Good Fire Weather

Benjamin J. Hatchett,[a,b] Emily M. Wells,[a,b]

[a] *Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado, USA*

[b] *Affiliate working on a cooperative agreement/grant with NOAA/Global Systems Laboratory, Boulder, Colorado, USA*

Corresponding author: Benjamin Hatchett, Benjamin.Hatchett@colostate.edu

ABSTRACT: Extreme fire weather receives substantial attention, yet conditions allowing readily manageable fire, or “good fire weather” remain less studied with no formal definition. We propose a qualitative definition of good fire weather as ”the set of atmospheric conditions before, during, and following ignition allowing wildland fire to achieve beneficial outcomes while minimizing hazards from fire and smoke.” We explain beneficial fire outcomes and share examples of the multiscalar challenges in observing and forecasting good fire weather to inform decision making using schematics, example tools, and a case study. Suggestions for ways the weather enterprise can support good fire weather forecasting are provided.

Keywords: Beneficial Fire, Fire Weather, Prescribed Fire, Wildland Fire

1. What Is "Fire Weather"?

Weather comprises a foundational component of the total fire environment, defined as "the surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behavior" (National Wildfire Coordinating Group 2025). Fire weather directly influences the probability of fuels igniting, all aspects of fire behavior (e.g., the rate of fire spread, fire intensity, flame length, and flame height) and the strategies and tactics used for fire suppression (National Wildfire Coordinating Group 2025). Fire weather is commonly evaluated using near-surface air temperature and relative humidity as well as low-level stability, wind speed and direction at various heights, radiation, cloud cover, and precipitation.

2. When Is Fire Weather "Good"?

Good fire weather creates an environment allowing readily manageable fire behavior. This environment facilitates safely achieving wildland fire management objectives by minimizing extreme fire behavior (Werth et al. 2011). Wildfires often burn during good fire weather producing a mosaic of beneficial effects; they are also more easily suppressed during good fire weather. During wildfires, protecting life and property is a key objective. Management objectives vary when fires are determined to provide benefits or are ignited intentionally for beneficial outcomes. Location, fire history, the season, and community as well as ecological needs influence objectives. These can include reducing fuels to lower wildfire hazard and producing ecological outcomes by reducing vegetation competition, mitigating invasive species, stimulating regeneration of fire-adapted species, improving soil health, and enhancing habitat (Figure 1a-b; Huffman et al. 2020; Hankins 2024). An equally valuable objective is increasing well-being through ecocultural stewardship (Hankins 2024). Beneficial fires lit by humans, including traditional, prescribed, and cultural fire, are planned to coincide with good fire weather to achieve these benefits. A range of temperatures, relative humidities, and winds both on and before the burn day can achieve fuel moistures yielding desired outcomes. However, conditions evolving over multiple weeks-seasonal timescales (and beyond) govern fuel moisture in live and dead fuels.

The parameters defining good fire weather (the "prescription") occupy a range (Figure 1a) but vary markedly depending on the location, fuel type, objectives, scale, and complexity of a burn. The weather must be sufficiently warm and dry to allow ignitions and fire spread but not so hot, dry and windy that a fire cannot be controlled with available holding resources. Good fire weather is therefore a “Goldilocks” situation (Lutz 2024), where weather and associated fuels conditions are often marginal by wildfire standards (Hiers et al. 2020). Wind often differentiates environments conducive to dangerous fire behavior versus an environment where fire can be readily managed. Un-forecast wind increases, shifts in wind direction, and rapid relative humidity decreases are common weather-related ingredients in prescribed burns that spot over control lines (Dether 2005). At best, fire outside the designated burn unit distracts from the beneficial fire mission and at worst leads to a wildfire declaration, additional resource expenditure, and poses hazards to values-at-risk. These weather changes can result from localized topographic and thermally-driven circulations or outflow from isolated moist convection that are poorly resolved by operational forecast models (Figure 1b). Yet some circumstances, such as in grassland or chaparral systems, dictate wind is required to carry fire across low-angle terrain. Once burning is winding down, cloud cover, increased relative humidity, and precipitation helps control fires during securement. Thus, good fire weather includes a temporal component to forecast both combustion-favoring and combustion-suppressing environments (i.e., a skillful multi-hour or multi-day forecast).

A complete definition of good fire weather includes an atmosphere that favorably transports and disperses pollutants. Minimizing smoke impacts from beneficial fire to human health, visibility, and agricultural production will ensure community support for burning (Figure 1b-c). During burning, an unstable vertical profile of temperature and presence of winds aloft allows smoke to rise and become available for transport and dispersion; the direction of transport will ideally transport smoke away from populated areas, roads or agriculture.

