Improving IDSS: Enhancing Forecaster Situational Awareness of Extreme Rainfall Events

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Project Overview

Goal:

Validate and deliver a situational awareness tool

Anticipated Result:

Provide improved IDSS for top 1% rainfall events

Where we are...

Kelly Mahoney (ESRL PSD), David Gochis (NCAR RAL), and Rob Cifelli (ESRL PSD) → WRF Hydro

Curtis Alexander, Isidora Jankov, Tim Schnieder, and Steve Weygandt from GSD → HRRR RAP Development

Tom LeFebvre, Paul Schultz, and Woody Roberts (GSD) → GFE Situational Awareness Display

Russ Schumacher (CSU) → NOAA 14 (ARI)

Tom Hamill (ESRL PSD) and Tom Galarneau (NCAR MMM) → PQPF & Analogs

Key Considerations

M-Climate vs. R-Climate

- Raw QPF and M-Climate vs. Post-processed QPF and R-Climate

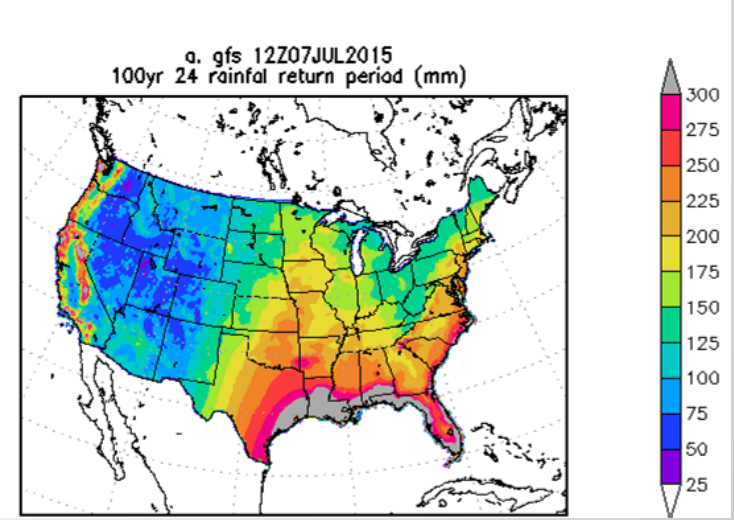
AWIPS II vs. web-based

Experimental datasets

NOAA Atlas-14 limitations

OCONUS needs

NCEP and RFCs also need to be included



Critical Questions

Should GSD be contracted?

Should tool be centrally processed?

What platforms and perspectives should display?

Which framework, GFE or Web based?

Mockup of Situational Awareness Dashboard

Uses 6-hr Recurrence Intervals	Day 0	Day 1	Day 2	Day 3
HRRR Time lag	14	27		
SSEO	5	32	164	212
SREF MME	9	17	180	166
GEFS	11	41	134	192
NBM R-Climate	0	0	103	122
Official R-Climate	0	0	94	66

