

Research Question

How do variations in updraft structure influence the evolution of drop size distributions and precipitation formation?

Multi Doppler Wind Retrieval

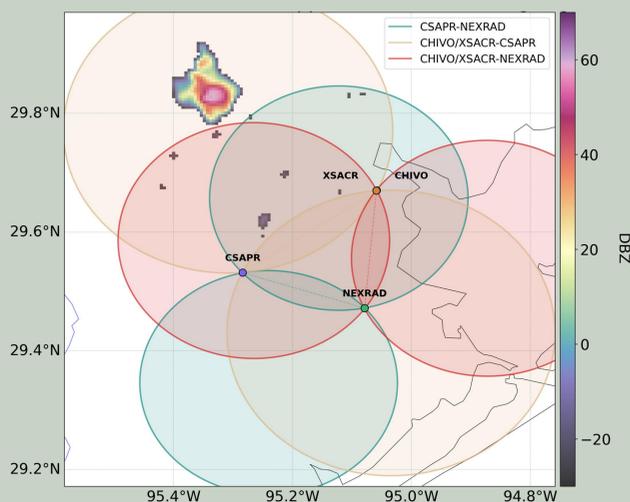


Figure 1: dual-Doppler (30° crossing angle) lobes for three radar pairs (CSAPR-NEXRAD in teal, CHIVO/XSACR-CSAPR in tan, and CHIVO/XSACR-NEXRAD in red) with the convective cell observed on August 7, 2022

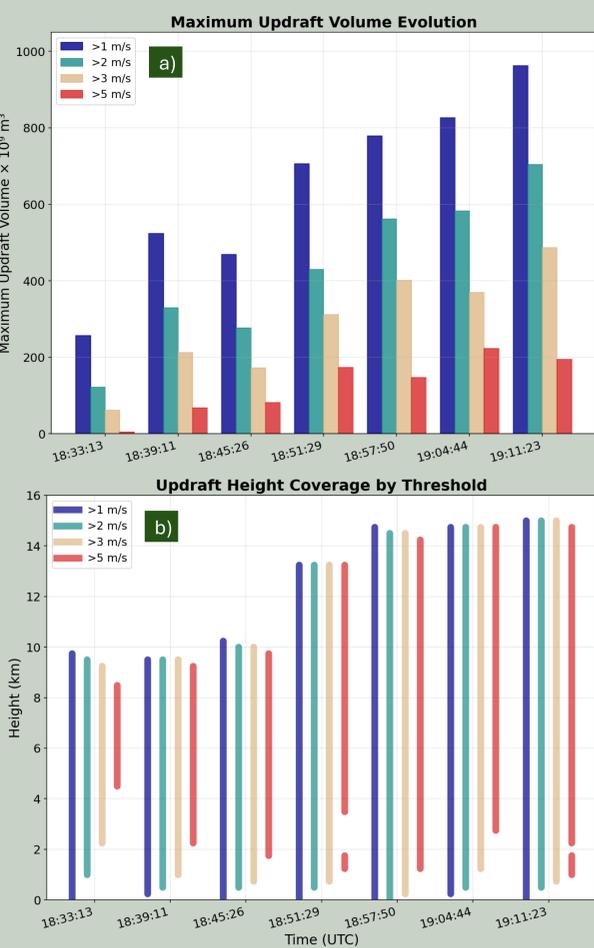


Figure 2: (a) largest updraft volume at each time step across four vertical velocity thresholds (>1, >2, >3, and >5 m/s), (b) corresponding vertical extent of the updraft, and the height ranges of the thresholds.

Conclusions and Future Work

- Peak DSD characteristics (D_0 , $\log_{10}N_w$) do not collocate with maximum updraft strength, suggesting microphysical evolution lags dynamical forcing
- Updraft structure modulates drop size growth via collision-coalescence below the melting layer
- Cases 2 and 3 (September 17, 2022) are in progress but require additional quality control

Introduction

- The **TRACER** and **ESCAPE** field campaigns in Houston, Texas, provided a multi-Doppler radar network to observe convective storm dynamics and evolution
- During the campaigns, CSU **CHIVO** operated in coordination with DOE **CSAPR** and **XSACR** to capture fine-scale vertical structures which enhanced the overall coverage beyond the local **KHGX** NEXRAD radar with our focus on August 7 and and 2 cases on September 17, 2022

