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January 20, 2025

Dr. James W. Boylan, Chief
Air Protection Branch
4244 International Parkway, Suite 120
Atlanta, Georgia 30354

Re: Exceptional Event Demonstrations for 129 event days

Dear Dr. Boylan:

The Midwest Ozone Group[1]("MOG") is pleased to provide comments in support of these proposed demonstrations.

While the Clean Air Act (the "Act") requires States to meet certain air quality standards, the Act also recognizes that exceptional events, including wildfires and prescribed burns, may sometimes prevent that from happening. Exceptional events can cause air quality monitoring data to exceed permissible concentrations of a pollutant, also called an exceedance. When that happens, the Act directs the

[1] The membership of the Midwest Ozone Group includes: Ameren, American Electric Power, American Forest & Paper Association, American Iron and Steel Institute, American Wood Council, Appalachian Region Independent Power Producers Association, Associated Electric Cooperative, Berkshire Hathaway Energy, Big Rivers Electric Corp., Buckeye Power, Inc., Citizens Energy Group, City Water, Light & Power (Springfield IL), Cleveland-Cliffs Inc., Council of Industrial Boiler Owners, Duke Energy Corp., East Kentucky Power Cooperative, ExxonMobil, FirstEnergy Corp., Indiana Energy Association, Indiana-Kentucky Electric Corporation, Indiana Municipal Power Agency, Indiana Utility Group, Hoosier Energy REC, inc., LGE/ KU, Marathon Petroleum Company, National Lime Association, North American Stainless, Nucor Corporation, Ohio Utility Group, Ohio Valley Electric Corporation, Olympus Power, Steel Manufacturers Association, and Wabash Valley Power Alliance.

Administrator of the United States Environmental Protection Agency (USEPA) to exclude that data from further consideration if the state demonstrates to USEPA's satisfaction that the event caused the exceedance.

On December 20, 2024, the Georgia Environmental Protection Division (EPD) issued a public notice regarding the availability for comment of proposed draft "Exceptional Event Demonstrations for 129 event days " in the state of Georgia. The deadline for the submittal of comments is January 21, 2025.

The proposed exceptional events demonstrations detail the $PM_{2.5}$ episodes occurring in the state of Georgia between 2021 and 2023. The proposed demonstrations specifically address $PM_{2.5}$ episodes occurring at six monitors, including monitors in Augusta, Columbus, Macon, Sandersville, Atlanta, and Rossville, Georgia. Specifically, for these monitors, the proposed demonstrations provide technical documentation to support EPD's request to U.S. Environmental Protection Agency (EPA) to exclude $PM_{2.5}$ monitoring data for multiple days in 2021, 2022, and 2023 that were strongly influenced by unusual events including holiday fireworks, prescribed fires, and Canadian wildfires.

The following comments are offered on behalf of MOG in support of these proposed exceptional events demonstrations.[2]

MOG is an affiliation of companies and associations that draws upon its collective resources to seek solutions to the development of legally and technically sound air quality programs that may impact on their facilities, their employees, their communities, their contractors, and the consumers of their products. MOG's primary efforts are to work with policy makers in evaluating air quality policies by encouraging the use of sound science. MOG has been actively engaged in a variety of issues and initiatives related to the development and implementation of air quality policy, including the development of transport rules (including exceptional events demonstrations, implementation of NAAQS standards, nonattainment designations, petitions under Sections 126, 176A and 184(c) of the Clean Air Act ("CAA"), NAAQS implementation guidance, the development of Good Neighbor State Implementation Plans ("SIPs"), the development of greenhouse gas and Mercury and Air Toxics Standards Rules and related regional haze issues. MOG Members and Participants own and operate numerous stationary sources that are affected by air quality requirements including the $PM_{2.5}$ NAAQS.

[2] These comments were prepared with the technical assistance of Alpine Geophysics, LLC.

By way of background, when amending the Clean Air Act in 2005, Congress intended to provide regulatory relief for NAAQS nonattainment resulting from exceptional events negatively affecting air quality that were outside of a state's control. That concern led to enactment of provisions specifically establishing the process by which USEPA could exclude air quality monitoring data directly related to an exceptional event. *See* 42. U.S.C. § 7619. Subsequently, USEPA promulgated the exceptional events rule. 40 C.F.R. § 50.14. Under the exceptional events rule, USEPA excludes "any data of concentration of a pollutant above the NAAQS (exceedances) if the air quality was influenced by exceptional events." *Bahr v. Regan*, 6 F.4th 1059, 1066 (9th Cir. 2021) (cleaned up).

A state requesting data exclusion under the exceptional events rule must demonstrate "to the Administrator's satisfaction that such event caused a specific air pollution concentration at a particular air quality monitoring location." 40 C.F.R. § 50.14(a)(1)(ii). That demonstration must include certain regulatory required information:

> (A) A narrative conceptual model that described the event(s) causing the exceedance or violation and a discussion of how emissions form the event(s) led to the exceedance or violation at the affected monitor(s);
>
> (B) A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;
>
> (C) Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times to support the requirement at paragraph (c)(3)(iv)(B) of this section. The Administrator shall not require a State to prove a specific percentile point in the distribution of data;
>
> (D) A demonstration that the event was both not reasonably controllable and not reasonably preventable; and
>
> (E) A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event.

40 C.F.R. § 50.14(c)(3)(iv).

A state must also comply with pre-request requirements, which include notifying USEPA of the intent to request exclusion, flagging data to be excluded, engaging in public comments, and implementing mitigation measures. See 40 C.F.R. § 50.14(c)(2)(i); 40 C.F.R. § 50.14(c)(3)(v); 40 C.F.R. § 51.930. In short, there are three core statutory elements: (1) a clear causal relationship; (2) a showing that the event was not controllable, and (3) a showing that the event was human activity unlikely to recur a particular location or was a natural event.

Depending on the circumstances of a particular exceptional event, a particular tier of evidence is required to provide a compelling case to USEPA to exclude data under the Exceptional Events Rule. In instances where a state provides sufficient evidence to showcase that a given event is indeed an irregularity, USEPA will make a concurring determination and issue an exclusion of that specific event from the dataset. 40 C.F.R. 50.14(c)(2)(ii).

USEPA has recognized that particular events are exceptional and that states may request to exclude them from the dataset, given that a sufficient evidentiary standard is met. *Id*; see generally, 81 Fed. Reg. 68216. There are several tiers of evidentiary showings related to $PM_{2.5}$ demonstrations. These three tiers create a ladder of increasing evidentiary burdens on the states to convince USEPA that an event merits exclusion.

- Tier 1 clear causal analyses are intended for wildland fire events that cause unambiguous $PM_{2.5}$ impacts well above historical 24-hour concentrations, thus requiring less evidence to establish a clear causal relationship.

- Tier 2 clear causal analyses are likely appropriate when the impacts of the wildland fire on $PM_{2.5}$ concentrations are less distinguishable from historical 24-hour concentrations, and require more evidence, than Tier 1 analyses.

- Tier 3 clear causal analyses should be used for events in which the relationship between the wildland fire and $PM_{2.5}$ 24-hour concentrations are more complicated than a Tier 2 analysis, when 24-hour $PM_{2.5}$ concentrations are near or within the range of historical concentrations, and thus require more evidence to establish the clear causal relationship than Tier 2 or Tier 1.

U.S. Environmental Protection Agency, *$PM_{2.5}$ Wildland Fire Exceptional Events Tiering Document* (April 2024) at 5. It is important to note that the overall processes for exceptional event demonstrations for wildfire ozone and wildland fire

$PM_{2.5}$ are the same. See *id*. at 6. EPA has also acknowledged that, "[a]lthough the O3-specific tiering structure does not apply to PM, nearly all of the same types of individual analyses may apply to PM…" [3]

MOG also agrees with EPD's analysis of the impact of holiday fireworks, citing 40 CFR 50.14(b)(2), which states that "The Administrator shall exclude data from use in determinations of exceedances and violations where a State demonstrates to the Administrator's satisfaction that emissions from fireworks displays caused a specific air pollution concentration in excess of one or more national ambient air quality standards at a particular air quality monitoring location and otherwise satisfies the requirements of this section. Such data will be treated in the same manner as exceptional events under this rule, provided a State demonstrates that such use of fireworks is significantly integral to traditional national, ethnic, or other cultural events including, but not limited to, July Fourth celebrations that satisfy the requirements of this section."

MOG notes that the proposed demonstrations show that the events affected the monitors Augusta, Columbus, Macon, Sandersville, Atlanta, and Rossville, Georgia, during each of the documented episodes. This caused average $PM_{2.5}$ concentrations at monitors in those area to experience multiple daily Tier 1 and 2 level exceedances, as defined in EPA's Tiering Tool[4], during the relevant periods and as seen in EPD's demonstrations.

MOG fully supports the EPD request that the USEPA Administrator exclude the ambient $PM_{2.5}$ concentrations measured at the Augusta, Columbus, Macon, Sandersville, Atlanta, and Rossville, Georgia, monitoring sites during all these documented events from calculations of annual $PM_{2.5}$ design values and from other regulatory determinations.

As set forth in its proposed demonstrations, EPD has shown that the documented events caused the $PM_{2.5}$ exceedances at the monitors in Augusta,

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[3] "Exceptional Events Guidance: Prescribed Fire on Wildland that May Influence Ozone and Particulate Matter Concentrations" August 2019 (https://www.epa.gov/sites/default/files/2019-08/documents/ee_prescribed_fire_final_guidance_-_august_2019.pdf)

[4] U.S. Environmental Protection Agency. "Tiering Tool – for Exceptional Events Analysis". Air Quality Analysis. U.S. Environmental Protection Agency, March 26, 2024, https://www.epa.gov/air-quality-analysis/tiering-tool-exceptional-events-analysis

Columbus, Macon, Sandersville, Atlanta, and Rossville, Georgia. EPD correctly notes that exclusion of the data on the relevant dates would result in attainment of the 2024 revised primary annual $PM_{2.5}$ NAAQS at these monitors.

The proposed demonstrations address such remaining factors as a narrative conceptual model describing the events as not reasonably controllable and not caused by human activity and satisfy requirements related to notification of the public of the events and participation of the public in the submission of these requests.

The monitors and episode days that are carefully addressed in the proposed EPD demonstrations are far from the only ones that have influenced air quality during those time frames. Many $PM_{2.5}$ monitors in the same area also observed 24-hour average $PM_{2.5}$ concentrations at significantly elevated levels on the same exclusion dates, as well as on days around these dates. As has been noted, additional days, even if not currently 'regulatorily significant,' may in the future be relevant and significant not only to Georgia but also to other states. USEPA should consider allowing these proposed demonstrations to stand for those additional monitors and days, as needed.

MOG appreciates this opportunity to offer comments in support of the proposed EPD exceptional events demonstrations for the exceedances of the revised 2024 Annual $PM_{2.5}$ NAAQS at the Augusta, Columbus, Macon, Sandersville, Atlanta, and Rossville, Georgia, monitoring sites due to these well documented exceptional events. Congress has made it clear that data of the nature described in this proposed demonstration cannot and should not be used to implement a National Ambient Air Quality Standard and other matters of regulatory significance.

Very truly yours,

Edward L Kropp

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January 21, 2025

Submitted via email to EPD.comments@dnr.ga.gov

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4244 International Parkway, Suite 120
Atlanta, Georgia, 30354

Re: Draft Prescribed Fire Exceptional Event Demonstration for Exceedances of the 2024 Annual PM2.5 NAAQS at Sandersville, GA, in 2021-2023

Dear Dr. Boylan,

Please accept these comments supporting the subject Prescribed Fire Exceptional Event Demonstration prepared by the Georgia Environmental Protection Division (EPD). No response from Georgia EPD is needed to address these supportive comments. This demonstration is an essential model for how prescribed fire Exceptional Events can be prepared for other sites struggling to achieve the new annual PM2.5 National Ambient Air Quality Standards. Other southeastern states and those western states where prescribed fire is slated to increase are likely to applaud this submission.

Notably, we support EPD's batching of prescribed fire events throughout the three-year reporting period used to establish the average for the annual PM2.5 standard. This logical approach reduces the burden on private landowners and public agencies working hard to apply prescribed fire for shared biodiversity benefits, reduced wildfire risk, and better managed air quality in our communities.

We also support the scope of analysis and the justifications you and your staff have provided to address the Exceptional Events Rule qualifications. These will be critical for other states faced with the same issues.

Thank you for your leadership on this issue. We recognize Georgia EPD, the Georgia Forestry Commission, and the Georgia Department of Natural Resources as leaders in supporting prescribed fire.

Across federal land management agencies and the broad scientific community, the consensus is that the US needs more prescribed fire. For example, the Wildland Fire Leadership Committee's National Wildland Fire Cohesive Strategy Addendum Update (March 2023), led by Agriculture and Interior Undersecretaries —with NIH and EPA representation— strongly advocates for more prescribed fire implementation to abate wildfire hazards, reduce human health issues caused by wildfire smoke, restore plant and animal biodiversity, promote ecosystem resilience, and to sustain local economies.

Federal R&D in the Forest Service, US Geological Survey, and National Science Foundation have all supported recent scientific syntheses that reveal the solid scientific consensus that more prescribed fire will be needed to restore ecological integrity and resilience, protect human health, and reduce real wildfire threats.

More broadly, we provide the following recommendations for the EPA to consider. Tall Timbers and the fire research community (Federal R&D, Universities, and NGOs) stand ready to assist.

1. Develop Best Management Practices and technology for prescribed fire and air quality. Prescribed fire is patchy across the US. Each “hotspot” of prescribed fire has unique challenges and characteristics. For each of these areas, funding and supporting communities of practice should be provided to develop and implement Best Management Practices, as we do for Clean Water Act implementation. These regional Best Management Practices would mesh well with State Implementation Plans for air quality. Investing in the practices and technology to aid the prescribed fire community and the state agencies that regulate them in evaluating, predicting, and avoiding air quality exceedances will have real air quality benefits.

2. Fund Prescribed Fire Air Quality Research. Research on prescribed fire lags behind wildfire-focused research at a ratio of 1:3. Prescribed fire science has unique needs with implications for how well we understand smoke generation, emissions, and the decision support tools needed by managers and regulators. EPA and the broader Federal R&D enterprise should vastly increase research efforts to better understand prescribed fire smoke and air quality in our communities. This increased investment in prescribed fire research will support the prescribed fire air quality Best Management Practices concepts described above.

Again, we thank Georgia EPD for your leadership and the US EPA for considering these recommendations. We welcome the opportunity for further dialogue on this critical topic. Please contact Dr. Holly Nowell, Tall Timbers Smoke Science Director, to discuss this (holly.nowell@talltimbers.org).

Sincerely,

William Palmer, Ph.D.

President/CEO

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January 21, 2025

<u>Via Email and Regular U.S. Mail</u>
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Atlanta, Georgia, 30354
EPD.comments@dnr.ga.gov

RE: Draft PM2.5 Exceptional Events Demonstrations for Augusta, Atlanta, Columbus, Macon, Rossville, and Sandersville, Georgia

Dear Mr. Boylan:

On behalf of Clean Energy Columbus, Environment Georgia Research & Policy Center, the Georgia Chapter of the Sierra Club, Georgia Interfaith Power & Light, Healthy Communities Augusta, the Natural Resources Defense Council, the Savannah Riverkeeper, and itself, the Southern Environmental Law Center respectfully submits the following comments regarding the draft exceptional event demonstrations for the fine particulate matter National Ambient Air Quality Standard in Augusta, Atlanta, Columbus, Macon, Rossville, and Sandersville, Georgia.

As set forth below, the exceptional events demonstrations fail to provide the information necessary to show that the air quality exceedances were caused by exceptional events, as is required by the applicable law and regulations. Accordingly, we encourage these demonstrations to be revised and limited to the dates where the clear causal relationship between the exceptional event and the monitor exceedance can be proven.

I. Introduction

The Georgia Environmental Protection Division (EPD) intends to submit to the U.S. Environmental Protection Agency (EPA) exceptional event demonstrations (collectively, "the EE Demonstrations") to exclude 129 instances in which air pollution data at Georgia air quality monitors exceeded federal air quality standards. The most frequent basis for excluding this data is the impact of prescribed fires, but EPD also seeks to exclude data based on smoke from Canadian wildfires and Fourth of July fireworks. In all of these instances, excluding the exceedances as exceptional events would allow these areas to be classified as attainment areas under the 2024 national ambient air quality standard (NAAQS) for fine particulate matter (PM2.5). If this data is not excluded, design values for these areas would require them to be classified as nonattainment areas.

Under the Clean Air Act, exceptional events are unusual or naturally occurring events that affect air quality but are not reasonably controllable. As set forth below, the EE

Demonstrations fail to provide the necessary information to support the clear causal relationship required for exceedances to be disregarded as exceptional events. Further, the EE Demonstrations make clear that Georgia has a problem managing the impact of smoke from open burning on air quality. Whether or not these events are deemed exceptional events, EPD must enhance its coordination with the Georgia Forestry Commission to ensure that the state complies with the new, more stringent PM2.5 standards and maintains the necessary information to properly document exceptional events going forward.

