The influence of the Pacific Decadal Oscillation on annual floods in the rivers of Western Canada

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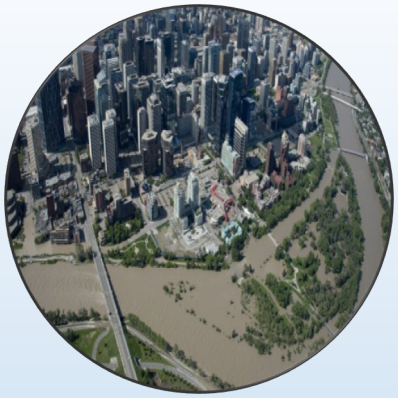
INTRODUCTION

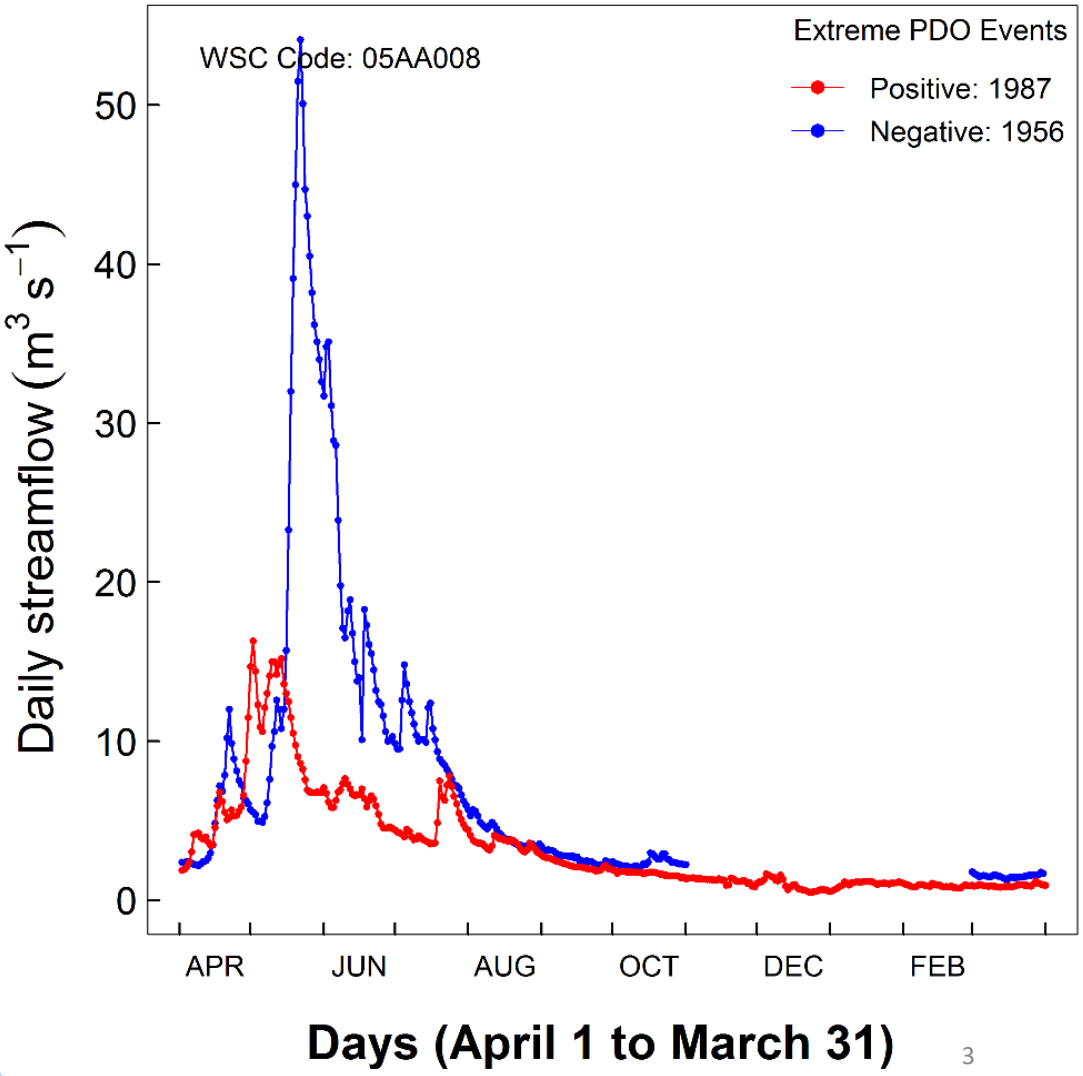


- Hydrological extremes
- Planning and Design of Infrastructure
- Flood Frequency Analysis (Design Flood)
- Assumes that Peak flows are independent and identically distributed (i.i.d)

