High pressure systems favor sea breezes over southeastern Texas

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Objectives

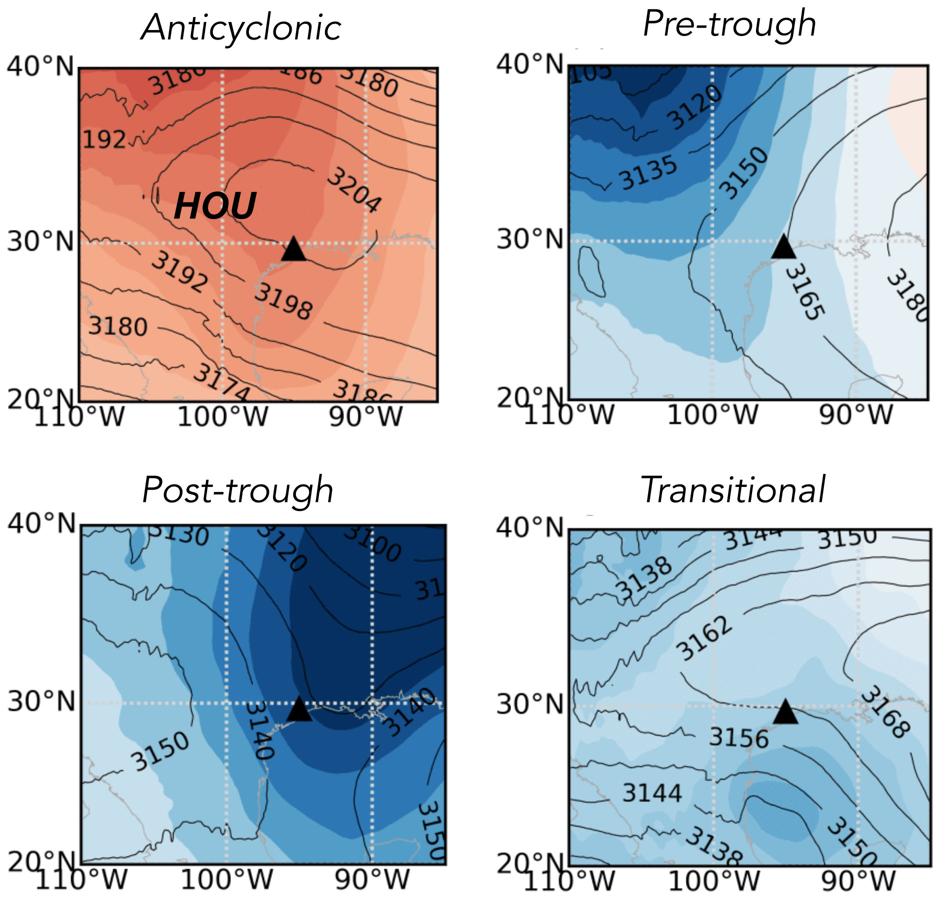
- Understand how the weather system circulations effect cloud properties over SE Texas.
- Identify the large-scale conditions that support sea breeze formation.

Approach

- Use a Self-Organizing Map (SOM) to capture the major synoptic regimes during 2010 to 2022, including the TRACER IOP.
- Project satellite and radar data onto each SOM regime to investigate the characteristics of cloud and precipitation properties.

Impact

- Machine learning reveals the relationships between the variability in synoptic circulations and cloud physics in SE Texas.
- These insights provide important constraints for the study of aerosol and cloud life cycle, and aerosol-cloud interactions during TRACER.



Anticyclonic *Pre-trough* *Post-trough* *Transitional*

***Figure**. Composite of geopotential heights [m] (contours) and anomalies (colors) at 700 hPa for each SOM node.*

Wang, D., et al. (2022). Linking synoptic patterns to cloud properties and local circulations over southeastern Texas. JGR-A, 127, e2021JD035920.

Aerosol Influence on Microphysical Processes in Simulated Deep Convection

Stephen M. Saleeby[1], Susan C. van den Heever[1], Peter J. Marinescu[1], Mariko Oue[2], Pavlos Kollias[2]
[1]Colorado State University, [2]Stony Brook University

Objectives

Examine aerosol effects on the evolution of microphysical characteristics of ordinary convective cells simulated by multiple models.

Data Source

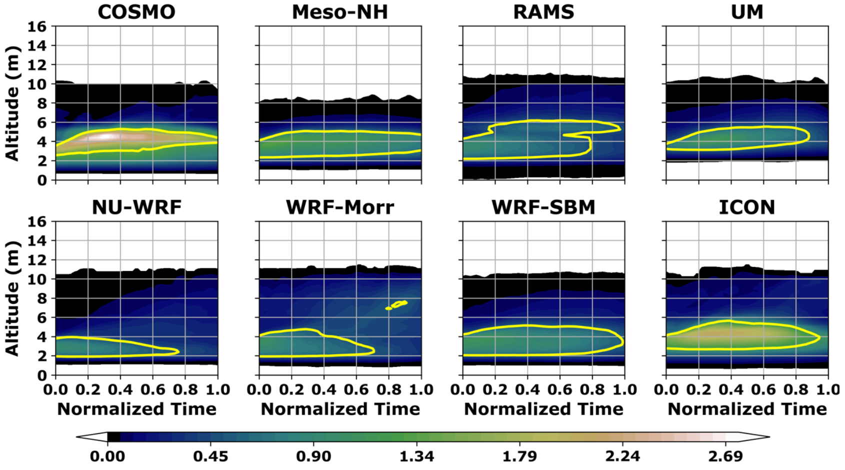
Deep convection simulations from the *ACPC* MIP. TOBAC cell-tracking used to sample convective cores. Figures to the right are composite averages of cell cores normalized over cell lifetimes (20-60 min). Yellow contours in left column plots denote the 50%-of-max contour for the given model.

