



National Weather Service

Climate Prediction Center

# Regional Analysis of the 2023 Summer via a CPC-Internal Week 2 Extreme Heat Forecasting Tool

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ERT Inc./NOAA CPC  
March 26, 2024

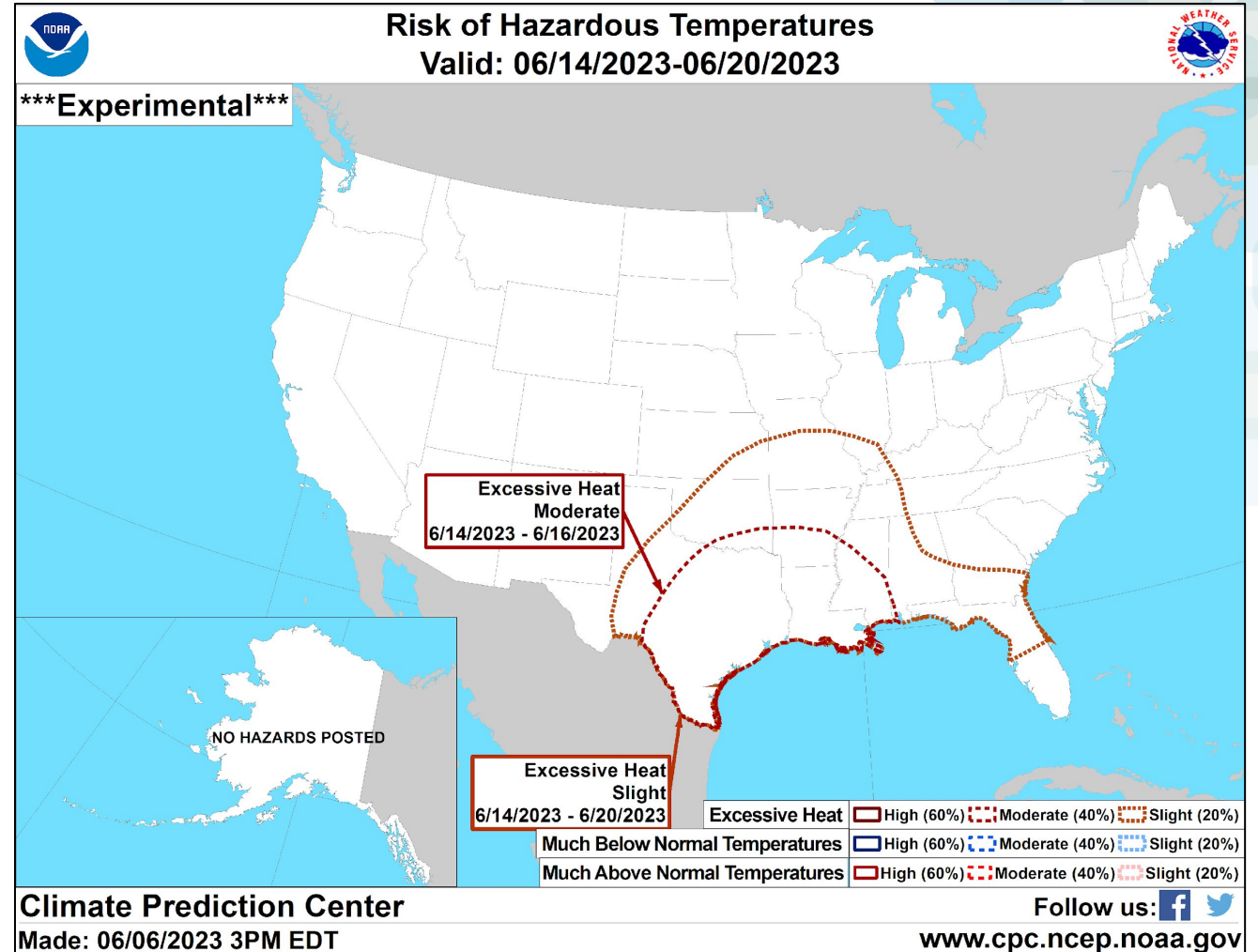
# Background

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# CPC forecasts extremely hot weather

- CPC forecasting extreme heat
  - US Hazards outlook product
  - Daily M-F at 3pm
  - Archives publicly available
  - “Much above normal Temperatures” and “Excessive Heat”
  - Probabilistic forecast synonymous with heat hazardous to public health



