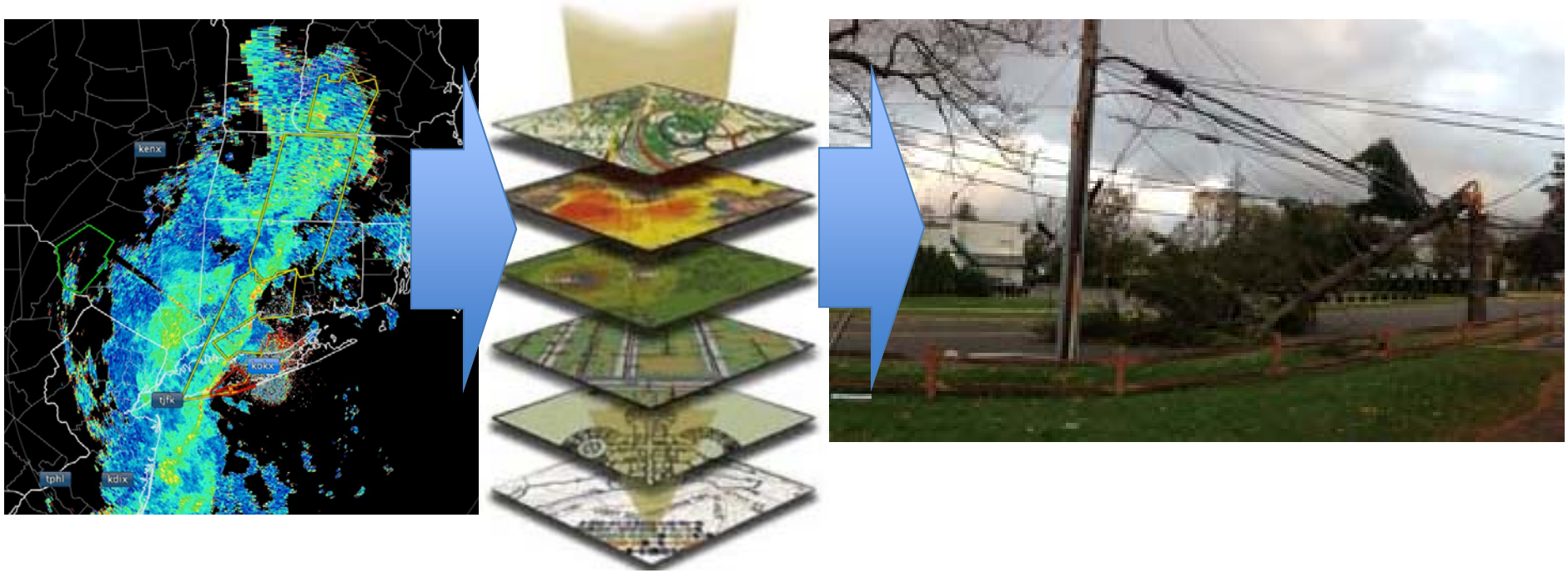
Untapped Weather Resources That Can Help

(A focus on Weather Radar Applications)



Michael Jensen & Scott Giangrande, BNL

Weather Impacts on Utility Systems

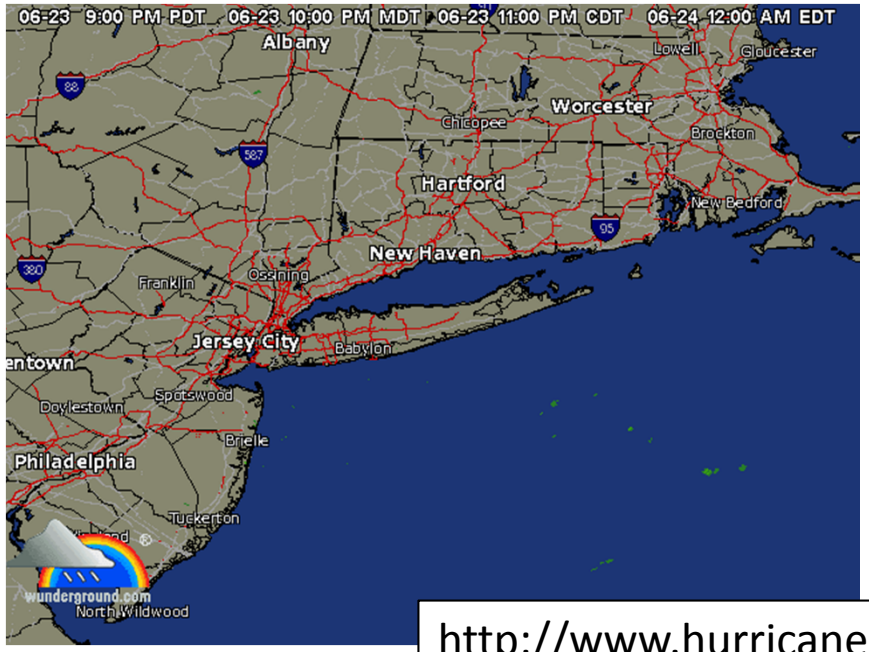
December 3, 2013

BROOKHAVEN NATIONAL LABORATORY

Motivation – What are the needs?

