

Soil temperature, runoff, and the earliness of spring

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introduction

- In the Northern Hemisphere, carbon dioxide concentrations in the atmosphere increase in winter and decrease in summer, mainly in response to seasonal growth patterns of land vegetation.
- The spring decline in CO_2 concentrations now occurs about 7 days earlier than in the mid-1970's.
- These observations suggest that plant growth is now starting earlier in spring than in the mid-1970's.

Objective

- To look at meteorological records at Swift Current for evidence of warmer and, therefore, earlier springs.

Methods

- We analyzed the average daily soil temperature at the 10 cm depth during winter (December, January, February), early spring (March and April), the growing season (May, June, July, August), and autumn (September, October, November).
- We determined the last day in spring of subzero (freezing) temperatures at the 10 cm soil depth.
- We determined the day when spring runoff from cropland was 75% complete. We averaged the runoff across three watersheds located at SPARC. (At 75% complete, most of the cropland is snow free. The remaining 25% of the runoff comes from residual snow drifts and, occasionally, from spring time snows.)
- Thirty-three years of temperature data (1963 to 1996) and 34 years of runoff data (1962 to 1996) were included in the analysis.

Results

- At Swift Current, the average soil temperatures at the 10 cm depth for winter and early spring have significantly increased since 1963 (Figure 1).
- Average daily soil temperatures at 10 cm for the growing season and for autumn have not changed (Figure 2).
- Soil temperatures at the 10 cm depth in both winter and early spring have increased at an average rate of about $0.075\text{ }^{\circ}\text{C}$ per year ($P < 0.05$).
- Soil temperatures for winter and early spring have increased on average by about $2.5\text{ }^{\circ}\text{C}$ since 1963, and by about $1.6\text{ }^{\circ}\text{C}$ since the mid-1970's.
- The last day of subzero (freezing) soil temperatures at the 10 cm depth is generally occurring earlier now than in the past (Figure 3).
- Runoff data also suggest that our springs have become warmer over the past 30 years.
- The day when spring runoff is 75% complete has occurred an average of about 0.63 days earlier ($P < 0.05$) each year since 1962 (Figure 4).
- On average, spring runoff for 1996 was 75% complete 23 days earlier than in 1963, and 13 days earlier than in the mid-1970's.

Conclusions

- In the area surrounding Swift Current, winter and early spring soil temperatures at the 10 cm depth are higher now than they were in the early 1960's.
- Summer and fall soil temperatures at the 10 cm depth have not changed.
- Snow melt and runoff are occurring earlier in the year than during past years.
- On average, springs are occurring earlier now than in the 1960's and 1970's.
- The early springs provide an opportunity for plants to begin growing, and for producers to begin field work earlier in the year.

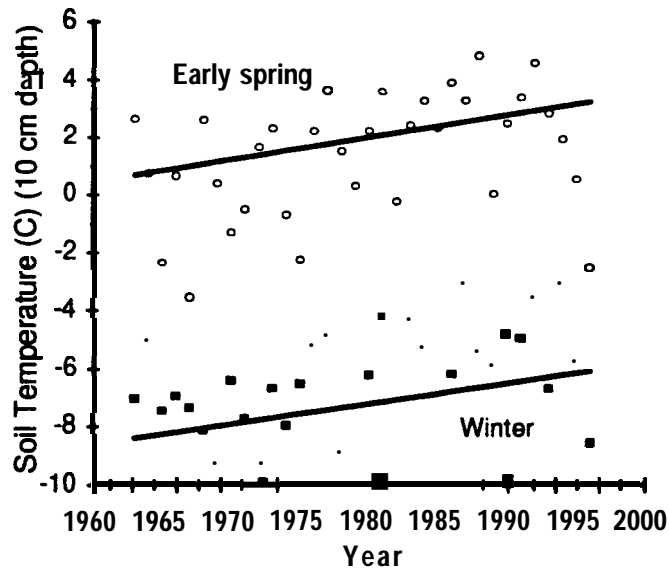


Figure 1: From 1963 to 1996, the seasonal average soil temperature at the 10 cm depth for winter (December, January, February) and for early spring (March and April) at Swift Current.

