

National Transportation Safety Board
Office of Research and Engineering
Washington, D.C. 20594

Airplane Performance Study

Specialist Report
Timothy Burtch

A. ACCIDENT

Location:	San Antonio, Texas
Date:	January 25, 2017
Time:	1540 CST (2140 GMT)
Airplane:	Cirrus SR22, Registration N401SC
NTSB Number:	CEN17FA084

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On January 25, 2017, about 1540 central standard time (CST), a Cirrus Design SR22, N401SC, was substantially damaged when it impacted trees and terrain about one mile southeast of the Stinson Municipal Airport (SSF), San Antonio, Texas. The pilot was fatally injured. The airplane was registered to and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Visual meteorological conditions prevailed for the short eight-minute flight. No flight plan had been filed. The flight originated from the San Antonio International Airport (SAT) about 12 nautical miles (NM) to the north at about 1532.

Federal Aviation Administration (FAA) air traffic control (ATC) radar data indicate that the flight departed from runway 4 at SAT and proceeded southbound toward SSF at an altitude of about 2,500 feet (ft) mean sea level (msl). At 1535, the pilot contacted the SSF control tower and was instructed to enter a right downwind for runway 32, a 4,128 ft by 100 ft, asphalt, runway. At 1538, the SSF tower controller cleared the pilot to land. The controller subsequently observed the airplane turn from downwind to base in the traffic pattern. He did not observe the accident sequence itself.

See Figures 1 and 2 for pictures of the accident airplane and the accident site, respectively.

D. PERFORMANCE STUDY

The accident airplane was equipped with an Avidyne Primary Flight Display (PFD) with a logging function as well as an Avidyne Multifunction Display (MFD). Both contained recorded data from the accident flight that were successfully recovered and used in the performance study. See the “Cockpit Displays – Recorded Flight Data Specialist’s Factual Report” for more details on the PFD and MFD.

In addition, secondary radar returns (transponder code 0433) from the short-range Airport Surveillance Radar (ASR-9) located north of SAT and approximately 14 NM north of the accident site were used in the study. Short-range radar data have approximately a 60 NM range and an inherent uncertainty of ± 2 Azimuth Change Pulses (ACP) = $\pm (2 \text{ ACP}) \times (360^\circ/4096 \text{ ACP}) = \pm 0.176^\circ$ in azimuth, ± 50 ft in altitude, and $\pm 1/16$ NM in range.

Times in the study are reported in CST as well as Greenwich Mean Time (GMT or “Z”): CST = GMT – 6 hr.

Weather Observation

Stinson Municipal Airport is an official weather reporting station. The weather reported at SSF about thirteen minutes after the accident is as follows:

METAR KSSF 252153Z 01012KT 10SM CLR 21/M06 A2992 RMK AO2

Plain text: KSSF weather on the 25th at 2153 GMT / 1553 CST, the wind is from 010° (true) at 12 knots (kt), visibility 10 statute miles (SM), clear, temperature 21° Celsius (C), dew point -6°C, altimeter 29.92 inches Hg. Remarks: Automated station with precipitation discriminator.

See the “Meteorology Weather Study” for more detailed weather information.

Airplane Ground Track, Altitude, and Airspeed

N401SC approached SSF from the north and entered a 45° leg to the right downwind for runway 32. (See Figures 3 and 4 for an overview of the ground track. The radar “points” in the figures are actually boxes shown in red. This is because of the uncertainty associated with the radar data mentioned earlier.) The airplane was at about 117 kt calibrated airspeed (KCAS) and 1,400 ft mean sea level (msl) when it entered a right downwind for runway 32. See Figure 5.

The data show that the airplane slowed to about 95 KCAS and descended to about 1,200 ft msl on the downwind leg. The airplane then entered a continuous right turn from downwind towards final¹. Recorded data indicate that, at 1539:44 CST, the airplane briefly leveled and started climbing again at 177 ft/min while in the base position. At this point, the airplane was

¹ The pilot did not fly a traditional “box” or rectangular traffic pattern. Instead, the pilot flew a circling base to final pattern.

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quickly approaching the extended runway centerline to runway 32 (denoted in green in Figure 4) at an airspeed of 103 KCAS, an altitude of 796 ft msl (219 ft above the airport), and in a right bank of about 48°. The wind from the northeast was pushing the airplane to the south as highlighted in Figure 4: this would increase the right bank angle/right aileron required to align and to stay aligned with the runway.

A second later, at 1539:45 CST, the airplane started to descend again, and six seconds later the airplane was descending at over 1,800 ft/min (fpm) with the right bank angle continuously increasing. Figures 6 and 7 include time histories of the airplane's altitude, speed, and attitude recorded on the Avidyne and estimated from radar during the eight-minute flight.

A witness reported observing the airplane from the opposite side of the San Antonio River and stated that the airplane's wings were "totally vertical." A second witness observed the airplane for about two seconds before it descended below the tree line and stated that the airplane appeared to be northbound with the wings oriented nearly vertical. The Avidyne and radar data as well as the witness reports suggest that the airplane stalled around the base position in the circling pattern to runway 32 at SSF.

However, stall speed calculations performed by both Cirrus Corporation and the NTSB (that include normal load factor from the Avidyne) indicate that N401SC still had margin to stall.

$$C_L = \frac{n_z W}{qS} \quad \text{where,}$$

vertical load factor, n_z (from Avidyne)
gross weight, $W = 2,324 \text{ lb}$ (estimated)
dynamic pressure, $q = \frac{1}{2} \rho V^2$
wing area, $S = 144.9 \text{ ft}^2$ (as per Cirrus Corporation)

$$\text{or, } C_{L_{max}} = \frac{2n_z W}{\rho V_S^2 S}$$
$$V_S = \sqrt{\frac{2n_z W}{C_{L_{max}} \rho S}} \quad (1)$$

See Figure 8 for a comparison of the estimated stall speed from equation (1) to the indicated airspeed recorded on the Avidyne. The recorded airspeed was always about 20 kt faster than the estimated stall speed at the accident conditions, suggesting there was sufficient speed margin to stall on the turn to final approach.

Angle-of-attack (AOA), α , was also computed as a second means to quantify the margin to stall in the accident. Unlike the stall speed calculation above, this approach accounted for sideslip. The large lateral acceleration recorded on the Avidyne suggests that N401SC was

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experiencing large sideslip angles during the circling turn to final at the end of the flight². The sideslip was computed using Avidyne data and equation (4) below. The computed sideslip is shown in Figure 9. Note: Cirrus Corporation indicated that flight test data show that sideslip angles increase the stall speed³ for the SR22.

