

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

October 9, 2018

Cockpit Displays - Recorded Flight Data

Specialist's Factual Report
By Sean Payne

1. EVENT SUMMARY

Location: Clearwater, Florida
Date: May 5, 2017
Aircraft: Cirrus SR22
Registration: N271TS
Operator: Eagle Flyers LLC.
NTSB Number: ERA17FA174

On May 5, 2017, about 1922 eastern daylight time, a Cirrus SR22, N271TS, impacted terrain while attempting to land on runway 16 at the Clearwater Airpark (CLW), Clearwater, Florida. The private pilot was fatally injured and the airplane sustained substantial damage. The airplane was registered to a private company and operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Visual meteorological conditions prevailed at the airport at the time of the accident. No flight plan was filed for the flight that departed Marion County Airport (MAO), Mullins, South Carolina, about 1620.

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model: **Avidyne PFD**
Recorder Serial Number: **20063087**

Recorder Manufacturer/Model: **Avidyne MFD Card**
Recorder Serial Number: **N/A**

3.1. Avidyne Primary Flight Display (PFD) Description

The PFD unit includes a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot/static inputs for altitude, airspeed, and vertical speed information. Each PFD contains two flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD

displays. Additionally, the PFD has a data logging function, which is used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consists of system information, event data and flight data.

The PFD samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached, the oldest record is dropped and a new record is added. Data from the Attitude/Heading Reference System (AHRS) is recorded at a rate of 5 Hz. Air data information such as pressure altitude, indicated airspeed, and vertical speed are recorded at 1 Hz. Global Positioning System (GPS) and navigation display and setting data are recorded at a rate of 0.25 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

3.1.1. PFD Data Recovery

The recorder was damaged in the event. The extent of the damage is shown in figure 1. When the device was opened, the card containing the data chip was found to be damaged. The data chip was removed from the associated board, cleaned, downloaded and converted to engineering units.

Figure 1. Damaged exterior of PFD.



3.1.2. PFD Data Description

The PFD recording contained records of seven flights and approximately 18 hours of data. The accident flight was associated with the seventh recorded flight. The duration of the seventh recorded flight was approximately 3 hours and 13 minutes. Timing of the PFD data is measured in seconds from power-on.

As stated in section 3.1, the PFD records most data at regular time intervals. The recorded data has shown, at times, to drop data records for up to 6 seconds in duration. The dropout condition has been reported to the manufacturer of the PFD. The condition that causes the dropouts is related to time overruns in the low-priority data logging code, which results in the input buffer overflowing. In later PFD software versions, if a drop-out occurs, an event is recorded in the event log.

3.1.3. PFD Engineering Units Conversions

Conversion of the PFD data from the raw recorded information to engineering units is performed by NTSB software and checked by Avidyne. Acceleration data, as provided by Avidyne, was converted from meters per second-squared (m/s^2) to standard acceleration units (g).

Where applicable, changes to the conversions have been made to ensure the parameters conform to the Safety Board's standard sign convention that climbing right turns are positive (CRT=+).¹

APPENDIX A lists the PFD parameters verified and provided in this report.

3.2. Avidyne Multi-Function Display (MFD) Description

The MFD unit is able to display the pilot checklist, terrain/map information, approach chart information and other aircraft/operational information depending on the specific configuration and options that are installed. One of the options available is a display of comprehensive engine monitoring and performance data.

Each MFD contains a compact flash (CF) memory card located in a slot on the side of the unit. This memory card contains all of the software that the MFD needs to operate. Additionally, this card contains all of the checklist, approach charts, and map information that the unit uses to generate the various cockpit displays.

During operation, the MFD display receives information from several other units that are installed on the aircraft. Specifically, the MFD receives GPS position, time and track data from the aircraft's GPS receiver. The MFD may also receive information from the aircraft concerning altitude, engine and electrical system parameters, and outside air temperature. This data is also stored on the unit's CF memory card.

The MFD generates new data files for each MFD power-on cycle. The oldest file is dropped and replaced by a new recording once the storage limit has been reached. MFD data are sampled every six seconds, and recorded to memory once every minute. If an interruption of power occurs during the minute between MFD memory write cycles, data sampled during that portion of a minute are not recorded.

3.2.1. MFD Data Recovery

The CF card was in good condition and the data were downloaded using the manufacturer's procedure which involves the use of a surrogate workstation containing an undamaged MFD.

¹ CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +.

Figure 2. Recovered MFD Card



3.2.2. MFD Data Description

The MFD CF card contained 284 data files. One data file was identified as recording during the accident flight. The data file was approximately 3 hours and 8 minutes in duration.

3.2.3. MFD Engineering Units Conversions

The data files downloaded from the MFD are in engineering units.

APPENDIX A lists the MFD parameters verified and provided in this report.

3.3. Time Correlation

Correlation of the PFD data to EDT was established using the recorded GPS time parameter from the PFD data. Recorded GPS time is updated in 6 second intervals on the PFD². The GPS time is recorded in Universal Coordinated Time (UTC). The difference between EDT and UTC is 4 hours. The PFD starts recording when power is applied to the unit. Each power cycle the timing begins at 0 seconds and the PFD data is measured in seconds from power-on. An offset is applied to each power cycle plotted to display the data with the local time zone. Therefore, for the rest of this report, all times are referenced as EDT, not recorded time.

The incident flight data has been offset from recorded MFD time to EDT by subtracting 3,600 seconds.

Due to the six second update rate of the GPS time, the times noted in this report could be up to six seconds off from actual GPS time.

An additional 387 second offset was subtracted to align the timing to the meteorology factual report, as the timing in the meteorology factual report was determined to be authoritative.

