

The NWS Winter Program: Enabling Innovation to Achieve Consistent, Collaborated Products and Messaging



Winter Weather Experiment Seminar Series January 24, 2023

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National Weather Service Headquarters



Outline

- Winter Program Overview
- Research to Operations at HQ
- Winter Probabilistic Framework
- What's New for 2022-2023?
 - Winter Storm Severity Index (WSSI)
 - Probabilistic WSSI (pWSSI)
 - Modernized Watch/Warning Snowfall Criteria
 - Winter Storm Outlook (WSO)
 - Local Probabilistic Winter Precipitation Forecasts (PWPF)
- Future Ice Initiative
- Wrap-Up



Winter Program Overview

- The Winter Weather Services Program is one of 11 National Service Programs in the National Weather Service (NWS). The Winter Program works with internal and external stakeholders to facilitate improvements to winter weather products and services.
- The program goals include moving toward a consistent suite of products and services that are **collaborative, probabilistic, and impact-based**.



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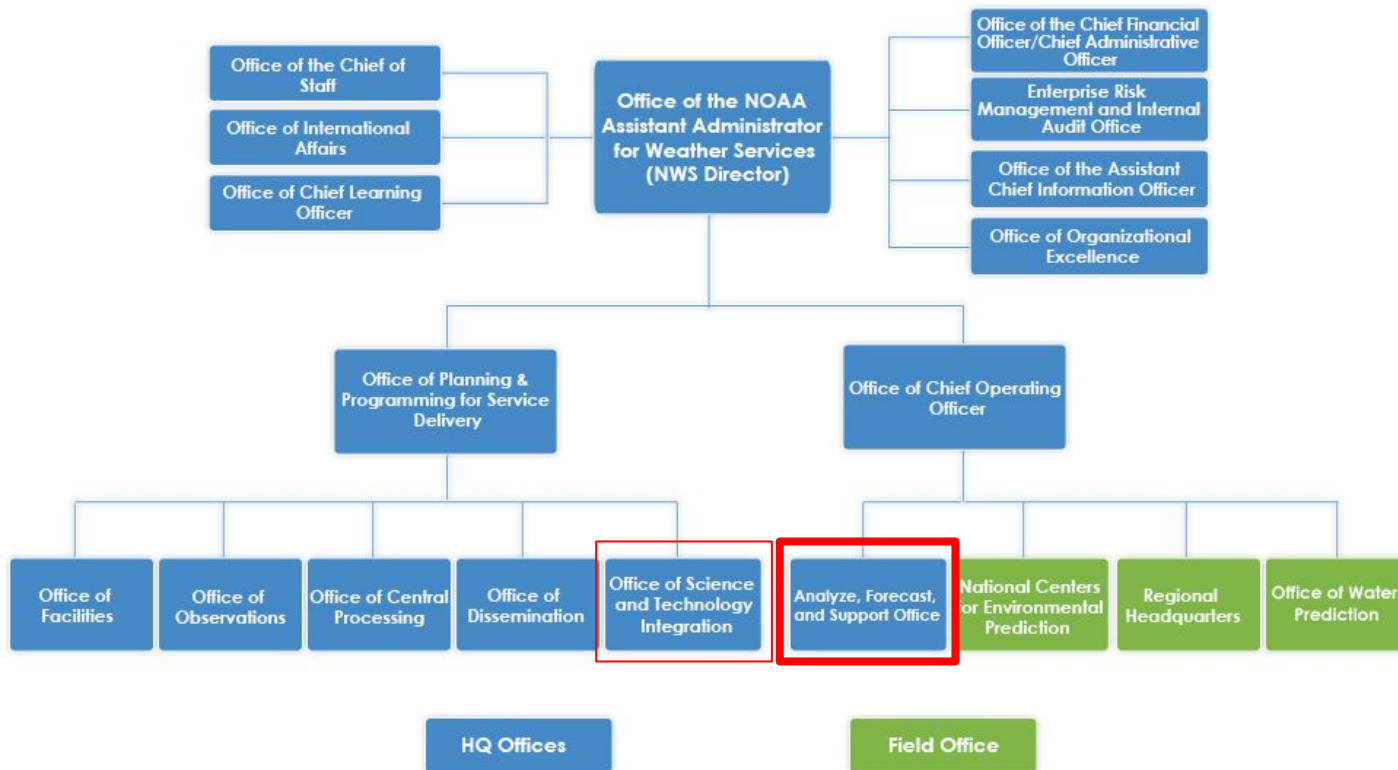
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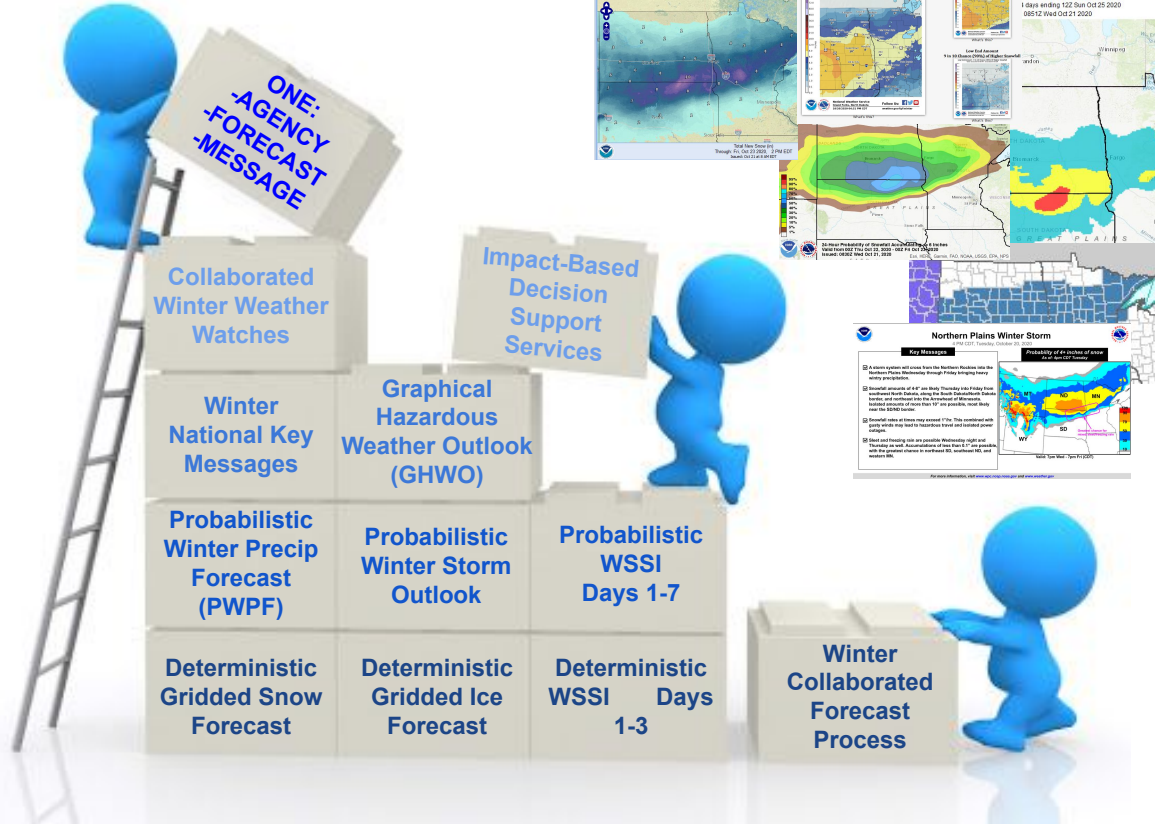
Where Does the Winter Program Sit?

