



Engineering Research Center for  
**Collaborative Adaptive Sensing of the Atmosphere**

## ***CASA Radar Project***

Brenda Philips, Paros Research Professor, UMass/CASA

Eric Adams, AAMTEX/CASA

Spring 2024 FPAW Meeting



## ***Collaborators***

Eric Adams, AAMTEX

David Westbrook, UMASS

V. Chandresekar, CSU

Francesc Junyent, CSU

DFW Airport

NWS Fort Worth

City of Fort Worth Storm Water

UT Arlington

University of North Texas

Amanda Everly, NCTCOG,  
Emergency Preparedness

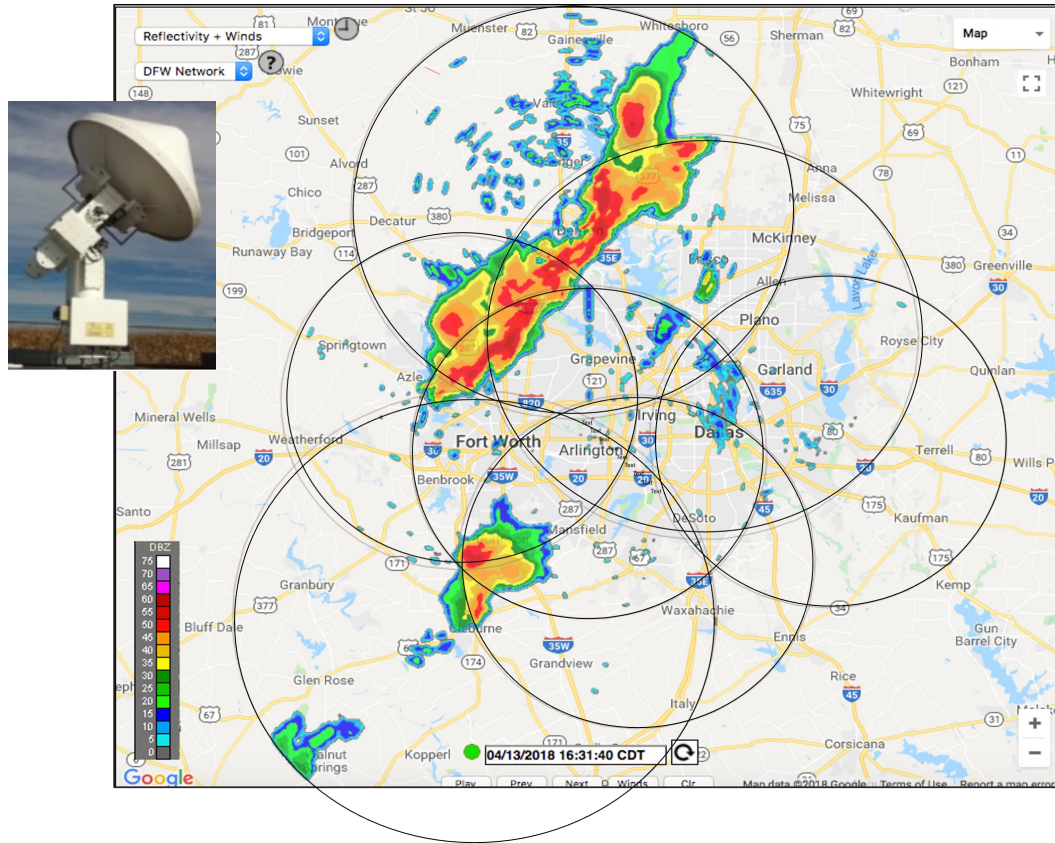
Chase Wheeler, EM Grand  
Prairie

William Wessel, EM Tarrant  
County

Ernest Huffman, NCTCOG



# Technology #1: High Resolution Radar Network

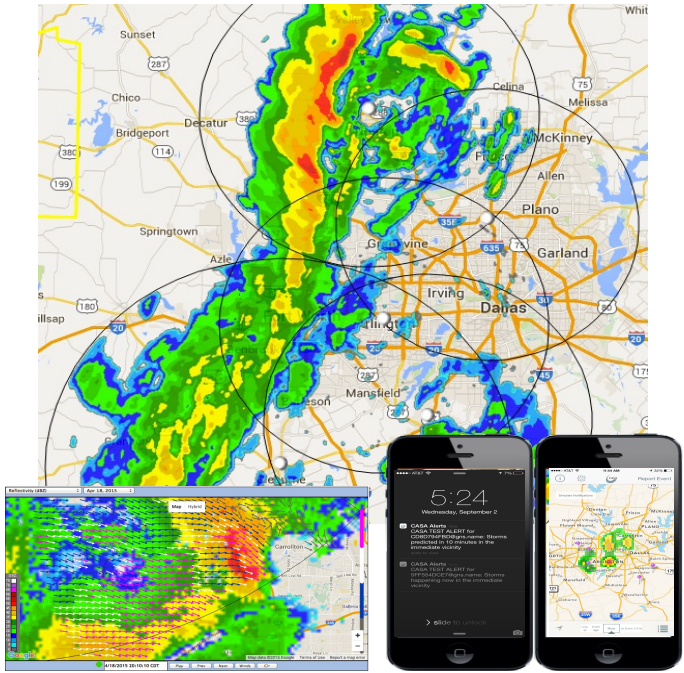


- Dual-Pol, X-band Doppler radars in DFW operating 24 /7/365
- Single Radar: 65m gate spacing, 1-minute updates
- Networked products: 500m resolution, 1-5 min updates
- Low-level observations

# ***Sensors-to-People Real-Time Warning System & Research Platform: Living Lab***



**SENSORS**



**PRODUCTS/DISPLAY**

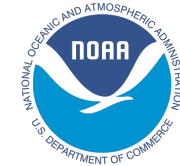


**USERS**





# *A multi-sector partnership for over 10 years*



Addison  
Aledo  
Anna  
Balch Springs  
Bedford  
Benbrook  
Burleson  
Cleburne  
Crowley  
Duncanville  
Euless  
Farmers Branch

Forest Hill  
Fort Worth  
Garland  
Godley  
Granbury  
Grand Prairie  
Haslet  
Highland Park  
Hurst  
Hutchins  
Joshua

Keller  
Lancaster  
Little Elm  
McKinney  
Mesquite  
Midlothian  
N. Richland  
Hills  
Plano  
Princeton

Red Oak  
Richardson  
River Oaks  
Roanoke  
Rowlett  
Sache  
Saginaw  
Waxahachie  
Westlake  
Wilmer  
Wylie

Ellis County  
Johnson County  
Parker County  
Tarrant County  
Midlothian ISD  
**UNT**  
**UTA**

