Observations and Applications of Data Taken with the Cloud Profiling Radar System

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Introduction

During the past year, the University of Massachusetts' Cloud Profiling Radar System (CPRS) team has been active in collecting and processing data. Participation in several field campaigns has produced new and interesting data sets. A classification software was also developed using rule-based techniques and neural networks to identify cloud particles. This paper describes the activities of CPRS from March of 1995 to March of 1996. In the first section, involvement in field experiments is briefly described. This is followed by a discussion of some of the new data sets acquired and a short description of the classification software.

Experiments

CPRS participated in several field experiments during the past year. Locations included different regions in the United States and the South Pacific lending a more global sampling of cloud data. Each experiment is described below.

During March of 1995, CPRS collaborated with the Pennsylvania State University Department of Meteorology to study continental stratus clouds. Data was taken concurrently with the Penn. State 94 GHz cloud radar over a three week period. In situ data was provided by the University of Wyoming's King Air research aircraft.

Immediately after the Penn. State experiment, the radar system was moved to the ARM-SGPCART site in Billings, OK to take part in the Ground Based Remote Sensing (GBRS)-IOP. The main goals where to further access the utility of dual-frequency radar and to study cloud geometry. One of the projects was to study the life cycle of anvil clouds with both CPRS and the GOES-8 geo-synchronous satellite.

In the summer of 1995, CPRS was repackaged into a sea container to participate in two South Pacific experiments. The first was the Maritime Continent Thunderstorm Experiment (MCTEX), a multi-sensor effort on Melville Island, Australia running from mid November to mid December of 1995. The primary goals were to study tropical storms known as "Hectors," in particular to study cirrus anvils associated with these storms. This experiment also involved new challenges of safely moving the system across the globe.

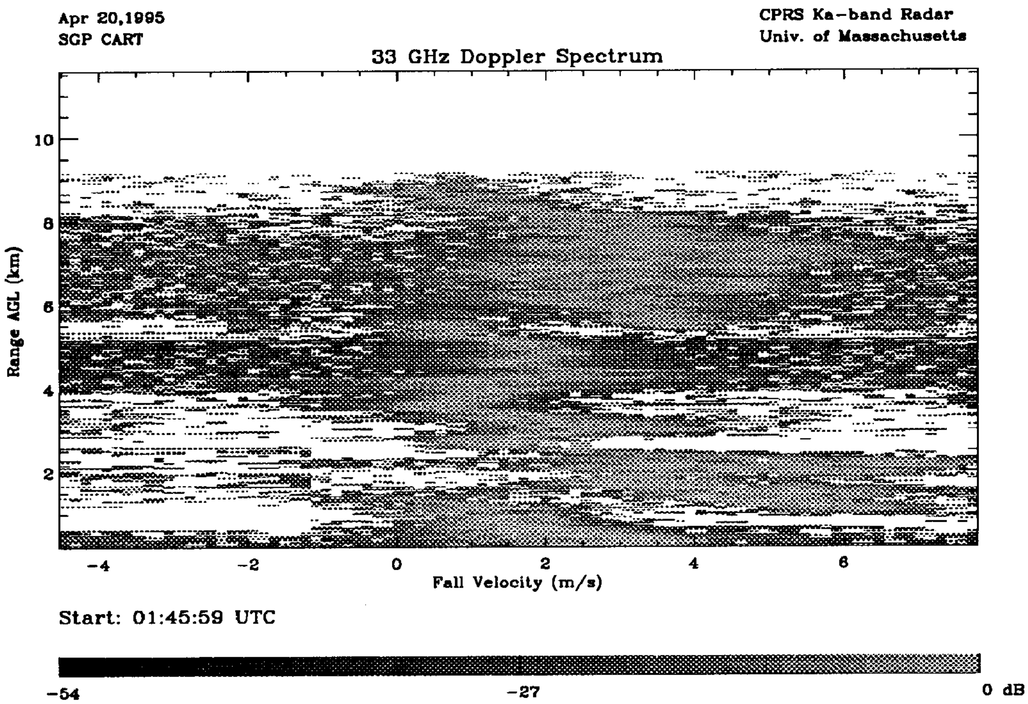
This month, CPRS is completing its South Pacific mission stationed on the NOAA research vessel Discoverer supporting the development of the Atmospheric Radiation and Cloud Station (ARCS) on Manus Island. CPRS will take cloud measurement while the ship sails around the island.

