The Association between Canadian Climatic Extremes and Interannual and Interdecadal Oscillations

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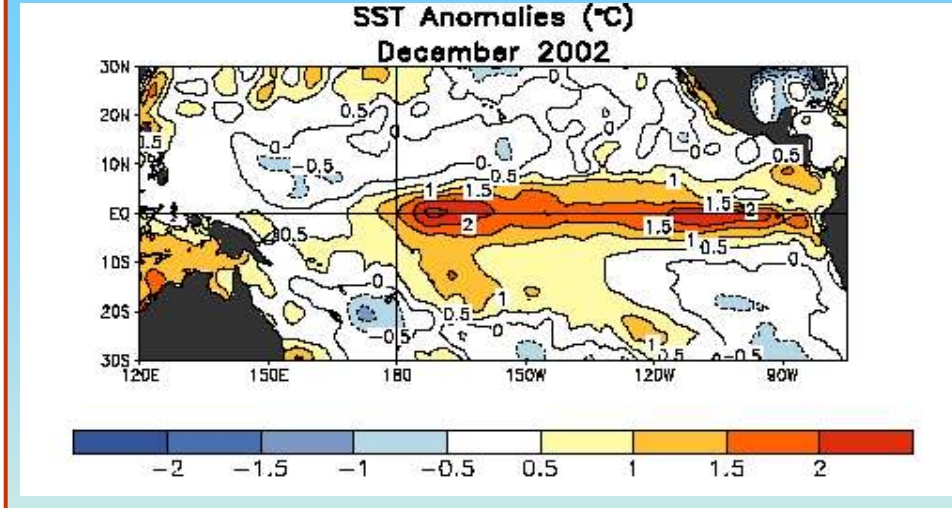
Outline

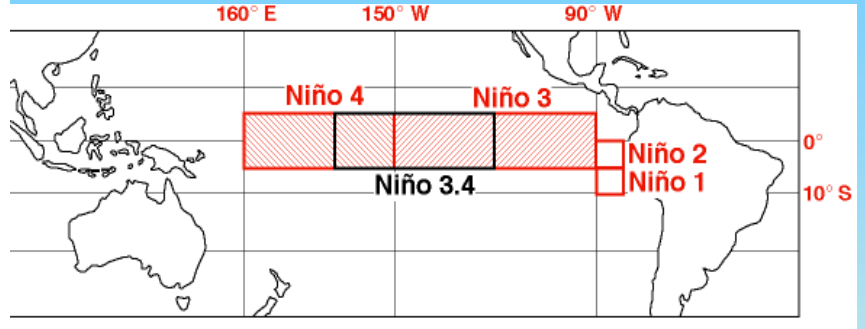
- Using composite and regression analysis to show combined effects of oscillations on Winter Temperature Extremes
- Regression of the indices on the winter Heat and Cold waves
- Frequency anomaly of extreme temps
- GEV model of temps extremes with ENSO and PDO as covariate

Climatic Indices – Winter (Dec-Mar)

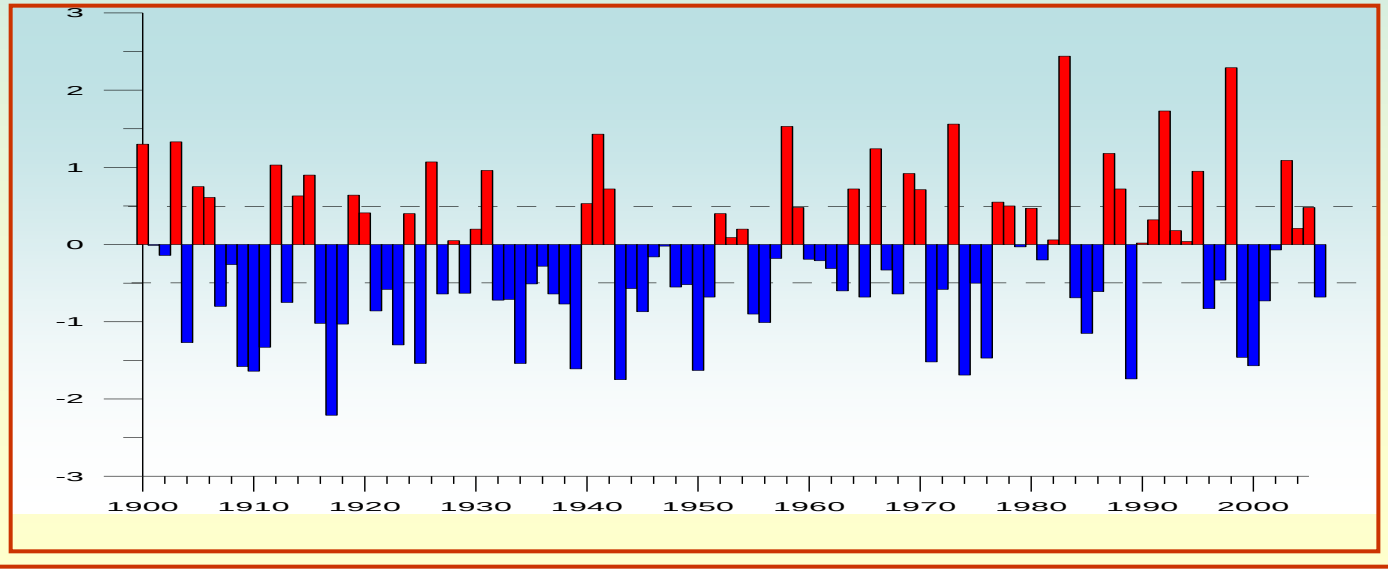
- Number of days with Tmax above 90th percentile (warm days) **Ndx90**
- Number of days with Tmin below 10th percentile (cold nights) **Ndn10**
- Heat wave frequency index (number of wave: 3-days with Tmax above 90th percentile) **Hwfi**
- Cold wave frequency index (number of wave: 3-days with Tmin below 10th percentile **Cwfi**

