

The Evolution of Snow Squall Science and Forecasting

Greg DeVoir - Lead Meteorologist

NWS State College, PA

NROW 2024 Albany, NY



Collaborators



STATE COLLEGE, PA

NWS State College, PA

John Banghoff
Michael Colbert
Greg DeVoir
Jonathan Guseman
Michael Jurewicz



NWS Weather Forecast Offices

Pete Banacos
Andrew Loconto
Dave Nicosia
Ashley Novak



NWS Winter Program, NWS HQ

Eric Guillot
Michael Muccilli
Sarah Perfater



PA Turnpike Commission

Renee Colborn
Bill Howard



PA Department of Transportation (PennDOT)

Erin Waters-Trasatt



PA Emergency Management Agency

Molly Dougherty
Jeff Jumper
Ruth Miller



PA State Police

LT Adam Reed
Myles Snyder



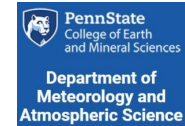
Storm Prediction Center

Andrew Lyons



Weather Prediction Center

Dana Tobin
Josh Weiss



Pennsylvania State University

Karl Schneider



Snow Squalls: What's the big deal?



SNOW SQUALLS

Snow squalls can be deadly if you are not prepared they are coming.

The new NWS Snow Squall Warnings will alert motorists to hazardous conditions.

For more information visit: weather.gov

817

Number of Fatalities

13 36 49 92 39 41 144 77 82 27



Winter Related Motor Vehicle	Winter Related Aviation	Winter from Wind Storm Data	Tornado	Rip Current	Lightning	Heat	Hurricane	Flood	Cold
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AMS journal Weather, Climate, and Society

Average number of fatalities per year from various meteorological hazards for the period 1996–2011. Totals for all hazards except winter-related motor vehicle and winter-related aviation fatalities are from Storm Data.



Snow Squalls: What's the big deal?

CNN.com / WEATHER

SEARCH GO

WEATHER: Vehicles pile up on Virginia's snowy roads

February 22, 2011
Web posted at 7:03 a.m. EST (0103 GMT)

From staff and wire reports

FREDERICKSBURG, Virginia (CNN) — A fierce snowstorm caused numerous multi-vehicle accidents in Virginia Thursday, including one involving 116 cars and trucks.

One person died, and at least 15

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CINCINNATI.COM POST REELS SIGNALS JOBS CARS HOMES WEATHER TRAF

The Cincinnati Post
FIND THE ON VIDEO in our vic

December 19, 2010 at 6:54 am Filed Under: Crash, Fatal Crash, Pile-Up, Snow Squall Warning, Union County

A little snow, a lot of trouble
By Craig Gamewson, Post staff reporter

NEWS OPINION BUSINESS LIVING SPORTS

2 Killed, Dozens Injured In Snow Squall Pile-Up On Pa. Highway



STORM WATCH Pile-up on I-80 in Union Co. left one person dead, 33 others injured

USA TODAY

Up to 50% off hotels...
Now that's a lot of room.

Weather
Snow causes mass pileups in Pennsylvania

By Dan Lenneman, The Associated Press

LOGANTON, Pa. — More than 100 vehicles crashed in separate pileups on snow-slickened Interstate Friday in central and northeast Pennsylvania. At least eight people were killed.

A crash on Interstate 80 near the Loganton exit involved 45 passenger vehicles and six tractor-trailers. Six people were killed, and at least 45 were injured, state police said.

Witnesses said one tanker caught fire and flames spread to other vehicles.

"I was driving on the freeway and all of a sudden, it was like somebody flipped a

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SEARCH

The Holland Sentinel
Thursday July 24, 2003

72-vehicle pileup kills one, shuts down I-94

Web posted Saturday, February 8, 2003

By JAMES PITCHARD
Associated Press writer

By Peter Neumann
January 31, 2013

Updated Jan 31, 2013 at 5:50 PM EST

HENDRICKS CO., In. (www.incnw.tv) --- A massive and perhaps unprecedented pile-up in Hendricks County has closed I-70 west of Indianapolis in both directions.

The initial accident happened at mile marker 59, near the Plainfield exit. Initial estimates are that forty vehicles are involved.

RELATED:
How to Drive in Whiteout Conditions
I-70 Pile-up Claims A Life (with Video & Photos)

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TRENDING TOPIC: JHONNY PERALTA U-M WIN BLUE CHIPS L. BROOKS PATTERSON PACKARD PLANT MARK BREY

Home Metro Wayne County

FEBRUARY 1, 2013 AT 7:35 PM

Deadly snow squalls set off pileups; 3 die on I-75

30 vehicles tangle in multiple crashes on slick freeway

BY LAUREN ABDEL-RAZZAQ, TONY BRISCOE AND TOM GREENWOOD THE DETROIT NEWS 7 COMMENTS

South Coast

Snow squall causes pileups, two killed

By The Associated Press
BOVARD, Miss. — Two people, including a 3-month-old girl, died yesterday as a result of a pileup involving nearly two dozen vehicles that was blamed on a sudden snow squall between 30 and 35 vehicles were involved in the accident in the northbound lanes of Interstate 495 near Route 2, state police said. The unsupervised snowfall at around 12:35 p.m. caused near-immediate conditions, police said.

State police said the baby girl, Mariah Fiedt, died at New England Medical Center from injuries sustained in the crash, after a tractor-trailer spun out of control on the slippery roadway. Also killed in the crash was Wayne Sunthorn, 45, of Paxton, according to state police.

The baby's mother, Michelle Fiedt of Burlington, was taken to Boston Medical Center, where she was listed in good condition.

Another of Fiedt's daughters, 3-year-old Miranda, was treated at Emerson Hospital in Concord and released, according to a hospital spokeswoman.

More than a dozen other vehicles were treated at local hospitals, state police said.

The highway was closed behind and traffic rerouted to Route 111.

Snow squalls also were the apparent cause of a massive pileup in Windham, N.H., yesterday, injuring at least 14 people and damaging dozens of vehicles.

In Springfield, an 18-vehicle pileup briefly closed the South Exit bridge between Springfield and Agawam, state police said.

No serious injuries were reported in the late-morning incident. But state police Sgt. John Quabbe said eight vehicles were towed.

He said the chain of accidents started when one car went out of control. He said the bridge could have been icy from a snow squall around 8 p.m.

The bridge connects Interstate 91 on the east side of the Connecticut River with Route 5 on the west.

Huge Pile-Up on Indiana Interstate (with Photo & Video)

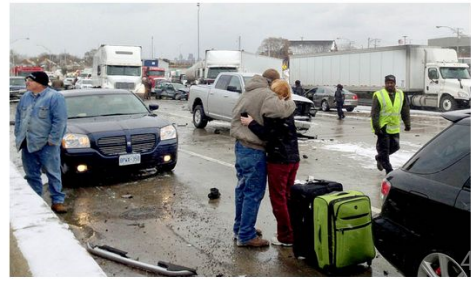
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RELATED:
How to Drive in Whiteout Conditions
I-70 Pile-up Claims A Life (with Video & Photos)

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A fatal, massive pileup during without conditions Thursday morning, Jan. 31, 2013, involving multiple semi-trucks and vehicles has closed southbound Interstate 75 near Springwells, prompting an emergency response.



Central PA: “Snow Squall Alley”



**Interstate 80: Loganton, PA
December 28, 2001**



100 vehicles, 8 dead, 45 injured

**Interstate 80: Milesburg, PA
January 6, 2004**



**3 separate multi-vehicle accidents,
6 dead, 17 injured**



The Early Years (2003 - 2004)



American Meteorological Society Annual Meeting Presentation

20th Conference on Weather Analysis and Forecasting
SESSION 10: PUBLIC FORECAST AND WARNING ISSUES

10.2 High Impact Sub-Advisory Snow Events: The Need to Effectively Communicate the Threat of Short Duration High Intensity Snowfall



Gregory A. DeVoir
NOAA/NWS State College, PA

January 13, 2004

High Impact Sub-Advisory Snow Events

- Short duration, high intensity snow (falling in bursts or squalls) with 1-3" amounts in a 1 to 2 hour period.
- Snowfall accumulation doesn't warrant Advisory issuance.
- Instantaneous whiteouts, rapidly changing road conditions and driver anxiety/confusion make chain reaction accidents more likely



The Early Years 2006–2008



- David Nicosia (MIC (then WCM) BGM and Greg DeVoir authored a Statement of Need for a formal Snow Squall Warning product.
- Submitted through Eastern Region Headquarters (ERH)

Statement of Need (SON)

1. Title A Proposal for a Short Fused Winter Weather Warning Product, SNOW SQUALL WARNING

2. Originator

Name: David Nicosia, WCM and Greg DeVoir, Senior Forecaster

Office: WFO Binghamton, NY and WFO State College, PA

Phone: 607-770-9531 x 223, 814-231-2401

Email: david.nicosia@noaa.gov, greg.devoir@noaa.gov

3. Submitting Authority ERH

4. Description

Presently, the National Weather Service does *not* have an efficient way to convey dangerous short-fused winter weather events related to convective snow squalls to our customers and partners. Snow squalls produce white-out blizzard-like conditions that last for much less than one hour. Each winter season, short-fused snow squall events cause numerous traffic accidents, injuries and deaths. These events also cause significant damage to highway infrastructure, personal property (vehicles) and negatively impact commerce with considerable transportation delays and closures of major transportation arteries.

