

MS Defense Announcement
Nicholas Kedzuf
Monday, November 2 at 2:00 p.m.

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November 2, 2020
2:00 p.m.

Defense
Virtual (Teams link sent out closer to the defense)

Post Defense Meeting
Virtual

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RETRIEVING CLOUD ICE NUMBER CONCENTRATION USING POLARIMETRIC RADAR

Ice and mixed phase clouds are critical components of Earth's climate system via their strong controls on global precipitation distribution and radiation budget. Their microphysical properties have been characterized commonly by polarimetric radar measurements. However, there remains a lack of robust estimates of ice number concentration, due to the difficulty in distinguishing embedded pristine ice from snow aggregates in remote sensing observations. This hinders our ability to study detailed cloud ice microphysical processes from observations.

This thesis presents a rigorous method that separates the scattering signals of pristine ice and snow aggregates in scanning polarimetric radar observations, which was previously thought impossible. This method, dubbed ENCORE-ICE, is built on an iterative ensemble retrieval framework. It provides number concentration, median volume diameter, and ice water content of pristine ice and snow aggregates with full error statistics. The retrieved cloud properties are evaluated against in-situ aircraft measurements from a UK field campaign. For a stratiform cloud system associated with observed ice number concentration of 0.1–10 L⁻¹ and ice water content from 0.01–0.6 g m⁻³, the retrievals are mainly in the range of 3.9–12.5 L⁻¹ and 0.3–0.8 g m⁻³.

To investigate the ice property evolution in a Lagrangian sense, the retrieval method is also applied to along-wind scanning radar measurements from an Atmospheric Radiation Measurement (ARM) campaign in Finland. For the cases presented, snow aggregates are typically 5–10 mm in diameter, which is ~10 times larger than pristine ice and thus dominates radar reflectivity. However, the partitioning in ice water content between pristine ice and aggregates varies and largely depends on ice number concentration. More importantly, the retrieved pristine ice number concentration exceeds the predicted concentration of primary ice nuclei at a temperature of –15°C by two orders of magnitude, suggesting possible secondary ice production, one of the outstanding issues in cloud physics. This highlights the potential of using ENCORE-ICE to identify secondary ice production events and understand their trigger mechanisms.