HRRR Time lag: last 3 HRRR runs
1 hour exceedances

SSEO: HIRES NMM and ARW
NAM Nest last 2 cycles
3-hour exceedances in AWIPS

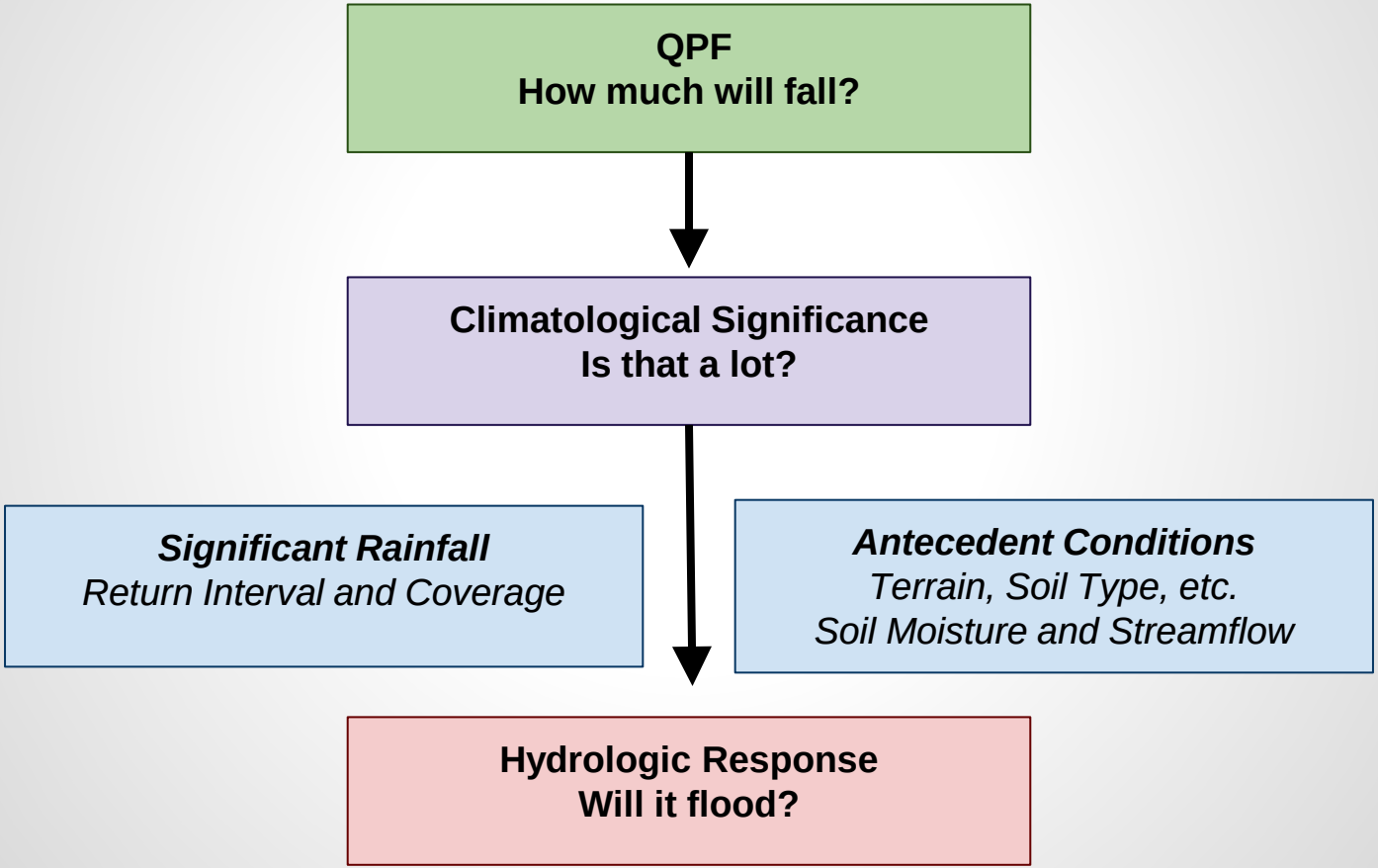
SREF MME: Use NAM, SREF, and/or GFS

GEFS: Either GEFS vs M-Climate or
Calibrated GEFS vs R-Climate
6-hour exceedance

National Blender R-Climate

Official R-Climate

A simplistic view...



Fractional Percentages

Display the percentage of 100 year interval precipitation reached by highest QPF data point in domain, including all members.

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Phase 1

Prototype

a. Contains HRRR Time lag, SSEO, GEFS, NBM, and Official

b. Color curves consistent with HazSimp

c. Uses 100 year recurrence interval
   i. National mosaic as provided by Russ Schumacher
   ii. CONUS-wide NOAA Atlas-14 not available

d. Displays exceedance of 100-yr recurrence interval and fractional percentages

Phase 2

IOC

a. Available via software collaboration portal (SCP)

a. Still needs to have colors calibrated to probability values
    i. We want to make sure we are appropriately signalling risk

a. Probability of exceedance thresholds used for OCONUS

a. Tested via OPG/testbeds

a. Prototype NCEP solution

Phase 3 (Full Implementation)

Color table thresholds are calibrated

a. Training and case studies formalized

a. Color table thresholds are calibrated

b. Verification and validation

a. Full NCEP solution implemented

Phase 4

Wishlist items

a. Centralized post-processing

a. FFMP and/or FLASH integration
   i. Basin-based alerting

a. Integration of WRF Hydro

a. Implement ECMWF and CMC M-Climates (possibly HRRR)

a. Evolution of calibrated PQPF from GEFS and SREF (HREF/SSEO)

Contractor work

- Build GFE/A2 R-climate for NOAA-14 currently on 4km grid
- Build GFS/A2 M-Climate for GEFS 1x1 degree grid
- GFE SmartInit and procedure development (primarily in Python)
- Verification and validation of tool
- SCP software maintenance

Other Team Work

Training on using SA tool in GFE

Training on using NOAA 14 and M-Climate

Case studies across NWS WFO/RFC/WPC

How it can work for YOU!

Paradigm shift in forecasting

M-Climate: internal model based climate

- Models produce known patterns
  - Forecasters can recognize these
  - Models can produce strong signals relative to climatology
- Model knows where it has the lift
  - Where each member produces QPF
  - In correct pattern get QPF
  - Ensemble provides probability
  - M-Climate provides potential for high impact event

Events for 2014/2015 are catalogued

- Recent events: 17-18 July 2015 NV-CA
- May 2015 flooding rains southern Plains
- Ohio Valley events
- Western heavy rains December (2014) and January 2015 (December event →)