NWS Organizational Structure



Detailed Winter Program Vision

- Building blocks to ***One Consistent, Collaborated, Impact-based Forecast*** among the National and Local Levels
- Communicating the range of possible outcomes while still leveraging single-value forecasts for better decisions
- Engaging with partners and agency experts across the weather enterprise to continually improve the winter suite of products and services



Research to Operations from HQ

How does the Winter Program get things done to improve NWS operations?

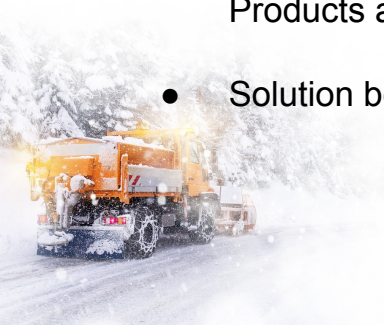
- NWS partners both internally and externally with the academic, science, technical and operational communities
- Work to develop techniques, tools, and applications that improve forecasting and associative messaging
- AFS Winter Program R2O function paves the way by ensuring proper testing, evaluation, training, and policy development
- Work closely with NOAA's Office of Atmospheric Research (OAR), the NWS Office of the Chief Learning Officer (OCLO) and Office of Science and Technology Integration (OSTI), WPC, NWS Regions, and WFOs



Research to Operations from HQ

What is the process to get techniques, applications and tools operational?

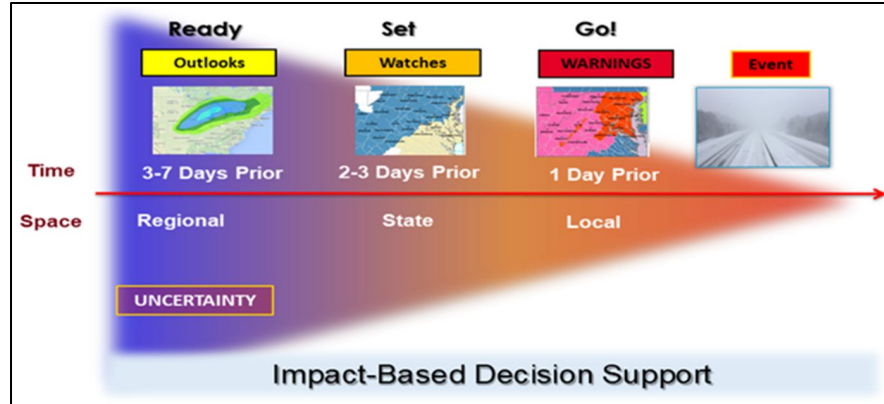
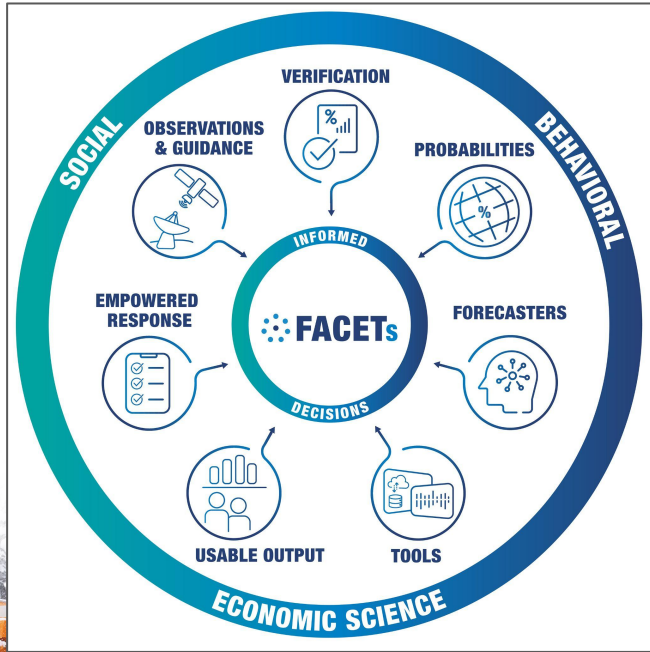
- Need/Requirement/Potential Solution identified by a researcher or operational field forecaster
- Need/Requirement is recorded in a database at HQ called **CaRDS** (Capabilities and Requirements Decision Support) and validated by Mission Delivery Council (MDC)
- Need/Requirement is prioritized by Portfolio Integration Council (PIC) and assigned to a service delivery portfolio to develop potential solutions
- Solution is tested in a pseudo-operational environment, such as a testbed or parallel field operations
- Solution is made experimentally available for scientific and societal evaluation through the Products and Service Change Management process (aka 10-102 process)
- Solution becomes operational

A snowplow is shown in the bottom left corner, clearing a snowy road. The plow is orange and white, and it is moving from left to right, leaving a trail of snow behind it. The background is a snowy landscape with trees.

IDENTIFIED GAPS ↔ SOLUTIONS

The Framework: Winter FACETs

Forecasting a Continuum of Environmental Threats



An evidence-based framework that can be applied to any hazard and geospatial scale to modernize the creation, communication, and effective dissemination of risk-based, probabilistic information for effective response

This is a long-term programmatic goal for NWS!

The Winter Probabilistic Framework:

Following Snow & Ice Hazards and Impacts Probabilistically Through Space and Time

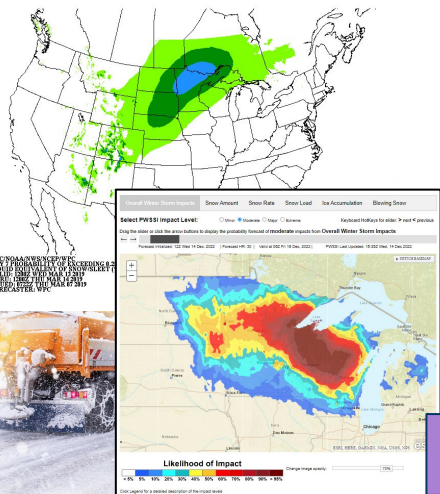
Forecast Lead Time Prior to Winter Event

7 Days

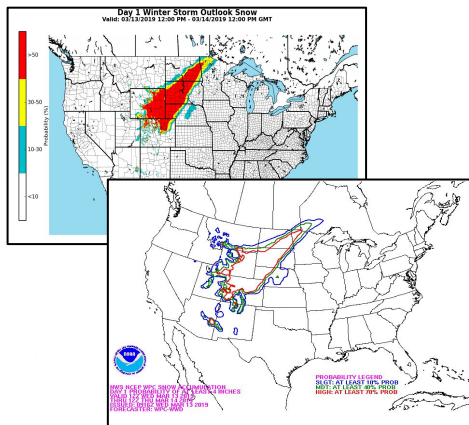
1-3 Days

Hours

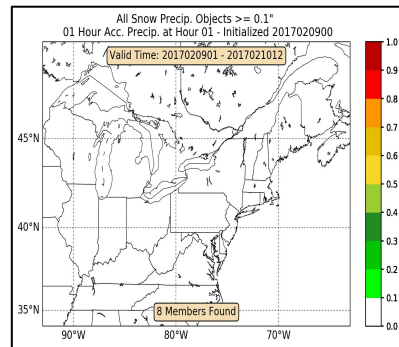
Day 4-7 Probabilistic Winter Weather Outlook &
Day 1-7 Probabilistic Winter Storm Severity Index



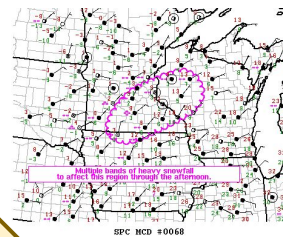
Day 1-4 Probabilistic Winter Storm Outlook &
Day 1-3 Probabilistic Snowfall



