

# Communicating Winter Weather Using Uncertainty-Driven and Probabilistic Graphics



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NOAA Hollings Scholarship



Penn State Schreyer Honors College Thesis

**NWA Conference – August 23, 2021**

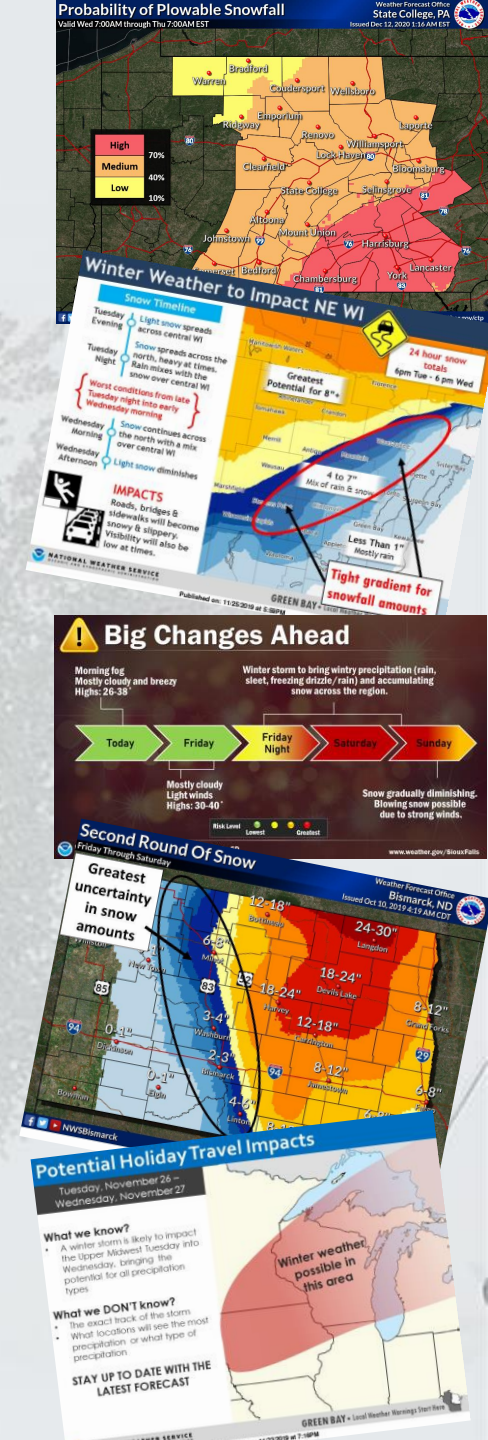
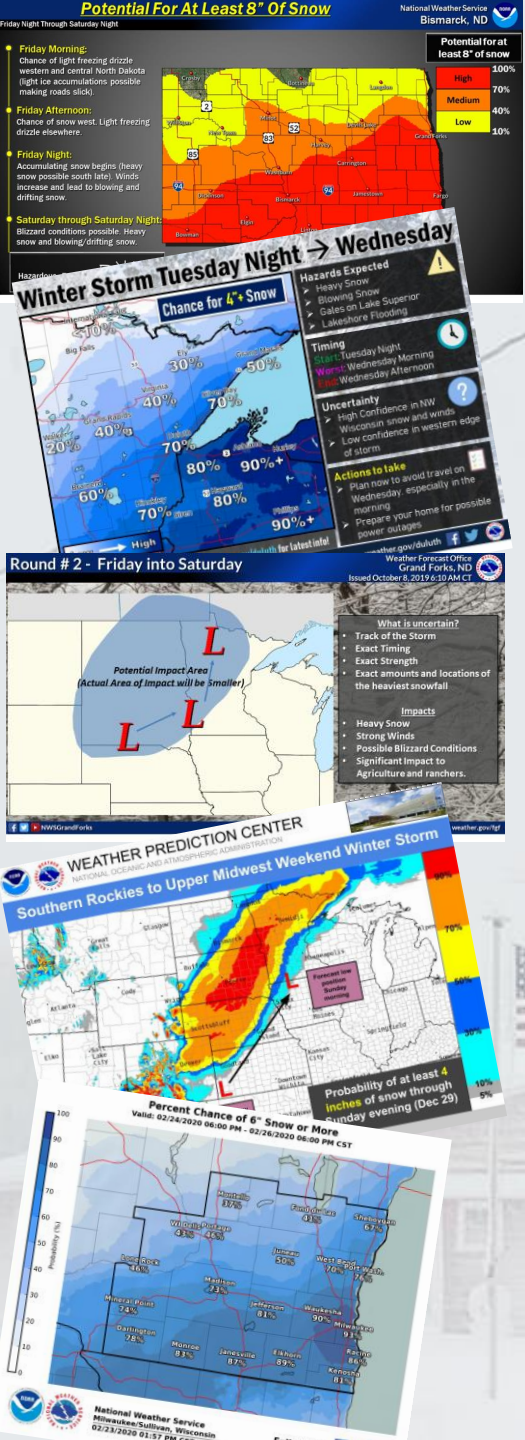
**KFYR-TV Meteorologist (Bismarck, ND)**

**Penn State Meteorology Alumnus ('21)**

**Research started at NWS Bismarck with Chauncy Schultz**

**See thesis for full details on this research project and its findings:**

**[jacobmorsewx.com/research](http://jacobmorsewx.com/research)**





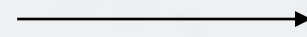
# GOAL:

