

Reviewer 1

general comments

The objective of the paper is very interesting and extremely useful. Although remote sensing increasingly plays an important role in monitoring the earth surface, and in particular wildfire activity, it lacks the temporal extent to bring the needed confidence of results that assess the role and interaction of fire in the earth systems. This paper addresses this gap by merging different datasets to build a comprehensive and consistent geo-database of wildfire activity over western US. The paper reads well and is clear. In terms of presentation, the paper could benefit from a visual diagram, in the methods section, on how the datasets interact and the rules (temporal and spatial) applied to remove duplicate fire records. In addition, for a paper on a new compiled dataset, it would benefit presenting all the attributes in a table, including also the definition/characteristics that are contained in dataset attributes. This not only makes it clear what the measurements and classification are, but also quickly informs potential users on the fit-for-purpose of the dataset is for their application.

We thank the reviewer for their thorough and constructive review of our paper. We address each comment below (in blue font). In addressing the reviews we discovered some minor errors in our code and also performed additional manual inspections of the fire lists and burned area maps that led to a revised dataset with approximately 1% fewer wildfires. This revision did not cause notable changes to the regional patterns of fire frequency or burned area. The paper and the WUMI2024a database archived online have been revised to reflect these changes.

In response to the suggestions made in the general comments above:

Diagram: In response to this recommendation as well as a similar recommendation from Reviewer #2 we have now added a flow chart (new Fig. 1, and pasted below) that visualizes the process of data preparation, quality control, and inter-dataset merging. We feel that the flow chart is most effective if the details it provides remain at a relatively high level and we continue to use the main text to describe the specific rules used to identify duplicate fires within and between datasets are best left in the methods text.

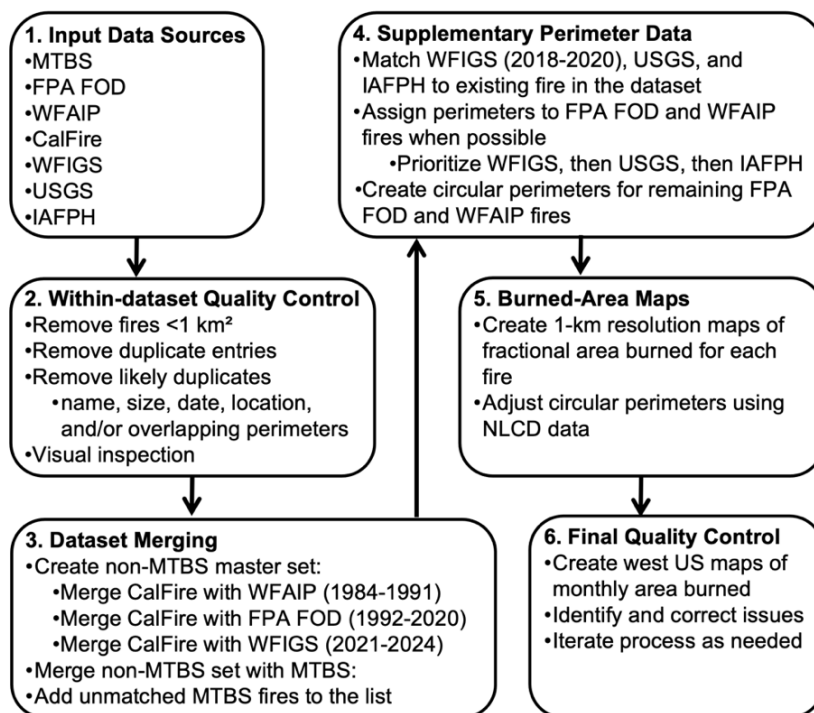


Figure 1. Flowchart outlining the approach to develop the WUMI2024a.

Attribute table: We agree that a table listing and describing the attributes of the dataset would be helpful. We have added a table to the Supplement (also provided below) and reference the table in section 2.4 (Summary of the final dataset).

Table S1. Attribute names (left) and descriptions (right) provided in the lists of WUMI2024a wildfire events.

