

# J-FLiC UAS Flights for Acoustic Testing Research



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# ERA Integrated Technology Demonstration (ITD) 50A

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1)	Altitude at center microphone = 100 +/- 20 ft AGL
2)	Centerline deviation = 0 +/- 10 ft
3)	Nominal cruise speed for J-FLiC testing : 60 – 130 kts



- PI determined each pass to be Good or Bad
  - visual observation of centerline offset
  - airspeed/altitude callout
  - expressed preference for repeatability



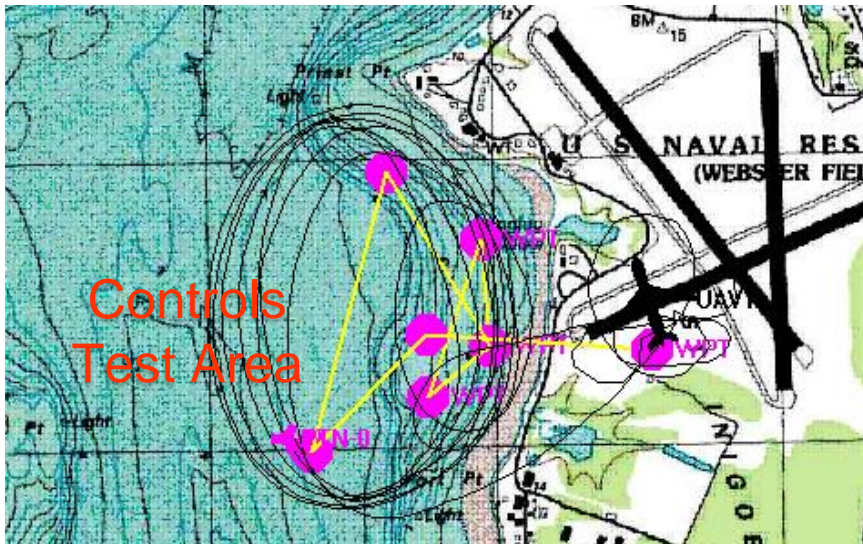
# Remotely Piloted Vehicles for Experimental Flight Control Testing



FLying Controls Testbed (FLiC)

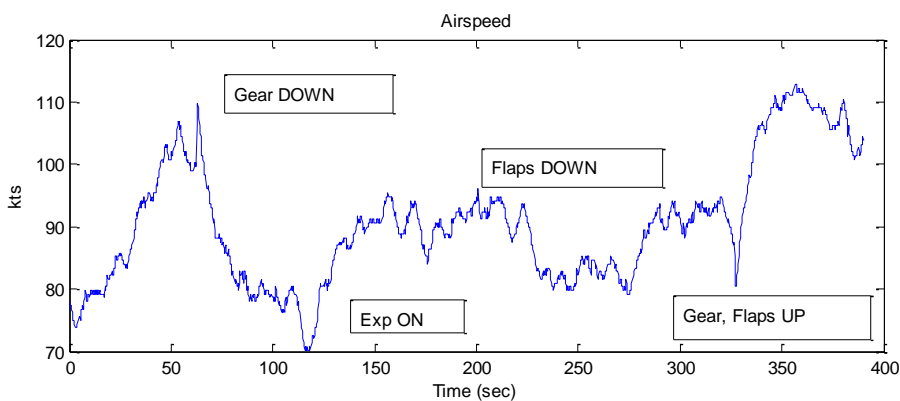


J-FLiC



## Operational Concept

- External pilot (EP) executes manual takeoff
  - EP alternately monitors auto-takeoff
- EP engages autopilot in local area if manual
- Autopilot transitions to designated test area
- Ground station operator (GSO) engages experimental controls
  - Induce unanticipated disturbances
    - Landing gear / flaps
- Experimental controller compensates
- Discontinue disturbances
- GSO disengages experimental controller
- GSO engages autopilot Return to HOME
- EP executes manual landing
  - Alternately monitors auto-landing
- 12-15 minutes total flight time



National Aeronautics and Space Administration

# J-FLiC

- Wingspan : 80 inches
- Length: 94 inches
- Weight: 40 lbs
- Wing area : 1600 sq in
- Wing loading: 58 oz/sq ft
- Thrust: 34 lbs
- Speed range: 35 – 200 kts
- Flight time: 14 minutes
- Radio gear: Futaba 14MZ // 2.4 GHz
- Futaba R6014HS receiver with failsafe
- Micropilot 2128g autopilot installed
- 900 MHz radio modem for telemetry// GCS



- First flight : 17 Aug 2004
- Recent flight: 03 Sep 2015
- Total flights: 276
- Autopilot engaged : 170
- AUVSI UAV Demo 2007

# ➤ Test Configurations

➤ Landing gear down, full flaps



➤ 60 / 80 / 95 kts

➤ Clean

➤ 80 / 130 kts









# J-FLiC Flight Test Team

- James W. High, ESB – Ground Control Station operator
- Jeff Hill, RSD – Range safety Officer (RSO) / Observer
- Robert McSwain, AESB – Test coordinator / FDAS/photos
- Zak Johns, NIA – Observer / runway alignment coach
- Jeff Werner , AESB – model servicing and support
- Michael Logan , AESB - Range Officer in Charge (OIC)
- Mark Motter – Pilot in Command (PIC) , autopilot



