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

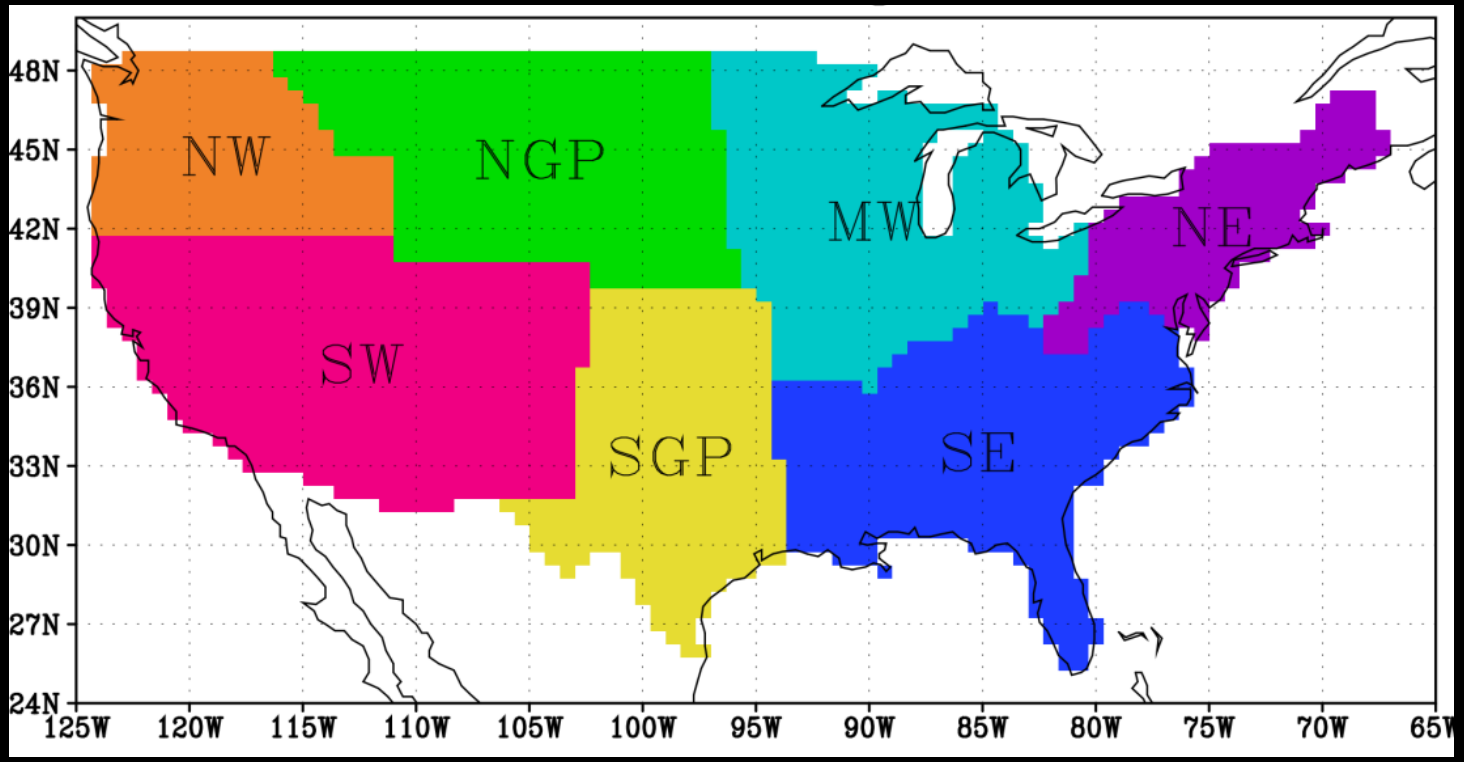
Modern-Era Retrospective analysis for Research and Applications (MERRA)

- 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)

