ASSESSING THE CAUSES OF 20th CENTURY WETTING IN THE EASTERN US

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Featuring: **Park Williams, Richard Seager, Arlene Fiore, Benjamin Cook, Justin Mankin, Deepti Singh, Jason Smerdon, Mukund Rao**

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Lamont-Doherty Earth Observatory
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New Orleans | 11-15 December 2017

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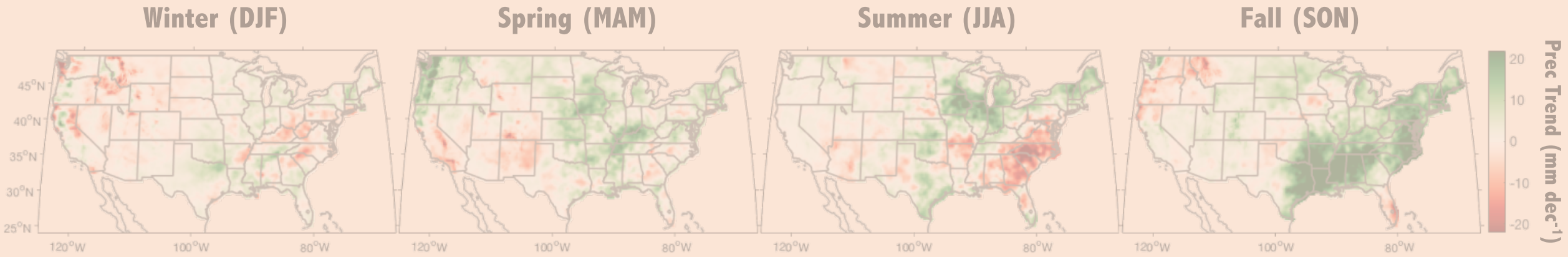
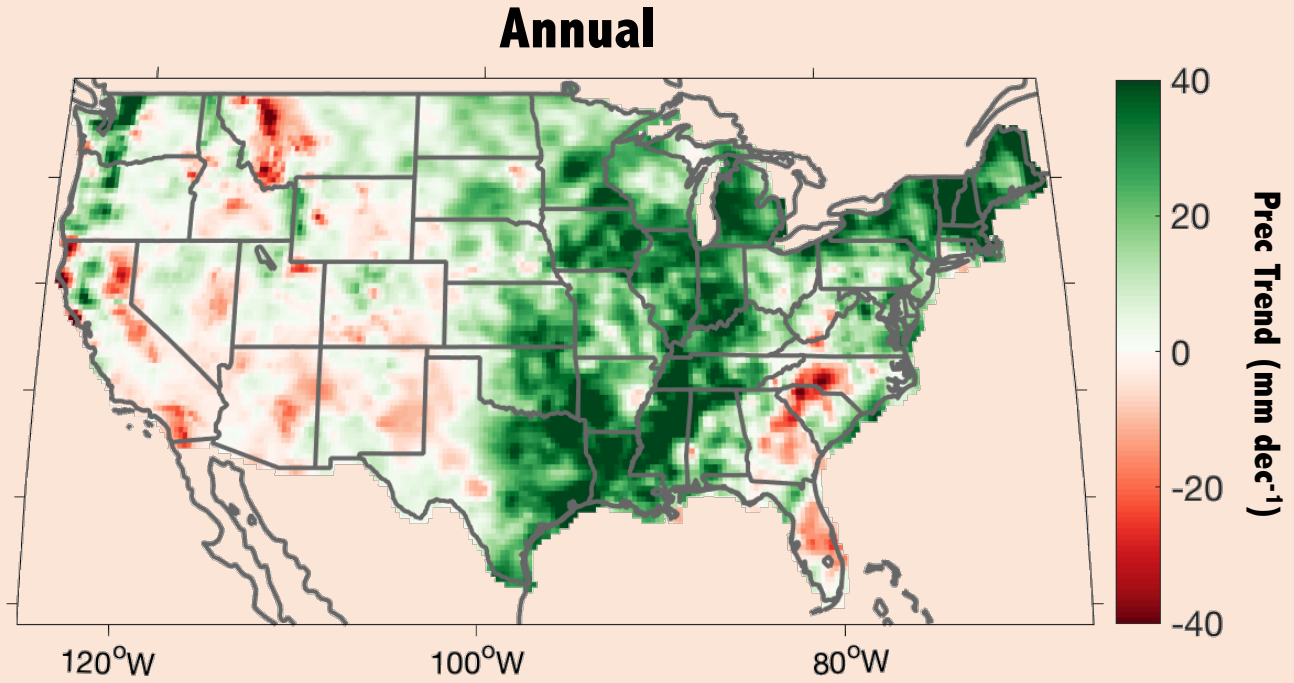
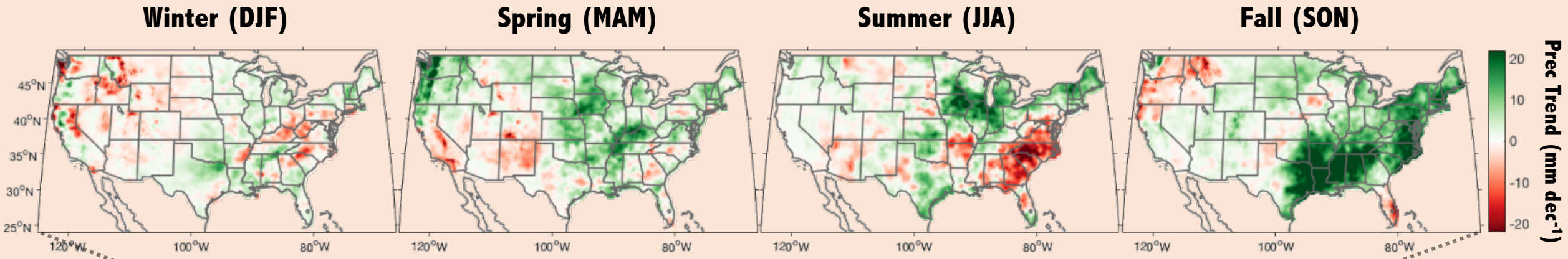
Positive precipitation trend east of 100°W (1895-2016)



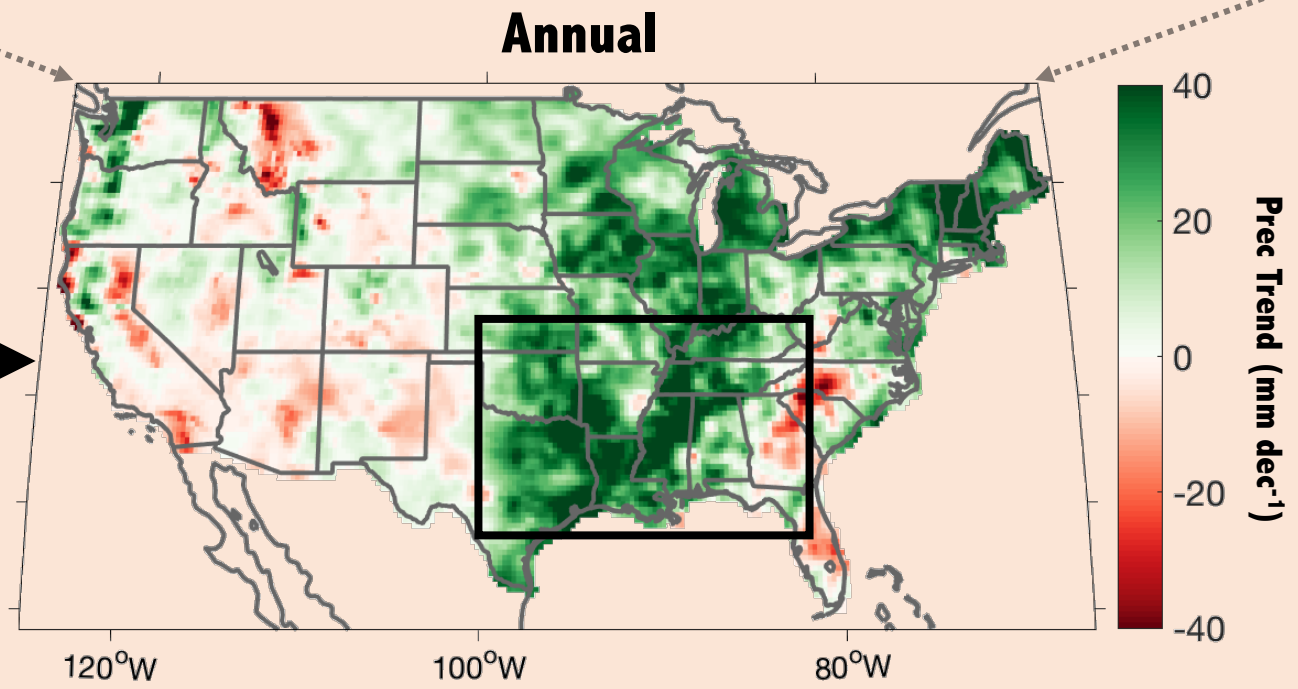


Data: *NOAA GHCN Climgrid*
Source: *Vose et al. 2014*
Timespan: *1895-2016*

Which seasonal contribution is most pronounced?



10% Increase in Annual SE Precipitation 1895-2016



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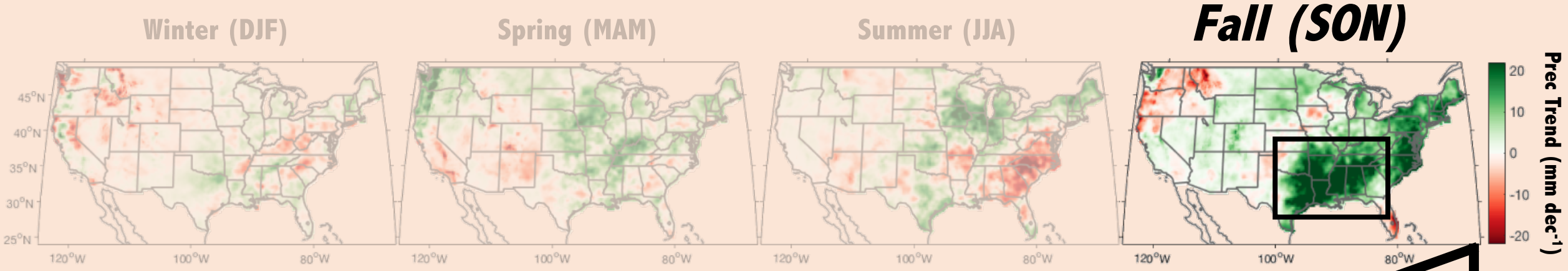
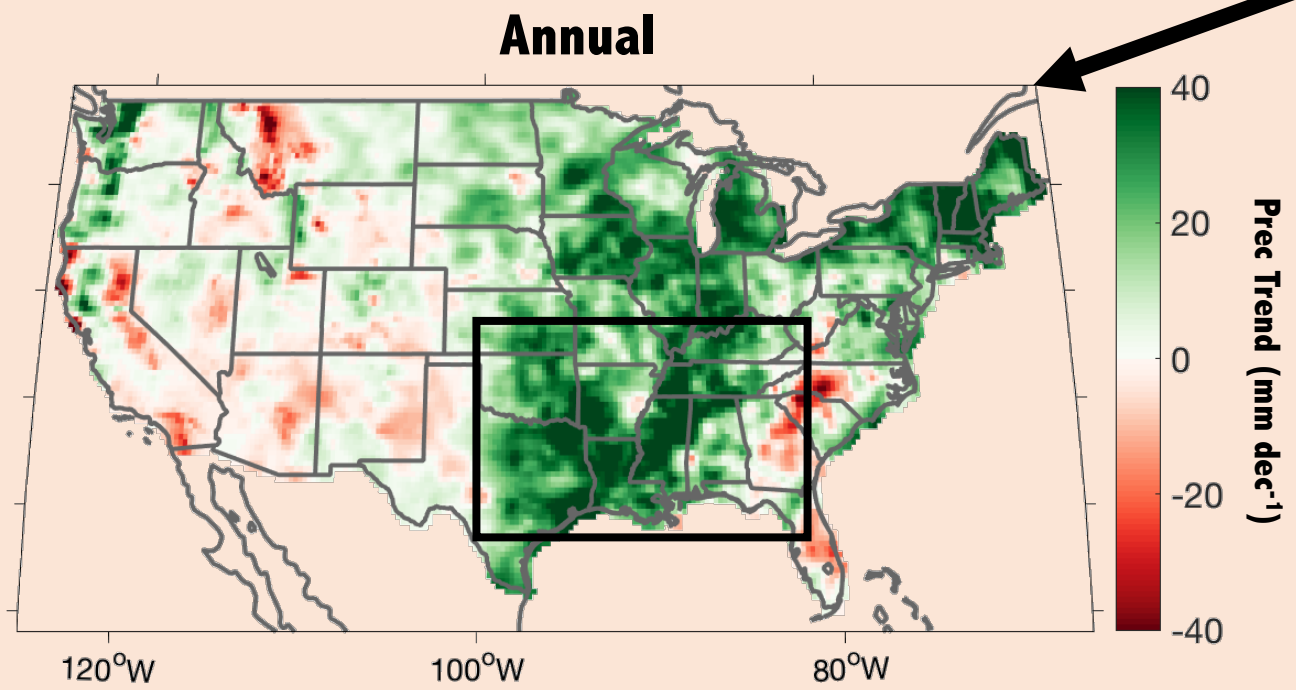
Source: *Vose et al. 2014*
Timespan: *1895-2016*