Snow squalls *are* detectable by the WSR-88D network, and the conditions favorable for the development of squalls are understood and easily identified by NWS meteorologists. Presently, forecasters use either the special weather statement (SPS) or short term forecast (NOW) to get the word out on these dangerous events. Although these methods provide some advance notice, a more specific and efficient dissemination method, analogous to warm season severe convective warnings, is needed to immediately notify and convey to users the threat the impending event. Given the life- and property-threatening dangers posed by sudden white-out conditions, we propose adding a new short-fused winter weather warning product. The efficiency gained by this is a way to alert customers and partners (especially emergency management, road crews and the police) of dangerous short-fused snow squalls with a warning product. The warning would trigger the EAS and be issued in a



Snow Squall Warning Implementation



- ~15 year endeavor
- Difficult to add a new product in the era of "Hazard Simplification"
- Unique EAS code unavailable

First Snow Squall Warning - 2 Feb 2018

738
 WNU51 KBGM 021428
 SQWBGGM

BULLETIN - IMMEDIATE BROADCAST REQUESTED
 Snow Squall Warning
 National Weather Service Binghamton NY
 927 AM EST Fri Feb 2 2018

NYC011-017-023-053-067-077-109-021515-
 /O.NEW.KBGM.SQ.W.0001.180202T1427Z-180202T1515Z/
 Otsego NY-Madison NY-Cayuga NY-Cortland NY-Onondaga NY-Tompkins NY-
 Chenango NY-
 927 AM EST Fri Feb 2 2018

The National Weather Service in Binghamton has issued a

- * Snow Squall Warning for...
 Northern Otsego County in central New York...
 Madison County in central New York...
 Southern Cayuga County in central New York...
 Northern Cortland County in central New York...
 Southern Onondaga County in central New York...
 Northeastern Tompkins County in central New York...
 Northern Chenango County in central New York...
- * Until 1015 AM EST.
- * At 927 AM EST, a dangerous snow squall was located along a line extending from Unadilla Forks to near Morrisville to near Cazenovia to near Otisco to Casowasco to near Aurora, moving southeast at 25 mph.

HAZARD...Extremely poor visibility in heavy snow.

ing travel.

AM EST.

50 AM EST.

EST.

around 1010 AM EST.

11 and 15.

...

lights! During snow squalls, the
 or zero in whiteout conditions.

7597 4252 7643
 8 4275 7674
 7 4295 7567
 L
 4284 7521 4293 7560 4296 7590 4292

SNOW SQUALLS

A new Snow Squall Warning will debut January 3rd at 7 initial sites:

2018

- State College, PA,
- Buffalo, NY,
- Binghamton, NY,
- Burlington VT,
- Pittsburgh, PA,
- Cheyenne, WY,
- Detroit, MI.

It will expand to the rest of the Nation during the winter of 2018-2019.
 For more information visit weather.gov



What is a SNOW SQUALL WARNING ?

#SnowSquallSafetyPA

* Snow Squall Warnings are short in duration and specify a localized area, similar to what you would see with a Tornado, Severe Thunderstorm, or Flash Flood Warning

* Issued when a snow squall is occurring or will happen in the near future

* Warning typically in effect for 30-60 minutes and may trigger an alert on your cell phone

AS ALWAYS, MAKE SURE YOU STAY WEATHER AWARE!

Snow Squall Warning

Valid Until
4:00 PM EST Friday
November 18, 2022

Threat Information



Hazard

White out conditions in heavy blowing snow



Impact

Dangerous life-threatening travel

Potential Exposure



Population: 179,168
Highways: I-80
US-220
US-322



⚠ This is a life threatening situation! Delay or avoid travel!



*These warnings provide critical, highly localized life-saving information



What is a snow squall? Impact-based definition



- **NOAA glossary**

- A snow squall is an intense, but limited duration, period of moderate to heavy snowfall, accompanied by strong, gusty surface winds and possibly lightning

- **Snow Squall Warning Criteria**

- Visibility $\frac{1}{4}$ mile or less
- Gusty winds
- Potential for snow covered roads or a flash freeze
- Typically lasting 1 hour or less

- **ASOS definition of squall**

- 2-minute wind speed ≥ 22 kts and exceeding the 2-minute average from two minutes ago by 16 kts or more



What is a snow squall? Structure-based definition



Translating, shallow convective lines or cells residing in the boundary layer, producing rapid-onset heavy snow and gusty winds.

- Can take the form of a single band, multiple bands, or a hybrid of cells and lines
- The translating criteria is there to discriminate between snow squalls and quasi-stationary lake effect snow bands, although we can use a snow squall warning for a particularly heavy lake effect streamer that extends down to an interstate and is not covered by another advisory/warning product



How do snow squalls form?




Three Ingredients Method for Convection

- 1. Instability** - Upright (CAPE 50-100 J/kg), symmetric (negative EPV in the boundary layer), or potential instability (Theta-e decreasing with height)
- 2. Moisture** - Influences accumulation via band width and SLRs
- 3. Lift** - Broad and weak (multiple lines/cells) or strong and focused (single band)


Wintertime Snow Squall:

- * Brief but intense period of heavy snow
- * Up to 2 inches in just 30 mins
- * Strong winds (30+ mph)
- * Whiteout conditions, visibility < 1/4 mile



Summertime Thunderstorm:

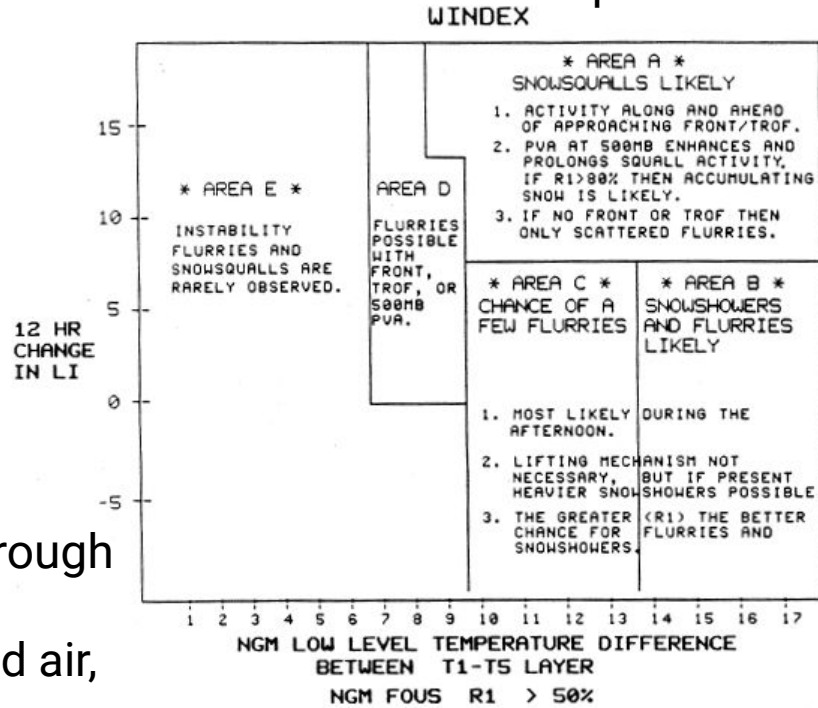
- * Violent short-lived weather disturbance
- * Heavy rain, up to 4 inches in just 30 mins
- * Strong winds (60+ mph)
- * Lightning, thunder, hail, tornadoes, etc.





A Pioneering Parameter for Snow Squalls

- Weir Lundstedt (NWS CWSU Nashua, NH) and Steven P. Nogueira (NWS Concord, NH) in 1993 to forecast wintertime instability and non-lake effect snow squalls across northern New England.
- Winter INstability inDEX (WINDEX)
 - Low-level temperature difference
 - Boundary layer relative humidity
 - 12-hr change in Lifted Index
- Snow squalls most likely where instability, lift, and moisture are maximized.
- Same forecasters coined the term **NORLUN** trough for inverted troughs extending from a surface low beneath a middle or upper level pool of cold air, localized bands of heavy snow could result.



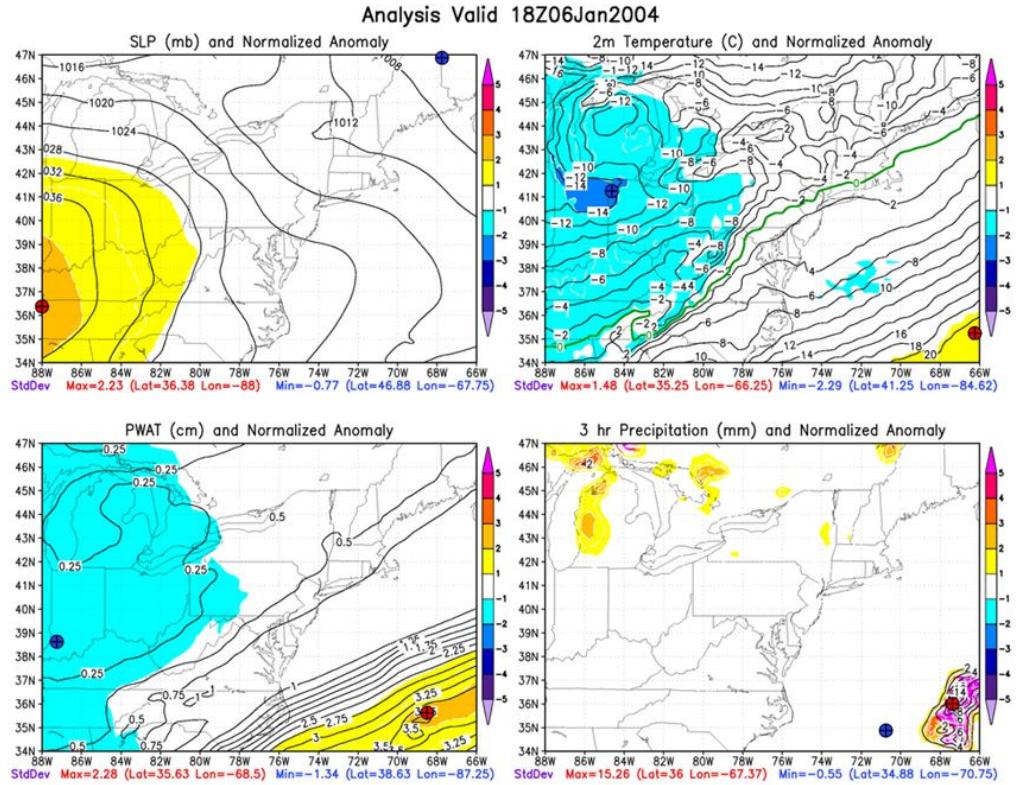


The Early Years 2006–2008



2008 National Weather Association Annual Meeting, Louisville, KY

- DeVoor, Grumm and Scala reconstructed high impact sub-advisory/ snow squall events from NCEP reanalysis fields
- Created synoptic “fingerprints” of significant snow squall events using standardized anomalies