AOA was estimated from parameters recorded on the Avidyne using equations (2), (3), and (4) and is shown in Figure 10.

$$\alpha = \tan^{-1} \left(\frac{\tan \theta}{\cos \phi} \right) - \sin^{-1} \left(\frac{\sin \gamma + \sin \beta \cos \theta \sin \phi}{\cos \beta \sqrt{1 - \cos^2 \theta \sin^2 \phi}} \right) \quad (2)$$

pitch angle, θ (from Avidyne)

bank angle, ϕ (from Avidyne)

$$\text{flight path angle, } \gamma = \sin^{-1} \left(\frac{\dot{h}}{V_T} \right) \quad \text{where,} \quad (3)$$

rate of climb, $\dot{h}$ (from Avidyne)

airspeed, V_T (from Avidyne)

$$\text{sideslip angle, } \beta = \frac{C_Y}{\frac{\partial C_Y}{\partial \beta}} \quad \text{where,} \quad (4)$$

$$\text{sideforce coefficient, } C_Y = \frac{Y}{qS}$$

$$\text{sideforce, } Y = W n_y$$

lateral load factor, n_y (from Avidyne)

$$\text{stability derivative, } \frac{\partial C_Y}{\partial \beta} = -0.637456 \quad (\text{as per Cirrus Corporation})$$

The estimated AOA exceeded the stall angle provided by Cirrus Corporation of about 24° at approximately 1539:48, two seconds before the Avidyne recorded a descent rate of over 1,800 fpm. Figures 11 and 12 show the sideslip angle and AOA, respectively, for the last two minutes of flight.

Figure 14 shows the stall speeds from the Airplane Performance Operating Handbook (POH). The airplane manufacturer estimates that the Cirrus SR22 wing will stall at 70 KCAS and 84 KCAS at bank angles of 45° and 60°, respectively. However, the stall speeds published in the POH assume power off, level flight, and a maximum airplane gross weight of 3,400 lb. The accident airplane, on the other hand, had an estimated gross weight of 2,324 lb and likely was

² Airplane control inputs were not recorded; however, the recorded lateral acceleration indicate that the pilot was inputting left rudder pedal.

³ This is most likely due to the reduced chordwise flow and reduced dynamic pressure at the wing. See Figure 13.

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carrying some power. Both the lighter gross weight and power would lower the stall speed. However, the lower stall speeds in the POH do not account for sideslip, which was present in the accident.

E. SUMMARY AND CONCLUSIONS

According to Avidyne, radar, wind, and airplane manufacturer data, the pilot of N401SC exceeded the critical angle-of-attack while turning base during approach to Stinson Municipal Airport. The airplane was approximately 600 ft agl when the pilot turned a right, circling, one half nautical mile base for runway 32. Recorded data indicate that the sideslip angle exceeded 15°-20° during the turn. The estimated AOA exceeded the stall angle of about 24° about two seconds before the Avidyne recorded a descent rate of over 1,800 fpm.

It is possible that the pilot may have been performing a sideslip maneuver while turning base to avoid overshooting the runway centerline as drawn in Figure 15. An intentional slip can be used to adjust airplane ground track during an approach and is often used when a crosswind is present. A sideslip is a combination of forward movement and sideward movement (toward the low wing). In the case of the accident, the right crosswind would have required a sideward movement to the right and exacerbated the right bank angle required in the turn as shown in Figure 15.