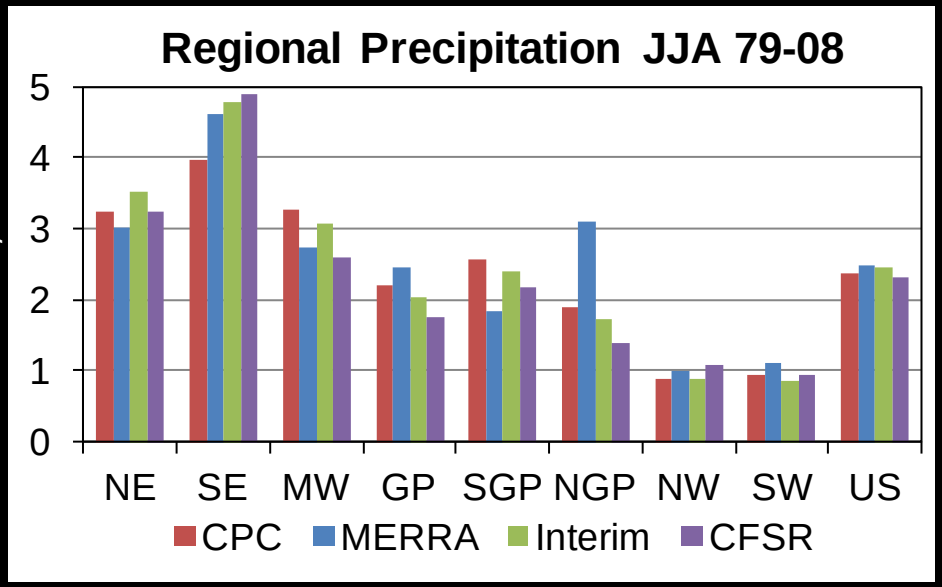
Regions



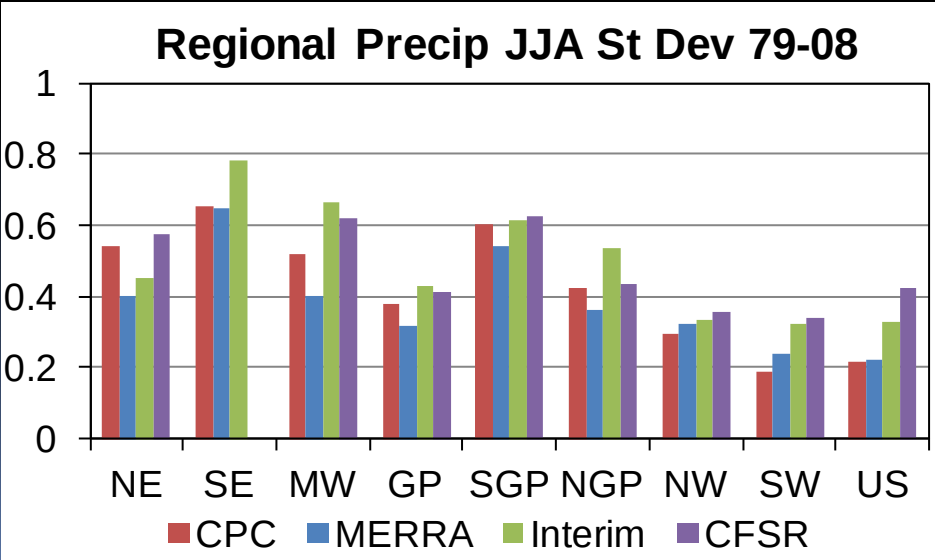
- Regions track those defined For the USGCRP National Climate Assessment

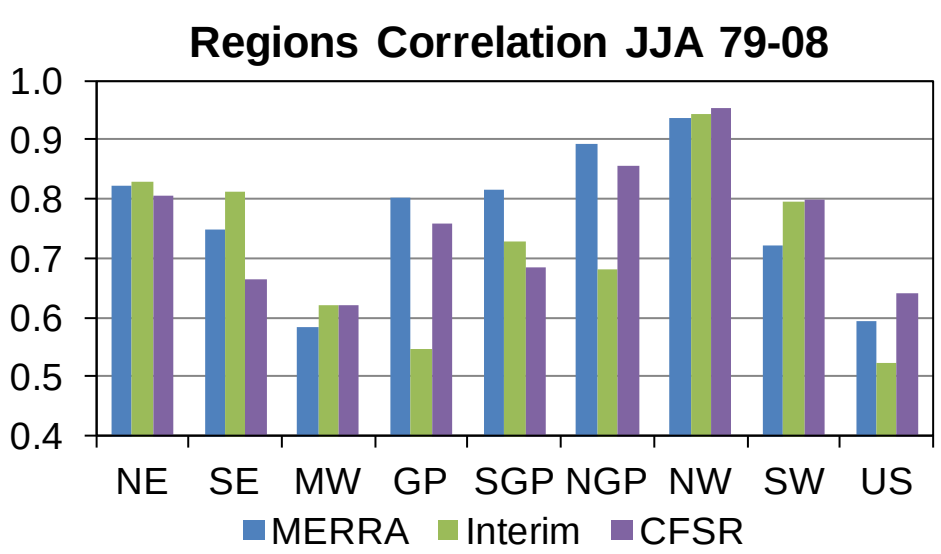
- A first order approximation
- Not optimal for some regional climate features
- Many results are also reflected in basin scale evaluation (e.g. Mississippi River)

Summer Seasonal Precipitation

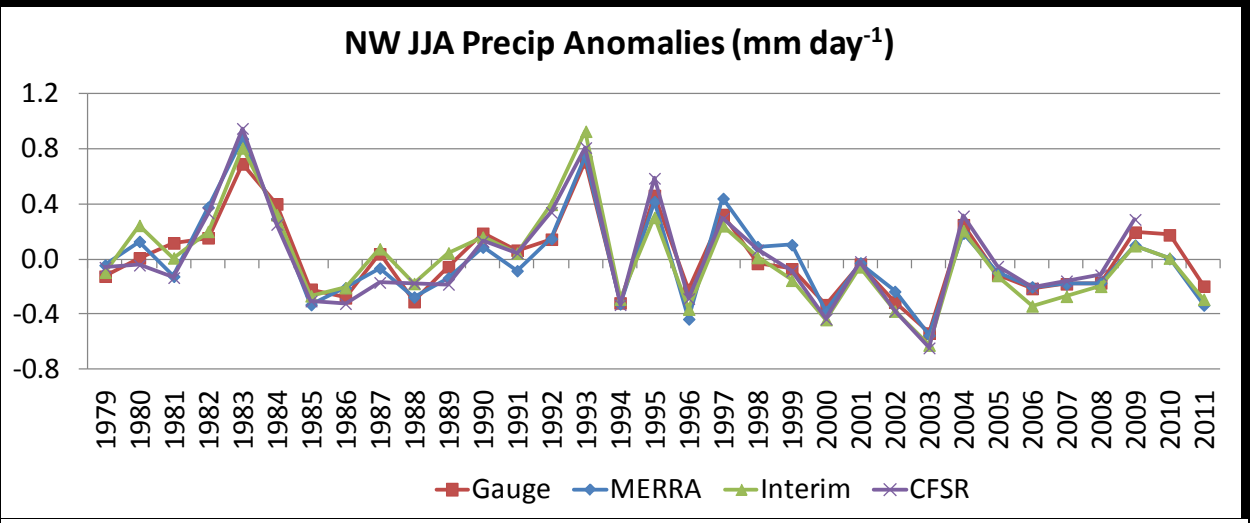


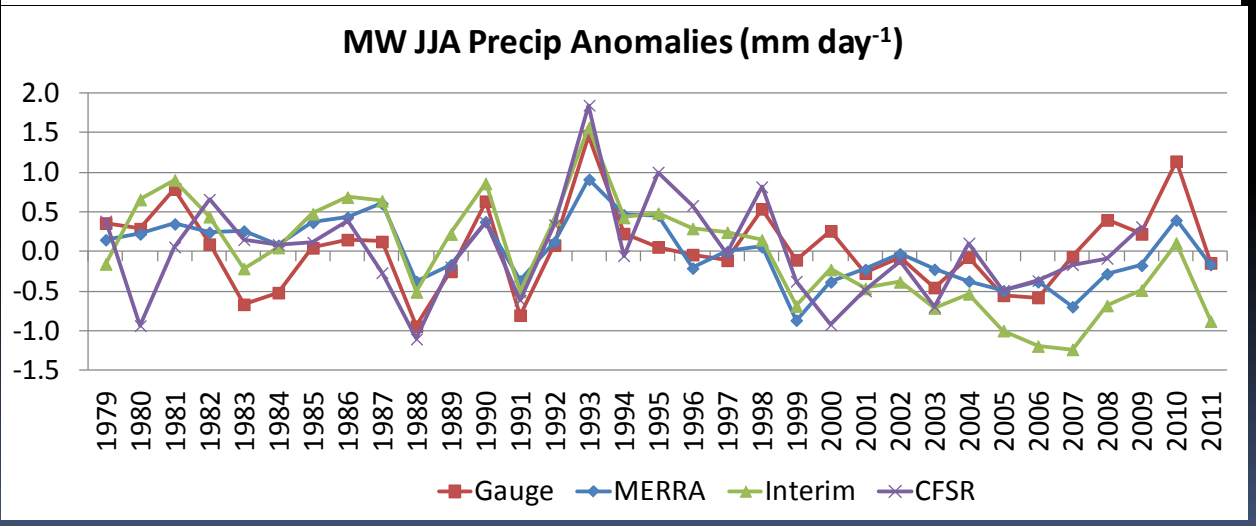
- For MERRA
  - dry southern plains, wet northern
  - Correlations are high or comparable
  - St Dev lean low, esp MW





