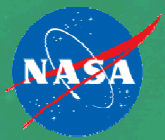


ADAMA

Autonomous Distributed Atmospheric
Measurement Acquisition

*Three Dimensional Meteorological
Measurements using Large Swarms of μ UAVs*

Edward Adcock
NASA
Langley Research Center



ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



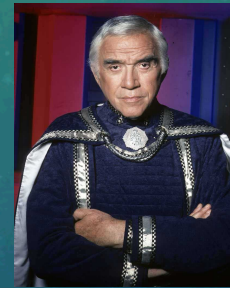
Objective

Experimentally resolve the capability of a fully autonomous swarm of MET sensors in support of earth science UAV missions.

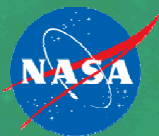
Approach

- Large number of disposable sensors used
- 112 CICADA gliders orbit single waypoint
- Payload platform: 4 Hive UAVs
- Data collection: Logged onboard and telemetered to Ground Station
- MET/flight data analyzed and compared to expected results

ADAMA



*Autonomous
Distributed
Atmospheric
Disposable
Acquisition*



ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team

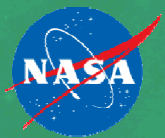


112 CICADAs used for Mission

65g ready-to-fly weight.
Includes autopilot,
battery, MEMS sensors,
XBee radio.



Payload- CICADA (*Close-In Covert Autonomous Disposable Aircraft*): Designed by NRL



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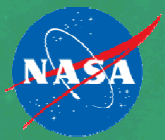
CoIs: Danette Allen, Jim Neilan and ADAMA team



Hive- "Mothership" X-8 Multirotor Heavy Lift sUAS



Cross Dimension	1200mm
Vehicle Weight	33lbs with 2x Tattu 22k mah
Min. Flight Weight	30lbs
Max Flight Weight	55 lbs
Payloads	Up to 20 lbs
Range	Line of Sight
Endurance	25min with 1KG payload
Prop Size	20" Diameter
GCS	Mission Planner, QGround Control, APM Planner



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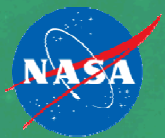
OWLETS

CICADAs flown as sensors

CICADA



Ozone
Water
Land
Environmental
Transition
Survey



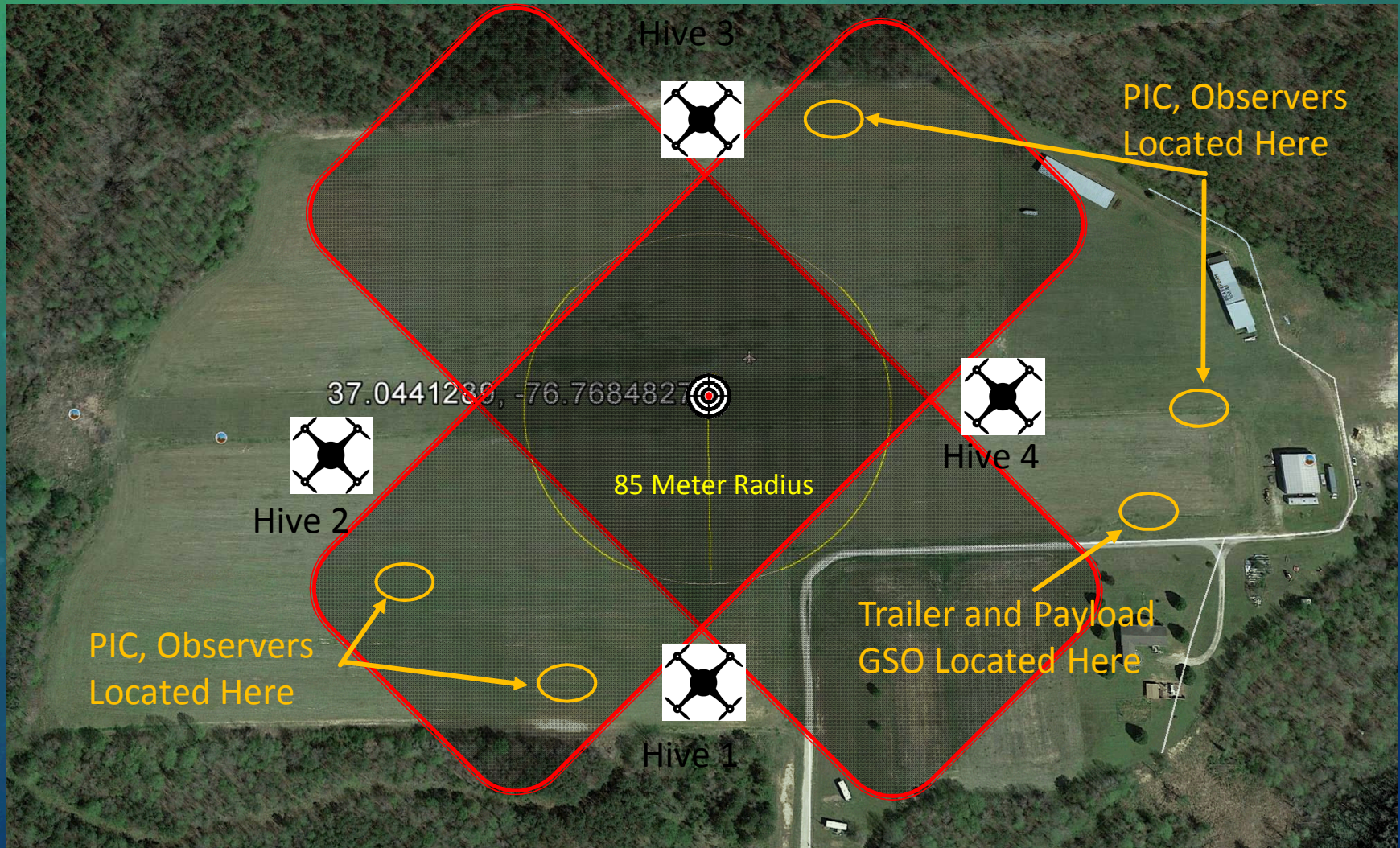
ADAMA

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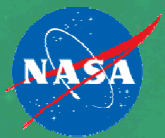


Flight operations conducted at the Beaver Dam site



No Fly Zone for HIVE-HIVE-CICADA collision mitigation

12/9/2019



ADAMA

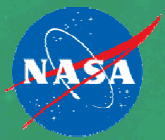
PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



