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Simulation of "green-ocean", "smoky"- and pyro-clouds observed during SMOCC using a spectral microphysics cloud model

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The unique measurements of cloud microstructure during SMOCC experiment in The Amazon region indicate strong differences in concentration and size distributions of droplets in convective clouds arising in clean ("green-ocean"), smoky and extremely dirty air in zones of biomass burning (pyro-clouds). The time evolution of these clouds, the formation of droplet size distributions and size distribution of ice particles, as well as processes of precipitation formation are simulated using a spectral microphysical cloud model HUCM developed in the Hebrew University of Jerusalem. The model reproduces well droplet spectra measured in the clouds of these types. Clouds developing in clean air rapidly produce warm rain. Precipitation in smoky air forms by melting of ice particles (graupel) and reach the surface with a significant time delay. The delay in precipitation is especially significant ($\sim$50 min) in pyro-clouds. Possible mechanism of precipitation formation (including hail precipitation) in a pyro-cloud is analyzed. The mechanism is related to recirculation of drops and ice particles. These particles fall downwind of cloud, but, penetrate cloud through the cloud base being forced by convergence in the boundary layer caused by strong heating. As a result, cloud contains a lot of small droplets, and large drops penetrated by the recirculation. This process gives rise to intensive collisions and to rapid freezing with the formation of graupel and hail.

It is shown that smoky- and pyro-clouds transport a significant amount of non-activated aerosols to the upper troposphere. The changes of size distributions as well in spatial distribution of atmospheric aerosols caused by clouds are evaluated.

Effects of wind shear on precipitation in pyro-clouds are analyzed.