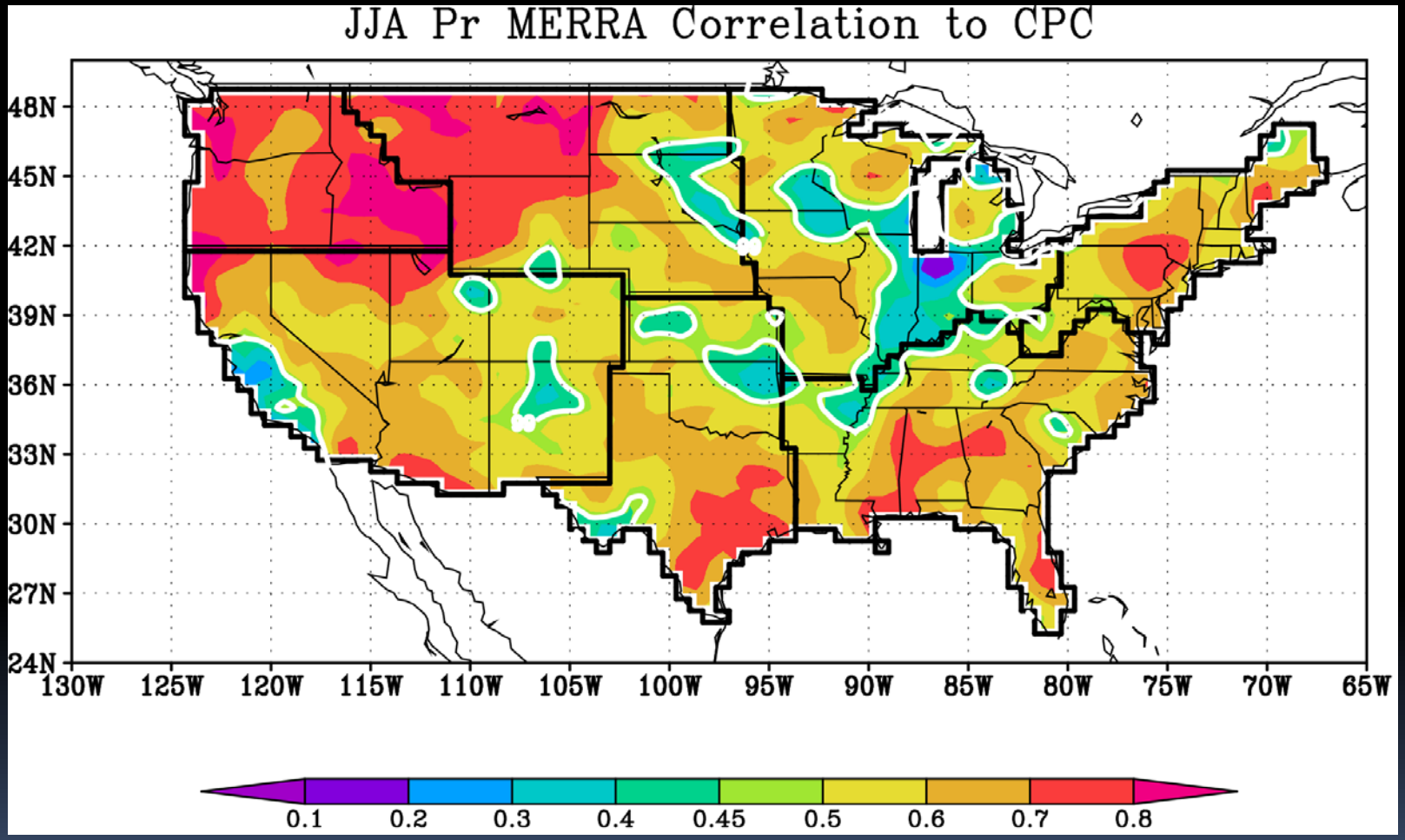
Regional Precipitation





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

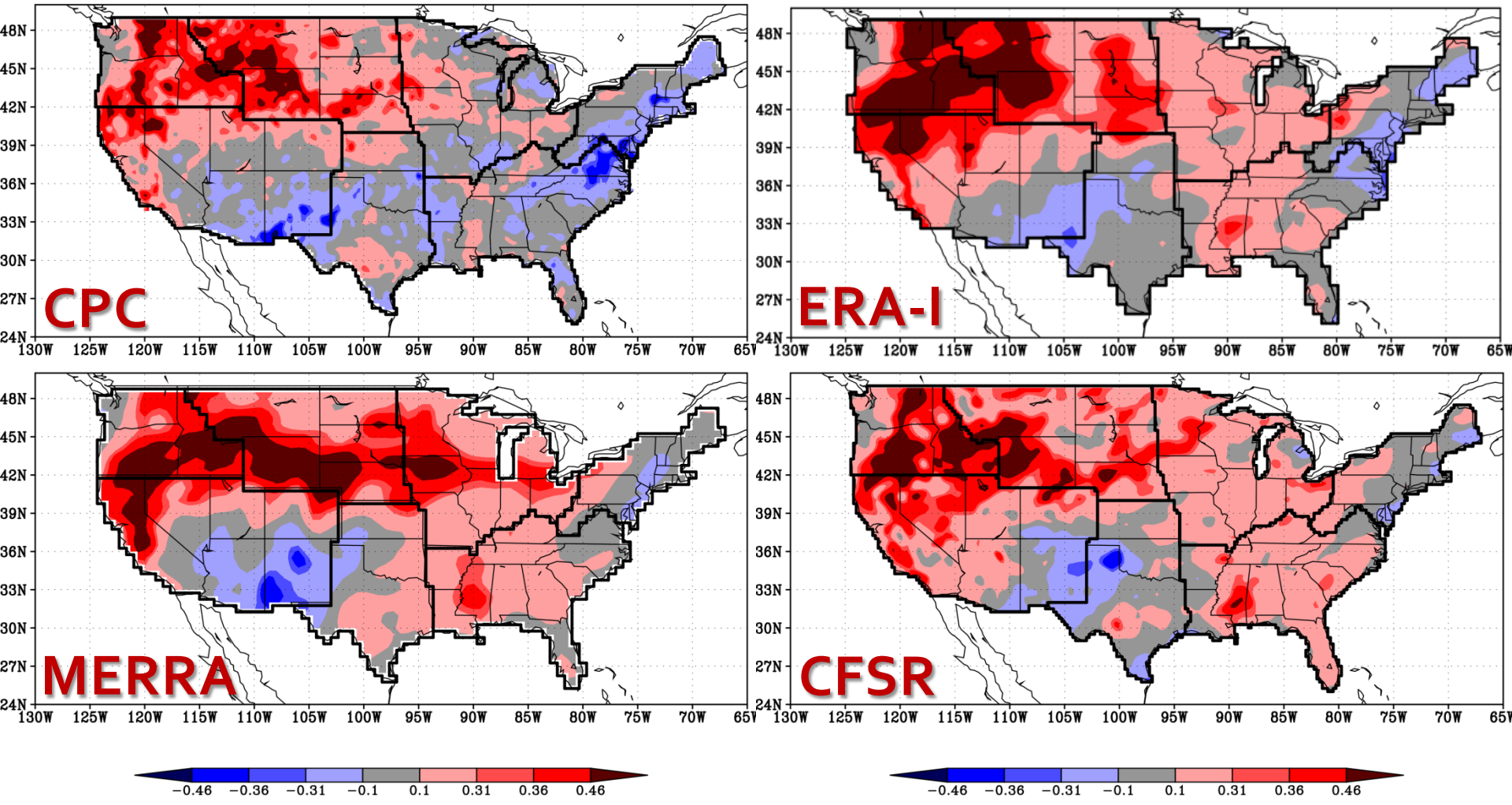
MERRA – Gauge Correlation



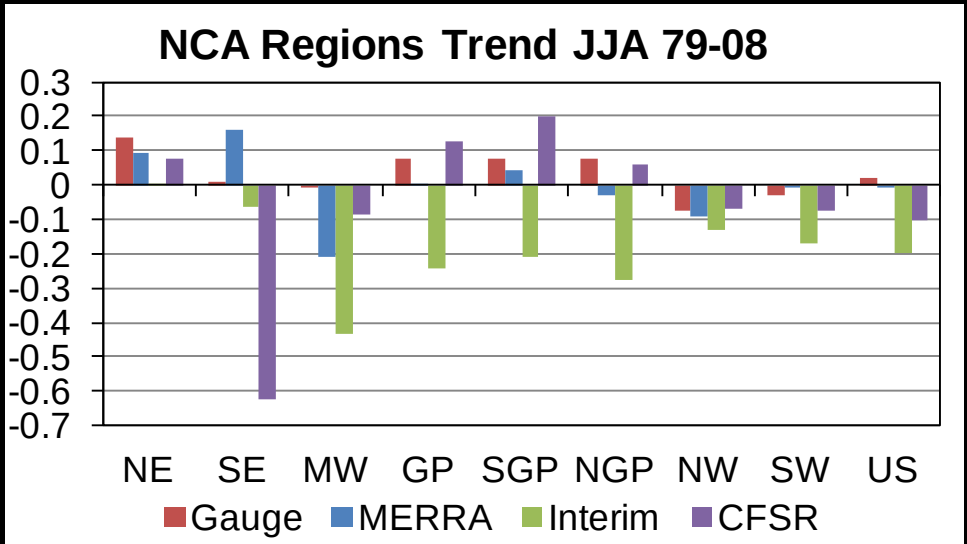
- Barlow et al show some correlation of NW precipitation to ENSO

