



Forest Service
U.S. DEPARTMENT OF AGRICULTURE



SERDP



ESTCP

Study Goals and Motivation: Optimizing Research on Experimental Prescribed Fires to Improve Understanding of Wildland Fire and Smoke Behavior – Meeting 1

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Goal of this study

- Document successes and challenges of multi-agency/multi-national prescribed fire campaigns in the U.S. to improve the state of the fire and smoke science:
 - Build on successes
 - Mitigate challenges

Outcomes from this study

- Findings will be available for use by federal, state, private, and Tribal entities to inform investments in future collaborative prescribed fire campaigns



Anticipated recommendations from this study

- Governance structure of research teams
- Research focus(es) and theme(s)
- Shared funding from multiple federal agencies (and other sectors)
 - Longitudinal studies versus piloting high-risk technologies
- Integrating and sequencing knowledge across campaigns to inform fire behavior and smoke models
- Integrating fire, fuels, and smoke research with land management
- Integrating domain scientists with data scientists
- Transitioning wildland fire research and technology for use in operations



Tall Timbers, 2025-01-29

Pillars of the U.S. Forest Service

National Forest System

- Management of 193+ acres of public land, familiarly known as National Forests and National Grasslands
- 9 regions
- 154 National Forests
- 20 National Grasslands

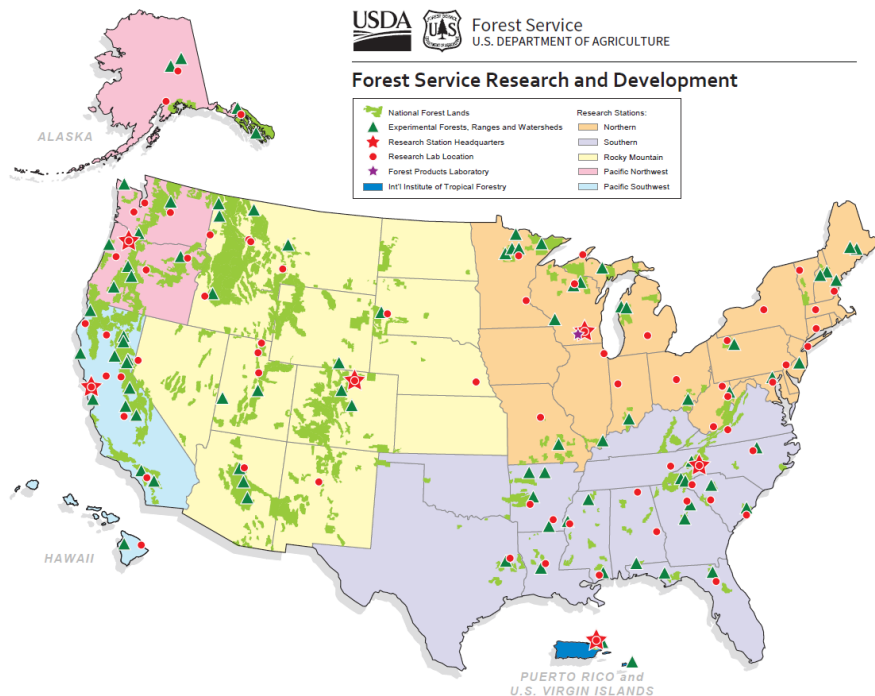
State, Private, & Tribal Forestry

- USFS brings forest management and assistance to partners across various sectors
- Staff areas include forest health protection, **fire and aviation management**, cooperative forestry, conservative education, and urban and community forestry

Research & Development

- Largest forestry research organization in the world
- Basic and applied research to study biological, physical, and social sciences and bridge the gaps to land management, applications, and operations
- 5 research stations/areas
- Partners with academia, private sector, interagency, and international research institutions.

