Toward Probabilistic IDSS

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9th NOAA Ensemble Users Workshop
NCWCP, College Park, MD
August 22-23, 2023

Priorities & Action Strategies for the Future - "Ken's 10"

Short-Term/Quick Wins

- Slack/NWSChat Conversion
- Spot Forecast
- CMU Next Steps & Governance Update

Medium-Term

- Tsunami Program
- Weather.gov
- AWIPS in the Cloud

Long-Term/Strategic

- Ops Model & Staffing Requirements
- NWS IT Architecture & IT Governance
- DEIA: Recruitment & Retention
- Probabilistic IDSS/ Hazard Services

Completed:

- Radar Lite & Radar GIS – Access and Speed

Watchlist

Underway and Well in Hand

- Flood Inundation Mapping & Next Gen Water Modeling Framework
- Shift Flexibility Team
- DEIA Tiger Team Task Force

Emerging

- Next Gen Radar

Updated: Dec 19, 2022

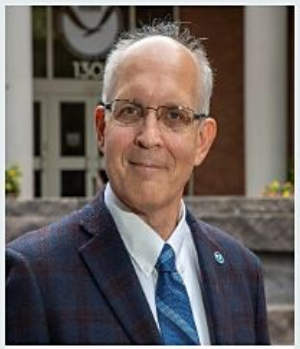
Change Initiative Charge

This **Probabilistic IDSS** Change Initiative was charged by Ken to:

- Develop the ability to assess and communicate science-based probabilistic forecast information to provide a range of scenarios to allow partners/customers to make informed decisions based on actionable user tolerances

Grant Cooper

Change Initiative Lead
(WR HQ)



Steve Smith

Change Initiative Lead
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Rich Bandy

Team Lead
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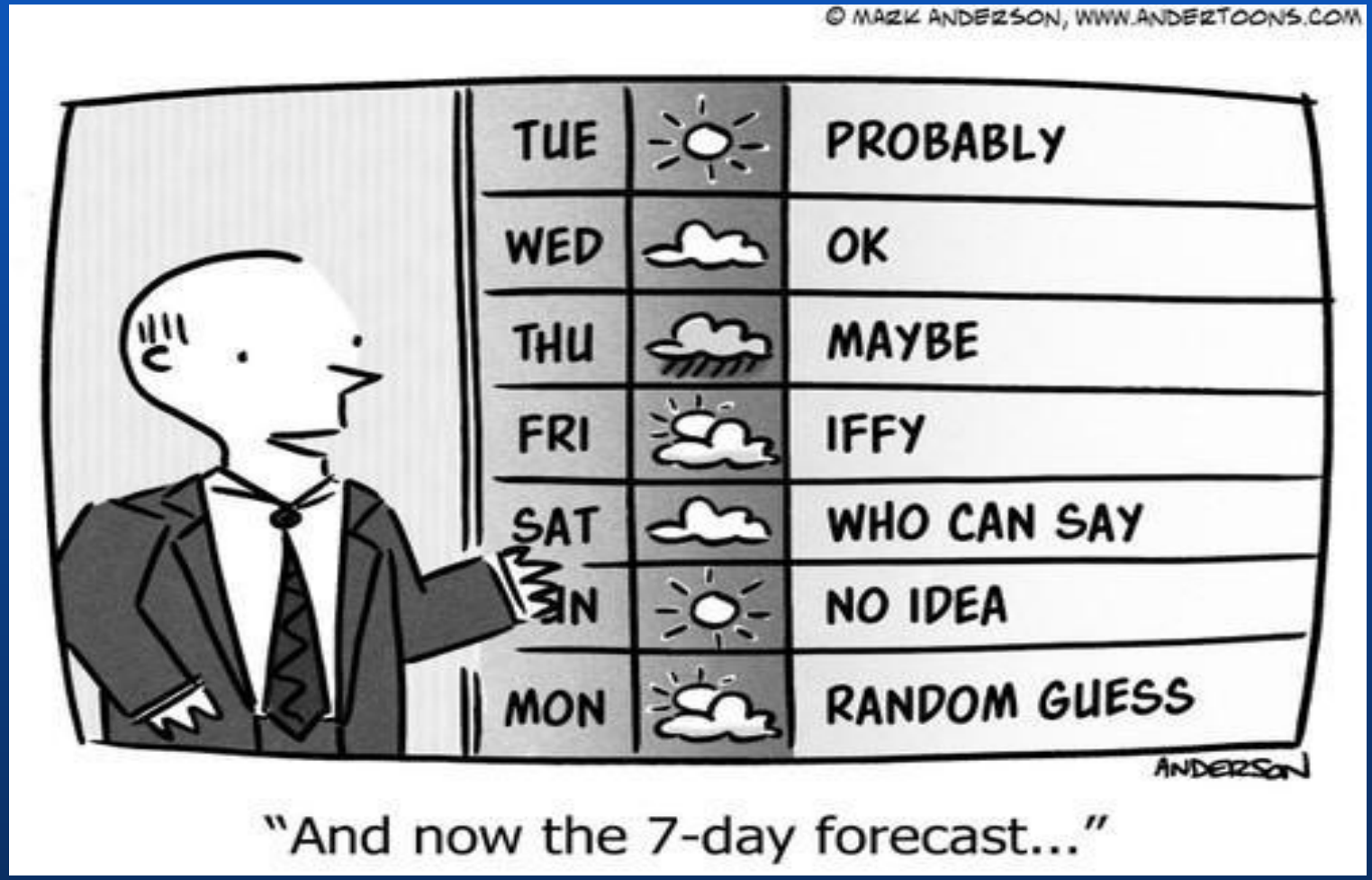
- Andy Foster (AFS)
- Bruce Smith (WFO GRR)
- Dana Strom (MDL)
- David Levin (AR HQ)
- Greg Mann (WFO DTX)
- J.J. Brost (OPG)