The El Nino-La Nina Cycle (ENSO)





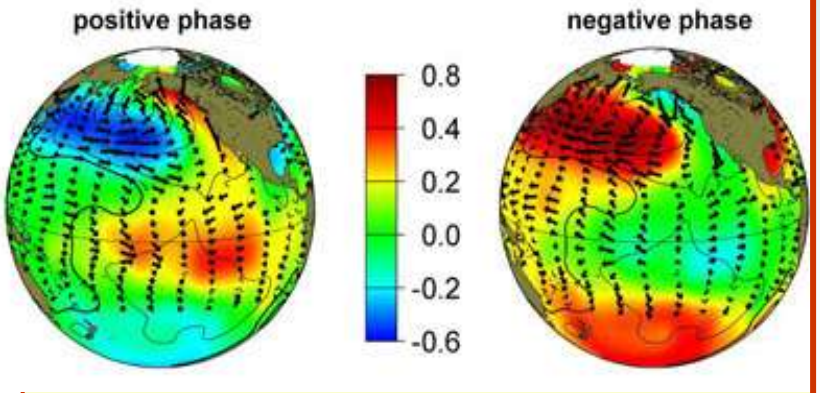
Standardized Nino3.4 Index

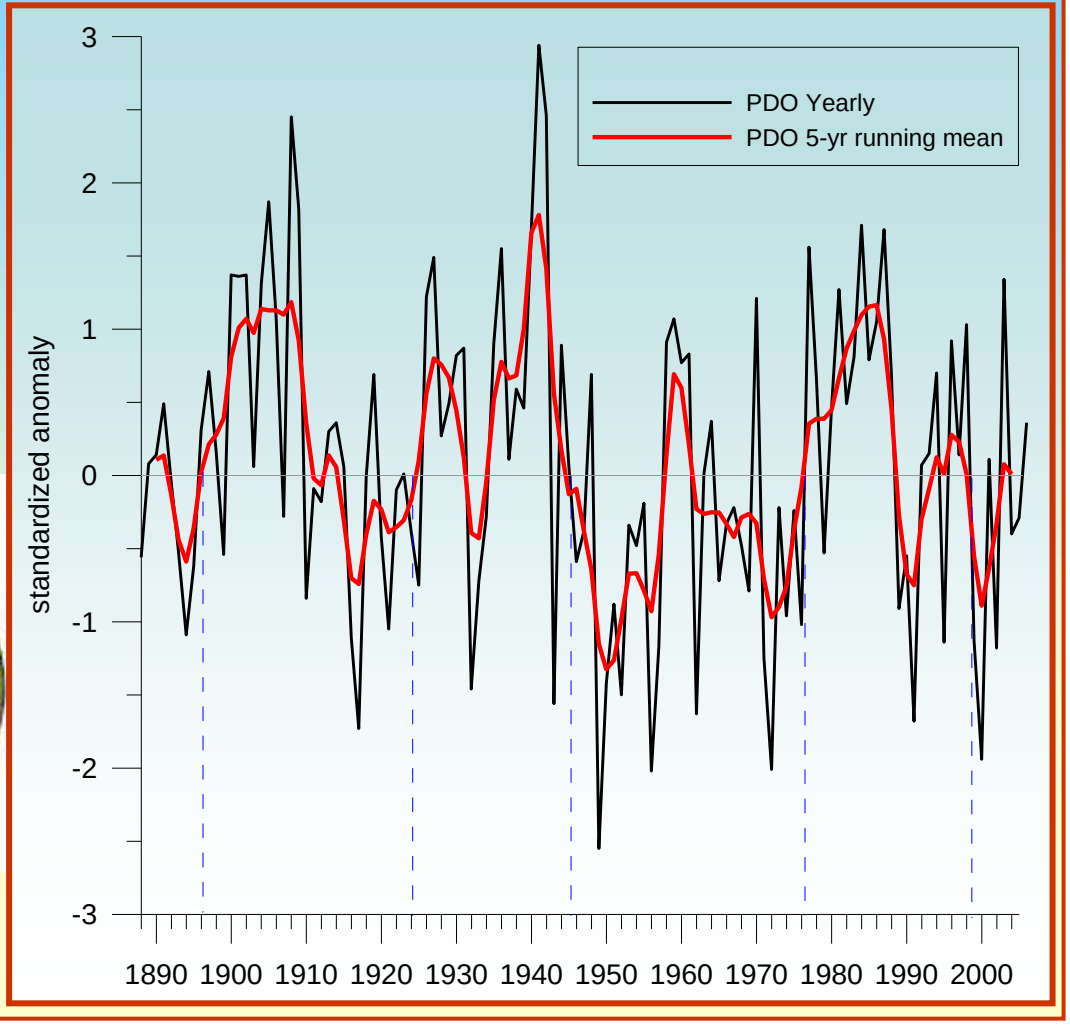


Pacific Decadal Oscillation (PDO)

- Leading mode of Natural Variability in the North Pacific
- It has a 25-year cycle. Currently cycle has shifted into negative phase

