Reply to Reviewer 4 Comments

Manuscript: *CONFEX: A Database for CONUS Fire EXtent (essd-2026-116)*

Reviewer comments are in red, author responses are in blue, and revised manuscript sections are in black.

General Comment: Qadiri and Cerrai present a new fire event dataset for the continental US (CONUS) and Alaska using clusters of active fire detections from the Suomi-NPP VIIRS instrument. The CONFEX dataset provides an estimated size and duration of individual fire events on an annual basis, with corrections to the estimated area of active fire clusters to remove areas without burnable fuels. CONFEX provides a set of attributes derived from the clustered fire detections for each fire perimeter, including start date and location, end date, duration, and size. Data from the Monitoring Trends in Burn Severity (MTBS) dataset were used to provide initial validation of large fire events in the overlapping time period (2012-2023).

General Response: We thank Reviewer 4 for the detailed evaluation and for recognizing the potential value of the CONFEX dataset. The manuscript has been substantially revised to address concerns related to validation depth, interpretation of regional results, comparison with existing datasets, and methodological clarity.

MAJOR COMMENT

Reviewer comment: "The paper provides summary statistics for initial comparisons with MTBS data, but the limited information on matched and unmatched fires does not provide sufficient context for the potential strengths or limitations of the CONFEX data compared to MTBS. For example, the processing approach for CONFEX is retrospective, and the time lags for data production are not specified, such that it is unclear what the potential advantage of CONFEX would be for fires that also appear in the MTBS record. Further, the dataset provides a small subset of characteristics for each event, with few derived estimates of fire behavior compared to existing databases like FIRED, FEDS, or the Global Fire Atlas. What do clusters represent in this analysis, and do they provide further insights into periods of growth or other patterns? What potential uses are there for the specific attributes associated with each CONFEX cluster?"

Response: We thank the reviewer for this important comment. We revised the manuscript to provide more context for matched and unmatched CONFEX–MTBS comparisons. The revised threshold-tuning and validation framework now includes object-level agreement, area-level agreement, split/fragmentation diagnostics, merge diagnostics, candidate counts, and unmatched rates, rather than relying only on summary F1 values. We also clarified that MTBS is used as a structural reference rather than a complete truth set, so unmatched CONFEX detections are interpreted cautiously.

We also clarified what clusters represent in CONFEX. A cluster is the group of VIIRS hotspot detections identified by DBSCAN, a fire event is the retained geospatial object represented by that cluster after filtering and attribution, and the fire perimeter is the polygon generated from those detections. CONFEX is therefore best interpreted as a retrospective event-level perimeter and attribute database, not a near-real-time fire-progression product. Its main advantages are broad CONUS and Alaska coverage, VIIRS-based event perimeters, ignition-proxy timing and location, centroid, duration, and CSV-ready event attributes that can support ignition modeling, fire-regime analysis, and comparison with other fire inventories.

Revised manuscript text: "Threshold selection was based on a multi-objective comparison of object-level agreement, area-level agreement, fragmentation, merging, and candidate-count behavior. Strict object precision, recall, and F1 measured whether individual CONFEX perimeters corresponded to individual MTBS perimeters under a one-to-one intersection-over-union (IoU) ≥ 0.10 matching rule. Area precision, area recall, and area F1 measured whether the regional union of CONFEX perimeters reproduced the total MTBS mapped area. Split counts identified MTBS fires represented by two or more CONFEX objects, while merge counts identified CONFEX objects overlapping two or more MTBS fires. The number of candidate CONFEX perimeters and the unmatched rate were used as additional diagnostics to avoid selecting thresholds that improved one metric by producing excessive fragmentation or many unmatched candidate fires. MTBS was used as a structural reference rather than a complete truth set for all fires; therefore, unmatched CONFEX detections were interpreted cautiously."

Additional revised manuscript text: "Each cluster is taken as a candidate fire event. In this study, a cluster refers to the group of VIIRS hotspot detections identified by DBSCAN, a fire event refers to the retained geospatial object represented by that cluster after filtering and attribution, and the fire perimeter refers to the polygon geometry generated from the cluster detections."

