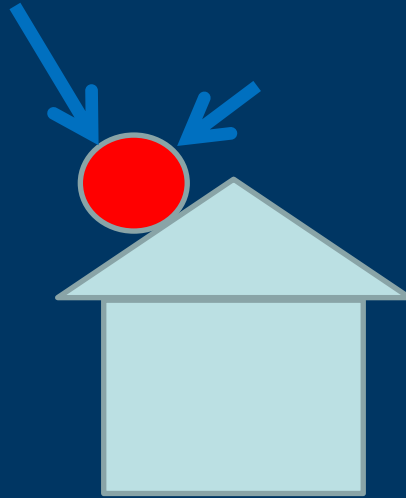


Lesson 3 – Impact Load of Hail

Part 3

Load

- Size
- Speed
- Wind Direction
- Angle with Roof
- Weather Data



Part 2

Resistance

Part 4

Effect





ENERGY



4. Potential Energy = mass x height



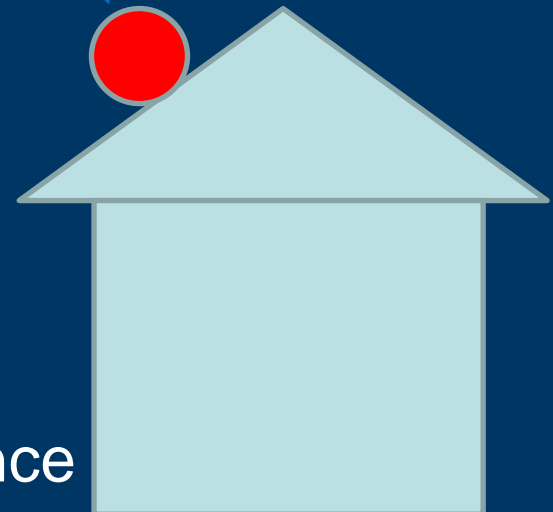
3. Kinetic Energy
 $\frac{1}{2} (\text{mass}) (\text{Velocity})^2$

5. Kinetic Energy

2. Potential
Spring Energy

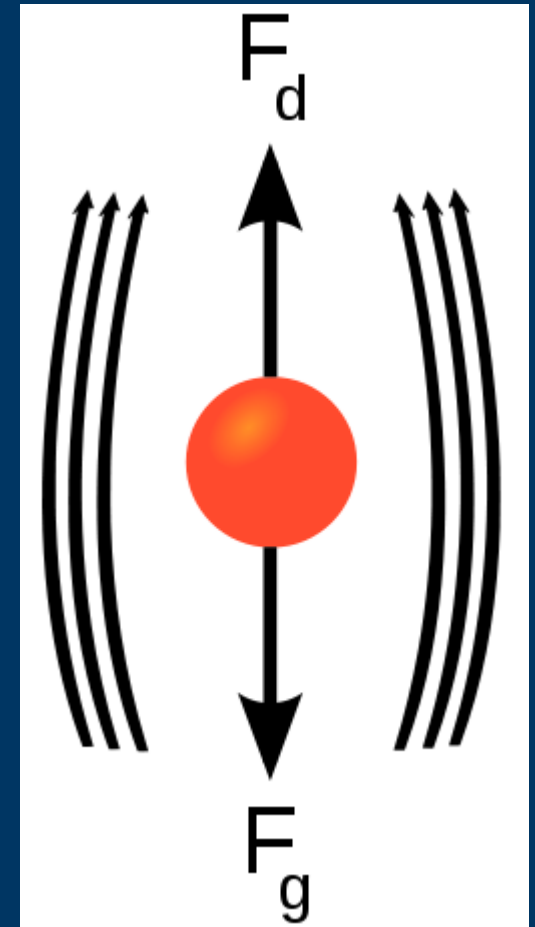


1. Work Energy
Force x distance



Terminal Velocity

$$E = \frac{1}{2} (\text{mass}) (\text{Velocity})^2$$



Energy or Hail

$$E \cong \frac{1}{2} (\text{diameter})^3 (\text{Velocity})^2$$

$\frac{3}{4}$ "	hail = 4	times Energy of $\frac{1}{2}$ " Hail
1"	hail = 13	times " "
1 $\frac{1}{4}$ "	hail = 30	times " "
1 $\frac{1}{2}$ "	hail = 60	times " "
1 $\frac{3}{4}$ "	hail = 120	times " "
2"	hail = 200	times " "

$\frac{1}{2}$ " Hail = 1/2 lb roll of quarters @ 6 in

$\frac{3}{4}$ " Hail = 1/2 lb roll of quarters @ 1 ft

{ 1" Hail = 1 lb can of soup @ 1 ft

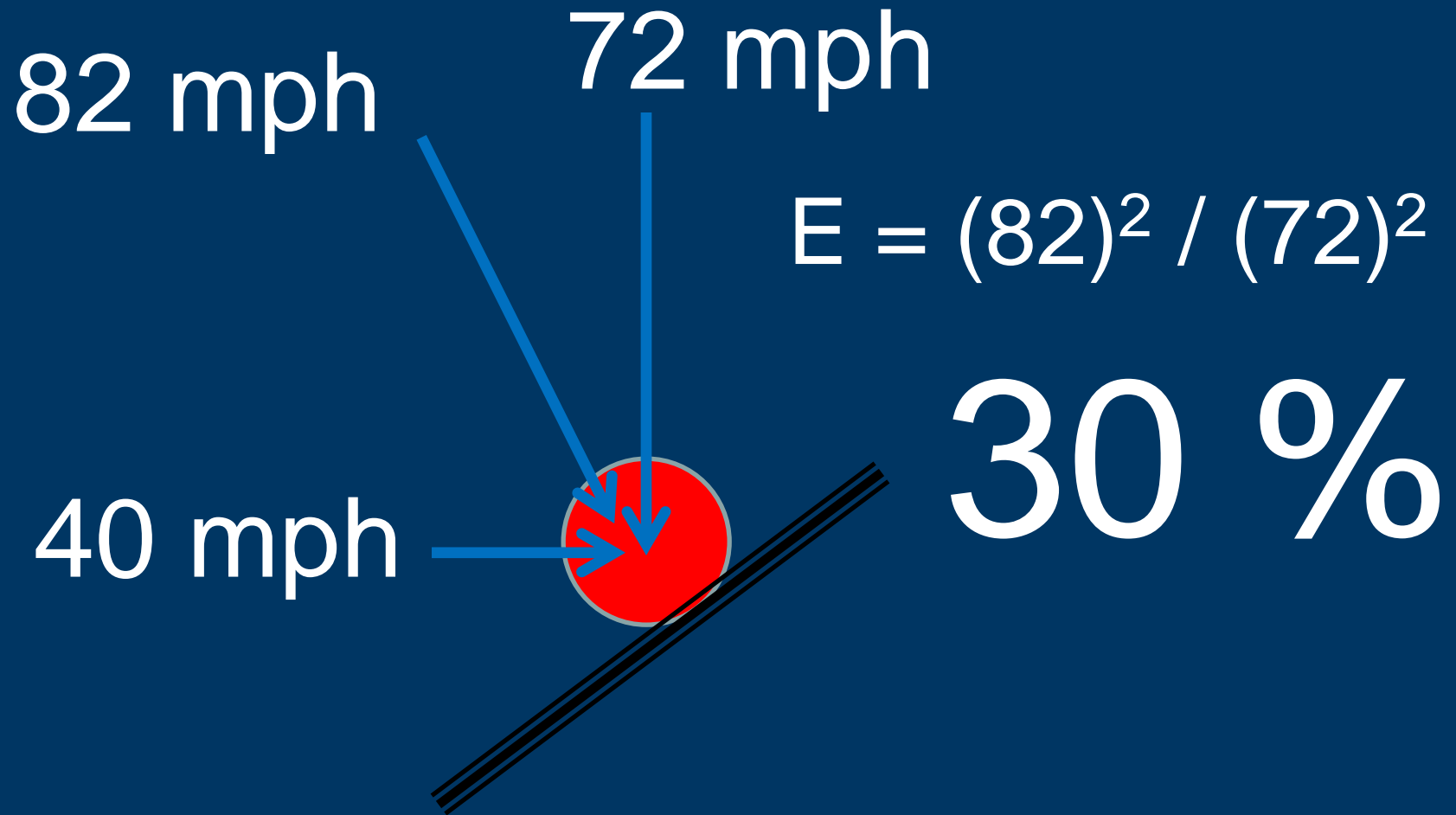
1 $\frac{1}{4}$ " Hail = 1 lb can of soup @ 4 ft

