CLIMATE SUMMARY FOR:
NORTHEAST REGION

PART OF A SERIES ON THE RESOURCE REGIONS OF BRITISH COLUMBIA

ABOUT THIS SERIES

There is a strong scientific consensus that the Earth's climate is changing, primarily due to greenhouse gas emissions. This series of climate summaries, for the eight resource regions of British Columbia, is meant to help inform readers about past climate and future projected changes. It is intended that the series will be updated with new information as research progresses.

GENERAL OVERVIEW

British Columbia's climate exhibits large variations over short distances, due to complex topography.

Long-term historical trends show warming, more rapid for night-time low temperatures than day-time highs and more rapid in winter than summer. Precipitation trends are less certain due to data limitations and also exhibit increases, except in the winter season when large variability results in trends that depend highly on the period considered.

Further warming and precipitation changes are projected throughout the 21st century. The magnitude of the projected warming is relatively large compared to historical variability. Some possible consequences of these projected changes on resource operations are considered.

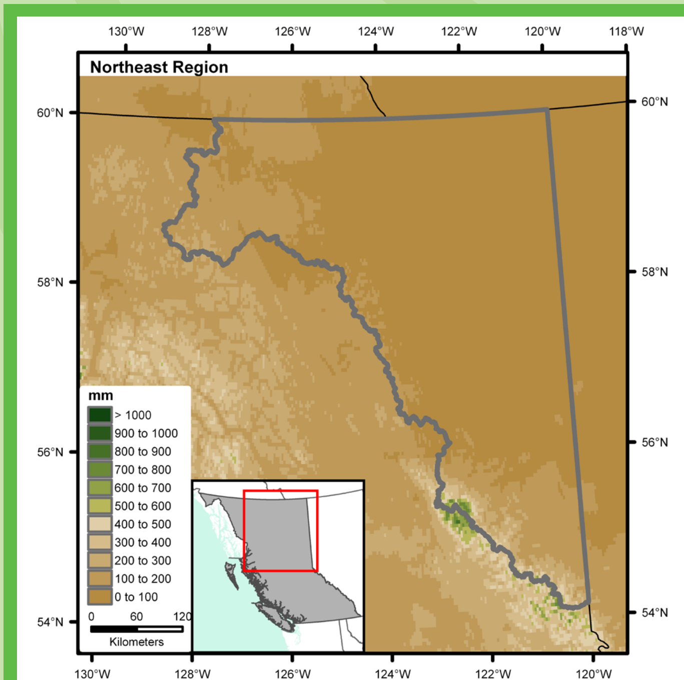

Figure 1: Winter precipitation for the region. The region is bounded in grey and the red box shows its location in BC.

ABOUT THIS REGION

The Northeast Region, with a population of just under 50,000, is in the northeastern corner of British Columbia, south of Yukon and stretching west from Alberta to the Skeena and Omenica Regions (Figure 1). The region contains parts of a number of major drainage basins, including the Liard, Upper Slave and Peace. Owing to the complex topography, which includes part of the Rocky Mountains as well as the Northeastern Plains, the area's climate varies considerably over short distances. Also, two major Pacific climate patterns—El Niño and the Pacific Decadal Oscillation—exert their influence over the region's year-to-year variability.

The forests of the region are dominated by black and white spruce, tamarack, lodgepole pine and aspen. Higher elevations in the northern Rocky Mountains feature Engelmann spruce and subalpine fir. There are extensive willow-dominated shrublands in cold, northern areas and alpine plant communities in the Rocky Mountains and foothills. The economy is largely based around trade, construction, foresty, agriculture, fishing, mining, oil and gas.

University of Victoria

PCIC gratefully acknowledges the support of the Ministry of Forests, Lands and Natural Resource Operations.

Precipitation is historically considerably greater in the summer than other seasons. Most of the region receives less than 100 mm in the winter. The western edge of the region includes locations in and near the Rocky Mountains with winter precipitation estimated at over 400 mm and at the highest elevations over 1000 mm.

HISTORICAL TRENDS

The historical annual trend (based on the CANGRID dataset[1]) indicates that over 2 °C of warming has already occurred during the 20th century. Summer and winter trends are plotted in Figures 2 and 3, while trends for all seasons are provided in Tables 1 and 2. The winter warming trend is greater over the 1951-2009 period. These trends are regional averages. In regions with complex topography, trends could vary considerably with elevation.

