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Mass flux estimates and their relationship to cloud-base cloudiness during the EUREC4A campaign

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The trade-cumulus cloud feedback in climate models is mostly driven by changes in cloud-base cloudiness, which can largely be attributed to model differences in the strength of lower-tropospheric mixing. Using observations from the recent EUREC^{4}A field campaign, we test the hypothesis that enhanced lower-tropospheric mixing dries the lower cloud layer and reduces near-base cloudiness. The convective mass flux at cloud base is used as a proxy for the strength of convective mixing and is estimated as the residual of the subcloud layer mass budget, which is derived from dropsondes intensively launched along a circle of ~200 km diameter. The cloud-base cloud fraction is measured with horizontally-pointing lidar and radar from an aircraft flying near cloud base within the circle area. Additional airborne, ground- and ship-based radar, lidar and in-situ measurements are used to estimate the total cloud cover, the surface fluxes and to validate the consistency of the approach.

Preliminary mass flux estimates have reasonable mean values of about 15 mm/s. 3- circle (i.e. 3h) averaged estimates range between 0-40 mm/s and reveal substantial day-to-day and daily variability. The day-to-day variability in the mass flux is mostly due to variability in the mesoscale vertical velocity, whereas the entrainment rate mostly explains variability on the daily timescale, consistent with previous large-eddy simulations. We find the mass flux to be positively correlated to both the cloud-base cloud fraction and the total cloud cover (R=0.55 and R~0.4, respectively). Other indicators of lower-tropospheric mixing due to convection and mesoscale circulations also suggest positive relationships between mixing and cloudiness. Implications of these analyses for testing the hypothesized mechanism of positive trade-cumulus cloud feedback will be discussed.