Supporting Information for "How moisture shapes low-level radiative cooling in regimes of shallow cloud organization"

B. Fildier[1] *, C. Muller[1,2], R. Pincus[3], and S. Fueglistaler[4]

[1]Laboratoire de Météorologie Dynamique (LMD)/Institut Pierre Simon Laplace (IPSL), École Normale Supérieure, Paris Sciences & Lettres (PSL) Research University, Sorbonne Université, École Polytechnique, CNRS, F-75005 Paris, France

[2]Institute for Science and Technology, Vienna, Austria

[3]Lamont-Doherty Earth Observatory, Palisades, New York, USA

[4]Geosciences Department, Princeton University, Princeton, New Jersey, USA

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1. Figures S1 to S5

References

Bony, S., Schulz, H., Vial, J., & Stevens, B. (2020, jan). Sugar, Gravel, Fish, and Flowers: Dependence of Mesoscale Patterns of Trade-Wind Clouds on Environmental Conditions. *Geophysical Research Letters*, *47*(7). doi: 10.1029/2019gl085988

George, G., Stevens, B., Bony, S., Pincus, R., Fairall, C., Schulz, H., ... Radtke, J. (2021). Joanne: Joint dropsonde observations of the atmosphere in tropical north atlantic meso-scale environments. *Earth System Science Data*, *13*(11), 5253–5272. doi: 10.5194/essd-13-5253-2021

Schulz, H. (2022). C^{3}ontext: a common consensus on convective organization during the eurec^{4}a experiment. *Earth System Science Data*, *14*(3), 1233–1256. doi: 10.5194/essd-14-1233-2022

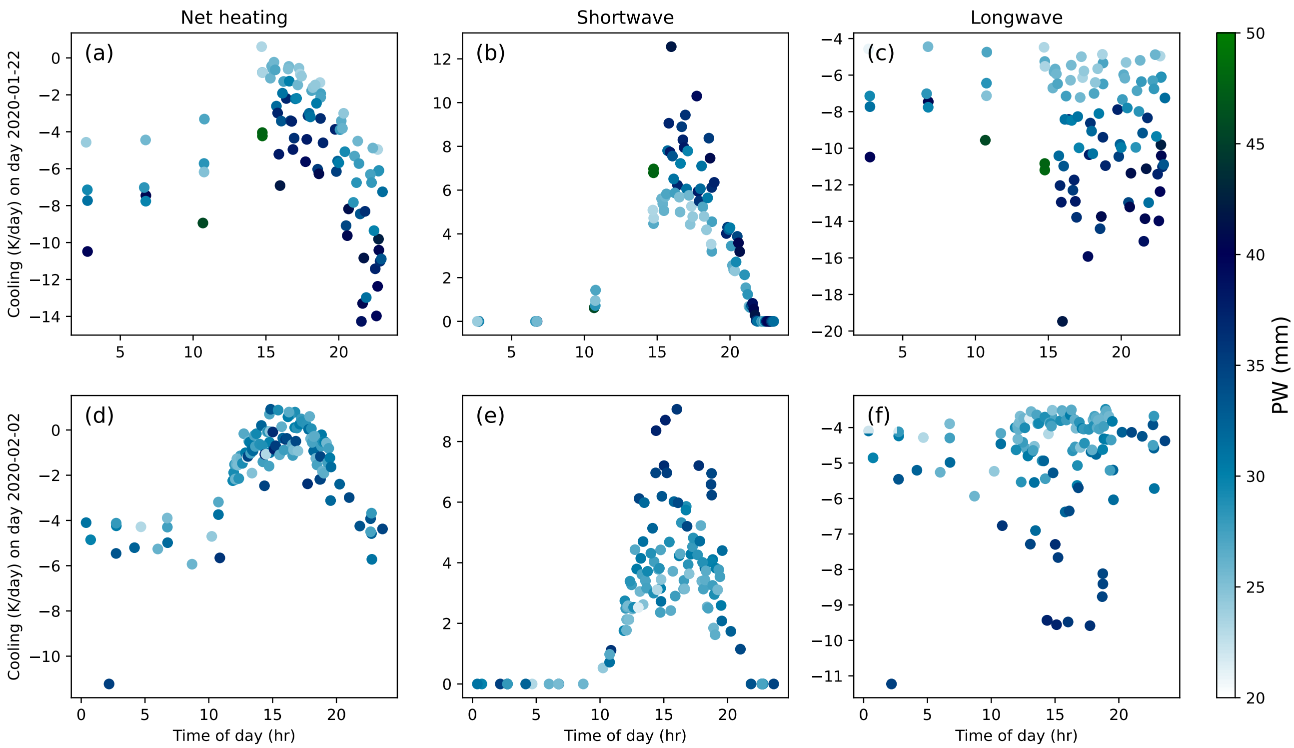

Figure S1. Decomposition of net radiative cooling at the height of the longwave peak (a,d) into shortwave (b,e) and longwave components (c,f), for days 2020-01-22 (example of Fish, a-c) and 2020-02-02 (example of Flower, d-f), colored by column precipitable water. The shortwave components captures most of the diurnal cycle so that only the dependence on PW remains for the longwave component.

