# REGIONAL CLIMATE AND VARIABILITY OF THE SUMMERTIME CONTINENTAL UNITED STATES IN REANALYSES

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# Motivation

- Global reanalyses assimilate many observations, and the state fields can depict well the associated large scale circulation and weather variations
- The background model produces many fields that are not observed regularly, if at all
- How well are precipitation and temperature interannual variations represented in sub-continental regions?
  - **Focus on U.S. summer**, when there are concerns on extremes and when forecasts are most difficult

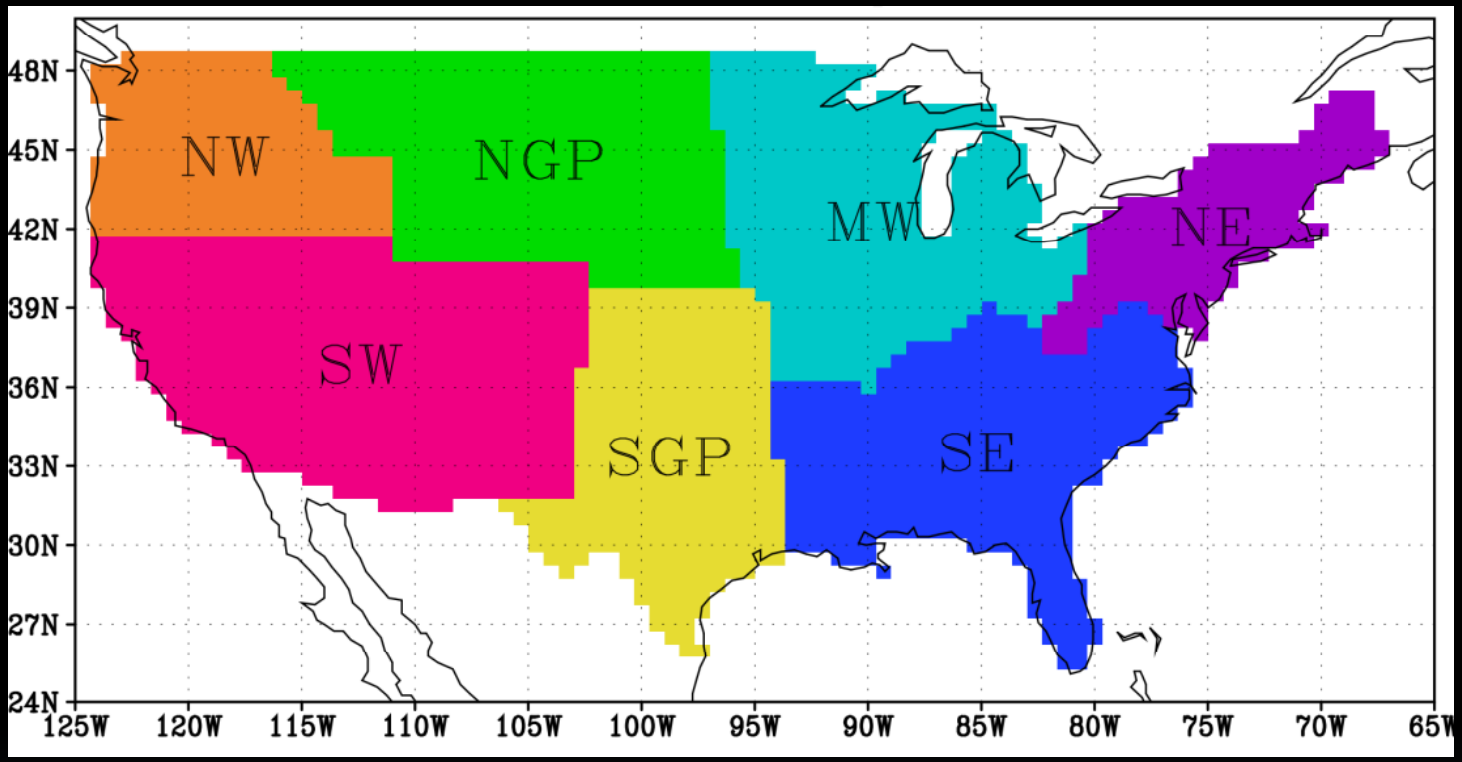
# Modern-Era Retrospective analysis for Research and Applications (MERRA)

- 1979-Present (will not continue, depending on remotely sensed observations)
- ½° lat x ⅔° lon, 42 pressure levels (derived from 72 terrain following model levels)
- 1 hourly Surface/2D fields, 3 and 6 hourly 3D fields; over 300 variables
- NCEP GSI analysis (~2008)
- GEOS5 GCM (~2008)
- New offline land and ocean reprocessing products
- Gridded Innovations and Observations (GIO)

# Additional Data

- NCEP CFSR (Saha et al. 2010)
  - Includes obs precipitation forcing in land analysis cycle
- ERA Interim (Dee et al. 2011)
  - Includes surface meteorology data assimilation
- CPC Gauge Analysis (Chen et al. 2008)
- CRU 3.1 Surface Temperature (Mitchell and Jones, 2005)

