

# NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division  
Washington, D.C. 20594

June 22, 2021

## Electronic Device

**Specialist's Factual Report  
by Gerald Kawamoto**

### 1. EVENT

Location: Eatonton, GA  
Date: June 5, 2020  
Aircraft: Piper PA-31T  
Registration: N135VE  
Operator: Private  
NTSB Number: ERA20LA206

### 2. DETAILS OF INVESTIGATION

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

**Device:** Appareo Stratus 2S  
**Device Serial Number:** 026413

#### 2.1. Device Description

The Appareo Stratus 2S device is a self-contained battery-powered unit that contains an internal AHRS, GPS/WAAS receiver, and ADS-B receiver in one compact unit.<sup>1, 2, 3</sup> The unit communicates wirelessly with compatible devices to display all the acquired information. In addition to communicating with compatible devices, the Stratus device records GPS position and AHRS information internally on a non-volatile flash memory chip.<sup>4</sup> Internal memory has the space to store over 13 hours of flight data that is sampled at approximately 5 data records per second (5 Hz).

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<sup>1</sup> The Attitude Heading Reference System consists of a set of 3-axis gyroscope, accelerometers and heading reference sensors that enable the unit to compute pitch, roll, and yaw motions.

<sup>2</sup> The Wide Area Augmentation System (WAAS) is an air navigation aid to augment the Global Positioning System (GPS), by improving its accuracy, integrity, and availability.

<sup>3</sup> Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance technology deployed throughout the national airspace system. The ADS-B system is composed of aircraft avionics and a ground infrastructure. Onboard avionics determine the position of the aircraft by using the GPS and transmit its position along with additional information about the aircraft to ground stations for use by air traffic control (ATC) and other ADS-B services. This information is transmitted at a rate of approximately once per second. Operators equipped with ADS-B realize additional benefits from ADS-B broadcast services: Traffic Information Service - Broadcast (TIS-B) (traffic information) and Flight Information Service - Broadcast (FIS-B) (weather information).

<sup>4</sup> Non-volatile memory (NVM) is semiconductor memory that does not require external power for data retention.

## 2.2. Data Recovery

Upon arrival at the Vehicle Recorder Division, an external examination revealed the device had sustained damage, as shown in Figure 1, rendering it inoperable. The non-volatile memory chip was removed, read out, and converted to engineering units using laboratory tools.



Figure 1. Front and back of the Appareo Stratus 2S as received.

## 2.3. Data Description

The data extracted included sessions from April 10, 2020, through June 5, 2020.<sup>5</sup> The session determined to be relevant to the accident event was parsed out and started at 18:18:12.4 UTC and ended at 19:20:45.7 UTC on June 5, 2020.

The accident recording didn't appear to have captured the takeoff event and started at 18:18:12.4 near Archer, Florida. The aircraft took off from Williston Municipal Airport (X60) approximately 12 miles from the first recorded data point. Location parameters did not receive a GPS lock until 18:18:48.4. The ground speed when the GPS received lock was 180.8 knots. Accuracy of gyroscopic parameters on the Stratus is dependent on the device being properly oriented and calibrated while the device is stationary.

## 2.4. Parameters Provided

Table 1 describes data parameters recorded and derived by the device.

<sup>5</sup> All dates and times are referenced to Coordinated Universal Time (UTC).

**Table 1. Appareo Stratus 2S Parameters**

| Parameter Name | Parameter Description (units)                   |
|----------------|-------------------------------------------------|
| Date           | Date for recorded data point (MM/DD/YYYY)       |
| Time           | Time (UTC) for recorded data point (HH:MM:SS.0) |
| Latitude       | Recorded Latitude (degrees)                     |
| Longitude      | Recorded Longitude (degrees)                    |
| Acceleration X | Acceleration in X-Axis (g)                      |
| Acceleration Y | Acceleration in Y-Axis (g)                      |
| Acceleration Z | Acceleration in Z-Axis (g)                      |
| MSL Altitude   | Mean Sea Level Altitude (feet)                  |
| Ground Speed   | Averaged derived ground speed (knots)           |
| Heading        | Magnetic Heading (degrees)                      |
| Pitch          | Pitch Angle (degrees)                           |
| Bank           | Bank Angle (degrees)                            |
| Vertical Speed | Vertical Speed (feet per minute)                |

## 2.5. Plots and Corresponding Tabular Data

Figure 2 is a graphical overlay generated using Google Earth showing the entire accident flight. Weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 3 is a Google Earth overlay showing the start of the recording near Archer, Florida, and Williston Municipal Airport (X60).