Day 1-2 Snowband Probability Tracker

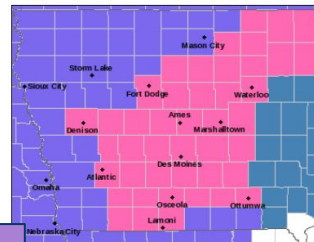


Mesoscale Snowfall Discussion



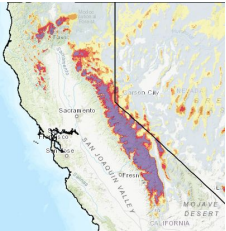
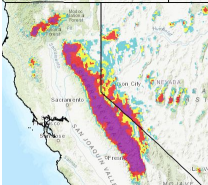
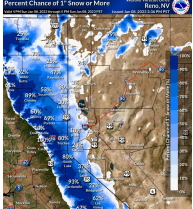
Informs

Winter Watches / Warnings



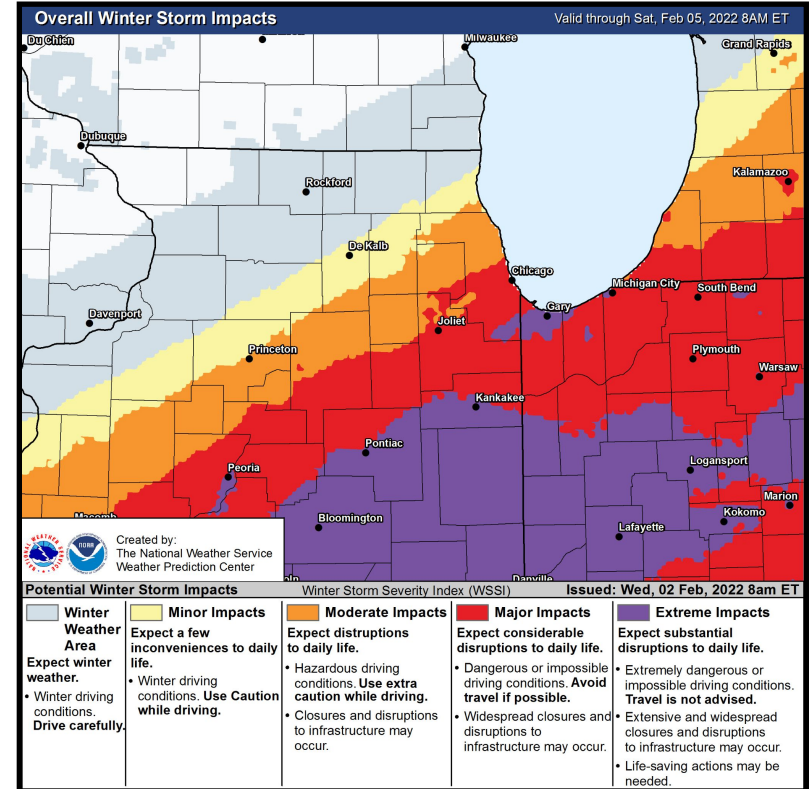
R2O: Identifying gaps, seeking solutions within this continuum

Winter Research to Operations Product Examples

Product	Winter Storm Severity Index (WSSI) 	Probabilistic WSSI (pWSSI)  Likelihood of Impact < 5% 5% 10% 20% 30% 40% 50% 60% 70% 80% 90% > 95%	Winter Storm Outlook (WSO)  Maximum Probability of Exceeding Warning Criteria <10% 10-30% 30-50% 50-80% >80%	Probabilistic Winter Precipitation Forecast (PWPF)  Percent Chance of 1" Snow or More
Status	Operational (research and improvements continue)	Experimental (External)	Experimental (External)	Experimental (External)
Source	WFO Forecasts, GIS data, Climatology (snow load, snow amount, ice accumulation, ground blizzard, flash freeze, blowing snow)	61 member ensemble, GIS data, Climatology (snow load, snow amount, snow rate, ice accumulation, blowing snow)	61 member ensemble (calculated using new 2022-2023 Winter Storm Watch / Warning criteria)	61 member ensemble (ensemble mode is the WFO "expected snow amount" forecast)
Output	Impact categories for Days 1-3 forecast period: Winter Weather Area, Minor, Moderate, Major, Extreme	Probability of impact categories for Days 1-7 forecast period: Winter Weather Area, Minor, Moderate, Major, Extreme	Probability of exceeding Winter Storm Watch / Warning criteria for Days 1-4 forecast period	• 10th percentile (high-end snow amount) • 90th percentile (low-end snow amount) • Mode (expected snow amount) • Probability of exceedance of

Winter Storm Severity Index (WSSI)

- **Goal:** Forecast the potential severity of community impacts from winter storms throughout the CONUS, including tree damage, property damage, transportation impacts, and disruptions to daily life.
- Provides winter storm impact information out to 72 hours, and in 24 hour intervals...includes meteorological & non-meteorological factors.
- Five levels of impact provided, updated every 2 hours.
- Summary graphic is a composite of the maximum impact from any of the six components
 - **New this year:** updated impact definitions, new static images for the CONUS, State and WFO perspectives, and the elimination of the "Limited" category. A new Winter Weather Area depicting where NWS forecasts are expecting winter weather is now included.



Output available here: www.weather.gov/wssi

WSSI - Components & Scale



Ground Blizzard

Indicates the potential travel-related impacts of strong winds interacting with pre-existing snow cover



Flash Freeze

Indicates the potential of flash freezing during or after precipitation events.



Blowing Snow

Indicates the potential disruption due to blowing and drifting snow



Ice Accumulation

Indicates potential infrastructure impacts due to combined effects and severity of ice and wind



Snow Load

Indicates potential infrastructure impacts due to the weight of snow



Snow Amount

Indicates potential impacts due to the total amount of snow or snow accumulation rate

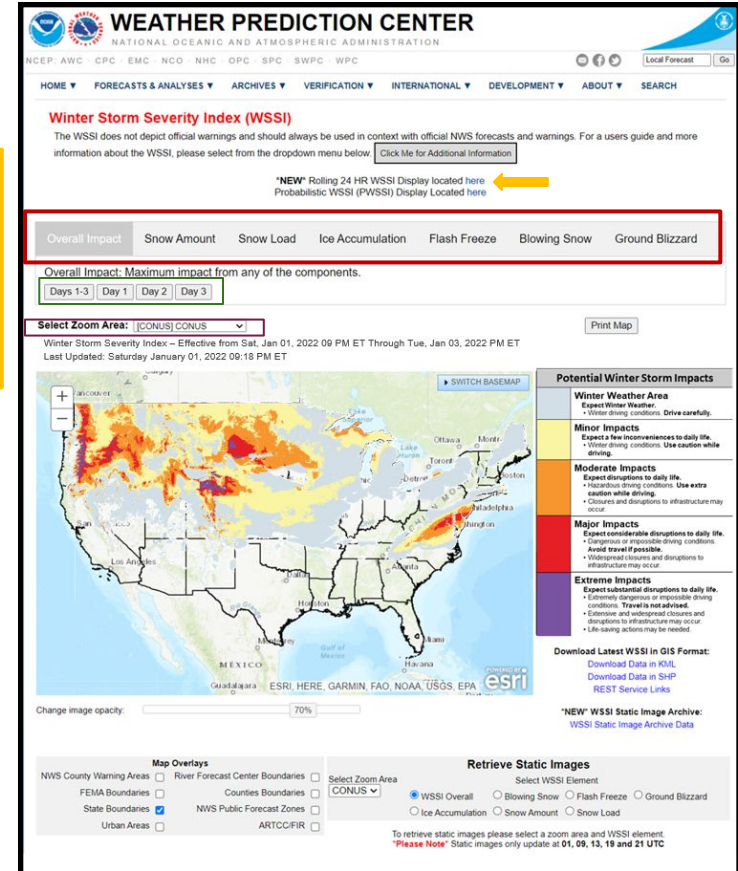
Potential Winter Storm Impacts	
	Winter Weather Area Expect Winter Weather. • Winter driving conditions. Drive carefully.
	Minor Impacts Expect a few inconveniences to daily life. • Winter driving conditions. Use caution while driving.
	Moderate Impacts Expect disruptions to daily life. • Hazardous driving conditions. Use extra caution while driving. • Closures and disruptions to infrastructure may occur.
	Major Impacts Expect considerable disruptions to daily life. • Dangerous or impossible driving conditions. Avoid travel if possible. • Widespread closures and disruptions to infrastructure may occur.
	Extreme Impacts Expect substantial disruptions to daily life. • Extremely dangerous or impossible driving conditions. Travel is not advised. • Extensive and widespread closures and disruptions to infrastructure may occur. • Life-saving actions may be needed.

