DHS S&T Wildland Fire Sensors R&D

July 2023

SCIENCE AND TECHNOLOGY DIRECTORATE (S&T)
WILDLAND FIRE SENSORS R&D

Threat: Wildland fires are a clear and present danger to the U.S. and the world.

Response: S&T is developing and testing a new form of wildfire sensor that detects near-term ignitions.

R&D Status: Two small business industry partners deployed 200 Alpha phase sensors in the U.S., Canada, and Germany with promising early results, including several wildfires identified within 30 to 60 minutes of ignition.

Milestones: Alpha Phase concludes at the end of 2023. Beta Phase 1 launches in 2024 with enhancements to artificial intelligence (AI) algorithms, form factor, user interface, communications infrastructure, and power source. The current plan is to deploy approximately 200 additional sensors in 2024 for operational testing and evaluation.

LANDSCAPE—WILDFIRE IMPACTS
The Costs and Losses of Wildfires
National Institute of Standards and Technology (NIST)
Special Publication (NIST SP) − 1215
November 2017

"The annualized economic burden from wildfire is estimated to be between \$71.1 billion to \$347.8 billion (\$2016 US). Annualized costs are estimated to range from \$7.6 billion to \$62.8 billion. Annualized losses are estimated to range from \$63.5 billion to \$285.0 billion." *

*The economic burden is decomposed into 1) intervention costs; 2) prevention/preparedness, mitigation, suppression, and cross-cutting; and 3) into direct and indirect wildfire related (net) losses.

Wildfire smoke PM2.5 and mortality in the contiguous United States
By National Institute of Health/National Library of Medicine (NLM)
February 2023

"In recent years, wildfire contributed to up to 25% of fine particulate matter ($PM_{2.5}$) across the U.S., and up to half in some Western regions…study found that about 1,141 deaths per year were contributed by wildfire smoke $PM_{2.5}$ in the contiguous U.S."

NLM map of monthly county-level mean wildfire smoke PM2.5 concentration and annual average attributable all-cause mortality burden in the contiguous U.S., 2006-2016
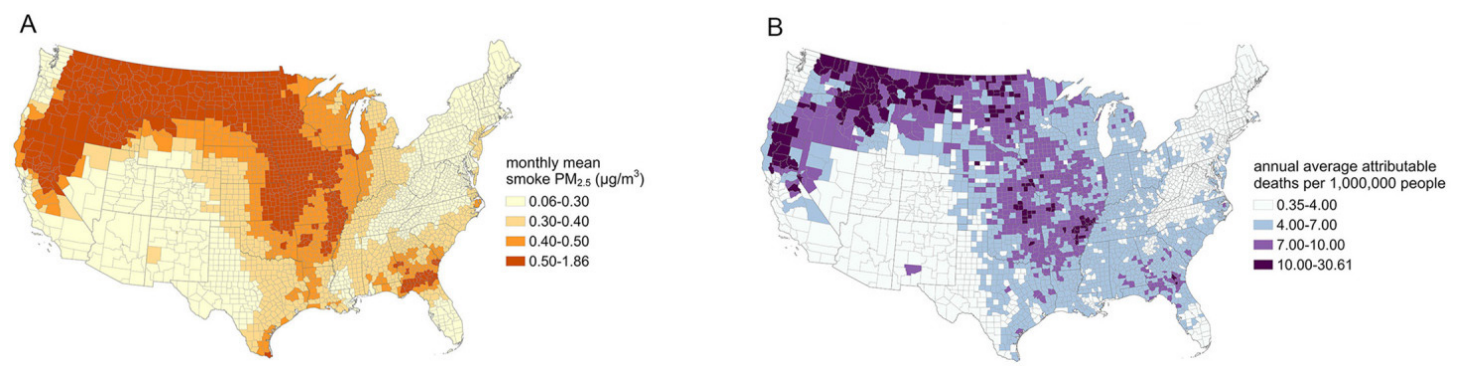

A: The distribution of monthly mean smoke $PM_{2.5}$ in contiguous U.S. counties (µg/m³). **B:** The distribution of annual average all-cause mortality burden attributable to wildfire smoke $PM_{2.5}$ in contiguous U.S. counties (deaths per 1,000,000 people).