DFW International Airport, Bell, ParosScientific, Raytheon



# A Multi-sector Partnership



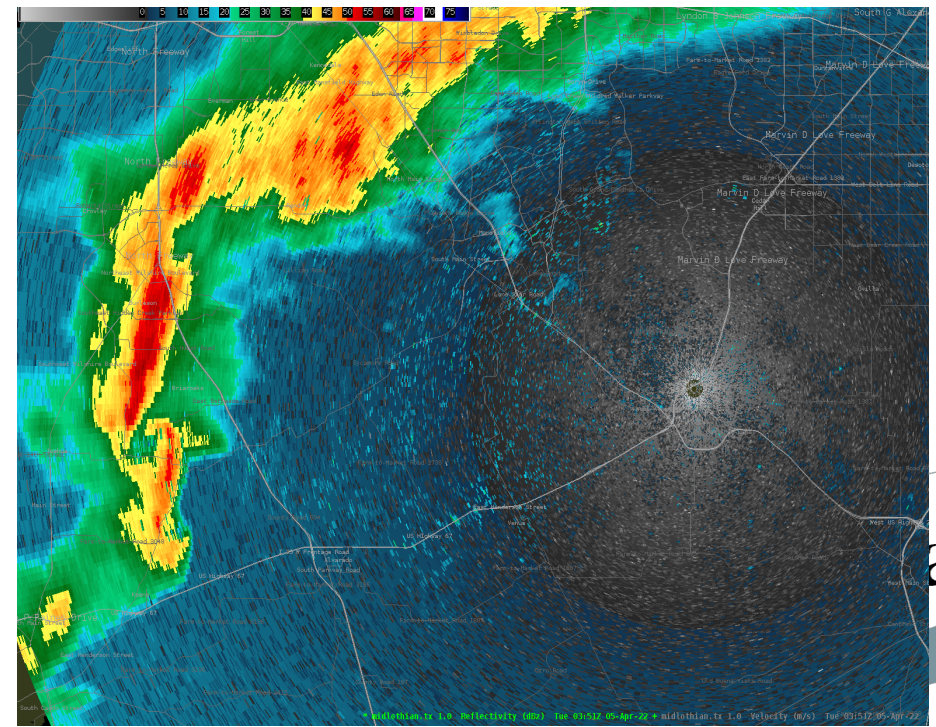
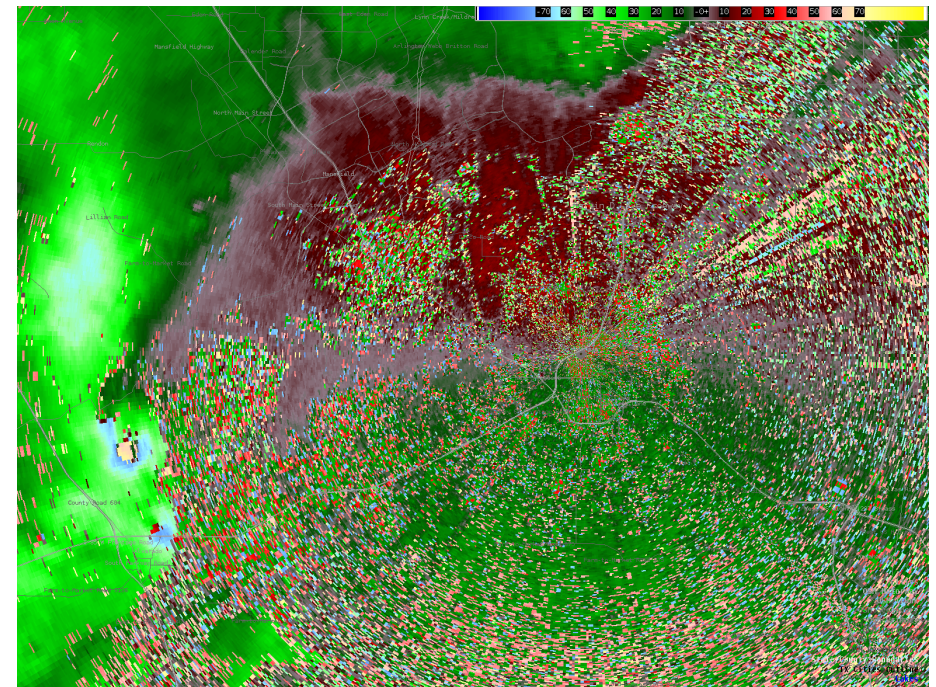
- ❑ NCTCOG Emergency Preparedness, UMASS, CSU have an MOU
- ❑ Exec committee of EMs, media, NWS-FO oversees local policy
- ❑ Academic/Practitioner Leadership committee
- ❑ Towns/Cities “host” radars and use data
- ❑ Funding:
  - ❖ Membership fees from local towns and cities
  - ❖ Federal Grants: NSF, NASA, NOAA
  - ❖ Sponsored Research: DFW Airport, City of Fort Worth
  - ❖ National Mesonet Program (NOAA)
  - ❖ Sensor providers



# April 4, 2022 Tornado: NWS Decision-Making

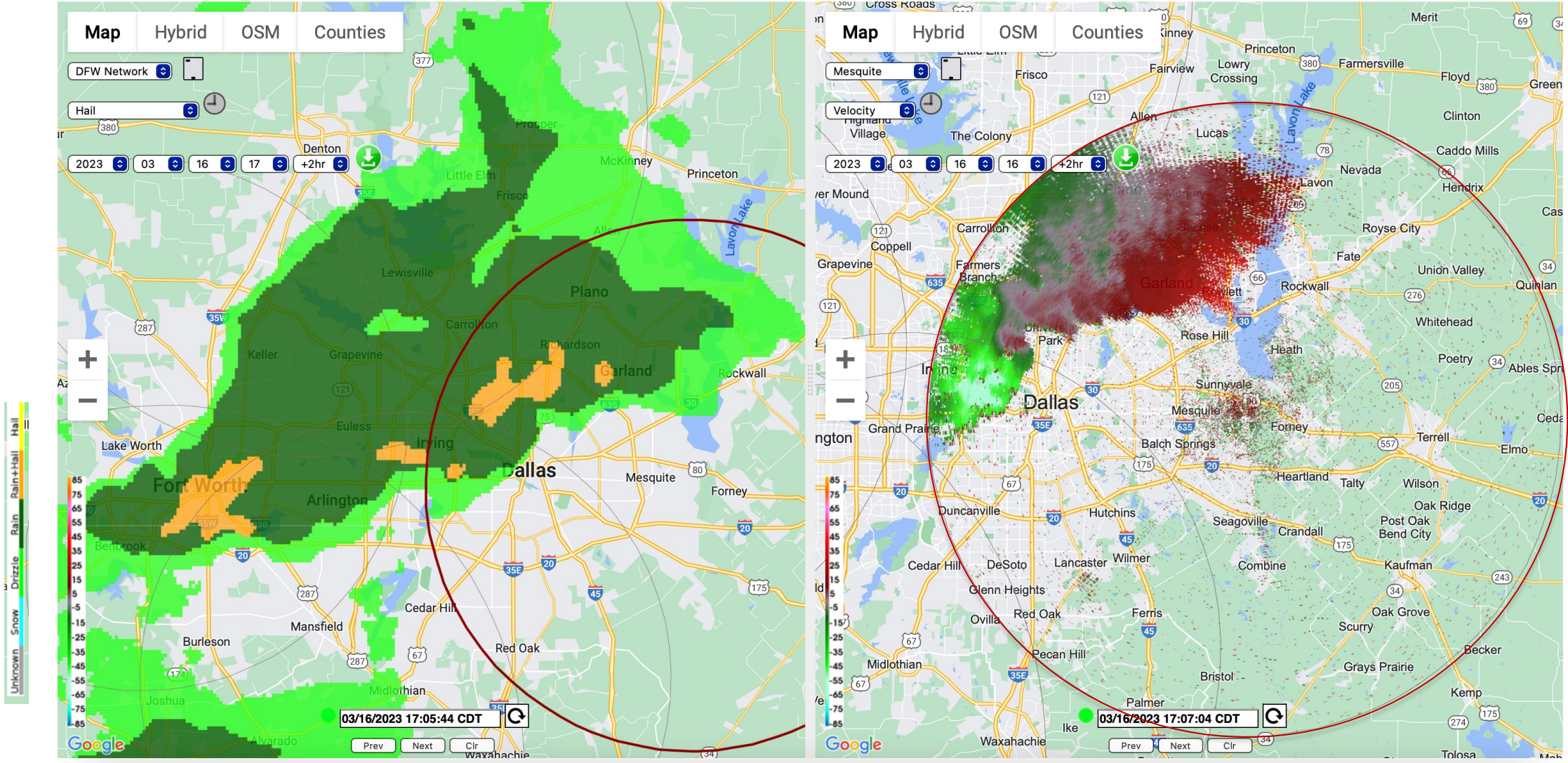
*“We used the CASA radar that night for warning decisions and to track tornadoes. CASA radar provided 1-minute updates which were helpful and showed two separate tornadic circulations. We messaged the threat as it approached Midlothian.”*

