



# **A paleo-perspective on hydroclimate variations in the south-central US**

Chijun Sun

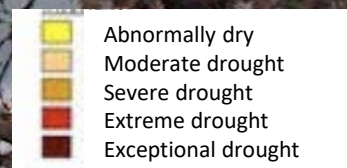
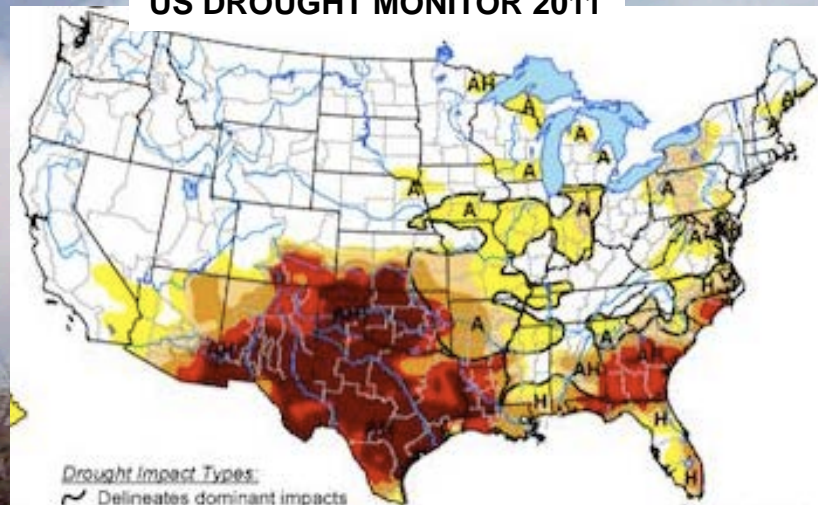
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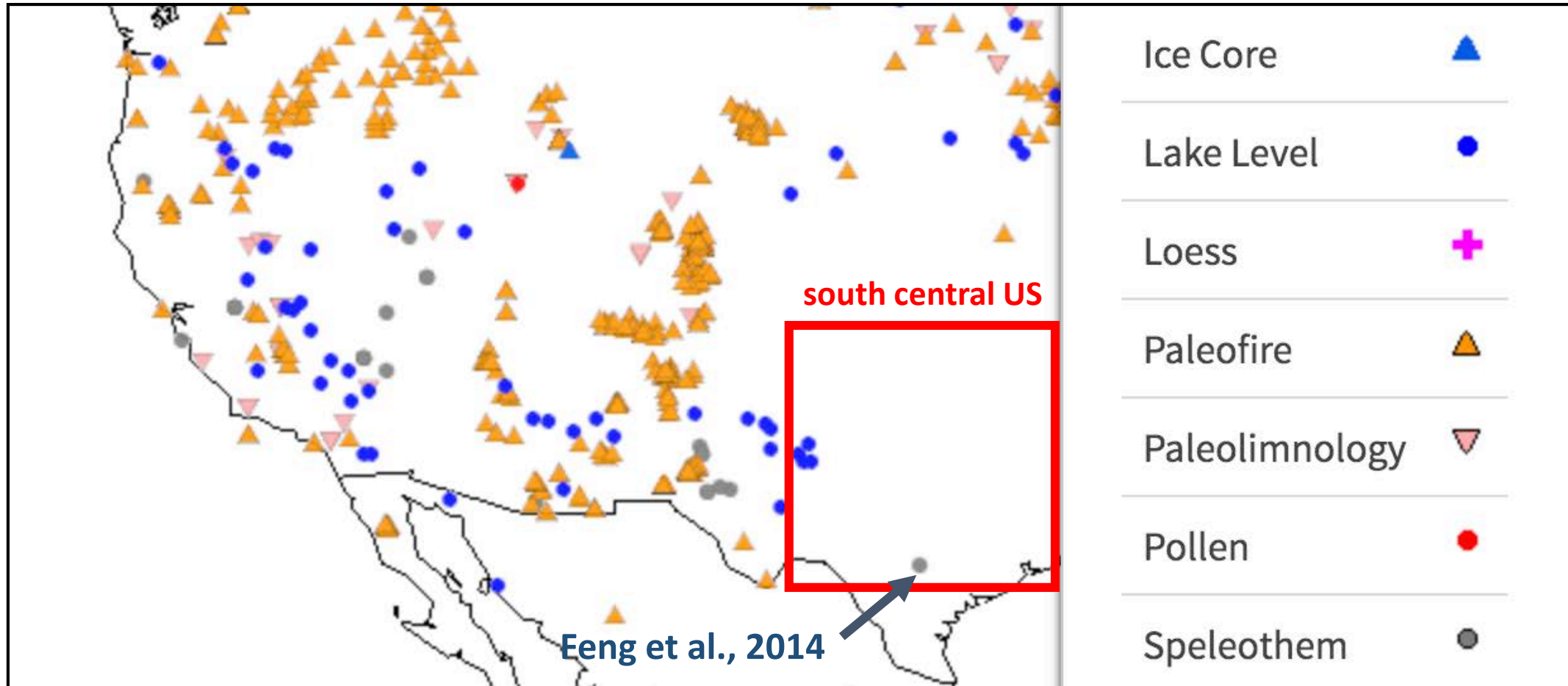
# 300 million trees killed

US DROUGHT MONITOR 2011



September 2011,  
Zilker Park, Austin TX

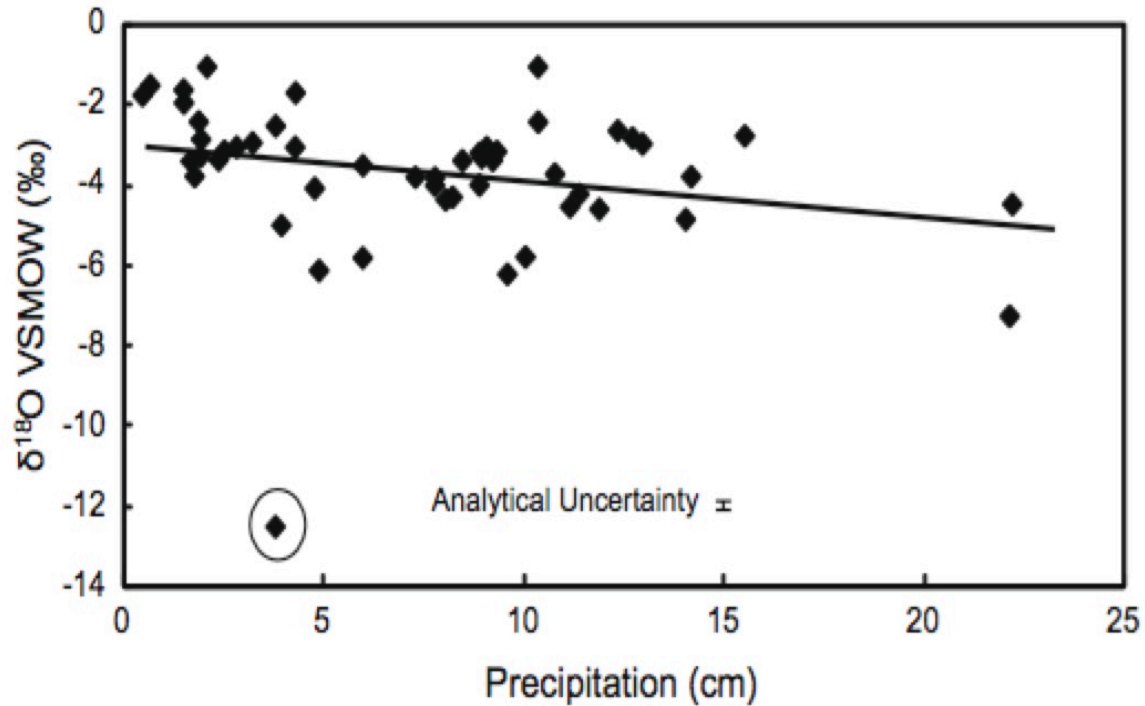
# Paleoproxy perspective on the western US