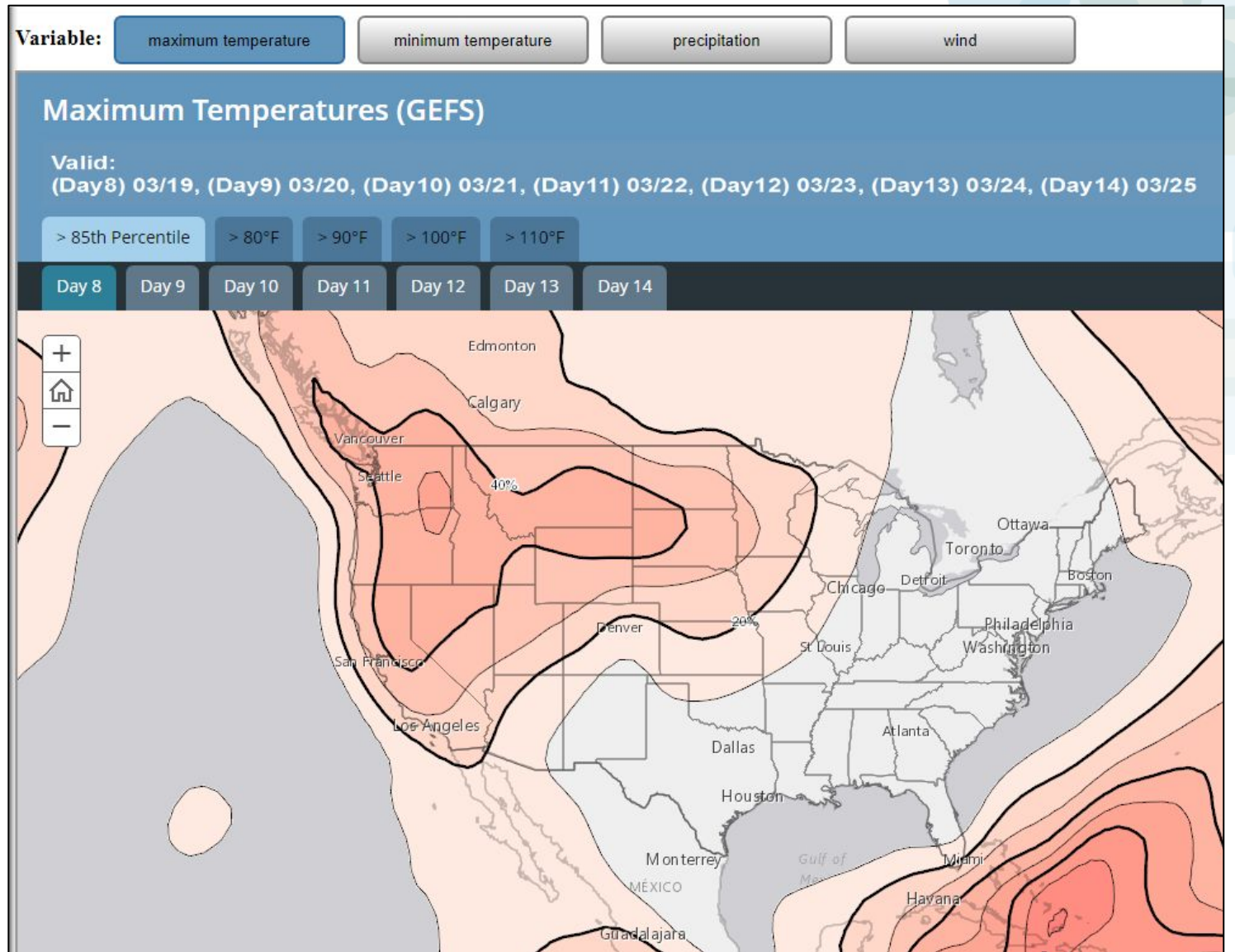




# Wk 2 extreme heat tools at CPC

## ■ Probabilistic Extremes Tool

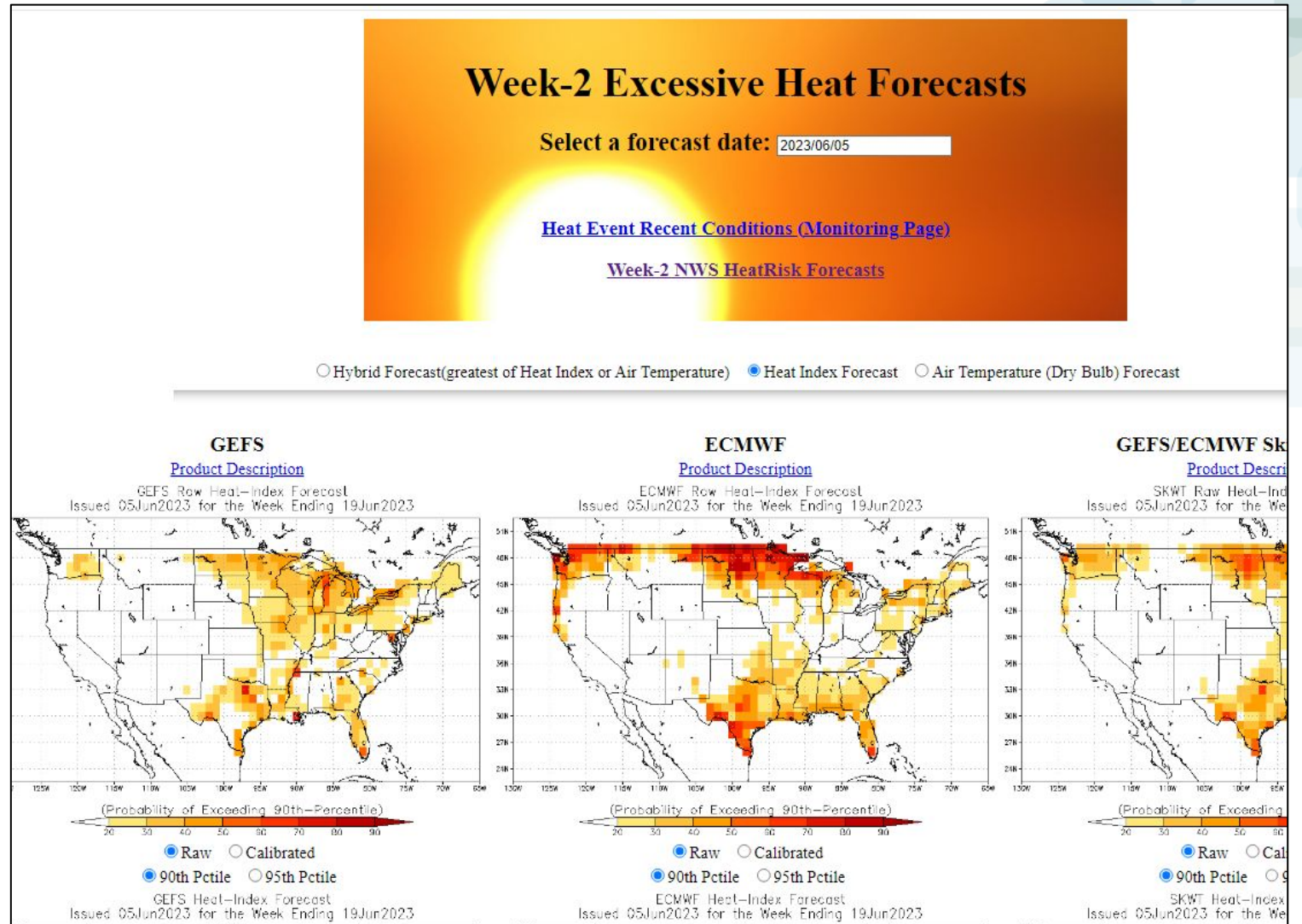
- Probabilities of extremes as a function of day in period
- Variables
  - Max Temp
  - Min Temp (partial func)
- Public facing (subsample) vs Internal (full)
- Multi Model
  - GEFS (public)
  - ECMWF (internal)
  - Canadian (internal)
- Managers
  - Mike Charles  
[mike.charles@noaa.gov](mailto:mike.charles@noaa.gov)
  - Melissa Ou  
[melissa.ou@noaa.gov](mailto:melissa.ou@noaa.gov)





# Wk 2 extreme heat tools at CPC

- Week 2 Excessive Heat tool
  - Range of forecast metrics
    - Probabilistic
      - primary →
        - 2-consecutive dates of various percentile thresholds
        - NWS Heatrisk scenarios
        - Probability of exceedance
      - Deterministic
        - Weekly maximum
    - Biometric variables
      - Air temperature (day max)
      - Air heat index (day max)
      - NWS Heatrisk\*

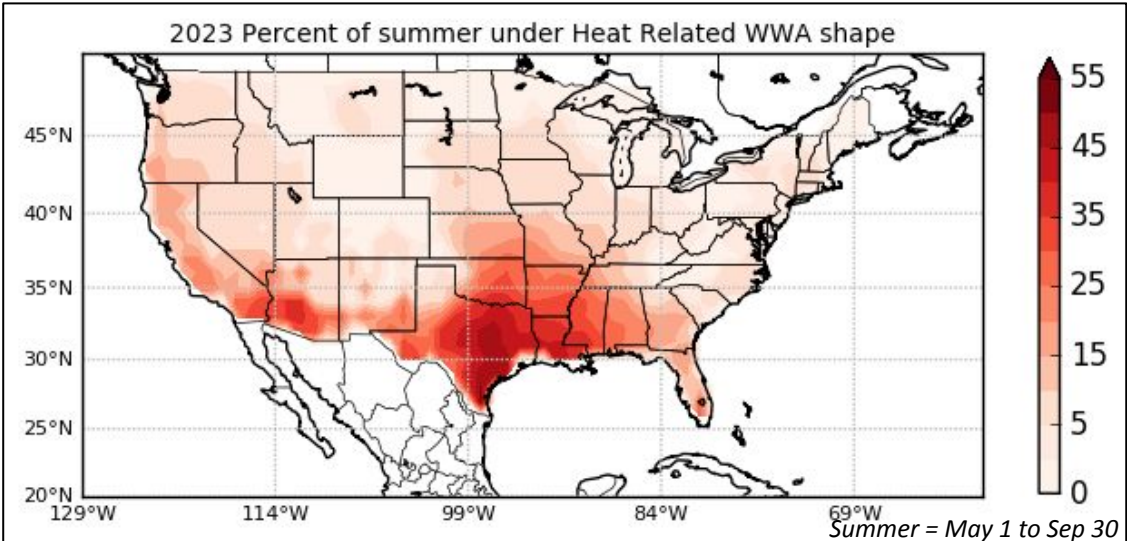
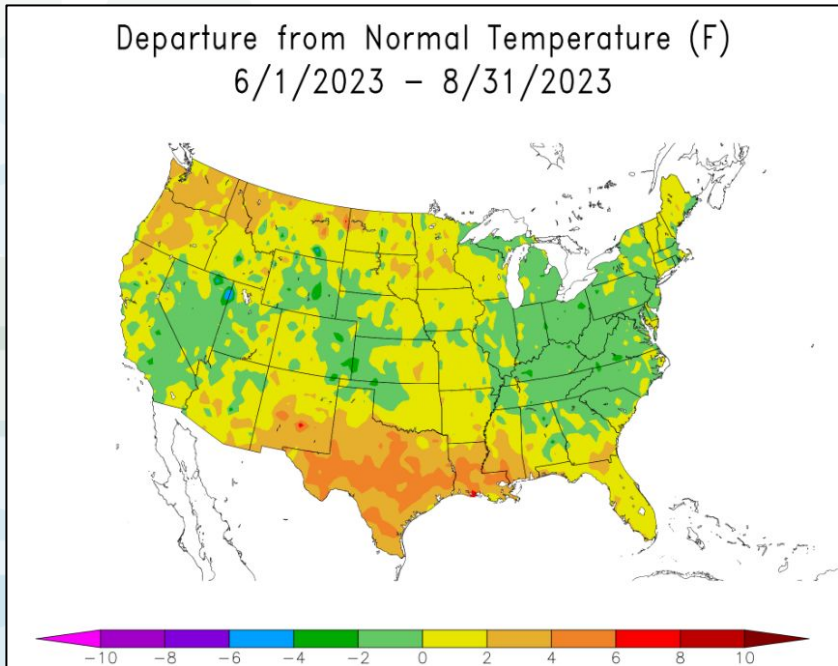
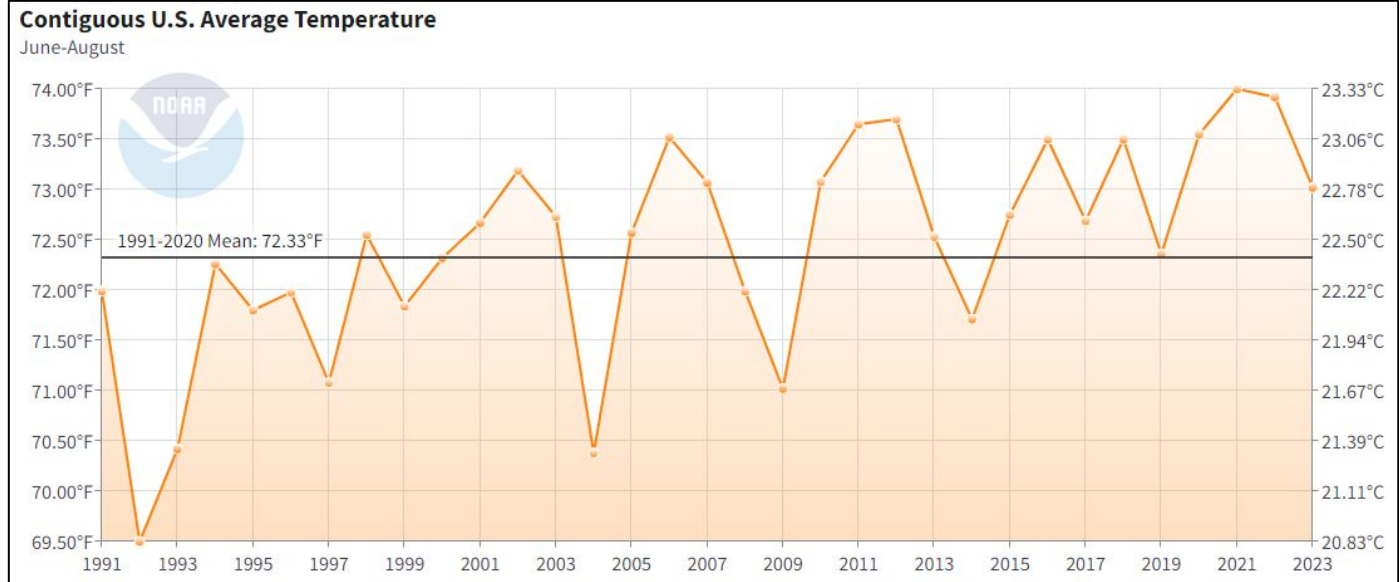