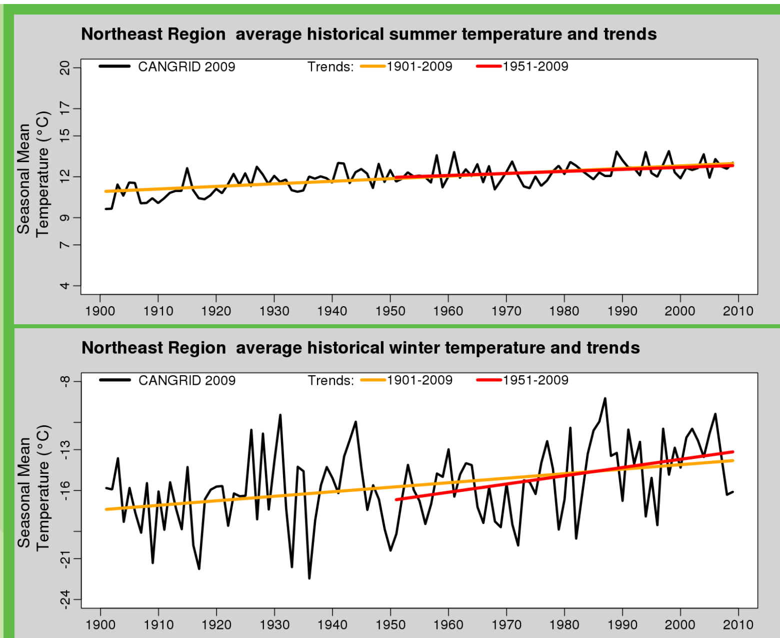

Figure 2: Historic summer and winter temperature time series, 1901-2009.

Table 1: Temperature Trends (°C per decade) for the Northeast Region

Period	Trend* 1901-2009	Statistical Uncertainty in Trend[3] 1901-2009	Trend* 1951-2009	Statistical Uncertainty in Trend[3] 1951-2009
Spring (MAM)	**0.26**	0.15 to 0.38	0.30	-0.02 to 0.58
Summer (JJA)	**0.19**	0.14 to 0.24	**0.15**	0.06 to 0.24
Autumn (SON)	**0.13**	0.02 to 0.23	0.10	-0.23 to 0.38
Winter (DJF)	**0.33**	0.14 to 0.53	**0.61**	0.11 to 1.07
Annual	**0.22**	0.14 to 0.30	**0.25**	0.09 to 0.41

*The reported trend is the trend that best describes the change over time in the observations. **Bold** indicates a trend that is statistically significant at the 5% significance level. Multiply the trend by 5 or 10 to get the total amount of change over a 50 or 100-year period, respectively.

Warming has occurred in all seasons. In most cases trends are large relative to historical variability, as indicated by statistical significance.

The historical mean seasonal precipitation for the region is greatest in the summer (about 210 mm). Compared to other regions of British Columbia, precipitation is fairly uniform across the region, with the exception of slightly larger precipitation amounts in the mountainous terrain along the southwestern border of the region. However, precipitation varies considerably from year to year, as shown in Figure 3.

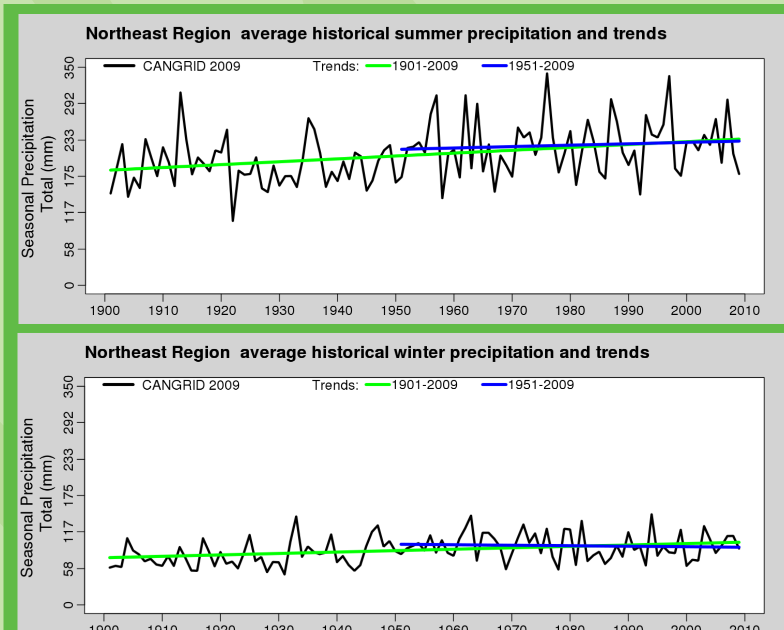

Figure 3: Historic summer and winter precipitation time series, 1901-2009.

