

Observed Ice Crystal Characteristics and Atmospheric Conditions Near Cloud Top in Northeast U.S. Winter Storms

NC STATE

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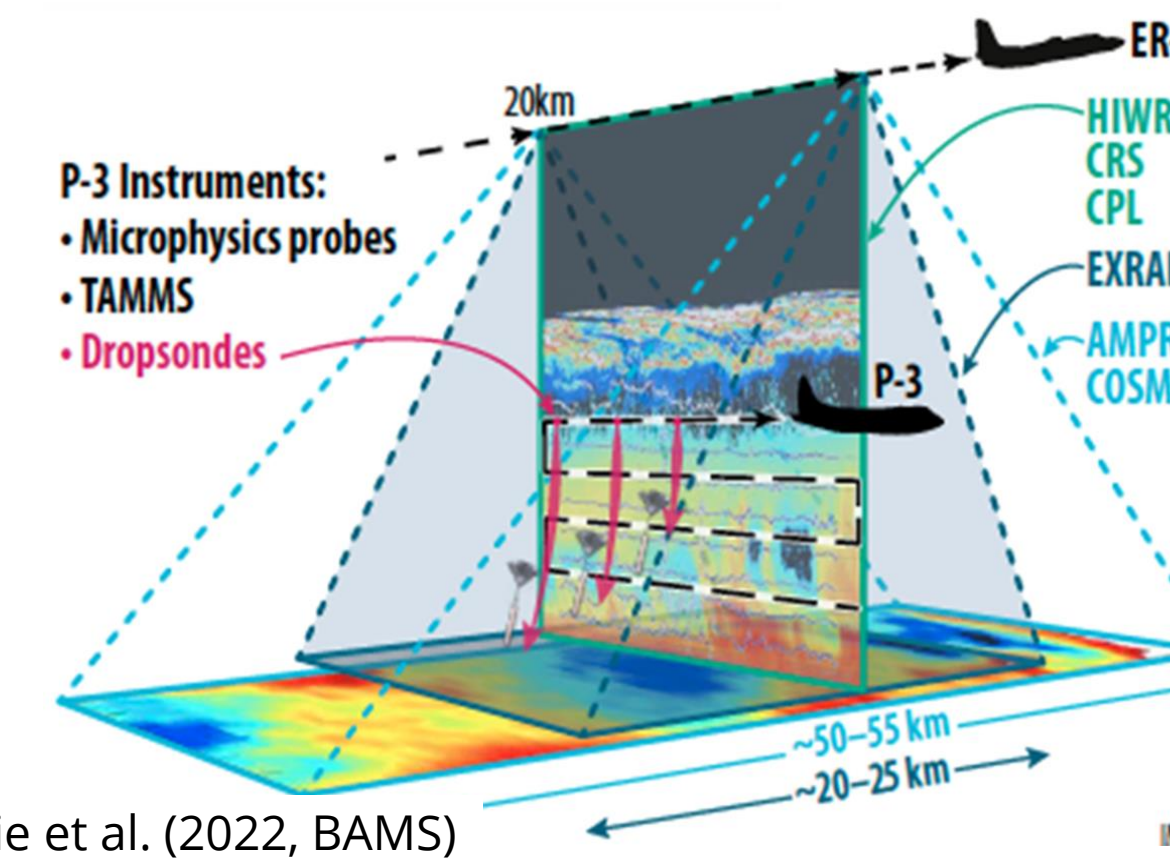
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Data and Methods



Winter storms often have a layer of generating cells near cloud top where ice first grows to precipitation-size (> 0.2 mm diameter) and subsequently falls for an hour or more through the storm to the surface. The journey through environments with different relative humidities and temperatures influences the sequence of possible stages of how snow can grow by vapor deposition, shrink by sublimation, and collect supercooled liquid droplets yielding various degrees of riming. We analyze data from two research aircraft deployed during NASA's Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) 2020-2023 campaign to investigate near cloud top environments and snow shape characteristics. Snow particles obtained near cloud top represent initial stages as compared to snow particles sampled at the surface which represent a longer sequence of stages. In situ data from the NASA P-3 aircraft including high-resolution images of snow particles obtained from the Particle Habit Imaging and Polar Scattering (PHIPS) probe are put in context of airborne cloud radar data obtained by the overflying NASA ER-2 aircraft.

