Wildfire Mitigation R&D

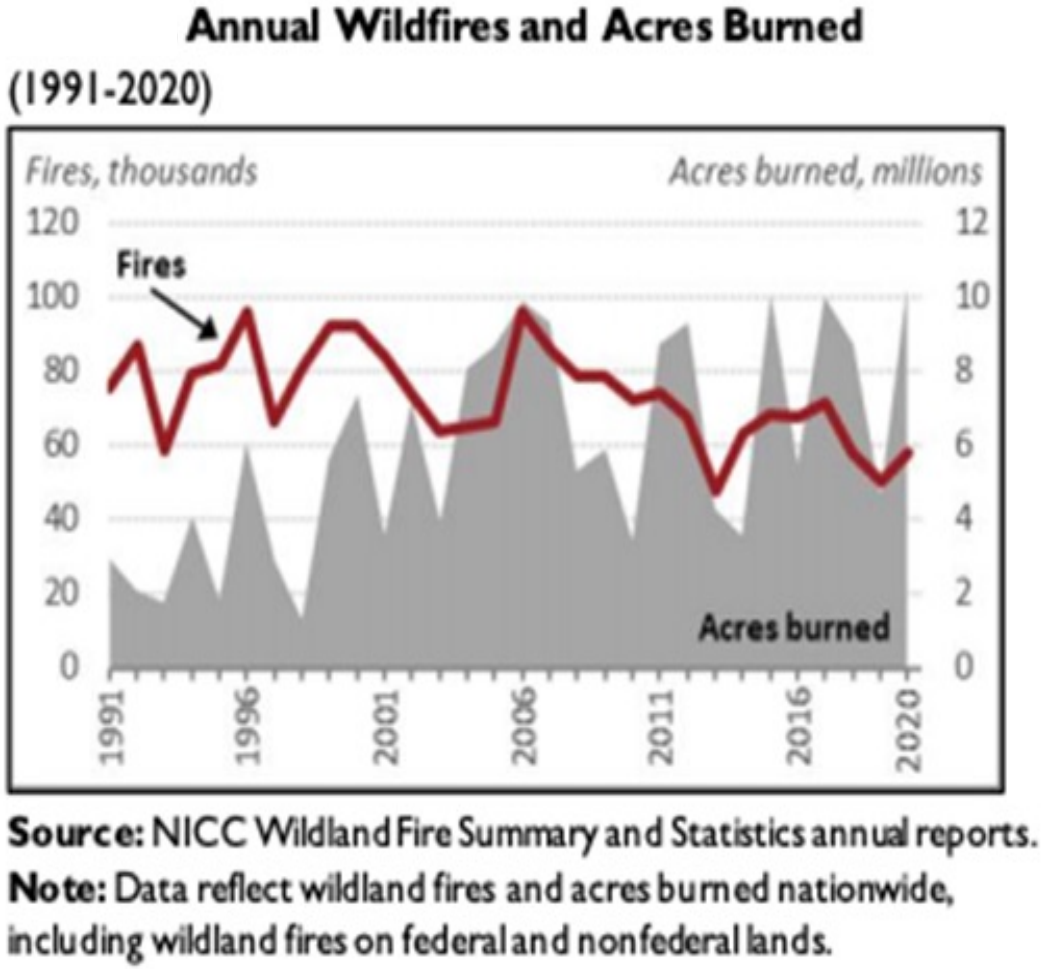
Marcus Johnson, PhD

marcus.johnson@nasa.gov

Wildfire Impacts

- Total suppression costs
  - 5-year average $2.351B
  - 10-year average $1.910B
- 10-year average
  - 20,510 fires
  - 1,048,649 acres
- 2020 Statistics
  - 58,950 fires and 10,122,336 acres
- **2021 Statistics (as of 8/2/21)**
  - **34,014 fires, and 3,079,748 acres**

https://fas.org/sgp/crs/misc/IF10244.pdf
https://www.nifc.gov/fire-information/statistics



Wildfires contribute to climate change and climate change increases likelihood of wildfires

Needs Assessment Workshop

NASA ARMD, in collaboration with SMD, STMD and US Forest Service, conducted a workshop to understand the state-of-the-art, needs, and opportunities to improve wildfire management

- Identify the needs and challenges of stakeholders at various decision cycles from planning, prediction, detection, tracking, mitigation, suppression, and post-fire remedial efforts
- 154 attendees from other government organizations, academia, industry, and NASA

