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Measurements and shape classification of natural snow crystals and snowflakes in Kiruna, Sweden

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Knowledge of snow microphysical properties, including particle shape, is required for snow retrievals from remote sensing methods. Particle shape and morphology affect radar measurements and microwave brightness temperatures.

In this work, we present ground-based in-situ measurements of snow particle shape carried out in Kiruna, north of the Arctic Circle in Sweden during the snowfall seasons from 2014 to 2018 between the beginning of November and the middle of May. These measurements of natural snow, covering particle sizes from 50 μm to 4 mm, are classified using an updated classification with over 100 shapes. Our classification includes new snow shapes that have been found in Kiruna. To carry out this study a ground-based in-situ instrument has been used, which takes high-resolution dual images—from the side and the top—of falling hydrometeors. With these dual images ambiguities in shape determination can be minimized. In addition to assigning a shape to each particle, our proposed classification sorts particle shapes into 15 different shape groups depending on their morphology. These groups are: *Needles and thin/long columns*; *Crossed needles and crossed columns*; *Thick columns and bullets*; *Capped columns and capped bullets*; *Plates*; *Stellar crystals*; *Bullet rosettes*; *Branches*; *Side planes*; *Spatial plates*; *Spatial stellar crystals*; *Graupel*; *Ice, melting/evaporating particles*; *Irregulars and aggregates*; and *Droplets*. Then, with the help of this classification, microphysical properties such as particle size, area, area ratio, aspect ratio, shape, and fall speed are studied for the different shape groups. From this, relationships between these microphysical properties specific for shape groups, for instance particle size and area can be derived, which will be useful for climate and forecast models.