Figure 4 is a Google Earth overlay of the end of the accident flight.

Figure 5 is a Google Earth overlay of the end of the accident flight showing data points where the recorded vertical and horizontal position accuracy parameters on the device had reached large values (low accuracy).

Figure 6 is a Google Earth overlay showing the last recorded data point and the reported wreckage location.

Figure 7 is a plot of parameters for the entire accident flight. The time interval shown is 18:15:00 to 19:25:00 UTC.

Figure 8 is a plot of parameters at the end of the accident flight. The time interval shown is 19:18:30 to 19:21:00 UTC.

The corresponding tabular data used to create Figures 2 through 8 are provided in electronic comma-separated value (.CSV) format as Attachment 1 to this report. Two time columns are included in the tabular data, one corresponding to GPS parameters and the other to AHRS parameters.

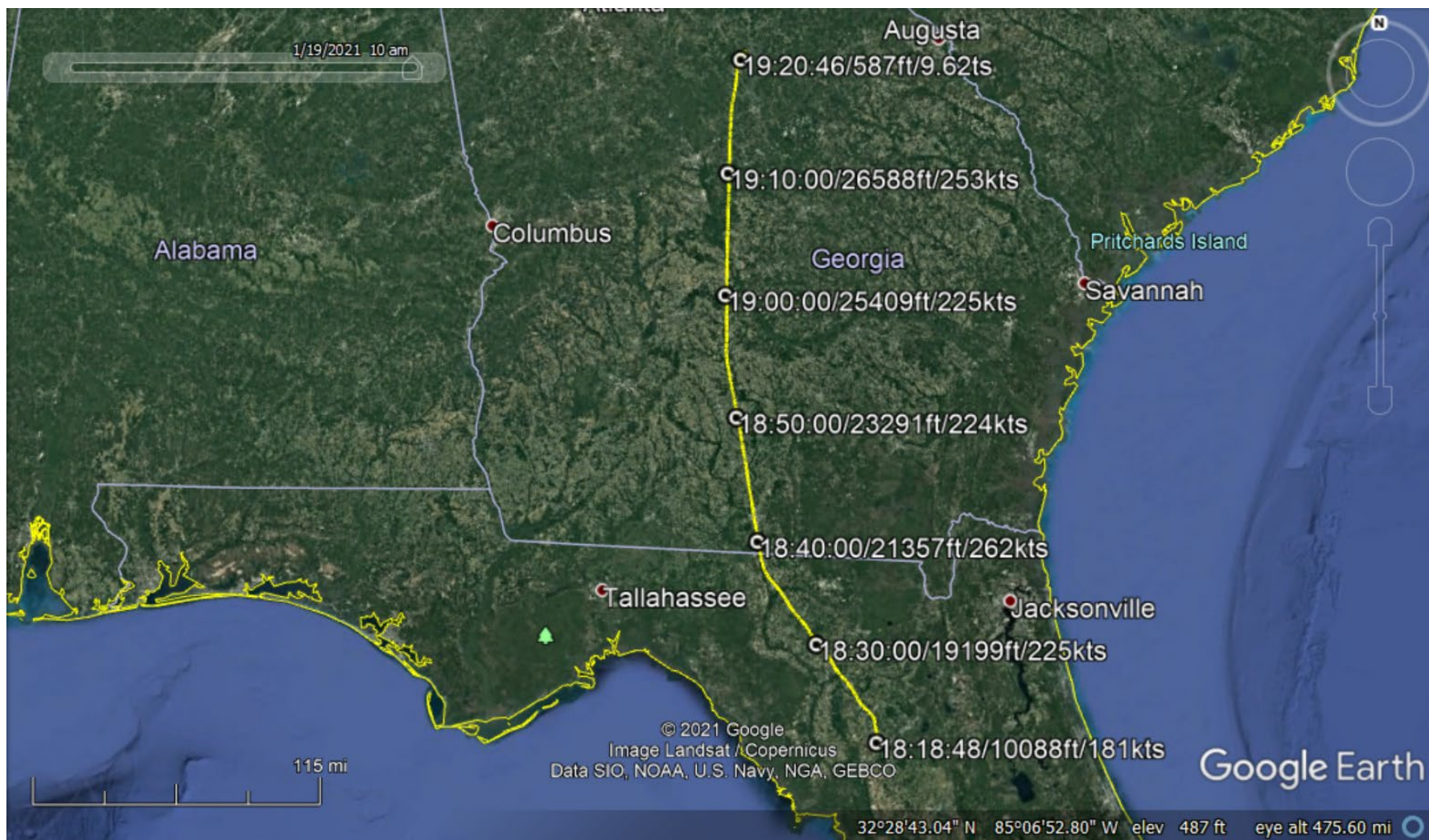


Figure 2. Google Earth overlay of the entire accident flight.

