Severe Thunderstorm Research

in the Department of Meteorology and Atmospheric Science

Paul Markowski, Yvette Richardson
{supercell thunderstorms, tornadoes}

Matt Kumjian, Kelly Lombardo
{supercell thunderstorms, giant hail}

John Peters
{supercell thunderstorms}

Dave Stensrud, Yunji Zhang
{computer-generated forecasts of storm formation and behavior}

Steve Greybush
{AI-based predictions of storms}

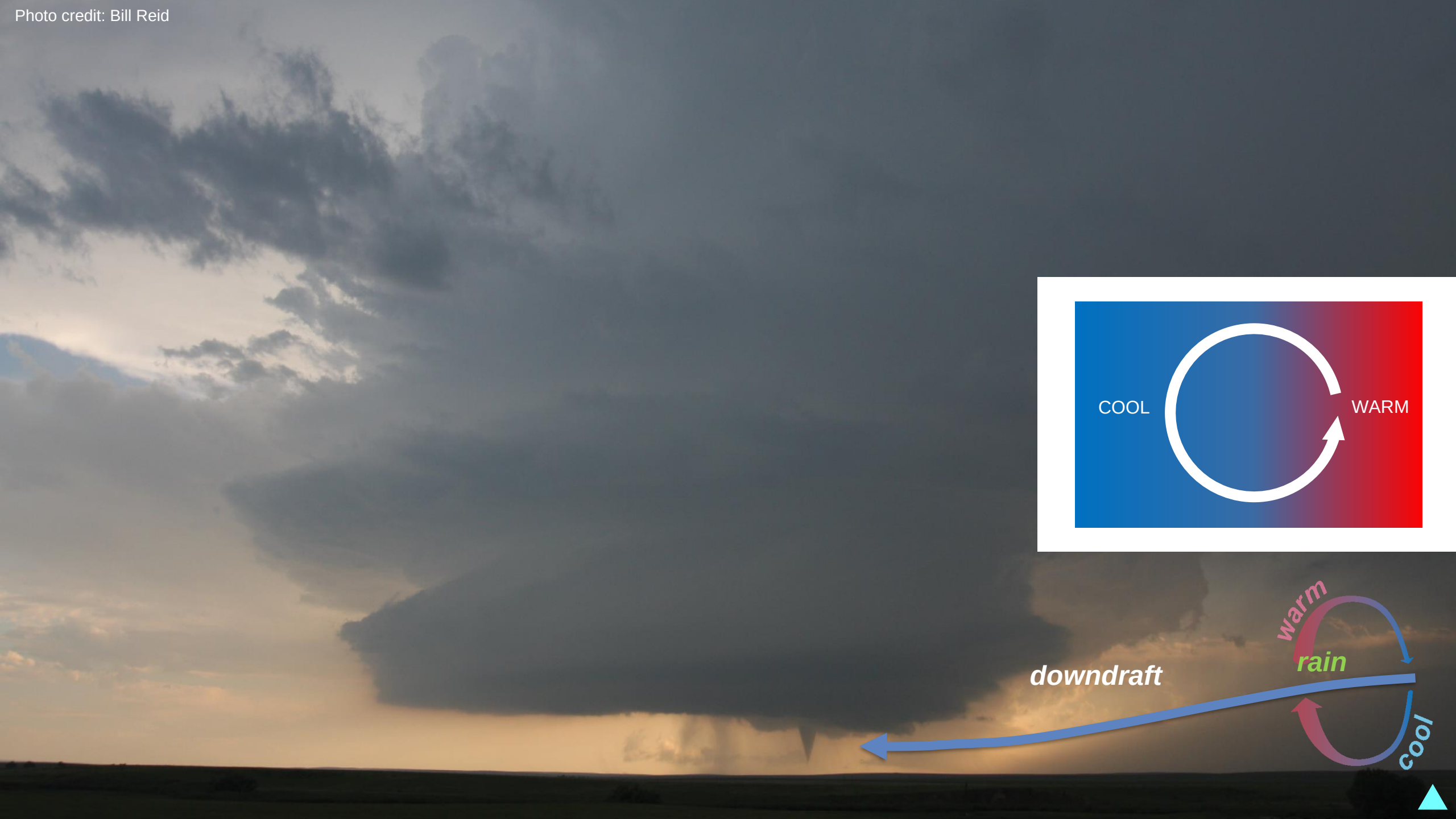
PennState
College of Earth
and Mineral Sciences