ADAMA Sim Video

12/9/2019



ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



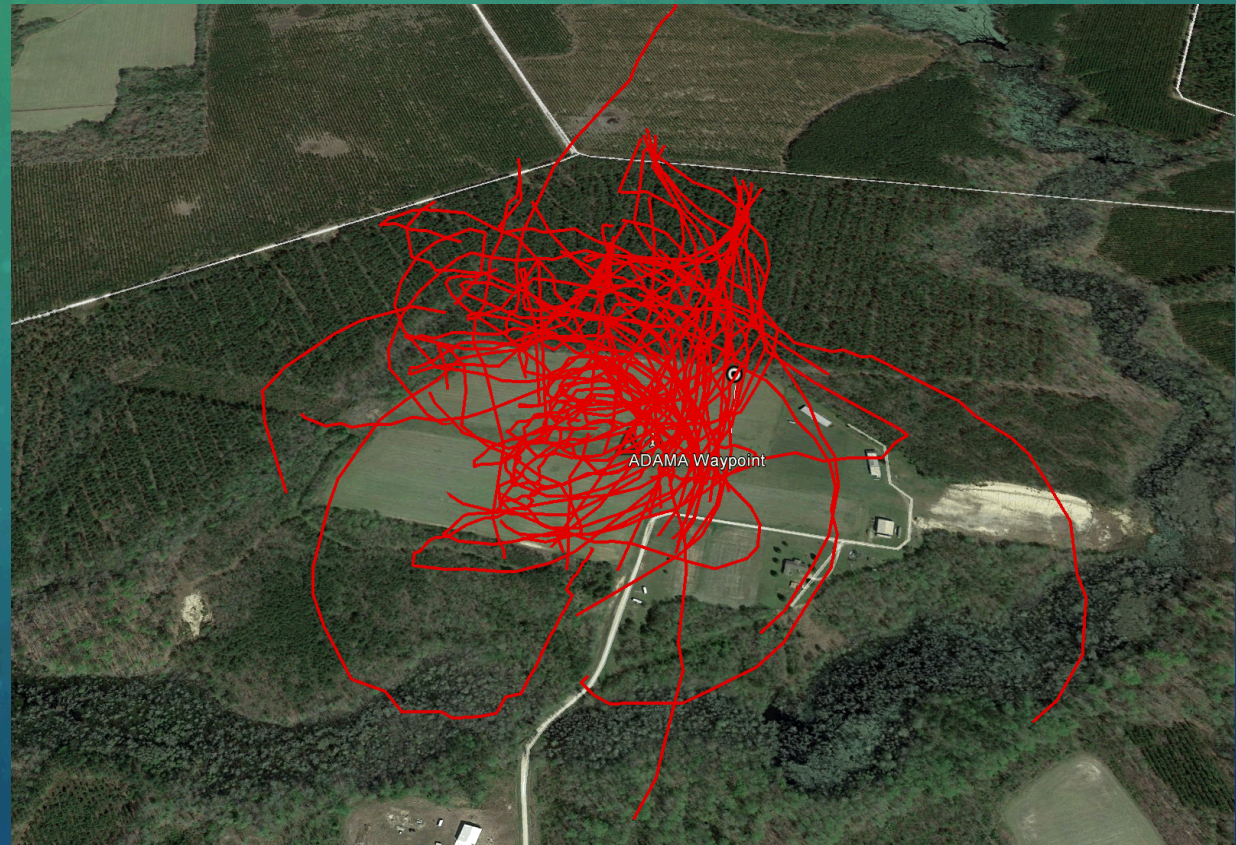
All flights paths shown

Hive1 = White (17)

Hive2 = Red (13)

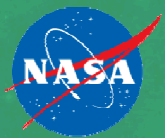
Hive3 = Blue (12)

Hive4 = Yellow (18)



- 63% CICADAs w/ good data (60)
 - *Meaningful altitude descent data*
- 15% “Good Flights” (14)
 - *At least 1 Revolution and landing near radius*