Type: GEFS M-Climate QPF

Recent Cases / Historic Cases

Date: 12/02/2014 12Z

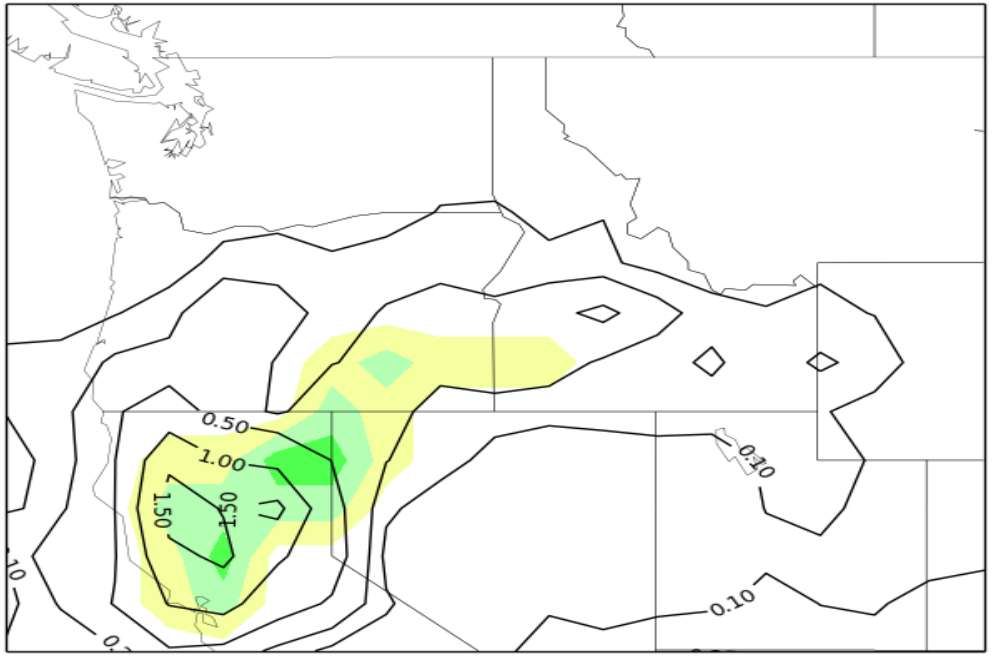
Region: Northwest U.S.

View Table

Fcst Hr: 42

Northwest U.S. Table Dec 2, 2014 12Z Run			6-h	12-h	24-h	48-h	72-h
6	Tue 2nd	18Z	<90				
12	Wed 3rd	00Z	94.7	<90			
18		06Z	99.2	96.2			
24		12Z	98.1	98.2	95.6		
30		18Z	97.8	97.7	94.7		
36	Thu 4th	00Z	95.6	98.2	95.0		
42		06Z	93.6	95.7	97.1		
48		12Z	93.8	91.8	97.8	<90	
54		18Z	91.6	92.2	93.2	90.4	
60	Fri 5th	00Z	90.2	<90	90.7	91.4	
66		06Z	91.9	<90	93.8	91.9	
72		12Z	92.4	90.0	92.1	91.3	<90
78		18Z	92.5	<90	91.7	<90	<90
84	Sat 6th	00Z	96.4	90.9	<90	<90	<90
90		06Z	98.2	96.0	<90	<90	90.4
96		12Z	91.8	94.0	90.8	<90	91.5
102		18Z	98.0	96.1	91.1	<90	<90
108	Sun 7th	00Z	96.6	97.4	92.9	91.9	<90
114		06Z	96.3	95.6	94.7	<90	<90
120		12Z	96.2	95.4	94.9	<90	<90
126		18Z	96.2	97.0	92.9	93.5	<90
132	Mon 8th	00Z	<90	92.5	94.0	91.9	<90
138		06Z	90.5	<90	94.6	<90	90.5
144		12Z	95.5	91.1	<90	90.9	92.5
150		18Z	97.9	94.8	90.7	93.1	93.0
156	Tue 9th	00Z	98.3	96.9	93.9	95.1	93.9
162		06Z	98.5	98.2	96.1	97.5	96.5
168		12Z	97.7	98.7	97.6	97.3	96.7
174		18Z	97.8	97.2	98.5	96.9	97.6
180	Wed 10th	00Z	95.1	96.2	98.0	96.9	98.2

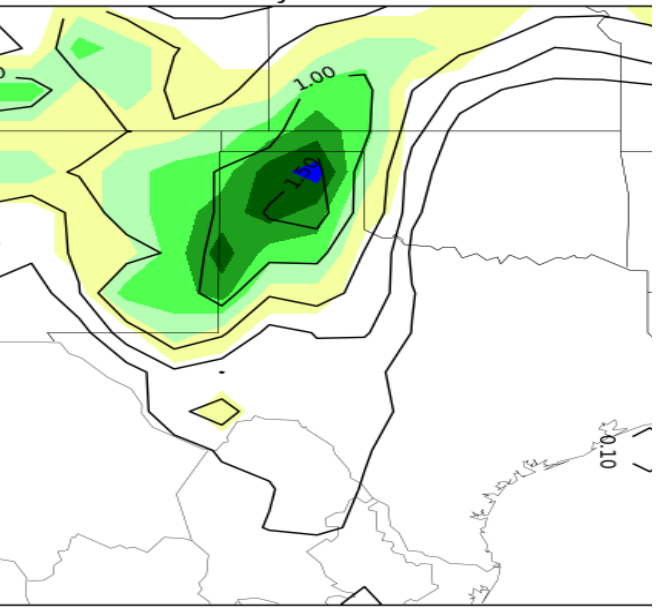
GEFS Mean QPF (in) and M-Climate percentile
18-42-h forecast valid
06Z Wed Dec 03 2014 to 06Z Thu Dec 04 2014