Additional revised manuscript text: "CONFEX is a retrospective fire-event perimeter database generated from archived VIIRS S-NPP active-fire detections and should not be interpreted as a near-real-time fire-progression product. Unlike fire-progression products such as FEDS, CONFEX does not currently provide daily spread vectors, fire-line progression, spread rate, or direction estimates. Its main event-level attributes—ignition-proxy timing and location, end time, duration, centroid, area, and perimeter geometry—are intended to support fire-regime analysis, ignition-focused studies, and comparison with other fire inventories."

Reviewer Comment: In addition, the descriptive material in the Results and Supplement lacks depth and context. What drives the differences between CONFEX and MTBS data by region, by state, or by year? How would one interpret the increase in fire events in VIIRS for specific seasons or land cover types relative to material in MTBS? What might be the advantages of CONFEX in these circumstances? These concepts are not clearly explored or explained.

Response: We thank the reviewer for this important comment. We agree that additional context is needed to interpret differences between CONFEX and MTBS. In the revised manuscript, we expanded the Results and Discussion to include regional threshold decisions, numeric performance metrics, and limitations of the tuning framework, and we clarified that differences between CONFEX and MTBS arise from both dataset characteristics and regional fire-regime differences. In particular, we note that MTBS is limited to large fires and constrained by Landsat revisit timing, while CONFEX is based on VIIRS active-fire detections and can capture additional smaller, shorter-duration, or temporally separated fire activity.

We also clarified that increases in CONFEX event counts relative to MTBS may reflect a combination of true additional fire activity, prescribed burning, fragmented detections, and differences in event definition, rather than a direct one-to-one correspondence between datasets. A fully stratified analysis by state, season, and land cover type is beyond the scope of this data description article, but the dataset structure (including event-level attributes and CSV outputs) enables such analyses and is intended to support future work in this direction. CONFEX is therefore presented as complementary to MTBS rather than a replacement, with advantages in providing VIIRS-derived event perimeters, ignition-proxy timing and location, duration, centroid, and event-level attributes for fire-regime and ignition-focused studies.

Revised manuscript text: "Because MTBS is not a complete truth set, unmatched CONFEX objects were not automatically interpreted as errors; however, high unmatched rates indicate weaker tuning confidence."

Additional revised manuscript text: "MTBS is not a complete truth set for all fires. The standard MTBS archive maps only fires ≥1000 acres in the western zone, including Alaska, and ≥500 acres in the eastern zone. Consequently, additional CONFEX detections outside MTBS cannot be interpreted uniformly as errors. MTBS is Landsat-based and is constrained by revisit timing and cloud/smoke obscuration. This limits its ability to represent short-lived events and can merge temporally distinct ignitions before a usable Landsat observation is acquired."

Additional revised manuscript text: "CONFEX is a retrospective fire-event perimeter database generated from archived VIIRS S-NPP active-fire detections and should not be interpreted as a near-real-time fire-progression product. Unlike fire-progression products such as FEDS, CONFEX does not currently provide daily spread vectors, fire-line progression, spread rate, or direction estimates. Its main event-level attributes—ignition-proxy timing and location, end time, duration, centroid, area, and perimeter geometry—are intended to support fire-regime analysis, ignition-focused studies, and comparison with other fire inventories."

Reviewer comment: Overall, the clustering approach provides a reasonable reproduction of final fire extent as estimated from MTBS in Alaska and the western US, with more mixed performance in eastern CONUS where fires tend to be smaller. Without further investigation of specific strengths and limitations of the CONFEX dataset, it is not clear that this methodology or dataset provides a substantial advance in our understanding of individual fire events across CONUS or Alaska.

Response: We thank the reviewer for this assessment. We agree that the original manuscript did not sufficiently explain the specific strengths and limitations of CONFEX. In the revised manuscript, we expanded the Results and Discussion to better define where CONFEX performs strongly, where performance remains limited, and how the dataset should be interpreted relative to MTBS. The revised validation shows stronger performance in Alaska and the western CONUS, while the eastern CONUS remains more challenging because fires are generally smaller, more fragmented, more frequently prescribed, and often lower intensity. We now present this regional difference as a limitation rather than overinterpreting it as a strength.

We also clarified the main contribution of CONFEX. It is not intended to replace MTBS or to provide a full fire-progression product. Instead, it provides a spatially consistent, VIIRS-derived fire-event perimeter database for CONUS and Alaska with ignition-proxy timing and location, end time, duration, centroid, area, and perimeter geometry. These attributes provide consistent event-level characterization at 375 m resolution across a national domain, which is not available from existing datasets.