## Identify best messaging strategies for winter storms and achieve more consistency

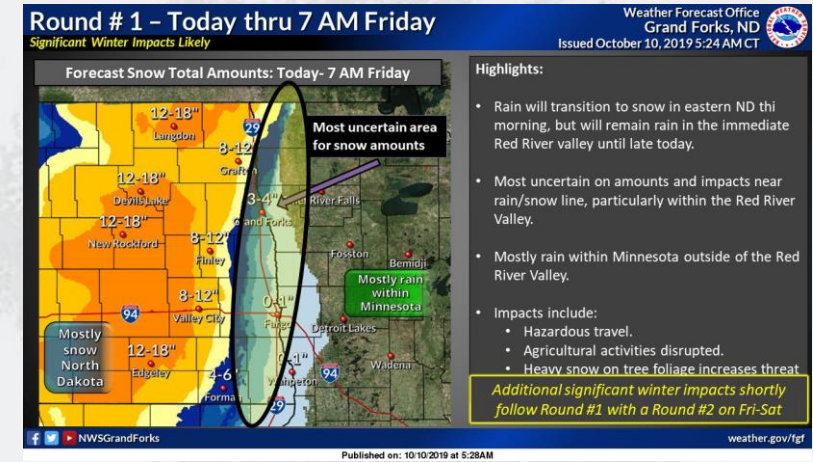
Days 3-7 before storm



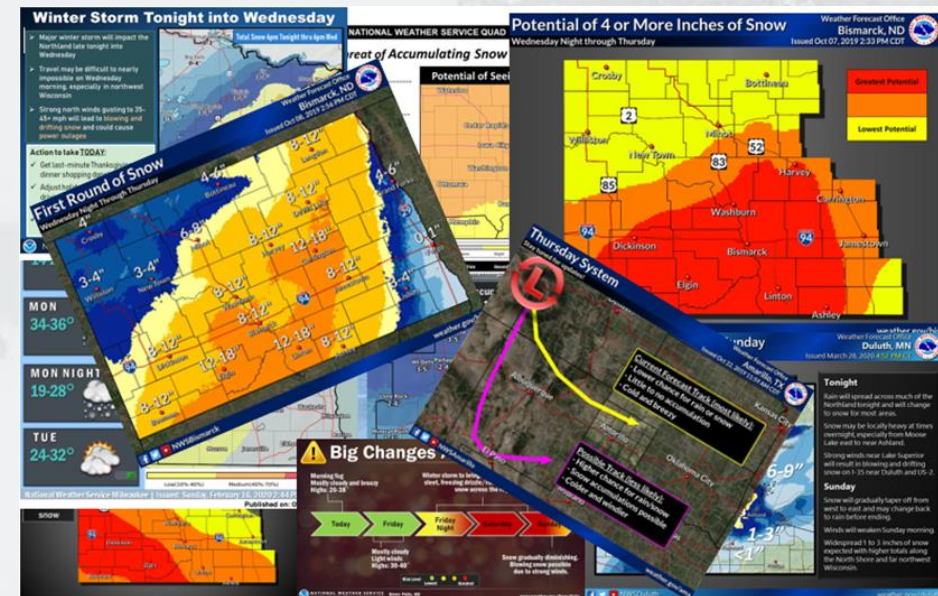
Days 2-3 before storm



Days 1-2 before storm



1. Gathered hundreds of NWS graphics
2. Organized and identified key differences among graphics
3. Used social media analytics to study specific storms
4. Received feedback through surveys and focus groups
  - a. Survey of U.S. public (N=833)
  - b. Survey of meteorologists (N=40) and non-meteorologists (N=32) at NWS offices





# LONG RANGE: Identified four common graphic types used at this lead time

EXAMPLE 1



EXAMPLE 2



EXAMPLE 1

### UPDATE: WINTER STORM POTENTIAL FRIDAY-SATURDAY

**WHAT WE KNOW**

- The greatest potential for snowfall amounts of 6"-8" or more continues to be across the eastern half of Minnesota and western Wisconsin.
- The potential for heavier amounts of 8"-12" is increasing.
- Gusty winds are expected with this system, and could lead to additional impacts from blowing and drifting snow.

**WHAT WE DON'T KNOW**

- Exact snowfall amounts - or where exactly the heaviest snow will fall
- Exact timing of snowfall - although snow continues to look likely from Friday morning into Saturday afternoon

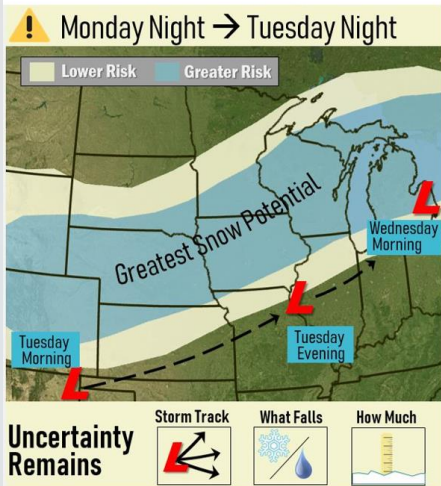
**WHAT YOU CAN DO**

- Consider the need to alter travel plans this weekend
- Monitor forecast updates at [weather.gov/mpx](http://weather.gov/mpx) and [weather.gov/mpx/winter](http://weather.gov/mpx/winter)

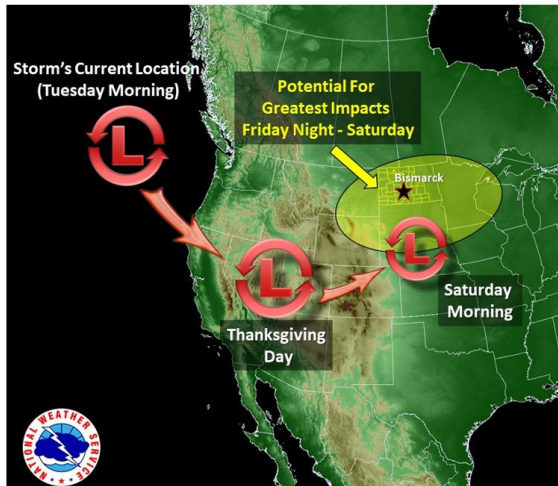
EXAMPLE 1

SUN	None	Potential for accumulating snow and travel impacts
MON	None	
TUE	Chance of PM Snow and Rain	
WED	Chance of AM Light Snow/Rain	
	Slight Chance of Snow or Mix	

EXAMPLE 1



EXAMPLE 2



EXAMPLE 2

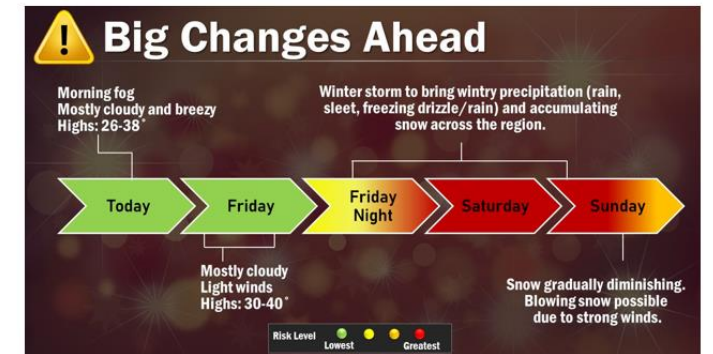
### WHAT WE KNOW

- Risks of a widespread impactful snow continue to increase Tuesday/Tuesday night.
- This system is expected to only produce snow.
- Snow amounts have trended upwards, with the potential for moderate accumulations possible.
- Travel will be difficult beginning by late Tuesday morning and continuing Wednesday morning across the region.

### WHAT WE DON'T KNOW

- There is some uncertainty in the track of the storm. This will impact who receives the most snow.
- The exact snowfall totals are still uncertain (due to track), but confidence is growing that many will see plowable snow.
- How strong the winds will be Tuesday night. This could lead to blowing snow and drifting issues into Wednesday.

