



# Summer and Winter Season Precipitation Prediction over North American with the Eta Regional Climate Model

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*National Centers for Environmental Prediction*

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# Presentation Outline

- Brief Introduction to the Eta RCM
- Model Predictions using CFS Hcst data
- Eta RCM results (Precip, tmp2m, LHTFL, 500h, 200h etc)
- Preliminary Conclusions
- Future work

# The Eta Regional Climate Model Development at NCEP

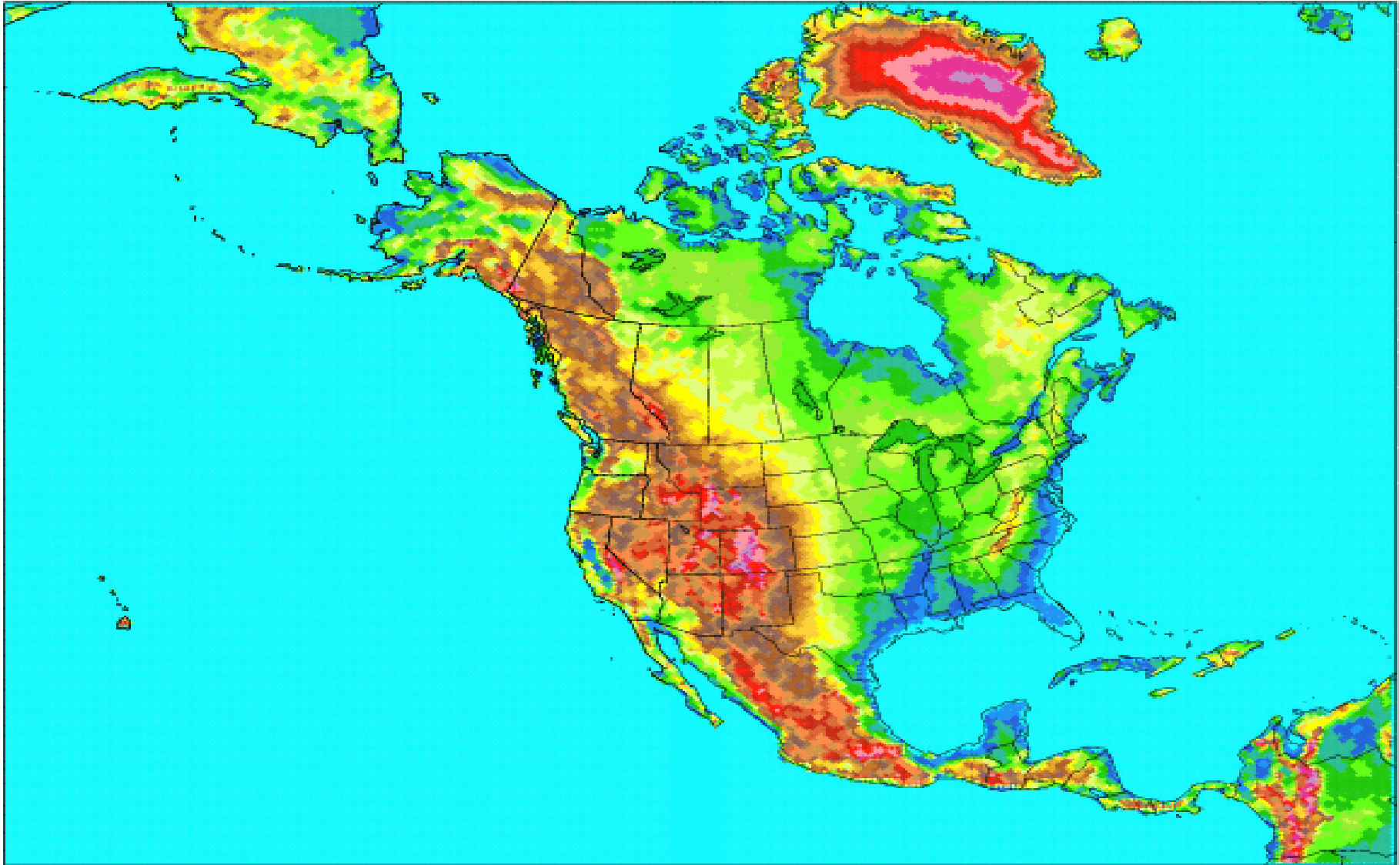
- Developed: uses very recent version of Eta Model physics
  - As implemented in operational NCEP Eta on 24 Jul 01
  - As implemented in NCEP Regional Reanalysis
- Virtually exact match to Eta model in Regional Reanalysis (R/R)
  - R/R domain and grid (32-km, 45-levels, large R/R domain)
  - R/R Eta model physics, e.g. Noah Land Model 2.3, with 4 soil layers
- Daily updates of several surface boundary fields
  - Daily observed 1-deg weekly Reynolds/Stokes SST or NCEP predicted SST
  - Satellite NDVI-based 0.15-degree monthly greenness (NESDIS)
  - Seasonal 1.0-deg snow-free albedo climatology (NASA)
- Initial land states of soil moisture and soil temperature
  - Soil moist/temp from Global Reanalysis II and NCEP Regional Reanalysis (RR)
  - Snow depth: USAF operational 47-km daily global snow depth

# Model Prediction (Experiments)

- Model Executions using GR2 Initial Land States
  - Predicted Lateral Boundary Conditions (CFS Hindcast)
  - Predicted SSTs (CFS Hindcast)
  - 10 summer members (mid-April/early May through mid-November)
  - 1999, 2000~ 2004 summer
  - Winter 7 members (from Dec. 19 to Dec. 31)
  - 1983, 2000-2004 winters

*10 members for Summer, 7 members for Winter to Establish Model Climo (2000-2004)*

# The Eta RCM Big Domain



# Eta Model Execution Mode in this Presentation:

## • Prediction Mode

- **Use predicted SST and predicted lateral boundary conditions (LBC) from:**
  - NCEP's operational Climate Forecast System (CFS) (coupled global atmosphere/ocean/land model) and its 25-year ensemble hindcast database at T62. CFS Ocean model is GFDL MOM3.
- **Configuration of ensemble set of Eta RCM forecasts in full prediction mode:**
  - Summer-season predictions:
    - 10 Eta RCM members: one each from each 00Z initial state of April 19 through May 03
    - For each summer period of 2000-2004 and summer 1999 (strong U.S. monsoon)
  - Winter-season predictions:
    - 7 Eta RCM members: one each from each 00Z initial state of Dec 19 through Dec 31
    - For each winter period of 2000-2004 and winter 1983 (strong ENSO event)

# Model Execution Modes in this Presentation (Con't) :

!!!! → • **Role of the 5-year 2000-2004 Eta RCM hindcast set:**

- provide an Eta RCM mini-hindcast for a period of relatively ENSO-neutral years
- Eta RCM seasonal predictions for summer 1999 & winter 1983 are then cast as the prediction of Eta RCM ensemble mean anomaly defined with respect to Eta RCM's own ensemble mean 5-year mini-hindcast of 2000-2004, and compared with CFS seasonal predictions of CFS anomaly with respect to CFS ensemble mean hindcast of same 2000-2004 period

