NARCCAP Multi-Model Simulations: Initial NCEP-Driven Results

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(Iowa State University)
and
The NARCCAP Modelers Team

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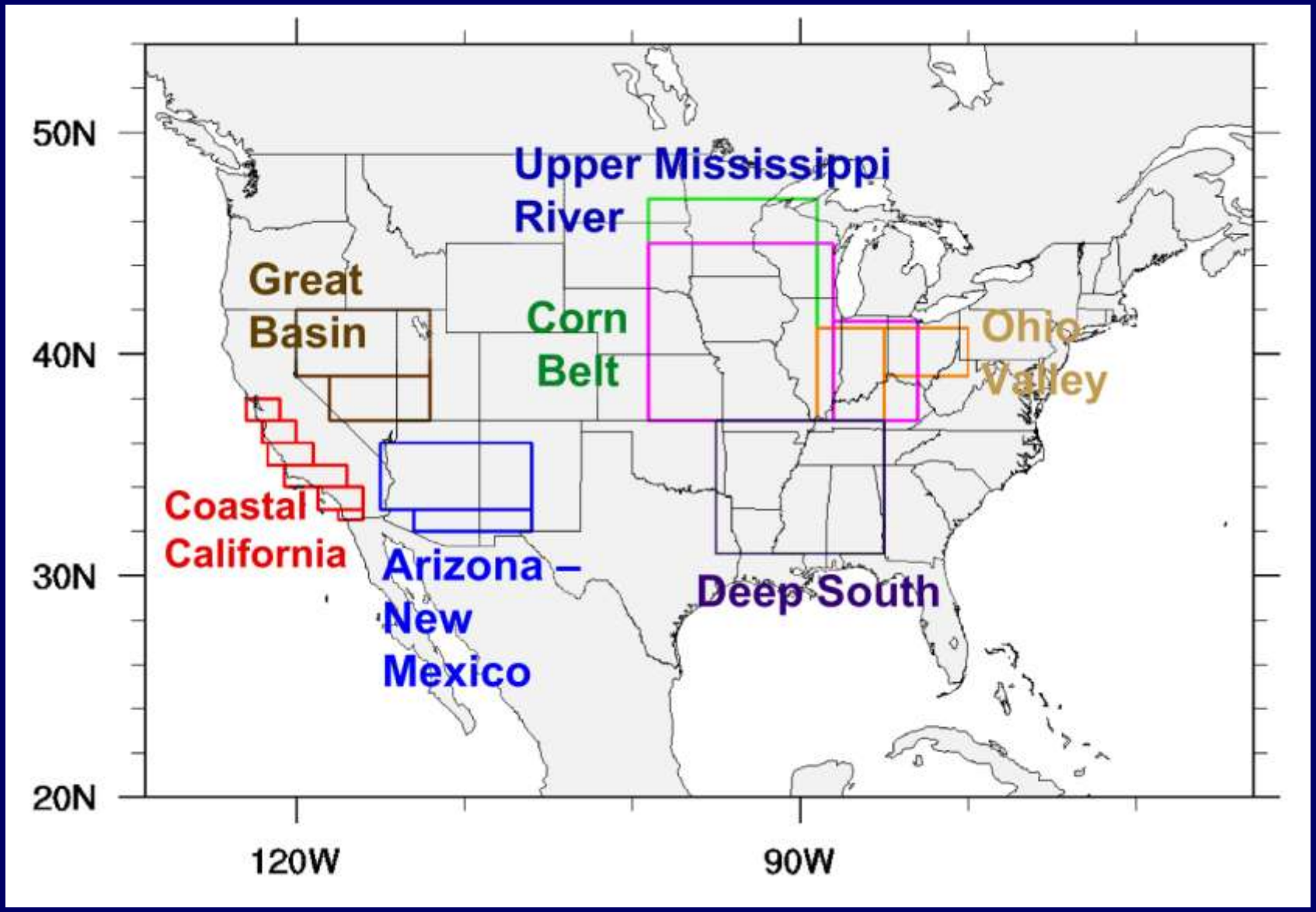
Comparison with observations

- Observations
  - **Precip: University of Washington VIC retrospective analysis**
  - **500 hPa Heights: North American Regional Reanalysis**
- Comparison period: 1980-1999
  - **1979 omitted - (a) spinup (b) WRFP began 1 Sep 79**
  - **UW data end in mid-2000**
- Analyses: monthly mean precipitation & 500 hPa Z
  - **Fields received at Iowa State for format check**
  - **For several regions in the U.S. (UW analysis extends to ~ 53^{o}N)**

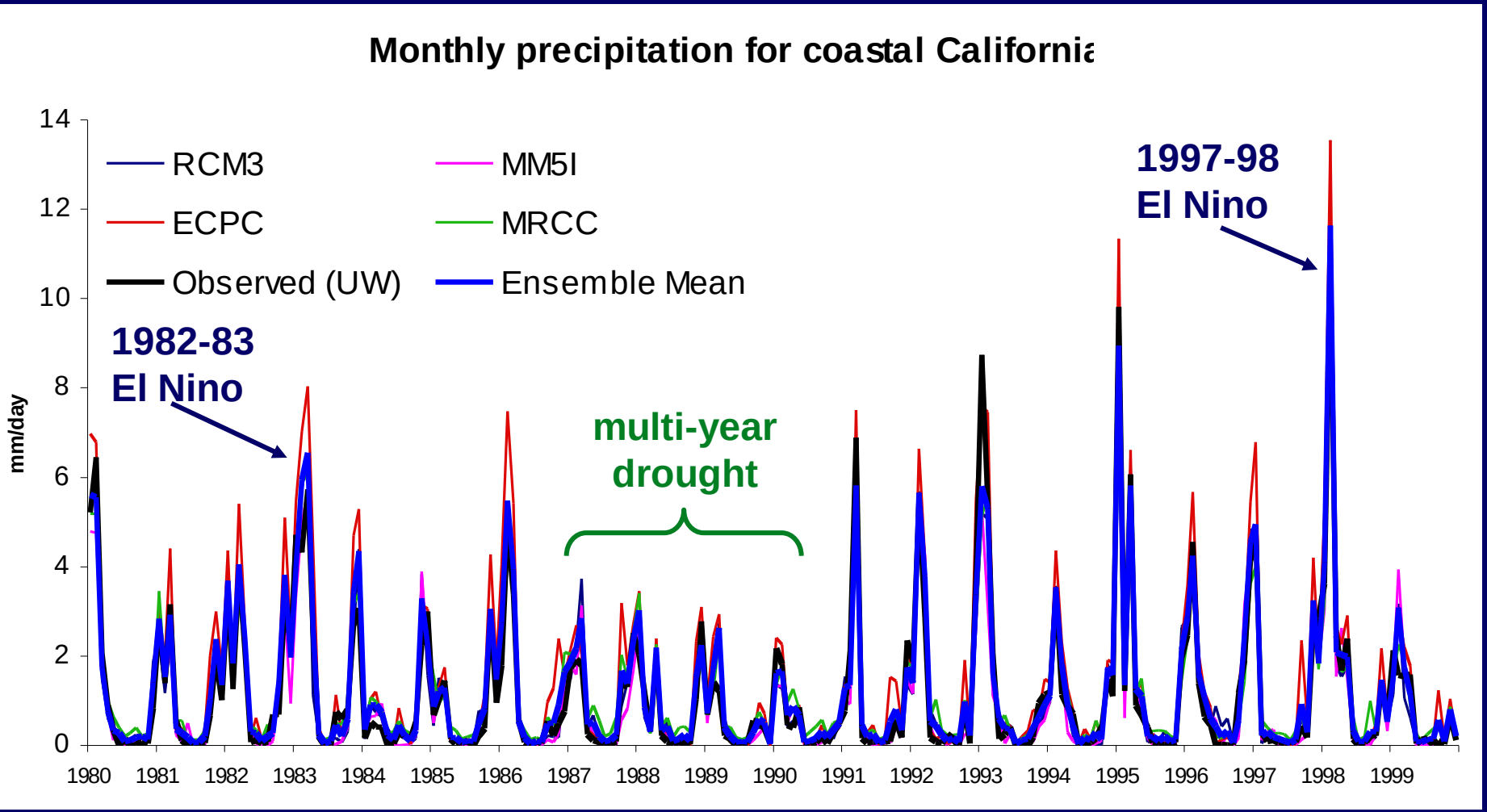
Regions Analyzed



Coastal California

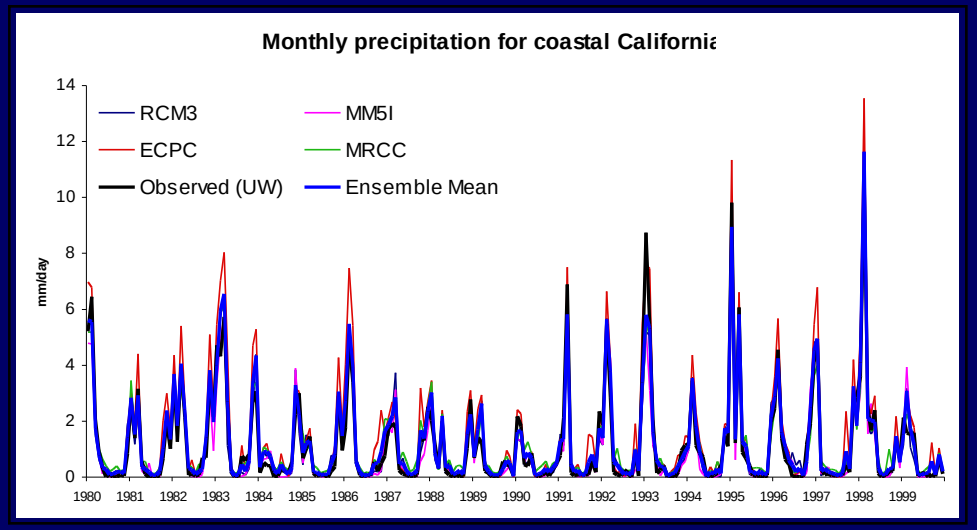
- Mediterranean climate: wet winters and dry summers (Koeppen types Csa, Csb)
- ENSO can have strong effects on interannual variability of precip

Monthly Time Series - Coastal CA

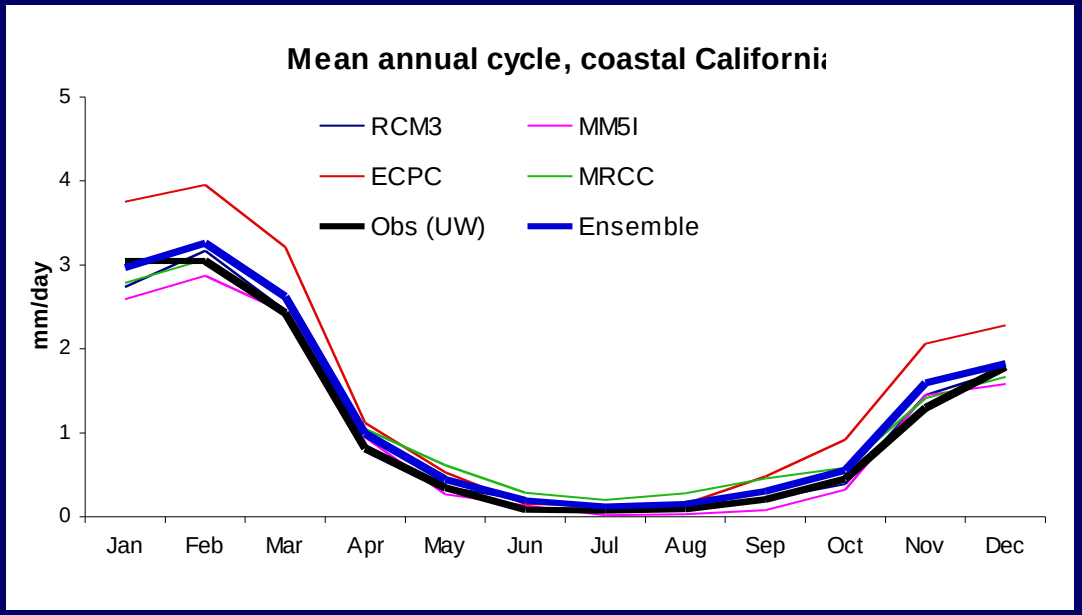


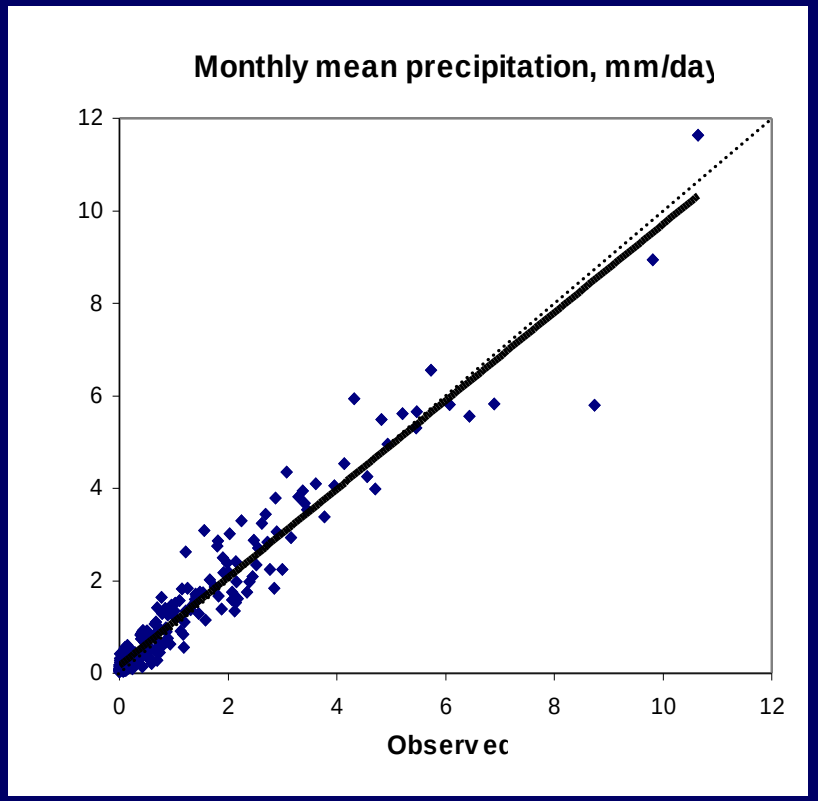
Time Series Correlations - Coastal CA

Model	Correlation
RCM3	0.946
MM5I	0.946
ECPC	0.966
MRCC	0.959
Ensemble	**0.968**



Further Statistics - Coastal CA



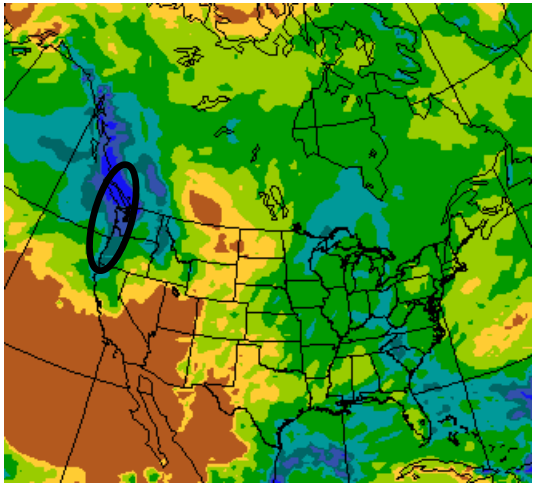


1997-1998 El Niño

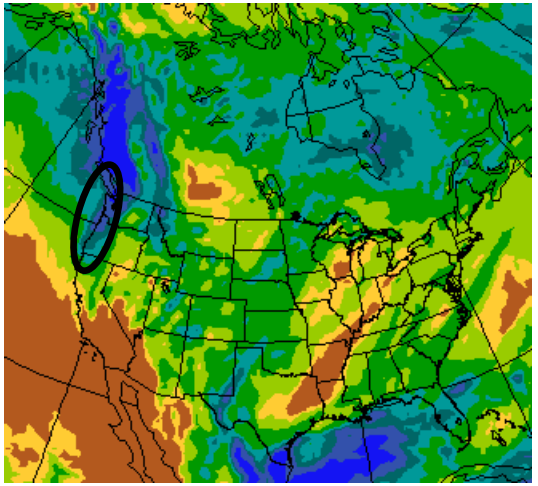
- Strongest El Niño in the instrumental record.