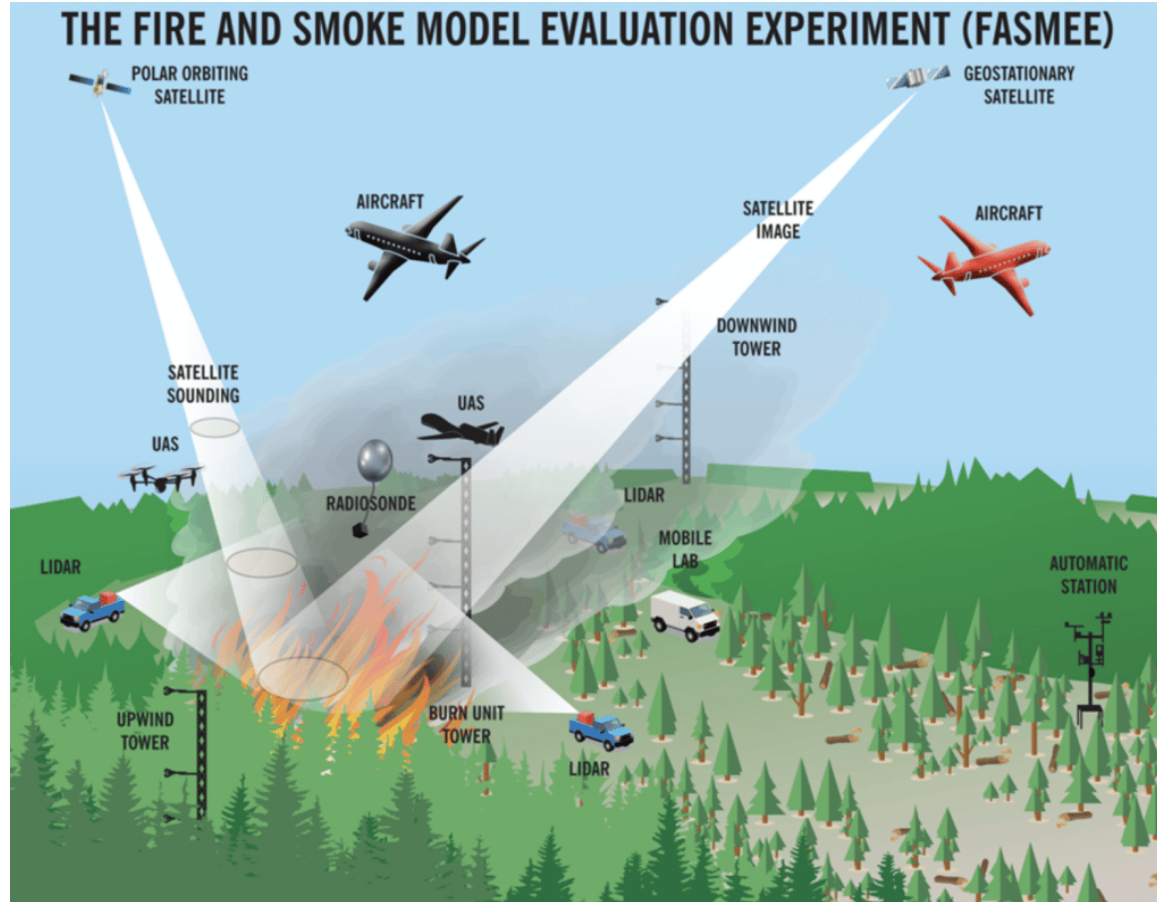
USFS R&D Wildland Fire, Fuels, and Smoke Research Program



- Over 120 scientists nationally conduct research and development related to wildland fire, fuels, and smoke
- Strategic Goals
 - Advance knowledge and innovate technologies across disciplinary themes related to wildland fire, fuels, and smoke
 - Transition research to operational tools to support effective fire, fuels, and smoke management
 - Collaborate with federal, state, Tribal, academic, and private partners to understand and enact fire and forest management
- Research Themes (5)
 - **Physical fire and fire behavior science** such as fire spread and behavior, combustion, fire danger, fire weather, and fire-atmospheric interactions
 - **Fire ecology and fire effects** such as future fire regimes, fire history, fire-vegetation feedbacks, fire effects on wildlife habitat, interactions with invasive plants/pests, and post-fire recovery, water quantity/quality
 - **Fuels characterization and fuels management** such as fuels characterization/mapping, fuels treatment, prescribed fires, and fire management science, and wildland urban interface characterization
 - **Smoke** emissions, dispersion, and atmospheric chemistry
 - **Community, Safety, and Operations** including community engagement, cultural practices, safety, and organizational learning

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Connecting field observations to weather modeling



SERDP Wildland Fire Science Initiative: Delivering critical new tools and technology to manage wildfire risks and sustain DoD Installations and Ranges

DoD's Mission is a Fire Starter: Across its 27M acres, DoD has the highest incidents of wildfire and uses more prescribed fire than any other federal fire agency. For the past decade, **SERDP & ESTCP Fire Science Strategy** planned for actionable fire science and tools to meet the long-term needs of DoD fire managers.

