# CLIMATE SUMMARY FOR:
# WEST COAST REGION

PART OF A SERIES ON THE RESOURCE REGIONS OF BRITISH COLUMBIA

PACIFIC CLIMATE IMPACTS CONSORTIUM

## 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.

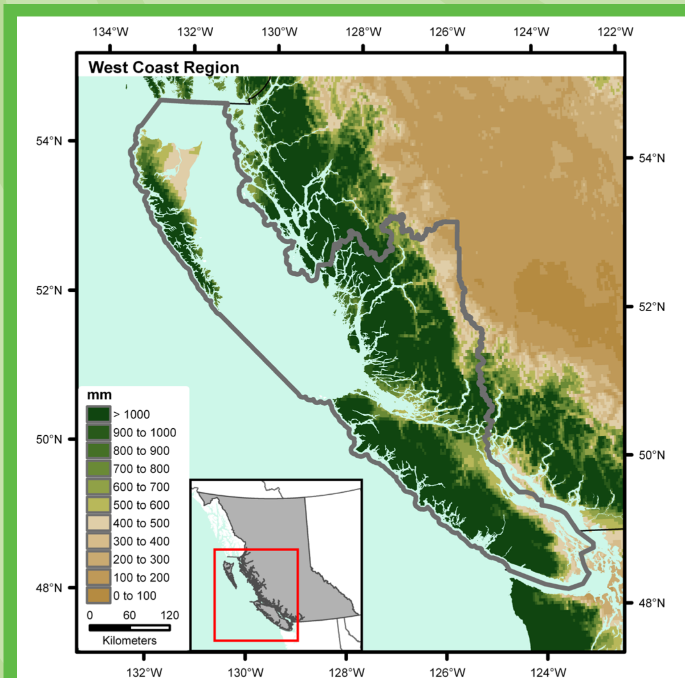


Figure 1: Winter precipitation for the region. The region is bounded in grey and the red box shows its location in BC.

## ABOUT THIS REGION

The West Coast Region (Figure 1), with a population of just under 800,000, contains a large number of small, coastal watersheds. It is the wettest part of the province and has relatively mild seasonal variations in temperature, moderated by the ocean. Owing to the complex topography, which includes the Vancouver Island ranges and part of the Coast Mountain system, 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 region is dominated by western hemlock, western redcedar, and Sitka spruce and with coastal Douglas-fir occurring north to Dean Channel. Mountain hemlock, amabilis fir, and yellow cedar occur in higher elevation forests, and alpine communities and glaciers at the highest elevations. Interior valleys in the east of the region have lodgepole pine and interior Douglas-fir forests. Garry oak and arbutus occur in the drier southern part of the region. The economy is largely dominated by retail and wholesale trade, health care, professional and scientific services, education, tourism, forestry and fisheries.

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Precipitation is historically greatest in the autumn and winter seasons, and least in the summer. Precipitation varies considerably throughout the region and between seasons. There are large interannual variations in seasonal and annual precipitation. Areas with the least winter precipitation historically include the rainshadow of the Cascadia Mountains and part of Haida Gwaii (Figure 1). In contrast, Vancouver Island, Haida Gwaii and the Coast Mountains include several locations with winter precipitation over 500 mm and at the highest elevations well over 1000 mm.

## HISTORICAL TRENDS

The historical annual trend (based on the CANGRID dataset[1]) indicates that over 1 °C of warming has already occurred during the 20[th] 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 warming trend is greater over the 1951-2009 period, except in autumn. These trends are regional averages. In regions with complex topography, trends could vary considerably with elevation[1]. Warming has occurred in all seasons and 1901-2009 trends are large relative to historical variability, as indicated by statistical significance.

The historical mean seasonal precipitation for the region is greatest in autumn (about 580 mm). Precipitation varies across the region and also considerably from year to year within the region, as shown in Figure 3.

