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

November 25, 2014

Global Positioning System (GPS)

Specialist's Factual Report
by Charles Cates

A. EVENT

Location:	Coldfoot, Alaska
Date:	August 24, 2014
Aircraft:	Ryan Navion A
Registration:	N4827K
Operator:	Kirst Aviation
NTSB Number:	ANC14LA068

B. GROUP

A GPS group was not convened.

C. SUMMARY

On August 24, 2014, a Ryan Navion A airplane, N4827K, was substantially damaged when it impacted terrain while maneuvering in Atigun Pass, approximately 15 nautical miles northeast of Coldfoot, Alaska. The airplane was operated by Kirst Aviation, Fairbanks, Alaska, as an on-demand sightseeing flight under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 135. The commercial pilot and three passengers were seriously injured. Visual meteorological conditions prevailed, and a VFR flight plan was filed. The flight originated at the Fairbanks International Airport about 1003.

D. DETAILS OF INVESTIGATION

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

GPS Manufacturer/Model:	Garmin GPSMAP 196
Serial Number:	65421386

Garmin GPSMAP 196 Device Description

The Garmin GPSMAP 196 is a portable GPS unit equipped with a detachable antenna, and a 320 x 240 12-level grayscale LCD display. The unit is equipped with a built in base map and internal Jeppesen aviation database. The unit employs a parallel 12 channel WAAS-capable receiver and can be operated using external power, or alternatively by four standard AA-size batteries. The GPSMAP 196 is capable of storing date, route of flight, and flight time information for up to 50 individual flights in the form of a flight log. Flight logging begins when the GPS unit senses a speed increase of greater than 30 knots together with an altitude gain of greater than 500 feet. Recorded flight log data is saved when the speed is sensed to decrease to below 30 knots, and a new log is started if more than 10 minutes passes from this time. A detailed track log – including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points – is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Track log position is updated as a function of time or distance moved, depending on how the unit has been configured. Once the current track log memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured. The current track log can be saved to long-term memory and 15 saved track logs can be maintained in addition to the current track log. Track log storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory[1]. The unit contains hardware and software permitting the download of recorded waypoint, route, and track log information to a PC via a built-in serial port using the NMEA 0183 version 2.0 protocol.

GPS Data Recovery

Upon arrival at the NTSB's Vehicle Recorder Division, an exterior examination of the unit revealed that the LCD screen appeared to be cracked, but there was no other exterior damage noted. Power was applied to the unit and the screen damage was confirmed; however, information was extracted normally using the manufacturer's software, without difficulty.

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.

Figure 1. Photo of damaged Garmin GPSMAP 196

GPS Data Description

The data extracted included 10 sessions from August 11, 2014[2] through August 24, 2014. The accident flight was the last session recorded, starting at 19:57:41 UTC and ending 21:04:43 UTC on August 24, 2011. This session contained 395 total data points.

GPS Parameters Provided

Table 1 describes data parameters provided by the GPS device. Date, Time, Latitude, Longitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived from the recorded parameters. Ground elevation and Height Above Ground Level (AGL) are derived using the Google Maps Elevation Service[3].

Table 1: GPS Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (UTC) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded GPS Altitude (feet)
Groundspeed	Average groundspeed between current and previous data point (knots)

[2] All dates and times are referenced to Coordinated Universal Time (UTC).
[3] Google Maps Elevation Service provides elevation data for latitude/longitude pairs. In cases where Google does not possess exact elevation measurements at the precise coordinates, the service will interpolate and return an averaged value using the four nearest locations.

Parameter Name	Parameter Description
Track	Average true course between current and previous data point (degrees)
Elevation	Elevation at Ground Level (feet)
Height AGL	Height Above Ground Level (feet)

OVERLAYS AND TABULAR DATA

All graphical overlays generated in this report were created using Google Earth. Weather shown may not be representative of conditions at the time of the accident.

Figures 2 through 8 show that the aircraft departed the Bettles airport and navigated to Atigun Pass. The track ran coincident with two rivers and the altitude generally remained around 500 ft AGL. While enroute the aircraft circled in several different locations. The last recorded points showed the aircraft climbing in Atigun Pass.

