Regional District of Nanaimo Climate Assessment: Data Descriptor Document

12 February 2024

Summary

This short guide contains an overview of the data provided as part of the Regional District of Nanaimo climate assessment. The results in this document are obtained from a set of high-resolution (∼800m) downscaled climate model simulations following the SSP5 8.5 emissions pathway; results from two other scenarios are also included in the data package. Averages from past and future periods are shown, along with projected changes. Variables provided in the summary tables and maps include annual and seasonal averages, degree days, return period events, and "Climdex" indices of extreme values from the Expert Team on Climate Change Detection and Indices (ETCCDI). Definitions and further information about the Climdex variables can be found at http://etccdi.pacificclimate.org/indices.

After reviewing this document, users may want to begin exploring the complete data package by viewing the summary tables first, provided as Excel (xslx) files. In the tables, results are shown as area average values for the Regional District of Nanaimo, and are provided for low (SSP1 2.6), moderate (SSP2 4.5) and high (SSP5 8.5) emissions pathways in order to allow inter-comparison of possible future outcomes. A complete set of maps for all variables described in the workplan are also provided, as PNG files.

Summary tables are also provided for the seven Water Regions in the regional district, and separately for areas of high elevation ($>$ 450m) and low elevation ($<$ 450m). Separate tables are also provided containing projected changes from the individual climate models that are used in this assessment.

Title

Regional District of Nanaimo Climate Assessment: Data Descriptor Document

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Destination of Services

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Citation

Sobie, S.R. and Curry, C.L., 2024, Regional District of Nanaimo Climate Assessment: Data Descriptor Document, Project Report, Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 17pp

About PCIC

The Pacific Climate Impacts Consortium is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change in the Pacific and Yukon Region of Canada. PCIC operates in collaboration with climate researchers and regional stakeholders on projects driven by user needs. For more information see http://pacificclimate.org.

Disclaimer

1. Regional District of Nanaimo Assessment Region

The area of focus for this regional climate impacts assessment is the Regional District of Nanaimo. Figure 1 displays the district boundaries bordered by the Strait of Georgia to the east, and the Alberni-Clayoquot and Cowichan Valley regional districts to the west and south, respectively. The regional district is enclosed by the irregular black and gray curve in Figure 1, while the irregular black and blue curve defines the outer boundary for the seven watersheds coinciding with the district.

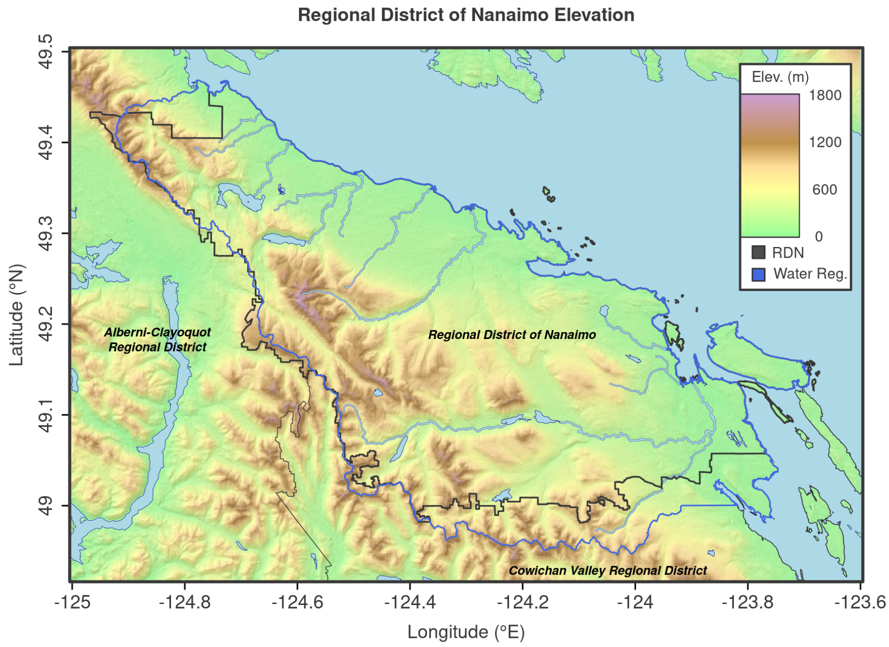

Figure 1: Elevation map for the Regional District of Nanaimo assessment region. District boundaries are shown in the centre of the map outlined with an irregular black curve. The outer boundary of the seven watersheds located within the district boundary is shown by the irregular blue curve.

