On the Aerodynamics of Snowflakes: An Experimental Study of the Relation Between the Shape and Aerodynamics of Early Aggregates

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The diversity and complexity of snowflakes make it difficult to predict their fall and interactions in weather and climate models. Nevertheless, snowflake aerodynamics affect both precipitation, cloud cover and the radiation balance. Previous studies have described their aerodynamics in terms of generalized shape factors, ranging from diameter or area ratio to circularity. However, a recent study concludes that some parameterisations overestimate the terminal speeds of snowflakes by up to 80%, suggesting that snowflake aerodynamics cannot be modelled in terms of generalized shape factors. In this research, I present a novel approach to studying the relation between the shape and aerodynamics of early aggregates composed of two hexagonal plates; as opposed to generalizing shape factors, the plates are assembled systematically, forming a variety of X-shaped, V-shaped, and planar aggregates. Their aerodynamics are studied experimentally by recording dynamically similar, 3D-printed analogues falling in water. The falls are analysed by tracking the analogues to reconstruct their trajectories (translational and rotational motion) and determine their drag coefficients and Reynolds numbers. Another novel addition to the field is the examination of tortuosity factors and mean oblique angles, which have the potential to improve weather and climate models. It is concluded that whilst planar aggregates exhibit similar aerodynamic properties, the 3D-shape of an early aggregate changes its aerodynamic properties extensively. Despite being limited to early aggregates, my research suggests that this very first aggregation may be vital to the evolution of snow as it falls to the ground.

Awards Won:

Third Award of $1,000