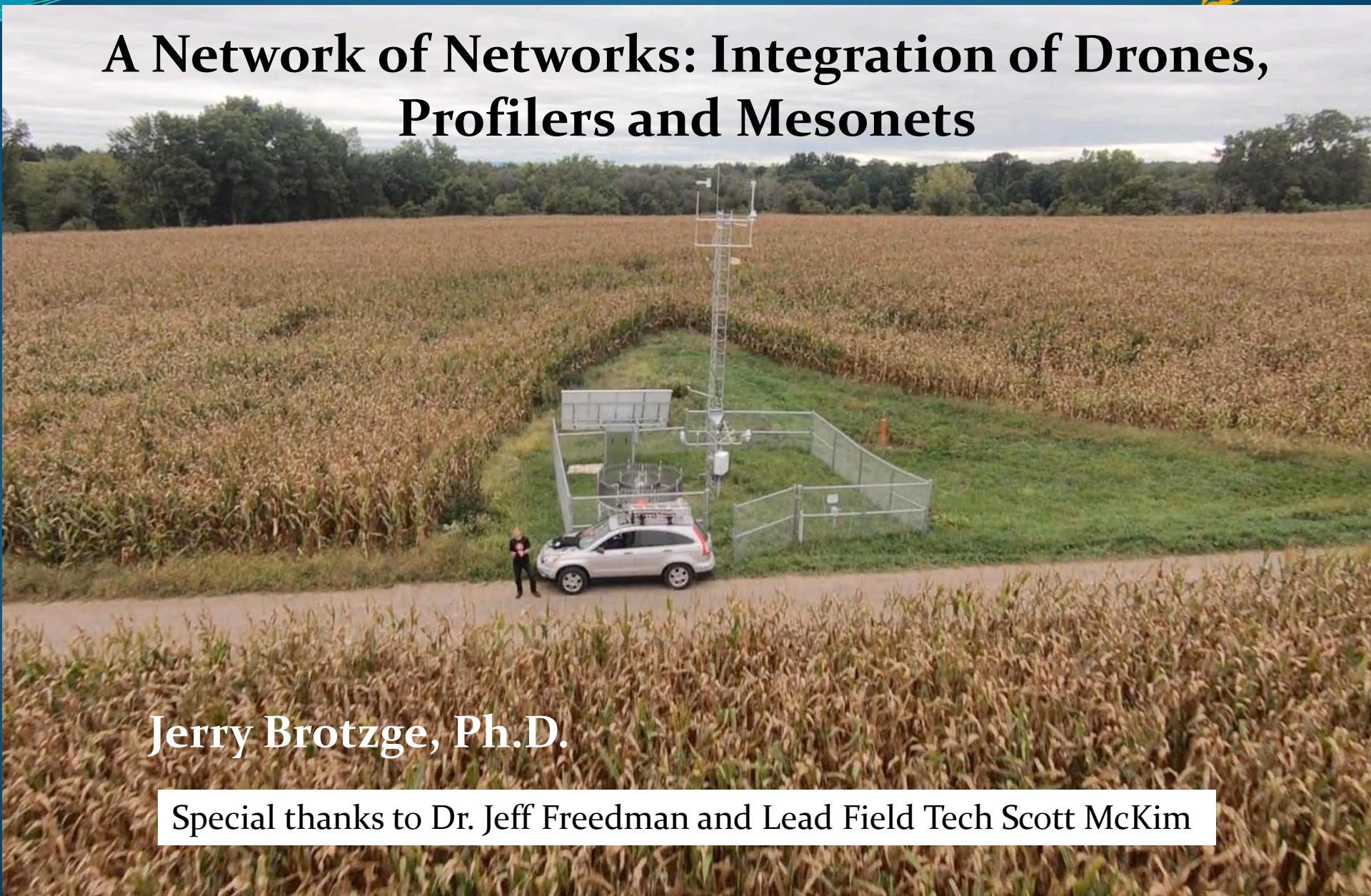
A Network of Networks: Integration of Drones, Profilers and Mesonets



Jerry Brotzge, Ph.D.

Special thanks to Dr. Jeff Freedman and Lead Field Tech Scott McKim

Outline

1. Drones used in operations today (in New York)
2. Integrating Drones and Profilers into the New York State Mesonet
3. Future Integration of Drones, Profilers and Mesonets

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Drones in New York

- New York State government is a leader in the use of drones for operations.

  Susquehanna River, New York – January 2018

(Dan Heather Krohmalney/YouTube) - Washington Post, 16 Jan 2018

Drone Testbed Corridor in New York

- $30M investment.
- One of 7 FAA testing facilities nationwide for gov't and commercial users.
- Goal: Develop FAA rules for drone "highways".
- Network of X-band radars improves situational awareness.

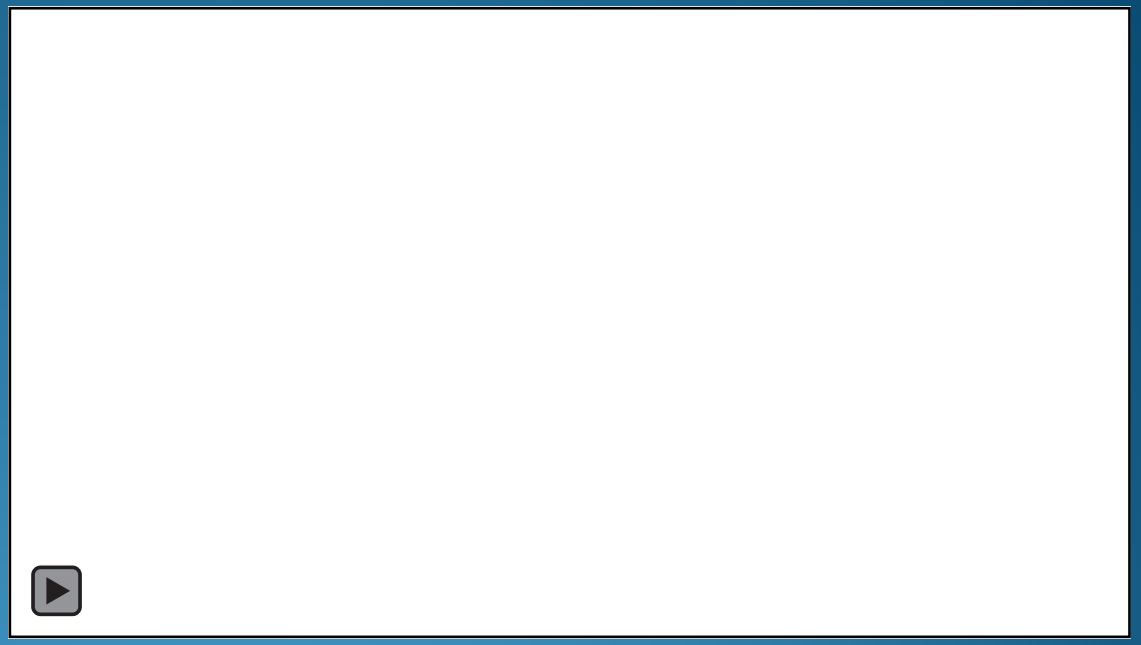

Figure courtesy of NUAIR (https://nuair.org/nyuasts/)

- Weather information enables drone flight "beyond line of sight".
- In return, weather data can be collected from drones.

