The microphysical properties of ice crystals, including size, shape, concavity and roughness, are very important in the context of radiative properties of ice and mixed phase clouds. Optical resolution limitations of current cloud probes to measure such properties can be circumvented by acquiring two-dimensional (2D) light scattering patterns instead of particle images. This method has been implemented in the Small Ice Detector family of instruments, developed at University of Hertfordshire. The latest SID probes, collectively known as SID-3, use intensified CCD cameras to capture high-resolution 2D patterns. It is possible to recover the size and shape of ice particles by comparing such patterns to the RTDF scattering model. Here we focus on the application of 2D patterns to ice particle roughness.

SID-3 was flown in the UK in 2010 on the FAAM aircraft during CONSTRAIN and APPRAISE. Unlike most results from cloud chambers, where 2D patterns showed sharp, well-defined bright arcs and spots, the majority of the cloud data was characterized by much more random, “speckly” appearance. Laboratory experiments show that this is characteristic of particles with rough surfaces. Quantitative comparison of lab and cloud data was done using pattern texture measures, originally developed for surface roughness analysis using laser speckle. The results were consistent with the presence of significant roughness in the majority of cirrus and mixed phase cloud ice crystals, at levels similar to those found, for example, in rough mineral dust particles. Possible reasons for this roughness are discussed, including the influence of supersaturation.