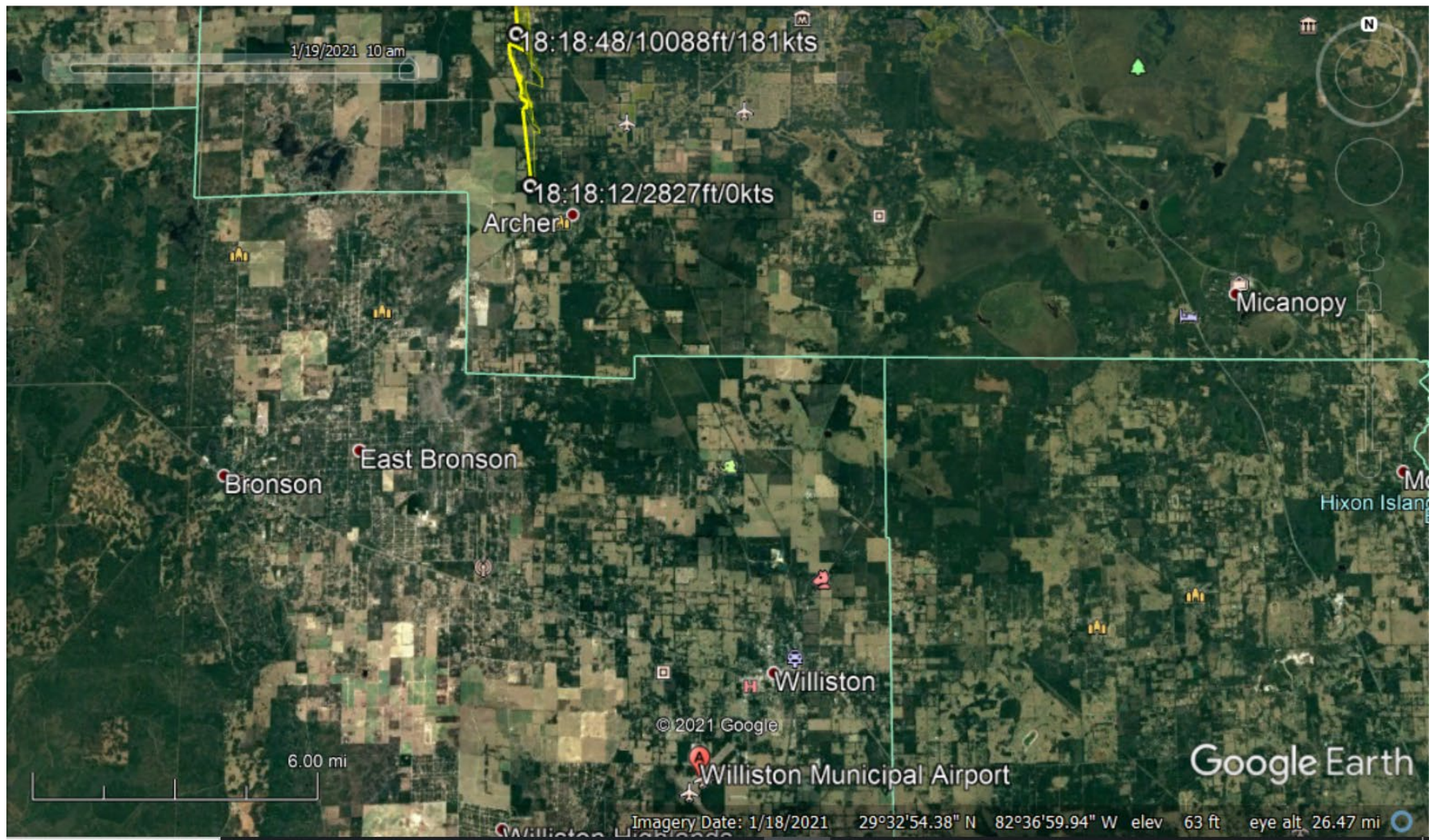


Figure 3. Google Earth overlay showing the start of the recording and Williston Municipal Airport (X60).

