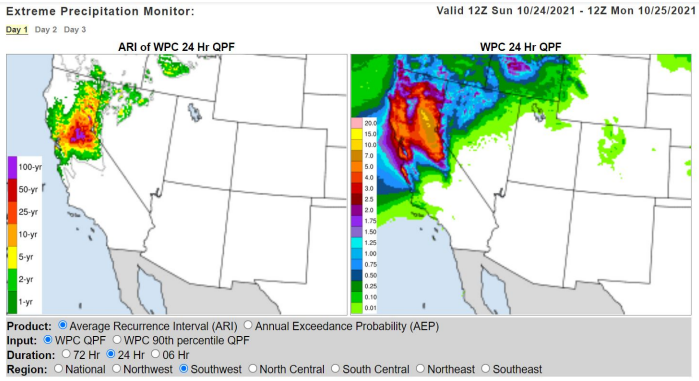
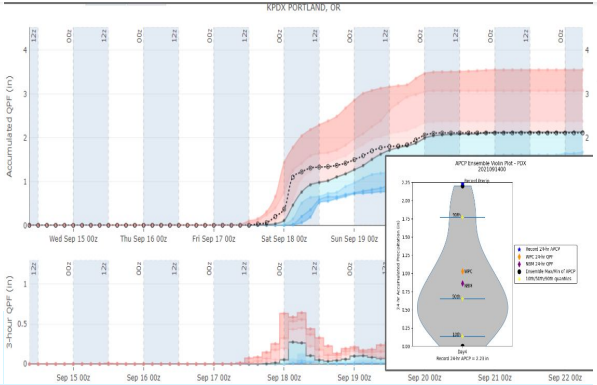
QPF Services, Challenges, and Verification at the Weather Prediction Center

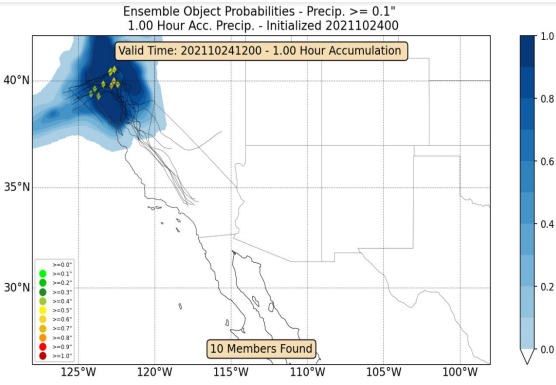
Ninth Annual Forecast Informed Reservoir Operations (FIRO) Workshop

NATIONAL WEATHER SERVICE

Brian Hurley, Senior Branch Forecaster
Dr. David Novak, Director
Kathryn Gilbert, Deputy Director
Benjamin Albright, Meteorological Developer, Systems Research Group







The Weather Prediction Center

MISSION: Provide national weather situational awareness and precipitation expertise to enable readiness for hazardous weather events

National Weather Situational Awareness

- Heavy Rainfall
- Winter Weather
- Temperature Extremes

Lead R2O-O2R to Advance Winter Weather, Extreme Rainfall, and Extended Range Forecasts

Serve as forum to bring meteorologists, hydrologists, modelers, and academics together to improve forecasts

–Test new forecasting and verification techniques

–Evaluate deterministic and ensemble models, with focus on UFS components

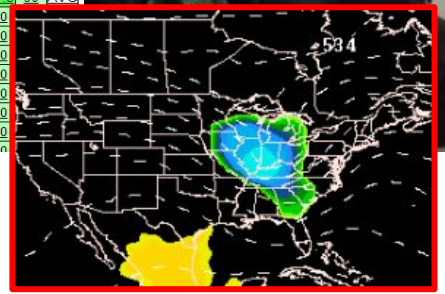
–Leverage social science to aid product design and test effective communication

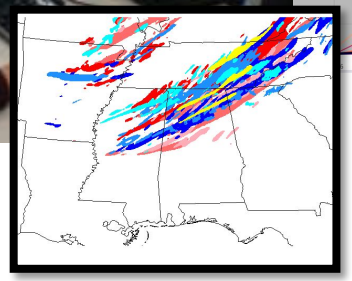
Ensembles Are In Our DNA

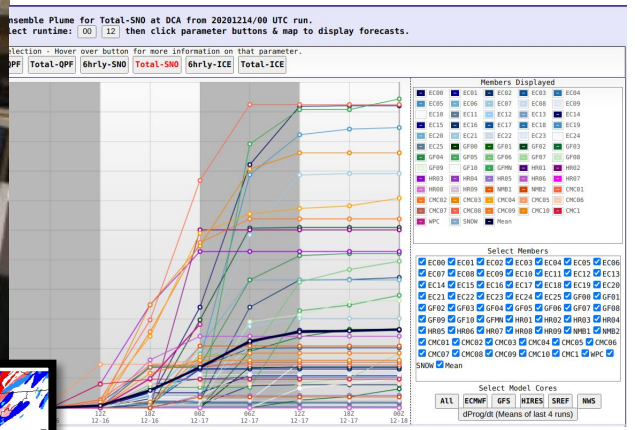
CWA SGX Table Feb 26, 2014 00Z Run

Forecast Hour

			Z	T	U	V	WSP	SLP	Q	PW	IVT
6	Wed 26th	06Z	AVG	97.5	AVG	90	AVG	AVG	97.5	90	AVG
12		12Z	AVG	97.5	AVG	AVG	AVG	AVG	90	90	AVG
18		18Z	AVG	90	90	AVG	AVG	AVG	90	90	90
24	Thu 27th	00Z	AVG	90	90	AVG	90	AVG	90	90	90
30		06Z	90	90	97.5	90	90	AVG	99	97.5	90
36		12Z	90	90	97.5	AVG	90	AVG	99	97.5	90
42		18Z	90	97.5	97.5	AVG	90	AVG	99	97.5	90
48	Fri 28th	00Z	90	90	99	AVG	97.5	AVG	97.5	90	90
54		06Z	10	AVG	97.5	90	97.5	10	99	97.5	97.5
60		12Z	2.5	90	90	99.5	99	2.5	99.5	99	99.5
66		18Z	2.5	90	97.5	99.5	99.5	2.5	99	99.5	MAX
72	Sat 1st	00Z	2.5	AVG	97.5	99.5	99.5	1	99.5	99	MAX
78		06Z	2.5	90	90	99	99	1	99.5	97.5	99
84		12Z	2.5	90	90	97.5	97.5	2.5	99	90	97.5
90		18Z	10	90	90	97.5	90	10	97.5	90	90
96	Sun 2nd	00Z	10	90	90	90	AVG	10	97.5	90	90
102		06Z	AVG	AVG	AVG	AVG	AVG	AVG	97.5	90	AVG
108		12Z	AVG	AVG	AVG	AVG	AVG	AVG	90		
114		18Z	AVG	AVG	AVG	AVG	AVG	AVG	90		
120	Mon 3rd	00Z	AVG	AVG	AVG	AVG	AVG	AVG	90		
126		06Z	AVG	AVG	AVG	AVG	AVG	AVG	90		
132		12Z	AVG	AVG	AVG	10	AVG	AVG	90		
138		18Z	AVG	AVG	AVG	10	AVG	AVG	90		
144		00Z	AVG	AVG	AVG	AVG	AVG	AVG	90		