But at what benefit and cost?

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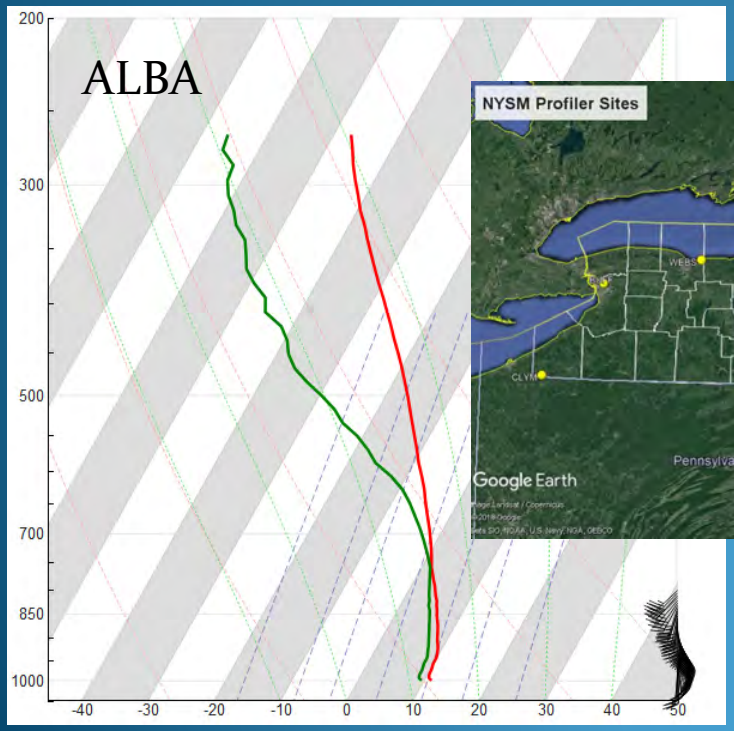
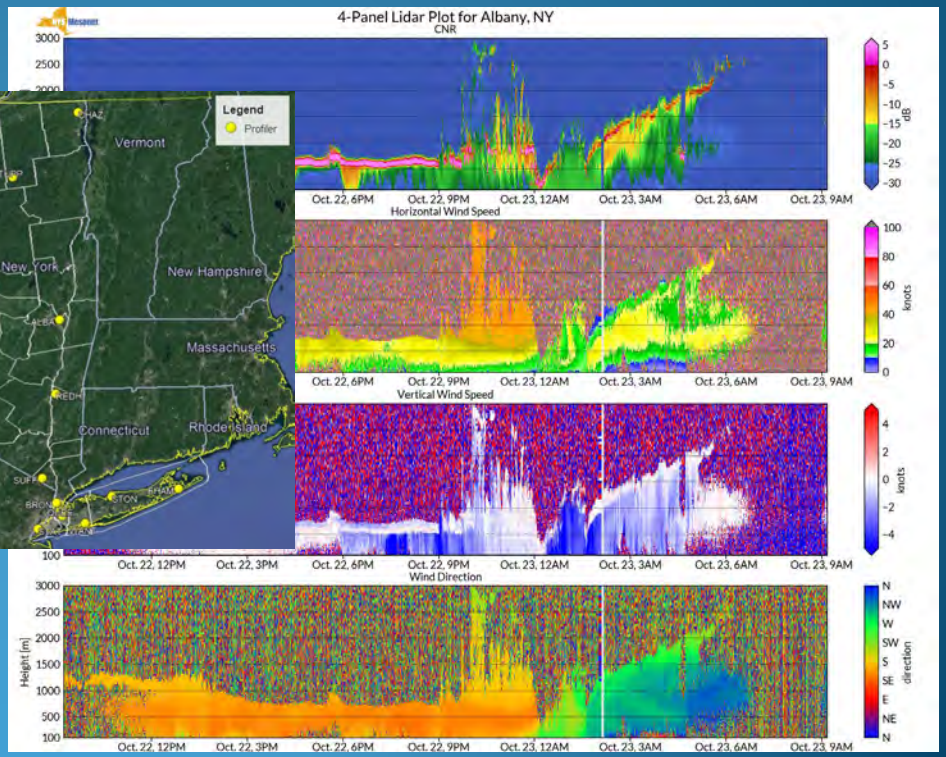
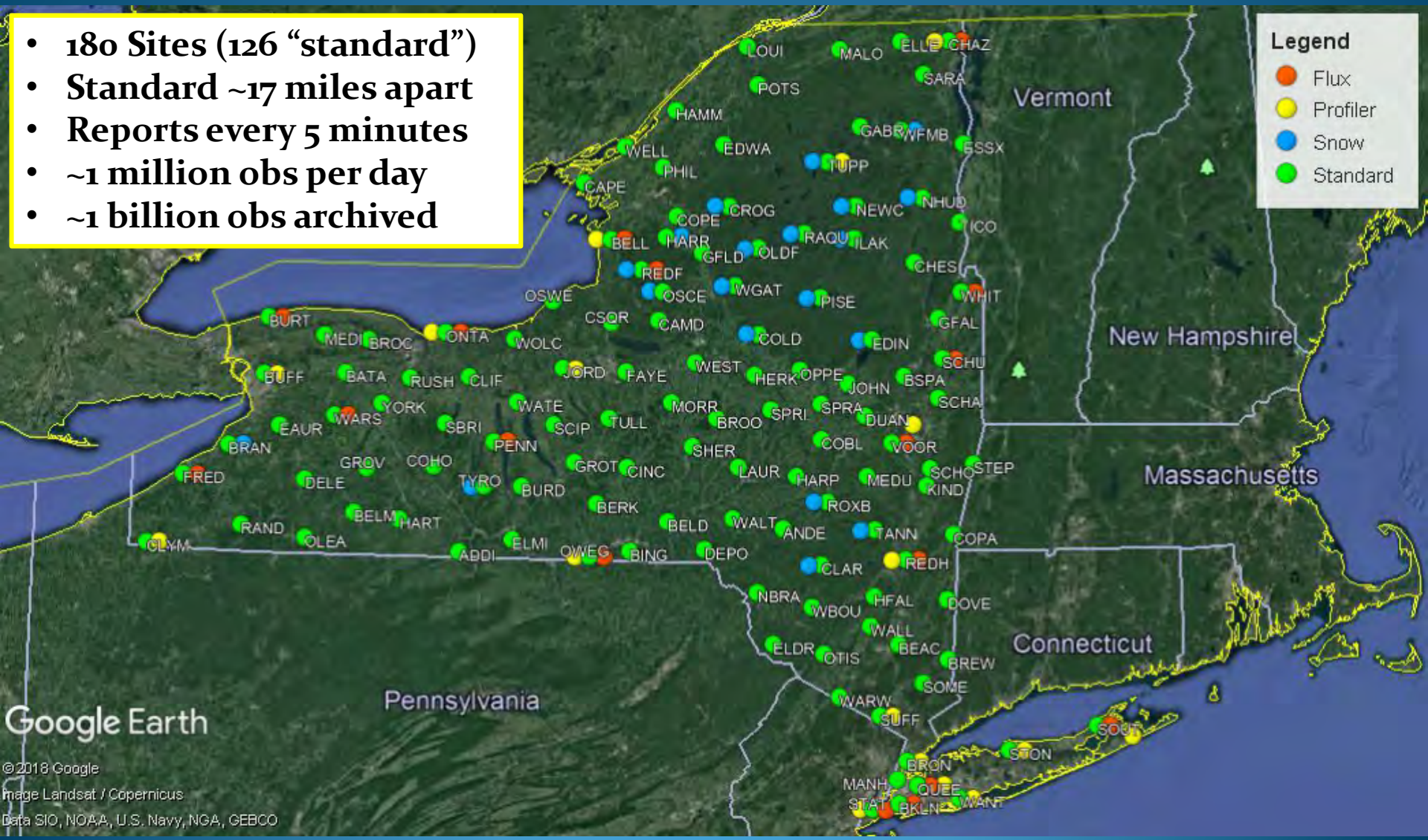




