IMPACTS OF CLIMATIC CHANGE ON CANADIAN AGRICULTURE: AN EVALUATION OF IMPACT ASSESSMENT PROCUDURES

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Supported by and Prepared for

Government of Canada's
Climate Change Action Fund
CCAF Project A 318
Natural Resources Canada
Ottawa, Canada

March 2002

Table of Contents ii

SECTION 1
SUMMARY

The overall purpose of this study was to assess the extent to which two potential sources of bias which might alter and thereby call into question assessments of the estimated impacts of climatic change on agricultural opportunities. The two potential sources of bias stem from (a) data interpolation methods which are routinely employed to transform macro-scale GCM-derived data to a more refined scale, and (b) the land suitability and crop yield models employed in impact assessments. A two-step procedure was employed to test for these potential sources of biases.

Under Step 1, a standard impact assessment research framework was employed to estimate the impacts of multiple climatic change scenarios on climate properties, land suitability for spring-seeded cereals and spring wheat yields at nine sites in Manitoba, Saskatchewan, Alberta and the southwest portion of the Northwest Territories. The climatic change scenarios were derived from the GCMs developed and applied by the Canadian Climate Centre, The Hadley Centre and the National Center for Atmospheric Research. Then, three interpolation methods (nearest neighbour, kriging and triangulation interpolation network) were employed to transform the macro-scale output from the GCMs to a regional scale. These regional scale data where then used as input to land suitability and crop yield models.

Under Step 2, the Kruskal-Wallis analysis of variance and the Spearman Rank Correlation tests were employed to detect if the data interpolation methods or land suitability-crop yield models introduced bias into the impact assessment process.

The main findings are:

1. No statistical correlation was found between interpolation methods and impacts on climate properties, land suitability assessments and crop yields; indicating the various interpolation methods do not introduce a source of bias to impact assessments, and
2. The land suitability and crop yield models generated impacts were statistically correlated, indicating it was unlikely that bias could be attributed to the two models.

These findings renew confidence in previous assessments of the agricultural impacts stemming from climatic change. Previous to this study, there had not been a systematic investigation of the extent to which impact assessments were influenced by data interpolation methods and impact modeling techniques. This study provides at least preliminary evidence that the data interpolation methods and agricultural modeling techniques which are routinely employed in impact assessments do not bias findings.

SECTION 2
INTRODUCTION

Prior to 2000, the majority of the research into the impacts of climatic change on Canadian agriculture employed the following six-step process (see Brklacich et al. 1998 for more information).

Step 1: Specify Macro-Climatic Change Scenarios
Step 2: Transform Macro-Climatic Change to Regional Scales Required for Agricultural Analyses
Step 3: Estimate 1st-Order Impacts (Regional Climatic Properties)
Step 4: Estimate 2nd-Order Impacts (Agricultural Land Suitability)
Step 5: Estimate 3rd-Order Impacts (Crop Yields)
Step 6: Estimate Higher-Order Impacts (Farm and Regional Production)

In Step 1, the uncertainty surrounding long-term projections for global climatic change has routinely been captured in impact studies by specifying several climatic change scenarios. These scenarios are most often derived from the application of General Circulation Models (GCMs) under elevated CO_2 conditions.

Under Steps 2 and 3, macro-scale climatic change data derived from GCM output are transformed into meso- or regional scale data which are consistent with the requirements of agricultural impact analyses undertaken in Steps 4 through 6. A wide variety of data transformation methods have been employed but within a typical impact assessment study, a single method is invariably selected and applied to all climatic change scenarios.

Steps 4 through 6 extend impact assessments beyond climate properties and estimate the impacts of climatic change on agricultural attributes such as land suitability, crop yields and regional production potential. Once again, a review of previous studies revealed that several methods have been employed but a single method is typically used within a particular study.

The execution of Steps 2 through 6 have the potential to introduce at least the following two sources of bias which could ultimately affect impact assessments.

Source 1: Data Interpolation Bias: Under Step 2, most impact assessment studies *a priori* select one data transformation approach but several methods have been employed, including the:

- interpolation and data smoothing methods of GCM-point data to spatial grids, and
- application of nearest neighbour methods to relocate GCM-point data to nearby weather stations.

Source 2: Impact Model Bias: Similarly, one approach is typically selected and employed to estimate agricultural land suitability and crop yield sensitivities to climatic change even though there are a range of models available which:

- employ alternative time steps (e.g.: daily vs seasonal), and

- are founded upon varying level of complexity (e.g.: weather only vs integrated CO_2–weather dependent models).

A systematic assessment of the extent to which studies into the impacts of climatic change on regional climatic properties, agricultural land suitability and crop yields reflect the changes specified in the climate scenarios rather than the two sources of potential bias described above has not been conducted, and as a result, the reliability of previous studies is brought into question.

SECTION 3
PURPOSE OF THE REPORT

The overall purpose of this report is to systematically evaluate the extent to which impact studies using the framework outlined in Section 2 accurately capture the influences of climatic change on regional climatic properties, agricultural land suitability and crop yields rather than the characteristics and biases of the data transformation methods and impact models used in a particular study.

SECTION 4
METHODS, DATA AND SCOPE

Study Sites

This research builds upon previous assessments of the agricultural impacts of climatic change and conducts analyses for the following nine sites:

Province/Territory	Selected Sites
Manitoba	Winnipeg, Dauphin
Saskatchewan	Swift Current, Prince Albert
Alberta	Lethbridge, Ellerslie, Beaverlodge, Fort Vermillion
Northwest Territories	Hay River

These sites were selected for several reasons including they:

- Cover the range of ecozones which characterize the grasslands, the major agricultural zone within Canada,
- Include sites which are near the current northern limit for commercial agriculture,
- Include sites which have soils which are suitable for agriculture but are located beyond the current northern limit for commercial agriculture, and
- Have been employed in previous studies into the impacts of climatic change on Canadian agriculture.

Climatic Baseline

The weather station closet to each of the nine selected sites was selected and the climatic baseline was derived from the observed daily record for minimum temperature, maximum temperature and precipitation for 1961-1980. Baseline climate data are presented in Appendix 1.

Climatic Change Scenarios

Long-term estimates of climatic change stemming from anthropogenic increases in atmospheric levels of CO_2 are derived from the outputs from the following GCMs:

- Canadian Centre for Climate Modeling and Analysis (CCC).
- Hadley Centre for Climate Prediction and Analysis (HadCM3).
- National Centre for Atmospheric Resarch (NCAR).

The climatic change estimates employed in this study are based upon daily data generated by each GCM for the 2041-2060 period.

Transforming GCM Data

The following three methods were employed to transform the climatic change data derived from the three GCMs employed in this study into a form that could be applied to the baseline data at each selected site.

- Nearest Neighbour (NN).
- Kriging (KR).
- Triangulated Interpolation Network (TIN).

All three approaches have been used widely in previous climate change impact assessments. In summary, macro-climate change scenarios were derived from the three GCM applications selected for inclusion in this study. Regional climatic change scenarios were developed by applying the NN, KR and TIN interpolation methods to the climatic change output derived from each GCM, resulting in 9 climatic change scenarios for each site. These scenarios are presented in Appendix 1.

Land Suitability Modelling

A land rating model developed by Agriculture Canada and employed by Brklacich et al (1997) to estimate the effects of climatic change in the Mackenzie River Basin was employed for this study. The model was applied the soil or soils which are common to each of the selected sites, resulting in a total of 18 site-soil combinations.

Land suitability ratings reflect the extent to which soil and climate represent limitations for the commercial production of common spring-seeded grains (e.g. wheat, oats and barley). The climate and soil components are rated separately and each component is assigned an initial value of 100. Then the extent to which a range of factors (e.g. effective growing degree days, top soil depth) impair crop growth and development is determined, and points are deducted to reflect the severity of the limitation.

The overall rating of land suitability ranges is based on the most limiting of the climate and soil components. An overall rating in the 45 to 100 range is considered physically suitable for sustained production of spring-seeded cereals. A rating in the 30 to 44 range designates lands which are marginal for spring-seeded cereals, and a rating below 30 indicates a land areas which is physically unsuitable for cereal production. Land suitability values generated for and employed in this study are presented in Appendix 2.

Crop Yield Modelling

Spring wheat yields under baseline and changed climates were estimated by applying the CERES-Wheat model for each of the 18 site-soil combinations considered in this study. Once again, regional climatic change scenarios were developed by applying the three data interpolation methods (NN, KR and TIN) to the macro-climatic scenarios derived from the CCC, HadCM3 and NCAR GCMs (see Appendix 1 for climate data).

This crop growth and yield model has been used extensively to assess climatic change impacts in Canada and elsewhere. CERES-Wheat employs functions which advance on a daily time step and predicts growth and yields for individual wheat varieties as a function plant genetics, daily weather (solar radiation, maximum and minimum temperature, and precipitation), soil conditions and management factors. Modeled processes include phonological development, growth of vegetative and reproductive parts, biomass production and its partitioning among above and below ground plant parts. The model also tracks moisture inputs and withdrawals, and estimates the impacts of crop-mositure deficits on photosynthesis and biomass portioning.

Further information on the version of CERES-Wheat employed in this study is presented in Brklacich and Stewart (1995). Spring wheat yields values estimated under baseline and changed climates for this study are presented in Appendix 3.

Analysis of Variance

The non-parametric Kruskal-Wallis analysis of variance was employed to detect for bias stemming from interpolation methods and the impact assessment tools (see Table 1). The three GCMs considered in this study (i.e.: CCC, HadCM3, NCAR) are known to provide substantially different estimates for a CO_2-induced long-term climatic change and therefore the test hypotheses developed for this study were:

- The estimated ***impacts on selected climate properties*** (i.e.: average monthly and seasonal temperature, minimum monthly and seasonal temperature, maximum monthly and seasonal temperature, average monthly and seasonal precipitation) and agricultural properties (i.e. land suitability, crop yield) ***are correlated to the GCM-derived climatic change scenarios.***

and

- The estimated impacts on selected climate properties (i.e.: average monthly and seasonal temperature, minimum monthly and seasonal temperature, maximum monthly and seasonal temperature, average monthly and seasonal precipitation) and agricultural properties (i.e. land suitability, crop yield) are ***NOT correlated to either (a) the interpolation methods used to transform macro-scale output from a GCM to regional scales required for agricultural assessments, or (b) the land suitability and crop yield models used to conduct the impact assessments.***.

Table 1: Sample Calculations of the Kruskal-Wallis Analysis of Variance

Site:
Beaverlodge AB

Climate Variable:
Changes to Minimum Temperature for the Averaging Period April to September

GCM	Kriging	Nearest Neighbour	Triangulated Interpolation network	Rank of values from table to the left			R	Compared by Interpolator	Compared by GCM
CCC	2.4595	2.4934	2.4686	7	9	8	576	0.0889	7.2000
HadCM3	2.2235	2.2074	2.2219	6	4	5	225		
NCAR	1.8283	1.9004	1.8310	1	3	2	36		
			R=	196	256	225			

Values are computed using the equation: $H = \frac{12}{N(N+1)} x \sum \frac{R^2}{n} - 3(N=1)$

Where H = the calculated test statistic
N = the total number of observations (9 in this example)
n = the number of observation in each grouping (3 in this example)
R = the sum of each group.

Given the sample size used in this study, the critical value for R is 5.6. Values above this threshold indicate a statistical correlation was detected.

SECTION 5
EFFECTS OF DATA INTERPOLATION METHODS ON IMPACT ASSESSMENTS

5.1: First-order Impacts: A Climatic Properties Perspective

Tables 2 and 3 summarize the effects that the GCM-derived climatic change scenarios and the data interpolation procedures respectively have on monthly and seasonal estimates of precipitation, minimum temperature, maximum temperature, and average temperature.

The results presented in Table 2 indicate that for the vast majority months and seasons (i.e. 486 out of 504 cells) monthly and seasonal estimates of climate change are statistically correlated to the three GCMs employed in this study. In other words, the climatic change scenarios derived from the CCC, HadCM3 and NCAR GCMs are significantly different from one another and therefore the resulting first-order impacts (i.e.: monthly and seasonal temperature and monthly) are also substantially different.

Furthermore, the findings summarized in Table 2 do not display a recognizable pattern across the less than 4% of the cells where there is not a significant correlation amongst the GCM (i.e.: the non-significant results do not appear to be clustered in particular months or seasons).

Overall, the findings summarized in Table 2 suggest there ***are considerable differences amongst the climatic change scenarios derived from CCC, HadCM3 & NCAR GCMs and first-order impact assessments mirror these differences.***

The second step in this assessment views the problem from a data interpolation perspective rather than a climatic change scenario perspective. That is, the investigation shifts from studying whether the impact assessments are sensitive to the GCM used to estimate a climatic change scenario to studying the influence of the data interpolation methods on impact assessments. Three interpolation methods were employed (nearest neighbour, kriging and triangulation) were employed and, in all cases, ***no statistical correlation was found between interpolation methods and first-order impacts.*** In other words, similar impact assessments were generated regardless of the data interpolation method used to convert macro-scale GCM-derived data into regional scale data.

The importance of the two sets of findings summarized above (i.e.: first-order impacts are statistically correlated to climatic change scenarios but are not statistically correlated to data interpolation methods) is that it provides new confidence in previous assessments of the impacts of climatic change on agricultural systems. Previous to this assessment, there has not been a systematic investigation of the extent to which impact assessments were influenced by data interpolation methods. This study, like all research, is limited by its scope (i.e.: three climatic change scenarios, three data interpolation models and 18 site-soil combinations) but nevertheless it does consider:

3. sites which encompass regions ranging from some of the best agricultural regions in the Canadian prairies to regions which are beyond the current northen frontier for commercial agriculture, as well as
4. climatic change scenarios and data interpolation methods which characterize many assessments of first-order impacts of climatic change on agriculture.

It is in this context that this study suggests that the various data interpolation methods which have been used in previous research have not to a large extent influenced assessments of the impacts on regional climates.

Table 2: Effects of Three Climatic Change Scenarios on Climatic Properties[1]

Precipitation

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	7.200	7.200	6.489	7.200	7.200	5.600	5.956	7.200	5.600	5.956	7.200	5.422	5.600	5.600
Alta, Ellerslie	7.200	5.422	5.600	7.200	7.200	7.200	7.200	7.200	7.200	6.489	5.422	7.200	7.200	7.200
Alta, Fort Vermilion	6.489	7.200	7.200	6.489	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.422	7.200
Alta, Lethbridge	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	6.489	7.200	7.200
Man, Dauphin	6.489	7.200	7.200	5.956	7.200	5.422	7.200	5.422	7.200	7.200	7.200	7.200	6.489	7.200
Man, Winnipeg	7.200	7.200	5.600	7.200	7.200	7.200	7.200	5.422	7.200	7.200	7.200	7.200	7.200	7.200
NWT, Hay River	7.200	7.200	7.200	7.200	5.422	7.200	5.600	7.200	7.200	7.200	5.600	7.200	7.200	5.600
Sask, Prince Albert	7.200	7.200	7.200	7.200	7.200	7.200	3.289	7.200	5.600	7.200	7.200	7.200	7.200	5.422
Sask, Swift Current	5.422	5.956	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200

Minimum Temperature

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Alta, Ellerslie	7.200	7.200	7.200	5.600	7.200	7.200	7.200	7.200	7.200	5.600	7.200	7.200	7.200	7.200
Alta, Fort Vermilion	7.200	7.200	7.200	7.200	7.200	7.200	5.956	7.200	7.200	7.200	7.200	7.200	5.956	7.200
Alta, Lethbridge	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.956	7.200	7.200
Man, Dauphin	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Man, Winnipeg	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.600	7.200	7.200	7.200	7.200	7.200
NWT, Hay River	5.600	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Sask, Prince Albert	7.200	7.200	7.200	5.600	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	6.489
Sask, Swift Current	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200

[1] Table values are results for the Kruskal-Wallis analysis of variance test. Values greater than or equal to 5.6 indicates the estimated change in the selected climatic property are significantly correlated to the GCMs. Values below 5.6 (i.e. not statistically correlated) are highlighted. MJJA represents May through August which is roughly equivalent to the current growing season. AMJJAS represents April through September which is representative of an expanded growing season that might occur under a CO_2-induced climatic change.

