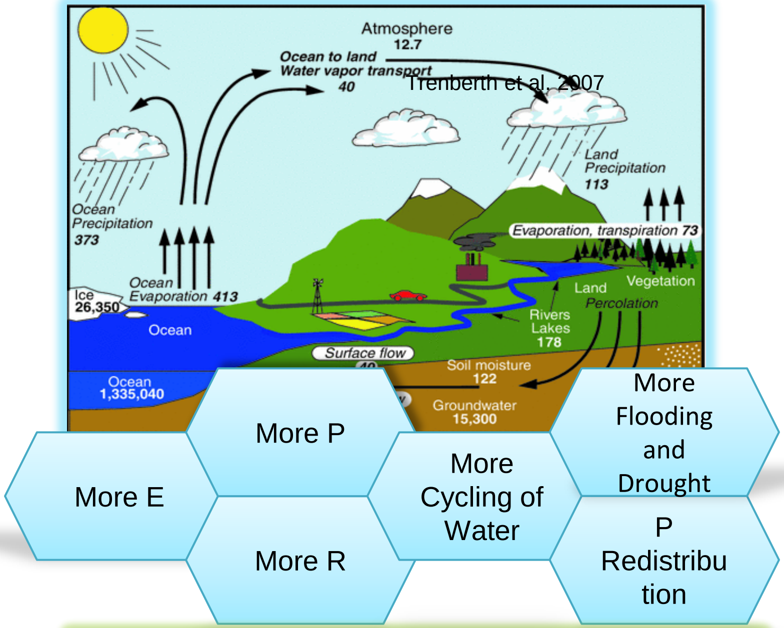
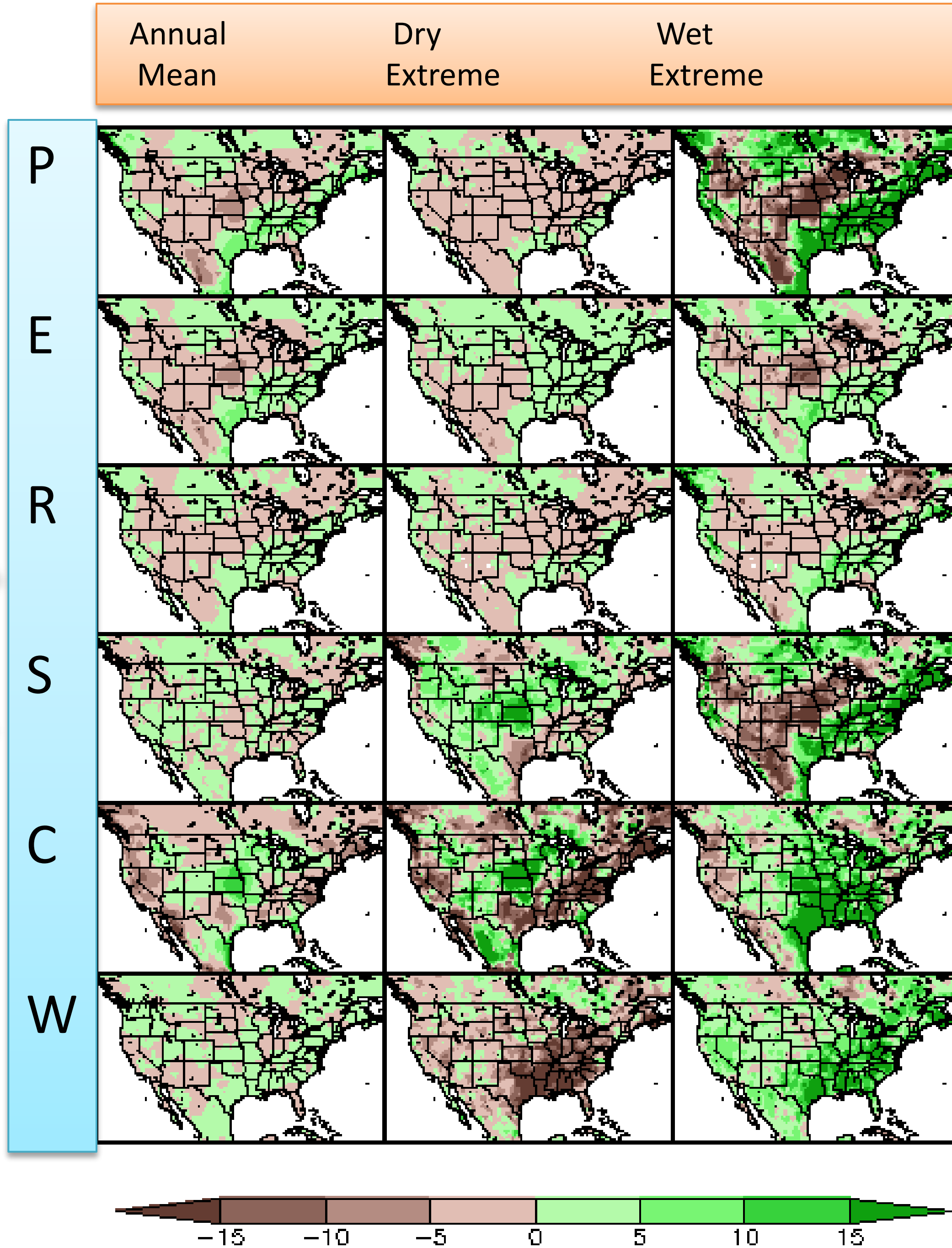
Water Cycle Intensification Indicator (WCI)

