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The defective nature of ice Ic and its implications for atmospheric science

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The possible atmospheric implication of ice Ic (cubic ice) has already been suggested some time ago in the context of snow crystal formation [1]. New findings from air-borne measurements in cirrus clouds and contrails have put ice Ic into the focus of interest to understand the so-called "supersaturation puzzle" [2,3,4,5]. Our recent microstructural work on ice Ic [6,7] appears to be highly relevant in this context. We have found that ice Ic is characterized by a complex stacking fault pattern, which changes as a function of temperature as well as time. Indeed, from our own [8] and other group's work [9] one knows that (in contrast to earlier believe) ice Ic can form up to temperatures at least as high as 240K – thus in the relevant range for cirrus clouds. We have good preliminary evidence that the "cubicity" (which can be related to stacking fault probabilities) as well as the particle size of ice Ic are the relevant parameters for this correlation. The "cubicity" of stacking faulty ice Ic (established by diffraction) correlates nicely with the increased supersaturation at decreasing temperatures observed in cirrus clouds and contrails, a fact, which may be considered as further evidence for the presence of ice Ic. Moreover, the stacking faults lead to kinks in the outer shapes of the minute ice Ic crystals as seen by cryo scanning electron microscopy (cryo-SEM); these defective sites are likely to play some role in heterogeneous reactions in the atmosphere. The cryo-SEM work suggests that stacking-faulty ice Ic has many more active centres for such reactions than the usually considered thermodynamically stable form, ice Ih.

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