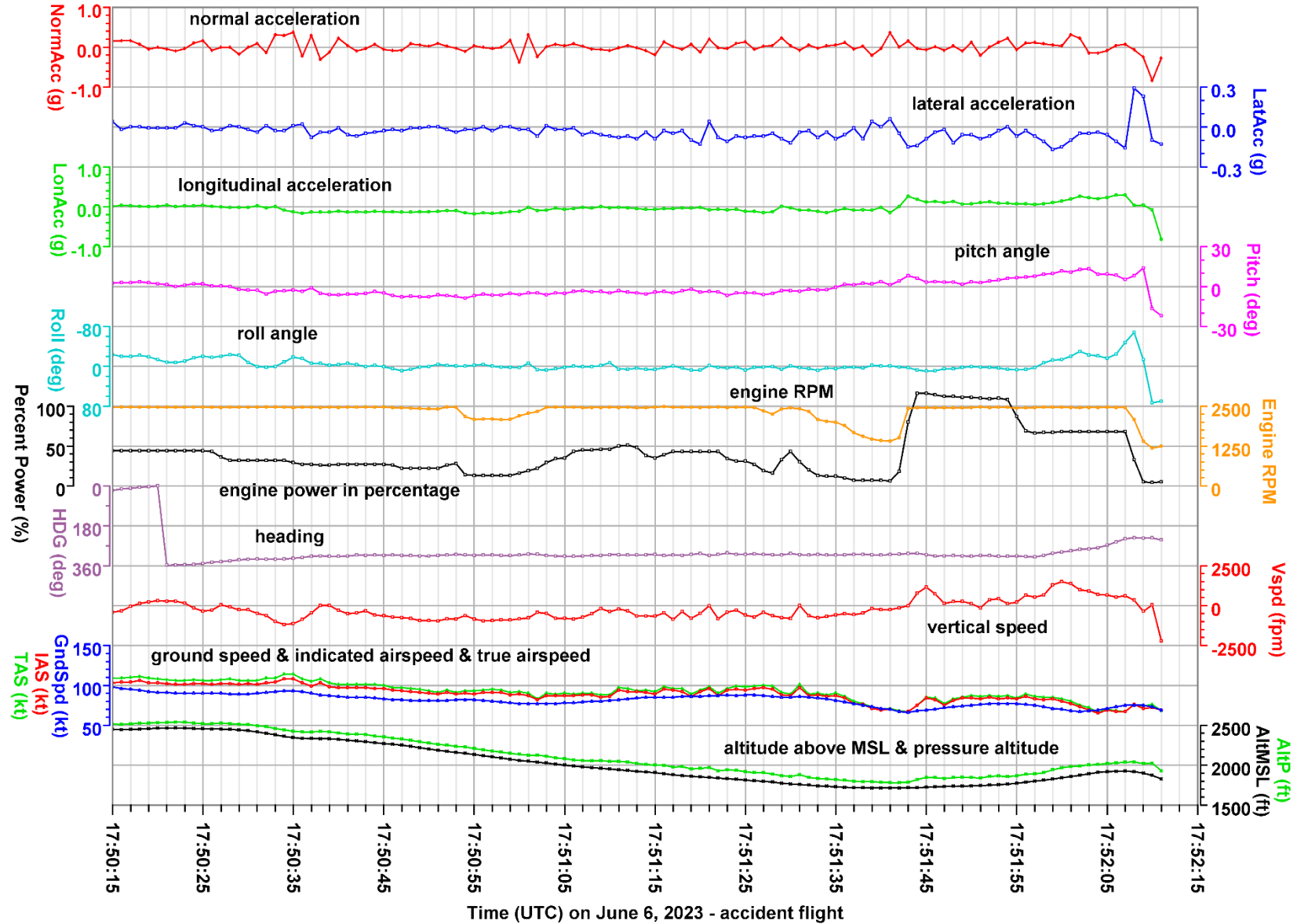


Figure 4. Plot of basic flight parameters for approximately the last 2 minutes of the accident flight.

