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

Ninth Annual Forecast Informed Reservoir Operations (FIRO) Workshop

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
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

- 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

Underpinned by Specialized Post-processing Tools and Techniques

NATIONAL WEATHER SERVICE
Precipitation Prediction is a Probabilistic Endeavour
...There are Various Precipitation Hazards

Credit: M. Ralph
...Occurring on Different Space & Time-scales

<table>
<thead>
<tr>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
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<tbody>
<tr>
<td>California Burn Scars...</td>
<td>Vulnerable Basins...</td>
<td>and Tropical Cyclone Landfalls</td>
<td></td>
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<tr>
<td>0.79&quot; in 15 min.</td>
<td>6&quot; in 3 hours</td>
<td>3 feet in four days!</td>
<td></td>
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<tr>
<td>0.66&quot; in 15 min.</td>
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...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
Regional Verification for the 2020-21 and 2021-22 Cool Seasons (Oct - Mar)
Day 3, Two Inch Threshold
Objective Scenarios

What kind of solutions is this mean composed of?
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)

Highway 1, near Big Sur, CA
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 ....

![Graph showing GFS 24/48/72h annual Equitable Threat Score 1" / day threshold 2002-2020](Image)

**Fig. 9 from Priorities for Weather Research Report**

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

From ‘no skill’ to ‘some skill’ at Day 10

![Graph showing GEFS Brier Skill Score for >10mm/day 2014-2020](Image)
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