The following is a summary of figures 2 through 8:

- Figure 2 is a graphical overlay of the entire accident flight, and Figure 3 shows the data plotted from the full flight. The flight departed the Bettles airport and the aircraft track generally followed the Koyukuk River to the northeast, maintaining about 500 ft AGL. At about 20:48 UTC, the aircraft made four circles at the point where the Koyukuk joins the Dietrich River. The recorded altitude and terrain data showed that during the maneuvering the aircraft was as low as 139 ft AGL. Following the maneuvering, the aircraft track then continued north coincident with the Dietrich River, and climbed back to about 500 ft AGL.

  At about 21:02 UTC, the aircraft passed the Chandalar Shelf Airport at about 365 ft AGL headed north towards Atigun Pass. The last recorded data point, at 21:04:52 UTC, shows the aircraft at 4564 ft GPS altitude (about 36 ft AGL) and in a shallow climb with a ground speed of 41 knots.

- Figure 4 shows the track for the first 30 minutes of the accident flight. The aircraft took off at about 20:01:15 UTC and made one circle around the town of Evansville immediately after takeoff while climbing to 500 ft AGL.

- Figure 5 shows the track for the second half hour of the flight. The period of low altitude maneuvering discussed above is depicted in the middle of this image.

- Figure 6 is a Google Earth view looking southwest from Atigun Pass at the accident site and the track of the airplane for about the final 10 minutes of the flight.

- Figure 7 shows the track of the airplane as it completed a right turn leading up to Atigun Pass. At the initial point in the image the aircraft is at 4,308 feet (682 feet AGL). The aircraft continued to climb for the remainder of the recording, however the underlying terrain was also rising, resulting in a net decrease in height above terrain until the end of the recording.

- Figure 8 shows a plot of the recorded data from the last 10 minutes of the flight. It shows that the aircraft was climbing for the full 10 minutes, however the ground elevation rose faster than the aircraft was climbing. In the final two and a half minutes, ground speed decayed from 105 knots to 41 knots. In the final minute, as the aircraft climbed from 4,308 feet to 4,564 feet, height above ground level decayed from 682 feet to 36 feet.

Figure 2. Google Earth aviation sectional overlay showing entire accident flight.

Figure 3. Plot showing recorded data for entire flight.