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F. Figures



Figure 1: Accident Airplane N401SC, a 2004 Cirrus Corporation SR22



Figure 2: Accident Site

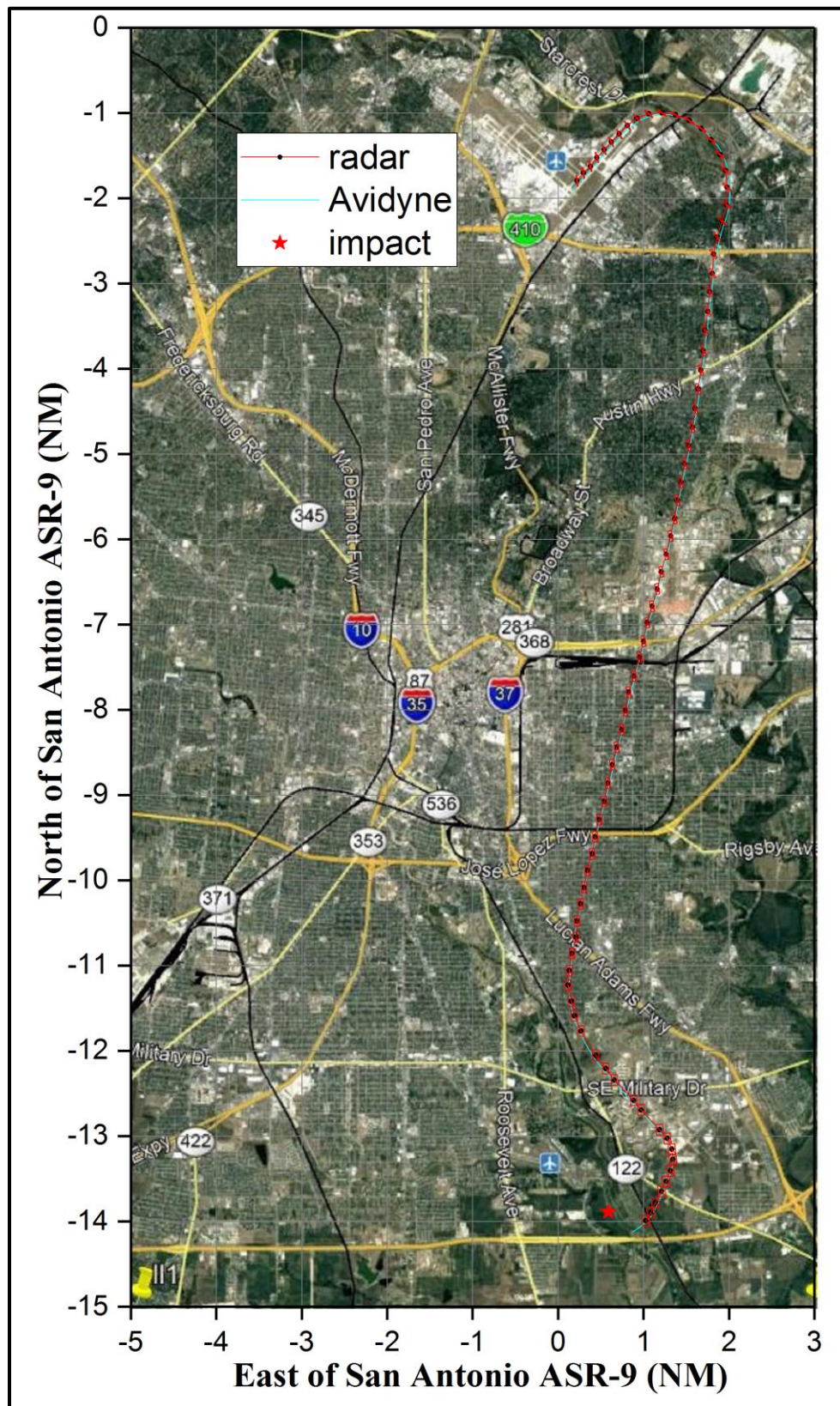


Figure 3: Ground Track for Flight from SAT

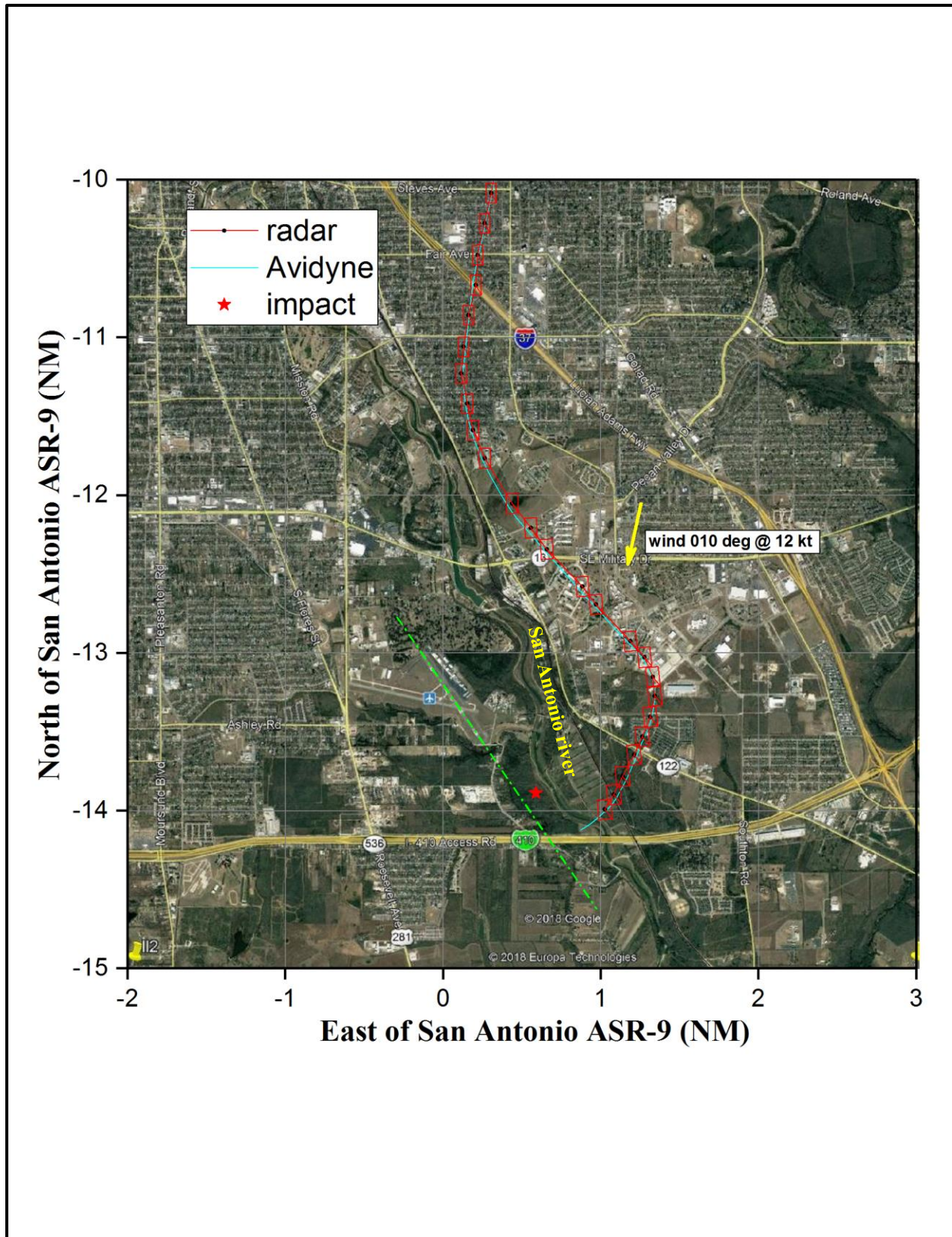


Figure 4: Ground Track Near Accident Site with Extended Runway Centerline

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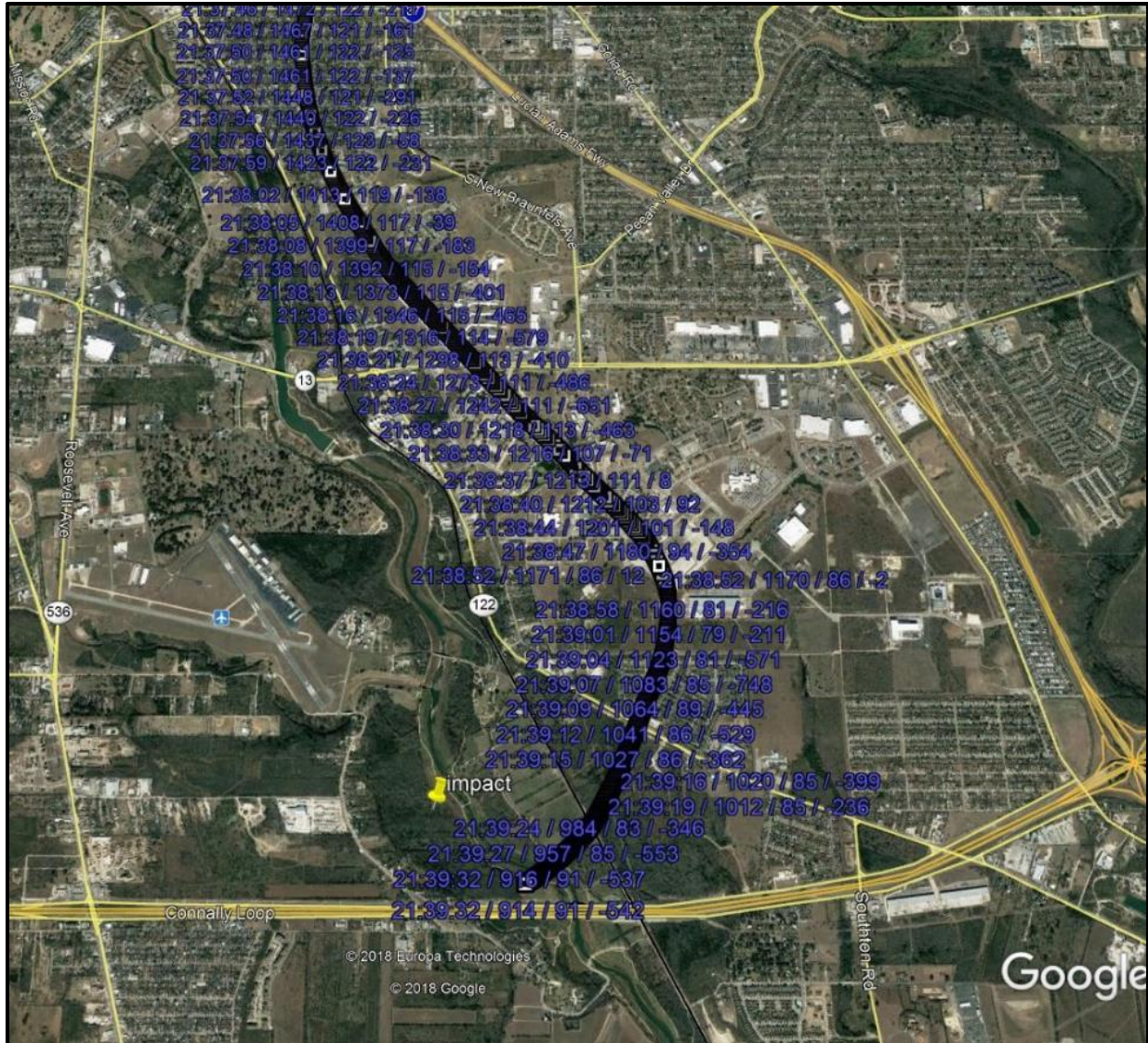


