



FDM Data Processing for Cessna Caravan

Background

At the Aviassist conference in Entebbe, an operator provided Flight Data Services (FDS) with some files from their G1000 equipped Cessna Caravan aircraft.

FDS took on the task to determine whether this data could be used as a basis for an effective Flight Data Monitoring programme.

This report identifies the steps taken to process the data, and then examines some of the more unusual flights to indicate the kind of results that this analysis can achieve. For each flight selected, the flight file identifier and unusual KPVs will be listed, then the flight described with supporting illustrations.

FDS are not familiar with the Caravan operation, and flights have been chosen simply because they are different from others. FDS are not suggesting that these represent unsafe operation of the aircraft.

Data Processing

The files are not in a standard format used for analysis by FDS, so we developed software to read the files and convert the data into the Hierarchical Data Format (HDF) format used by the POLARIS analysis suite.

Flights Processed

Of the 92 files supplied, 83 were found to be valid files while the remainder did not include airborne data or were corrupt in some way. For the 83 flights, the parameters listed in Annex A were converted ready for analysis.

There were too few files here to start statistical trend analysis of the FDM results.

Aircraft Issues

The analysis system needs to know certain aircraft characteristics and as we do not currently have a configuration for the Caravan, we substituted a Beech 1900D, registration 5N-BRG, as this has the most comparable flight envelope of those types currently monitored by FDS.

In fact, as no flap data is available on the Caravan this was not a significant issue as no V-speed values are computed.

Analysis Process Modifications

Some changes to POLARIS were then introduced to allow the processing to operate correctly with the Caravan data. As an example, the value of AIRSPEED_THRESHOLD (a speed at which the aircraft cannot be airborne) was reduced from 80kts to 50 kts.

The analysis required remarkably few changes to the POLARIS analysis suite, and it would be straightforward to adapt the web site to handle this data, however for the purposes of illustrating what could be achieved using this type of analysis, only the simple spreadsheet data and KML files have been used for this report.

Airports

All 83 flights were processed. Six airports were not identified as these were not in the FDS database, however the precision of the latitude and longitude data was good enough to provide a clear indication of the airfield in use. These strips could be added to the database if FDS were provided with identity of the landing strip.

Limitations of the Processing

There are limitations arising from the available data, the most significant of which is the lack of flap position data, so no flap limiting speeds can be checked and it is not possible to confirm that the landing configuration was established at a suitable point on the approach.

Analysis Outputs

From the analysis, a spreadsheet of the measurement Key Point Values, Key Time Instances and Flight Phase start and end points was created, as well as HDF files augmented by the derived parameters created during the processing and KML files that can be plotted on Google Earth.

The following examples identify the abnormal Key Point Values recorded on each flight, and use parameters from the HDF file plotted using Excel to illustrate the flight.

For a production system all these sources of data would be available on the POLARIS web site.

