Preliminary analysis of the CSAPR2 convective cell tracking observations during TRACER

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Katia Lamer, Paloma Borque, Jason Barr and Zackary Mages







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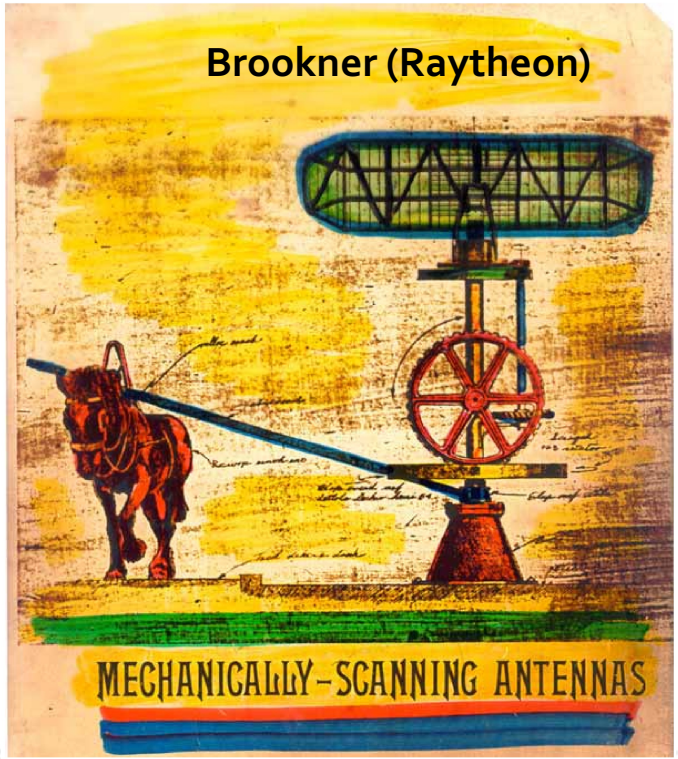
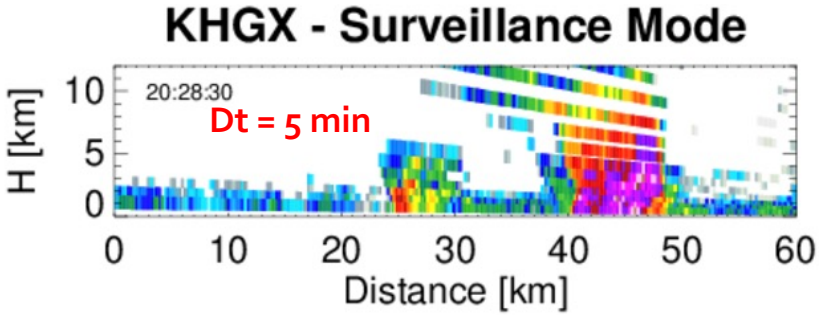
Radar spatiotemporal sampling



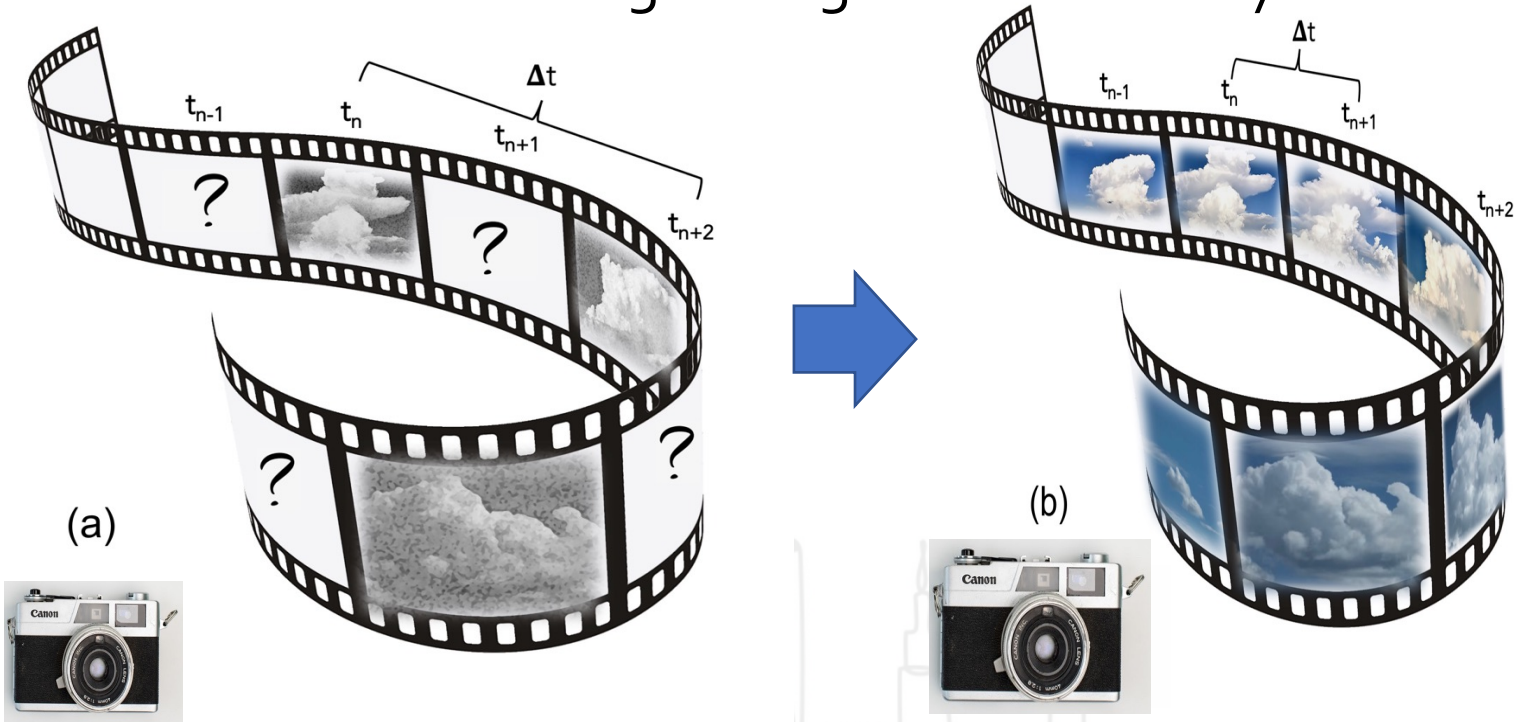


The mechanical inertia introduced by using a large reflector antenna placed on a positioner is one aspect of meteorological radars that has remained essentially the same over the past 60 years.

This single factor exerts considerable influence on a radar's spatiotemporal sampling.