Figure 5: Ground Track Near Accident Site with Time (GMT), Altitude (ft, msl), Estimated Airspeed (kt), and Rate of Climb (ft/min)

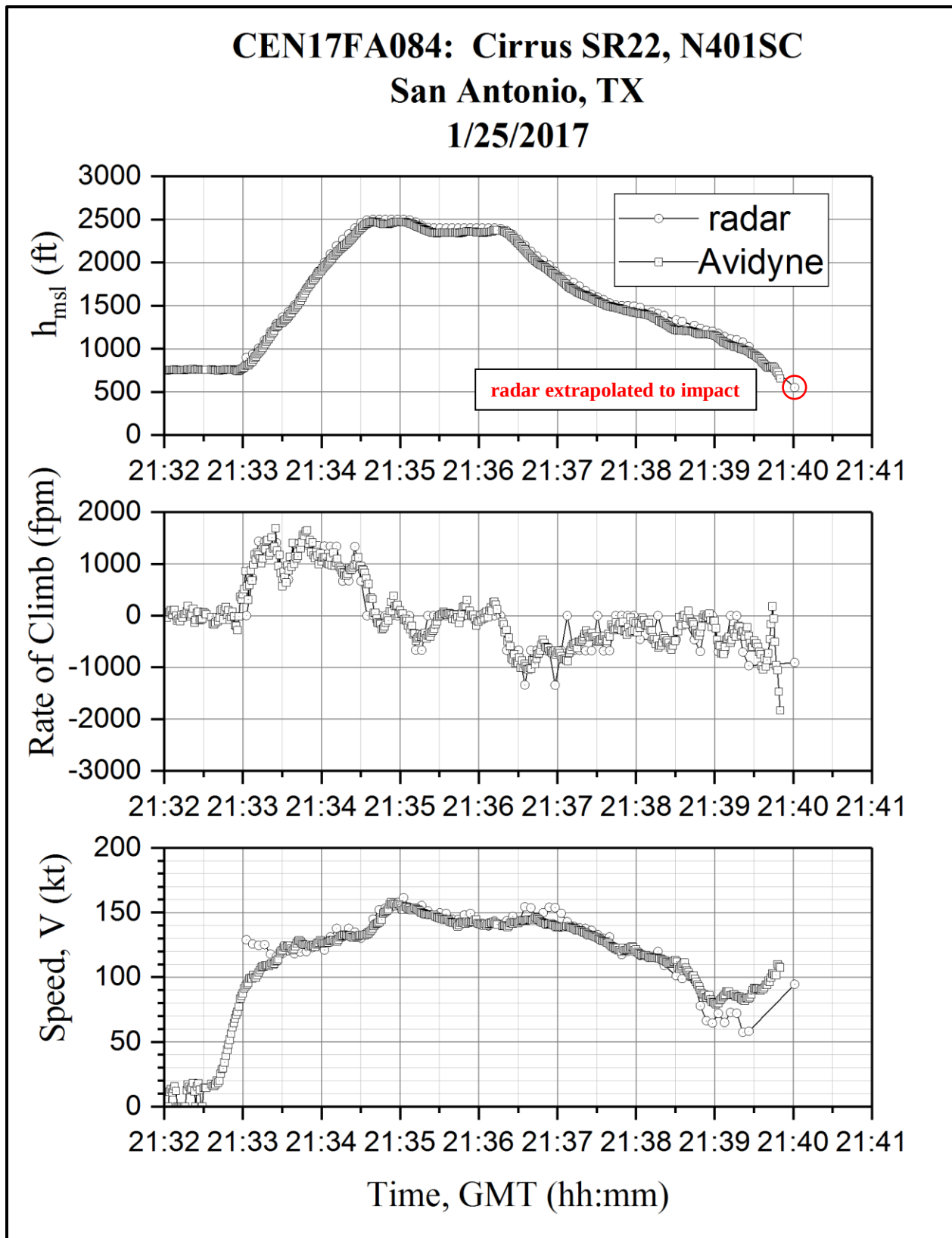


Figure 6: Altitude and Calibrated Airspeed Based on Avidyne and Radar Data

