Evidence of Change in Climate Data in the Southern Ontario Region

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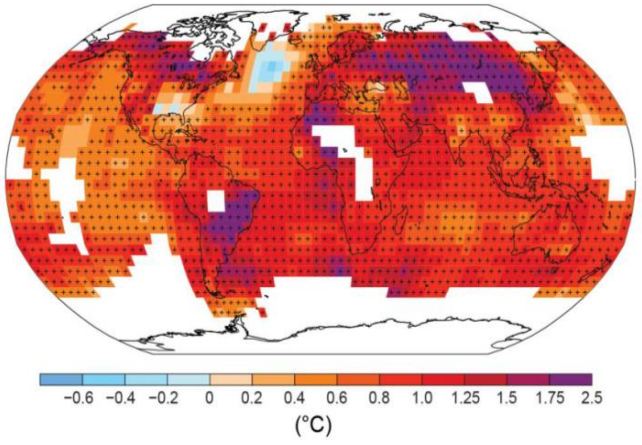
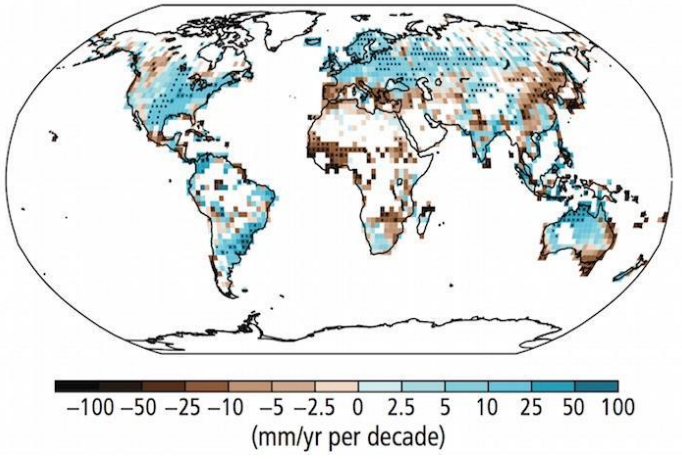
Background

- **Weather** describes the condition of the atmosphere **over a short period** of time (e.g., day to day or week to week)
- **Climate** represents the state of atmosphere **over a long period**
- **Weather and climate extremes** have an important role in **shaping the natural environment**
- Analysis of observations indicates **significant changes** in climate

Observed change in surface temperature 1901-2012 (Trend)



Observed change in annual precipitation over land 1951–2010



Source: Intergovernmental Panel on Climate Change IPCC-AR5

Background & Objective

- **Climate indices** are used to describe the state and the changes in the climate system (Expert Team on Climate Change Detection and Indices ETCCDI)
- They provide a **means to communicate** with modelers, analysts and policy makers regarding our understanding of changes in climate
- More than **27 indices** are currently being used in the literature

  ~16 for temperature (e.g., Warm or cool nights)

  ~11 for precipitation (e.g., annual total wet day)

