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Geoscientific Model Development Discussions

Interactive comment on "Introducing UCLALES-SALSA: a large-eddy model with interactive sectional microphysics for aerosols, clouds and drizzle" *by* Juha Tonttila et al.

Anonymous Referee #1

Received and published: 8 August 2016

General Comments:

This manuscript presents a new large-eddy simulation model (UCLALES-SALSA), which includes bins for aerosols, clouds and drizzle. The goal of this model development is to enable better representation of aerosol-cloud interactions, particularly cloud processing and wet scavenging of aerosols. In this study, the UCLALES-SALSA model is used to simulate a marine stratocumulus case and a nocturnal radiation fog case. The results indicate that aerosol-cloud interactions have important influences on the boundary layer dynamics. The manuscript is well written and documents scientifically interesting model developments in the complex field of aerosol-cloud interactions. The manuscript should be suitable for publication provided that the following points can be

satisfactorily addressed. My main concern is that although the simulation results are clearly presented, the manuscript lacks a developed comparison of these results with observations. Confidence in the model developments would be improved with more explicit comparison with observations. As well, there are aspects of the model parameterizations that need clearer description as outlined in the specific comments below.

Specific Comments:

1) P2, L10: To help put the present model developments in context, are you able to point out any previous LES models that have developed similar aerosol-cloud couplings? The text only mentions that such aerosol-cloud schemes are sparse.

2) P3, L19: The sub-range indices 1a and 2a do not appear on Fig. 1 (only a and b are shown, not 1 and 2). Please check this on the figure and check the later references in this paragraph to 2a and 2b. The labels 1 and 2 are confusing because they do not appear on Fig. 1.

3) P4, L3-4: One goal of this work is stated as 'to reproduce the evolution of the aerosol size distribution through cloud processing and wet scavenging by precipitation accurately'. Please consider whether the manuscript would be improved by showing aerosol size distributions. Figure 7 does show the time series of the number concentrations in each bin – would a size distribution figure for hours 0 and 8 be helpful to illustrate the changes? Also please consider showing observed size distributions to improve confidence in the simulations.

4) P4, L8: 'defined to be parallel' – the meaning of this is not quite clear – please clarify.

5) P4, L9-11: ' This way, the properties of the aerosol size distribution are preserved upon cloud droplet activation, as well as evaporation of cloud droplet, though subject to the typical uncertainties inherent in the sectional approach' – please consider rewording this sentence to clarify what is meant by 'properties'.

6) Section 2: Could equations be added to describe the key microphysical processes?

7) P5, L29: Please provide further details about the source for the coagulation kernels.

8) P5, L30-32: How is the dry size of the particle determined when the drizzle drop evaporates? Please clarify.

9) P8, L17: How do you define 'deeper and more massive shallow convection elements'?

10) P8, L32-34: In comparing the LEV3 and LEV4 simulations, it would be helpful to have a clearer description of the parameterization of drizzle formation/loss in LEV3 (the default UCLALES configuration). Perhaps this could be added earlier on in the model description.

11) Fig 4: Where is LEV3 on panel 4b?

12) P9, L33-35: How is scavenging treated in the below-cloud layers? Please consider adding this information.

13) P10 L6: 'lack of representation for aerosol scavenging' – How is aerosol scavenging represented in LEV3? Consider adding this information earlier on in the text to help the reader in understanding these comparisons between the LEV3 and LEV4 simulations.

14) P10, L11-12: 'LWP and rain water path show quite similar features as those obtained with a cloud system resolving model with interactive aerosols' – Please state these 'similar features' more explicitly.

15) Section 3.2: This section includes a detailed discussion of the simulation results for the case DYCOMS-II flight RF02, which was a marine stratocumulus case that took place off the coast of California. Would there be observations available that could be explicitly compared to the simulation output presented here?

16) P11, L22: Why was the drizzle formation switched off for this fog case?

17) P12, L19: Consider adding a table to describe the simulations A200, A400, A800 A400W.

18) P13, L4-5: 'These findings illustrate the ability of the UCLALES-SALSA to provide a realistic description of not only the thermodynamic and microphysical properties. . ..' – Please consider if this statement would be better supported by explicitly showing model-observation comparisons in the manuscript.

19) P 13, L8-9 'growth rate is considerably lower than the observed'. . .'see figure 5 in Porson et al., 2011' – are there observations that could be explicitly shown here to help the reader understand these comparisons?

20) P13, L21: 'These results point towards the importance of detailed representation of the microphysical processes.' This sentence does not appear to be finished – do you mean in cases of fog?

21) P13, L22: 'UCLALES-SALSA does well' – Are you able to quantify what is meant by 'does well'?

22) P13, L26 'UCLALES-SLASA also agrees well with observations' – again please quantify what is meant by 'agrees well' and consider showing model-observation comparisons in the manuscript.

23) P13, L30: 'a more detailed land surface scheme is needed' – did you test any limiting cases?

24) P14, L29-30 'very similar to the observations'. . .'even more resembles the observed properties' – Please consider showing these comparisons in the manuscript, likewise showing some model-observations comparisons would be helpful for understanding the model performance for the stratocumulus case.

25) P14, L29: If a realistic wind profile improved the model-measurement agreement – why was the case with winds not used as a default? Did you test A200W and A800W?

Technical Corrections

1) P2,L10: Do you mean 'of' instead of 'off'?

2) P5, L20: ‘Evolution of the drizzle droplet population’ – should this read drizzle/rain since the upper diameter limit is 2mm?

3) Fig. 3a: Should HI be removed from the legend?

4) P12, L27: Do you mean Fig 8 as opposed to Fig. 9?

5) P12, L31: Consider starting a new paragraph with the start of the Fig. 11 discussion.

6) P13, L13: Do you mean Fig. 9 as opposed to Fig. 10? There is no dashed line on Fig. 9.

7) Fig. 1: What is the meaning of the light blue arrows on the dark blue for the drizzle rain bins? What is the size range for the cloud droplets?

8) Fig 2: Could g kgˆ-1 be placed beside the color bar?

9) Fig 3: Could drizzle be added to the title of panel b? Also, please check legend for error in simulation names.

10) Fig 7: Please check units on the legend – did you mean m?

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