Indicator Trends for Canadian Climate Changes during the Last 60 to 140 Years

Presented to CPANS, Edmonton Luncheon Forum

by Kurt Hansen, P. Eng.
President, Green Inc., Calgary, Alberta
greeninc@telus.net

6 March 2015

Acknowledgements

My sincere thanks to Dr. Stanley Hall and Klym Bolechowsky for suggestions and assistance

This presentation is dedicated to Marie & Edith – both diligent weather-observing Danish farmers (from 1890 to 1974), who inspired me about weather conditions

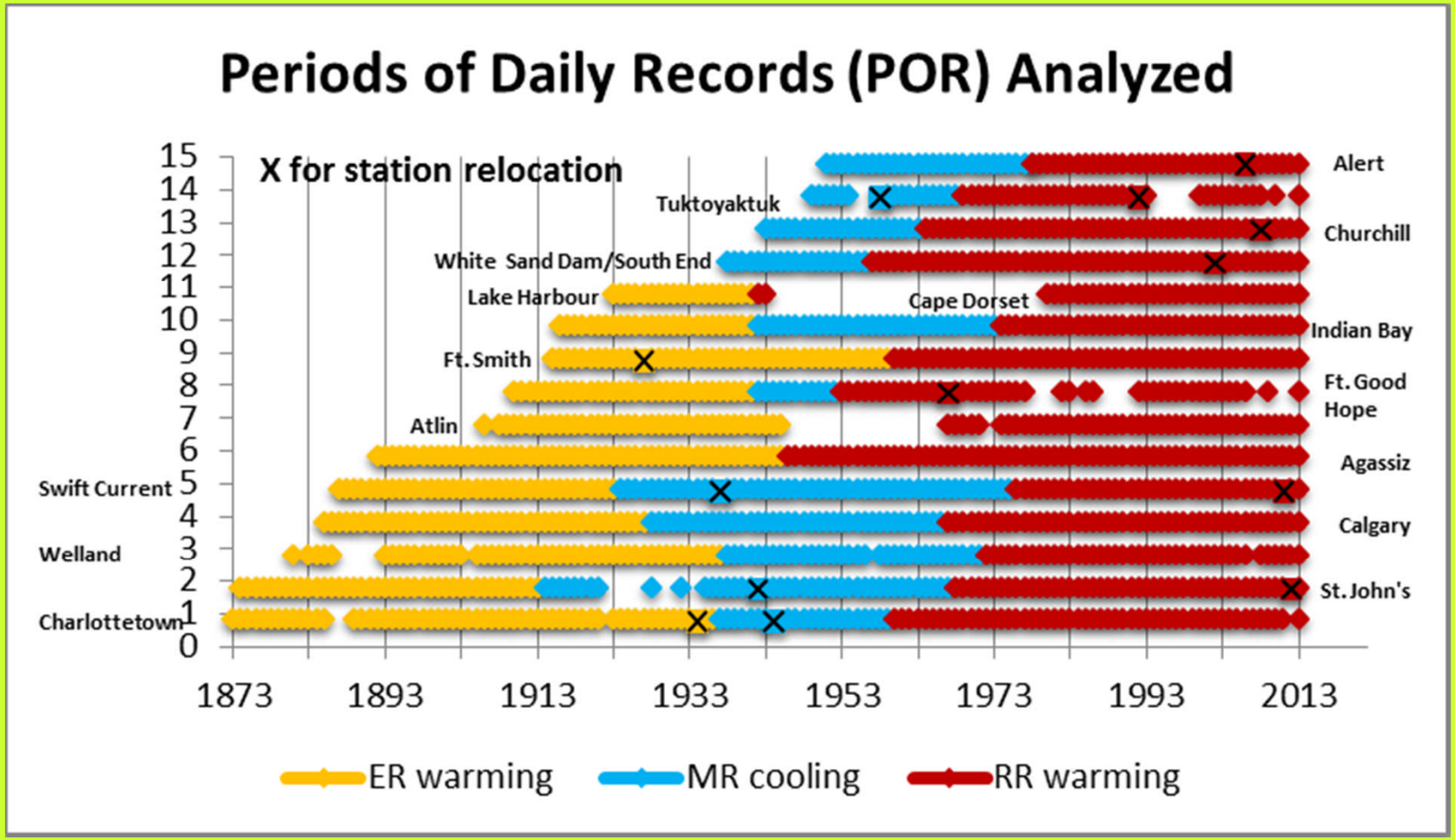
Overview

- Stations & periods of records (POR)
- Climate change (CC) indicators
- Temperature related indicator findings
- Precipitation related indicator findings
- Conclusions from findings

Weather Station Locations

Periods of Temperature Records (POR)

(enginering daily data)



Climate Change Indicators

Temperature related trends:

- Extreme temperatures (indicators for deep freezes & heat waves)
- Mean annual & seasonal temperatures
- Days between absolute min and max of cumulative degree days, with carry-over into next year (relative to 0°C)

Precipitation related trends:

- Average annual precipitation (total & snow)
- Extreme “drought & drench” (D&D) rain to temperature ratio indicators

Indicator Trend Metrics

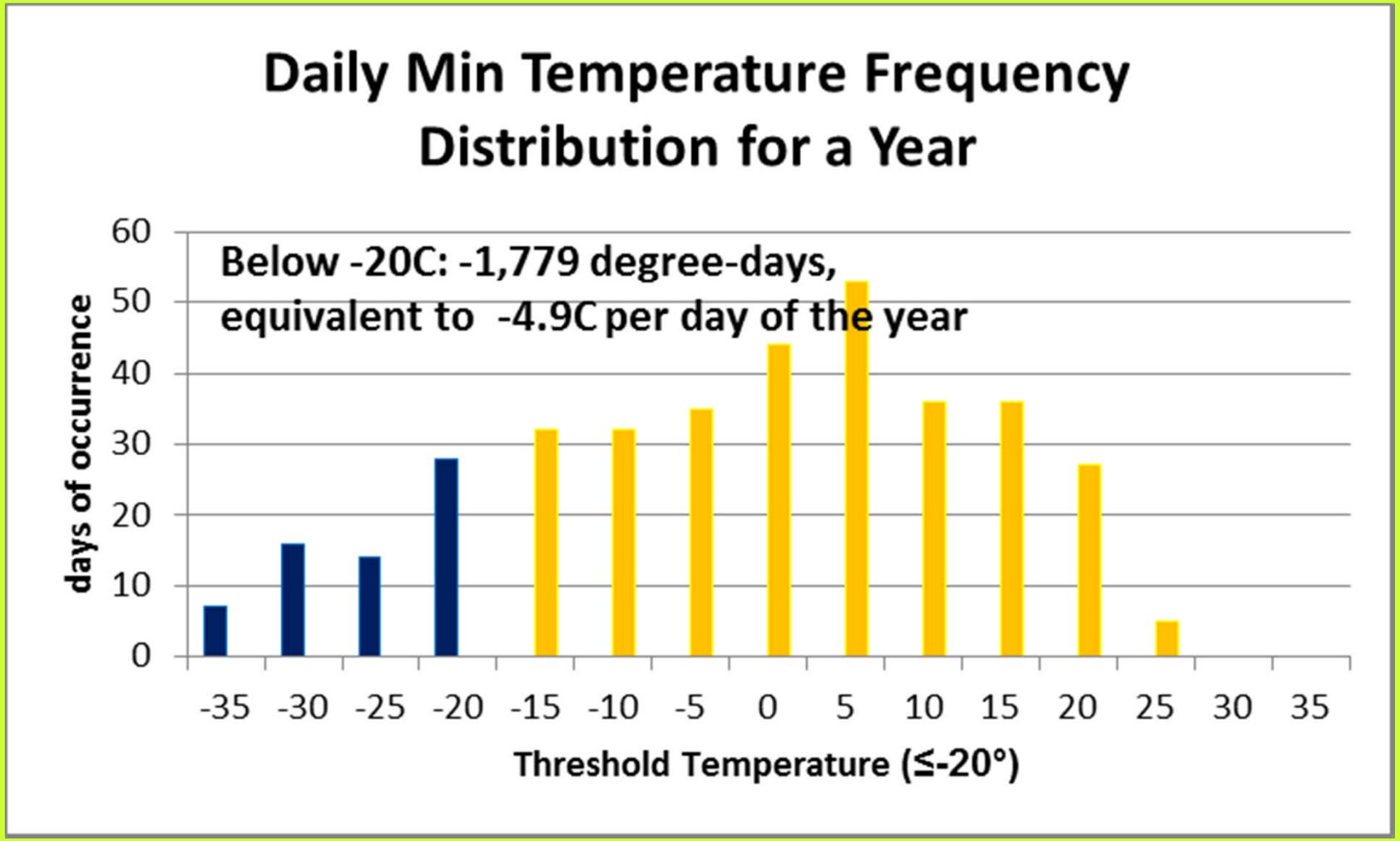
Years for increasing (+) or decreasing (-) trend change of:

- 1°C (and the related variable: Cdays relative to 0°C)
- 1 day duration, between absolute plus to minus seasonal temperature changes (cumulative min and max Cday values)
- 10 mm rain (and equivalent 10 cm snow)
- APR-SEP growing period: rain to temperature ratio (increment unit of 0.025 mm Cday ≈10% average summer pan evaporation)

