# Comparison of a global-climate model to a cloud-system resolving model for the long-term response of thin stratocumulus clouds to preindustrial and present-day aerosol conditions

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The response of a case of thin, warm marine-boundary-layer (MBL) clouds to preindustrial (PI) and present-day (PD) conditions is simulated by a cloud-system resolving model (CSRM). Here, both the aerosol conditions and environmental conditions match those of a general circulation model (GCM). The environmental conditions are characterized by the initial condition and the large-scale forcings of humidity and temperature, as well as the surface fluxes. The response of the CSRM is compared to that simulated by the GCM.

The percentage increase of liquid-water path (LWP) due to a change from the PI to PD conditions is ~3 times larger in the CSRM than that in the GCM due to the formation of cumulus clouds. The formation of cumulus clouds is controlled by a larger increase in the surface latent-heat (LH) flux in the PD environment than in the PI environment rather than by the change in aerosols. However, the aerosol increase from the PI to PD level determines the LWP response in the stratocumulus clouds, while the impacts of changes in environmental conditions are negligible for stratocumulus clouds. The conversion of cloud liquid to rain through autoconversion and accretion plays a negligible role in the CSRM in the response to aerosols, whereas it plays a role that is as important as condensation in the GCM. Also, it is notable that the explicit simulation of microphysics in the CSRM leads to a smaller LWP in the CSRM than that in the GCM using heavily parameterized microphysics for stratocumulus clouds. The smaller LWP in the CSRM is closer to an observed LWP than the LWP in the GCM for stratocumulus clouds.

Supplementary simulations show that increasing aerosols increase the sensitivity of the cloud responses to the PI and PD environmental conditions. They also show that aerosol effects on clouds depend on the cloud type. The LWP of warm cumulus clouds is more sensitive to aerosols than that of stratocumulus clouds.

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