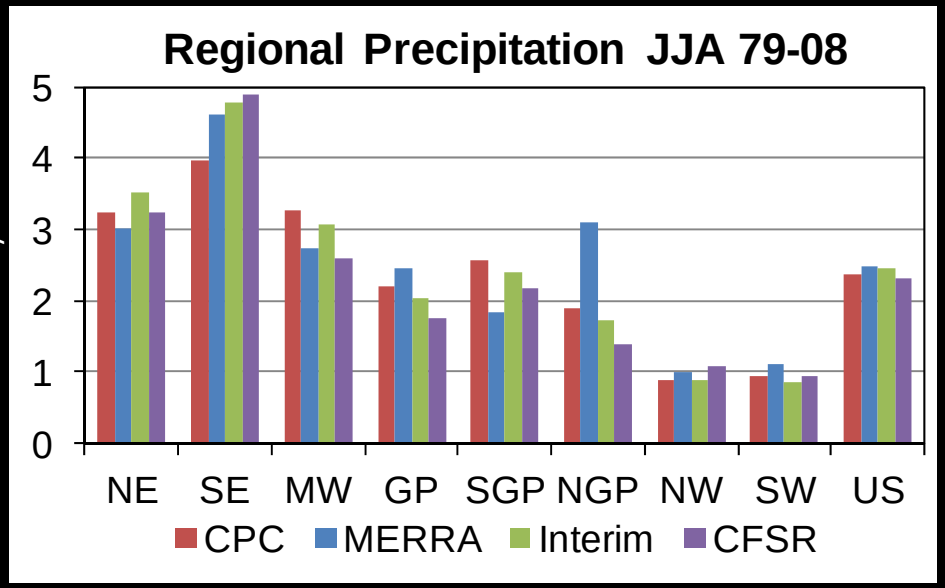
# Regions



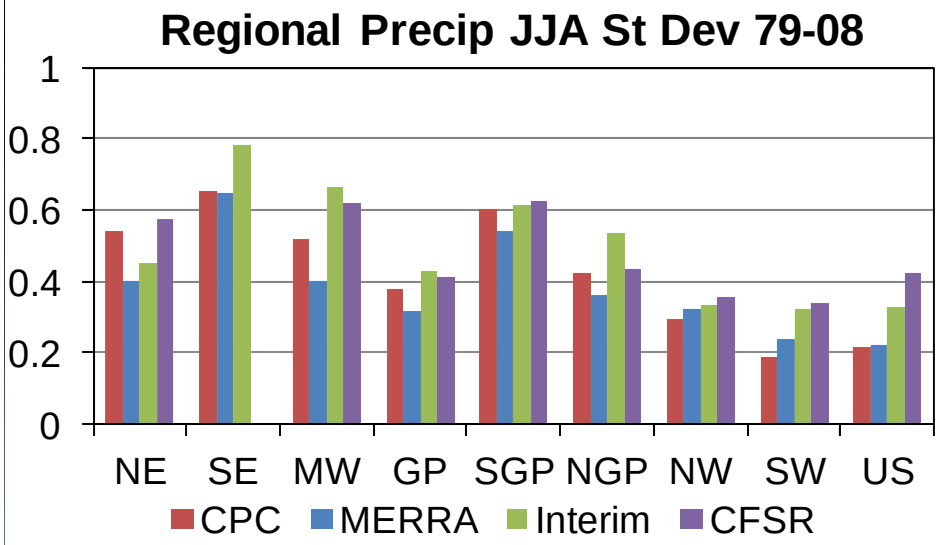

- Regions track those defined For the USGCRP National Climate Assessment

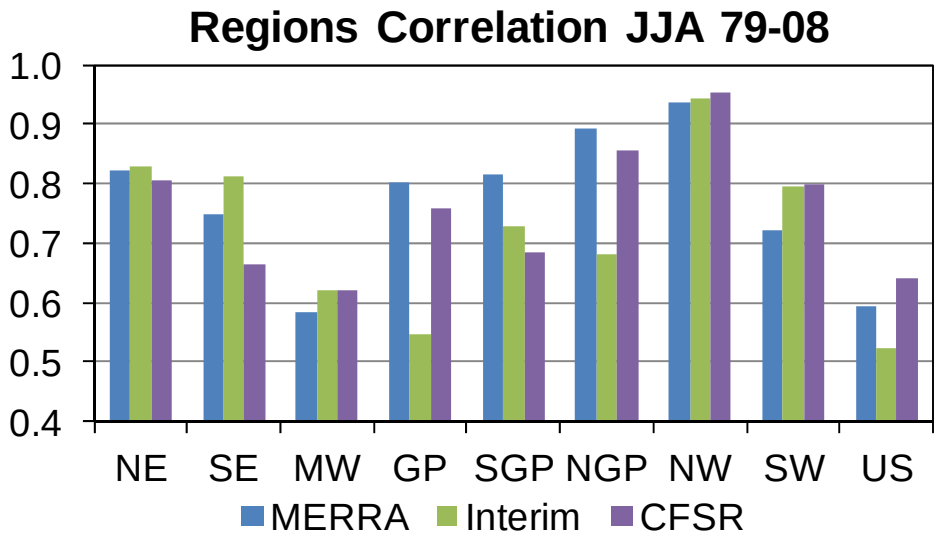
- A first order approximation
- Not optimal for some regional climate features
- Many results are also reflected in basin scale evaluation (e.g. Mississippi River)