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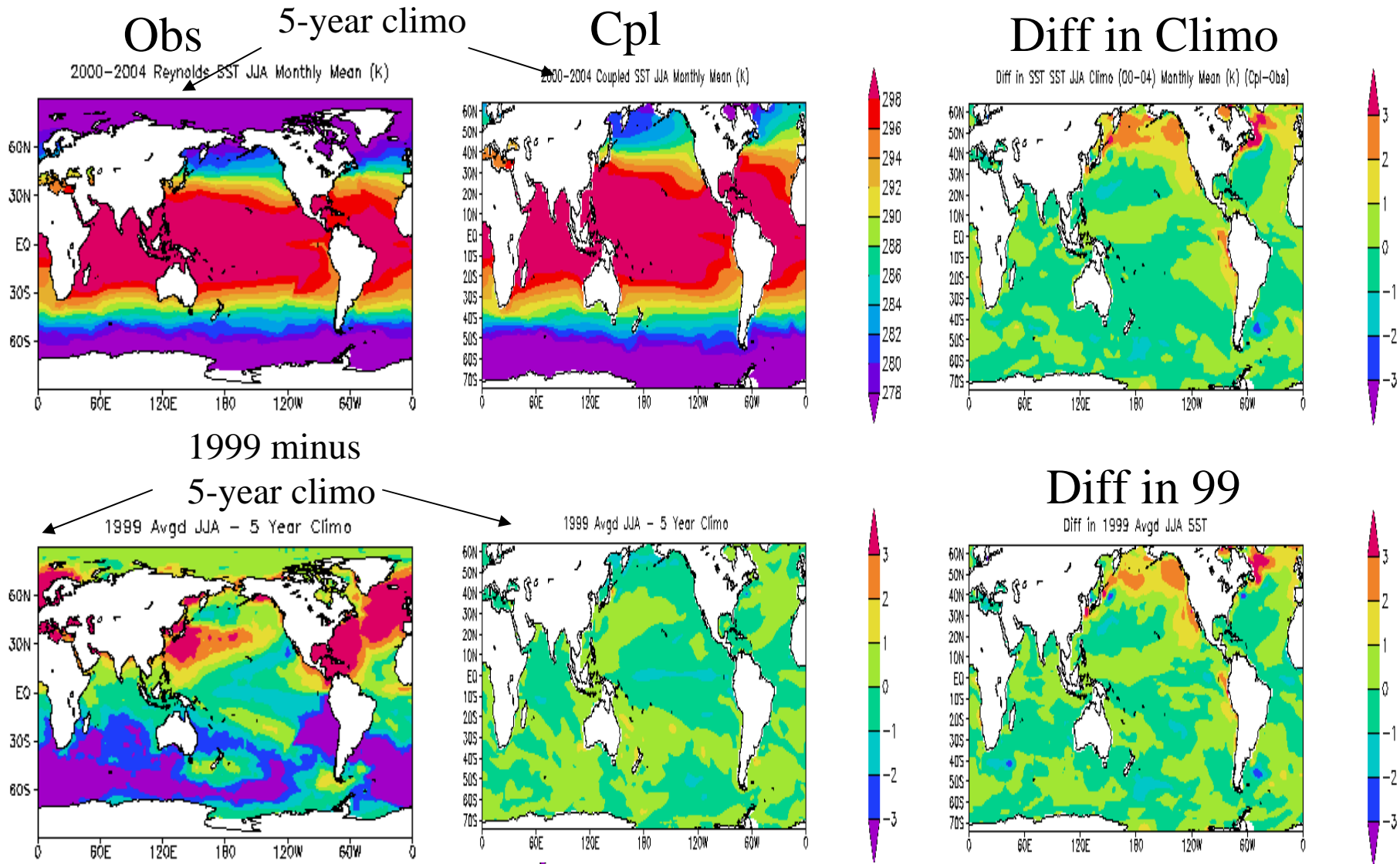
## Summer 1999 Case

(a strong U.S. monsoon event)

- Observed and Predicted anomalies:
  - SST (prediction by CFS only)
  - Precipitation
  - 2-m Temperature (near surface)
  - 200 hPa Height fields
  - 500 hPa Height Fields

# SST Climo and anomaly Comparison (00-04 & 99) Monsoon Event

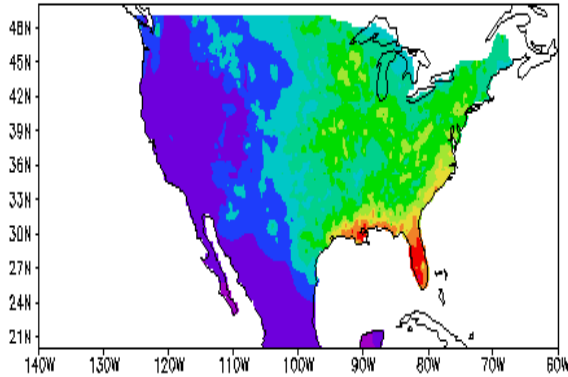
Left: Obs Mid: Prediction: Right: Difference



# JJA Monthly Mean Precip

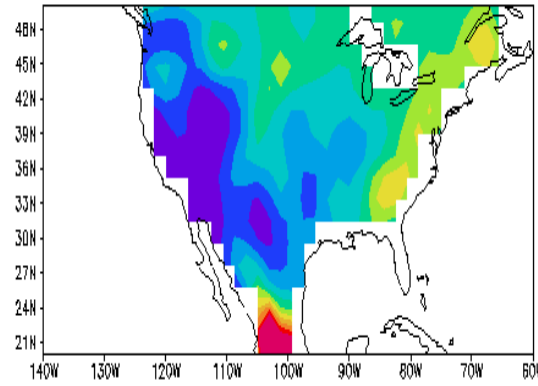
Top: Climo Bottom: 99-Climo

2000-2004 CPC Avgd JJA Monthly Precip



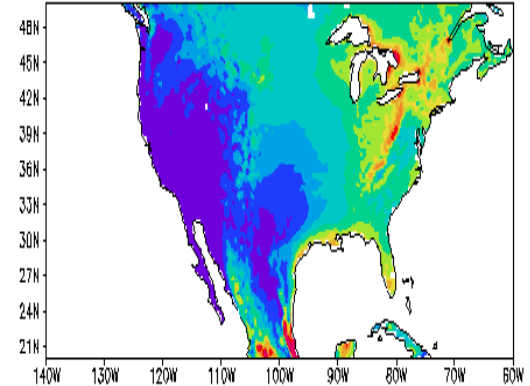
Obs

CFS 2000-2004 JJA Precip Model Climo (m06-15)

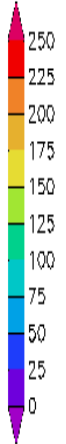


CFS

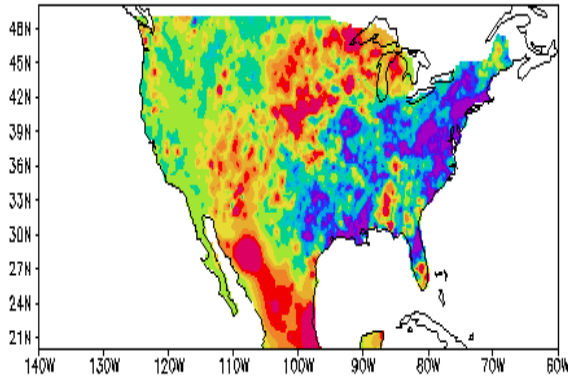
Eta RCM 00-04 Monthly Avgd JJA Precip Climo (10 Mem)



