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Analysis of Agrometeorological Extremes in the Oldman Basin

¹Stefan Kienzle, ²Jessica Vanstone, ²Robert ²Armstrong,
²Aston Chipanshi ²Darrell Corkal & Brent Patterson

¹University of Lethbridge

²Agriculture and Agri-Food Canada



Outline

- General approach (method)
- Water based indices
- Heat based indices
- Other indices

Our focus is on **TRENDS, VARIABILITY and CHANGE** over time

The study of extreme events under VACEA/Boundary Org. collaborative

- Develop appropriate extremes indicators suitable for the Swift Current and Oldman Basins;
- Analyze historical trends, frequency, intensity, duration and variability of extreme events in the 2 basins;
- Make projections of extreme indicators under climate change scenarios;
- Use decision support tools to assess basin response to extreme events (other groups).

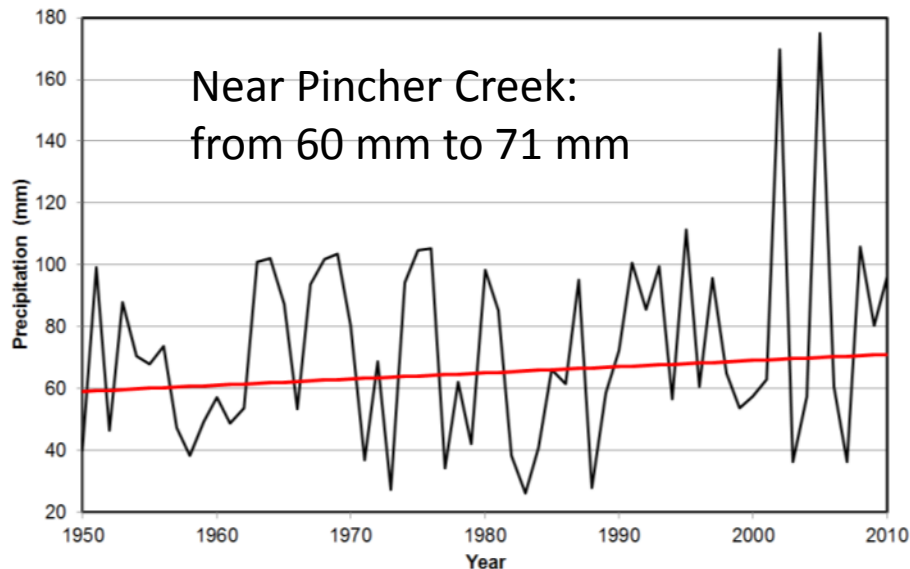
Is it getting drier or wetter?

- Precipitation-based indices:
 - 5-day rainfall totals
 - Annual Water Deficit (P-PE)
 - Standardized Precipitation Evaporation Index
 - Cumulative Precipitation Deficits

