National Aeronautics and Space Administration

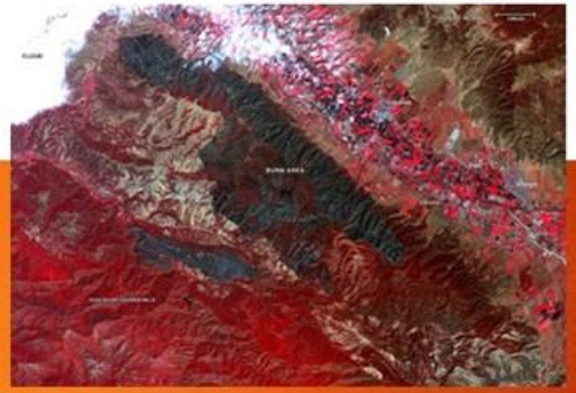
NASA's Perspective on Living with Wildland Fires

Making *Wildland FireSense*

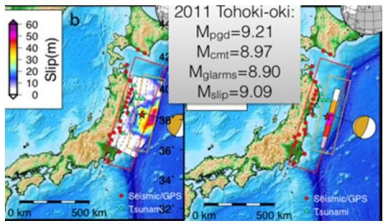
Dr. David Green
david.s.green@nasa.gov
NASA SMD ASP Wildfire Management Program
May 2022

