



SO YOU WANT TO BE A METEOROLOGIST? (Weather and Your Venue)

Dr. Kevin Kloesel
University Meteorologist
University of Oklahoma
Office of Emergency Preparedness

Certified Emergency Manager, State of Oklahoma

@TexasEmbassy
@OUEmergencyPrep

APPS RANKED BY FREQUENCY OF USAGE


Weather is more frequently used than search or maps by all app users

Q. How often do you use the following apps? Check all that apply.

Frequently/Very Often

App Category	Usage Frequency
Weather	81%
Search	62%
Maps	61%
News	56%
Social Networking	51%
Sports	51%
Games	46%
Entertainment	42%
Banking	38%
Travel	29%
Productivity	30%
Education	34%
Health & Fitness	35%
Shopping	27%
Finance	19%

The proof is in the pudding! Weather doesn't make the top of this list if the information isn't correct most of the time!




NCEP Operational Forecast Skill
36 and 72 Hour Forecasts @ 500 MB over North America
(100 * (1-S1)/2) Method

The Top 24 "Grossing" iPhone Weather Apps Downloads in the MILLIONS!

We know that NOAA National Weather Service (NWS) weather radar data and NOAA NWS warning "Alerting" apps are a critical part of daily decision making in safety-related fields. (many apps do both)

iPhone app data pulled from the Apple App Store on 19 January 2017
This slide is not an endorsement of these Apps

But the reality is, it doesn't matter what you think. It only matters what the judge and jury think...

After storm, a dad's death at Wood Dale fest is lamented, will be litigated

"The true tragedy to this situation is that matters such as this are not only potentially predictable, they are preventable with prudent caution and control of events in the face of available meteorological information,"



Daytona 500 rain delay gambled with fans' lives

News, nearly two years later (after a fire died in a lightning strike at Phoenix's track officials at Daytona International Speedway exhibited a similar pattern of negligence. A timeline of internal communications between the NWS-MetSource and track officials, public warnings issued by NWS, MetSource and warning experimental between track officials and spectators shows that track officials waited an hour to communicate the threat of severe weather to fans, putting the lives of more than 150,000 fans at risk. — **Daytona 500 Deaths Warning, Track Officials Waited an Hour Before Evacuating Fans From Dangerous Weather**

Family of boy struck by lightning seeks \$10 million in lawsuit

Inmate's death by lightning is state's fault, lawsuit says

Families of 2 hit by lightning sue Boy Scouts of America

NEW JERSEY WIFE FILES SUIT OVER HUSBAND'S LIGHTNING STRIKE DEATH

Three separate **wrongful death suits** have been filed in connection with weather incidents which occurred in various parts of the nation.

Archives: \$50M settlement reached in State Fair stage collapse

Pocono Raceway sued over lightning death

What is your "Duty of Care" when hazardous weather threatens?

Emergency Policies and Procedures

Emergency policies are not one-size-fits-all. They must address the reasonably foreseeable risks for the events, crowds, and weather conditions that apply on any given day, and the people charged with implementing those policies must be trained to implement them. The authors should be aware of important issues such as the Incident Command System, private weather consulting, and trigger charts to activate the emergency action plan. As helpful as an event organizer's documentation can be in proving that they behaved reasonably under the circumstances, policy documents that are not followed or internal communications showing a lack of training can be the clearest evidence that an organizer has failed to meet even their own standard of care.



DeCastillo, lived a few months ago, is likely to need surgery to fix "a couple of broken vertebrae" in his lower back but is expected to recover, said his father-in-law, Dan Reeves, the longtime NFL coach.

"They say he's lucky not to be paralyzed," said Reeves. The coach was seen being stretchered on a stretcher on the field.

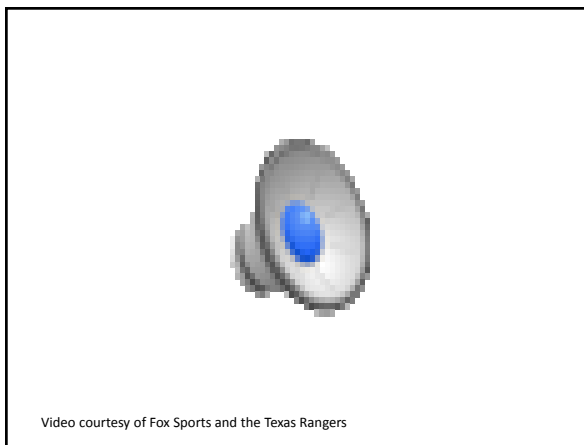
Dallas Cowboys employees settle lawsuit over 2009 practice facility collapse

Cowboys assistant coach Rich Behn underwent surgery on his spinal cord late Saturday night at Parkland Memorial Hospital, according to ESPN.com's Matt Muly.


Others with serious injuries included a person with a head injury, one with an open fracture below the knee and someone who was impaled with metal, said Tommy Gonzalez, Irving's city manager.



Two Dallas Cowboys employees seriously hurt in the 2009 collapse of the team's Valley Ranch practice facility have settled another part of the lawsuit over their injuries and will receive a combined \$54 million, their attorney announced Monday.



Declan Sullivan's Death Could Cost Notre Dame \$30 Million



Student dies in video tower collapse

Marquette Sports Law Review

Volume 24 Issue 1 Fall Article 9

The Duty of Care College Football Coaches Owe to Student Staff Members: Analyzing the Tragic Death of a Student Videographer at Notre Dame





Video courtesy of Jeffrey King

Cloud to ground Lightning strike 3 – 1:29 (You can see the distance!)



