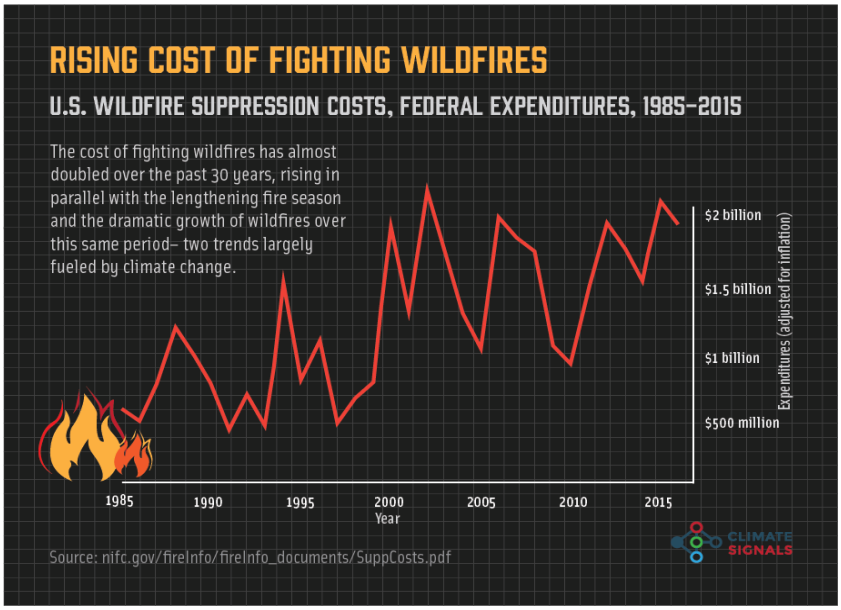
Fighting Fires from Space

By: Ilsa Mroz

*The National Interagency Fire Center (NIFC) has identified the 10-year average cost of fire suppression as **$2,358,603,800**. In 2022 alone, they tracked **68,988 fires** that burned **7,577,183 acres**. Utilizing space technology can help address these challenges.*



Every year, dry seasons around the world are defined by a near-constant threat of wildfires. In the U.S, these fires can destroy over seven million acres each year. The ability to predict and respond to wildfires efficiently can mean the difference in hundreds of lives, millions of acres of land, and billions of dollars in property. Fire seasons are growing longer, and wildfires are increasing in severity and cost. Meeting this evolving threat requires taking advantage of all existing capabilities and advancing our existing technologies on the ground and in the air – and in space.

How does space help fight wildfires?

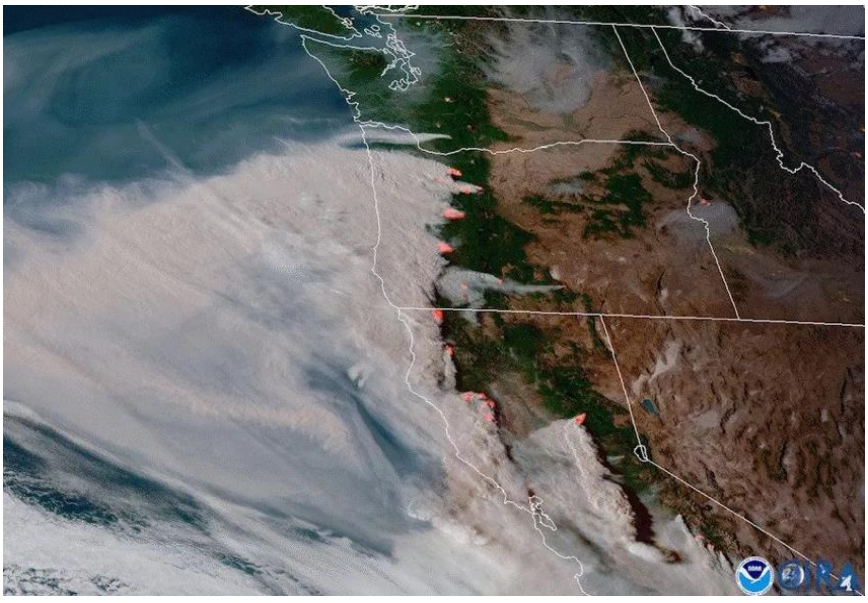
Space has become an essential piece of the firefighting infrastructure for protecting life on the ground. Space-based technologies provide critical information to fire responders and earth scientists. Private companies and agencies capture millions of images of the planet, collect atmospheric data, and work with international governments to contribute to earth observations records. This information is often streamlined by interagency groups designed for fire management, and is used to analyze potential fire hazard areas, locate fires, and shape an effective pre- and post- burn response.

The National Wildfire Coordinating Group (NWCG) is a leading interagency group that provides wildland fire operations leadership and standards. The group works closely with member agencies, such as the Department of Defense (DoD) and U.S Forest Service, to coordinate wildfire management practices. The NWCG is also composed of a number of committees that focus on the varying elements of fire management, and these committees strategically partner with the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), industry, and university affiliates to identify and fill gaps in information and technologies necessary for fire response. The data provided by space technologies helps to fill many of these gaps.