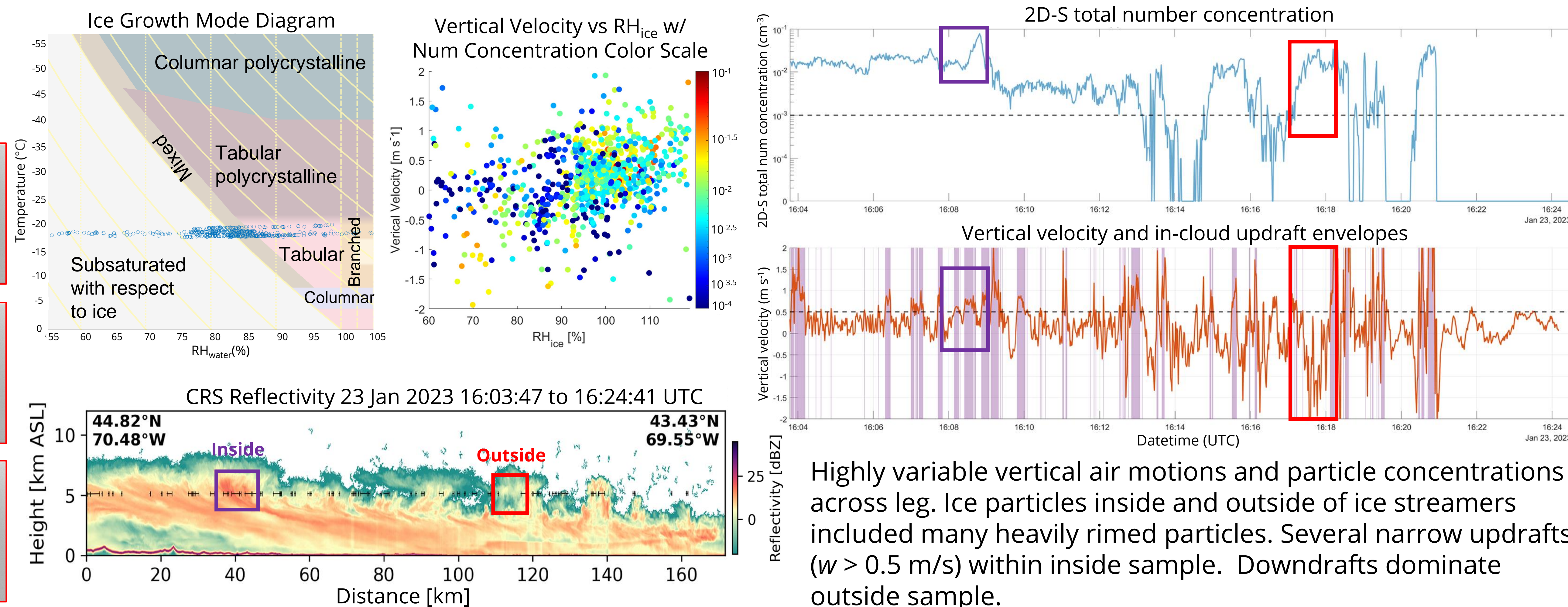
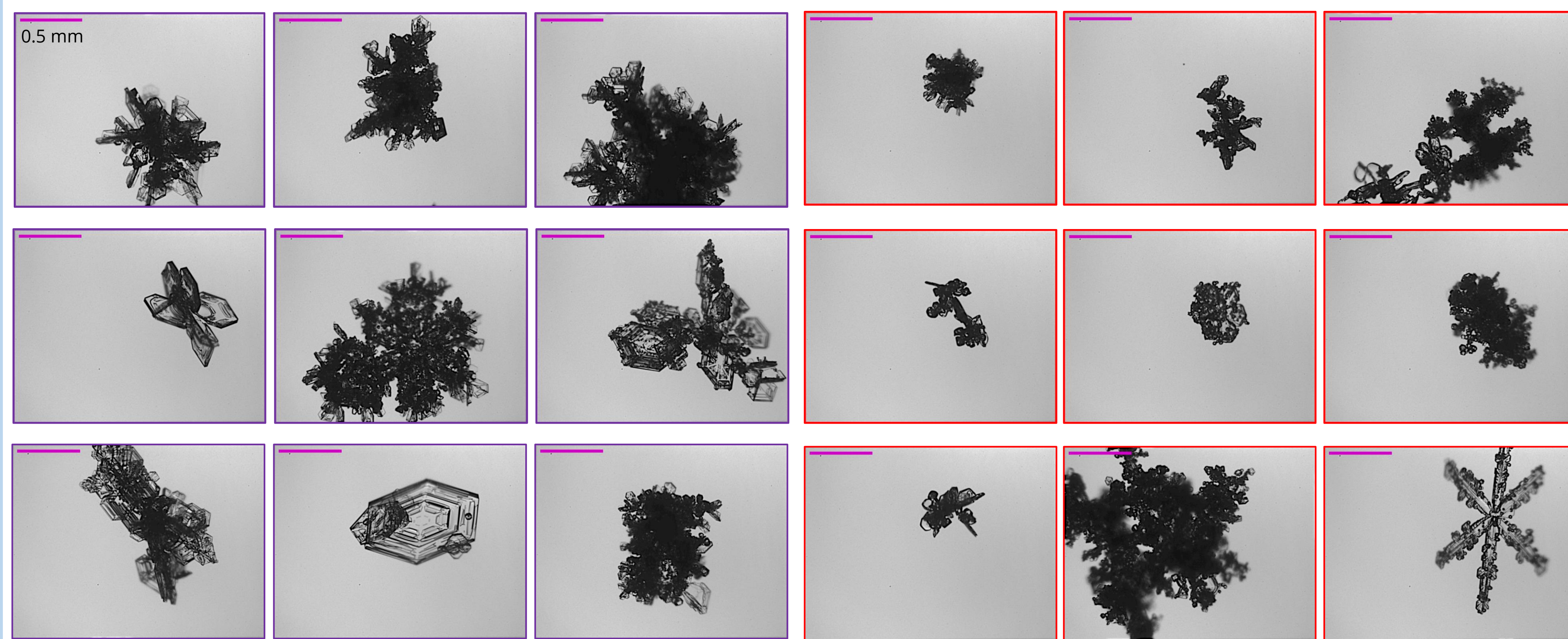


