



Date: June 2, 2026

To: Jason Aguilera, Office of Aviation Safety

From: John O'Callaghan, Office of Research and Engineering

Subject: Accident and flight-test airplane performance comparison plots for CEN23FA359

Jason:

This memorandum transmits plots of recorded and computed airplane performance information for the Vans RV14 (N6161) accident in Virden, Illinois, on August 12, 2023 (CEN23FA359). The plots present recorded avionics data from N6161, and additional performance parameters computed from these data. The airplane was destroyed after impacting the ground following a sudden dive from about 4,200 ft. MSL, and the pilot was fatally injured.

An analysis of the recorded data from N6161 provides evidence that a disturbance in the airflow over the airplane's static pressure port was likely present as the airplane initiated its final dive. This disturbance is manifested as unusual deviations in the recorded pressure-based altitude and airspeed of the airplane that are not reflected in the speed and altitude data based on Global Navigation Satellite System (GNSS) information, and that do not appear in the data recorded in four dives performed with an exemplar RV14 during a test flight.

The recorded avionics data, the additional parameters computed from the recorded data, and the details of the static pressure data analysis are presented below.

Description of Garmin G3X Touch avionics data

The avionics data presented in this memorandum was recovered from the Garmin G3X Touch (G3X) displays installed in N6161, as described in the *Electronic Devices Specialist's Factual Report* for this accident (Reference 1). Per Reference 1,

Two Garmin G3X Touch displays were recovered from the accident site. Each display contained an SD memory card capable of recording flight data. The SD card from the pilot side (herein referred to as the PFD [Primary Flight Display]) was recovered and read out normally. [This report] covers information from the SD card associated with the PFD only.

Reference 1 contains several sections that describe flight data recovered from the G3X pilot's side SD card for various flights. The flight number, date, and a description of each flight are provided, along with plots of selected parameters. A detailed sequence of events and set of parameter plots for the accident flight is also provided.

The following sections of this memorandum present the subset of G3X parameters used to characterize the performance of the airplane and to identify and analyze the disturbance at the static pressure port at the beginning of N6161's final dive.

Airplane position and speed; evidence of a static pressure disturbance

Figure 1 presents a plan view of N6161's flight path during the last two minutes of flight based on G3X latitude and longitude data. Time and altitude are labeled every 10 seconds in Figure 1a, and every 5 seconds in Figure 1b.

The G3X GNSS, pressure, and indicated altitudes are plotted in Figure 2. The barometric altimeter setting recorded in the G3X data is 29.89 "Hg, which suggests that the indicated altitude should be about 28 ft. below the pressure altitude. This is the case for times up to 08:47:03, after which the recorded indicated altitude is *higher than* the recorded pressure altitude. The reason for this is unknown, though it might be the result of filtering of the indicated altitude presented on the PFD (Garmin concurs that it is probably a "filtering/logging artifact"). The vertical line labeled "Final 'canopy closed' point" at 08:46:57 in Figure 2 corresponds to the last time the "canopy closed" parameter recorded on the G3X is recorded as "1;" subsequent to this point, the values of the parameter are always "0." The "canopy closed" parameter is plotted in Figure 7 and discussed further below.

The "Shifted G3X GNSS altitude" (green line) plotted in Figure 2 is equal to the "G3X GNSS altitude" (black line), shifted downwards to match the G3X indicated altitude at the start of the final dive. Shifting the GNSS altitude in this way allows this altitude to be compared with the barometric-based pressure and indicated altitudes more easily. Note that between 08:47:00 and 08:47:05, the barometric-based altitudes dip below the GNSS altitude. This dip, along with a similar deviation of airspeed from ground speed (see Figure 4), indicates a disturbance or error in the sensed static pressure at the airplane's static pressure port.

The static pressure disturbance is quantified and plotted in Figure 3. The top plot in the Figure shows the static atmospheric pressure that would have to be sensed at the static port to yield a) the pressure altitude recorded on the G3X (blue line), and b) the shifted G3X GNSS altitude plotted in Figure 2 (red line). The red line shows a smooth increase in pressure as altitude decreases, while the blue line shows a more abrupt increase in pressure at the start of the dive. The bottom plot in Figure 3 presents the difference between these pressures, and depicts the abrupt increase and decrease in this difference between 08:47:00 and 08:47:05 that suggests an airflow disturbance at the

static pressure port. After 08:47:05 and as the dive progresses, the difference between pressure altitude and GNSS altitude grows, though the mechanism of this difference is likely different from that of the brief disturbance between 08:47:00 and 08:47:05. During the dive, the growing difference might be the result of lags in the combination of the pressure sensing and recording system as the airplane descends rapidly.

Figure 4 plots the G3X ground speed, total speed computed from GNSS data (i.e., G3X ground speed combined with GNSS-based rate of climb), true airspeed, and indicated airspeed. Note that while the total GNSS speed and indicated airspeed match closely before 08:47:00, the indicated airspeed dips below the total speed at that time, and the total speed exhibits an increase as the airplane pitches down (as expected) instead of a dip.¹ The dip is also reflected in the true airspeed, though the airspeeds start to increase again after 08:47:04. Both true and indicated airspeeds depend on both the total pressure measured by the airplane's pitot tube, and on the static pressure measured at the airplane's static pressure port. Hence, an airflow (pressure) disturbance at the static pressure port not only affects the barometric-based altitude, but also the measured airspeeds. To determine if the static pressure disturbance plotted in Figure 3 (which is computed from the difference between the indicated G3X altitude and shifted G3X GNSS altitude) could also account for the dip in the indicated and true airspeeds plotted in Figure 4, the calibrated airspeed corresponding to the static pressure computed from the shifted G3X GNSS altitude (the green line in Figure 2) was computed, and is plotted as the green line labeled "Calibrated airspeed using P_{GNSS} " in Figure 4b (the total pressure in this calculation is the same total pressure corresponding to the recorded G3X indicated airspeed). Note that the resulting dip in the P_{GNSS} -based calibrated airspeed is delayed, and that this airspeed matches the G3X ground speed between 08:47:00 and 08:47:04, though it still does not increase right after 08:47:01 as the total GNSS-based speed does. Nonetheless, the improved match between the P_{GNSS} -based calibrated airspeed and total speed in first 3 to 4 seconds following the start of the dive suggests that the same pressure disturbance at the static pressure port can account for the deviations of both pressure-based altitude and airspeed from GNSS-based altitude and airspeed as the airplane enters its final dive.

While the recorded data indicates that a disturbance in pressure at the static pressure port was present at the start of the airplane's dive, it cannot be determined from the data alone what the source of this disturbance could have been, or whether such a disturbance is a "normal" result of the airplane's maneuvering (its sudden decrease in pitch rate as the airplane entered the dive). For example, Flight Data Recorder (FDR) data from airliners routinely record an erroneous dip in pressure altitude during takeoff rotation that results from pressure disturbances associated with the rotation maneuver itself. Consequently, it is of interest to determine whether the pressure disturbance at

¹ The ground speed decreases during the dive while the total GNSS speed increases because as the dive steepens, the ratio of the vertical component of speed to the total speed increases while the ratio of the horizontal component (which contributes to ground speed) decreases.

the start of N6161's final dive could similarly be the result of the pitch-down maneuver itself, or if it must be attributed to some other phenomenon. To help address this question, at the request of the NTSB Vans Aircraft performed a series of dives in an exemplar RV14 to collect data to compare with the accident flight. This comparison is presented below in section "*Accident and flight-test data comparison.*"

Airplane attitude (Euler angles) and load factors

Figure 5 presents the G3X attitude parameters (Euler angles), consisting of pitch (θ), roll (ϕ), and magnetic heading (ψ_M), as well as the flight path angle (γ) and angle of attack (α) computed using both GNSS and barometric-based rate of climb data. The top plot in the Figure depicts how θ abruptly decreases 2 seconds after the final "canopy closed" point. The Figure also shows that as the airplane pitched down, it also started rolling to the right. The rate of change of ϕ between 08:47:00 and 08:47:08 was about $6^\circ/\text{sec}$, and increased to about $29^\circ/\text{s}$ between 08:47:08 and 08:47:11. The airplane rolled through 90° right at about 08:47:09.5, and reached 178° (fully inverted) at 08:47:15.

Figure 6 presents the G3X lateral and vertical (normal) load factors (n_y and n_{lf} , respectively), as well as the longitudinal load factor (n_x) computed from the G3X position and Euler angle data (n_x is not recorded on the G3X). Because of the relatively low sample rate of the data (1 Hz) and the nature of the calculation, the computed n_x cannot capture any sudden changes in this parameter that might actually have occurred (and that might mirror the sudden drop in n_{lf} at 08:47:00 shown in Figure 6).

Engine and canopy parameters

Figure 7 presents the G3X engine RPM and manifold pressure parameters, which depict a reduction in engine power starting at 08:47:03.

Figure 7 also presents the status of the "canopy closed" parameter. The source of this parameter is described in Reference 1 as follows:

Canopy Latch Micro Switch

The canopy latch micro switch in a Van's RV aircraft is a compact electrical switch installed on the canopy latch mechanism to detect whether the canopy is securely closed and latched. It provides a discrete signal to the cockpit, when wired correctly, it can interface with an Electronic Flight Information System (EFIS) to provide an alert to the pilot as to the canopy's latch position.

A "canopy closed" value of 1 indicates that the latch is compressing the micro switch (canopy closed and latched position), and a value of 0 indicates that the latch is not compressing the micro switch (canopy not latched). Reference 1 describes the behavior of the "canopy closed" parameter during several flights prior to the accident flight and during the accident flight itself. Regarding the accident flight, Reference 1 states

At 8:43:40, the aircraft was oscillating slightly around 4040 feet MSL in GPS FD lateral and FD altitude hold mode. At this time the first in a series of intermittent, but frequent canopy open warning state information was recorded. This intermittent but frequent canopy open warning state information would persist until a few data samples prior to the negative pitch and roll event that lead to the aircraft's impact with the ground.

In the four minutes prior to the dive (08:43:00 – 08:47:00), the longest interval during which the "canopy closed" parameter maintains a value of 0 without recording a value of 1 is 9 seconds. In contrast, at the end of the recorded data, the "canopy closed" parameter was 0 for the final 32 seconds of recorded data, from 08:46:58 to 08:47:30.

Accident and flight-test data comparison

As stated above, to help determine whether the static pressure disturbance apparent in the altitude and airspeed data at the start of N6161's final dive could be a "normal" result of the airplane's pitch maneuver, at the request of the NTSB Vans Aircraft performed a series of dives ("pushovers") in an exemplar RV14 to collect data to compare with the accident flight. Four separate pushovers were performed, described by the Vans Aircraft test pilot in an email to the investigative team as follows:

On the test flight I originally leveled off at approximately the altitude and speeds at 24² where the event occurred. We had convective activity which was too turbulent so I then climbed to 10K plus feet to find smooth air on top of the cloud layer.

The accident aircraft was approx. 24² [2400 RPM and 24 "Hg manifold pressure] and 160 KIAS.

I replicated the first 6 seconds of the pushover.

At second 3 the accident aircraft pulled back the power. At second 5 the aircraft was near 0 g's. At 6 seconds the aircraft was approx. 0 g and -22 deg.

I conducted four pushovers:

Pushover 1: Pushover for 6 seconds power left full (speed quickly went to Vne which terminated the pushover).

Pushover 2: Pushover but with a power reduction after 3 seconds. Rate of pushover was greater than the accident. This gives a higher rate comparator.

Pushover 3: The aircraft was trimmed nose down (not all the way but significantly). Altitude was held with back stick pressure. I then let go of the stick transitioning to the stick free condition. The pitch down was rapid to slightly less than 0 g.