Supercell Thunderstorms

Tornadic Supercell Thunderstorms

Nontornadic Supercell Thunderstorms

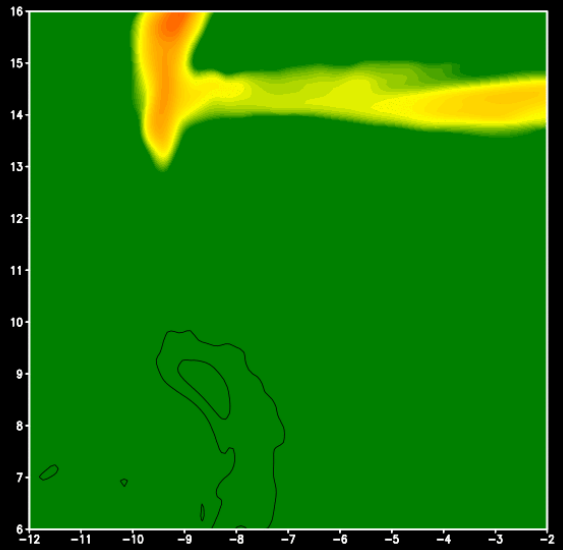
Photo credit: Bill Reid

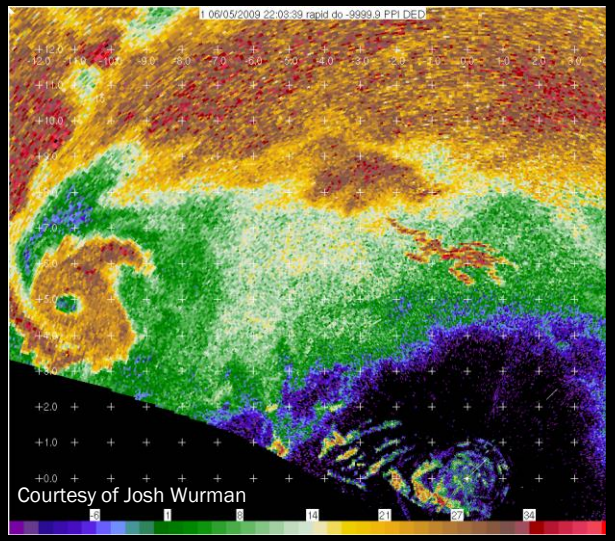


Observations

This team of scientists launches weather balloons into violent storms. What they learn could improve tornado forecasts.

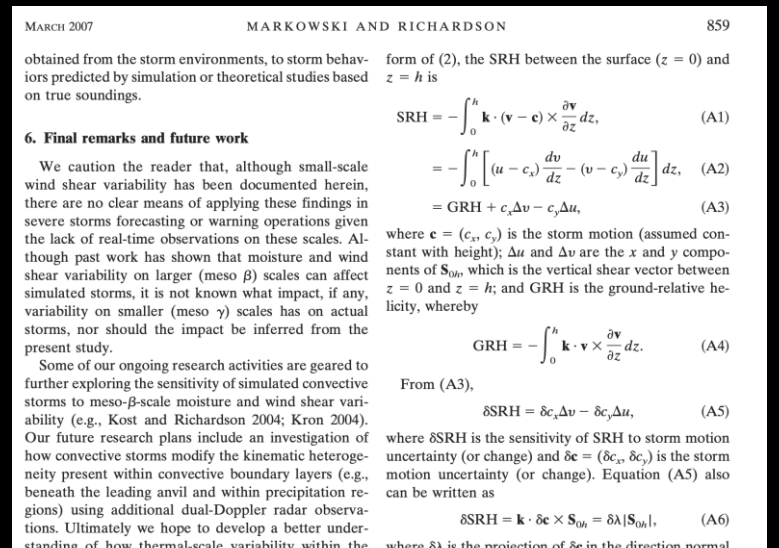
Computer simulations





Our tools

Theory



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obtained from the storm environments, to storm behaviors predicted by simulation or theoretical studies based on true soundings.

6. Final remarks and future work

We caution the reader that, although small-scale wind shear variability has been documented herein, there are no clear means of applying these findings in severe storms forecasting or warning operations given the lack of real-time observations on these scales. Although past work has shown that moisture and wind shear variability on larger (meso β) scales can affect simulated storms, it is not known what impact, if any, variability on smaller (meso γ) scales has on actual storms, nor should the impact be inferred from the present study.

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form of (2), the SRH between the surface ($z = 0$) and $z = h$ is

$$\mathrm{SRH} = -\int_0^h \mathbf{k} \cdot (\mathbf{v} - \mathbf{c}) \times \frac{\partial \mathbf{v}}{\partial z}\, dz, \tag{A1}$$

$$= -\int_0^h \left[(u - c_x)\frac{dv}{dz} - (v - c_y)\frac{du}{dz} \right] dz, \tag{A2}$$

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where $\mathbf{c} = (c_x, c_y)$ is the storm motion (assumed constant with height); Δu and Δv are the x and y components of $\mathbf{S}_{0h}$, which is the vertical shear vector between $z = 0$ and $z = h$; and GRH is the ground-relative helicity, whereby

$$\mathrm{GRH} = -\int_0^h \mathbf{k} \cdot \mathbf{v} \times \frac{\partial \mathbf{v}}{\partial z}\, dz. \tag{A4}$$

From (A3),

$$\delta\mathrm{SRH} = \delta c_x \Delta v - \delta c_y \Delta u, \tag{A5}$$

where δSRH is the sensitivity of SRH to storm motion uncertainty (or change) and $\delta\mathbf{c} = (\delta c_x, \delta c_y)$ is the storm motion uncertainty (or change). Equation (A5) also can be written as

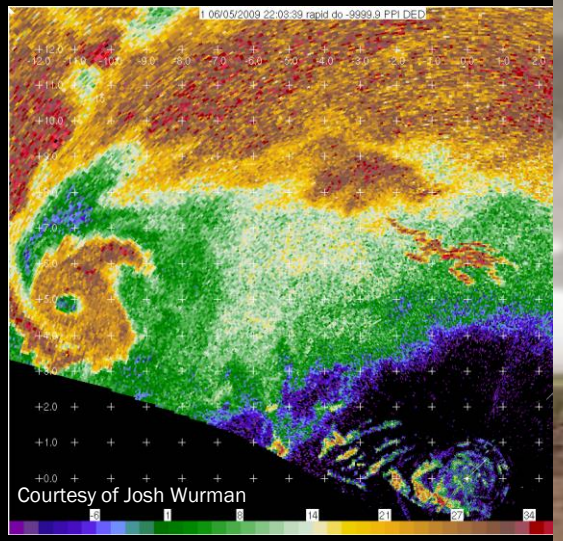
$$\delta\mathrm{SRH} = \mathbf{k} \cdot \delta\mathbf{c} \times \mathbf{S}_{0h} = \delta\lambda |\mathbf{S}_{0h}|, \tag{A6}$$

where $\delta\lambda$ is the projection of $\delta\mathbf{c}$ in the direction normal