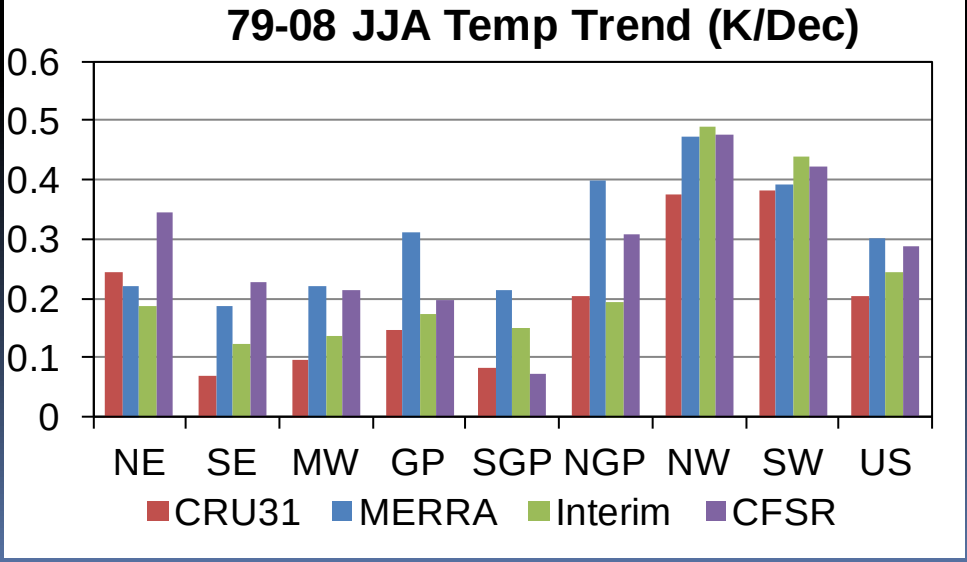
ENSO Connection

JJA Precipitation Correlation with MAM Niño34



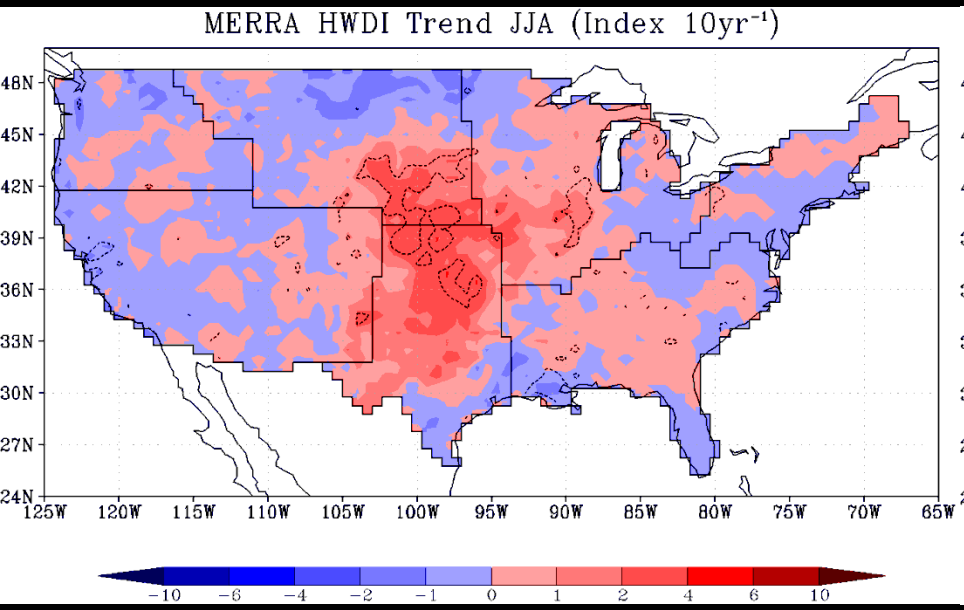
Summer P and T Trends

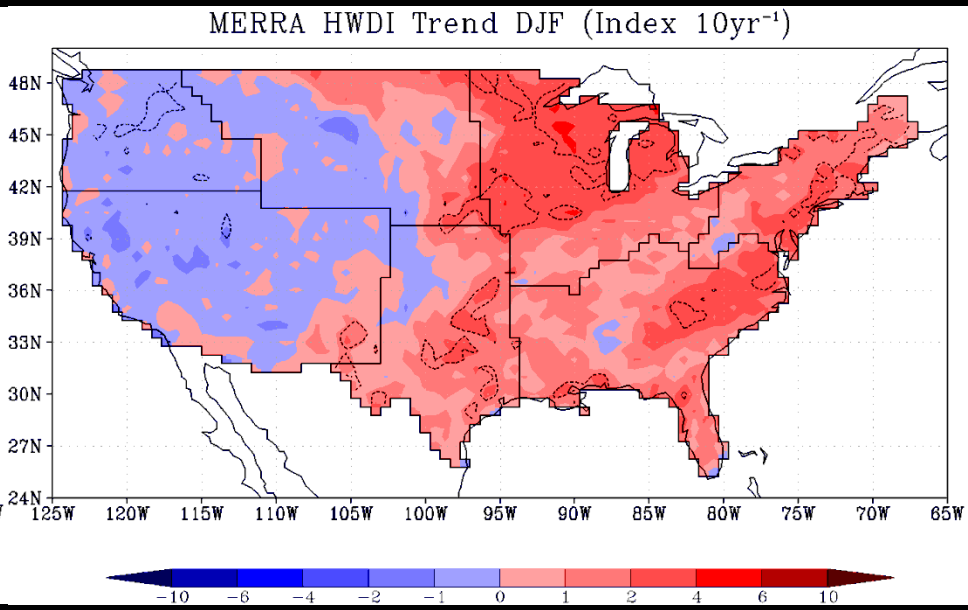




- SE Pr – CFSR discontinuity in 1998
- ERA-I Pr – Systematic decreasing trend over much of US
- T – All have warming trends (MERRA largest)
- Obs – new corrections may increase trends (Vose et al 2012)

