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Interactive comment on "A study of the influence of forest gaps on fire-atmosphere interactions" *by* Michael T. Kiefer et al.

Anonymous Referee #2

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General comments:

This study examined the impact of two disturbance sources including forest gaps and fire sensible heat on ambient atmosphere at small scales using a series of idealized numerical experiments. Technically, it's a well-organized paper with professional analyzing and writing skills. The structure is very clear with few typo or redundancy. However, the major issue with this manuscript is about its experiment design. In another words, the numerical experiments conducted here have limited capability to address the proposed scientific question that how could forest gaps influence the interactions between fire and atmosphere. The major difference between this study and previous ones (Linn et al., 2005, 2013; Pimont et al., 2009, 2011; Potter 2012) is that there is no feedback in fire behavior to induced atmosphere disturbance, not to mention that fire in this study is highly simplified as a line of enhanced surface sensible heat flux without any other

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Discussion paper

burning processes. In this way the modeling results cannot be used directly to investigate the role of forest gaps in fire propagation, which is no doubt a very interesting topic with high scientific merits in forest management and fire protection. Under the current framework, we can only draw information about the interactive impacts from two independent disturbance sources as forest gaps and fire sensible heat on the near-surface meteorological properties. If this is what the authors intend to say (and they did make a clarification in the introduction that their focus is "on fire-atmosphere interactions in general"), then the current title of the manuscript is somewhat misleading.

Another issue with the current modeling experiments is that the differences among each sensitivity simulations are too subtle to draw definitive conclusions. Such limited sensitivity could also be a consequence of low-intensity fire perturbations in experiment design. It's suggested that an ensemble modeling experiment with high-intensity perturbations and statistical significance tests would be more convincing to evaluate the sensitivity of atmospheric responses to the two disturbances.

Overall, I recommend major revisions with additional ensemble modeling experiments before a potential publication on the ACP journal. More detailed comments are specified as follows.

Specific comments:

(1) Model description:

In section 2.1, the authors introduce multiple modifications in the model to suit the numerical experiments. These modifications include adding the drag force, the enhancement of turbulence dissipation, and radiation interception due to the canopy, etc. But no information is provided about changes in surface latent heat flux in the heterogeneous canopy due to evapotranspiration variability. In line 117, a constant albedo for forested areas is utilized. How about the albedo in these gap areas without the canopy coverage?

(2) Experiment design:

In line 158, a low-intensity fire strip is represented as a 25 kWmˆ-2 surface static sensible heat flux within a 50-m wide north-south strip. How about the length and duration of this fire strip? Previous studies (Scott and Reinhardt, 2001; Rogers, et al., 2015) have identified the distinct characteristics of low-intensity surface fire and high-intensity crown fire as well as their different impacts on the ecosystem and climate. Though the scale is different in this study, it would be still interesting to see differences of the two types of fire from a small-scale perspective.

(3) Simulation results:

In section 3.2, examination of different mean variables ends up with the same conclusion that the strongest fire anomaly occurs in the CG case and the weakest occurs in the UG case. However, this conclusion is based on the static fire assumption that fire itself has no response to ambient atmosphere disturbance. Would this conclusion be robust if we consider a more realistic fire with dynamic propagation? In the real world, fire reacts to local meteorological disturbances as well as changed fuel supplies in forest gaps with variable burning intensity, which may further interacts with ambient atmosphere in different ways like what we see here. In Pimont et al. (2011), their Fig. 5/7 demonstrates the variation of fire intensity along different forest zones. Such variability in fire intensity reaches the maximum in the Het0 case in their Fig. 7 that is similar with the forest gap setting in this study. It's suggested to consider and discuss the potential limitations related to the idealized assumption before drawing the conclusion in the context.

Technical corrections:

(1) In line 197, it should refer to "Section 3.1" instead of "Section 2.3" for a description of the averaging procedure.

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