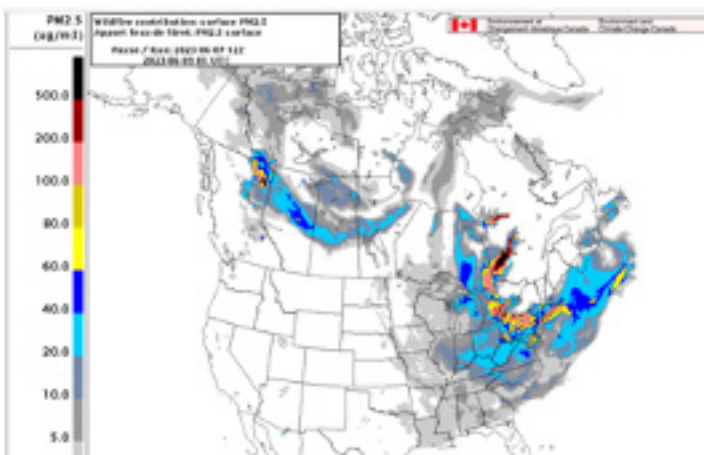**June 7-10, 2023 Canadian Wildfires and PM$_{2.5}$ impacts on the U.S.**

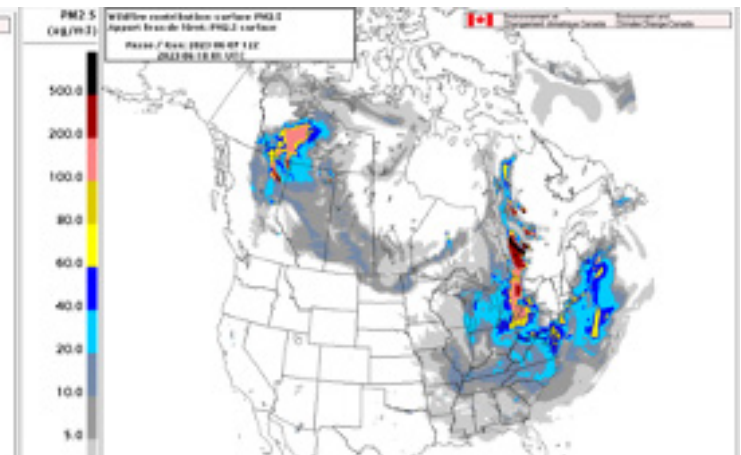[Smoke forecast maps captured via Canada's Wildfire Smoke Prediction System website](#)
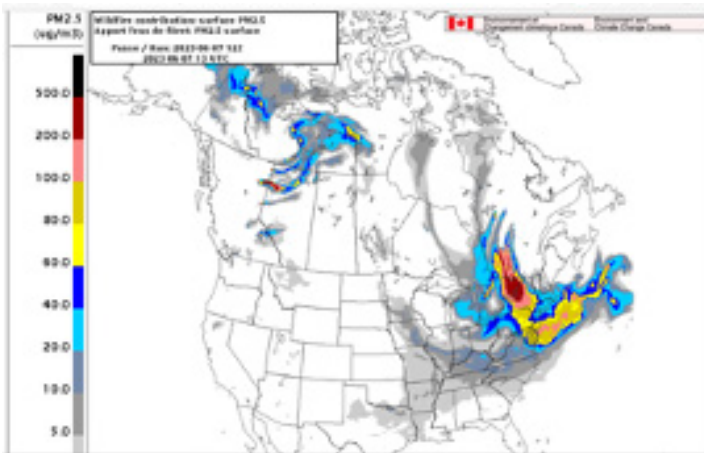
June 7, 2023
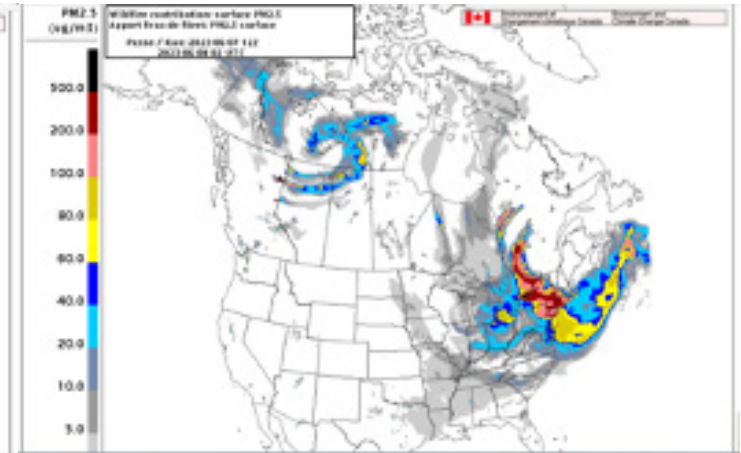
June 8, 2023

