

# Variability of the Great Plains Low-Level Jet: Large Scale Circulation Context and Hydroclimate Impacts

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# The Great Plains Low-Level Jet

- A river of air and moisture in the lower atmosphere
- Transports roughly half of the *warm season* moisture to the continental interior
- Enhances upward vertical motion - linked to generation and maintenance of MCS
- Correlation between strength and frequency of GPLLJ and droughts and floods
- Exhibits diurnal, *intraseasonal*, and *interannual* variability

# Motivation

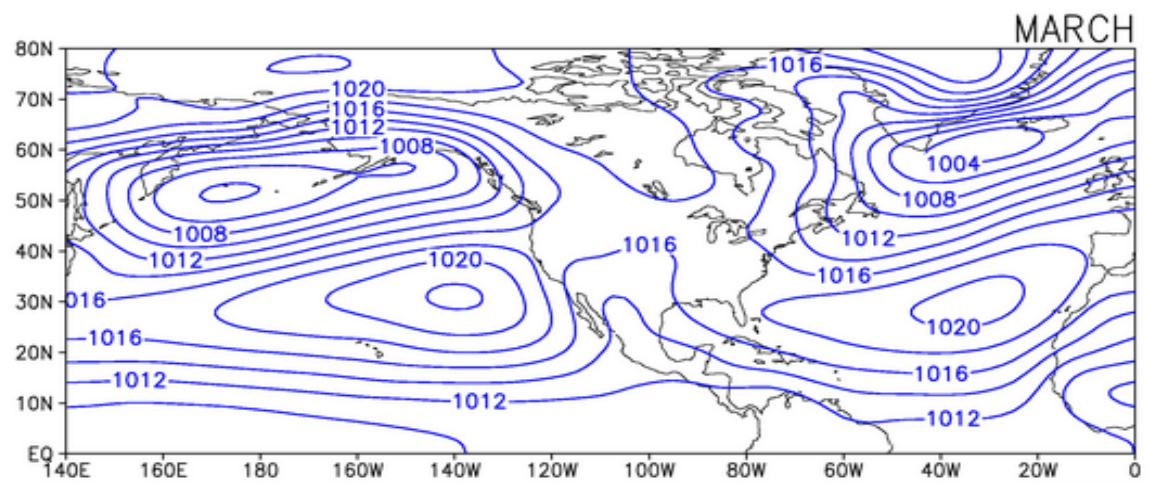
- Great Plains exhibits precipitation variability in the warm season, which is also the growing season
- Moisture transports (i.e., GPLLJ) appear important in generating subseasonal and interannual precipitation variability.
- Summertime circulation teleconnection patterns are shown linked to Great Plains precipitation variations, but the mechanisms are not well understood

# Data Sets

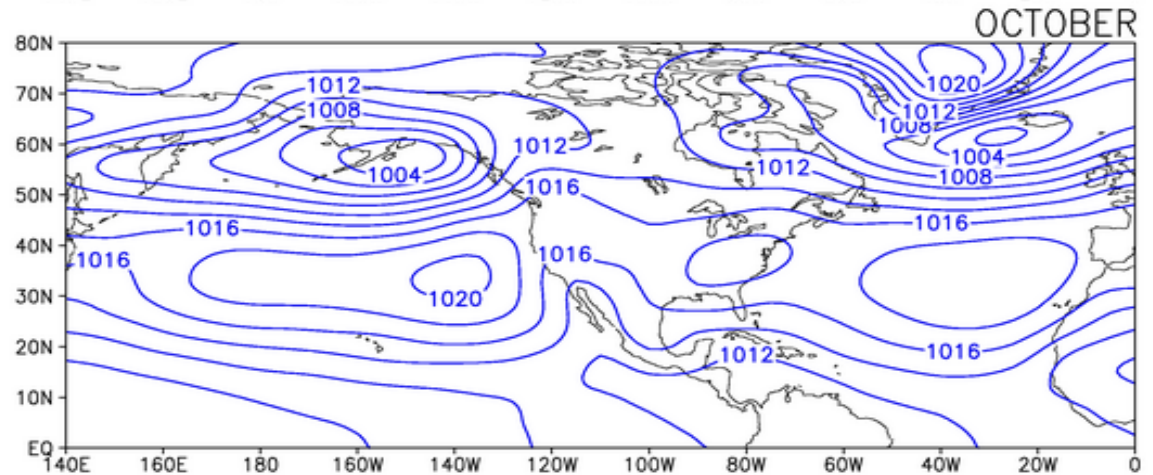
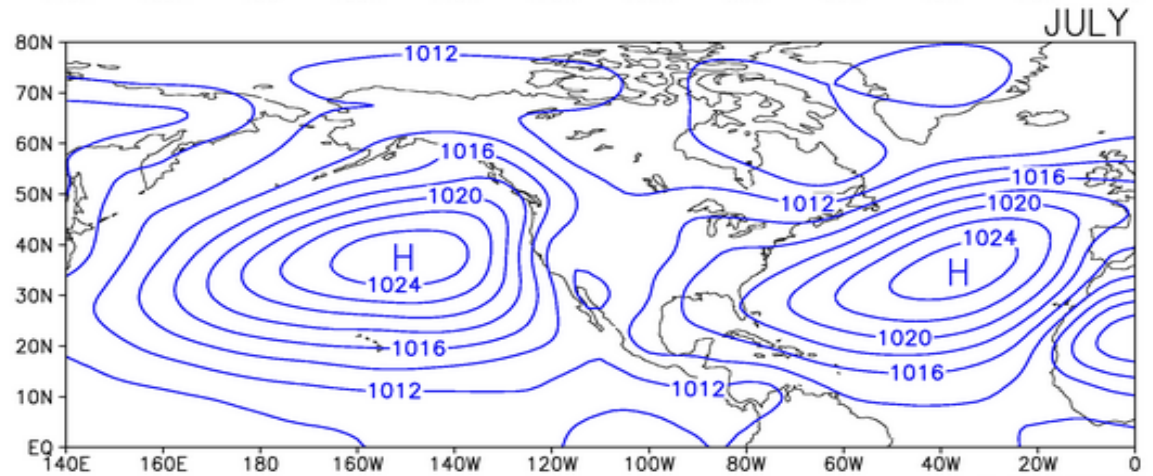
- NARR (Regional)
  - High Resolution: 32 km, 3-hourly, 29 levels with 13 isobaric levels below 700 hPa
  - 1979-2005
  - Assimilates precipitation, radiances, and....
- ERA-40 (Global)
  - 100 km, 6-hourly, 17 levels 1958-2001
- CAM 3.5 and CCSM 3 runs