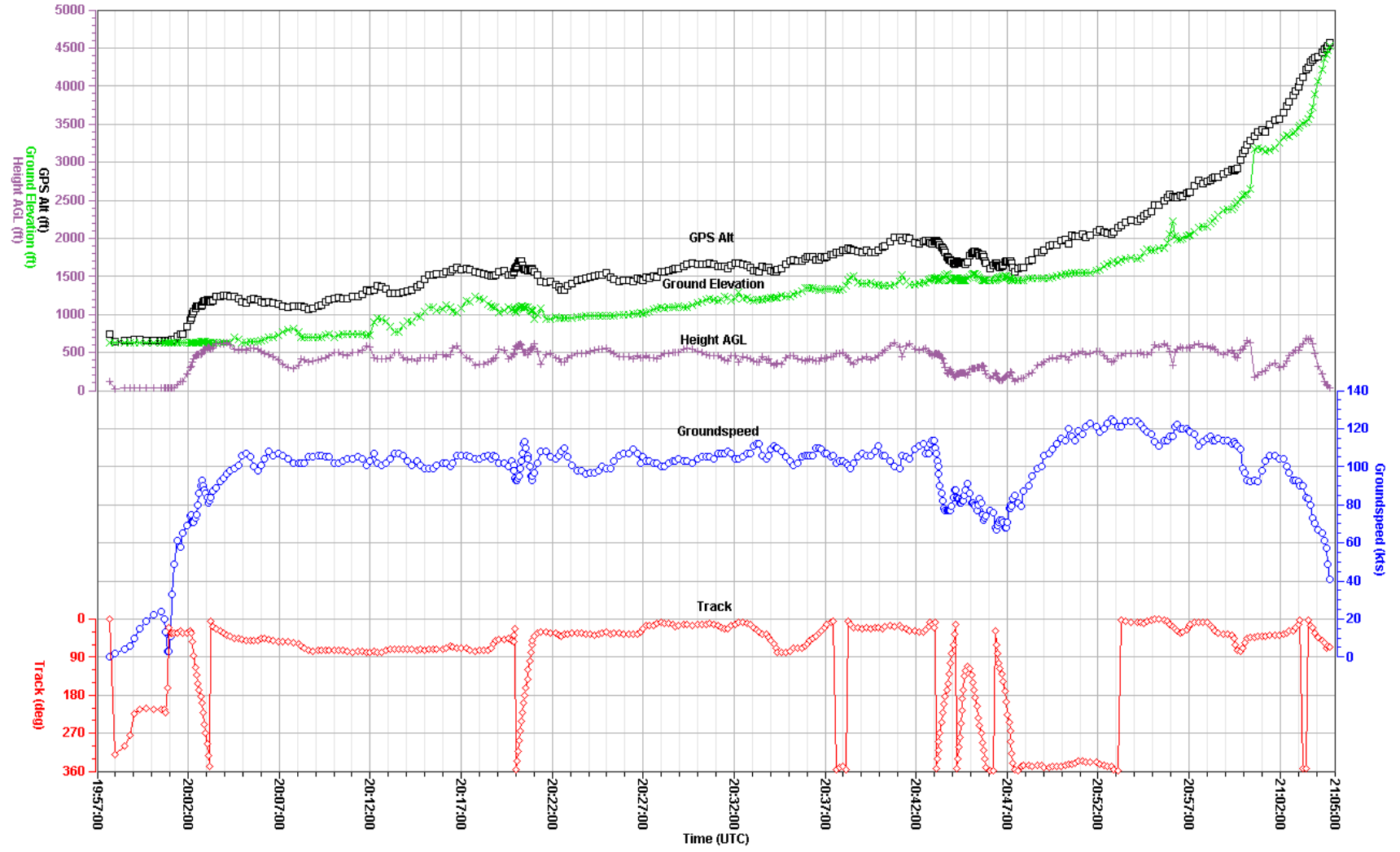


Figure 4. Google Earth overlay showing first 30 minutes of accident flight

Figure 5. Google Earth overlay showing second 