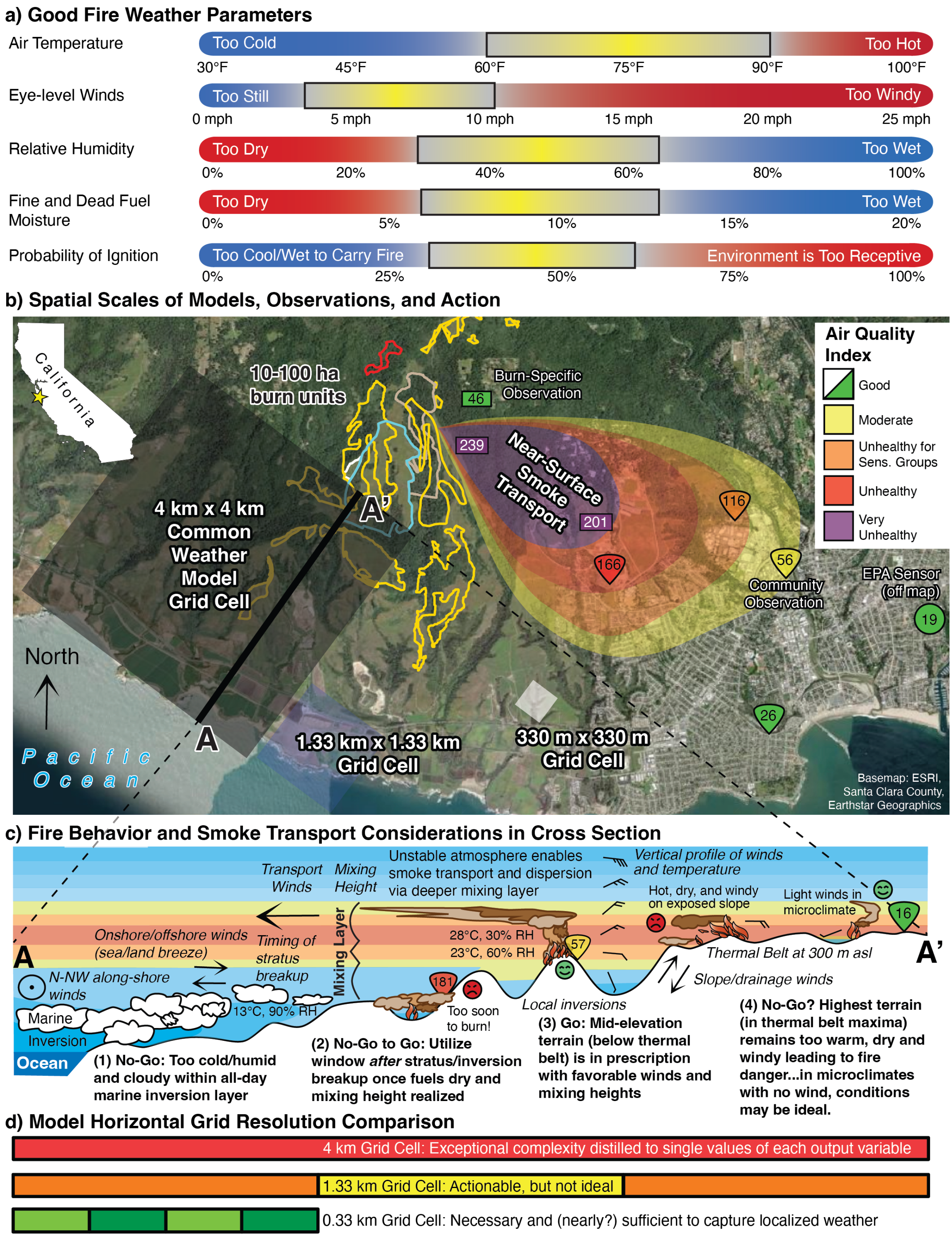


FIG. 1. Good fire weather requires understanding and skillful forecasting of numerous environmental components across the weather parameter space, highlighting the value of high-resolution observations and models. Nonetheless a mismatch occurs between the desired forecast precision and the reality of weather and fire behavior, especially in complex environments.

3. Examples Of Good Fire Weather

Because good fire weather occupies a middle-ground (“Goldilocks”) between weather extremes, the environment can quickly become unfavorable. Too cool and moist means insufficient consumption to meet objectives and may prove costly in terms of resources allocated to the burn. Conversely, the weather may abruptly turn hot, dry, and windy leading to unintended ecosystem responses associated with higher severity fire effects like crown scorch and inducing extreme fire behavior such as spotting, rapid fire spread, or fire whirls posing safety and containment concerns. However, microclimates can provide good fire weather refugia despite unfavorable conditions elsewhere (Figure 1c). Observations from a Remote Automatic Weather Station in Santa Rosa, California highlight an example of this variability during a spring 2025 period (Figure 2). Comparisons to hourly mean values calculated daily between 1991–2025 provide climatological context.