² GPS information is recorded at 4 second (0.25 Hz) intervals; however it is possible to have the same UTC time recorded in consecutive GPS data records due to the 6 second update rate of the GPS time parameter.

3.4. Plots and Corresponding Tabular Data

The following ten figures contain data recorded during the May 5, 2017, event.

The aircraft's route of flight was between Groton-New London Airport (GON), Groton, CT, Marion County Airpark (MAO), Mullins, SC and Clearwater Airpark (CLW), Clearwater, Florida. A Google Earth route of flight is given for all aircraft operations on May 5th. Detailed plots were only constructed for the leg from MAO to CLW.

Autopilot parameters did not show the autopilot was active near the time of the accident.

Figure 3 is a plot of basic aircraft parameters for the leg between MAO and CLW, from 16:00 to 19:30. The plot begins as the aircraft arrived MAO around 16:15 and subsequently departed around 16:21. The aircraft was in cruise flight between 2,000 and 3,000 feet MSL (pressure altitude) for the majority of the flight. Data ended at 19:21:44 in the vicinity of the runway at CLW.

Figure 4 is a plot of basic aircraft parameters between 19:00 and 19:22 in the vicinity of CLW.

Figure 5 is a plot of basic aircraft parameters between 19:15 and 19:22 in the vicinity of CLW.

Figure 6 is a plot of available engine parameters between 16:00 and 19:30.

Figure 7 is a plot of available engine parameters between 19:00 and 19:22.

Figure 8 is a Google Earth overlay of the aircraft's route of flight between GON and MAO. The aircraft had stopped at MAO around 15:47:46.

Figure 9 is a Google Earth overlay of the aircraft's activity in the vicinity of MAO. Data showed the aircraft spent approximately 40 minutes on the ground at MAO.

Figure 10 is a Google Earth overlay of the aircraft's route of flight between MAO and CLW.

Figure 11 is a Google Earth overlay of the aircraft's activity in the vicinity of CLW.

Figure 12 is a Google Earth overlay of the final recorded tracklog points in the vicinity of CLW. The approximate wreckage location is marked with a yellow pin. The manufacturer of the avionics stated that this system could lose between 4 and 6 seconds of data when subject to an abrupt loss of power.

The corresponding tabular data used to create these ten plots are provided in electronic (*.csv³) format as Attachment 1 to this report.

³ Comma Separated Value format.

Figure 3. Plot of basic parameters during entire flight from MAO to CLW.

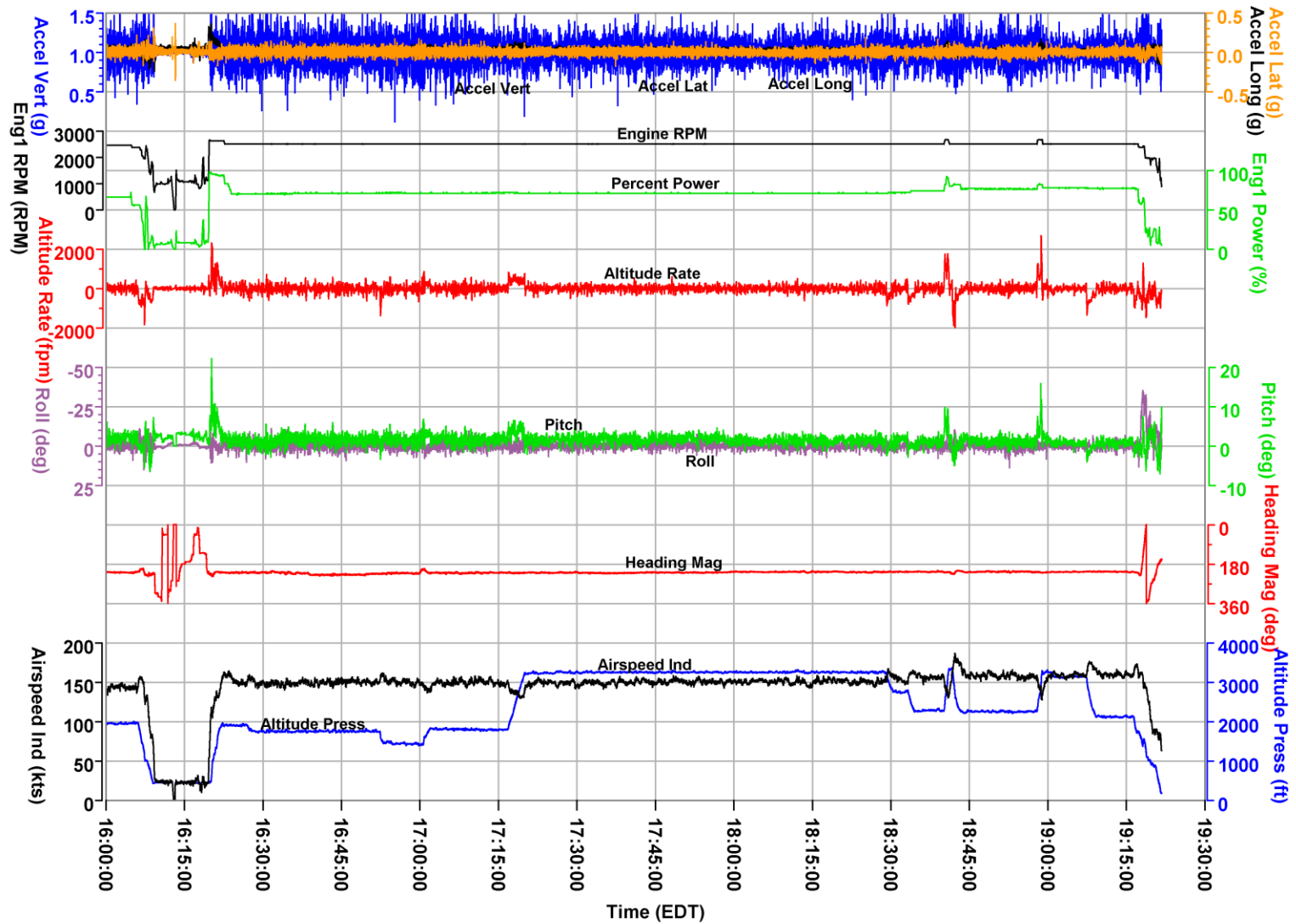


Figure 4. Plot of basic parameters in the vicinity of CLW.