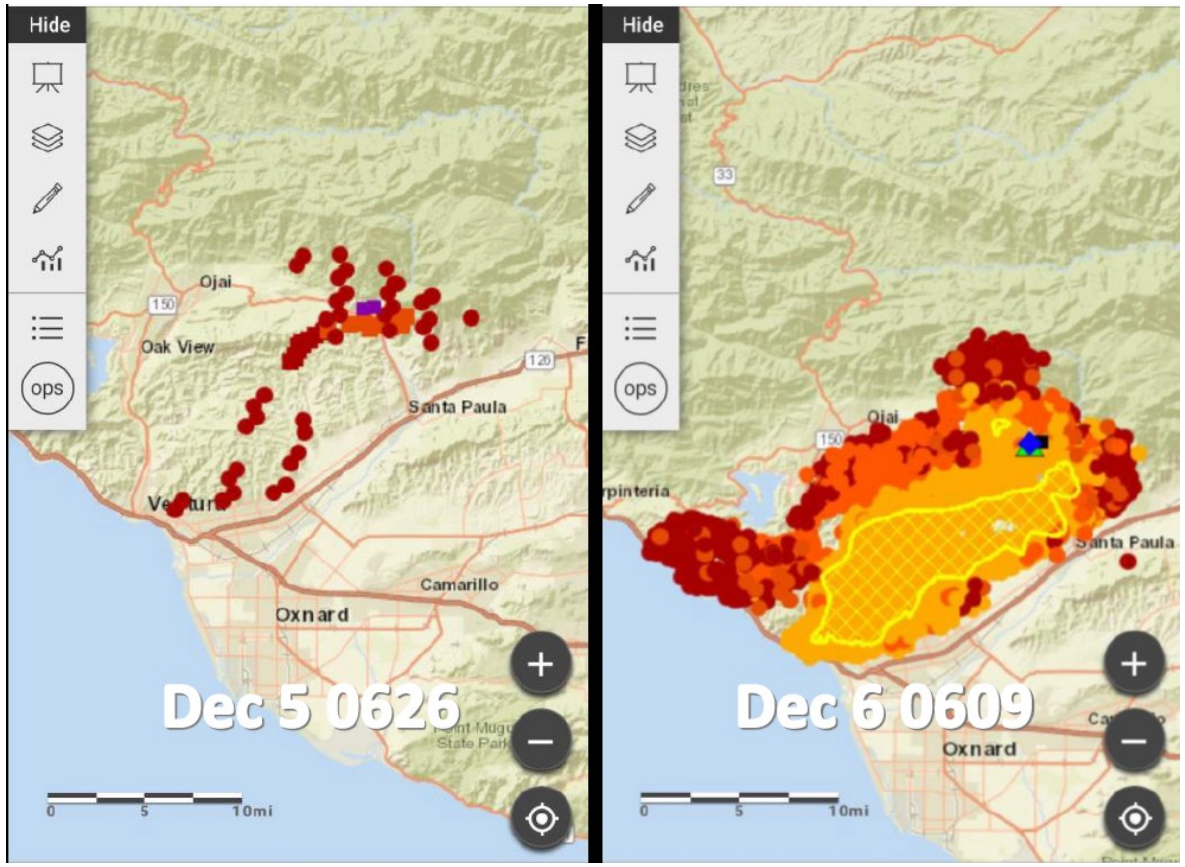
Main Findings

- Lack of persistent surveillance for fire detection and tracking
- Lack of persistent communications
- Lack of persistent aerial operations particularly under poor visibility
- Lack of airspace technologies to enable multiple types of aircraft operating simultaneously
- Lower aircraft safety record than other areas of aviation
- Lack of adequate coordination among multiple government agencies
- Need a clear plan to mature research for operational use in the field

