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Supplement of

The diurnal susceptibility of subtropical clouds to aerosols

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The Diurnal Susceptibility of Subtropical Clouds to Aerosols

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Surface fluxes of latent and sensible heat

Figure 1 presents time series of the surface latent heat flux for the pristine (red) and polluted (blue) cases, along with results from the sensitivity experiments. Differences begin to emerge after day 1, remaining consistently larger during the daytime and more similar at night. The main point is that although the moisture supply increases in the polluted case, the overall impact is relatively small: the 6-day averages are 137 W/m^2 and 145 W/m^2 for the pristine and polluted cases, respectively. All other sensitivity experiments fall within this range.

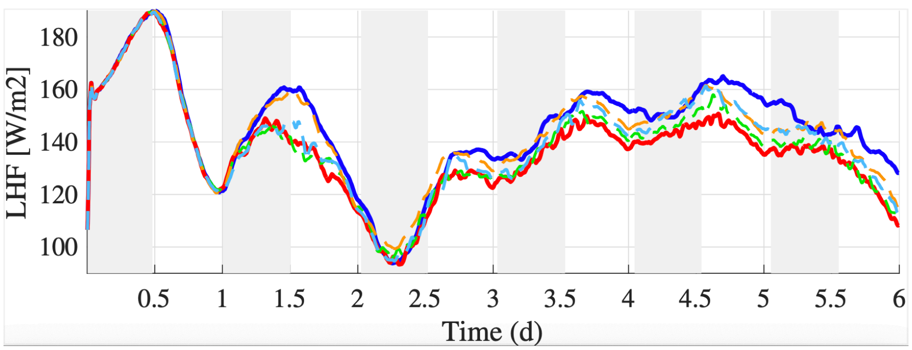

Fig. S1. Time series of surface latent heat flux for the sensitivity experiments.

The surface sensible heat fluxes are generally an order of magnitude smaller than the latent heat fluxes (Fig. 2). Although the relative differences between simulations are larger than for latent heat flux, the absolute changes are smaller—about 8–10 W/m^2. The 6-day averages for the pristine and polluted cases are 14 W/m^2 and 8 W/m^2, respectively.

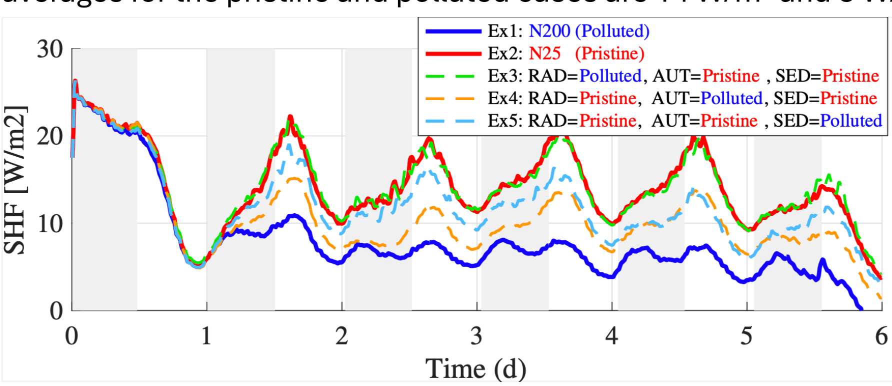

Fig. S2. Time series of surface sensible heat flux for the sensitivity experiments.

Impact of rain evaporation on LWP, turbulence, and PBL growth

For the most precipitating case, the sensitivity experiment with rain evaporation disabled is shown in Figs. 3, 4, and 5. While the surface moisture supply remains comparable with and without rain evaporation (Fig. 3; left), the impact of this process is non-negligible for both the amount of available—and thus condensed—water in the cloud layer (Fig. 4), and its subsequent evolution through interactions with turbulence and radiation (Fig. 5). Overall, rain evaporation plays an important role in maintaining higher LWP, which in turn leads to stronger PBL growth, i.e., larger entrainment, at night. Notably, the largest differences in entrainment rate occur at night, when longwave cooling strongly interacts with the cloud structure—either rapidly deepening the PBL (if sufficient cloud condensate is present) or doing so more slowly (when condensate is reduced). During the daytime, these differences tend to be smaller and the two simulations converge to each other.