Cloud to ground Lightning strike 1 – 0:08, thunder followed at 0:25 (~ 3 miles)
(Note: More thunder is audible at 0:38)



Microseconds after the flash, the tree is still on fire.

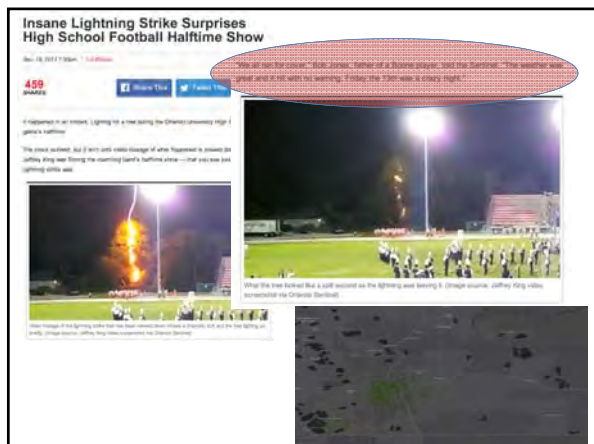


Cloud to ground Lightning strike 2 – 1:04, thunder followed at 1:23 (~ 4 miles)



And microseconds after that, the tree is still on fire, and a leader is visible.
(and the "Please take shelter" announcement comes at 1:56)





:04 Shulman: Right now, nobody throwing in the Tampa Bay pen... and MORE lightning.

:12 Kruk: Is that lightning or are the lights flickering down here.

:14 Lightning strikes...

:15 Shulman: Noooo, that's lightning (laughter)
Thunder booms 1.8 seconds later..

:17 Shulman: And that's thunder

CROWD ROARS (this drives me insane)

More thunder is audible at :26 Lightning flashes again at :38

:39 Shulman: Yeah, that's Lightning. Kruk: That IS Lightning

:40 Shulman: If this is the 5th inning, the tarp's probably on the field right now.
But, with 2 outs in the 9th?

What we know...

Lightning doesn't always strike the tallest object.
Lightning doesn't always strike the best conductor or lightning rod.
Lightning isn't always preceded by rain.

Lightning is NOT insane, and lightning storms in most cases can be anticipated (with the appropriate professional expertise).

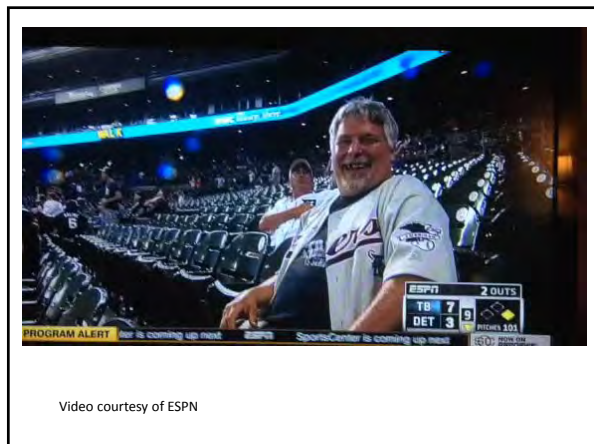
There are no NWS warnings for lightning (or sub-severe winds).

Your safety plans MUST take into account that life-saving actions in threatening weather will be necessary in the absence of official government weather warnings.

19 Cloud to Ground Lightning Strikes w/in 6.9 miles during the bottom of the 9th inning

Date	Time	Lat	Long	Amps	Distance (miles)	Energy (Joules)
Jul 6, 2014	11:10:56 PM EDT	42.3083	-83.0354	-30140 amps	2.26	159,781
Jul 6, 2014	11:10:57 PM EDT	42.2877	-83.0152	-18013 amps	3.98	152,8746
Jul 6, 2014	11:11:53 PM EDT	42.3253	-83.0383	-40359 amps	3.98	146,2682
Jul 6, 2014	11:11:51 PM EDT	42.3265	-83.0297	-40168 amps	3.17	128,9769
Jul 6, 2014	11:11:51 PM EDT	42.3023	-83.0134	-48233 amps	3.17	143,0918
Jul 6, 2014	11:12:23 PM EDT	42.3073	-83.0224	-58443 amps	2.63	146,6294
Jul 6, 2014	11:12:23 PM EDT	42.2938	-83.02	-32220 amps	3.49	153,3067
Jul 6, 2014	11:14:00 PM EDT	42.3474	-83.1035	-19525 amps	2.76	282,2353
Jul 6, 2014	11:16:33 PM EDT	42.2966	-82.9994	-41700 amps	3.93	138,1377
Jul 6, 2014	11:16:33 PM EDT	42.2947	-82.9918	-22300 amps	4.29	135,426
Jul 6, 2014	11:16:34 PM EDT	42.2974	-82.9887	-21061 amps	4.28	132,2224
Jul 6, 2014	11:16:34 PM EDT	42.2853	-82.966	-21239 amps	5.70	130,5962
Jul 6, 2014	11:18:13 PM EDT	42.3091	-82.9834	-30230 amps	4.01	121,0205
Jul 6, 2014	11:18:13 PM EDT	42.2942	-82.961	-33443 amps	5.53	124,0344
Jul 6, 2014	11:18:13 PM EDT	42.2899	-82.9621	-95512 amps	5.66	126,8282
Jul 6, 2014	11:18:13 PM EDT	42.2864	-82.9491	-32180 amps	6.34	124,9446
Jul 6, 2014	11:18:13 PM EDT	42.2877	-82.9477	-21591 amps	6.35	123,9456
Jul 6, 2014	11:20:33 PM EDT	42.3438	-82.9401	-21821 amps	5.66	86.6
Jul 6, 2014	11:20:33 PM EDT	42.2845	-82.9386	15762 amps	6.86	123,2687


Also note how long it took to play the bottom of the 9th. After going to a 3-ball count on one hitter for 8 innings, Rays pitcher David Price proceeded to walk 2, forcing a pitching change, and extending the time of risk.



