Article

Exploratory simulations of experimental burns for instrumentation deployment.

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Abstract: A single paragraph of about 200 words maximum. For research articles, abstracts should give a pertinent overview of the work. We strongly encourage authors to use the following style of structured abstracts, but without headings: (1) Background: place the question addressed in a broad context and highlight the purpose of the study; (2) Methods: describe briefly the main methods or treatments applied; (3) Results: summarize the article's main findings; (4) Conclusion: indicate the main conclusions or interpretations. The abstract should be an objective representation of the article, it must not contain results which are not presented and substantiated in the main text and should not exaggerate the main conclusions.

Keywords: experimental burn; fire modeling; observational data; WRF-SFIRE; Pelican Mountain; fire behavior; smoke emission and dispersion; coupled feedbacks

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1. Introduction

[1]

Collecting detailed observational data of wildfire activities is extremely difficult. As a result of its highly dynamic behavior, the size, shape, and direction(s) of the wildfire can change rapidly. The reasons for these behavioral changes are numerous. In addition to the coupled fire-atmospheric processes, fuel type, moisture content, terrain, and even the mitigation measures employed by fire response teams all impact wildfire behavior. As a result of these and other factors, wildfire observational datasets are nearly nonexistent. Thus, the fire science community relies on experiential burns to collect critical data which is then used to develop, improve and/or verify numerical wildfire-atmosphere models.

Advancements in computational power and efficiency have enabled more physical processes to be implemented within numerical wildfire-atmosphere modeling [1]. These models, still rely on underlining semi-empirical models and parametrization, each of which contains inherent errors. Over the years, data collected at serval experimental burns have improved the underlying parameters subsequently improving the accuracy of the numerical wildfire-atmosphere model(s) [1-5].

These experimental burns have also led to process enhancements such as better instrument placement [1], and the development of lower-cost (disposable) instrumentation. For process improvements to continue, more experimental burns, using novel experimental designs and conducted in varied forest ecosystems are required. These experiments will deepen our understanding of the complex coupled wildfire-atmospheric processes which in turn will improve our ability to mitigate the destruction caused by wildfires.

The Pelican Mountain experimental fire research site in central Alberta, Canada was created to examine fire behavior in a boreal black spruce forest [6]. The research site provides a unique opportunity for wildfire-atmosphere research and model development. Since well-observed experimental burns in black spruce forests are uncommon, the ability to monitor the behavior of this fuel type provides an opportunity to improve our understanding and modeling of wildfires in this forest ecosystem. An additional benefit of the site is its size and layout. It consists of 22 individual blocks that will provide researchers the opportunity to conduct experimental burns over the next several years. Since the fuel characteristics of a block can be modified (i.e., by thinning underbrush) a variety of situations can be studied more easily. Most importantly, studying the results of a burn within a particular block allows researchers to continually address lessons learned, and apply them moving forward.

Even considering the advantages Pelican Mountain provides, experimental burns are expensive and require very site-specific weather conditions. The natural question becomes can modeled simulations improve the design and layout of the instrumentation used in the experimental burn, thereby reducing costs?

In this paper, we will investigate this question by using the 2019 Pelican Mountain Unit 5 burn as a case study to:(1) verify the forecast accuracy of the WRF-SFIRE model; (2) assess the pros and cons of the model configuration and the observed data; and (3) discuss the potential use of model forecasts to optimize instrumentation placement at the future burns.

2. Materials and Methods

Materials and Methods should be described with sufficient details to allow others to replicate and build on published results. Please note that publication of your manuscript implicates that you must make all materials, data, computer code, and protocols associated with the publication available to readers. Please disclose at the submission stage any restrictions on the availability of materials or information. New methods and protocols should be described in detail while well-established methods can be briefly described and appropriately cited.

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This is an example of a quote.

3. Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

3.1. Subsection

3.1.1. Subsubsection

Bulleted lists look like this:

- First bullet;
- Second bullet;
- Third bullet.

Numbered lists can be added as follows:

1. First item;
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3. Third item.

The text continues here.

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All figures and tables should be cited in the main text as Figure 1, Table 1, etc.

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Table 1. This is a table caption. Tables should be placed in the main text near to the first time they are cited.

Title 1	**Title 2**	**Title 3**
Entry 1	Data	Data
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Text.
Text.

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This is the example 1 of equation:

$$a = 1, \tag{1}$$

the text following an equation need not be a new paragraph. Please punctuate equations as regular text.

This is the example 2 of equation:

$$a = b + c + d + e + f + g + h + i + j + k + l + m + n + o + p + q + r + s + t + u + v + w + x + y + z \tag{2}$$

Figure 2. This is a wide figure.

Please punctuate equations as regular text. Theorem-type environments (including propositions, lemmas, corollaries etc.) can be formatted as follows:

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Proof of Theorem 1. Text of the proof. Note that the phrase "of Theorem 1" is optional if it is clear which theorem is being referred to. □

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Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

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Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	Linear dichroism

Appendix A

Appendix A.1

The appendix is an optional section that can contain details and data supplemental to the main text—for example, explanations of experimental details that would disrupt the flow of the main text but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data are shown in the main text can be added here if brief, or as Supplementary Data. Mathematical proofs of results not central to the paper can be added as an appendix.

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Appendix B

All appendix sections must be cited in the main text. In the appendices, Figures, Tables, etc. should be labeled, starting with "A"—e.g., Figure A1, Figure A2, etc.

References

1. Huda, Q.; Lyder, D.; Collins, M.; Schroeder, D.; Thompson, D.K.; Marshall, G.; Leon, A.J.; Hidalgo, K.; Hossain, M. Study of Fuel-Smoke Dynamics in a Prescribed Fire of Boreal Black Spruce Forest through Field-Deployable Micro Sensor Systems. *Fire* **2020**, *3*, 30. doi:10.3390/fire3030030.