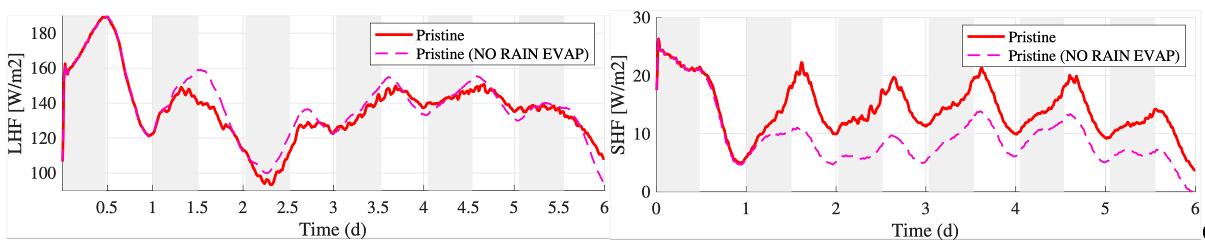

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Fig. S3. Time series of surface (left) latent and (right) sensible heat fluxes for the pristine case with and without rain evaporation.

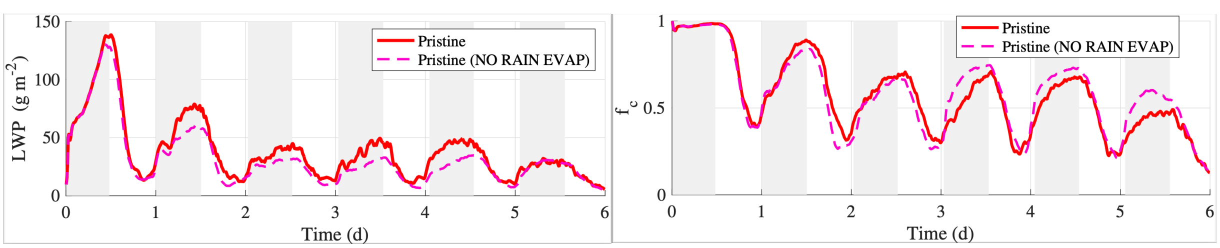

Fig. S4. Time series of (left) LWP and (right) cloud fraction for the pristine case with and without rain evaporation.

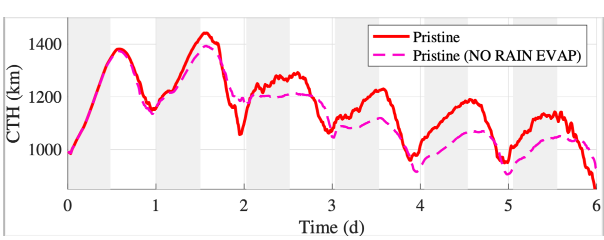

Fig. S5. Time series of cloud top height for the pristine case, with and without rain evaporation. Differences primarily develop at night, when cloud-top entrainment driven by longwave cooling is strongest, with a tendency to converge by the end of the daytime period.

Finally, Fig. 6 illustrates the relationship between surface buoyancy flux and cloud-layer TKE. In general, both weaker precipitation (in the polluted case) and the absence of rain evaporation have a similar effect on sub-cloud temperature: they suppress atmospheric cooling, which reduces the air–ocean temperature contrast and lowers the buoyancy flux. However, reduced buoyancy flux does not directly lead to lower TKE in the cloud layer. In fact, TKE is higher at night in the polluted and no-rain-evaporation cases, suggesting that longwave radiative cooling is the primary source of TKE, at least in the simulated scenario.

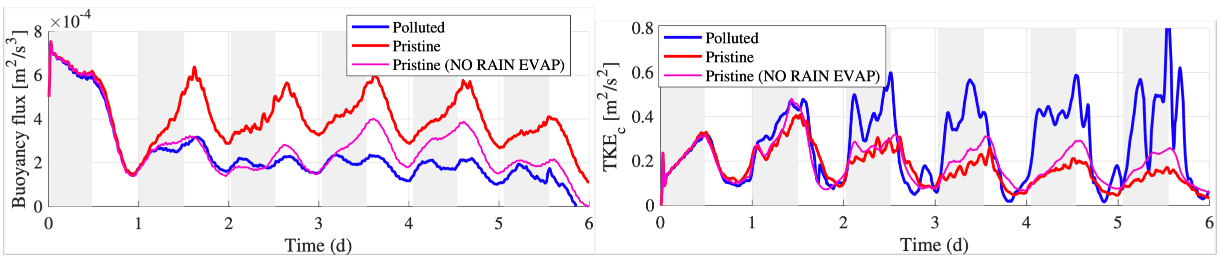

Fig. S6. Time series of (left) surface buoyancy flux and (right) mean cloud-layer TKE for the polluted and pristine cases. The pristine case with rain evaporation disabled is also included (magenta).