Fall is primary contributor to total annual SE wetting





10% Increase in Annual SE Precipitation 1895-2016

37% Increase in Fall SE Precipitation 1895-2016

Data: *NOAA GHCN Climgrid*
Source: *Vose et al. 2014*
Timespan: *1895-2016*

Motivating Question

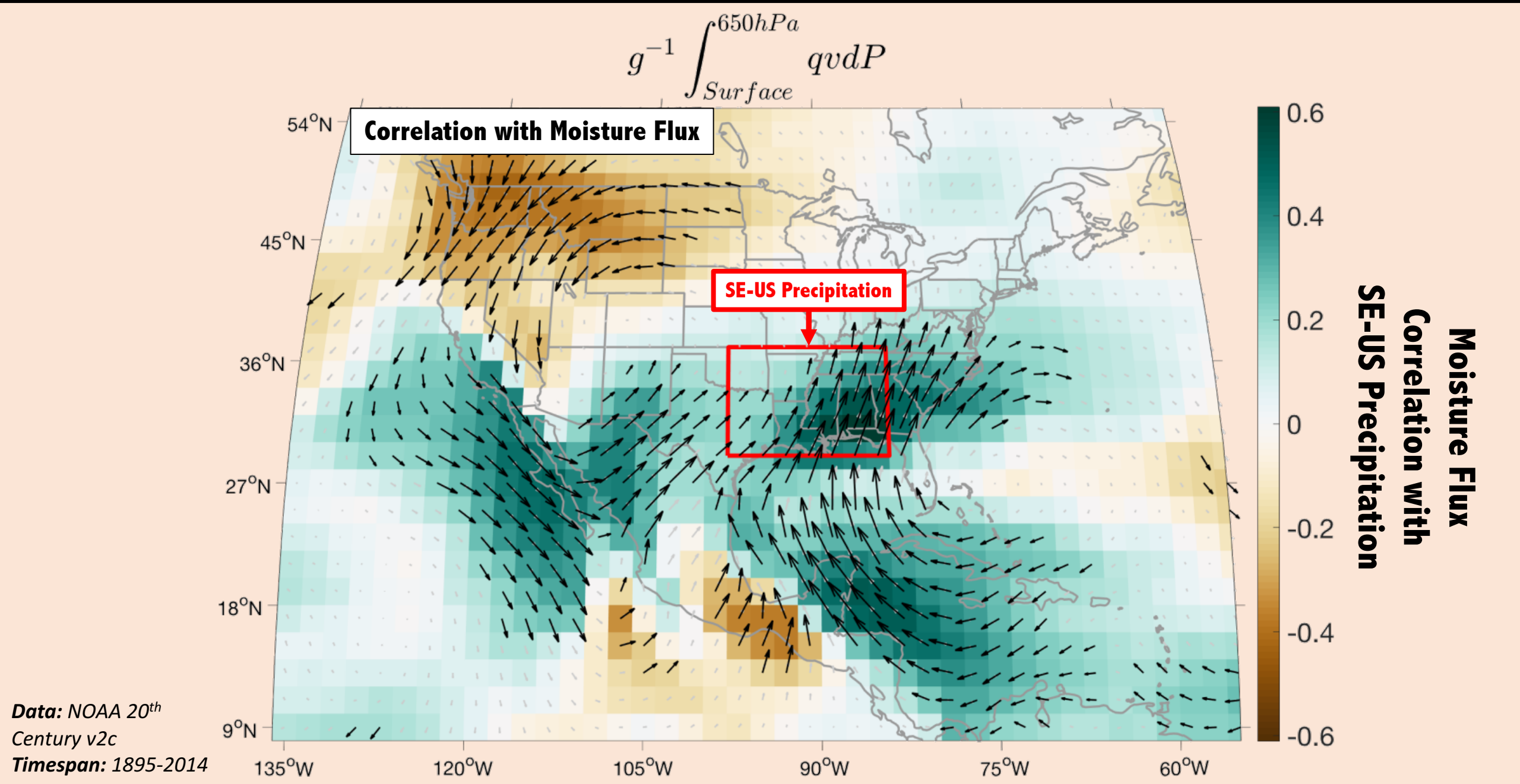
What is driving increases in SE fall precipitation over the 20th century?

Motivating Questions

What is driving increases in SE fall precipitation over the 20th century?

- **General circulation pattern?**
- **Circulation change or increased water vapor?**
- **SST forcing?**

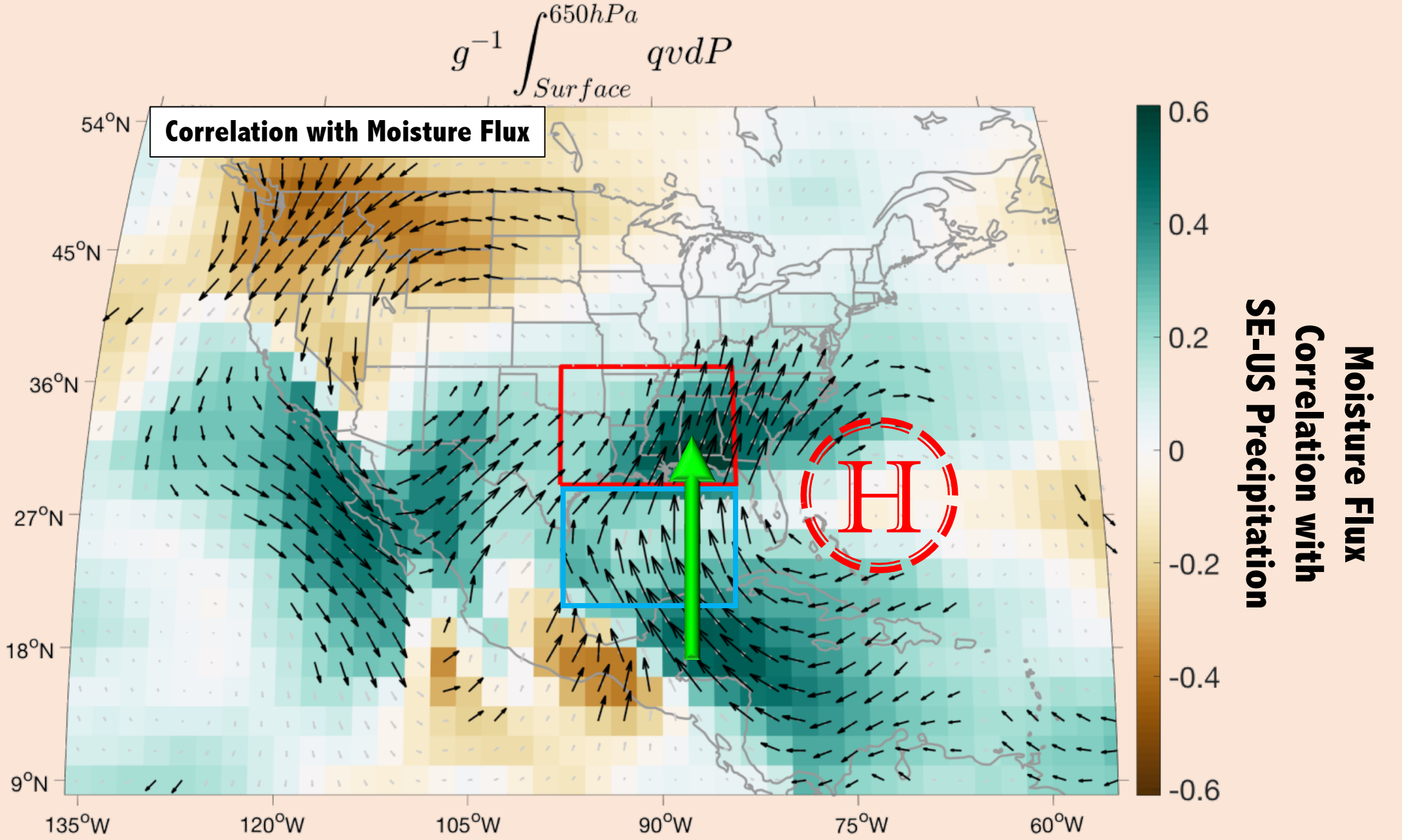
Fall SE-US Precipitation (red box) correlated with Fall Moisture Flux (colors/vectors)