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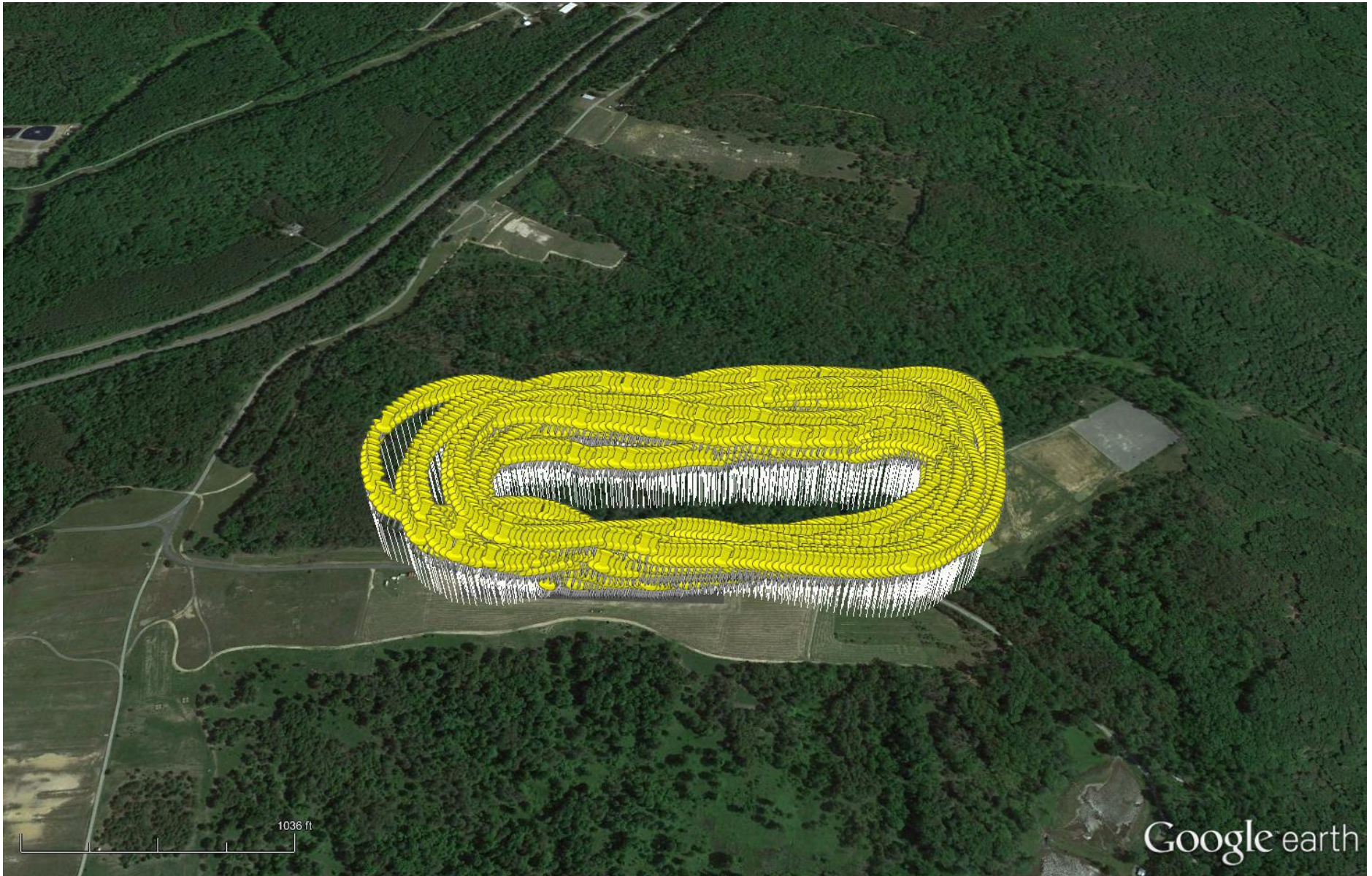


# Challenges

- J-FLiC last operated on 11 Sep 2012 at beginning of program
- Preliminary flights scheduled for 12 May
  - Limited flights (8) due to winds and mechanical problems
    - Engine startup, landing gear air system leaks
  - Only three autopilot flights
    - Lost link - return to HOME waypoint, climb to 800', 80 kts
    - Good speed regulation for both clean and landing config
    - AP climb/ descent configured for 65 kts, clean only
    - No flights to check AP ground tracking performance
  - PI reviewed data from manual flights, deemed acceptable
    - Airspeed
    - Altitude
    - vertical profile
    - centerline offset

