STEVENS INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY®

North Pacific Influences on Long Island Temperature Variability

Justin Schulte[1], Nickitas Georgas[1], Vincent Saba[2], Penelope Howell[3]

1. Stevens Institute of Technology
2. GFDL
3. Connecticut DEP

Stevens Institute of Technology, Hoboken, NJ

Background - Estuaries

- Climate change may threaten the ecology and biology of estuaries through increases in water temperature.
- Marine species are migrating poleward as a result of warming water temperatures (Howell and Auster, 2012).
- Water temperature across the LIS has exhibited an upward trend.
- LIS water temperature changes may also be related to fluctuations in large-scale atmospheric circulation patterns or climate modes.

Background – Climate Modes

What is a climate mode?

- Climate modes have preferred geographic positions (atmospheric quasi-stationary Rossby waves).
- Characteristic timescales can also be a distinguishable characteristic.
- For example, the El-Nino/Southern Oscillation has a time scale of 2 to 7 years.
- Climate indices are a way to quantify the evolution and the intensity of the climate modes.

Background – Climate modes

- Climate modes have been shown to impact temperature and precipitation variability across the Northeast, including the LIS region (Schulte et al., 2016).
- The North Atlantic Oscillation (NAO) is often thought to be the most important climate mode for Northeast climate variability.
- Unfortunately, the NAO is a red-noise process with decorrelation timescale of 7 to 10 days so it is not the most useful from a seasonal forecasting prospective.
- Also, decadal fluctuations in the NAO are most likely stochastic and we therefore cannot predict them (Schulte et al., 2015).

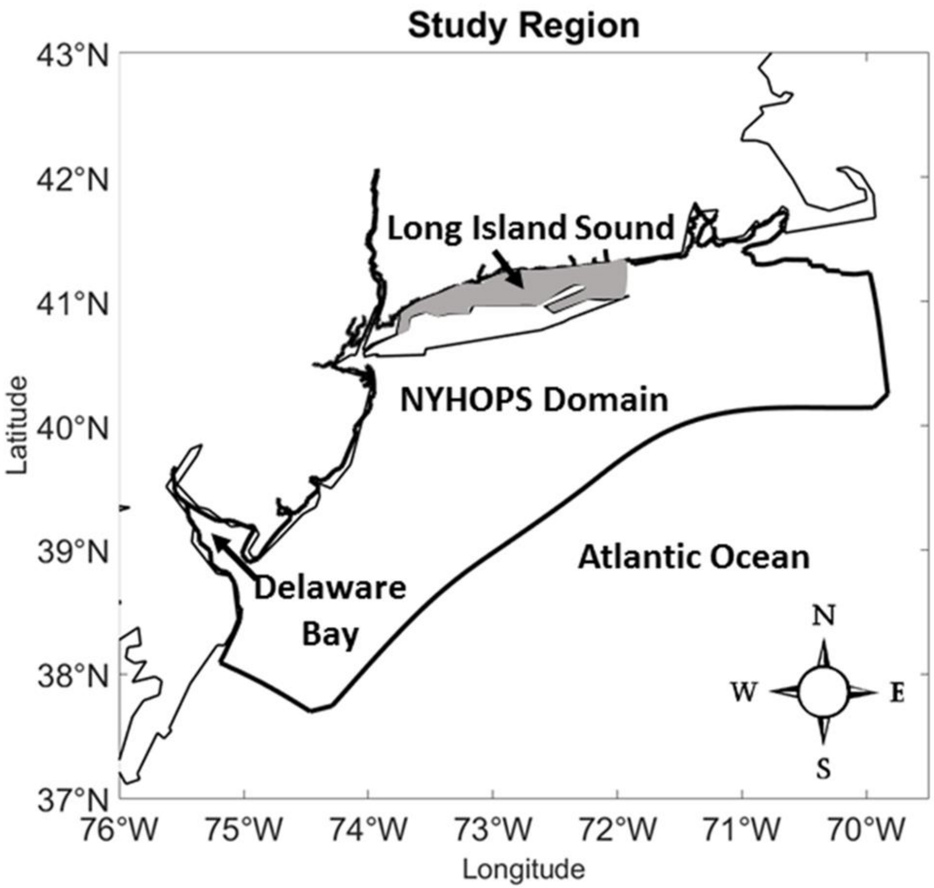
Research Objectives – revisiting climate mode-temperature relationships

- Identify key climate patterns influencing LIS temperature variability.
- Quantify the relationship between climate patterns and LIS temperature variability.
- Identify the time scales on which the relationships are the strongest.
- Show that the Pacific Decadal Oscillation (PDO) index may be useful for LIS temperature seasonal predictability.