fireid	Unique fire identifier indicating date (YYYYMMDD) followed by latitude in degrees north times 10000 followed by longitude in degrees west times 10000
dataset	Name of the dataset used to retrieve the fire name, start date, and ignition location (mtbs, calfire, wfigs, fpa_fod, or wfaip)
agency	Agency reporting the fire (not available for mtbs fires)
name	Fire name
year	Year of fire start
month	Month of fire start
day	Day of month of fire start
lat	Latitude of ignition
lon	Longitude of ignition
lat_ll	Minimum latitude of fire perimeter (if fire perimeter is available)
lon_ll	Minimum longitude of fire perimeter (if fire perimeter is available)
lat_ur	Maximum latitude of fire perimeter (if fire perimeter is available)
lon_ur	Maximum longitude of fire perimeter (if fire perimeter is available)
poly_area_ha	Reported fire size in hectares (within perimeter area if fire perimeter is available)
burn_area_ha	Area burned (actual area burned within the perimeter if an mtbs fire or a subfire of an MTBS fire with an adjusted area burned)
mtbs_name	Name of the mtbs fire (for fires either in the mtbs dataset or non-mtbs subfires that are part of an mtbs parent fire)
mtbs_ID	Identification code the mtbs fire (for fires either in the mtbs dataset or non-mtbs subfires that are part of an mtbs parent fire)
irwinid	Integrated Reporting of Wildfire Information (IRWIN) Identification code
FOD_ID	Fire Occurrence Dataset identification codes for fpa_fod fires
FPA_ID	Fire Program Analysis identification codes for fpa_fod fires
object_ID_wfaip	If a wfaip fire, the identification number that can be cross-referenced to the object_id attribute in the original list of wfaip fires provided in fire_lists/wfaip/wfaip_fires_qc.txt
object_ID_fpa_fod	If an fpa_fod fire, the identification number that can be cross-referenced to the object_id attribute in the original list of fpa_fod fires provided in fire_lists/fpa_fod/fpa_fod_fires_qc.txt
object_ID_wfigs	If a wfigs fire, or an fpa_fod fire that was matched to a wfigs fire, the identification number that can be cross-referenced to the object_id attribute in the original list of wfigs fires provided in fire_lists/wfigs/wfigs_fires_qc.txt
object_ID_calfire	If a calfire fire, or a non-calfire fire that was matched to or part of a calfire fire, the identification number that can be cross-referenced to the object_id attribute in the original list of calfire fires provided in fire_lists/calfire/calfire_fires_qc.txt
object_ID_usgs	If matched to a usgs fire, the identification number that can be cross-referenced to the object_id attribute in the original list of calfire fires provided in fire_lists/usgs/usgs_fires_qc.txt
object_ID_iafph	If matched to an iafph fire, the identification number that can be cross-referenced to the object_id attribute in the original list of calfire fires provided in fire_lists/usgs/usgs_fires_qc.txt
cause_human_or_natural	General ignition cause if available, HUMAN or NATURAL
cause_specific	Specific ignition cause if available

specific comments

The purpose of the paper is achieved but the work is not of exceptional quality and completeness. I was expecting that for such an important topic - where one needs to merge old and new and different information types – that the new dataset and its merging methodology would set a standard on how it could be done with the perspective that it would be regularly updated with attributes that are of important to fire managers, ecologist, fire ecologist and climate researchers, to name a few. Attributes like end-date, fire spread rate, intensity, power, landcover, and fragmentation, can be retrieved and added, especially to recent records. The dataset, although very useful, is limited to what is commonly recorded by the different datasets and struggles to show added value in terms of new information useful for different applications

We agree with the reviewer that there are many opportunities to deepen the dataset by providing additional attributes for the fires represented in our database and we have heavily revised the final paragraph of the Conclusions section to better describe how the WUMI2024a can and should be deepened.

As the reviewer implies, there are many variables that one could consider, and each would add value to the database, but also each would come with its own caveats and would warrant unique attention from peer reviewers. The current version of the WUMI2024a was not developed to serve as an end-all data clearinghouse for all-things fire, but instead as the most comprehensive database available for the start dates, locations, and, when possible, perimeters for wildfires ≥ 1 km² in the western US from the mid-1980s to near-present. We are confident that this database, in its current form, will provide unique value beyond any database of fire occurrences and perimeters developed for the region to date, including by easing the work required on future efforts to align western US wildfire events with information from other databases related to fire attributes and effects.

The new Conclusions paragraph reads (L511-526):

“Finally, the value of the WUMI2024a can be improved upon by expanding it to include more than wildfire start dates, locations, causes, perimeters, and 1-km resolution maps of area burned. For example, many fires in the WUMI2024a can be linked to those represented in the ICS-209-PLUS database (St. Denis et al., 2023) to provide information about fire management costs, personnel, and impacts on people and property. Additionally, Landsat imagery can be used to improve our maps of area burned for fires in the WUMI2024a that are not represented among the very large >4.04 km² fires mapped by the MTBS. Landsat imagery can also be used to detect the perimeters and areas burned for fires with unknown perimeters that we currently assume to be circular, identify additional fire events not yet represented in our database, and expand beyond our maps of burned area to also develop high-resolution maps of fire severity (e.g., Parks et al., 2019) for all fires in the database. Likewise, the MODIS-based FIRED dataset (Balch et al., 2020) can be used to decompose the fire maps in our database into maps of daily fire progression, and capabilities for mapping of fire spread are deepening further through use of the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument (Schroeder et al., 2014; Chen et al., 2022). Imagery from MODIS and VIIRS can also be used to map fire intensity via retrievals of fire radiative power (Schroeder et al., 2014; Giglio et al., 2016). While the WUMI2024a database of wildfire events has been designed to accommodate future updates and expansions, including additional metrics related to fire processes (e.g., spread) and impacts (e.g., severity), its current form advances beyond currently available databases of western US wildfire events and will be a robust and valuable resource for researchers and practitioners in the field of wildfire science.”