Developing the Snow Squall Parameter



- WINDEX was run on a model that no longer exists. NARR Reanalysis Fingerprints didn't address the mesoscale.
- [Banacos et al. 2014](#) sought to develop a modern, graphical composite parameter for forecasting snow squalls – in a method similar to what had been done for other types of moist convection including the significant tornado and supercell composite parameters (Thompson et al. 2003, 2004) and derecho composite parameter (Fritsch and Doswell II 2001)

Snow Squall Parameter (SNSQ, non-dimensional)
 plot only for values > 0 and where $T_w \leq 1\text{ C @ } 2\text{m}$ ← Cold enough for snow

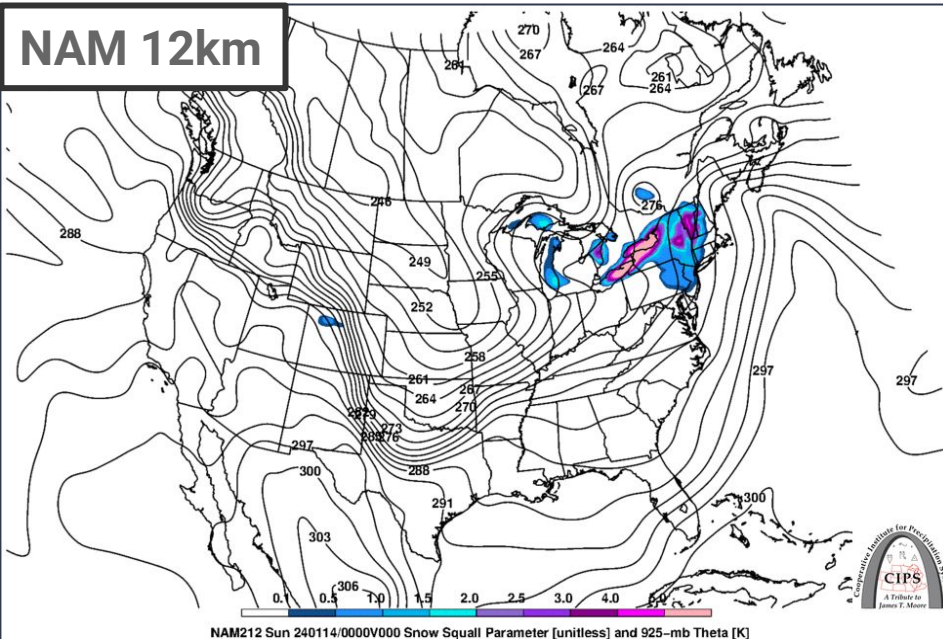
$$SNSQ = \left(\frac{\overline{RH}_{0-2km} - 60\%}{15\%} \right) \left(\frac{4\text{ K}/2km - \left. \frac{\partial \theta_e}{\partial z} \right|_{0-2km}}{4\text{ K}/2km} \right) \left(\frac{\|\vec{V}\|_{0-2km}}{9\text{ m s}^{-1}} \right)$$

Moisture low-level Instability Wind

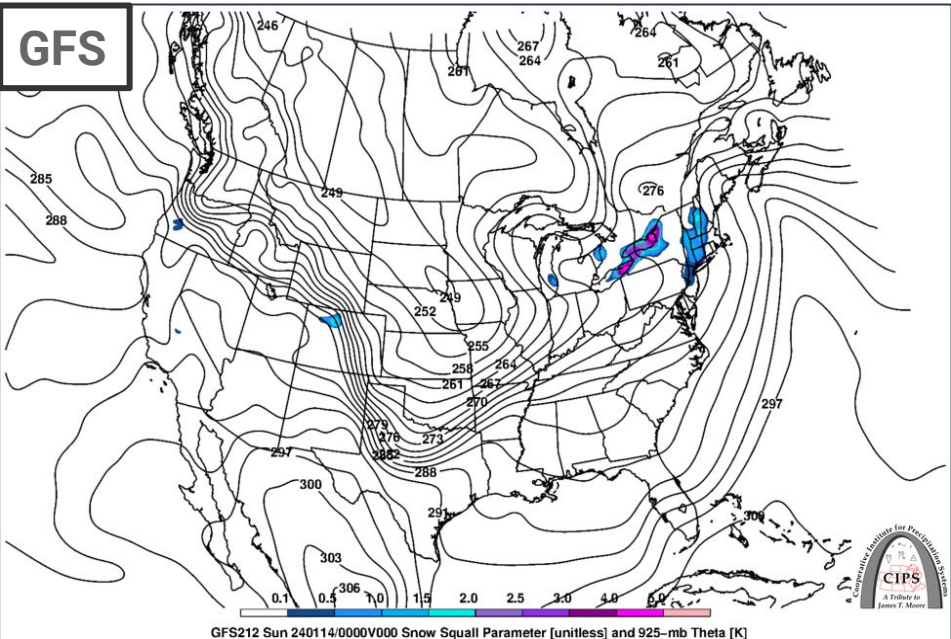


Want SNSQ >1 (climatologically tuned to 1/2sm or less vsby) DON'T FIXATE ON MAGNITUDE - CAN VARY BETWEEN MODELS

NAM 12km



GFS



<https://www.eas.slu.edu/CIPS/MODEL/WXmodel.php?&map=SNSQ>

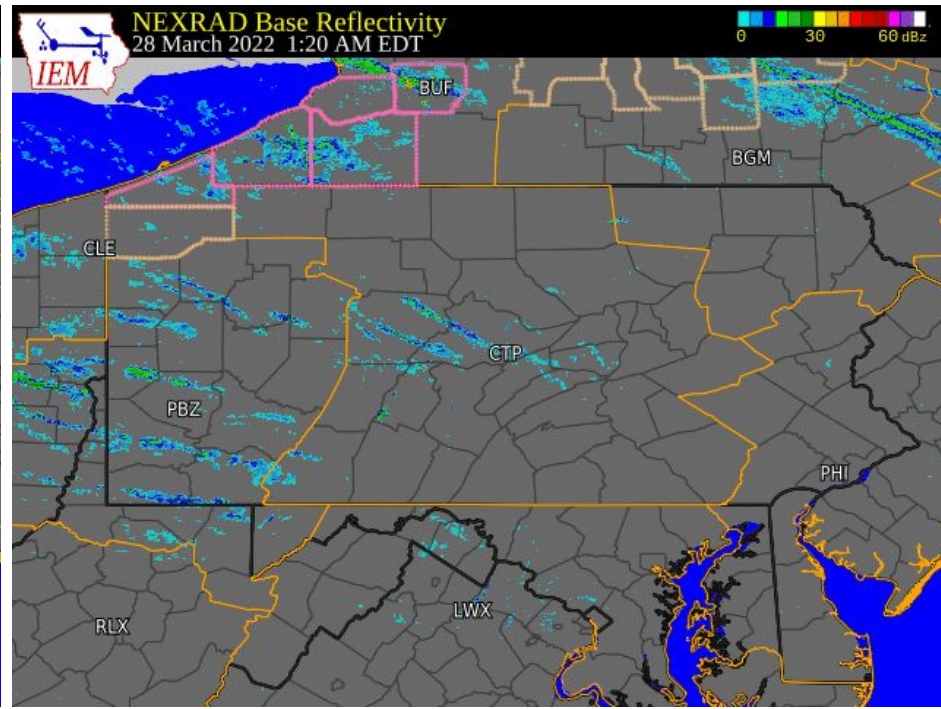
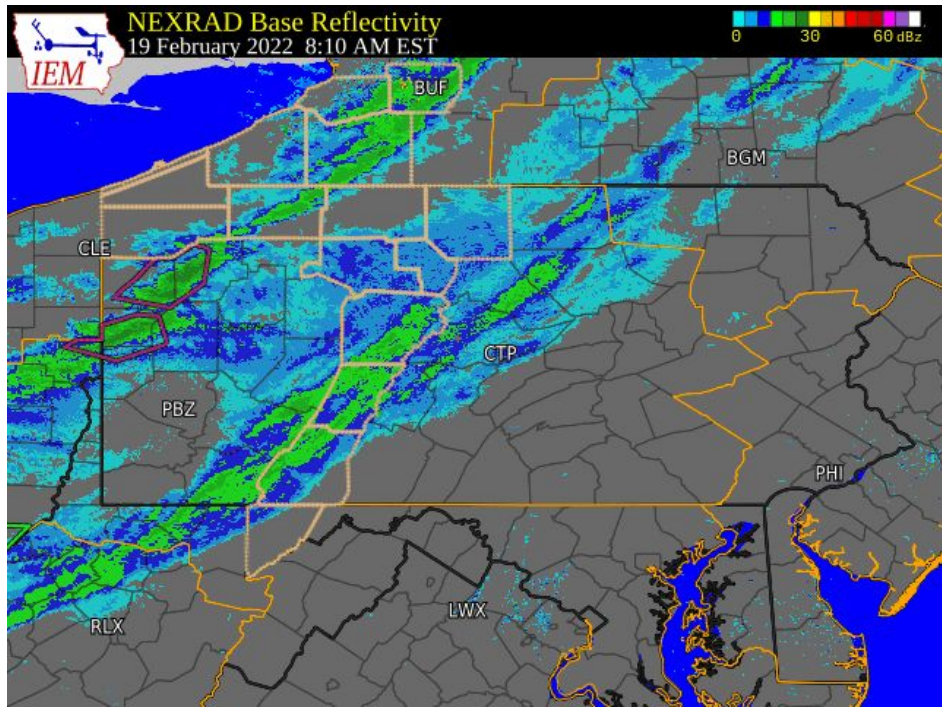