TRENDS IN TEMPERATURE RELATED INDICATORS

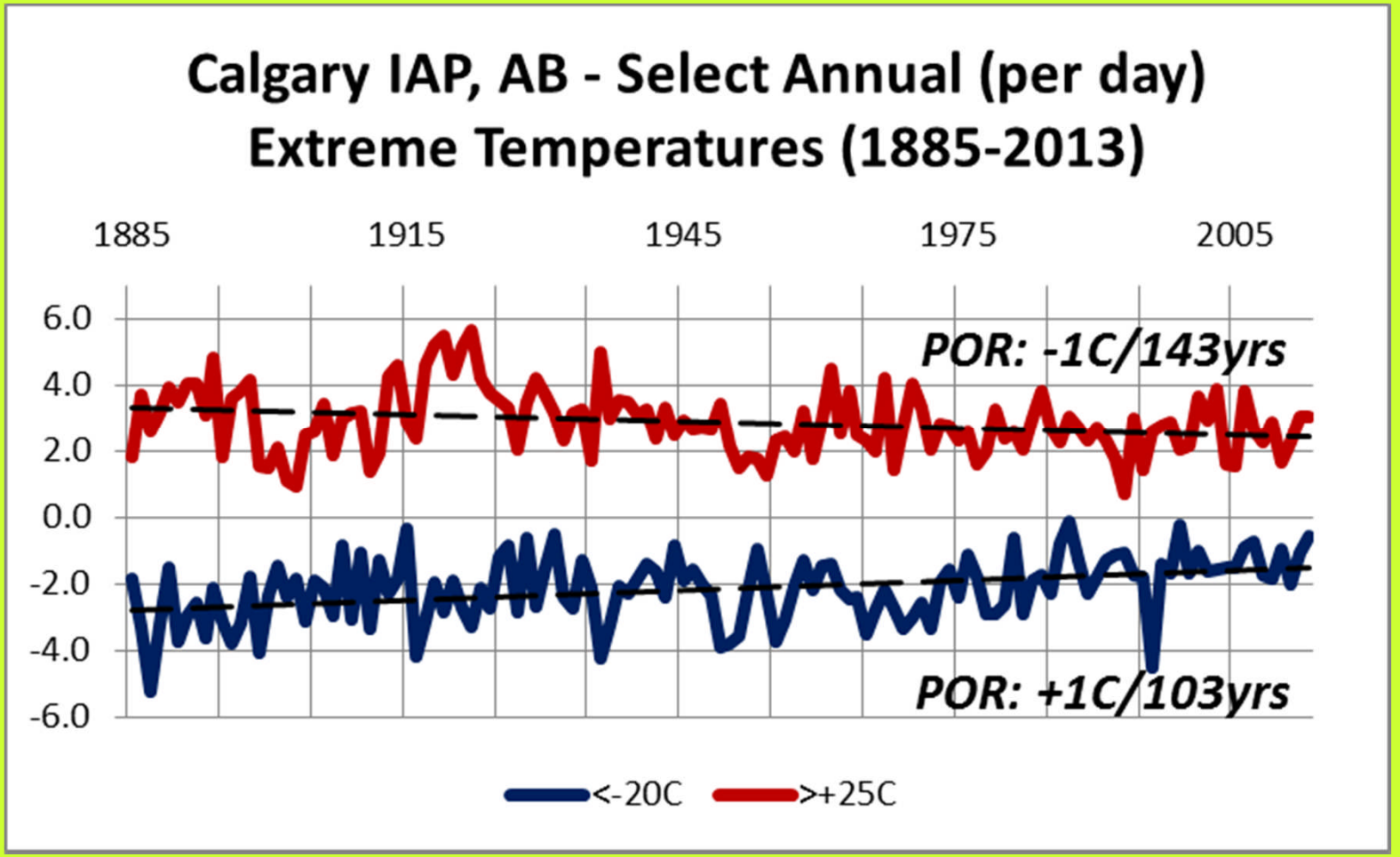
EXAMPLES & SUMMARIES

Approach: Extreme Min Temperature Indicator



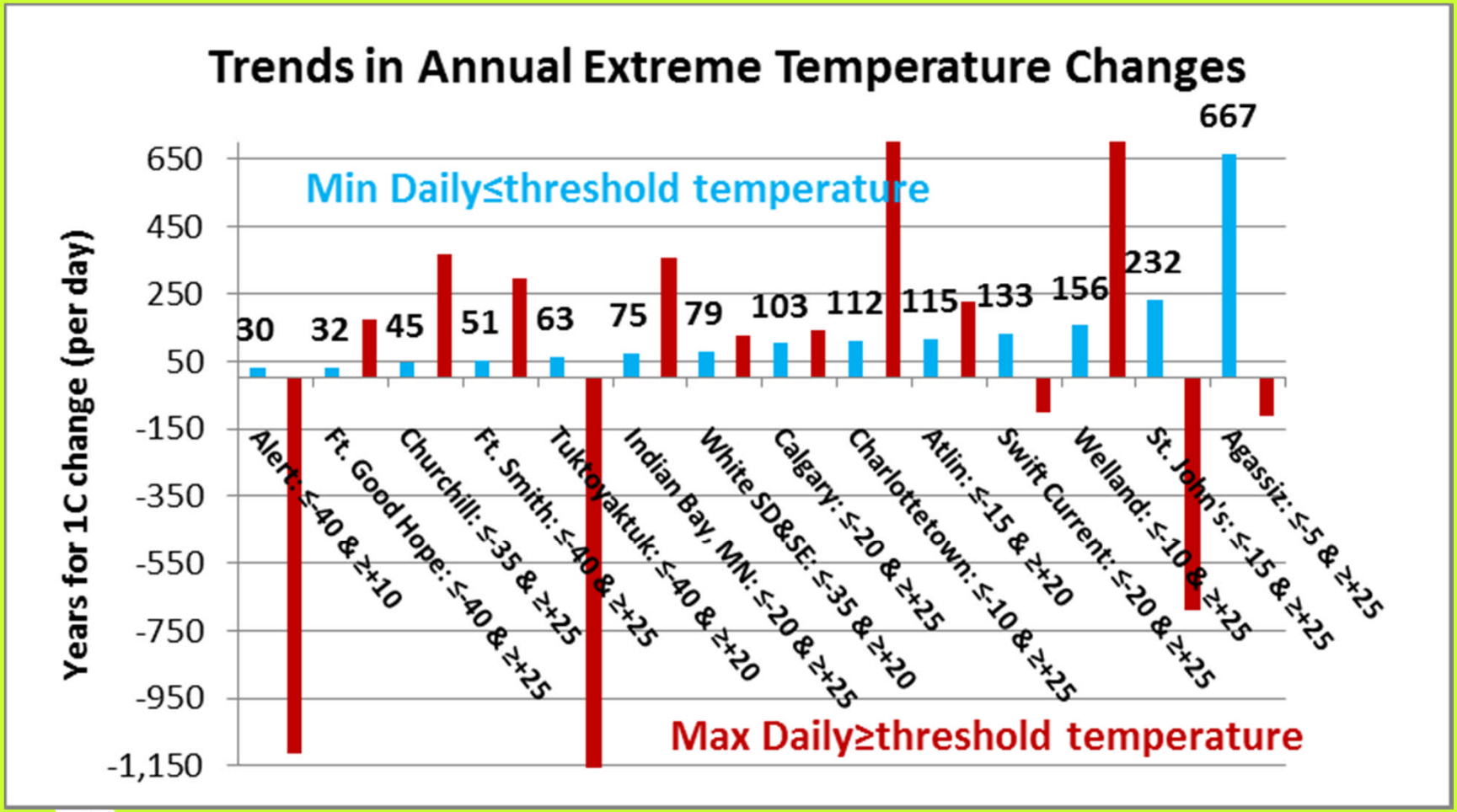
Example: Extreme Annual Temperatures

(engineering daily data)