ADDITIONAL COMMENTS

Reviewer comment: 1. "The introduction is somewhat generic, and does not provide a clear motivation for the development of CONFEX relative to other VIIRS-based products, or for active fire detection based products over burned area products. FIRED is already publicly available over the full extent of this study."

Response: We thank the reviewer for this important comment. We revised the Introduction to provide a clearer motivation for CONFEX and to distinguish it from both VIIRS-based and burned-area-based products. Specifically, we clarified that FIRED is publicly available but is derived from the MODIS burned-area product at coarser spatial resolution, whereas CONFEX is derived from VIIRS S-NPP 375 m active-fire detections and provides event-level perimeters, ignition-proxy timing and location, centroids, and duration estimates across CONUS and Alaska. We also clarified that active-fire-based products are useful for event-level timing and ignition-focused applications because they detect thermal anomalies during burning, while burned-area products represent post-fire surface change and may require later observations. CONFEX is therefore presented as complementary to FIRED and MTBS, not as a replacement.

Revised manuscript text: "While BA products are valuable for mapping the final fire footprints, they are less suitable for rapid assessment because their algorithms require a sustained interval of post-fire observations to confirm surface changes (Chen et al., 2022). Seminal work by Giglio et al. (2006) established the foundational methodology for using AF pixel counts as a statistical proxy for burned area, at a coarse 1° resolution. Perimeter-based datasets generated from active fire detections are better for event-level analysis, as they synthesize these scattered detections into coherent fire objects that provide ignition and event duration information."

Additional revised manuscript text: "Similarly, the FIRED (Fire Events Delineation) database (Balch et al., 2020) provides a comprehensive inventory for the CONUS and was later expanded into a global dataset (Mahood et al., 2022). Conversely, high-resolution datasets like FEDS (Fire Events Data Suite) (Chen et al., 2022) and Firelytics (McClure et al., 2023) leverage the 375 m Visible Infrared Imaging Radiometer Suite (VIIRS) active fire product but are geographically restricted to California."

Additional revised manuscript text: "To date, no publicly available dataset provides high-temporal-resolution (twice-daily), event-level fire perimeters at 375 m spatial resolution across CONUS and Alaska using the VIIRS S-NPP active fire product. Existing products are either too coarse (MODIS/FIRED), geographically limited (FRAP/FEDS), omit smaller fires (MTBS), or lack perimeter geometry (NASA FIRMS hotspots)."

Reviewer comment: 2. "Methods: the full history of active fire detection by satellite is not needed."

Response: We thank the reviewer for this suggestion. We agree that the full history of active fire detection by satellite was not needed in the Methods section. In the revised manuscript, the standalone "Satellite Wildfire Measurements" section was removed/condensed, and the Methods now focus only on the VIIRS S-NPP 375 m product used to generate CONFEX. Concise product details were incorporated into the "Data Sources and Preprocessing" subsection, including VNP14IMGML, the relevant VIIRS channels, temporal coverage, filtering, and confidence-screening steps.

Revised manuscript text: "We used the standard VNP14IMGML (Suomi-NPP VIIRS 375 m ASCII fire location data) csv data from the NASA FIRMS (NASA FIRMS, n.d.) for the period 2012 – 2024, which is the VIIRS-SNPP 375 m active fire product. The VIIRS has 22 moderate 750 m resolution M (Moderate resolution) bands, and 6 high 375 m resolution I (Imaging) bands. The temporal resolution is 12 h or less, and the threshold for fire detection at nighttime is as low as 5 m^2 (Schroeder et al., 2014). Each VIIRS instrument (S-NPP, NOAA-20 (National Oceanic and Atmospheric Administration-20), and NOAA-21) has a ~3,040 km swath and completes ~14 sun-synchronous orbits per day (orbital period ~100 min), resulting in ~2 overpasses per day at the equator and ~3–4 at mid-latitudes. For this study, only the S-NPP VIIRS data were used because they provide a continuous record since late 2011. The S-NPP VIIRS sensor data record has been extensively validated and is suitable for long-term analyses (Cao et al., 2013).