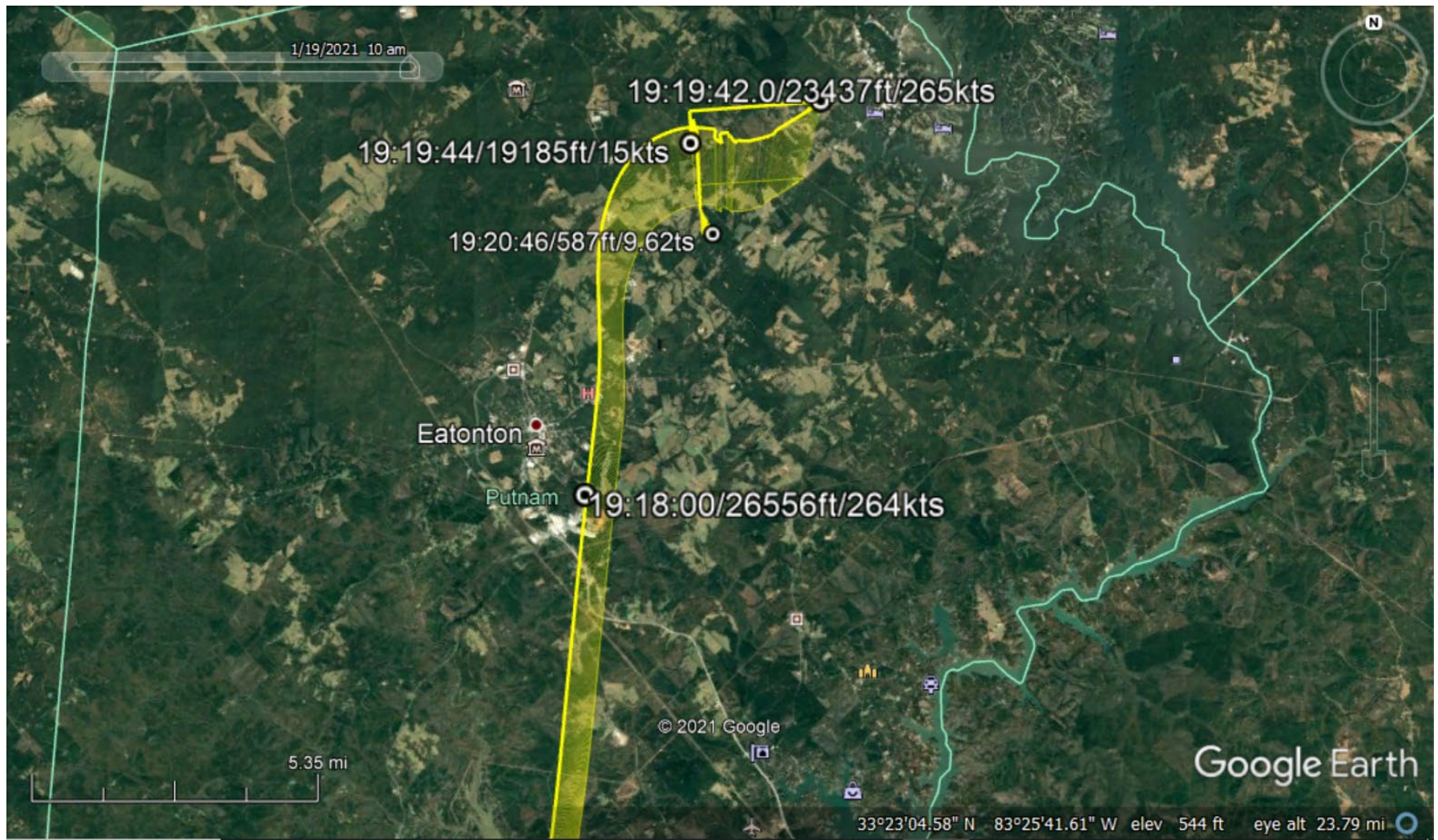


Figure 4. Google Earth overlay showing the end of the accident flight.