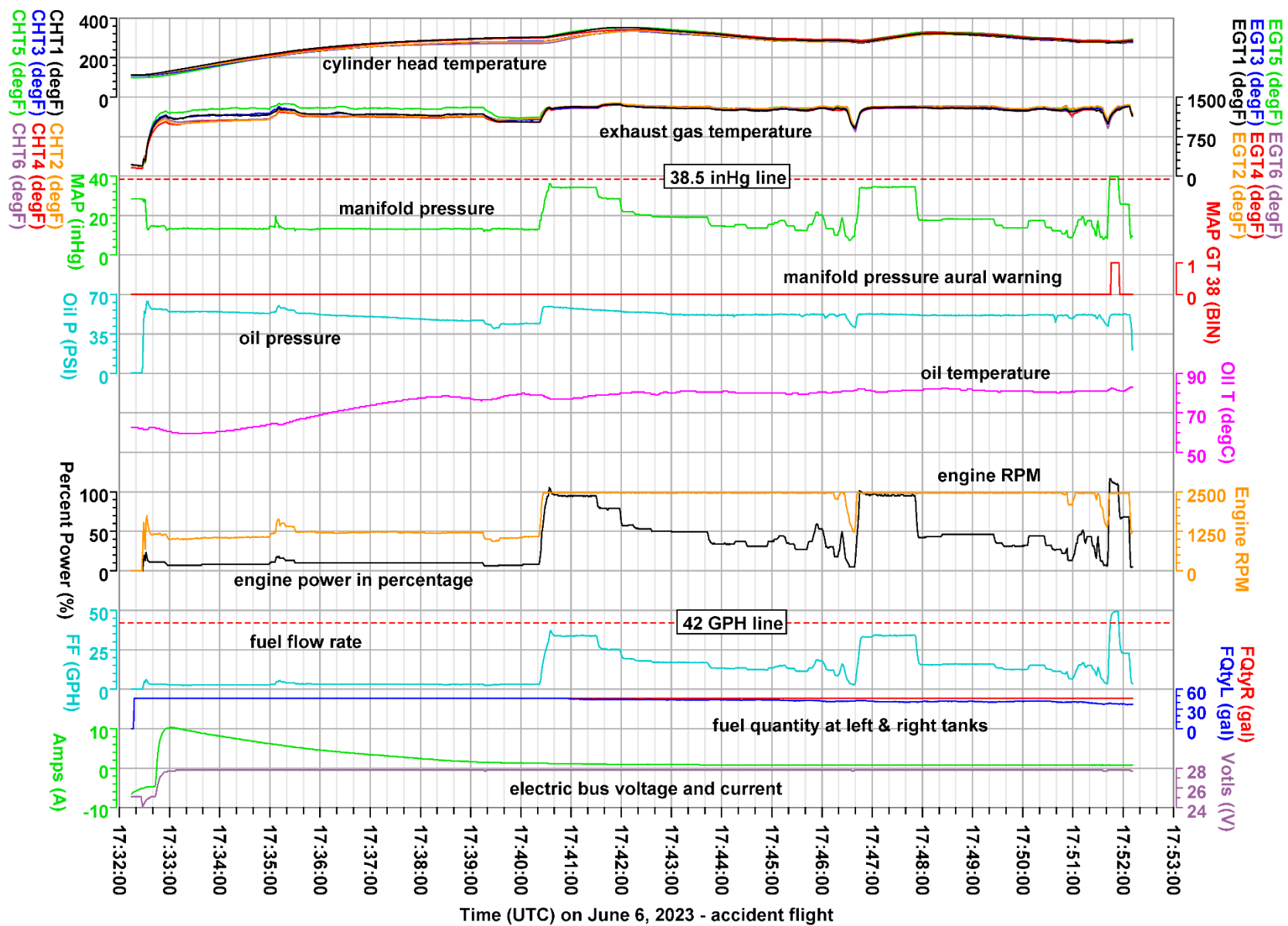


Figure 5. Plot of engine parameters of the entire accident flight recording.

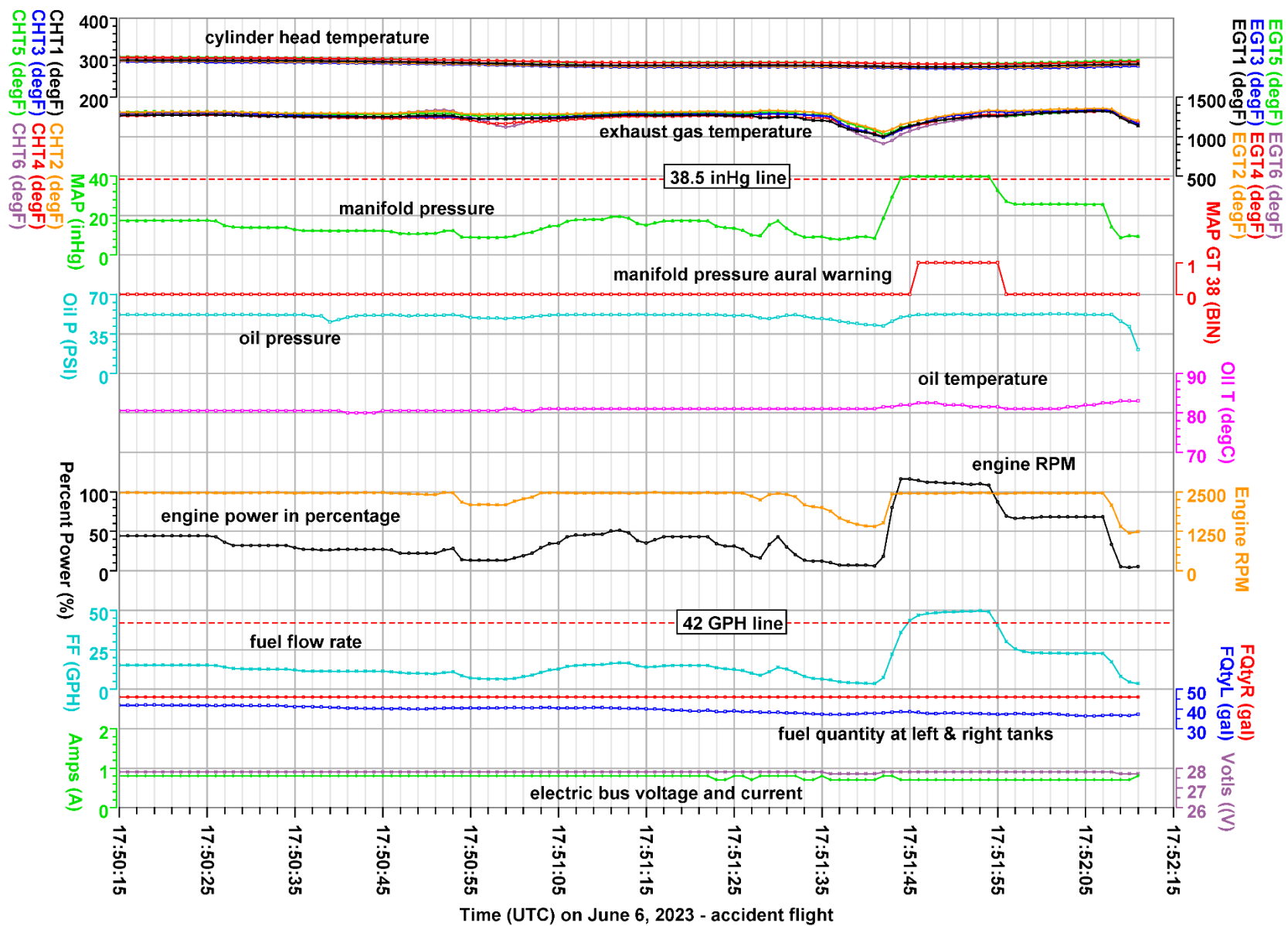


Figure 6. Plot of engine parameters for approximately the last 2 minutes of the accident flight.