1 $\frac{1}{2}$ " Hail = 1 lb can of soup @ 8 ft

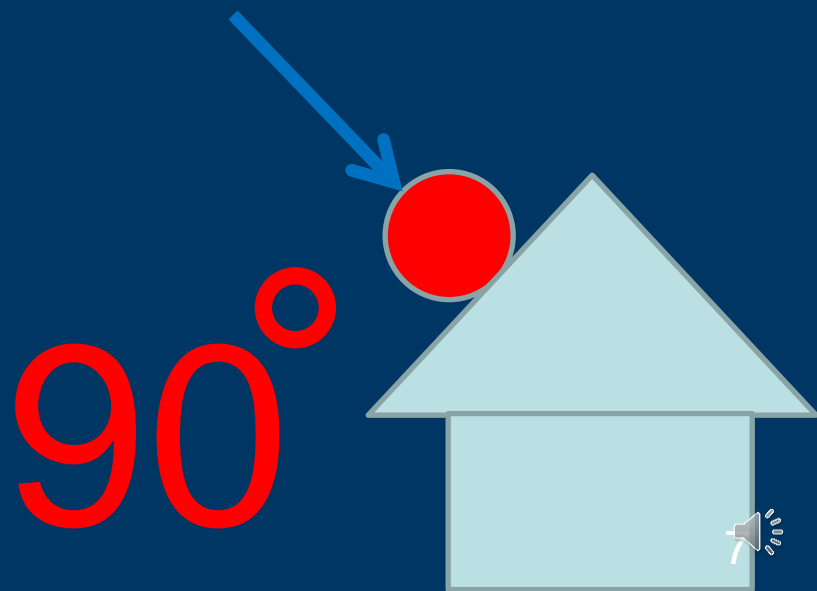
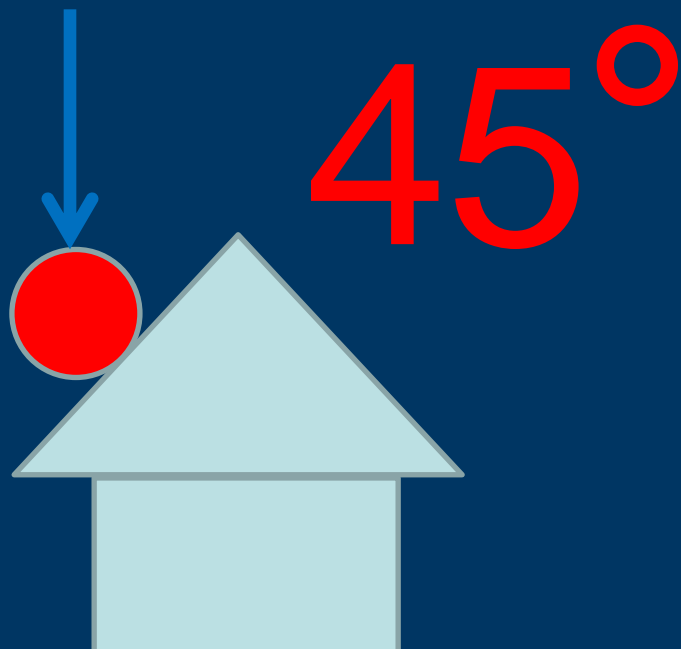
1 $\frac{3}{4}$ " Hail = 3 pound toaster @ 5 ft