Table 2: Precipitation Trends (mm/season per decade) for the Northeast Region				
Period	Trend* 1901-2009	Statistical Uncertainty in Trend[3] 1901-2009	Trend* 1951-2009	Statistical Uncertainty in Trend[3] 1951-2009
Spring (MAM)	**2**	1 to 3	2	-1 to 6
Summer (JJA)	**5**	2 to 7	2	-4 to 9
Autumn (SON)	**3**	1 to 4	3	-1 to 6
Winter (DJF)	**2**	1 to 4	-1	-4 to 3

*The reported trend is the trend that best describes the change over time in the observations. **Bold** indicates a trend that is statistically significant at the 5% significance level. Multiply the trend by 5 or 10 to get the total amount of change over a 50 or 100-year period, respectively.

Precipitation in the region has been increasing over both time periods during all seasons, with the exception of 1951-2009 winter precipitation, which has a negative trend. Low confidence in precipitation observations in the early part of the century implies a need for caution in interpreting the difference between short- and long-term winter precipitation trends. Large year-to-year and decade-to-decade variability in winter precipitation and the choice of time period used for fitting trends also influence this result.

FUTURE CLIMATE PROJECTIONS

Climate models project[4] warming throughout the 21st century for all seasons that is relatively large compared to historical variability (Figure 4). The black bar shows historical interannual variability as represented by ± one standard deviation of temperature around the 1961-1990 average (vertical line). The projected change in the average is shown for three future periods.

Winter is projected to warm slightly more than other seasons, by 2.4 °C (0.7 °C to 3.6 °C) by the 2050s and 3.5 °C (1.8 °C to 6.0 °C) by the 2080s.

Projected precipitation changes are relatively modest compared to historical variability, as shown in Figure 4. By the 2080s the median projection indicates an increase of about 15 %, relative to the 1961-1990 baseline, in all seasons but summer.

Note that in Table 3 and Figure 4, the projections from two different emissions scenarios (A2 and B1) are combined to give a range of anticipated future change. In the early and middle of the 21st century, the emissions scenario has little influence on the amount of projected change. The ensemble

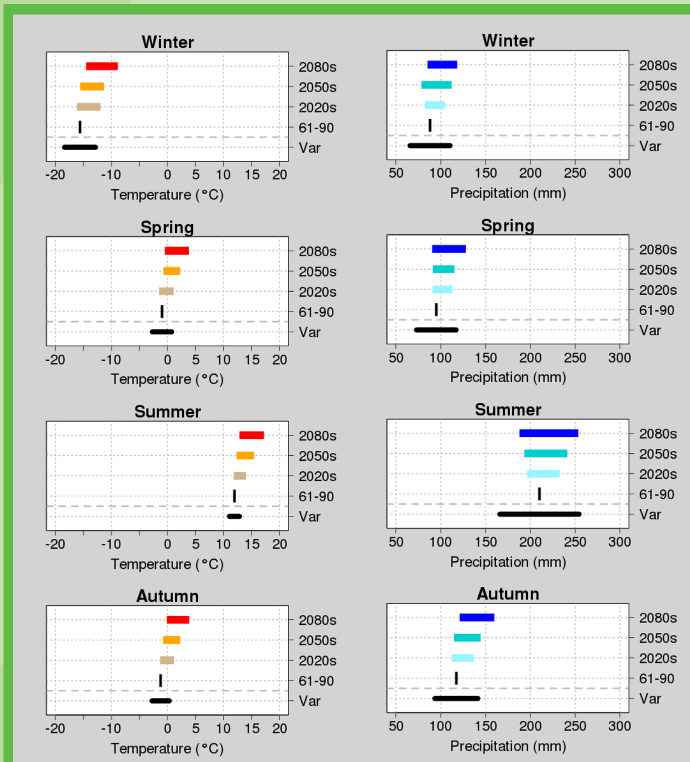

Figure 4: Cumulative seasonal precipitation and mean seasonal temperature projections for three future periods, the 2020s (2011-2040), 2050s (2041-2070) and 2080s (2071-2100). These are 30-year regional averages. The width of the bands indicate the range of projections. The thin, upper black line and the lower band indicate the average and the variability, respectively, over the 1961-1990 reference period.

projected annual warming is 2.8 °C (1.8 °C to 4.6 °C) by the 2080s. The projections following the higher (A2) emissions scenario represent the warmer portion of the projected range of change (and vice versa for lower emissions, B1).

