

# WILDLAND FIRE DECISION SUPPORT SYSTEM AIR QUALITY TOOLS



***A new air quality portal provides wildland fire decisionmakers with access to a variety of real-time and forecast air quality information.***

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Smoke and air quality information have an important role in wildland fire decisionmaking that is reinforced in the 2009 “Guidance for Implementation of Federal Wildland Fire Management Policy.” A key intent of the guidance is to allow consideration and use of the full range of strategic and tactical options that are available in the response to every wildland fire. This guidance directs that wildland fire responses will be developed through evaluations of situational assessment and analysis of hazards and risk. It also defines implementation actions and directs documentation of decisions and rationale. Smoke and air quality are now among the top issues in decisionmaking, both on wildfires (unplanned ignitions) and prescribed fires (planned ignitions).

The Wildland Fire Decision Support System (WFDSS) is a new Web-based system designed to integrate science and technology in support of risk-informed decisionmaking

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for wildland fires. This system currently incorporates access and use of numerous datasets and models, including weather analyses, fire behavior prediction tools, economic assessment tools, and landscape data acquisition and analysis processes, to provide users with critical information when making decisions on wildland fires. WFDSS replaces three past wildland fire decision analysis and documentation systems as a single system applicable for all wildland fires. Developed over the past 4 years, this system was delivered for use in 2009, but Federal agencies have chosen to implement it on an agency-specific and sometimes phased-in approach. Since April 2009, use of WFDSS has resulted in documentation and analysis for more than 7,500 wildfires by the five Federal wildland fire management agencies and by 17 States and Alaska Native corporations in partnership with Federal agencies. This fire season, all five Federal wildland fire agencies are implementing WFDSS to a much greater degree and some require WFDSS on all wildland fires.

Air quality is a human health and safety factor related to all fire, and

air quality tools are needed as part of the decision analysis and documentation process to support management decisions on unplanned as well as planned ignitions. In response to recent medical findings, the U.S. Environmental Protection Agency (EPA) has strengthened virtually all air quality standards. The increase in wildfire activity and emissions along with the need to increase the use of prescribed fire present a substantial challenge in meeting those standards. This challenge further supports the need and use of air quality tools, particularly on long-duration wildfires, which are well-suited for air quality analyses to address public and air regulatory concerns regarding smoke impacts. Geographic information system (GIS) layers like the EPA National Ambient Air Quality Standard (NAAQS) nonattainment areas are being incorporated into WFDSS along with the creation of a new WFDSS Air Quality component (WFDSS-AQ) to assist in those analyses.

## WFDSS-AQ

The goal of WFDSS-AQ is to advance decisionmaking through the acquisition, analysis, and con-

sideration of air quality information. Decisionmakers linked to the larger collection of available air quality tools can markedly improve situational analyses and outcomes.

Currently, WFDSS-AQ is a stand-alone Web portal where users can access specific air quality tools as needed to gain a variety of informa-

tion. Version 1.0 is now available in beta version as an experimental design that can be accessed directly through the Web (<<http://firesmoke.us/wfdss>>) or through a link from WFDSS. The WFDSS-AQ will be evaluated based on user feedback throughout the 2010 western wildfire season. User comments are encouraged and can be

submitted via a feedback form at the bottom of the portal window.

Eight air quality tools are available through the WFDSS-AQ portal covering the contiguous United States. Future iterations will include additional tools as well as regional components and increased data integration with WFDSS.

Users can filter the eight air quality tools available on WFDSS-AQ using the following attributes to meet their specific needs:

- **TEXT-BASED:** the information returned from the tool is provided as text;
- **GRAPHICAL:** the information returned from the tool is provided graphically, generally as a map or time series;
- **ATMOSPHERIC CONDITIONS:** the tool provides information about the state of the atmosphere (weather, climate) that can be used to infer air quality conditions or potential dispersion of smoke;
- **SMOKE:** the tool provides information on smoke concentrations directly (forecasted or observed);
- **INSTANT ACCESS:** information is returned from the tool immediately, generally with “one-click” access from the portal;
- **EASY TO USE:** a subjective assessment of the air quality tool’s user interface—those marked as such have little or no learning curve required to access data;
- **LOCALIZED:** the tool utilizes the fire location from WFDSS to provide information local to the fire;
- **REGIONAL:** the tool utilizes the fire location from WFDSS to provide information from a regional area around the fire; and
- **INTERACTIVE:** the tool’s interface allows the user to manipulate parameters, input data, and rerun the underlying model, thereby allowing the user to interact with the tool’s model and customize results.