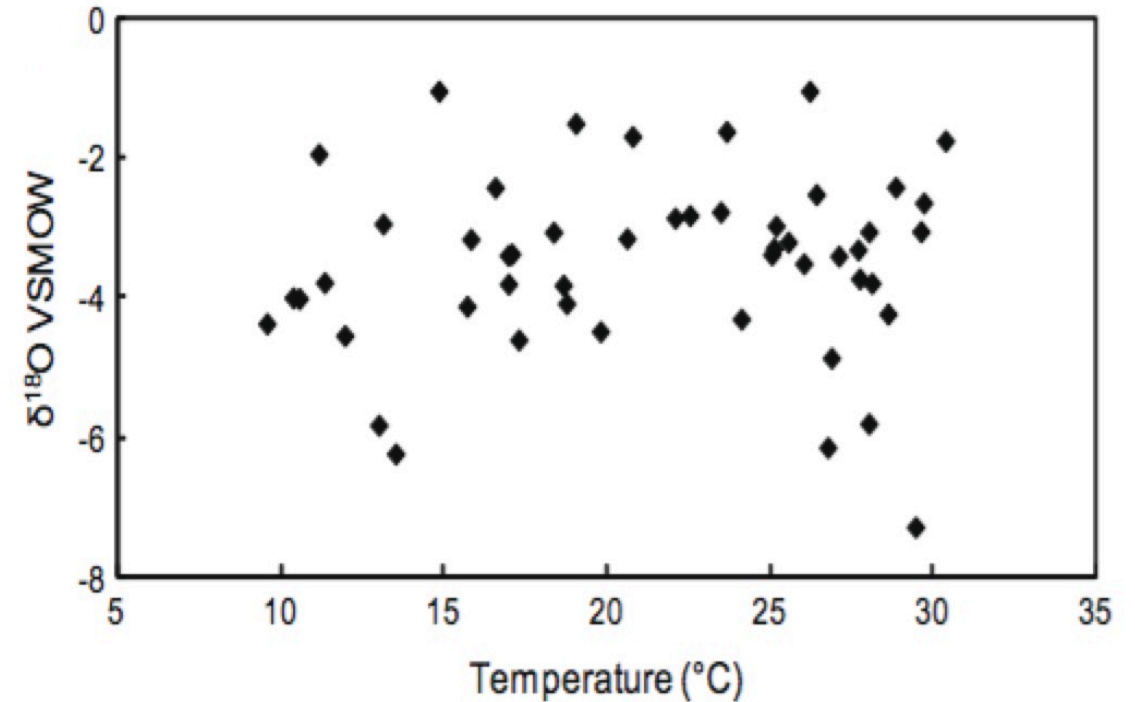
Paleoclimate data in the World Data Center for Paleoclimatology archive (downloaded Feb 28, 2018)

# Understanding the stable isotope ( $\delta D$ , $\delta^{18}O$ ) composition of precipitation in the south central USA

Amount effect: weak



Temperature effect: None



~ monthly precipitation data for Austin, TX 1999-2007 (Pape et al., 2010)

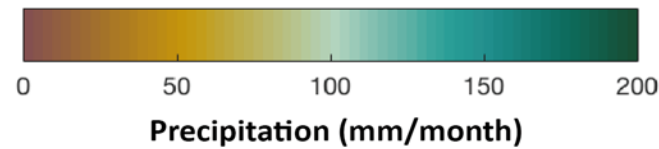
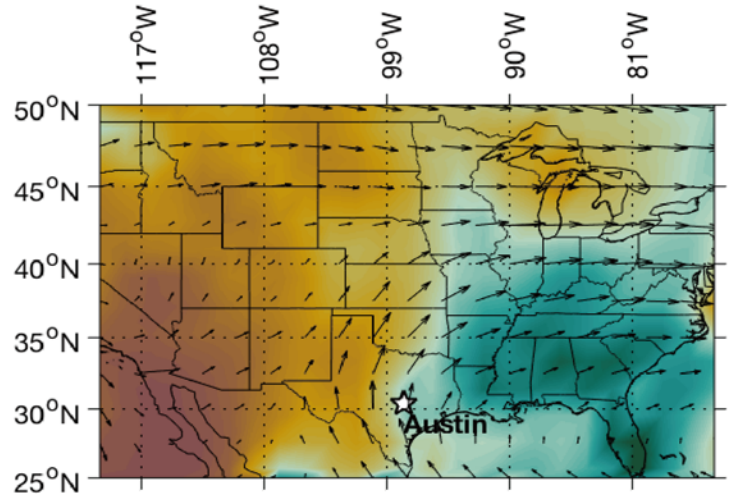
# New insights into isotope controls from event-based sampling

- Trajectory tracing of sources
- Averaging issues with monthly data (temperature, precipitation, humidity)
- Rainfall type characterization (convective, stratiform)

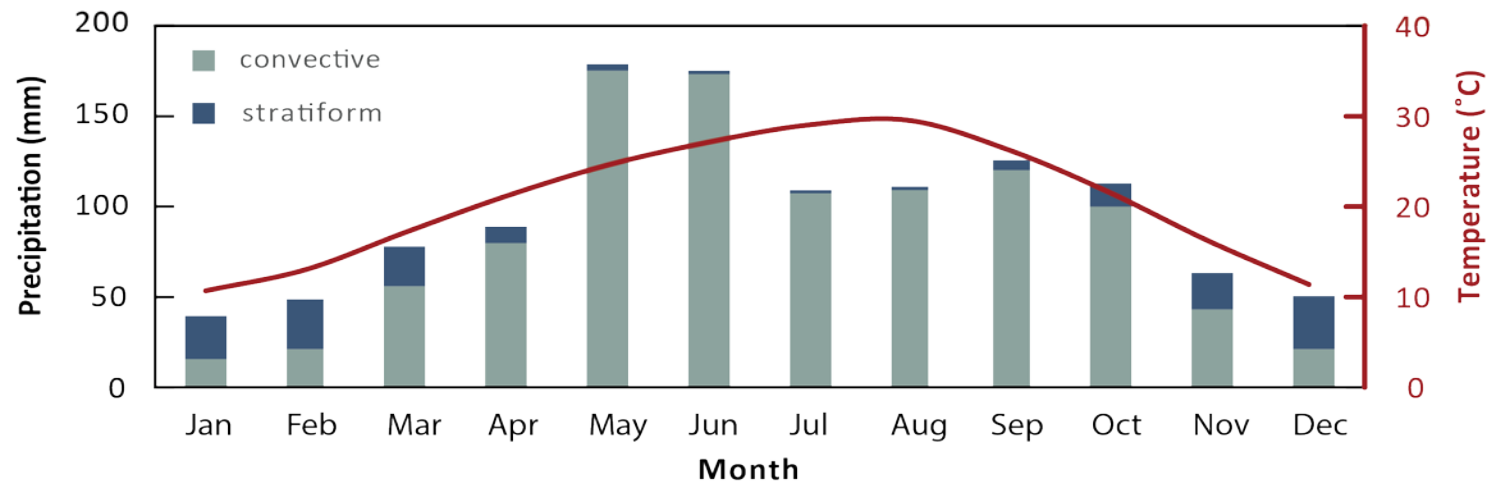
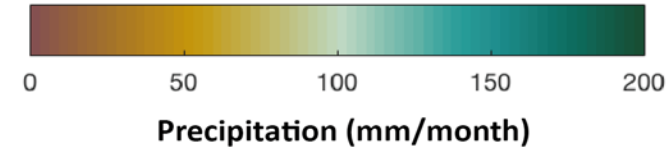
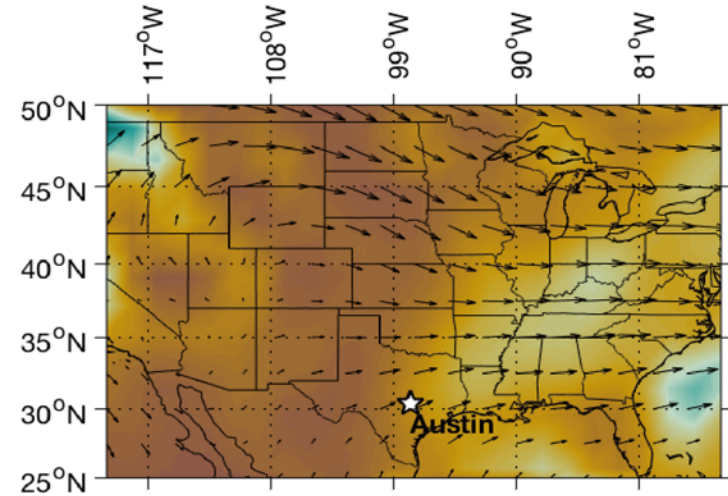