Video courtesy of ESPN



Comerica Park
Home of the Detroit Tigers



AUDIENCE PARTICIPATION TIME!!!

What is your general impression of the lightning risk in Detroit, MI?

Would it be greater, or less than say, Globe Life Park in Arlington, TX?

Comerica Park
Home of the Detroit Tigers



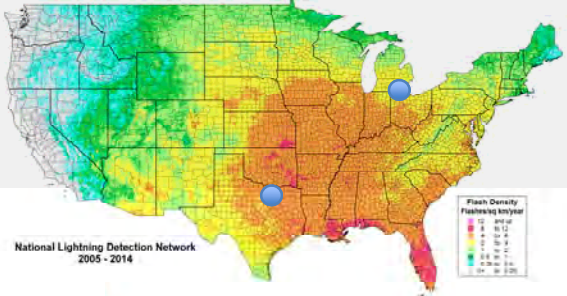
During the 2014 Major League Baseball Regular Season...

2,583 Cloud to Ground Lightning Strikes w/in 8 miles of Comerica Park
These CGs occurred on 31 days during the season. (avg. = 83 per day)

On 21 of these 31 days, the Tigers were playing away games or idle.

That leaves 10 days...

Both ballparks have approximately the same climatological flash density.



National Lightning Detection Network
2005 - 2014

Flash Density
Flashes/km²/year

12	400 or more
10	300 - 399
8	200 - 299
6	100 - 199
4	50 - 99
2	10 - 49
1	0 - 9
0	0 or less


Comerica Park
Home of the Detroit Tigers



During the 2014 Major League Baseball Regular Season...

CG Lightning occurred on 10 home game dates (1322 CGs)
An average of 132 CGs on each home game date.
12% of home schedule threatened by lightning

During 5 home game days, lightning did not occur during the game.
But it did during the other 5 games...
and you've already seen the video from July 6



Robinson Cano's at-bat in the sixth inning of Monday's Blue Jays-Mariners game was briefly interrupted when a bolt of lightning distracted him. The ensuing clap of thunder caused Toronto pitcher Brad Mills to jump on the mound.

How did the crowd in Seattle react? **RAUCOUS CHEERING**, followed by a "U-S-A, U-S-A" chant. It was as if Abe Lincoln himself had just hit a grand slam.

July 6, 2014
July 30, 2014
Aug 2, 2014
Aug 26, 2014
Sep 5, 2014



The home games on July 30 and August 26 were delayed, due to torrential downpours that made play impossible.

July 6, August 2, and Sept 5 games continued play with CGs within 8 miles.

Why? It wasn't raining at the ballpark (or the storm arrived in the 9th inning – July 6)



Aug 2, 31 CGs w/in 8mi



Sept 5, 11 CGs w/in 8mi

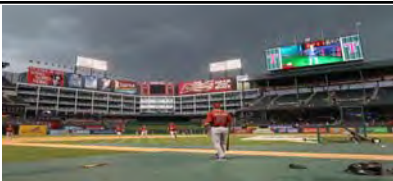


Based on the video clips, data, etc. what does your "situational awareness" tell you about the Major League Baseball policy regarding lightning?



It appears that if it's not raining at the time? Play on!

Globe Life Park
Home of the Texas Rangers



During the 2014 Major League Baseball Regular Season...

1,170 Cloud to Ground Lightning Strikes w/in 8 miles of Globe Life
These CGs occurred on 22 days during the season. (avg. = 53 per day)


On 12 of these 22 days, the Rangers were playing away games or idle.

That leaves 10 days... (sound familiar?)

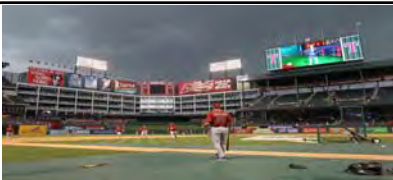
Rule 4.03 (e) of the Official Baseball Rules, 2015 Edition states:

4.03 (e) As soon as the home team's batting order is handed to the umpire-in-chief the umpires are in charge of the playing field and **from that moment the umpire-in-chief shall have sole authority to determine when a game shall be called, suspended or resumed on account of weather or the condition of the playing field.**

Not only are umpires in charge of your weather safety, but Rule 4.03 also carries the following directive: "The umpire-in-chief shall at all times try to complete a game."



Globe Life Park
Home of the Texas Rangers




During the 2015 Major League Baseball Regular Season...

