

# **A Cooperative Pilot Project on Weather and Emergency Management Decision Support**

**Ken Galluppi**  
**Renaissance Computing Institute**  
**University of North Carolina at Chapel Hill**

**Jessica Losego-RENCI**  
**Burrell Montz-East Carolina University**  
**Catherine Smith-East Carolina University**  
**Steve Schotz-NWS OS&T**  
**Darin Figurskey-NWS Raleigh MIC**

# Weather and Emergency Management (WxEM)

- To understand the potential impact of NWS products & services on critical EM decisions by examining EM processes, collaborations, and product & services utilization.
- Collaborators
  - RENCI
  - East Carolina University
  - NWS OS&T
  - NWS OCWWS
  - NOAA GSD
  - Local NWS Offices



NOAA's National Weather Service

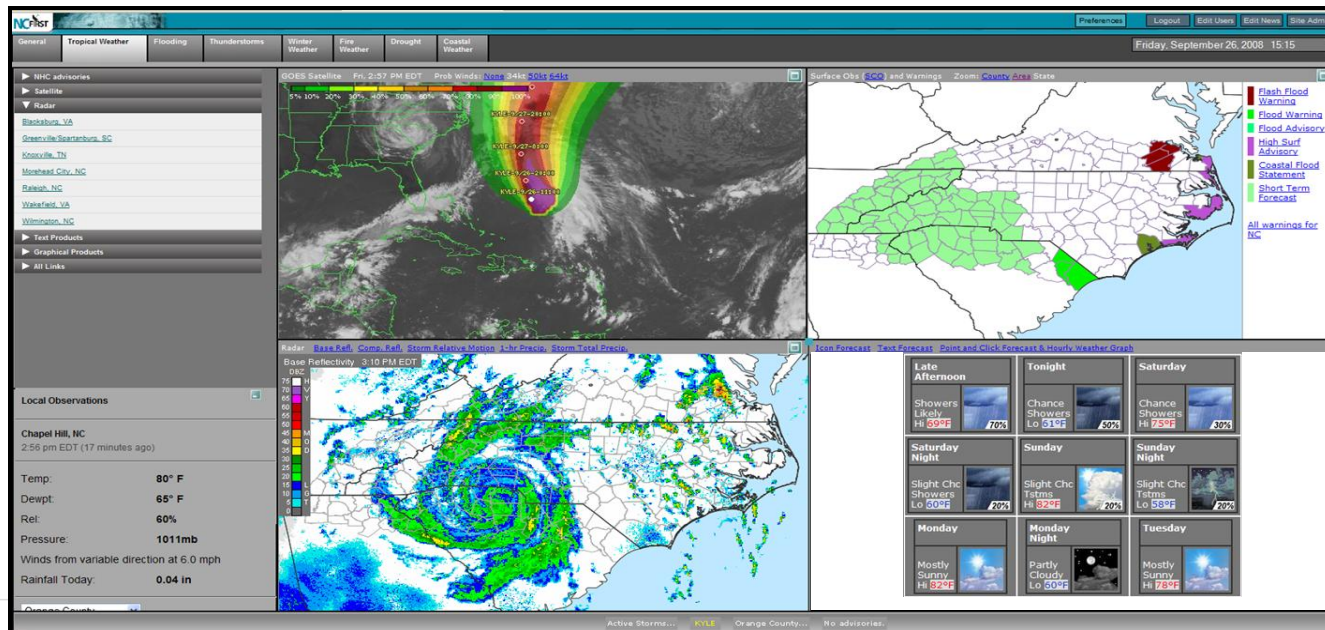


# Project Goals

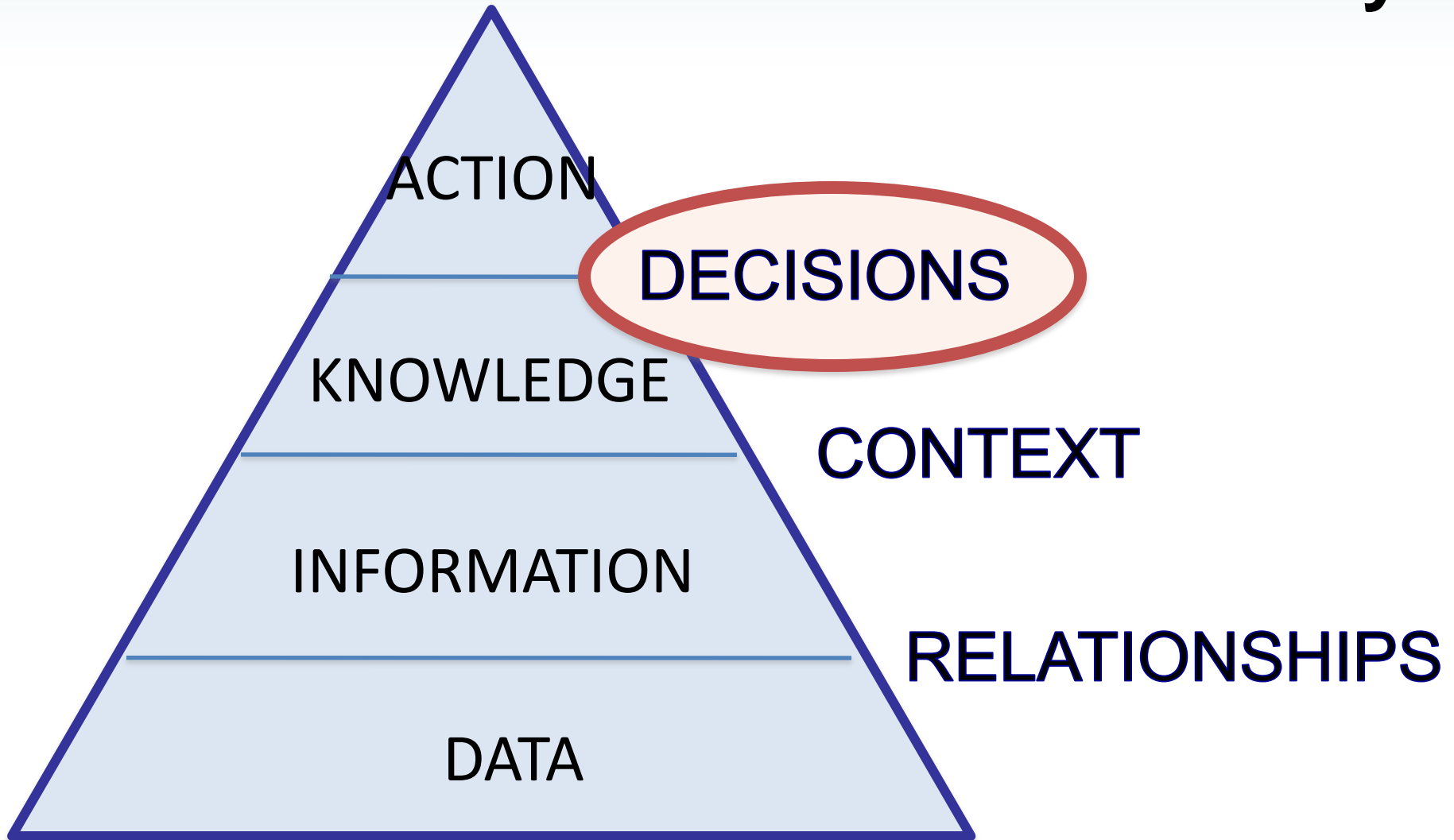
- Enhance the infusion of weather and climate information into **decision processes for risk and crisis management**
- Develop prototypes that **enable effective weather translation**
- Explore collaborative technologies to **facilitate knowledge exchange and situational understanding**
- **Demonstrate an incremental and iterative prototyping** process that shows the inclusion of social science analysis and evaluation of decision support applications, technology enhancements, and infusion into practice.

# How WxEM Began

- NC-FIRST (collaboration with NWS WFO's)
  - EMs have trouble finding & understanding weather info
  - Weather information portal & training for NC EMs
  - Now standard tool in NC EM community
- Still not resolving the whole problem
  - Info can be hard to relate to decisions & impacts