Kollias et al., 2022 (BAMS)

Measurement requirement: radar-based convective cell tracking through out their lifecycle



We collect frames of different clouds not the entire storyline of the same cloud; sampling is static, not <u>when and where is needed;</u>

Kollias et al., 2022 Bulletin AMS

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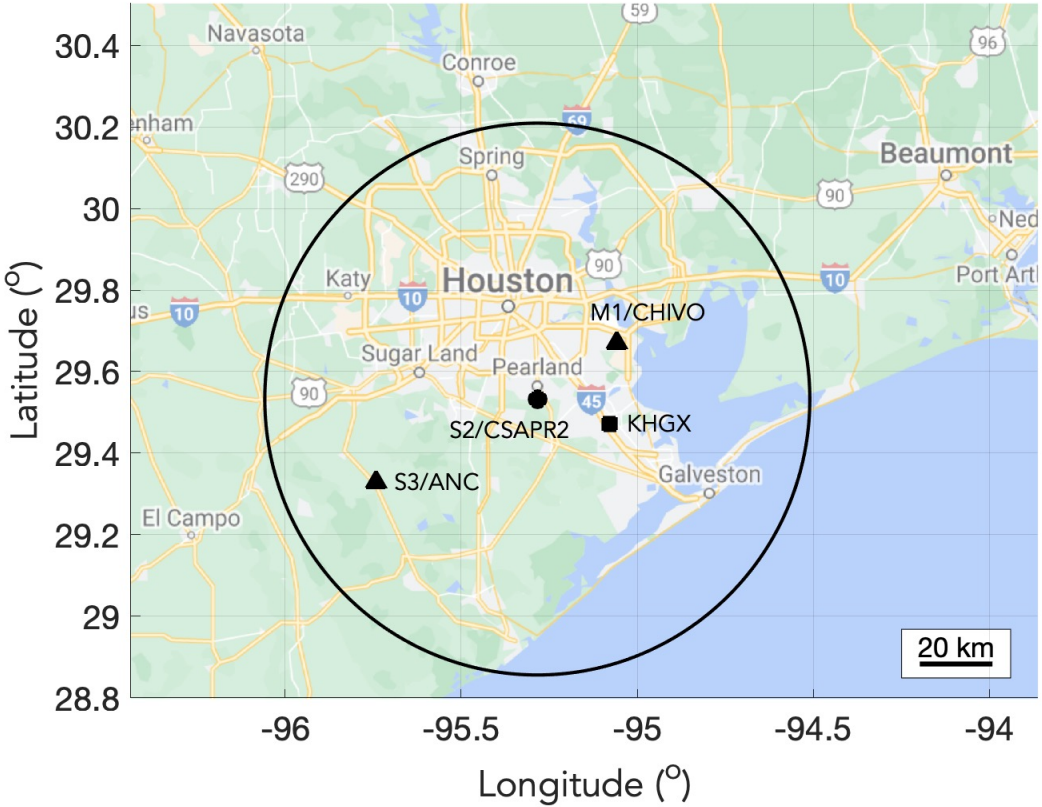
Cell tracking radars



National Weather Service
KHGX: WSR-88D

DOE - ARM
2ND generation C-band Scanning ARM Precipitation Radar (**CSAPR2**)

NSF – ESCAPE
CSU C-band Hydrological Instrument for Volumetric Observation (**CHIVO**)
Available: August - September

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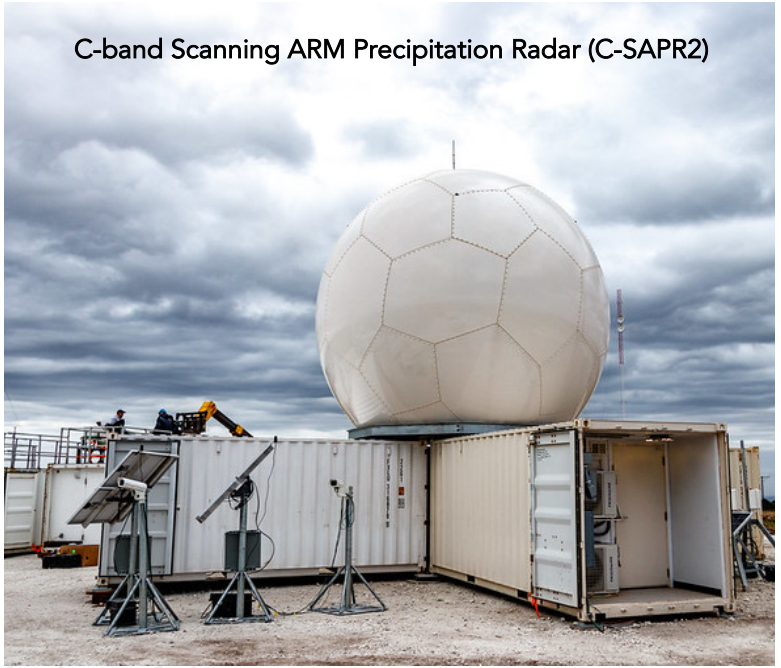
Tracking the lifecycle of convective storms using the Multisensor Agile Adaptive Sampling (MAAS)

MAAS provides autonomous resource management (CSAPR2) using external-to-the-CSAPR2 observations for continuous tracking of the same convective cell through its lifecycle (Kollias et al., 2020).

Inputs:

- GOES (ch 2 & 13),
- NEXRAD (all tilts, all variables),
- Terminal Doppler Weather Radar (TWR)
- Geostationary Lightning Mapper (GLM)
- Manual



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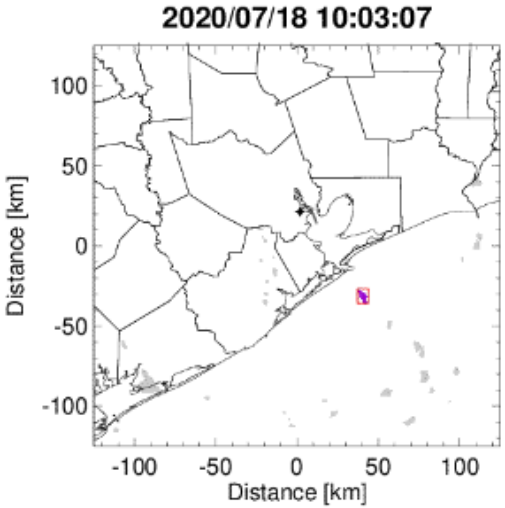
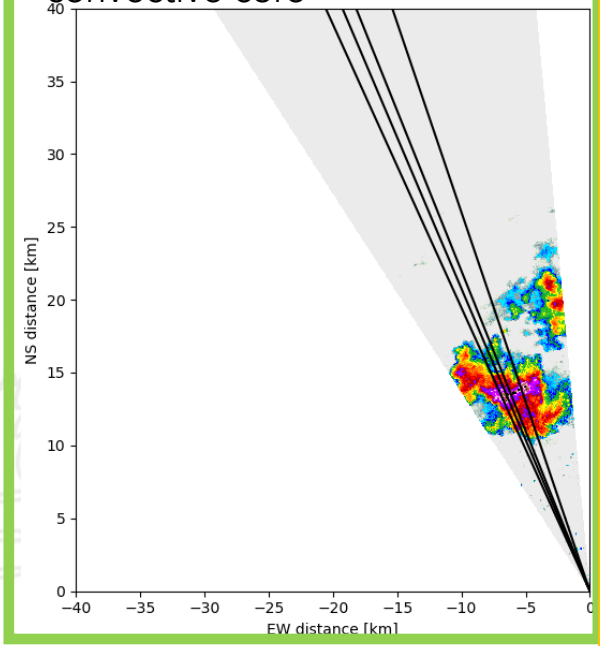
1

MAAS nowcasting provides cell location and size (width/top) based on operational data sources (GOES, NEXRAD)