Pushover 4: Pushover covering 6 seconds with 3 second power reduction reaching 0 g at 5 seconds maintaining to 6 seconds when ~25 deg nose down was reached (my best attempt of the exact accident conditions).

Data from the four pushovers from the test flight are compared with data from the final dive on the accident flight in Figures 8-15. The data on the test flight was recorded on a Dynon Avionics Skyview system (Dynon), which records at a higher sample rate than the G3X (4 Hz vs. 1 Hz).

Figures 8 and 9 present altitude and speed increments from the “time 0” point or initial condition, which is defined as the point where the pitch rate drops below zero at the beginning of each flight-test pushover, and at the beginning of the final dive during the accident. Presenting the data as speed and altitude increments from the initial condition as a function of time from the initial condition allows for an easy comparison between the accident flight and each of the test flight pushovers. The pushovers are identified as Push 1, Push 2, Push 3, and Push 4, per the test pilot’s description above.

The top plots in Figures 8 and 9 present altitude and speed parameters based on the air-data system, and the bottom plots present the same parameters based on GNSS data. This allows deviations in the air-data system caused, potentially, by pressure disturbances at the static pressure port to be more easily identified. The plot of the true airspeed increments on the top of Figure 9 clearly shows that the true airspeed from the accident flight behaves differently from the true airspeed from the flight-test pushovers (showing an initial 8-9 knot drop), suggesting a unique pressure disturbance at the static port was present during the accident flight. A similar effect can be observed with the pressure altitude data on the top plot of page 8, where the initial drop in pressure altitude on the accident flight is not mirrored in the GNSS altitude data, or in the pressure altitude data of the flight-test pushovers.

The differences in the altitude and speed increments between the air-data and GNSS data sources is highlighted further in Figure 10. Here, the different character of the pressure altitude deviation on the accident flight compared to the pressure altitude deviations for the flight-test pushovers is more apparent. The difference between the air-data and GNSS speed increments is also more pronounced for the accident flight than for the flight-test pushovers.

Figure 11 presents the static pressure increment required to produce the difference between the air-data and GNSS altitude increments. The top plot presents the results in terms of absolute pressure difference (in lb/ft²), and the bottom plot shows the coefficient of pressure difference (the absolute pressure difference normalized by the dynamic pressure). Again, the large pressure increment evident in the accident flight does not appear in the flight-test pushovers.

Figure 12 compares the accident and flight-test pushover pitch angles, and shows that Push 4 does the best job of matching the accident pitch angle, as was the test pilot’s intent per his description above. Note that the accident flight and Push 4 have initial pitch rates that are notably slower than those for Push 1, Push 2, and Push 3.

Figure 13 compares the accident and flight-test pushover roll angles. The flight-test pushovers remain approximately wings-level, whereas the accident roll rate increases to an approximately constant 6 deg/sec to the right until increasing about 10 sec after the start of the dive.

Figure 14 compares the accident and flight-test pushover nlf and n_x (nlf is recorded and n_x is computed, as described above). Again, Push 4 matches the accident best. Note that the sampling rate of the data from the Dynon on the test flight is higher than that from the G3X on the accident flight, but even so it does appear that the drop in nlf at the beginning of the pitch-over is more sudden for the accident than for Push 4.

Figure 15 compares the accident and flight-test pushover engine parameters: RPM, manifold pressure, and the recorded “percent power.” Note that the “percent power” parameter is not directly sensed by the avionics systems, but is computed by these systems based on proprietary algorithms designed by their manufacturers using sensed inputs such as engine fuel flow, RPM, and manifold pressure, atmospheric data, and possibly other parameters. Consequently, the “percent power” parameters recorded by the G3X on the accident flight and by the Dynon on the test flight likely do not result from the exact same algorithms, and so might differ. Nonetheless, both calculations of “percent power” should provide a good measure of the relative power applied during each flight, and of power changes during those flights.

On the test flight, the manifold pressure and “percent power” parameters had dropouts (no data recorded) in several places during the pushovers, and no “percent power” data was recorded during Push 4 at all.

Summary

The recorded data from the accident flight and test flight presented in this memorandum indicate that a significant pressure disturbance at N6161’s static pressure port was present at the beginning of the airplane’s final dive, and that a similar disturbance is not observed in any of the test flight pushover maneuvers. The pressure disturbance observed on the accident flight could possibly have been produced by the canopy opening in flight. The team could not identify a potential different cause of the pressure disturbance that would not also have been observed during the test flight pushovers.

Submitted by:

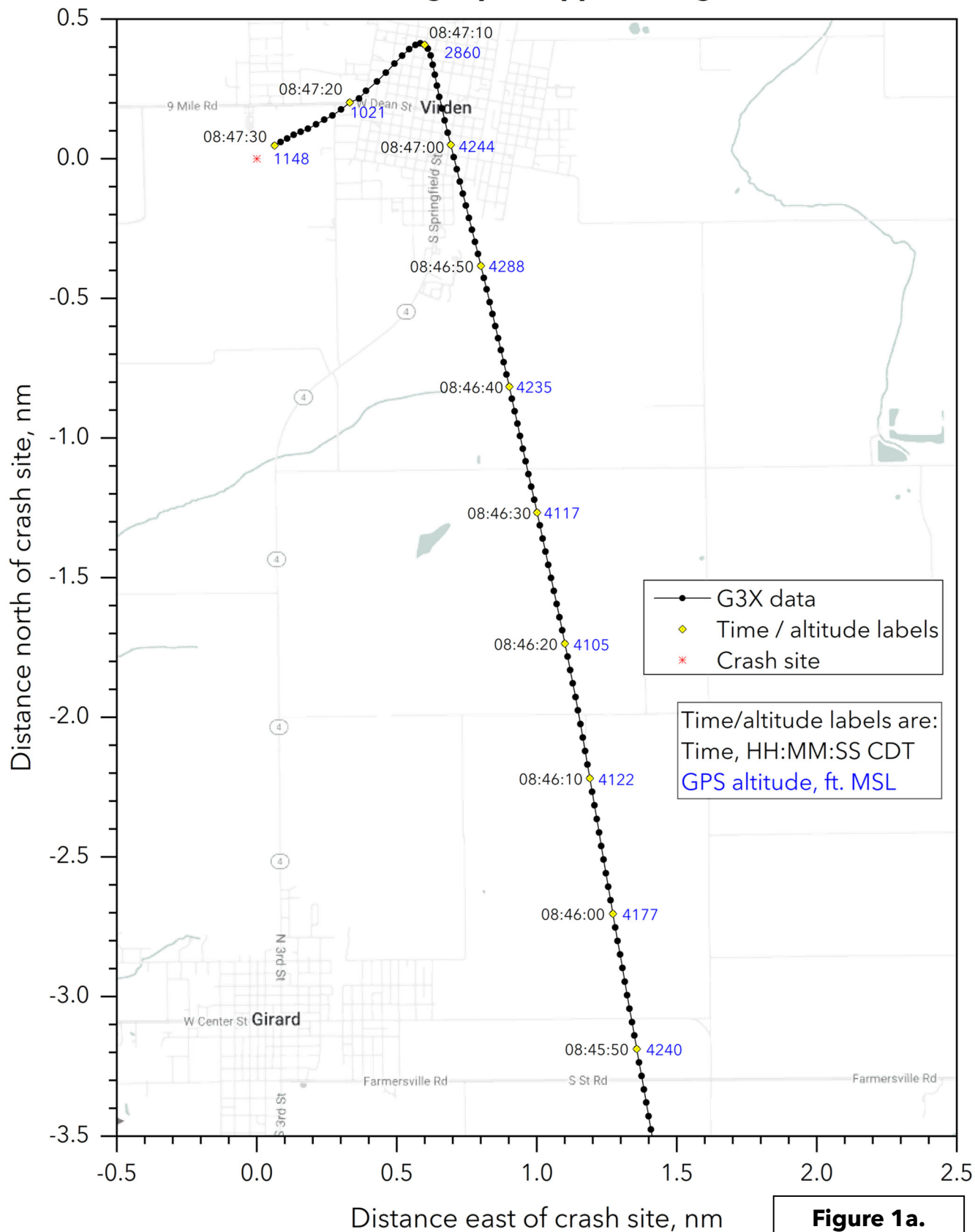
John O’Callaghan
National Resource Specialist – Aircraft Performance

References

1. National Transportation Safety Board, *Electronic Devices Specialist’s Factual Report*, NTSB accident # CEN23FA359, June 2, 2026.

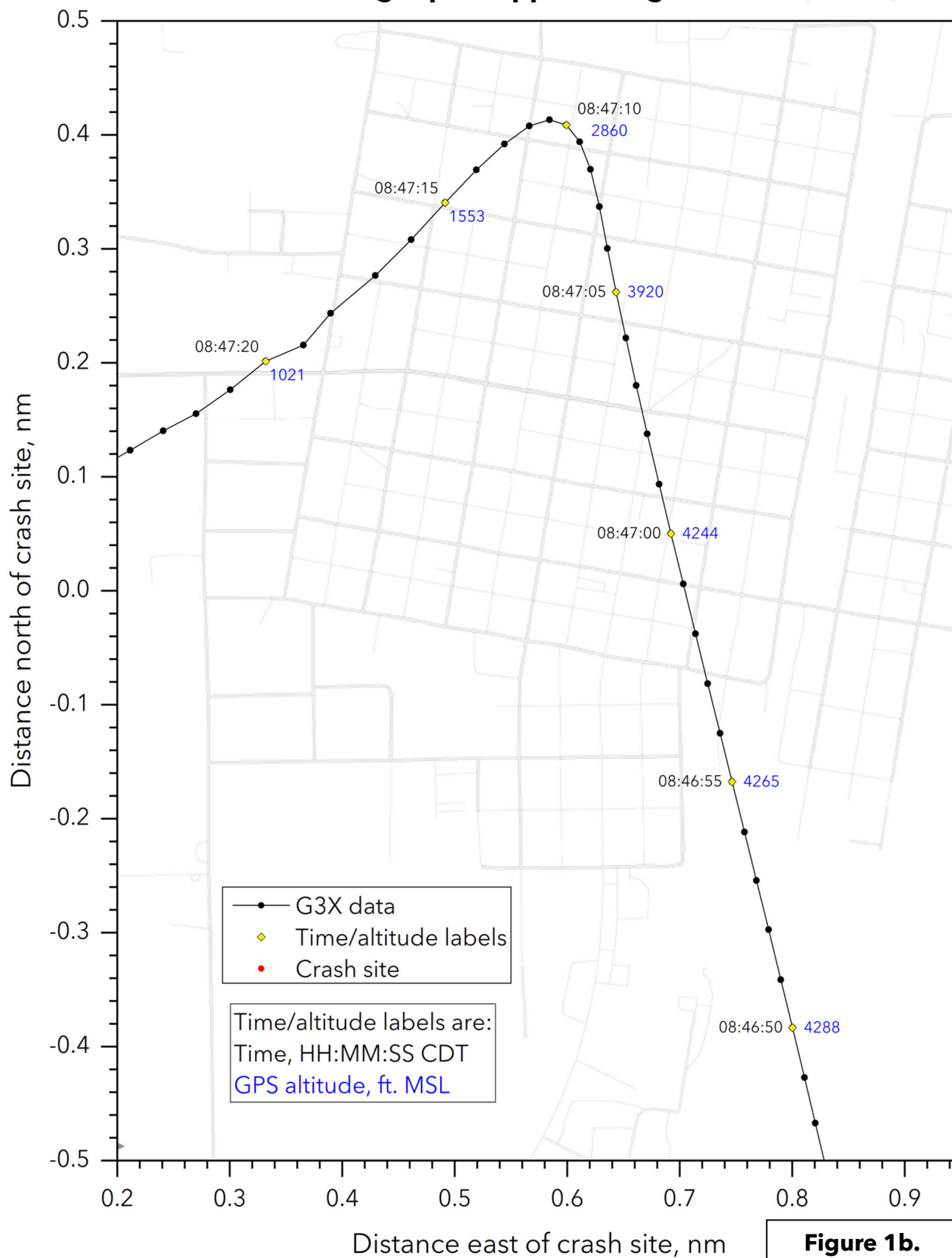
CEN23FA359: Vans RV-14A, N6161, Virden, IL 08/12/2023⁸