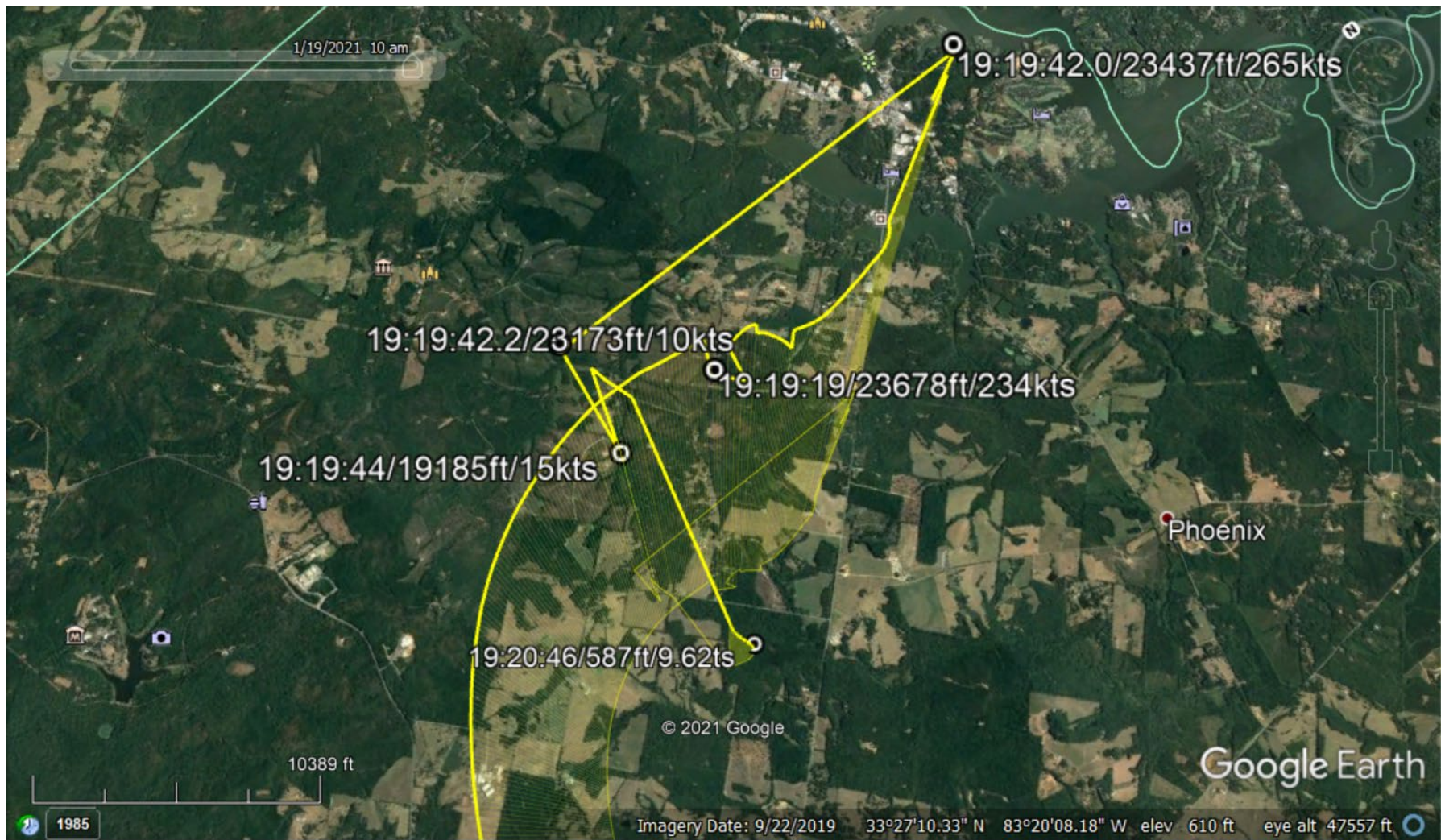


Figure 5. Google Earth overlay showing the end of the accident flight and data points where horizontal and vertical position accuracy was low.



