

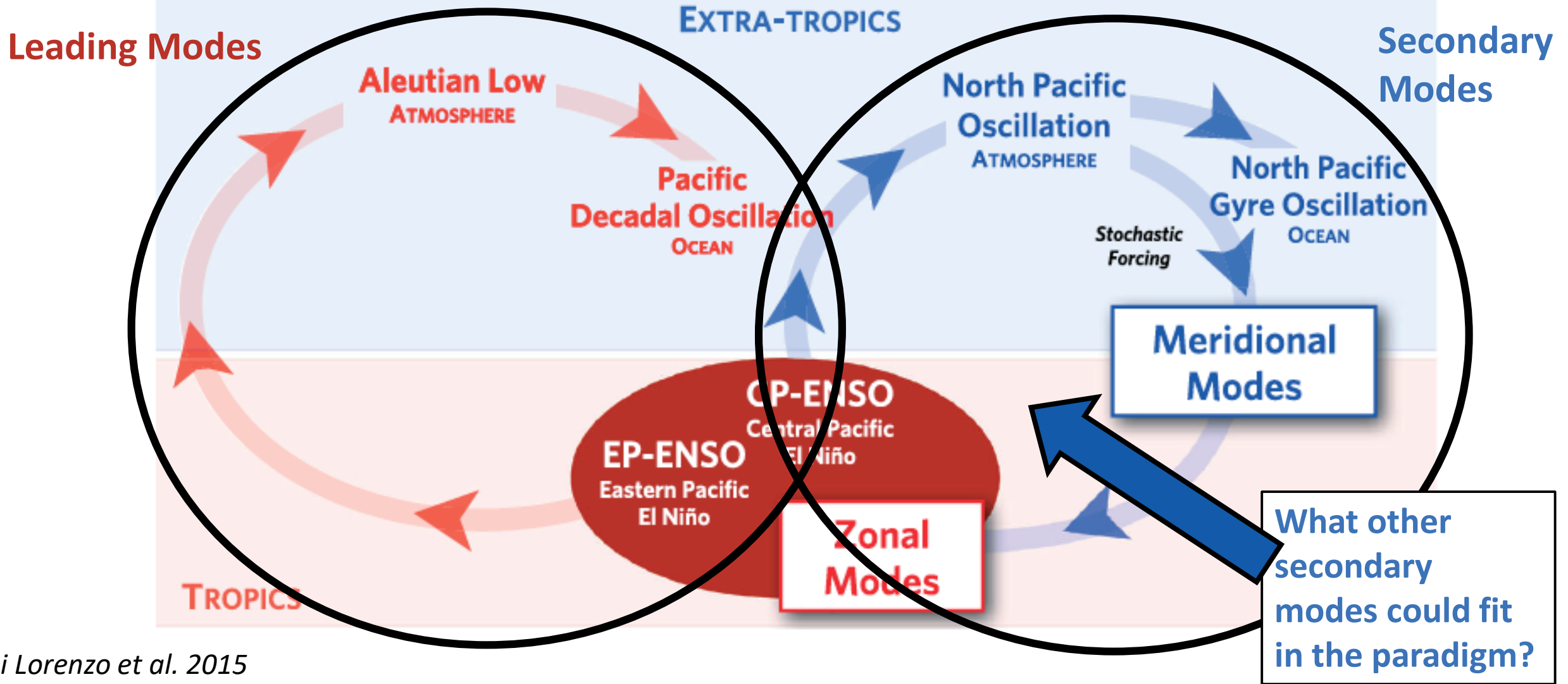
LINKS BETWEEN THE PACIFIC DECADAL PRECESSION AND NORTH AMERICAN WINTER CLIMATE EXTREMES

Jason C. Furtado¹, Bruce T. Anderson², and Matthew H. Rogers¹

¹*School of Meteorology, University of Oklahoma, USA* ²*Dept of Earth and Environmental Sciences, Boston University, USA*

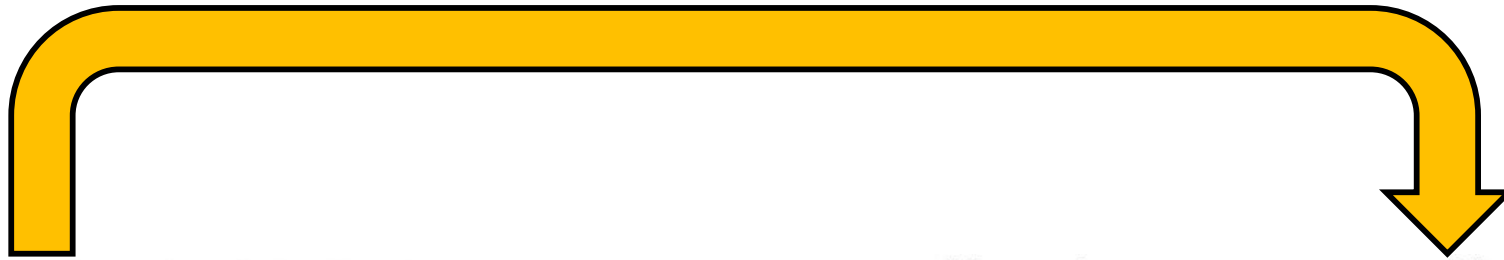
45th Annual NOAA Climate Diagnostics and Prediction Workshop
22 October 2020

A NULL-HYPOTHESIS FOR PACIFIC CLIMATE VARIABILITY

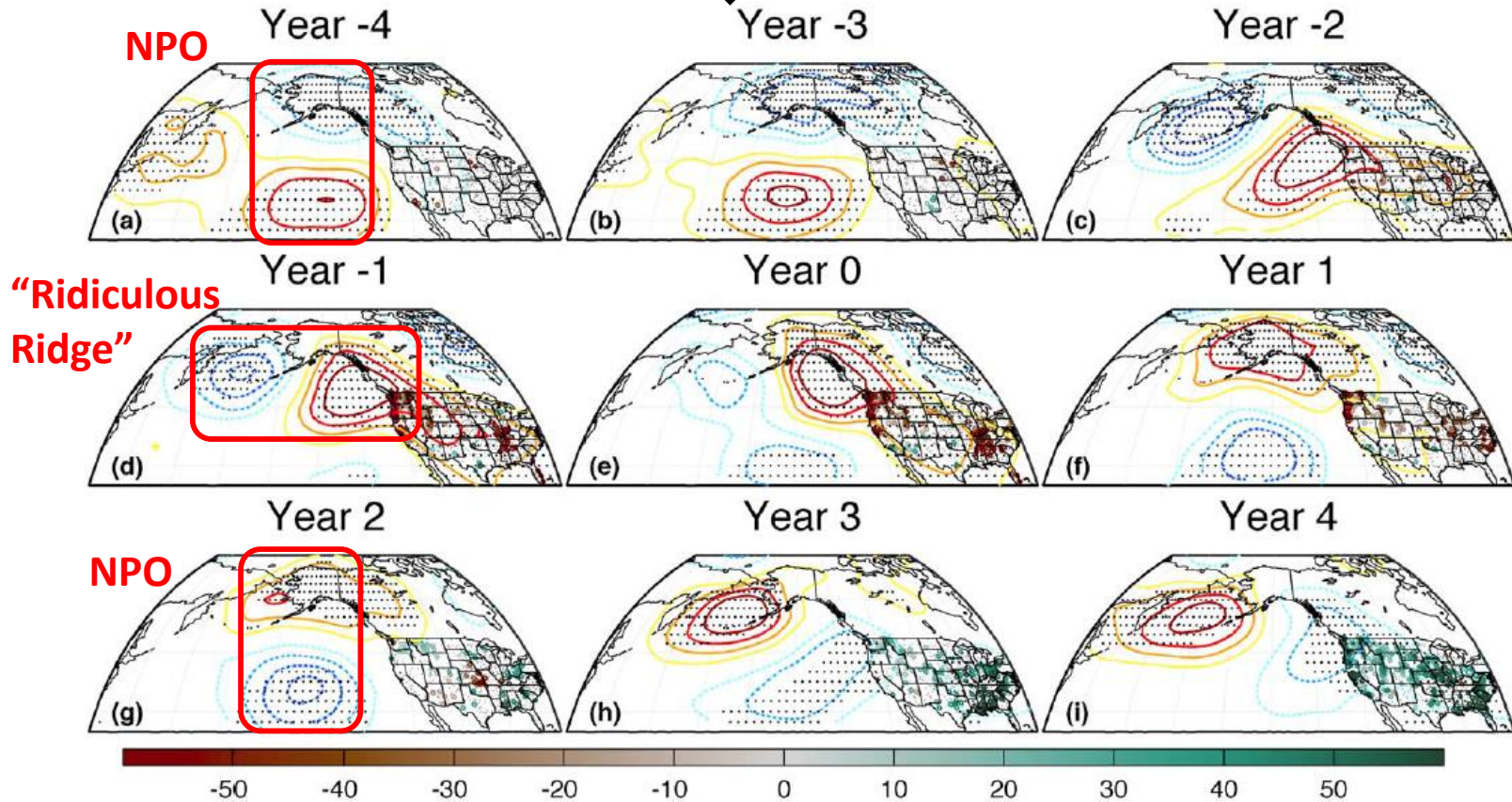
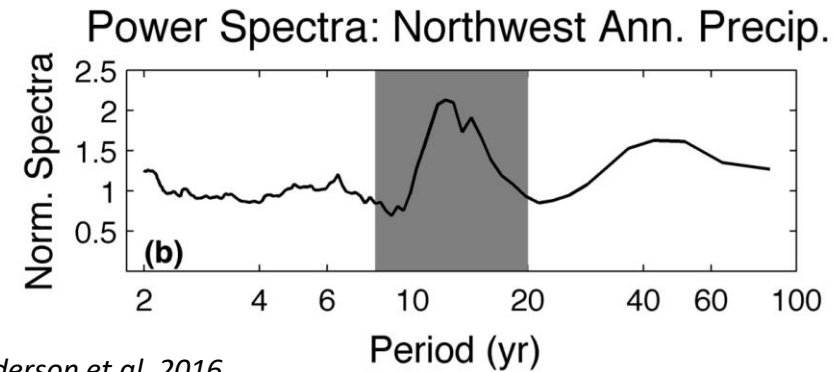
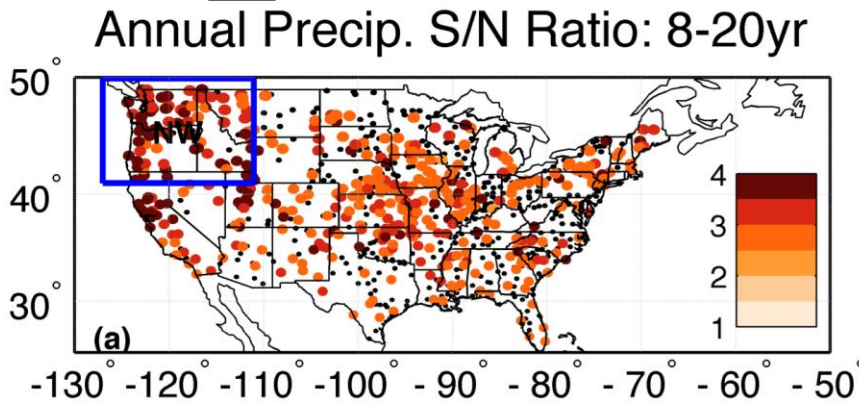


