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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling of biomass smoke injection into the lower stratosphere by a large forest fire (Part I): reference simulation" *by* J. Trentmann et al.

J. Trentmann et al.

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Reply to Referee 2 (The Reviewers comments are contained in brackets):

[Biomass burning is an increasing important subject in atmospheric research as it has the potential of greatly disturbing the thermodynamic, dynamic and chemical equilibriums of the atmosphere. This is especially so if its influence extends up to the stratosphere and this is precisely what is addressed in this paper. This paper also deals with the injection of the forest fire smoke into the stratosphere by pyro-Cbs in high latitudes. High latitude regions are traditionally considered as convectively inactive and yet recent observational studies show that strong convections can occur, especially with the additional energy released by combustion. Water vapor and other chemicals can then be carried into the stratosphere and their impacts on the global atmospheric processes must be carefully assessed. The paper is clearly written and the results are also discussed nicely. I would like to suggest the following minor revisions that I believe would clarify a few points.]

We thank the referee for his/her kind words, the replies to the specific comments are given below.

[(1) The model ATHAM is used for this study. The authors have presented some information of this model in Sec. 4 and provided a few references. Nevertheless, it may be a good idea to discuss a few more details about the model properties. Specifically, what is the model spin up time? This is important since some models take long time to spin up and hence the results of the earlier time steps are often discounted somewhat. Since the results presented here are for the first 40 min, it is necessary to indicate that this is much longer than the spin up time and hence the results are representative.]

In the model simulations presented here, the fire forcing is initiated into the model without any spin-up time of the model. Since we use no topography in the model simulations, the initialized thermodynamic fields and the wind field do not need to adjust. In a previous study, a model spin-up of 6 minutes was used before the fire emissions were initialized in the model [Trentmann et al., 2002]. We therefore assume that the simulation time of 40 minutes is significantly larger than the model spin-up time. We added the following sentence at the end of the second paragraph of Section 4:

’Since flat topography is employed in the model simulations, the model spin-up time is substantially shorter than the simulation time.’

[(2) In sec. 5, many numbers of the model results are provided. Of course the authors are familiar with the numbers but readers may get confused after reading back and forth about various quantities. Maybe it is a good idea to come up with a table so that readers will have easier time to figure out how some numbers are arrived? (For example, on liner 349, how is the number 5% to the total energy released calculated?

It will be easier to see that in a table).]

We agree with the referee that in Section 5 many numbers related to the model results are presented. However, we do not think that a table would help the reader to figure out how the numbers were derived, especially since some quantities require some explanation and further description, which is harder to give in a table than in the text. In the accompanying paper by Luderer et al., we present four tables that include some of the numbers from the reference simulation in comparison with the results from sensitivity studies.

The contribution of the latent heat released from the fire to the total release of latent heat can be inferred from the total release of water vapor from the fire (4.7$\times10^8$ kg H2O, Section 4.1) compared to the total mass of hydrometeors (frozen and liquid) in the plume. This yields a contribution of 4.9 % of the water mass released from the fire to the total mass of hydrometeors in the plume. Since, condensed and frozen mass is proportional to the latent energy released, the 4.9 mass % transfer into 'less than 5% of the total energy released from condensation and freezing.' We tried to clarify the sentence, it now reads:

'Comparing the total water mass released from the fire (4.7$\times10^8$ kg, see Sect. 4.1) to the total mass of liquid and frozen hydrometeors in the plume (9.62$\times10^9$ kg) yields a contribution of the latent heat release from the fire of less than 5% to the total energy released from condensation and freezing.'

[(3) If I understand it correctly, you use constant fire induced fluxes to initialize the pyro-Cb on the observed sounding background. Can you provide some comments about the advantages and/or disadvantages of this initialization technique as compared to other possible techniques?]

The reviewers is correct: the fire fluxes were set constant throughout the model simulation. We chose to use the most simple way to describe the fire forcing based in two reason: 1)There is no accurate information on the fire behaviour during the time of main blow-up. Every more detailed description of the temporal and spatial behaviour of the fire emissions therefore would rely on additional assumptions. 2)Numerical sensitivity studies showed only very little dependence of the simulated pyro-convection on the way the fire forcing is incorporated into the model. For example, including a moving fire front with the observed rate of spread did not lead to a substantially different development of the pyro-convection. We therefore decided to describe the fire forcing as simple as possible, and to focus on the atmospheric effect. We expect a substantial improvement in the physical description of the atmosphere-fire interaction by including an interactive fire module, driven by the predicted wind. However, this coupling is way beyond the scope of the present work. We added the following sentences at the end of the second paragraph of Section 4.1:

’In the model, the fire fluxes are held constant throughout the simulation. Not enough information on the fire behaviour is available to include a more realistic spatial and temporal distribution of the fire emissions. As part of this study, test simulations using a moving fire front have been conducted (not shown here), which showed no impact of the moving fire front on the model results.’

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 6041, 2006.