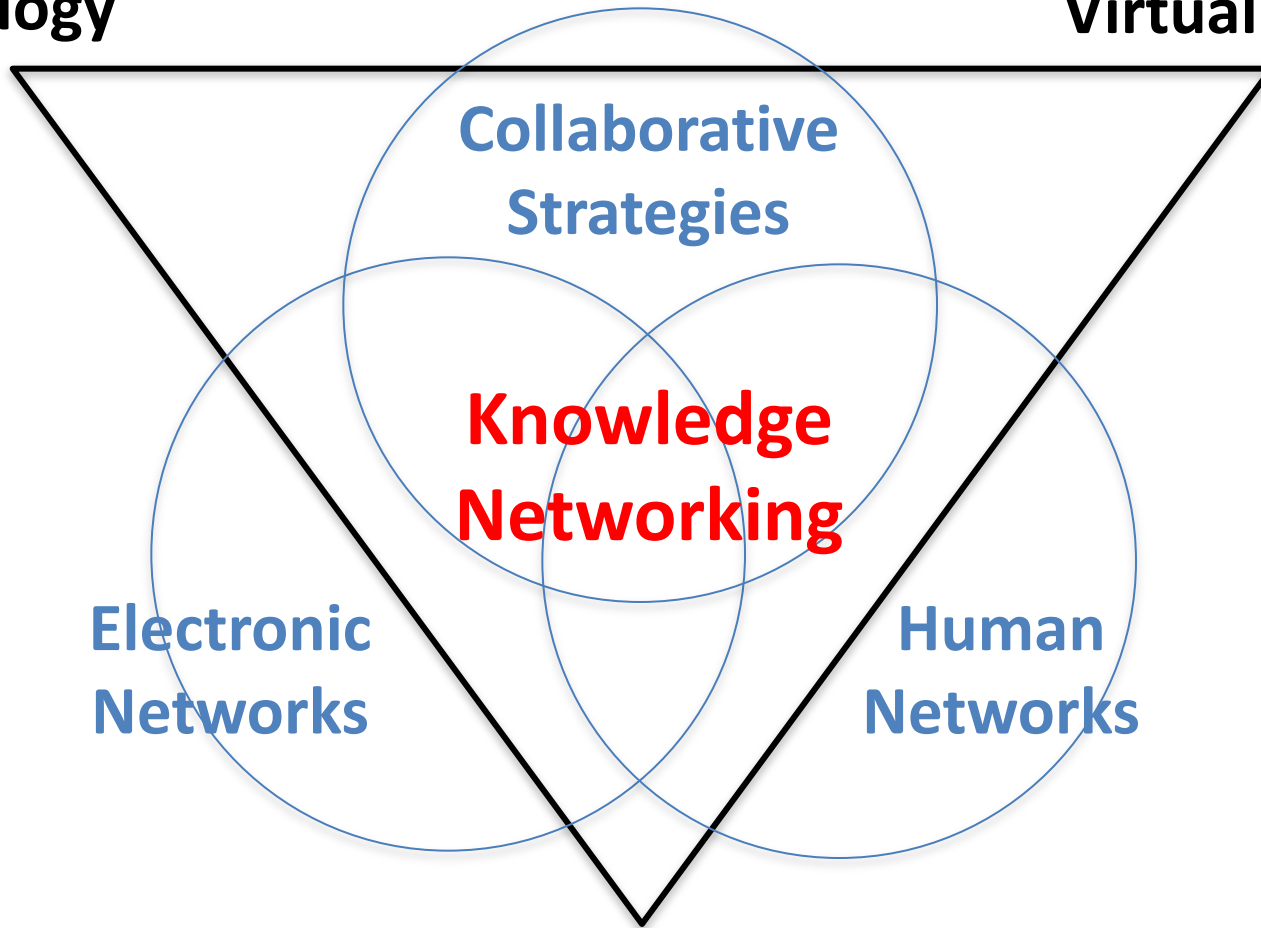
# “Information” Hierarchy



# Knowledge to Decisions

Technology

Virtualization



# WxEM Knowledge Elements

- **Human Dynamics-Social Science**
  - Learn about decision processes, info flow, communication between groups
- **Technology**
  - From decision makers' perspective
  - How to translate, transmit, transform information to be usable
  - Rapidly develop prototypes to test
- **Collaboration**
  - Enables knowledge to be conceptualized, conveyed
  - Person-to-person & human-to-computer interaction

# Approach (Knowledge to Decisions)

- Step 1: Understand Emergency Management (EM)community - baseline
  - Who are they, what do they do, who do they work with, what are their key decisions?
- Step 2: How is weather information currently used in risk and crisis management.
  - What products and services are used. Are they understood and effective?
- Step 3: What are the gaps and deficiencies
  - How might it be done differently?
- Step 4: Apply to next case or iteration



# First Steps

- Understand processes beyond the county EM director
- Winter weather use case
- 3 focus groups
- 5 weather time scenarios
