ICAMS

Interagency Council for Advancing Meteorological Services

COMMITTEE ON RESEARCH AND INNOVATION INITIAL WILDFIRE WORKSHOP

1 April 2022

Workshop Organizers: David Turner (NOAA), Lesley Ott (NASA), Olga Tweedy (DoE), Paul Steblein (USGS) , Marc Stieglitz (NSF), Toral Patel-Weynand (USFS), Gary Geernaert (DOE), Stan Benjamin (NOAA)

USGS science for a changing world

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

NASA

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NOAA U.S. DEPARTMENT OF COMMERCE

DEPARTMENT OF ENERGY UNITED STATES OF AMERICA

NSF

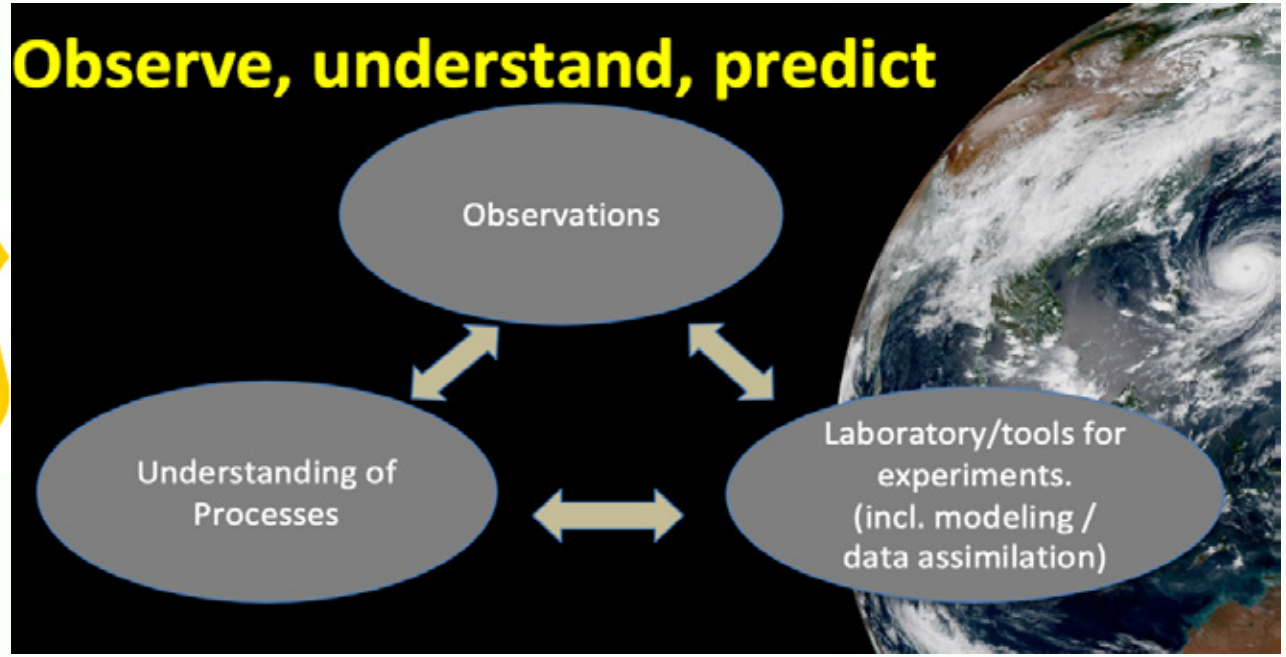
Code of Conduct

The organizers of ICAMS Wildfire Workshop are committed to providing safe, welcoming, and productive environments in the field and the lab, and at meetings and conferences, and have adopted the American Geophysical Union Scientific Code of Conduct. The Code of Conduct rejects discrimination and harassment by any means, based on factors such as ethnic or national origin, race, religion, citizenship, language, political or other opinion, sex, gender identity, sexual orientation, disability, physical appearance, age, or economic class. This Code also includes information on expected behavior, unacceptable behavior, consequences, and how to report unacceptable behavior.

If you have any concerns or need an ally contact: David Turner, Lesley Ott, Olga Tweedy, Paul Steblein , Marc Stieglitz, Gary Geernaert, or Stan Benjamin.

Introductory Remarks

Stan Benjamin (NOAA), Gary Geernaert (DOE)
Co-Chairs, ICAMS Committee on Research and Innovation



- Learn from each other.
- What are the gaps?
- What are our opportunities?

Agenda

1200 (Eastern Time) Welcome and Introductory Remarks

Stan Benjamin (NOAA) , Gary Geernaert (DoE)

1210 Remarks from Scott Weaver (OSTP),

Director, Interagency Meteorological Coordination Office (IMCO)

1220 Agency Presentations (15 Minutes Each)

- USFS, USGS, NOAA, NASA, DoE, NSF

1350 Break Time

1400 Panel Discussion

Representatives from each of the six agencies

1445 Wrap Up

Final Thoughts

Next Workshop

ICAMS Overview

Scott Weaver

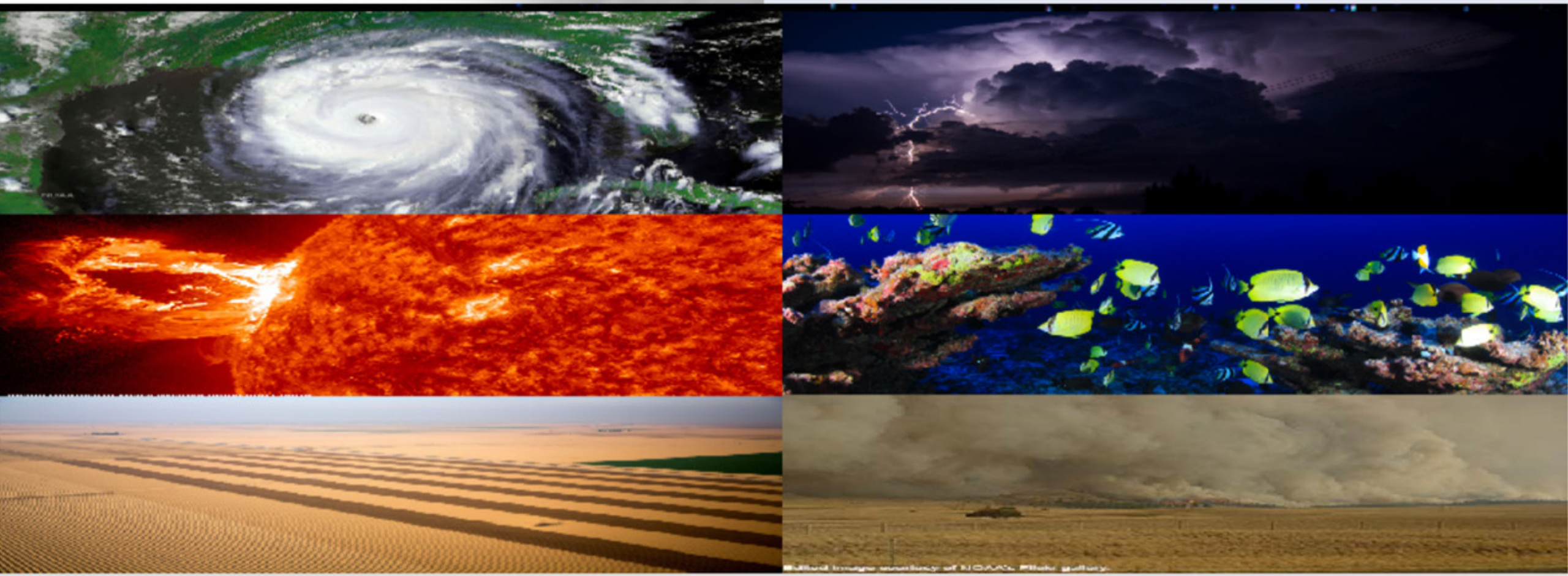
Executive Director, Interagency Meteorological Coordination Office

Office of Science and Technology Policy (OSTP)/ICAMS
Executive Office of the President

ICAMS

Interagency Council for Advancing Meteorological Services

ORGANIZATION | RESOURCES | FAQS | ABOUT

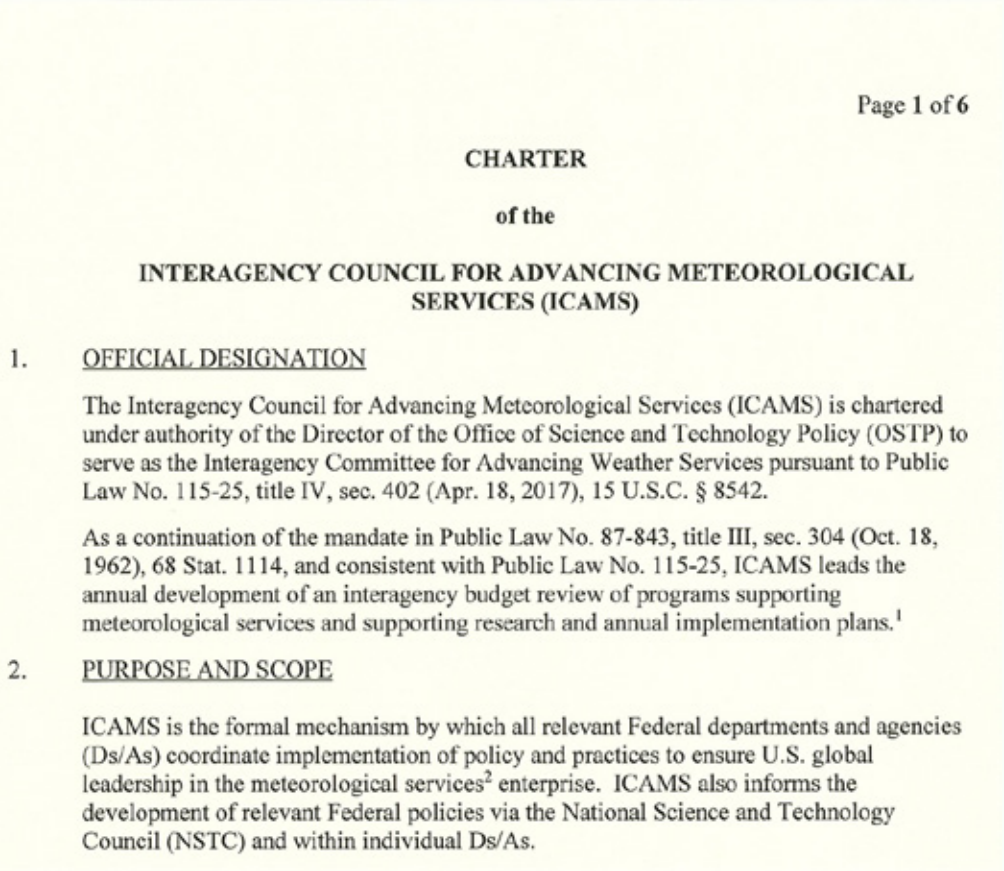


ICAMS: ENSURING U.S. GLOBAL LEADERSHIP IN METEOROLOGICAL SERVICES FROM LOCAL WEATHER TO GLOBAL CLIMATE

WHAT IS ICAMS?

ICAMS is the formal mechanism by which all relevant Federal departments and agencies coordinate *implementation* of policy and practices to ensure U.S. global leadership in the meteorological services enterprise.

A 10-year charter was put in place on July 31st 2020 after a year of planning and robust engagement with 50+ leaders across ICAMS Federal departments and agencies.



Page 1 of 6

CHARTER

of the

INTERAGENCY COUNCIL FOR ADVANCING METEOROLOGICAL SERVICES (ICAMS)

1. OFFICIAL DESIGNATION

The Interagency Council for Advancing Meteorological Services (ICAMS) is chartered under authority of the Director of the Office of Science and Technology Policy (OSTP) to serve as the Interagency Committee for Advancing Weather Services pursuant to Public Law No. 115-25, title IV, sec. 402 (Apr. 18, 2017), 15 U.S.C. § 8542.

As a continuation of the mandate in Public Law No. 87-843, title III, sec. 304 (Oct. 18, 1962), 68 Stat. 1114, and consistent with Public Law No. 115-25, ICAMS leads the annual development of an interagency budget review of programs supporting meteorological services and supporting research and annual implementation plans.[1]

2. PURPOSE AND SCOPE

ICAMS is the formal mechanism by which all relevant Federal departments and agencies (Ds/As) coordinate implementation of policy and practices to ensure U.S. global leadership in the meteorological services[2] enterprise. ICAMS also informs the development of relevant Federal policies via the National Science and Technology Council (NSTC) and within individual Ds/As.

WHY IS ICAMS NEEDED?

ICAMS fulfills the mandate of the *2017 Weather Research and Forecasting Innovation Act* by fostering collaboration on "*meteorological services via an Earth system approach, providing societal benefits with information spanning local weather to global climate.*"

Public Law 115-25: Weather Research and Forecasting Innovation Act (2017)

SEC. 402. INTERAGENCY WEATHER RESEARCH AND FORECAST INNOVATION COORDINATION. (a) ESTABLISHMENT.—The Director of the Office of Science and Technology Policy shall establish an Interagency Committee for Advancing Weather Services to improve coordination of relevant weather research and forecast innovation activities across the Federal Government. The Interagency Committee shall—

(1) include participation by the National Aeronautics and Space Administration, the Federal Aviation Administration, National Oceanic and Atmospheric Administration and its constituent elements, the National Science Foundation, and such other agencies involved in weather forecasting research as the President determines are appropriate;

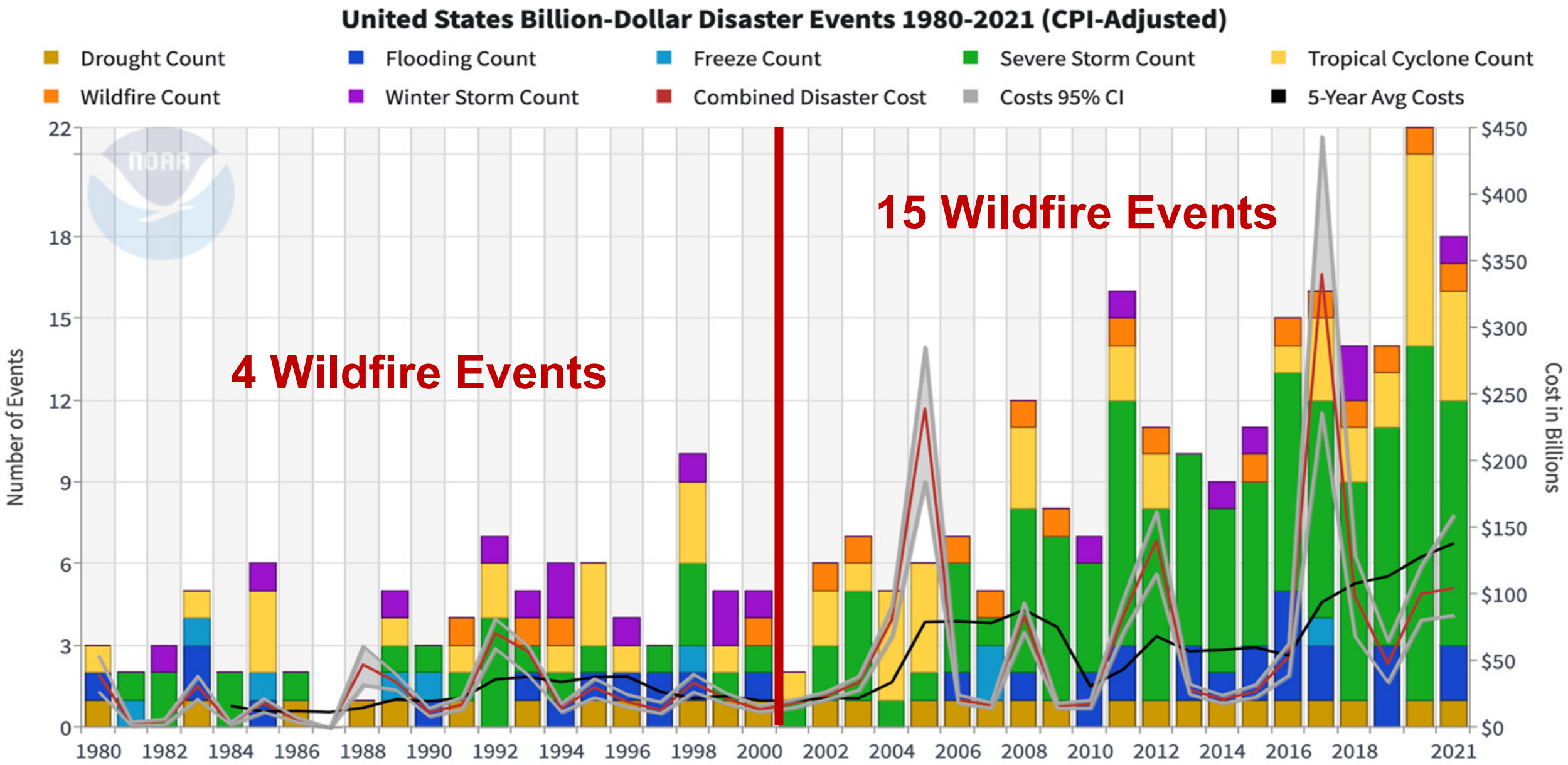
(2) identify and prioritize top forecast needs and coordinate those needs against budget requests and program initiatives across participating offices and agencies; and

(3) share information regarding operational needs and forecasting improvements across relevant agencies.

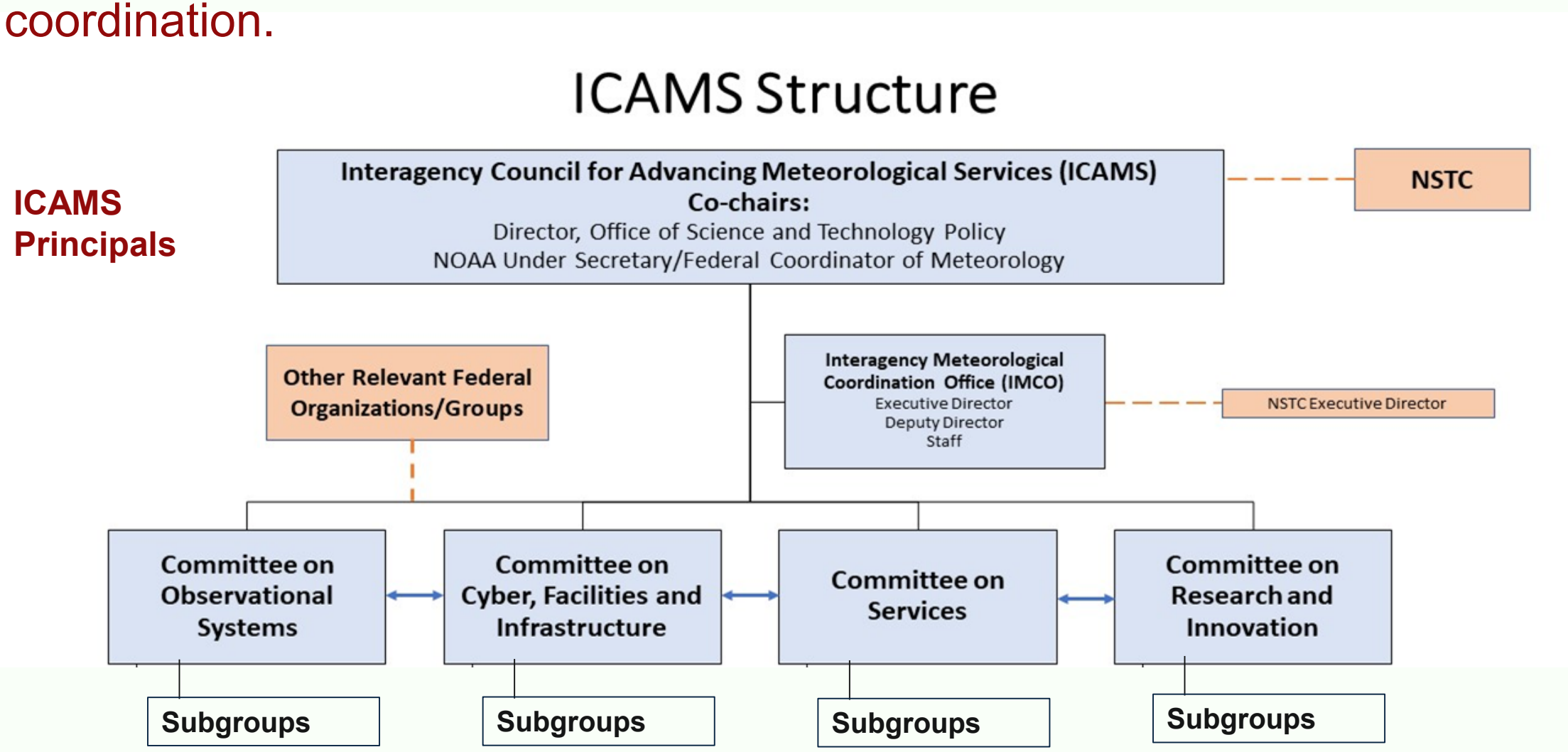
(b) CO-CHAIR.—The Federal Coordinator for Meteorology shall serve as a co-chair of this panel.

(c) FURTHER COORDINATION.—The Director of the Office of Science and Technology Policy shall take such other steps as are necessary to coordinate the activities of the Federal Government President. Determination. with those of the United States weather industry, State governments, emergency managers, and academic researchers.

Meteorological Disasters are Increasing



The new ICAMS coordination structure aims to simplify and improve coordination.



ICAMS 1.0 STRUCTURE

Committees on Observational Systems

WG on Non-Governmental Data

SC on Space-Based Observations

SC on Airborne Observations
- WG on Aerial Reconnaissance Equipment
- WG on Future Radar Systems
- WG on NEXRAD Radar

SC on Surface and Sub-Surface Observations
- WG on Satellite Telemetry

Committees on Cyber, Facilities, & Infrastructure

SC on High Performance and Cloud Computing for Earth System Applications

SC on Earth System Data Infrastructure and Stewardship

SC on Operational Processing Centers
- WG on Cooperative Support and Backup
- WG on Centralized Communications Management
- WG on Observational Data

Committees on Services

WG on Environmental Services supporting Social Equity

SC on Weather
- IT on Disaster Impact Assessments & Plans
- WG on Decision Support Services

SC on Water
- WG on Inland Water Services
- WG on Coastal Water Services
- WG on Ocean Services

SC on Climate
- WG on Climate Information Services
- WG on Climate Adaptation Services
- WG on Climate Mitigation Services

SC on Atmospheric Composition
- WG on Atmospheric Transport, Dispersion & Volcanic Ash
- WG on Wildfires, Controlled Burns, and other Sources Services

Committees on Research & Innovation

SC on Earth System Modeling & Prediction
- IT on Common Model Architecture
- IT on Coupled Global Modeling
- IT on High Performance Computing

SC on Data Assimilation and Observation Strategy

SC on Application of Weather and Climate Prediction to Decision Making

SC on Earth Systems ML/AI and Advanced Technologies

JOINT ACTION GROUPS

Integrated Observations for Meteorological Extremes and Regional Information

Earth System Predictability

Transition of R&D into Services

Space Weather Observations, Services and Research

ICAMS PRINCIPLES

The following set of principles guides the work of ICAMS:

- **The meteorological enterprise is a national asset** for ensuring personal and community safety, economic success, national security, and education;
- Individuals, and their creativity and dedication, are the greatest asset of the U.S. meteorological enterprise;
- **Effective cross-agency coordination and external engagement are critical to success;**
- Success for the individuals and organizations is achieved via success of the enterprise as a whole;
- **Efficiency is foundational** to the stewardship of taxpayer dollars;
- Research, operations, and applications are mutually beneficial, mutually reinforcing, and equally important for realizing ICAMS goals;
- **Open debate and a diversity of opinions promote excellence and teamwork;**
- Excellence results in quality and promotes public trust

Agency Presentations

USDA Forest Service Wildfire Crisis

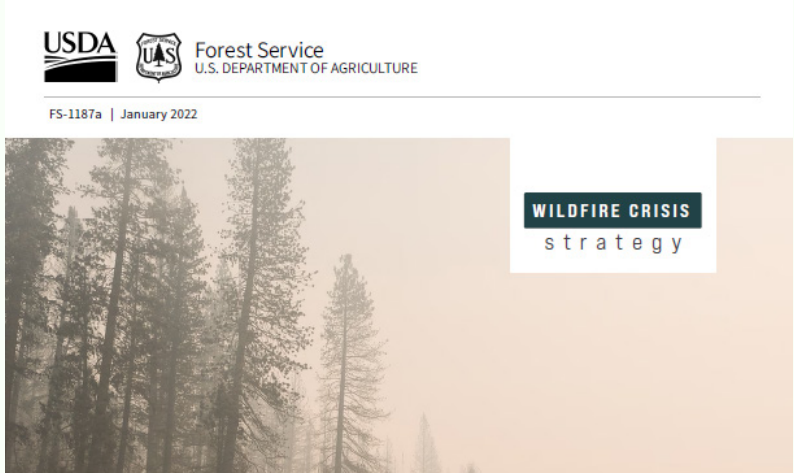
Initial ICAMS Wildfire Workshop

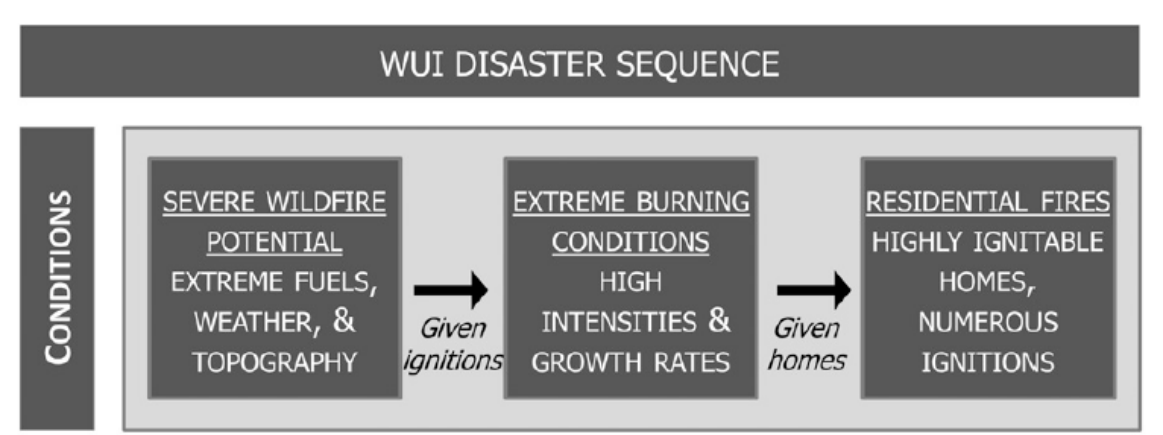
Toral Patel-Weynand
Acting Associate Deputy Chief
USDA Forest Service Research and Development

