Review of egusphere-2024-594: 'Effect of Secondary Ice Production Processes on the Simulation of ice pellets using the Predicted Particle Properties microphysics scheme'

The manuscript describes forecast experiments for a winter storm event that produced snow, freezing rain, and ice pellets. The forecast model does a remarkable job of reproducing the precipitation rates at the comparison site, which could in part be a reflection of the system being in a more predictable regime of synoptic forcing. The experiments conclude that the P3 scheme is able to produce realistic ice pellet accumulations with a parameterization of small ice production by shattering of freezing drops. I think this is nice study that presents a problem and a physically plausible solution. I have a just a few questions to clarify some points.

Minor Comments:

1. Line 112: 'Immersion freezing of cloud droplets and rain can occur when T < −4C, following the volume and temperature dependent formulation presented in Bigg (1953)'

From Bigg's plot, highest practical mean temperature for freezing is about −20C for very large drops. I would not expect any freezing from that paramterization at −4C, but I'm not familiar with the Barklie and Gokhale (1959) formulation. Does P3 really produce much drop freezing from this process at temperatures higher than, say, −15C? Freezing by ice crystal capture could happen, of course. Also, Bigg 1953 used distilled water, so I consider it to be something of a lower limit for homogeneous freezing.

2. Line 139: 'collect 1 mg of rain'

Should 'rain' be 'droplets'? Studies of the HM process have used small droplet riming, which probably does not apply to collection of larger rain-sized drops.

3. Concerning the modified merging criteria: Clearly this change produces a more realistic result in this case, but I'm curious if this was also tested on other types of convection to see if has any adverse affects.

4. Line 217: 'but the critical success index for ice pellets was better with the experiments that included the FFD SIP process'

I think calling it 'better' is an understatement. The base simulation has essentially zero CSI, and the differences with HM and then FFD are quite substantial and worth saying a bit more about.

5. Line 415: 'Snow was initialized from the model top' What were the values of number concentration, mass mixing ratio, etc. for the snow? What was the mean diameter of the particles?

6. Figure B1: The rain number by height seems to drop about an order

of magnitude, which would be more than accounted for by air density change over 2km. Are there processes that are affecting the rain number (such as the liquid fraction)?

7. Figure B1: Why do FFD and FFD-MOD have abrupt melting of all ice compared to the first two (e.g., blue circles at 2-3km in panel i vs. panel j)?

8. Line 454: 'or the precipitation rate was lower'

Can you elaborate very briefly on how the precipitation rate affected freezing? Is it simply an insufficient production of ice crystals such that collection was too small to initiate freezing?

9. Fig. B1: Would it be possible to plot the number concentration as number/m3 so that it is easier to compare different altitudes? Not a big deal if not. (Likewise in the upper row, mass content would be easier to compare vertically than mixing ratio.)

10. Are panels B1a and B1g the same plot? If so, please make that clear. Or perhaps there is something else that could replace the second one.

11. Fig. B1 (one more thing!): Does 'rain' here represent only qr (and nr) or does it include liquid mass on ice? Can you represent the liquid fraction on ice here, perhaps as a line plot in the range of 0-1?

Editorial comments:

1. Line 239: 'This is consistent with our observation'

Is this referring to the "UQAM-PK weather station in downtown Montreal"? If so, that could be made clear. Or is it a personal observation (if so, at what approximate times)?

2. Line 344: 'The hydrometeors simulated with nCat2-FFD were small and had a high number mixing ratio (Fig. 8f)'

This is specifically for ice species 1, correct? Not all hydrometeors. The following sentence would then make more sense. (Although instead of "In parallel" I would suggest 'Conversely' or something that indicates opposite characteristics for ice2.)

3. Line 434: 'In this experiment'

I suggest clarifying this as 'In experiment nCat2FFD' to avoid confusion since two experiments are stated in the first sentence.

4. Line 437: 'a similar size to the original raindrops' And what size are they?