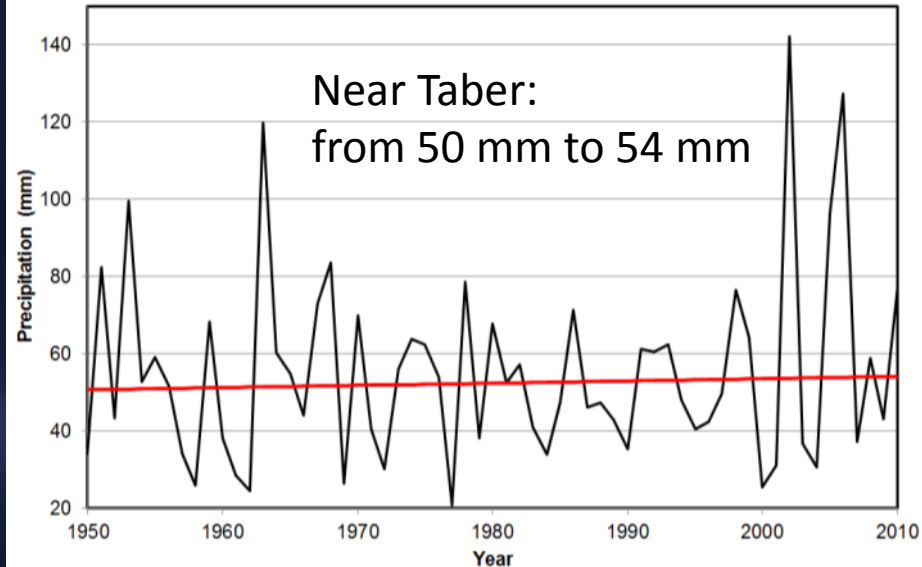


TREND IN GREATEST NUMBER OF 5-DAY RAINFALL TOTAL

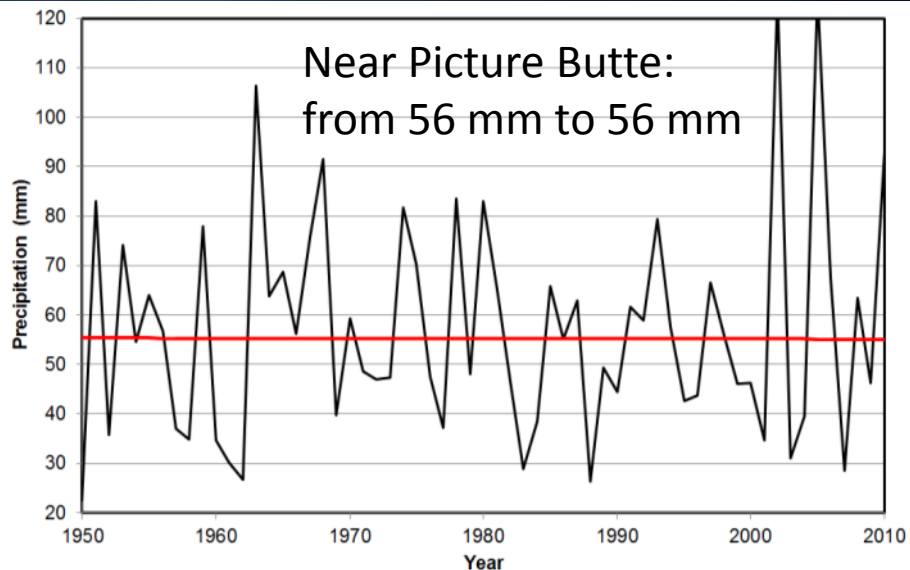
Near Pincher Creek:
from 60 mm to 71 mm



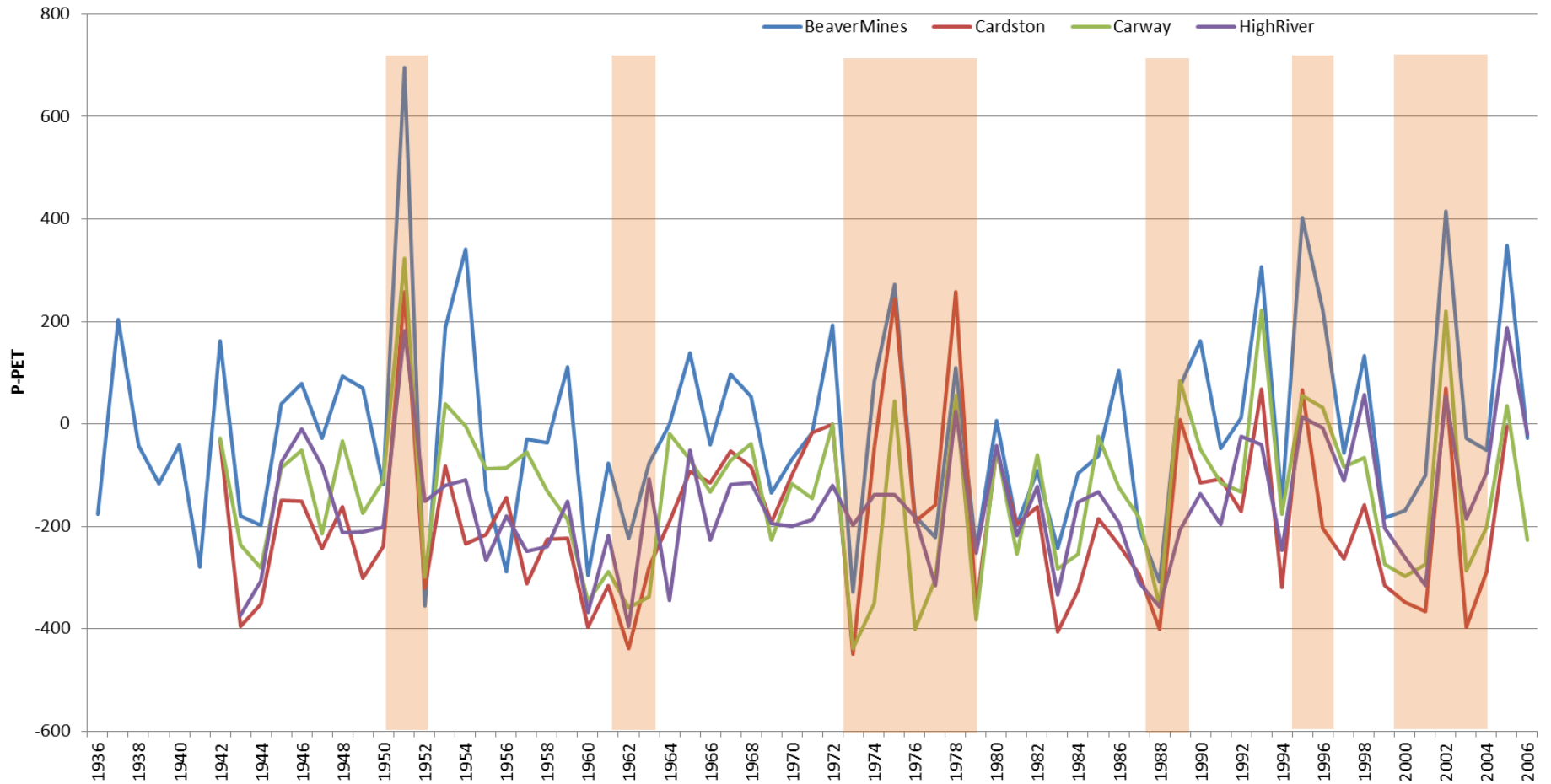
Near Taber:
from 50 mm to 54 mm



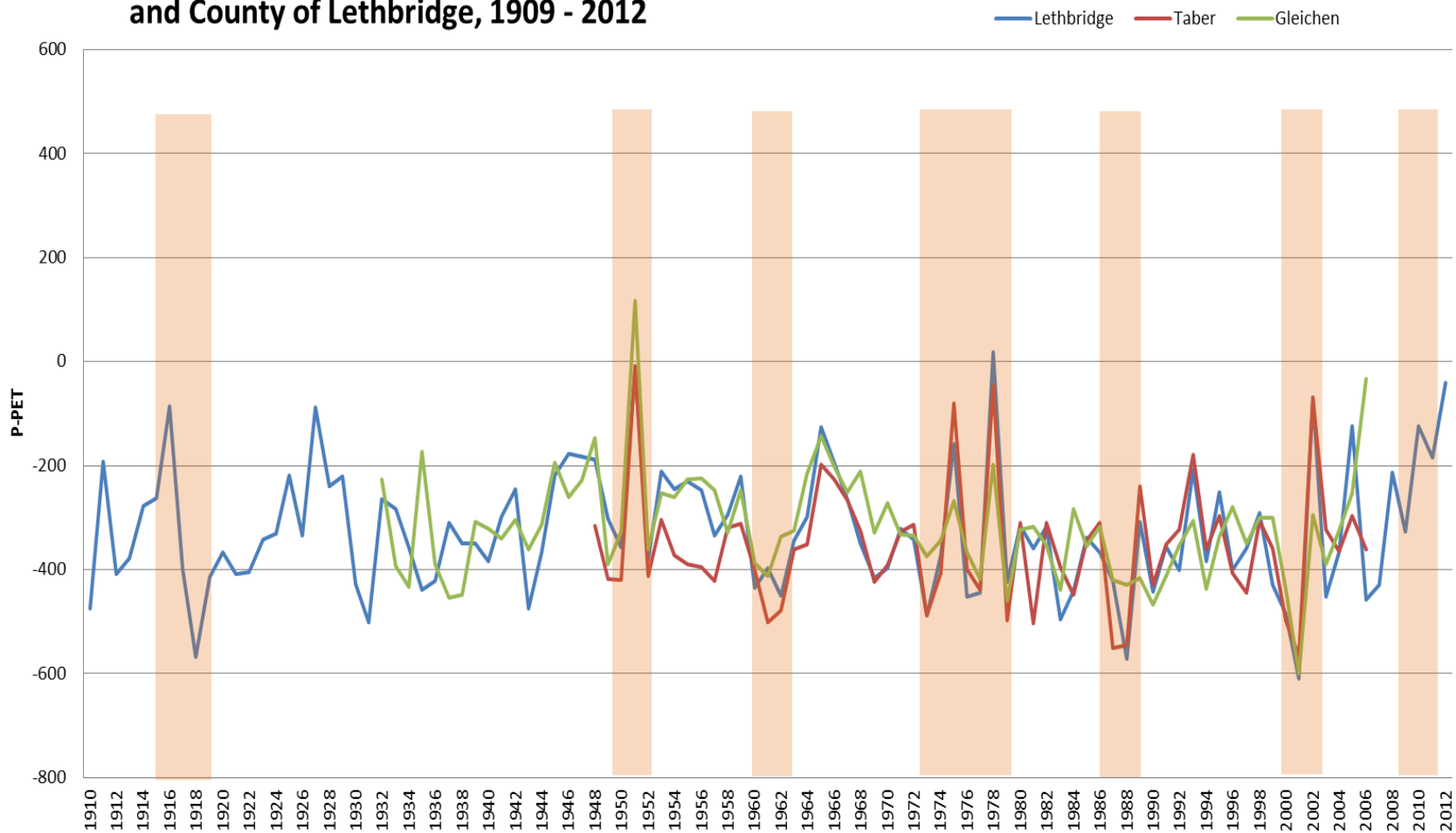
Near Picture Butte:
from 56 mm to 56 mm



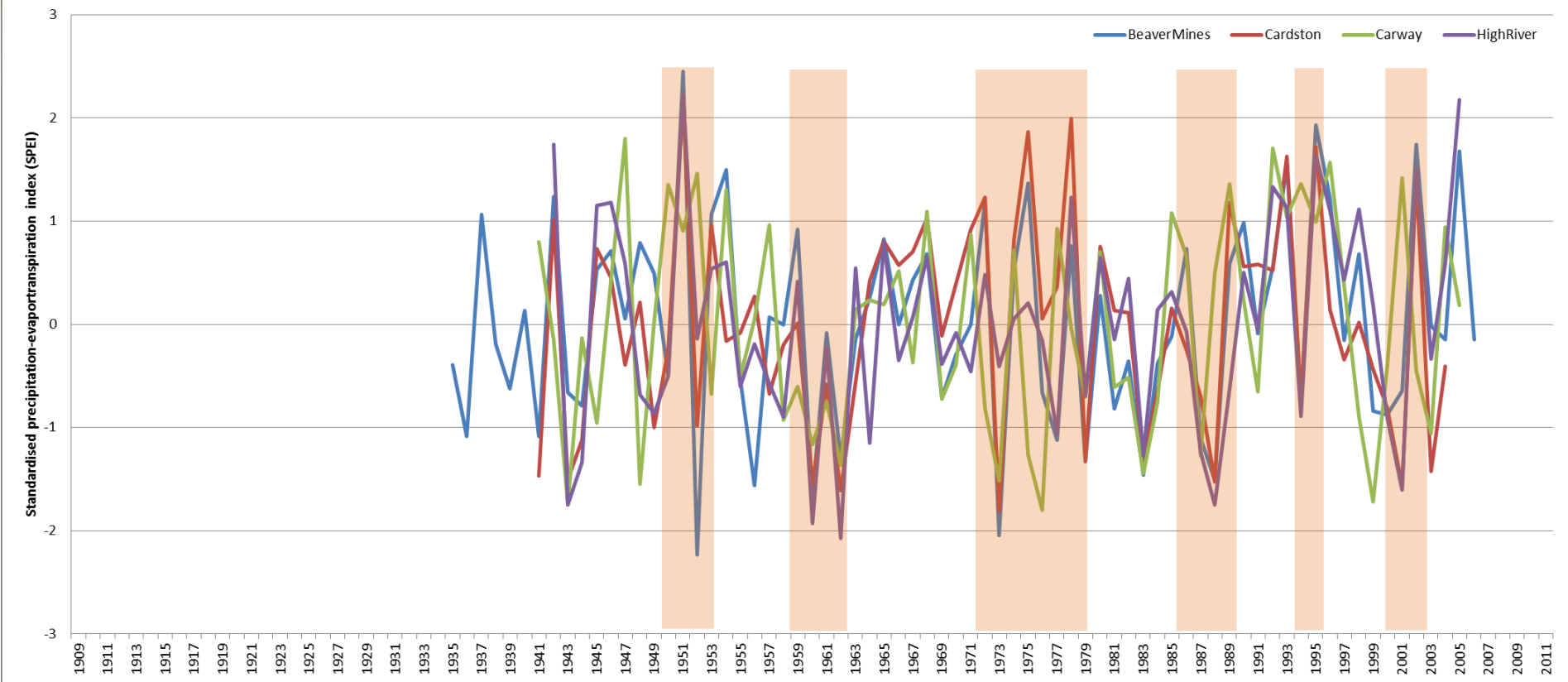
Annual Water Deficit (P-PE) for MD of Pincher Creek, 1936 - 2006



