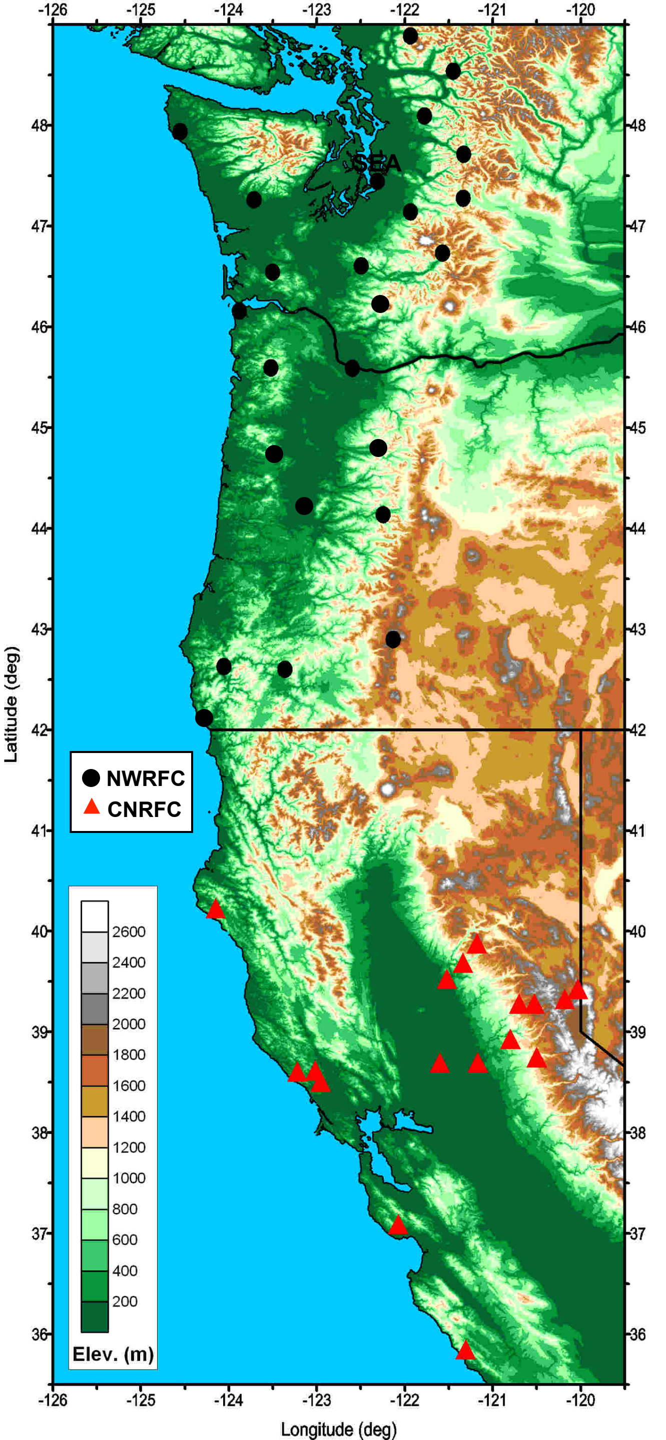

Assessment of Extreme Quantitative Precipitation Forecasts (QPFs) and Development of Regional Extreme Event Thresholds Using Data from HMT-2006 and COOP Observers

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Motivation

- Many key end-users of QPFs require accurate forecasts (e.g., location, timing, and amount of precipitation) of extreme events (e.g., > 3 in/24 h).
- Current QPF performance evaluation (i.e., > 1 in/24 h threat score) is sub-optimal for extreme precipitation events which tend to occur less frequently and over smaller areas.

Objective

- To develop a QPF evaluation method that is effective for extreme precipitation events and that could be considered for use as a formal performance measure by NOAA.

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ABSTRACT

Extreme precipitation events, and the quantitative precipitation forecasts (QPFs) associated with them, are examined. The study uses data from the Hydrometeorology Test Bed (HMT), which conducted its first field study in California during the 2005/06 cool season. National Weather Service River Forecast Center (NWS RFC) gridded QPFs for 24-h periods at 24-h (day 1), 48-h (day 2), and 72-h (day 3) forecast lead times plus 24-h quantitative precipitation estimates (QPEs) from sites in California (CA) and Oregon–Washington (OR–WA) are used. During the 172-day period studied, some sites received more than 254 cm (100 in.) of precipitation.

