Relationship between Fatal Weather-Related Crashes and El Niño Southern Oscillation Teleconnections



Image from Houston Chronicle

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Motivation

In a 10-year average:
(2007-2016)
1,235,145 yearly crashes
5,376 casualties
418,005 injuries

From this 10 year average:
21% of ***ALL*** vehicle crashes are *weather-related*
16% of all ***fatal*** vehicle crashes are *weather-related*

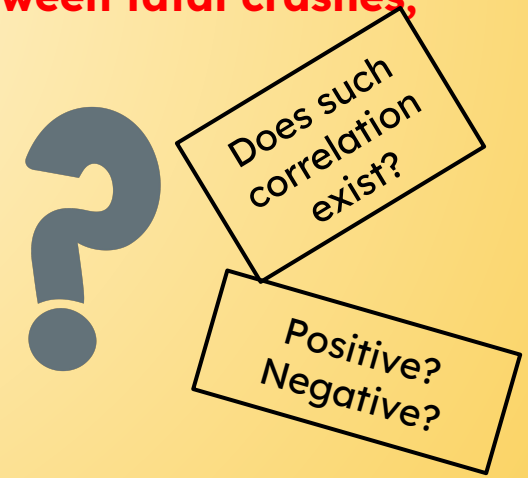
How do weather events impact roads?. How Do Weather Events Impact Roads? - FHWA Road Weather Management. (n.d.). https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm

Motivation (cont.)

- Past work found a *direct* correlation between fatal weather-related crashes and annual precipitation values (Pisano et al. 2008; Elyoussoufi et al. 2023) ✅
- Teleconnections such as the El Niño-Southern Oscillation (ENSO) influence precipitation patterns ✅
- **RESEARCH QUESTION: What is the relationship between fatal crashes, precipitation variability, and ENSO?**

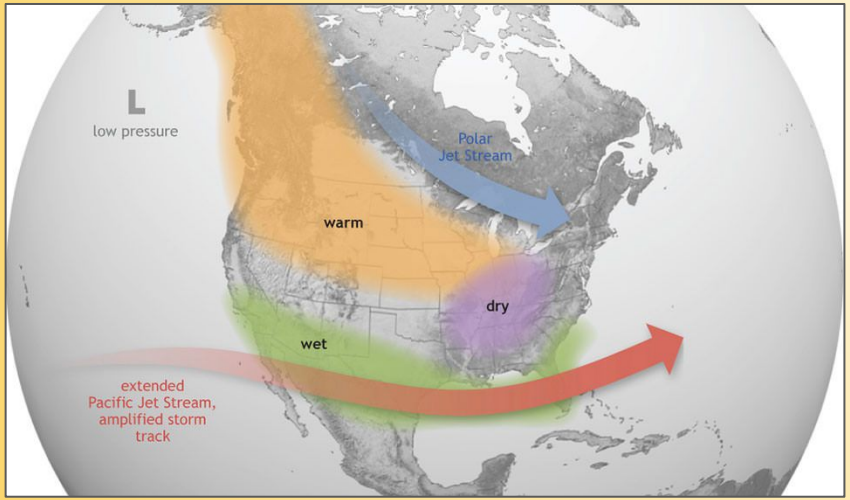
ENSO Type, Precipitation & Weather-related Crash Fatalities