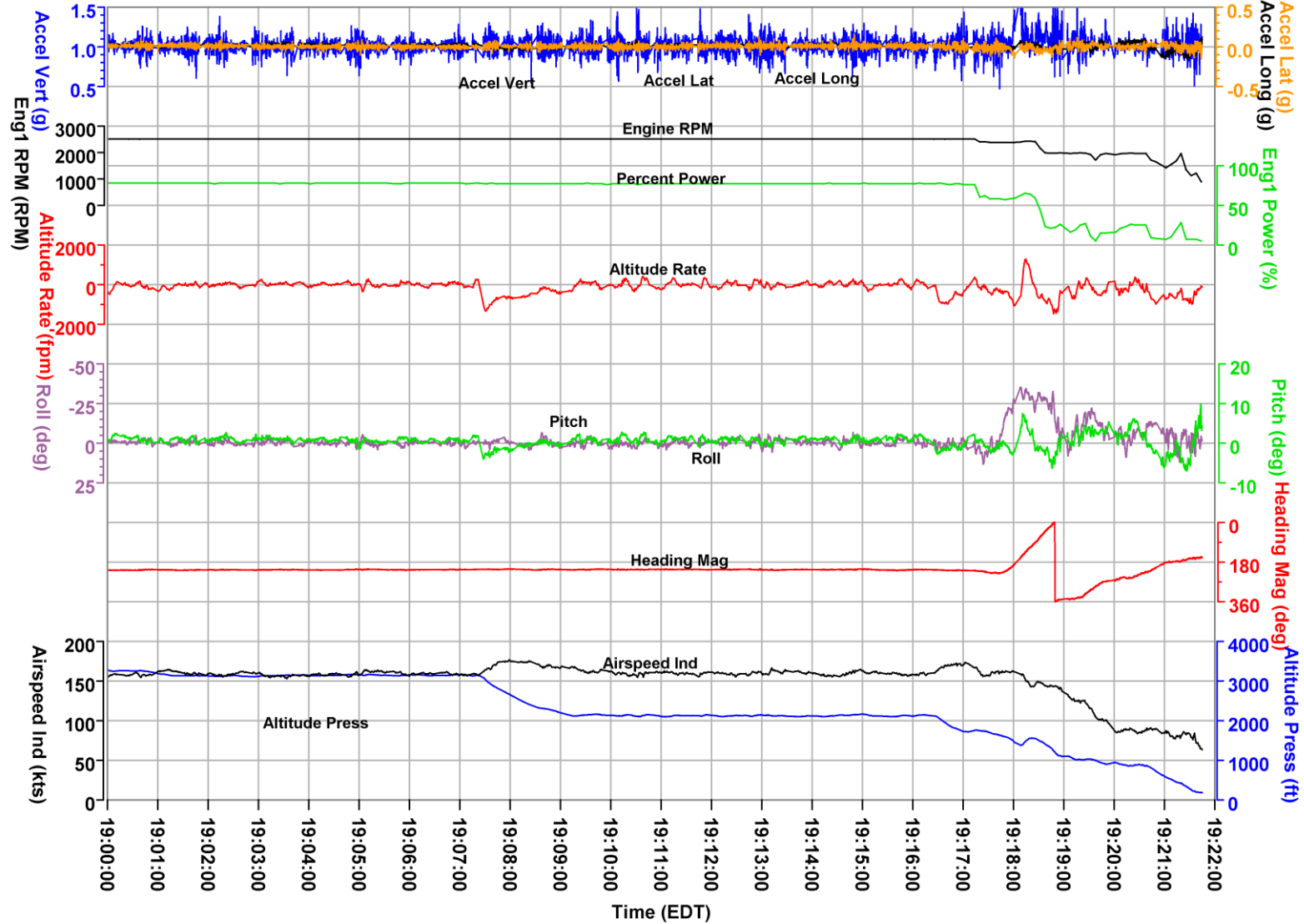


Figure 5. Plot of basic parameters for the final portion of flight.