# Study area: modern climatology

**Warm Season:**  
March -  
November

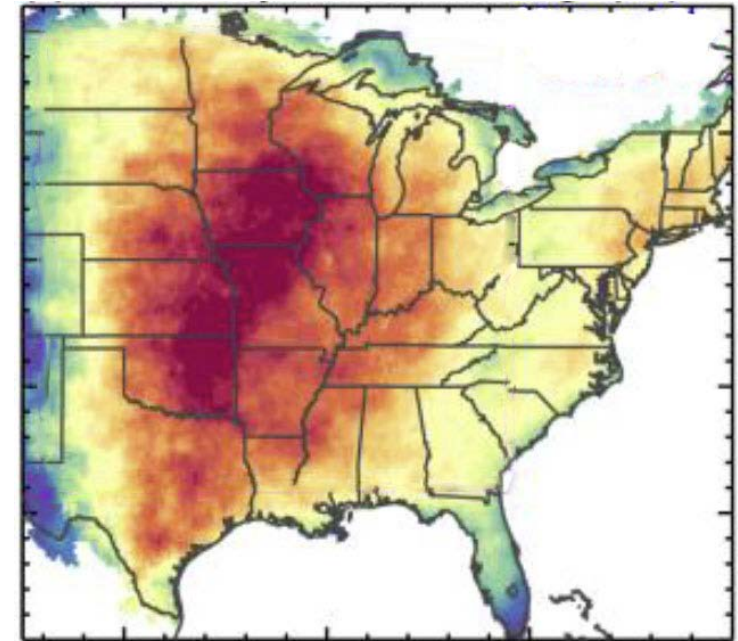
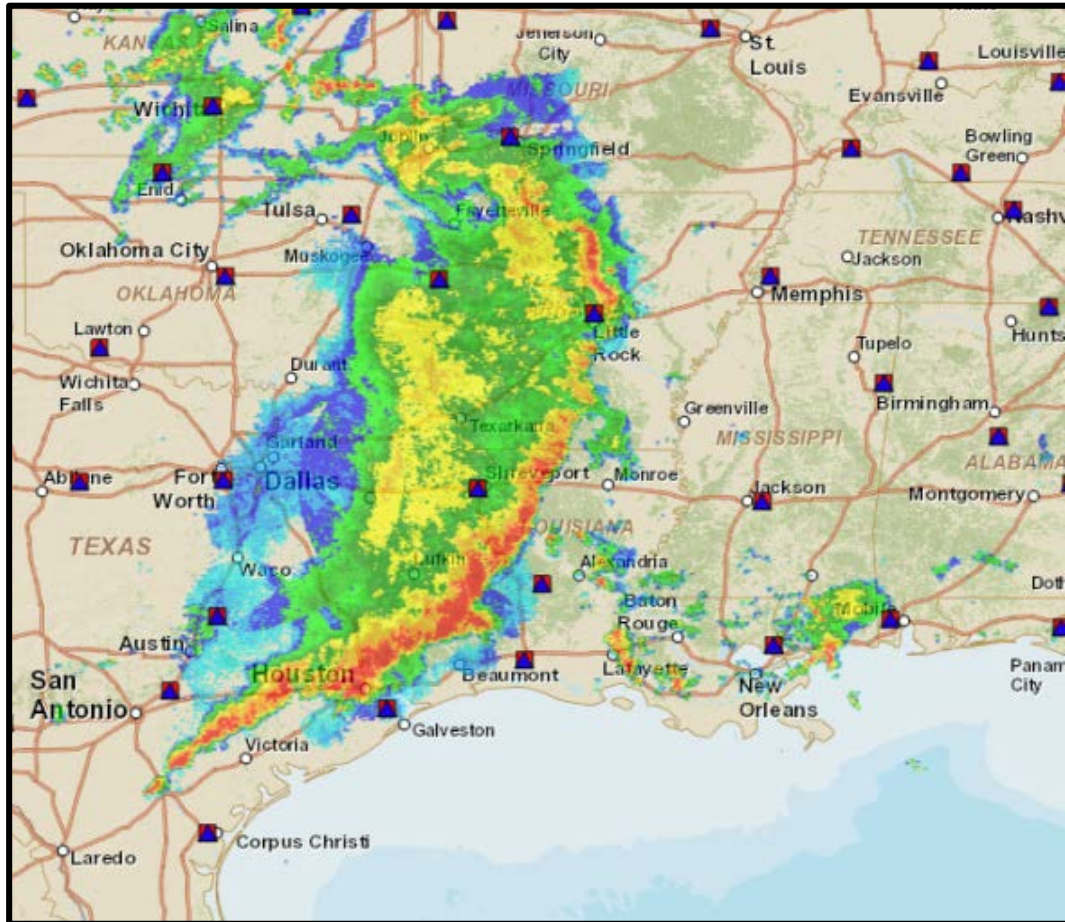


**Cold Season:**  
December -  
February

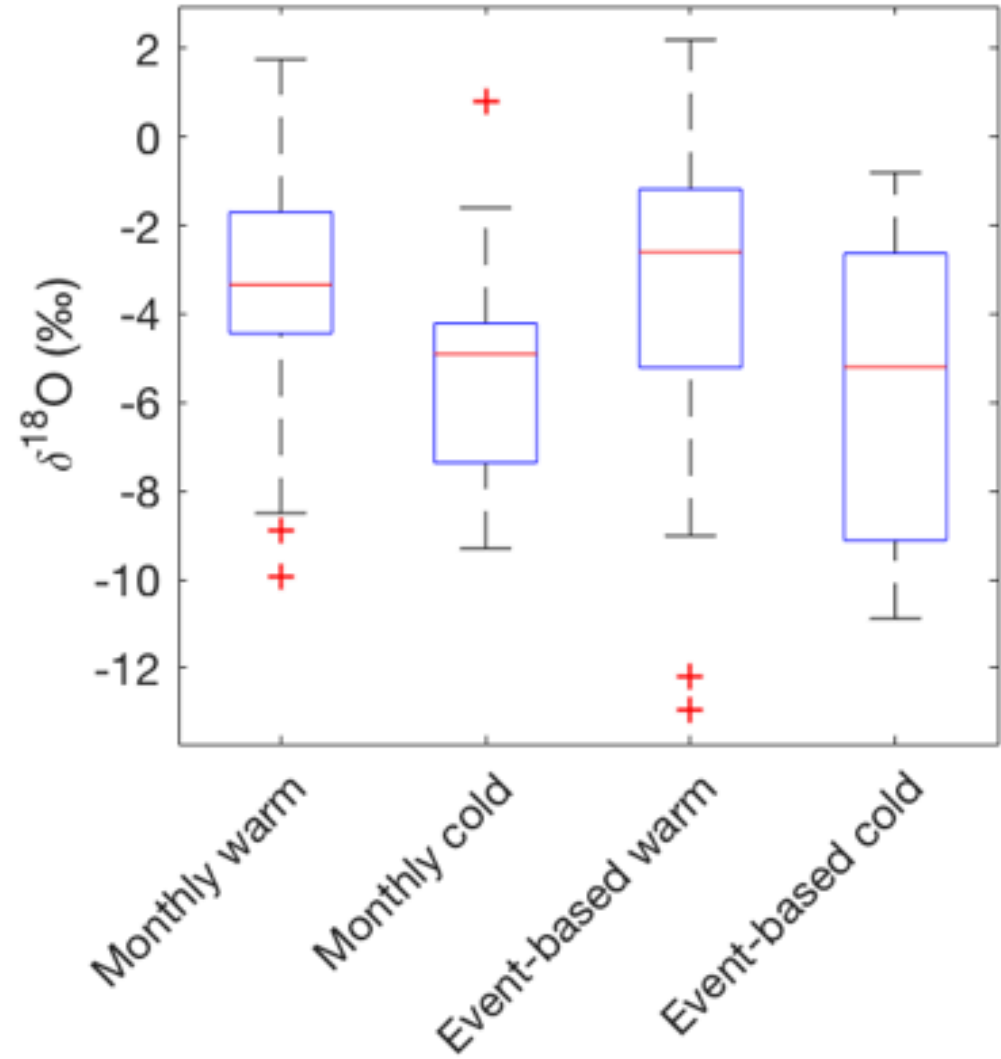
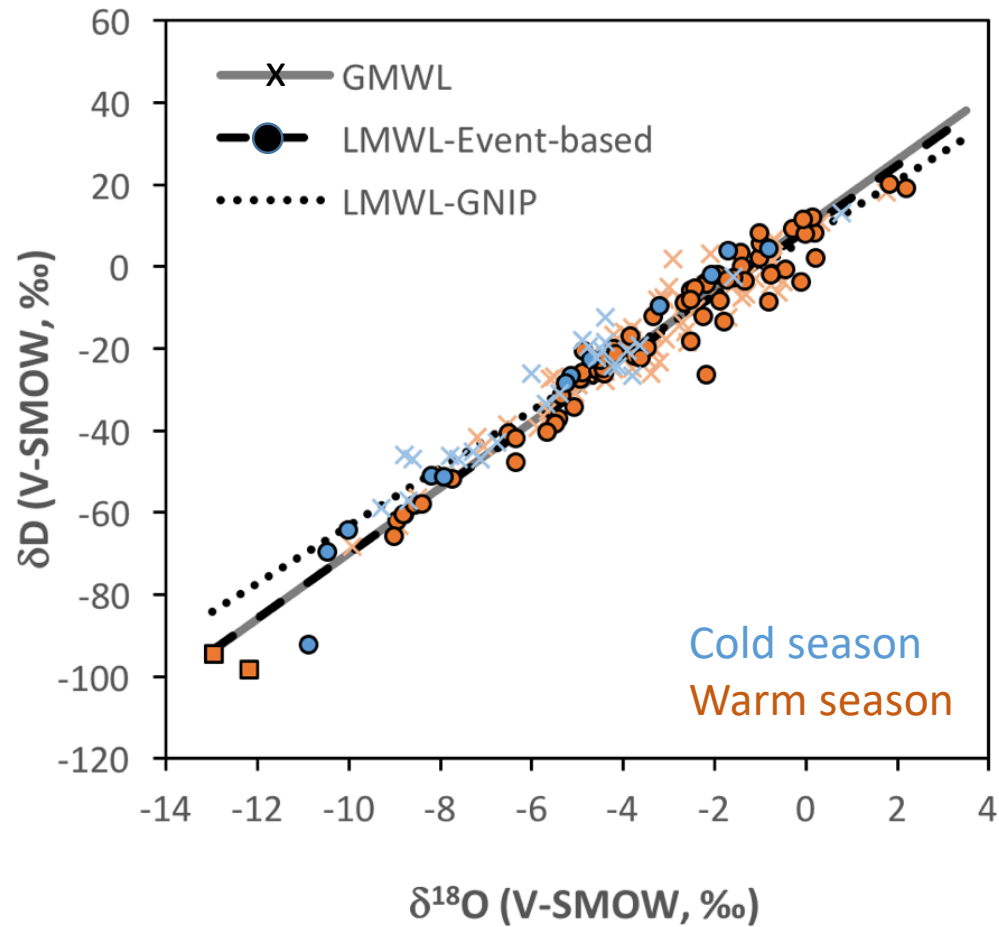