Table 2 cont'd: Effects of Three Climatic Change Scenarios on Climatic Properties

Mean Temperature

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	7.200	7.200	7.200	7.200	7.200	7.200	6.489	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Alta, Ellerslie	7.200	7.200	7.200	5.422	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.422	5.956	5.956
Alta, Fort Vermilion	7.200	7.200	7.200	5.956	7.200	7.200	5.956	7.200	7.200	7.200	5.422	5.956	7.200	7.200
Alta, Lethbridge	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Man, Dauphin	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	6.489	7.200	7.200	7.200	7.200	7.200
Man, Winnipeg	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
NWT, Hay River	5.600	7.200	7.200	7.200	7.200	7.200	5.600	7.200	7.200	7.200	7.200	7.200	5.600	7.200
Sask, Prince Albert	6.489	7.200	7.200	5.600	7.200	7.200	7.200	7.200	7.200	5.600	7.200	7.200	7.200	5.422
Sask, Swift Current	5.600	7.200	7.200	7.200	7.200	6.489	7.200	7.200	7.200	7.200	7.200	6.489	7.200	7.200

Maximum Temperature

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.600	7.200	6.489
Alta, Ellerslie	7.200	7.200	5.600	5.422	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Alta, Fort Vermilion	7.200	5.600	7.200	2.489	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200
Alta, Lethbridge	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.956	7.200	7.200
Man, Dauphin	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.956	5.600	5.956	5.600	5.600	7.200	7.200
Man, Winnipeg	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	6.489	5.422	7.200	7.200	7.200
NWT, Hay River	7.200	7.200	7.200	5.956	7.200	7.200	7.200	5.600	7.200	7.200	7.200	7.200	7.200	7.200
Sask, Prince Albert	5.600	7.200	5.956	5.600	7.200	5.600	5.600	7.200	7.200	7.200	7.200	7.200	5.600	5.600
Sask, Swift Current	7.200	7.200	7.200	7.200	7.200	7.200	7.200	7.200	5.067	7.200	7.200	7.200	7.200	7.200

Table 3: Effects of Three Data Interpolation Procedures on Climatic Properties[2]

Precipitation

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	0.622	0.089	0.089	0.089	0.089	0.089	0.267	0.622	0.800	1.867	0.622	0.356	0.089	0.0889
Alta, Ellerslie	0.089	0.356	0.622	0.356	0.089	0.089	0.089	0.356	0.089	0.089	0.622	0.267	0.089	0.0889
Alta, Fort Vermilion	1.067	0.089	0.622	0.089	0.267	0.622	0.089	0.000	0.622	0.267	0.622	0.800	0.622	0.0889
Alta, Lethbridge	0.267	0.000	0.089	0.089	0.267	0.089	0.089	0.800	0.622	0.267	0.267	1.156	0.089	0.0889
Man, Dauphin	1.156	0.356	0.089	0.089	0.089	0.089	0.000	2.222	0.267	0.356	0.356	0.622	0.089	0.0889
Man, Winnipeg	0.089	0.089	1.156	0.267	0.089	0.267	0.089	1.067	0.089	0.622	0.089	0.089	0.267	0.0889
NWT, Hay River	0.267	0.356	0.089	0.622	0.622	0.089	1.689	0.089	0.800	0.267	1.156	0.089	0.622	1.0667
Sask, Prince Albert	0.089	0.356	0.622	0.089	0.800	0.267	1.689	0.356	1.867	0.089	0.267	0.622	0.089	0.0889
Sask, Swift Current	1.689	0.800	0.089	0.356	0.089	0.267	0.267	0.089	0.267	0.267	0.000	0.267	0.800	0.2667

Minimum Temperature

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	0.089	0.267	0.089	0.622	0.089	0.356	0.356	0.267	0.089	0.089	0.800	0.622	0.089	0.0889
Alta, Ellerslie	0.089	0.089	0.089	0.622	0.622	0.089	0.267	0.622	0.267	0.622	0.267	0.800	0.622	0.0889
Alta, Fort Vermilion	0.089	0.622	0.089	0.089	0.089	0.089	1.156	0.267	0.800	0.089	0.622	0.356	0.622	0.6222
Alta, Lethbridge	0.800	0.267	0.622	0.356	0.800	0.089	0.267	0.089	0.089	0.356	0.089	0.267	0.089	0.0889
Man, Dauphin	0.089	0.622	0.089	0.622	0.089	0.089	0.356	0.800	0.267	0.622	0.622	0.622	0.267	0.0889
Man, Winnipeg	0.089	0.356	0.089	0.267	0.800	0.267	0.622	0.267	0.622	0.622	0.089	0.089	0.622	0.6222
NWT, Hay River	1.422	0.089	0.089	0.267	0.089	0.089	0.622	0.089	0.089	0.356	0.089	0.622	0.089	0.2667
Sask, Prince Albert	0.089	0.089	0.089	0.356	0.267	0.089	0.089	0.267	0.089	0.622	0.622	0.800	0.089	0.0889
Sask, Swift Current	0.356	0.622	0.089	0.356	0.356	0.622	0.800	0.089	0.000	0.089	0.800	0.267	0.267	0.8000

[2] Table values are results for the Kruskal-Wallis analysis of variance test. Values less 5.6 indicates the estimated change in the selected climatic property are NOT significantly correlated to the interpolation procedures. MJJA represents May through August which is roughly equivalent to the current growing season. AMJJAS represents April through September which is representative of an expanded growing season that might occur under a CO_2-induced climatic change

Table 3 cont'd: Effects of Three Data Interpolation Procedures on Climatic Properties

Mean Temperature

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	0.089	0.089	0.089	0.622	0.089	0.356	0.267	0.089	0.089	0.089	0.800	0.622	0.267	0.0889
Alta, Ellerslie	0.622	0.089	0.356	1.067	0.622	0.089	0.089	0.622	0.356	0.267	0.267	2.222	1.689	1.8667
Alta, Fort Vermilion	0.089	0.622	0.089	0.622	0.089	0.089	0.622	0.267	0.622	0.089	1.867	1.689	0.089	0.0889
Alta, Lethbridge	0.267	0.622	0.622	0.089	0.800	0.622	0.622	0.622	0.089	0.089	0.089	0.000	0.267	0.0889
Man, Dauphin	0.089	0.622	0.089	0.089	0.089	0.089	0.622	0.089	0.356	0.622	0.089	0.622	0.089	0.0889
Man, Winnipeg	0.089	0.356	0.089	0.089	0.800	0.267	0.800	0.089	0.000	0.622	0.089	0.267	0.089	0.6222
NWT, Hay River	0.622	0.089	0.267	0.267	0.089	0.089	1.156	0.267	0.622	0.356	0.089	0.622	0.622	0.3556
Sask, Prince Albert	0.356	0.089	0.089	0.267	0.267	0.622	0.267	0.089	0.089	0.800	0.356	0.800	0.089	0.0889
Sask, Swift Current	2.222	0.089	0.089	0.622	0.267	0.089	0.622	0.089	0.089	0.267	0.800	0.089	0.089	0.6222

Maximum Temperature

Station Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	0.089	0.267	0.089	0.356	0.089	0.356	0.356	0.089	0.089	0.089	0.800	1.156	0.089	0.0889
Alta, Ellerslie	0.622	0.267	0.622	1.156	0.622	0.622	0.089	0.267	0.267	0.267	0.267	0.267	0.622	0.6222
Alta, Fort Vermilion	0.089	0.800	0.089	1.156	0.089	0.267	0.089	0.089	0.089	0.089	0.800	0.622	0.089	0.0889
Alta, Lethbridge	0.267	0.622	0.622	0.089	0.800	0.622	0.800	0.622	0.089	0.356	0.089	0.267	0.267	0.6222
Man, Dauphin	0.089	0.622	0.089	0.267	0.089	0.089	0.622	0.622	0.622	1.867	0.089	1.689	0.089	0.0889
Man, Winnipeg	0.089	0.356	0.089	0.089	0.267	0.089	0.089	0.089	0.089	0.089	0.089	0.267	0.089	0.0889
NWT, Hay River	0.089	0.089	0.267	0.622	0.089	0.089	0.267	0.800	0.622	0.000	0.267	0.622	0.089	0.2667
Sask, Prince Albert	0.622	0.089	0.356	0.089	0.267	1.156	0.622	0.089	0.089	0.267	0.622	0.800	0.089	0.2667
Sask, Swift Current	0.622	0.089	0.089	0.622	0.267	0.089	0.622	0.089	0.800	0.267	0.089	0.089	0.089	0.6222

5.2: Second- and Third-order Impacts: Land Suitability and Crop Yield Perspectives

Second- and third-order impact assessments employ a wide range of models to estimate the effects climatic change on properties of agricultural systems. Second order impacts typically assess the suitability of sites or regions for broad groupings of agricultural activities such as cereals, oil seeds or tender fruits. Third-order impacts are more refined and typically estimate impacts for specific crops such as grain corn, soybeans or apples. In this study, the assessment of second-order impacts focuses on spring-seeded cereals and assessments of third-order impacts are based on spring wheat yields. The structure of the analyses presented in this section follow the approach used in Section 5.1, starting with a climatic change perspective and then moving onto investigating the influences of data interpolation methods on impacts.

Land Suitability

Estimates of the sensitivity of the suitability of 18 site-soil combinations in western Canada for spring-seeded cereals is to a large degree influenced by the GCM used to derive a climatic change scenario. In all cases, a ***statistically significant correlation was detected between the climatic change scenario and the impacts on land suitability*** (Table 4).

The analysis of the extent to which data interpolation methods affected the impacts of climatic changes on land suitability for spring-seeded cereals was consistent with findings for first-order impacts. That is, ***a statistical correlation between interpolation method and impacts on land suitability was not detected*** (Table 4).

Crop Yields

The extent to which GCM-derived climatic change scenarios vs data interpolation methods influence estimates of the impacts on spring wheat yields are presented in Table 5. For 17 of 18 cases included in this study, ***there was a statistically significant correaltion between climatic change scenarios and impacts on crop yields***. Once again, this trend was reversed and it was found that ***crop yield impacts were not statistically correlated to data interpolation methods***.

The results presented in this section with respect to second- and third-order impacts build upon the findings presented in Section 5.1. A wide range of interpolation methods have been used to transform macro-scale climatic change estimates generated by GCMs into a format that is amenable for studying agricultural at a more refined spatial scale. It does not however appear that assessments of the impacts of climatic change on agricultural land suitability and on crop yields have been unduly influenced by the *a priori* selection of an interpolation method.

Table 4: Effects of Climatic Change Scenarios and Data Interpolation on Land Suitability for Spring-Seeded Cereals [3]

Site & Soil Profile		Comparison by GCM	Comparison by Interpolation Procedure
Beaverlodge	Dom1	5.7556	0.6222
	Sub1	5.9556	0.0000
Ellerslie	Dom1	7.2000	0.0889
	Sub1	7.2000	0.0889
Fort Vermillion	Dom1	7.2000	0.0889
	Sub1	7.2000	0.0889
Lethbridge	Dom1	5.6000	0.2000
	Sub1	5.6000	0.2000
Dauphin	Dom1	7.2000	0.0667
Winnipeg	Dom1	5.9556	0.6222
Hay River	Dom1	7.2000	0.0667
	Sub1	6.8222	0.3556
Prince Albert	Dom1	7.2000	0.0889
	Dom2	7.2000	0.0667
	Sub1	7.2000	0.0667
Swift Current	Dom1	7.2000	0.2667
	Dom2	7.2000	0.2667
	Sub1	7.2000	0.2667

NOTES:
SITE refers to weather station.
SOIL PROFILE refers to either the dominant (DOM) or sub-dominate (SUB) soil. All sites have at 1 or 2 Dom soils. Not all sites have a SUB soil. Maximum number of SUB soils at one site is 2.
GCM refers to the three General Circulation Models employed in this report.

[3] Table values are results for the Kruskal-Wallis analysis of variance test. Values less than 5.6 indicate the estimated change in land suitability for spring seeded cereals are NOT significantly correlated.

Table 5: Effects of Climatic Change Scenarios and Data Interpolation on Average Spring Wheat Yields[4]

Site	Soil Profile	Comparison by GCM		Comparison by Interpolation Procedure	
		YIELD	STD	YIELD	STD
Beaverlodge	DOM 1	7.2000	7.2000	0.6222	0.0889
	SUB 1	7.2000	7.2000	0.0889	0.0889
Ellerslie	DOM 1	7.2000	7.2000	0.0889	0.0889
	SUB 1	6.4889	6.4889	0.0889	1.1556
Fort Vermillion	DOM 1	7.2000	7.2000	0.0889	0.3556
	SUB 1	**5.4222**	7.2000	1.8667	0.2667
Lethbridge	DOM 1	7.2000	7.2000	0.0889	0.3556
	SUB 1	7.2000	7.2000	0.3556	0.3556
Dauphin	DOM 1	7.2000	7.2000	0.2667	0.2667
Winnipeg	DOM 1	7.2000	6.4889	0.2667	0.0889
Hay River	DOM 1	7.2000	7.2000	0.3556	0.6222
	SUB 1	7.2000	7.2000	0.6222	0.8000
Prince Albert	DOM 1	5.9556	7.2000	0.6222	0.0889
	DOM 2	7.2000	**1.8667**	0.0889	1.1556
	SUB 1	7.2000	7.2000	0.0889	0.0889
Swift Current	DOM 1	7.2000	7.2000	0.6222	0.0889
	DOM 2	7.2000	**2.7556**	0.2667	2.4889
	SUB 1	7.2000	6.4889	0.6222	0.3556

Note:
SITE refers to weather station.
SOIL PROFILE refers to either the dominant (DOM) or sub-dominate (SUB) soil. All sites have at 1 or 2 Dom soils. Not all sites have a SUB soil. Maximum number of SUB soils at one site is 2.
YIELD refers to average annual spring wheat yield estimated for the 2041-60 period.
STD refers to standard deviation in YIELD over the 2041-60 period.
GCM refers to the three General Circulation Models employed in this report.

[4] Table values are results for the Kruskal-Wallis analysis of variance test. Values less than 5.6 indicate the estimated change in spring wheat yield are NOT significantly correlated.

SECTION 6
EFFECTS OF IMPACT MODELS
ON IMPACT ASSESSMENTS

Section 5 investigated the extent to which data interpolation methods might bias assessments of the impacts of climatic change on first-, second- and third-order impacts. The models used to estimate impacts could also introduce a source of error or bias into the impact assessment process. This section focuses on the two models used to estimate second- and third-order agricultural impacts considered in this study. The second-order impacts are derived from the relatively simple land suitability model for spring-seeded cereals where as the third-order impacts are generated via the considerably more complex CERES-wheat model (see Section 4).