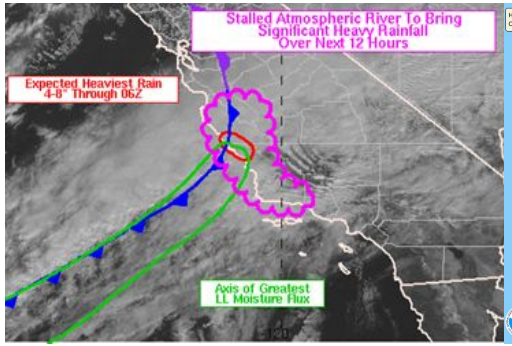




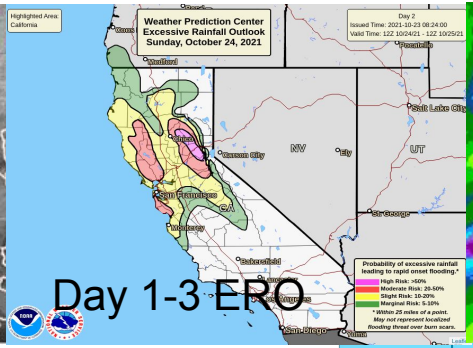


- WPC receives extensive ensemble data and has tools to incorporate into the forecast
- Deep knowledge of model/ensemble biases
- Co-located with EMC, with post-event model analysis to learn more

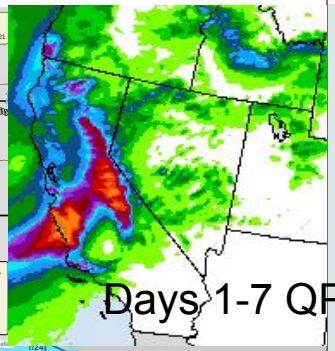
Atmospheric Rivers and WPC Services



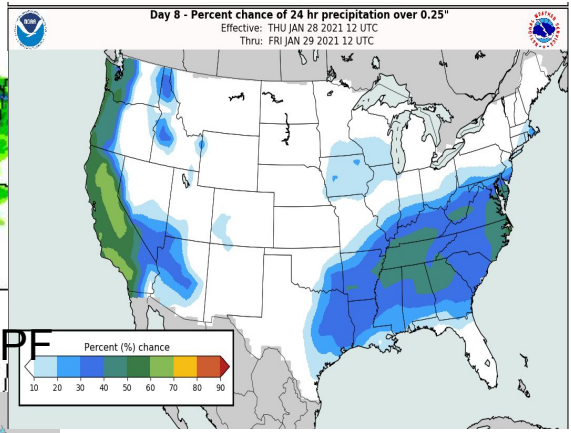
Mesoscale Precipitation Discussions



Day 1-3 ERO



Days 1-7 QPF



Hazards Outlook

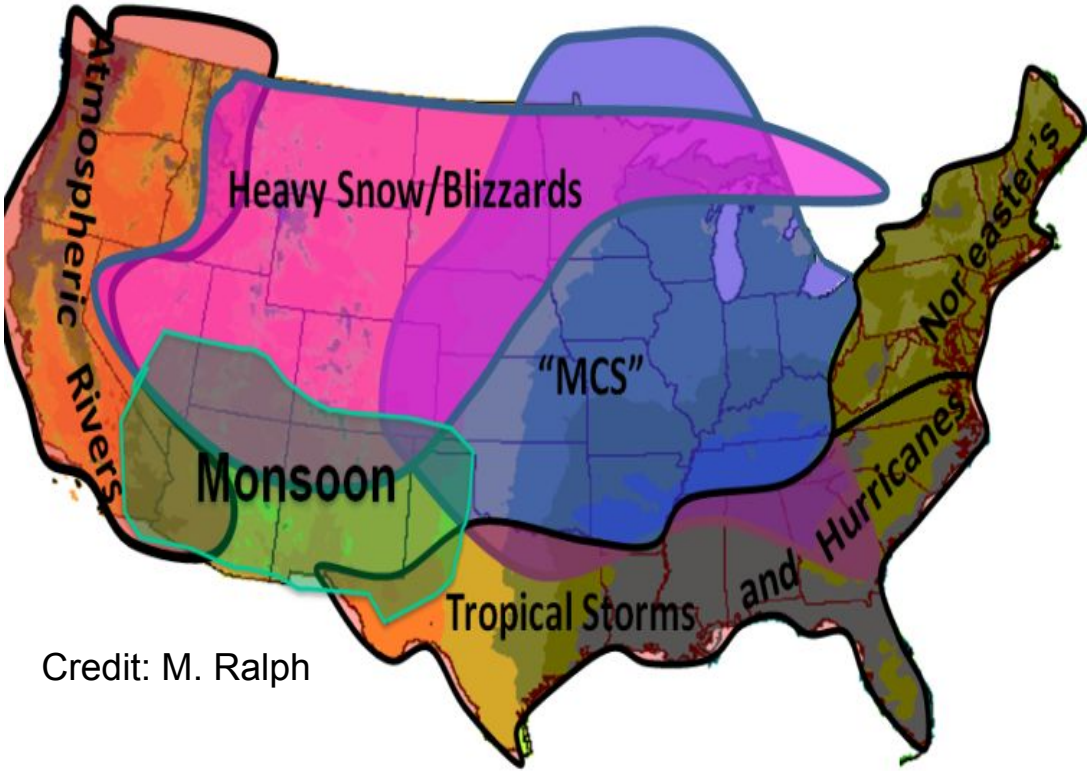
Prototype Day 8, 9, 10

Hours | Days | Week

Underpinned by Specialized Post-processing Tools and Techniques

Precipitation Prediction is a Probabilistic Endeavour

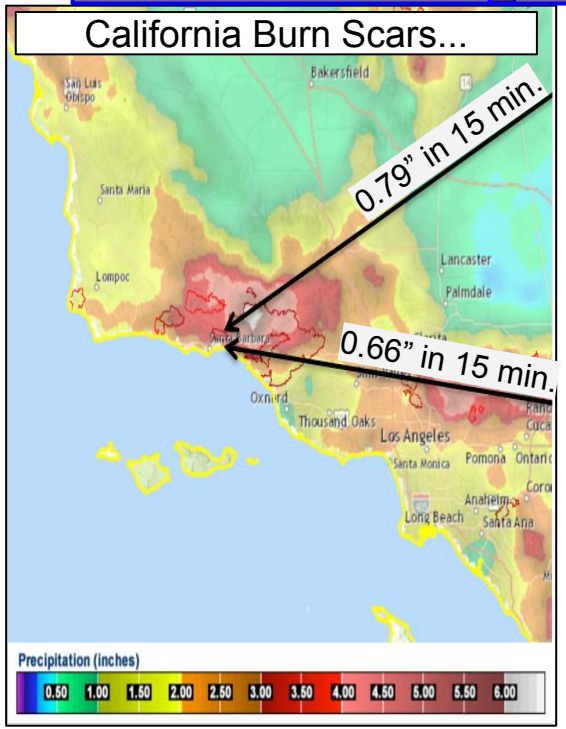
...There are Various Precipitation Hazards