The winter season produced many extreme precipitation events, including 90 instances when a site received more than 7.6 cm (3.0 in.) of precipitation in 24 h (i.e., an "event") and 17 events that exceeded 12.7 cm $(24\ h)^{-1}$ [5.0 in. $(24\ h)^{-1}$] For the 90 extreme events {>7.6 cm $(24\ h)^{-1}$ [3.0 $(24\ h)^{-1}$]}, almost 90% of all the 270 QPFs (days 1–3) were biased low, increasingly so with greater lead time. Of the 17 observed events exceeding 12.7 cm $(24\ h)^{-1}$ [5.0 in. $(24\ h)^{-1}$], only 1 of those events was predicted to be that extreme. Almost all of the extreme events correlated with the presence of atmospheric river conditions.

Total seasonal QPF biases for all events {i.e., ≥0.025 cm $(24\ h)^{-1}$ [0.01 in. $(24\ h)^{-1}$]} were sensitive to local geography and were generally biased low in the California–Nevada River Forecast Center (CNRFC) region and high in the Northwest River Forecast Center (NWRFC) domain. The low bias in CA QPFs improved with shorter forecast lead time and worsened for extreme events. Differences were also noted between the CNRFC and NWRFC in terms of QPF and the frequency of extreme events.

A key finding from this study is that there were more precipitation events >7.6 cm 24 h^{-1} [3.0 in. $(24\ h)^{-1}$] in CA than in OR/WA. Examination of 422 Cooperative Observer Program (COOP) sites in the NWRFC domain and 400 in the CNRFC domain found that the thresholds for the top 1% and top 0.1% of precipitation events were 7.6 cm $(24\ h)^{-1}$ [3.0 in. $(24\ h)^{-1}$] and 14.2 cm $(24\ h)^{-1}$ [5.6 in. $(24\ h)^{-1}$] or greater for the CNRFC and only 5.1 cm $(24\ h)^{-1}$ [2.0 in. $(24\ h)^{-1}$] and 9.4 cm $(24\ h)^{-1}$ [3.7 in. $(24\ h)^{-1}$] for the NWRFC, respectively. Similar analyses for all NWS RFCs showed that the threshold for the top 1% of events varies from ~3.8 cm $(24\ h)^{-1}$ [1.5 in. $(24\ h)^{-1}$] in the Colorado Basin River Forecast Center (CBRFC) to ~5.1 cm $(24\ h)^{-1}$ [2.0 in. $(24\ h)^{-1}$] in the northern tier of RFCs and ~7.6 cm $(24\ h)^{-1}$ [2.0 in. $(24\ h)^{-1}$] in both the southern tier and the CNRFC. It is recommended that NWS QPF performance in the future be assessed for extreme events using these thresholds.

1. Introduction

One of the greatest challenges in meteorology is the prediction of precipitation, particularly the accurate prediction of extreme precipitation events (i.e., events with large precipitation amounts). Recent surveys of public use of forecast information (Lazo et al. 2009) have documented that precipitation prediction (e.g., the location, timing, and amount of precipitation) is the most heavily utilized part of standard forecasts. This general public demand for precipitation forecasts is echoed by the needs of many specific forecast user communities, such as