Snow Squall Mode



Linear

Cellular





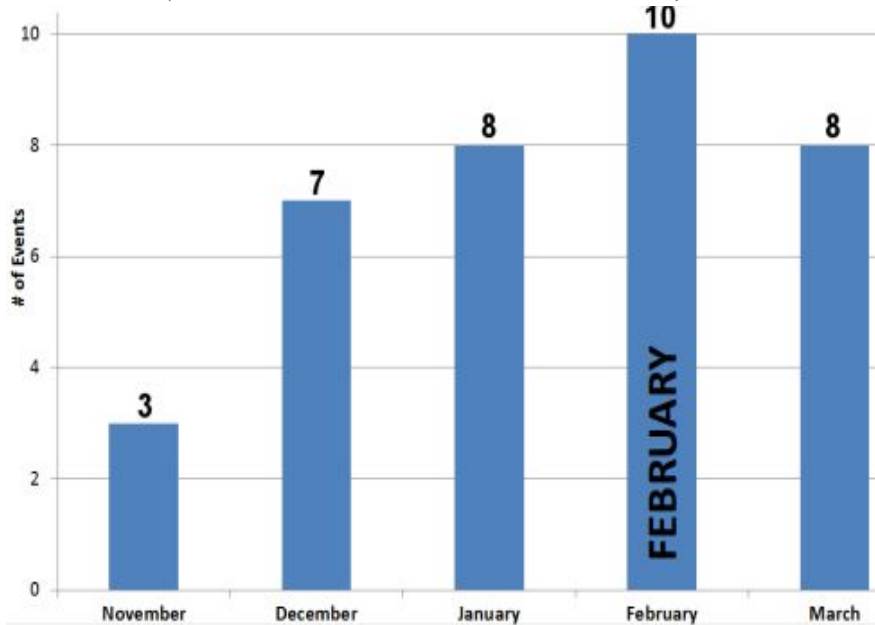
Snow Squall Climatology



Banacos et al. (2014)

Monthly Count of Snow Squall Cases

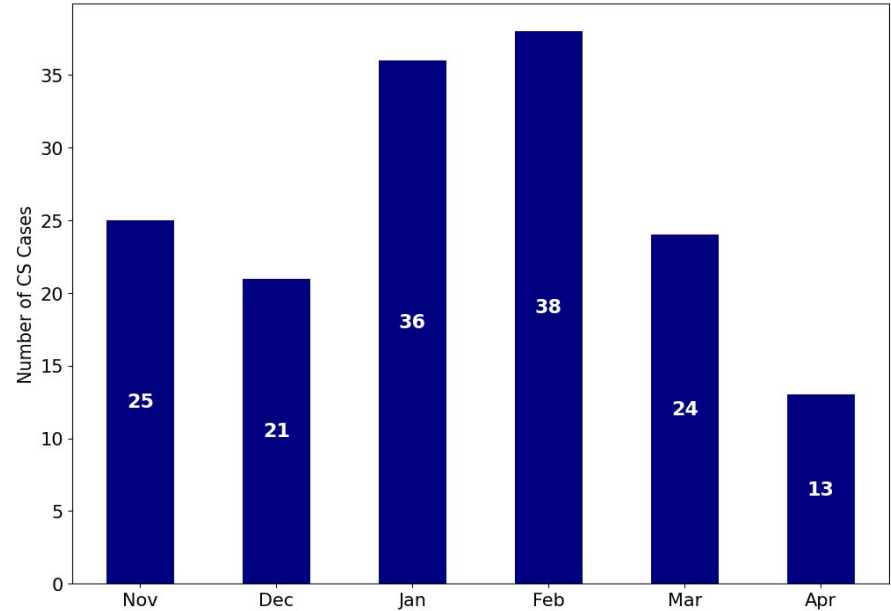
(Northern NY & VT 2002-2011)



Schneider (Penn State University) -

Convective Snow Cases

(Central PA 2012 - 2022)

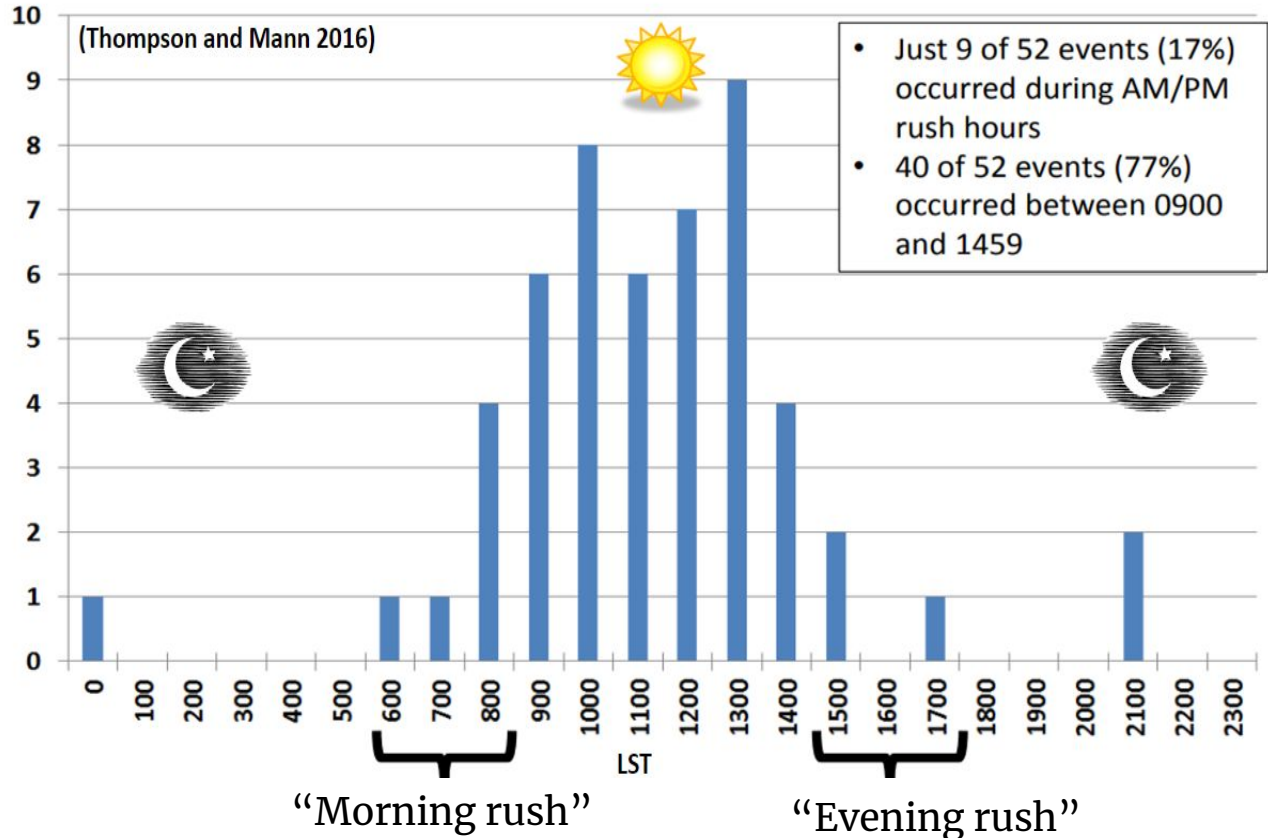




Snow Squall Climatology



Hour of Crash (Local)





Flash Freeze Component



- Rapid formation of ice on road surfaces as surface temperatures drop below freezing and melted snow freezes into a dangerous layer of ice.
- Antecedent road temperatures can be **>50°F** before a flash freeze IF air temperatures are at or below freezing and duration of snowfall is sufficient.

What is a Flash Freeze?

Snow Squall Along Arctic Front:



- Snow falls on pavement that is above freezing. Melts on contact

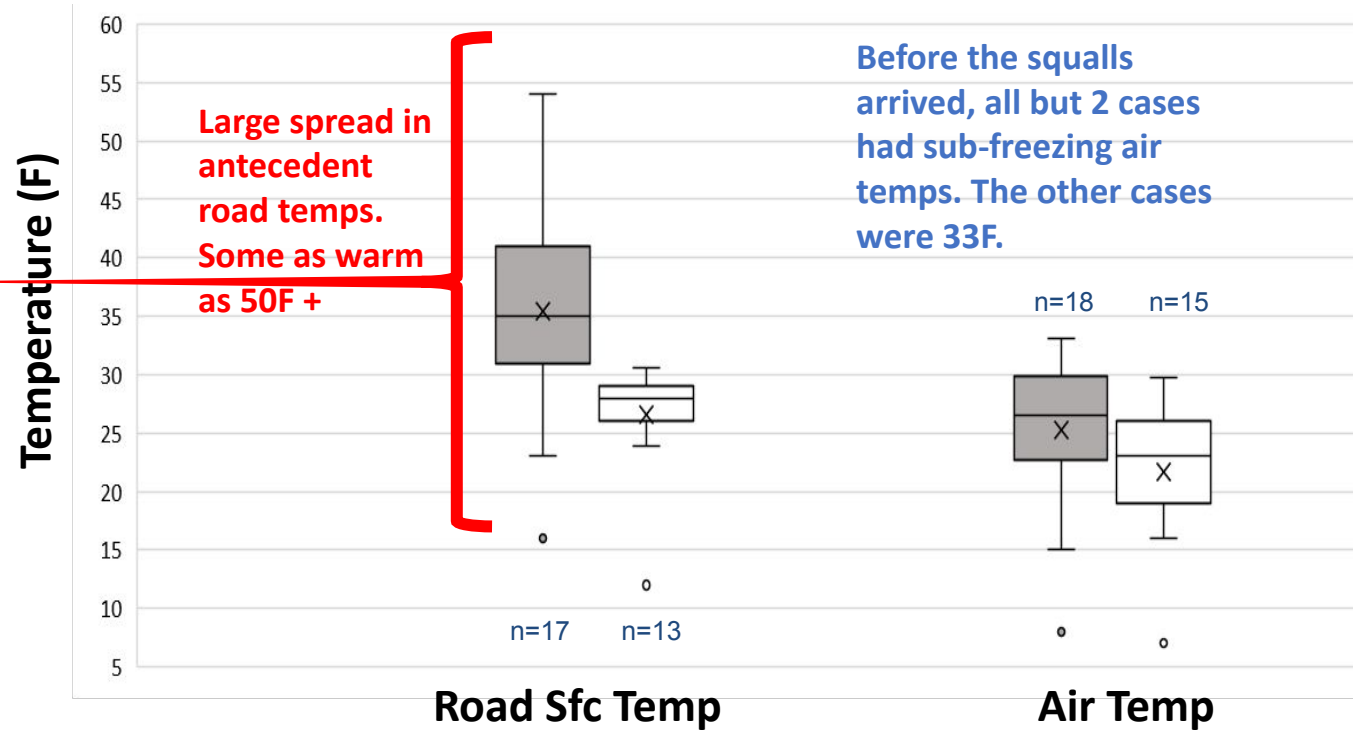
Post Frontal Air Mass:



- Temperatures fall rapidly behind the squall, road temperature falls below freezing
- Water freezes forming dangerous layer of ice



Road Sfc Temp (left) and Air Temp (right) Before (gray) and During (white) High-Impact Snow Squalls



The box represents the 25th-75th percentile.