II. Protecting Georgians from Unsafe Levels of PM2.5 is Essential for Public Health.

The EE Demonstrations would carry significant consequences for communities living with PM2.5 levels above the standard. Exposure to fine particle pollution causes serious health problems.[1] Fine particles in the air we breathe, such as PM2.5, are small enough to penetrate and lodge deep into the lungs, leading to asthma attacks, shortness of breath, fatigue, missed workdays, costly emergency room visits, and more.[2] In fact, fine particles cause more detrimental health effects than any other pervasive pollutant in the United States—nearly 63 million people nationwide experience unhealthy spikes in daily PM2.5 pollution.[3]

While even short-term exposure to fine particles can lead to these health issues, long-term exposure, which is experienced by people living in areas with high particle levels for many years, can lead to more serious consequences, such as reduced lung function, chronic bronchitis, diabetes, cancer, heart attacks, and premature death.[4] Communities that are most at risk from

[1] *Final Rule to Strengthen the National Air Quality Health Standard for Particulate Matter, Fact Sheet,* U.S. ENVIRONMENTAL PROTECTION AGENCY (Feb. 2024), https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-overview.pdf.

[2] *EPA finalizes stronger standards for harmful soot pollution, significantly increasing health and clean air protections for families, workers, and communities,* U.S. ENVIRONMENTAL PROTECTION AGENCY (Feb. 7, 2024), https://www.epa.gov/newsreleases/epa-finalizes-stronger-standards-harmful-soot-pollution-significantly-increasing#:~:text=By%20strengthening%20the%20annual%20health,to%204%2C500%20premature%20deaths%20and.

[3] *Inhalable Particulate Matter and Health (PM2.5 and PM10)*, CALIFORNIA AIR RESOURCES BOARD https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health#:~:text=In%20addition%2C%20of%20all%20of,Global%20Burden%20of%20Disease%20Project (last visited Dec. 18, 2024).

[4] *Health and Environmental Effects of Particulate Matter (PM)*, U.S. ENVIRONMENTAL PROTECTION AGENCY, https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm (last updated July 16, 2024).

particle pollution are those already suffering from pre-existing health hardships, and vulnerable populations such as communities of color, low-income communities, children, and older adults.[5]

To combat these health burdens, EPA recently strengthened the annual health-based NAAQS for PM2.5 from 12 to 9 micrograms per cubic meter.[6] The updated standard will prevent up to 4,500 early deaths and generate as much as $46 billion in net health benefits in 2032.[7] To deliver these health benefits to the people of Georgia, however, it is crucial that EPD properly identifies areas that are not meeting the new national standard by taking into consideration data that shows exceedances and violations.

III. Legal Framework for Exceptional Event Demonstrations

Exceptional events are "unusual or naturally occurring events that can affect air quality but are not reasonably controllable using techniques that tribal, state, or local air agencies may implement in order to attain and maintain the National Ambient Air Quality Standards."[8] Under the Clean Air Act, a "clear causal relationship must exist between the measured exceedances of a national ambient air quality standard and the exceptional event to demonstrate that the exceptional event caused a specific air pollution concentration at a particular air quality monitoring location."[9]

The demonstration of this relationship must be supported by analyses that compare the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times unaffected by the event.[10] In determining whether an air agency has adequately demonstrated a clear causal relationship, EPA reviews each exceptional event demonstration on

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[5] *EJScreen Indicators Overview – Particulate Matter 2.5 (PM2.5),* U.S. ENVIRONMENTAL PROTECTION AGENCY, https://www.epa.gov/ejscreen/ejscreen-indicators-overview-particulate-matter-25-pm25#:~:text=Children%2C%20older%20adults%2C%20people%20with,parts%20of%20the%20United%20States (last updated July 30, 2024).
[6] *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter*, 89 Fed. Reg. 16202 (Mar. 6, 2024) (codified in 40 C.F.R. Parts 50, 53, and 58).
[7] *Final Rule to Strengthen the National Air Quality Health Standard for Particulate Matter, Fact Sheet,* U.S. ENVIRONMENTAL PROTECTION AGENCY (Feb. 2024), https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-overview.pdf.
[8] *Treatment of Air Quality Monitoring Data Influenced by Exceptional Events,* U.S. ENVIRONMENTAL PROTECTION AGENCY, https://www.epa.gov/air-quality-analysis/treatment-air-quality-monitoring-data-influenced-exceptional-events (last updated Dec. 19, 2024).
[9] 42 U.S.C. § 7619((b)(3)(B)(ii).
[10] *Guidance on Preparation of Exceptional Events Demonstrations for Stratospheric Ozone Intrusions* ("Ozone Exceptional Events Guidance") at 2, U.S. ENVIRONMENTAL PROTECTION AGENCY (Nov. 8, 2018) https://www.epa.gov/sites/default/files/2018-11/documents/exceptional_events_soi_guidance_11-8-2018.pdf.

a "case-by-case basis using a weight of evidence approach."[11] Air agencies must "demonstrate by the weight of evidence in the record that the event caused the specific air pollution concentration at issue."[12] Ultimately, EPA has stated that its goal is "to ensure that exceptional events demonstrations satisfy the rule criteria and support the regulatory determination(s) for which they are significant."[13]

EPA uses a tiered approach to evaluate whether a demonstration has properly shown a causal relationship for certain exceptional events. For example, EPA has designated three tiers for wildland fire-related PM2.5 exceptional events demonstrations, and there are different requirements to demonstrate a causal relationship under each tier.[14] The tiers differ based on how clear it is that the event in question led to the higher-than-normal PM2.5 concentration, with Tier 1 being the clearest causal relationship, and Tier 3 being the least clear.

Under 40 C.F.R. § 50.14(b)(8), an event must not be "reasonably controllable or preventable" in order to be properly deemed exceptional. This criterion has two independent prongs that the air agency must demonstrate: (1) prevention; and (2) control. For the prevention element, an event can be considered "not reasonably preventable" if the air agency shows that "reasonable measures to prevent the event were applied at the time of the event."[15] For the control element, an event can be considered "not reasonably controllable" if the air agency shows that "reasonable measures to control the impact of the event on air quality were applied at the time of the event."[16] The air agency may present evidence such as enforceable control measures in the state implementation plan, tribal implementation plan, or federal implementation plan.

In summary, an exceptional events demonstration must include the following six elements:

1. A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);

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[11] *Treatment of Data Influenced by Exceptional Events,* 81 Fed. Reg. 68216, 68227 (Oct. 3, 2016) (codified in 40 C.F.R. Parts 50 and 51).
[12] *Treatment of Data Influenced by Exceptional Events,* 80 Fed. Reg. 72840, 72850 (Nov. 20, 2015) (codified in 40 C.F.R. Part 50).
[13] *Exceptional Events Guidance: Prescribed Fire on Wildland that May Influence Ozone and Particulate Matter Concentrations* ("Prescribed Fire Guidance") at 2, U.S. ENVIRONMENTAL PROTECTION AGENCY (Aug. 2019), https://www.epa.gov/sites/default/files/2019-08/documents/ee_prescribed_fire_final_guidance_-_august_2019.pdf.
[14] *PM2.5 Wildland Fire Exceptional Events Tiering Document* ("Wildland Fire Tiering Guidance"), U.S. ENVIRONMENTAL PROTECTION AGENCY (Apr. 2024), https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf.
[15] 40 C.F.R. § 50.14(b)(8)(ii).
[16] 40 C.F.R. § 50.14(b)(8)(iii).

2. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;
3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times;
4. A demonstration that the event was both not reasonably controllable and not reasonably preventable;
5. A demonstration that the event was caused by human activity that is unlikely to recur at a particular location or was a natural event; and
6. Documentation that the air agency followed the public comment process.[17]

If all of these conditions are met, the EPA may exclude certain air-quality monitoring data when designating an area as nonattainment or attainment. Importantly, the occurrence of an exceptional event must be demonstrated by "reliable, accurate data that is promptly produced and provided by Federal, State, or local government agencies."[18]

Finally, 40 C.F.R. § 51.930 provides that an air agency requesting to exclude air quality data due to exceptional events must also take appropriate and reasonable actions to mitigate and protect public health from exceedances or violations of NAAQS. At a minimum, in order to exclude data as an exceptional event, the air agency must undertake mitigation efforts in the form of public notice, public education, and "the implementation of appropriate measures to protect public health from exceedances or violations of ambient air quality standards caused by exceptional events." Areas with historically documented or known seasonal events that may cause exceedances are required to develop a mitigation plan that contains provisions that are outlined in 40 C.F.R. § 51.930(b)(2).

IV. Prescribed Fires as Exceptional Events in Georgia

The EE Demonstrations make clear that Georgia has a problem managing smoke from prescribed fires to the extent necessary to comply with the new PM2.5 NAAQS standard.

Prescribed fire is an important tool for managing both public and private lands to achieve ecological, silvicultural, and other purposes. In 2008, EPD and the Georgia Foresty Commission entered a Memorandum of Understanding and adopted a "Basic Smoke Management Plan" ("Georgia SMP") to address the potential impacts of prescribed fires on air quality in Georgia. One of the Georgia SMP's stated goals is to avoid potential NAAQS violations.[19]

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[17] *Exceptional Events Rule: Update to Frequently Asked Questions* ("Exceptional Events FAQ") at B.2, U.S. ENVIRONMENTAL PROTECTION AGENCY (Nov. 6, 2024), https://www.epa.gov/system/files/documents/2024-11/updated-ee-faqs_2024_final_0.pdf.
[18] 42 U.S.C. § 7619((b)(3)(B)(i).
[19] *Basic Smoke Management Plan* ("Georgia SMP") at 3, GEORGIA ENVIRONMENTAL PROTECTION DIVISION AIR PROTECTION BRANCH (April 16, 2008).

The Georgia SMP includes several measures intended to prevent smoke from prescribed fires from causing NAAQS exceedances. Areas "especially susceptible to violations of air quality standards will be given special attention to avoid issuance of permits during measured or expected high air pollution periods."[20] "When air quality is a concern, forest management practices should be considered in lieu of burning or as a pretreatment to reduce the amount of smoke from the planned burn."[21] And, "when EPD's air quality monitors indicate actual exceedances or likely exceedances of air quality standards, EPD and the Georgia Forestry Commission will work together to restrict burning as appropriate."[22]

EPA issued a series of guidance documents explaining how air agencies should prove exceptional event demonstrations resulting from prescribed fires. These documents envision a far smaller role for prescribed fires in exceptional events than EPD has set forth in the EE Demonstrations. In EPA's view, prescribed fires "are generally less likely than wildfires to be extreme or have clear impacts on a monitored exceedance or violation" due to their controlled nature.[23] But the EE Demonstrations, in contrast, point to prescribed fires as the cause of 88 exceptional event days at four different locations. EPA also anticipated that "multi-day exceedances or violations would rarely occur when a prescribed fire is properly managed."[24] But the EE Demonstrations identify eighteen multi-day fire events in Georgia, including one that extended for five consecutive days in Sandersville.

In short, Georgia has not controlled the impact of smoke from prescribed fire (and other open burning events) in the manner envisioned by EPA guidance or as described in the Georgia SMP. As a result, smoke from prescribed fire and other open burning is creating a persistent and pervasive challenge to Georgia's ability to comply with the new PM2.5 NAAQS. The impact of prescribed fire smoke on air quality in Georgia does not appear to be exceptional at all; rather, it appears to be troublingly routine.

IV. The Prescribed Fire EE Demonstrations Do Not Provide the Necessary Support for Excluding the Identified Dates as Exceptional Events.

The Prescribed Fire EE Demonstrations do not provide the information necessary to show a clear causal relationship between the exceedances and prescribed fires on the identified dates, as is required by the Clean Air Act and EPA guidance.

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[20] *Id*. at 6.
[21] *Id*. at 9.
[22] *Id*.
[23] *Prescribed Fire Guidance* at 10.
[24] *Prescribed Fire Guidance* at 15.

1. *<u>The Prescribed Fire EE Demonstrations must clarify whether the prescribed fie occurred on public or private lands.</u>*

As a threshold matter, the Prescribed Fire EE Demonstrations do not distinguish between prescribed fires conducted on public lands or on private property. Throughout its guidance documents, EPA distinguishes between prescribed fire on public lands from those on private property. [25] Yet the EE Demonstrations do not distinguish between the two. The Prescribed Fire EE Demonstrations must clarify whether the site of all prescribed fires referenced in the demonstrations occurred on public lands or private property so they can be properly evaluated as potential exceptional events.

2. *<u>The Prescribed Fire EE Demonstrations lack information required for prescribed fire exceptional event demonstrations.</u>*

The Prescribed Fire EE Demonstrations lack information required by EPA guidance to support an exceptional event approval. EPA directs that exceptional event demonstrations for prescribed fires must provide the following information regarding the fire's nature and location in order to support an exceptional event finding:

(1) geographical parameters of the fire, including latitude/longitude and physical description of the area(s) burned;

(2) date of the burn(s) that is the subject of the demonstration;

(3) the dates of past burns in the same area;

(4) time of initial ignition;

(5) approximate time of end of burn;

(6) total acres burned; and

(7) a description of dominant fuel type burned.[26]

Without this information, it is impossible to understand how prescribed fire(s) may have contributed to the high PM2.5 levels measured at the relevant monitors.

Some of this information is included in Appendix B of each Prescribed Fire EE Demonstration,[27] but none contain elements 3, 4, 5, or 7. Further, the appendices only include

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[25] For example, "EPA expects to evaluate the eligibility of prescribed fires on other lands, <u>including private lands</u>, as possible exceptional events on a case-by-case basis." *Prescribed Fire Guidance* at 4. (Emphasis added).

[26] *Prescribed Fire Guidance* at 16.

[27] *See* Columbus Draft Prescribed Fire EE Demonstration at Appx. B; Augusta Draft Prescribed Fire EE Demonstration at Appx. B; Macon Draft Prescribed Fire EE Demonstration at Appx. B; and Sandersville Draft Prescribed Fire EE Demonstration at Appx. B.

latitude/longitude information for a subset of the fires. These appendices must be supplemented with the required information to meet the threshold requirements for exceptional event demonstrations.

The Prescribed Fire EE Demonstrations must provide more information to establish the clear connection between the location, size, and type of burn events and the exceedance at a given monitor. The Prescribed Fire EE Demonstrations' Narrative Conceptual Model uses an aggregate approach, listing information from all Georgia Forestry Commission permits within 100 km of the monitor on the relevant date.[28] But this information alone is not sufficient to demonstrate that one fire (or the cumulative impact of several fires) caused the exceedance. Simply listing all of the fires that occurred within 100 km on a given day does not capture the full picture. For example, the list may include fires the occurred downwind from the monitor, fires that were initiated too early or late to result in the monitor exceedances, fires that were too small to impact monitor readings over a long distance, or fires that involved fuel types or land management activities unlikely to result in PM2.5 readings.

Element 7 - EPA's requirement that states provide information regarding the dominant fuel type used in the prescribed fire - is particularly important in understanding the duration of the fire and the type of smoke it might produce. A fire involving large quantities of wood, for example, will likely behave differently than a fire involving grasslands. Annual burns of agricultural waste are likely to produce different amounts of smoke than woodlands burned for land clearing or timber plantations burned for silvicultural purposes. Likewise, silvicultural burns are likely to be distributed across an entire property, whereas land clearing and other open burns are likely to be concentrated in specific locations. Without this type of information, it is impossible to understand a prescribed fire's impact on PM2.5 readings.

In other words, the information required in elements 1-7 above, which is largely absent from the Prescribed Fire EE Demonstrations, is crucial in understanding whether it was the prescribed fires that actually caused the exceedances at the monitor. Merely listing the number and size of fires in the absence of this other information is insufficient to establish the clear causal relationship required by regulations.

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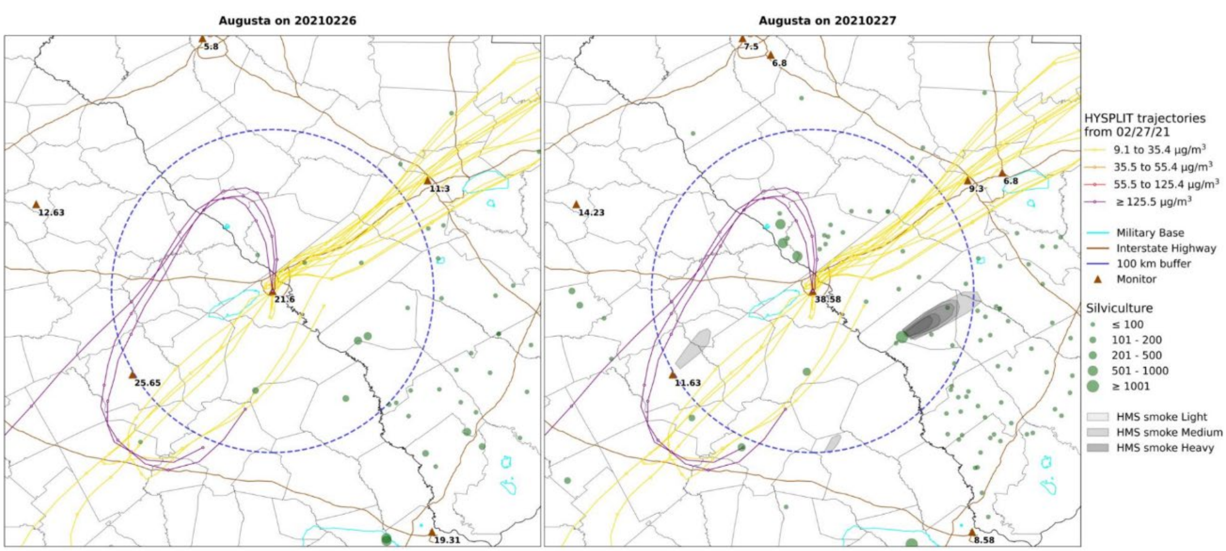
[28] For example, the Augusta Draft Prescribed Fire EE Demonstration includes the following description for April 8, 2021:

> A few silviculture fires were found in the path of the HYSPLIT back trajectories from the Augusta monitor associated with high PM2.5 concentrations measured on April 8, 2021. The exceedance on this day was due to fires on the day before (April 7) being transported to the monitor in the early morning hours. A total of 74 GFC permits covering 3,215.5 acres (93.4% from silviculture) were issued in a 100-km radius on April 7, 2021. The NOAA HMS smoke plumes are present in the Augusta area on both April 7 and 8.

