Automated Hail Size Distributions from Hail Pads

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INTRODUCTION

Distributed by the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS), hail pads are used to document hail events.

Hail pads are 12"-by-12" Styrofoam blocks covered in aluminum foil.

BACKGROUND

CoCoRaHS has expanded its hail pad network.

Currently, hail pad processing is manual and based on estimation.

A CoCoRaHS employee measures dents from smaller sample areas and scales these results to the size of the pad, estimating the hail distributions using four generic size categories.

Developments in image processing have created an opportunity to automate this process.

METHODOLOGY

Hail pads from CoCoRaHS are photographed with a digital camera in outdoor sunlight.

Photography method allows for hail pad images to be documented remotely.

Photographs are analyzed using a developed program based on Circular Hough Transform (CHT).

Basic image processing methods are used to enhance images.

CHT algorithm is used to detect round markings.

Initial tests were completed with four hail pads.

Fig. 1: Four Initial Hail Pads

Pads from Fort Collins 07/14/11 Hail Event (from top): CO-LR-509, CO-LR-36, CO-LR-290, CO-LR-834

RESULTS & APPLICATIONS

Small / Medium hail dents were more accurately detected using the algorithm than CoCoRaHS' estimation on three of four hail pads, when compared to counts conducted by researchers.

Significant image processing needed to mitigate the distortions in deformed pads (e.g. too many wrinkles: CO-LR-509 or jumbo hail: CO-LR-834).
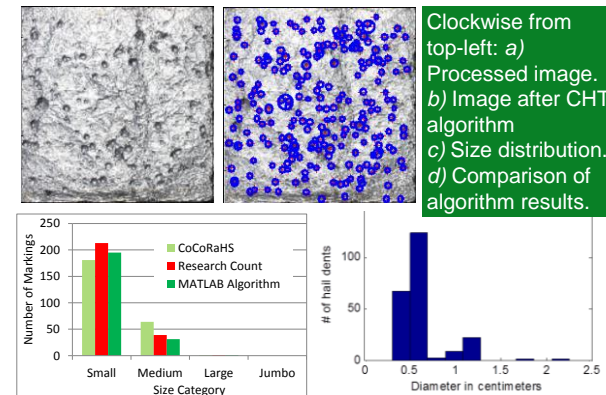
Detailed hail size distributions created, as in Fig. 2.c.

Fig. 3: HCA Hail Detection Map and Radar Data Overlaid with Two Hail Pad Locations and Hail Distributions from Fort Collins 07/14/2011 Event
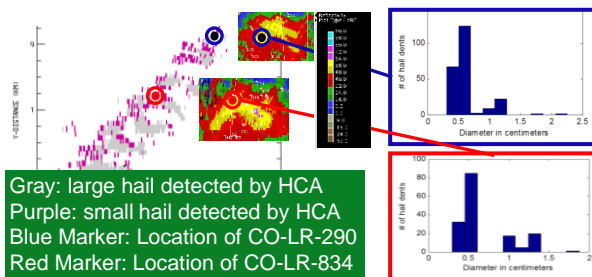
Gray: large hail detected by HCA
Purple: small hail detected by HCA
Blue Marker: Location of CO-LR-290
Red Marker: Location of CO-LR-834

Fig. 2: Algorithm Results from CO-LR-290 Pad

Clockwise from top-left: a) Processed image. b) Image after CHT algorithm c) Size distribution. d) Comparison of algorithm results.

Continuous hail distributions produced can provide detailed data regarding ground hail observations that can be executed extensively and inexpensively.

Distributions can be useful for both research and forecasting, such as in hail climatological studies, convective precipitation research or hydrometeor classification algorithm (HCA) verification (Fig. 3).

CONCLUSIONS

Results from initial hail pads demonstrate that an automated and accurate algorithm is feasible.

Automated hail size distributions from hail pads may be useful to both CoCoRaHS and the atmospheric science research community.

FUTURE WORK

Larger Sample: Twenty additional hail pads have been photographed and provided for testing.

Advanced Processing: Additional image processing methods will be implemented to mitigate pad features that cause false detections.

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