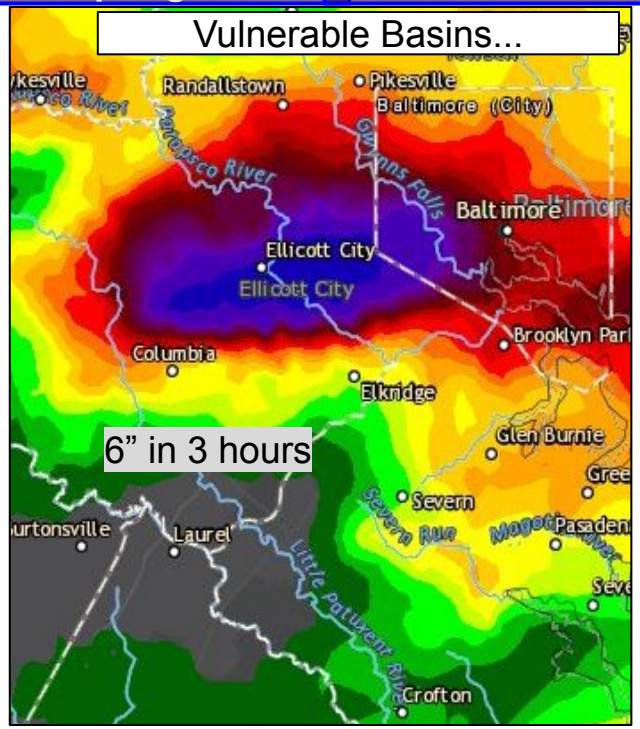


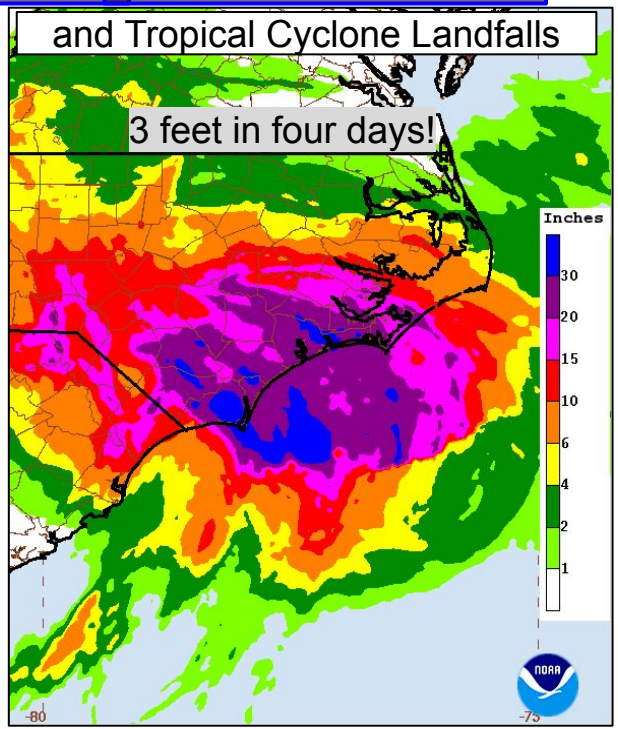
Credit: M. Ralph

...Occuring on Different Space & Time-scales

Winter | Spring | Summer | Fall



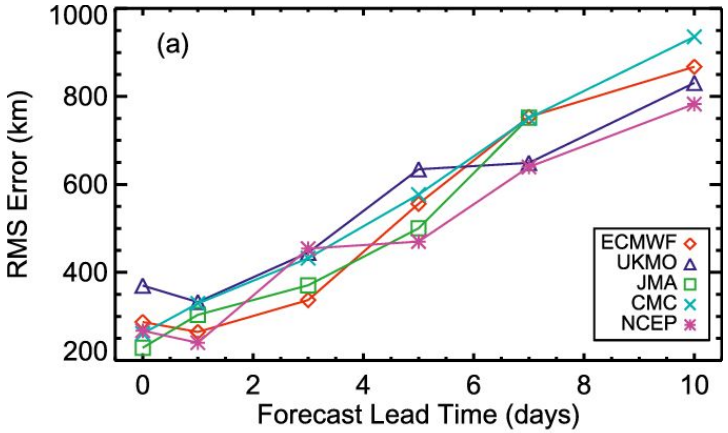




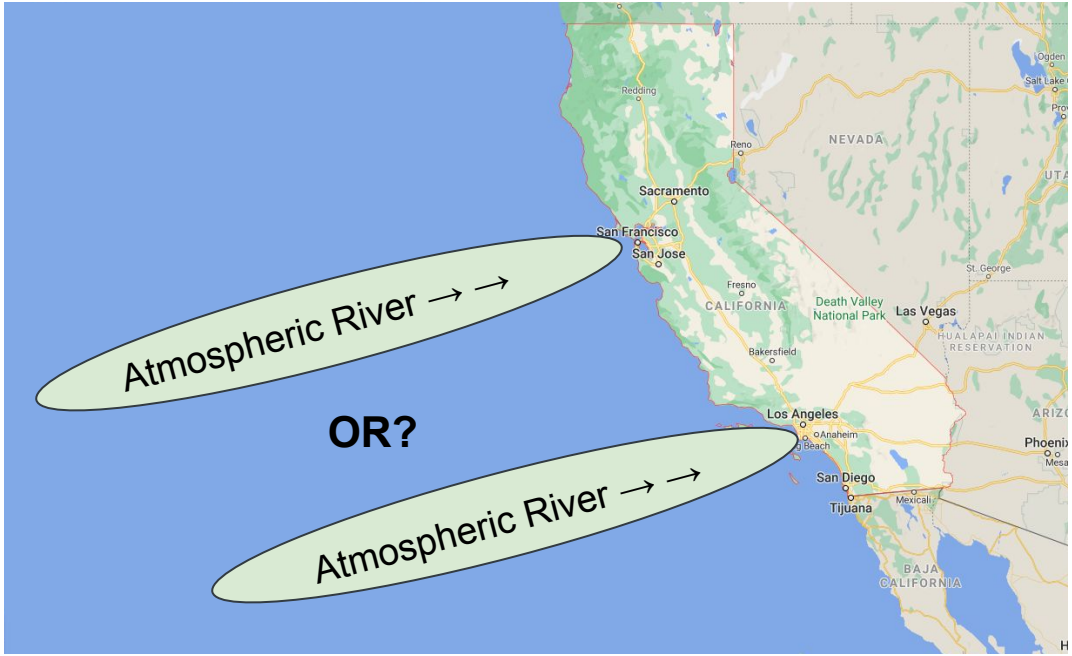
...with Different Predictability

Atmospheric River Challenge (6 Days)