Wildfire investment priorities for SERDP & ESTCP

A Understanding vegetation & fuels	B Predicting fire behavior	C Forecasting smoke plumes	D Fire effects on species
Testing different approaches to predictive modeling of prescribed fire spread and strength with varied fuel sources	Experiments to observe fire spread and strength under different wind, humidity, precipitation, and other weather conditions	Development of object-based models to forecast migration and density of smoke plumes and their impact on mission readiness	Tests and evaluates strategies for T&E species habitat management. Limits invasive species damage to DoD infrastructure and equipment

Prior to the DoD Wildland Fire Science Initiative (2014), prescribed fire modeling tools did not exist. Prescribed fire is a critical tool in DoD's arsenal to prevent and contain the outbreak of wildland fire and reduce its impact on mission readiness.



WILDLAND FIRE

~7.2M acres, an area bigger than the state of Vermont, burn each year due to wildfire in the U.S.

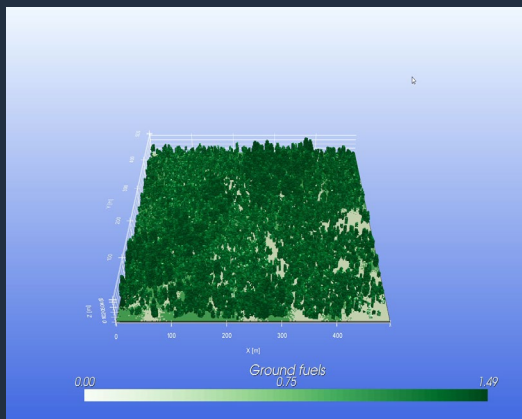
~1.0M acres of DoD lands are impacted by fire each year

Fire and smoke from fires on or near installations frequently result in **lost mission days** for DoD

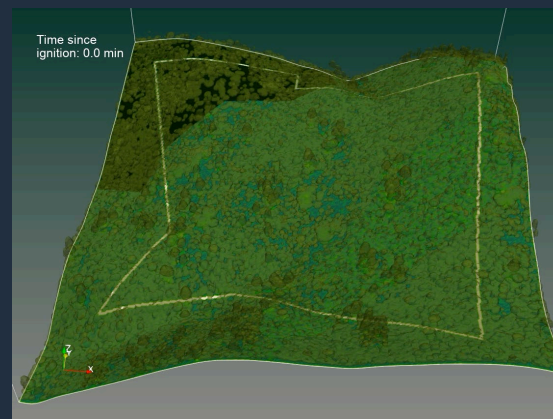
Next Generation Tools: SERDP & ESTCP advances fuels management, wildfire preparedness, and prescribed fire planning

Prescribed fire science focuses on how vegetation and controllable factors change over time to predict wildland fire behavior and create desired outcomes. A range of tools have been developed to measure, model, and monitor these dynamics.