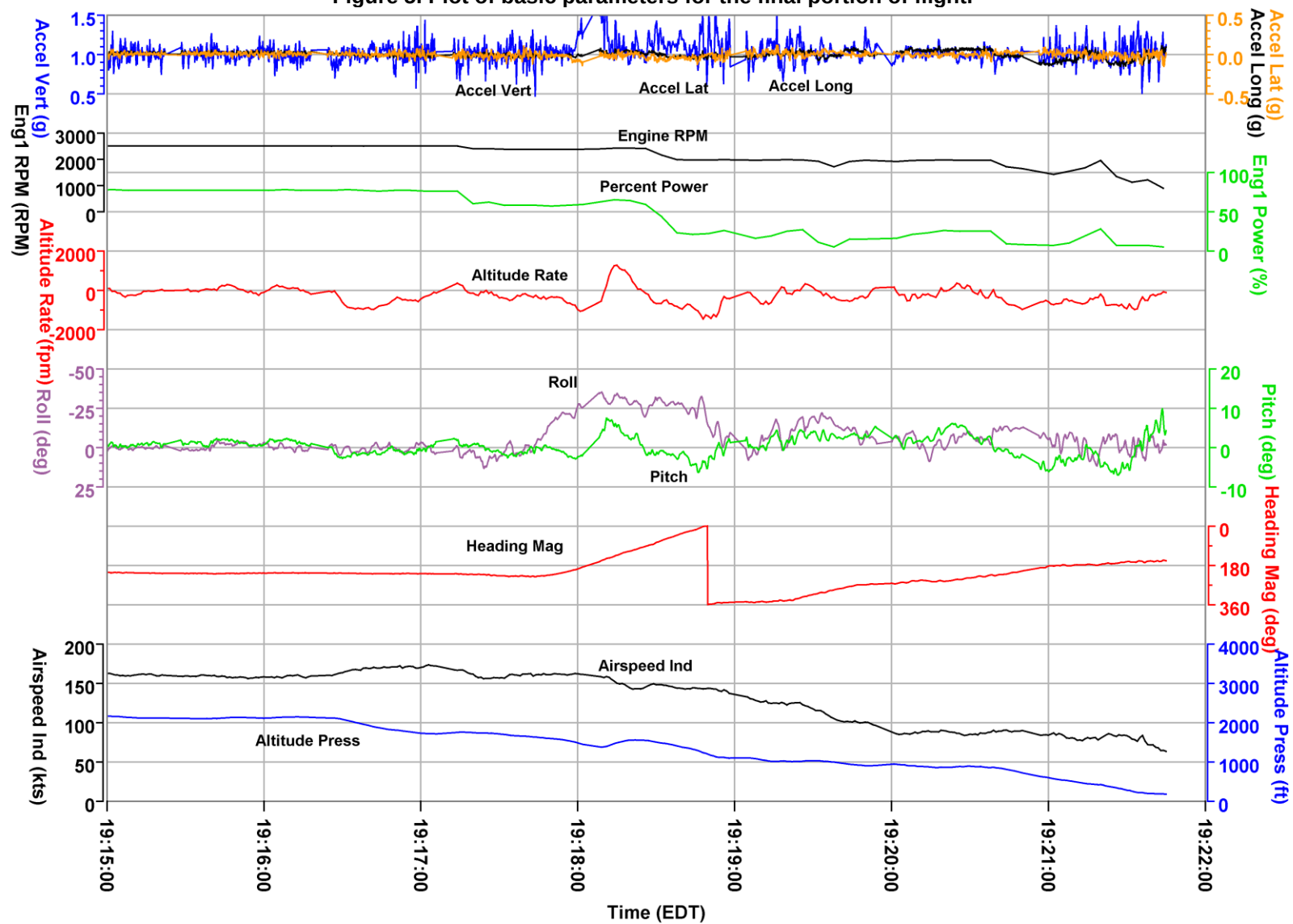


Figure 6. Plot of engine parameters during entire flight from MAO to CLW.