Why the PDO and EP/NP patterns?

- The PDO is a persistent pattern.
- If we know the current PDO phase we also know the PDO phase months in advance (autocorrelation).
- The East Pacific/North Pacific (EP/NP) pattern has been shown to be excited by tropical convection and may be useful for intra-seasonal predictions (Tan et al. 2015).
- The influence of the EP/NP pattern has been strengthening since the 1950’s (Schulte and Sukyoung, 2016).

Study Region and Data

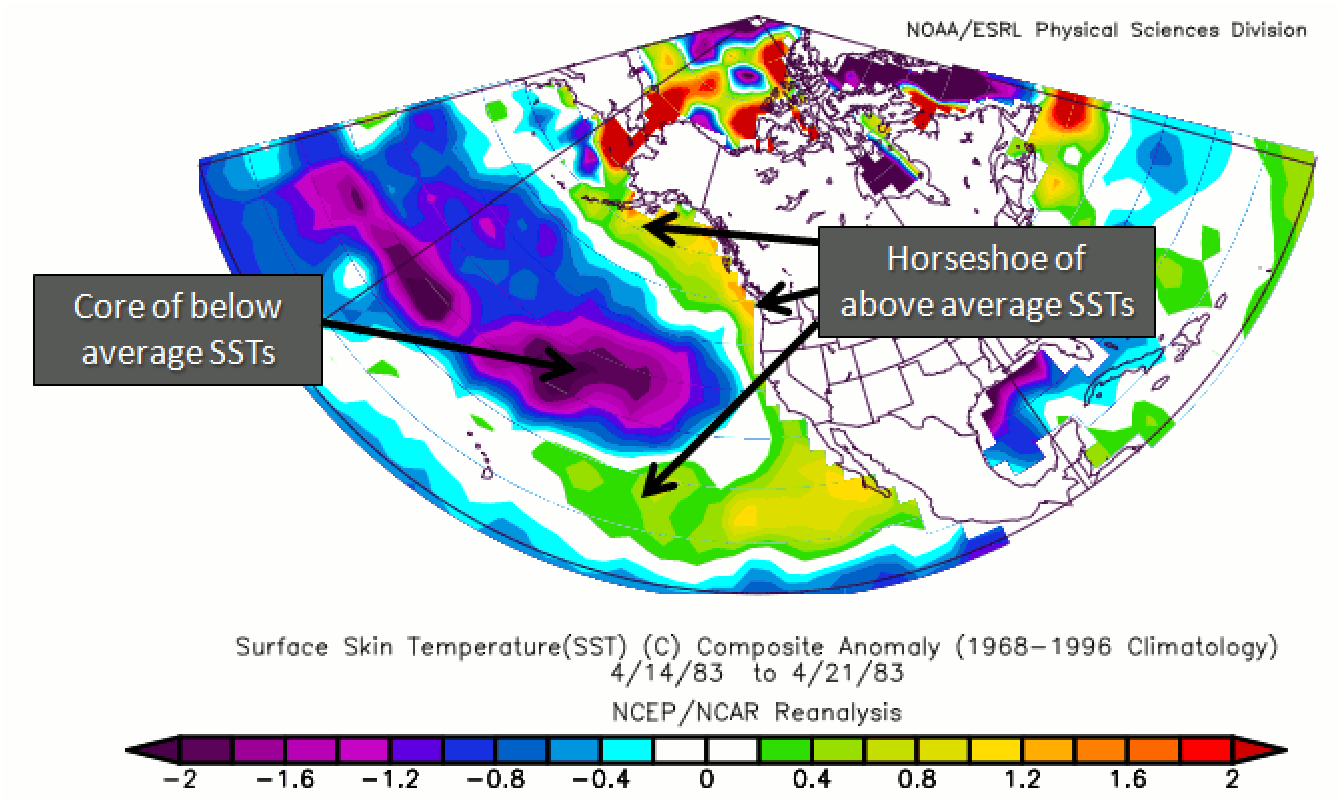


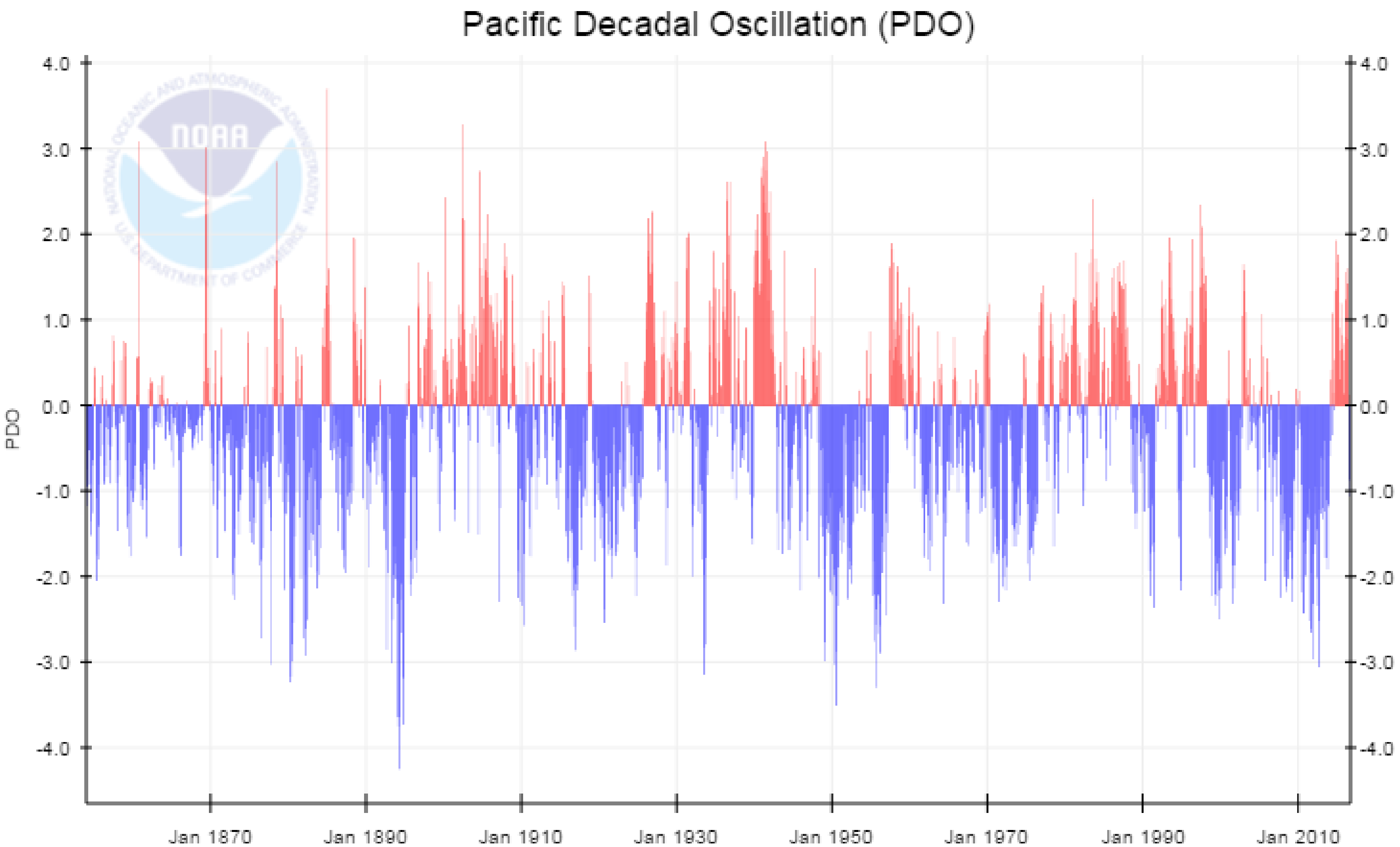
LIS temperature data is based on an evaluated hindcast from 1979 to 2013 produced from the New York Harbor Observation System (NYHOPS) model (Georgas, et al. 2016)