USDA Forest Service Wildfire Crisis Strategy (WCS)

- Issued in January 2021
- Science-informed plan to prioritize fuel management actions at the necessary scale over the next ten years
  - Treat up to an additional 20 million acres on the National Forest System
  - Treat up to an additional 30 million acres of other Federal, Tribal, State, and private lands
  - Long-term maintenance beyond 10 years
- The IIJA supports some of this work

USDA Forest Service Wildfire Crisis Strategy (WCS)

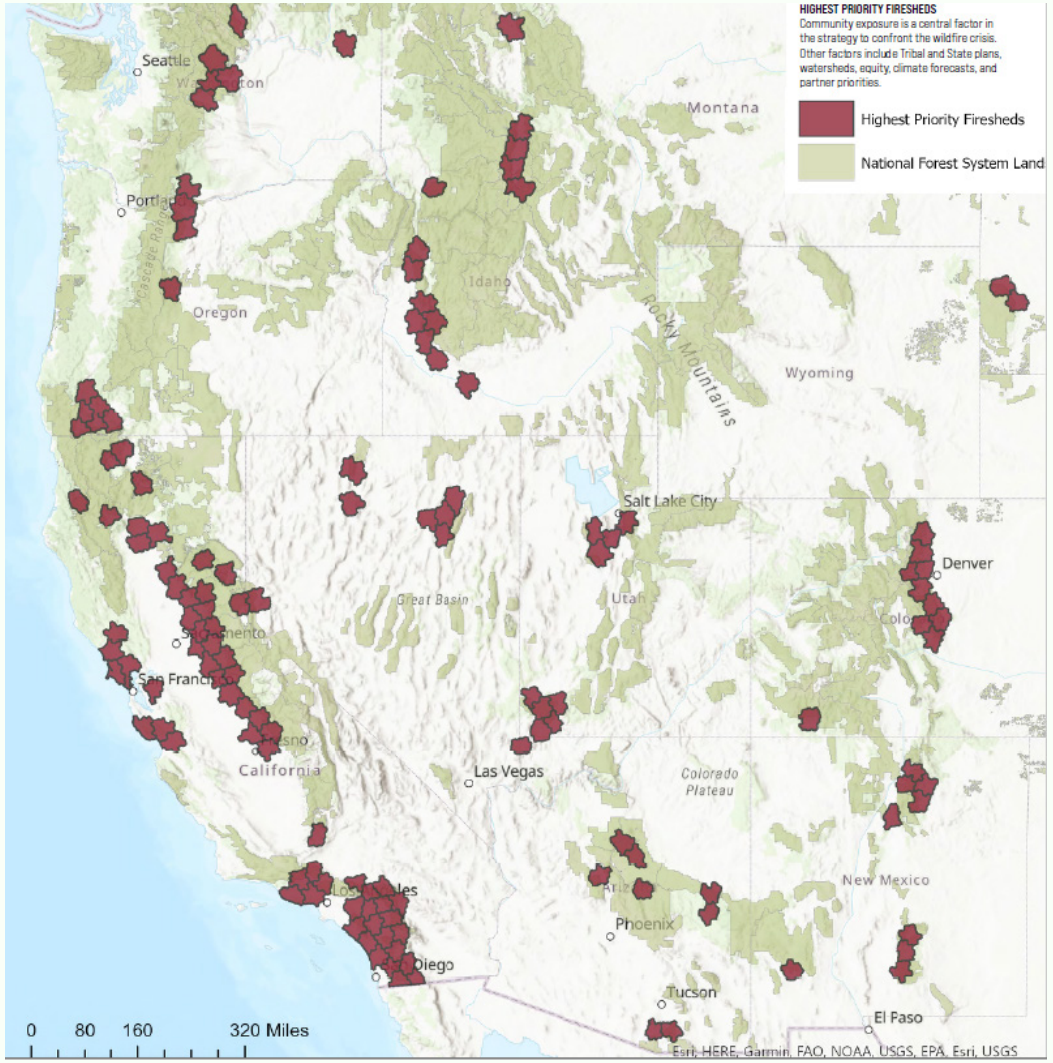




Calkin et al. 2014

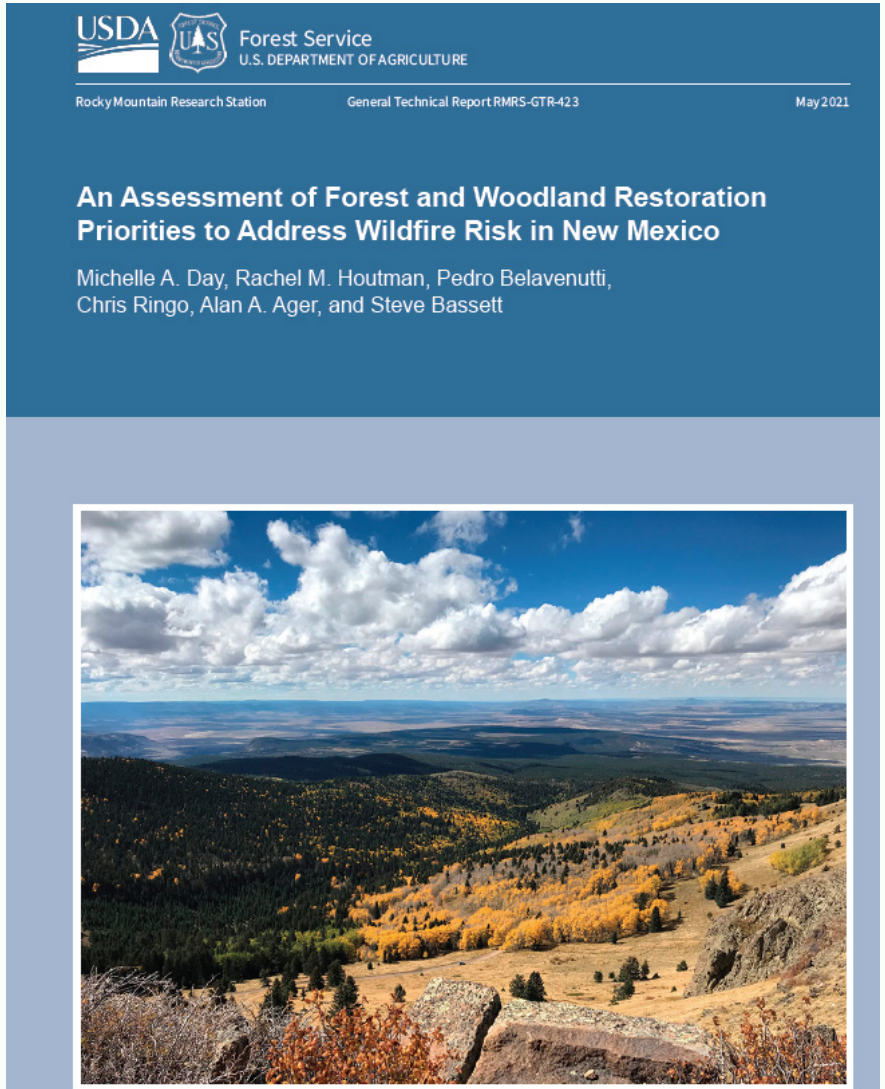
- Three pillars of the National Cohesive Wildland Fire Management Strategy
  - Fire adapted communities
  - Fire resilient landscapes
  - Safe and effective wildland fire response
- R&D research supports all of these pillars
  - Threats to our communities emerge because of landscape fuel conditions in the wildlands, extreme weather conditions, and vulnerable communities

Fire adapted communities



- Community vulnerability
  - Building materials (Forest Products Laboratory)
  - Social and economic risk factors
- Community exposure
  - Firesheds – 250,000 acre planning units – are delineated based on millions of wildfire simulations using R&D-developed tools and technology.
- Wildfire simulations require meteorological data to predict fire activity based on historical climate-fire relationships
  - Historical fire weather available from Weather Information Management System (WIMS) and FireFamilyPlus

Fire resilient landscapes


USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

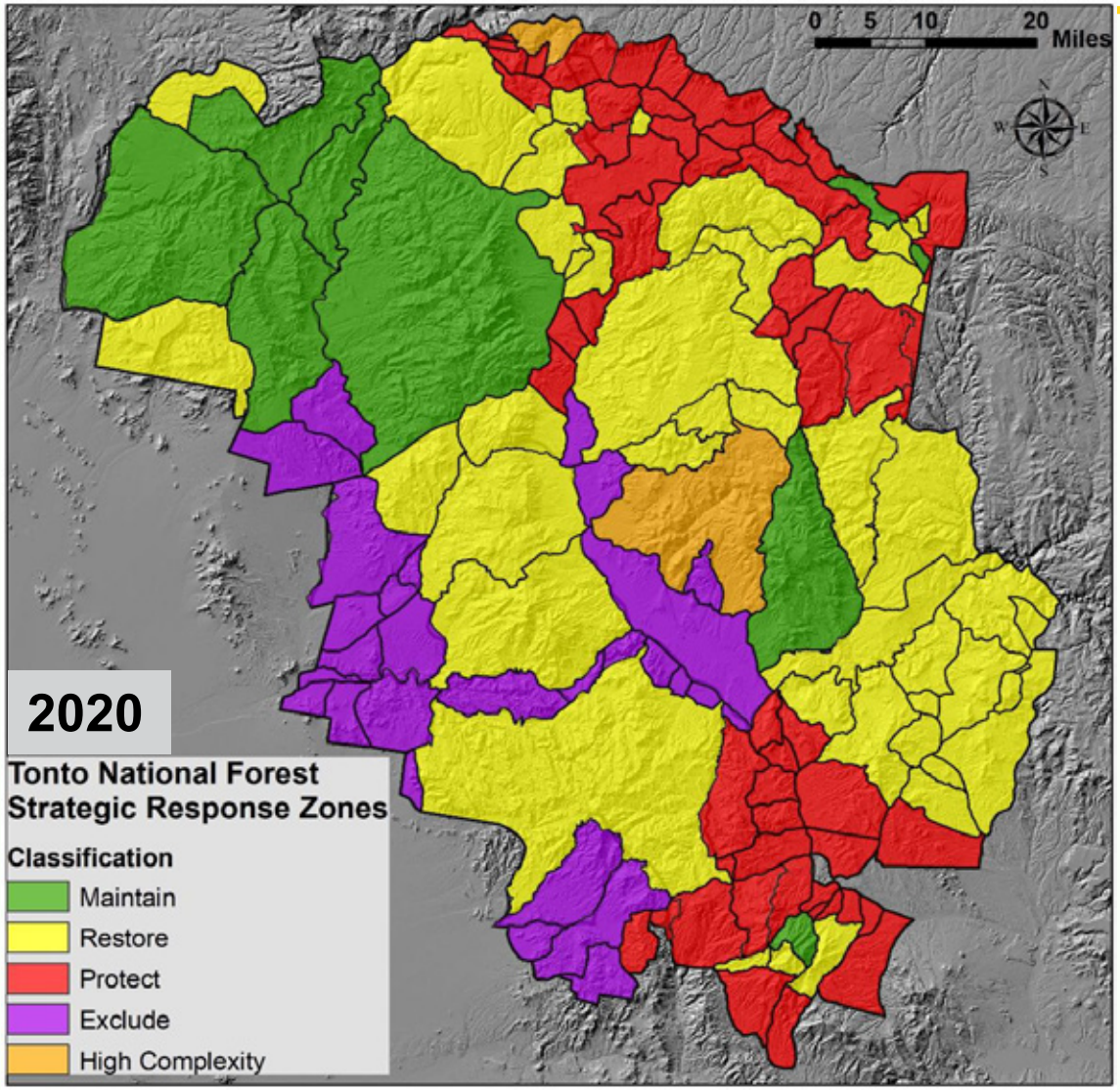
Rocky Mountain Research Station General Technical Report RMRS-GTR-423 May 2021

An Assessment of Forest and Woodland Restoration Priorities to Address Wildfire Risk in New Mexico

Michelle A. Day, Rachel M. Houtman, Pedro Belavenutti, Chris Ringo, Alan A. Ager, and Steve Bassett

- Landscape fuel conditions and climate drive fire exposure
  - Firesheds quantity exposure to communities from fires that start elsewhere.
- Priority landscapes have been identified
  - Interior Pacific Northwest
  - Sierra Nevada Range in California
  - Front Range in Colorado
  - Southwest (AZ and NM)

Safe and Effective Wildland Fire Management Response



- Potential Operational Delineations (PODs) Framework
  - Spatial containers called "Strategic Response Zones" for wildfire response objectives
  - Determined based on Potential Control Locations
- PODs are used for
  - Interior Pacific Northwest
  - Sierra Nevada Range in California
  - Front Range in Colorado
  - Southwest (AZ and NM)

Wildfire Risk Reduction Infrastructure Team (WRRIT)

National Roundtables

- *Covering each Region, through the end of May*

Incorporation of best available science

- *Integration of biophysical and social sciences*
- *Understanding of local contexts*
- *Improved understanding of smoke dynamics*
- *Shareable platforms, databases and datasets*
- *Leveraging Joint Fire Sciences Program*

Questions?

Toral Patel-Weynand

Toral.patel-weynand@usda.gov

ICAMS Fire Workshop
April 1, 2022

USGS
Wildland Fire science

Paul Steblein

Wildland Fire Science Coordinator

Expert Assist today:

- **Brian Ebel, Water Mission Area**
- **Kurtis Nelson, EROS**
- **J. Kevin Hiers, Deputy Fire Science Coordinator**

For additional information:
www.usgs.gov/fire
USGS Fire Science Fact Sheet
https://doi.org/10.3133/fs20193025
12-year compendium of fire science at USGS
https://doi.org/10.3133/ofr20191002
USGS Wildland Fire Science Strategic Plan
https://doi.org/10.3133/cir1471
Firelight – USGS Fire Science Newsletter

USGS
science for a changing world

USGS Fire Science Scope

Geographic

- National
- DOI land – about 20% land surface
- Local projects

Interdisciplinary

- All Mission Areas – Ecosystems, Natural Hazards, Water, Core Science, Energy & Minerals

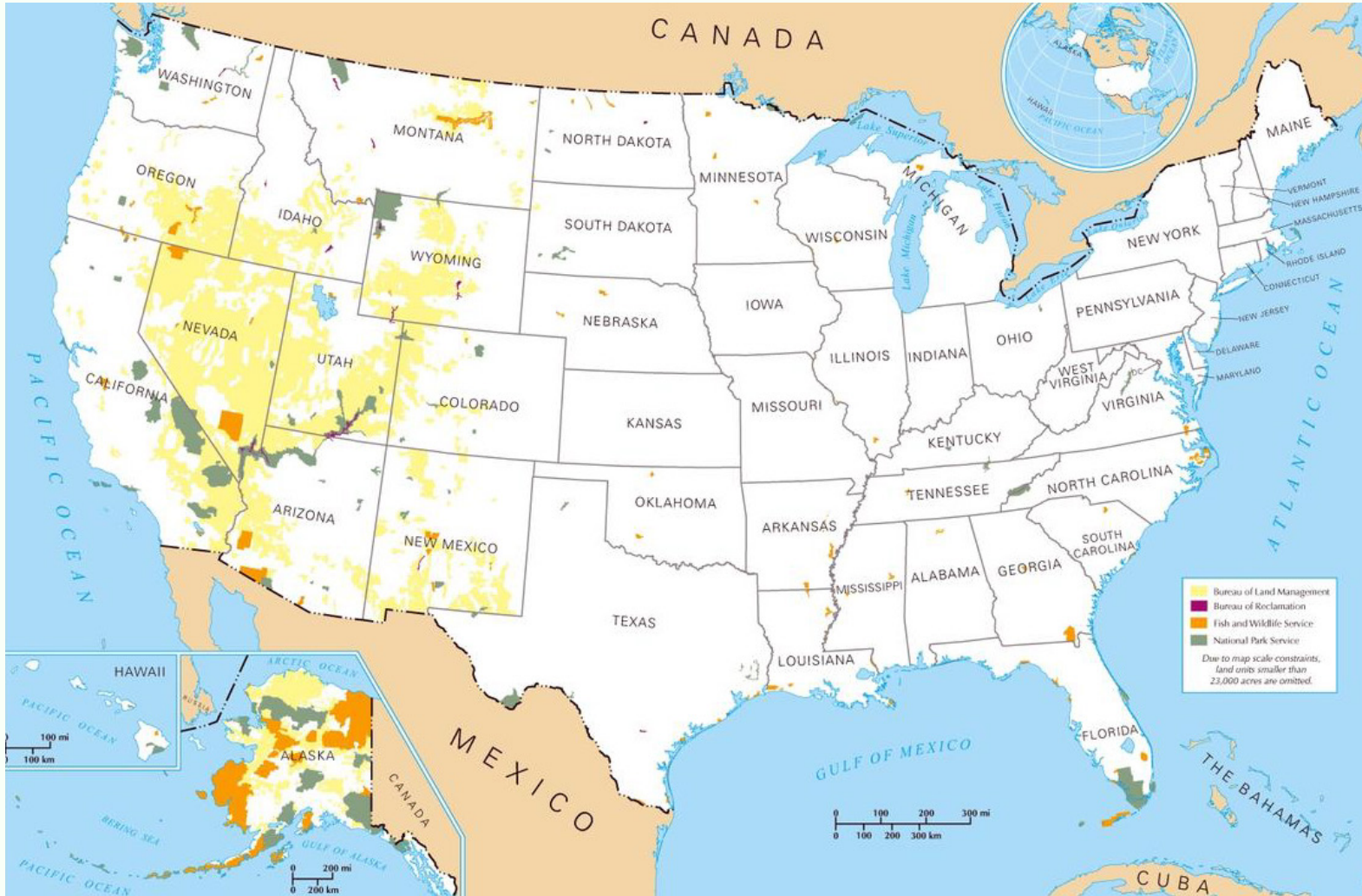
Thematic – very diverse

- Fire History & Management
- Fire Ecology & Recovery
- Post-fire Risks
- Geospatial, Imagery & Tech

Science Organization & Results

- 8,000 scientists & staff
- >200 scientists in very active fire sci CoP

Department of the Interior lands



USGS Wildland fire science strategic plan: 2021-2026

Priority 1: Produce state-of-the-art, actionable fire science

- **Goal 1:** Improve understanding of the impacts of climate changes and other ecosystem stressors, and their synergistic interactions, on fire behavior, fire risk, and fire effects in natural systems and human communities.
- **Goal 2:** Gain a better understanding of the relationships of fire and fire management to biodiversity conservation, ecosystem resilience, and post-fire recovery.
- **Goal 3:** Conduct science to help protect human lives, livelihoods, property, and infrastructure.
- **Goal 4:** Develop state-of-the-art tools and decision-support systems that enable land, fire, and emergency-managing bureaus and partners to obtain essential fire information.

Priority 2: Engage stakeholders in science production

Priority 3: Effectively communicate USGS fire science capacity, products, and information

Priority 4: Enhance USGS organizational structure and advance support for fire science

USGS Wildland Fire Science Strategic Plan
https://doi.org/10.3133/cir1471

USGS
science for a changing world

USGS Fire Science

Wildland Fire Threat, Hazard, Risk & Mitigation

Phases of Wildland Fire

Before a Fire

Escaped Fire

Insects

Disease

Invasive Species

Weather & Drought

Climate Change

Human Activity & Development

Forest & Rangeland Mgmt Pract

Prescribed Fire

Inv Spp Control

Fuel Breaks

Restore & Maintain Landscapes

Wildfire Prevention

Homeowner Actions

Create Fire-Adapted Communities

Fire Resistant Buildings

Community Wildfire Protection Plan

During a Fire

Human Caused Ignitions

Job Hazards

Ash

Smoke

Fire

Landfire & WFDSS

Wildfire Suppression

Manage Fire for Resource Objectives

Improve Wildfire Response

Cultural Resources

Plants & Wildlife

Public Warning Systems

Human Health & Safety

Public Evacuation

Infrastructure

Economic Costs Direct & Indirect

After a Fire

Wind Erosion

Debris-Flows & Flooding

Water Quality/Quantity & Supply Systems

Invasive Spp Response

Lost Vegetation & Organic Matter

Public Warning Systems

Public Evacuation

Human Health & Safety

Infrastructure

Restore Vegetation

Inv Spp Control

Burn Severity Maps

BAER Plans

Ecosystem Services

Plants & Wildlife

Land Uses

Carbon

Threat/Hazard

Values at Risk

Mitigation

Integration with Other Hazards & Risks

USGS science for a changing world

1. Advanced Integrated Fire Science

Integration of Fire Behavior with Post-fire & Ecosystem Processes

Current Fuels & Vegetation

Invasive Species

Land Uses

Wildfire

Insects

Disease

Fuel Treatments
- RxFire
- Fuel Breaks
- Mech Trt
- Inv Spp Trt

Remote Sensing
Ground Sampling
Modeling

Other Data & Models
- Weather/climate
- Terrain

Weather/Climate
Terrain
Veg regrowth

Before a Fire

During a Fire

Fire Behavior

After a Fire

Fire character
Burn severity

Predicted & Observed Post-fire Hazards
- Input to decision support & monitoring system
  - Debris flow, water flow/quality, sedimentation
  - Mitigation options
- Couple with other ecosystem & socioeconomic models
  - Vegetation, wildlife habitat, invasive spp, health & safety, infrastructure

Predicted & Observed Fire Character
- Input to decision support systems
- Couple with post-fire hazards
- Couple with other models (carbon, emissions)

Fire Monitoring
- Detection
- Perimeter mapping
- Intensity
- Burn severity

Critical Role of Partnerships
- Internal across disciplines
- With other agencies & programs
- Remote sensing, process research, modeling & application