- Collected data via CRC Cards
  - Who, what, when, how, why

## Emergency Support Function

#1: Transportation

#2: Communications

#3: Public Works and Engineering

#4: Firefighting

#5: Emergency Mgmt

#6: Mass Care, Emergency Assistance, Housing, and Human Services

#7: Logistics Mgmt and Resource Support

#8: Public Health and Medical Svc

#9: Search and Rescue

#10: Oil and HazMat Response

#11: Ag and Natural Resources

#12: Energy

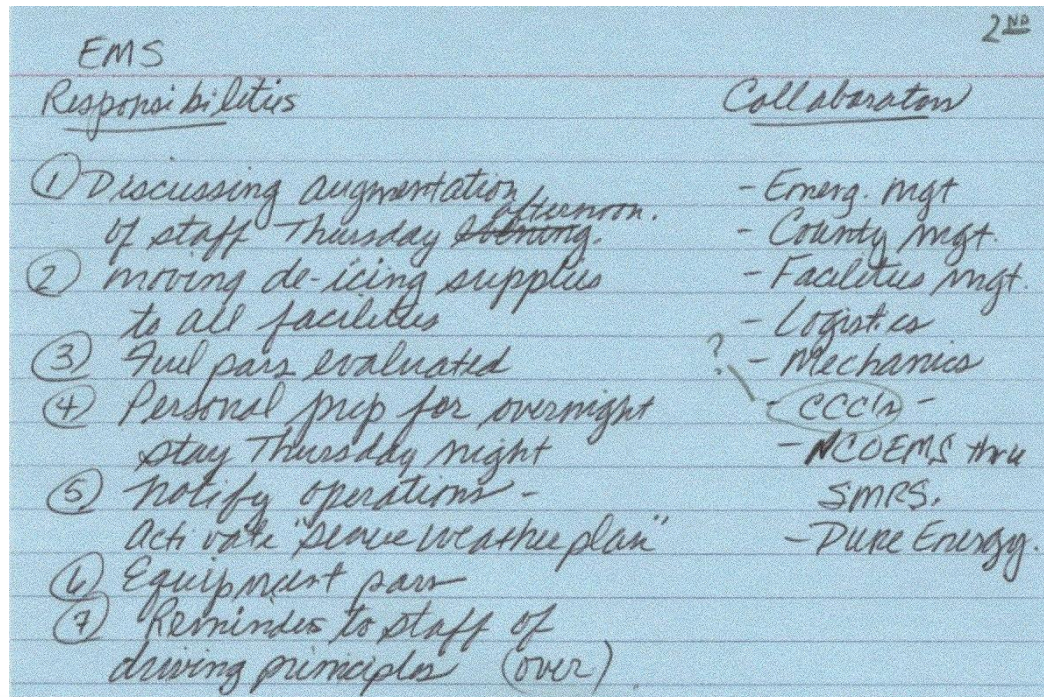
#13: Public Safety and Security

#14: Long-Term Community Recovery

#15: External Affairs

# CRC Cards

- Class, Responsibility, and Collaboration
- Originally used for software design (Beck & Cunningham, 1989)
- Consistent way to collect information



A handwritten CRC Card on lined paper. The title 'EMS' is at the top left, and '2ND' is at the top right. The card is divided into two columns: 'Responsibilities' on the left and 'Collaboration' on the right. The 'Responsibilities' column contains a numbered list of seven items. The 'Collaboration' column contains a list of roles and organizations, some of which are connected to the responsibilities by lines.