2,736 Cloud to Ground Lightning Strikes w/in 8 miles of Globe Life
These CGs occurred on 31 days during the season. (avg. = 88 per day)

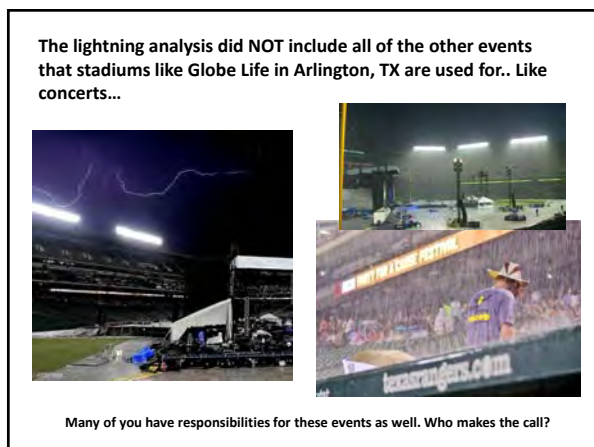
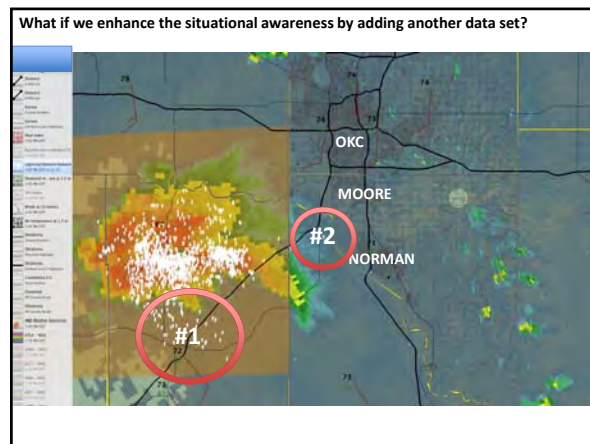
On 21 of these 31 days, the Rangers were playing away games or idle.

That leaves 10 days... (this is getting creepy!)



Video courtesy of the Kansas City Royals

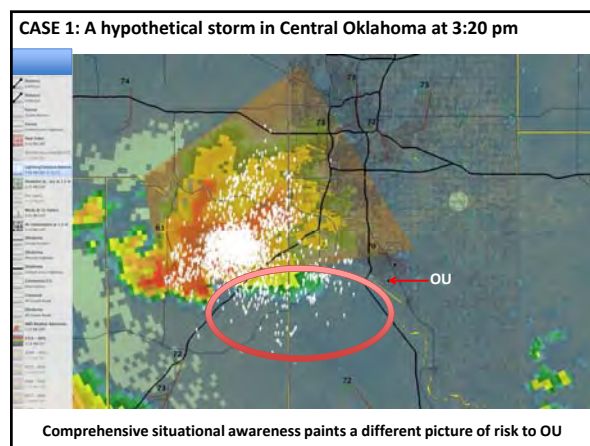
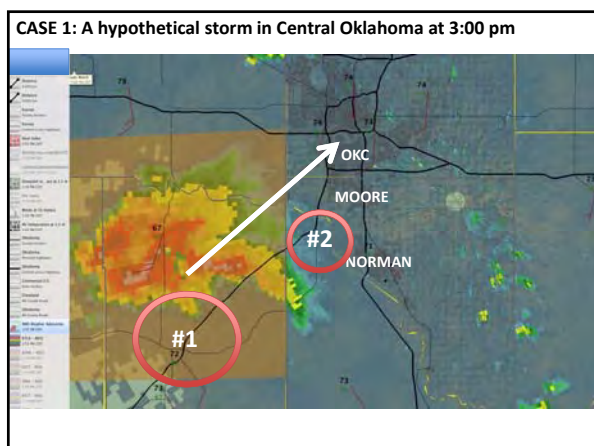
0.10" on a baseball tarp weighs ~15,000 lbs, 7.5 tons of water

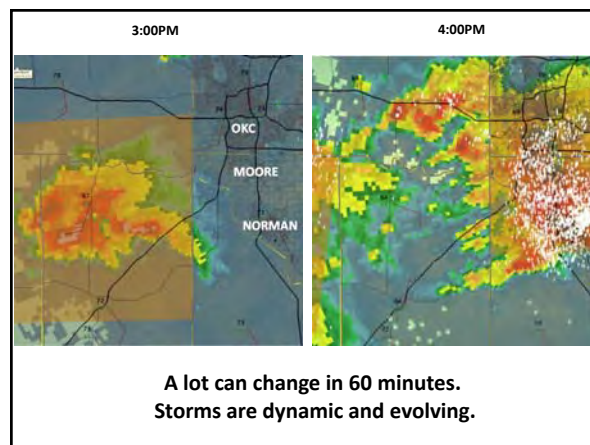
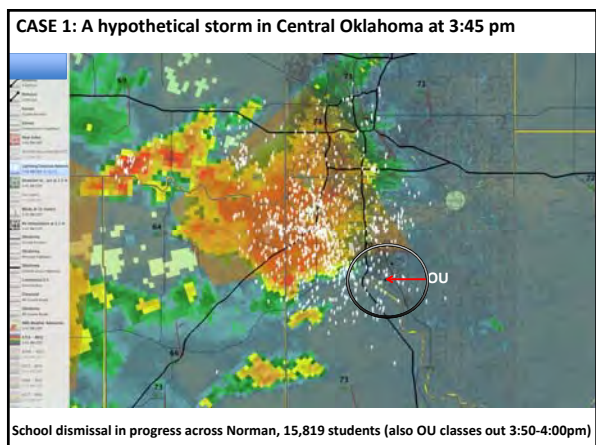
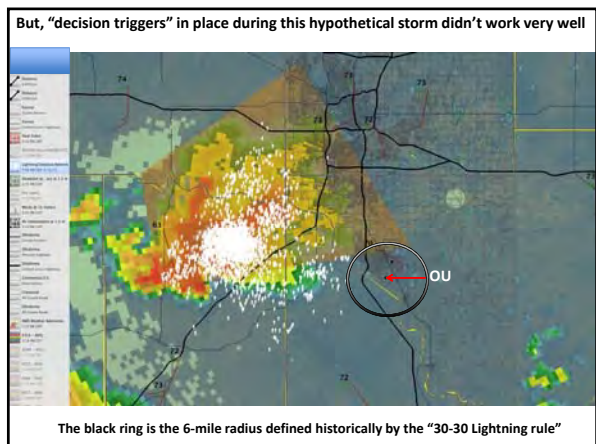


TAKEAWAY #1

Although radar data is a great weather situational awareness tool, the limitations of radar demand that you use these data in concert with other datasets.