# Seasonal Cycle of SLP

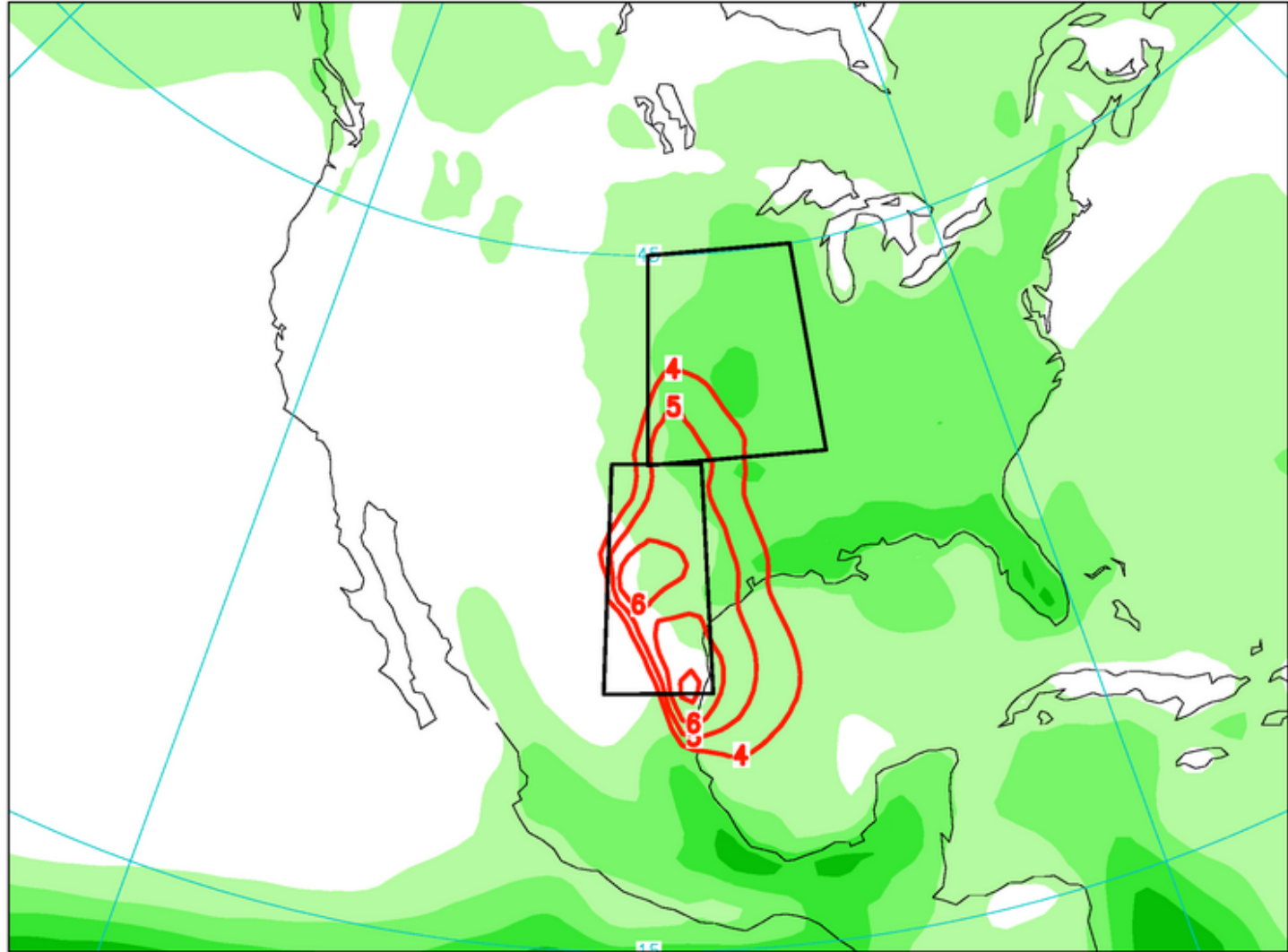


GPLLJ embedded  
in western arm of  
Bermuda High



# MJJ GPLLJ & Precipitation Climatology

1979-2005

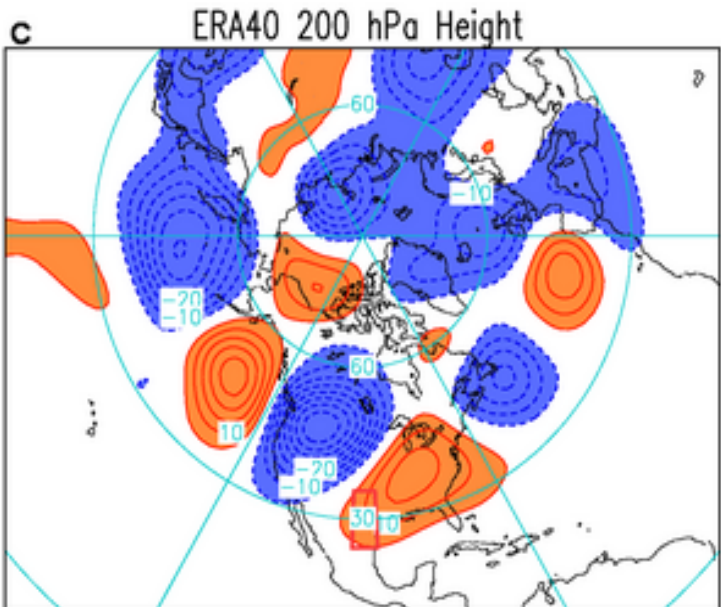
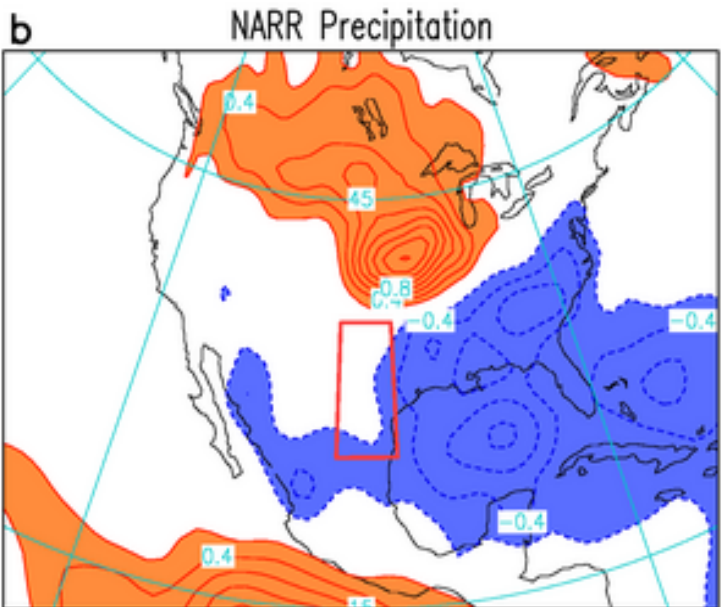