Gray shaded region was used to calculate LIS time series

ERA reanalysis air temperature data were used to create the air temperature time series

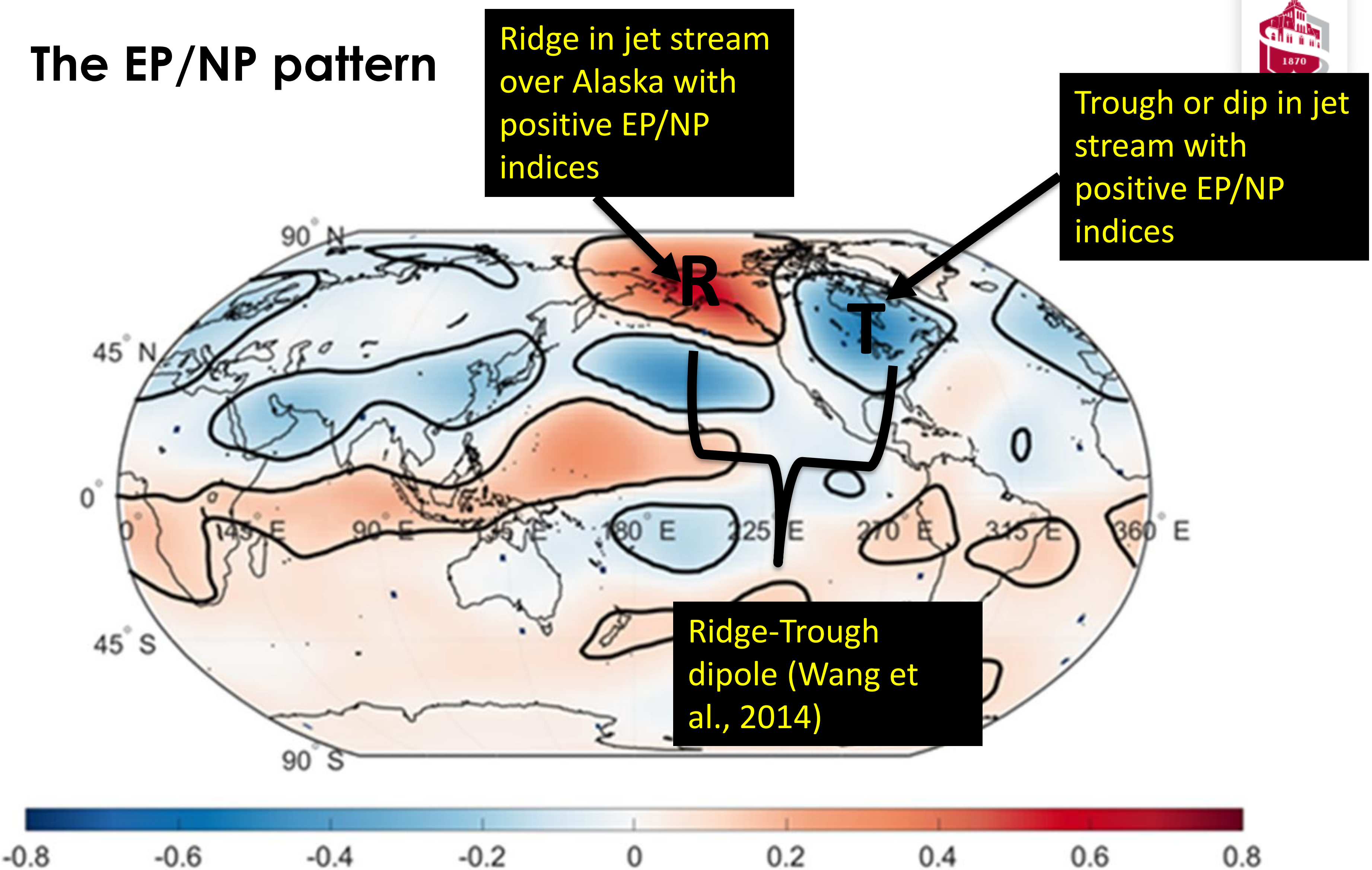
SST Anomalies during Positive PDO Phase





