Review of manuscript titled: “Effect of vertical wind shear on convective clouds: development, organization, and turbulence.”
Authors: G. Bidou, D. Ricard, and C. Lac

General comments:

In this study, a suite of 10 large eddy simulations was performed to explore the sensitivity of vertical wind shear on deep convection evolution. The results are generally consistent with our previous understanding of shear-convection interactions in strongly sheared flows: increased precipitation, larger and fewer cold pools/updrafts, and higher cloud tops through decreased fractional entrainment. While I have no issue with reaffirming the findings of previous studies, it would be nice to have the authors highlight what they believe are novel contributions from this study. In my mind, the main contribution of this paper is the TKE analysis, which I find intriguing for a plethora of reasons. The authors find that up-shear TKE is larger than down-shear TKE, which contrasts with much of the existing literature on shear flow interactions/wake turbulence. Furthermore, I find it surprising that the up/down-shear TKE asymmetry is self-similar, even when transitioning from multicell to supercell modes. I believe there should be some effort to explain “why” the TKE differences exist. This could be done through an analysis of the TKE or vorticity budgets and I believe it would vastly improve the the potential impact of the current study. It would also be beneficial to see cross-sections or cloud-edge composites of the TKE to get a better idea for how the TKE varies spatially, since much of the useful information may be lost in the averaging process.

Minor comments:

Lines 24-25: *“On the other hand, bending thermals may help trigger and organize deep convection”*… This comment requires a citation or at least some explanation of the physical reasoning behind the idea.

Lines 25-26: *“Helfer et al. (2020) shows that both mechanisms operate: shear delays the rise of hot air via thermals and weakens wind velocities, yet remains a necessary condition for sustained deep convection.”*… It would be nice to add an explanation/discussion for why shear delays the rise of hot air via thermals and weakens wind velocities. Some literature review of thermal force balance is required.

Lines 30-31: *“Bending of thermals horizontally may separate the heat source and the updraft core from precipitation resulting from the convection of moist air, preventing cooling of both the heat source and the updraft.”*… This is a bit hard to follow. This is explaining the shear-driven tilted updraft that allows for the hydrometeors to not fall directly through the parent updraft, but outside of it, correct?

Lines 31-33: It should be mentioned that Helfer et al. (2020) and Helfer and Nuijens (2021) both examine the impacts of vertical wind shear on shallow convection.

Lines 36-37: *"Entrainment itself is strongly modified under shear : thermals under strong shear conditions entrain environmental air in peculiar ways (LeBel and Markowski, 2023), and convective systems under shear entrain more than their non-sheared counterparts."*...This statement is very vague and latter part of the sentence requires a citation.

Lines 38-41: I'm unsure of how this excerpt fits in with the broader discussion. Seems to be misplaced.

Lines 61-62: *"As a result, the domain experiences a gradual increase in total energy because surface heating is included but radiative cooling is not. As such, it limits the total simulation time before becoming unrealistic."*... How do you determine the time window for which the simulation remains "realistic"?

Lines 73-75: Doesn't the white noise method also introduce a characteristic scale (it is grid scale noise)?

Line 149-150: I'm not sure that I fully agree with this statement. This would only be true if entrainment was the only other term in the vertical momentum equation, but as we know, the pressure perturbation dynamics play a major role. In supercells, the upward-directed pressure gradient driven by rotational dynamics cannot be neglected as it is a significant source of vertical momentum. Using the same concept, an overshooting top would imply net detrainment over the course of the parcel's life (not impossible, but something to consider).

Line 156: correct to bulk-plume

Line 156: "we derive fractional entrainment rates…" … The fractional entrainment rates will not tell you all that much about the actual fluid flow through the cloud interface, given the assumption that you are entraining the mean environmental air. Also, it is mentioned elsewhere in the paper that the convection nearly fills the domain rather quickly and in that case you cannot cleanly partition the "environment".

Line 159: smoothen —-> smooth

Line 184: asymetry —-> asymmetry

Lines 191-196: Maybe this is already what is being referred to, but the increased TKE could also be associated with the thermals interacting with the mean flow, acting as obstacles, although this can also produce wake turbulence on the down-shear side (Malkus, 1949; Heymsfield et al., 1979; Kingsmill and Wakimoto, 1991; McMichael et al., 2022; LeBel and Markowski, 2023). Interestingly, in shallow convection studies, the TKE enhancement is seen on the down-shear side (Gu et al., 2021; McMichael et al., 2022), with organized entrainment occurring on the up-shear side (McMichael et al., 2022). It's possible that the wake-related TKE enhancement on the down-shear side is outside of the plume core examined in the paper. It also seems conceivable that the much larger shear magnitudes in deep convection are creating more pronounced obstacle effects, especially on the up-shear side in supercells. Or perhaps, there are some vorticity processes (stretching/tilting) related to the mesocyclone.

Line 229: "*verifying this requires to quantify objectively this organization*"… I suggest a rewording.

Line 242: The four indicators need to at least be briefly described within the paper, as they are not overly common indicators.

Line 247: Tendencies appear on these graphs. —> Needs a figure reference.

Line 270-271: It is also consistent with increased upward-directed pressure perturbation gradient force driven by the rotating updraft. It would be nice to see some vertical momentum budgets to quantify some of these qualitative statements.

Line 287: kinetical —> kinetic

Minor aesthetic point: Figures 4, 8, 9, 13 seem to have lower image quality than the other figures.

References:

Gu, J.-F., Plant, R.S., Holloway, C.E. & Jones, T.R., 2021: Composited structure of non-precipitating shallow cumulus clouds. *Q J R Meteorol Soc*, 147: 2818–2833, https://doi.org/10.1002/qj.4101.

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Kingsmill, D. E., and R. M. Wakimoto, 1991: Kinematic, Dynamic, and Thermodynamic Analysis of a Weakly Sheared Severe Thunderstorm over Northern Alabama. *Mon. Wea. Rev.*, 119, 262–297, https://doi.org/10.1175/1520-0493(1991)119<0262:KDATAO>2.0.CO;2.

Malkus, J. S., 1949: Effects of wind shear on some aspects of convection. Eos, Trans. Amer. Geophys. Union, 30, 19–25, https://doi.org/10.1029/TR030i001p00019.

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