Annual Water Deficit (P-PE) for MD of Taber and County of Lethbridge, 1909 - 2012

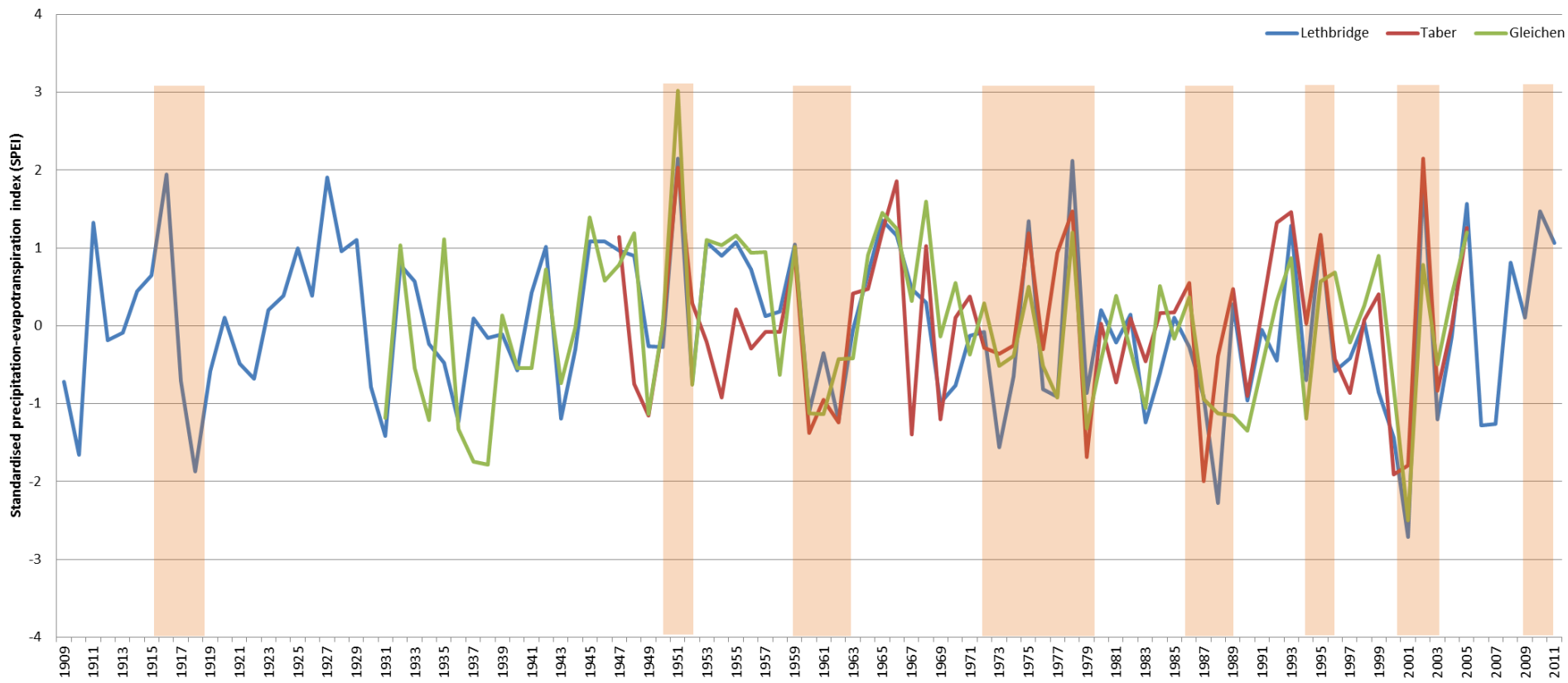


Standardised precipitation-evapotranspiration index (SPEI), MD of Pincher Creek 1909-2011



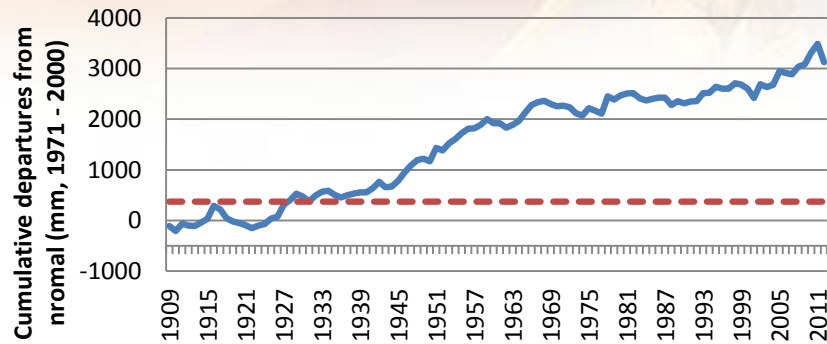


Standardised precipitation-evapotranspiration index (SPEI), MD of Taber and County of Lethbridge 1909 - 2011

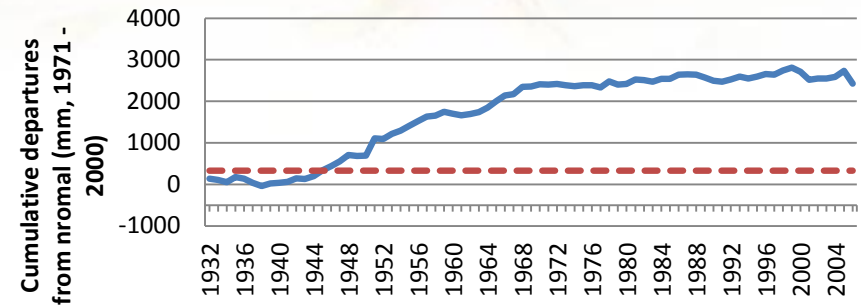


Cumulative Precipitation Deficit (current difference from average is added to previous year, blue)