VNP14IMGML is based on fire detections from VIIRS 375 m channels and fire radiative power (FRP) values from the 750 m channel. We are only using the 375 m hotspots in our product generation and the FRP analysis is out of the scope of our product. The product algorithm processes five I band, and one M band, given in Table 2. I4 (3.55 – 3.93 µm) is the main channel for fire detection and distinguishes between subpixel fires and non-fires, with a 367 K saturation temperature (Schroeder et al. 2014). Channel I5 (10.5 – 12.4 µm) is the thermal channel against which the I4 channel checks for non-fires. The rest of the three channels are used in the algorithm for water body discrimination, sun glint and clouds. For validation of VIIRS 375 imagery, Landsat- 8 data is used.
Table 2. Channels used in the 375 m active fire detection algorithm (adapted from Schroeder & Giglio, 2016).

VIIRS Channel	Spatial Resolution (m)	Spectral Resolution (µm)	Primary Purpose
I1	375	0.60 – 0.68	Cloud & water classification
I2	375	0.846 – 0.885	Cloud & water classification
I3	375	1.58 – 1.64	Water classification
I4	375	3.55 – 3.93	Fire detection
I5	375	10.5 – 12.4	Fire detection & cloud classification
M13*	750	3.973 – 4.128	FRP retrieval, fire detection over water and across the South Atlantic magnetic anomaly region

* Aggregated (750×750 m nominal) & un-aggregated (250×750 m nominal) data are used

We filtered the data to keep only the vegetation type. We excluded low-confidence detections that are often glint, water, or false alarms, and we only kept nominal and high confidence pixels that the algorithm considers physically valid and robust detections (Schroeder & Giglio, 2016; Schroeder et al., 2014)."

Reviewer comment: **3. Methods: the calibration of the clustering approach (2000 m, 48 h) uses FRAP data from 2020. Does this approach work universally across the three primary study regions (Alaska, Western US, Eastern US)? Existing databases use much longer time intervals to account for observational constraints and episodic changes in fire behavior (FIRED 11 days (from burned area), FEDS 5 days). What impact does this shorter clustering interval have on fragmentation of fire events in CONFEX?**

Response: We thank the reviewer for this important comment. We agree that applying the original California-derived 2000 m / 48 h threshold universally across CONUS and Alaska was not sufficient. In the revised workflow, the California-only calibration has been replaced with region-specific threshold tuning using MTBS across seven regions: Alaska, CONUS West, Southwest, Southeast, Northeast, Eastern Midwest, and Western Midwest. This directly addresses parameter transferability by allowing the clustering distance, temporal window, and alpha value to vary by region.

The impact of shorter temporal windows on fragmentation is now explicitly considered in the tuning framework. Split counts were used to identify MTBS fires represented by multiple CONFEX objects, while merge counts were used to identify CONFEX objects overlapping multiple MTBS fires. The final thresholds were selected using object agreement, area agreement, fragmentation, merging, and candidate-count behavior rather than F1 score alone. For example, Alaska retained a much longer temporal window of 360 h to accommodate prolonged cloud gaps and slow-moving fires, while several regions retained shorter windows where longer thresholds did not provide a defensible improvement. The revised manuscript therefore no longer assumes that the 48 h window works universally; instead, fragmentation is treated as a diagnostic in selecting regional thresholds and as a remaining limitation in more weakly constrained regions. Fragmentation was also considered in the final validation framework, not only during tuning. The revised validation uses the same object-based, area-based, fragmentation, merging, and near/far unmatched diagnostics described in the threshold-tuning workflow, so split and merge behavior is evaluated for the final CONFEX perimeters as well.

Revised manuscript text: "We tuned the clustering distance, temporal-window, and alpha-shape thresholds using MTBS reference perimeters, which apply different mapping thresholds in the western and eastern United States. The parameter-tuning validation was performed separately across seven broad regions to provide a practical regional framework for applying different clustering thresholds across CONUS and Alaska, while broadly reflecting known differences in fire regimes and MTBS East-West mapping thresholds."

Reviewer comment: 4. Methodology issues: Clustering vs. tracking. Very low "object" scores compared to area scores indicates an issue with the matching methodology, likely due to the overly strict 2 day threshold. This is discussed around L320: "Taken together, these results demonstrate that CONFEX adds value to FRAP by providing detection-inferred ignition location and characterization of fires with complex growth behavior at substantially higher temporal resolution than incident-based perimeter products"... is CONFEX supposed to be a final fire perimeter dataset, or a fire progression dataset? Inconsistent throughout.

