



**The Abdus Salam  
International Centre for Theoretical Physics**



**2148-9**

**Fifth ICTP Workshop on the Theory and Use of Regional Climate  
Models**

*31 May - 11 June, 2010*

**Extreme precipitation by RegCM3 and other RCMs in NARCCAP**

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# Simulations of Regional, Extreme Precipitation by NARCCAP RCMs

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Iowa State University  
and  
The NARCCAP Team**



# OUTLINE

- ✧ Motivation & Goals
- ✧ Monthly extremes
- ✧ Daily extremes

# Analysis of Extremes

**Societal importance, esp. for climate change**

**Key Question: Do climate models behave like observations?**

**Diagnosis of physical mechanisms**

- **Necessary for model vs. obs. comparison**
- **Basis for developing confidence in projections**

# Simulations Analyzed

HRM3

Hadley Centre

ECPC

Scripps

MM5I

Iowa State/  
PNNL

MRCC

Quebec,  
Ouranos

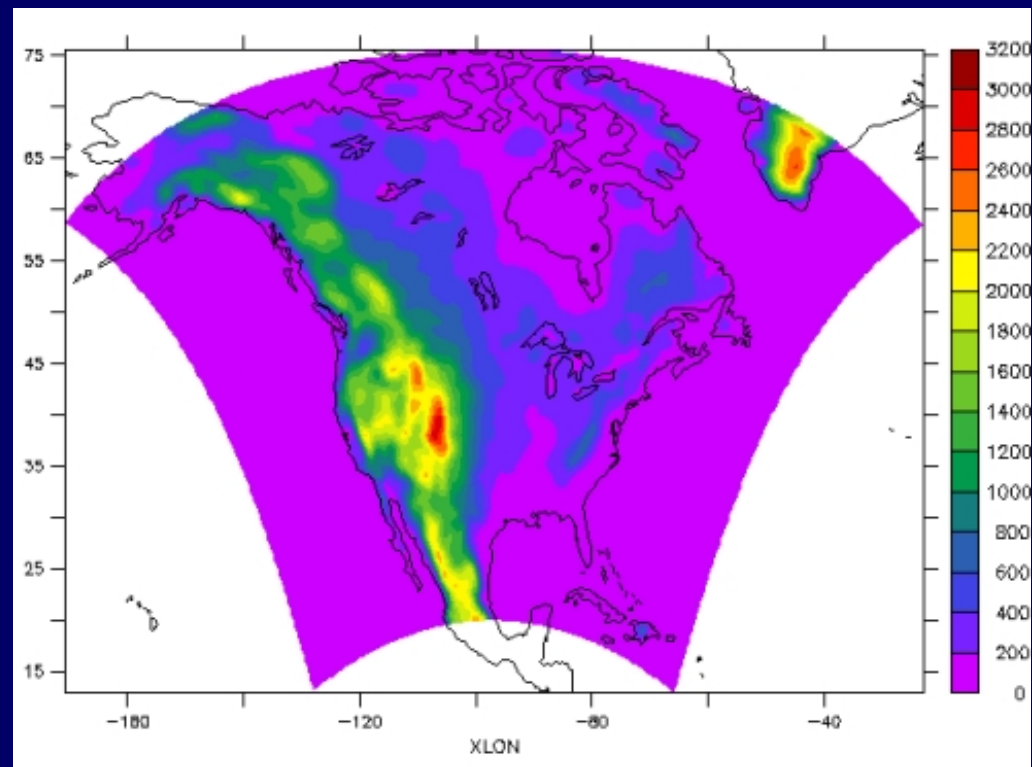
RCM3

UC Santa Cruz  
ICTP

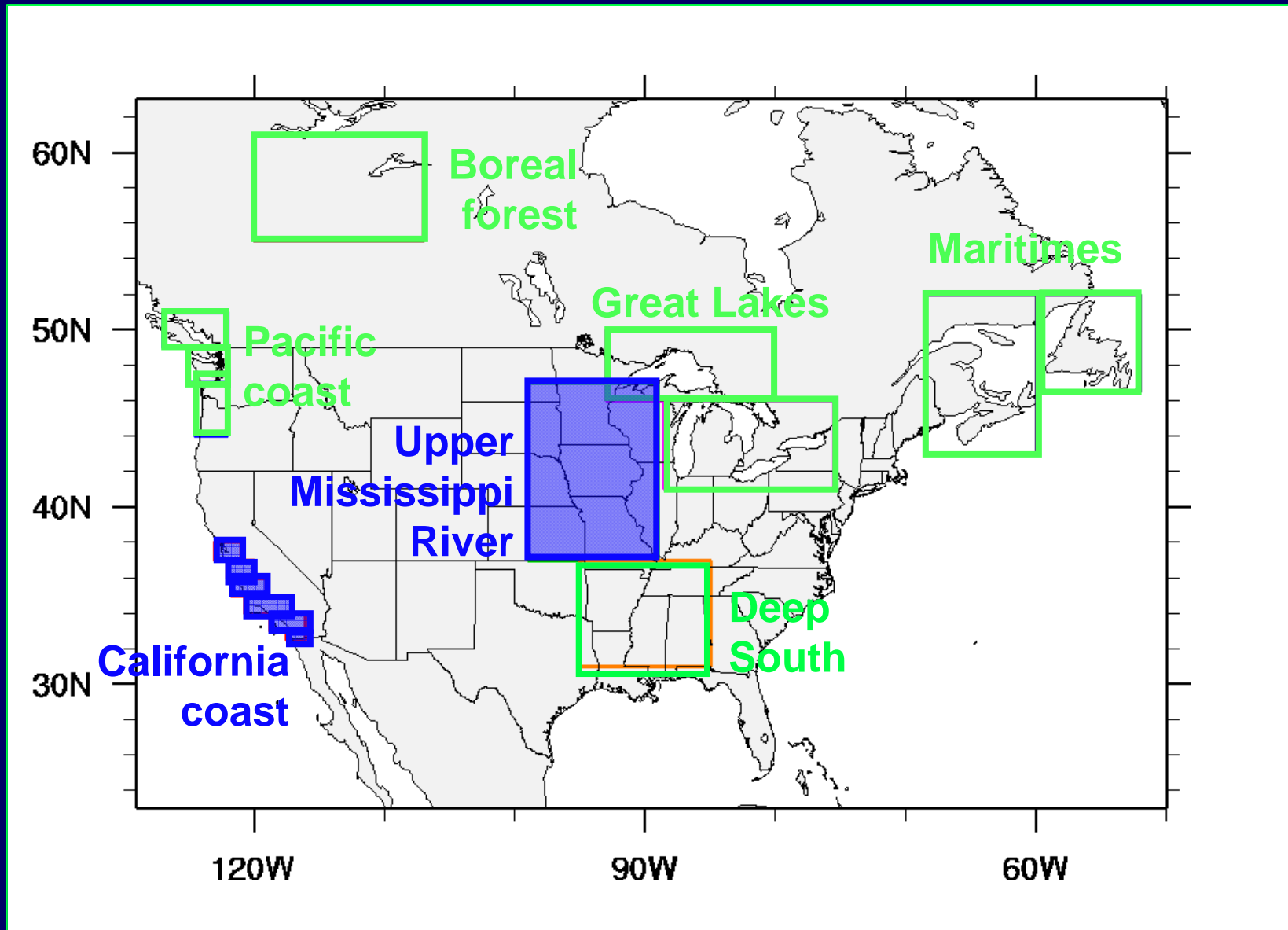
WRFP

NCAR/  
PNNL

- Domain
  - Most of North America
- Period
  - 1979-2004
- Boundary Conditions
  - NCEP/DOE reanalysis



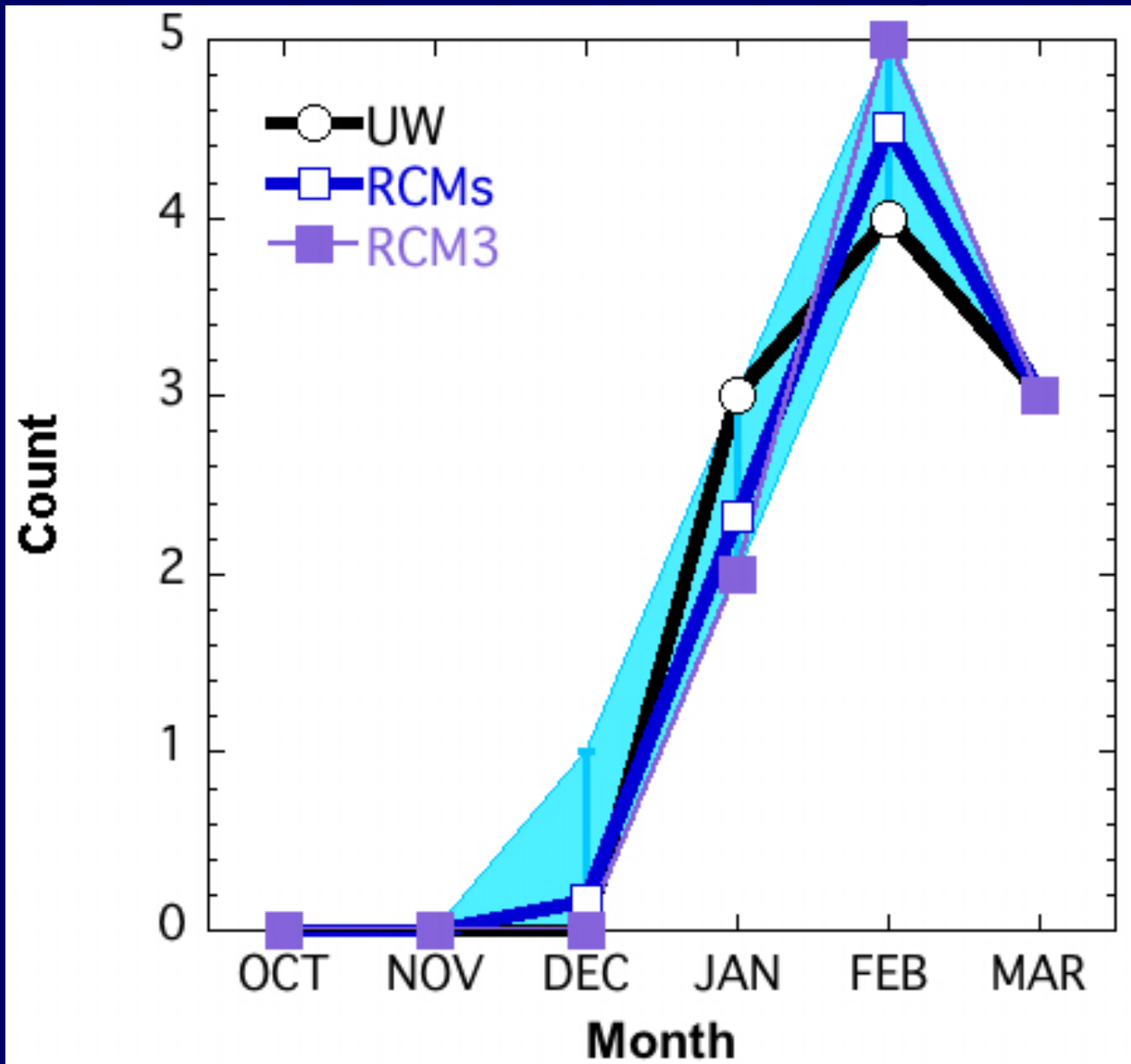
# Regions Analyzed



# Comparison with observations (monthly extremes)

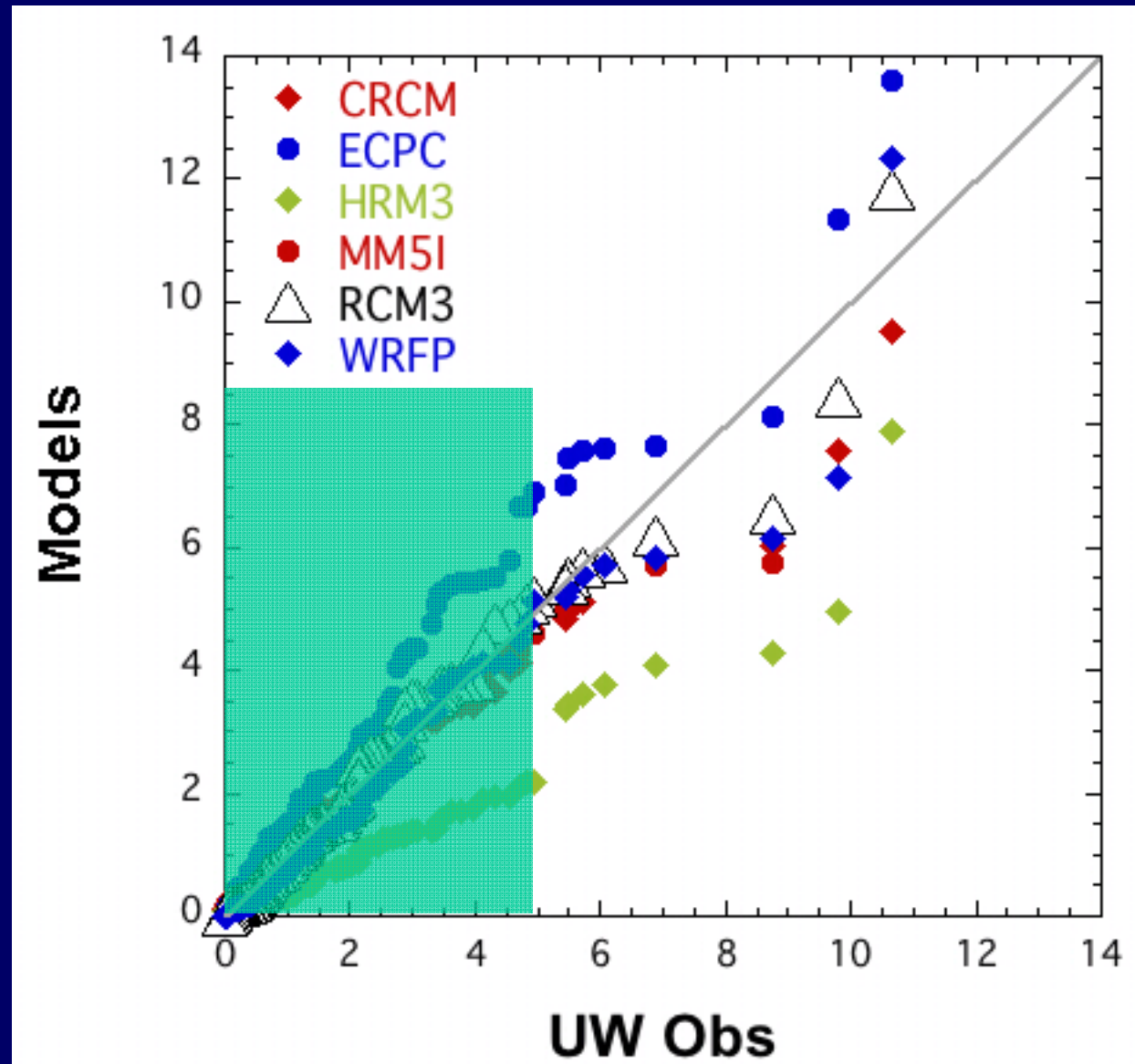
- Observations
  - ★ Precip: University of Washington VIC retrospective analysis
  - ★ 500 hPa Heights: North American Regional Reanalysis
- Comparison period: 1982 -1999
  - ★ 1979-1981 omitted - spinup
  - ★ UW data end in mid-2000
- Analysis
  - ★ Cold season (October-March)
  - ★ 10 wettest months (top 10%)