Data: *NOAA 20th Century v2c*

Timespan: *1895-2014*

Correlations suggest circulation around western edge of subtropical High



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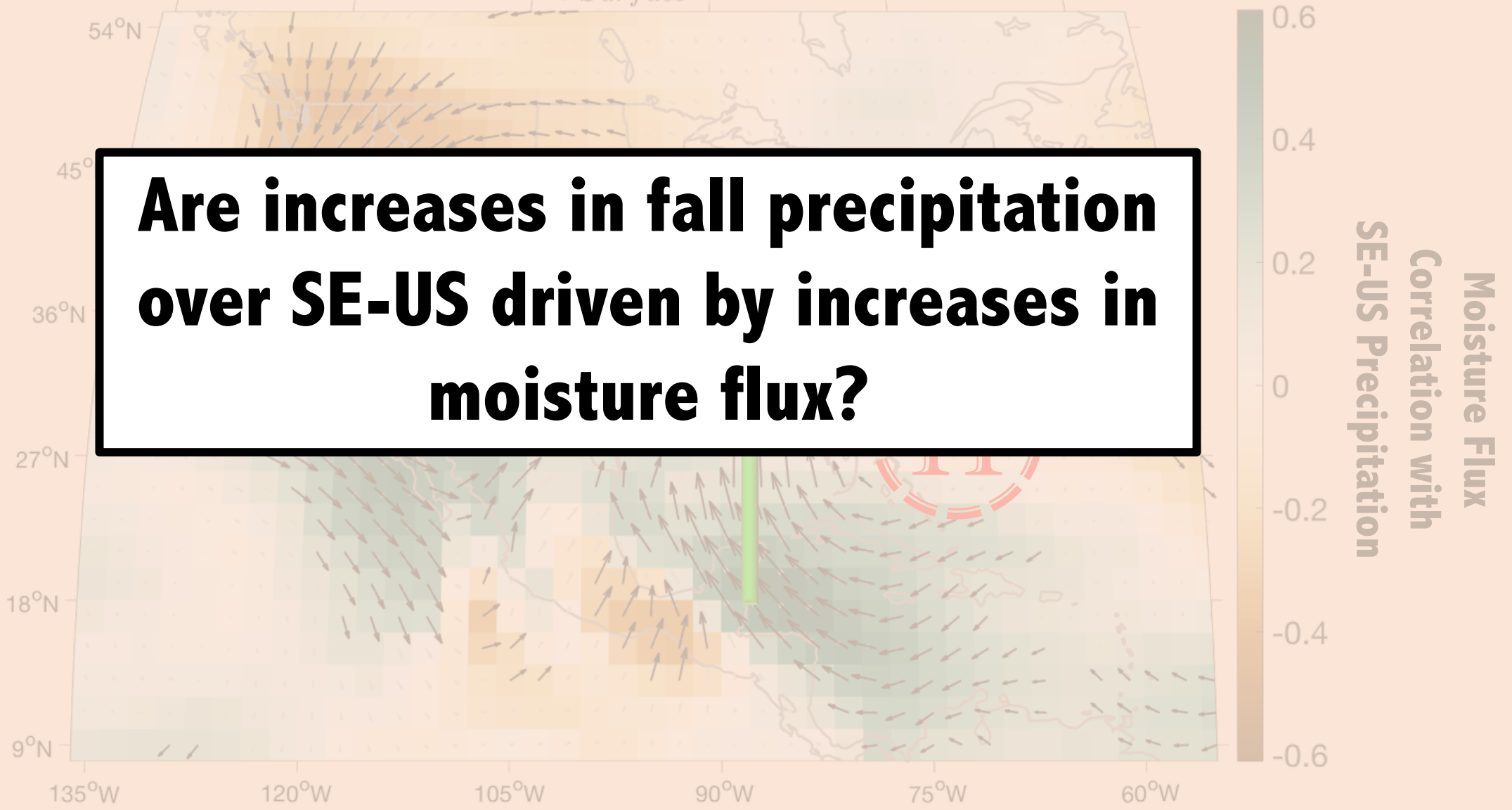
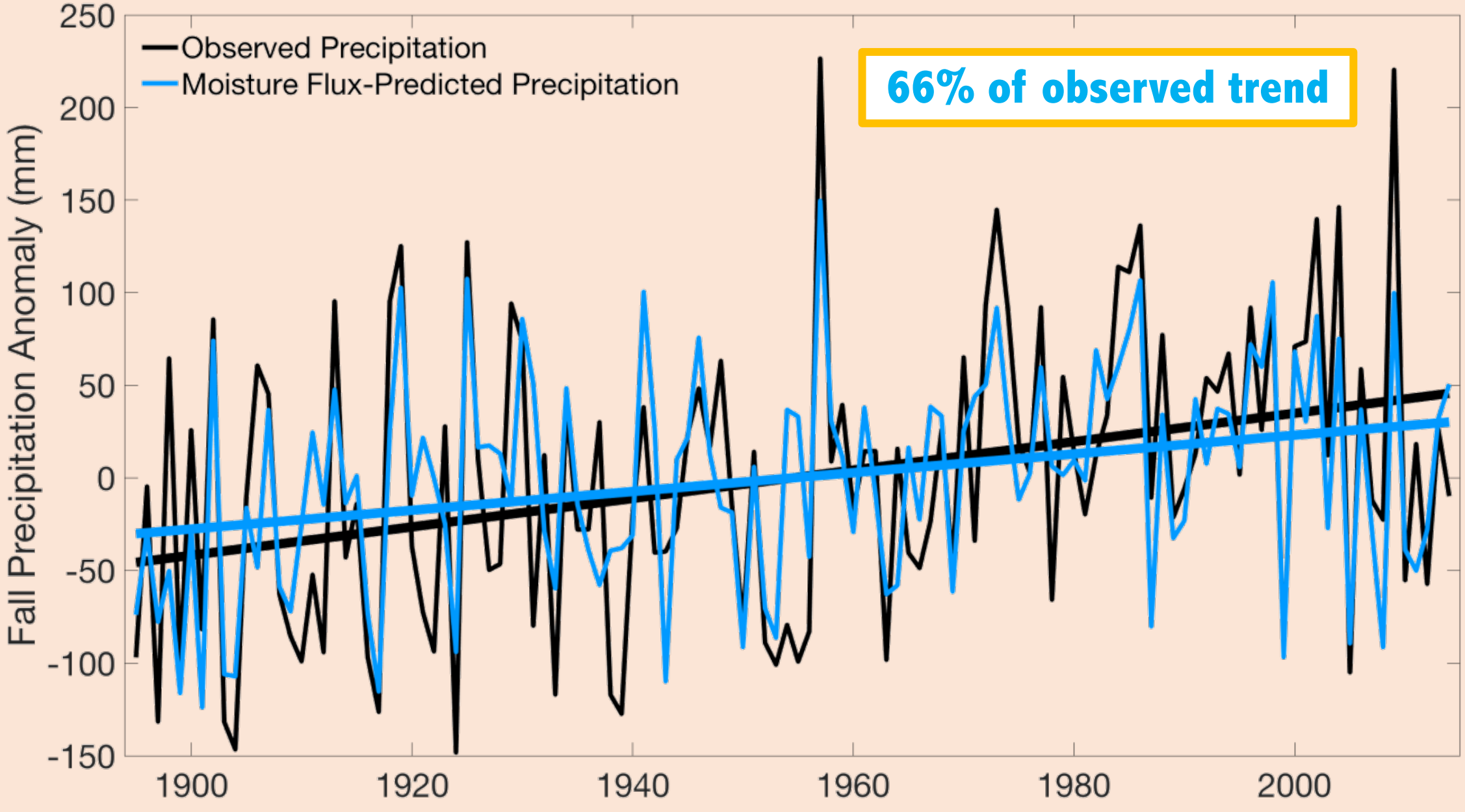
$$g^{-1}\int_{Surface}^{650hPa} qvdP$$



Are increases in fall precipitation over SE-US driven by increases in moisture flux?

Data: *NOAA 20th Century v2c*
Timespan: *1895-2014*

Bulk of increased precipitation explained by meridional moisture flux over Gulf



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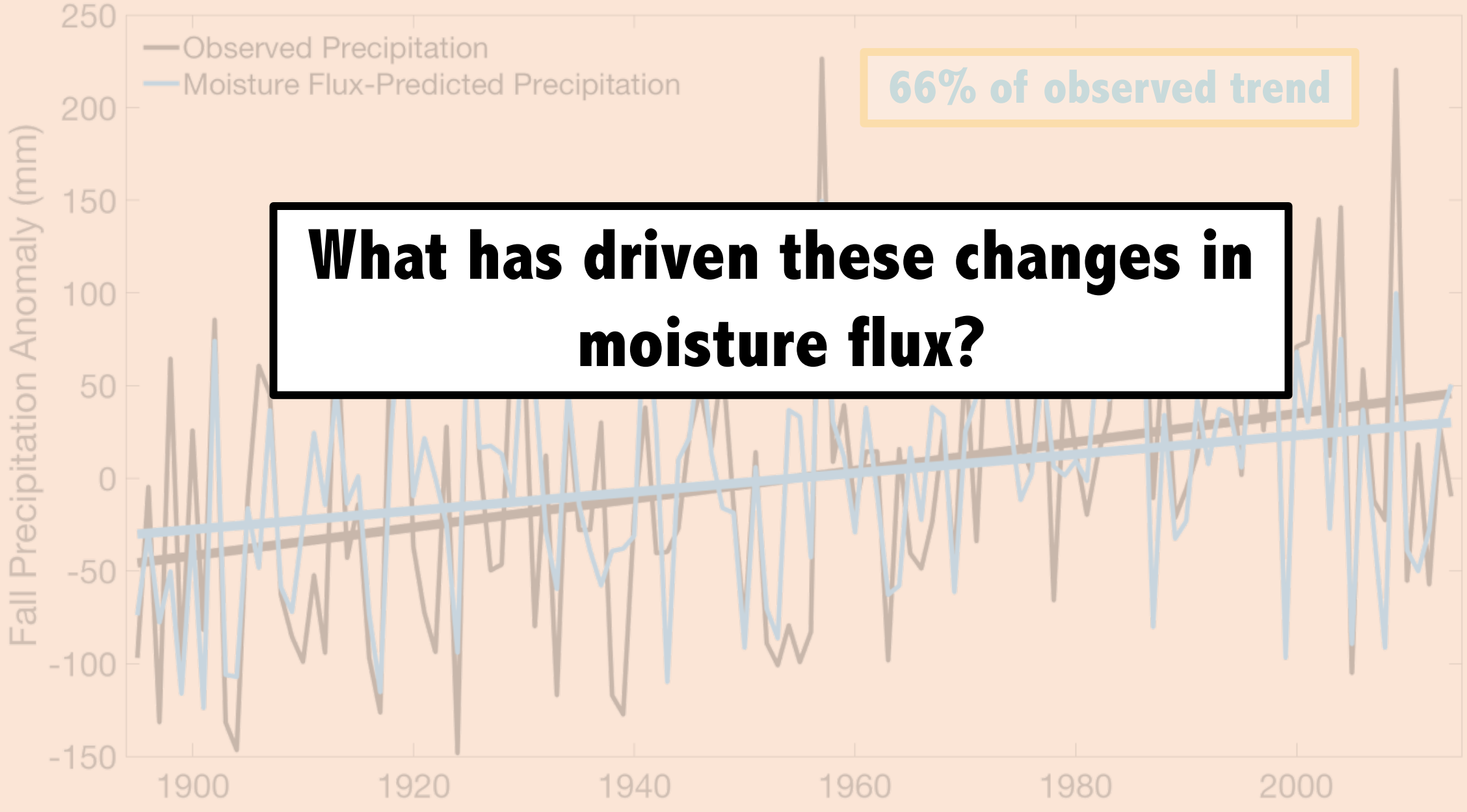
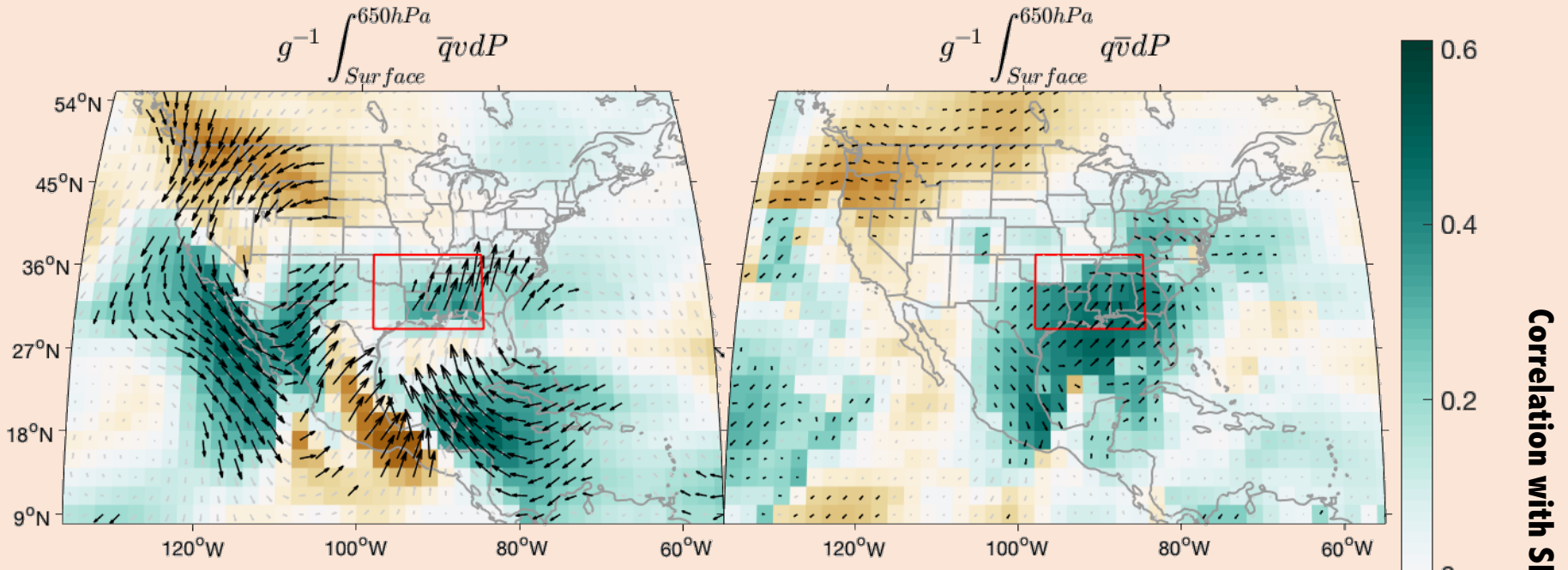
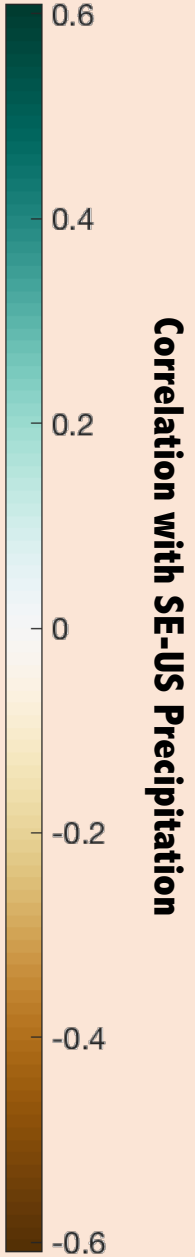


What has driven these changes in moisture flux?