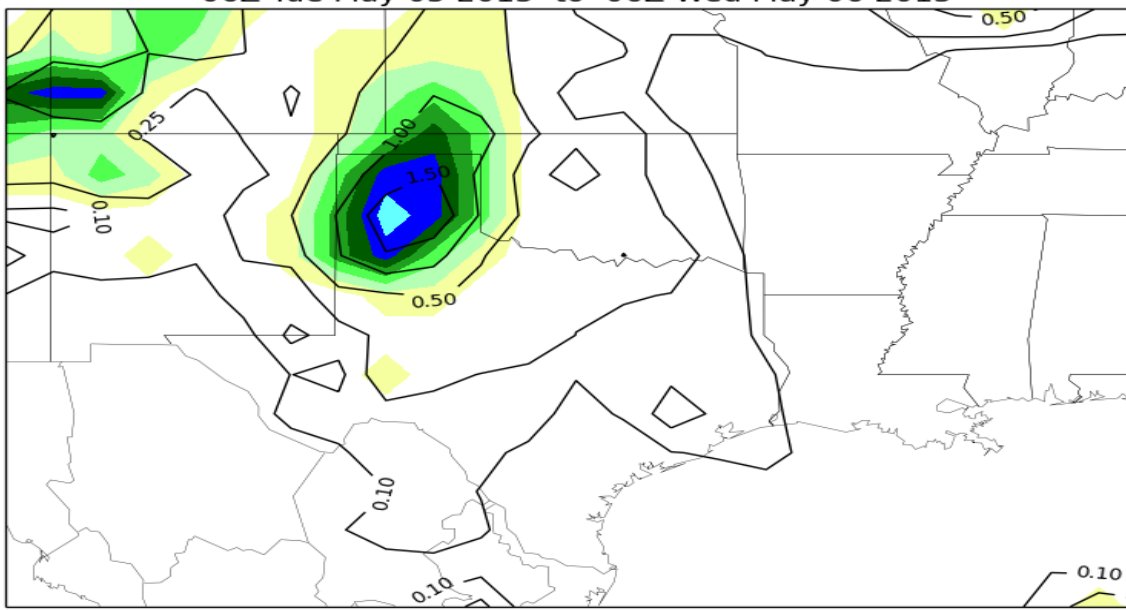


relative to GEFS reforecasts initialized
18-Oct to 16-Jan (1985-2012)