June 9, 2023

June 10, 2023

S&T R&D RESPONSE

[Fire Sensor Technology (Video)](#)

S&T has engaged in a novel research approach, as opposed to more traditional methods where sensors use optical (visible/near-infrared spectrum) to identify existing wildfires burning. The S&T sensors detect elements found in wildfire conditions, including particulate matter microns (PM2.5, PM5.0, and PM10) and environmental air quality conditions and gases (e.g., temperature, humidity, NOx, SOx, and O3). AI algorithms are used to compare ambient background conditions against wildfire elements to provide warnings if levels are elevated and alerts if spikes of concentrations are detected. Internal batteries are recharged through solar panel energy harvesting with LTE cellular network communications. A web portal and graphical user interface allow stakeholders to review sensor performance, download data, and receive text and email notifications for the warnings and alerts.

SENSOR FIELD EVALUATION

The 200 initial Alpha Phase sensors have had intermittent deployments over the past 6 to 9 months with stakeholders in state, local, and international government, as well as not-for-profit partners. Early assessment of the design testing has yielded promising results, with two examples provided below.

Defence Research and Development Canada (DRDC)

20 sensors deployed to Canadian Forces Base Valcartier in Quebec were successful in detecting an initial prescribed burn that took place on May 29, 2023, as well as wildfires that started as a result of training exercises on the base on May 13 and May 23.
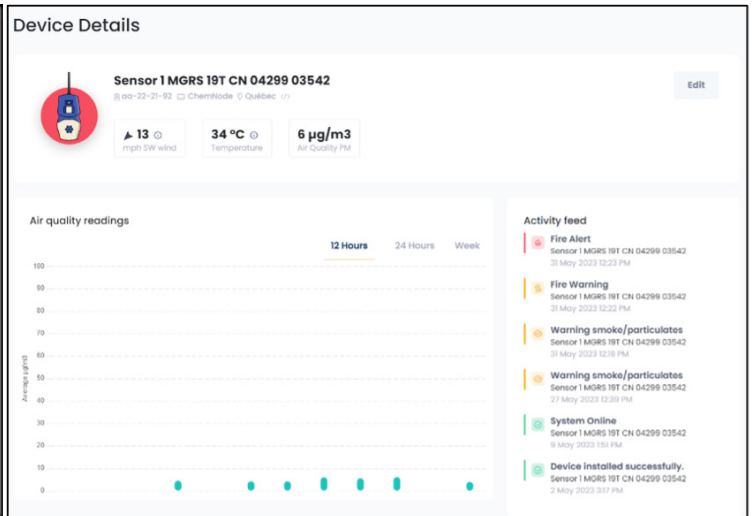

Wildfire Warning (yellow) and Wildfire Alert (red)

Wildfire Ignition and Wind Direction/Speed

**Particulate Profile Concentration vs. Time**

Wildfire Warning and Alert Dashboard

Gilpin County, Colorado

The U.S. Forest Service and Gilpin County, Colorado, performed controlled burns in February 2023. S&T wildfire sensors remained after the fires were extinguished. Later that night, a flare-up occurred, resulting in a 911 dispatch call 37 minutes after the sensors had already detected and notified the local Gilpin County fire department.
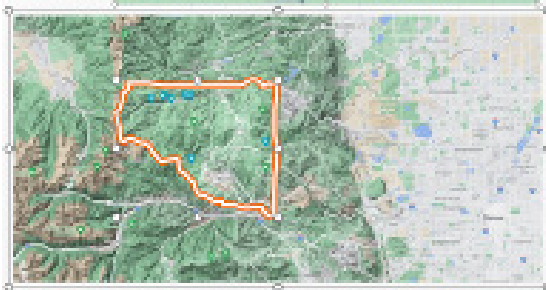
Sensor Deployment Gilpin County CO.

Controlled Burn Flare Up & Sensor

911 Dispatch