

## ***Interactive comment on “Modelling the effects of gravity waves on stratocumulus clouds observed during VOCALS-UK” by P. J. Connolly et al.***

**Anonymous Referee #1**

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Summary:

The manuscript presented an LES study of gravity wave effects on stratocumulus clouds observed during VOCALS. The authors simulated and analyzed the variability of stratocumulus induced by a single or multiple gravity waves and concluded that the dominant mechanism for wave-induced clearing is the additional entrainment of dry air at the cloud top. Drizzling and CCN scavenging were found less important. The manuscript contained some scientifically interesting results and helps advance our understanding of stratocumulus variability. On the negative side, some of their conclusions may be dependent on their model configuration, specifically the small domain size and relatively coarse grid spacings, and accordingly are problematic. Additional sensitivity simulations are needed to justify the current configuration and to

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strengthen the manuscript. In addition, the authors appeared to be over-ambitious, examining the effects of wave amplitudes, numbers of waves, timing of waves, cloud evolution, drizzling, CCN concentration, and entrainment in one paper. In my opinion, a narrower-scope and better-focused paper with solid conclusions is usually much better than a little-bit-of-everything one, which runs the risk of being superficial. These points are further elaborated in my general comments. Overall, I recommend major revision.

General Comments:

1. A major conclusion from this work is that cloud clearing is largely due to additional cloud-top entrainment of dry air rather than drizzling. However, the vertical model spacing they used is 20 m, apparently too coarse for the study of entrainment effect. As suggested by previous studies (e.g., Bretherton et al. 1999; Berner et al. 2011), 5-m or small vertical spacing is needed to resolve small eddies in the inversion, which are important for entrainment. The authors at least should conduct one or two additional simulations to test the sensitivity of the entrainment of the passive tracer to grid spacings.

LES studies of stratocumulus over recent several years highlighted the importance of the domain size. As demonstrated by Feingold et al. (Nature, 2010), cloud variability results from nonlinear interplay among cellularization and oscillation of clouds, precipitation and mesoscale circulations. A small domain such as 16 by 16 km<sup>2</sup> used in this study surely inhibits cloud cellularization and mesoscale circulations, which feedback on the precipitation process. While I understand that computation cost is always a limiting factor, I still want to see at least one larger domain (60 by 60 km<sup>2</sup>?) simulation to show that their key conclusions still hold for a larger domain. Otherwise, the authors should add some discussion of these caveats and in the meantime, restrain themselves from speculating on what we can learn about POCs from this study.

2. A wide variety of “effects” ranging from wave amplitude, wave timing, wave numbers to entrainment and precipitation have been investigated; each was roughly dis-

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cussed/described on one page. It may strengthen the paper by focusing on some of them instead of all of them, just something for the authors to consider.

3. The manuscript can be better organized as well. The current version includes many short sub-sections, and the shortest sub-section, section 3.2 only has 2 sentences. The authors may want to make the manuscript flow better by combining some of them. In the meantime, some model description seems lengthy and unnecessary (e.g., lines 20-30 on page 1725, top paragraphs on page 1729; a couple of good references should be enough).

4. The following papers are highly relevant and should be cited: Berner et al. (ACP, 2011; entrainment effect on POCs); Wang et al. (ACP 2010; gravity wave effect on clouds); Jiang and Wang (JAS, 2012; wave impact on clouds).

Specific Comments:

1. Figure 5 doesn't help much and should be removed.
2. Figure 10: Please change the interval between the tick-marks on x-axis to 30 min.
3. P1727, line 18: What's a "time-dependent stationary wave"? Please reword it.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 1717, 2013.