EXAMPLE 2





# Key Takeaway #1

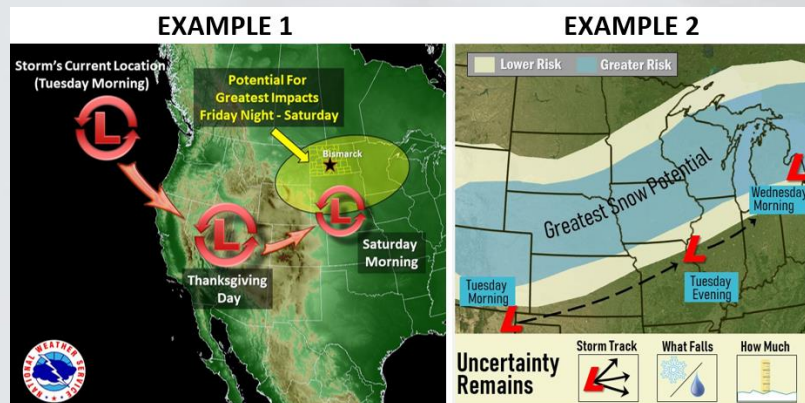
## Map-based graphics for long-range messaging

1. Circling one or more areas on a map for snowfall potential
2. Using the track of the storm to communicate the timing and impact area

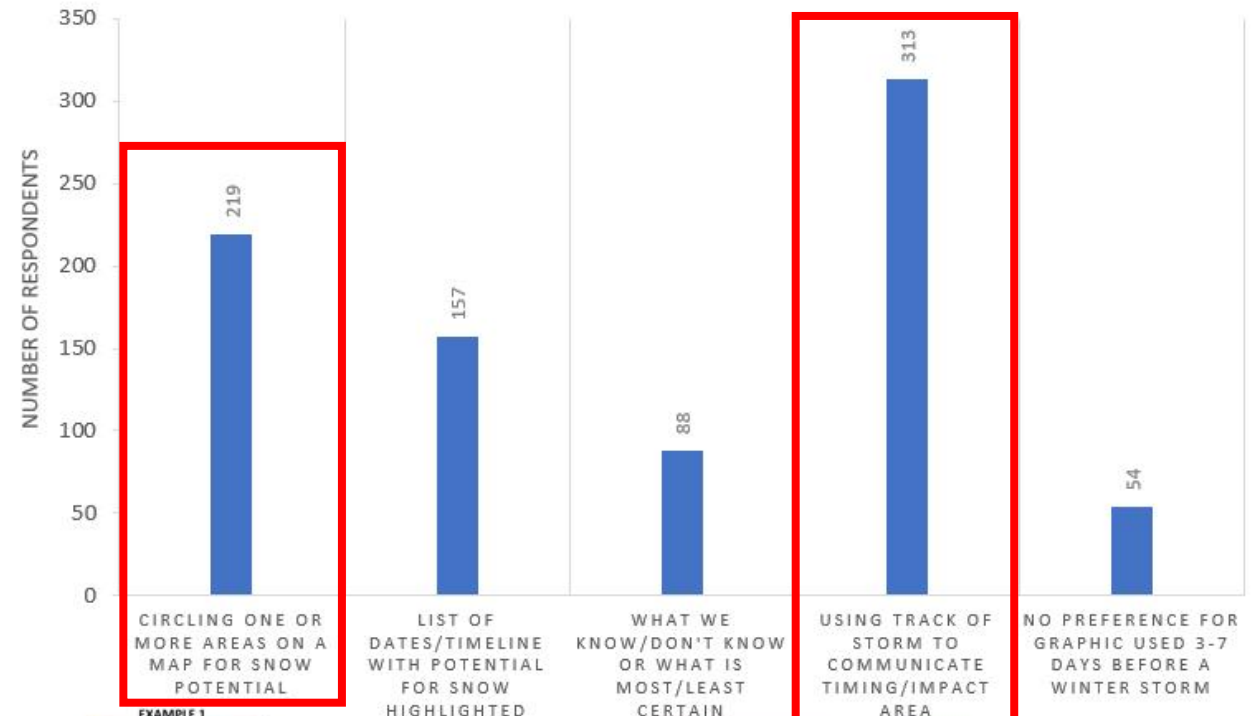
(1)



(2)



## LONG-RANGE WINTER WEATHER GRAPHIC STYLE PREFERENCE OF RESPONDENTS TO THE SURVEY OF MEMBERS OF THE U.S. PUBLIC

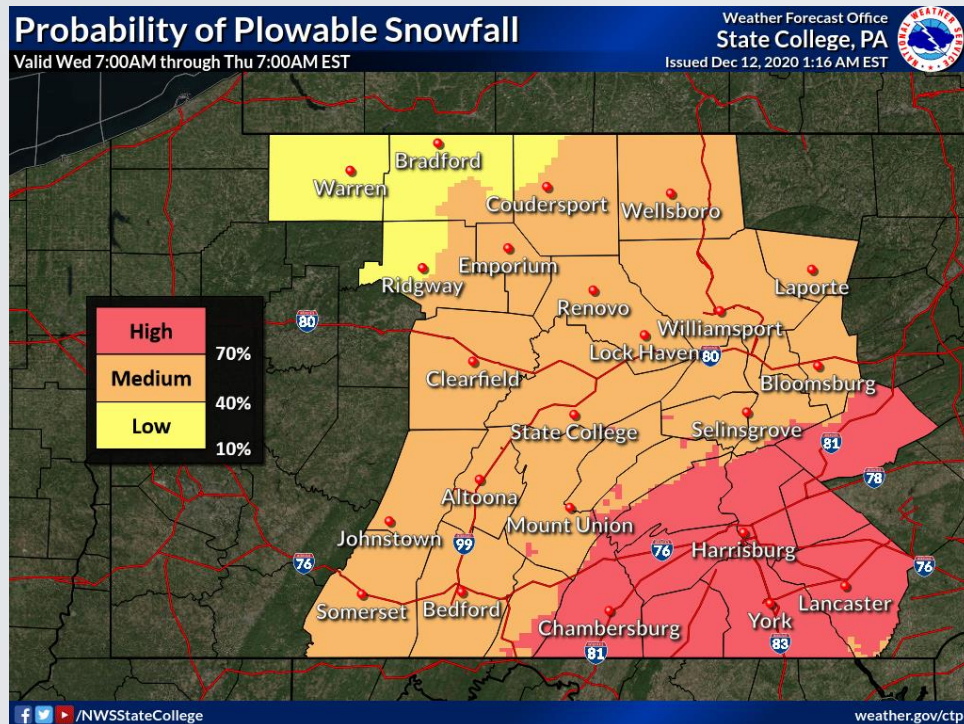


Some text-based information communicating the uncertainty or confidence in the forecast was found to be useful

