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

June 2, 2021

Global Positioning System (GPS) Device

Specialist's Factual Report
By Sean Payne

1. EVENT SUMMARY

Location: Pineview, GA
Date: April 13, 2021
Aircraft: Cessna A188B
Registration: N4912Q
Operator: A & C Ag Aviation Inc.
NTSB Number: ERA21FA184

2. DETAILS OF INVESTIGATION

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

Device Manufacturer/Model: **SATLOC M3 Bantam**
Serial Number: **1439-HH08201-0093**

2.1. SATLOC M3 Bantam Device Description

The SATLOC M3 is part of an on-board control system designed to programmatically control agricultural, aerial spray operations based on vendor and user specified prescription maps. The SATLOC M3 can drive a cockpit mounted lightbar guidance system and a real-time graphic moving map display providing visual guidance to the pilot. Flow rates can be pilot selected or based on mapping created using a proprietary software package called MapStar that runs on a desktop computer. The SATLOC M3 can record historical information to an internal, compact flash (CF) card.

2.1.1. SATLOC M3 Bantam Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the devices had sustained minor impact damage around a USB connector. No other obvious damage was noted. The device is shown in figure 1. The internally mounted CF card was removed from the SATLOC and data was extracted normally using laboratory tools and the manufacturer's software. The software was used to convert internal log files to comma separated values (.CSV) data files.

Figure 1. The recovered SATLOC M3 Bantam.

2.1.2. SATLOC M3 Data Description

The data extracted included 154 log files. Log files can be associated with either a singular flight, or multiple flights, depending on how the user sets up the unit.

The last log file was determined to pertain to the accident. The last log file was dated April 13, 2020. The accident occurred on April 13, 2021. According to the manufacturer, the unit should record data in UTC, and the user is responsible of setting an offset from UTC to local time. It could not be explained why the unit recorded the date of the log as 2020, however, the log file's data tracklog matched the profile of the accident. Using information related to the time of the accident being reported as 9:00AM EDT[1], the log data ended 05:52:43.450 unit time. To qualify the time, the following was considered: A) this was the last flight on the data log recording. B) the flight matched the profile of the accident flight. C) the last recorded point was only 4,000 feet from the accident site along a congruent heading and D) the time stamp from the unit comes from the GPS system and the time zone is offset by the user. The elapsed minute information was assumed to be correct. To rectify the data to the recorded time of the accident, one year and three hours were added to the data to bring the unit time in line with EDT.

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[1] The accident time was provided by the FAA, and the accuracy of the reported data could not be confirmed.

Regarding the final values recorded by the unit for this log file, data is buffered in volatile[2] memory continuously during the recording and periodically written to the internal flash drive (in this case, an internal CF card). According to the manufacturer, the length of this data buffer varies depending on the internal processor workload but can be on the order of 10-20 seconds, or longer. Data stored in the buffer and not written to the flash drive is permanently lost when power is interrupted to the SATLOC M3 Bantam. When contacted about exploring the device for potentially latent buffered data, the manufacturer did not have experience in recovering any further data.

Table 1 is a list of validated parameters recovered from the log file. Not all parameters have been assigned units. When contacted, the manufacturer was not able to supply unit information for many of the parameters. Date, Time, Latitude, Longitude, GPS Altitude, application rate, DOP, and spray condition are recorded by the device. Groundspeed, groundtrack and application per area are derived from the recorded parameters.

Table 2 describes the unit abbreviations and unit names.

Table 1. Parameter Abbreviations and Parameter Names.

Parameter Abbreviation	Parameter Name
Time (HH:MM:SS.000)	Time
Lat (deg)	Latitude
Lon (deg)	Longitude
Alt (ft GPS)	GPS Altitude
App_Per_Area (gAc)	Application Per Area
App_Rate (gpm)	Application Rate
Date (MM/DD/YYYY)	Date
DOP (no unit)	Dilution of Precision
Hdg (deg true)	Groundtrack
Speed (mph)	Groundspeed
Spray (discrete)	Spray Condition

Table 2. Unit Abbreviations and Unit Names.

Unit Abbreviation	Unit Name
HH:MM:SS.000	Hours: Minutes: Seconds. Subseconds
deg	degrees
deg true	degrees true
discrete	discrete
ft GPS	feet GPS
gAc	gallons per acre
gpm	gallons per minute
mph	miles per hour

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[2] Volatile memory requires a continuous application of power to retain data. Any power interruption will result in irreversible data loss.

2.2.   OVERLAYS AND TABULAR DATA

Figure 2 is a graphical overlay generated using Google Earth for the entire 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. The data has been downsampled in this figure for easier computation and display.