Paul Houser (PI), Xia Feng (Co-I)





Methodology

Terrestrial water balance equation is

$$\frac{\partial S}{\partial t} = P - E - R$$

S is Terrestrial storage, P is precipitation, E is evaporation, R is runoff.

Atmospheric water balance equation is

$$\frac{\partial W}{\partial t} = C + E - P$$

W is atmospheric water content, C is moisture convergence flux.

Developing and Testing Water Cycle Intensification Indicator (WCI) over the U.S.

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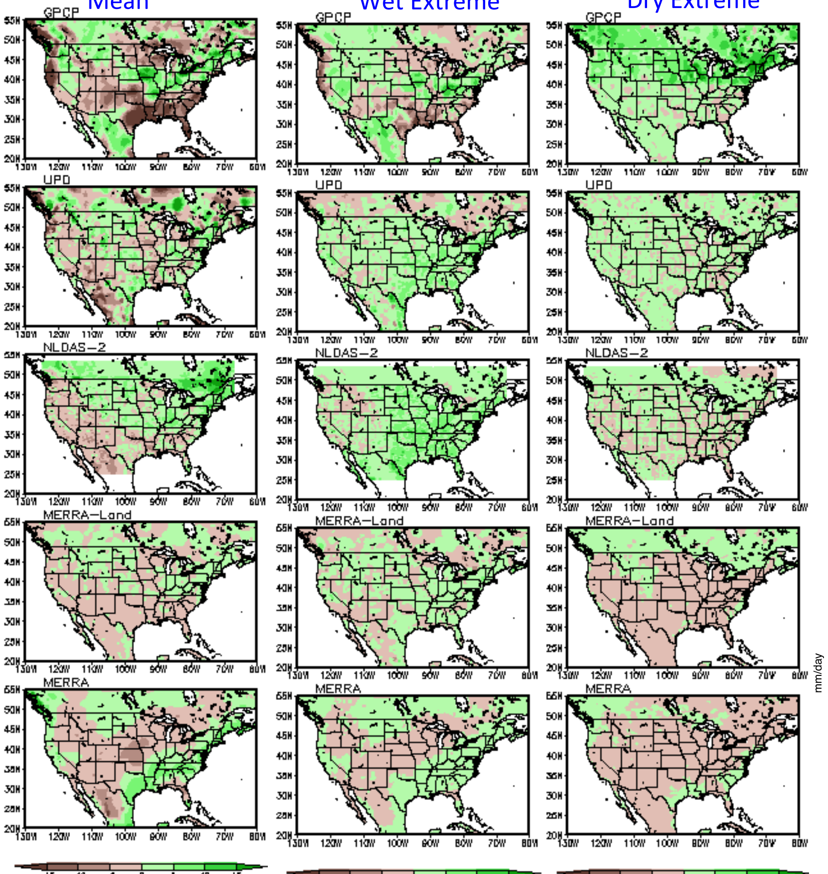
Objective: Develop and test spatially- and temporally-scalable WCI to quantify the current and future change in the strength of the water cycle across the U.S.

