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Comment

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 #1

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Review of Freitas et al., 2006

The manuscript by Freitas et al., presents a novel approach to represent the emissions of vegetation fires by including a one-dimensional plume rise model in a regional model. The vertical displacement of fire emissions due to the heat emitted from fires is often neglected or very simplified considered in larger scale models. By explicitly considering the thermodynamical state of the atmosphere and the heat emitted by the fire, the current approach presents a first step towards a more process-oriented description of the injection height of fire emissions in larger-scale models.

The manuscript is well written and contains a good description of the underlying equa-

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tions of the one-dimensional plume rise model, its implementation into a regional model, and first model results that show and evaluate the impact of considering the injection height in the regional model. Enclosed are my specific comments that should be considered before publication of the manuscript in ACP.

Specific Comments:

page 11523, line 23: the reference 'Wang et al., 2005' should read 'Wang et al., 2006'.

page 11526, line 8: It is stated that the 'final height that the plume reaches is controlled by the thermodynamic stability of the atmospheric environment and the surface heat flux release from the fire.'. While I generally agree with this statement, I am wondering if horizontal wind might also contribute to the final plume height. Especially for small fires, the horizontal wind might prevent the fire plume from reaching the condensation level and/or enhance the entrainment. Both aspects should lead to a lower height of the plume. On the other hand, the fire itself probably will intensify at higher surface winds. It might be worth to include a brief statement on the possible impact of horizontal wind on the resulting injection height.

Section 2: It might be easier to follow, if the equations 1 to 5 would be presented before the explanation of the variables.

page 11527, line 4: please specify the definition of the buoyancy term B (does it include g ?)

page 11530, line 1 ff: Please include a reference for the emission factor of water vapor, and the rate by which biomass is consumed.

page 11531, lines 15 ff, Fig. 2: The two radiosonde profiles have very similar surface properties (temperature slightly above 30 deg C, and dew point slightly below 20 deg C). I am wondering if the discrimination of the two radiosonde profiles based on their humidity (dry and wet) is appropriate here, since the evolution of the ascending parcel is highly determined by the initial (i.e., the surface) properties. Only entrainment at

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higher levels leads to differences in the water content of the rising plume between these two cases. The differences between the plume rise calculated for the two atmospheric profiles are (correctly) explained by the different temperature profiles and not so much by the difference in the humidity. This might be worth mentioning.

page 11531, line 24: It might be worth including the values of the initial conditions for the vertical velocity (w_0), the density (ρ_0) and the temperature (T_0) in the rising parcel for this case.

page 11534, line 19: please explain what is meant by the 4DDA technique, maybe include a reference.

page 11534, line 19: how are the background values of CO initialized in the model?

page 11534, line 25: some more information on the BFEMO would be useful, e.g., what are the underlying assumptions (e.g., emission factors, biomass density, combustion factors)? The numerical values are given in Freitas et al., 2005, as stated, but it might be insightful to remind the reader that some basic assumptions are required for the calculation of fire emissions from satellite derived fire.

page 11536, line 13, Figure 8: Is the plume model also used for the injection of the African fire emissions? How are the emissions calculated (it seems that the BFEMO emission model focuses on Brazilian emissions)? Are the underlying assumptions also valid for Africa? Is data from ABBA also available for Africa?

page 11536, line 11 ff, Figure 8: It is stated that the fire in Africa are mostly due to savanna fires that produce a broader and lower injection layer. However, the injection height over Africa reaches above 6 km, which seems to be rather unusual for savanna fires. Please comment on the high values for the plume rise calculated over Africa.

page 11537, line 14 ff: The motivation for the selection of the different CO tracers is not convincing to me. It is rather obvious that transport of CO that takes only into account advection and PBL diffusion (COAD) is inaccurate. It still is interesting to

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investigate the impact of no convection (COAD), shallow convection (COSH) and deep convection (CODP) on the transport of CO, but it seems that this is not the main focus of this paper. The main focus of this paper is the impact of including the plume rise (COALL) on the model results. Unfortunately for the comparisons of the model results with observations (5.1., 5.2) the model tracer CONOPR is not presented, even though it is discussed before (page 11534, line 21). This tracer seems to be best suited for an evaluation of the impact of the plume rise mechanism. I suggest to include the CONOPR tracer into these intercomparisons and maybe remove some other tracer (e.g., COAD).

page 11538, line 15f: Why was the boundary layer development suppressed over regions of dense smoke? Is this a radiative effect? Is this effect included in the model simulation? Please comment and maybe add an appropriate reference.

page 11539, line 17f, Figure 13: Please explain (and/or give a reference) how the model results were modified in Figure 13a. What is meant by 'applying the averaging kernel and a priori data < 50 %'? In particular I am confused that at 850 hPa tracer COALL has the lowest CO mixing ratio of all model simulations before the modification (Figure 13b), but the highest mixing ratio after the modification (13a). Please explain.

page 11539, line 22, 23: It is not clear where the '(A)' and '(B)' is referring to, please specify.

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

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