Wind-driven and humidity-driven moisture flux





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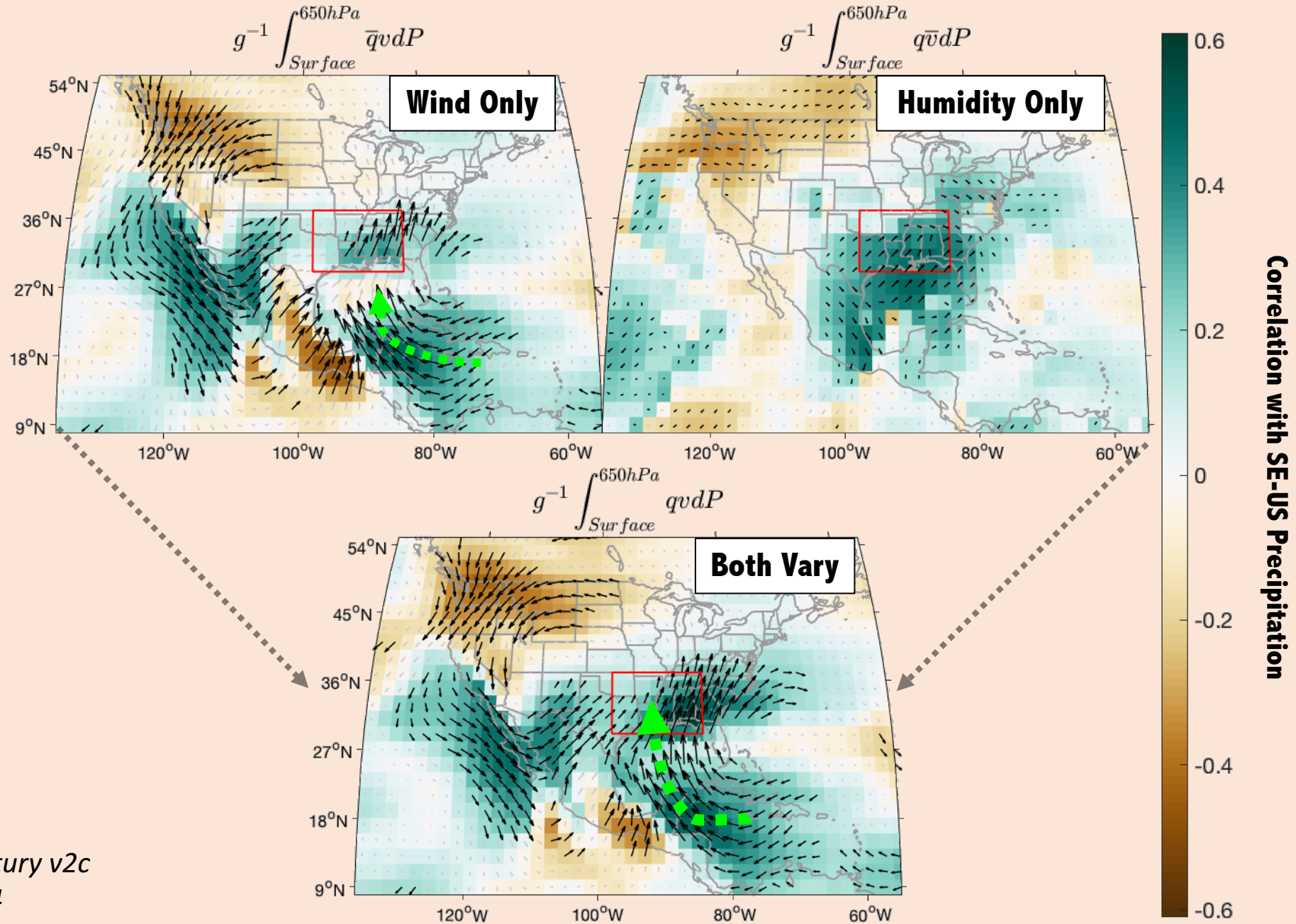
Region-specific dependence on both wind and specific humidity



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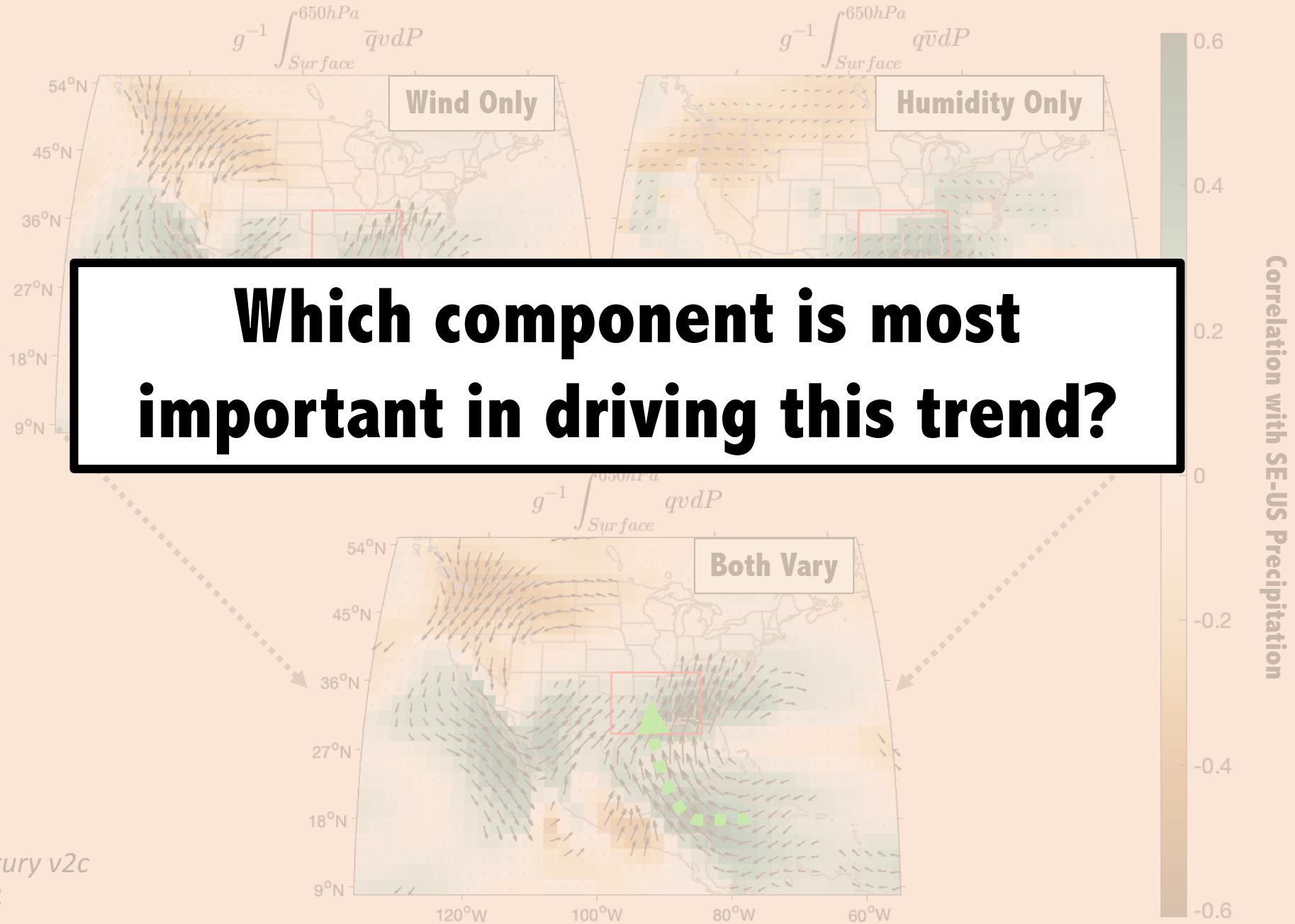
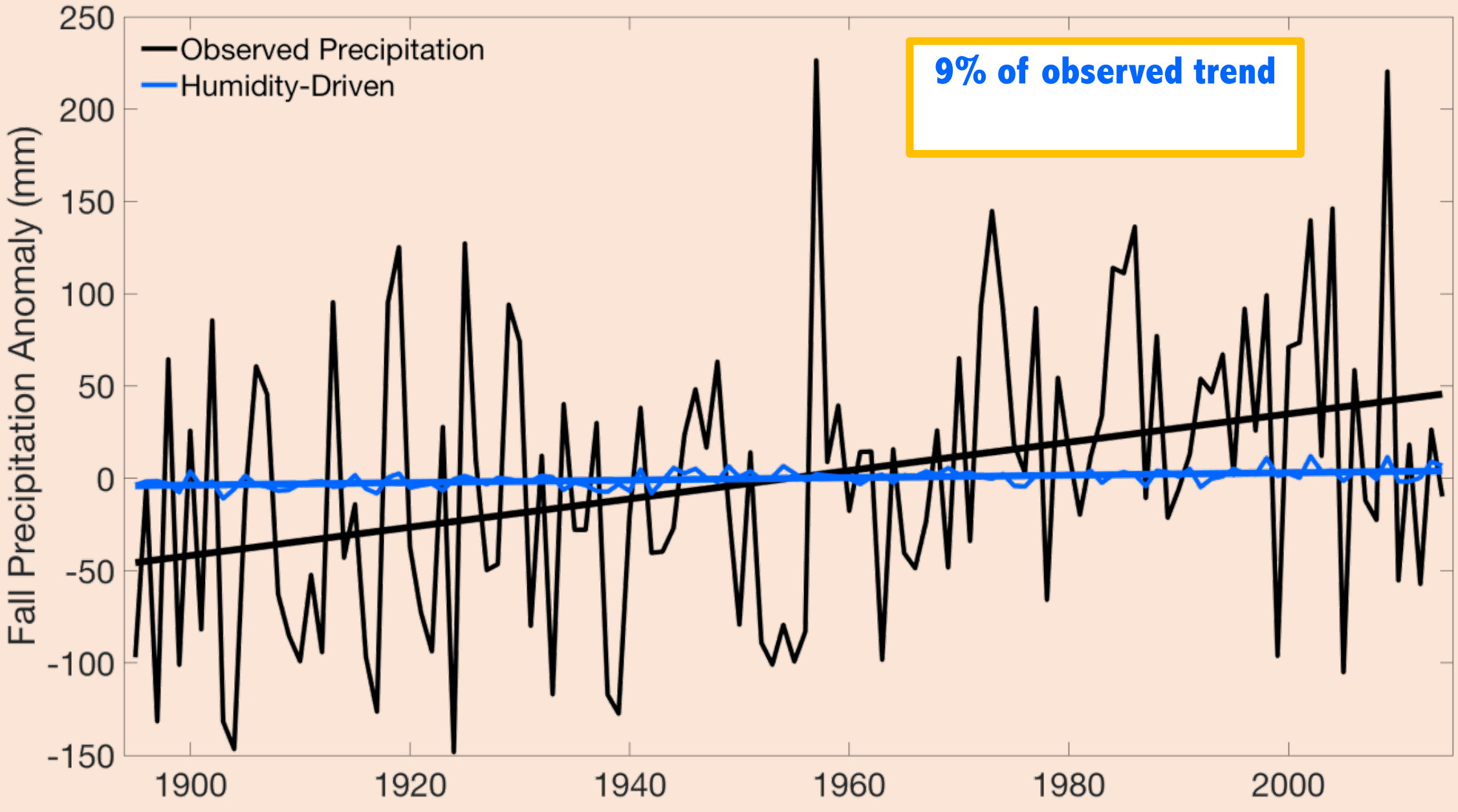
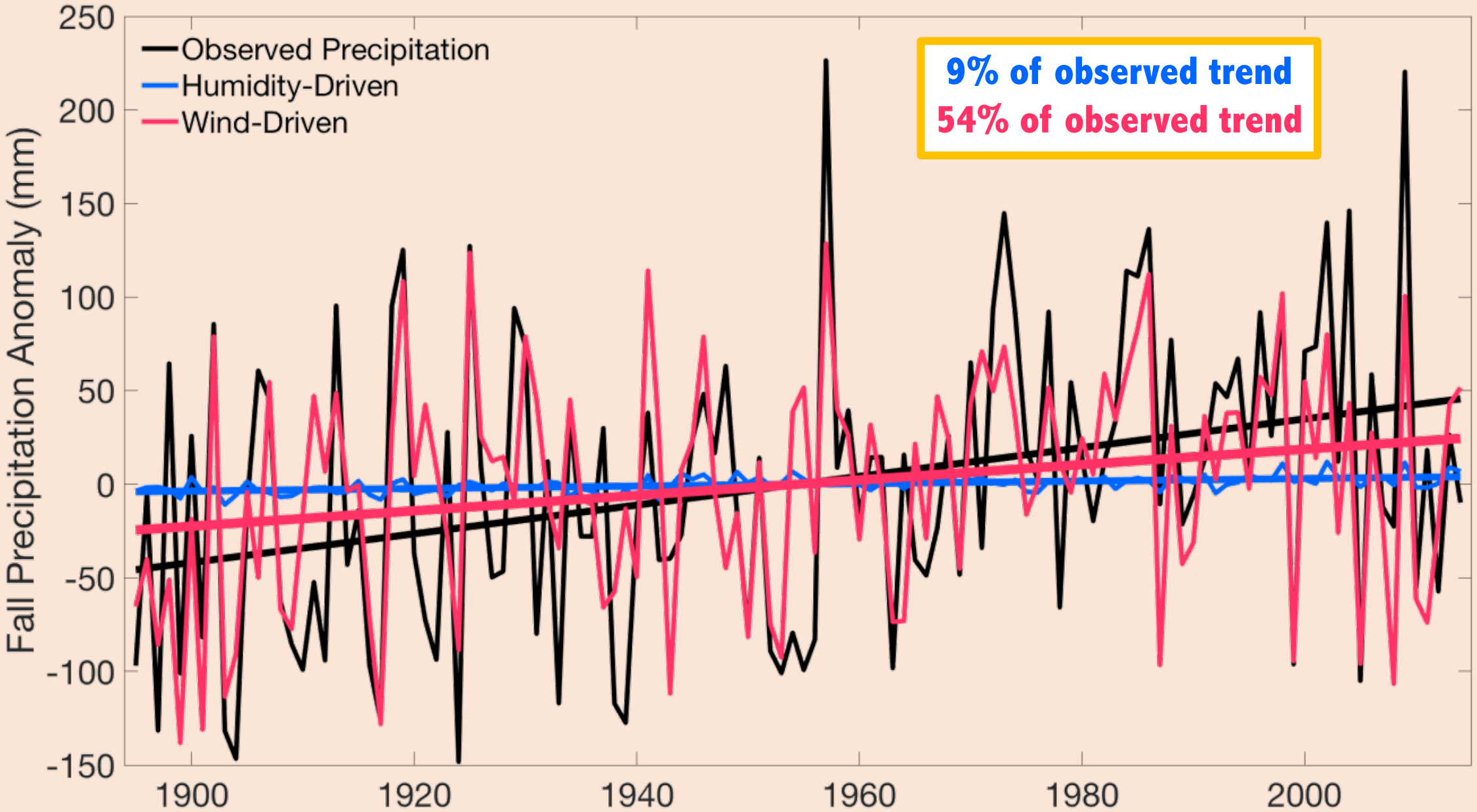