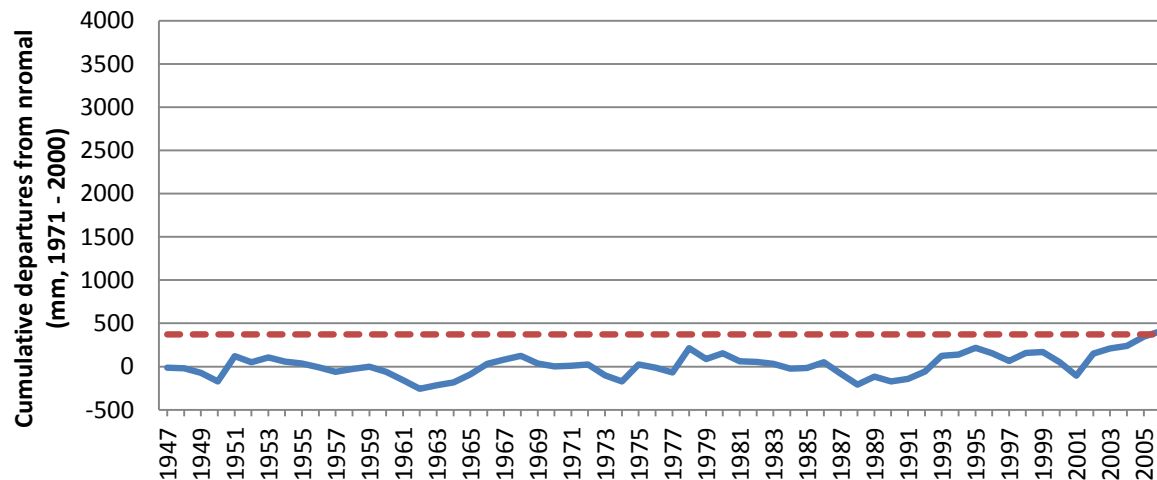
Lethbridge 1909 - 2012



Gleichen 1932 - 2006

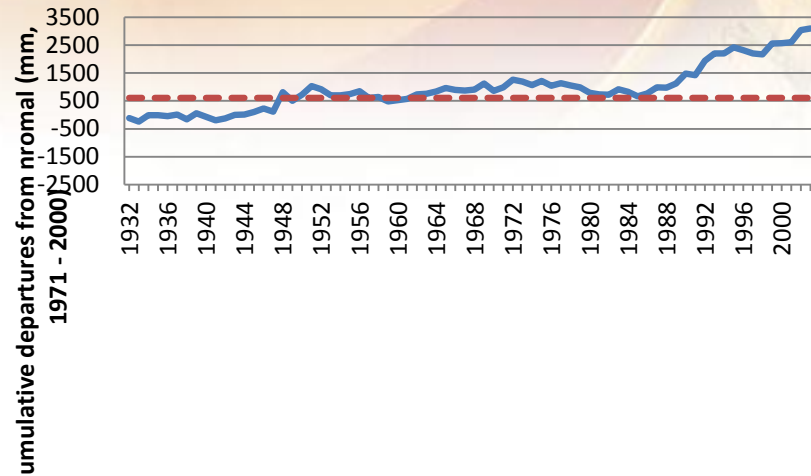


Taber 1947 - 2006

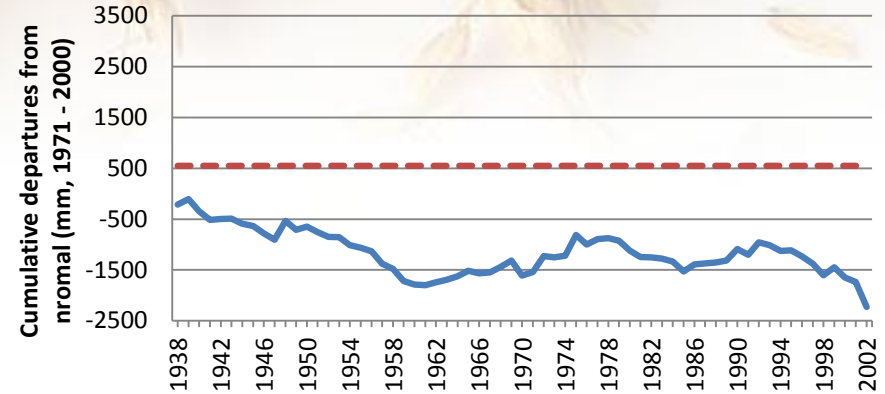


Cumulative Precipitation Deficit (current difference from average is added to previous year, blue)

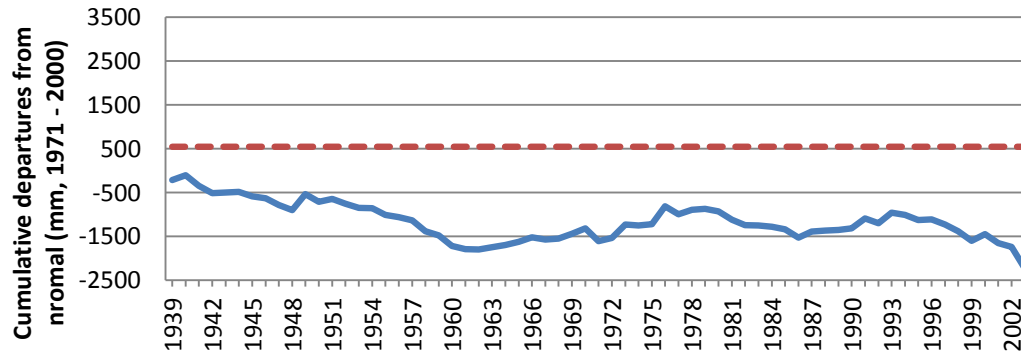
Beaver Mines 1932 - 2003



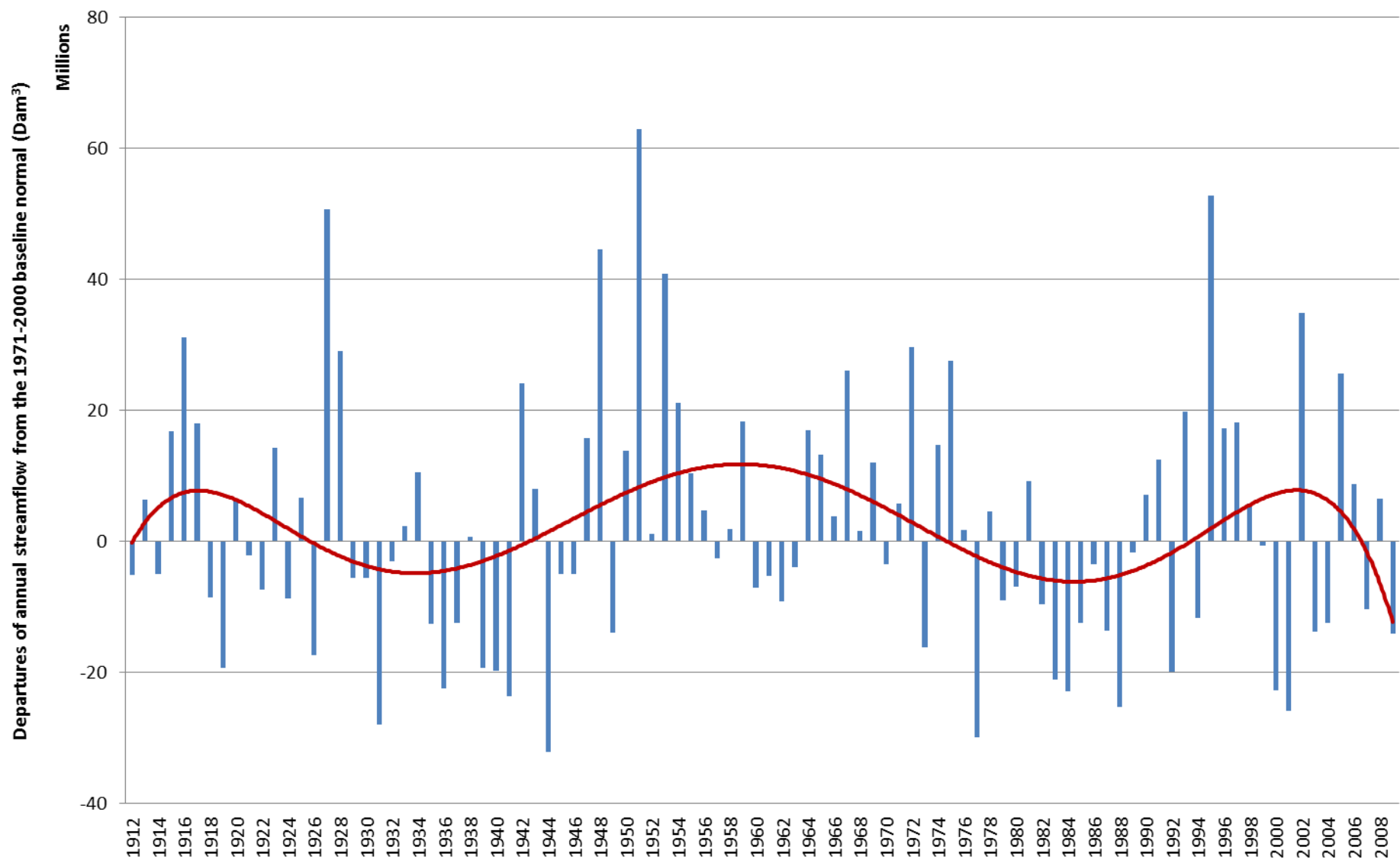
Cardston 1938 - 2002



Carway 1939 - 2003



Streamflow departures from the 1971-2000 normal, Oldman River, AB

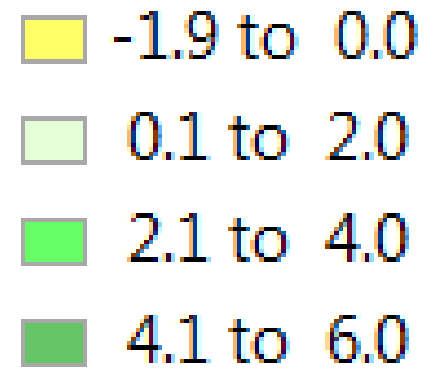


Has the growing season changed?