Datasets: GPCP precipitation data, CPC Unified precipitation data (UPD), MERRA, NLDAS-2 and MERRA-Land estimates

Annual Trend of P from GPCP, UPD, NLDAS-2,MERRA-Land and MERRA

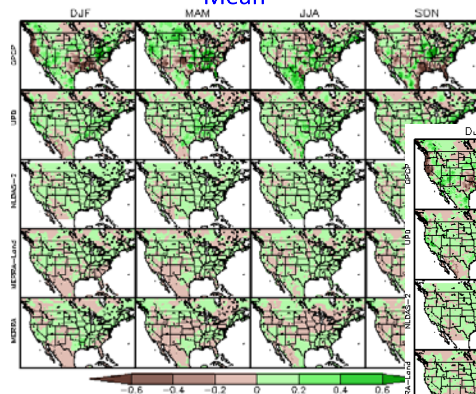
Mean | Wet Extreme | Dry Extreme



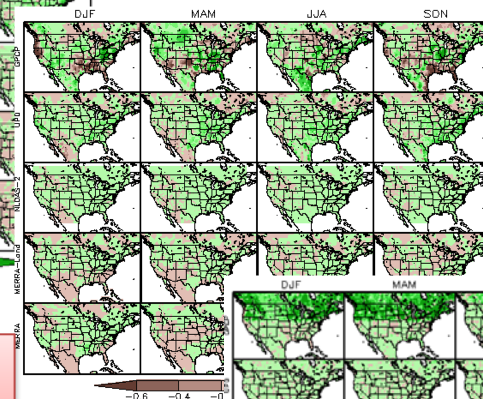
Mean and wet extreme have good consistency among different data except MERRA, while dry extreme shows differences for MERRA-Land and MERRA.