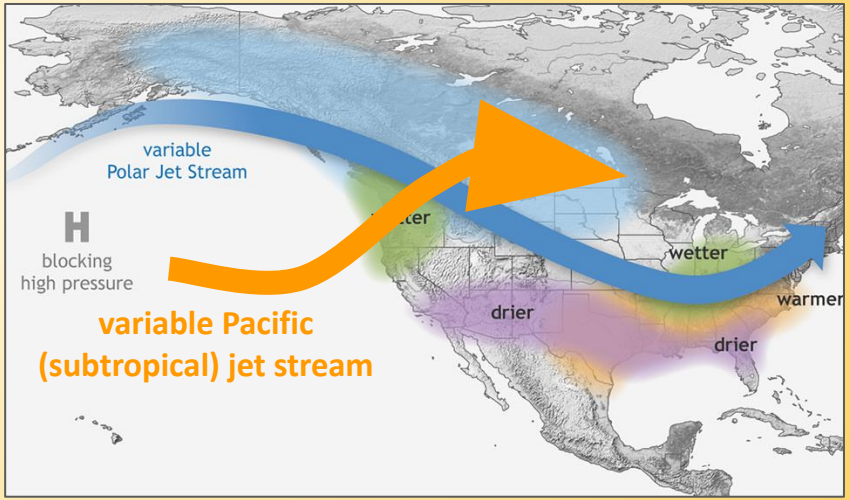


ENSO Types

El Niño



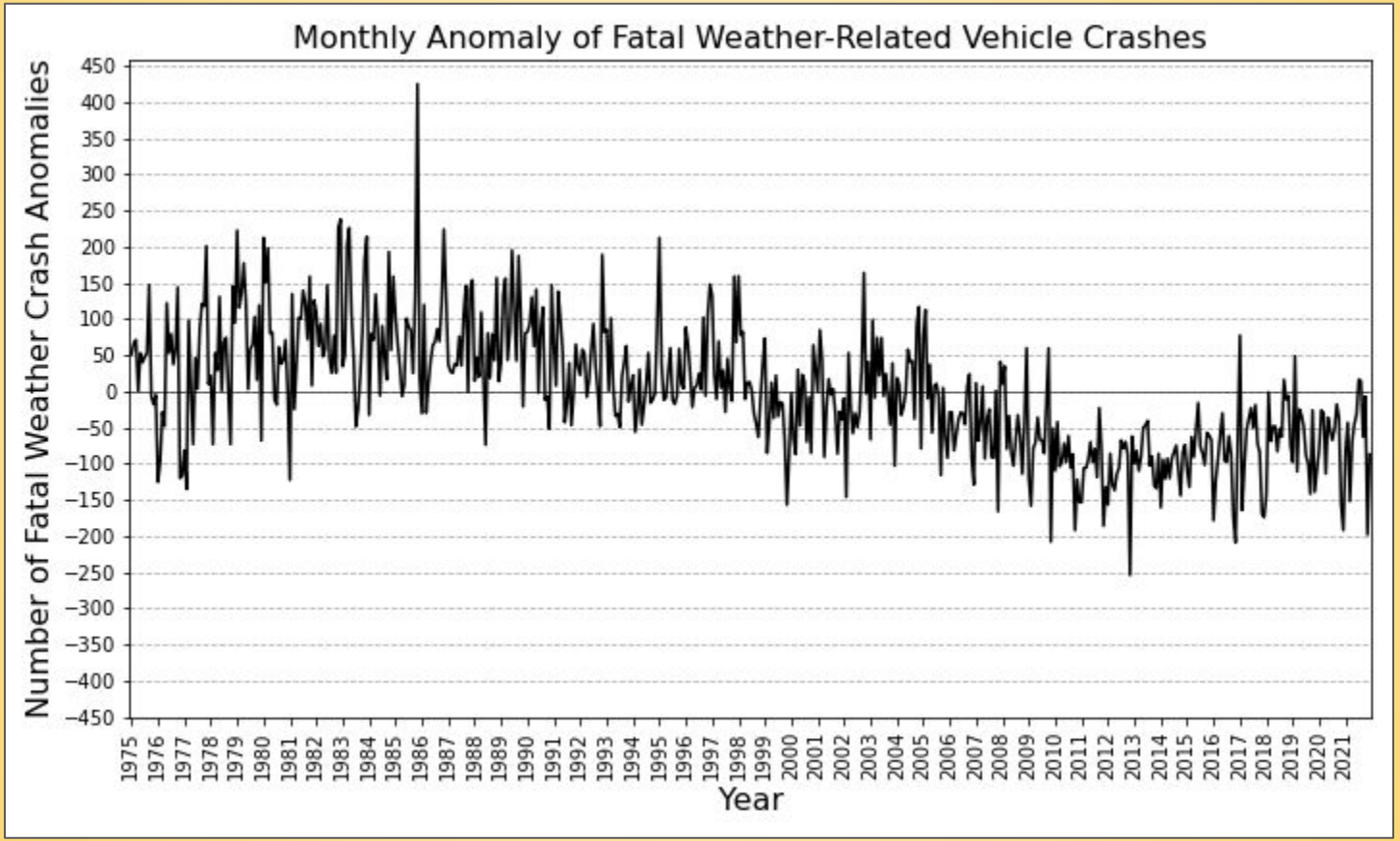
La Niña

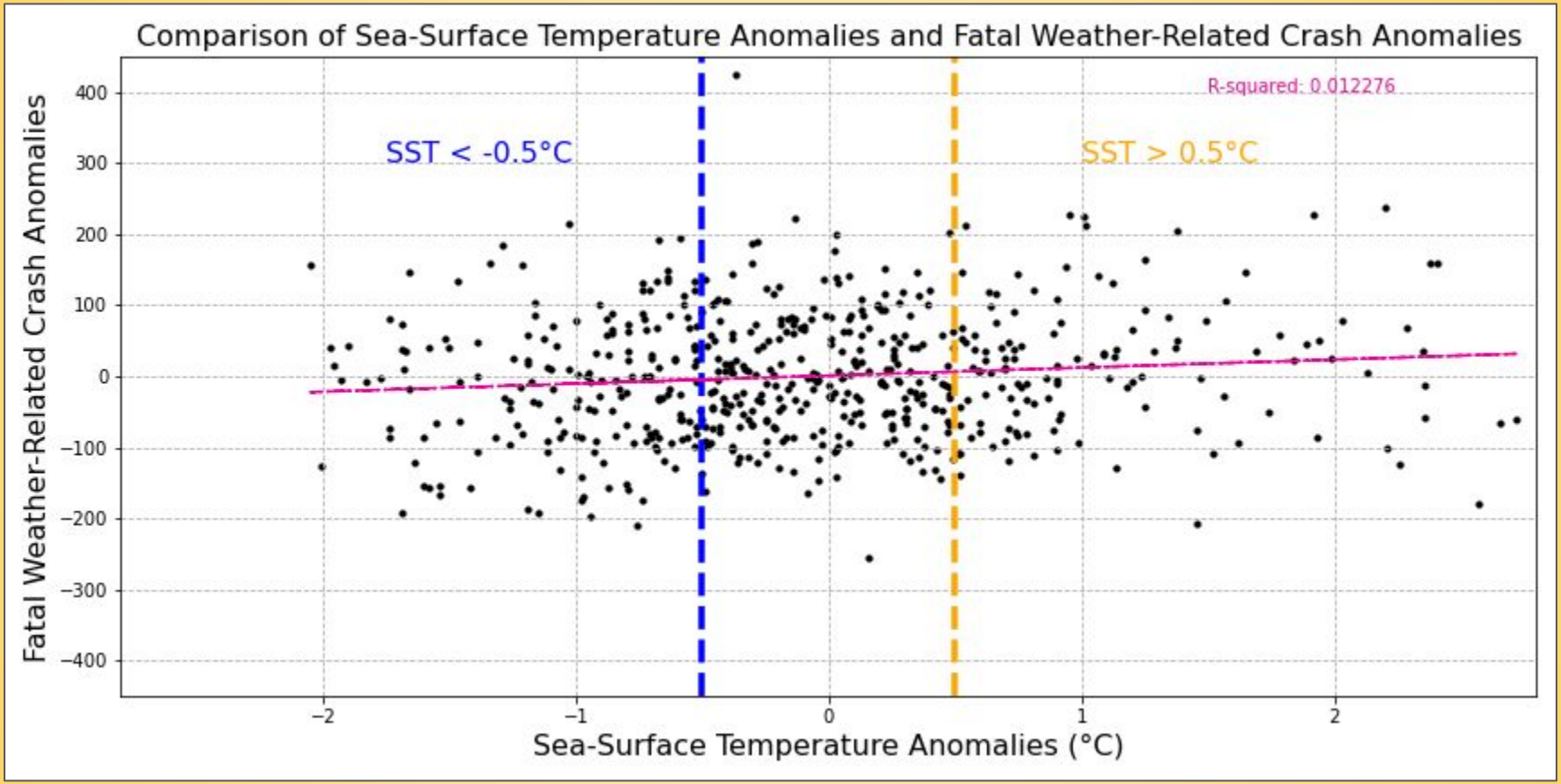


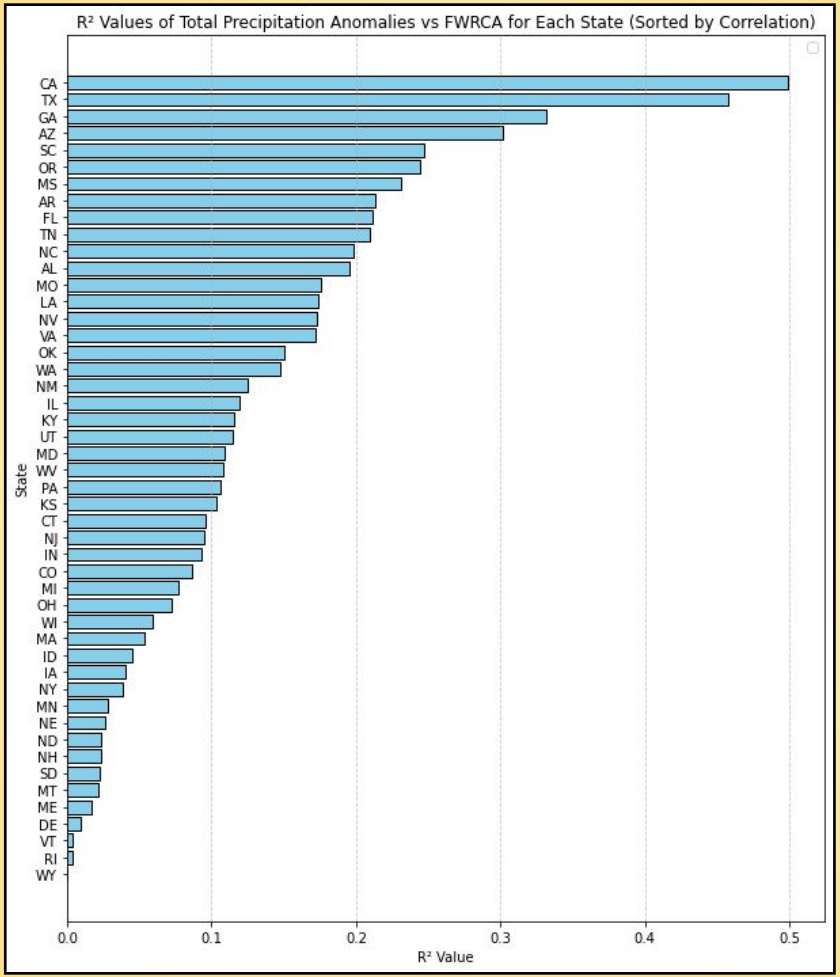
Methods