Outcomes

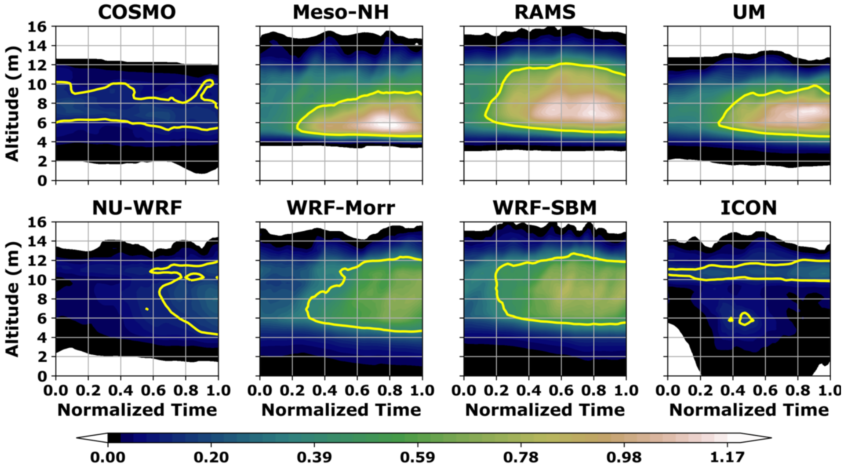
- Limited variability among models in cloud water vertical extent, cell lifetimes, and regarding aerosol impacts on the change in cloud water.
- Substantial variability among models in the ice phase in vertical extent and placement, over cell lifetime, and in response to aerosol loading.
- Though not shown here, increased latent heating and reduced latent cooling due to aerosol loading is rather consistent across models, similar to cloud water response.

Low CCN Simulations

Cloud Water Mixing Ratio ($g\ kg^{-1}$)

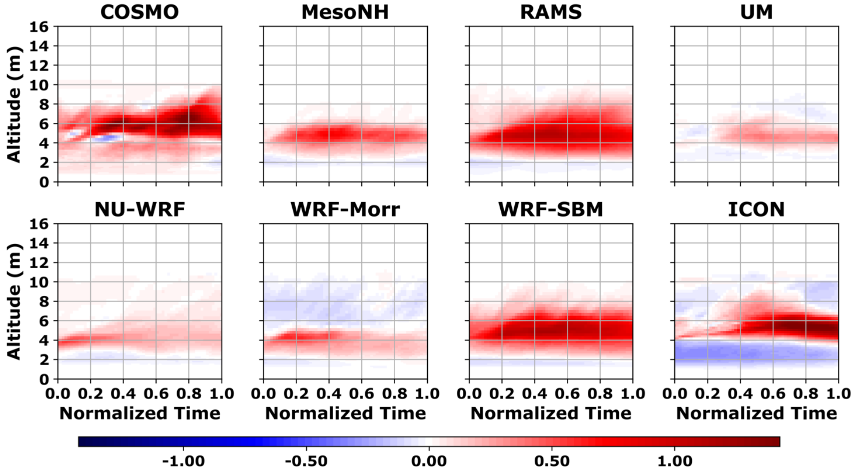


Ice Mixing Ratio ($g\ kg^{-1}$)

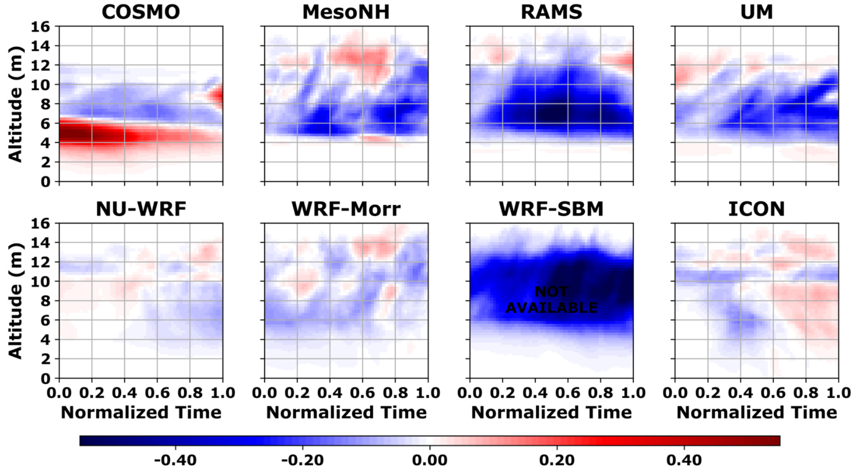


High CCN – Low CCN

Difference in Cloud Mixing Ratio ($g\ kg^{-1}$)



Difference in Ice Mixing Ratio ($g\ kg^{-1}$)



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Convective Cell Evolution Analysis Using High-Spatiotemporal Cell Tracking Observations

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1. Stony Brook University, 2. Colorado State University, 3. McGill University, Montreal, 4. Brookhaven National Laboratory

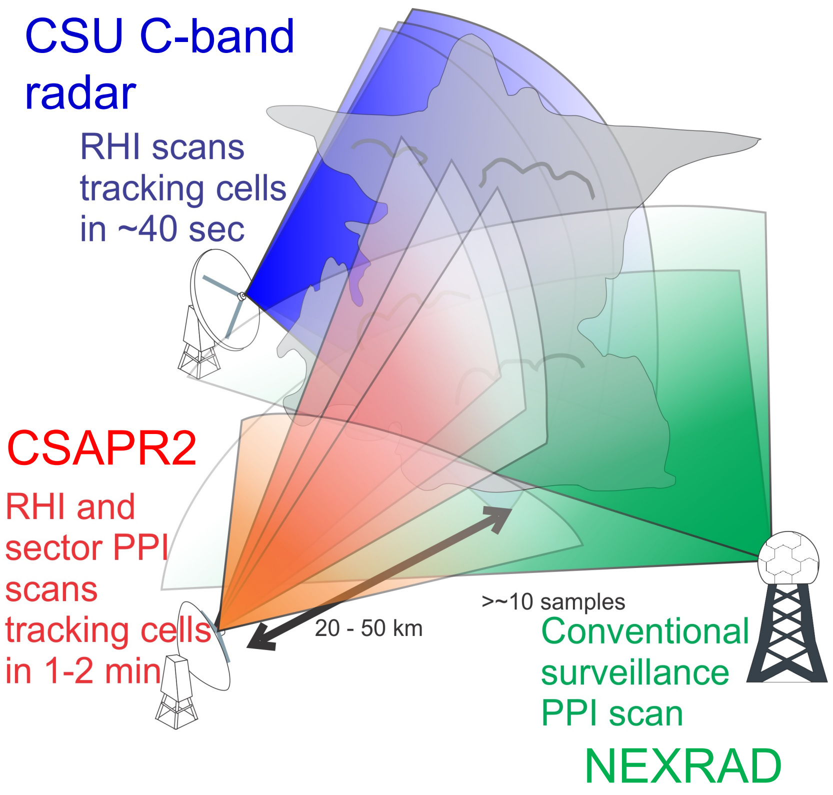
Objectives

Analyze convective cell evolution using cell tracking data from TRACER.