October 1997

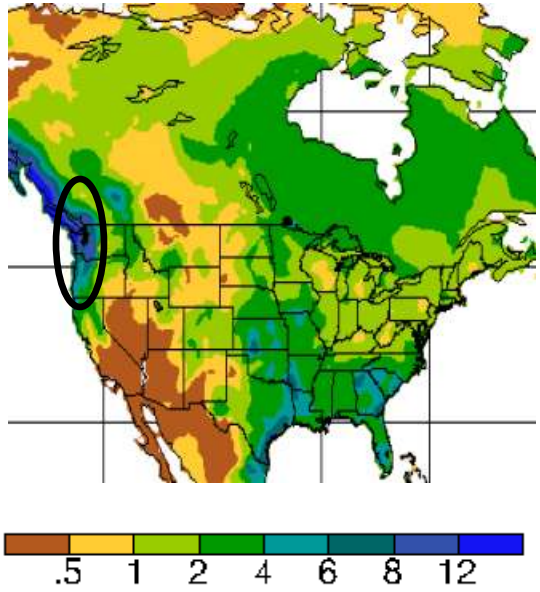
RegCM3



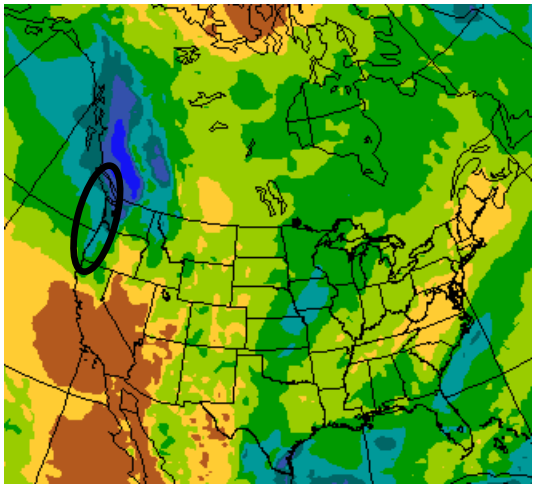
RSM



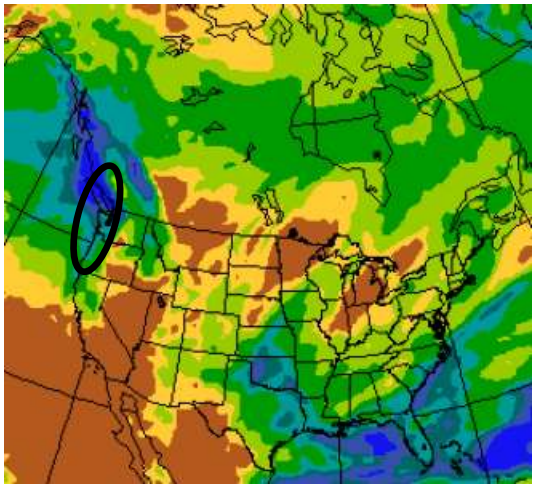
Observed (CRU)



MRCC

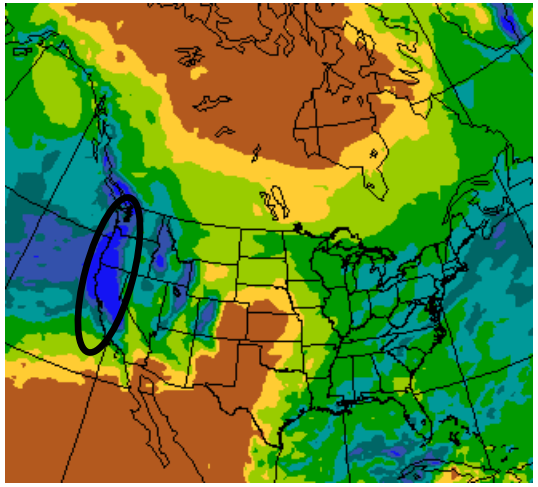


MM5

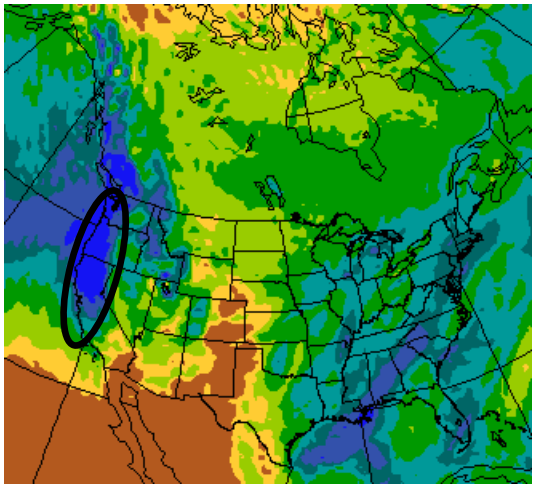


January 1998

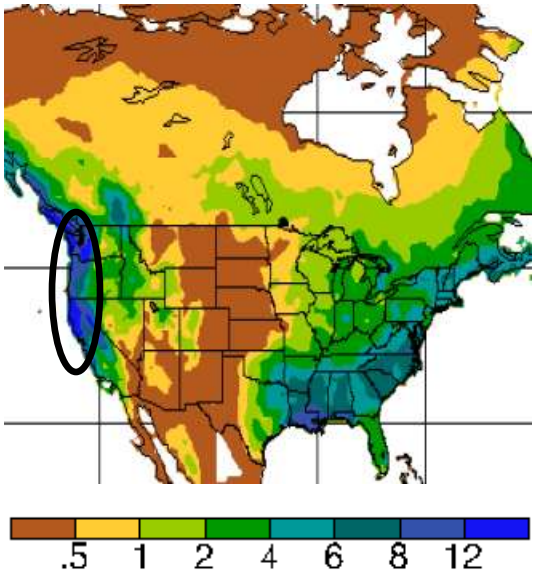
RegCM3



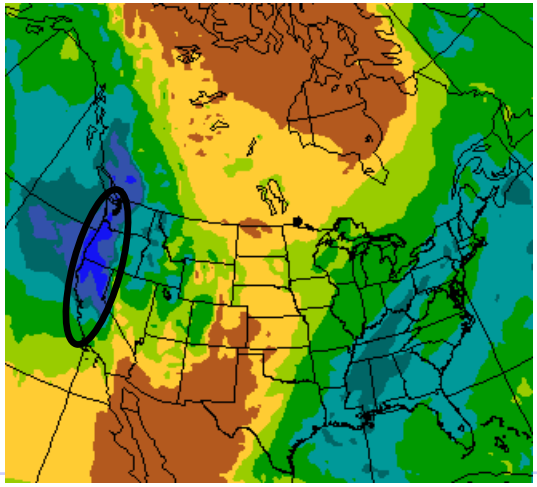
RSM



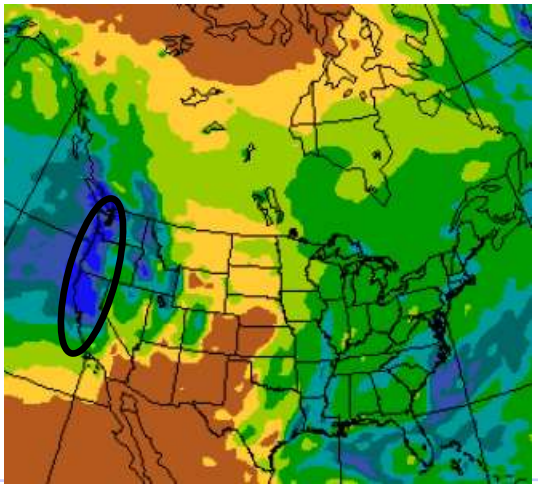
Observed (CRU)



MRCC

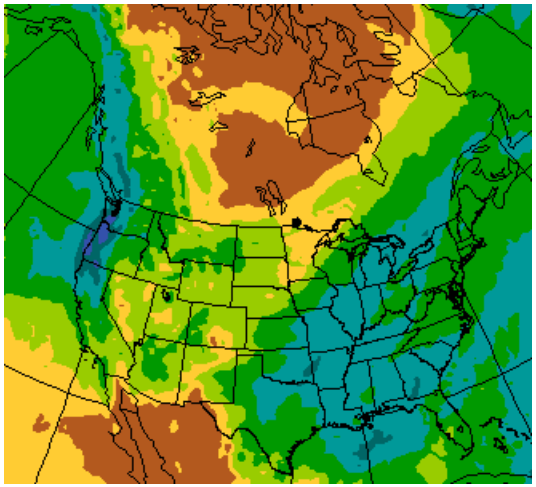


MM5

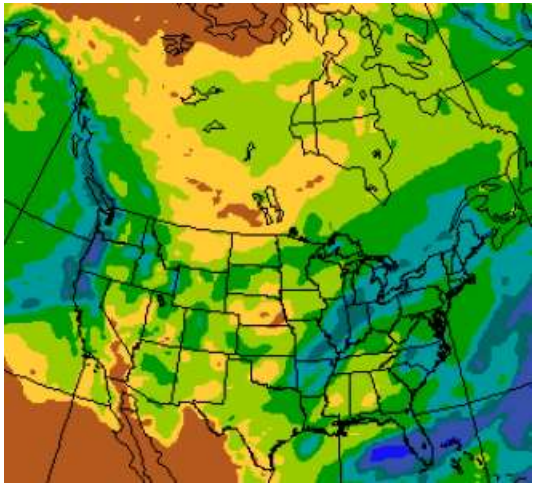


March 1998

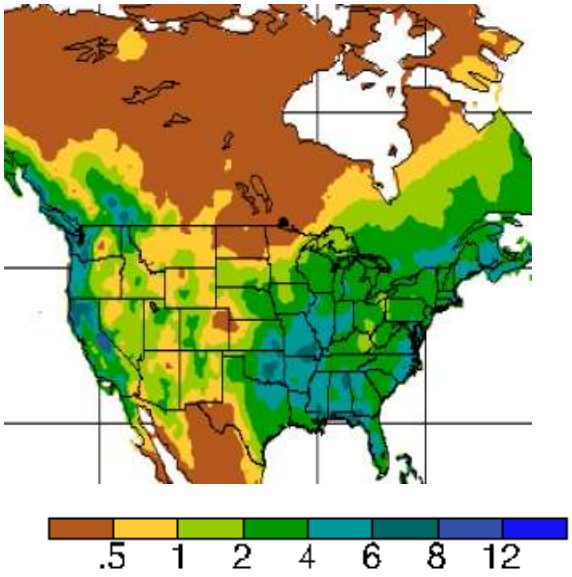
RegCM3



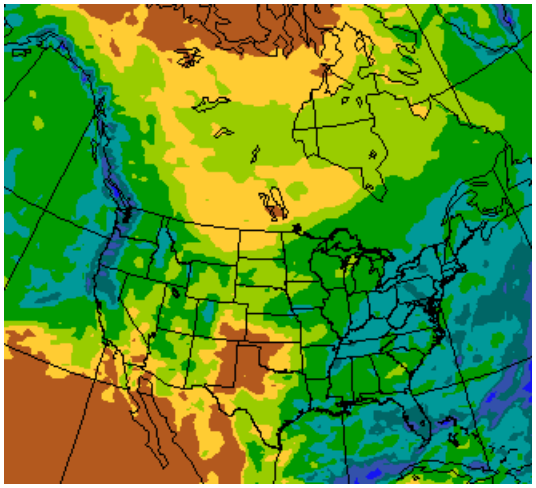
RSM



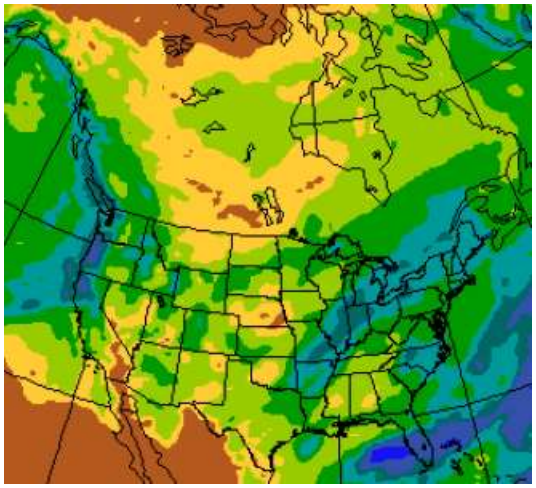
Observed (CRU)