Di Lorenzo et al. 2015

INTRODUCING: THE PACIFIC DECADAL PRESSION

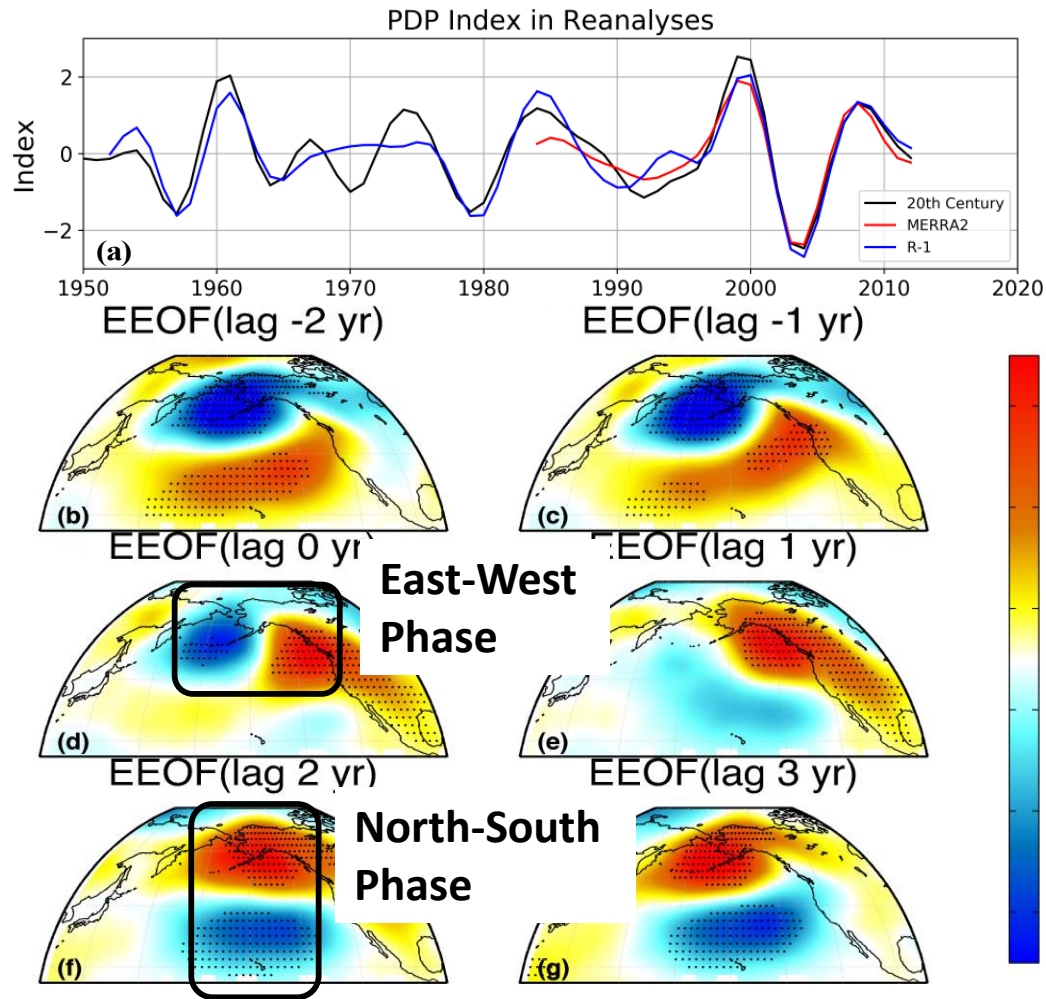


Regress 850 hPa GPH anomalies onto 1st PC of low-passed NW US Precip.



Anderson et al. 2016

THE PACIFIC DECADAL PRECESSION + MOTIVATION

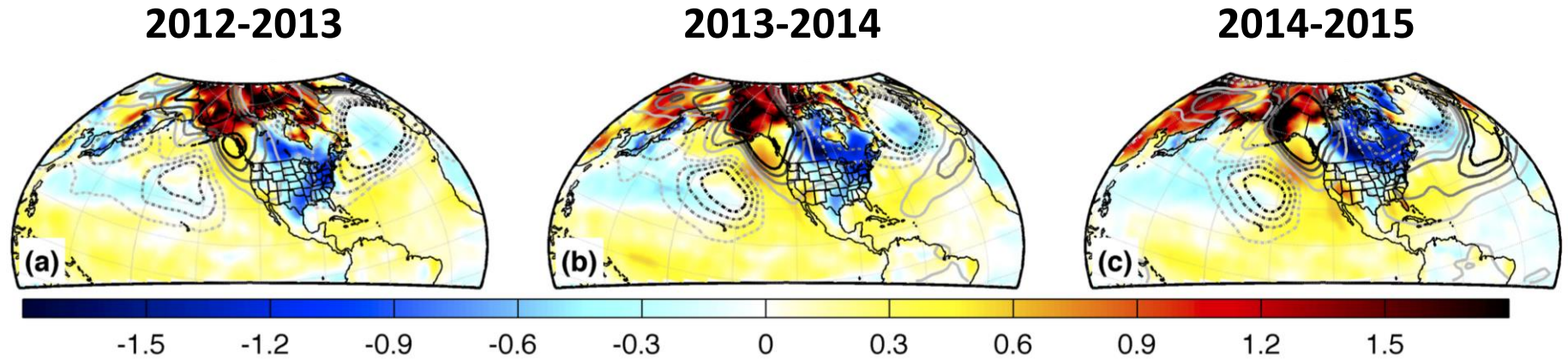


The Pacific Decadal Oscillation: Leading extended EOF (EEOF) mode of band-pass ($7-20 \text{ yr}^{-1}$) filtered *residual* 850 hPa wintertime GPH anomalies (remove **Aleutian Low** variability from 850 hPa GPH anomalies).