2

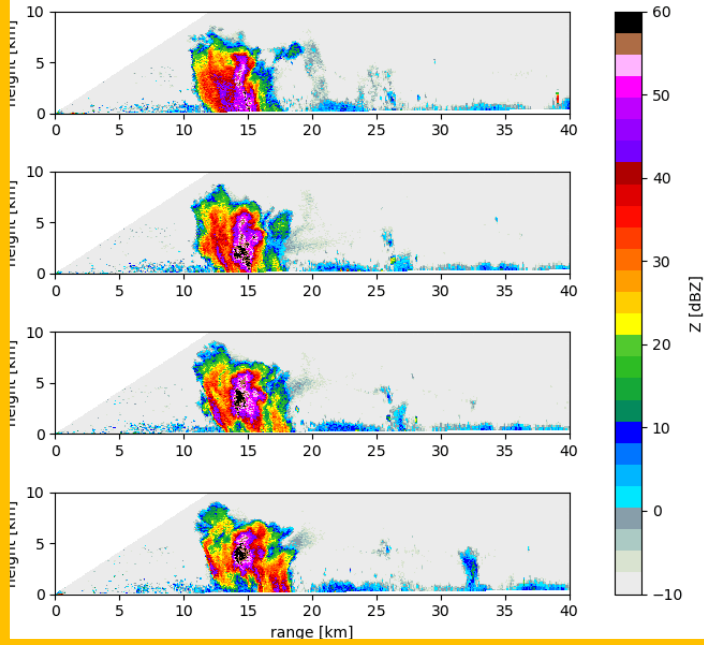
CSAPR2 conducts three horizontal scans (low, middle and top). **Edge computing** extracts the location of the convective core



3

Lamer et al., 2022

Targeted vertical scans are conducted and repeated for higher temporal resolution.



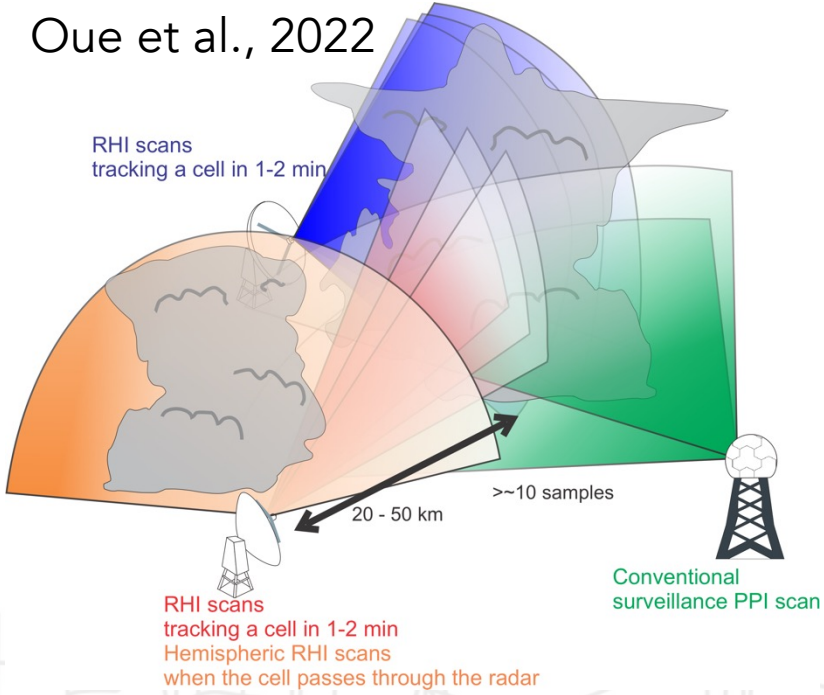
Distributed radar network demonstration using the TRACER (DOE) and ESCAPE (NSF) precipitation radars

August - September

Edge computing information is shared with CHIVO (NSF radar) located 27 km from CSAPR2 at the main AMF site

Both radars sample the same convective cell for combined dynamical and microphysical retrievals

Oue et al., 2022



Optimized Scan Strategy based on OSSEs

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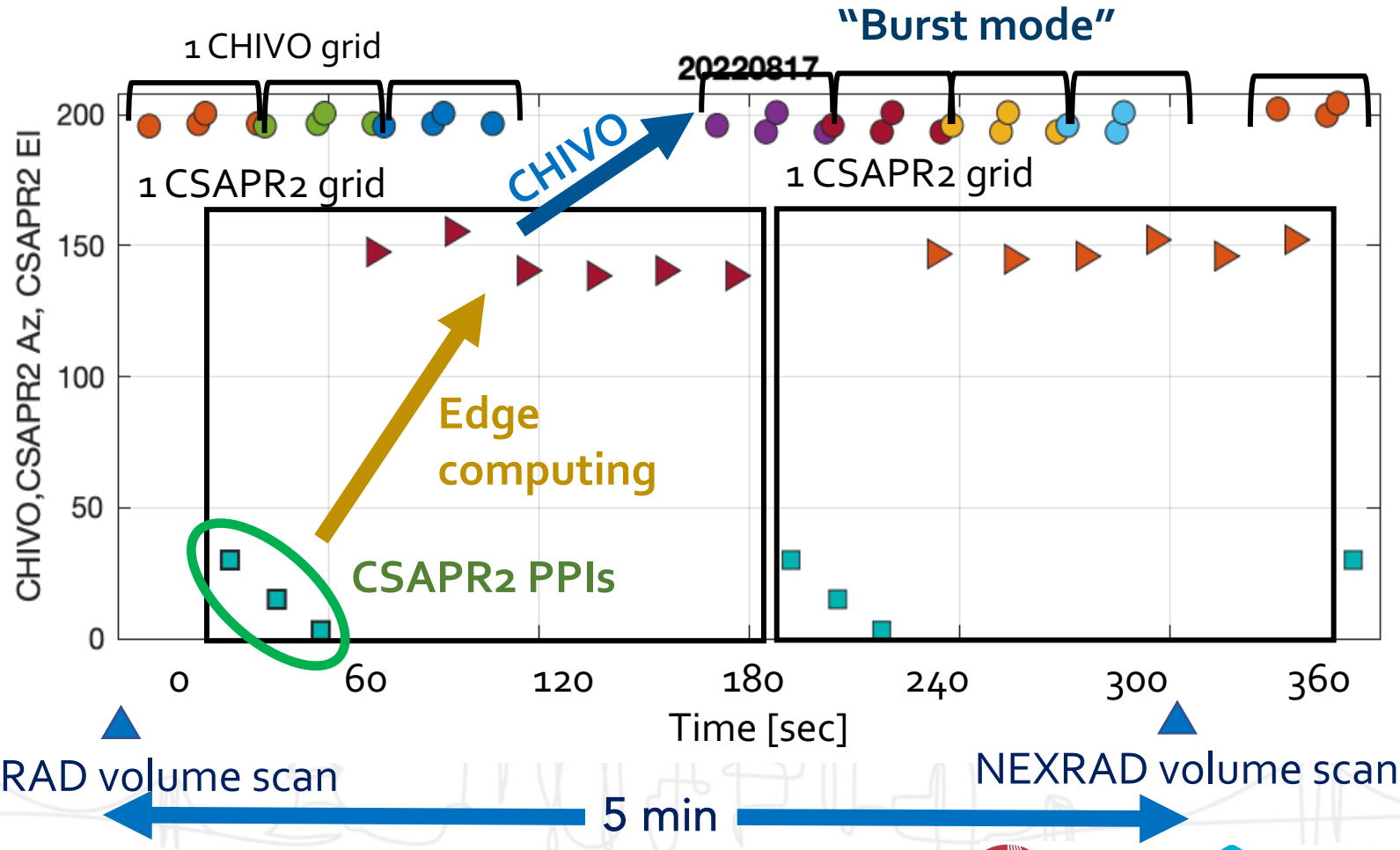