# Study area: modern climatology

Warm season precipitation:  
MESOSCALE CONVECTIVE SYSTEMS (MCS) AND THE LOW-LEVEL JET (LLJ)



# Seasonal control on stable isotopes

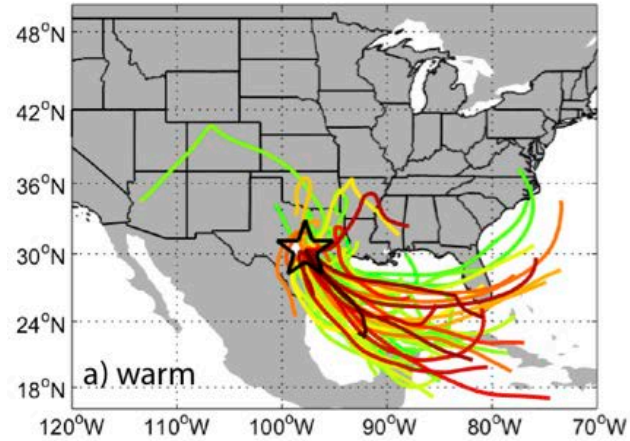




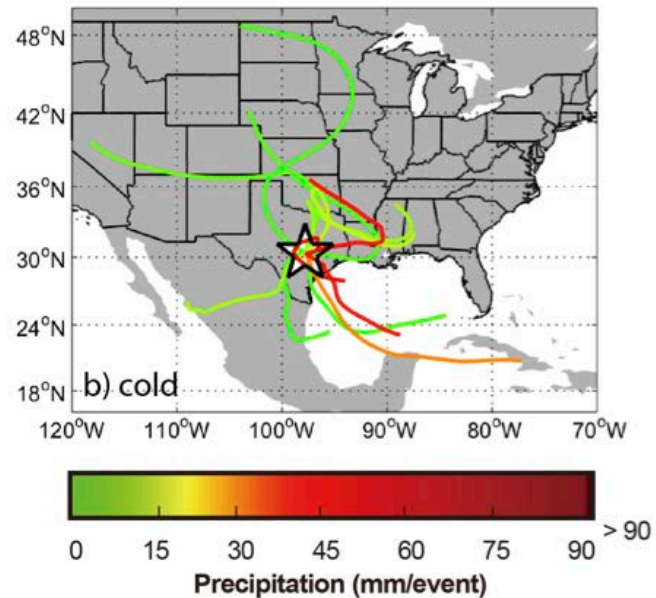
# Seasonality and source effects

2015-2017 event data

Warm season

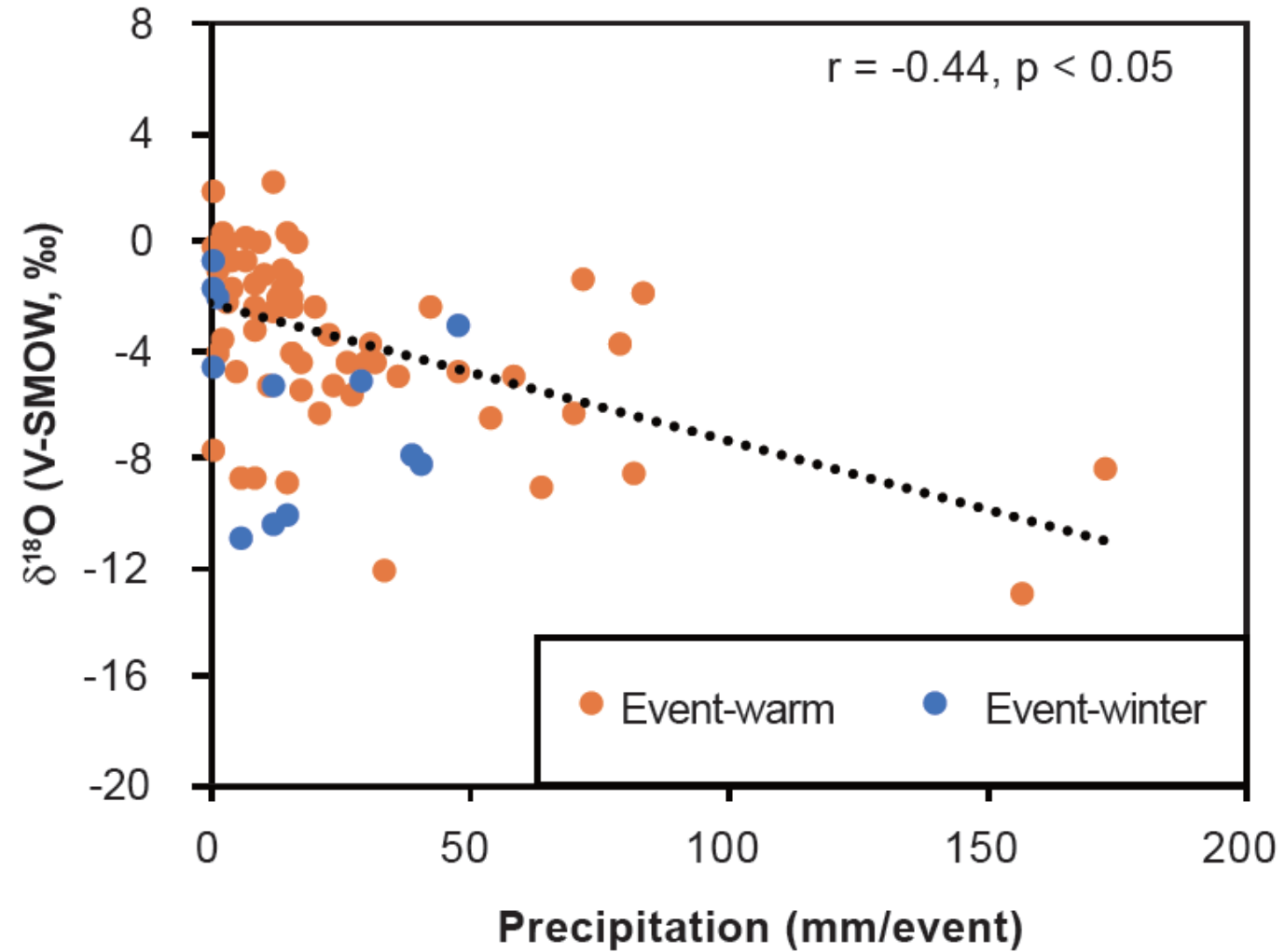


Cool season