2" Hail = 5 pound bottle of pop @ 5 ft

Cross Winds & Hail Impact

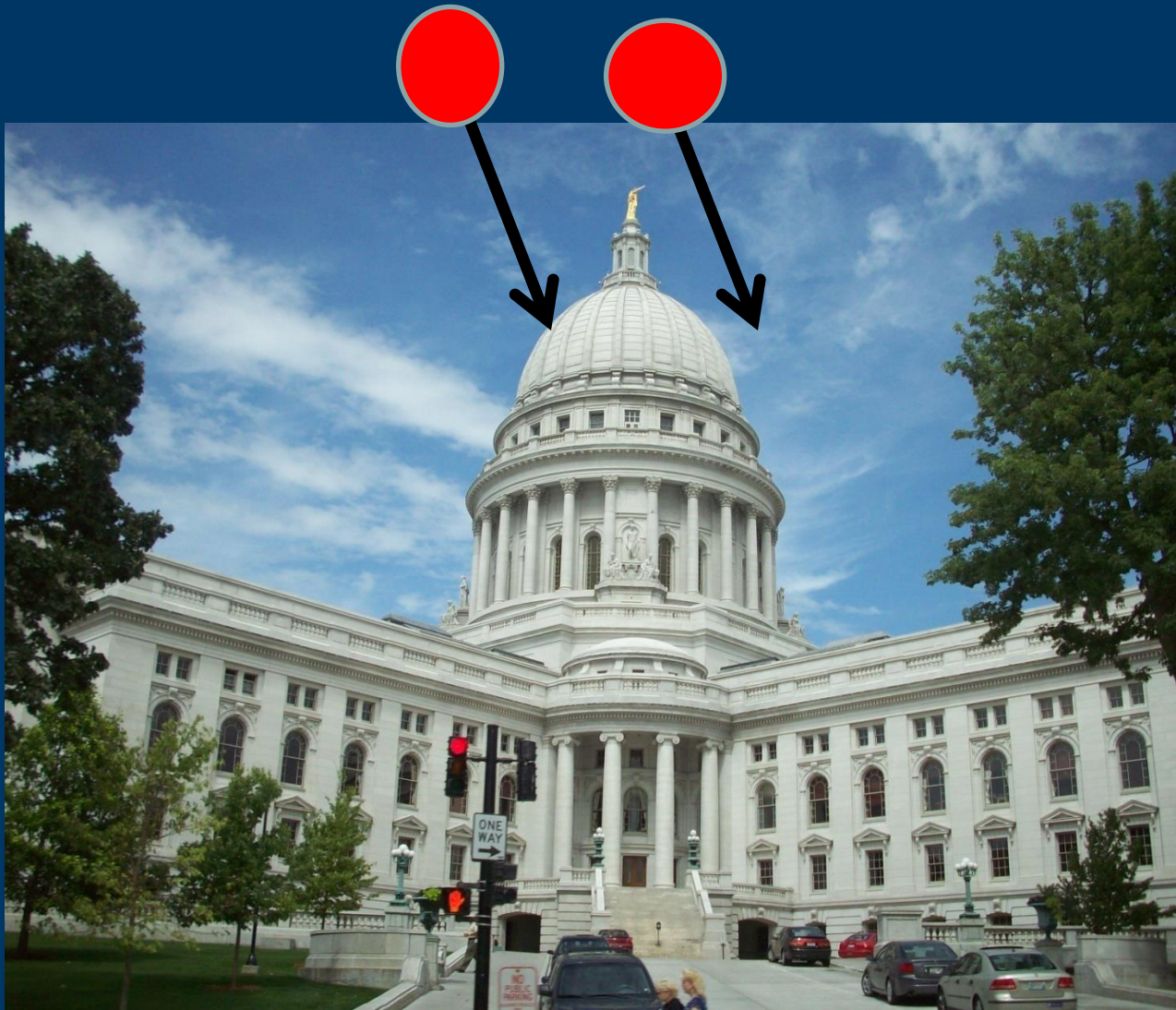


$$E = \frac{1}{2} (\text{mass}) (\text{Velocity})^2$$



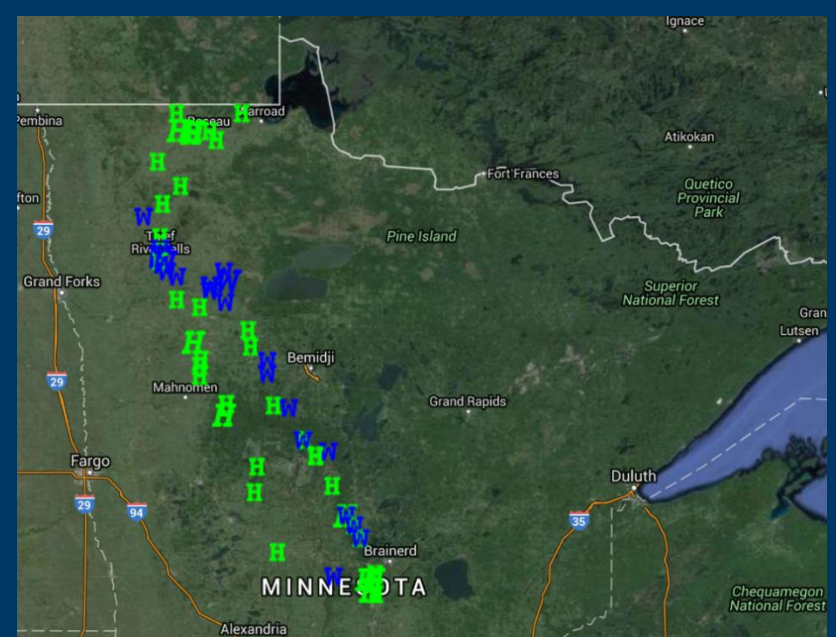
Impact Angle

0 – 90 degrees



<http://www.spc.noaa.gov/climo/online/>

NOAA's National Weather Service Storm Prediction Center



Hail Reports (CSV) (Raw Hail CSV)(?)						
Time	Size	Location	County	State	Lat Lon	Comments
2049	100	10 NE MIDDLE RIVER	MARSHALL	MN	4854 9601	TIME ESTIMATED BY RADAR (FGF)
2200	175	5 WSW PINECREEK	ROSEAU	MN	4895 9604	(FGF)
2215	275	6 N BADGER	ROSEAU	MN	4886 9602	(FGF)
2224	175	FOX	ROSEAU	MN	4884 9590	(FGF)
2226	275	FOX	ROSEAU	MN	4884 9590	(FGF)
2228	425	1 N FOX	ROSEAU	MN	4885 9590	NUMEROUS VERY LARGE HAILSTONES WERE COLLECTED AND PHOTOGRAPHED ... MEASURING FROM 4 TO 4.5 INCHES IN DIAMETER. REPORTS AND PHOTOS WERE POSTED VIA SOCIAL MEDIA. (FGF)
2230	400	6 W ROSEAU	ROSEAU	MN	4885 9589	RULER MEASURED 3.5 INCH HAIL (FGF)
2232	100	1 N CLEARBROOK	CLEARWATER	MN	4771 9543	(FGF)
2245	175	ROSEAU	ROSEAU	MN	4885 9576	A MIX OF QUARTER TO GOLF BALL SIZED HAIL ... (FGF)
2255	100	4 SE ROSEAU	ROSEAU	MN	4880 9570	(FGF)
2336	100	2 E EMMAVILLE	HUBBARD	MN	4707 9494	(FGF)
2350	125	NEVIS	HUBBARD	MN	4697 9484	(FGF)
2354	100	1 N NEVIS	HUBBARD	MN	4698 9484	(FGF)
0020	175	3 W OSHAWA	CASS	MN	4680 9470	(DLH)
0050	200	6 ENE POPLAR	CASS	MN	4663 9458	SPOTTER FOUND HAIL APPROX 1 HOUR AFTER STORM PASSED. (DLH)

20150812's Storm Reports (1200 UTC - 1159 UTC) (Print Version)

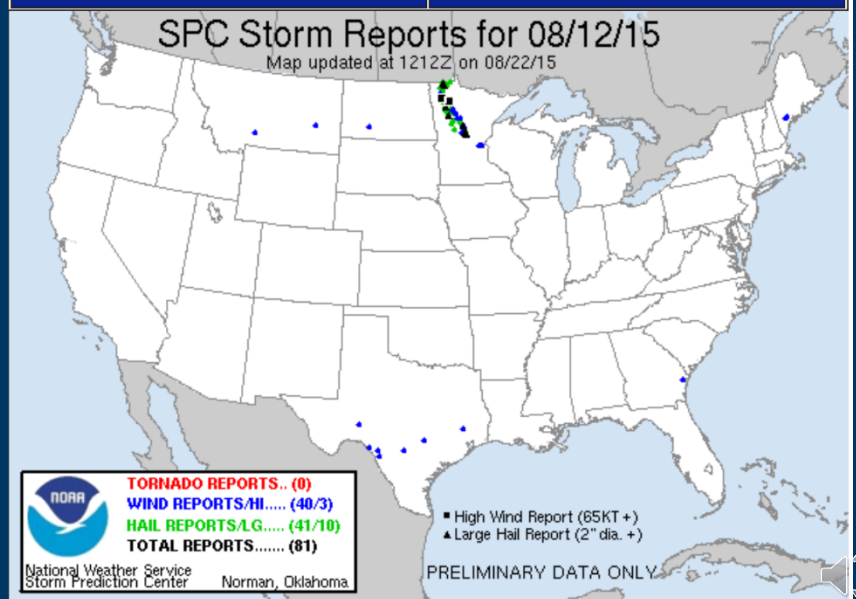
< 150811 Reports 150813 Reports >
Note: All Reports Are Considered Preliminary