Focus on summertime thunderstorms and associated severe weather
- Microburst - Derecho - Tornado

Target 1 Storm Hardening: Determine areas/communities most susceptible to severe weather impacts (geography, vegetation, infrastructure)



http://www.hurricanes-blizzards-noreasters.com/greatneck.html

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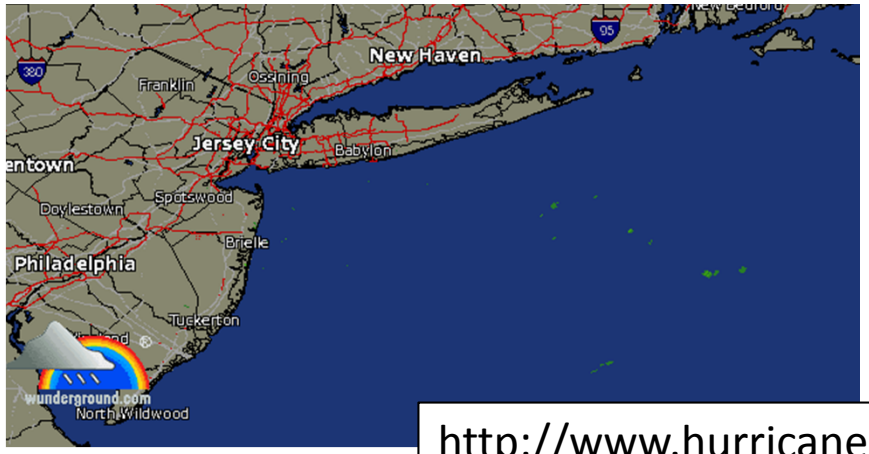

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Target 3 Outage preparedness: Forecast track of severe storm events (after they have formed) to determine where impacts may be expected

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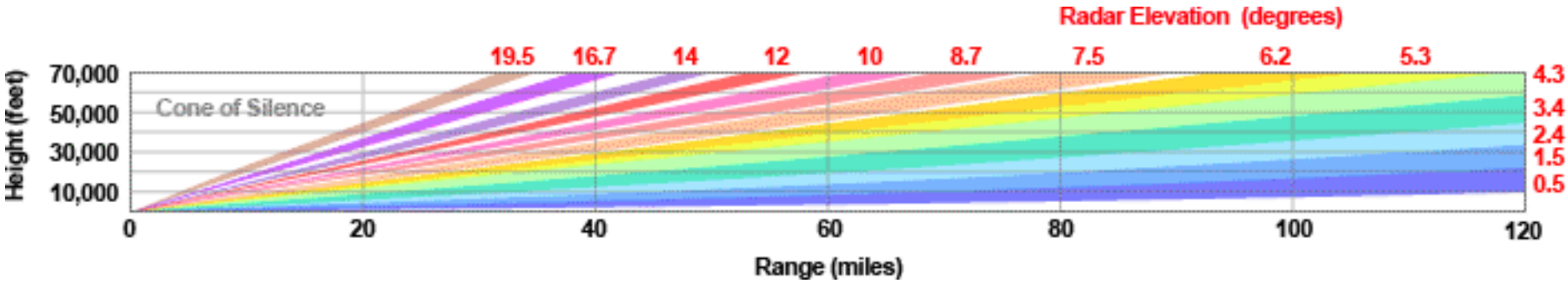
Weather radar as a tool - Basics

