NOAA Fire Weather Testbed Launches First In-Person Evaluation

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Wildland fire presents complex, time-sensitive, and uncertain decision spaces wherein fire and emergency management agencies use various fire weather–related information sources to assess their interplay with other aspects of the fire environment, all while considering local context, response capacity, and identified risks to life and property. The National Weather Service (NWS) and other purveyors of fire weather–related information support emergency and land management partners by providing observations, models, tools, and workflows that enhance impact-based decision support services (IDSS) before, during, and following wildland fires. To support innovation and address growing needs in the fire weather space, an operations-to-research-to-operations testbed focused on wildland fire weather from physical and social science perspectives is crucial to address the challenges of the fire environment (weather, fuels, and topography) and to protect critical assets. In response, the National Oceanic and Atmospheric Administration (NOAA) established the Fire Weather Testbed (FWT) at NOAA's Global Systems Laboratory (GSL) in Boulder, Colorado, in 2023, with support of the Bipartisan Infrastructure Law, the 2022 Disaster Relief Supplemental Act, and congressionally allocated base funding (https://gsl.noaa.gov/fire-wx/fire-weather-testbed). The FWT provides opportunities for both coordinated and disparate groups with the shared mission of fire management to collaboratively assess emergent fire weather–related products and services.

The FWT is a "knowledge translation platform" that connects end users (e.g., NWS meteorologists, state, federal, and tribal land managers, and emergency managers) with researchers developing fire weather–focused technologies, tools, and products. Scientific integrity, user and developer engagement, and transdisciplinarity are core FWT values, ensuring that evaluations and recommendations are objective, creative, scientifically rigorous, operationally actionable, and contextually appropriate. To achieve this, the FWT integrates physical and social sciences to understand the complex and interconnected technical and human aspects of fire management influencing decision-making in uncertain situations. To facilitate engagement between and information gathering from participating end users and developers, the FWT applies social and behavioral science principles and data collection activities (e.g., focus groups, surveys, roundtable discussions) informed by the FWT's operational and research meteorology experience. Knowledge gleaned

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Evaluation outcomes include recommendations for user-centered product development and refinement leading to improved fire weather–related IDSS, workflows, and communication between meteorologists, other scientists, fire partners, and the public.

through these integrative activities aims to advance fire weather observation, prediction, and communication capabilities by grounding evaluated information, products, and services within characteristic end-user situations.

Specifically, the FWT designs and conducts objective, third-party evaluations of fire weather products and services by gathering, analyzing, and synthesizing end-user feedback for product developers. Evaluation design centers on understanding the function, dependability, and social factors involved in accelerating development, prototyping, and delivery of new products and services into varied operational environments. Evaluation outcomes include recommendations for user-centered product development and refinement leading to improved fire weather–related IDSS, workflows, and communication between meteorologists, other scientists, fire partners, and the public. The first FWT evaluation of the Warn-On-Forecast System's (WoFS) wildland fire-focused products occurred virtually in November 2023 and included seven participants, four of whom are active incident meteorologists. This evaluation began with training from WoFS developers, included four scenarios to evaluate new WoFS fire weather–focused capabilities spanning the prefire, during fire, and postfire environments, and concluded with an FWT-facilitated focus group discussion. Findings suggest WoFS provides actionable probabilistic information supporting many fire-related management aspects in rapidly changing environments and complements existing operational products, but it will require additional computational resources and visualization capabilities to ensure reliability and usability. While this virtual evaluation showcased the FWT's conceptual approach, here, we highlight the FWT's first multiday in-person evaluation in June 2024.

The evaluation brought together NWS fire weather meteorologists and state fire management partners to evaluate the use and utility of (i) the Next Generation Fire System (NGFS; https://cimss.ssec.wisc.edu/ngfs/), an automated satellite-based fire detection capability developed by NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) and the University of Wisconsin–Madison accompanied with text message–based hot spot (detection) notifications disseminated by NWS meteorologists to partners; (ii) an extension of the integrated warning team (IWT) for fire operations; and (iii) the extended IWT approach to collaboratively issuing Fire Warnings between NWS and partners.