The average error of the landfall point of an atmospheric river hitting California 6 days in advance is the distance between San Francisco and Los Angeles



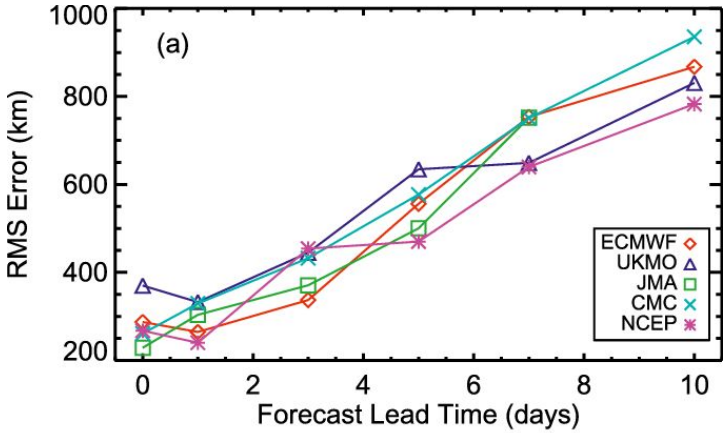
Wick et al. (2013)



...with Different Predictability

Atmospheric River Challenge (2 Days)

The average error of the landfall point of an atmospheric river hitting California 2 days in advance is the distance between Los Angeles and San Luis Obispo



Wick et al. (2013)

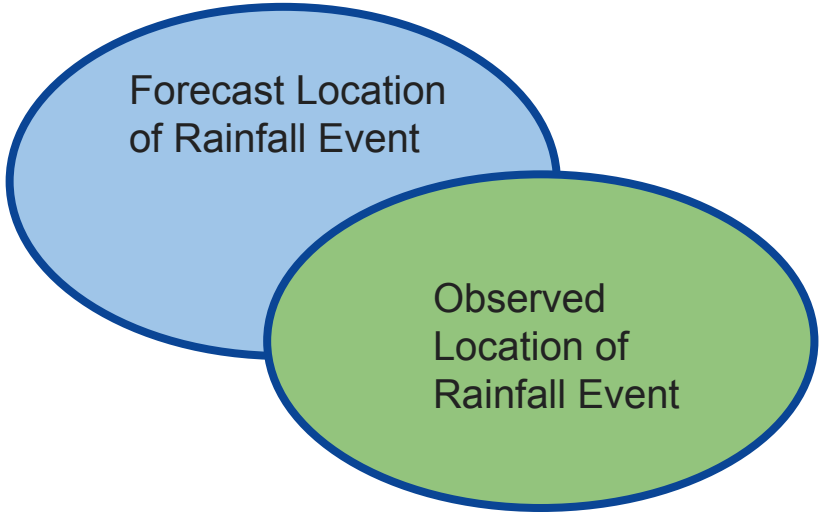
QPF Verification

- Regional Critical Success Index for the 2020-2022 cool seasons (composite)
  - Data compiled by Ben Albright (WPC)
  - Day 3 24 hour Quantitative Precipitation Forecasts (QPF), valid at 00Z
  - 1.00 inch threshold (CONUS)
  - 2.00 inch threshold (Western CONUS)

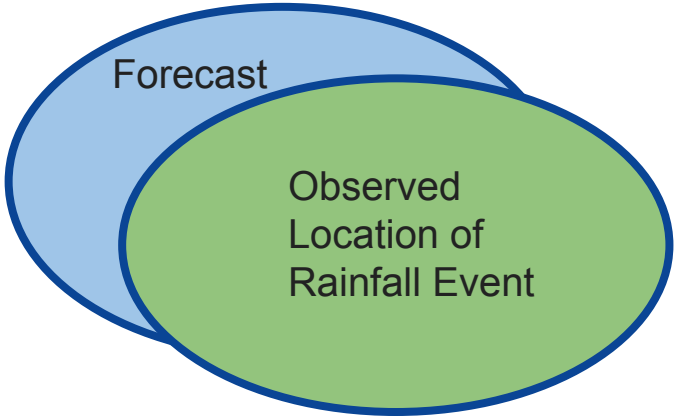
What does a Threat Score Mean?

Threat Score of 0 = NO overlap between forecast & observed location.
Threat Score of 1 = COMPLETE overlap between forecast & observed location.