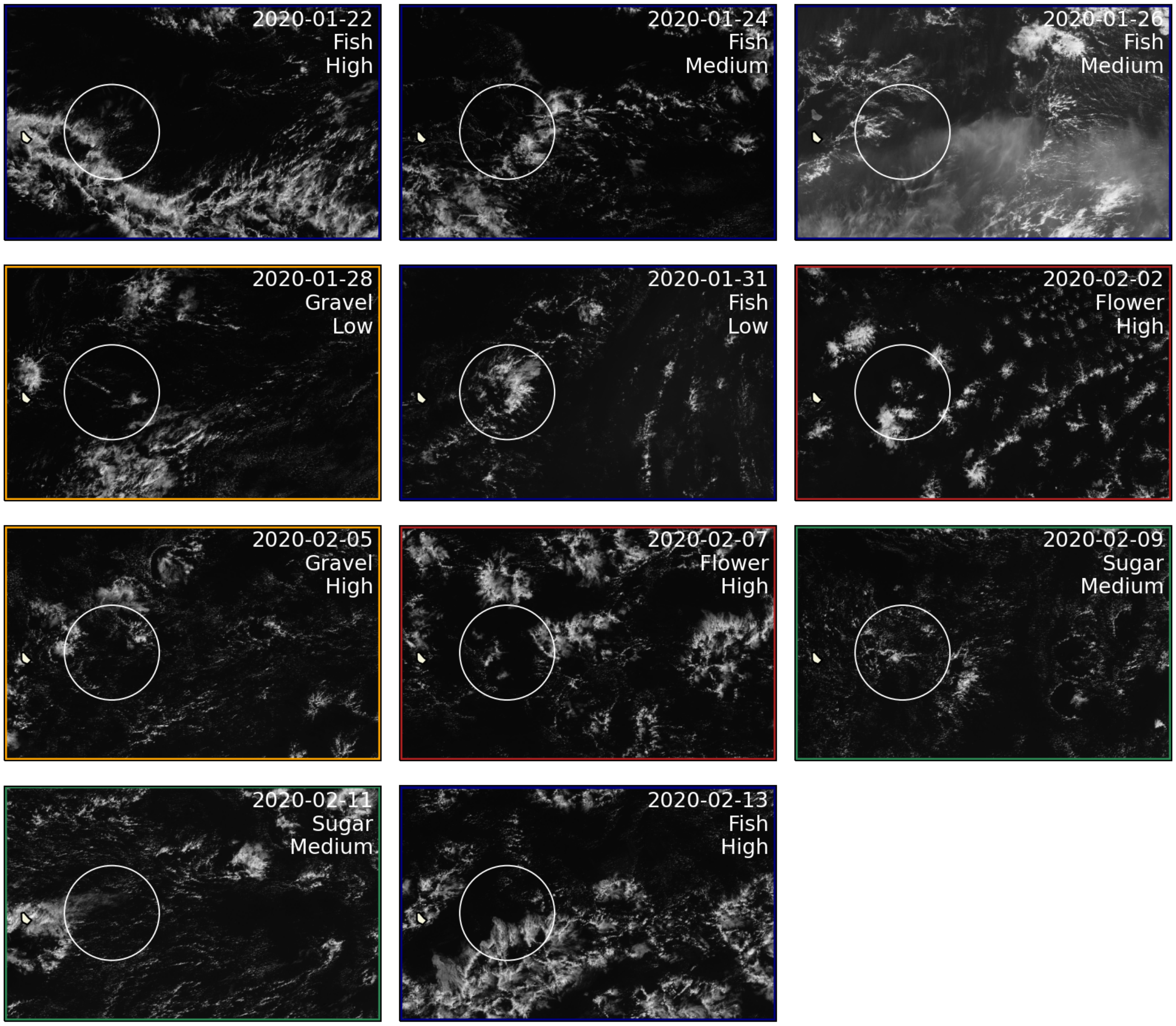

Figure S2. Manual classification of scenes of shallow organization as Fish (blue frames), Flower (red), Gravel (yellow) and Sugar (green) patterns (Bony et al., 2020). Categories are assigned to each scene, in agreement with a classification previously made on a larger domain as a reference (Schulz, 2022), but adapted by eye for our domain of interest (60W-52W, 10N-16N, centered on the circle followed by the HALO aircraft). On 2020-01-26, the image contrast was enhanced to better highlight the pattern, which revealed an upper thin cirrus in this case, but not counted as cloud fraction and ignored from the analysis. Text indicates the day, pattern and confidence level for attributing each label.