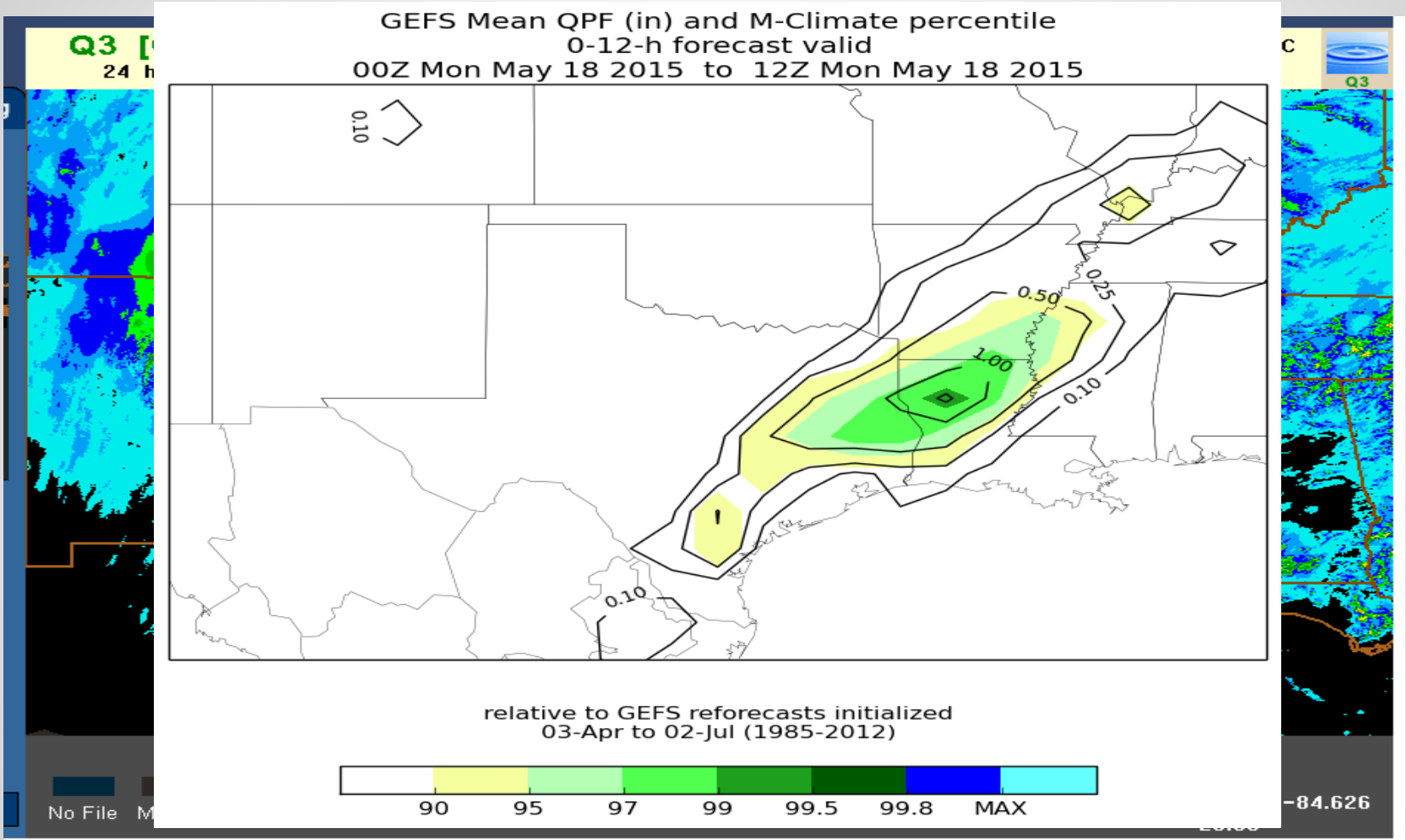
Plains Example

- Texas Rainfall 5-6 May
  - There was a signal for this convective event
  - Maximum in NMQ Q2 was 10 inches
  - Resolution matters here
- Louisiana Rain
  - Mesoscale so some signal but not great


GEFS Mean QPF (in) and M-Climate
18-42-h forecast valid
18Z Mon May 04 2015 to 18Z Tue M
0.50
1.00
1.50
0.10
0.25
0.10
relative to GEFS reforecasts initial
20-Mar to 18-Jun (1985-2012)
90
95
97
99
99.5
99