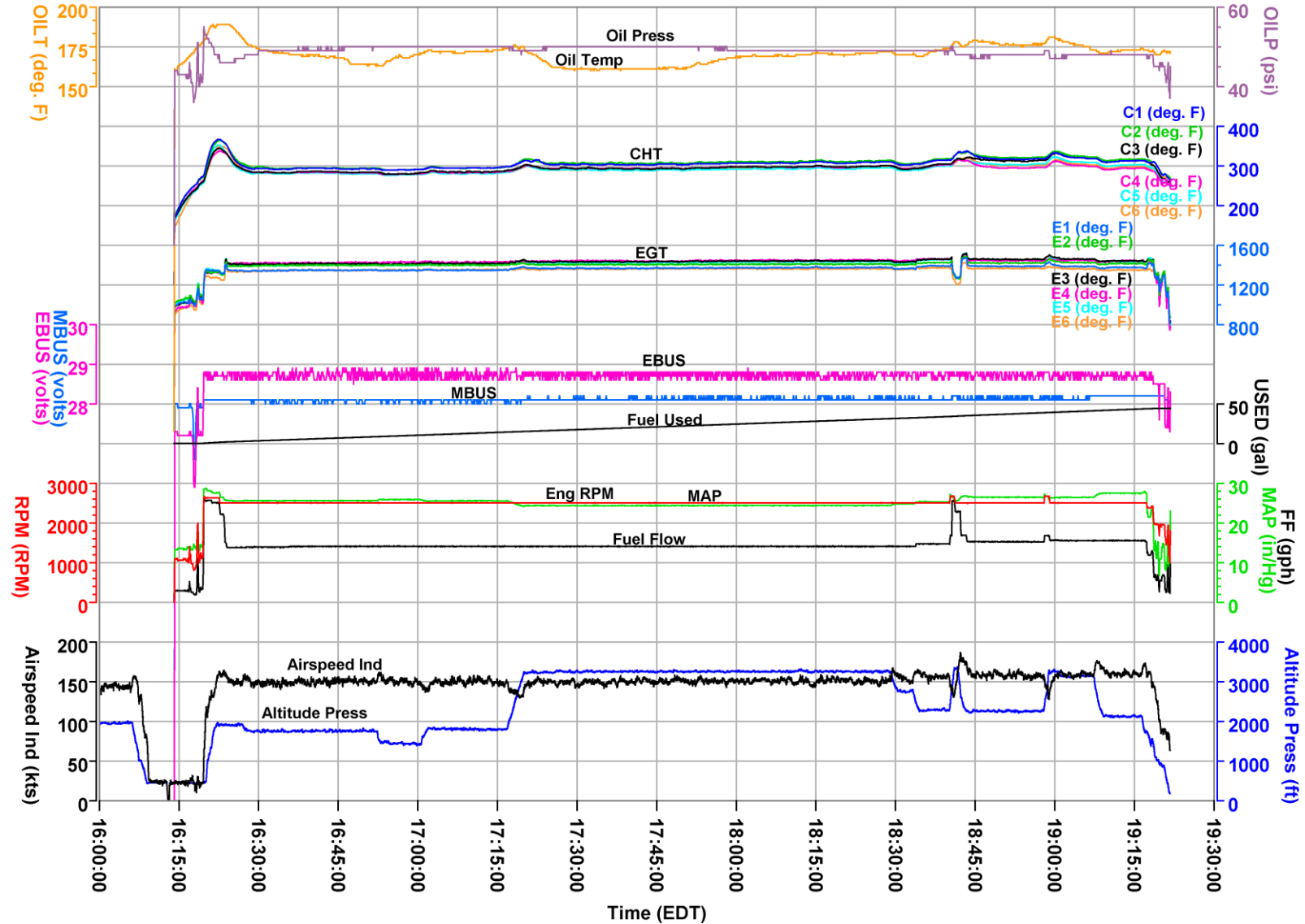


Figure 7. Plot of engine parameters for the final portion of flight.

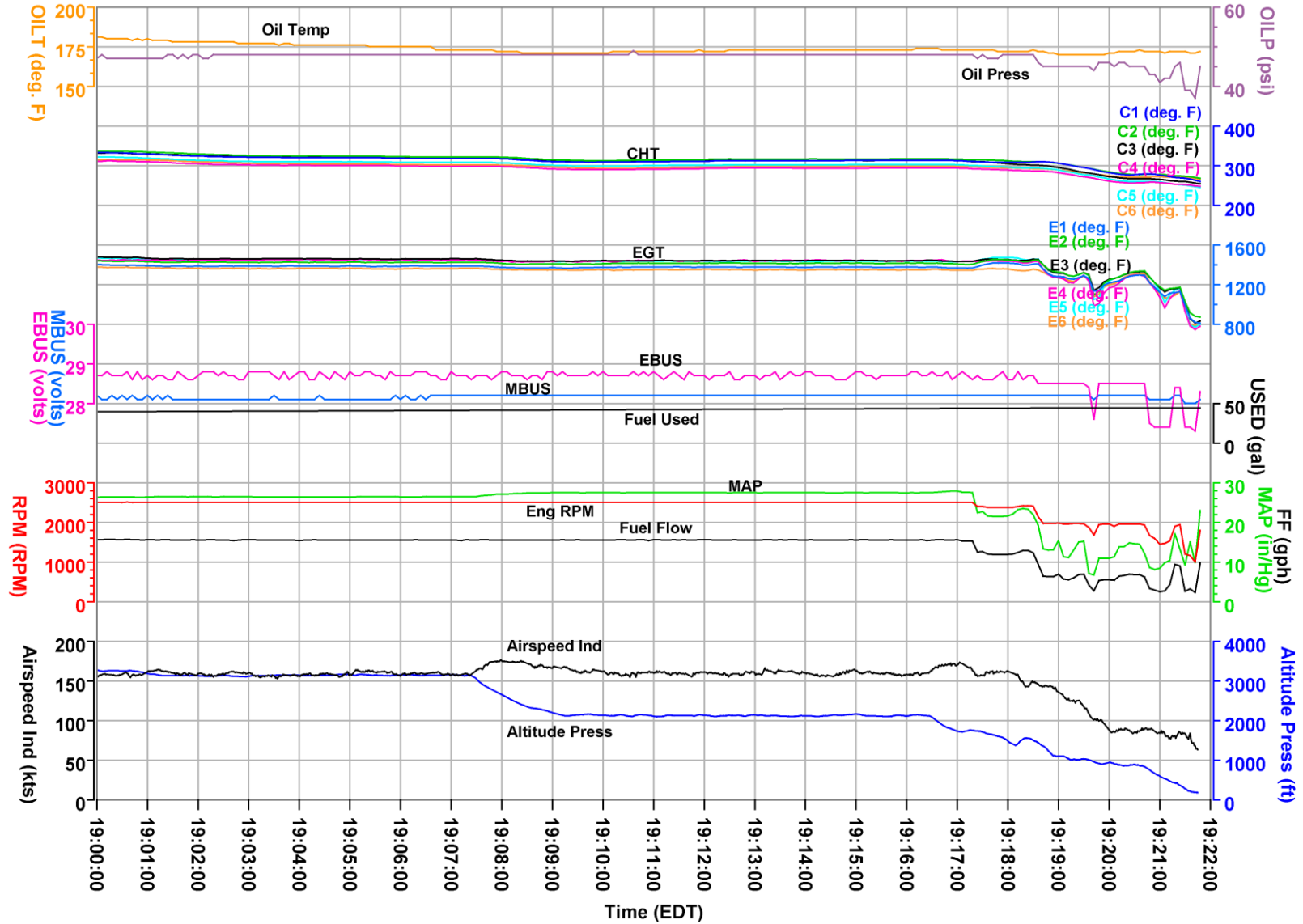


Figure 8. The aircraft's overall route of flight between GON and MAO.