Plan view of flight path approaching crash site



CEN23FA359: Vans RV-14A, N6161, Virden, IL 08/12/2023⁹

Plan view of flight path approaching crash site (detail)



CEN23FA359: Vans RV-14A, N6161, Virden, IL 08/12/2023

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Altitude vs. time

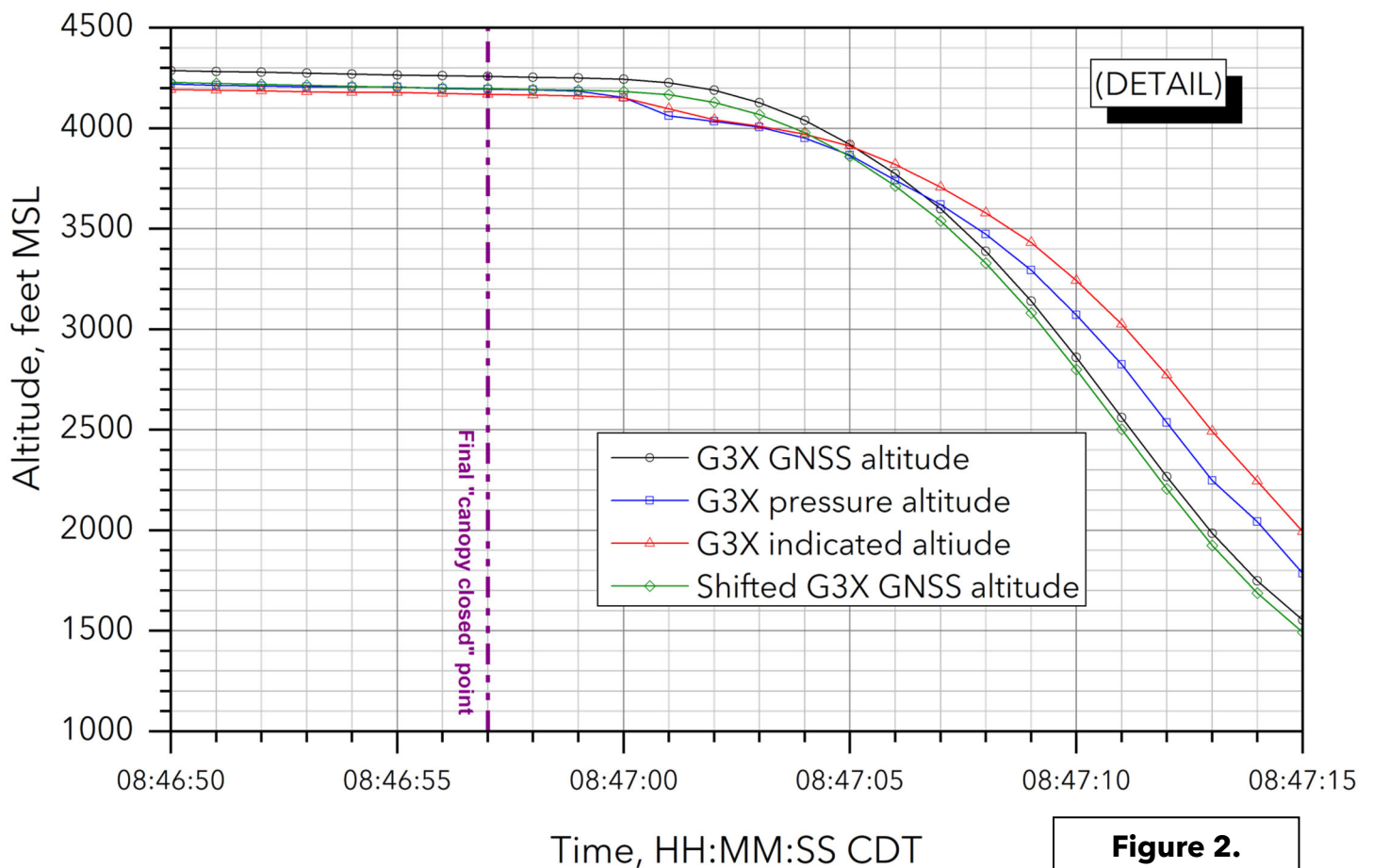
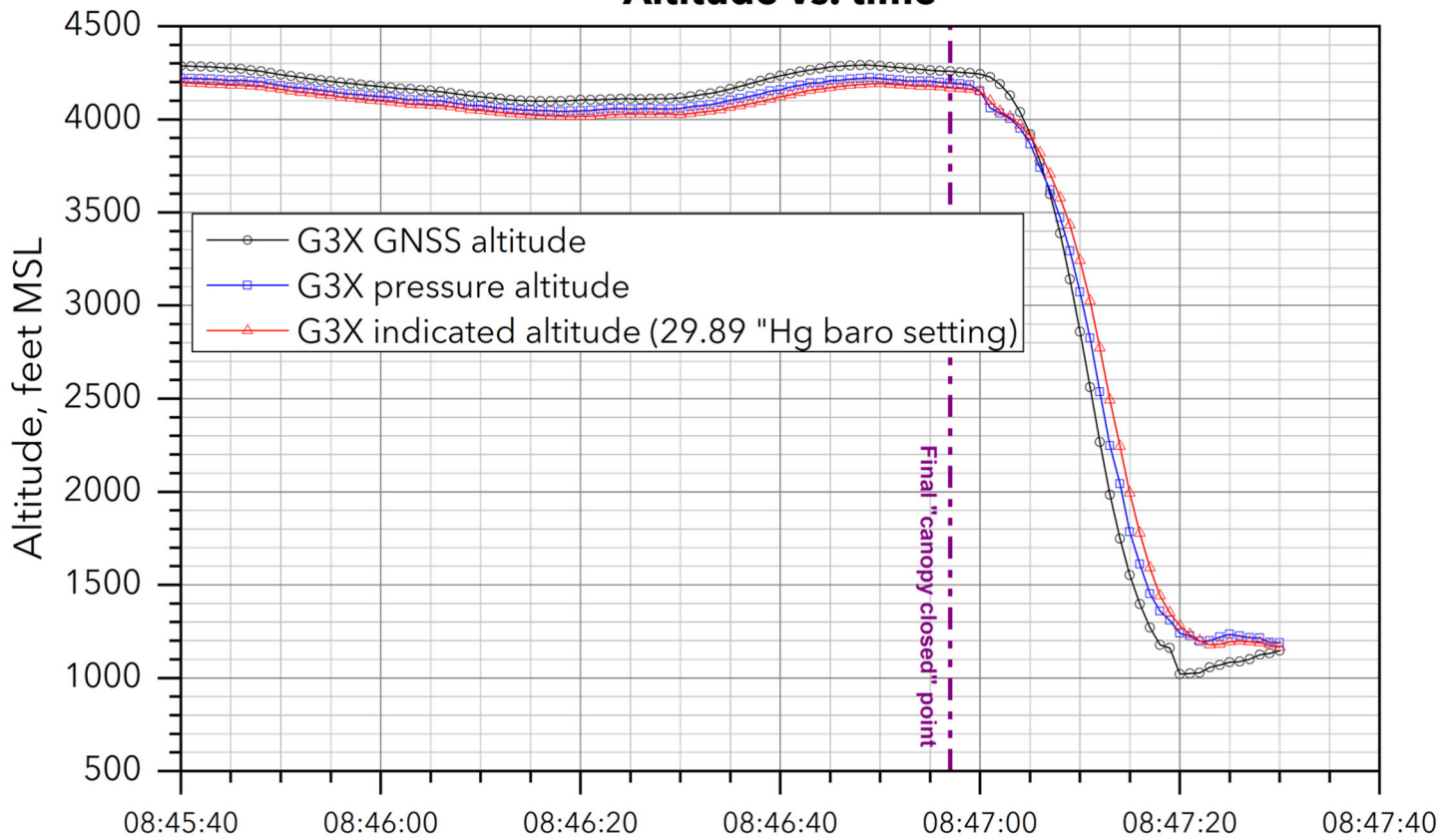


Figure 2.

Pressure at static pressure port vs. time

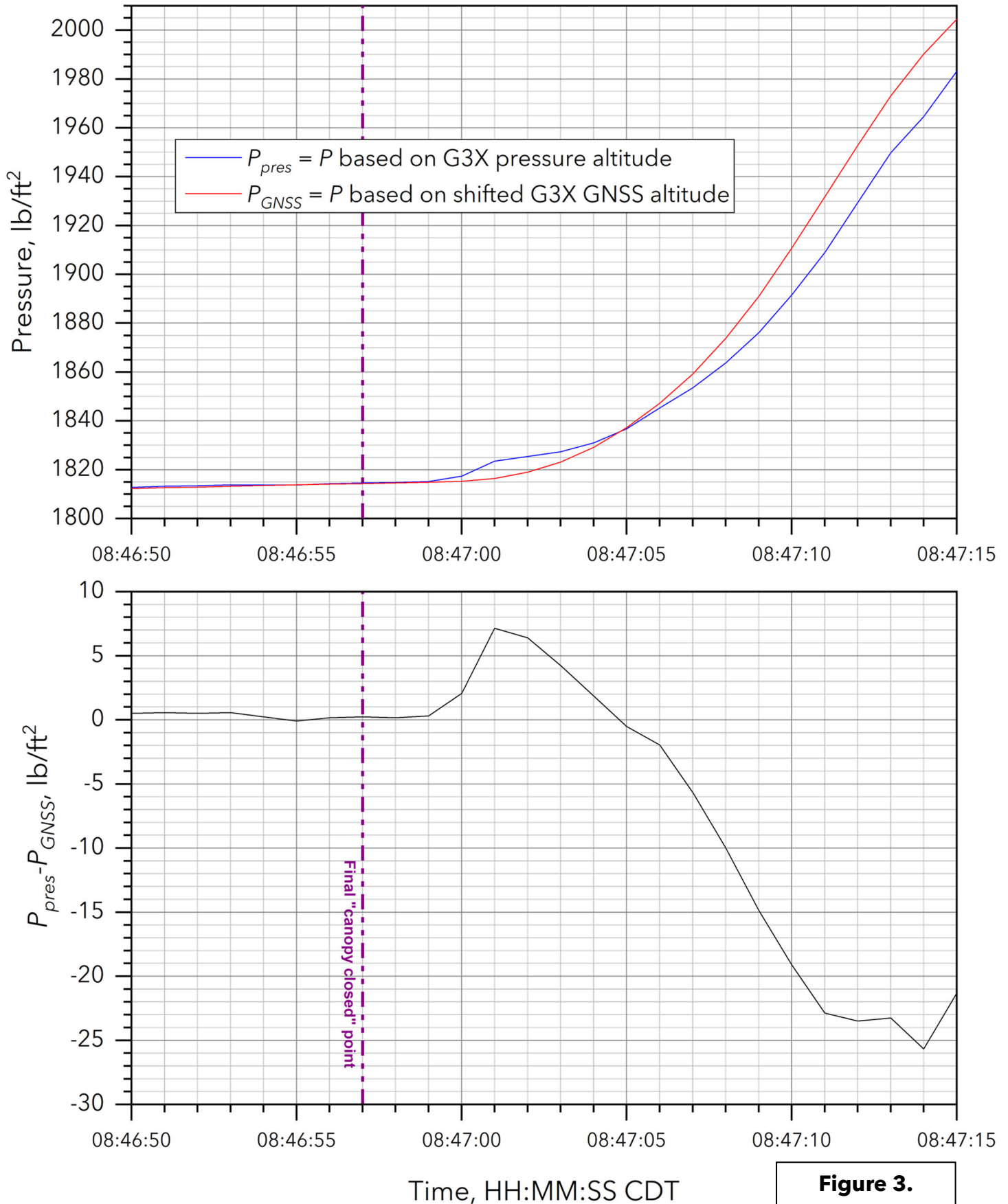


Figure 3.