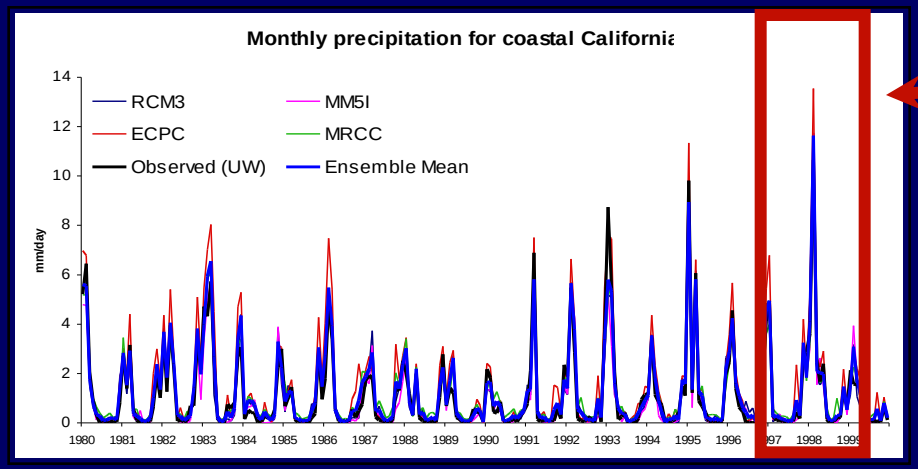
MRCC



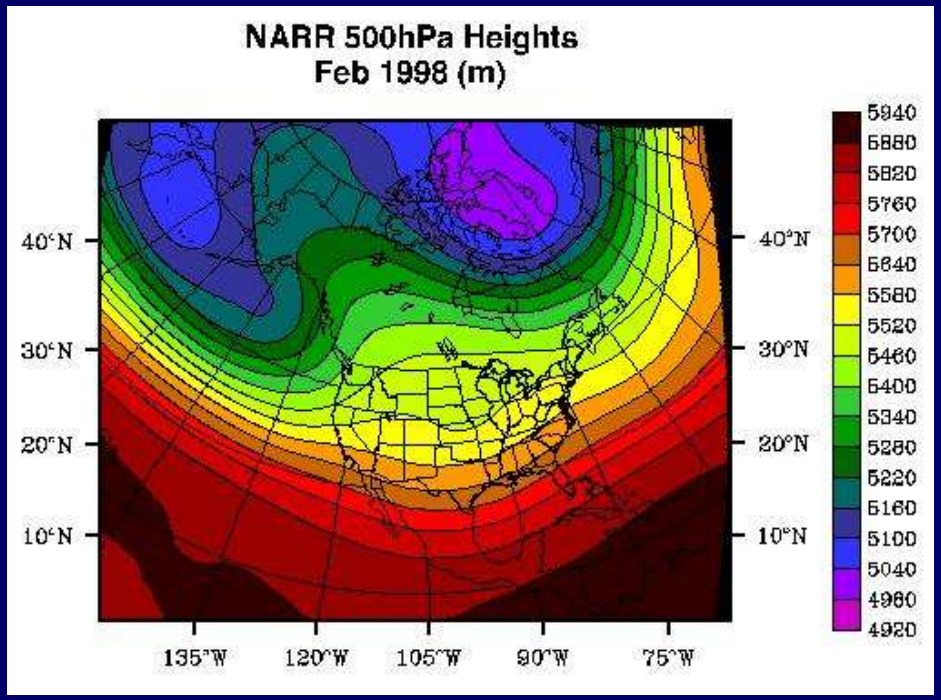
MM5

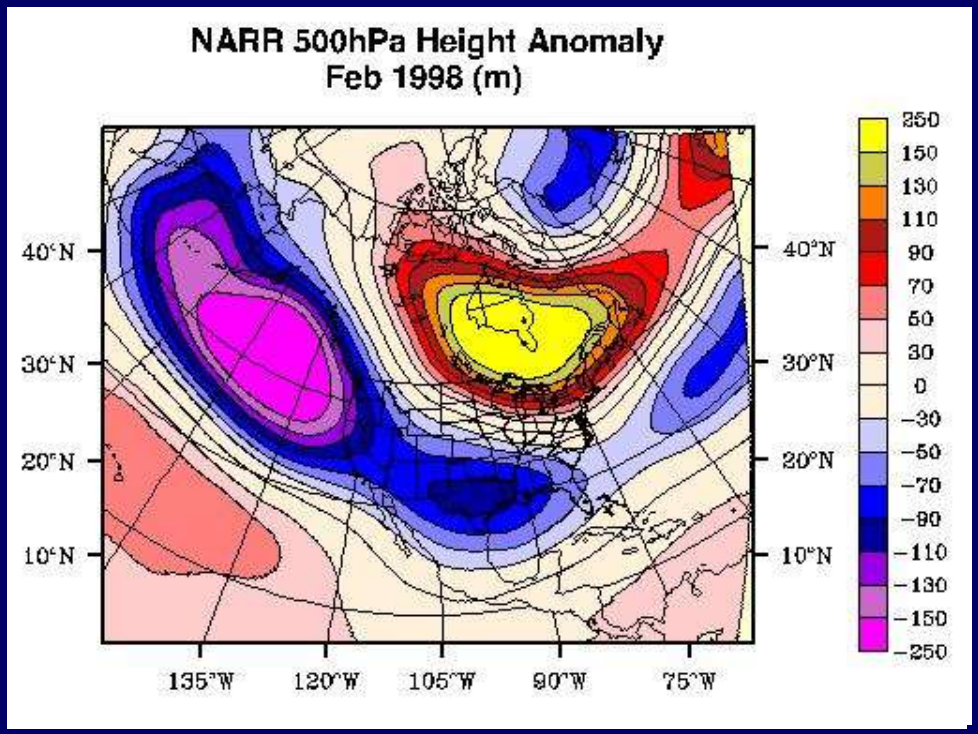


Circulation with Extreme Precipitation

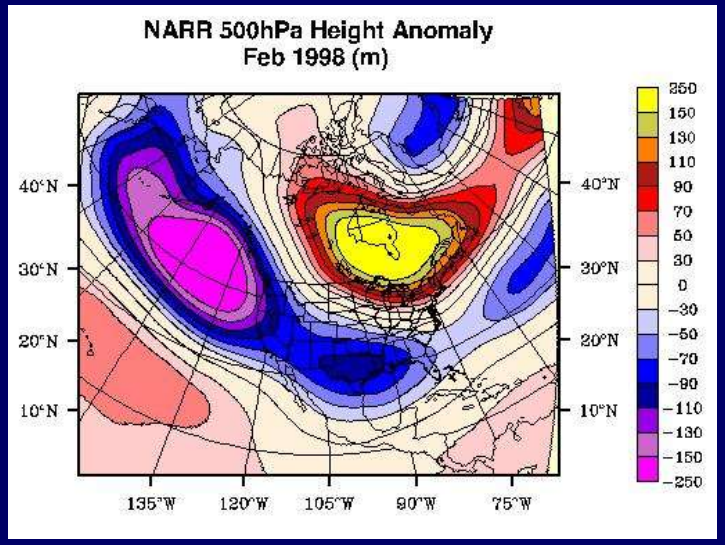


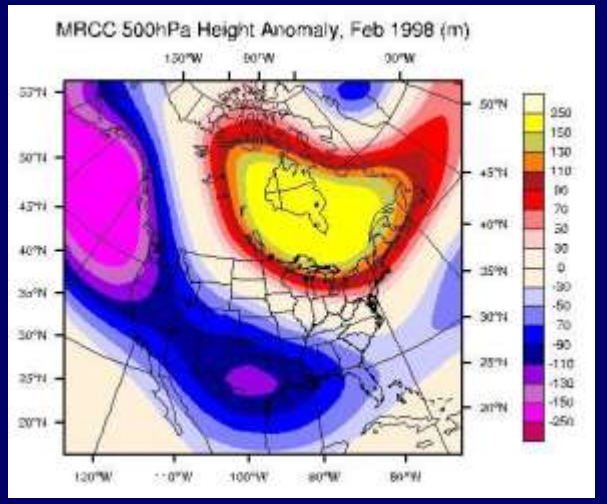
Precip. Max.: Feb 1998

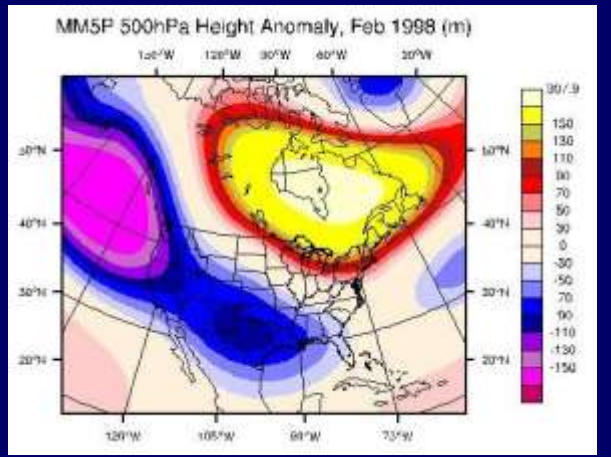


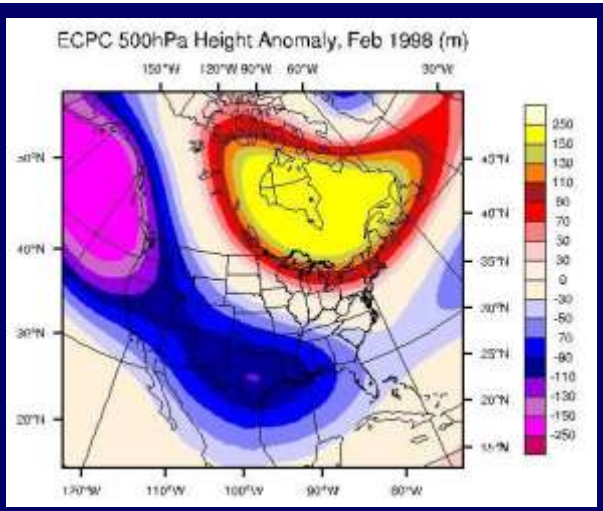


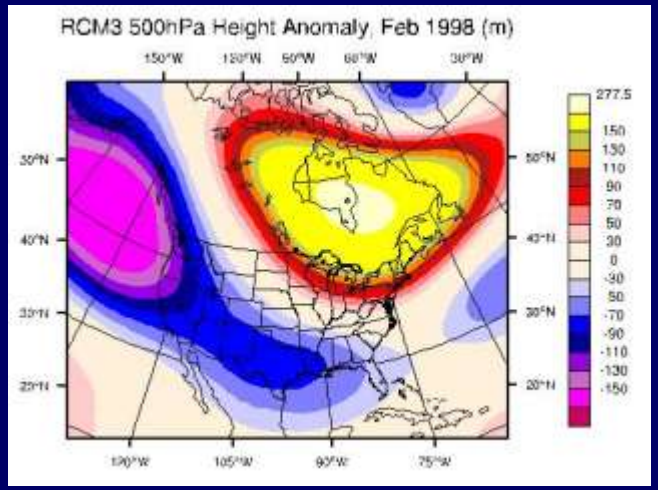
Simulated Circulation with Extreme Precipitation

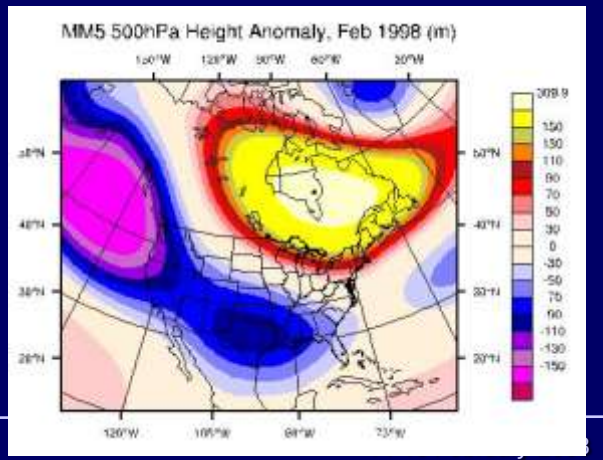








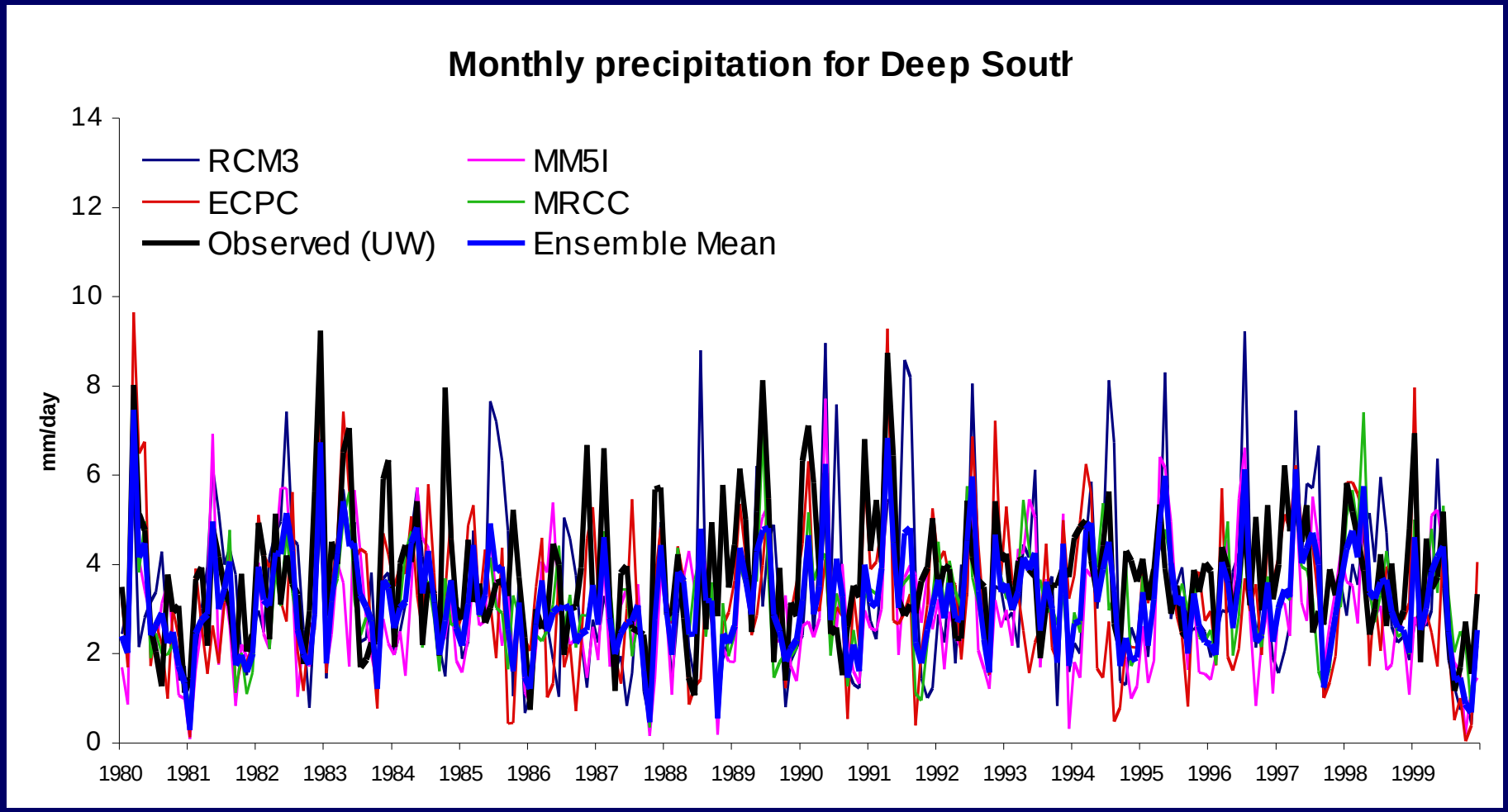




Deep South

- Humid mid-latitude climate with little seasonality in precip amount (Koeppen type Cfa).
- Past studies have found problems with RCM simulations of cool-season precip in this region.