# Summer 2023

- 2023 hotter than normal
- Southern Plains + Lower Mississippi Valley
- Heat related WWA %



# Regional Analysis

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*Analysis done December 2023*

*Presented to CPC post-mortem on 12/21/23*



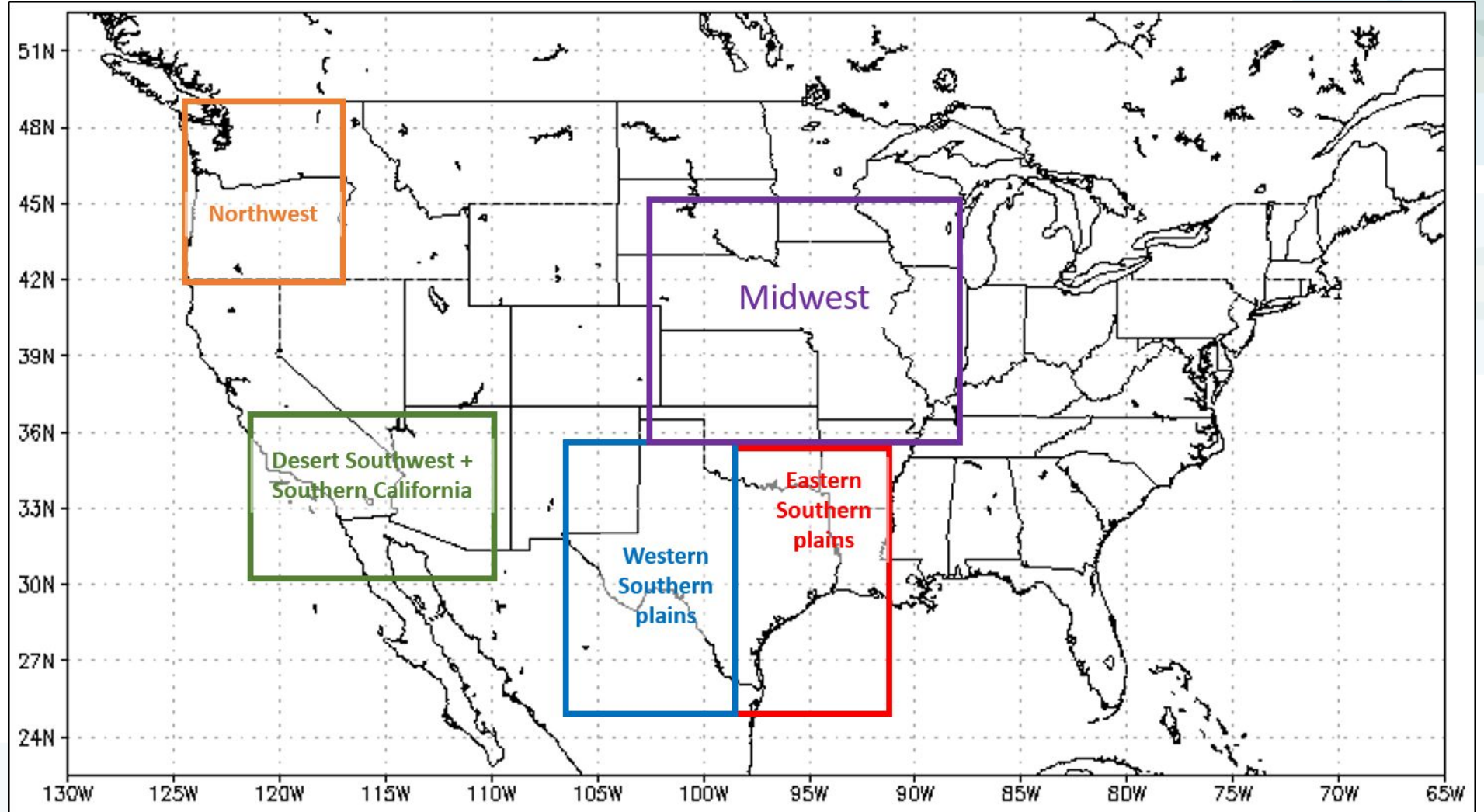
# Regional analysis data

- Reference data
  - Heat related WWA data (Justin Hicks CPC)
  - ERA5 reanalysis data (Leigh Zhang CPC)
- Week 2 forecast
  - GEFS version 12
  - ECWMF version 48r1 (post June 27); 47r3 (prior)
  - GEFS-ECMWF skill-weighted blend
- Domain
  - May 1-Sep 30
  - 1x1 grid across the CONUS
  - “5 regions”



# Regional analysis regions

- Focus on regions through time
- Easy to visualize patterns of error
- Averaged over US land in domain