3. *Given the known limitations of HMS modeling, the EE Demonstrations must provide additional, corroborating information.*

The EE Demonstrations rely on the National Oceanic and Atmospheric Administration's Hazard Mapping System (HMS) smoke plume data to establish the impact of prescribed fire smoke on the exceeding monitors. However, recent research highlights the limitations of HMS smoke data in predicting the presence of ground-level smoke. Comparing HMS modeling to meteorological conditions observed at airports, research found the HMS modeling to be least accurate in predicting ground level conditions on days classified as "low smoke" days in HMS.[29] Geographically, HMS modeling was found to be least accurate in the "West South Central, East South Central and South Atlantic" regions.[30] In fact, the study recommends that "light smoke plumes should generally be excluded for a binary classification of smoke and non-smoke days at the surface."[31] Applying the findings of this research to the EE Demonstrations, the HMS modeling should not be taken as dispositive, particularly on days with low smoke conditions. A copy of this research is attached.

Even setting aside these limitations, the HMS data still does not support an exceptional event finding for several of the listed dates. For example, the HMS maps for Feb. 26-27, 2021, in Augusta show little evidence of prescribed fire smoke in the area.



The HMS maps for Augusta on April 27-28, 2021, show virtually no smoke within 100 km of the monitor site on the date of the exceptional event or the preceding day.

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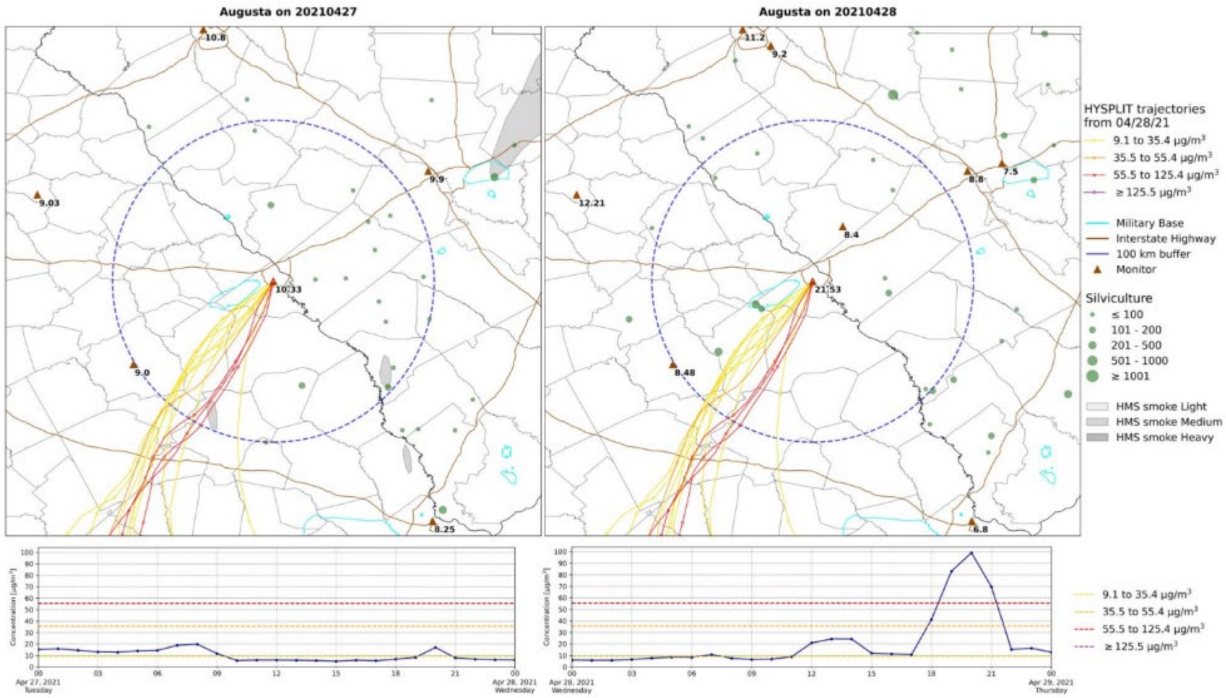
[29] Tianjia. Liu et al., "*Is the smoke aloft? Caveats regarding the use of the Hazard Mapping System (HMS) smoke product as a proxy for surface smoke presence across the United States*," INT'L J. OF WILDLAND FIRE (Oct. 2024).
[30] *Id.* at 7.
[31] *Id*. (emphasis added).



Other dates where little HMS smoke is present near the monitor include:

Augusta: 2/4/2021, 2/28/2021, 3/8/2021, 3/9/2021, 12/4/2021, 12/16/2021 and 12/8/2023;

Columbus: 2/8/2023 and 3/1/2023;

Sandersville: 1/15/2022, 10/25/2022, 11/19/2022, 1/2/2023, 1/8/2023, 1/17/2023, 1/29/2023, 2/7/2023, and 11/30/2023.

If the exceptional event requests are limited to dates where the HMS data shows medium or heavy smoke present in the vicinity of the monitors (as the International Journal of Wildland Fire research recommends), multiple other dates currently included in the Prescribed Fire EE Demonstrations should be removed.

The Prescribed Fire EE Demonstrations' Narrative Descriptions also include a number of dates with relatively limited prescribed fire activity in the vicinity of the exceeding monitor. For example, the Augusta Prescribed Fire EE Demonstration claims that data from Dec. 4-6, 2021 should be excluded, but the Narrative Description for those dates lists only fifteen permits for 196 acres on Dec. 4th, thirteen permits for 70 acres on Dec. 5th, and no permits on Dec. 6th.

These represent a small fraction of the fire activity reported on other exceptional events dates, which routinely involve over 100 permits and thousands of acres.[32]

The HMS data provides no additional support for concluding that Dec. 4-6, 2021, were exceptional events. Instead, the HMS data shows low levels of smoke widely dispersed throughout the region on these days.[33] Compared to other challenged dates, there is no reason to believe that the low level of prescribed fire activity on the dates would impact the monitors unless they were in close proximity to the exceeding monitor. Applying this example more broadly, a clear causal relationship cannot be shown for any dates on which the Narrative Descriptions identify "few" fires and the HMS data provides no corroborating evidence in the form of medium or high smoke levels in the immediate vicinity of the monitor.[34] The EE Demonstrations should be revised to remove any dates in which there is a low level of prescribed fire activity (according to the Narrative Description's permit summary) and the HMS data does not provide evidence of medium or high levels of smoke in the immediate vicinity of the monitor.

The EE demonstrations should also include speciation data to corroborate the exceptional events claims. Speciation data, or data about the chemical composition of emissions, directly addresses the nature of the PM2.5 readings at specific monitors on specific dates. The monitors at Augusta, Columbus (Baker), and Macon (Allied) are PM2.5 speciation monitors, so they have this capacity.[35] EPA guidance indicates that information regarding "chemical composition and/or size distribution" should be used to link pollution at the monitors "with particular sources or phenomenon."[36] Given that speciation information is available at these monitors, it should be provided to establish the clear causal relationship between prescribed fire smoke and the exceedances. The absence of this information should either be explained or should be inferred to not support the claim that these are exceptional events.

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[32] The Augusta Prescribed Fire Draft EE Demonstration actually characterizes Dec. 4-6, 2021, as dates with "some" prescribed fire activity. But, in comparison, other dates include more than ten times more fire activity. *See,* March 9, 2021 (10,372.9 acres); March 10, 2021 (10,651.5 acres); and March 3, 2022 (14,017.9 acres).
[33] Augusta Prescribed Fire Draft EE Demonstration Appx. A at 16-18.
[34] Other dates which include "few" prescribed fires according to the Narrative Descriptions are:
Augusta: 2/28/21; 4/8/21; 4/28/21; 7/23/21; 10/15/21; 12/16/21; 11/6/23;
Macon: 10/3/23; and
Sandersville: 4/8/21; 5/18/22; 8/7/22; 8/24/22; 11/2/22; 11/19/22; 1/29/23; 11/5/23.
[35] *2023 Air Quality Report*, GEORGIA ENVIRONMENTAL PROTECTION DIVISION AIR PROTECTION BRANCH (Nov. 25, 2024), https://storymaps.arcgis.com/stories/4eeea016f4c046378d412f1303384a4c; *see also Chemical Speciation Network,* U.S. ENVIRONMENTAL PROTECTION AGENCY, https://www.epa.gov/amtic/chemical-speciation-network-csn (last updated Jan. 8, 2025).
[36] 81 Fed. Reg. 68216, 68241 at Table 1 (Oct. 3, 2016).

4. *<u>The EE Demonstrations lack necessary information regarding fire intervals to demonstrate that fires are unlikely to recur.</u>*

The EE Demonstrations also lack the necessary information to meet the "unlikely to recur" element. To qualify as an exceptional event, emissions resulting from human activities must be "unlikely to recur at a particular location." But prescribed fires are, by definition, initiated by human activity at a scheduled interval. To square the statutory language with the nature of prescribed fire, EPA guidance directs that prescribed fires demonstrations:

> [M]ust describe the actual frequency with which a burn was conducted and may rely upon an assessment of either the natural fire return interval or the prescribed fire frequency needed to establish, restore and/or maintain a sustainable and resilient wildland ecosystem (as documented in a land or resource management plan).[37]

More specifically:

> An assessment of whether the prescribed fire meets the "unlikely to recur" criterion based on an area's natural fire return interval should include (1) a review of the number of years between successive naturally occurring fires for a given vegetation type and (2) a review showing that the actual frequency by which the prescribed fires were conducted matches the natural fire return interval.[38]

To satisfy the first element, the EE Demonstrations cite research regarding the natural fire cycle across the United States. This research categorizes ecosystems at an extremely high level and does not reflect localized nuances. More granular information regarding natural fire cycles in Georgia is available and should be used here.[39]

The EE Demonstrations are unable to meet the second element regarding the actual fire cycle used for these locations. Meeting this requirement is a challenge given the large number of dates covered in the Prescribed Fire EE Demonstrations (88 days) and the number of fires conducted on any given date (often in excess of 100 per monitor per day). Instead of submitting information regarding the actual fire cycle for each of the prescribed fire events, the EE Demonstrations attempt to recreate a generic fire cycle for each county. This number was created by assuming that all areas within 100 km of a monitor and categorized as "rural'" by the 2020 U.S. Census are part of the "total burn area." This number is then divided by the average number

[37] *Exceptional Events FAQ* at B.13.
[38] *Wildland Fire Tiering Guidance* at 17; *see also Exceptional Events FAQ* at B.19.
[39] For example, one source of more granular information on fire cycle in these areas is the LANDFIRE database maintained by the Department of Agriculture and the Department of Interior (https://landfire.gov/fire-regime/fri).

of acres burned in each county per year to create the county's calculated burn cycle.[40] The problems with this approach are numerous and obvious.[41] In reality, a subset of properties in each county are actively managed with prescribed fire and the remainder are not. But without actual, site-specific information regarding the frequency of prescribed fire at thousands of specific locations, the EE Demonstrations fail to demonstrate the fire interval required for the unlikely to recur element.[42]

As with the other information missing from the EE Demonstrations, the lack of information regarding the fire interval used to manage specific properties illustrates the fact that EPD and the Georgia Forestry Commission are not maintaining the information necessary to properly document prescribed fires and comply with EPA's current exceptional event guidance. Likewise, without this information, it is unsurprising that cumulative impacts of widespread prescribed fire are creating frequent and pervasive challenges for air quality throughout middle Georgia.

5. Georgia's Smoke Management Plan must be enhanced and improved to ensure compliance with the new PM2.5 standard.

To qualify as an exceptional event, air pollution must result from an activity that is neither reasonably controllable nor preventable. In the context of prescribed fire, EPA interprets this provision to require that prescribed fire be conducted pursuant to an adopted smoke management plan or basic smoke management practices.[43] The EE Demonstrations use the former approach and rely on the Georgia SMP adopted by Georgia DNR and the Georgia Forestry Commission in 2008.

However, in the intervening sixteen years since the Georgia SMP was adopted, the PM2.5 NAAQS has been revised, EPA promulgated guidance regarding prescribed fire and

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[40] *See, e.g.,* Augusta Prescribed Fire Draft EE Demonstration at 14; Columbus Prescribed Fire Draft EE Demonstration at 9; Macon Prescribed Fire Draft EE Demonstration at 9; Sandersville Prescribed Fire Draft EE Demonstration at 19.

[41] The U.S. Census uses the rural designation for any area with a population of less than 5,000. https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html Thus, areas designated as rural (and therefore part of the EE Demonstrations total burn area) would include all cities with a population of 4,999 or less; areas developed for non-residential purposes, such as warehouses, factories, or distribution centers; landscape features not subject to prescribed fires like roads, rivers, forests, and lakes. Or, in other words, this approach assumes that everything except cities with over 5,000 residents are potentially the sites prescribed fires.

[42] The fact that many of the prescribed fires identified in the EE Demonstrations likely occurred on private property does not eliminate this requirement. To the contrary, EPA's Exceptional Events FAQ addresses this question directly, repeating the requirement that demonstrations provide information on the fire-return interval necessary to accomplish the land management goals of that specific property. *See Exceptional Events FAQ* at B.14.

[43] *Wildfire Fire Tiering Guidance* at 19.

exceptional events, and Georgia's open burning requirements have been amended. As a result, the Georgia SMP is outdated in several critical respects. Given that the EE Demonstrations identify over 88 exceedance days related to prescribed fires, it is clear that the Geogia SMP is falling short of its goal of ensuring compliance with federal air quality standards.

EPA identifies "surveillance and enforcement" and "program evaluation" as critical elements of a smoke management plan.[44] But the EE Demonstrations do not describe any efforts to evaluate the Georgia SMP's performance and ensure its success since it was adopted in 2008. And with respect to the 2021-2023 timeframe, the EE Demonstrations describe no additional measures undertaken to reduce the impact of prescribed fire smoke between the events occurring in 2021 and those in 2023.

"The [Clean Air Act] as a whole, and Section 319(b) in particular is premised on the idea that states should undertake reasonable actions to control emissions and protect public health."[45] The exceptional events provision is intended to apply "in addition to, rather than in place of, reasonable controls."[46] To this end, air agencies seeking to exclude air quality data must show that "appropriate and reasonable" steps have been taken to prevent future exceedances of air quality standards.[47] These steps include preparation of mitigation plans for areas with "historically documented or known seasonal events."

Given the widespread and repeated impacts of smoke from prescribed fires on air quality around Georgia, EPD should have taken steps since 2008 to ensure the Georgia SMP was sufficient. Likewise, additional measures should have been undertaken between 2021 and 2023 to address the problem of prescribed fire smoke. In the absence of such remedial measures to ensure the Georgia SMP's adequacy and reduce the number of monitor exceedances, the recurring impacts of prescribed fire smoke should not be disregarded as exceptional events.

Finally, the Georgia SMP commits to restrict the use of open burning or encourage the use alternative management practices if burning proves an obstacle to attaining air quality standards.[48] This precise scenario described in the Georgia SMP is occurring, but the EE Demonstration does not describe any efforts undertaken to implement these provisions of the Georgia SMP.

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[44] *Exceptional Events FAQ* at B.16.
[45] *Treatment of Data Influenced by Exceptional Events*, 81 Fed. Reg. 68216, 68266 (Oct. 3, 2016) (codified in 40 C.F.R. Parts 50 and 51).
[46] *Id.*
[47] 40 C.F.R. § 51.930.
[48] *Georgia SMP* at 9.

6. *The EE Demonstrations should exclude open burning events other than prescribed fires.*

The Prescribed Fire EE Demonstration for each area includes an Excel spreadsheet with additional detail regarding burn events that occurred within 100 km of the applicable monitor on the relevant dates. However, these spreadsheets are based on open burn permits and include activities that go beyond what is considered prescribed fire under its colloquial meaning, EPA's definition, or the framework established in Georgia's Prescribed Burning Act. [49]

For example, these spreadsheets include agricultural burns and land clearing among the burn events that occurred on the relevant dates and purportedly contributed to the exceptional events.[50] But agricultural burns and land clearing are not prescribed fires. Prescribed fires are the "controlled application of fire to existing vegetative fuels to accomplish land management objectives or to mitigate catastrophic wildfires. Prescribed fire is a land management and resource protection tool used for Georgia's forest lands."[51] Agricultural burns and land clearing are considered by EPD to be separate "burn types," and therefore do not fall under the general category of "prescribed fires."[52] This distinction is important because EPA defines prescribed fire as "any fire intentionally ignited by management actions in accordance with applicable laws, policies, and regulations to meet specific land or resource management objectives."[53] Therefore, if fires burning agricultural waste or for land clearing are not "prescribed fire" under state law, they should not be considered as such for the exceptional event regulations.