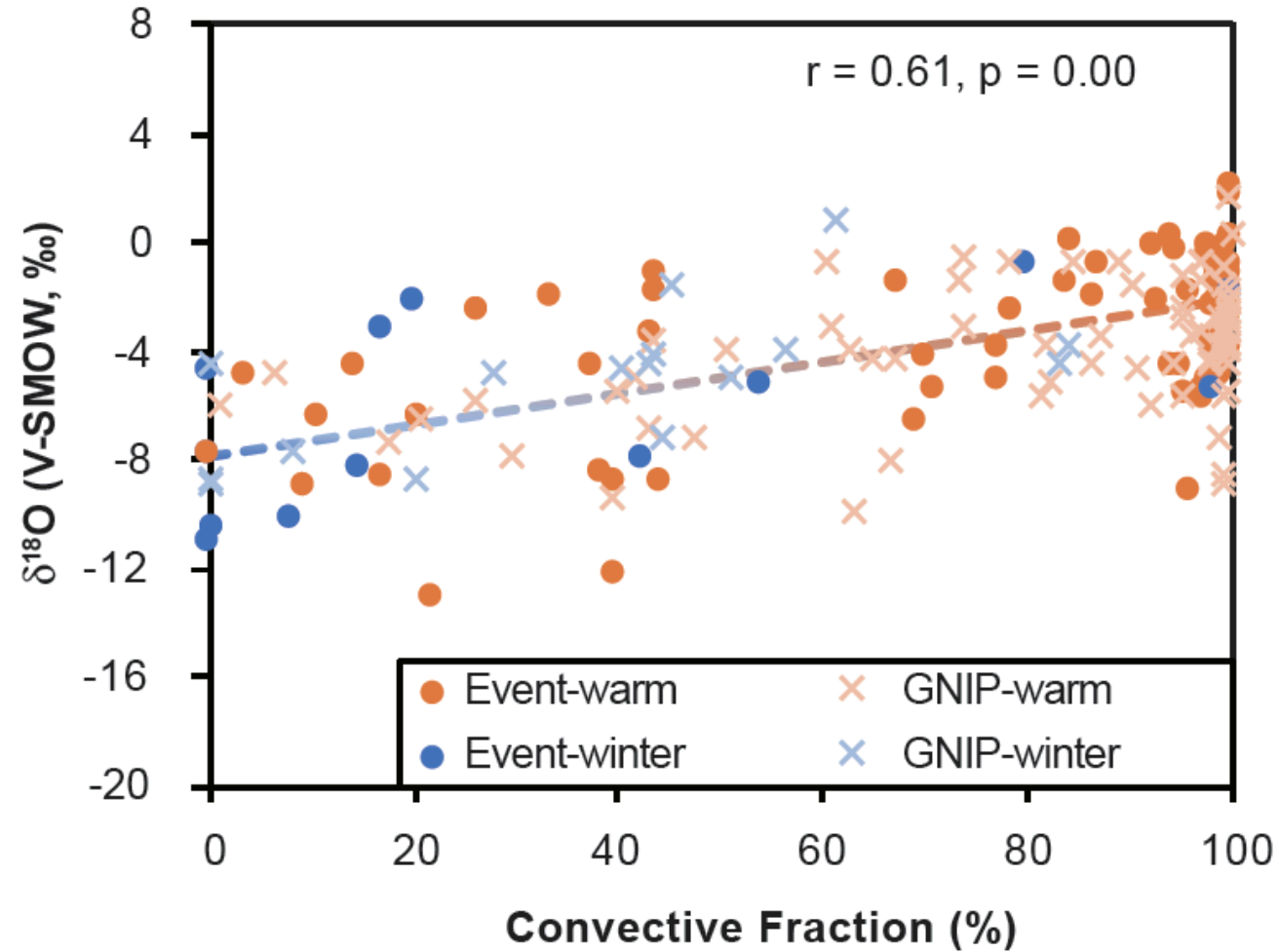


From Sun et al., in prep  
Moisture back trajectories  
generated using NOAA Hysplit

# Precipitation amount control

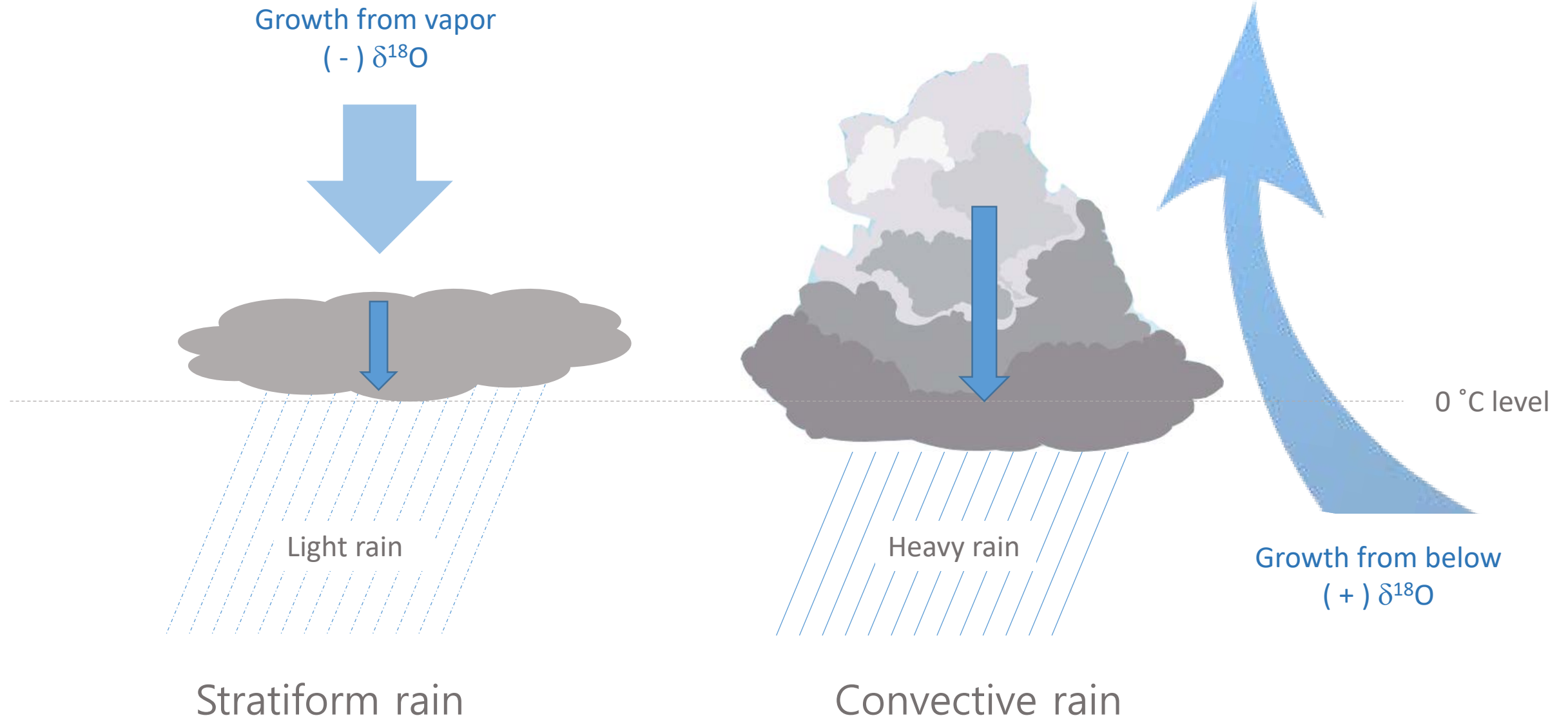


# Precipitation type control



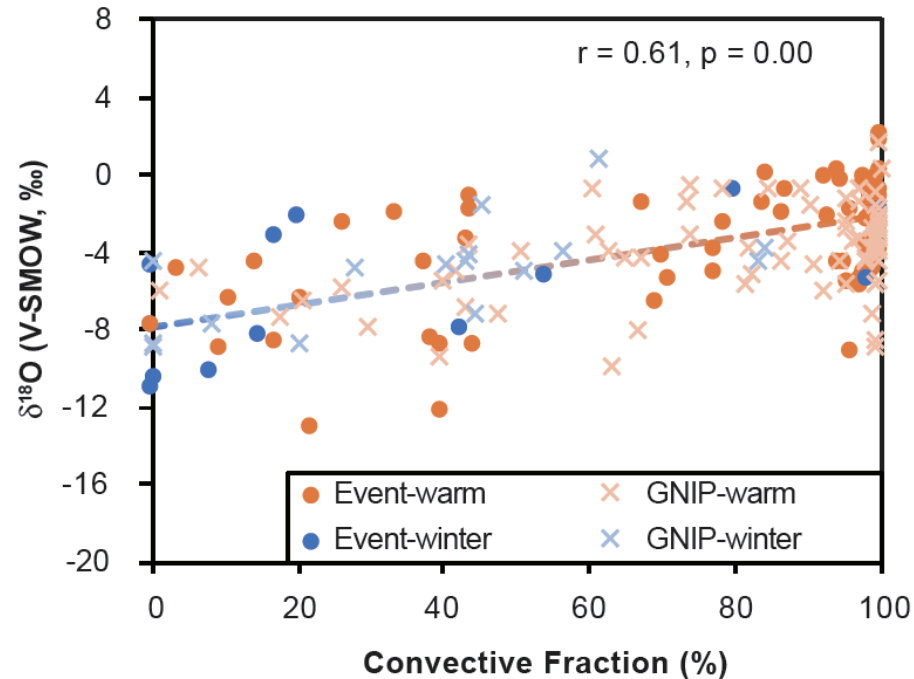
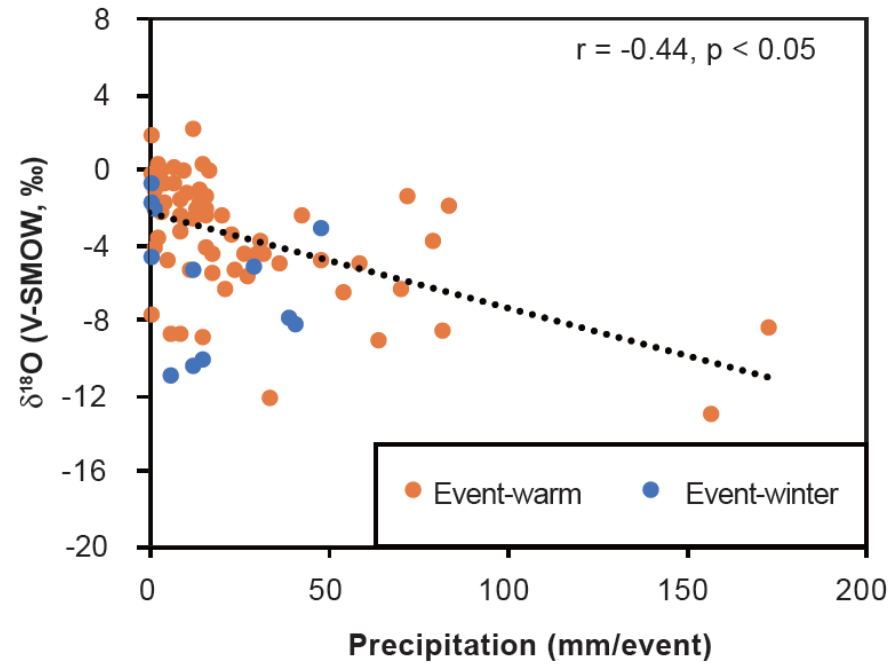
Convective fraction data from: North American Land Data Assimilation System