Near-to-slightly-below-average daytime temperatures and light winds on 30 April–3 May produced brief windows of good fire weather for prescribed burning. Elevated nighttime relative humidities provided recovery. Drier conditions on 3 May increased fine fuel availability to burn, though afternoon winds likely exceeded prescriptions. Above-average temperatures and below-average relative humidity on 4 May were in prescription but with a catch: warming continued with notable overnight drying and increased vapor pressure deficits into 5 May with the onset of gusty, offshore, downslope “Diablo” winds. Good fire weather returned on 6 May with in-prescription conditions before becoming colder, moister, and cloudier on 7 May. The lagged drying effect of the warm Diablo winds on 10 hr fuels and the subsequent recovery implies 6 May offered an optimal beneficial fire window.

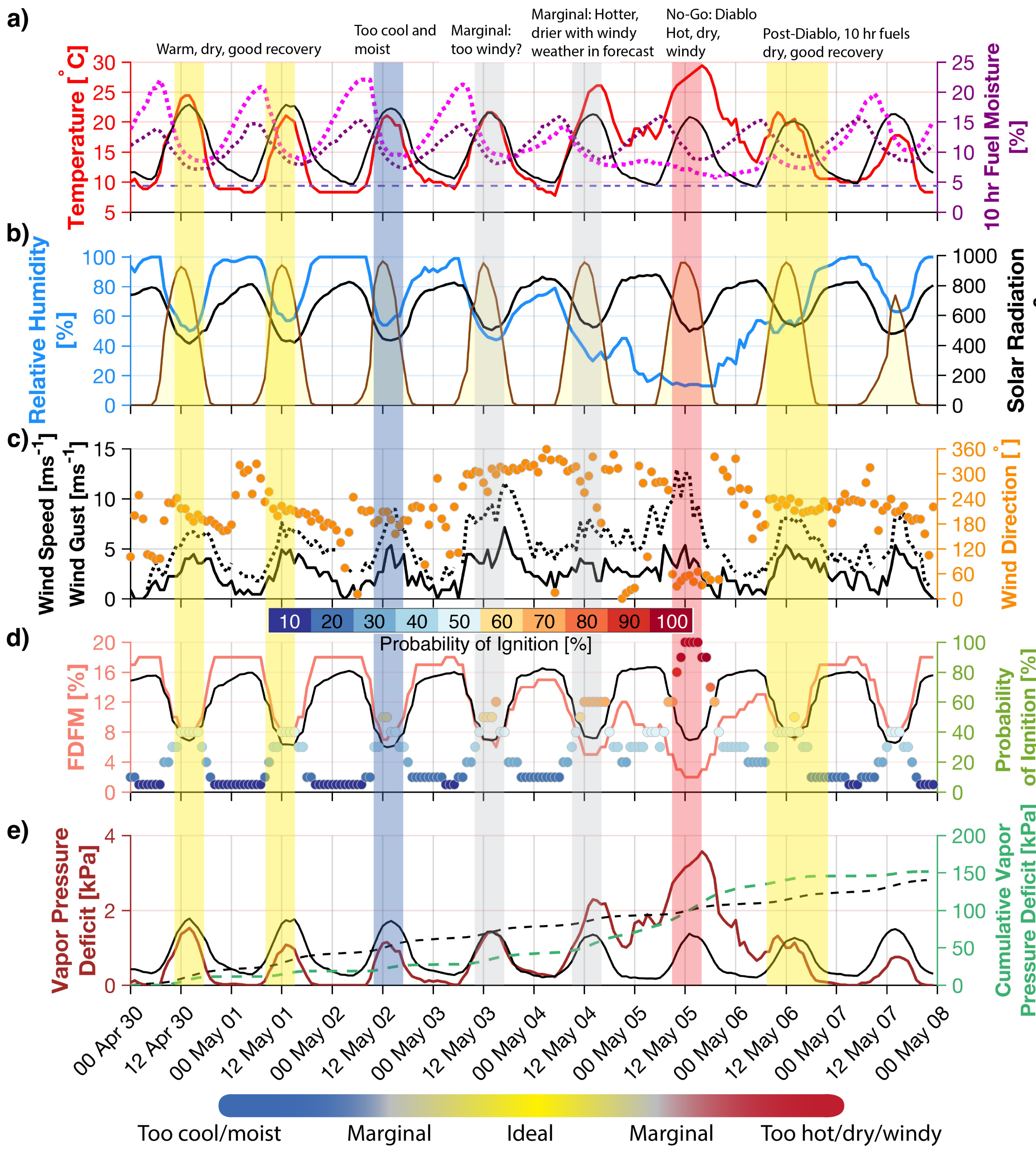
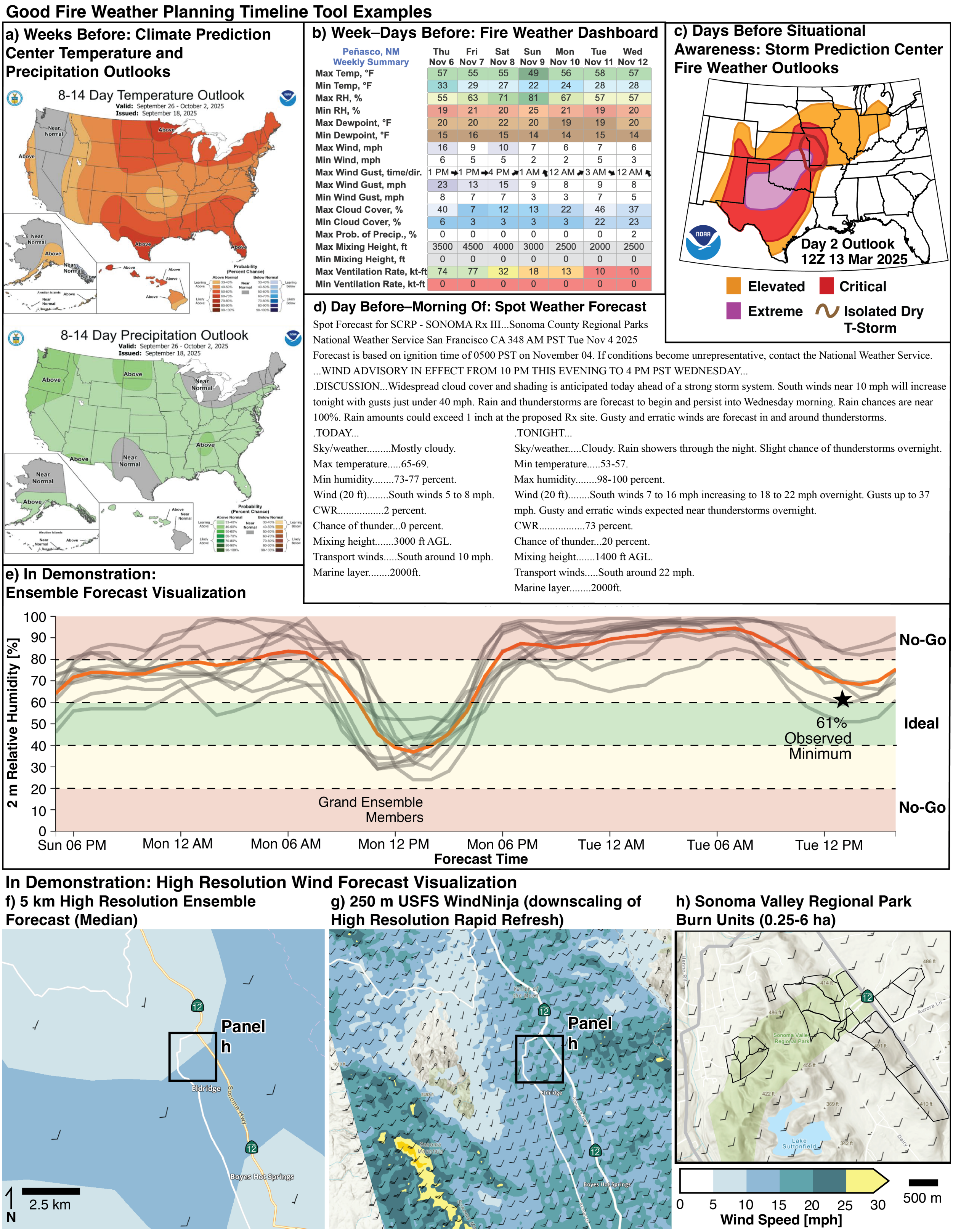


FIG. 2. Hourly observed and calculated fire weather information spanning 30 April–8 May 2025 from the Santa Rosa, California Remote Automated Weather Station. Fine and dead fuel moisture (FDFM) and probability of ignition (d) are calculated at a low-angle, South aspect level with the fire. Black lines in a-b, d-e (as well as dashed purple in a and dashed black in e) show hourly climatologies calculated for each day between (1991–2025). In (c), wind speed (gust) is solid (dashed).