Climb During Final Descent

File

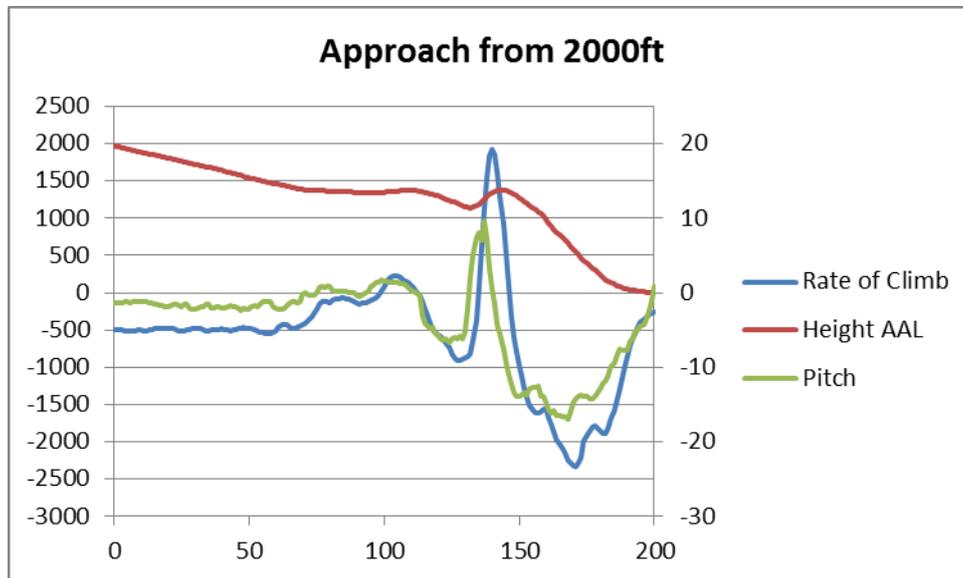
5N-BRG_log_131210_083803_HTMW.hdf5

Key Point Values

Rate Of Descent 1000 To 500 Ft Max	-2331.45	fpm
Pitch 1000 To 500 Ft Min	-17.02	deg
Pitch 500 To 20 Ft Min	-14.28	deg
Height 1 Mins To Touchdown	1347.134	ft

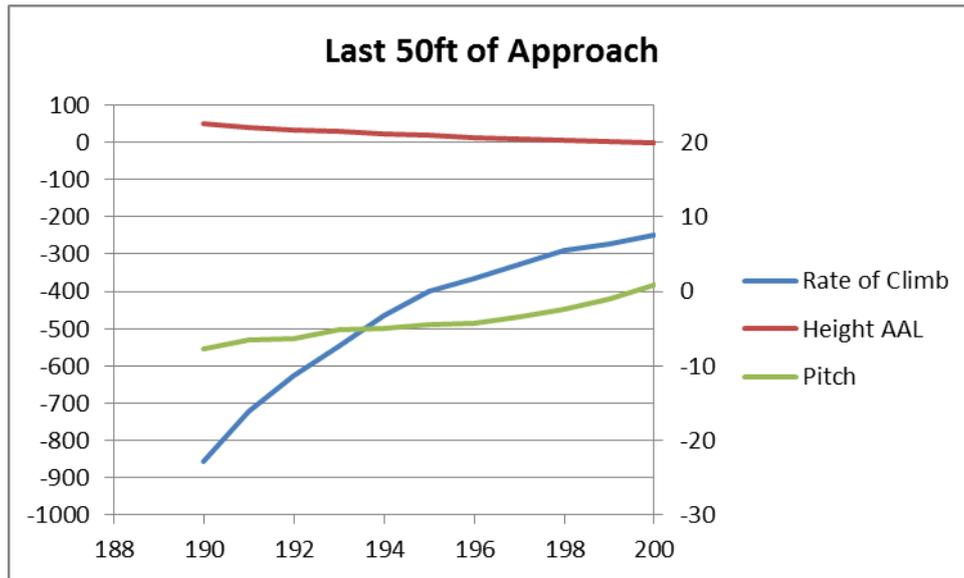
Description of this flight

On this flight the aircraft was in the descent approaching Bukoba, flying level at about 1300ft above the airfield. The final descent towards the airport had started when the pilot climbed sharply 240ft before resuming the descent.