7. *Whether EPA approves the EE Demonstrations or not, Georgia EPD must undertake actions to prevent the impact of prescribed fire on air quality.*

We do not dispute the importance of prescribed fires for ecological, silvicultural, and other reasons. Likewise, we recognized the logistical issues posed by the widespread use of prescribed fire in Georgia and the fact that these activities largely occur at a smaller scale and

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49 *See* O.C.G.A. § 12-6-145 *et seq*.
50 *See, e.g.,* Augusta Draft Prescribed Fire EE Demonstration at Appx. B (25 instances of "land clearing" and 10 instances of "agriculture"); *see also* Draft Prescribed Fire EE Demonstrations for Columbus, Macon, and Sandersville at Appx. B.
51 O.C.G.A. § 12-6-147; *see also Prescribed Fire Smoke Management Plan*, GEORGIA ENVIRONMENTAL PROTECTION DIVISION AIR PROTECTION BRANCH, https://epd.georgia.gov/air-protection-branch/open-burning-rules-georgia/burn-types/prescribed-fire-smoke-management-plan.
52 *Burn Types,* GEORGIA ENVIRONMENTAL PROTECTION DIVISION, https://epd.georgia.gov/air-protection-branch/open-burning-rules-georgia/burn-types#:~:text=Burn%20Type%202%20%2D%20Agricultural%20Procedures,is%20greater%20than%205%20acres.
53 40 C.F.R. § 50.1(m).

more often on private property than in other parts of the country. But the pervasive impacts of these prescribed fires on air quality throughout Georgia documented in the EE Demonstrations make clear that the current approach is not working and must be revisited to ensure that prescribed fires are not conducted at the cost of Georgia's air quality.

V. The EE Demonstrations Must Provide Additional Support to Demonstrate the Ground-Level Impacts of Canadian Wildfire Smoke on Tier 2 Days.

There is no dispute that Georgia's air quality was impacted by smoke from Canadian wildfires in the summer of 2023. But the dates, locations, and extent of those impacts must be documented and supported by the weight of the evidence for exceedances to be disregarded as exceptional events. As they stand, the Canadian Wildfire EE Demonstrations lack the necessary information to support the clear causal relationship between wildfire smoke and exceedances on the Tier 2 dates.

EPA guidance provides a tiered approach to guide air agencies in documenting exceptional events related to wildfires. Historical PM2.5 data is used to set certain thresholds, and potential exceptional event dates are categorized based on those thresholds as Tiers 1, 2 or 3.[54] Tier 1 events show the greatest deviation from historic data and therefore require less documentation. Tier 2 events differ from the historic trend to a lesser degree and require "more detailed information to establish a clear causal relationship between smoke transport from the event to the monitored exceedance."[55] For Tier 2 events, air agencies cannot simply demonstrate that smoke was transported to the monitor location (as required for Tier 1 events). Rather, Tier 2 dates require two additional sources of information demonstrating that wildfire smoke was present at and affected the monitor.[56] EPA guidance lists different types of ground-level information that can be used to make this showing.[57] Tier 2 demonstrations should also "distinguish the difference in the non-event pollutant behavior (e.g., concentration, timing, ratios, and/or spatial patterns) from the behavior during the event impact to more clearly show that the emissions from the wildland fire(s) affected the monitor(s)."[58]

The Canadian Wildfire EE Demonstrations include several Tier 2 dates based on the presence of Canadian wildfire smoke. But they lack the localized, ground-level information

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[54] The tiering threshold is set based on the lesser of (a) the most recent 5-year month-specific 98th percentile for 24-hour PM 2.5 data, or (b) the minimum annual 98th percentile for 24-hour PM 2.5 data for the most recent 5-year period. *Wildland Fire Tiering Guidance* at 6.
[55] *Wildland Fire Tiering Guidance* at 16.
[56] *Id*. at 17.
[57] *Id*. at 17-18.
[58] *Id*. at 18.

required to support the clear causal relationship for Tier 2 dates.[59] The Canadian Wildfire EE Demonstrations rely on HYSPLIT back-trajectory maps showing the prevailing wind patterns and EPA Air Now data showing PM2.5 at monitors across the country. But these maps conflate information across three dates and three different elevations, making it impossible to discern what is occurring at the ground level on a specific date. Further, because the maps depict a broad range of air quality readings in the same color (monitors reading between 9.1 and 35.5 $\mu g/m^3$ are yellow), it is not possible to distinguish between monitor readings that are fractionally above the 9.0 standard, versus those nearly quadruple the standard.

The Canadian Wildfire EE Demonstrations also provide regional maps showing PM2.5 readings at air quality monitors throughout adjacent states on the exceedance dates. But without more context and a comparison to historical trends, they shed little light on ground level conditions at the challenged monitors. If anything, these maps illustrate that regional variations occur between monitors and underscore the need for more location-specific analysis.

As with prescribed fire, the Canadian Wildfire EE Demonstrations rely on HMS smoke data to demonstrate the presence of wildfire smoke in the area. But the same limitations on this data apply here, with recent research questioning the reliability of HMS data in predicting ground level PM2.5 readings based on low smoke days in the Southeast. Accordingly, as with prescribed fire, the Canadian Wildfire EE Demonstrations must provide additional support demonstrating that wildfire smoke was present at ground level and caused the exceedance at the relevant monitors. The comments above regarding the use of speciation monitor data apply here as well. The availability of speciation information from the monitors at Augusta, Columbus, Macon, and Rossville should be provided to validate the HMS conclusions with respect to wildfire.

Finally, the Canadian Wildfire EE Demonstrations pose a consistency problem with respect to wildfire smoke when taken together. They rely on macro scale data and repeatedly reference the regional impacts of wildfire smoke, yet the dates claimed as exceptional events vary widely. For example, although Sandersville and Atlanta are roughly 100 miles apart, the EE Demonstrations claim sixteen dates as exceptional events at Sandersville but only two at Atlanta. This discrepancy underscores the need for more localized information to support these demonstrations.

VI. The EE Demonstrations Do Not Meet the Mitigation Requirements for Smoke Resulting From Fourth of July Fireworks.

The EE Demonstrations seek to exclude monitoring data on three days in Augusta, GA, based on smoke from Fourth of July fireworks. Federal regulations allow exceedances resulting

[59] Columbus Canadian Wildfire Draft EE Demonstration (6/29/23 and 7/17/23); Macon Canadian Wildfire Draft EE Demonstration (6/29/23; 7/20/23; 7/26/23; and 8/25/23); Rossville Canadian Wildfire Draft EE Demonstration (6/8/23 and 6/17/23).

from firework smoke to be excluded only if the air agency's demonstration otherwise satisfies the relevant statutory and regulatory requirements.[60]

The three days EPD seeks to exclude data from are July 4, 2021, July 5, 2021, and July 4, 2023. All three exceedances took place in Augusta and are Tier 1 events. Although smoke from Fourth of July fireworks may qualify as a significant integral national celebration, the EE Demonstrations must further show that adequate mitigation efforts were undertaken to minimize the impacts of the fireworks. Air agencies are required, at a minimum, to provide prompt public notification when air quality concentrations exceed or are expected to exceed the applicable standard; to provide for public education regarding actions that individuals can take to reduce exposure to unhealthy levels of air quality following the exceptional event; and to provide for the implementation of appropriate measures to protect public health from exceedances caused by the exceptional event.[61]

The Augusta Firework EE Demonstration only provides information about *general* mitigation strategies that it has undertaken with respect to the health impacts of smoke—not mitigation strategies specific to fireworks. For example, it discusses the interactive wildfire and burn permit map on the Georgia Forestry Commission's website. That map, however, contains no information specific to firework smoke and is not an obvious place for the public to seek information related to the health impacts of Fourth of July firework smoke.

The Augusta Firework EE Demonstration does not explain any public education or public notification measures that were undertaken specific to firework smoke to mitigate public health risks that may have resulted from Fourth of July fireworks. For example, other parts of the country have established incentive programs to encourage the use of drones or laser shows instead of firework displays to celebrate the occasion with less smoke.[62] The Augusta Firework EE Demonstration also lacks any information related to public notifications about the unhealthy air quality resulting from the fireworks on those days. This is particularly important because the public would not necessarily assume that the risk from firework smoke would extend to the following day on July 5th.[63]

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[60] 40 C.F.R. § 50.14(b)(2).

[61] 40 C.F.R. § 51.930.

[62] *Item Number 8: Allocate Up to $600,000 in Additional Funding for the District's Clean Alternatives to Fireworks Pilot Incentive Program*, SAN JOAQUIN VALLEY AIR POLLUTION CONTROL DISTRICT (Mar. 21, 2024), https://ww2.valleyair.org/media/wicbzq5w/item-8_-allocate-up-to-600-000-in-additional-fund.pdf.

[63] Notably, the EE Demonstrations for all three types of exceedances—prescribed burns, wildfires, and Fourth of July fireworks—contain nearly identical descriptions of the website containing a smoke map and other mitigation techniques. *See, e.g.,* Augusta Firework Draft EE Demonstration at 4; *see also* Augusta Prescribed Fire Draft EE Demonstration at 4; *see also* Macon Canadian Wildfire Draft EE Demonstration at 3-4. These generalized and boilerplate

The Augusta Firework EE Demonstration also states that there are "several areas of Georgia that have historically presented fireworks displays on July Fourth." Federal rules institute additional mitigation requirements for areas with historically documented or known seasonal events.[64] The Augusta Firework EE Demonstration fails to include any of those heightened mitigation requirements, despite claiming the Fourth of July fireworks to be exceptional events that are historically documented and known. If high levels of firework smoke are a recurring problem and are significant enough to be categorized as exceptional events, the Augusta Firework EE Demonstration should have engaged in the required mitigation steps and created a mitigation plan.

CONCLUSION

Thank you for the opportunity to provide comment on the draft Exceptional Event Demonstrations for Augusta, Atlanta, Columbus, Macon, Sandersville, and Rossville, Georgia. Correctly designating these areas is critical to ensure that residents are appropriately protected by the Clean Air Act and have healthy air to breathe.

Although the 2023 Canadian wildfires posed a unique challenge for air quality in Georgia, the majority of exceedance dates covered in the EE Demonstrations are related to prescribed fire smoke. Whether due to smoke from prescribed fires, wildfires, or fireworks, however, the EE Demonstrations fail to provide the necessary information to support the clear causal relationship between the events and the monitor exceedances. To the extent this causal relationship cannot be proven, or if the necessary information does not exist, we encourage EPD to limit its applications to the dates and locations where these standards can be met. Further, whether or not these exceedances are ultimately excluded as exceptional events, EPD must take action to ensure that smoke from prescribed fires is better controlled in the future and similar exceedances do not occur.

Thank you for your consideration of these comments. Should you have any questions, please feel free to contact me at the phone number or email listed below.

Sincerely,

/s/ Brian L. Gist

Brian Gist, Senior Attorney
Aradhana Chandra, Associate Attorney
Southern Environmental Law Center

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discussions of mitigation are insufficient under 40 C.F.R. § 51.930, which requires air agencies to provide prompt public notification for each specific claimed exceptional event at the time of the event. Based on the information provided in the EE Demonstrations, it appears that the requirement to provide contemporaneous and subject-matter specific notice has not been met for any of the three types of claimed exceedances.

[64] 40 C.F.R. § 51.930(b).

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EXHIBIT 1

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Is the smoke aloft? Caveats regarding the use of the Hazard Mapping System (HMS) smoke product as a proxy for surface smoke presence across the United States

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ABSTRACT

Background. NOAA's Hazard Mapping System (HMS) smoke product comprises smoke plumes digitised from satellite imagery. Recent studies have used HMS as a proxy for surface smoke presence. **Aims.** We compare HMS with airport observations, air quality station measurements and model estimates of near-surface smoke. **Methods.** We quantify the agreement in numbers of smoke days and trends, regional discrepancies in levels of near-surface smoke fine particulate matter ($PM_{2.5}$) within HMS polygons, and separation of total $PM_{2.5}$ on smoke and non-smoke days across the contiguous US and Alaska from 2010 to 2021. **Key results.** We find large overestimates in HMS-derived smoke days and trends if we include light smoke plumes in the HMS smoke day definition. Outside the western US and Alaska, near-surface smoke $PM_{2.5}$ within areas of HMS smoke plumes is low and almost indistinguishable across density categories, likely indicating frequent smoke aloft. **Conclusions.** Compared with airport, Environmental Protection Agency (EPA) and model-derived estimates, HMS most closely reflects surface smoke in the Pacific and Mountain regions and Alaska when smoke days are defined using only heavy plumes or both medium and heavy plumes. **Implications.** We recommend careful consideration of biases in the HMS smoke product for air quality and public health assessments of fires.

Keywords: data evaluation, emissions, fine particulate matter, fires, Hazard Mapping System, observations, $PM_{2.5}$, pollutants: air, remote sensing, satellite data, scale: regional, smoke.

Introduction

Smoke pollution from wildfires in the western United States is increasingly a major public health concern with recent record-breaking fire seasons in 2018, 2020 and 2021 (Burke *et al.* 2021; Zhou *et al.* 2021). Decades of fire suppression in the 1900s and droughts in a warming climate together led to longer and more severe fire seasons, punctuated by megafires that spiral out of control (Syphard *et al.* 2017; Williams *et al.* 2019; Juang *et al.* 2022). The growing human population living in the wildland–urban interface is vulnerable to fires and in turn may cause more accidental ignitions. There is an increasing effort to attribute public health impacts to wildfire smoke pollution, but the caveats of underlying datasets used to quantify smoke are not yet fully explored (O'Dell *et al.* 2021; Zhou *et al.* 2021; Qiu *et al.* 2024).

Recent public health studies have relied on the National Oceanic and Atmospheric Administration's (NOAA) Hazard Mapping System (HMS) smoke product to quantify the smoke fraction in surface fine particulate matter ($PM_{2.5}$) in the US (Aguilera *et al.* 2021; O'Dell *et al.* 2021; Zhou *et al.* 2021). This statistical approach diagnoses smoke $PM_{2.5}$ in surface $PM_{2.5}$ observations on days when $PM_{2.5}$ anomalies align with digitised HMS smoke plume polygons. 'Background' $PM_{2.5}$ from other pollution sources in these studies is often calculated as the median $PM_{2.5}$ observed during non-smoke days (Burke *et al.* 2021; Childs *et al.* 2022). More advanced methods interpolate station measurements onto a grid

(O'Dell *et al.* 2021) or fill in the cloud-induced gaps in HMS data by tracking the trajectory of smoke transport from active fires (Childs *et al.* 2022). When using a statistical method to calculate smoke $PM_{2.5}$ – that is, using total $PM_{2.5}$ observations with HMS to partition smoke and non-smoke days – overestimates in smoke days may result in overestimates of smoke-related air pollution and public health impacts. This is because the calculation of the background $PM_{2.5}$ using median or mean values is imperfect, and elevated $PM_{2.5}$ may be incorrectly attributed to smoke. Traditional air quality and public health assessments of fires on air quality have relied on 3D chemical transport models with input emissions inventories to estimate smoke $PM_{2.5}$ by comparing model runs with and without fire (Wiggins *et al.* 2018; Carter *et al.* 2020) or calculating the sensitivity footprint of a receptor to nearby emissions (Koplitz *et al.* 2016; Marlier *et al.* 2019; Kelp *et al.* 2023); however, this process is computationally expensive. The HMS statistical approach circumvents having to grapple with model biases stemming from uncertainty in the meteorology driving the smoke transport and plume rise and in the fire emissions estimates, which are calculated from fire activity, fuel load and combustion efficiency and depend on poorly constrained emissions factors (Liu *et al.* 2020). Additionally, the HMS smoke product is observationally grounded and readily accessible to experts in fields adjacent to the atmospheric sciences. However, without prior knowledge of emissions levels from different sectors, uncertainty arises from the reliance on the HMS smoke product to distinguish smoke $PM_{2.5}$ from other types of $PM_{2.5}$. Thus, here we seek to understand: how well does the HMS smoke product reflect surface smoke conditions?

