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Investigating extreme precipitations in tropical squall lines

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Squall lines are the consequence of the interaction of low-level shear with cold pools associated with convective downdrafts, and beyond a critical shear, squall lines tend to orient themselves. It has been shown that this orientation has the effect of reducing the incoming wind shear to the squall line and maintains equilibrium between wind shear and cold pool spreading (Abramian et al 2021).
While the mechanisms behind squall line orientation seem to be increasingly well understood, few studies have focused on the implications of this organization. However, Roca & Fiolleau 2020 shows that mesoscale convective systems, including squall lines, are disproportionately involved in rainfall extremes in the tropics. One may then question whether the orientation of squall lines has an impact on the rainfall extremes, and if so, then how and why.
Using a CRM, we perform simulations of tropical squall lines by imposing a vertical wind shear in radiative convective equilibrium. Our results show that the extreme precipitation in the squall lines is more intense in the critical organized case. With a scaling of the precipitation extremes (Muller & Takayabu 2019, Da Silva et al 2021), we show that the condensation rates control the precipitation extremes in tropical squall lines. It seems that the critical case is also optimal for the vertical dynamics, a hypothesis that we further investigate here.

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