2. Deliverables

As outlined in the project workplan, high-resolution downscaled climate scenarios have been produced for the Regional District of Nanaimo (RDN) and used to produce a suite of impacts-related indices. Tables and maps for all selected indices have been produced and are provided separately, accompanying this document. A complete list of the indices calculated and summarized is provided in Section 4. Tables and maps describing the results include past, future, and projected change values from an ensemble of climate models. Values for each time period (1981-2010 or “1990s” for short, 2021-2050 or “2030s”, 2041-2070 or “2050s”, and 2071-2100 or “2080s”) are climatological averages over 30-year intervals and projected changes display the differences between the two intervals (e.g. 2050s - 1990s). Model values from the past are taken from downscaled scenarios following historical greenhouse gas concentrations, while values from the future are from scenarios following low, moderate, and high emissions pathways. Seasons in the maps and tables are defined using meteorological definitions as winter (December-January-February), spring (March-April-May), summer (June-July-August), and fall (September-October-November).

Climate projections used in the assessment originate from nine models that have been selected to be a representative subset for British Columbia (Curry et al., 2023). Results from downscaled scenarios produced using these climate models are presented as both ensemble median values (best estimate), and ranges spanning the 10^{th} to 90^{th} percentiles of the ensemble (model uncertainty).

2.1. Summary Tables

Summary tables containing past and future climate indices for RDN and several subregions are provided separately in formatted spreadsheets (Excel files). In each spreadsheet table, past and future values represent regional averages. Each table is presented using the same format, with excerpts from the RDN summary table for the high future emissions pathway SSP5-8.5 shown here. Results for the other two emissions pathways and other regions are available at the location mentioned in Section 3 below.

The RDN summary table contains three tabs: “RDN Indices”, “RDN Return Levels”, and “RDN Return Period Changes”. These tabs present different types of indices and are described in the following sections.

2.1.1. Tab One: RDN Indices

The first summary table tab contains results for annual and seasonal averages, Climdex indices, and heatwave indices. Figure 2 displays an excerpt from the tab showing results for precipitation, rainfall, and snowfall (as snow water equivalent). The left-hand column lists the variables considered and displays the season over which the index is calculated. Further information about the variable including the full names and definitions are provided as comments in the variable name cells and can be revealed by hovering the cursor over the cells.

The next two columns list under the “Observed Past” heading display results from an observation-based dataset (PCIC-Blend) that has been downscaled using the same procedure applied to the climate model simulations. These results allow for comparison with the climate model results during the past 1990s interval. The “Obs. Average” column displays the climatological average of each index during the 1981-2010 30-year period. The “Std. Dev” column displays the standard deviation of each index during the 30 years within the 1990s interval. This quantity provides a measure of the year-to-year variability that naturally occurs and illustrates the potential range of values that may occur for each index.

The fourth column labelled “Scenario Past” displays results from the downscaled climate models for the 1990s. Results presented here are shown using the median value from the ensemble of nine models used in the analysis to provide a best estimate. Values for the individual models are calculated using the same climatological average over the 1990s as is done for the observed past.

	Regional District of Nanaimo Projections Summary (SSP585)				
	Observed Past		Scenario Past	2030s Future	
	Obs. Average	Std. Dev.	Median	Median	10th%-90th%
PR	**mm**	**mm**	**mm**	**mm**	**mm**
Winter	737	182	736	761	(702 to 833)
Spring	377	97	377	386	(362 to 419)
Summer	136	55	136	122	(114 to 131)
Fall	534	136	534	551	(536 to 600)
Annual	1781	255	1782	1848	(1786 to 1908)
RAIN	**mm**	**mm**	**mm**	**mm**	**mm**
Winter	488	170	472	591	(514 to 684)
Spring	318	96	318	355	(326 to 394)
Summer	136	55	136	122	(114 to 131)
Fall	476	125	479	520	(507 to 577)
Annual	1417	235	1401	1578	(1503 to 1721)
SNOW	**mm**	**mm**	**mm**	**mm**	**mm**
Annual	365	97	380	248	(164 to 283)

Figure 2: Excerpt from the assessment summary table for the Regional District of Nanaimo with results for the high (SSP5 8.5) emissions pathway. Examples shown for this part of the table include index names and intervals, results from the observed past, and results from downscaled scenarios for the past and future.