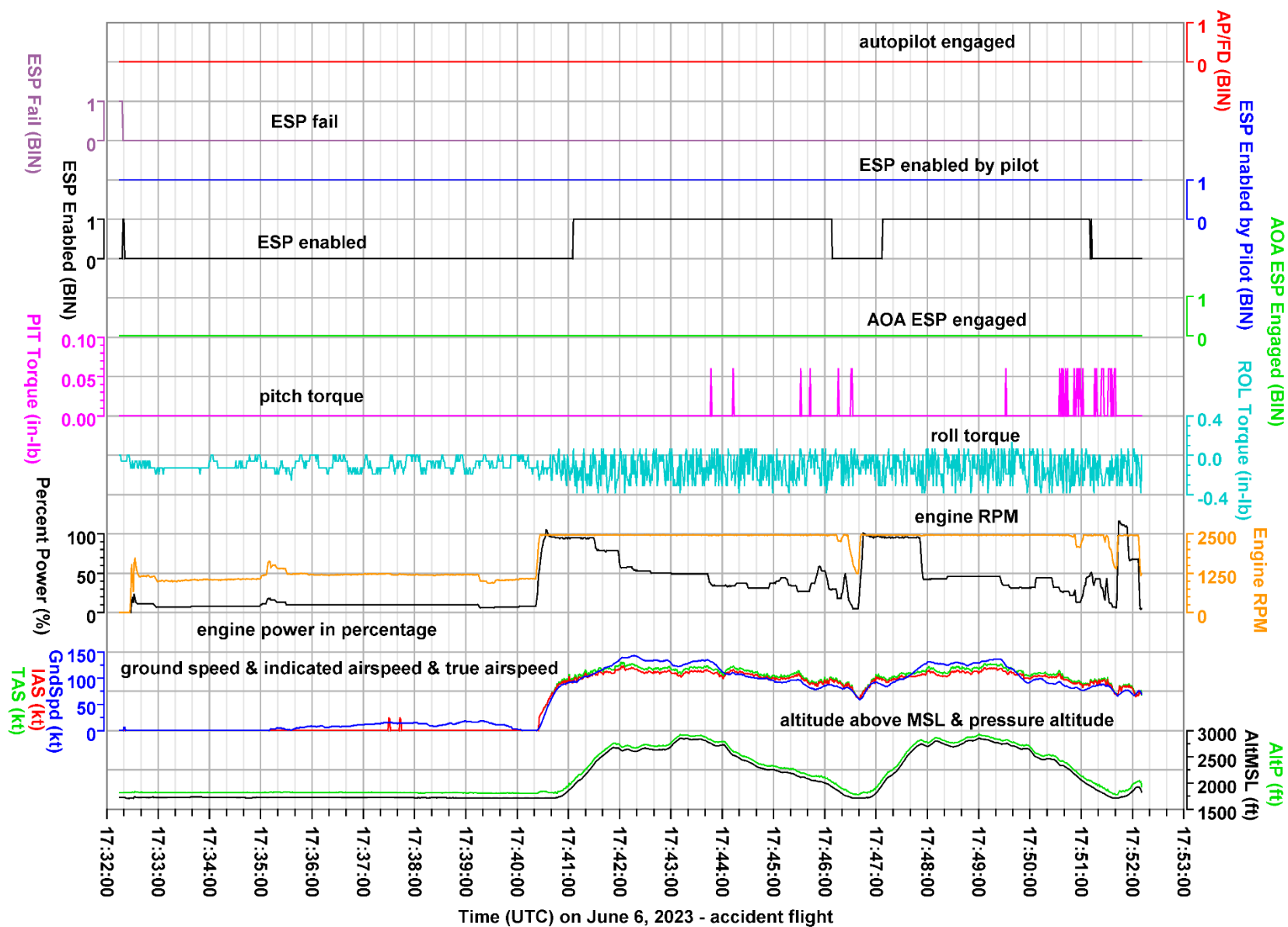


Figure 7. Plot of autopilot and ESP parameters of the entire accident flight recording.

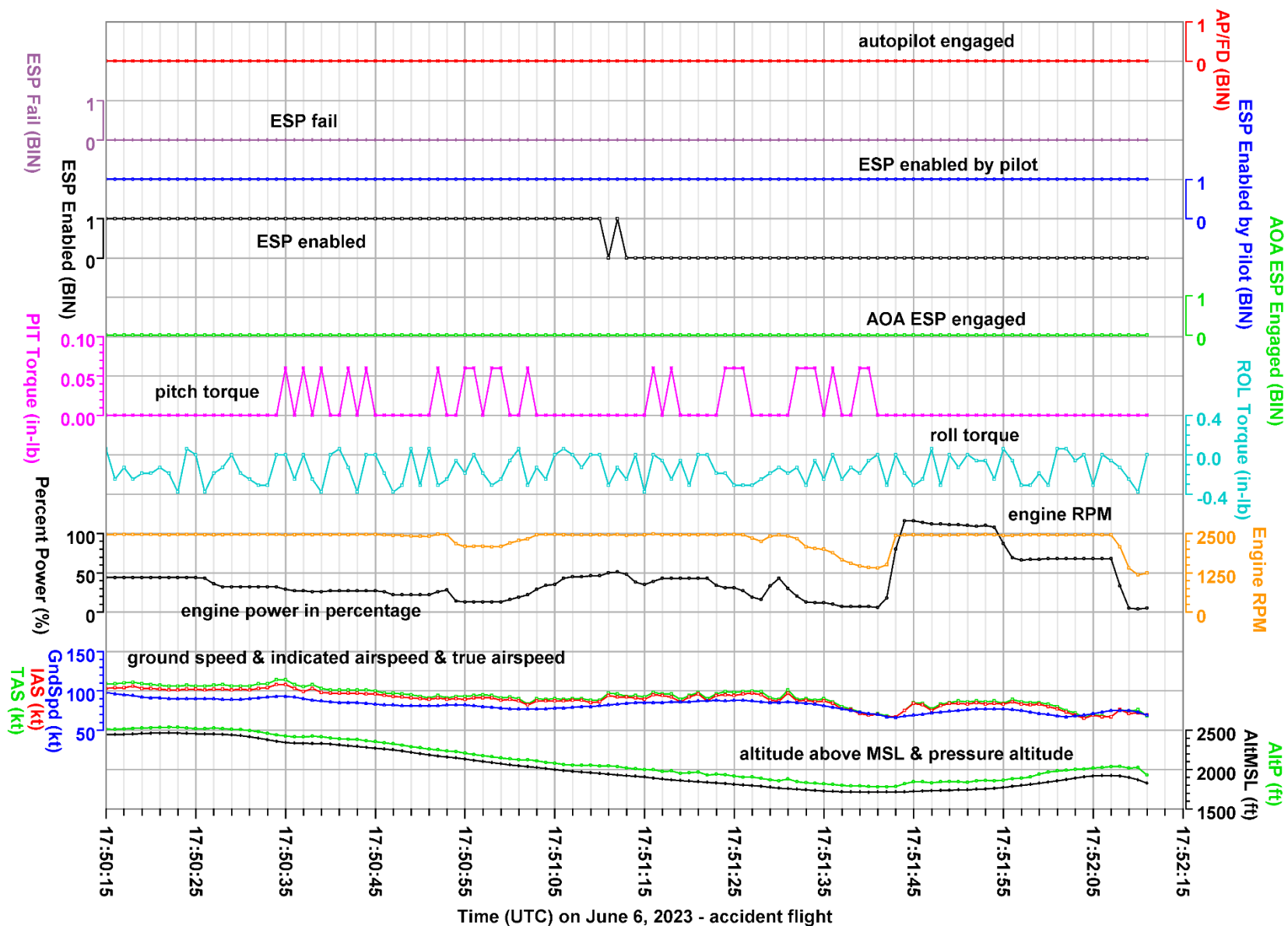


Figure 8. Plot of autopilot and ESP parameters for approximately the last 2 minutes of the accident flight.

