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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Microphysical controls on the stratocumulus topped boundary-layer structure during VOCALS-REx" *by* I. A. Boutle and S. J. Abel

Anonymous Referee #2

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The authors summarize a suite of nested mesoscale model simulations run over the southeast Pacific for a two-day period during VOCALS-Rex. In particular, the manuscript explores the behavior of boundary layer properties and precipitation outcomes for two different microphysical parameterizations. The article is interesting from a scientific perspective, and the figures are well done. Although I was generally able to follow along, the final version would benefit greatly from a careful read-through for clarity. I recommend publication, subject to my concerns being addressed.

My only concern with the methodology in the paper concerns the use of the diagnostic cloud scheme of Smith (1990). These kinds of subgrid-scale cloudiness schemes are

meant for GCMs and are rather ill-posed for grid spacings of O(1 km). Couldn't the scheme simply have been turned off for the 1-km and 4-km meshes? The authors blame various artifacts of the simulations on this scheme, and I feel the revision should address these concerns more comprehensively.

The simulations employ a mesoscale modeling approach, yet the authors cite very little of the literature on mesoscale simulations of boundary-layer clouds. They are surprisingly few in number, but here are a few off the top of my head: Wang., S, et al. 1993 JAS Mocko and Cotton 1995 JAS Mechem and Kogan 2003 MWR Bretherton et al. 2004 MWR McCaa and Bretherton 2004 MWR Ivanova and Leighton JAS 2008 Wang et al. ACP 2011

Specific comments:

P. 526, lines 23–25. This doesn't really tell the whole story. For sufficiently strong cloud-top cooling, the turbulent eddies will span the entire depth of the MBL, resulting in a coupled boundary layer.

P. 527, lines 4–5, "initiation of cumulus convection beneath the stratocumulus." Note that the cumulus rising into stratocumulus may or may not be present, and the cumulus does not simply happen but rather typically is a result of stratification from shortwave heating or the effects of drizzle.

P. 527, lines 12–14. This sentence is, for want of a better term, clunky.

P. 529, lines 10–11, "re-initialized." Is this a model update cycle, i.e., a standard data assimilation procedure at 0000 UTC, or is a complete cold starting of the model at this time (I assume the former)?

P. 529, line 19, "horizontal resolution of 12 km." This is a minor peeve of mine, but a horizontal grid spacing of 12 km results in a horizontal resolution at the very best of $2\Delta x = 24$ km, and really more like $4\Delta x$–$8\Delta x$.

P. 529–530, lines 27–3, CAPE convective closure. Curious. Generally, convective

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parameterizations are not used in simulations that use 4-km grid spacing ("convection-permitting simulations").

P. 532, line 9, ". . .thick layer of coupled capping stratocumulus." Please clarify.

P. 532, line 10–11, "The boundary layer also decouples more strongly on the second day." What is this assertion based on?

P. 532, lines 26–28, "cloud cover." What is meant by "cloud cover" âĂŤ cloud fraction?

P. 536, lines 8–10, ". . .large change in temperature and dewpoint around 975 hPa in Fig. 4a." I see the stratification in the moisture profile but not in temperature. Stratification is much more evident in plots of conservative variables such as liquid water potential temperature and total water.

P. 536, lines 17–19. What do "decoupled stratocumulus over cumulus convection" look like on the 12-km grid?

P. 537, lines 7–12. Which of these entrainment mechanisms is more important for these simulations? In large-eddy simulations, skewness of the vertical velocity field can aid in answering this question. Perhaps skewness would be useful here as well.

P. 537, lines 14–20. I don't follow. What happens during the day to maintain the total flux constant? If sensible heat increases, the latent heat flux must decrease, but why?

P. 537–538, lines 25–6. Why is the diurnal cycle so wimpy in the model? Is the reason simply because of the model's tendency to favor decoupled states?

P. 539, lines 3–6. Please supply a citation for the VOCALS droplet concentrations.

P. 541–542, lines 23–11. These single-time reflectivity snapshots are much less persuasive than the PDFs/CFADs. I do not see what they accomplish, unless it is to give the reader an appreciation of the observed vs. simulated cell size.

P. 524, lines 23–24, "lack of convection parameterization." Isn't it fair to say that a

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convective parameterization would never be used with a 1-km horizontal grid spacing?

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 525, 2012.