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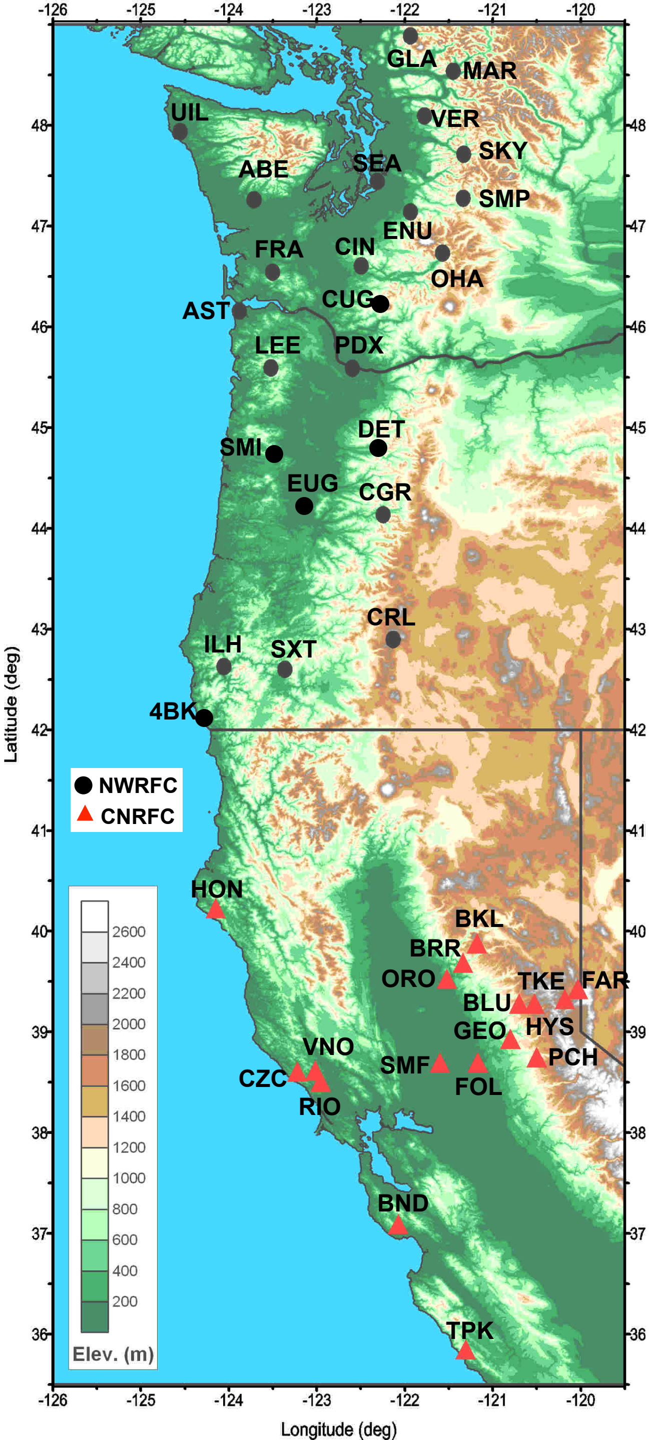