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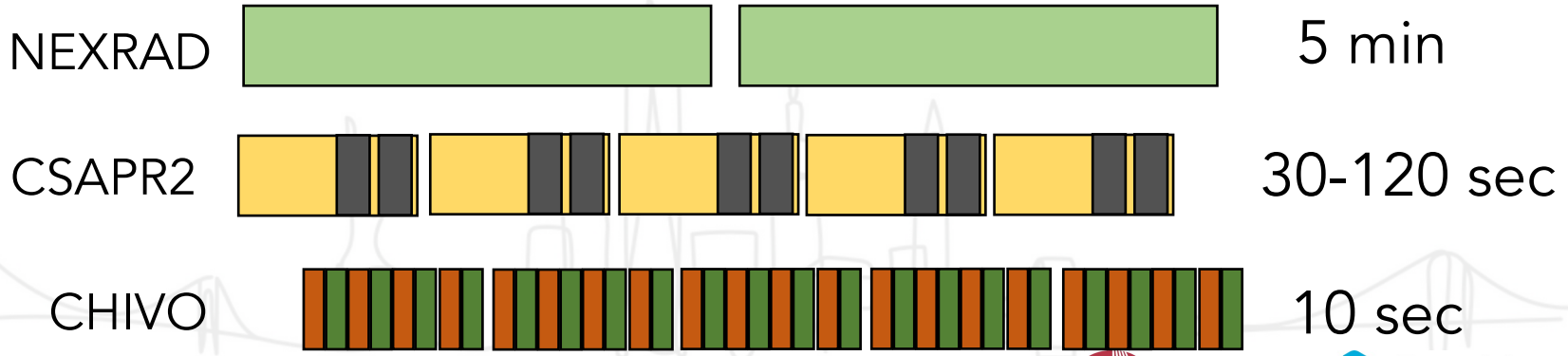
Definition of a convective cell sample during the 4-month IOP

Period	CSAPR2 Cell sample Horizontal scans	Vertical scan	CHIVO Cell sample Vertical scan	Time duration (sec)
June – July	3	4	-	<90
August – September	3	6	12-16	<120

"A CubeSat like revolution in spatiotemporal sampling from the ground-up"



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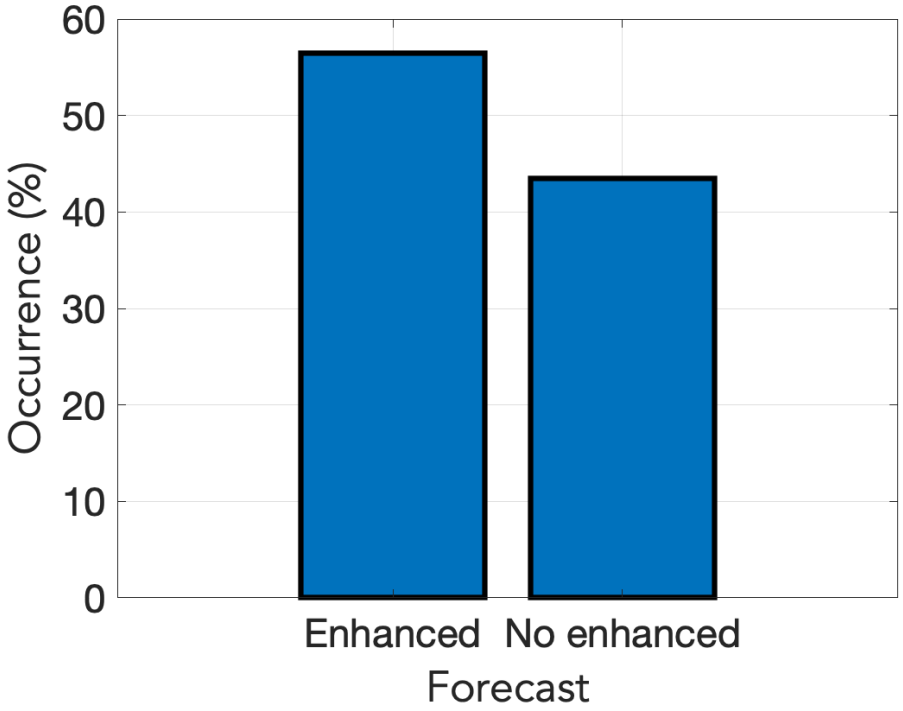
Cell tracking Operations



Cell tracking (Enhanced Obs)
12472 scans (56.5% of the time)

Cell tracking (No enhanced Obs)
9611 scans (43.5% of the time)

Total of ~680 hours of cell tracking
~28.3 days of tracking

Each scan is ~90-120 sec of targeted observations

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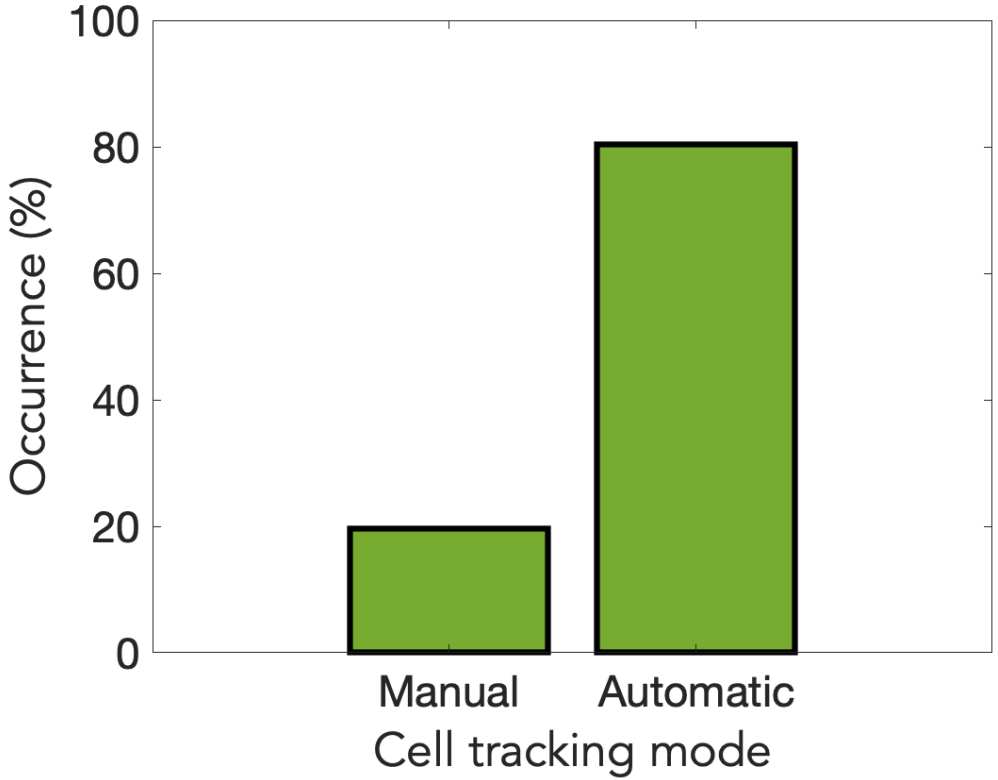
Cell tracking observations mode