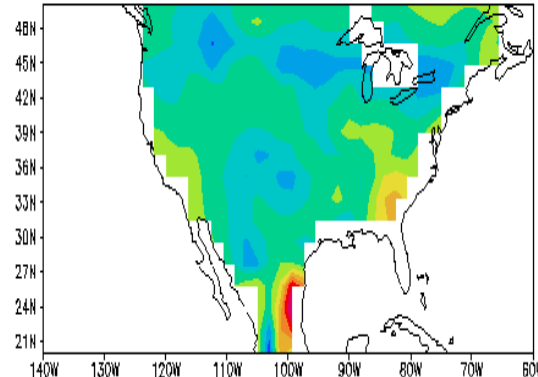
Eta RCM



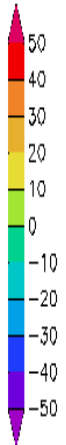
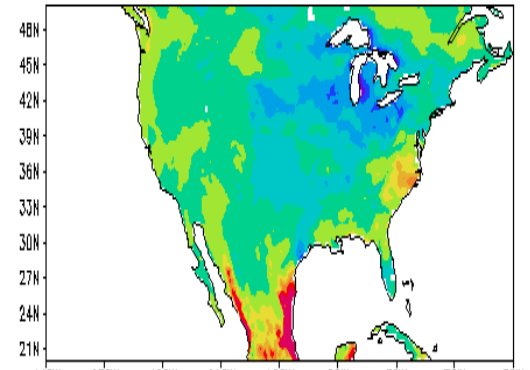
1999 Avgd JJA - 5 Year Climo



1999 CFS JJA Monthly Precip - 5 Year Climo



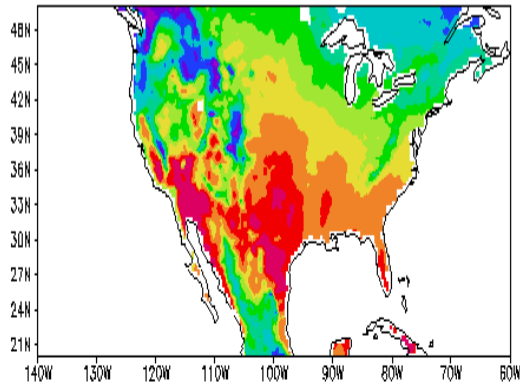
99 Eta RCM JJA Avgd Monthly Precip - 5 Year Climo



# JJA Monthly Mean T2m

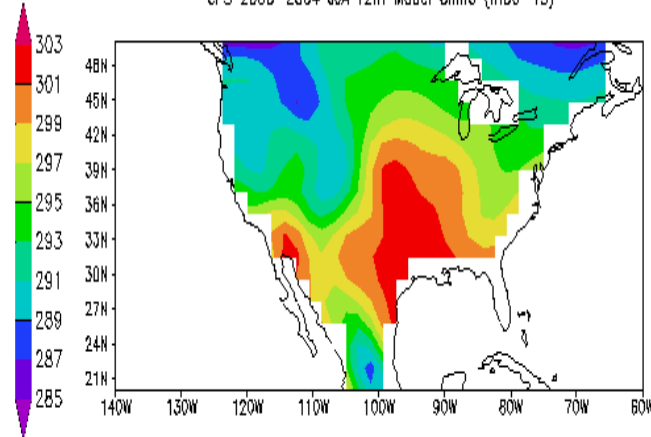
Top: Climo Bottom: 99-Climo

NARR 2000–2004 JJA TMP2m Climo



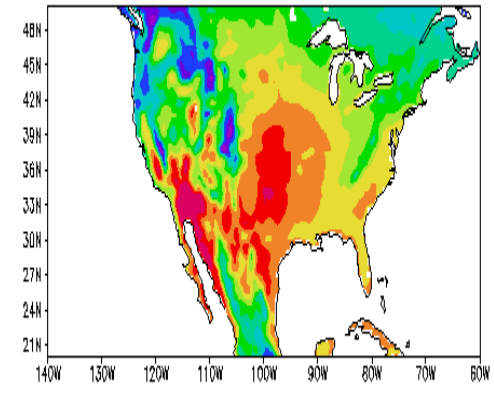
**NARR**

CFS 2000–2004 JJA T2m Model Climo (mD6–15)



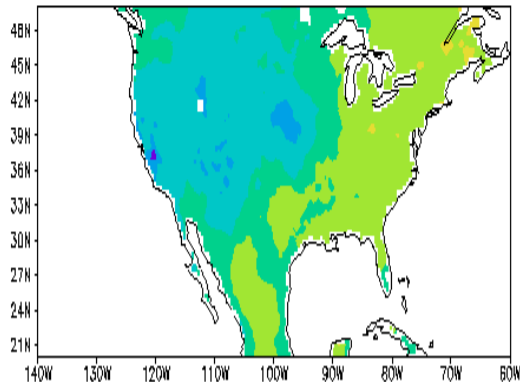
**CFS**

Eta RCM 00–04 Monthly Avgd JJA TMP2m Climo (10 Mem)

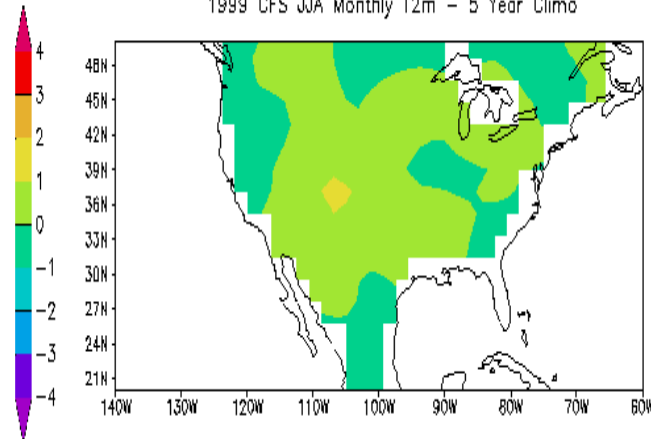


**Eta RCM**

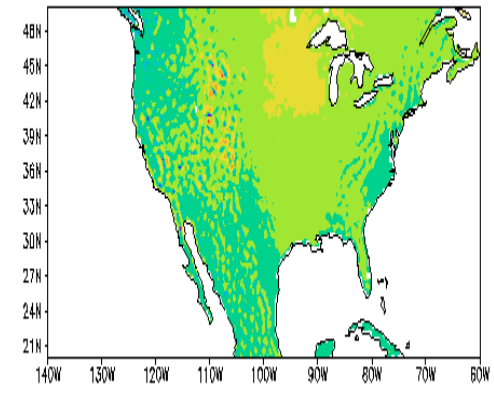
1999 TMP2m – 5 Year Climo



1999 CFS JJA Monthly T2m – 5 Year Climo



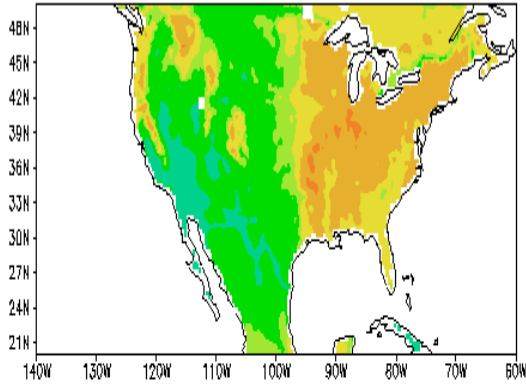
99 Eta RCM JJA Avgd Monthly TMP2m – 5 Year Climo



