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Preliminary numerical study on the cumulus-stratus transition induced by the increase of formation rate of aerosols

Shin-ichiro Shima (1,2,3), Koichi Hasegawa (4), Kanya Kusano (5,6)

(1) Graduate School of Simulation Studies, University of Hyogo, Kobe, Japan (s_shima@sim.u-hyogo.ac.jp), (2) Advanced Institute for Computational Science, RIKEN, Kobe, Japan, (3) WPI Immunology Frontier Research Center, Osaka University, Suita, Japan, (4) ChudenCTI Co., Ltd., Nagoya, Japan, (5) Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan, (6) Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan

The influence of aerosol-cloud interactions on the steady state of marine stratocumulus is investigated through a series of numerical simulations of an idealized meteorological system in which aerosols are formed constantly.

We constructed the system by modifying the set-up based on the RICO composite case defined in van Zanten et al. (2011). The super-droplet method (SDM) (Shima, 2008; Shima et al., 2009) is used for the simulation of cloud microphysical processes. The SDM is a particle-based and probabilistic method, with which the time evolution of aerosol/cloud/precipitation particles are calculated in a unified and accurate manner. For the simulation of atmospheric fluid dynamical processes, the cloud resolving model CReSS (Tsuboki, 2008) is used, in which the quasi-compressible approximation and the sound mode splitting method are applied.

The steady states of the system are compared changing the aerosol nucleation rate and the initial number density of aerosols. It is observed that the system gradually evolves to reach its final steady state in a few days, which is irrelevant to the initial number density of aerosols. A transition of the final steady state from cumuli to strati occurs when the aerosol formation rate is increased.

Chemical reactions in the gas phase and the liquid phase are not yet incorporated in the model, and the numerical simulations are performed in two dimensions. For these limitations, the results obtained are still preliminary.