Fourth International Conference on Earth System Modelling
4ICESM-22-1, 2017

Non-monotonic, time dependent aerosol effect on warm convective clouds and its dependency on the environmental thermodynamic conditions

G.D. Dagan, I.K. Koren, and O.A. Altaratz
Weizmann Institute of Science, Department of Earth and Planetary Sciences, Rehovot, Israel (guy.dagan@weizmann.ac.il)

The mutual effect of the environmental conditions and aerosol loading on the time evolution of warm convective clouds and the feedbacks of the clouds on their environment are studied. We explore both the cloud and the cloud field scales, using single cloud and LES numerical simulations. We show how changes in cloud's processes are manifested in the cloud field's properties and vice versa. For a given thermodynamic conditions, an increase in aerosol concentrations leads to a competition between processes that amplify clouds development versus those that suppress it. Specifically, the invigorating processes include an increase in the condensation efficiency, a longer condensational growth and better mobility of the condensate allowing the liquid water to move higher in the atmosphere. On the other hand, the suppressing processes include stronger mixing with the surrounding sub-saturated air and larger water loading. This competition dictates an optimal aerosol concentration for which key macrophysical properties reach their maximal values. This optimal aerosol concentration depends on the thermodynamic conditions such that deeper clouds would have larger optimum.
The coupling between the clouds and the field's thermodynamic conditions adds another layer of complexity. Under polluted conditions rain suppression acts to increase the atmospheric instability whereas cloud and rain forming in clean conditions tend to stabilize the lower atmosphere. The time evolution and the interaction between competing processes in the cloud and in the field scales will be discussed.