Speeds and rate of climb

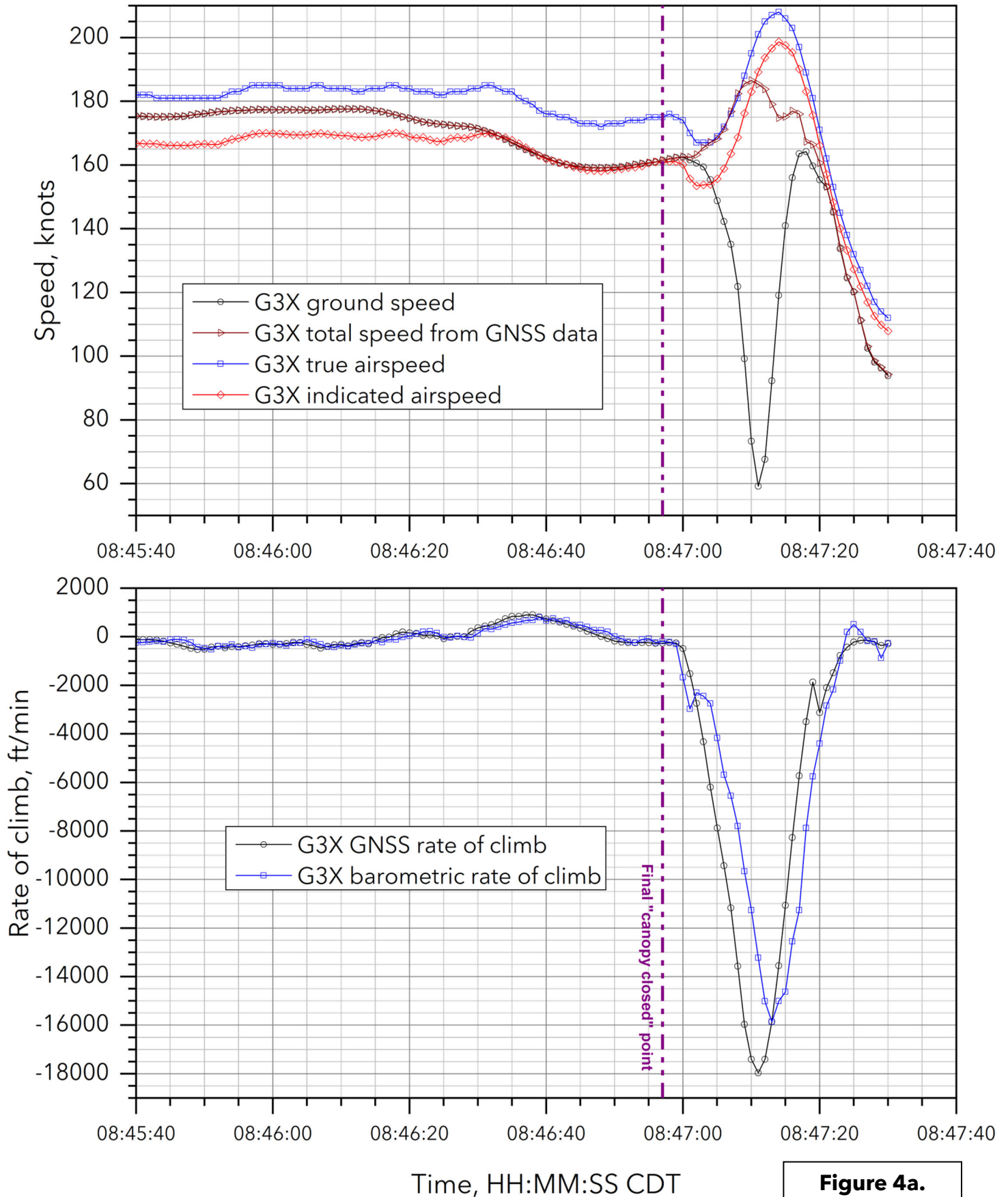


Figure 4a.

Speeds and rate of climb (detail)

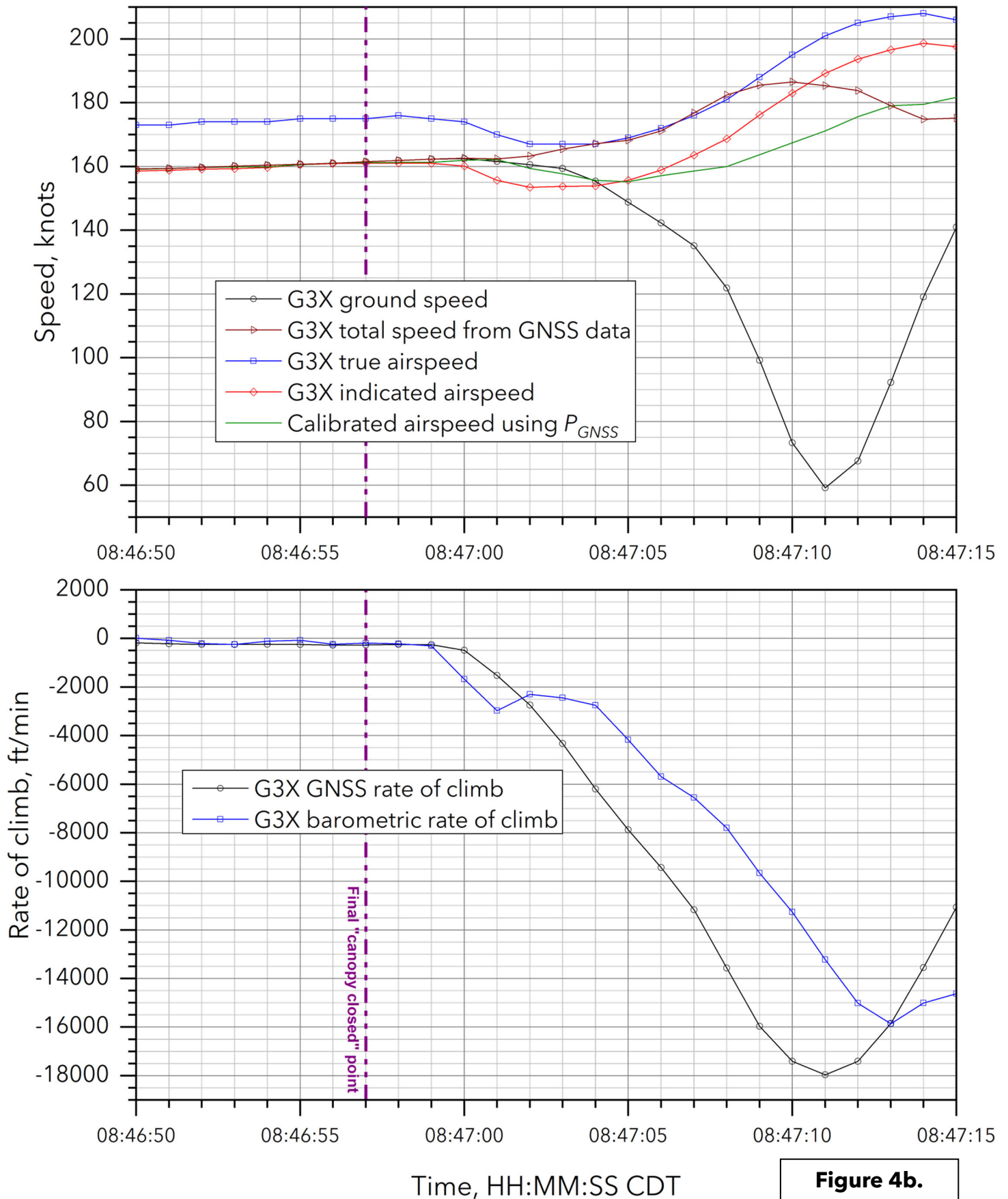


Figure 4b.

Euler angles

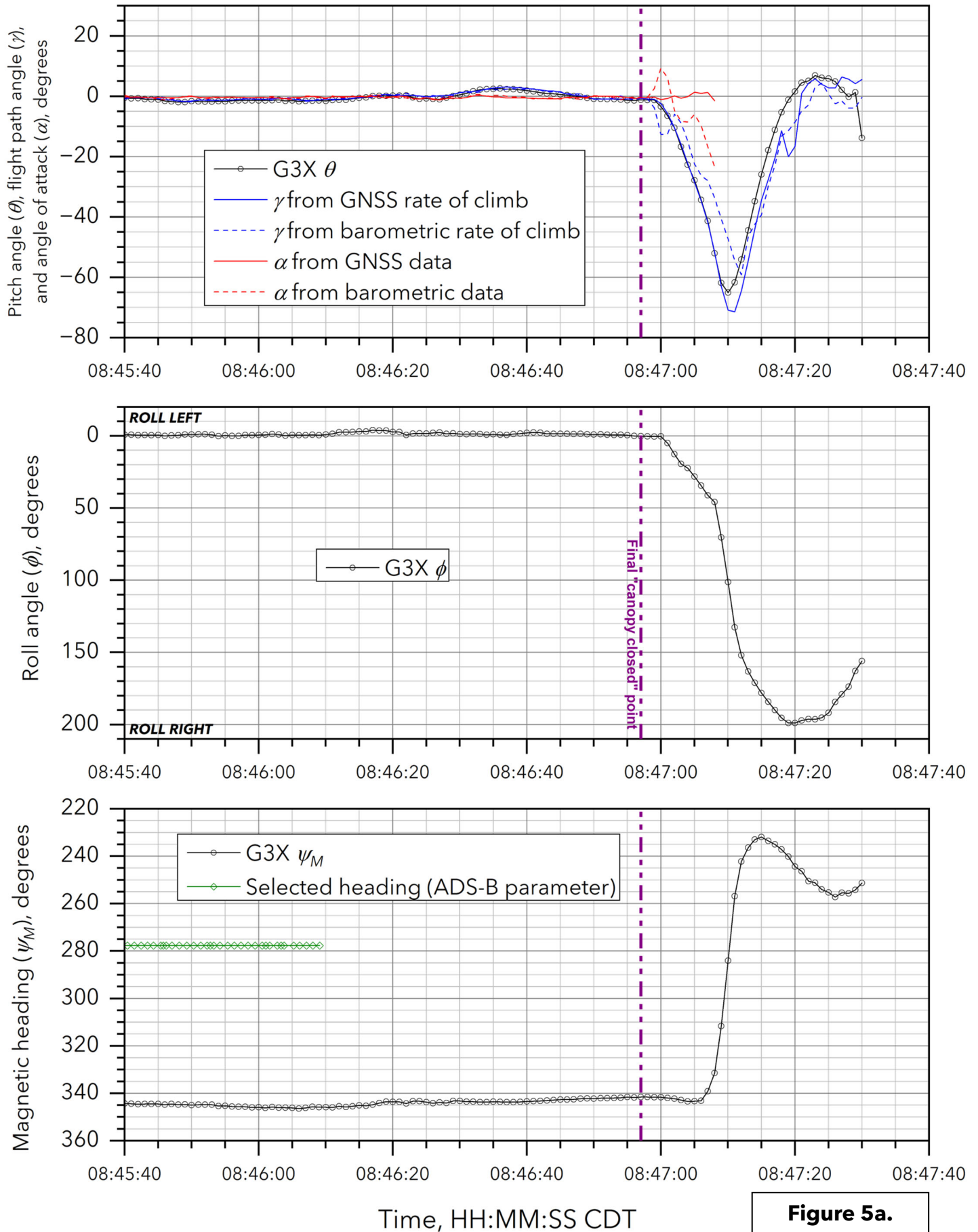


Figure 5a.