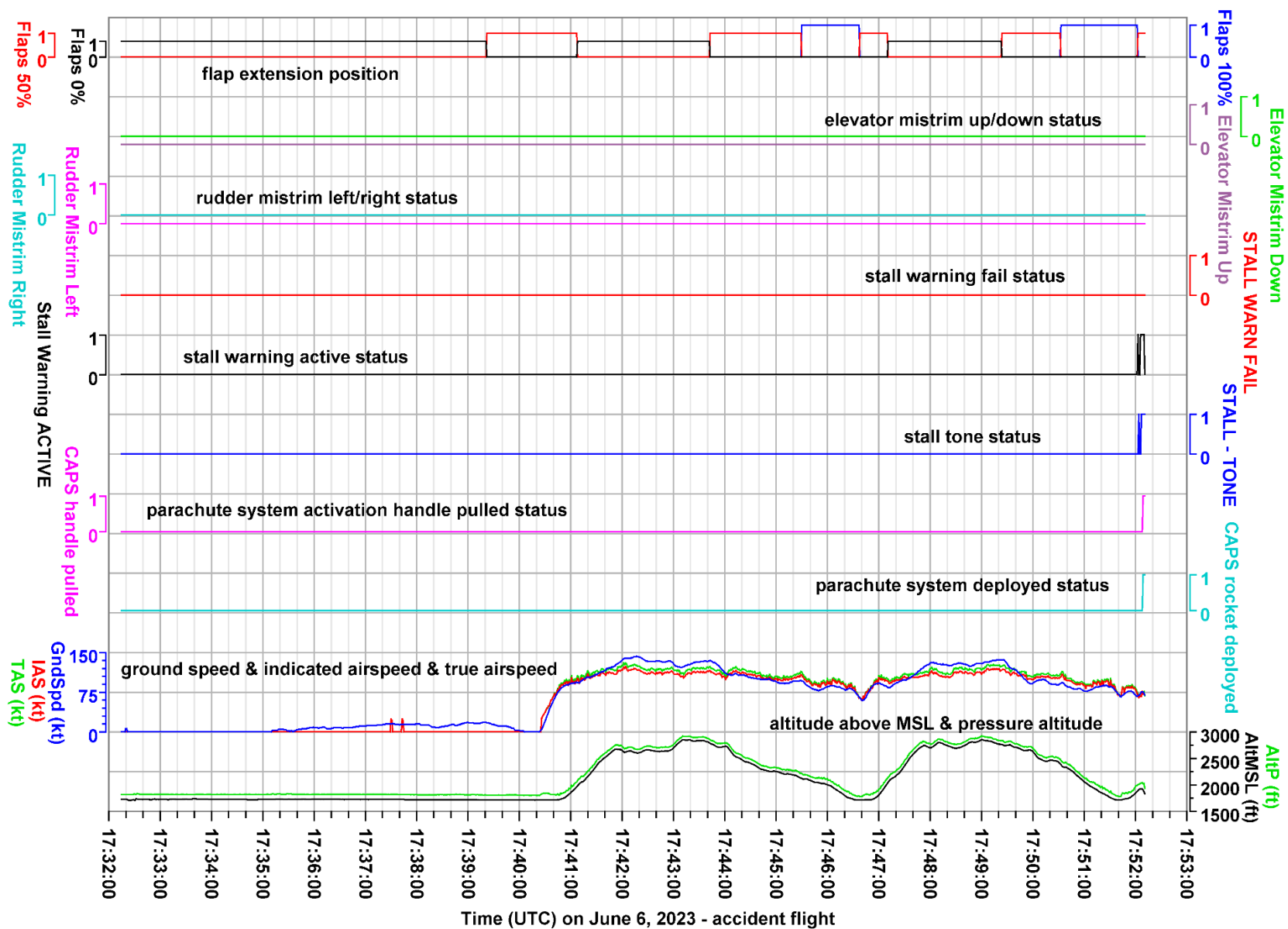


Figure 9. Plot of selected parameters of the entire accident flight recording.