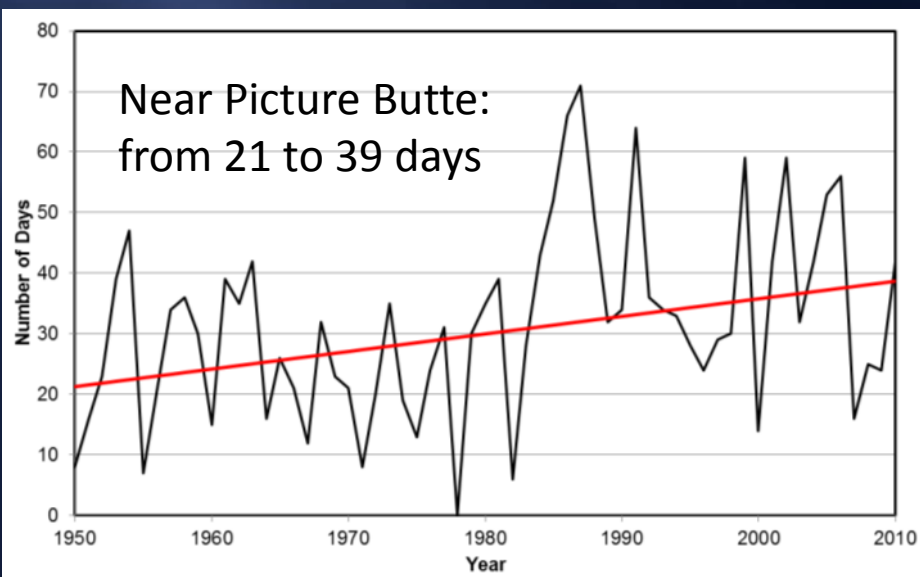
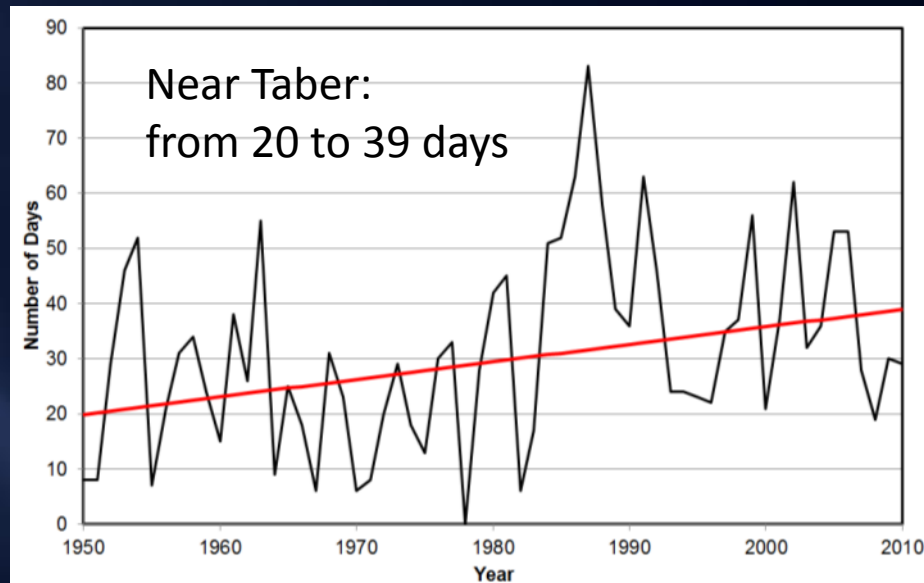
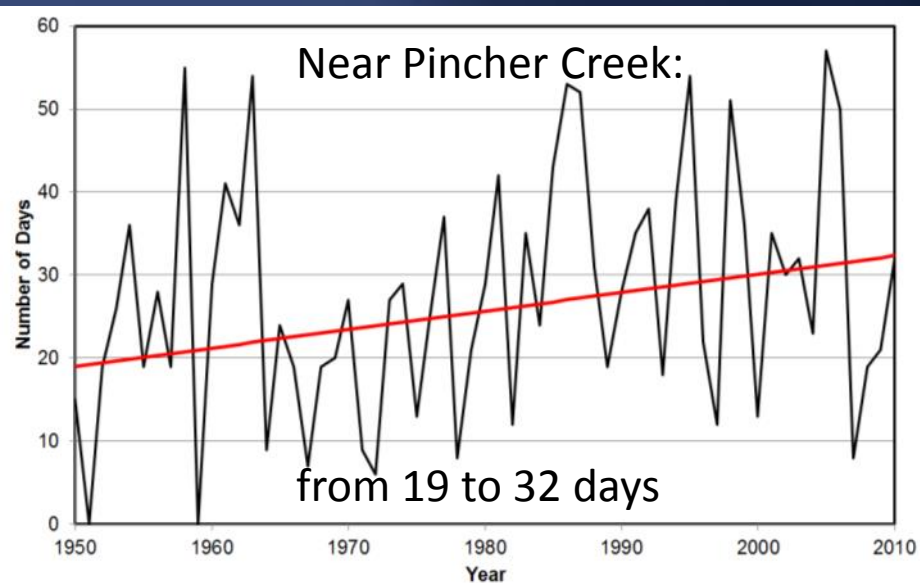
- Heat-based indices:
 - Growing season length
 - Consecutive days with $T > 5^{\circ}\text{C}$
 - Frost Days
 - Heat Units



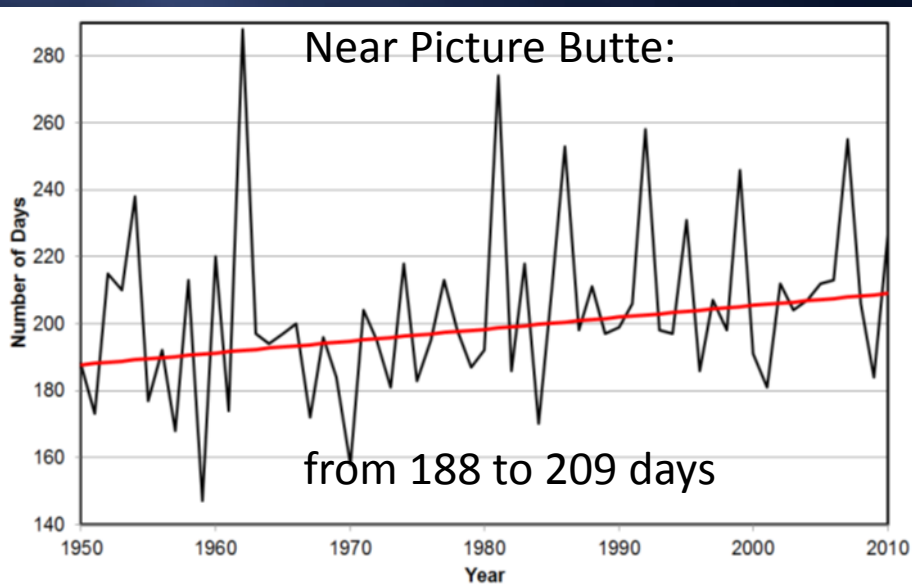
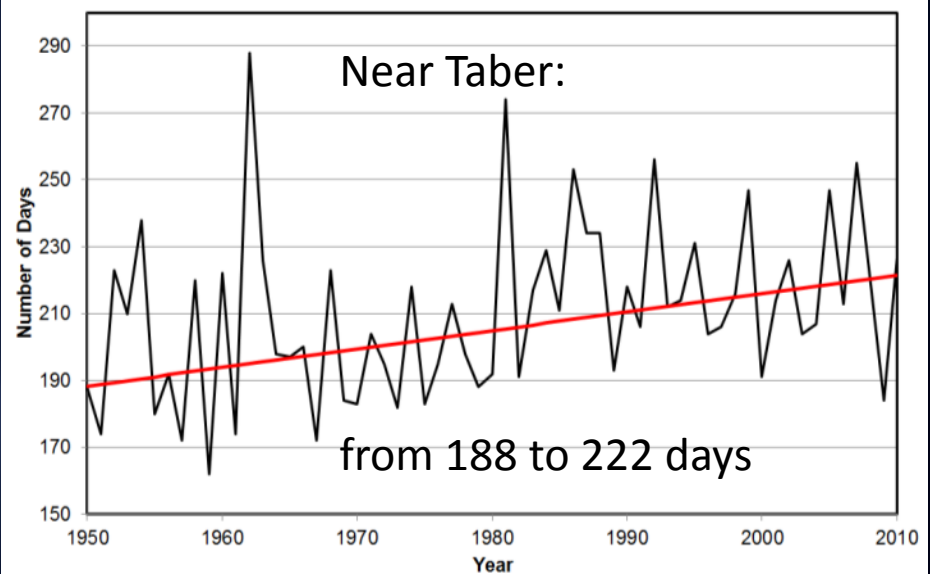
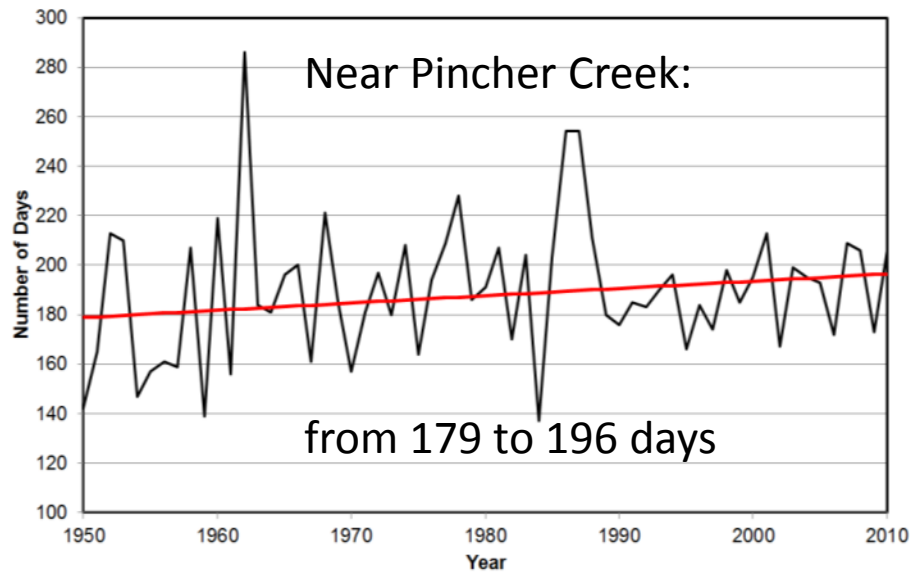
1950 – 2010
Trend in Growing
Season Length
(days/decade)