The FWT evaluated the collaborative, interagency detection-to-warning process that centered on the IWT concept. Originally, IWTs aimed to improve hazard messaging and to promote mitigating actions through partnerships between NWS meteorologists, decision-makers, and media representatives. Through interagency partnerships, IWTs build the trust essential for effective IDSS to enhance consistency and improve the dissemination of hazard messaging.

Traditionally, IWTs operated through intermittent meetings and workshops. Wildfire's multidisciplinary, multijurisdictional, and fast-moving nature makes it an ideal application for extending the IWT paradigm by increasing the frequency of interactions to continually assess the fire environment to drive timely and unified wildfire response and messaging. This "tactical IWT" approach was first implemented during 2022 in the southern Great Plains. The approach involves a coordinated workflow incorporating (i) prefire multiagency coordination of fire environments, (ii) remote sensing–based fire detection, (iii) ground-truth corroboration of wildfire, and (iv) requests by state land management agencies for Fire Warning dissemination from the

NWS using its communication infrastructure. Following these successful demonstrations, the NWS is exploring expanded implementation of tactical IWTs nationally across all Weather Forecast Offices.

To explore potential expansion, the FWT's evaluation assessed the end-to-end fire detection, notification, and warning workflow within the tactical IWT framework during past wildfire scenarios (Fig. 1). The evaluation's success hinged on the active participation of both NWS meteorologists and fire managers working in teams to reflect an operational environment. The FWT invited participant teams from California, Florida, Kansas, and North Carolina to capture a range of fire management agency resource capacities and experiences.

With support from Oklahoma Forestry Services, NWS Norman, NWS Warning Decision Training Division, NESDIS, the University of Wisconsin, and the Warn-On-Forecast team at the NOAA National Severe Storms Laboratory, the FWT developed displaced real-time simulations (i.e., participants fill the role of an NWS meteorologist and corresponding fire management partner during a simulated wildland fire event that played forward at normal speed, allowing participants to experience the event as if in real time) of wildfire events using the Weather Event Simulator (WES), model forecasts, observational data, and information sourced from after-action reviews, news articles, and social media. The support team provided training on tools, workflows, and past experiences. Wildfire events in Colorado, Kansas, New Mexico, Oregon, Oklahoma, Texas, and Washington were selected to assess applicability across fire environments. While these wildfire events were characterized by rapid spread due to strong winds and receptive fuel conditions, specific fire environments varied, and not all events met local Red Flag Warning criteria. Given the immediate threats to life and property, these events created