# Context of GPLLJ Variability



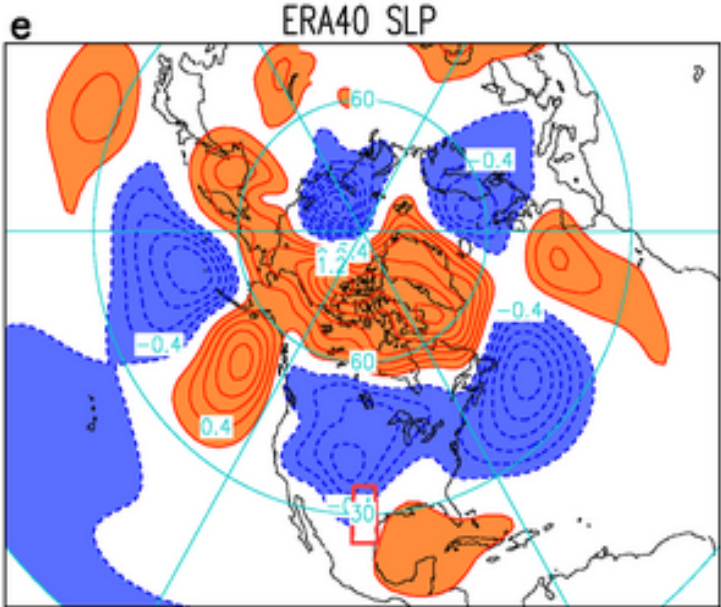
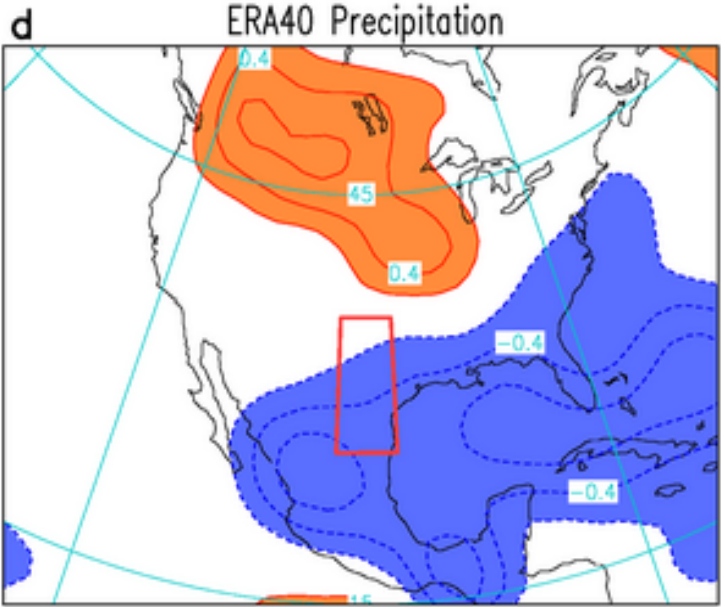
# ***GPLLJ Index Regressions***

***P-1.5 mm/day  
3 mm/day  
climatology***



***Tele-  
Connection  
influence***

***ATL SLP  
NAO?***



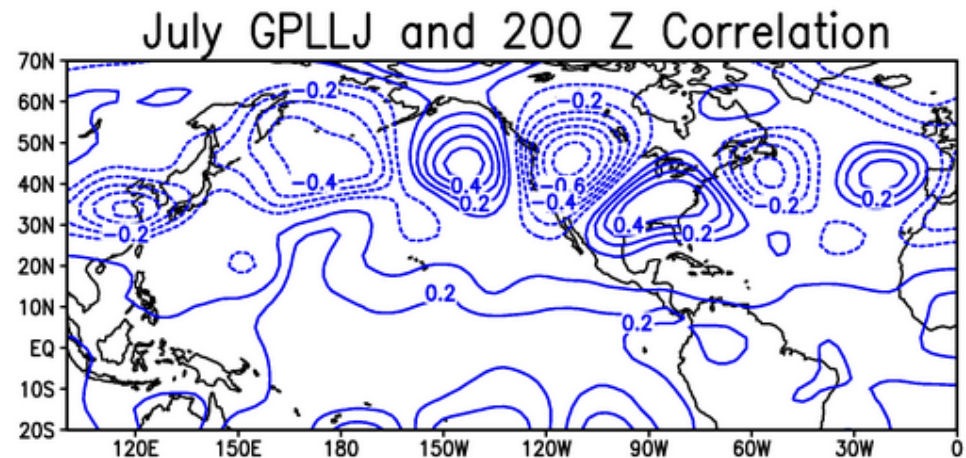
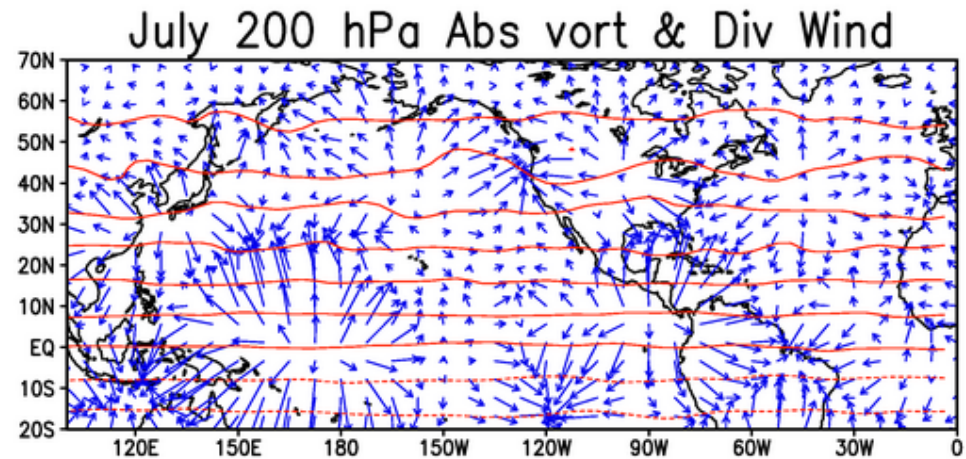
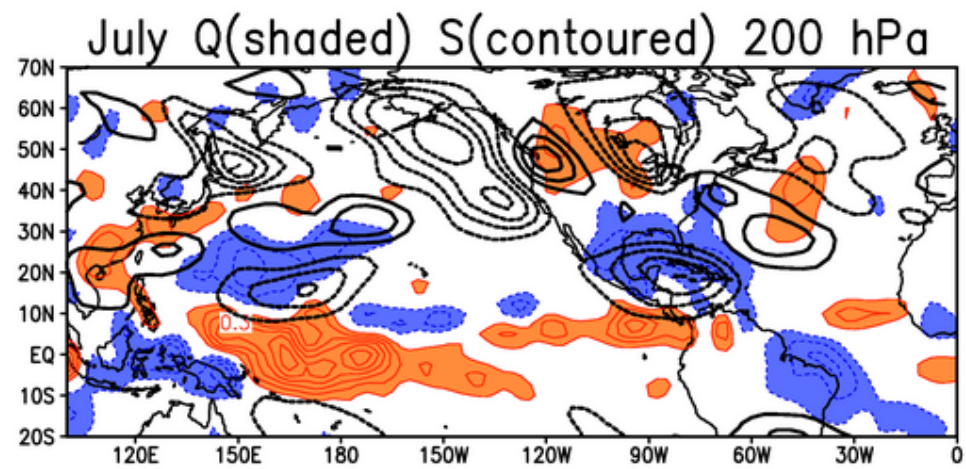


$$\begin{aligned} \text{RWS} &= -\nabla \cdot (\mathbf{v}_\chi \zeta) \\ &= -(\mathbf{v}_\chi \cdot \nabla \zeta) - (\zeta \nabla \cdot \mathbf{v}_\chi) \end{aligned}$$