Having radar data on an app or a laptop does not magically enhance your ability to assess weather risk. In fact, in many cases, it can lead you to misrepresent or completely miss the actual risk.





TAKEAWAY #2

There are as many weather threats to life and property outside the "pretty colors" as inside.

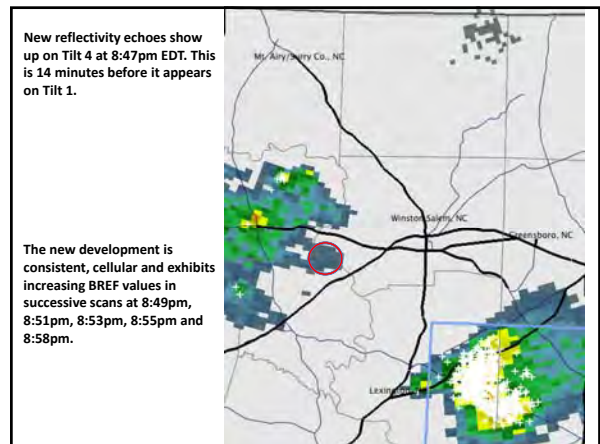
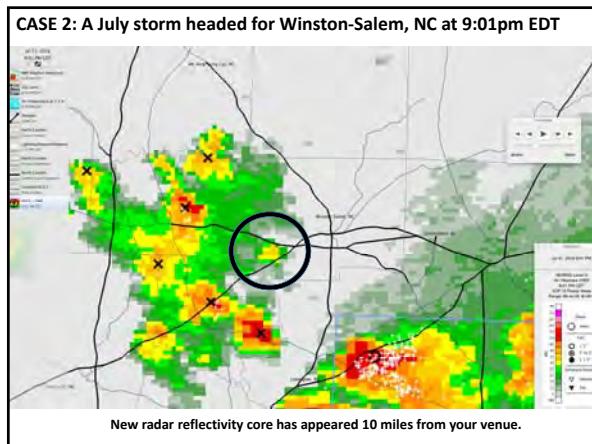
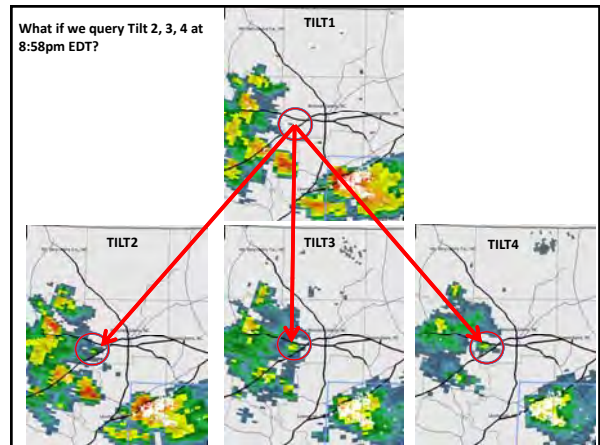
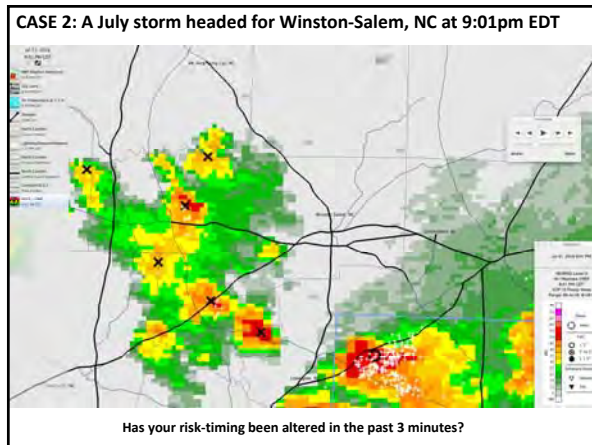
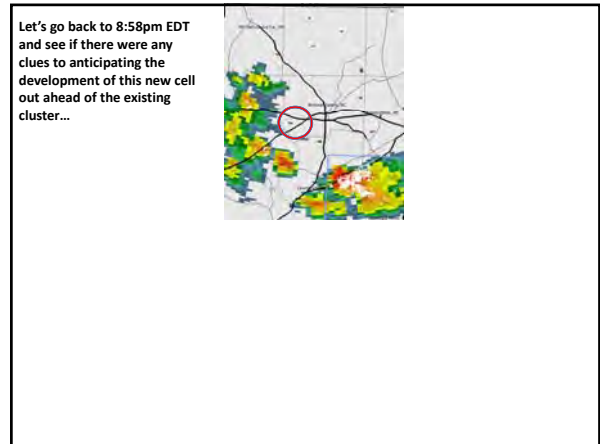
Your eye is always drawn to colorful "blobs" on radar images.