Seasonal Trend of P from GPCP, UNP, NLDAS-2,MERRA-Land and MERRA

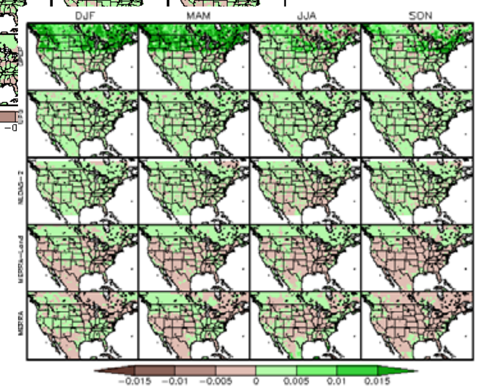
Mean



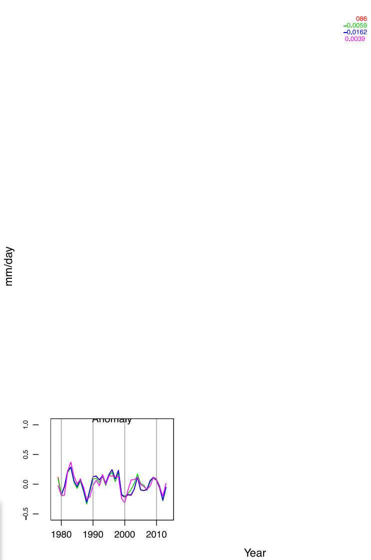
Wet Extreme



Dry Extreme



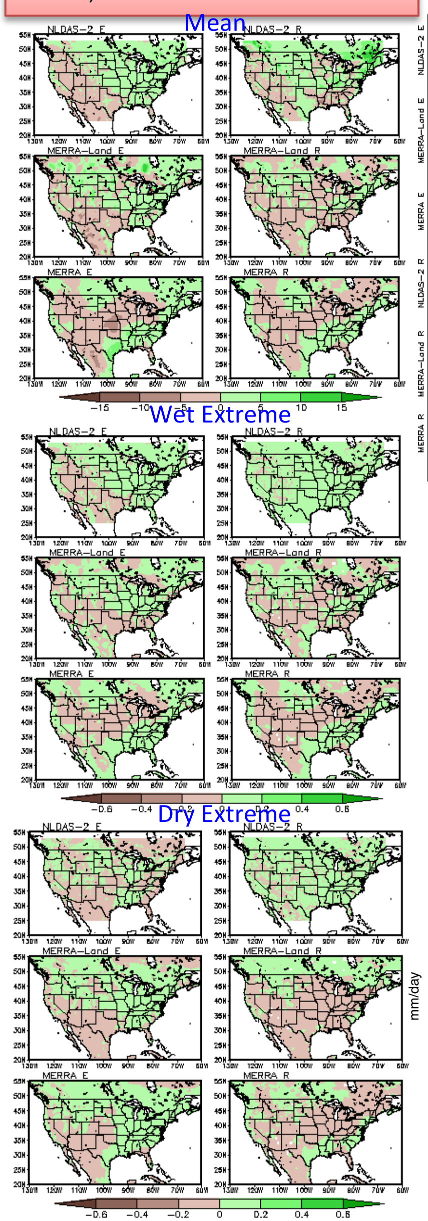
Annual and Seasonal Anomaly and Extremes over CONUS. Numbers denote the trends.



- There are distinct variations in seasonal trends.
- Trends in seasonal mean and extremes exhibit similar patterns with the corresponding annual trends for each dataset
- NLDAS-2 and MERRA-Land are close to UPD.

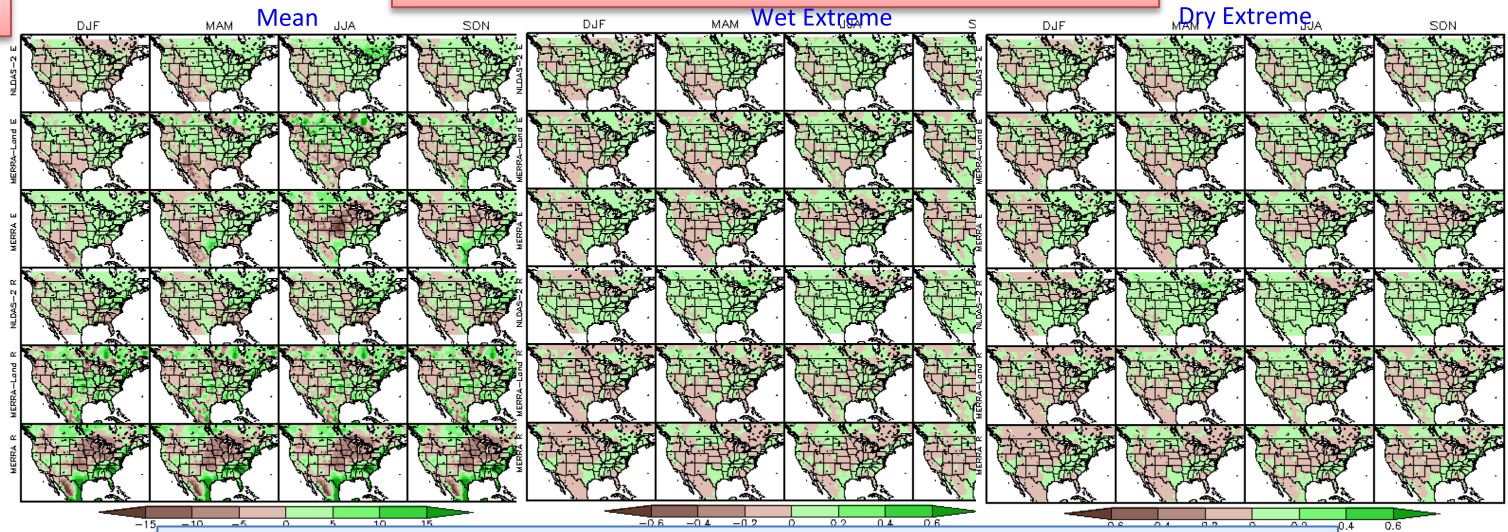
- Area averaged annual and seasonal anomalies are more or less consistent among each dataset.
- Magnitude and sign trend show differences especially for MERRA in DJF and NLDAS-2 in JJA.