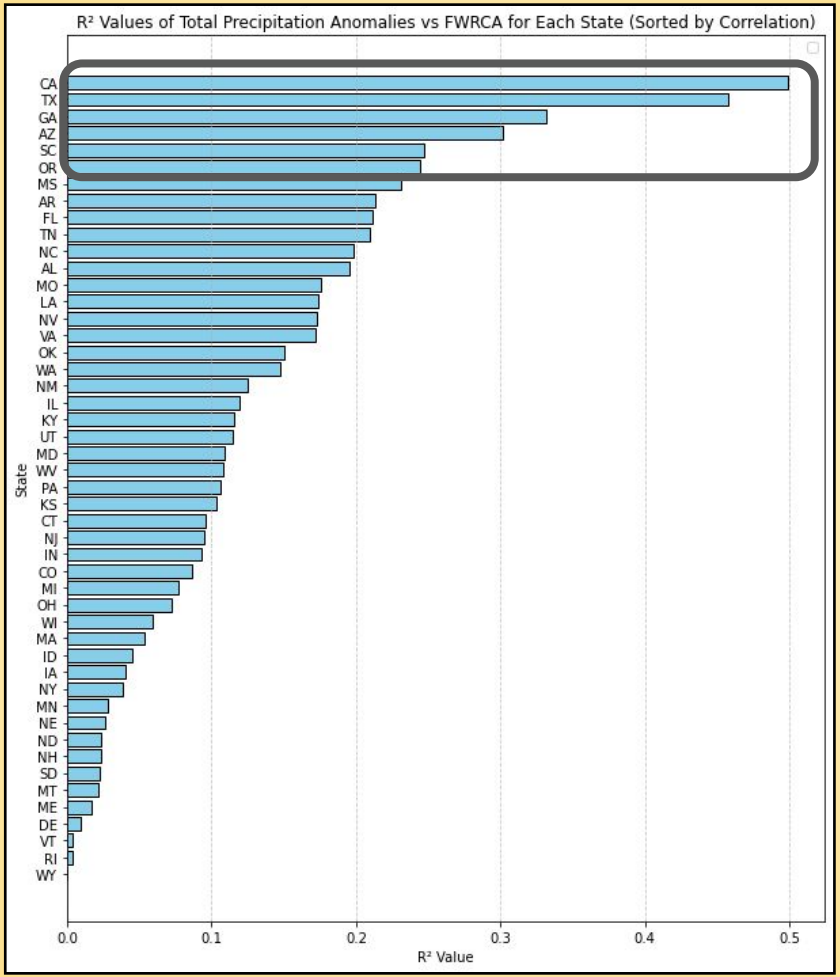
Study Region	**All 50 states in the United States**
Fatal Crash Data	**FARS (Fatal Analysis Reporting System)**
ENSO Data	**Niño 3.4 SST Index**
Precipitation Data	**CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) v2**
Time Period & Season	**1979-2020** **Winter Season (December, January, February)**

FWRCA (Fatal Weather-related Crash Anomaly Distribution) (1975-2021)