4. How Are Good Fire Weather Forecasts Produced?

While planning for intentional fires begins months-to-years in advance, the timescales of good fire weather span the weeks before to the day of ignition, varying little between burn practitioner types (Davis and Triplett 2026). Figure 3a-d showcases several commonly used products by practitioners from Davis and Triplett (2026). At the weeks-ahead timescale, temperature and precipitation outlooks from the Climate Prediction Center (`https://www.cpc.ncep.noaa.gov/`; Figure 3a) signal the potential for a favorable fire environment. At the week-to-days before timescale, point-based forecasts of weather parameters from tools like the Fire Weather Dashboard (`https://www.weather.gov/dlh/fwd`; Figure 3b)–including those influencing air quality–impact the decision to move forwards with mobilization of resources and external public communication. The NOAA Storm Prediction Center's Fire Weather Outlooks (`https://www.spc.noaa.gov/products/fire_wx/`) provide situational awareness on regional fire weather conditions that may impact suppression contingency resource availability (Figure 3c). The final, location-specific forecast is typically requested on the day before the ignition from a local National Weather Service Weather Forecast Office via the Spot Weather Monitor (`https://spot.weather.gov/`; Figure 3d). This text-based forecast contains a brief discussion and information regarding key fire weather parameters for the day-of and days-following ignition.



Peñasco, NM Weekly Summary	Thu Nov 6	Fri Nov 7	Sat Nov 8	Sun Nov 9	Mon Nov 10	Tue Nov 11	Wed Nov 12
Max Temp, °F	57	55	55	49	56	58	57
Min Temp, °F	33	29	27	22	24	28	28
Max RH, %	55	63	71	81	67	57	57
Min RH, %	19	21	20	25	21	19	20
Max Dewpoint, °F	20	20	22	20	19	19	20
Min Dewpoint, °F	15	16	15	14	14	15	14
Max Wind, mph	16	9	10	7	6	7	6
Min Wind, mph	6	5	5	2	2	5	3
Max Wind Gust, time/dir.	1 PM	1 PM	4 PM	1 AM	12 AM	3 AM	12 AM
Max Wind Gust, mph	23	13	15	9	8	9	8
Min Wind Gust, mph	8	7	7	3	3	7	5
Max Cloud Cover, %	40	7	12	13	22	46	37
Min Cloud Cover, %	6	3	3	3	3	22	23
Max Prob. of Precip., %	0	0	0	0	0	0	2
Max Mixing Height, ft	3500	4500	4000	3000	2500	2000	2500
Min Mixing Height, ft	0	0	0	0	0	0	0
Max Ventilation Rate, kt-ft	74	77	32	18	13	10	10
Min Ventilation Rate, kt-ft	0	0	0	0	0	0	0

Spot Forecast for SCRP - SONOMA Rx III...Sonoma County Regional Parks
National Weather Service San Francisco CA 348 AM PST Tue Nov 4 2025
Forecast is based on ignition time of 0500 PST on November 04. If conditions become unrepresentative, contact the National Weather Service.
...WIND ADVISORY IN EFFECT FROM 10 PM THIS EVENING TO 4 PM PST WEDNESDAY...
.DISCUSSION...Widespread cloud cover and shading is anticipated today ahead of a strong storm system. South winds near 10 mph will increase tonight with gusts just under 40 mph. Rain and thunderstorms are forecast to begin and persist into Wednesday morning. Rain chances are near 100%. Rain amounts could exceed 1 inch at the proposed Rx site. Gusty and erratic winds are forecast in and around thunderstorms.

.TODAY...
Sky/weather.........Mostly cloudy.
Max temperature.....65-69.
Min humidity........73-77 percent.
Wind (20 ft)........South winds 5 to 8 mph.
CWR.................2 percent.
Chance of thunder...0 percent.
Mixing height.......3000 ft AGL.
Transport winds.....South around 10 mph.
Marine layer........2000ft.

.TONIGHT...
Sky/weather.....Cloudy. Rain showers through the night. Slight chance of thunderstorms overnight.
Min temperature.....53-57.
Max humidity........98-100 percent.
Wind (20 ft)........South winds 7 to 16 mph increasing to 18 to 22 mph overnight. Gusts up to 37 mph. Gusty and erratic winds expected near thunderstorms overnight.
CWR.................73 percent.
Chance of thunder...20 percent.
Mixing height.......1400 ft AGL.
Transport winds.....South around 22 mph.
Marine layer........2000ft.

115 Fig. 3. Examples of current (a-d) and in demonstration (e-h) tools used for good fire weather forecasting across typical planning timelines spanning weeks before to the morning of ignition and the days that follow.