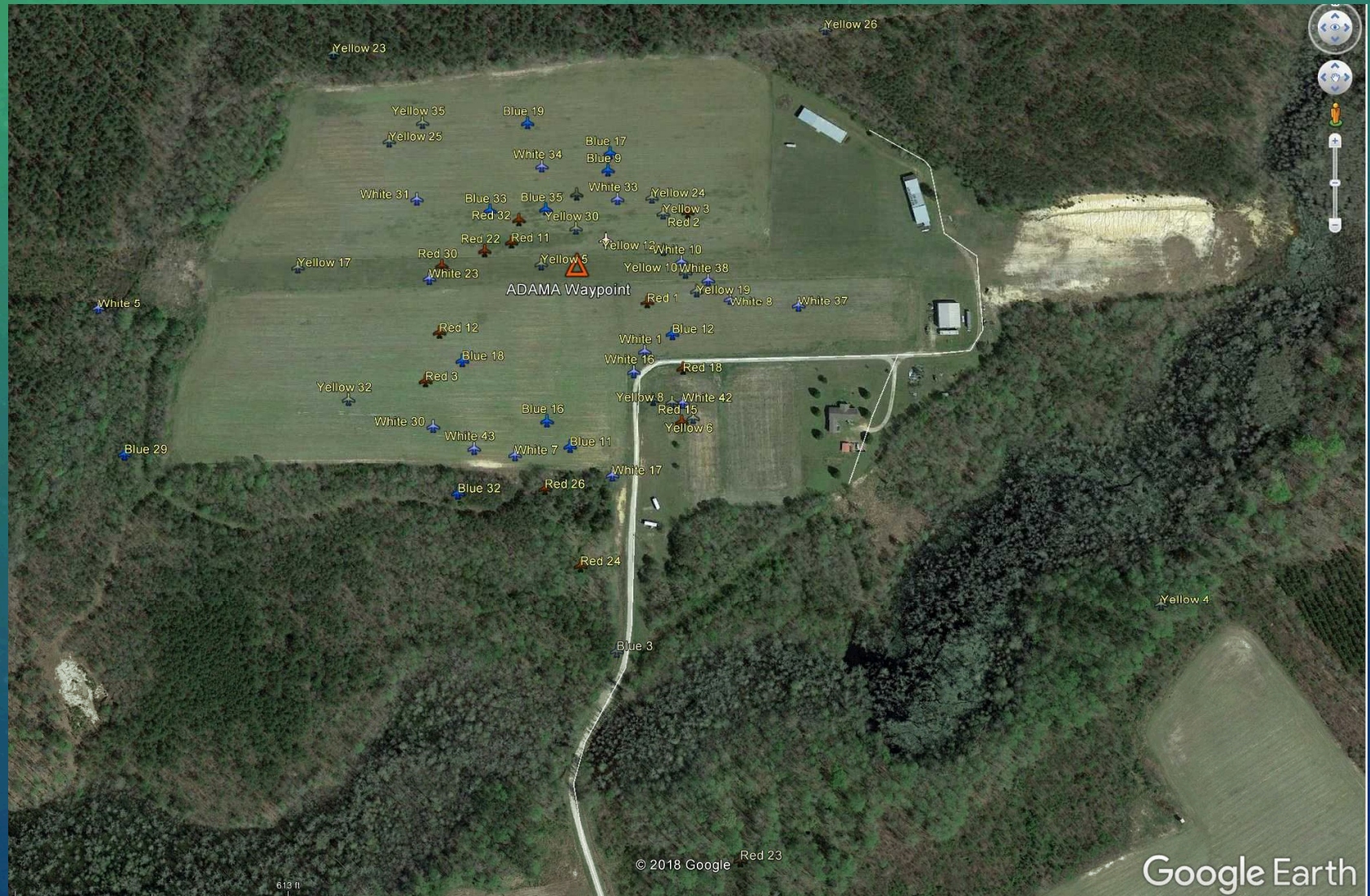
ADAMA Flights



ADAMA

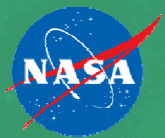
PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



All Flights/ Scatter

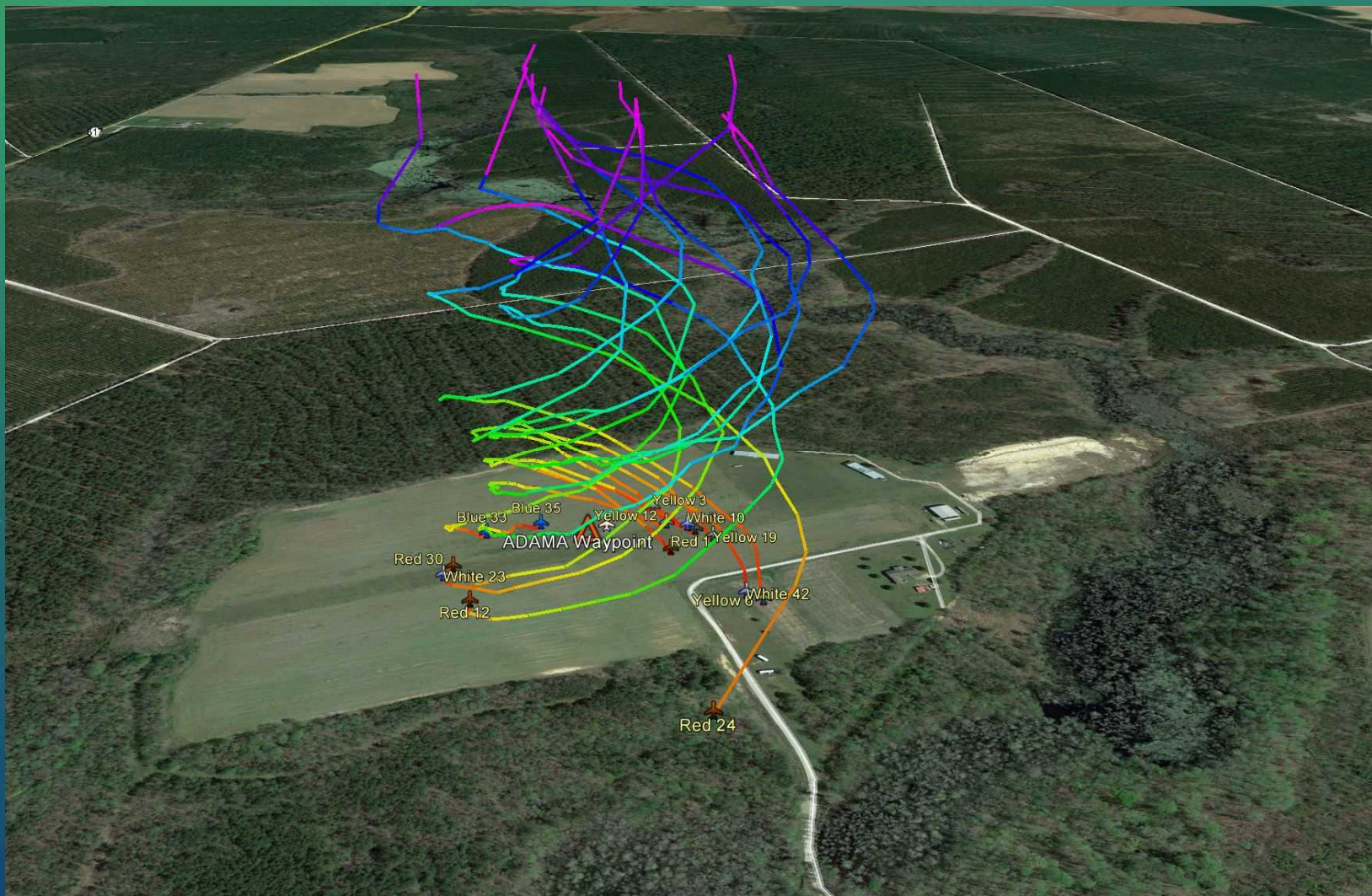
12/9/2019



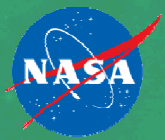
ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



All "Good" Flights



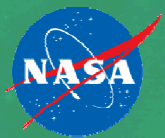
ADAMA

PI: Eddie Adcock

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Video removed to allow Transfer