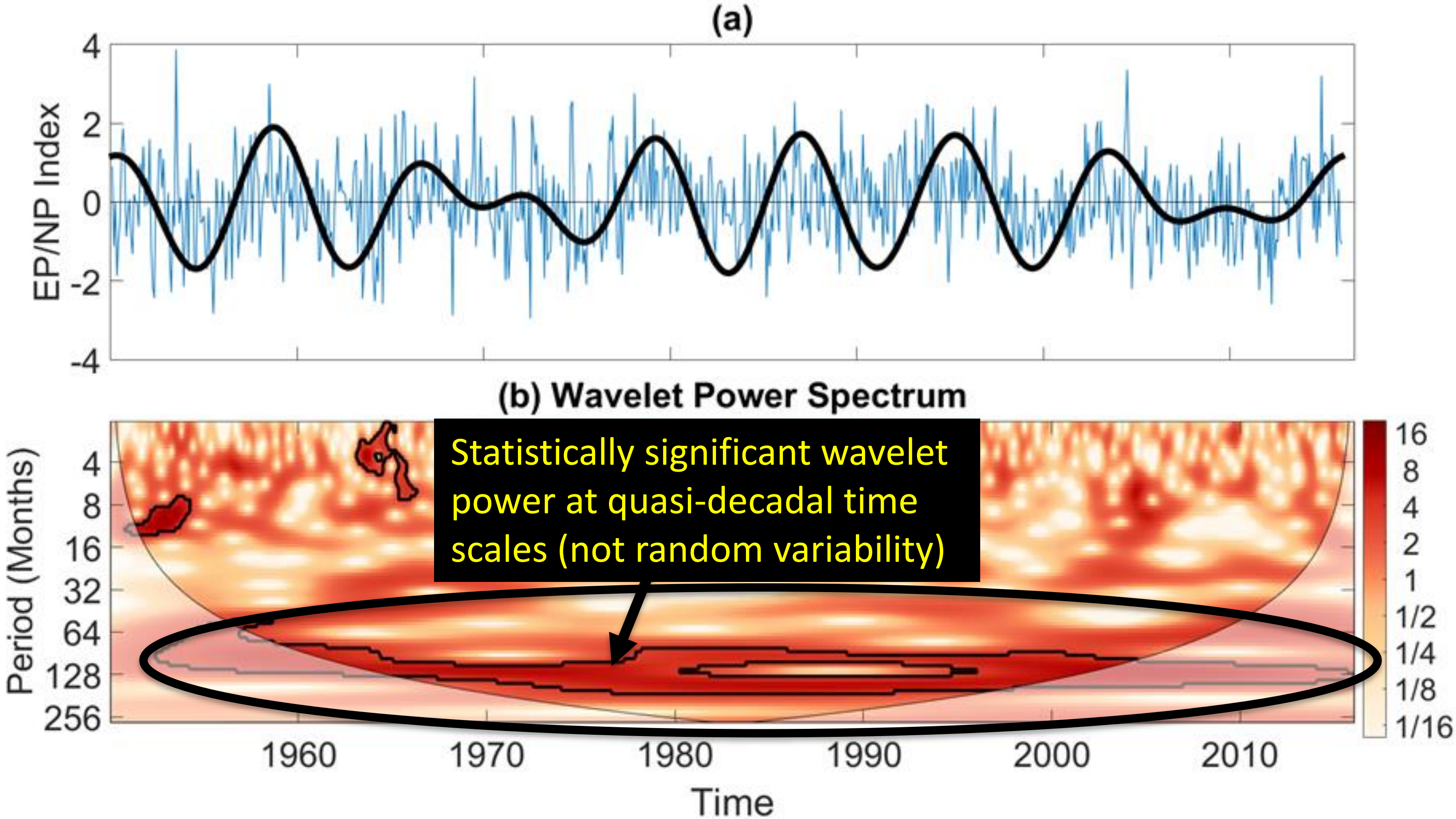
Pacific Decadal Oscillation (PDO)
PDO
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
Jan 1870
Jan 1890
Jan 1910
Jan 1930
Jan 1950
Jan 1970
Jan 1990
Jan 2010