http://www.crh.noaa.gov/

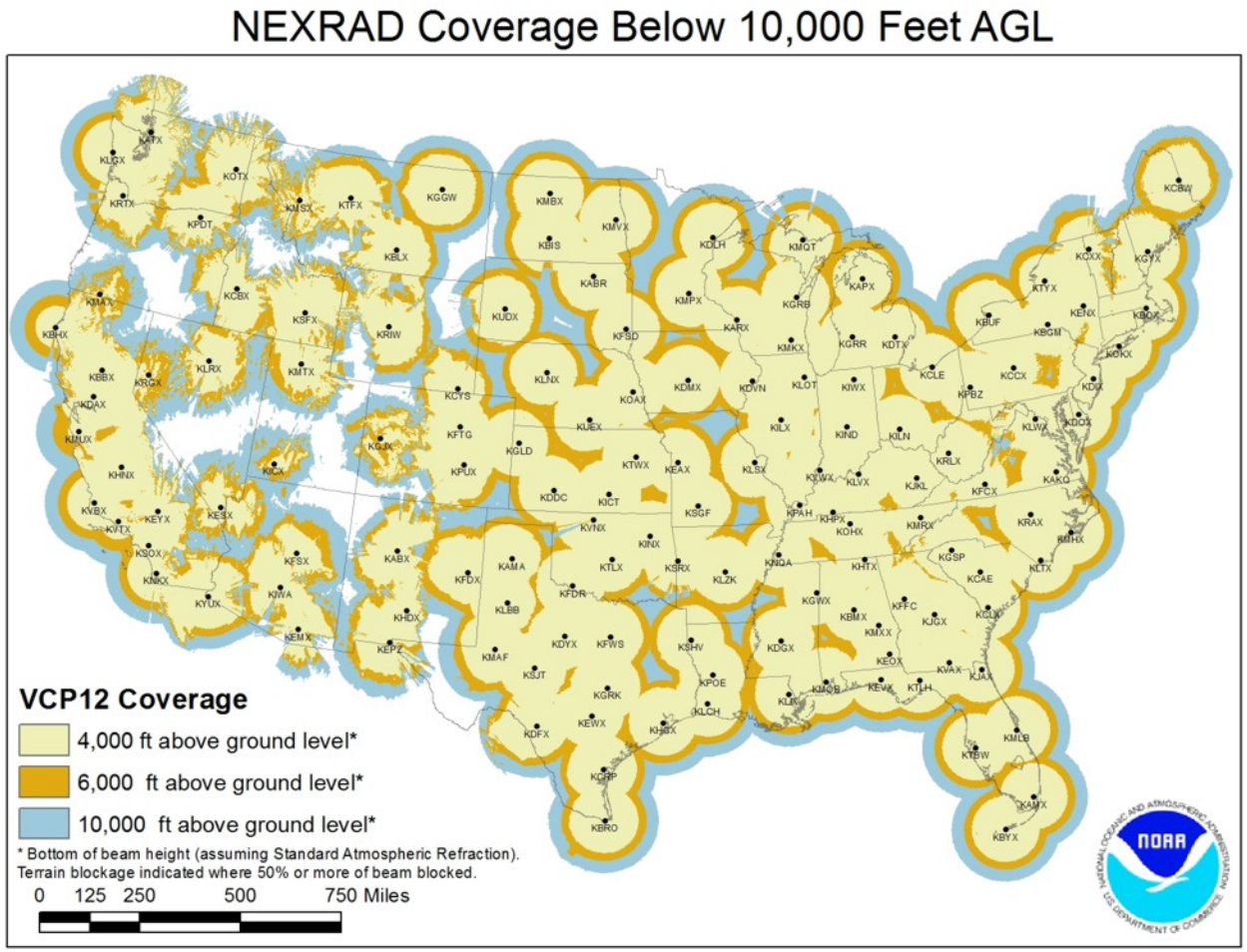
- Transmit a pulse of electromagnetic energy (10 cm)
- Scattered by targets (raindrops, snowflakes, hail, birds, bugs)
- Small amount of energy is scattered back to radar
- Measure power, time, frequency, polarization
- Scans a 3-D volume of atmosphere



NWS WSR-88D weather radar network

122 NEXRAD radars
45 TDWR radars

Most of continental US under radar coverage



What does radar measure? Radar Reflectivity

- The greens, yellows and reds that you often see on the local news weather report show the radar reflectivity
- Measure of energy reflected from target