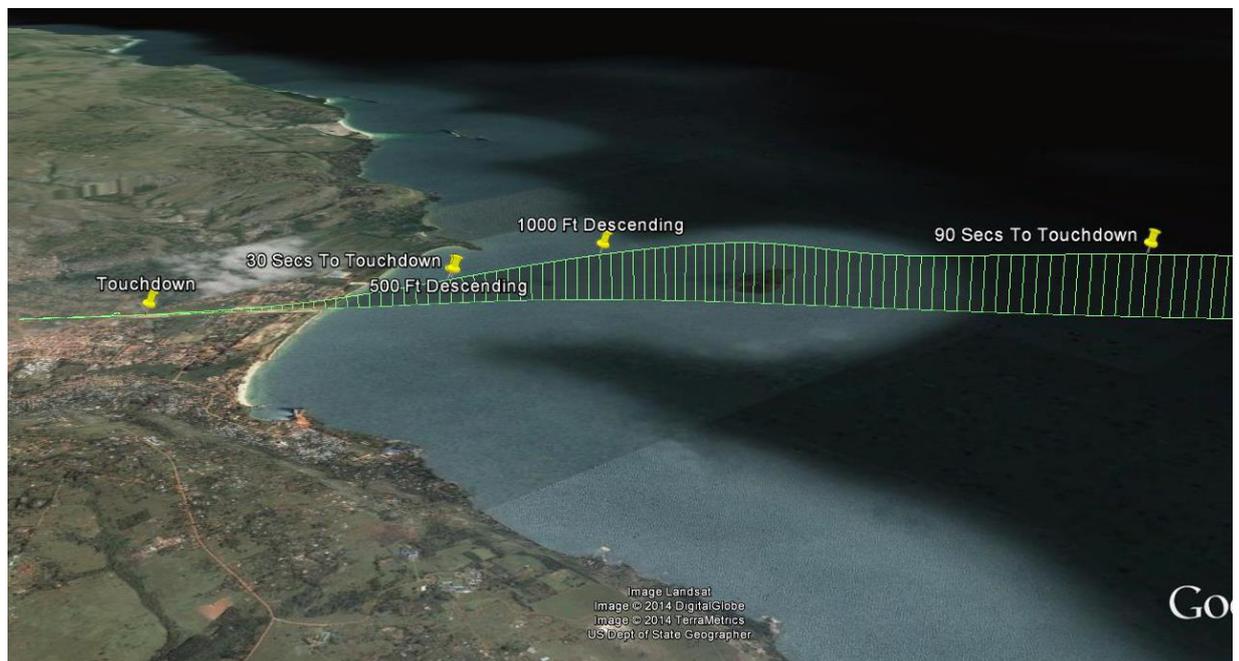
The short climb put the aircraft higher than normal, close to the runway, and in recovering the flight path a descent rate of 2330 fpm was reached at a height of 550 ft AAL. The aircraft was pitched nose down to the last second before touchdown, risking a nosewheel first landing.

FDM Data Processing for Cessna Caravan



As pure conjecture, the climb may have been to avoid a bird strike over the lake, however this is entirely guesswork and would need to be supported by a report from the crew concerned.

A Google Earth presentation of the final stages of the approach conveys this more easily.



Note: The indicated touchdown point is too far along the runway on this flight. This relates to the temporary configuration for this analysis and could be corrected in a production system.

Late turn onto Finals

This is one of the flights with a curving approach, where the aircraft is still turning late on the approach.