The final two columns in the Figure 2 excerpt display future projections for the indices during the "2030s Future" (2021-2050) interval. The "Median" column displays the median value from the ensemble of nine climate models using the same approach as for the past. The "10th%-90th%" column displays the range of future projections from the ensemble spanning the 10^{th} percentile to the 90^{th} percentile. The percentile range describes the uncertainty in the magnitude of projected change from both the projections of different models, and the inter-annual variability within each model. Additional columns are also provided for the 2050s Future and 2080s Future.

Differences between the "Future" intervals and the "Scenario Past" are shown in the "Change" and "Percent Change" columns that are highlighted with yellow shading in the tables. Figure 3 displays an example of these columns for the 2030s. Similar to the columns for the future projections, results for the changes are shown using ensemble median values and 10^{th} percentile to the 90^{th} percentile ranges. For some indices such as most temperature-based variables, percent changes are not meaningful and are therefore listed as "NA". Additional columns for projected changes are also provided for the 2050s and 2080s.

Indices presented in the summary tables are distinguished between those calculated using precipitation-based quantities and those calculated using temperature-based quantities. Indices derived from precipitation are highlighted using headers with blue shading as in Figures 2 and 3. Indices derived from temperatures are highlighted using headers

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with orange shading as in Figure 4. The format in which the results are presented is otherwise the same for both precipitation and temperature-based indices.

	2030s Change		2030s Percent Change		2050s Future	
	Median	10th%-90th%	Median	10th%-90th%	Median	10th%-90th%
PR	**mm**	**mm**	**%**	**%**	**mm**	**mm**
Winter	25	(-32 to 90)	3	(-4 to 12)	742	(717 to 885)
Spring	9	(-16 to 41)	2	(-4 to 11)	404	(378 to 424)
Summer	-14	(-22 to -5)	-10	(-16 to -3)	124	(100 to 135)
Fall	17	(3 to 67)	3	(1 to 12)	592	(561 to 624)
Annual	66	(5 to 127)	4	(0 to 7)	1876	(1806 to 2033)
RAIN	**mm**	**mm**	**%**	**%**	**mm**	**mm**
Winter	119	(26 to 202)	25	(5 to 42)	634	(590 to 759)
Spring	37	(7 to 74)	12	(2 to 23)	375	(357 to 407)
Summer	-14	(-22 to -5)	-10	(-16 to -3)	124	(100 to 135)
Fall	41	(27 to 102)	9	(6 to 21)	573	(545 to 620)
Annual	177	(107 to 316)	13	(8 to 22)	1706	(1627 to 1902)
SNOW	**mm**	**mm**	**%**	**%**	**mm**	**mm**
Annual	-132	(-212 to -92)	-35	(-57 to -25)	167	(78 to 213)

Figure 3: Same as Figure 2 but displaying an excerpt showing columns with projected changes in precipitation quantities.

	Regional District of Nanaimo Projections Summary (SSP585)				
	Observed Past		Scenario Past	2030s Future	
	Obs. Average	Std. Dev.	Median	Median	10th%-90th%
TX	**°C**	**°C**	**°C**	**°C**	**°C**
Winter	4.1	0.9	4.1	5.3	(4.7 to 6.2)
Spring	10.7	0.9	10.7	12.2	(11.7 to 13.1)
Summer	19.9	0.8	19.9	21.9	(21.2 to 23.2)
Fall	11.8	0.8	11.8	13.4	(12.9 to 14.6)
Annual	11.7	0.5	11.7	13.2	(12.8 to 14.4)
TM	**°C**	**°C**	**°C**	**°C**	**°C**
Winter	1.8	1	1.7	2.8	(2.4 to 3.9)
Spring	6.8	0.8	6.8	8.2	(7.8 to 9.1)
Summer	15.1	0.6	15.1	17	(16.4 to 18)
Fall	8.3	0.7	8.3	9.8	(9.5 to 11.2)
Annual	8	0.5	8	9.5	(9.2 to 10.7)

Figure 4: Same as Figure 2 but displaying an excerpt showing columns for temperature-based indices. TX and TM are the daytime high and mean daily temperature, respectively, averaged over all days in a season/year and also over all 30 years of the climatological period.

