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Comment on acp-2022-559

Anonymous Referee #2

Referee comment on "Gravity waves generated by the high graupel/hail loading through buoyancy oscillations in an overshooting hailstorm" by Xin Guo et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-559-RC2, 2022

This paper presents results from a single mesoscale model simulation of a thunderstorm. In its present form, I do not think the paper sufficiently advances the state-of-the-art to warrant publication. My reasons are as follows.

- The model seems to be over two decades old. In the late ’90s, when many of the referenced articles were written, 3D mesoscale models had 1 to 2 km horizontal grids, 0.5 km vertical grids, 100 to 500 km horizontal domains, and vertical domains reaching the Stratopause. This model seems to belong to that family with a 35km horizontal domain. By comparison, the 2018 Muller et al. paper looks at convection-allowing simulations with a 5000km horizontal domain.
- It is not clear to me how the authors can confidently ascribe the downward propagating gravity waves to the novel process since the “buoyancy restoration force” occurs in the same area where the updraft overshoots the tropopause. I would have expected the authors to conduct a spectral analysis of the downward propagating gravity waves in order to identify clear distinguishing spectral properties (vertical and horizontal wavelengths and frequency) to associate with the length scales of the suggested originating process.
- The authors claim that it is necessary to understand these new waves because of the role they play in tropospheric dynamics. I do not see where the authors make the case for an important role for downward propagating waves. The only argument I discern is that these waves cause storm splitting. But storm splitting by downward propagating waves is argued based on the fact that the split occurs at a given time. This explanation is unsatisfying. Storm splitting is a common phenomenon. Is it always caused by downward propagating waves?
- As far as the upward propagating waves caused by reflection from the surface go, the authors claim that they “significantly change the dynamic and thermodynamic structure in the lower stratosphere”. I do not see that a significant effect was measured or even described. Did the waves break and deposit momentum?

Perhaps the authors could consider extending the physical and temporal domain of the simulation and produce a spectral analysis of the waves they detect in order to support their conclusions that a new generating process is being observed. They should also produce quantitative arguments that downward propagating GWs cause storm splitting, and that ground-reflected GWs have a significant effect on stratospheric dynamics.