Responsibilities	Collaboration
① Discussing augmentation of staff Thursday <sup>afternoon</sup> evening.	- Emerg. Mgt.
② moving de-icing supplies to all facilities	- County Mgt.
③ Fuel pails evaluated	- Facilities Mgt.
④ Personal prep for overnight stay Thursday night	- Logistics
⑤ Notify operations - activate "Severe weather plan"	? - Mechanics
⑥ Equipment pass	- CCCA -
⑦ Reminders to staff of driving principles (over)	- NCOEMS thru SMRS.
	- Pure Energy.

## re



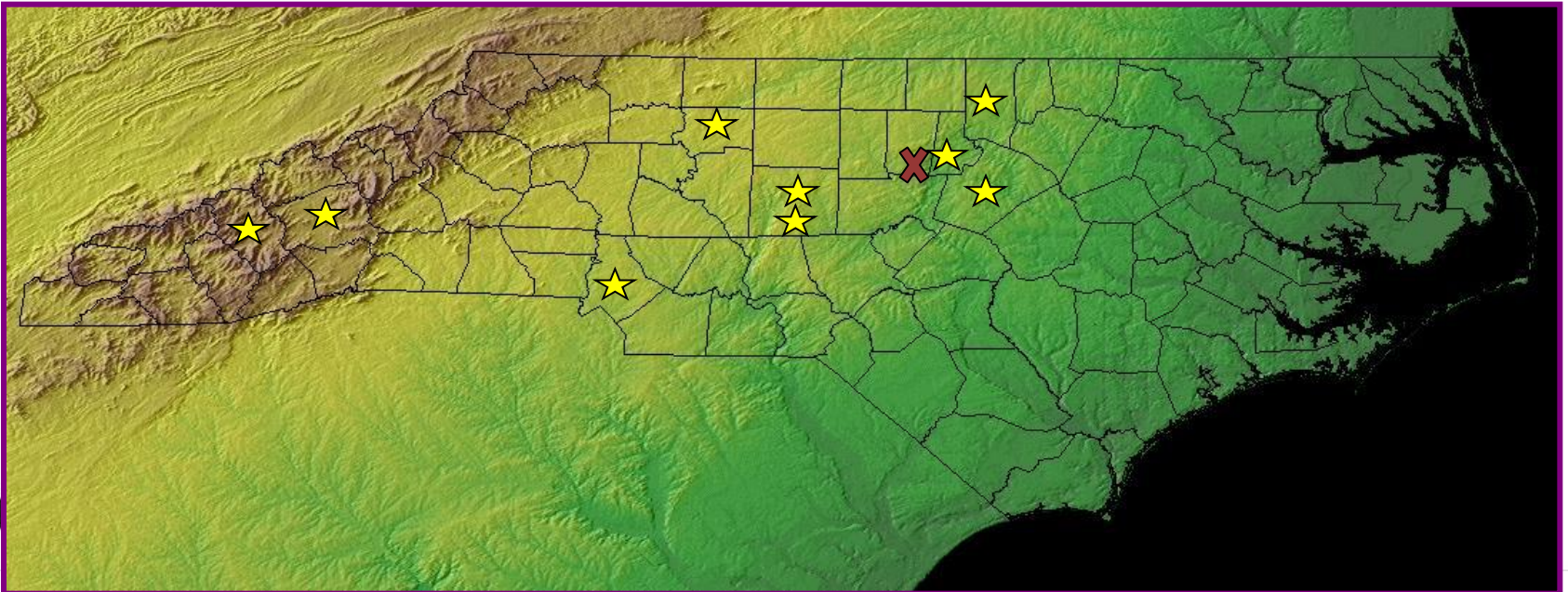
# Winter Use Case: Critical Sub-Groups

- Critical Decision Makers: societal impact (on people)
  - Power companies (private sector)
  - DOT (complicated across jurisdictions)
  - Schools (underserved and impacts are large)
- Focus: Schools
  - What is the inclement weather decision process
  - Compare to county EM directors for generalization



# School Use Case

- 3 rounds of development/testing
- 9 test schools
  - Chosen based on level of interaction with local NWS
  - Rural/urban
  - Geography across state

