Classification of riming extent in the Arctic with the Multi-Angle Snowflake Camera

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The Rayleigh–Gans approximation (RGA) is often invoked as a simplified model for the scattering of radar energy by low-density aggregate snowflakes [1–3]. Aggregates tend to exhibit negligible riming and thus allow for an assumption of non-interference. Implicit in the use of this approximation is the assumption that such low-density aggregates comprise a significant portion of the distribution of snowflake types being observed and detected by weather radar. In order to gain a better understanding of the properties of solid hydrometeors in the Arctic, millions of ice particles in freefall have been captured by the surface-based Multi-Angle Snowflake Camera (MASC) at the Department of Energy's Atmospheric Radiation Measurement (ARM) Mobile Facility at Oliktok Point, Alaska.

A subset of approximately 40,000 frozen hydrometeors collected between June 2016 and July 2017 have been analyzed. As a proxy for riming extent, a "complexity" variable was calculated for each particle based on inter-pixel variability and the degree of departure from sphericity, which were themselves determined using simple algorithms involving OpenCV image processing software. This riming proxy was then used to classify the particles according to riming extent. Of the total, 25% were classified as graupel (low complexity), 48% as rimed aggregates, and 27% as aggregates (high complexity). However, many of those in the latter category still exhibited some degree of riming, and the portion of those exhibiting negligible riming was less than 5% of all particles. Therefore, riming appears to be quite common. Based on prior work, this suggests that the RGA may have limited applicability, even at colder temperatures characteristic of the Arctic.

References

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