

Advanced Capabilities for Emergency Response Operations

*Applications and considerations for UAS to support
wildland fire management*

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Wildland Fire Impacts and Costs

- **Increased Severity**

- 2015, 2017, and 2020 each had over 10M acres burned
- In 2021: 58k Fires and 7.1M acres burned

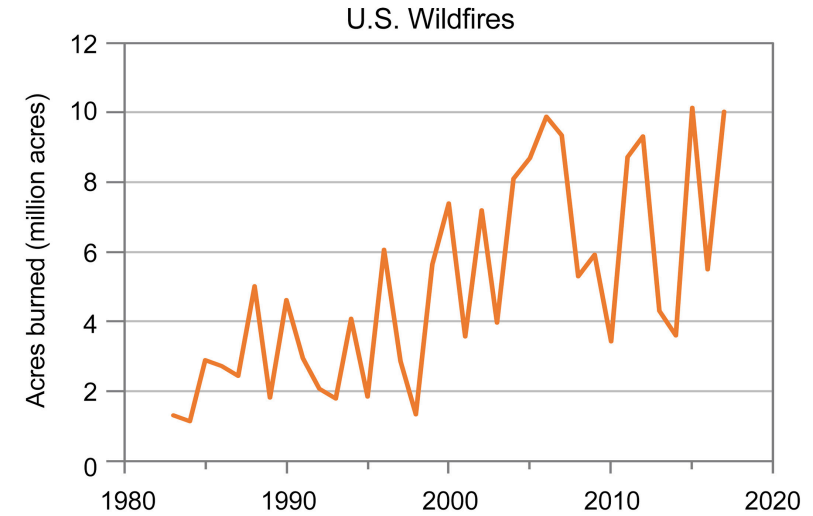
- **Increased Costs**

- 10-year average: \$2.3B Suppression & \$8.4B Total
- 5-year average: \$2.8B Suppression & \$16.8B Total
- In 2021: \$4.3B Suppression & \$11.2B Total

- **Increased Risk**

- Climate change affects wildfire risk
- Wildfires affect Climate (e.g., CO₂, black/brown carbon)
- Wildfires affect Air Quality
- Wildfires increase risk of Landslides and Flooding

<https://fas.org/sgp/crs/misc/IF10244.pdf>
<https://www.nifc.gov/fire-information/statistics>
<https://www.ncei.noaa.gov/access/billions/>



Source: Fourth National Climate Assessment (NCA4)

2021 Estimated Costs and Duration

Dixie Fire:	\$637M (over 3 months)
Beckwourth Complex:	\$542M (over 2 months)
Caldor Fire:	\$271M (over 2 months)
Monument:	\$163M (over 2 months)
Bootleg:	\$100M (over 1 month)

Wildfires are increasing in occurrence and increasing the risk of greater property damage and loss of life

Needs Assessment Workshops

NASA, in collaboration with the U.S. Forest Service, conducted a series of workshops to understand the state-of-the-art, needs, and opportunities to improve wildfire management

- May 2021 Workshop - Focused on pre-fire fighting, during fire fighting, and post-fire needs
- Feb. 2022 Workshop – Focused on understanding barriers in integrating science and technology into wildfire management
- March 2022 Workshop – Focused on understanding top safety-oriented risks, gaps, and enabling technologies

Main Findings

- Need for cross-agency coordination and a clear plan to mature research for operational use
 - Lack of persistent surveillance for fire detection and tracking, and reliable communications
 - Lack of persistent aerial operations particularly under poor visibility
 - Lack of airspace technologies to enable multiple types of aircraft operating simultaneously
 - Need for enhanced situation awareness and timely access to information
 - Current fuels map of limited utility for operational management
 - Need to reduce debris flow prediction uncertainty including landslides, floods, impacts to watersheds
 - Fire behavior models do not have the necessary fidelity and/or timeliness to accurately predict fire behavior and fire spread to support operational fire management
- May 2021 Workshop report available at https://nari.arc.nasa.gov/sites/default/files/attachments/NASA%20ARMD%20WILDFIRE%20MANAGEMENT%20WORKSHOP_6.1.2021_v13.pdf
 - Feb 2022 Workshop report available at <https://aam-cms.marqui.tech/aam-portal-cms/assets/ki2yd52vavkccskc>
 - March 2022 Workshop report available at <https://ntrs.nasa.gov/citations/20220014721>





Advanced Capabilities for Emergency Response Operations (ACERO)



AIR TACTICAL GROUP SUPERVISOR



DAYTIME OPERATIONS

NIGHTTIME OPERATIONS

TERRESTRIAL COMMUNICATIONS



LOGISTICS



AIRCRAFT SAFETY



TANKER

PILOTED HELICOPTER



SEARCH AND RESCUE



REMOTE SENSING



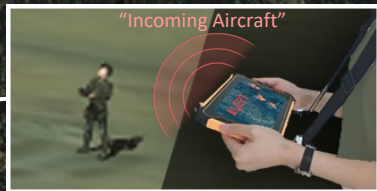
REMOTELY PILOTED HELICOPTER



AERIAL IGNITION



WILDFIRE AIRSPACE MANAGEMENT



DECISION SUPPORT



GOAL: Develop, demonstrate, and transition to operations, emerging aviation technologies to identify, monitor, and suppress wildland fires, as a means to enhance safety, improve efficiency, and prevent economic loss.