Unfiltered Reports (Google Maps)

Filtered Reports (Google Maps) (More Info)

SPC Storm Reports for 08/12/15

Map updated at 1212Z on 08/22/15




TORNADO REPORTS... (0)
WIND REPORTS/HI..... (40/3)
HAIL REPORTS/LG..... (41/10)
TOTAL REPORTS..... (81)

■ High Wind Report (65KT+)
 ▲ Large Hail Report (2" dia.+)

PRELIMINARY DATA ONLY

Storm Events Database

Data available from 01/1950 to 11/2015

State/Area:

Begin Date: / /

End Date: / /

County:

- Polk
- Pope
- Ramsey
- Red Lake
- Redwood
- Renville
- Rice
- Rock
- Roseau**
- Scott

Event Type(s):

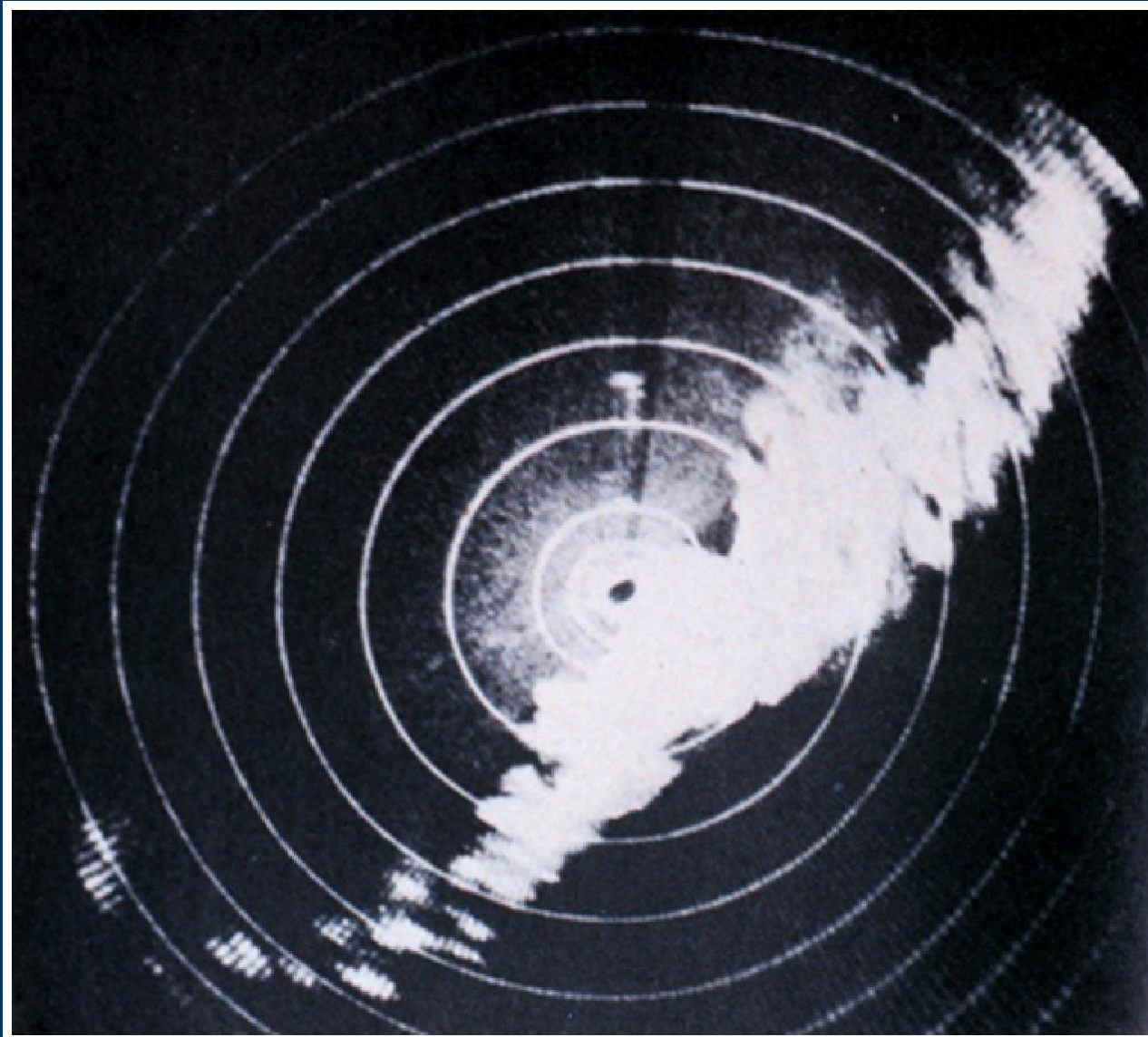
- Drought
- Dust Devil
- Dust Storm
- Excessive Heat
- Extreme Cold/Wind Chill
- Flash Flood
- Flood
- Freezing Fog
- Frost/Freeze
- Funnel Cloud
- Hail**
- Heat
- Heavy Rain
- Heavy Snow
- High Surf
- High Wind

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
STRATHCONA	ROSEAU CO.	MN	08/12/2015	14:21	CST-6	Hail	0.75 in.	0	0	0.00K	0.00K
STRATHCONA	ROSEAU CO.	MN	08/12/2015	14:33	CST-6	Hail	0.88 in.	0	0	0.00K	0.00K
DUXBY	ROSEAU CO.	MN	08/12/2015	16:00	CST-6	Hail	1.75 in.	0	0	0.00K	0.00K
DUXBY	ROSEAU CO.	MN	08/12/2015	16:15	CST-6	Hail	2.75 in.	0	0	0.00K	0.00K
FOX	ROSEAU CO.	MN	08/12/2015	16:24	CST-6	Hail	1.75 in.	0	0	0.00K	0.00K
FOX	ROSEAU CO.	MN	08/12/2015	16:26	CST-6	Hail	2.75 in.	0	0	0.00K	0.00K
FOX	ROSEAU CO.	MN	08/12/2015	16:28	CST-6	Hail	4.25 in.	0	0	0.00K	0.00K
FOX	ROSEAU CO.	MN	08/12/2015	16:30	CST-6	Hail	4.00 in.	0	0	0.00K	0.00K