Outcomes

- High-spatiotemporal cell tracking was performed during TRACER based on OSSEs (Oue et al. 2022).
- Multi-Doppler radar wind retrieval is applied and provides vertical velocity data at 100-m horizontal and vertical resolutions every ~30-40 sec.
- K_{DP}/Z_{DR} columns representing particle size evolution are also tracked.
- Lifecycle of more cells for different aerosol environments will be analyzed (>10 cells for each).

Optimized Scan Strategy Based on OSSEs



CSU C-band radar

RHI scans tracking cells in ~40 sec

CSAPR2

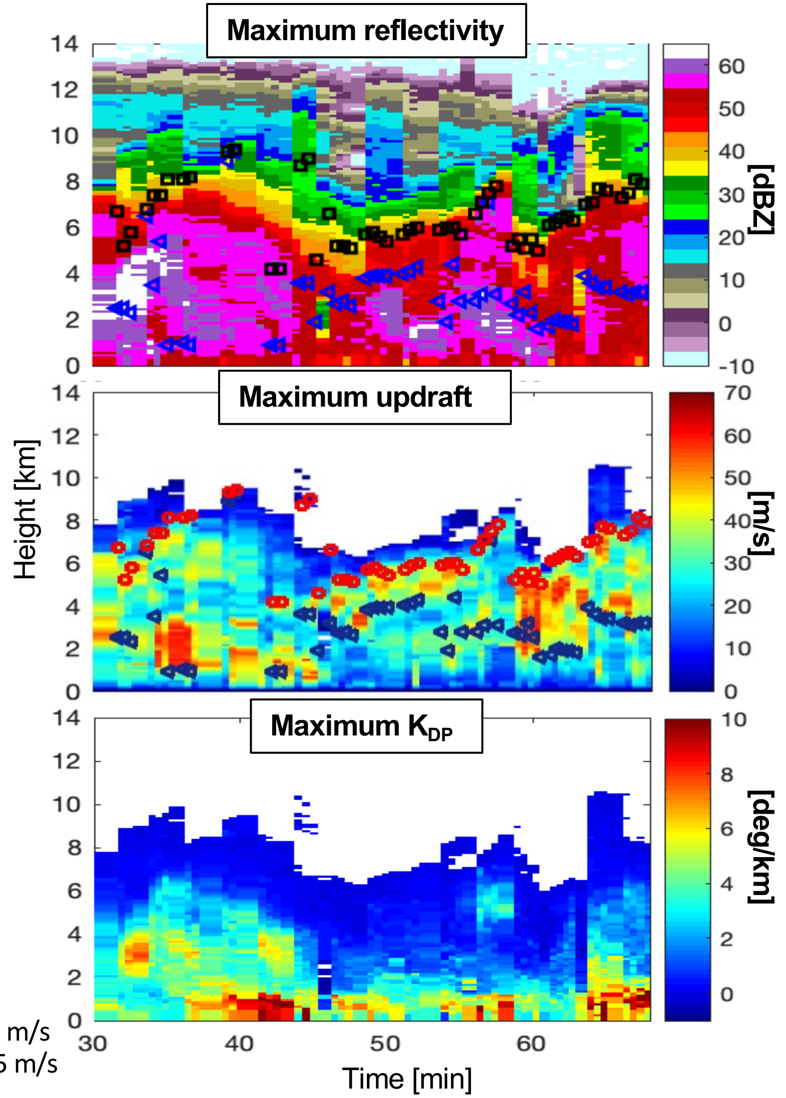
RHI and sector PPI scans tracking cells in 1-2 min

20 - 50 km

>~10 samples

Conventional surveillance PPI scan

NEXRAD



Square: Maximum height of mean updraft > 5 m/s
Triangle: Minimum height of mean updraft > 5 m/s

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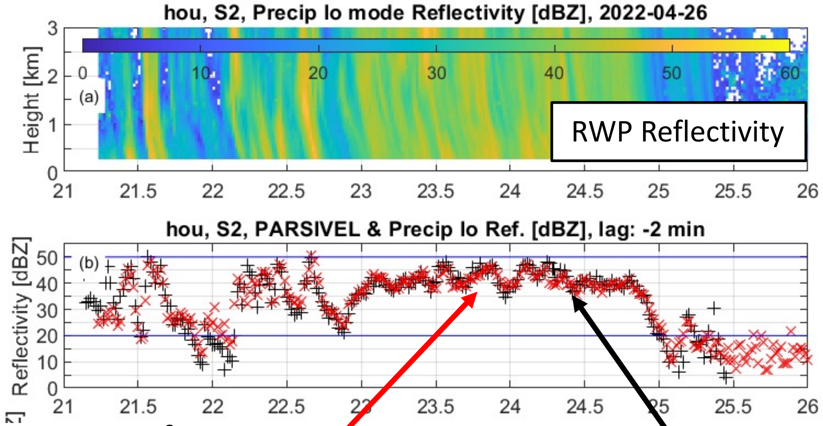
Calibrating TRACER CSAPR2: Upscaling Disdrometer to RWP to CSAPR2

Step #1. Calibrate RWP to Disdrometer

Using RWP reflectivity at 500 m AGL, adjust RWP calibration until reflectivity agrees with surface PARSIVEL reflectivity.