*Ted Ryan, NWS, Science and Operations Officer*





# CASA Website

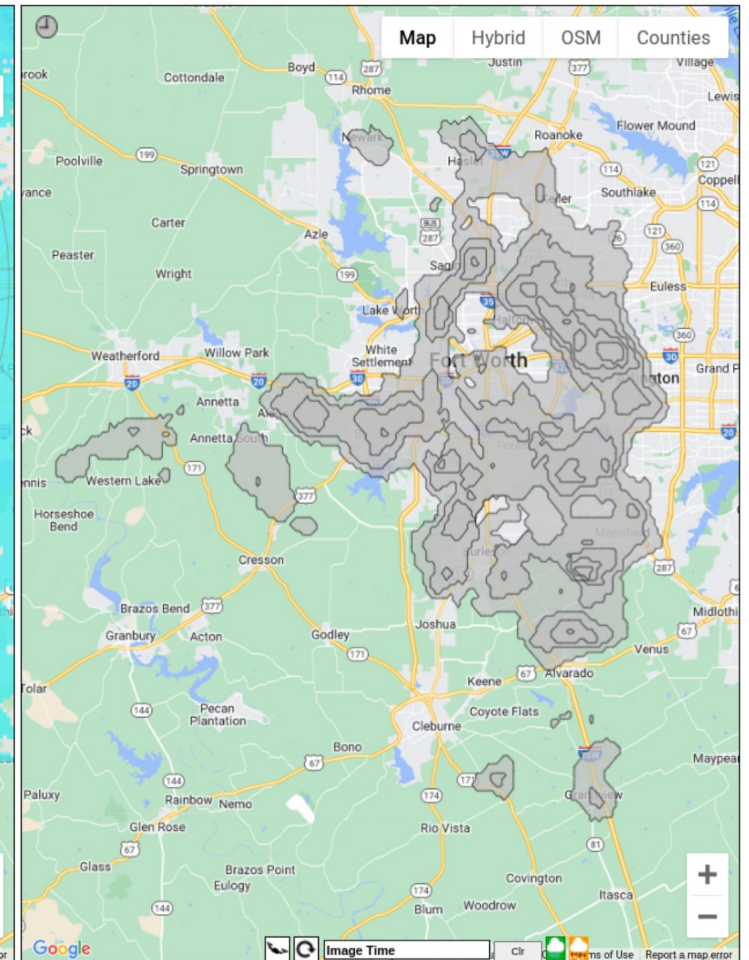
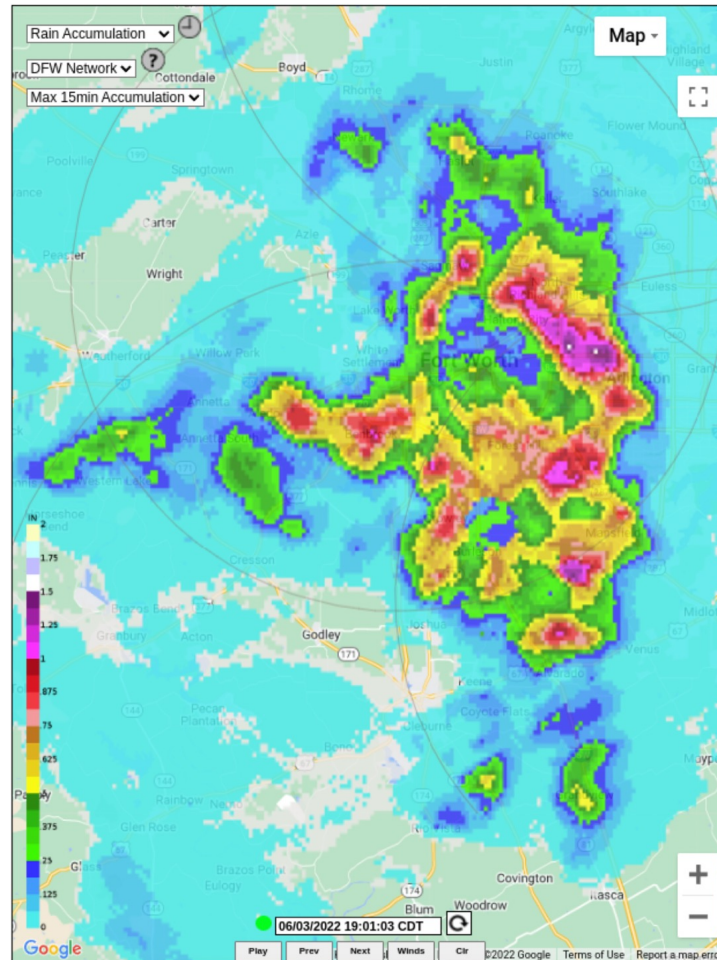




# CASA City of Fort Worth Google Maps Website

## Customized Rainfall Accumulation Products:

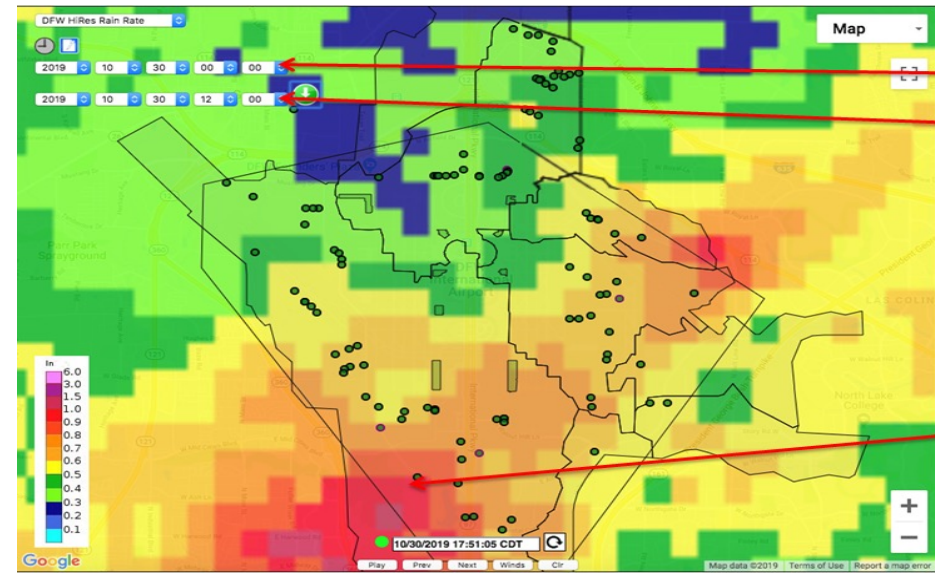
15 min max product



# DFW Airport



Clean Water Act (CWA) requires monitoring of stormwater runoff associated with municipal, industrial, and construction activities

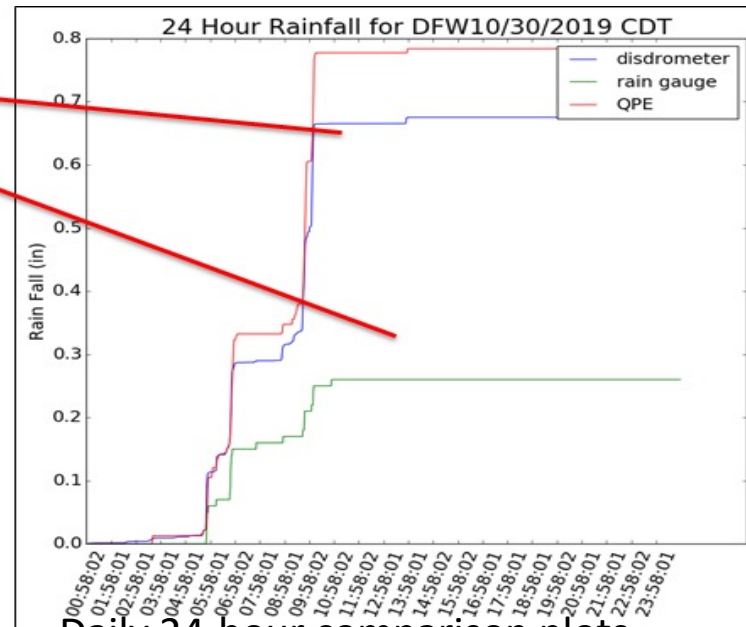


Set start time

Set stop time

Outfall

CASA developed a custom tool to accumulate rainfall over user-defined time period.