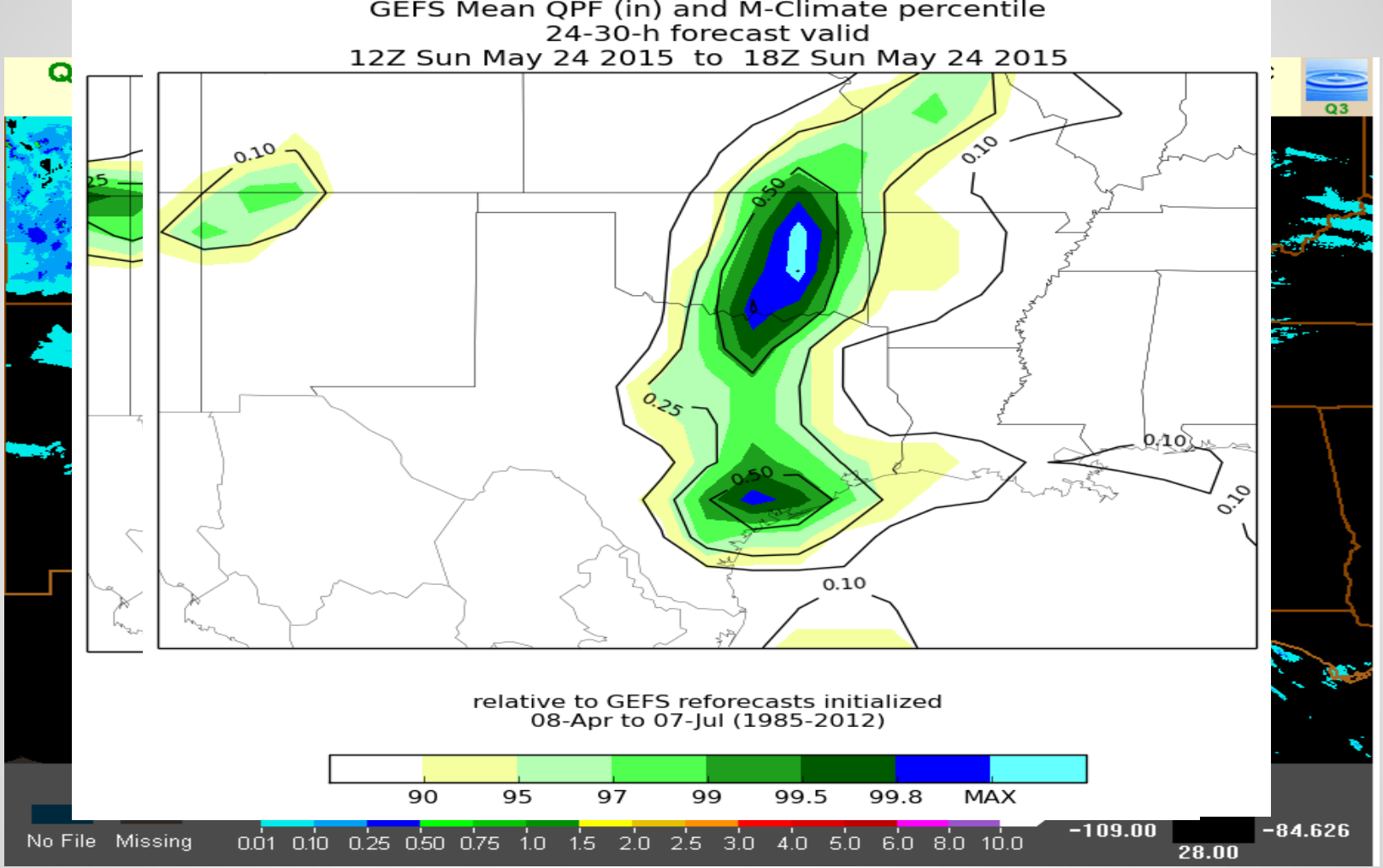

GEFS Mean QPF (in) and M-Climate percentile
18-42-h forecast valid
06Z Tue May 05 2015 to 06Z Wed May 06 2015
0.50
0.25
1.00
1.50
0.10
0.50
0.10
0.10
0.10
relative to GEFS reforecasts initialized
20-Mar to 18-Jun (1985-2012)
90
95
97
99
99.5
99.8
MAX

Q3 [Gauge Adj Rad]
Valid: 05/05/2015 18:00:00 UTC
No File Missing
0.01 0.10 0.25 0.50 0.75 1.0 1.5 2.0 2.5 3.0 4.0 5.0 6.0 8.0 10.0
28.00


GEFS Mean QPF (in) and M-Climate percentile
0-12-h forecast valid
00Z Mon May 18 2015 to 12Z Mon May 18 2015
0.10
0.50
0.25
1.00
0.10
0.10
relative to GEFS reforecasts initialized
03-Apr to 02-Jul (1985-2012)
90
95
97
99
99.5
99.8
MAX
Q3
No File
-84.626

24 May 2015 OK-TX

- Big rainfall event
  - Texas- Oklahoma area
- Had some signal in GEFS M-Climate
  - Why? Good pattern and model had some knowledge of instability and where lift might be
- Time to use other tools to help us here

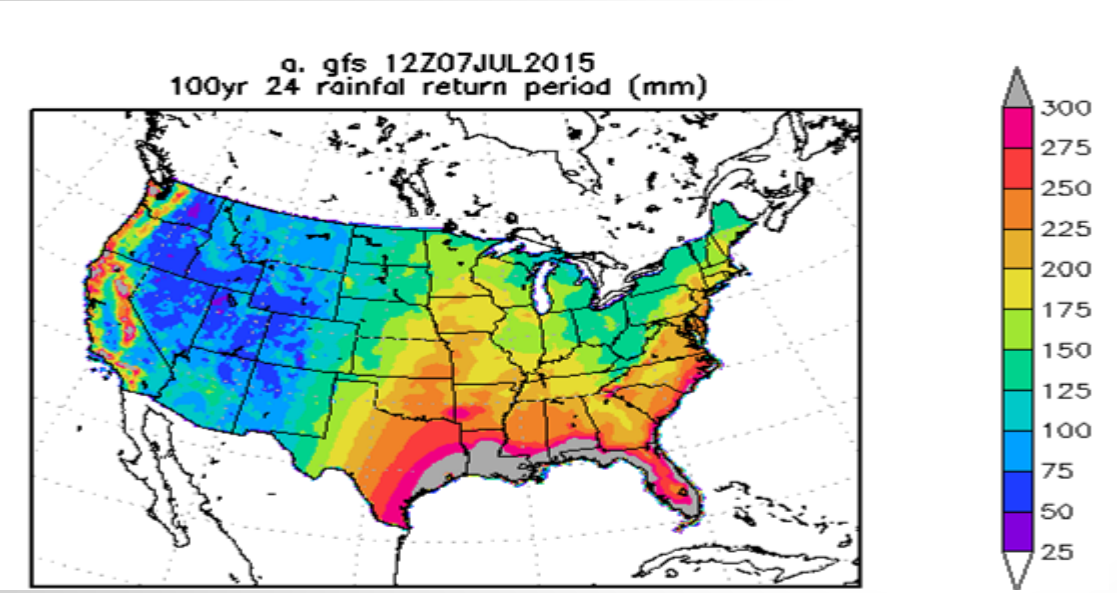

GEFS Mean QPF (in) and M-Climate percentile
24-30-h forecast valid
12Z Sun May 24 2015 to 18Z Sun May 24 2015
0.10
0.50
0.25
0.10
0.50
0.10
0.10
0.10
relative to GEFS reforecasts initialized
08-Apr to 07-Jul (1985-2012)
90 95 97 99 99.5 99.8 MAX
No File Missing
0.01 0.10 0.25 0.50 0.75 1.0 1.5 2.0 2.5 3.0 4.0 5.0 6.0 8.0 10.0
-109.00
28.00
-84.626