5. How Can the Weather Enterprise Improve Good Fire Weather Forecasts?

We defined good fire weather as the set of atmospheric conditions before, during, and following ignition allowing wildland fire to achieve beneficial outcomes while minimizing hazards from fire and smoke. Although undesired extreme fire behavior or fire effects may still occur, good fire weather represents a parameter space for beneficial fire. A 2018 report by the National Association of State Foresters and the Coalition of Prescribed Fire Councils identified weather and air quality/smoke management as two of the top three impediments for prescribed fire implementation, with 44% of respondents citing weather as the primary limitation (Melvin 2018).

Intentional beneficial fires range from meter scales (pile burns) to 2,000+ ha prescribed burns (Hankins 2024). Active burning typically lasts 0.5–8 hours. Considering contemporary operational numerical weather and smoke transport models use horizontal resolutions of 1.33–4 km (133–1,600 ha) with hourly updates (Dowell et al. 2022), a scale mismatch is apparent (Figure 1). While the synoptic to mesoscale environment broadly indicates good fire weather, forecasters have indicated finer spatial (0.5–1 km^2) and temporal resolutions (output every 5–30 min) with hourly initializations approach necessary and sufficient resolutions to meet operational needs (Hatchett et al. 2024).

Advances in computing, model initialization and physics, and post-processing will improve forecast skill and resolution from physically-based (Bauer et al. 2015) and artificial intelligence-based models (Bouallègue et al. 2024) at the scales needed to support beneficial fire. Coincident with these improvements, ensemble forecasts and visualization tools are increasing available (e.g., the NOAA Global Systems Laboratory's Dynamic Ensemble-based Scenarios for Impact-based Decision Support Tool; `https://sites.gsl.noaa.gov/desi/`), providing users with capabilities to evaluate potential forecast outcomes and likelihoods (Figure 3e). Training practitioners to use probabilistic forecast information (e.g., Skinner et al. 2023; Heggli et al. 2023) is important to improve user decision making (Ripberger et al. 2022) and trust (Burgeno and Joslyn 2023). Communicating forecast information is especially salient when good fire weather leads to widespread community and/or agency burning, but forecast rapid changes in the fire environment necessitate securement (Lindley et al. 2025). Improvements in the spectral, spatial and temporal resolution of satellite and aerial remote sensing will aid real-time monitoring of fuel moisture and fire behavior (e.g., rates of spread and fire intensity) and assessment of burn outcomes such as changes in fuel loading and vegetation burn severity (LoPresti et al. 2024). Integrating traditional knowledge of weather, fuels, and fire use will increase the success of intentional burning across scales. However, incorporation of this knowledge requires trust and respect that comes from partnerships built upon sharing traditional and western fire knowledge through a process that includes culturally-sensitive consultation, coordination, and communication (Lake et al. 2017). Successful examples of this collaborative approach abound, with groups such as the Tribal EcoRestoration Alliance in Lake County, California integrating traditional knowledge and techniques into National Wildfire Coordination Group courses as well as community-based trainings and burns. Last, cloud computing is being leveraged to bridge the spatial scale resolution gap (Figure 1b) and forecaster resource limitations to better forecast localized wind patterns. For example, a cloud-based implementation of WindNinja, which produces a 250 m, 24 hour simulation for each Spot Weather Forecast request (Figure 3f-h; Wagenbrenner et al. 2016), is being evaluated in NOAA's Fire Weather Testbed in partnership with the U.S. Forest Service Missoula Fire Sciences Laboratory's development team.

Expanding official and community-provided weather and smoke observations from ground- and aerial-based platforms (e.g., Sablan et al. 2024) enables initialization and verification of weather and smoke transport forecasts while also supporting smoke early warning systems (Prince et al. 2024) and general data assimilation into numerical weather models. Improving the effectiveness of these systems requires incorporating community risk perceptions into educational campaigns with recommended protective actions (Rosen et al. 2023) but also comprehensively assessing weather and fuels conditions during successful past burns (Worsnop et al. 2026).

6. Closing Remarks

To remain viable management options that meet objectives while minimizing negative impacts, practitioners implementing large-scale beneficial fires need skillful predictions of weather and smoke (Hiers et al. 2020). However, tools, products, and services should also support smaller-scale burns (i.e., pile burns to sub-20 ha broadcast burns), as community-led burning with organization, training, and resources provided by prescribed burn associations, continues to expand across the United States (Deak et al. 2025). Regardless of the scale and lead organization(s), the frequent proximity of burns to critical assets implies improving good fire weather-related decision support products and tools through operations-to-research-to-operations-based approaches (e.g., Hiers et al.