Daily 24-hour comparison plots

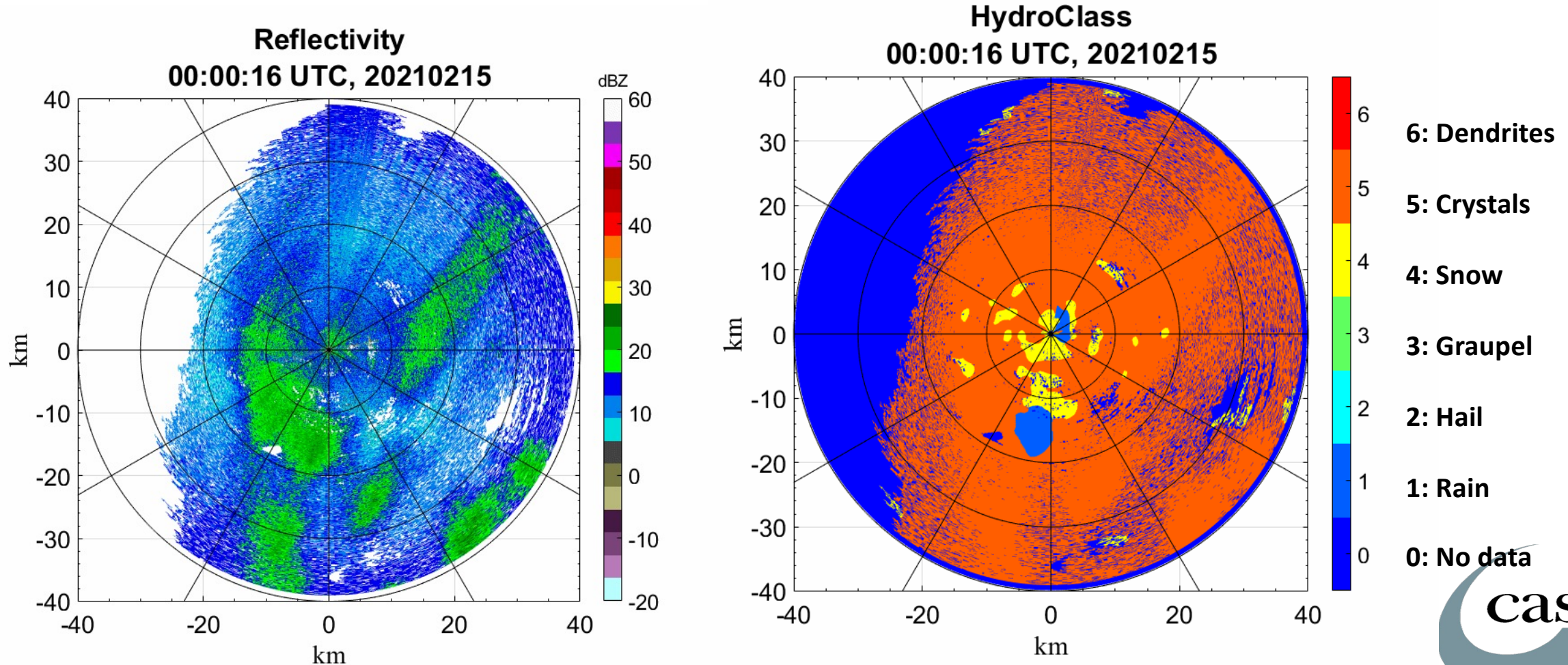




# Winter Weather Experiments with DFW Airport

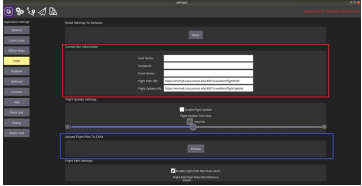
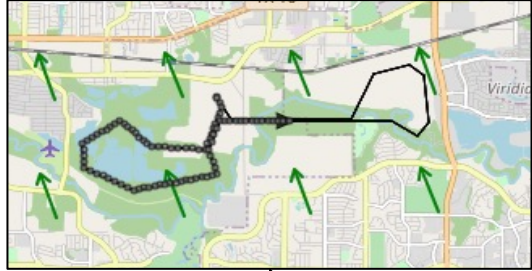
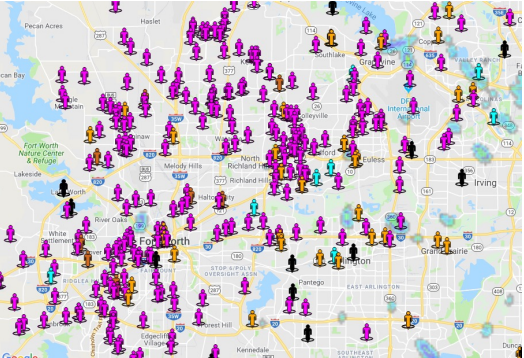
Site: Fort Worth, Radar: XFTW

Time Period: 00:00 - 14:00 UTC, Feb 15<sup>th</sup>, 2021, Elevation: 1.0 degree



# Technology #2: CityWarn, Software for Context-Aware Alerts

Alertable Objects:  
People, Cars, Flight  
Paths, UAVs,  
Vertiports



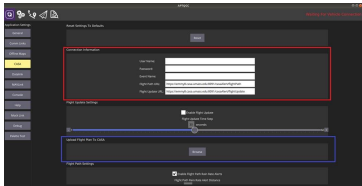
Requirements/  
preferences

Location

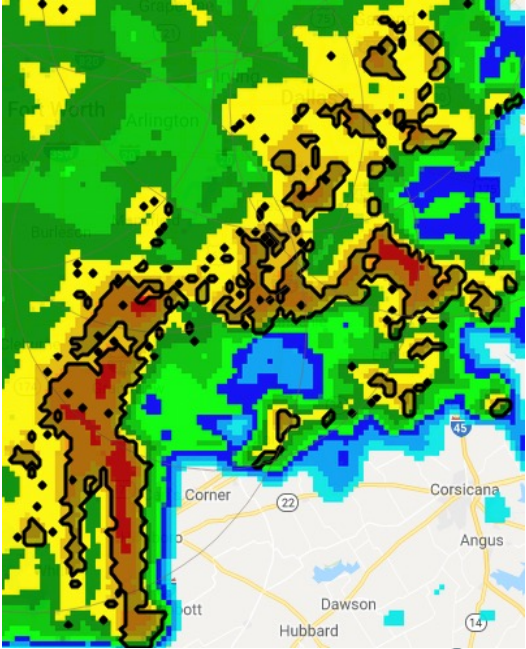


Threat  
Polygons

Alerts



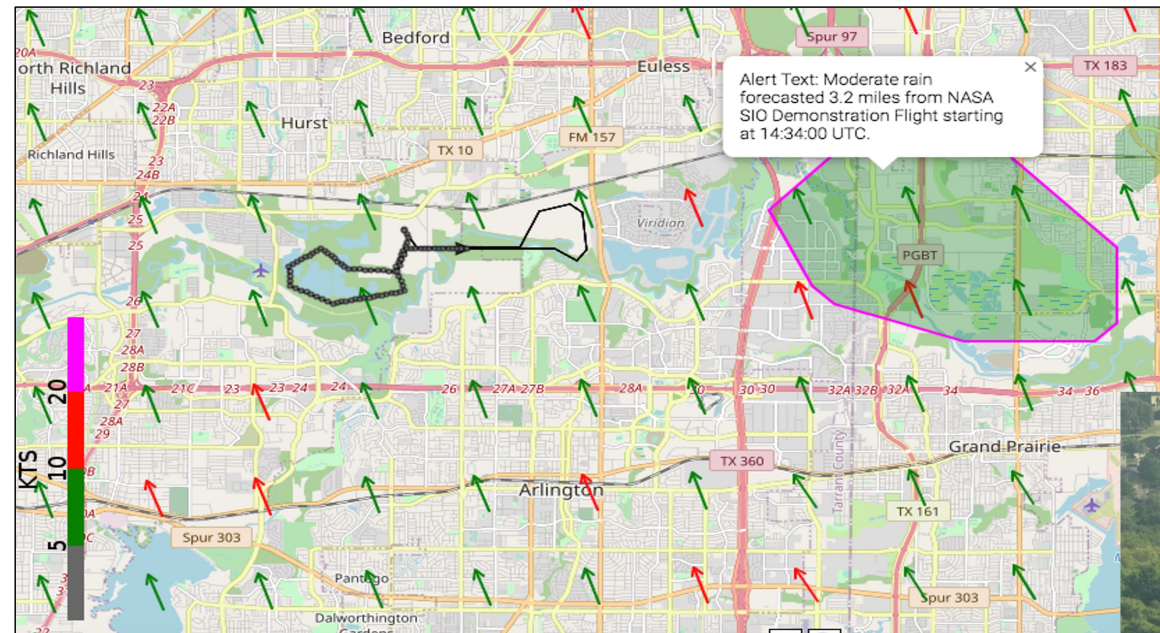
Environmental  
Monitoring & Threat  
Extraction