# Frequency – Coastal CA



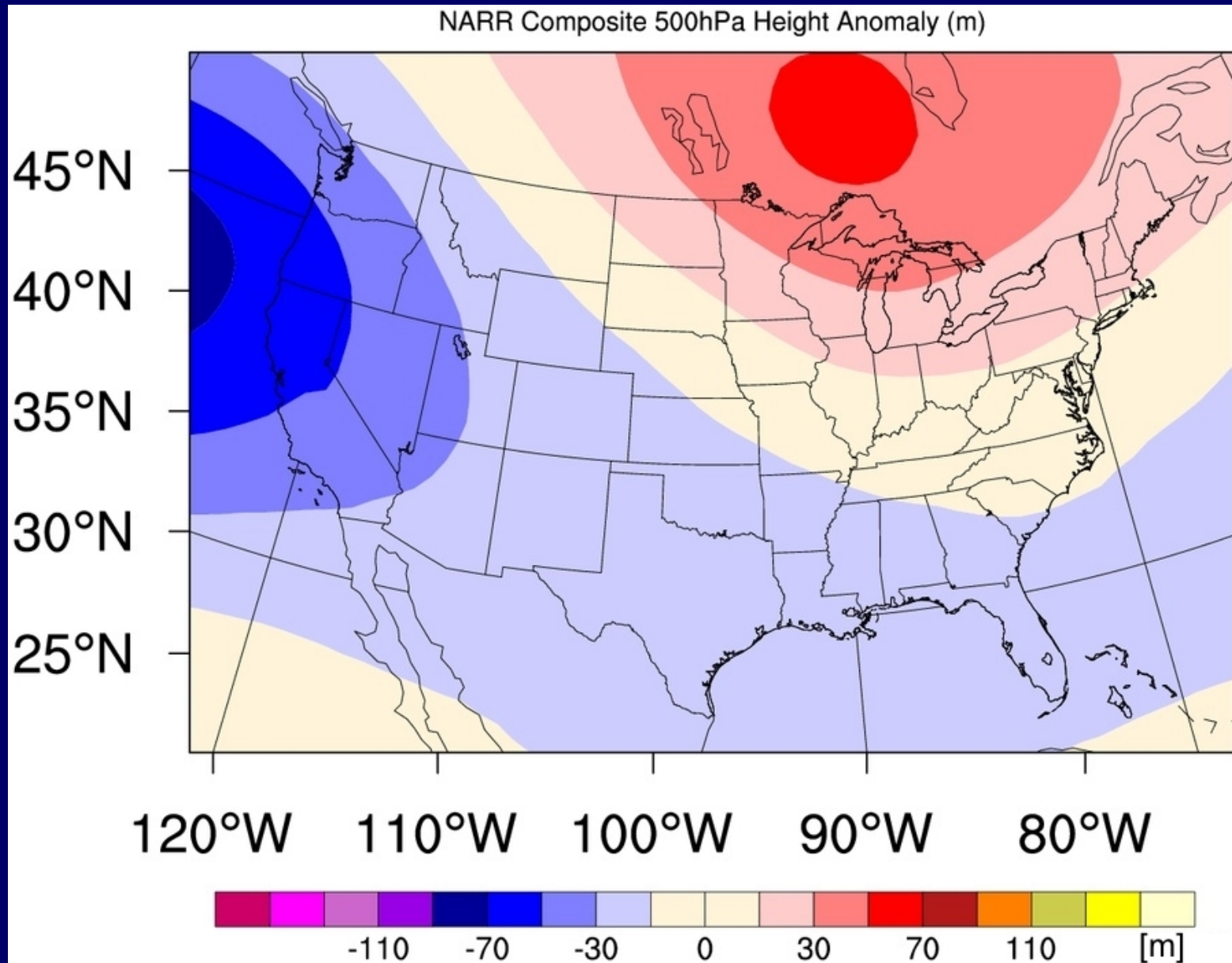


# Ranked Precipitation – Coastal CA

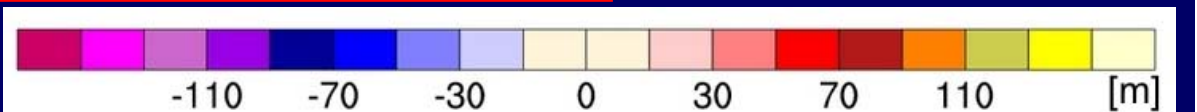
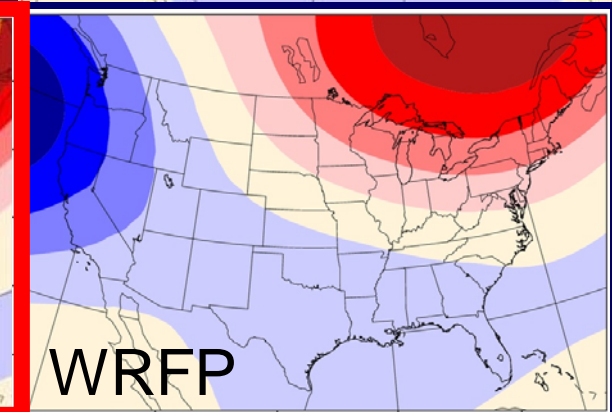
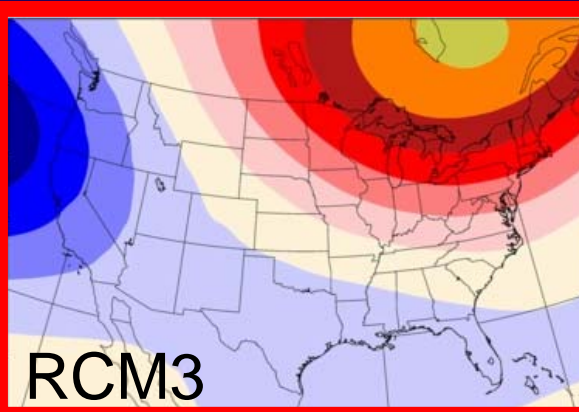
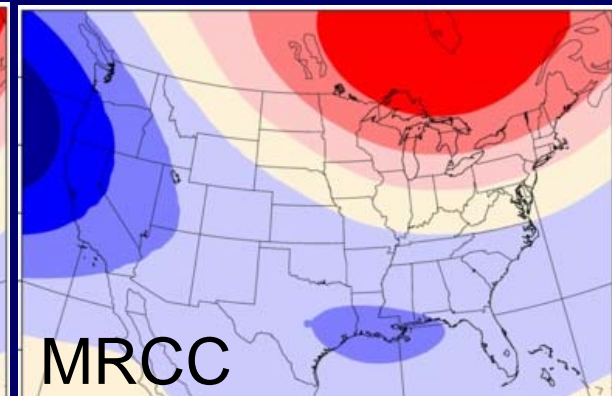
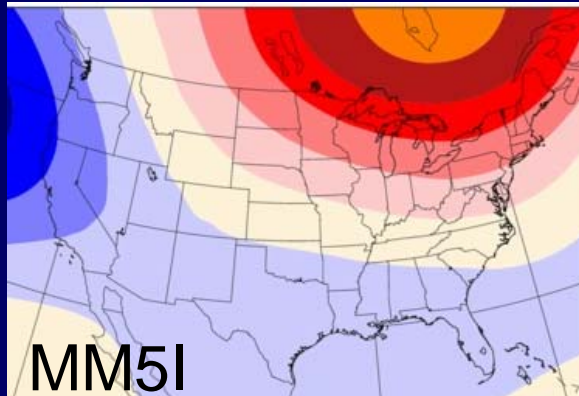
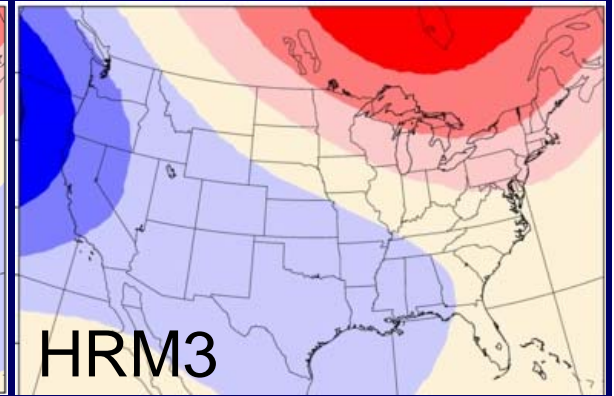
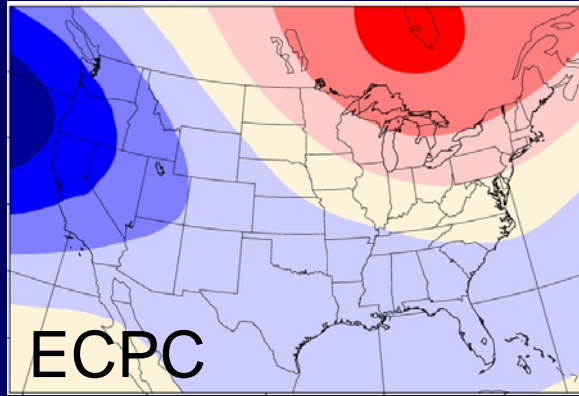
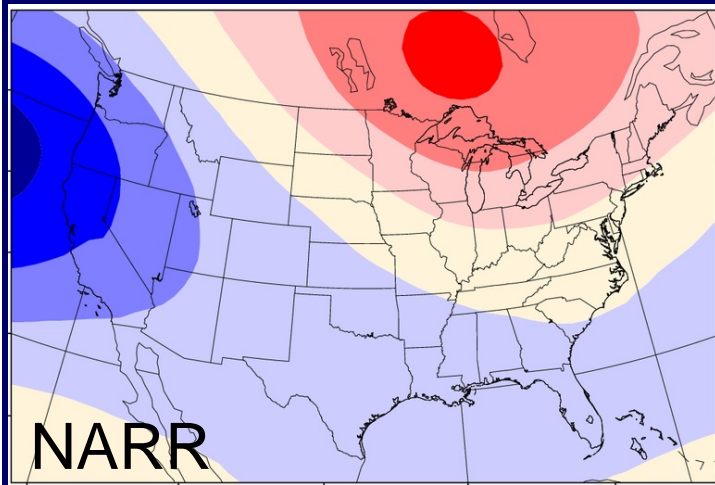


Ensemble  
average of  
top 10 = 9  
% smaller than  
UW

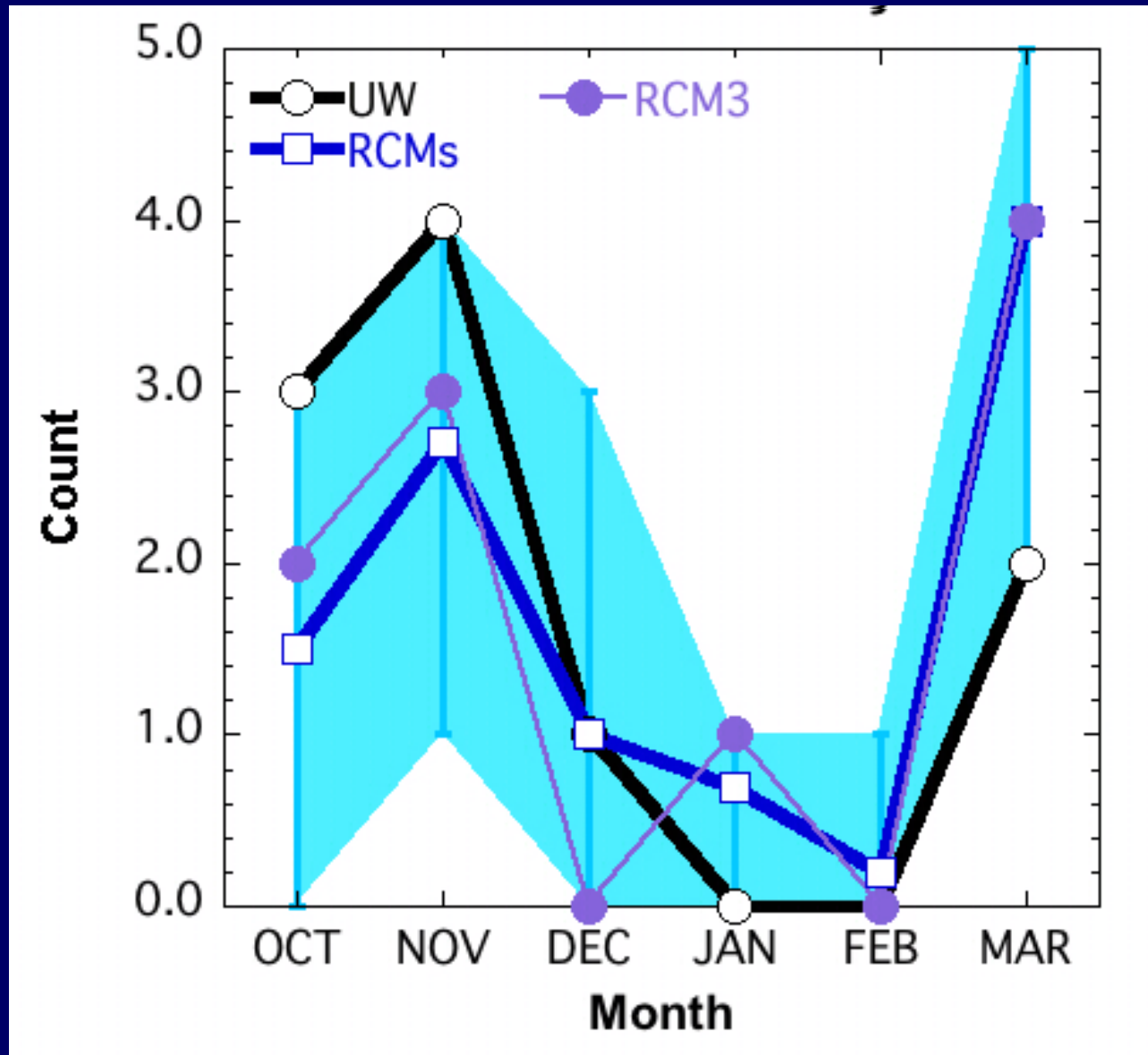
# 500 hPa Height Anomalies – Coastal CA Extreme