Correlation between PDO and SST and wind anomaly

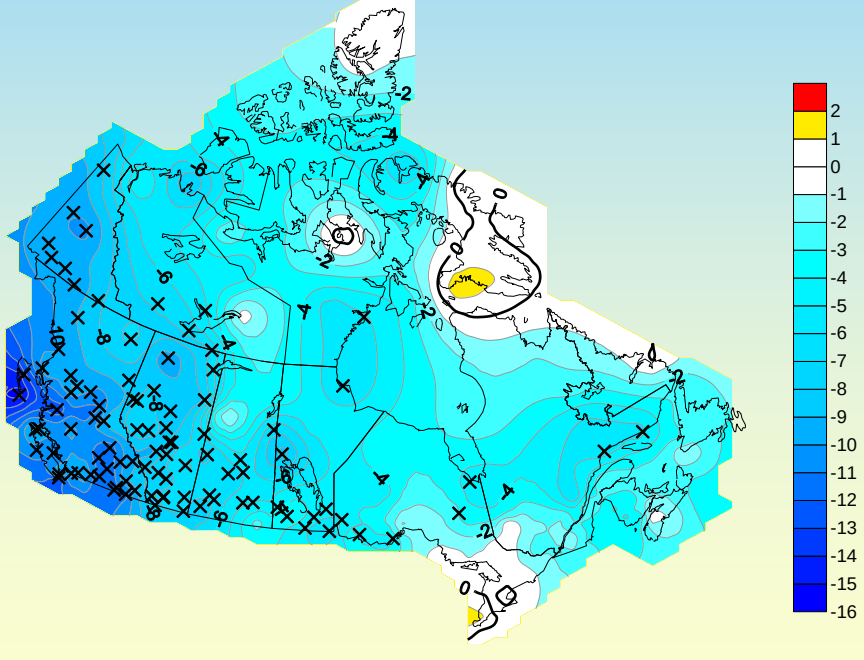




Composite Difference: Interaction between ENSO and PDO Oscillations