# Summer Seasonal Precipitation

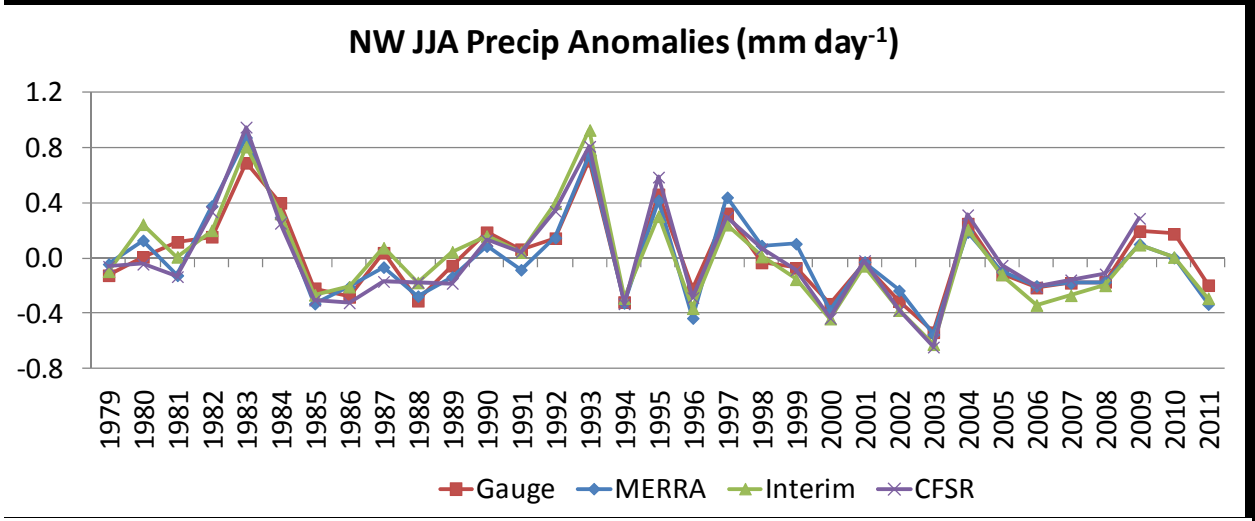


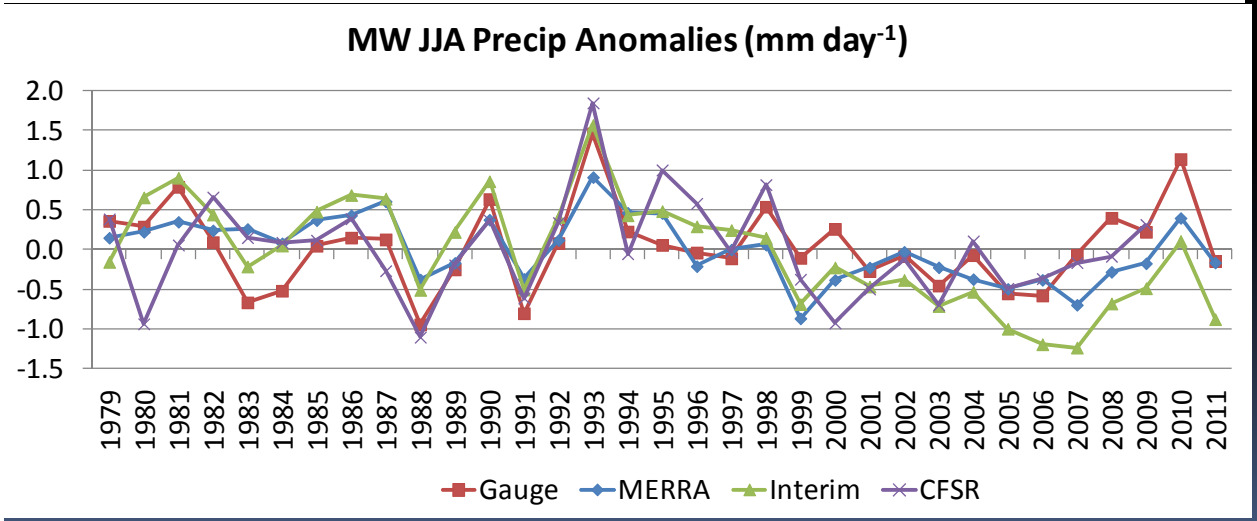

- For MERRA
  - dry southern plains, wet northern
  - Correlations are high or comparable
  - St Dev lean low, esp MW