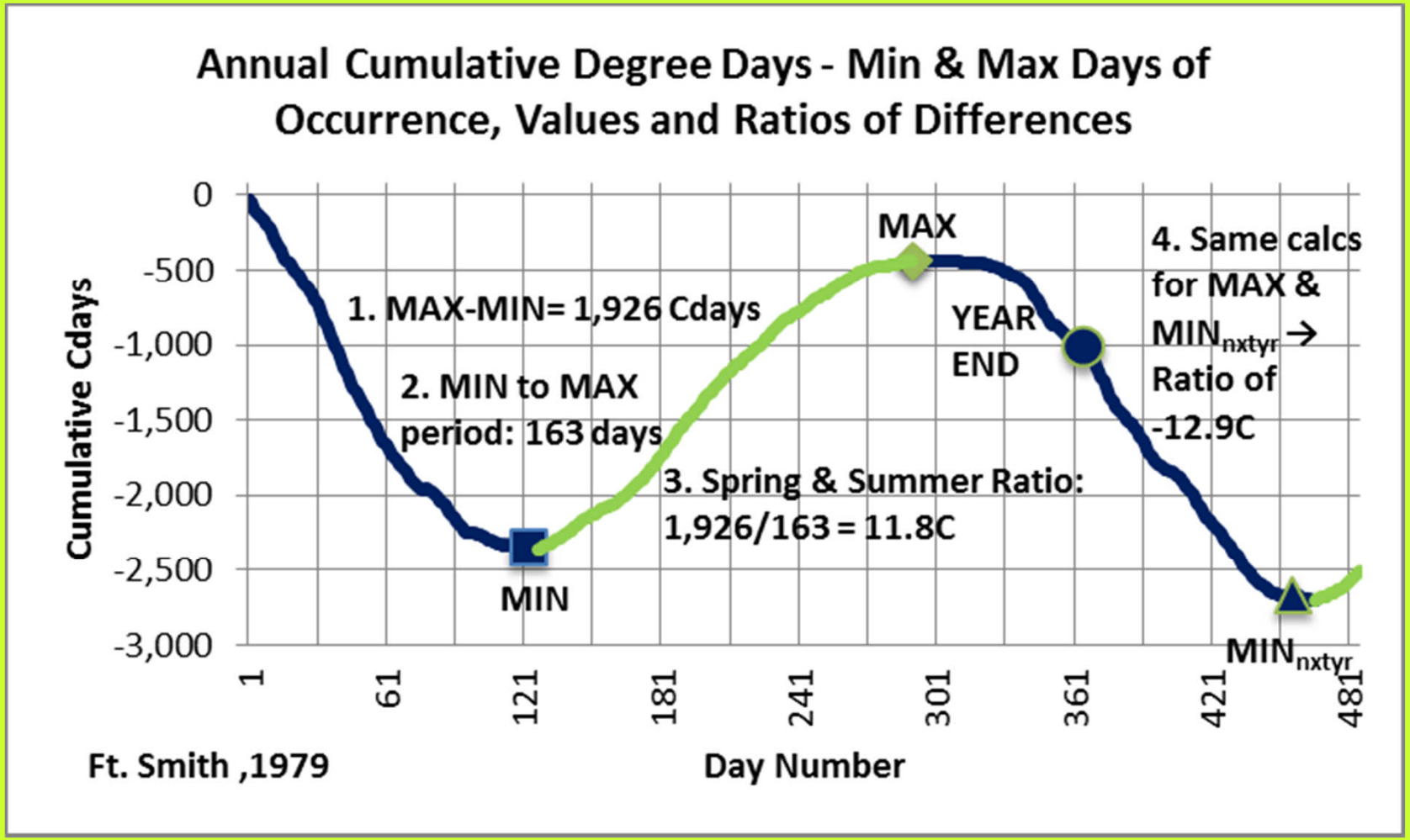
Summary: Extreme Annual Temperatures

(engineering daily data)

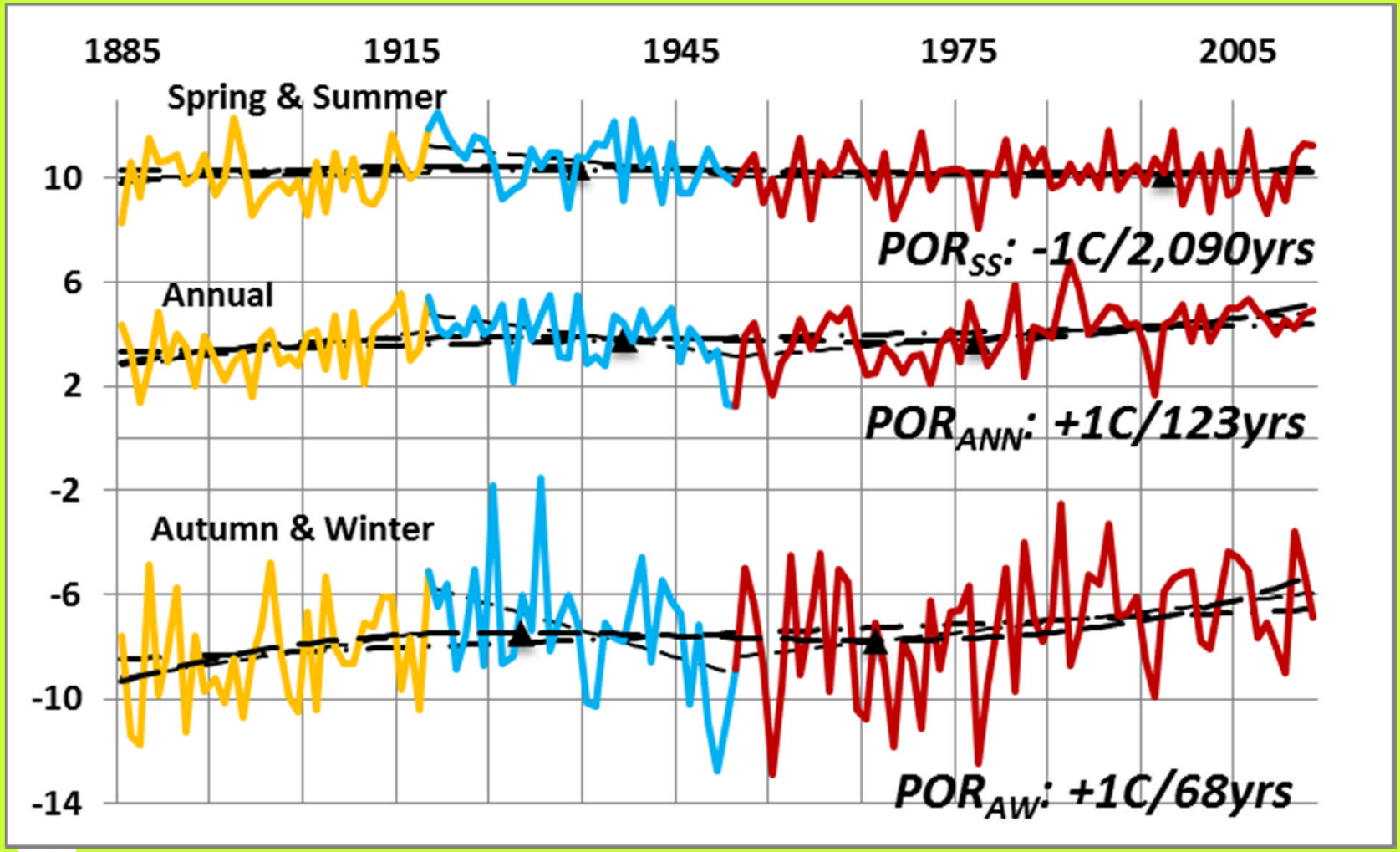


Approach: Indicators for Seasonal Mean Temperatures

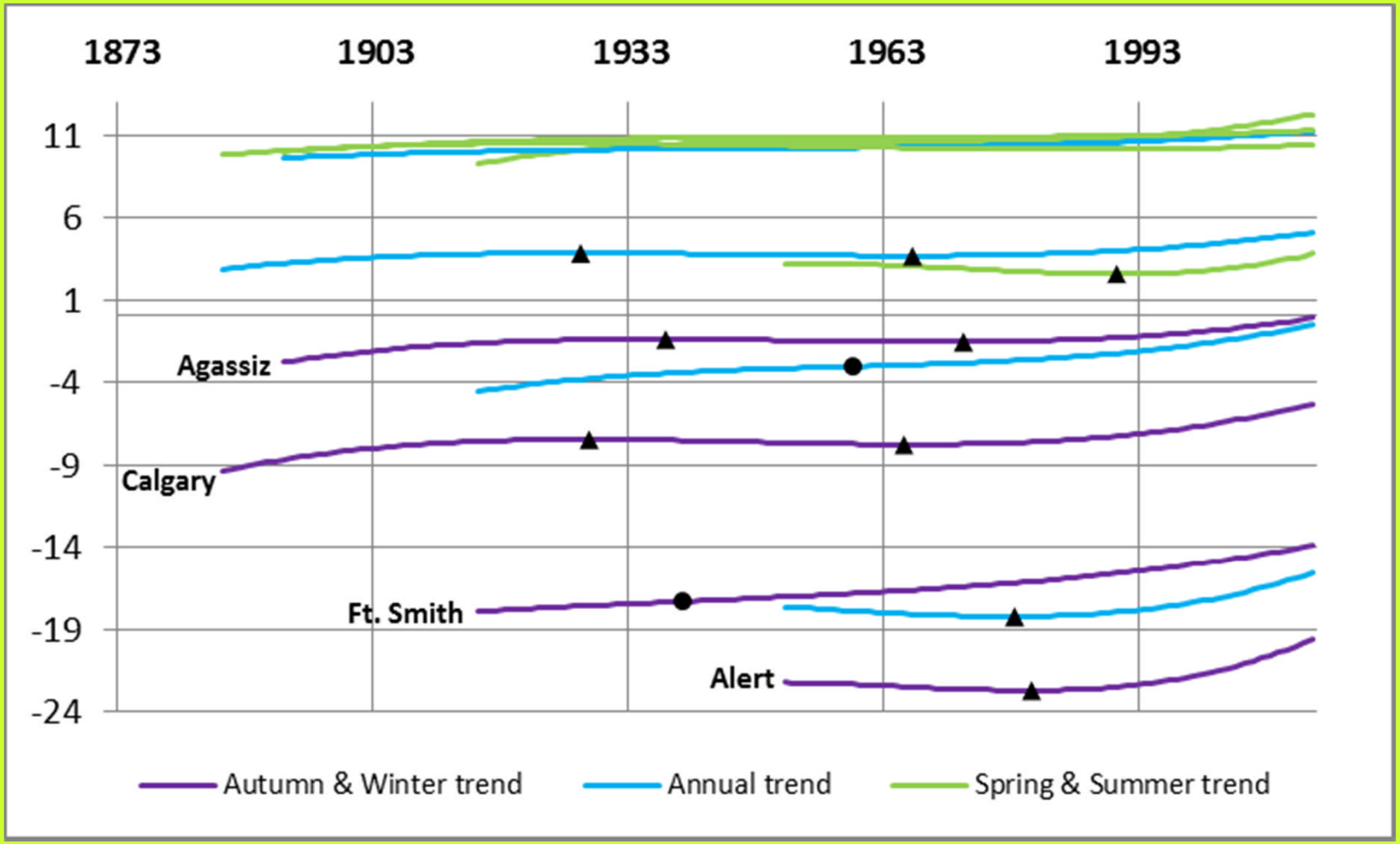
(Spring & Summer (SS) and Autumn & Winter (AW) periods)