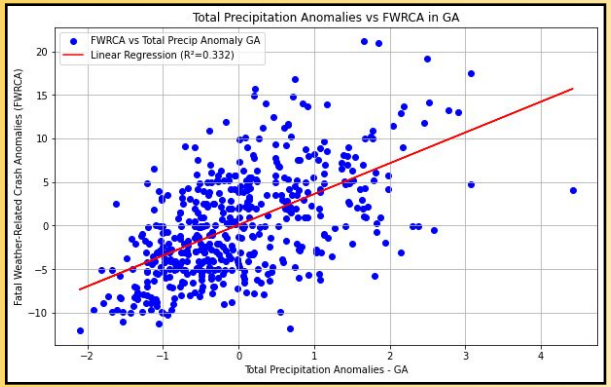


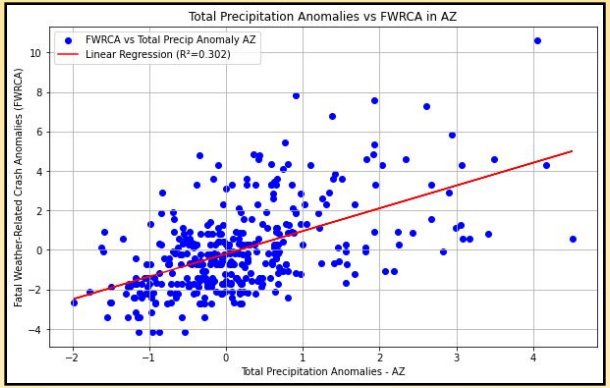

Comparison of Sea-Surface Temperature Anomalies and Fatal Weather-Related Crash Anomalies
R-squared: 0.012276
SST < -0.5°C
SST > 0.5°C
Fatal Weather-Related Crash Anomalies
Sea-Surface Temperature Anomalies (°C)
400
300
200
100
0
−100
−200
−300
−400
−2
−1
0
1
2

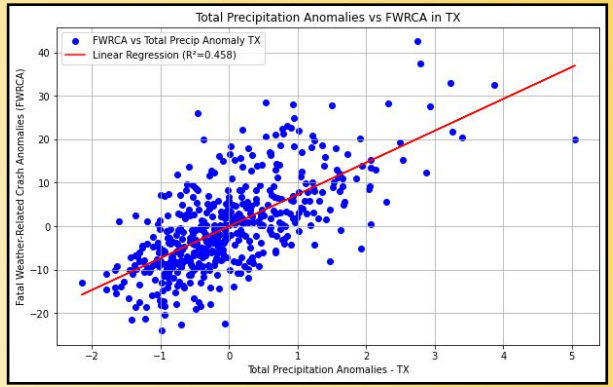

R² Values of Total Precipitation Anomalies vs FWRCA for Each State (Sorted by Correlation)
State
CA
TX
GA
AZ
SC
OR
MS
AR
FL
TN
NC
AL
MO
LA
NV
VA
OK
WA
NM
IL
KY
UT
MD
WV
PA
KS
CT
NJ
IN
CO
MI
OH
WI
MA
ID
IA
NY
MN
NE
ND
NH
SD
MT
ME
DE
VT
RI
WY
0.0
0.1
0.2
0.3
0.4
0.5
R² Value

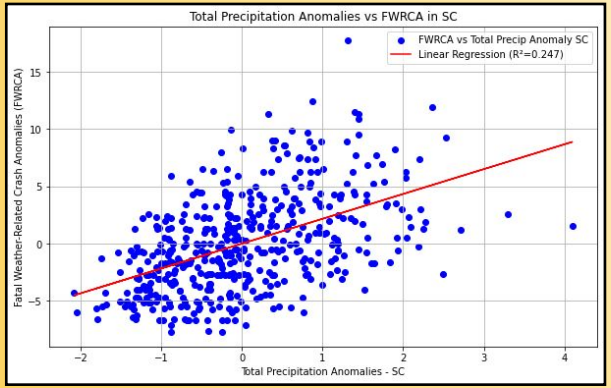

R² Values of Total Precipitation Anomalies vs FWRCA for Each State (Sorted by Correlation)
State
CA
TX
GA
AZ
SC
OR
MS
AR
FL
TN
NC
AL
MO
LA
NV
VA
OK
WA
NM
IL
KY
UT
MD
WV
PA
KS
CT
NJ
IN
CO
MI
OH
WI
MA
ID
IA
NY
MN
NE
ND
NH
SD
MT
ME
DE
VT
RI
WY
0.0
0.1
0.2
0.3
0.4
0.5
R² Value

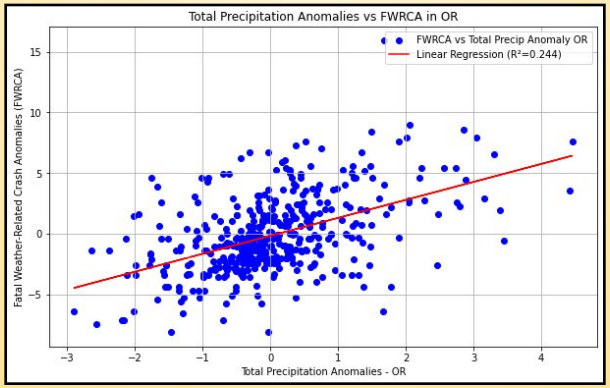
Scatter Plots of FWRCA vs Total Precipitation Anomalies