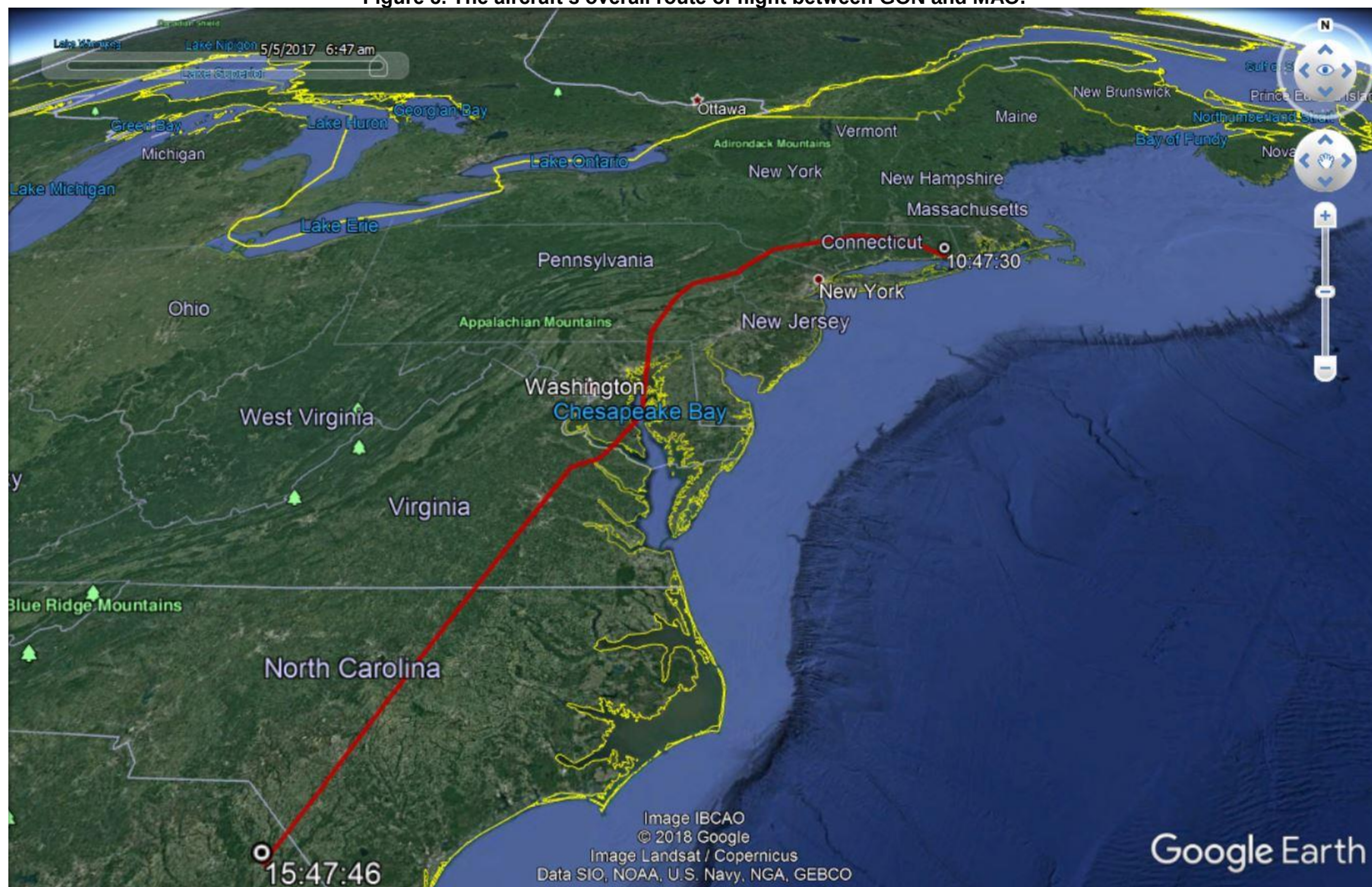


Figure 9. The aircraft's activity around MAO.