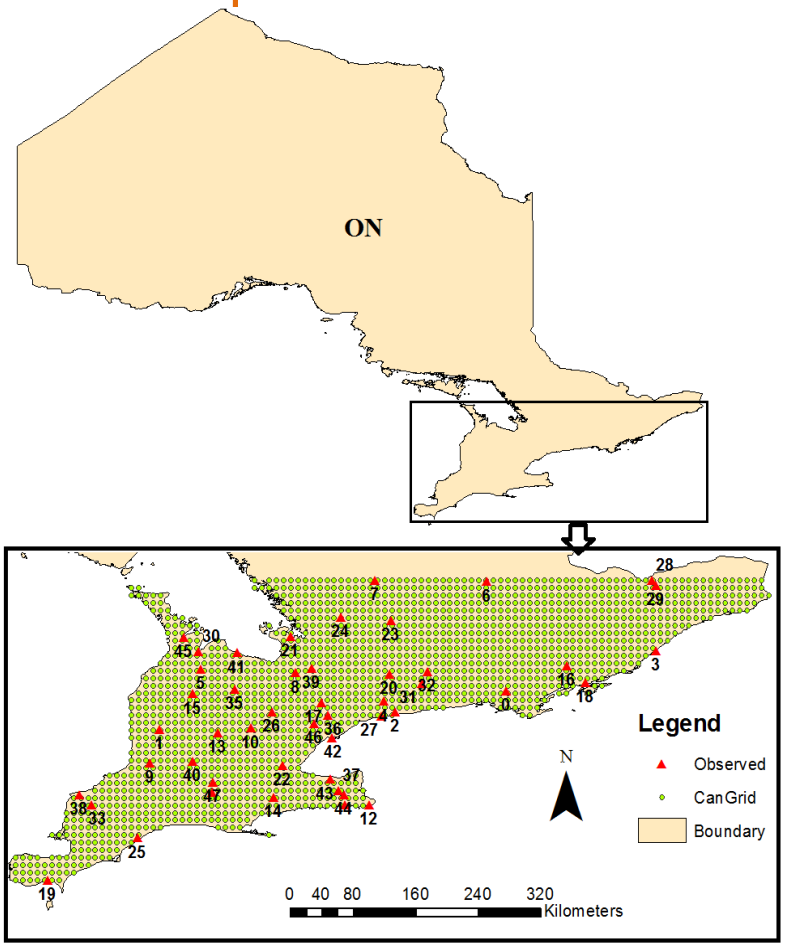
Objective & Research Significance:

- Assess **spatial and temporal patterns and trends** in climate indices series in South Ontario
- This study help to **quantify the effects of climate change** on South Ontario

Case Study

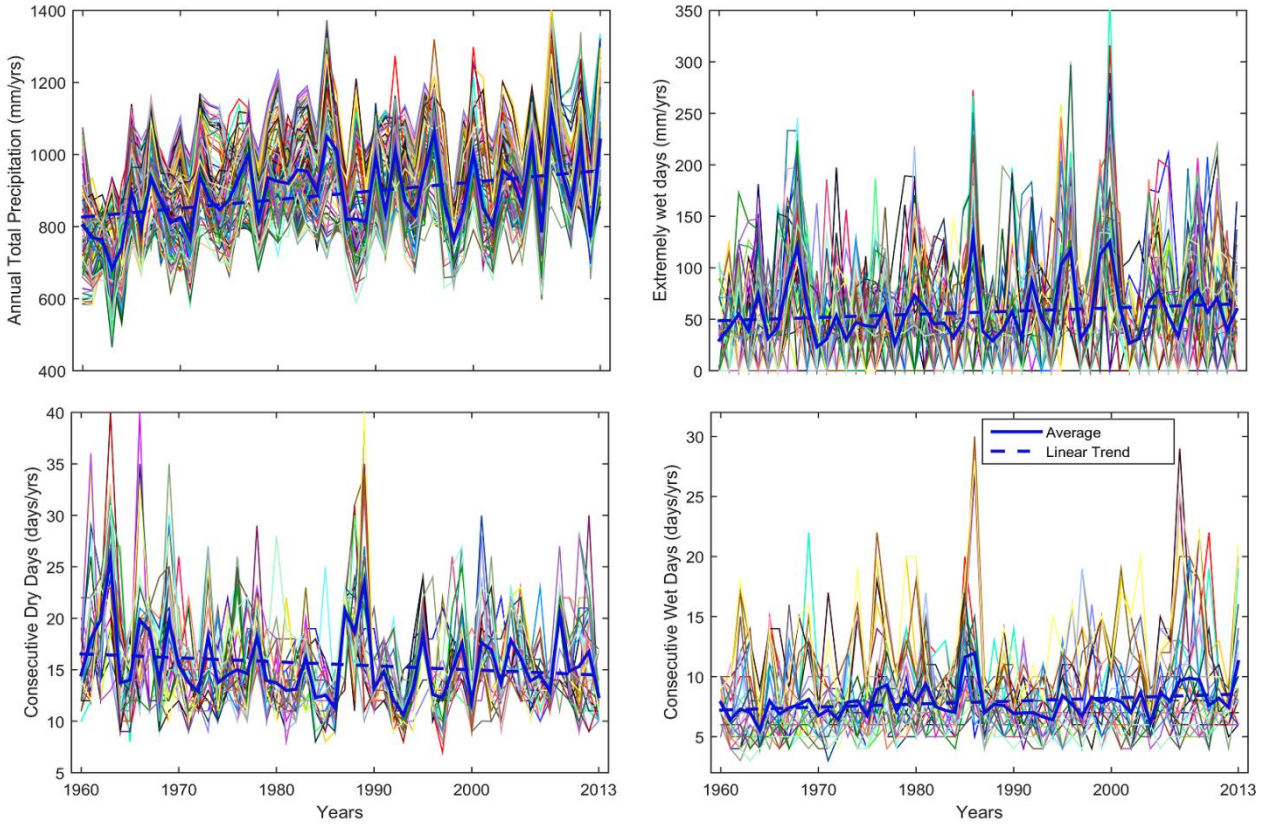
- **Region:** Southern Ontario (is home to 10 million people)
- **Climate Indices:** Four precipitation and four temperatures