Additionally, a second set of attributes is assigned based on the time period of the information presented by the tool:

- **USES CLIMATOLOGICAL DATA:** for tools that utilize and provide historical information;
- **CURRENT CONDITIONS:** for tools that provide the real-time (or near-real-time) conditions;
- **7 DAY+ FORECAST:** for tools that provide forecasts extending into the future 7+ days;
- **3 DAY+ FORECAST:** as above, but for forecasts extending 3+ days (note that all tools meeting 7 DAY+ FORECASTS will also be listed in this attribute); and
- **1 DAY+ FORECAST:** as above, but for forecasts extending 1+ days (note that all tools meeting 3 DAY+ FORECASTS will also be listed in this attribute).

Each tool is listed on the page with a number of attributes that can help the user filter down to those tools that meet his or her specific needs (see sidebar).

## Included AQ Tools

### Smoke Guidance Point Forecast and Smoke Guidance Regional Maps

Many different pieces of information available from weather and smoke forecast models are relevant to air quality. These include simple measures such as mixing height and transport winds as well as derived quantities such as the Haines index, all of which are important for understanding a fire’s potential smoke impact. These tools, from the National Fire Consortia for the Advanced Modeling of Meteorology and Smoke (FCAMMS) and hosted at the Desert Research Institute (DRI), provide a single point of access to a variety of these elements. This can inform decisionmakers about fire and smoke activity that may influence their respective area. Fine particulate matter (PM<sub>2.5</sub>) smoke concentration values are also available through forecasts enabled by the BlueSky Smoke Modeling Framework using SMARTFIRE fire information (reflecting primarily wildfires). The Point Forecast tool produces a text summary listing of smoke dispersion parameters for

the location of the fire (fig. 1a), while the Regional Maps can be viewed at either regional or national (CONUS) scale (fig. 1b). Both tools utilize National Weather Service model forecast guidance available at 7.5-mile (12-km) resolution out to 3 days and 25-mile (40-km) resolution out to 7 days.

### Diurnal Surface Wind Pattern Analysis

Wind speed and direction can be critical factors affecting air quality impacts. This tool, provided by DRI's Western Regional Climate Center, provides climatological wind roses from the collected network of remote automated weather stations (RAWS) for the site nearest

a fire. The wind roses are divided into day and night, utilizing the full period of the RAWS data record to develop the climatology (fig. 1c). The bars on the wind rose represent the percentage of time from that direction, and the color indicates the percentage of time that particular range of speed occurs.