New York State Mesonet

- 180 Sites (126 “standard”)
- Standard ~17 miles apart
- Reports every 5 minutes
- ~1 million obs per day
- ~1 billion obs archived



Drones

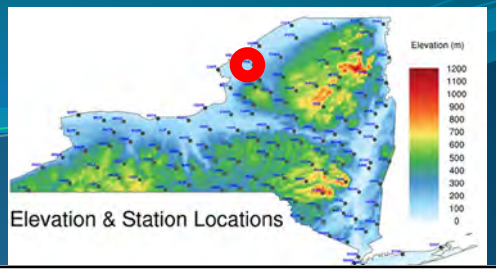
Advantages

1. Flexible flight pattern
2. Autonomous or manual
3. Wide variety of applications

Disadvantages

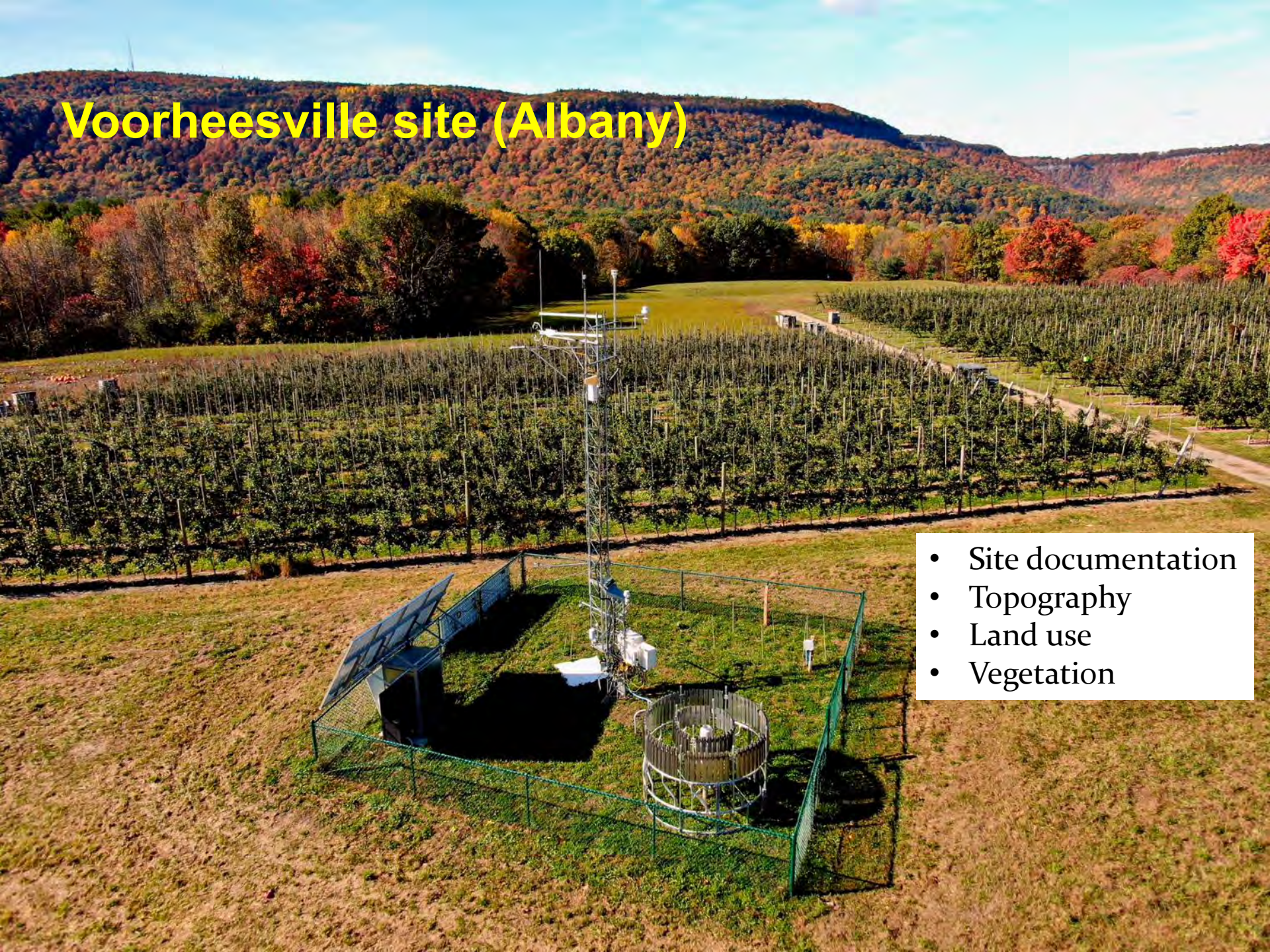
1. Weather-sensitive
2. Batteries required
3. FAA limits
4. Privacy!