# Bell Textron - Systems Integration & Operations (SIO) NASA Funded

Alerting Criteria		
Weather Hazard	Alert Threshold	Distance from Hazard; Alert Update Frequency
Moderate Rain Nowcast	Any moderate rain expected in 10 minutes	Within 5 miles of flight path; 1 minute updates
Heavy Rain	Rain $\geq$ 3.0 inches / hour **	Within 10 miles of flight path; 1 minute updates
Wind speed or gust (surface)	Winds $\geq$ 20 knots	Within 10 miles of flight path; 1 minute updates
Hail	Any Hail	Within 10 miles; 5 minute updates
Visibility	Visibility < 3 miles	As reported by an ASOS within 10 miles; updated hourly as new data comes in.
Ceiling	Ceiling < 2000 feet	As reported by an ASOS within 10 miles; updated hourly as new data comes in.
NWS Severe Thunderstorm Warning	On issuance (or continuance)	Within 10 miles of flight path; On expiry
NWS Tornado Warning	On issuance (or continuance)	Within 30 miles of flight path; On expiry



# CityWarn Technology Licensed to TruWeather Solutions



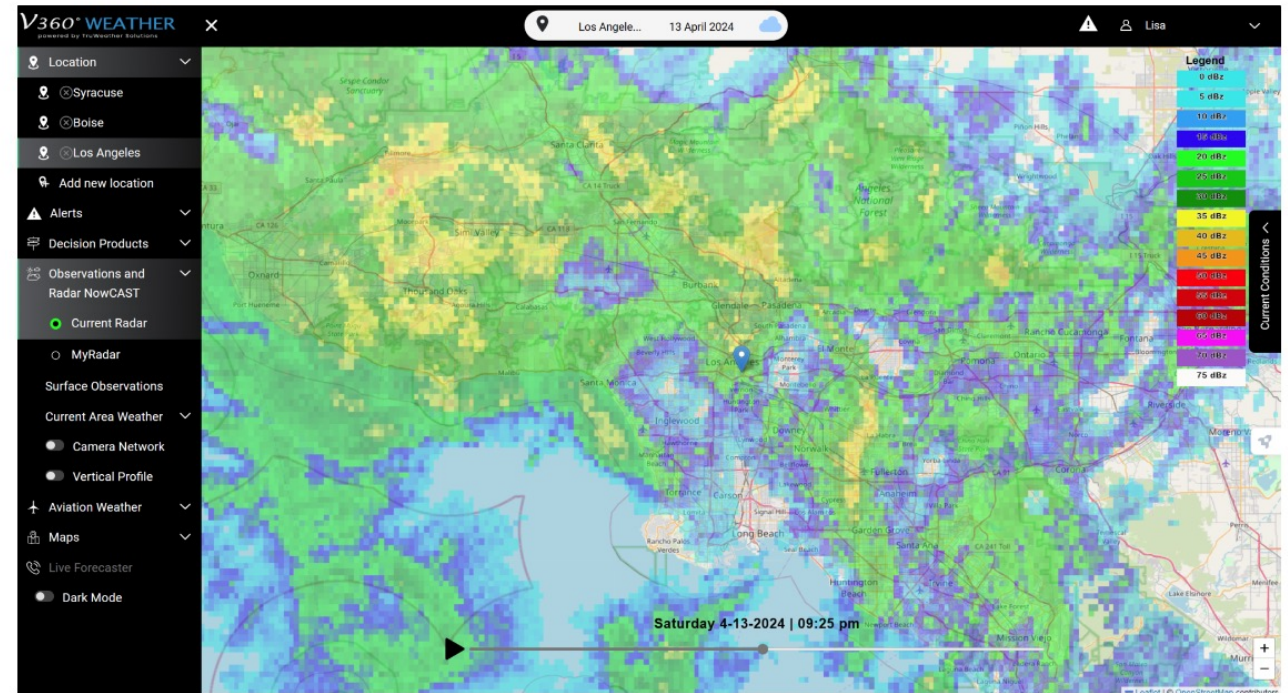
**V360° Weather Workbook**

We built the first micro-weather data and analytics platform for UAS and AAM operations with a full suite of software products

- MyRadar
- Aviation Weather
- MissionCAST
- RouteCAST
- Alerting
- Surface Observations
- Current Weather Depiction Tiles
- Camera Network
- Lightning Alerting
- Micro Prediction
- Meteorologist Services

## TruWeather Solutions Unveils Next-Generation Product Suite to Revolutionize Low-Altitude Weather Decision-Making

by Lisa Tinnesz in News on April 19, 2024



### For Immediate Release:

**Reston, VA 19 April 2024** - TruWeather Solutions is taking another step forward as a prominent supplier of weather data analytics and groundbreaking weather risk management products, specializing in both crewed and uncrewed low-level aviation and ground transportation systems. Set to be released at AUUSI XPONENTIAL on Monday, April 22, 2024, is their next-generation V360° product suite, aimed at transforming weather decision-making for operators, dispatchers, schedulers, airspace managers, and others. New premium features and enhanced products offer unparalleled capabilities for mission planning, route optimization, and real-time weather monitoring in an all-in-one interface.

The new release includes two premium services, Alerting and RouteCast. The powerful alerting tool provides ground point and airspace weather alerts customized based on user-defined thresholds and locations. Parameters include cloud/ceiling, visibility, surface wind, low-altitude wind, lightning, and NWS warnings. If user thresholds are met, an automated email message will promptly be sent. RouteCast, a route evaluation tool, pulls the best predictive weather data and displays a color-coded risk indicator based on route waypoints and user-defined wind and cloud thresholds.

## *Upcoming Projects*

- ❑ SMART MOBILITY GRANT –  
Department of Transportation with  
City of Fort Worth
  
- ❑ NCTCOG Transportation Pilot  
Program on Drone Delivery





# Advanced Air Mobility National Campaign The North Texas Cohort

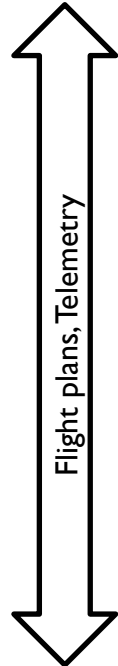


 **LONE STAR UAS**  
CENTER OF EXCELLENCE & INNOVATION  
**Mission Planning**

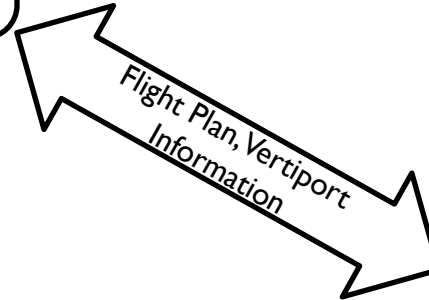
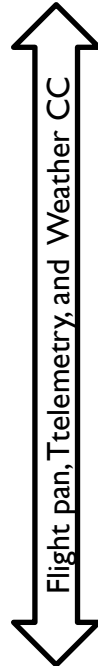
 **PSU**

 **Weather Service**  


**X4+  
Architecture  
&  
Interfaces**



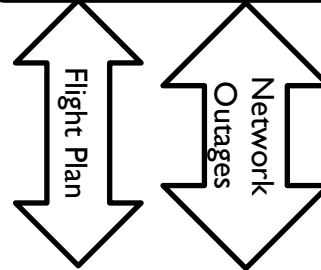
 **UNT**  
CIIMS  
Center for Integrated  
Intelligent Mobility Systems