Figure 6. Google Earth overlay showing the last recorded data point and the reported wreckage location.

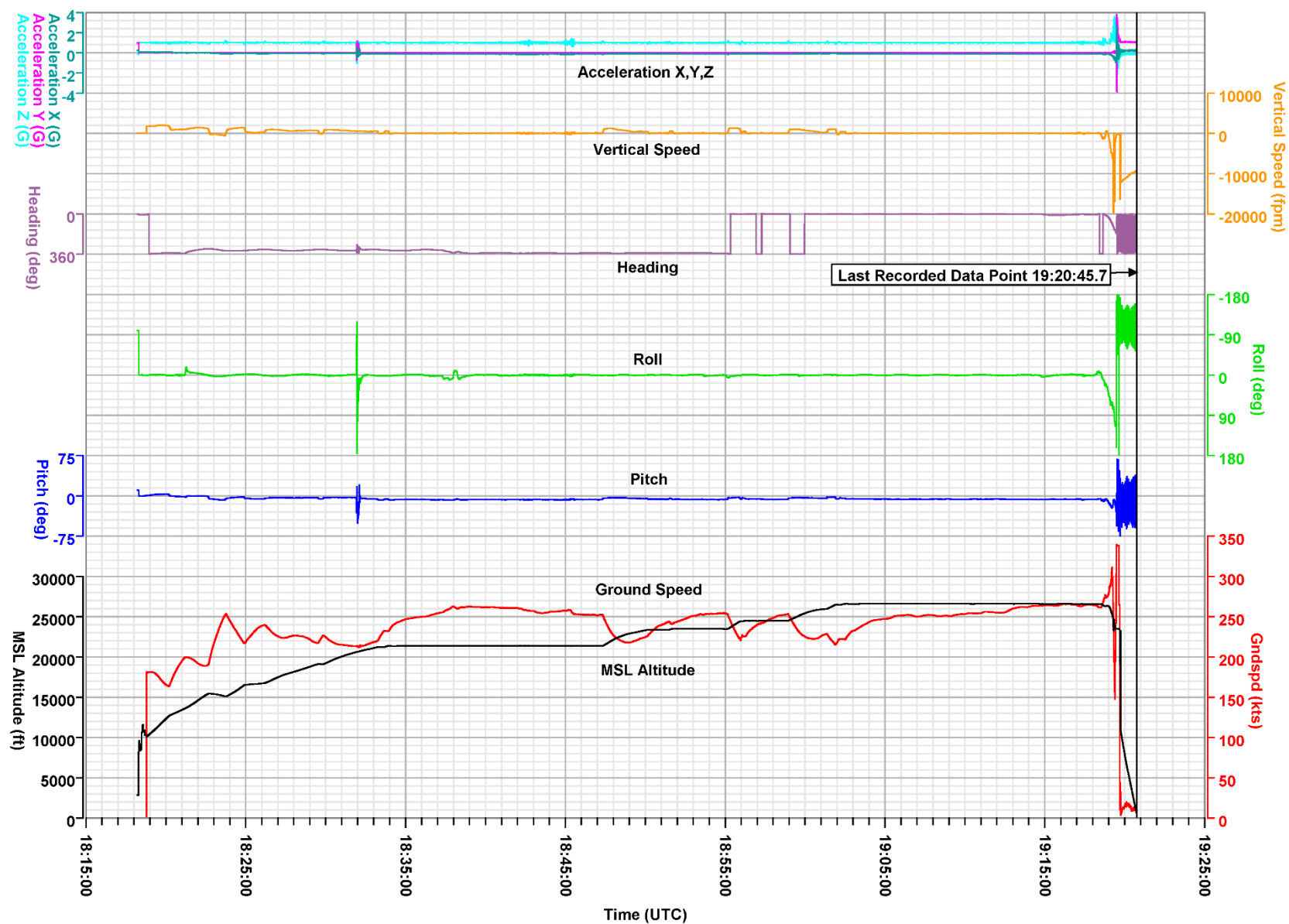


Figure 7. Plot of parameters for the entire accident flight.