30 minutes of accident flight

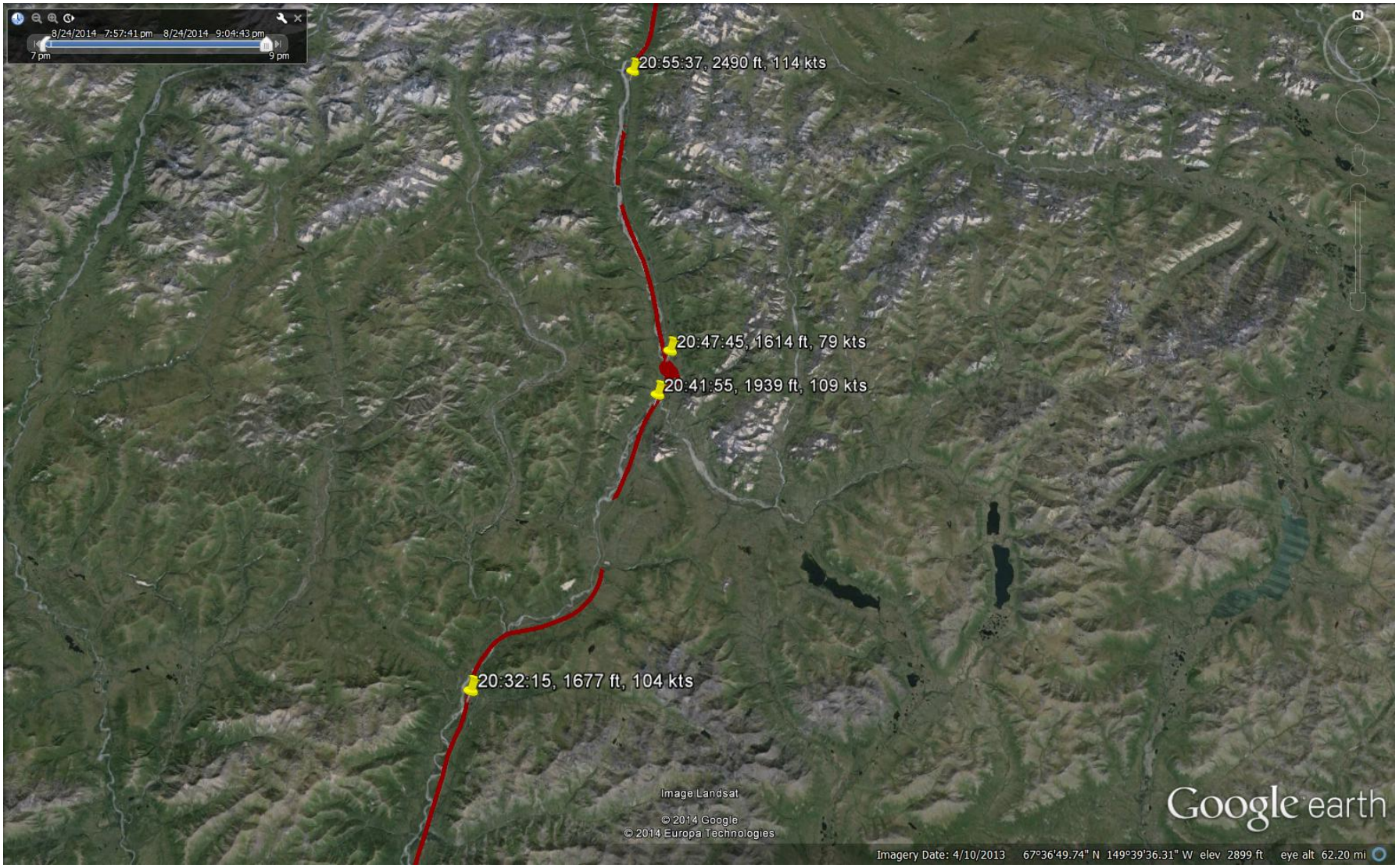


Figure 6. Google Earth overlay looking southwest from Atigun Pass to accident site.