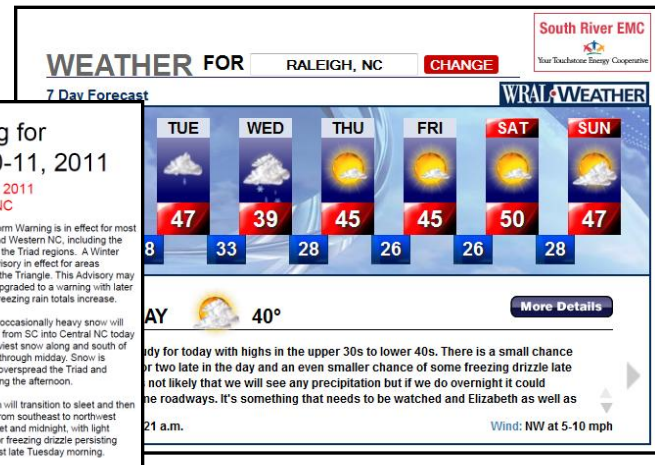
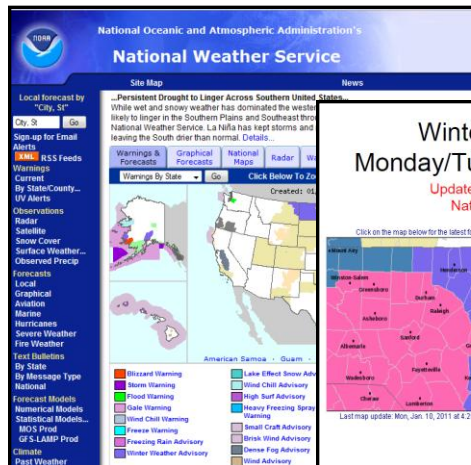


# School Interviews

- Round 1: establish basic process
- Who gathers info?
  - Mostly transportation directors
  - Not trained on using weather information
  - Communication
- What info is needed to make decision?
  - Can struggle to find & understand this info
  - Onset time of precip, precip type, duration
  - Road conditions, road temperature

# School Interviews

- Sources of info
  - Unanimous: TV
  - NWS: web page, email briefings, or phone calls
  - 1 uses no NWS info directly
  - 1 not aware NWS could be contacted for info
  - Not much interaction with county EM





# School Interviews

- Round 2: follow-up after real storm
  - Timeline
  - Specific products
- Round 3: knowledge testing
  - Interpreting current products correctly?
  - Aware of existing NWS products?
- Survey

Your National Weather Service forecast

Indianapolis IN

Enter Your "City, ST" or zip code

BOOK-MARK

NWS Indianapolis, IN

Point Forecast: Indianapolis IN  
39.77°N 86.16°W (Elev. 728 ft)

Mobile Weather Information | En Español

Last Update: 11:35 am EST Jan 11, 2011

Forecast Valid: 12pm EST Jan 11, 2011-6pm EST Jan 17, 2011

**Forecast at a Glance**

This Afternoon	Tonight	Wednesday	Wednesday Night	Thursday	Thursday Night	Friday	Friday Night	Saturday
100% Snow	40% Blowing Snow	40% Blowing Snow	20% Slight Chc Snow	Partly Sunny	Mostly Cloudy	Partly Sunny	30% Chance Snow	30% Chance Snow
Hi 26 °F Lo 18 °F	Hi 27 °F Lo 18 °F	Hi 27 °F Lo 17 °F	Lo 11 °F	Hi 24 °F	Lo 10 °F	Hi 24 °F	Lo 20 °F	Hi 32 °F

**Detailed 7-day Forecast**

Hazardous weather condition(s):

**Winter Weather Advisory**  
**Hazardous Weather Outlook**

**This Afternoon:** Snow. High near 26. Calm wind becoming west between 6 and 9 mph. Chance of precipitation is 100%. Total daytime snow accumulation of 3 to 5 inches possible.

**Tonight:** Widespread blowing snow and a chance of snow. Cloudy, with a low around 18. West northwest wind between 14 and 17 mph, with gusts as high as 24 mph. Chance of precipitation is 40%.

**Wednesday:** Widespread blowing snow and a chance of snow showers. Cloudy, with a high near 27. West northwest wind around 16 mph, with gusts as high as 23 mph. Chance of precipitation is 40%.

**Wednesday Night:** A 20 percent chance of snow showers. Mostly cloudy, with a low around 11. West northwest wind between 10 and 14 mph, with gusts as high as 20 mph.

**Thursday:** Partly sunny, with a high near 24. West northwest wind between 6 and 8 mph.

**Thursday Night:** Mostly cloudy, with a low around 10.

**Friday:** Partly sunny, with a high near 24.

**Friday Night:** A 30 percent chance of snow. Mostly cloudy, with a low around 20.

**Saturday:** A 30 percent chance of snow. Cloudy, with a high near 32.

**Saturday Night:** A 30 percent chance of snow. Cloudy, with a low around 16.

**Sunday:** A 30 percent chance of snow. Cloudy, with a high near 24.

**Sunday Night:** A 20 percent chance of snow. Mostly cloudy, with a low around 10.

**M.L.King Day:** Partly sunny, with a high near 22.

**Current Conditions** [view Yesterday's Weather](#)

**Indianapolis International Airport**  
Lat: 39.73 Lon: -86.27 Elev: 810  
Last Update on Jan 11, 10:54 am EST

**Light Snow Fog/Mist**

24 °F (-4 °C)

Humidity: 88 %  
Wind Speed: Calm  
Barometer: 30.02" (1017.4 mb)  
Dewpoint: 21 °F (-6 °C)  
Visibility: 0.75 mi.  
More Local Wx: [3 Day History](#)

**Radar and Satellite Images**

**Detailed Point Forecast** [\(Move Up\)](#)

Click Map for Forecast [Disclaimer](#)

Map Satellite Terrain

Requested Location: Indianapolis  
Forecast Area  
Lat/Lon: 39.77°N 86.16°W Elevation: 728 ft