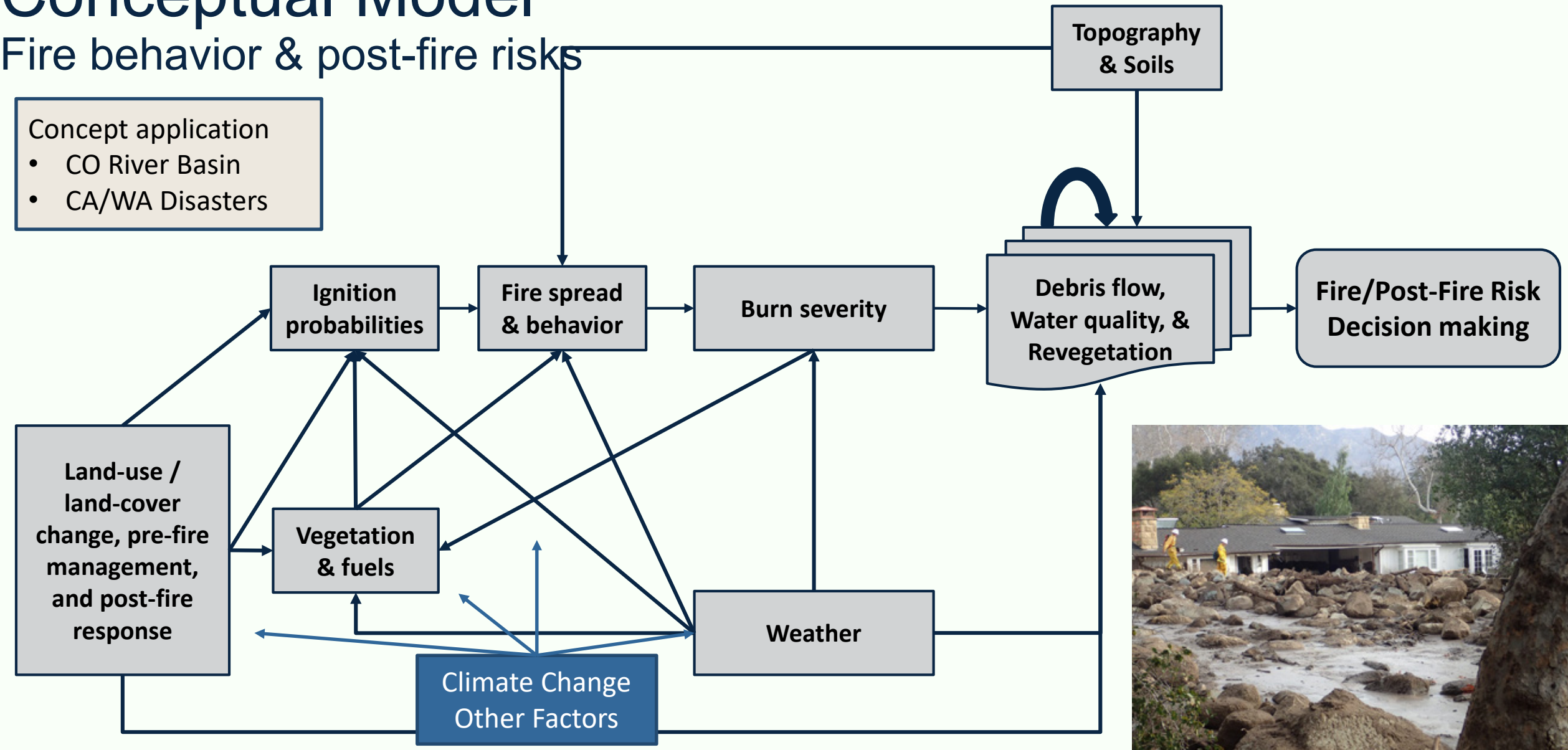
USGS science for a changing world

1. Advanced Integrated Fire Science

Advanced Integrated Fire Science Conceptual Model

Fire behavior & post-fire risks

Concept application
- CO River Basin
- CA/WA Disasters

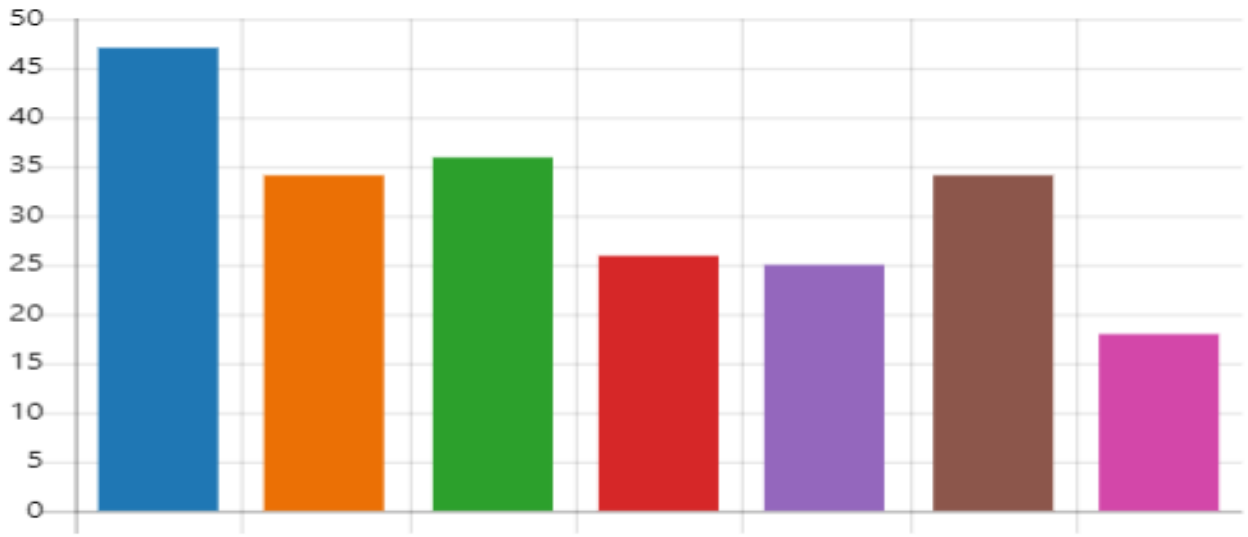


66 records so far
Catalog of Fire Science Scientists and Programs

Purpose of Data Call:	Compile wildland fire research capability from participating agencies meet the workshop goal - current agency activies and opportunities for collaboration					
Agency	**Program**	**Description of Capability or Use**	**Science Phase**	**Fire Phase**	**Point of Contact**	**Link to doc or webpage**	**Notes**
USGS	Core Science, EROS	The Fire Danger Forecasting Project focuses on research and development of digital map products suited for monitoring and forecasting fire potential within the conterminous U.S. The project maintains and operates an automated, daily production process which generates a suite of digital map products related to the forecasting of fire ignition and subsequent spread potential.	Application	Before	Kurtis Nelson, EROS Fire Science PI, knelson@usgs.gov	Fire Danger Forecast | U.S. Geological Survey (usgs.gov)	Additional r
NIFC*	RAWS	RAWS - Remote Automatic Weather Stations - Nearly 2,200 interagency Remote Automatic Weather Stations (RAWS) strategically located throughout the United States. These stations monitor the weather and provide weather data that assists land management agencies with a variety of projects such as monitoring air quality, rating fire danger, and providing information for research applications.	Observation	Before, during, after	Nicole Finch, RAWS Program Manager, 208-387-5475, rawshelp@blm.gov	Home | RAWS (nifc.gov)	

What science phase(s) are associated with your work?

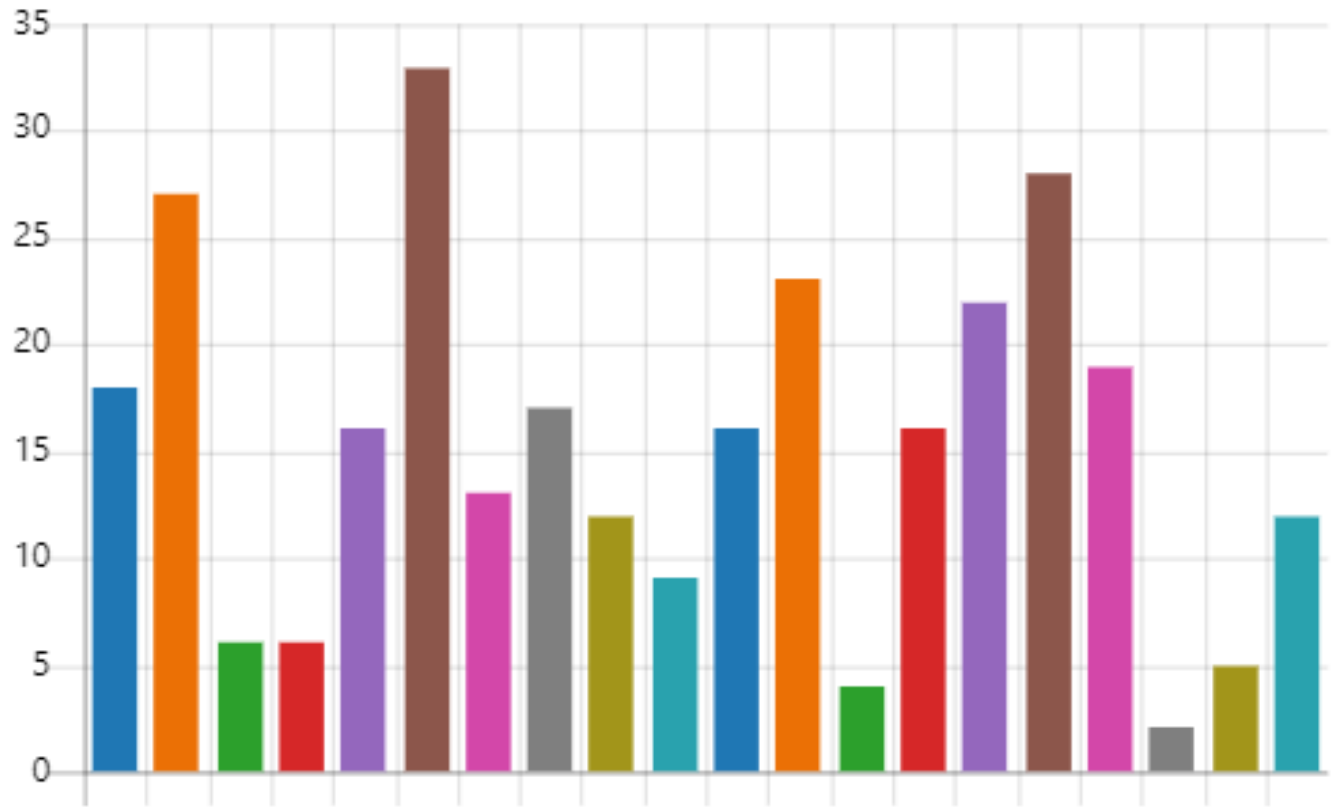
Observations	47
Process-oriented Research	34
Modeling	36
Operational predictions and p...	26
Real-time aspects (e.g., remot...	25
Applications for operational use	34
Science management/leaders...	18



What phase(s) of wildland fire best describe your work?

Before a fire occurs	26
During a fire or fire response	14
After a fire occurs (post-fire)	58

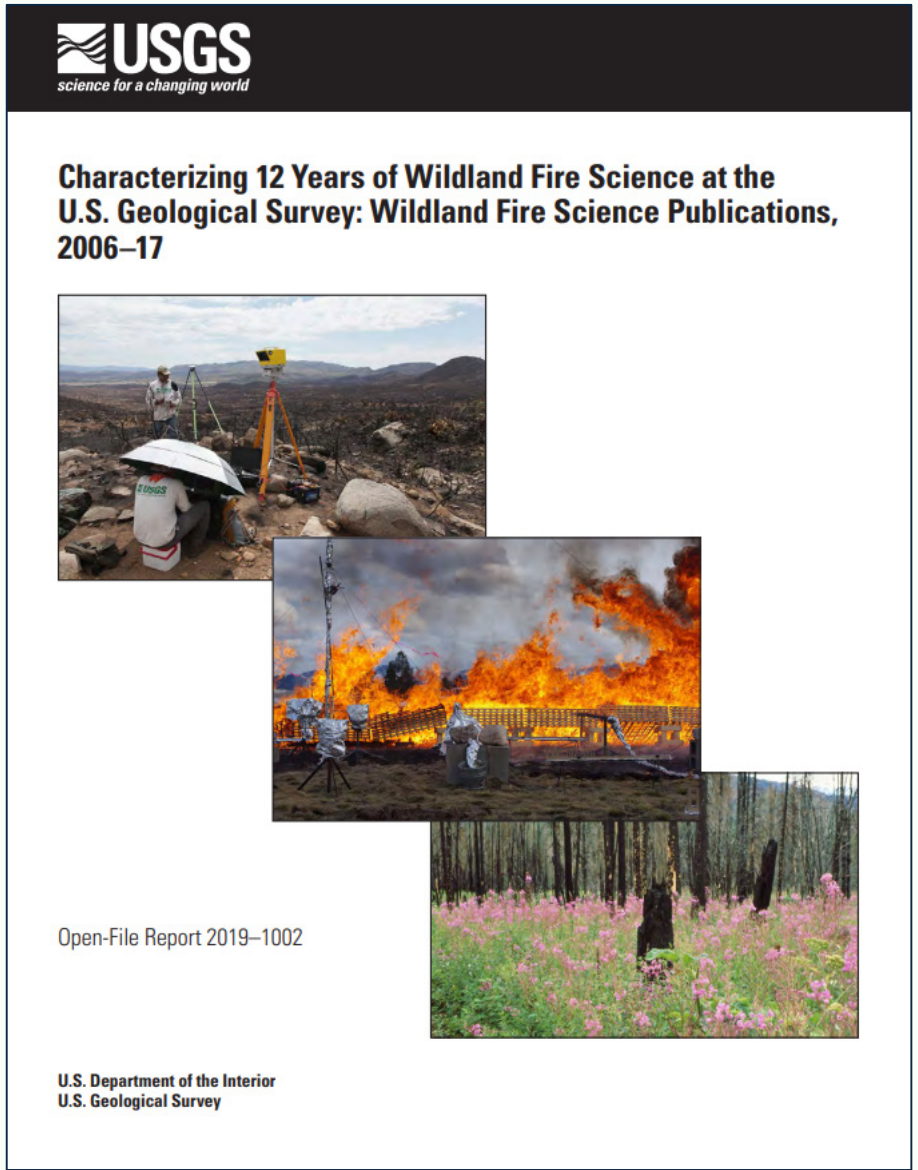
Areas of fire science focus



Carbon	18
Climate Change	27
Cultural Resources	6
Contaminants and Fire	6
Debris flow/landslides	16
Fire Effects	33
Fuel Treatments	13
Fire Prone Ecosystems	17
Human Dimensions	12
Integrated Fire Science	9
Invasive Species and Fire	16
Remote Sensing	23
Smoke/Emissions	4
Water Quality	16
Hydrology	22
Geospatial Data	28
Post Fire Risk	19
Wildland Fire Behavior	2
Wildland Urban Interface	5
Other	12

USGS
science for a changing world

USGS Fire Science Publications/Products 2006-2017



970 publications, linked and searchable
https://doi.org/10.3133/ofr20191002

Average 81 peer-reviewed publications per ye

Publications & Products	Before Fire	During Fire	After Fire	Total
Fire History & Management	144	4	124	**272**
Fire Effects & Recovery	157	2	237	**396**
Post Fire Risk	37	1	108	**147**
Geospatial & Imagery	53	6	104	**163**
Total	**391**	**13**	**573**	

Summary:
Sample of USGS Science Resources to Support Management Before, During and After Fires

- Landfire - > 20 data products
  - https://www.landfire.gov/
- LCMAP – Land change monitoring, assessment & projection
  - https://www.usgs.gov/special-topics/lcmap
- National Map data
  - https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/download?qt-science_support_page_related_con=0#qt-science_support_page_related_con
- Lidar 3DEP Data
  - https://www.usgs.gov/core-science-systems/ngp/3dep
- Landsat Data & Tools
  - https://www.usgs.gov/core-science-systems/nli/landsat/data-tools
- Fire Danger Forecast
  - https://www.usgs.gov/fire-danger-forecast/about-fire-danger-forecast
- Wildland Fire Science Strategic Plan
  - https://doi.org/10.3133/cir1471
- 12-year compendium of fire science
  - https://doi.org/10.3133/ofr20191002
- Burn Severity Mapping, USGS/USFS
  - https://fsapps.nwcg.gov/mtbs/birch/requests/list
- Monitoring Trends in Burn Severity
  - https://www.mtbs.gov/
- Debris flow assessments:
  - https://landslides.usgs.gov/hazards/postfire_debrisflow/
- Streamgage Network:
  - https://www.usgs.gov/mission-areas/water-resources/science/usgs-streamgaging-network?qt-science_center_objects=4#qt-science_center_objects
- Hazard Data Distribution System – includes commercial satellite imagery (e.g., WorldView) obtained on fires:
  - https://hddsexplorer.usgs.gov/
- Invasive Species Maps
  - https://eros.usgs.gov/doi-remote-sensing-activities/2019/usgs/mapping-cheatgrass-sagebrush-ecosystem-western-us

USGS
science for a changing world

NOAA’s Wildland Fire Observations, Research and Services (FOReST)

Dave Turner
Global Systems Laboratory

NOAA

OAR
NESDIS
NWS

22 March 2022

Charge from CoRI for this workshop

- To provide high-level overview of what NOAA is doing
  - Before the wildfire
  - During the wildfire
  - After the wildfire
- With an emphasis on
  - Observations
  - Process-oriented research
  - Modeling (across time / spatial scales)
  - Operational predictions and products
  - Applications, decision support systems, and social science

NOAA Science & Services

NOAA supports each phase of the fire lifecycle

Fire Weather Customers / Partners

Local

Regional

Geographic Area Coordination Centers

National

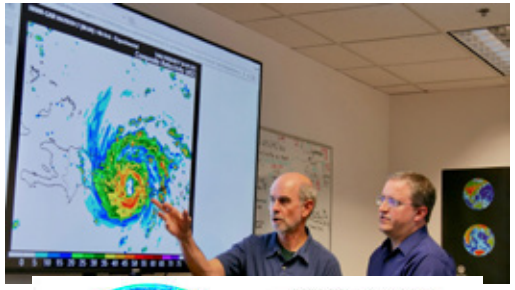
NGOs **Academia** **Media** **Research Consortias**

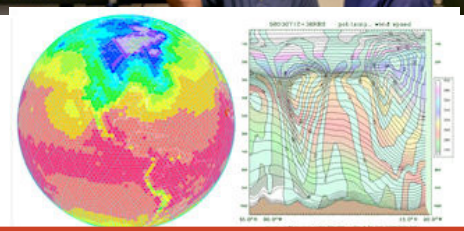
Meaningful Forecast Information

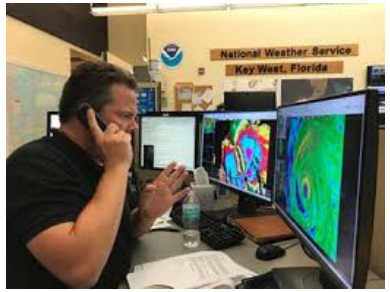
Research:
science and technology development

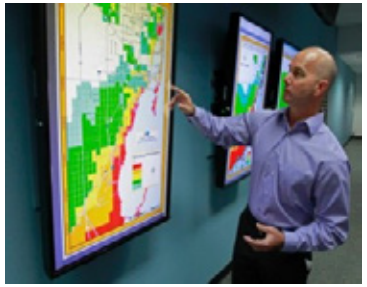
Operations:
Forecasters using and communicating information