Which component is most important in driving this trend?

Data: *NOAA 20th Century v2c*
Timespan: *1895-2014*

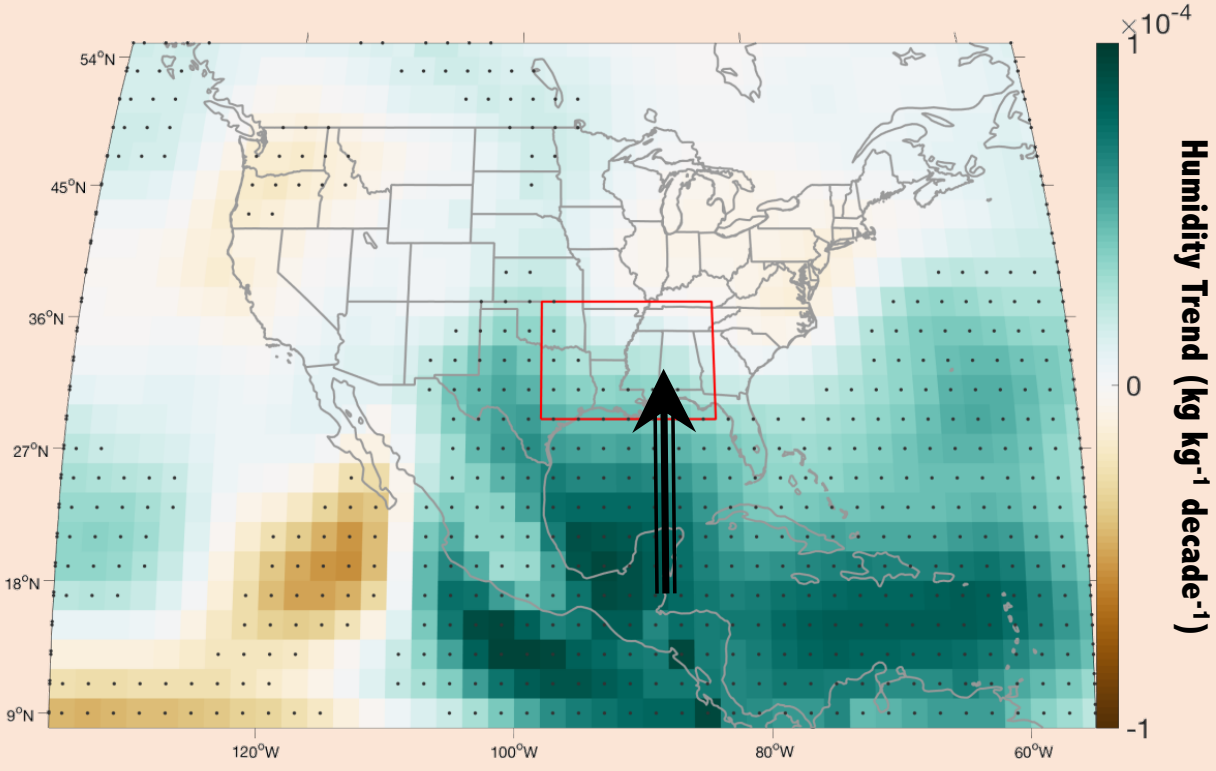

Observed Precipitation
Humidity-Driven
9% of observed trend
Fall Precipitation Anomaly (mm)
250
200
150
100
50
0
-50
-100
-150
1900
1920
1940
1960
1980
2000