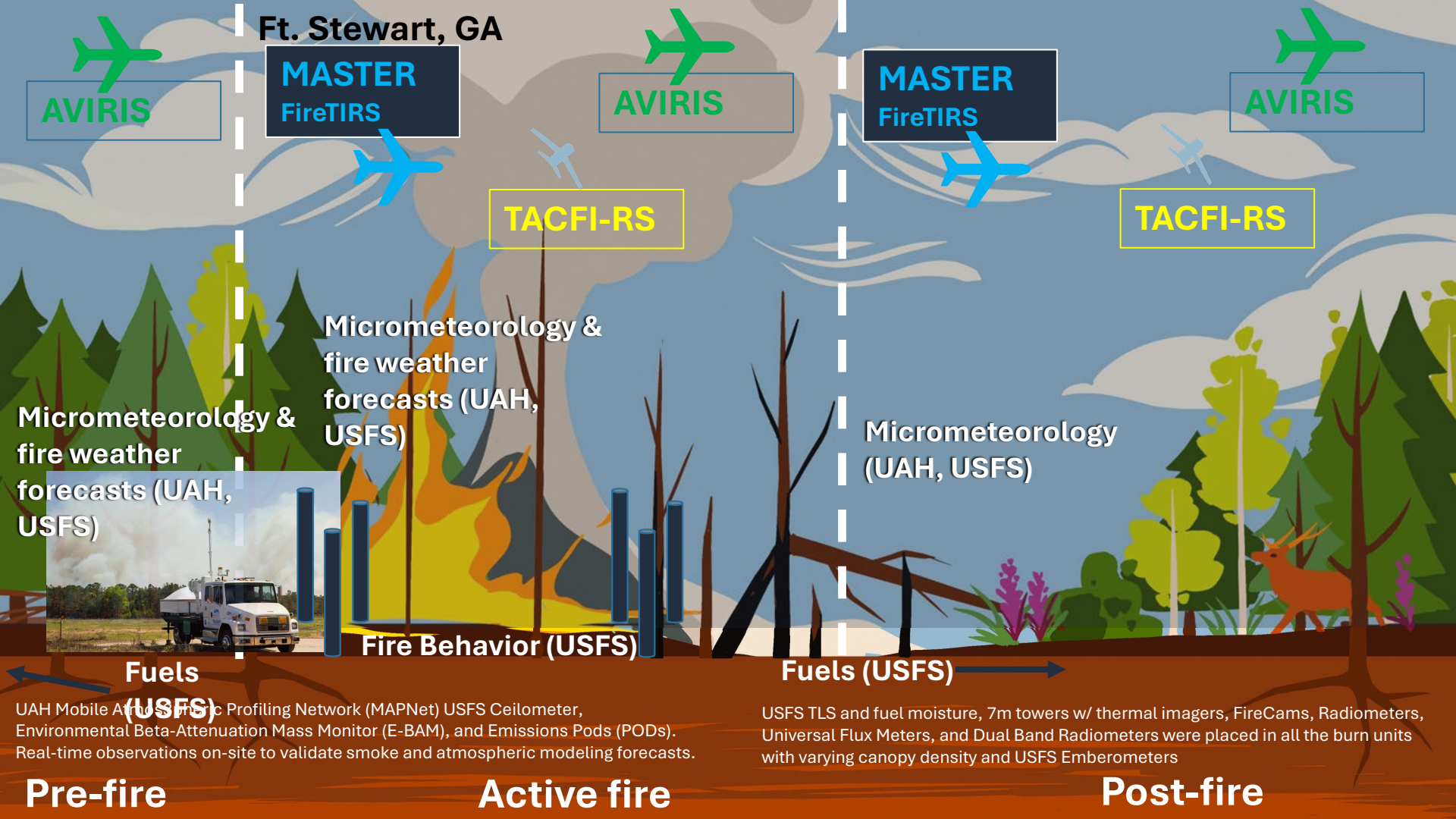
Delivering an Integrated Suite of Tools for Fuel Measurements to Fire Managers



FastFuels: Data fusion to produce 3D fuels representation for fire managers



QUIC-Fire: Physics-based fire models use 3D fuel structure and demo fire response of different prescribed fire ignition patterns and environment conditions



Meeting the Challenge with Urgency: NASA-DoD Fort Stewart prescribed fire research campaign



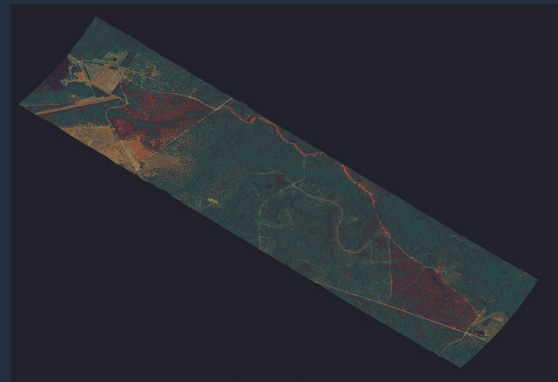
In April 2025, DoD, NASA FireSense, and the Forest Service conducted a multi-agency prescribed burn research operation at Fort Stewart-Hunter Army Field, Georgia.



Cross-calibrated instrumentation in space, in the air, and on the ground to generate a **first-of-its-kind dataset** for wildland fire science and management.



Over 3,300-acre burns in April focused on vegetation, fire, and smoke measurements to validating understanding of sensors, fire behavior modeling and smoke dynamics.



Generated real-time data products **to support wildland firefighting** and response. Data informs prediction models for improved wildfire and smoke management.