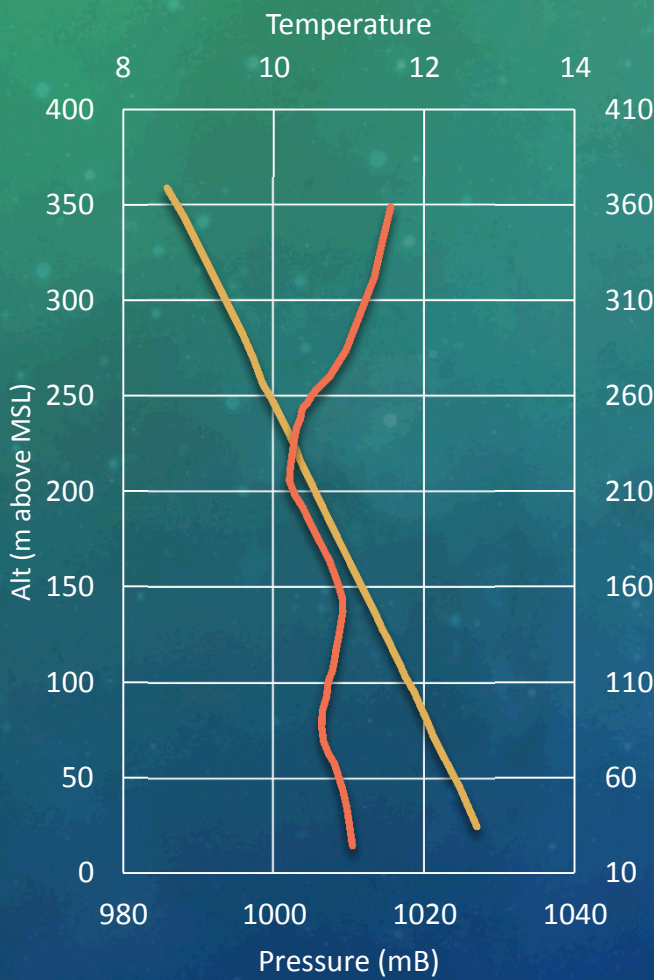
ADAMA

PI: Eddie Adcock

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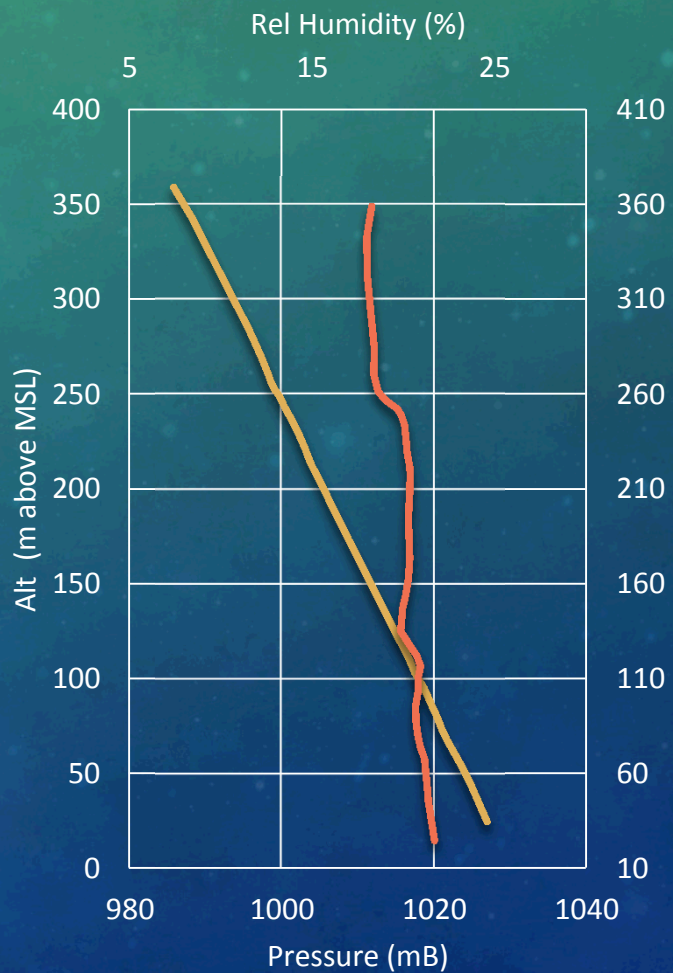