- Jeff Waldstreicher (ER HQ)
- Ji Sun Lee (STI)
- Kevin Scharfenberg (OCLO)
- Mark Glaudemans (AFS)
- Matt Jeglum (WR HQ)
- Jessica Brooks (CRH)

- Matt Moreland (SR HQ)
- Sarah Perfater (AFS)
- Justin Bienio (CMU Support)
- Kofi Sarfo-Kantanka (CMU Support)

Vision for Success



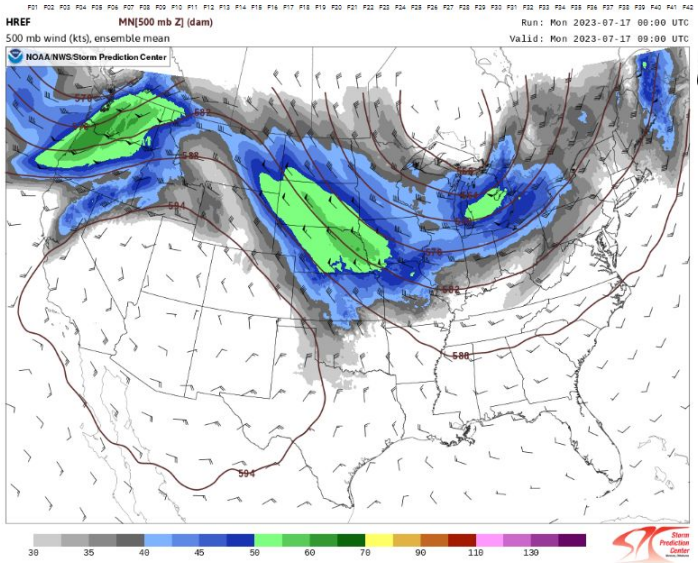
Vision for Success

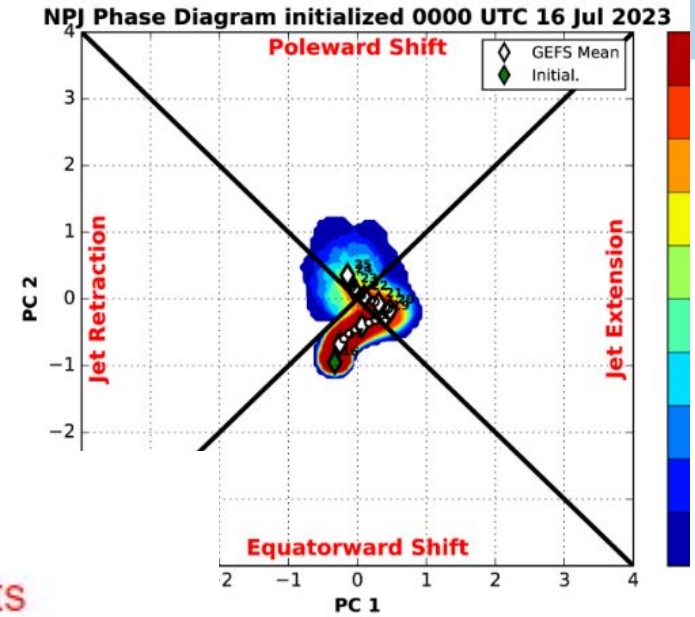