Automatic cell selection
17708 scans
80.34%

Manual cell selection
4332 scans
19.66% of the time

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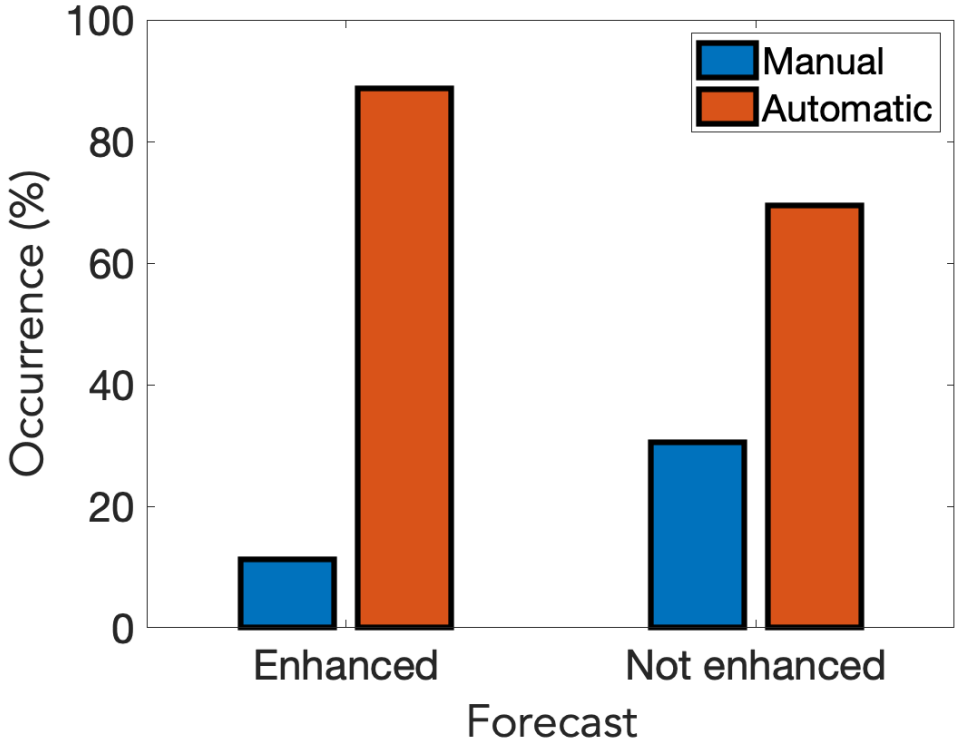
Manual cell tracking (Enhanced vs not enhanced)



Cell tracking (Enhanced)
Automatic
11036, 88.7%
Manual
1409, 11.3%

Cell tracking (Not enhanced)
Automatic
6672, 69.5%
Manual
2923, 30.5%

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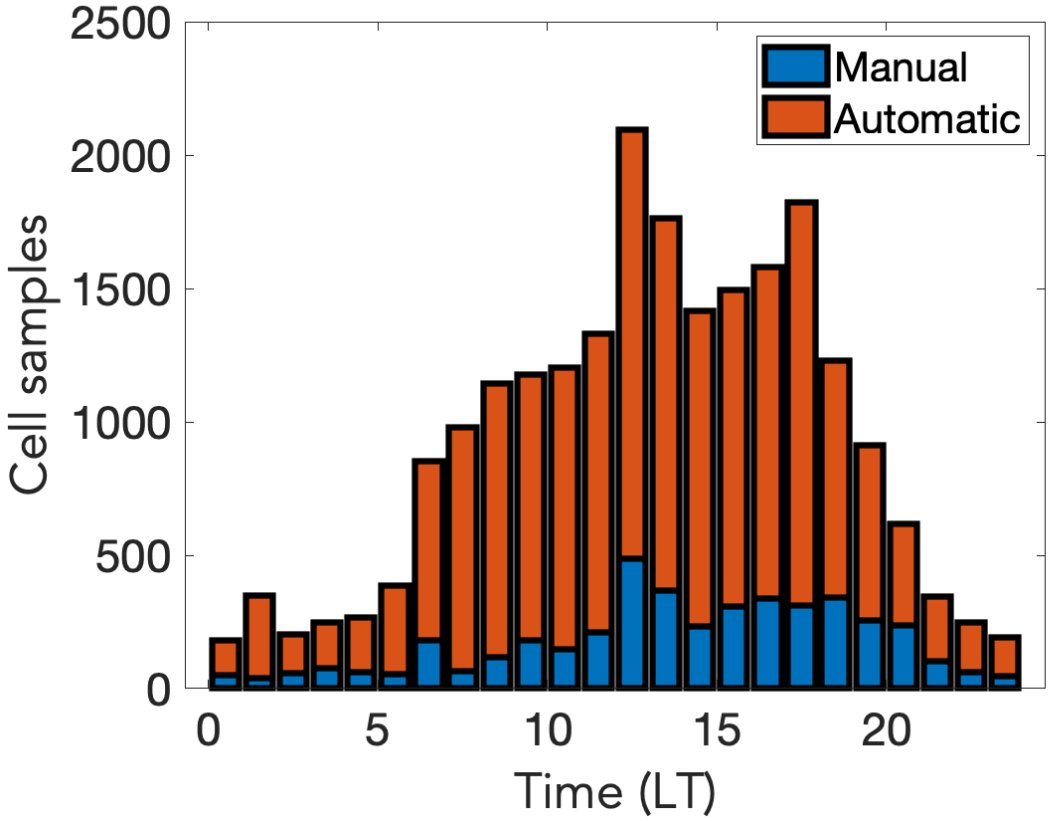
Cell tracking – Diurnal cycle



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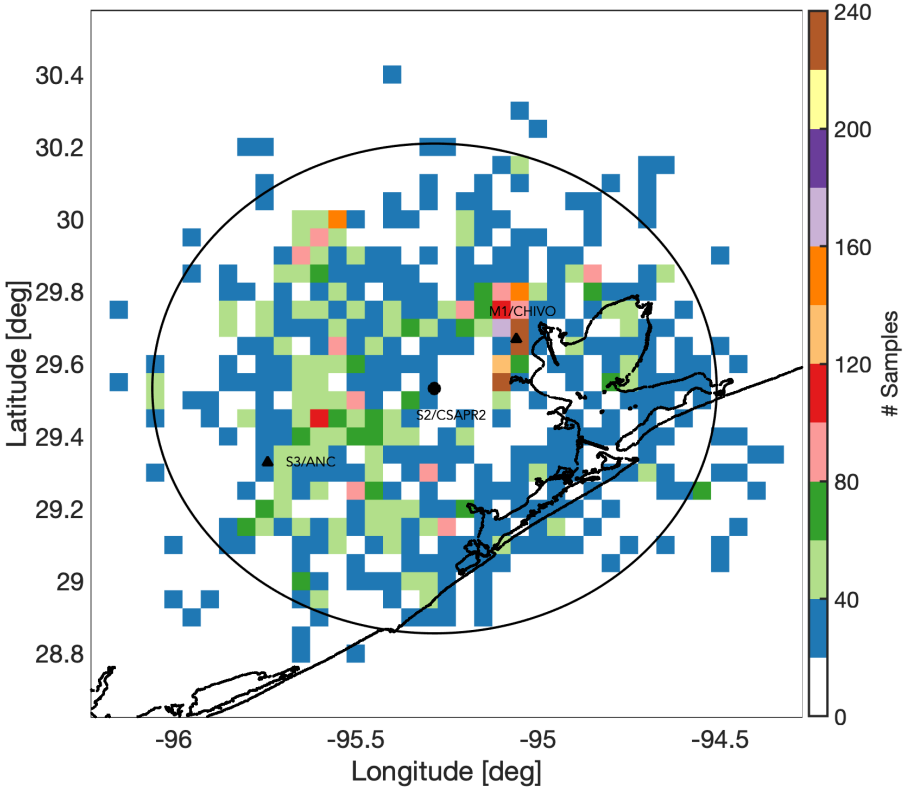
C-SAPR2 sampling locations



