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The time-dependence of the defective nature of ice Ic (cubic ice) 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]. Our recent microstructural work on ice Ic [5,6] 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 [7] and other group's work [8] 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. Recently, we have studied the time-dependency of the changes in both "cubicity" and particle size at various temperatures of relevance for cirrus clouds and contrails by in-situ neutron powder diffraction. The timescales over which changes occur (several to many hours) are similar to the life-time of cirrus clouds and contrails and suggest that the supersaturation situation may change within this time span in the natural environment too. Some accompanying results obtained by cryo-SEM (scanning electron microscopy) work will also be presented and suggest that stacking-faulty ice Ic has kinky surfaces providing many more active centres for heterogeneous reactions on the surface than in the usually assumed stable hexagonal form of ice Ih with its rather flat low-indexed crystal faces.

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