25% Overlap =
Threat Score of 0.15

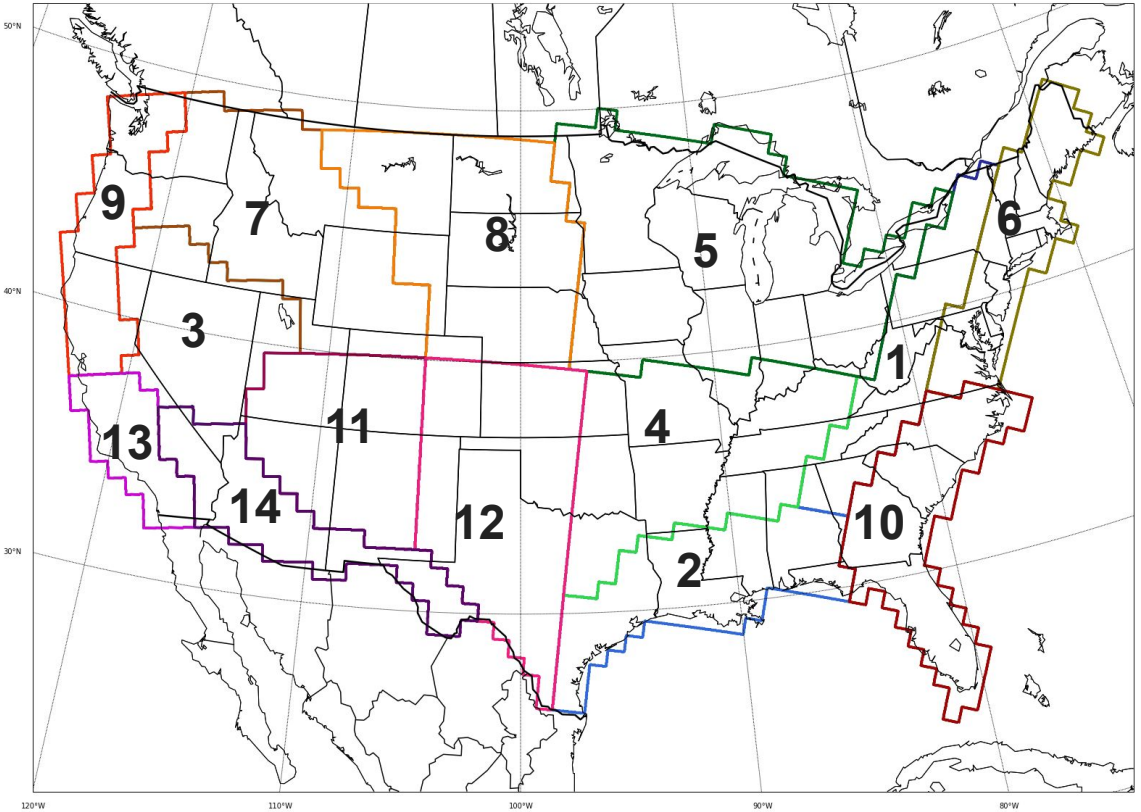


66% Overlap =
Threat Score of 0.50



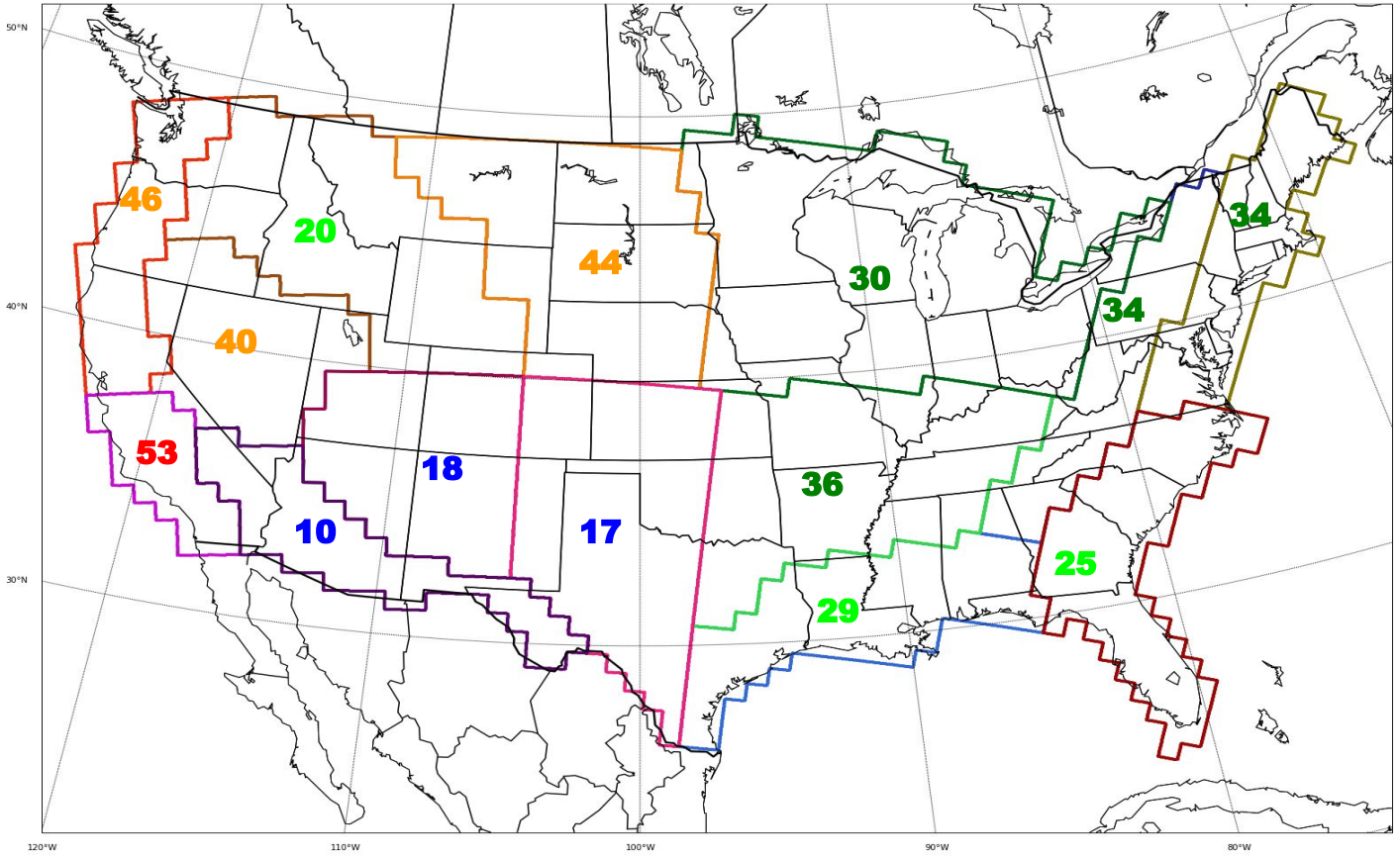
Critical Success Index (CSI) and frequency bias calculated over 14 distinct regions in the CONUS:

1. APL -- Appalachians
2. GMC -- Gulf of Mexico Coast
3. GRB -- Great Basin
4. LMV -- Lower Mississippi Valley
5. MDW -- Midwest
6. NEC -- Northeast Coast
7. NMT -- Northern Mountains
8. NPL -- Northern Plains
9. NWC -- Northwest Coast
10. SEC -- Southeast Coast
11. SMT -- Southern Mountains
12. SPL -- Southern Plains
13. SWC -- Southwest Coast
14. SWD -- Southwest Desert



Regional Verification for the 2020-21 and 2021-22 Cool Seasons (Oct - Mar)
Day 3, One Inch Threshold