- **the AMF1 main site (M1)** in La Porte, Texas, an area that experiences significant polluted conditions
- **the ancillary site (S3)** to the southwest of downtown Houston in a rural region with less pollution
- **the CSAPR2 site (S2)** located approximately midway between the AMF1 and ancillary sites.

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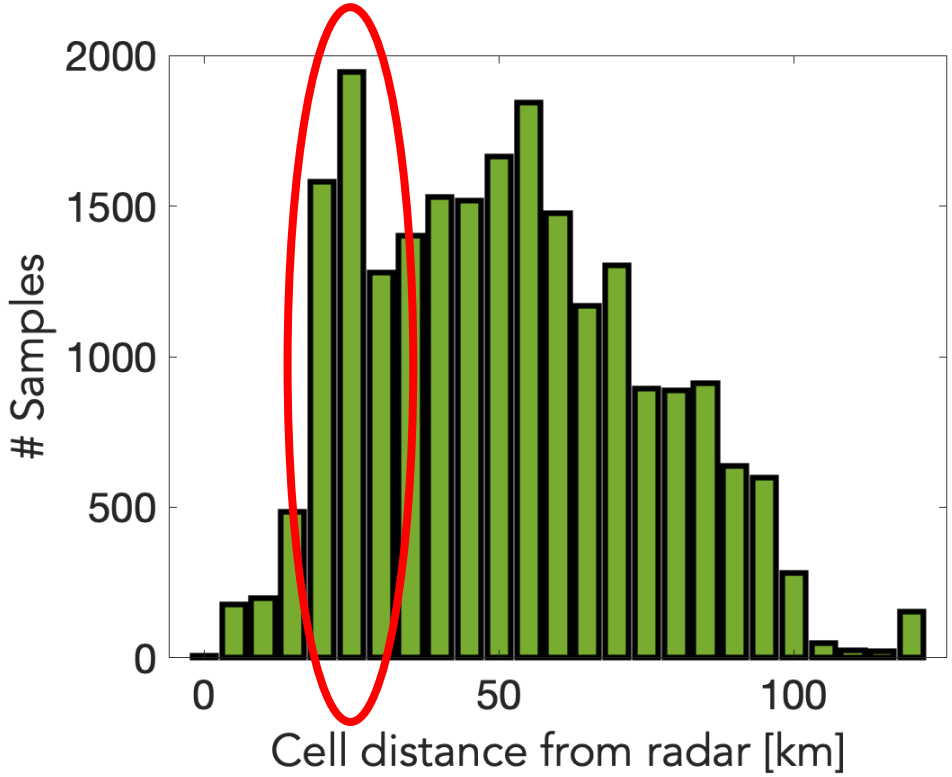
Convective cells distance from CSAPR2



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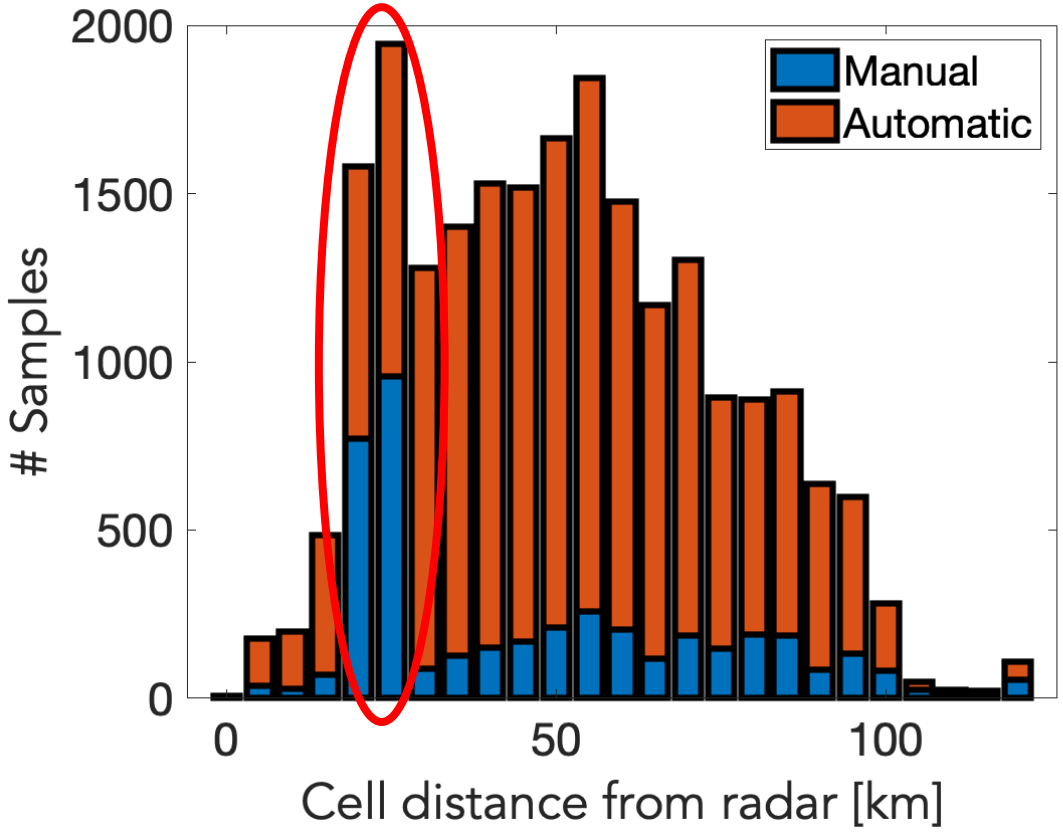
Cell distance from CSAPR2 per mode