Observations

Courtesy of Josh Wurman

This team of scientists launches weather balloons into violent storms. What they learn could improve tornado forecasts.



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Computer simulations

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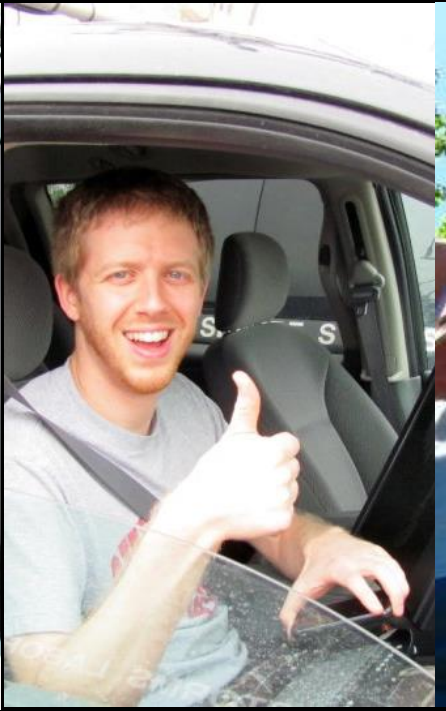
Computer simulations

Some challenges like sharing the road...

and with the hordes.

with the herds...

photo credit: Julie Malingowski



Student Participants

Photo credits: Julie Malingowski, Chris Nowotarski, and Andrew Oberthaler

The PIs

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http://bigstormpicture.com

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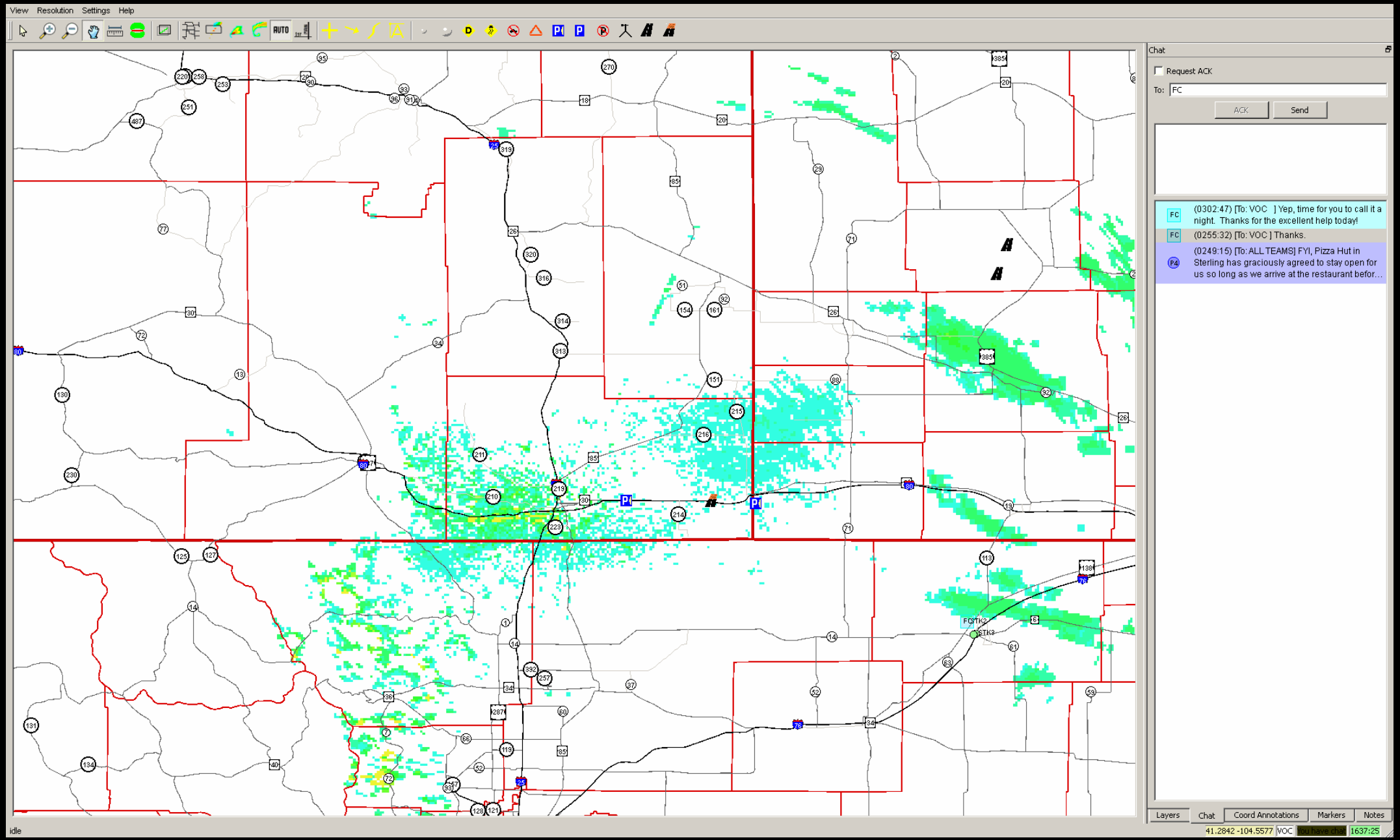
Example of a real tornado chase