Calgary IAP Example: Mean SS, Annual & AW Temperatures
(linear and 3rd power polynomial trends)

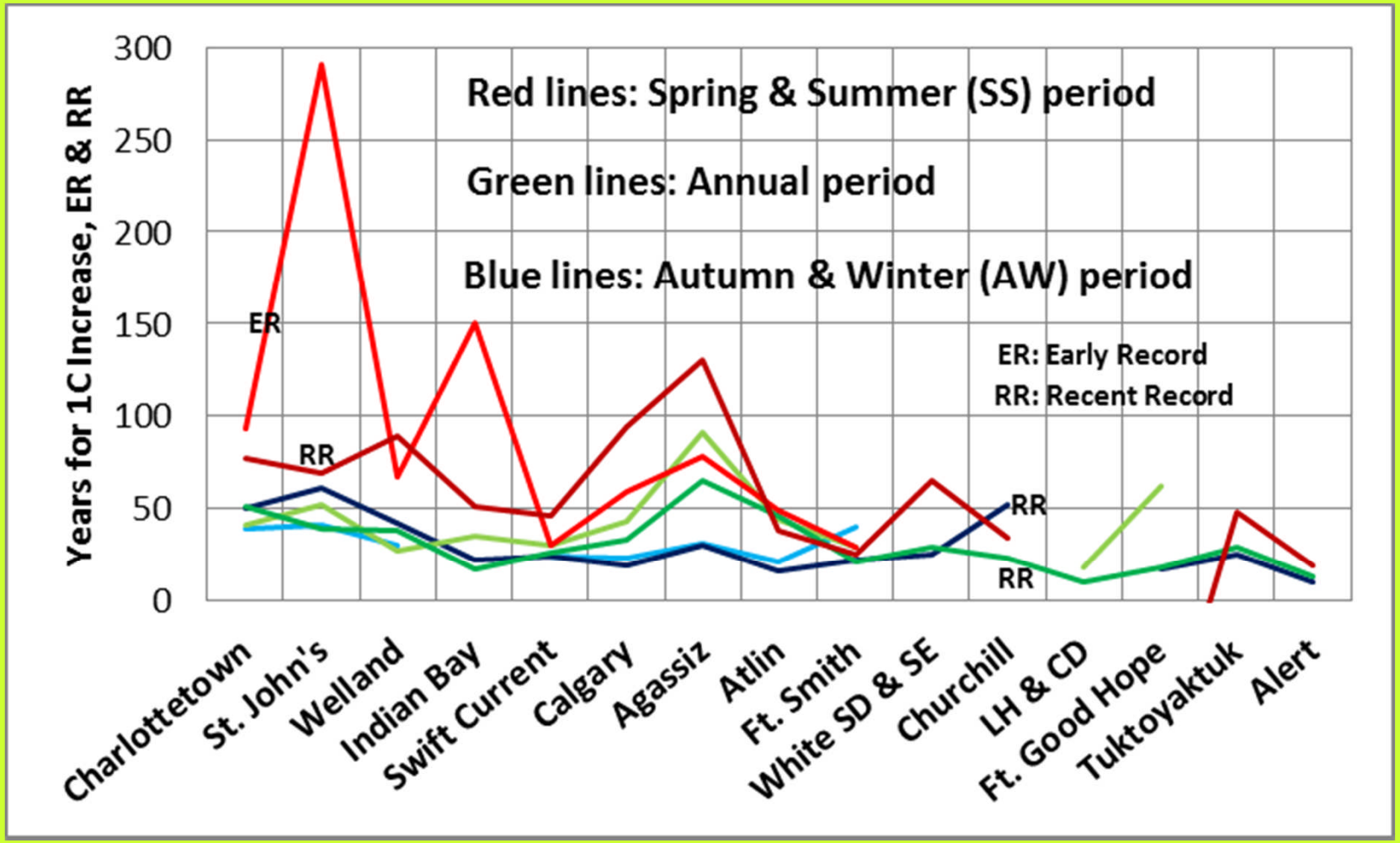


Other Examples: Mean SS, Annual & AW Temperatures
(3rd power polynomial trends)



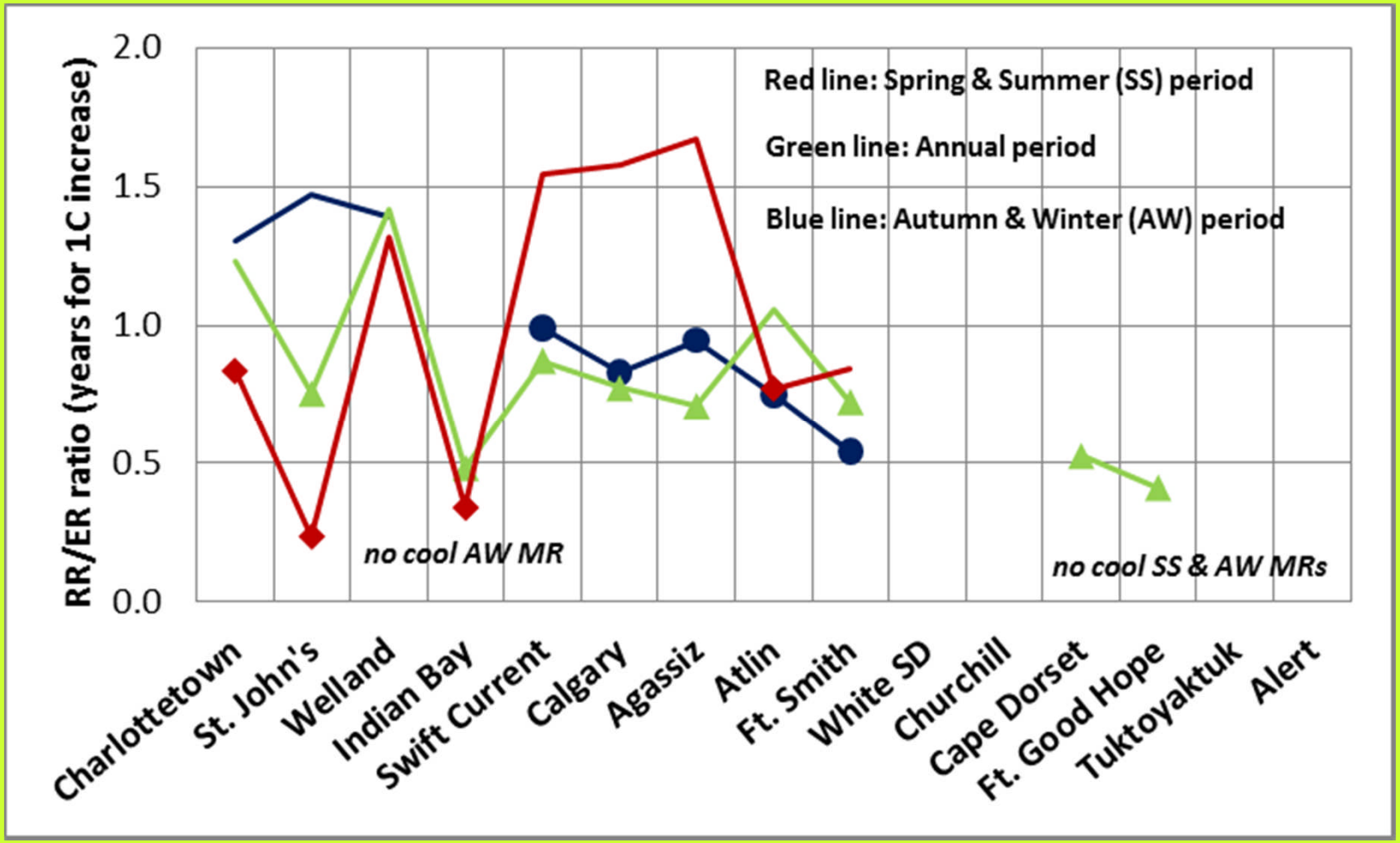
Summary: Warming Trends (ER & RR)

(3rd power polynomial trends)