The approach taken here is to compare the impact assessments generated by the land suitability and crop yield models. Should the two models estimate similar results, then one would expect a high degree of correlation between the impacts on suitability and crop yields. This would, in turn, indicate that in a relative sense the two models do not introduce another source of error into the impact assessments. Should the two models provided noticeably different impacts, then this would be detected via a low degree of correlation between land suitability and crop yield impacts. This would indicate that second- and third-order impacts would be heavily influenced by the choice of model as well as initial assumptions about climatic change.

Figure 1 illustrates for each climatic change scenario – data interpolation method combination the relationships between land suitability and crop yield impacts. The Spearman Rank Correlation method was used to test for a statistical correlation between impacts generated by the two models, with the results summarized in Table 6.

Overall, it was found that ***the land suitability and crop yield models generated impact assessments which were statistically correlated, indicating the two approaches to estimating impacts did not introduce a new set of biases into impact assessments***.

This is an important finding from two perspectives. First, it provides supporting evidence that previous studies into the impacts of climatic change on agricultural systems were not heavily influenced by whether a land suitability or crop model was employed. This is reassuring in the sense that one can with some certainty conclude that similar results can be expected from the range of models which are typically used to estimate second- and third-order impacts.

The other important point to be made relates to the complexity of the models. With similar results being generated by the two approaches, this suggests that the land suitability model which is considerably easier to implement, maintain and apply is a reliable substitute for the more complex crop models. Unless there is an explicit requirement to measure impacts on crop yields, then it would appear that the more general assessment based on land suitability will provide useful and reliable estimates of the impacts of climatic change on agriculture.

Table 6: Effects of Two Impact Models on Impact Assessments

Spearman's Rank Correlation Co-efficients

	Kriging	NN	TIN
CCC	0.671	0.730	0.682
HadCM4	0.666	0.680	0.666
NCAR	0.825	0.807	0.814

The correlation co-effiecient has a range of 0 to 1, with a larger co-efficient indicating greater significance. Critical value for n=18 at 95% confidence is 0.399. Values above 0.399 indicate a statistically significant correlation at a confidence.

Figure 1: A Comparison of Climatic Change Impacts as Estimated by Agricultural Land Suitability and Crop Yield Models

The graphs compare impacts of climatic change on land suitability for spring-seeded cereals to the impacts of climatic change of spring wheat yields for the 18 site-soil combinations considered in this study (See Section 4). The GCMs from which the climatic change scenario were derived and the method used to interpolate GCM output are indicated in each frame. The following abbreviations are used: CCC: Canadian Climate Centre GCM. HadCm3: Hadley Centre GCM. NCAR: National Centre for Atmospheric Research GCM. TIN: Triangulated Interpolation Network. A trend line has been applied to the data to show an approximate relationship between the two approaches for estimating impacts.

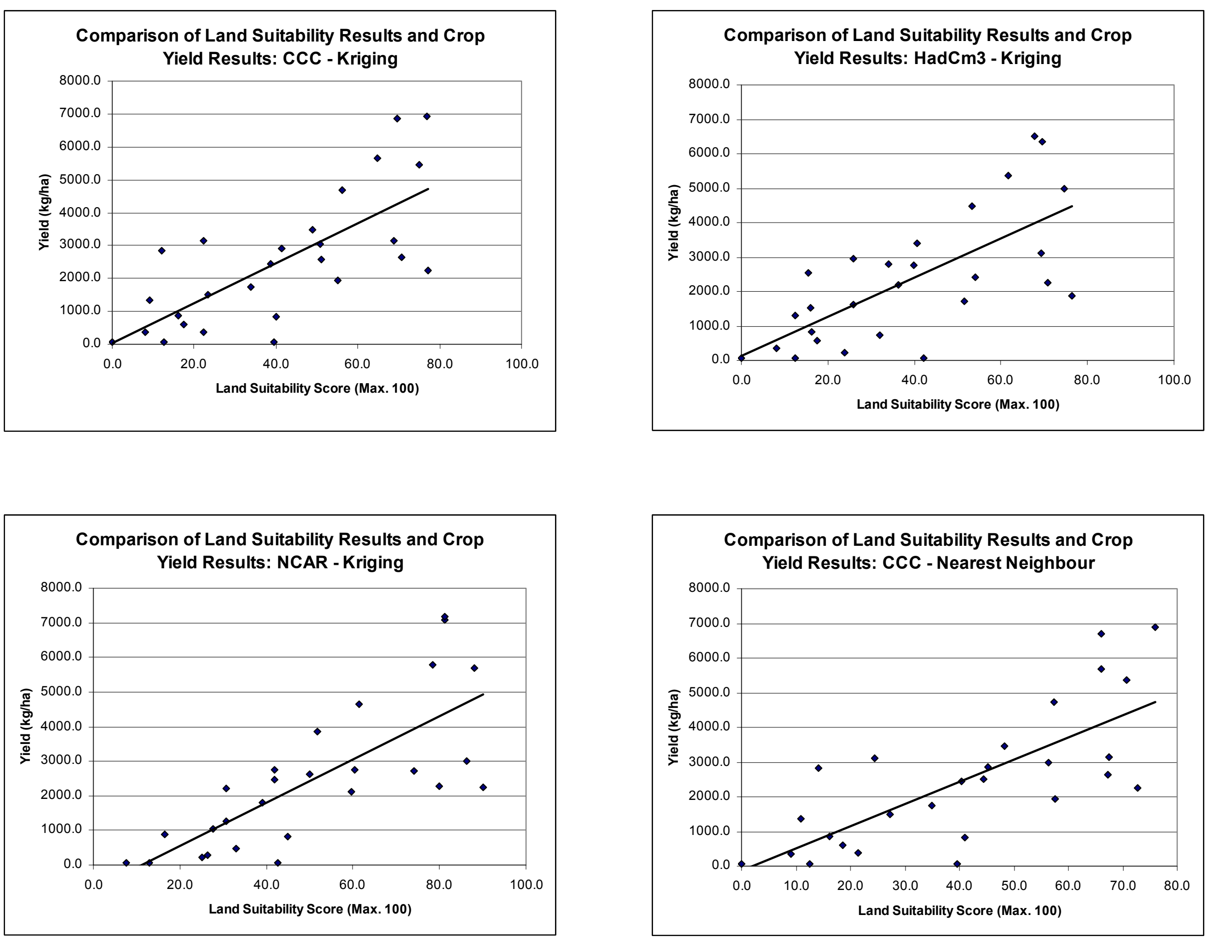
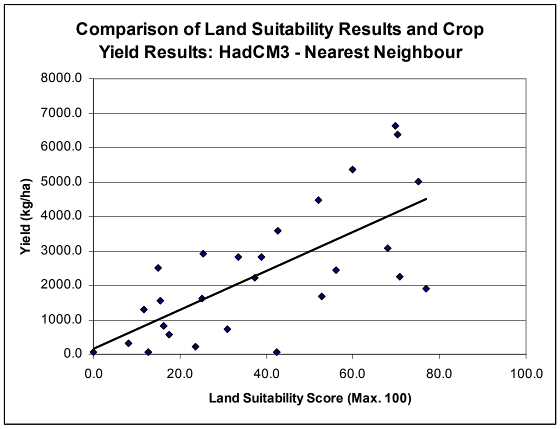
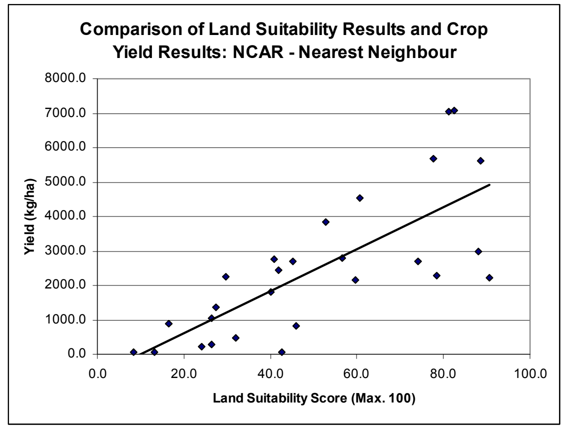
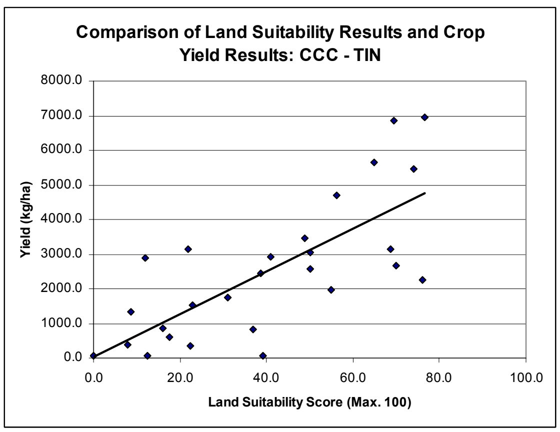
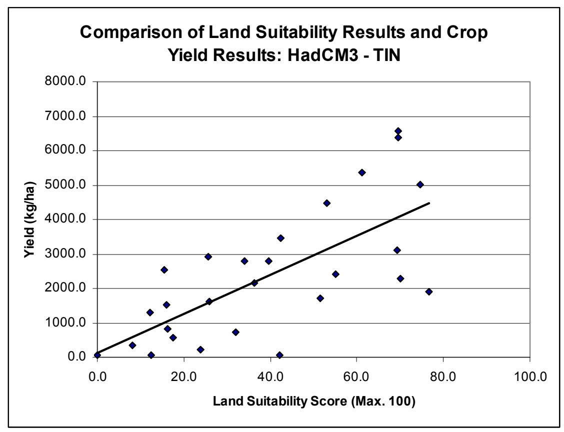


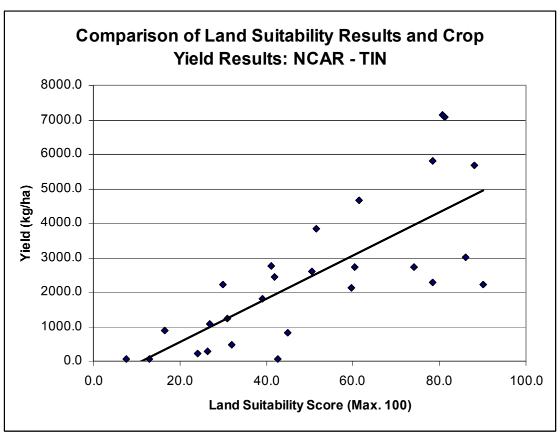
Figure 1 Cont'd











SECTION 7
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APPENDIX 1: CLIMATE DATA

Baseline Climate (1951-1980)

Precipitation

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	33.0	24.5	24.5	21.0	36.6	68.6	61.1	68.6	47.5	23.0	29.7	71.8	234.9	303.4
Alta, Ellerslie	25.4	18.2	15.8	19.4	44.6	79.5	89.6	67.1	40.9	15.8	16.5	25.9	280.8	341.1
Alta, Fort Vermilion	21.6	16.7	22.5	17.2	33.6	49.0	65.8	51.5	38.2	27.0	21.7	19.2	199.8	255.2
Alta, Lethbridge	23.1	13.9	23.8	40.8	50.3	70.9	39.5	44.7	38.2	15.3	15.4	22.5	205.4	284.3
Man, Dauphin	21.4	17.3	24.4	33.7	48.1	76.2	73.7	60.2	63.4	28.9	23.1	22.6	258.2	355.2
Man, Winnipeg	19.4	15.9	22.5	42.2	72.9	71.7	76.3	77.8	54.8	25.8	20.9	19.6	298.6	395.6
NWT, Hay River	23.4	17.8	18.0	15.6	19.9	29.1	44.8	35.4	39.4	28.8	35.6	46.4	129.2	184.1
Sask, Prince Albert	15.3	15.0	15.7	19.3	38.1	75.8	67.6	51.5	37.6	21.0	15.1	21.2	232.9	289.8
Sask, Swift Current	21.7	18.6	18.8	28.2	40.4	70.1	42.7	39.4	33.0	17.7	14.4	21.6	192.6	253.8

Minimum Temperature

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-20.1	-14.9	-10.6	-2.5	3.0	7.0	8.8	7.9	3.7	-0.4	-9.7	-17.1	6.7	4.65
Alta, Ellerslie	-21.3	-16.3	-11.7	-2.3	3.8	8.1	9.9	8.9	4.0	-1.2	-9.8	-18.1	7.7	5.39
Alta, Fort Vermilion	-28.1	-23.1	-16.5	-4.1	3.7	8.3	10.5	8.6	3.2	-2.3	-14.2	-24.4	7.8	5.05
Alta, Lethbridge	-16.5	-11.4	-7.9	-1.4	4.0	8.6	10.4	9.6	4.9	0.4	-7.2	-12.8	8.1	6.01
Man, Dauphin	-25.2	-22.3	-14.7	-4.0	3.0	9.1	11.7	10.2	5.0	-0.4	-10.1	-20.4	8.5	5.84
Man, Winnipeg	-25.0	-21.9	-13.7	-2.5	4.3	10.4	13.1	11.3	6.0	0.4	-9.1	-19.6	9.8	7.11
NWT, Hay River	-30.7	-27.5	-22.9	-9.6	0.7	6.8	10.8	9.1	3.4	-2.9	-15.9	-26.0	6.8	3.53
Sask, Prince Albert	-27.9	-23.7	-16.8	-4.0	2.6	8.0	10.5	8.7	3.2	-2.3	-12.3	-23.0	7.5	4.83
Sask, Swift Current	-20.1	-15.4	-10.4	-2.0	3.9	8.9	11.2	10.2	5.0	-0.3	-9.1	-15.9	8.5	6.18

Appendix 1 Cont'd: Baseline Climate (1951-1980)

Mean Temperature

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-15.5	-10.2	-5.8	2.9	9.2	13.2	15.0	14.3	9.4	4.7	-5.6	-12.7	12.9	10.66
Alta, Ellerslie	-16.2	-10.9	-6.3	3.5	10.5	14.5	16.2	15.2	10.2	5.0	-5.1	-13.1	14.1	11.69
Alta, Fort Vermilion	-23.4	-17.5	-10.3	2.0	10.3	14.9	16.7	14.9	8.8	2.3	-10.4	-20.1	14.2	11.27
Alta, Lethbridge	-10.5	-5.3	-1.5	5.1	10.8	15.4	18.0	17.2	12.1	7.3	-1.3	-7.0	15.4	13.12
Man, Dauphin	-19.8	-16.2	-8.8	2.1	10.3	16.0	18.4	17.0	11.3	5.5	-5.3	-15.2	15.4	12.54
Man, Winnipeg	-19.8	-16.3	-8.1	3.2	11.2	16.9	19.5	17.9	12.3	6.0	-4.6	-14.7	16.4	13.50
NWT, Hay River	-25.9	-21.8	-16.7	-3.8	6.2	12.3	15.9	14.3	8.0	1.1	-11.7	-21.5	12.2	8.81
Sask, Prince Albert	-21.7	-16.8	-10.0	2.2	10.1	15.0	17.3	15.8	9.8	3.9	-7.4	-17.4	14.6	11.71
Sask, Swift Current	-14.9	-10.1	-5.0	3.9	10.6	15.5	18.3	17.5	11.6	5.9	-3.9	-10.9	15.5	12.90