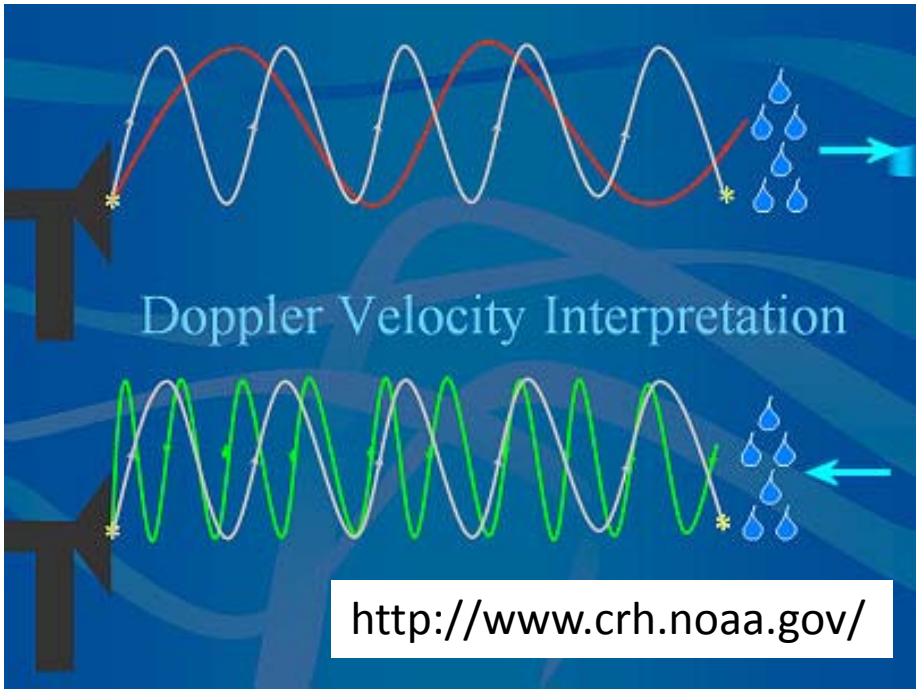
$$\frac{\sum_j D_j^6}{V_c}$$

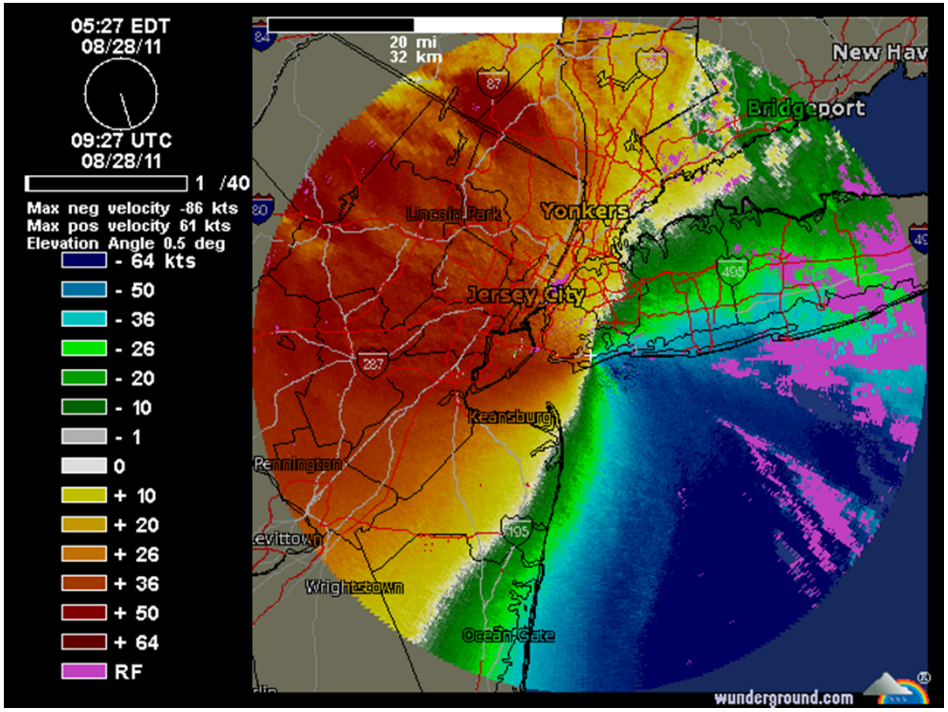
Proportional to: Number of Drops
6th power of size of drops
Bigger drops >
More intense rainfall
Strong updrafts and downdrafts

Some Typical Values

60+ dbZ = giant hail
45-50 dbZ = heavy rain
25 dbZ = snow/light rain
-28 dbZ = haze droplets

What does radar measure? Doppler Velocity





Landfall of Hurricane Irene 8/28/11

- Doppler shift of radar signal
- Provides information on movement of raindrops
- Away or towards the radar
- Cannot measure wind perpendicular to radar beam
- Cannot measure wind in clear skies
- Magnitude of wind and circulation signatures

What does radar measure? Derived Quantities

- **Other relevant quantities freely available from NWS**

Accumulated Rainfall - 1 hr. / 3 hr.

Hail Index – Identifies regions of high reflectivity above freezing level

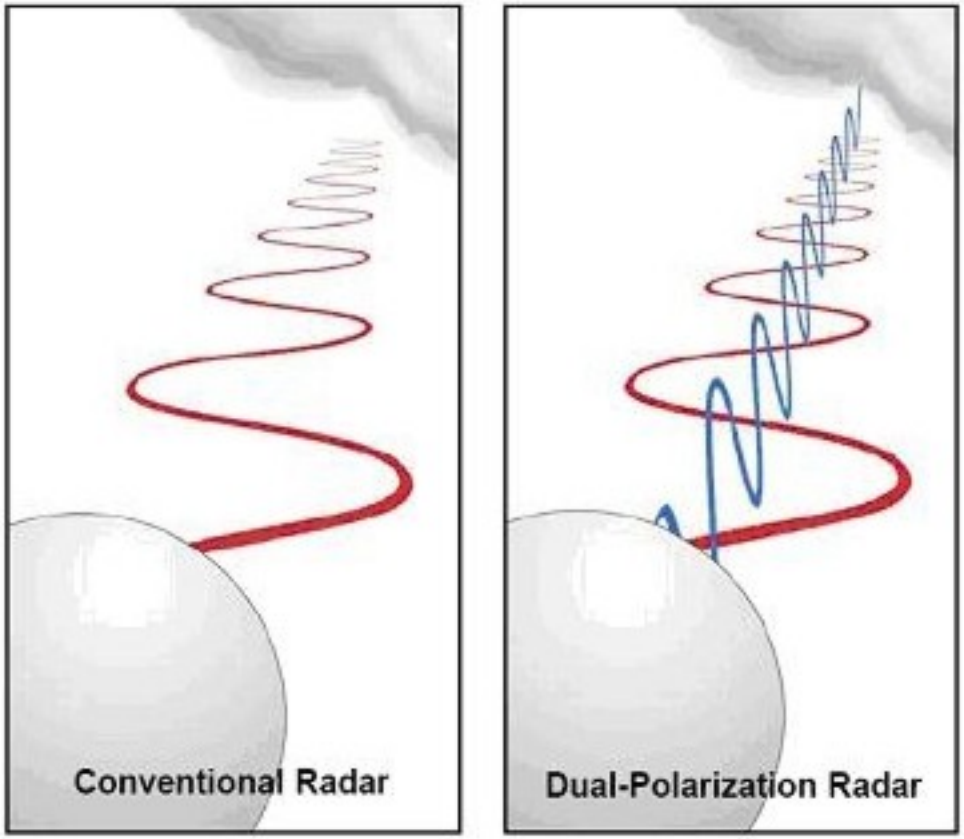
Mesocyclone – Uses Doppler velocities to identify rotations