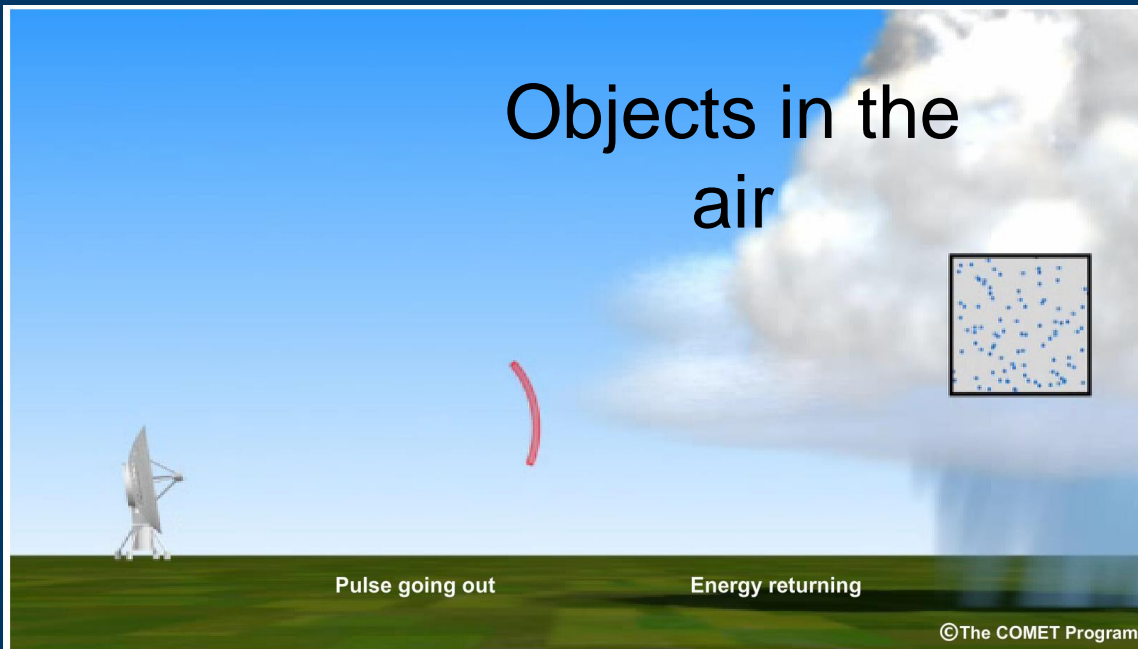
Hail Swath Maps



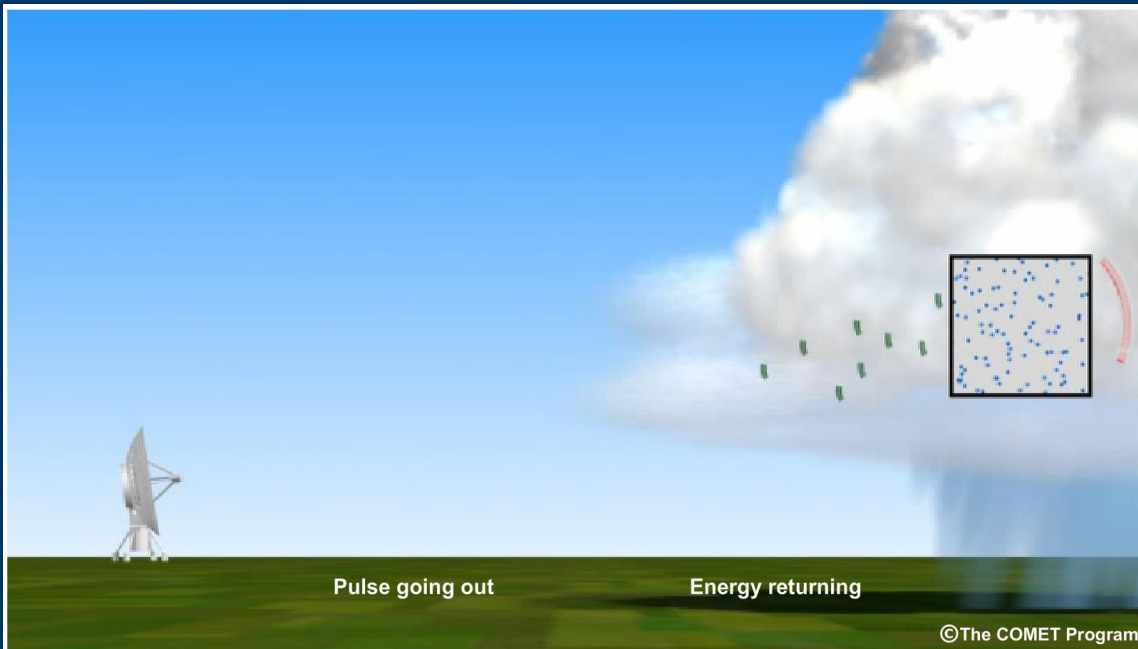
WW1 – Invention of Radar



Objects in the air



emitted pulses of electromagnetic energy at microwave frequencies



Reflected energy back (reflectivity)

How the Radar Works

"radar reflectivity factor" (Z).

$$Z = \sum_{i=1}^n D_i^6$$

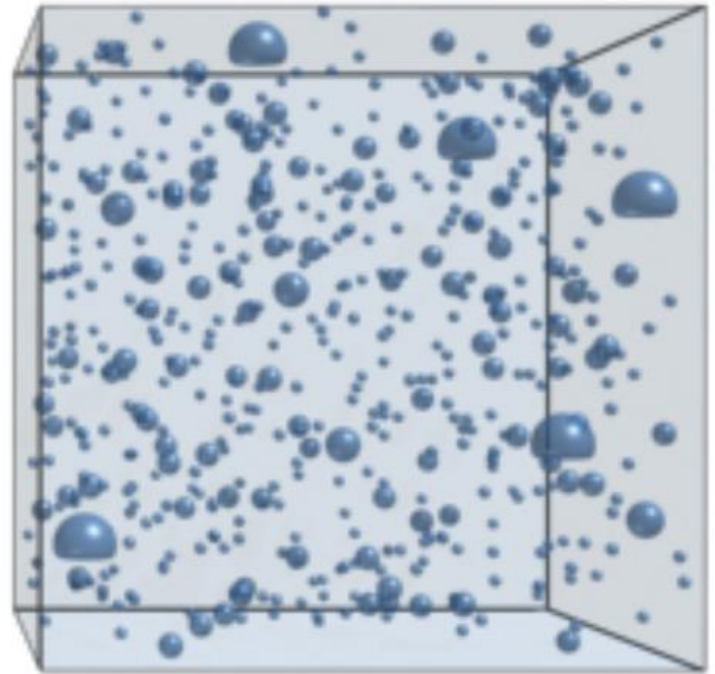
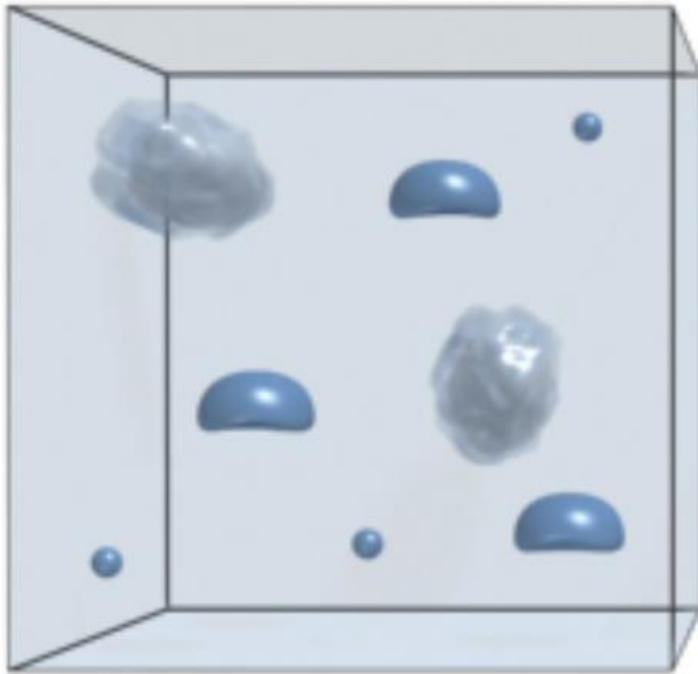