The Past

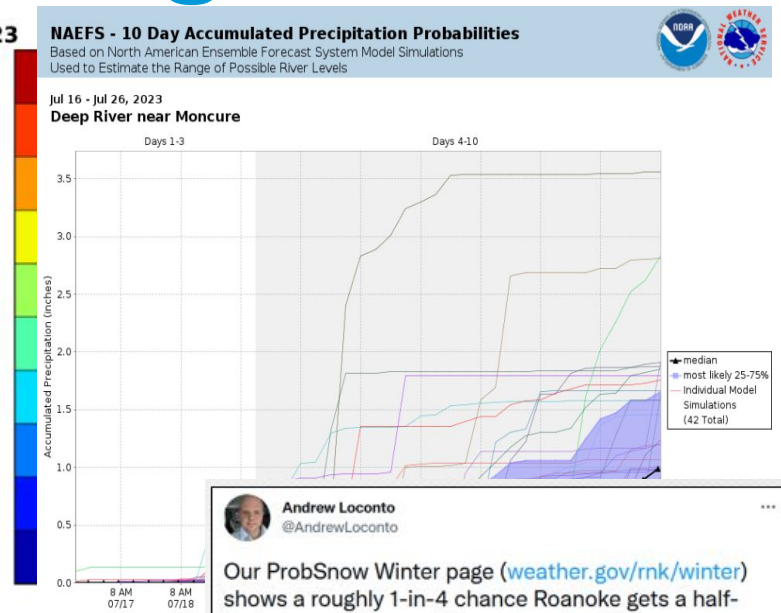
With Decision Support

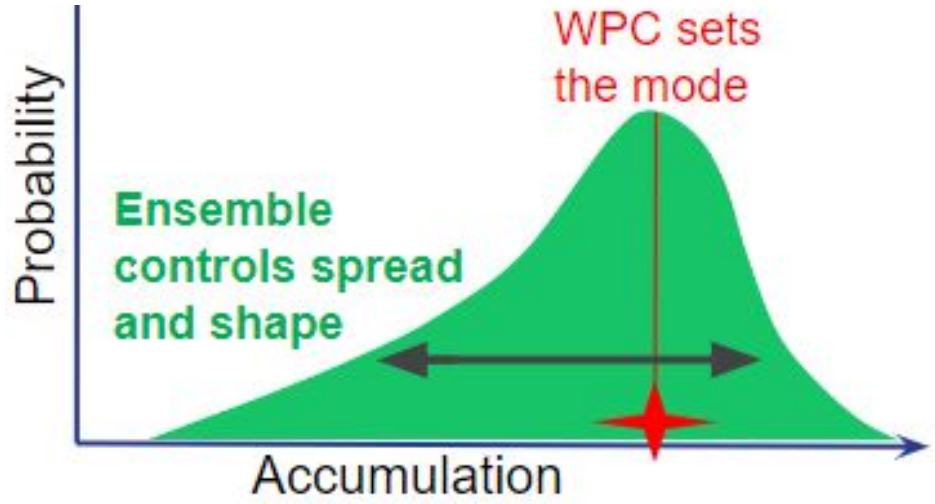
A successful implementation of Prob IDSS provides effective probabilistic guidance for our partners and the public to make informed risk-based decisions based on their unique circumstances, risk tolerances, and decision thresholds for all time scales from minutes to months.