Tornadic Vortex Signature – Uses Doppler velocities to identify rotations, and reflectity to identify other characteristics of tornadoes

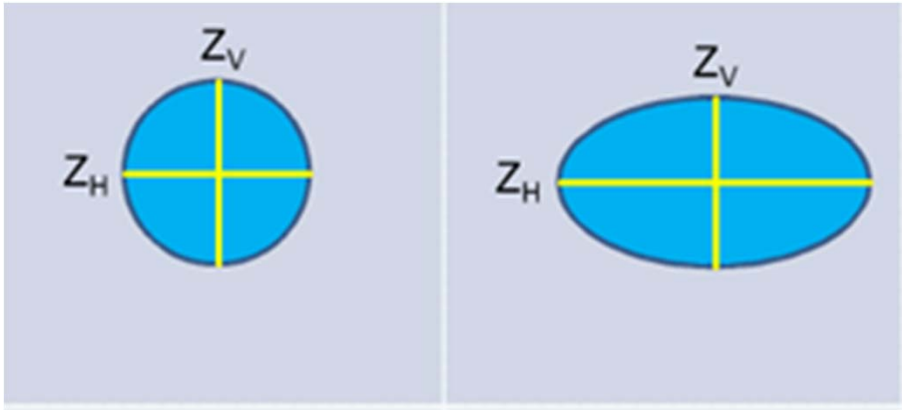
Vertical Integrated Liquid – Measure of depth of storm and total amont of water

NWS Radar Polarization Upgrade

2011 – 2013 All NEXRAD radar systems were upgraded to dual-polarimetric capability



- Non-spherical targets will have different reflectivity for different polarizations