RWP Reflectivity

Hour of Day

RWP @ 500 m

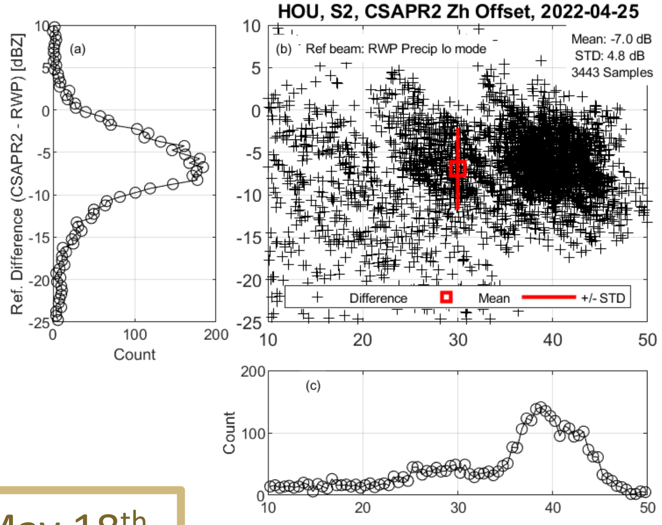
PARSIVEL

(RWP: **R**adar **W**ind **P**rofiler)

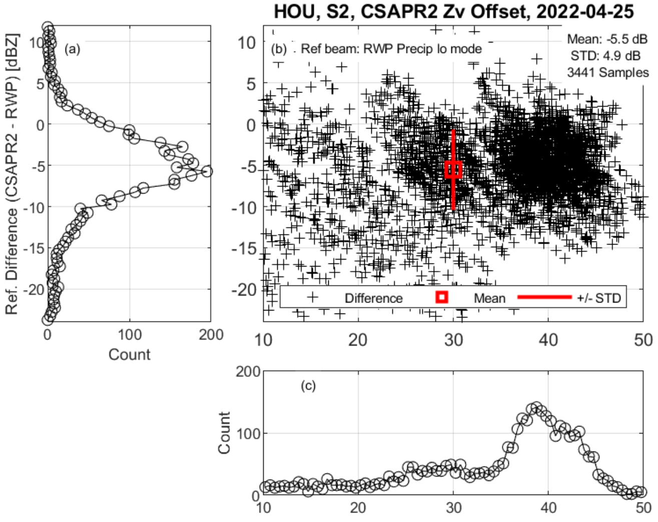
Step #2. Calibrate CSAPR2 to RWP

Using simultaneous RWP and CSAPR2 vertically pointing observations, compare CSAPR2 reflectivity with RWP reflectivity.

Reflectivity Difference



RWP Reflectivity [dBZ]



RWP Reflectivity [dBZ]

As of May 18th

CSAPR2 Horizontal Polarization

CSAPR2 **Zh is 7.0 dBZ to low**

(STD = 4.8 dBZ)

CSAPR2 Vertical Polarization

CSAPR2 Zv is 5.5 dBZ to low

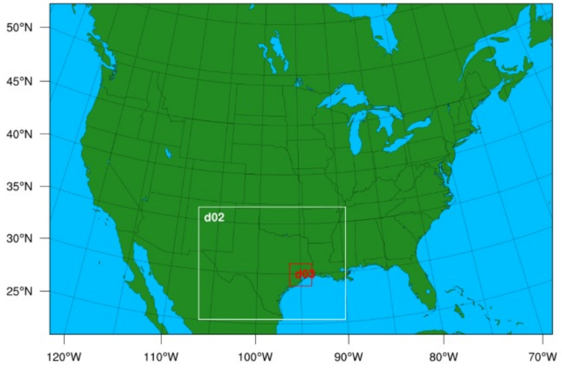
(STD = 4.9 dBZ)

University of Colorado **Boulder**

Christopher R. Williams, Paytsar Muradyan, Scott Giangrande, Karen Johnson, Ya-Chien Feng, and Alyssa Matthews

Incorporating ARM TRACER Campaign Data into a Fine-Resolution WRF-Chem-SBM Data Assimilation Framework