Updated impact definitions

WSSI: Webpage

- Clickable tabs
 - Loads WSSI components upon click
 - Day Period tabs
- Rolling 6-Hr Data Viz Option
 - Allow users to visualize the impact levels progression through time versus viewing per calendar day
 - 24-hour forecast period with the start time advancing every 6 hours (i.e. 18Z to 18Z, 00Z to 00Z, etc.)
- Zoom-to-WFO Drop-down Box
- Print map button
 - Creates a PDF of the map with your specifications
- Variety of basemaps via Basemap dropdown button
- Ability to browse static images
- Links to download GIS data (REST Service, SHP and KML)

www.weather.gov/wssi

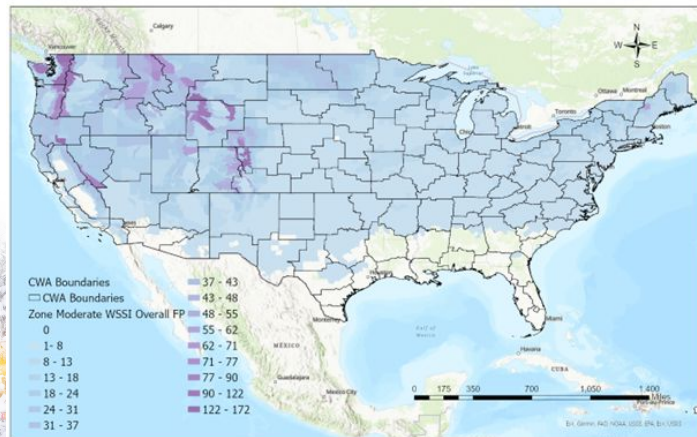


Exploring Methods for Evaluating WSSI Utility

- WPC 2022 Summer intern performed a WSSI verification study using NORHSC and Storm Data information for a 181 day sample from 2021 - 2022
- Only verifying WSSI categories of "Moderate", "Major" or "Extreme" impacts were analyzed
- 60% of cases verified as "Good" while 27% verified as "Poor"

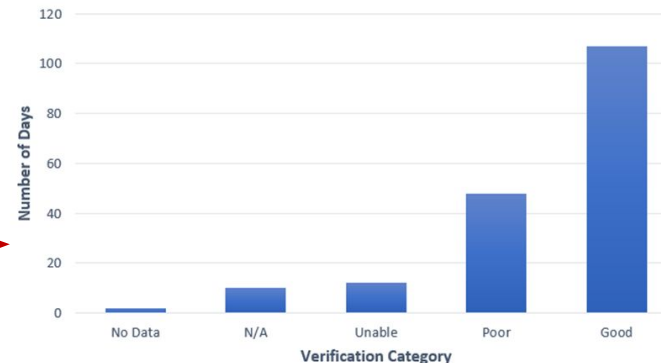
Zonal Statistics, Moderate WSSI Overall

Zones with CWA Boundaries



WSSI "Moderate" frequency

How the WSSI Verified



No Data: No WSSI forecast exists

N/A: No Moderate/Major/Extreme forecasted

Unable: No storm reports available to verify forecast

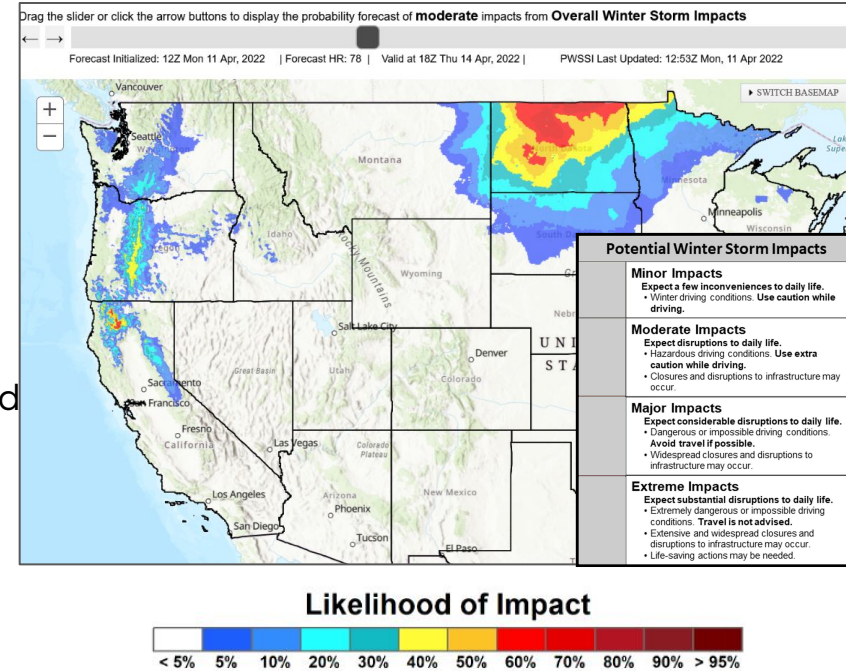
Poor: $\geq 50\%$ of impact levels did not verify

Good: $\geq 50\%$ of impact levels verified

- WSSI verification also showed that most "Moderate" and higher impacts are in zones in the mountainous regions
- This highlights the need for WSSI to handle these areas differently than the rest of the CONUS

Probabilistic Winter Storm Severity Index (pWSSI)

- Probabilistic WSSI is now experimentally public-facing to support messaging of potential impacts of winter storms from Days 1-7
- Robust social science research applied to impact definitions, aligned with the deterministic WSSI, to effectively communicate the likelihood of winter storm severity
- Public training material available to improve understanding and usability among a broad base of users
- Please provide feedback!