Decision Support:
Informing decisions based on the weather information provided

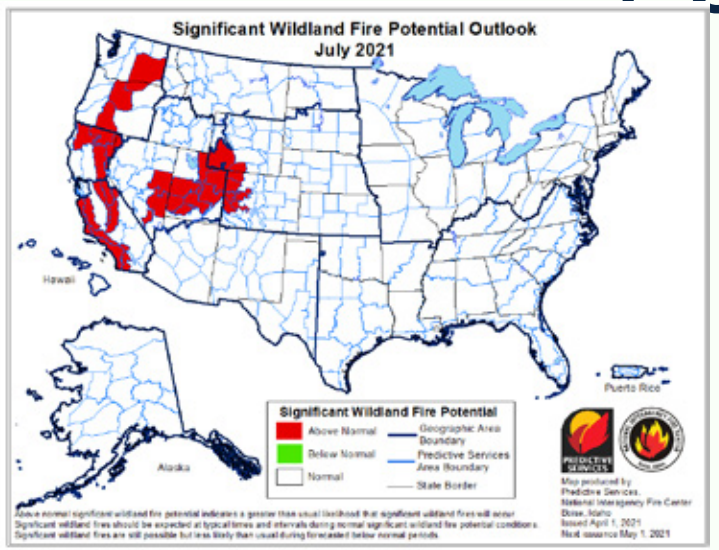




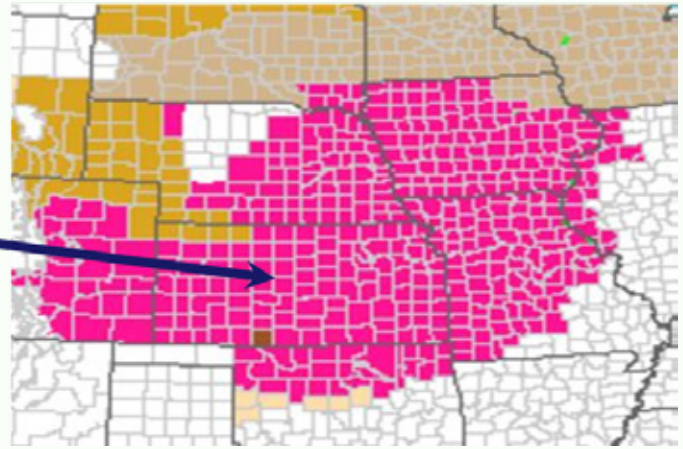


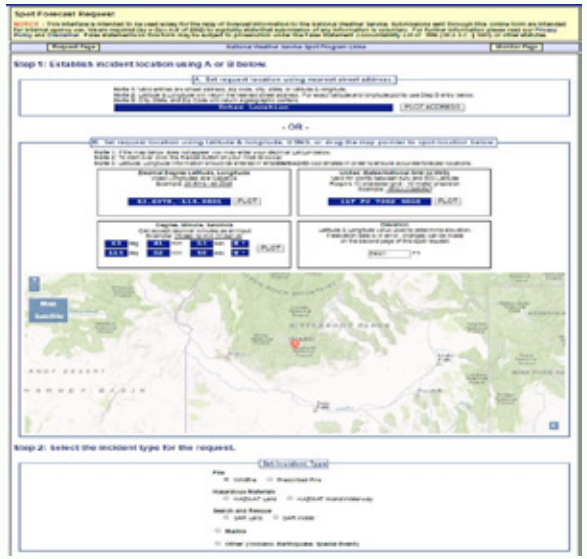


Current Operational Coordination: Forecast Services

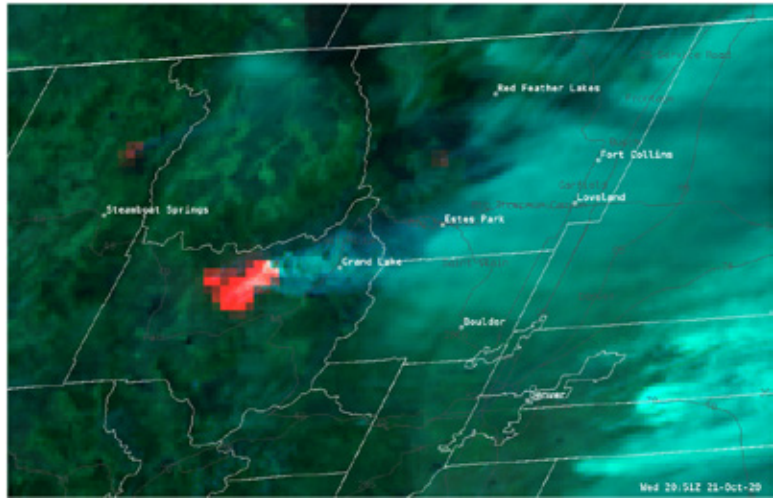


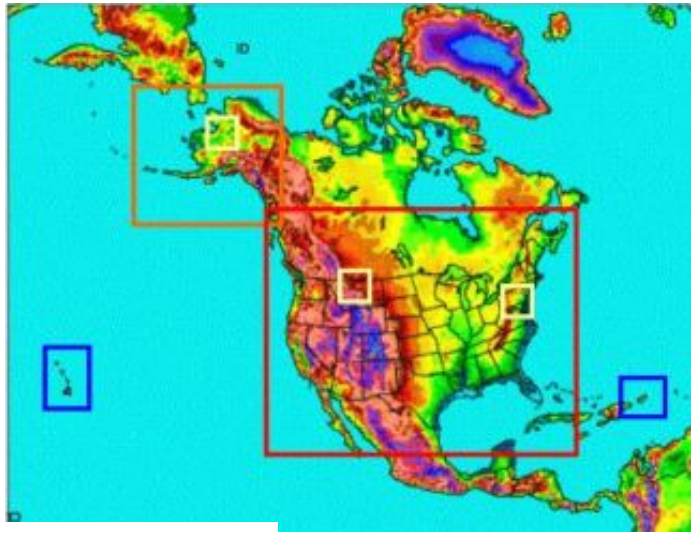
Red Flag Warning

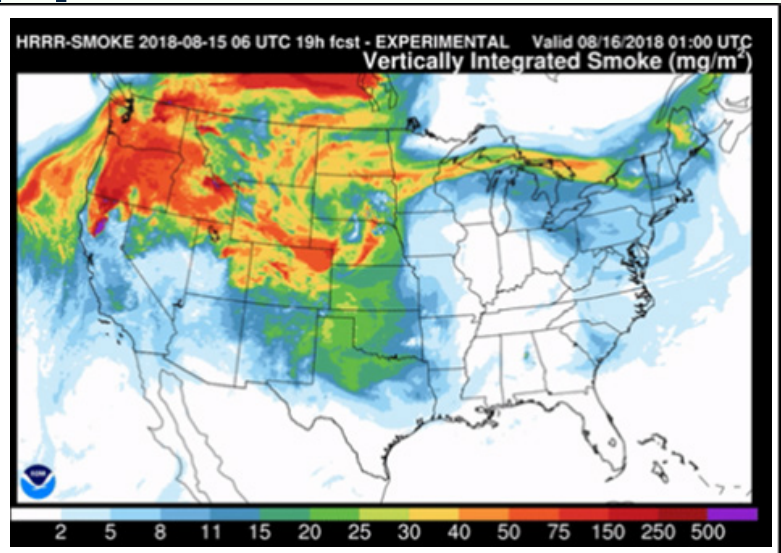




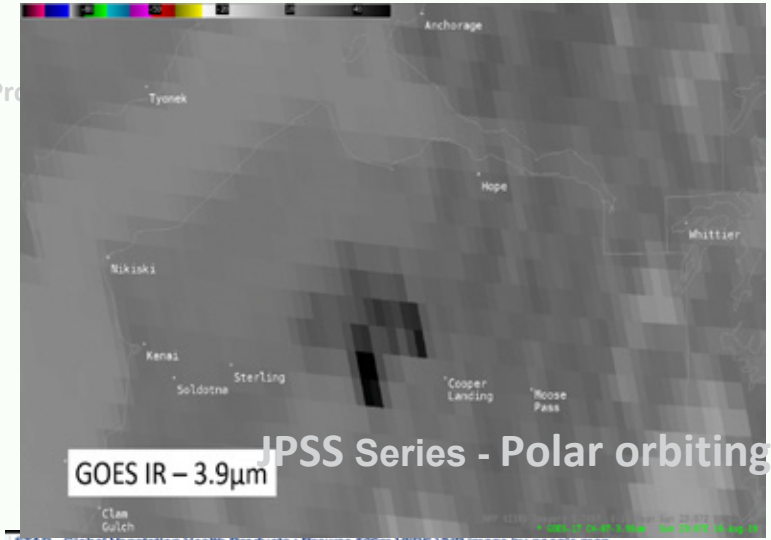
Improved Decision Support

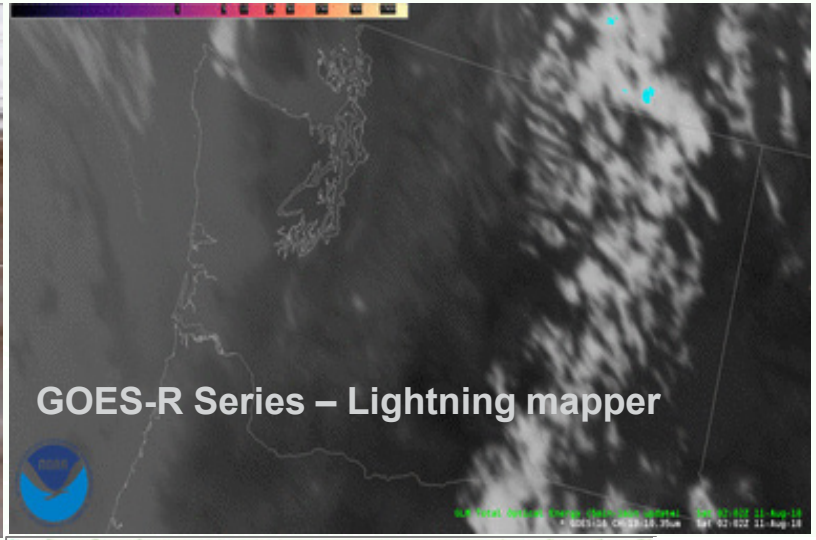


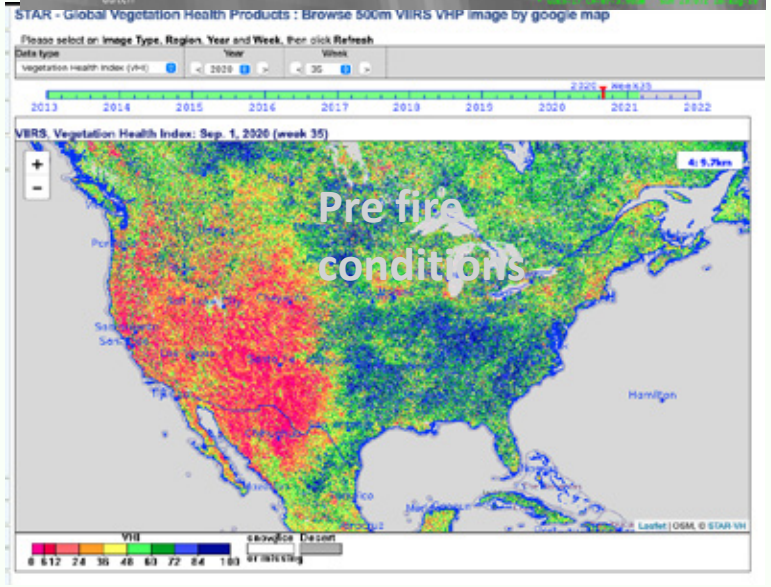


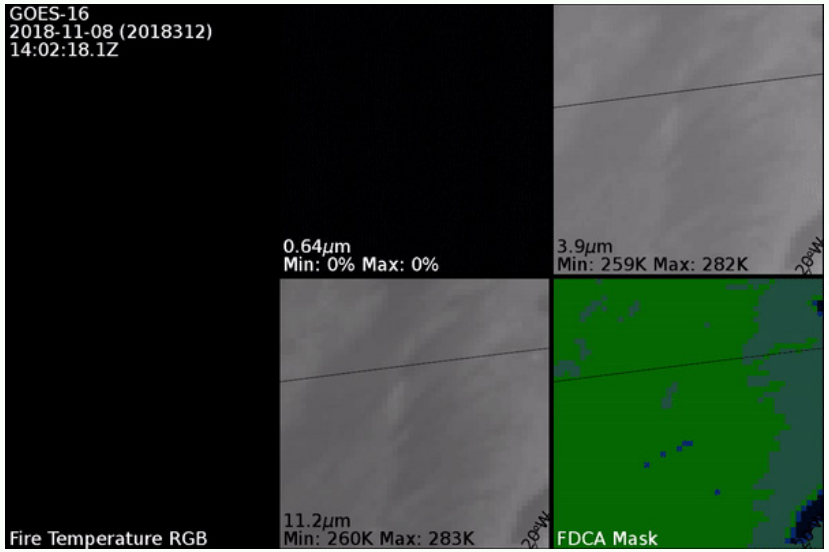


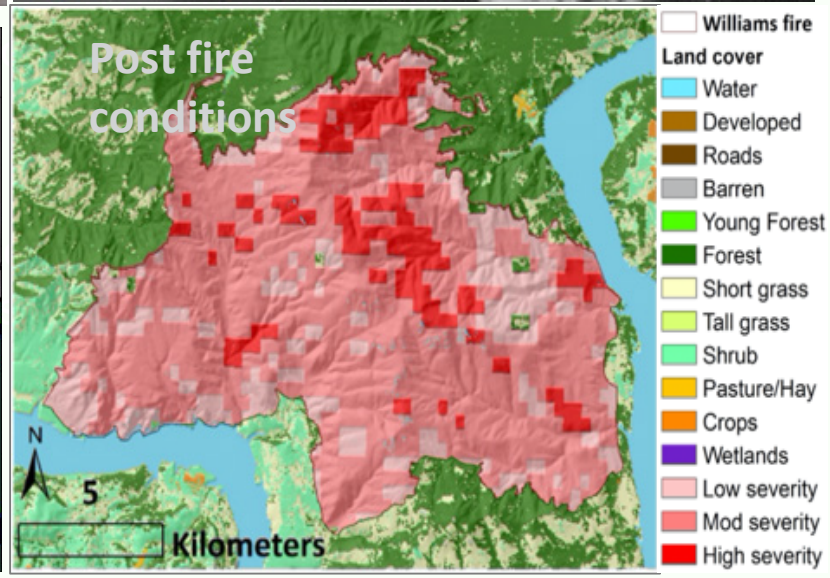
NOAA Satellites for Fire Information



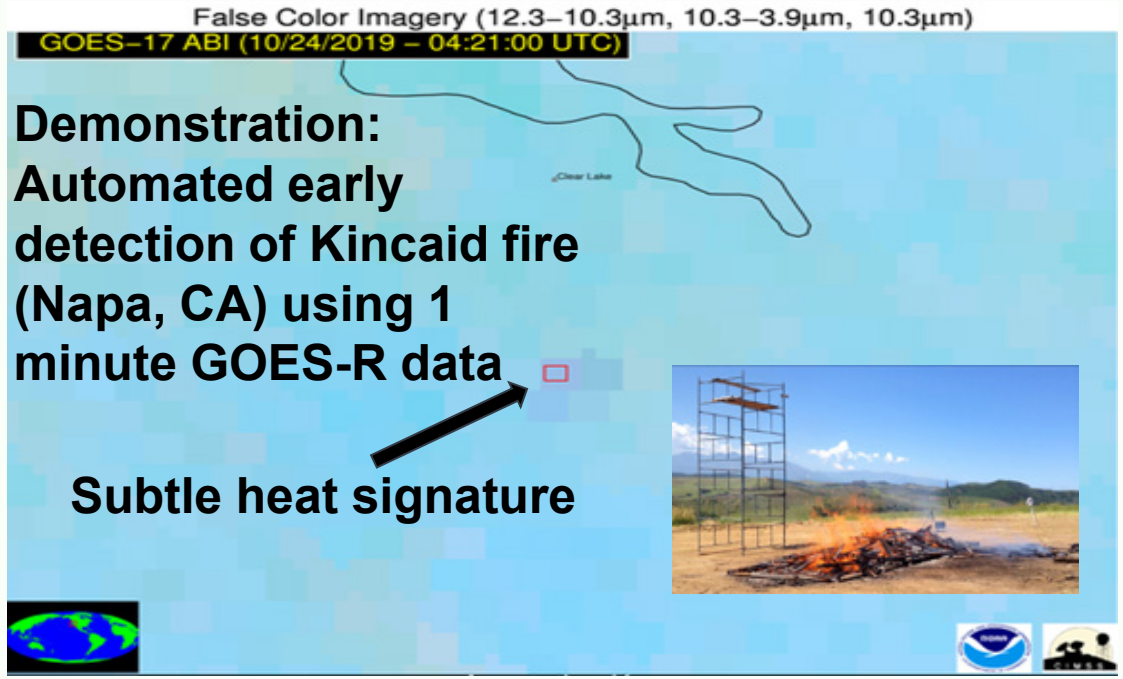




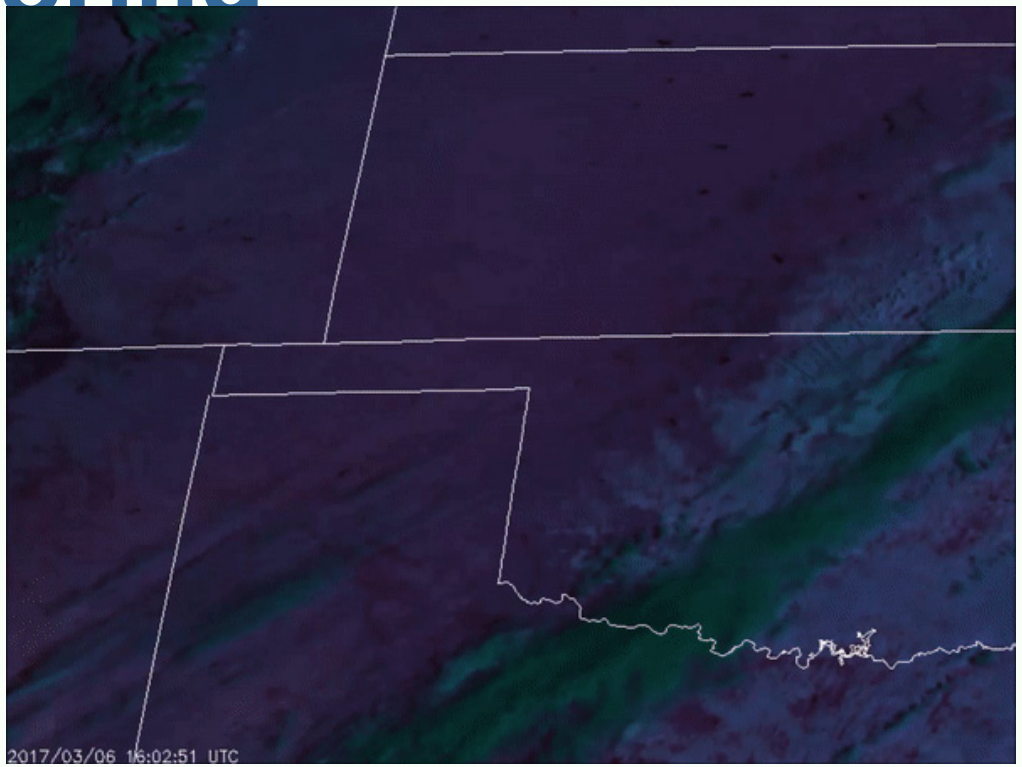




Improving Satellite-based Fire Detection and Monitoring



Above: Artificial intelligence and machine learning algorithms are being developed to detect fires earlier

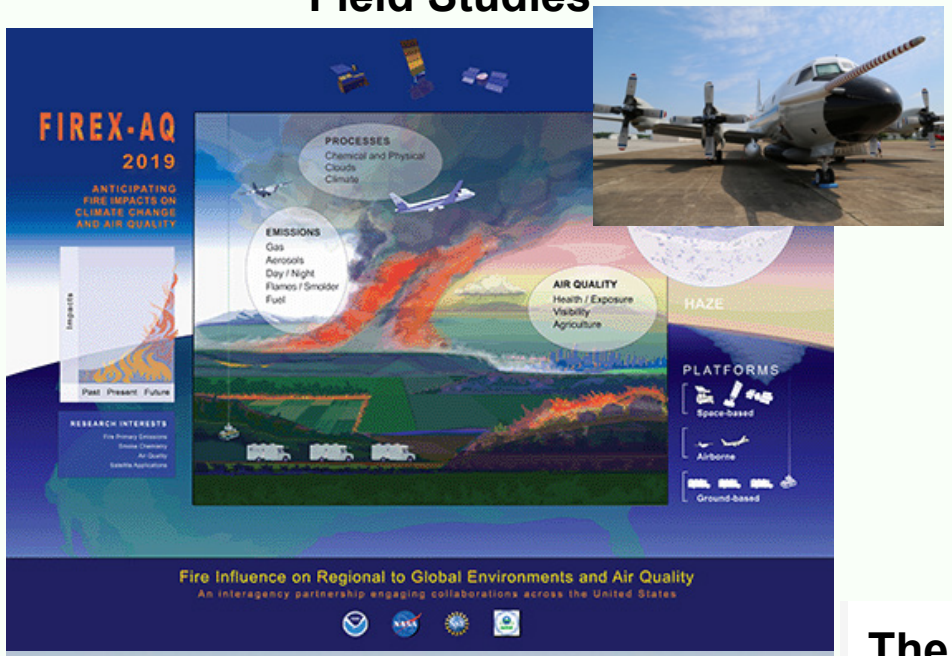


March 7, 2017 - GOES-16 Oklahoma, Kansas and Texas Fires

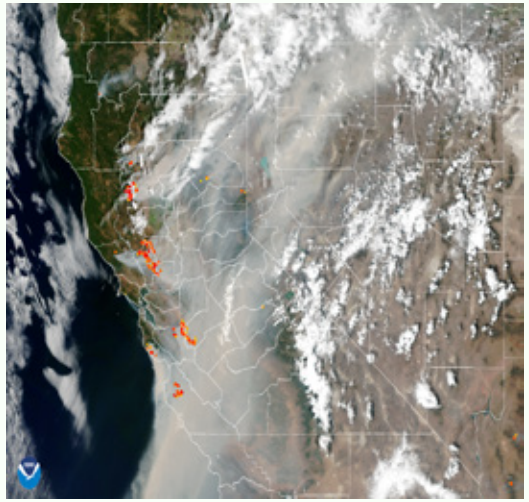
"The greatest and most urgent demand for satellite data by the wildland fire community (including local, state, federal, and commercial entities) is related to the provision of timely detection and notification of newly ignited wildfires within critical fire environments that support extreme fire behavior." (2020 NWCG SDTT, p. 10)

Research to Improve Understanding and Prediction

Field Studies



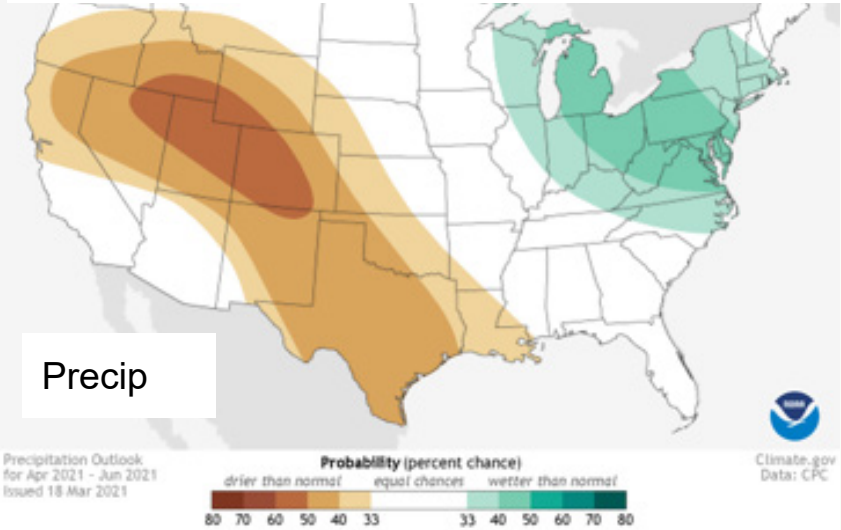
Satellite Observations



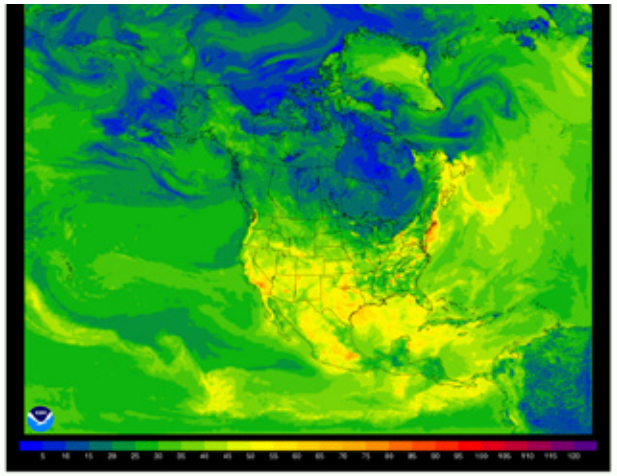
Advanced Forecast Systems and Decision Support Tools