Euler angles (detail)

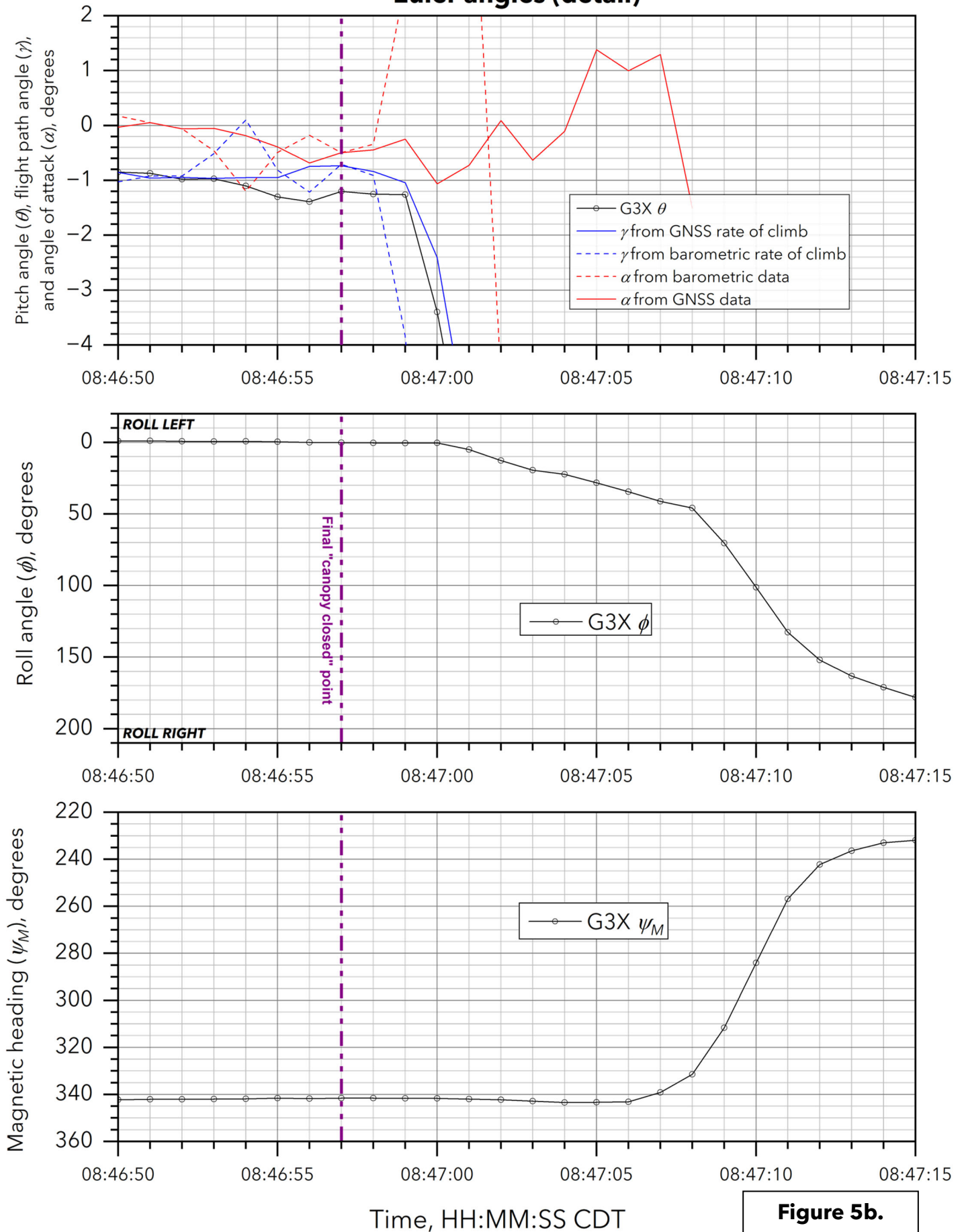


Figure 5b.

Load factors

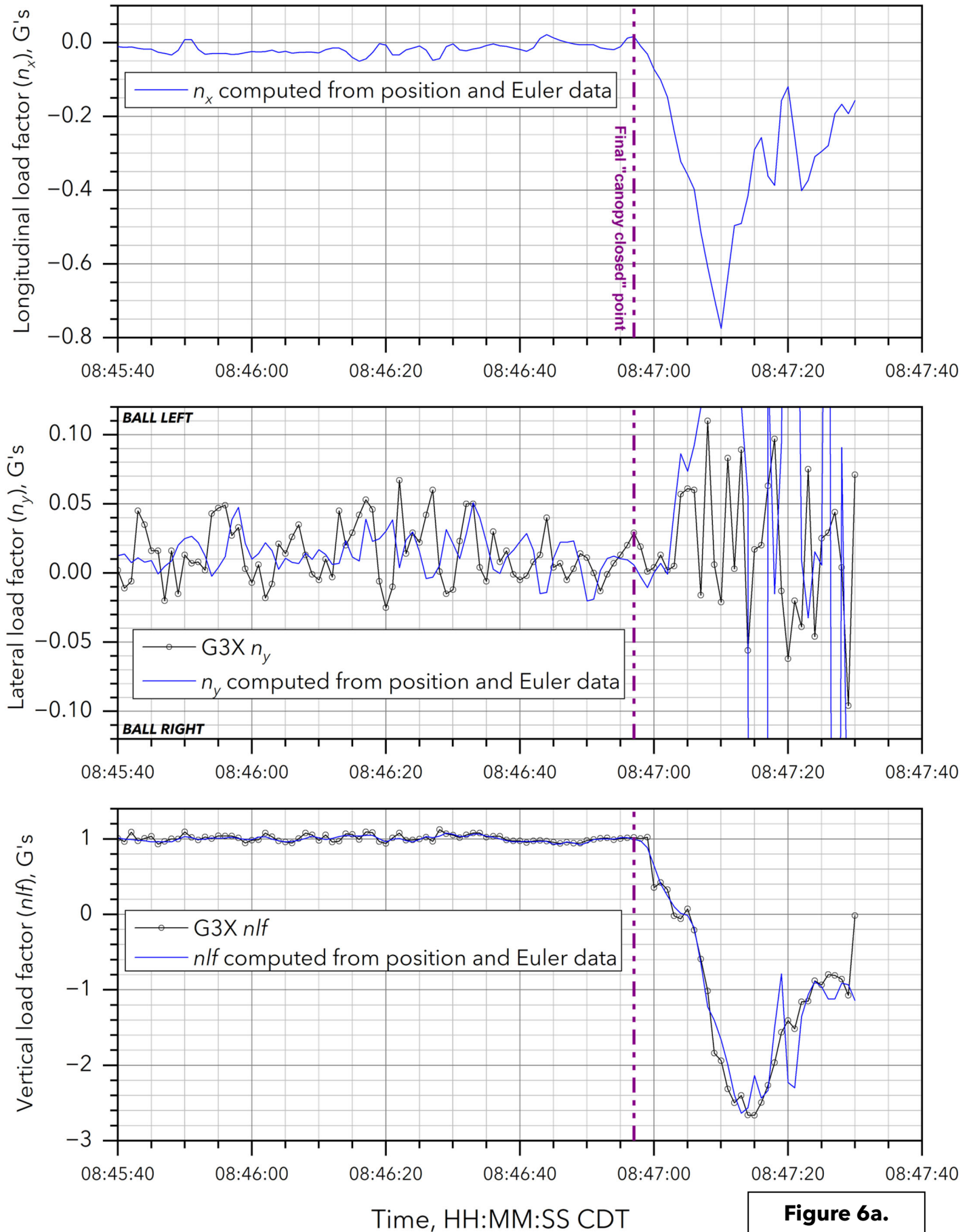


Figure 6a.

Load factors (detail)

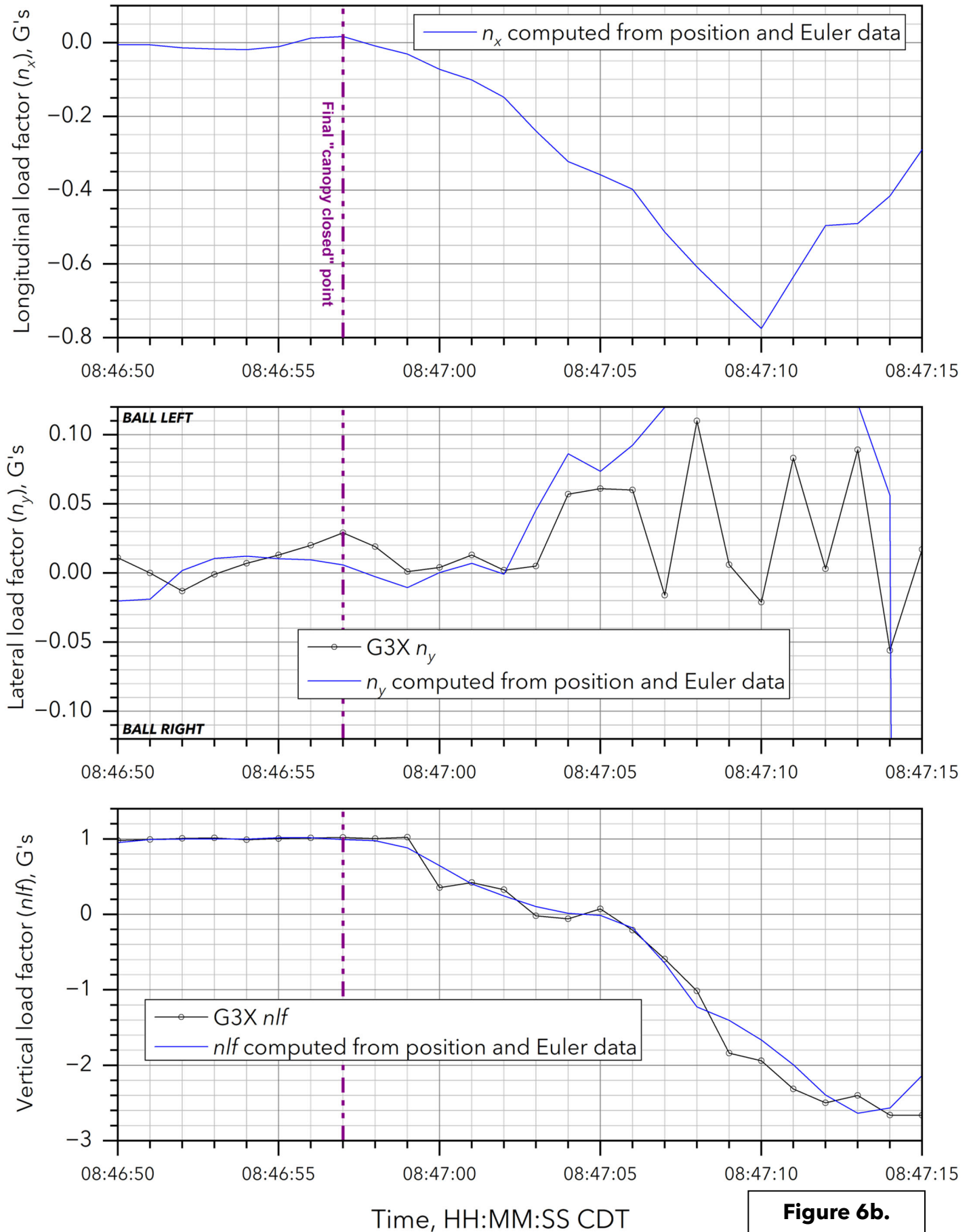


Figure 6b.