- Research scheduled for Aug 24 – Sep 4
- Microphone array setup and calibration 24-26 Aug
- Initial J-FLiC flights 27 Aug, no data taking flights
  - Simulated engine out approaches, lost link response
- 28 AUG
  - One “practice” data taking flight – 6 of 24 passes good
    - 80 kts, landing configuration, manual
  - Two autopilot development flights late in the day
    - Ground tracking for runway alignment
- 29 AUG
  - Three data taking flights - 18 of 35 passes good
    - 60 / 80 / 95 knots landing configuration , manual (10/22)
    - 80 / 130 clean , manual (8/13)
  - Three autopilot development flights late in the day
    - 800 to 500’, 600 to 300’, 400 to 100’, good runway alignment

manual flight path , 60/80/95 kts, landing configuration, 29 Aug 15



manual flight path , 80/130 kts, clean configuration, 29 Aug 15



➤ 30 AUG (Rest day)

➤ 31 AUG

➤ Three data taking flights - 21 of 32 passes good

➤ 80 knots clean , autopilot (6/6)

➤ 80 knots landing config, manual (7/13)

➤ 95 knots, landing config, manual (8/13)

➤ Three autopilot development flights late in the day

➤ Determined throttle settings for climb and descend in landing configuration

➤ Check runway alignment in landing config, 80 kts

➤ Climb/descend from 800' to 500'

➤ 01 SEP

➤ Ready for 80 kts, landing config, 400' - 100', autopilot

➤ No flights that day

## ➤ 02 SEP

- Three data taking flights - 17 of 21 passes good
  - 80 knots landing config, autopilot (6/6)
  - 80 knots clean, autopilot (3/4)
  - 60 knots , landing config, manual (8/11)

## ➤ 03 SEP

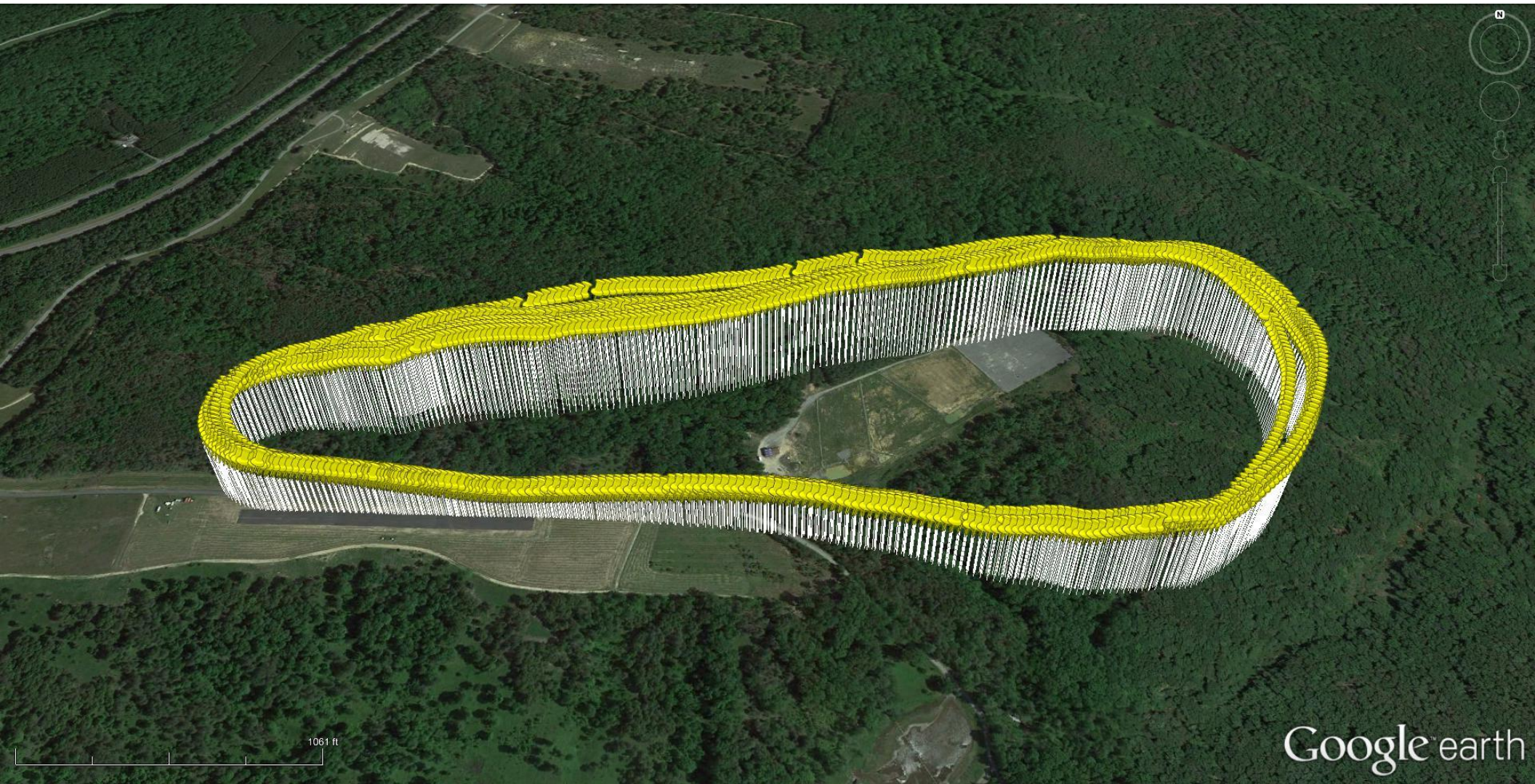
- Three data taking flights - 17 of 20 passes good
  - 80 knots landing config, autopilot (6/6)
  - 80 knots clean, autopilot (6/6)
  - 80 / 130 knots , clean, manual (5/8)