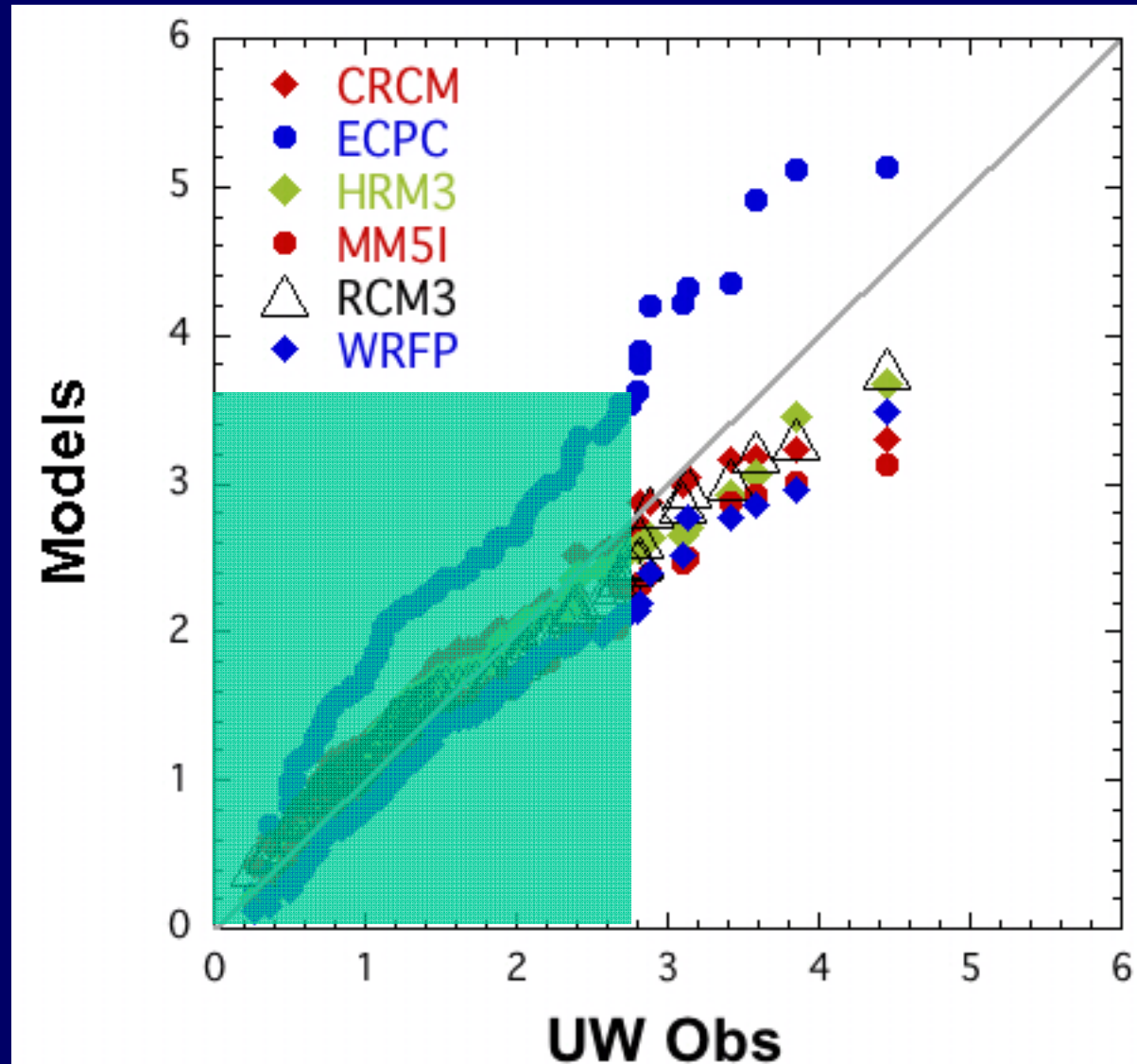
# Composite 500 hPa Height Anomalies Top 10 Extremes Coastal CA



# Frequency – Upper MS

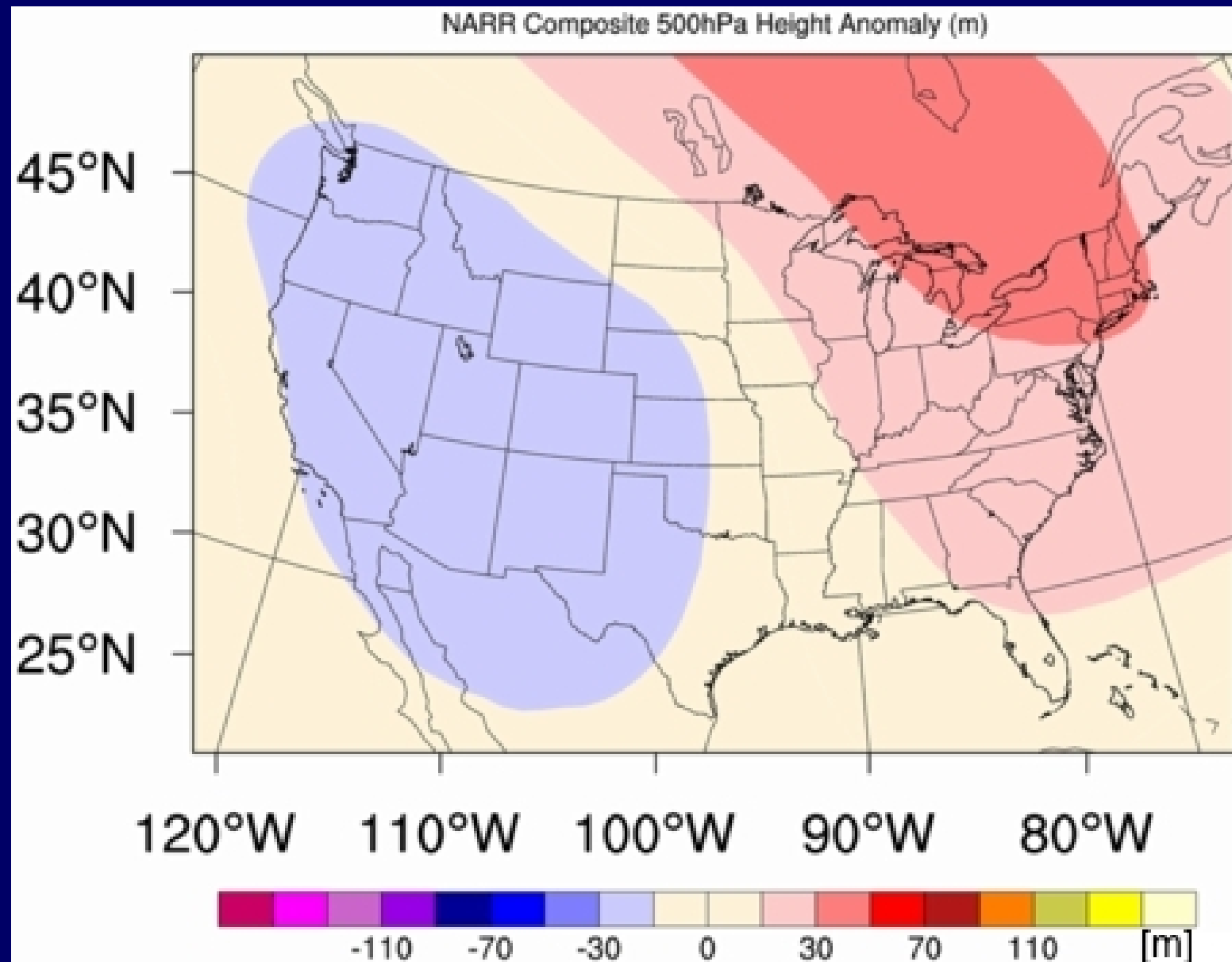


# Ranked Precipitation – Upper MS

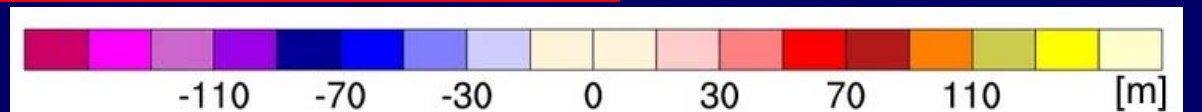
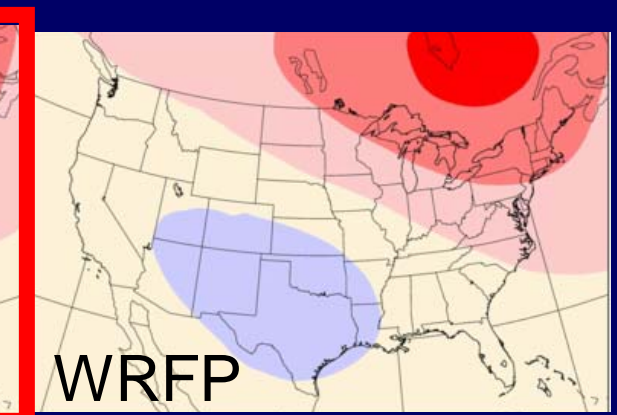
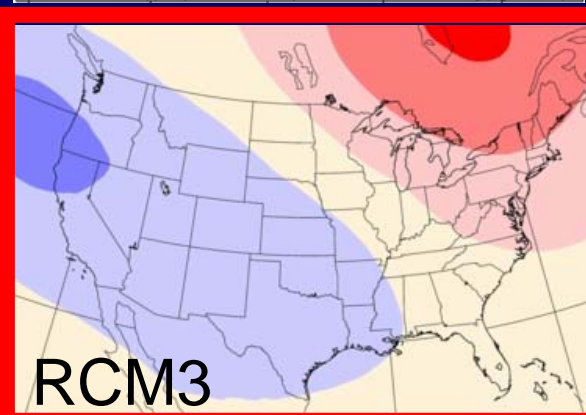
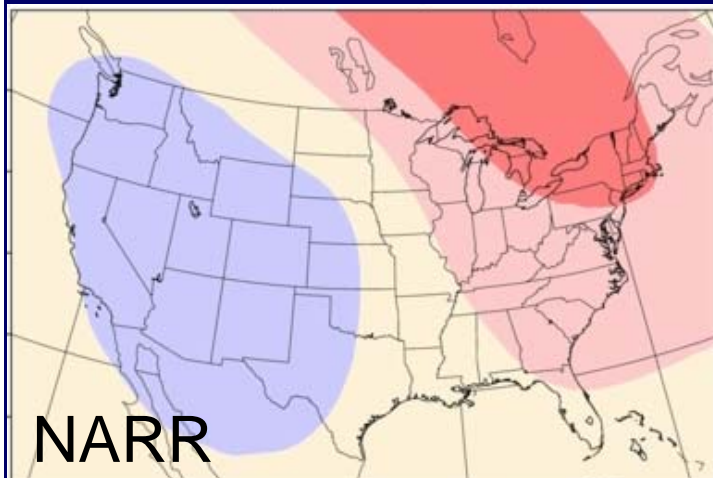
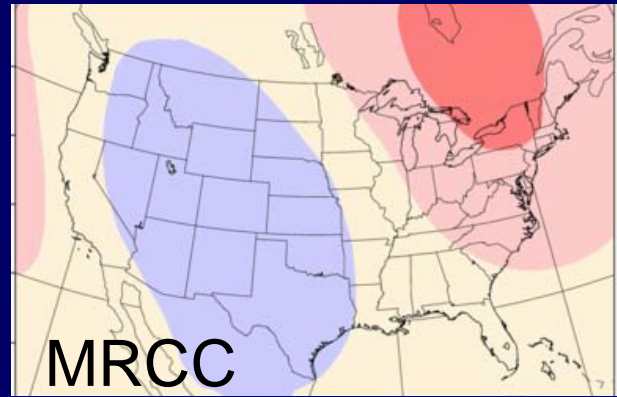
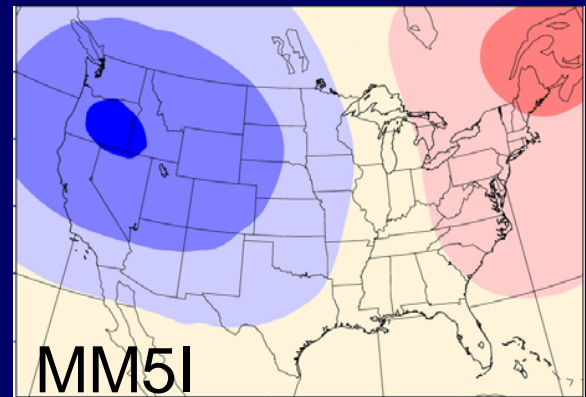
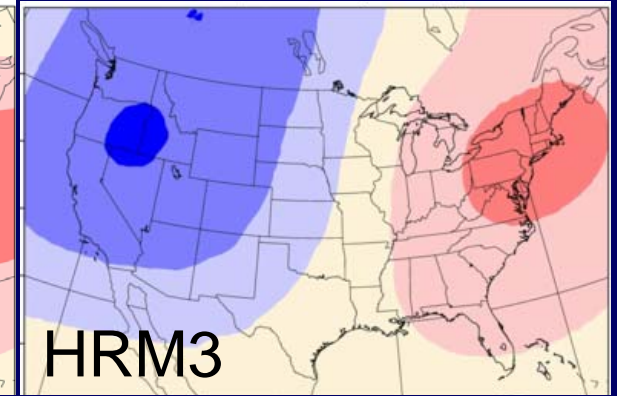
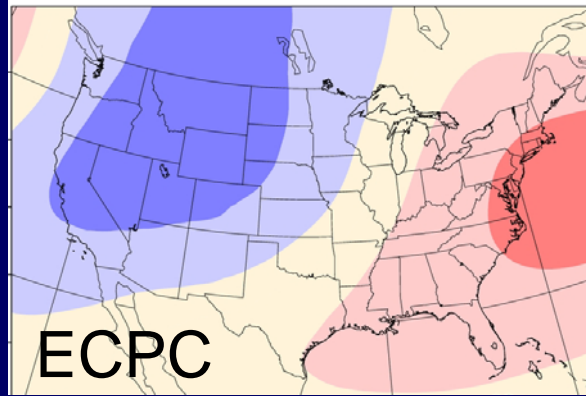