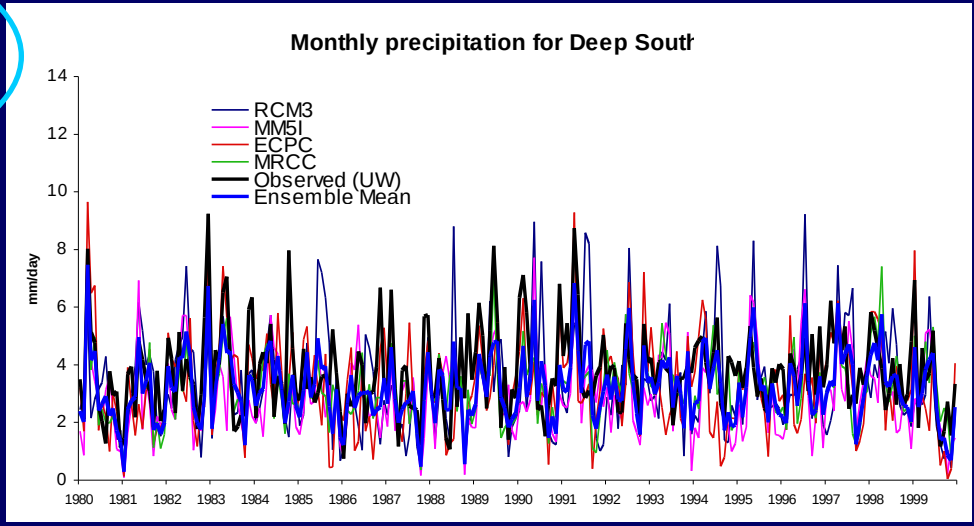
Monthly Time Series - Deep South



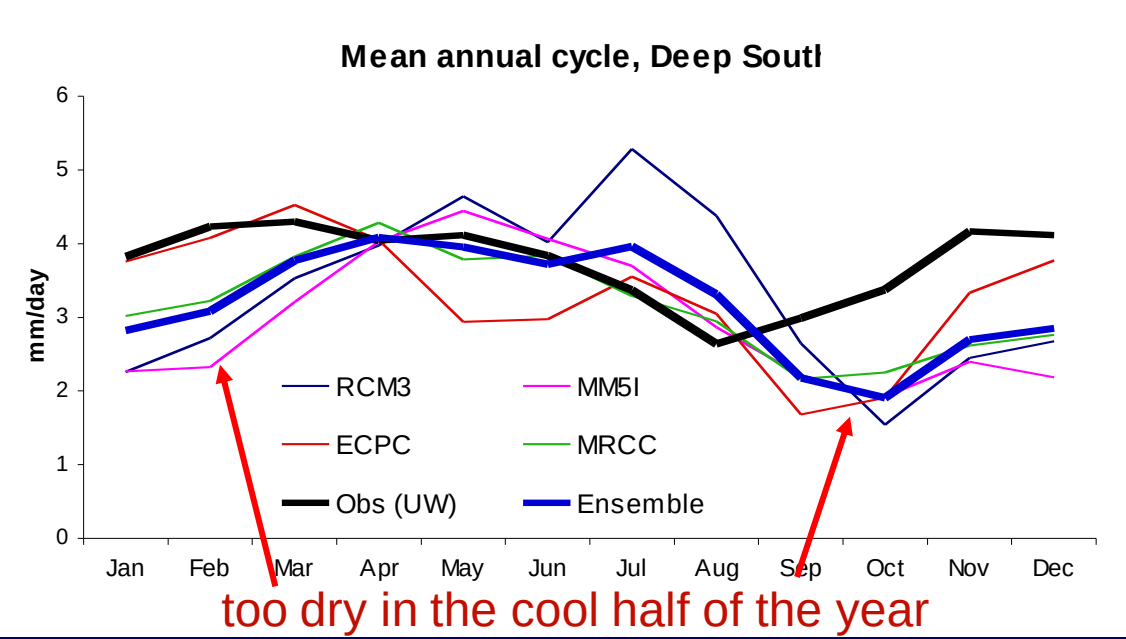
Time Series Correlations - Deep South

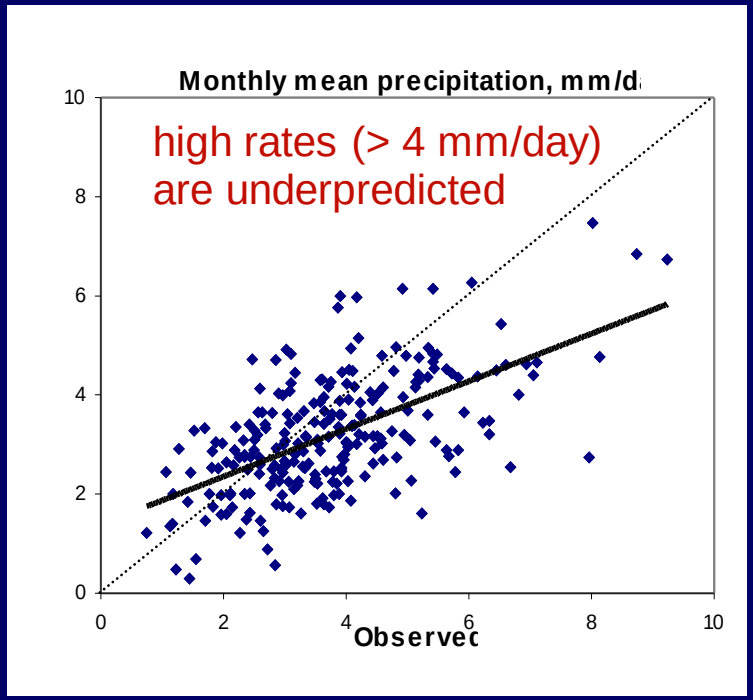
Model	Correlation
RCM3	0.257
MM5I	0.377
ECPC	0.636
MRCC	0.645
Ensemble	**0.597**
Ensemble of MRCC and ECPC	**0.709**

ECPC and MRCC both incorporate large-scale information in the domain interior: ECPC is a perturbation model (RSM), while MRCC uses spectral nudging.

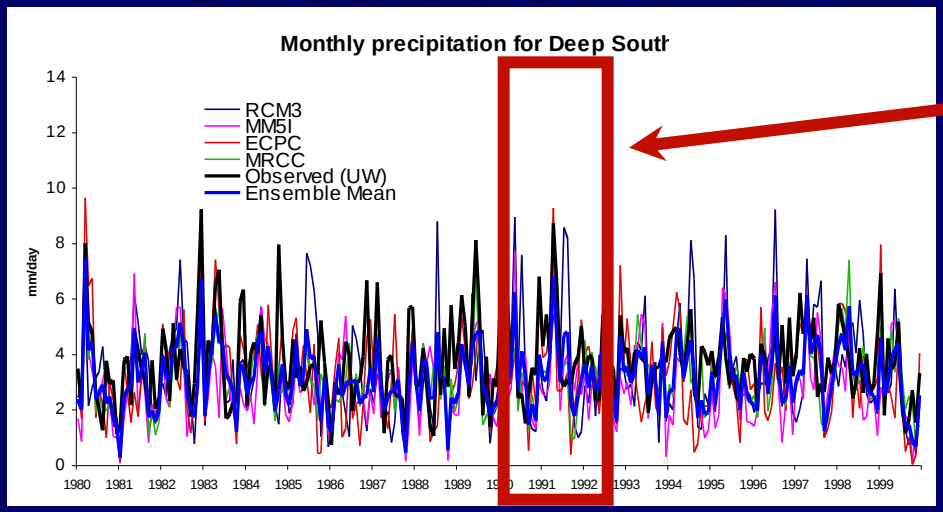


Further Statistics - Deep South

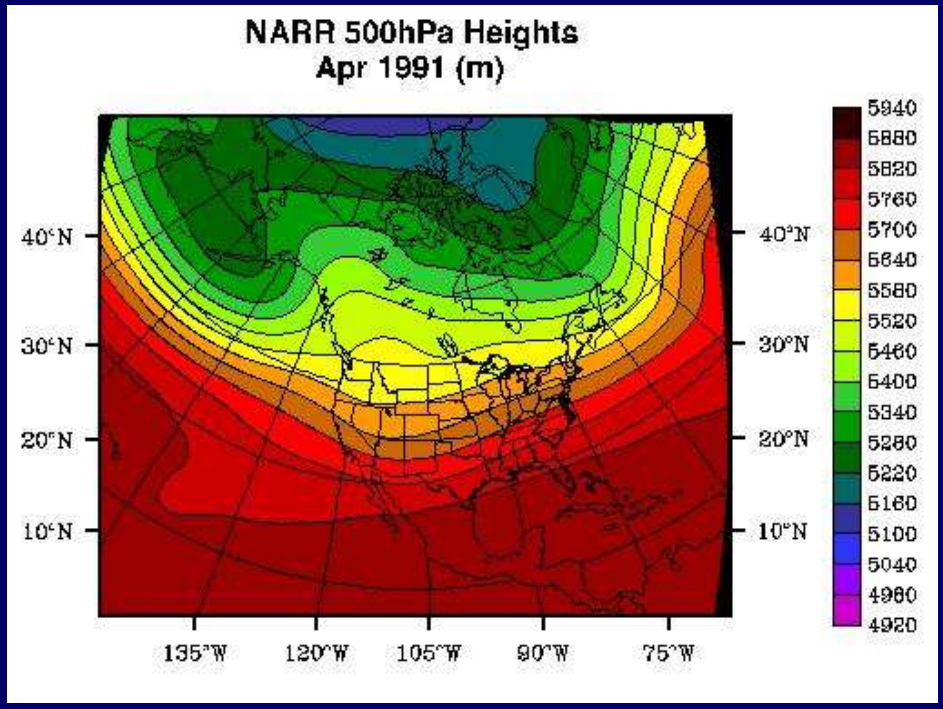


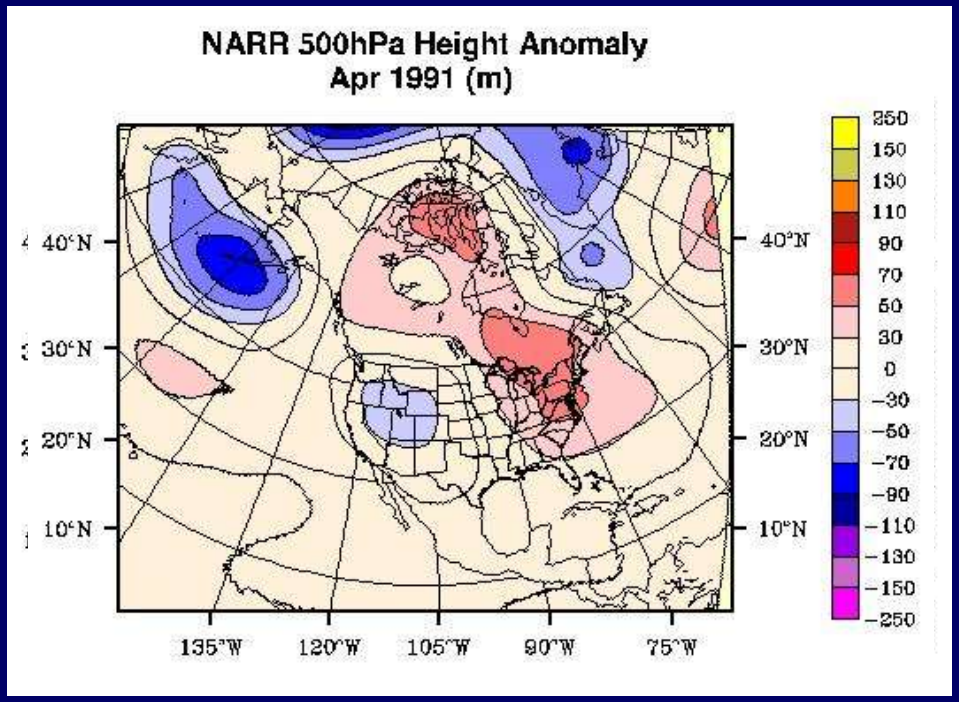


Circulation with Extreme Precipitation

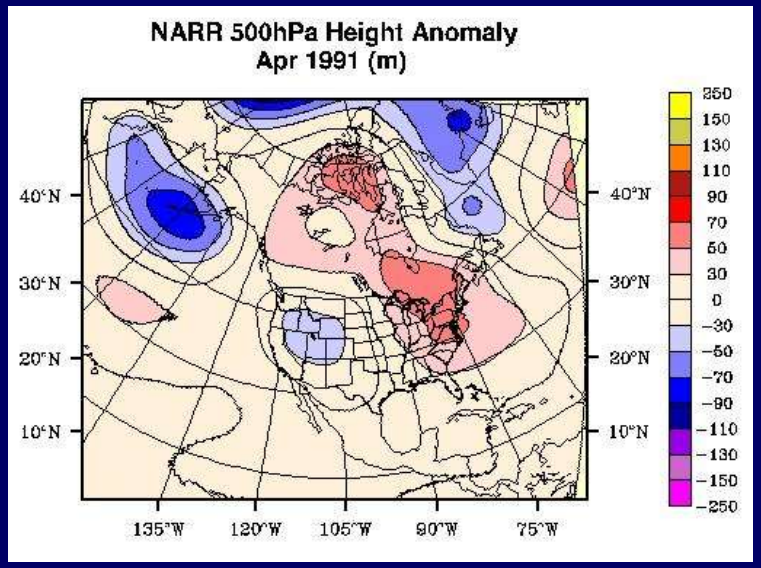


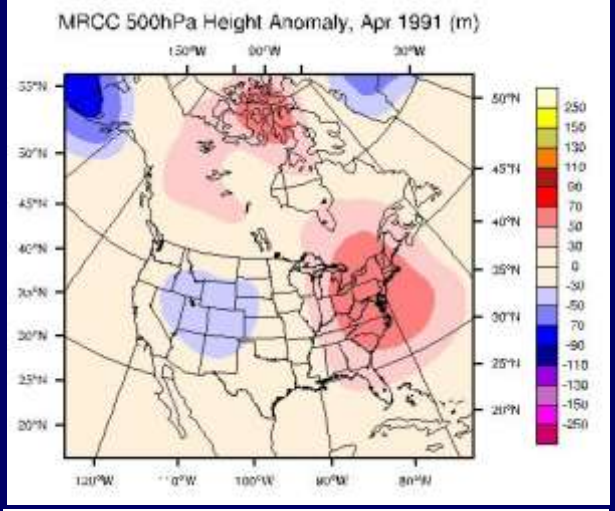
Precip. Max.: April 1991

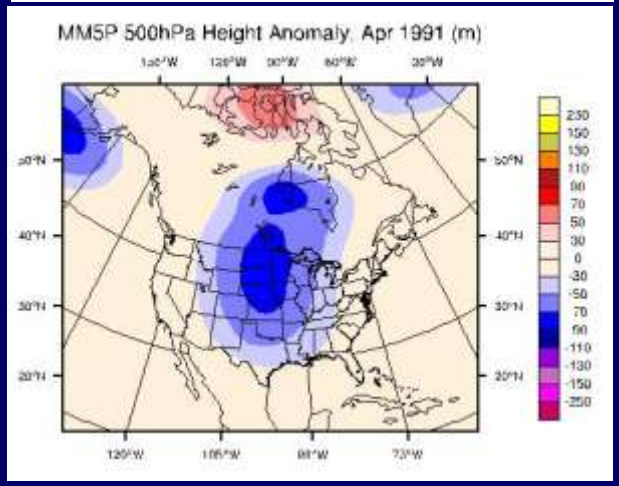


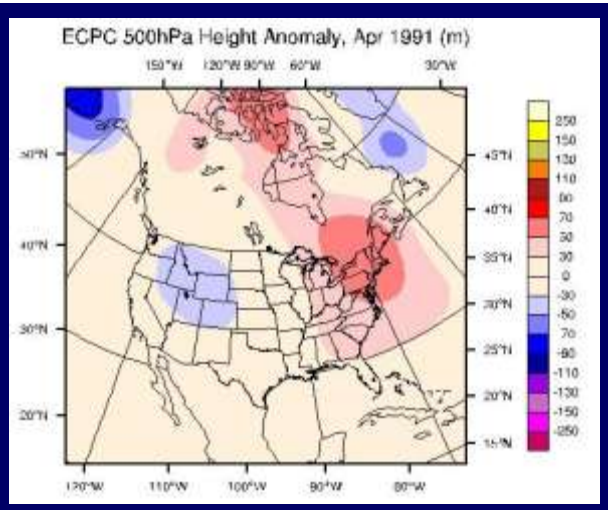


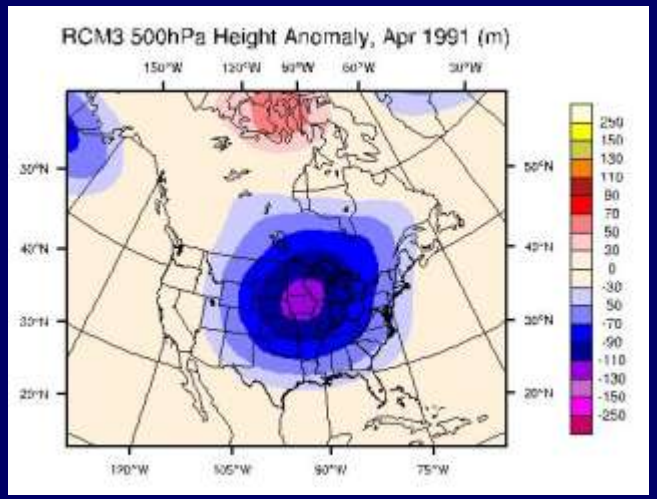
Simulated Circulation with Extreme Precipitation