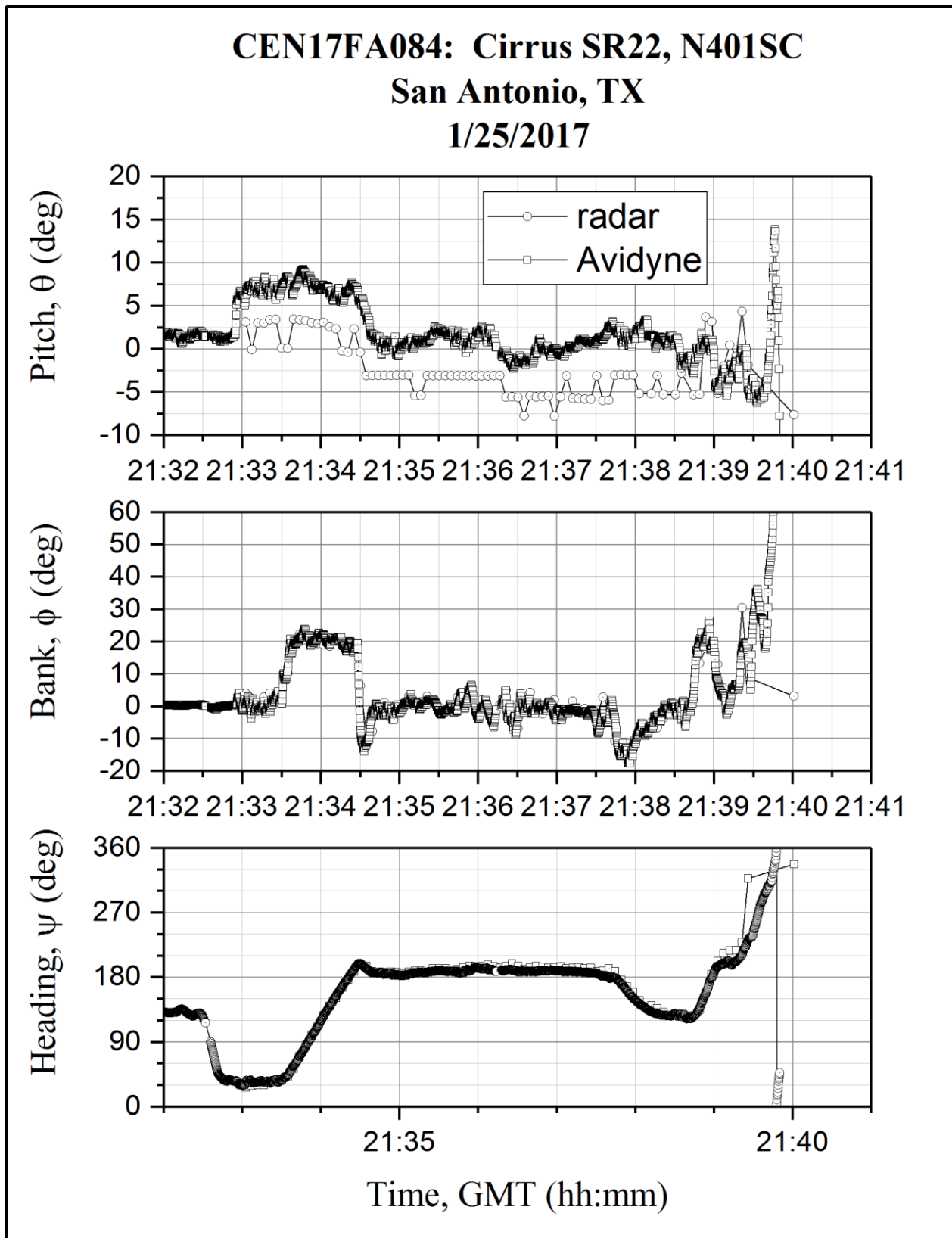


Figure 7: Pitch, Bank, and Heading Based on Avidyne and Radar Data

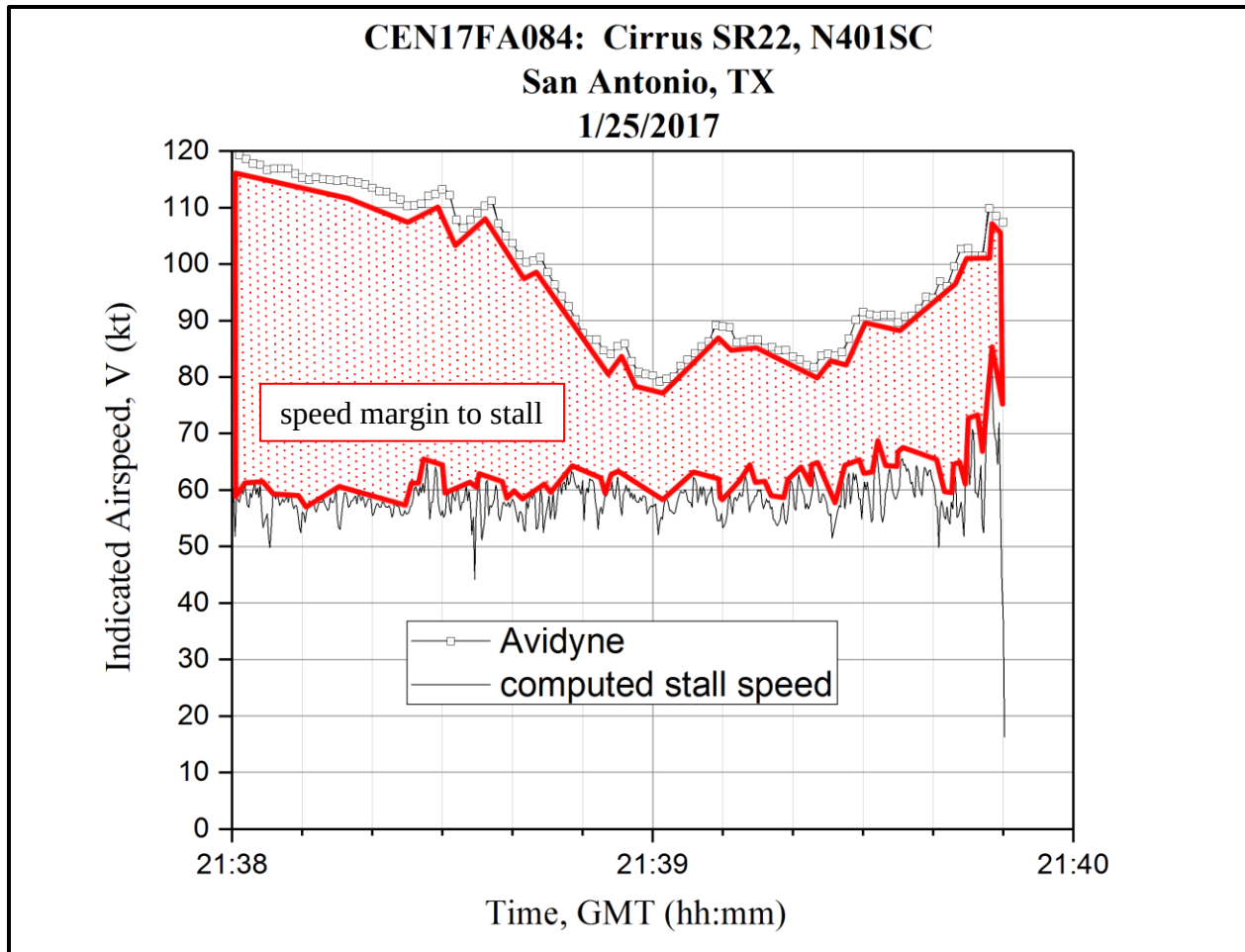


Figure 8: Indicated Airspeed vs. Computed Stall Speed Based on Avidyne Data

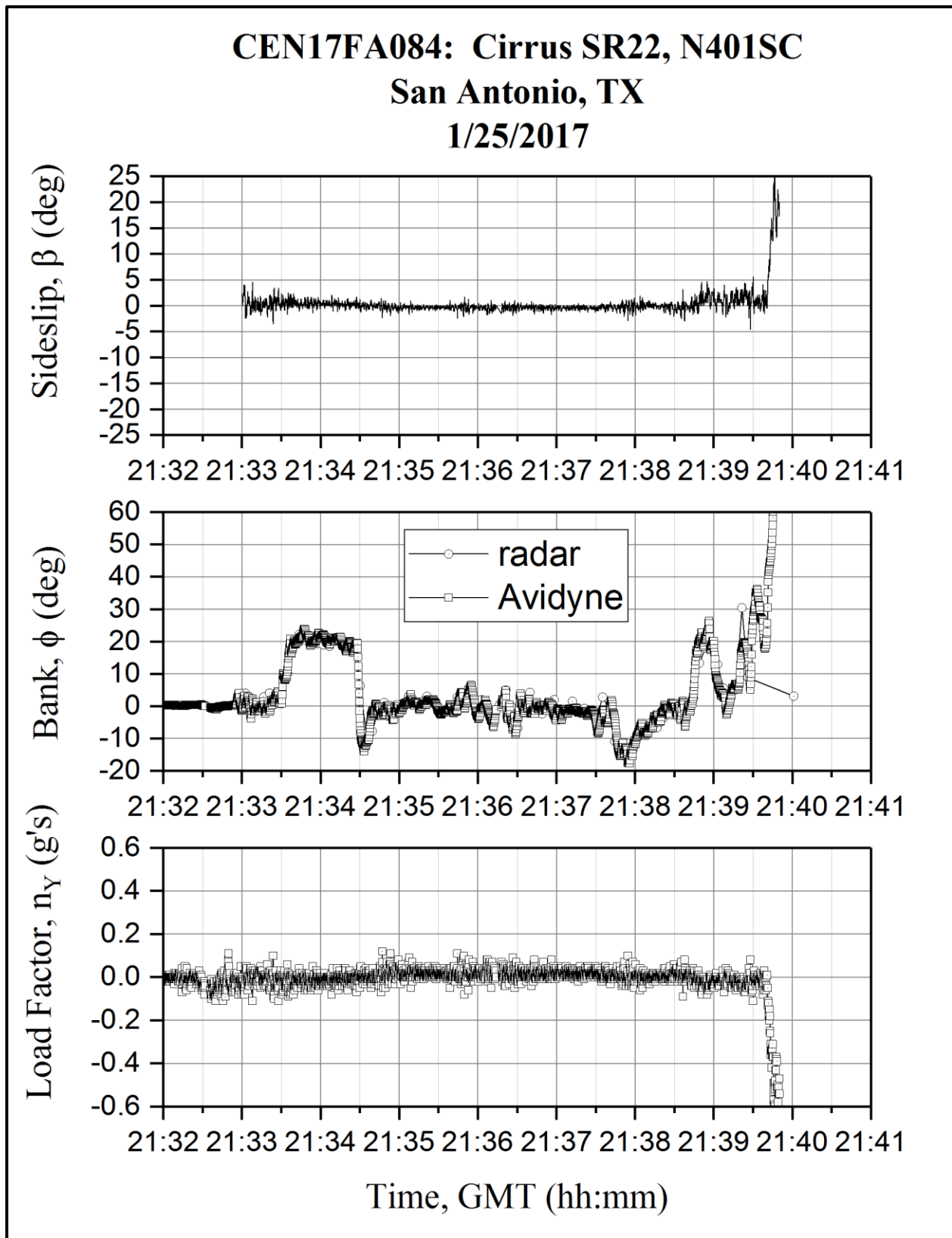


