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Modeling of a boreal pyro-cumulonimbus cloud: Sensitivity to background meteorology, cloud microphysics and fire energetics

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Several observational studies report measurements of aerosol particles from biomass fires in the stratosphere [*Fromm et al.*, 2004]. Observations of the Chisholm fire that burned in Alberta, Canada, in early summer of 2001 show that boreal forest fires can be intense enough to directly inject smoke even into the lower stratosphere [*Fromm and Servranckx*, 2003]. Hence, biomass burning emerges as an additional, previously underestimated source of aerosol in the upper troposphere and lower stratosphere (UT/LS) region. Due to the enhanced lifetime in the UT/LS region, this might have a significant impact on the Earth's radiation budget as well as on stratospheric chemistry.

We used the cloud resolving plume model ATHAM (Active Tracer High Resolution Atmospheric Model) to investigate different factors contributing to the severe intensification of the Chisholm fire convection. Our simulations show strong sensitivity of the fire convection to the background meteorology. This explains the observed coincidence of convective blow up of the fire and the passage of a synoptic cold front. Furthermore, we performed sensitivity studies to fire emissions of sensible heat and water vapor emissions. Whereas the convection is very sensitive to the heat flux from the fire, the fire emissions of water vapor play a less significant role.

Aerosol contamination has a strong impact on the microphysical structure of convective clouds. The consequent suppression of precipitation at low levels can result

in invigoration of polluted clouds, as has been reported from observations in pyro-clouds over the Amazon [*Andreae et al.*, 2004]. However, our simulations show that for the case of the Chisholm fire the aerosol-microphysics interactions only have a minor effect on convection dynamics, at least with the currently used bulk microphysics scheme.

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