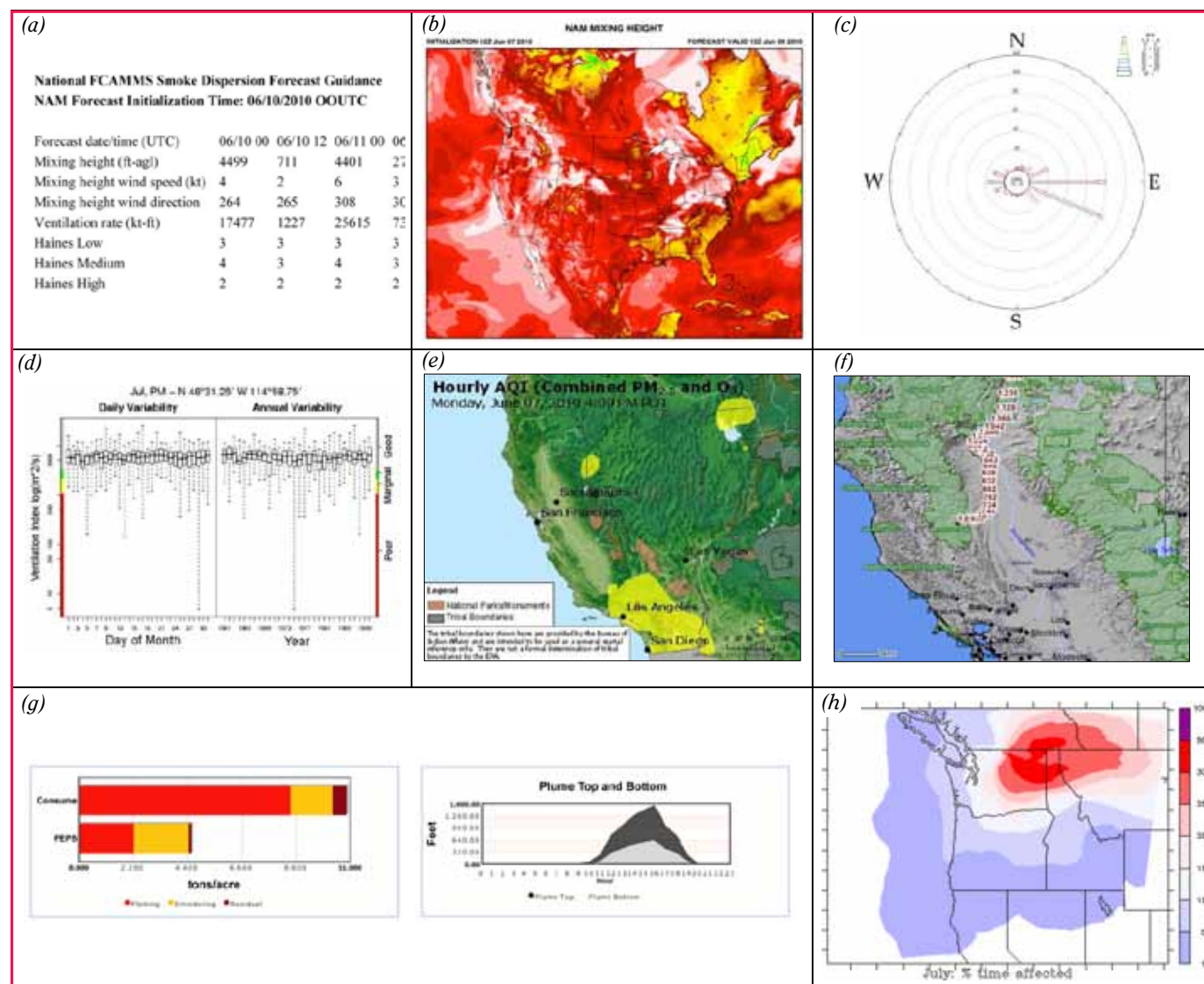


Figure 1—Examples of air quality information accessible through the WFDSS-AQ portal: (a) point forecast text table of weather and smoke information; (b) national map of mixing height [from National FCAMMS]; (c) daytime wind rose [from RAWS station data]; (d) climatology summary of ventilation index values [from VCIS]; (e) current conditions map of hourly AQI [from AIRNow]; (f) custom trajectories from fire locations [from SMARTFIRE Viewer]; (g) custom fuels, plume, and dispersion modeling [from BlueSky Playground]; (h) custom probabilistic impact maps based on climatological weather [from AQUIPT]. Additional types of output are also available.



## How To Use the WFDSS-AQ Site

Access the WFDSS-AQ portal site from WFDSS or by going directly to <<http://firesmoke.us/wfdss>>. In WFDSS, select *Fire Related Links* under the Information Tab, then select *Weather Related Links* and *Air Quality* and follow the steps below.

### Step 1: Check your location of interest

Upon arriving on the Web site, check (or enter, if not accessing through WFDSS) the location of interest (usually the location of the active fire) using a Google Maps interface or by entering the latitude and longitude.

### Step 2: Select your tool(s)

After the fire location information is set, scan down the list of tools. This list can be filtered to meet the user's requirements by selecting the pertinent attributes. Each tool is briefly described through a listing that shows: the name of the tool; a tag line describing what the tool provides; the organization that created and runs the tool; a minigraphic of sample output; a bulleted listing of the models, data, and other highlights of the tool; and a list of attributes assigned to the tool (see image below). The WFDSS-AQ help section on the side or at the bottom of the screen describes in further detail some potential uses for the tool's information output, caveats on the limitations and assumptions of the tool, and how to navigate the tool's Web site. At the bottom of the listing is a button that takes the user to the tool's site and attempts to drill down, set common controls, and—whenever possible—present the user with useful information via a single click.



The WFDSS-AQ portal (<http://firesmoke.us/wfdss>). The site can be accessed from within WFDSS, or as a stand-alone portal for other purposes, such as training.