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

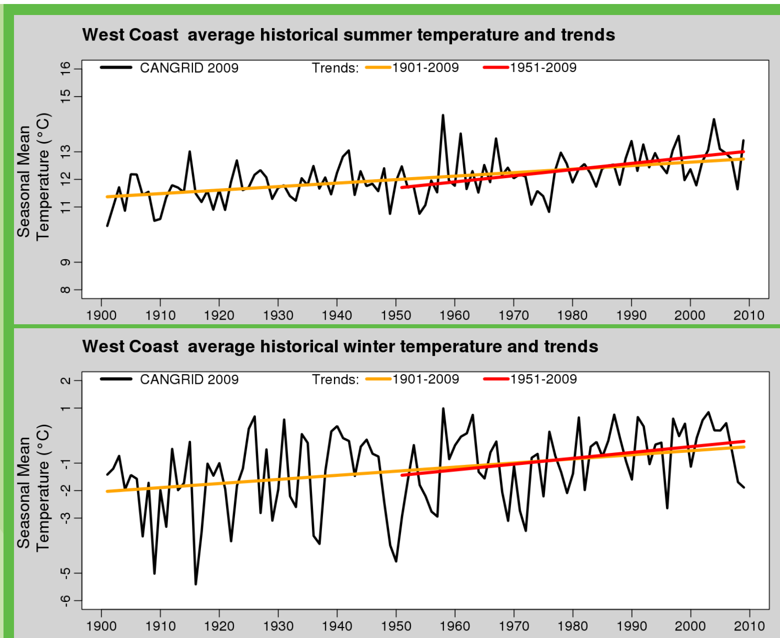

Figure 2: Historic summer and winter temperature time series, 1901-2009.

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

| Period | Trend* 1901-2009 | Statistical Uncertainty in Trend[3] 1901-2009 | Trend* 1951-2009 | Statistical Uncertainty in Trend[3] 1951-2009 |
|---|---|---|---|---|
| Spring (MAM) | **0.14** | 0.06 to 0.21 | 0.17 | 0.00 to 0.36 |
| Summer (JJA) | **0.13** | 0.09 to 0.17 | **0.22** | 0.12 to 0.32 |
| Autumn (SON) | **0.09** | 0.04 to 0.13 | 0.06 | -0.06 to 0.19 |
| Winter (DJF) | **0.15** | 0.05 to 0.25 | 0.21 | 0.00 to 0.44 |
| Annual | **0.13** | 0.08 to 0.18 | **0.18** | 0.06 to 0.30 |

*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.

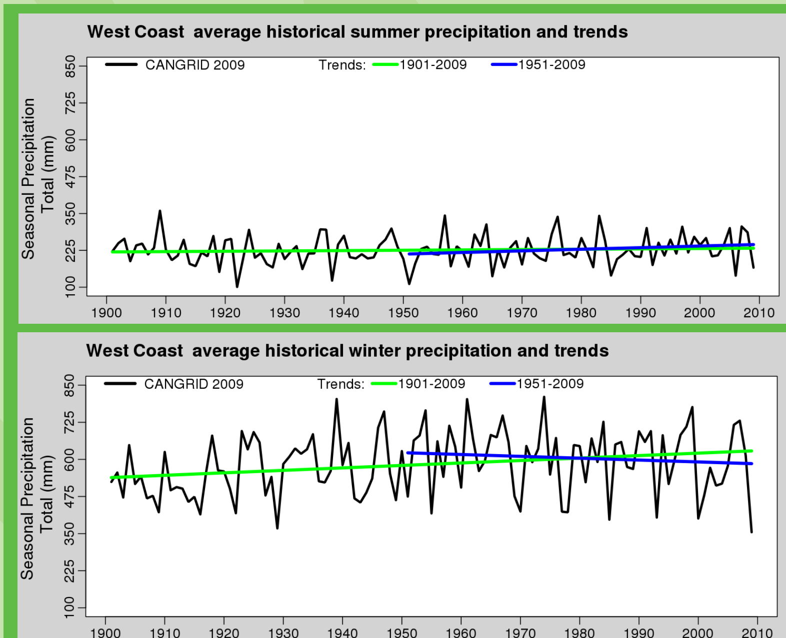

Figure 3: Historic summer and winter precipitation time series, 1901-2009.

| Table 2: Precipitation Trends (mm/season per decade) for the West Coast Region | | | | |
|---|---|---|---|---|
| Period | Trend* 1901-2009 | Statistical Uncertainty in Trend[3] 1901-2009 | Trend* 1951-2009 | Statistical Uncertainty in Trend[3] 1951-2009 |
| Spring (MAM) | **4** | 0 to 9 | 11 | 0 to 25 |
| Summer (JJA) | 1 | -2 to 4 | 5 | -3 to 14 |
| Autumn (SON) | 4 | -3 to 11 | 8 | -9 to 25 |
| Winter (DJF) | **8** | 1 to 15 | -6 | -24 to 10 |

*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 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 affect this result.

## FUTURE CLIMATE PROJECTIONS

Climate models project[4] warming throughout the 21st century for all seasons that is 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.