Ensemble  
average of  
top 10 = 6  
% smaller than  
UW

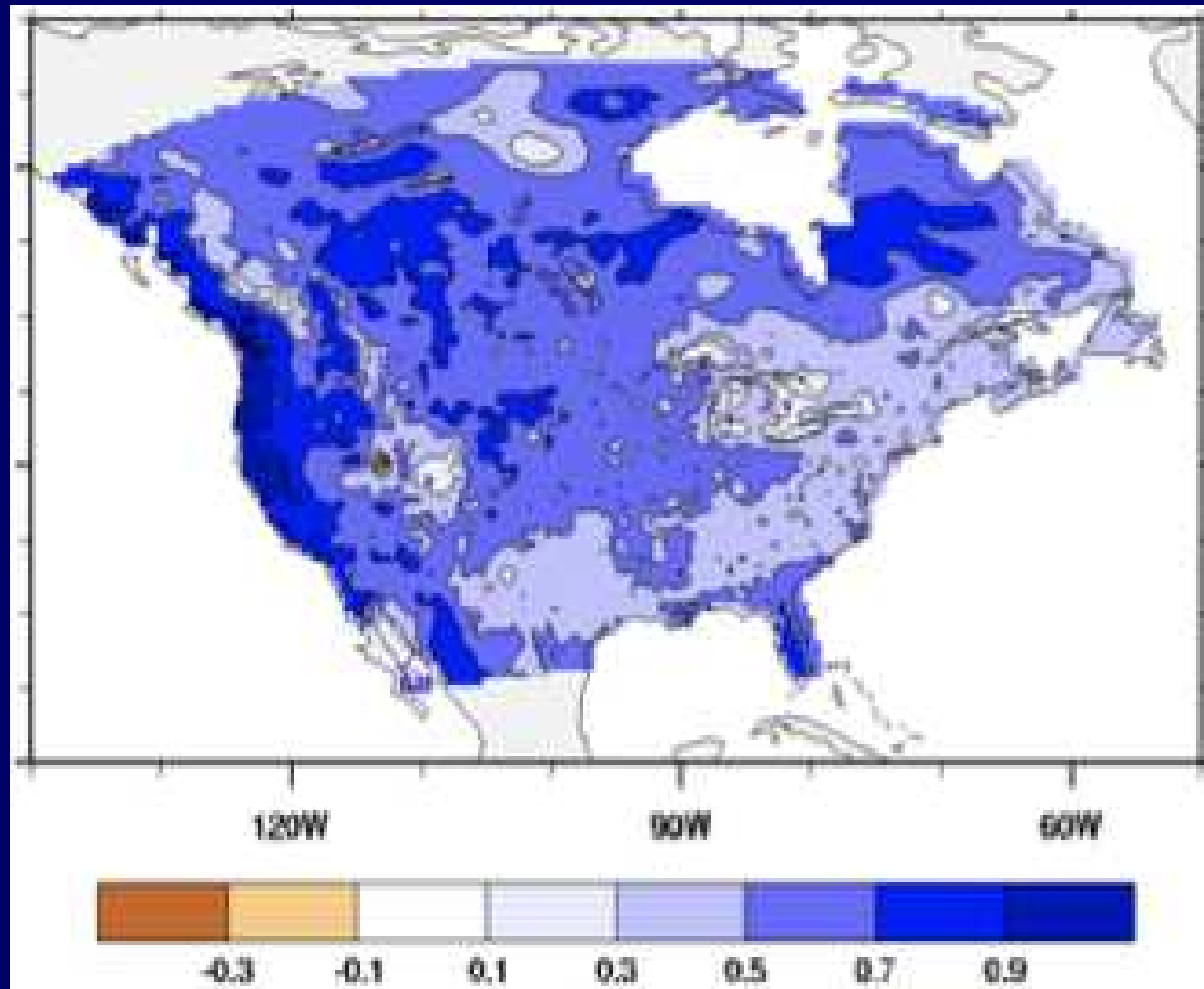
# 500 hPa Height Anomalies – Upper MS Extreme



# Composite 500 hPa Height Anomalies Top 10 Extremes Upper MS



# Correlation: Monthly Observations and Ensemble Mean



(RW Arritt, 2009)



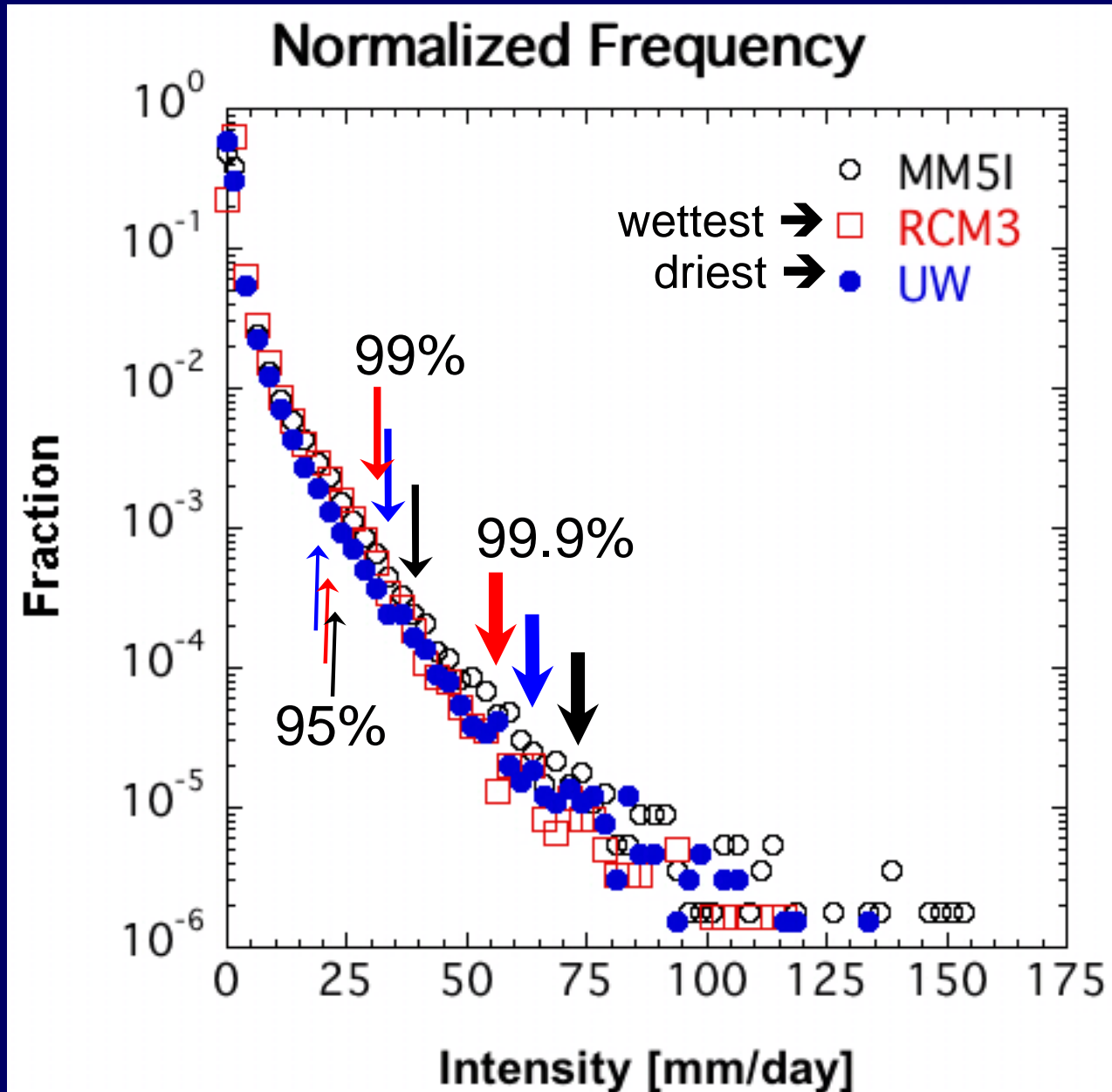
# Comparison with observations (daily extremes)

- Observations
  - ★ Precip: University of Washington VIC retrospective analysis
- Comparison period: 1982 -1999
  - ★ 1979-1981 omitted - spinup
  - ★ UW data end in mid-2000
- Analysis
  - ★ Winter season (December-January-February)
  - ★ Summer season (June-July-August)
  - ★ Nonzero daily precipitation at 1 grid point = 1 event

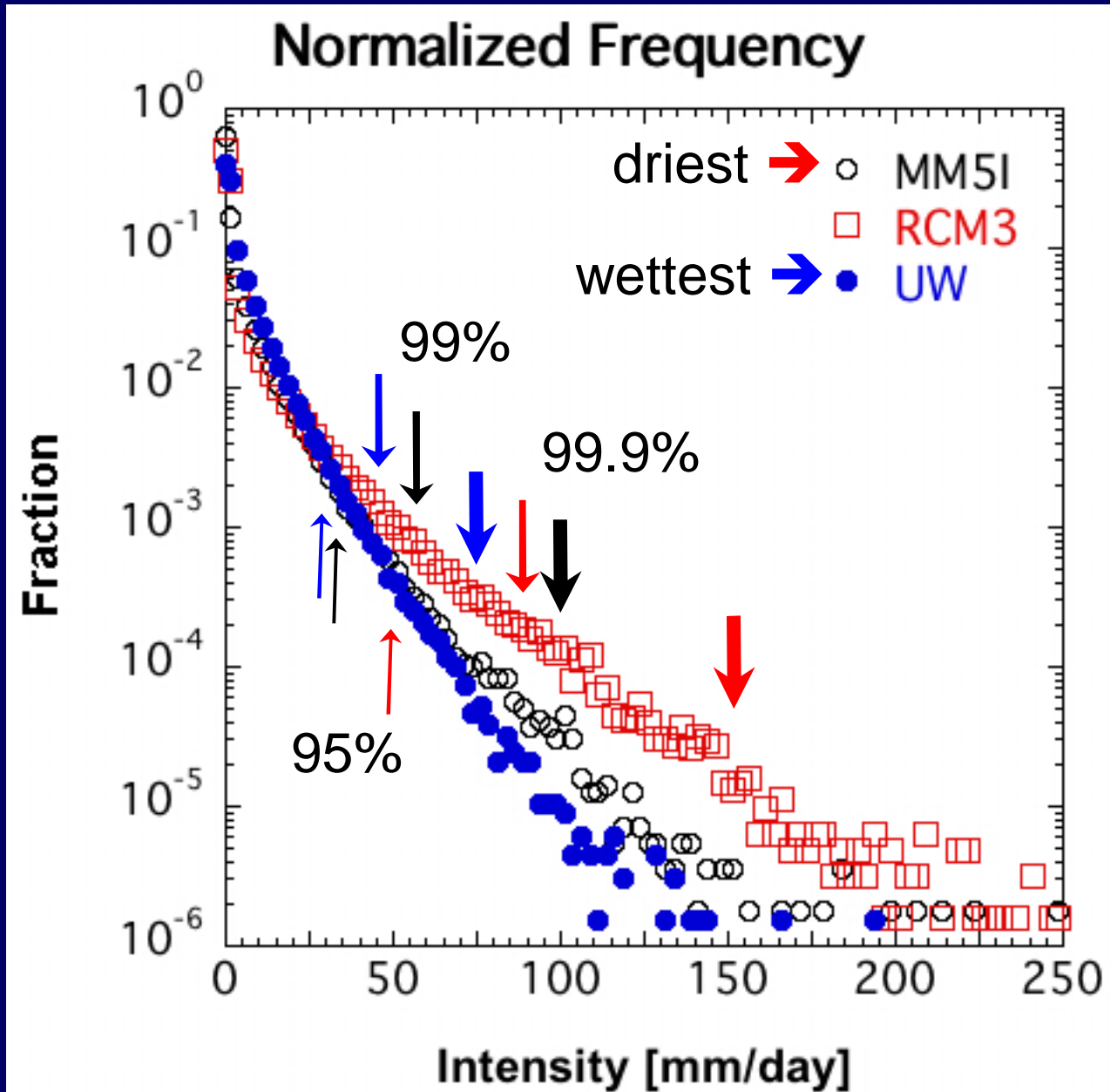
# Daily Average Precipitation

[mm/day]	UW Gridded Precipitation	RCM3	MM5I
DJF	1.02	1.35 (+32%)	1.23 (+21%)
JJA	3.31	3.15 (-5%)	2.57 (-22%)

# Extremes - DJF



# Extremes - JJA



# Summary

For monthly precipitation, for two regions examined, the models reproduce fairly well

- ◆ Seasonal variation
- ◆ Interannual variability
- ◆ Supporting circulation

Other regions? (e.g., Deep South)

For daily precipitation

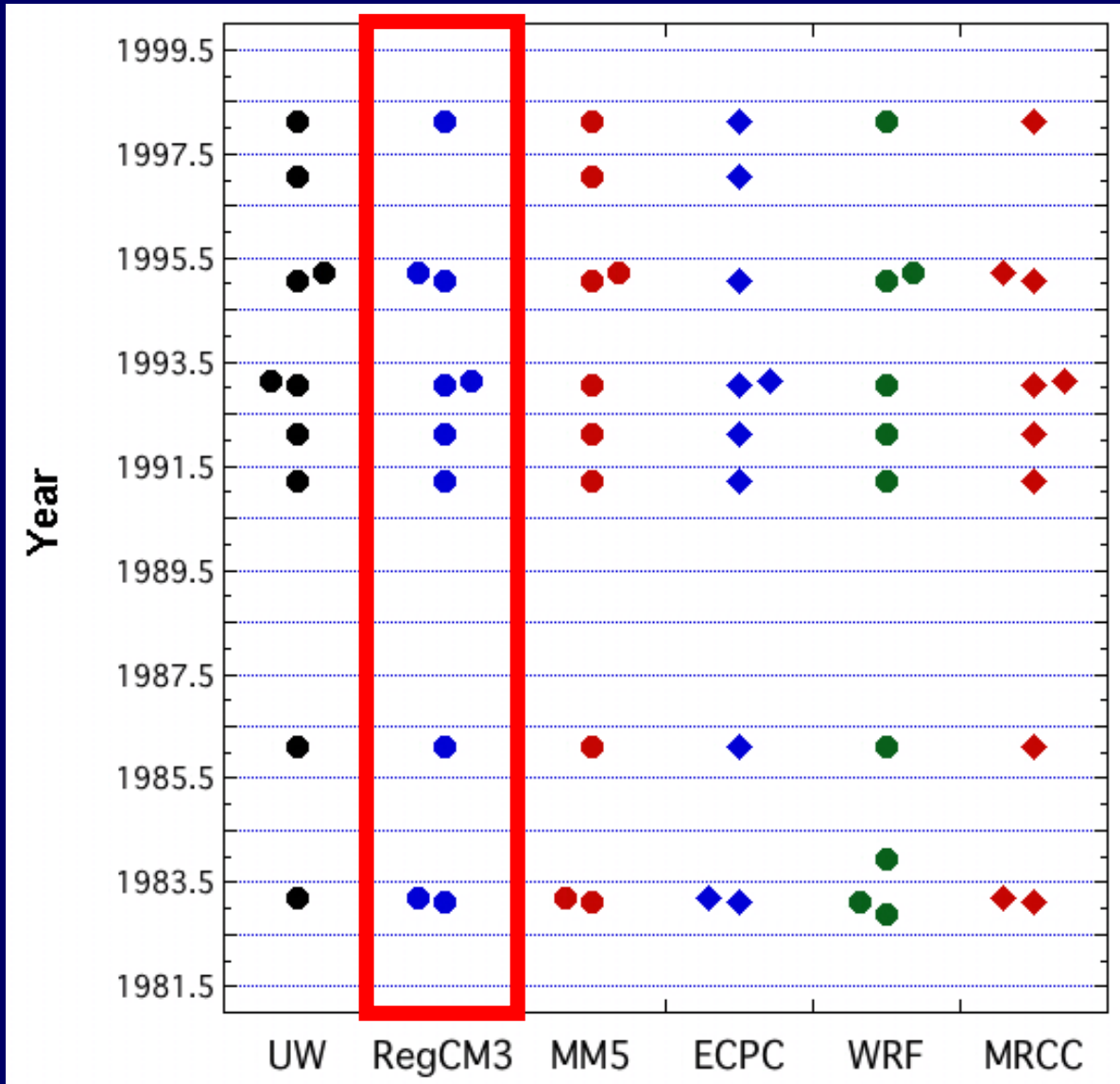
- ◆ Good DJF statistics
- ◆ Overly intense JJA precipitation?