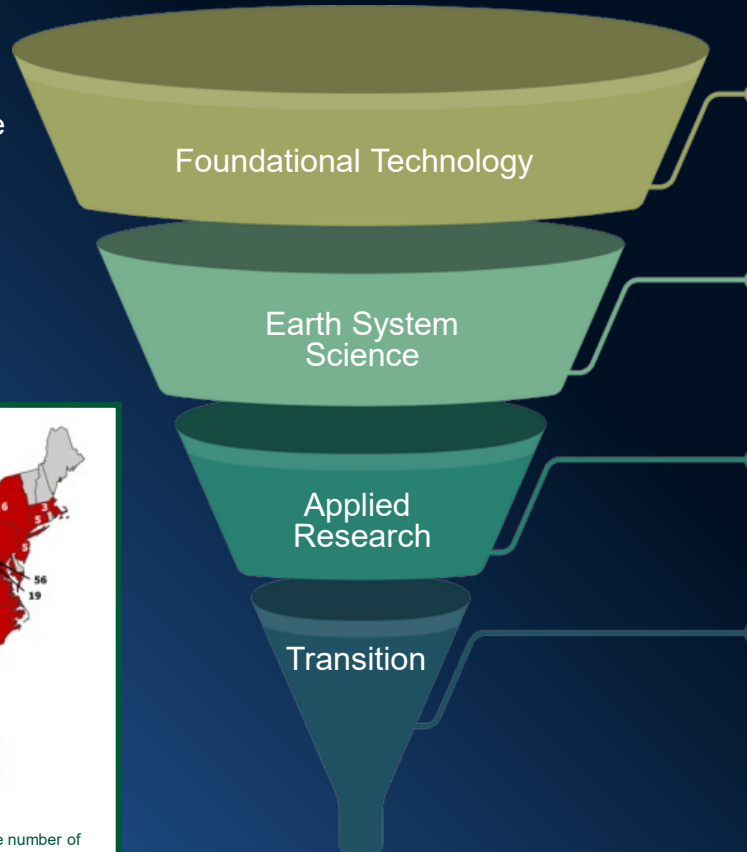
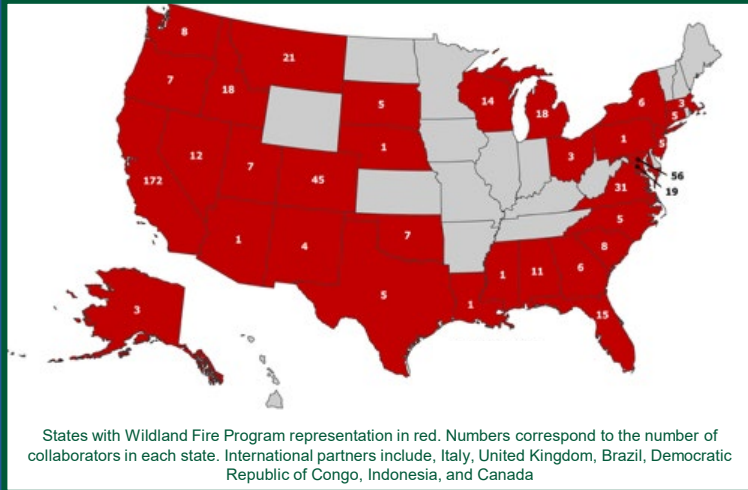
Images L-R: Personnel using a drip torch to ignite the prescribed burn; a forest scene during the burn (Credit: M. Loiacono / NASA); and a time lapse animation of AVIRIS FireRGB Real-Time Spectroscopic Product (RTSP) from 4/14/25 over the F8.1 and F8.2 burn units at Fort Stewart (Credit: AVIRIS-3, Created by Joseph White)



Wildland Fires Program Overview

The NASA Wildland Fires program develops Earth Observation and modeling technology, research, and applications that improve the end-to-end management of wildland fires, ultimately reducing the impact that fires have on communities and the economy.

The program works closely with wildland fire management agencies, researchers, and technologists in government agencies, academic institutions, and the private sector within the United States and abroad.



Program Goals

- Continue to develop foundational Earth Observation and modelling technology for measuring aspects of wildland fire across the entire fire life cycle (pre-, active, & post-fire)
- Leverage Earth Observation in use-inspired research to advance our understanding of the role that wildland fire plays in the Earth System
- Co-develop and incubate applications that leverage Earth Observation data to support decision makers in wildland fire management
- Deliver mature technological capabilities to operational fire management agencies to address key challenges in wildland fire management (e.g., FireSense Project)

NASA FireSense Project



NASA FireSense is stakeholder driven and defined by stakeholder engagement with a focus on the co-development and transition of technology and capabilities that support wildland fire management



Pre-fire: Provision of near real-time fire risk assessments based on fuel characteristics, soil moisture, surface temperature.