Science **Applied – Serving Society**

Wildfires and cascading impacts



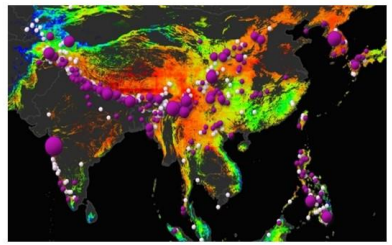
Observational and Collection Systems

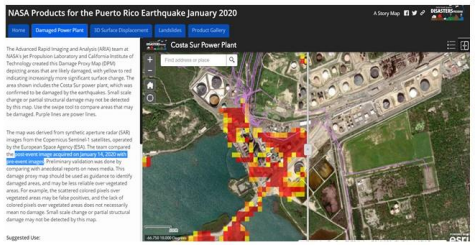


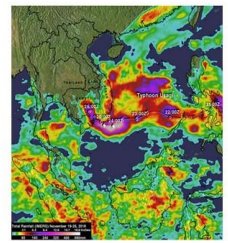
How We Work

End-to-End Innovation and Integration

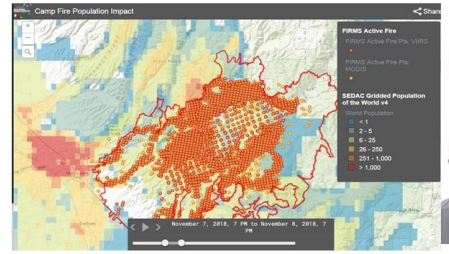
Advanced Modeling and Risk Analysis

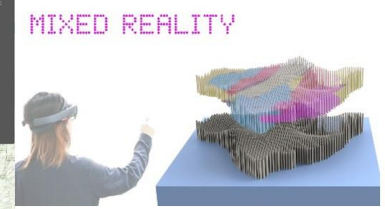


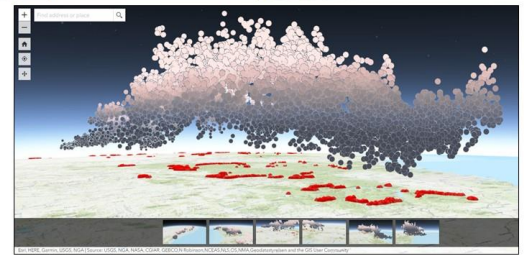




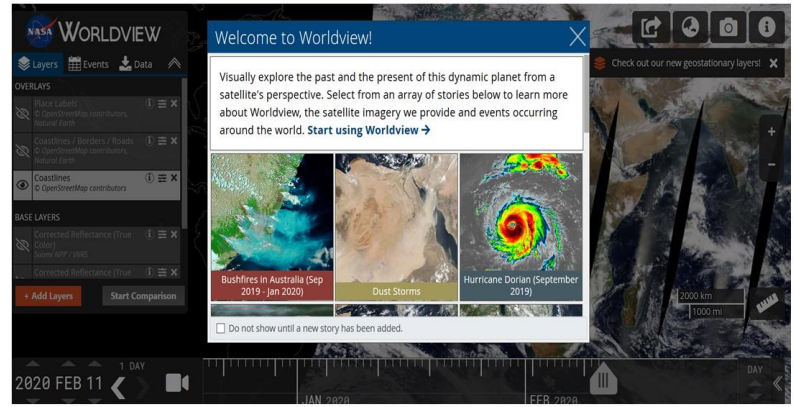
GIS and visualization systems







Computing and Communication Technologies

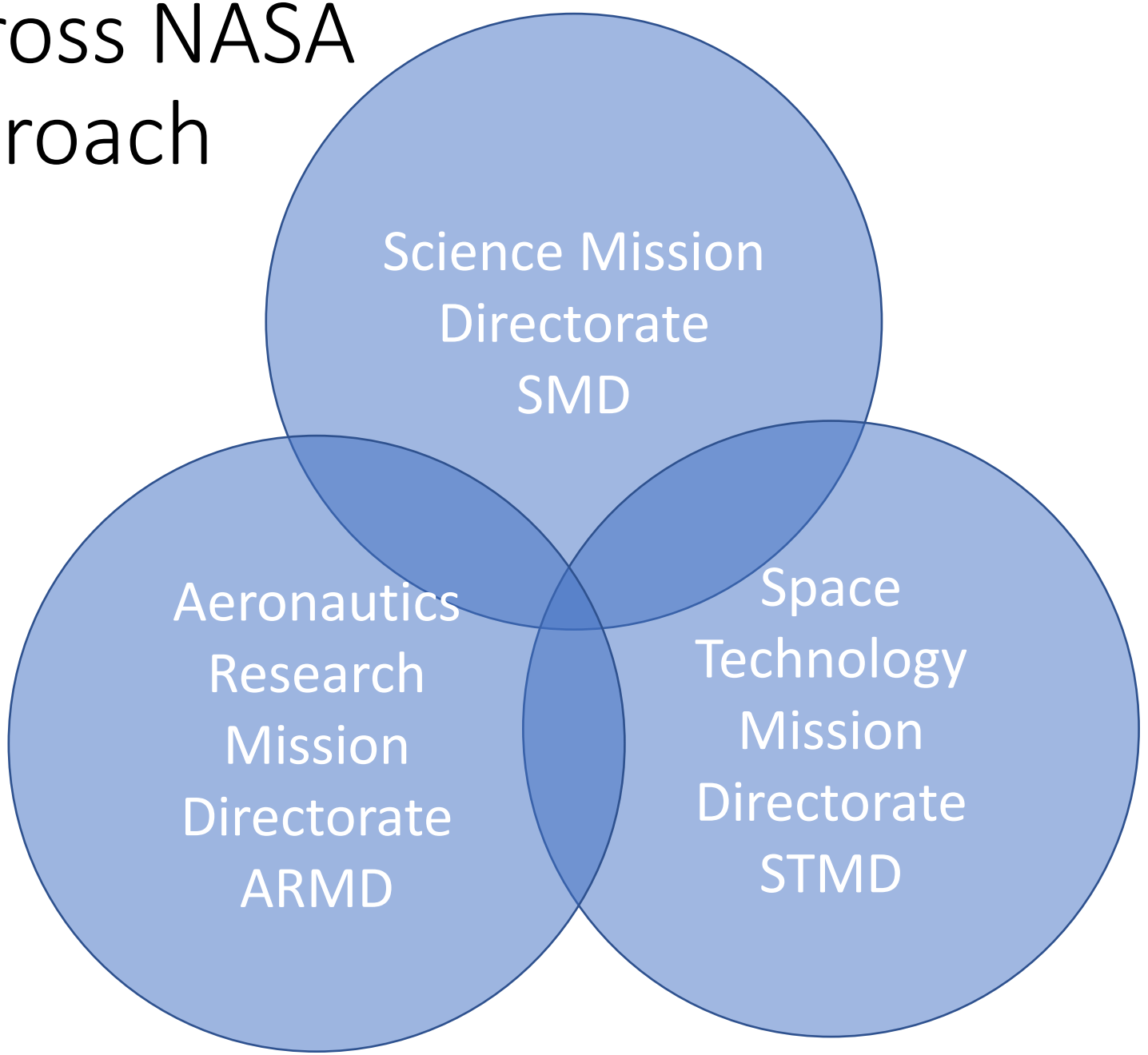


Research to Application R2A

- Outreach and Engagement
- Community and Coalition Building
- Regime Studies and Research
- Hazard and Risk Assessment
- Analytics and Simulation
- Pilot and Demonstration
- Transition to Operations

https://nari.arc.nasa.gov/smdwildfire

A Cross NASA Approach



Bringing FireSense to **All Fire Phases**

Pre-Fire

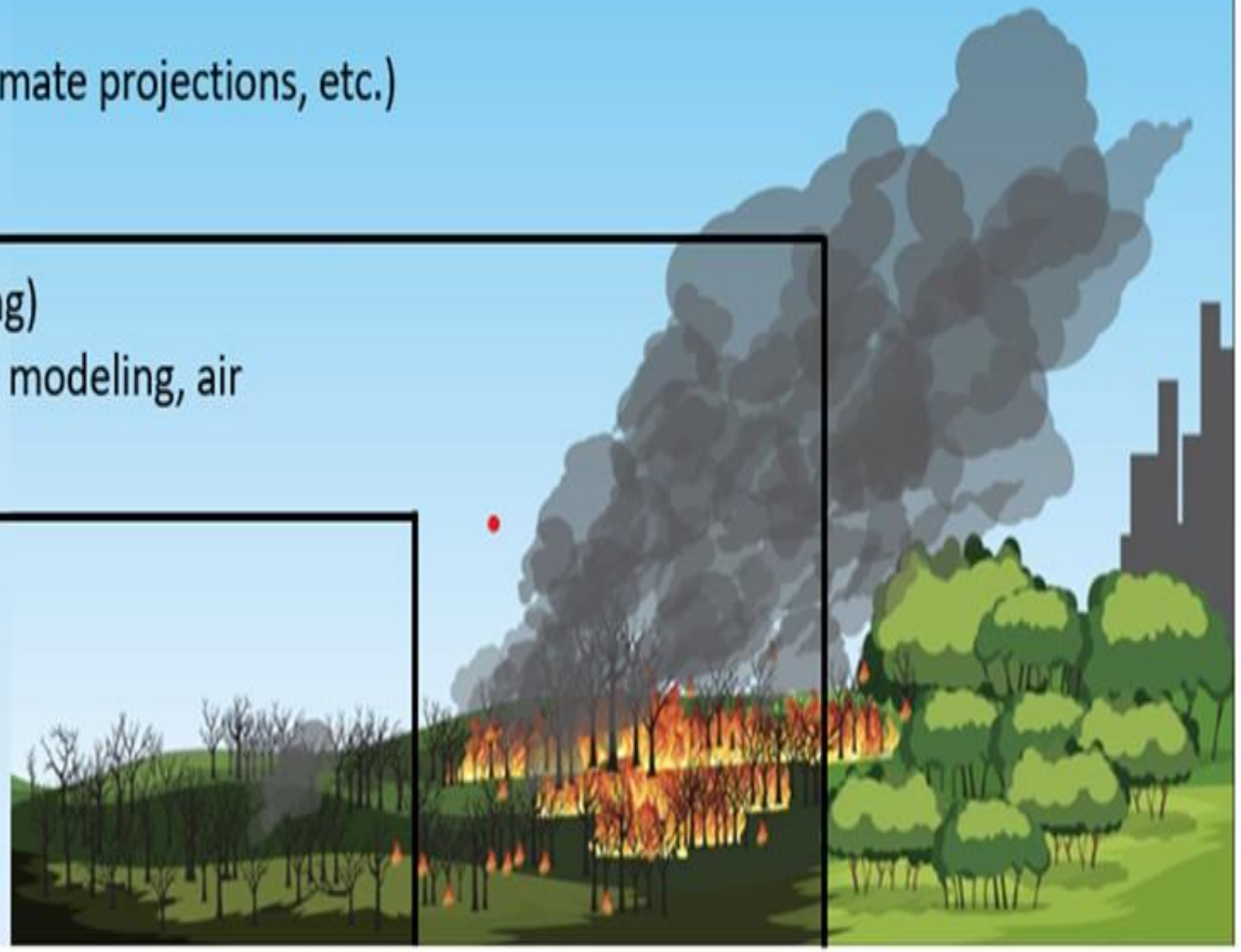
- **Mitigation and adaptation** (fuels management, climate projections, etc.)
- **Fire prediction** (potential and intensity)