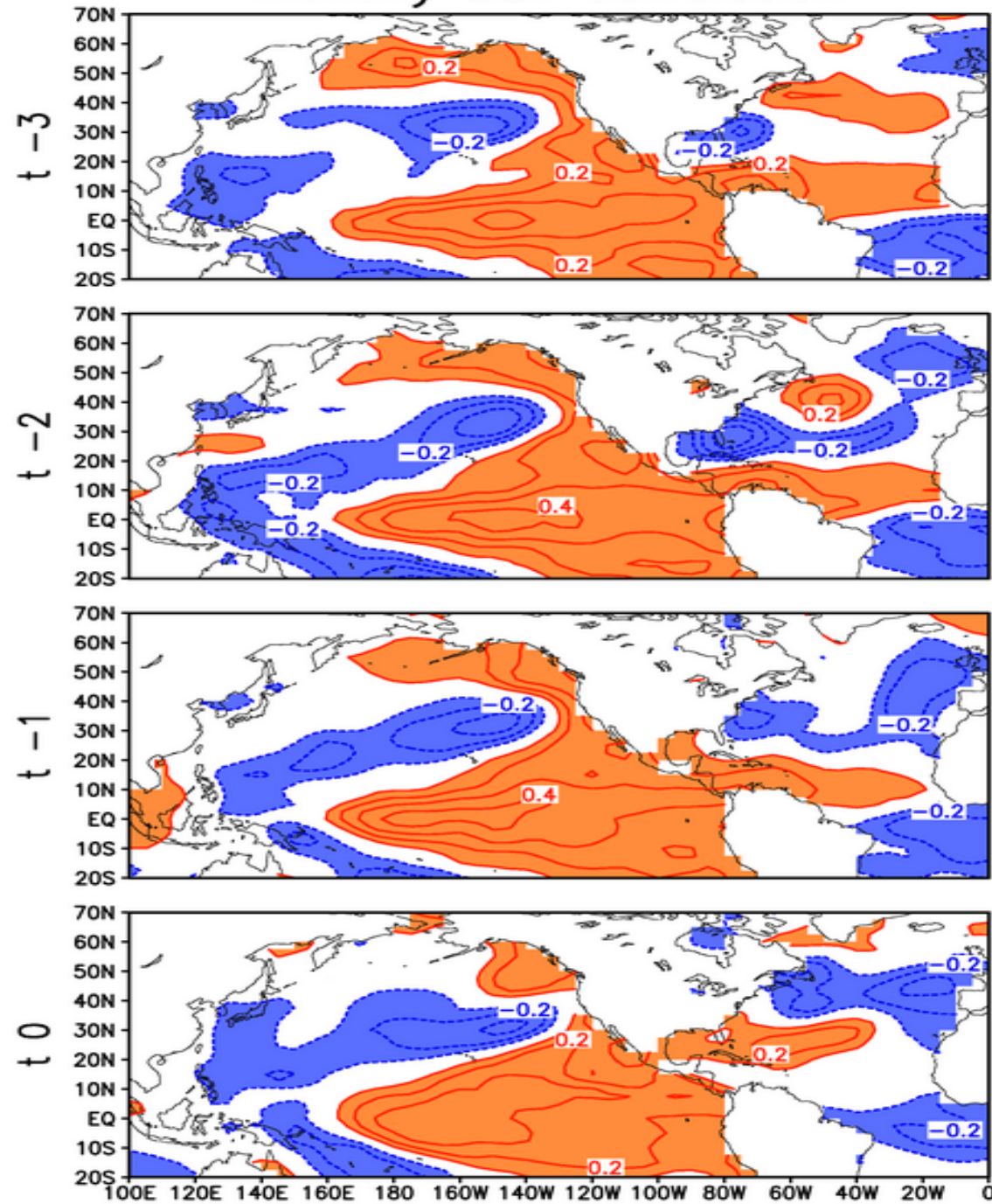
Notable divergent outflows in west central and east Pacific coincident with subtropical RWS

Suggests potential for tropically induced circulation influence on GPLLJ variations

Height correlations further suggest tropical links



# Monthly SST Correlation



Diabatic heating hints at the existence of SST anomalies

Antecedent ENSO feature in Pacific

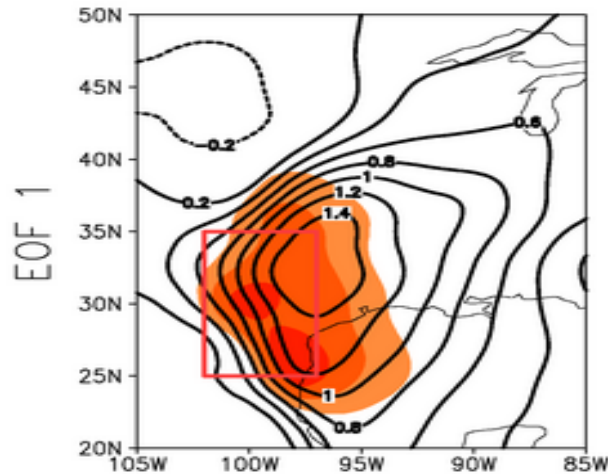
Atlantic is not so easily characterized, NAO?

# GPLLJ Variability Modes

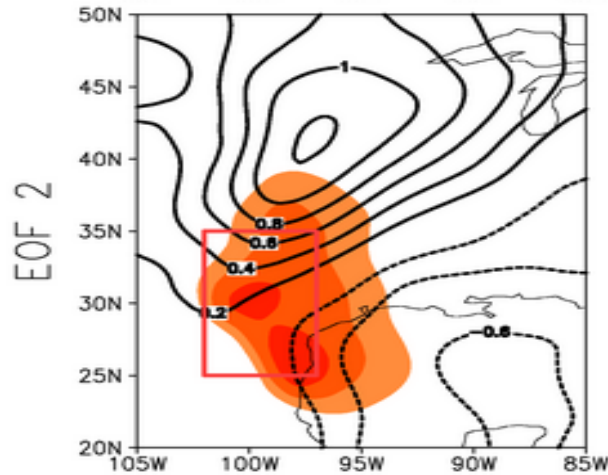
- Indices are attractive for their simplicity
- Index variations may be influenced by a superposition of variability patterns
- May not provide information about mechanisms
- EOF analysis of can identify recurrent patterns of GPLLJ variability