Workshop Report:
https://nari.arc.nasa.gov/

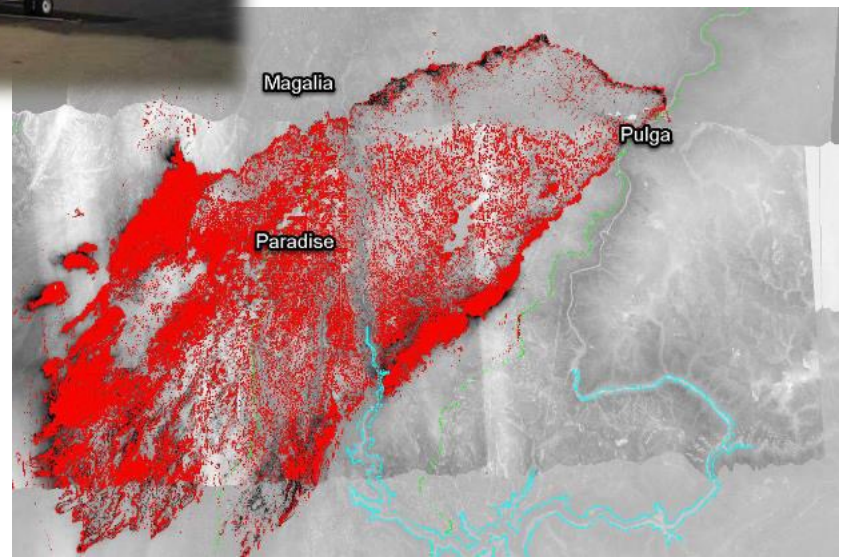
Findings offer insights where NASA SMD and ARMD research and development could make a significant impact

Examples of Known Challenges



- Satellite-based fire detection
- Only 4 fire snapshots per day
- Some stakeholders augment with military data

National Infrared Operations Program (NIROPS)



- Only 1 aircraft currently operational
- Provides infrared images of fires from aerial platform
- Single nightly snapshot of fire perimeter

Current Wildfire Management Operations and Challenges

Detection Tracking, Surveillance, and Prediction

- Surveillance - infrequent satellite or aircraft observations (satellite every 4 hours)
- Fire detection accuracy is not precise enough for effective targeting
- Few models for tracking and predicting fire progress, many are unreliable
- Better sensing is needed, difficult to observe through cloudy conditions
- Data and model fusion is limited

Aerial Suppression Support

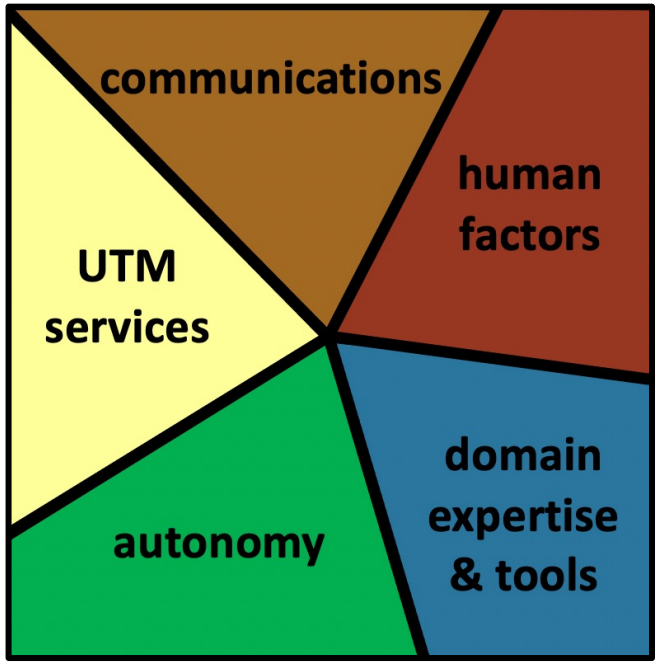
- Duration of aerial firefighting limited to daylight, clear visibility (4-6 hours/day)
- Airspace operations is manual and workload intensive; only a few aircraft allowed at a time
- Not able to accommodate drones in the same airspace as other aircraft
- Lower aircraft safety record in aerial firefighting than other areas of aviation

Multi-Agency Planning

- Multi-agency collaboration for resource and technology roadmap does not exist
- Current focus on tactical firefighting, low investment in R&D and strategic planning