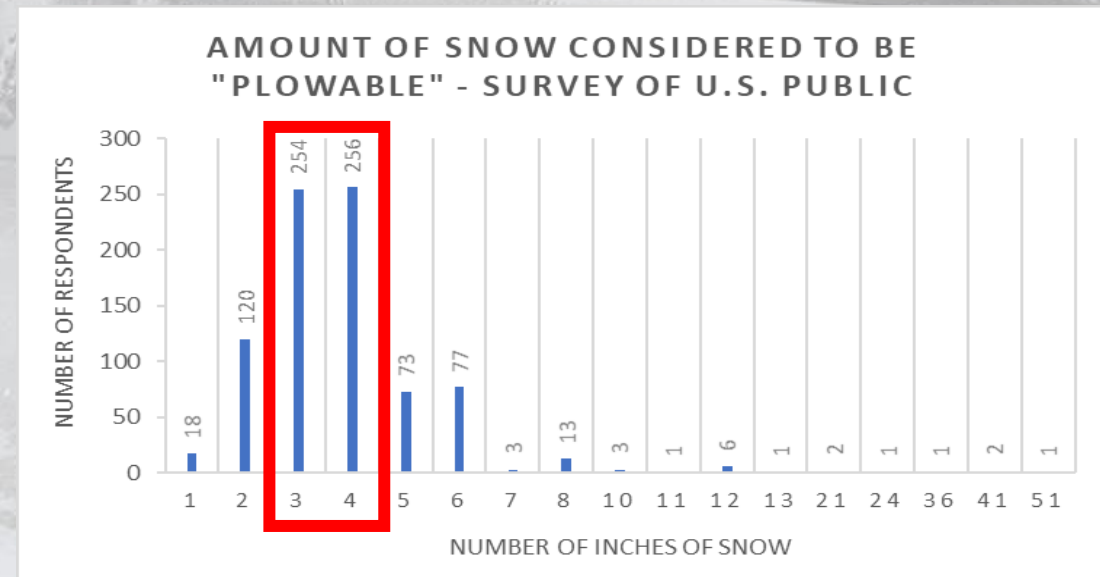
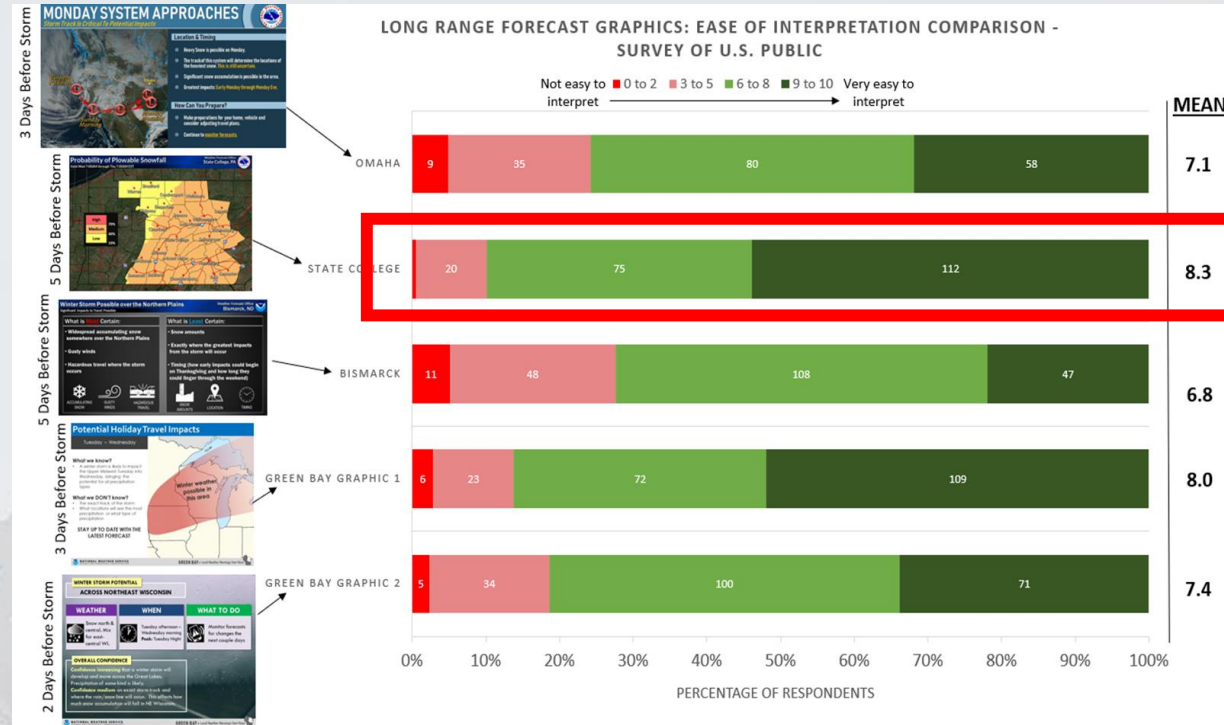
# Key Takeaway #2

## NWS State College's Probability of Plowable Snowfall Graphic

Allows WPC's probability of exceeding 0.25" of liquid equivalent of snow/sleet maps to be turned into helpful long-range weather information that is focused on the local area of the NWS office.



Found to be easy to interpret and useful to the public 4-7 days before a storm.