Observations and Monitoring

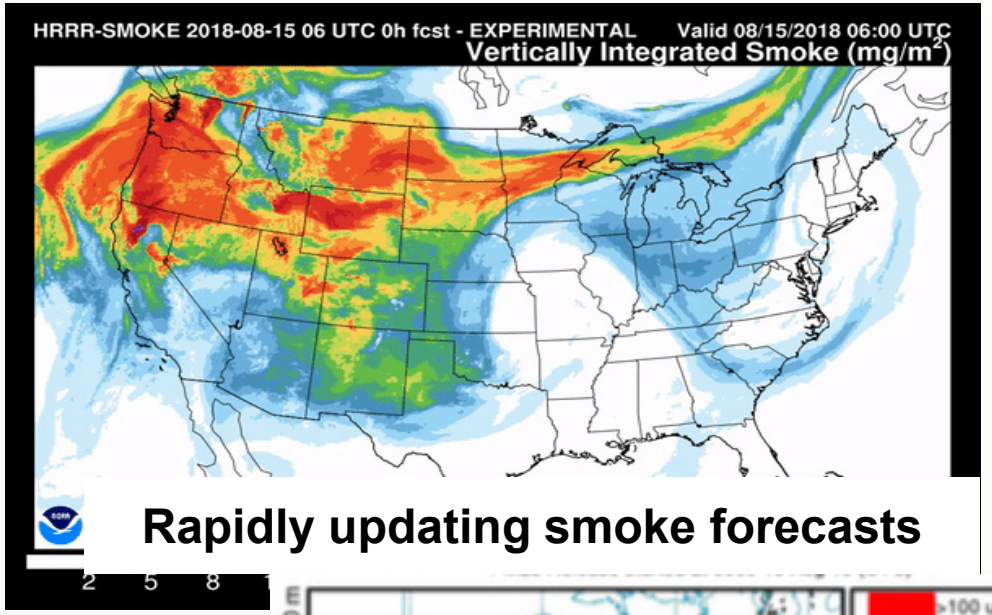
The Climate and Wildfire Connection



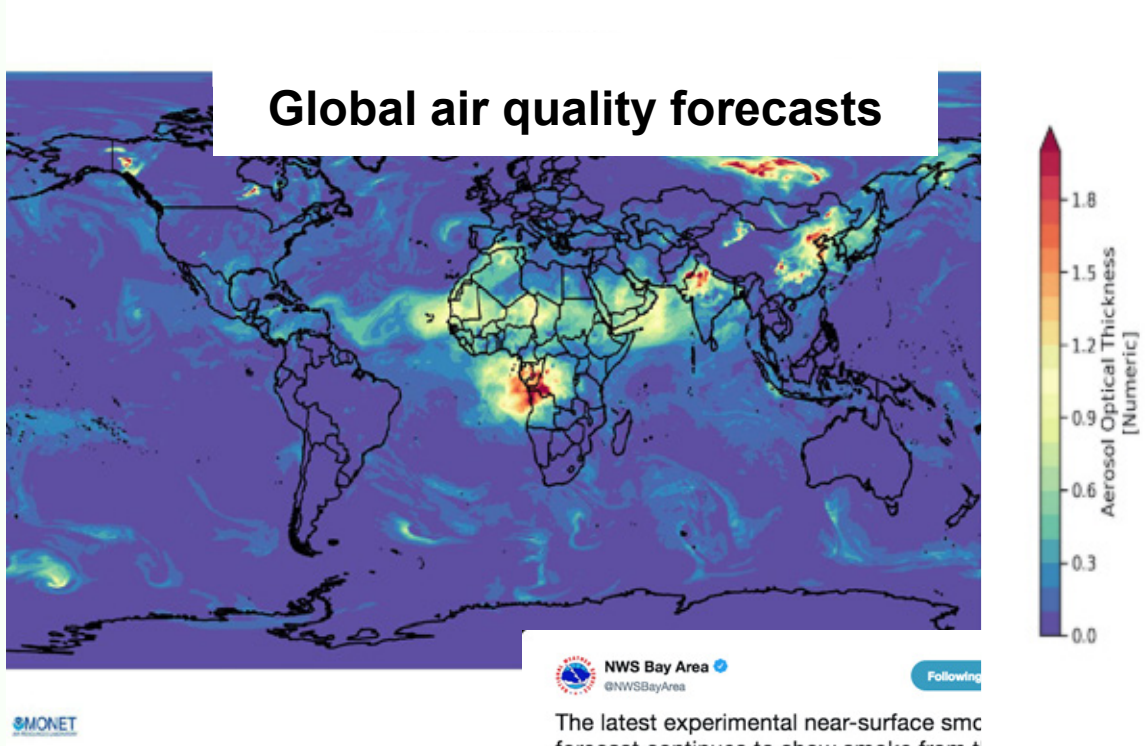
Air Quality and Fire Weather Modeling



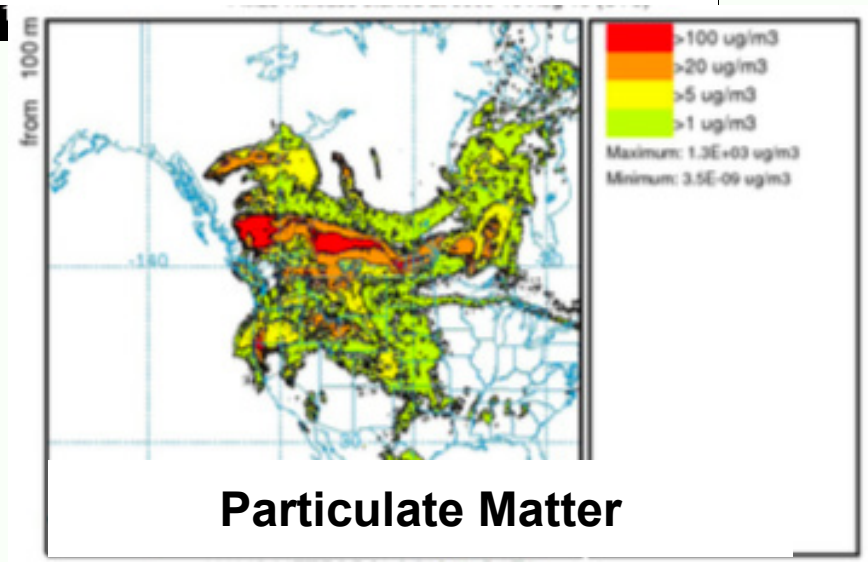
Newly Implemented Products



Rapidly updating smoke forecasts



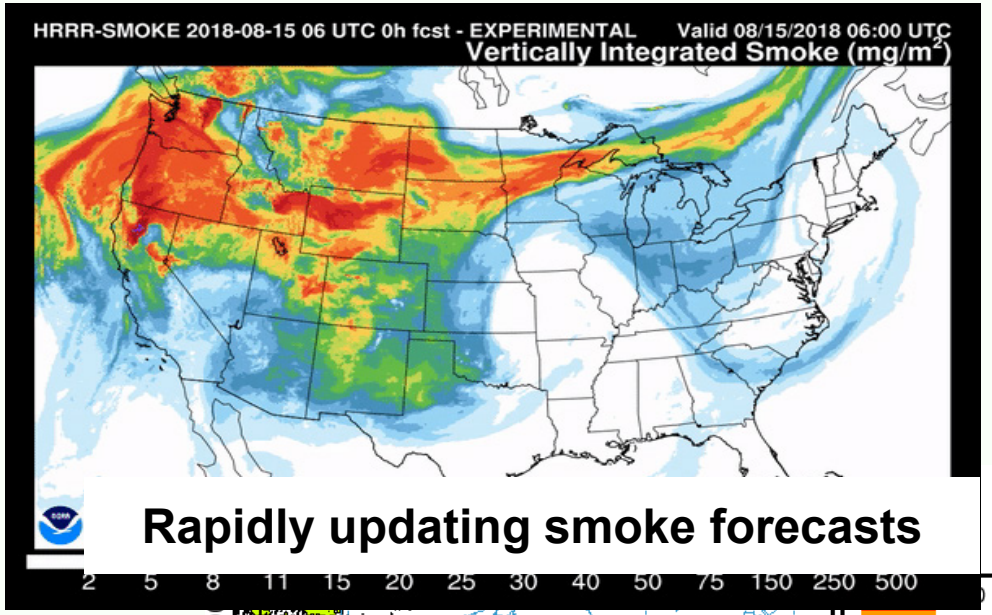
Global air quality forecasts



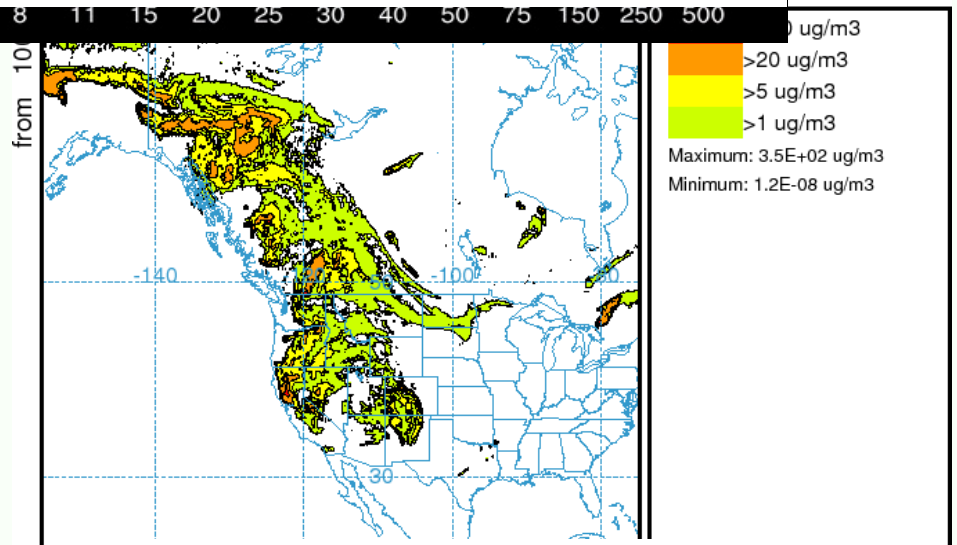
Particulate Matter

Improved tools for information dissemination

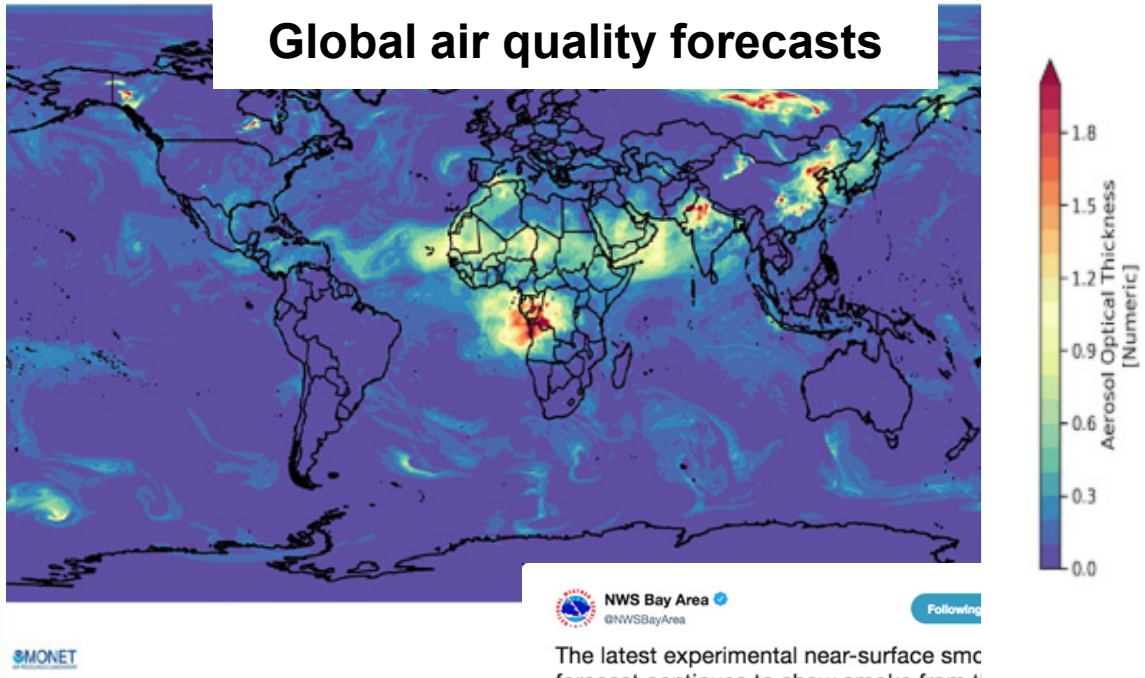
Newly Implemented Products



Rapidly updating smoke forecasts



Particulate Matter



Global air quality forecasts

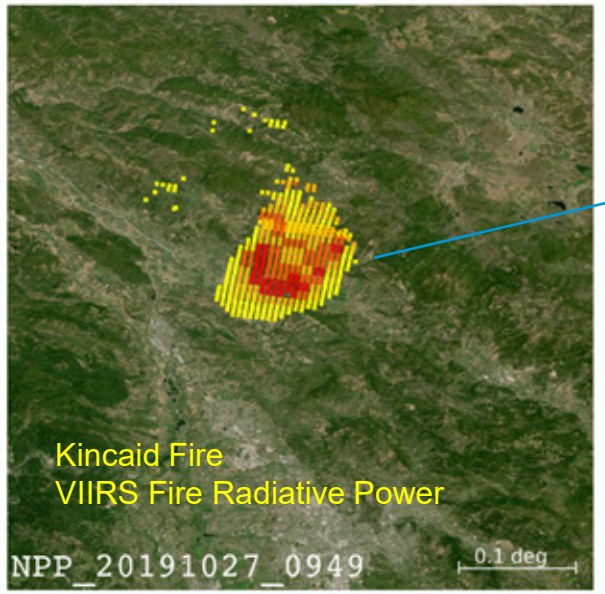
Improved tools for information dissemination

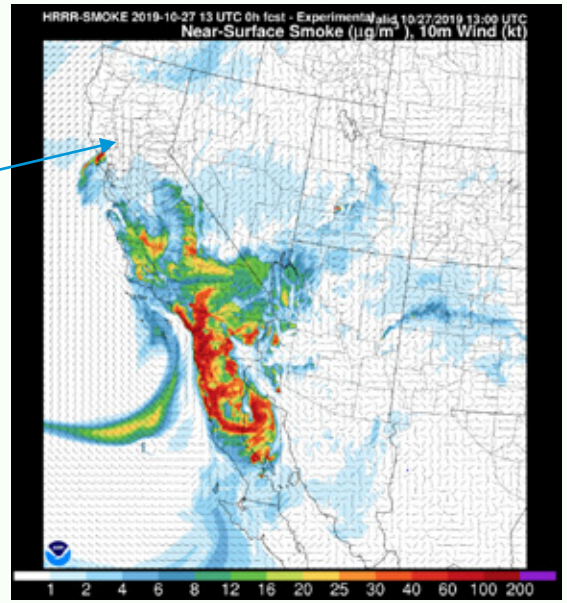
Satellite Proving Ground

NOAA engages external user community/stakeholders (e.g., U.S. Forest Service).

Fire and smoke initiative goals include:

- Improve satellite fire and aerosol product use for fire spread, air quality, visibility.
- Enhance HRRR model to improve smoke forecasts.
- Address feedback from users/stakeholders.
- Train users
- Enhance websites to display key products





"I've been at California State Emergency Services and the smoke model data was VITAL and still is for our Department of Transportation partners dealing with AMTRAK running through northern and central California. I've met these DOT folks in person and they would like to say thank you too!"
– NWS Science and Operations Office in Hanford, CA

"I want to thank you all for the tremendous support we received from JPSS for the Camp Fire and Woolsey Fire incidences in California! My sincere gratitude to all of you who made the extra effort to support California!"
– California Department of Forestry and Fire Protection

A Future NOAA Fire Weather Testbed

Objectives

- Move advanced technologies and applications to operational platforms as quickly as possible
- Bring fire weather community together to leverage knowledge and expertise resulting in quick technological advances
- Leverage other NOAA testbeds and proving ground capabilities
- Reach beyond NOAA to build collaborations and partnerships

Anticipated Outcomes

Advanced fire weather models, products, and tools

- Better tools to detect fires early
- Advanced tools for incident-based product delivery (e.g. extreme fire behavior altering, smoke emission forecasts, improved weather forecasts at the site of a fire)
- Improved week to seasonal fire weather forecasts that incorporate climate and drought information
- Fill information gaps throughout the fire weather communities

A Way Forward: Establishing Priority Gaps

Fire, Smoke and Fuels Observations

- Enables early fire detection and real-time fire monitoring (spread & behavior)

Meteorological Observations

- Allows for improved smoke and fire behavior analysis and forecasting, and improved forecast tools in Alaska.

Modeling Improvements

- Improved fire spread and smoke predictions. Enables extreme fire behavior modeling and risk analyses.

Decision Support Tools

- Actionable forecast information in seasonal time period and tools for field use.

NOAA Wildfire Support

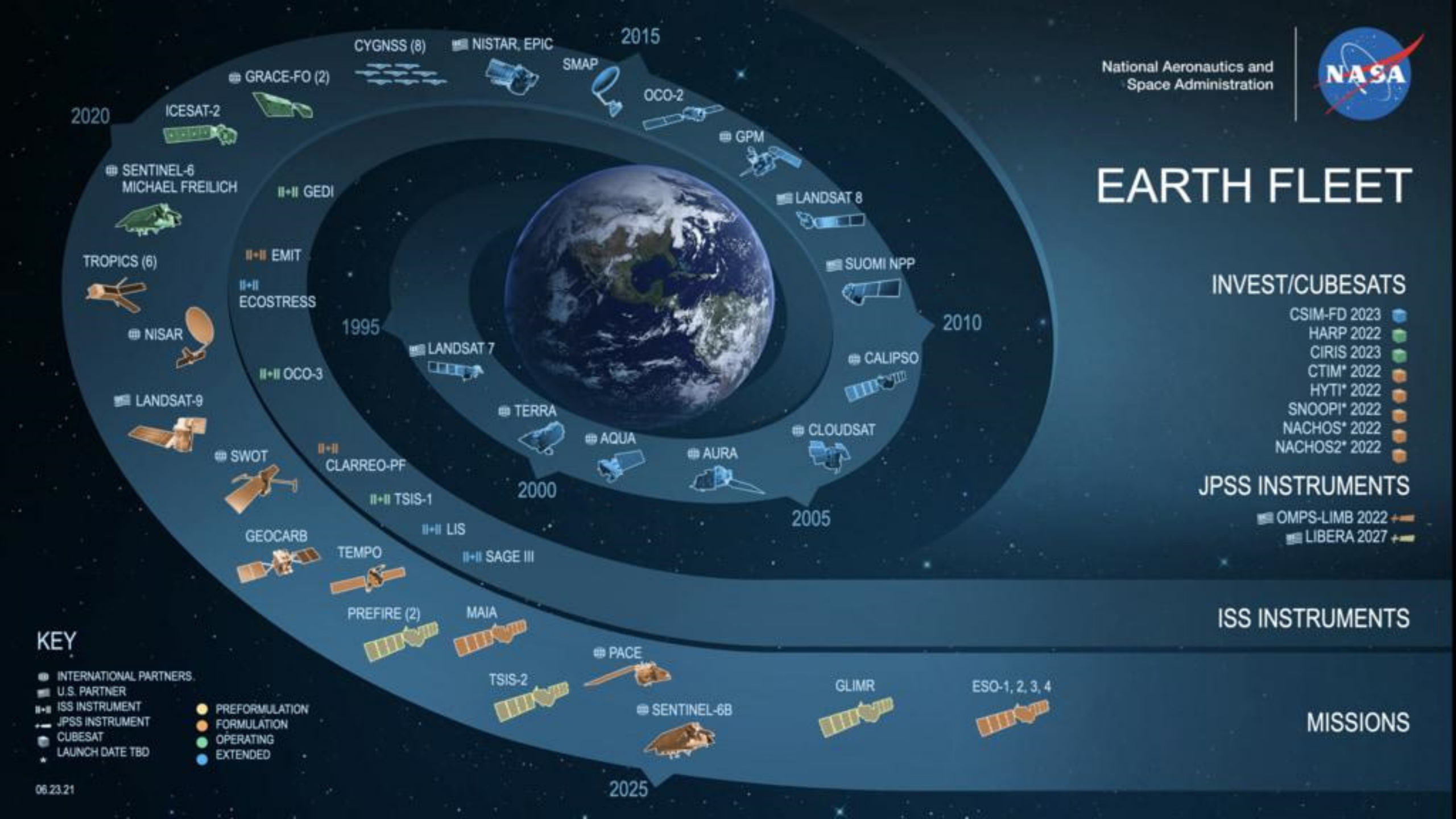
NASA research contributions to the U.S. fire community

Lesley Ott

Global Modeling and Assimilation Office, NASA Goddard Space Flight Center

With contributions from Melanie Follette-Cook, Vince Ambrosia, Barry Lefer, Mike Falkowski, David Green, Doug Morton, Robert Field, and Liz Wiggins

April 1, 2022

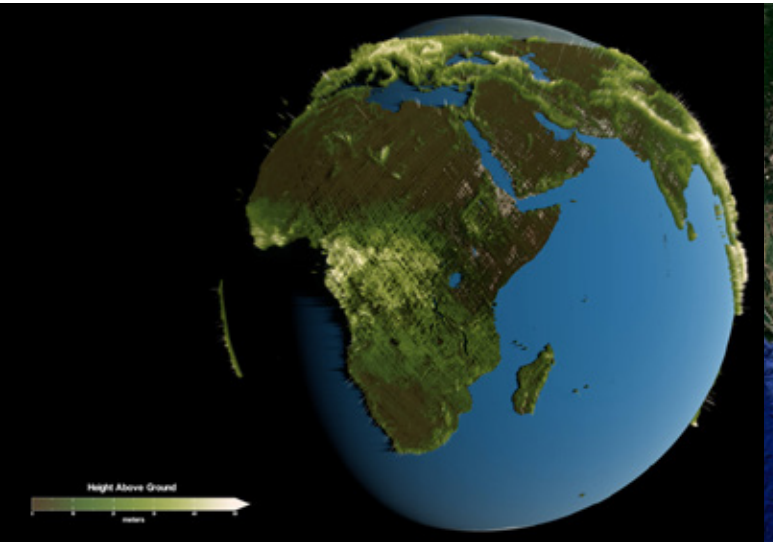

National Aeronautics and Space Administration
NASA
EARTH FLEET
2015
CYGNSS (8)
NISTAR, EPIC
SMAP
OCO-2
GPM
LANDSAT 8
SUOMI NPP
2010
CALIPSO
CLOUDSAT
AURA
AQUA
TERRA
2000
LANDSAT 7
1995
2005
2020
GRACE-FO (2)
ICESAT-2
SENTINEL-6 MICHAEL FREILICH
GEDI
EMIT
ECOSTRESS
TROPICS (6)
NISAR
OCO-3
LANDSAT-9
SWOT
CLARREO-PF
TSIS-1
LIS
SAGE III
GEOCARB
TEMPO
PREFIRE (2)
MAIA
PACE
TSIS-2
SENTINEL-6B
GLIMR
ESO-1, 2, 3, 4
2025
INVEST/CUBESATS
CSIM-FD 2023
HARP 2022
CIRIS 2023
CTIM* 2022
HYTI* 2022
SNOOPI* 2022
NACHOS* 2022
NACHOS2* 2022
JPSS INSTRUMENTS
OMPS-LIMB 2022
LIBERA 2027
ISS INSTRUMENTS
MISSIONS
KEY
INTERNATIONAL PARTNERS
U.S. PARTNER
ISS INSTRUMENT
JPSS INSTRUMENT
CUBESAT
LAUNCH DATE TBD
PREFORMULATION
FORMULATION
OPERATING
EXTENDED
06.23.21

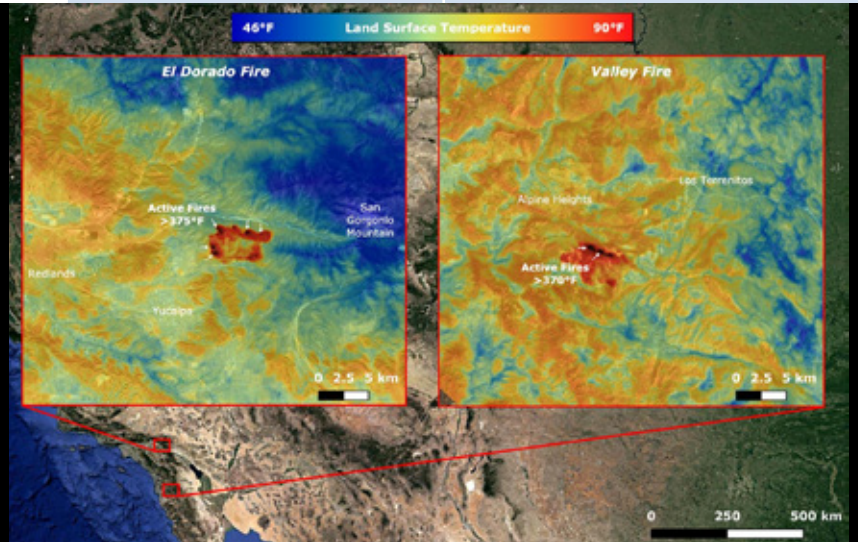
NASA Satellite observations – Vegetation/Land Surface

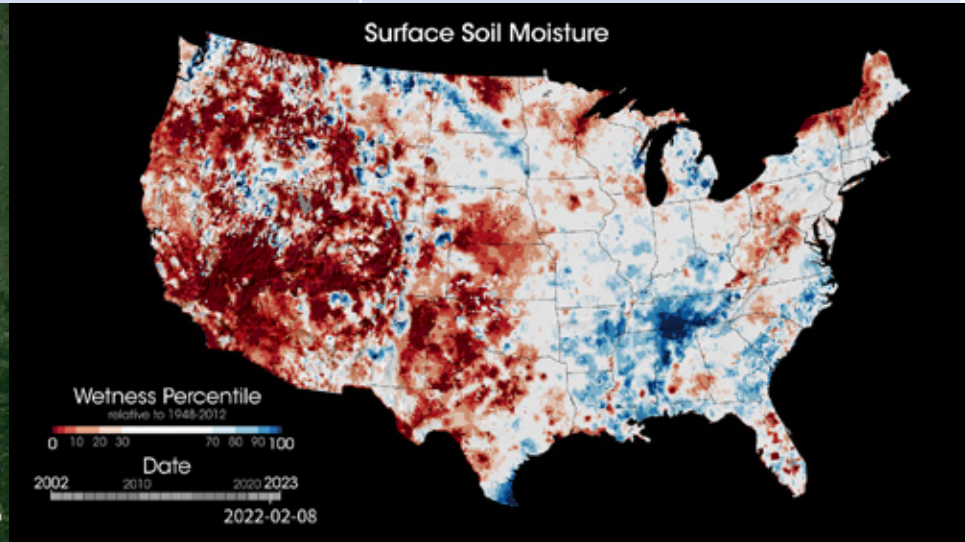
NASA satellite data provide comprehensive information that guides understanding of pre-fire risk and post fire recovery (right). NASA also works collaboratively with other agencies and international partners to harmonize datasets and provide expertise on cal/val and retrieval algorithms (*).

Below (L-R): GEDI vegetation height, ECOSTRESS surface temperature, and GRACE soil moisture

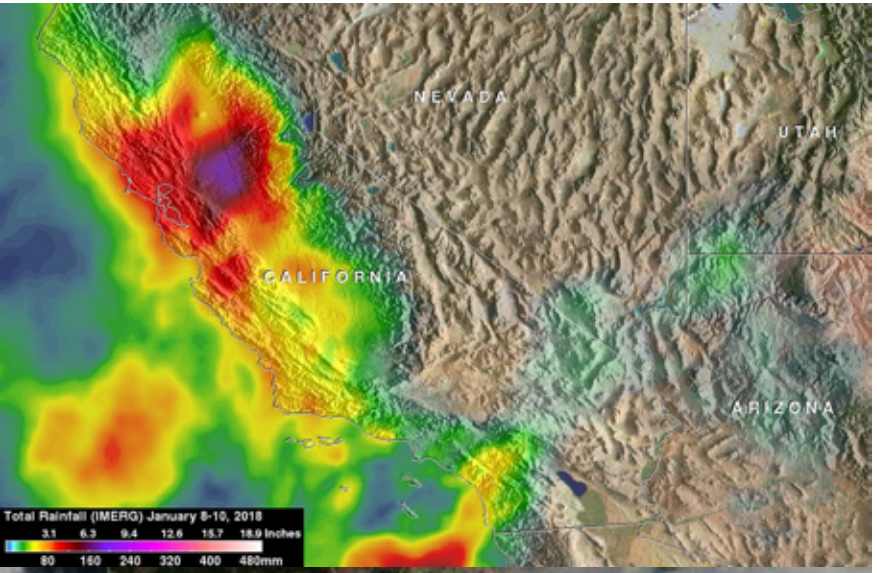
Satellite/Sensor	Fire Application	Data Products
LandSat*	Land class, Vegetation indices, Moisture	Imagery, NDVI, EVI, SAVI. NDWI
MODIS	Land class, Vegetation indices	Imagery, NDVI, EVI
VIIRS*	Vegetation indices	Imagery, Vegetation health
SMAP	Soil moisture	Soil moisture
GRACE	Groundwater Storage	Groundwater, Soil moisture
ECOSTRESS (ISS)	Moisture, Evaporative Stress	Thermal Data, ESI
GEDI (ISS)	Vegetation Structure	LIDAR Data, Biomass
IceSat-2	Vegetation Structure	LIDAR Data, Biomass
SRTM	Topography	Topography (DEM)







NASA Satellite observations – Active fire, smoke, and precipitation



Satellite/Sensor	Smoke-related Products
MOPITT	Mid-, lower troposphere CO
MISR	Aerosol optical depth, plume height
MODIS	Fire Radiative Power, Aerosol optical depth
AIRS	Mid-troposphere CO
OMI	Aerosol index, total column O_3
MLS	Upper troposphere CO
CALIPSO CALIOP	Aerosol optical depth, profile
DSCOVR EPIC	Aerosol optical depth
VIIRS*	Fire Radiative Power, Aerosol optical depth
Suomi-NPP OMPS*	Aerosol index
SAGE III (ISS)	Stratospheric aerosol optical depth

During a fire, data from MODIS and VIIRS provide information on fire intensity that is used to estimate emissions. Additional observations characterize plume composition, transport, and injection height (table). Following a fire, satellite-based precipitation can provide advance warning of conditions that could lead to deadly landslides.

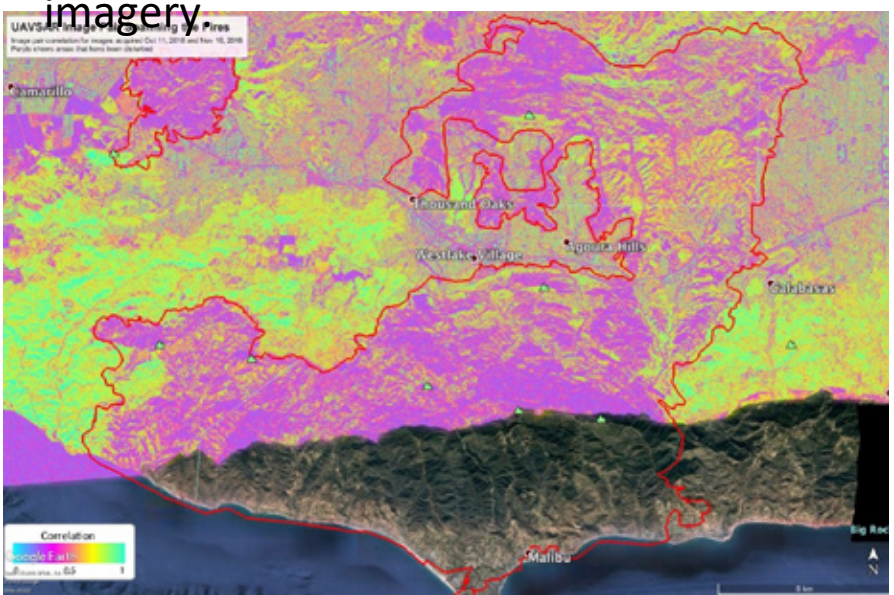
Left: IMERG satellite-based precipitation estimates over the Thomas Fire burn scar (top); MODIS image of CA wildfires overlaid with MISR plume heights (bottom)

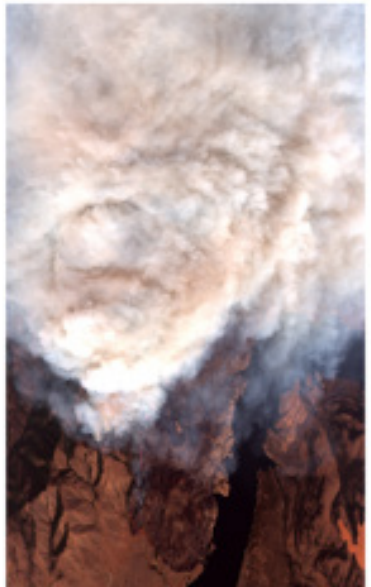
NASA Airborne Observations

Airborne observations provide additional information before, during, and after fires, covering areas of interest more frequently, at higher spatial resolution, and observing quantities not available from spaceborne observations.

Right: Coordinated field campaigns like the 2019 NOAA-NASA FIREX-AQ collect observations of trace gases and aerosol properties that help improve satellite retrievals and smoke modeling. Photos show fires in western Washington (top), Mississippi River Valley (middle) from the NASA DC-8 along with DC-8 flight tracks (bottom).