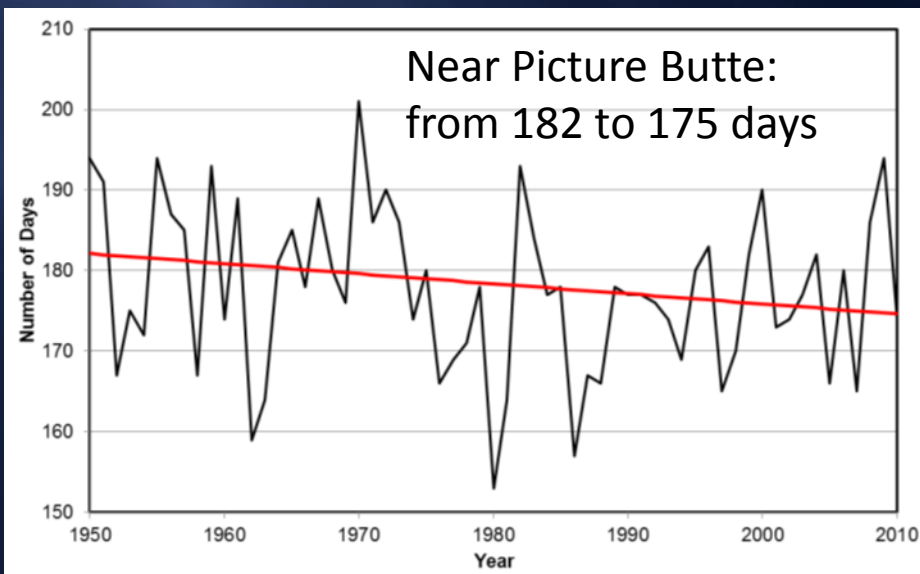
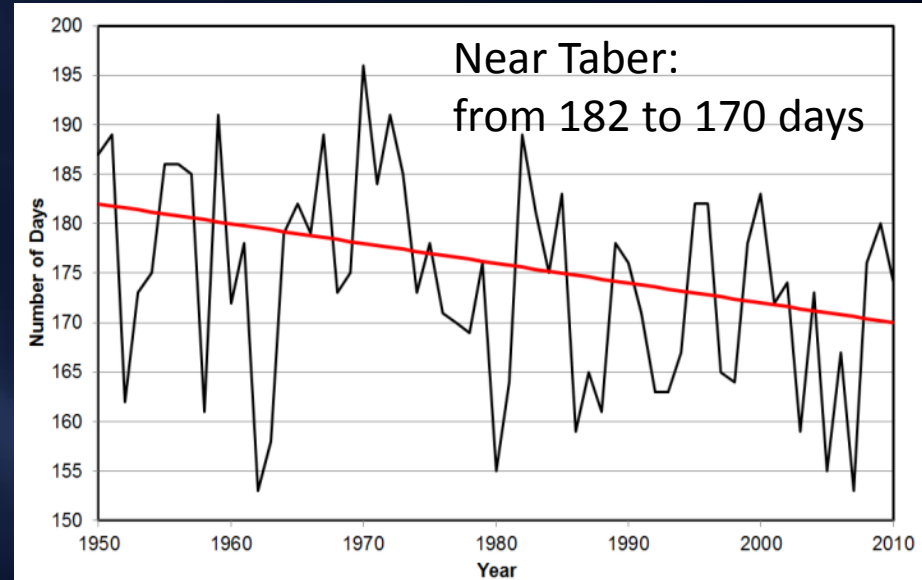
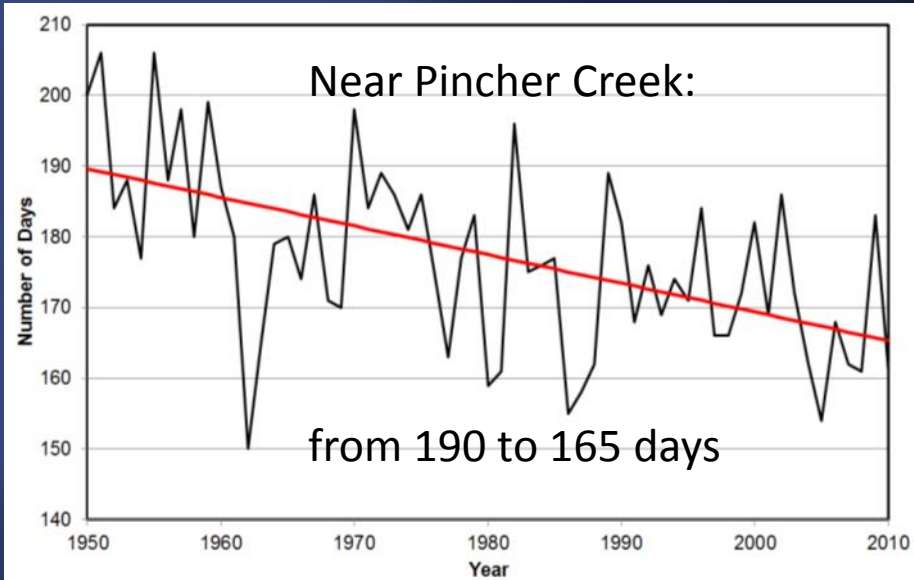
TREND IN NUMBER OF AT LEAST 5 CONSECUTIVE DAYS WITH TEMPERATURES ABOVE 5°C OVER NORMAL