The EP/NP pattern



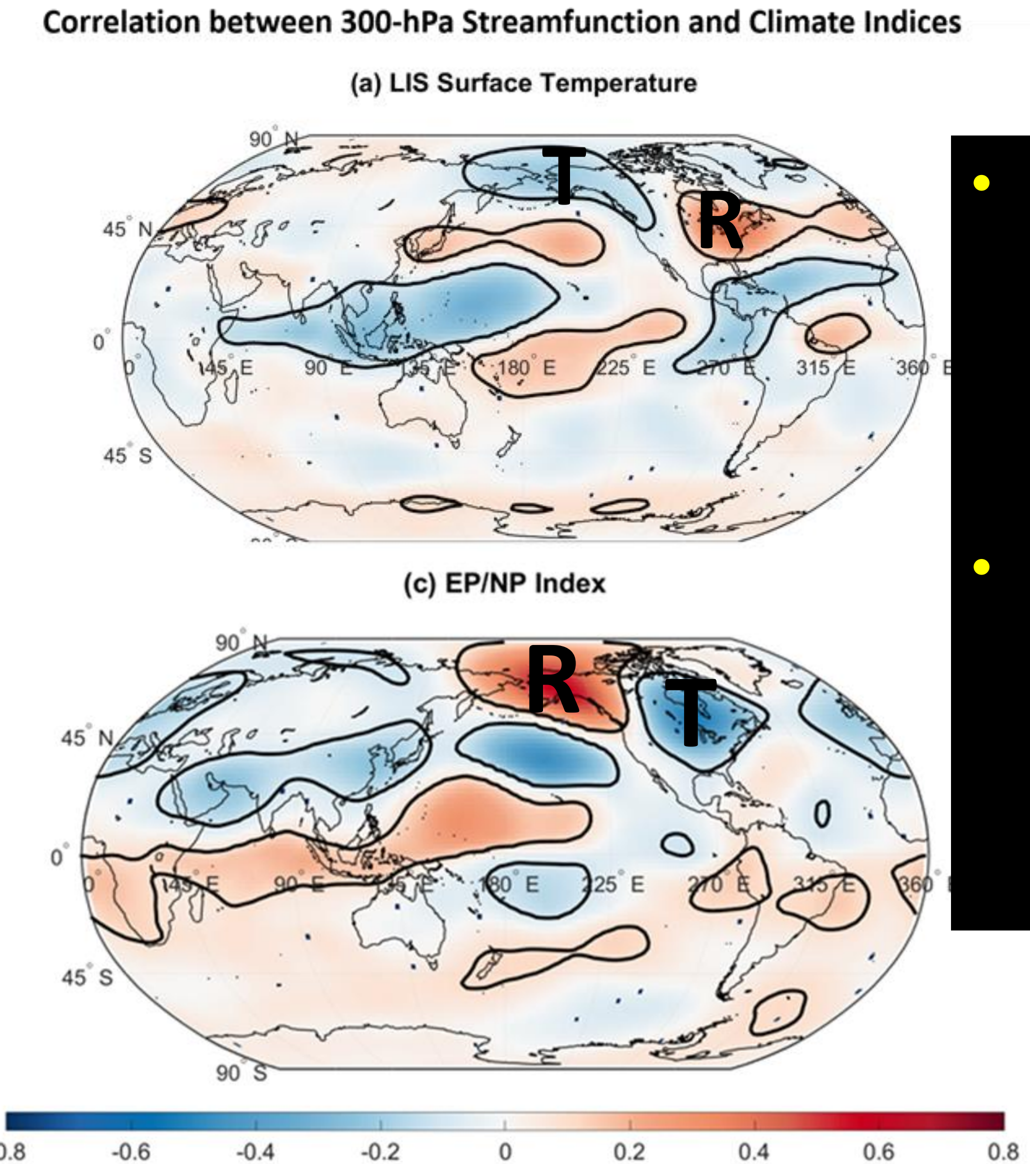
Correlation Coefficient

The EP/NP Index – Time Series and Characteristic Time Scale



Contours = 5% Cumulative Areawise Significance (Schulte, 2016)

