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Measurement of Acidic Ions and Their Qualitative Effects on Snow Crystal Morphology and the Quasi-liquid Layer

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Ice crystals play in integral role in polar-regions as they provide surfaces upon which heterogeneous chemistry can occur; including that leading to halogen activation and ozone depletion events in both the stratosphere and troposphere. Furthermore, snow crystal growth is a useful system for studying crystal growth dynamics because of the ease in which crystals can be grown under non-elaborate laboratory conditions. However, despite the ease with which crystals can be made, a thorough understanding of the snow crystal's surface structure, chemistry, and its relationship to crystal morphology, has proven to be difficult. Though natural ice crystals (snow crystals) have been studied for over seventy years, there has been relatively little progress in our understanding of its physics of formation, surface structure, and conditions of formation at the point of crystal growth. Indeed, there is a paucity of data even regarding the humidity and chemical composition of the air at the point of crystal growth. To improve our understanding of the life cycle of snow crystals we constructed a snow crystal growth chamber, within which we were able to grow crystals under controlled conditions and record the temperature, relative humidity, and acetic acid content at the point of crystal growth. From this we were able to better understand the importance of ice's quasi-liquid layer on the morphology of the snow crystal. Furthermore, we were able to bring some clarity to the humidity dependence of the crystal morphologies, and show the necessity of gas phase impurities, that get deposited on the ice surface, for morphological diversity. The results of our study are presented herein.