2.1.2. Tab Two: RDN Return Levels

The second summary table tab contains results for extreme events of rainfall and temperature. Extreme events presented here are defined using return periods, which define the frequency or probability of occurrence for rarer and more severe events. For example, a 5-year return period event has a 20% chance of occurring in any given year and the magnitude of that event is the return level.

Figure 5 displays an excerpt from the second tab showing results for 1-day and 2-day rainfall totals. As with the first tab, the left-hand column lists the variables considered and displays the season over which the index is calculated, with full names and definitions provided as cell comments. In this tab, for simplicity, results are provided for the downscaled climate scenarios showing the past and future projections only. For each of the "Past" and "Future" interval columns, results are provided for the ensemble median and 10^{th} percentile to the 90^{th} percentile ranges as in the first tab.

	Regional District of Nanaimo Return Levels (SSP585)			
	Past		2030s Future	
	Median	10th%-90th%	Median	10th%-90th%
Rainfall Return Levels				
RP5 1-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	62	(59 to 63)	71	(65 to 74)
RP10 1-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	69	(66 to 73)	82	(75 to 84)
RP20 1-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	77	(73 to 82)	92	(84 to 94)
RP30 1-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	81	(77 to 86)	98	(89 to 99)
RP50 1-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	86	(82 to 93)	105	(96 to 107)
RP5 2-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	91	(88 to 93)	107	(99 to 111)
RP10 2-DAY RAIN	**mm**	**mm**	**mm**	**mm**
Return Levels	103	(99 to 105)	122	(111 to 125)

Figure 5: Excerpt from the second tab of the assessment summary table for the Regional District of Nanaimo. Examples shown for this part of the table include results for extreme rainfall events with different return period frequencies.

2.1.3. Tab Three: RDN Return Period Changes

The third summary table tab contains results showing how the frequency of current extreme events are expected to change in the future. Figure 6 displays an excerpt from the third tab showing results for 1-day and 2-day rainfall return periods. The second column ("Past") displays the return period frequency for events during the 1990s. The "Future" columns display the expected frequency of those same events during future intervals. For example, a 1-day rainfall event with a 5-year return period (20% probability of occurrence) is expected to become a 3-year return period event (33% probability of occurrence) in the 2030s under the SSP5 8.5 scenario (Figure 6). Further results are provided for the 2080s and additional variables in the remainder of the table.

	Regional District of Nanaimo Return Period Frequency Changes (SSP585)				
	Past	2030s Future		2050s Future	
	Return Period	Median	10th%-90th%	Median	10th%-90th%
Rainfall Return Period Frequencies					
RP5 1-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	5	3	(2 to 3)	2	(2 to 3)
RP10 1-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	10	5	(4 to 6)	4	(3 to 5)
RP20 1-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	20	8	(6 to 11)	7	(5 to 8)
RP30 1-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	30	12	(8 to 17)	9	(7 to 12)
RP50 1-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	50	18	(12 to 28)	13	(10 to 18)
RP5 2-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	5	3	(2 to 3)	2	(2 to 3)
RP10 2-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	10	4	(3 to 6)	3	(2 to 5)
RP20 2-DAY RAIN	Year	Year	Year	Year	Year
Return Periods	20	8	(6 to 10)	6	(3 to 8)

Figure 6: Excerpt from the third tab of the assessment summary table for the Regional District of Nanaimo. Examples shown for this part of the table include changes in the frequency of extreme rainfall events.

2.2. RDN Watershed and Elevation-based Tables

Additional summary tables are provided for several smaller regions overlapping with RDN. These include summary tables for seven Water Regions (Figure 7, left panel) that occur within RDN. Results for areas of RDN at high elevation (> 450 m) and low elevation (< 450m) are also provided (Figure 7, right panel). Summary tables for each of these regions are structured using the same format as described Section 2.1, with files provided for each emissions scenario as well.