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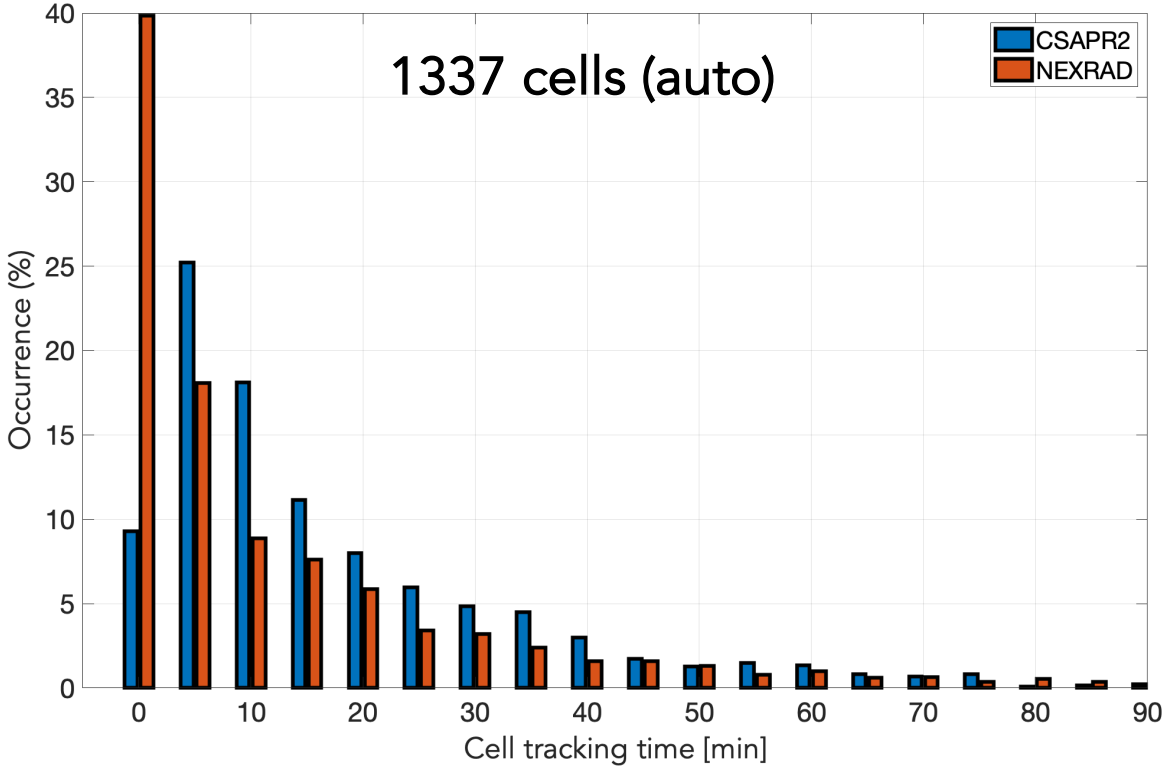
Cell tracking time duration



47.5% of the cells (637) tracked for over 15 min

22.3% of the cells (298) tracked from over 30 min

These results are only from the automatic mode (~80% of the cell tracking time)

NEXRAD: The selected cells by MAAS through out the IOP

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Thoughts on convective cell tracking PI products

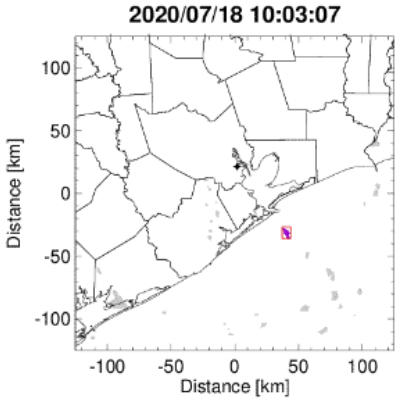
Gridded, quality controlled NEXRAD/GOES data cubes for 5 warm (June to September) seasons (2018-2022)

NEXRAD/GOES-based cell tracking statistics for the entire population of convective cells initiated in the Houston domain. Use same cell ID with the CSAPR2/CHIVO dataset

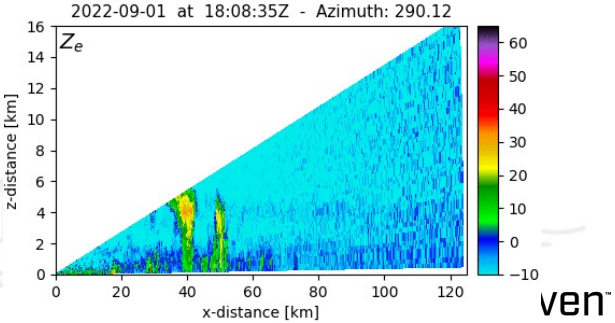
CSAPR2 cell tracking data (one file per convective cell)

CHIVO cell tracking data (one file per convective cell)

Advance products (polarimetry (KDP), multi-Doppler, Delta-t)



Same cell ID



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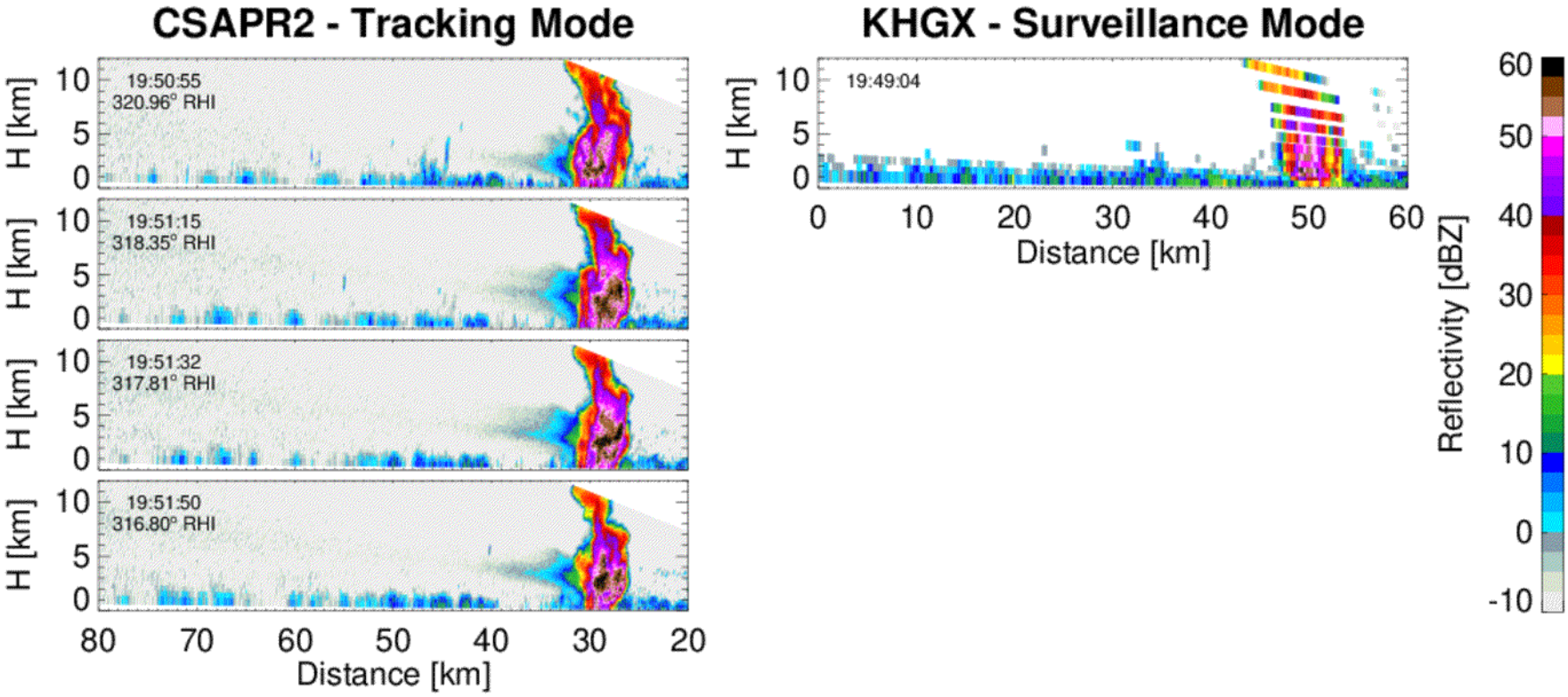