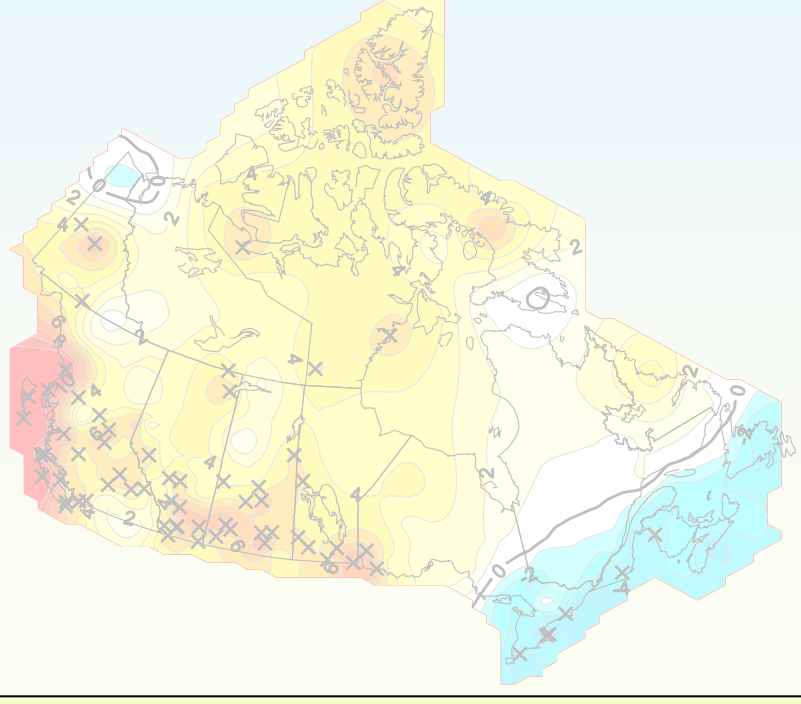
Min Temp < 10th percentile

ENSO & PDO

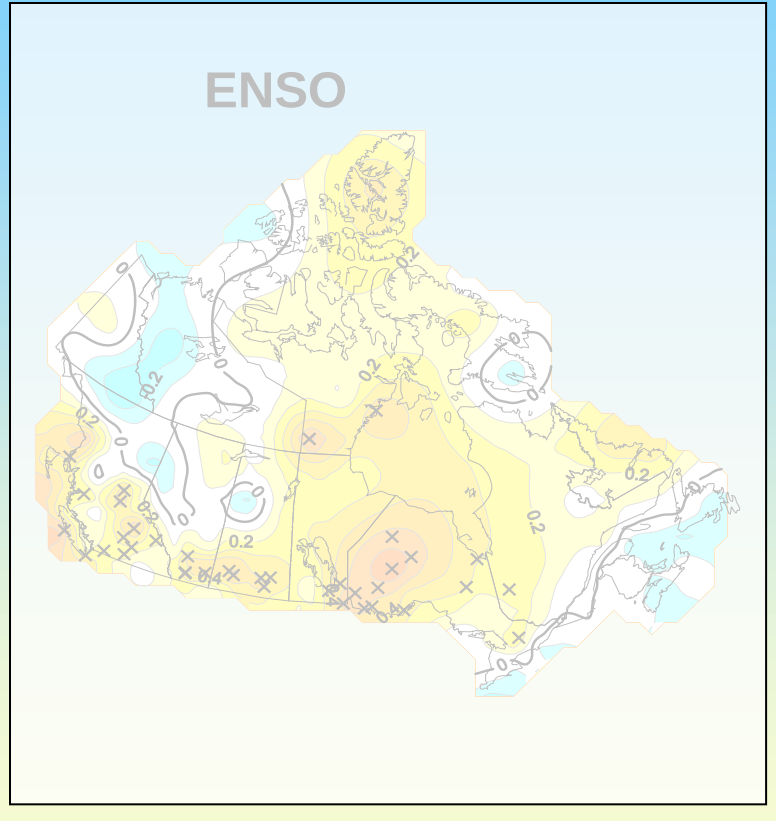


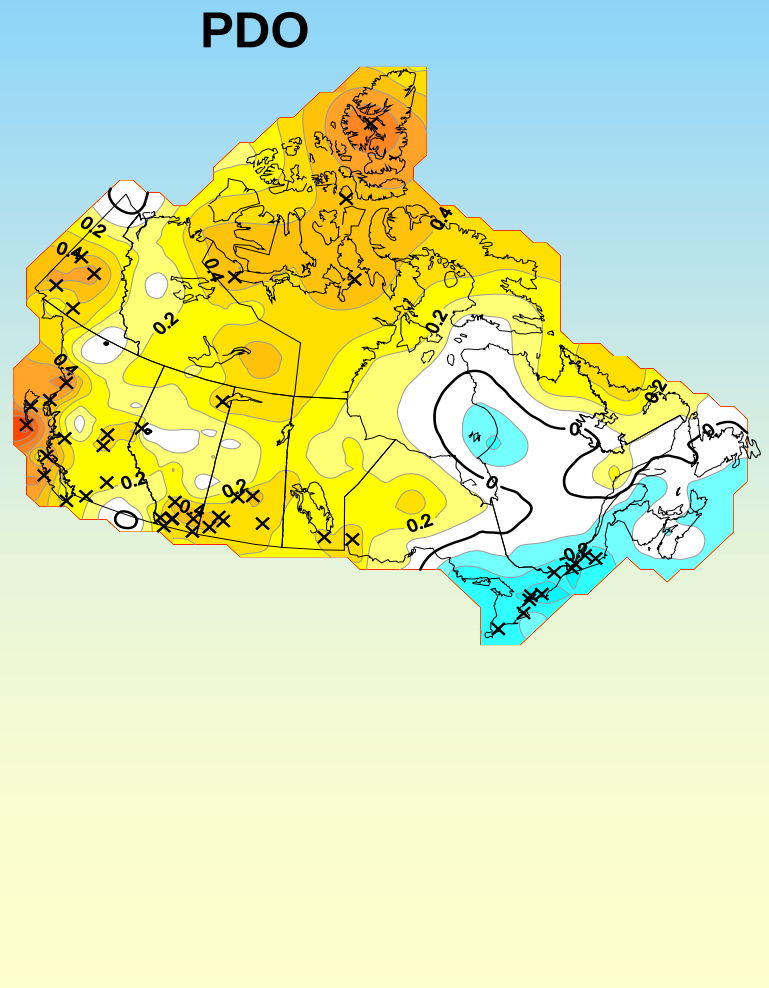