Atmospheric Pattern Comparison



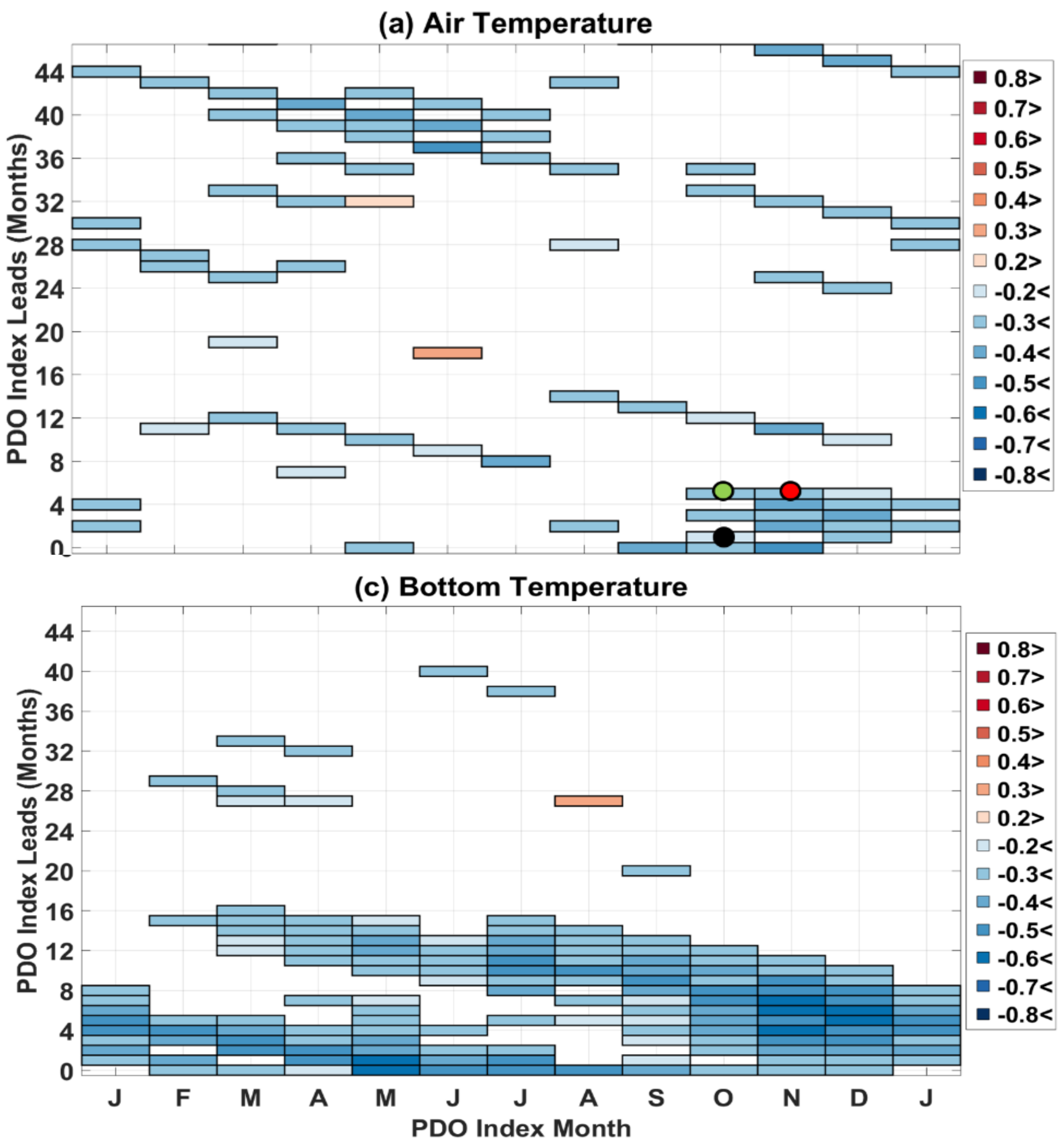
- The upper-atmospheric pattern associated with LIS temperature anomalies is similar to the EP/NP pattern
- Warmer-than-normal LIS conditions are associated with a ridge of high pressure over the eastern US and a trough of low pressure over Alaska