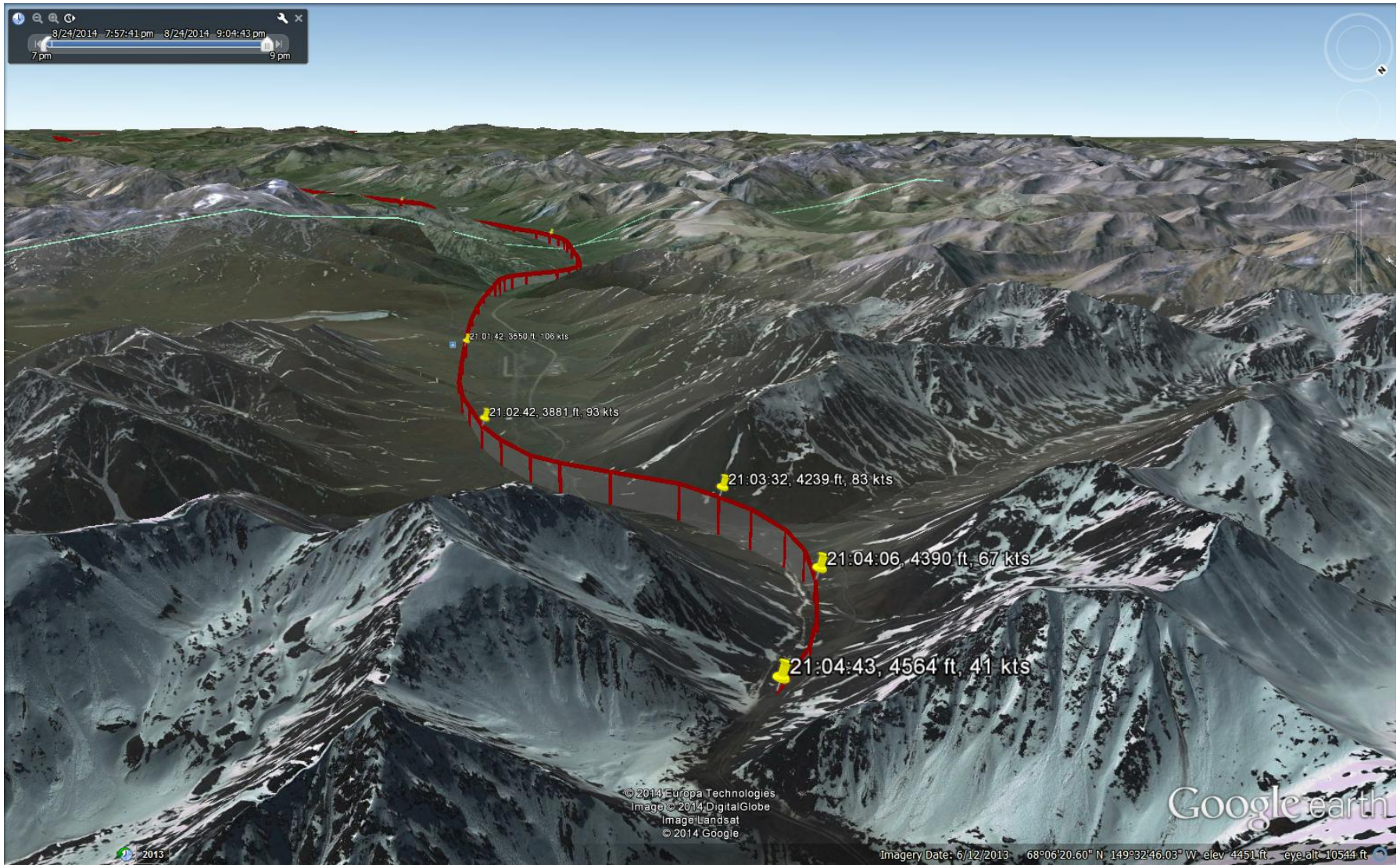


Figure 7. Google Earth overlay showing aircraft track rounding final curve to Atigun Pass