Forecast and Evaluation Data

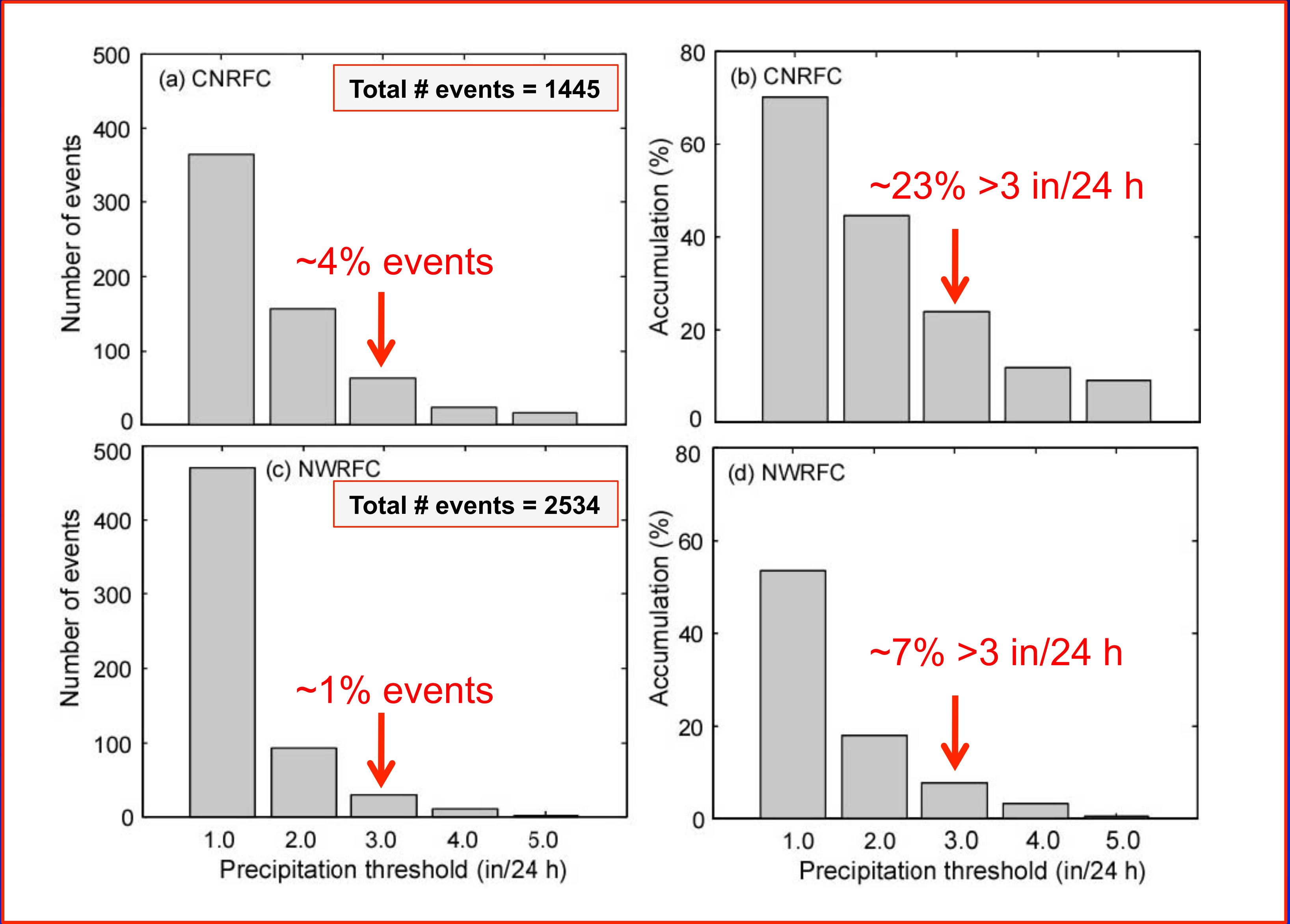
SITES

- Northwest river forecast center (NWRFC)
  - –24 sites in 5 distinct geographic regions: coastal, coastal mts, interior flats, Cascade foothills, and Cascade mts
- California-Nevada river forecast center (CNRFC)
  - –17 sites in 7 distinct geographic regions: coastal, coastal mts, coastal valley, Central Valley, Sierra foothills, Sierra mts, and Sierra lee