Projected warming is quite uniform across the seasons, with an annual warming of 1.4 °C (0.8 °C to 2.2 °C) by the 2050s and 2.3 °C (1.2 °C to 3.5 °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 10 %, relative to the 1961-1990 baseline, in all seasons but summer when a 10 % decrease is projected.

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 projected annual warming is 2.3 °C (1.2 °C to 3.5 °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).

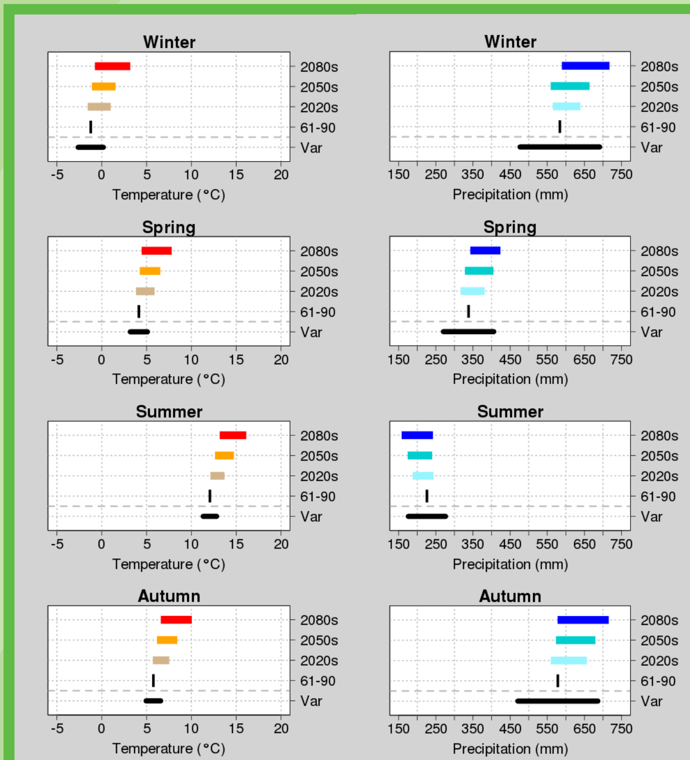


Figure 4: Cumulative seasonal precipitation and mean seasonal temperature projections for three future periods, the 2020s (2011-2040), 2050s (2041-2070) and 2080s (2071-2100). These are 30-year regional averages. The width of the bands indicate the range of projections. The thin, upper black line and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

The summer mean temperature for the West Coast region during the 20th century was about 12 °C. The warmest 10 % of summers were about 2 °C warmer than this average, about 14 °C averaged across the entire region. Under the median summer warming of 2.3 °C by the 2080s, about 60 % of summers would be warmer than the warmest 10 % of summers in the past, even 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 change projected for the region.

Warming will decrease snowpack. Increases to high-intensity precipitation and seasonal moisture variability could affect ecosystems and disturbance regimes. A seasonal increase in hot and dry conditions could decrease water supply and lake productivity, and affect inland fisheries and related tourism.

A change in agricultural productivity could result from a longer growing season, seasonally waterlogged soil and decreased water availability. New crops and varieties may become viable.

Adapting forests will likely require increasing species diversity and assisted migration. If the dry and fire seasons lengthen, forest fire severity could increase.

Both river flooding and ocean storm surge events may increase in frequency and magnitude; stream bank erosion and strain on flood protection infrastructure may increase. Stormwater design standards may no longer be adequate and seasonal water quality may be reduced.

There could be a transition to rainfall-dominant watersheds, causing an increased need for water conservation and storage.

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 West Coast Region

| Climate Variable | Season | Projected Change from 1961-1990 Baseline | |
|---|---|---|---|
| | | Ensemble Median | Range (10th-90th %ile) |
| Mean Temperature, 2050s (°C) | Annual | +1.4 °C | +0.8 °C to +2.2 °C |
| Precipitation, 2050s (%) | Annual | +6% | -0% to +11% |
| | Summer | -10% | -18% to +2% |
| | Winter | +6% | -2% to +12% |
| Snowfall*, 2050s (%) | Winter | -28% | -46% to -10% |
| | Spring | -51% | -72% to -14% |
| Growing Degree Days*, 2050s (degree days) | Annual | +327 degree days | +204 to +506 degree days |
| Heating Degree Days*, 2050s (degree days) | Annual | -534 degree days | -816 to -318 degree days |
| Frost-Free Days*, 2050s (days) | Annual | +22 days | +13 to +32 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.