# Precipitation type control

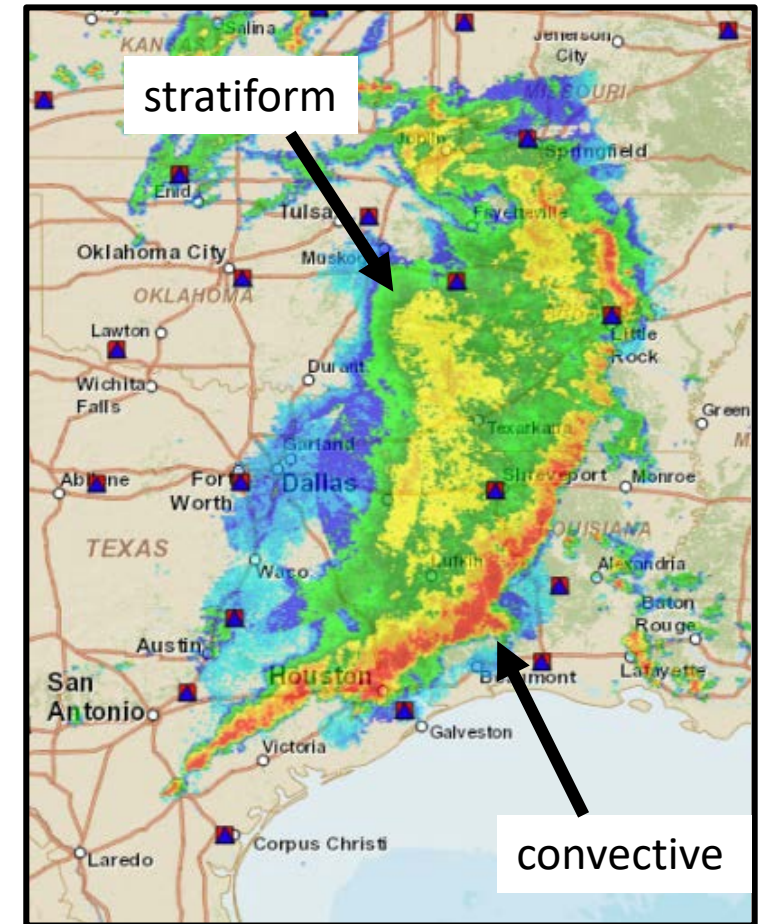


# Reconciling two conflicting observations

- More precipitation = more *negative*  $\delta^{18}\text{O}$
- More convective = more *positive*  $\delta^{18}\text{O}$

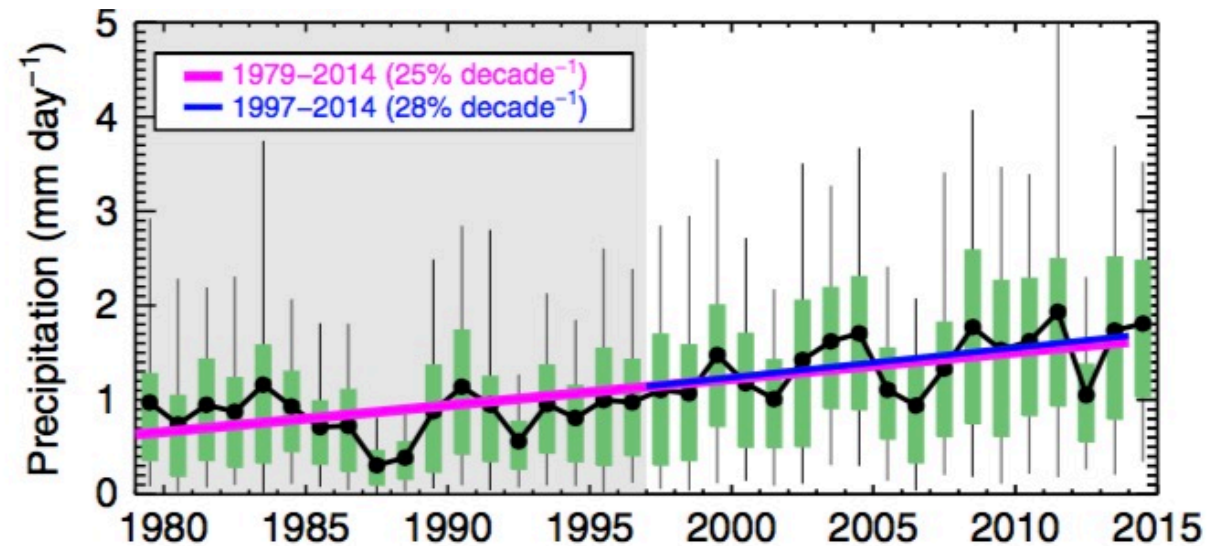
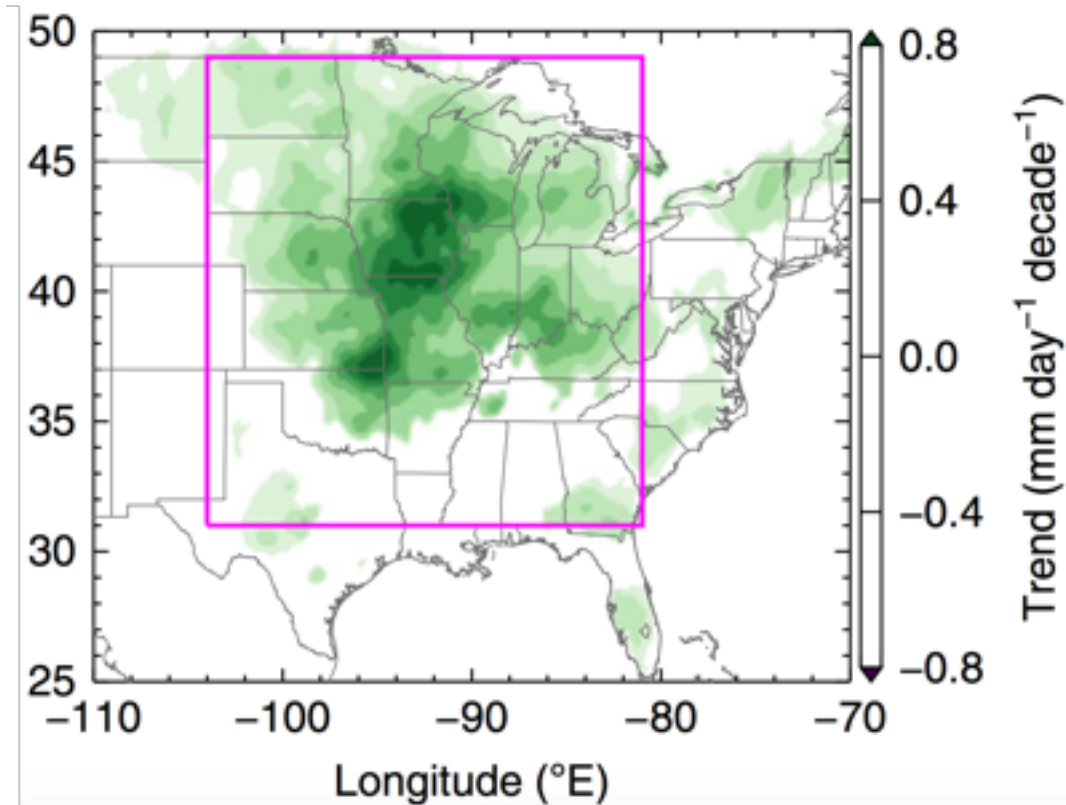