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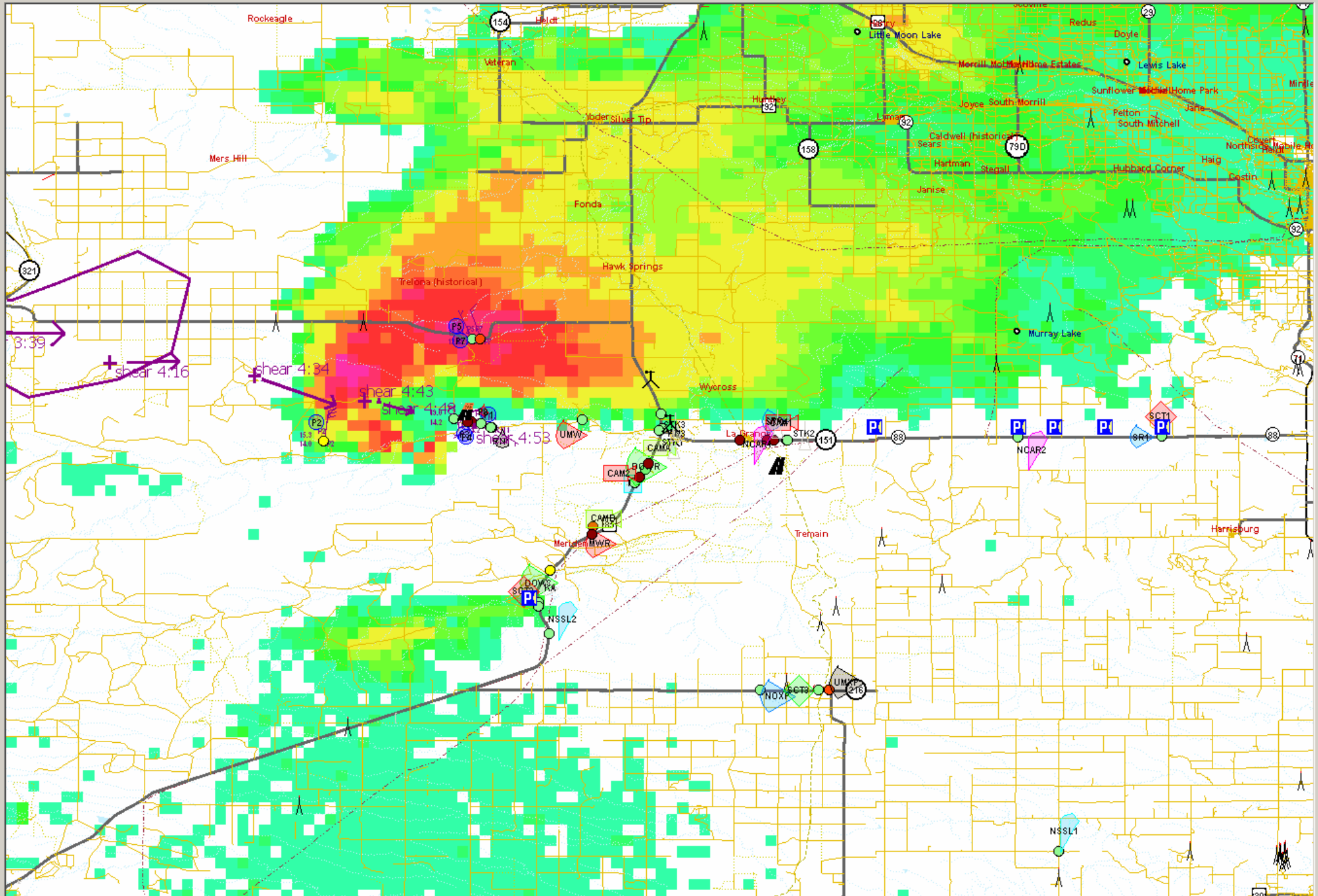

Chat

Request ACK

To: FC2 COORDINATORS

ACK Send

DOW7 (2157:31) [To: coordinators sct1 sct2] very strong surface tornado. 16 km from 85

FC2 (2157:04) [To: COORDINATORS] We should probably gath can in this deployment, and then bust S and E for a secon

FC2 (2156:43) [To: COORDINATORS] 290 az seems to be hold

P2 (2152:31) [To: FC2 ALL_TEAMS] golfballs west side of circ

DOW7 (2152:27) [To: coordinators sct1 sct2] stronger near surfa

DOW7 (2151:47) [To: coordinators sct1 sct2] rotation is 20 km fro convergence and rotation at surface. heading directly tow

FC2 (2149:49) [To: ALL_TEAMS] Major reflectivity descending i

FC (2148:17) [To: ALL TEAMS] Tornadogenesis likely next sev

FC2 (2146:18) [To: ALL_TEAMS] 90 kt gate-to-=gate near tip of

FC (2144:27) [To: COORDINATORS] DOW6 and DOW7 are s north of FC. Use the veggieburger tool to see the lobes.