How do we use drones?



Old Forge site (Adirondacks)

Voorheesville site (Albany)



- Site documentation
- Topography
- Land use
- Vegetation

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Profilers – Drone alternative?

Advantages

1. High-resolution data
2. High accuracy, precision
3. Continuous "Ground truth"

Disadvantages

1. Expensive!!
2. Fixed locations
3. Calibration issues

Drone Alternative - Ground-based, profiling sensors

NYS Mesonet
UNIVERSITY AT ALBANY

Profiler Network – 17 sites

Profiler Network – 17 sites

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* **Generally placed within 500 m of a Standard Site**

LIDARs

- Vertical wind profiles up to 3 km AGL
- RNRG/Leosphere 100S

Microwave Radiometers

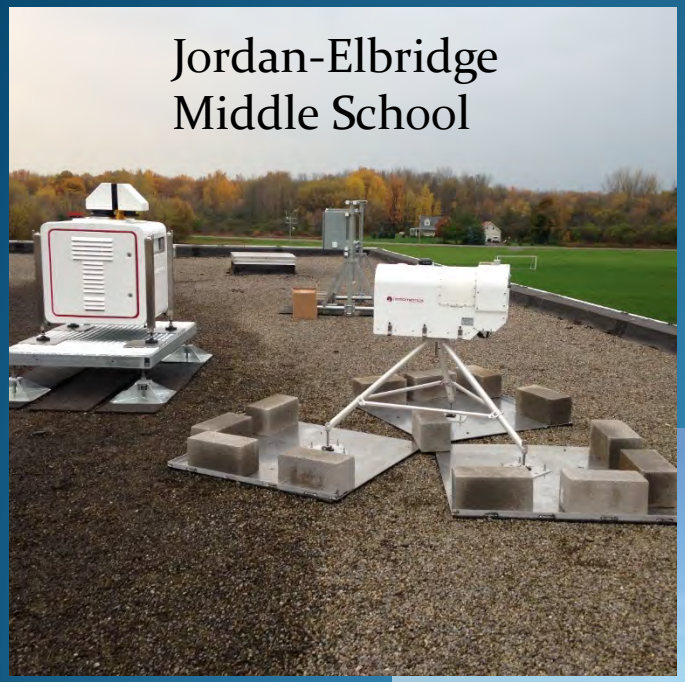
- Vertical temperature and moisture profiles up to 10 km AGL
- Selected Radiometrics MP-3000A

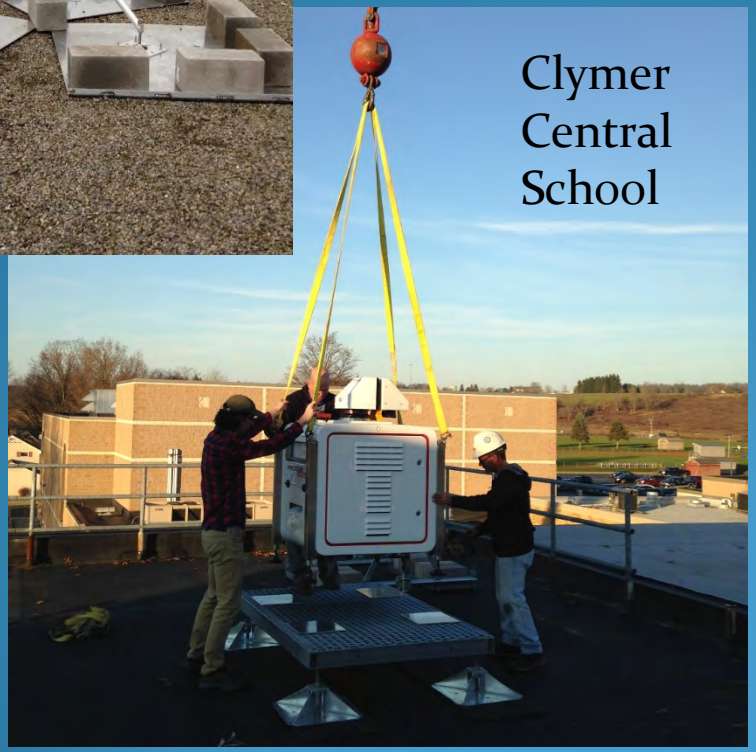
Photometer/sky imager(MMR/SSI)

- Multi-scan Multi-channel Radiometer
- Shadowband Sky Imager
- Designed/built by Mesonet/ASRC
- Patent application submitted.

Tupper Lake Profiler Site

Profiler Network – 17 sites





Siting:
- Access to Ethernet, utility power
- Generally rooftop deployments
- Most within 0.5 km of standard site

Challenges:
- Bi-annual liquid nitrogen calibration of microwave radiometer
- Bi-weekly TIP calibration of microwave radiometer
- Annual LiDAR maintenance
- Host networking dependency
- Roof access