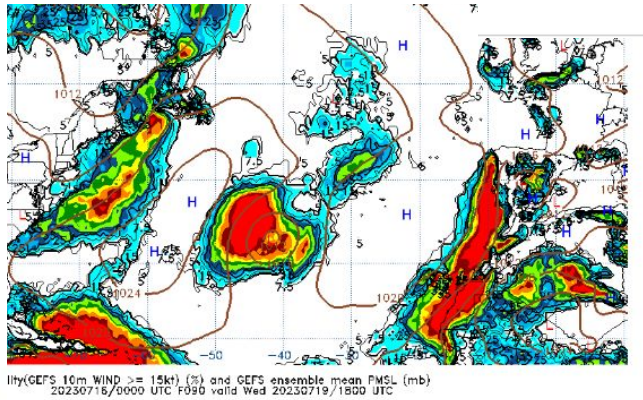
Aren't We Already Doing This?

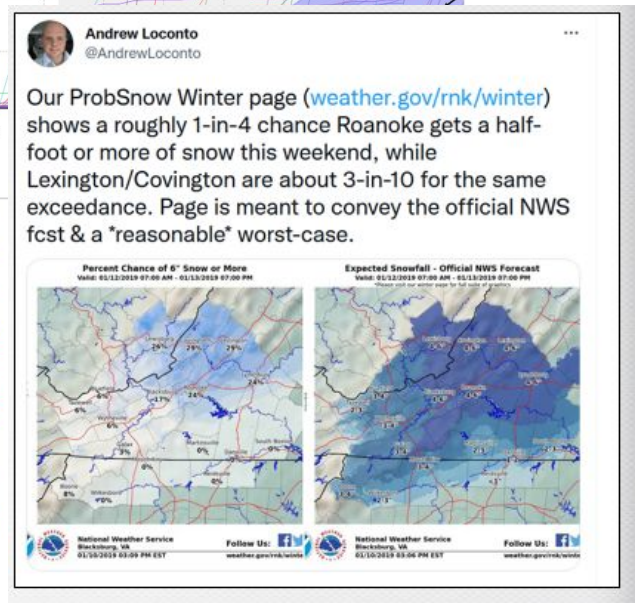




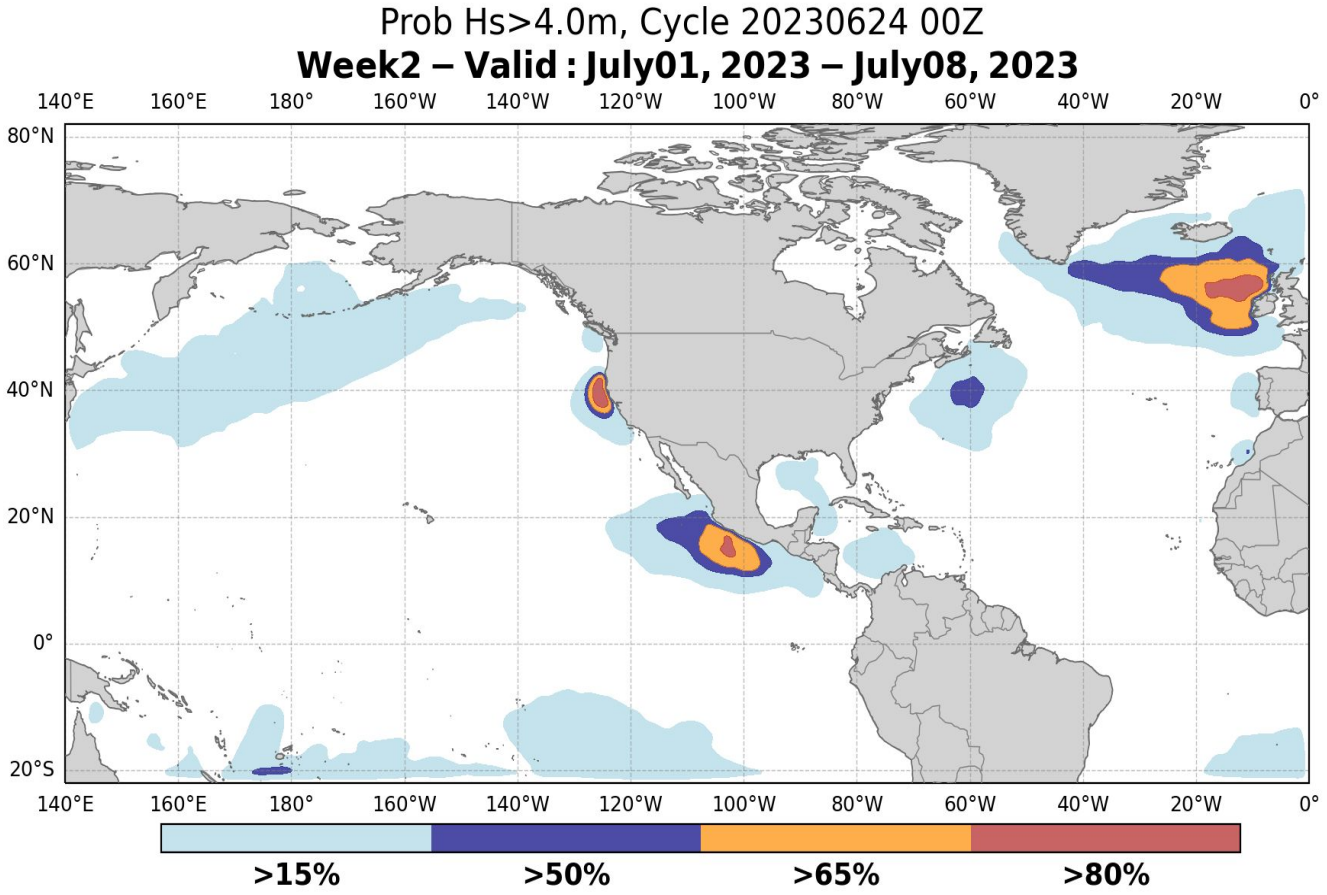


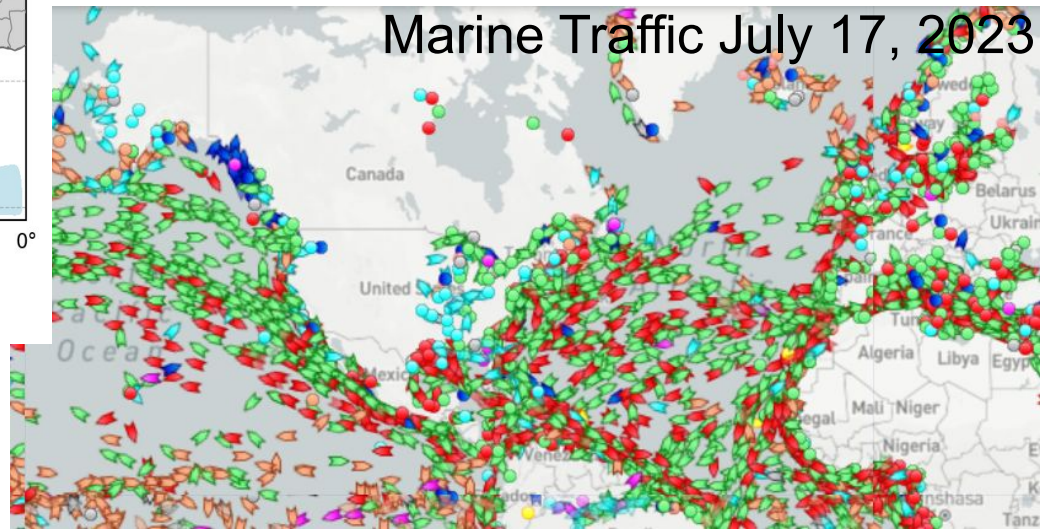






GEFS-based Probability of Wave Heights exceeding 4m

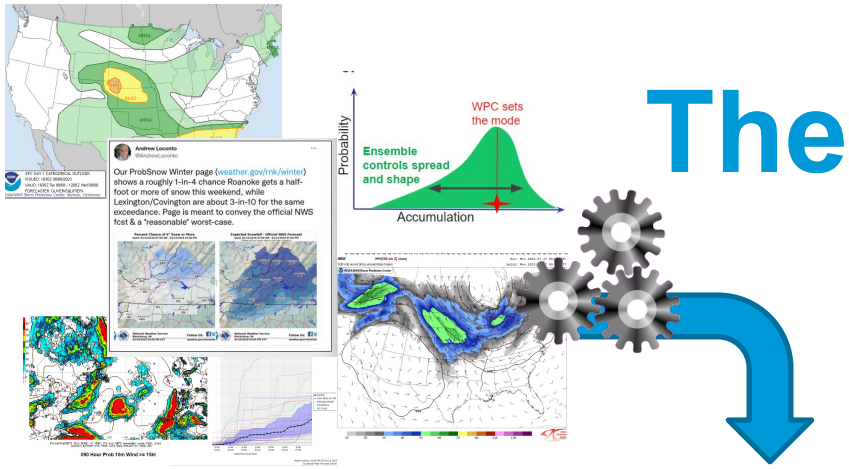




credit: Ricardo Campos, CIMAS affiliate

Sarah Perfater
Jeff Waldstreicher

The ProbIDSS Portal



ProbIDSS Team and additional experts populated a repository of data, projects and products based on the 6 Organizational Pillars as the First Deliverable

NOAA

File Automation Forms — Prob IDSS Portal (DRAFT) — Share

Grid View | Filter | Arial | 10

	Pillar	Data / Project / Product / Service	Brief Description	Organizing Entity (AFS, STI, OAR, WPC, Region, etc	Funding Source (if applicable)	NWS Governance Status (if applicable: CaRDS, MDC/P	Readiness for Operations (within 1 year, 1-3 years	References (Background, hyperlinks, etc)
1	Foundational Data	GEFS	Global Ensemble	EMC			Ready	
