Geoscientific Model Development Discussions

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Comment on gmd-2020-439

Anonymous Referee #1

Referee comment on "Simulation study of a Squall line hailstorm using High-Resolution GRAPES-Meso with a modified Double-Moment Microphysics scheme" by Zhe Li et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-439-RC1, 2021

SUMMARY:

This manuscript summarizes a mesoscale modeling study of a hailstorm using the GRAPES-Meso NWP model with a 2-moment bulk microphysics scheme (BMS). The authors run GRAPES to simulate a hail-producing squall line for a 24-h simulation at a 3-km horizontal grid spacing. Comparisons are made between model fields and observations for accumulated precipitation and radar reflectivity. Some other model fields are also shown and discussed briefly, including vertical motion, hydrometeor mixing ratios and hail microphysical process rates. The authors claim that the simulation appears to be reasonable and conclude that GRAPES-Meso with the 2-moment BMS is therefore capable of simulating hailstorm (and presumably of predicting hail).

To be frank, there is very little scientific value in this manuscript for the meteorological, NWP, or modeling community. There is very little depth in the analysis. There is no way of telling what the effects of the 2-moment BMS are since no comparisons to other schemes are made, nor any sensitivity tests conducted. The comparisons to observations are very superficial and show little more than that the model happened to produce a reasonable simulation for this single case. The authors do not even show accumulated hail from the model for comparison to the surface observations (Fig. 1). There is not really any knowledge demonstrated about hail or hail modeling in the manuscript. So, in my opinion there is no publishable material here. Any necessary revisions needed would be too great to turn this into a publishable paper.

SOME SPECIFIC COMMENTS:

The background description of natural hail growth is quite weak. For example, "conversion" of graupel to hail is discussed as though this were a natural process (it is not; it is a modeling concept). No mention of frozen raindrops as hail embryos is made.

The description of the 2-moment scheme is strange. For example, most of the equations given are "final" equations, without the original "base" equations (though references are given) – but what is the purpose of this? The reader is not going to try to code a BMS based on these equations. The functional form of the hydrometeor size distributions is not stated. There are also a few strange aspects to this scheme that I see – e.g., what is the basis for a fixed collection efficiency of 0.8 (line 98)? What is the physical basis and meaning of the conversion parameter A (line 103)? Is there no distinction between wet and dry growth of hail?

The comparison to observations is quite week. For the observed precipitation (Fig. 4a), is this radar-based or gauge-based? Why are not plots of model hail precipitation (similar to Fig. 4b) shown (for comparison to Fig. 1)? [I recognize that hail mixing ratios at the surface are shown in Fig. 8.] For the radar reflectivity comparisons, this is tempting and common thing to do, but there are subtleties in model reflectivity that must be understood (and should be discussed in this paper). For example, uncontrolled size sorting in 2-moment bulk schemes can lead to an artificially broad size distribution, which inflates the calculation of the 6th moment (reflectivity).

There is no discussion about the impact of the specific model configuration. It is well recognized that grid spacing of 3 km is quite coarse and insufficient to resolve the updrafts in severe convection. But updrafts are strongly linked to hail (in nature and models). So what does this imply as far as this study is concerned? Discussion is needed.

What should be take away from the hail production rates shown in Fig. 10? There is a brief description of this figure in the text, but no discussion of what the reader should learn from this regarding the utility of this model to simulate hail. Is this better than a 1-moment BMS? What strikes me as the strangest is that most of the hail growth comes from "autoconversion" of graupel to hail, rather than accretion of liquid water (this does

not seem realistic).