The HMS smoke product relies on NOAA analysts to digitise smoke plumes using satellite imagery primarily from the Geostationary Operational Environmental Satellites (GOES) (Rolph *et al.* 2009; Brey *et al.* 2018). However, the ability of the HMS smoke product to represent surface smoke conditions with high spatial accuracy is uncertain as the product has not yet been fully validated against surface observations. First, HMS smoke polygons represent limited daytime snapshots of column smoke presence and do not contain information about the vertical location of smoke, i.e. whether the smoke is aloft or near the surface. HMS may be a poor indicator of surface smoke where smoke is expected to be mostly aloft, such as over states in the Midwest and Northeast that do not receive large amounts of smoke from wildfires and prescribed fires but instead receive smoke transported from other regions. Second, the spatial accuracy of HMS, particularly at the edges of smoke polygons, is affected by the coarse spatial resolution of GOES imagery. The GOES imagery from which HMS smoke is derived has a spatial resolution of 2 km at the equator, but the resolution over the contiguous United States (CONUS) and Alaska is lower depending on the pixel's latitude and proximity to the edge of the viewing disc – i.e. the satellite viewing angle. If a region is prone to high-altitude cloud cover, GOES satellites have an advantage over polar-orbiting satellites (e.g. Terra, Aqua, S-NPP, NOAA-20) as they can potentially wait until the clouds move away from the smoke layers. Additionally, HMS does not account for the parallax effect, in which objects observed by GOES are displaced from their actual location. This displacement is dependent on its location and altitude and can affect spatial accuracy of HMS plume edges. Third, HMS does not fully capture the dynamic nature of smoke dispersion. Although HMS labels the apparent density of individual plumes as light, medium, or heavy, there may still be high variation in smoke levels within polygons. Because HMS analysts must cover North America every day with only two major updates, the spatial and temporal information HMS provides is coarse. The potential spatial heterogeneity in accuracy suggests that caution should be exercised in public health analyses dependent on the HMS smoke product.

In this study, we evaluate the use of the HMS smoke product as a proxy for surface smoke on a regional level across the US. For comparison, we select three open-access datasets and products available in near-real-time: airport observations from the NOAA Integrated Surface Database (ISD), air quality station (AQS) measurements from the US Environmental Protection Agency (EPA), and model estimates from the NOAA High-Resolution Rapid Refresh (HRRR)-Smoke operational model. Although each has its own strengths and caveats, end-users may draw more robust conclusions in regions with good agreement between HMS and other estimates, whereas strong disagreement could undermine HMS-based results. First, we compare the magnitude and trends in HMS smoke days with a network of ISD airport observations. Second, we use EPA AQS measurements to quantify the regional variation in surface smoke $PM_{2.5}$ concentrations within HMS smoke plumes and differences among the density categories. Third, we use HRRR-Smoke model estimates during a high fire year in a similar regional analysis of spatial variation but not limited to locations of EPA monitors.

Data and methods

NOAA's Hazard Mapping System (HMS) smoke product

To produce NOAA's Hazard Mapping System (HMS) smoke product, analysts use visible satellite imagery to draw polygons of the extent of wildfire smoke (Rolph *et al.* 2009; Brey *et al.* 2018). The HMS smoke product is available from August 2005 and produced daily, in near-real-time (https://www.ospo.noaa.gov/Products/land/hms.html). HMS analysts use true-colour images primarily from the GOES-East and GOES-West satellites for smoke plume digitisation. The longitudinal position of GOES-East is 75°W and that of GOES-West is 137°W. Currently, the GOES full disc view of North and South America is 2 km in spatial resolution at the equator and recorded every 10 min, whereas the CONUS-specific view is recorded every 5 min. Owing to favourable optics at high solar zenith angles, analysts typically update smoke plume polygons for large areas of smoke just twice per day – early morning after sunrise and late afternoon before sunset – whereas smaller smoke plumes can be updated anytime during daytime hours. Analysts use an animated sequence of satellite images to identify smoke-affected areas and digitise the maximum extent of smoke visible. Each plume's density is further qualitatively classified as light/thin, medium, or heavy/thick smoke based on the apparent opacity of the plume in satellite imagery. Starting from 2008, HMS smoke plumes are categorically labelled as 5, 16 and 27, which approximately correspond to $PM_{2.5}$ equivalents based on the now discontinued GOES Aerosol Smoke Product (GASP): 5 [0–10] $\mu g/m^3$ (light/thin), 16 [10–21] $\mu g/m^3$ (medium) and 27 [21–32] $\mu g/m^3$ (heavy/thick). However, an update to the HMS smoke product in 2022 removed this connection to the $PM_{2.5}$ equivalents, instead opting for the text labels of 'light', 'medium' and 'heavy.' Owing to data loss of smoke density information for almost all polygons in 2009, we set our study time period as 2010–2021. For quality control, we remove malformed HMS polygons with edges crossing, unclosed rings, out-of-bounds coordinates and insufficient number of vertices, i.e. drawn as lines; these excluded polygons comprise $<0.1\%$ of all polygons.

NOAA's Integrated Surface Database airport observations

NOAA's Integrated Surface Database (ISD) collates observations of meteorological parameters at airports at varying temporal frequencies (Smith *et al.* 2011) (accessed from: https://www.ncei.noaa.gov/data/global-hourly/). Meteorological observations include air temperature, surface pressure and visibility, as well as indicators of low visibility due to haze, clouds/mist, dust and smoke. We use the atmospheric condition codes from the automated weather (AW) reports in the ISD dataset. To define a smoke observation, we use the 'smoke' (AW = 5) code. Observer guidelines define visibility reduction associated with smoke as 'a suspension in the air of small particles produced by combustion'; further visual cues outlined for smoke include the colour of the disc of the sun appearing red during sunrise/sunset or orange when above the horizon (Office of the Federal Coordinator for Meteorological Services and Supporting Research 1995; US Department of Transportation Federal Aviation Administration 2016). We filter out airports that have no smoke observations and on average have less than one valid observation of visibility per day from 2010 to 2021. We use a total of 1598 airports across CONUS and 108 airports in Alaska (Fig. 1). To filter out spurious ISD smoke observations, we designate a day as a smoke day if $>5\%$ of all observations during that day are labelled as smoke.

Evaluating HMS smoke days with ISD airport observations

For HMS, we test three definitions of smoke days based on presence of the light, medium and heavy smoke density categories: (1) all (light, medium, or heavy), (2) medium/heavy, and (3) heavy only. In the heavy-only definition, for example, we designate a day as a smoke day only if a heavy smoke plume overlaps with a particular location; otherwise,

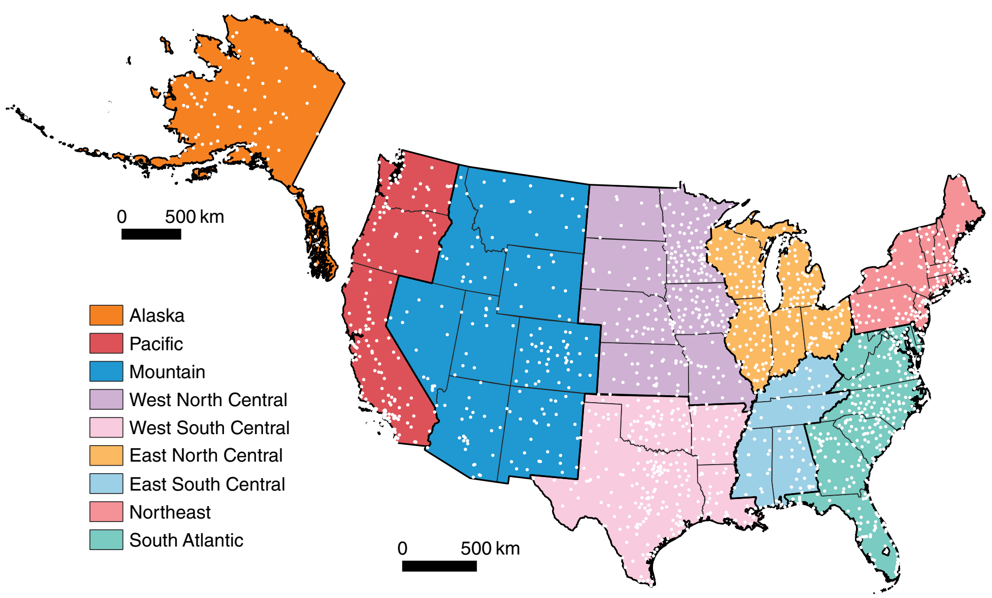

Fig. 1. Map of CONUS regions and Alaska with ISD airport locations. Each white dot represents the location of an airport in the Integrated Surface Database (ISD) used in this study (note that Alaska is not shown on the same scale as CONUS).

days are considered non-smoke days. At each airport, we compare the average number of smoke days and linear trend in smoke days as derived from smoke observations from ISD airport and HMS data during smoky-heavy months, or months with >5% of annual HMS smoke days. This constraint limits our analysis to months when fire-related smoke is likely a dominant pollution source.

For each airport location, we quantify the difference in HMS and airport average smoke days per year and trend in smoke days from 2010 to 2021. We compare statistics and accuracy metrics for nine sub-regions: Alaska, Pacific, Mountain, West North Central, West South Central, East North Central, East South Central, Northeast and South Atlantic (Fig. 1). Broader regions referred to in this study are defined as follows: the West covers Pacific and Mountain and parts of West North Central and West South Central; the East covers the rest of CONUS outside of the West; the Midwest covers East North Central and West North Central; and the Southeast covers East South Central and South Atlantic. We use two accuracy metrics, Cohen's kappa (κ) and Matthews correlation coefficient (MCC), to evaluate the agreement between HMS and airport smoke day classifications. Cohen's kappa is a widely used metric for validation in remote sensing studies that involve classification, such as mapping land cover types and change (Cohen 1960). The MCC is a proposed alternative for Cohen's kappa; although both metrics are derived from confusion matrices, the MCC performs better on imbalanced datasets and overall is a more informative and reliable metric to evaluate binary classification (Matthews 1975; Chicco *et al.* 2021). For two-class comparisons, the Cohen's kappa and MCC metrics are calculated as follows:

$$\kappa = \frac{2\,(\mathrm{TP} \times \mathrm{TN} - \mathrm{FP} \times \mathrm{FN})}{(\mathrm{TP} + \mathrm{FP}) \times (\mathrm{TN} + \mathrm{FP}) + (\mathrm{TP} + \mathrm{FN}) \times (\mathrm{TN} + \mathrm{FN})} \quad (1)$$

$$\mathrm{MCC} = \frac{(\mathrm{TP} \times \mathrm{TN}) - (\mathrm{FP} \times \mathrm{FN})}{\sqrt{(\mathrm{TP} + \mathrm{FP}) \times (\mathrm{TP} + \mathrm{FN}) \times (\mathrm{TN} + \mathrm{FP}) \times (\mathrm{TN} + \mathrm{FN})}} \quad (2)$$

where TP is number the true positives (i.e. both airport and HMS = smoke day), TN is the number of true negatives (i.e. both airport and HMS = non-smoke day), FP is the number of false positives (i.e. airport = non-smoke day, HMS = smoke day) and FN is the number of false negatives (i.e. airport = smoke day, HMS = non-smoke day).

Additionally, we calculate the true positive rate (TPR, recall), positive predictive value (PPV, precision), false positive rate (FPR) and negative predictive value (NPV) to complement our analysis:

$$\mathrm{TPR} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}} \quad (3)$$

$$\mathrm{PPV} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FP}} \quad (4)$$

$$\mathrm{FPR} = \frac{\mathrm{FP}}{\mathrm{FP} + \mathrm{TN}} \quad (5)$$

$$\mathrm{NPV} = \frac{\mathrm{TN}}{\mathrm{TN} + \mathrm{FN}} \quad (6)$$

Evaluating elevated $PM_{2.5}$ at EPA stations during HMS smoke days

As an additional way to evaluate the HMS smoke density categories, we use daily average $PM_{2.5}$ measurements at EPA stations across CONUS and Alaska. We obtain daily average EPA $PM_{2.5}$ data under parameter codes 88801 and 88502, which refer to the designation of federal reference method (FRM) and federal equivalent method (FEM) for quality control (https://aqs.epa.gov/aqsweb/airdata/download_files.html). For our study period of 2010–2021, we use a total of 1024 EPA stations that have at least a decade of measurements from 2009 to 2022 (buffer years to calculate background $PM_{2.5}$) and over an average of 100 measurements per year (Supplementary Fig. S1). To approximate smoke $PM_{2.5}$, we subtract the total $PM_{2.5}$ from the background $PM_{2.5}$. Following Childs *et al.* (2022), we calculate the background $PM_{2.5}$ as the median $PM_{2.5}$ on days with no coincident HMS smoke plumes during the same month across a 3-year period. For example, the background $PM_{2.5}$ for January 2019 is the median of $PM_{2.5}$ on non-smoke days during January 2018, 2019 and 2020. We then classify the $PM_{2.5}$ anomalies on HMS smoke days by the maximum HMS smoke density category of each day and compare across regions. Large variation exists in the background $PM_{2.5}$, but we would expect the $PM_{2.5}$ anomalies on the HMS smoke days to fall at the higher end of the distribution of $PM_{2.5}$ anomalies on non-smoke, or 'background', days. To test this, we also report the percentile at which the $PM_{2.5}$ anomalies on smoke days lies on the cumulative probability distribution of $PM_{2.5}$ anomalies on non-smoke days. The percentile measures the separation between the $PM_{2.5}$ on smoke and non-smoke days; higher percentiles imply greater confidence in attributing elevated $PM_{2.5}$ to smoke.

Evaluating the spatial consistency of modelled near-surface smoke $PM_{2.5}$ within HMS polygons

We use the NOAA's operational HRRR-Smoke model forecast products to track the spatial consistency in near-surface smoke $PM_{2.5}$ across CONUS (https://rapidrefresh.noaa.gov/hrrr/HRRRsmoke/). HRRR-Smoke is based on the Weather and Research Forecasting model coupled with Chemistry (WRF-Chem) and input fire emissions calculated from fire radiative power (FRP), a proxy for fire intensity that is directly proportional to emissions (Ahmadov *et al.* 2017; Benjamin *et al.* 2021; Dowell *et al.* 2022). The FRP is derived from observations by the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor aboard the Suomi-NPP and

NOAA-20 satellites and Moderate Resolution Imaging Spectroradiometer (MODIS) sensor aboard the Terra and Aqua satellites. HRRR-Smoke provides real-time hourly surface smoke concentrations (primary $PM_{2.5}$ from wildland fires) at 3-km spatial resolution that we then average to daily scale. We use the HRRR-Smoke 2D outputs ('wrfsfc') at forecast Hour 0 in 2021, a high fire year and the first full year that the near-surface smoke $PM_{2.5}$ variable ('MASSDEN') became available in the operational product (accessed from: https://noaa-hrrr-bdp-pds.s3.amazonaws.com/index.html). We track how the HRRR-Smoke simulated smoke concentrations vary across smoke polygons with the same density category. For example, the occurrence of low smoke $PM_{2.5}$ values ($<10\ \mu g\ m^{-3}$) from HRRR-Smoke located within heavy HMS smoke polygons may signal that the smoke is lofted, and that HMS does not accurately reflect surface smoke levels in those areas. Surface smoke concentrations from HRRR-Smoke have been evaluated using observations from ground-based monitors for California (Rosenthal *et al.* 2022) and extreme fire events such as the Camp Fire (Chow *et al.* 2022) and Williams Flats Fire (Ye *et al.* 2021) in 2019. Generally, HRRR-Smoke well represents the temporal coherence of smoke $PM_{2.5}$ compared with observations, but biases may arise from assumptions for nighttime burning, biomass burning emission persistence and fire plume injection heights. It should be noted that the model does not include any smoke chemistry owing to limited computational resources available for the HRRR forecast model.

Results and discussion

Evaluating HMS and ISD average smoke days and trends in smoke days by airport

We compare HMS and ISD average smoke days (Fig. 2, Supplementary Table S2) and trends in smoke days (Fig. 3,

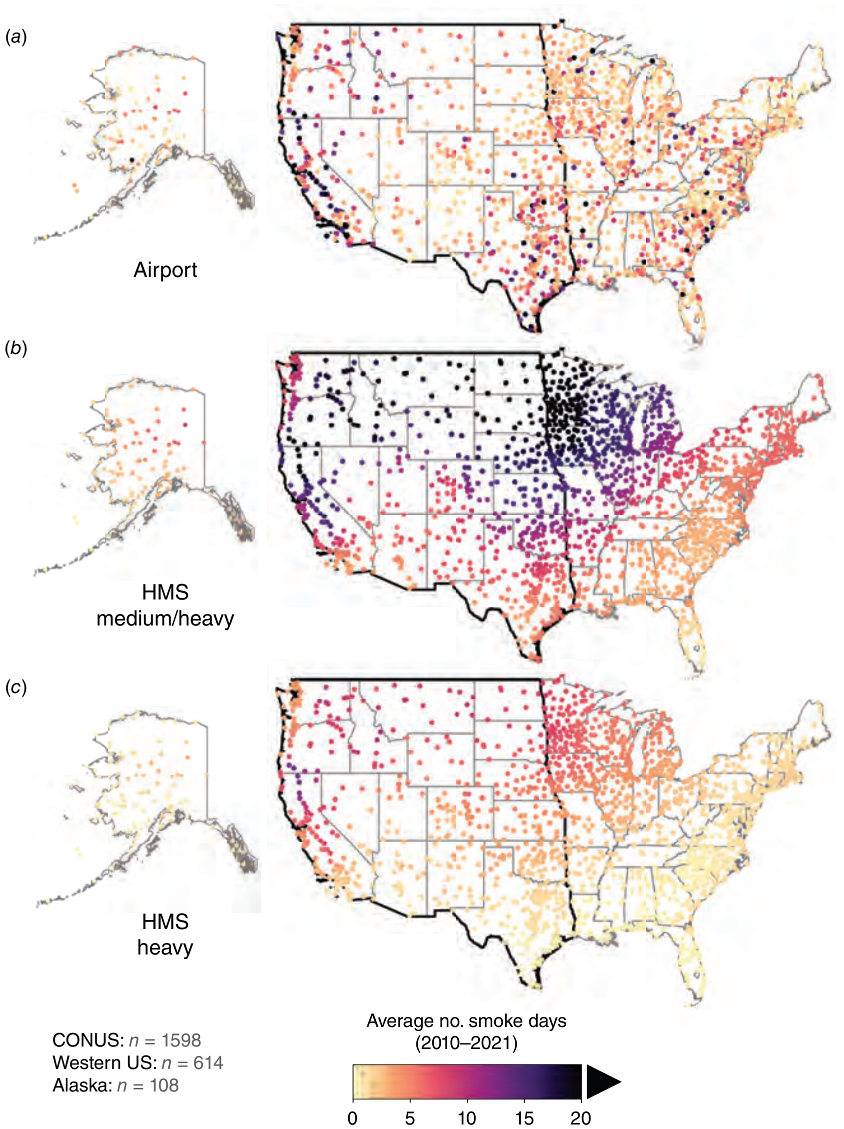

Fig. 2. Average number of smoke days across the contiguous United States (CONUS) and Alaska from 2010 to 2021. Smoke days for each year are derived from: (*a*) ISD airport smoke observations; (*b*) HMS medium and heavy smoke plumes; and (*c*) HMS heavy smoke plumes. The colour indicates the average number of HMS smoke days at airport locations. Values inset indicate the total number of airport locations in CONUS, western US and Alaska. States in the western US are outlined by the thick border.

