

# **An Evaluation of a Convolutional Neural Network for Classifying Images from In-situ, High-resolution Cloud Probes**

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## **Abstract**

A vast amount of ice crystal imagery exists from the high-resolution cloud probes, such as the Particle Habit Imaging and Polar Scattering (PHIPS) probe and Cloud Particle Imager (CPI), which have been deployed on aircraft during a variety of field projects. During a cirrus anvil experiment near Cape Canaveral, Florida in 2019 (CapeEx19), a vast amount of ice crystal imagery was obtained where a large percentage of particles were classified as chain aggregates. Our objective is to classify crystals by habit and identifying chain aggregates to provide information about their origin since different habits form under different temperature and humidity conditions. Identifying ice crystals' properties leads to better understand of the microphysical processes, which play an important role in the Earth radiation budget and precipitation processes. Traditional classification methods where images are manually reviewed show reasonable performance; however, it requires a large amount of a scientist's time. Given the sizable data set gathered during recent field projects such as CapeEx19 and NASA's Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field projects, there is a need for an automated classification approach. Convolutional Neural Networks (CNN) have the potential to reduce the time required by using a training data set produced by manual classification to create a complex nonlinear model directly from the images. The performance of CNN models to classify particles by habit, including chain aggregates, is evaluated. The approach uses a data-driven model to classify the PHIPS and CPI images gathered during the CapeEx19 and IMPACTS field projects, based on training the models using a manually labeled data set of images. An evaluation data set is used to test the developed network and evaluate its performance. All evaluation metrics show the models' good performance for classifying single ice crystals followed by chain aggregates and aggregates.