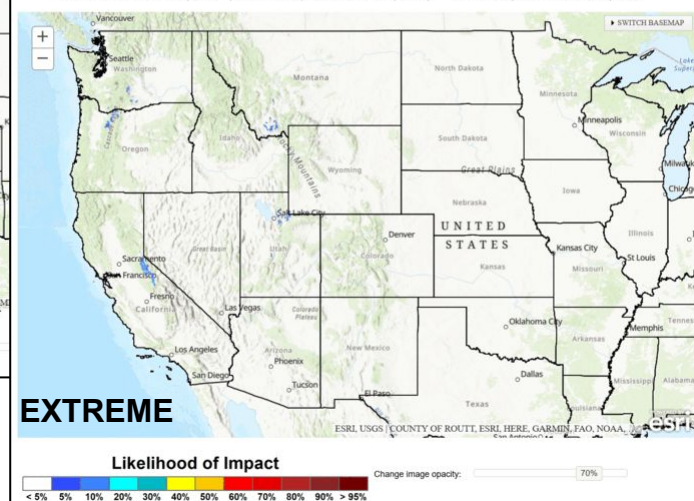
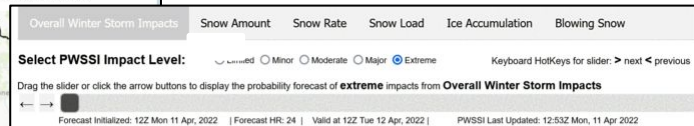
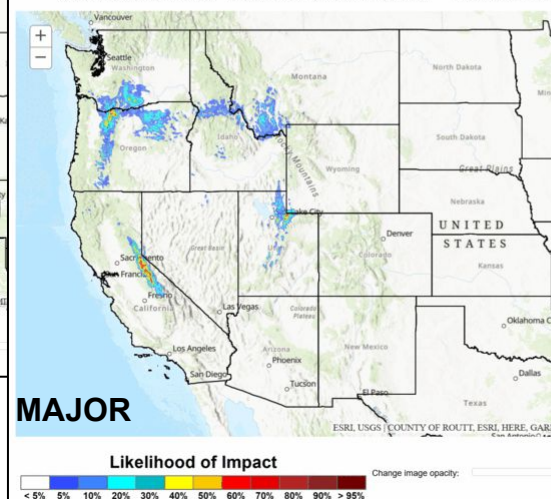
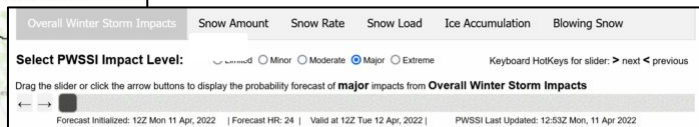
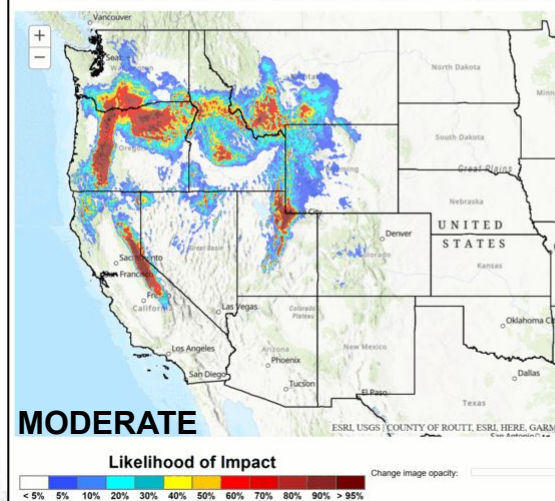
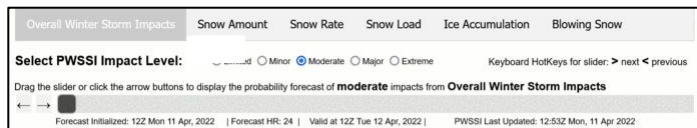


Depicts probability of reaching an impact level for winter hazards using the WSSI impact thresholds

Available here:

https://www.wpc.ncep.noaa.gov/wwd/wssi/prob_wssi.php

pWSSI Winter Storm Impacts Comparison



Potential Winter Storm Impacts	
Minor Impacts	Expect a few inconveniences to daily life. • Winter driving conditions. Use caution while driving.
Moderate Impacts	Expect disruptions to daily life. • Hazardous driving conditions. Use extra caution while driving. • Closures and disruptions to infrastructure may occur.
Major Impacts	Expect considerable disruptions to daily life. • Dangerous or impossible driving conditions. Avoid travel if possible. • Widespread closures and disruptions to infrastructure may occur.
Extreme Impacts	Expect substantial disruptions to daily life. • Extremely dangerous or impossible driving conditions. Travel is not advised. • Extensive and widespread closures and disruptions to infrastructure may occur. • Life-saving actions may be needed.

*The likelihood of realizing **Moderate, Major, or Extreme** Impacts from a Winter Weather Event*



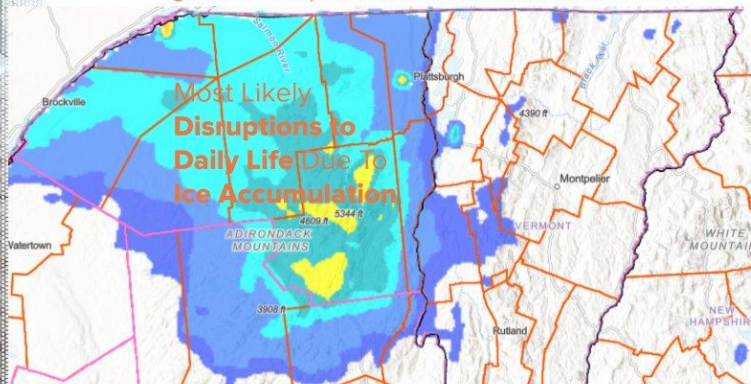
pWSSI WFO Messaging Support

Widespread Hazardous Travel

Mixed Precipitation, Including Freezing Rain, Will Cause Hazardous Travel

Wednesday Afternoon Through Thursday

A mix of frozen precipitation will likely cause **slippery conditions**, especially where **ice accumulations** are greatest in portions of northern New York.



What to do...

Remain **weather aware** and keep an eye on the forecast ahead over the next couple of days.



weather.gov/NWSBurlington

National Weather Service · NWS Burlington

Updated: Tue Jan 3, 2023 6:22 AM EST

Follow:   Burlington

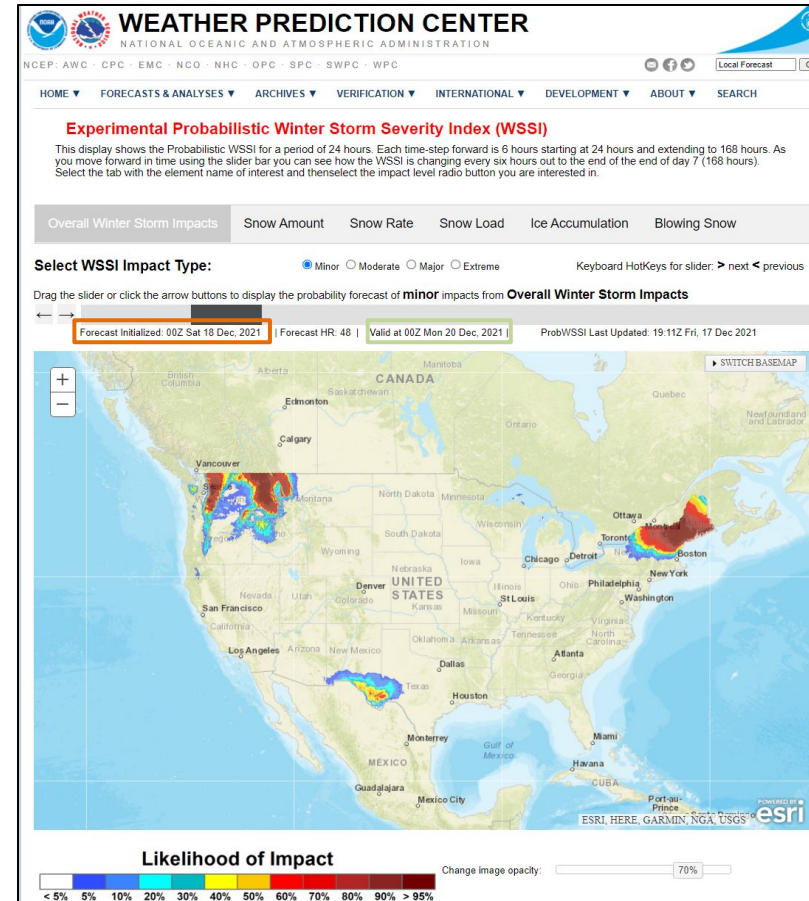
Listen: NOAA Weather Radio for Latest Forecasts & Warnings

pWSSI Website Navigation

- The PWSSI forecasts are rolling 24h probabilistic impact forecasts from 24h through 168h using a 6h cadence
 - This means every time step represents a 24h period moving forward six hours at a time.
- The "Forecast Initialized" time indicates the beginning of the time period for this forecast. In this example 00Z Fri 18 Dec 2021
- The "Valid at" time indicates the end of that forecast period.
 - For example, the image here depicts a 48-hour forecast valid 00Z Mon December 20, 2021
 - This covers the period from 00Z Saturday December 18th through 00Z Monday, December 20th.
 - The next time step, (forecast hour 54) would cover 06Z Saturday December 20th through 06Z Monday December 20th, with a valid time of 06Z Monday Dec 20th.