ARMD Technologies/Capabilities - STEReO

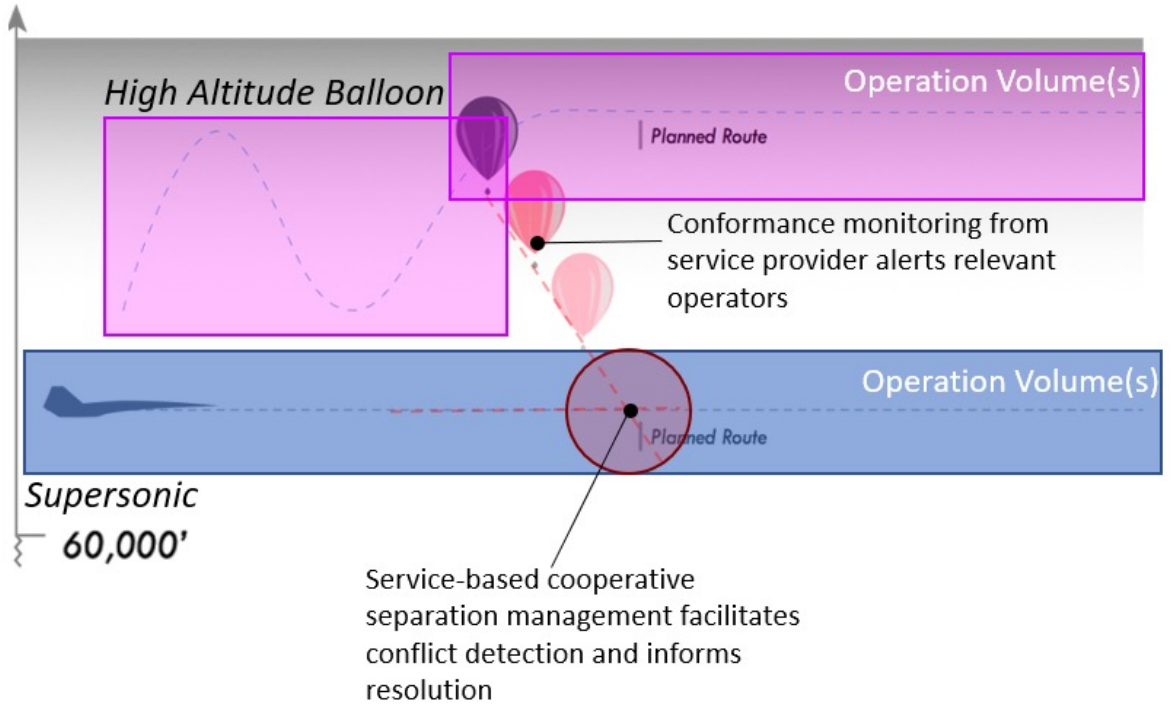
- Scalable Traffic Management for Emergency Response Operations (STEReO)
  - NASA developed Unmanned Aircraft Systems Traffic Management (UTM) concept and technology to enable large-scale small unmanned aircraft operations in the same airspace as other manned aircraft operate
  - STEReO builds on UTM and focuses on emergency operations such as wildfire
  - Initial proof of concept was also shown together with JAXA's Disaster Network (D-NET/UTM) program
  - Combining NASA technologies and partnerships to transform current-day emergency response operations
  - Recently completed testing in collaboration with Cal Fire and USFS where manned and unmanned aircraft operated in the same airspace.
    - Live NASA sUAS vehicles, as well as piloted CAL FIRE aircraft
    - Simulated NASA sUAS vehicles exercising functions of autonomy
    - STEREO provided a common situation awareness and operating picture to ensure safe operations (including on mobile device)
    - Communications



POC: Joey Mercer, NASA Ames Research Center

ARMD Technologies/Capabilities: Upper Class E Traffic Management (ETM)

- What is ETM?
  - A cooperative approach to airspace integration and management that is safe, scalable, efficient, and fair that accommodates all missions and use cases