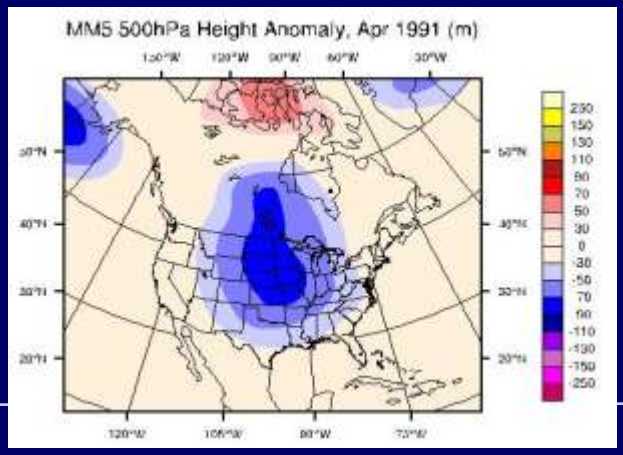












Comments and speculations

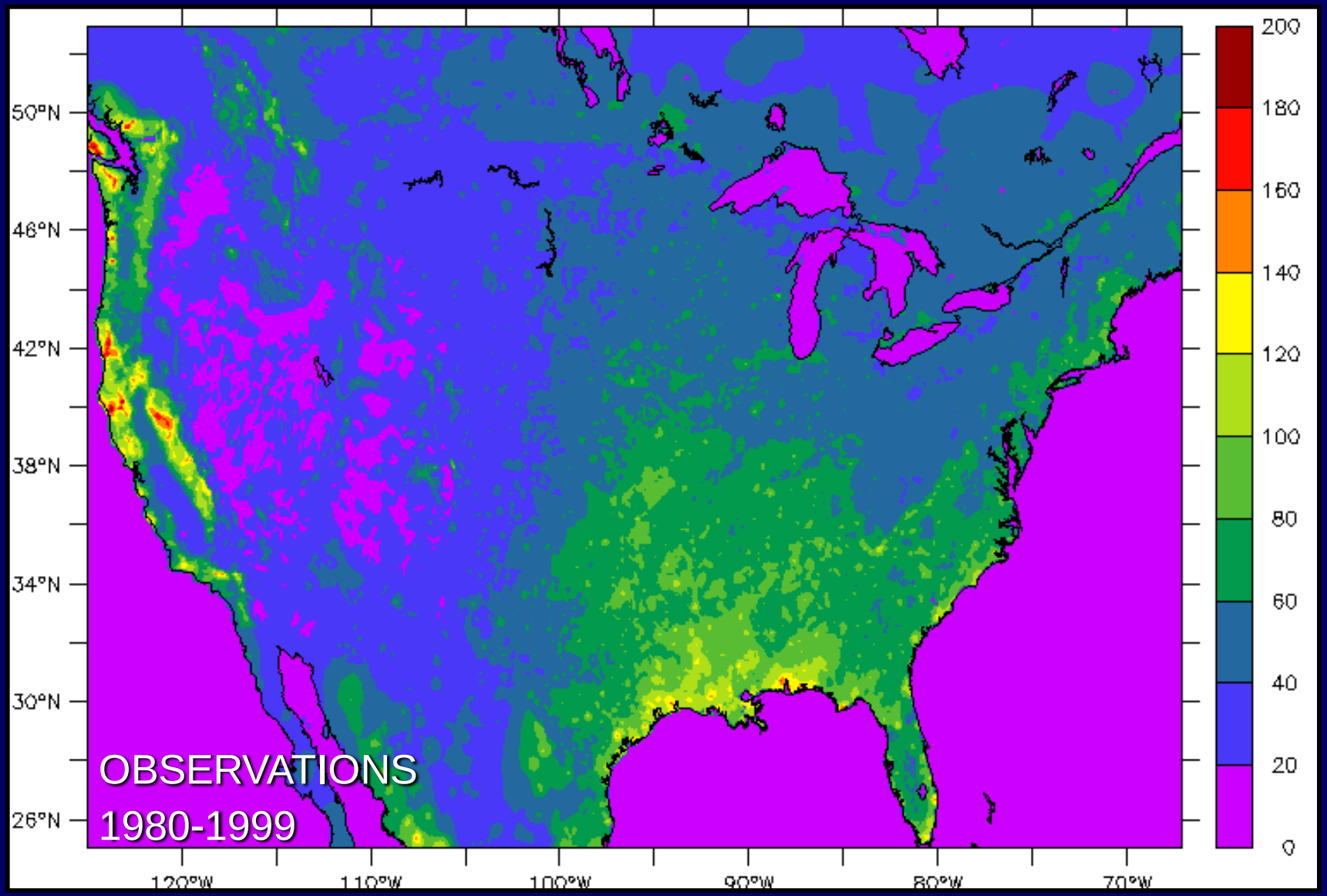
- A simple unweighted ensemble mean usually performs better than the best individual model, or close to the best model when spread is large.
- Hypothesis: Downscaling of ENSO could be an especially suitable use for a coupled GCM-RCM:
  - **RCMs perform well in coastal California during ENSO**
  - **Some AOGCMs can produce reasonable ENSO (see e.g., Van Oldenborgh et al. 2005).**
  - **Two of these AOGCMs are used in NARCCAP: GFDL CM2.1 and HadCM3.**

Comments and speculations

- Incorporation of large-scale information into the RCM (whether through spectral nudging or use of a perturbation form of the governing equations) appears to be an advantage for the Deep South region.
  - **This advantage does not carry over to other regions (or is outweighed by other factors, e.g., model physics).**

5-Yr Return Period Amounts

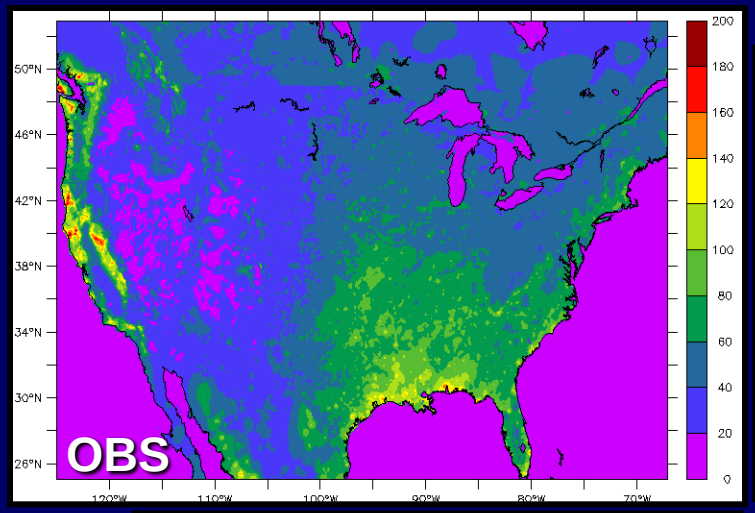
[mm/day]

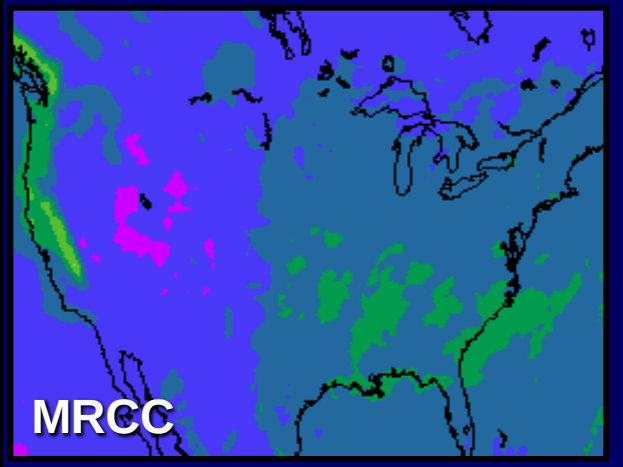


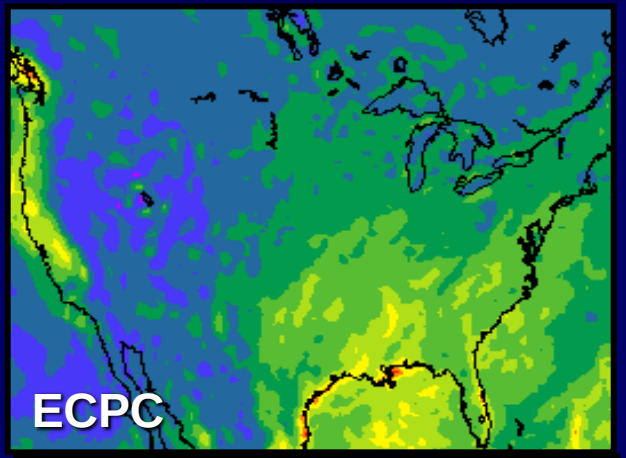
Thanks to Hayley Fowler for diagnostic code

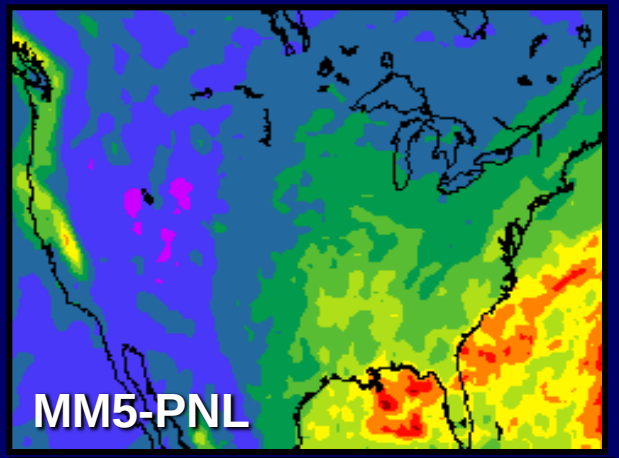
5-Yr Return Period Amounts

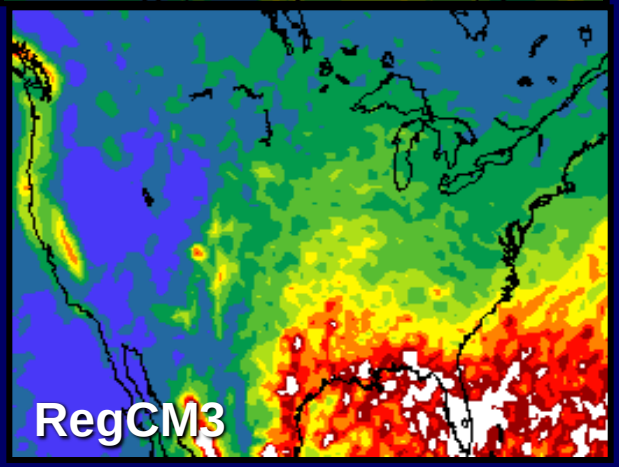
[mm/day]

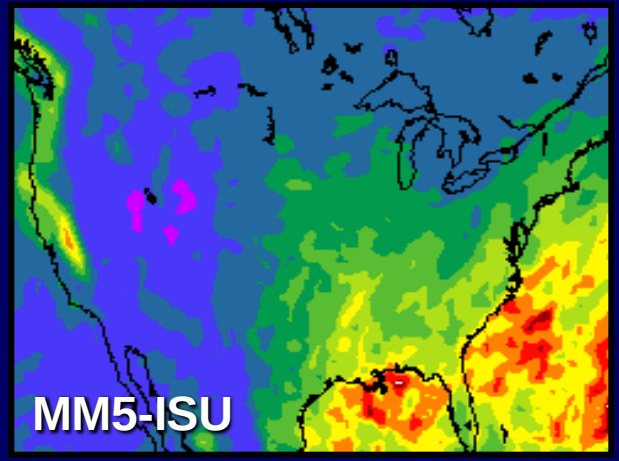












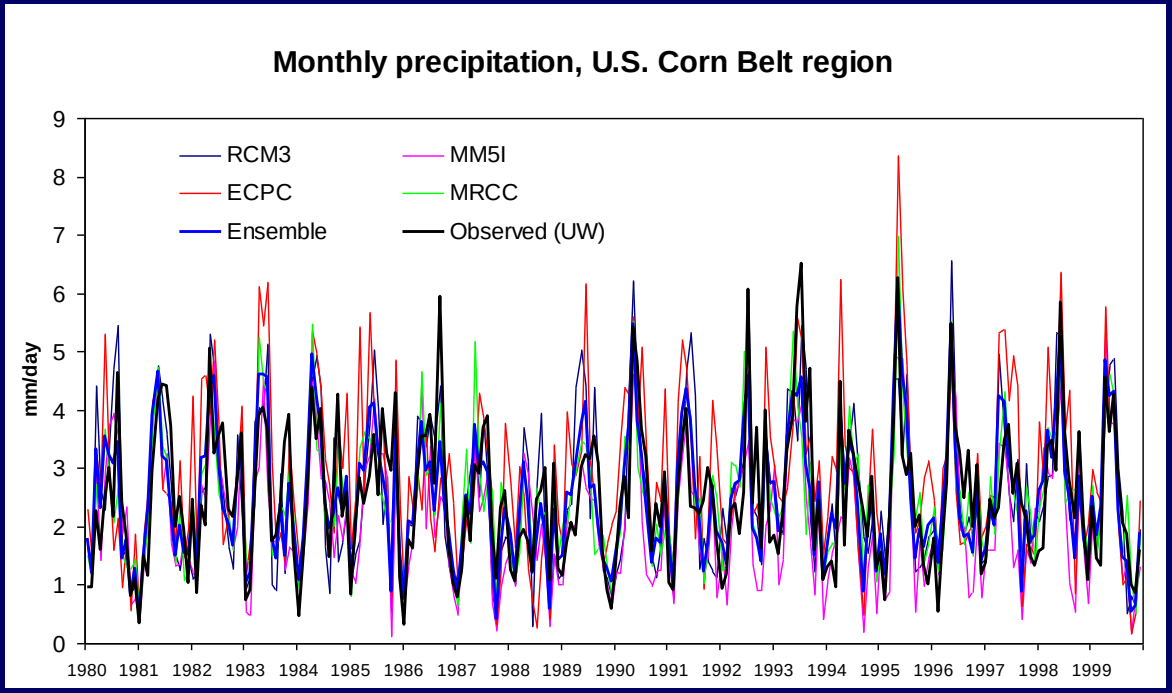
Thank You

Further Information

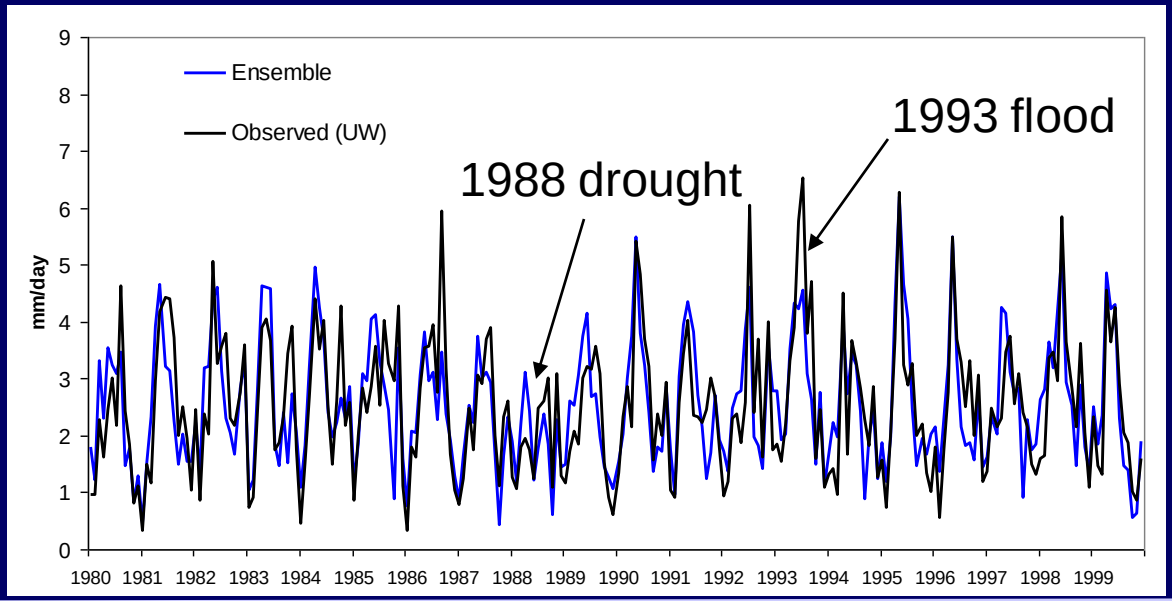
1. General:
   http://www.narccap.ucar.edu
2. Archive Information:
   http://rcmlab.agron.iastate.edu/narccap/output_archive.html
3. Data portal:
   http://esg.ucar.edu/forward.htm?forward=narccap