Thank You!



[www.narccap.ucar.edu](http://www.narccap.ucar.edu)

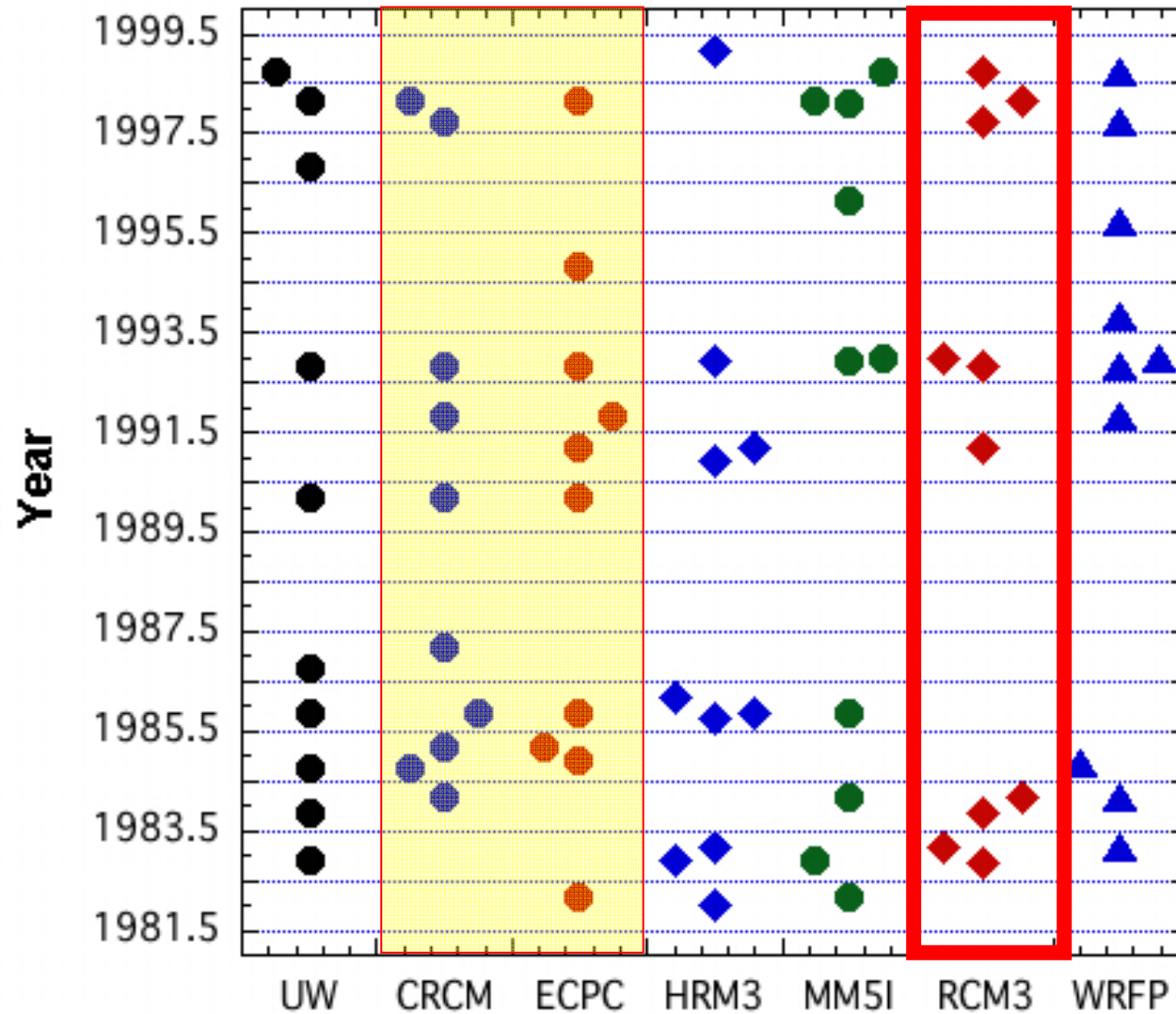
# Interannual Variability – Coastal CA



59 of 60 (98%)  
simulated  
extremes occur  
in cold seasons  
with an  
observed  
extreme.

(random  
chance: 27)

# Interannual Variability – Upper MS

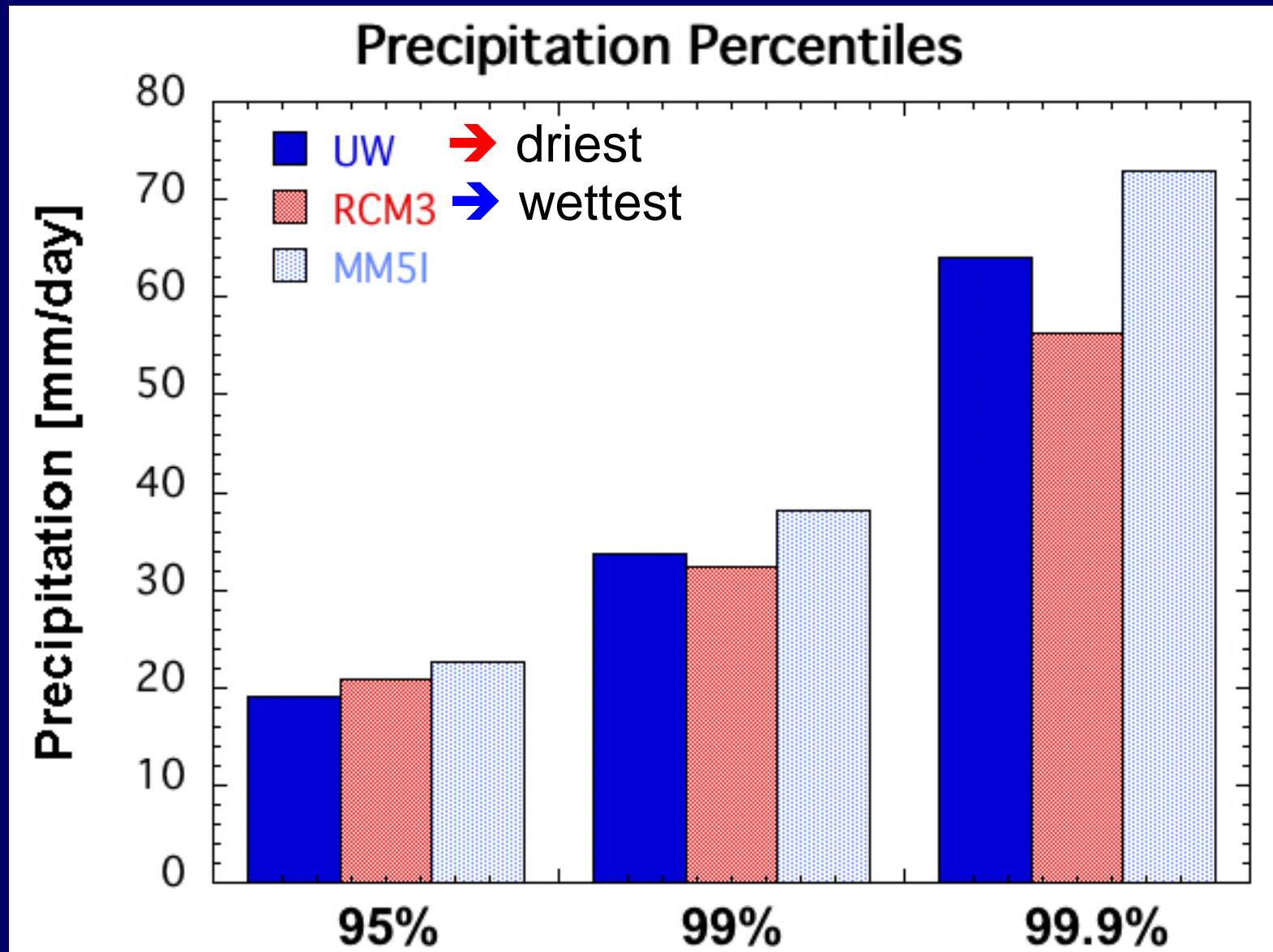


46 of 60 (77%)  
simulated  
extremes occur  
in cold seasons  
with an  
observed  
extreme.

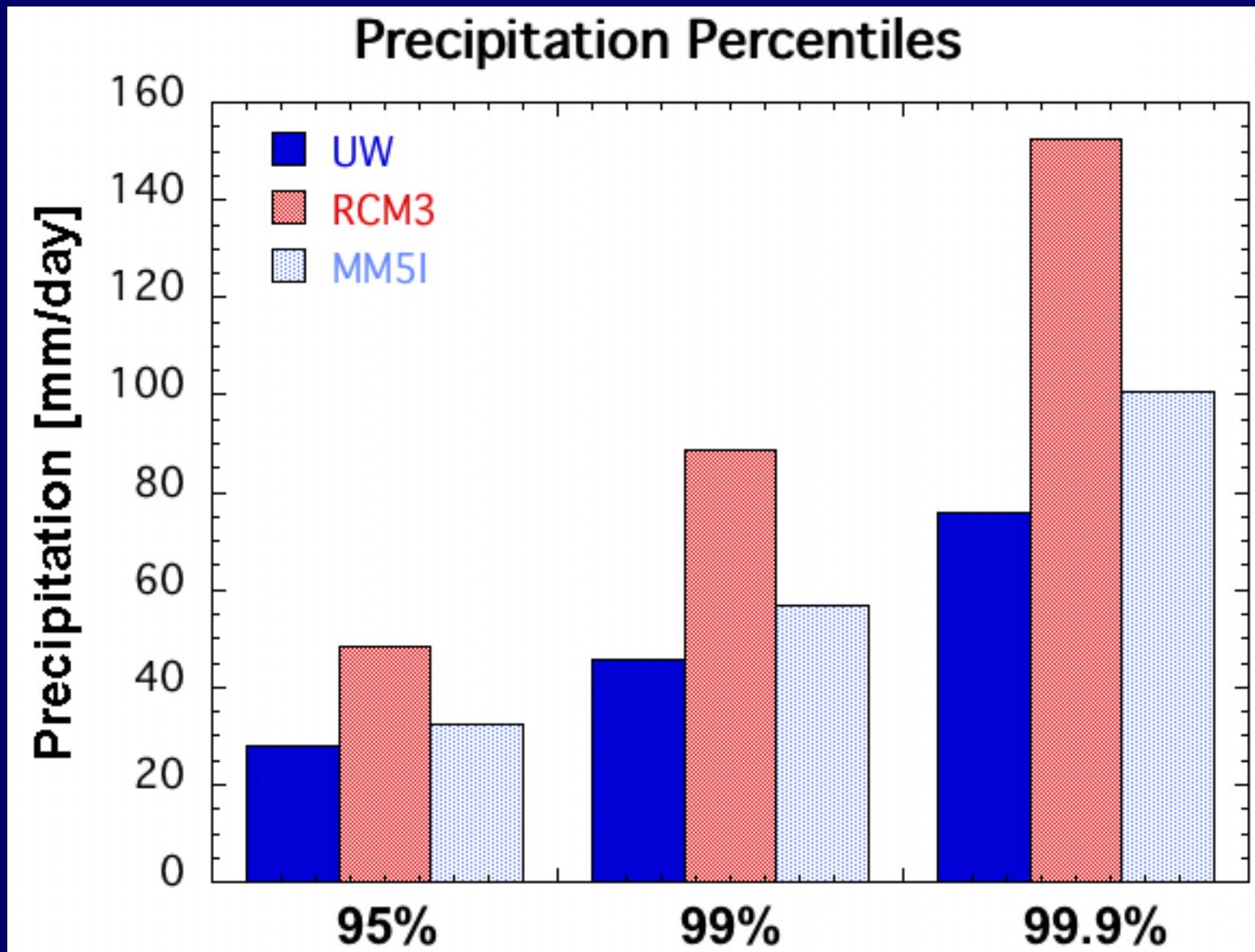
(random  
chance: 33)