2020; Wells et al. 2025) will support successful training and implementation. Success is paramount to ensuring a positive perception of beneficial fire by managers and the public to further aid strategic expansion of beneficial fire and stewardship (North et al. 2024). Such expansion across scales will better prepare communities and their landscapes to experience wildland fire in a fire-dependent and increasingly fire-prone world.

Acknowledgments. Brian Peterson, Sasha Berleman, Erica Lutz, Nick Nauslar, Tim Brown, and Michael Kaplan provided inspiration, mentorship and feedback on this work. BJH and EMW were supported in part by the NOAA Cooperative Agreement NA19OAR4320073 for the Cooperative Institute for Research in the Atmosphere. The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect those of NOAA or the Department of Commerce.

Data availability statement. Prescribed fire perimeters from the California Department of Forestry and Fire Protection (CAL FIRE) Fire Resource Assessment Program were acquired from: `https://www.fire.ca.gov/Home/What-We-Do/Fire-Resource-Assessment-Program/GIS-Mapping-and-Data-Analytics`. Remote Automatic Weather Station (RAWS) data were acquired from the Western Regional Climate Center at the Desert Research Institute: `https://raws.dri.edu`.

References

Bauer, P., A. Thorpe, and G. Brunet, 2015: The quiet revolution of numerical weather prediction. *Nature*, **525 (7567)**, 47–55, https://doi.org/10.1038/nature14956.

Bouallègue, Z. B., and Coauthors, 2024: The rise of data-driven weather forecasting: A first statistical assessment of machine learning–based weather forecasts in an operational-like context. *Bulletin of the American Meteorological Society*, **105 (6)**, E864 – E883, https://doi.org/10.1175/BAMS-D-23-0162.1.

Burgeno, J. N., and S. L. Joslyn, 2023: The impact of forecast inconsistency and probabilistic forecasts on users' trust and decision-making. *Weather, Climate, and Society*, **15 (3)**, 693–709, https://doi.org/10.1175/WCAS-D-22-0064.1.

Davis, S. J., and A. Triplett, 2026: Informational needs and decision-making for prescribed burns within the united states. *Weather Ready Research Award Report Series, Report X*.

Deak, A., J. E. Fawcett, L. Quinn-Davidson, C. Adlam, J. R. Weir, and J. Stackhouse, 2025: Burning from the ground up: the structure and impact of prescribed burn associations in the united states. *International Journal of Wildland Fire*, **34 (3)**, WF24 178, https://doi.org/10.1071/WF24178, https://connectsci.au/wf/article-pdf/doi/10.1071/WF24178/1636871/wf24178.pdf.

Dether, D., 2005: Prescribed fire lessons learned: escaped prescribed fire reviews and near miss incidents–initial impressions report. *Wildland Fire Lessons Learned Center*.

Dowell, D. C., and Coauthors, 2022: ”The High-Resolution Rapid Refresh (HRRR): An Hourly Updating Convection-Allowing Forecast Model. Part I: Motivation and System Description”. *Weather and Forecasting*, **37 (8)**, 1371–1395, https://doi.org/10.1175/WAF-D-21-0151.1.

Hankins, D. L., 2024: Climate resilience through ecocultural stewardship. *Proceedings of the National Academy of Sciences*, **121 (32)**, e2310072 121, https://doi.org/10.1073/pnas.2310072121, https://www.pnas.org/doi/pdf/10.1073/pnas.2310072121.

Hatchett, B. J., J. L. Vickery, Z. T. Tolby, T. A. Jones, P. S. Skinner, E. M. Wells, and K. J. Thiem, 2024: Fire Weather Testbed Evaluation #001: The Warn-on-Forecast System for Smoke. NOAA Technical Memorandum OAR GSL-68, https://doi.org/https://doi.org/10.25923/nd0m-4j95.

Heggli, A., B. Hatchett, Z. Tolby, K. Lambrecht, M. Collins, L. Olman, and M. Jeglum, 2023: Visual communication of probabilistic information to enhance decision support. *Bulletin of the American Meteorological Society*, **104 (9)**, E1533 – E1551, https://doi.org/10.1175/BAMS-D-22-0220.1.

Hiers, J. K., and Coauthors, 2020: Prescribed fire science: the case for a refined research agenda. *Fire Ecology*, **16 (1)**, https://doi.org/10.1186/s42408-020-0070-8.

Huffman, D. W., J. P. Roccaforte, J. D. Springer, and J. E. Crouse, 2020: Restoration applications of resource objective wildfires in western us forests: a status of knowledge review. *Fire Ecology*, **16 (1)**, 18, https://doi.org/10.1186/s42408-020-00077-x.