ACERO's Objectives:

- ❑ Provide a systematic vision for the future by leading the development of a Concept of Operations
- ❑ Demonstrate emerging airspace management technology to improve emergency responder's effectiveness and safety during a wildland fire
- ❑ Develop and demonstrate new mission capabilities using emerging aviation technologies that support 24-hour operations:
 - ❑ Expand use of UAS for prescribed burns and remote sensing
 - ❑ UAS for Aerial connectivity
 - ❑ UAS for Logistics
 - ❑ UAS for Suppression
- ❑ Improve the safety of operations by leveraging technologies from an in-time aviation safety management system
- ❑ Leverage public, private, and philanthropic partnerships and cross-mission directorate technologies to develop and demonstrate prototype capabilities



ACERO research aims to improve the effectiveness and safety of wildland fire management through the modernization of aerial operations

Considerations for weather in wildland fire management

► PRE-FIRE

Planning and Monitoring | Prescribed Burns



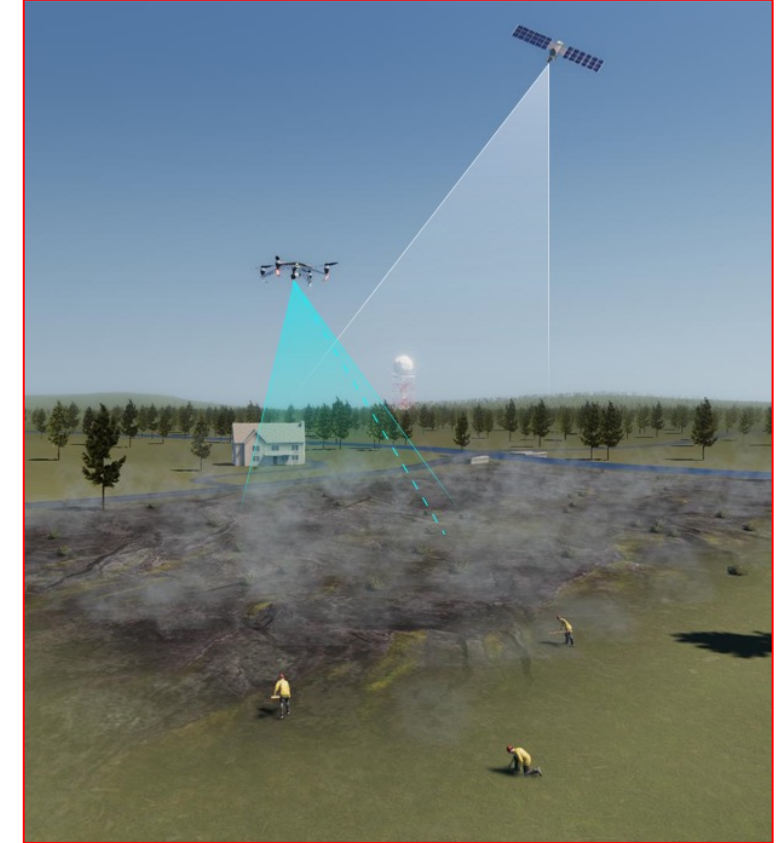
► ACTIVE FIRE

Decision Support and Suppression



► POST-FIRE

Mop-up and Rehabilitation



Weather has a strong influence on fire behavior and weather information can be used to support aerial operations, risk and fire-spread modeling, and critical decision support functions

Challenges and Opportunities:



Challenges:

- Weather information and forecasts are not always timely
- Improved spatial resolution is needed (i.e. improved modeling in complex terrain to better understand fire behavior and smoke dispersion)
- Connectivity and communication of in-time weather information remains a challenge
- Lack of awareness or access to available weather products