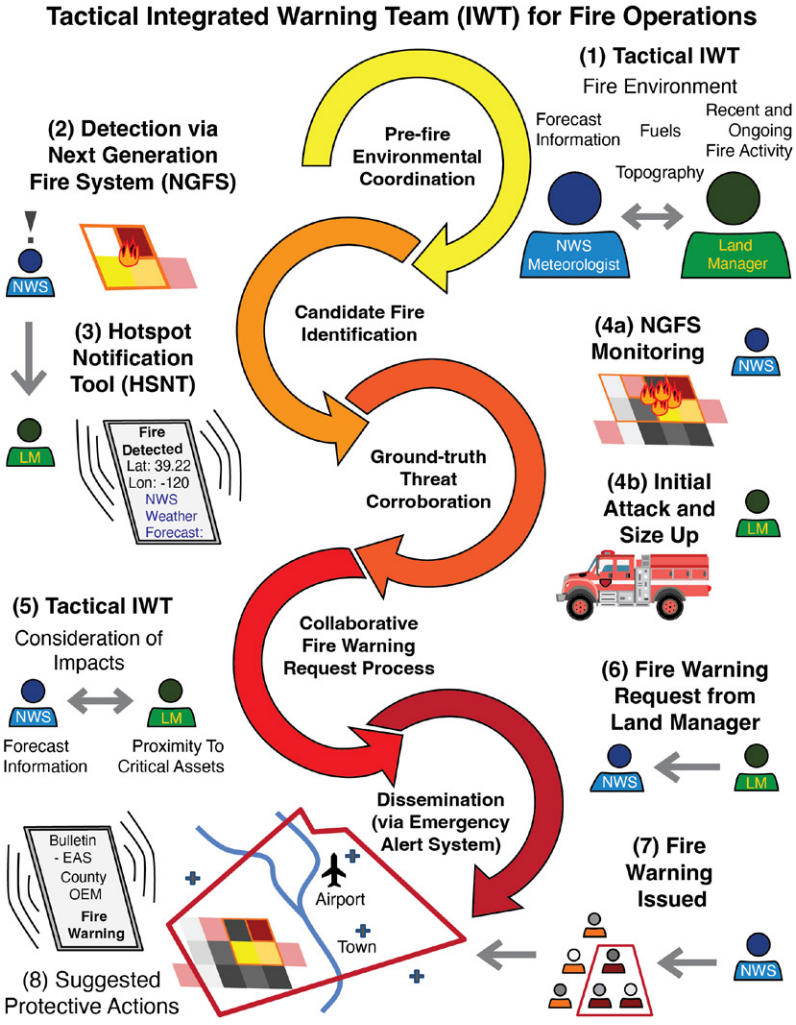

Fig. 1. Schematic of the workflow for the tactical IWT for fire operations adapted from research by Todd Lindley et al. published in 2024 to encompass the evaluated products (NGFS, hot spot notification tool) and processes (interaction of tactical IWTs, monitoring and initial attack, Fire Warning request and issuance) spanning the steps from prefire coordination to the issuance of Fire Warnings. Evaluated steps 1–7 are bolded; suggested protective actions or language expressed in the issuance of Fire Warnings were not evaluated (step 8; not bold).

ideal scenarios for participants to consider issuing Fire Warnings. Each simulation followed a workflow utilizing the products and processes under evaluation (Fig. 1).

Participants provided feedback on the products and processes through daily roundtable discussions, surveys, and guided focus group discussions, leveraging the

Fig. 2. The evaluation included (a) training, (b) simulations using the IWT approach where meteorologists relayed fire detections and weather conditions to fire managers via (c) chat and hot spot notification tools and (d) culminated in collaboratively issued Fire Warnings followed by (e) end-of-day roundtable discussions. (f) A field trip with guest speakers from first responders and researchers visited key locations of Colorado's 2021 Marshall Fire including one of the fire's two ignition origin locations, one of the wildland–urban interfaces (g) where the fire transitioned to an urban conflagration and (h) where postfire urban hydrological measurements occur.

FWT team's social science expertise (Fig. 2). Given the in-development nature of the products and services under evaluation, the FWT focused on collecting exploratory, qualitative data on participants' use of each product throughout the evaluation and their perspectives on the associated strengths, challenges, and opportunities for implementation. Postevaluation surveys were included to elicit participant feedback and recommendations for future FWT participant experiences and evaluation design.

The next phase of transitioning operations-informed research back into operations involved the FWT's qualitative coding and thematic analysis of the focus group, survey, and roundtable discussion data, along with analyzing hot spot notification points and the 74 Fire Warning polygons issued by the four tactical IWTs throughout the simulations. Our results highlight that by advancing the capabilities to detect and notify fire managers of new ignitions via the evaluated tools. By strengthening the interagency collaborative mission space to assess the fire environment (i.e., the tactical IWT approach), the NWS and its partners can improve their ability to save lives and protect property (the mission of the NWS). Enhanced collaboration and communication between fire managers and the NWS have the potential to increase their situational awareness as well as that of emergency responders and the public by facilitating unified messaging. However, evaluation findings also point toward the challenges of building tactical IWTs in new regions and implementing a new paradigm for Fire Warnings throughout the country. Detailed evaluation findings and recommendations are expected to be released in summer 2025 and intend to inform the direction and improvement of NOAA's satellite fire detection and dissemination capabilities and the implementation of tactical IWTs to support fire management. ●

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Data availability statement.

Comprehensive evaluation information, including the evaluation schedule, survey and focus group questionnaires, participant data, anecdotes, and feedback, as well as recommendations are documented in the full evaluation report (expected in summer 2025 and available at the NOAA Institutional Repository: https://doi.org/10.25923/4pqf-7g49).

FOR FURTHER READING

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