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On the observation of unusual high concentration of small ice particles near the top of a deep convective system during the CIRCLE-2 experiment

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During the CIRCLE-2 experiment carried out over Western Europe in May 2007, in situ and remote observations have been obtained with the DLR Falcon aircraft in cirrus clouds and convective systems. The aircraft was equipped with a unique set of instruments including the Polar Nephelometer, FSSP-300, Cloud Particle Imager (CPI) and PMS 2D-C for the extensive in-situ cloud measurements of microphysical and optical properties and the DLR WALES Lidar (Water Vapor Lidar Experiment in Space) for nadir looking remote sensing observations. During the sampling near the top (-60°C) of an overshooting convective cell over Germany in situ measurements revealed the occurrence of very high concentration (∼120 cm-3) of small ice crystals (Deff ∼ 40 microns) with subsequent very high extinction and ice water content values (∼ 30 km-1 and ∼ 1.5 g/m3 respectively). A careful examination of the data suggests that the cloud measurements are not significantly affected by ice crystal shattering since the largest measured particles are about 300 microns diameter. The shape of the ice crystals suggest that supercooled droplets lofted in the updrafts are frozen by homogeneous nucleation near the -38°C level, producing high concentrations of very small ice particles. These observations address scientific issues related to the microphysical properties and structure of deep convective cloud and are contrary to the findings that particles larger than 50 microns control the radiative properties in convective-related clouds. These unusual observations may also provide some possible insights regarding engineering issues related to the failure of jet engines commonly used on commercial aircraft during flights through areas of high ice water content. The communication presents a detailed description of this situation in terms of microphysical and optical properties with comparison to usual features observed in anvil and cirrus clouds. The dynamical and thermodynamical data with the interpretation of satellite and remote sensing observations are discussed.