Indicator Name	Indicator Definition	Units
Total Precipitation (PRCPTOT)	Annual total precip.	mm/years
Extremely Wet Days (R99p)	Annual total precip. > 99th perc.	mm/years
Consecutive Wet Days (CWD)	Consecutive days precip. ≥ 1 mm	days/years
Consecutive Dry Days (CDD)	Consecutive days precip. < 1 mm	days/years
Cool Days (TX10p)	Day max. temp.< 10th percentile	days/years
Warm Nights (TN90p)	Day min temp. >90th percentile	days/years
Min Tmin (TNn)	Min. of daily min temp.	°C/years
Max Tmax (TXx)	Max. of daily max temp.	°C/years



- **Data:** Daily precipitation, Tmax,Tmin
  - EC (48 weather stations)
  - CanGrid: Historical gridded data produced using observed weather stations and interpolation models (1700 grids 8km resolution)

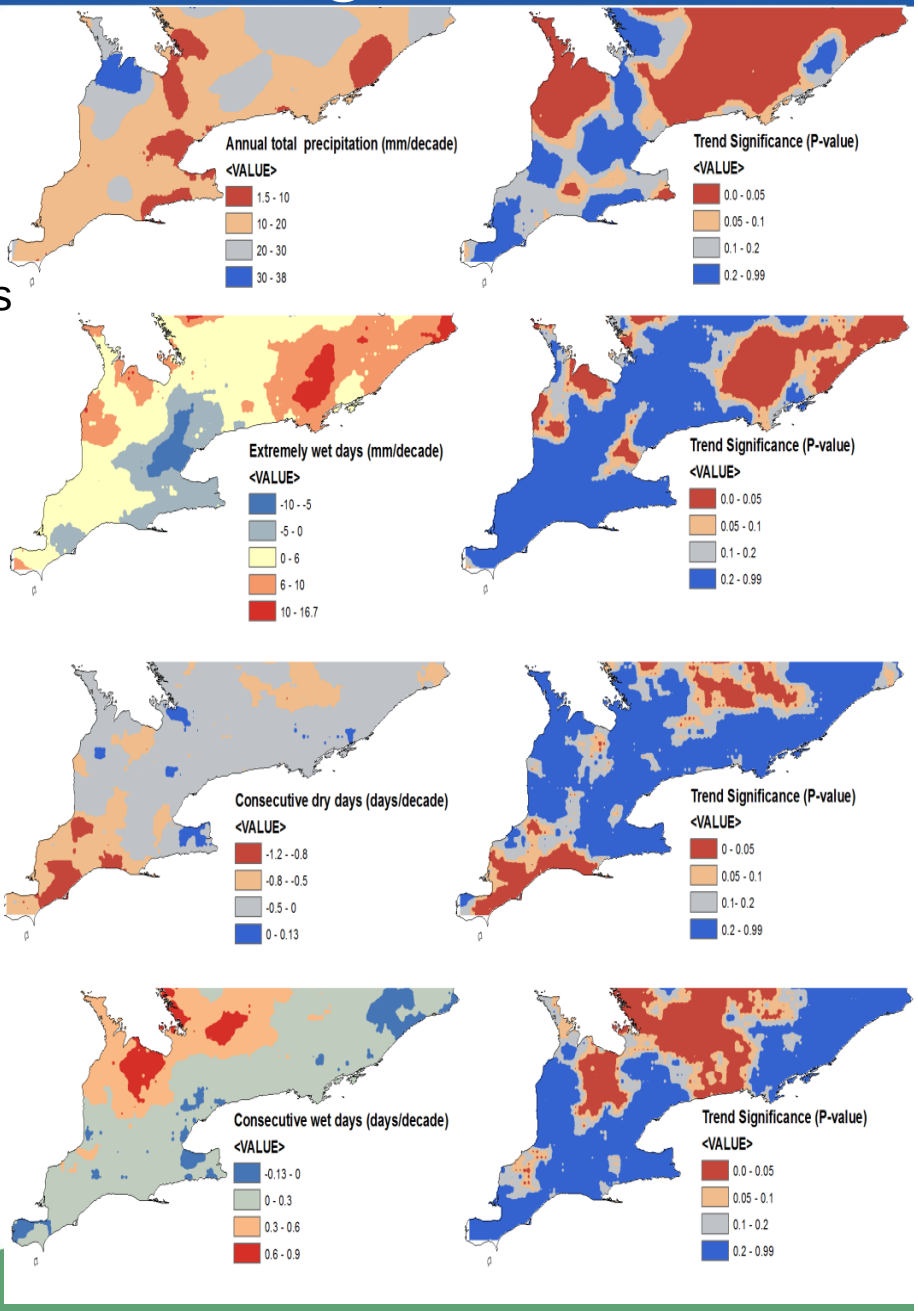
Precipitation – Over Time



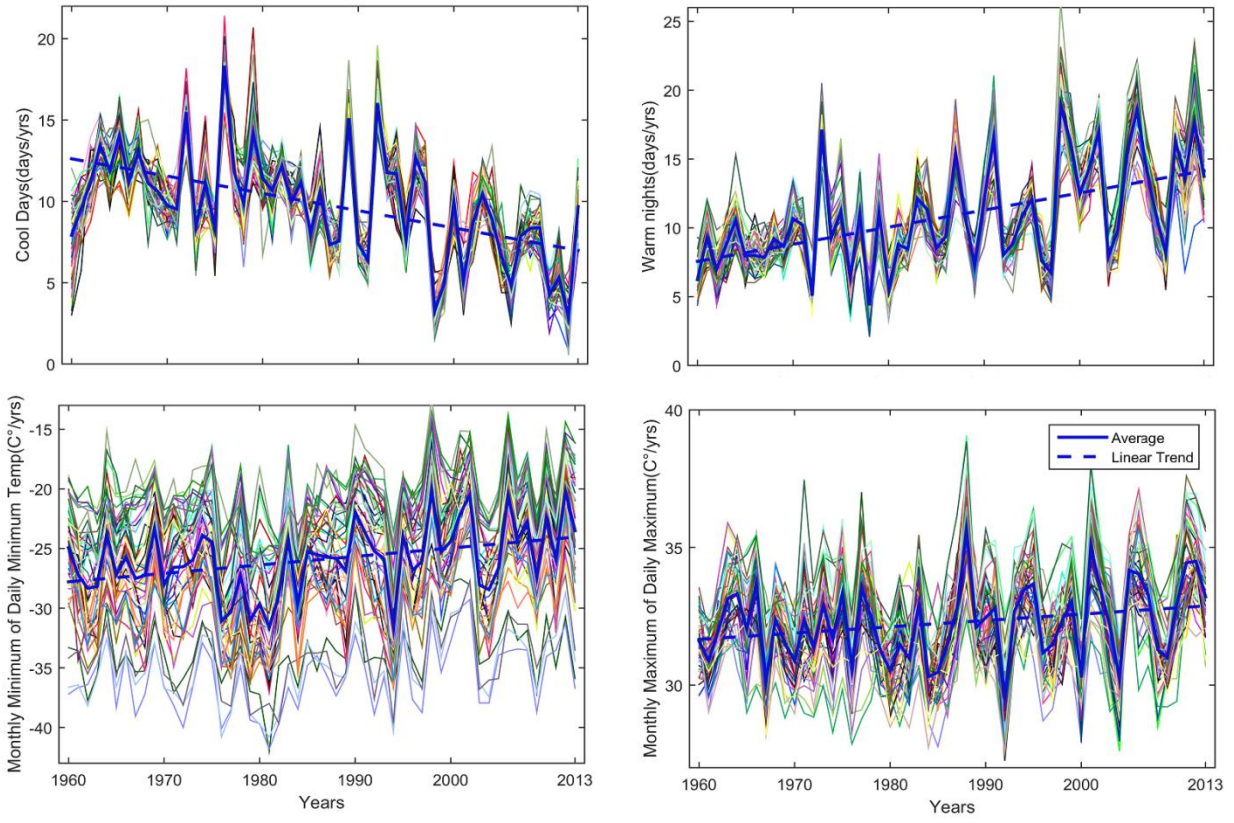
- Increase PRCPTOT (+17 mm /decade), R99p (+4.75 mm /decade), CWD (+0.3 Days/decade)
- Decrease CDD (-0.5 Days/decade).
- **Toronto Island Airport** experienced the minimum PRCPTOT amount, maximum number of CDD, minimum number of CWD (shielded from the lake effect snow because the position of Niagara Escarpment and Oak Ridges Moraine)

Precipitation – Over Region

- PRCPTOT has positive significant trends in 61% of the area and especially in the eastern and central parts
- R99p trends are significant in 35.3 % of region and they are more significant in the eastern parts
- The largest PRCPTOT and R99p trends are founded in Bruce, Grey and Haliburton districts.
