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Experimental evidence for millisecond activation timescales using the Fast IN Chamber (FINCH) measurements

U. Bundke (1), R. Jaenicke (2), H. Klein (1), B. Nillius (1), B. Reimann (1), T. Wetter (1), and H. Bingemer (1)

(1) Institut für Atmosphäre und Umwelt, Universität Frankfurt, Frankfurt a. M., Germany (bundke@iau.uni-frankfurt.de), (2) Institut für Physik der Atmosphäre, Johannes Gutenberg Universität Mainz, Germany

Abstract:

Ice formation in clouds is a subject of great practical and fundamental importance since the occurrence of ice particle initializes dramatic changes in the microphysical structure of the cloud, which finally ends in the formation of precipitation. The initially step of ice formation is largely unknown. Homogenous nucleation of ice occurs only below -40 °C. If an ice nucleus (IN) is present, heterogeneous nucleation may occur at higher temperature. Here deposition freezing, condensation and immersion freezing as well as contact freezing are known. Also growth rates of ice particles are known as function of crystal surface properties, temperature and super saturation. Timescales for homogenous freezing activation in the order of 0.01 seconds and nucleation rates have been measured by Anderson et al. (1980) and Hagen et al., (1981) using their expansion cloud chamber.

This contribution of deposition mode freezing measurements by the ice nucleus counter FINCH presents evidence that the activation timescale of this freezing mode is in the order of 1E-3 seconds. FINCH is an Ice Nucleus counter which activates IN in a supersaturated environment at freezing temperatures. The activation conditions are actively controlled by mixing three gas flows (aerosol, particle-free cold-dry and warm-humid flows).See Bundke et al. 2008 for details. In a special operation mode of FINCH we are able to produce a controlled peak super saturation in the order of 1 ms duration. For several test aerosols the results observed in this particular mode are comparable to normal mode operations, where the maximum super saturation remains for more than a second, thus leading to the conclusion that the time for activation is in the order of 1ms or less.

References:

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