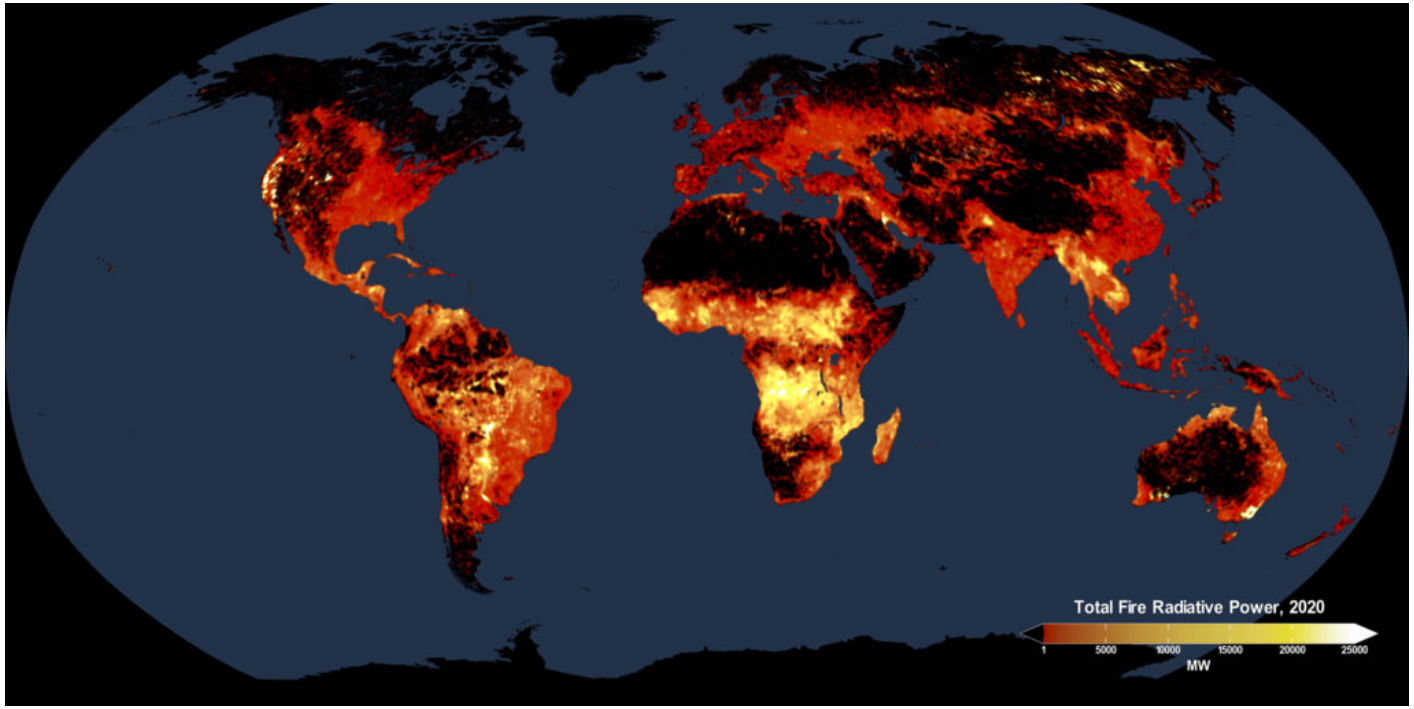
Below: NASA aircraft data are also frequently used to survey fires in the western US. UAVSAR data (left) are used to map burn scars and characterize risk for post-fire debris flows. Hyperspectral imagers like MASTER (middle) observe at different wavelengths to capture both thermal signatures and visible imagery.



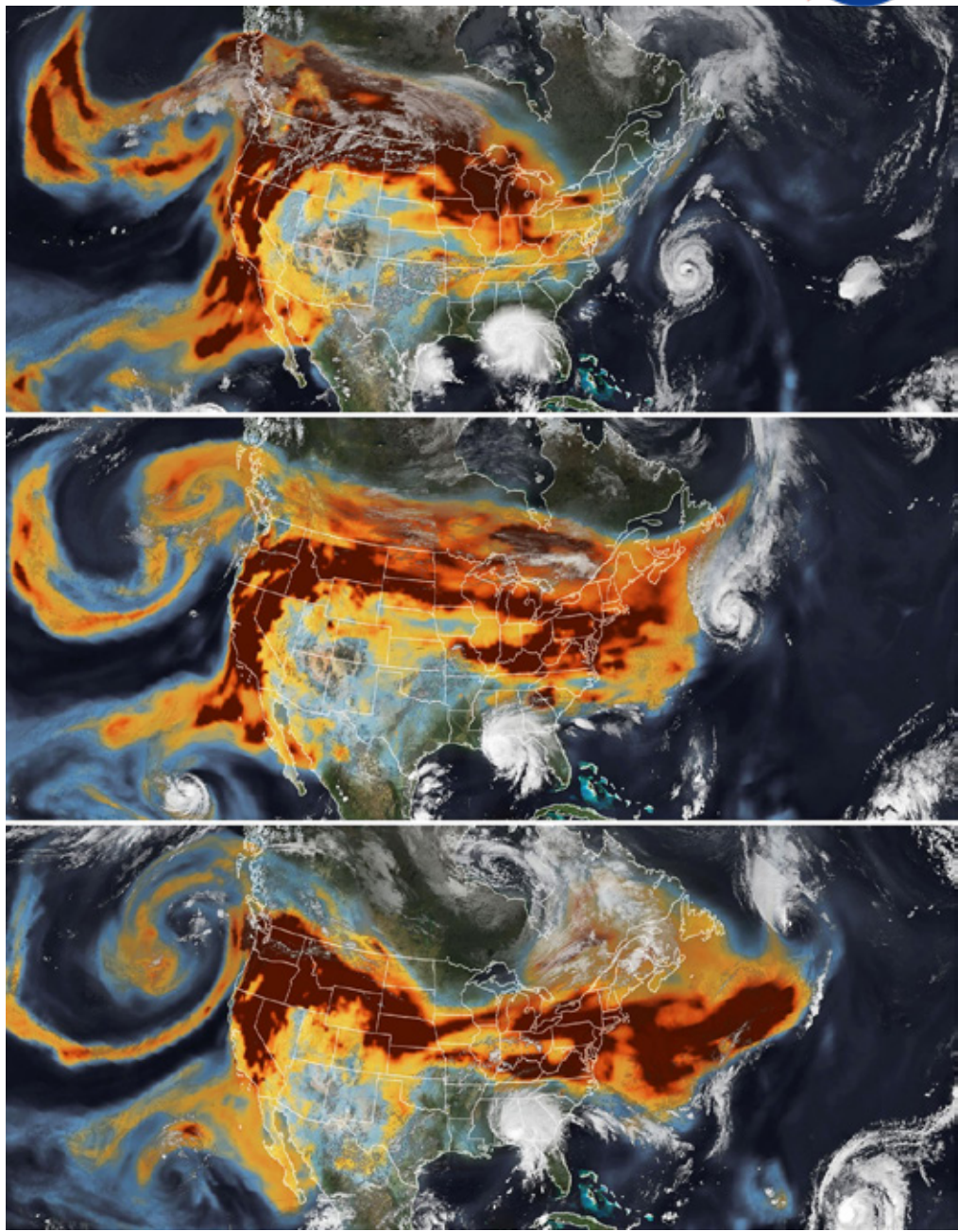


Observation-driven Modeling – Emissions and composition

Below: NASA has developed multiple approaches to estimating fire emissions using both burned area and fire radiative power (FRP). FRP-based datasets like the Global Fire Emissions Database Near Real Time (GFED-NRT) and the Quick Fire Emissions Dataset (QFED) estimate emissions in near real time, helping communities worldwide estimate risks from smoke exposure.

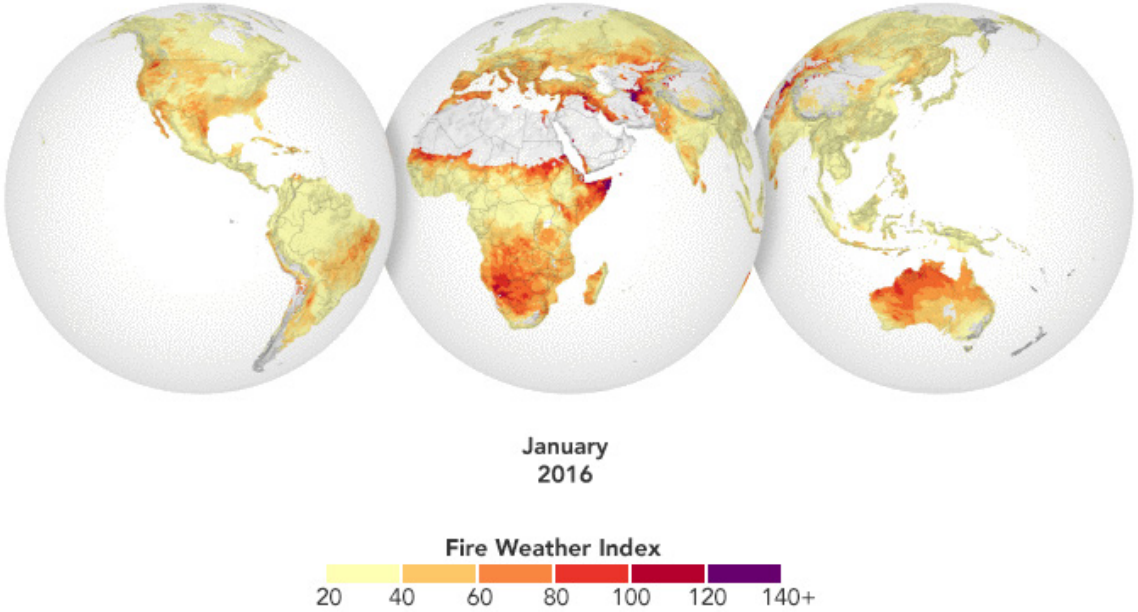


Right: These data are ingested into NASA's Global Earth Observing System Models (GEOS), which also assimilates aerosol optical depth, to predict the evolution of smoke plumes. GEOS also provides an experimental Composition Forecast (GEOS-CF) that simulates detailed ozone photochemistry.

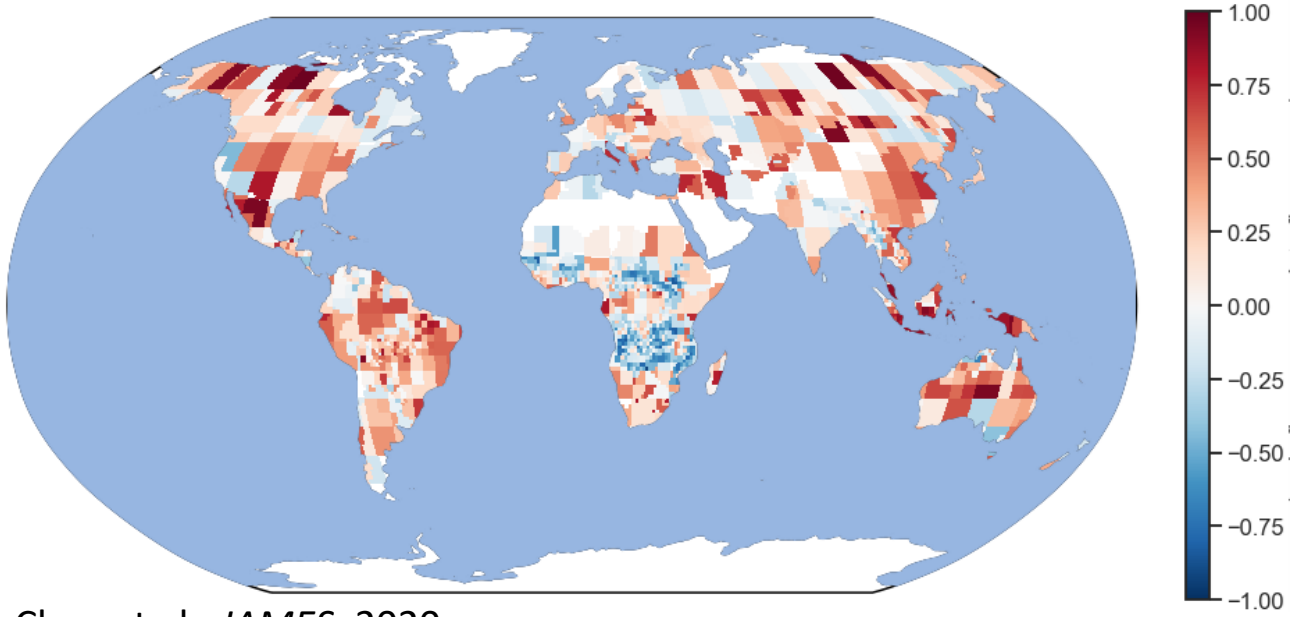


Observation-driven Modeling – Fire weather on NWP to S2S Timescales

Right: The Global Fire WEather Database (GFWED) integrates multiple NASA datasets (including IMERG precipitation) indicating the likelihood of a vegetation fire starting and spreading. It includes both retrospective versions based on NASA's MERRA-2 reanalysis and experimental forecasts that incorporate GEOS data.



Correlation between early, late fire season severity



Chen et al., *JAMES*, 2020.

Left: NASA also supports research efforts to assess the predictability of fire risk on S2S timescales. Work done at the University of California, Irvine shows that in many regions, the strength of the early fire season provides information about activity in the late season (correlation can be positive or negative). Relationships like these can be used to build statistical models of fire risk months in advance.

Data Services and Applications

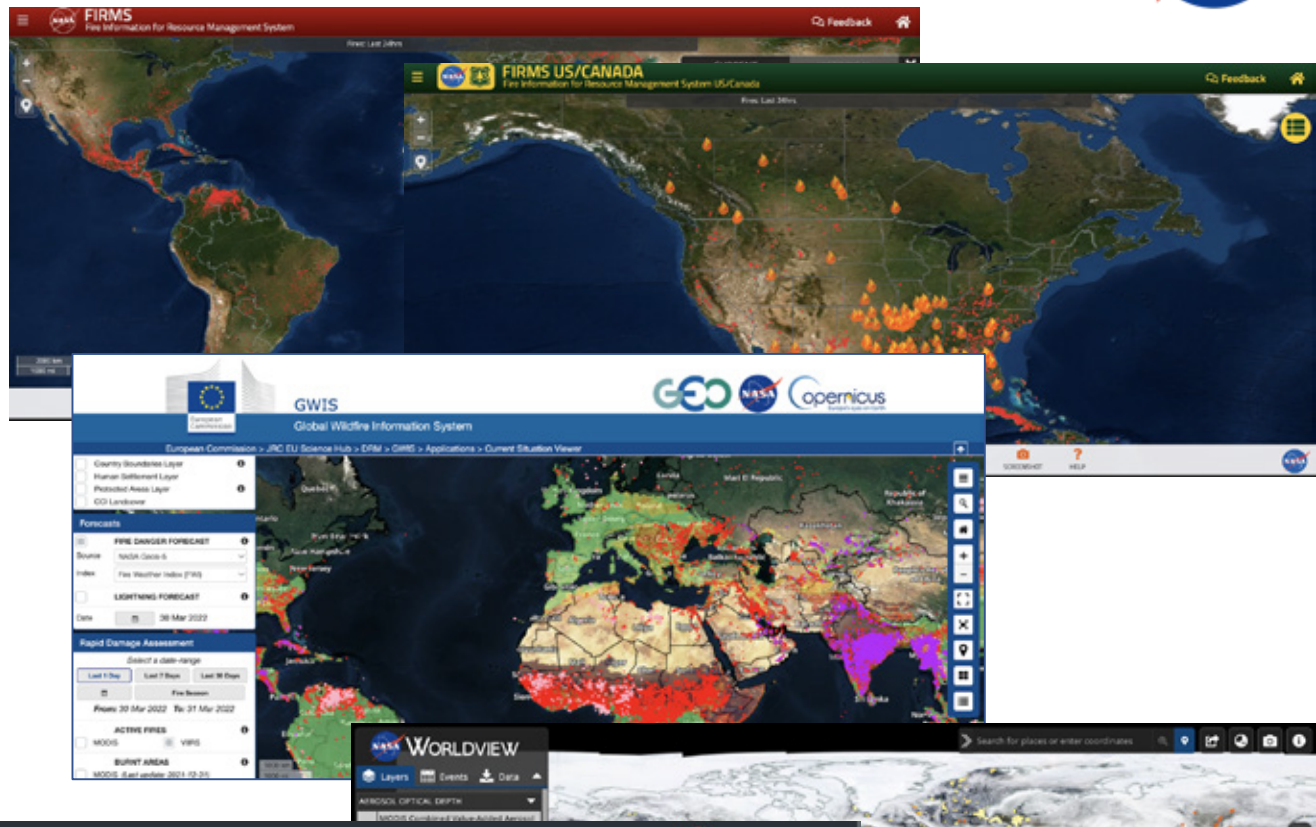
FIRMS – Global and US/Canada (joint with USFS) sites provide map-based analysis tools for burned area and active fire data.

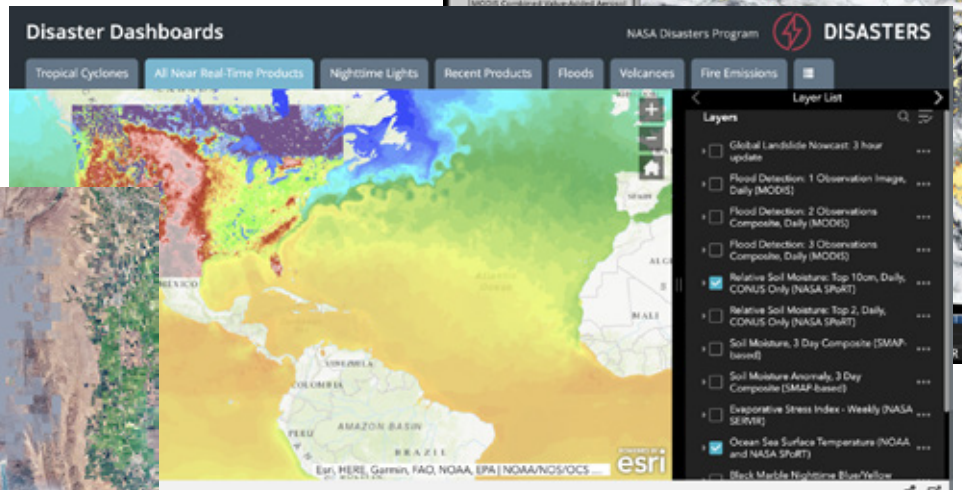
GWIS – Led by the Group on Earth Observations (GEO) and Copernicus, provides burned area and active fire data alongside lightning and fire danger forecasts, and emissions estimates.

Worldview – Versatile map viewer for satellite data products supporting overlays of surface imagery, fires, clouds, and composition data.

Disasters Portal - Powerful interface for viewing, analyzing, and downloading the latest near real-time and disaster specific data products from NASA Applied Sciences.

ARSET - Offers cost-free online and in-person trainings covering a range of datasets, web portals, and analysis tools and their application to climate, air quality, agriculture, disaster, land, and water resources management.





Major Gaps/Opportunities for collaboration

Observations:

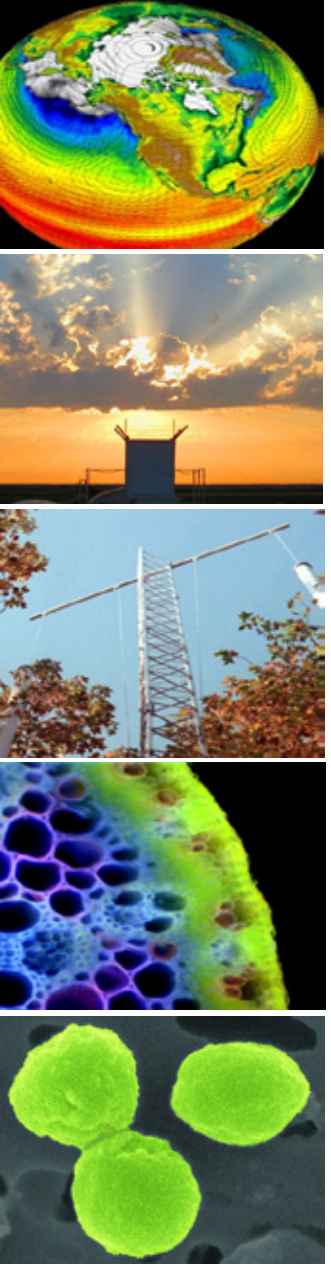
- More information on PBL and plume height
- More diurnal information to characterize emissions, air quality risks
- Better temporal and spatial resolution for data products

Modeling:

- Improve prediction of fire risk on both NWP, S2S timescales
- Improve connection between high-resolution, global modeling capabilities
- Develop of AI/ML techniques for downscaling predictions

Cross-cutting:

- Improve data services that support more reliable access, interoperability between datasets
- Streamline the R2O pathway to facilitate more rapid adoption of new technologies, modeling approaches
- Improve communication across federal, state, and local agencies and the general public



ICAMS CoRI Wildfire Workshop

April 1, 2022

Presenter: Olga Tweedy
Department of Energy | Office of Science | Biological and Environmental Research Programs

DOE National Laboratories

"The Energy Department's National Labs tackle the critical scientific challenges of our time -- from combating climate change to discovering the origins of our universe -- and possess unique instruments and facilities, many of which are found nowhere else in the world. They address **large scale, complex research and development challenges with a multidisciplinary approach that places an emphasis on translating basic science to innovation**."

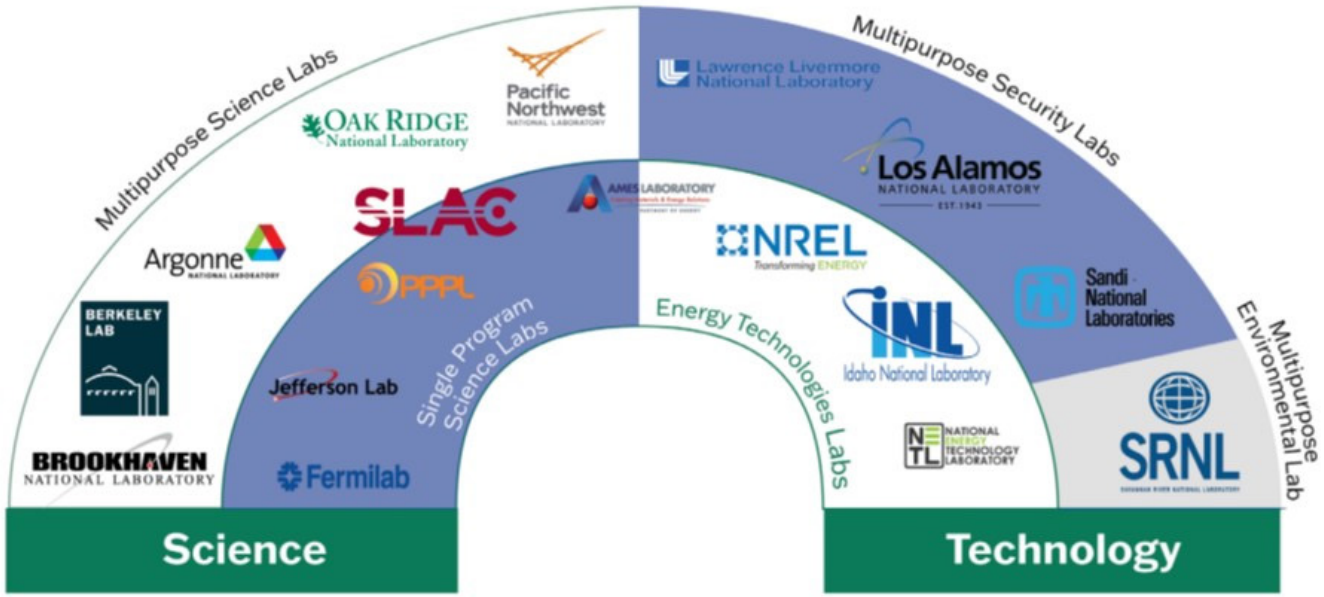
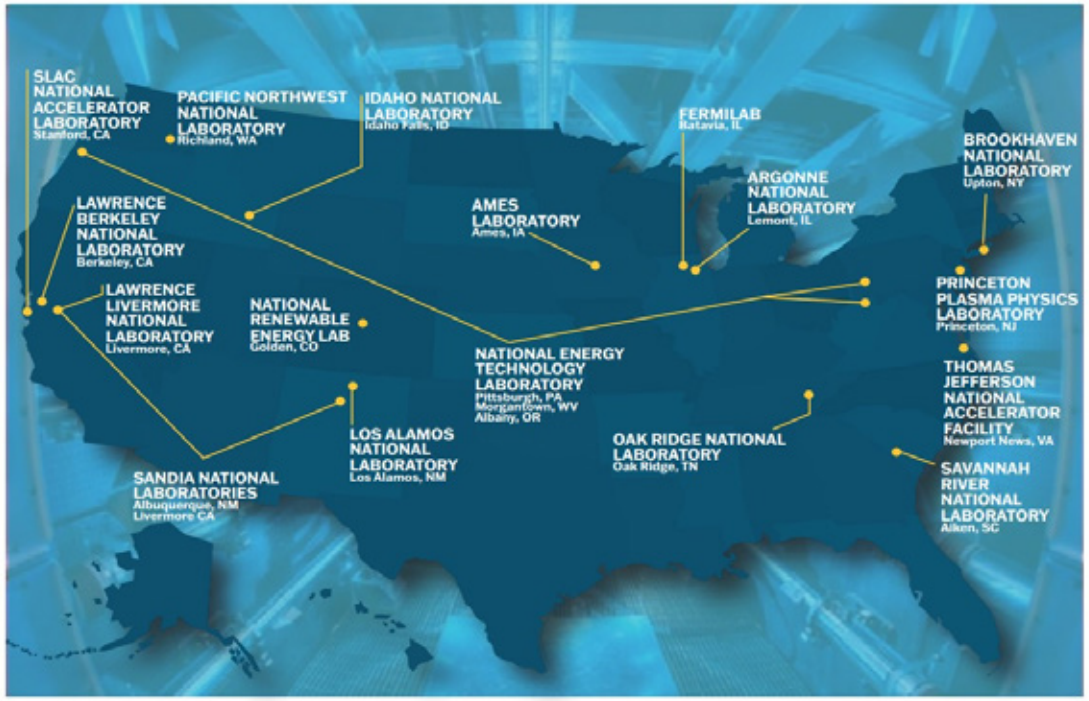