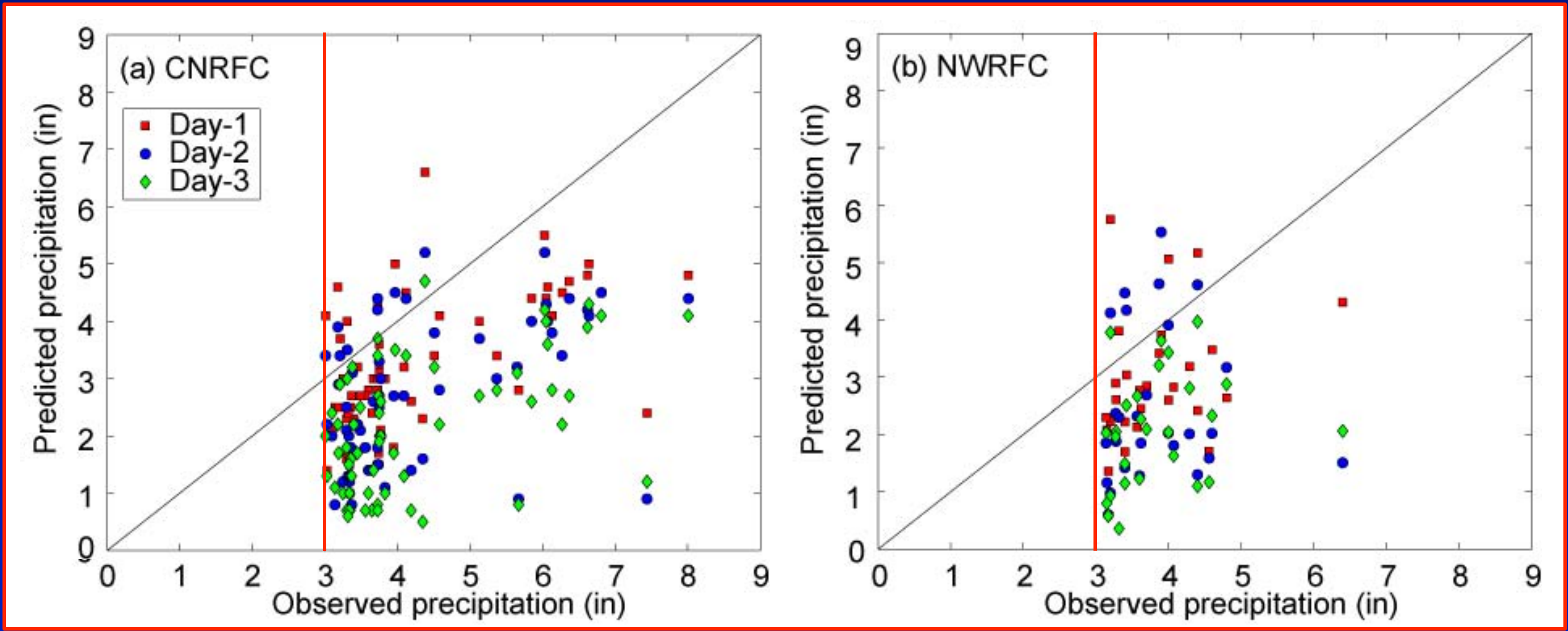
DATA

- Winter season: 5 Nov. 2005 to 25 Apr. 2006
- RFC quantitative precipitation forecasts (QPF)
  - –Day 1 (24 h), Day 2 (48 h), and Day 3 (72 h)
  - –Forecasts made from 12 Z to 12 Z
  - –Resolution of 4 km
- RFC quantitative precipitation estimates (QPE)
  - –Gage-based
  - –12 Z to 12 Z
  - –Resolution of 4 km