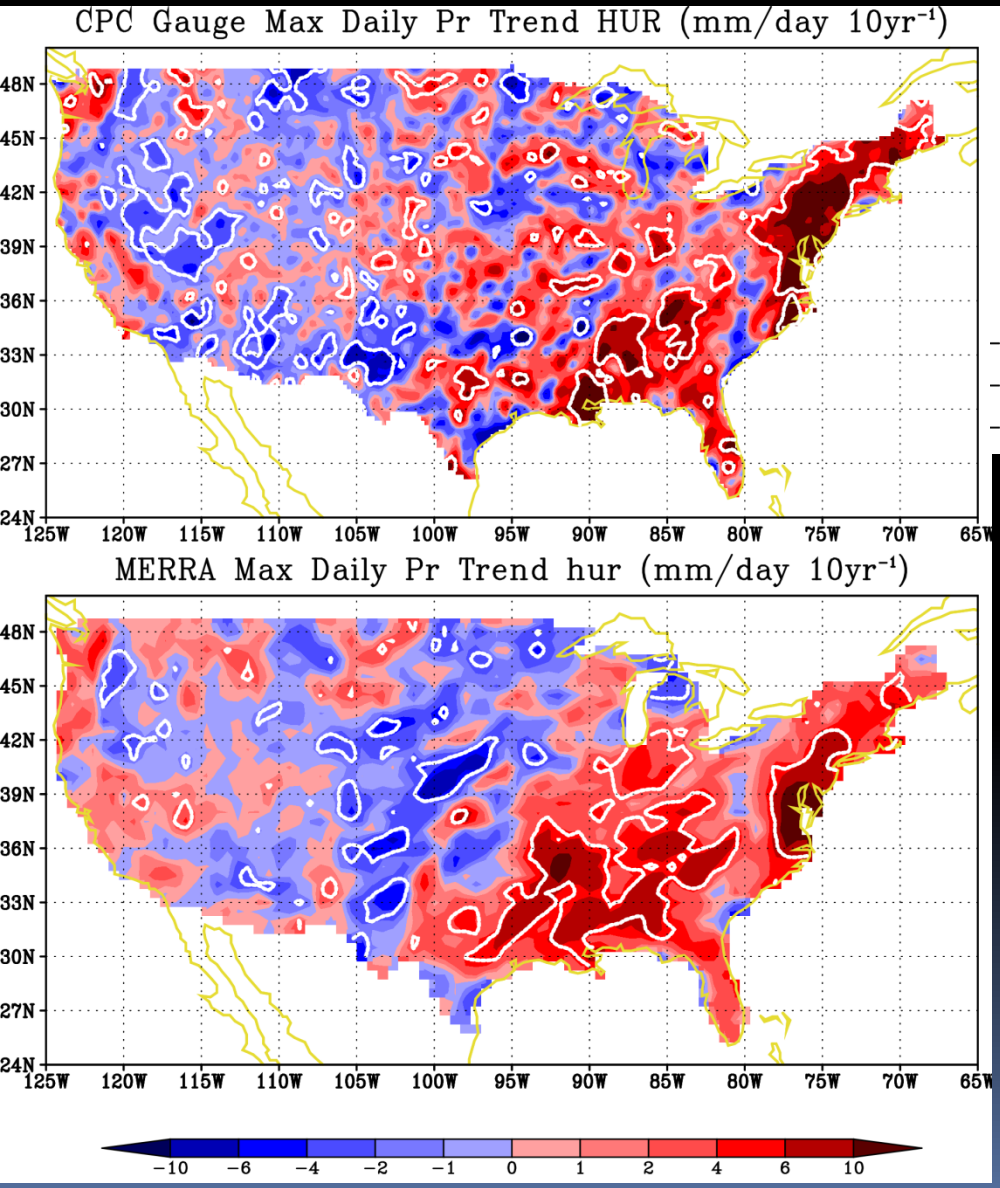
Heat Wave Duration Index

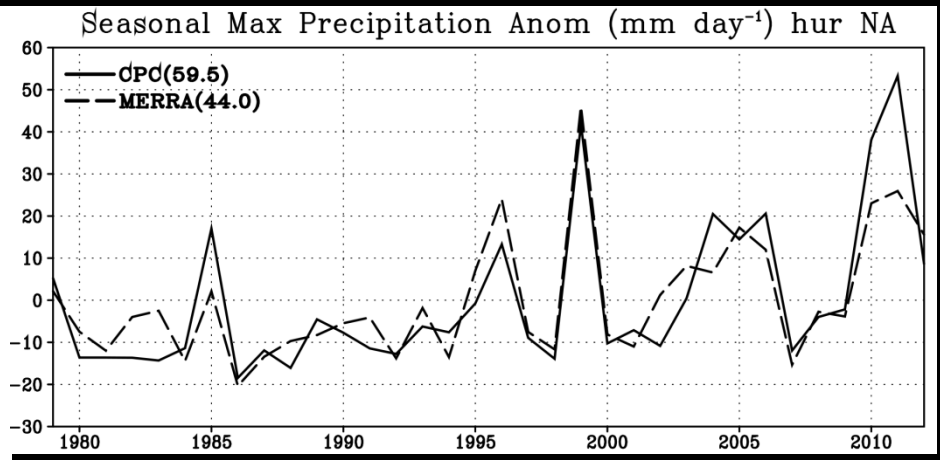




- 5K above climatology for 5 day stretches
- Not exactly warming, but affected by warming
- Identifying an appropriate daily temperature data set for comparisons