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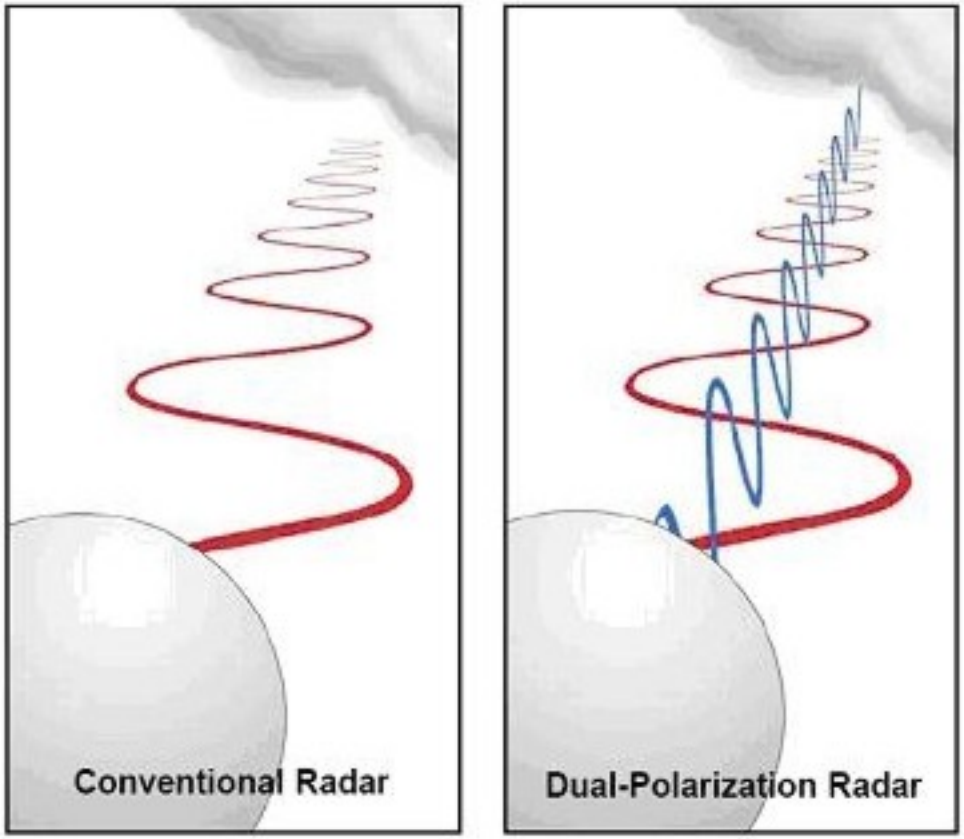
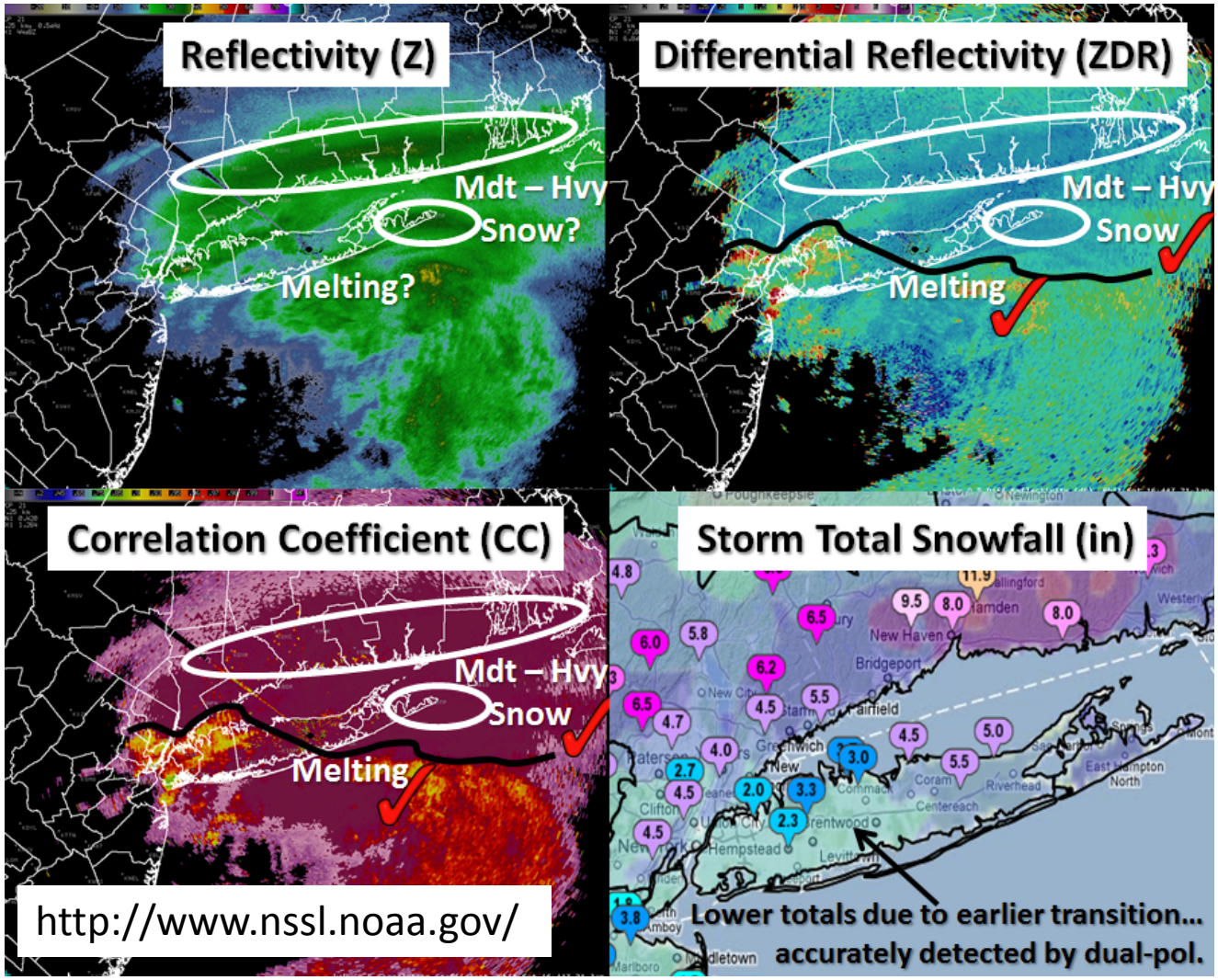


- Non-spherical targets will have different reflectivity for different polarizations
- Water droplets tend to be more spherical than ice particles
- Polarimetric observations can be used to distinguish precipitation types (rain, snow, hail)

What does radar measure? Polarimetric Obs.

