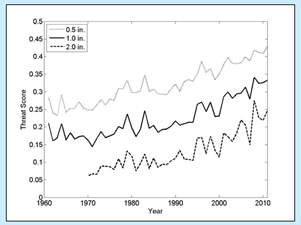
Analyzing Extreme Quantitative Precipitation Forecast Performance

E. Sukovich[1,2], F. M. Ralph[1], D. Novak[3], F. Barthold[3,4], and D. Reynolds[1,2]

[1]NOAA/Earth System Research Laboratory, Boulder, CO; [2]University of Colorado, CIRES, Boulder, CO; [3]NOAA/NWS/Weather Prediction Center, College Park, MD ; [4]I.M. Systems Group, Inc., Rockville, MD

Objective and Motivation

- Apply lessons learned from the Hydrometeorology Testbed's (HMT) extreme precipitation analysis (Ralph et al. 2010) to NCEP/Weather Prediction Center (WPC) QPFs over an 11 year period (2001-2011).
- Current QPF evaluation method (i.e., > 1 in 24 h^{-1} threat score) is sub-optimal for extreme events.



Annual threat scores for the HPC's 0.50-, 1.0-, and 2.0-in forecasts for day-1 from 1961 through 2011.

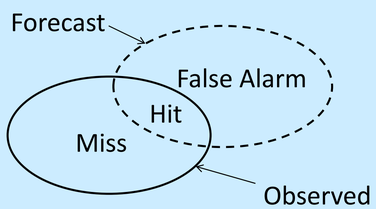
Data and Methodology

- Forecast data: NCEP/WPC's 32-km gridded QPFs
- Verification data: NWS/River Forecast Centers (RFC) Stage IV data gridded to 32-km
- Analysis period: January 1, 2001 to December 31, 2011
- Verification software: Developmental Testbed Center (DTC) Model Evaluation Tools (MET)

QPF Performance Measures

Events	Observed (O)	Not observed
Forecast (F)	Hit (H)	False alarm (FA)
Not Forecast	Miss (M)	Correct rejection

- Probability of detection
  POD = H/(H+M)
- False alarm ratio
  FAR = FA/(FA+H)
- Critical Success Index (aka Threat Score)
  CSI = H/(H+M+FA)
- Bias
  Bias = QPF/QPE



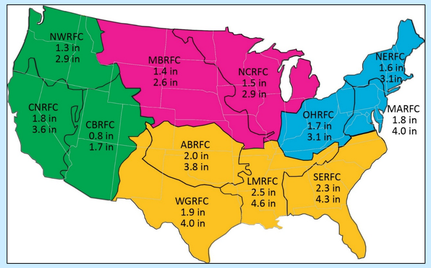
- Mean absolute error
  $MAE = \frac{1}{n}\sum_{i=1}^{n} | Fi - Oi |$

Acknowledgements

This research was supported by NOAA's HMT program and the United States Weather Research Program (USWRP).

Extreme Precipitation Thresholds

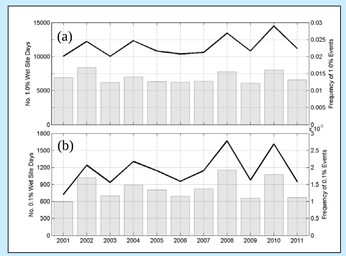
- 99th and 99.9th percentile event thresholds (i.e., top 1.0% and top 0.1% of all precipitation events) from 2001 to 2011



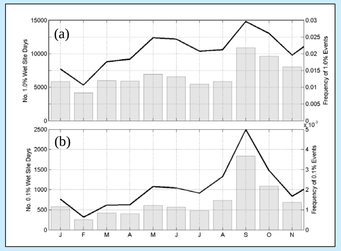
Derived regional thresholds by RFC; upper/lower number is the top 1.0%/0.1% of precipitation events. RFCs are color-coded by broad U.S. geographical regions: West (green), Upper Midwest (red), Central and South (yellow), and East/Northeast (blue.)

Extreme Event Distribution

BY YEAR



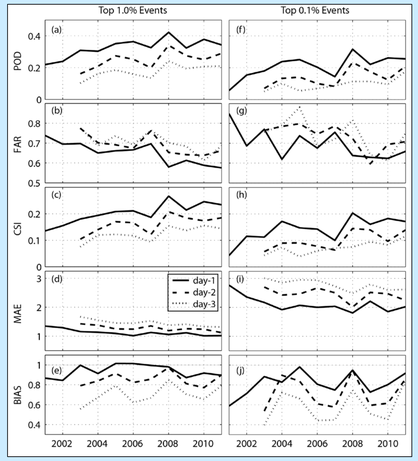
BY MONTH



- Top 1.0% events: Minimally 10,000 events/year
- Top 0.1% events: Minimally 700 events/year
- Cool (warm) season months have less (more) events
- Min # events in Feb. Max # events in Sept.

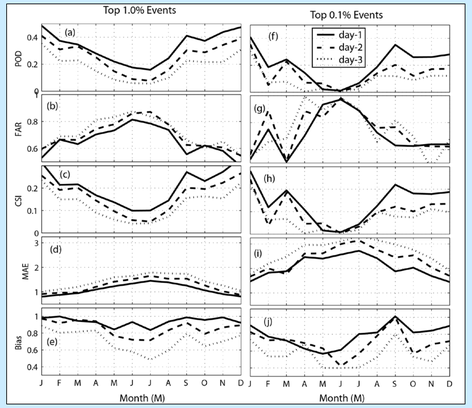
National Extreme QPF Performance

- Metrics calculated by applying regional extreme precipitation thresholds to each RFC, aggregating those QPFs, and then computing.
- POD, FAR, and CSI values decrease in skill with longer lead time.
- POD, FAR, and CSI values have improved from 2001 to 2011 for all 3 lead times.
- At times, the day-3 QPF skill exceeds the skill of the day-2 QPFs for the 0.1% events.



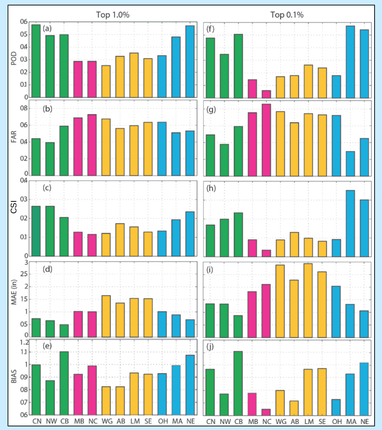
Seasonal Extreme QPF Performance

- POD, FAR, and CSI decrease during warm season (JJA).
- POD, FAR, and CSI increase during cool season (DJF).
- At times, the day-3 skill exceeds the skill of the day-2 QPFs.



Regional Extreme QPF Performance

- For 1.0% and 0.1% events, western and northeastern RFCs (CNRFC, CBRFC, NWRFC, MARFC, NERFC) are more likely to have:
  - Higher skill
  - Lower error
  - Bias = 1 (unbiased) or Bias > 1 (overforecast)



Scores for the five year period of 2007 to 2011. RFCs are color-coded by broad U.S. geographical regions: West (green), Upper Midwest (red), Central and South (yellow), and East/Northeast (blue.)

Summary

- Extreme precipitation events are defined by RFC region.
- National extreme QPF performance has incrementally improved since 2001.
- Extreme QPF performance tends to be lower with longer lead times and larger precipitation thresholds.
- Extreme QPF performance is lower during the warm season (JJA) and higher during the cool season (DJF).
- Extreme QPFs in most of the western and northeastern RFCs have better scores and lower errors than the other RFCs regions.