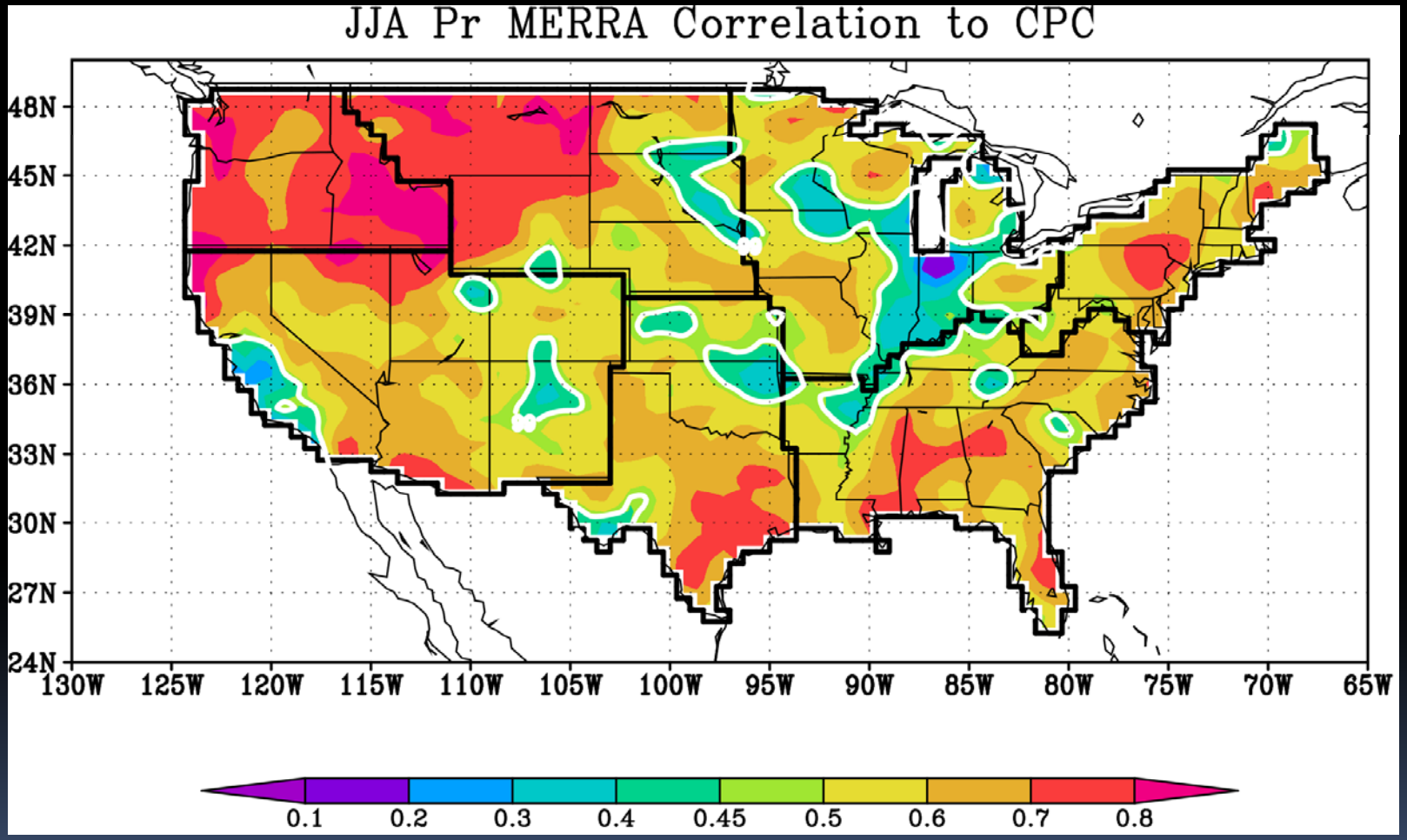
# Regional Precipitation



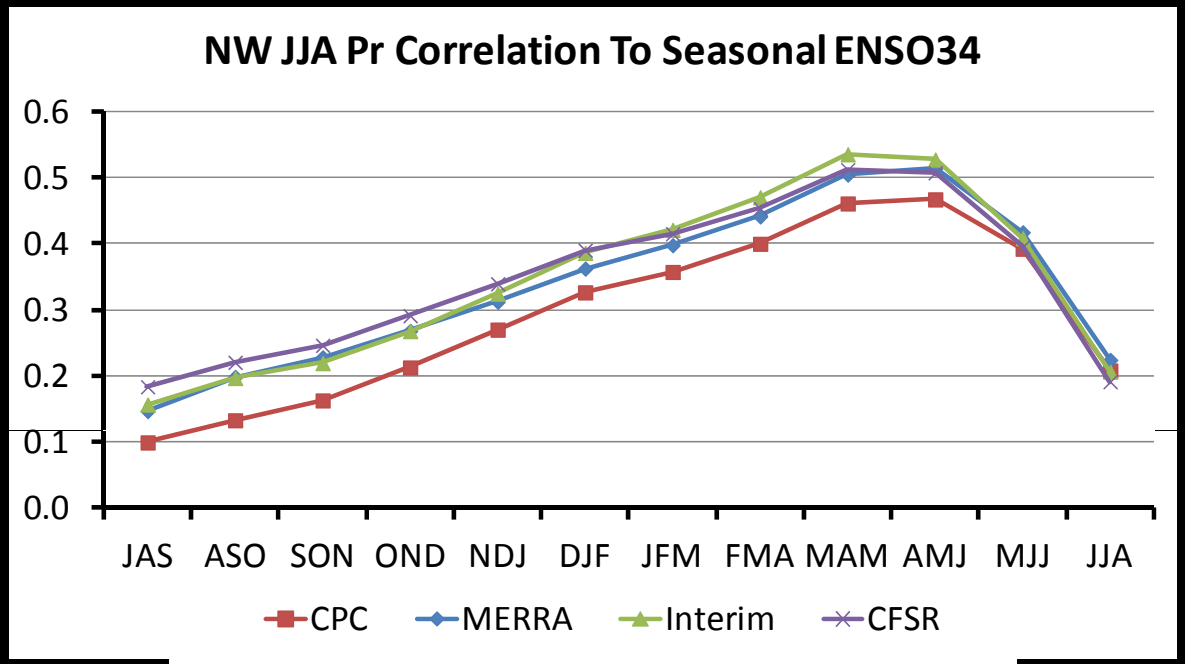

- All reanalyses agree well in NW
- In MW
  - MERRA underestimates anomaly magnitude
  - CFSR completely misses some anomalies
  - Interim has a persistent trend