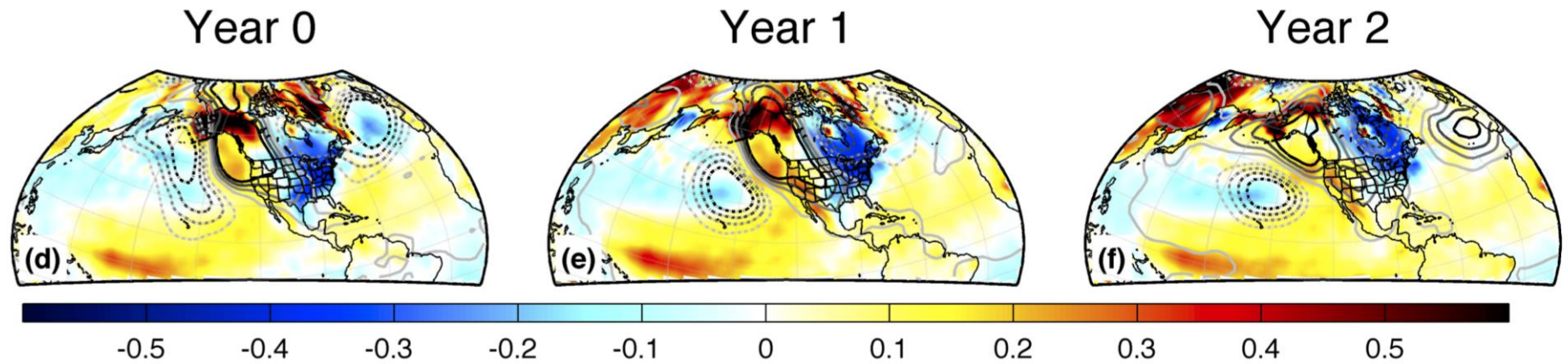
We have shown the connections to drought/pluvial cycles in the Pacific Northwest of the US, but could the PDP be tied to **other** North American winter weather extremes?

EXAMPLE: THE PDP + RECENT CLIMATE EXTREMES

OBSERVED: 7-20 yr⁻¹ NDJFM 850 hPa GPH anomalies (contours) + near-surface temperature anomalies (shading)



Regressions onto the PDP Index: 7-20 yr⁻¹ NDJFM 850 hPa GPH anomalies (contours) + near-surface temperature anomalies (shading)



Anderson et al. 2016

RESEARCH QUESTIONS

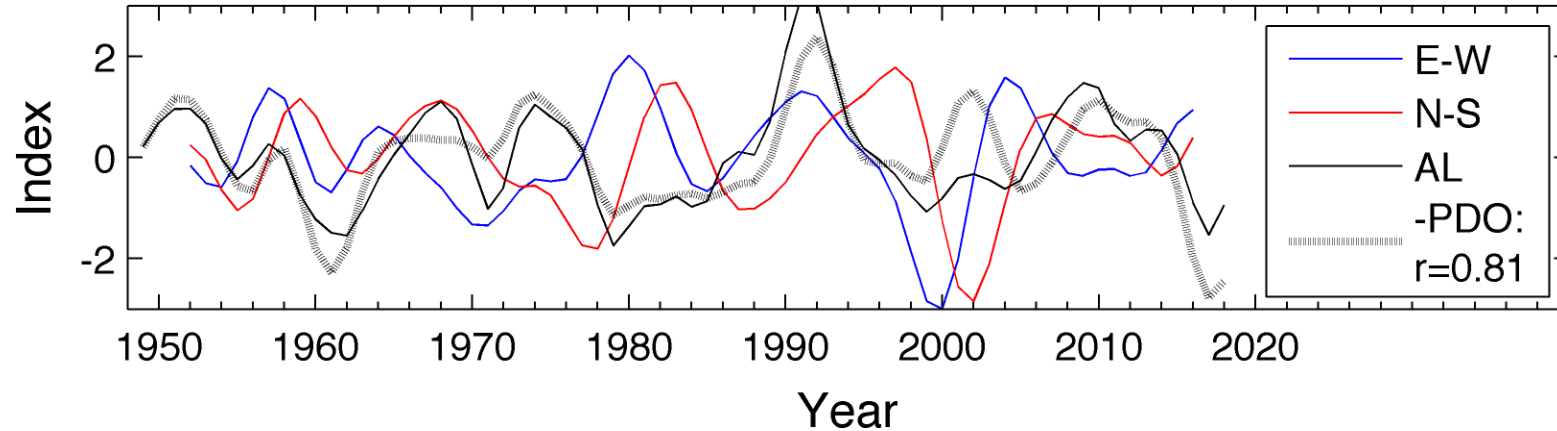
1. Does the PDP (i.e., its two phases) impact *concurrent* climate extremes across North America, as compared to those connected with Aleutian Low (AL) / PDO variability?
2. How does the PDP compare with the AL / PDO in explaining *decadal* patterns of North American climate extremes?

DATA

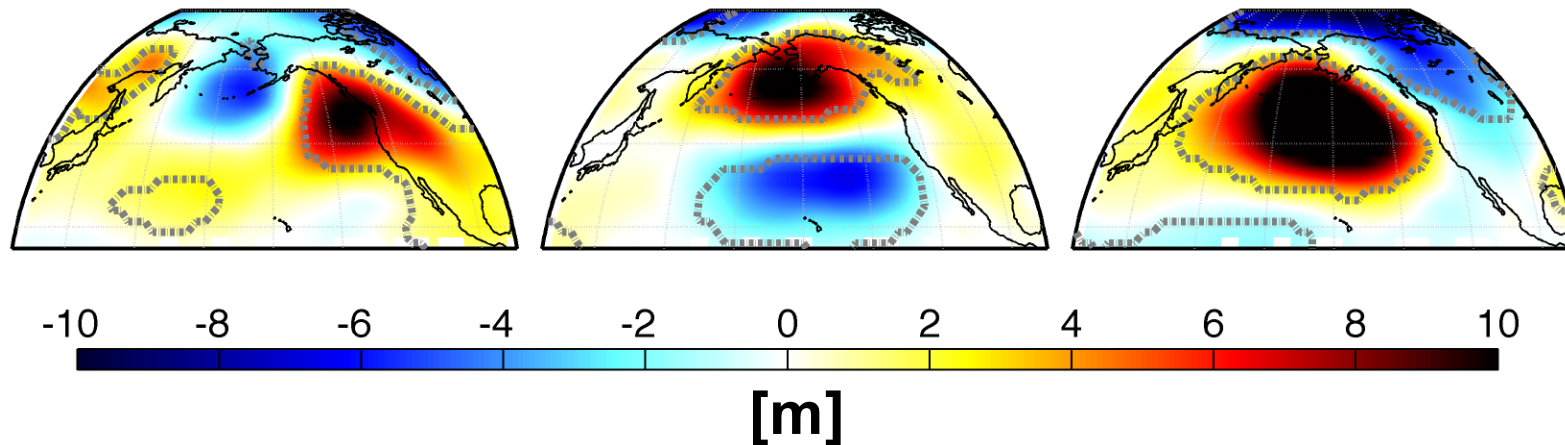
- **NCEP/NCAR Reanalysis** for geopotential height fields for defining the PDP and the Aleutian Low. November – March, 1950 – 2019.
- **Global Historical Climatology Network (GHCN)** for climate extremes. Monthly values averaged.
 - Maximum 1-day (**Rx1day**) and 5-day (**Rx5day**) precipitation
 - Maximum (**TXx**) and minimum (**TNn**) temperatures
 - Frequency of maximum T > 90th percentile (**TX90p**)
 - Frequency of minimum T < 10th percentile (**TN10p**)

DEFINE: THE AL/PDO MODE + TWO PHASES OF THE PDP

(a) Pacific Decadal Precession and Aleutian Low Indices



(b) Z850hPa: E-W (c) Z850hPa: N-S (d) Z850hPa: AL



Grey contour: $p < 0.05$

Furtado et al., in prep.