Maximum Temperature

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-11.0	-5.5	-1.0	8.2	15.4	19.4	21.3	20.6	15.1	9.8	-1.5	-8.3	19.2	16.67
Alta, Ellerslie	-11.0	-5.6	-1.0	9.3	17.3	20.9	22.5	21.6	16.4	11.2	-0.3	-8.1	20.6	17.98
Alta, Fort Vermilion	-18.7	-11.8	-4.0	8.0	16.9	21.5	23.0	21.1	14.4	7.0	-6.7	-15.8	20.6	17.50
Alta, Lethbridge	-4.6	0.7	4.8	11.7	17.6	22.2	25.6	24.8	19.4	14.2	4.6	-1.2	22.6	20.22
Man, Dauphin	-14.3	-10.0	-2.9	8.2	17.5	22.9	25.2	23.8	17.7	11.3	-0.5	-10.1	22.4	19.23
Man, Winnipeg	-14.6	-10.6	-2.6	8.9	18.0	23.4	25.8	24.5	18.6	11.5	-0.2	-9.9	23.0	19.89
NWT, Hay River	-21.1	-16.1	-10.4	2.1	11.6	17.8	21.0	19.5	12.6	5.1	-7.6	-17.1	17.5	14.09
Sask, Prince Albert	-15.5	-10.0	-3.1	8.5	17.7	21.9	24.1	22.9	16.5	10.1	-2.4	-11.8	21.7	18.59
Sask, Swift Current	-9.7	-4.9	0.3	9.8	17.2	22.2	25.4	24.9	18.3	12.0	1.3	-5.8	22.4	19.63

Appendix 1 Cont'd: Precipitation (mm) Values Derived from the Canadian Climate Centre GCM Using 3 Data Interpolation Methods

CCC - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	35.1	26.2	25.0	22.1	45.2	73.2	58.9	63.9	50.0	24.5	32.2	74.2	241.2	313.3
Alta, Ellerslie	25.9	20.1	16.3	20.4	54.8	81.0	88.4	66.9	42.2	18.1	17.9	30.2	291.0	353.6
Alta, Fort Vermilion	20.4	13.2	23.3	17.7	42.0	57.8	70.3	53.1	37.9	31.1	22.4	19.8	223.1	278.6
Alta, Lethbridge	23.0	16.0	24.0	49.5	62.5	69.2	33.9	39.5	44.3	16.7	16.2	23.4	205.2	299.0
Man, Dauphin	19.1	16.5	21.6	37.0	61.8	76.6	72.2	52.9	77.0	29.2	24.6	24.5	263.5	377.5
Man, Winnipeg	18.2	14.9	21.6	46.2	96.4	71.6	69.4	70.9	62.4	24.2	22.3	20.6	308.3	416.9
NWT, Hay River	19.9	14.5	15.7	15.4	22.1	31.5	45.1	35.2	41.9	35.1	36.5	44.2	134.0	191.3
Sask, Prince Albert	15.3	14.9	14.2	24.2	48.2	83.7	67.8	47.1	52.3	23.1	16.3	24.5	246.8	323.3
Sask, Swift Current	20.6	18.9	17.6	36.4	54.8	71.6	37.3	32.8	39.6	20.1	15.4	25.0	196.6	272.6

CCC - Nearest Nieghbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	34.4	27.3	24.3	21.3	41.3	66.1	53.2	64.0	50.5	22.8	33.3	71.8	224.8	296.6
Alta, Ellerslie	25.9	19.4	16.7	20.0	55.4	83.1	91.4	68.8	41.4	18.4	17.7	31.4	298.6	360.0
Alta, Fort Vermilion	21.1	13.4	24.6	17.8	42.8	58.2	70.8	52.8	36.8	30.3	22.7	19.9	224.7	279.3
Alta, Lethbridge	22.8	16.4	24.1	50.3	62.6	68.9	34.5	40.6	45.9	17.4	16.0	23.3	206.5	302.7
Man, Dauphin	18.9	16.7	22.2	35.2	63.5	71.8	67.1	55.6	74.8	29.5	24.3	24.5	258.0	368.0
Man, Winnipeg	17.9	14.4	21.0	44.6	94.2	71.6	70.3	68.0	63.8	24.4	22.4	20.5	304.0	412.3
NWT, Hay River	19.7	14.7	14.9	15.4	21.3	31.4	44.1	35.8	42.3	35.2	36.6	42.6	132.6	190.3
Sask, Prince Albert	15.7	14.9	14.0	24.7	47.1	85.9	70.0	47.6	54.4	22.9	16.2	24.1	250.6	329.7
Sask, Swift Current	21.1	19.4	18.0	36.8	54.4	72.8	37.4	31.2	40.5	20.5	15.1	25.2	195.8	273.2

CCC - Triangulated Interpolated Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	34.3	25.2	24.9	21.8	43.7	72.3	57.6	64.9	49.9	24.0	32.4	73.1	238.6	310.3
Alta, Ellerslie	25.9	20.0	16.3	20.5	55.1	81.2	88.7	66.5	42.1	18.1	17.8	29.9	291.5	354.2
Alta, Fort Vermilion	20.5	13.6	23.6	17.7	41.7	56.7	69.8	52.1	37.7	30.8	22.6	19.5	220.3	275.7
Alta, Lethbridge	23.2	16.1	24.1	49.4	62.9	69.3	34.3	39.8	44.2	16.7	16.1	23.3	206.2	299.8
Man, Dauphin	18.8	17.0	22.0	36.3	62.2	75.1	73.0	54.3	74.2	29.4	24.2	24.5	264.6	375.2
Man, Winnipeg	18.2	14.9	21.7	45.9	95.6	71.9	70.4	69.9	62.3	24.3	22.2	20.6	307.9	416.2
NWT, Hay River	20.2	14.9	16.0	15.5	22.1	31.3	45.1	35.0	41.6	34.6	36.7	44.1	133.5	190.6
Sask, Prince Albert	15.3	14.9	14.2	24.2	48.3	83.1	67.3	47.7	51.4	23.1	16.3	24.2	246.4	322.1
Sask, Swift Current	20.6	19.0	17.6	36.2	54.7	71.2	37.2	32.8	39.4	20.2	15.5	24.9	195.9	271.5

Appendix 1 Cont'd: Precipitation (mm) Values Derived from the Hadley Centre GCM Using 3 Data Interpolation Methods

HadCM3 - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	45.3	36.5	36.3	22.7	31.9	78.4	57.8	66.4	53.7	25.8	40.1	105.5	234.4	310.8
Alta, Ellerslie	34.1	25.9	19.9	21.1	38.6	91.4	73.3	61.7	47.9	15.3	19.2	38.0	265.1	334.2
Alta, Fort Vermilion	23.3	19.4	32.8	17.9	34.6	46.1	56.4	45.5	40.1	33.2	27.8	27.5	182.5	240.6
Alta, Lethbridge	34.2	17.2	27.1	41.1	47.2	85.6	35.9	44.5	29.3	15.6	17.3	23.0	213.2	283.6
Man, Dauphin	24.6	21.8	25.3	42.6	48.7	72.6	74.5	53.4	63.0	32.8	27.5	28.8	249.1	354.8
Man, Winnipeg	22.6	20.6	23.9	51.4	78.8	69.9	78.0	70.4	48.8	24.7	24.6	25.7	297.1	397.3
NWT, Hay River	24.2	22.0	22.7	18.5	22.1	23.8	46.7	34.4	46.6	33.9	42.2	61.8	127.0	192.1
Sask, Prince Albert	16.7	18.3	18.7	21.1	38.0	74.4	64.9	45.0	36.1	24.0	17.9	26.9	222.3	279.4
Sask, Swift Current	26.4	26.0	18.3	32.8	34.5	81.4	40.9	37.5	30.2	18.0	16.1	27.1	194.4	257.4

HadCM3 - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	45.8	37.6	36.2	23.1	31.0	78.3	59.1	67.9	53.2	25.5	40.7	104.0	236.3	312.6
Alta, Ellerslie	35.2	25.6	18.3	21.0	36.3	90.7	66.9	63.4	48.2	14.1	18.4	35.2	257.3	326.5
Alta, Fort Vermilion	23.7	19.4	34.6	17.7	34.2	49.5	54.3	44.1	38.2	34.4	28.5	27.7	182.1	238.0
Alta, Lethbridge	36.9	17.2	27.0	40.5	45.2	86.1	35.7	44.9	30.3	15.2	17.5	22.5	212.0	282.7
Man, Dauphin	24.1	21.3	23.7	42.9	47.6	80.7	76.0	54.6	62.3	32.9	25.5	28.6	258.9	364.2
Man, Winnipeg	22.9	21.0	23.9	53.1	79.1	68.5	78.0	68.4	47.9	26.0	24.3	25.3	294.0	395.0
NWT, Hay River	23.6	20.8	23.4	17.5	20.7	23.8	43.6	34.3	47.6	33.4	42.6	62.2	122.5	187.6
Sask, Prince Albert	16.3	17.9	18.2	20.6	37.1	72.7	63.8	45.3	36.3	25.7	18.0	26.0	218.9	275.8
Sask, Swift Current	28.9	26.6	19.1	32.6	33.8	82.5	39.1	37.9	28.5	17.1	16.4	26.2	193.2	254.4

HadCM3 - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	45.2	36.6	36.2	22.8	31.9	78.4	58.2	66.5	53.4	25.7	39.9	105.8	235.1	311.3
Alta, Ellerslie	34.6	25.3	19.7	20.9	38.3	91.4	71.0	62.0	47.8	15.0	18.9	37.1	262.7	331.3
Alta, Fort Vermilion	23.3	19.6	32.8	18.1	34.5	46.8	57.4	45.7	40.3	33.0	27.6	27.3	184.4	242.9
Alta, Lethbridge	34.6	17.1	27.5	40.8	47.1	85.5	35.7	44.7	29.5	15.5	17.3	22.9	213.1	283.3
Man, Dauphin	24.4	22.0	25.1	43.0	49.1	75.0	75.5	54.4	64.2	32.3	27.4	29.1	254.0	361.2
Man, Winnipeg	22.6	20.5	24.0	51.1	78.9	70.1	77.5	70.5	49.6	24.6	24.8	25.6	297.1	397.7
NWT, Hay River	24.4	22.1	22.6	18.6	22.2	24.2	46.8	34.2	46.0	33.9	42.3	61.8	127.5	192.0
Sask, Prince Albert	16.7	18.2	18.6	20.8	38.0	74.1	65.1	44.9	36.0	24.3	17.9	26.7	222.1	278.9
Sask, Swift Current	26.9	26.0	18.3	32.5	34.7	81.1	40.7	37.2	29.9	18.1	16.1	26.5	193.7	256.1

Appendix 1 Cont'd: Precipitation (mm) Values Derived from the National Centre for Atmospheric Research GCM Using 3 Data Interpolation Methods

NCAR - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	36.6	24.5	23.7	18.9	38.8	77.4	79.0	78.2	52.8	24.5	34.6	72.2	273.4	345.1
Alta, Ellerslie	28.6	20.0	17.4	16.7	50.2	103.7	107.0	78.0	43.1	15.1	18.9	29.5	338.8	398.5
Alta, Fort Vermilion	23.7	18.9	20.4	16.8	38.0	51.8	71.3	60.9	44.5	27.2	26.3	18.9	222.0	283.2
Alta, Lethbridge	32.3	12.7	28.8	43.2	53.6	94.9	37.9	51.9	40.0	18.0	19.1	24.1	238.2	321.5
Man, Dauphin	25.1	18.8	25.7	35.3	59.3	111.7	84.8	63.8	58.9	32.9	38.5	36.2	319.5	413.7
Man, Winnipeg	22.5	17.5	21.6	44.4	82.3	96.2	82.7	85.4	60.2	26.7	31.4	29.2	346.6	451.3
NWT, Hay River	24.9	19.6	16.2	16.6	25.1	29.7	41.9	40.2	45.1	28.0	42.1	49.6	136.9	198.5
Sask, Prince Albert	15.1	15.8	16.6	17.9	42.2	102.0	71.6	57.9	35.7	23.2	20.7	28.5	273.7	327.2
Sask, Swift Current	27.2	19.5	21.6	29.7	49.0	100.8	47.4	39.3	34.0	20.7	18.0	28.2	236.5	300.2

NCAR - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	37.6	24.2	24.3	18.2	40.5	81.0	79.4	78.3	49.8	23.8	36.1	74.0	279.2	347.2
Alta, Ellerslie	26.6	21.1	16.1	15.7	49.6	98.3	110.4	78.6	44.3	15.9	19.0	28.8	337.0	397.0
Alta, Fort Vermilion	24.0	18.9	20.7	16.1	36.2	53.3	75.9	63.0	44.2	27.2	27.0	19.1	228.5	288.8
Alta, Lethbridge	33.3	12.4	28.8	44.5	51.9	92.6	36.8	52.2	40.1	18.9	19.4	23.4	233.6	318.1
Man, Dauphin	24.6	18.5	26.8	35.4	59.0	112.7	84.4	64.0	54.0	33.0	38.9	35.4	320.0	409.5
Man, Winnipeg	22.4	19.0	20.8	42.5	88.6	100.4	80.8	85.6	59.6	26.9	31.8	31.0	355.4	457.6
NWT, Hay River	25.8	19.9	16.2	16.6	25.3	29.6	41.8	40.0	45.2	27.7	42.8	49.0	136.8	198.7
Sask, Prince Albert	13.3	15.7	14.9	15.6	38.2	96.1	64.6	61.5	38.3	24.0	22.0	27.1	260.4	314.3
Sask, Swift Current	27.4	19.3	20.5	28.4	49.5	97.0	44.6	39.0	36.3	23.3	17.9	27.2	230.1	294.8

NCAR - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	36.4	24.5	23.9	18.9	39.4	77.6	78.6	78.4	52.4	24.5	34.5	72.2	274.0	345.3
Alta, Ellerslie	28.2	19.7	17.2	16.4	49.9	102.8	104.6	79.4	43.6	15.5	19.1	28.8	336.6	396.6
Alta, Fort Vermilion	23.6	18.5	20.4	16.5	37.9	52.4	71.1	61.6	44.4	27.0	26.1	18.8	223.0	283.9
Alta, Lethbridge	32.5	12.8	28.6	44.0	52.6	93.6	37.9	51.9	39.9	18.0	19.0	24.0	236.0	319.9
Man, Dauphin	25.1	18.6	25.5	35.0	59.2	110.7	84.1	64.0	60.2	33.0	37.9	35.9	317.9	413.1
Man, Winnipeg	22.5	17.7	21.5	44.0	81.8	96.5	81.6	85.8	61.0	26.6	31.2	29.3	345.7	450.7
NWT, Hay River	25.2	19.6	16.2	16.7	24.9	29.8	42.4	40.3	44.9	27.9	42.0	50.2	137.4	199.0
Sask, Prince Albert	15.3	16.3	16.8	18.0	44.1	101.3	71.0	59.1	35.5	23.3	21.0	28.6	275.5	329.0
Sask, Swift Current	26.5	19.2	21.2	29.2	47.2	99.2	46.7	40.2	34.0	20.9	17.8	27.4	233.2	296.4

Appendix 1 Cont'd: Minimum Temperature (°C) Values Derived from the Canadian Climate Centre GCM Using 3 Data Interpolation Methods

CCC - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-13.7	-9.8	-5.4	0.5	5.9	9.5	11.2	10.0	5.5	1.0	-9.1	-13.6	9.2	7.1
Alta, Ellerslie	-13.6	-10.5	-6.8	2.8	9.1	10.9	12.3	11.3	5.7	0.2	-9.1	-14.4	10.9	8.7
Alta, Fort Vermilion	-21.8	-18.7	-11.0	-2.1	6.3	10.9	13.2	11.2	5.0	-1.1	-13.4	-19.1	10.4	7.4
Alta, Lethbridge	-8.2	-3.6	-1.3	4.9	8.4	11.1	12.6	11.9	7.1	2.1	-6.4	-10.8	11.0	9.3
Man, Dauphin	-18.2	-16.5	-8.3	2.2	7.9	11.9	14.3	12.5	7.2	0.9	-9.2	-16.1	11.6	9.3
Man, Winnipeg	-17.7	-16.5	-8.1	3.3	10.2	13.3	15.8	13.6	8.4	1.7	-8.2	-15.2	13.2	10.8
NWT, Hay River	-25.6	-23.2	-17.7	-7.2	2.9	9.2	13.4	11.7	5.0	-1.9	-14.2	-21.6	9.3	5.8
Sask, Prince Albert	-20.8	-17.7	-11.1	-0.7	6.3	11.0	13.1	11.3	5.5	-0.8	-11.5	-18.2	10.4	7.7
Sask, Swift Current	-11.4	-7.3	-2.3	5.2	8.9	11.5	13.4	12.5	7.0	1.3	-8.2	-13.4	11.6	9.8