Event Sampling

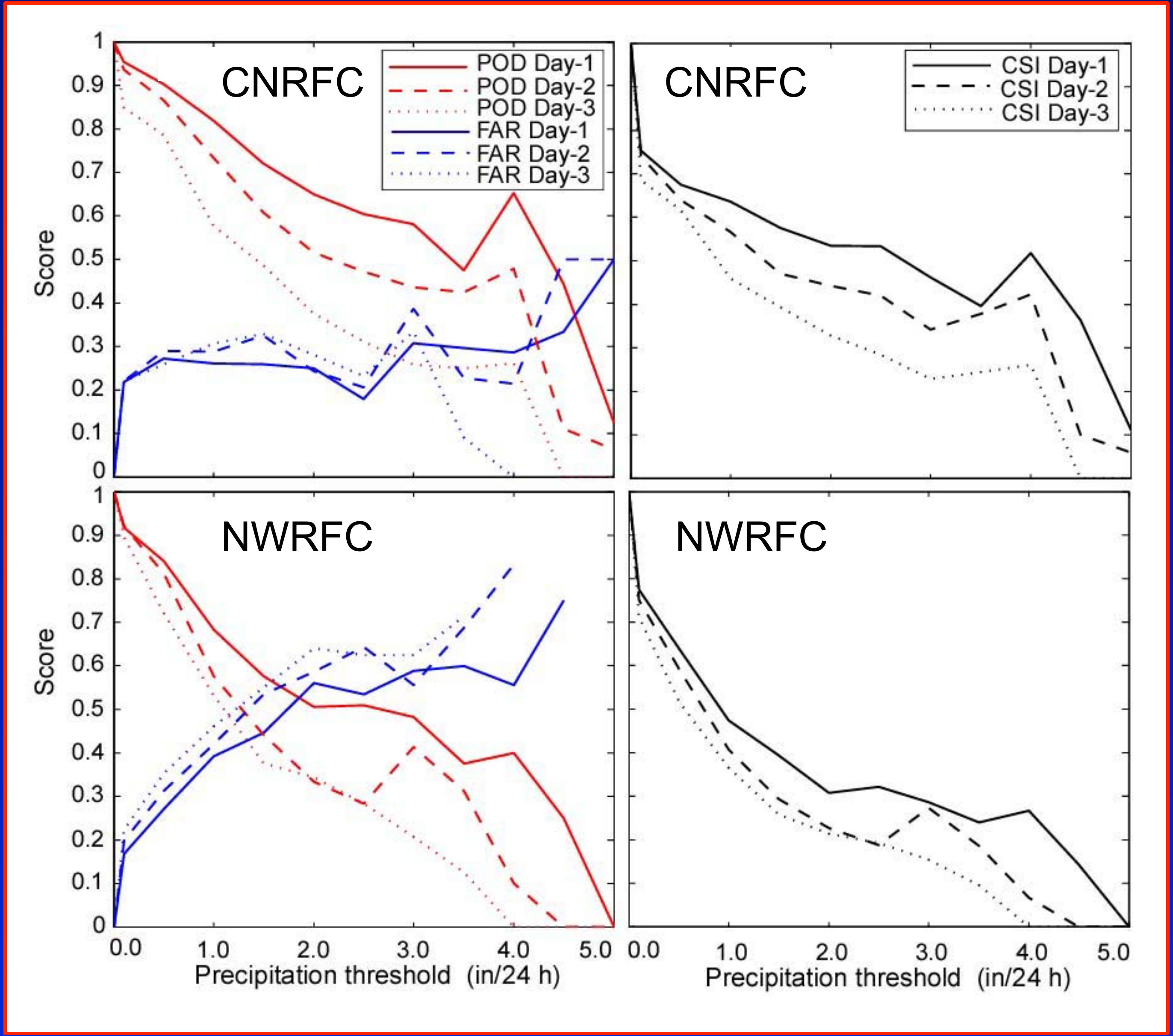


Extreme QPF Event Bias by Lead Time

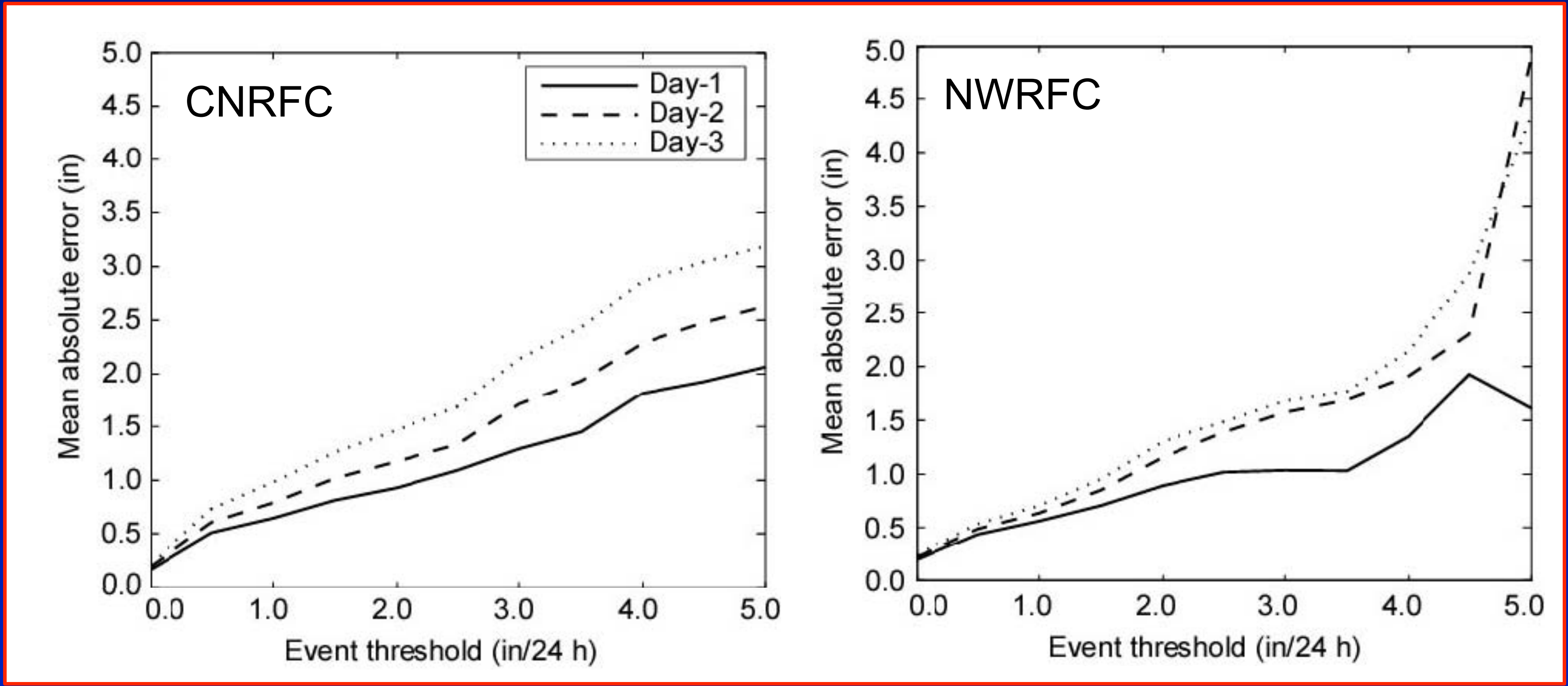


- CNRFC has more extreme precipitation events.
- Both CNRFC & NWRFC under-forecasted extreme events, especially with longer lead time.