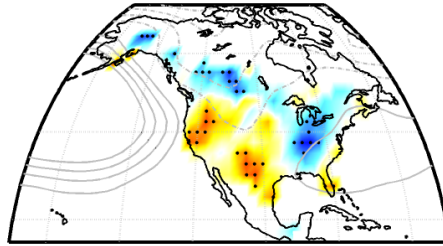
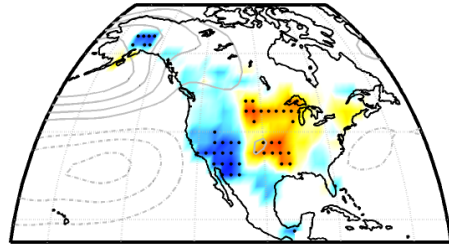
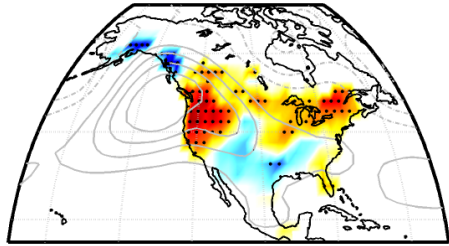
CONCURRENT CLIMATE EXTREMES

NDJFM-AVERAGED 1-DAY & 5-DAY PRECIPITATION TOTALS

(a) Rx1day: E-W

(b) Rx1day: N-S

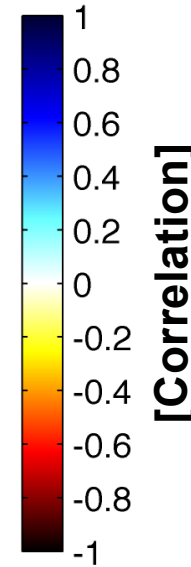
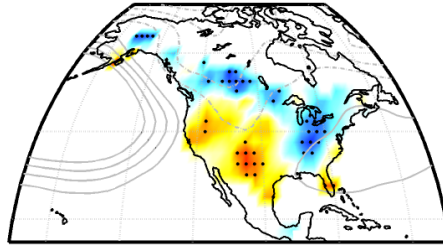
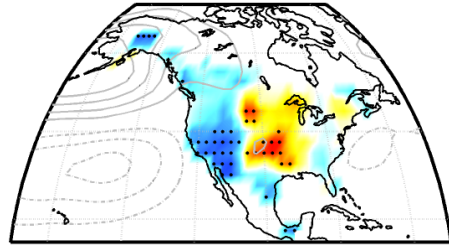
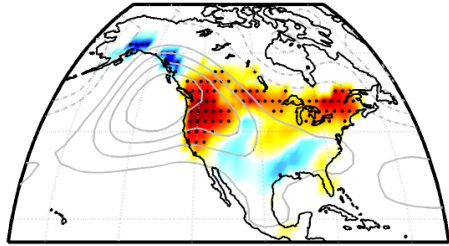
(c) Rx1day: AL



(d) Rx5day: E-W

(e) Rx5day: N-S

(f) Rx5day: AL



PDP E-W Phase: Neg. correlations Pac NW and across Northern Tier of US

PDP N-S Phase: Wet/dry couplet between SW US and Plains

AL Mode: Neg. correlations for W TX / Pos. correlations in parts of the Midwest

Furtado et al., in prep.

Grey contours: Regressions of 850 hPa

GPB onto the index

Stippling: $p < 0.05$

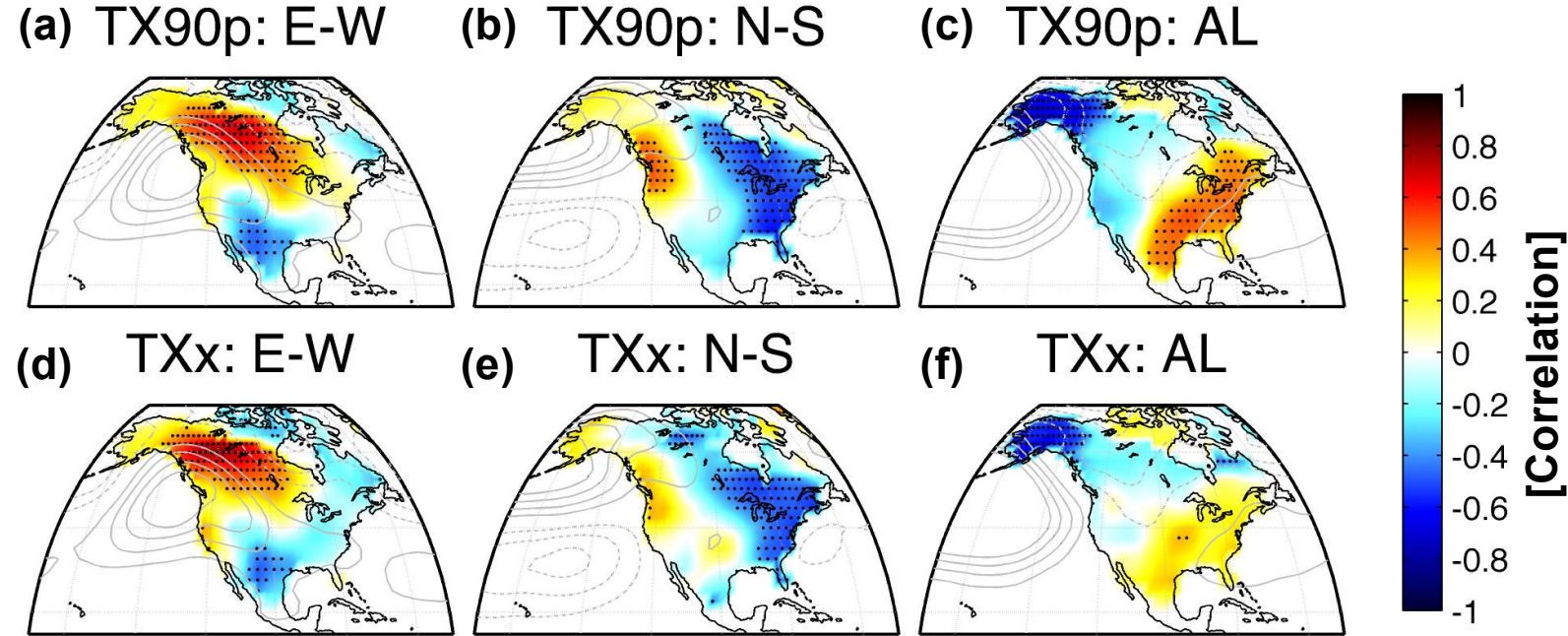
NDJFM-AVERAGED TX90P + MAX T

PDP E-W Phase: Largest correlations across central / NW Canada + TX/northern Mexico

PDP N-S Phase: Widespread negative correlations across eastern North America

AL Mode: Significant correlations with frequency of warmth, but not on absolute maxes

Grey contours: Regressions of 850 hPa GPH onto the index
Stippling: $p < 0.05$



Furtado et al., in prep.

NDJFM-AVERAGED TN10P + MIN T

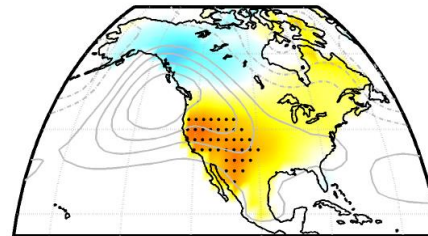
PDP E-W Phase: Impact mostly in western North America.

PDP N-S Phase: Coast-to-coast changes in frequency of and absolute cold min Ts.

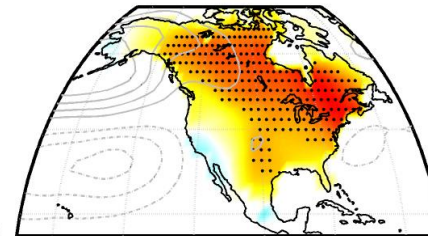
AL Mode: Zonal dipole across CONUS; Widespread signal for Alaska / N Canada.

Grey contours: Regressions of 850 hPa GPH onto the index
Stippling: $p < 0.05$

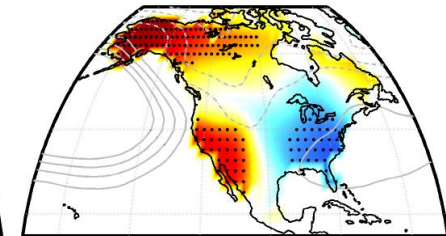
(a) TN10p: E-W



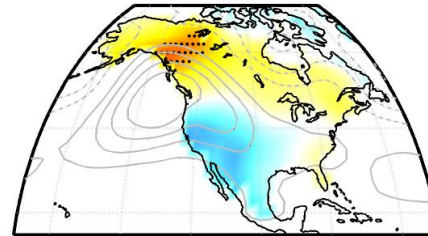
(b) TN10p: N-S



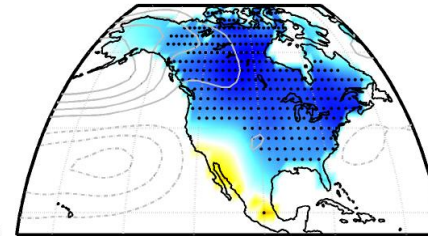
(c) TN10p: AL



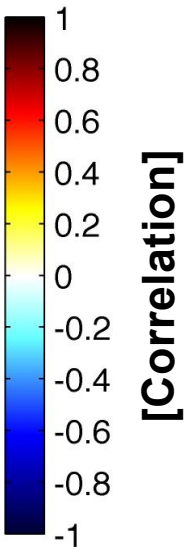
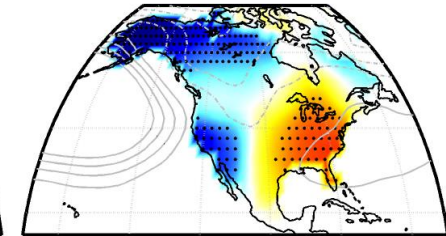
(d) TNn: E-W