File

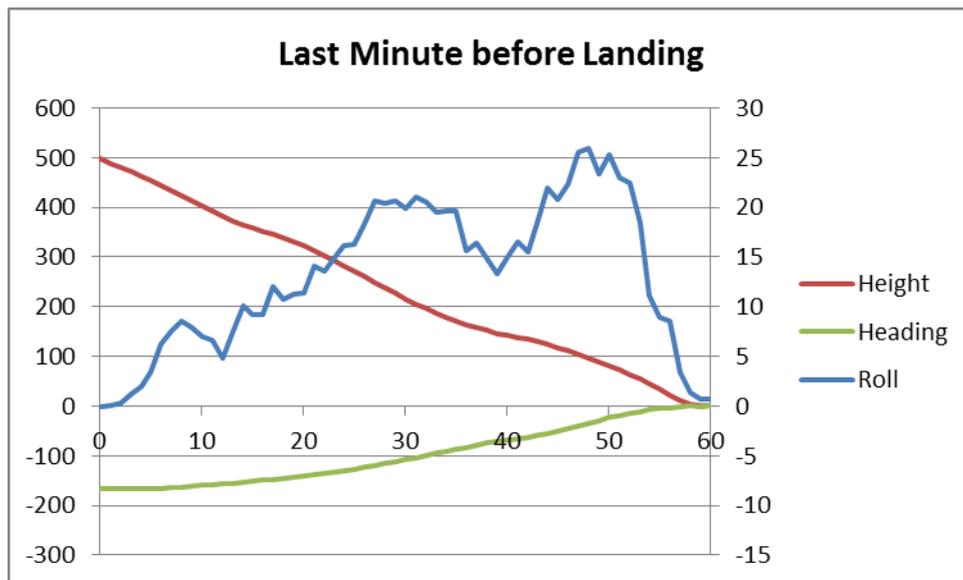
5N-BRG_log_131210_131633_HTTG.hdf5

Key Point Values

Heading Variation 300 To 50 Ft	119.9	deg
--------------------------------	-------	-----

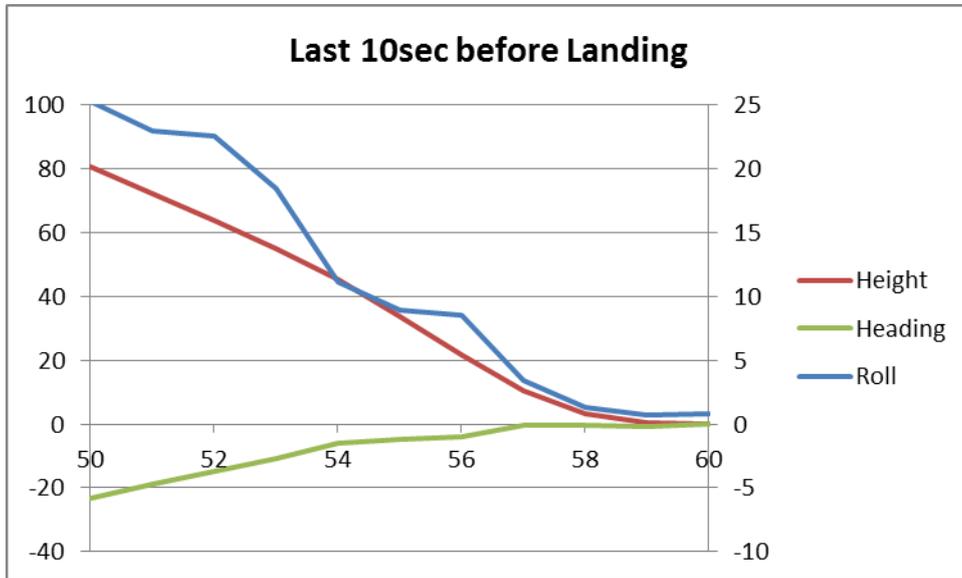
Description of this flight

Plotting the data for the last minute before landing shows a 167 degree heading change with bank angles reaching 25 deg right wing low.



FDM Data Processing for Cessna Caravan

The last ten seconds show the aircraft only became wings level at about ten feet above the runway.



A Google Earth presentation of the final stages of the approach conveys this more easily.