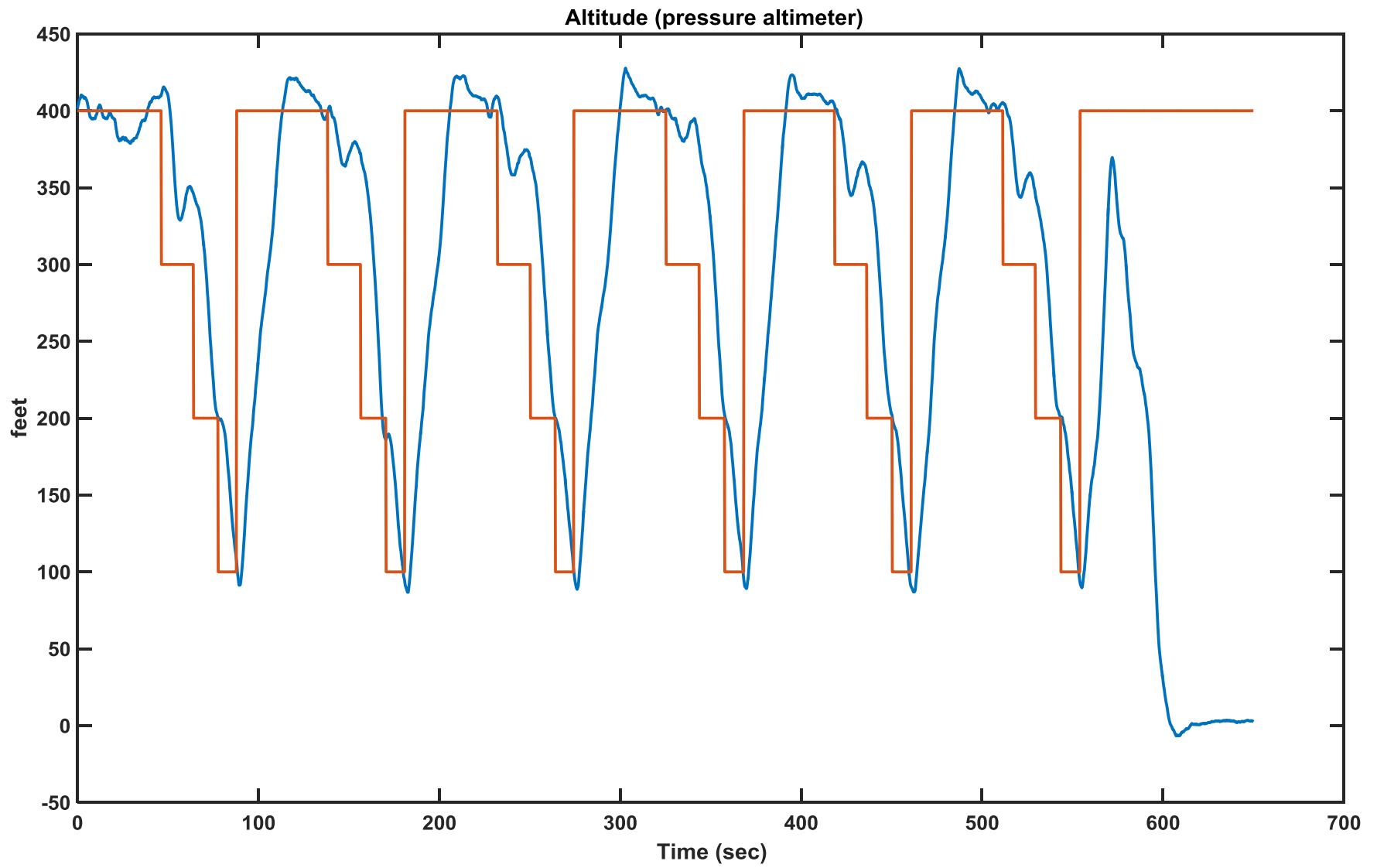
## ➤ Overall

- 73 / 108 passes good
  - Manual - 46/80 58%
  - Autopilot – 27/28 96%