FIGURE 1-2: OVERVIEW OF THE NATIONAL LABORATORY SYSTEM



Department of Energy, Office of Science, Office of Biological and Environmental Research

DOE Wildland Fire and Fire Weather Capabilities

Outline:

DOE capabilities based on work performed at the DOE's labs:

- Observational and Analytical capabilities
- Modeling and Predictions
- Detection and Assessment
- Process-oriented research
- Applications and decision support systems

Major focus on pre-fire, during the fire, and wildland fire 1st order impacts

Observational and Analytical Capabilities

DOE labs support various analytical facilities, field measurements/studies, and networks of instrumentation

Facilities	Field Studies	Networks of instrumentation

- **Atmospheric Radiation Measurement (ARM) user facility**
- **Center for Accelerator Mass Spectrometry - CAMS (LLNL)**
- **Center for Aerosol-Gas Forensics (CAFÉ) (LANL)**
- **Environmental Molecular Sciences Laboratory (PNNL)**

- **Air quality in prescribed burns** (ANL; DoD-funded project)
- **Prescribed fire behavior experiments** (LANL; funded through DoD SERDP)

- **AmeriFlux** (A network of PI-managed sites)
- **WHONDRS** (PNNL; a network for watershed science)
- **SAGE** (ANL; a Software-Defined Sensor Network)

Model Development

Microscales

Multi-fidelity coupled fire/atmosphere modeling resolving phenomena at meter scales over landscape-scale domains:

- **Physics-based coupled fire/atmosphere modeling, FIRETEC (LANL).**
- **Fast-running phenomena-based coupled fire/atmosphere modeling, QUIC-Fire (LANL).**

Mesoscales

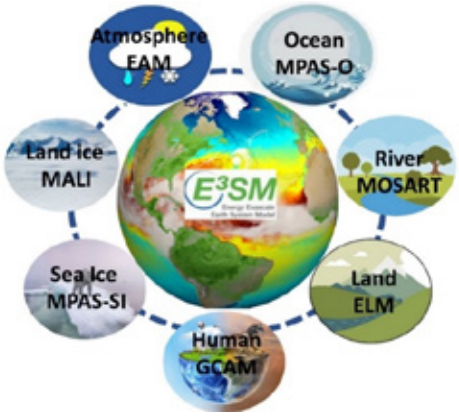
Wildfire capabilities are being added to Weather Research and Forecasting model (WRF) based tools to:

- **To better represent steep terrain conditions relevant to California, Colorado, and other wildfire-prone states (LLNL).**
- **To develop the use of WRF-SFIRE for wildfire aerosol modeling - a model that couples wildfire, aerosols, and meteorology (ANL)**

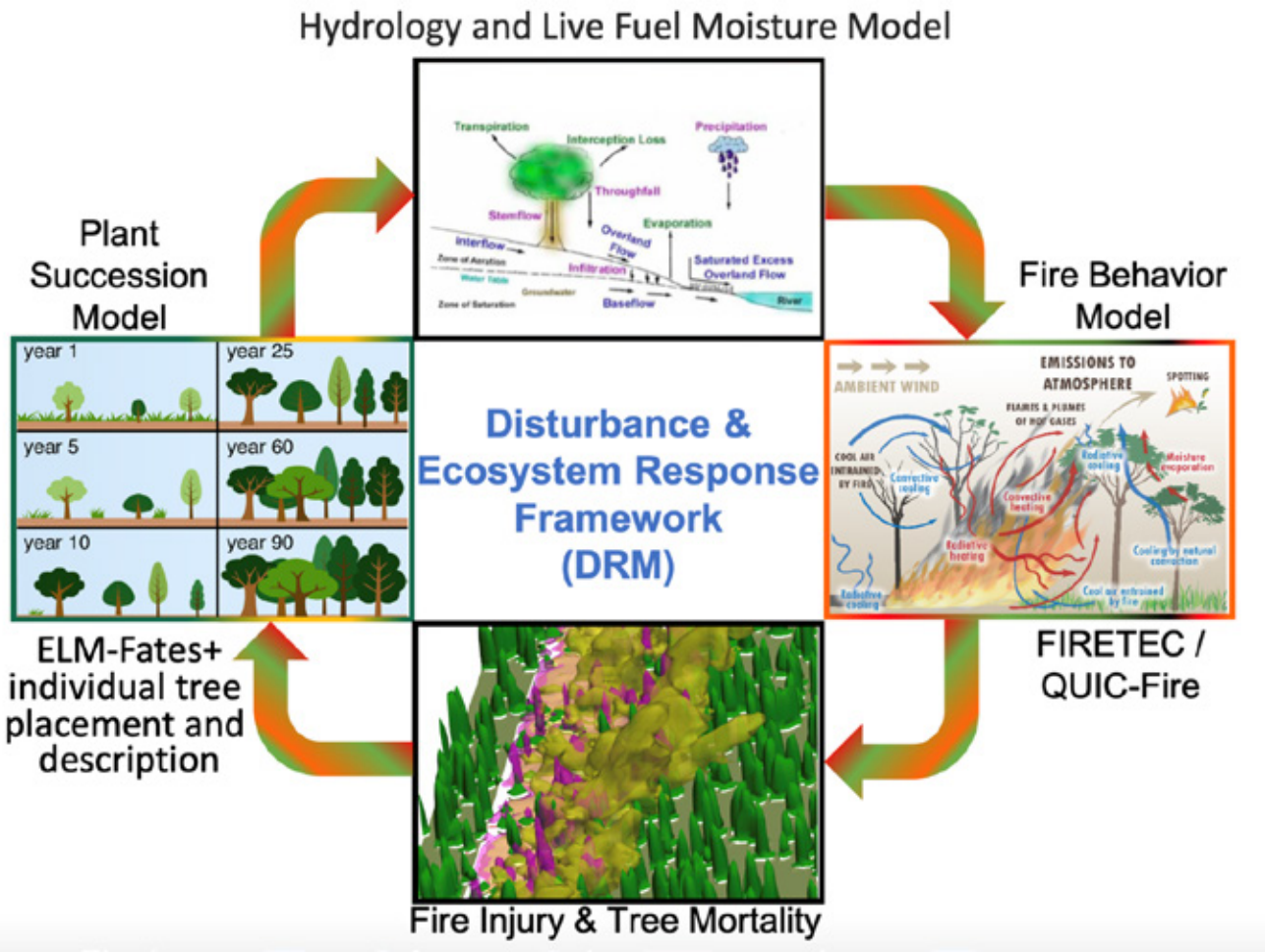
Regional to global scales

E3SM is a DOE fully coupled, state-of-the-science Earth system model capable of global high-definition configuration (25 km and 3 km atmosphere)

- **LLNL is adding critical capabilities to E3SM for improved representation of the wildfire influences on earth system at regional and global scales**

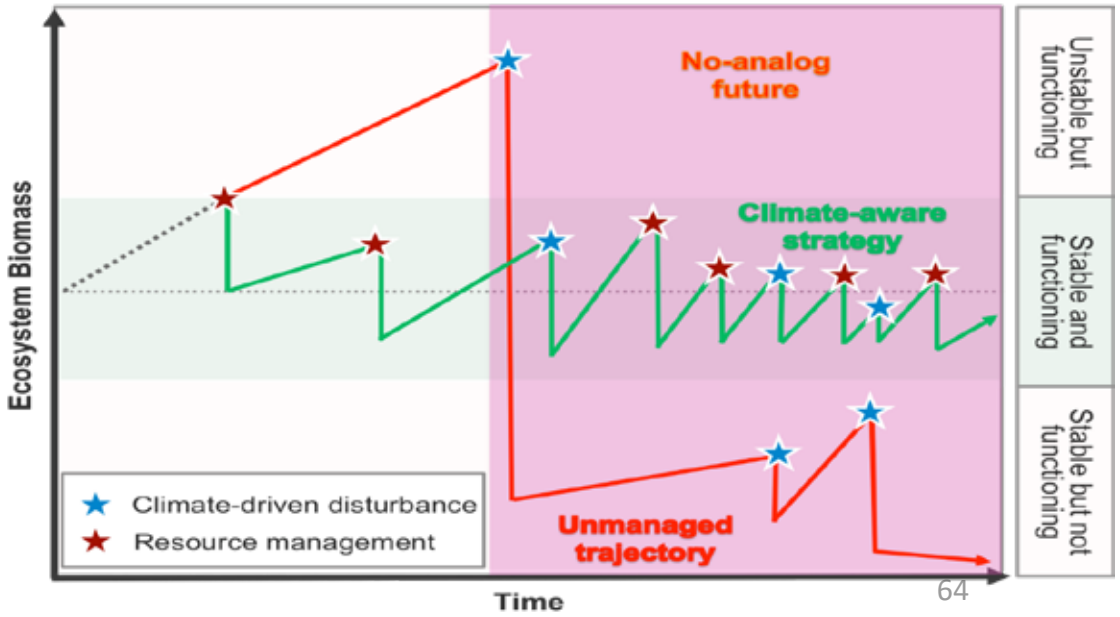


Model Development – Coupled ecosystem/fire modeling

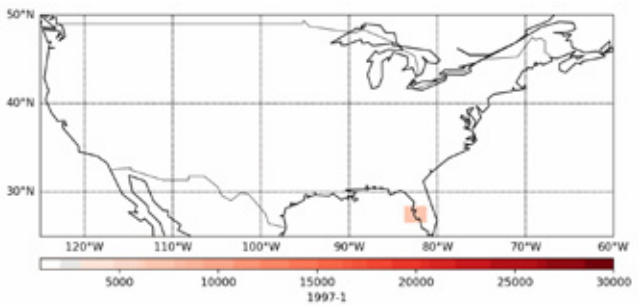


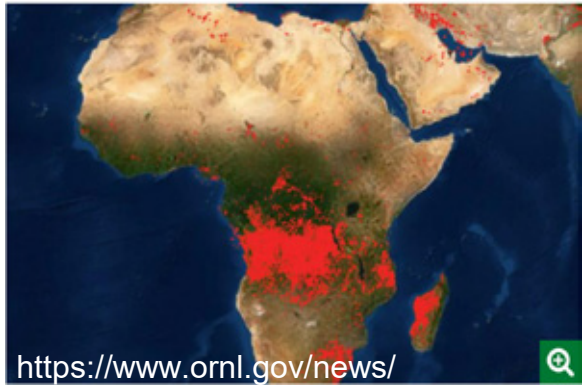
Coupling physics-based fire/atmosphere, fire effects, plant succession, and hydrology models to understand ecosystem trajectories under managed and unmanaged scenarios as we approach no-analogue climate scenarios.

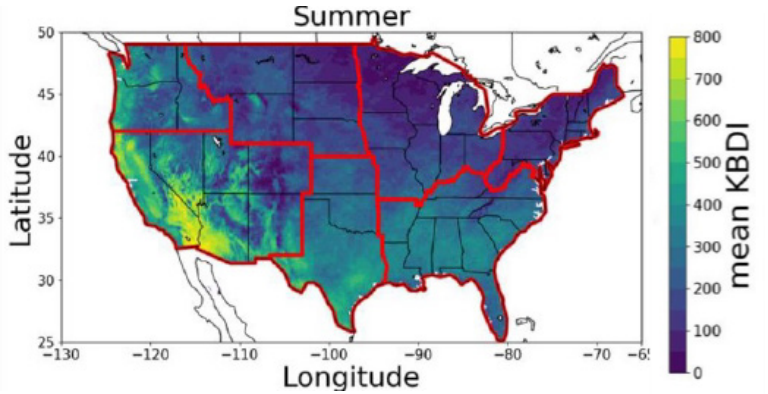
- Trade offs between managed and unmanaged landscapes
- Impacts of fire frequency on ecosystem stability
- Watershed security
- Carbon budgets



Predictive Modeling with AI/ML







- **LBL**: Using ML to **predict wildfires several months** in advance and **develop wildfire surrogate models** for calibrating E3SM fire projections

- **ORNL:** Developed a range of ML models **to predict seasonal fire risk**. These models have been used to forecast wildfires in Africa and Alaska.

Africa contains about 70% of the global burned area, shown in red (image is created by NASA)

- **ANL:** Developed analytic models for **assessment of US wildfire danger potential**, based on five commonly used fire danger indices (FDIs) that incorporate weather and fuel conditions; modeling wildfire occurrences and burned areas in the US using ML.

Seasonal mean fire index from 1982–2017 (from Brown et al., 2021)

Fire Detection and Assessment

A variety of sensors and devices are funded by DOE for wildfire detection and mitigation:

Example: ORNL and LLNL are working on the installation of a high-fidelity **optical sensor cluster** in an operational utility service area. This technology will help **to identify and mitigate fire risk**

Satellite-based Fuel Load Analysis:

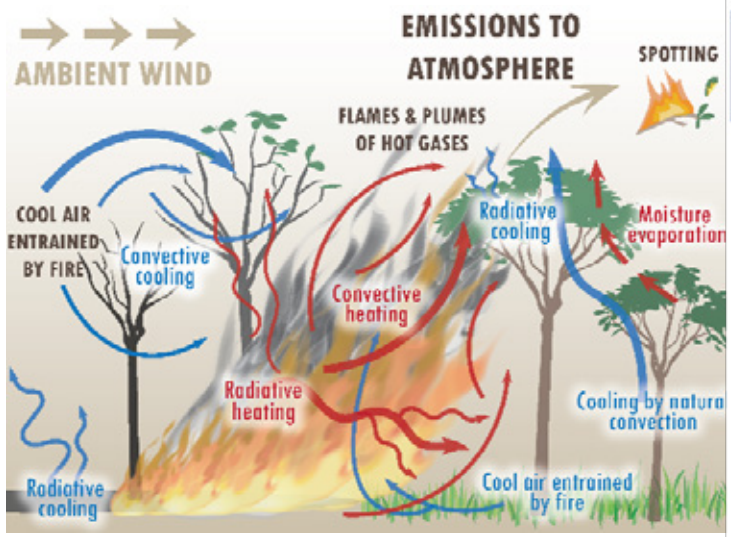
LLNL is developing **image processing techniques** for combining high-resolution aerial photography with lower resolution satellite images to provide detailed regional maps of surface vegetation conditions and **support modeling and hazard assessment activities**.

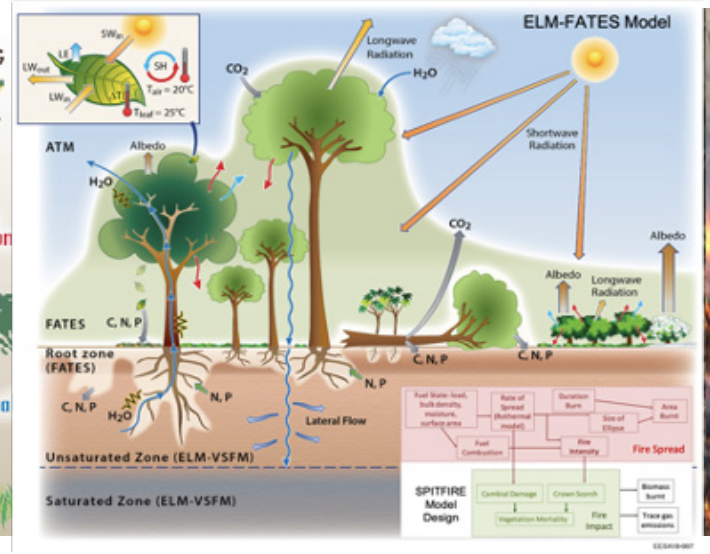
Process-Oriented Research

Fire dynamics, Physical and chemical processes, wildfire impacts

Coupled Fire – Ecosystem– hydrology studies

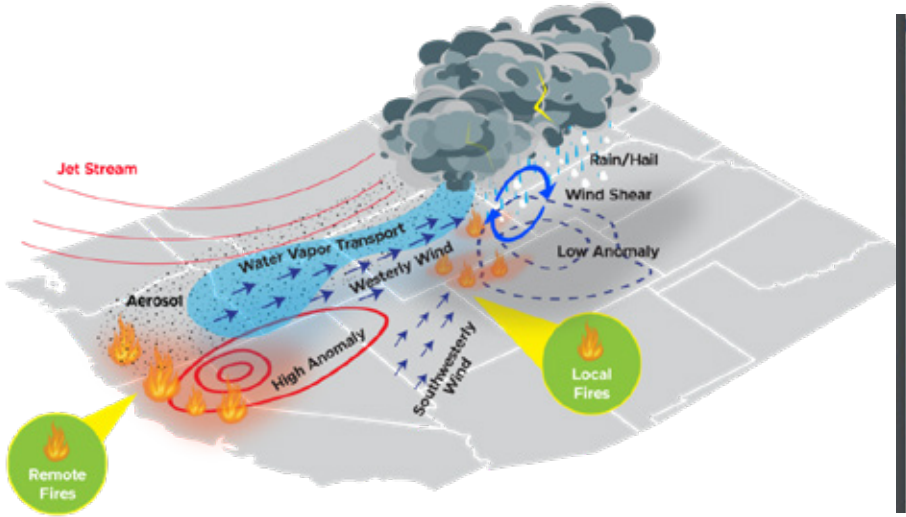
Ecosystem-resilience and landscape-management-implication research





Fire dynamics, physical and chemical processes, and wildfire impacts

Regional impact of biomass burning aerosols (PNNL)



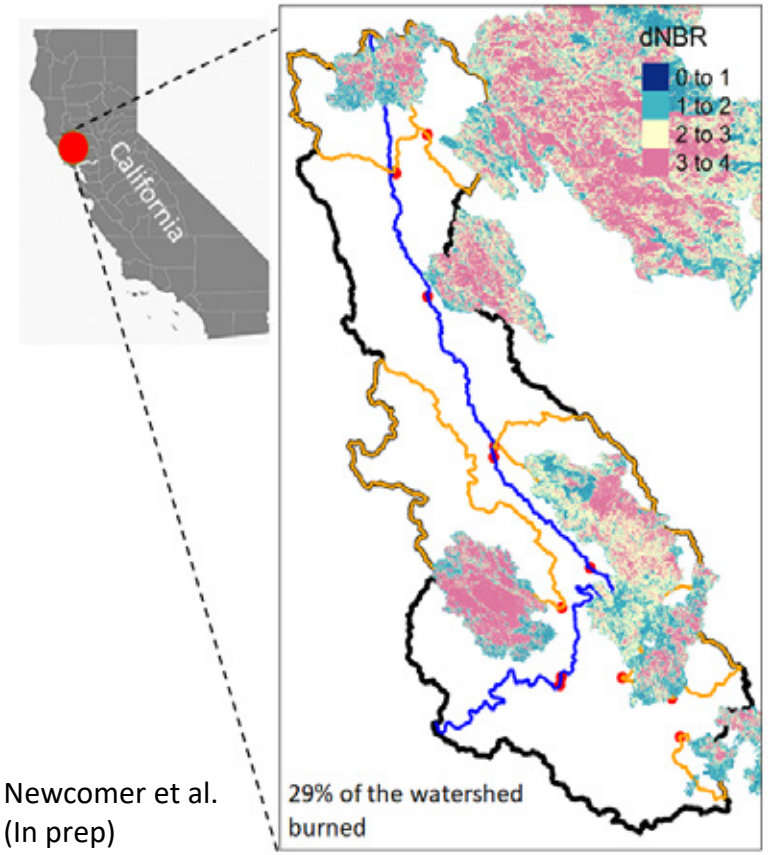
Zhang, Y., Fan, J., et al. (Submitted ; 2022).

The western US wildfires notably increase occurrences of heavy precipitation rates by 38% and significant severe hail (2 inches or larger) by 34% in the central US.

Understanding urban and wildland fire dynamics (LLNL)

Examined sensitivities and gain knowledge about the ignition, spread, and emissions of fire in wildland and urban areas.

Wildfire effects on water quality in California (LBL)



Newcomer et al. (In prep)

Coupled Fire-Ecosystem-Hydrology Studies

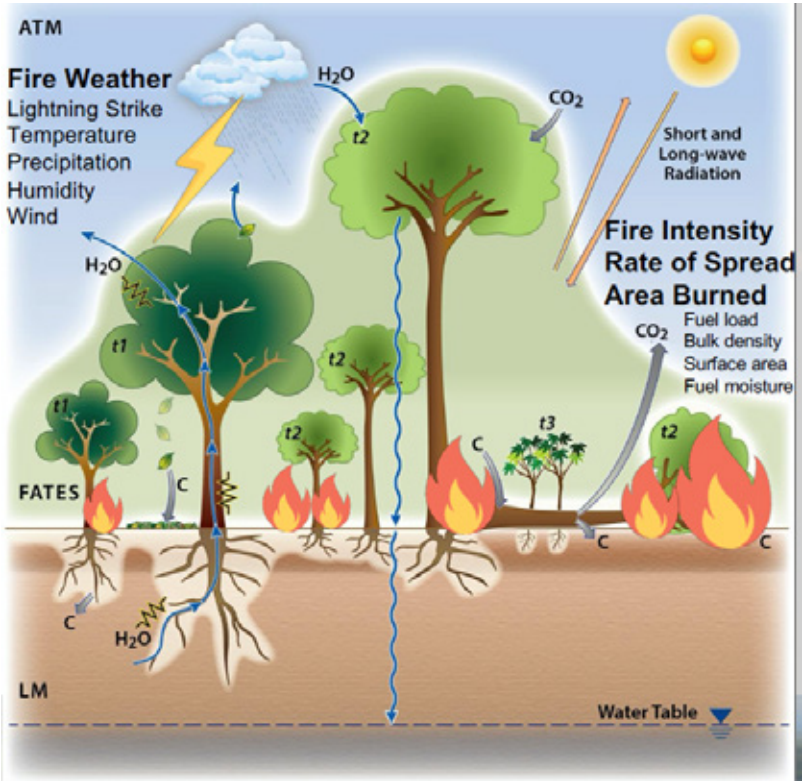
- **Ecosystem response and recovery (ORNL)**: modeling and spatial scaling of ecosystem dynamics related to fire, including soil carbon and nutrient cycling, forest composition, demography, and ecology, and impacts to watershed hydrology and water quality.

- **Coupled ecosystem-fire science (LANL):** using FIRETEC to and QUIC-Fire's to better understand fire's role in ecosystem dynamics and ecosystem sustainability

- **Tropical forest recovery following fire** (a study within the DOE-funded multi-institutional project - NGEE-Tropics)

- **Modeling the effects of wildfire on basin-scale hydrology and ecosystem carbon cycling (LBL)**

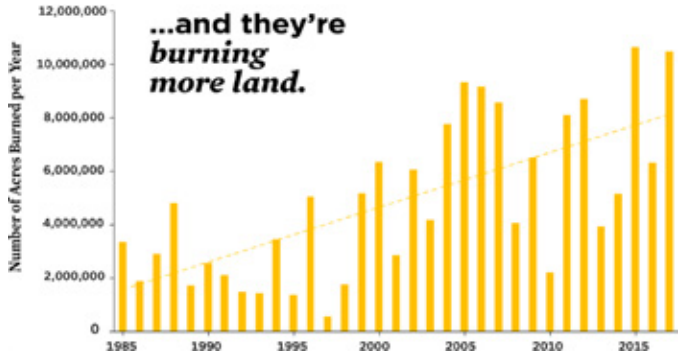
- **The role of ecosystems and extremes in future water resources (LBL):** assess future fire across the western US, and interactions with societies water resources

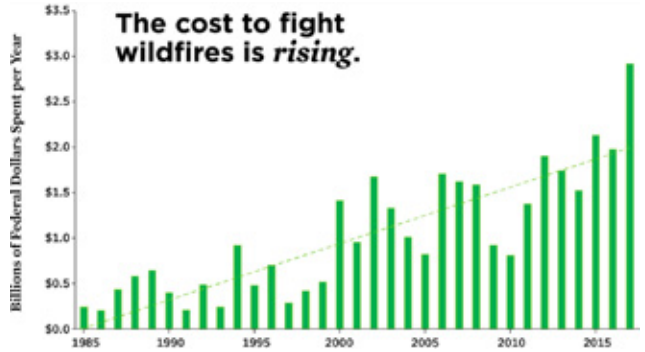


Ecosystem-resilience and landscape-management-implication research

DOE lab scientists address challenging question related to ecosystem-resilience and land management practices

- **The impact of land management practices on fire risk and soil carbon stocks (LLNL):**
  - Fighting fire with fire: Can traditional Native American burn practices reduce devastating wildfires and increase soil carbon storage?
- **Determining the effectiveness of wildfire treatments (LBL):**
  - analyzed the fire CO2 emissions in California from 1998-2015 over forested areas that were treated and untreated and compared emissions.
- **Prescribed fire and ecosystem response (LANL)**
  - Prescribed fires are understudied
  - Prescribed Fire reduces fuel load & maintains ecosystem stability.