Active Fire

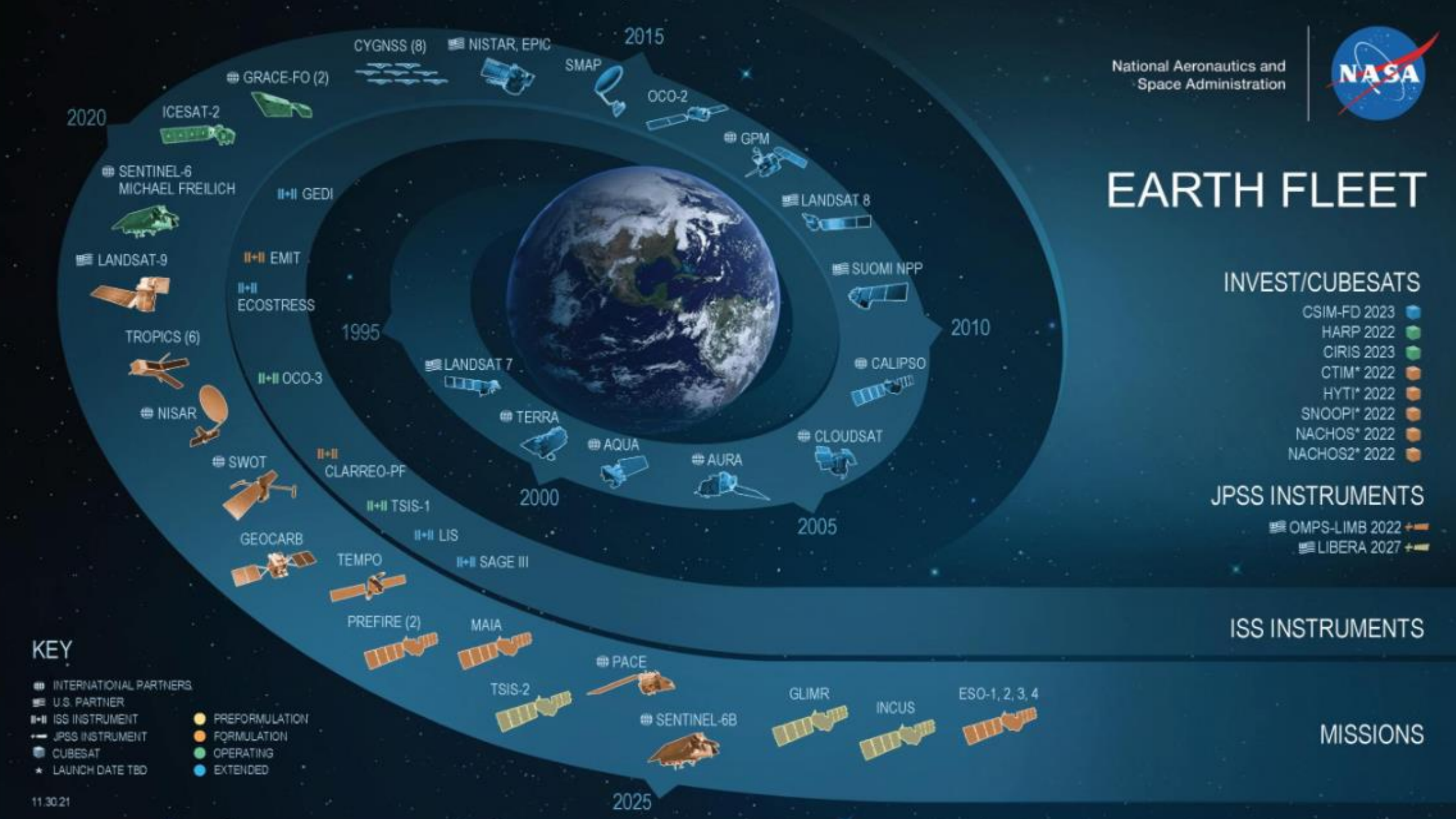
- **Detection and monitoring** (strategic fire monitoring)
- **Firefighting** (tactical fire monitoring, fire behavior modeling, air traffic control, smoke and air quality, etc.)

Post-Fire

- **Post-fire assessment** (severity assessment, landslide potential, carbon release, etc.)
- **Rehabilitation and restoration** (land cover, ecosystems, etc.)



Post-Fire | Active Fire | Pre-Fire


National Aeronautics and Space Administration
NASA
EARTH FLEET
1995
2000
2005
2010
2015
2020
2025
CYGNSS (8)
NISTAR, EPIC
SMAP
OCO-2
GPM
LANDSAT 8
SUOMI NPP
CALIPSO
CLOUDSAT
AURA
AQUA
TERRA
LANDSAT 7
GRACE-FO (2)
ICESAT-2
SENTINEL-6 MICHAEL FREILICH
GEDI
LANDSAT-9
EMIT
ECOSTRESS
TROPICS (6)
OCO-3
NISAR
SWOT
CLARREO-PF
TSIS-1
LIS
SAGE III
GEOCARB
TEMPO
PREFIRE (2)
MAIA
PACE
TSIS-2
SENTINEL-6B
GLIMR
INCUS
ESO-1, 2, 3, 4
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
11.30.21

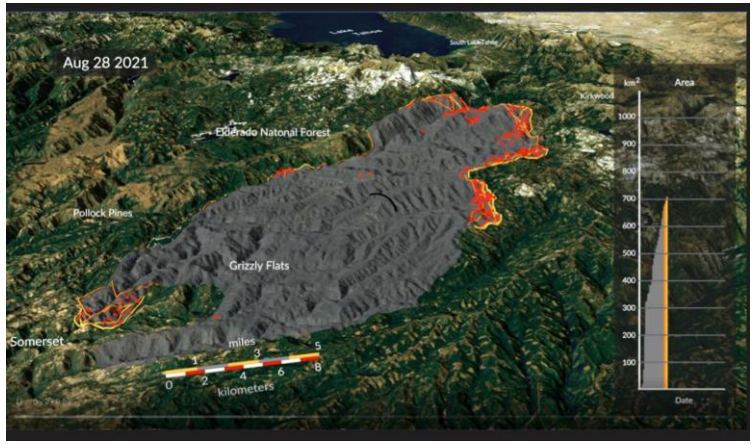
Firesense Integrating Tools for Earth System Solutions

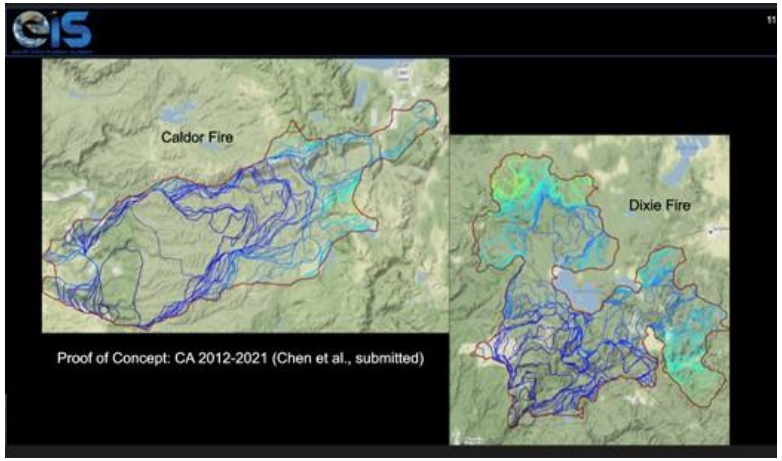
Pre-Fire
Landsat, NISAR, MC, SBG, SDC, G-LiHT