Engine & canopy parameters

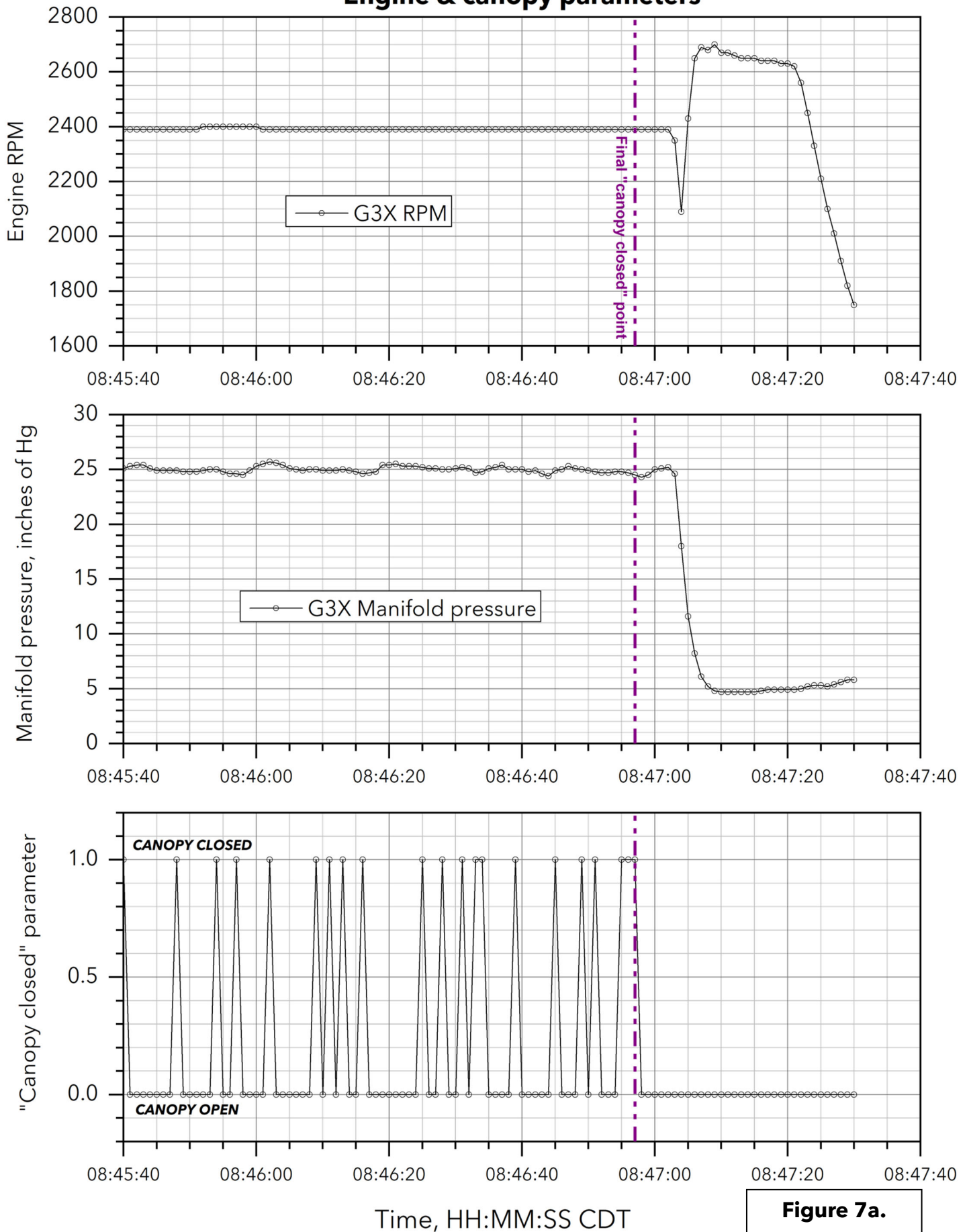


Figure 7a.

Engine & canopy parameters (detail)

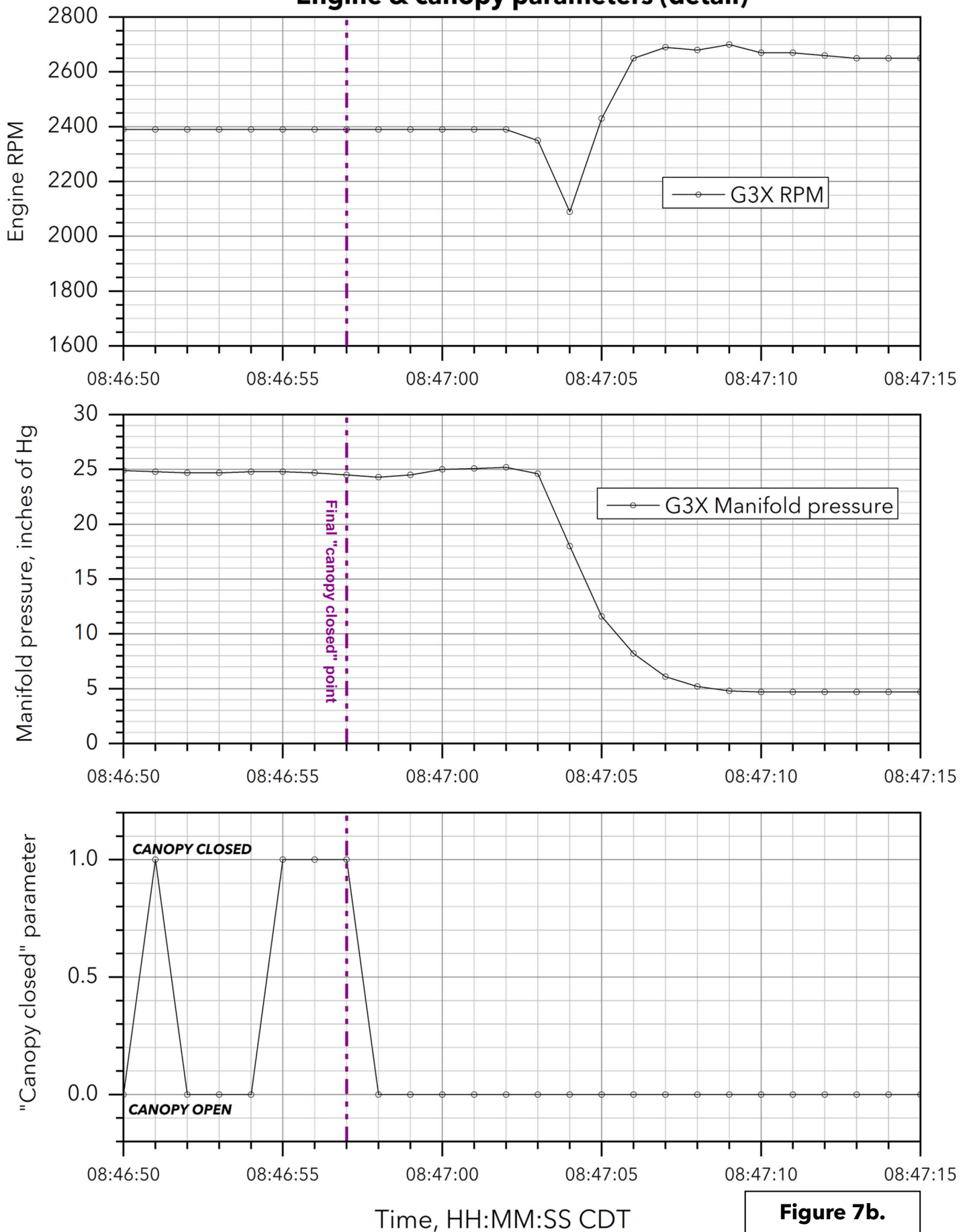


Figure 7b.

Accident & test flight altitude increment comparisons

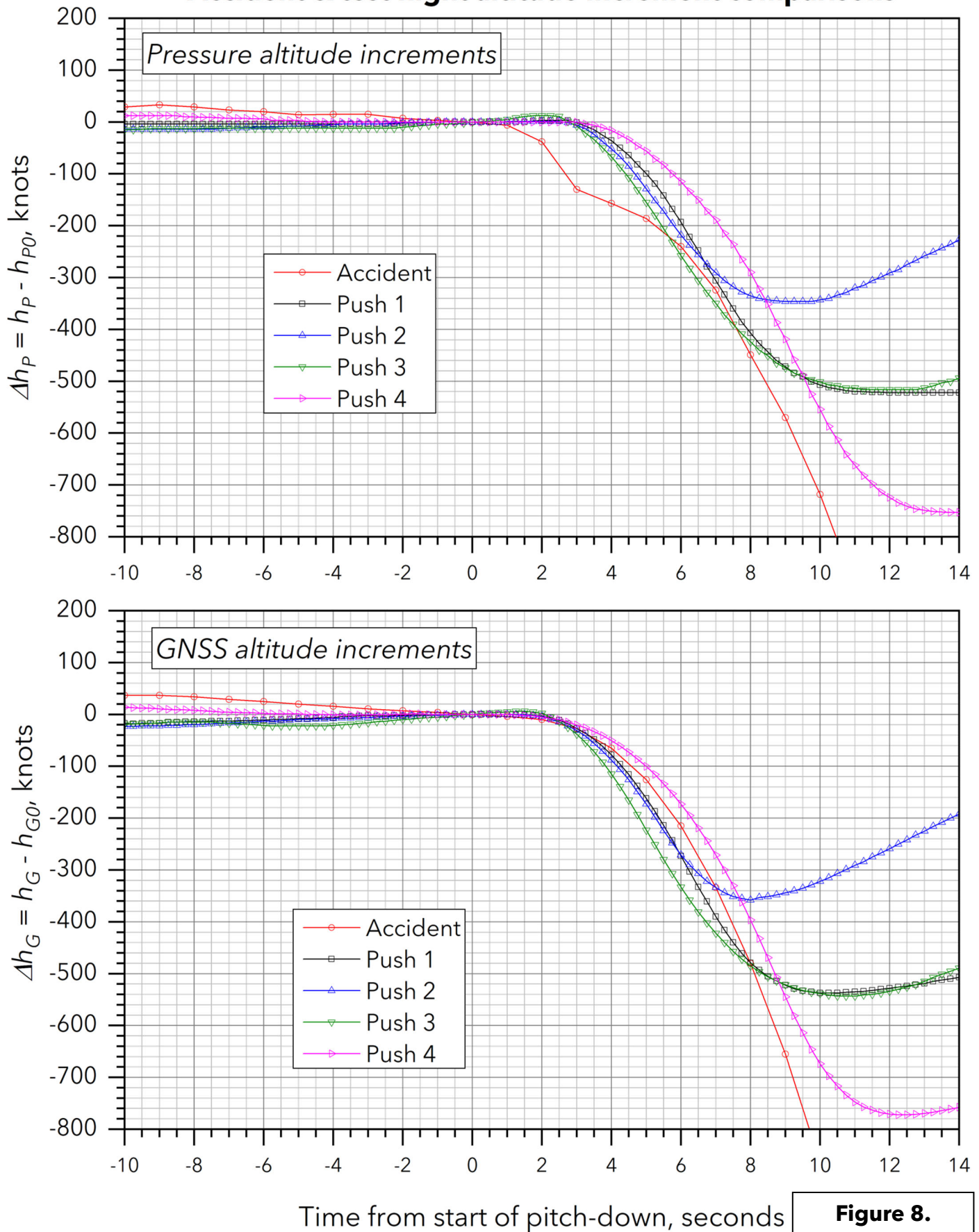


Figure 8.