CICADA Blue 33 3/19/2019 Beaver Dam



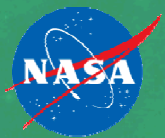
— Pressure — Temperature

CICADA Blue 33 3/19/2019 Beaver Dam



— Pressure — Humidity

Flight Data
Blue 33



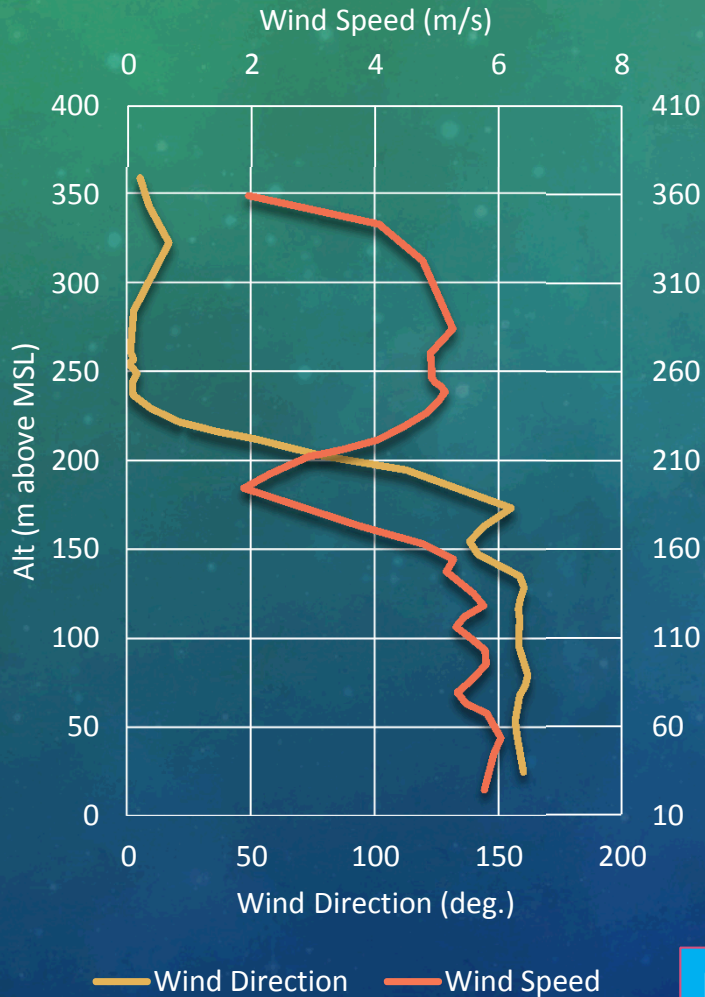
ADAMA

PI: Eddie Adcock

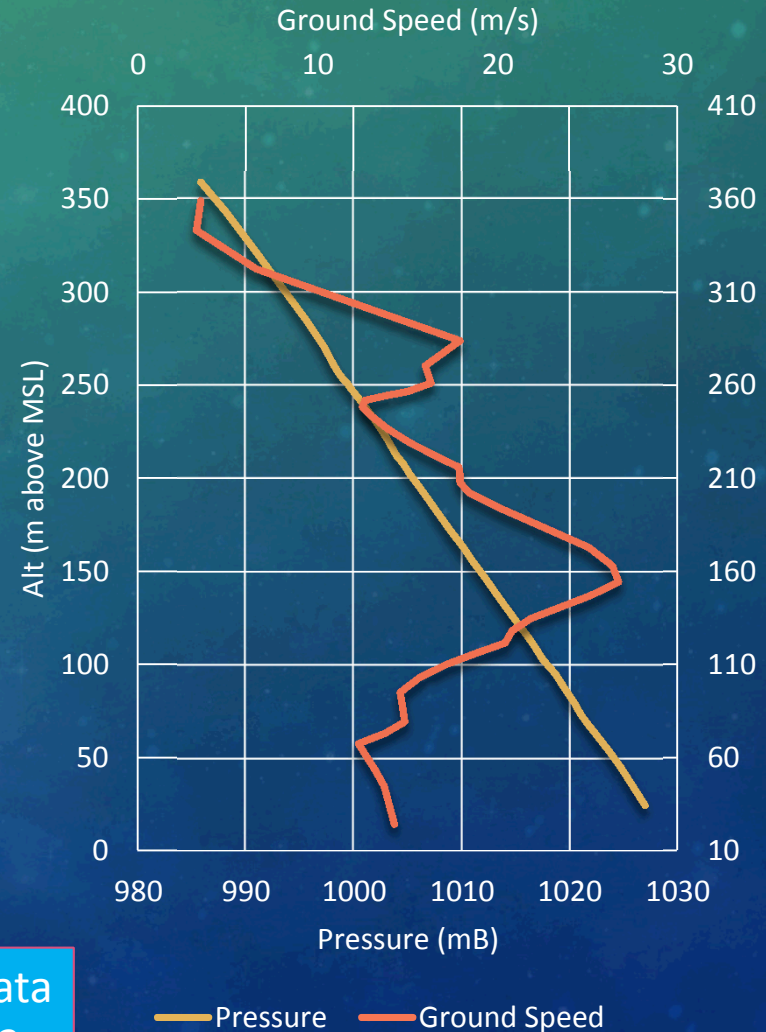
CoIs: Danette Allen, Jim Neilan and ADAMA team



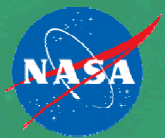
CICADA Blue 33 3/19/2019 Beaver Dam



CICADA Blue 33 3/19/2019 Beaver Dam



Flight Data
Blue 33



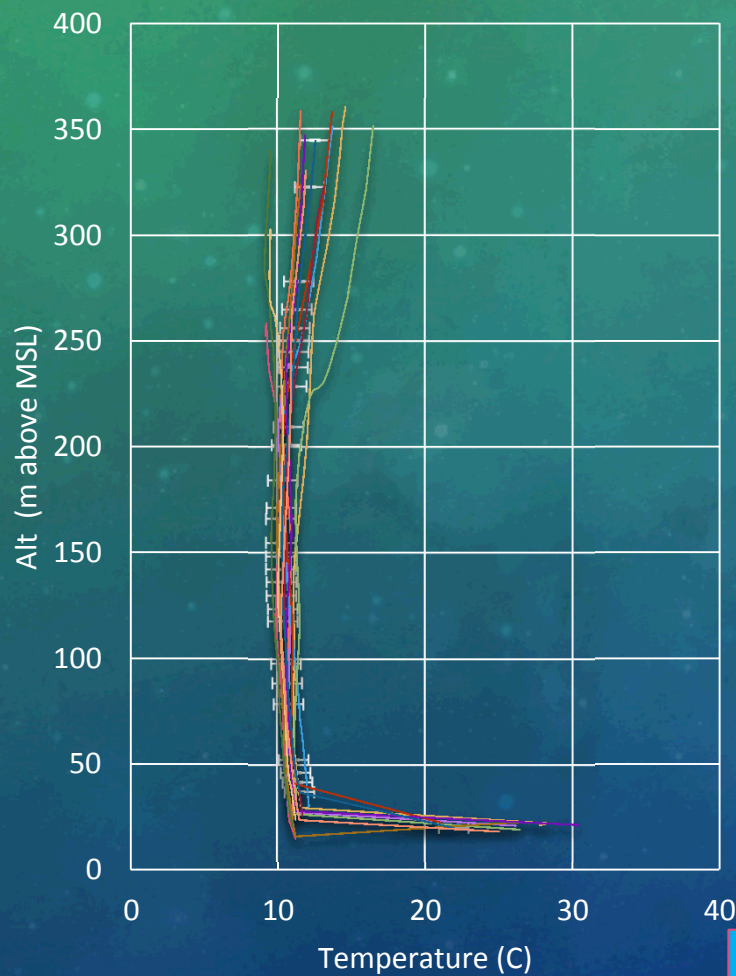
ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team

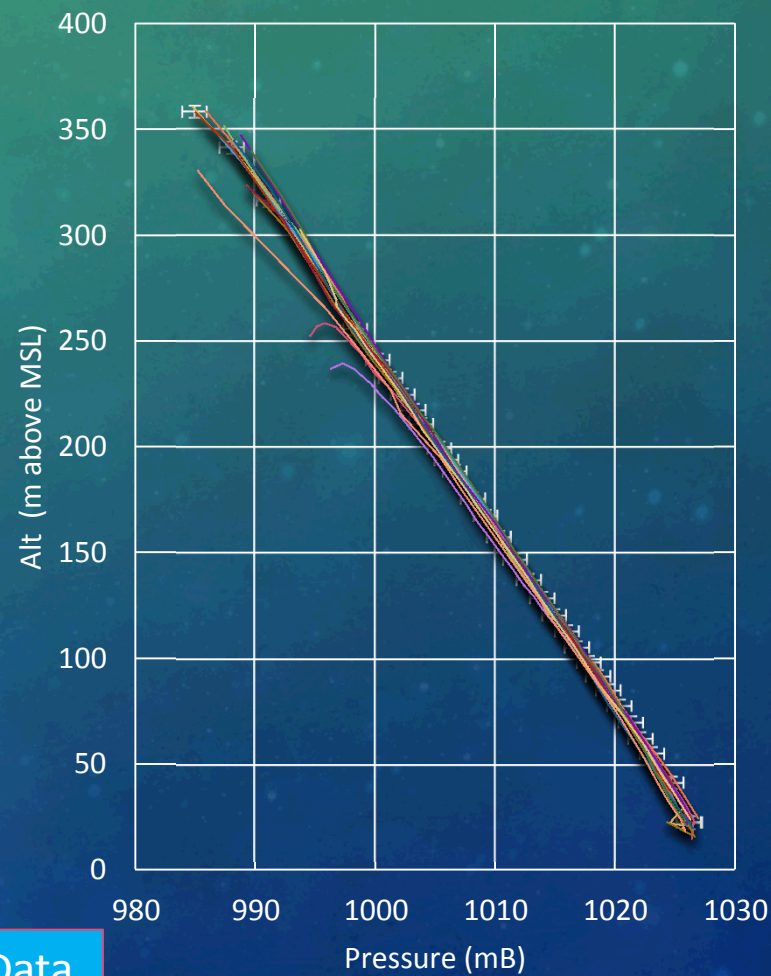


CICADA Temp 3/19/2019 Beaver Dam



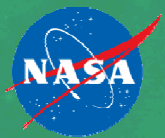
Ground Temp = 10deg. C
Accuracy = +/- 0.3deg. C