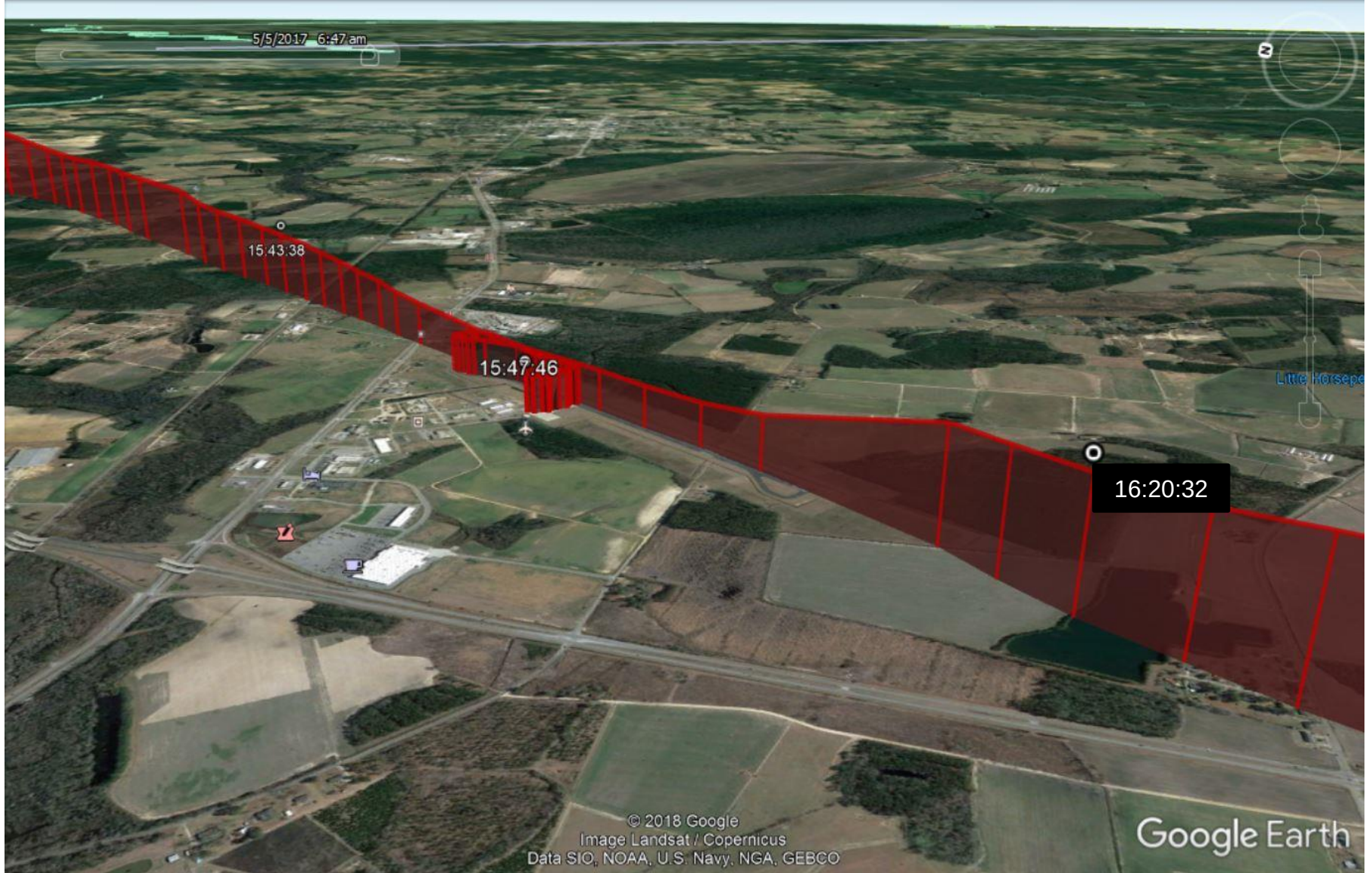


Figure 10. The aircraft's overall route of flight between MAO and CLW.

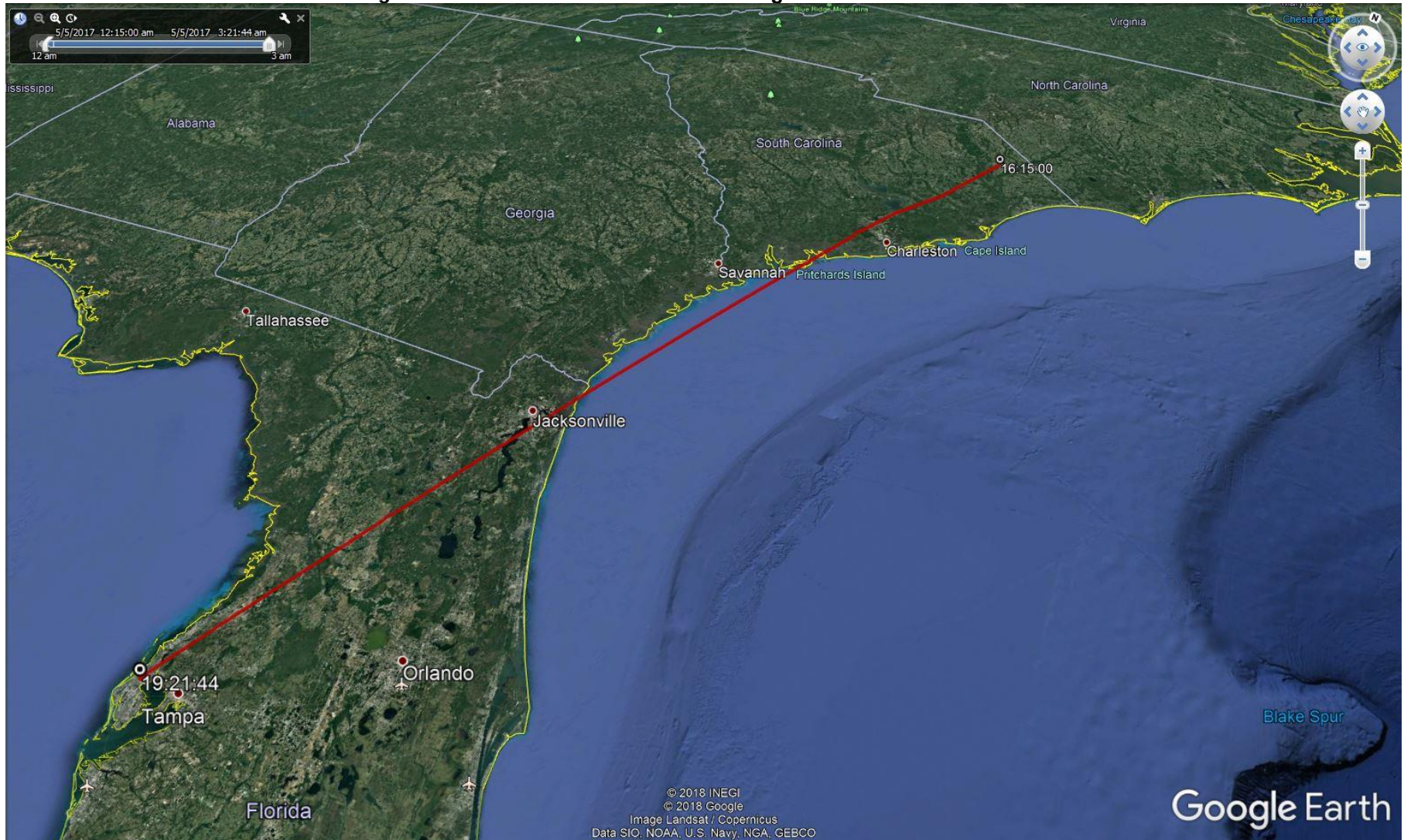


Figure 11. The aircraft's pattern entry and arrival at MAO.