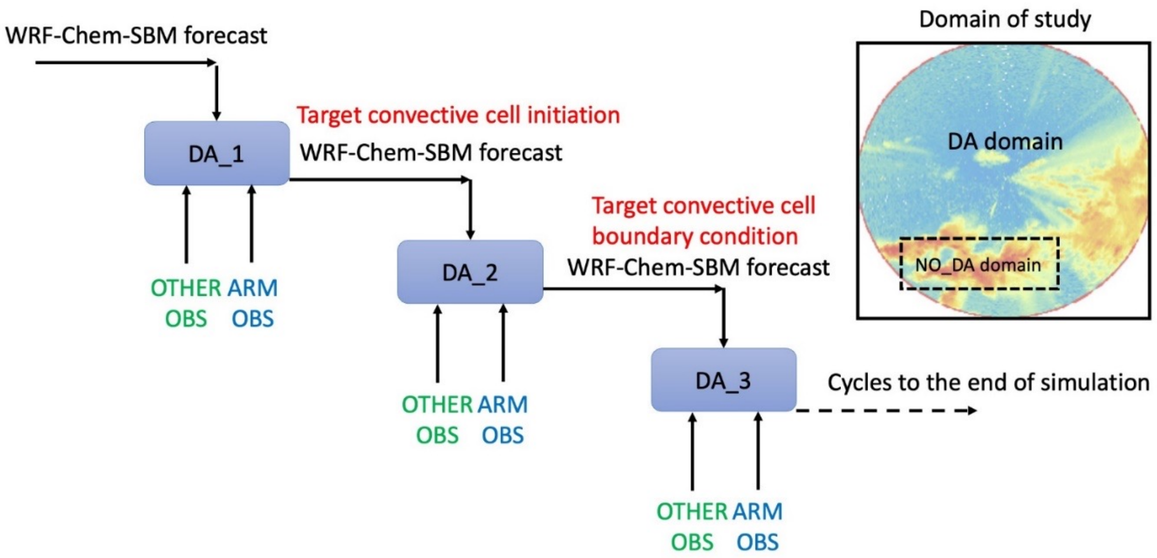
PI: Yunsoo Choi, University of Houston



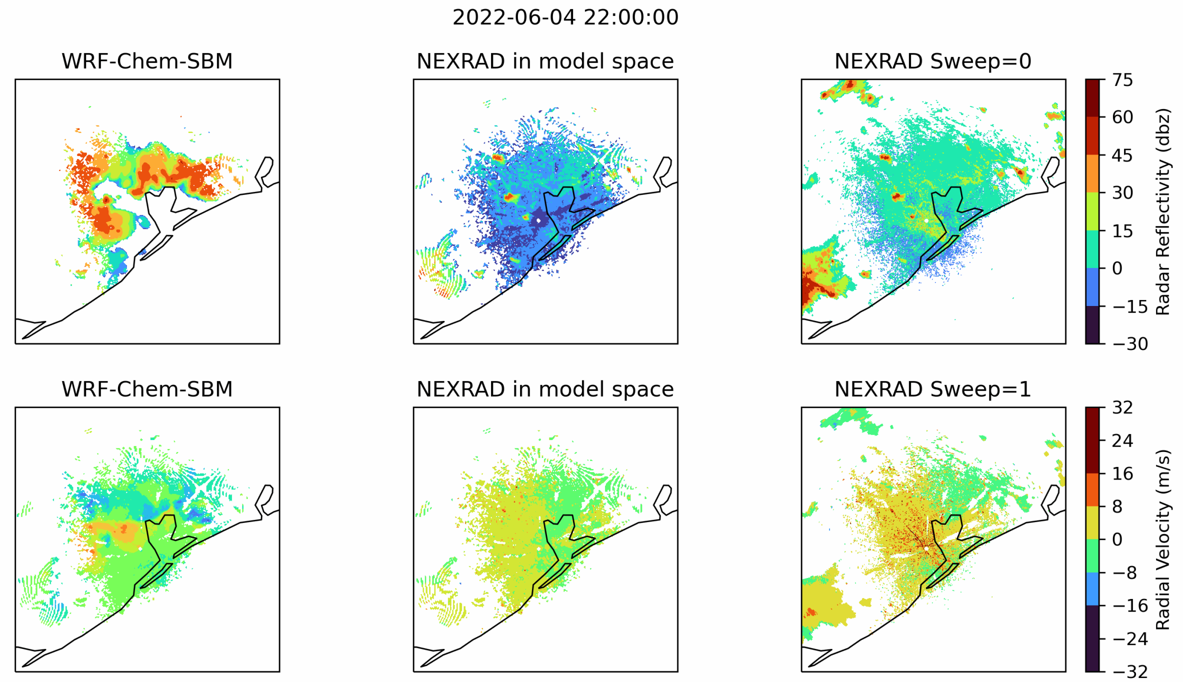
Objectives: Studying about

(1) the role of aerosols as CCN
(2) the impact of aerosols on convective strength
(3) the characteristic of in-cloud aqueous chemistry
(4) the impact of aerosols on radiative forcing of clouds

Novel Data Assimilation approach

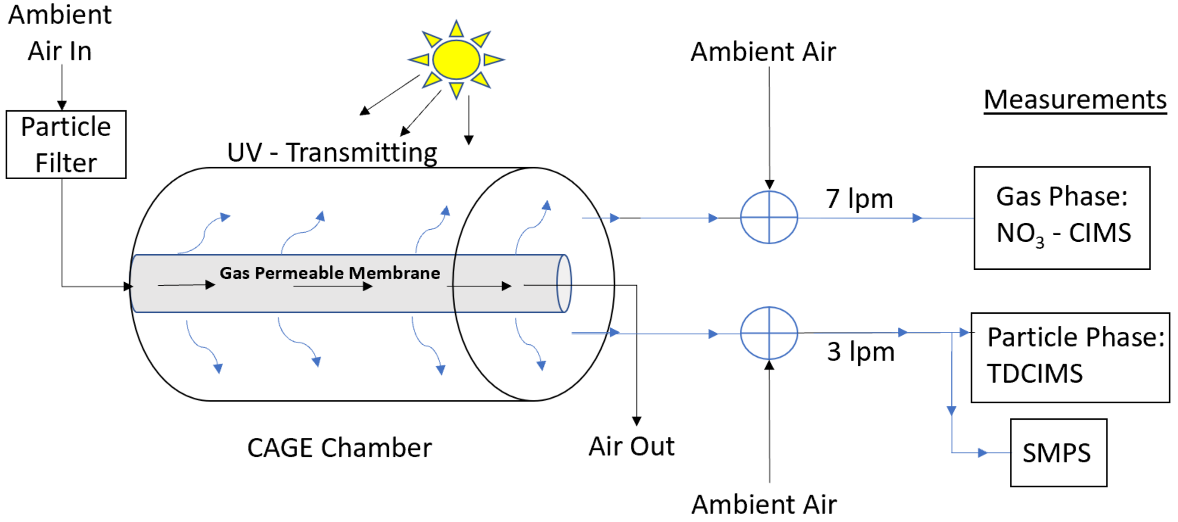


WRF-Chem-SBM / Forward Operator preliminary results



TRACER- Ultrafine Aerosol Formation and Impacts (TRACER-UFI)

Setup:

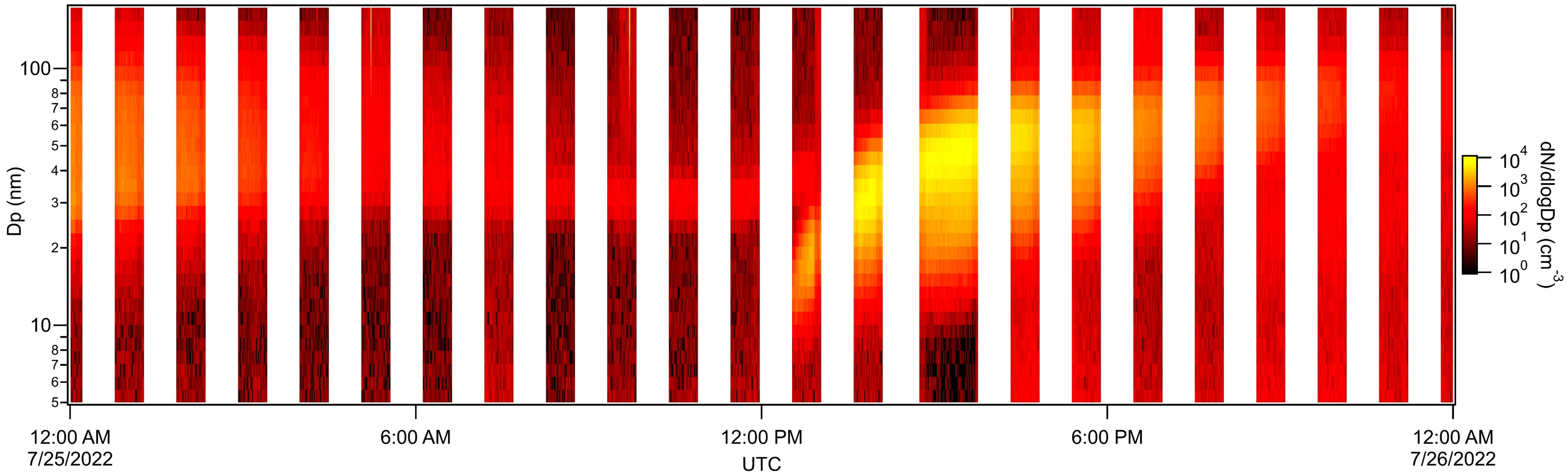


Key Findings:

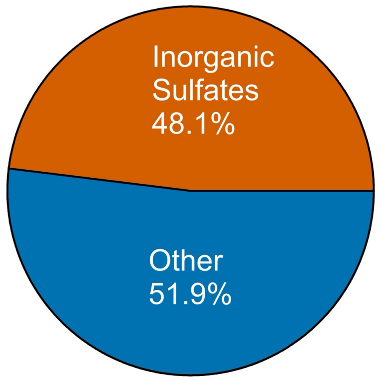
- New particle formation was observed most days in CAGE while rarely observed in ambient air
- Composition was measured and inorganic sulfates were found to be the dominant species
- Sulfuric acid concentration increased during event (not shown) suggesting key role in particle growth

Results: Ambient air sampling

CAGE air sampling



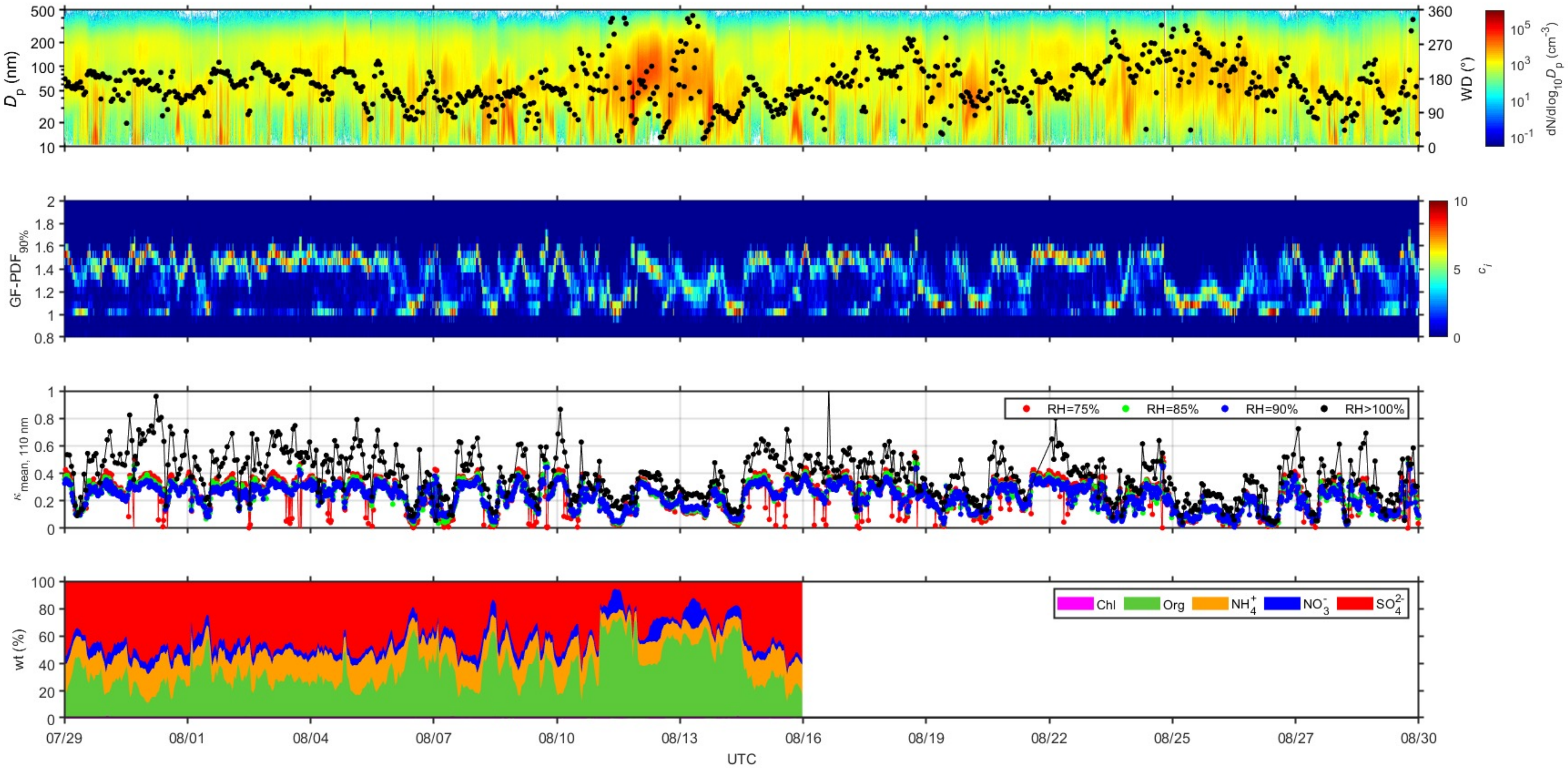
Particle Composition



Aerosol Hygroscopicities Under Both Supersaturated and Subsaturated Conditions at the ANC Site

center for
aerosol science
and engineering
WASHINGTON UNIVERSITY IN ST. LOUIS

Jing Li, Jiaoshi Zhang, Xianda Gong, Ashish Singh, Maria Zawadowicz, Chongai Kuang, and Jian Wang | Washington University in Saint Louis



- Particle hygroscopicities (κ_{CCN} and κ_{GF}) show strong diurnal variations and vary with the wind direction (i.e., aerosol sources).
- External mixtures of hydrophobic and hydrophilic particles
- Correlation of κ value with sulfate volume fraction.
- Highest κ values observed when the wind was from the south (i.e., gulf region).