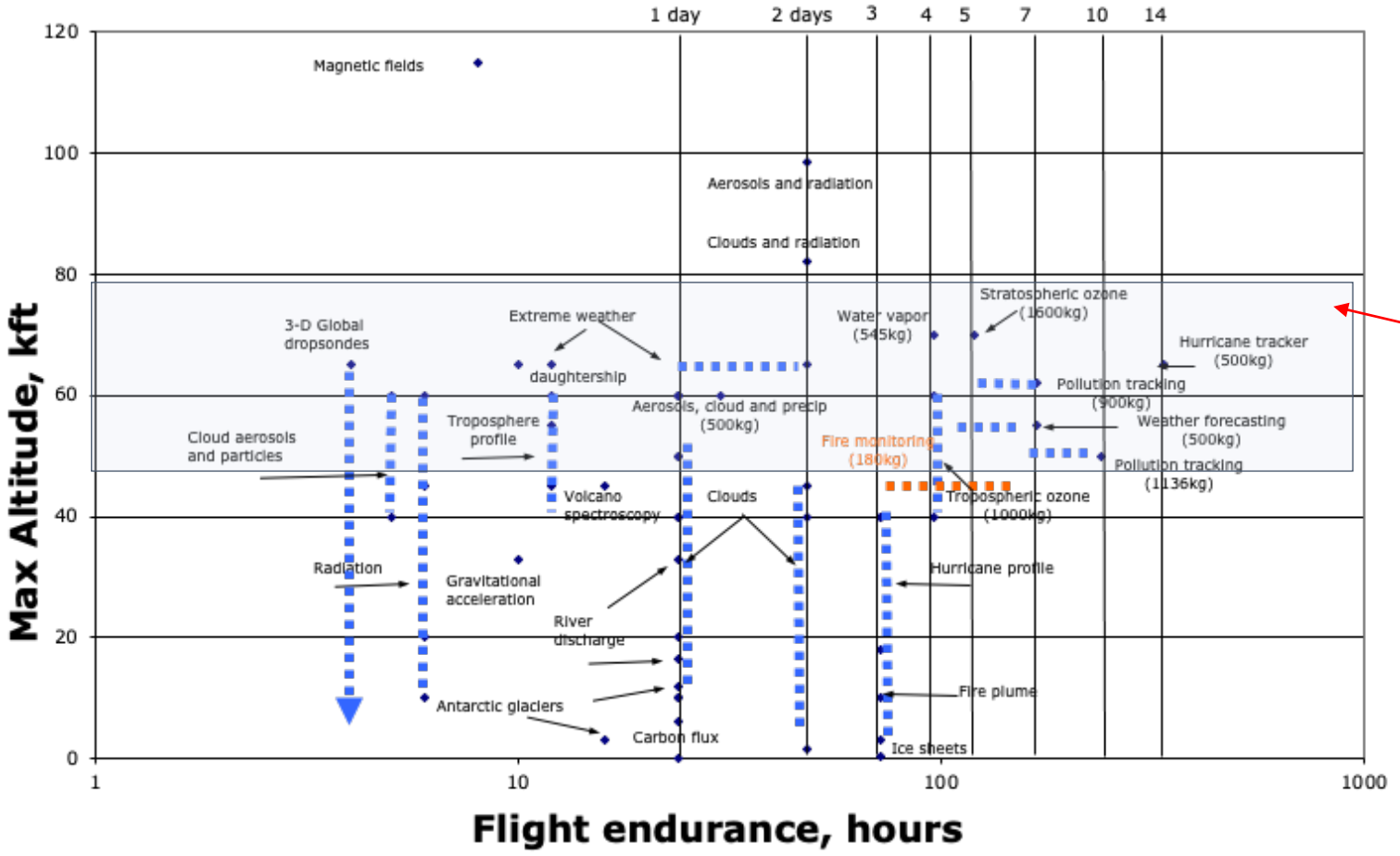


- Why is ETM needed?
  - New entrants are emerging
  - Existing users need continued safety and access
  - Demand for Upper Class E airspace use is projected to increase
  - A diverse set of vehicle and operation types are expected
  - In the US, ATC services are limited in Upper Class E airspace, which will impact the ability for industry to scale

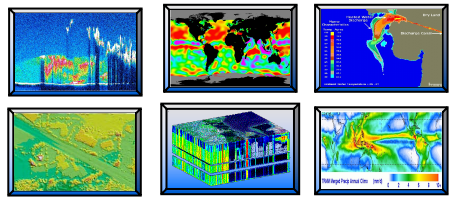
POC: Jaewoo Jung, NASA Ames Research Center

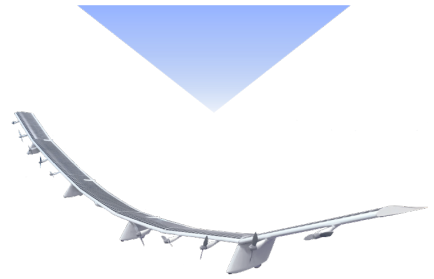
Considerations for Observation and Science

Suborbital Science Missions of the Future Workshop Summary Report, July 10-12, 2004



Multiple Remote Sensing Approaches





Numerous science missions would benefit from long endurance aircraft operations in the stratosphere

Stratospheric Operations could fit with fit within the New Observing Strategies for connecting observations from different vantage points

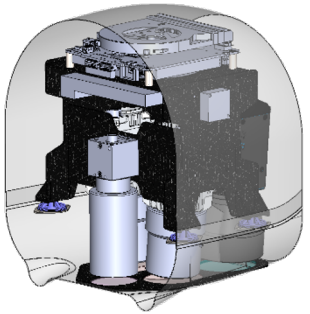
HALE-X – A USFS-NASA partnership with Swift Engineering to demonstrate sustained IR imagery for weeks to months with next generation solar-electric uncrewed aircraft systems UAS

Overview: HALE-X (High Altitude Long Endurance eXperiment) is an innovative partnership between the US Forest Service, NASA and Swift Engineering designed to test high altitude UAS capabilities for providing persistent, real-time mapping and intelligence over a wildfire incident. Platform and payload testing is scheduled to occur during summer 2022 at SpacePort America and adjacent airspace in New Mexico.