[XML](#)

**National Digital Forecast Database**

**Additional Forecasts & Information**

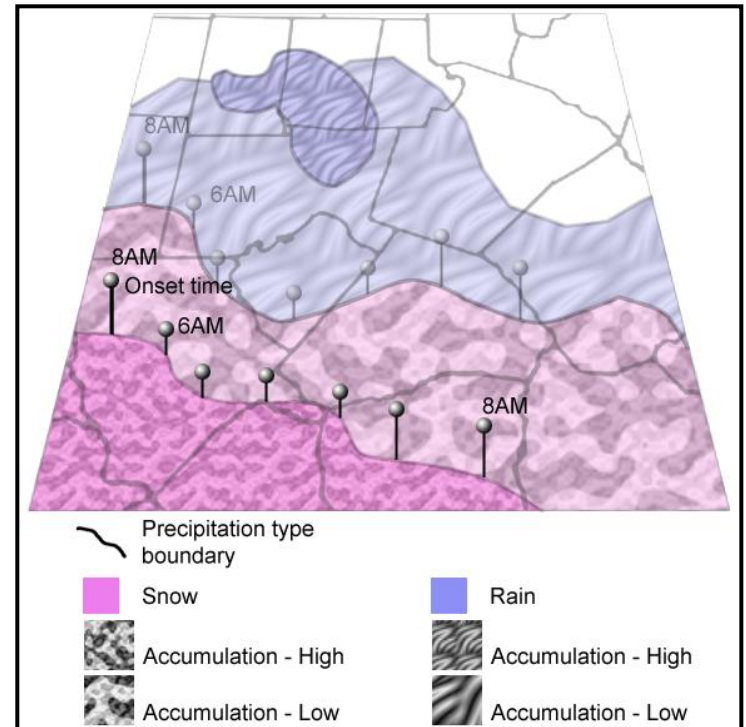
Zone Area Forecast for Marion County, IN

Forecast Discussion	Air Quality Forecasts
Printable Forecast	Text Only Forecast
Hourly Weather Graph	Tabular Forecast
Quick Forecast	
International System of Units	About Point Forecasts
Local Climatology	Severe Weather
Hydrology (AHPS)	Precipitation
Aviation	Winter Weather
NOAA Weather Radio	What's New at IND?
Submit a Severe Storm or a Winter Storm Report	Our Office



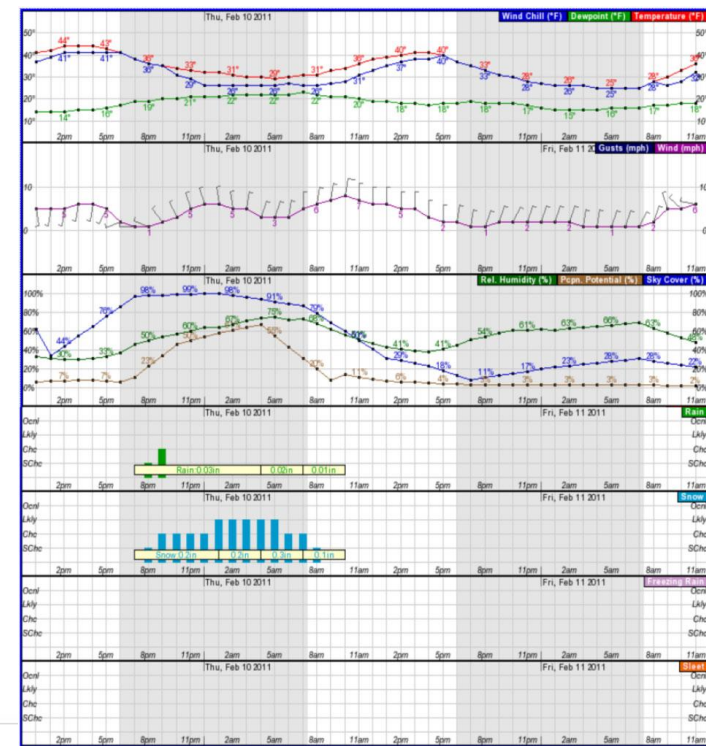
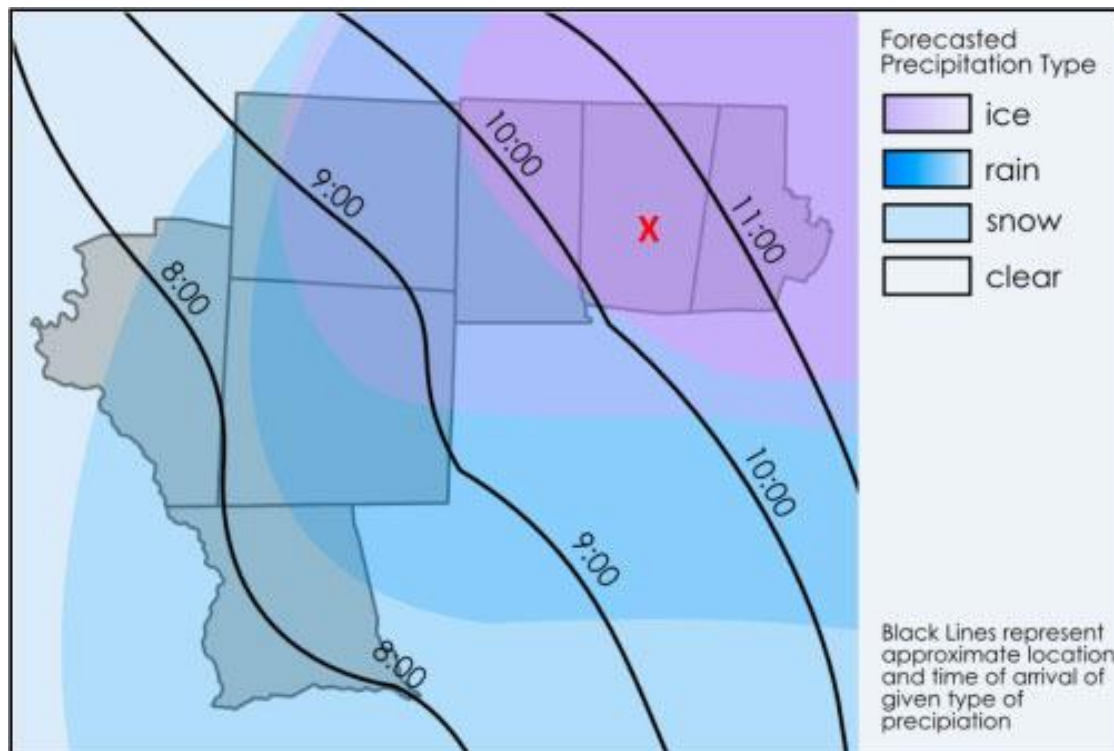
# Rapid Prototyping