**METRON**  
DCB

 **UNMANNED  
EXPERTS**

 **RESILIENX**



 **HAAMS**  
HERMES AUTONOMOUS AIR MOBILITY SOLUTIONS

Data Exchange Hub

System Level Connectivity

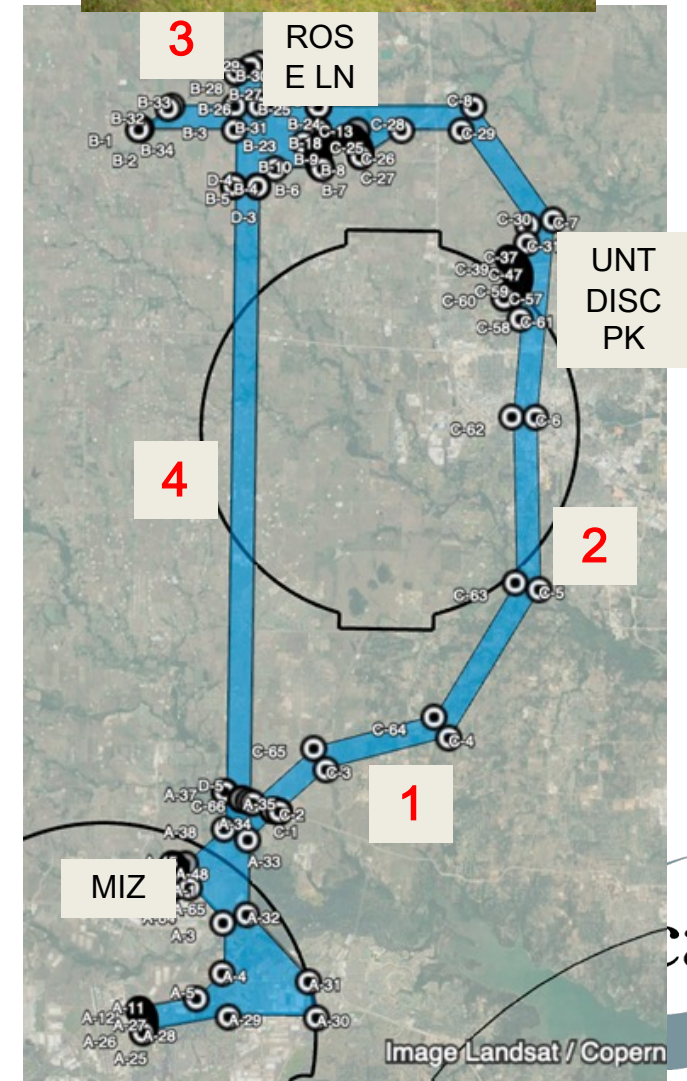
**FREQUENTIS**



## AAM – North Texas Cohort: X4+

- ❑ Goal: Test AAM PSU-based connectivity and CONOPS
- ❑ CityWarn used to create UVRs from CASA and NOAA weather data
- ❑ UVRs ingested into Discovery and Synchronization Service to create constraints for flight paths
- ❑ PSUs register flight paths and receive weather information
- ❑ Simulations + one live test

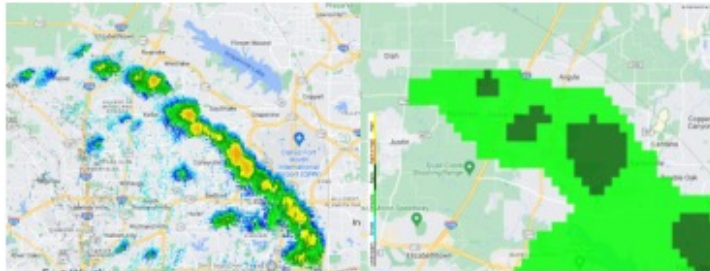
Next Steps: Provide data to North Texas Awareness Pilot through DSS and Investigate NTAP approval



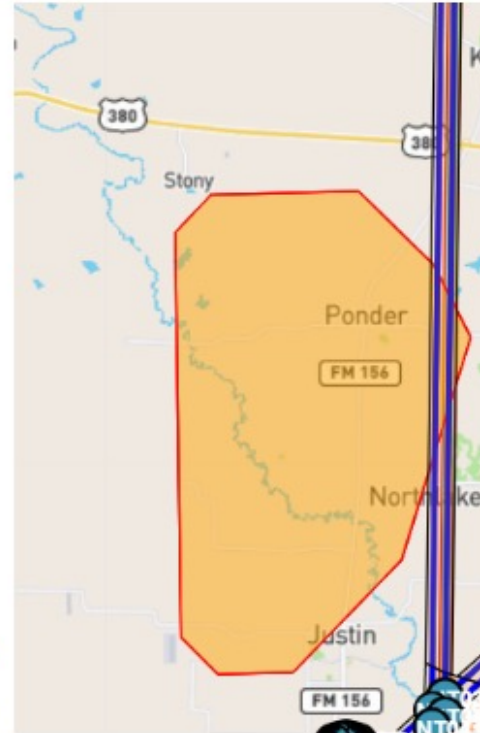
# UTM Constraint Management

## ActiveAlert-- Transitioning a Customized Weather Alerting Platform to UTM/PSU Constructs

- Interfaces with the University of Massachusetts Amherst CityWarn Platform
- Weather Constraints include:
  - ceiling height
  - visibility
  - winds (surface and aloft)
  - wind gusts
  - precip rate (from CASA & MRMS)
  - temperature
  - lightning (from Earth Networks)
  - National Weather Service warnings
  - Sigmets and airmets
  - Radar based nowcasts
  - Hydrometeor Classification
- Grid based extractions of concave polygons representing contoured thresholds
- GeoJSON -> UTM GIS format for UVRs (UAS Volume Restrictions)

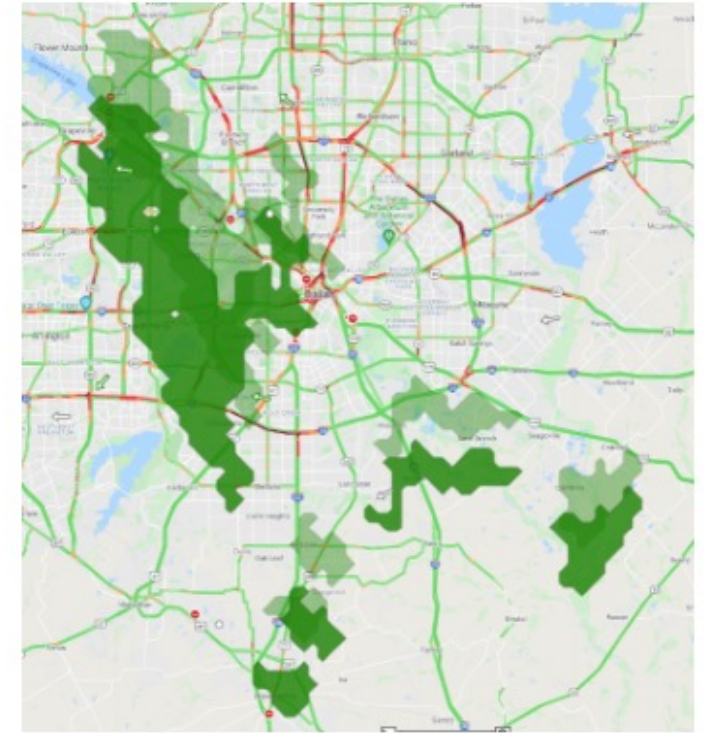


Left: Reflectivity from Ft Worth CASA radar day of live flight. Fast moving poorly forecast line of showers  
Right: Zoomed in hydroclass showing embedded heavier rain areas in test loop during flight.



### CityWarn API

- Receives contoured geofences of meteorological data from extraction algorithms
- "Event" registration for weather monitoring
- Provides email alerts and APIs for user access



### Radar Nowcast Contours

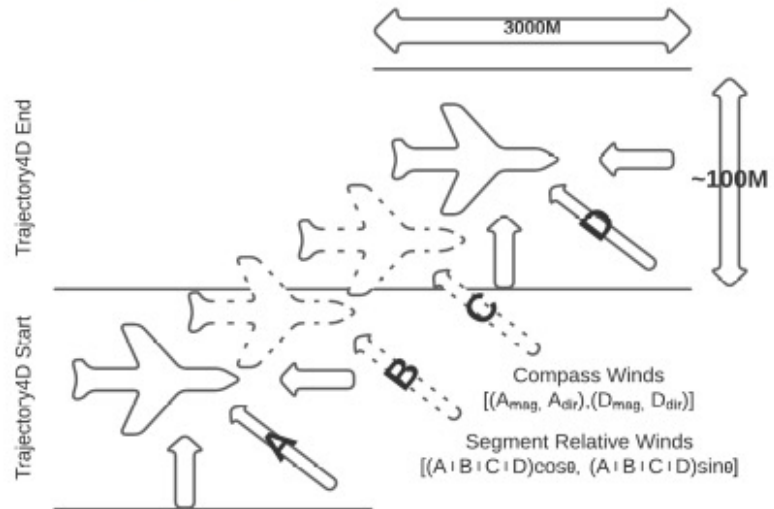
- Rapidly updating 20 minute nowcast of precipitation cores
- Depicted above at 5 and 10 minutes into the future
- Constraints generated in forward looking time windows
- Updated constraints supercede previous constraints