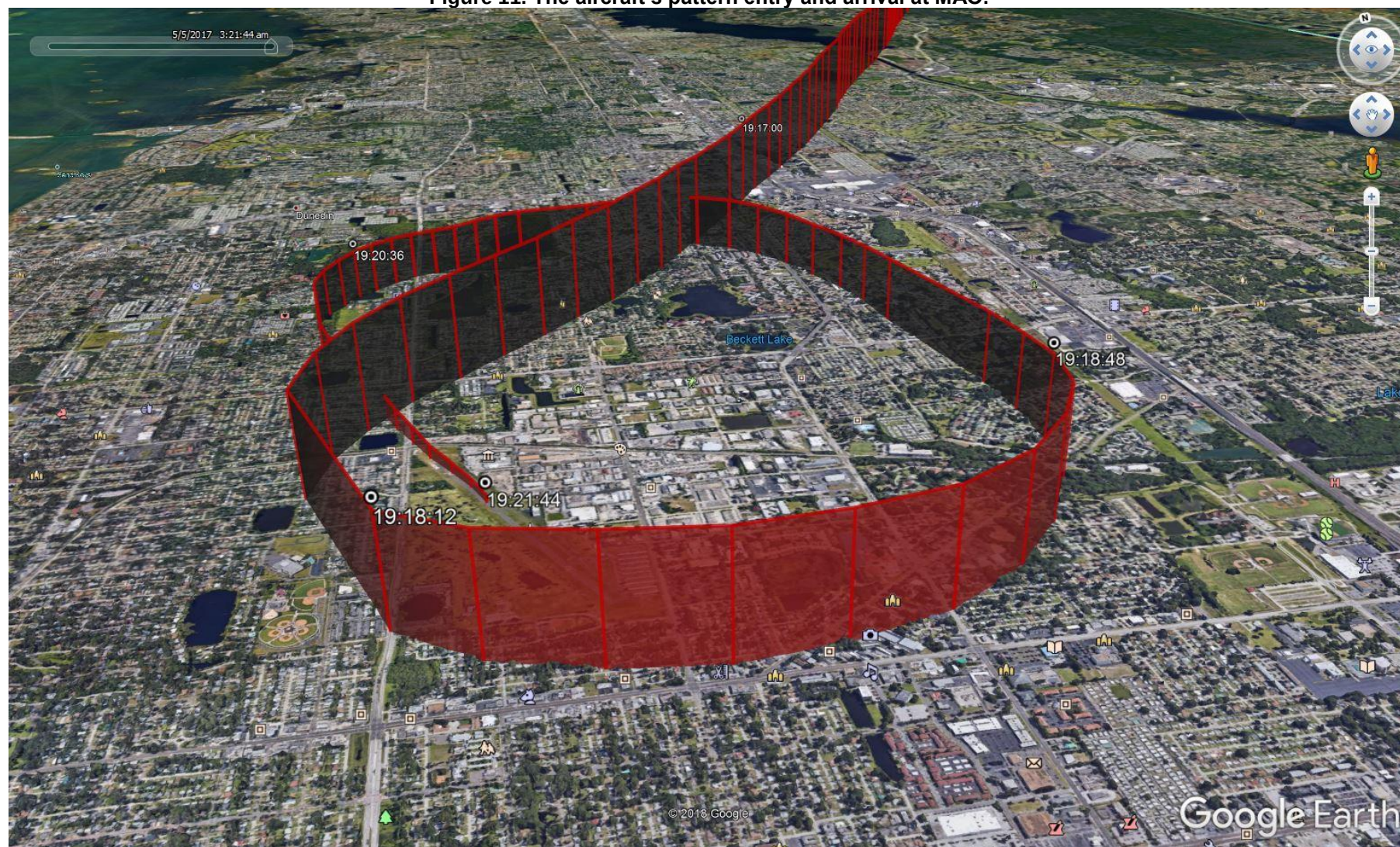


Figure 12. The last recorded portion of flight and the approximate wreckage location.



APPENDIX A - PFD and MFD Parameters

This appendix describes the parameters provided and verified in this report. Table A-1 lists the PFD and MFD parameters and table A-2 describes the unit abbreviations used in this report for PFD and MFD parameters.

Table A-1 - Verified and provided parameters.

Parameter Name	Parameter Description	Source
Accel Lat (g)	Lateral Acceleration	PFD
Accel Long (g)	Longitudinal Acceleration	PFD
Accel Vert (g)	Vertical Acceleration	PFD
Airspeed Ind (kts)	Indicated Airspeed	PFD
Altitude Press (ft)	Pressure Altitude	PFD
Altitude Rate (fpm)	Altitude Rate (Vertical Speed)	PFD
EBUS (V)	Essential Bus Voltage (Volts)	MFD
Eng1 CHT Cyl#-MFD (degF)	Engine 1 Cylinder Head Temperature Cylinder # ⁴ (degrees Fahrenheit)	MFD
Eng1 EGT Cyl#-MFD (degF)	Engine 1 Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)	MFD
Eng1 Fuel Flow (gph)	Engine Fuel Flow	MFD
Eng1 MAP (inHg)	Engine Manifold Pressure	MFD
Eng1 Oil Press (psi)	Engine Oil Press	MFD
Eng1 Oil Temp (degF)	Engine Oil Temp	MFD
Eng1 Power (%)	Engine Power	PFD
Eng1 RPM (rpm)	Engine RPM	MFD
Heading (deg)	Heading	PFD
Latitude (deg)	Latitude	MFD
Longitude (deg)	Longitude	MFD
MBUS (V)	Main Bus Voltage (Volts)	MFD
Pitch (deg)	Pitch	PFD
Roll (deg)	Roll	PFD

The PFD records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

⁴ Depending on aircraft configuration, the number of cylinders that are instrumented varies. In the data plots the '#' is replaced with the appropriate cylinder ID.

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
%	percent
rpm	revolutions per minute
deg	degrees
degF	degrees Fahrenheit
ft	feet
fpm	feet per minute
g	acceleration
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
V	Volts DC

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.