The middle line is the median. X is the mean.

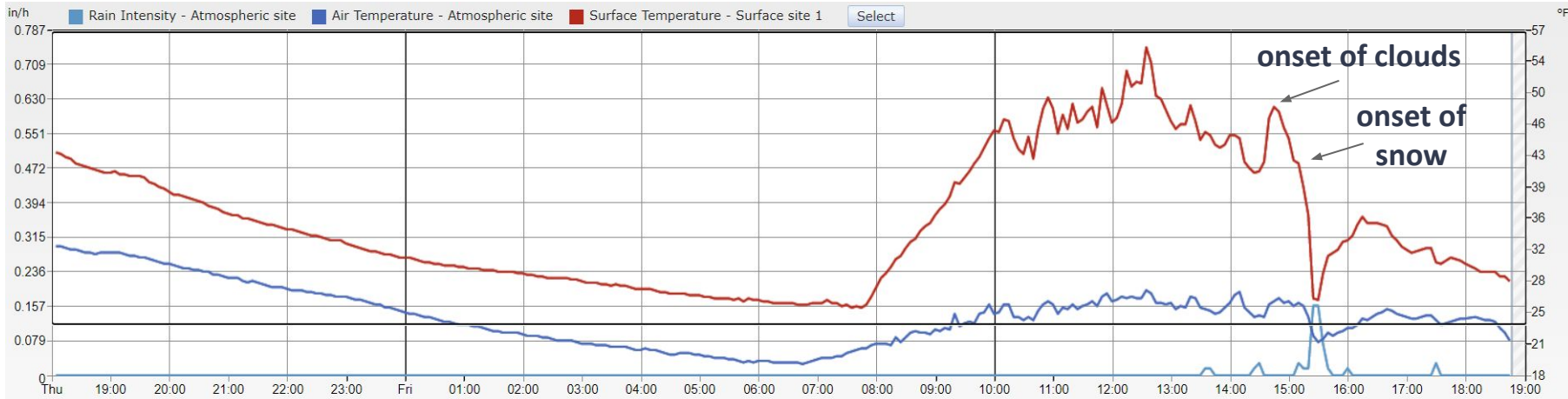
Whiskers represent the min and max of the sample within 1.25 times the interquartile range (anything outside this range is an outlier)



How Quickly Can Road Temps Fall?



On March 3, 2017 a snow squall led to a flash freeze and a *32-vehicle accident* on Interstate 81 in Schuylkill County, PA. **The road surface temperature just before the snow squall was 48F. The air temperature was in the mid 20s.**

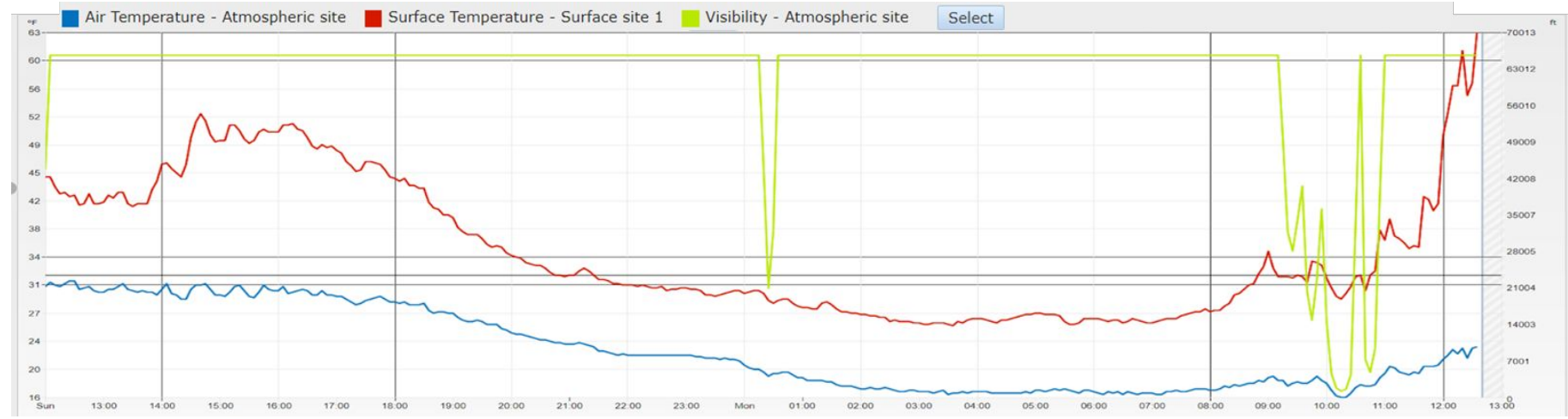


- The road surface temperature dropped from 48F to 32F in **37 minutes** (0.43 deg/minute) then ultimately reached a min of 26F.
- Snow was falling only for about 10-15 minutes of that time. The road temperature started cooling before snow was observed. This was likely due to clouds moving in and reducing solar radiation.



How Quickly Can Road Temps Fall?

March 28, 2022



When snow squalls arrived, the road had warmed to about 34°F, while the air temperature was 19°F. Road temp fell to 29°F after heavy snow began, and snow/ice accumulated on the roadway. Visibility was reduced to between ¼ and ½ mile in snow and fog.

A major pileup occurred on I-81 in Schuylkill County. 39 commercial vehicles and 41 passenger vehicles were involved. Six people were killed and more than two dozen were injured. All fatalities occurred in fire.

This RWIS site was about 8 miles away from the crash site. Due to the time of year and the warm stretch of days leading up to the cold surge, the road temperatures were running about 10°F warmer than the air temperature, even at night.



How Quickly Can Road Temps Fall?



- On average, when a snow squall hit an RWIS site that started with road temps above freezing and air temp below freezing, the **road temp fell at a rate of 2-3F every 5 minutes.**
- Road temp drops of 1+ degree per minute were noted in one of the snow squall cases.
- Remember, in daytime events, road temp will begin to drop before the snow squall begins as clouds darken the sky.



How quickly can road temps fall?



March 3, 2017: I-80 in Clinton County, PA

45-vehicle pileup around 2:30PM

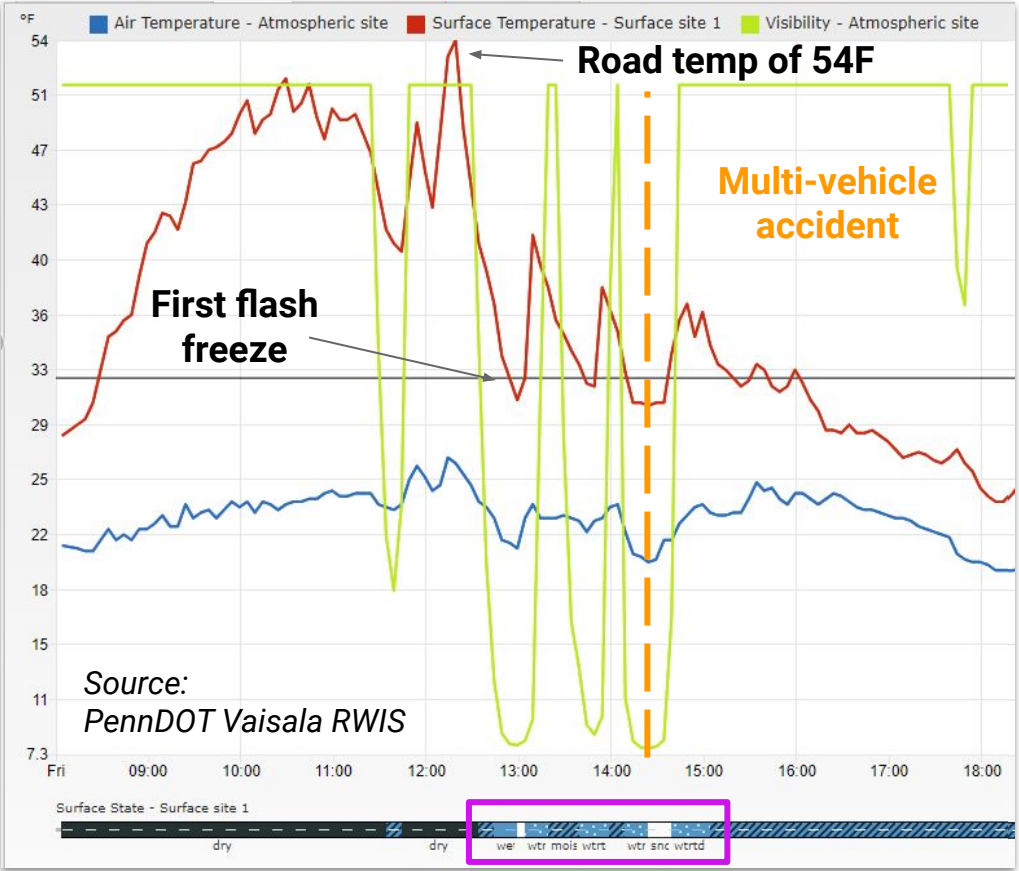
The road surface temperature 2 hours before the pileup was as warm as 54°F.