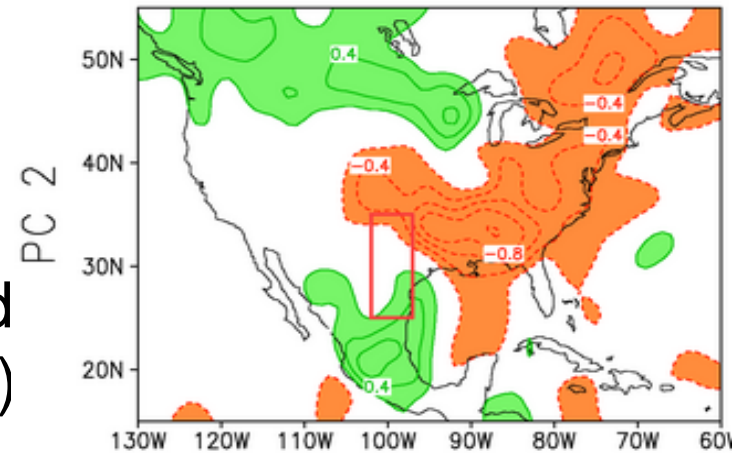
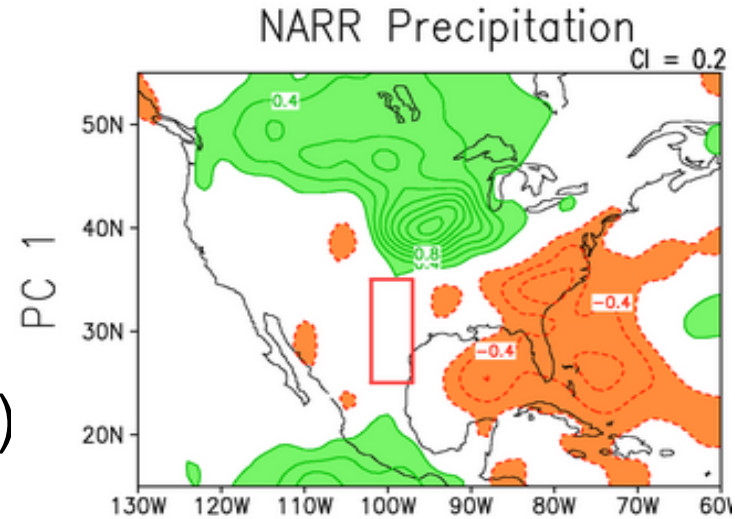
# GPLLJ Variability Modes in NARR



Pev = 37.8%  
eastward shift  
and meridionally  
stretched;  
enhanced  
precipitation(1993)

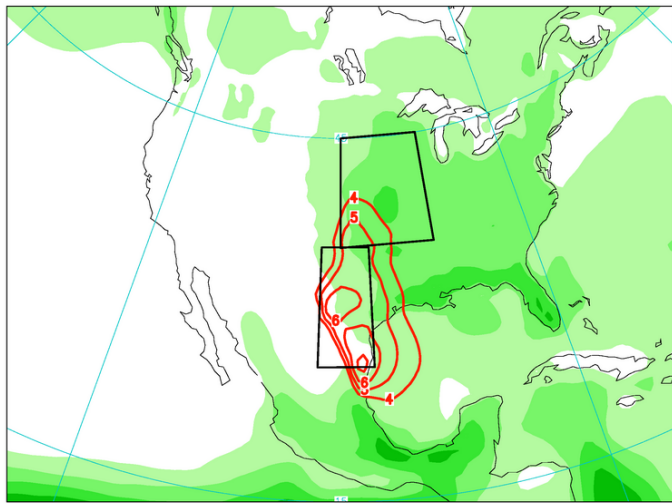


Pev = 23.3%  
Northward shift;  
decoupled from  
the Gulf moisture  
source; decreased  
precipitation(1988)





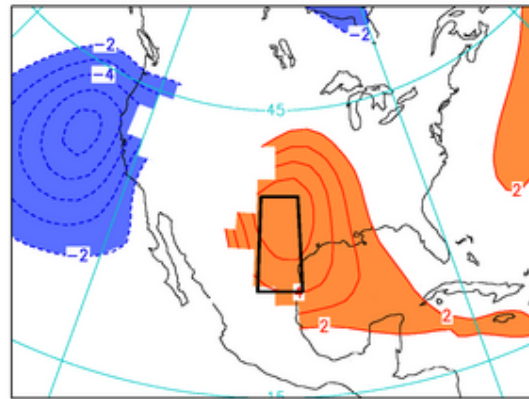
# GPLLJ Variability in CAM 3.5 and CCSM Simulations



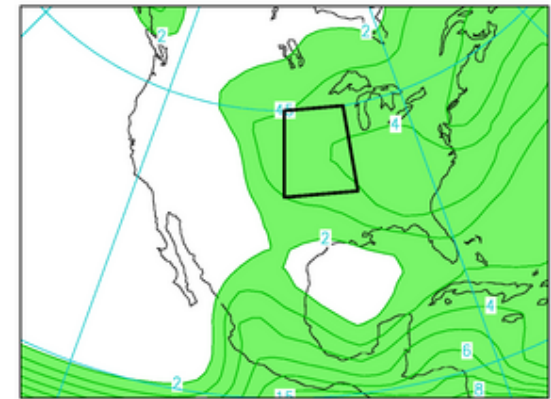
GPLLJ and Precipitation climatology nicely captured

2XCO2 features stronger jet, however precipitation does not show attendant increase