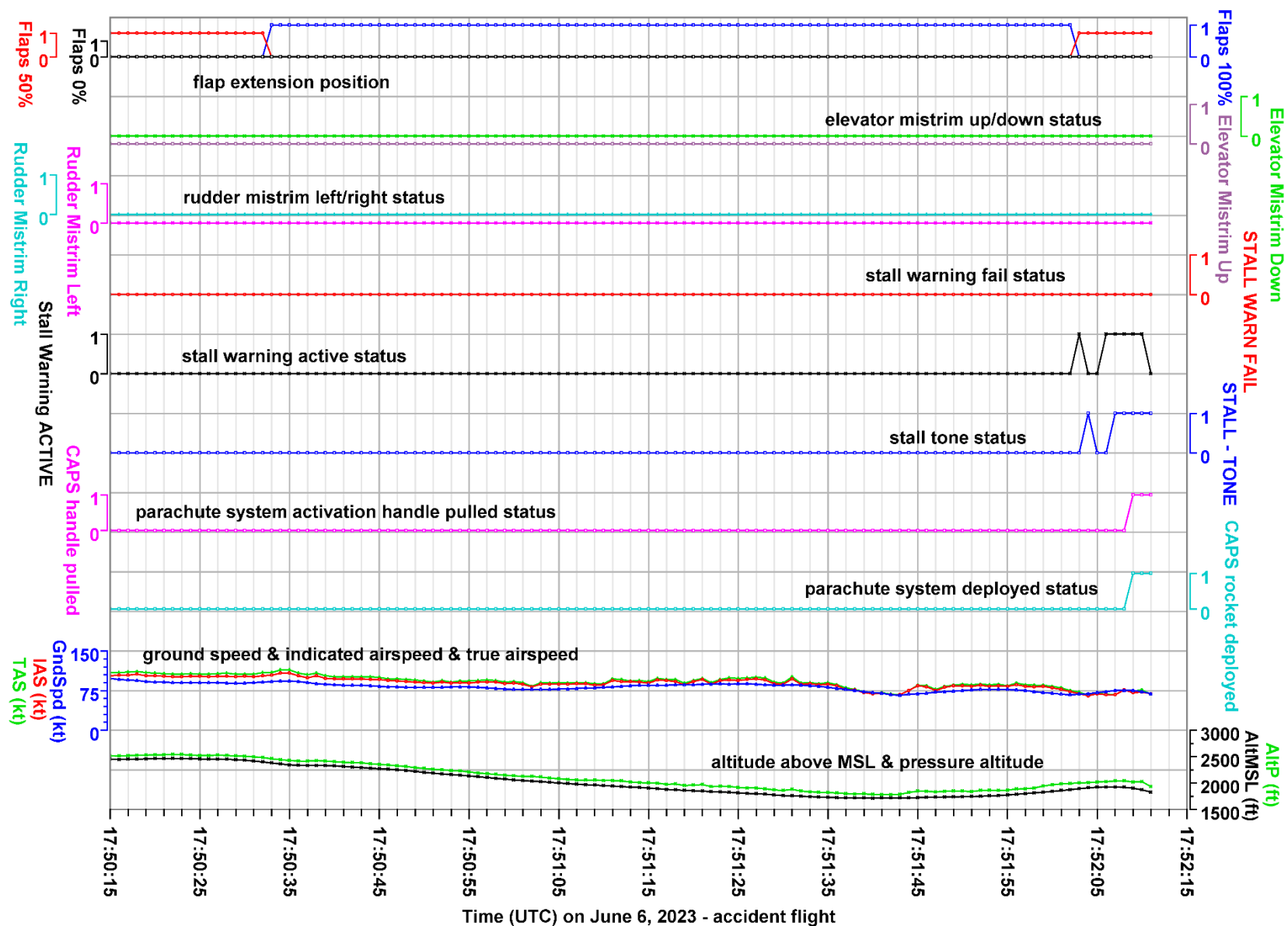


Figure 10. Plot of selected parameters for approximately the last 2 minutes of the accident flight.

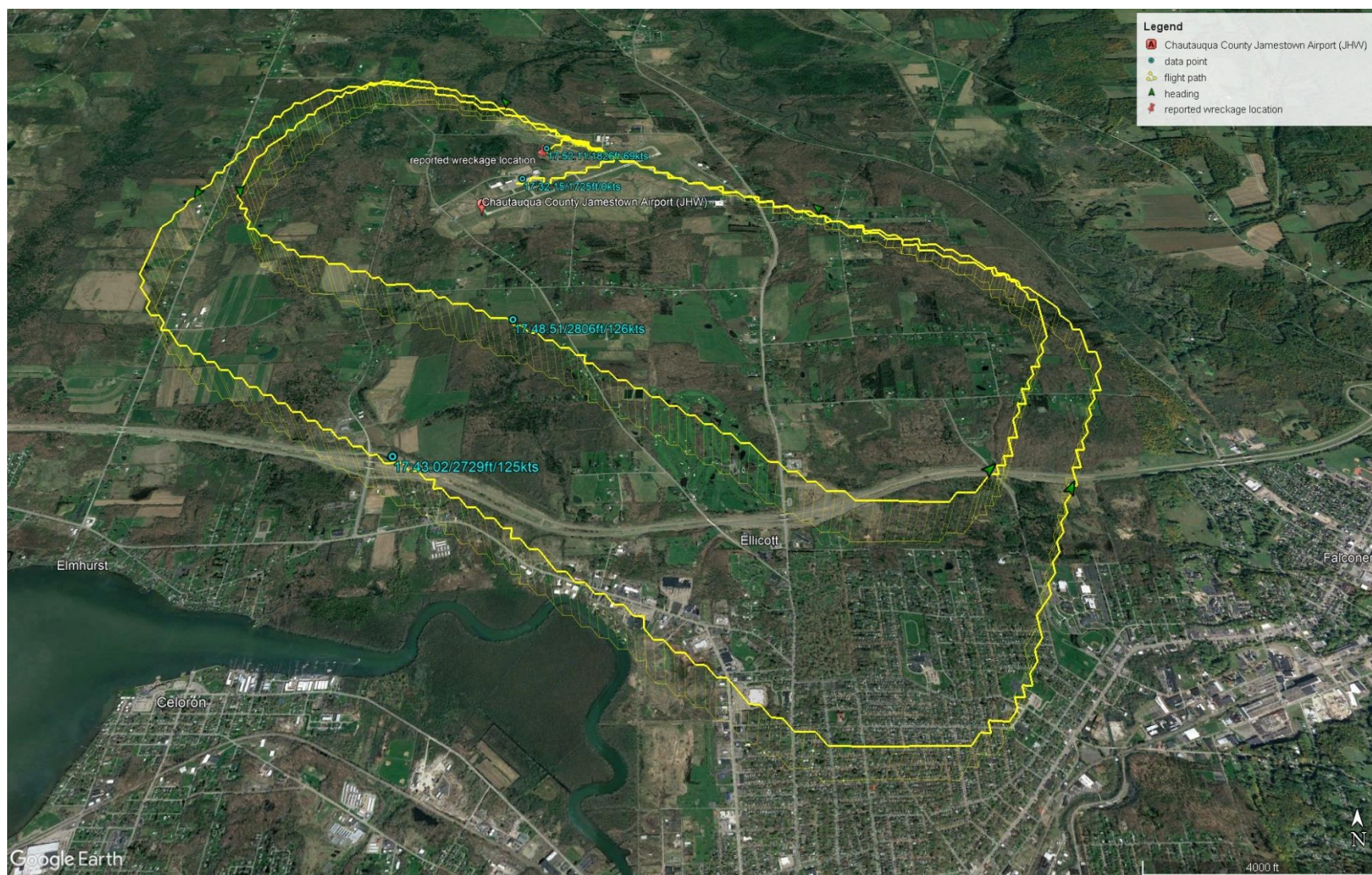


Figure 11. Google Earth overlay of the entire accident flight.