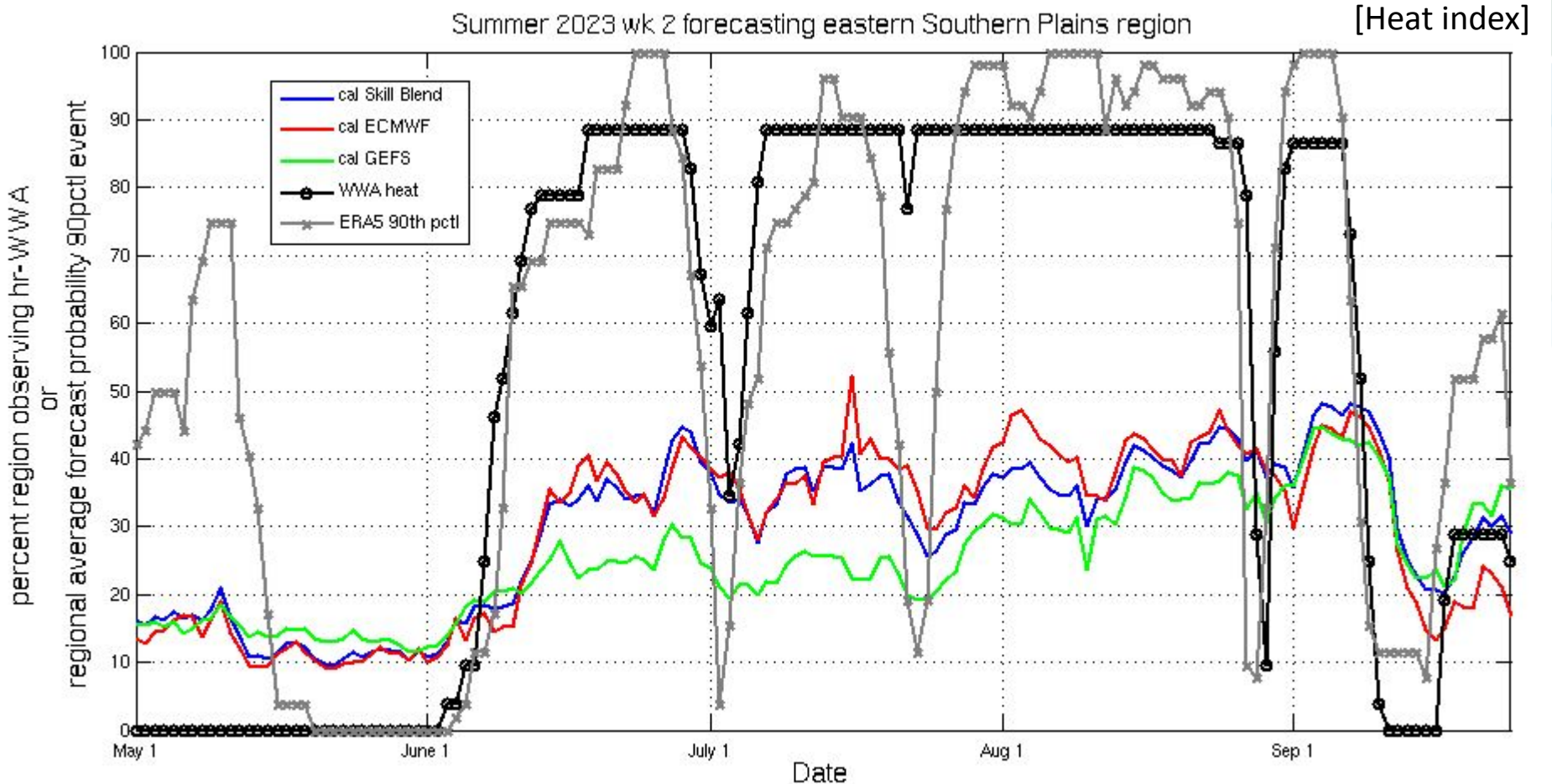




# Eastern Southern Plains

## Explaining figures

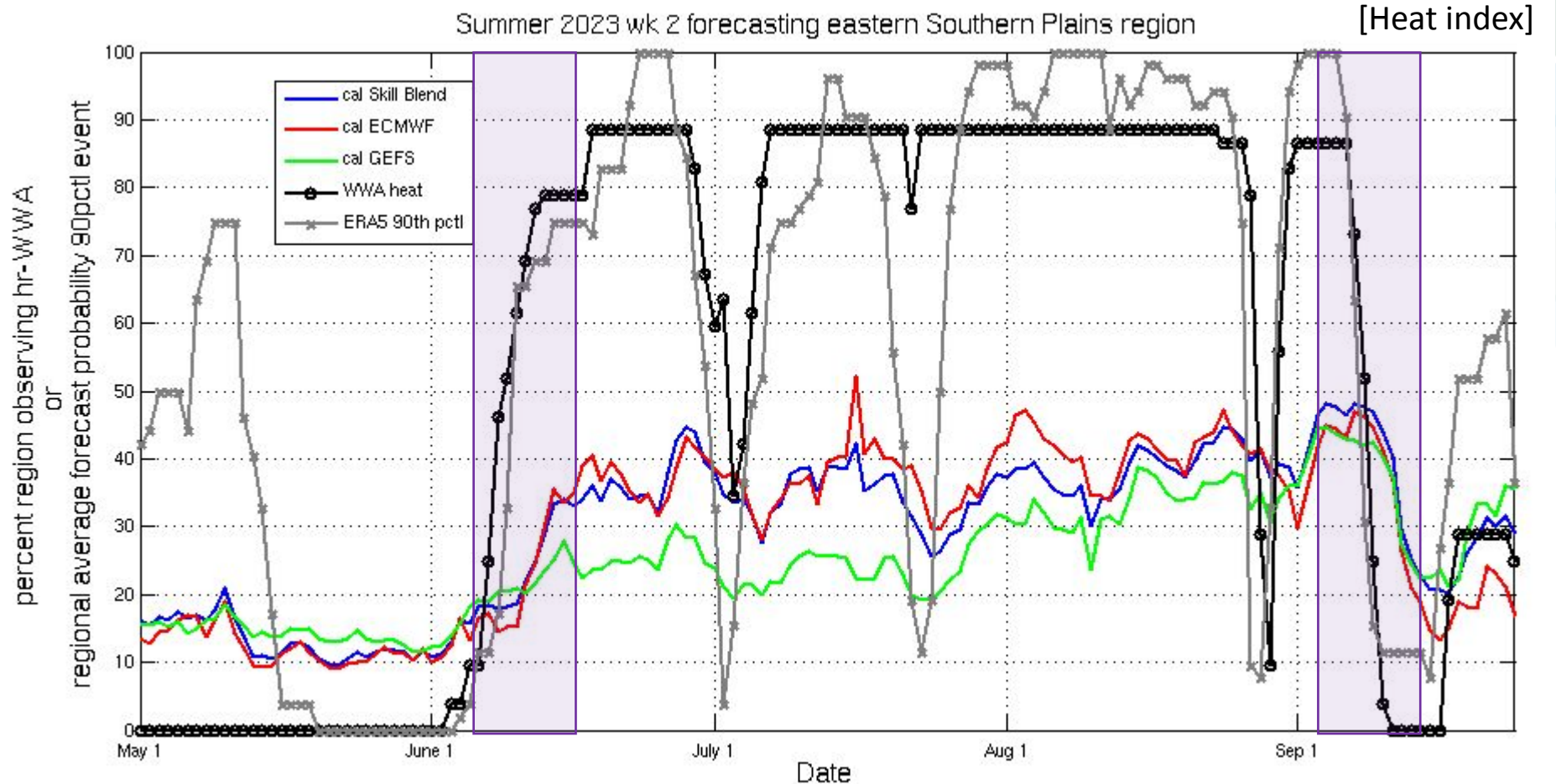
- 2 Y-Axis
- Obs: % of region qualifying
  - HR WWA
  - Consec 90<sup>th</sup> pctl days
- Fcsts: region average probability
  - Calibrated
  - ECMWF, GEFS and a weighted mean





# Eastern Southern Plains

- Early season *heat* didn't trigger WFO advisories
- Onset of heat (~June 11-14) wasn't forecasted in models
- Removal of heat in Sep (9-10th) not forecasted in models