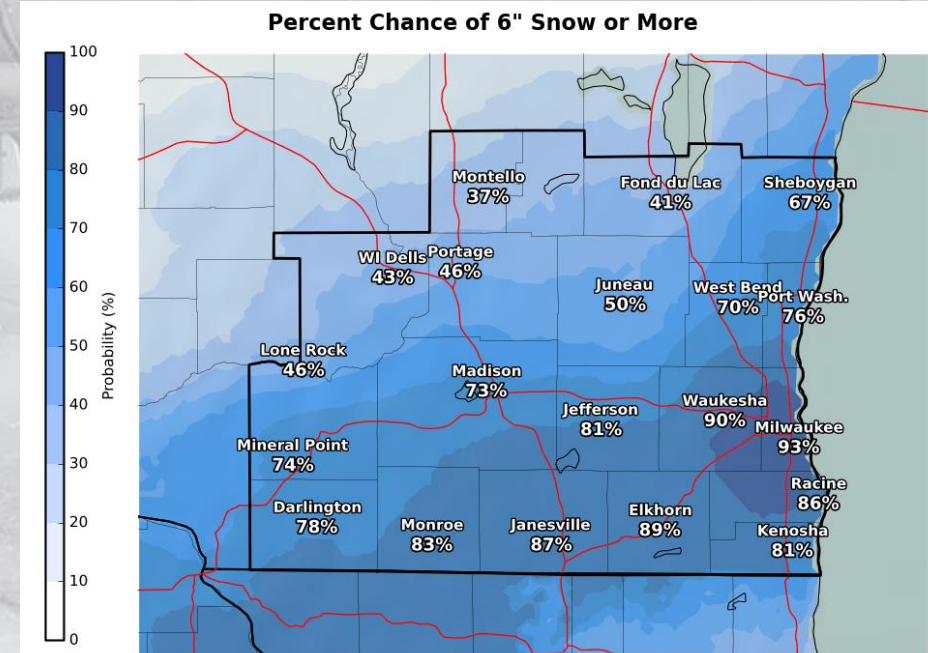
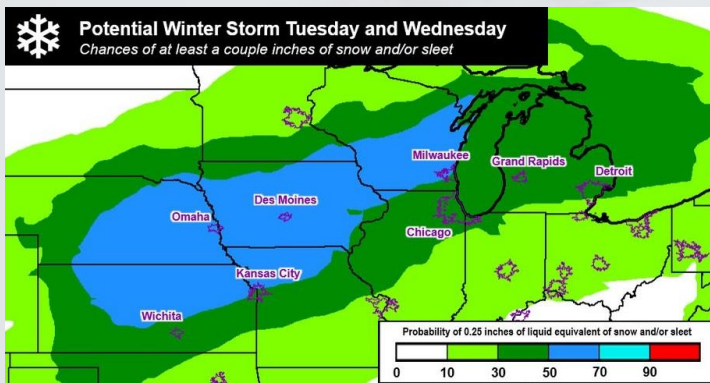
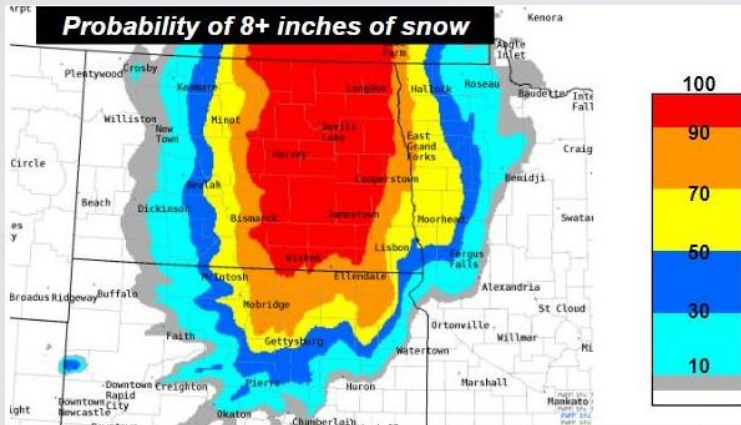
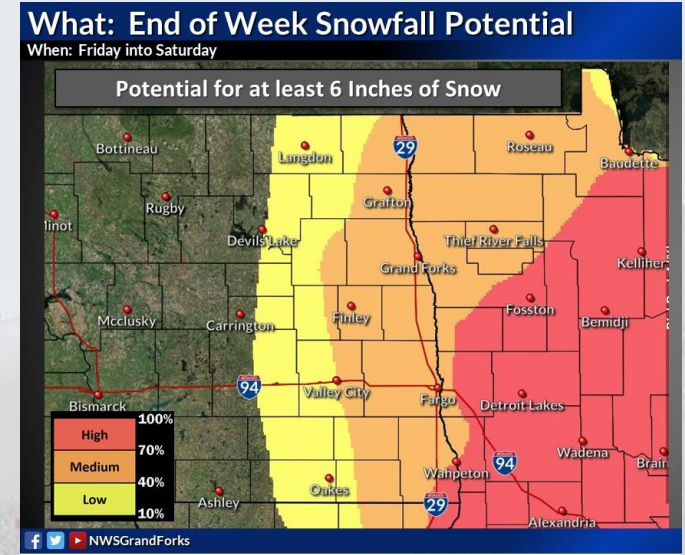


# RISK PROBABILITY GRAPHICS: What's the purpose of these graphics?

## Probability of exceeding X inches of snowfall – ensemble based

- Used when there's too much uncertainty for snow maps to be released
- Communicates the spatial coverage *and* likelihood of the threat
- Conveys the uncertainty in the forecast and encourages user to check back for updates

## But there are many different color schemes used for these graphics:



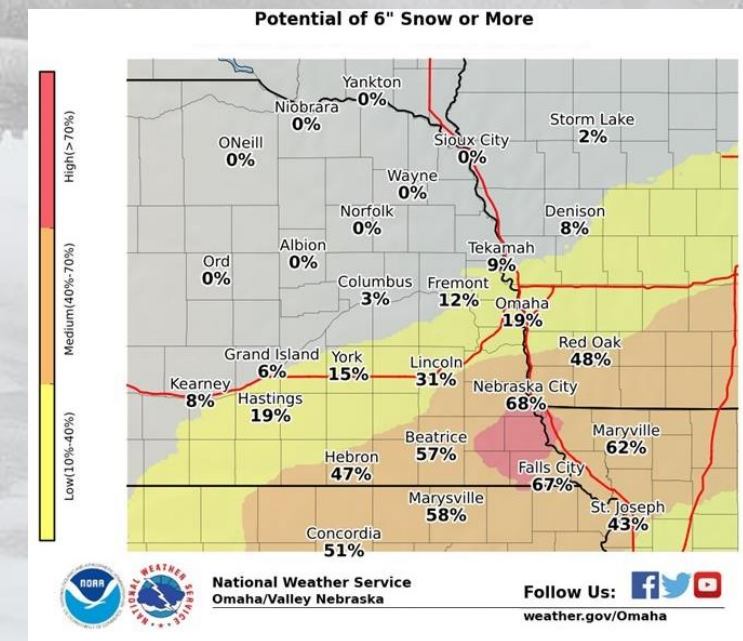
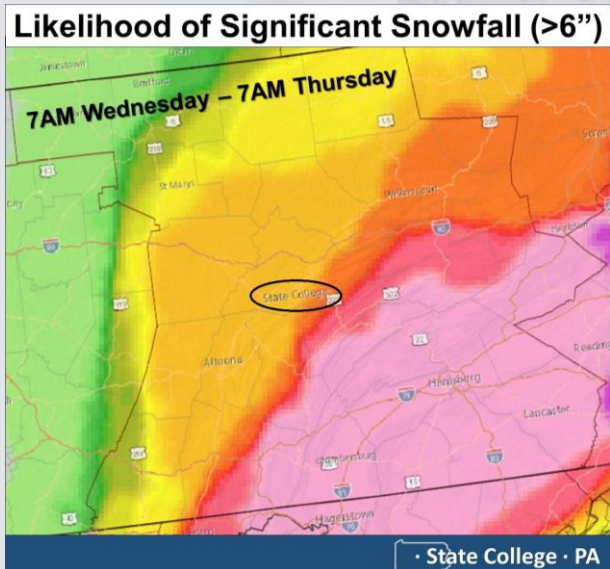
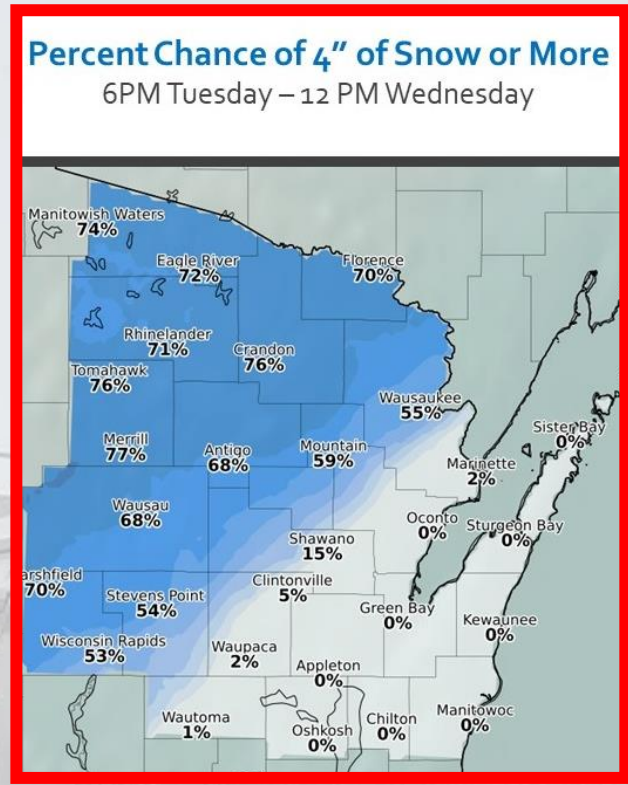


