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 90\textsuperscript{th} percentile (warm days) \textbf{Ndx90}

- Number of days with Tmin below 10\textsuperscript{th} percentile (cold nights) \textbf{Ndn10}

- Heat wave frequency index (number of wave: 3-days with Tmax above 90\textsuperscript{th} percentile) \textbf{Hwfi}

- Cold wave frequency index (number of wave: 3-days with Tmin below 10\textsuperscript{th} percentile) \textbf{Cwfi}
The El Nino-La Nina Cycle (ENSO)

SST Anomalies (°C)

December 2002

Standardized Nino3.4 Index


-3  -2  -1  0  1  2
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

Max Temp > 90th percentile
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 75\textsuperscript{th} 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 \(2(L_1-L_0)\) 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