To respond effectively to a burn, firefighters must first know that there *is* a fire and exactly where it is located. U.S Geological Survey (USGS), NASA, and NOAA satellites provide timely data on pre- and post-fire environments, as well as near real-time information about ongoing burns. Data from systems like these can be integrated with climate and visual information from other satellites to provide fire and land managers with holistic, actionable information for predicting and preventing wildfires. For example, in 2020, the NASA/NOAA Suomi National Polar-orbiting satellite captured crucial images of the Bighorn Fire in Arizona. The images helped to map the scope of the fire, and indicated the flow of smoke to surrounding areas – enabling responders to visually process the burn line. Data such as these are used with computer models to predict how a fire will change direction based on land and weather conditions, and this information is then provided to incident responders.

Satellite data is also used by wildfire response efforts from the DoD. The National Geospatial-Intelligence Agency's Firefly algorithm utilizes data from unmanned aerial vehicles (UAVs), satellites, and sensors to compile imagery information, which is then used to map the location of probable fires. This data is shared with multiple firefighting agencies, including the California National Guard, the U.S Forest Service, and the DoD. The DoD oversees initiatives such as the National Guard's FireGuard program, which utilizes the data provided by the Firefly algorithm to improve real-time fire management. Interagency data-sharing initiatives such as this are essential to wildfire response.

Once a fire is detected, space plays a critical role in understanding the fire's spread and pinpointing where to direct immediate firefighting action. This is extremely dangerous for firefighters to do on the scene, and it can take an aircraft or drone hours to map fire lines when hindered by heavy smoke. From the vantage point of space, satellites can quickly collect images of the fire line over the smoke, and this visual data can be used to help incident commanders plan where to drop fire retardant, direct firefighters, and prioritize evacuations.



This image from NOAA's GOES-17 satellite depicts heat signatures from wildfires across the western United States in September 2020.

During fires, satellite instruments are used to measure physical properties like heat intensity, burn extent and air quality, and can provide images of smoke, fire lines, and cloud cover every five to 15 minutes. Polar-orbiting satellites like NASA's Aqua and Terra survey the planet several times a day and aid in fire forecasting and management around the world. Satellite instruments and light detection and ranging (LiDAR) systems

can also monitor air quality and predict wildfire smoke movement by tracking visible and infrared data from harmful particles in the air.

Space also plays a key role in protecting against wildfires before they begin. Predicting potential fire conditions is essential to managing, or even preventing, wildfires. Space-based instruments are currently used to identify and map fuels for fires, such as dry brush, and measure moisture in the soil and plant life. The Landsat 8 and Landsat 9 visible and short-wave infrared (SWIR) Operational Land Imaging (OLI) instruments provide vegetation characterization and help determine the extent of vegetation stress before wildfires. Instruments like NASA's ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) are used to monitor thermal wavelengths and evapotranspiration from plants and soil. This data can be used to identify predictive fire conditions such as drought and high temperatures, as well as pinpoint at-risk regions of dry brush or infrastructure. Additionally, NOAA's Geostationary Operational Environmental Satellite (GOES) can track lightning strikes, which are responsible for many backcountry wildfires, and NASA's Jet Propulsion Laboratory is currently developing a satellite system of orbiting thermal sensors that will be able to detect fires once they spread over 35 feet and within 15 minutes of ignition. After wildfires burn out, satellite systems provide measurements of erosion, burned area extent, and landscape and inland waterway degradation.

What is next for using space technologies to fight wildfires?
In 2021, NASA Administrator Bill Nelson announced a new wildfire initiative for the agency. This initiative includes plans for a new Earth Information Center that will help to provide actionable open-source data on Earth's water, land, fire, and climate, as well as new wildfire management programs within NASA's Earth Science Division. In 2022, NASA's Earth Science Technology Office (ESTO) launched the FireSense Technology program, which will coordinate NASA science and technology applications while developing new sensors and information systems for managing wildfires.

Maintaining consistent funding support from U.S government, and therefore support for the continuity of these programs, is crucial for wildfire resilience. The President's budget request for fiscal year 2024 proposed continued investment in future earth observation technologies, including $1.786 billion for the U.S Geological Survey, which will support the Landsat Next program. The budget's almost $2.5 billion for NASA's Earth Science includes the Earth System Observatory (ESO) which will provide open access to actionable data and information on climate change and earth systems data. Additionally, the budget request also totaled $2.97 billion for the USDA Forest Service wildland fire and hazardous fuels management, and $1.33 billion for the Department of the Interior's (DOI) wildland fire management.

Fires are a natural reality of life on earth. They are beneficial to the regenerative ecological health of a region, and controlled burns can help to regulate dry conditions and prevent unchecked wildfires. However, climate change is extending the wildfire seasons and increasing their severity, and staying ahead of these fires will demand strengthening in our ability to respond. To meet this demand, space-based technologies are advancing the firefight, and will continue to provide support for life on earth from the vantage point of space.