Average Return/Recurrence Intervals: ARI

R-Climate: based on some observed dataset

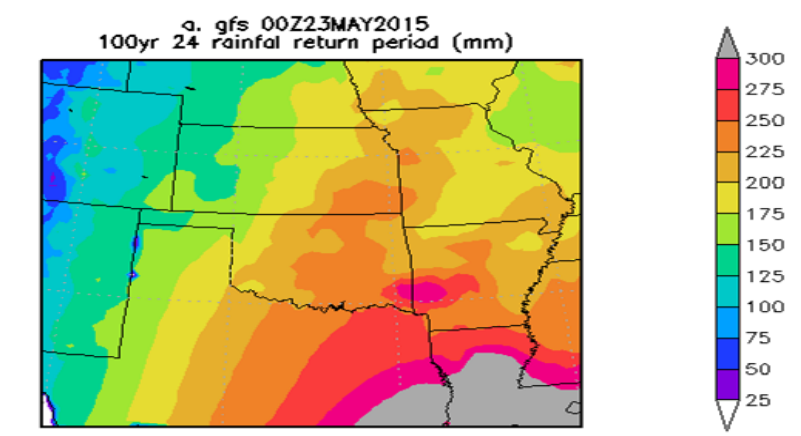
- NOAA-14 and NOAA-40 provide us with return periods
- Our models and EFS produce forecasts QPF
- We can relate the two to identify extreme rainfall
  - These data lack antecedent condition information
  - But help us with flood and flood potential issues

24 hour 100 year ARI



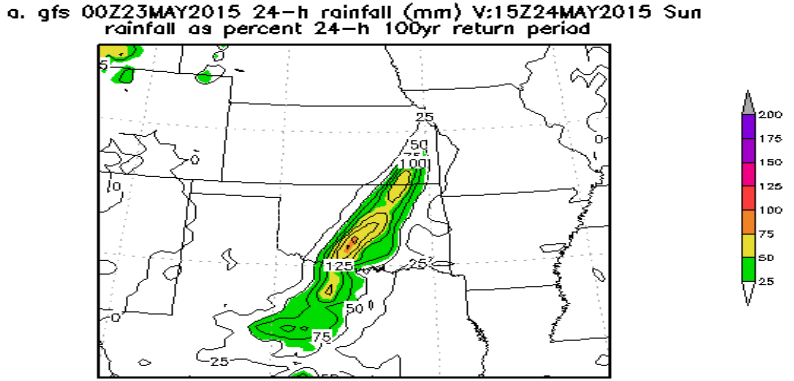
- ARI on GFS Grid
- Mix of NOAA-14 and NOAA-40
- We can define forecasts of significant rainfall events.
- Other intervals are

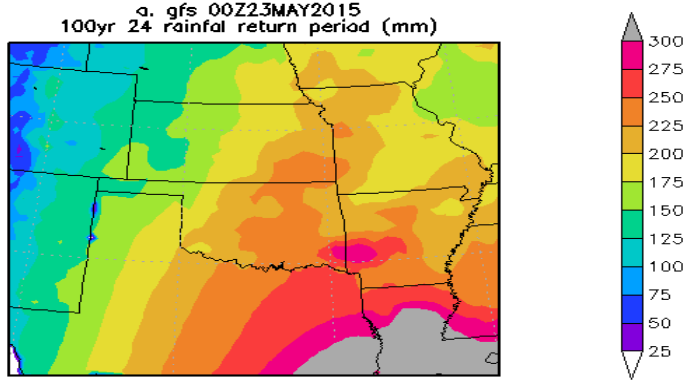
24 May rainfall and flood case GFS forecasts

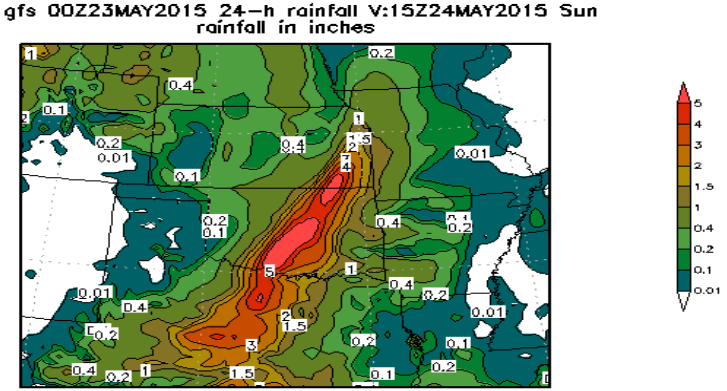


- Southern Plains ARI
- Big rainfall event
- 24 hour GFS data shown here verse 100 year return periods