Improved assessment of pre-fire (fuel, weather, etc.) conditions to enable more prescribed fire.



Post-Fire: Improved maps of burn severity for post-fire rehabilitation efforts.

Improved predictions of post fire hazards and impacts.



Active Fire: Tracking for prioritization with higher spatial resolution and update frequency - toward 24/7 fire prioritization and monitoring.

Development of new, innovative sensors and models for precisely characterizing fires, fuels conditions, and smoke.



Air Quality: Enhanced tracking and analysis of smoke plumes, composition, and transport.

Improved forecasts of air quality impacts to natural and human systems as well as operations.

NASA FireSense Airborne Tech Demo Campaigns



FireSense 2023

Airborne sensors used radar, thermal, and imaging spectroscopy at 9 locations to help understand fire risk, spread, and impacts

FireSense 2024

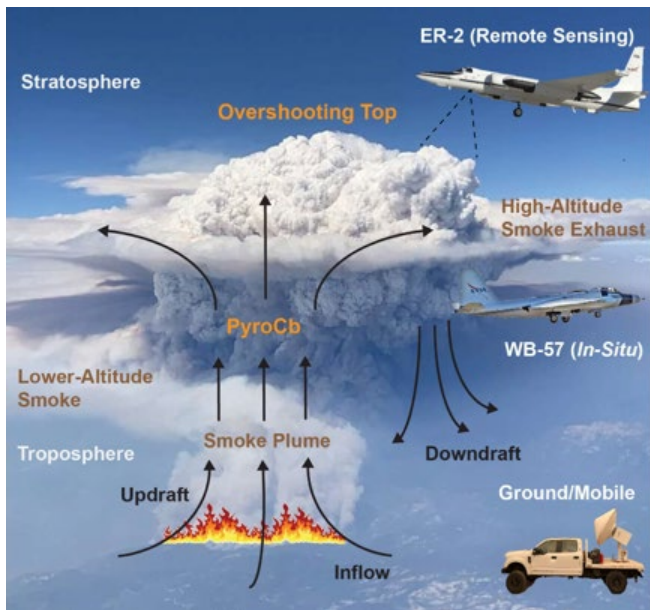
Airborne imaging spectroscopy used to help understand fire behavior and impacts for Lake Fire. Uninhabited Aerial Systems (UAS) collected measurements to support fire weather forecasting in Missoula smoke impacted airshed. Cross-agency coordination between NASA, NOAA, and USFS

FireSense 2025

Campaign included wildfires and prescribed fires in SW US. Cross-agency coordination with multiple state and federal agencies

EVS-4 Investigation Summary:

INjected Smoke and PYRocumulonimbus Experiment (INSPYRE)



PI: David Peterson (Naval Research Lab - Monterey)
Deputy PI: Neil Lareau (University of Nevada Reno)
Deputy PI: Olga Kalashnikova (JPL, Caltech)
Investigation Manager: Vidal Salazar (ESPO)
EVS Program Scientist: Barry Lefer (HQ)
EVS Program Executive: Bruce Tagg (HQ)
Program Scientists: Will McCarty and Ken Jucks (HQ)
Program Applications Lead: Mike Falkowski (HQ)
ESSP Program Manager: Greg Stover (ESSP PO)
EVS-4 Mission Manager: Diane Hope (ESSP PO)

Science: Increasing wildfire size and intensity in a warming climate will amplify pyroCb-driven smoke injection into the stratosphere resulting in measurable changes in Earth's radiative balance.

Investigation start date: October 1, 2025

Airborne elements:

- Platforms: ER-2 and WB-57
- Remote sensing: fire characteristics, plume dynamics, thermodynamics, smoke vertical distribution, radiation, lightning/electric field
- *In-Situ*: aerosol size and composition, trace gases, clouds and large particles, meteorology

Other observing systems:

- Ground-based radar and lidar, balloon profiles
- Satellites and NEXRAD radar network

Modeling systems:

- Coupled fire-atmosphere, aerosol/chemistry

Deployments:

- 2026 and 2027 in western North America
- 6-8 weeks: July-early September

(Burning) Questions?

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Photo credit: Milan Loiacono, Ft Stewart, 2025-14-04