CCC - Nearest Nieghbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-14.0	-9.9	-5.9	1.1	5.9	9.4	11.1	9.8	5.5	1.0	-9.0	-14.4	9.1	7.1
Alta, Ellerslie	-13.5	-10.7	-7.2	3.2	9.9	11.0	12.3	11.3	5.7	0.2	-9.0	-13.7	11.2	8.9
Alta, Fort Vermilion	-21.3	-18.6	-11.0	-2.1	6.5	11.0	13.2	11.1	5.0	-1.1	-13.7	-19.2	10.4	7.4
Alta, Lethbridge	-7.8	-3.6	-1.1	5.8	8.7	11.1	12.6	12.0	7.0	2.1	-6.4	-10.9	11.1	9.5
Man, Dauphin	-17.6	-15.6	-7.1	4.2	8.5	11.7	14.1	12.5	7.1	0.9	-9.2	-17.2	11.7	9.7
Man, Winnipeg	-18.1	-17.0	-8.5	3.5	10.6	13.3	15.8	13.6	8.4	1.6	-8.1	-14.7	13.3	10.9
NWT, Hay River	-25.7	-23.2	-17.8	-7.2	2.8	9.1	13.5	11.7	5.0	-2.0	-13.7	-22.4	9.3	5.8
Sask, Prince Albert	-21.4	-18.3	-11.7	-2.2	5.6	11.0	13.2	11.4	5.6	-0.8	-11.5	-17.5	10.3	7.4
Sask, Swift Current	-11.3	-7.2	-2.4	5.1	8.8	11.5	13.3	12.5	7.0	1.4	-8.2	-13.8	11.5	9.7

CCC - Triangulated Interpolated Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-13.9	-10.0	-5.6	0.6	5.8	9.5	11.2	10.0	5.5	1.0	-9.1	-13.6	9.1	7.1
Alta, Ellerslie	-13.6	-10.5	-6.7	2.8	9.0	10.9	12.3	11.3	5.7	0.2	-9.0	-14.4	10.9	8.7
Alta, Fort Vermilion	-21.6	-18.6	-11.1	-2.0	6.4	10.9	13.2	11.1	5.0	-1.1	-13.4	-19.3	10.4	7.4
Alta, Lethbridge	-8.1	-3.7	-1.4	5.0	8.5	11.1	12.6	11.9	7.1	2.0	-6.3	-10.6	11.1	9.4
Man, Dauphin	-18.1	-16.2	-8.0	2.7	7.6	11.9	14.3	12.5	7.2	0.8	-9.1	-16.5	11.6	9.4
Man, Winnipeg	-17.6	-16.5	-8.3	3.2	10.3	13.3	15.8	13.6	8.5	1.7	-8.1	-15.2	13.3	10.8
NWT, Hay River	-25.4	-23.1	-17.7	-7.1	3.0	9.3	13.5	11.6	5.0	-1.9	-14.0	-21.7	9.3	5.9
Sask, Prince Albert	-20.9	-17.7	-11.0	-0.8	6.2	11.0	13.1	11.3	5.5	-0.8	-11.5	-18.1	10.4	7.7
Sask, Swift Current	-11.4	-7.3	-2.3	5.2	8.8	11.5	13.4	12.5	7.0	1.3	-8.2	-13.5	11.6	9.7

Appendix 1 Cont'd: Minimum Temperature (°C) Values Derived from the Hadley Centre GCM Using 3 Data Interpolation Methods

HadCM3 - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-19.9	-13.7	-10.3	-1.6	4.5	9.6	11.5	11.3	5.8	1.4	-7.1	-15.9	9.2	6.9
Alta, Ellerslie	-20.8	-13.7	-9.5	-1.2	5.8	10.7	13.0	12.7	6.4	0.9	-7.2	-16.1	10.6	7.9
Alta, Fort Vermilion	-27.7	-21.9	-17.5	-3.5	5.5	11.0	13.0	12.2	5.2	-0.4	-11.4	-22.9	10.4	7.2
Alta, Lethbridge	-15.2	-8.2	-5.1	0.0	6.2	11.2	13.8	13.5	7.8	2.8	-4.6	-10.8	11.2	8.8
Man, Dauphin	-23.0	-19.3	-12.6	-1.7	5.2	11.4	15.3	13.4	7.3	1.9	-7.4	-18.5	11.3	8.5
Man, Winnipeg	-22.6	-19.0	-10.8	-0.4	6.4	12.6	16.8	14.8	8.4	2.6	-6.4	-17.5	12.7	9.8
NWT, Hay River	-29.4	-26.2	-24.3	-9.4	2.5	9.4	13.1	12.5	5.2	-1.0	-12.6	-24.0	9.4	5.5
Sask, Prince Albert	-26.7	-20.9	-15.1	-2.2	4.7	10.4	13.8	12.1	5.4	-0.3	-9.7	-21.4	10.3	7.4
Sask, Swift Current	-19.2	-12.0	-6.4	0.0	6.0	11.3	14.6	13.8	7.5	2.2	-6.4	-13.9	11.4	8.9

HadCM3 - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-19.8	-13.7	-10.2	-1.6	4.5	9.6	11.5	11.3	5.8	1.3	-7.0	-15.9	9.2	6.9
Alta, Ellerslie	-20.3	-13.0	-8.5	-1.0	5.9	10.7	13.2	13.1	6.6	1.2	-6.9	-15.7	10.7	8.1
Alta, Fort Vermilion	-27.9	-21.9	-17.3	-3.4	5.5	11.0	13.1	12.2	5.3	-0.4	-11.5	-23.0	10.5	7.3
Alta, Lethbridge	-15.1	-7.8	-4.9	0.0	6.3	11.1	13.7	13.5	7.7	2.8	-4.4	-10.5	11.2	8.7
Man, Dauphin	-23.3	-19.0	-12.1	-1.2	5.1	11.4	15.3	13.3	7.4	2.2	-7.4	-18.5	11.3	8.5
Man, Winnipeg	-22.5	-19.0	-11.1	-0.4	6.4	12.6	16.8	14.9	8.5	2.5	-6.3	-17.5	12.7	9.8
NWT, Hay River	-29.7	-26.3	-24.3	-9.5	2.5	9.4	13.0	12.5	5.2	-1.0	-12.8	-24.0	9.4	5.5
Sask, Prince Albert	-26.6	-20.7	-14.8	-1.9	4.7	10.4	13.9	12.0	5.4	-0.2	-9.6	-21.4	10.3	7.4
Sask, Swift Current	-19.3	-12.0	-6.2	-0.4	6.0	11.3	14.5	14.0	7.5	2.2	-6.4	-13.8	11.4	8.8

HadCM3 - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-19.9	-13.7	-10.2	-1.6	4.5	9.6	11.4	11.3	5.8	1.4	-7.1	-15.9	9.2	6.9
Alta, Ellerslie	-20.6	-13.5	-9.3	-1.1	5.8	10.7	13.0	12.9	6.5	1.0	-7.0	-16.0	10.6	8.0
Alta, Fort Vermilion	-27.7	-21.9	-17.4	-3.5	5.5	11.0	13.0	12.2	5.2	-0.4	-11.4	-22.8	10.4	7.2
Alta, Lethbridge	-15.1	-8.2	-5.1	0.0	6.2	11.2	13.8	13.6	7.8	2.8	-4.6	-10.8	11.2	8.8
Man, Dauphin	-23.1	-19.3	-12.6	-1.7	5.2	11.3	15.3	13.4	7.3	1.9	-7.4	-18.4	11.3	8.5
Man, Winnipeg	-22.6	-19.0	-10.8	-0.4	6.4	12.6	16.8	14.8	8.4	2.6	-6.4	-17.5	12.7	9.8
NWT, Hay River	-29.4	-26.2	-24.2	-9.4	2.5	9.4	13.1	12.5	5.2	-1.0	-12.6	-23.9	9.4	5.6
Sask, Prince Albert	-26.7	-20.9	-15.1	-2.2	4.7	10.4	13.8	12.1	5.4	-0.3	-9.6	-21.4	10.3	7.4
Sask, Swift Current	-19.2	-12.0	-6.5	0.0	6.0	11.3	14.6	13.8	7.5	2.2	-6.4	-13.9	11.4	8.9

Appendix 1 Cont'd: Minimum Temperature (^{o}C) Values Derived from the National Centre for Atmospheric Research GCM Using 3 Data Interpolation Methods

NCAR - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-18.7	-13.6	-9.5	-1.6	3.9	8.0	11.5	10.3	6.7	1.6	-8.8	-15.3	8.4	6.5
Alta, Ellerslie	-19.9	-14.6	-10.5	-1.1	4.8	9.2	12.5	11.7	7.2	0.0	-9.6	-16.9	9.6	7.4
Alta, Fort Vermilion	-26.9	-21.5	-16.0	-3.3	4.7	9.2	12.9	11.5	6.0	0.7	-13.0	-22.5	9.6	6.9
Alta, Lethbridge	-14.8	-9.3	-6.1	0.1	5.2	10.0	12.4	12.2	8.3	0.6	-6.6	-11.9	10.0	8.0
Man, Dauphin	-23.7	-20.3	-14.0	-2.8	4.1	10.5	13.7	13.9	8.9	1.0	-9.9	-18.6	10.6	8.0
Man, Winnipeg	-23.4	-20.0	-12.9	-1.4	5.5	11.9	15.0	15.4	10.1	1.6	-8.4	-17.6	12.0	9.4
NWT, Hay River	-29.5	-26.0	-22.4	-9.0	1.7	8.1	13.0	12.3	5.6	0.4	-14.3	-23.4	8.8	5.3
Sask, Prince Albert	-26.5	-21.6	-16.1	-3.0	3.8	9.0	12.7	12.1	6.8	-0.8	-12.5	-21.6	9.4	6.9
Sask, Swift Current	-18.7	-13.3	-9.1	-1.0	5.0	10.2	13.3	13.2	8.4	-0.3	-9.2	-14.7	10.4	8.2

NCAR - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-18.7	-13.6	-9.5	-1.5	3.9	8.0	11.6	10.4	6.9	1.5	-8.7	-15.4	8.5	6.5
Alta, Ellerslie	-19.9	-14.6	-10.9	-1.2	4.9	9.1	12.5	11.8	7.2	0.4	-9.7	-16.9	9.6	7.4
Alta, Fort Vermilion	-26.9	-21.4	-16.0	-3.2	4.7	9.1	13.1	11.5	6.3	0.6	-13.3	-22.8	9.6	6.9
Alta, Lethbridge	-14.8	-9.3	-6.0	0.2	5.3	9.9	12.3	12.2	8.3	0.6	-6.5	-11.9	9.9	8.0
Man, Dauphin	-23.7	-20.2	-14.0	-2.8	4.1	10.4	13.7	13.8	8.8	1.2	-10.0	-18.7	10.5	8.0
Man, Winnipeg	-23.5	-19.9	-12.9	-1.4	5.6	11.9	15.1	15.4	10.1	1.3	-8.4	-17.7	12.0	9.5
NWT, Hay River	-29.5	-25.9	-22.4	-8.9	1.8	8.0	13.0	12.3	5.7	0.4	-14.2	-23.6	8.8	5.3
Sask, Prince Albert	-26.5	-21.5	-16.3	-3.0	3.8	9.0	12.5	12.1	6.7	-0.3	-12.1	-21.4	9.4	6.8
Sask, Swift Current	-18.7	-13.2	-8.9	-1.0	4.9	10.3	13.1	12.9	8.1	-0.9	-8.8	-14.6	10.3	8.0

NCAR - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-18.7	-13.6	-9.5	-1.5	3.9	8.0	11.5	10.3	6.7	1.6	-8.7	-15.3	8.4	6.5
Alta, Ellerslie	-19.9	-14.6	-10.6	-1.0	4.8	9.3	12.5	11.7	7.2	0.1	-9.5	-16.9	9.6	7.4
Alta, Fort Vermilion	-27.0	-21.5	-16.0	-3.3	4.7	9.2	13.0	11.5	6.0	0.7	-13.0	-22.6	9.6	6.8
Alta, Lethbridge	-14.8	-9.3	-6.1	0.1	5.2	9.9	12.4	12.2	8.3	0.7	-6.6	-11.9	10.0	8.0
Man, Dauphin	-23.7	-20.3	-14.0	-2.9	4.1	10.5	13.7	13.9	8.8	0.9	-9.8	-18.6	10.5	8.0
Man, Winnipeg	-23.4	-20.0	-12.9	-1.4	5.6	11.9	14.9	15.4	10.0	1.5	-8.3	-17.6	11.9	9.4
NWT, Hay River	-29.5	-26.1	-22.4	-9.0	1.7	8.1	13.0	12.3	5.6	0.4	-14.3	-23.4	8.8	5.3
Sask, Prince Albert	-26.5	-21.6	-16.2	-3.0	3.7	9.1	12.7	12.1	6.7	-0.8	-12.4	-21.6	9.4	6.9
Sask, Swift Current	-18.7	-13.3	-9.1	-1.0	5.0	10.2	13.2	13.2	8.4	-0.2	-9.1	-14.7	10.4	8.2

Appendix 1 Cont'd: Mean Temperature (^{o}C) Values Derived from the Canadian Climate Centre GCM Using 3 Data Interpolation Methods

CCC - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-11.2	-5.8	-2.4	4.4	12.4	15.4	17.2	16.0	11.0	6.1	-4.8	-10.6	15.3	12.7
Alta, Ellerslie	-10.6	-5.6	-2.5	6.6	15.5	16.9	18.3	17.0	11.8	6.4	-4.1	-11.0	16.9	14.3
Alta, Fort Vermilion	-18.5	-13.3	-6.4	3.3	13.2	17.1	19.0	17.0	10.4	3.6	-9.7	-16.4	16.6	13.3
Alta, Lethbridge	-5.1	0.6	2.9	10.0	15.3	17.6	20.1	19.2	14.1	9.2	-0.1	-5.9	18.1	16.1
Man, Dauphin	-14.1	-10.7	-3.6	6.8	15.7	18.7	21.1	19.5	13.6	7.1	-4.1	-12.0	18.7	15.9
Man, Winnipeg	-13.9	-11.0	-3.4	7.3	17.3	19.5	22.0	20.2	14.5	7.5	-3.4	-11.4	19.8	16.8
NWT, Hay River	-21.6	-17.7	-12.6	-2.1	8.9	14.5	18.4	16.7	9.6	2.2	-10.4	-17.7	14.6	11.0
Sask, Prince Albert	-16.2	-11.4	-5.7	4.8	14.1	17.5	19.5	17.9	11.8	5.3	-6.5	-14.3	17.3	14.3
Sask, Swift Current	-8.7	-3.4	1.0	9.6	15.9	18.0	20.5	19.8	13.7	7.7	-2.7	-9.5	18.6	16.3