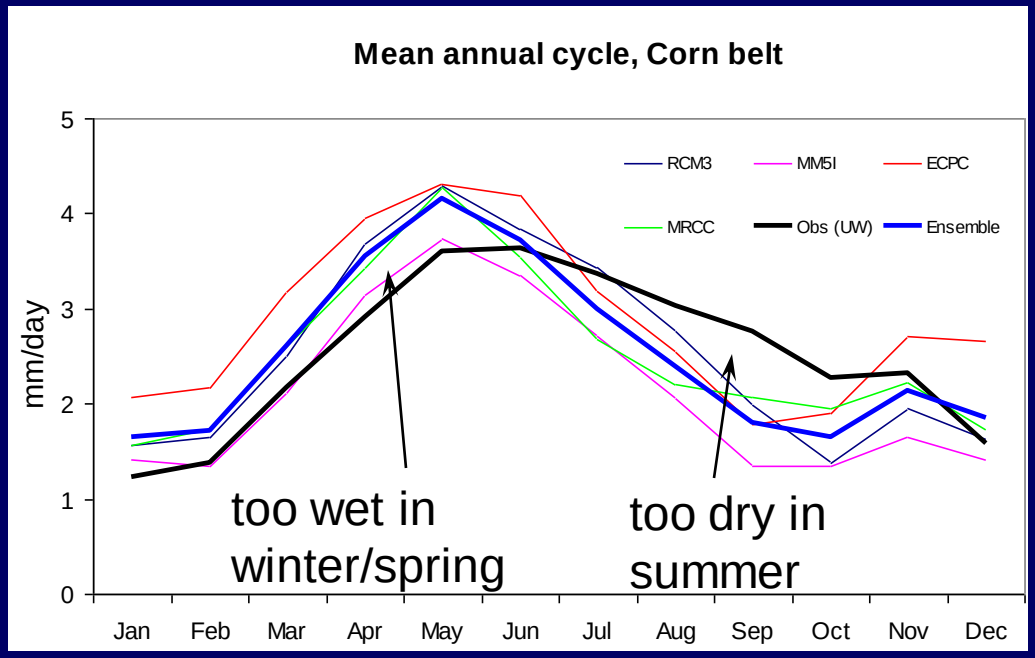
U.S. Corn Belt

- Western part is a continental climate with warm summers and cold winters becoming less continental to the east. (Koeppen types Dfa, Dfb)
- Maximum precipitation in April-June
  - **seasonality of precip is important for agriculture, e.g., drawdown of soil moisture during the growing season**
- Includes the Upper Mississippi River basin

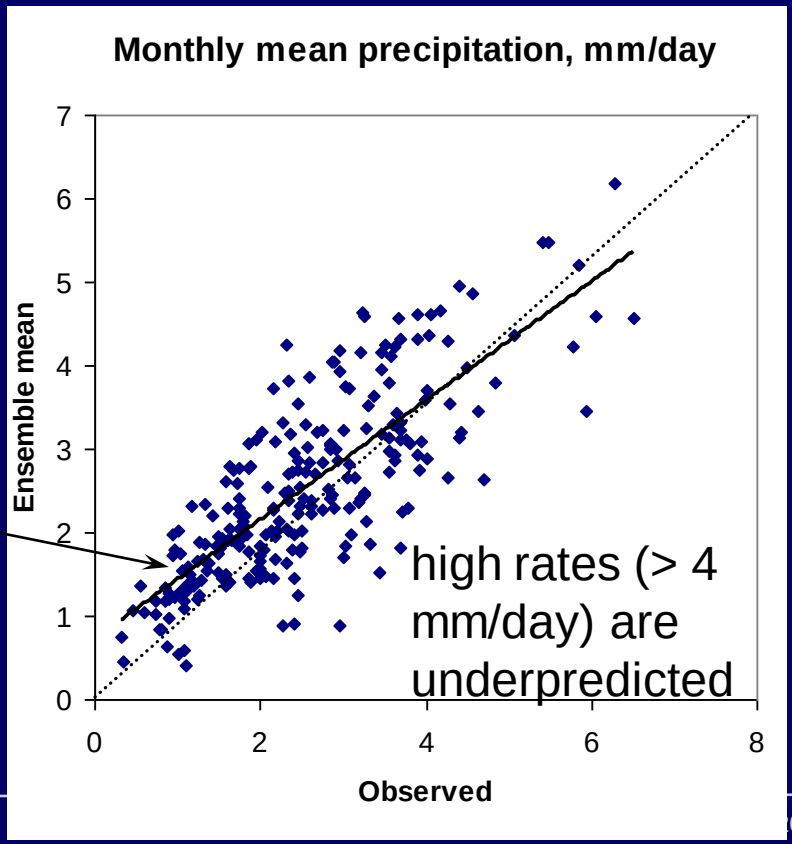


Model	Correlation
RCM3	0.722
MM5I	0.692
ECPC	0.636
MRCC	0.760
Ensemble	**0.788**



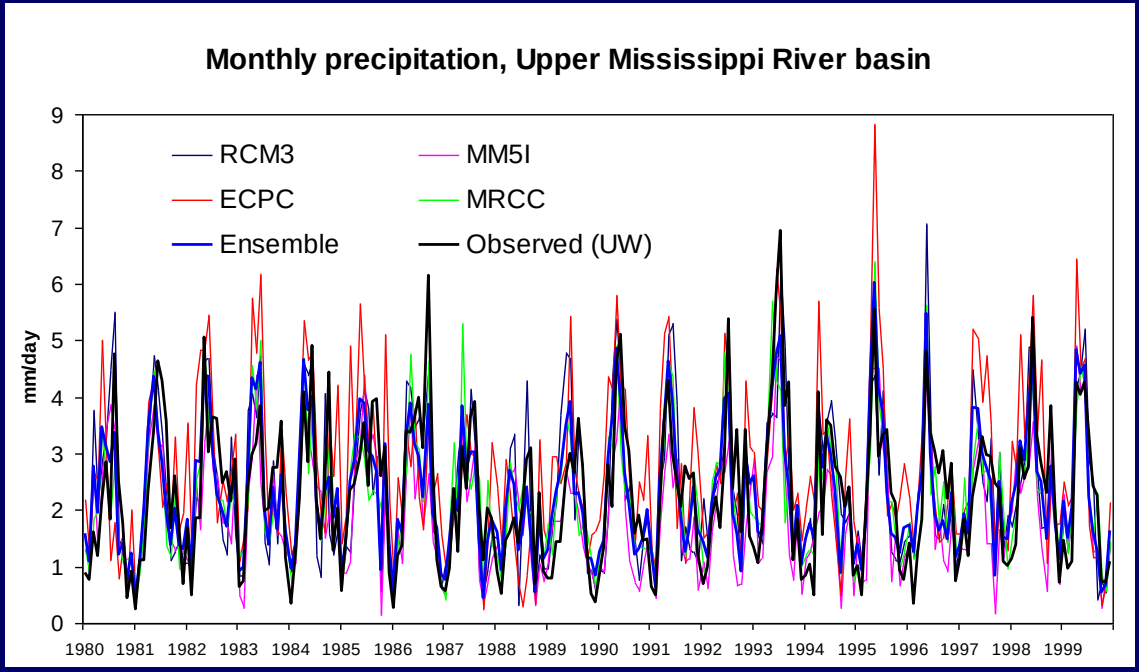


low rates (< 2 mm/day) are overpredicted

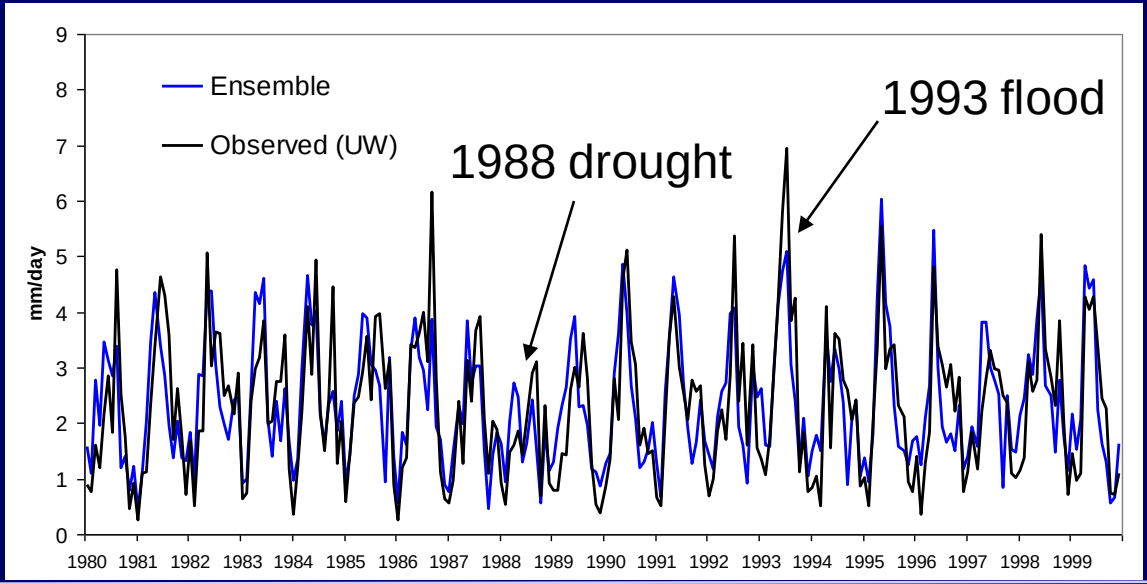


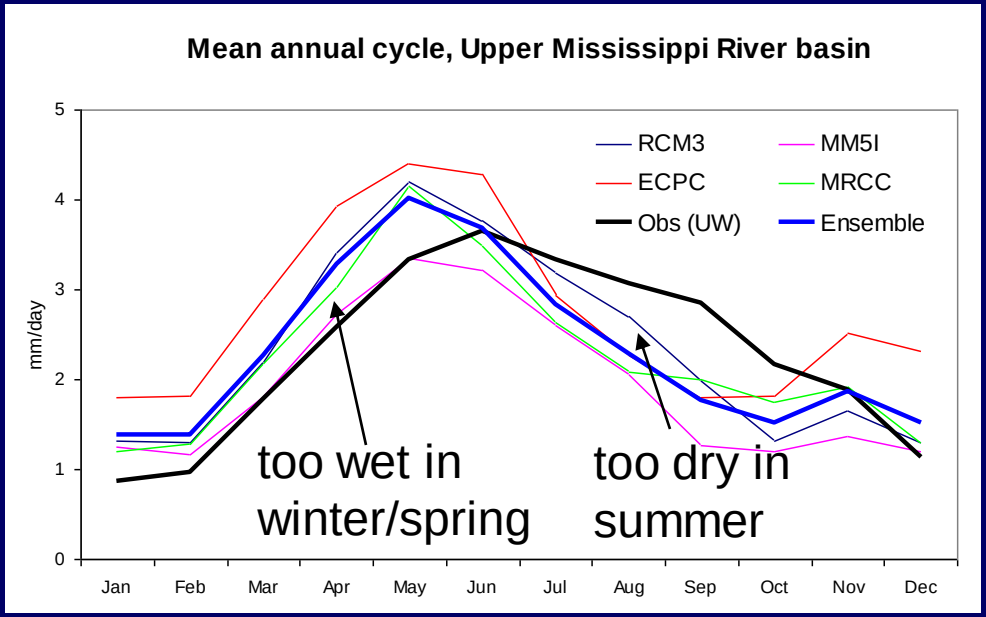
Upper Mississippi River Basin

- Continental climate with warm summers and cold winters (Koeppen types Dfa, Dfb).
- Maximum precipitation in April-June:
  - **seasonality of precip is important for impacts, e.g., drawdown of soil moisture during the growing season**
- Most NARCCAP models simulated this region in the PIRCS project.

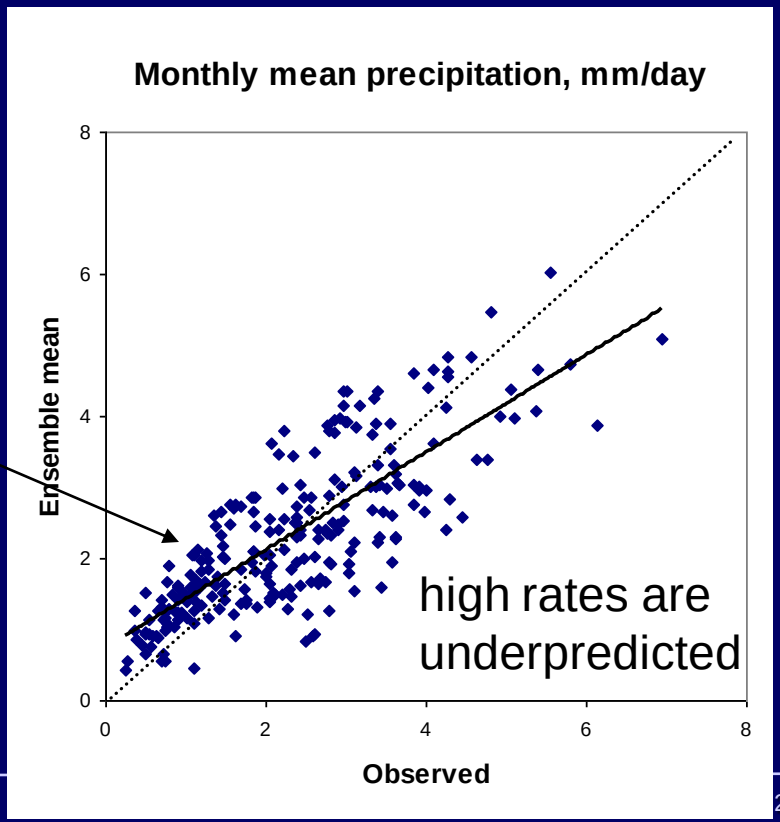


Model	Correlation
RCM3	0.745
MM5I	0.696
ECPC	0.627
MRCC	0.779
Ensemble	**0.791**





low rates (< 2 mm/day) are overpredicted

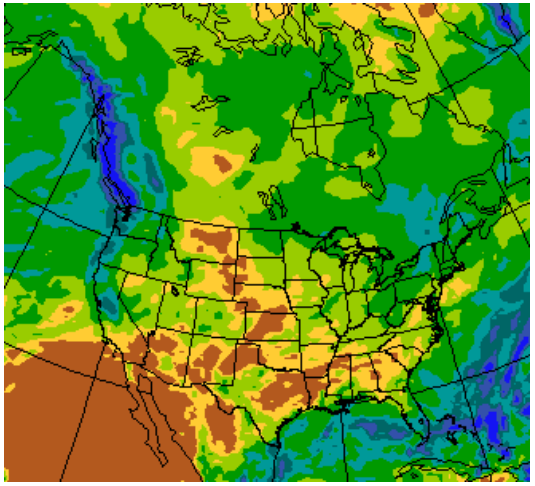


1982-1983 and 1997-98 El Niños

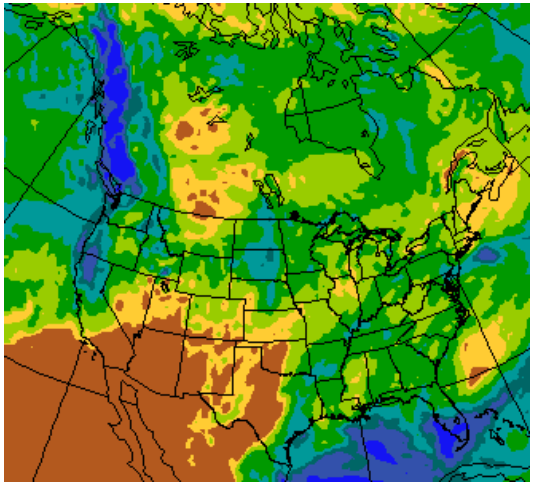
- Some AOGCMs give realistic simulation of ENSO:
  - **see e.g., van Oldenborgh et al. (2005, Ocean Science) for IPCC AR4 models**
- Do regional models give realistic precipitation during El Niño events?
  - **If so, perhaps a combined AOGCM-RCM approach can give useful results for ENSO in future climates.**
- We examine evolution of precipitation during the 1982-1983 and 1997-1998 El Niño: onset, peak, and withdrawal.