Mesoscale convective systems – lots of stratiform precipitation



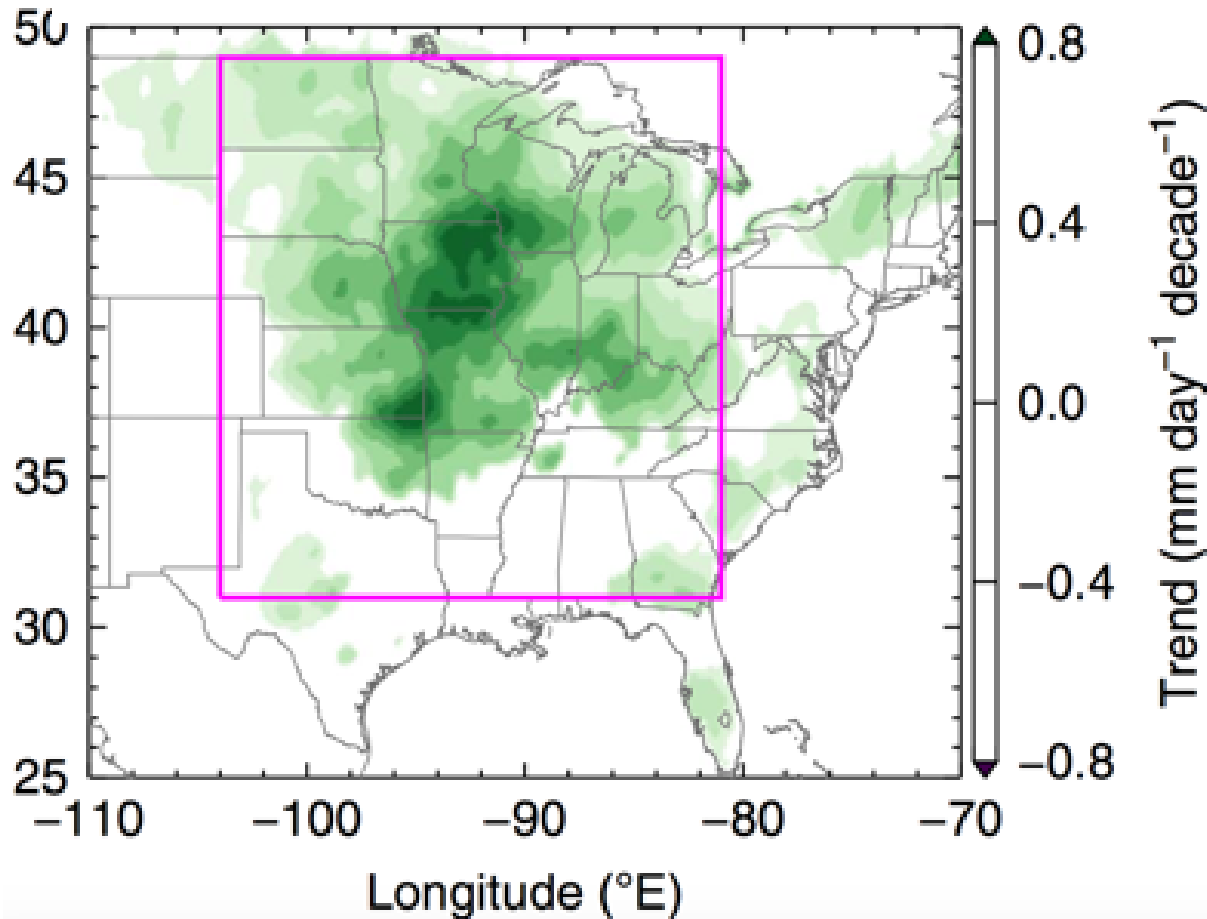
# Increasing frequency and intensity of MCS's