DOW7 (2141:28) [To: coordinators sct1 sct2] dow6 dow7 up and

FC2 (2141:19) [To: COORDINATORS] Psbl blob echo (DRC) fo hook.

FC2 (2139:25) [To: ALL_TEAMS] 80 kt differential base scan, tw

P3 (2138:53) [To: P3 FC ALL TEAMS] at the split it goes unpav

FC2 (2136:52) [To: COORDINATORS] More extreme deviance t question, we will alert you if we see it happening.

P3 (2136:32) [To: FC ALL TEAMS] road 242 or bear creek roa drive on...terrain issues though exist in some spots for bo

View from our vehicle

Being in the storm does not give you a better view!

4:20 pm

Kristine Allen

Program Director

Kristine Allen is Program Director of WPSU-FM. She also files feature stories for WPSU on the arts, culture, science, and more. When she's not at WPSU, Kris enjoys playing folk fiddle, acting, singing and portrait-sketching. She is also a self-confessed "science geek." Kris started working in public radio in college, at age 17, and says she "just couldn't stop."

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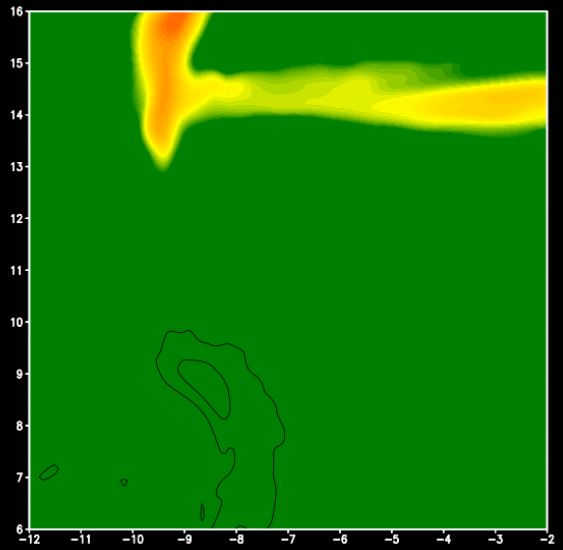

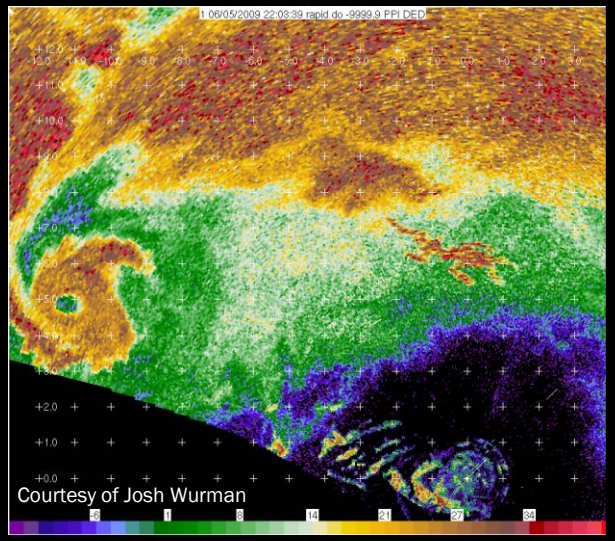

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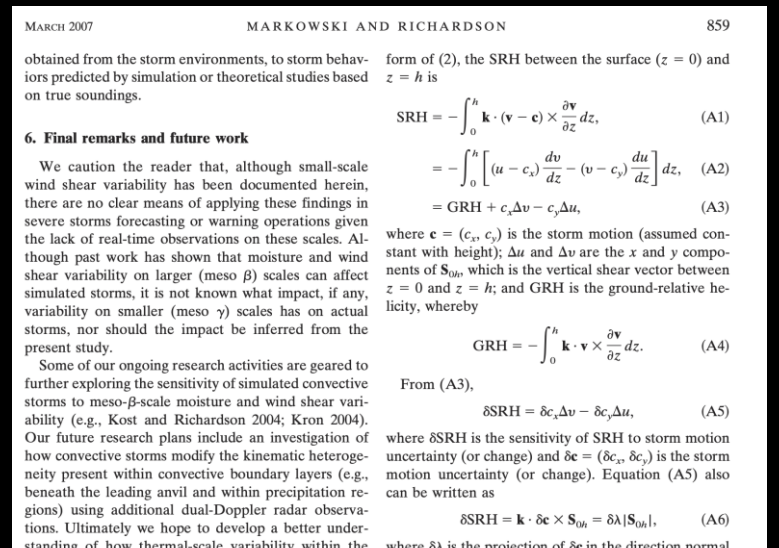

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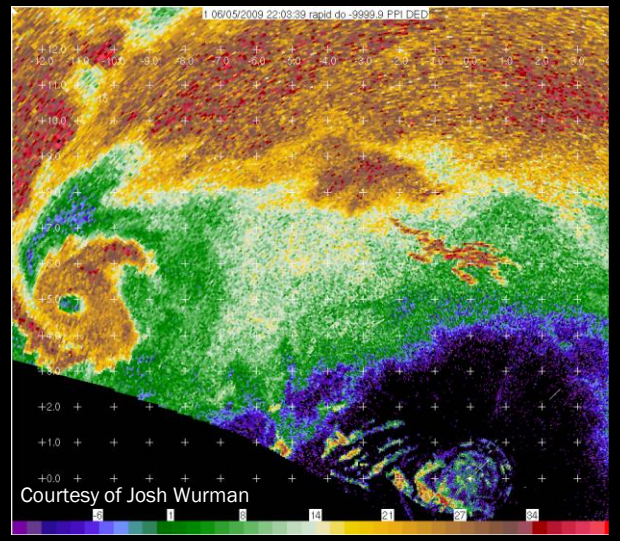