CICADA Pressure 3/19/2019 Beaver Dam



Ground Pres. = 1026.08 mB
Accuracy = +/- 1.5 mB

Flight Data
All CICADAs



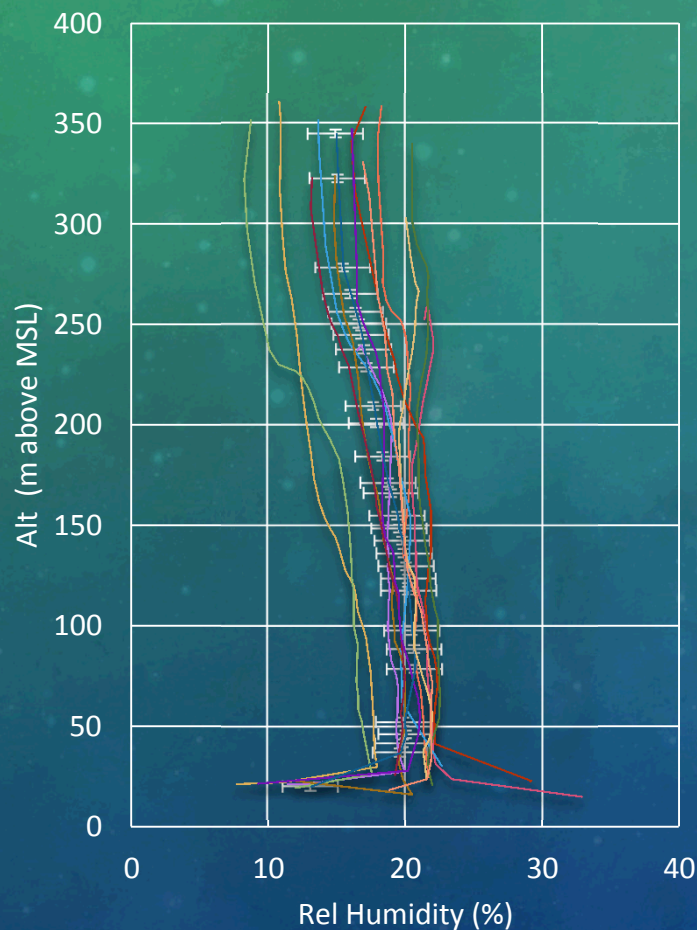
ADAMA

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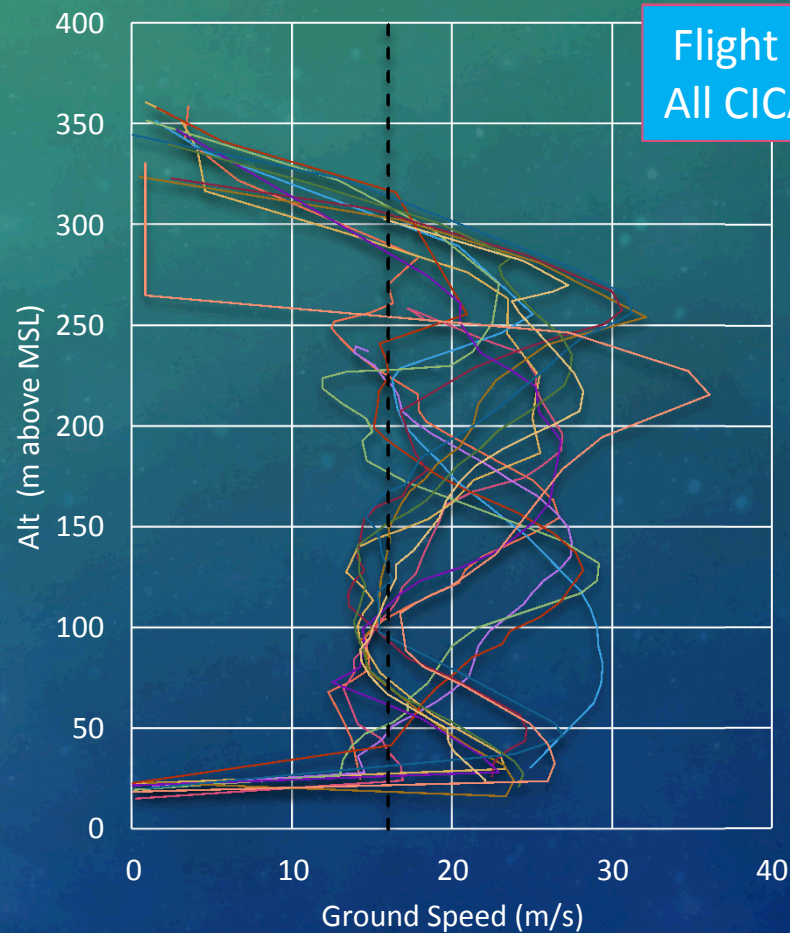


CICADA Humidity 3/19/2019 Beaver Dam



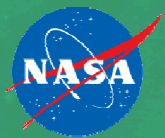
Ground Humidity = 52.2%
Accuracy = +/- 2%

CICADA Gnd Speed 3/19/2019 Beaver Dam



Flight Data
All CICADAs

Published Flight Speed = 15.6 m/s



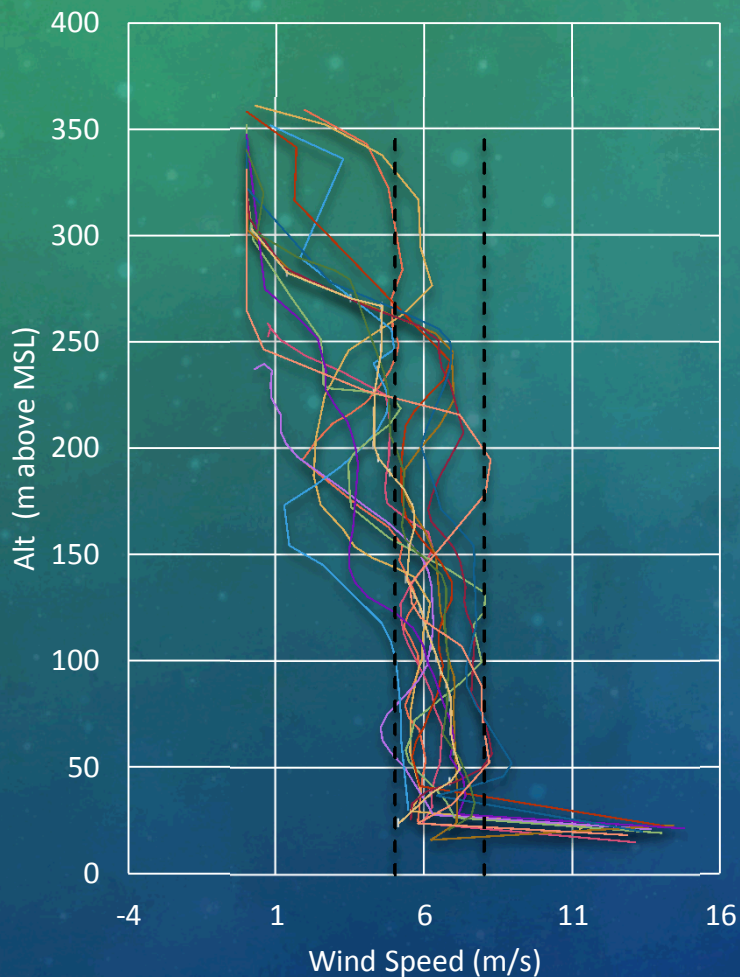
ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team