2	Foundational Data	HREF (EMC)	Regional Ensemble of opportunity	EMC			Ready	https://www.emc.ncep.noaa.gov/us
3	Foundational Data	HREF (SPC)	Regional Ensemble of opportunity	SPC			Ready	https://www.spc.noaa.gov/exper/hr
4	Foundational Data	SREF	Regional Ensemble	EMC			Ready	
5	Foundational Data	RTMA/URMA	Mesoscale analysis	EMC			Ready	
6	Foundational Data	NBM	Post-processed super ensemble	MDL			Ready	
7	Foundational Data	GEFS reforecasts	Reforecasts of GEFS back 20 years	EMC			Ready	
8	Foundational Data	P-ETSS	Probabilistic Stratropical Storm Surge	MDL			Ready	
9	Foundational Data	Probabilistic medium-range hazards guidance with an FV3-based convection-allowing ensemble and machine learning	Hazardous Weather Testbed Project	Craig Schwartz (PI), Ryan Sobash, Lucas Harris (NCAR/GFDL)	WPO FY22 Testbed Project			
10	Foundational Data	FV3-LAM CAM Ensemble Forecast System and Improving Ensemble Probabilistic and Consensus Forecast Products in Support of HMT Winter Weather and Heavy Precipitation Forecasting	Hydrometeorology Testbed (WWE) Project	Keith Brewster (PI), Nathan Snook (Co-PI), Timothy Supinie (Co-PI) OU, Ming Xue (Co-PI)	WPO FY22 Testbed Project			
11	Foundational Data	RRFS (Rapid Refresh Forecast System) ensemble	3-km storm-scale ensemble prediction system with about 10 members. Under development but being used by various testbeds	EMC and GSL			within 1-3 years (implementation plan is Q4 FY2024)	
12	Foundational Data	Proton Prediction Model	Provides probabilistic based output for various levels of energetic proton energy levels and flux expectations. Mainly empirical and statistical in nature	SWPC			Ready and in use	
13	Foundational Data	WSA-Enlil Model	Provides CME arrival solutions based on	SWPC			Ready and in use	

A Database of Existing Probabilistic Efforts

- Inputs range from discovery to operational
- Spans across Line offices (i.e. NWS, OAR)
- Includes activities developed within NWS as well as through funded research
- Can use the information to identify gaps as well as connect themes
- Can use to identify areas to which SBES must be applied

