

Monday, November 15, 2021

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Dear Madams and Sir:

1. In addition to hazard reduction, the USFS letter specifically mentions fuels reduction (removal of downed woody fuels) as a motivation, and the scoping document titled “Region 5 Post-Disturbance Hazardous Tree Management” also identifies the need to reduce forest fuels – it devotes two paragraphs to this topic, and it cites [Coppoletta et al. \(2020\)](#) as justification.

2. The proposed activities are claimed to be “not novel”; however, the 300-foot distance to roads is larger than the standard 200-foot distance, making it novel.

3. Furthermore, the not-novel claim implies that the activities are well-understood and lack controversy, which heightens my concern, because the proposed activities do not adequately integrate a critical component of fire science, which is the important role of atmospheric coupling via buoyancy to a burning fire.

4. The reason this component of fire science is inadequately considered in current USFS treatment practices is because it is missing from the operational fire-behavior models used by the Service to design and evaluate landscape treatments. For example, the FARSITE user manual (Finney 1998, RMRS-RP-4 Revised 2004, FARSITE: Fire Area Simulator – Model Development and Evaluation) states,

“Obviously, feedback between the fire and environment could alter fire growth patterns from those simulated here. Fire behavior that is strongly dependent on fire-environment coupling such as plume-dominated fires (Rothermel 1991), fire whorls (Byram and Martin 1970), and mass-fires (Countryman 1964) cannot be reliably modeled with this simulation.”

The same FARSITE manual also states,

“Fire behavior during mass fires or plume-dominated fires is obviously controlled by fire-environment interaction and cannot be modeled here.”

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Therefore, this model, and derivative models based on it (e.g., BehavePlus, FlamMap, FVS-FFE, and FSPro), cannot predict the behavior of plume fires that grow into today's megafires, which cause the greatest risks to life and property and are year-by-year grabbing headlines and causing record destruction.

5. The reason operational fire-behavior models are missing this important aspect of fire physics is because the models are designed to run fast enough to be applied rapidly and repeatedly in operational settings, and by approximating the fire physics by leaving out fire-atmosphere coupling, it was hoped by the model developers that this approximation would not compromise the utility of the models to real-world scenarios. Unfortunately, when choosing to decouple the atmospheric response from the fire in the operational models in order to get them to run fast, the models have given up the ability to even approximately simulate today's devastating megafires, like the 2020 Creek Fire, which generated a pyrocumulonimbus cloud that reached up to the stratosphere. Obviously, if a megafire can drive fire weather that reaches completely through the troposphere all the way up to the stratosphere, it is strongly coupled to the atmosphere, and operational models that neglect this important physics cannot adequately guide land management decision makers via realistic simulation of the fire's behavior.

6. The physics of fire-atmosphere coupling is more important than the forest fuel load, and it is more important than current climate trends. This is the conclusion of the USFS-funded research of Coen, Stavros, and Fites-Kaufman (2018), titled, "Deconstructing the King megafire" in *Ecological Applications*, 28(6), 2018, pp.1565-1580. This paper presents high-resolution simulations of California's 2014 King Fire using the CAWFE (Coupled Atmosphere-Wildland Fire Environment) numerical simulation model, which includes fire-atmosphere coupling, unlike the USFS operational fire-behavior models. While these CAWFE simulations run much slower and require much more computer time than USFS operational models, CAWFE is able to simulate plume fires and the megafires they may become. After Coen et al. (2018) verified that the CAWFE simulations of the King Fire reasonably reproduce observations of the fire, they then repeated the simulations while varying the forest fuel load on the computer, and they varied the climate conditions too, and what they quantitatively demonstrated is that the physics of fire-atmosphere coupling left out of the operational models is quantitatively more important than the forest fuel load, and it is more important than the climate scenarios simulated. Therefore, when USFS operational fire-model users stress the importance of fuel load and climate scenarios based on insights gleaned using current USFS operational models, they are leaving out more important physics, and they could very well come to errant conclusions about the efficacy of the treatments they are carrying out to address plume fires. Given this situation, this is not the time to suggest that treatments based on models that are known to be deficient should get the green light to streamlined implementation with reduced oversight.

7. Once fire-atmosphere coupling is identified as more important than forest fuel load or climate variables, a different set of explanatory and response variables are suggested when analyzing statistical data of fire-reburn severity, like 1) vegetation and canopy openings, rather than vegetation cover, 2) correlations of vegetation-opening shapes and the mean wind direction, 3) correlations of vegetation-opening shapes with topographic slope, 4) vegetation

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wind-drag distributions, rather than vegetation distributions, etc. Without this insight, the variables analyzed may be of secondary importance. This may very well be the case for the analysis cited by the Service in [Coppoletta et al. \(2020\)](#). More work is required to be sure, and that work will not be considered and integrated if fast-track approval is given. Given the severity and intensity of California's 2020 and 2021 megafires, we cannot afford to rapidly implement solutions based on incomplete fire science.

8. Other USFS-funded high-resolution numerical research demonstrates the importance of fire-atmosphere coupling. Namely, Atchley et al. (2021), titled, "Effects of fuel spatial distribution on wildland fire behaviour" in the International Journal of Wildland Fire, 30(3) and Banerjee et al. (2020), titled, "Effects of canopy mid-story management and fuel moisture on wildfire behavior" in Nature, Scientific Reports, 10, 17312. Both of these papers use a detailed supercomputer numerical model to definitively demonstrate that fuel treatments that neglect detailed fire-atmosphere coupling can easily lead to unphysical results, and it is easy to make matters worse with poorly designed fuel treatments, when trying to make them better. Until the Service takes the time to understand how to make use of these newly acquired results based on more complete fire physics, they should not operate on a fast track using operational models that cannot simulate fires that strongly couple to the atmosphere.

9. I fear the requested fast-track authority without sufficient oversight is a dangerous mistake because it allows rapid implementation of current USFS treatment practices, which as I've discussed above, inadequately address fire-atmosphere coupling. USFS-funded research demonstrates that fire-atmosphere coupling induced by a fire's buoyancy is more important than the forest fuel load, and it is also more important than climate variation. Until the Service addresses this most important neglected element in its fire-behavior models, oversight is imperative, especially when the Service proposes to move rapidly, possibly in the wrong direction. Consultation with atmospheric scientists knowledgeable of the atmosphere's response when driven by the buoyancy induced by a fire is a minimal necessary step, as is including estimates of the wind-resistance changes resulting from proposed fuel treatments.

Sincerely,

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