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Closure study of cloud aerosol interactions using trajectory ensemble model

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A closure study of the cloud aerosol interactions in stratocumulus cloud was carried out. In this study we use LEM (Large Eddy Model) to produce similar conditions to those observed during CLOPAP (Cloud Processing of regional Air Pollution advecting over land and sea) project flights. LEM is further employed to produce a set of trajectories that can be used to run a detailed cloud parcel model, which includes differential equations describing condensation/evaporation of different gases, coagulation, and chemical reactions in the liquid and gas phases. In simulations cloud parcel model is initialized with the out-of-cloud aerosol compositional data from the AMS-measurements, and observed (or estimated) gas phase concentrations of water soluble gases. The existing adiabatic cloud parcel model is modified so that instead of adiabatic expansion, the temperature and total water concentration are taken from LEM produced trajectories and the change in water saturation ratio is calculated based on these values.

Our preliminary results show that when the measured in-cloud vertical velocities agree well with the LEM produced velocities, the agreement between measured and simulated cloud droplet number concentrations is good. However, even a small widening of probability density function of the simulated updraft velocities can lead to remarkable overestimation of the cloud droplet number concentration. It is also shown that modelled and observed droplet number concentration tends to increase downstream of pollution source as a result of aqueous phase chemistry. Further coagulation produces a steady decrease in the number of fine aerosol with distance downstream.