Profiler Network

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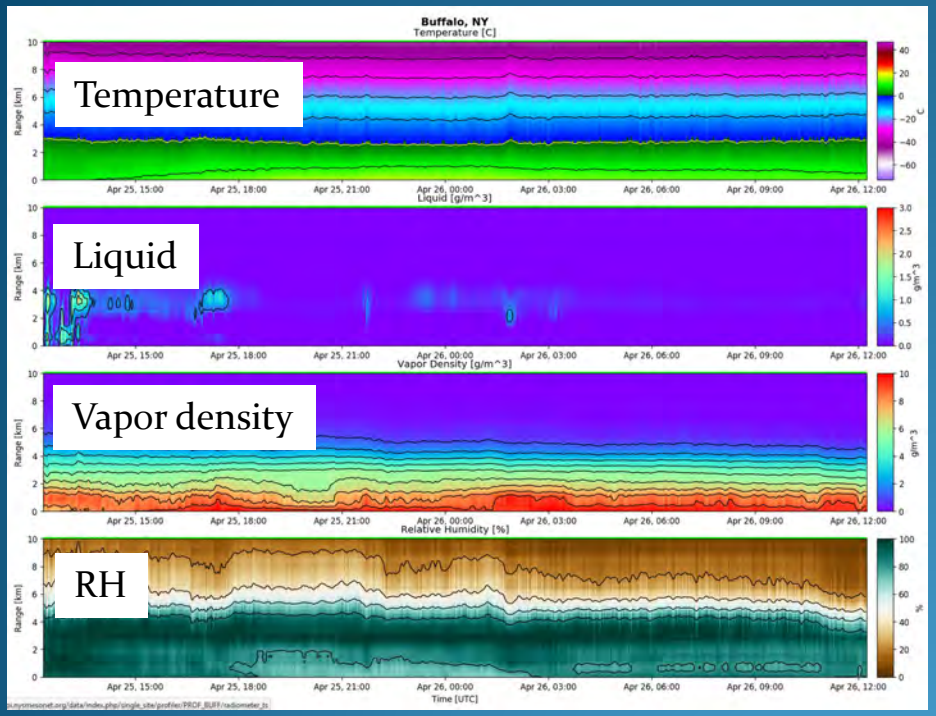
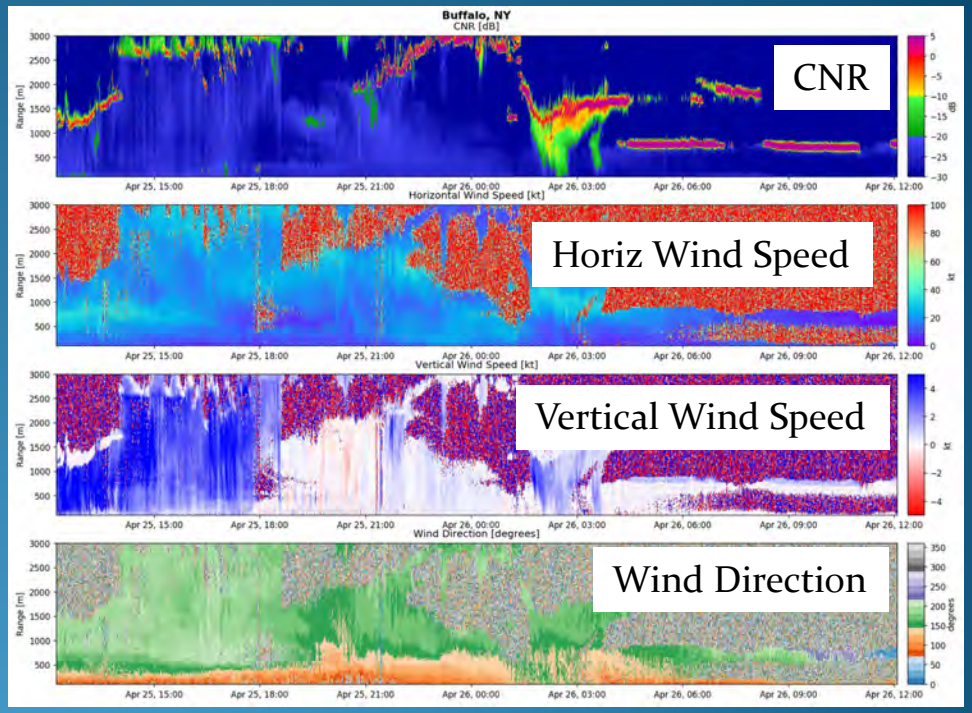
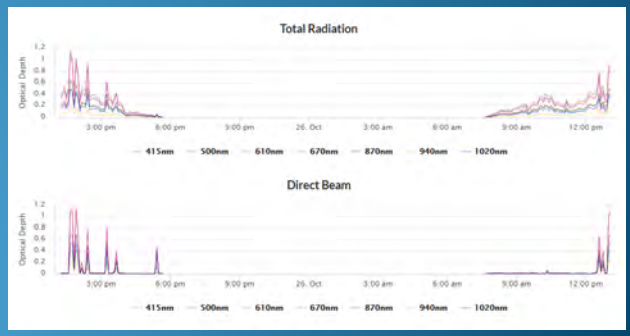
Microwave Radiometer



LiDAR



Environmental Sky Imager-Radiometer (eSIR)



Profiler Network

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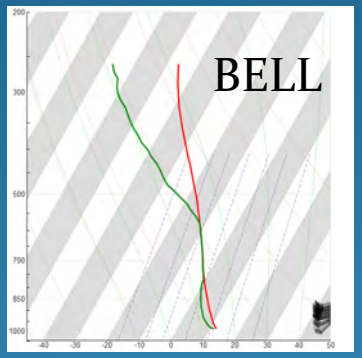
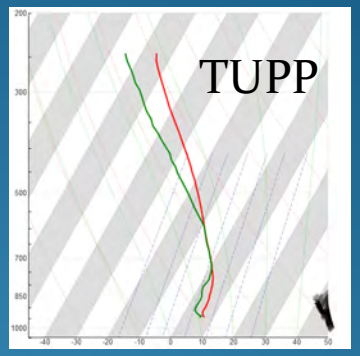
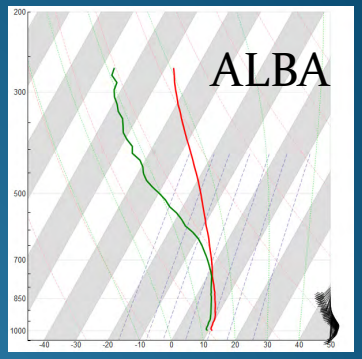
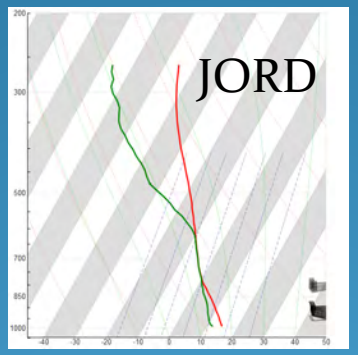
Radiosondes in NY
6 daily – BUF, ALB, UPT