Flight 20230123 - 16:03:47 to 16:24:41 UTC

PHIPS Images:

Inside ice streamer
35 to 45 km or 16:07:55 to 16:09:09 UTC

Outside ice streamer
108 to 118 km or 16:17:04 to 16:18:15 UTC

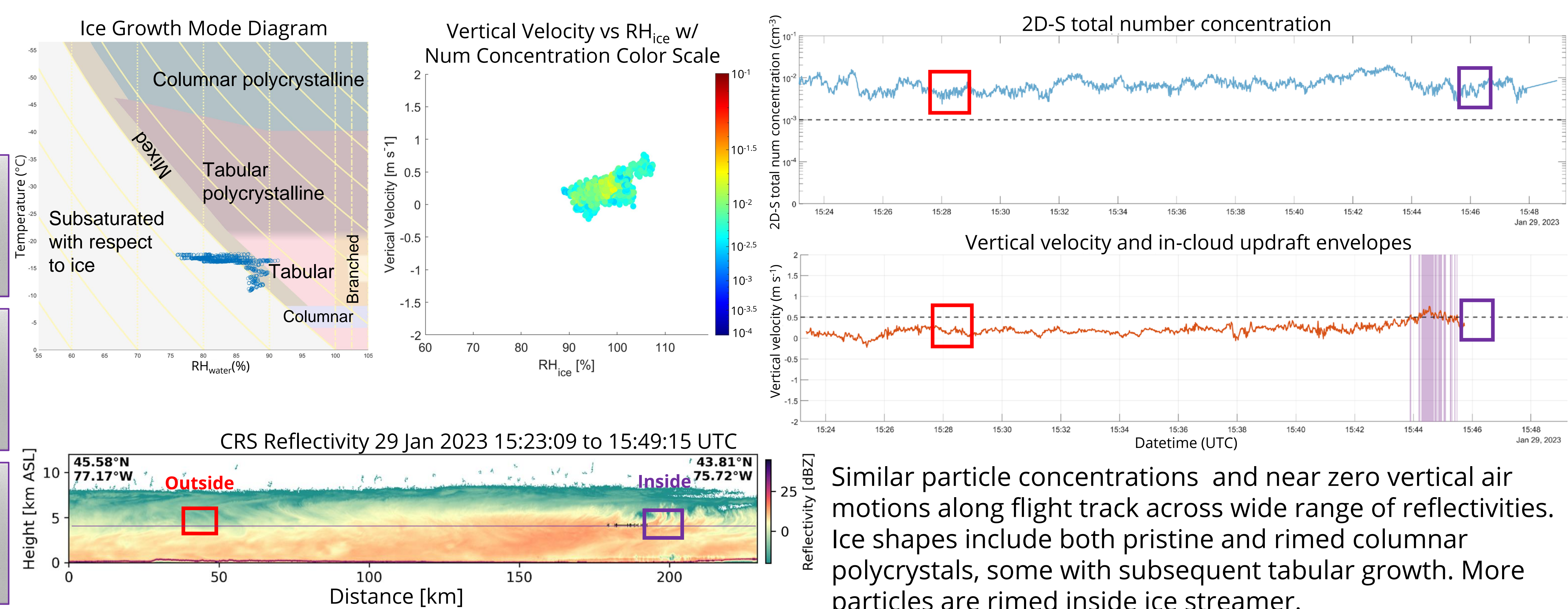
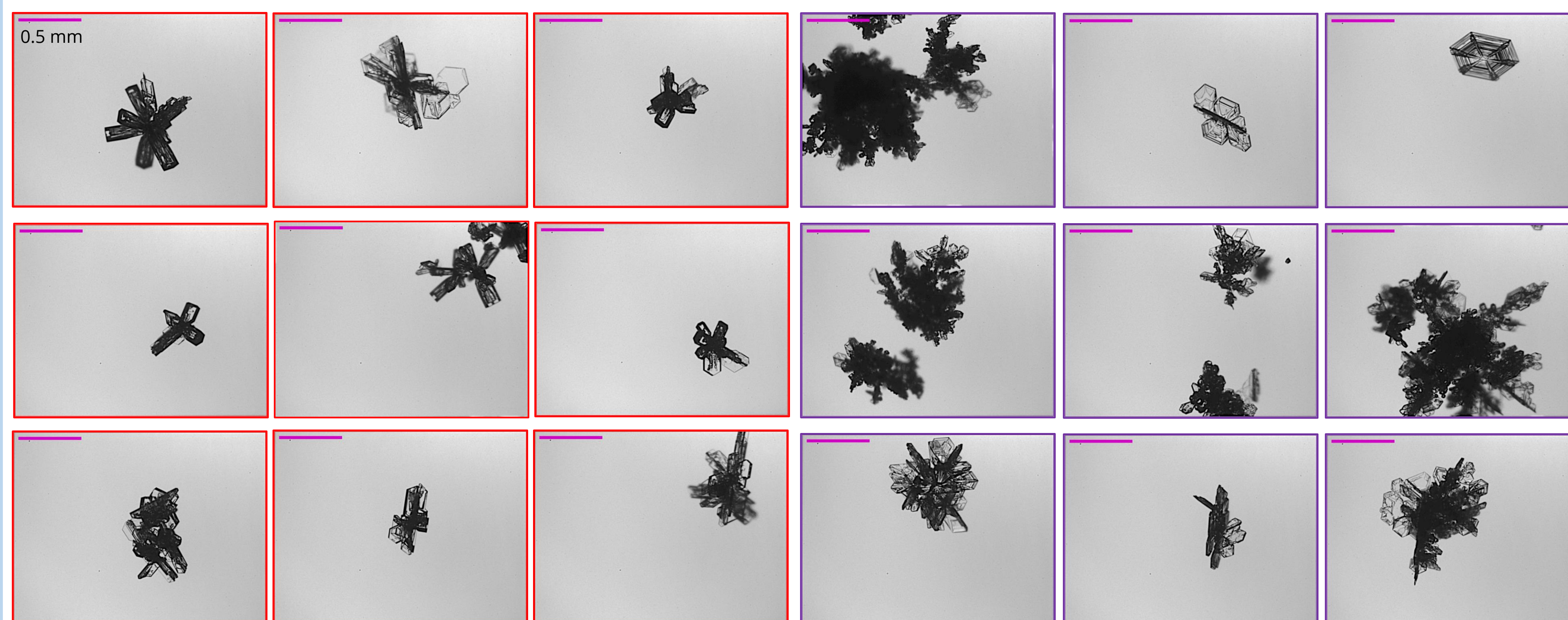


Flight 20230129 - 15:23:09 to 15:49:15 UTC

PHIPS Images:

Outside ice streamer
40 to 50 km or 15:27:37 to 15:28:45 UTC

Inside ice streamer
195 to 205 km or 15:45:48 to 15:46:34 UTC



Summary: Varied snow particle shapes and degrees of riming (no riming to heavily rimed) were sampled within a few km of cloud top. Heavily rimed particles were not expected since the concentration of super-cooled droplets tends to decrease with decreasing temperatures. Both flight legs are at temperatures $> -20^\circ\text{C}$. Particles falling through flight level included tabular polycrystals (formed at temperatures between -22°C and -40°C) and columnar polycrystals (formed at temperatures $< -40^\circ\text{C}$). Mixtures of shapes indicate that nearby ice particles originated in different RH and temperature conditions and had traversed through different sequences of environments even near the top of the storm where precipitation-size ice particles are usually younger than those at lower altitudes.

Acknowledgements

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