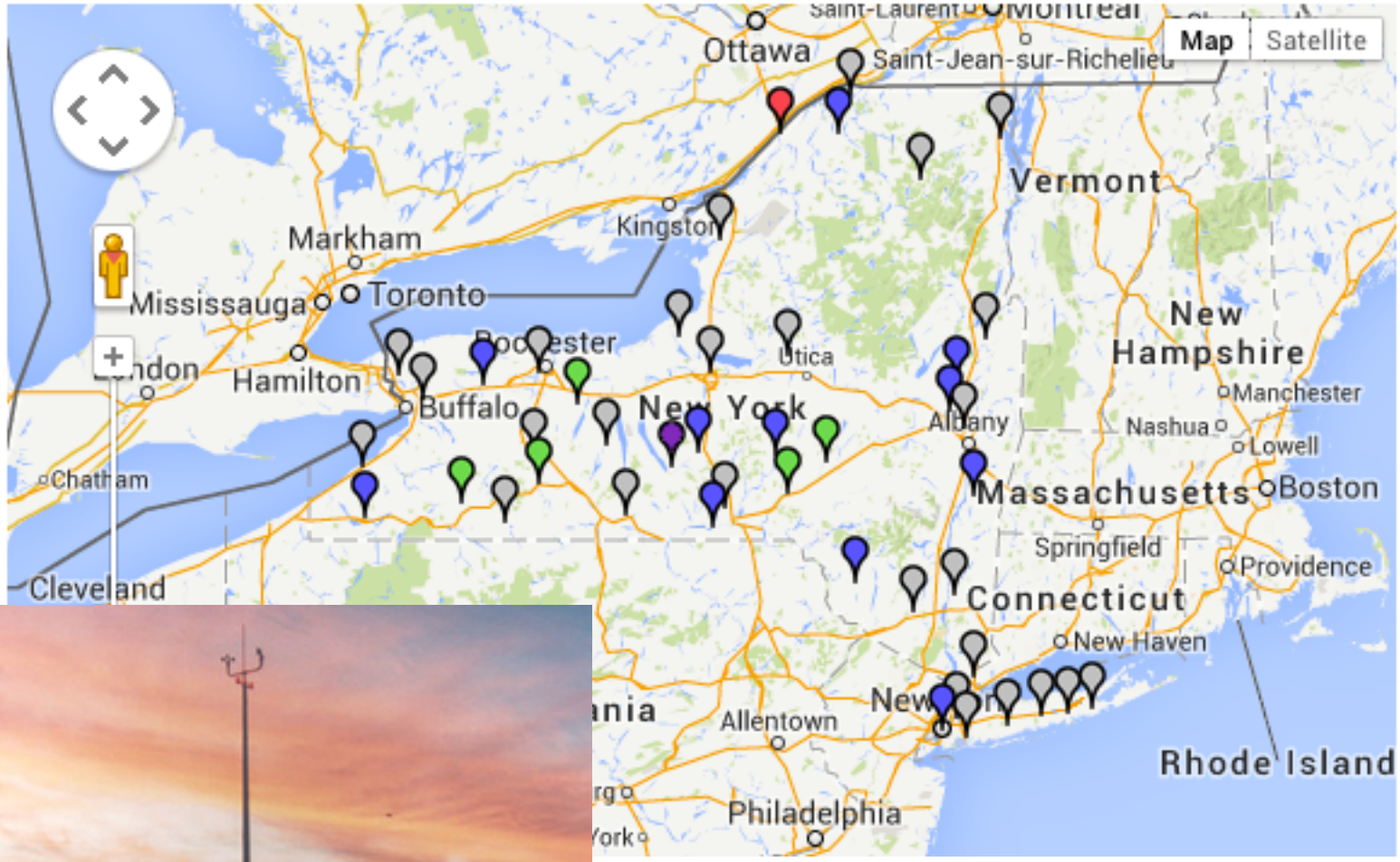


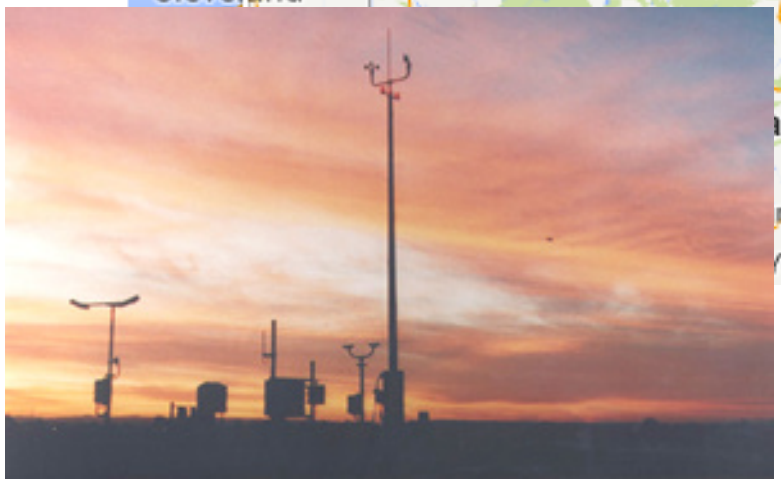
- Polarimetric variables (ZDR, CC) help identify snow vs. mixed precipitation
- Help in determining snowfall totals, “heaviness” of snow, icing
- Possible impacts on trees and power lines