NOAA

diameter (D)

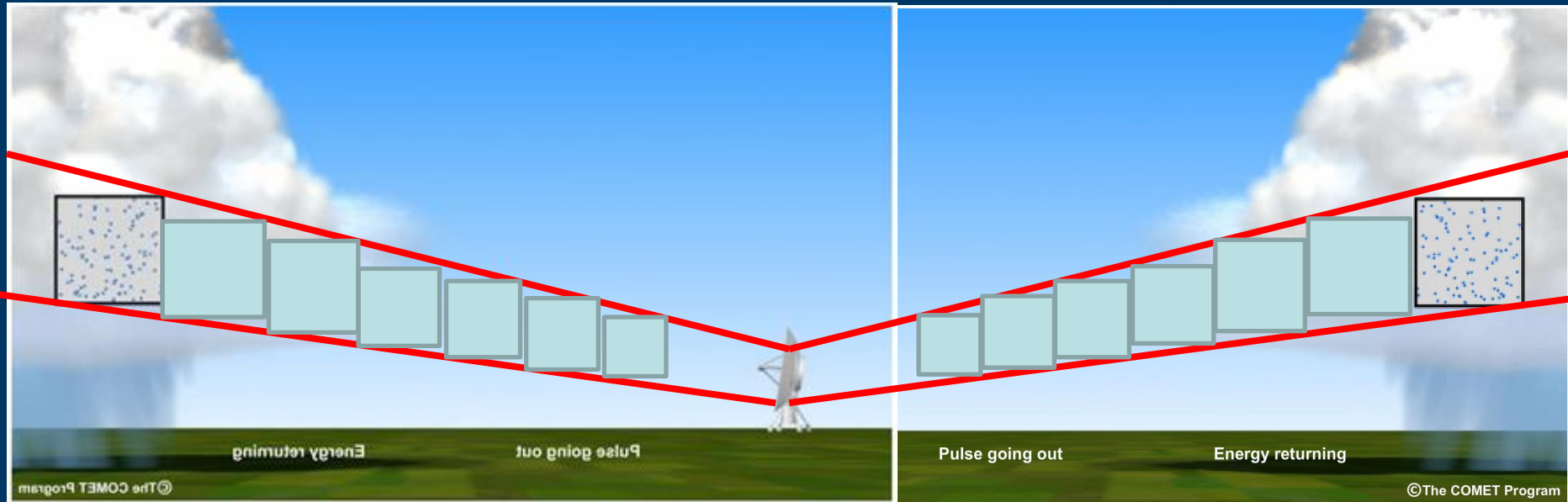


$$\text{dBZ} = 10 \log_{10} \frac{Z}{1 \text{ mm}^6 / \text{m}^3}$$



“there isn’t a direct relationship between hail size and reflectivity value”