Annual Trend of E and R from NLDAS-2, MERRA-Land and MERRA



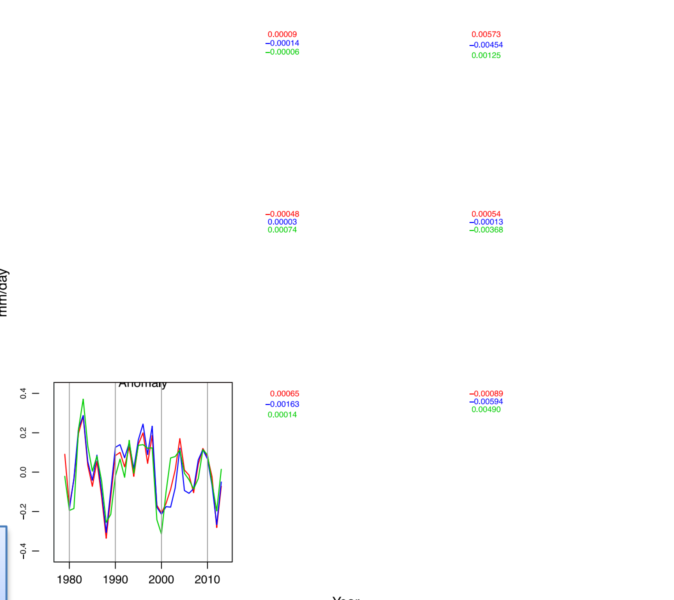
Trends in annual E and R are generally consistent with corresponding P for each data set. NLDAS-2 and MERRA-Land have more similarity.

Seasonal Trend of E and R from NLDAS-2, MERRA-Land and MERRA



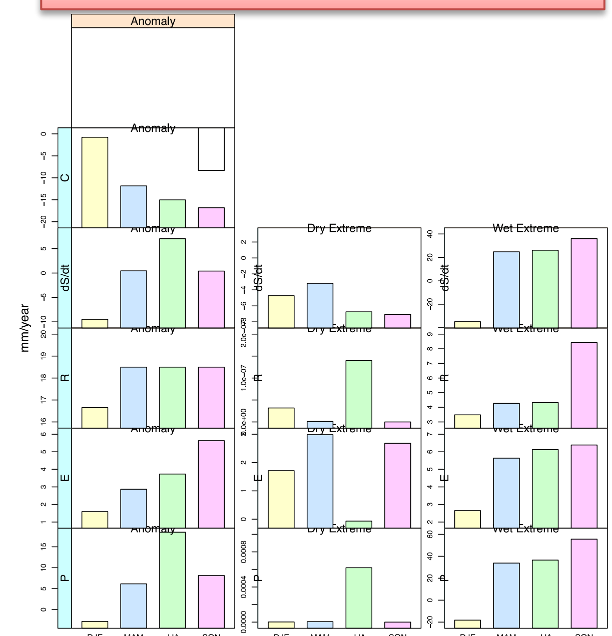
- ✧ Trends in seasonal mean and extremes of E and R exhibit similar feature with the corresponding annual values.
- ✧ MERRA shows large discrepancy in comparison with the other two datasets especially for runoff.