CCC - Nearest Nieghbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-11.6	-5.9	-2.7	4.7	12.5	15.4	17.2	15.9	11.0	6.2	-4.6	-11.1	15.2	12.8
Alta, Ellerslie	-10.3	-5.5	-2.5	6.7	16.1	17.0	18.3	17.0	11.8	6.4	-4.1	-10.6	17.1	14.5
Alta, Fort Vermilion	-18.2	-13.3	-6.5	3.2	13.3	17.2	18.9	16.9	10.4	3.6	-9.9	-16.7	16.6	13.3
Alta, Lethbridge	-4.7	0.8	3.2	10.3	15.7	17.6	20.1	19.2	14.0	9.1	-0.1	-6.0	18.1	16.1
Man, Dauphin	-13.6	-10.0	-2.6	8.5	16.5	18.7	21.1	19.7	13.7	7.2	-4.1	-12.9	19.0	16.4
Man, Winnipeg	-14.1	-11.2	-3.4	7.3	17.6	19.6	22.0	20.3	14.5	7.5	-3.4	-10.9	19.9	16.9
NWT, Hay River	-21.7	-17.8	-12.6	-2.0	8.8	14.5	18.6	17.0	9.7	2.2	-10.0	-18.2	14.7	11.1
Sask, Prince Albert	-16.6	-12.0	-6.3	3.6	13.4	17.5	19.5	17.9	11.8	5.2	-6.5	-13.9	17.1	13.9
Sask, Swift Current	-8.8	-3.5	0.8	9.4	15.6	17.9	20.4	19.7	13.6	7.7	-2.7	-9.8	18.4	16.1

CCC - Triangulated Interpolated Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-11.3	-5.9	-2.5	4.5	12.4	15.4	17.2	16.0	11.0	6.1	-4.8	-10.5	15.3	12.8
Alta, Ellerslie	-10.6	-5.6	-2.5	6.6	15.4	16.9	18.3	17.1	11.8	6.4	-4.1	-11.0	16.9	14.3
Alta, Fort Vermilion	-18.4	-13.3	-6.5	3.3	13.3	17.2	19.0	17.0	10.4	3.6	-9.7	-16.5	16.6	13.4
Alta, Lethbridge	-5.0	0.6	2.8	9.9	15.5	17.7	20.1	19.2	14.1	9.2	-0.1	-5.8	18.1	16.1
Man, Dauphin	-14.0	-10.5	-3.4	7.2	15.5	18.7	21.1	19.6	13.6	7.1	-4.1	-12.3	18.7	16.0
Man, Winnipeg	-13.9	-11.0	-3.4	7.2	17.3	19.6	22.0	20.2	14.5	7.5	-3.3	-11.4	19.8	16.8
NWT, Hay River	-21.5	-17.7	-12.6	-2.0	8.9	14.6	18.4	16.7	9.6	2.2	-10.3	-17.8	14.7	11.0
Sask, Prince Albert	-16.2	-11.5	-5.7	4.8	14.1	17.5	19.5	17.9	11.8	5.4	-6.5	-14.3	17.3	14.3
Sask, Swift Current	-8.7	-3.4	1.0	9.6	15.8	18.0	20.5	19.8	13.7	7.7	-2.7	-9.6	18.5	16.3

Appendix 1 Cont'd: Mean Temperature (^oC) Values Derived from the Hadley Centre GCM Using 3 Data Interpolation Methods

HadCM3 - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-15.3	-9.0	-5.4	3.8	10.8	15.8	17.7	17.7	11.5	6.5	-2.9	-11.5	15.5	12.9
Alta, Ellerslie	-15.6	-8.3	-4.1	4.6	12.5	17.1	19.3	19.1	12.6	7.1	-2.4	-11.1	17.0	14.2
Alta, Fort Vermilion	-23.0	-16.3	-11.2	2.5	12.1	17.6	19.3	18.4	10.8	4.2	-7.7	-18.5	16.9	13.5
Alta, Lethbridge	-9.2	-2.2	1.3	6.5	13.0	18.0	21.4	21.1	15.0	9.7	1.3	-5.0	18.4	15.9
Man, Dauphin	-17.6	-13.2	-6.7	4.4	12.5	18.3	22.0	20.3	13.7	7.7	-2.6	-13.3	18.3	15.2
Man, Winnipeg	-17.4	-13.3	-5.3	5.3	13.2	19.1	23.2	21.4	14.7	8.1	-2.0	-12.7	19.2	16.2
NWT, Hay River	-24.6	-20.5	-18.0	-3.5	8.0	14.9	18.2	17.7	9.8	3.0	-8.4	-19.5	14.7	10.8
Sask, Prince Albert	-20.5	-14.1	-8.3	4.1	12.3	17.4	20.6	19.2	12.0	5.9	-4.7	-15.8	17.4	14.2
Sask, Swift Current	-14.0	-6.8	-1.1	5.9	12.6	17.9	21.7	21.2	14.2	8.4	-1.3	-8.9	18.4	15.6

HadCM3 - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-15.3	-9.0	-5.3	3.8	10.7	15.8	17.7	17.7	11.5	6.4	-2.9	-11.5	15.5	12.9
Alta, Ellerslie	-15.2	-7.6	-3.2	4.8	12.7	17.1	19.5	19.4	12.8	7.3	-2.1	-10.7	17.2	14.4
Alta, Fort Vermilion	-23.2	-16.3	-11.0	2.7	12.1	17.7	19.3	18.5	10.9	4.3	-7.8	-18.7	16.9	13.5
Alta, Lethbridge	-9.1	-1.7	1.4	6.5	13.1	18.0	21.3	21.1	14.9	9.7	1.6	-4.7	18.4	15.8
Man, Dauphin	-17.8	-12.8	-6.2	4.9	12.3	18.3	22.1	20.1	13.7	8.0	-2.6	-13.3	18.2	15.2
Man, Winnipeg	-17.3	-13.3	-5.5	5.3	13.2	19.1	23.2	21.5	14.8	8.1	-1.9	-12.6	19.3	16.2
NWT, Hay River	-24.9	-20.6	-18.0	-3.6	8.0	14.9	18.2	17.7	9.8	3.0	-8.6	-19.6	14.7	10.8
Sask, Prince Albert	-20.4	-13.9	-7.9	4.3	12.3	17.3	20.7	19.2	12.1	6.0	-4.7	-15.8	17.4	14.3
Sask, Swift Current	-14.1	-6.7	-0.8	5.5	12.6	18.0	21.6	21.3	14.2	8.4	-1.2	-8.8	18.4	15.5

HadCM3 - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-15.3	-9.0	-5.4	3.8	10.8	15.8	17.7	17.7	11.5	6.5	-2.9	-11.5	15.5	12.9
Alta, Ellerslie	-15.4	-8.2	-3.9	4.7	12.5	17.1	19.3	19.2	12.7	7.2	-2.2	-11.0	17.1	14.3
Alta, Fort Vermilion	-23.0	-16.3	-11.2	2.5	12.1	17.6	19.3	18.4	10.8	4.3	-7.6	-18.5	16.8	13.5
Alta, Lethbridge	-9.2	-2.1	1.3	6.5	13.1	18.0	21.4	21.2	15.1	9.7	1.3	-5.0	18.4	15.9
Man, Dauphin	-17.6	-13.2	-6.7	4.4	12.5	18.2	22.0	20.3	13.7	7.8	-2.6	-13.3	18.2	15.2
Man, Winnipeg	-17.4	-13.3	-5.2	5.3	13.2	19.1	23.2	21.4	14.7	8.1	-2.0	-12.7	19.2	16.2
NWT, Hay River	-24.6	-20.5	-17.9	-3.5	8.0	14.9	18.2	17.7	9.8	3.0	-8.4	-19.5	14.7	10.8
Sask, Prince Albert	-20.5	-14.1	-8.2	4.1	12.3	17.4	20.6	19.2	12.0	5.9	-4.7	-15.8	17.4	14.2
Sask, Swift Current	-13.9	-6.8	-1.1	5.9	12.6	17.9	21.7	21.2	14.2	8.4	-1.3	-8.9	18.4	15.6

Appendix 1 Cont'd: Mean Temperature (^oC) Values Derived from the National Centre for Atmospheric Research GCM Using 3 Data Interpolation Methods

NCAR - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-14.0	-8.6	-4.7	4.0	10.1	14.3	17.7	16.3	11.9	6.1	-5.1	-11.4	14.6	12.4
Alta, Ellerslie	-14.6	-9.1	-5.5	4.7	11.5	15.6	18.7	17.8	13.0	5.8	-4.9	-12.1	15.9	13.5
Alta, Fort Vermilion	-22.0	-16.2	-9.8	2.7	11.3	15.8	19.2	17.6	11.2	4.7	-9.7	-18.4	16.0	13.0
Alta, Lethbridge	-9.3	-2.9	0.0	6.4	11.8	16.4	19.8	19.6	15.1	7.3	-0.7	-6.1	16.9	14.8
Man, Dauphin	-18.7	-14.4	-8.0	3.2	11.3	17.2	20.4	20.5	14.9	6.3	-5.2	-13.9	17.3	14.6
Man, Winnipeg	-18.6	-14.6	-7.2	4.4	12.3	18.3	21.1	21.6	16.0	6.7	-3.9	-13.1	18.3	15.6
NWT, Hay River	-24.6	-20.7	-16.3	-3.3	7.0	13.5	18.2	17.4	10.0	3.9	-10.7	-19.3	14.0	10.5
Sask, Prince Albert	-20.4	-15.0	-9.4	3.3	11.2	15.9	19.4	19.0	13.1	4.9	-7.6	-16.4	16.4	13.7
Sask, Swift Current	-14.0	-8.1	-4.1	4.8	11.5	16.6	20.2	20.4	14.7	5.6	-3.9	-9.9	17.1	14.7

NCAR - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-14.0	-8.5	-4.8	4.1	10.1	14.3	17.7	16.4	12.0	5.9	-5.0	-11.4	14.6	12.4
Alta, Ellerslie	-14.6	-9.3	-5.7	4.7	11.5	15.5	18.7	17.9	13.0	6.2	-5.1	-12.0	15.9	13.6
Alta, Fort Vermilion	-22.0	-16.1	-9.8	2.8	11.3	15.8	19.3	17.6	11.4	4.5	-9.9	-18.6	16.0	13.0
Alta, Lethbridge	-9.3	-2.9	0.1	6.4	11.9	16.4	19.7	19.5	15.2	7.4	-0.7	-6.1	16.9	14.8
Man, Dauphin	-18.7	-14.4	-8.1	3.2	11.3	17.1	20.4	20.4	14.9	6.4	-5.3	-14.0	17.3	14.5
Man, Winnipeg	-18.9	-14.5	-7.1	4.5	12.3	18.2	21.2	21.6	16.0	6.4	-4.0	-13.2	18.3	15.6
NWT, Hay River	-24.6	-20.6	-16.3	-3.3	7.1	13.4	18.2	17.3	10.1	3.9	-10.7	-19.4	14.0	10.5
Sask, Prince Albert	-20.1	-15.0	-9.5	3.3	11.3	15.9	19.4	19.1	13.2	5.4	-7.5	-16.1	16.4	13.7
Sask, Swift Current	-14.2	-8.0	-3.9	4.7	11.5	16.7	20.0	20.2	14.5	5.3	-3.5	-9.7	17.1	14.6

NCAR - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-14.1	-8.6	-4.7	4.0	10.1	14.3	17.7	16.3	11.8	6.1	-5.1	-11.4	14.6	12.4
Alta, Ellerslie	-14.6	-9.0	-5.4	4.8	11.5	15.6	18.6	17.8	13.0	5.9	-4.8	-12.1	15.9	13.5
Alta, Fort Vermilion	-22.0	-16.2	-9.8	2.7	11.3	15.9	19.2	17.6	11.2	4.7	-9.7	-18.5	16.0	13.0
Alta, Lethbridge	-9.3	-3.0	0.0	6.4	11.9	16.4	19.8	19.5	15.1	7.4	-0.8	-6.1	16.9	14.8
Man, Dauphin	-18.7	-14.4	-8.0	3.2	11.3	17.2	20.3	20.4	14.9	6.2	-5.1	-13.8	17.3	14.6
Man, Winnipeg	-18.6	-14.6	-7.2	4.4	12.3	18.3	21.1	21.6	16.0	6.6	-3.9	-13.0	18.3	15.6
NWT, Hay River	-24.6	-20.7	-16.3	-3.3	7.1	13.5	18.2	17.4	10.0	3.9	-10.8	-19.4	14.0	10.5
Sask, Prince Albert	-20.4	-15.0	-9.4	3.3	11.2	15.9	19.4	19.0	13.1	4.9	-7.6	-16.3	16.4	13.7
Sask, Swift Current	-14.0	-8.1	-4.0	4.8	11.5	16.6	20.2	20.3	14.7	5.7	-3.8	-9.9	17.2	14.7

Appendix 1 Cont'd: Maximum Temperature (°C) Values Derived from the Canadian Climate Centre GCM Using 3 Data Interpolation Methods

CCC - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-7.6	-2.8	0.4	8.8	19.9	21.7	23.4	22.4	16.7	11.6	-0.3	-6.9	21.8	18.8
Alta, Ellerslie	-6.1	-1.4	1.6	11.3	23.5	23.4	24.5	23.5	18.0	13.0	1.2	-6.5	23.7	20.7
Alta, Fort Vermilion	-14.2	-8.5	-2.3	8.8	20.7	23.7	25.0	23.2	16.1	8.9	-5.8	-12.9	23.2	19.6
Alta, Lethbridge	-0.8	4.7	7.1	16.8	23.2	24.6	27.8	27.2	21.8	16.5	6.7	-0.1	25.7	23.6
Man, Dauphin	-8.3	-4.8	0.7	12.8	24.5	25.8	28.0	27.2	20.7	13.6	1.8	-7.9	26.4	23.2
Man, Winnipeg	-8.5	-5.7	0.9	12.6	25.7	26.2	28.3	27.3	21.4	13.6	2.5	-7.7	26.9	23.6
NWT, Hay River	-16.9	-12.2	-8.0	3.3	15.3	20.1	23.6	22.2	14.7	7.1	-6.3	-14.0	20.3	16.5
Sask, Prince Albert	-10.2	-5.8	-0.7	11.3	22.6	24.4	26.2	25.4	18.5	12.0	-0.9	-9.5	24.6	21.4
Sask, Swift Current	-4.6	0.5	4.1	15.8	23.9	24.9	27.8	27.9	21.1	14.5	3.5	-4.6	26.1	23.6

CCC - Nearest Nieghbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-8.2	-3.0	0.3	8.9	20.1	21.7	23.4	22.4	16.7	11.7	0.0	-7.2	21.9	18.9
Alta, Ellerslie	-5.5	-1.0	2.0	11.2	24.1	23.4	24.5	23.5	18.0	13.0	1.1	-6.2	23.9	20.8
Alta, Fort Vermilion	-14.0	-8.6	-2.4	8.7	20.8	23.8	24.9	23.1	16.0	8.8	-5.9	-13.1	23.2	19.6
Alta, Lethbridge	-0.3	5.2	7.3	16.5	23.6	24.6	27.7	27.1	21.6	16.3	6.6	-0.2	25.7	23.5
Man, Dauphin	-8.0	-4.0	1.4	14.4	25.7	26.0	28.3	27.7	21.2	14.0	2.2	-8.5	26.9	23.9
Man, Winnipeg	-8.2	-5.6	1.2	12.3	26.0	26.2	28.4	27.5	21.4	13.6	2.4	-7.4	27.0	23.6
NWT, Hay River	-16.9	-12.1	-7.9	3.6	15.2	20.2	23.9	22.6	14.9	7.2	-6.0	-14.3	20.5	16.8
Sask, Prince Albert	-10.5	-6.6	-1.4	10.3	21.5	24.3	26.1	25.1	18.3	11.8	-1.1	-9.2	24.2	20.9
Sask, Swift Current	-4.9	0.1	3.7	15.5	23.5	24.7	27.6	27.5	20.9	14.3	3.5	-4.7	25.8	23.3