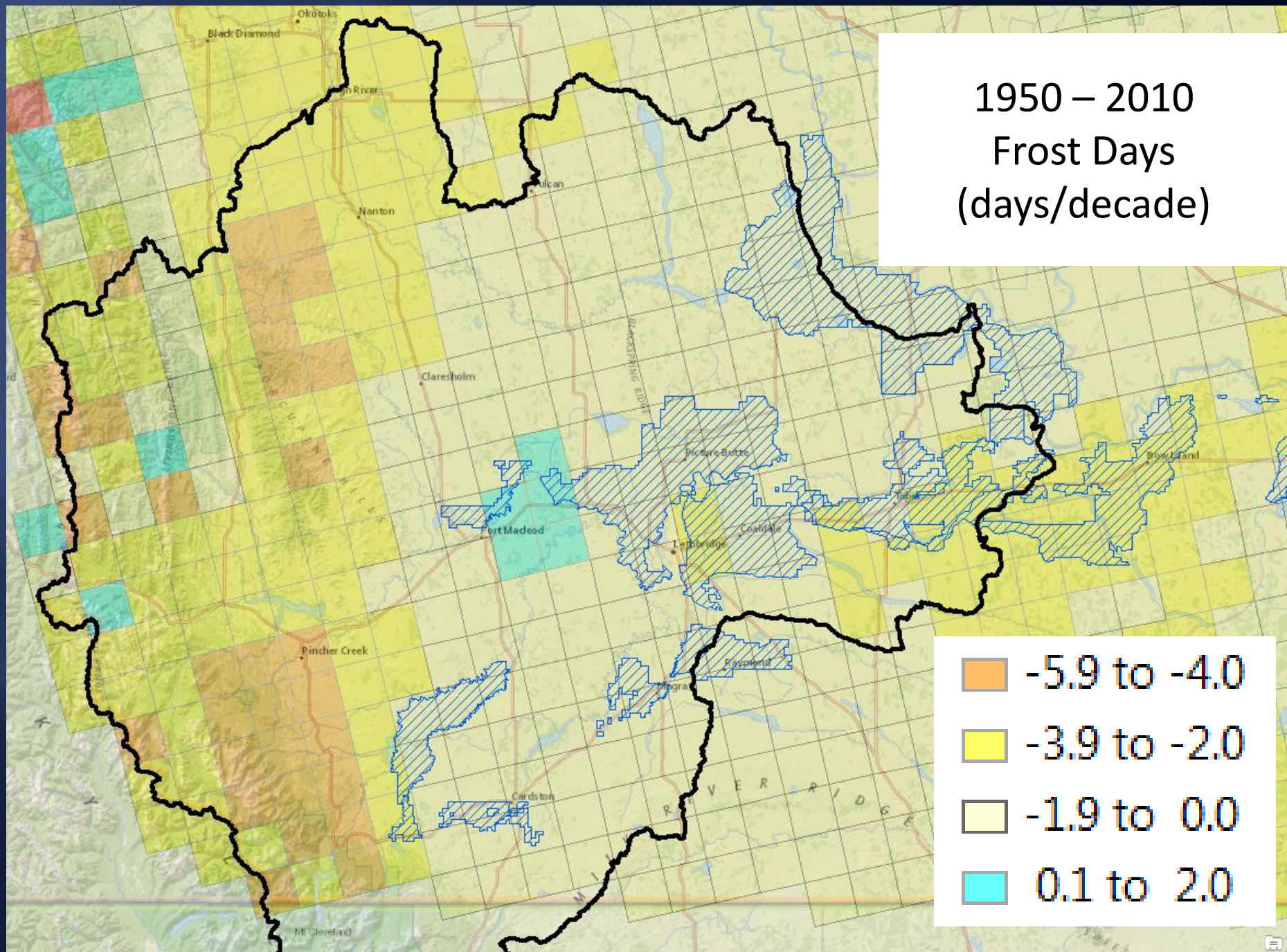
TREND IN GROWING SEASON LENGTH



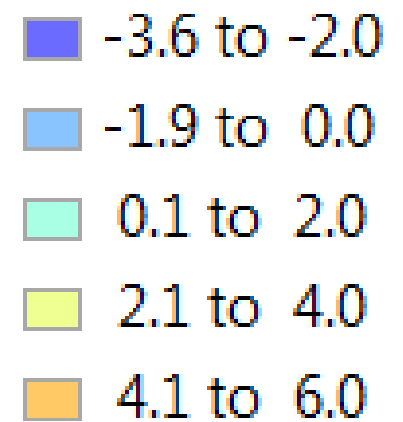
TREND IN NUMBER OF FROST DAYS



1950 – 2010
Frost Days
(days/decade)

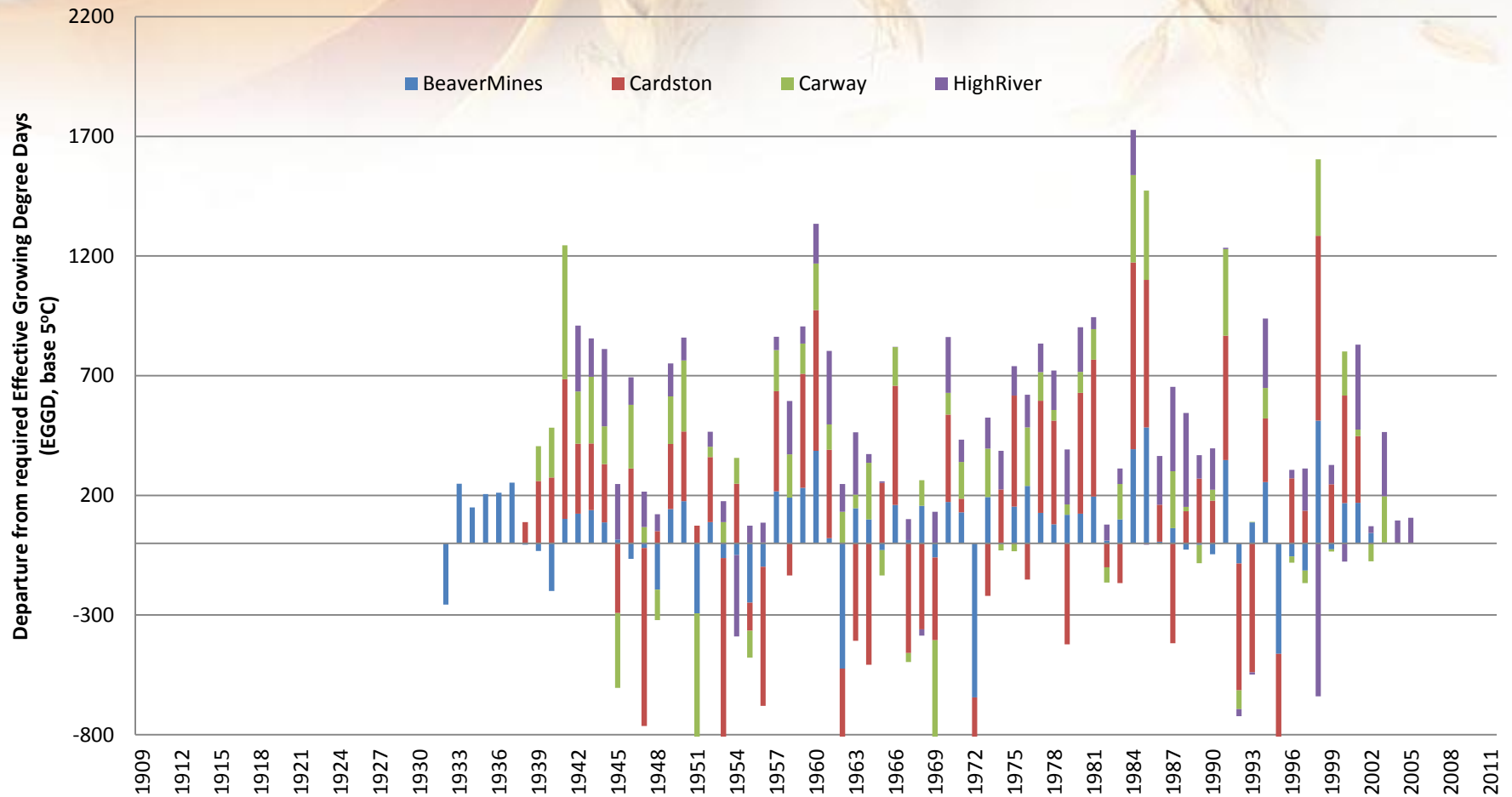


1950 – 2010
Heat Duration Index
(days/decade)