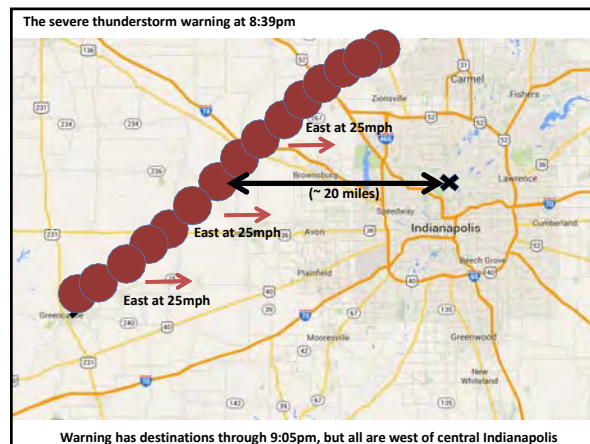
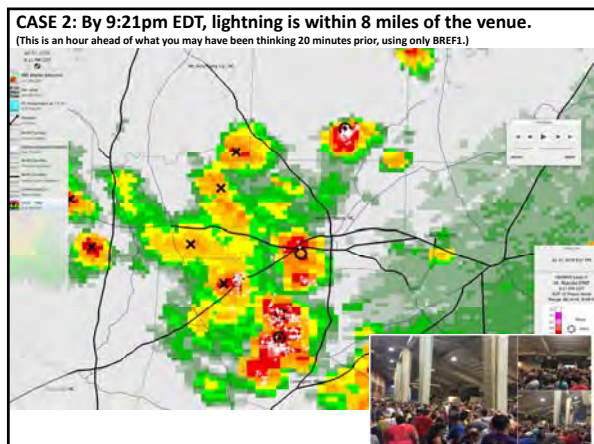
Resist that temptation!

TAKEAWAY #3

Misconception by Advection

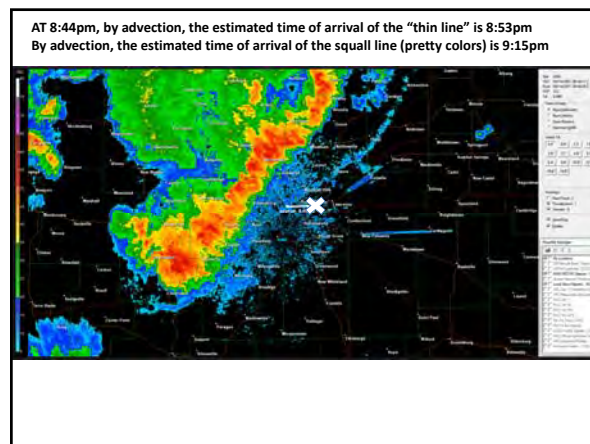
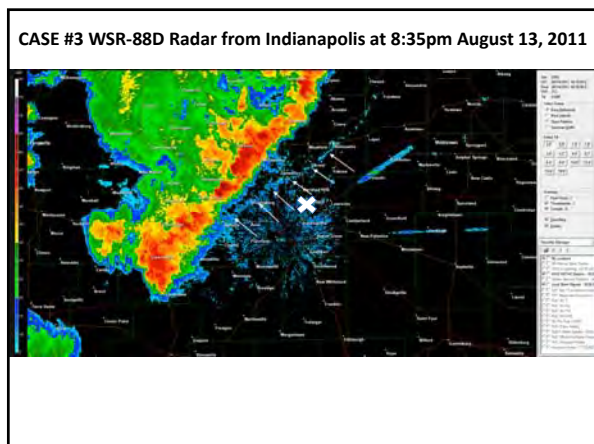
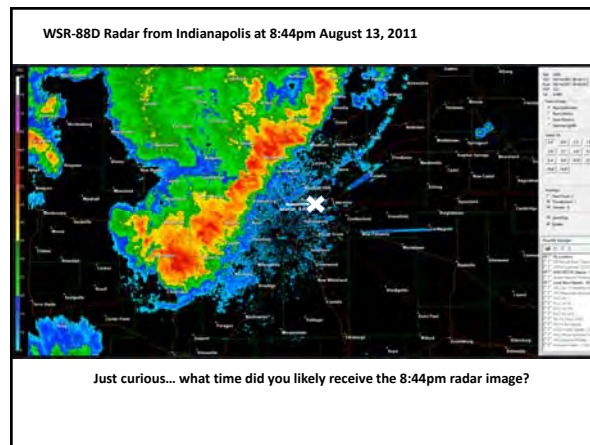
Storms don't stay the same intensity, shape, speed, direction, etc. during their lifetimes.

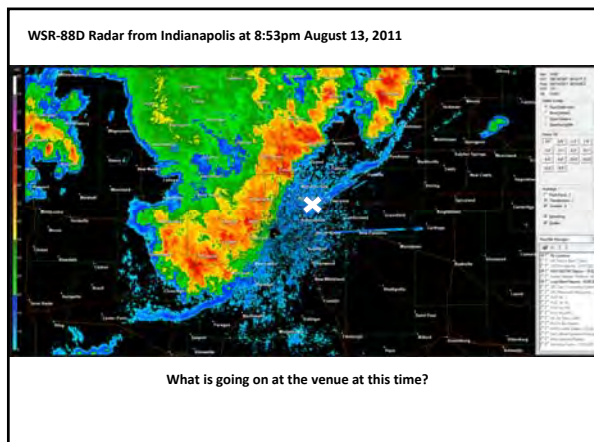




TAKEAWAY #4
 Meteorologists have access to more complete 3-D info!

Lightning storms are vertically developed. In most cases, precipitation sized particles (and hail) develop aloft! Therefore, upper tilts can provide earlier clues to risk than the most popular lowest elevation radar scan. (TV and most Apps ONLY use the lowest radar scan!)





From the Investigator's Report by Witt and Associates, Inc.