Figure 9: Estimated Sideslip, Bank Angle, and Lateral Load Factor Based on Avidyne and Radar Data

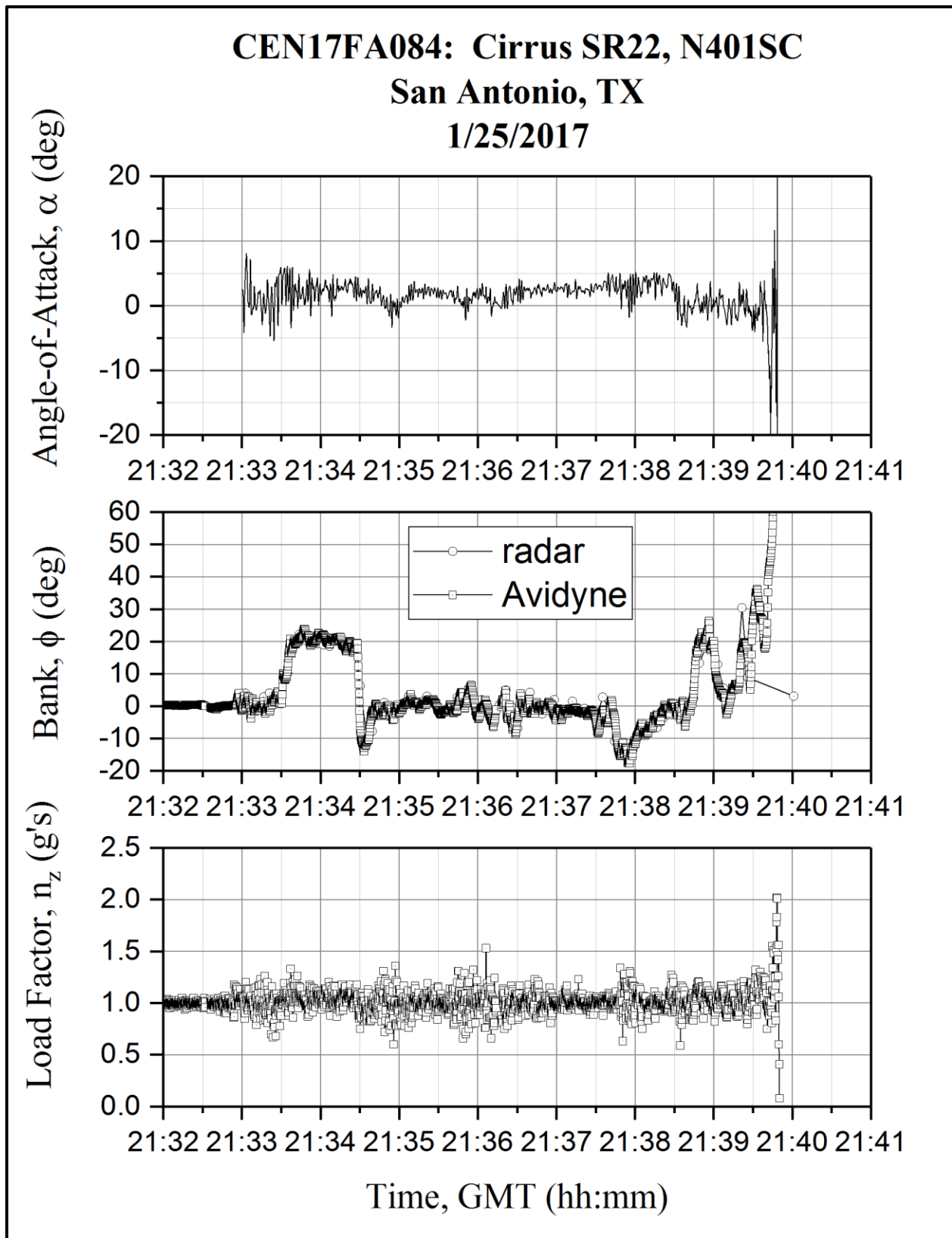


Figure 10: Estimated Angle-of-Attack, Bank Angle, and Normal Load Factor Based on Avidyne and Radar Data