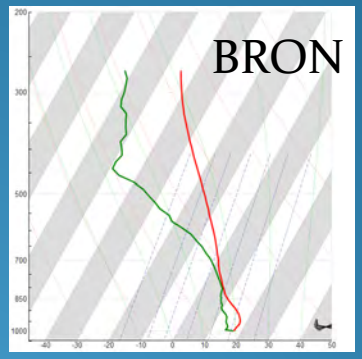
Virtual Soundings
~ 2500 daily

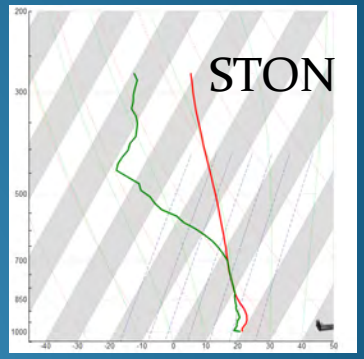


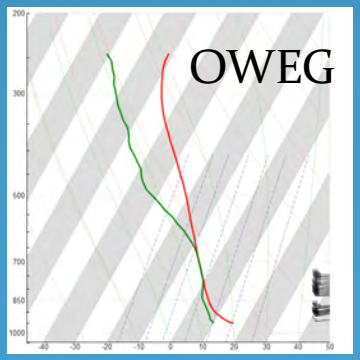


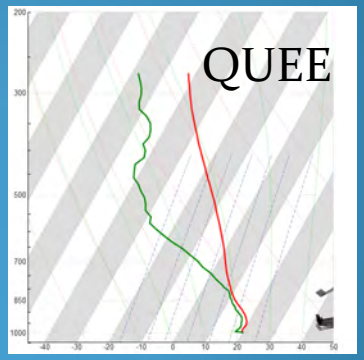


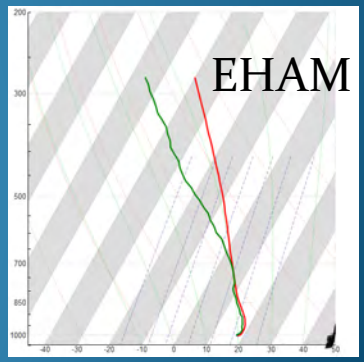


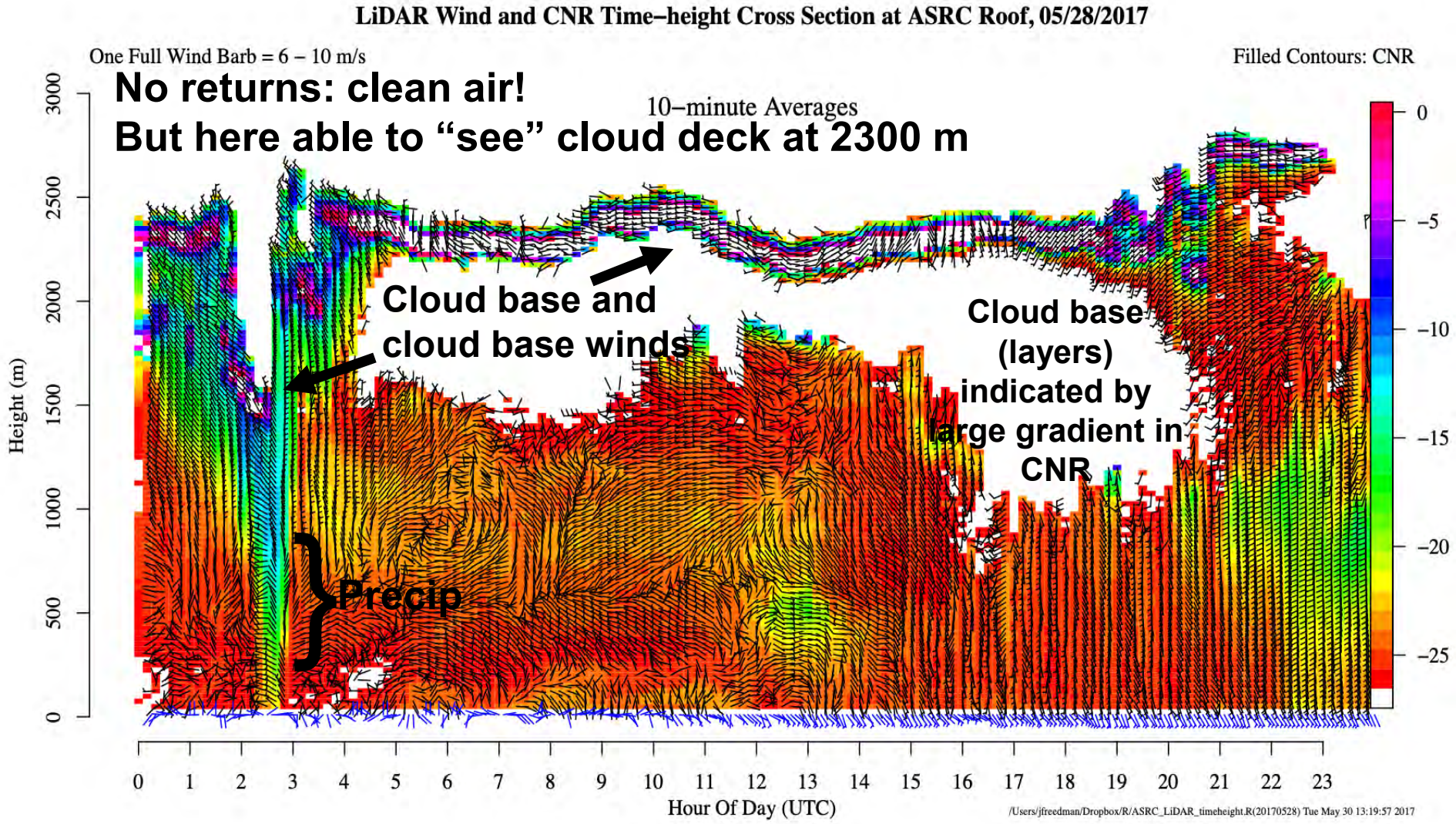






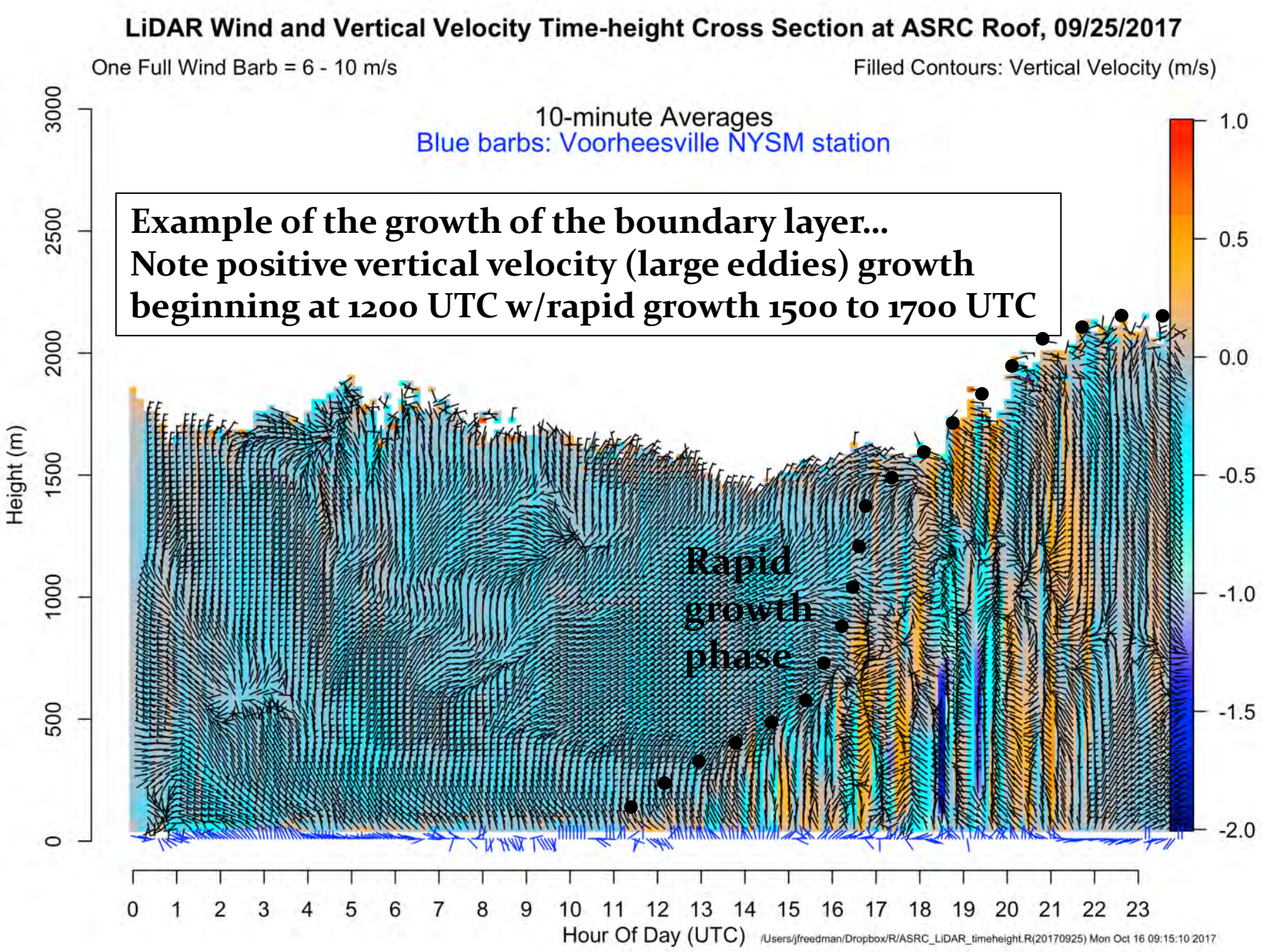




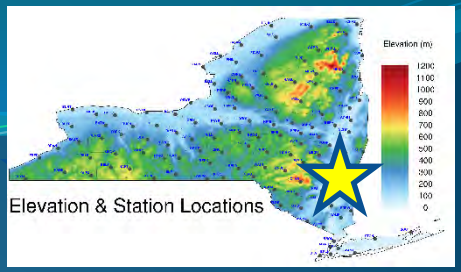


Light rain shower between 0200 and 0300 UTC

CNR: carrier to noise ratio (similar to SNR)


LiDAR Wind and Vertical Velocity Time-height Cross Section at ASRC Roof, 09/25/2017
One Full Wind Barb = 6 - 10 m/s
Filled Contours: Vertical Velocity (m/s)
10-minute Averages
Blue barbs: Voorheesville NYSM station
Example of the growth of the boundary layer...
Note positive vertical velocity (large eddies) growth beginning at 1200 UTC w/rapid growth 1500 to 1700 UTC
Rapid growth phase
Height (m)
0
500
1000
1500
2000
2500
3000
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour Of Day (UTC)
/Users/jfreedman/Dropbox/R/ASRC_LiDAR_timeheight.R(20170925) Mon Oct 16 09:15:10 2017