Base Reflectivity

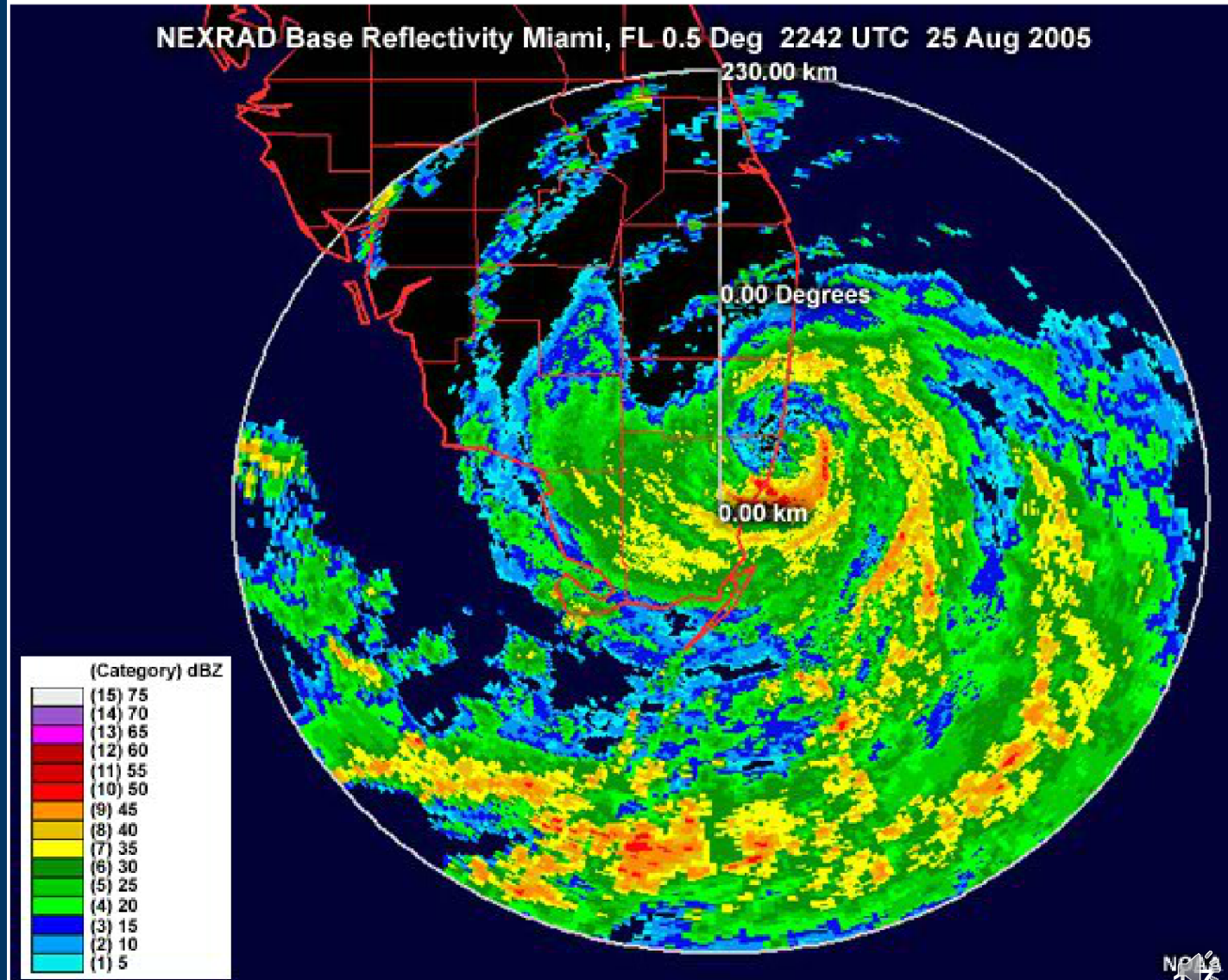


5-30 DBZ

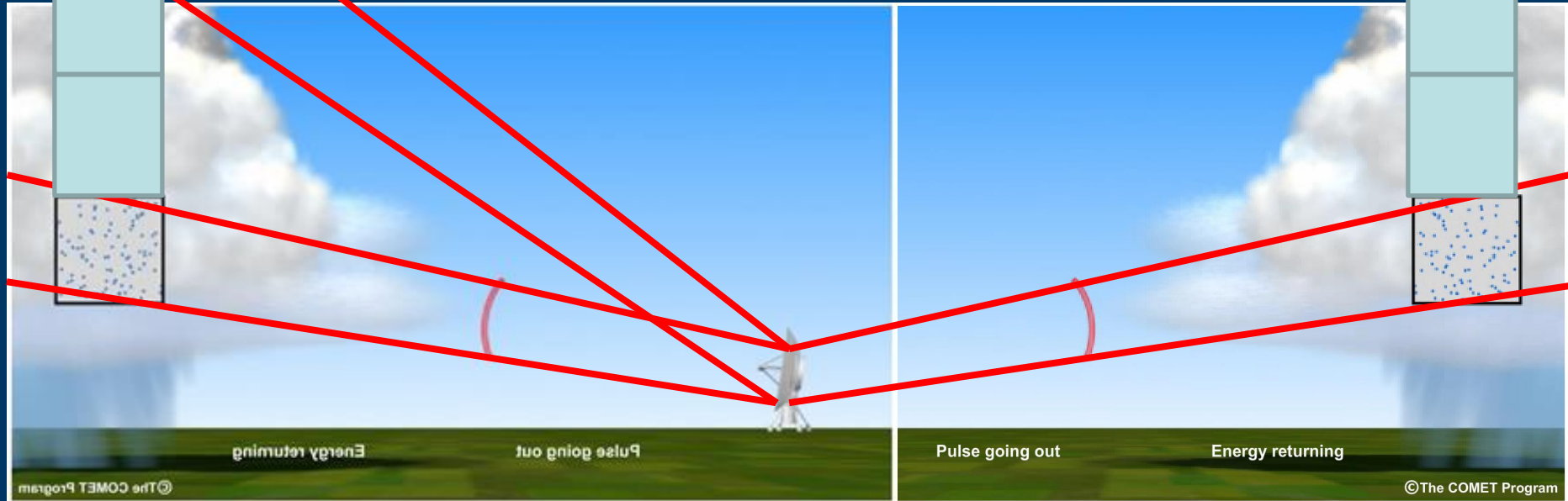
(blue and green colors) indicate light precipitation