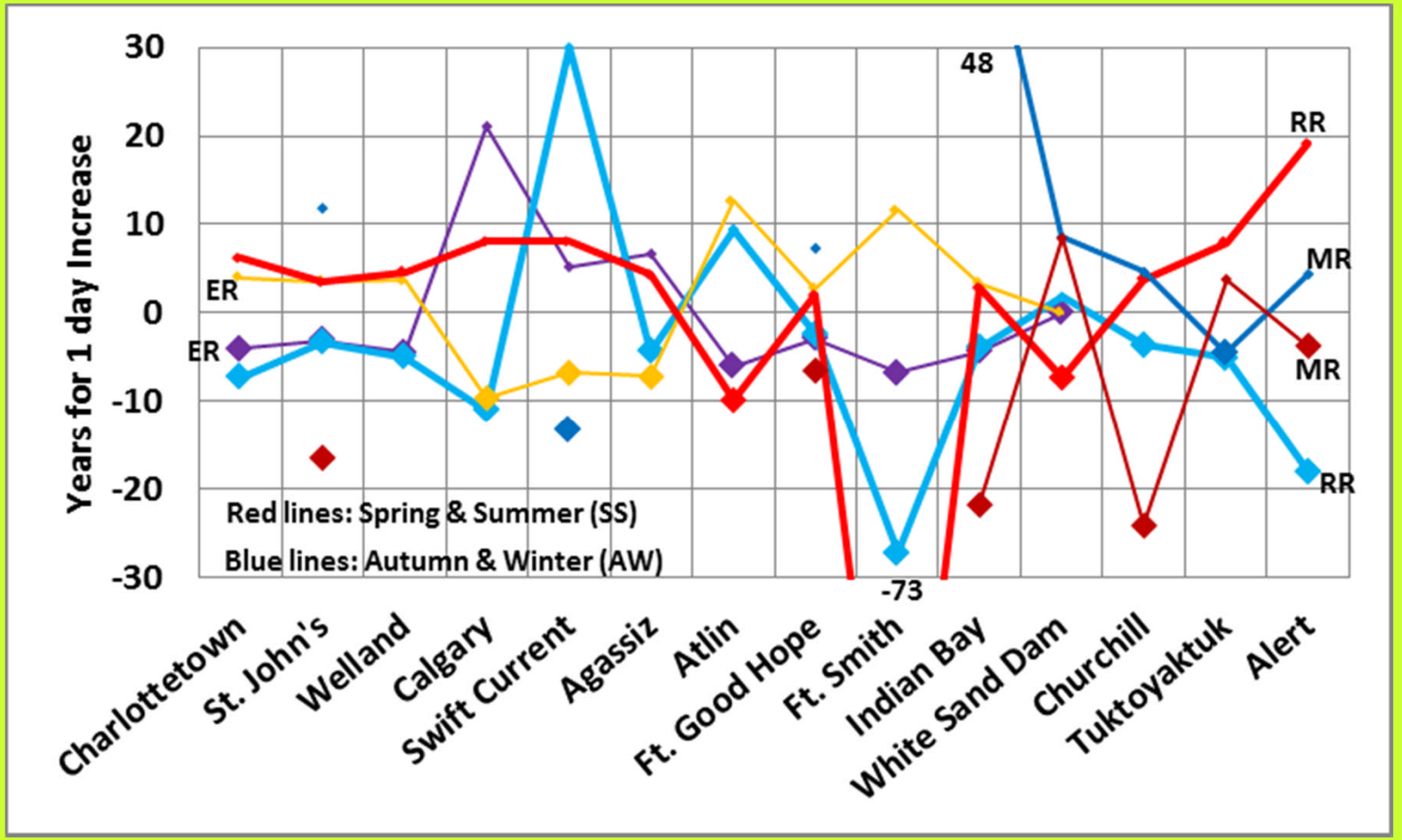


Summary: Recent versus Early Warming Trends

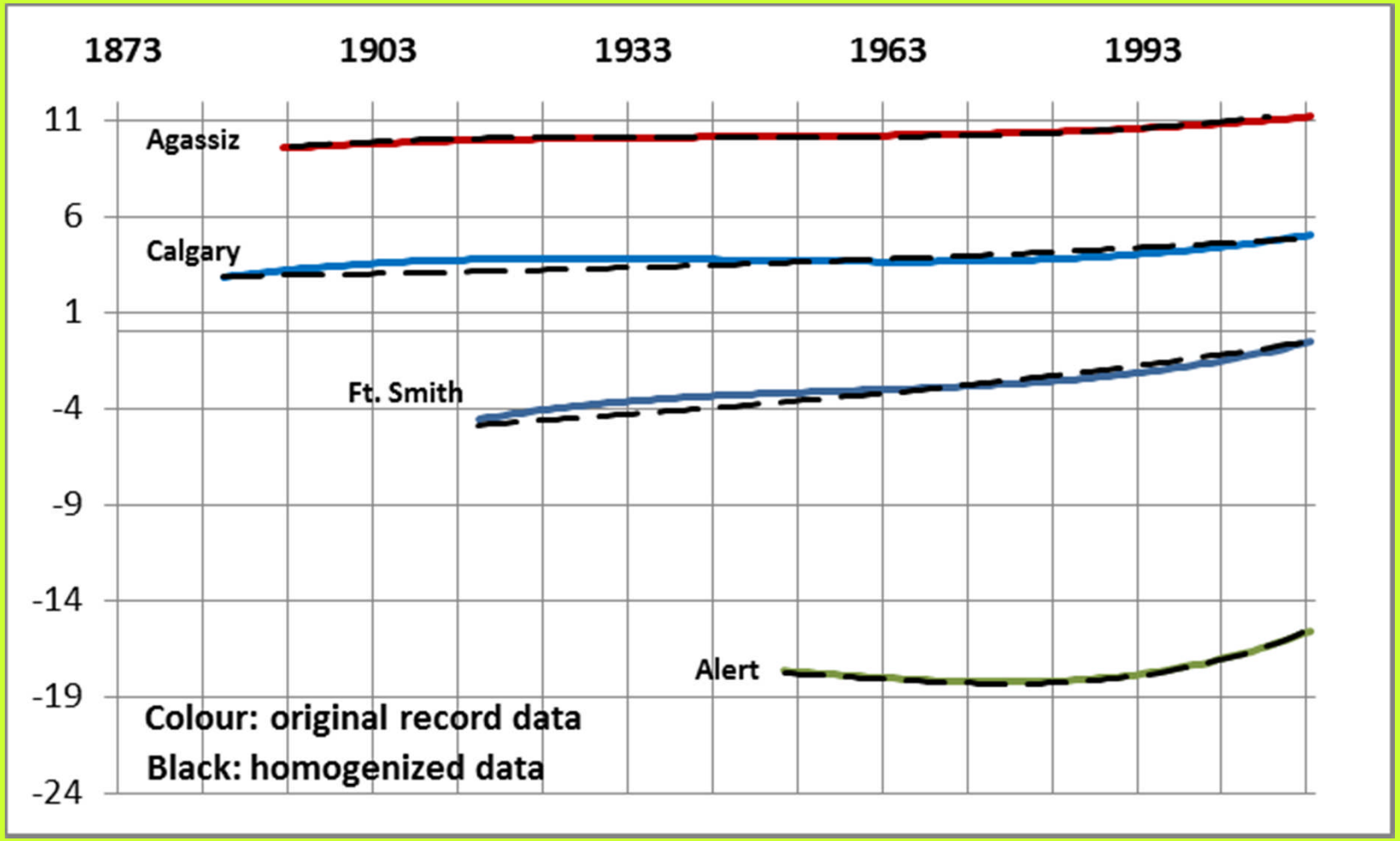
(3rd power polynomial trends)



Summary: Recent versus Early SS & AW Period Trends

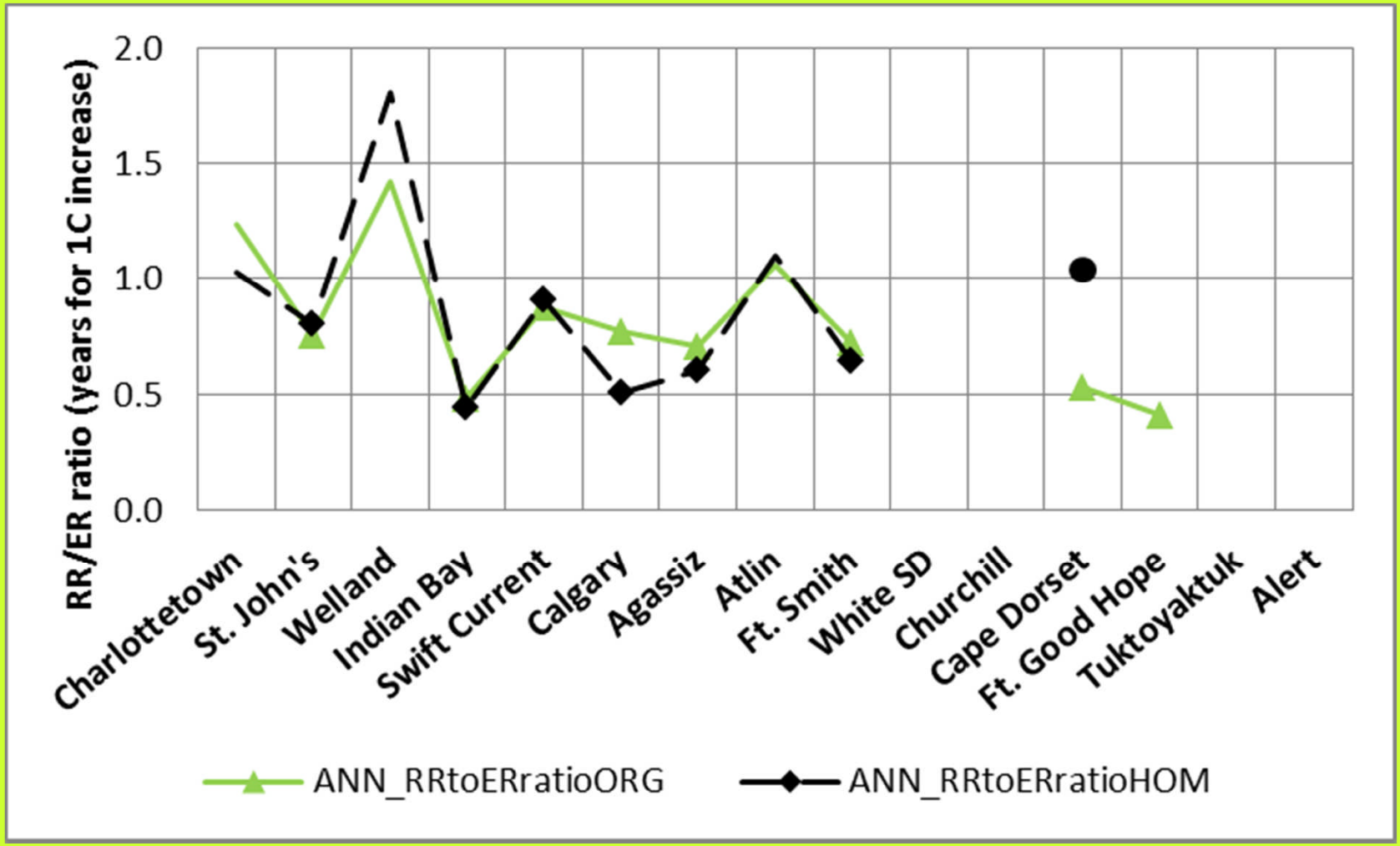


Example: Engineering Daily versus Homogenized Monthly Data
(mean annual temperature trends)