# JJA Monthly Mean Latent Heat

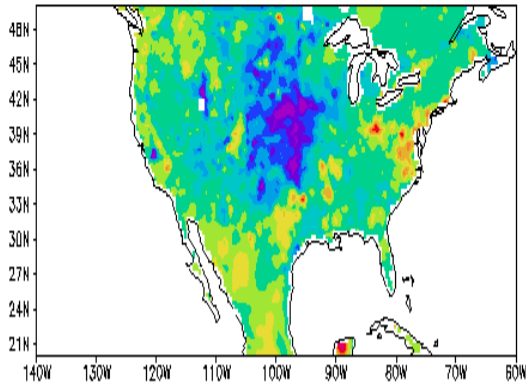
Top: Climo Bottom: 99-Climo

NARR 2000-2004 JJA LHTFL Climo

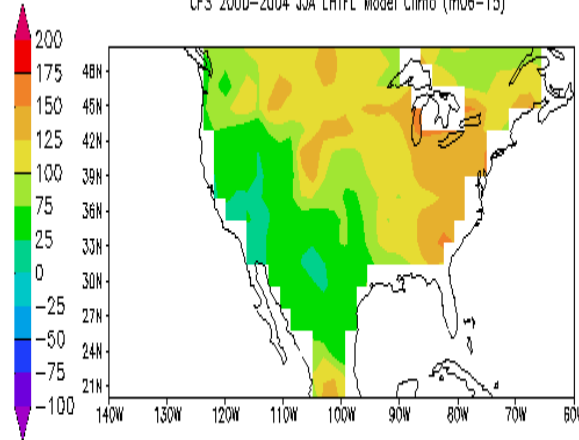


## NARR

1999 LHTFL - 5 Year Climo

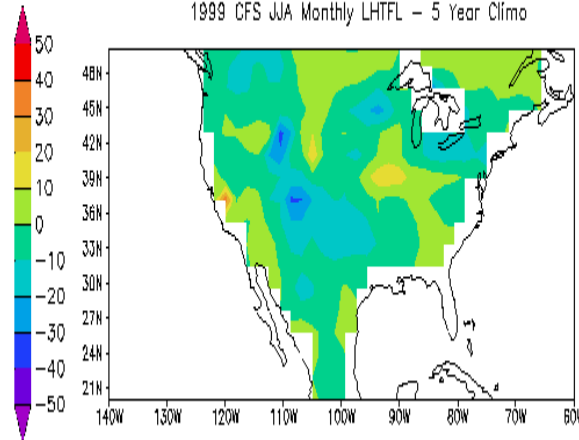


CFS 2000-2004 JJA LHTFL Model Climo (m06-15)

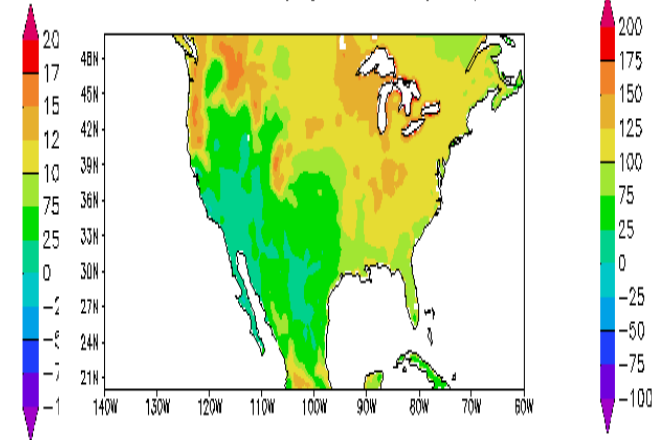


## CFS

1999 CFS JJA Monthly LHTFL - 5 Year Climo

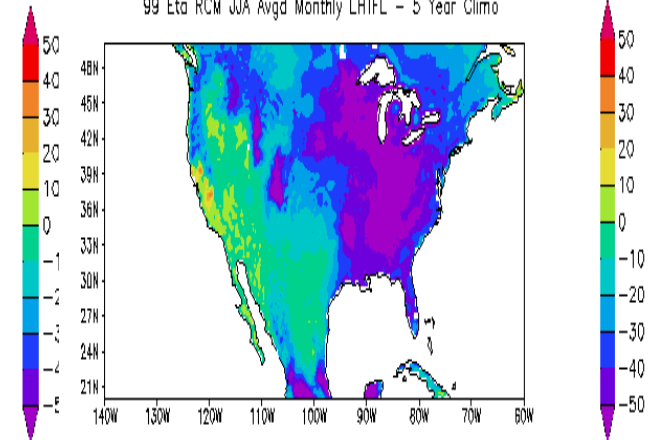


Eta RCM 00-04 Monthly Avgd JJA LHTFL Climo (10 Mem)



## Eta RCM

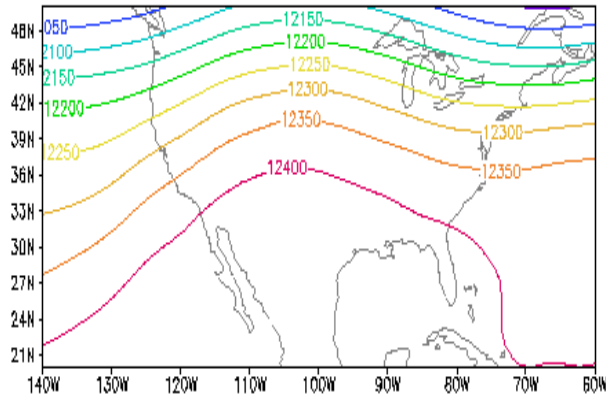
99 Eta RCM JJA Avgd Monthly LHTFL - 5 Year Climo



# JJA Monthly Mean 200mb GPH

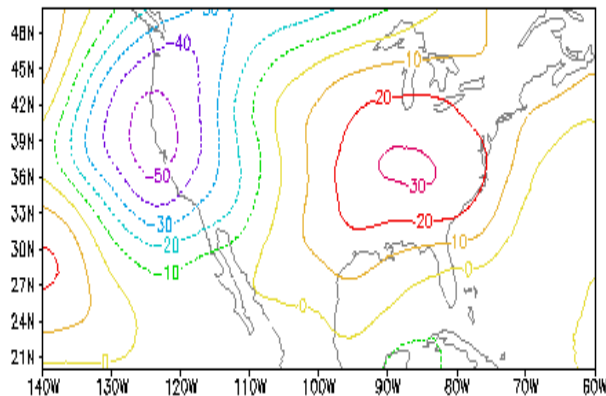
Top: Climo Bottom: 99-Climo

NARR 2000-2004 JJA 200H Climo

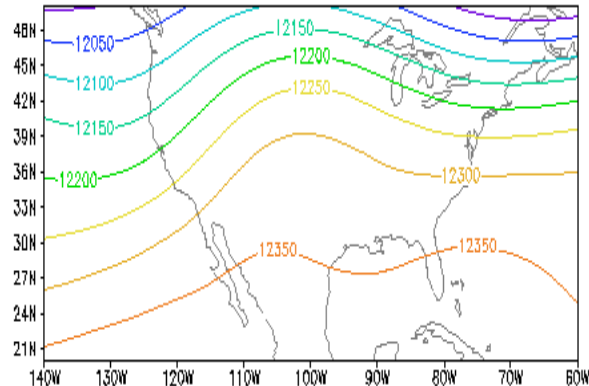


## NARR

1999 200H - 5 Year Climo

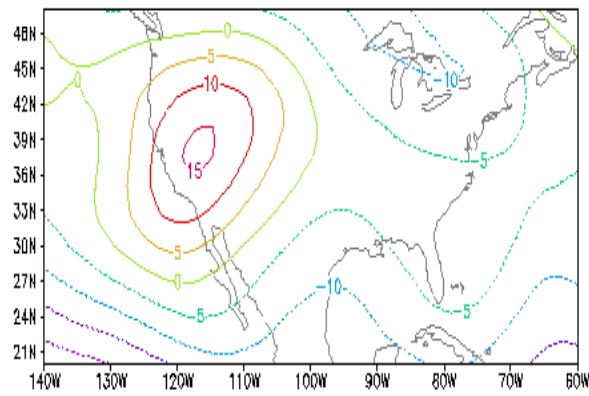


CFS 2000-2004 JJA 200H Model Climo (200h, m06-15)

