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Evidence for buffering of aerosol influences on trade cumulus cloud fields

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Vivid examples of aerosol influences on clouds are often provided as an illustration of their importance. A common example is the transition from closed to open-cellular convection that sometimes ensues when drizzle is prevalent in the marine boundary layer. The case of little-to-no influence of aerosol on clouds is less compelling, but no less interesting given the multitude of process interactions that conspire to yield this null result. In the current work we explore the influence of aerosol on shallow convective trade cumulus clouds for the Rain in Cumulus over Ocean (RICO) case study, using a numerical model that captures large eddies but also allows for mesoscale interactions. The simulations are of order 30 h to allow sufficient time for the aerosol perturbations to manifest themselves. We show that the aerosol initiates changes to the rate at which instability is developed in the trade-cumulus system. The response of the cloud-system is such that the instabilities are in-turn consumed at different rates. The net result is that after $\sim$ 20 h, many of the perturbed and unperturbed cloud fields converge to very similar states. One exception, however, is the precipitation field: aerosol-perturbed conditions suppress precipitation, which suggests that any aerosol-related deepening of clouds is insufficient to overcome the suppression of collision-coalescence. The talk will explore the mechanisms that lead to this convergence of the cloud fields and discuss timescales for equilibration, duration of aerosol perturbation, robustness, and generality of results. Finally, it will place these results, as well as the counter example of a strong aerosol influence in the context of resilience of dynamical systems.