# Key Takeaway #3

The **blue gradient** color scheme with probability percentages plotted at each location was the **most preferred**.

**Easiest to interpret and the best communicator of the uncertainty present in the forecast** based on the survey of the U.S. public.

Past research that suggests numerical expressions of uncertainty should be prioritized over purely categorical statements as numerical expressions of uncertainty are interpreted more consistently (Budescu et. al 1988, Jaffe-Katz et. al 1989).



# Key Takeaway #4

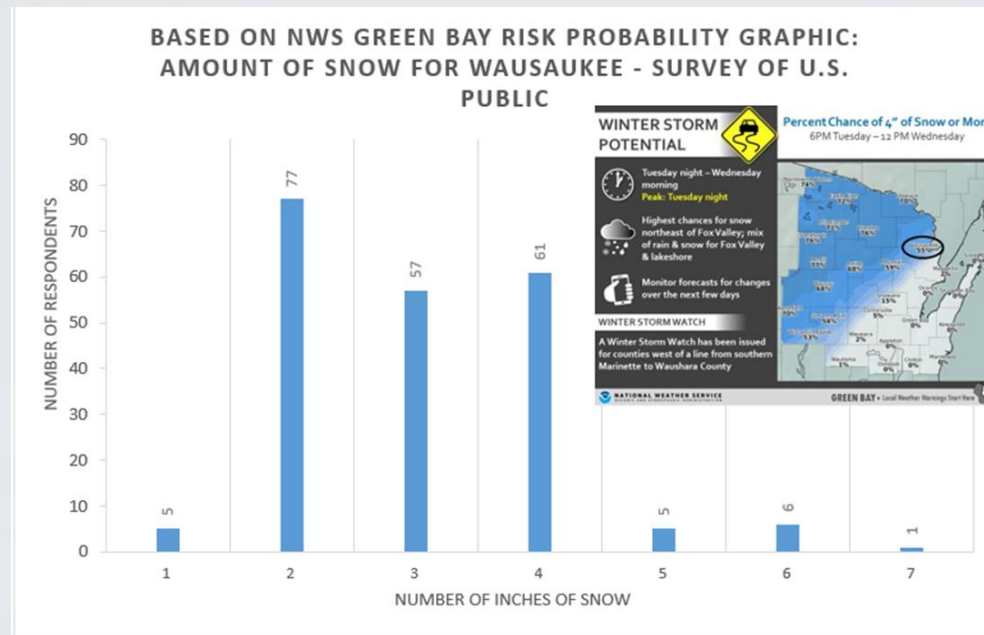
Risk probability graphics were found to be understandable & helpful with decision making.

## Interpretation:

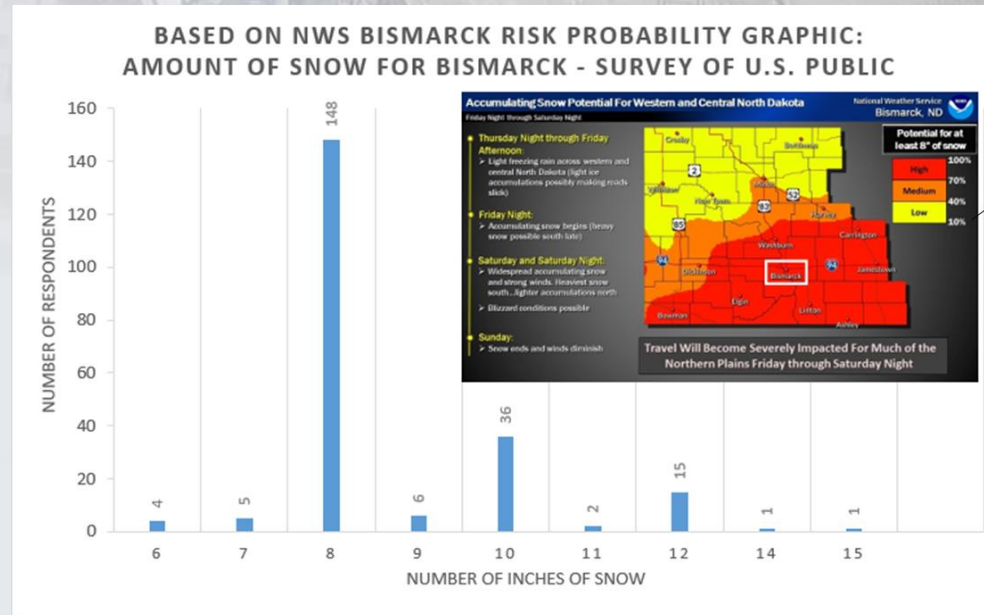
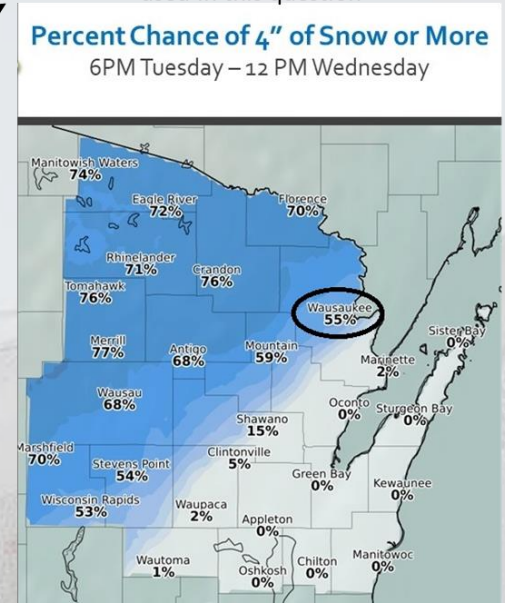
People consistently thought that the city on the map would get the amount of snow listed in the title of the map or a range of values lower than that.