The air temperature was in the mid 20s.

4 different snow showers leading up to the accident (visibility reductions).

During the first flash freeze, the road surface temperature dropped from 54°F to 32°F in 35 minutes (0.63 deg/minute) then reached a min of 30°F.

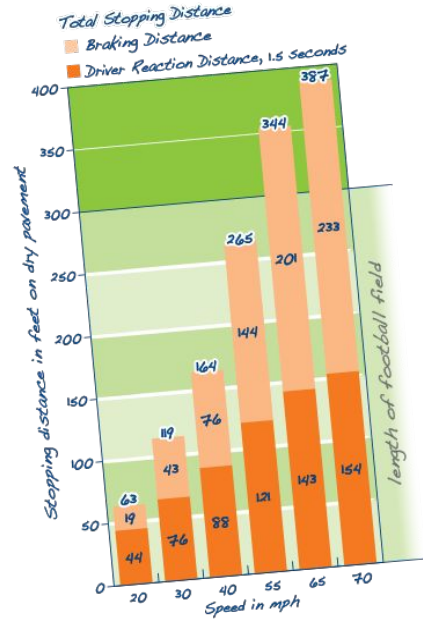
Road surface briefly snowy at 1PM, longer duration at 2:30PM.





Stopping Distances

Total stopping distance in feet at various speeds (mph), by the time (distance) it takes the driver to react plus the braking distance. The driver takes the same amount of time to react regardless of speed. As speed doubles, stopping distance quadruples.



- **Passenger Vehicle on Dry Pavement:**

- 144 feet when traveling at 55 mph
 - This is in addition to driver reaction time
 - Stopping distance quadruples as speed doubles



- **Commercial Truck on Dry Pavement:**

- Roughly double the passenger vehicle stopping distances

- **Vehicles on Ice:**

- Multiply dry pavement stopping distances by 10 times

144 ft x 2 x 10 = 2880 ft ≈ 0.5 mile

Approximate distance a commercial truck will continue to travel on ice after hitting the brakes if starting at 55 mph





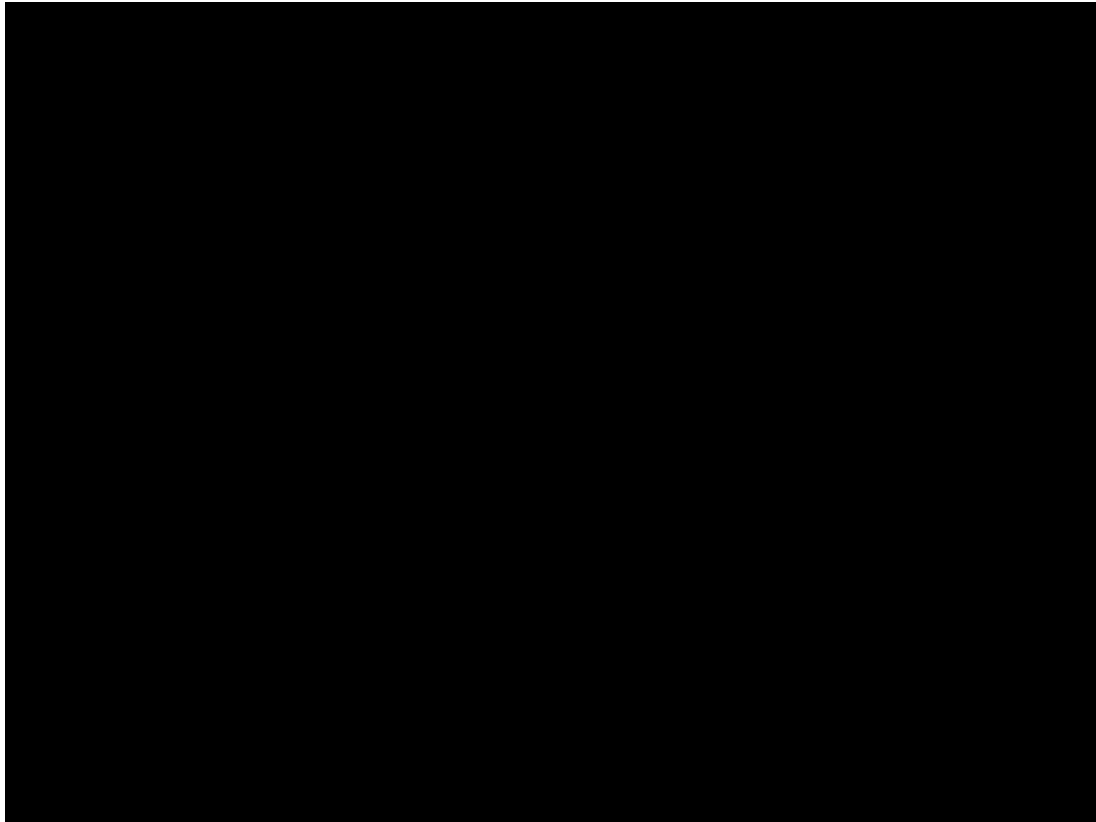
Snow Squall Forecasting: 0-1 days



Continue to use Snow Squall Parameter & CAMs, but don't get faked out by composite reflectivities. Isallobaric couplets force snow showers into more intense bands.

DESI - 90th Percentile 1-hr Snow from HREF

- 90th Percentile will often emphasize where/when snow squalls are most likely.
- Works better for linear cases than cellular