Teleconnections

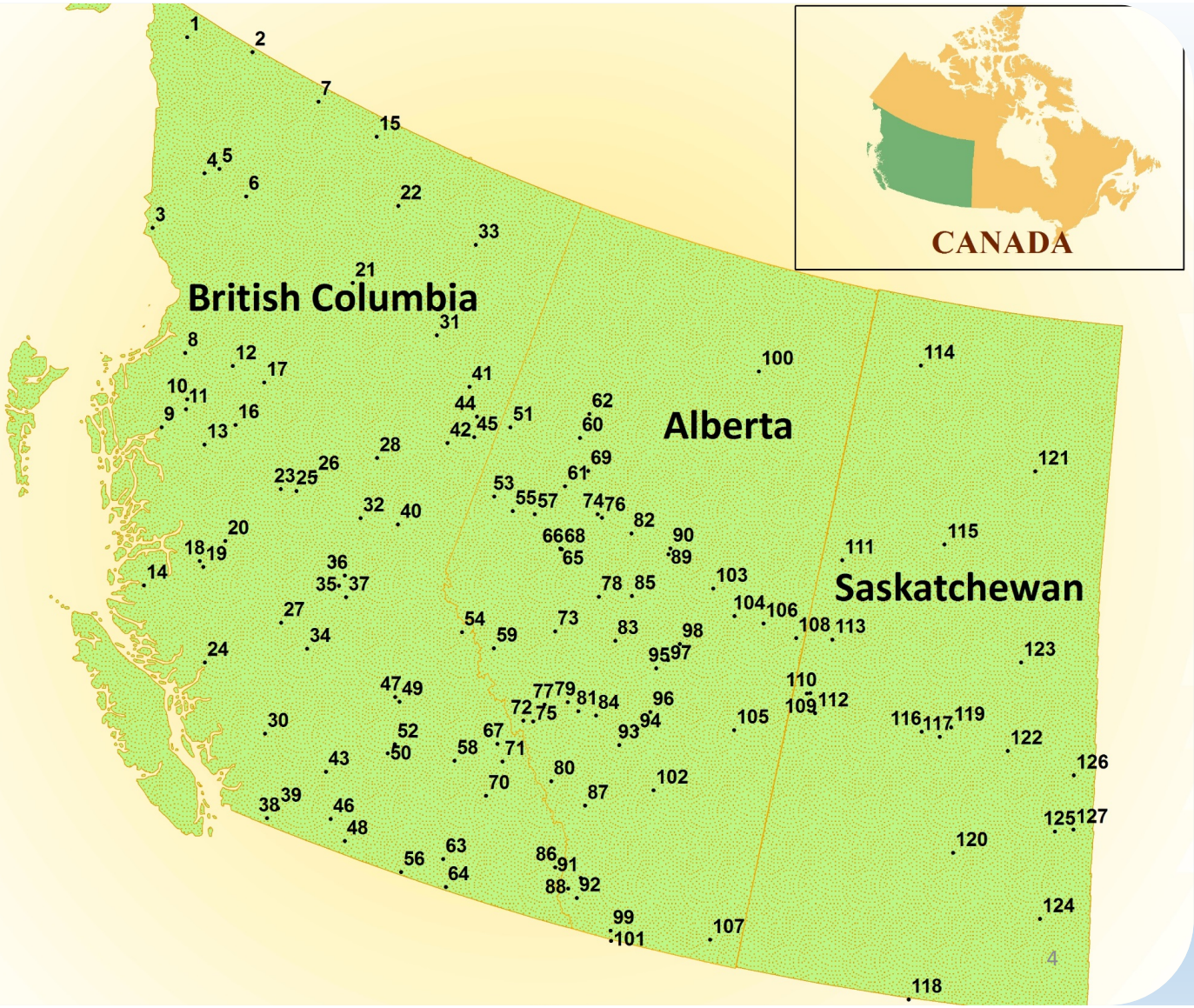
Western Canada

- Pacific Decadal Oscillation
  - **Negative PDO** produce wet years
- El Niño-Southern Oscillation
  - **La Niña** events produce wet years



Study Area

- **127** Flow Gauges
  - 119 Natural
  - 8 Naturalised
- 1905 - 2010
- Minimum **30** years