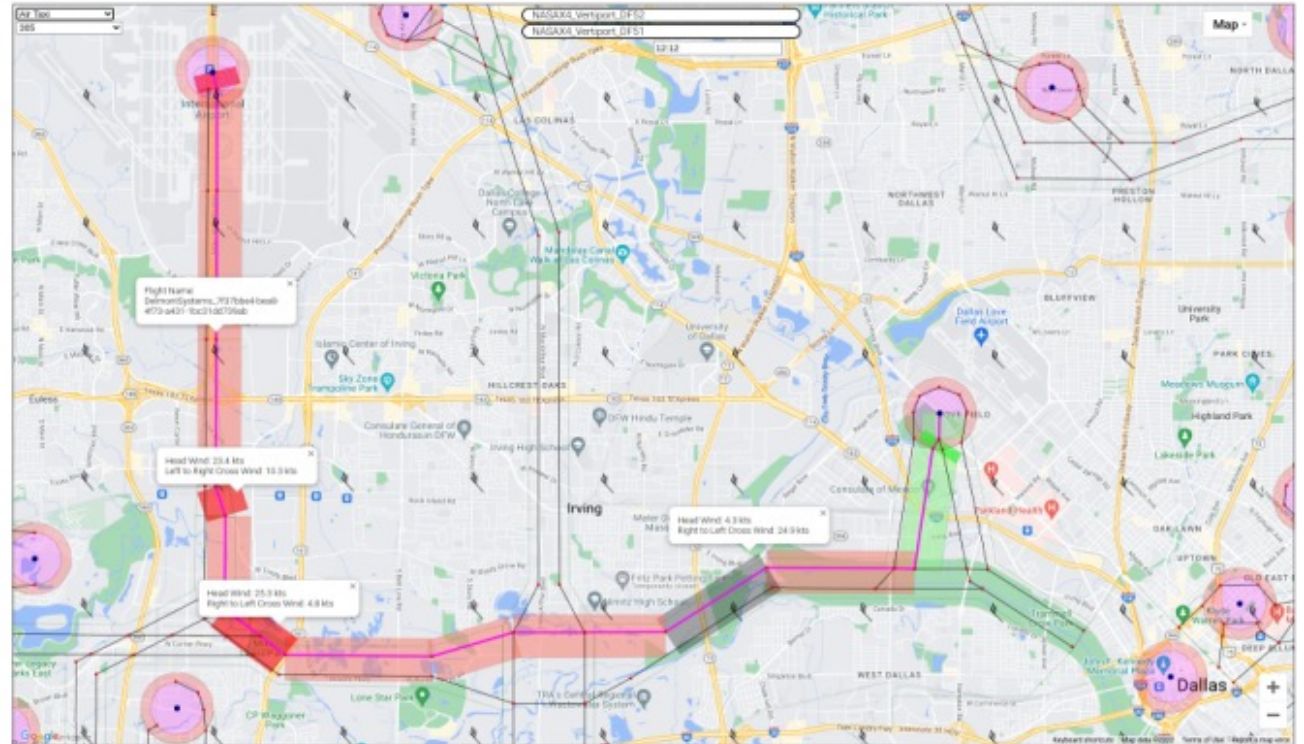
# Flight Winding Service

## Implications of the Modeled 3D Wind Field on Published Operational Intent

- Uses a modified Bresenham3D algorithm to advect trajectory through the grid
- Calculates segment relative head/tail winds, and cross winds
- Adjusts expected waypoint arrival times, or adjusts air speeds within limits to meet given waypoint arrival times



HRRR Data Provided By:



## Operational Intent Depicting Flight from Dallas Love Field to DFW Airport

- ~25 KT NW winds
- Net tail wind segments shown in green, headwinds in red, with increasing opacity for strength
- Crosswinds shift operational flight volume buffer around track in direction of wind

# Enabling Tactical Deconfliction

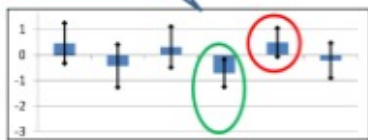
## Dynamic Parallax Radii and Bump Bubbles

Relating to future position uncertainty due to:

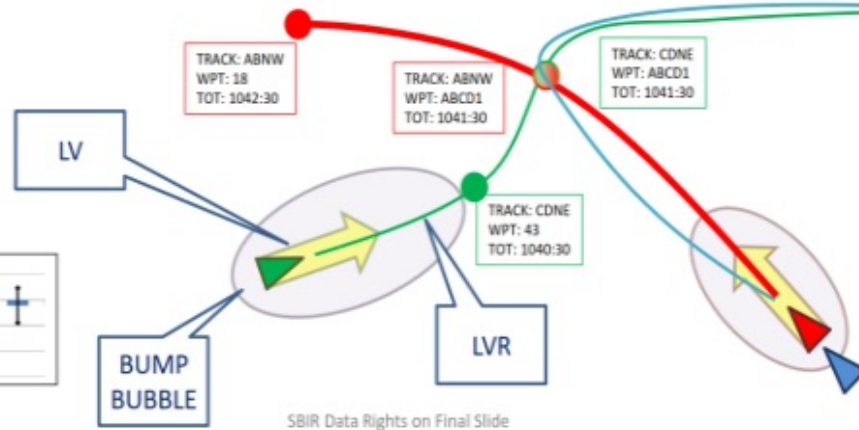
- Wind Gusts
- Observed Model Error
- Sparse Sensing Regions
- Wind Canyons

- *BUMP - Bubble*
- *LV - Location and Vector*
- *LVR - Location, Vector and Routing*

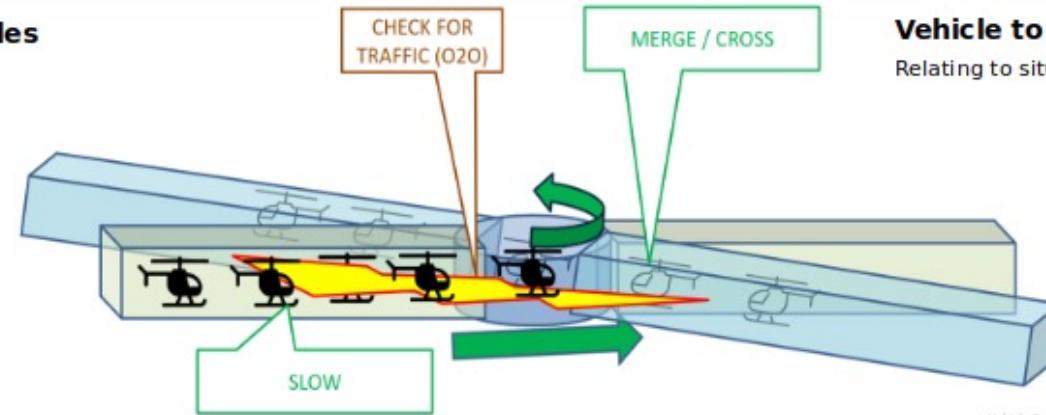
DELTA ENVELOPES



DIOXIDE



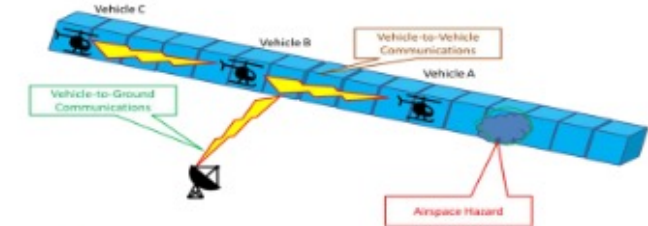
SBIR Data Rights on Final Slide



## Vehicle to Vehicle Communications

Relating to situational awareness:

- Turbulence detected
- Decentralized relay of observations (AIRMETs for low flying aircraft)
- Icing conditions detected
- Inaccurate modeling of meteorological conditions (wind, visibility, rainfall)