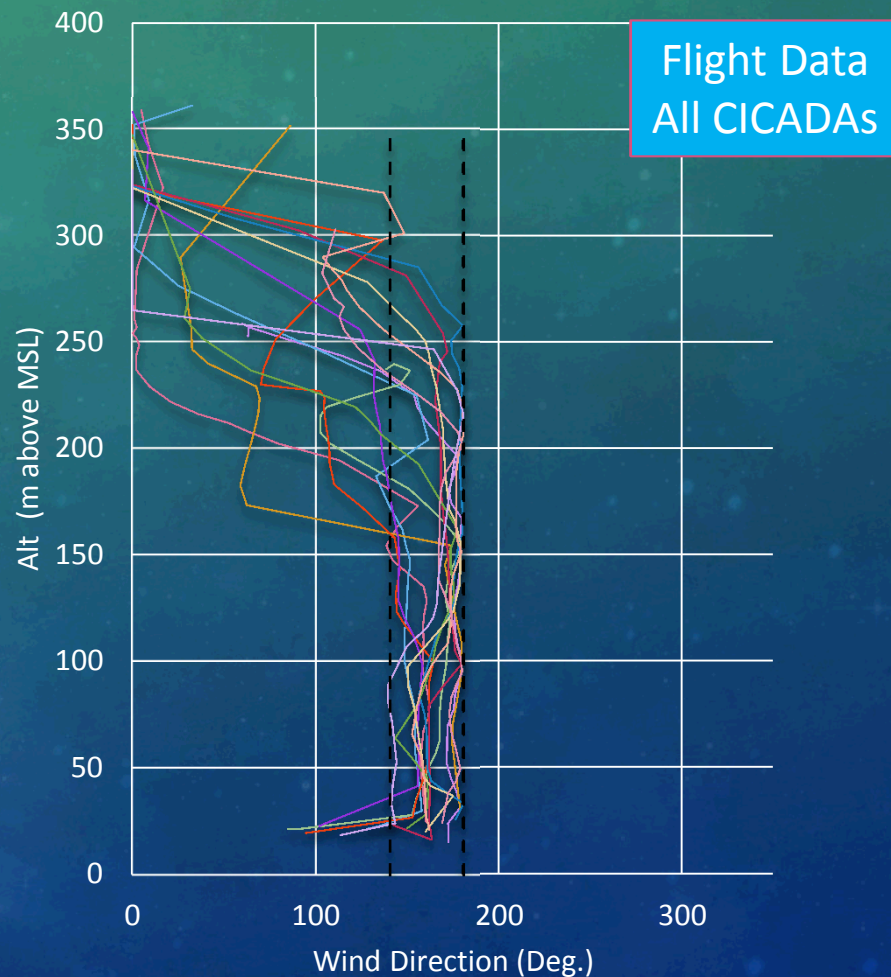


CICADA Wind Speed 3/19/2019 Beaver Dam

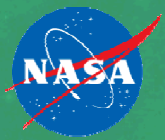


Ground Wind Speed = 3 m/s
Error Shown = +/- 2 m/s

CICADA Wind Direction 3/19/2019 Beaver Dam



Ground Wind Direction = ENE
Error Shown = +/- 25 deg.



ADAMA

PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



Conclusion

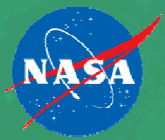
- Feasibility demonstrated for distributed network of MET sensors.
- Real time data captured from autonomous swarm.
- Hives shown to be a stable launch platform.
- More testing planned from higher altitudes.
- Follow-on mission planned: cloud research.

Thanks ADAMA Team: *Danette Allen, James Neilan, Matthew Vaughn, Ralph Williams, Zachary Johns, Brian Duvall, Nicholas Rymer, Jim Farrington, Jim Plant, Clayton Mills, Cesar Lopez, Kyle McQuarry and Ben Kelley.*

[USA Today](#)