ARM Tethered Balloon Operations during TRACER

- Ancillary Site (Guy, TX)
- 11 days b/t 03 -14 June (46 flights)
- 13 days b/t 02-14 July (32 flights)
- 13 days b/t 02-14 Aug (44 flights)
- 12 days b/t 02-14 Sept (28 flights)

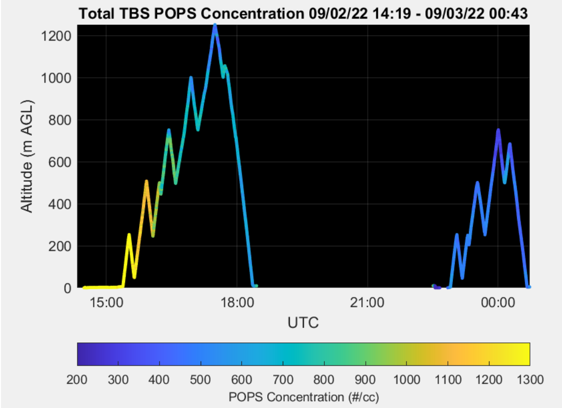
Tot 49 days, 150 flights

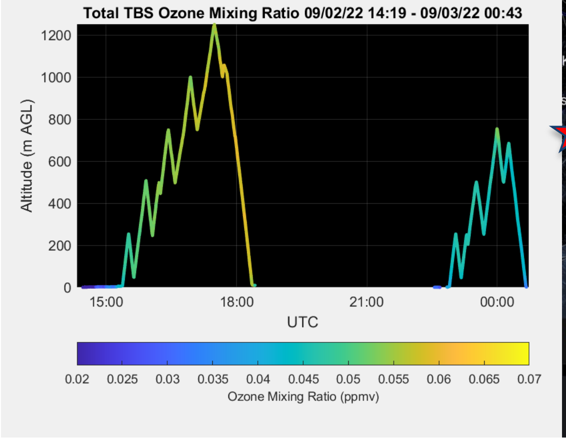
- Profiling/loitering
- Various instrument combinations

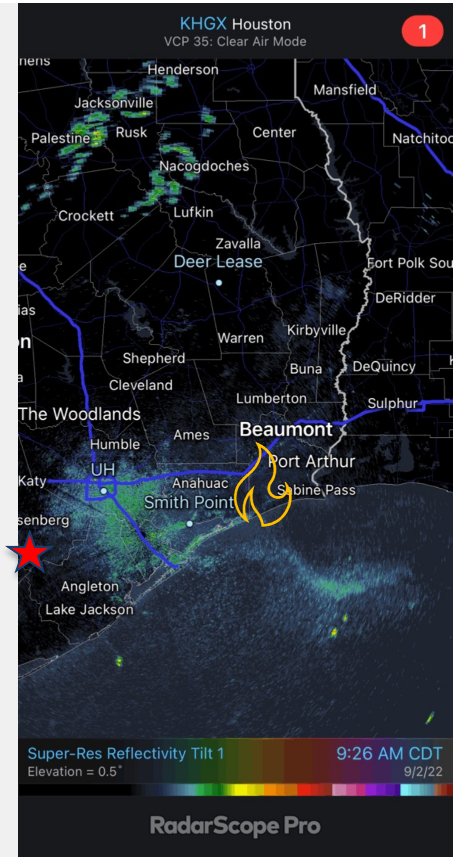
June – September 2022 ARM TBS Activities at TRACER

- TBS operated during multiple conditions during TRACER including:

Petrochemical industry fires





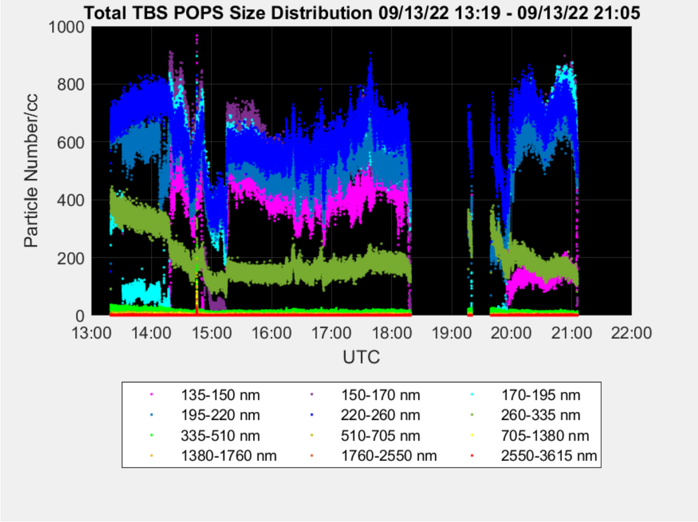


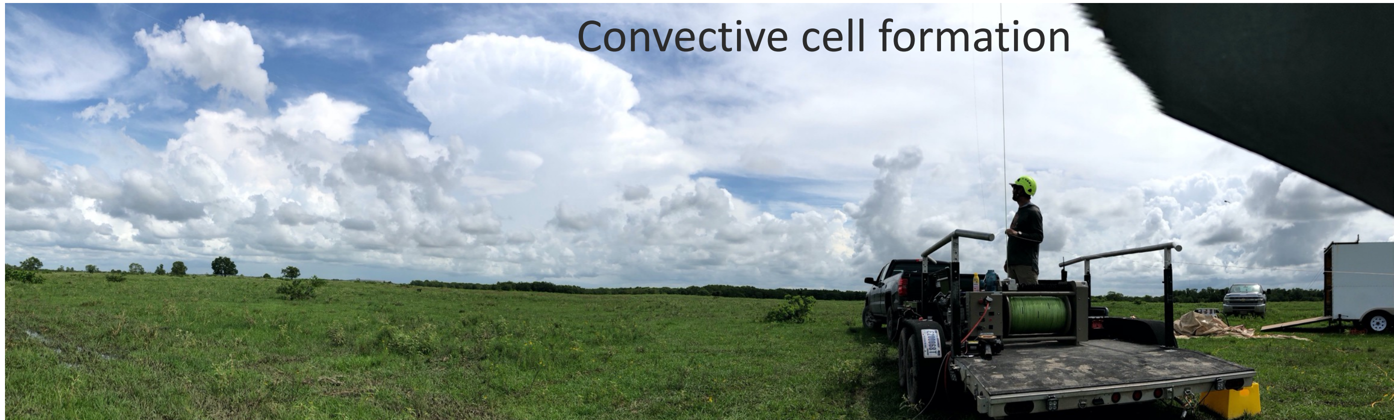
RadarScope animation courtesy of Travis Griggs, University of Houston

Lightning strike fires

Grass fires

Observed reductions in small particles (135 – 150 nm diameter) after convective cell development