Value of a network…



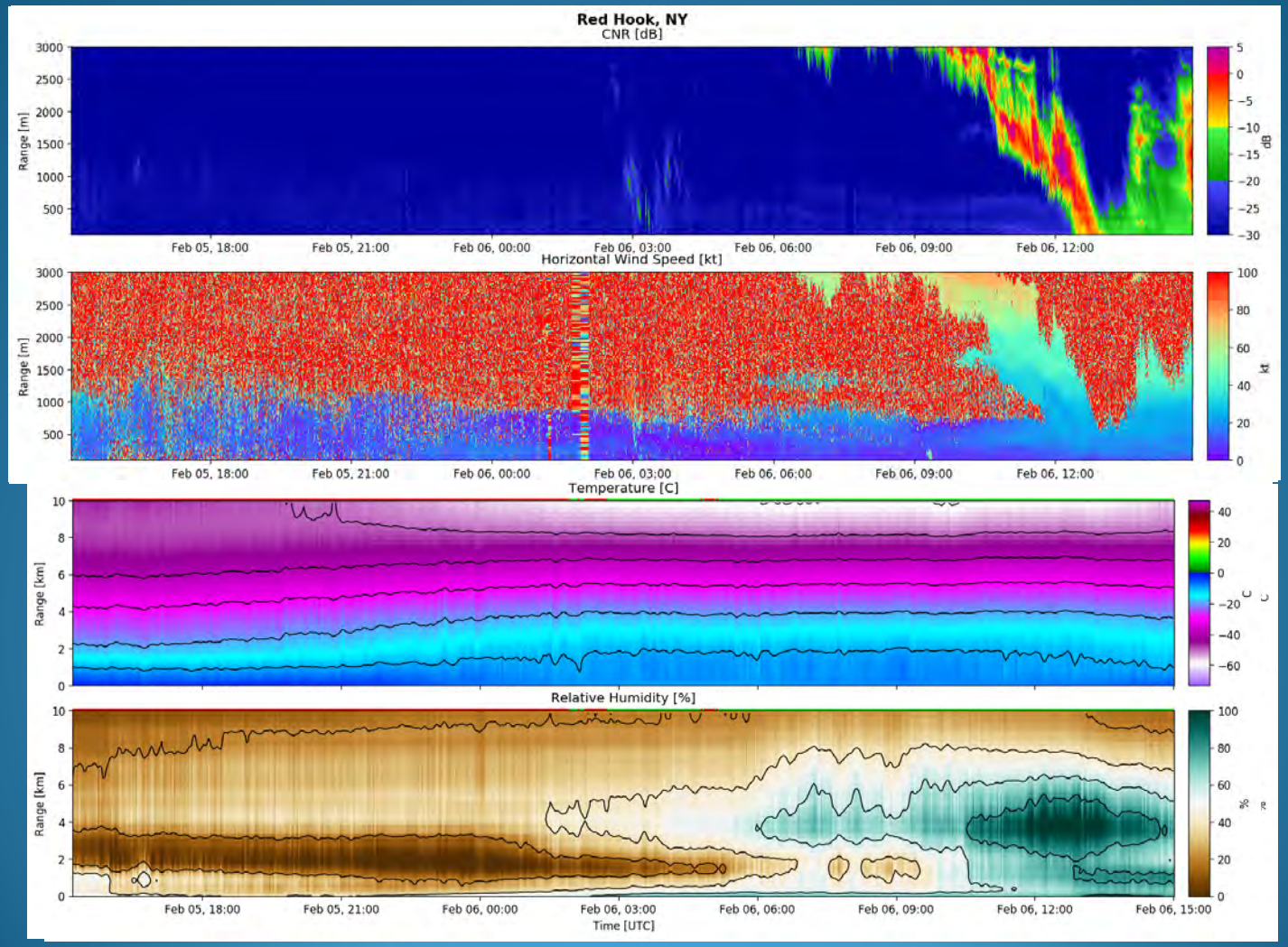
Light snow band moving west to east, very dry surface layer.

3 km

10 km

LiDAR

Microwave Radiometer



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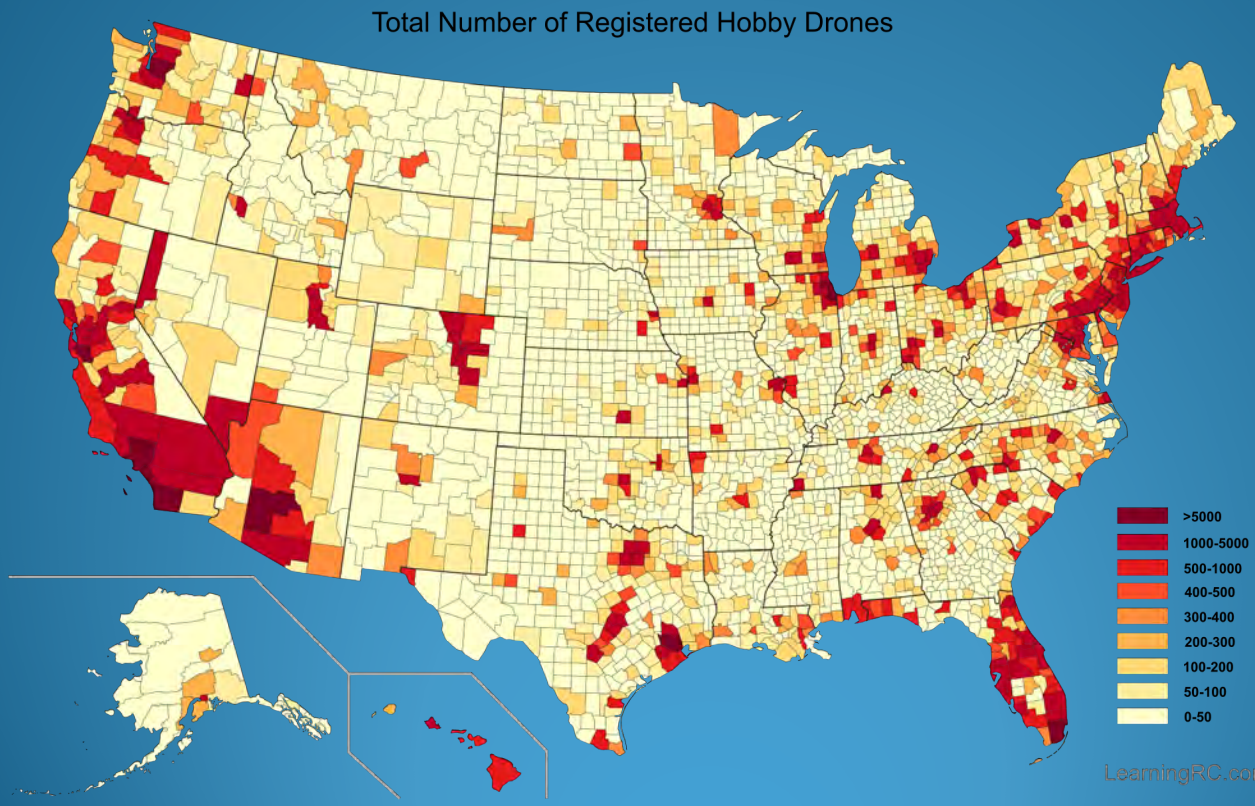

NY State Upper-air Network Regional Impact Study (NYSUNRIS) Testbed

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A five-year (2020 – 2025) testbed for advancing profiler technology. Expand to include UAS tech?

Goals:

1. Improve quality, robustness of technology.
2. Integrate data into NWS real-time operations.
3. Assimilate data into NWP and evaluate impact.
4. Utilize data to validate space-based profiling methods.
5. Assess cost-effectiveness of integrating profilers (& UAS?) into the national observing infrastructure.

A "Network of Networks"…

Short-term (next 10 years)

1. More immediate utility from a network of ground-based profilers
2. In parallel, continue testing integration of data from drones, and other crowd-based sources

Long-term (10+ years)

1. Likely most cost effective to extract weather data from commercial drone services (e.g., Amazon), at least in high pop density areas
2. May need a "drone mesonet" of sorts in rural areas to supplement high population density areas.
3. High-quality ground-based profilers will still be needed, much like surface-based gauges validate radar QPE today.

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NYS Mesonet

Photo courtesy of Tim Keegan, Town of Webster