<https://www.cnet.com/news/see-nasa-test-a-swarm-of-100-us-navy-cicada-drones/>

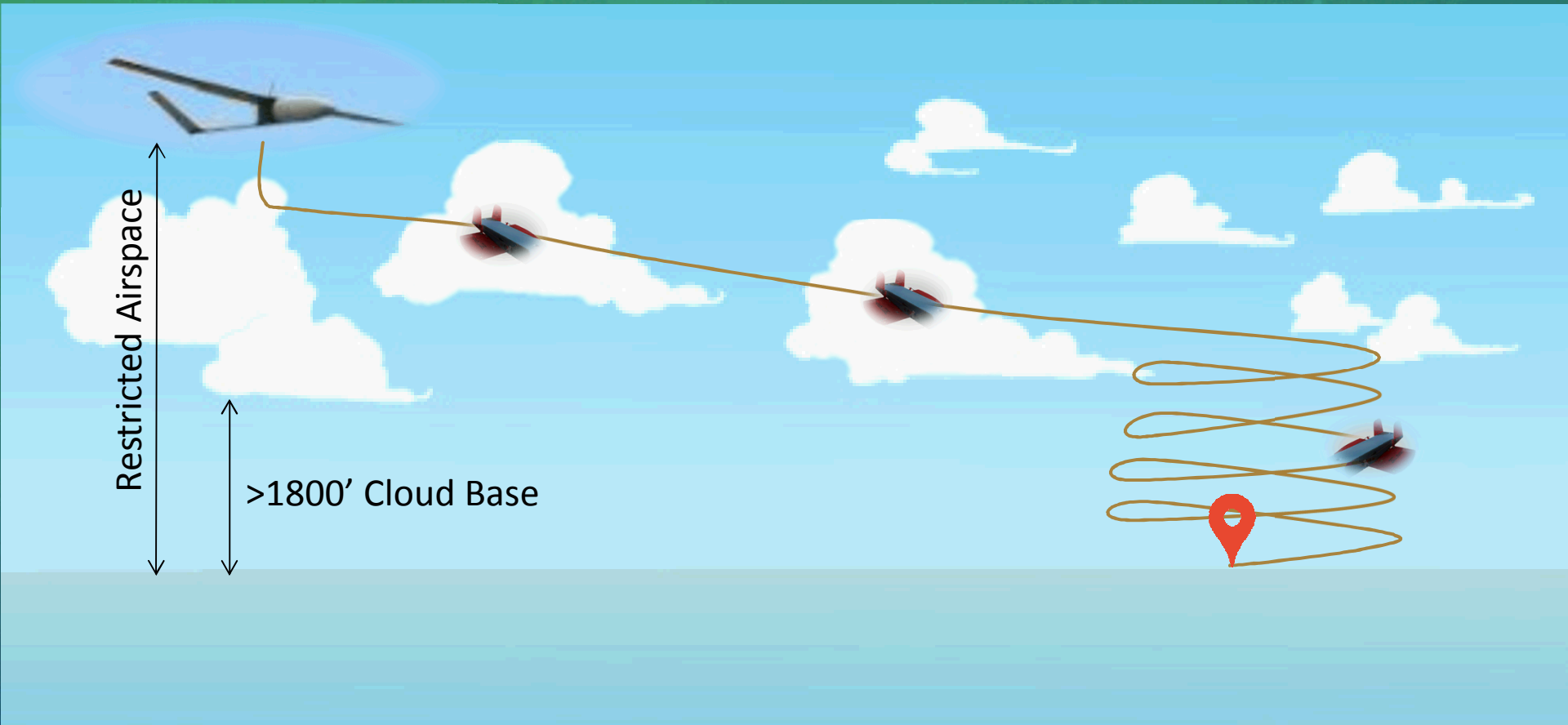
https://www.youtube.com/watch?time_continue=21&v=nS_iO8uNBMA



ADAMA

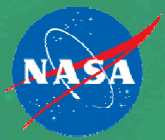
PI: Eddie Adcock

CoIs: Danette Allen, Jim Neilan and ADAMA team



What's Next? *Cloud Research*

- Fixed Wing “Mothership”
- Fly BVLOS
- Collect in-cloud MET & Droplet Size Data
- 90min flight time
- 3lb Payload (21 CICADAs)
- 20,000 ft. Flight Ceiling



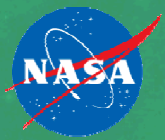
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Questions?



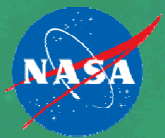
ADAMA

PI: Eddie Adcock

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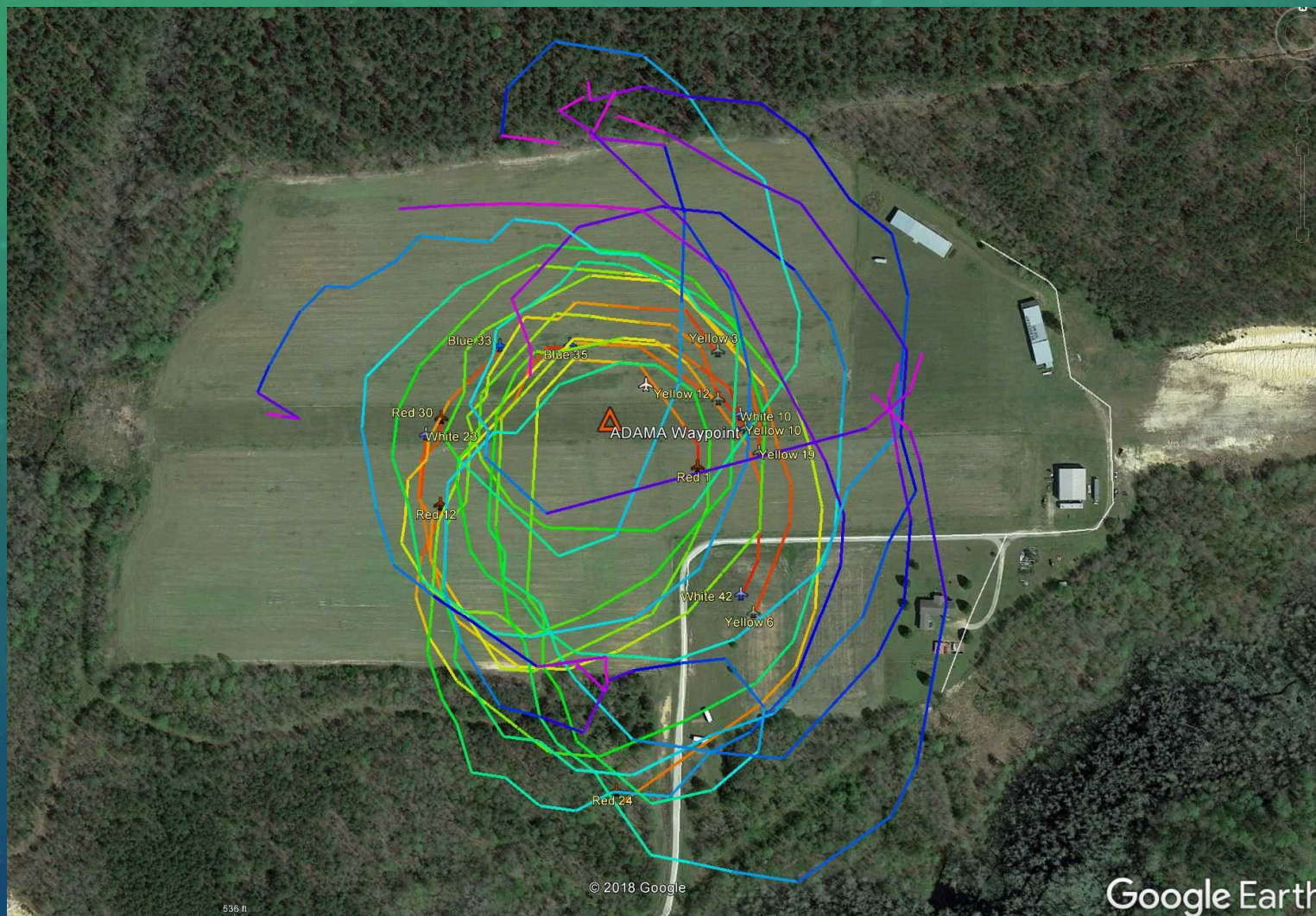
Spare Slides



ADAMA

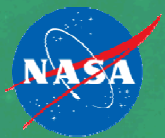
PI: Eddie Adcock

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All "Good" Flights

12/9/2019



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UCARE
Wallops Island