Methods

- **SAMURAI** (Cha and Bell 2023) is a 3D variational wind retrieval framework within the LROSE ecosystem
- **Multi-radar volumes** were organized into ~5-minute intervals to produce 3D wind fields
- **Drop size distribution** parameters were derived from polarimetric variables following Bringi et al. (2009)

SAMURAI Analysis - 18:51:29 UTC

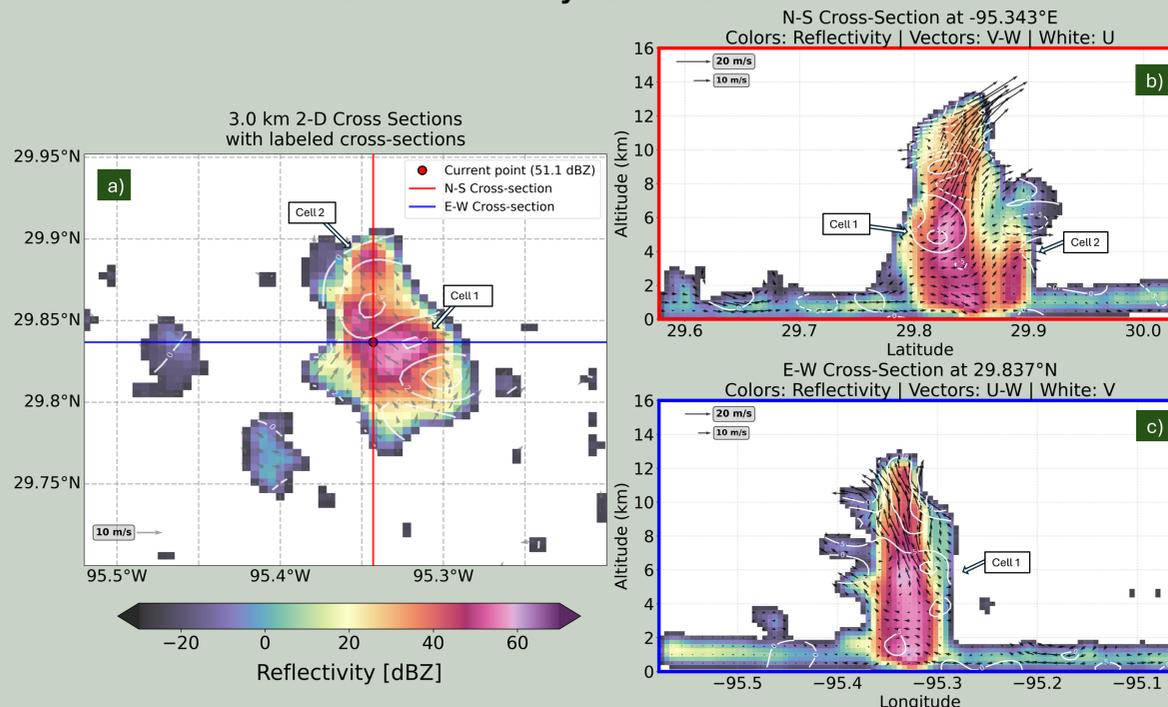
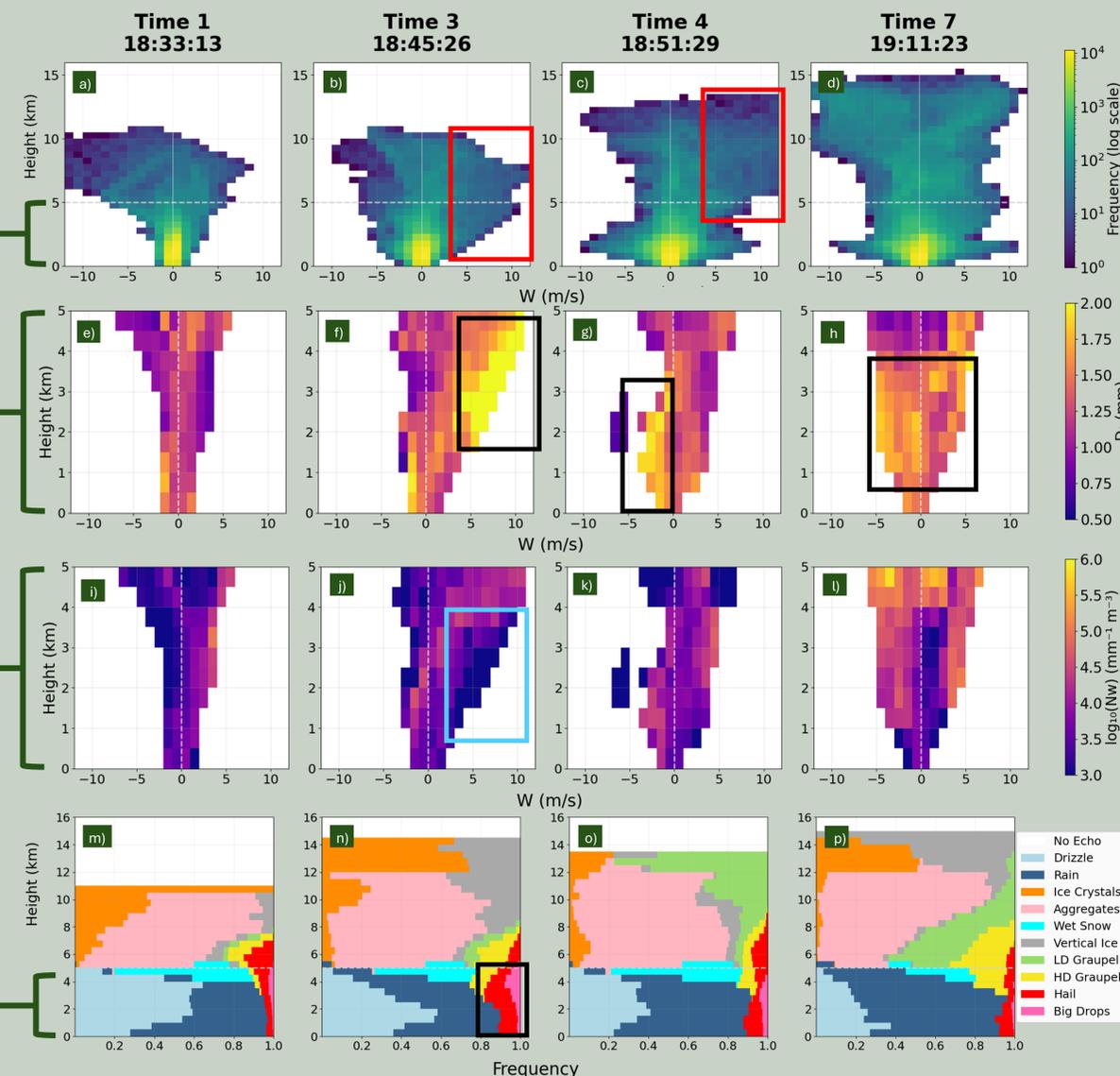