Accident & test flight speed increment comparisons

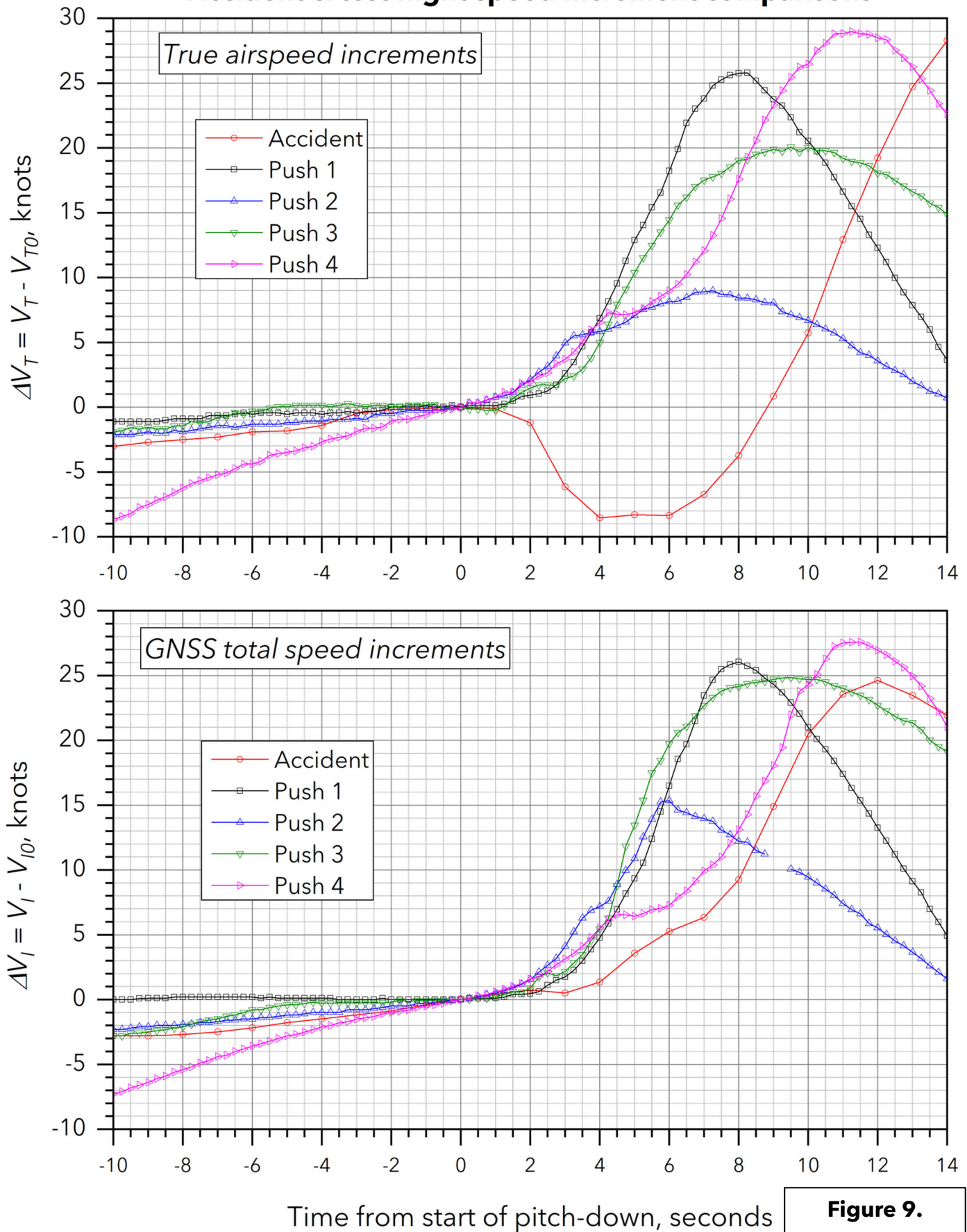


Figure 9.

Accident & test flight air data / GNSS increment comparisons

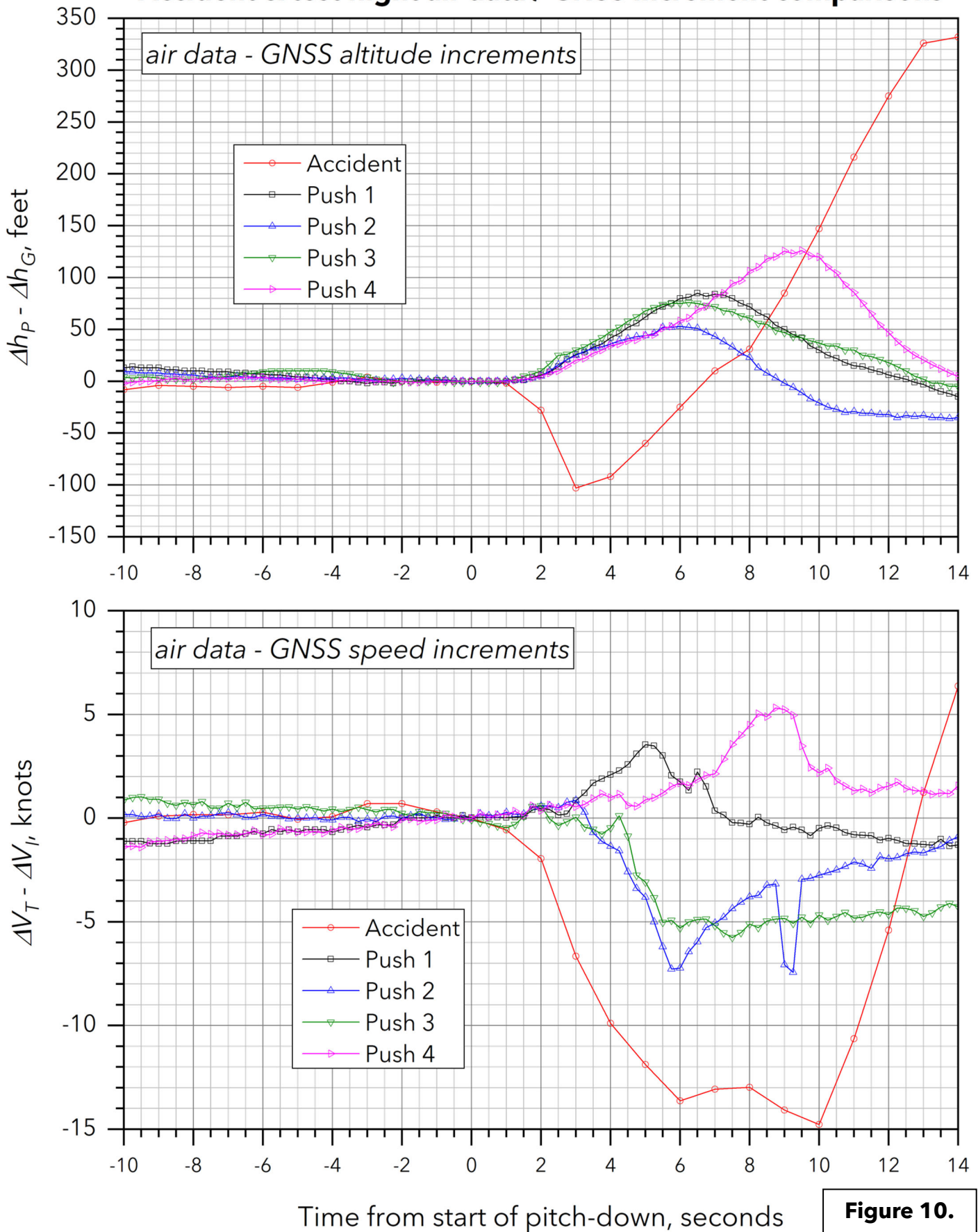


Figure 10.

CEN23FA359: Vans RV-14A, N6161, Virden, IL 08/12/2023²³

Accident & test flight static pressure increment comparisons

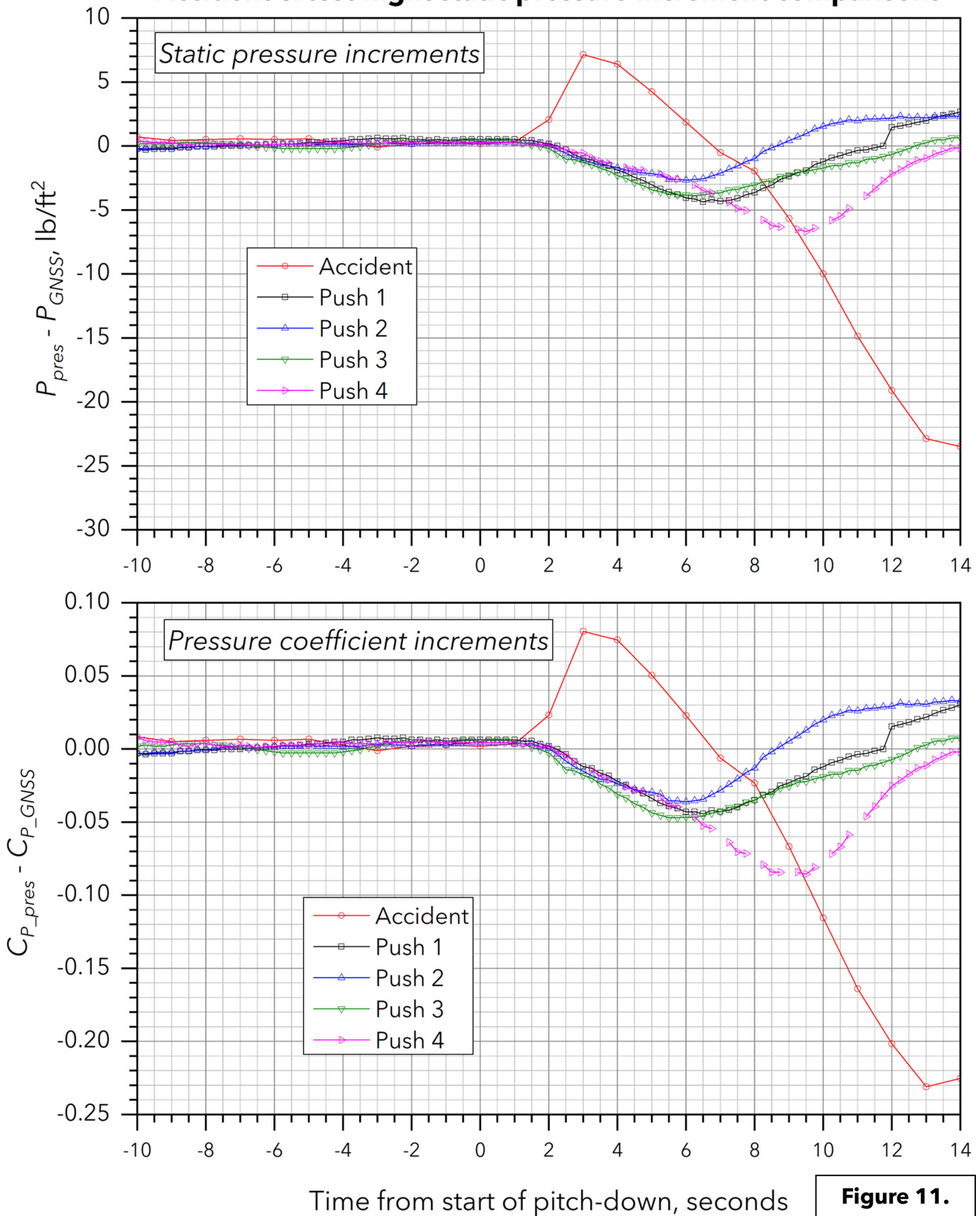


Figure 11.