Max Temp > 90th percentile

ENSO & PDO

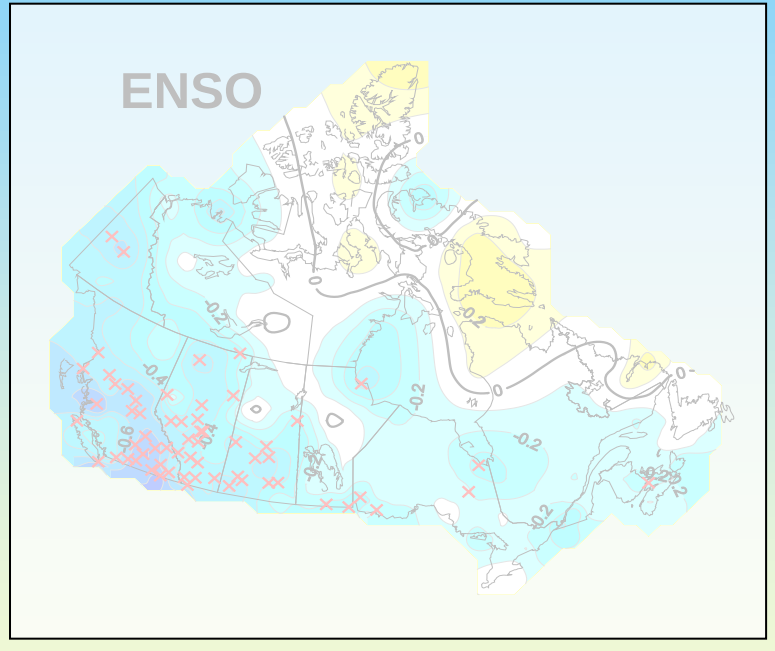


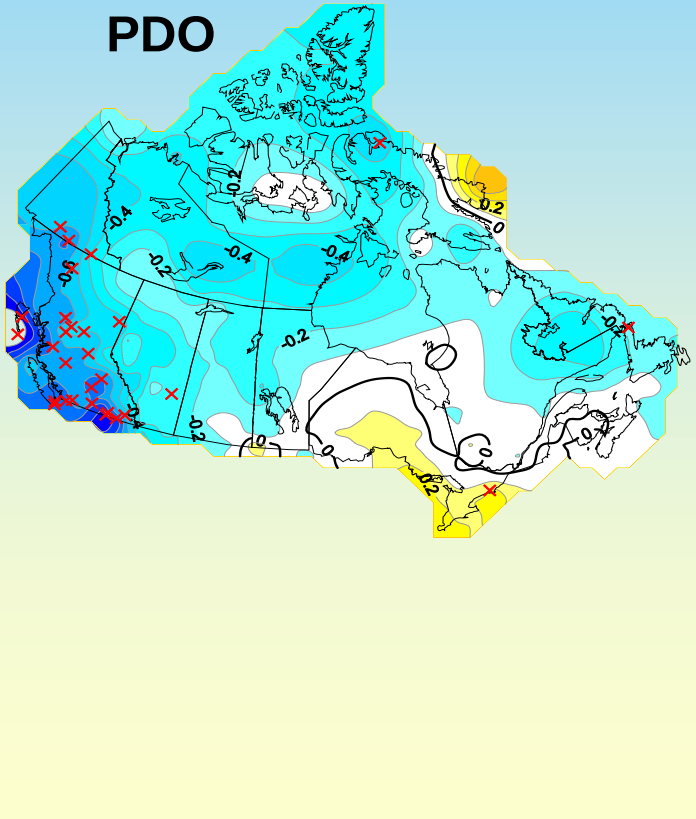
Regression: ENSO and PDO on Number of Heat waves