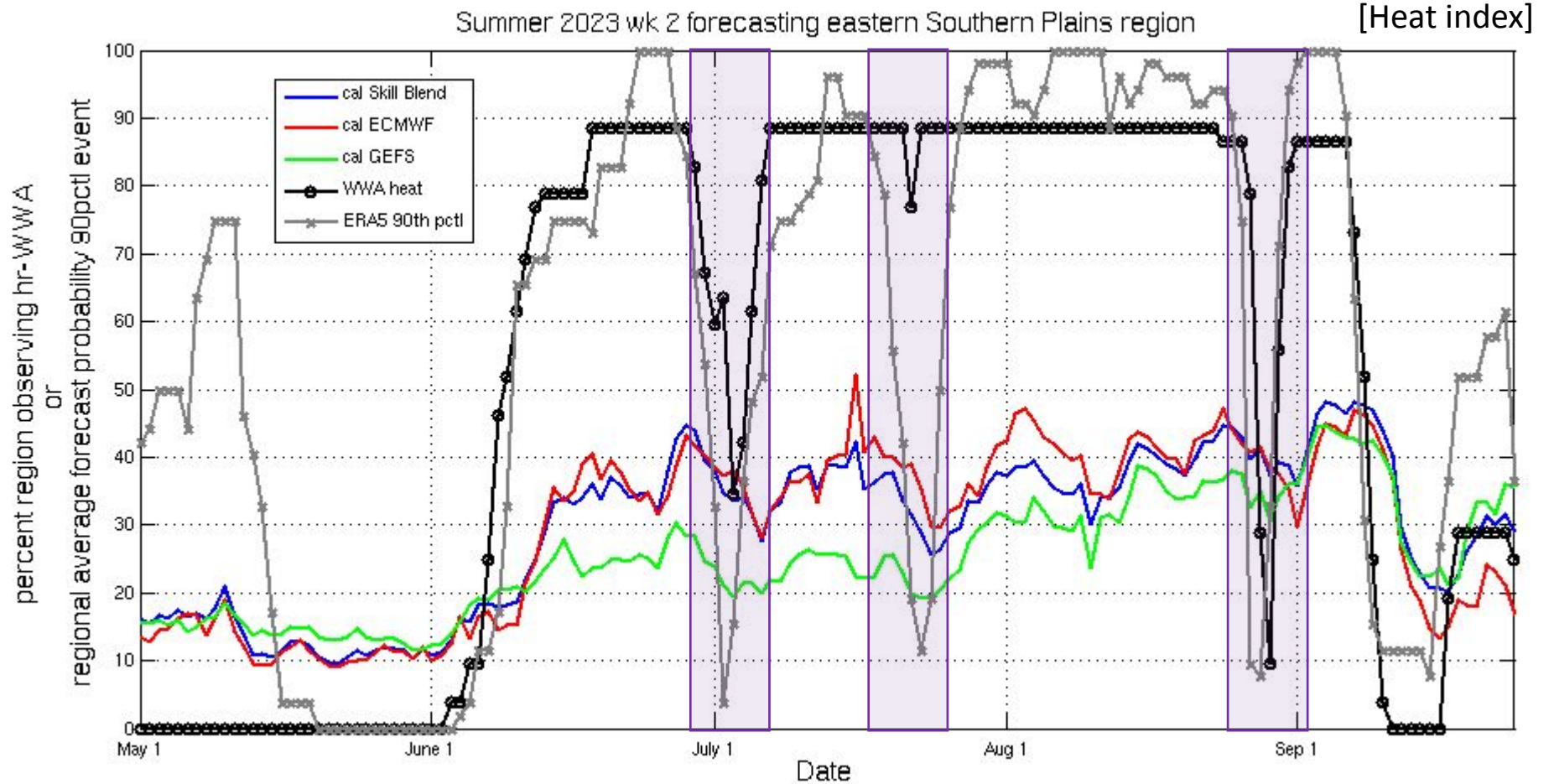






# Eastern Southern Plains

- Other reductions in the observations *were* seen in the forecasts

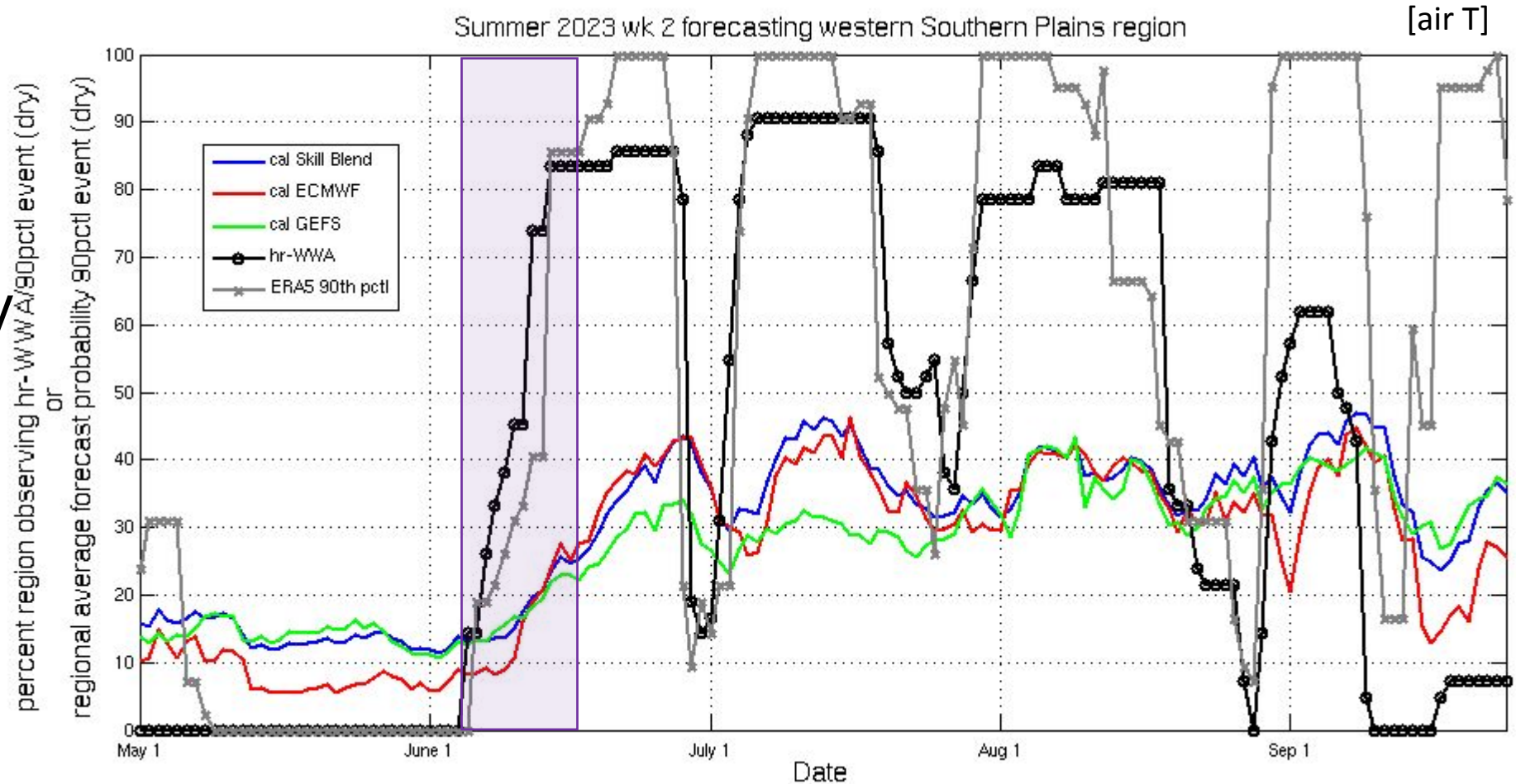






# Western Southern Plains

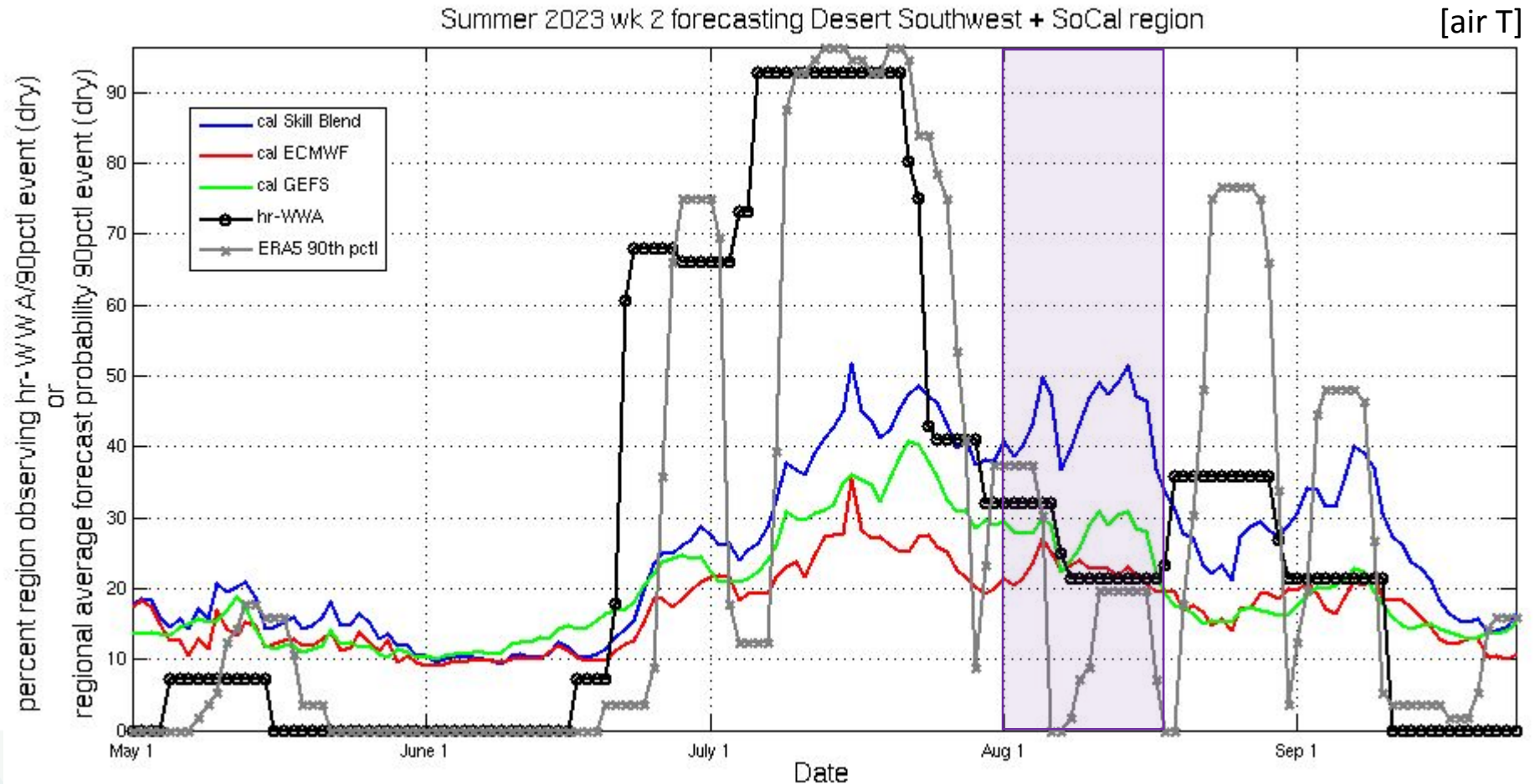
- Less heat than eastern southern plains
- Arrival in early June was under predicted