October 1982

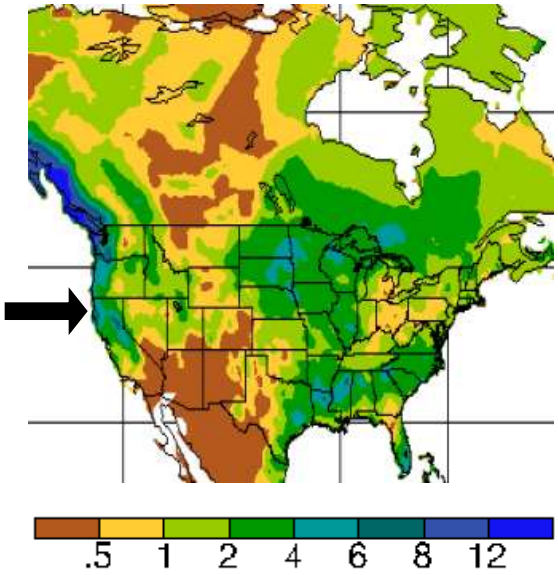
RegCM3



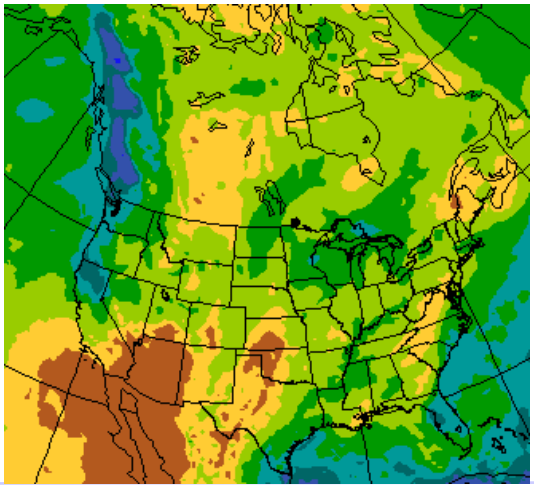
RSM



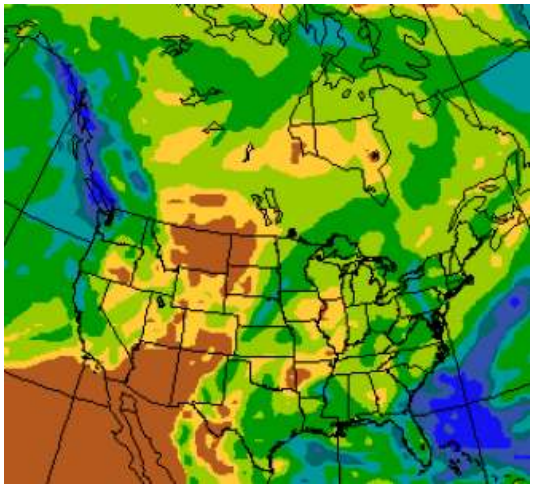
Observed (CRU)



MRCC

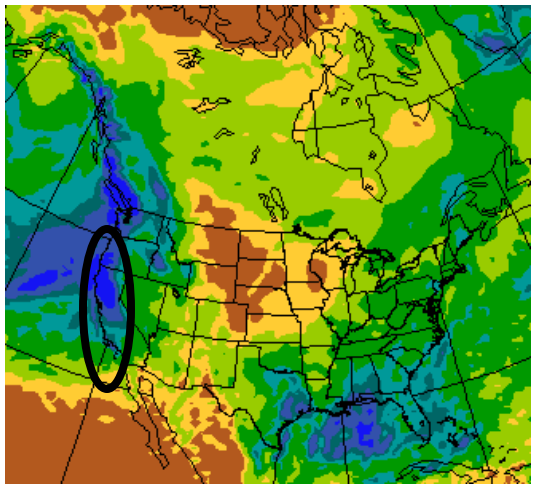


MM5

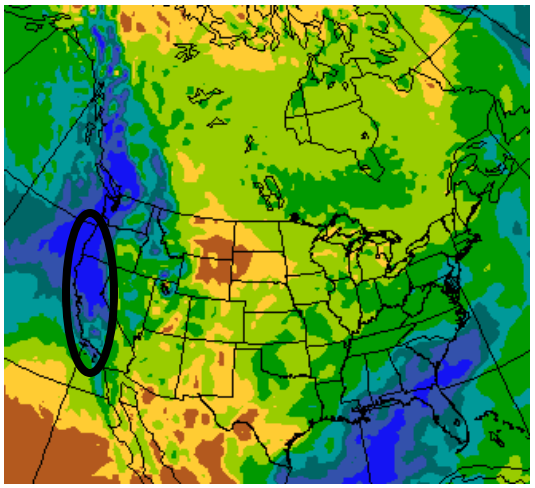


February 1983

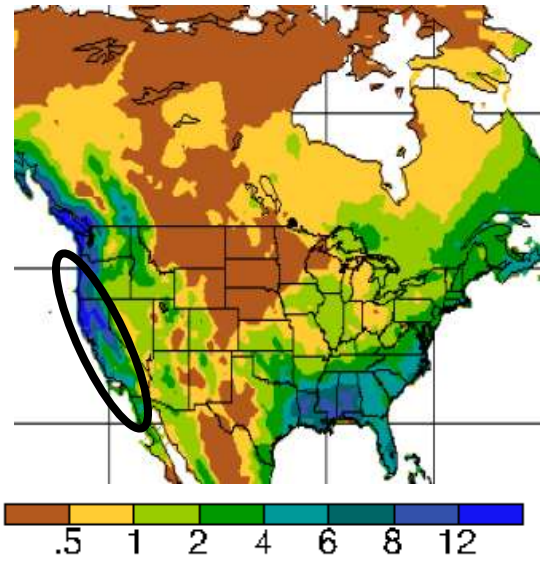
RegCM3



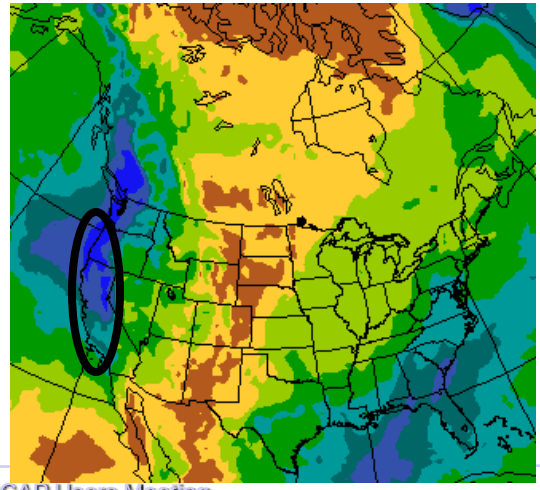
RSM



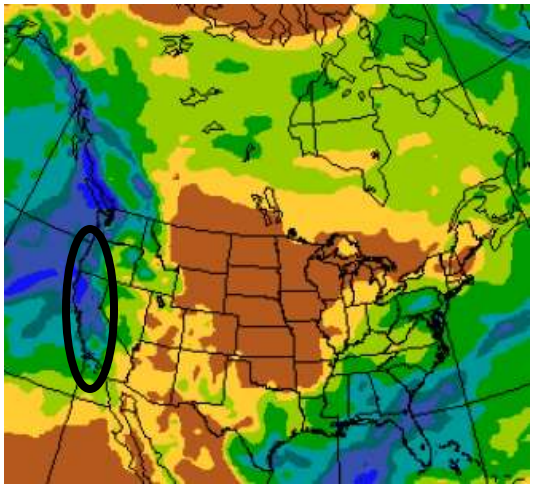
Observed (CRU)



MRCC

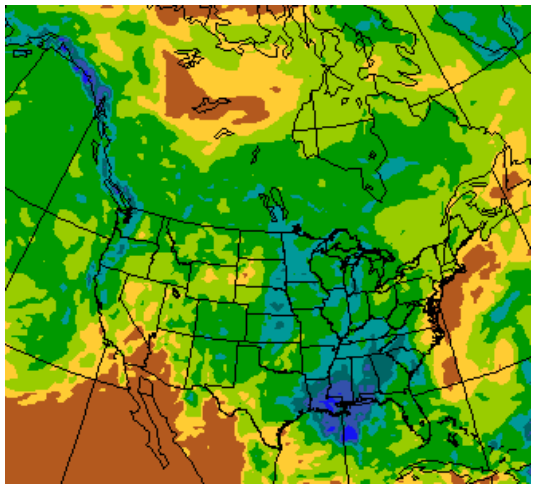


MM5

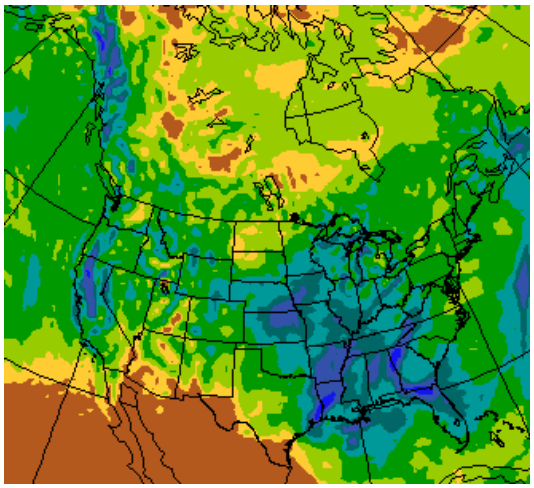


April 1983

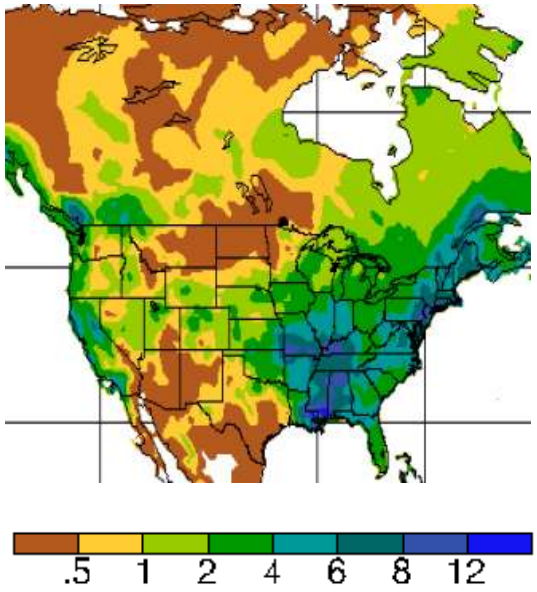
RegCM3



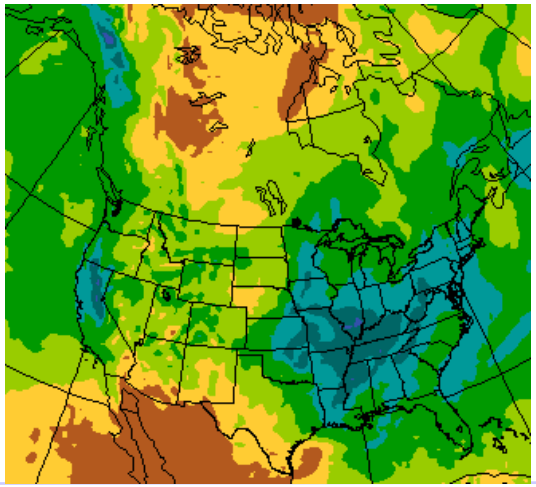
RSM



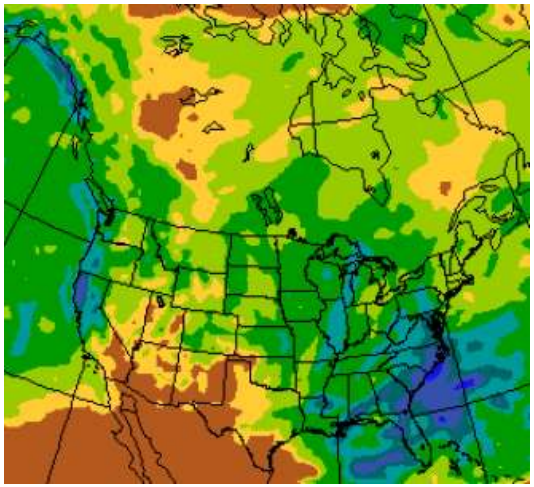
Observed (CRU)



MRCC



MM5

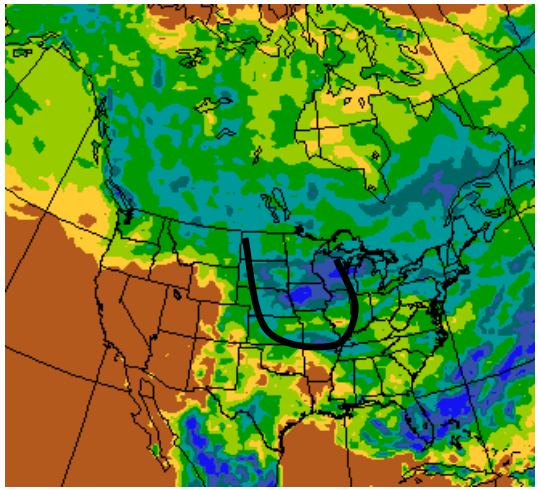


1993 flood in the north-central U.S.

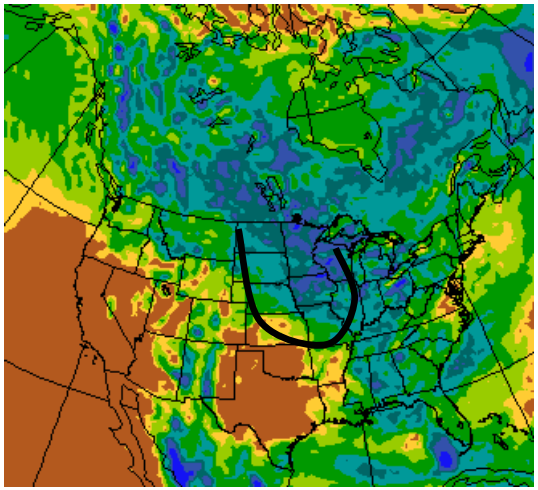
- The event mainly was the result of synoptic-mesoscale dynamics with little direct influence by terrain.
- This event was the subject of an early regional model intercomparison which performed 60-day simulations (PIRCS, 1B).

Summer 1993 flood in central U.S.