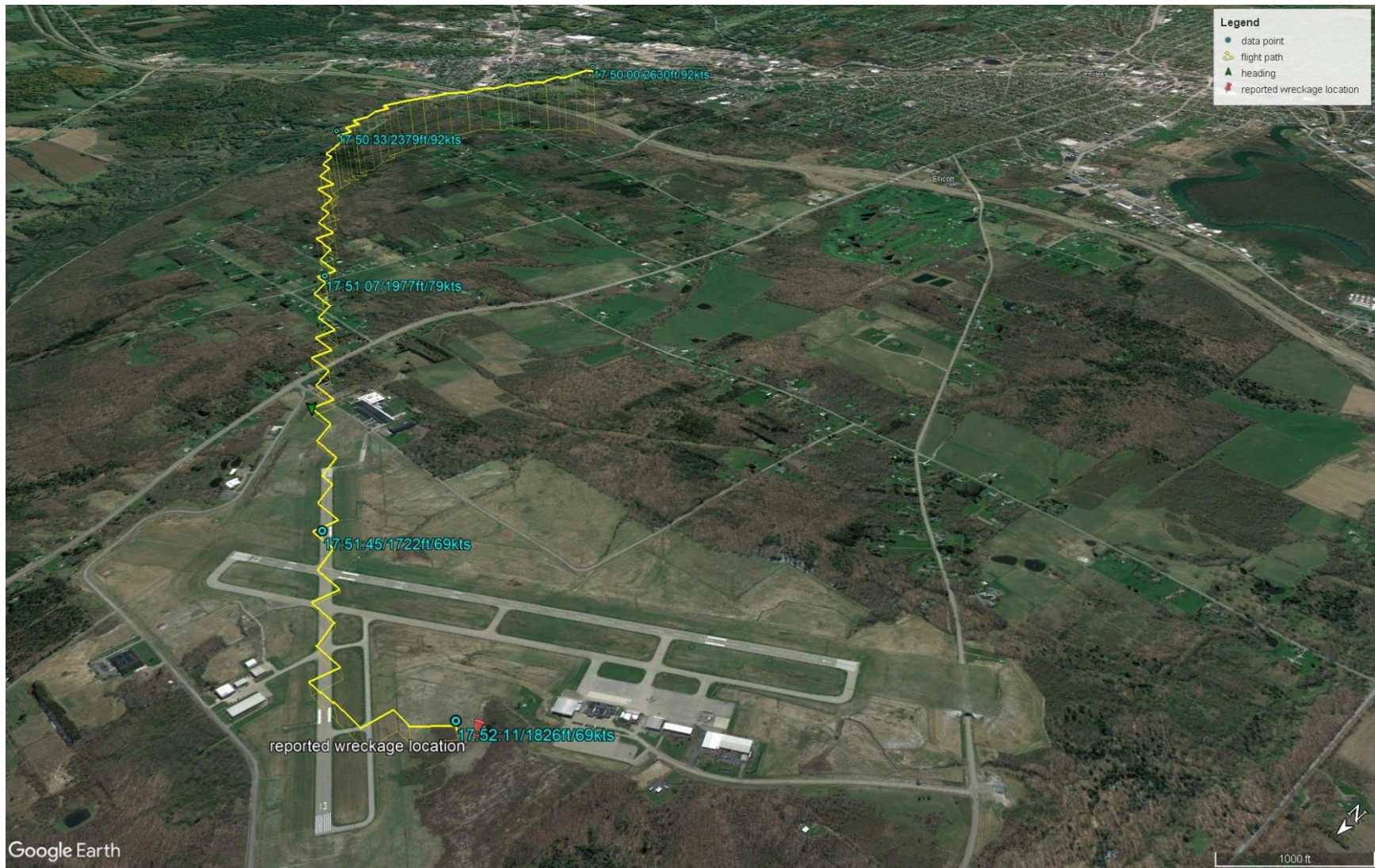


Figure 12. Google Earth overlay of the final portion of the accident flight.

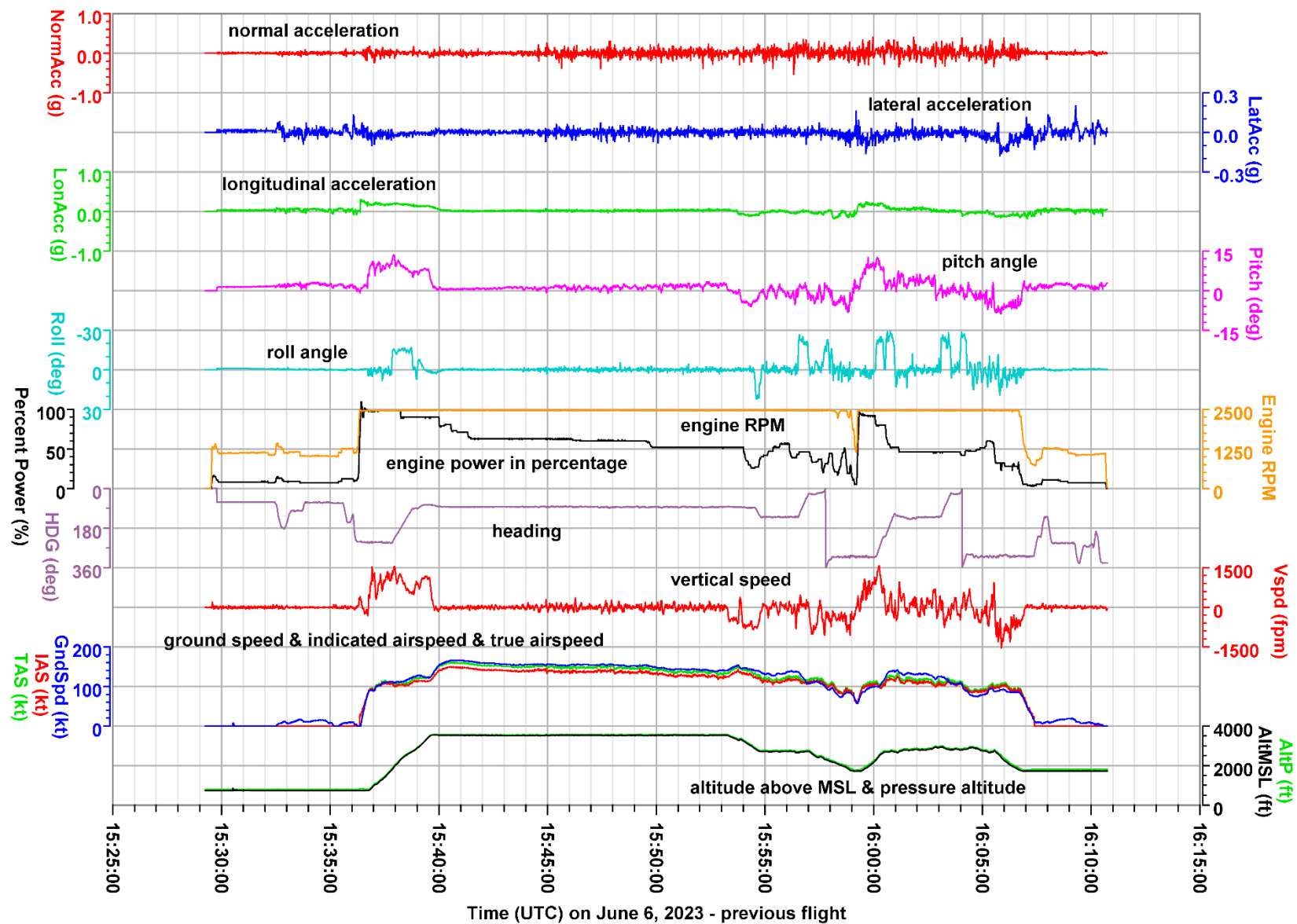


Figure 13. Plot of basic flight parameters of a previous flight recorded on the same day.