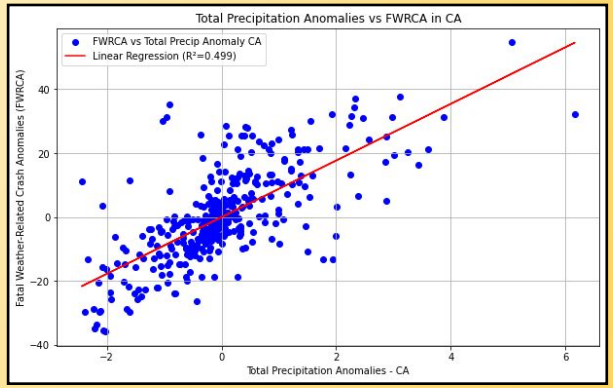


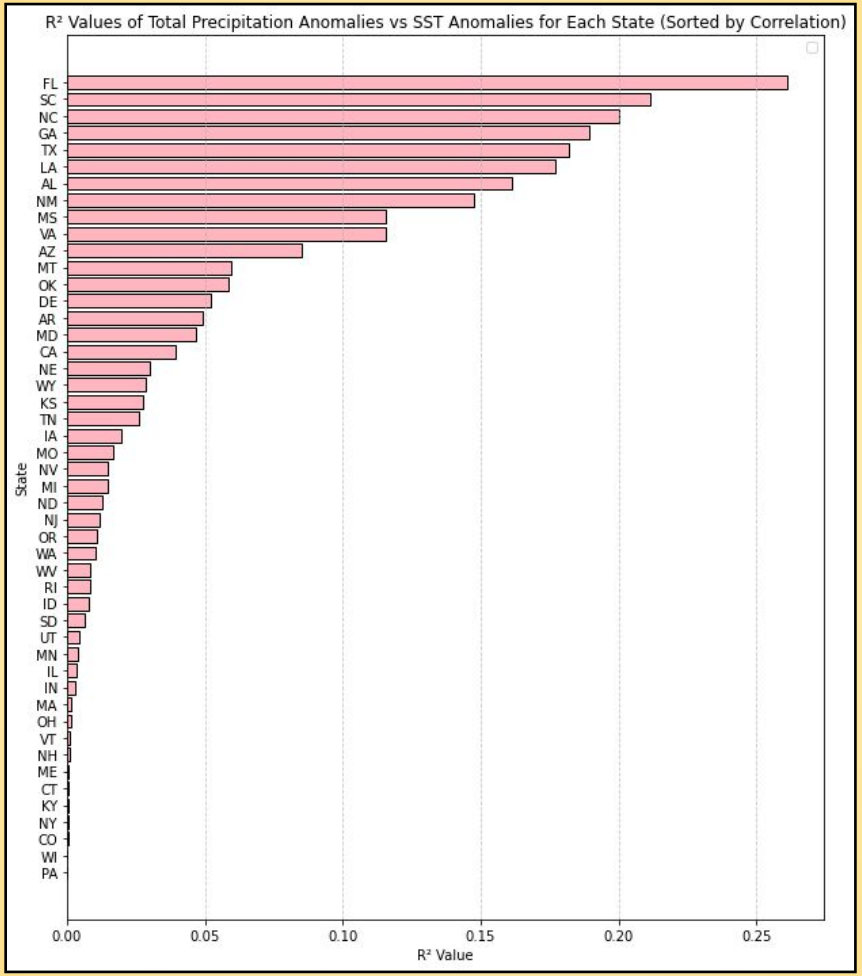


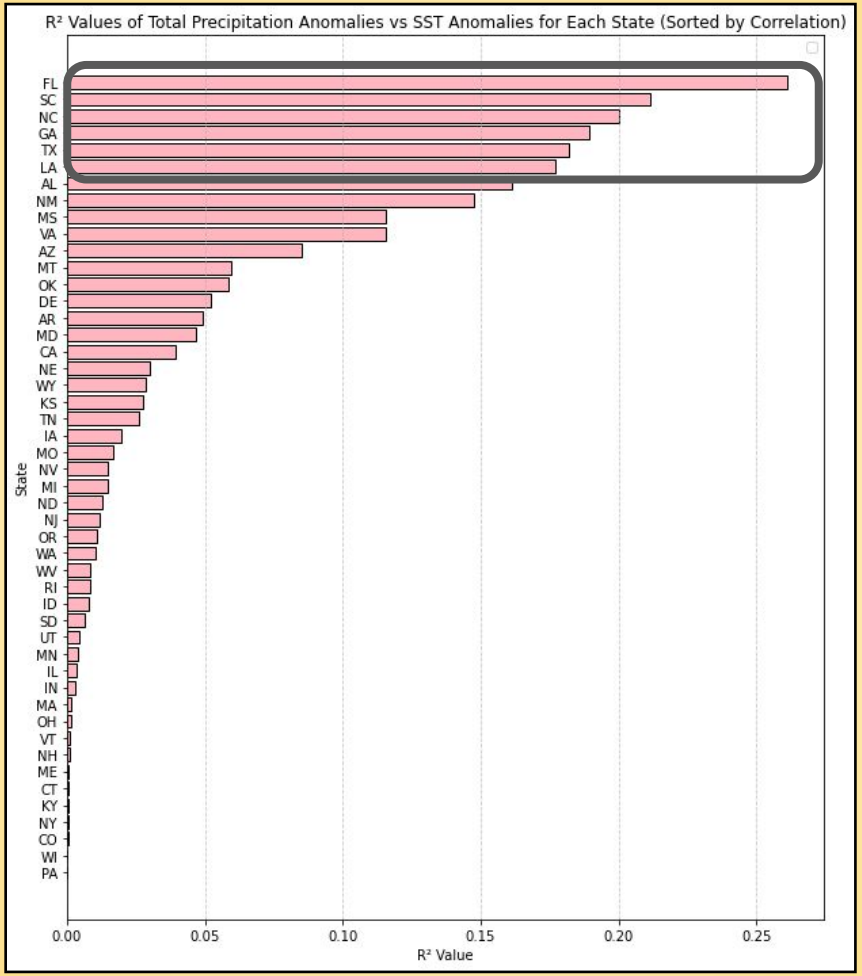




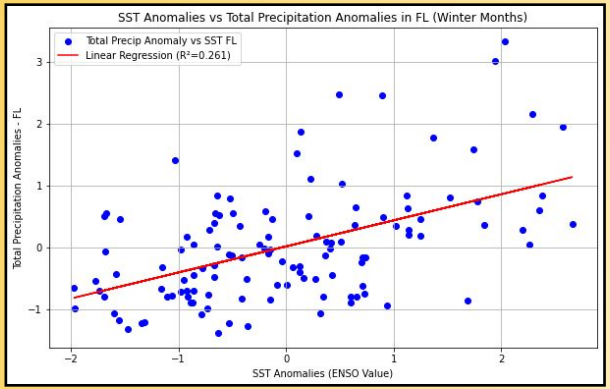


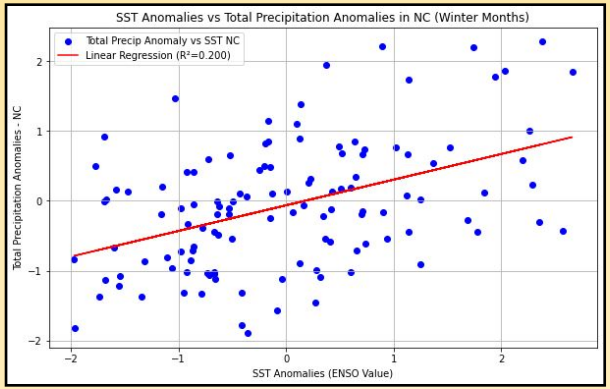


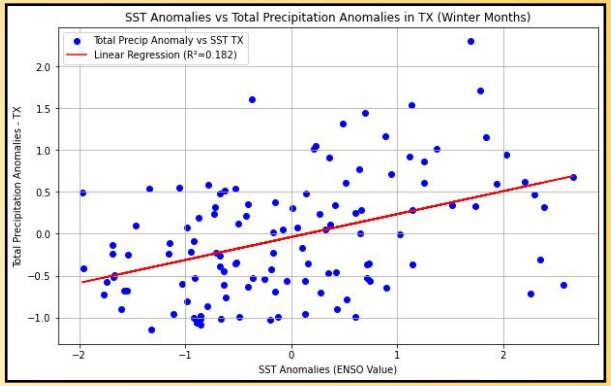

R² Values of Total Precipitation Anomalies vs SST Anomalies for Each State (Sorted by Correlation)
State
FL
SC
NC
GA
TX
LA
AL
NM
MS
VA
AZ
MT
OK
DE
AR
MD
CA
NE
WY
KS
TN
IA
MO
NV
MI