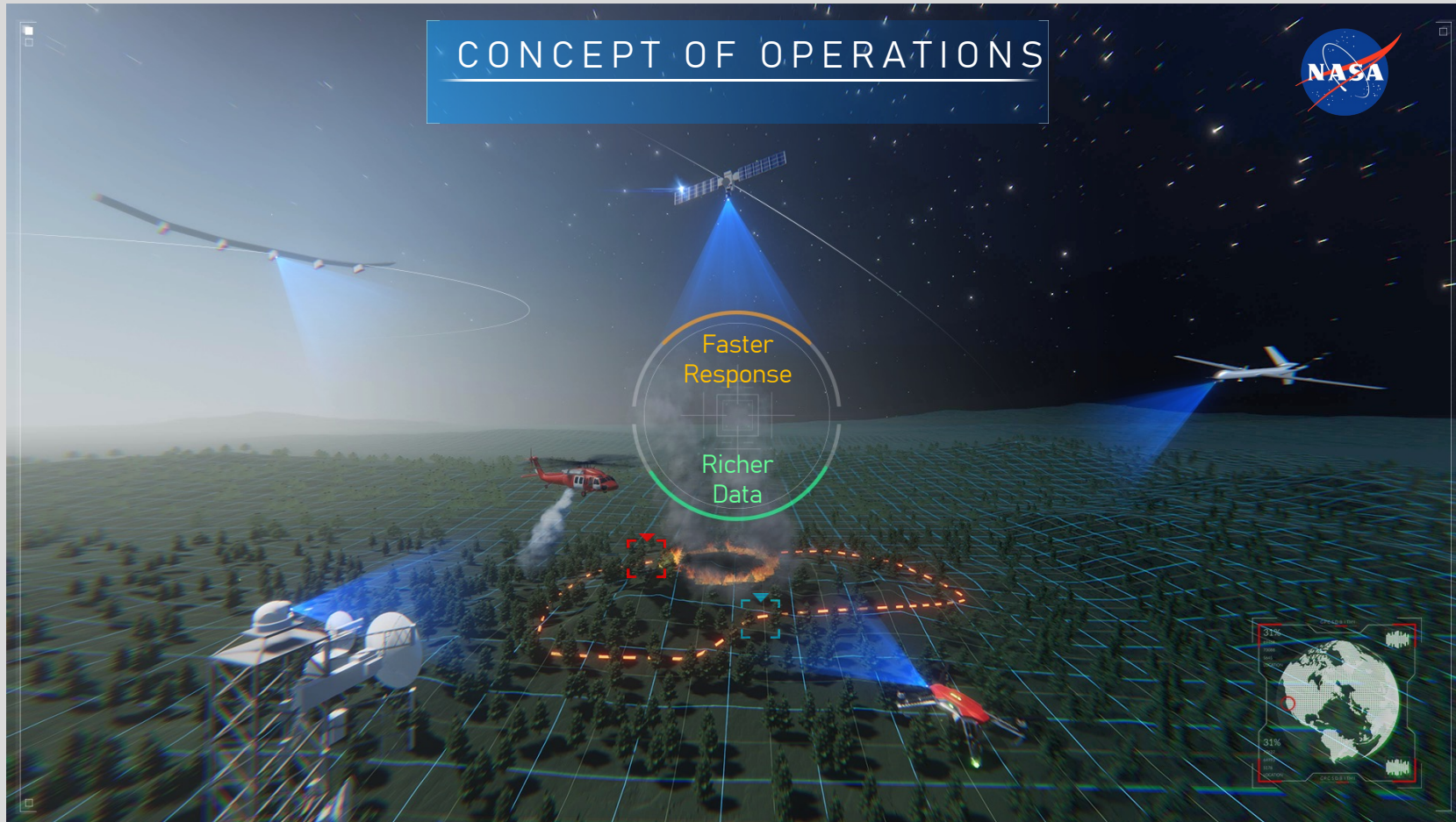
Opportunities:

- UAS can augment weather information to provide improved temporal and spatial resolution
- Standardization of information and communication architectures
- Aerial connectivity using UAS can support dissemination of real-time weather information
- Mission planning tools can help coordinate availability of weather data products to improve reliability



Inter-Agency Wildland Fire Management CONOPS

NASA is leading the development of an inter-agency CONOPS to ensure consistency of operational priorities, technology adoption, and programmatic alignment for national needs



Provides a stakeholder vision

Describes an envisioned system

Demonstrates various use cases

Defines verifiable requirements

Informs a roadmap towards the envisioned system



Concluding Remarks

- Wildfires are a growing national and global issue and NASA is working to unify the wildland fire community around a future vision for improved wildland fire management
- Weather has a strong influence on fire risk and behavior and there are opportunities for UAS to enhance weather services for pre-, active, and post-fire management
- NASA is bringing together diverse expertise from the science, space, and aeronautics communities across the Agency in an integrated “One NASA” approach and working with other government stakeholders to address current challenges in wildland fire management
- NASA will continue to develop concepts and prototype technologies, and leverage public, private, and philanthropic partnerships to transfer technology to other agencies to meet operational needs of the wildland fire community