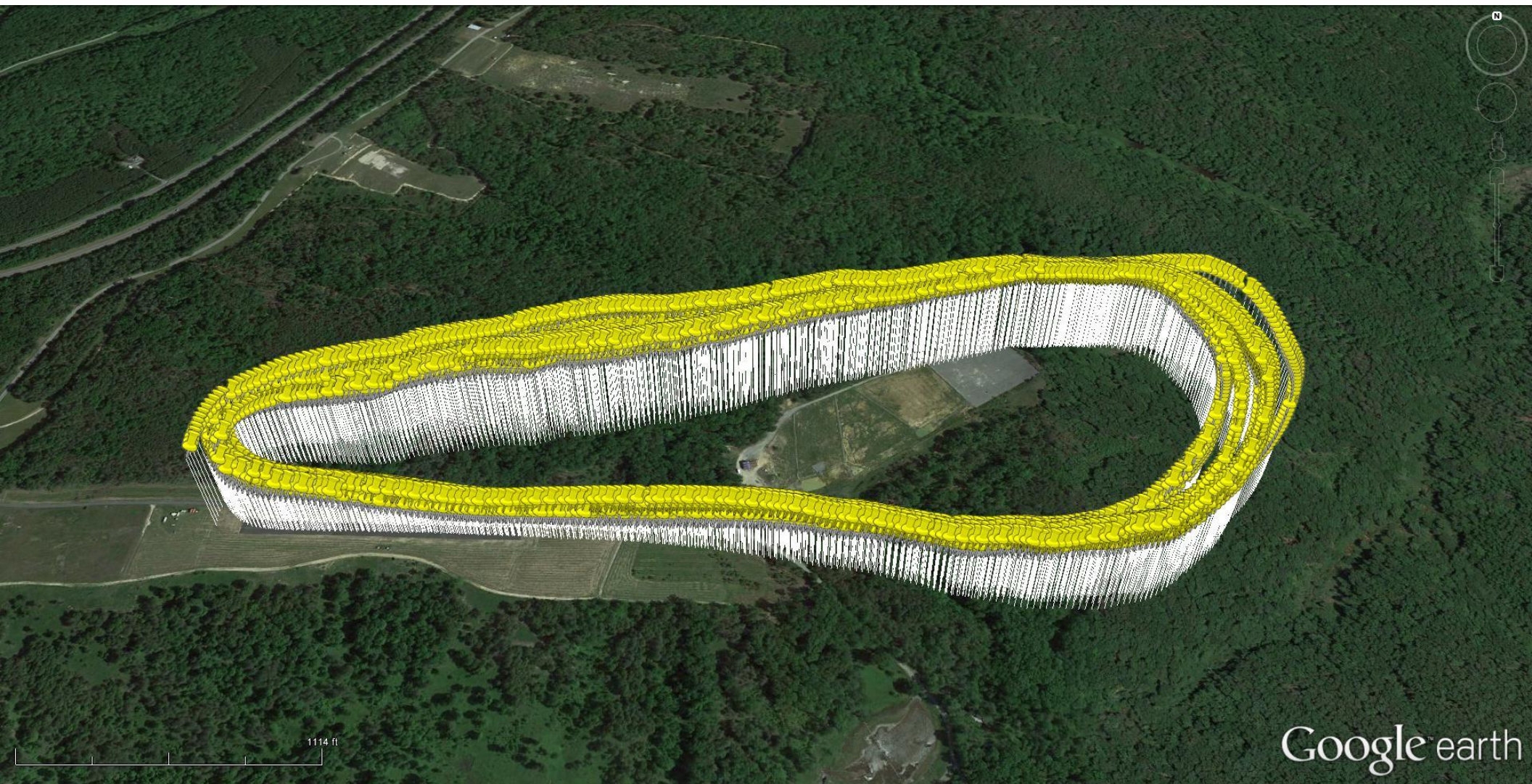


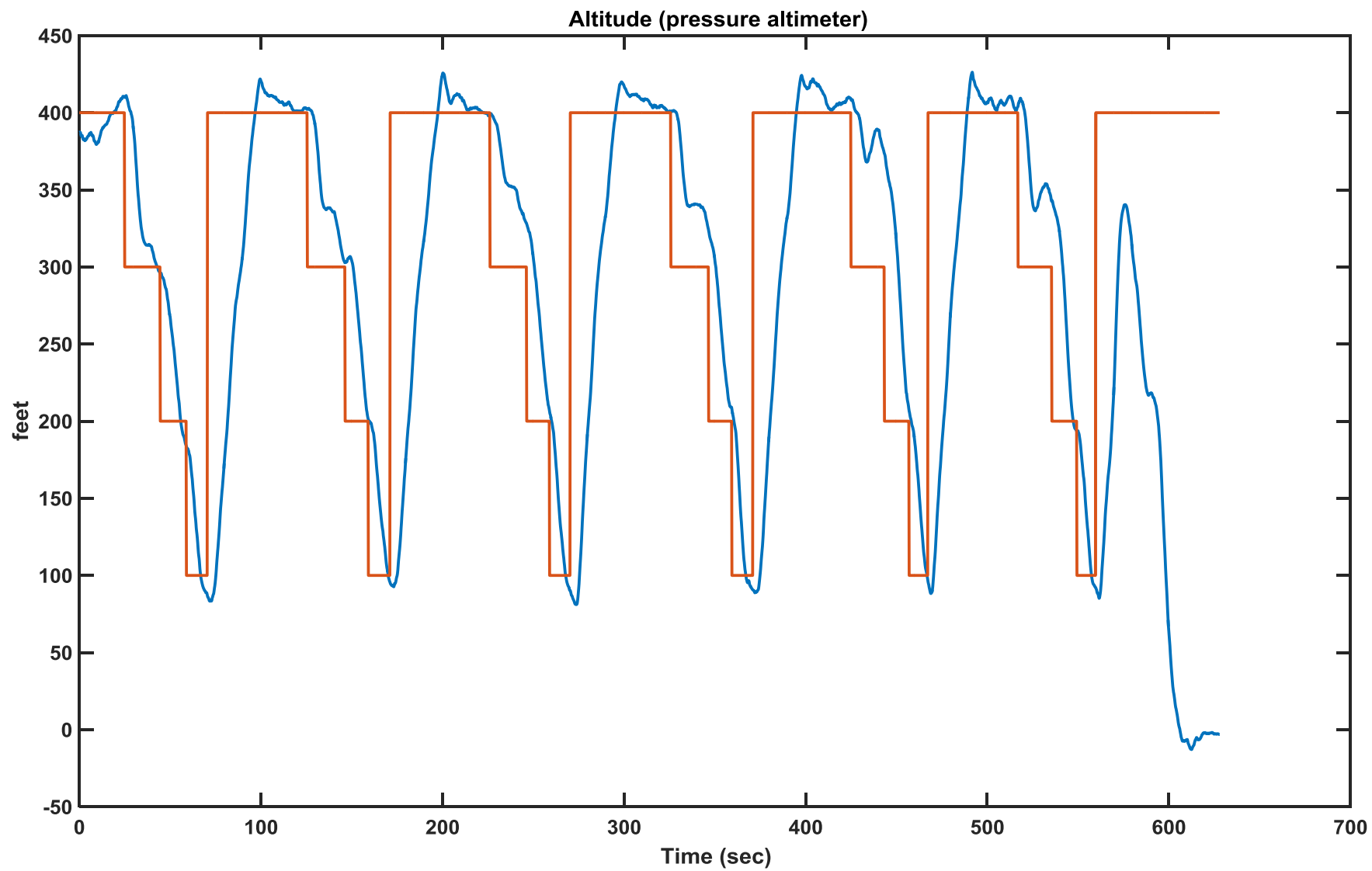
# Autopilot flight path , 80 kts, landing configuration, 02 Sep 15