The summer mean temperature for the Northeast region during the 20th century was about 12 °C. The warmest 10 % of summers were 2 °C warmer than this average, about 14 °C averaged across the entire region. Under the median summer warming of 2.5 °C, about two-thirds of summers in the 2080s would be warmer than the warmest 10 % of summers in the past even if no change in the distribution of temperature extremes occurs.

SUMMARY OF PROJECTED CHANGE

Table 3 is from Plan2Adapt.ca, a PCIC product that provides projections for the 21st century, as well as interactive maps and information on impacts.

By the 2050s, there are substantial projected decreases in spring snowfall and a decrease in heating degree days. Along with these changes, an increase in frost-free days and growing degree days is indicated.

POTENTIAL IMPACTS

Changes to the overall climate of the region can result in a variety of associated impacts. This section makes use of Plan2Adapt's impacts tab, which displays impacts that could potentially be associated with the amount of temperature and precipitation change projected for the region.

Warming will decrease snowpack throughout much of the region. Increases to high-intensity precipitation and seasonal moisture variability could have effects on a variety of habitats. A seasonal increase in hot and dry conditions could decrease the supply of water. Adapting forests to the region's climate changes will likely require increasing species diversity and using assisted migration.

A change in agricultural productivity is possible due to a longer growing season, seasonally waterlogged soil and decreased water availability. New crops and varieties may become viable.

Warming and an accompanying reduction in snowpack could result in a shorter winter logging season.

Both river flooding frequency and runoff may increase; stream bank erosion and strain on flood protection infrastructure may increase. Seasonal water quality may be reduced. Stormwater design standards may no longer be adequate.

1. CANGRID is a historical gridded data set with a spatial resolution of 50 km based on station observations, composed by Environment Canada (Zhang et al., 2000: Temperature and precipitation trends in Canada during the 20th century. *Atmosphere Ocean*, **38**, 395-429.).
2. These values are from the PRISM data set, the details of which are given in: Daly, C., et al., 2008. Physiographically-sensitive mapping of temperature and precipitation across the conterminous United States. *International Journal of Climatology*, **28**, 2031-2064.
3. The statistical uncertainty indicates the range of trend estimates that are plausibly consistent with the year-to-year variation in seasonal means. This range is calculated as a statistical "95 % confidence interval."
4. The projected change given is the median from an ensemble of 30 global climate model projections from the Coupled Model Intercomparison Project 3 (CMIP3). The range, in brackets, is the 10th to 90th percentile of projected changes. Details about the ensemble, known as PCIC30, are given in: Murdock, T. Q. and D. L. Spittlehouse, 2011: Selecting and Using Climate Change Scenarios for British Columbia. Pacific Climate Impacts Consortium, University of Victoria, Victoria, British Columbia.

Table 3: Summary of Climate Projections for the Northeast Region

Climate Variable	Season	Projected Change from 1961-1990 Baseline	
		Ensemble Median	Range (10th-90th %ile)
Mean Temperature, 2050s (°C)	Annual	+1.8 °C	+1.4 °C to +2.8 °C
Precipitation, 2050s (%)	Annual	+6%	+0% to +16%
	Summer	+4%	-6% to +13%
	Winter	+11%	-6% to +22%
Snowfall*, 2050s (%)	Winter	+7%	-7% to +19%
	Spring	-57%	-69% to -23%
Growing Degree Days*, 2050s (degree days)	Annual	+226 degree days	+148 to +392 degree days
Heating Degree Days*, 2050s (degree days)	Annual	-659 degree days	-997 to -483 degree days
Frost-Free Days*, 2050s (days)	Annual	+16 days	+9 to +23 days

The table above shows projected changes in average (mean) temperature, precipitation and several derived climate variables from the baseline historical period (1961-1990) for the 2050s. The ensemble median is a mid-point value, chosen from a PCIC standard set of Global Climate Model (GCM) projections (Murdock and Spittlehouse 2011). The range values represent the low and high results within the set. Further information, including projections for the 2020s and 2080s see www.Plan2Adapt.ca.

* Derived from temperature and precipitation.