

[Reviewer 1]

This protocol paper outlines the Fire Model Intercomparison Project (FireMIP) in the Coupled Model Intercomparison Project Phase 7 (CMIP7). It establishes a comprehensive experimental design, including specific simulations, required inputs and outputs, and a detailed analysis framework. The primary contribution is to provide a standardized, community-wide approach for evaluating fire simulations in Earth System Models, assessing past and future fire regime changes and their drivers, and quantifying the multifaceted impacts of fires on climate, ecosystems, and society within a fully coupled modeling framework. The protocol is clearly written and well structured. However, while the paper well describes the technical specifications and experimental design, the accompanying discussion of fire associated in-depth scientific analyses remains comparatively general and would benefit from a stronger theoretical framework or clearer metrics. Given the critical importance of fire in the earth system and the global need to reduce model uncertainties, this FireMIP paper is a substantial contribution that merits careful revision before publication.

Reply: We thank the reviewer for the positive assessment and constructive comments. We have revised the manuscript accordingly. In particular, Section 5 (Recommended analyses) has been revised to improve the framework and organization as well as to provide clearer evaluation metrics. A point-by-point response is provided below.

Major Remarks:

The “recommended analyses” section requires further strengthening. Currently, its three subsections align well with the three scientific questions outlined in the paper: (1) How do models perform? (2) How do fire regimes change? (3) What is the impact? Yet the subsection titles remain overly general, limiting their ability to reflect the specific features of a FireMIP. To enhance the clarity, I recommend introducing structured subsections that explicitly reflect the unique scope and design of FireMIP. For instance, under the first question (How do models perform?), subsections could include: “Regional evaluation (e.g., permafrost fires, Amazon fires, and African fires)”, “Evaluation of burned area, fire frequency, and carbon emissions”, “Variability and sensitivity analysis”. Such structuring would better articulate the key dimensions of fire model assessments, ensuring the recommendations are tailored to the project’s objectives and actionable for future implementations.

Reply: Thanks for the helpful suggestion. We agree that Sec. 5 benefits from clearer, more FireMIP-specific structure. We kept the top-level subsection titles (5.1 Fire simulation evaluation; 5.2 Fire changes and drivers; 5.3 Fire impacts) to align with the experiment-group names and scientific questions, but have strengthened each subsection by (1) adding structured run-in headings that reflect FireMIP-specific dimensions, (2) clarifying key metrics and definitions, and (3) adding introductory text to clarify the framework and scope.

The revised Sections 5.1–5.3 are now structured as follows:

5.1 Fire simulation evaluation

- Target variables and experiments

- Evaluation metrics (totals, spatial pattern, seasonality, interannual/decadal

- variation, extreme fire frequency, links to local factors (climate and socioeconomic), links to teleconnections, and sensitivity tests)
- Evaluation focus (CMIP6 limitations)
- Key regions (Africa, Amazon; Arctic-boreal zone including permafrost fires)
- Benchmarks (present-day, long-term, regional)
- 5.2 Fire changes and drivers
 - Fire changes
 - Uncertainties in simulated fire changes
 - Fire drivers and causal pathways
- 5.3 Fire impacts
 - Impacts of fire and fire aerosols (historical)
 - Impacts of changes in fire and fire aerosols (future)
 - Underlying mechanisms
 - Benefits of the coupled CMIP7 framework

Minor Comments:

(1) Line 116-129: Both “scientific question 1” and “critical issue addressed by Li et al., (2024)” use “(1)”. Consider using different notations to avoid confusion.

Reply: Thanks for pointing out this. (1), (2), and (3) for the critical issues addressed by Li et al. (2024) have changed to (i), (ii), and (iii).

(2) Line 130: The key point of the second scientific question is unclear, as multiple aspects are combined without clear distinction. While Figure 1 provides a good summary of Q2, the corresponding text description (Line 132-136) lacks clarity.

Reply: According to your suggestion, we have revised the description of Q2 to “This question focuses on two linked aspects: (i) characterizing fire changes in the past, present, and future, and (ii) attributing these changes. Regarding fire changes, CMIP6-simulated fire changes still have large uncertainties, and CMIP7 offers an opportunity to revisit them with improved models and scenarios. The uncertainties in fire change simulations can be quantified and separated into contributions from model uncertainty, internal climate variability (initial-condition uncertainty), and scenario uncertainty. Regarding attribution, earlier studies focused either on local, direct fire drivers (e.g., local weather and climate) or on attributing climate changes to anthropogenic versus natural forcings. CMIP7 FireMIP integrates the two by analyzing how anthropogenic and natural forcings shape global fire changes by altering local, direct fire drivers.”.