Wind-driven moisture transport explains bulk of precip trend

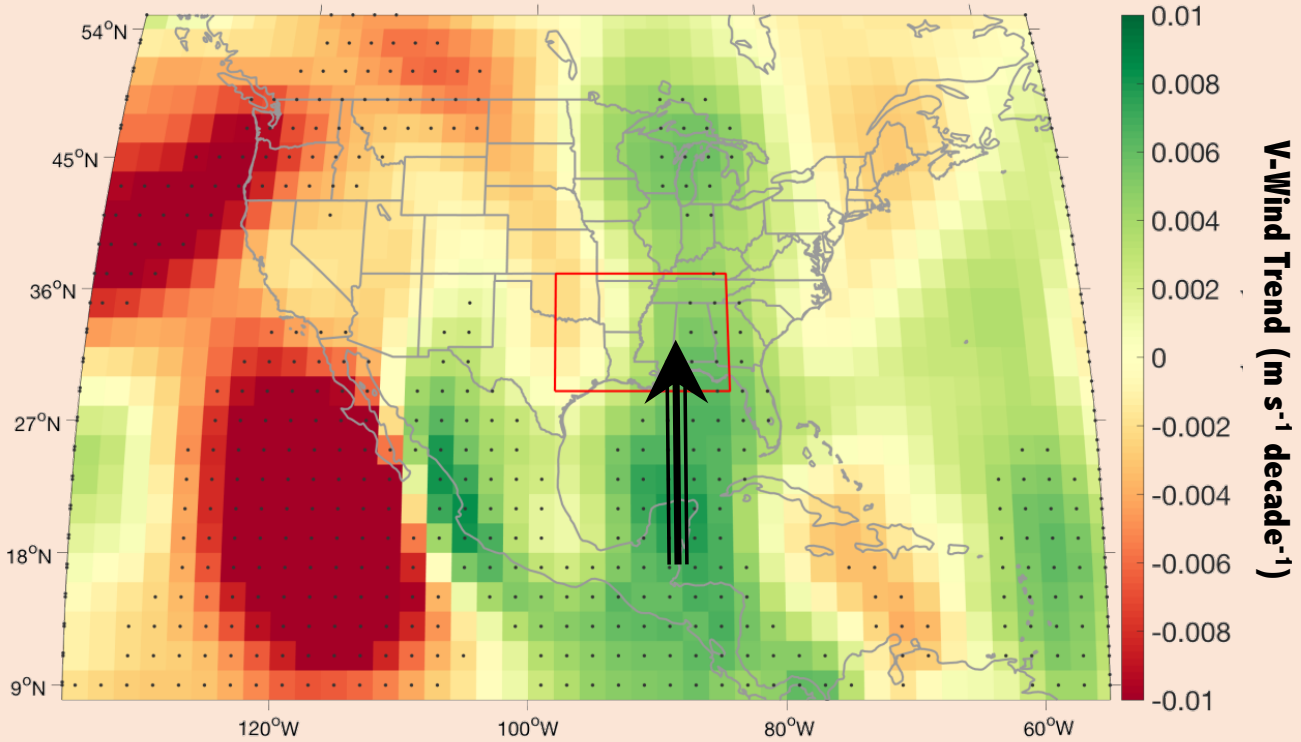


Vertically integrated wind and humidity have been increasing

Fall Specific Humidity Trends



Fall Meridional Wind Trends



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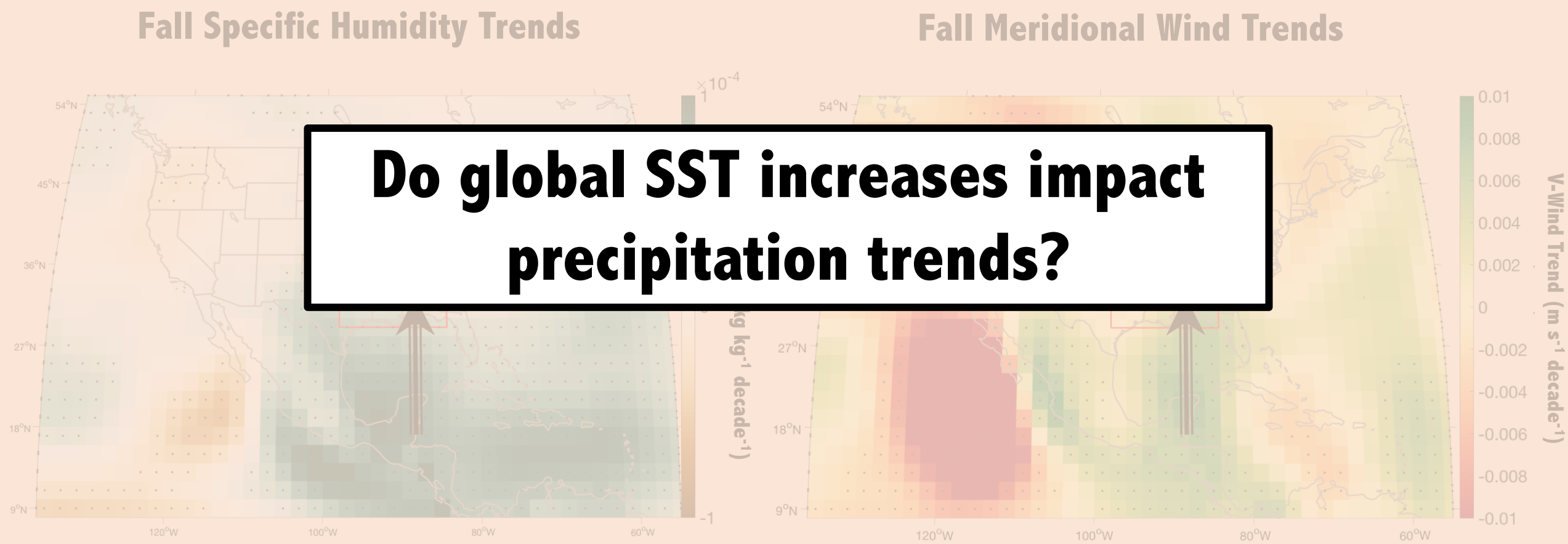

Data: *NOAA 20th Century v2c*
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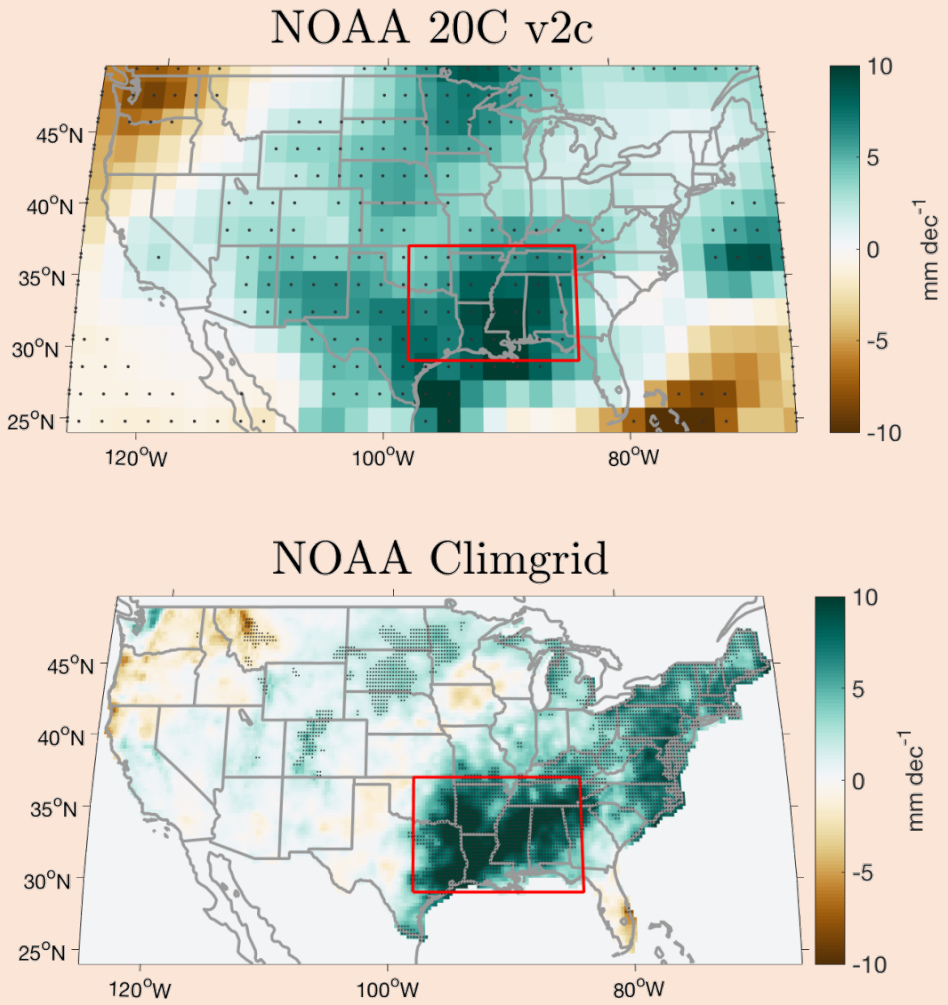
Do SST-forced models capture precipitation trend?

Fall Precip Trend

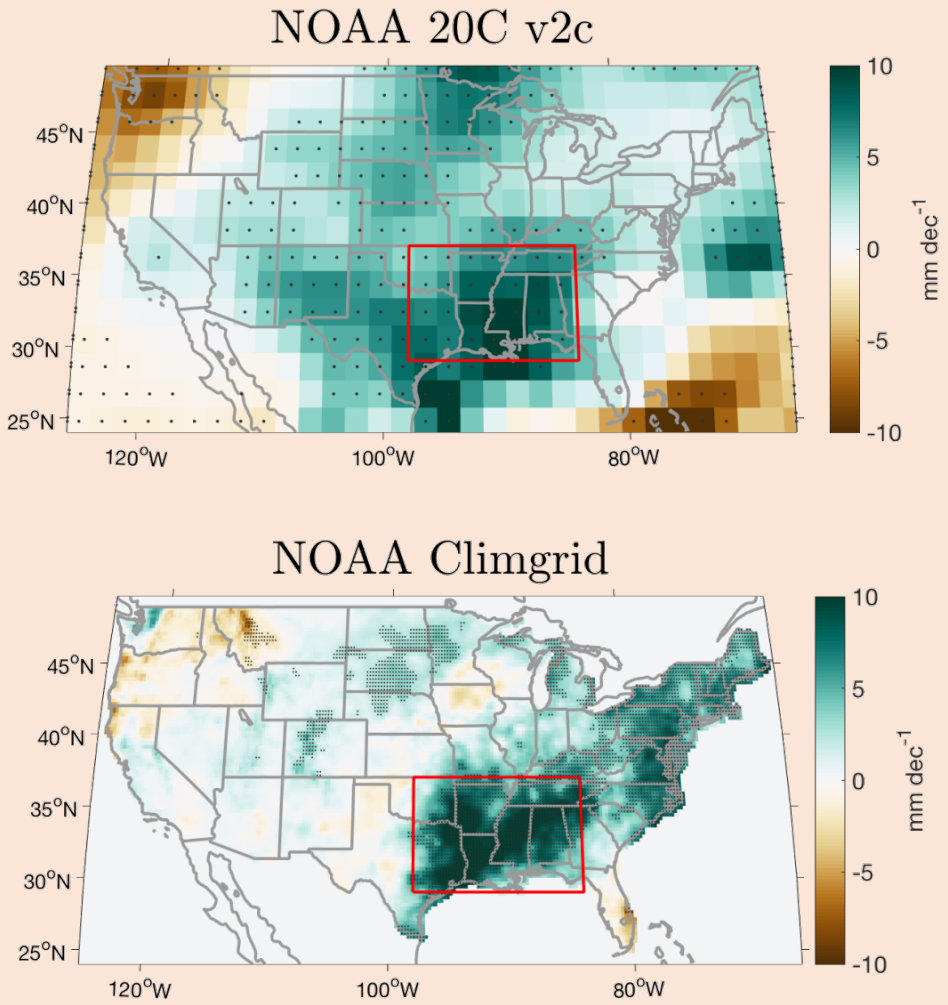


Timespan: *1895-2014*

Reanalysis & observed capture trends…

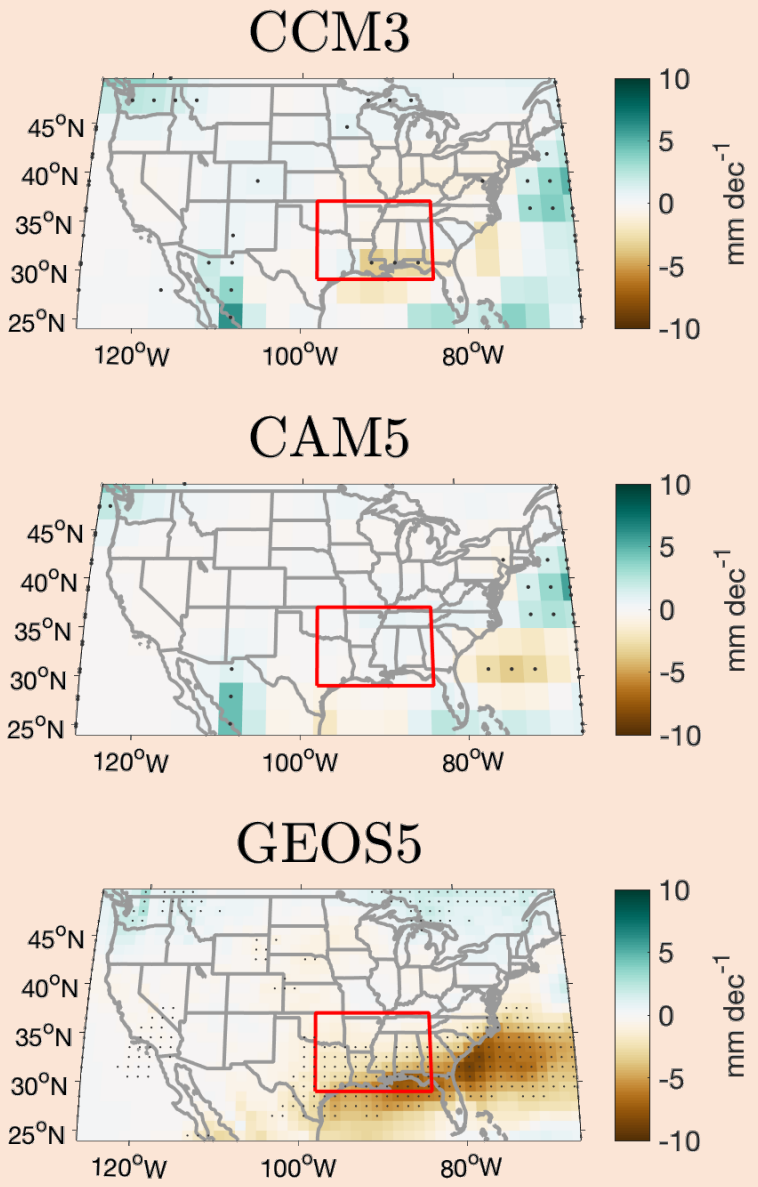
…but reanalysis & observed precip trends do not match models