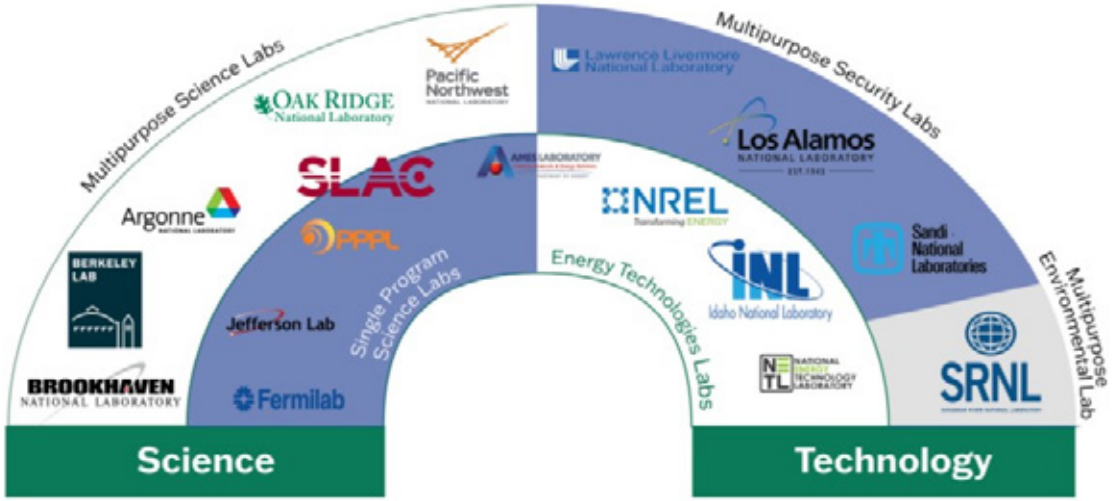


Applications and Decision Support Systems

	Use catagory	Tools/Lab	Specific application
Pre-fire	Ecosystem monitoring and wildfire risk assessment	ForWarn II (ORNL, US Forest Service) PlanetSense (ORNL)	Recognizing and tracking landscape changes using satellite-based change detection algorithms to provide near real-time CONUS-scale fire risk potential assessments. Providing ground-based near-real-time social listening capability that generates situational awareness for wide-area monitoring of wildfires and landscapes disasters.
Pre-fire	Landscape-management planning	Forest System Health DST (PNNL with DOE and USFS) BurnPro3D (LANL with UCSD, USGS)	Estimating sustainable forest biomass, hydrologic and wildfire risk using high-resolution spatial vegetation characteristics data in a multi-objective analysis framework. Using AI and PGML and process-based wildland fire modeling to evaluate and compare landscape level treatment sequences for risk reduction and ecosystem resilience.
Pre-fire	Fuels treatment and prescribed fire optimization	QUIC-Fire and BurnPro3D (LANL with UCSD, USGS)	Assisting with development of optimal prescribed fire windows and operations to meet ecological and fire risk mitigation targets using large ensembles of process-based coupled fire atmosphere simulations.
Pre-fire	Data sharing, access, and management	Pilot Data Management Platform for WFSI (LBL)	Promoting data storage, sharing, use, and long-term archiving; Enabling modeling/analysis on the harmonized data.
During fires	Wildfire detection	ML/AI (ANL) RADR-Fire (PNNL)	Detecting wildfires using machine learning techniques. Detecting wildfires as part of its broader Rapid Analytics for Disaster Response toolset.
During fires	Wildfire spread and patterns	EMBYR (ORNL)	Providing probabilistic fire pattern and spread predictions based on fire weather, meteorological conditions, and fuel characteristics.
Post fires	Multi-scale fire effects estimation	Disturbance response model (DRM) (LANL) FATES-SPITFIRE (LBL)	Coupling fire behavior, fire effects, ecosystem succession, and hydrology at km to 10s of km scales. Representing larger-scale forest fire behavior and recovery for predicting ecosystem function.

Summary

- The DOE labs have a wide range of fire weather and wildfire capabilities
- Funding comes from many sources and DOE scientists are actively collaborating with research communities outside of the DOE labs:
  - DOE (including BER and Office of Electricity)
  - Internal laboratory funding (LDRD)
  - USDA Forest Service (WO, RMRS, SRS, NRS)
  - USGS
  - DoD SERDP/ESTCP program
  - State and local governments
  - Other stakeholders
- Additional partner institutions include
  - At least a dozen academic institutions
  - Canadian Forest Service
  - INRAE, L'Institut National De Recherche Pour L'
  - A variety of NGO collaborators



NSF’s Strategic Opportunity in Wildland Fire Science

Marc Stieglitz

Yulia R. Gel, Yu Gu, Kendra McLauchlan

Liz Blood, Carla D'Antonio, John Daily, Tom Evans, Justin Lawrence,

Daan Liang, Megan Lewis, Joy Pauschke, Asli Sezen-Barrie,

Regina Sievert, Colette St. Mary

U.S. National Science Foundation (NSF)

1 April 2022

NSF by the Numbers

$8.5B FY 2021 Enacted

94% funds research, education, and related activities

$1.4B for STEM education

$200M to seed public/private partnerships

248 NSF-funded Nobel Prize winners

43K proposals evaluated

12K awards funded/year

2K funded institutions

307K people funded

Investigator-driven Science

Infrastructure

Centers and Institutes

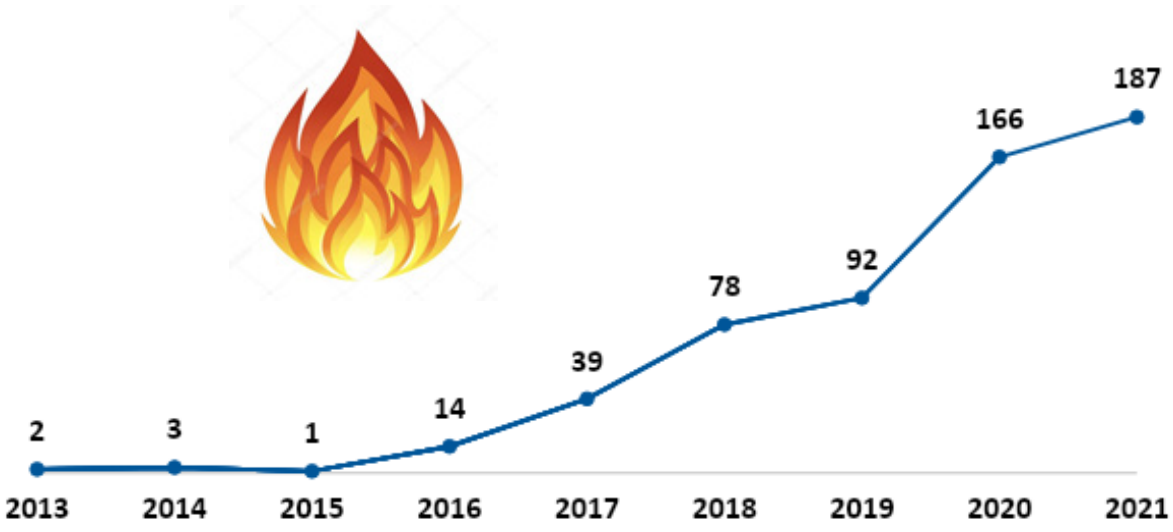
Researchers

Trainees and Students

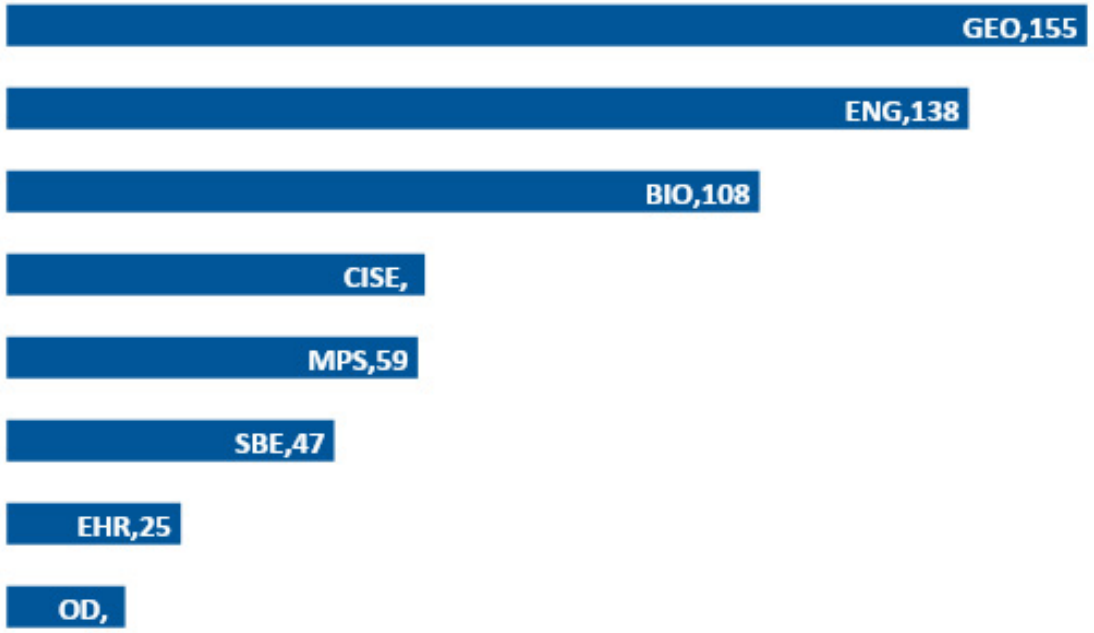
Industry and Others

Fire-related awards have increased over the past 8 years

Total Count of Awards by Year



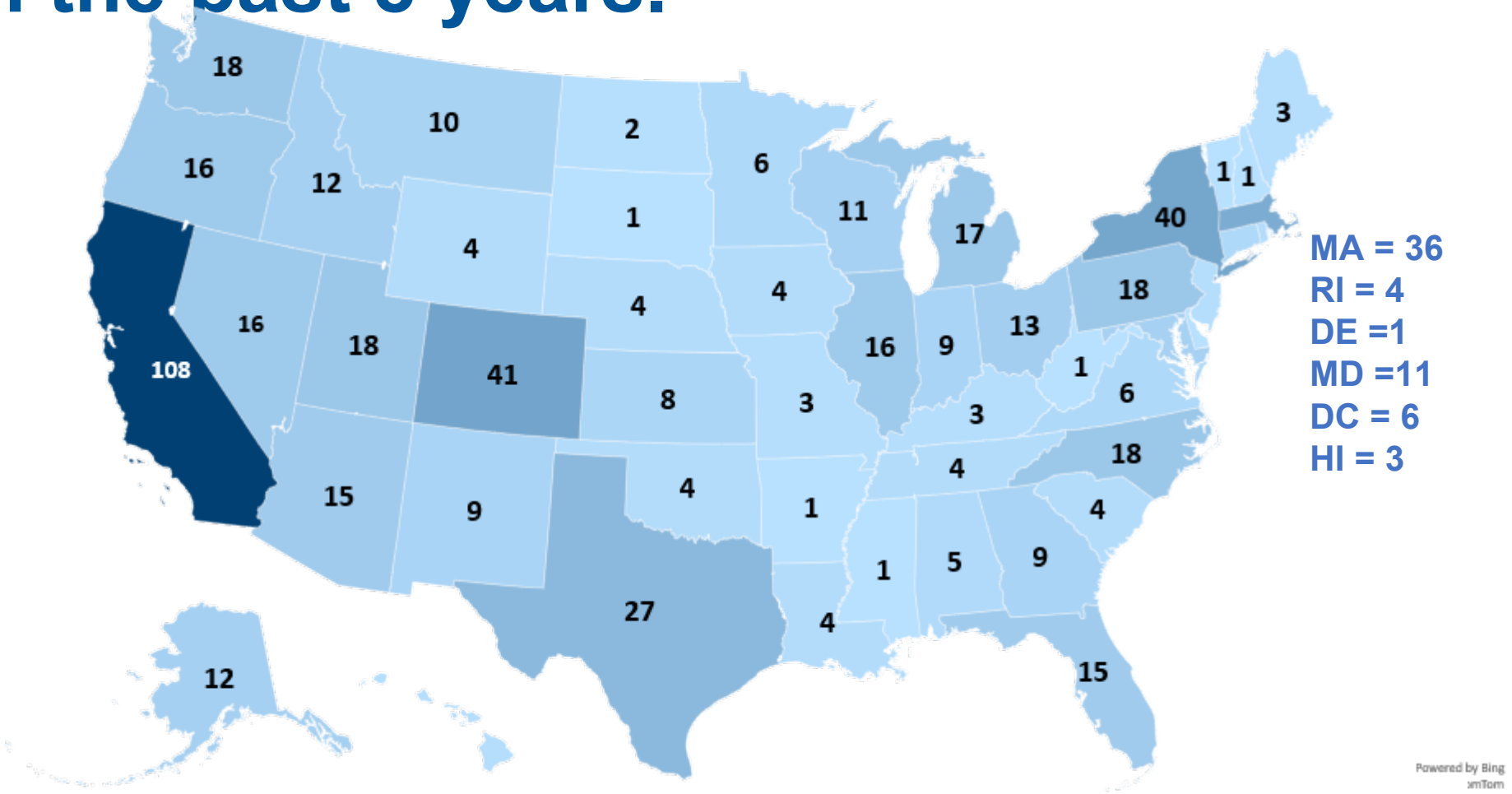
Awards by NSF Directorate



Fire-related research is supported through regular awards as well as special proposal types

Regular awards over the past 5 years (n=359) totaled $287 M.

Every state in the U.S. has at least one fire-related award in the past 8 years.



California has the most fire-related awards.

MA = 36
RI = 4
DE =1
MD =11
DC = 6
HI = 3

Research Focus Areas

Modelling & Analysis → **Observations** → **Operational**

Research Oriented

CAWFE (Couped Fire-NWP) (GEO)
WE-CAN (GEO)
Smoke Plume Forecasting (MPS, ENG)
Orography on Extreme Weather (EHR)
Uncertainty in Operational Smoke Forecasts (MPS)
Attribution Studies for Extreme Events (MPS)
Decision Making (SBE)
Land-use Change on Fire Regimes & Feedbacks (GEO-OD, MPS)
Post-Fire Nanomaterials Fate Modelling (ENG)

Satellite Remote Sensing
NEON (BIO)
Drones & Intelligent Sensor Networks (GEO, BIO, CISE)
UAV Fire Observation For Management, & Evacuation (CISE, SBE)
Wireless Sensors & Monitoring of Electric Power Infrastructures (ENG-CNS)
Low-Cost Efficient Wireless Intelligent Sensors in Native American Communities (CIVIC)

Application Oriented

WIFIRE (CISE-OAC)
WRF-(S)FIRE (GEO)
WIRC (GEO)
Soil Moisture Data Base (NSF-NCAR)

Machine Learning, AI, Novel Statistical Techniques

Examples of NSF-funded Research: Before Fire

Observed increases in extreme fire weather driven by atmospheric humidity and temperature

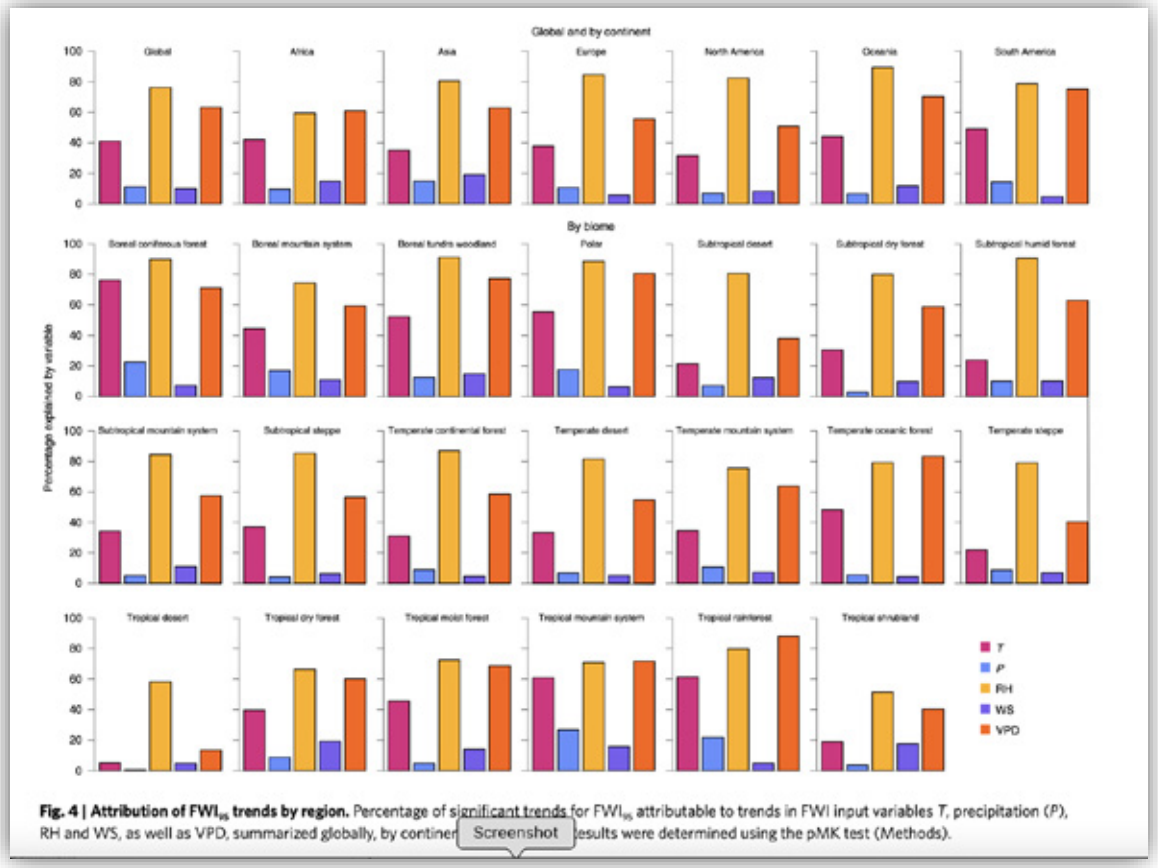


Fig. 4 | Attribution of FWI_{95} trends by region. Percentage of significant trends for FWI_{95} attributable to trends in FWI input variables *T*, precipitation (*P*), RH and WS, as well as VPD, summarized globally, by contine esults were determined using the pMK test (Methods).

Screenshot

Global Attribution

Piyush Jain et al., *Nature* 2022
OAI-2019762

Examples of NSF-funded Research: Before Fire

Preparing communities for wildfire

CIVIC INNOVATION CHALLENGE

Low-Cost Efficient Wireless Intelligent Sensors (LEWIS) for Greater Preparedness and Resilience to Post-Wildfire Flooding in Native American Communities

Ohkay Owingeh Pueblo in New Mexico

NSF Award ID: 2043618

PI: Fernando Moreu, University of New Mexico

- Will co-build, develop, and deploy over 100 LEWIS sensors
- Community will use data through a secure online portal
- Data and Decision Support
- Leaders and students at Ohkay Owingeh Pueblo

Research Partners

THE UNIVERSITY OF NEW MEXICO

Bohannan Huston

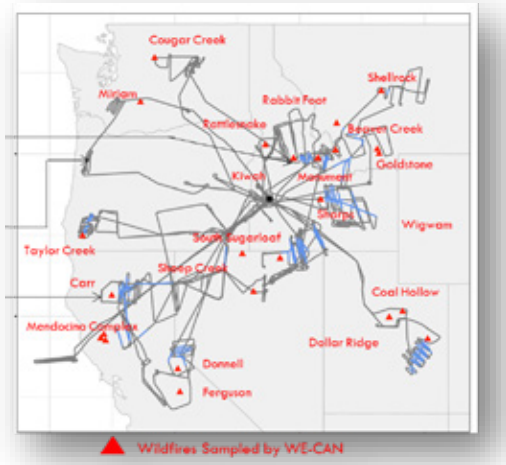
Stantec

Civic Partners

NMDOT

HIGH WATER MARK

Examples of NSF-funded Research: During Fire



Impact on air quality

Science themes:

- Fixed nitrogen emissions and evolution
- Evolution of aerosol optical properties
- Cloud activation and chemistry in wildfire plumes

WE CAN

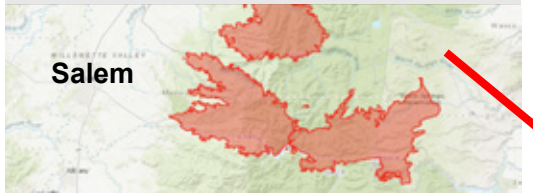
WESTERN WILDFIRE EXPERIMENTS FOR CLOUD CHEMISTRY, AEROSOL ABSORPTION, AND NITROGEN

2018

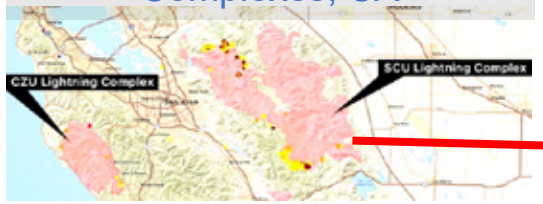
Examples of NSF-funded Research: After Fire

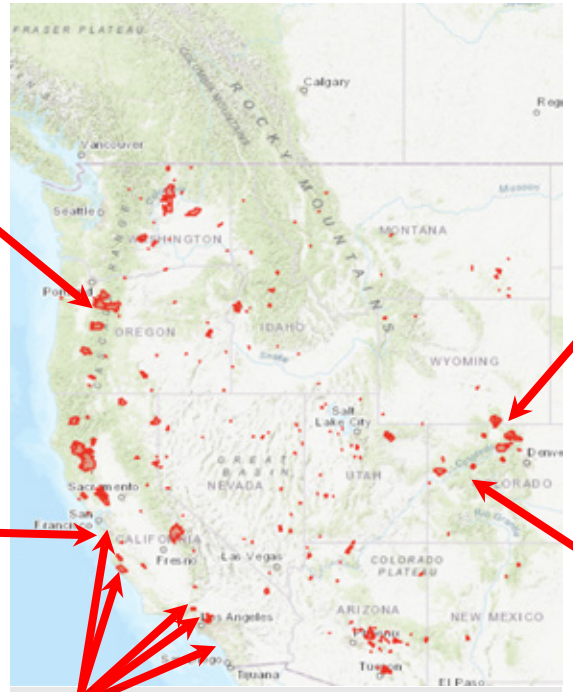
Earth Science responses to 2020 wildfire season (RAPID)

Lionshead and Beachie Creek Fires, OR



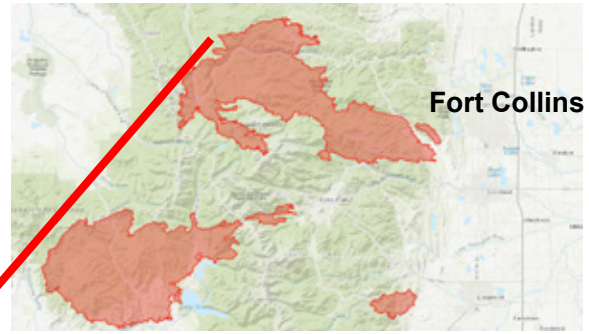
CZU and SCU Lightning Complexes, CA



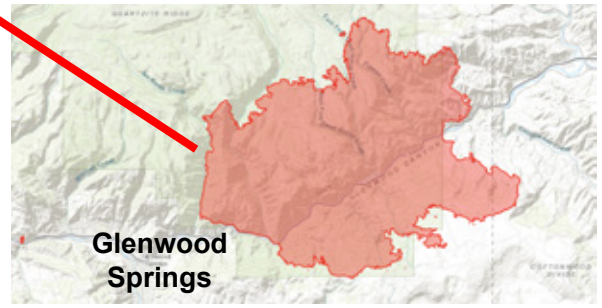


Apple Fire, Holster Fire, Lake Fire, Dolan Fire and SCU Lightning Complex, CA

Cameron Peak Fire, CO



Grizzly Creek Fire, CO



Themes:

- Snow water storage
- Snowpack
- Flow paths
- Sediment dynamics
- Soil characteristics
- Geomorphic change in river estuary
- Streamflow response

NSF has a unique role in wildland fire research

- Fundamental science conducted by the research community
- Convergence research that includes social science
- Innovative ways to connect with stakeholders and rights holders
- Diverse programs and approaches
- Mechanisms for broadening participation, education, and outreach
- Potential for partnerships with: USFS, NASA, USGS, NOAA, JFSP, international

Gaps in existing fire-related research at NSF

- Wildland fire convergence research
- Infrastructure or facilities to support wildland fire data, modeling, and forecasting
- Non-academic partnerships
- Education programs for convergent professional learning and enhanced public engagement
- Dedicated support for Indigenous fire science
- Decision making under uncertainties and uncertainty quantification (UQ)

Opportunities for Cross-agency coordination/collaboration

- Participate in other agencies' relevant meetings, hold regular interagency update meetings, or set up channels of communication among agencies
- Explore coordinated opportunities for interagency wildland fire programs
- Establish a network to coordinate wildfire related research (e.g., a portal for inventory of all wildfire related projects so that agencies can avoid over-allocating federal funds in one specific area)
- Build an integrative information system for wildfire management so that observations, modeling results, knowledge, and findings produced from projects of various agencies can be shared
- Leverage the infrastructure of agencies with applied science and operations (e.g., NASA, USGS, NOAA, DOE, etc.)
- Explore ways to expand diversity, equity, and inclusion in our research investments
- Develop large scale interagency and interdisciplinary collaborative programs or research centers

Panel Discussion

J. Kevin Hiers

Brian Ebele

Kurtis Nelson

Jenn Mahoney

Robyn Heffernan

Mike Pavolonis

Robert Field, GISS

Doug Morton, GSFC

Liz Wiggins, LaRC

Rod Linn, LANL

Charlie Koven, LBL

Jeffrey D. Mirocha, LLNL

Kendra McLauchlan

Yulia Gel

Yu Gu

Wrap Up

- Final Thoughts from the Organizers

- Next Workshop
  - Common Challenges and Opportunities

- Thank you all for coming to support this important ICAMS effort

- Save the date! Next ICAMS Fire-weather/Wildfire Workshop

  Thursday 5 May 2022, 1100 - 1400 Eastern