# Extremes - DJF

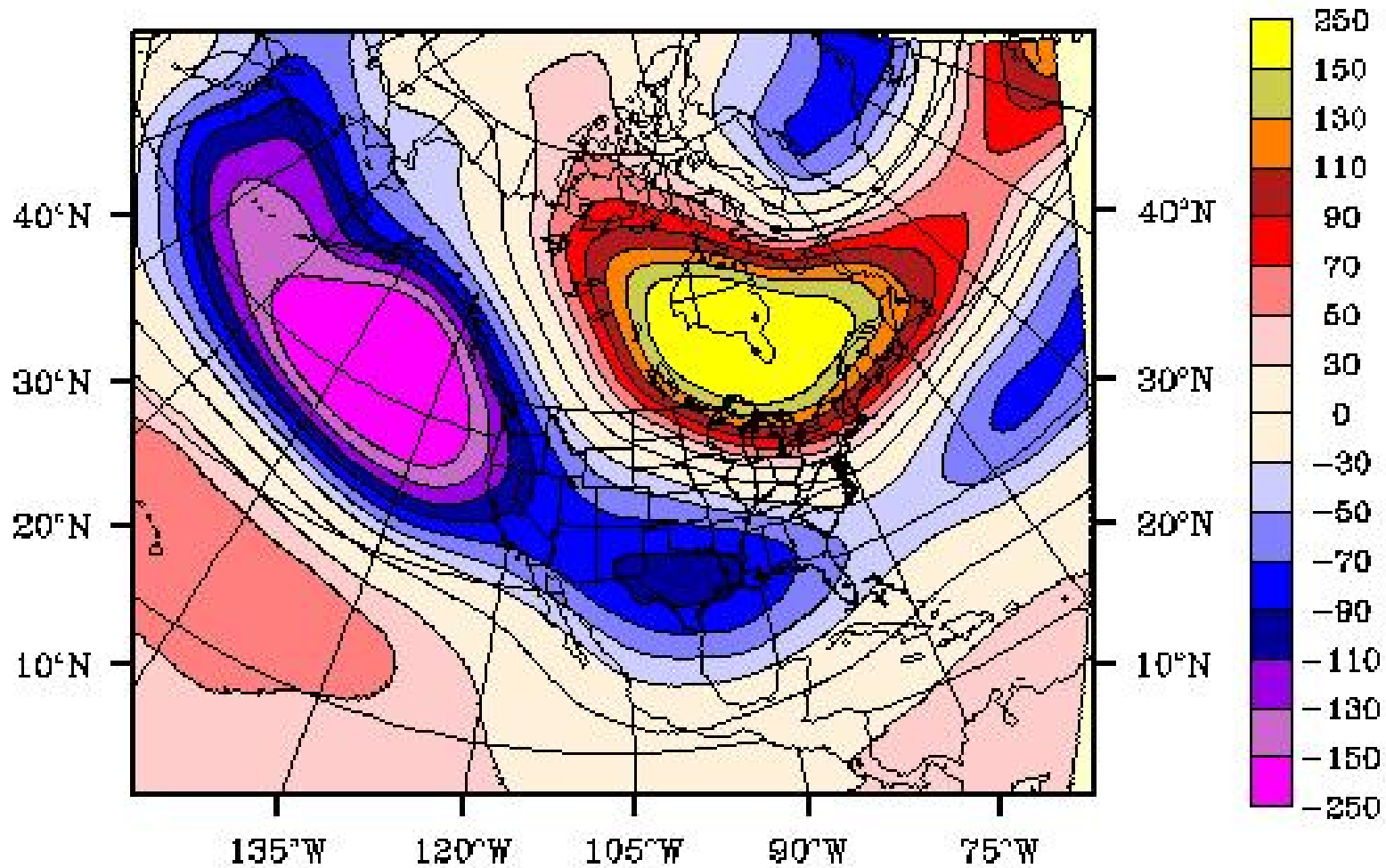


# Extremes - JJA



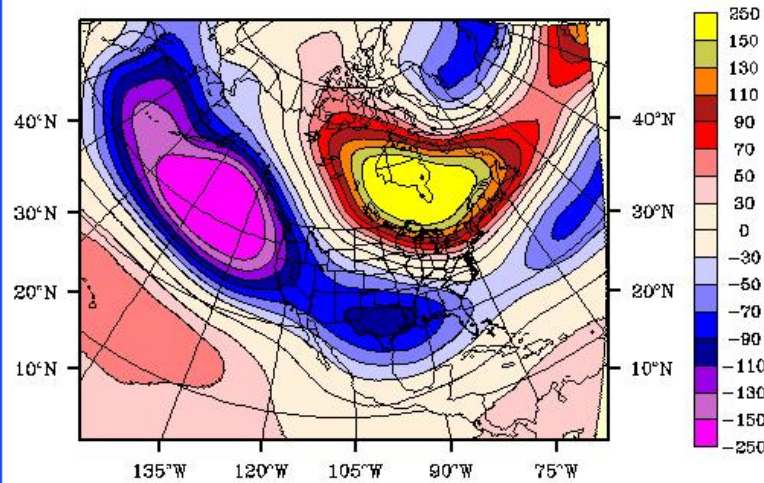
# 500 hPa Height Anomalies – Coastal CA Extreme

NARR 500hPa Height Anomaly  
Feb 1998 (m)

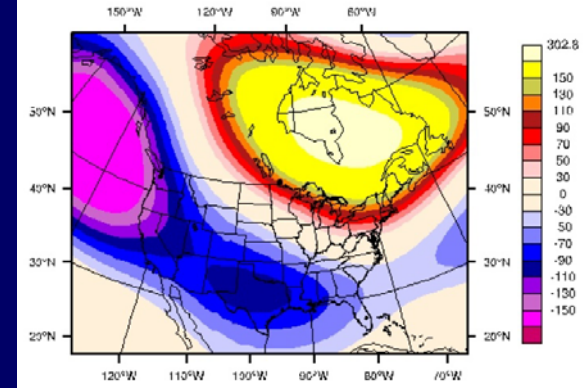


# 500 hPa Height Anomalies – Coastal CA Extreme

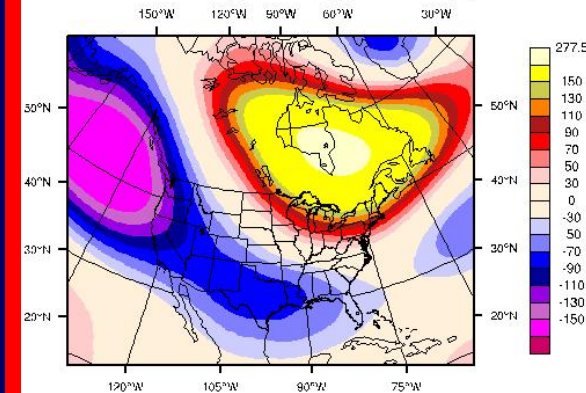
NARR 500hPa Height Anomaly  
Feb 1998 (m)



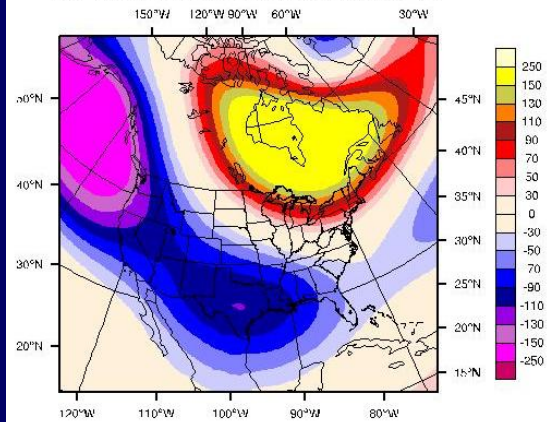
WRFP 500hPa Height Anomaly, Feb 1998 (m)



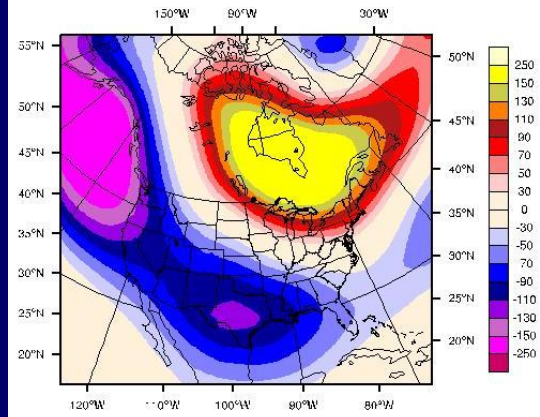
RCM3 500hPa Height Anomaly, Feb 1998 (m)



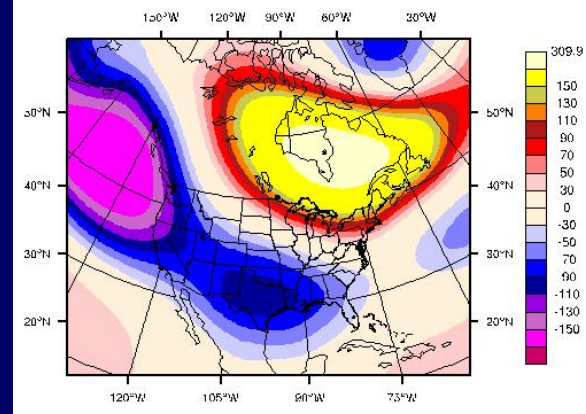
ECPC 500hPa Height Anomaly, Feb 1998 (m)



MRCC 500hPa Height Anomaly, Feb 1998 (m)

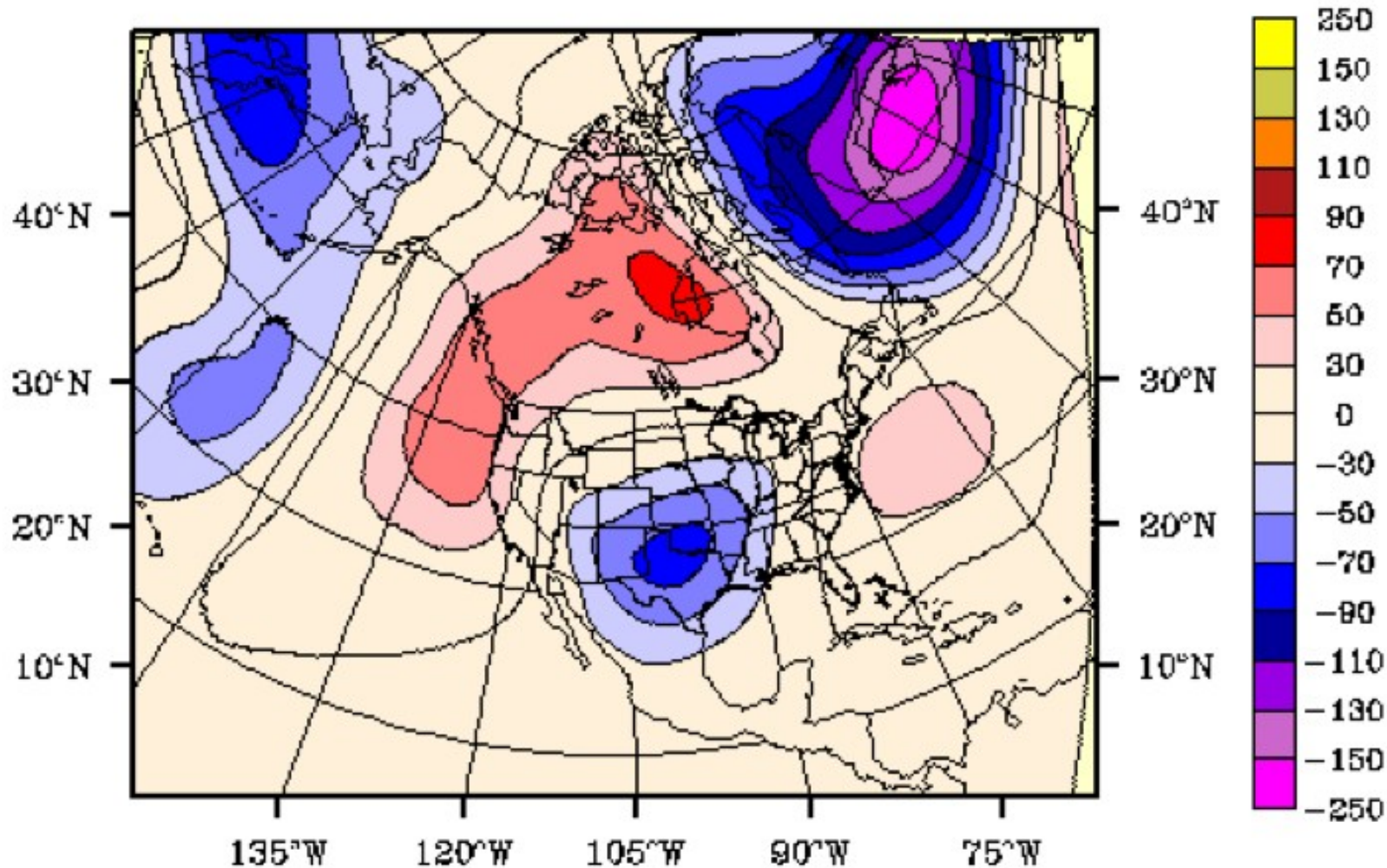


MM5 500hPa Height Anomaly, Feb 1998 (m)



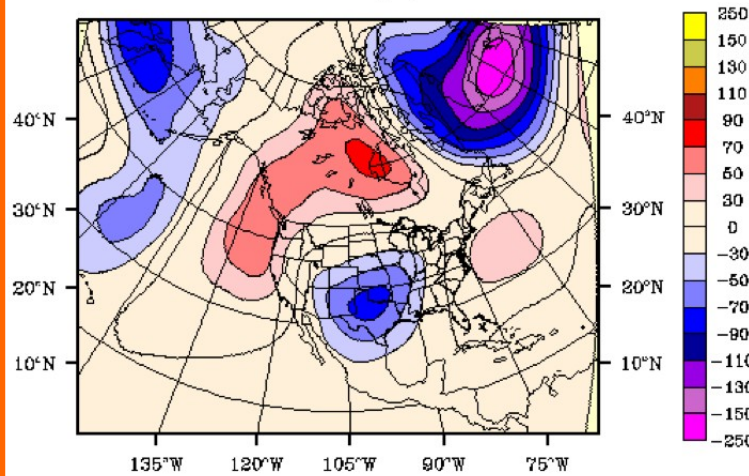
# 500 hPa Height Anomalies – Upper MS Extreme

NARR 500hPa Height Anomaly  
Nov 1992 (m)

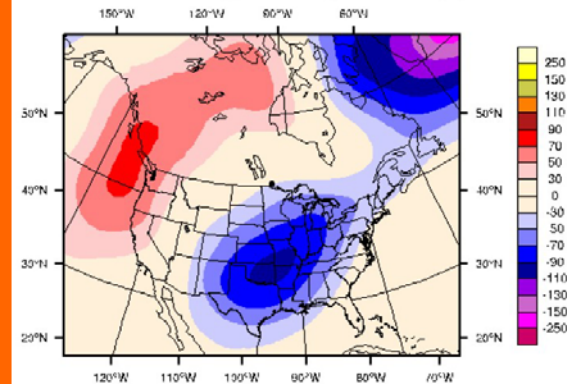


# 500 hPa Height Anomalies – Upper MS Extreme

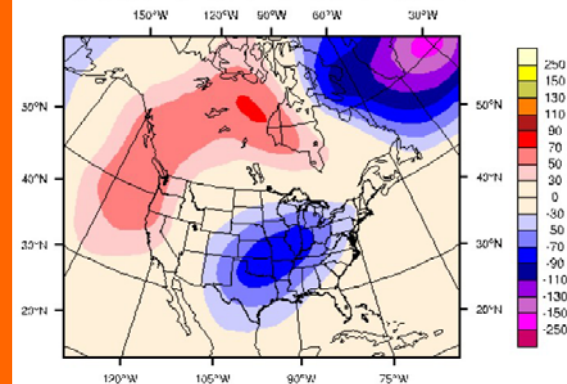
NARR 500hPa Height Anomaly  
Nov 1992 (m)



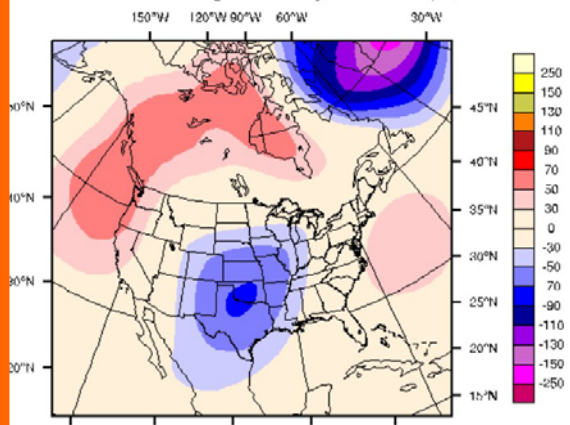
WRF 500hPa Height Anomaly, Nov 1992 (m)