Annual Anomaly and Extremes of P, E, R over conus from NLDAS-2, MERRA-Land and MERRA. Numbers denote trends.



Similar interannual variations, different magnitude and trend

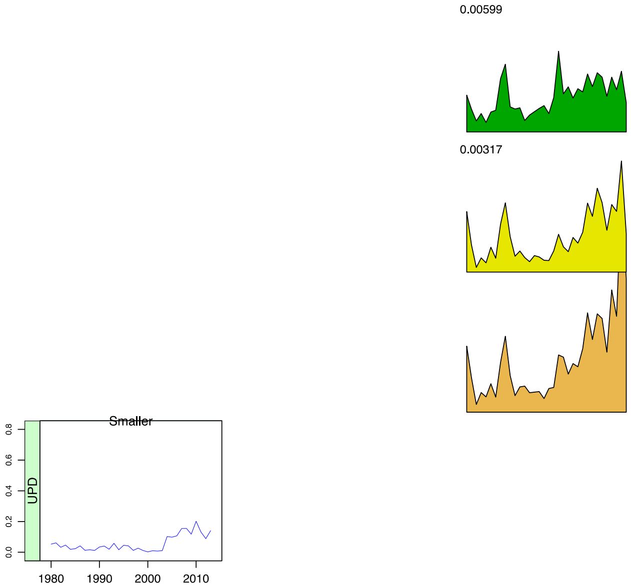
Seasonal Trend from MERRA Variables at (35N, 80W)



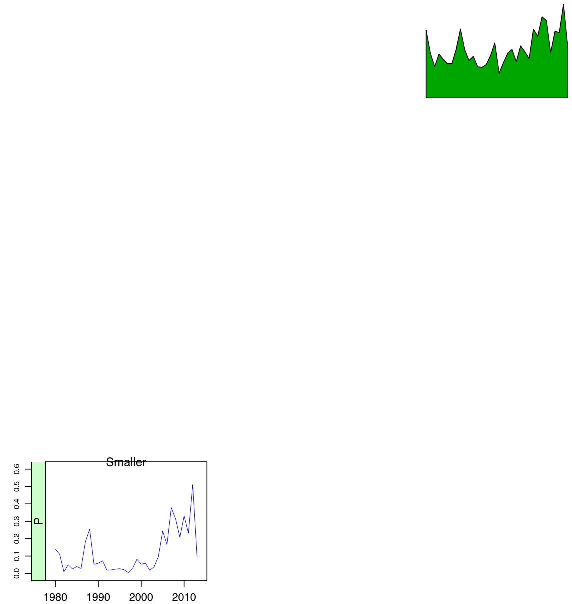
- ✧ P, R, and C have larger trend than E, dS/dt and dw/dt.
- ✧ Large variability in dry extreme, DJF shows more variability