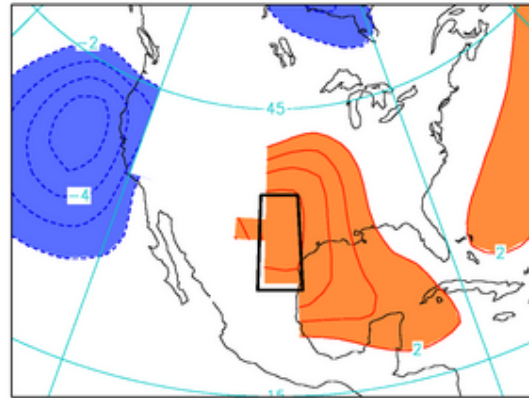
CAM 3.5 V850



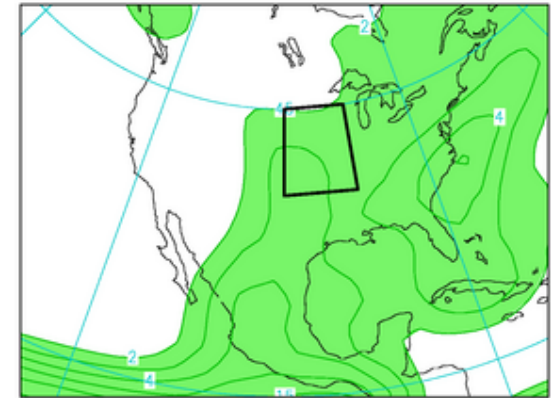
CAM 3.5 Prec



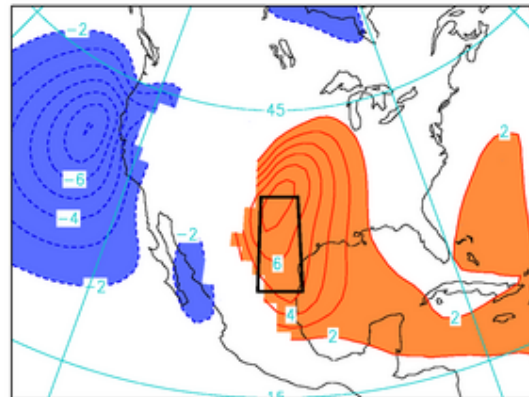
CCSM CTL V850



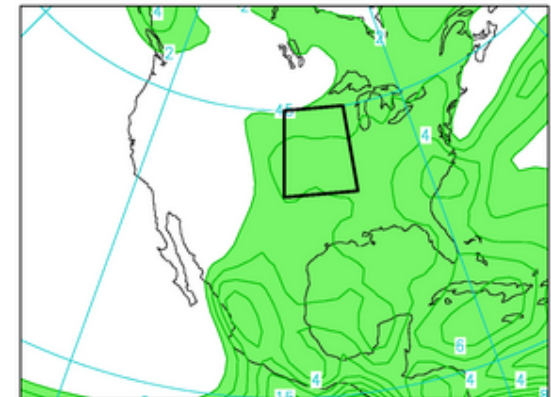
CCSM CTL Prec

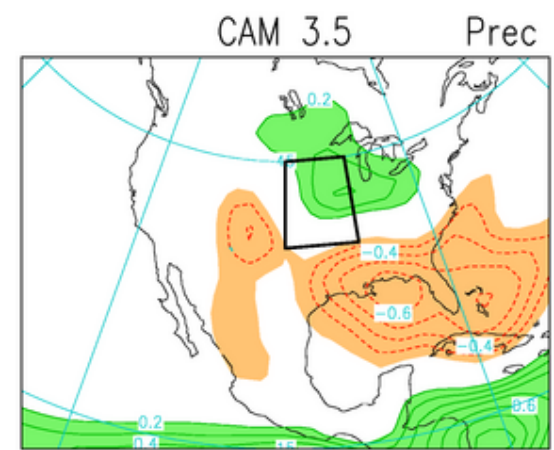
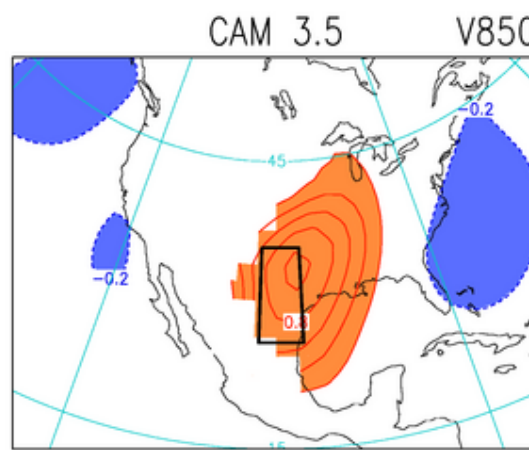
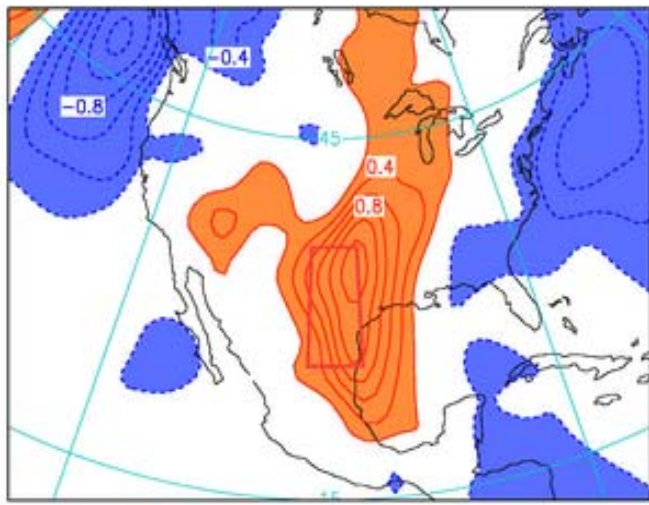


CCSM 2XCO2 V850

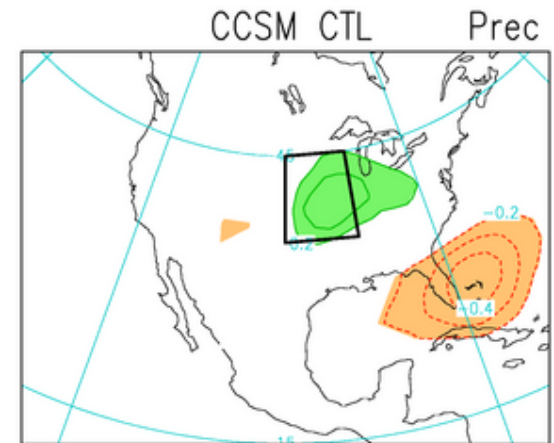
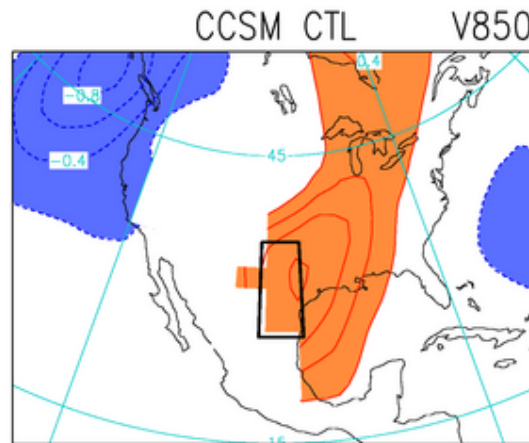


CCSM 2XCO2 Prec

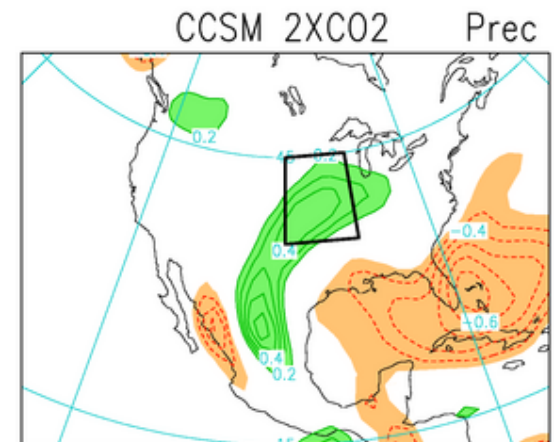
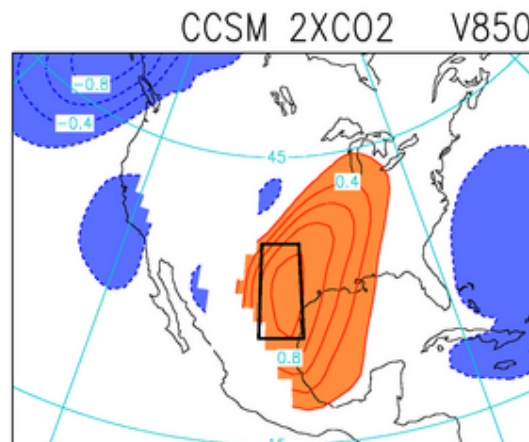




CAM 3.5 exhibits robust amplitude and position of GPLLJ and precipitation anomalies