New Data

This past year's active field schedule produced a growing data archive of a variety of clouds. Among the new data sets are full Doppler spectrum measurements of both precipitating and nonprecipitating clouds. Figure 1 shows an example of a normalized power weighted velocity spectrum for a cloud with precipitation. A melting layer is located at 2.5 km which can be easily identified by the sharp decrease in fall velocity and narrowing of the spectral width.

Another of the new data sets are the first fully polarimetric measurements at 33 and 95 GHz. Measurements of correlation magnitude ($(|P\mathit{hv}(0)|)$ specific differential phase *(KDP),* and differential reflectivity *(ZDR)* were taken during precipitation events. Comparing the data with reflectivity and linear depolarization measurements should provide information on particle phase, shape, and orientation.

While on Melville Island, CPRS obtained cases of tall, convective thunderstorms unlike conditions observed in previous experiments. Analysis of both pulse-pair and spectral data is on going.



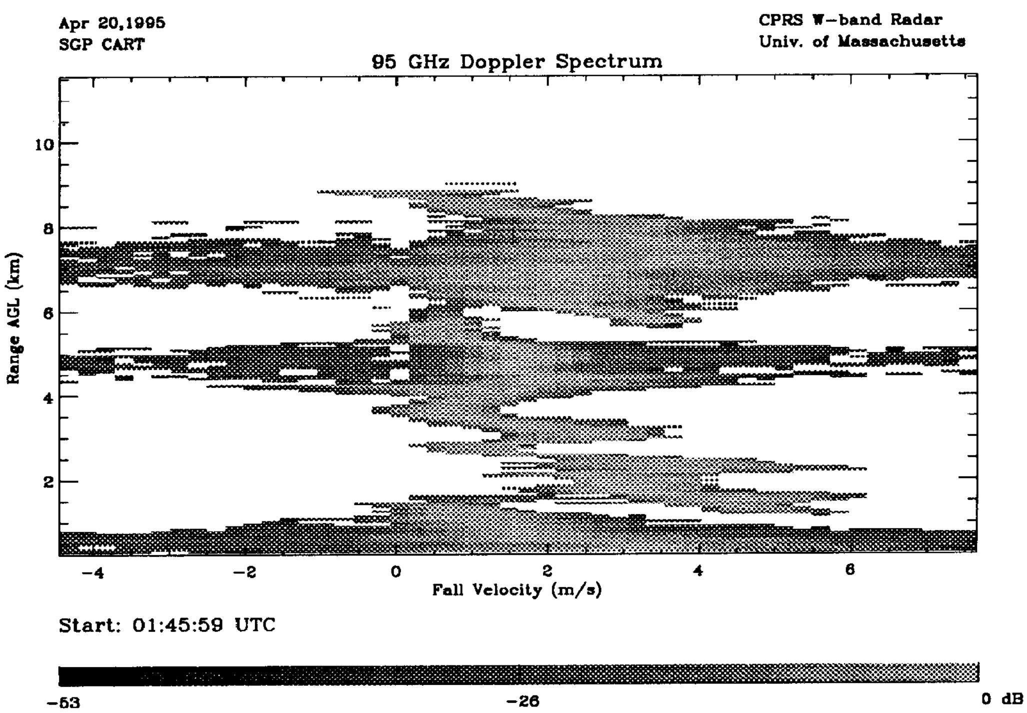


Figure 1. 33 and 95 Ghz Doppler spectrum of precipitation.

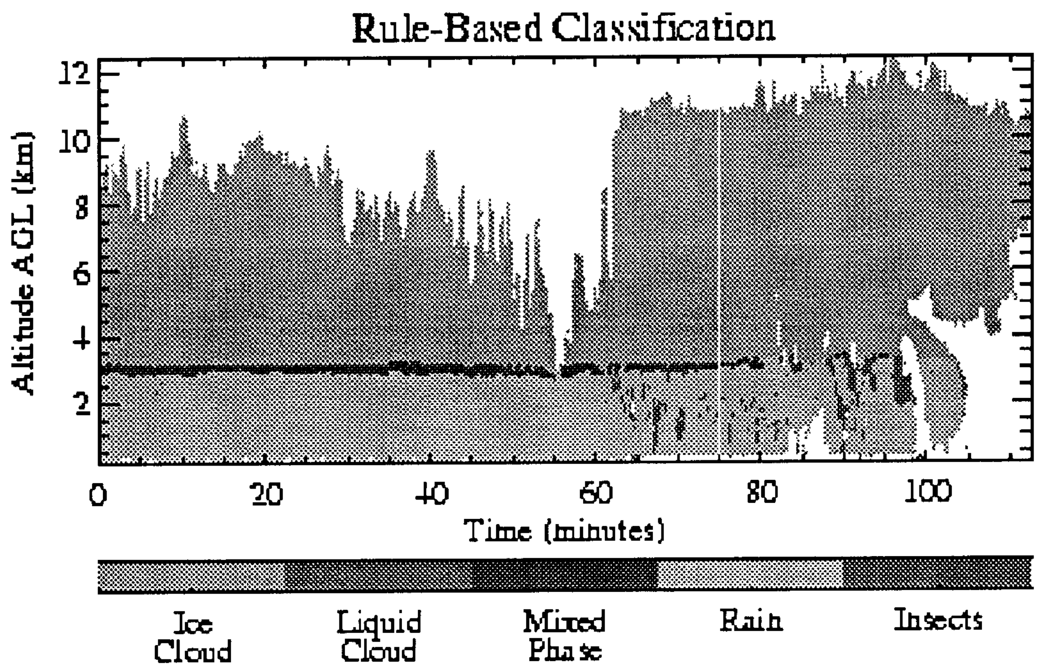
Classification of Clouds and Precipitation