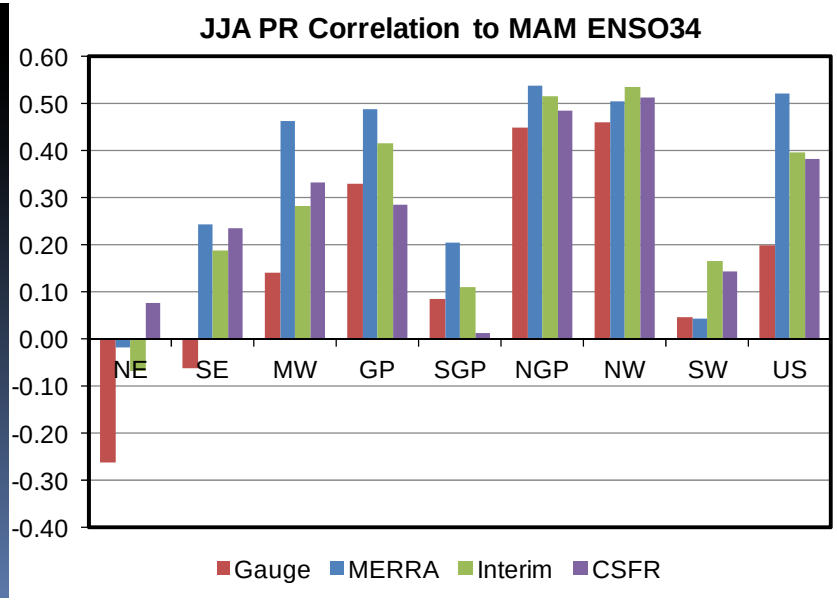
# MERRA – Gauge Correlation




- Barlow et al show some correlation of NW precipitation to ENSO

# ENSO Connection

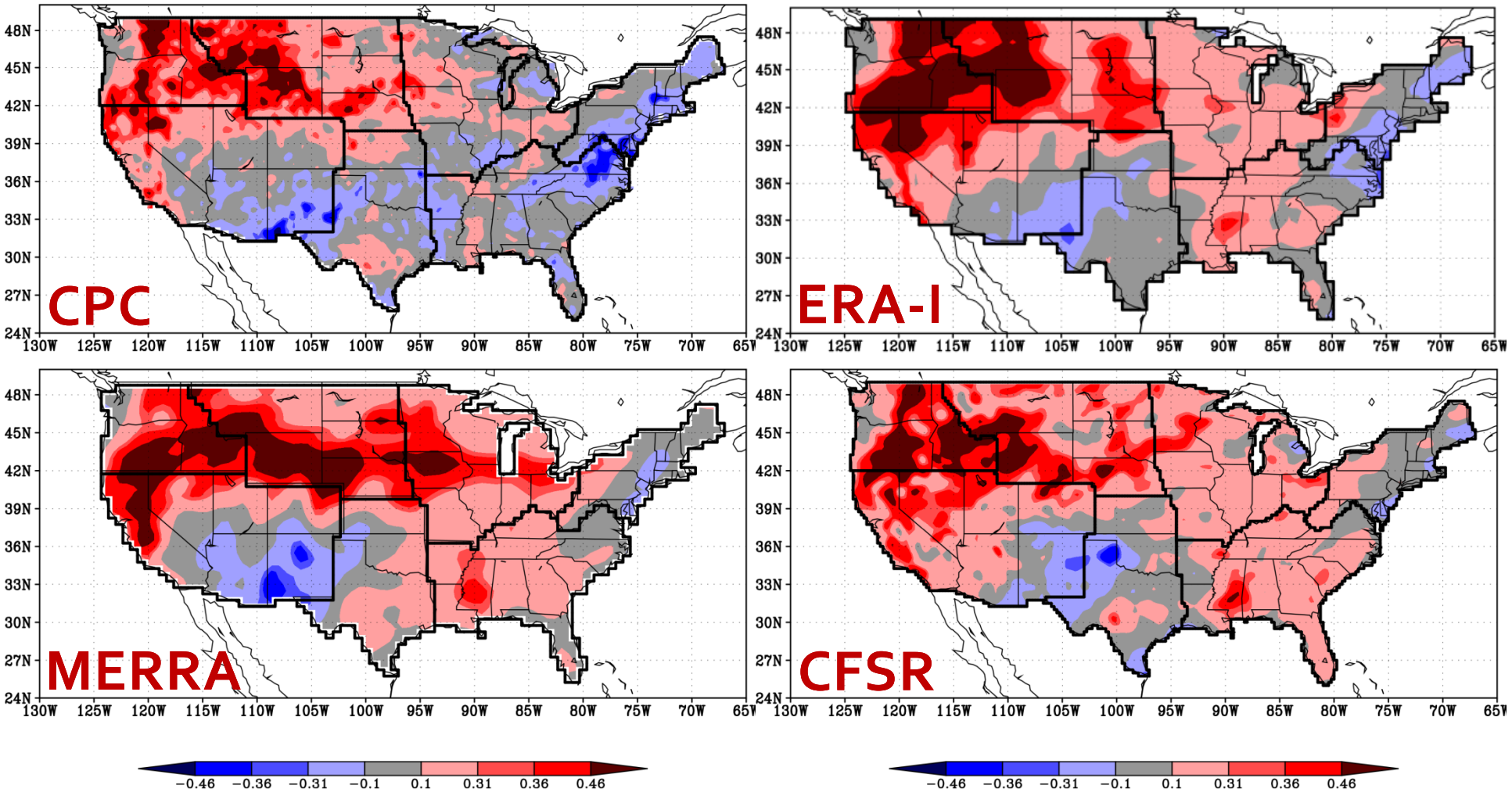


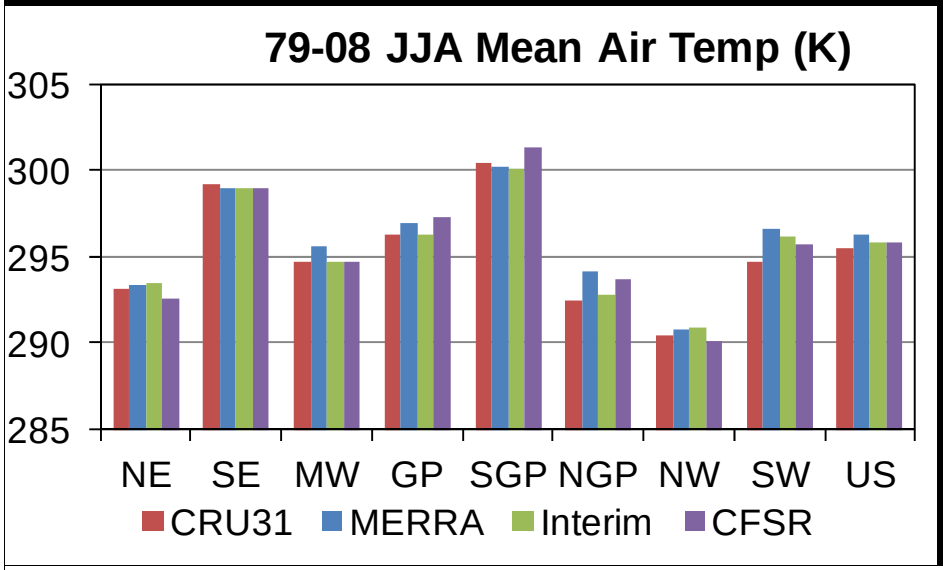