The authors, although focusing on achieving the higher quality records for the dataset, do not supply a quality/confidence indicator associated with each record. Meaning that users that may want to screen the dataset to remove data that could be uncertain. The compiled dataset should offer a confidence layer. In that regard, the paper fails to set a standard for dataset compilation, and it comes across that quality is reduced to removing duplicates. The authors should consider developing a confidence indicator.

We thank the reviewer for this comment, while we have not added fire-specific confidence indicators, we have revised the paper to clarify our advice as to how the fire data from various datasets should be prioritized. We do not develop and implement an official confidence scoring system because all of the fire datasets we use are observational, and thus theoretically true. Of course no dataset is perfect, thus the reason why a confidence indicator would be nice, but this cuts both ways. Because all of the datasets we use are not only imperfect, but also incomplete in terms of fire size, temporal coverage, and/or availability of perimeter information. In addition, all datasets, possibly with the exception of CalFire, are subject to temporal instabilities due to changes in the type of information that they incorporate during their periods of coverage. This all contributes to our determination that there is no ideal ‘ground truth’ dataset against which to benchmark our dataset in terms of occurrence probability, size, start-date, or perimeter, and if such a benchmark dataset did exist, then we’d just use that dataset for our research rather than put forth such an effort to develop our own dataset.

Although we chose to not add confidence indicators to the dataset, this comment as well as a suggestion from Reviewer #2 did encourage us to add a new paragraph to the Conclusions section about limitations of our dataset and associated recommendations for use. That new text is (L489-509):

“The WUMI2024a also has caveats. First, it relies on publicly available government records of wildfire incidents, which can be more accurately characterized as records of fire response and management rather than as purely records of wildfire occurrence. This means the WUMI2024a is missing any wildfires not recorded by a fire management agency and incorporated into a publicly available database. For example, some wildfires may have never been detected and reported, and others may have been extinguished without receiving official attention from a fire management agency. Thus, the database’s completeness and accuracy are subject to temporal and geographic inconsistencies related to changes in practices related to fire detection, management, and data archival. These limitations are well exemplified by the fact that the WUMI2024a indicates zero wildfires in Wyoming and New Mexico in 1984 (Fig. S2). The lack of large 1984 wildfires in two western US states is likely an artifact and we suggest excluding 1984 in assessments that include the interior Western US. We further presented evidence that fire frequencies in the WUMI2024a are highly likely to be artificially low prior to 1992 (the first year of the FPA FOD) in non-forested areas of the interior West because many wildfires in these areas are addressed by non-federal agencies (ST/C&L), which are not represented in the WFAIP database (Figs. 4, S3a). The negative biases in pre-1992 frequencies are likely to be largest in the non-forest areas of New Mexico, Arizona, Colorado, and Wyoming, as these are the areas where ST/C&L fires are most common in the FPA FOD, so we caution against analyses that rely on consistent fire reporting from the 1980s through 1990s in these areas. Our database does comprehensively represent non-federal fires in California, on the other hand, via data from CalFire. Finally, we were unable to find perimeter data for 29% of the wildfire events in the WUMI2024a. While these fires are relatively small, only accounting for less than 5% of area burned in the dataset, and we do adjust the circular perimeters and maps of burned area to exclude open water, ice, and barren ground, we warn against use of the circular fire features for applications that require accurate maps of area burned. These derived features are provided as

resources for applications where an approximated map of area burned is better than none at all (e.g., as inputs for some hydrological or smoke-emission modelling exercises), but should be used with caution.”

The authors used several rules to remove duplicate records when merging the different datasets. These rules are mostly based on chosen thresholds in space and time. The authors should state what is the rationale behind these, and why the chosen values.

In response to this comment as well as a comment from Reviewer #2 we have added additional text to sections 2.2.1 (Within-dataset quality control) and 2.2.2 (Dataset merging).