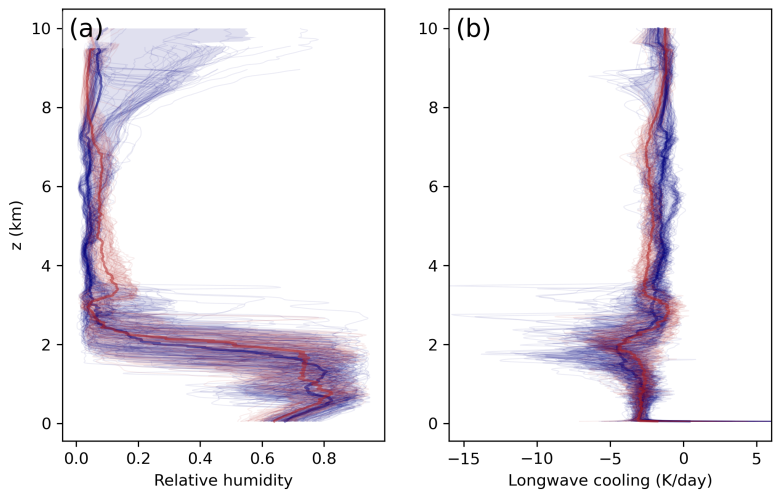

Figure S3. Comparison of relative humidity and longwave radiative cooling profiles for Fish (blue) and Flower (red) patterns in cloud-free environments as indicated in Figure 3f (solid dots). The Fish pattern is associated with a drier free troposphere, so lower layers can cool more efficiently to space. Both patterns show a rapid transition from the surface moist layer to the upper drier layer.

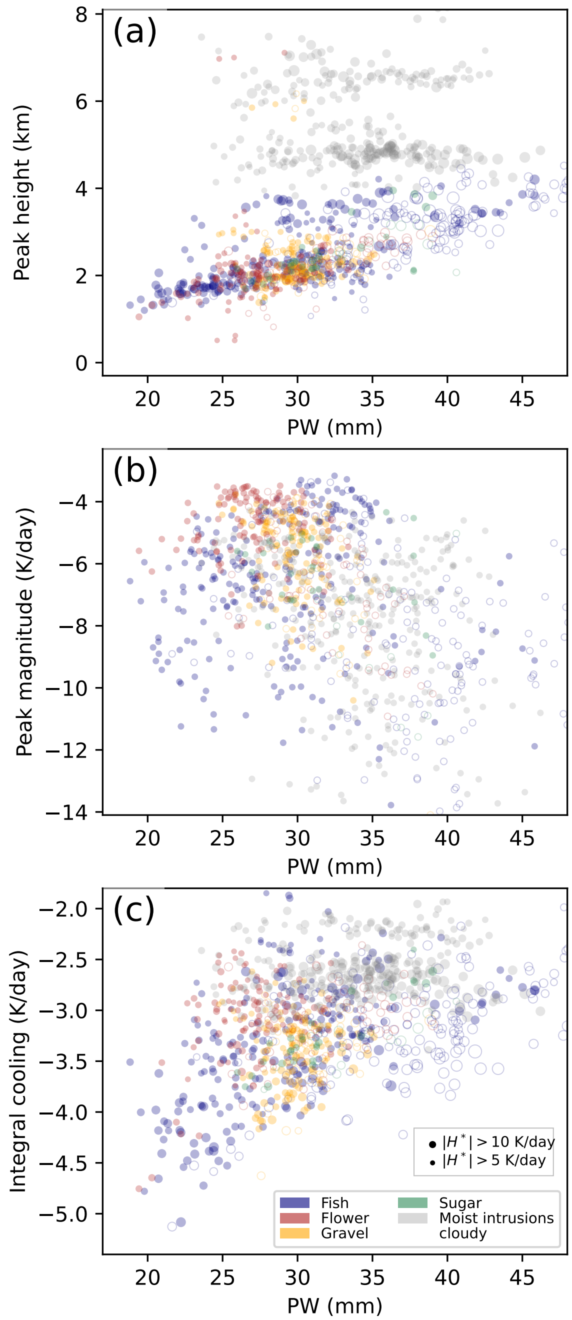

Figure S4. Height (a), magnitude (b) and boundary layer integral (c) of low-level longwave cooling peaks vs. column precipitation water. On all panels, colors indicate by organization pattern, open circles show soundings possibly falling through clouds (containing a level exceeding 95% relative humidity, following (George et al., 2021)). On panels (a) and (c), circle size indicate longwave cooling peak magnitude. Notably, Fish patterns show the largest clear-sky radiative cooling in cloud-free regions.