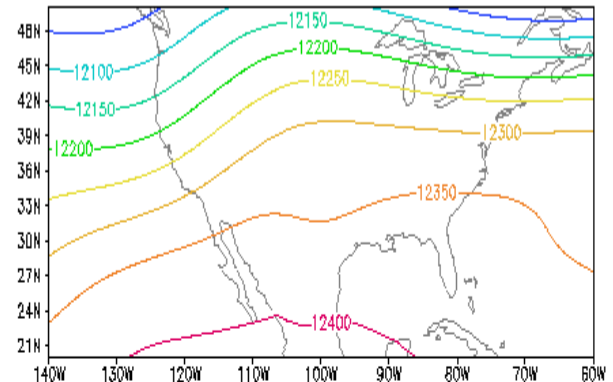


## CFS

1999 200H - 5 Year Climo

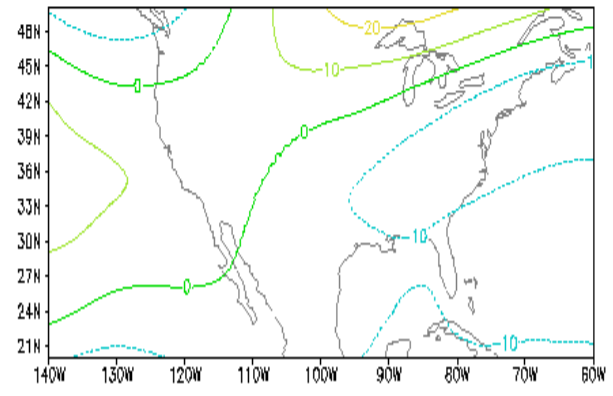


Eta RCM 00-04 Monthly Avgd JJA 200GPH Climo (10 Mem)



## Eta RCM

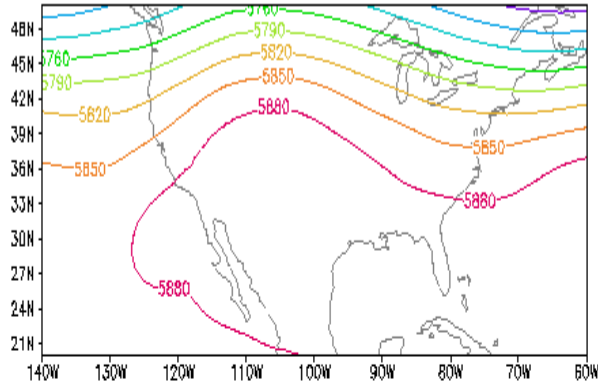
99 Eta RCM JJA Avgd Monthly 200GPH - 5 Year Climo



# JJA Monthly Mean 500mb GPH

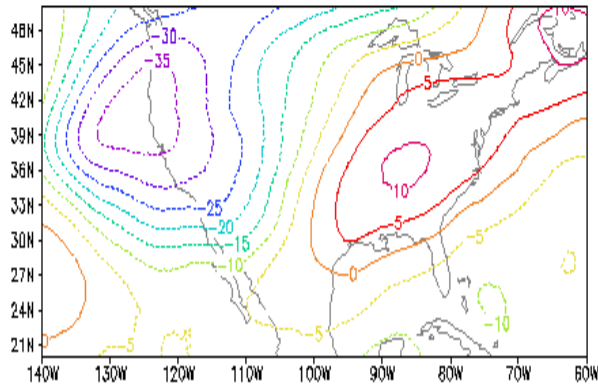
Top: Climo Bottom: 99-Climo

NARR 2000-2004 JJA 500H Climo

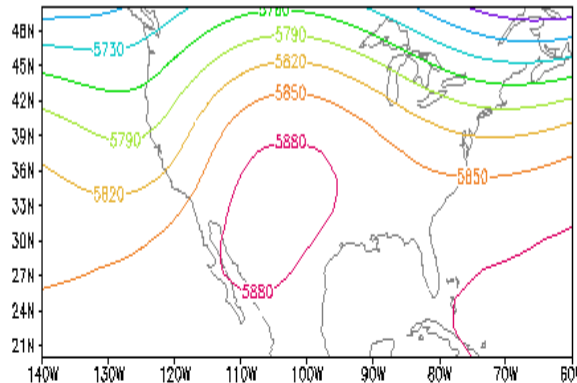


**NARR**

1999 500H - 5 Year Climo

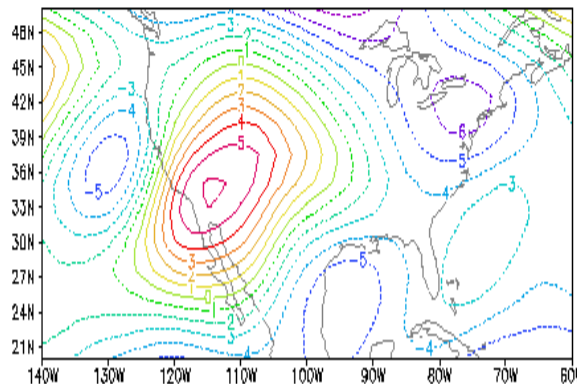


CFS 2000-2004 JJA 500H Model Climo (500h, m06-15)

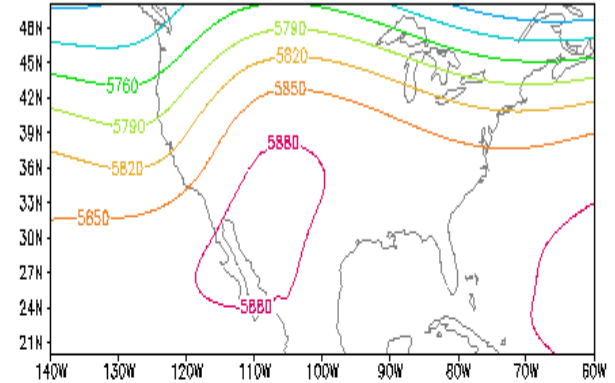


**CFS**

1999 500H - 5 Year Climo

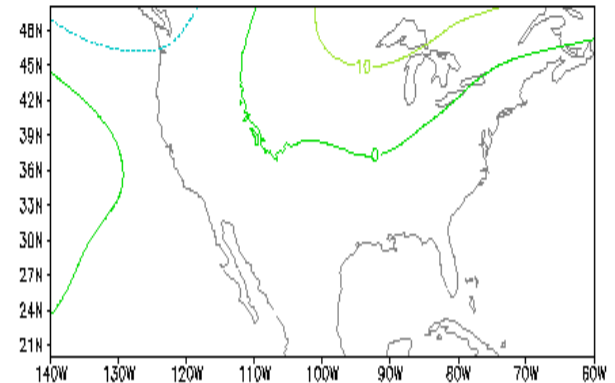


Eta RCM 00-04 Monthly Avgd JJA 500GPH Climo (10 Mem)



**Eta RCM**

99 Eta RCM JJA Avgd Monthly 500GPH - 5 Year Climo



## Winter 1983 Case

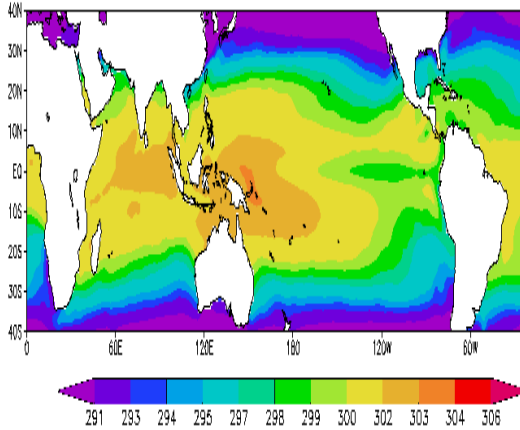
(a strong ENSO event)

- Observed and Predicted anomalies:
  - SST (prediction by CFS only)
  - Precipitation
  - 2-m Temperature (near surface)
  - 200 hPa Height fields