Capital Weather Gang

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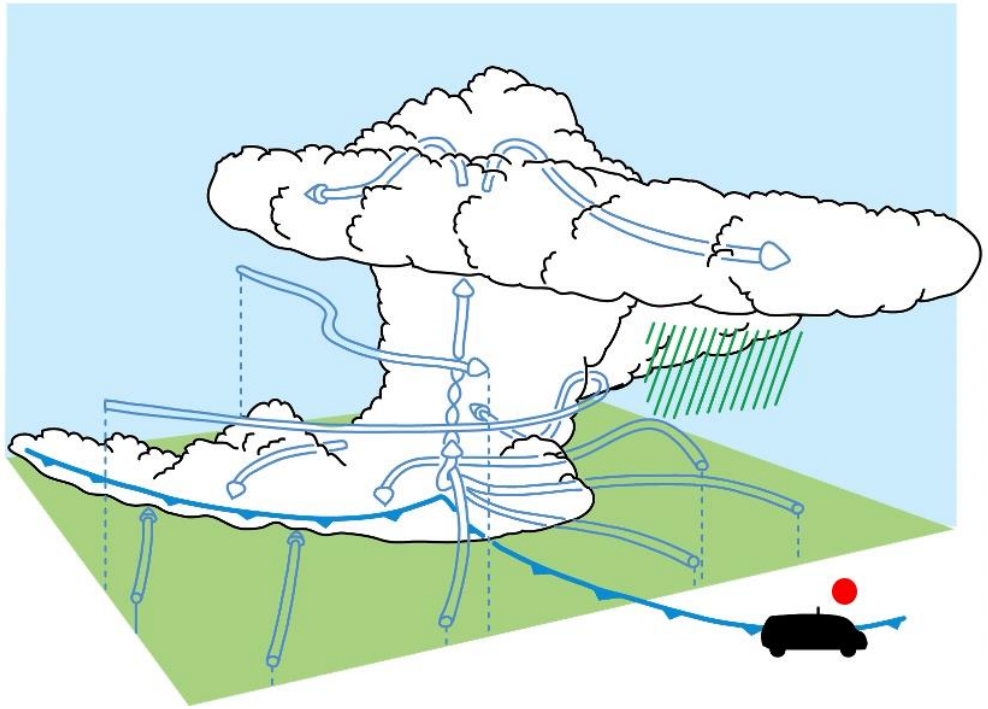
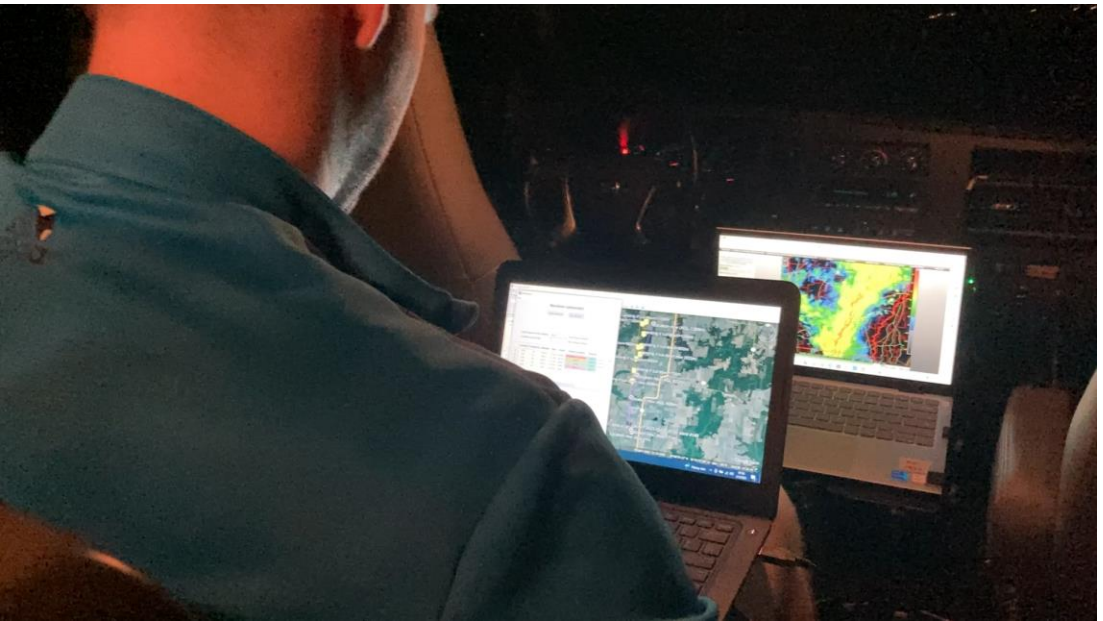
May, 1996