Summary: Recent versus Early Warming Trends

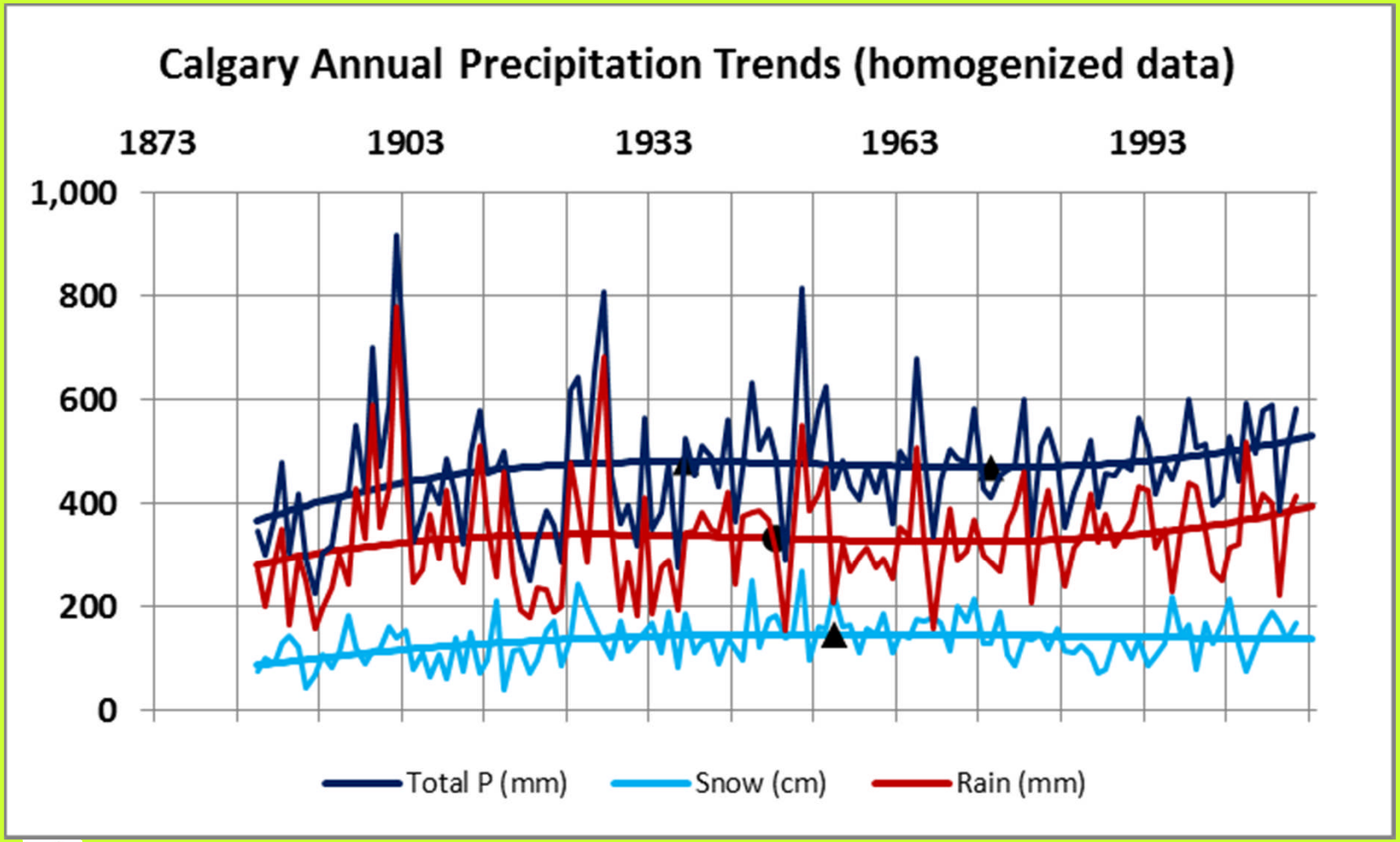
(Original (ORG) vs homogenized (HOM) data)