CCC - Triangulated Interpolated Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-7.6	-2.8	0.5	8.9	19.8	21.7	23.4	22.5	16.7	11.7	-0.2	-6.7	21.9	18.8
Alta, Ellerslie	-6.1	-1.4	1.6	11.3	23.5	23.4	24.5	23.5	18.1	13.1	1.2	-6.5	23.7	20.7
Alta, Fort Vermilion	-14.1	-8.5	-2.2	8.8	20.8	23.8	25.1	23.2	16.1	8.9	-5.8	-13.0	23.2	19.6
Alta, Lethbridge	-0.7	4.8	7.1	16.5	23.3	24.6	27.8	27.2	21.8	16.5	6.7	-0.1	25.7	23.5
Man, Dauphin	-8.4	-4.6	0.8	13.2	24.3	25.9	28.1	27.3	20.9	13.7	1.8	-8.0	26.4	23.3
Man, Winnipeg	-8.5	-5.7	0.9	12.4	25.7	26.2	28.3	27.3	21.4	13.6	2.5	-7.6	26.9	23.6
NWT, Hay River	-16.8	-12.2	-7.9	3.3	15.3	20.2	23.6	22.2	14.7	7.1	-6.2	-14.0	20.3	16.6
Sask, Prince Albert	-10.2	-5.8	-0.7	11.3	22.5	24.4	26.2	25.4	18.6	12.0	-0.9	-9.5	24.6	21.4
Sask, Swift Current	-4.6	0.6	4.1	15.9	23.8	24.9	27.9	27.9	21.1	14.5	3.6	-4.6	26.1	23.6

Appendix 1 Cont'd: Maximum Temperature (^oC) Values Derived from the Hadley Centre GCM Using 3 Data Interpolation Methods

HadCM3 - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-10.7	-4.3	-0.6	9.1	17.0	22.1	24.0	24.0	17.2	11.6	1.2	-7.1	21.8	18.9
Alta, Ellerslie	-10.4	-2.9	1.2	10.4	19.3	23.5	25.6	25.4	18.8	13.3	2.4	-6.1	23.4	20.5
Alta, Fort Vermilion	-18.3	-10.6	-5.0	8.6	18.7	24.2	25.5	24.7	16.4	8.9	-3.9	-14.2	23.3	19.7
Alta, Lethbridge	-3.3	3.9	7.7	13.1	19.9	24.8	29.0	28.8	22.3	16.7	7.2	0.8	25.6	23.0
Man, Dauphin	-12.2	-7.0	-0.8	10.5	19.7	25.2	28.7	27.1	20.1	13.5	2.2	-8.2	25.2	21.9
Man, Winnipeg	-12.2	-7.7	0.3	11.0	20.1	25.7	29.6	28.0	21.0	13.7	2.5	-7.8	25.8	22.6
NWT, Hay River	-19.8	-14.8	-11.7	2.4	13.4	20.3	23.3	22.9	14.3	7.0	-4.3	-15.0	20.0	16.1
Sask, Prince Albert	-14.3	-7.2	-1.4	10.3	19.8	24.3	27.3	26.3	18.6	12.1	0.2	-10.2	24.5	21.1
Sask, Swift Current	-8.8	-1.5	4.2	11.8	19.3	24.6	28.8	28.5	20.8	14.5	3.9	-3.9	25.3	22.3

HadCM3 - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-10.7	-4.3	-0.5	9.1	16.9	22.1	24.0	24.0	17.1	11.6	1.3	-7.1	21.7	18.9
Alta, Ellerslie	-10.0	-2.2	2.2	10.7	19.4	23.5	25.8	25.8	19.0	13.5	2.7	-5.6	23.6	20.7
Alta, Fort Vermilion	-18.4	-10.6	-4.8	8.8	18.7	24.3	25.6	24.8	16.4	8.9	-4.0	-14.4	23.3	19.7
Alta, Lethbridge	-3.2	4.3	7.8	13.1	19.9	24.8	28.9	28.7	22.2	16.7	7.5	1.1	25.6	22.9
Man, Dauphin	-12.4	-6.7	-0.3	11.0	19.6	25.2	28.8	27.0	20.1	13.8	2.2	-8.2	25.1	21.9
Man, Winnipeg	-12.1	-7.7	0.0	11.0	20.1	25.6	29.6	28.1	21.1	13.6	2.6	-7.8	25.8	22.6
NWT, Hay River	-20.1	-14.9	-11.7	2.3	13.4	20.4	23.3	22.9	14.4	7.0	-4.5	-15.1	20.0	16.1
Sask, Prince Albert	-14.2	-7.0	-1.1	10.6	19.9	24.3	27.4	26.3	18.7	12.2	0.2	-10.2	24.5	21.2
Sask, Swift Current	-8.9	-1.5	4.5	11.4	19.3	24.6	28.7	28.7	20.9	14.5	4.0	-3.8	25.3	22.3

HadCM3 - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-10.7	-4.3	-0.6	9.1	17.0	22.1	24.0	24.0	17.2	11.6	1.2	-7.1	21.8	18.9
Alta, Ellerslie	-10.2	-2.8	1.4	10.5	19.3	23.5	25.6	25.6	18.9	13.4	2.6	-6.0	23.5	20.6
Alta, Fort Vermilion	-18.2	-10.6	-4.9	8.6	18.7	24.2	25.5	24.7	16.4	8.9	-3.9	-14.2	23.3	19.7
Alta, Lethbridge	-3.2	3.9	7.7	13.1	19.9	24.8	29.0	28.8	22.3	16.7	7.2	0.8	25.6	23.0
Man, Dauphin	-12.2	-7.1	-0.8	10.5	19.7	25.1	28.7	27.1	20.1	13.6	2.2	-8.2	25.2	21.9
Man, Winnipeg	-12.2	-7.7	0.3	11.0	20.1	25.6	29.6	28.0	21.0	13.7	2.4	-7.8	25.8	22.6
NWT, Hay River	-19.8	-14.8	-11.6	2.4	13.4	20.3	23.3	22.9	14.4	7.0	-4.3	-15.0	20.0	16.1
Sask, Prince Albert	-14.3	-7.2	-1.4	10.4	19.8	24.3	27.3	26.3	18.6	12.1	0.2	-10.2	24.4	21.1
Sask, Swift Current	-8.7	-1.5	4.2	11.8	19.3	24.6	28.8	28.5	20.8	14.5	3.9	-3.9	25.3	22.3

Appendix 1 Cont'd: Maximum Temperature (^{o}C) Values Derived from the National Centre for Atmospheric Research GCM Using 3 Data Interpolation Methods

NCAR - Kriging

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-9.3	-3.5	0.1	9.6	16.2	20.6	23.7	22.3	16.9	10.5	-1.4	-7.3	20.7	18.2
Alta, Ellerslie	-9.5	-3.4	-0.2	10.5	18.0	21.7	24.7	23.7	18.7	11.6	-0.2	-7.2	22.0	19.6
Alta, Fort Vermilion	-17.2	-10.7	-3.5	8.7	17.8	22.4	25.3	23.8	16.5	8.5	-6.6	-14.4	22.3	19.1
Alta, Lethbridge	-3.9	3.5	6.2	12.6	18.5	22.7	27.2	26.8	21.9	14.0	5.3	-0.1	23.8	21.6
Man, Dauphin	-13.8	-8.4	-2.0	9.2	18.2	23.7	26.8	27.0	21.1	11.4	-0.5	-9.2	23.9	21.0
Man, Winnipeg	-13.9	-9.0	-1.3	10.2	18.7	24.5	27.3	27.9	22.1	11.6	0.4	-8.5	24.6	21.8
NWT, Hay River	-19.7	-15.2	-10.2	2.4	12.4	18.7	23.4	22.4	14.5	7.3	-7.3	-15.4	19.2	15.6
Sask, Prince Albert	-14.3	-8.1	-2.6	9.6	18.4	22.6	26.1	25.8	19.6	10.5	-2.8	-11.1	23.2	20.3
Sask, Swift Current	-9.4	-2.7	1.2	10.4	17.8	22.8	27.1	27.4	21.0	11.6	1.6	-5.0	23.8	21.1

NCAR - Nearest Neighbour

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-9.3	-3.3	0.0	9.7	16.2	20.5	23.7	22.3	17.1	10.3	-1.3	-7.3	20.7	18.3
Alta, Ellerslie	-9.4	-3.7	-0.4	10.5	18.1	21.8	24.9	24.0	18.8	11.9	-0.4	-7.2	22.2	19.7
Alta, Fort Vermilion	-17.1	-10.5	-3.5	8.9	17.8	22.4	25.3	23.7	16.7	8.3	-6.6	-14.5	22.3	19.1
Alta, Lethbridge	-4.0	3.6	6.4	12.6	18.6	22.6	27.1	26.8	21.9	14.0	5.4	-0.1	23.8	21.6
Man, Dauphin	-13.7	-8.4	-2.1	9.2	18.2	23.7	26.9	26.9	21.1	11.5	-0.8	-9.3	23.9	21.0
Man, Winnipeg	-14.4	-8.9	-1.1	10.3	18.7	24.4	27.2	27.7	22.0	11.5	0.5	-8.6	24.5	21.7
NWT, Hay River	-19.7	-15.2	-10.1	2.5	12.4	18.7	23.3	22.4	14.5	7.2	-7.3	-15.4	19.2	15.6
Sask, Prince Albert	-13.9	-8.3	-2.7	9.8	18.5	22.6	26.2	26.1	19.8	11.1	-2.9	-10.8	23.4	20.5
Sask, Swift Current	-9.8	-2.7	1.4	10.3	17.9	22.9	27.1	27.3	20.8	11.4	1.9	-4.7	23.8	21.0

NCAR - Triangulated Interpolation Network

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MJJA	AMJJAS
Alta, Beaverlodge	-9.3	-3.5	0.0	9.6	16.2	20.5	23.7	22.3	16.9	10.5	-1.4	-7.3	20.7	18.2
Alta, Ellerslie	-9.5	-3.3	-0.2	10.6	18.0	21.7	24.7	23.8	18.8	11.7	-0.2	-7.1	22.0	19.6
Alta, Fort Vermilion	-17.2	-10.7	-3.5	8.7	17.8	22.4	25.3	23.8	16.5	8.5	-6.5	-14.4	22.3	19.1
Alta, Lethbridge	-3.9	3.5	6.2	12.6	18.5	22.7	27.2	26.8	21.9	14.1	5.3	-0.1	23.8	21.6
Man, Dauphin	-13.7	-8.4	-2.0	9.2	18.2	23.8	26.9	27.0	21.1	11.5	-0.5	-9.1	24.0	21.0
Man, Winnipeg	-13.9	-9.0	-1.3	10.2	18.7	24.5	27.3	27.9	22.1	11.7	0.4	-8.5	24.6	21.8
NWT, Hay River	-19.7	-15.2	-10.2	2.4	12.4	18.8	23.4	22.4	14.5	7.3	-7.3	-15.4	19.2	15.6
Sask, Prince Albert	-14.3	-8.2	-2.6	9.6	18.4	22.6	26.1	25.9	19.6	10.5	-2.8	-11.0	23.2	20.4
Sask, Swift Current	-9.3	-2.7	1.2	10.5	17.9	22.8	27.1	27.4	21.0	11.7	1.6	-4.9	23.8	21.1

Appendix 2: Land Suitability Ratings for Spring Seeded Cereals Under Baseline Conditions and Climatic Change Scenarios

Beaverlodge Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	58.3	70.2	58.3	3H

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	83.0	70.8	70.8	2A
Kriging HadCM	82.7	70.8	70.8	2A
Kriging NCAR	89.6	74.2	74.2	2
NN CCC	79.0	67.3	67.3	2A
NN HadCM	83.1	70.8	70.8	2A
NN NCAR	90.6	74.2	74.2	2
TIN CCC	82.4	70.0	70.0	2A
TIN HadCM	82.8	70.0	70.0	2A
TIN NCAR	89.6	74.2	74.2	2

Beaverlodge Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	58.3	77.0	58.3	3H

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	83.0	69.5	69.5	2A
Kriging HadCM	82.7	69.5	69.5	2A
Kriging NCAR	89.6	81.2	81.2	1
NN CCC	79.0	66.1	66.1	2A
NN HadCM	83.1	70.3	70.3	2A
NN NCAR	90.6	81.2	81.2	1
TIN CCC	82.4	69.5	69.5	2A
TIN HadCM	82.8	69.5	69.5	2A
TIN NCAR	89.6	81.2	81.2	1

Ellerslie Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	74.4	56.9	56.9	3HD

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	81.3	56.2	56.2	3DM
Kriging HadCM	77.2	53.4	53.4	3AD
Kriging NCAR	98.3	61.3	61.3	2D
NN CCC	82.5	57.3	57.3	3DM
NN HadCM	74.9	52.0	52.0	3AD
NN NCAR	97.1	60.7	60.7	2D
TIN CCC	81.3	56.2	56.2	3DM
TIN HadCM	76.5	53.1	53.1	3AD
TIN NCAR	97.9	61.3	61.3	2D

Ellerslie Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	74.4	72.8	72.8	2HD

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	81.3	64.8	64.8	2AD
Kriging HadCM	77.2	61.6	61.6	2AD
Kriging NCAR	98.3	78.4	78.4	2D
NN CCC	82.5	66.0	66.0	2AD
NN HadCM	74.9	60.0	60.0	2AD
NN NCAR	97.1	77.6	77.6	2D
TIN CCC	81.3	64.8	64.8	2AD
TIN HadCM	76.5	61.2	61.2	2AD
TIN NCAR	97.9	78.4	78.4	2D

Fort Vermillion Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	74.7	40.0	40.0	4M

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	75.1	34.0	34.0	4M
Kriging HadCM	66.5	26.0	26.0	5M
Kriging NCAR	79.1	39.0	39.0	4M
NN CCC	75.7	35.0	35.0	4M
NN HadCM	65.9	25.0	25.0	5M
NN NCAR	80.4	40.0	40.0	4M
TIN CCC	74.2	31.0	31.0	4M
TIN HadCM	67.0	26.0	26.0	5M
TIN NCAR	79.3	39.0	39.0	4M

Fort Vermillion Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	74.7	46.0	46.0	3HEM

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	75.1	40.0	40.0	4ME
Kriging HadCM	66.5	32.0	32.0	4ME
Kriging NCAR	79.1	45.0	45.0	3AE
NN CCC	75.7	41.0	41.0	4ME
NN HadCM	65.9	31.0	31.0	4ME
NN NCAR	80.4	46.0	46.0	3EM
TIN CCC	74.2	37.0	37.0	4ME
TIN HadCM	67.0	32.0	32.0	4ME
TIN NCAR	79.3	45.0	45.0	3AE

Note: Clim = Climate component score of LSRS, Soil = Soil component score of LSRS, Final = Overall LSRS score, Suit = Suitability class and subclass