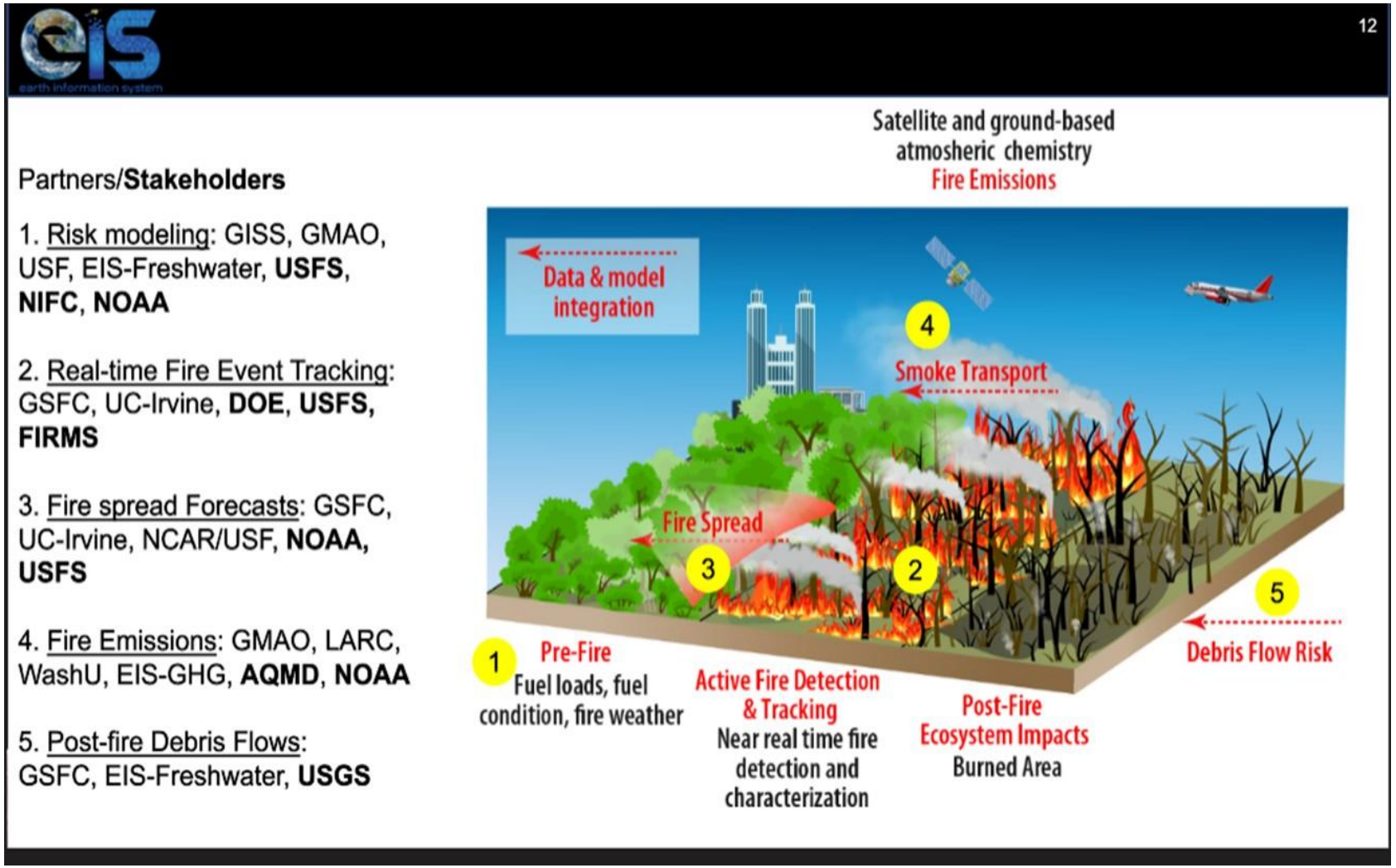
Active-Fire
MODIS, VIIRS, GOES, AOS

Post-Fire
Landsat, MODIS, SBG, SDC, NISAR, AVIRIS-NG

NASA Earth Information System Wildfire Pilot







Fuel structure and fuel moisture opportunities

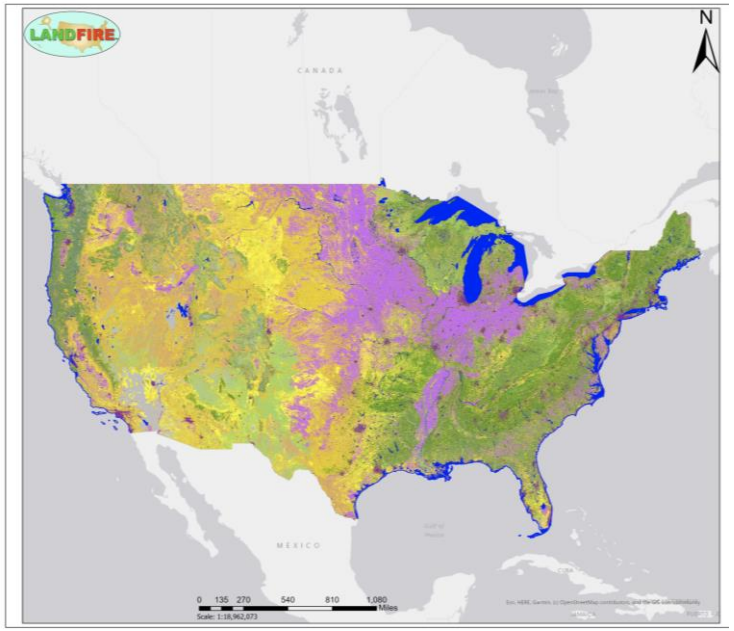
- **Fuel Structure**: Leverage existing data from USFS/FASMEE, LandFire, airborne campaigns (NASA and partners), GEDI, ICESat-2
- **Fuel Moisture**: Leverage ongoing investments through SBG on vegetation water content (SHIFT, algorithm development, historic AVIRIS data), ECOSTRESS, SMAP, GRACE, HLS
- **Pre-post fire assessments of fuel consumption** will improve emissions estimates of individual fires
- **Diurnal campaign** (Y2): evaluate duration of flaming and smoldering, influence of sub-daily fire behavior on fuel consumption.
- **HALE campaign (Y4**): Confirm fire lifetime and fire-climate relationships that drive variability in fuel consumption

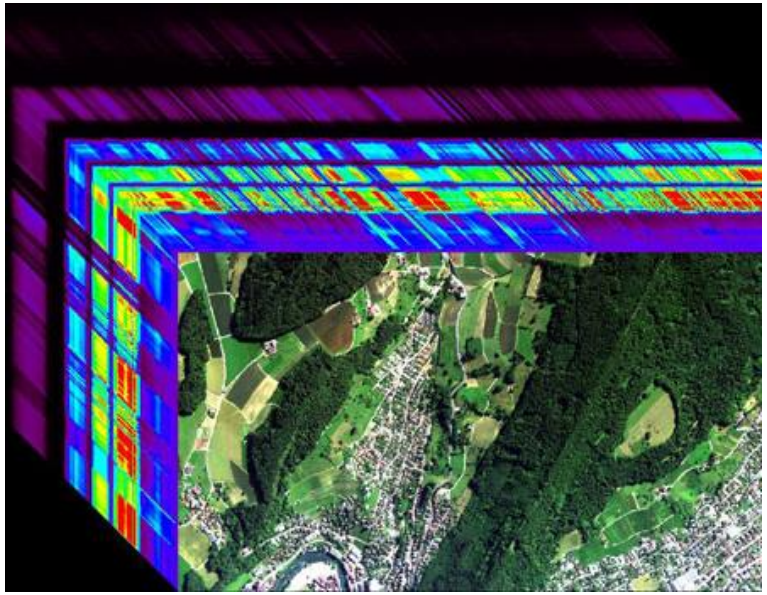
Wildland FireSense: *Targets of Opportunity*

The composition, structure, and moisture status of fire fuels interact to drive fire behavior. Having an accurate characterization of the pre-fire fuels can help managers mitigate fire risk (e.g., fuels treatment) and aid in the management of active fire.