Steep Approach to Landing

File

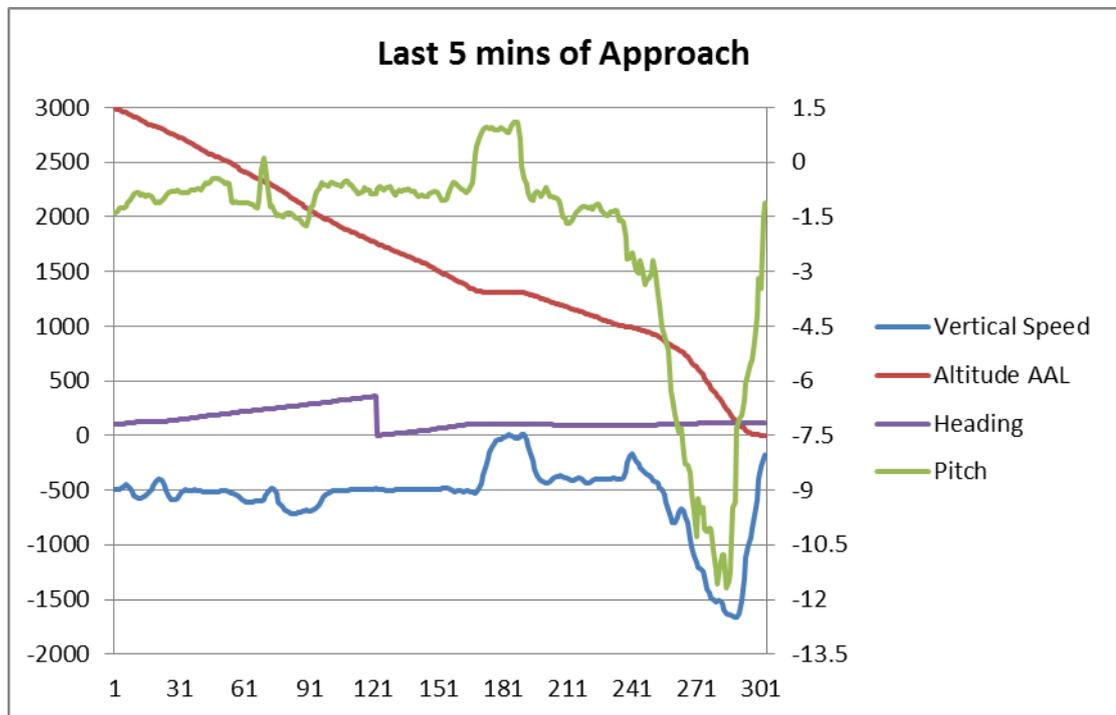
5N-BRG_log_131217_092903_HTBU.hdf5

Key Point Values

Pitch 20 Ft To Touchdown Min	-5.43	deg
------------------------------	-------	-----

Description of this flight

This is another flight where the pitch attitudes in the approach were low. This is especially curious as the pilot had carried out a descending turn and almost level section of flight before the final brief dip to the runway. The graph of descent characteristics shows the turn taking almost three minutes from 3000ft to about 1350ft, then a short level section of flight before the approach is continued, then in the last 45 seconds the approach steepens dramatically to land.



FDM Data Processing for Cessna Caravan

Again, a 3-D view of the approach is easier to interpret.



Discussion

The aircraft's engine limitations can all be monitored automatically by the POLARIS analysis system, and alerts to exceedances would be sent to engineers immediately on receipt of the data. From the data supplied, no engine exceedances were observed.

This brief exercise has illustrated that it is possible to obtain good quality data from the Caravan G1000 avionics system, and with a few modifications to the POLARIS analysis system, Flight Data Services could provide an FDM monitoring service for these aircraft.

Annex A – Converted Parameters

CSV Name	POLARIS Name
Longitude	Longitude
Latitude	Latitude
Pitch	Pitch
Roll	Roll
AltB	Altitude STD
NormAc	Acceleration Normal
HDG	Heading
OAT	SAT
IAS	Airspeed
GndSpd	Groundspeed
LatAc	Acceleration Lateral
TAS	Airspeed True
WndSpd	Wind Speed
WndDr	Wind Direction
Lcl Date	Date_string
Lcl Time	Time_string
VSpd	Vertical Speed
TRK	Track
FQtyL	Fuel Qty (1)
FQtyR	Fuel Qty (2)
E1FFlow	Eng (1) Fuel Flow
E1 OilT	Eng (1) Oil Temp
E1 OilP	Eng (1) Oil Press
E1 Torq	Eng (1) Torque
E1 NP	Eng (1) NP
E1 NG	Eng (1) N1
E1 ITT	Eng (1) Gas Temp
HPLfd	Eng (1) N2