(e) TNn: N-S

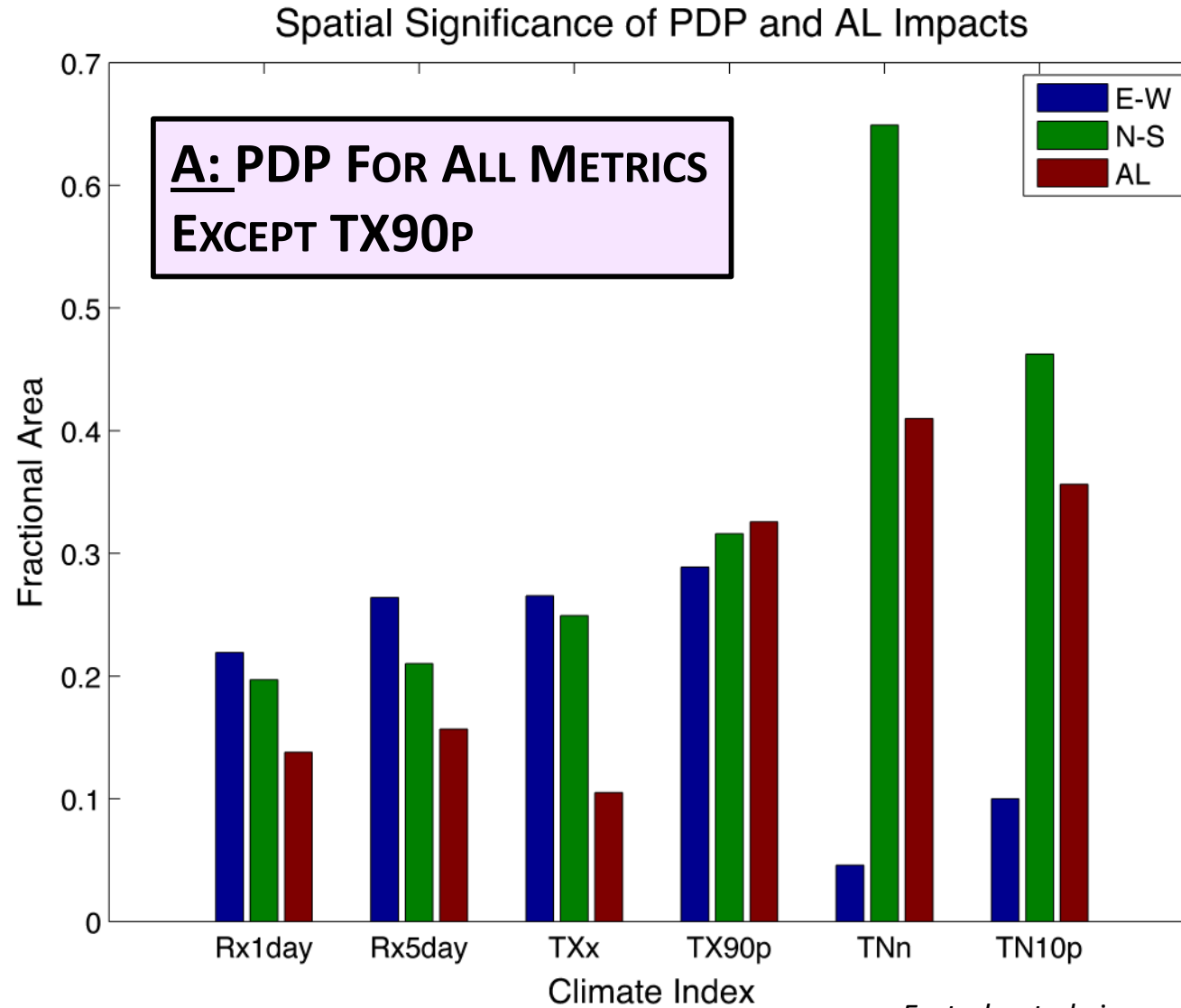


(f) TNn: AL



Furtado et al., in prep.

Q: WHICH MODE HAS MORE WIDESPREAD IMPACTS?



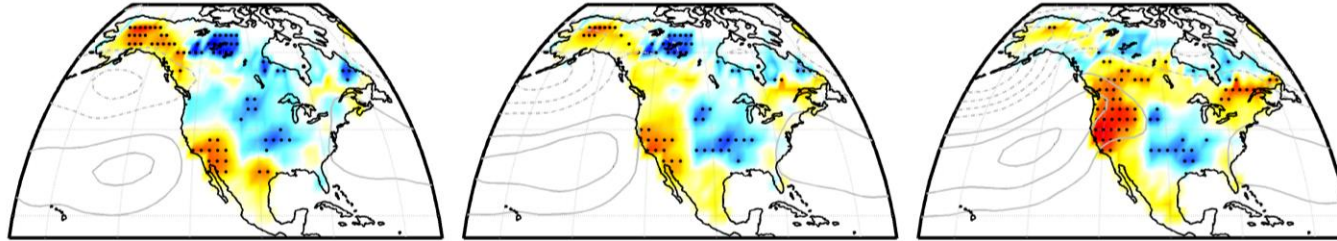
Furtado et al., in prep.



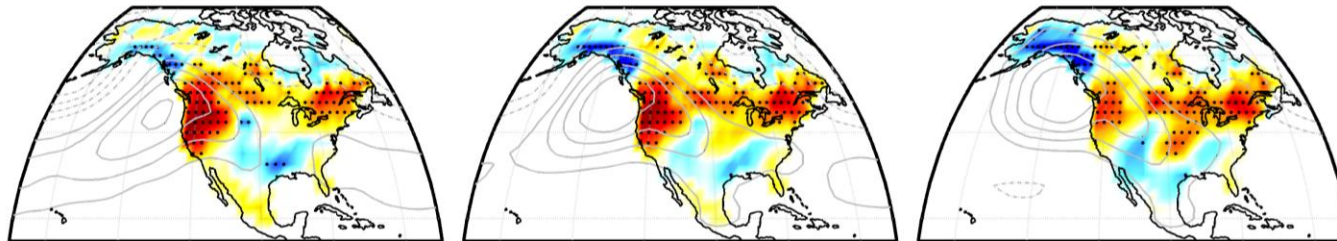
INTERANNUAL TO DECADEAL VARIABILITY

NDJFM-AVERAGED RX5DAY – DECADAL – PDP E/W PHASE

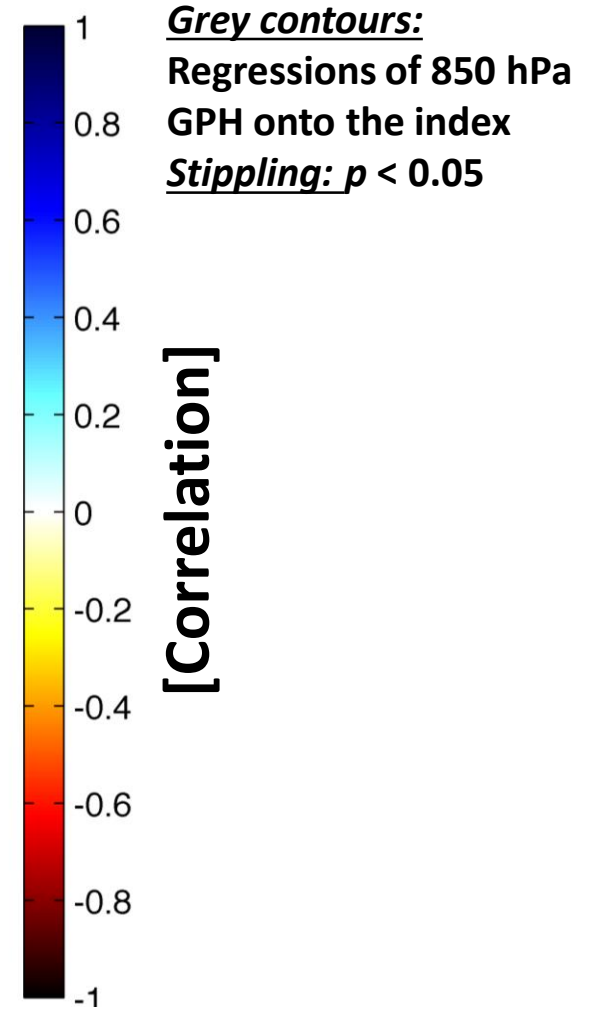
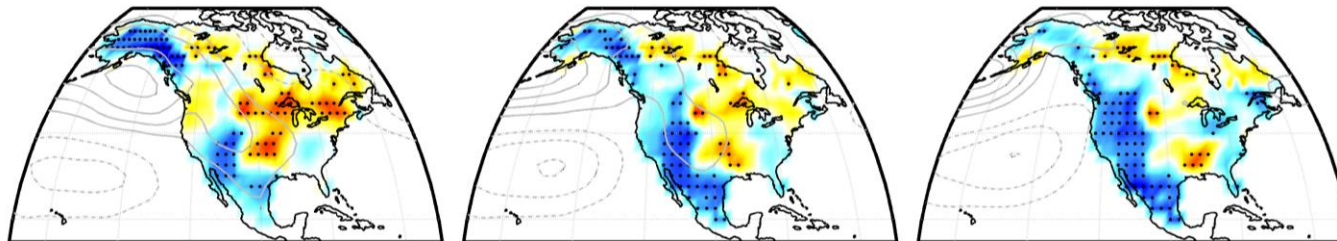
E-W Rx5day: -4yr E-W Rx5day: -3yr E-W Rx5day: -2yr