Current data on the structure and composition of fire fuels are of limited accuracy and are updated infrequently (e.g., Landfire)

Future, NASA airborne and spaceborne sensors (LiDAR, Hyperspectral) are being used to improve the accuracy and lower the latency of fire fuels data in fire prone areas



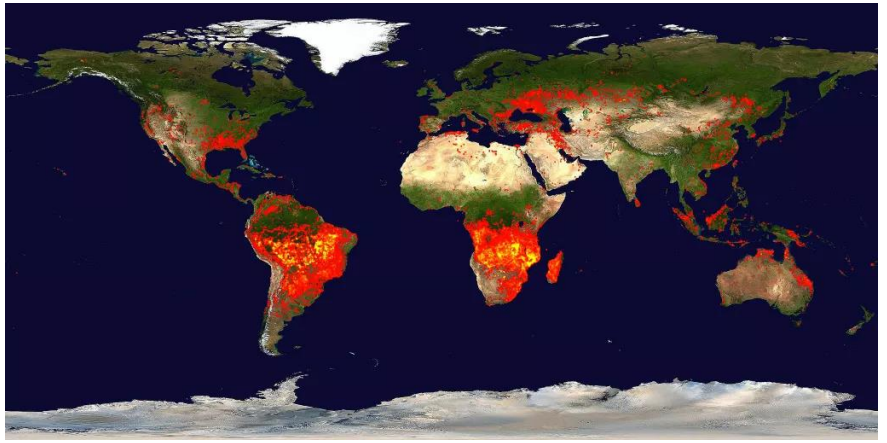


Wildland FireSense *FireTech Opportunities*

The detection and characterization of active fires are fundamental to supporting real-time applications for fire management and supply information on fire behavior and severity needed to advance fire science and applications.

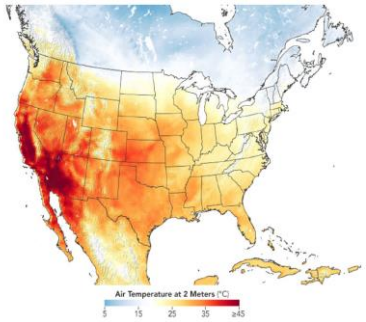
Current data on fire sheds and watersheds are collected too infrequently (2-4 times per day from polar orbiters) or at too coarse of a spatial resolution (geostationary sats) to support action

Future, NASA technology development in sensors and platforms will provide more timely observations of fire and water behavior from un-crewed aerial vehicles, high altitude platforms, and aircraft at spatial and temporal resolutions that directly support planning, mitigation, adaptation and active management.

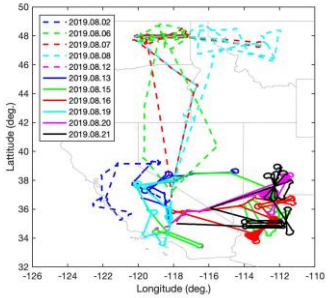


Revealing Impact on Fire sheds and Watersheds

The Woolsey Fire scar on the landscape showing how wildfires radically alter land cover and soil characteristics of the region, which in turn can affect the area's watershed



Trend analysis for Fire Prone Areas

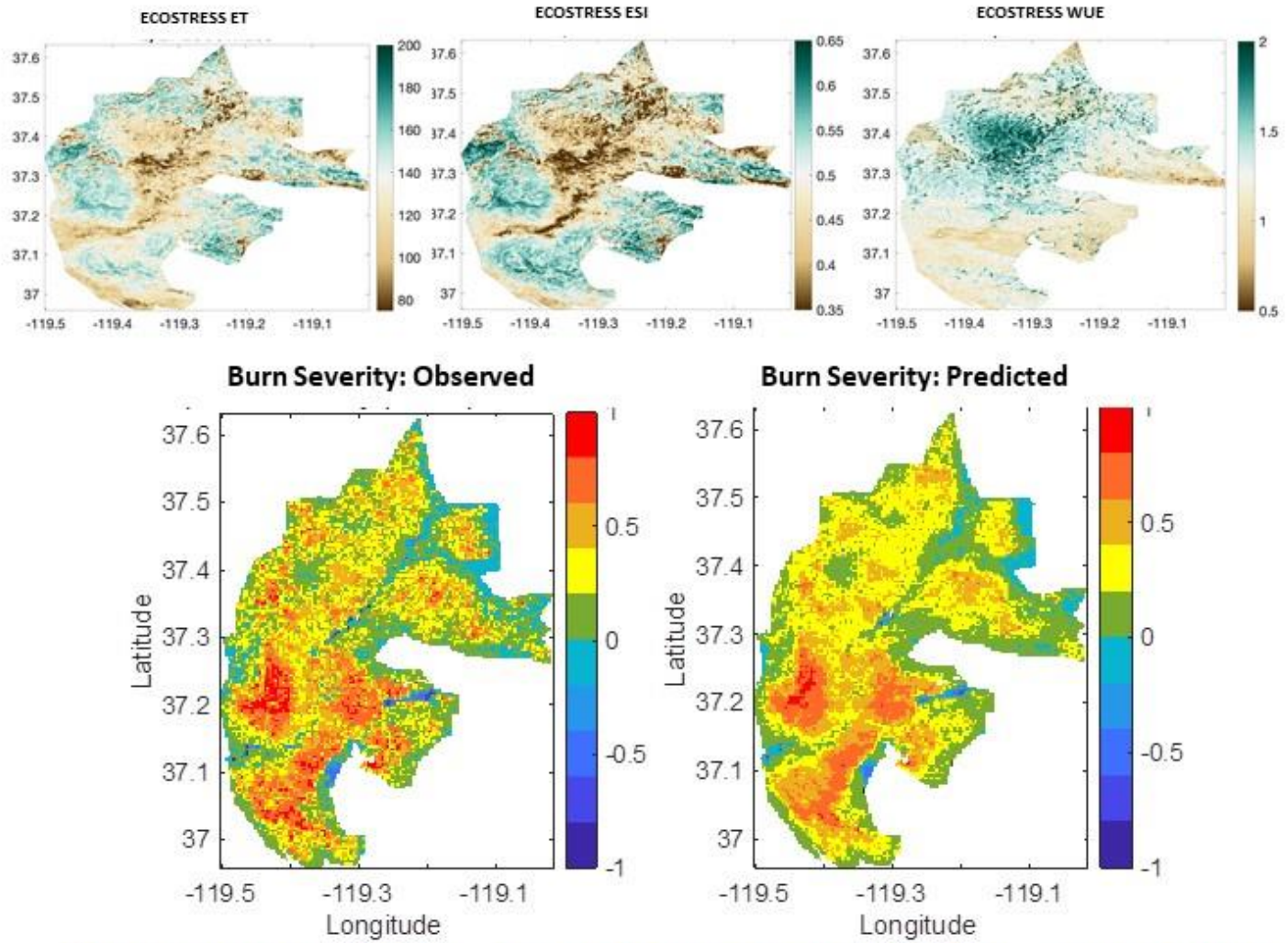


Flight campaigns, smart sensor webs; cloud computing and AI/ML analysis and VR visualization