CCSM control run depicts general variability features

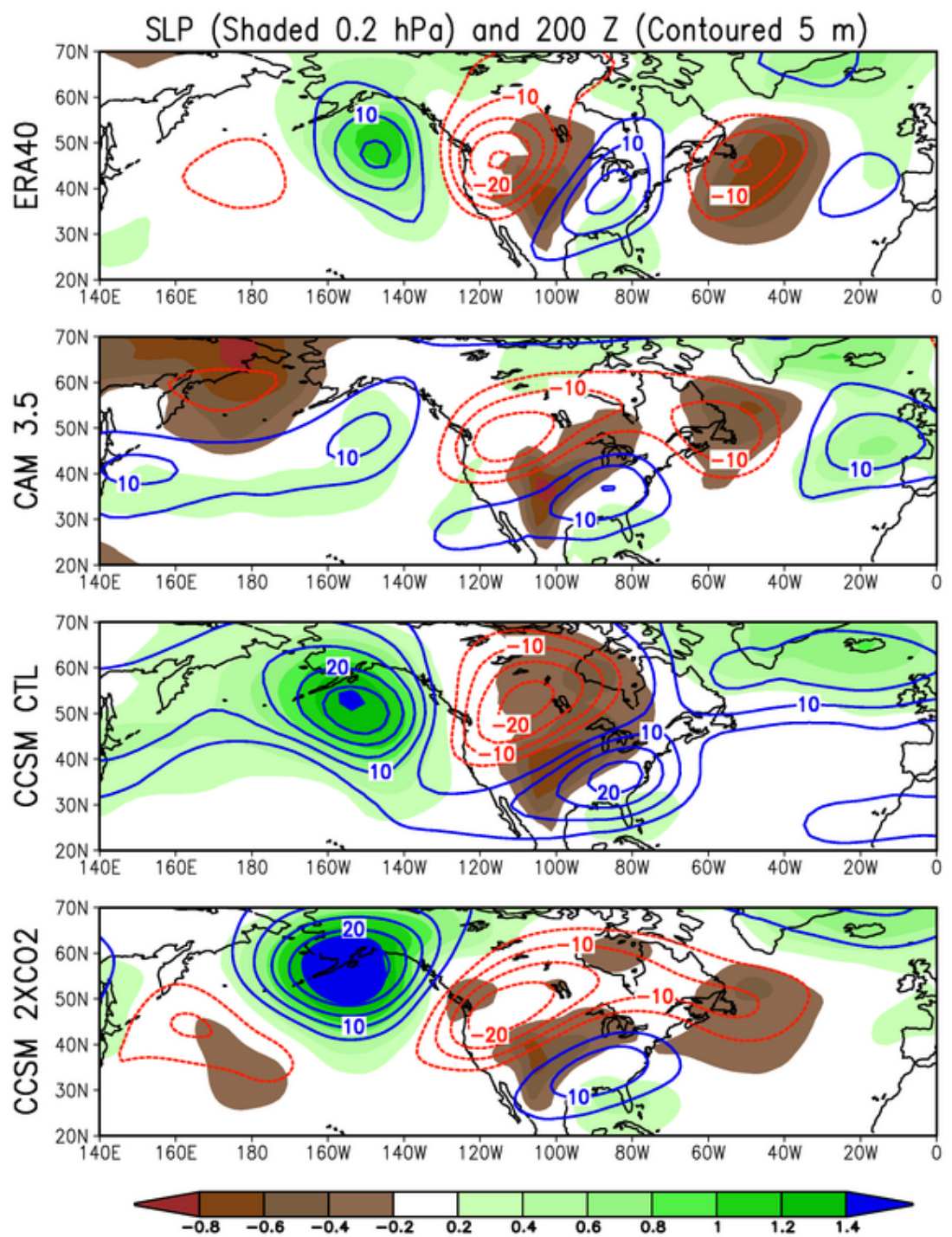


Anomalous precip shows interesting structure in 2XCO2 run



Model simulations and Reanalysis depict wave train with Pacific origin

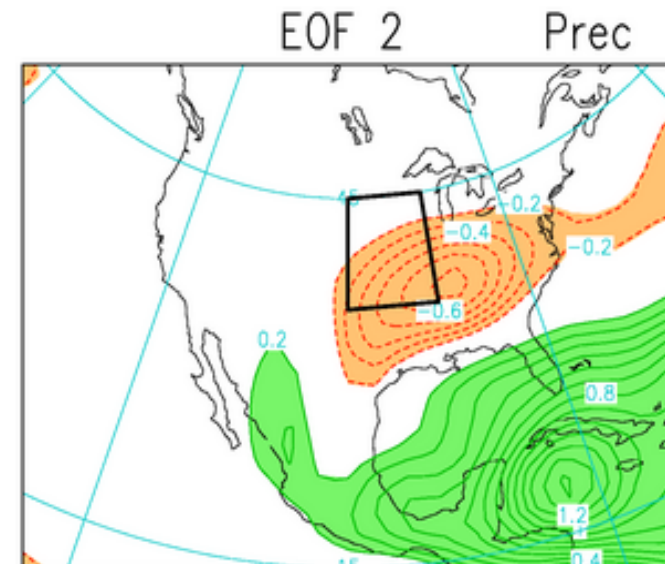
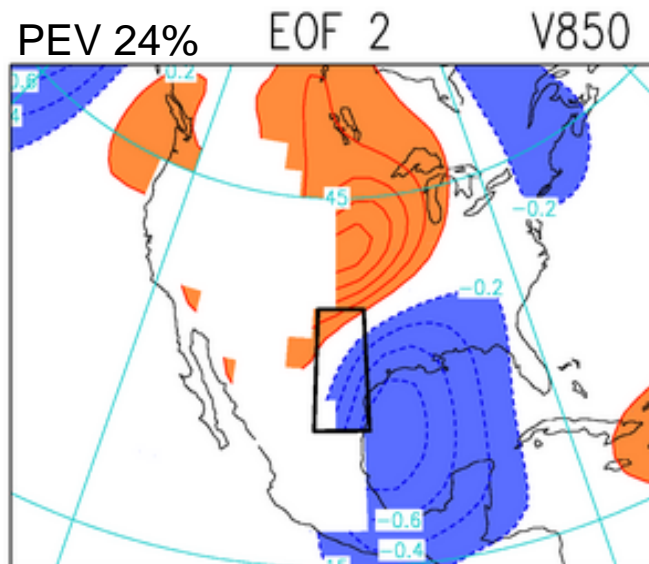
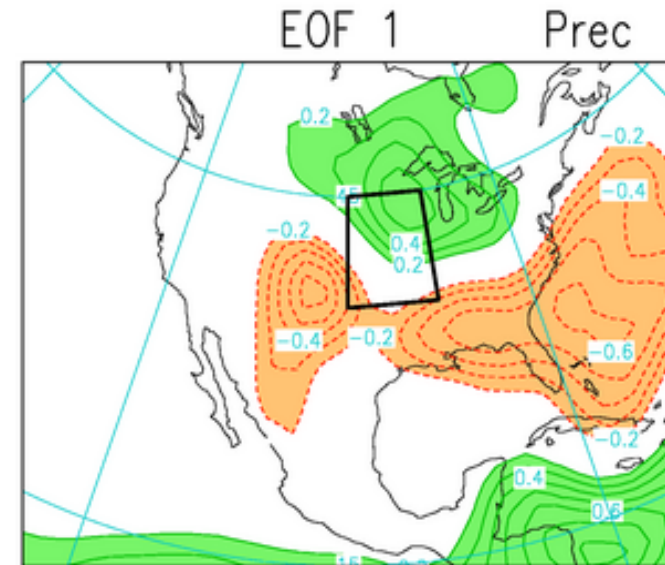
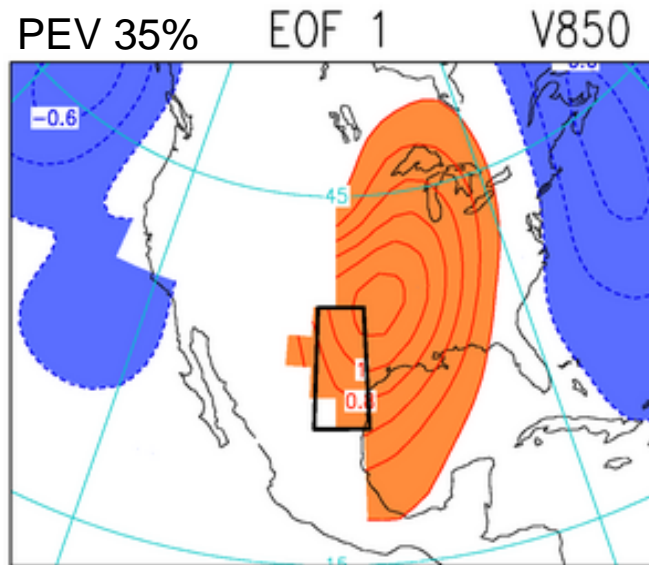
Absence of N. Atlantic negative height anomaly in CCSM 3 control run