- Send ideas to 3 school reps
- Forecast Information Prototype
  - Take NWS forecast grids – visualize according to feedback
- Real-time Gathering & Sharing Prototype
  - “Map conferencing”
  - Share road temps, conditions, etc. in real-time for everyone to see



# Onset Time of Precip Prototype

- Highest ranked:
  - Map with times
  - NWS Hourly Weather Graph
  - Combine on one display?



# Area Forecast Discussion Prototype

- Highlight keywords, click to find
- Lower case letters

## Area Forecast Discussion (AFD) Renaissance Computing Institute renci

Highlight words in AFD by clicking on keywords below. Click repeatedly on a word to see all its occurrences in the AFD.

Keywords found: COLD (7), SNOW (7), ADVISORY (5), RAIN (3), WATCH (3), WARNING (3), INCHES (2), MIX (2), STORM (2), HEAVY (1) (text size and number indicate # occurrences)

Keywords not found: , 0.05 , 0.10 , Accumulate , Accumulation , Black ice , Changeover , Chilly , Clear , Freezing , Hot , Numerous , Severe , Sleet , Snowcover , Sunny , Threat , Widespread.

These features will bring **snow** to the passes today with 6 - 12 inches this afternoon through tonight and another 4 - 6 inches on tue. **snow** levels around 3500 feet this afternoon will fall to around 2500 feet or so tonight and 1500 feet tue. The winter weather advisory looks good -- will adjust the **snow** levels down a few hundred feet with the late morning update.

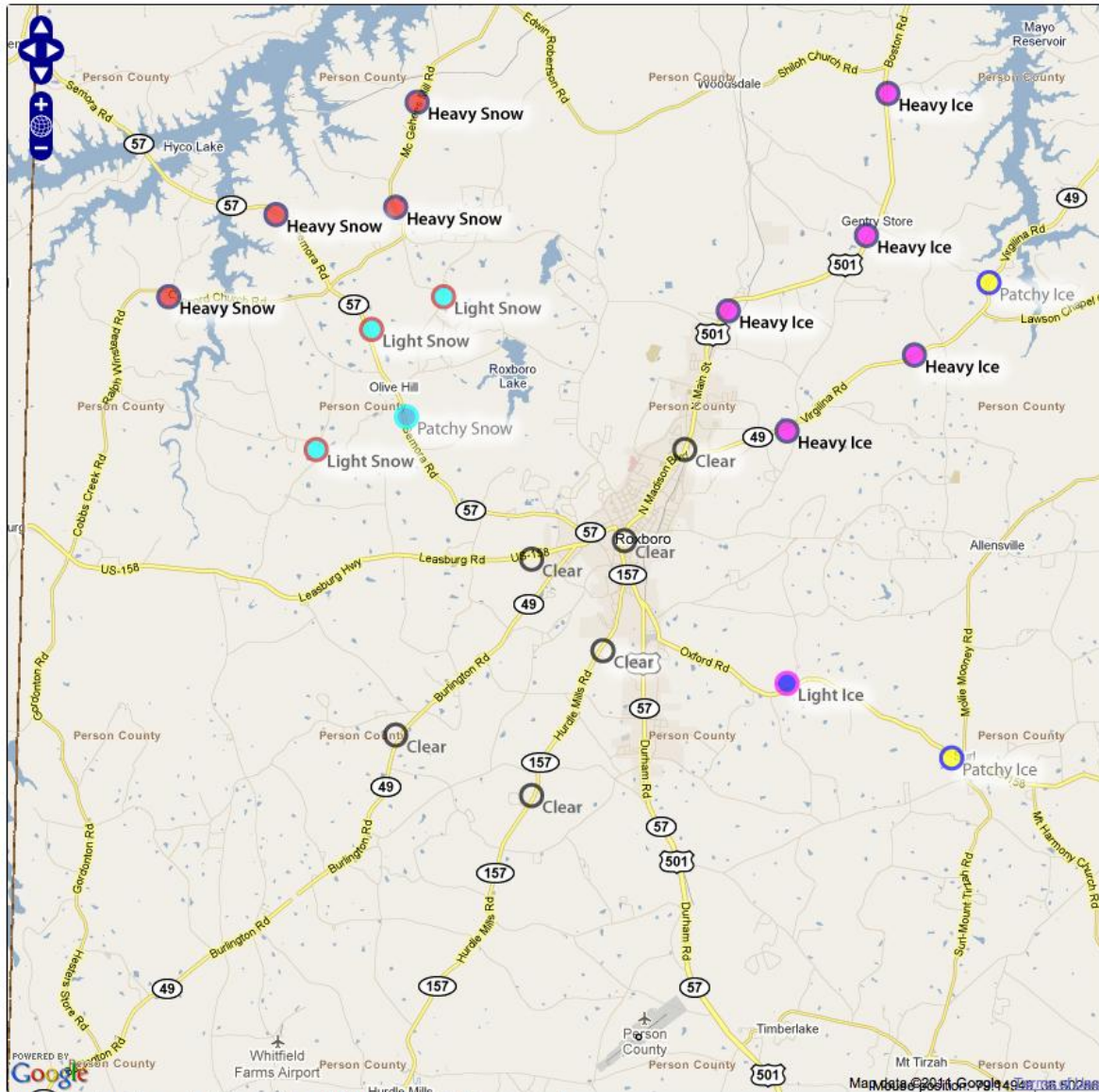
Yet another low spins up in the cold air over the coastal waters tue then hangs up off central vancouver island. This will keep rather blustery conditions over the area -- but with winds remaining below wind advisory criteria -- tue into tue night. Showers will continue across the area tue into tue night.