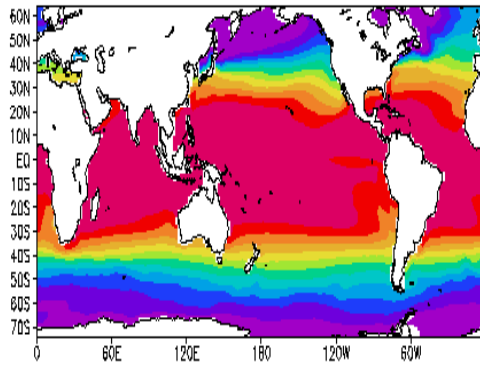
# SST Climo & anomaly for Winter 1983 ENSO Event

Left: Obs Mid: Cpl Right: Diff

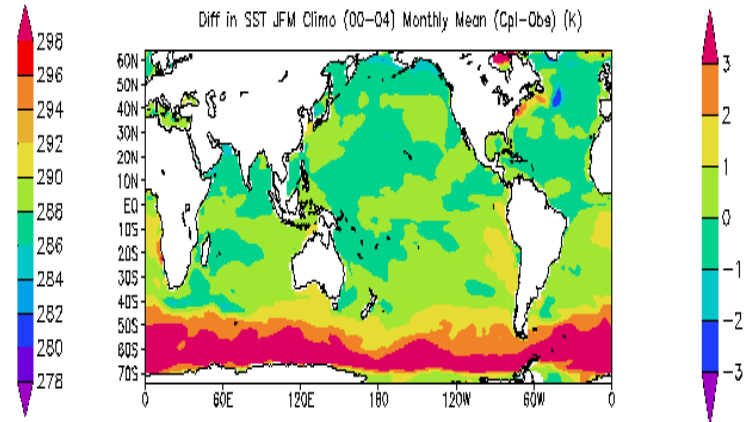
2000-2004 Reynolds SST JFM Tropical Monthly Mean



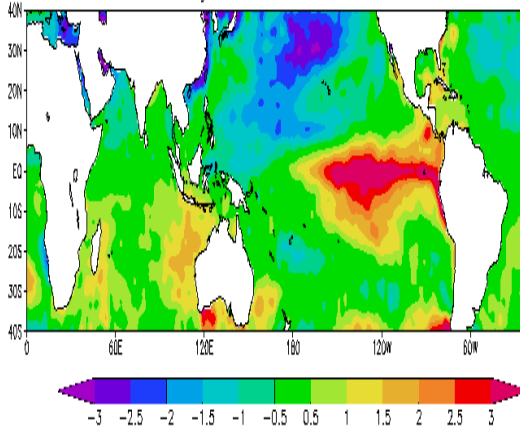
2000-2004 Coupled SST JFM Monthly Mean (K)



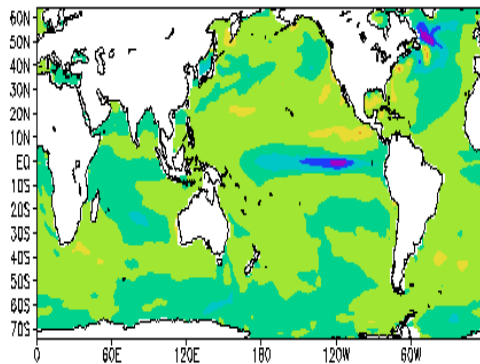
Diff in SST JFM Climo (00-04) Monthly Mean (Cpl-Obs) (K)



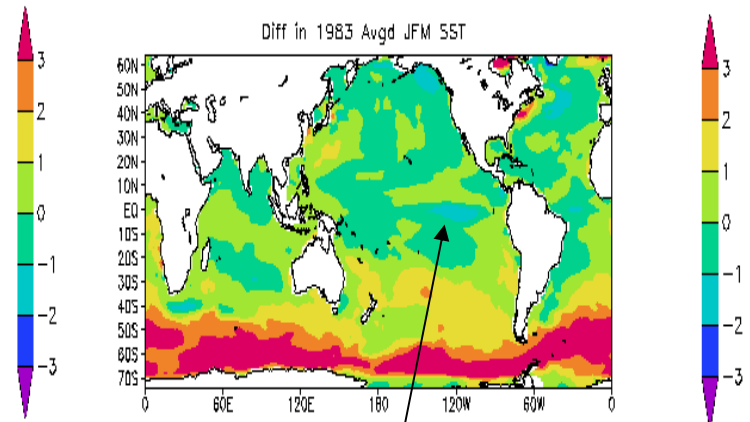
1983 Avgd JFM - 5 Year Climo



1983 Avgd JFM - 5 Year Climo



Diff in 1983 Avgd JFM SST



Caution:

Both of these panels are derived only from 7 of the 15 members of the CFS and only from 5-year rather than 25-year CFS climo.

CFS predicted eastern tropical Pacific anomaly is not warm enough.

# Winter 1983 JFM

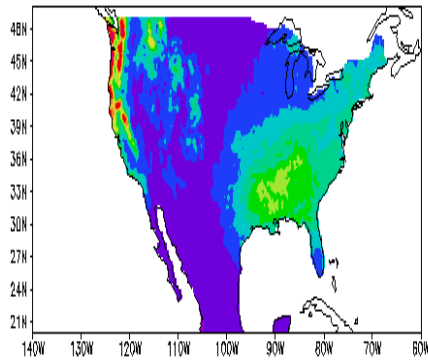
- Precipitation
- Air temperature (2-m)
- 200 hPa height
- 500 hPa height

Observed, CFS, Eta RCM

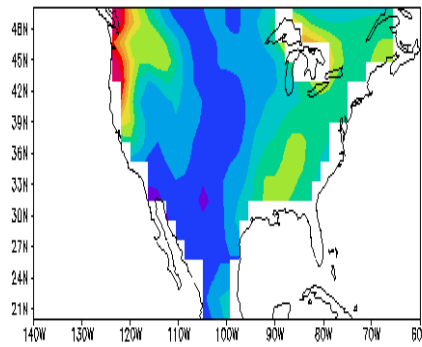
# JFM Monthly Mean Precip

Top: Climo Bottom: 83-Climo

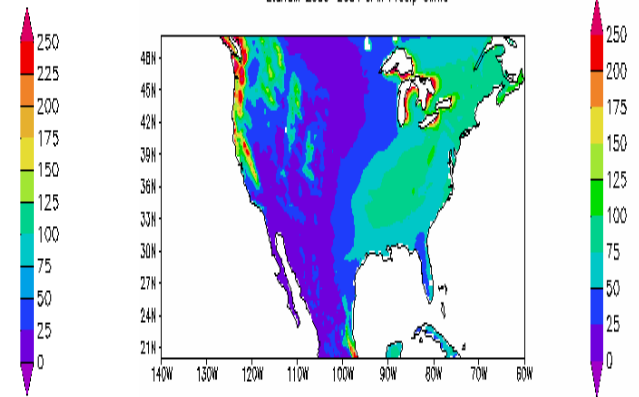
2000-2004 CPC Avgd JFM Monthly Precip



CFS 2000-2004 Model JFM Precip Climo (prate to monthly, m06-12)