Integrated Observations including UAS Platforms

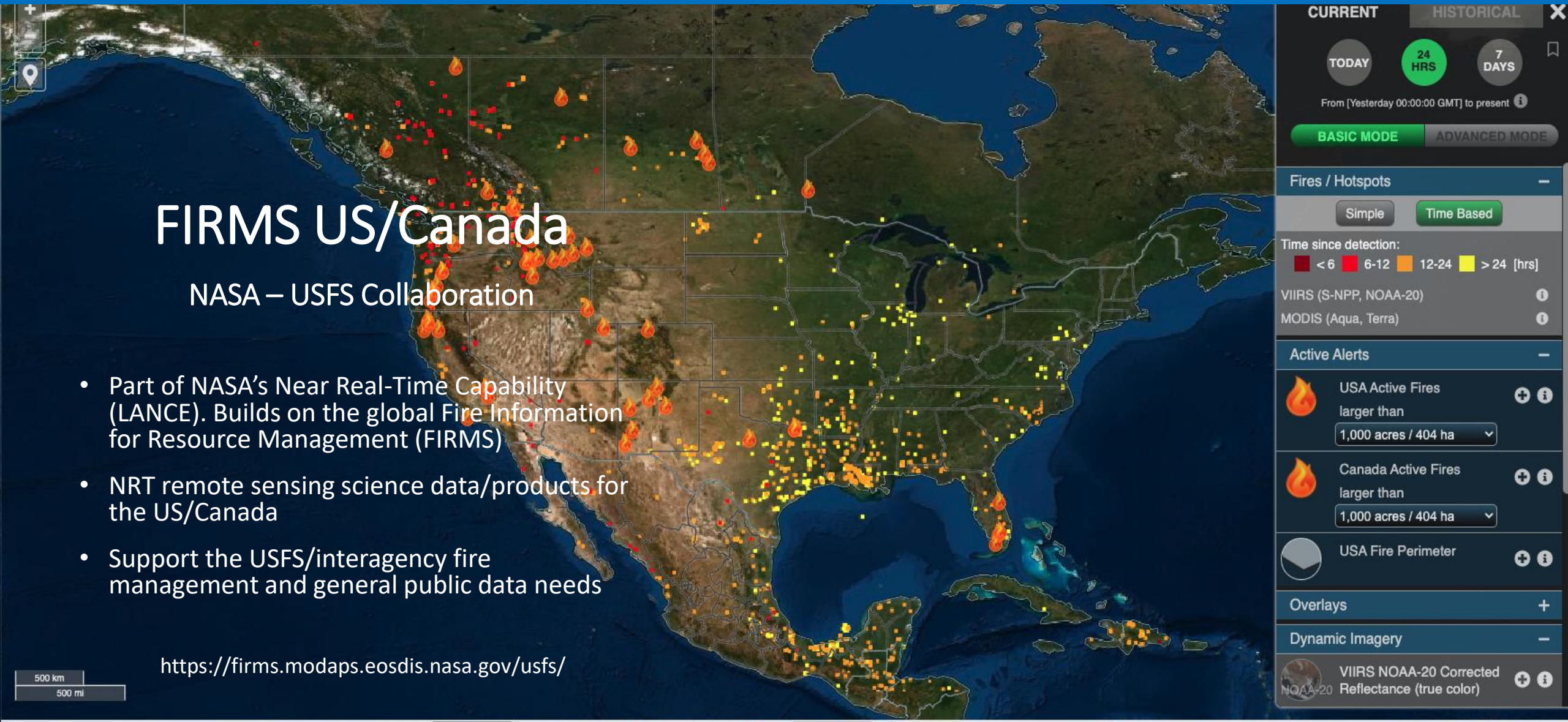
ECOSTRESS reveals pre-fire vegetation controls on California Wildfires of 2020

M. Pascolini-Campbell, C. Lee, N. Stavros, J. B. Fisher



Plant water stress (evapotranspiration (ET), evaporative stress index (ESI) and water use efficiency (WUE)) from the year before the wildfire (top row), are used to predict the spatial patterns of burn severity (bottom row). Example for the Creek Fire, Sierra Nevada, California (September 4 2020).

Wildland FireSense **to Co-Develop Trusted Tools**



FIRMS US/Canada

NASA – USFS Collaboration

- Part of NASA's Near Real-Time Capability (LANCE). Builds on the global Fire Information for Resource Management (FIRMS)
- NRT remote sensing science data/products for the US/Canada
- Support the USFS/interagency fire management and general public data needs

https://firms.modaps.eosdis.nasa.gov/usfs/

NASA Coordinates with Local Agencies to Understand the Risk and Impacts from the Western U.S. Fires

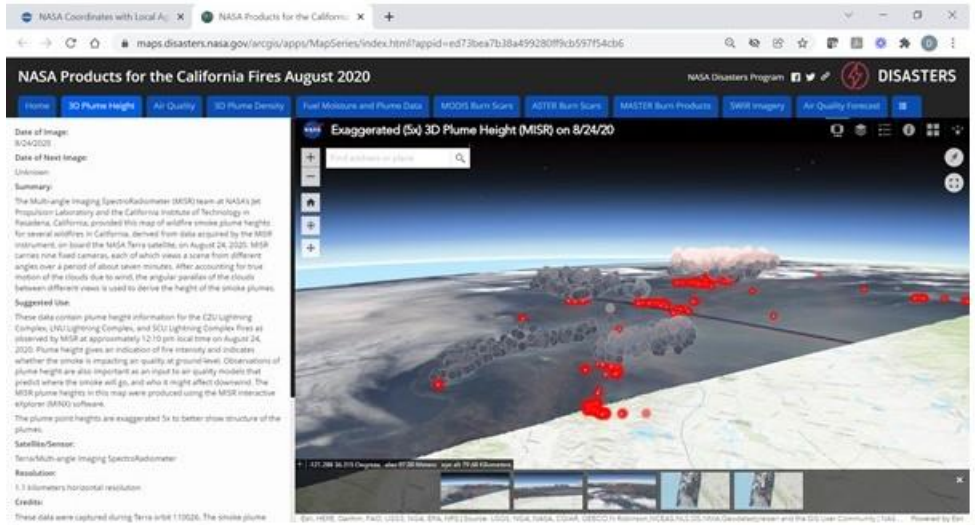
PROGRAM AREA: DISASTERS | REGION: NORTH AMERICA