50+
40s
30s
20s
10s



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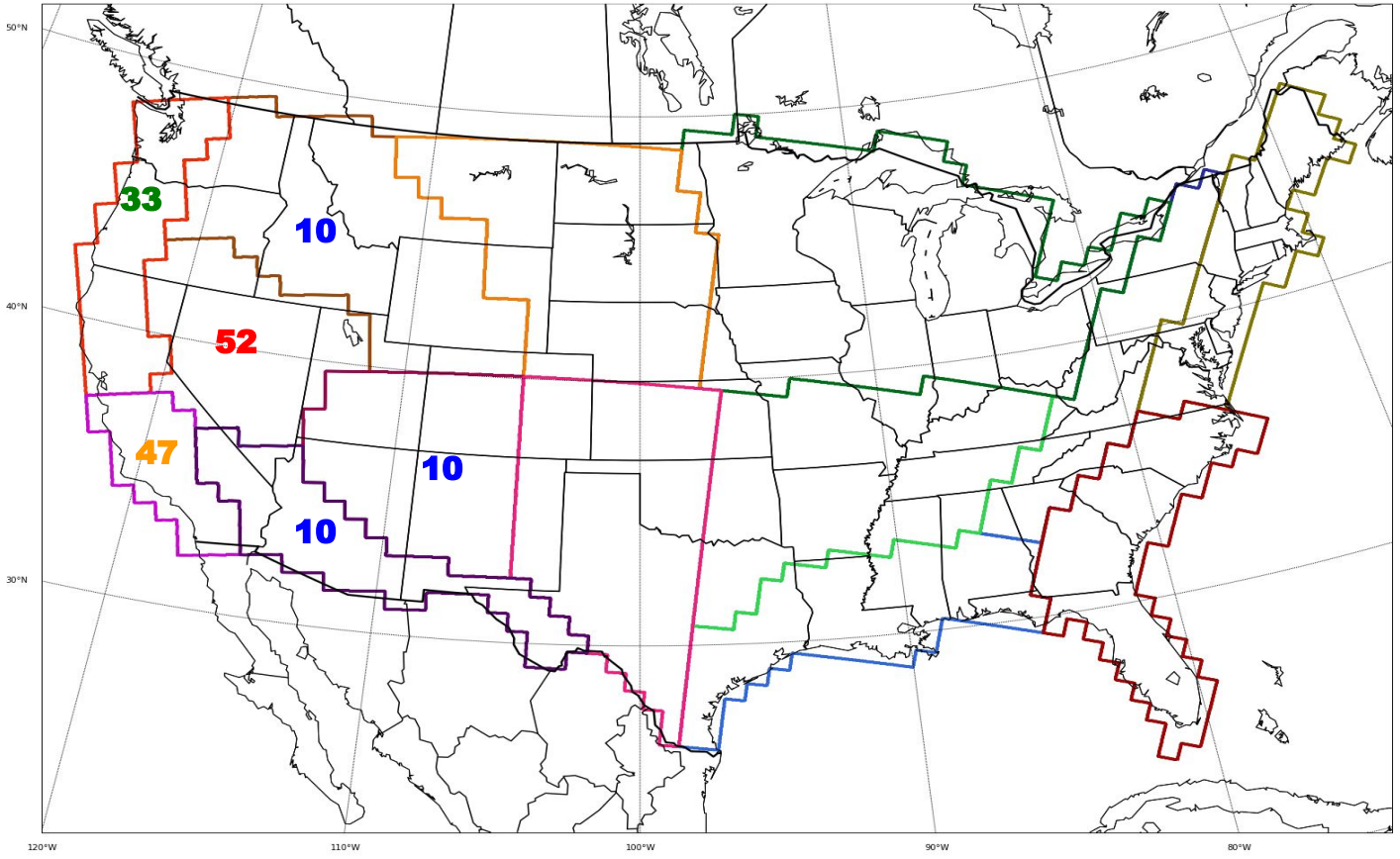
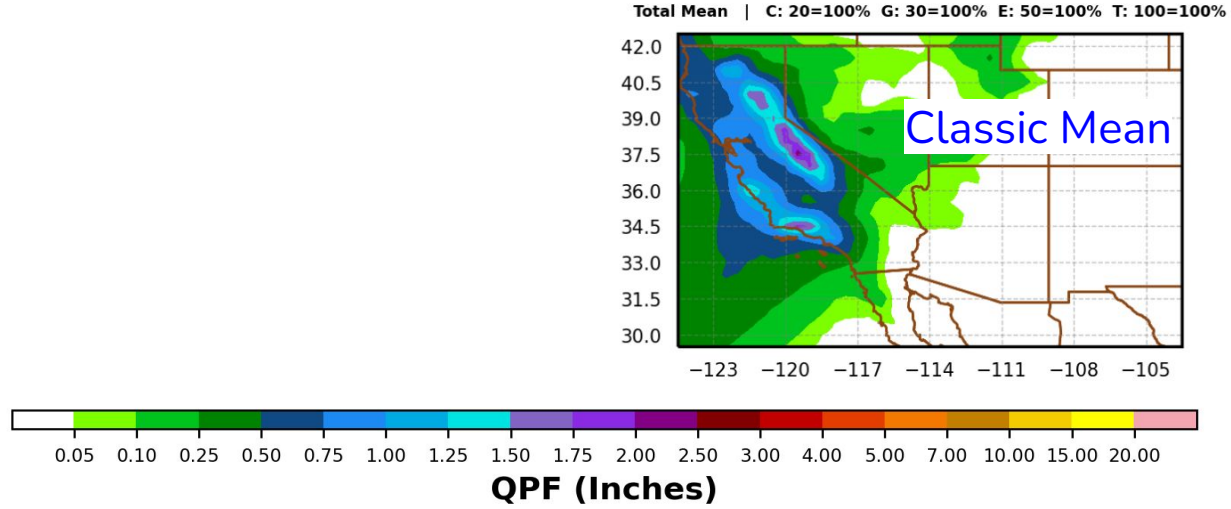


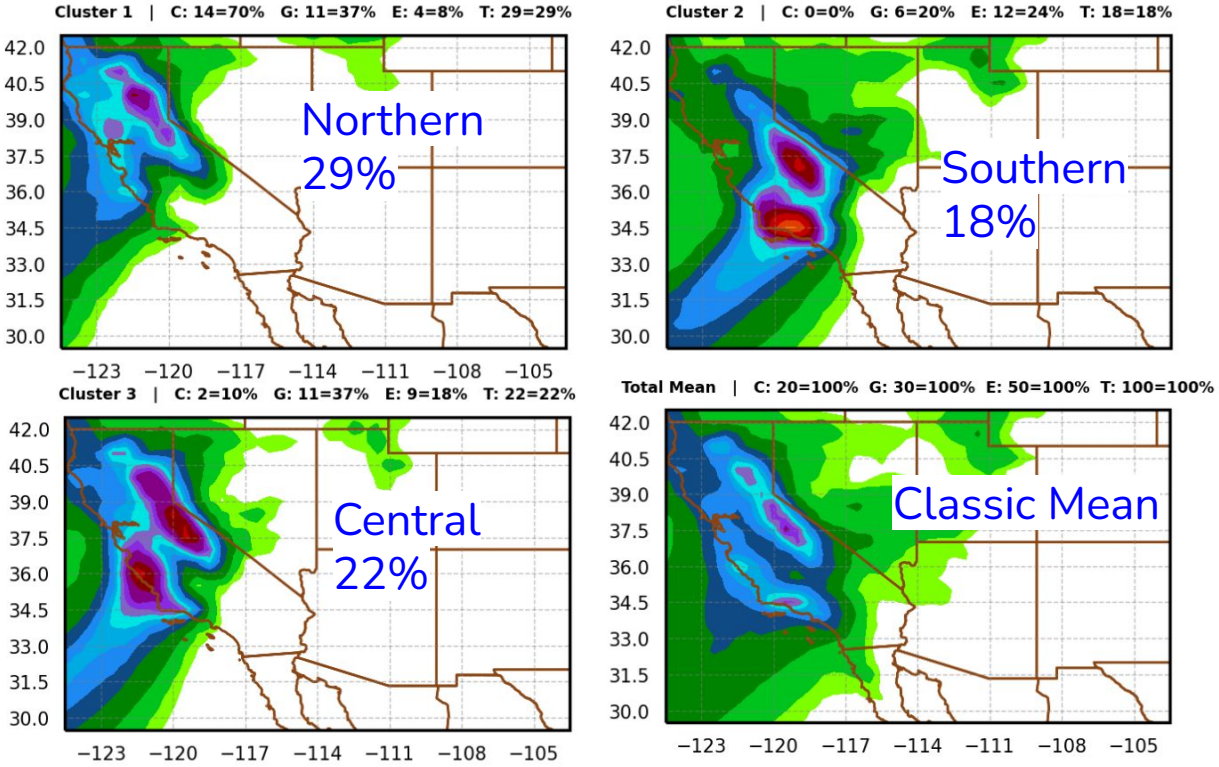
Objective Scenarios

What kind of solutions is this mean composed of?