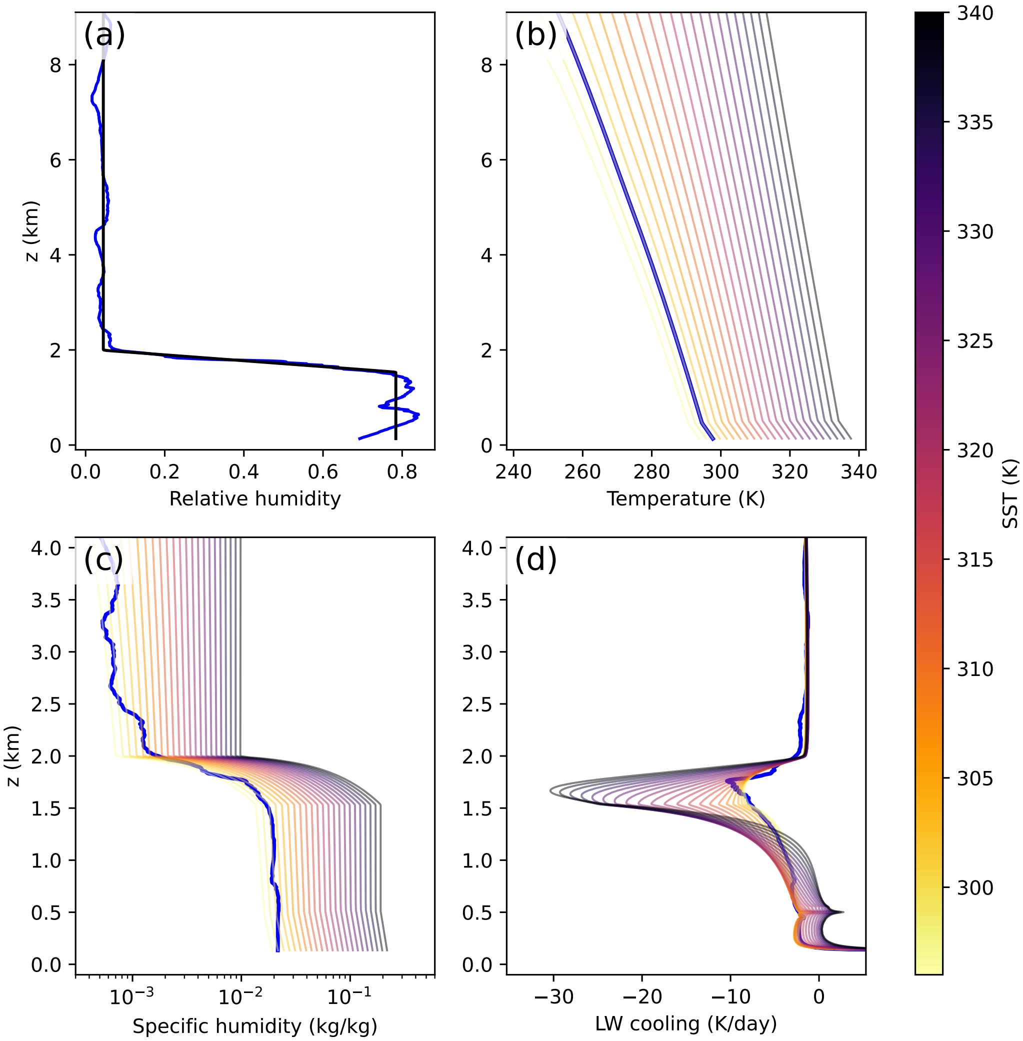

Figure S5. Amplification of low-level radiative cooling with warming, calculated from RRT-MGP with moist-adiabatic lapse rates between 296K and 340K. The reference relative humidity profile is the median profile from January 26, 2020 (Fish day, in blue, also see Fig. 1 in main text), fitted as piecewise linear and used for all calculations. Note that the vertical transition from moist to dry is gradual, which slightly reduces the magnitude of radiative cooling peaks. Warming makes the free-troposphere and lower layers moister, but at fixed relative humidity, the Planck term induces an amplification of radiative cooling at the top of the moist layer with increasing temperatures.