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Discussions

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

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General comments: This research investigates the possible role forest gaps have on fire-perturbed atmospheric variables such as mean and instantaneous wind velocity, turbulence kinetic energy, and temperature using an ARPS-CANOPY model. A series of idealized simulations were conducted to examine the sensitivity of the variables modified by the low-intensity surface heat source (25 kW m-2) to the presence of forest gaps at different locations relative to the fire. Overall, I think the paper is well-written, concise, and easy to follow. The research topic will improve our current understanding in fire-atmosphere interactions in forested environments. Even though the ARPS-CANOPY model does not have a fire spread model, in my opinion it has its own merit of eliminating uncertainty and complexity embedded in current fire spread models when studying the interactions between low-intensity fire (very slow moving), atmosphere,

and forest canopy. However, I feel that more physical interpretations for what is simulated including general analysis of fire-atmosphere circulation in the forest (and forest gap) are necessary. Idealized simulations like these allow for determining the dominant forcing and feedback mechanism leading to the simulated results (and observed phenomena if any). For example, I would feel necessary that the authors address whether the fire enhances or suppresses existing recirculation in the gap; and whether updrafts and downdrafts are affected by the presence of canopy layer and strong shear layer in the gap. I think these are some of the important aspects of fire-atmosphere interaction in this study. I will present my specific comments/suggestions below, which could be worth considering before final manuscript acceptance. I recommend publication with changes made accordingly if the authors agree with my suggestions. Please feel free to reply me if my comments are unclear. Specific comments: line 212: It seems to me that the canopy layer plays a role in absorbing downward motion as shown in Figs 3a and 3d, which may contribute to lower mean Ufire-no-fire maxima (Fig.2) relative to the CG case. Is this because fire-atmosphere circulation (please see Fig. 2 in Potter 2002) is interrupted by the presence of forest canopy? I ask this question because it is related to your discussion of horizontal and vertical heat transport (line 250). Another possible explanation I can think of is the role of the strong vertical wind shear in the gap on the downward motion in case of UG (See Figs. 2b and 3b). Would it be possible to address these questions based on your simulations? I believe that such discussion would be important as the authors' main focus is on fire-atmosphere interaction in general in forested environments with gaps.

line 223: the very small differences in the positive fire anomaly found in this study may be associated with spatial averaging in y-direction. I assume that there are both positive and negative vertical velocity variations within canopy sub-layer along the lateral direction above the heat source as I imagine from Fig. 6a in Kiefer et al. (2015). If this is true, then the mean vertical velocity plots in Fig. 3 are somewhat misrepresentative of mean updraft/downdraft intensities. Even though overall structure of fire-atmosphere circulation may be true, the authors may need to inspect lateral patterns of the vertical velocity field.

line 263 (section 3.3): It may be appropriate to present a plot showing values for the no-fire case next to the fire values (green bar/box for example). If those maximum positive and negative instantaneous values with similar magnitude were present without the fire, then the statement 'the fire has a pronounced effect on the magnitude of horizontal wind gusts... ' (line 270-271) does not hold true. I think the authors should be cautious when analyzing instantaneous max/min values although I suspect the instantaneous no-fire max/min values exceed those with the fire.

Figure 12: The conceptual model is very useful in summarizing the paper; however, the figure may be misleading because: (1) the authors did not investigate the interactions between the fire and the flow recirculation, which is one of the important features present in the forest gap. In fact, analysis of their interactions may deserve its own small section before constructing the conceptual model. Does the recirculation contribute to the overall increases in the gust and TKE? Or does the fire-induced flow circulation overcome the flow circulation in the gap? why Fig. 3b and 12b, UG case, has weakest downdrafts despite the fact that gap-induced downdraft zone meets fire-induced downdraft zone? (2) it is not clear if the model is based on mean or instantaneous variables found from your simulations? Based on Figure 10, I would think that the TKE in zone D in figur12d should be marked with red because the zone has very similar instantaneous max TKE value as the zone C in the CG case. But if I looked at Fig. 4, max TKE occurs in the CG case. Minor: line 46: are there any similarities found in this study and Pimont et al. (2009, 2011) in terms of simulated fire-atmosphere interactions inside forest gaps? If so, it would be nice to mention in your result section?

Figures 8-11: it would make the readers easier to interpret the results if you could indicate where the fire is by highlighting the zone C by orange color, just to remind them the gap location shifts relative to fire location at C.

References: Potter, B. E., 2002: A dynamics based view of atmosphere-fire interac-

tions. International Journal of Wildland Fire, 11, 247-255.

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