ND
NJ
OR
WA
WV
RI
ID
SD
UT
MN
IL
IN
MA
OH
VT
NH
ME
CT
KY
NY
CO
WI
PA
0.00
0.05
0.10
0.15
0.20
0.25
R² Value

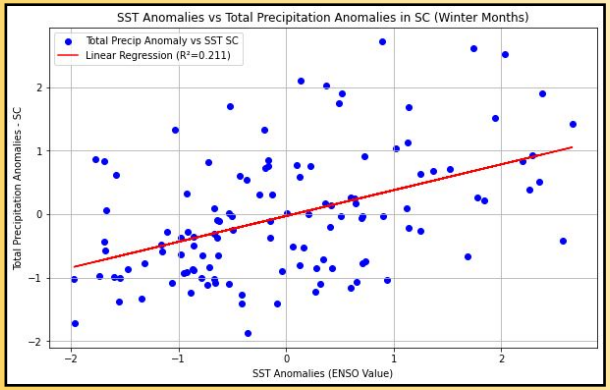

R² Values of Total Precipitation Anomalies vs SST Anomalies for Each State (Sorted by Correlation)
State
FL
SC
NC
GA
TX
LA
AL
NM
MS
VA
AZ
MT
OK
DE
AR
MD
CA
NE
WY
KS
TN
IA
MO
NV
MI
ND
NJ
OR
WA
WV
RI
ID
SD
UT
MN
IL
IN
MA
OH
VT
NH
ME
CT
KY
NY
CO
WI
PA
0.00
0.05
0.10
0.15
0.20
0.25
R² Value