Data & Methods

DATA

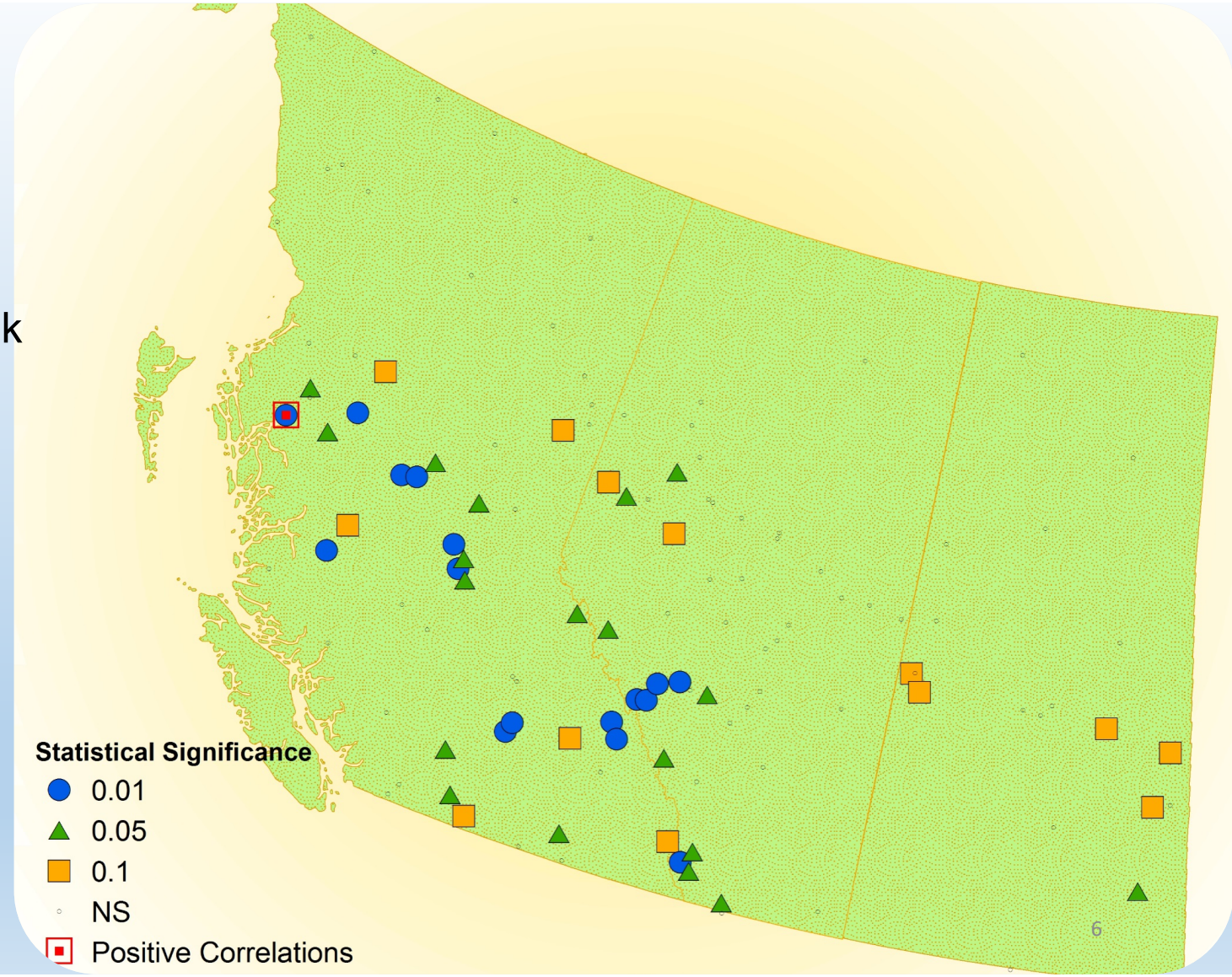
- **Observed Streamflow**: Water Survey of Canada
- **Naturalised Streamflow**: Alberta Environment
- **PDO**: Joint Institute for the study of Atmosphere and Ocean (JISAO), University of Washington
- **SOI (ENSO)**: Climate Research Unit (CRU), University of East Anglia

METHODS

- Correlation Analysis
- Quantile-Quantile (Q-Q) Plots
- Permutation Test on Q-Q Plots
- Flood Frequency Analysis
- Flood Ratio