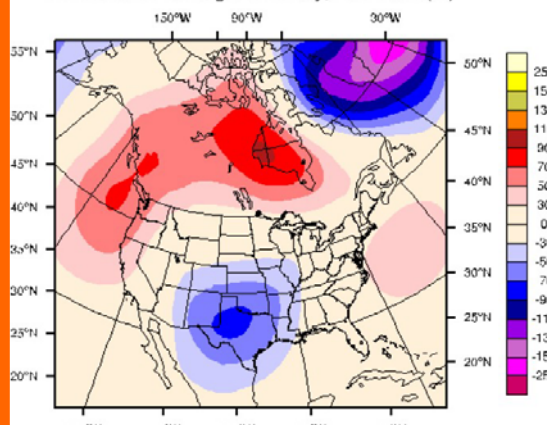
RCM3 500hPa Height Anomaly, Nov 1992 (m)



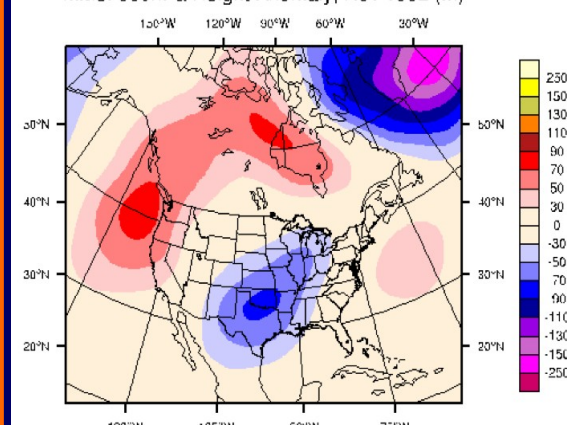
ECPC 500hPa Height Anomaly, Nov 1992 (m)



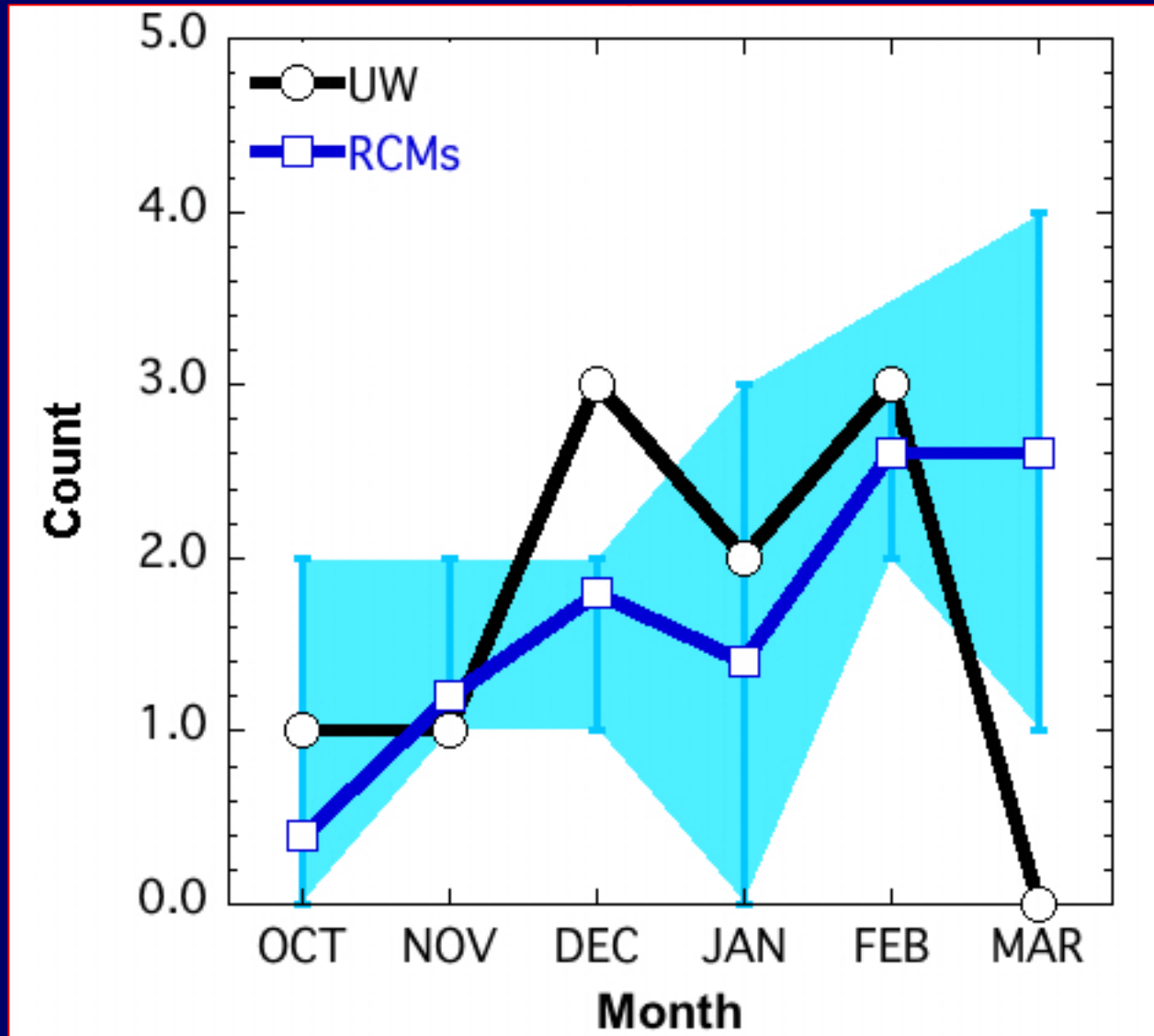
MRCC 500hPa Height Anomaly, Nov 1992 (m)



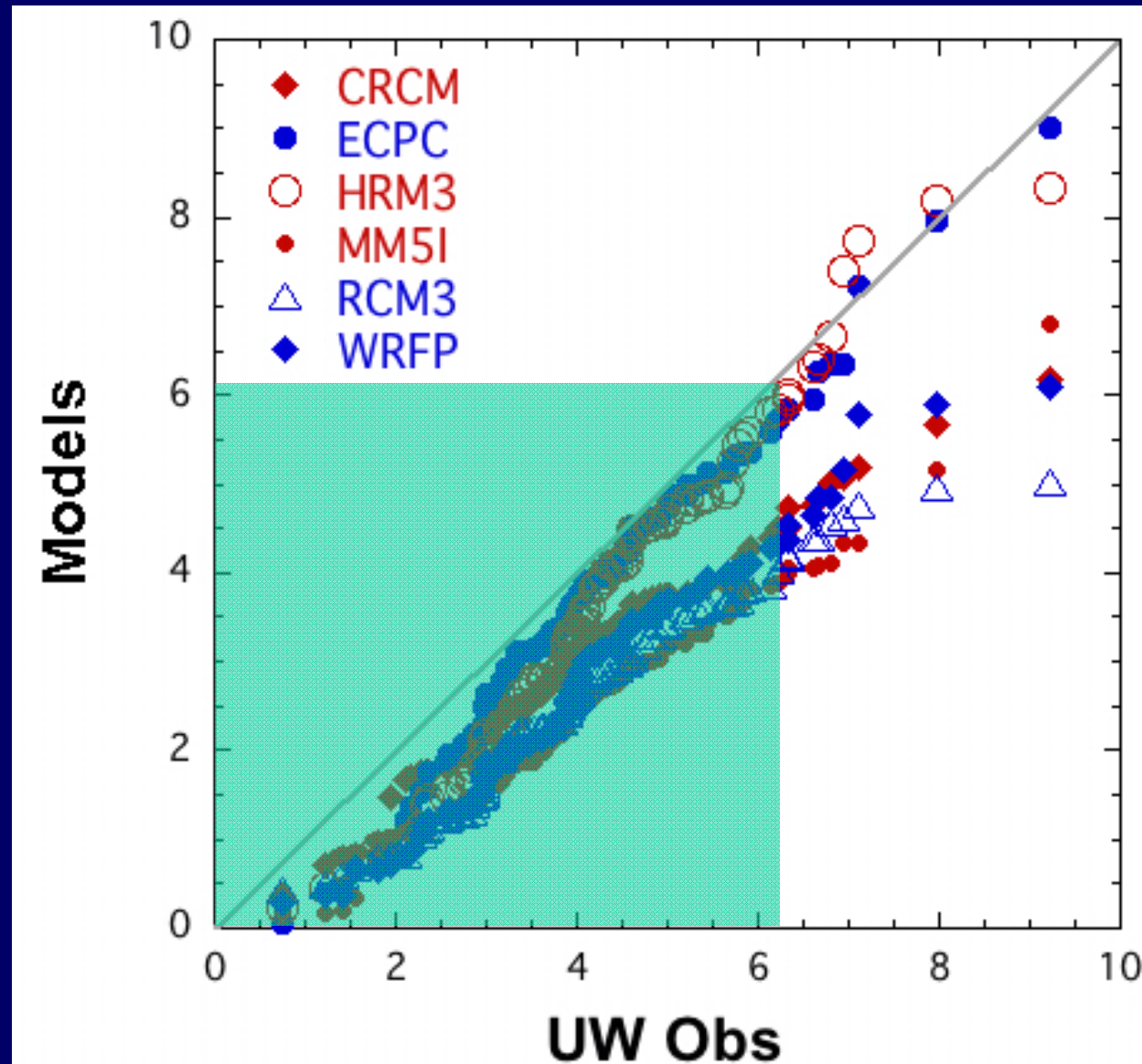
MM5I 500hPa Height Anomaly, Nov 1992 (m)