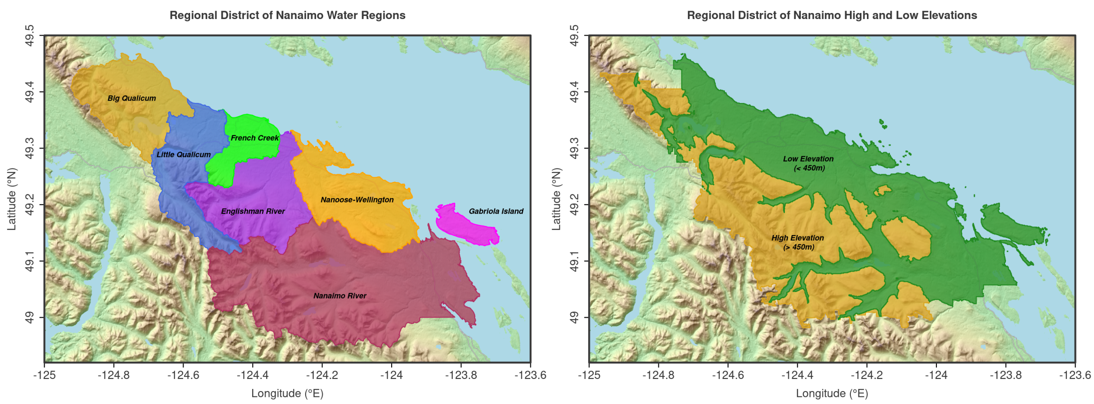

Figure 7: Map of the seven water regions, and high elevation (> 450 m) and low elevation (< 450m) areas for the Regional District of Nanaimo. Separate summary tables are provided for each water region and both elevation areas in addition to the tables produced for the entire Regional District.

2.3. GCM Tables

In addition to the summary tables encapsulating results from the ensemble of climate models, tables containing results from individual models have been included. These tables are provided as csv files, with files provided for past (1990s) and future (2030s, 2050s, 2070s) intervals, along with projected change (absolute anomalies) and percent change (percent anomalies) where applicable. An example excerpt from a GCM Table for Big Qualicum Water Region is shown in Figure 8 displaying future projections for the 2050s of average temperature. The left-hand column in the table shows the individual models included and summary statistics calculated from the set of these nine models. Results from each of these models and summary statistic values are provided in the remaining columns to the right. Results are provided for annually, as well as all months and seasons, where applicable.

Table: Average Temperature for Big-Qualicum

Model	Jan	Feb	Mar	Apr	May
CNRM-ESM2-1	3.21	2.67	4.19	6.71	10.54
FGOALS-g3	2.45	3.56	4.56	8.31	11.02
IPSL-CM6A-LR	2.02	2.97	4.77	8.21	12.44
MIROC-ES2L	2.61	2.92	5.36	8	11.34
MPI-ESM1-2-HR	2.18	3.63	4.88	7.61	11.01
MRI-ESM2-0	2.51	2.69	5.18	8.27	11.58
NorESM2-LM	3.55	4.39	5.68	7.55	10.68
TaiESM1	4.14	5.77	7.6	10.19	13.07
UKESM1-0-LL	3.51	5.05	7.08	10.01	14.57
Ens_Avg.	2.91	3.74	5.48	8.32	11.81
5th_%ile	2.09	2.68	4.34	7.04	10.6
10th_%ile	2.15	2.68	4.49	7.38	10.65
Median	2.61	3.56	5.18	8.21	11.34
90th_%ile	3.66	5.2	7.18	10.05	13.37
95th_%ile	3.9	5.48	7.39	10.12	13.97

Figure 8: Excerpt from the GCM table (csv file) for the Big Qualicum Water Region displaying future (2050s) average temperatures from individual models. Values for the remaining calendar months, seasons, and annually are provided in the full table. The lower 6 rows contain statistics calculated from the ensemble of 9 models included here.

2.4. Assessment Maps

Example maps displayed in this section show the average past, future, and projected change values from the ensemble of downscaled climate scenarios. The indices shown here are for average summer daytime high temperatures (Figure 9), average annual heatwave days (Figure 10), and 1-in-20-Year 2-Day rainfall (Figure 11). Maps for all indices listed in Section 4 are provided for each emissions pathway, and time interval. Results shown in the maps originate from downscaled scenarios at $\sim$ 800m resolution, and are spatially smoothed for presentation in the figures; see Appendix A.