Enabling Probabilistic IDSS

Applying Social, Behavioral and Economic Science

Innovative Technological Development

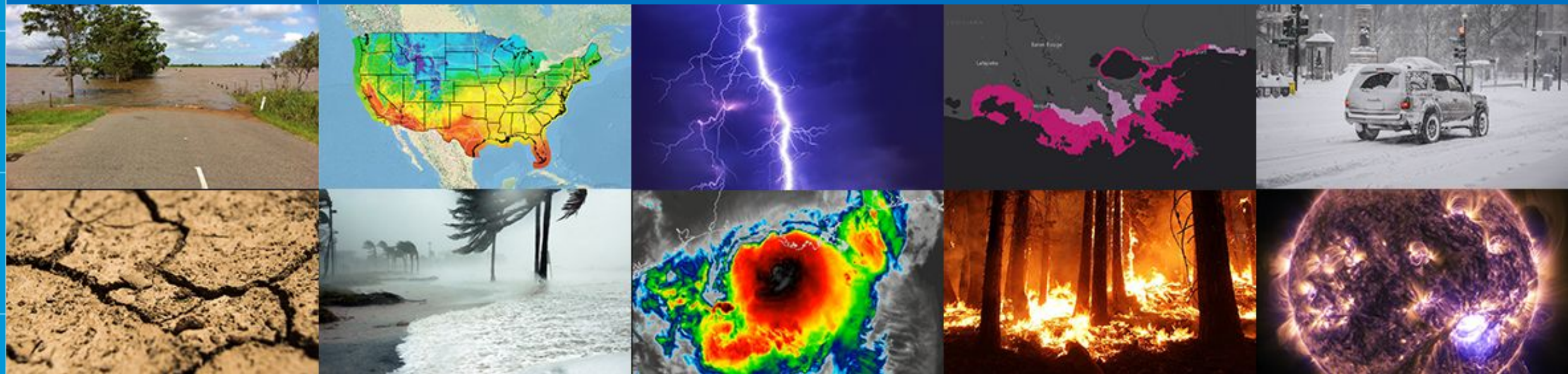
Evidence-based Testing and Evaluation through NOAA's Testbeds and the Operations Proving Ground

NATIONAL WEATHER SERVICE

DRAFT

Probabilistic IDSS Goals and Key Objectives

DRAFT In Review-August 2023

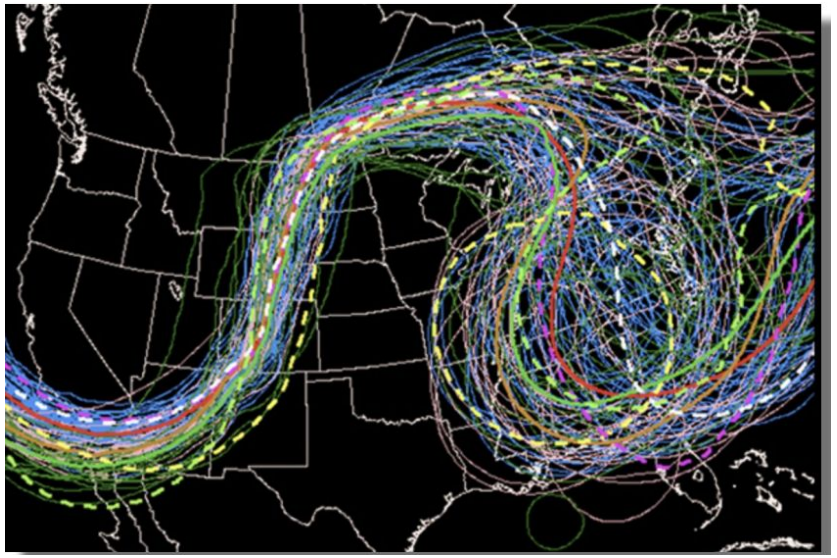


A Path to Enable Probabilistic IDSS (Our Narrative)

1. We need foundational probabilistic data that is good enough that our scientists don't want to spend time modifying it. This will give us high quality information with enough time left to analyze and effectively communicate it.
2. We need a way to interrogate, visualize, and disseminate this data that is portable, fast and operationally supported.
3. We need to develop a depth of relationship that allows us to know what decisions our users are making and the thresholds and times at which they make those decisions . We ask "What decisions do you need to make?" not "What do you want?".
4. We need scientists that can identify and interpret meteorological, hydrological, and climatological phenomena and communicate in a way that acknowledges uncertainty and is clear to the decision maker.
5. We need an operating model that allows our scientists to maximize their capability to support decision makers.
6. We need to close the feedback loop. Meteorological and SBES data is used to assess both the quality of our forecasts and user decisions to ensure we are meeting our mission.
7. We need a robust continuous training model, that allows our forecasters to "train like they fight".