Figure 3 is a graphical overlay generated using Google Earth showing a north-up view of the final recorded tracklog points. The final recorded log point from the exported data log is displayed, as well as the wreckage location as a yellow pin. The wreckage location was approximately 4,000 feet away from the final recorded log point on a heading of roughly 044 degrees true. In the final recorded log data, the aircraft was in a slight climb trend with a speed recorded between 115 and 120 miles per hour (mph). The final recorded GPS altitude was shown as 334 feet and the spray condition had just changed from "on" to "off." The data has been downsampled in this figure for easier computation and display.

Figure 4 is a graphical overlay generated using Google Earth oriented in such a way that it is presented along the flightpath of the final recorded log points. The data has been downsampled in this figure for easier computation and display.

Figure 5 is a screenshot of the Satloc Mapstar software showing the final point of the final log recorded in the software's display. This data varies from the final exported .CSV log exported from the same software. The manufacturer did not have an explanation for this discrepancy.

Figure 6 is a plot of the data presented in the screenshot in figure 5. This final data point was approximately 160 feet from the last exported data point, and along a heading that was congruent to the accident site. The recorded time of this datapoint was approximately 1 second after the last exported tracklog datapoint.

Tabular data used to generate figures 2 through 6 are included as Attachment 1 in electronic comma-delimited (.CSV) format. The data provided in Attachment 1 has not been downsampled as it was for figures 3 through 5.
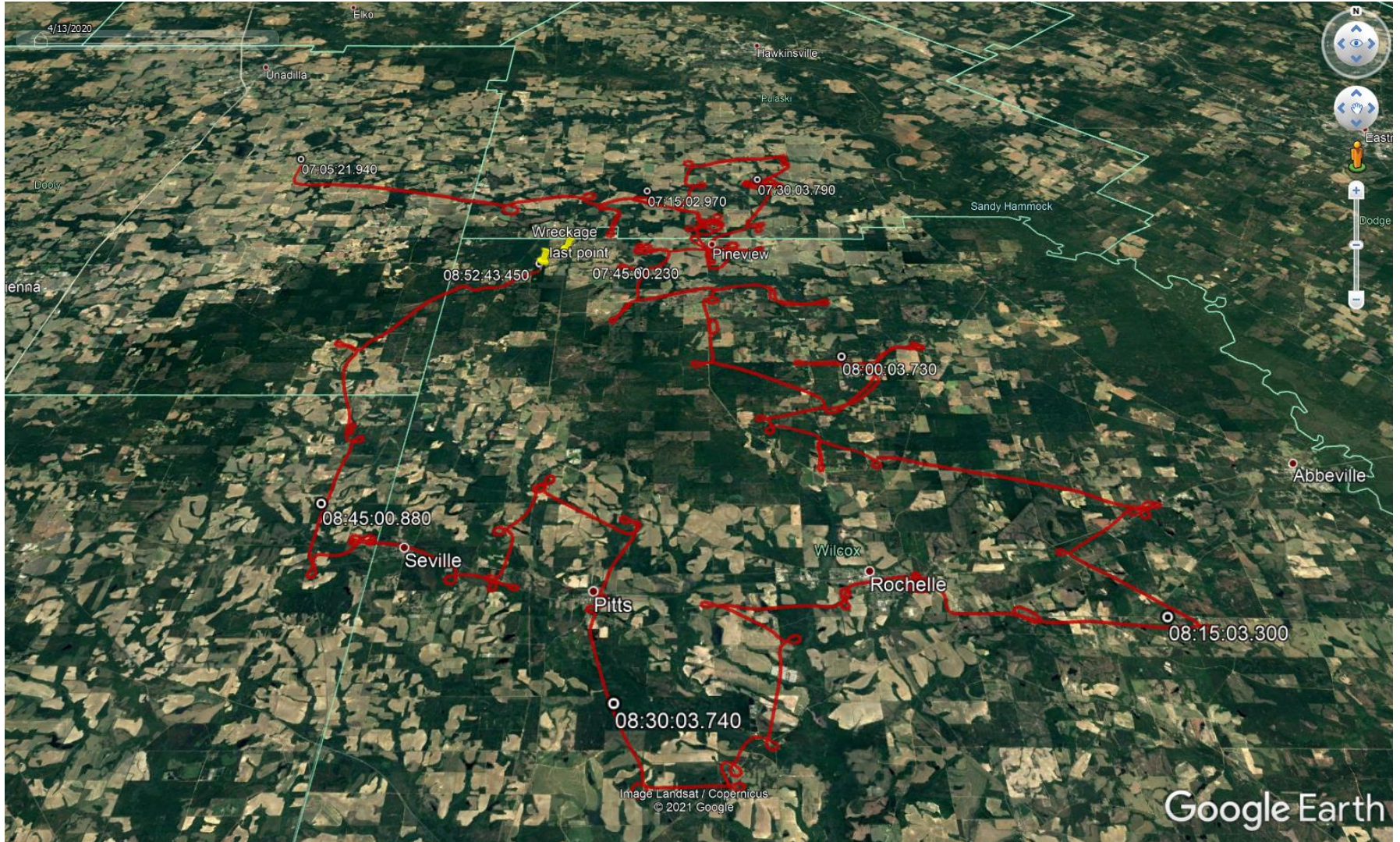
Figure 2. Google Earth overlay showing the flight tracks from the SATLOC device. In addition to the first data point and last data point being labeled, time points are given in 15 minute increments.