Fall Precip Trend

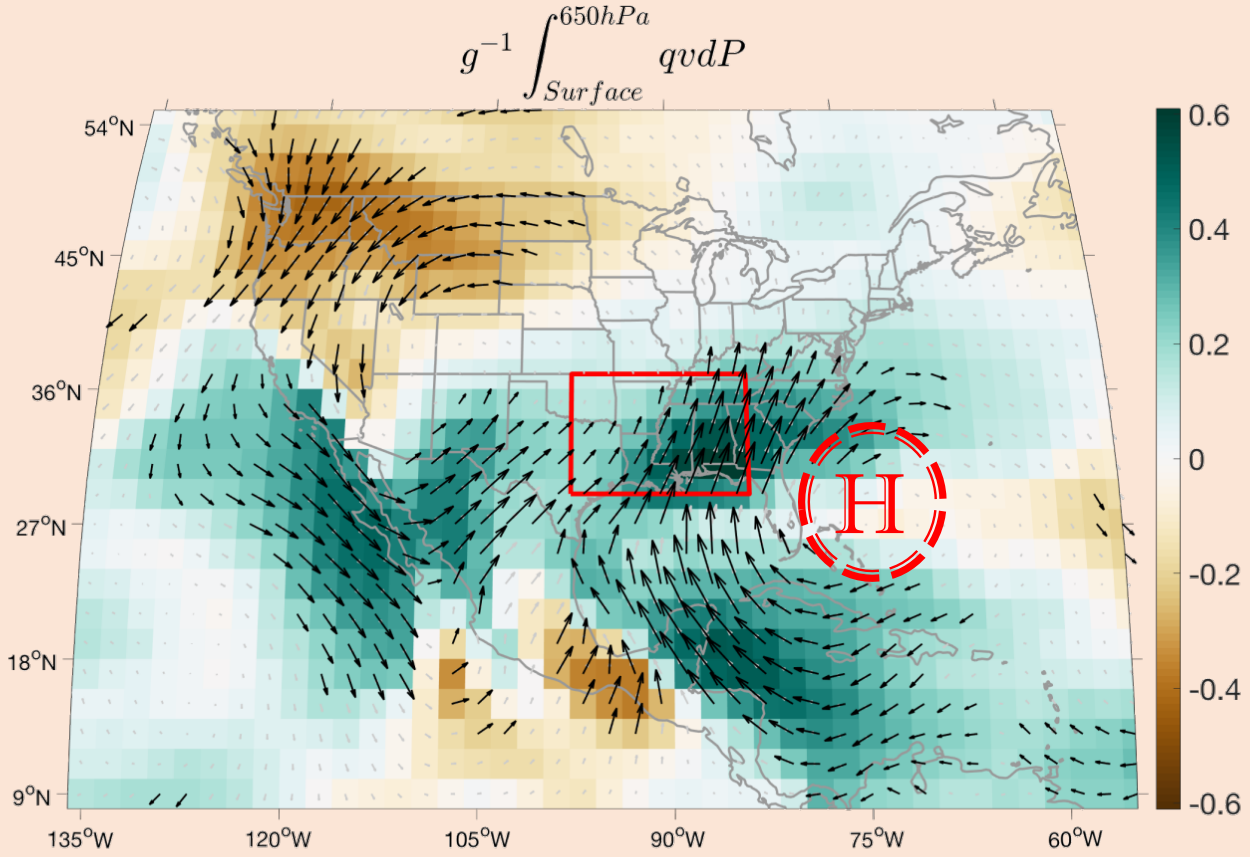


Timespan: *1895-2014*

SST-forced Model Fall Precip Trend



Local changes unlikely given large-scale circulation relationship

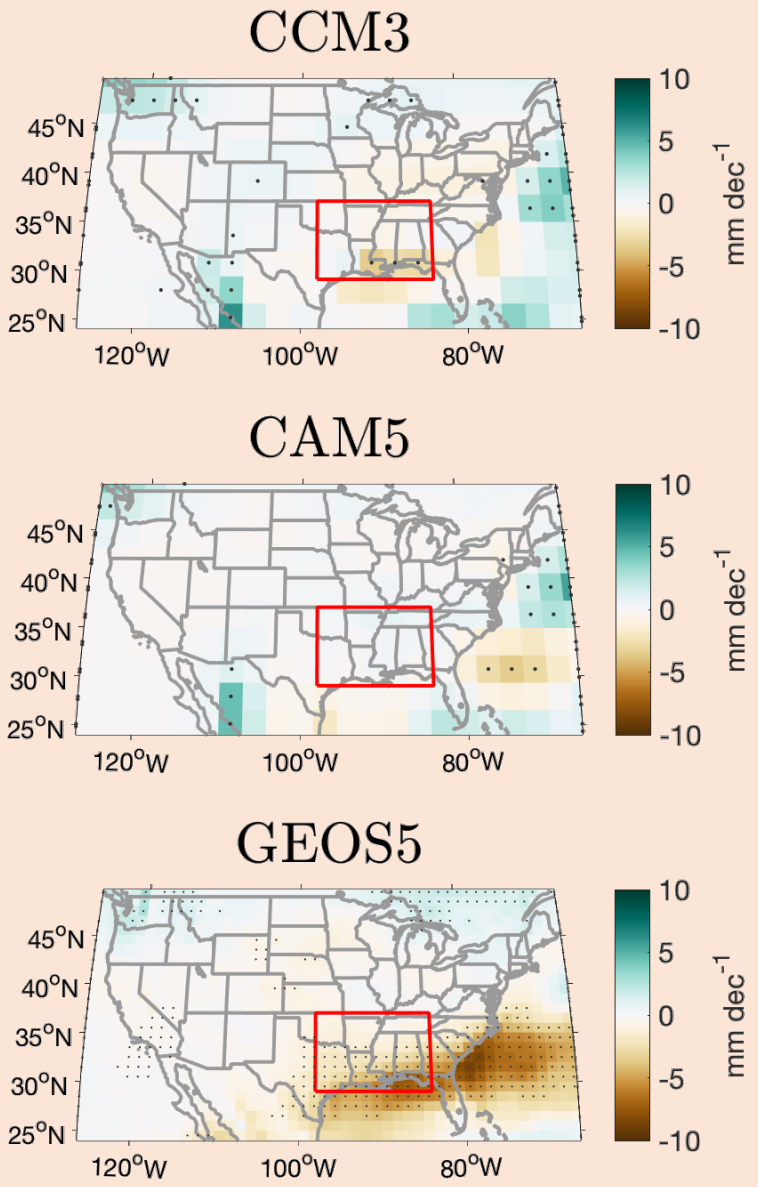


Further…

Link between SST & humidity increase unclear

Timespan: *1895-2014*

SST-forced Model Fall Precip Trend



Conclusions

1. **Fall precipitation increase of 37% from 1895-2016 in SE-US.**

2. **Low-level, southerly moisture transport via Gulf of Mexico into SE-US.**

   Westward expansion or intensification of subtropical high?

3. **Circulation drives moisture transport trends.**

   But both humidity- and wind-driven moisture transport play a role.

4. **Global SST increases may not force SE-US wetting.**

Acknowledgments

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Future Questions

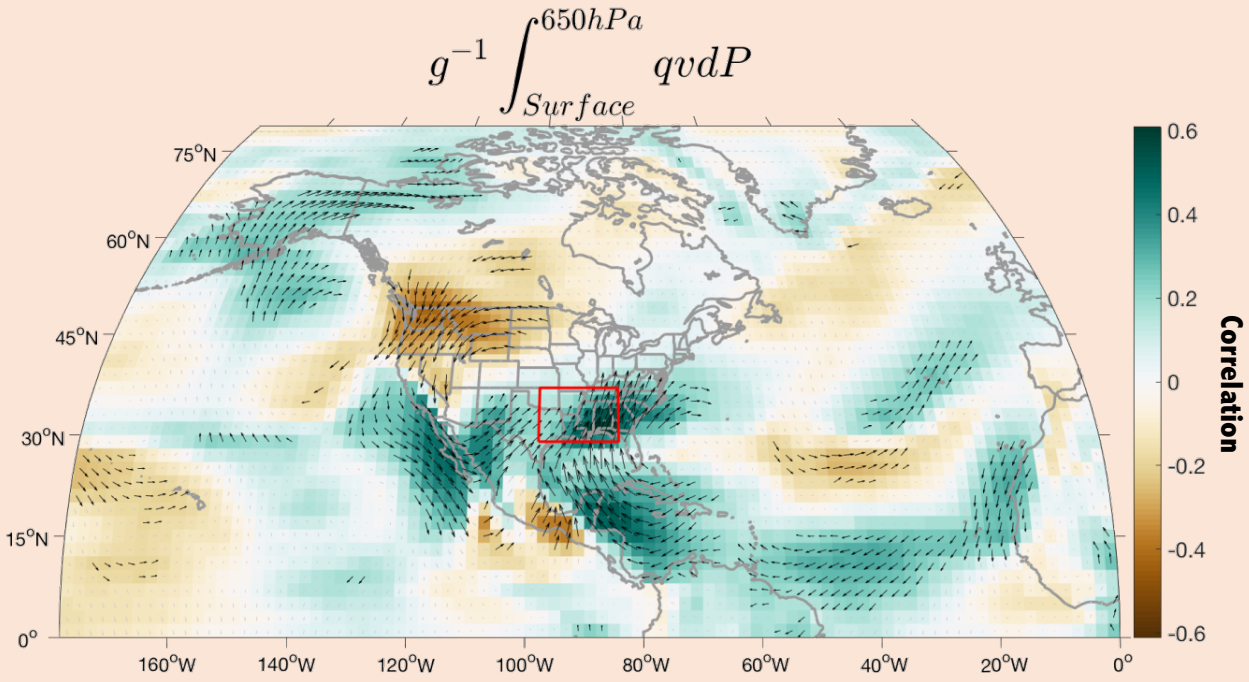
1. Trends: Abrupt or gradual?

2. ‘Warming hole’: Increased evapotranspiration leading to reduced warming?

3. **What is driving increases in SE fall precipitation over the 20th century?**

4. Future changes?

Did increased evapotranspiration lead to reduced SE warming?



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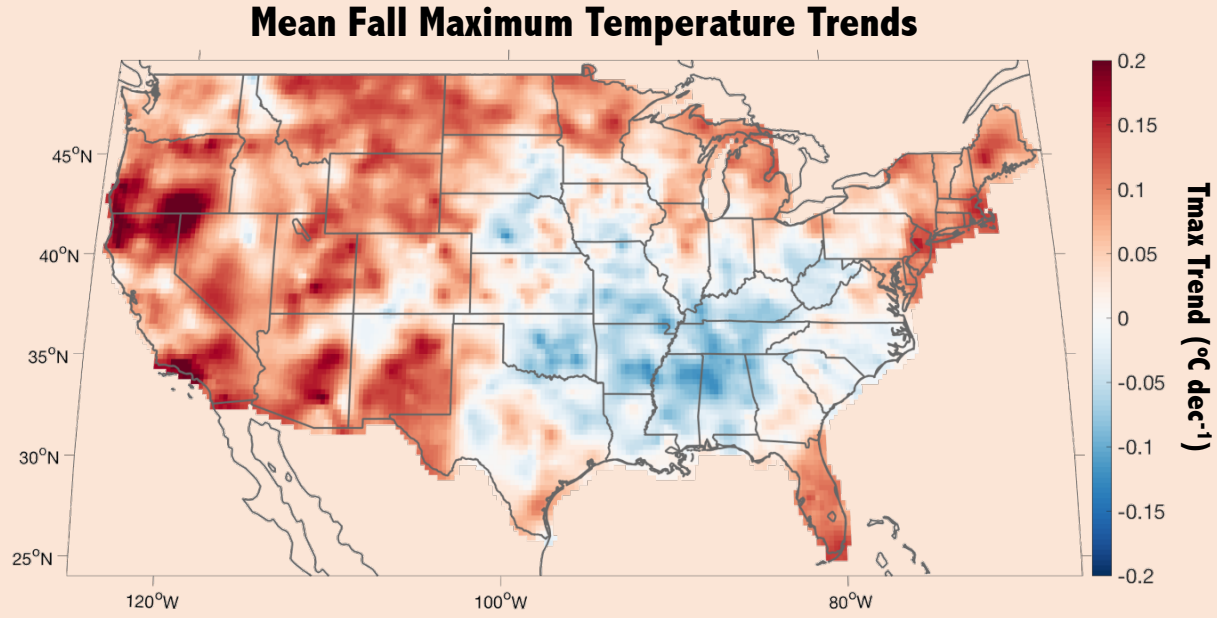