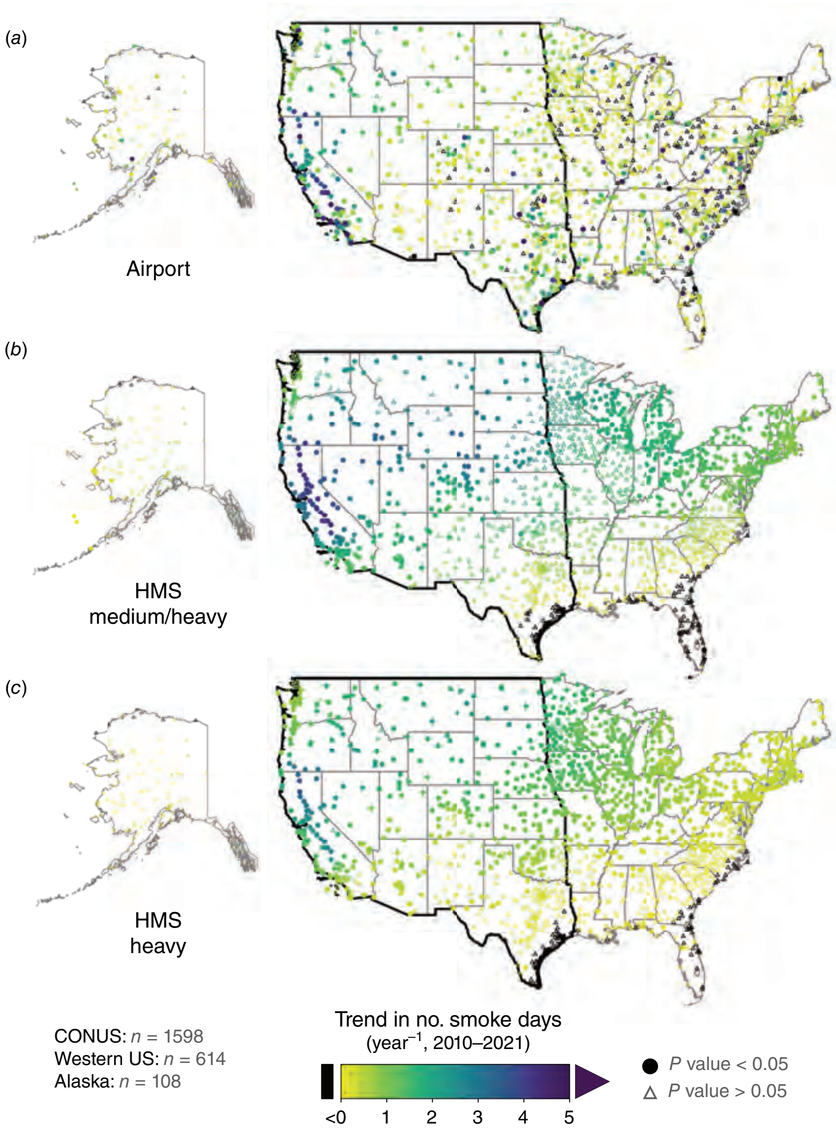

Fig. 3. Linear trends in number of smoke days per year across the contiguous United States (CONUS) and Alaska from 2010 to 2021. Trends are calculated from: (*a*) ISD airport smoke observations; (*b*) HMS medium and heavy smoke plumes; and (*c*) HMS heavy smoke plumes. HMS trends in (*b*) and (*c*) are shown at the ISD airport locations in (*a*). The colour indicates the magnitude of the linear trend in smoke days per year at airport locations. Locations with statistically significant trends (P value < 0.05) are denoted by filled-in circles; conversely, locations where linear trends are not statistically significant (P value > 0.05) are denoted by small triangles. Values inset indicate the total number of airport locations in CONUS, western US and Alaska. States in the western US are outlined by the thick border.

Supplementary Tables S1, S3) from 2010 to 2021 across airport locations in CONUS (n = 1598) and Alaska (n = 108). In general, HMS shows large-scale changes in smoke presence with high spatial autocorrelation, whereas ISD shows more localised patterns in smoke days and their trends. Sporadic hotspots evident in ISD smoke days across the East and Midwest may be attributed to inconsistencies in the automated system for smoke detection or contamination from nearby local pollution sources. Despite this caveat in ISD data, we can still examine differences between HMS and ISD on a broad regional scale (Fig. 1).

The dominant source of smoke varies by region. Wildfires dominate the West and Alaska, while the Southeast mainly sees agricultural fires and prescribed burns; the Midwest and Northeast typically experience smoke transported from western states or Canada (Cottle *et al.* 2014; Brey *et al.* 2018). HMS identifies the highest smoke pollution in Pacific and Midwest states. Consistent across HMS and ISD-derived smoke days, Pacific states (CA, WA and OR) comprise the most smoke-polluted region (Figs 2, 3). This finding is underscored by a cluster of airport locations observing over 10 smoke days per year within California's Central Valley, which is in close proximity to large wildfires and experiences frequent temperature inversions that trap smoke near the surface. In contrast, a large discrepancy between HMS and ISD is evident in the Midwest, or the East North Central and West North Central states. The high smoke pollution derived from HMS in the Midwest – on par or exceeding that in Pacific states in some cases – is largely absent in ISD data. This result suggests that the smoke over the Midwest is often aloft and may not affect surface air quality, in line with key findings by Brey *et al.* (2018).

The contrast between Pacific and Midwest states is supported by the spatial variation in Cohen's kappa and MCC values calculated from the HMS-ISD agreement in smoke days (Fig. 4). We observe the highest HMS-airport agreement

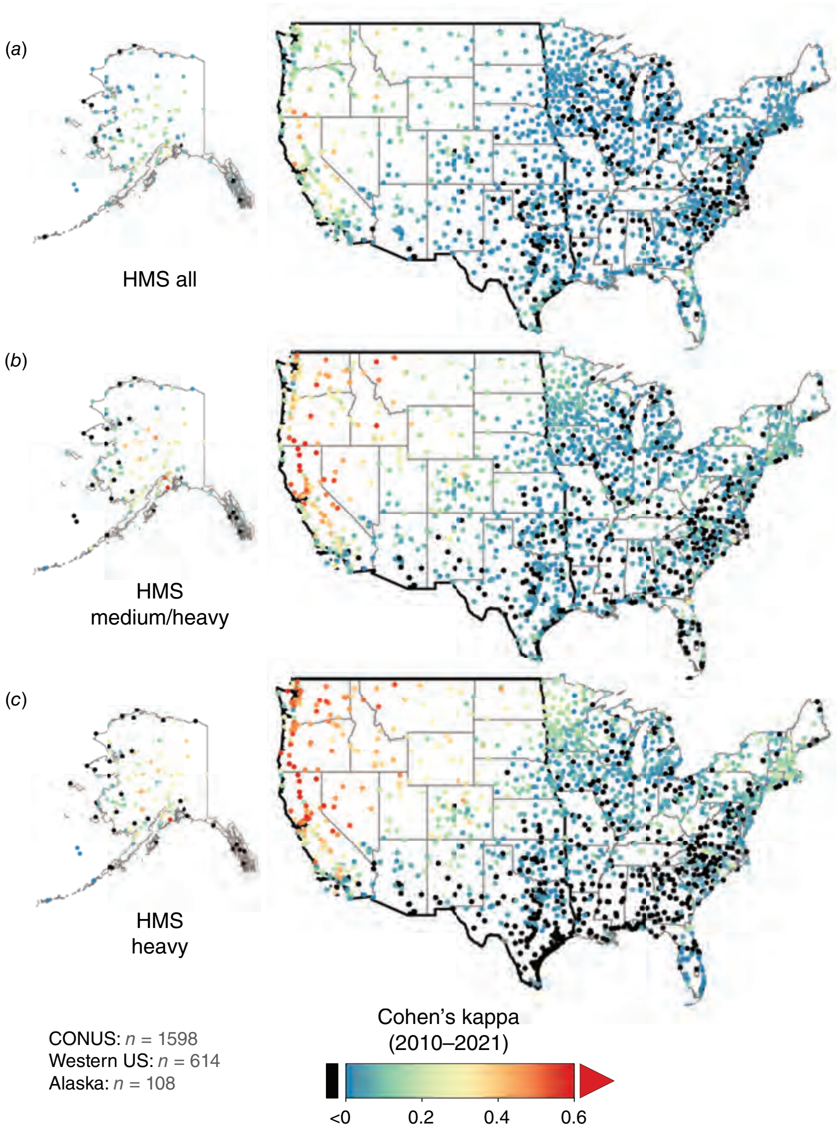

Fig. 4. Agreement between airport and HMS no. smoke days across the contiguous United States (CONUS) and Alaska from 2010 to 2021. For HMS, smoke days for each year are derived from: (*a*) all smoke plumes; (*b*) medium and heavy smoke plumes; and (*c*) heavy smoke plumes. Agreement is shown at airport locations, and states in the western US are outlined by the thick border. Inset values denote the total number of airport locations in CONUS, western US and Alaska. Agreement is shown as Cohen's kappa, where higher values (warmer colours) indicate greater agreement. Negative Cohen's kappa, or no agreement, is indicated by black dots.

in Pacific states (median $\kappa = 0.36$, MCC = 0.38), weak agreement in Mountain states and Alaska (median $\kappa = 0.13$–0.18, MCC = 0.18–0.20) and low agreement elsewhere (median $\kappa < 0.1$, MCC < 0.1) for the heavy-only HMS smoke day definition (Fig. 5). Across almost all regions, using heavy-only HMS smoke leads to lower recall (TPR) but higher precision (PPV) and lower false positive rates. This results in higher Cohen's kappa and MCC values for the heavy-only HMS smoke day definition compared with those using both medium and heavy plumes or all HMS plumes. Exceptions where the medium/heavy smoke definition slightly outperforms the heavy-only smoke definition are in West South Central, East South Central and South Atlantic, where the accuracy for all HMS smoke definitions is among the lowest across all regions (median $\kappa \leq 0.03$, MCC ≤ 0.03). The negative predictive value is close to 1 in all regions and for all HMS smoke definitions, indicating low misclassification of non-smoke days.

The overestimation of smoke days and their trends by HMS compared with ISD is evident when including medium smoke with heavy smoke, and even more pronounced when all smoke types are considered (Figs 2, 3, 6, 7, Supplementary Tables S2, S3). In the western US, we estimate 7.1 average airport-observed smoke days from 2010 to 2021 at 614 airport locations. In contrast, the number of average HMS-observed smoke days is highly variable depending on the definition, ranging from 3.7 days for heavy smoke to 10.7 days for medium/heavy smoke to 36.2 days for all smoke categories combined (Fig. 6). This pattern extends across all CONUS regions and Alaska, where the inclusion of light smoke plumes leads to 2.4–14.6 times the number of airport smoke days (Fig. 7). Our results suggest that light smoke plumes should generally be excluded for a binary classification of smoke and non-smoke days at the surface.

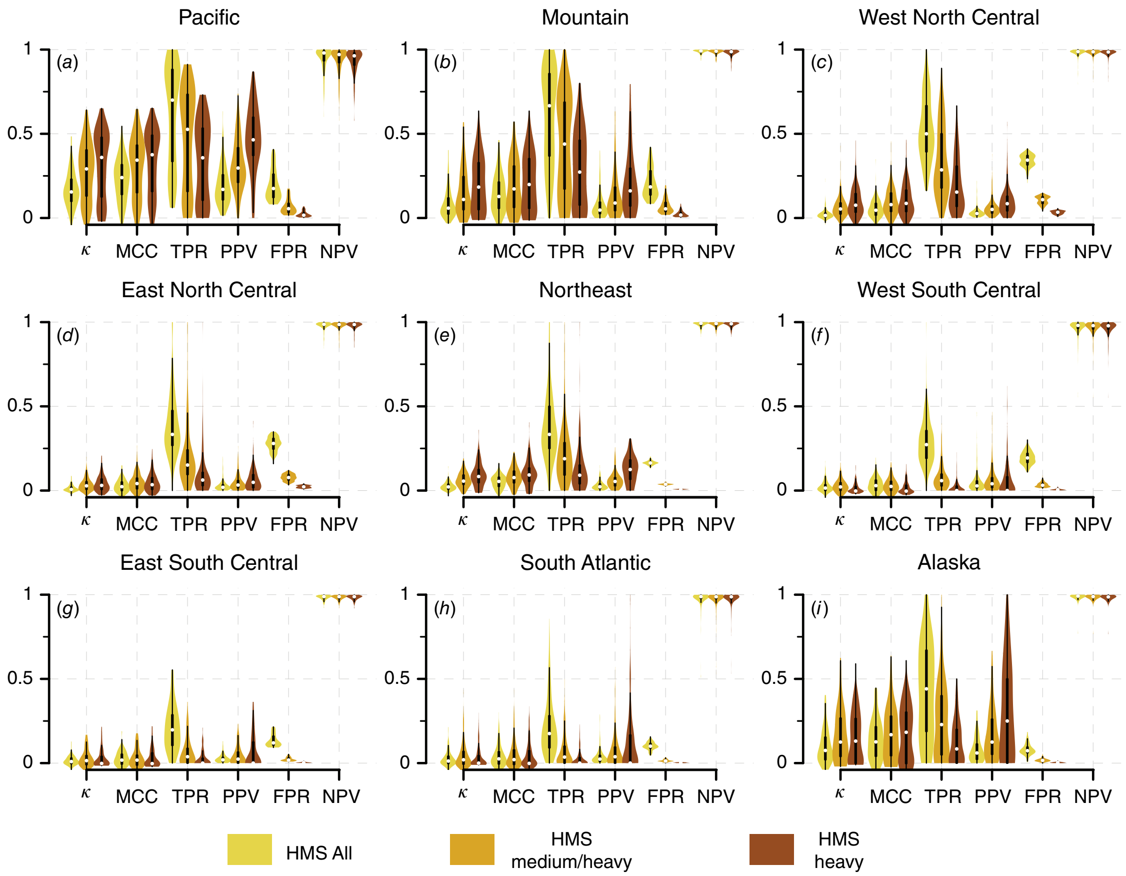

Fig. 5. Violin plots of the agreement between HMS and airport no. smoke days in the United States and Alaska by region from 2010 to 2021. Regions represented in (*a*)–(*i*) are defined in Fig. 1. The violin plot is a hybrid of a box plot and a kernel density plot (as shown by the shape). Smoke days are derived from ISD airport smoke observations and compared with those derived from all HMS smoke plumes (yellow), HMS medium and heavy smoke plumes (goldenrod) and HMS heavy smoke plumes (brown). The agreement metrics – Cohen's kappa (κ), Matthews correlation coefficient (MCC), true positive rate (TPR), positive predictive value (PPV), false positive rate (FPR) and negative predictive value (NPV) – are spatially averaged across airport locations in each region. A value of 1 for κ, MCC, TPR, PPV and NPV and a value of 0 for FPR indicate perfect agreement. The plots show that the best agreement between HMS and airport smoke days – e.g. the greatest κ and MCC – occurs in Pacific and Mountain states and Alaska.

Spatial variability in observed and modelled near-surface smoke $PM_{2.5}$ levels within HMS smoke polygons

In general, we find that the EPA $PM_{2.5}$ – particularly on days with a heavy HMS plume overhead – is more easily separated from the $PM_{2.5}$ on non-smoke days in the Pacific and Mountain regions and Alaska (Fig. 8). On HMS smoke days with heavy plumes, surface concentrations of total $PM_{2.5}$ in these regions fall in the range of 86–91% on the cumulative probability distribution of background $PM_{2.5}$ values, whereas those in other regions range from 69 to 78%. Because the 50th percentile, or the median, is often used as the upper limit for background $PM_{2.5}$ (Koplitz *et al.* 2016; Childs *et al.* 2022), $PM_{2.5}$ on HMS smoke days falling in low percentiles may be misclassified as smoke-affected. The percentiles are generally lowest for light smoke days (58–69%), and highest for heavy smoke days (69–91%), which indicates greater confidence in attributing elevated $PM_{2.5}$ to smoke during the latter.