One application: Winter Weather

Other relevant weather information (1)

- Automated Surface observing Systems (ASOS) – T, p, RH, winds

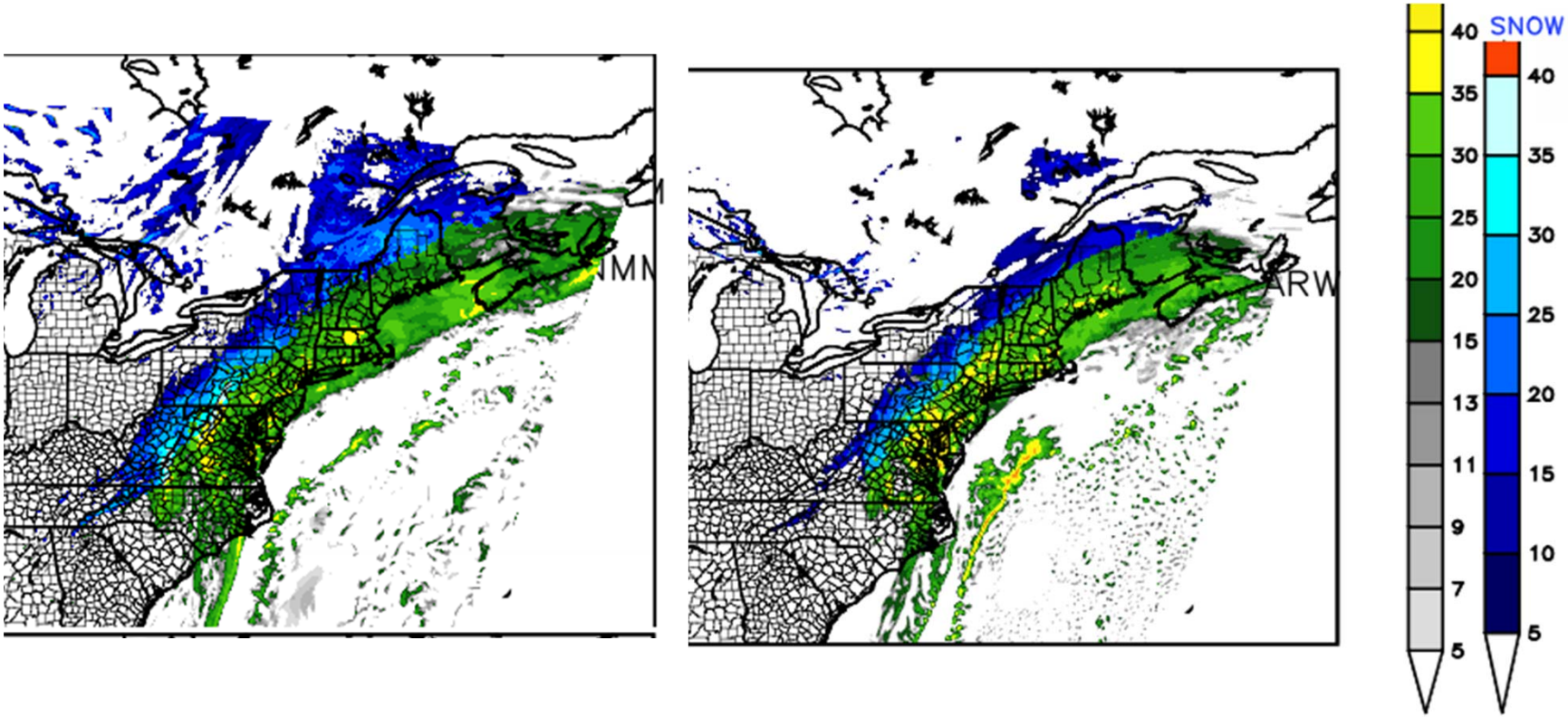




Other relevant weather information (2)

- High resolution computer model output
- High –Resolution Rapid Refresh (HRRR) [http://ruc.noaa.gov/hrrr/]

"The HRRR is an *experimental* NOAA real-time 3-km resolution, hourly updated …. atmospheric model"



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Advantage – Provides ALL of the meteorological variables that may be important for determining storm impacts (winds, precipitation, temperature, etc.)

Advantage – No data gaps

Disadvantage – It is a model. Output depends on model physics and sub-grid scale parameterizations.

Take Home Messages

- Radar data offer detailed observations of characteristics of storms that may have impacts on utility infrastructure
- Much of this data is feely available in near-real time but may need some expertise to interpret
- Offers possibility of statistical analysis of storm characteristics and outages that may be used towards storm hardening efforts
- Offers possibility of real-time tools to identify important severe weather events

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