Init: 0000 UTC Sat Jan 23 2021 Valid: 24-hours Ending 0000 UTC Fri Jan 29 2021

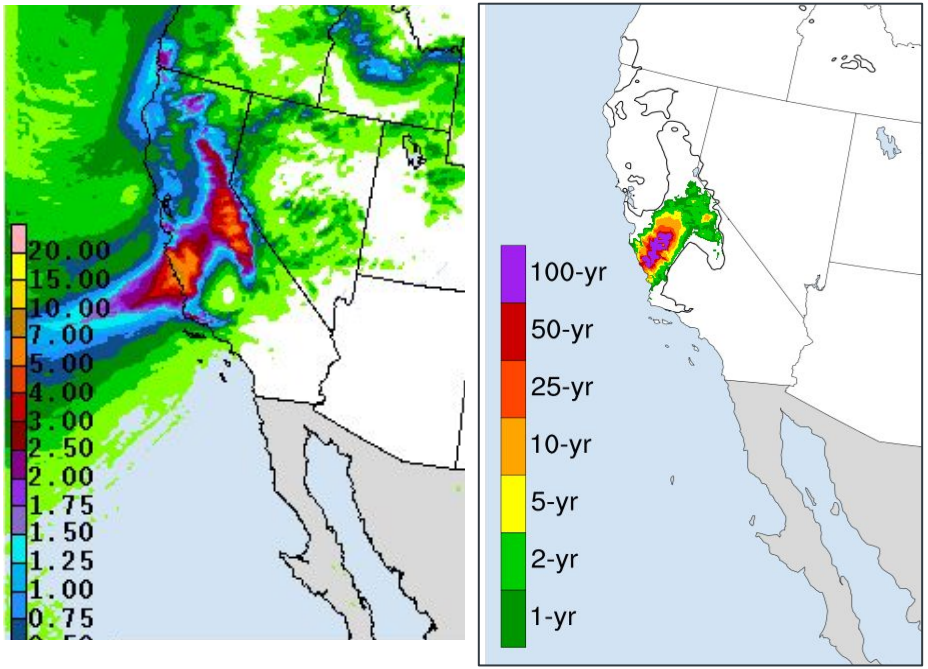
Fairly even split between the latitude of AR landfall - not evident in full mean



Putting the Forecast in Context

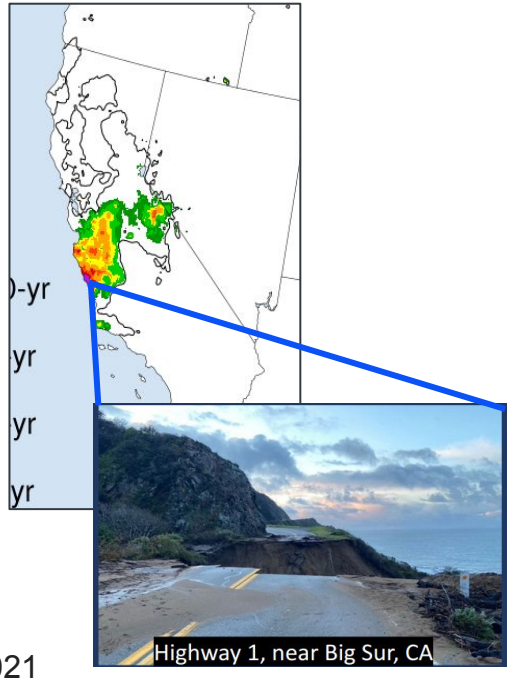
"How rare is that forecast?"

Day 1 24-hr Forecast

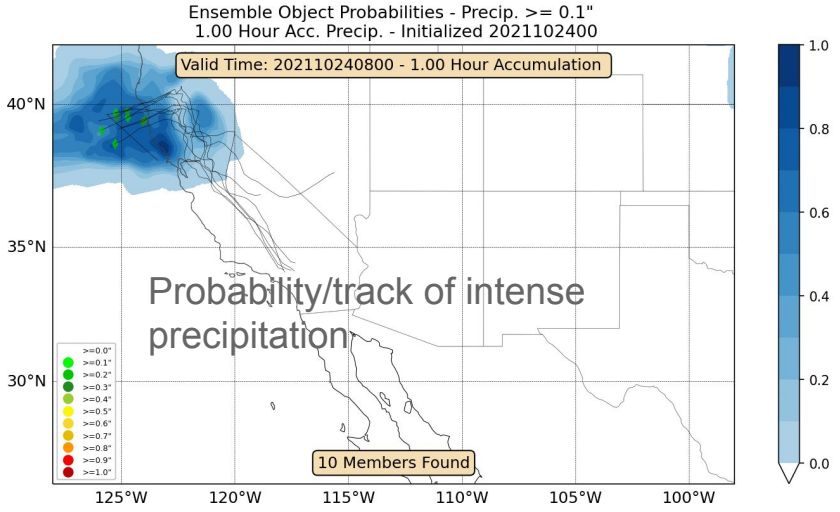


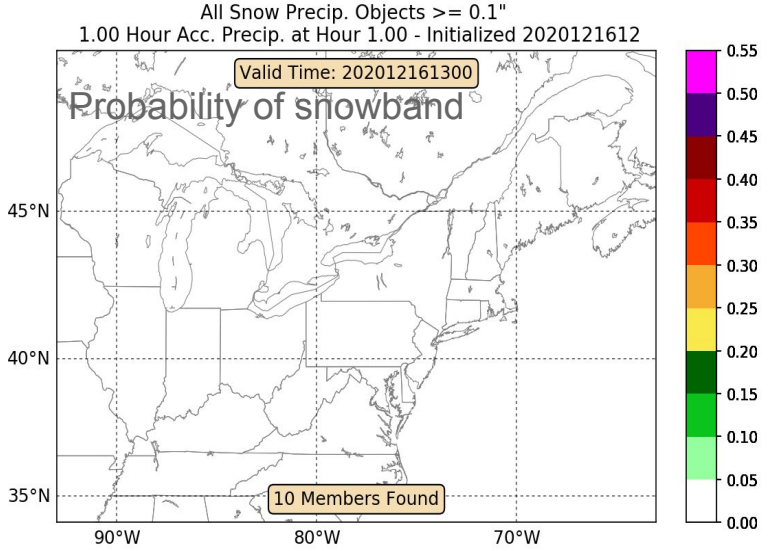
Valid starting Wednesday 12Z Jan 27 thru Thursday 12Z Jan 28 2021

Observed ARI Exceedance (RFC QPE)



Data Mining and Visualization





Data mining and data visualization of ensemble data and extensive training to:

1) Make a better forecast
2) Communicate risks and impacts (ultimately, probability of an impact)