# Desert SW + SoCal region

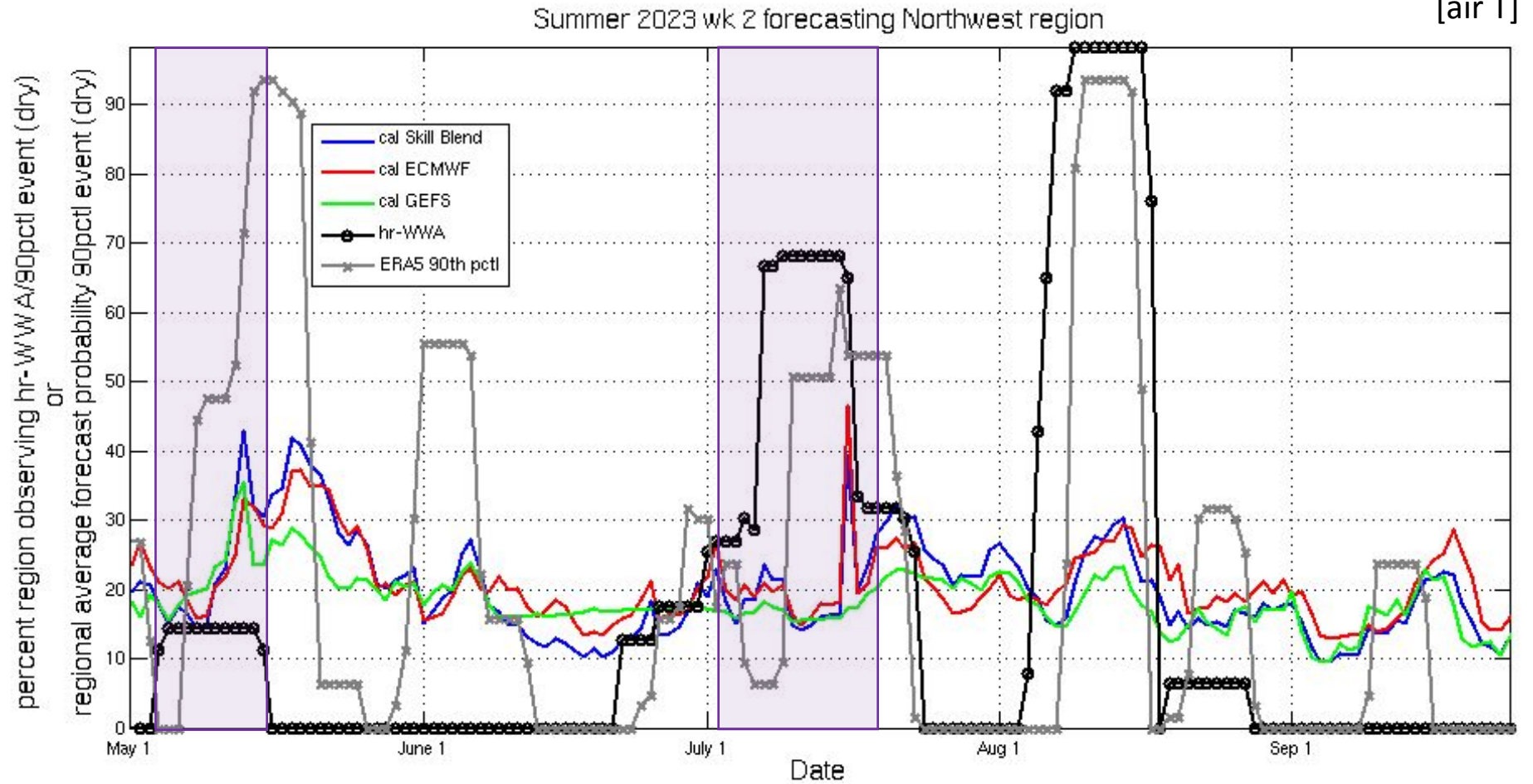
- GEFS and skill blend bit *hard* on signal that did *not* intensify in August
- Models indicated early season heat





# Northwest Region

- May event signal late
- Models seemed to miss the July and late Aug events

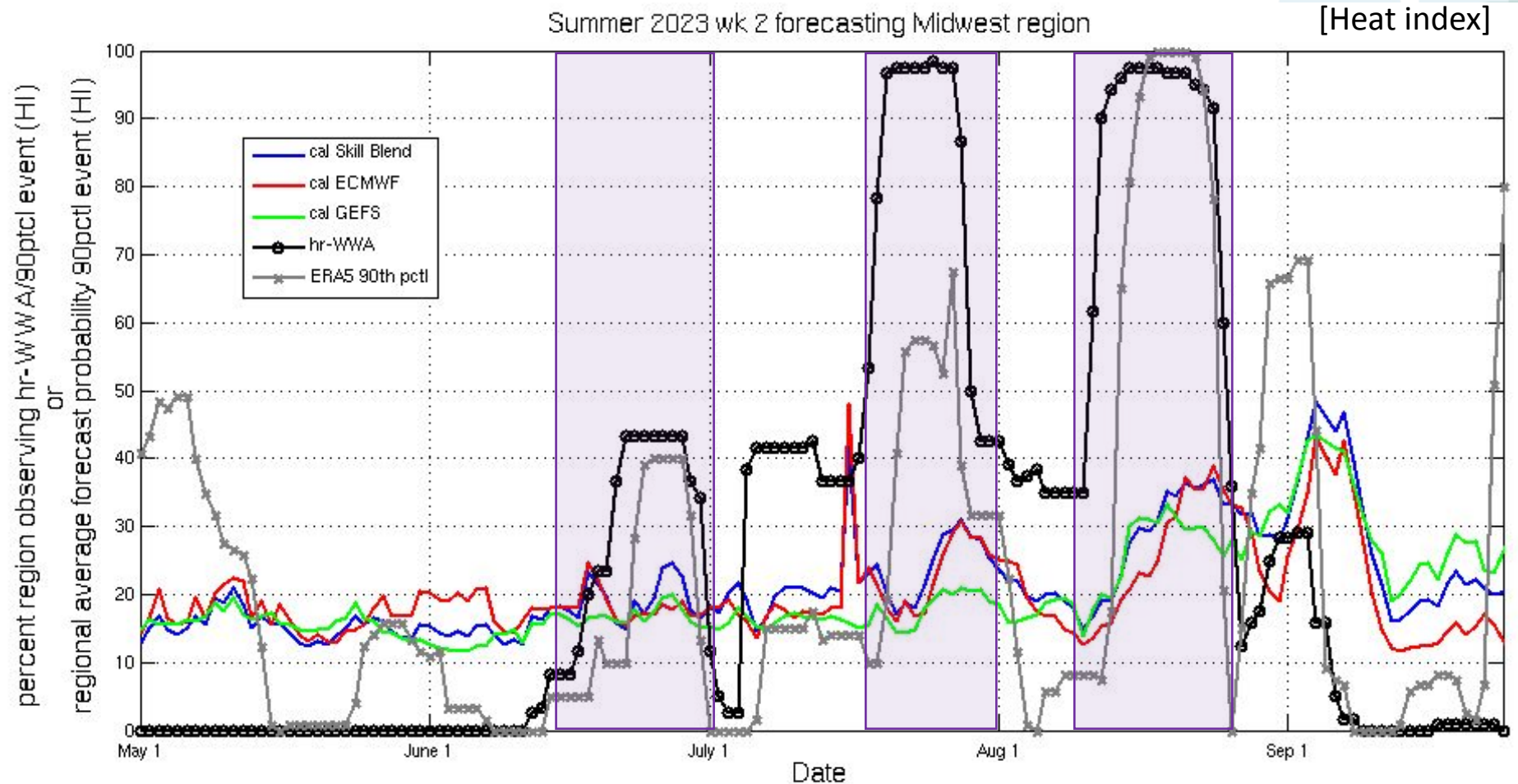






# Midwest Region

- 2 early season episodes but no WWA response
- Very little/too late signal for June, July events.
- August event had a signal in the forecasts