Please provide feedback!

https://www.surveymonkey.com/r/ExpProbabilisticWSSI_2022-2023



pWSSI Website Navigation cont'd

- The PWSSI web page has several interactive mechanisms that work together to produce the image overlay on the web map.
- Each image depicts a likelihood of impact, ranging from 5% to >95%, for a component and impact level.
- Default option shown when the page loads is the likelihood of Moderate impacts from the Overall Winter Storm components.

• Click a component tab to view the impact forecast for each component or the Overall Winter Storm Impacts tab to view the combined greatest threat.

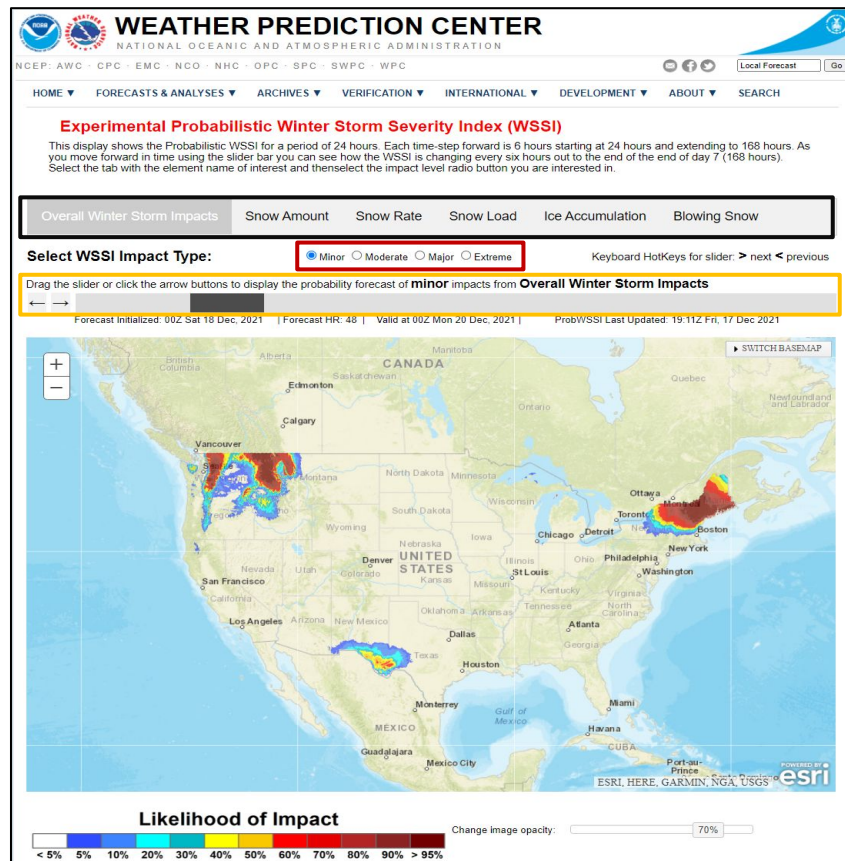
• Component options are: Overall Winter Storm Impacts, Snow Amount, Snow Rate, Snow Load, Ice Accumulation, and Blowing Snow.

• Select a WSSI Impact Level radio button for the level of impact

○ Impact types include: Minor, Moderate, Major, Extreme

• The slider bar controls the forecast time.

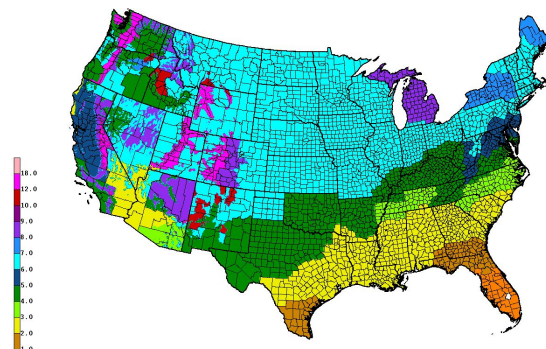
○ Advance or retreat the dark gray slider or click the arrow buttons, or use the > to go forward in time or the < key to go back in time.



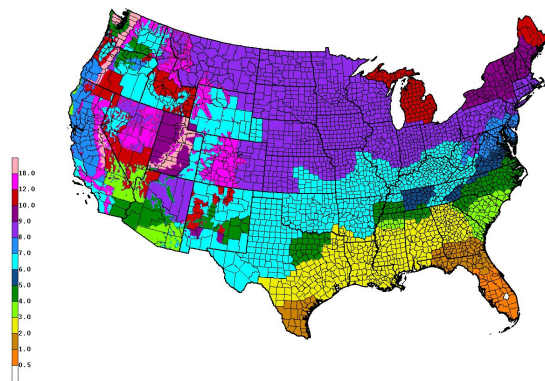
Modernizing NWS Heavy Snow Watch/Warning Criteria

Why change our existing criteria?

- NWS Weather Forecast Offices inconsistently apply event-based, 12 hr, 24 hr, and even more than one to determine appropriate snow criteria thresholds for winter storm watches and warnings
- Some offices consider climatology, though some do not
- Lack of criteria continuity across the county warning areas can create **timing and geospatial challenges with collaboration, coordination and public messaging** with respect to winter storms
- Agency-wide, we continue to work toward **issuing products and services based on anticipated impacts**, and not singularly dependant upon exceeding criteria thresholds



Current 12 hr Heavy Snow Criteria

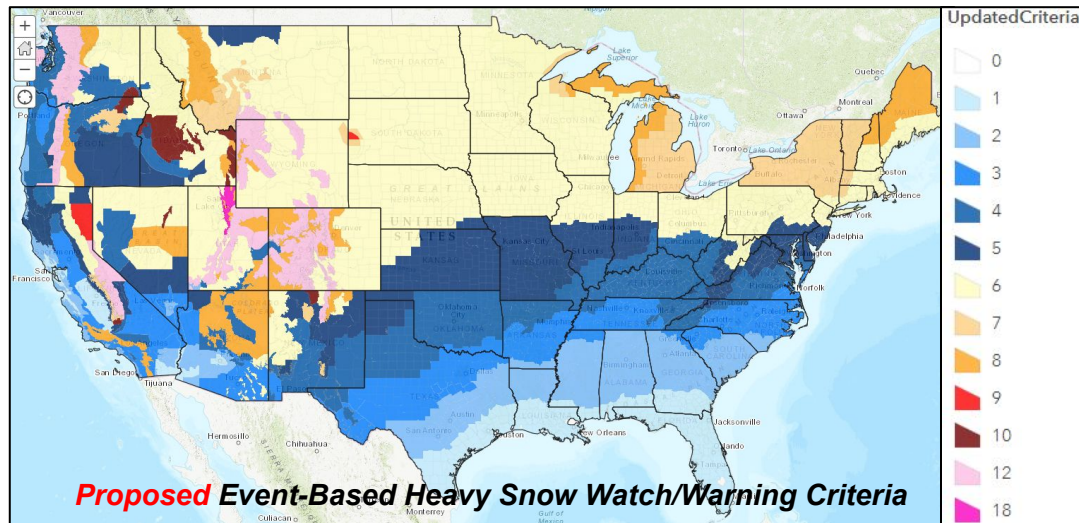


24 HR WINTER STORM WARNING SNOWFALL CRITERIA

Current 24 hr Heavy Snow Criteria

Modernizing Heavy Snow Watch/Warning Criteria

- Our NWS Region representatives created local teams that worked internally as well as with external partners to establish the changes to the heavy snow winter watch/warning criteria
- The vast majority of zones only results in a 1 or 2 inch change, but with this small change, we remove many non-meteorological boundaries and move toward a more science-based set of criteria
- The proposed criteria will be **evaluated this winter** with the goal of finalizing and implementing the changes prior to the winter of 2023-2024. WFOs will be collecting feedback from core partners.