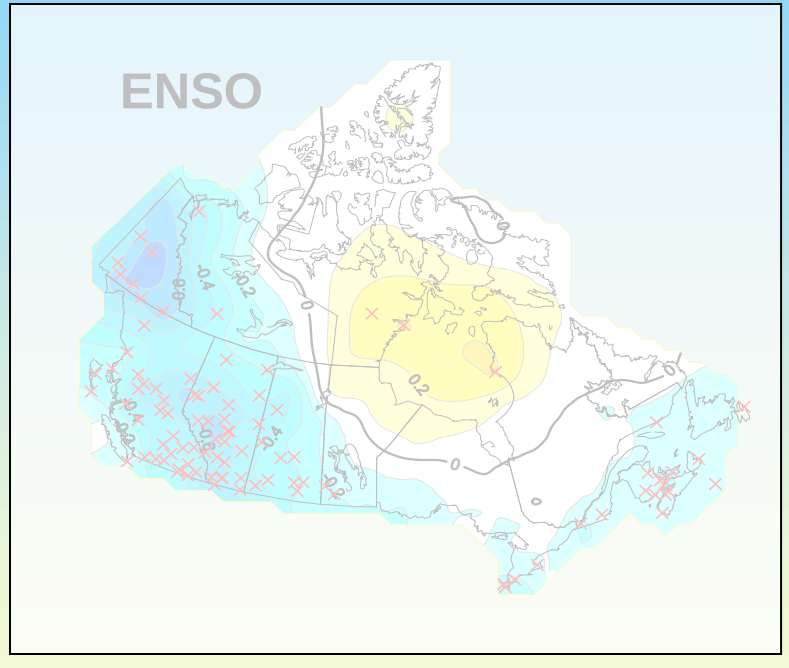


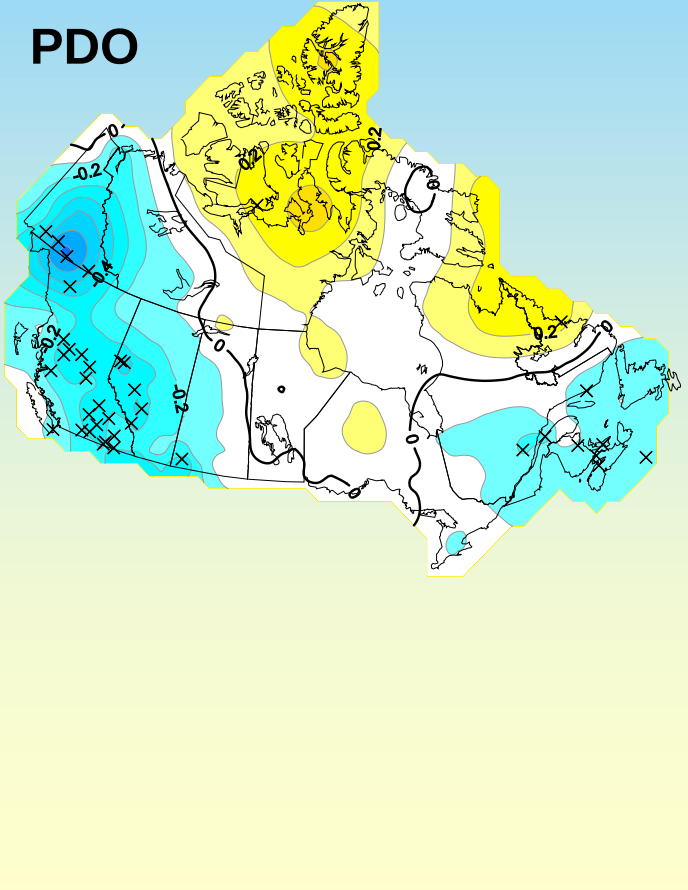
Regression: ENSO and PDO on Number of Cold waves





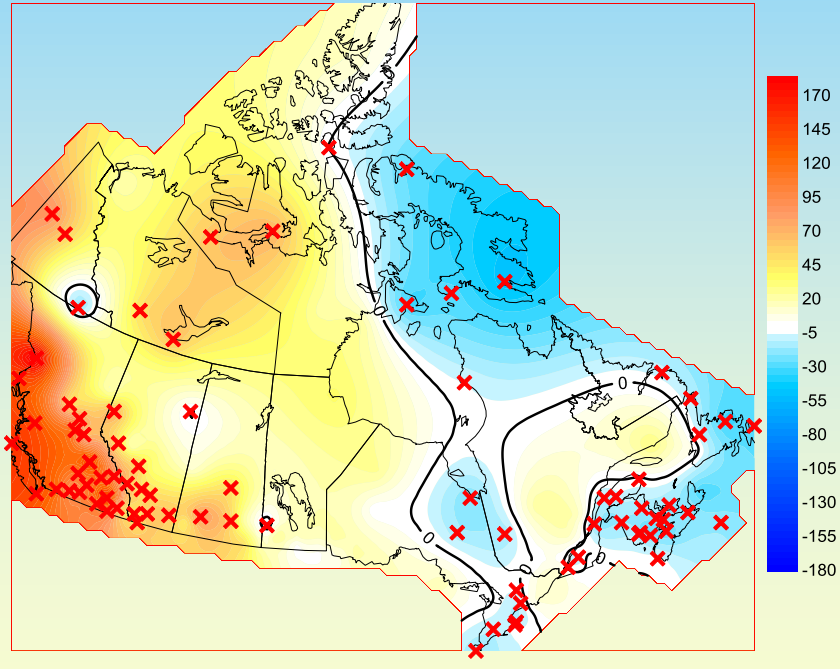
Regression: ENSO and PDO on Intraseasonal Variability