Improved understanding of cloud physics depends on accurate identification and parameterization of clouds and precipitation. Currently, this information is obtained with a combination of remote sensing instruments and in situ measurements. However, collecting in situ data is often difficult and expensive.

In the absence of physical in situ data, clouds can be classified on the basis of dual-frequency radar measurements. Data from CPRS has been used to develop rule-based and neural network classification software. Broad classes such as ice, water, mixed phase clouds, rain, and insects can be identified using rules based on pixel measurements of reflectivity, linear depolarization ratio, fall velocity, and selected morphological and contextual information. For example, Figure 2 demonstrates the classifier's results for a thunderstorm which moved over the CART site on May 7, 1995.

Conclusions

The CPRS team is currently processing and interpreting the new data sets, as well as making plans for future experiments. Collaboration with other researchers to produce meaningful results is also a priority. We are most interested in examining the utility of our new measurements, such as the polarimetric and Doppler spectrum measurements, and making full use of the classification software.



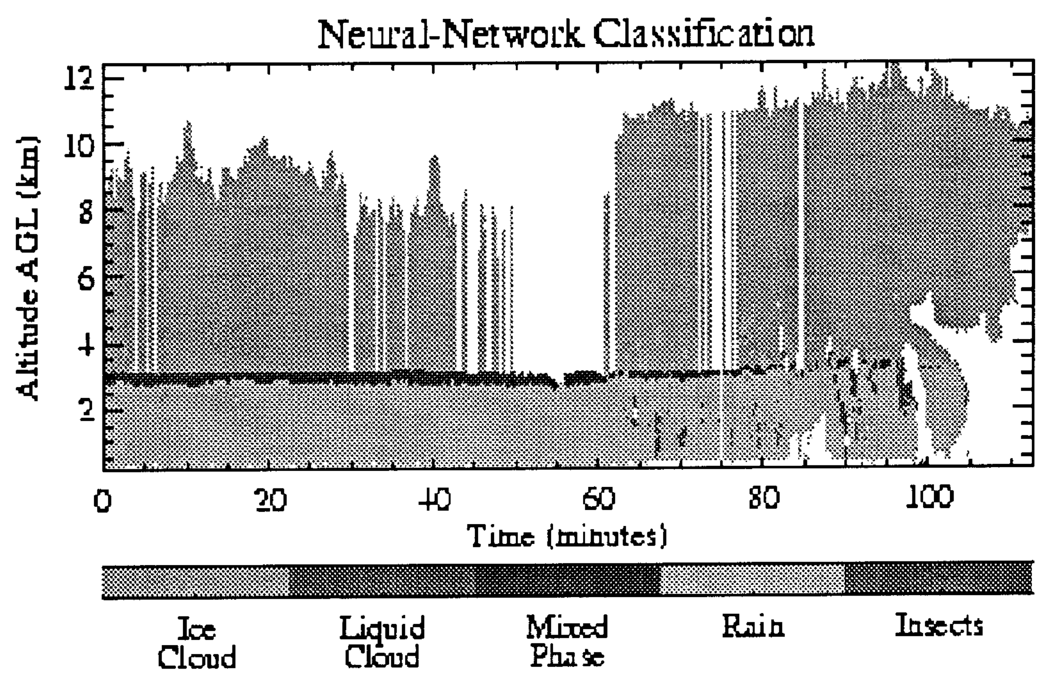


Figure 2. Cloud-region classification by a neural network and rule based classifier.