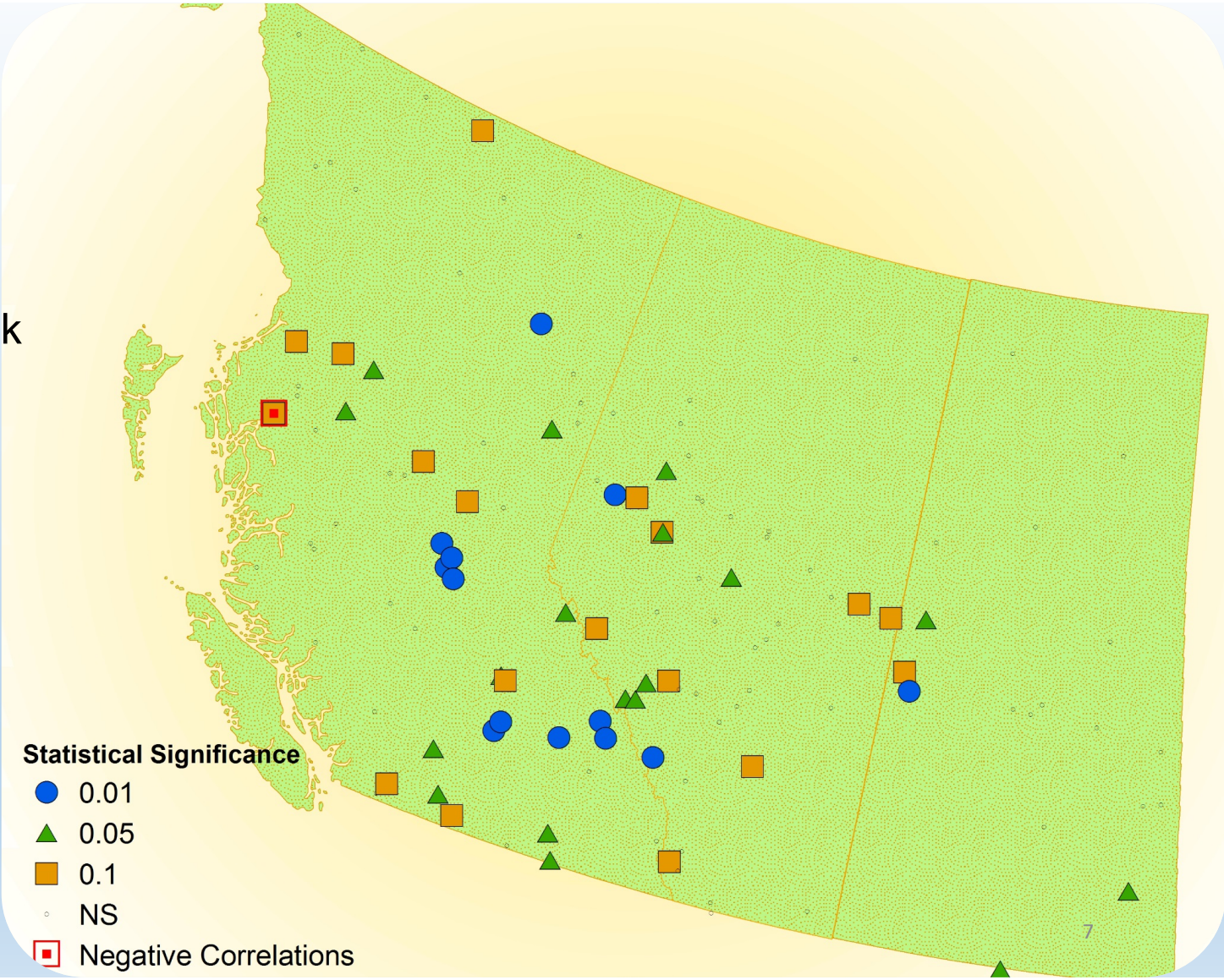
Correlations

- PDO vs Annual Peak Flows
- Spearman's Rank based correlation
- **Negative**

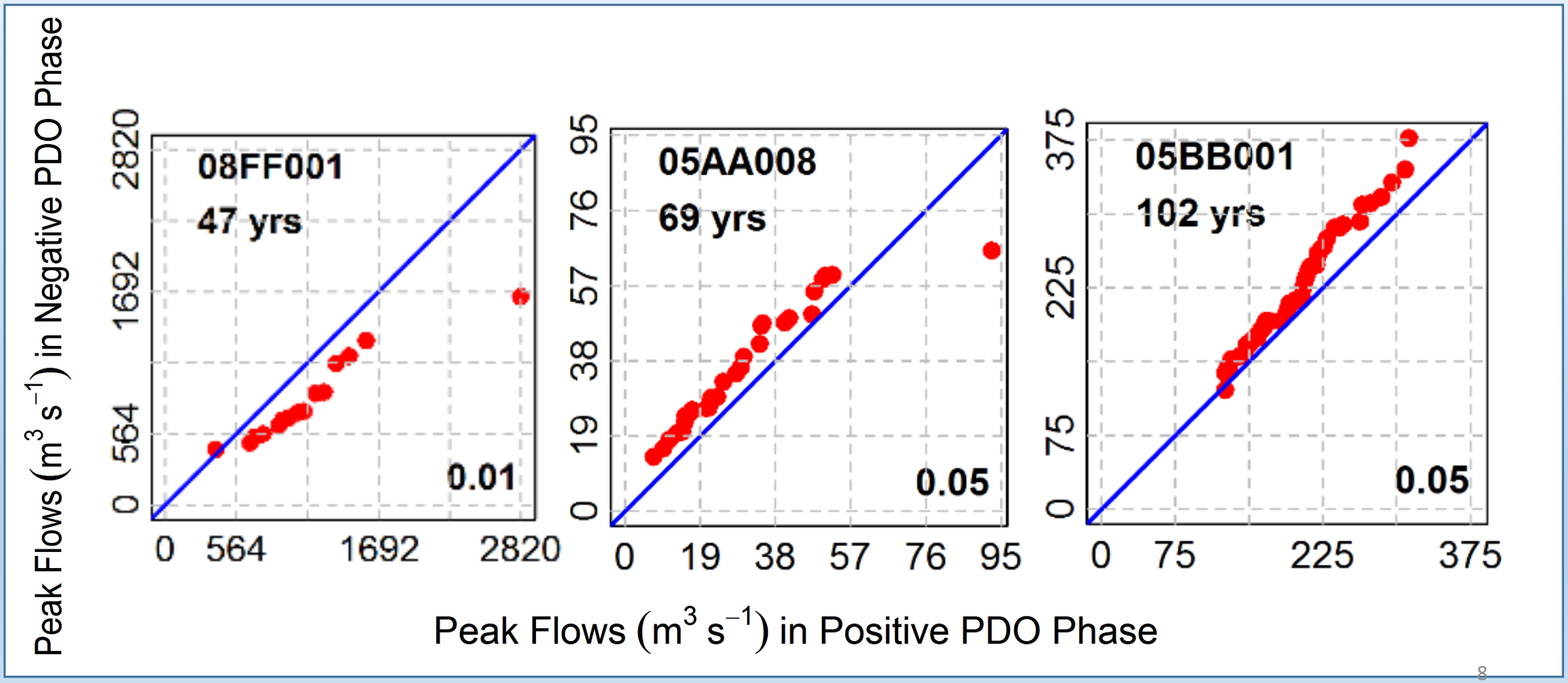


Correlations

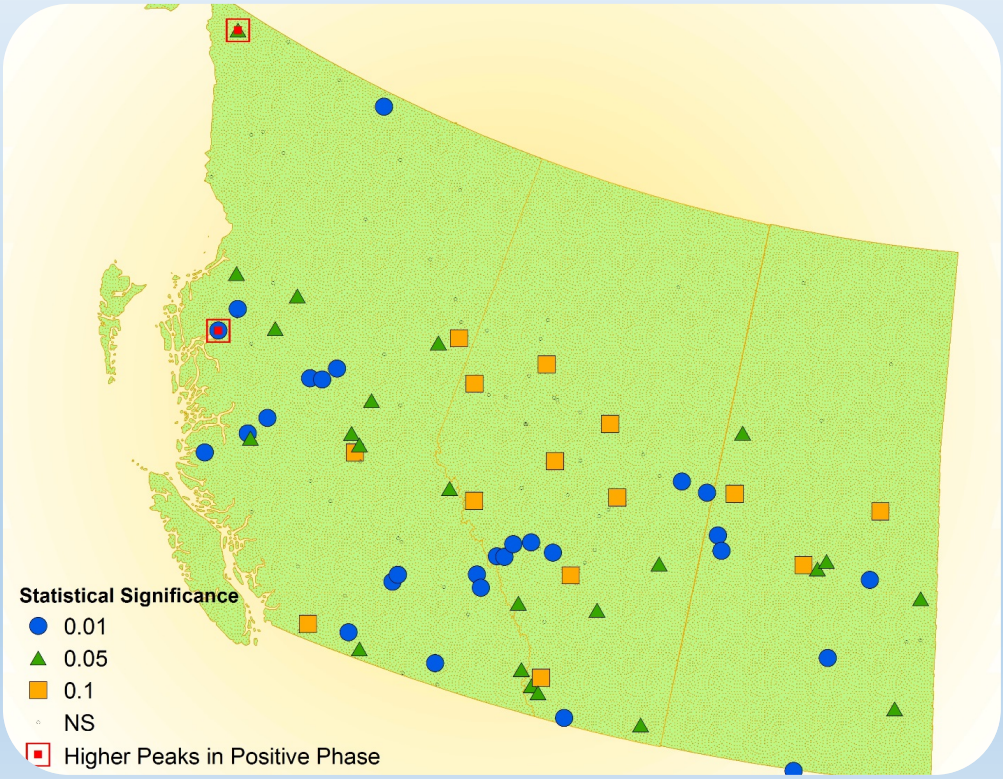
- ENSO (SOI) vs. Peak Flows
- Spearman's Rank based correlation