Background: A HALE (High Altitude Long Endurance) UAS (Uncrewed Aircraft System) that can loiter for weeks, months or the duration of an incident can provide many significant benefits over currently available technologies. The US Forest Service is interested in evaluating the feasibility of using High Altitude Long Endurance (HALE) systems to collect and provide Incident Awareness and Assessment (IAA) data on wildfire incidents. Real time imagery of fire perimeters will provide greater situational awareness, while enhanced communications capabilities can provide an important data link to remote areas. A strategic network of geographically prepositioned HALE platforms would allow existing aircraft to be reprioritized to other areas. Additionally, sensor payloads are highly configurable with the intent of accommodating multiple data collection missions during operational flights.

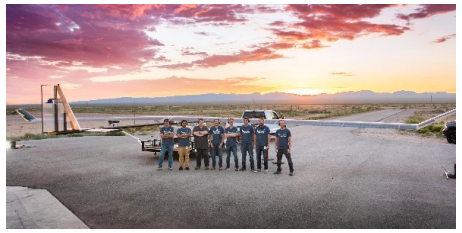
Gross Take-off weight – 175 lbs
Payload mass – 15-20 lbs
Operating Altitude – 55,000-65,000 ft
Endurance – 30+day design

Capability: The HALE-X platform, developed by Swift Engineering through a Small Business Innovation Research (SBIR) grant administered by Ames Research Center, completed its maiden flight and successful flight trials at New Mexico's Spaceport America in July 2020. The 72-foot solar-powered air vehicle weighs less than 180 pounds and can safely carry up to 15-pound payloads for missions.



5-camera Imaging Payload for 2021 flight

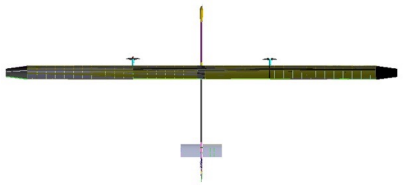
Mission: In collaboration with NASA Ames and Swift, the Forest Service awarded a Phase III contract to conduct a demonstration flight over an active wildfire and capture high resolution Infrared and visible imagery. The flight will be the first of its kind, occurring in the National Airspace over southwest New Mexico in the summer of 2022. The Forest Service entered into an Interagency Agreement with NASA to facilitate the airworthiness and flight safety reviews and assist in securing the mission's Certificate of Authorization (COA) from the FAA. NASA will maintain operational control of the mission. The scheduled mission will originate at Spaceport America where it will climb to operational altitude and perform system check out prior to 10-day loitering flight in the National Airspace System over wildfires and or prescribed burns to evaluate the resultant data products and aircraft performance. The team is also coordinating with the NASA ARMD ATM-x/ETM project regarding future concepts-of-operations.



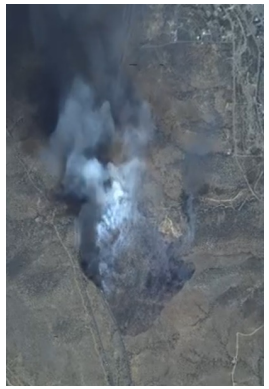
Swift Engineering Inc Flight Ops Team

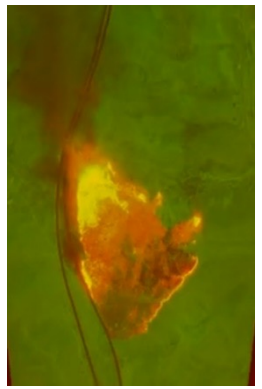
Contacts:

Sean Triplett – Tools and Technology Team Lead, USFS Fire & Aviation Aviation Management
Hamed Khalkhali – VP Engineering, Swift Engineering, Inc.
Matt Fladeland – Airborne Science, NASA Ames Research Center



72' wingspan designed to enable shipping in standard shipping containers for rapid response





Example data of imaging fire front through smoke