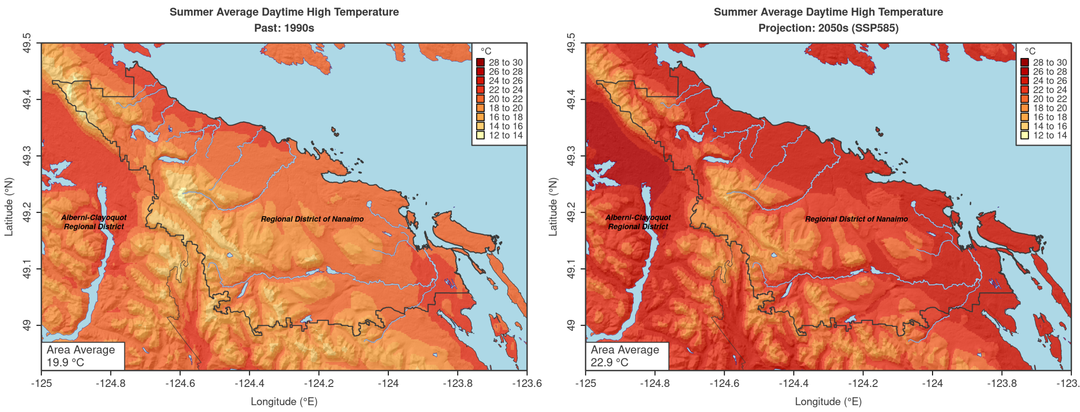

Figure 9: Summer daytime high (daily maximum) temperature for the Regional District of Nanaimo during the 1990s and 2050s. The regional average value for the district (outlined) is shown in the lower left corner of each panel.

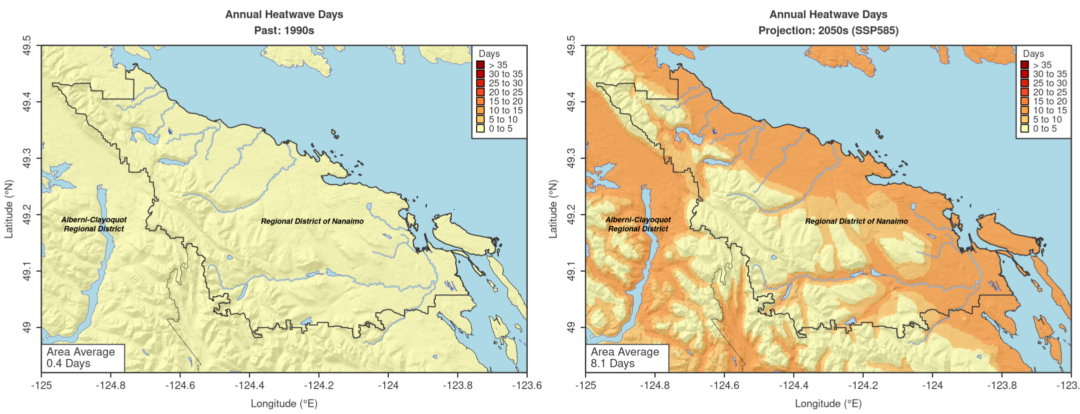

Figure 10: Average annual number of heatwave days for the Regional District of Nanaimo during the 1990s and 2050s.