## Collision Avoidance Strategies

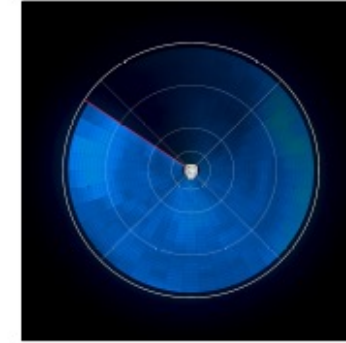
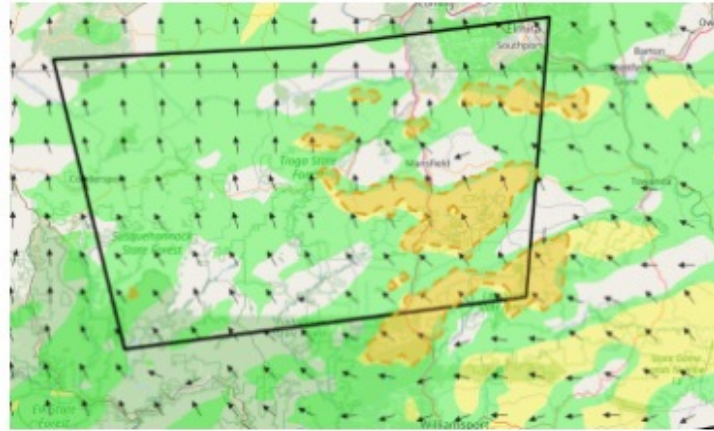
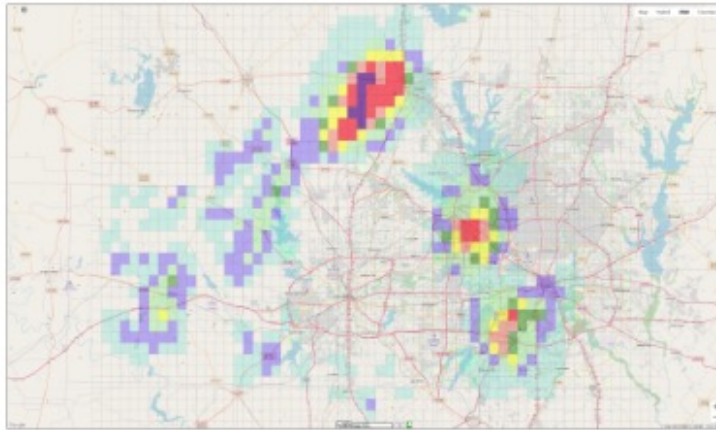
Relating to the ability to perform tactical deconfliction due to:

- Winds and wind gusts affecting safe bank angles
- Poor visibility impeding image processing
- Thermal updrafts and precipitation downdrafts
- Ice accretion degrading capabilities

4



# Advanced Product Development



## TWS/ MetroWeather/ CASA All Weather Winds

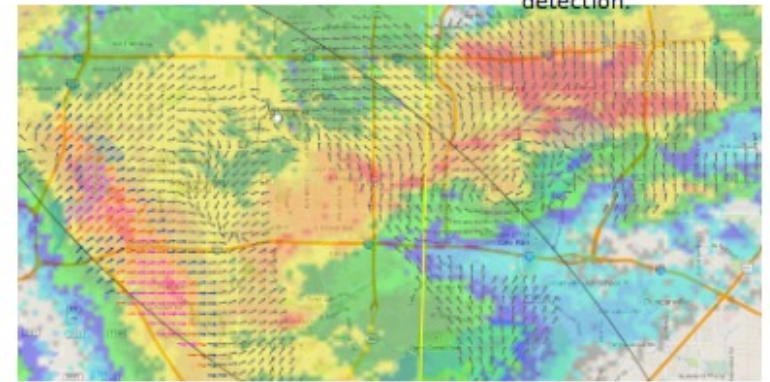
- Combined Doppler lidar and multi-Doppler radar winds
- Lidar in clear air, X-band radar in precipitation
- Daily verification of wind model accuracy
- New, high resolution gridded wind analysis for winding service
- Enhanced vertiport safety, downdraft detection

### TruWeather Solutions TruFlight v360

- Leveraging the CityWarn architecture, TWS takes airspace weather monitoring to the next level
- Automated delivery of user defined threshold extractions to REST interfaces in GeoJSON format
- Easy API access to rapidly updating model data
- Customized flight forecasts
- Attractive front end visualization

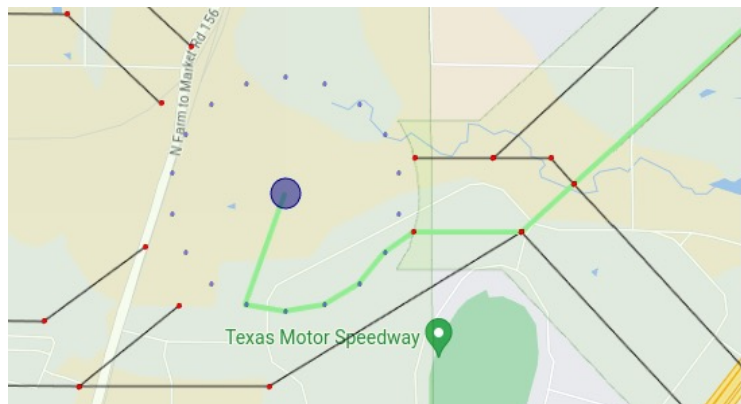
### Ensemble Nowcasting and Gridded Risk

- Perturb deterministic nowcasting input parameters
- Add alternative nowcasting approaches (ML-based)
- Extract member contours for relevant levels of reflectivity or rainfall rate
- Convert to gridded risk at various time intervals
- Develop standard formats and representations in conops
- Use stochastic based routing approaches
- See: Hu et al, Transportation Research Volume E Jan 2024

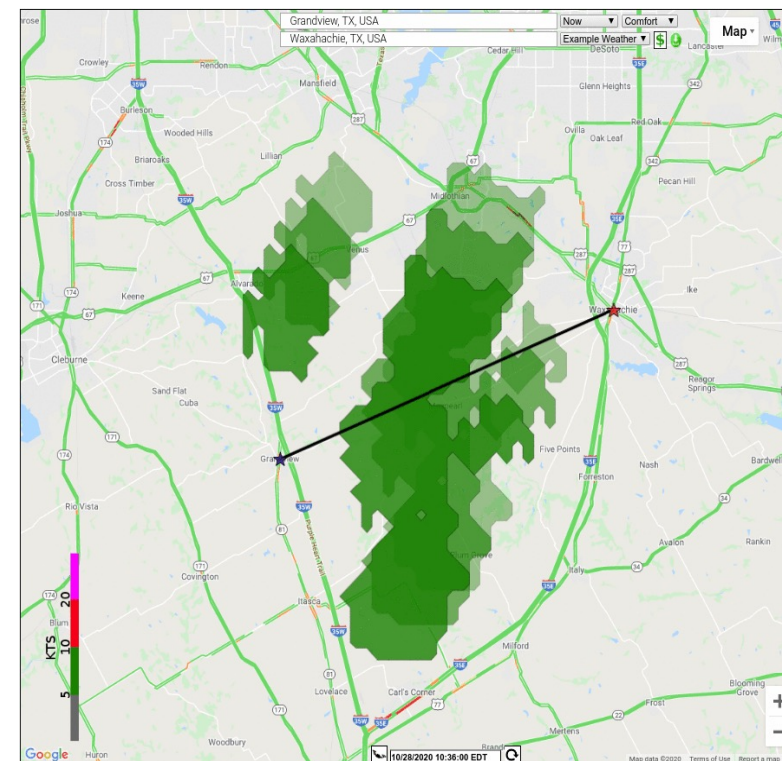




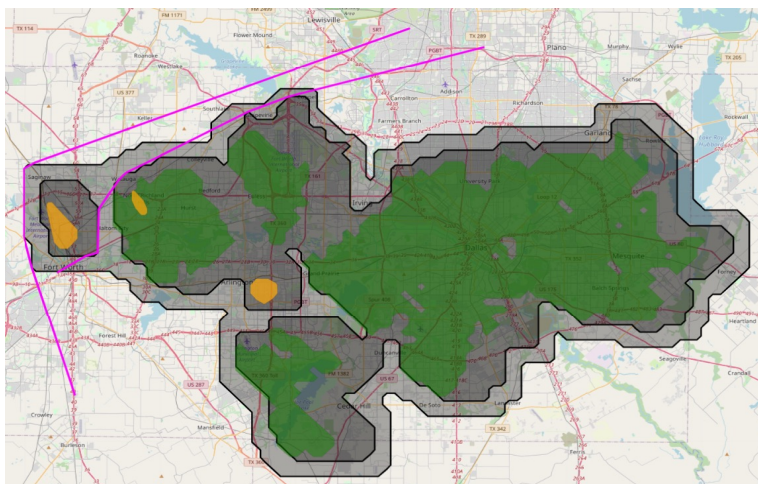
# Advanced Product Development Continued....



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```



Dynamic  
Vertiport  
Departure /  
Approach  
paths around  
wreath and  
into the wind



Convex  
Hulls for  
Planning /  
Concave  
Contours  
for In-Flight  
Avoidance /  
Rerouting

Continuous rerouting around  
weather in unstructured airspace  
outside of Class B