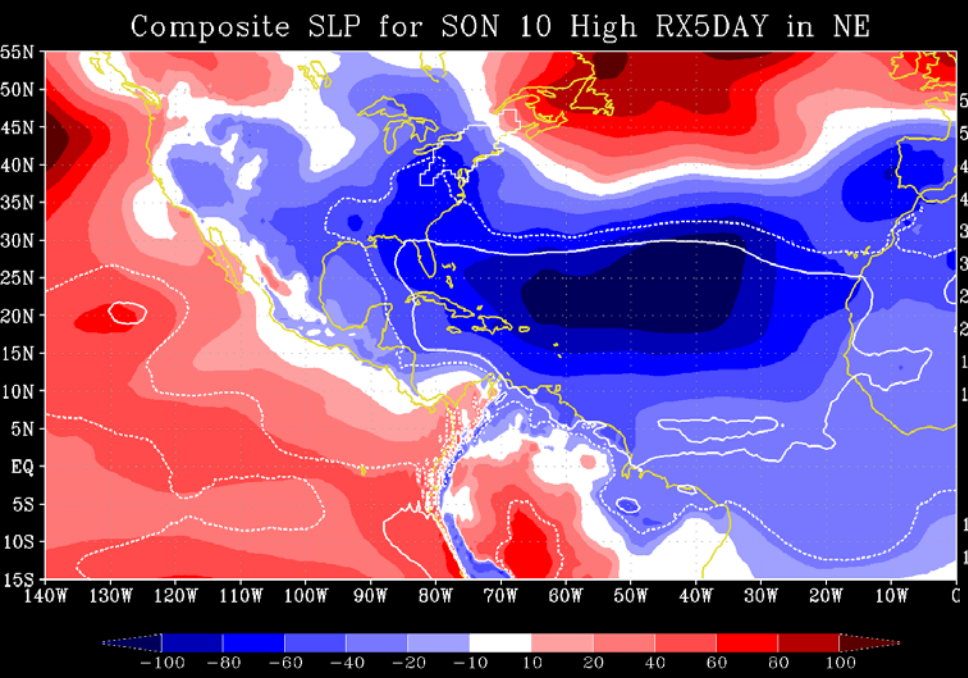
Max Precip in a Season

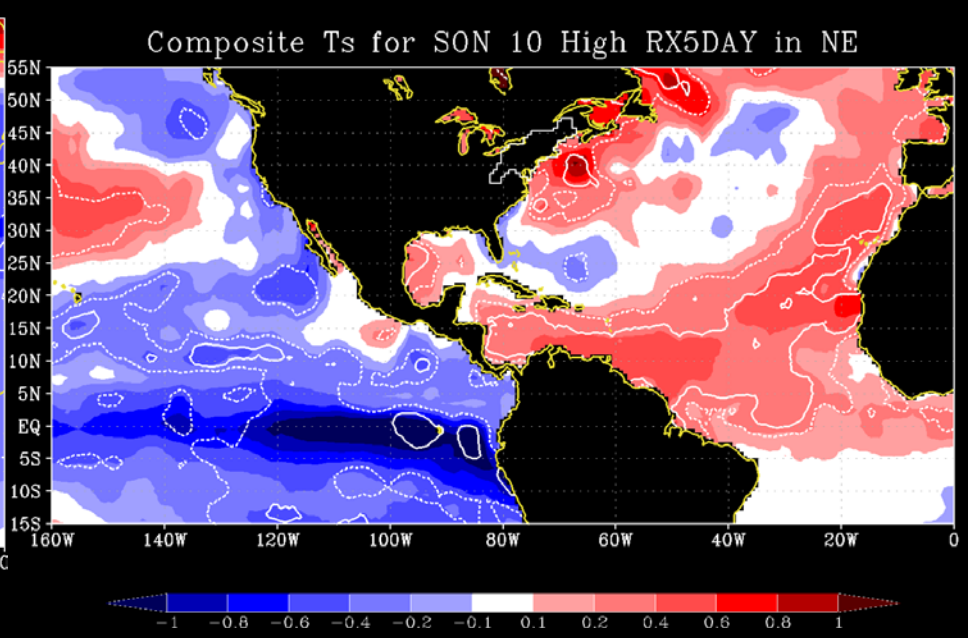




- Largest precip occurrence each season at each grid point
- Hurricane Season (Jun-Nov) shows increases along East Coast and SE US
- MERRA represents the variability of the extreme precipitation well

