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# An attempt to quantify aerosol-cloud effects in fields of precipitating trade wind cumuli

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Aerosol indirect effects are notoriously difficult to understand and quantify. Using large-eddy simulations (LES) we attempt to quantify the impact of aerosols on the albedo and the precipitation formation in trade wind cumulus clouds. Having performed a set of large-domain Giga-LES runs we are able to capture the mesoscale self-organization of the cloud field. Our simulations show that self-organization is intrinsically tied to precipitation formation in this cloud regime making previous studies that did not consider cloud organization questionable. We find that aerosols, here modeled just as a perturbation in cloud droplet number concentration, have a significant impact on the transient behavior, i.e. how fast rain is formed and self-organization of the cloud field takes place. Though, for longer integration times, all simulations approach the same radiative-convective equilibrium and aerosol effects become small. The sensitivity to aerosols becomes even smaller when we include explicit cloud-radiation interaction as this leads to a much faster and more vigorous response of the cloud layer. Overall we find that aerosol-cloud interactions, like cloud lifetime effects etc., are small or even negative when the cloud field is close to equilibrium. Consequently, the Twomey effect does already provide an upper bound on the albedo effects of aerosol perturbations. Our analysis also highlights that current parameterizations that predict only the grid-box mean of the cloud field and do not take into account cloud organization are not able to describe aerosol indirect effects correctly, but overestimate them due to that lack of cloud dynamical and mesoscale buffering.