Response: We thank the reviewer for this important clarification. We agree that the original manuscript was not sufficiently clear in distinguishing clustering-based event delineation from fire-progression tracking, and that the original fixed 2-day threshold could contribute to fragmentation. CONFEX is intended as a retrospective fire-event perimeter and attribute database, not a full fire-progression product. The revised manuscript now clarifies that clusters represent groups of VIIRS hotspot detections identified by DBSCAN, retained clusters become fire-event objects, and the perimeter is the polygon geometry generated from those detections.

We also revised the threshold approach. The earlier single 2000 m / 48 h setting is no longer applied universally. Instead, distance, time, and alpha thresholds are tuned regionally across seven regions, with fragmentation and merging diagnostics included in both tuning and validation. This directly addresses the concern that a strict 2-day threshold may artificially split fires; for example, Alaska now uses a longer 360 h temporal window to reduce fragmentation under prolonged cloud cover and slow-moving fire conditions. The discussion has also been revised to avoid implying that CONFEX provides complete fire progression. It now presents CONFEX as an event-level perimeter product with ignition-proxy timing and location, end time, duration, centroid, and area attributes.

Revised manuscript text: "Each cluster is taken as a candidate fire event. In this study, a cluster refers to the group of VIIRS hotspot detections identified by DBSCAN, a fire event refers to the retained geospatial object represented by that cluster after filtering and attribution, and the fire perimeter refers to the polygon geometry generated from the cluster detections."

Additional revised manuscript text: "CONFEX is a retrospective fire-event perimeter database generated from archived VIIRS S-NPP active-fire detections and should not be interpreted as a near-real-time fire-progression product. Unlike fire-progression products such as FEDS, CONFEX does not currently provide daily spread vectors, fire-line progression, spread rate, or direction estimates. Its main event-level attributes—ignition-proxy timing and location, end time, duration, centroid, area, and perimeter geometry—are intended to support fire-regime analysis, ignition-focused studies, and comparison with other fire inventories."

Additional revised manuscript text: "The parameter-tuning validation was performed separately across seven broad regions to provide a practical regional framework for applying different clustering thresholds across CONUS and Alaska, while broadly reflecting known differences in fire regimes and MTBS East-West mapping thresholds."

Reviewer comment: 5. It is unclear why the Short et al. 2022 (FPA-FOD) is mentioned, as it does not support the analysis and is explicitly intended as a point occurrence dataset. The authors may wish to consider NIFC's WFIGS fire perimeters dataset as a reference for the "best available" manually collected fire perimeters.

Response: We thank the reviewer for this suggestion. We agree that WFIGS is an important operational perimeter reference dataset and that FPA-FOD is not appropriate as a perimeter-validation reference because it is a point-occurrence database rather than a mapped fire-perimeter dataset. In the revised validation framework, we used GeoMAC historical fire perimeters for 2012–2018 and WFIGS operational perimeters for 2021–2024 as complementary operational-reference comparisons. GeoMAC and WFIGS are therefore used as perimeter-based operational references, while FPA-FOD is not used for perimeter validation. Direct comparisons with GeoMAC and WFIGS are useful for assessing spatial consistency of event perimeters, but differences in event timing, reporting practice, and temporal coverage must be interpreted cautiously.

Revised manuscript addition: "GeoMAC (2012–2018) and WFIGS (2021–2024) were used as independent operational perimeter references to assess whether the MTBS/FRAP patterns were consistent with incident-based perimeter datasets."

Reviewer Comment: 6. The paper lacks clear comparisons with the methods and results from similar recent efforts. Several recent products use DBSCAN–how does this inform the selection of this methodology for CONFEX, and what, if any, differences are there in the implementation or outcomes for the CONUS domain? Likewise, given that various perimeter delineation methods have been proposed and evaluated in depth (e.g. Bhuian et al. 2024), some justification of the choice of the alpha hull approach would be appreciated.