Appendix 2: Continued

Lethbridge Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	56.2	23.0	23.0	5MF
	2041-2060			
Interploation Method	Clim	Soil	Final	Suit
Kriging CCC	43.2	8.0	8.0	7MF
Kriging HadCM	42.7	8.0	8.0	7MF
Kriging NCAR	59.6	25.0	25.0	5MF
NN CCC	44.0	9.0	9.0	7MF
NN HadCM	42.9	8.0	8.0	7MF
NN NCAR	58.5	24.0	24.0	5MF
TIN CCC	43.3	8.0	8.0	7MF
TIN HadCM	42.6	8.0	8.0	7MF
TIN NCAR	58.9	24.0	24.0	5MF

Lethbridge Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	56.2	30.2	30.2	4A
	2041-2060			
Interploation Method	Clim	Soil	Final	Suit
Kriging CCC	43.2	17.6	17.6	6M
Kriging HadCM	42.7	17.6	17.6	6M
Kriging NCAR	59.6	32.9	32.9	4A
NN CCC	44.0	18.5	18.5	6M
NN HadCM	42.9	17.6	17.6	6M
NN NCAR	58.5	32.0	32.0	4A
TIN CCC	43.3	17.6	17.6	6M
TIN HadCM	42.6	17.6	17.6	6M
TIN NCAR	58.9	32.0	32.0	4A

Dauphin Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	78.5	73.0	73.0	2A
	2041-2060			
Interploation Method	Clim	Soil	Final	Suit
Kriging CCC	61.9	51.0	51.0	3A
Kriging HadCM	64.7	54.0	54.0	3A
Kriging NCAR	83.5	80.0	80.0	1A
NN CCC	55.5	44.5	44.5	4A
NN HadCM	66.7	56.0	56.0	3A
NN NCAR	82.6	78.5	78.5	2A
TIN CCC	60.6	50.0	50.0	3A
TIN HadCM	66.0	55.0	55.0	3A
TIN NCAR	83.3	78.5	78.5	2A

Winnipeg Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	82.6	83.7	82.6	1A
	2041-2060			
Interploation Method	Clim	Soil	Final	Suit
Kriging CCC	68.7	68.7	68.7	2A
Kriging HadCM	69.3	70.0	69.3	2A
Kriging NCAR	86.2	88.0	86.2	1
NN CCC	67.4	67.4	67.4	2A
NN HadCM	68.3	68.0	68.0	2A
NN NCAR	88.0	90.6	88.0	1
TIN CCC	68.8	68.8	68.8	2A
TIN HadCM	69.4	70.1	69.4	2A
TIN NCAR	86.1	87.9	86.1	1

Hay River Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	46.2	26.0	26.0	5EM
	2041-2060			
Interploation Method	Clim	Soil	Final	Suit
Kriging CCC	77.2	22.4	22.4	5ME
Kriging HadCM	79.3	23.9	23.9	5ME
Kriging NCAR	77.3	26.4	26.4	5ME
NN CCC	75.4	21.4	21.4	5ME
NN HadCM	78.6	23.5	23.5	5ME
NN NCAR	77.0	26.5	26.5	5ME
TIN CCC	77.1	22.4	22.4	5ME
TIN HadCM	79.3	23.9	23.9	5ME
TIN NCAR	77.5	26.4	26.4	5ME

Hay River Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	46.2	10.0	10.0	6WE
	2041-2060			
Interploation Method	Clim	Soil	Final	Suit
Kriging CCC	77.2	16.2	16.2	6EO
Kriging HadCM	79.3	16.3	16.3	6EO
Kriging NCAR	77.3	16.5	16.5	6EO
NN CCC	75.4	16.1	16.1	6EO
NN HadCM	78.6	16.2	16.2	6EO
NN NCAR	77.0	16.5	16.5	6EO
TIN CCC	77.1	16.1	16.1	6EO
TIN HadCM	79.3	16.3	16.3	6EO
TIN NCAR	77.5	16.5	16.5	6EO

Appendix 2: Continued

Prince Albert Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	71.6	59.2	59.2	3A

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	65.1	50.7	50.7	3A
Kriging HadCM	57.4	39.8	39.8	4A
Kriging NCAR	72.8	60.3	60.3	2A
NN CCC	69.1	56.4	56.4	3A
NN HadCM	56.7	38.8	38.8	4A
NN NCAR	69.2	56.5	56.5	3A
TIN CCC	64.7	50.2	50.2	3A
TIN HadCM	57.4	39.7	39.7	4A
TIN NCAR	73.1	60.5	60.5	2A

Swift Current Dominant Soil #1

	Clim	Soil	Final	Suit
Baseline	57.4	37.9	37.9	4A

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	41.1	22.4	22.4	5A
Kriging HadCM	44.8	25.9	25.9	5M
Kriging NCAR	61.7	42.0	42.0	4M
NN CCC	43.2	24.4	24.4	5M
NN HadCM	44.1	25.3	25.3	5M
NN NCAR	60.5	40.8	40.8	4M
TIN CCC	40.7	22.0	22.0	5M
TIN HadCM	44.6	25.7	25.7	5M
TIN NCAR	60.8	41.1	41.1	4M

Prince Albert Dominant Soil #2

	Clim	Soil	Final	Suit
Baseline	71.6	48.4	48.4	3A

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	65.1	41.4	41.4	4M
Kriging HadCM	57.4	34.1	34.1	4M
Kriging NCAR	72.8	50.1	50.1	3A
NN CCC	69.1	45.2	45.2	3M
NN HadCM	56.7	33.4	33.4	4M
NN NCAR	69.2	45.3	45.3	3A
TIN CCC	64.7	41.0	41.0	4M
TIN HadCM	57.4	34.1	34.1	4A
TIN NCAR	73.1	50.4	50.4	3A

Swift Current Dominant Soil #2

	Clim	Soil	Final	Suit
Baseline	57.4	26.9	26.9	5ME

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	41.1	12.2	12.2	6ME
Kriging HadCM	44.8	15.6	15.6	6ME
Kriging NCAR	61.7	30.8	30.8	4ME
NN CCC	43.2	14.1	14.1	6ME
NN HadCM	44.1	14.9	14.9	6ME
NN NCAR	60.5	29.6	29.6	5ME
TIN CCC	40.7	11.9	11.9	6ME
TIN HadCM	44.6	15.4	15.4	6ME
TIN NCAR	60.8	30.0	30.0	4ME

Prince Albert Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	71.6	29.5	29.5	5M

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	65.1	23.4	23.4	5M
Kriging HadCM	57.4	16.1	16.1	6M
Kriging NCAR	72.8	30.7	30.7	4M
NN CCC	69.1	27.2	27.2	5M
NN HadCM	56.7	15.4	15.4	6M
NN NCAR	69.2	27.3	27.3	5M
TIN CCC	64.7	23.0	23.0	5M
TIN HadCM	57.4	16.1	16.1	6M
TIN NCAR	73.1	30.9	30.9	4M

Swift Current Subdominant Soil #1

	Clim	Soil	Final	Suit
Baseline	57.4	23.8	23.8	5M

Interploation Method	2041-2060 Clim	Soil	Final	Suit
Kriging CCC	41.1	9.1	9.1	7M
Kriging HadCM	44.8	12.4	12.4	6M
Kriging NCAR	61.7	27.6	27.6	5M
NN CCC	43.2	11.0	11.0	6M
NN HadCM	44.1	11.8	11.8	6M
NN NCAR	60.5	26.5	26.5	5M
TIN CCC	40.7	8.7	8.7	7M
TIN HadCM	44.6	12.2	12.2	6M
TIN NCAR	60.8	26.8	26.8	5M

Appendix 3: Spring Wheat Yields (kg/ha) Under Baseline Conditions and Climatic Change Scenarios [5]

Beaverlodge Dominant Soil #1

	Yield	σ
BASELINE	2737.9	871.2

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	2630.9	676.3
Kriging HadCM	2263.9	682.8
Kriging NCAR	2732.4	617.3
NN CCC	2650.1	679.6
NN HadCM	2256.5	680.4
NN NCAR	2703.6	631.4
TIN CCC	2672.2	649.5
TIN HadCM	2270.2	683.4
TIN NCAR	2735.1	626.3

Beaverlodge Subdominant Soil #1

	Yield	σ
BASELINE	6969.1	1979.5

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	6851.3	1500.1
Kriging HadCM	6356.9	1442.8
Kriging NCAR	7075.7	1358.6
NN CCC	6707.2	1634.0
NN HadCM	6388.5	1438.5
NN NCAR	7043.3	1292.3
TIN CCC	6852.0	1547.6
TIN HadCM	6384.3	1431.3
TIN NCAR	7069.8	1354.9

Ellerslie Dominant Soil #1

	Yield	σ
BASELINE	4473.7	878.8

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	4693.0	740.5
Kriging HadCM	4471.0	846.2
Kriging NCAR	4636.5	988.0
NN CCC	4717.6	741.6
NN HadCM	4483.8	768.4
NN NCAR	4552.5	942.3
TIN CCC	4702.1	731.5
TIN HadCM	4463.6	782.5
TIN NCAR	4651.4	988.3

Ellerslie Subdominant Soil #1

	Yield	σ
BASELINE	5374.8	948.1

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	5661.6	815.2
Kriging HadCM	5365.9	853.1
Kriging NCAR	5785.2	958.5
NN CCC	5683.0	808.9
NN HadCM	5357.5	821.6
NN NCAR	5671.0	928.6
TIN CCC	5666.6	808.9
TIN HadCM	5365.1	809.6
TIN NCAR	5793.7	957.5

Fort Vermilion Dominant Soil #1

	Yield	σ
BASELINE	1897.7	551.9

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	1742.1	440.9
Kriging HadCM	1621.4	406.1
Kriging NCAR	1806.7	412.7
NN CCC	1748.5	435.0
NN HadCM	1612.9	405.4
NN NCAR	1815.3	407.6
TIN CCC	1740.7	443.7
TIN HadCM	1629.2	398.1
TIN NCAR	1817.6	410.9

Fort Vermilion Subdominant Soil #1

	Yield	σ
BASELINE	919.8	478.0

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	831.3	446.6
Kriging HadCM	724.3	411.7
Kriging NCAR	833.2	471.9
NN CCC	831.4	461.1
NN HadCM	723.5	433.1
NN NCAR	827.0	471.3
TIN CCC	838.0	447.7
TIN HadCM	726.7	416.7
TIN NCAR	837.8	473.0

Appendix 6: Continued

[5] Yields reported in tables are averaged over a 19 year period

Lethbridge Dominant Soil #1

	Yield	σ
BASELINE	270.0	252.3

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	369.4	392.7
Kriging HadCM	334.4	354.4
Kriging NCAR	219.1	219.2
NN CCC	363.7	394.6
NN HadCM	331.1	347.2
NN NCAR	226.1	228.8
TIN CCC	368.9	395.0
TIN HadCM	334.1	354.5
TIN NCAR	224.2	225.7

Lethbridge Subdominant Soil #1

	Yield	σ
BASELINE	475.2	227.7

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	608.9	280.8
Kriging HadCM	558.2	256.6
Kriging NCAR	470.1	223.6
NN CCC	614.2	288.1
NN HadCM	561.3	260.2
NN NCAR	474.2	227.9
TIN CCC	608.9	283.3
TIN HadCM	557.1	255.7
TIN NCAR	475.1	229.9

Dauphin Dominant Soil #1

	Yield	σ
BASELINE	2348.6	884.8

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	2562.4	618.7
Kriging HadCM	2408.4	597.0
Kriging NCAR	2269.5	574.3
NN CCC	2502.2	612.6
NN HadCM	2435.4	601.8
NN NCAR	2281.9	571.0
TIN CCC	2577.4	617.5
TIN HadCM	2411.7	604.1
TIN NCAR	2276.1	571.0

Winnipeg Subdominant Soil #1

	Yield	σ
BASELINE	3021.1	942.2

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	3130.0	629.3
Kriging HadCM	3101.6	660.2
Kriging NCAR	3000.9	693.2
NN CCC	3136.3	647.9
NN HadCM	3085.3	647.8
NN NCAR	2972.3	674.4
TIN CCC	3133.2	628.8
TIN HadCM	3101.8	660.5
TIN NCAR	3013.3	693.1

Hay River Dominant Soil #1

	Yield	σ
BASELINE	633.6	815.7

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	361.2	306.2
Kriging HadCM	233.2	208.6
Kriging NCAR	277.5	242.0
NN CCC	375.3	313.7
NN HadCM	236.8	212.6
NN NCAR	276.4	243.3
TIN CCC	360.6	310.4
TIN HadCM	233.3	208.8
TIN NCAR	273.1	240.6

Hay River Subdominant Soil #1

	Yield	σ
BASELINE	944.8	606.5

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	870.6	294.1
Kriging HadCM	813.5	278.4
Kriging NCAR	884.8	302.2
NN CCC	863.4	298.3
NN HadCM	811.0	283.5
NN NCAR	880.1	304.1
TIN CCC	872.7	291.7
TIN HadCM	814.2	276.0
TIN NCAR	883.8	301.2

Appendix 3: Continued

Prince Albert Dominant Soil #1

	Yield	σ
BASELINE	2653.9	1062.3

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	3033.1	931.2
Kriging HadCM	2770.8	992.9
Kriging NCAR	2763.8	1030.6
NN CCC	2991.4	942.8
NN HadCM	2817.6	990.7
NN NCAR	2802.1	1119.2
TIN CCC	3043.9	948.2
TIN HadCM	2779.1	1000.7
TIN NCAR	2742.4	1023.1

Swift Current Dominant Soil #1

	Yield	σ
BASELINE	2515.6	1092.3

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	3139.8	1259.5
Kriging HadCM	2949.7	1029.6
Kriging NCAR	2763.5	911.7
NN CCC	3106.4	1283.4
NN HadCM	2921.8	1036.6
NN NCAR	2748.8	904.0
TIN CCC	3127.4	1256.1
TIN HadCM	2924.5	1038.0
TIN NCAR	2764.9	923.2

Prince Albert Dominant Soil #2

	Yield	σ
BASELINE	2605.7	1050.8

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	2897.3	1116.4
Kriging HadCM	2786.0	1093.9
Kriging NCAR	2623.7	1095.2
NN CCC	2857.4	1080.9
NN HadCM	2815.6	1091.5
NN NCAR	2701.1	1147.4
TIN CCC	2909.5	1123.5
TIN HadCM	2787.6	1095.6
TIN NCAR	2610.2	1101.0

Swift Current Dominant Soil #2

	Yield	σ
BASELINE	2143.3	1384.5

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	2847.6	1134.2
Kriging HadCM	2525.8	1293.0
Kriging NCAR	2217.6	1221.6
NN CCC	2838.1	1534.9
NN HadCM	2517.8	1296.2
NN NCAR	2245.5	1266.0
TIN CCC	2899.5	1270.5
TIN HadCM	2529.7	1313.0
TIN NCAR	2237.0	1281.0

Prince Albert Subdominant Soil #1

	Yield	σ
BASELINE	1375.7	778.3

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	1505.0	946.2
Kriging HadCM	1509.9	769.9
Kriging NCAR	1265.9	715.4
NN CCC	1484.5	926.2
NN HadCM	1564.9	776.5
NN NCAR	1373.6	766.0
TIN CCC	1509.5	947.8
TIN HadCM	1519.9	770.0
TIN NCAR	1246.3	705.6

Swift Current Subdominant Soil #1

	Yield	σ
BASELINE	1093.1	689.5

Interpolation Method	2041-60	
	Yield	σ
Kriging CCC	1346.8	607.6
Kriging HadCM	1289.5	598.1
Kriging NCAR	1033.1	699.0
NN CCC	1365.0	623.7
NN HadCM	1294.8	601.2
NN NCAR	1057.9	693.2
TIN CCC	1347.2	599.5
TIN HadCM	1297.8	591.5
TIN NCAR	1066.7	705.2