Figure 3. Google Earth overlay showing a north-up overview of the final recorded accident flight track. The last data point is displayed as well as a yellow pin indicating the final resting point of the wreckage.
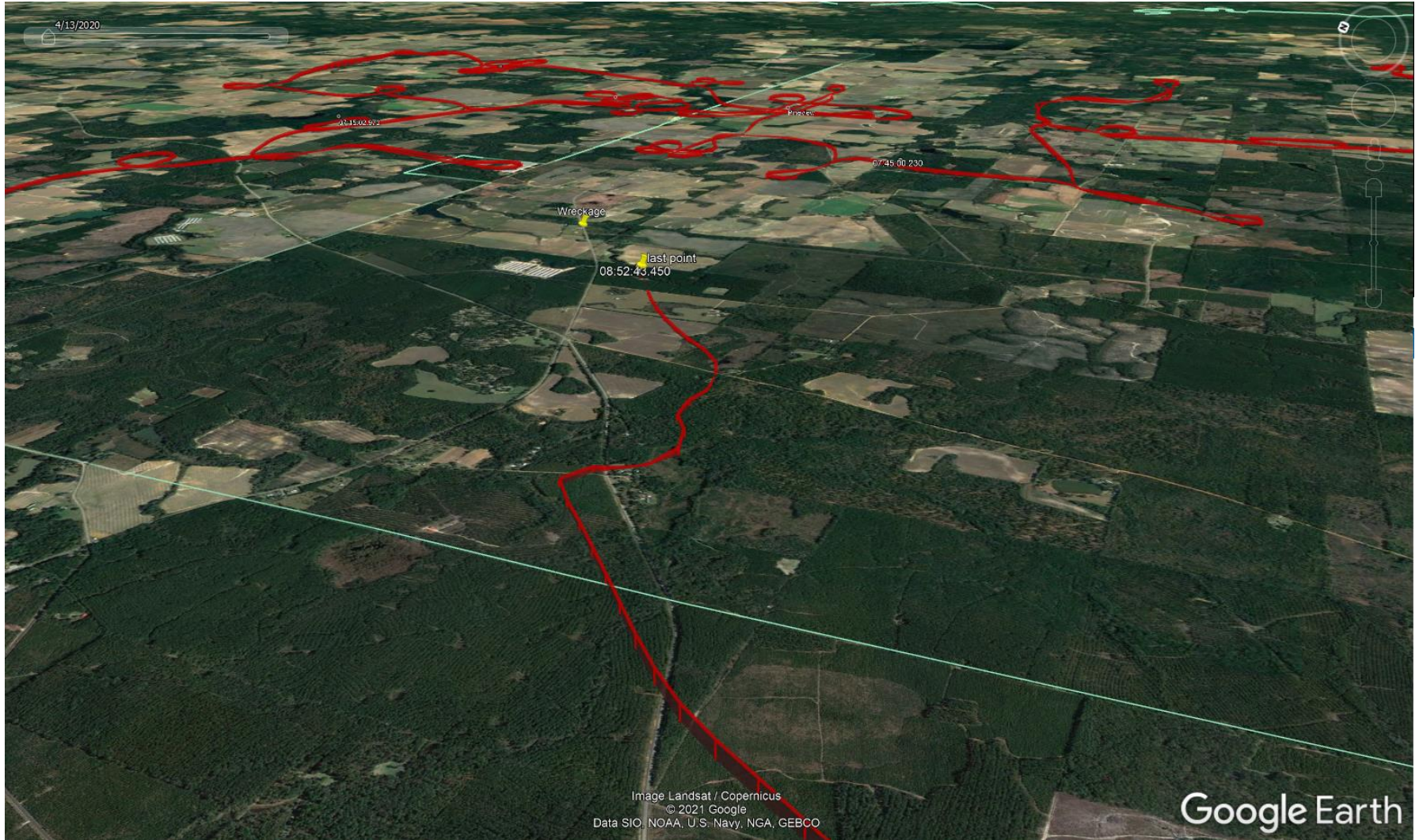
Figure 4. Google Earth overlay showing the end of the recording, oriented in a manner along the final route of flight.

Figure 5. A screenshot of the final display of the SATLOC Mapstar software showing data for the final tracklog point. Note that this display does not contain time offset information.

Figure 6. Google Earth overlay showing the datapoint represented in the Graphical User Interface (GUI) from figure 5 (above).