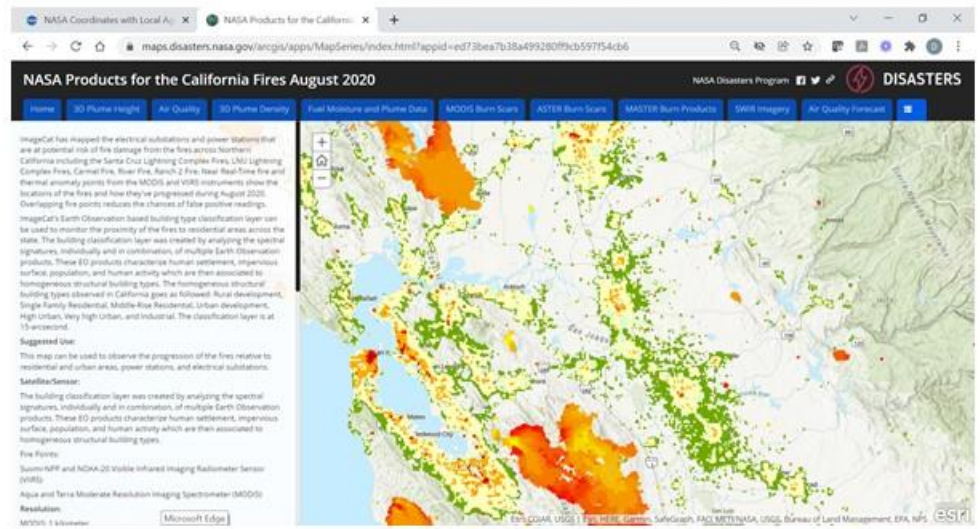
NASA Disasters Mapping Portal

Creating a collaborative community of practice

https://disasters-nasa.hub.arcgis.com/

https://appliedsciences.nasa.gov/what-we-do/disasters/fires

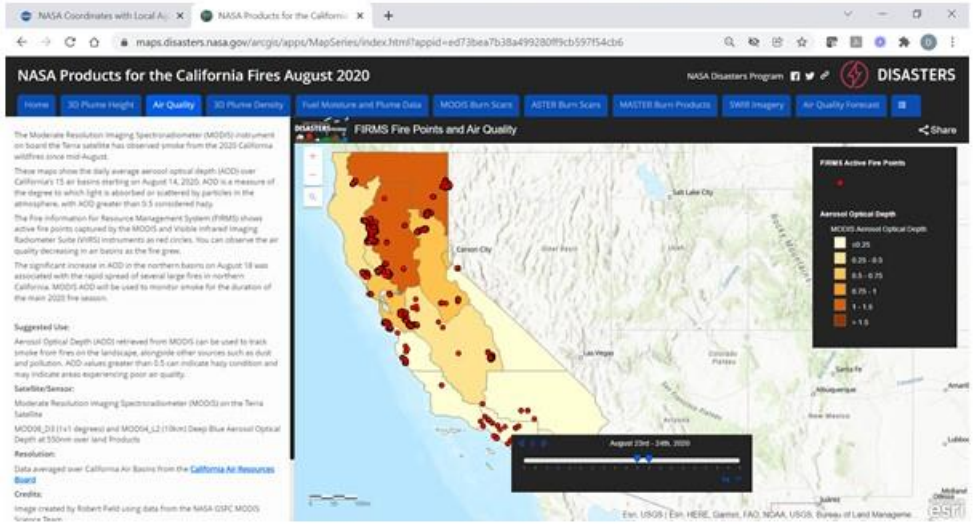


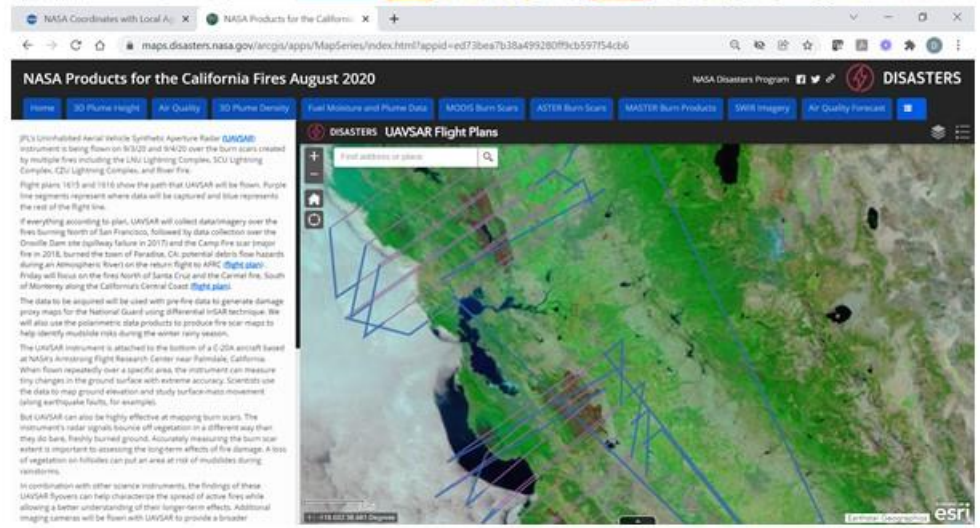


NASA GLOBAL FIRE WEATHER DATABASE (GFWED)

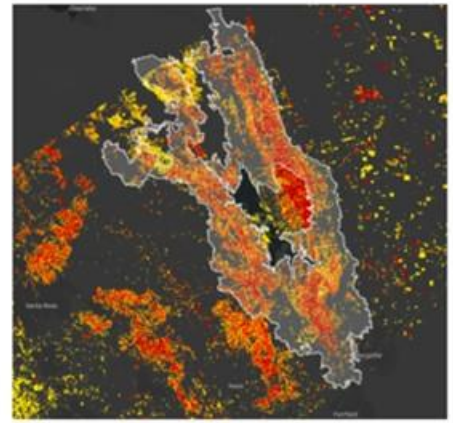
The Global Fire Weather Database (GFWED) integrates different weather factors influencing the likelihood of a vegetation fire starting and spreading, including NASA MERRA-2 and GEOS-5 model wind speed data and NASA IMERG precipitation data. It is based on the fire weather index (FWI) System, the most widely used fire weather system in the world.

MODIS burned area displayed for Northern California displaying burned areas in August and September 2020. Credits: NASA LANCE