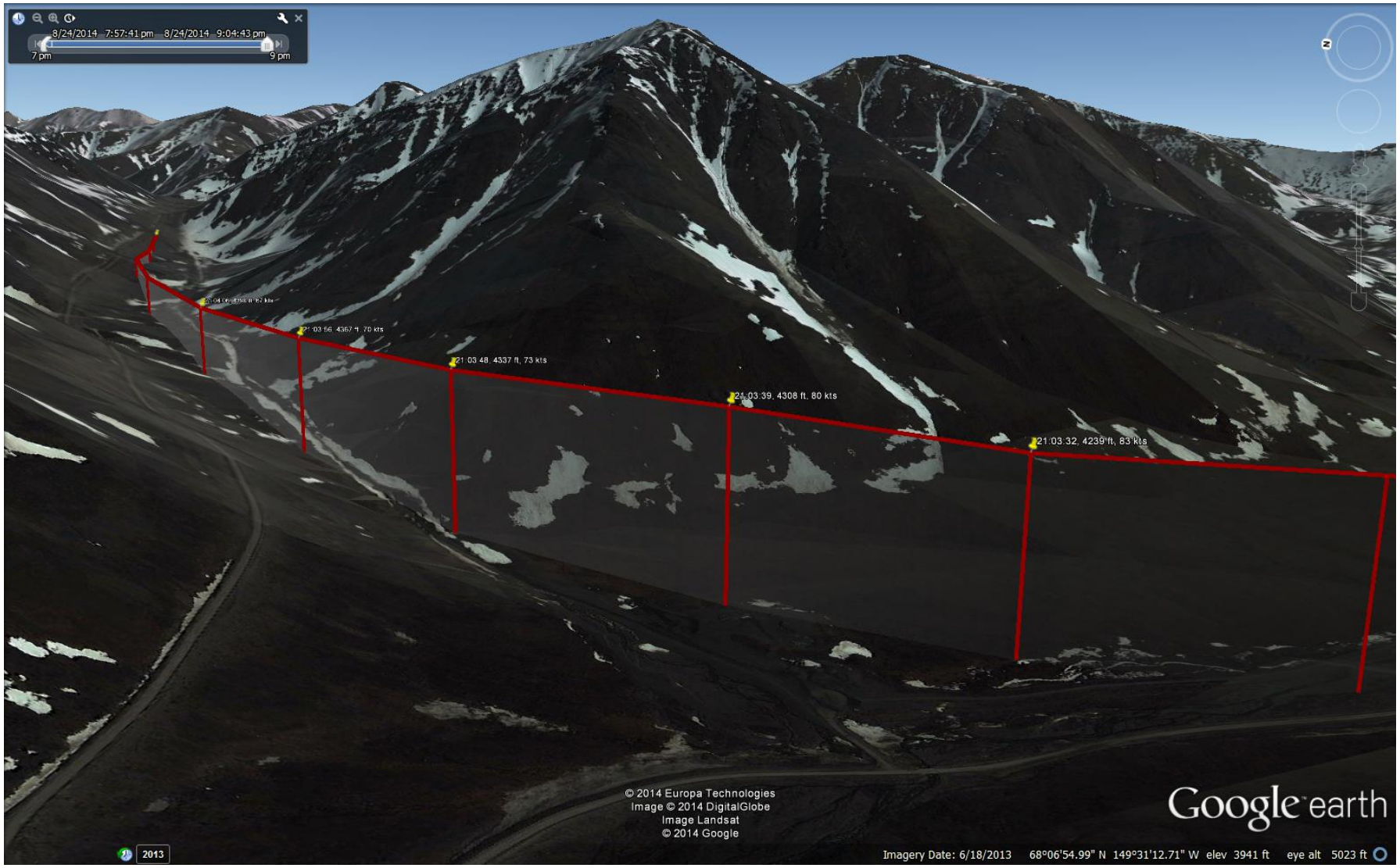
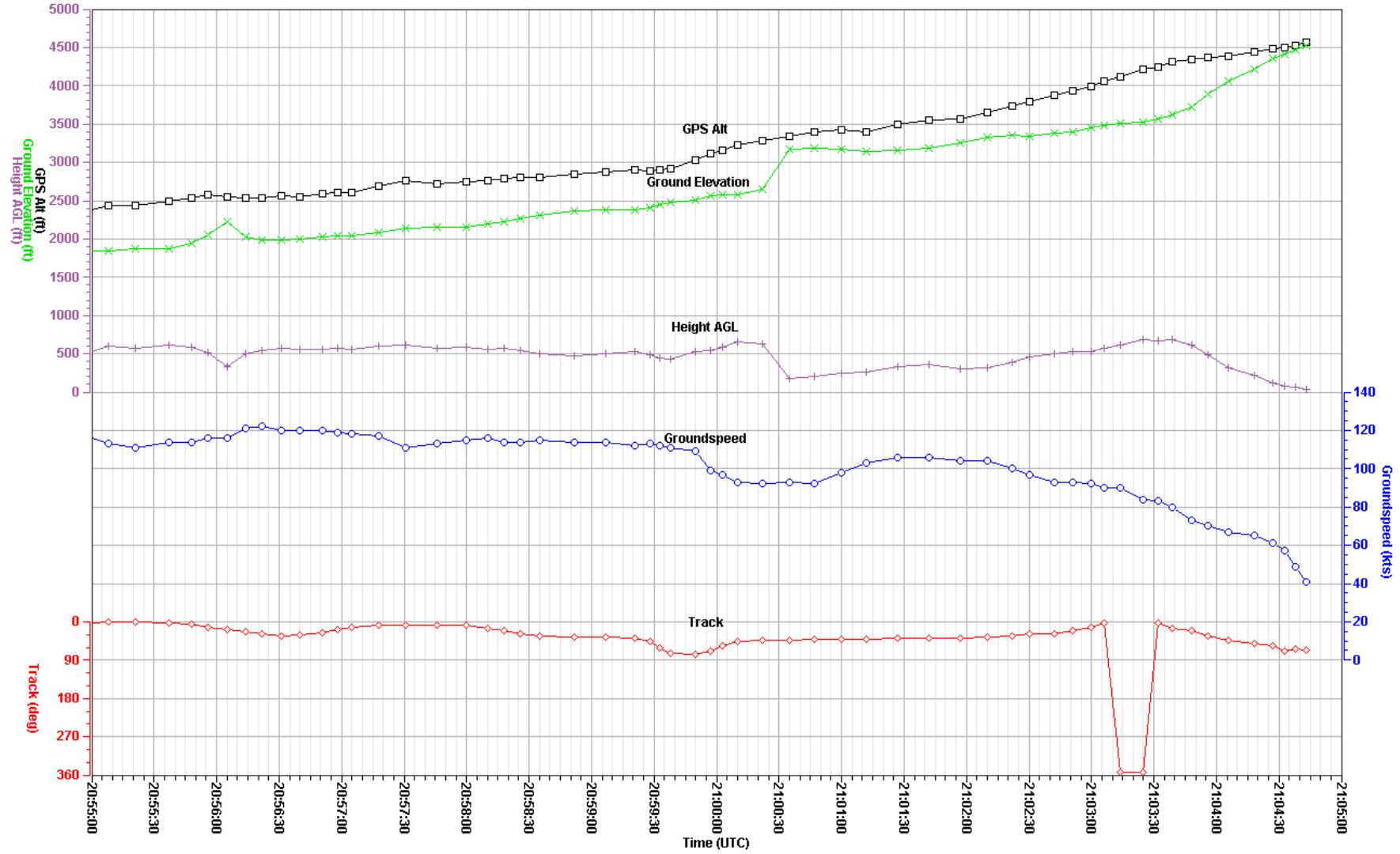


Figure 8. Plot showing recorded data from final 10 minutes of accident flight



Revised: 25 November 2014 GPS Parameters National Transportation Safety Board