- The smallest trends in PRCPTOT and R99p are founded in Haltom, Toronto, Peel, York, Leeds and Greenville, Simcoe and Muskoka districts.
- CDD have a significant trend in 25% (western parts) and CWD in 36% (north parts)
- High spatial variability of precipitation indices



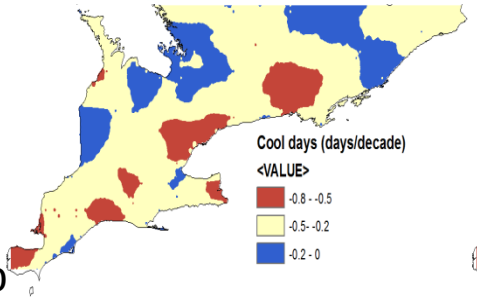
Temperature – Over Time

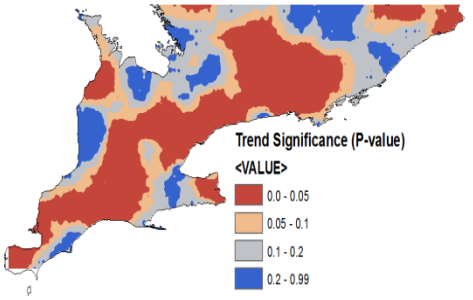


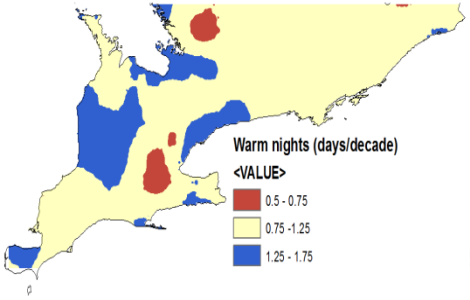
- Decrease TX10p (-0.4 Days/decade).
- Increase TN90p (+1 Days/decade), TNn (+0.3 °C /decade), TXx (+0.1 °C /decade)
- **Dwight** and **Proton** stations have the minimum values of daily minimum and daily maximum temperatures (located in rural area at high elevations)