TRENDS IN PRECIPITATION RELATED INDICATORS

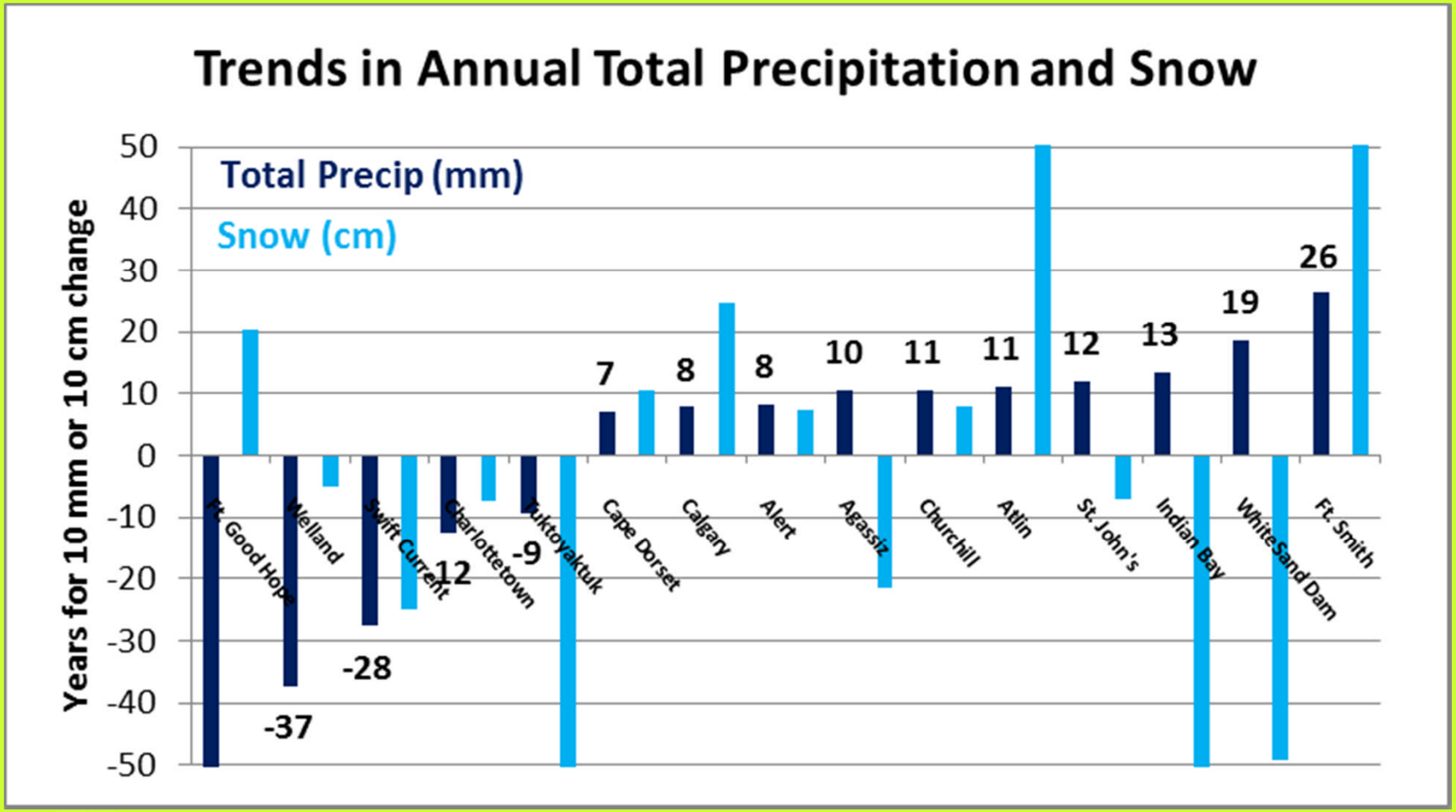
EXAMPLES & SUMMARIES

Example: Annual Total Precipitation & Snow



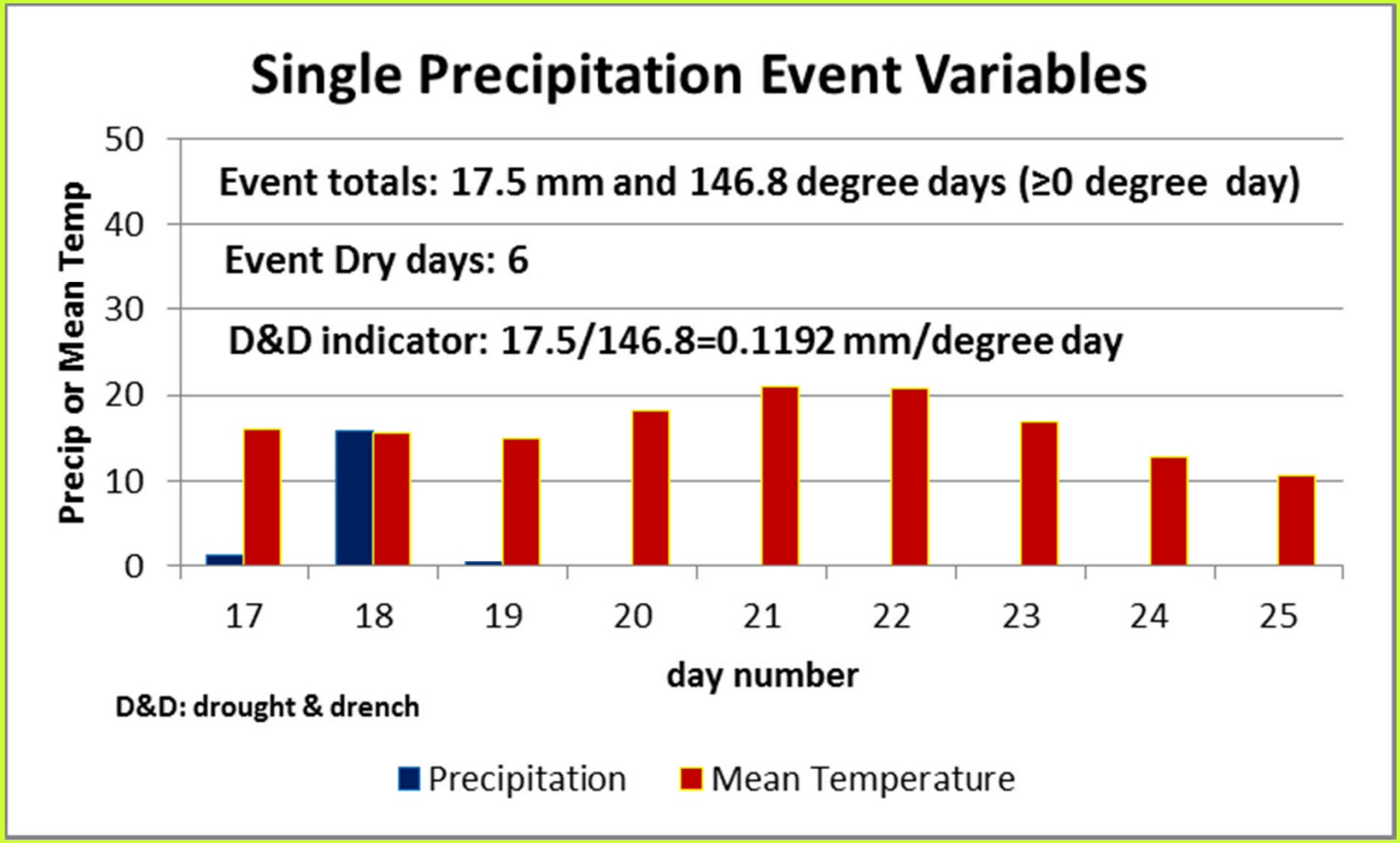
Summary: Annual Total Precipitation & Snow

(homogenized data)

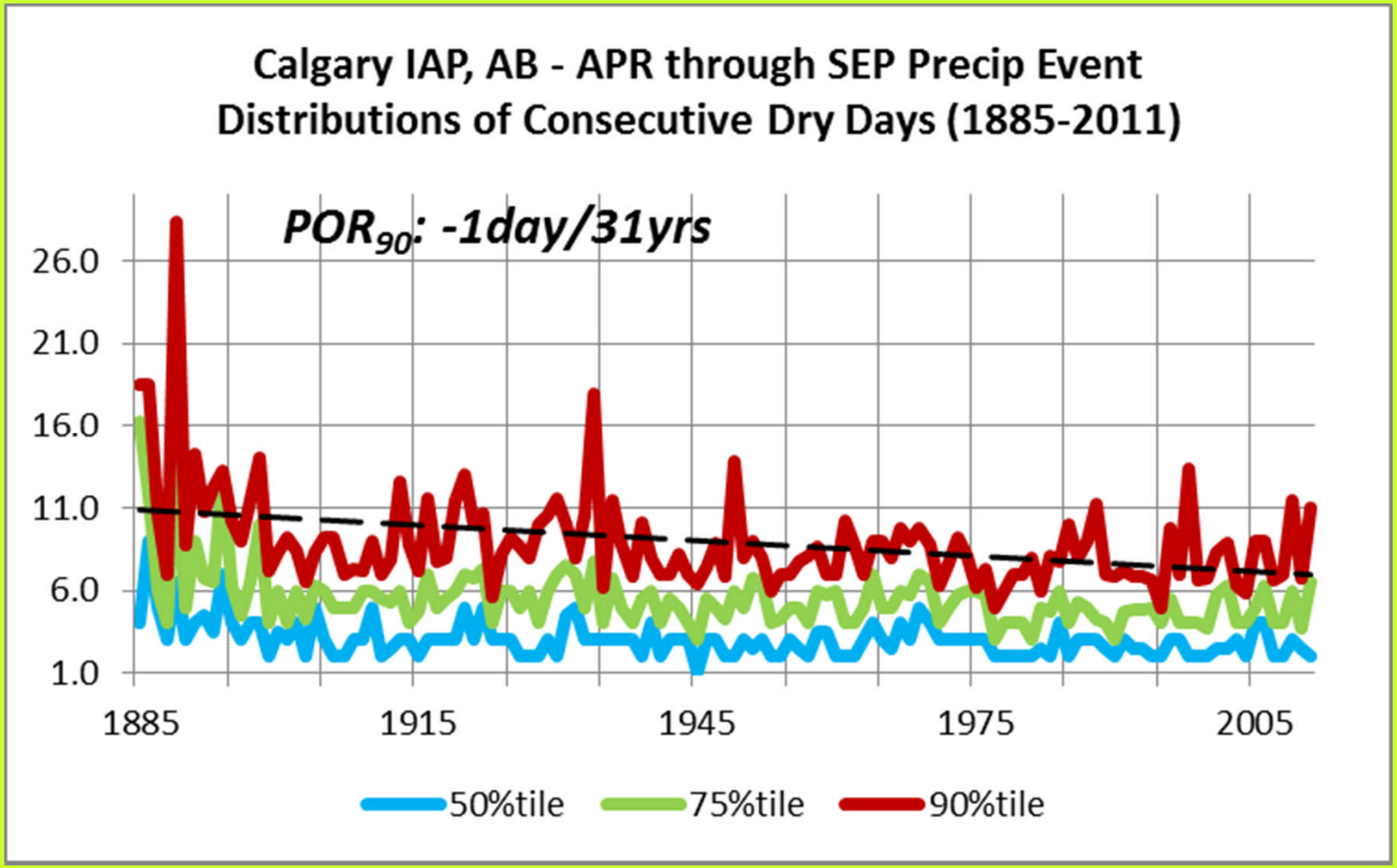


Approach: APR-SEP Precipitation Event Indicators

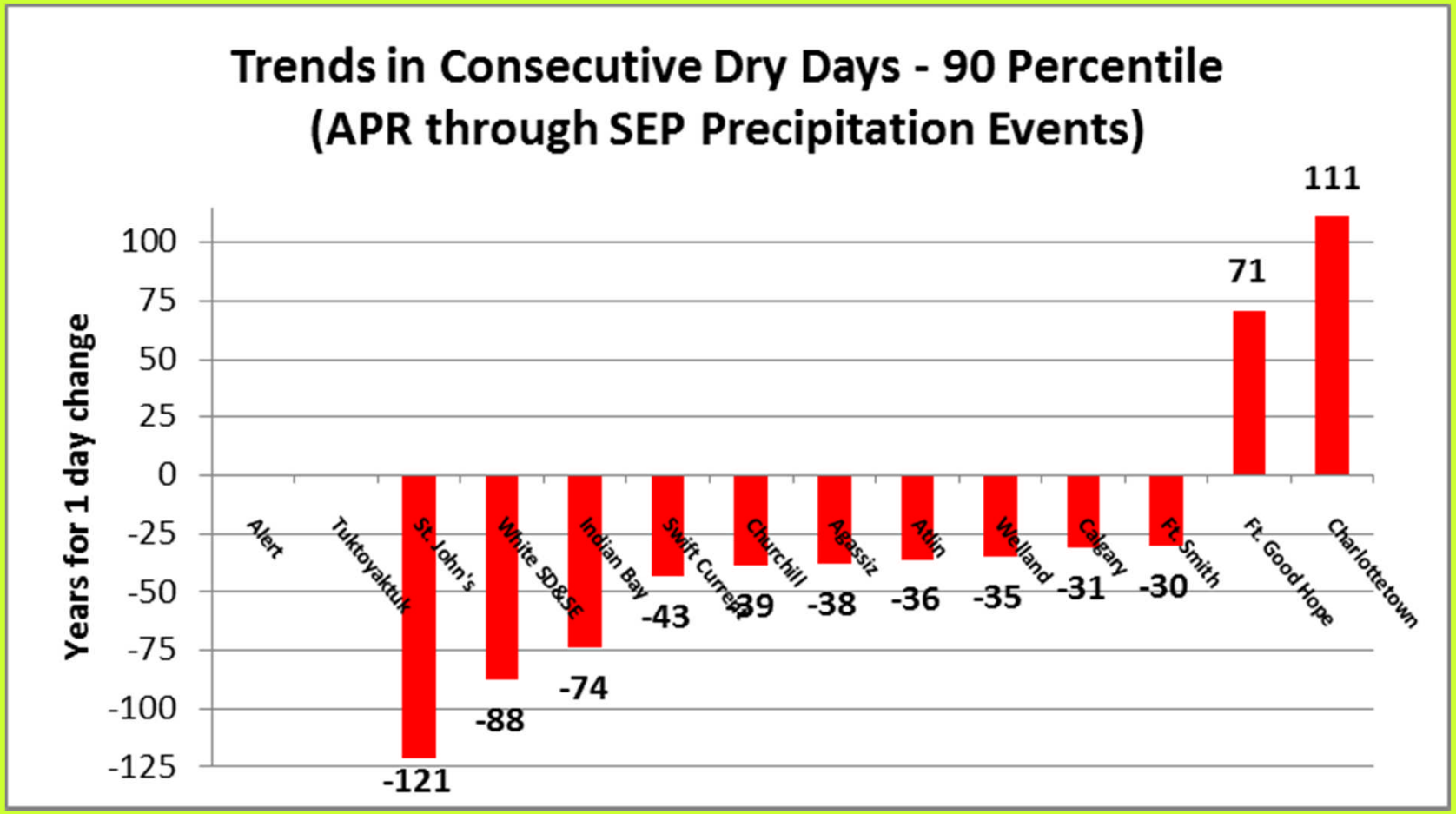
(15 to 45 annual events – event percentiles for each year)