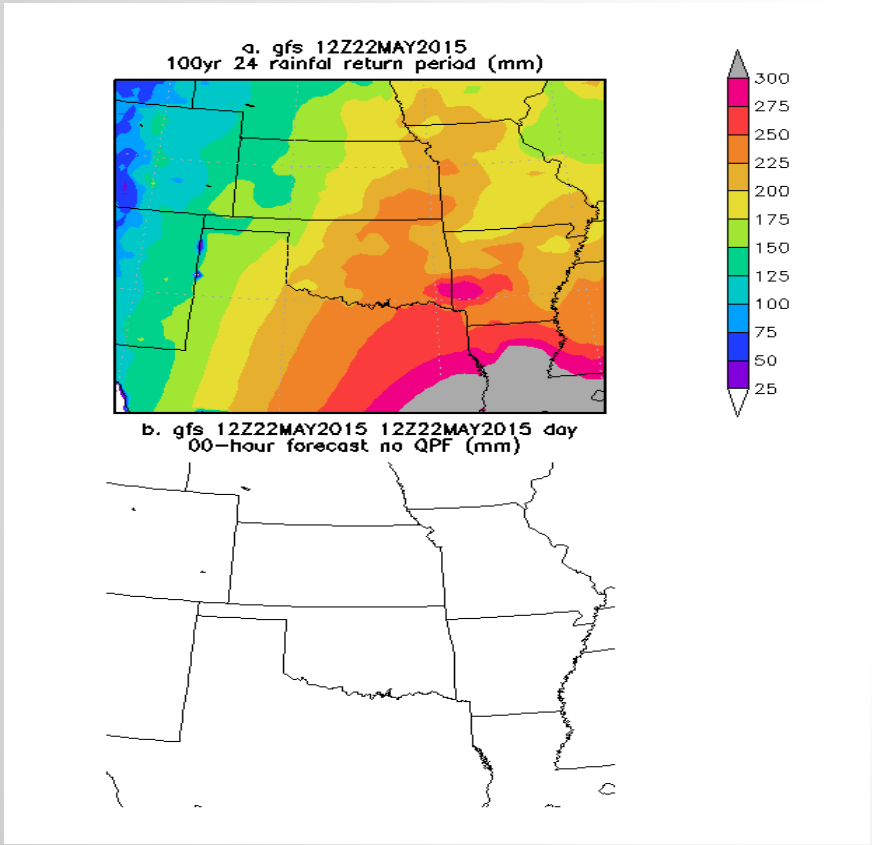
Static Image and Loop

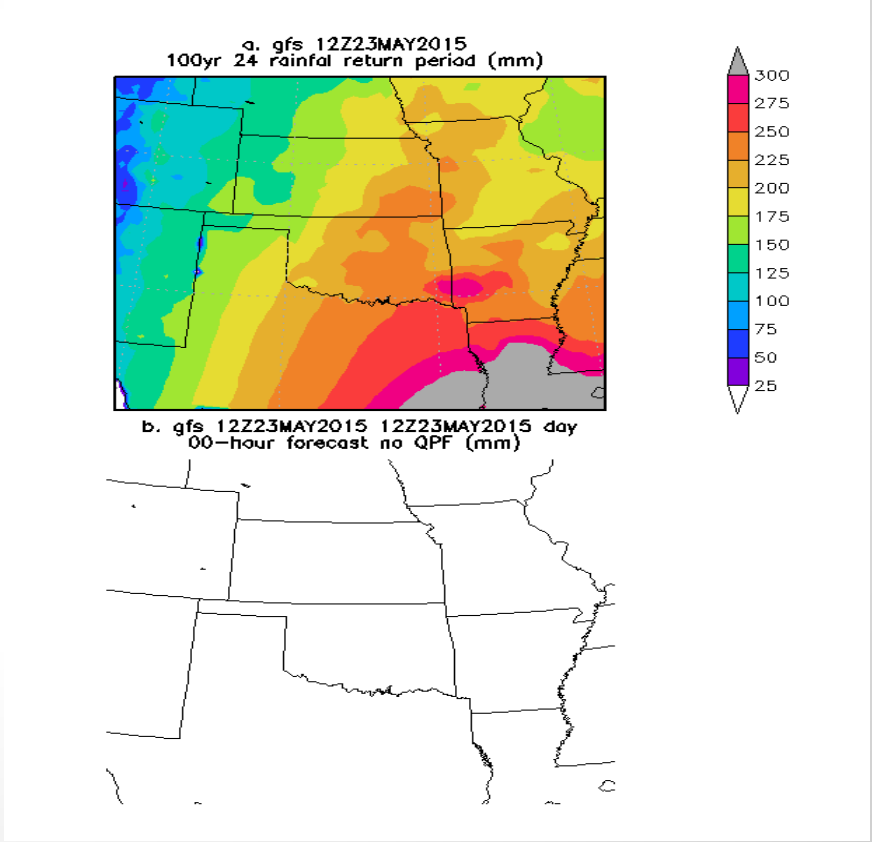






22 1200 and 23 12 Z forecasts





Summary

- The GEFS M-Climate helps identify potential big rainfall events
  - We did this without patterns and pattern recognition
  - EFS members know & where the lift is or may be.
  - Clues even in convection
- M-Climate and ARI hold out lots of hope for an alert system
- Need to build provable case library

Backup Slides

Acronyms and terms

SCP: Software Collaboration Portal

R-Climate is based on NOAA14 and, where not available, NOAA40 data 2 and 100 year return periods.

Some examples using the concepts

Forecast paradigm shift

Recent cases with M-Climate and ARI data