May, 2017–2023



1597
1565
1561

Windsond

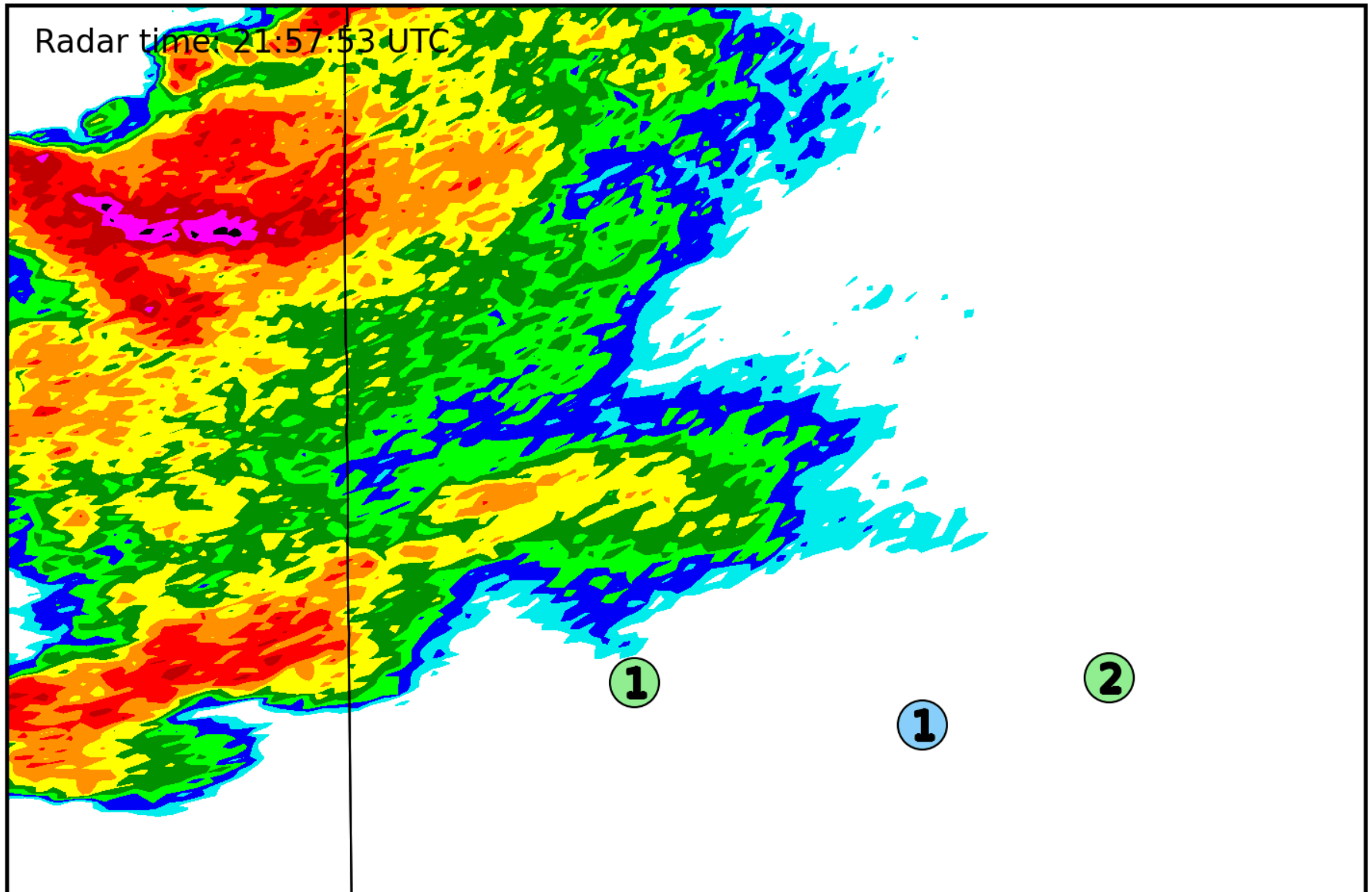
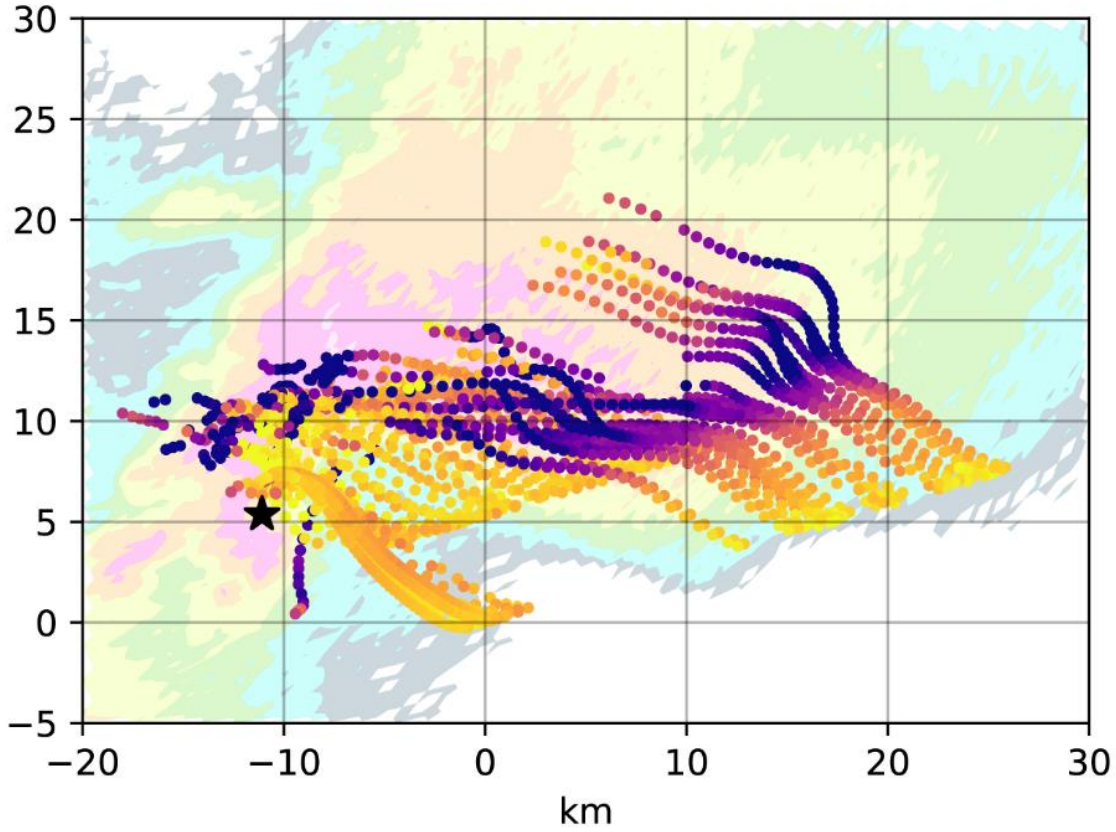
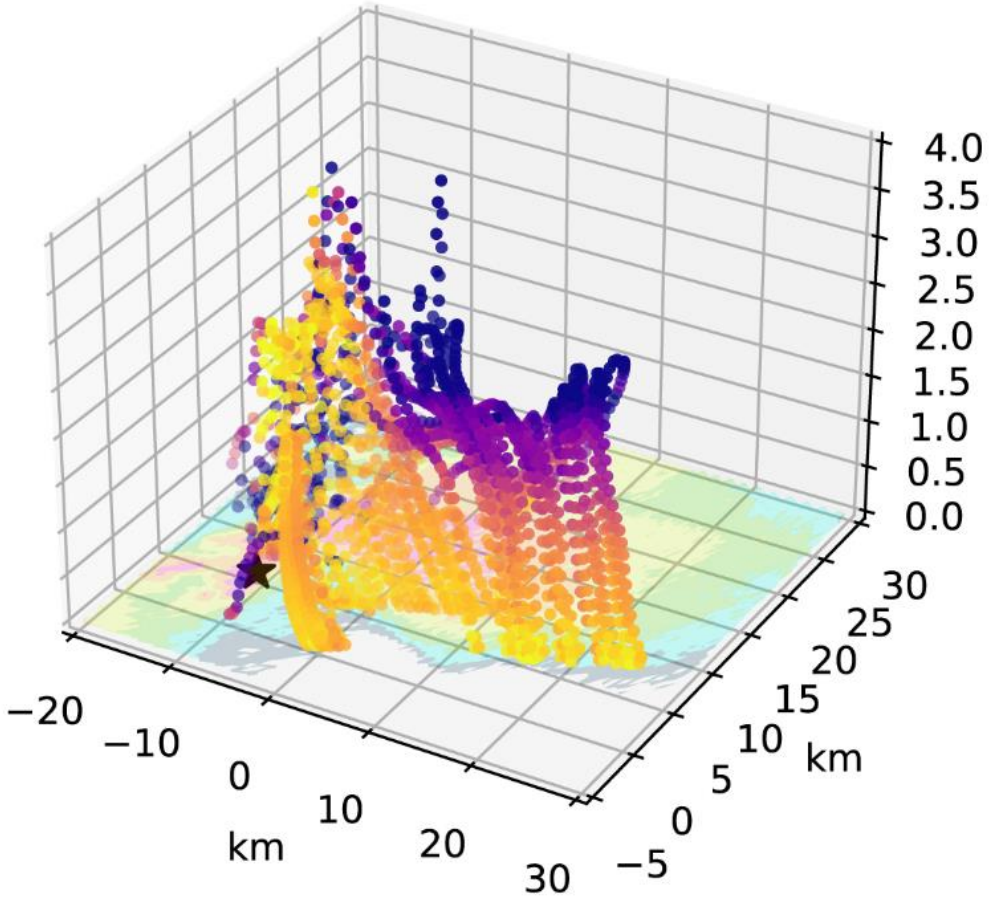
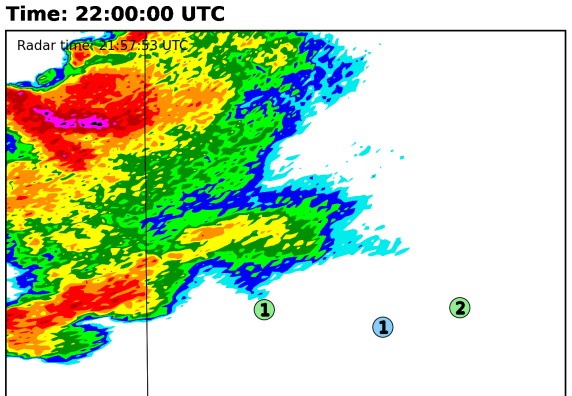


HOPE
PENN STATE
BASKETBALL
CLIMB WITH
US
PENN STATE

31 May 2022

near Arkansas City, KS

Time: 22:00:00 UTC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