## Remaining Question:

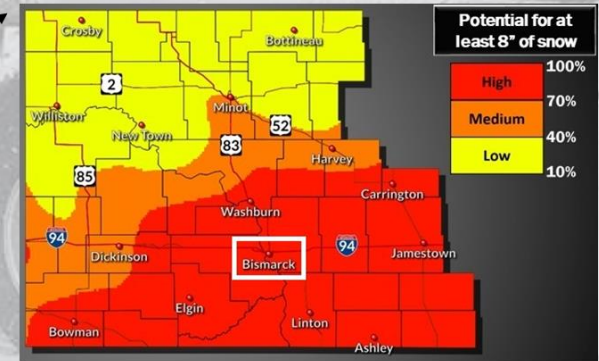
Is this the way we want people to interpret risk probability graphics?



Zoomed in view of the risk probability map used in this question



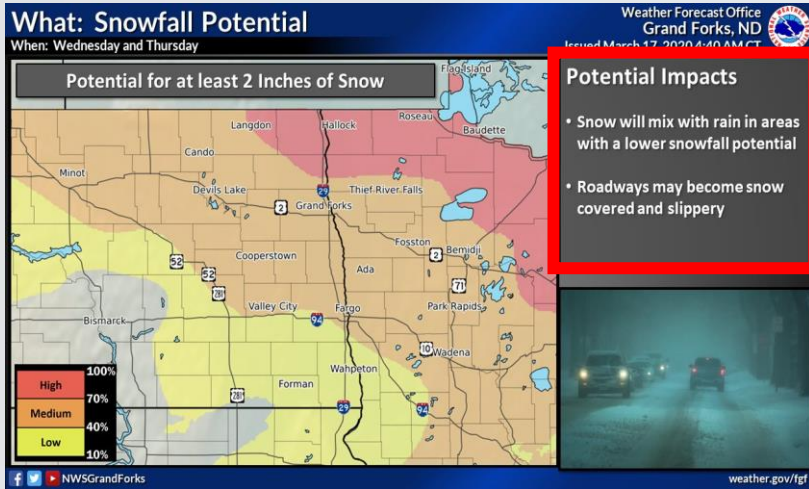
Zoomed in view of the risk probability map used in this question



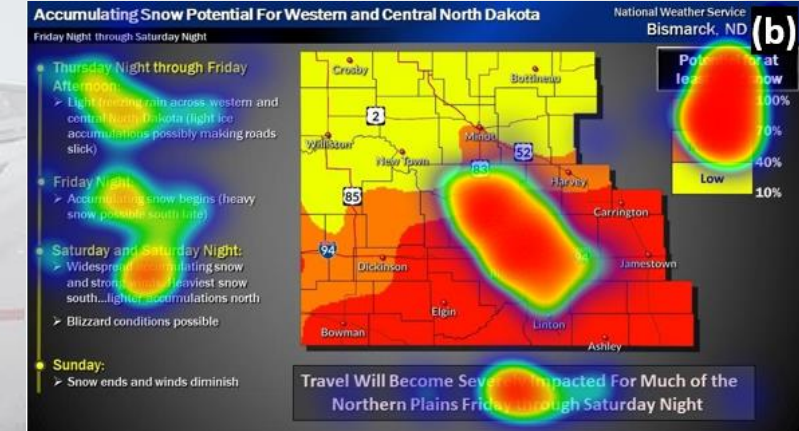
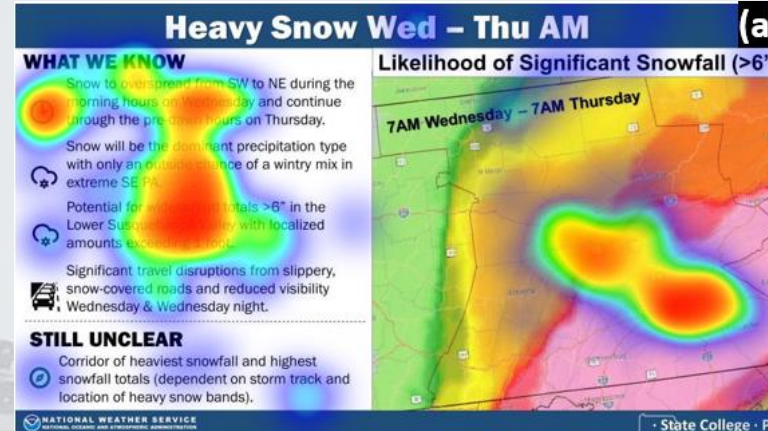


# Key Takeaway #5

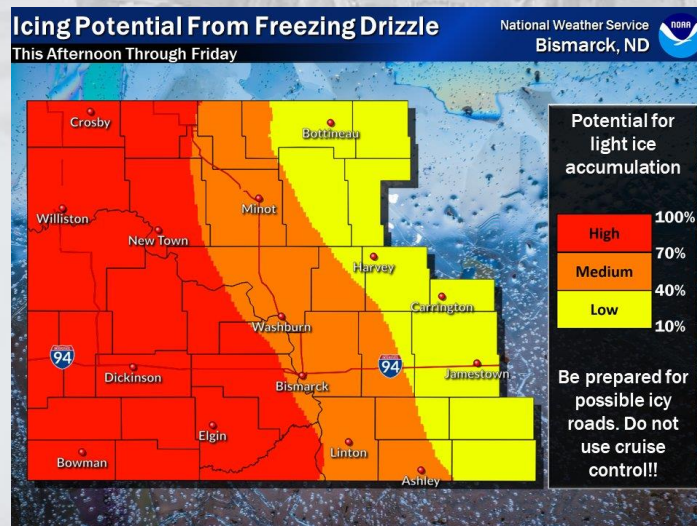
Risk probability graphics should overall be kept simple,  
but some brief, additional text should be added



Heat map question results – shows that some people find the text on the graphic important and helpful (see full thesis for more analysis)



Using risk probability graphics to communicate other hazards, such as for icing/freezing rain potential, was also shown to be something that NWS meteorologists would want to do.



