

General comments

This paper explored the effect of prognostic graupel density in WDM6. The goal of this modification was to better model snowfall events with more realistic fall speed-diameter and mass-diameter relationships. It was interesting to see assumptions in existing methods get replaced by theories in new studies with reasonable success (lower RMSE). However, the biggest concern I have with the comparison between WDM6_PD with WDM6_FD is that fall speed-diameter relationship does not converge when they have the same density (Figure 1). I understand that it might have been implemented this way because the authors tried to keep the off-the-shelf fixed density model unchanged, but this implementation fails to facilitate a fair comparison between fixed vs. prognostic density because no one knows if the difference in simulation results come from the prognostic density or the vastly different parameters (a_G , b_G). It also leads to physical inconsistency: starting L350 (also Figure 9), the graupel in WDM6_PD falls faster than WDM6_FD despite its lower prognostic density (250-350 kg/m³ vs 500 kg/m³ in WDM6_FD) and smaller size. I recommend adding a modified WDM6_FD that is simply WDM6_PD when $\rho = 500 \text{ kg/m}^3$ for a more meaningful comparison. This problem needs to be revisited because it could change the statistical skill scores shown in Table 4, but overall this is a study worth publishing once this problem is resolved.

Specific comments

L138. Why are the parameters in Table 2 so far off from the ones in the original WDM6 scheme? I don't think you need an extensive explanation but a one-sentence summary would be nice as it ties to points I made in the general comments.

L258/Fig. 5.

L316. Briefly explain equitable threat score (ETS) and why it's worth mentioning (even though the scores are similar).

L350. Physical inconsistency as mentioned in the general comments.

L379. The enhanced graupel fall velocity should not be attributed to the prognostic graupel density but rather the vastly different parameters (a_G , b_G) used.

L391. The slight enhancement of vertical velocity in the range of 0.1-0.5 m/s seems about equally insignificant for both CL and WL. The authors might also want to reexamine this figure with the WDM6_FD with modified parameters.