# Frequency – Deep South



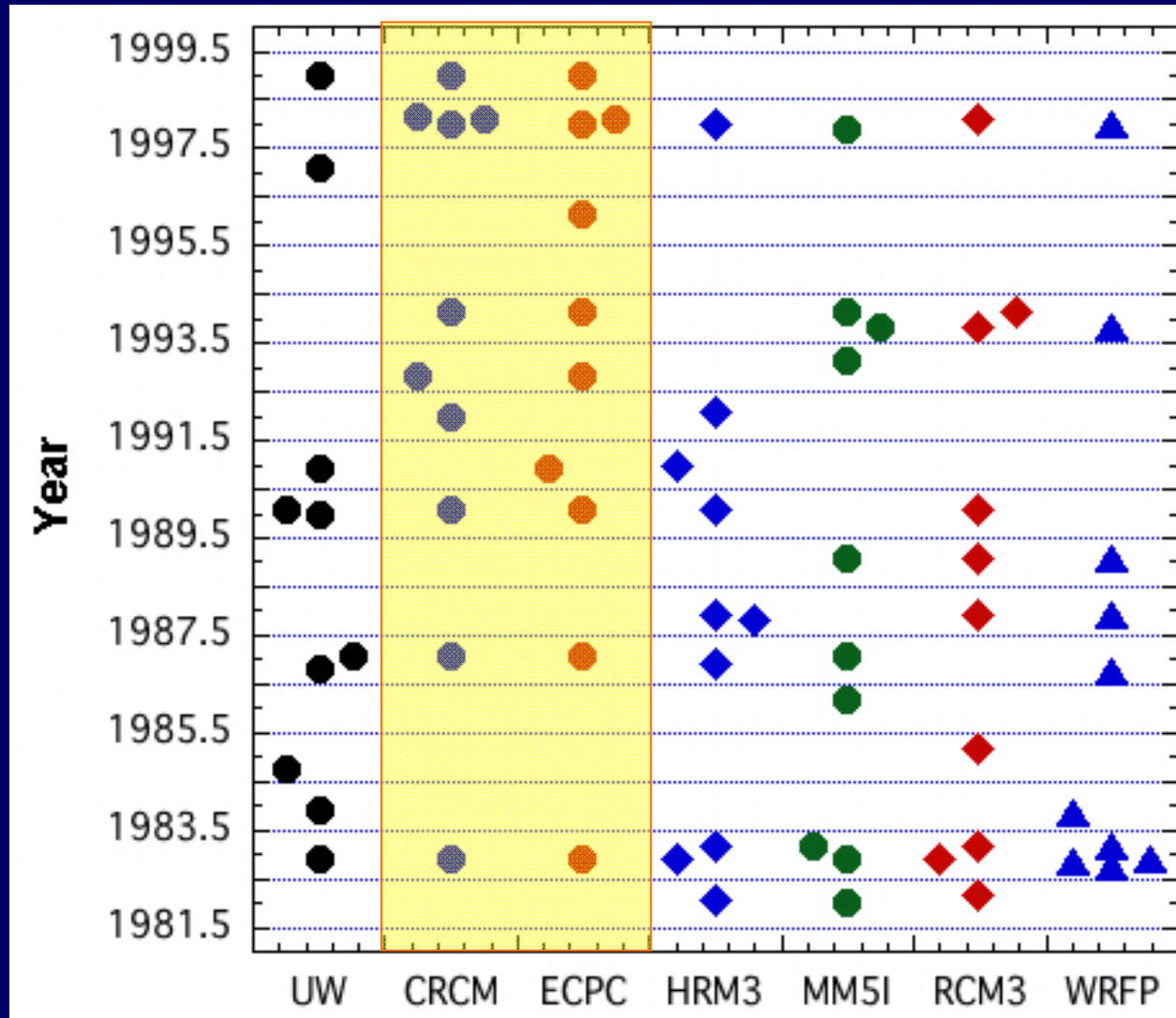
# Ranked Precipitation – Deep South



Ensemble  
average of  
top 10 = 22  
% smaller than  
UW



# Interannual Variability – Deep South

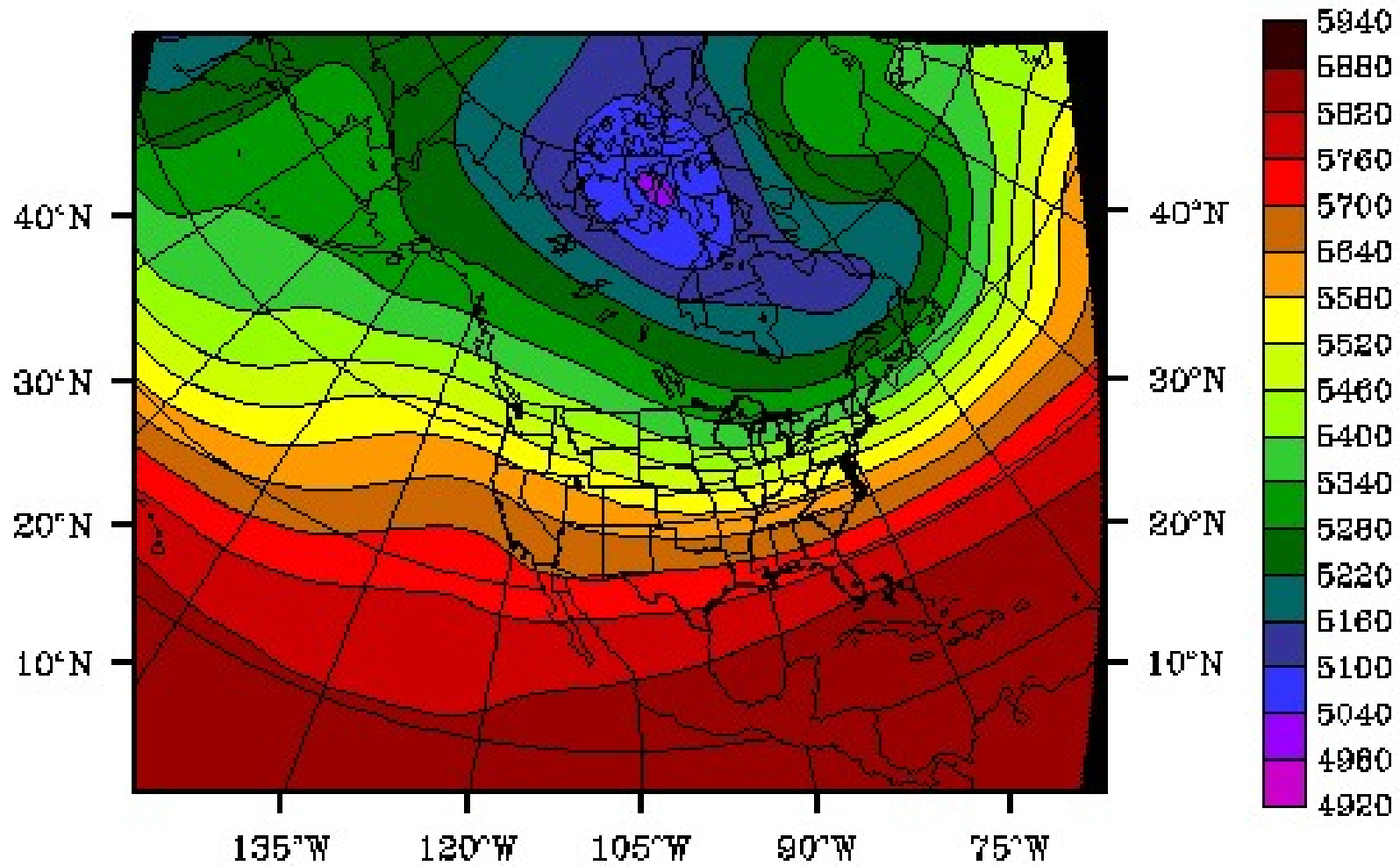


27 of 60 (45%)  
simulated  
extremes occur  
in cold seasons  
with an  
observed  
extreme.

(random  
chance: 27)

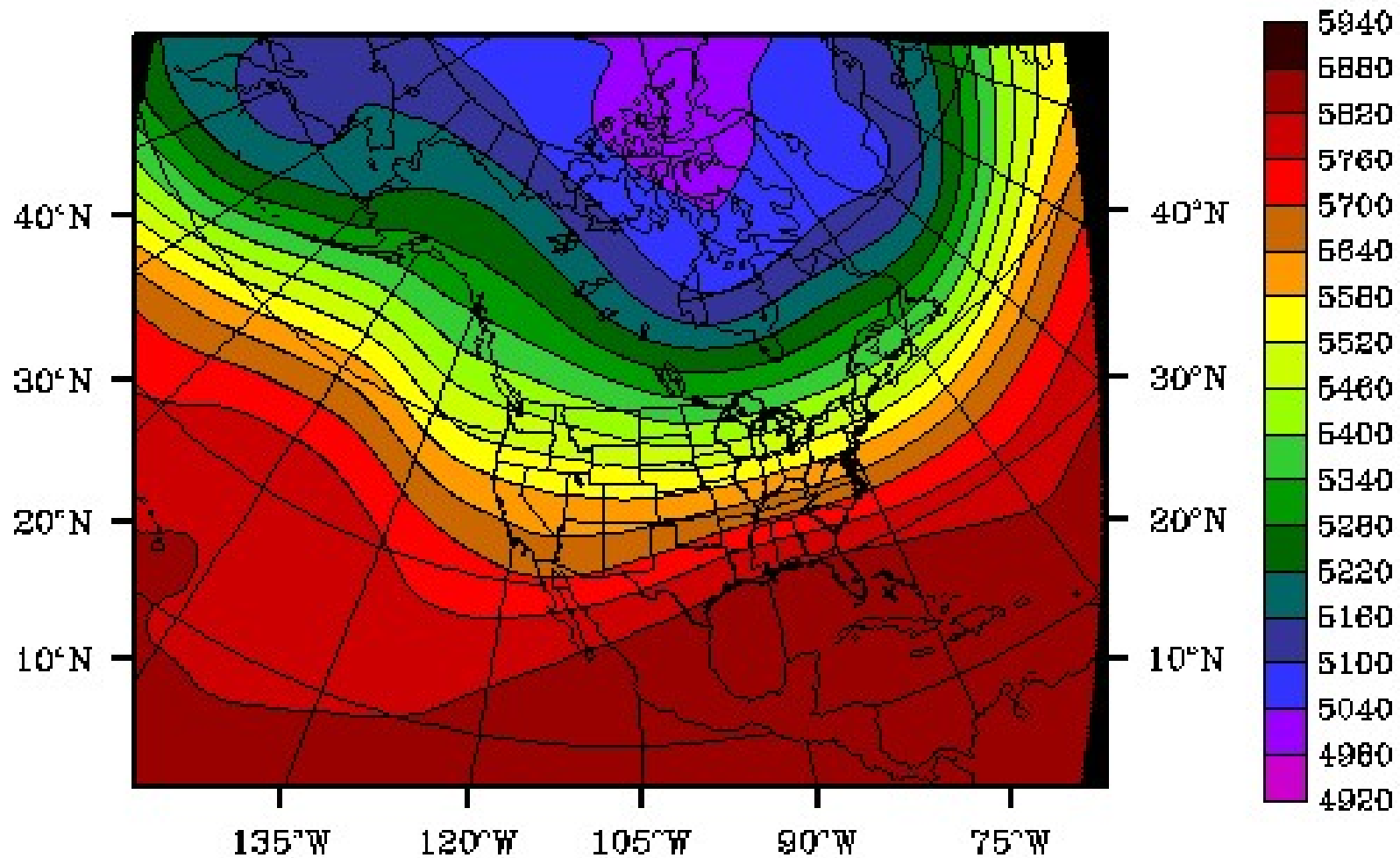
# 500 hPa Height Anomalies – Deep South Extreme

NARR 500hPa Heights  
Dec Mean (m)

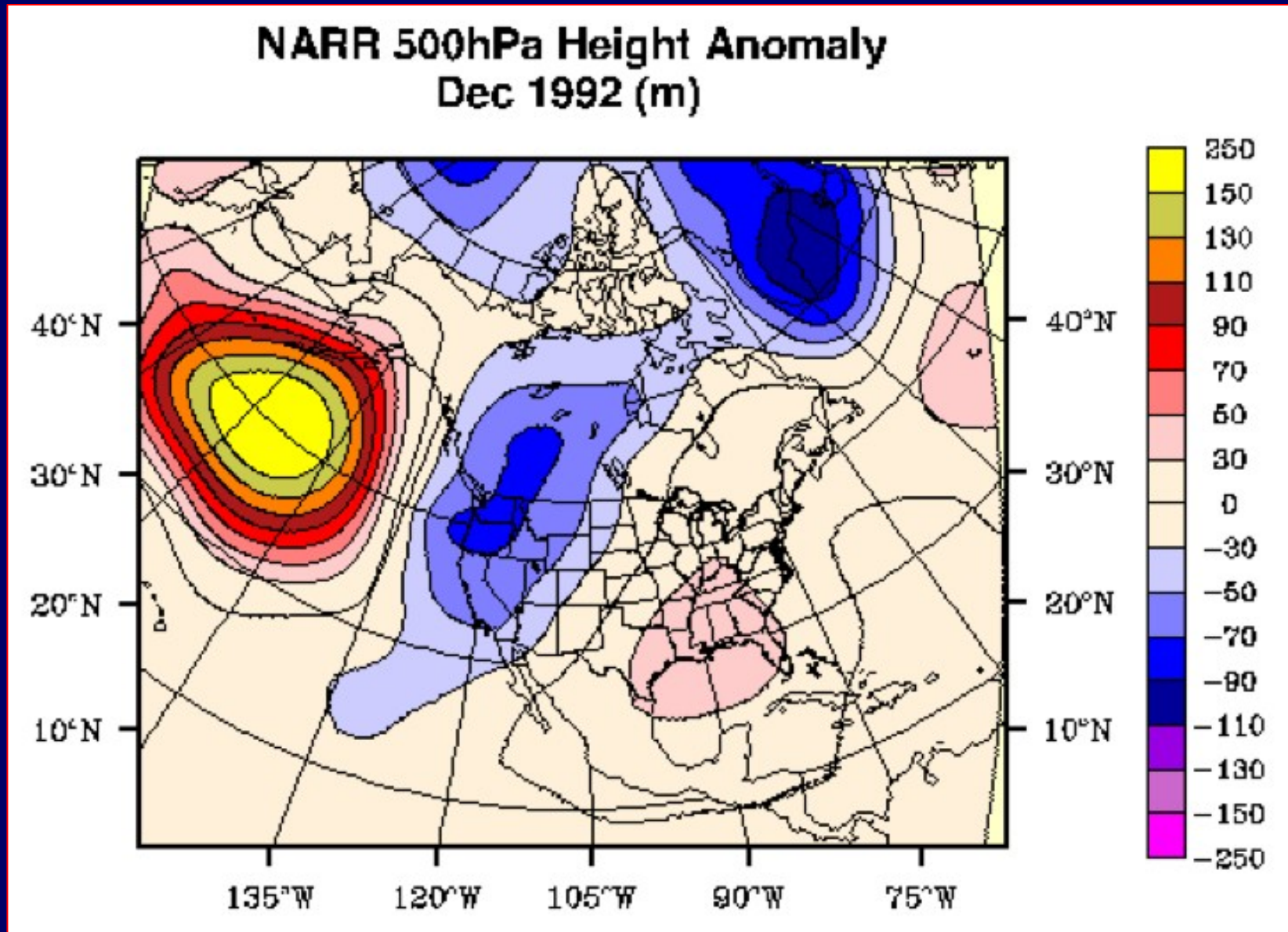


# 500 hPa Height Anomalies – Deep South Extreme

NARR 500hPa Heights  
Dec 1992 (m)

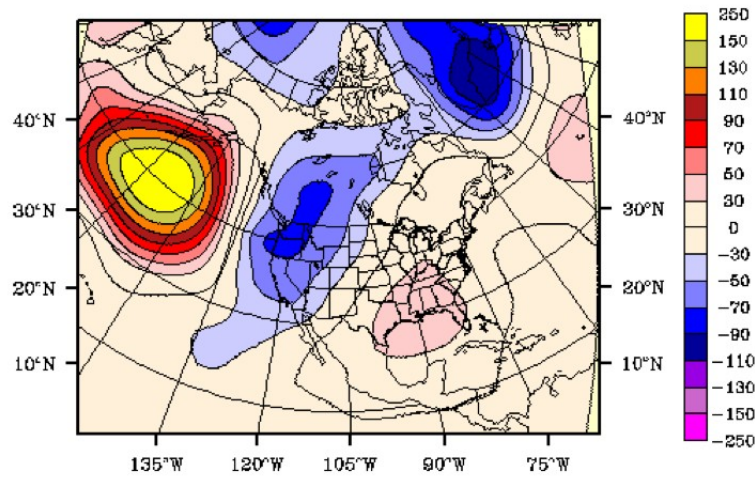


# 500 hPa Height Anomalies – Deep South Extreme

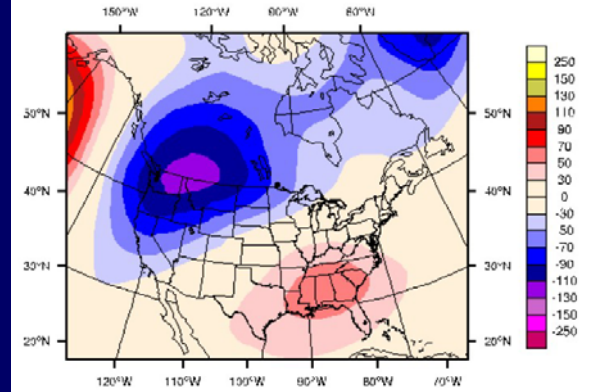


# 500 hPa Height Anomalies – Deep South Extreme

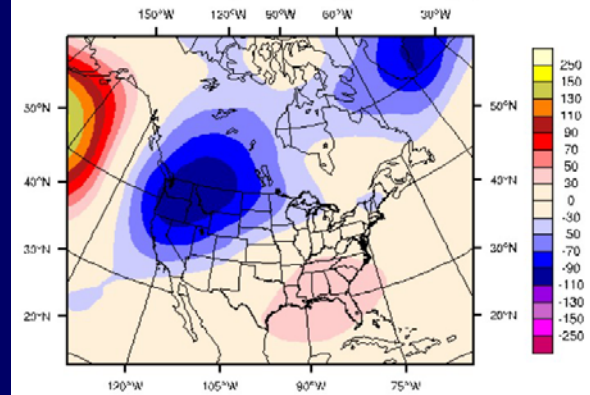
NARR 500hPa Height Anomaly  
Dec 1992 (m)



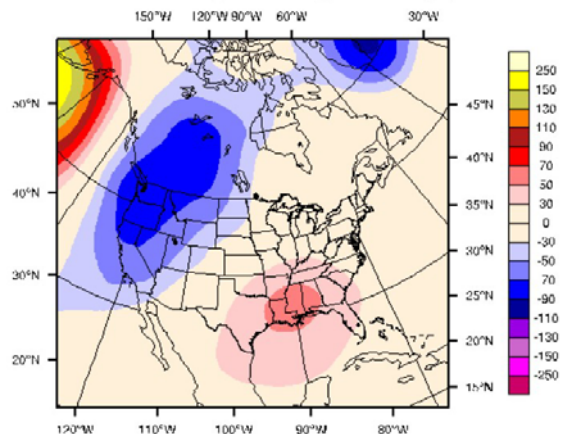
WRF 500hPa Height Anomaly, Dec 1992 (m)



RCM3 500hPa Height Anomaly, Dec 1992 (m)



ECPC 500hPa Height Anomaly, Dec 1992 (m)



MM5I 500hPa Height Anomaly, Dec 1992 (m)