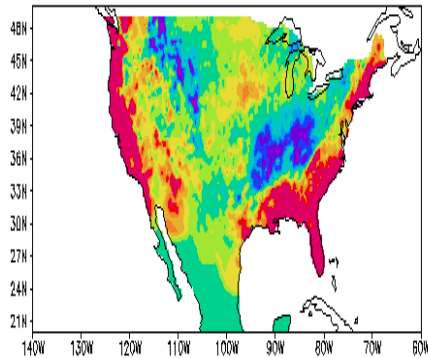


EtaRCM 2000-2004 JFM Precip Climo



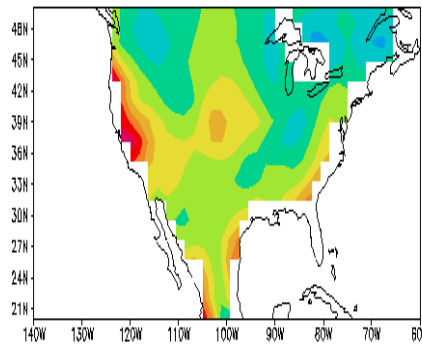
## Obs

1983 Avgd JFM - 5 Year Climo



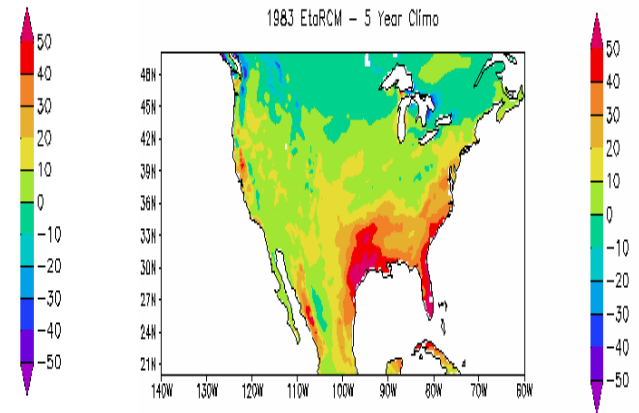
## CFS

83 Avg JFM Precip - 5 Yrs Climo



## Eta RCM

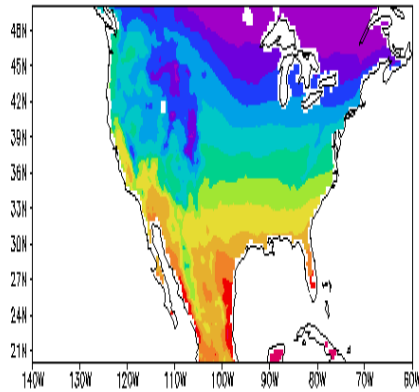
1983 EtaRCM - 5 Year Climo



# JFM Monthly Mean T2m

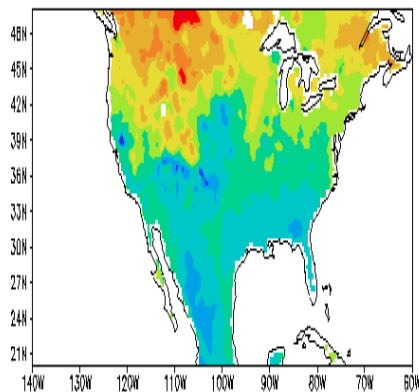
Top: Climo Bottom: 83-Climo

JFM NARR TMP2m CLIMO (00-04)

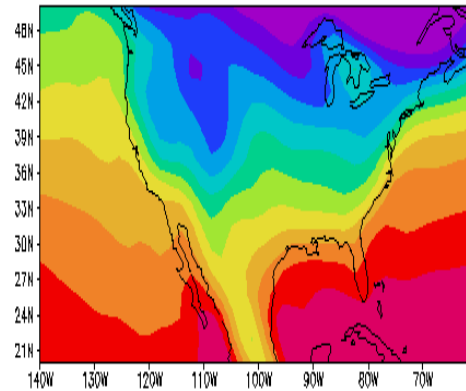


**NARR**

1983 - CLIMO JFM TMP2m

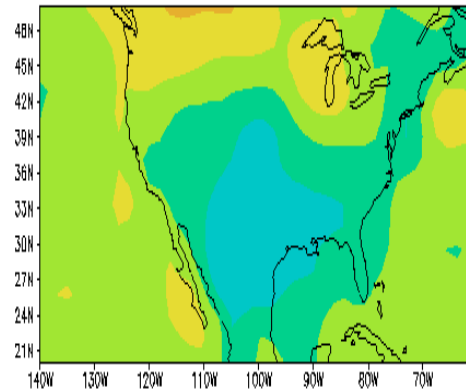


CFS 2000-2004 Model JFM TMP2m Climo (prate to monthly, m06-15)

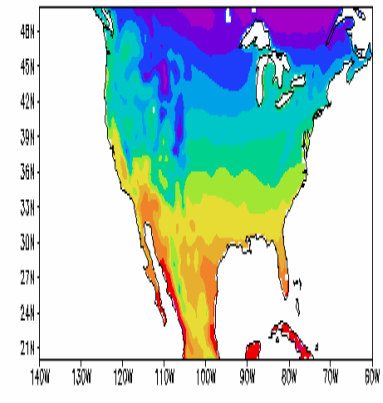


**CFS**

83 Avg JFM TMP2m - 5 Yrs Climo

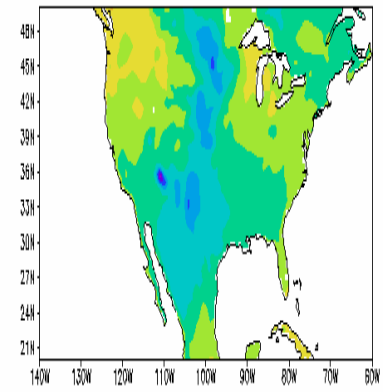


EtaRCM 2000-2004 JFM TMP2m Climo



**Eta RCM**

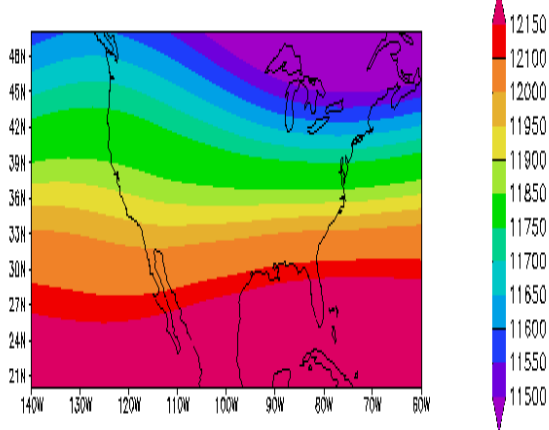
1983 EtaRCM - 5 Year Climo



# JFM Monthly Mean 200mb GPH

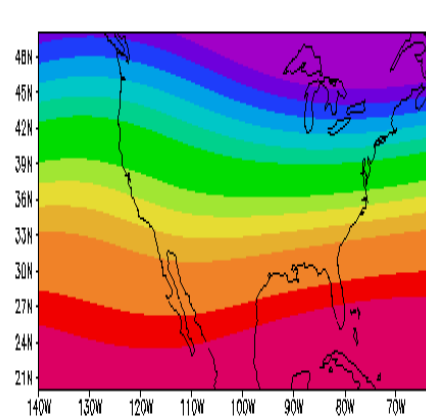
Top: Climo Bottom: 83-Climo

GR2 2000-2004 JFM 200 MB GPH Climo



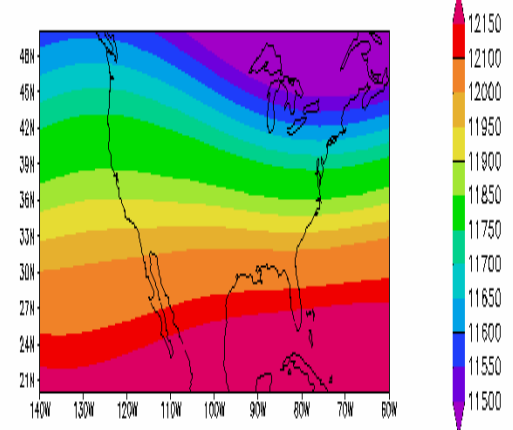
GR2

CFS 2000-2004 Model JFM 200 MB GPH Climo (prate to monthly, mDE)