- **Positive**

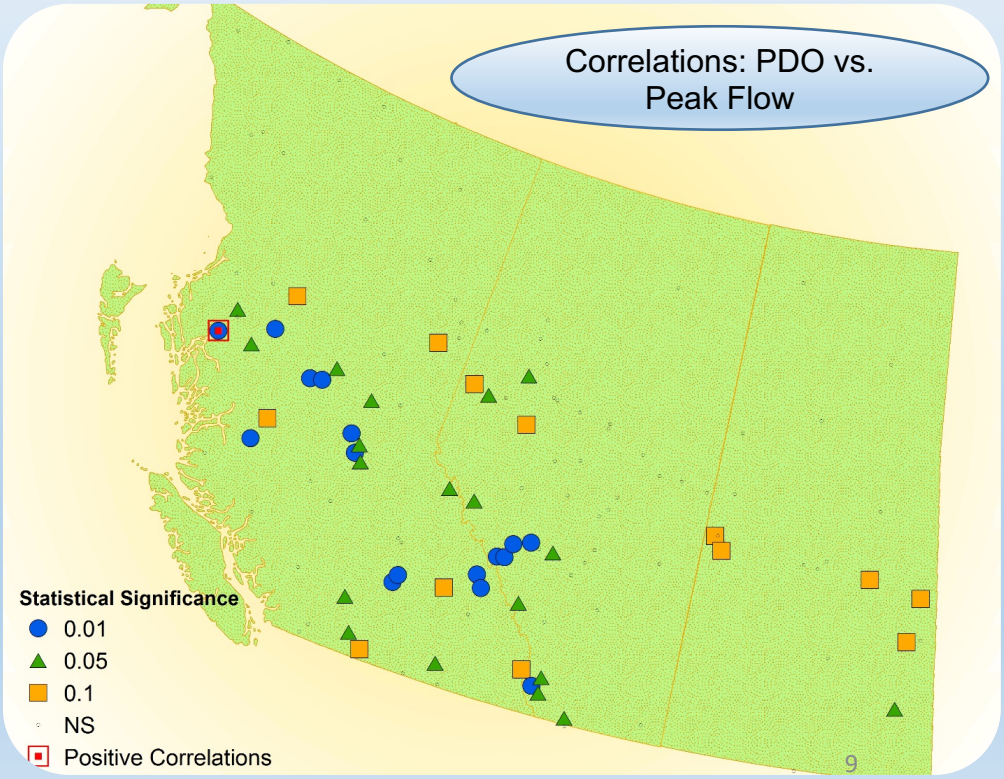


Q-Q Plots


Peak Flows ($m^3 s^{-1}$) in Negative PDO Phase
08FF001
47 yrs
0.01
0 564 1692 2820
05AA008
69 yrs
0.05
0 19 38 57 76 95
05BB001
102 yrs
0.05
0 75 225 375
Peak Flows ($m^3 s^{-1}$) in Positive PDO Phase