### Climatological Ventilation Index Point Statistics

Ventilation index, the product of mixing height and surface transport wind speed, is useful for understanding the ability of the atmosphere to remove smoke from the local area—the higher the ventilation index, the greater the rate that smoke is cleared from the local area. This tool provides a 40-year climatology of mixing height, surface transport wind, and ventilation index via the Ventilation Climate Information System (VCIS) developed by the Forest Service AirFire Team. It shows typical conditions at the location (based on modeled winds and interpolated mixing height fields), which can serve as a guide for planning purposes or to discern how unusual current conditions are. The information is depicted at a 3.1-mile (5-km) resolution across CONUS, and several different graphical summaries of point location are available for each calendar month (e.g., fig. 1d).

### Current Air Quality Conditions Map

A number of regional air quality monitoring networks exist that monitor conditions related to the NAAQS standards, such as PM<sub>2.5</sub> or ozone concentrations. Air quality data from most Federal, State, and local government monitors are collected via the EPA's AirNow program. The data from these sites are presented via maps showing the air quality index (AQI) equivalent values (fig. 1e). An AQI of green ("good") or yellow ("moderate") is below the NAAQS level, while orange or above represents the potential for health impacts for various groups. WFDSS-AQ currently accesses information available to the public, but work is underway to enable WFDSS users to access all the monitoring data and techni-

cal tools in EPA's AirNow program. Both national and regional maps are available.

### **Fire-Specific Smoke Trajectories**

Smoke trajectories can provide a quick way to examine the likely geographic extent of plume impact. This tool, provided by the SMARTFIRE Viewer created by the Forest Service AirFire Team and Sonoma Technology, Inc. (STI), allows the user to create trajectories on a while-you-wait basis, with response times of just a few seconds. Although they lack the spread of a full-plume model, these trajectories, coupled with the tool's ability to quickly create many different trajectories from nearby starting locations, can provide the user with a quick look at a fire's likely smoke transport. The tool is provided via a Web-based customizable GIS viewing system that allows the user to see fire location information from ground reports, satellite detects, and sensitive receptor locations (fig. 1f). The trajectories are run using the National Weather Service's meteorological model guidance forecast and the HYSPLIT model. The viewer provides multiple zoom levels and background layers for viewing purposes.

### **Customized Fuels, Consumption, and Smoke Modeling**

One of the most complex tools available through WFDSS-AQ, the BlueSky Playground by the Forest Service AirFire Team and STI, features a relatively simple interface (fig. 1g) that allows the user to walk through a series of steps: from fire activity information through fuel loading, fire consumption, fire emissions, and plume rise, all the way to surface smoke concentra-

tions. At each step, the user can choose from a variety of embedded models (e.g., CONSUME 3 and FEPS for consumption), and directly edit the model inputs. All modeling is done while-you-wait, with response times generally under 1 minute. The user can go back, edit previous choices, and experiment with different models or model options, thereby gaining insight into model variability.

### **Probabilistic Smoke Impacts Based on Past Weather**

The most complicated modeling system available through WFDSS-AQ, this tool (based on the Air Quality Impacts Planning Tool [AQUIPT] by the Forest Service AirFire Team) is meant for advanced modelers with an understanding of statistics. The objective is to use historical weather information to build a probabilistic forecast of a planned fire or unplanned fire of long duration.

Such a forecast is most useful when the period of interest is multiple weeks to months into the future, when weather forecast models cannot predict the weather directly. Utilizing a 30-year climatology, the tool runs multiple scenarios of the planned fire for the period of interest. This period can be set by date conditions (e.g., the month of June or the last week in September) or identified based on standard meteorological burn parameters (e.g., ranges of wind speed, temperature, and relative humidity). The output is a statistical representation of the smoke impacts modeled from the fire during past periods that meet the specified conditions. In this way, the tool provides information on what the probabilistic impacts of a fire occurring during the specified

period would have been and can serve as a guide for what may occur in the future. Maps of average impact, maximum impact, and percent time above a threshold impact level (e.g., the NAAQS standard for PM<sub>2.5</sub>) are provided (e.g., fig. 1h).

## **Future Development**

The WFDSS-AQ portal is designed to better incorporate air quality tools into a larger decision support framework. It will continue to undergo evaluation and evolution based on user feedback and emerging requirements. More and better tools will be required in order to fully address air quality, especially given changing regulations such as the new lower standards for ozone under the NAAQS. Improved user interfaces, more tailored graphics, and a closer integration with WFDSS will be necessary to enable users to access and utilize air quality information without undue burden. WFDSS-AQ is just the first step in this process, and we invite everyone to test out the WFDSS-AQ site and provide feedback.

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