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Implications of the ISOCLOUD campaigns at the AIDA Cloud Chamber for ice growth in cold cirrus

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In-situ water vapor measurements in the upper troposphere and lower stratosphere (UTLS) have routinely observed anomalous supersaturations on the order of 10-20particles when temperatures were below 200 K, raising questions about the physics of how ice forms at cold temperatures in the atmosphere[1,2,3,4]. The ISOCLOUD campaigns in 2012-2013 at the AIDA Aerosol and Cloud Chamber sought to investigate ice growth at cold temperatures by simulating cirrus clouds at temperatures and pressures characteristic of the upper troposphere. Experiments tested both homogeneous nucleation of sulfate aerosols and heterogeneous nucleation with various ice nuclei, including mineral dust and organic aerosols with and without nitric acid coatings. Optical instruments, both in-situ (TDLAS) and extractive (TDLAS and OFCEAS), measured ice particle number density, water vapor, total water, and water vapor isotopic concentrations, with multiple instruments measuring water. In a series of cirrus formation experiments, we observed no evidence of anomalous saturation vapor pressure and no evidence of ice growth inhibition at low temperatures for the parameter space tested during the ISOCLOUD campaigns. That is, we see no evidence for temperature dependence in the deposition coefficient. In these experiments we determined the deposition coefficient from bulk parameters of the gas (vapor concentration and ice number density). The ISOCLOUD experiments were particularly suited to deposition coefficient measurements since they involved lower pressures and often lower temperatures than previous similar campaigns, producing lower error bars.5 These results can aid in the interpretation of data from aircraft campaigns in the UTLS by solidifying our understanding of the microphysics of ice formation at cold temperatures.

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