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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Size-dependence in chord characteristics from simulated and observed continental shallow cumulus" *by* Philipp J. Griewank et al.

Anonymous Referee #1

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This study focuses on the properties of vertical velocity and moisture anomaly fields around shallow cumulus clouds based on large-eddy simulations and long-term lidar observations. Doppler and Raman lidars from 28 LASSO days are used to obtain the chord properties (including duration, length, and height) as well as vertical velocity and water vapor mixing ratio below the chord. The observed statistical properties of cloud chords are compared with modeling results of 1D column output and 3D snapshot based on MicroHH, in which the large-eddy simulations are applied to run all 28 cumulus days using LASSO forcing data. The motivation of this study is to determine how the amplitude and shape of the vertical velocity and moisture anomaly fields of cumulus clouds change with size and to determine if the LES simulations provide a reliable

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approximation of shallow cumulus cloud statistics. Differences and similarities among lidar observations, cloud chords from 1D column and 3D snapshot are discussed thoroughly in the manuscript. A scaling of vertical velocity and moisture anomalies below the cloud chords with chord size has been found. In summary, the merit of this study is the analysis of cloud chord properties based on a large amount of observational and modeling results. However, some conclusions should be clarified/justified. Besides, grammar and spelling should be improved. My major and technical comments are listed below and should be addressed properly before the manuscript is suitable for publication in ACP.

1. Page 5, Lines 18-20 and Figure 2: Explain the reason why there are lots of cases with the cloud fraction of 0 from MicroHH. The cloud fraction from MicroHH is the mean cloud fraction from the whole field or from 15-minute windows from one point or multiple points? It is not clear to me how to get the conclusions that "with no clear temporal evolution visible" and "This strong scattering is not evident in the model simulations". Where is the "temporal information" in Figure 2? All data are scattered in my point of view. It is hard to tell whether "this strong scattering is not evident in the model simulations".

2. Page 6, Line 9 and Figure 5c: "this is at least partially due to the model spin up causing the simulated clouds to appear roughly 2 hours later than in the observations." If this is true, how to explain the results in Figure 5c in which the distributions of when during the day the chords were detected show no marked shift.

3. Page 8, Line 15: "we use the LCL". Use the LCL for what? To choose cloudy cells that are no more than 300 m higher than LCL? Please also describe how to calculate LCL in this study.

4. section 3.1: At the beginning of this section "The 1D column outputs is created by outputting the model state in specific columns of the model grid at each timestep." It reads like this subsection only focuses on modeling criteria. However, the second

paragraph focuses on the observational criteria. “we use a mix of the vertical velocity variance and the lifting condensation level” is the criteria for cloud chord detected from observation? Consider modifying the title and content in section 3.1 to make sure they are consistent and easy to read.

5. Page 10, Line 16 and Figures 9&10: “merging them together”. All cloud chords are binned in three categories in Figures 9 and 10: 250-750 m, 750-1500 m, 1500-2500/3000 m. The x coordinate is the length of the chord. I understand the “merging” in y coordinate is by normalization, however, It is not clear to me how to merge them together in x coordinate if they have different chord lengths in each category.

6. Page 16, Line 6 and Figures 9&10: Clearly describe the method to choose the box in text, especially the four boundaries.

Technical comments:

1. Page 1, Line 14: “aspects” -> “aspect”
2. Page 1, Line 21: not a complete sentence.
3. Page 2, Line 2: “then” -> “than”
4. Page 3, Line 8: “provide” -> “provides”
5. Page 4, Line 27: “and are run using. . .” check grammar
6. Page 5, Line 1: “25.6 km2” -> “25.6 x 25.6 km^2”
7. Page 5, Line 2: “15 0m” -> “150 m”
8. Page 5, Line 20: “km” -> “km^2”
9. Page 6, Line 11: This paragraph has only one sentence.
10. Page 8, Line 8: “10-6” -> “10^{-6}”
11. Page 8, Line 12: “available” -> “unavailable”?

12. Page 9, Line 7: “is” -> “are”

13. Page 10, Line 10: “are confident that the various other differences in methodology between the how 1D and 3D chords are detected have a far greater effect.” Check grammar.

14. Page 14, Line 14: “the the” -> “the”

15. Page 16, Line 11: “For example if the cloud base determined by the lidar were 100 m too low the vertical velocity determined would be higher.” This sentence is not clear to me.

16. Page 19, Line 5: “have have” -> “have”

17. Page 19, Line 14: “at the how far. . .” -> “at how far”

18. Page 20, Line 13: “chords chords” -> “cloud chords”

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