HEIGHTS -- Temperatures aloft -- and thicknesses drop steadily tue and tue night and by wed night into early thu 850 mb temps drop to below - 6c. Temperatures between 850 and the surface appear sufficiently cold by thu morning that some wet **snow** could fall as low as higher hills in a convergence zone n and e of seattle. Will take a closer look at this after noon. Albrecht

LONG TERM -- Both the 12z gfs and the 00z ecmwf show cold weather thu night or fri and continuing through early next week. Both models show some potential for some lowland **snow** thu night into fri then again sat night or sun. Moderate fraser outflow is a possibility fri then again sun. Will await the 12z ecmwf before making changes to

# Gathering & Sharing Prototype

- Real-time reports from school transportation reps





# School Exercise (Gaps and Future)

- Visited with reps from 7 schools
  - Informal exercise using historical case
  - Provided scenario and P&S that would likely be used during event, held open discussion
- Provided further confirmation of awareness and effectiveness of products and services
- New schools provided additional insight
  - Example: unaware of products, such as HWG, that were popular with other schools

# Preliminary Findings – Winter Weather

- Major decision consideration: teenage drivers' (75,000 in NC) lack of experience
- Decisions are made based on road hazards
  - Need forecasted and current road condition products
- Use of NWS P&S varies greatly across schools
- School reps have very little formal weather training
- Briefing packages by NWS need to be decision oriented
- Putting relevant weather information for schools all in one place would be highly valuable
- Increased awareness of NWS P&S is needed for schools
  - Example: in informal survey, ~1/3 have never heard of the hourly weather graph

# Current Work (May-June)

- Replicate the approach and methods, for new use case
- Tropical weather use case underway
  - Annual NC Hurricane Workshop surveys
  - 4 focus groups in SE NC (3 counties) and NE SC (1 counties)
- Selected preliminary findings
  - MOMs/MEOWs stressed, but EMs are not using them. At workshop no one explained how to find them.
  - P-surge information issued within 48 hr of landfall – not useful operationally pre-storm, but is useful for recovery planning
  - Critical operational concern: arrival of tropical storm force winds (flooding, surge less so) out to 96 hours or more
  - Tendency towards probabilistic information, explore further: do they understand it, presentation preferences

# Year 2

- Second year (to be discussed at final quarterly review, 30 June 2011)
  - Continue tropical weather use case
    - Follow up on questions stemming from workshop and focus groups
    - Observe EM community during storms impacting NC
  - Continue exploring winter weather decisions during events
    - NC-FIRST for Schools
    - BigBoard



# Summary

- Findings and recommendations intended to inform potential impact of NWS products & services on critical EM decisions
- Broader Issues: (based on winter weather case study)
  - Struggling to find/understand weather information
  - Biggest need: confidence in forecast and how it is conveyed
  - Available information isn't always pertinent to decisions they need to make
  - EM social networks are functional, but not optimal for weather information
  - Decision makers are not weather savvy, and therefore rely on interpretations from many sources
- Approach and methods being applied to tropical weather:
  - Preliminary data collected, much more to explore on product usage, understanding, critical decisions, timelines
  - Went in “looking” for evacuation issues, as part of coordinated effort (different than approach of winter weather, more general questioning)

# Contact Information

Steve Schotz

NWS/OST

[Steve.schotz@noaa.gov](mailto:Steve.schotz@noaa.gov)

Ken Galluppi

[galluppi@unc.edu](mailto:galluppi@unc.edu)

Jessica Losego

[jlosego@unc.edu](mailto:jlosego@unc.edu)