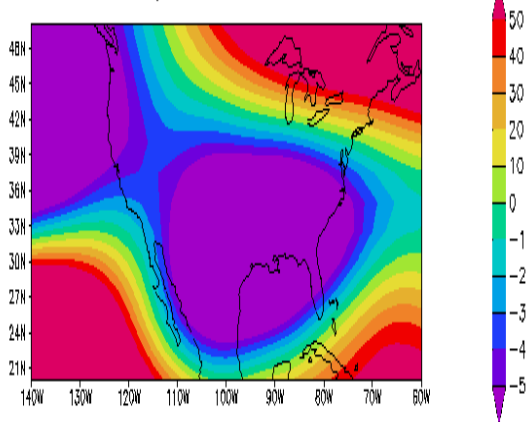
CFS

EtaRCM 2000-2004 JFM 200 MB GPH Climo

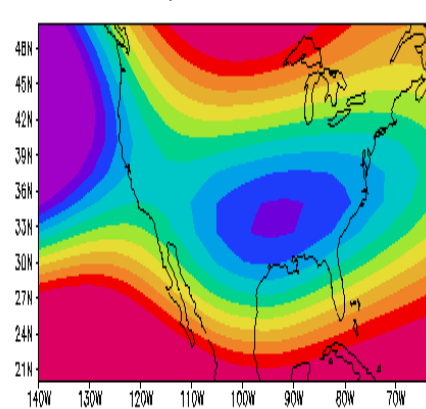


Eta RCM

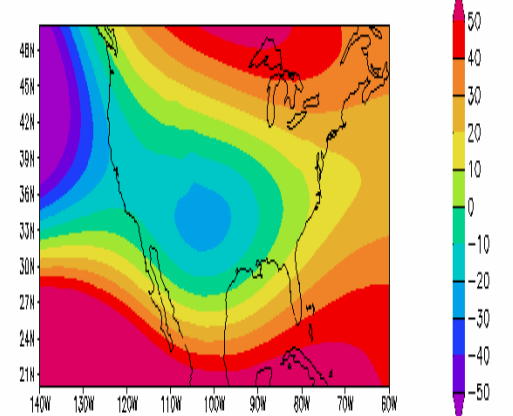
83 Avg JFM 200 MB GPH - 5 Yrs Climo



83 Avg JFM 200 MB GPH - 5 Yrs Climo



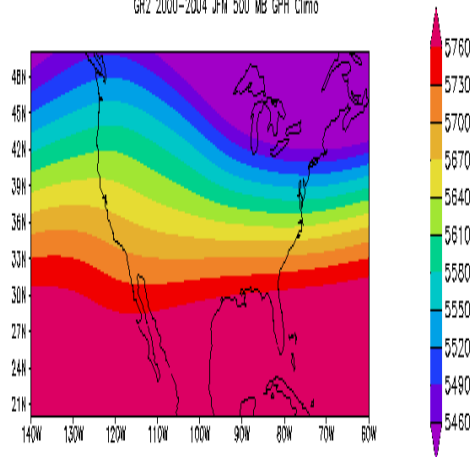
1983 EtaRCM - 5 Year Climo



# JFM Monthly Mean 500mb GPH

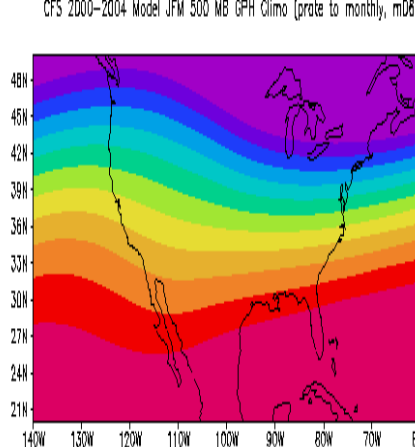
Top: Climo Bottom: 83-Climo

GR2 2000-2004 JFM 500 MB GPH Climo



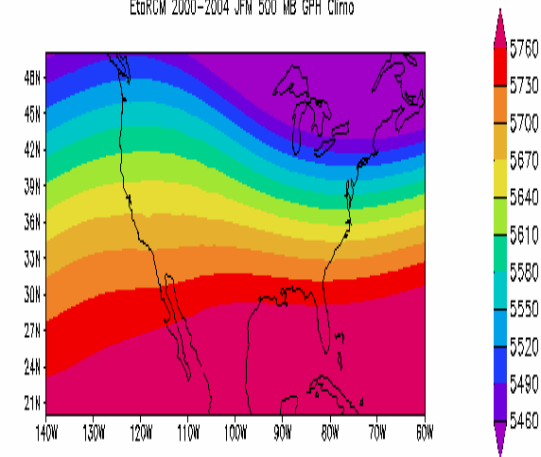
GR2

CFS 2000-2004 Model JFM 500 MB GPH Climo (prate to monthly, mD8-



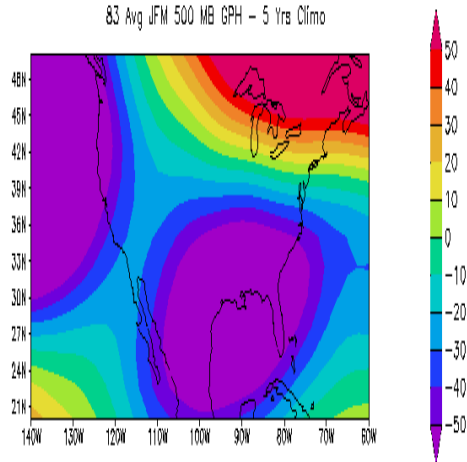
CFS

EtaRCM 2000-2004 JFM 500 MB GPH Climo

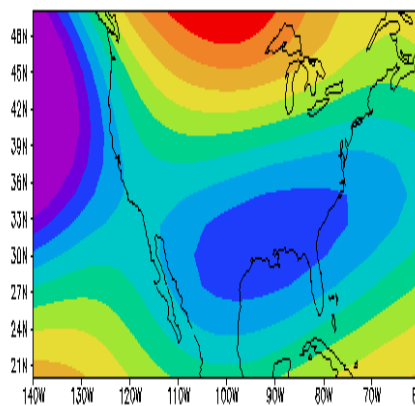


Eta RCM

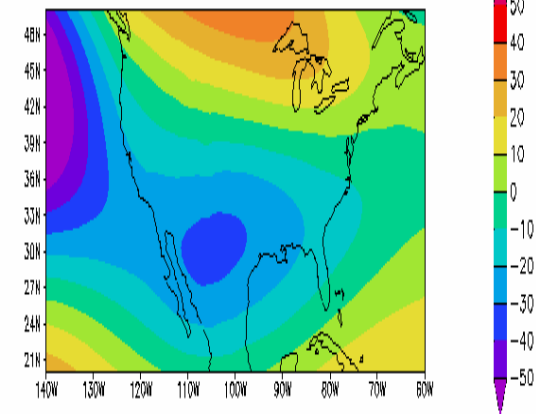
83 Avg JFM 500 MB GPH - 5 Yrs Climo



83 Avg JFM 500 MB GPH - 5 Yrs Climo



1983 EtaRCM - 5 Year Climo



## Conclusions

- CFS and Eta RCM show some skill in winter ENSO Event
  - Eta shows more promise than CFS in southeast U.S. but not southwest U.S.
- Neither CFS nor Eta RCM show skill in the 1999 enhanced U.S. Monsoon event
- We have demonstrated the testing protocol that NCEP desires of the external research community for demonstrating RCM prediction capabilities
  - Establish an RCM hindcast climatology

## Future Experiments

- Force the Eta RCM with bias corrected CFS SST
- Higher Resolution CFS (T126 vs T62) to drive Eta RCM

Thank you !