But the weather near the Indiana State Fairgrounds was starting to get dicey. Backstage, State Police special operations commander Brad Weaver was watching an uply storm moving in on radar via his smartphone. He and his Executive Director Cindy Hoye decided it was time to evacuate the crowd.

But a minute later, when WLHK program director Bob Richards addressed the crowd, the word was that the show would go on, and that the crowd should be prepared to find shelter if things change. Some of the crowd sensed the danger and left without further won. But the majority remained.

Your radar 'thin line' arrives at 8:53pm (and you probably received the image on your app at 8:57pm or so)

The "storm" was expected at 9:15-9:20pm

Gov. Daniels was choked up as he began talking about emergency response.

"What you saw last night was a display of best qualities, both public and private, of Hoosiers," Daniels said.

Burden updated previous injury numbers that 45 people were taken to the hospital last night. He said the early indication is it was an "isolated significant wind gust" and the midway and other areas on the grounds weren't damaged as severely.

Daniels said he stands by the State Fair's preparedness measures, citing that this was an unexpected occurrence -- the storm was expected at 9:15, but arrived 30 minutes earlier.

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE INDIANAPOLIS IN
858 PM EDT SAT AUG 13 2011

INC011-057-063-097-109-133-140145-
/D.CON.KIND.SV.W.0295.000000T000Z-110814T0145Z/
BOONE-HAMILTON-HENDRICKS-MARION-MORGAN-PUTNAM-
858 PM EDT SAT AUG 13 2011

...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT FOR SOUTHEASTERN ROONE...HAMILTON...HENDRICKS...MARION...NORTHERN MORGAN AND EAST CENTRAL PUTNAM COUNTIES UNTIL 945 PM EDT...

AT 853 PM EDT...TRAINED WEATHER SPOTTERS REPORTED A LINE OF SEVERE THUNDERSTORMS PRODUCING DESTRUCTIVE WINDS IN EXCESS OF 70 MPH. THESE STORMS WERE LOCATED ALONG A LINE EXTENDING FROM NOBLESVILLE TO 12 MILES NORTHWEST OF MARTINSVILLE...MOVING EAST AT 25 MPH.

A TRAINED WEATHER SPOTTER MEASURED A WIND GUST OF 77 MPH IN PLAINFIELD 850 PM.

SEVERE THUNDERSTORMS WILL BE NEAR...
MONROVIA...NOBLESVILLE AND CARMEL AROUND 905 PM EDT...
INDIANAPOLIS INT'L AIRPORT...WYMNEDALE...WILLIAMS CREEK AND SPRING HILL AROUND 910 PM EDT...
CENTERTON...CAMBY...BROAD RIPPLE AND MOOREVILLE AROUND 915 PM EDT...
INDIANA STATE FAIRGROUNDS...CASTLETON...BROOKLYN AND BETHANY AROUND 920 PM EDT...

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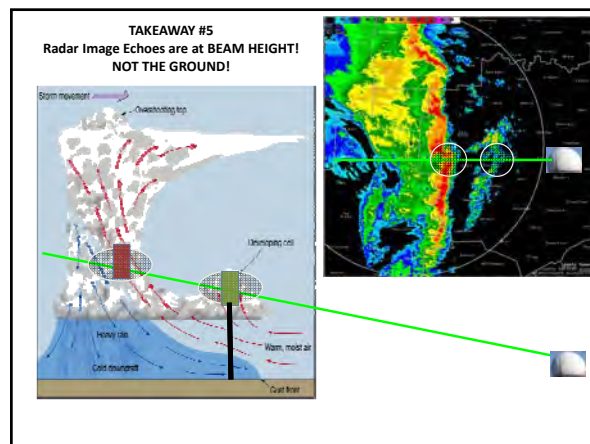
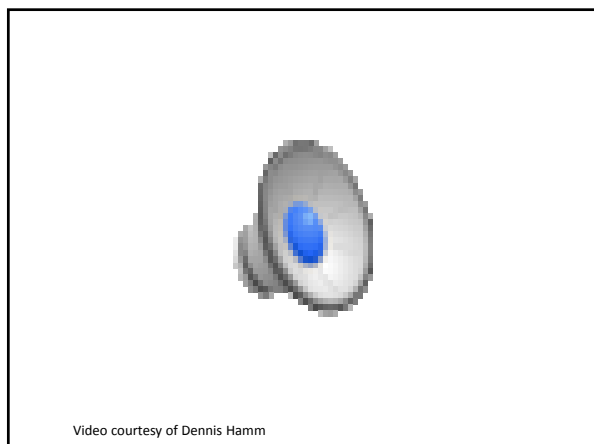
But the stage collapsed at 8:46pm!

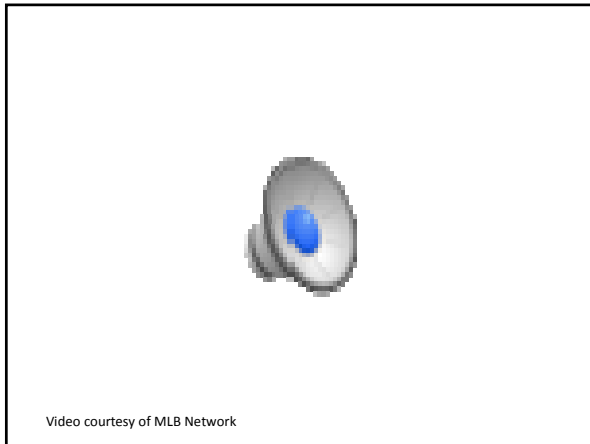
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OKLAHOMA
 MISSOURI TIGERS
 1st Inning
 Oklahoma: 0-0-0
 Missouri: 0-0-0
 Game Status: 1st Inning
 Pitcher: [Name]
 Batter: [Name]