We find that in 2021, the $PM_{2.5}$ equivalents of the HMS light (5 [0–10] μg/m^3), medium (16 [10–21] μg/m^3) and heavy (27 [21–32] μg/m^3) density categories correspond well to the EPA and HRRR-Smoke near-surface smoke $PM_{2.5}$ concentrations in the Pacific and Mountain regions and Alaska, but not so well elsewhere across CONUS (Fig. 9). Modelled smoke concentrations in 2021 for the Pacific region are close to the HMS equivalent values for those plumes, with averages of 9, 17 and 36 μg/m^3 in the three categories in order of increasing density (Fig. 9*b*). For the Mountain region, the distinctions between near-surface modelled $PM_{2.5}$ within the three categories of HMS plumes

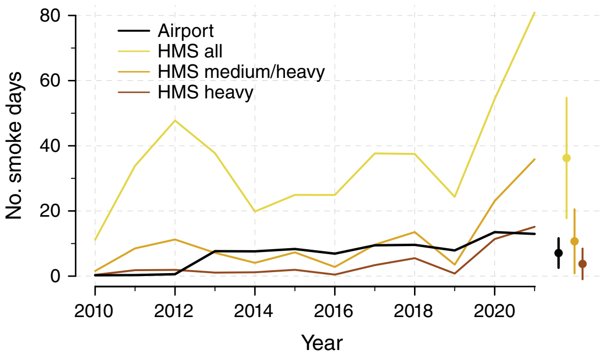

Fig. 6. Number of smoke days in the western United States from 2010 to 2021. Smoke days are spatially averaged across airport locations in the western US, as defined in Fig. 2, and are derived from ISD airport smoke observations (black line), all HMS smoke plumes (yellow line), HMS medium and heavy smoke plumes (goldenrod line) and HMS heavy smoke plumes (brown line).

are much less, with averages of 5, 9 and 16 μg/m^3; these modelled values also deviate from the HMS $PM_{2.5}$ equivalent ranges. For all other regions, the average near-surface $PM_{2.5}$ values within medium and heavy plumes all fall within the light smoke $PM_{2.5}$ equivalent range (<10 μg/m^3), which suggests that most smoke is actually aloft over these regions. We find similar patterns in the EPA AQS-derived smoke $PM_{2.5}$ in 2021 (Fig. 9*a*). Reasons for the slightly lower smoke $PM_{2.5}$ from EPA relative to HRRR-Smoke may include the imperfect assumption of the background $PM_{2.5}$ as the median $PM_{2.5}$ on non-smoke days, missing data and spatial bias of EPA stations in urban centres and overall sparsity in spatial coverage. Previous studies have found night-time overestimates in HRRR-Smoke and underestimates in this dataset when FRP is biased low compared with observations (Ye *et al.* 2021; Chow *et al.* 2022).

Even within HMS plumes of the same category, we find regional biases in the magnitude of the surface smoke $PM_{2.5}$ concentration and the separation of the $PM_{2.5}$ from the background $PM_{2.5}$. Although a smoke plume may have uniform opacity and thickness as seen from satellite imagery – thereby allowing an analyst to justify labelling it with a single HMS density category – the underlying surface smoke $PM_{2.5}$ may differ substantially depending on location. The reprocessing of the HMS smoke product in 2022 removed the link between the smoke density categories and $PM_{2.5}$ equivalents, which discouraged the data user from incorrectly deriving surface smoke $PM_{2.5}$ from HMS. We recommend that data users interpret the HMS smoke density categories with caution and carefully assess potential regional biases.

Comparison of strengths and caveats of HMS, airport and model estimates of surface smoke presence

Here, we outline the strengths and caveats of using HMS, airport observations, EPA AQS measurements and model estimates as indicators of surface smoke presence. Understanding the strengths and caveats of these different datasets is an important step in designing a study on quantifying the impacts of fire-induced smoke exposure.

HMS smoke product

The HMS smoke product is available in near-real-time and provides a simple classification of smoke density (light, medium, heavy) for digitised smoke plumes. However, the smoke plumes are mapped based on an analyst's interpretation of true-colour satellite imagery during the daytime, primarily around sunrise and sunset when it is easiest to isolate smoke in satellite imagery. Human error, limited digitisation of smoke throughout the daytime, the coarse resolution and parallax displacement of GOES imagery, as well as potential cloud cover, can all lead to biases and inconsistencies in the dataset. Additionally, the HMS smoke product represents column observations of smoke. When used as an indicator of surface smoke, regional biases arise, caused by variance in the altitude of smoke plumes. Using HMS leads to inflated surface smoke estimates in regions with mostly aloft smoke. This regional bias propagates to using the smoke density categories to differentiate surface smoke levels.

Airport observations

Airport observations are available in near-real-time and provide a ground-level view of smoke presence and levels of visibility reduction. However, the density of observations is sparse given the available airport locations (Fig. 1). Caveats include airport-to-airport differences in observations, potential contamination by local sources (e.g. industrial combustion unrelated to wildfires), or misdiagnosis of smoke as some other air pollutant, which could lead to errors in reporting smoke influence. Differences between the judgement of observers likely contribute to inconsistencies between airports. Dilute smoke may also be under-reported as such smoke is unlikely to create any visibility challenges for pilots. As airport data is underused, these caveats of the ISD dataset are currently not well understood.

EPA stations

EPA stations offer high-quality, ground-based observations of air pollution levels, often in near-real-time. Like the network of ISD airports, the EPA stations are sparsely distributed across the US with a bias toward urban centres (Supplementary Fig. S2). A main caveat is that EPA stations often only report the total $PM_{2.5}$. The task to separate smoke $PM_{2.5}$ from the background $PM_{2.5}$ is non-trivial, with many studies relying on statistical methods. Station measurements from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network and Chemical Speciation Network (CSN) offer some insights into the $PM_{2.5}$ composition – e.g. organic and black carbon (OC and BC) – but only report every 3 days. It is possible to infer smoke contribution to total

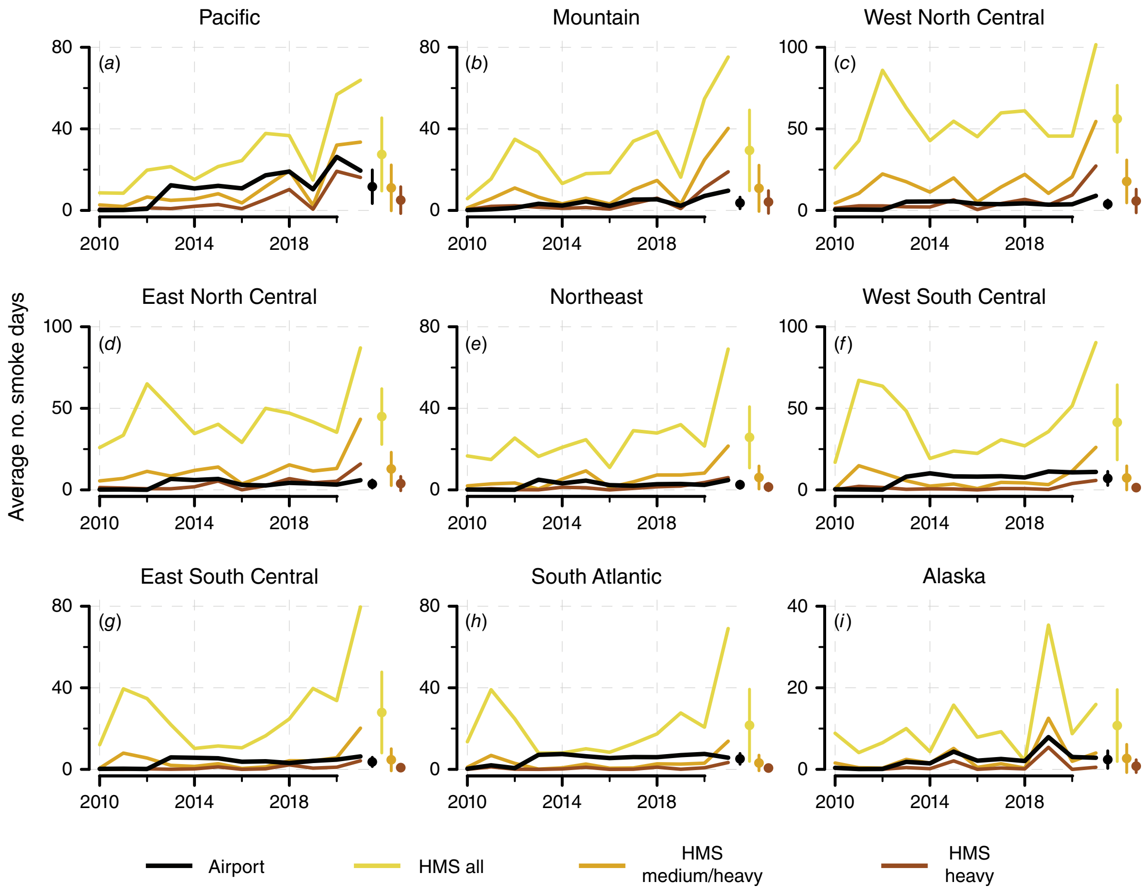

Fig. 7. Number of smoke days in the United States and Alaska by region from 2010 to 2021. Smoke days are spatially averaged across airport locations in each region (*a*)–(*i*), as defined in Fig. 1, and are derived from ISD airport smoke observations (black line), all HMS smoke plumes (yellow line), HMS medium and heavy smoke plumes (goldenrod line), and HMS heavy smoke plumes (brown line). Dots to the right of each panel denote annually averaged smoke day number across all years for the four conditions, with error bars representing 1 s.d.

$PM_{2.5}$ during days dominated by OC + BC, but direct attribution is difficult owing to co-varying sources, such as traffic, industrial facilities, dust and secondary organic aerosol formation. Additional data from low-cost sensors, such as the PurpleAir network, may supplement the EPA data and decrease the spatial sparsity of station locations. Barriers to using low-cost sensor data include inherent biases compared with EPA monitors that must be corrected (Jaffe *et al.* 2023) and recent adoption of pricing schemes that charge end-users for historical data downloads.

Model estimates

Surface smoke estimates from the HRRR-Smoke model or other atmospheric transport models are subject to important limitations and uncertainties. One of the key limitations is dependence on infrequent polar-orbiting satellite fire detections, which can be inaccurate under cloudy or thick smoke conditions (Chow *et al.* 2022). Beyond the limitation of missing fire detections, there are uncertainties in emission estimates and plume rise parameterisation, as well as deposition and wet and dry removal. The HRRR-Smoke model does not include any chemistry, which can lead to increased uncertainty for more aged smoke plumes. Despite these uncertainties, model outputs provide spatially cohesive smoke $PM_{2.5}$ estimates and are important where there are few to no ground monitors.

Airport observations, EPA AQS measurements and model estimates have their own biases and uncertainties. However, future studies can take advantage of the agreement and disagreement between ground, satellite and model estimates to draw more robust conclusions. Based on such comparison, we can pinpoint regions where HMS may not accurately reflect surface smoke presence, such as outside Alaska and the Pacific and Mountain regions.

Accounting for uncertainty in smoke $PM_{2.5}$ attribution and estimation

Aguilera *et al.* (2021) and Childs *et al.* (2022) used HMS smoke plumes as a binary input to statistical and machine

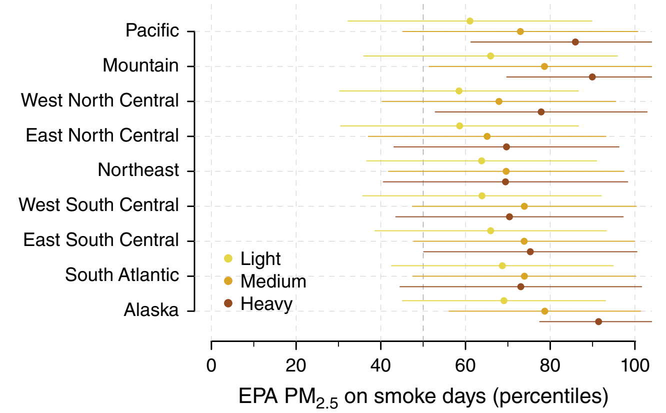

Fig. 8. Separation of $PM_{2.5}$ anomalies on smoke and non-smoke days by region at EPA stations from 2010 to 2021. The percentile of the $PM_{2.5}$ anomaly on an HMS smoke day is calculated relative to the empirical cumulative distribution of $PM_{2.5}$ anomalies on non-smoke days. Smoke days are classified as light, medium and heavy according to the designation of HMS plume density on that day; if there are multiple plumes, we use the maximum HMS density. The dots show the mean percentile, and the horizontal bars show ±1 s.d. across EPA stations in each region. The 50th percentile, denoted by the vertical grey dotted line, represents the typical value used as the background $PM_{2.5}$. Higher percentiles denote more separation between the $PM_{2.5}$ on smoke and non-smoke days and imply greater confidence in attribution of elevated $PM_{2.5}$ to smoke.

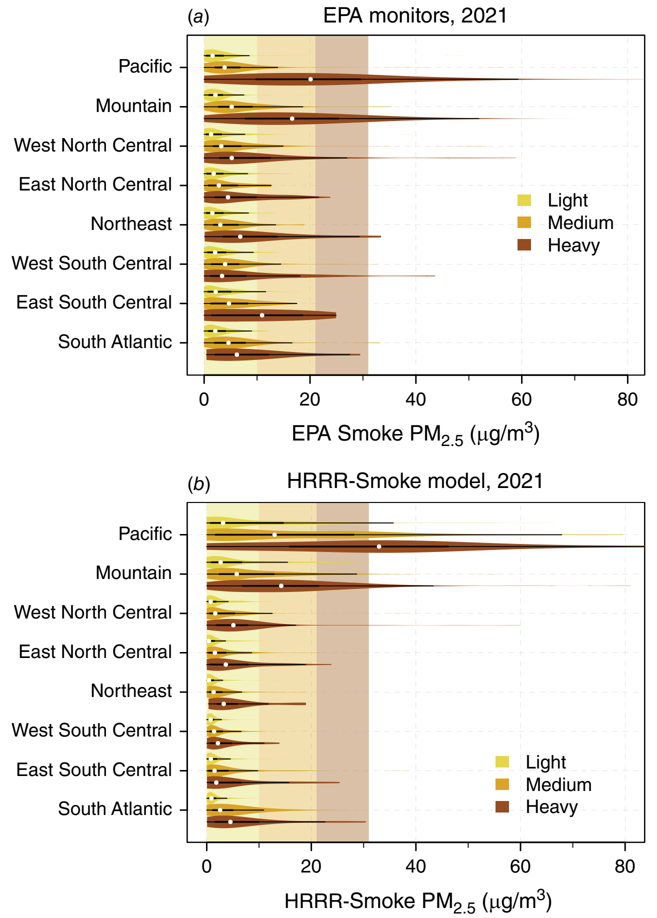

Fig. 9. Violin plots of daily smoke $PM_{2.5}$ from EPA monitors and the HRRR-Smoke by region and HMS smoke density category in 2021. The violin plot is a hybrid of a box plot and a kernel density plot (as shown by the shape). The violin plots show the distribution of daily $PM_{2.5}$ within light (yellow), medium (goldenrod) and heavy (brown) HMS smoke polygons (*a*) at EPA monitors, and (*b*) from the HRRR-Smoke model. The vertically shaded areas show the equivalent $PM_{2.5}$ ranges for the HMS smoke density categories. For example, the brown violin for the Northeast US shows the range of EPA and HRRR-Smoke $PM_{2.5}$ concentrations occurring within HMS polygons designated as heavy. The median of this subset in both the HRRR and EPA datasets in the Northeast (white dots) is <10 μg m^{-3}, whereas the approximate range of values for heavy HMS smoke is designated as 21–32 μg m^{-3}. This large mismatch suggests that much of the heavy smoke detected by HMS in this region is likely aloft.

learning models to designate $PM_{2.5}$ as smoke or non-smoke related. In line with our results, Qiu *et al.* (2024) found that chemical transport models outperform HMS-based models in the Midwest and eastern US where smoke is generally aloft.

We show that HMS-based studies can account for uncertainty in smoke attribution by leveraging (1) the three smoke density categories inherent to the HMS smoke product, as well as (2) the degree of separation between $PM_{2.5}$ anomalies and the distribution of historical non-smoke $PM_{2.5}$ anomalies. For example, those days with a heavy HMS plume overhead and $PM_{2.5}$ anomaly at a high percentile relative to background $PM_{2.5}$ anomalies are more likely to be smoke-driven. Using the two criteria, we can define 'confidence' levels ranging from low to high, where high confidence represents a conservative or lower bound estimate, and conversely, low confidence represents a lax or upper bound estimate (Supplementary Table S4, Supplementary Fig. S2). We find the lowest ratios of low versus high confidence categories for smoke $PM_{2.5}$ in Alaska and the Pacific and Mountain regions (1.6–2.8) compared with other regions (4.6–28.5) (Supplementary Fig. S3). Thus, inclusion of HMS light smoke plumes to designate smoke days leads to more positive bias in the Midwest and eastern US.