# GPLLJ Variability Modes in the CAM 3.5

CAM 3.5 captures essence of the 2 leading GPLLJ variability modes and their precipitation impacts

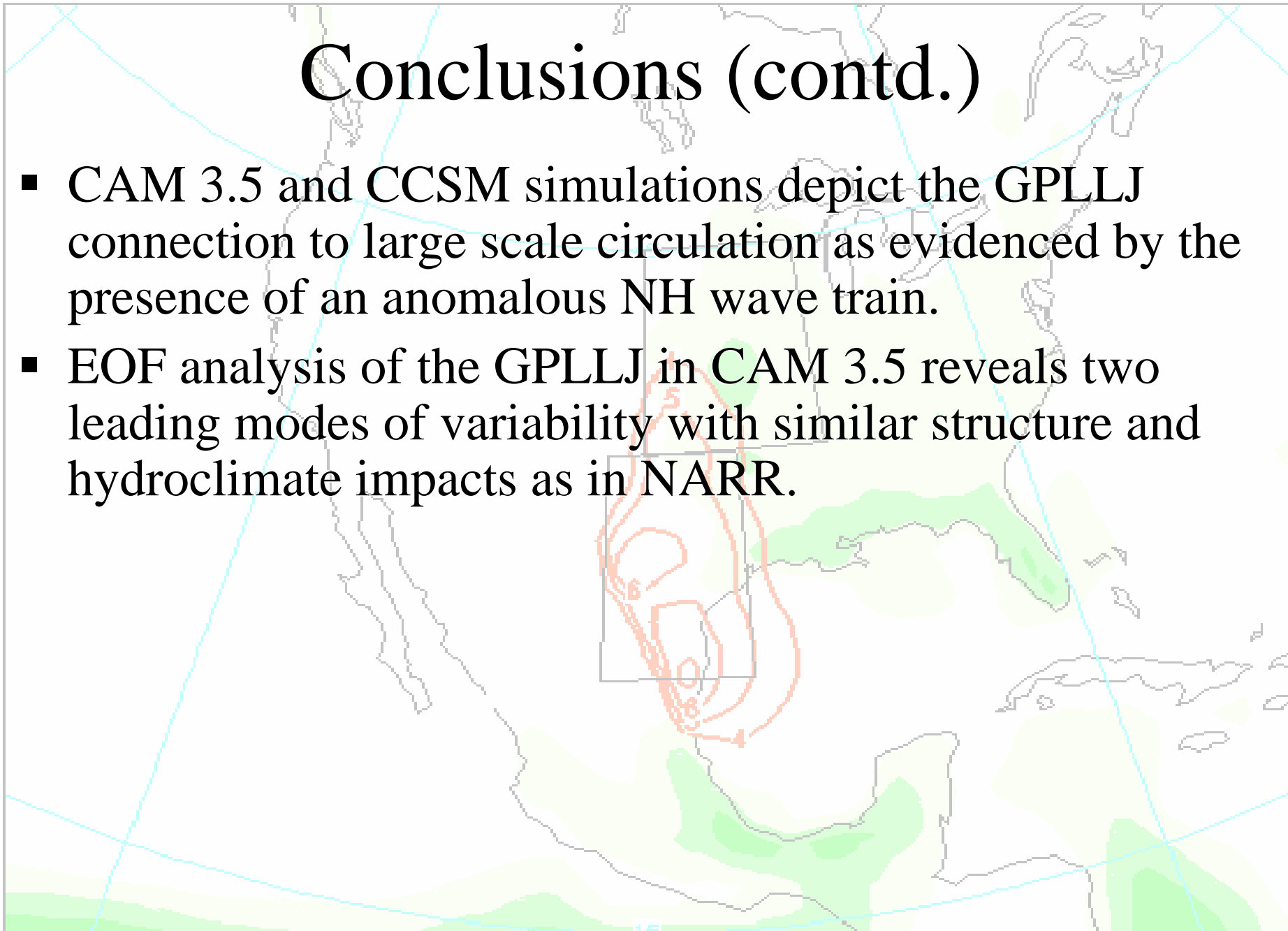


# Conclusions

- GPLLJ variability occurs in context of characteristic large-scale circulation patterns, indicating the significance of remote forcing
- Rossby wave source analysis reveals the importance of equatorial Pacific SST and diabatic heating anomalies in excitation of these large-scale circulation patterns
- EOF analysis links two prominent modes of GPLLJ variability with significant precipitation anomalies over the central and eastern U.S.
- CAM 3.5 and CCSM simulations capture features of GPLLJ climatology/variability and precipitation linkages
- 2XCO<sub>2</sub> shows strengthened jet in climatology (not precip.) and interannual variability (jet & precip.)

# Conclusions (contd.)

- CAM 3.5 and CCSM simulations depict the GPLLJ connection to large scale circulation as evidenced by the presence of an anomalous NH wave train.
- EOF analysis of the GPLLJ in CAM 3.5 reveals two leading modes of variability with similar structure and hydroclimate impacts as in NARR.





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