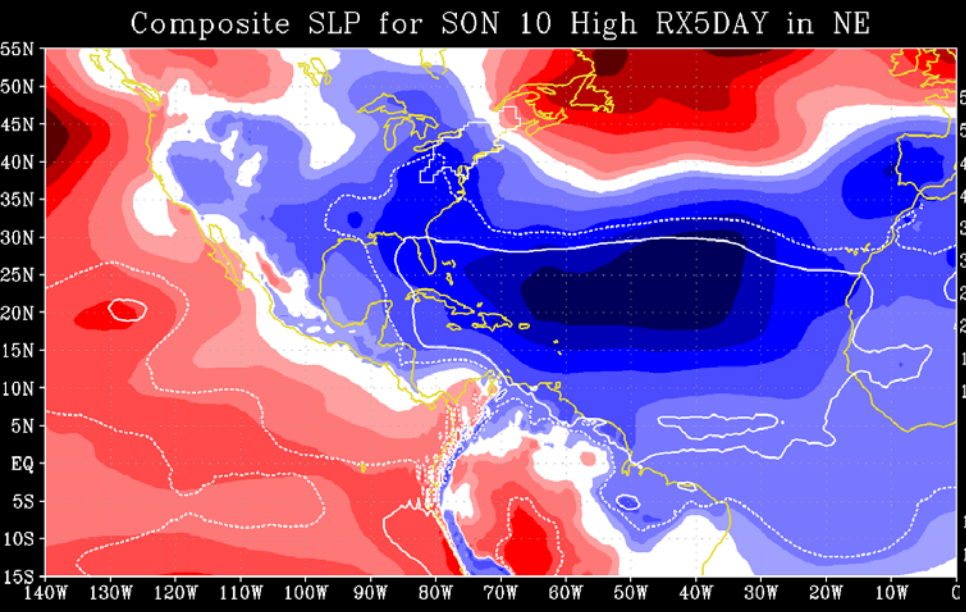
Max Precip SLP/Ts Composite Anomaly

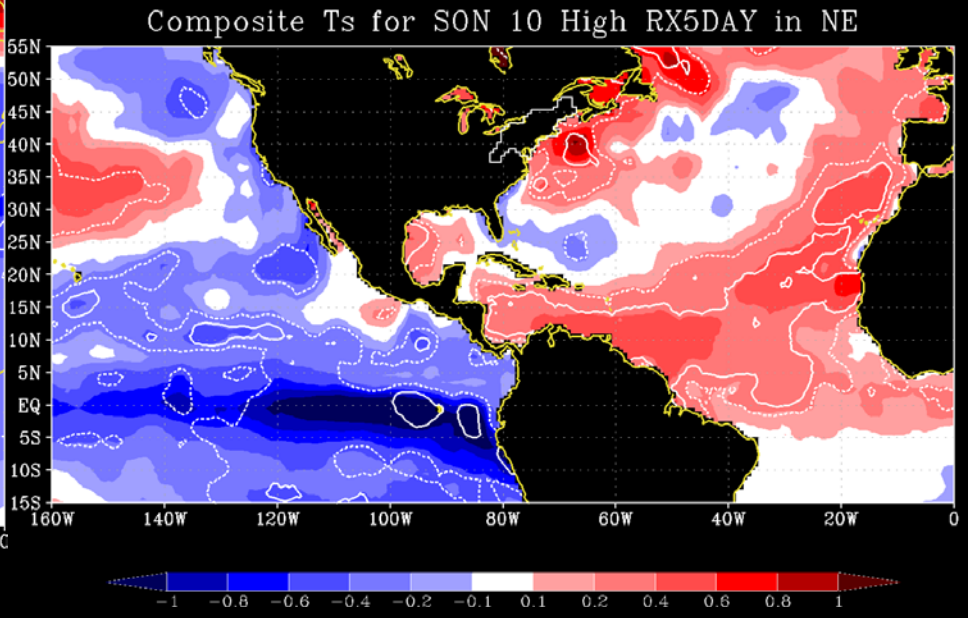


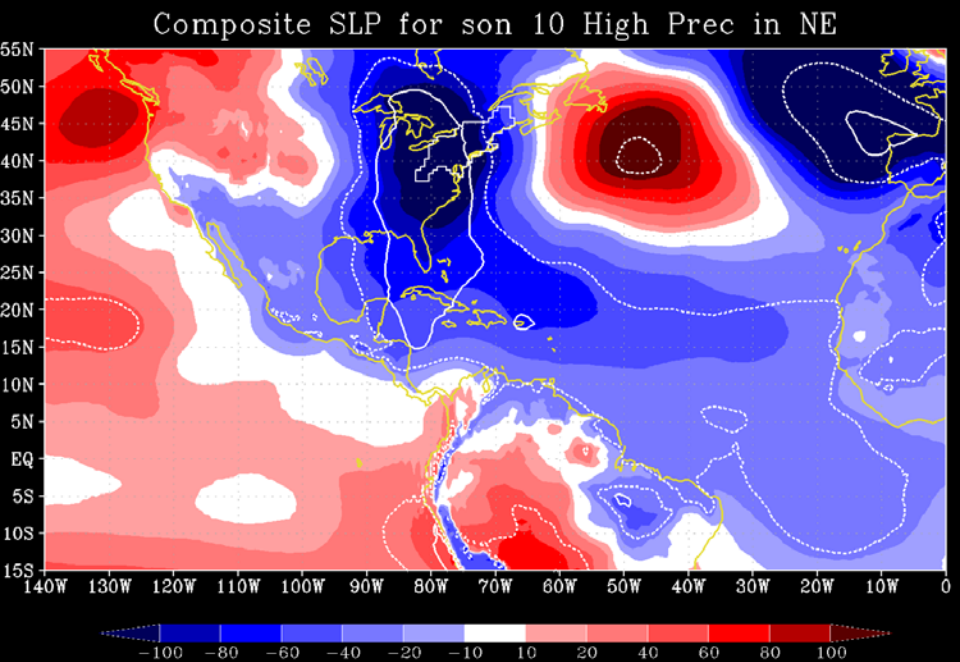


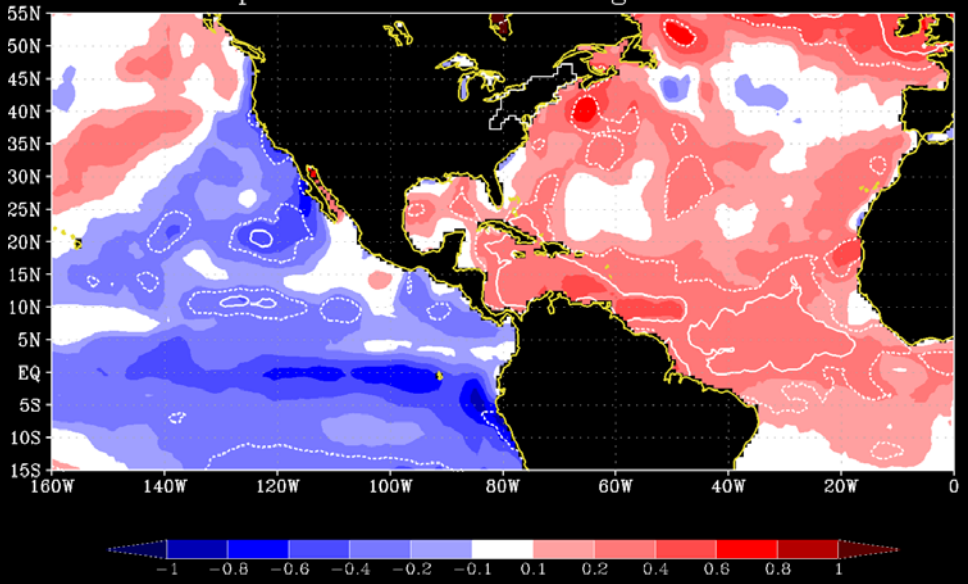
- Compositing the most extreme years to show the supporting large scale environment
- Low pressure in tropical Atlantic, with weaker westerly flow