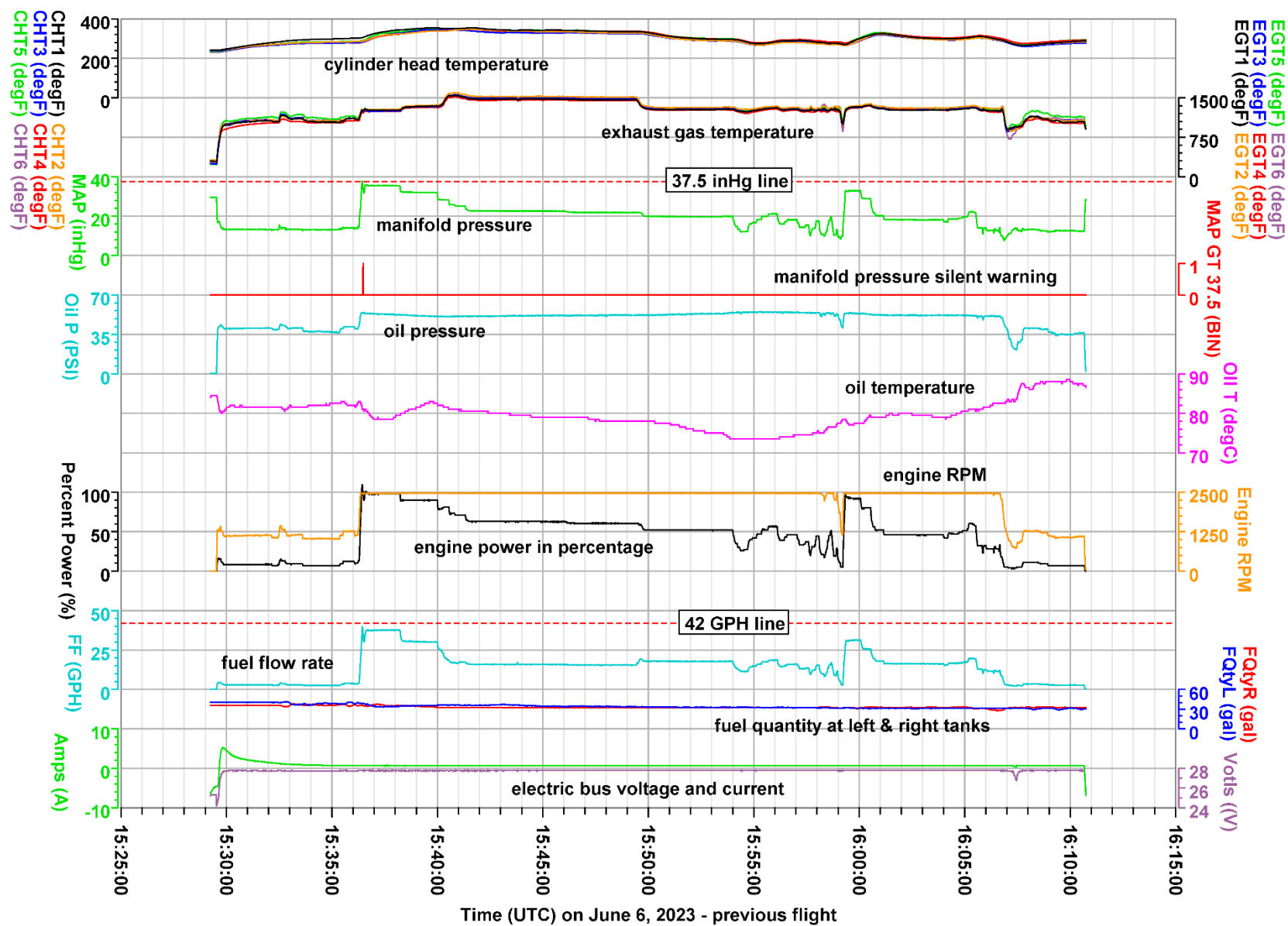


Figure 14. Plot of engine parameters of a previous flight recorded on the same day.