- In NW, reanalyses track CPC gauge obs with higher correlation to ENSO in MAM
- In MERRA, this correlation seems more wide spread than it should be

# ENSO Connection

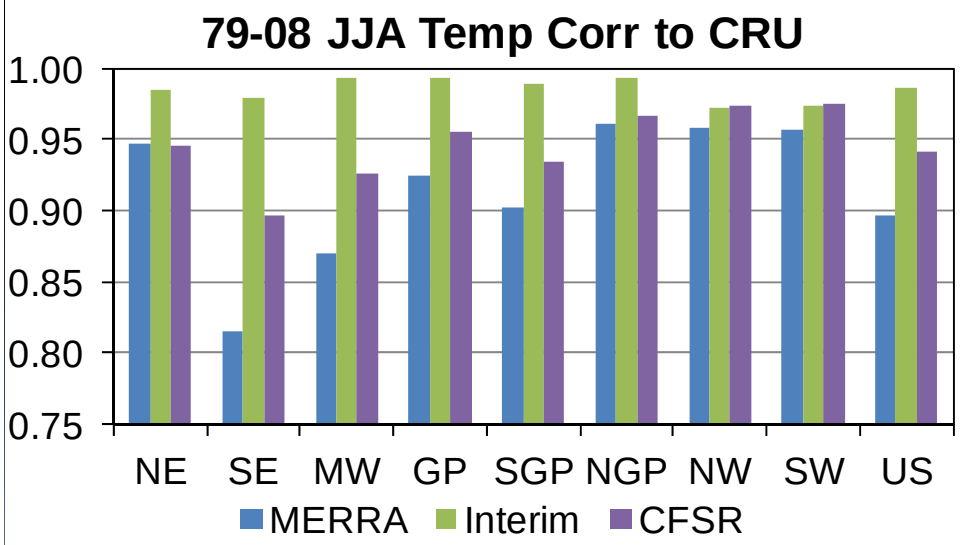
## JJA Precipitation Correlation with MAM Niño34

