



EGUsphere, referee comment RC2  
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## Comment on egusphere-2022-515

Anonymous Referee #2

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Referee comment on "Evolution of squall line variability and error growth in an ensemble of large eddy simulations" by Edward Groot and Holger Tost, EGUsphere,  
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Review of "Evolution of squall line variability and error growth in an ensemble of LES" by Edward Groot and Holger Tost

The study investigates the evolution of an ensemble of simulated squall lines. The simulations are performed with a comparatively fine computational mesh, and an ensemble consisting of 10 members is run. The characteristics of the simulated squall lines are discussed, and the evolution of the spread of the ensemble is investigated. Thereby, the focus is on points of the simulation, that are decisive for the generation of spread between individual members. The points in time when the convection starts to interact with itself through cold-pool dynamics and gravity waves turn out to be the points where the distance between ensemble members increases most. It is very nice to see simulations performed at such a high resolution, and very good to see that an ensemble was run. Yet, I do have some questions on the setup of the model. The quality of the manuscript is good, the text is well-written, but tends to be lengthy, descriptive and repetitive in some parts, with important information lacking at other instances. In these parts a short but concise statement on essential information to reproduce the study is needed. Overall, I suggest major revisions before the paper can be published.

### Major Comments:

- vertical grid spacing: while the authors invest a lot of computational resources into running an ensemble at a high horizontal resolution, the vertical grid spacing is relatively poor. The equidistant spacing of 100 m in the vertical is in my view inadequate to resolve the cold-pool dynamics and maybe also the melting layer properly. Especially as the cold pool plays a vital role for the further spread between ensemble members, a fine grid seems to be critical to resolve differences in the evolution of the cold pool, its interaction with the flow and the feedback onto the squall line dynamics. I suggest to rerun the control simulation with a vertically stretched grid and to document the differences in cold-pool dynamics with the equidistant grid.

- Please provide more information about the employed tracers, for example as a further subsection in section 2. How are they transported by the flow, in which way is the coupling to microphysics (sedimentation) and turbulence realized, what is the treatment of the tracers in the surface layer? The last point may be especially important as the lowest atmospheric layer is very deep, and without a careful treatment tracers may be stuck in the surface layer.
- The Weisman and Klemp (1982) sounding is established and popular. Yet, it has been criticized for being very unstable and favourable for convection. For the case at hand this means that in all ensemble members a squall line develops. A profile that is less favourable for convective development the ensemble spread may be much larger, as some members may not be able to produce a vivid squall line.
- The reference simulation appears at one end of the spectrum, while I would have expected it somewhere in the middle of the ensemble. Do you have an explanation for this behaviour?

### **Minor Comments:**

- subsection 2.1: please give more details about the formulation of microphysics, especially the treatment of the condensation process (via saturation adjustment ? ) and the evaporation process, as they will be crucial for the development of up- and downdrafts and thereby ensemble spread.
- Please provide more information on the perturbation of the initial conditions, especially on the perturbation of  $z_i$ . In which way is the perturbation of  $z_i$  transferred to the atmospheric profile.
- The top of the model domain is at 20 km, with a sponge extending down to 15 km. Taking a look at e.g. Figure 8 some of the convection seems to interact with the sponge already. Did you see any signals of interaction of the convection with the sponge?
- Figure 1: Please specify the computation of the parcel ascent. The red line seems to start at some elevated point. Please also remove the "(left)" statement.
- Section 3.1: please provide some detail about the computation of the radar reflectivity
- section 3.3.1: there is some directional shear in the simulations given by the increasing  $v$  velocity component. The averaging over the  $y$  direction ignores this directional shear. In which way did you account for this?
- Section 3.3.2: please give more detail on the ensemble sensitivity analysis. The section is impossible to understand without first taking a look into the cited papers. The 4th and 5th paragraph of the subsection is hard to follow, there is no figure supporting the statement "during the first 15 minutes of simulation time ..." and "After 15-20 minutes"
- Section 3.3.3 downdraft selection: by selecting only grid points that contain hydrometeors, the downdrafts where all rain has been evaporated will be disregarded. A better choice could be to increase the magnitude and/or to check for hydrometeors above.
- Line 461-467: I cannot follow the argumentation here. Judging from Figure 10 the downdraft mass flux at a height of  $\sim 1.5\text{-}2\text{km}$  seems to show the largest variability. Please be more specific or rephrase.
- Line 590-593: I disagree with this statement. Downdrafts will carve their space, irrespective if there is space available or not, thereby killing updrafts.

### **Technical Points:**

- please add labels to figure panels for better readability
- Line 9: insert "of" after "amount"
- Line 37: "can be" □ has been
- Line 68: "of error" □ "the error"
- Line 100: "an comprehensive" □ "a comprehensive"
- Line 165: insert "km" after "40"
- Figure 3: the units at the lower right corner of the figure are very hard to read, please also repeat in the figure caption
- Line 270: I do not understand the statement "so the upward transport of mid-level entrainment...". Did you mean the upward transport of diluted air masses that have undergone entrainment processes before ?
- caption Figure 4: insert "of" before "a new line"
- caption Figure 5: "salmon color": I interpret this as white ?
- Line 295: insert comma after "first"
- Line 312: insert a space between the full-stop after "LFC"
- Line 370: insert "the" before "y-averaged" and "x-z plane"
- Line 392: unit "km" should be text font.
- Line 420: "similar" □ "similarly"
- Line 471: remove parenthesis
- Line 509: insert "in" after "differences"
- Line 632: something is missing here
- Line 729: "which is varies" □ "which is varied" or "which varies"