E-W Rx5day: -1yr E-W Rx5day: 0yr E-W Rx5day: +1yr

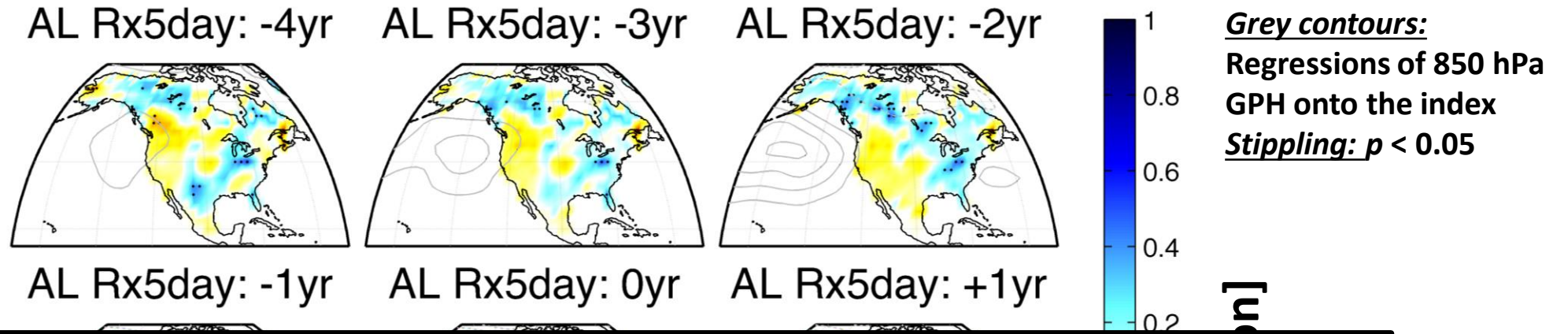


E-W Rx5day: +2yr E-W Rx5day: +3yr E-W Rx5day: +4yr

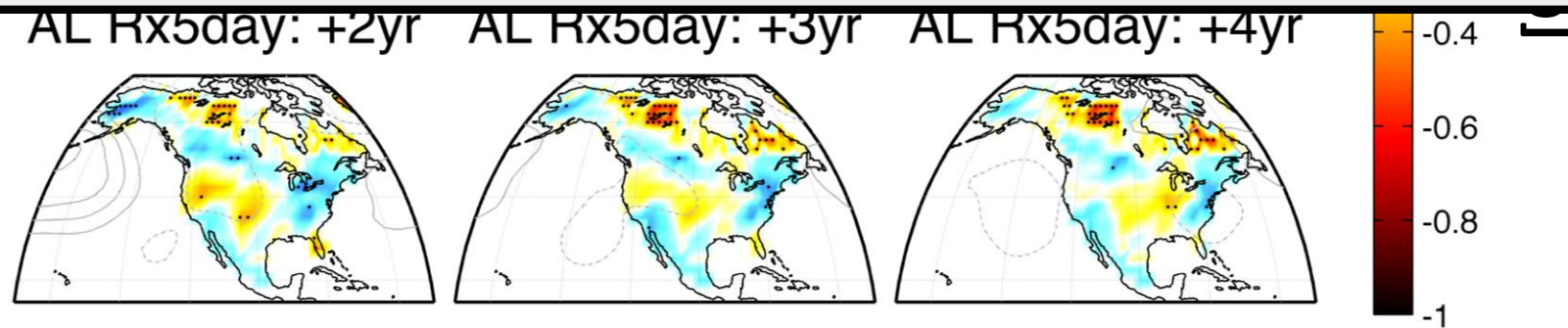


Furtado et al., in prep.

NDJFM-AVERAGED RX5DAY TOTALS – DECADAL – AL MODE

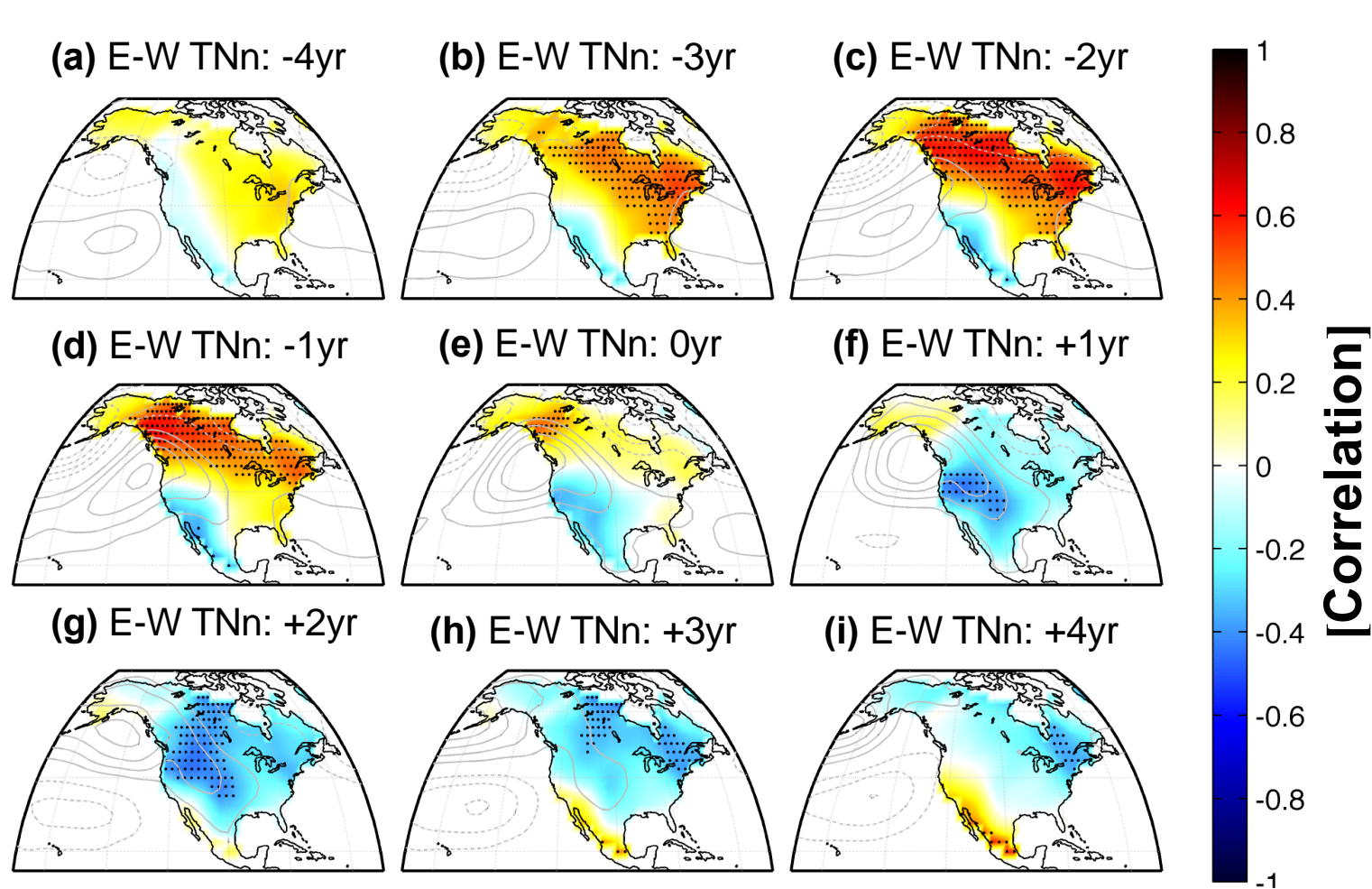


KEY POINT: The E-W phase of the PDP, NOT the AL/PDO mode, significantly relates to extreme 5-day precipitation totals across multi-year timescales.