The most substantive addition is to the end of section 2.2.2, where we now better explain that no one-size-fits-all set of rules can feasibly be used to identify and fix all of the issues related to duplicate fires that appear within and across datasets, and regardless of the rules we put in place, it was unavoidable that intensive manual work was necessary to supplement the automated process. We have therefore expanded on our previous statement at the end of 2.2.2 about the role of our visual inspections of the data (L224-232):

“Importantly, we found it infeasible to automate a one-size-fits-all set of rules that effectively detects duplicate fires within or between datasets without need for intensive additional scrutiny. For example, the same fire is often assigned different names by different government agencies; the same name may be spelled or misspelled in a range of ways; and dates, locations, and sizes are not always reported consistently across agencies, sometimes with large differences. Therefore, at every step of the quality-control and dataset-merging process we conduct rigorous visual inspections of fire lists and perimeter maps to identify additional duplicate fires between or within datasets as well as fires that were misidentified as redundant by our automated routine. Due to the intensive nature of the visual inspection and manual correction process we are confident that the quality of the final WUMI2024a dataset, while certainly not without remaining errors, is not highly sensitive to the specific rules implemented in the automated portion of the process.”

Our addition to 2.2.1 is specific to the 200-km and 5-day thresholds that Reviewer #1 asks about later in this review. We describe that revision later in this document in response to relevant reviewer question.

Circular areas are never representative of fire scars. Over flat grasslands under constant conditions burn scars can appear ellipsoidal, but over other landscapes they are rarely circular. By representing them as such, the authors risk overlaying a fire scar over bare soil or water, requiring users to treat the data prior to using it when landcover is important. This kind of inconsistencies should be avoided.

We thank the reviewer for this comment, which pertains to our use of circular fire perimeters symmetrical about the ignition point in cases of fires only represented in the FPA FOD or WFAIP databases, as these databases only include ignition location and fire size, but no information on shape. In response to this comment we have revised our approach by adjusting the shapes and sizes of circular perimeters to no longer allow for burned area in areas defined by the National Land Cover Database as open water or bare soil/rock/ice. In doing so, we have improved the realism of our estimated maps of perimeters and area burned for these fires by no longer assuming that fire burned in areas that are unable to burn in reality, but we retain the general approach of assuming a generally circular fire shape when no observations of fire shape are available from MTBS, CalFire, USGS, or IAFPH.

For context, we remind the reviewer that the circular-fire assumption is only made for the minority of fires, most relatively small, for which we do not have fire-perimeter data, which account for 29% of fire events and 4.5% of burned area in our database. Without using remotely sensed imagery to detect the true perimeters of these events ourselves, which we think would be a worthy but time- and resource-intensive effort that deserves a data release and method-intensive paper of its own, we must make an approximation if we wish to represent these fires in our maps of area burned.

We prefer to include these perimeter-less fires in our maps of area burned rather than leave them unmapped because, while surely inaccurate at fine spatial scales, including these fires improves the accuracy of our maps of area burned at broader, regional scales. This aids the accuracy of our dataset for assessments of temporal variations and trends in area burned and will improve the usefulness of our dataset for a range of applications, such as forcing models that simulate vegetation ecosystems, smoke/carbon emissions, or hydrology. Users of our perimeter and area-burned maps are of course free to disregard fires that we represent as circular by, if using our fire-specific maps, simply not using the data for these fires. If using our gridded maps of monthly area burned for the western US, one can easily subtract away the values from the gridded maps of area burned associated with circular fires.

To help users avoid placing undue trust in the circular fire perimeters we included the following disclaimer within the new Conclusions paragraph that we quoted in response to another reviewer comment above. The disclaimer reads (L504-509):

“Finally, we were unable to find perimeter data for 29% of the wildfire events in the WUMI2024a. While these fires are relatively small, only accounting for less than 5% of area burned in the dataset, and we do adjust the circular perimeters and maps of burned area to exclude open water, ice, and barren ground, we warn against use of the circular fire features for applications that require accurate maps of area burned. These derived features are provided as resources for applications where an approximated map of area burned is better than none at all (e.g., as inputs for some hydrological or smoke-emission modelling exercises), but should be used with caution.”

technical corrections

Line 37: sentence could finish with a reference to a study supporting the statement.

This sentence is the first of a two-sentence sequence that, together, make the point that fire and its coupled interactions with vegetation and humans are too complex to be modeled in a purely dynamic, process-based fashion when it comes to simulations across large spatial scales like the western US, and thus the models used for simulations across regional to global scales are largely statistical. The relevant references are provided at the end of the second sentence (L37-41):

“However, the complexity of wildfires and their coupled interactions with ecosystems and human society prevent such model simulations from being performed across the large spatial scale of the western US without high degrees of parameterization. Instead, fire models that operate at regional to global scales are largely statistical, based on equations parameterized to optimally reproduce historical observations in wildfire activity (Hantson et al., 2016; Williams and Abatzoglou, 2016).”