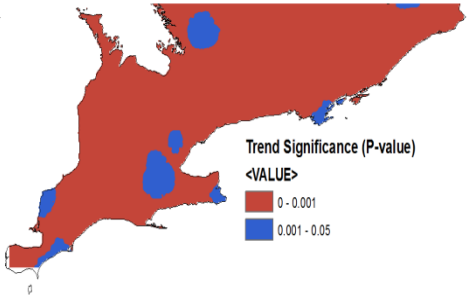
Temperature – Over Region

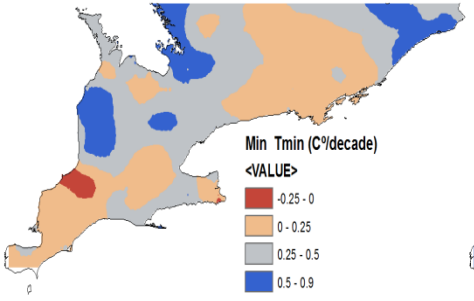
- TX10p has negative significant trends in 64.5% of the study area and especially in the central and western parts
- The highest trends in TX10p are founded in Essex, Elgin, Niagara, Haltom, Peel and Toronto districts.
- TN10p has positive significant trends
- The highest trend in TN10p are founded in Huron, Grey, Simcoe and Muskoka
- TNn has positive significant trends in 32.5% of region
- The highest TNn trends were founded in Huron, Simcoe and Ottawa districts
- TXx has positive significant trend in 25.3% of the area
- Nighttime warming has been greater than daytime warming

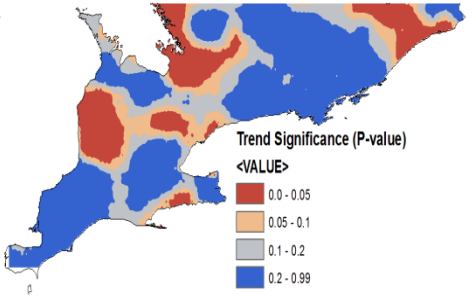


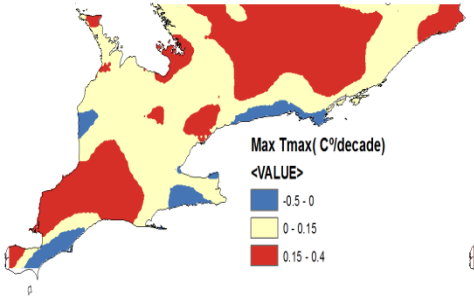


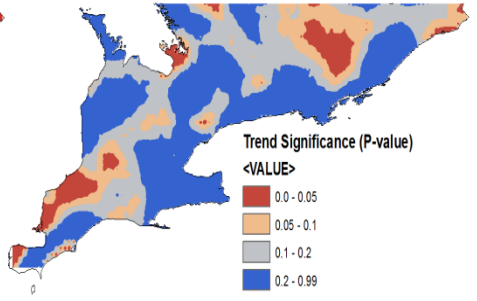












Conclusions

- Total Annual Precipitation and Extremely Wet Days are increased over the studied region
- More wet days and less dry days
- Frequency of cold temperature is decreased, while the frequency of warm is increased
- Min and Max temperature have an increasing trends
- Nighttime warming has been greater than daytime warming
- Precipitation indices have higher inter-station variability (comparing to the variability of temperature indices)

Acknowledgments

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Questions??