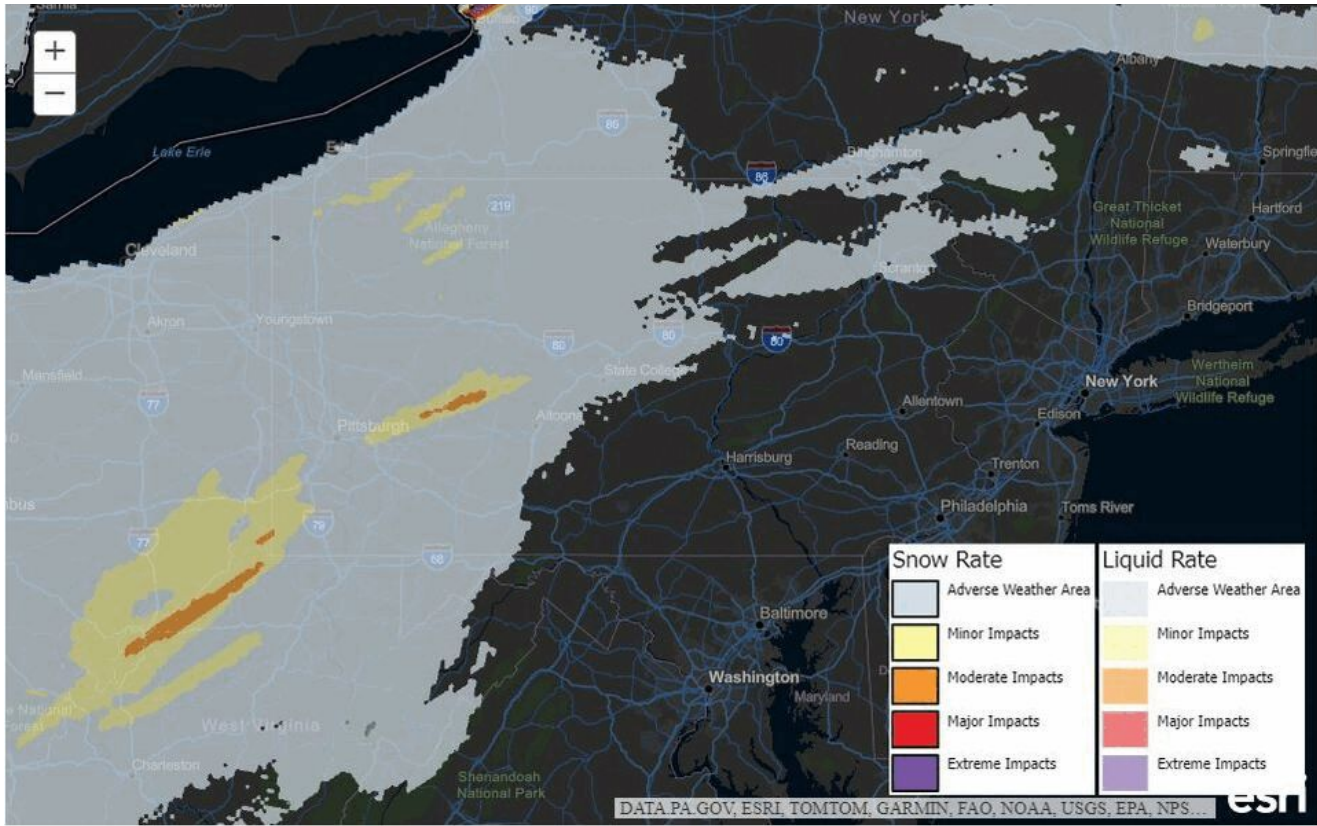


Winter Storm Severity Index - Hourly



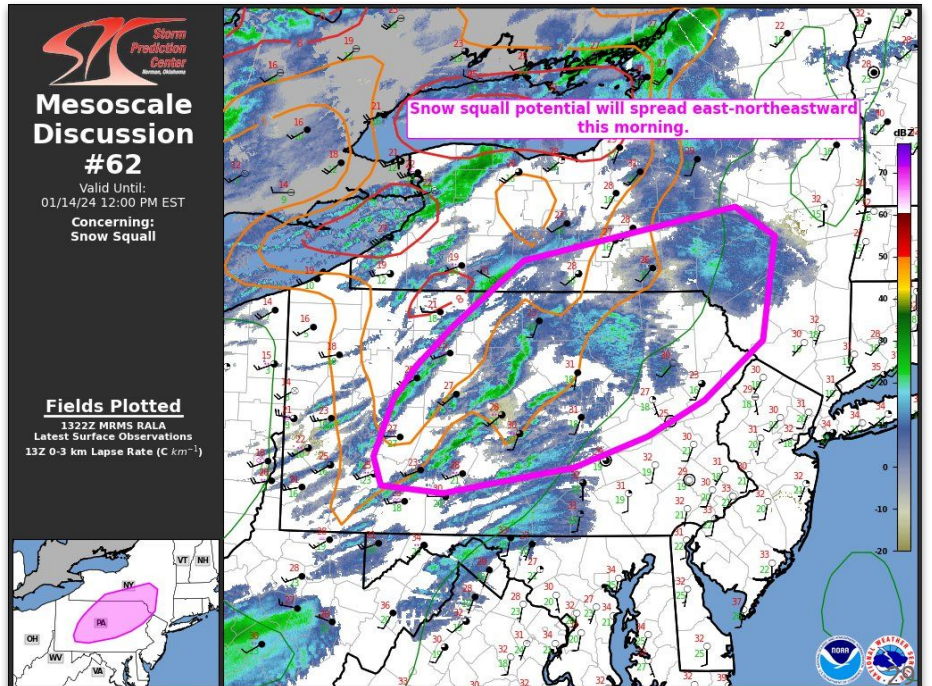
Based on HRRR Output
 Produced every 6 hours
 (2-3 hour lag time)
 Blowing Snow tuned for SNSQ:

- **Moderate**
1/4mi visibility
- **Major** 1/16mi
visibility
- **Extreme**
1/32mi visibility



Snow Squall Mesoscale Discussions

SPC Mesoscale discussions serve to provide guidance and raise awareness up to 3 hours prior to the onset of dangerous conditions associated with snow squalls.





Snow Squall Products



Key Messages for Snow Squalls

Issued by the Weather Prediction Center in collaboration with local Weather Forecast Offices

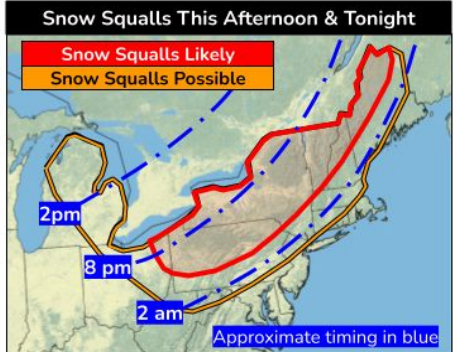


Key Messages for Northeast Snow Squalls

Updated Feb 2, 2023
12:00 PM EST

A strong Arctic cold front will bring the threat of snow squalls and bitterly cold wind chills

- A strong Arctic front will race across the Great Lakes today and then push through the Northeast tonight.
- Snow squalls will accompany the Arctic front, causing heavy bursts of snow and gusty winds. Sudden whiteout conditions within snow squalls will create very dangerous driving conditions, particularly on highways.
- In the front's wake, some heavy lake effect snow bands will be possible downwind of the Great Lakes.
- A combination of bitterly cold temperatures and gusty winds will lead to dangerous cold wind chills in the Northeast from Friday into Saturday. Wind chills in northern New England are likely to fall well below minus 30 degrees in many locations, which the area has not experienced for decades.
- Limit time outside and dress in layers as frostbite and hypothermia can occur in a matter of minutes.





Snow Squall Warning Best Practices

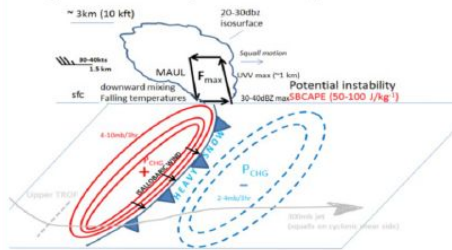
Forecasting & Situational Awareness



Tools for Forecasting a Snow Squall Day

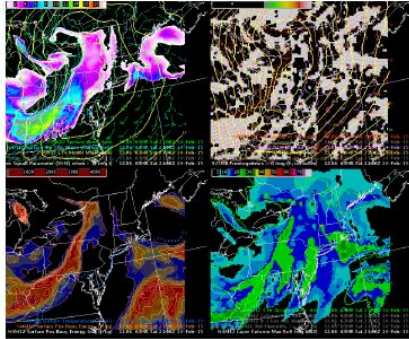
Snow Squall Conceptual Model

QLCS Snow Squall Conceptual Model



- Strongest UVV typically centered from 0-2km, ahead of cold front
- Intersection of UVV & saturated DGZ
- RHice super saturation
- θ_e decreasing with height in advance of squalls
- SBCAPE values of 50-100 J/kg or greater
- Strong surface wind/moisture convergence
- Strong synoptic forcing

Snow Squall Parameter (SNSQ)



* SNSQ, sea-level pressure, surface isobars, 10-meter winds (top left); SBCAPE (bottom left); 925mb frontogenesis (top right); 3-hour precipitation, reflectivity (bottom right)

Look For:

- SNSQ > 1
- Strong surface pressure couplet behind front and axis of high SNSQ
- Axis of any SBCAPE (can be as little as 10 J/KG) ➡
- Strong low level frontogenesis

How to Use:

- Most organized events, including hybrid cases
- AWIPS [procedure](#) exists for all model guidance, including NAM, GFS, ECMWF
- Also available online on [CIPS](#)
- In conjunction with BUFKIT forecast soundings

Other Indicators

- Steep 0-3km lapse rates
- Negative values of EPV
- HRRR Reflectivity/Visibility: banded snow w/ less than 0.5 mile vis
- Elevated values of [WSSI](#) Flash Freeze
- Flash Freeze on [Road Temperature Modeling](#)

Maintaining Situational Awareness

Office Tips & Tricks

- ➡ A **mesoscale analyst** can be invaluable to snow squall warning operations
- Use **Road Weather Information Systems** if available (work with partners)
- Employ the total observation concept, including the use of mesowest, RWIS, surface observations, **webcams**, and METRO Roadcasts
- Be aware that outcomes may be different if roadway chemical treatments have been applied
- ➡ **Ongoing communication with DOT** is essential, whether or not SQW or SPS is issued

Meteorological

- Real-time SNSQ plotted on [SPC Mesoanalysis](#) (located under Winter Weather)
- Note pre-squall ambient T/Td in relation to road surface temperatures. Road temperature cooling during SN+ when Td < 32°F can produce flash freeze, even when ambient road temperature is well above freezing
- Consider time of year and sun angle and its effect on road temperatures

Non-Meteorological

- Use traffic speed and live traffic, if available (work with partners)
- Sub-surface temperatures < 32°F will allow road surfaces to cool faster (some states' RWIS have these sensors installed)
- ➡ Be aware of **antecedent condition of roads** (if event follows rainfall, salt/road treatment may have been washed off the roads), or if the **surface temperature is above 32F but the air temperature is below 32F**.
- Be aware of unique roadway vulnerabilities



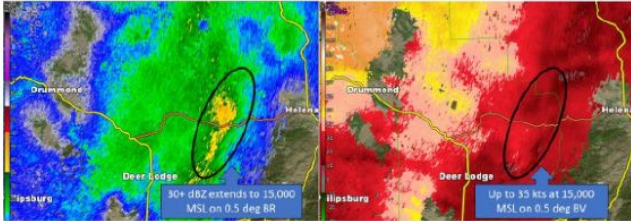
Snow Squall Warning Best Practices

Identification & Signatures



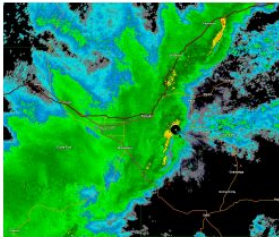
Radar Signatures

Significant Events



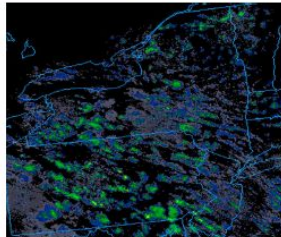
- ➔ - Max dBZ values typically exceed **30 dBZ**
- Max radial velocities typically in excess of **30 knots**
- Forward motion of the band can serve as a proxy for maximum wind gusts

Convective Mode: Linear vs. Cellular



LINEAR

- Most organized & intense
- Low level frontogenesis maximum
- Well defined pressure rise/fall couplet



CELLULAR

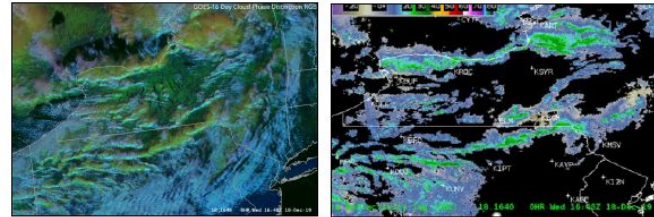
- Less organized & less intense
- Absence of frontogenesis maximum
- Absence of defined pressure rise/fall couplet

Other Radar Tips

- ➔ - Tweak your **color tables** to highlight certain important thresholds (30 dBZ, 30 knots)
- Use VCP 215 & SAILS in radar ops to help with low topped nature of squalls

Total Observation Concept

- ➔ - Use **all reliable** observations available to you, including but not limited to: radar, satellite, direct observations (e.g. ASOS, spotters), webcams, road network observations, pavement temperatures, traffic reports & live traffic
- ➔ - Request **GOES Meso-Sector** for 1 minute satellite data
- In areas of **poor radar coverage**, GOES satellite may be a reliable substitute, including 1-minute data and Day Cloud Phase Distinction (glaciated cloud tops in green which indicates snow bands)
- In areas of **radar beam blockage**, use all-tilts
- **Lightning data** may be useful in a triage scenario to isolate the strongest squalls



Above: GOES-16 Day Cloud Phase Distinction paired with radar

Below: Radar matched with webcam view





Snow Squall Warning Best Practices

Warning Theory



Considerations for SQW Issuance

Snow Squall Warning Criteria (Per NWSI 10-513)

- ➔ Radar or satellite indication and/or reliable reports of snow squalls meeting or exceeding the following:
 - **Visibility 1/4SM or less**, gusty winds, sub-freezing road temperatures
OR
 - Plunging temperatures sufficient for a **flash freeze** with significant reduction in visibility due to snow/blowing snow

General (no tag) – Use frequently for snow squall conditions, but mitigating actions, combined with societal context, will reduce the threat to safe travel.