To extend analyses prior to 2010, we develop a random forest model to recover the loss of smoke density categories with a test accuracy of 85% for light smoke, 58% for medium smoke and 66% for heavy smoke (Supplementary Information, Fig. S4, Table S5). Although the gap-filling method does not recover the smoke density categories perfectly, it is still useful – for example, for reducing overestimates in smoke $PM_{2.5}$ by excluding days with only light smoke plumes.

As we show here, end-users can implement a confidence-based system based on criteria such as HMS smoke density categories and the degree of separation from the background $PM_{2.5}$ anomalies to provide lower and upper-bound smoke $PM_{2.5}$ estimates and account for uncertainty in smoke $PM_{2.5}$ attribution. Additional observational, satellite, model-based information can be used to improve this system, in particular to identify underestimates in HMS smoke days due to observational constraints from daytime-only mapping or cloud cover.

Conclusion

In summary, we present three lines of evidence from airport observations, EPA AQS measurements and HRRR-Smoke model estimates that across much of CONUS and Alaska, the HMS smoke product conflates surface smoke presence with smoke aloft. Only in western US and Alaska does the HMS smoke product appear to agree consistently with other measures of surface smoke. For example, compared with the airport-observed average of 7.1 smoke days per year in the western US from 2010 to 2021, HMS severely overestimates the number of smoke days if all smoke density categories (light, medium and heavy) are included (36.2 days). Using only medium and heavy plumes (10.7 days) or only heavy plumes (3.7 days) leads to better agreement with airport observations in this region. Outside the western US and Alaska, observed and modelled surface smoke $PM_{2.5}$ concentrations occurring within medium and heavy HMS plumes are similar to those of light plumes ($<10\ \mu g/m^3$). This finding suggests that the impact of smoke on surface air quality is relatively low in areas where smoke is often aloft, though the corresponding plumes may be categorised as medium or heavy density by HMS. Exceptions to this, however, can be seen from Canada's recent record-breaking fire season in 2023, when smoke from these fires degraded surface air quality to unhealthy levels in northeastern and midwestern states. For future studies, we urge caution in using the HMS smoke product as a broad indicator of surface smoke, as its performance varies widely by region, and inclusion of light smoke – and sometimes, even medium smoke – inflates both the number of and trend in smoke days. We recommend using the HMS smoke product in conjunction with surface monitor observations and the HRRR-Smoke or other smoke forecast models. For defining smoke days, using only heavy or both medium and heavy smoke plumes can serve as lower and upper bound estimates, respectively.

Supplementary material

Supplementary material is available online.

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Data availability. The Hazard Mapping System (HMS) smoke product (https://satepsanone.nesdis.noaa.gov/pub/FIRE/web/HMS/Smoke_Polygons/Shapefile/), Integrated Surface Database (ISD) of airport observations (https://www.ncei.noaa.gov/data/global-hourly/archive/csv/) and HRRR-Smoke model outputs (https://rapidrefresh.noaa.gov/hrrr/HRRRsmoke/) are distributed by NOAA. The MODIS MAIAC aerosol product is distributed by NASA (https://doi.org/10.5067/MODIS/MCD19A2.006) and available from the Google Earth Engine public data catalogue. Code for processing and visualizing the HMS smoke product is available in a GitHub repository (https://github.com/tianjialiu/HMS-Smoke).

Conflicts of interest. The authors declare no conflicts of interest.

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EPA Region 4 Comments on Georgia's Public Review Draft Exceptional Events Demonstrations

General Comments Applicable to All Area Demonstrations

1. EPA was not able to reproduce the Tier 1 and Tier 2 Thresholds presented in the Figure 1 diagrams in all of the demonstrations. When using EPA's online Tiering Tool available here: https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis, the Tiering Thresholds are slightly different. For example for the Atlanta Canadian Wildfire Draft EE Demo, the threshold values for the Fire Station #8 Monitor (AQS ID # 13-121-0039) with "Rand I Fire Flags" excluded, as recommended by EPA's PM2.5 Wildland Fire Exceptional Events Tiering Document (https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf), are: Tier 1 Threshold = 24.3 ug/m^3 and Tier 2 Threshold = 16.2 ug/m^3. These are slightly higher than the Tier 1 Threshold = 22.65 ug/m^3 and Tier 2 Threshold = 15.1 ug/m^3 provided in the Atlanta Canadian Wildfire Draft EE Demo. Please explain this discrepancy and confirm that all of the Tiering Levels in all of the Draft EE Demos are in the correct Tier as provided by EPA's Tiering Tool. If this discrepancy results in any Tier 1 values being changed to Tier 2 values, additional supporting evidence should be provided in the Clear Causal Demonstration as discussed in Section 5.4 of the Tiering Guidance Document.

General Comments Applicable to All Canadian Wildfire Demonstrations

1. Section 3 of the documents discuss *Public Notification*. It is recommended that the documents be supplemented with any other actions taken to notify the public about the potential for elevated air quality impacts from the Canadian Wildfires, if any additional notification was done. Examples of other notification methods include: social media posts; press releases; providing information to local media outlets; and information provided by the National Weather Service.

2. In the *"Clear Causal Relationship and Supporting Analyses"* sections, the HYSPLIT Trajectories are stated to "begin at the time that the exceedance was observed," but in the Figures in Appendix C, the back-trajectories all appear to be started beginning at midnight of each exceedance day. Please address this discrepancy.

3. To provide additional support for the information provided in the *"Clear Causal Relationship and Supporting Analyses"* sections, we recommend addition of hourly PM2.5 concentration plots for each day and preceding day similar to those provided in the Appendix A diagrams for the Prescribed Fire Demonstrations. This would help to show the timing of the smoke intrusion episodes.

4. Appendix D: It is recommended that the AQI ranges shown in the figures be updated to be consistent with revisions provided in the final 2024 PM2.5 NAAQS (e.g., Good is now in the range of 0-9 ug/m^3).

General Comments Applicable to All Prescribed Fire Demonstrations

1. *Section 2: Narrative Conceptual Model Section*: Since only prescribed fires that occur on wildland are eligible to be treated as exceptional events according to the 2016 Exceptional Events Rule, it is recommended that it be clearly indicated that the permitted silvicultural prescribed fires that are the subject off the EE Demos occur on wildlands. It is also recommended to include the definition of wildland provided in the 2016 Exceptional Events Rule (or reference the definition in the rule) and to "connect the dots" between Georgia's prescribed burning definitions and those in the Exceptional Events Rule.

2. *Section 2: Narrative Conceptual Model Section*: It is recommended that this Section include more description of the prescribed fire events affecting the specific monitors in each demonstration. We suggest including a broad description of how similarities among these events generally affected the concentrations at the monitoring site and the environmental conditions that contributed to the exceedance (e.g., fires generally in close proximity to the monitor, fires upwind of monitor, acres burned, stable boundary layer, calm surface winds, etc.). This would more thoroughly address the requirement to explain how emissions from the events led to the exceedance or violation at the affected monitor(s).

3. *Section 2: Narrative Conceptual Model Section*: In the discussion of the public notification action, we recommend that discussion of any other actions taken to notify the public about the potential for elevated air quality impacts from large (greater than 1000 acres) prescribed fires as discussed in Section C of Georgia's April 16, 2008, certified *Basic Smoke Management Plan*. Examples of other notification methods could include: social media posts; press releases; providing information to local media outlets; and information provided by the National Weather Service.

4. *Section 4: Human Activity Unlikely to Recur at a Particular Location:* Georgia's approach for demonstrating that prescribed fires are unlikely to recur in specific counties appears to be acceptable to meet this criteria. We recommend that discussion also be added to explain that information on the actual prescribed fire return interval for specific tracts of land is not readily available, which is why the procedure described in this section was used. Also, we recommend briefly describing the fire-dependent ecosystems or species (e.g., long leaf pine, red-cockaded woodpecker, etc) that are found in the counties where there is frequent prescribed burning, and that it is needed to maintain these fire-adapted ecosystems or species.

5. Appendix A Figures:
    a. We recommend removing "satellite detected fires" from the caption as these are not displayed on the maps.
    b. For the maps, please indicate the averaging interval of the concentrations beside the monitor icons. We assume these values are the 24-hour average values, but this should be clarified.

We recommend stating that the solid blue line in the time series indicates the concentrations recorded by the monitor. It would also be helpful to state the significance of the yellow, orange, and red dashed lines.

<u>DRAFT Canadian Wildfire EED at Atlanta GA</u>

We recommend expanding the *Introduction* Section to include a discussion of the status of the existing monitors compared to the 2024 Annual PM2.5 NAAQS. The Atlanta-Sandy Springs-Roswell MSA is comprised of 13 monitoring sites, several are PM2.5 monitors. As shown on the maps in Appendix D, it would be helpful to add a brief discussion to the *Introduction* or *Narrative Conceptual Model* Section indicating that the other monitors in the MSA were also impacted by the Canadian wildfire smoke, but that these monitors are not exceeding the PM2.5 NAAQS and thus are not eligible for exclusion under the Exceptional Events Rule. This discussion would help demonstrate that there is a wide-scale impact from the long-distance transport of the smoke as discussed in the *Clear Causal Relationship* Section. Also, it would be helpful to acknowledge that Exceptional Event requests are being made for other monitors in Georgia which are violating the PM2.5 NAAQS that have also been impacted by Canadian wildfire smoke.

<u>DRAFT Canadian Wildfire EED at Augusta GA</u>

1. *Introduction (pg. 1):* The year of initial notification date in last paragraph should be 2024, not 2023.
2. *Appendix D:*
    a. The captions for all figures reference "three sites... in excess of the PM2.5 NAAQS". Which sites are being referenced? It is recommended that the captions be expanded to refer to the large number of sites reporting elevated PM2.5 concentrations.
    b. It is recommended that a marker be added denoting the Augusta monitor to help clarify the maps.

<u>DRAFT Canadian Wildfire EED at Columbus GA</u>

1. *Introduction (pg. 1):* The year of initial notification date in last paragraph should be 2024, not 2023.

2. *Figures B1, C1 for 6/29/23:* While these figures show that there is likely transport of Canadian Wildfire Smoke to the monitor, the back-trajectories do not clearly show smoke originating in wildfires in Canada, and there are many fires locally near the monitoring site. Given that the discussion on pg. 6 mentions smoke "descending to near-surface level," and because this event is Tier 2, it is recommended to include additional meteorological analyses supporting the transport and descent of smoke from Canada (e.g., upper air wind maps, vertical soundings at/near the site, convergence/divergence maps to infer large-scale vertical motions, time series showing increases in concentrations).

DRAFT Canadian Wildfire EED at Macon GA

1. *Introduction (pg. 1):* The year of initial notification date in last paragraph should be 2024, not 2023.

2. *Figures B3, C3 for 7/20/23:* While these figures show that there is likely transport of Canadian Wildfire Smoke to the monitor, the back-trajectories do not clearly show smoke originating in wildfires in Canada, and there are many fires locally near the monitoring site. Given that the discussion on pg. 6 mentions smoke “descending to near-surface level,” and because this event is Tier 2, it is recommended to include additional meteorological analyses supporting the transport and descent of smoke from Canada (e.g., upper air wind maps, vertical soundings at/near the site, convergence/divergence maps to infer large-scale vertical motions, time series showing increases in concentrations). Alternative, if it is believed that smoke from more localized fires in the southeast is the primary cause of the exceedance, additional information should be provided linking these fires to the exceedance.

DRAFT Canadian Wildfire EED at Rossville GA

No comments.

DRAFT Canadian Wildfire EED at Sandersville GA

1. *Figures B13, C13 for 7/20/23:* While these figures show that there is likely transport of Canadian Wildfire Smoke to the monitor, the back-trajectories do not clearly show smoke originating in wildfires in Canada, and there are many fires locally near the monitoring site. It is recommended to include additional meteorological analyses supporting the transport and descent of smoke from Canada (e.g., upper air wind maps, vertical soundings at/near the site, convergence/divergence maps to infer large-scale vertical motions, time series showing increases in concentrations). Alternatively, if it is believed that smoke from more localized fires in the southeast is the primary cause of the exceedance, additional information should be provided linking these fires to the exceedance.

DRAFT Holiday Fireworks EED at Augusta

1. EPA recommends strengthening the *Narrative Conceptual Model* Section for the fireworks exceptional events demonstration with more detail, such as time, location, and duration of specific fireworks displays. Despite listing fireworks locations as part of the demonstration on page 3, the demonstration does not identify any fireworks locations except for the vague descriptor, “downtown Augusta.” It is recommended that a specific organized fireworks display presented by the city of Augusta or nearby municipality be identified and referenced as the cause of the exceedances at the monitor. A key criterion of the Exceptional Events Rule for

fireworks is that “such use of fireworks is significantly integral to traditional national, ethnic, or other cultural events including, but not limited to, July Fourth celebrations.” A general reference to undocumented use of fireworks by local citizens without a specific time and location does not adequately demonstrate that fireworks caused the exceedance at the monitor.

2. For the July 4, 2023, HYSPLIT plot (Appendix A, Figure 3), the trajectories originate from west of the monitor while downtown Augusta is located northeast of the monitor. Especially in this case, additional information is needed to demonstrate that emissions were transported to the monitor to show a clear causal relationship between the event and exceedance.

3. Appendix A: The captions for each of the Figures in Appendix A should be revised to describe the link to the specific time and location where the fireworks displays were held. The discussion about silvilculture burn permits should be removed as that is not the claimed reason for the Exceptional Events, or an explanation should be added as to why they are included in the Figure.

<u>DRAFT Prescribed Fires EED at Augusta</u>

1. *Appendix A:* In order to help interpret the figures in Appendix A, we recommend that they be revised to identify the duration of the HYSPLIT back trajectories, and/or the length of time that the markers represent on each trajectory.
    a. July 23, 2021: The pervasive smoke visible the day before along with the limited permits (and acreage) issued for silviculture prescribed burns seems inconsistent with the description that the silviculture fires caused the exceedance. We recommend that additional information be provided to demonstrate the clear causal relationship.
    b. December 5, 2021: The description of the event does not agree with the timeseries concentrations. The exceedance seems driven by concentrations in the late morning. We recommend revising the description of the event in the *Clear Causal Relatio*nship Section.
    c. December 16, 2021: The limited silviculture prescribed fires near the back trajectories calls into question the claim that these fires caused the exceedance. We recommend that additional information and discussion be provided to support the claim.
    d. November 6, 2023: The pervasive smoke visible the day before along with the limited permits (and acreage) issued for silviculture prescribed burns seems inconsistent with the description that the local silviculture prescribed fires caused the exceedance. Based upon the level of widespread elevated PM2.5 concentrations across the southeast and entire eastern U.S., it appears likely that the cause could be long distance transport of wildfire smoke. We recommend that additional information be provided to demonstrate the clear causal relationship.
    e. December 7 & 8, 2023: It is difficult to interpret the hourly concentration plots at the bottom of these figures for these dates since it appears that a constant PM2.5 concentration occurred for the entire day. If this is due to only FRM data being available for the hourly concentration plots, we suggest explaining this in the caption.

DRAFT Prescribed Fires EED at Columbus

1. Appendix A: Given that 2/8/23, 3/1/23, and 3/7/23 are tier 2 events, it is recommended that additional information be provided to support these days as discussed in Section 5.4 of the PM2.5 Wildland Fire Exceptional Events Tiering Guidance Document. This information could include additional analyses of the meteorology for this day.

DRAFT Prescribed Fires EED at Macon

1. Appendix A includes maps for every date listed in Table 1, including the Canadian wildfires. These maps are confusing because the separate Canadian Wildfire Demonstration for those dates identified in Table 1 make a clear causal connection to the wildfires. If it is believed that the prescribed fires on these dates were also the cause of the exceedances at the Macon monitor, the prescribed fire demonstration should be revised to discuss the cumulative effects of both the Canadian Wildfires and nearby prescribed fires. If the inclusion of these figures in Appendix A was an error, we recommend removing them.

2. Appendix A: For 4/7/21, 12/3/21, 3/3/22, 3/7/22, it is difficult to interpret the concentration plots for these dates since it appears that a constant PM2.5 concentration occurred for the entire day. If this is due to only FRM data being available for the hourly concentration plots, we recommend explaining this in the caption.

3. Appendix A: Given that 10/3/23 and 11/8/23 are Tier 2 events, it is recommended that additional information be provided to support these days as discussed in Section 5.4 of the PM2.5 Wildland Fire Exceptional Events Tiering Guidance Document. This information could include additional analyses of the meteorology for this day.

DRAFT Prescribed Fires EED at Sandersville

1. Table 1: The discrepancy in the Tier 1 thresholds using EPA's Tiering Tool discussed in General Comment 1 above results in a number of days that are identified as Tier 1 in Table 1, should instead be classified as Tier 2. Using EPA's PM2.5 Tiering Tool, the Tier 1 threshold for the Sandersville monitor is 18.75 ug/m^3. Therefore, the following dates should be Tier 2: 5/18/22; 10/7/22; 11/3/22; 1/2/23; and 2/24/23._Given that that these dates should be Tier 2 events, it is recommended that additional information be provided to support these days as discussed in Section 5.4 of the PM2.5 Wildland Fire Exceptional Events Tiering Guidance Document. This information could include additional analyses of the meteorology for these days.