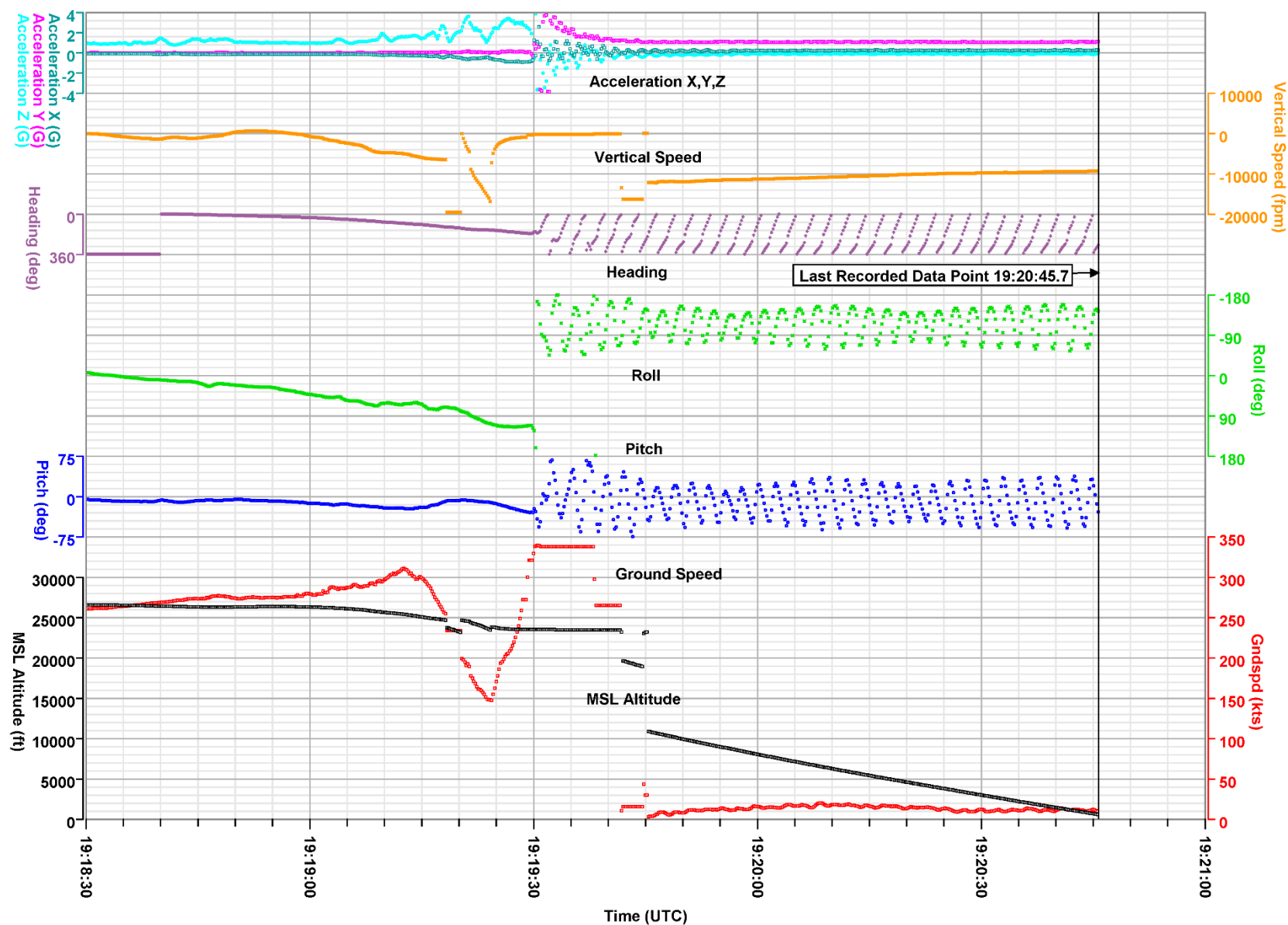


Figure 8. Plot of parameters at the end of the accident flight.