Values
above 45
intense
precipitation

Anything
above 60 dBZ
generally
means that
the sample
volume
contains some
hail

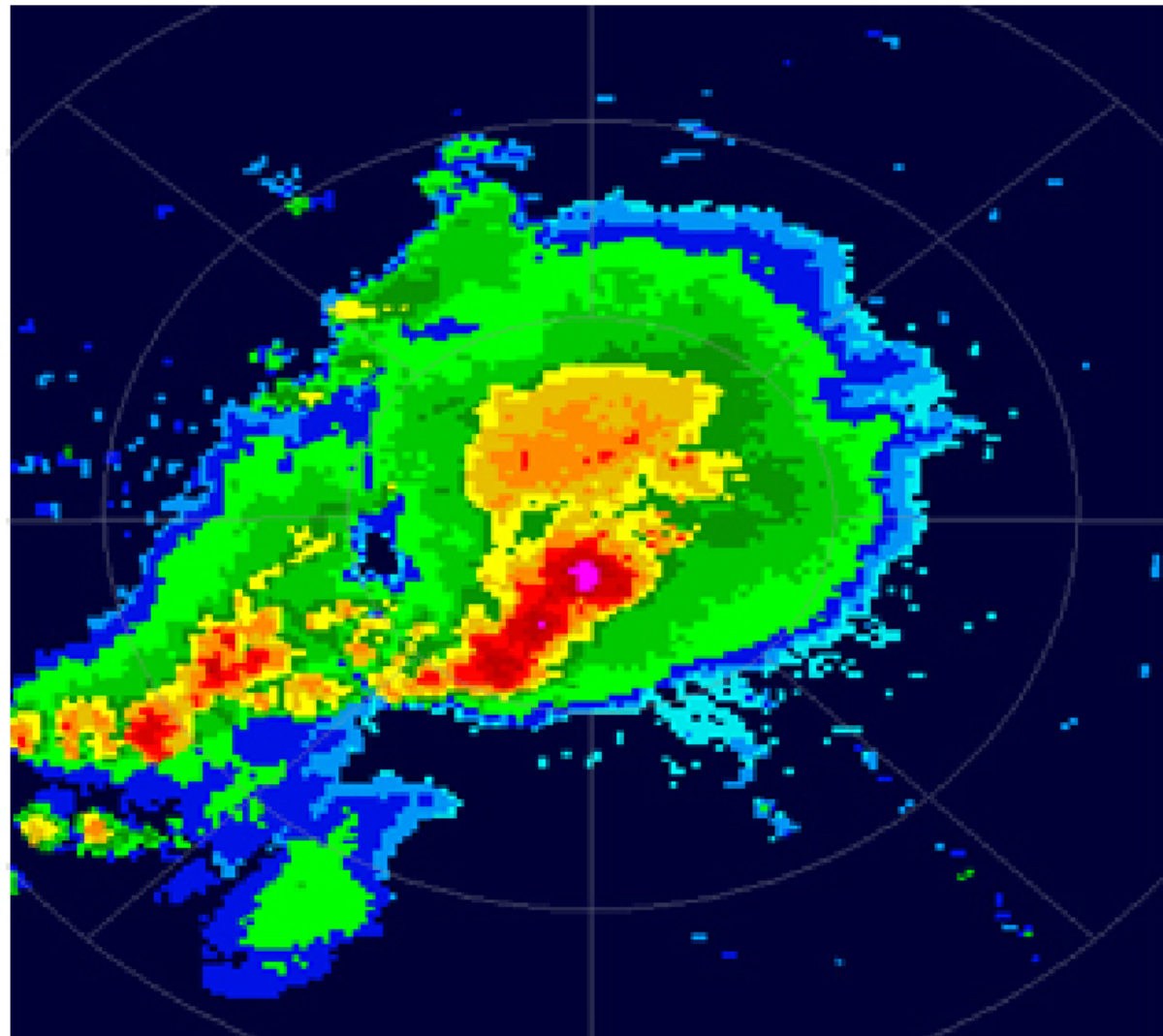


Composite Reflectivity



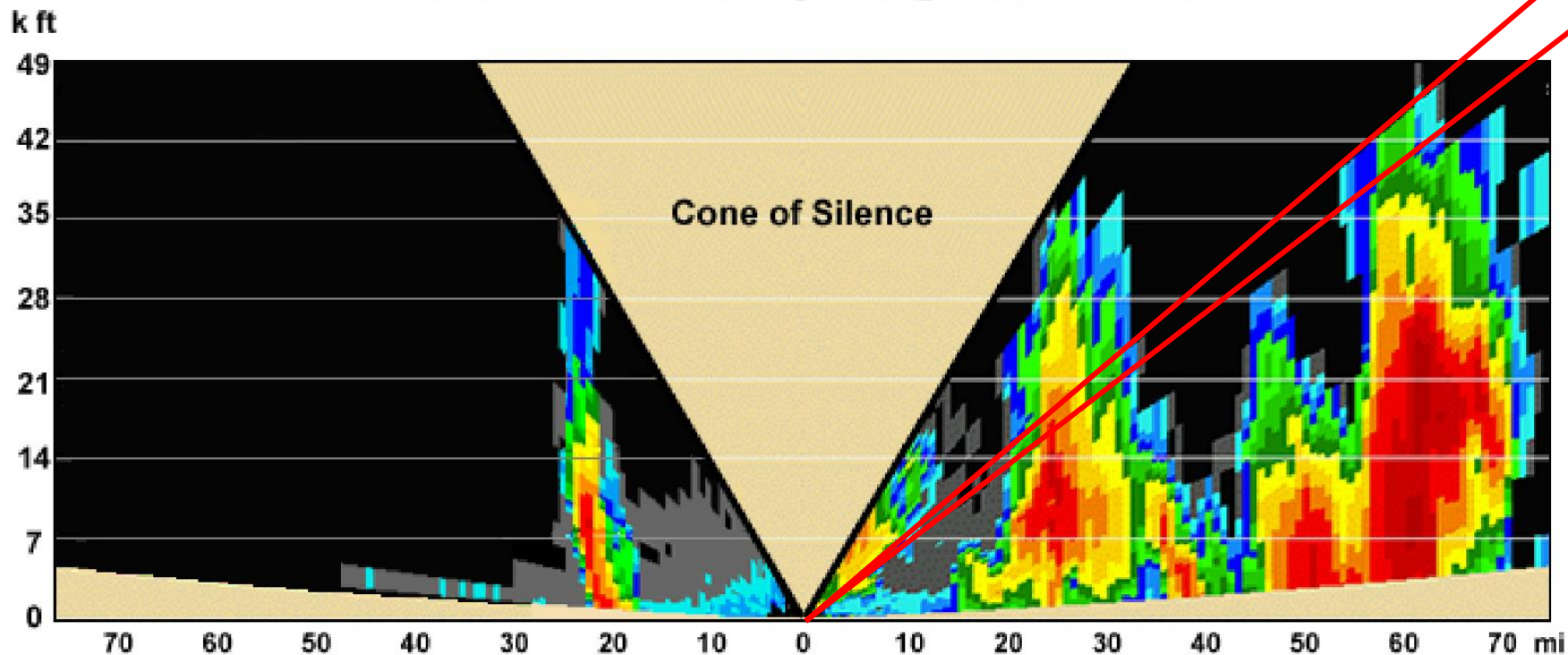
Composite Reflectivity

Composite Reflectivity



"composite reflectivity," shows the maximum reflectivity (dBZ) in a given vertical column for all columns in the radar's range.

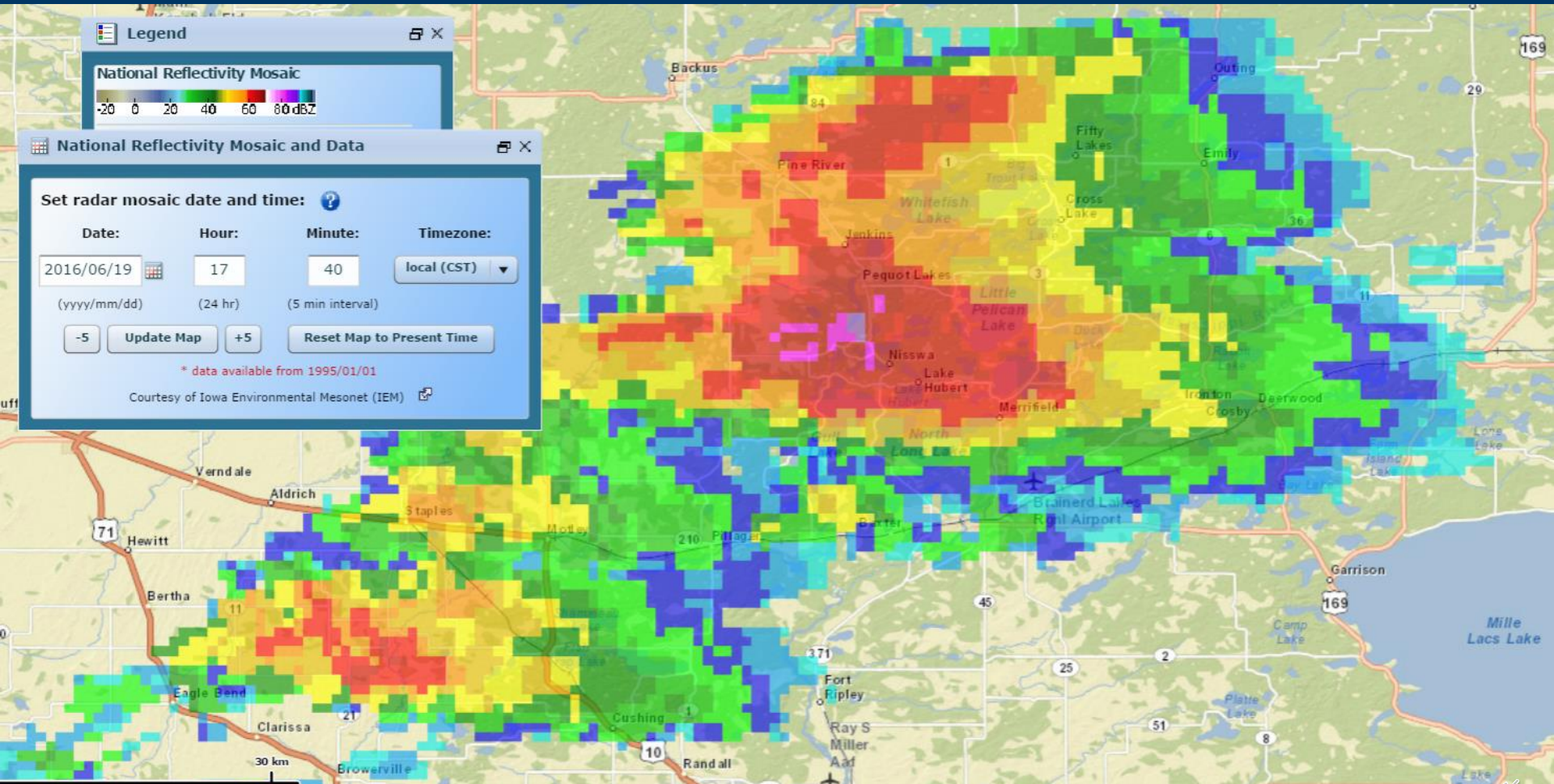
Cross-section of Reflectivity through Radar Location



NOAA

NOAA National Oceanic and Atmospheric Administration National Centers for Environmental Information

<https://www.ncdc.noaa.gov/data-access/radar-data>



What can Radar tell us?

1. Interpret precipitation intensity
2. Interpret precipitation movement
3. Detect presence of hail in atmosphere
(using radar reflectivity imagery)

4. Interpret wind speed
5. Interpret wind direction
(using Doppler radial velocity imagery)

Hail Swath Maps



DISCLAIMER

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2. Company-X does not warrant and makes no representations regarding the completeness, accuracy, or predictive value of the Map.
3. **Company-X assumes no responsibility for the accuracy of the Map** and is not responsible for errors resulting from omitted, misstated or erroneous information or assumptions.

“I know of no source for NOAA-produced hail swath maps and I know of no plans for NOAA to begin generating them.”

Meteorologist

NOAA's National Centers for Environmental Information

Center for Weather and Climate