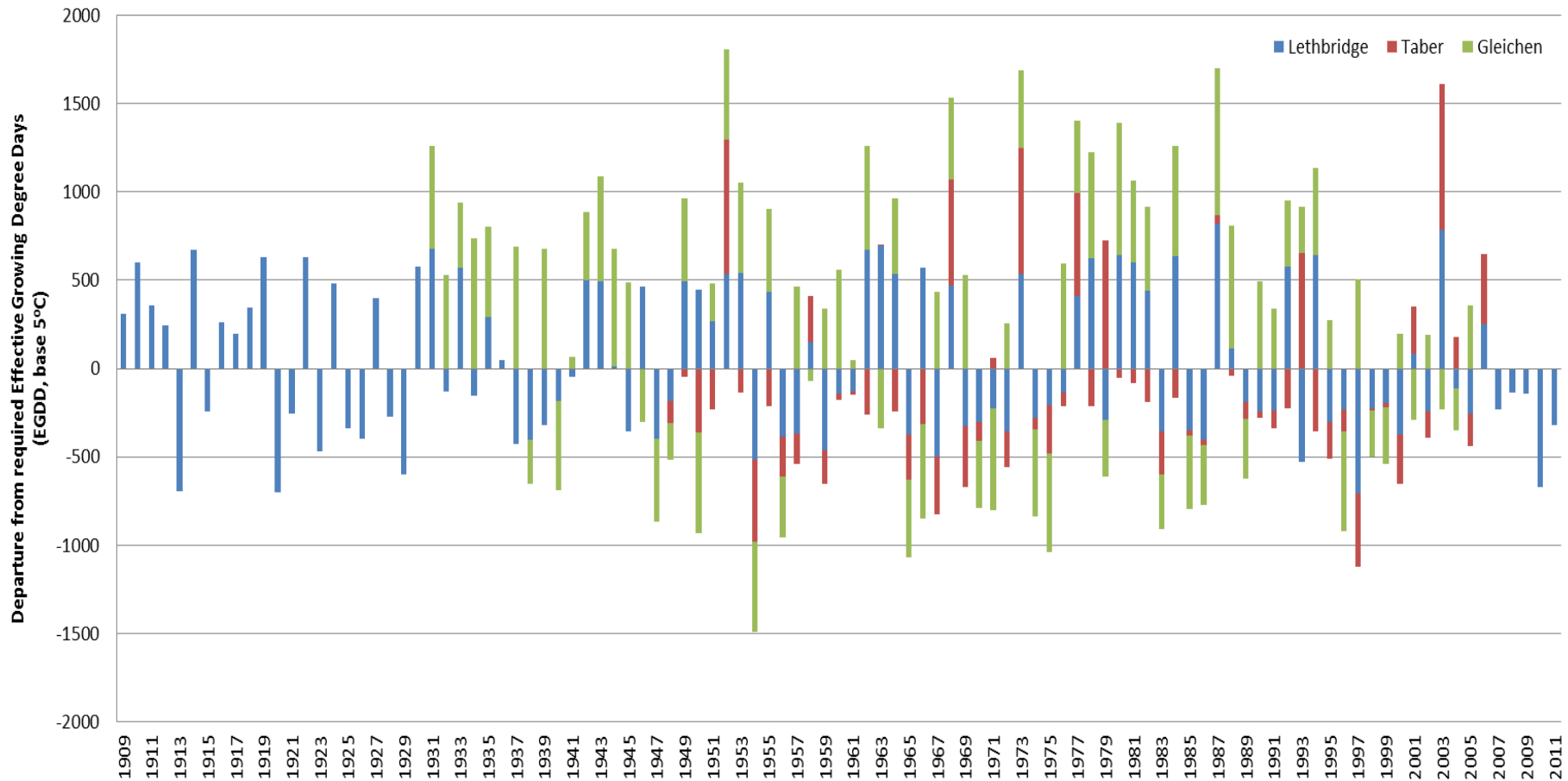


Departure from required Effective Growing Degree Days (EGGDs) for maturity

using the 1250 threshold, MD Pincher Creek, 1909 - 2011

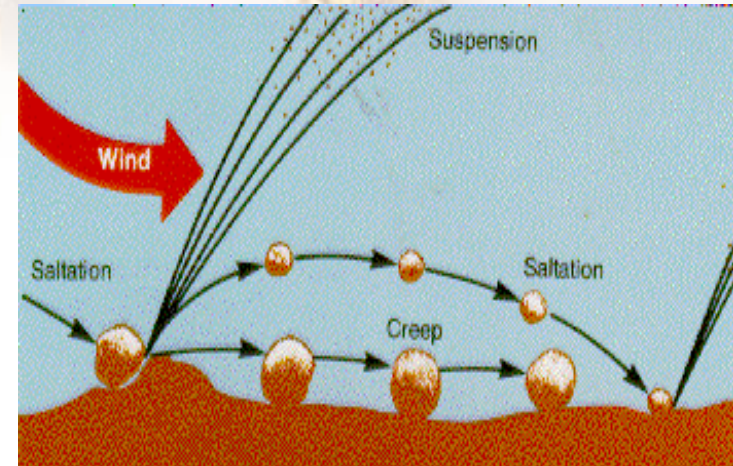


Departure from required Effective Growing Degree Days (EGGD) for maturity base 1250, MD Taber/County of Lethbridge, 1909 - 2011



Other Indices under investigation

- Wind-based indices:
 - Maximum daily wind speed (MDWS),
 - Number of strong wind days (NSWD);
- Freeze-based indices:
 - Number of frost-free days (NFFD),
 - Number of ice-freeze days (NIFD)



Summary

- Heat Based-Growing conditions showing signs of improvement with time,
- Water Indices- Water deficits are occurring when evaporative losses are taken into account,
- Future: Analyses will be repeated for climate change scenarios when data becomes available (warming trends should result in longer growing season).



Canada

Cardinal temperature criteria for selected types of field-crop growth during the growing season ...

Crop type	CT_{min} (°C)	T_{opt} (°C)	CT_{max} (°C)
Cool season crops	5.0	25.0	30.0
Warm season crops	10.0	30.0	35.0
Over-wintering crops	5.0	25.0	35.0

Crop cardinal temperature-based time frames for growing season start (GSS) and growing season ending (GSE) dates ...

Type of field crops	$GSS = CT_{\min}$	$GSE = CT_{\min}$, or CT_{\max} , or Fixed date
Cool season crops	$GSSc = 5.0\text{ }^{\circ}\text{C}$	$GSEc = 30\text{ }^{\circ}\text{C}$, or Aug. 1 at the earliest / Aug. 31 at the latest
Warm season crops	$GSSw = 10.0\text{ }^{\circ}\text{C}$	$GSEw = 10.0\text{ }^{\circ}\text{C}$
Over-wintering crops	$GSSo = 5.0\text{ }^{\circ}\text{C}$	$GSEo = 5.0\text{ }^{\circ}\text{C}$

Traditionally fixed time frames of crop growing season and agricultural year in Canada* ...

Type of field crops	Crop growing season	Agricultural year
Cool season crops	Apr. 1 to Aug. 31	Sep. 1 to Aug. 31
Warm season crops	May 1 to Sep. 30	Oct. 1 to Sep. 30
Over-wintering crops	Apr. 1 to Sep. 30	Oct. 1 to Sep. 30

* The time period beyond crop growing season is considered as non-growing season in an agricultural year.

Number of frost-free days required for field crops to maturity on the Prairies ...

Crop type	Cool season crops					Warm season crops		
Crop name	Wheat	Buck wheat	Oat	Barley	Canola	Corn	Bean	Soy-bean
Range	83 to 103	70 to 90	82 to 98	70 to 90	85 to 102	100 to 120	85 to 100	105 to 120
Criteria	On an average, cool-season crops: 87 days					On an average, warm-season crops: 105 days		

Number of frost-free days required for field crops to maturity on the Prairies ...

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Criteria	On an average, cool-season crops: 87 days					On an average, warm-season crops: 105 days		

Effective growing degree days (EGDD) for different field crops in Canada ...

Crop type	Cool season crops				Warm season crops		
Crop name	Wheat	Oat	Barley	Canola	Corn	Bean	Soybean
EGDD Range	1538 to 1680	1483 to 1750	1269 to 1540	1152 to 1445	1173 to 1779	1100 to 1300	1186 to 1719
Criteria	On an average, cool-season crop: 1485				On an average, warm-season crop: 1375		

Criteria for Critical Frost Killing Temperature of field crops during the growing season ...

Crop type	Critical frost killing temperature
Warm season crops	0.0 °C
Cool season crops, and over-wintering crops	-2.0 °C