Spring MCS precipitation 1979-2014

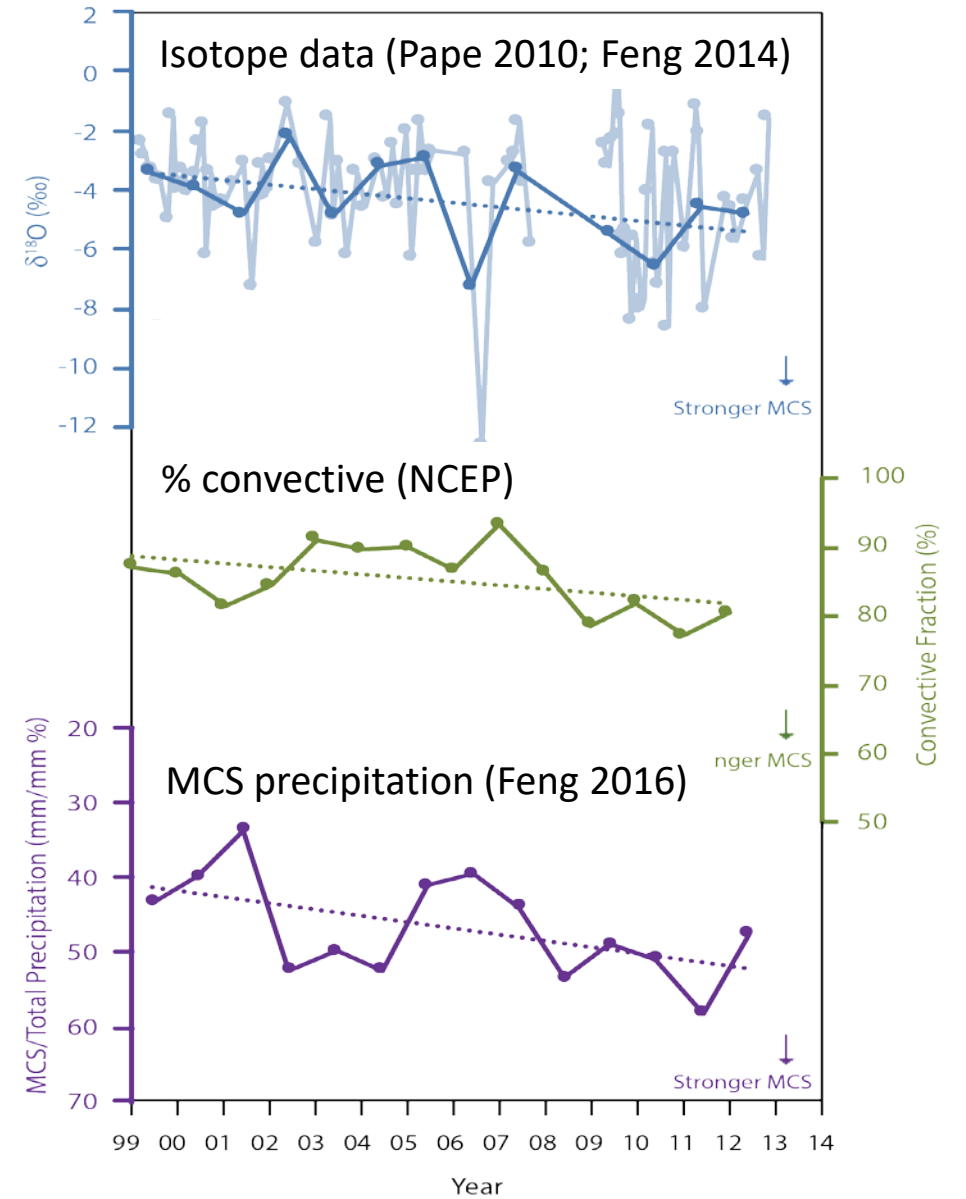


# Long-term instrumental isotope data consistent with increasing MCS

Summer MCS precipitation 1979-2014



Feng et al., 2016



# What about the paleo-perspective on climate changes in the south central US?

Hall's Cave, Texas

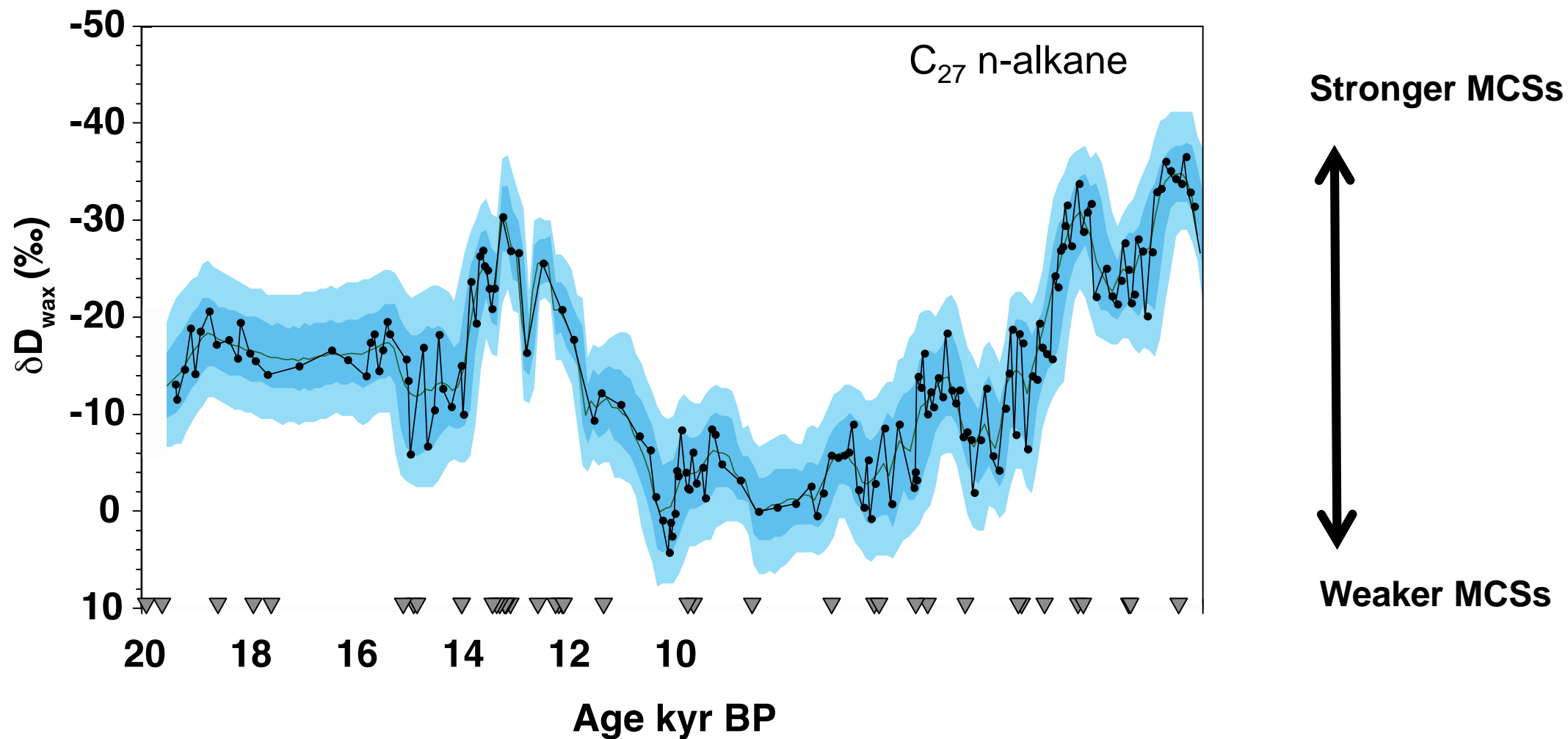


2°W 98°W 94°W 90°W



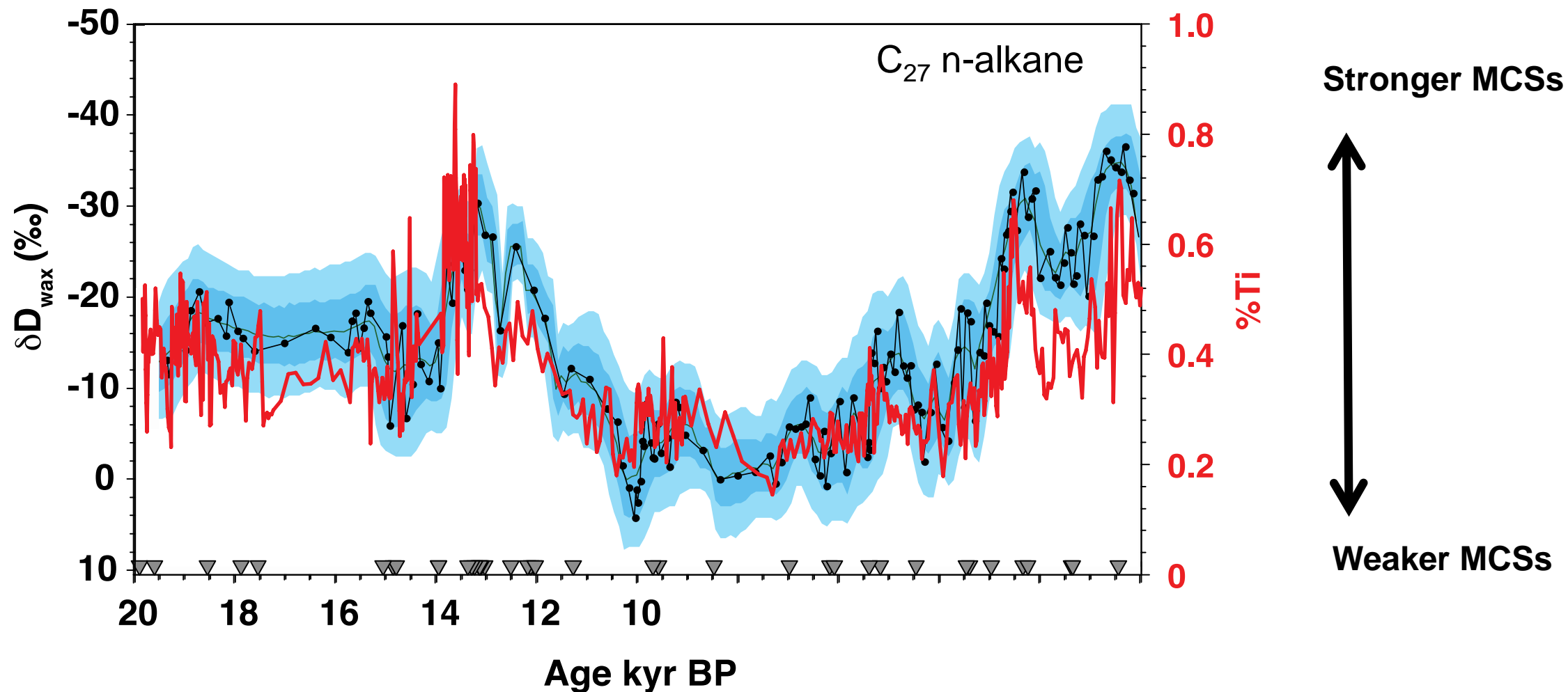


# Hall's Cave: hydrogen isotopes in leaf waxes



\*  $\delta D_{WAX}$  record corrected for biosynthetic fractionation and ice volume changes

# Hall's Cave: hydrogen isotopes in leaf waxes

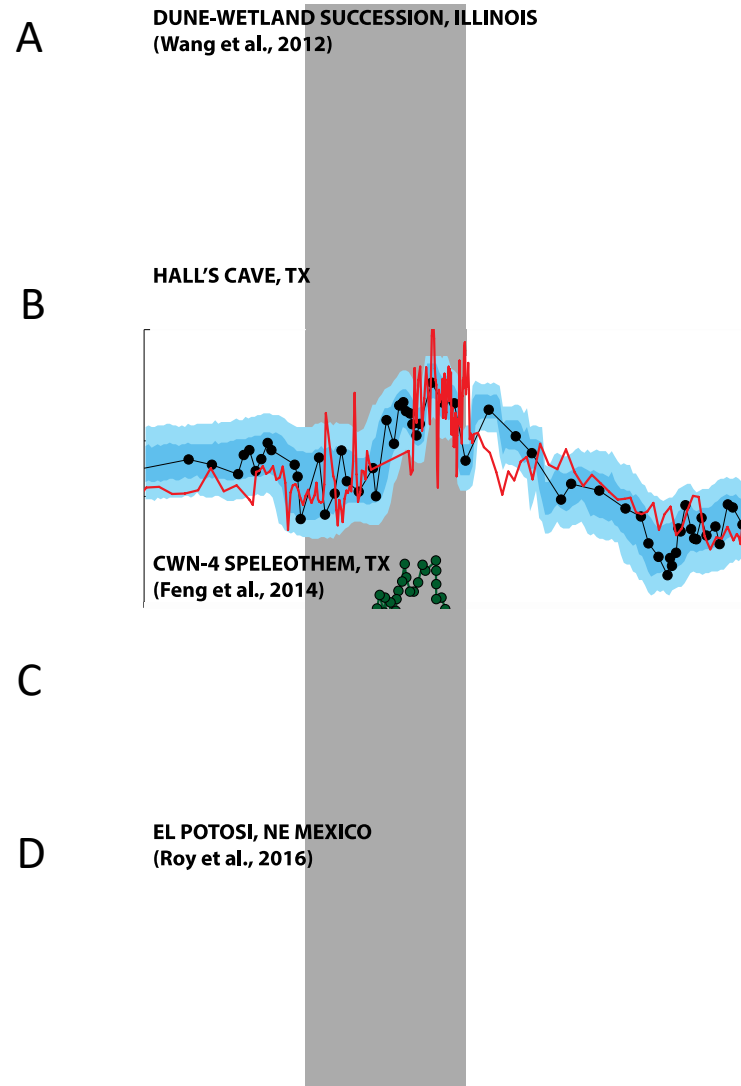


\*  $\delta D_{WAX}$  record corrected for biosynthetic fractionation and ice volume changes

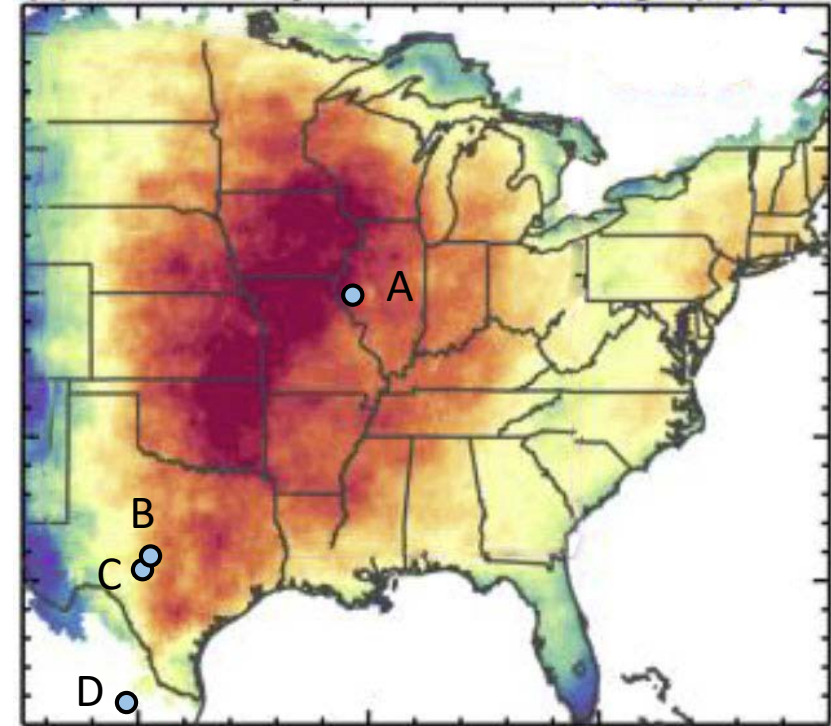


Thanks!!

# Bolling-Allerod LU intensification



Greyscale



# Vegetation changes from d13C reflect