Example: Consecutive Dry Days

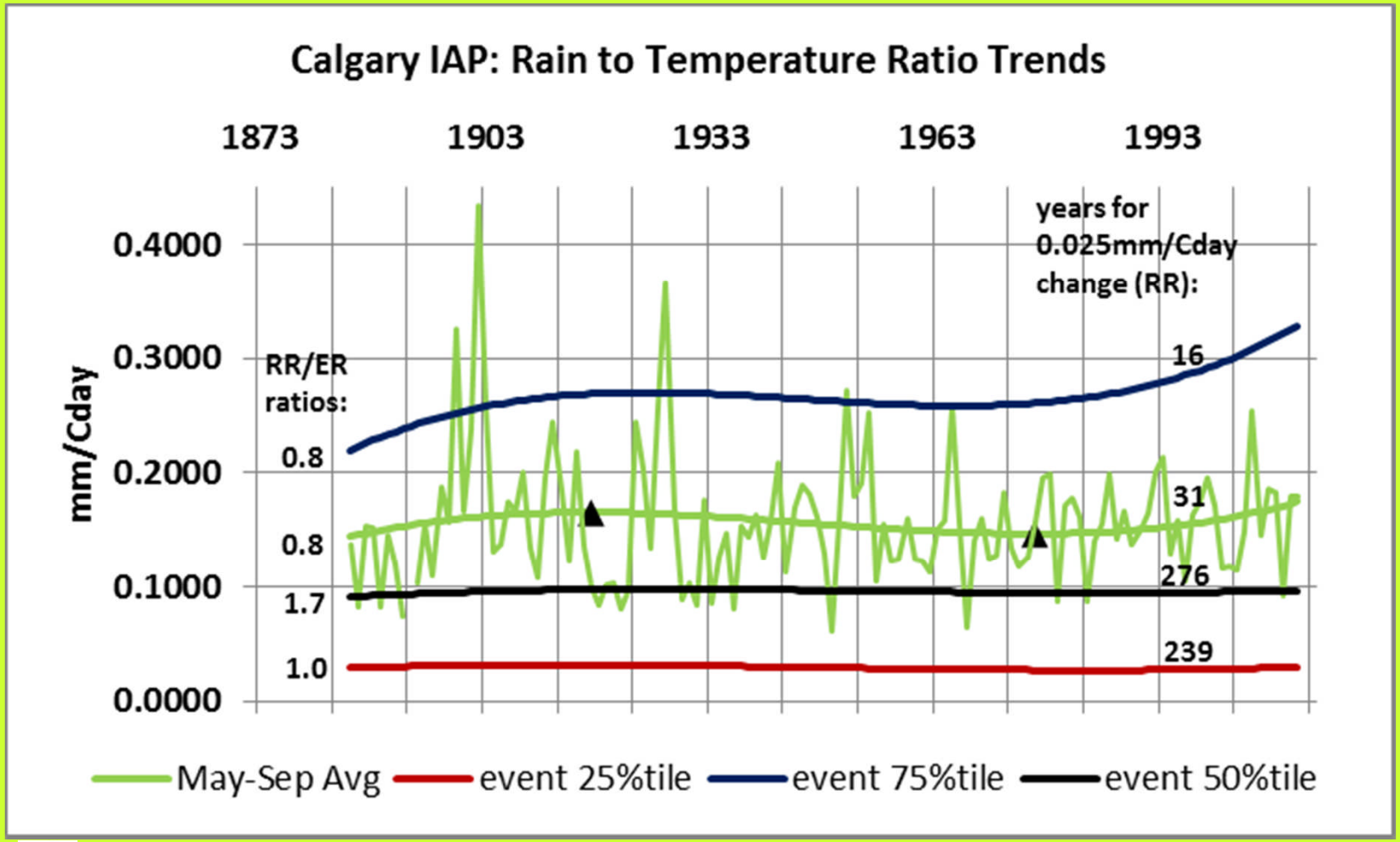


Summary: Consecutive Dry Days (90th Percentile)

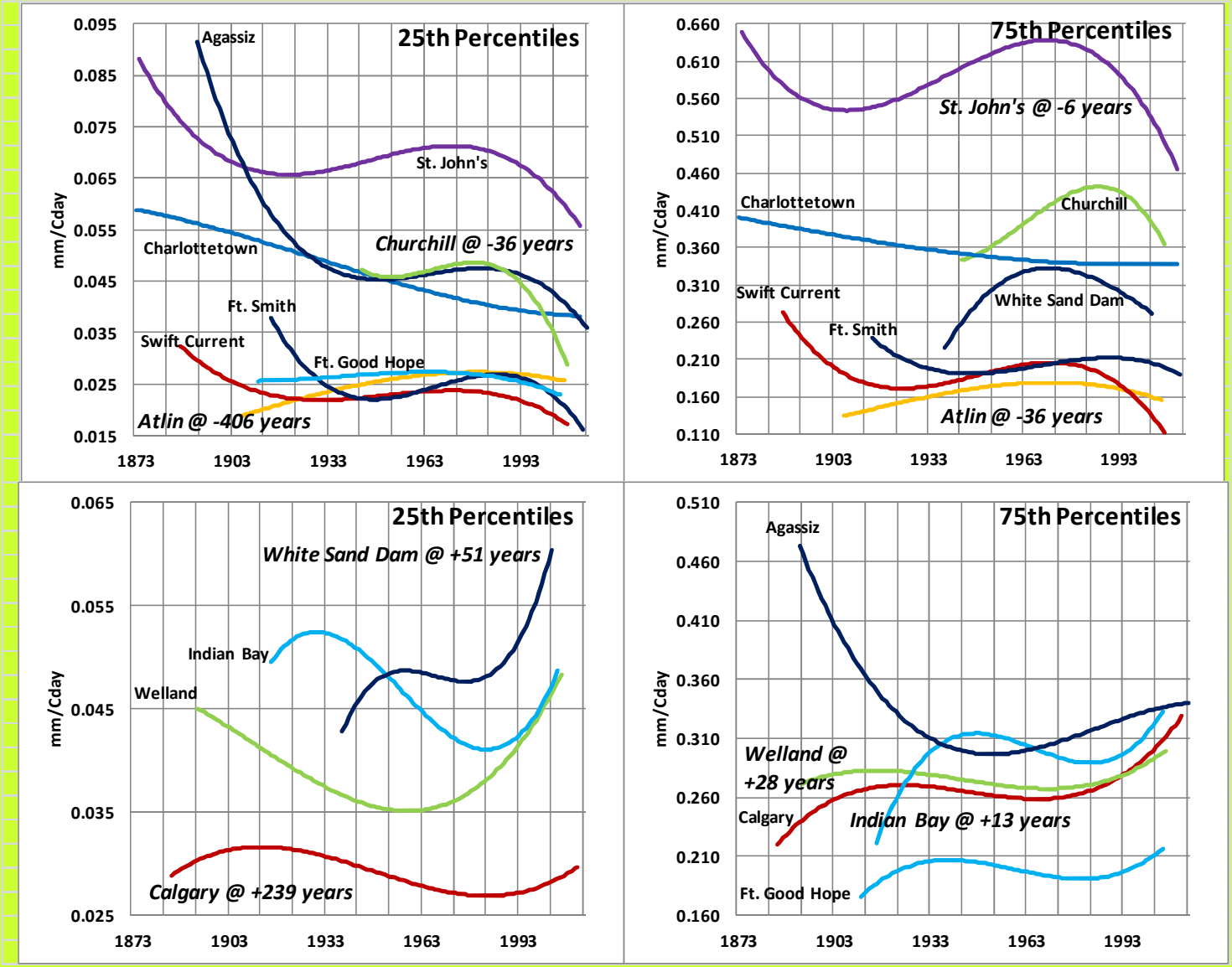


Example: Rain to Temperature (D&D) Event Ratio Trends

(original (percentiles) & homogenized (average) data)



Summary: Rain to Temperature (D&D) Event Ratio Trends
(years for 0.025mm/Cday change)



Conclusions

1. Past trend has been *longer, warmer spring & summer periods versus shorter, warmer autumn and winter periods*
2. Moderate cooling periods of 20-50 years duration occurred from 1913 to 1978. Otherwise more than moderate warming periods
3. Recent decades of annual rates of warming range from 10 to 65 years for a 1°Celcius increase in annual mean temperature (versus 18 to 92 years for early decades of the records)
4. Overall trend at two-thirds of the stations is toward more Total Annual Precipitation (7 to 26 years for a 10 mm increase)
6. Recent trend in the spring & summer *rain precipitation to temperature event ratio* is toward “drought” at two-thirds of the stations (versus “50/50” trend toward “drench”) - however at slower trend decreases than during earlier record periods

Thank you for your attention

Questions are much welcomed