POD, FAR, CSI Metrics

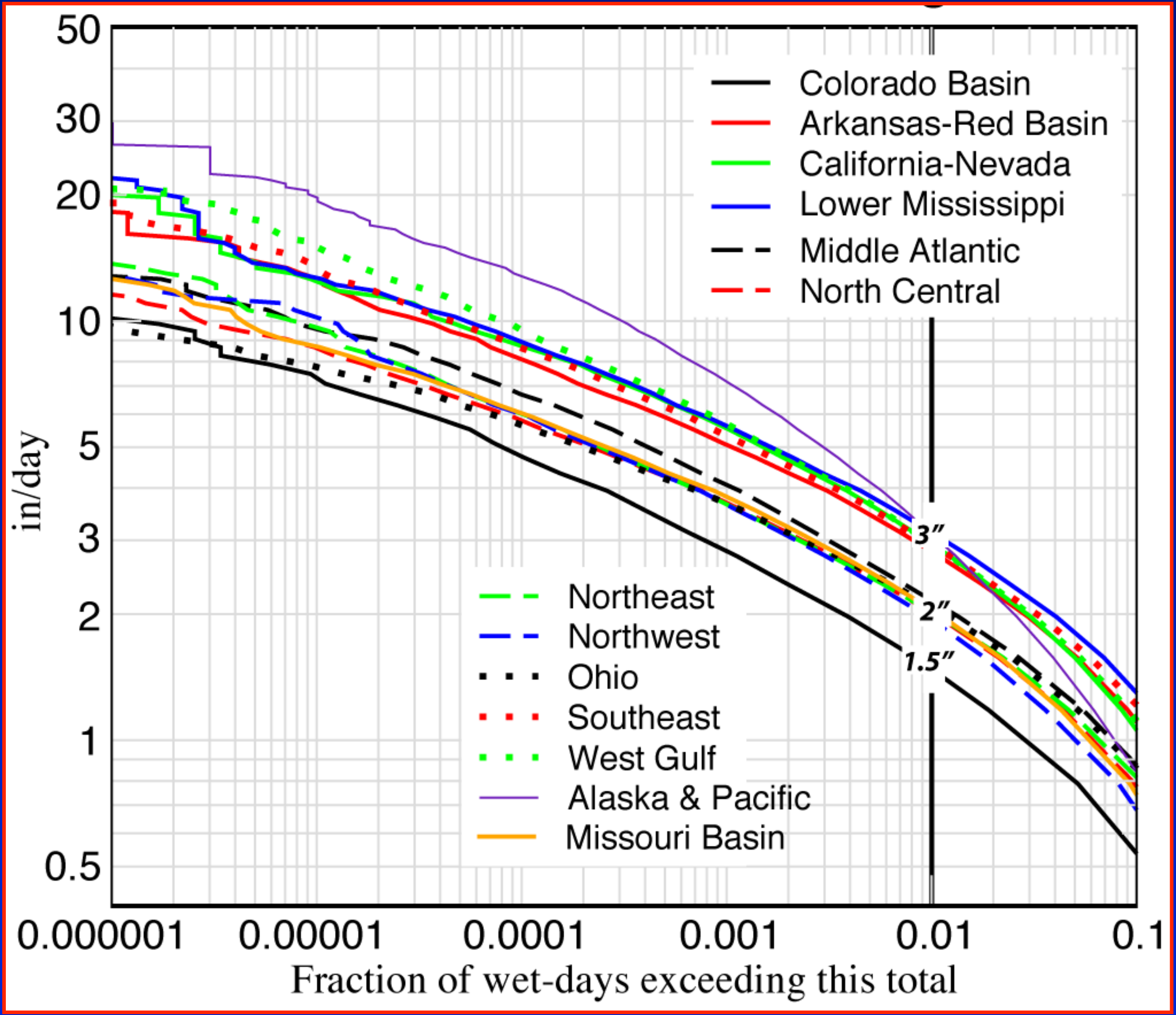


Mean Absolute Error

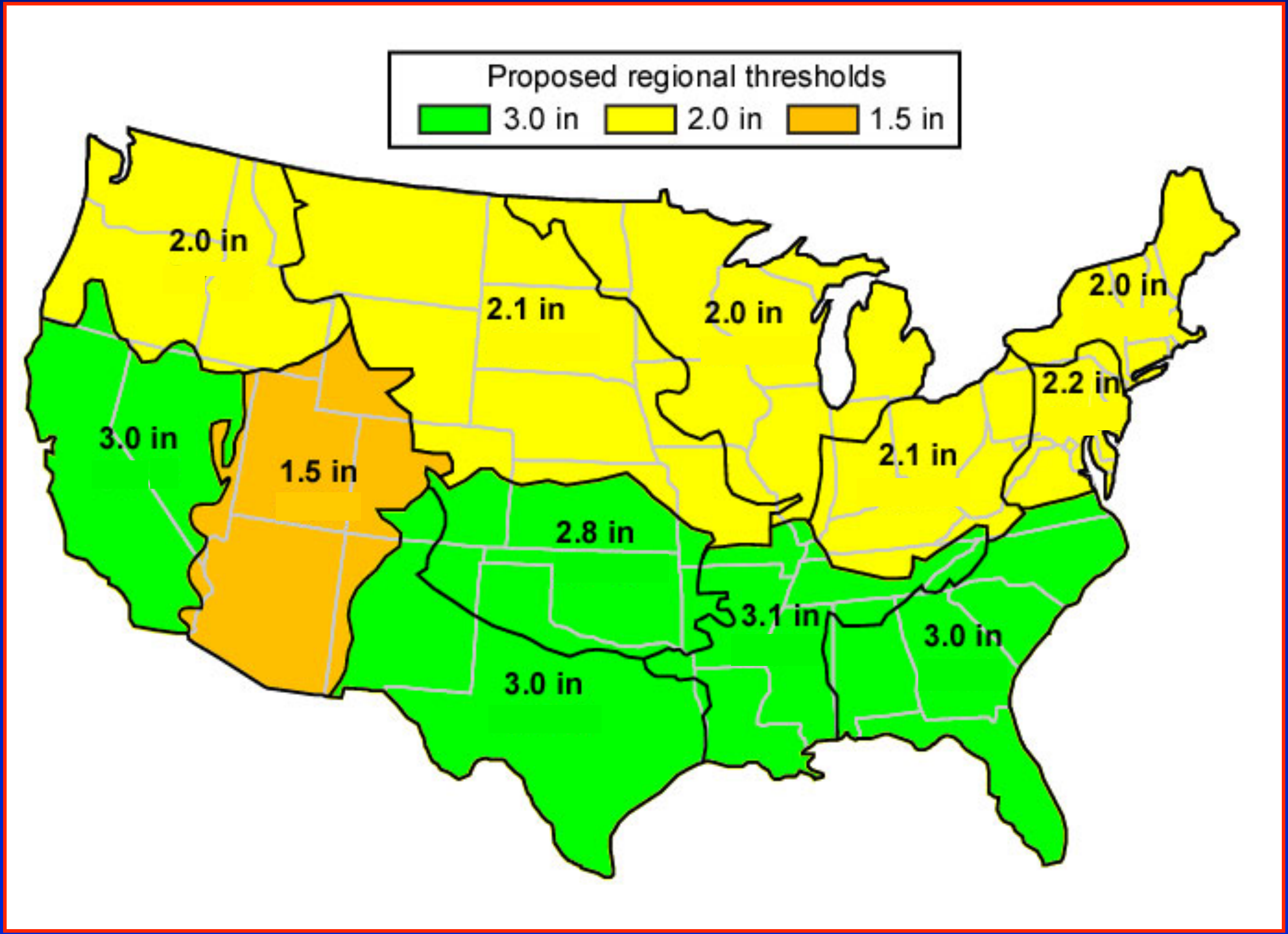


- MAE increases with event threshold in both RFCs.
- MAE increases with lead time in both RFCs.

COOP Observer Analysis



Proposed regional extreme precipitation thresholds



Summary

- A QPF evaluation method is needed to assess forecast performance of extreme precipitation events.
- Five measures provide the most useful metrics of extreme QPF performance (POD , FAR, CSI, bias and MAE).
- Application of QPF verification method to CNRFC & NWRFC regions during HMT 2005/06 for forecast lead times of 24 h, 48 h, and 72 h indicate:
  - Both RFCs generally under-predicted extreme events.
  - POD, FAR, CSI, bias, & MAE values are worse with lead time.
  - However, extreme event frequency varies by RFC.
- COOP daily precipitation totals were examined to objectively determine regionally relevant thresholds of extreme precipitation events.

Future work

- QPF evaluation method & regional thresholds will be applied to all CONUS RFCs retrospectively to establish a baseline of POD, FAR, CSI, MAE, and bias for future extreme QPF performance.
- In collaboration with NCEP/HPC, QPF method & regional thresholds will be applied to NCEP/HPC gridded QPF data.
- Method & thresholds will be applied to 6-h QPFs to quantify the timing of extreme precipitation within the 24-h accumulation period.

Thank you