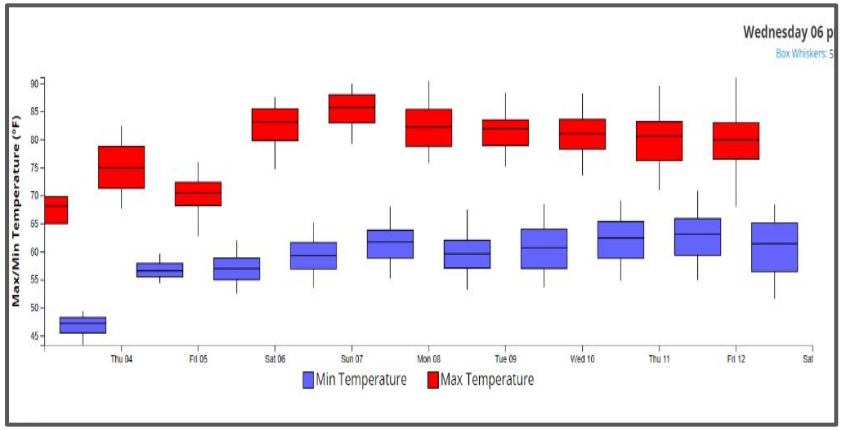
“Ensemble Fluency” Training, FY24 Q2

Primary learning objectives



Statistics/probabilities basics

- Appropriate distributions: Gamma vs. Gaussian, etc.
- Visualizations: Violin plots vs. box/whiskers, etc.
- Introduction to cost-loss problems



Understanding resolvability

- Comparing characteristics of ensemble systems with temporal & spatial scales of potential hazards
- Blending techniques strengths/weaknesses

Ensemble Fluency Training

- Expected to be mandatory for all operational meteorologists, hydrologists, and IDSS providers
- Target delivery by January 31, 2024 - duration of training TBD
- Prerequisites TBA soon

Details in Session 6a, presentation by Jason Jordan, Forecast Decision Training Division

Ensemble Prediction System Needs to Support Probabilistic IDSS

What is the goal?

"Meteorologists tend to view forecasting as a description of nature, rather than as inputs to a decision process." *-Eva Regnier, NPS*

- The end goal of ensemble forecasting is not reliability, skill over climatology, or ideal dispersion.
- Instead, it is to help people make good risk-based decisions in the face of weather uncertainty!
- As we think about ensembles and how they are used, we should keep that goal in mind.

Ensemble Prediction System Improvements

- EPS under-dispersion
- Improved representation of extreme events
- Reforecasts for as many systems as possible with every update
- Parity of ensemble with deterministic. No more GFS?

Post-Processing Improvements

- Raw data is not what is best for the field. We need a top-tier post-processed probabilistic database. NBM is an example.
- This is the reason for the reforecasts - Lots of training data
- AI/ML applications - It's trendy but has huge promise
- Analysis of record - Post-processing is only as good as your truth

Access to Ensemble Data

- NWS Data Lake – Cloud-based access
- Display tools for forecasters to interrogate ensemble data
  - Examples – DESI and WSUP
  - Current official tools are *extremely* limited for probabilistic analysis

Hydrologic Ensemble Forecasts

- HEFS currently uses only GEFS mean QPF
- Multi-ensemble framework would help
- Need to leverage member data to calibrate met forcings
- Also requires reforecast/analysis

Questions for Discussion

- How can EPS forecasts of extreme/hazardous weather be improved to support probabilistic IDSS?
- How can AI/ML post processing be leveraged to improve the quality of EPS information?
- How can access to full resolution ensemble data for operational forecasters and application developers be improved?
- How can we create/support a robust R2X environment for developer-forecaster interaction and evaluation of ensemble interrogation tools?

Thank You!