- SST Shows warm Atlantic, including off the east coast and La Niña Pacific pattern

Max vs Mean Precip Composite Anomaly

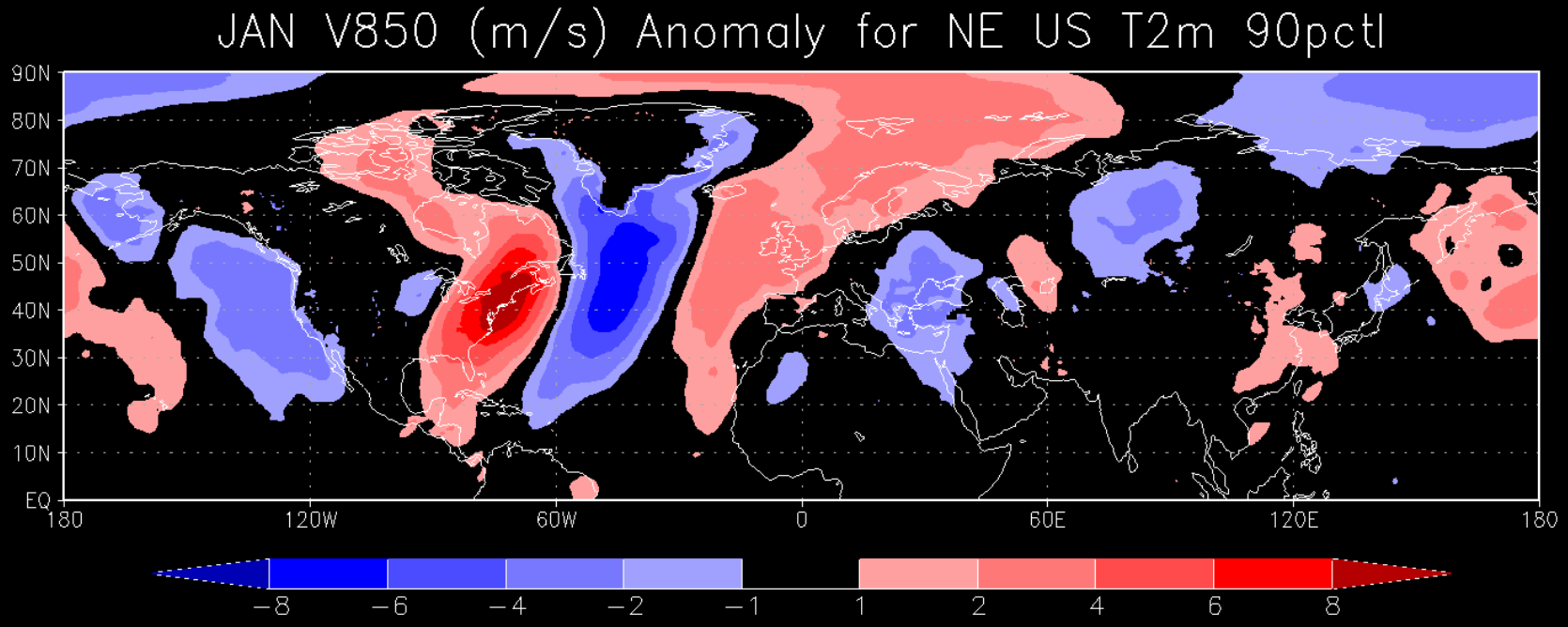








Daily Composites of Extremes



- Choose days when mean T2m exceeds 90th%
- JAN days in the Northeastern US
- Strong southerly flow ahead of low pressure to the west

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