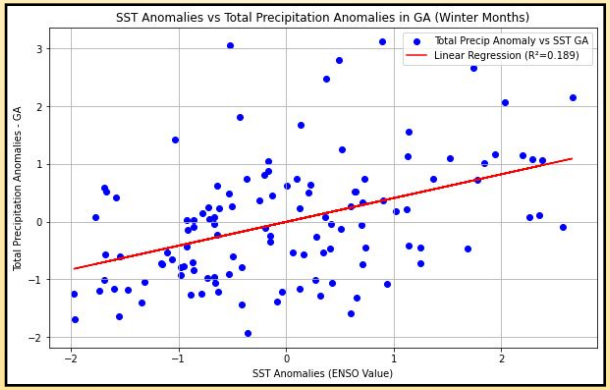
Scatter Plots of SST vs Total Precipitation Anomalies

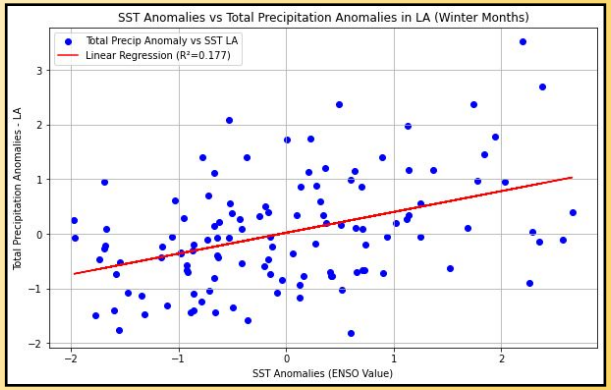






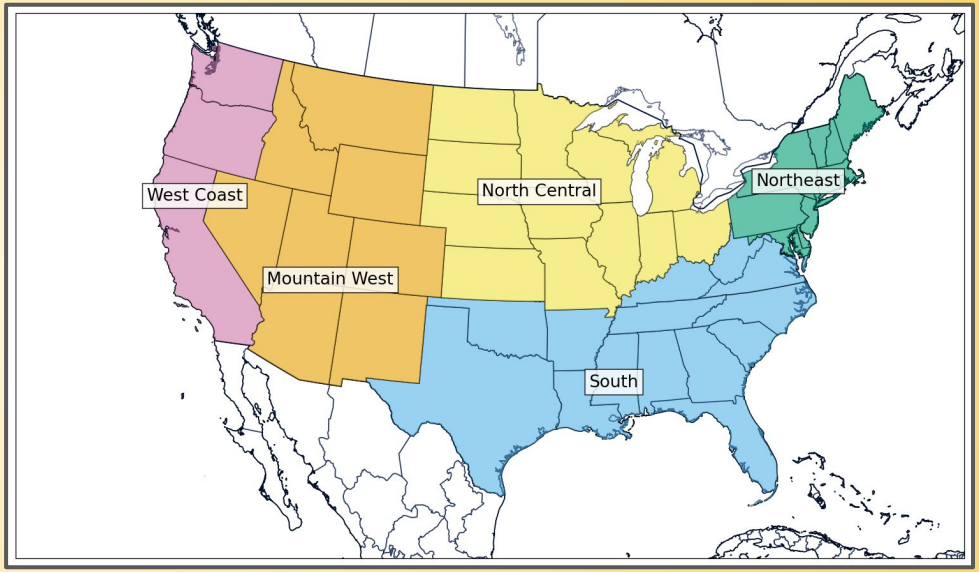






Conclusion

- Linear correlations between SST and FWRCA with total precipitation anomalies are most significant in the ***southern*** United States
- ***West Coast*** states show a ***strongest*** statistical relationship between FWRCA and total precipitation anomalies, ***weakest*** between SST and total precipitation anomalies
- Fatal weather-related crash anomalies peak near the beginning or end of each year
- Seasonal fatal crash peak alignment with SSTs indicates ENSO influence



Future Work

- Conduct analysis by county / MSA (metropolitan statistical area)
  - Not every part of a state is affected by SST changes
- Filter out state counties with little to no historical changes in subseasonal to seasonal variability
  - Helps address future changes in commuting behavior due to teleconnections such as ENSO
  - Inform the National Weather Service on how to better deliver risk communication to groups without any meteorological knowledge

Acknowledgements

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Kathy Pegion: Co-research mentor; Graduate Advisor

Amin Taziny: Writing & Computing Mentor

Thank you! Questions?

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