NOAA's Precipitation Prediction Grand Challenge

David Novak (speaking for many others)
NOAA/NWS

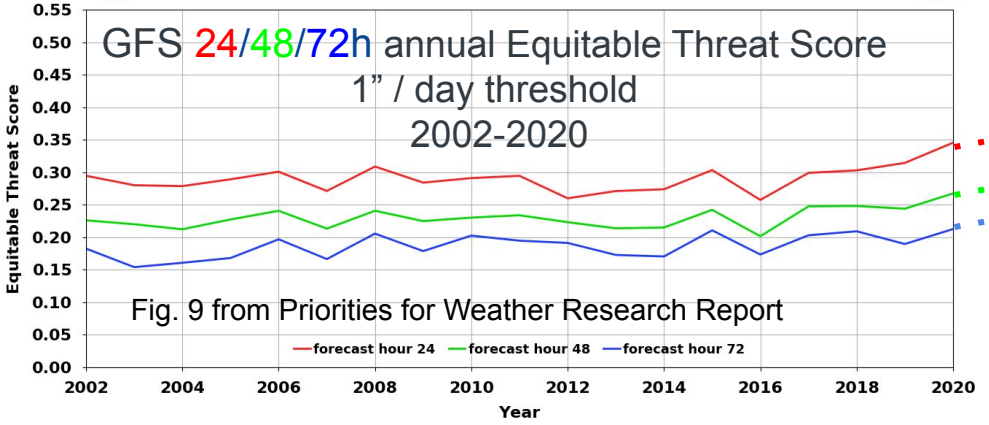
Imperative to Improve Precipitation Forecasts

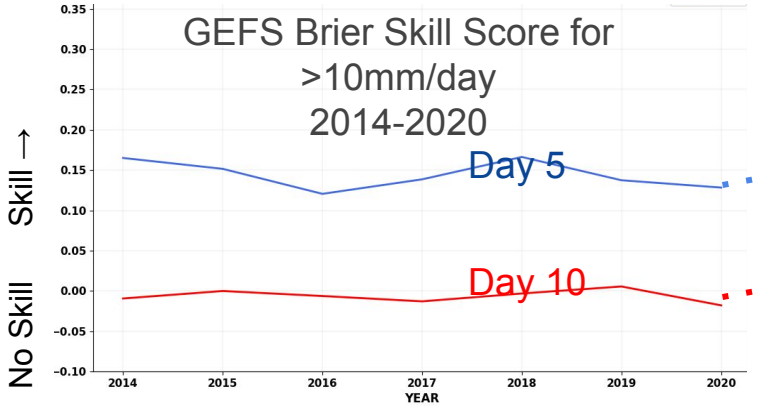
Deadly and damaging threat from too much or too little water - exacerbated by climate change

Progress in flood and drought forecasting largely dependent on improved precipitation forecasts

Improve Operational Model Skill...

Painfully slow improvement in past ....





could be...

2030

* DOUBLE the historical rate of improvement, **adding 2 days of lead time.**

From 'no skill' to **'some skill' at Day 10**

NOAA Precipitation Prediction Grand Challenge

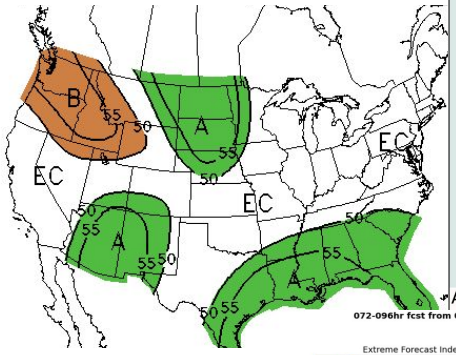
GOAL

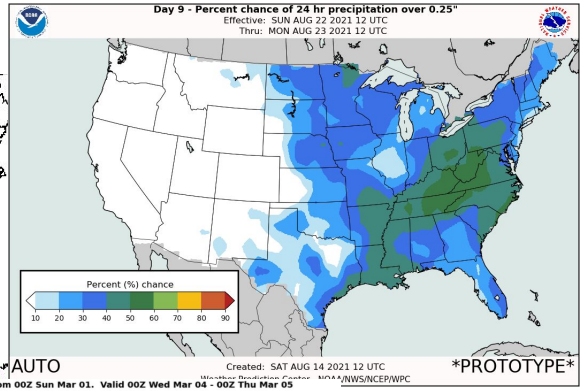
To provide more accurate, reliable, and timely precipitation forecasts across timescales from weather to subseasonal-to-seasonal (S2S) to seasonal-to-decadal (S2D) timescales through the development and application of a fully coupled Earth system prediction model

Improved Modeling Enables New Services...

Translate model forecasts into actionable information for critical decisions

Day 8, 9, 10 probabilistic daily precipitation forecasts

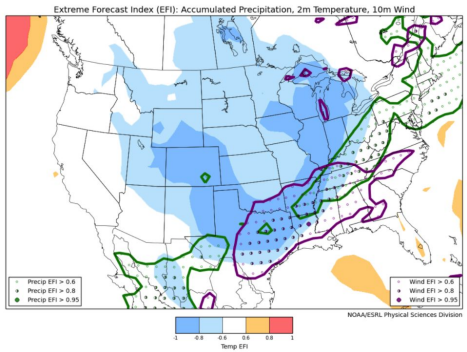




Improved Week 3&4 forecasts

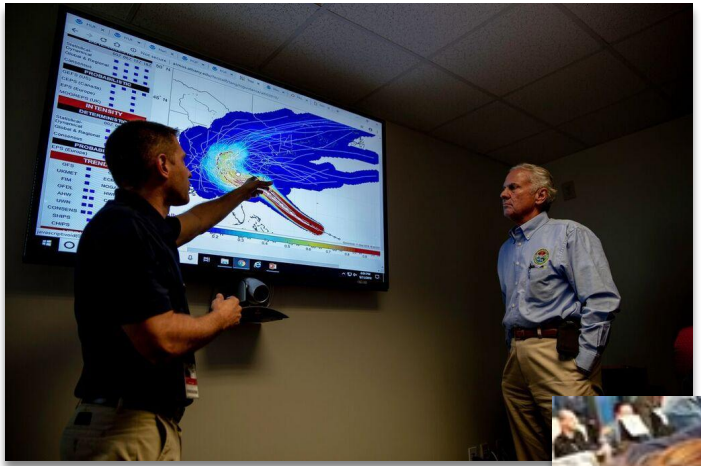
Flash Drought services

New tools based on reforecasts -
such as the Extreme Forecast Index, AI-powered applications



...and Fuels Impact-based Decision Support Services

Translate model forecasts into actionable information for critical decisions



Summary

- WPC is at the heart of the Nation's Weather Enterprise
- WPC has a strong meteorology and science focus to best serve the American Public
  - WPC meteorology enables DSS at local level
  - WPC-WFO collaboration critical to forecast consistency
  - Driving towards probabilistic approaches to guide consistent communication
- Precipitation Prediction Grand Challenge is an historic R2O Opportunity
- Tremendous WPC - CW3E partnership opportunities