Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1056-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Open Access

ACPD

Interactive comment

Interactive comment on "Shape dependence of snow crystal fall speed" *by* Sandra Vázquez-Martín et al.

Anonymous Referee #2

Received and published: 8 December 2020

General Comments:

Studies that directly measure the fall speeds of naturally formed ice particles along with other properties that affect fall speeds are rare these days, and this paper is one of those rare papers. Obtaining ice particle imagery from two orthogonal viewing angles (top-down and horizontal) adds information not normally found in other studies, and allows for a more complete analysis of the fall speed physics. This adds new statistics to the orientation of ice crystals that have a preferred orientation (due to a much greater projected area associated with a given growth axis, such as found with hexagonal columns and plates). I am only aware of one other observational study that addresses this topic (Kajikawa, 1992, J. Meteor. Soc. Japan). The authors frame their results nicely in the context of other studies. Overall, the paper is well written and or-

Printer-friendly version

Discussion paper

ganized, and advances our knowledge of solid precipitation fall speeds. Some specific comments listed below should be addressed before the paper is published in ACP.

Specific Comments:

1. In the abstract, the points in the first "introduction" paragraph could be organized better and stated more succinctly, perhaps in about three sentences.

2. Lines 43 – 49: The recent work of Dunnavan (2020, JAS) should also be mentioned here as he shows how orientation and other factors account for much of the dispersion in ice fall speed for a given size.

3. Lines 50 – 52: Another reference that supports this is Mitchell et al. (2008, GRL), which shows how the cirrus ice fall speed affects cirrus cloud coverage and ice water path, and the resulting impact on radiation in the Community Atmosphere Model version 3 (CAM3).

4. Figure 3 and elsewhere in paper where shape category 13 is mentioned: Shape category 13 is ambiguous since it appears this can refer to any kind of ice particle and it also includes melting/sublimating ice particles of any shape apparently. Is this merely a "dust bin" category that includes all the other shapes that defy classification?

5. Figure 3 and elsewhere in paper where shape category 14 is mentioned: Irregulars as defined in Lawson et al. articles are high density, blocky-type particles that are subdivided into small and large irregulars, but other authors may define them differently. How are they defined here? If irregulars here are similar to irregulars in Lawson et al. papers, then grouping them with aggregates may be a mistake, since unrimed aggregates are NOT high density; rather they are notoriously low density. Please show a photo of irregulars so readers will know what they look like.

6. Lines 175 – 181: Regarding the large spread in fall speeds, the recent paper by Dunnavan (2020, J. Atmos. Sci.) shows snowflake (i.e., crystal aggregate) fall speeds are most sensitive to particle shape differences (largely accounted for in this study) with

secondary sensitivity to aggregate orientation. Please consider whether this Dunnavan study is relevant in explaining the large spread in fall speeds encountered here.

7. Figure 6: The legend contains a pink bar denoting the 68% confidence region, but a pink region is not evident in the plots. Perhaps it is sufficient to only show the 68% prediction bands?

8. Section 3.3.1 on Orientation: A study by Kajikawa is the only one I know of containing observational results on natural ice crystal orientation during free-fall; please include this reference (Kajikawa, 1992, J. Meteorol. Soc. Japan), comparing orientation results from this study with the Kajikawa results.

9. Section 3.4 (Comparison with previous fall speed relationships): Ice fall speeds depend on temperature T and pressure P; what were the values assumed here? Was this assumption applied universally to all of the studies in this intercomparison? If not, please ensure that all fall speeds in this intercomparison use the same T and P.

10. Figure 13, middle panel (stellar): Please mention that Curve 11 is based on the flow regime for larger ice particles, and should be closer to [VM] for the smaller D if the corresponding flow regime constants in [M] were used.

11. Lines 343-4: Sentence structure appears awkward; do you mean to say "Our shape group (5) contained only plates that were unrimed"?

Please also note the supplement to this comment:
https://acp.copernicus.org/preprints/acp-2020-1056/acp-2020-1056-RC2-supplement.pdf

---

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1056, 2020.