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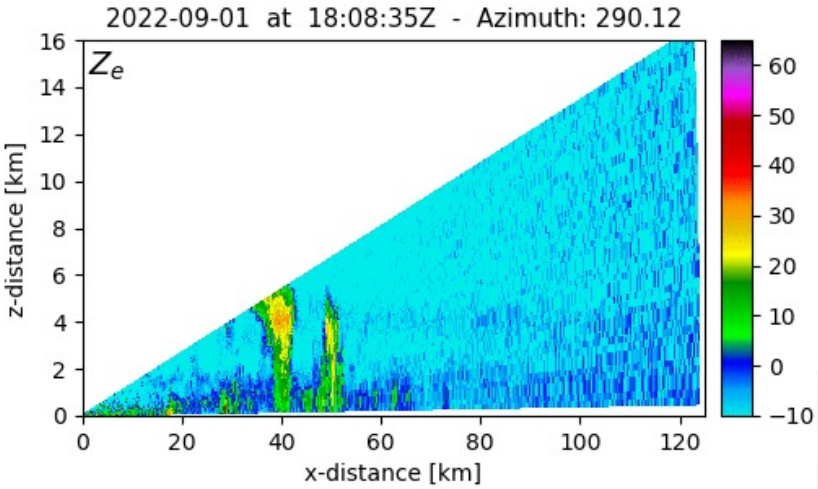
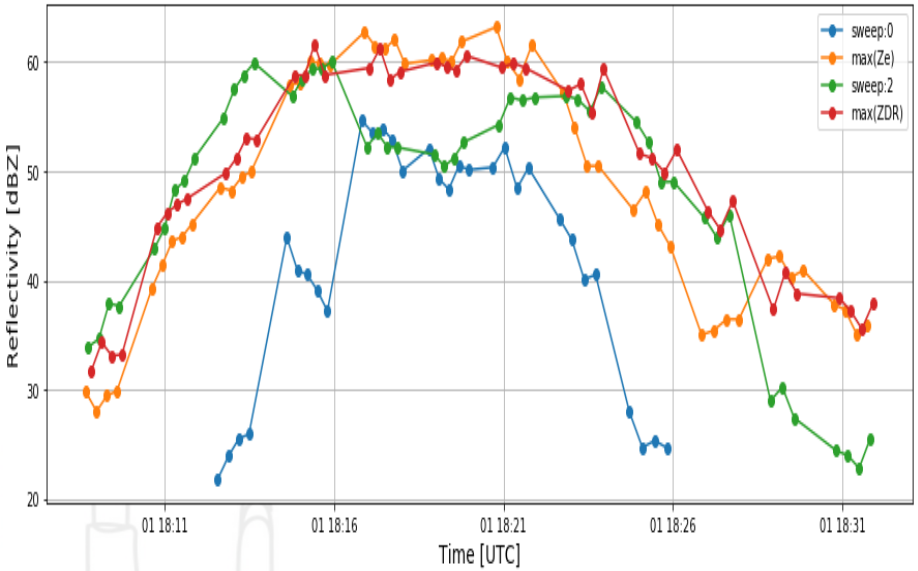
Extract delta-t convective cell properties from radar observations





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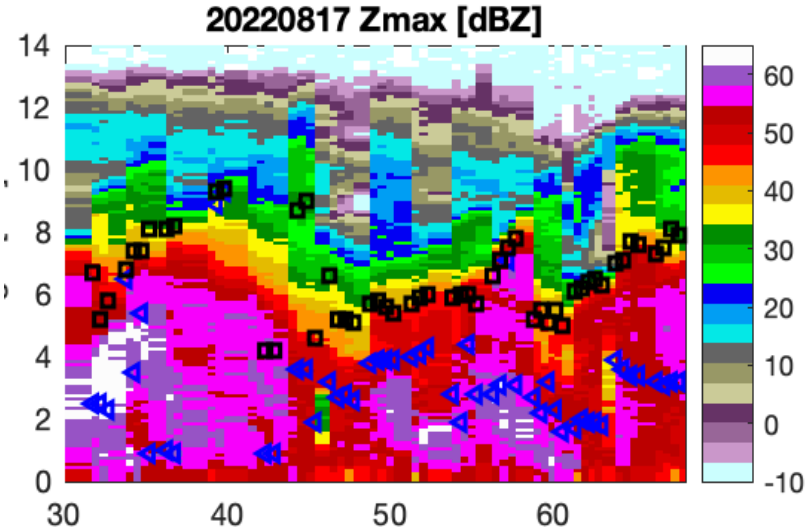
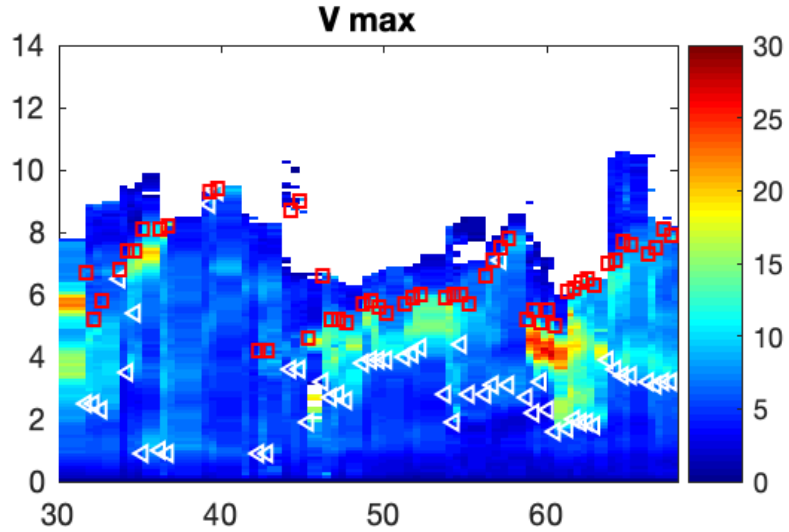
Multi-Doppler wind retrievals are performed for each CHIVO gridded (composed of 4 RHIs) using nearest gridded CSAPR2 and NEXRAD The multi-Dop outputs every ~40 sec.





The radars tracked multi cells within a storm. Maximum updraft is shown just above the maximum reflectivity height

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

Analysis by Mariko Oue (SBU)

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Experiment of Sea Breeze Convection, Aerosols, Precipitation and Environment (ESCAPE)

<u>Airborne (05/31 – 06/17)</u>
NRC Canada Convair 580
60 research hours, 13 RF

SPEC Learjet 35A 1
32 research hours, 11 RFs

<u>Mobile platforms (05/31 – 06/27)</u>
SBU X-band phased array + sounding
BNL CMAS mobile lab + soundings
OU RaXPol X-band radar
OU PX-1000 X-band radar

<u>Fixed precipitation radar (08/01 – 09/30)</u>
CSU C-band precipitation radar

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