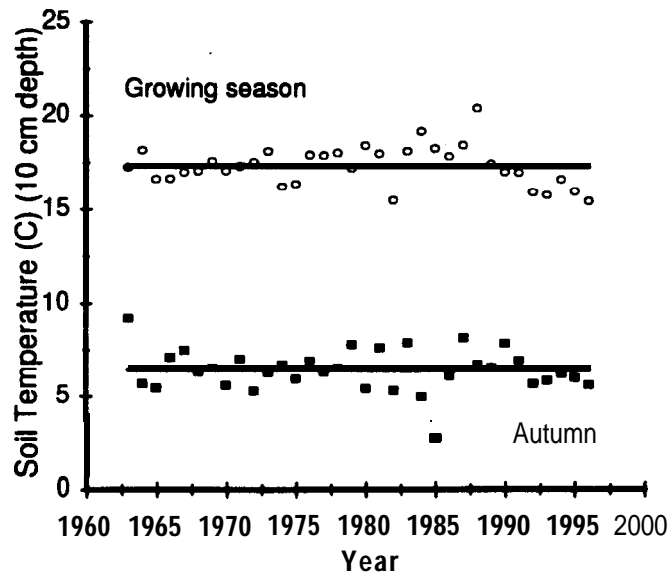


Figure 2: From 1963 to 1996, the seasonal average soil temperature at the 10 cm depth for the growing season (May, June, July, August) and for autumn (September, October, November) at Swift Current.

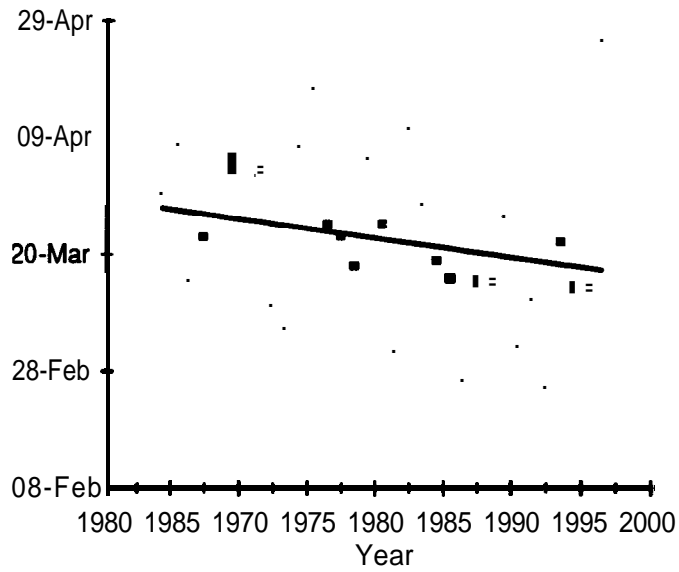


Figure 3: From 1963 to 1996, the last day of minus soil temperatures at the 10 cm depth.

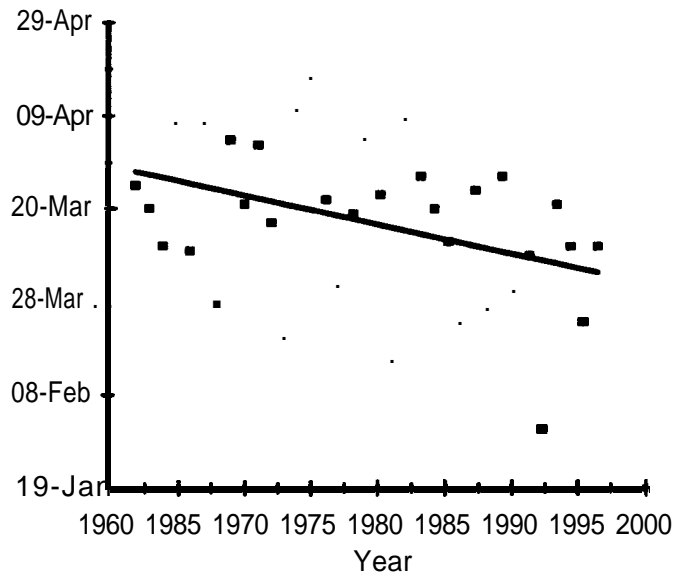


Figure 4: From 1962 to 1996, the day on which 75% of the spring runoff was completed at Swift Current.