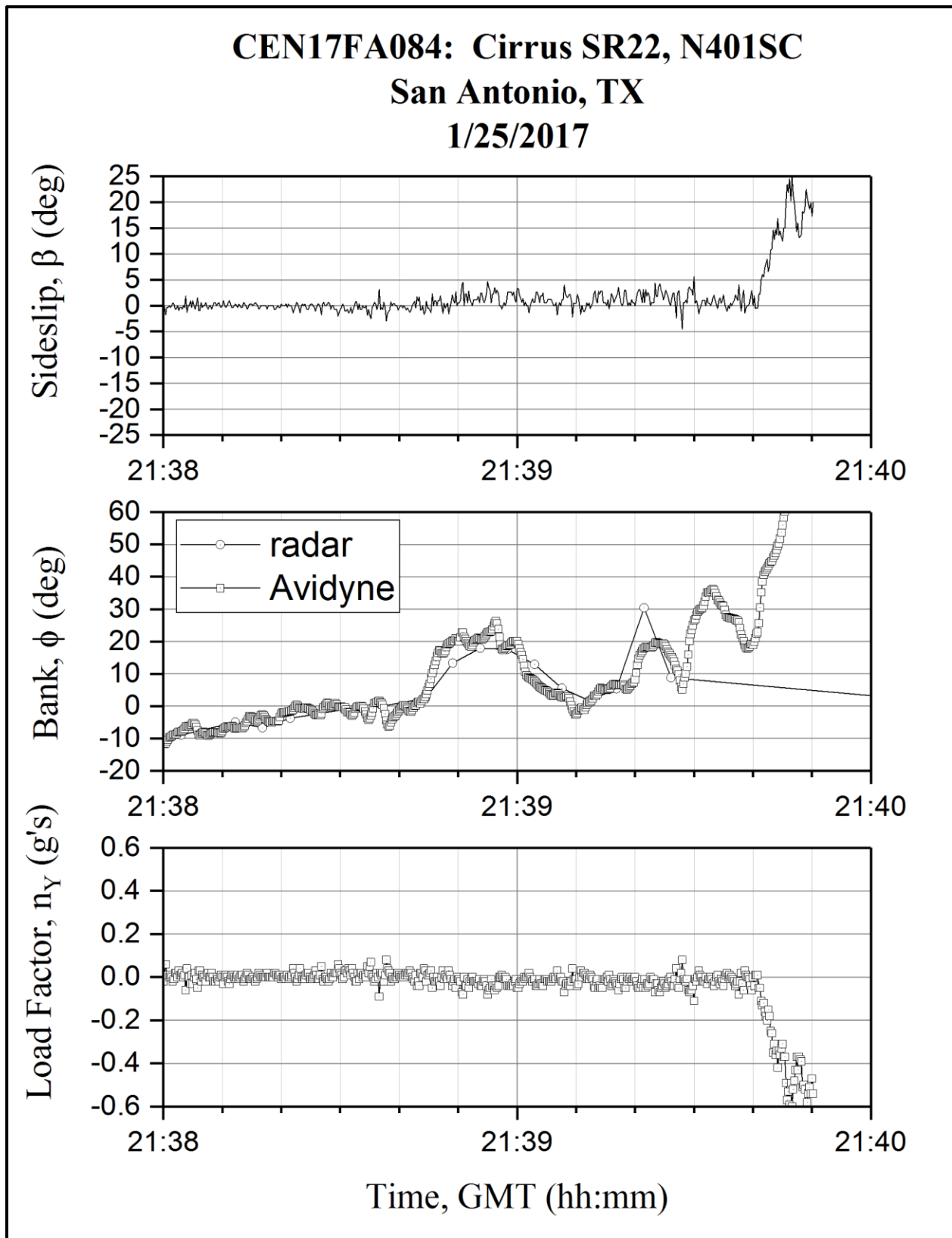


Figure 11: Estimated Sideslip, Bank Angle, and Lateral Load Factor Based on Avidyne and Radar Data for the Final Minutes of Flight