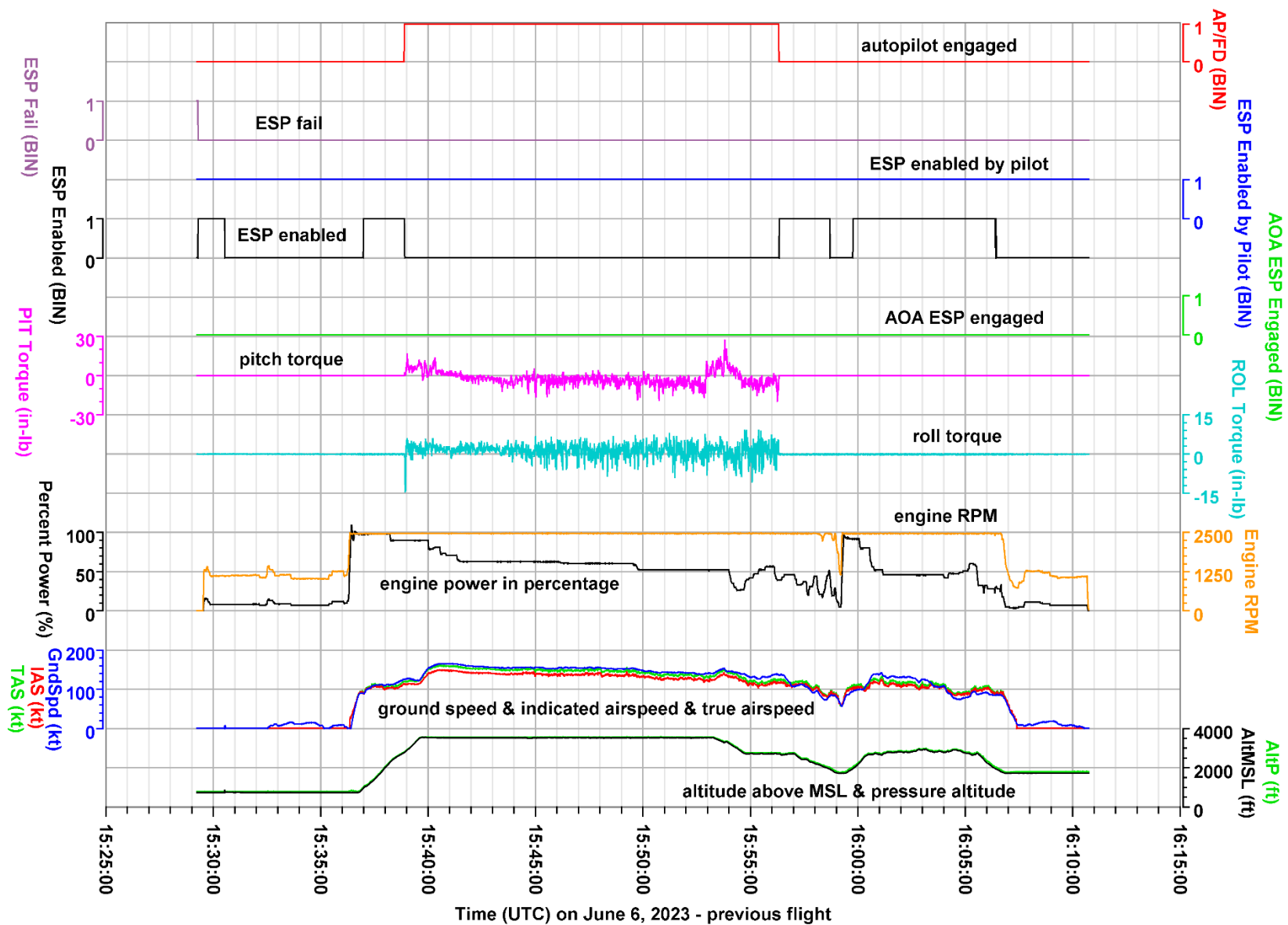


Figure 15. Plot of autopilot and ESP parameters of a previous flight recorded on the same day.

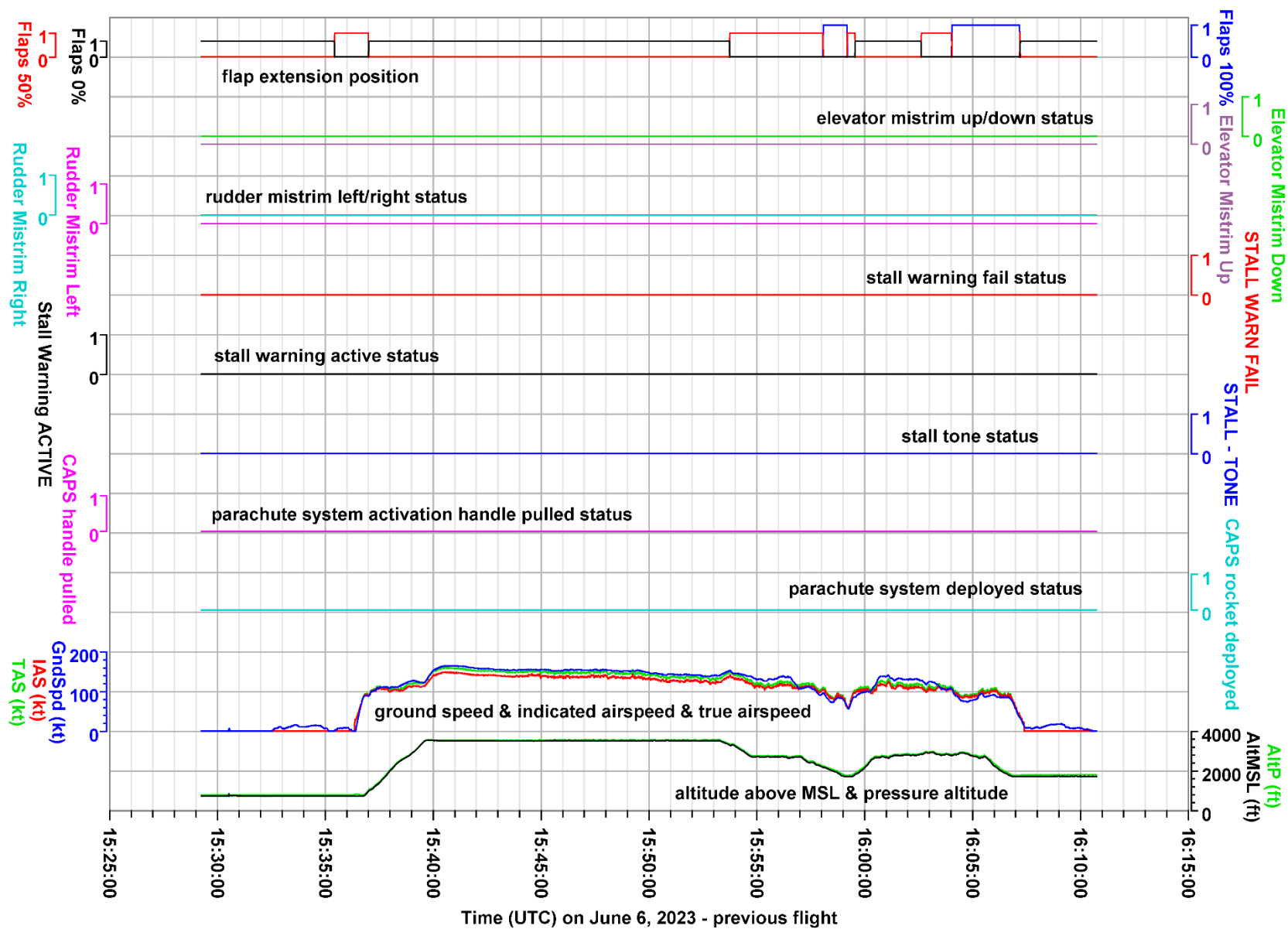


Figure 16. Plot of selected parameters of a previous flight recorded on the same day.



Figure 17. Google Earth overlay of the previous flight recorded on the same day.