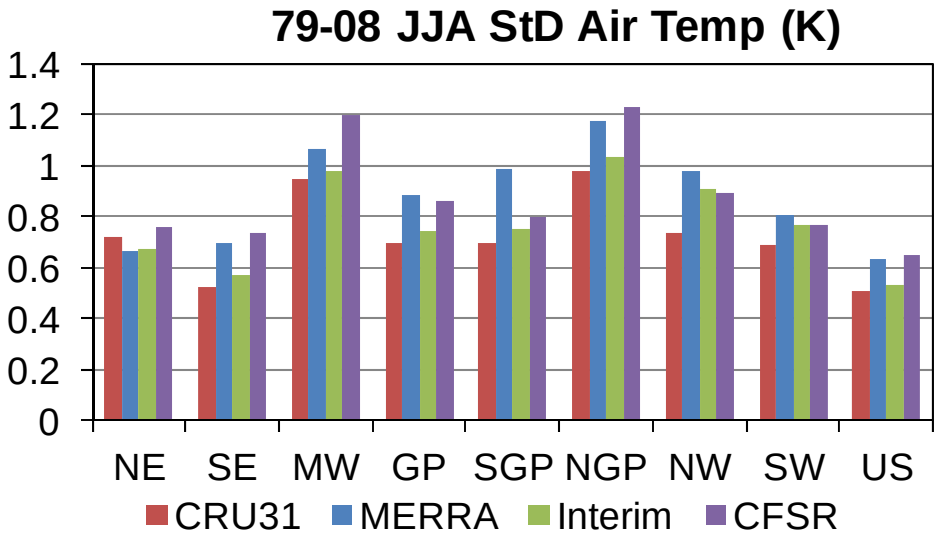


# Summer Seasonal Temperature

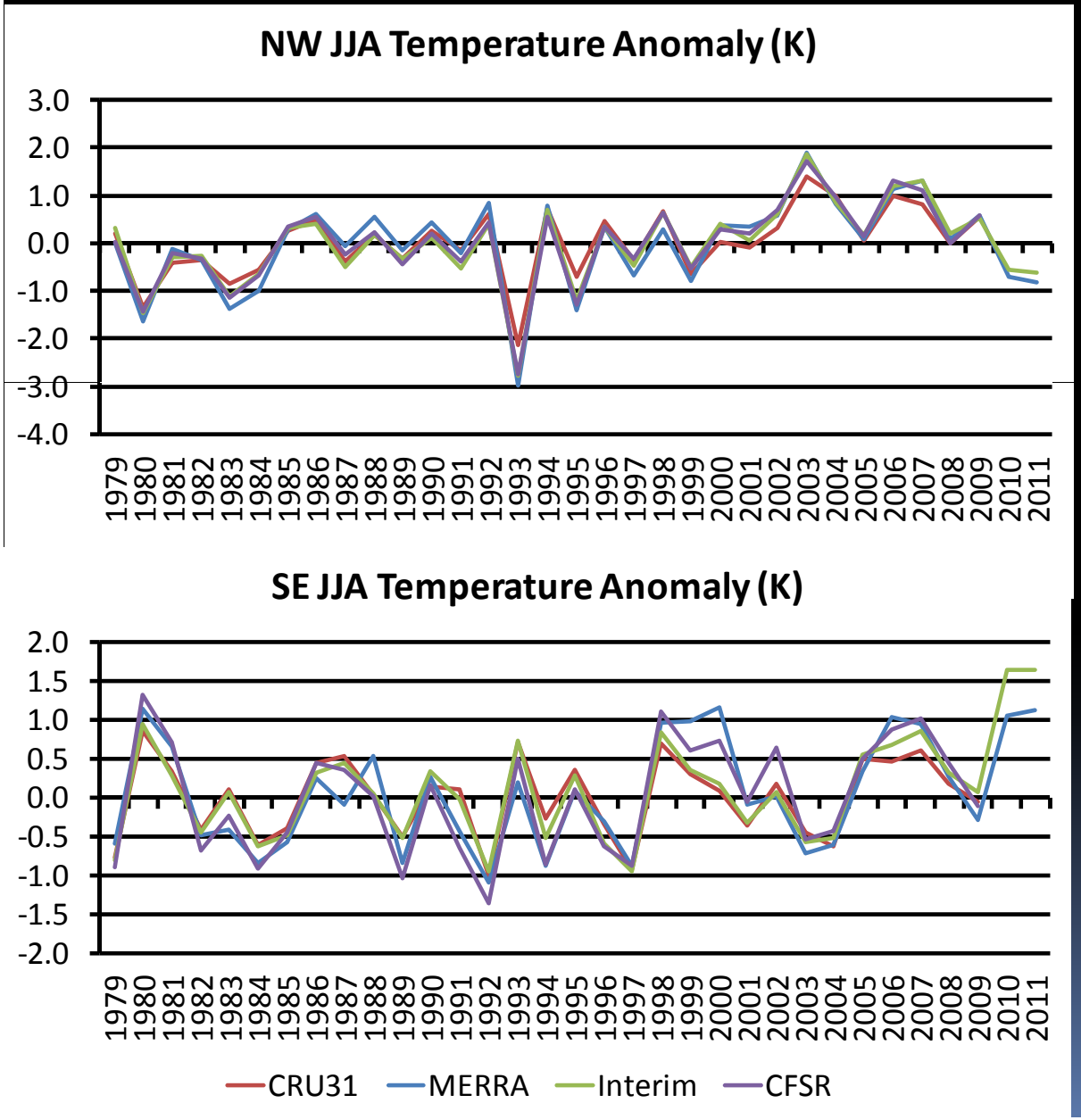



- MERRA Biases lean warm
- Interim has consistent high seasonal correlations



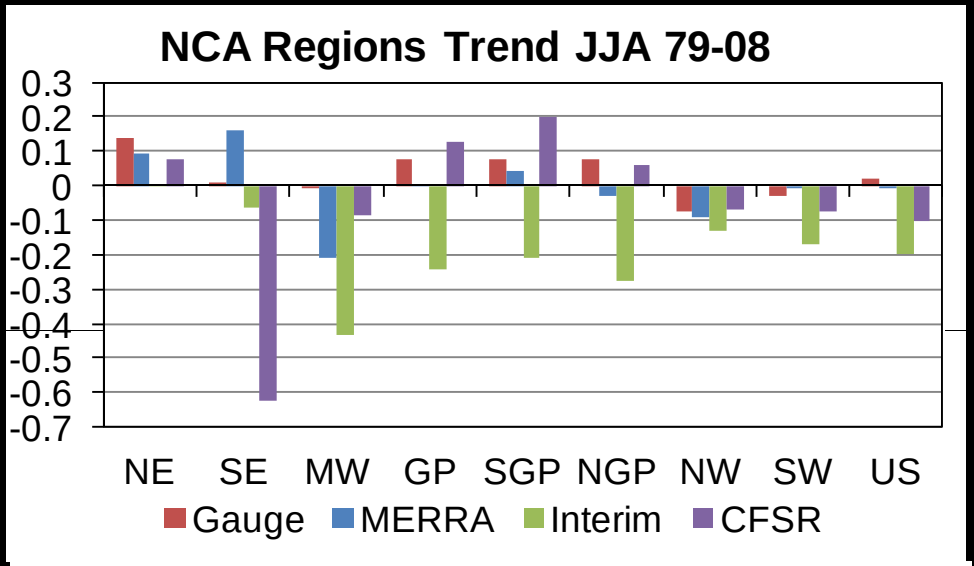



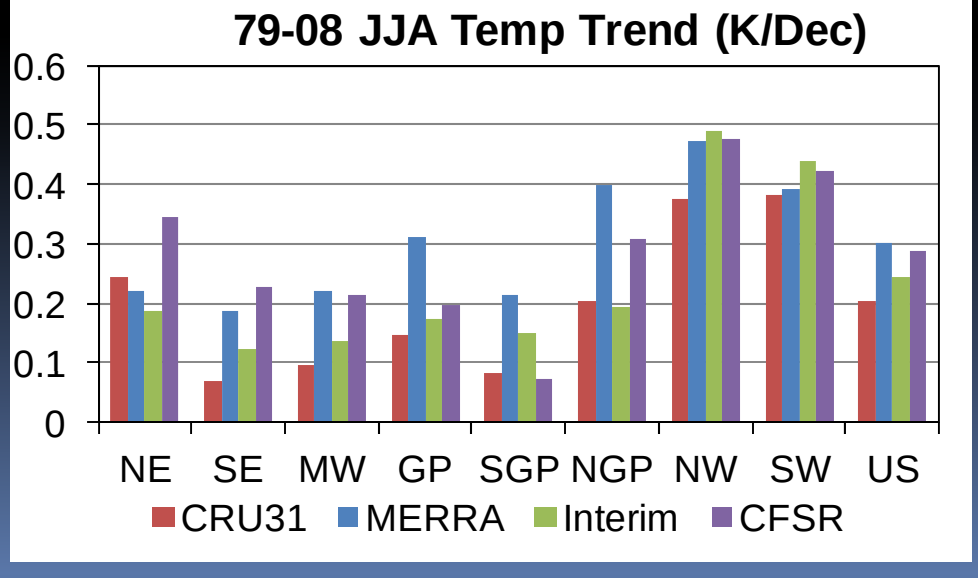
# Regional Temperature




- NW – reanalyses track data about the same
- SE – MERRA lowest corr, realistic with some clear deficient seasons

# Summer P and T Trends




- SE Pr – NCEP discontinuity in 1998
- EC Pr – Systematic decreasing trend over much of US
- T – All have warming trends (MERRA largest)
- Obs – new corrections may increase trends (Vose et al 2012)

# Summary

- MW weakness in precip variability seems a good target to learn about the system
- Is the strong ENSO a feature of global reanalysis, or perhaps a weakness in the ability to generate local feedback or circulations?
- EC surface station analysis has clear benefit for the near surface state representation (what about fluxes?)
  - Developing satellite surface temperature assimilation for GMAO systems

# MERRA Gridded Innovations and Observations

- Grids the observations and forecast error (innovations) data output from the data assimilation
- May link forecast error to physicals processes and their errors to improve models
- Here, identifies regions of high forecast error