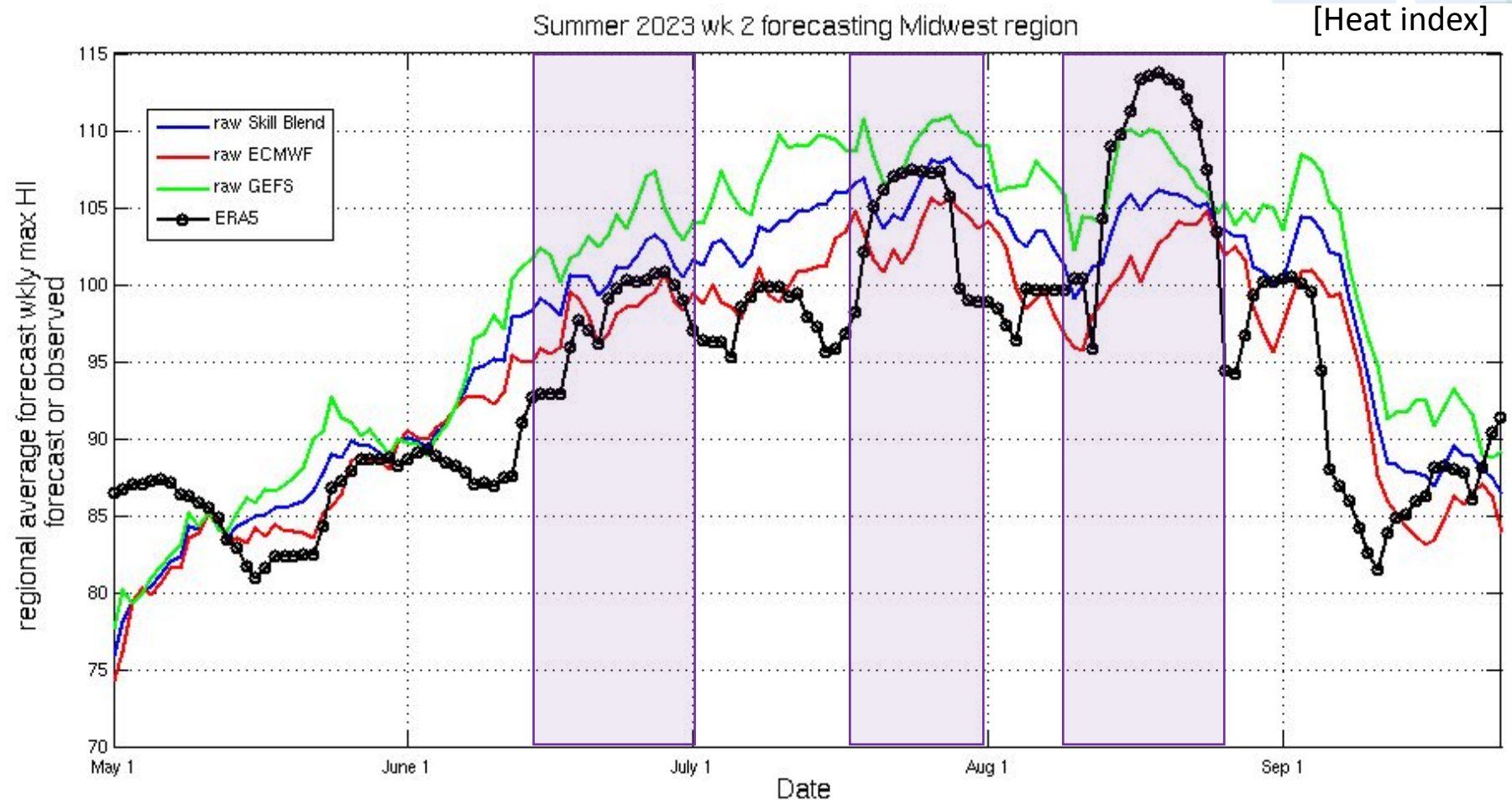






# Midwest Region

- GEFS model was *far* too hot this summer
- July event forecasted late
- August event had signal; still under forecasted



# Take Aways

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# Thoughts walking away

- Extremely large amount of heat in the Southern Plains and Lower Mississippi Valley in 2023
  - CPC forecasters *currently* leverage subtle signals in the calibrated tools to forecast *big* anomalies
    - Is calibration method impacting variance?
  - Large bias in the Midwest in GEFS model *did cause* issues in CPC ability to use the GEFS *and* the skill-blended forecasts to forecast extreme heat in July and August
    - Bias correction system now installed (see poster)
- 
- Thank you for your attention
  - Please send emails to [evan.oswald@noaa.gov](mailto:evan.oswald@noaa.gov) or [Jon.Gottschalck@noaa.gov](mailto:Jon.Gottschalck@noaa.gov)
  - Extra slides: focusing on skill maps, CPC forecasting Texas heat

# Bonus slides

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# Table of regional bias, error (def

2023 season regional breakdown; weekly maximum

High bias and Error in GEFS for Eastern Southern Plains and Midwest

HR-WWA dates: 60% of region-models have increased bias, 87% of region-models have decrease error

<i>Summer 2023 (HR-WWA *)</i>	GEFS	ECMWF	GEFS-ECMWF Blend
<i>Bias (F)</i>			
East southern plains (HI)	<b>+3.88</b> (+4.45)	+0.52 (+1.37)	+2.15 (+2.87)
West southern plains (air T)	+0.31 (-0.62)	+0.30 (+0.38)	+0.30 (-0.12)
Desert southwest (air T)	+0.65 (-0.24)	<b>+1.42</b> (+0.24)	+1.04 (+0.01)
Northwestern US (air T)	+0.81 (-1.03)	+0.43 (-1.72)	+0.61 (-1.39)
Midwest (HI)	<b>+4.82</b> (+4.97)	-0.10 (-1.32)	+2.27 (+1.72)
<i>Error (F)</i>			
East southern plains (HI)	<b>4.56</b> (4.47)	2.85 (1.97)	3.46 (2.96)
West southern plains (air T)	2.27 (1.21)	2.33 (1.63)	2.02 (1.18)
Desert southwest (air T)	1.98 ( <b>2.01</b> )	2.32 (1.82)	2.06 (1.82)
Northwestern US (air T)	3.01 (2.90)	3.32 (3.39)	3.10 ( <b>3.16</b> )
Midwest (HI)	<b>6.08</b> (6.07)	<b>3.73</b> (4.00)	4.36 (4.38)