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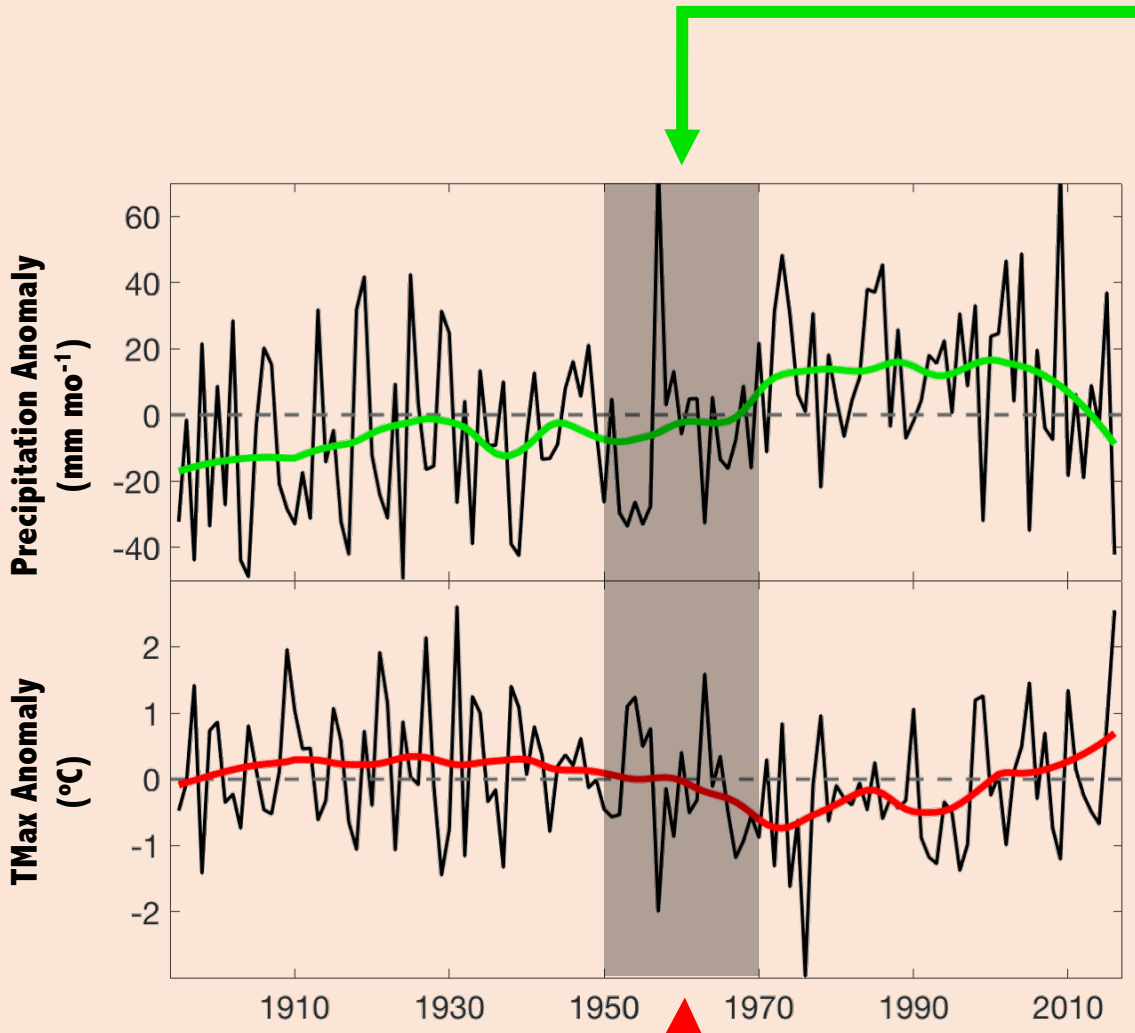
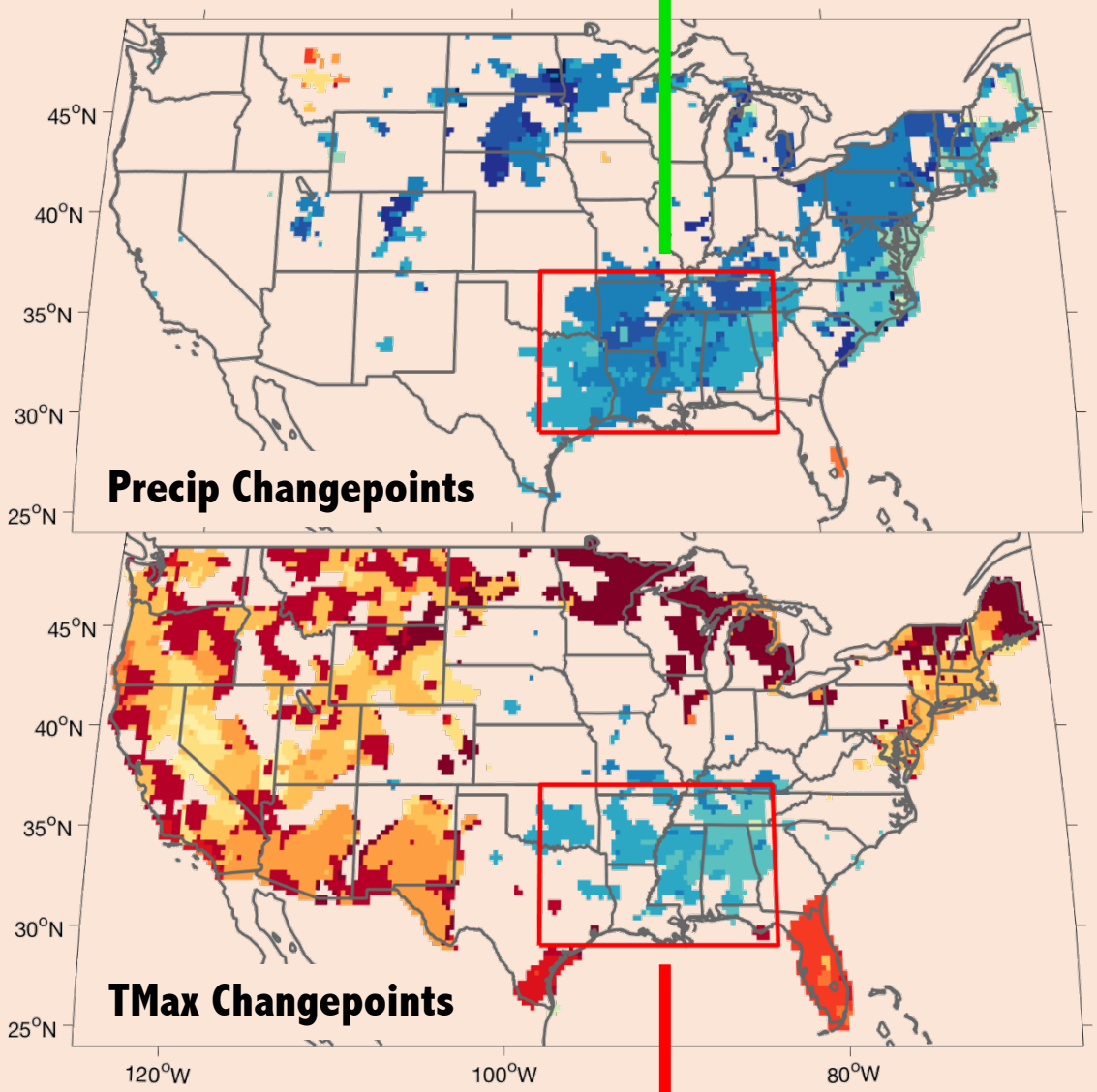
Southerly moisture transport ? **Warm air advection**

Did increased evapotranspiration lead to reduced SE warming?





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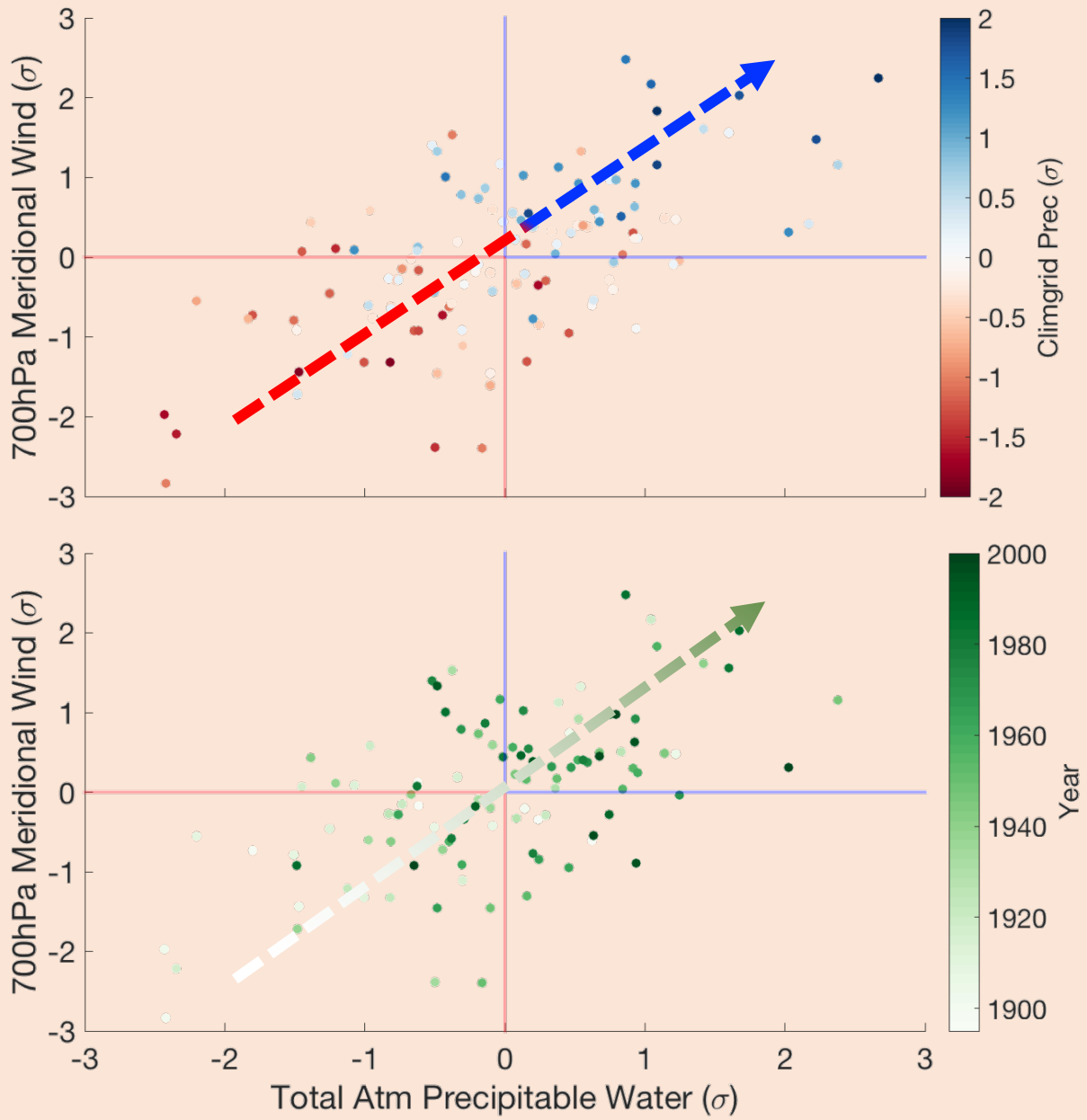
Regression analysis indicated SST effect is minimal

- **Internal climate variability dominates**

***However*, column-integrated precipitable water plays a partial role**



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