Furtado et al., in prep.

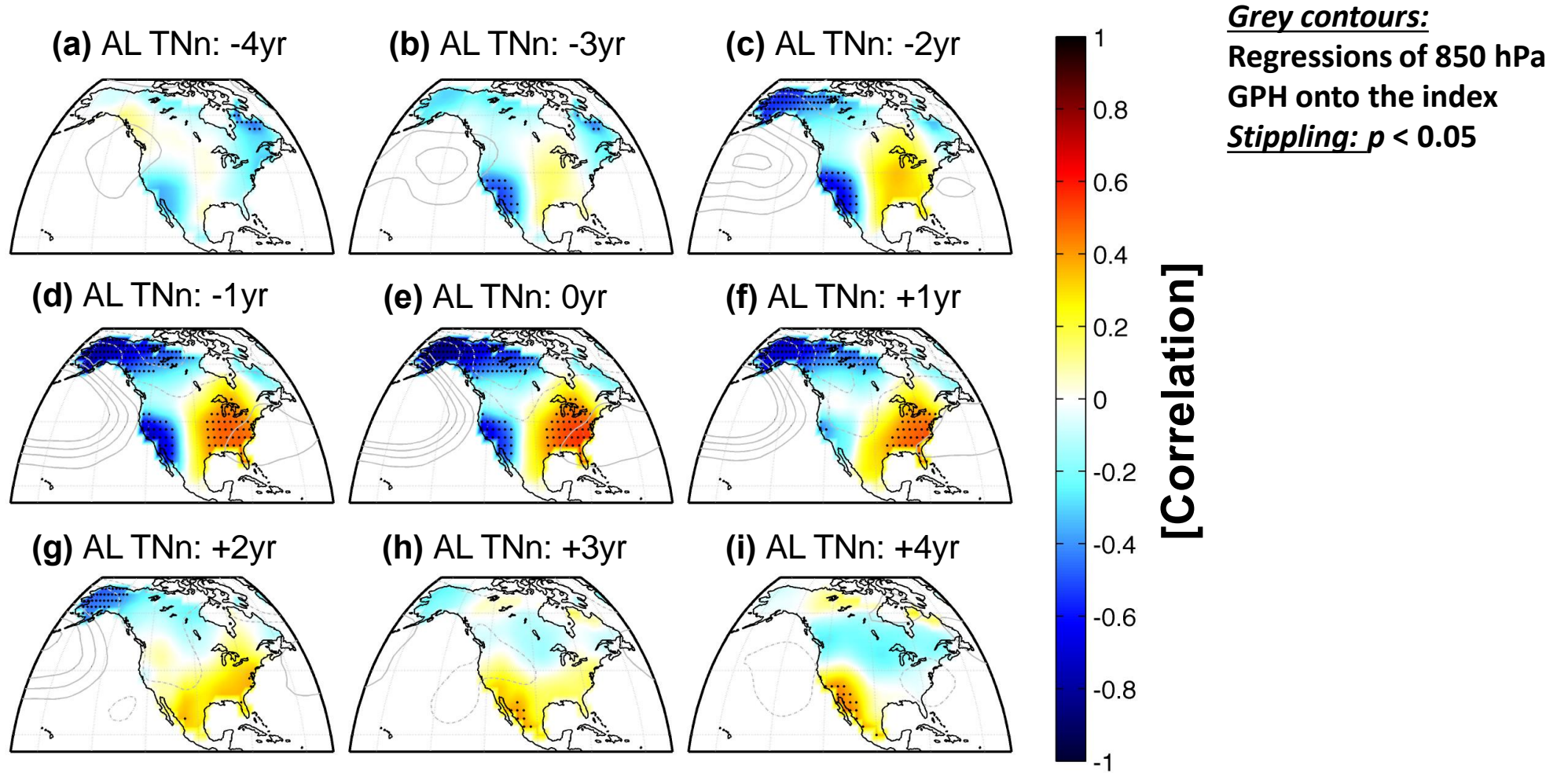
NDJFM MONTHLY MIN T- DECADAL – PDP E/W PHASE



Grey contours:
Regressions of 850 hPa
GPH onto the index
Stippling: $p < 0.05$

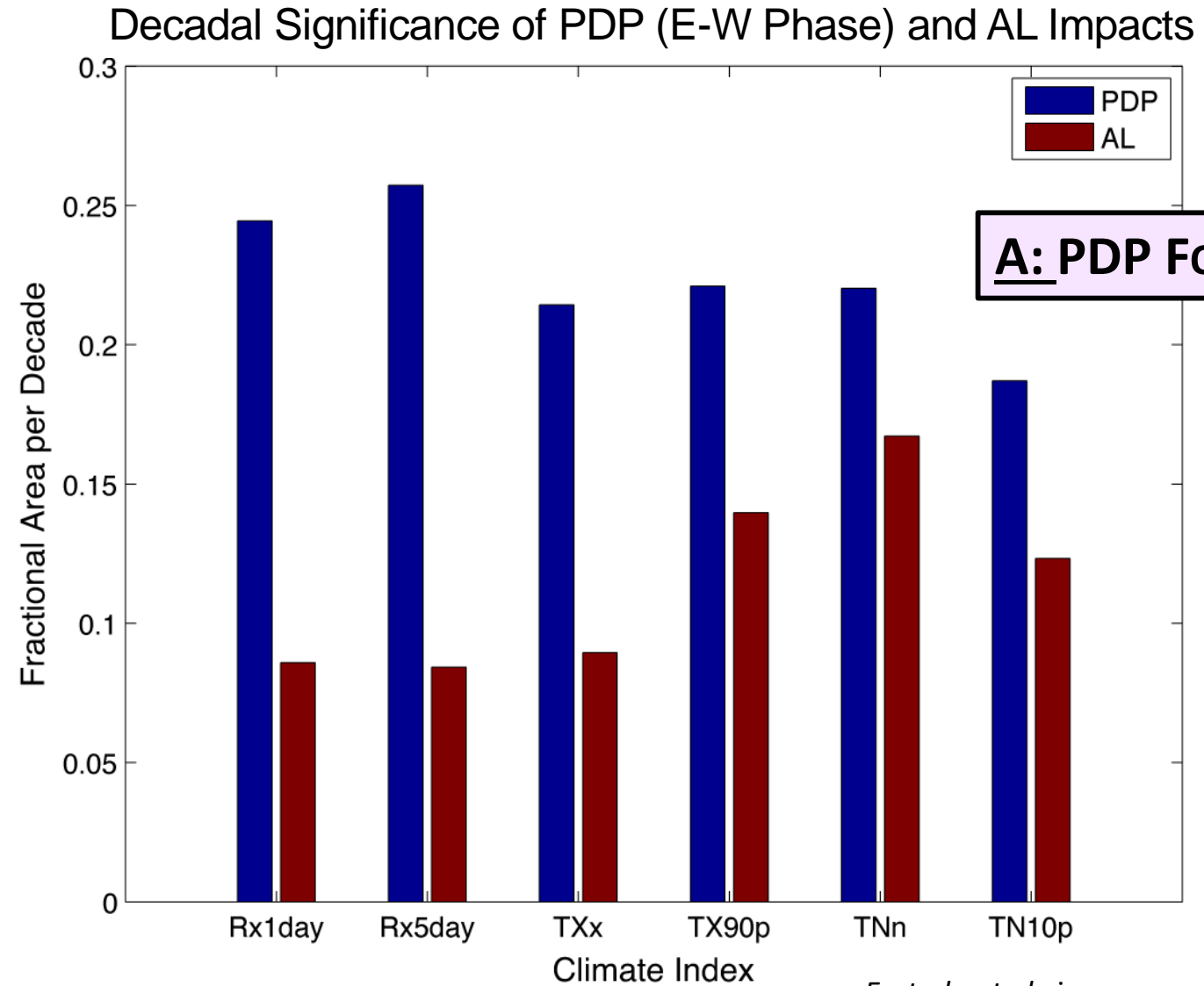
Furtado et al., in prep.