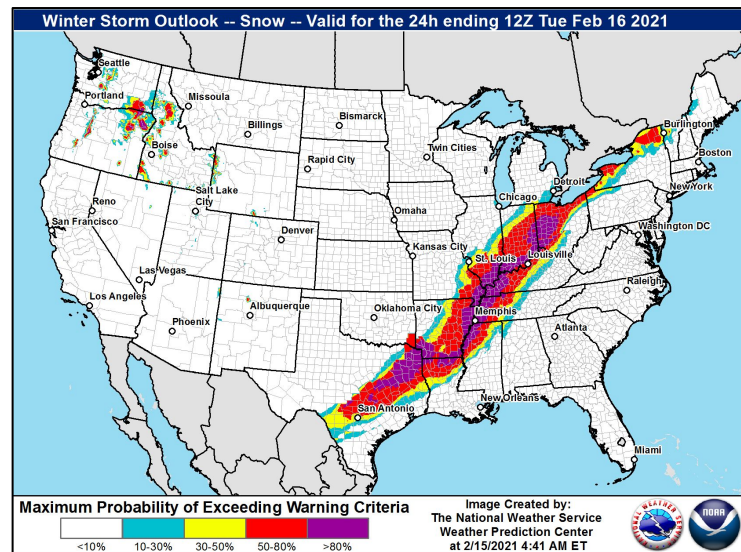


GOAL: Improve consistency in Winter Storm Watch/Warning Issuance and Public Messaging



Winter Storm Outlook (WSO)

- The Winter Storm Outlook (WSO) is an experimental product that displays the probability of realizing hazardous snow/ice accumulations using WFO-specific Watch/Warning criteria as a proxy threshold.
- Provides a Days 1-4 “Outlook” product in the winter program, serving to unify both external messaging and **internal collaboration** for consistent and collaborative Winter Storm Watch issuance.
- One of a few key factors considered in the issuance of Winter Storm Watches, as meeting certain thresholds for warning criteria triggers enhanced coordination between WPC & affected WFOs.
- **New this year:** The WSO will use the aforementioned proposed, event-based heavy snow watch/warning criteria as part of the evaluation. Please provide feedback via the survey link!



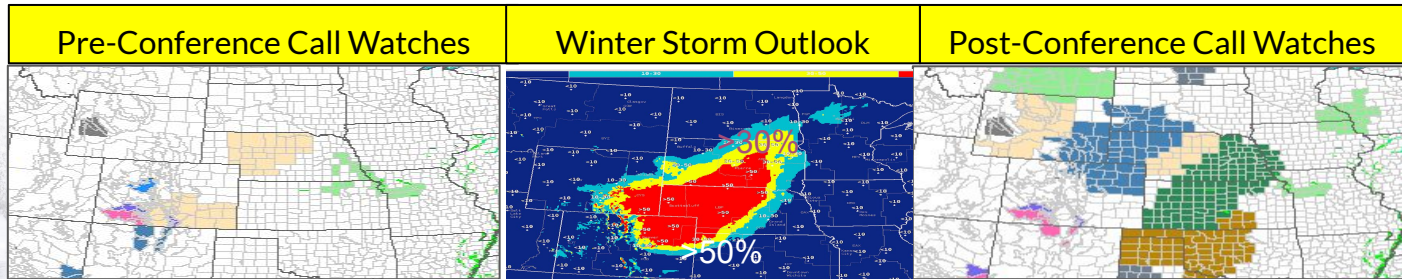
<https://www.wpc.ncep.noaa.gov/wwd/wso>

Provide Feedback:

<https://www.surveymonkey.com/r/winterstormoutlook2022-2023>

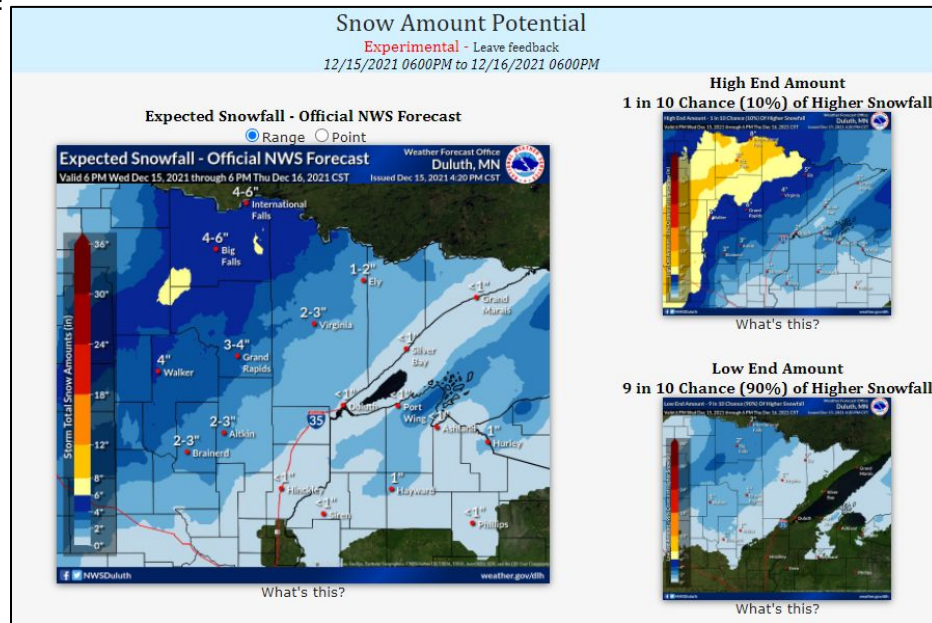
WPC/WFO Collaborated Winter Watch Experiment

- Collaborated Winter Watches is an effort begun in 2015 to enhance consistency in Winter Watch issuance and messaging. NWS Weather Forecast Offices (WFOs) will issue watches after collaborating with the Weather Prediction Center (WPC) Winter Weather Desk (WWD) and neighboring WFOs.
- **New this year:** Three “pods” of 6-8 WFOs participating for ~1 month each.
- Stakeholder benefits: Consistency in watch issuance times/spatial coverage for media cycles and decision makers (DOT, Emergency Management); consistency among national and local messaging (including more impact-based, probabilistic references in key messages)
- NWS benefits: Better utilization of winter weather expertise & forecast guidance from WPC WWD; improved coordination with surrounding offices by layering contributions; improved decision support services; no change to WFO operational responsibility



WFO Probabilistic Winter Precipitation Forecast (PWPF)