Seasonal Analysis

	DJF	MAM	JJA	SON	Annual
Air Temperature					
EP/NP	**-0.65**	**-0.51**	**-0.43**	**-0.47**	**-0.58**
NPGO	0.16	0.32	0.29	0.13	**0.35**
WP	0.20	**0.31**	**-0.48**	0.22	-0.07
PNA	0.09	-0.15	0.04	0.09	-0.01
PDO	**-0.44**	**-0.37**	**-0.34**	**-0.62**	**-0.54**
NAO	0.23	-0.07	-0.15	0.17	-0.32
GSI	0.07	-0.10	0.24	-0.09	0.21
AMO	0.30	0.17	**0.44**	**0.49**	**0.51**
Surface Temperature					
EP/NP	**-0.66**	-0.31	**-0.40**	-0.26	**-0.55**
NPGO	0.09	**0.50**	**0.54**	0.16	**0.45**
WP	0.29	0.15	**-0.37**	0.15	-0.13
PNA	0.15	-0.17	0.03	0.03	0.04
PDO	**-0.36**	**-0.48**	**-0.60**	**-0.46**	**-0.53**
NAO	0.27	-0.07	**-0.34**	0.27	-0.25
GSI	0.07	0.00	0.20	0.09	0.23
AMO	0.23	0.33	**0.59**	**0.38**	**0.48**

- **No** statistically significant relationships between air temperature and the NAO index!
- PDO index is correlated with air and surface water temperature for all seasons.
- **No** statistically significant relationships were identified with the Gulf Steam Index (GSI).
- The PDO index is considerably more correlated with surface water temperature than air temperature in the summer.
- The difference suggests a lagged PDO-water temperature relationship (discussed on next slide)

Cross-Correlation between PDO Index and Temperature

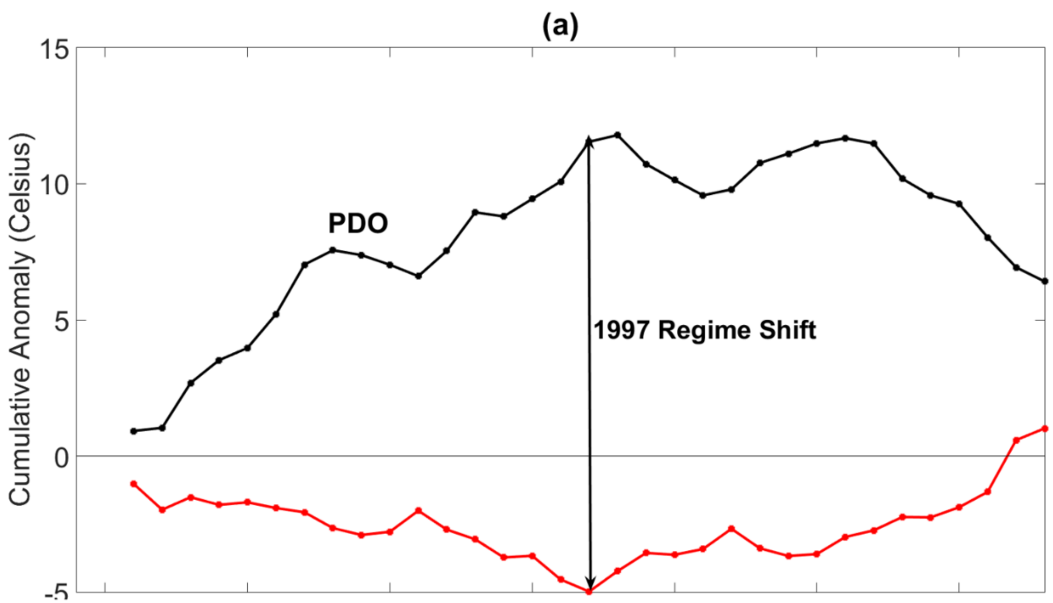


Green Dot – Correlation between October PDO index and March air temperature

Black Dot – Correlation between October PDO index and November air temperature

Red Dot – Correlation between November PDO and April air temperature

Cumulative Deviation Analysis



- **Positive PDO indices were favored from 1981 to 1997 (favoring LIS cooling)**
- **Negative PDO indices were favored from 1997 to 2013 (favoring LIS warming)**

Conclusions

- Not all recent LIS warming may be attributable to direct anthropogenic causes.
- One cannot exclude the possibility that the climate modes themselves are related to man-made greenhouse gas forcing.
- PDO index may have value in seasonal predictability.
- EP/NP has a characteristic timescale of 7 to 10 years.
- It may be possible to make decadal assessments about the LIS thermal system.
- What to expect for this winter – slightly greater chance of warmer-than-normal winter.