Fraction of CONUS with Much Smaller-Than-Normal and Greater-Than-Normal

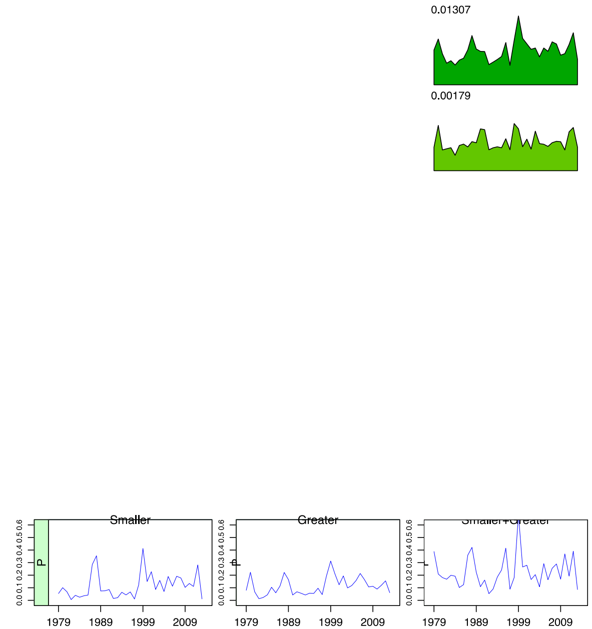
P from UPD, NLDAS-2, MERRA-Land and MERRA



P, E, R and dS/dt from MERRA-Land



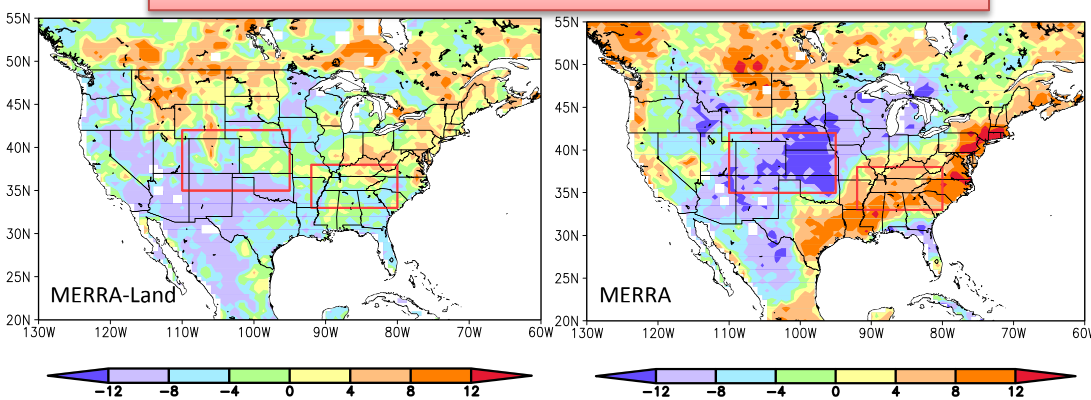
P, E, R, dS/dt, C and dw/dt from MERRA



- ✧ Overestimation in NLDAS-2, MERRA-Land and MERRA compared to UPD
- ✧ More regions are affected by extreme P.

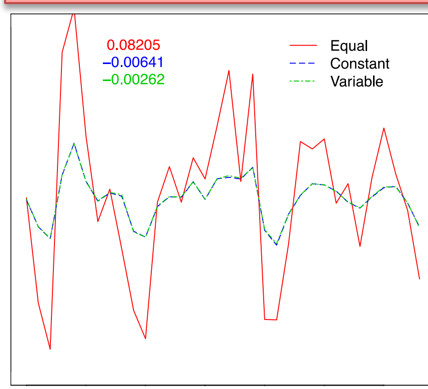
- ✧ MERRA-Land and MERRA consistently show positive trends in P, E and R but negative trends in dS/dt.
- ✧ There is a general increasing tendency that extreme water cycle events have more impact on CONUS.

Consistency among Annual Mean and Extreme Trends of All Water Cycle Variables



- ✧ Water cycle consistently intensifies over the northeastern, northern and southern CONUS.
- ✧ Discrepancy mostly occurs in central U.S. and southern Texas.

Sum of Normalized Time Series of Anomaly and Extremes from MERRA



Numbers indicate trends.
Lines indicate weights.
Red: equal weights
Blue: climatology mean
Green: annual mean

- ✧ Time series with climatology and annual mean weights are similar.
- ✧ Equal weight produces the largest variations.