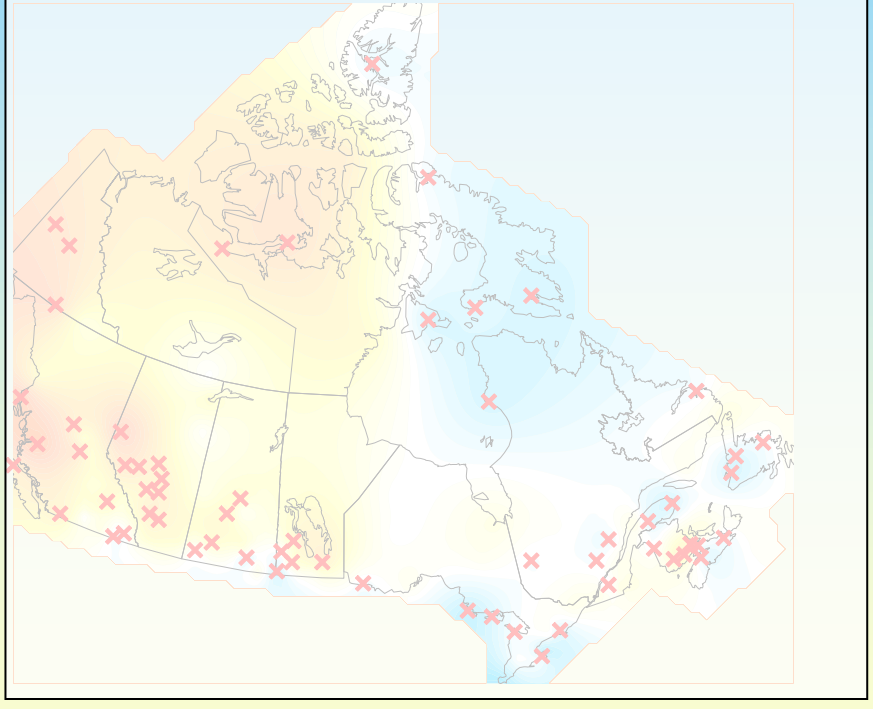


Temp Frequency Anomaly (ENSO and PDO phase)

Temp Frequency Anomaly Above Base q95 (N34posPDOpos) - DJFM 1900-2008



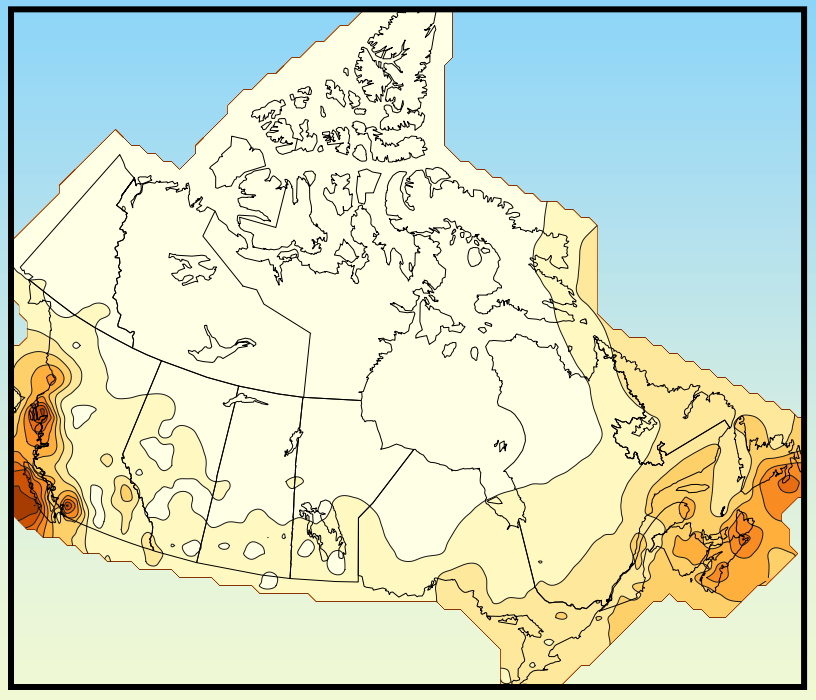
Temp Frequency Anomaly Below Base q05 (N34negPDOneg) - DJFM 1900-2008



Statistical significance determined by bootstrap resampling with replacement

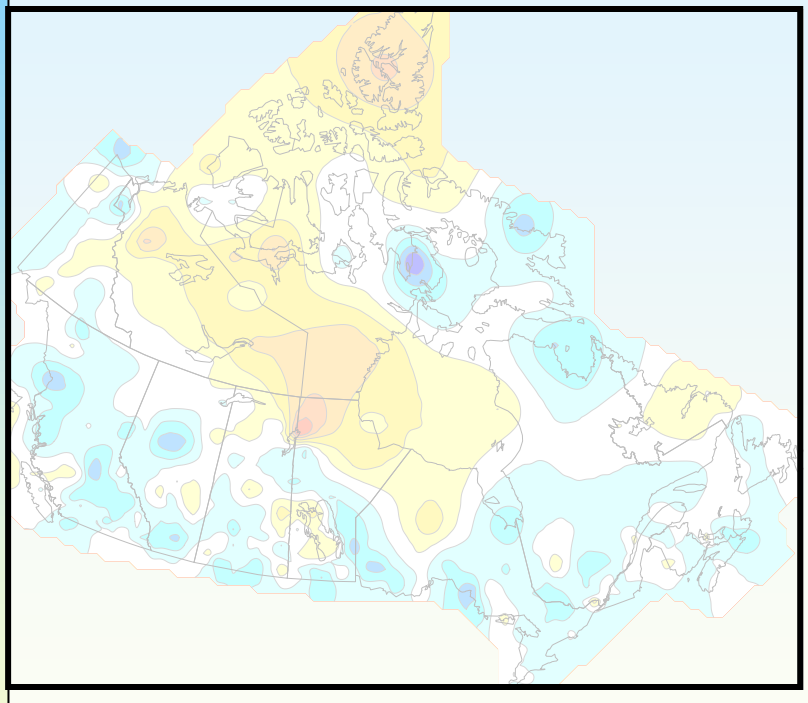
Precip Frequency Anomaly (ENSO and PDO phase)