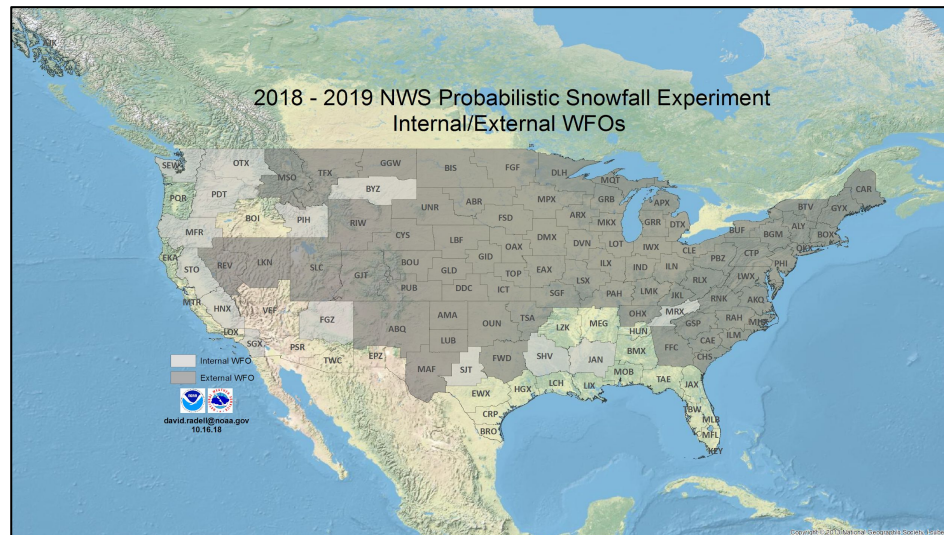
- **Goal:** Provide customers and partners a range of snowfall amounts to better communicate forecast uncertainty during winter weather events on a local level.
- 61-member ensemble of forecast models
 - Expert starting point provided by WPC
 - WFOs add local knowledge
- Significant model diversity contributes to a range of possible outcomes (*[“Understanding Uncertainty”](#) explainer*).
 - Experimental 10th and 90th percentile graphics are available on the National Digital Forecast Database ([NDFD](#)).



Local office Experimental PWPF page:
<https://www.weather.gov/btv/winter>

WFOs Participating in PWPF Experiment

- Number of sites remains frozen as a centralized operational prototype is in development.
- We are internally testing and evaluating the prototype this upcoming season for its ability to generate and disseminate these products.
 - A national GIS/Web-based prototype solution is now being developed (next slide)

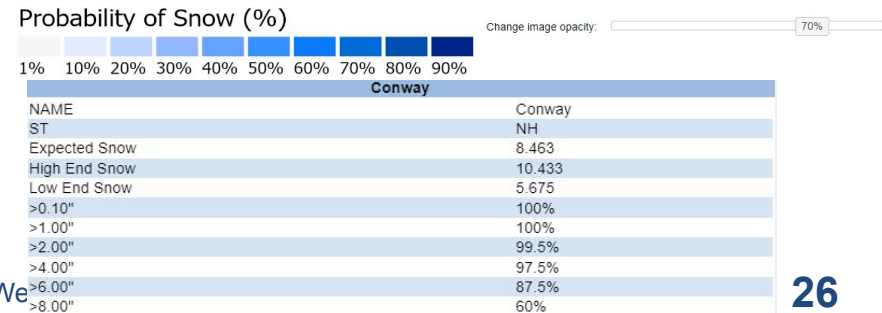
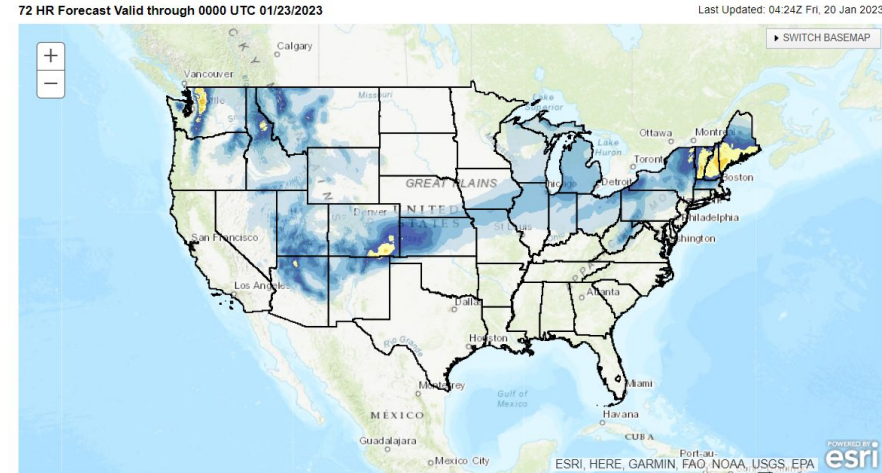


Provide feedback:

<https://www.surveymonkey.com/r/ProbWinterExp>

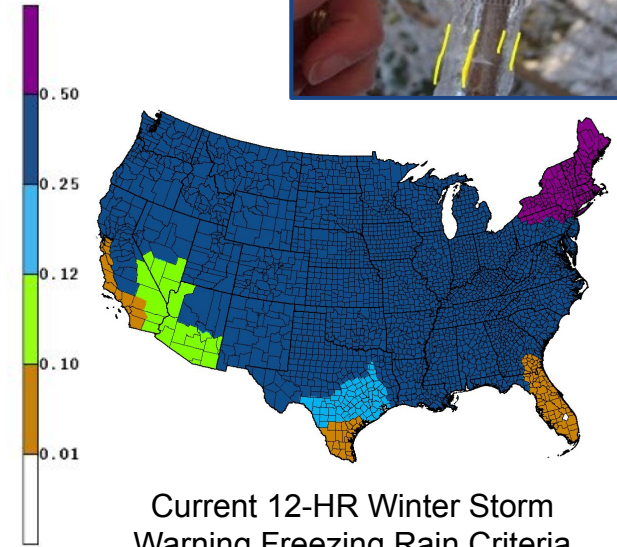
The New Probabilistic Precipitation Portal for Data Display and Access:

- The NWS is evaluating an **internal prototype** that displays the PWPF as well as PQPF (and eventually probabilistic ice forecasts).
- Collaborated probabilistic precipitation forecasts provides consistencies between WPC and among the WFOs
- Addresses the identified gap in the continuum of winter probabilistic products & services



Winter Program Future: Ice Initiatives

- Modernize WSW product freezing rain criteria
 - Impacts-based approach
 - Remove artificial boundaries
- JTTI project is currently funded to create a gridded ice analysis
 - Improved ice verification for calibration of products
 - Historical ice accumulation database
- Review of NWS policy for flat ice accretion forecasts - partners are asking for:
 - Flat ice accretion forecasts (roads)
 - Radial ice accretion forecasts (power lines, trees)



Current 12-HR Winter Storm
Warning Freezing Rain Criteria

Winter Program Vision: Putting Everything Together

- The NWS Winter Program is responsible for facilitating R2O activities that improve the NWS forecast and warning mission.
- National Center (WPC) and local (WFO) strengths are leveraged to provide state-of-the-art forecast information and decision support services as one unified agency forecast message to end users.
- We are working towards winter forecast products that are *probabilistic, collaborative, and impact-based*.





Update on Winter Weather Initiatives



Contributors:

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Alex Lamers
Jeff Waldstreicher
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Links:

WPC PWPF page:

https://www.wpc.ncep.noaa.gov/pwpf/wwd_accum_probs.php

Local office Experimental PWPF page:

<https://www.weather.gov/btv/winter>

Operational WSSI:

www.weather.gov/wssi

Experimental pWSSI:

https://www.wpc.ncep.noaa.gov/wwd/wssi/prob_wssi.php

Experimental WSO:

<https://www.wpc.ncep.noaa.gov/wwd/wso>

Questions? Eric.Guillot@noaa.gov