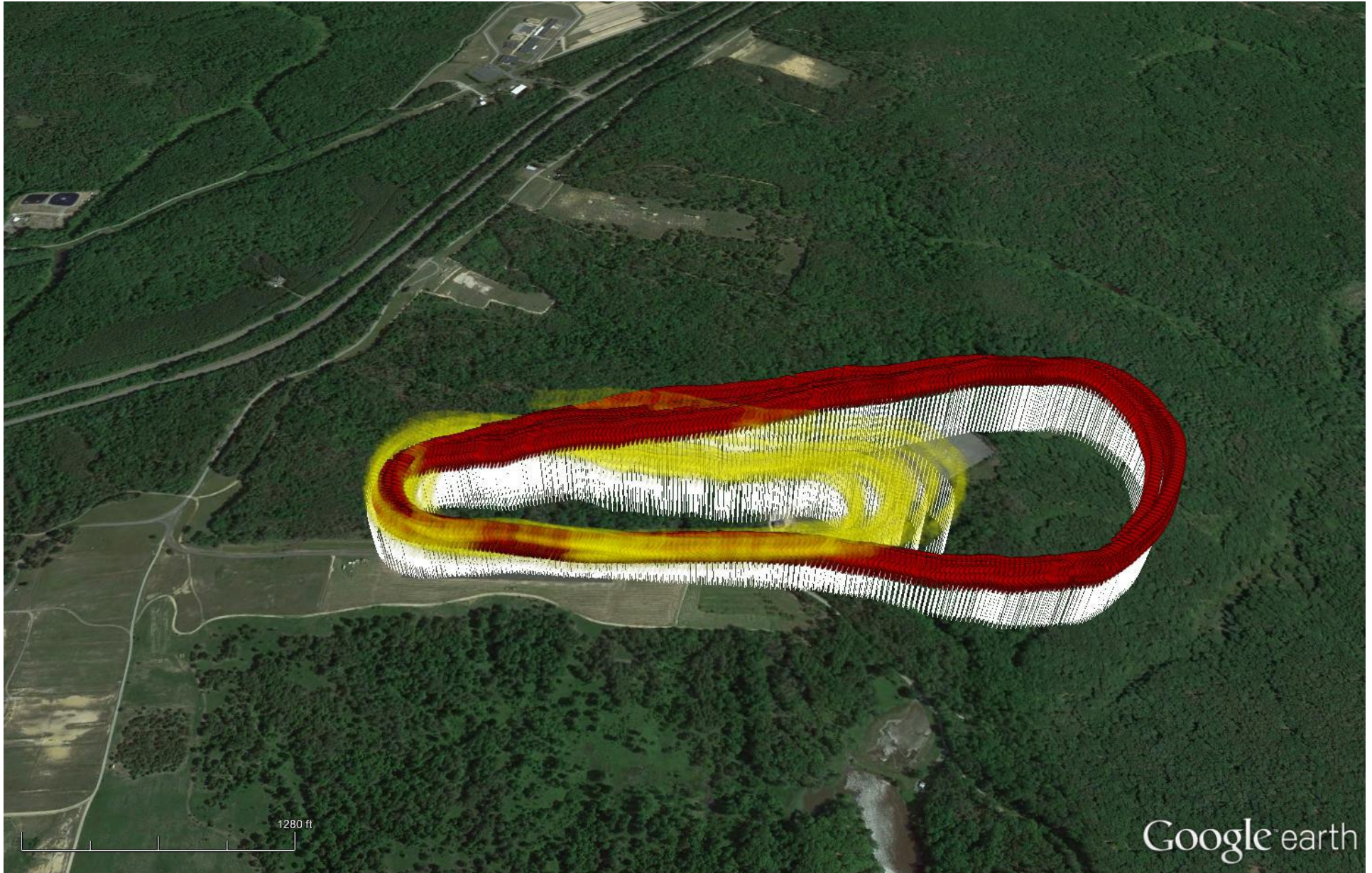


# Autopilot flight path , 80 kts, landing configuration, 03 Sep 15

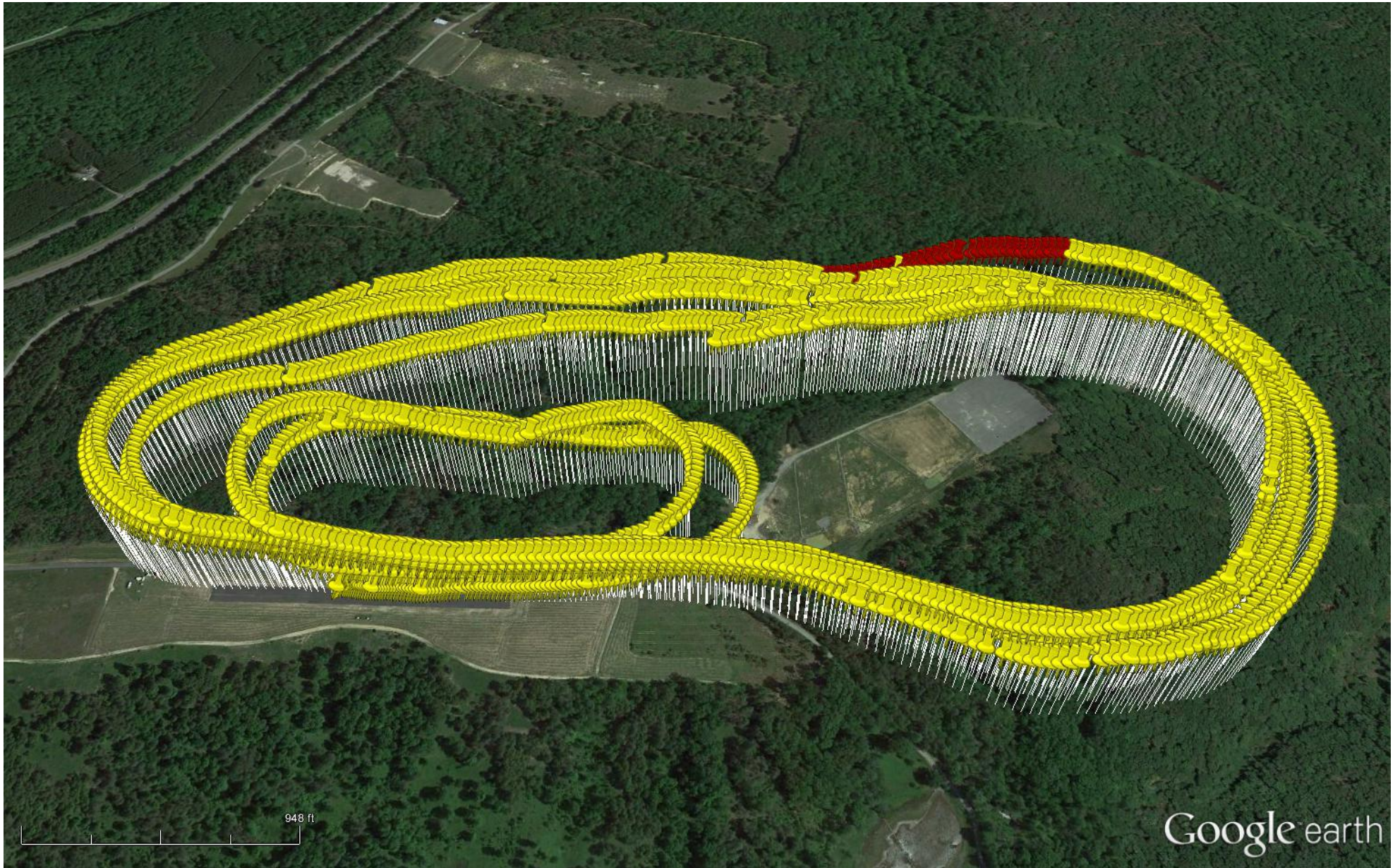


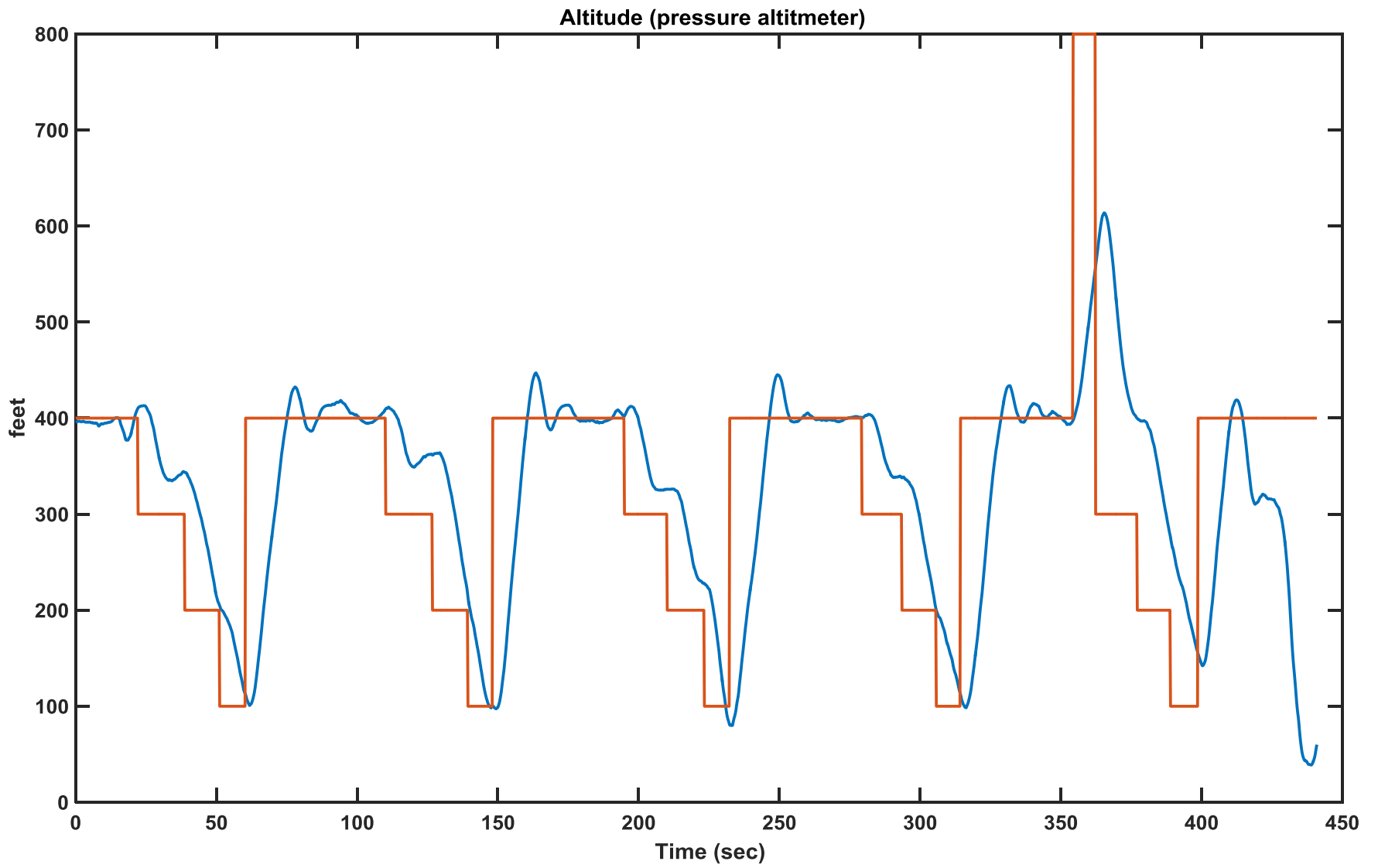


# Typical auto and manual flight paths



# Lost Link recovery 02 SEP 15 Flight #2





# Potential improvements/ Future Work

- Data-driven decision making for “good / no-good”
- Real-time adjustment of waypoints for better runway alignment (from one pass to the next)
- Operation with RC link de-energized except during landing and takeoff abort
- Lost link response triggered by loss of ground control station command and data telemetry link
- Operation beyond visual range in restricted airspace
- Fully automated flight – autoland and takeoff

Data-driven decision making for go around and takeoff abort