Lake, F. K., V. Wright, P. Morgan, M. McFadzen, D. McWethy, and C. Stevens-Rumann, 2017: Returning fire to the land: Celebrating traditional knowledge and fire. *Journal of*

Forestry, **115 (5)**, 343–353, https://doi.org/10.5849/jof.2016-043R2, https://academic.oup.com/jof/article-pdf/115/5/343/63888600/jof_115_5_343.pdf.

Lindley, T. T., and Coauthors, 2025: Dry return flow: a critical fire weather pattern on the southern Great Plains. *Journal of Operational Meteorology*, **13**, 69–82, https://doi.org/https://doi.org/10.15191/nwajom.2025.1306.

LoPresti, A., M. T. Hayden, K. Siegel, B. Poulter, E. N. Stavros, and L. E. Dee, 2024: Remote sensing applications for prescribed burn research. *International Journal of Wildland Fire*, **33 (6)**, WF23 130, https://doi.org/10.1071/WF23130, https://connectsci.au/wf/article-pdf/doi/10.1071/WF23130/154088/wf23130.pdf.

Lutz, E., 2024: The Goldilocks Rx: Seasonal sweet spots and other factors that shape timing of prescribed burns. URL https://www.egret.org/the-goldilocks-prescription-for-prescribed-fire/, Last Accessed: 2025-06-14.

Melvin, M. A., 2018: 2018 national prescribed fire use survey report. *Technical Report 03-18*.

National Wildfire Coordinating Group, 2025: NWCG Glossary of Wildland Fire, PMS 205. URL https://www.nwcg.gov/publications/pms205/nwcg-glossary-of-wildland-fire-pms-205, Last Accessed: 2025-07-24.

North, M. P., and Coauthors, 2024: Strategic fire zones are essential to wildfire risk reduction in the Western United States. *Fire Ecology*, **20 (1)**, 50, https://doi.org/10.1186/s42408-024-00282-y.

Prince, S. E., S. E. Muskin, S. J. Kramer, S. Huang, T. Blakey, and A. G. Rappold, 2024: Smoke on the horizon: leveling up citizen and social science to motivate health protective responses during wildfires. *Humanities and Social Sciences Communications*, **11 (1)**, 253, https://doi.org/10.1057/s41599-024-02641-1.

Ripberger, J., A. Bell, A. Fox, A. Forney, W. Livingston, C. Gaddie, C. Silva, and H. Jenkins-Smith, 2022: Communicating Probability Information in Weather Forecasts: Findings and Recommendations from a Living Systematic Review of the Research Literature. *Weather, Climate, and Society*, **14 (2)**, 481–498, https://doi.org/10.1175/WCAS-D-21-0034.1.

Rosen, Z., G. Henery, K. D. Slater, O. Sablan, B. Ford, J. R. Pierce, E. V. Fischer, and S. L. Magzamen, 2023: A culture of fire: identifying community risk perceptions surrounding prescribed burning in the flint hills, kansas. *Journal of Applied Communications*, **106 (4)**, 6, https://doi.org/https://doi.org/10.4148/1051-0834.2455.

Sablan, O., and Coauthors, 2024: Quantifying prescribed-fire smoke exposure using low-cost sensors and satellites: Springtime burning in eastern kansas. *GeoHealth*, **8 (4)**, e2023GH000 982, https://doi.org/https://doi.org/10.1029/2023GH000982, https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2023GH000982.

Skinner, P. S., and Coauthors, 2023: Interpreting Warn-on-Forecast System Guidance, Part I: Review of Probabilistic Guidance Concepts, Product Design, and Best Practices. URL /view/noaa/56441, journal Article.

Wagenbrenner, N. S., J. M. Forthofer, B. K. Lamb, K. S. Shannon, and B. W. Butler, 2016: Downscaling surface wind predictions from numerical weather prediction models in complex terrain with windninja. *Atmospheric Chemistry and Physics*, **16 (8)**, 5229–5241.

Wells, E. M., B. J. Hatchett, K. Thiem, Z. Tolby, S. Hoekstra, J. Vickery, and D. Nietfeld, 2025: Noaa fire weather testbed launches first in-person evaluation. *Bulletin of the American Meteorological Society*, **106 (6)**, 359–363, https://doi.org/10.1175/BAMS-D-24-0204.1.

Werth, P. A., and Coauthors, 2011: *Synthesis of knowledge of extreme fire behavior: Volume I for fire managers*. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, https://doi.org/10.2737/pnw-gtr-854, URL http://dx.doi.org/10.2737/PNW-GTR-854.

Worsnop, R. P., and Coauthors, 2026: Characterizing environmental conditions and windows-of-opportunity for prescribed pile and broadcast burning in northern california. *Submitted*.