Figure 3: Horizontal cross-section (a) shows reflectivity, horizontal winds, and vertical velocities (contour) within Cells 1 and 2 at 18:51:29. **North-south cross section** (b) shows meridional and vertical wind in vectors and white contours denote zonal wind. **East-west cross section** (c) shows zonal and vertical wind in vectors and white contours denote meridional wind.

Cell 1 exhibits a compact but intense updraft structure with **strong vertical velocities** despite its limited horizontal extent, while **Cell 2** remains in **early development**, showing weaker intensity but a clear strengthening trend throughout the analysis period.

Drop Size Distribution



Wind: Weak updrafts early (T1), strengthening to maximum above the melting layer at peak (T4), with near-surface downdrafts emerging at T4 driving large drop fallout. Structure becomes disorganized by T7.

D_0 : Small drops at T1, largest near/at peak (T3-T4), shifting to equilibrium size by T7 via collision-coalescence.

$\log_{10}N_w$: Concentration stays low even as drop size grows at T3 (under investigation). By T7, high intensity and equilibrium DSD indicate dominant collision-coalescence.

HID: Small drops dominate at T1. Peak hail and largest drops below the melting layer at T3-T4, dense ice aloft at T4. By T7, hail decreases below the melting layer, dense ice increases in mid-levels.

Figure 4: (a-d) CFADs of vertical velocity (0–16 km) from SAMURAI retrievals. (e-h) Mean drop size distribution vs. vertical velocity and height (0–5 km), colored by mean drop diameter. (i-l) Normalized intercept parameter (N_w) vs. vertical velocity and height (0–5 km), colored by drop concentration. (m-p) Normalized hydrometeor-type frequency (0–16 km)

Acknowledgements

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Radar analysis was done using LROSE (lrose.net), PyART (https://github.com/ARM-DOE/pyart) and CSU Radar Tools (https://github.com/CSU-Radarmet/CSU_RadarTools)