NDJFM MONTHLY MIN T – DECADAL – AL MODE



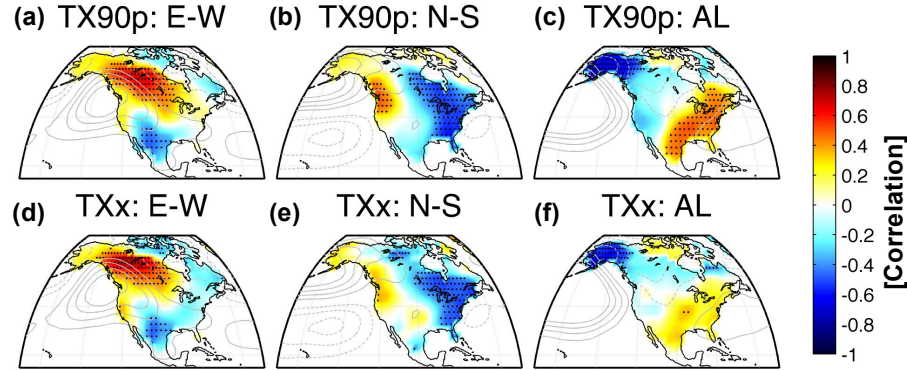
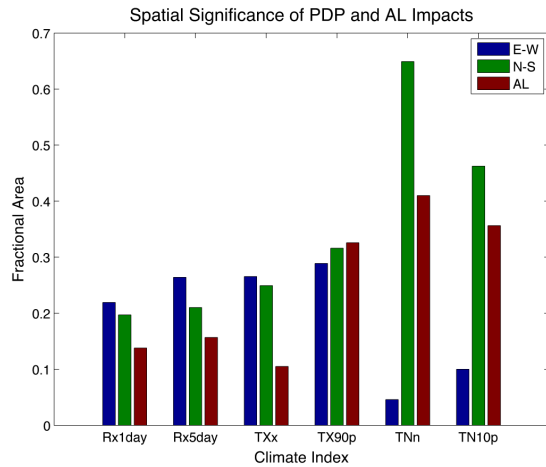
Furtado et al., in prep.

Q: WHICH MODE HAS MORE WIDESPREAD IMPACTS IN EXTREMES (DECADAL)?



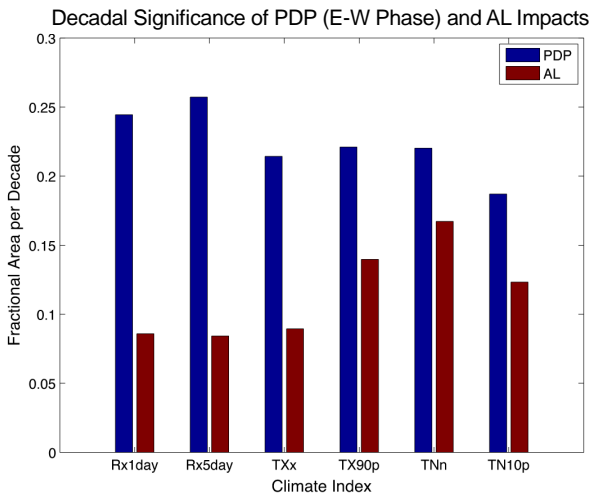
A: PDP FOR ALL METRICS

SUMMARY AND CONCLUSIONS



The PDP has:

- Demonstrable effects on concurrent *and* decadal winter climate extremes, including temperature and precipitation.
- Extreme weather impacts that are more widespread across North America than those associated with the AL/PDO.



Take Home Message:

Monitoring the PDP and its two phases could prove important for improving skill of S2S-to-S2D wintertime North American forecasts.



THANK YOU!

E-mail: jfurtado@ou.edu

Web: <http://ifurtado.org>

Twitter: [@wxjay](https://twitter.com/wxjay)

- Furtado, J. C., B. T. Anderson, and M. H. Rogers, 2020: Influence of the Pacific Decadal Precession on North American climate extremes. *J. Geophys. Res. Atmos.*, in prep.
- Rogers, M. H., J. C. Furtado, and B. T. Anderson, 2020: Representation of the Pacific Decadal Precession in the CMIP6 models. *J. Geophys. Res. Atmos.*, to be submitted.



EXTRA SLIDES

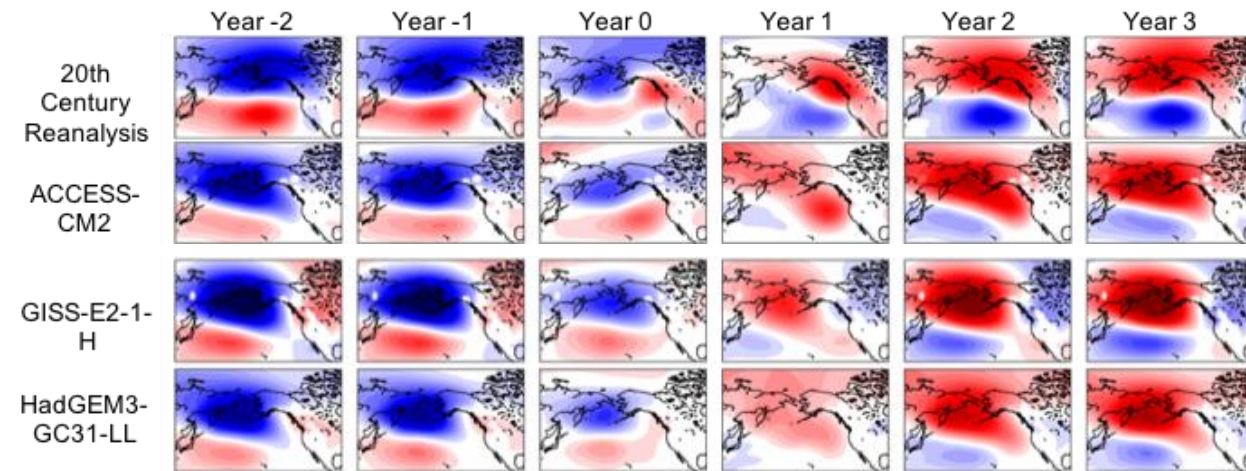
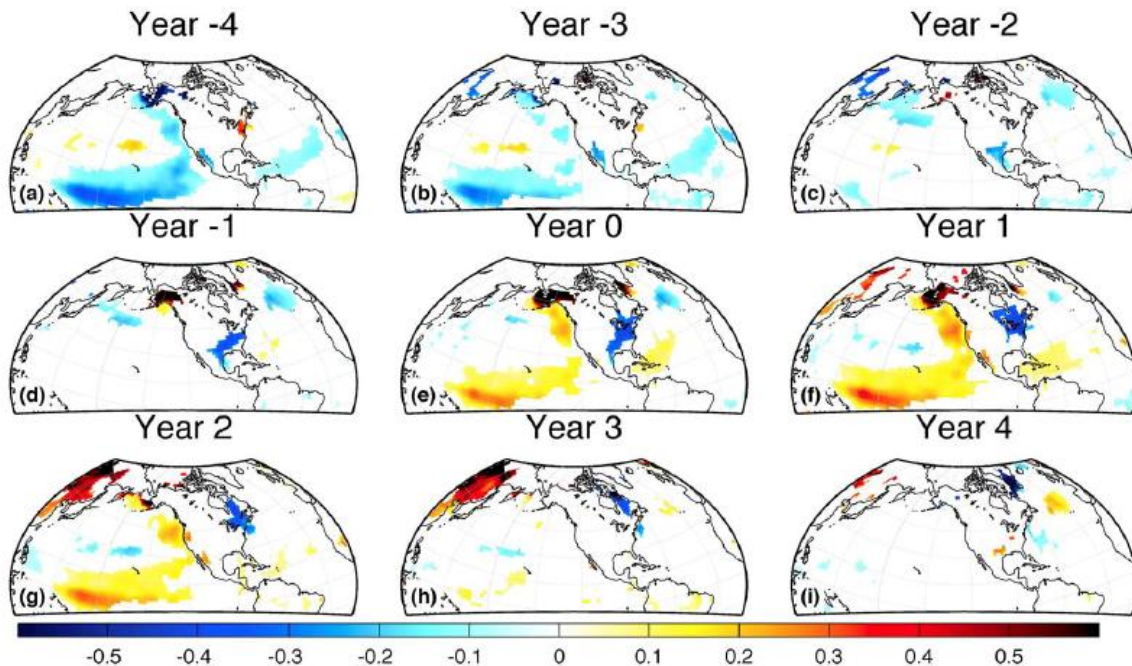


ONGOING / FUTURE WORK

1) Dynamics of the PDP → What controls the E-W/N-S phases?

2) The PDP teleconnections in climate models [*Rogers et al.*, 2020, in prep.] and S2S models [??].

Regressions of the PDP onto surface temperatures



PDP: REAL-TIME

Historic and Realtime PDP Indices