Line 83-84: this sentence can be confusing, I recommend reminding that the datasets includes fires that are lower than 1km and that proportion of BA is what is recorded in at every 1km² gridcell.

We have revised this sentence to more clearly specify that when a fire only burns a portion of a 1-km grid cell, then our 1-km maps of burned area indicate the fraction of the grid cell that burned. The revised sentence reads (L84-88):

“The WUMI2024a consists of a list of all wildfire events in the database, monthly maps at 1-km resolution of area burned across the full western US domain, and, for each event, a shapefile with the known or estimated fire perimeter as well as a 1-km resolution map of the fraction each grid cell that burned.”

Line 96: the different class of severity is presented here, it is not clear where these come from and if the classification is retained for further use. If these are all the range of possible classes provided by MTBS, and are no longer used, I recommend removing these as it will confuse the reader expecting such a classification.

We agree that mentioning the MTBS severity classifications is unnecessary here since we did not use them. We revised to simply say we calculate the area burned by MTBS fires as sum of area within 30-m grid cells classified as burned by MTBS.

Line 157: 200 kms is a large distance for exclusion, what is the rational for it and the impact of choosing a smaller distance.

This comment refers to a distance threshold we used to identify duplicate entries of the same fire in a fire database: when two fires have the same name (excluding fires of UNKNOWN name), start dates within 5 days, and ignition locations within 200 km, we determined these to be duplicates. We agree 200 km is a large distance and have revised the threshold down to 100 km. In this light, we also revised a previous criterion for linking non-MTBS fires to MTBS fires with matching names. We previously made linkages if a non-MTBS fire occurred within 1.5° of the bounding box of an MTBS fire (in addition to having a start date within 14 days), and we have revised this down to 1.0°.

Ultimately this decision about distance threshold is not majorly consequential. First, when two datasets, or the same dataset, lists a fire of the same name within days of each other, then the locations associated with these are generally near each other. For example, in our preparation of the FPA FOD dataset of >17,000 western US fires $\geq 1 \text{ km}^2$, using a threshold of 200 km previously led to an identification of 33 pairs of fires with identical names that were close enough in time and space to be treated as duplicates. Using the new threshold of 100 km reduces this number to 27. Among these 27 pairs, all but 6 are pairs are within 25 km of each other, and the 6 farther than 25 km appear highly likely based on closer inspection to be true duplicates. As for the 6 pairs originally flagged as duplicates with a 200 km threshold, but not flagged with a 100 km threshold, it appears somewhat less certain that these are true duplicates. Three of these duplicate pairs do not have identical dates, for example, differences in fire size tend to be larger, and the shared fire names are somewhat more common. After describing the 100 km / 5 days criteria for treating identically named fires as duplicates, we now add (L162-165):

“These thresholds were determined empirically to allow for the automatic detection of the vast majority of duplicate fires with identical names. We found that loosening the distance and start-date criteria increasingly led to automated detections of duplicates that did not stand up to scrutiny, as pairs of identically named fires that are distant in time or space are more likely to have large discrepancies in reported fire sizes or to have commonly used fire names.”

Importantly, similar to our response to the Reviewer's more general comment about the rules we use to detect duplicates, it is impossible to identify duplicate entries with 100% confidence and no set of thresholds used in our quality-control process can be perfect. This is why it is crucial that we perform rigorous manual screening of the datasets for duplicate or erroneous entries throughout the process of producing the WUMI. This includes countless visual inspections of fire lists as well as inspection of fire maps to identify instances where burned area accumulates in a given area within an unreasonably short time. Ultimately the distance and time thresholds we use to identify duplicate fires are not highly influential on the final dataset because of the rigor with which we manually pore over the data to minimize errors. We believe we have clarified this broader point through the text that we added to the end of section 2.2.2 (Dataset merging), which we also provided above in response to the Reviewer's general comment.

Line 162-163: I assume by "keep the first fire in the database" it is meant retaining the record with the earliest date. If so, please make it clear.

The text the reviewer refers to intends to say that when two or more fires have identical sizes and dates within a given database, such that they cannot be sorted by date, we retain just the first occurrence of that fire event in the database. We revised the text to clarify (L170-171):

"When fires within a given database have identical date and size, we retain only the first database instance."

Line 330: I might have missed but it is not clear what ST/C&L stands for

This abbreviation stands for state, county, and local agencies. The abbreviation was and still is defined on the previous line.