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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Including the sub-grid scale plume rise of vegetation fires in low resolution atmospheric transport models" *by* S. R. Freitas et al.

Anonymous Referee #2

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Review of "Including the sub-grid scale plume rise of vegetation fires in low resolution atmospheric transport models" by Freitas et al., for publication in Atmospheric Chemistry and Physics.

The paper deals with the injection of buoyant plumes of gases and aerosols from biomass burning regions. Typically 3-d atmospheric and chemistry transport models treat very simply (or not at all) the vertical injection of these materials from biomass burning sources. Because of the differences in the wind speed in the planetary boundary layer from the winds aloft, there are important implications for gas and aerosol lifetimes, chemistry, and morphology when considering or neglecting the vertical dis-

tribution of these materials over source regions. The authors present a 1-D cloud-resolving model that simulates the buoyant transport of air and material over a fire, taking as input the atmospheric vertical profile of temperature and moisture and information about fire size and fire energy. This model returns as output the injection altitude of the emissions from the fire. Embedded in a 3-D atmospheric and chemistry transport model and coupled to a database of biomass burning regions the cloud-resolving model leads to prediction of the injection altitude associated with the fires. The paper is generally well written and interesting, and the work should be especially useful to global and regional scale modelers interested in the important problem of how to properly account for the vertical injection of materials from biomass burning fires. There are several comments to make however: 1) In the introduction, the first paragraph should be split into two paragraphs, with the second paragraph beginning at the sentence "In spite of the continuous increase in computing power..." (page 11523, line 3). This could be further clarified: the first paragraph introduces the general importance of biomass burning events; the second paragraph should more smoothly connect the problem to a description of why modelers care, which is sort of neglected at the moment.

2) Page 11523, line 22, should read "...in an arbitrary way..."

3) In the paragraph continuing over onto page 11525, are all of these locations (Serra do Maranhao and Maraba) in Brazil?

4) Page 11529, lines 7-9, something doesn't make sense about how the fire size is treated in cases where there is no information about the instantaneous fire size. How then is the mean instantaneous fire size arrived at? I assume this is a typo.

5) Page 11530, line 25: This begins a bulleted list outlining how the 1-D model is implemented in the 3-D model. Something not clear at this point in the text is how smoldering phase is handled. Does the plume rise model only apply to the flaming phase? Why or why not? How are the flaming and smoldering phases distinguished?

6) The final two paragraphs on page 11530 and into the bulleted list connect the 1-D

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cloud-resolving model to the problem of 3-D transport models. This requires a little more explanation. Steady state for the 1-D model is arrived at in 50 minutes, but this is larger than the time-step of typical 3-D transport models (which may be more like 5 - 15 minutes). So what are the implications here if the ambient atmospheric state is changing on something less than the time allowed for the 1-D model to reach equilibrium?

7) Page 11531, line 16 (and other places in the text) word “diel” is used, and what I believe is meant is “diurnal.” This may be a difference of language, but I am unfamiliar with “diel” and suggest “diurnal” instead.

8) Page 11532, line 16: please clarify here that the “dry” case is insensitive to the heat flux. The “wet” case has sensitivity, although it is confounded also by the fire size.

9) Page 11532, line 20: referring again the “dry” case, the parameterized dependence of height on heat flux is pointed out to be smaller than that in Manins, but I don’t understand the point, since nothing else is said. The next sentence states that the results are “also consistent with the finding from Heikes...” These sentences seem out of order or out of context. Please clarify why these results are meaningful.

10) Page 11533, lines 17-18: you mean that “...we could not perform more comparisons...” and that “More thorough comparisons...” will appear later.

11) Page 11535, line 4: “thoses” should be “those.”

12) Page 11535: in discussing the frequency with which the 1-D model is called, since this model is clearly intended for inclusion in 3-D transport models, can you provide some statistics on how costly exactly this model is to run?

13) Page 11535 and Figure 6: The caption to the figure (6a and 6d) indicates a dotted line, but I see a solid grey line. In general, the lines in these plots could be made larger and more distinct. Also, referring to the text, it is simply not clear how we are to determine the injection altitudes from 6b and 6e. Particular for 6e, I do not understand

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how the 3 km height is arrived at, or what it means. Does the smoke go uniformly from the surface to 3 km? The high heat flux line on 6e reaches nearly zero vertical velocity at about 1.5 and 3.5 km; which altitude is relevant to the injection height?

14) Although some sensitivity of the model is explored to fire size and heat flux and atmospheric state on injection altitudes, what is not explored here is the interaction of those sensitivities on the distributions arrived at dynamically in the 3-D model. Can this be explored at all? In other words, although the plume rise versus surface injection is explored in Figure 7, what is the sensitivity to these other variables in a similar fashion?

15) Figure 9 - 13: These lines are very hard to tell apart. I suggest that the two panels of each plot be made somewhat wider and the colored lines thicker so that the studies are easier to tell apart.

16) What would really make this 1-D model more compelling is if the plume rise and surface injection cases were compared in the context of a horizontal plot showing geographic CO distributions. This seems curiously missing.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 11521, 2006.