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Atmospheric Chemistry and Physics Discussions

Interactive Comment

Interactive comment on "Growth-deviation model to understand the perceived variety of falling snow" *by* J. Nelson

Anonymous Referee #1

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Referee's report on

Growth-deviation model to understand the perceived variety of falling snow

by J. Nelson

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This paper proposes a theory of snowflake diversity in an attempt to give a scientific answer to the age-old question: are no two snowflakes alike? More generally, the paper develops a method for quantifying the number of different snow crystals at a given resolution.

While such a pursuit is commendable, I am not sure that this paper is able to make a significant contribution. The main problem is a very large number of simplifying assumptions, which make the final estimates little more than educated guesses. The author should at least justify these before the paper is ready for publication.

The most problematic assumption is stated in Section 2.4, in which humidity variations are dismissed. In particular, the claim seems to be that the diffusion-limited effects of vapor can be largely ignored, which is at least controversial — for example, it is at odds with much of K. Libbrecht's work. The fact is that the growth of crystals such as those depicted in Figure 2 *can* be a result of diffusion limited growth with no temperature variations at all. On the other hand I am not aware of any work which justifies the explanation with different temperatures as described in the caption; perhaps this could be remedied by citing relevant references.

Further remarks are listed below.

Abstract. "Range of conditions" and "qualitative result" are too vague to be understood. In fact, the claim that "the qualitative result is independent of the viewing resolution" is not clearly justified (or even interpreted) in the body of the paper.

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P. 4410, Section 2.2. The concept of a *feature* is central to the paper, yet its precise meaning remains unclear. A mathematical definition must be possible if one imagines a digital picture of a snow crystal. Also does one look at a crystal only from the top, or are oblique views also counted? This would also be a good place to clarify the meaning of *resolution*.

P. 4410, l. 21. There is *some* growth in the basal direction (albeit much slower), which certainly could generate some features.

P. 4413, l. 11. While this independence is one of the (relatively) less problematic assumptions, some discussion on its validity should be included.

P. 4414, l. 18–19. The reason for these numbers should be provided, in particular 39. Also, the resolution value should be discussed.

P. 4416, l. 9. Correct the first sentence on this line.

P. 4416, Sec. 5.2. Do the temperature fluctuations behave the same on all scales? This is important if the crystal is relatively stationary for a significant period in its growth.

P. 4417 , l. 9. Discuss the value of χ. How realistic it is to assume that χ is independent of space and time? Not very, intuitively, so this is another potentially problematic assumption. In a similar vein, what is the role of randomness here? Are there temperature variations across the crystal? These could significantly increase the number of features.

P. 4422, sec. 6.5. I cannot understand what the author is trying to say in this section. Perhaps it needs to be rewritten, with additional references.

P. 4425, l. 11. What is “crystal habit?”

P. 4424, formula (9). It is worth pointing out that if the probabilities of different combinations are not equal, this *decreases* $pd(i)$, and consequently increases the probability of a match.

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