

Snow crystals: order and mystery at the microscale

Snow crystals continually adjust their shape, adding new features as they tumble through varying air layers. The shape features, such as branch and needle extensions, can affect important cloud processes. But we can also view the features as a recording of the crystal history, a recording that, because of the high level of ordering (e.g., hexagonal symmetry), begs for explanation. This talk focuses on the explanation.

In meteorology courses that treat snow crystal microphysics, we learn only about the vapor transport part of growth. Cloud modeling also considers only this aspect of the initial phase of ice and snow crystal growth. By following such an approach, crystal shape is both a complete mystery and irresponsive to cloud heterogeneity. A whole new understanding awaits those who also consider the crystal growth mechanism.

Snow crystals grow by the layer nucleation growth mechanism. Layer nucleation, like other types of nucleation, is sporadic at low supersaturations. But at the high supersaturations in mixed-phase clouds, layer nucleation is both periodic and ultra-sensitive to supersaturation. These two properties lead to not only the crystal's intricate detail, but also its high degree of order. Some order is lost at lower supersaturations and low temperatures where another growth mechanism likely plays a role. New experiments are underway to reveal how the two mechanisms compete and thus to supply better growth parameterizations for cloud models, but we can nevertheless understand much of what we see in the snow crystal through the mechanism of layer nucleation.