- ➔ **SIGNIFICANT tag** – Use only when conditions, both meteorological and non-meteorological, suggest a substantial threat to safe travel, such that WEA is warranted to alert all devices in the path of the squall.
- ➔ Forecaster judgment of impact including time of day, day of week, and other **societal factors should be considered**. In those instances when lesser impacts are expected, a Special Weather Statement should be issued.

Local Considerations

- Work with partners to determine some of the local warning philosophy
- Work with partners to define which routes, sections of highways, and times of day are the most troublesome
- Work with partners to determine unique roadway vulnerabilities
- Create shapefiles in AWIPS to highlight these susceptible locations

Overlap with Long-fuse Winter Hazards

- ➔ **Winter Storm Warning:** A SQW should **NOT** be issued
- **Winter Weather Advisory:** A SQW **MAY** be issued if conditions will be significantly worse for a brief time

Mesoscale Snow Bands

- ➔ Temporal aspect is **critical**
- 1 Hour or Less: **Snow Squall Warning**
- 1 to 2 Hours: **Forecaster Discretion**
- 3+ Hours: Should be covered with a **long-fuse WSW**

Significant SQW vs. SQW vs. Special Weather Statement

SIGNIFICANT Snow Squall Warning

- **Impacts:** Reserved for the **most intense snow squall events** where the risk for **significant traffic pile-ups** is greatest; road conditions support a **likely flash freeze**; **High risk of significant societal impact**
- **Location:** Snow squalls that impact **high-speed highways**, or an accident/pile-up prone area
- **Timing:** During times of **higher traffic volumes and speeds**; occurring during **daylight hours** (6AM-10PM)
- **Confidence:** Ground truth from **reliable data** (see Total Observation Concept)

General Snow Squall Warning

- **Impacts:** **Snow Squall conditions** expected or occurring; **flash freeze risk is elevated**; **Societal impacts possible**
- **Location:** **Lower volume roads**
- **Timing:** During **lesser traveled hours**, especially at night (10PM-6AM)
- **Confidence:** Reliable tools have provided indication of occurrence

Special Weather Statement

- **Impacts:** Scattered, **less-organized heavy snow showers**; flash freeze risk is low; **Risk of societal impact is low**
- **Location:** Lesser traveled roads
- **Timing:** During lesser traveled hours, especially at night
- **Confidence:** **Lack of ground truth reports**

- ➔ The likelihood of **flash freeze conditions** is **most important discriminator** between SIGNIFICANT and non-significant snow squalls

Flash Freezes commonly occur on **untreated road surfaces** from heavy snow falling on initially >32F road surfaces, followed by melting and freezing as the road surface temperature approaches the <32F air temperature. Additionally, **plunging air temperatures** as well as **frictional warming, melting, and refreezing in high traffic volumes** can cause flash freezes.

- ➔ When upgrading to a "Significant" tag, **upgrade the entire warning polygon** rather than issuing a new polygon.



Snow Squall Warning Best Practices

Messaging & Reporting



Prior to Event

Office Tips & Tricks

- Create **Social Media & Briefing Templates** in Advance
- Make use of [Pathfinder](#), if possible
- Plan for **adequate staffing** and consult any office playbooks
- Conduct/lead impact-based webinar
- Templates Available on [VLAB](#)

Public Messaging

- Highlight in **Hazardous Weather Outlook** with as much lead time as possible
- Highlight in **Area Forecast Discussion** with as much lead time as possible
- Social Media graphics highlighting timing and significance (general at 2+ Days, more specific if possible on Day 1)
- ➔ Highlight in **Special Weather Statement** the morning of the event
- Communicate safety and preparedness information through the use of [National Safety Graphics](#)
- Host Facebook Live discussion if staffing allows
- Coordinate with **WPC/SPC** on development & amplification of **Key Messages**

Partner Messaging

- "Heads-Up" Communication including emails and NWSChat with as much lead time as possible
- Briefing graphics highlighting timing and significance (general at 2+ Days, more specific if possible on Day 1)
- ➔ Contact DOT, State, and Local Partners the morning of the event
- Disseminate Hazardous Weather Briefing (if widespread impacts) to EMs and other partners
- Consider impacts for aviation partners

During Event

Office Tips & Tricks

- Create **Social Media & Briefing Templates** in Advance
- ➔ **Collaborate with neighboring WFOs** on messaging snow squall potential for the day
- Templates Available on [VLAB](#)

Public Messaging

- Snow Squall Warning & Special Weather Statement products
- General Social Media Posts
- ➔ Auto-generated specific Snow Squall Warning graphics
- Communicate safety and preparedness information through the use of [National Safety Graphics](#)
- Share **webcam images**, if available, to paint a picture of what drivers might expect
- Encourage the use of mPING

Partner Messaging

- Continual communication, including DOT, state, and local partners
- Use of NWSChat
- ➔ Variable Message Boards Activation
- ➔ Consider thresholds for notifying **aviation partners** (control tower, TRACON) or issuing **Aviation Weather Warnings (AWW)**

After Event

Internal Reports

- Notify ROC of impacts

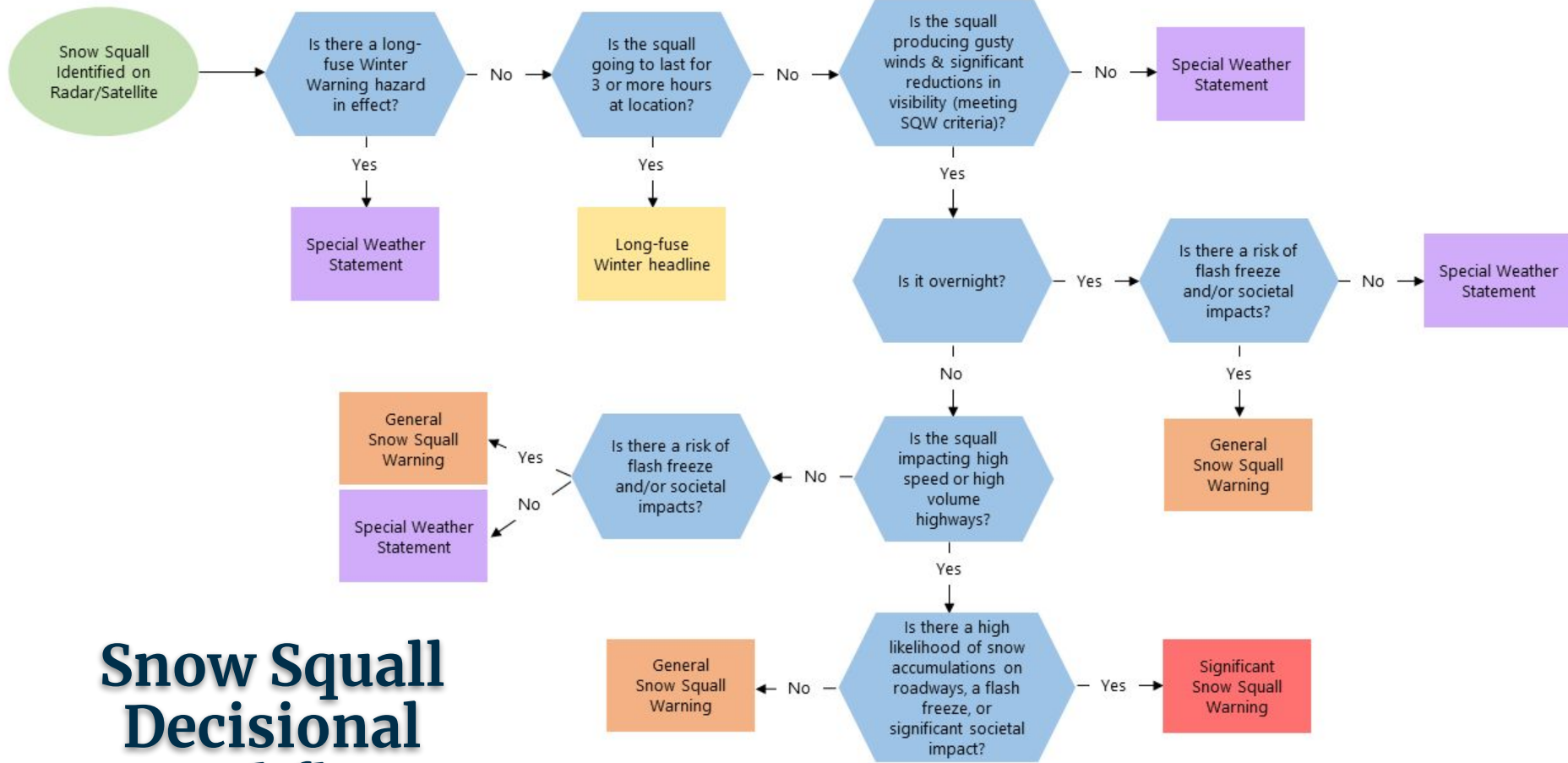
Local Storm Reports

- Use the **SNOW SQUALL** event type
- Issue LSR when SQW criteria is met (1/4SM Visibility in +SN, observed and documented Flash Freeze occurrence, and/or observed and documented Societal Impacts. Local WFO policy can further fine tune this guidance as necessary.
- If known, include the amount of snow, lowest reported visibility, any measured wind gusts, any impacts associated with the squall, and length of time in the Remarks section.

Storm Data

- Use **WINTER WEATHER** event type
- Please be especially careful here so that you do not inadvertently trigger the verification program.





Snow Squall Decisional Workflow

Questions?
greg.devoir@noaa.gov



NROW 2024 Albany, NY

