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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Large-scale subsidence promotes convection in sub-Arctic mixed-phase stratocumulus via enhanced below-cloud rain evaporation" *by* Gillian Young et al.

Anonymous Referee #2

Received and published: 15 September 2017

This manuscript describes a series of simulations of mixed-phase stratocumulus clouds designed to elucidate the role of large-scale subsidence in maintaining such clouds. The main conclusion is that subsidence enhances droplet evaporation at cloud top and below the cloud base, as well as supporting the cloud top inversion. Collectively, this isolates the cloud from entrainment of dry subsiding air from above, thereby enhancing in-cloud turbulence and promoting longevity. For southward moving mixed-phase Sc, such as during cold air outbreaks, simulations suggest advection over a relatively warmer surface promotes dynamic coupling and evolution of the cloud, but stabilization under high subsidence. The manuscript is well-researched and thorough, and is well-suited for publication in Atmospheric Chemistry and Physics. I recommend that it

be published after a minor revision addressing several comments below.

General Comments:

1) The manuscript is generally well-written, but it is quite long and the preponderance of details distracts from the take-home messages of each section. It is therefore difficult at times to follow. I am hoping that it can be tightened up throughout with the goal of drawing out the key points.

2) The simulations presented appear to be based on a case study from the eastern Arctic outlined by Young et al. (2017). Terms "Arctic", "low Arctic" and "sub Arctic" are variously used and I find myself somewhat lost geographically. I feel the necessary context may lie in Fig. 2 from Young et al (2017), but it is also not clear how much of the present study is hypothetical or how closely it relates to the previous work.

3) Following on from (2), the conclusions of the study are highly generalized, which is consistent with the experimental design of the simulations, except for the fact that it is ultimately based on a single atmospheric state case at initialization, which the reader learns little about. The importance of this limitation is not clear.

4) I don't understand how the model treats the surface properties and coupling, and thus to what degree dynamic coupling with the surface can feed back to the cloud, or if this can be evaluated at all (e.g., test 1 and test 4).

Specific Comments:

Title: "Large-scale... via ...evaporation" and also enhanced cloud-top radiative cooling, right?

Abstract Line 20: Clarify "warming surface", which you do not mean to be climatological, but rather southward advection.

Page7 Line5: "an" should be "a"

Page9 Line9: For the cases that become dynamically coupled, is the surface becoming a moisture source?

Page13 Lines1-6: Why the later, more rapid increase in CNTRLD10x2? Is this important somehow to understand the main thesis of this simulation?

Page13 Line5: “earlier” not “more quickly”?

Page13 Line7/Page27 Line13-14: This doesn’t seem right. Looks like the LWP response to Nice is much larger than the response to subsidence.

Page15 Line23: Is the ascent of the cloud exacerbating the difference relative to CNRTL in 7B(a,d) since its spatial position is changing relative to CNTRL?

Page21 Line4: Replace “extent” with “depth” or “physical thickness” so as not to be confused with horizontal extent.

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