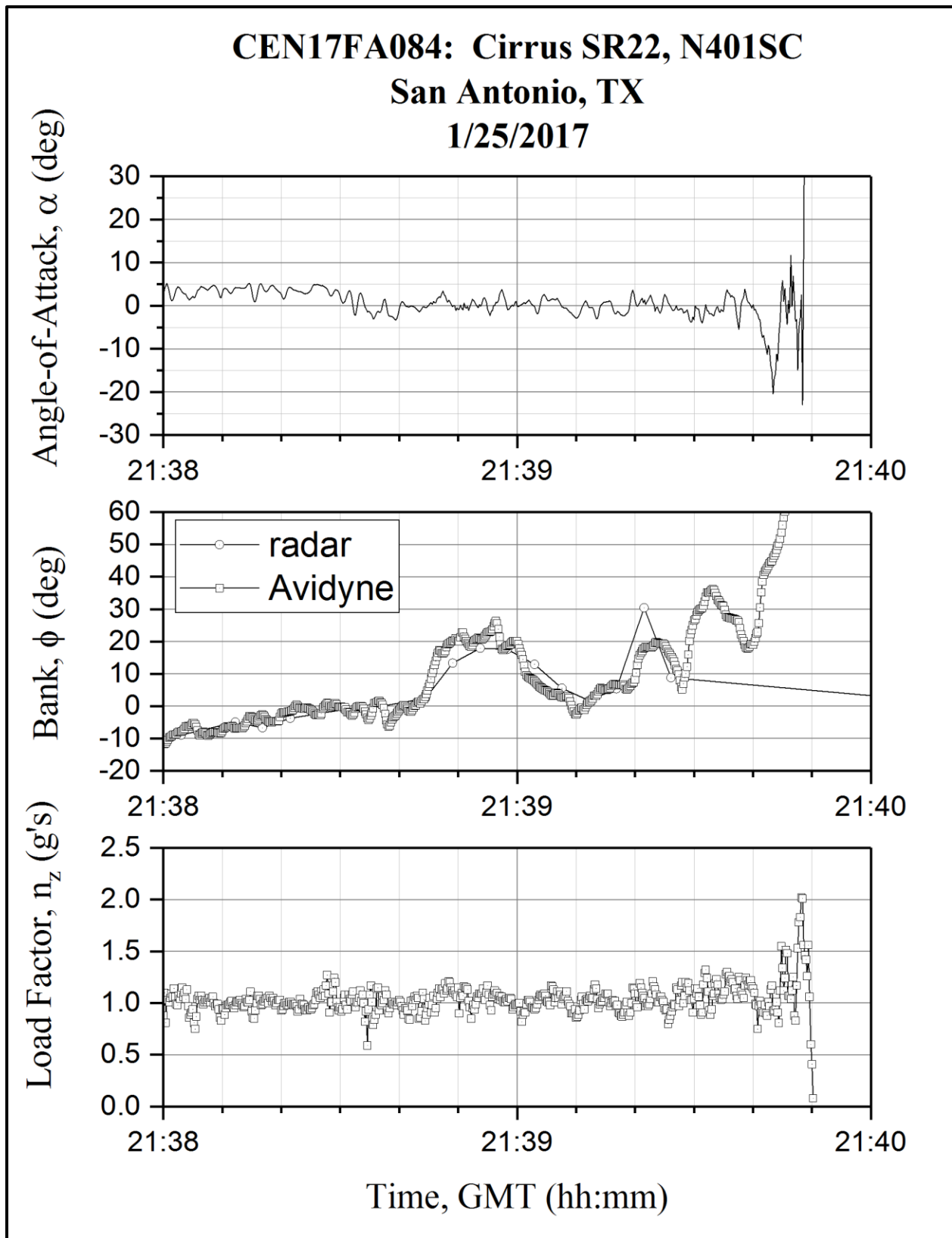


Figure 12: Estimated Angle-of-Attack, Bank Angle, and Normal Load Factor Based on Avidyne and Radar Data for the Final Minutes of Flight

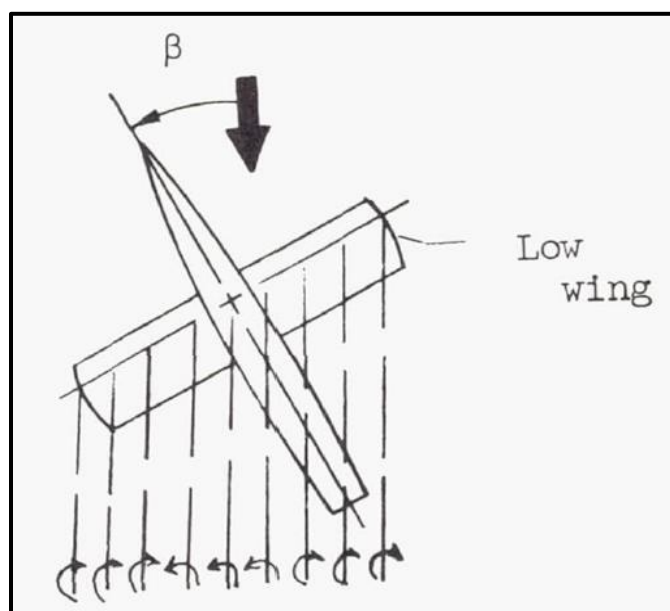


Figure 13: The Effect of Sideslip, β , on Chordwise Flow

Weight	Bank Angle	STALL SPEEDS					
		Flaps 0%Full Up		Flaps 50%		Flaps 100%Full Down	
LB	Deg	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
3400 Most FWD C.G.	0	70	69	67	64	59	59
	15	71	70	68	65	62	60
	30	75	74	72	69	66	64
	45	84	82	80	76	73	70
	60	99	97	95	90	87	84
3400 Most AFT C.G.	0	68	67	66	62	61	59
	15	69	68	67	63	62	60
	30	73	72	71	67	65	63
	45	81	79	78	74	72	70
	60	96	94	93	88	86	83

Figure 14: Stall Speeds at Maximum Gross Weight, Forward and Aft CG's, and Varying Bank Angles

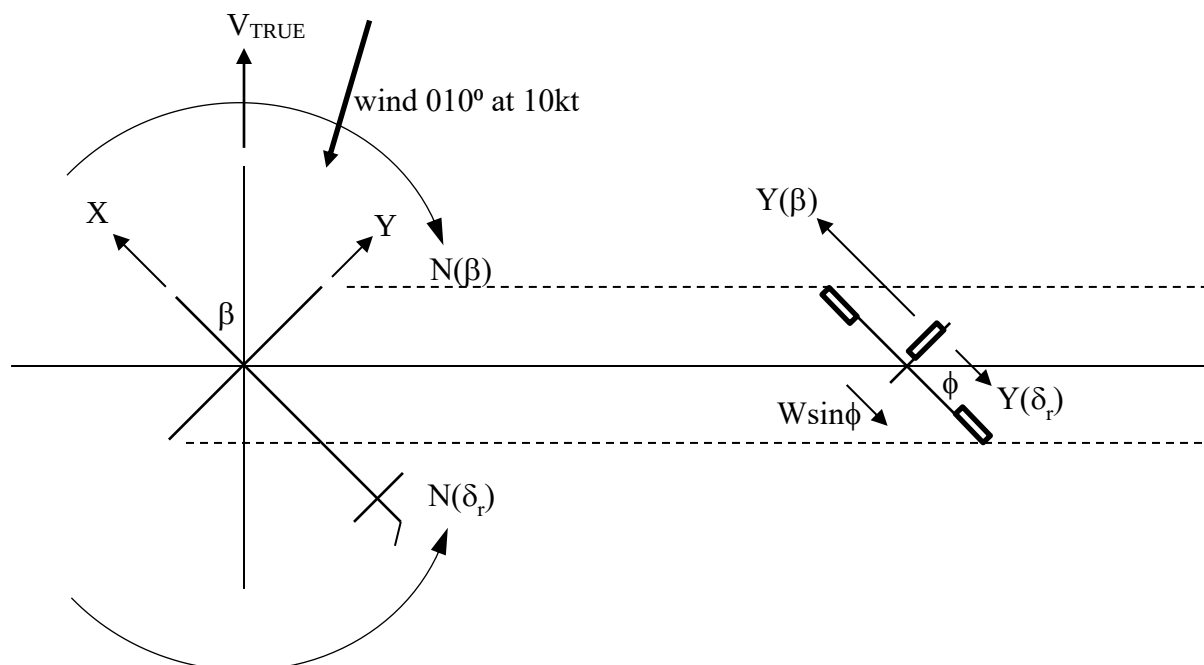


Figure 15: Recorded Data Indicate that the Pilot May have Performed a Sideslip Maneuver to Avoid Overshooting the Runway Centerline