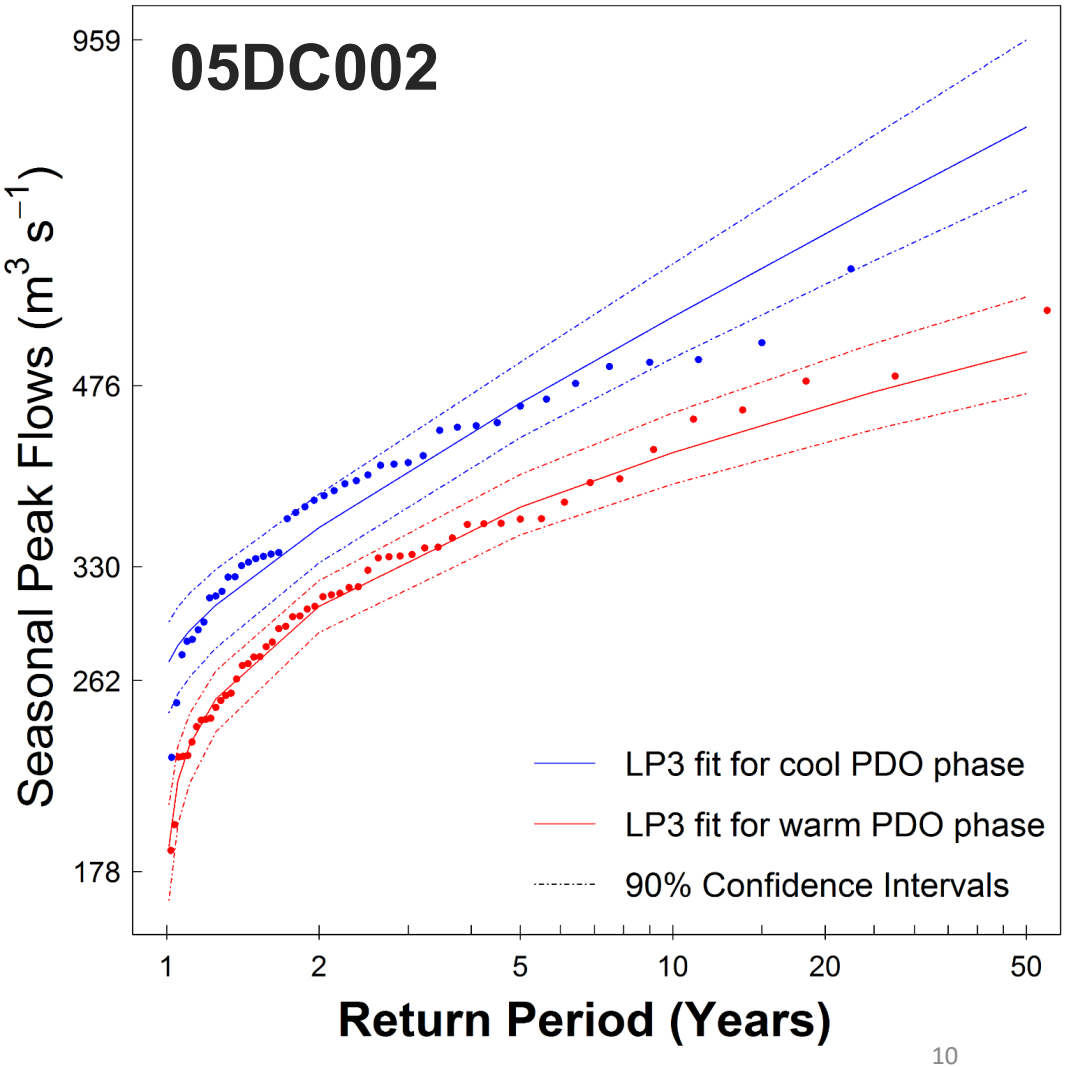
Significant Q-Q plots





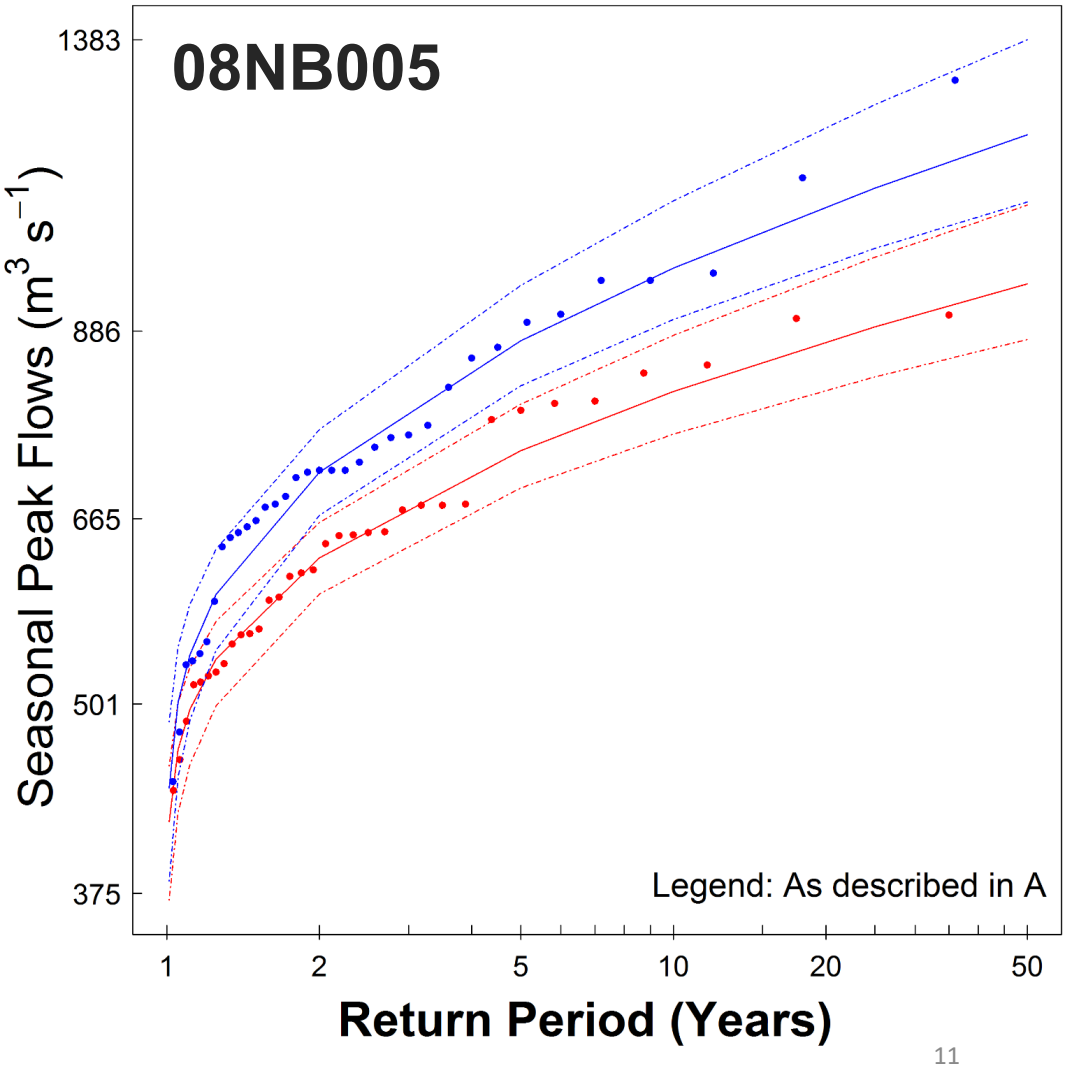
Flood Frequency Curves

- PDO stratified Peak Flows
  - **Neg**.: 1912-25, 1947-76, 2009-13
  - **Pos**.: 1926-46, 1977-2008
- Log-Pearson III (LP3) Fit
- 90 % Confidence Intervals



Flood Frequency Curves

- Overlapped Confidence Intervals
- Approx. **51 %** of gauges show either clear or partial separation
- Higher magnitude floods in negative PDO phase