Precip Base 75th Percentile



Precip Frequency Anom Above Base Q75

(N34posPDOpos)



Generalized Extreme Value Analysis

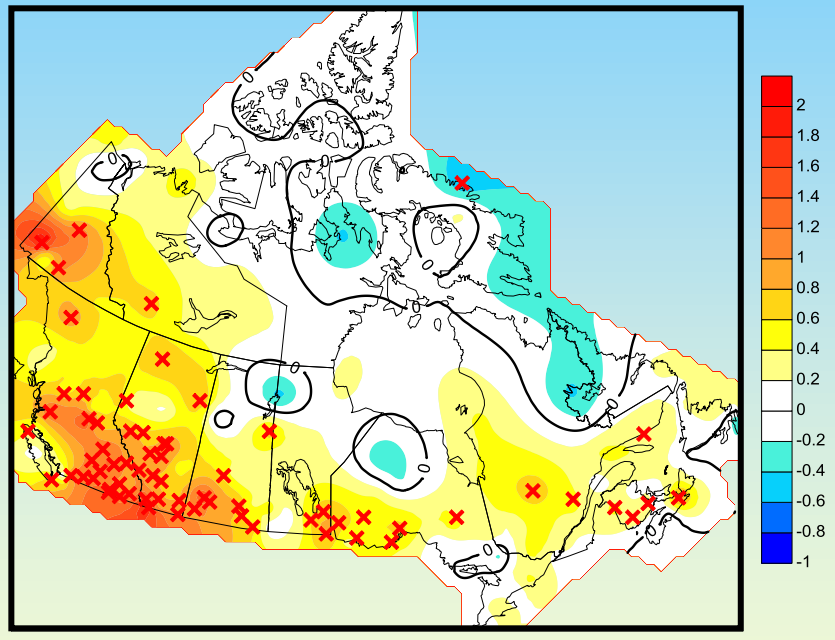
$$GEV_0 = (\mu, \sigma, \zeta)$$ Null Model

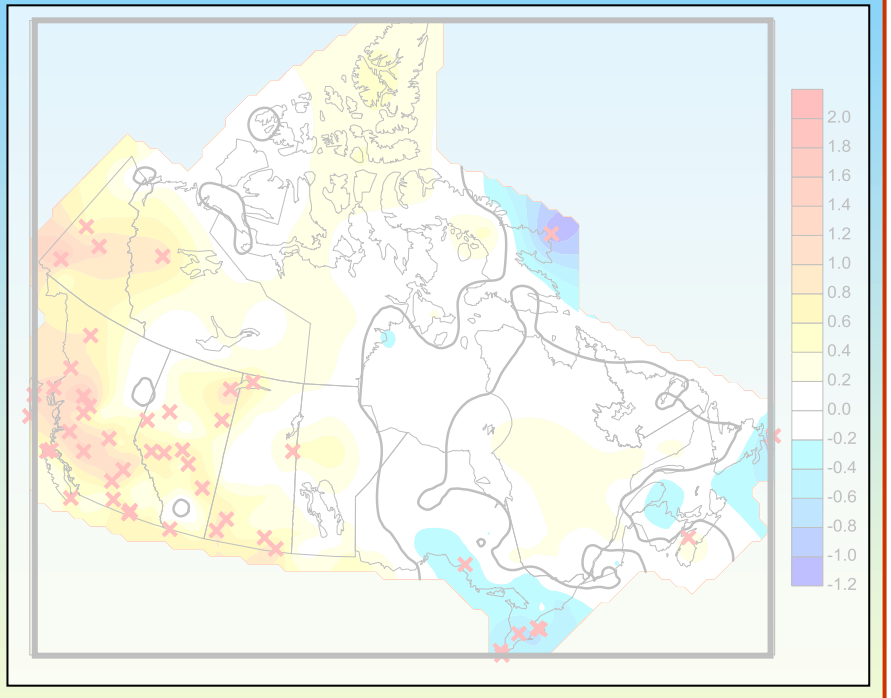
$$GEV_1(\mu_t = \mu_0 + r_1 N34, \sigma, \zeta)$$ Nino3.4 as covariate

$$GEV_1(\mu_t = \mu_0 + r_1 PDO, \sigma, \zeta)$$ PDO as covariate

Test statistics $2(L_1\text{-}L_0)$ assessed against chi square distribution at 5% significance, L_1 and L_0 are log likelihood

Regression of Location Parameter on Winter Extreme Min Temps on Nino3.4 and PDO





Summary

- ENSO and PDO significantly increases (suppresses) number of warm days (cold days) and frequency of heat (cold) waves across most of southern Canada. In phase relationship further enhances this effect
- Significant increases in the frequency of events above base 95th quantile in western Canada when both PDO and Nino34 in positive phase
- Significant increases in the frequency of events below base 5th quantile in western Canada when both PDO and Nino34 in negative phase
- GEV model with PDO and Nino34 covariate shows shift in minimum temperature distribution positively in western Canada


Thanks