(3) Line 163-165: How to generate the initial condition for offline land model is unclear.

Reply: Lines 163-165 refer to the coupled ESM simulations rather than offline land-model simulations. We have added “For coupled simulations,” to make this explicit.

For Groups 1–2 (CMIP7 DECK and FastTrack experiments), initial-condition ensembles follow the corresponding experimental design (e.g., branching from different times in the piControl run, or applying small perturbations to an atmospheric state variable such as temperature). Details of the initial conditions for Group 3 (FireMIP-specific) experiments are provided later in the dedicated Group 3 description

where Group 3 experiments are introduced.

(4) Line 175: Should the “Fire impacts” group 3 in Table 1?

Reply: Yes, we have corrected the typo.

(5) Line 183-187: The description of 2.3 and 2.4 are different with Table 1. What is “overshoot”? Could be more specific than Table 1.

Reply: We have revised the descriptions of 2.3 and 2.4 to match Table 1.

In addition, in descriptions of vllo and vlho, we have added “Here, “overshoot” denotes the magnitude by which global warming temporarily exceeds the 1.5°C target level during the 21st century (Van Vuuren et al., 2025).”

(6) Line 190: Should “failed-policy futures” be “future failed-policy”?

Reply: “Current-policy” and “failed-policy” are adjectival modifiers of “futures”, so “current-policy and failed-policy futures” is correct.

(7) Line 221-223: By comparing different experiment results, we are able to answer different questions. To summarize these potential comparisons in Figures or Tables would be helpful to enhance the clarity.

Reply: Thanks for the suggestion. We have added a new table (Table 2) to summarize the potential experiment comparisons and their associated scientific purposes.

(8) Line 226-234: How these inputs could be used in any example models could be demonstrated in Figures.

Reply: We have added a new table (Table 3) illustrating how each fire-specific input is used in ESMs and when it is required.

(9) Line 239-240: Not sure how common these (2-5) inputs are used by different models. If very common, standardized inputs will help reduce uncertainties.

Reply: Around half of the ESMs participating in CMIP7 FireMIP may use inputs (2-5). We have revised the manuscript to note that using standardized, consistent datasets (e.g., the CESM3 input set) is recommended to reduce uncertainty.

(10) Line 243 &249: “driver” should be “drivers”. Not clear what does “impact variables” exactly mean.

Reply: The “driver” and “impact” in “fire driver and impact variables” are used as attributive nouns modifying “variables”. We have changed it to “variables of fire drivers and fire impacts” to avoid confusing.

(11) Line 272-273: This sentence is unclear for me. Do you mean “Variables required by CMIP7 FireMIP are all listed in CMIP7 DECK and AFS experiments.”? I feel confused about “no additional requests specifically for FireMIP”. Aren’t burned area fraction and fire carbon emission specifically for FireMIP? If these two variables are already included in CMIP7 list, I don’t think it is necessary to mention

this sentence.

Reply: The two variables are already included in CMIP7 list, so we have removed the sentence as you suggested.

(12) Line 297-304: Showing the data uncertainties of fire counts and carbon emissions in Figures would be helpful to learn the quality of these benchmarks.

Reply: Thank you for the suggestion. The large uncertainty across fire benchmark products is well reflected by the spread in global totals of burned area and fire emissions listed in Table 5 (Table 7 in the revised version), which we believe shows the inter-product differences more clearly than figures. A quality assessment of benchmarks would require dedicated analysis which is beyond the primary objectives of this CMIP7 FireMIP protocol paper, and the fire observational community has not yet reached a consensus on quality ranking of these global products.

(13) Line 284: Figures could be used to help demonstrate potential analysis.

Reply: Potential analyses are demonstrated in Figure 1 as well as new Table 2.

(14) Line 285-321: Only data sources were introduced in this section. What kind of metrics can be used or what aspects can be focused on should be also introduced?

Reply: We have added dedicated headings in Sec. 5.1 to clearly distinguish evaluation metrics, and expanded the text to specify the key metrics/aspects that should be focused on. In Fig. 1, we have revised the label “characteristics” to “metrics” to align with the revised text made in Sec. 5.1.

(15) Line 322: I prefer to a clearer title “Fire-related changes and corresponding drivers”.

Reply: We agree that “Fire-related changes and corresponding drivers” may be clearer, but we prefer to keep the shorter sub-section title “Fire changes and drivers” for conciseness and consistency with the terminology used in Figure and Tables throughout the manuscript.

(16) Line 329-339: Categorizing drivers of fire-related changes would strengthen the clarity of the potential analysis.

Reply: Agree. Categorized.

(17) Line 341-353: Categorizing the impact would enhance the clarity of the potential analysis.

Reply: Agree. Categorized