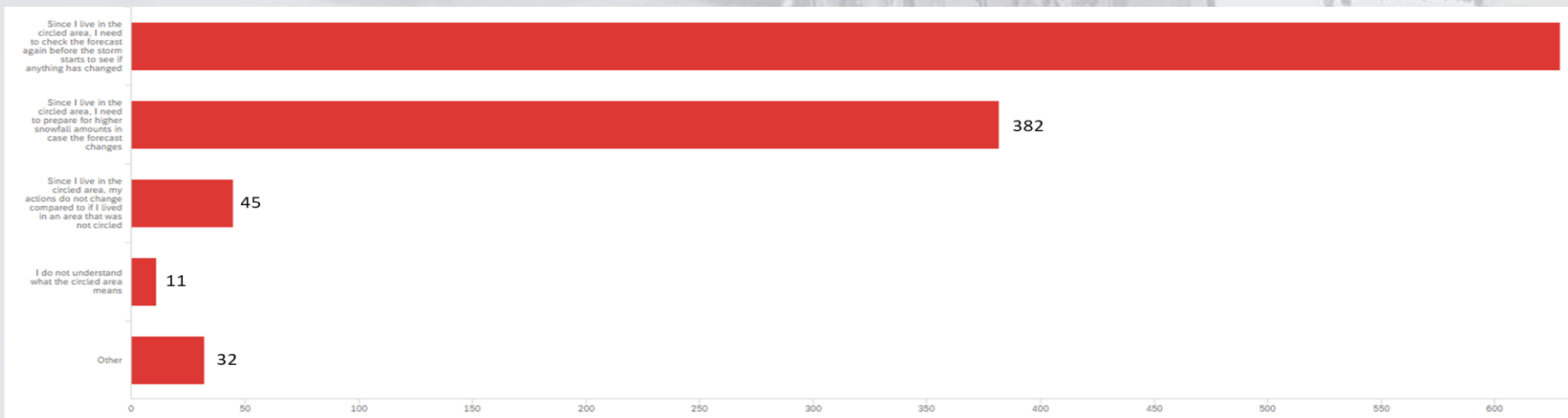
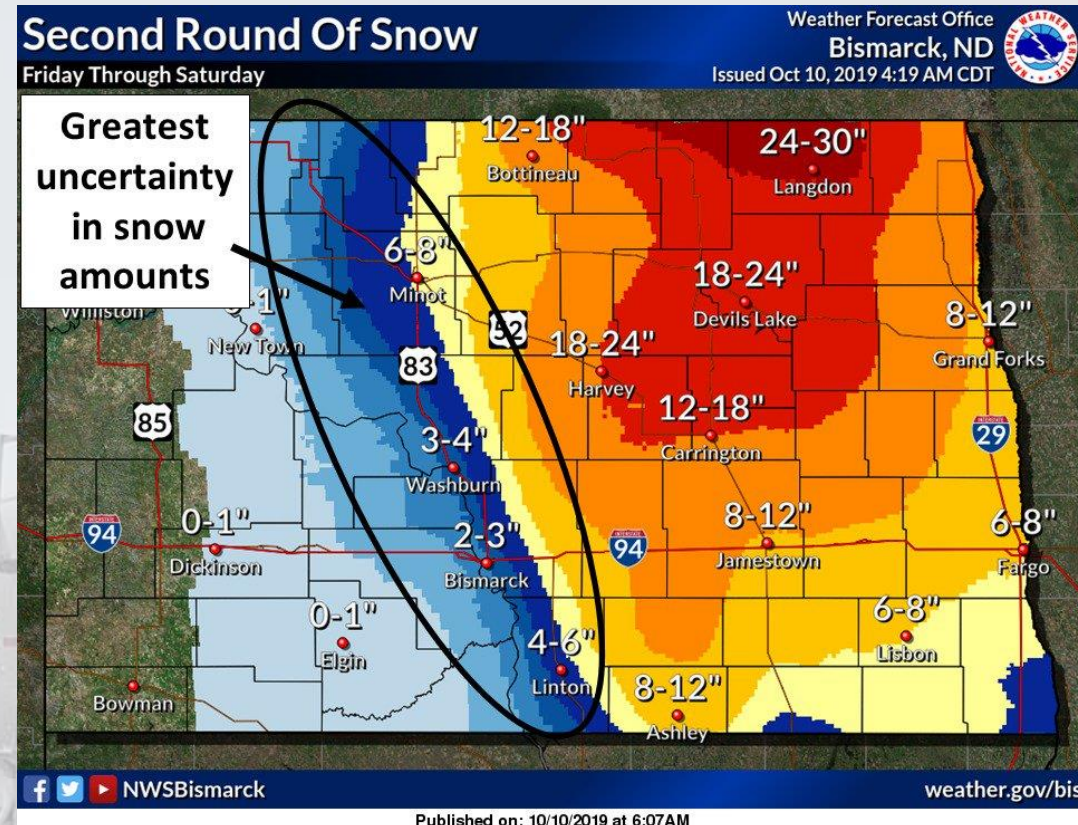


# SNOW MAPS: Circling areas of uncertainty

## Key Takeaway #6

Circling areas of uncertainty on snowfall forecast maps was liked by all and should be done by NWS offices and others in the weather enterprise when it is necessary.

Overall majority would check back for forecast updates if they lived in the circled area of uncertainty to see if anything had changed.





**METEOROLOGIST JACOB MORSE**

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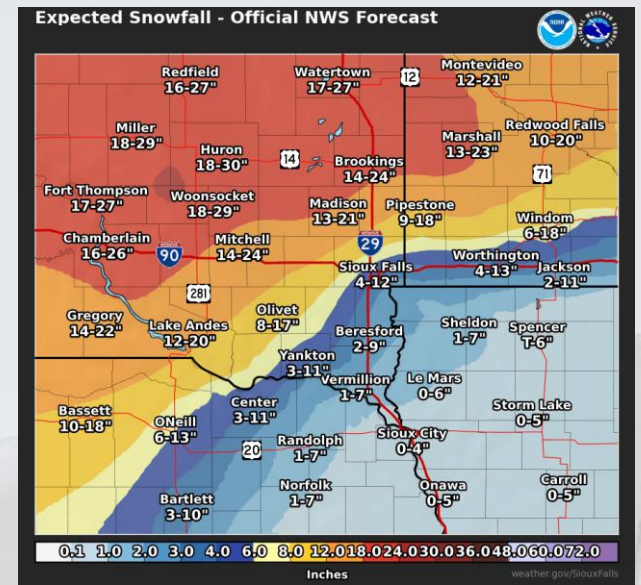
PSU Undergraduate Exhibition Research ... Risk Probability Graphics

2. Risk probability graphics are why they are an important "bridge" between long-range graphics and snow maps

These graphics communicate the probability of exceeding a certain amount of snow

Example: "probability of at least 6 inches of snow"

So much more with my research!  
25<sup>th</sup> to 75<sup>th</sup> percentile  
probabilistic snowfall ranges  
snow map →



**TAKE-HOME MESSAGE:** We need to be more comfortable talking about uncertainty and probabilistic information. People want to hear about this and find it helpful for decision-making.

**THANK YOU!**

**Reach out to me with questions:**

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Email: [jmorse879@gmail.com](mailto:jmorse879@gmail.com)