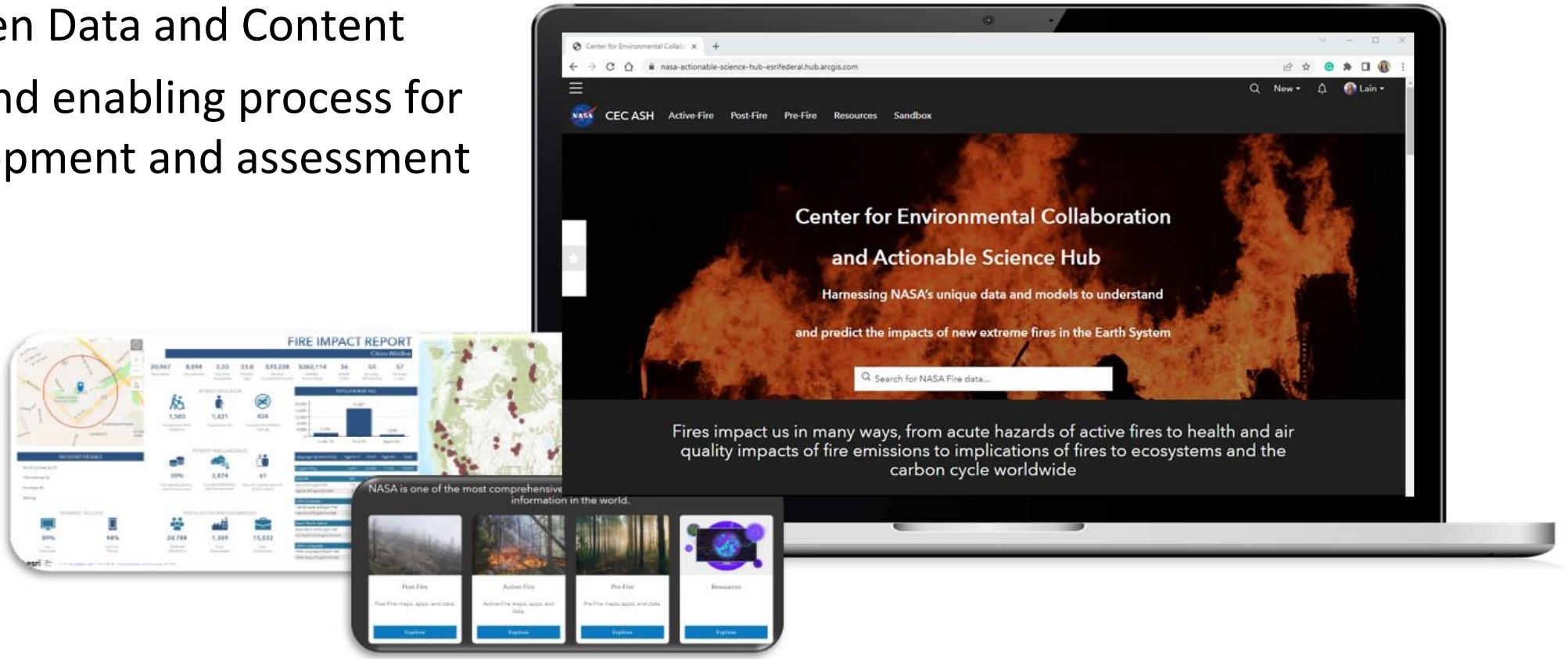


Damage Proxy Map of the LNU Lightning Complex fires



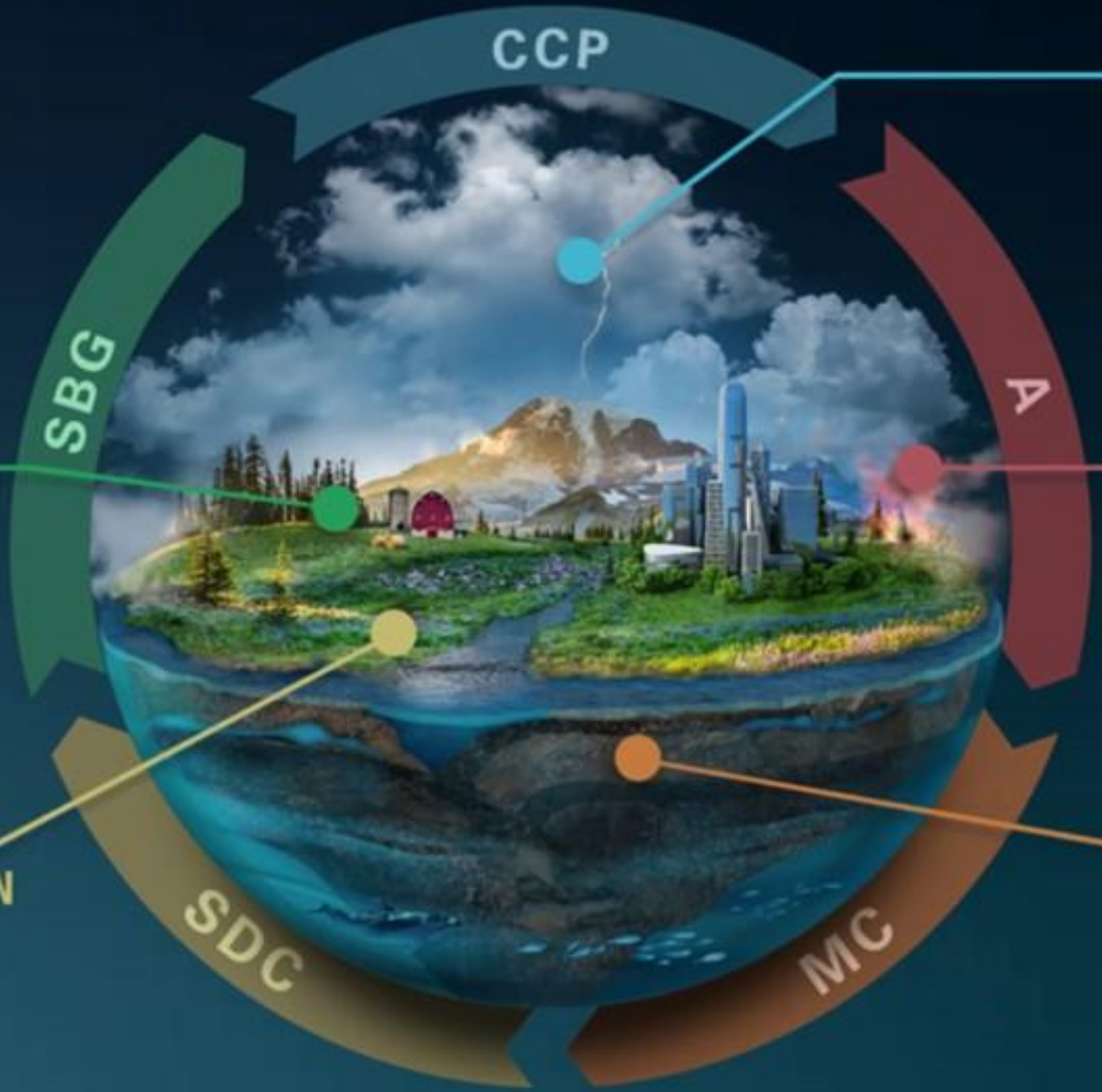
FireSense **a Center for Environmental Collaboration** *CEC ASH Hub*

- An actionable collaboration GIS “sandbox” for community engagement
- Establishing and sharing a common testbed for analytics
- Sharing Open Data and Content
- Providing and enabling process for joint development and assessment



EARTH SYSTEM OBSERVATORY

INTERCONNECTED CORE MISSIONS



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

AEROSOLS

Particles in the Atmosphere

MASS CHANGE

Large-scale Mass Redistribution

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

SURFACE BIOLOGY AND GEOLOGY

Earth Surface and Ecosystems

Wildfire Response is a Multi-organizational Effort

Requires coordination among numerous local, county, state and federal authorities

- National Interagency Fire Center
- Federal Aviation Administration
- United States Department of Interior
- United States Department of Agriculture
- Joint Fire Science Program
- National Science Foundation
- United States Environmental Protection Agency
- Centers for Disease Control
- National Guard
- United States Department of Defense
- United States Forest Service
- Bureau of Land Management
- National Oceanic and Atmospheric Administration
- Cal Fire
- National Institutes of Health
- NASA

… in addition to many others

NASA Wildland *FireSense* Management Team

Earth	Michael Falkowski	michael.falkowski@nasa.gov
Air	Barry Lefer	barry.lefer@nasa.gov
Tech	Michael Seablom	michael.s.seablom@nasa.gov
Application	David Green	david.s.green@nasa.gov