RegCM3

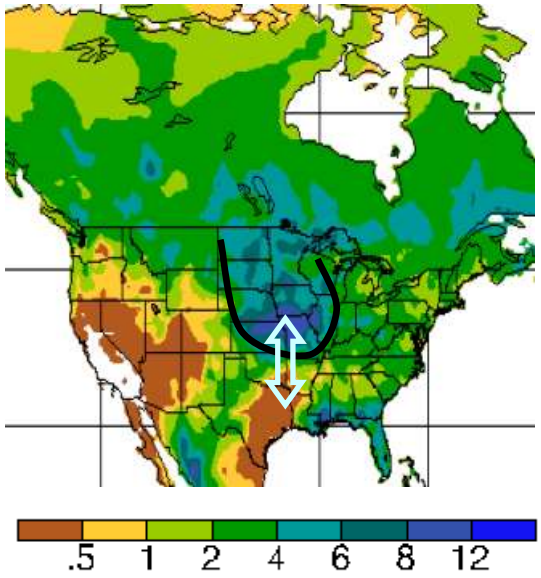


RSM

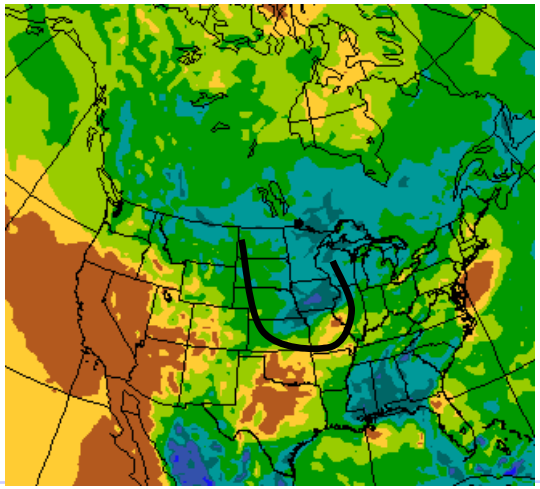


July 1993 precipitation

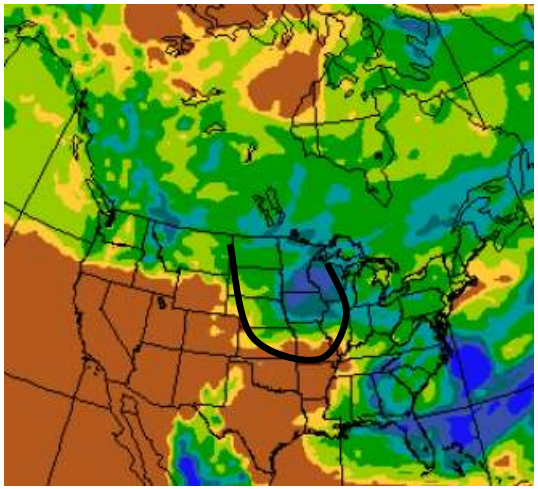
Observed (CRU)



MRCC



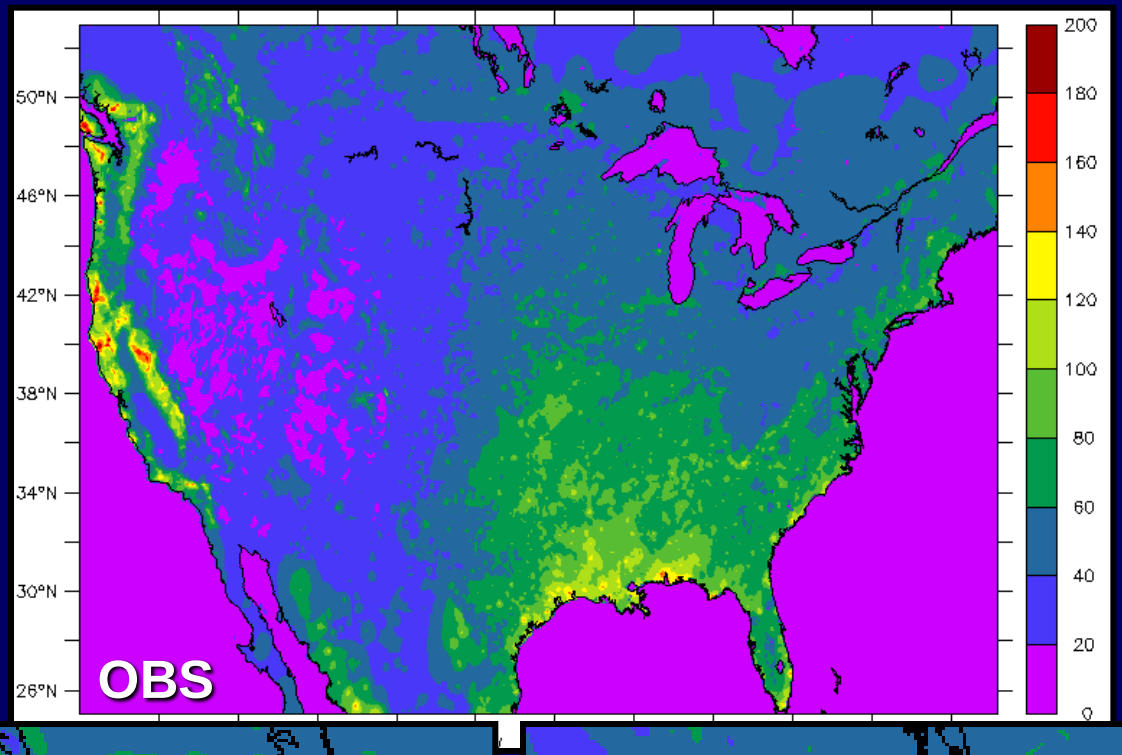
MM5

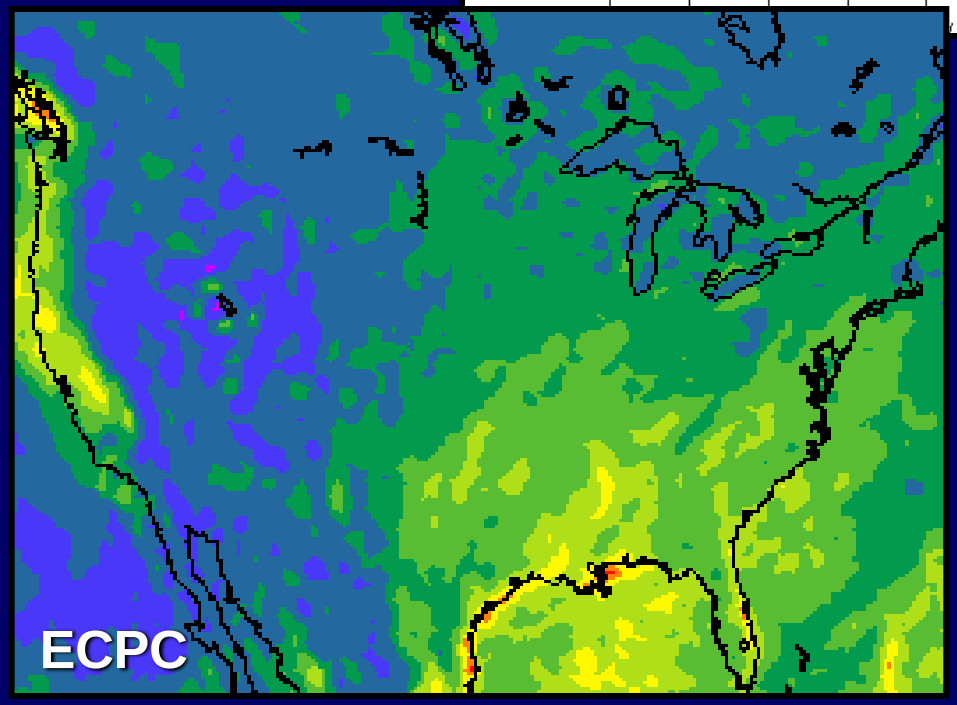


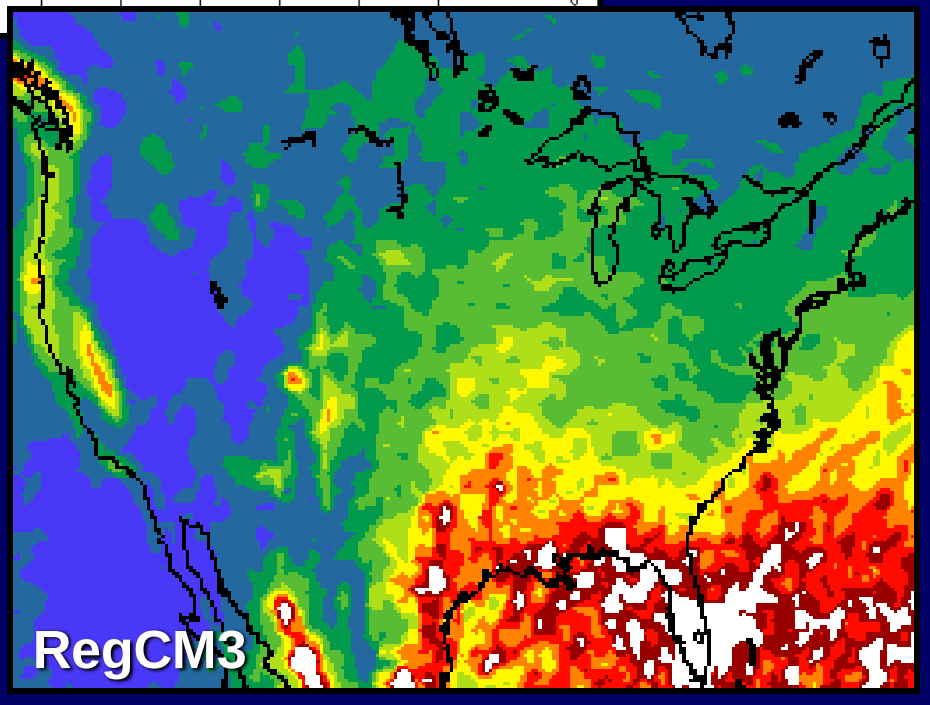
- model skill is very similar to PIRCS 1B

5-Yr Return Period Amounts

[mm/day]

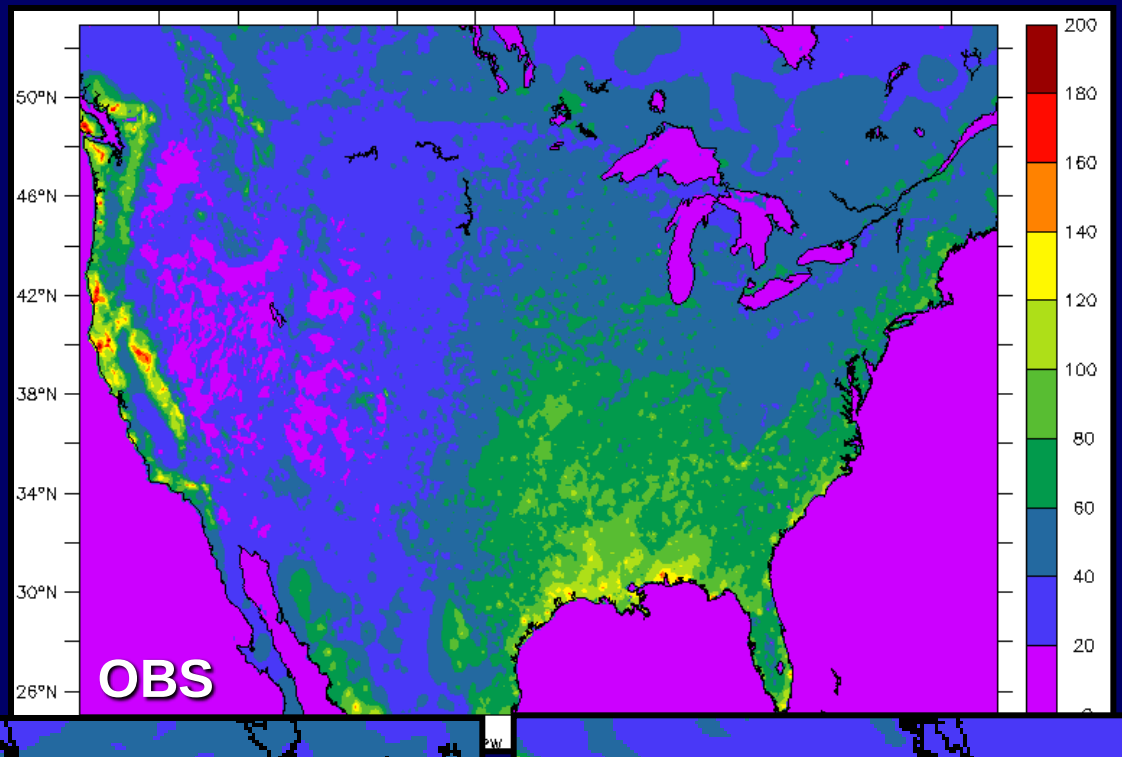


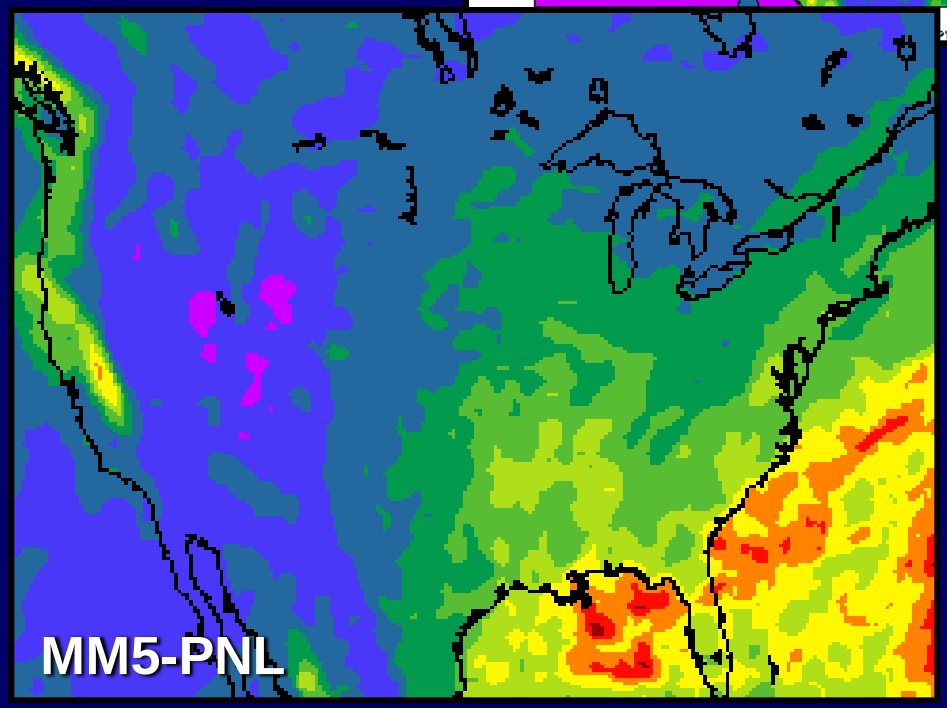


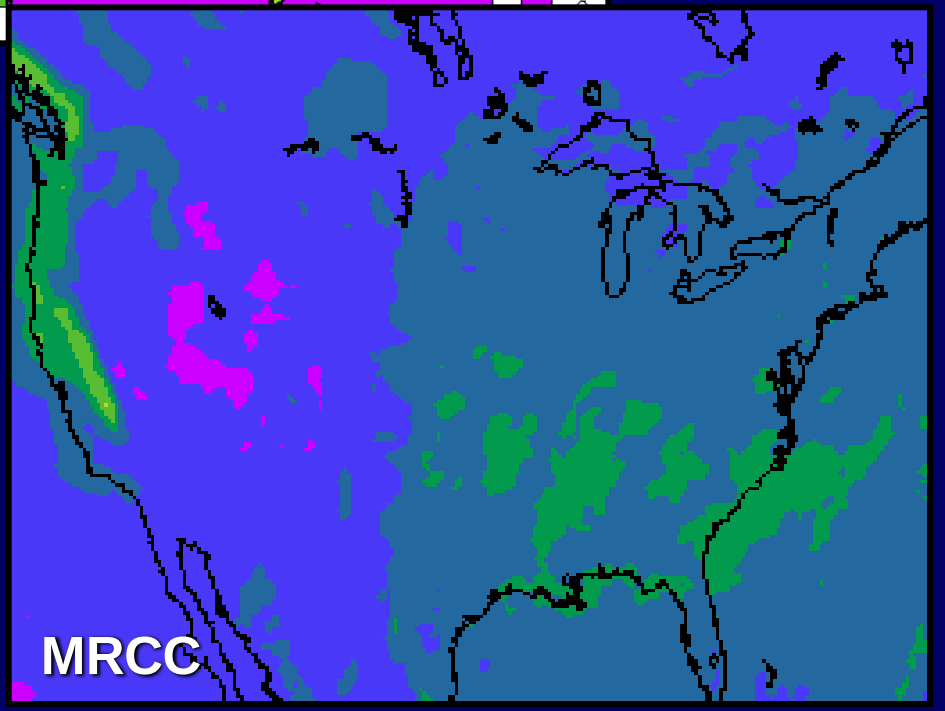


5-Yr Return Period Amounts

[mm/day]







5-Yr Return Period Amounts

[mm/day]