Accident & test flight pitch comparisons

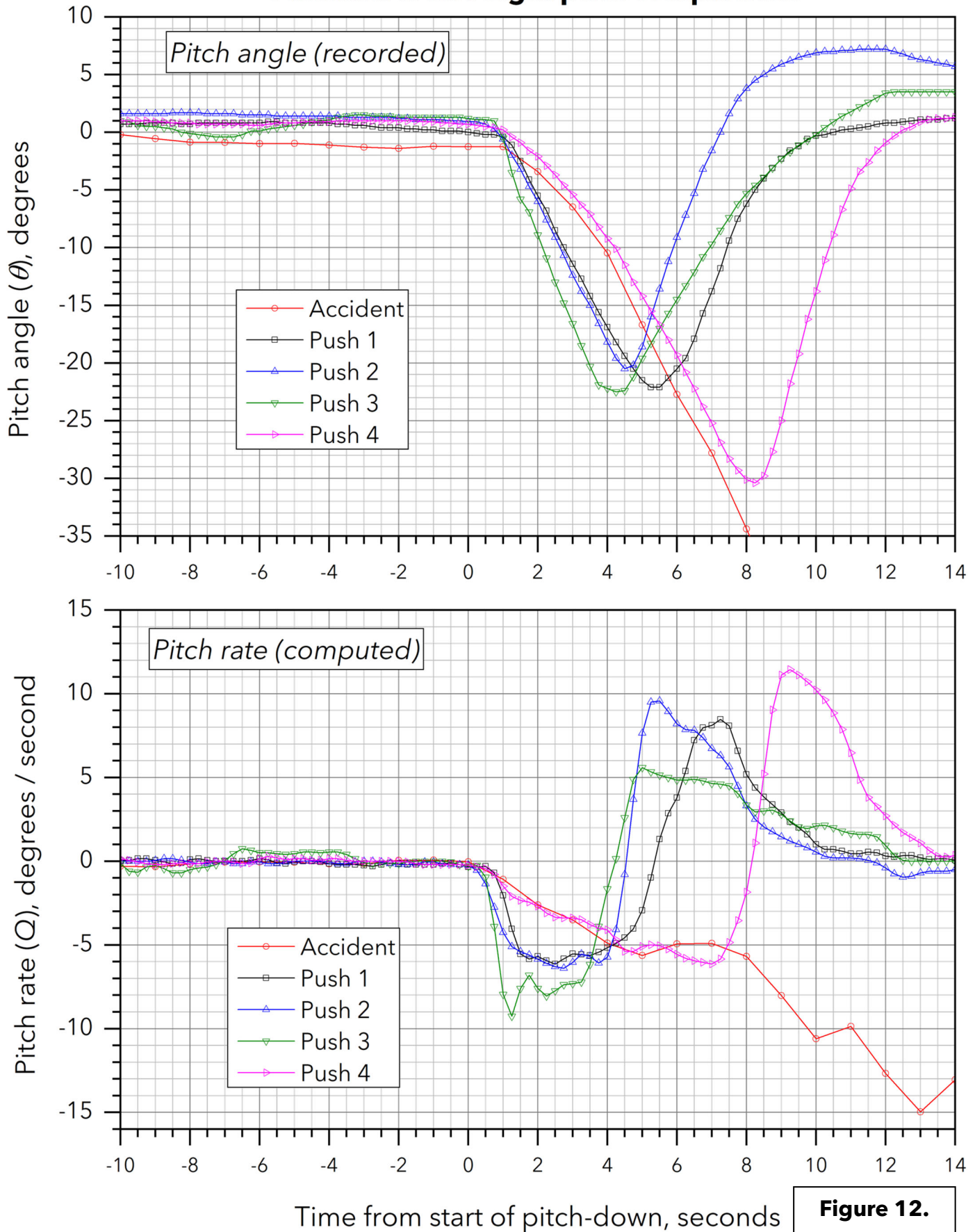


Figure 12.

Accident & test flight roll comparisons

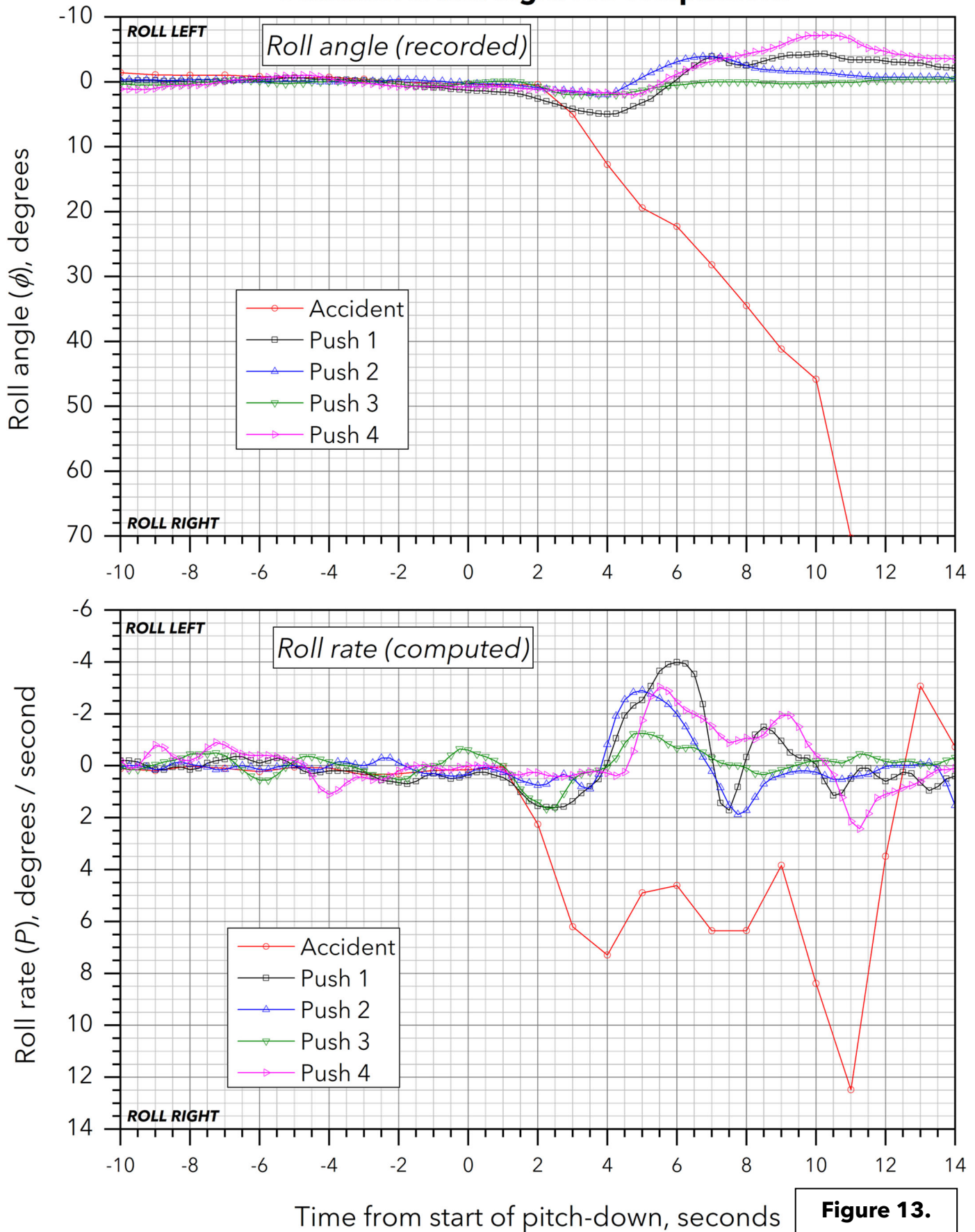


Figure 13.

Accident & test flight load factor comparisons

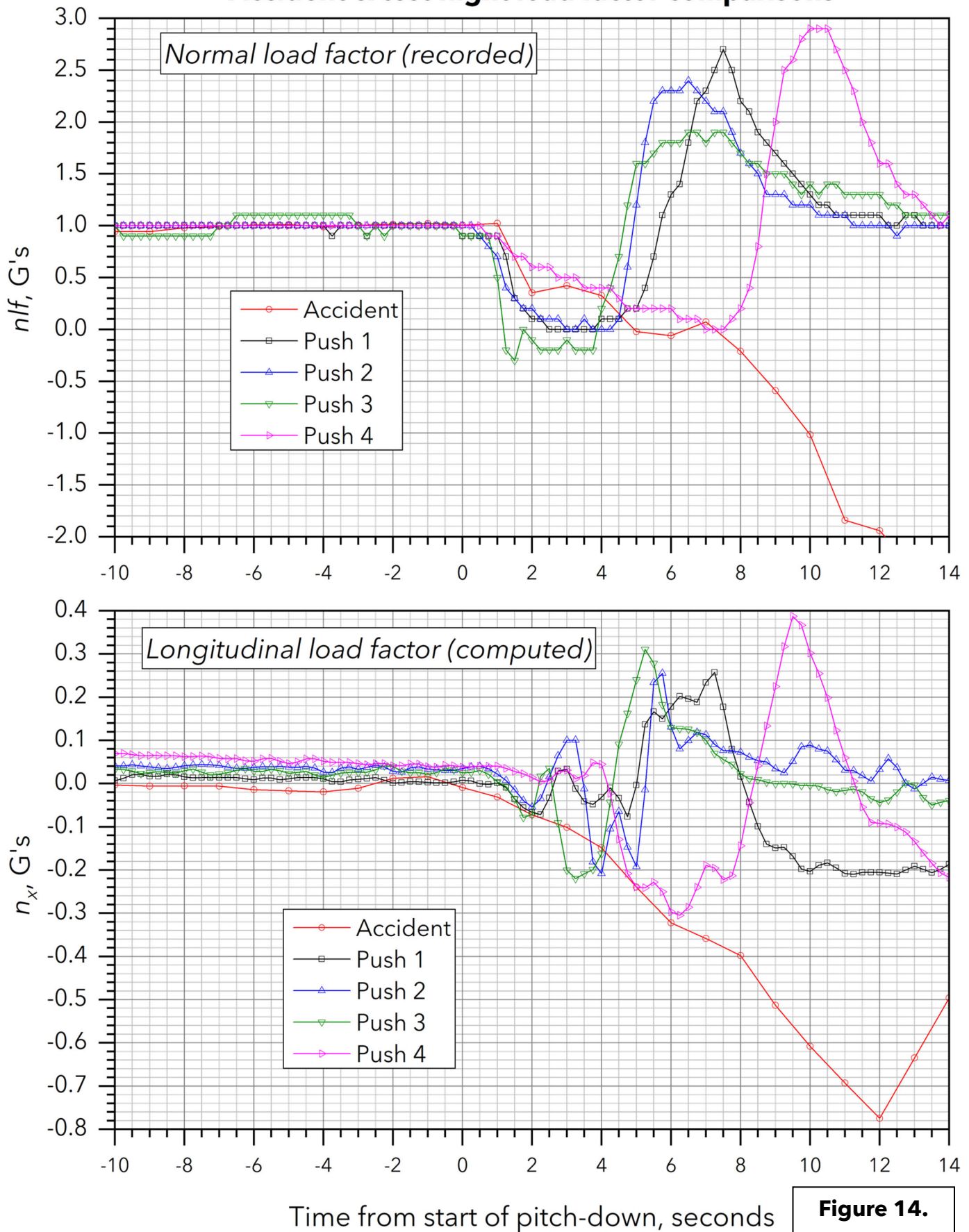


Figure 14.

Accident & test flight engine parameter comparisons