LIGHTNING DELAY

NO EARLIER THAN **12:30 PM** START TIME

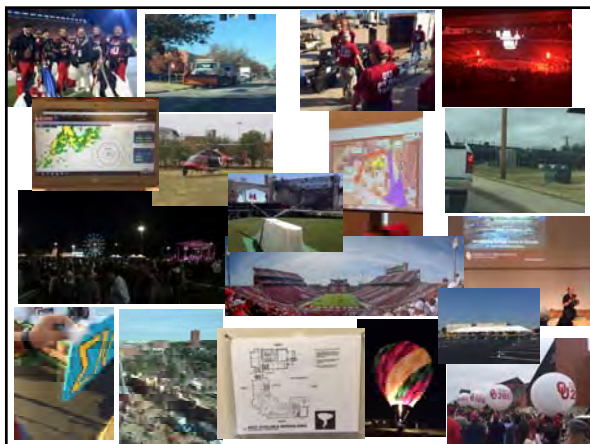
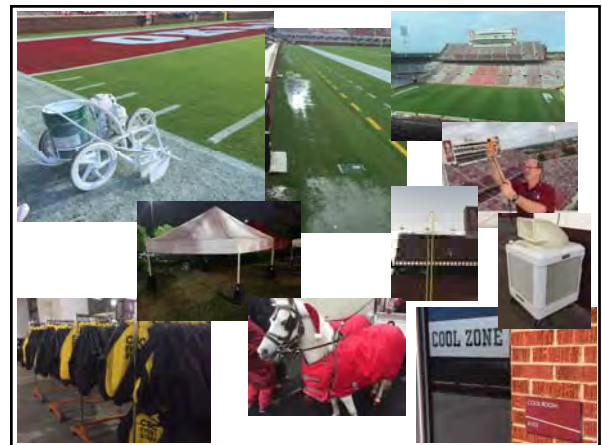
After consultation with commentators, our administration has been unable to locate the location of the lightning storm to 12:30 p.m. of the scheduled start to lightning in the area.

Mary Hutton-Willingham
Very very good

John De Block
Excellent display of effective decision support

Kath Brewster
How that was to be a first.

We MUST Model The Actions We Seek!



HOW CAN WE HELP?

Daytona Lightning Radii Chart: under cover at 8 miles out

Direction	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
North	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
South	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
East	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
West	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85

2016

DAYTONA INTERNATIONAL SPEEDWAY
STANDARD OPERATING GUIDELINES

Operations | Event Weather Coord. Plan | 408-277-4000

KEY SUMMARY

- 1 - 100% Rain
- 2 - 75% Rain
- 3 - 50% Rain
- 4 - 25% Rain
- 5 - 10% Rain
- 6 - 5% Rain
- 7 - 1% Rain
- 8 - 0% Rain

Thanks to Troy Willrick at DIS

VENUE SPECIFIC WEATHER ACTION PLAN						
SAFE SHELTERS = BUSES						
THREAT	ALERT METHOD	VIDEO	AUDIO	LIGHTING	FOH	CONCOURSE
FORECASTED WINDS GREATER THAN 40MPH	WEATHER & RADIO	POWER OFF & SHELTER	POWER OFF & SHELTER	POWER OFF & SHELTER	POWER OFF & SHELTER	POWER OFF & SHELTER
FORECASTED SIGNIFICANT RAINS	WEATHER & RADIO	POWER OFF COVER UP	POWER OFF COVER UP	POWER OFF COVER UP	POWER OFF COVER UP	POWER OFF COVER UP & SHELTER
FORECASTED WINDS GREATER THAN 30 LESS THAN 40	RADIO ALERT	TO THE ROOF	TO THE GROUND	TO THE ROOF	COVER AND SHELTER	SHELTER
FORECASTED WINDS GREATER THAN 15 LESS THAN 30	RADIO ALERT	MONITOR	MONITOR	VERIFY NO ONE IN THE AIR	PREPARE	STRONG TENT OR FULL SKINE
LIGHTING 850E & MILES TRACKING TOWARD SITE	RADIO ALERT	POWER OFF COVER & SHELTER	POWER OFF COVER & SHELTER	SECURE TO GROUND POWER OFF COVER & SHELTER	POWER OFF COVER & SHELTER	POWER OFF COVER & SHELTER
LIGHTING STORM TRACKING TO SITE WITHIN 20 MILES	RADIO ALERT	POWER OFF COVER & SHELTER	SECURE AND COVER GEAR	SECURE AND COVER GEAR	POWER OFF COVER & SHELTER	POWER OFF COVER & SHELTER
CLEAR TO REBROADCAST	RADIO ALERT	DRY POWER & STRUCTURAL INTEGRITY	DRY POWER & STRUCTURAL INTEGRITY	DRY POWER & STRUCTURAL INTEGRITY	DRY POWER & STRUCTURAL INTEGRITY	DRY POWER & STRUCTURAL INTEGRITY
SEPTEMBER 6, 2014	COMMON SENSE IS KEY - PROTECT YOURSELF AND YOUR FAMILY THE SHOW CAN BE REBUILT					

RESPONSE ACTIVE PROGRESS WITH FORECAST THREAT

FINAL COMMENT!
Your Weather Plan MUST also contain a Communications plan.



Pre-determined and pre-agreed upon signage/messaging tied to specific actions.



THANK YOU!

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