Response: We thank the reviewer for this suggestion. We have revised the manuscript to compare CONFEX more clearly with recent fire-event and perimeter-delineation studies. While CONFEX follows the broader class of methods that convert satellite fire detections into event-level objects, it differs from FIRED/FIREDpy, which is based on MODIS burned-area pixels and a spatiotemporal moving-window/flooding approach, and from FEDS, which dynamically tracks VIIRS fire objects at half-daily time steps. CONFEX instead uses retrospective VIIRS S-NPP 375 m active-fire detections across CONUS and Alaska and applies DBSCAN in normalized space–time coordinates to generate event-level candidate clusters. DBSCAN was selected because it can identify irregular hotspot groupings without requiring a pre-defined number of clusters. Low-detection candidate clusters are then removed during post-processing by excluding 1–2 point clusters from the final release.

We also added a scientific justification for the alpha-shape perimeter reconstruction. Bhuian et al. (2024) showed that perimeter delineation methods involve a tradeoff between spatial agreement and commission error, with more permissive perimeter definitions improving agreement but increasing area overestimation. This supports our use of alpha shapes as a practical compromise between overly simple convex or point-buffer envelopes and overly fragmented detection patterns. Finally, we clarified that CONFEX perimeters should be interpreted as detection-derived event envelopes rather than exact high-resolution burned-area boundaries.

Exact revised manuscript addition in the Spatiotemporal Clustering Algorithm subsection: "Recent comparative evaluations of active-fire perimeter delineation methods have demonstrated that point-buffer, convex-hull, and concave-hull approaches involve a fundamental tradeoff between spatial agreement and commission error (Bhuian et al., 2024). As shown by Bhuian et al. (2024), while more permissive perimeter definitions can improve agreement with reference data, they can also increase area overestimation. This finding supports the implementation of alpha-shape reconstruction in CONFEX as the primary perimeter-generation step; regionally selected alpha values are used to balance geometric detail and overestimation while preserving the irregular, lobed geometry implied by clustered VIIRS detections more effectively than a convex hull alone. Crucially, the additional 187.5 m expansion applied in CONFEX is not intended as a primary delineation method, but rather as a sensor-scale half-pixel adjustment applied after geometry construction to account for the nominal 375 m VIIRS footprint. Consequently, CONFEX perimeters are best interpreted as detection-derived event envelopes characterizing the broad spatial extent of thermal activity, rather than as exact high-resolution burned-area boundaries."

Reviewer Comment: **7. Conceptually, or analytically, how does CONFEX compare to existing data (FEDS, FIRED)? Given that previous work (e.g., Chen et al. 2022) has published open source code for fire event tracking using VIIRS active fire detections, why not use an existing algorithm to develop a dataset covering this time period and spatial extent? It is not clear from the manuscript why the authors chose to develop a new algorithm rather than applying an existing one.**

Response: We thank the reviewer for this important suggestion. We revised the manuscript to compare CONFEX more clearly with existing fire-event products and to explain why a separate framework was developed rather than directly applying an existing algorithm. FIRED/FIREDpy is based on MODIS burned-area pixels and a spatiotemporal event-delineation framework, whereas FEDS uses VIIRS active-fire detections in a dynamic fire-progression tracking framework that has been applied extensively in California-focused applications. In contrast, CONFEX is designed as a retrospective event-level perimeter and attribute database for CONUS and Alaska. To support broader national-scale application, the revised CONFEX workflow uses region-specific threshold tuning across seven regions: Alaska, CONUS West, Southwest, Southeast, Northeast, Eastern Midwest, and Western Midwest. CONFEX therefore prioritizes spatially consistent national-scale event delineation, ignition-proxy timing and location, end time, duration, centroid, area, and final VIIRS-derived perimeter geometry, rather than half-daily fire-line progression or spread-rate estimation.

Exact revised manuscript addition:

"CONFEX is a retrospective fire-event perimeter database generated from archived VIIRS S-NPP active-fire detections and should not be interpreted as a near-real-time fire-progression product. Unlike fire-progression products such as FEDS, CONFEX does not currently provide daily spread vectors, fire-line progression, spread rate, or direction estimates. Its main event-level attributes—ignition-proxy timing and location, end time, duration, centroid, area, and perimeter geometry—are intended to support fire-regime analysis, ignition-focused studies, and comparison with other fire inventories. The parameter-tuning validation was performed separately across seven broad regions to provide a practical regional framework for applying different clustering thresholds across CONUS and Alaska."