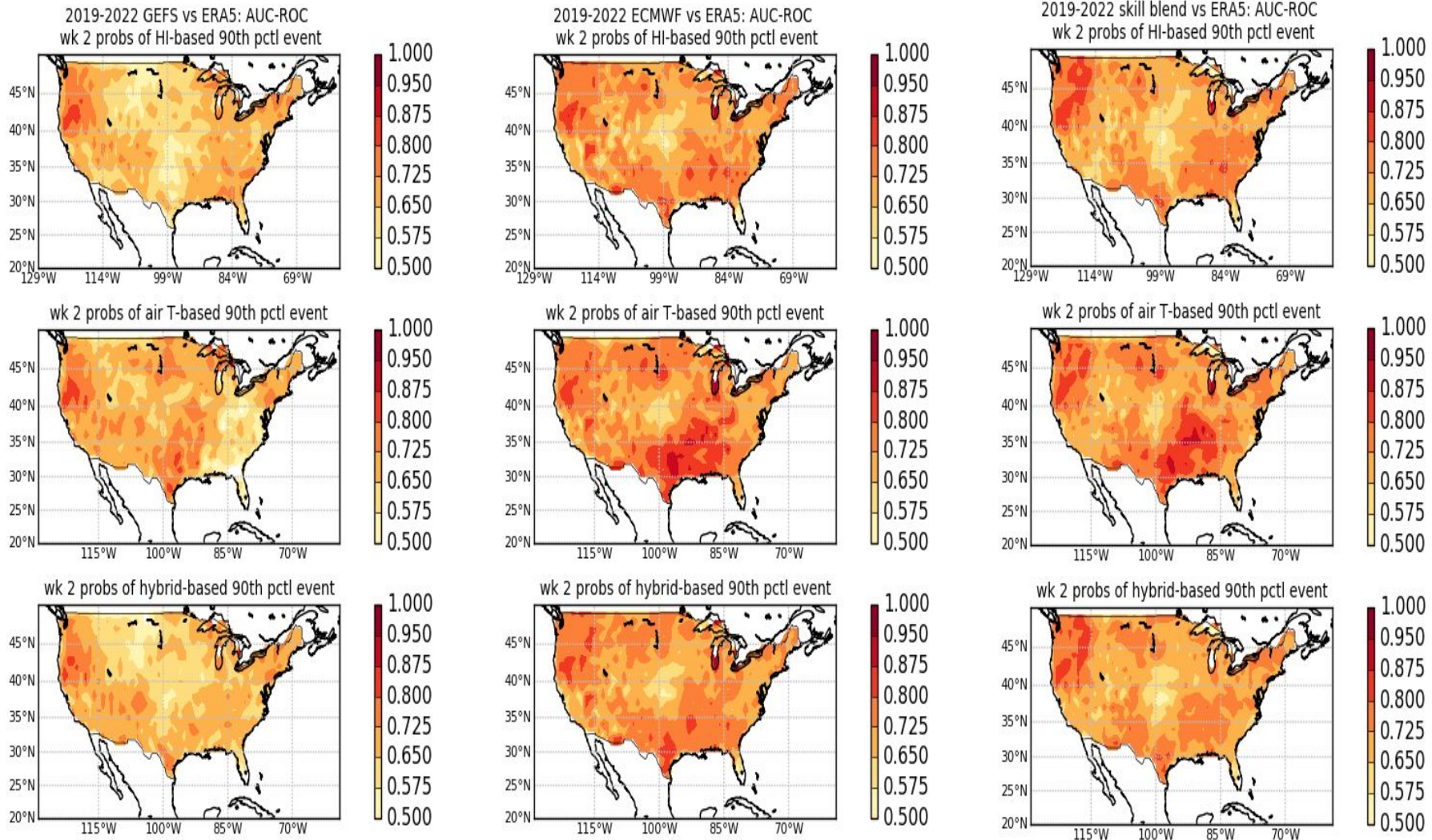
\*Red = worse!



# Maps of skill

Previous years  
[2019-2022]  
real time  
forecasts  
skillscores

More skill in  
ECMWF, the  
South Central  
+  
Northeastern  
US.



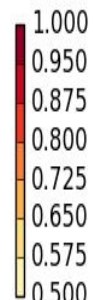
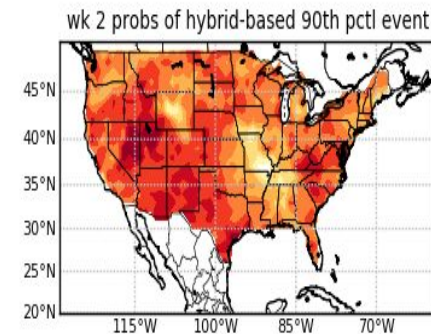
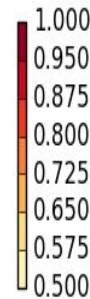
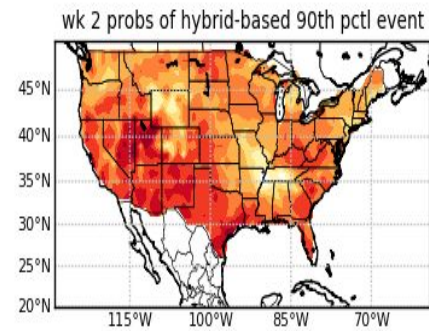
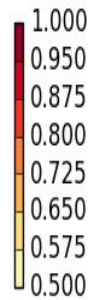
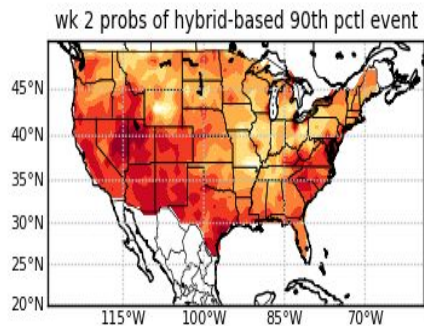
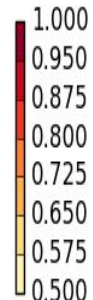
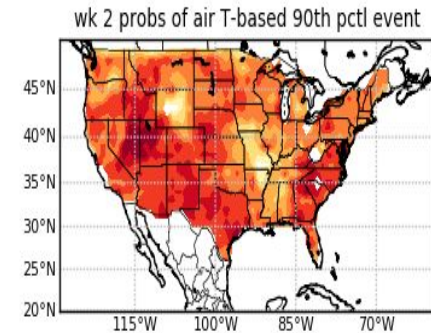
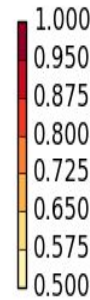
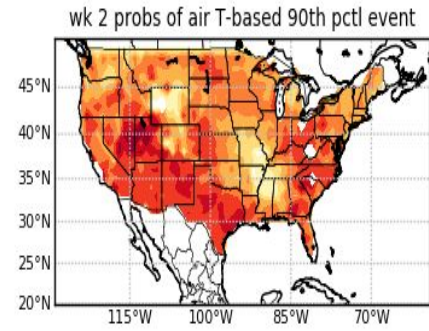
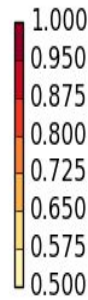
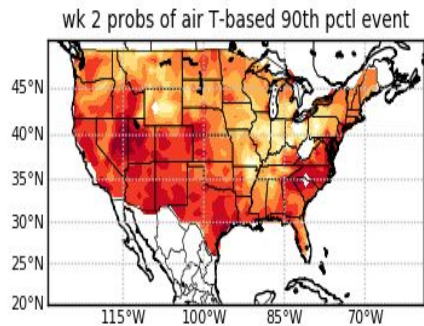
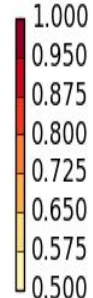
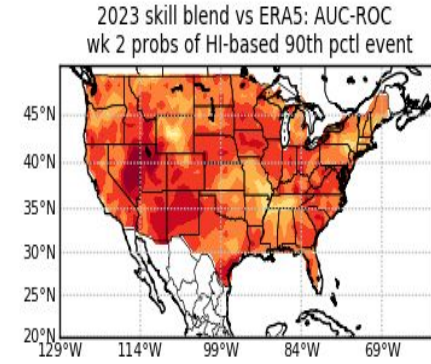
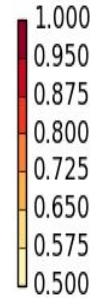
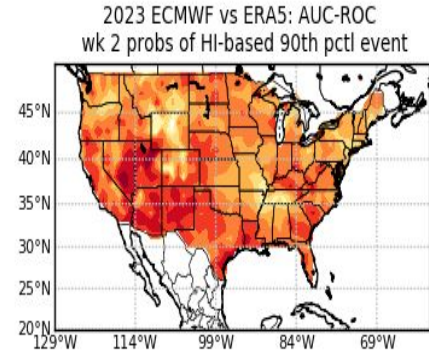
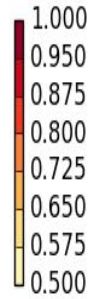
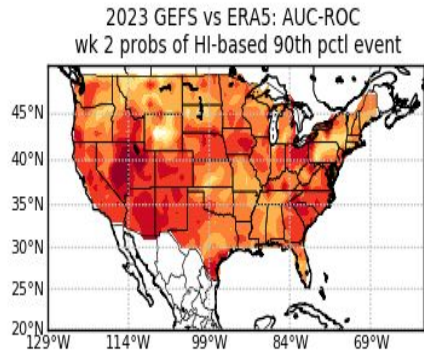




# Maps of skill

2023 real time forecasts skill scores

More skill in Southwest







# Southern Plains event onset; US Hazard outlook