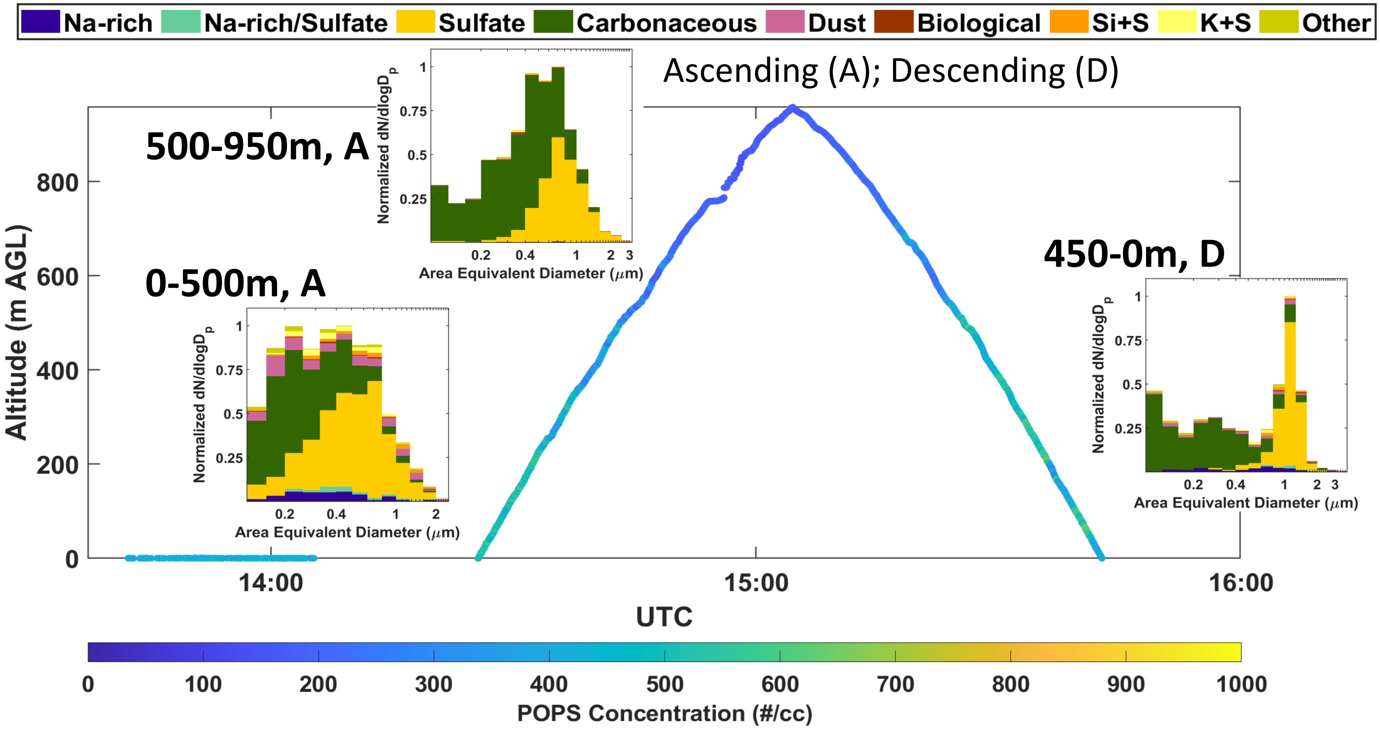


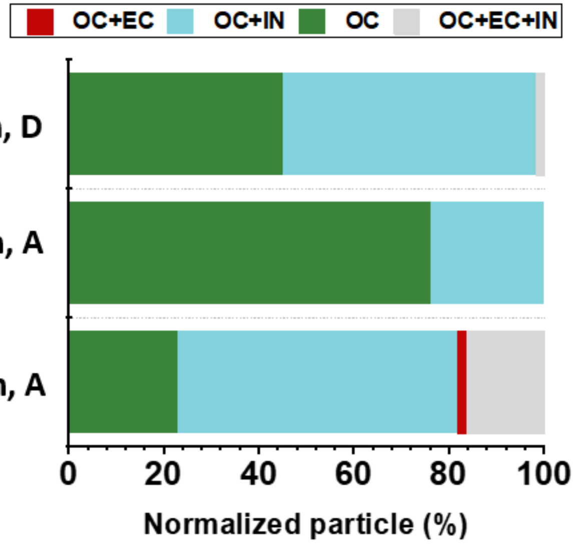


Convective cell formation

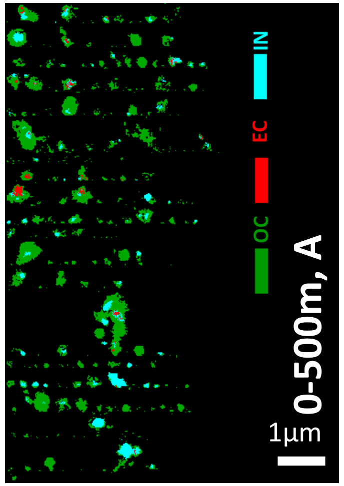
Vertical gradient of aerosol composition during TRACER

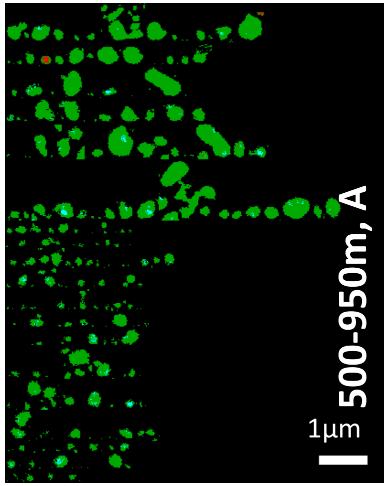
Nurun Nahar Lata, Darielle Dexheimer, Zezhen Cheng, Swarup China

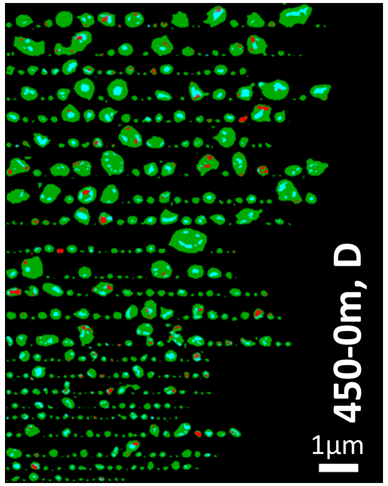




Mixing state derived from STXM/NEXAFS







- Size-resolved aerosol composition during a TBS flight (June 03, 2022), using multi-modal microanalysis (samples collected via STAC system)
- Particles are dominated by carbonaceous (smaller size) or sulfate (larger size) particles.
- High altitude particles are dominated with organic carbon (500-950m Ascending)