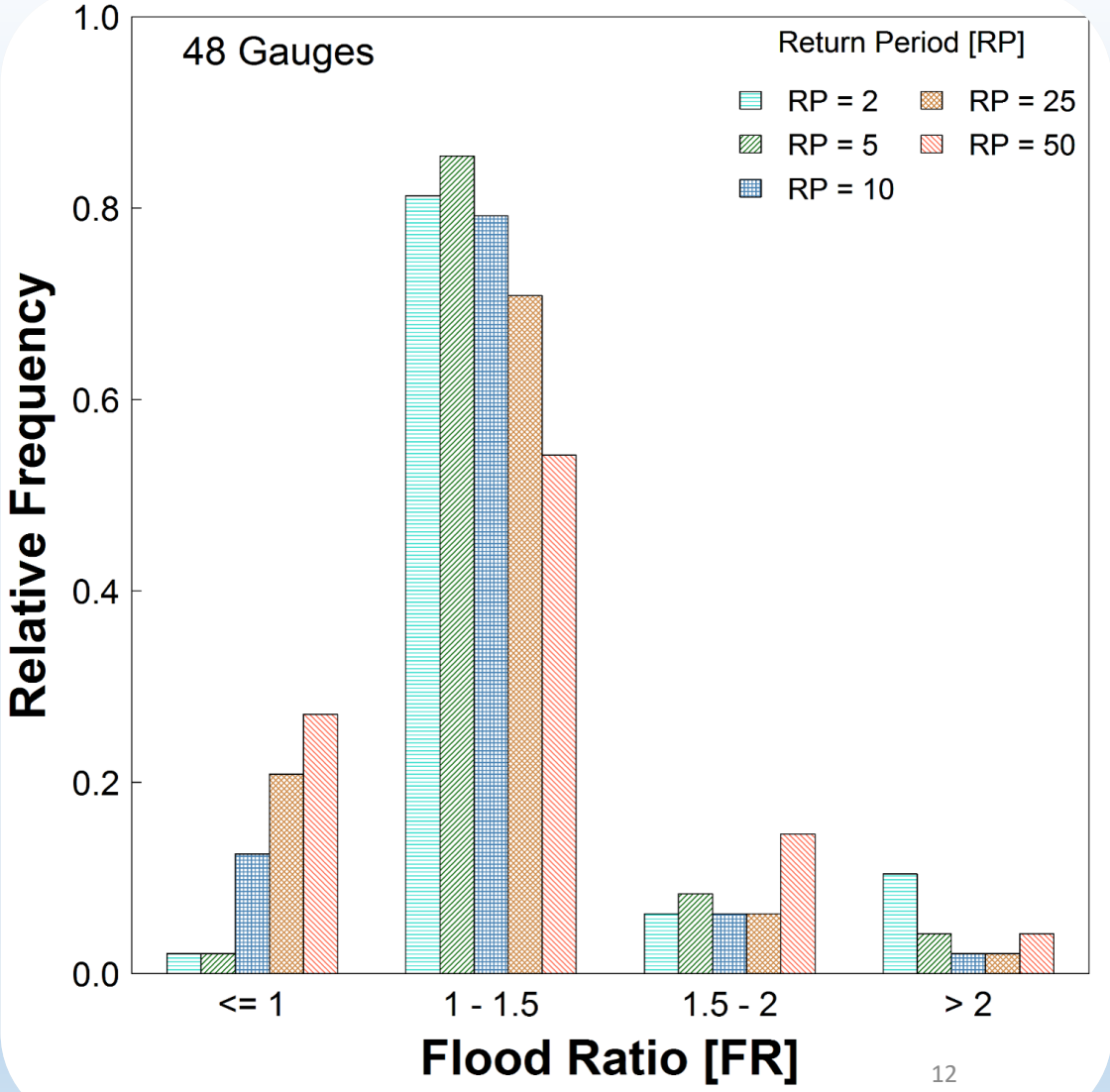


Flood Ratio

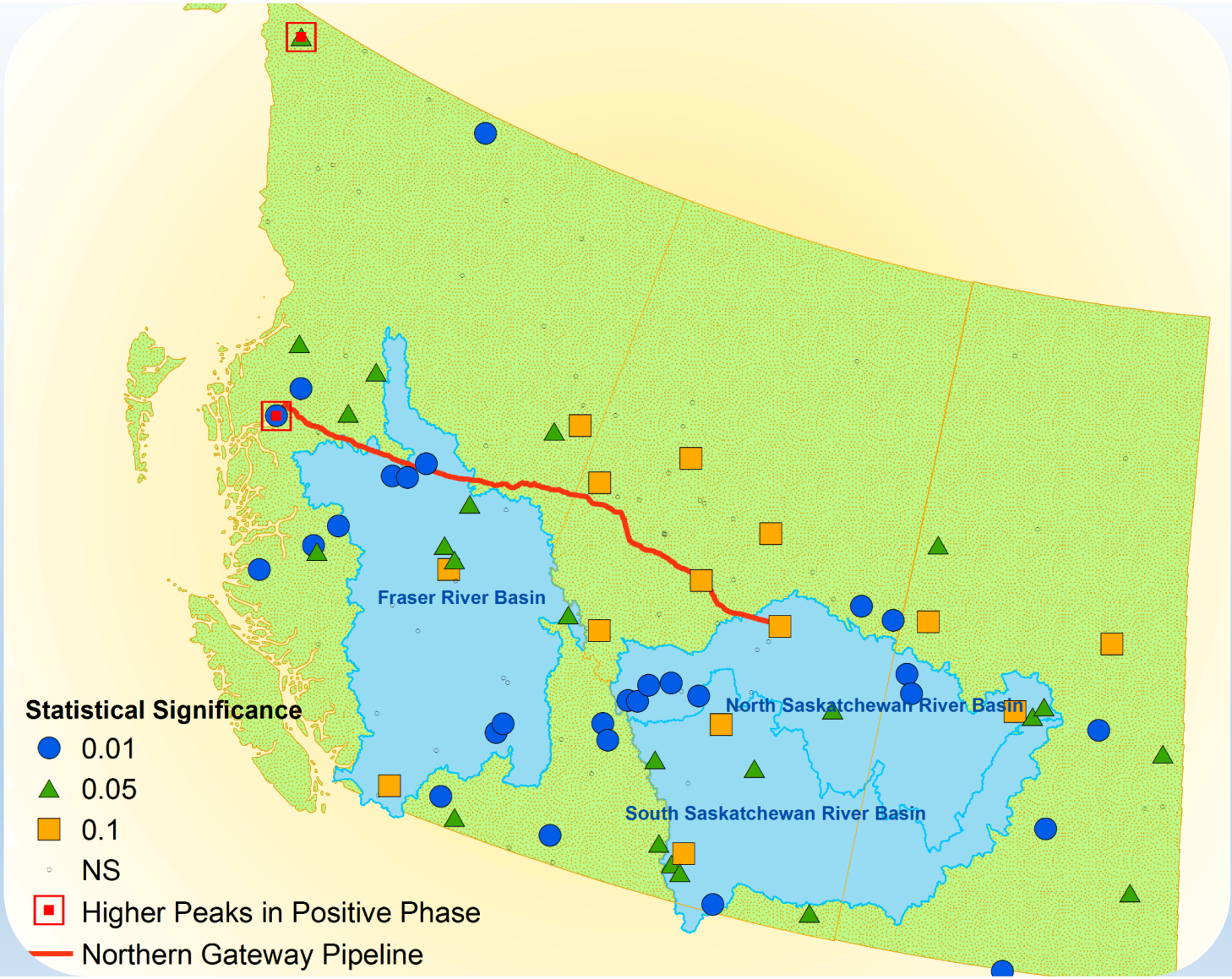
$$Flood\ Ratio = \frac{Q_{neg}}{Q_{pos}}$$

Q_{neg} - Flood Quantile in Negative phase

Q_{pos} - Flood Quantile in Positive phase



Impacts


Fraser River Basin
North Saskatchewan River Basin
South Saskatchewan River Basin
Statistical Significance
0.01
0.05
0.1
NS
Higher Peaks in Positive Phase
Northern Gateway Pipeline

CONCLUSIONS

- **Flood risk** in western Canada is **modified by the PDO**
- The **stationary climate** assumption **not valid** in Western Canada
- **Large-scale climate** should be considered during infrastructure **planning and design**
- Regions with **strong teleconnection** to large-scale climate may be subject to **underestimation** of flood risk.
- The extent of this problem in others regions needs to be explored.