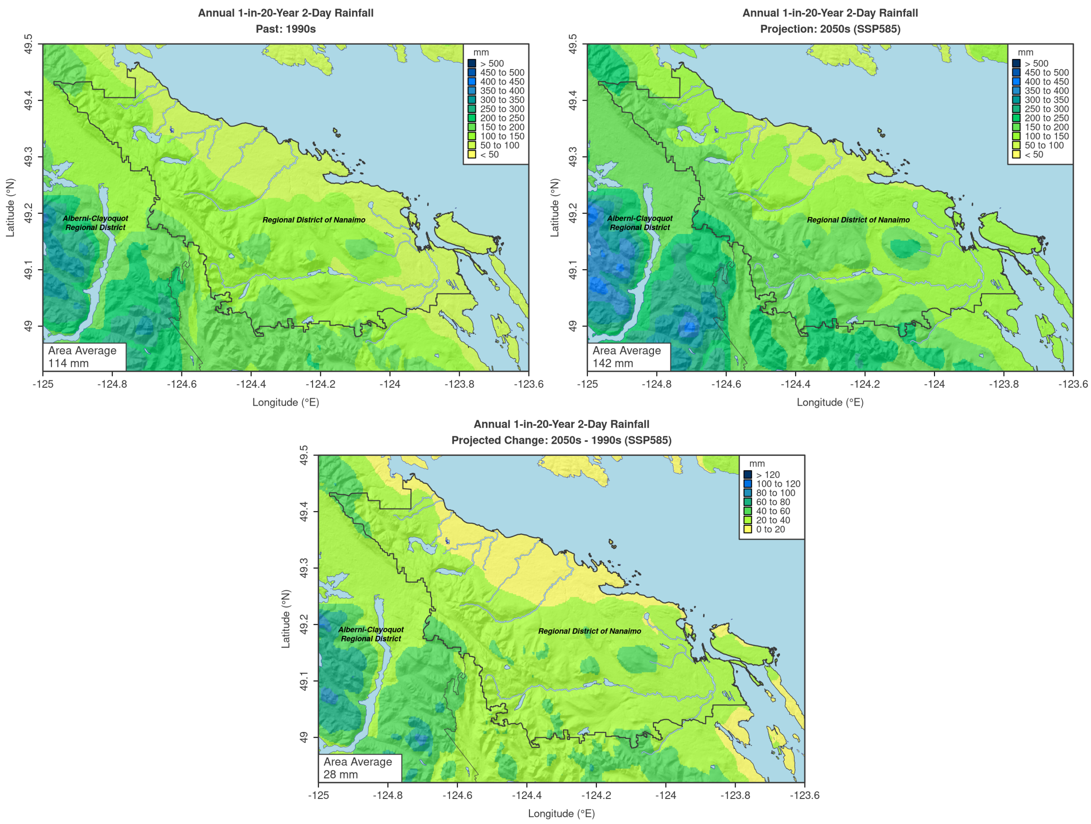

Figure 11: 1-in-20-Year 2-Day rainfall for the 1990s and 2050s, with the difference between the two periods shown in the bottom panel. The regional average value for the Regional District of Nanaimo (outlined) is shown in the lower left corner of each panel.

3. Data Delivery

Summary tables and maps for all variables in this assessment are available by request from the Regional District of Nanaimo.

Summary-Tables

Excel summary tables as described in Section 2.1 are provided as separate files for download. The file names are as follows:
Regional-District-Nanaimo_SSP126_Projections_Summary_Table.xlsx
Regional-District-Nanaimo_SSP245_Projections_Summary_Table.xlsx
Regional-District-Nanaimo_SSP585_Projections_Summary_Table.xlsx

Additional summary tables are also provided for each of the requested sub-regions within RDN, with names in Table 1 replacing "Regional-District-Nanaimo".

Table 1: List of regions considered in the analysis.

Water Regions			
Big-Qualicum	Englishman-River	French-Creek	Gabriola-Island
Little-Qualicum	Nanaimo-River	Nanoose-Wellington	
Elevation Areas			
RDN-Low-Elevation	RDN-High-Elevation		

GCM-Tables

GCM tables (Section 2.3) are provided in a set of compressed "zip" files such as:
Regional-District-Nanaimo.zip
Each zip file includes past, future, and difference maps (where applicable) for all of the variables listed in Section 4. Additional files are also provided for each of the sub-regions listed in Table 1.

Maps

Maps are provided in three compressed "zip" files:
Maps_SSP126.zip
Maps_SSP245.zip
Maps_SSP585.zip
Each zip file includes past, future, and difference maps for all of the variables listed in Section 4.

4. Index Inventory

The tables in this section list the indices calculated for RDN derived from daily precipitation and temperature. The indices are grouped into categories (eg. Standard Indices) corresponding to the same organization used to compile the maps. For each variable the "Index" identifier matches the name used in the summary tables and in the map files. In the tables below, full names and the intervals for which results are provided are also listed. Further information about individual indices can be found in the index name cells in the summary tables (left-hand column).

Table 2: List of Standard, Degree Day, and Heatwave indices provided in the maps and tables.

Standard Indices

Index	**Name**	**Intervals**
PR	Total Precipitation	Annual, Seasonal
RAIN	Total Rainfall	Annual, Seasonal
SNOW	Total Snowfall (SWE)	Annual
TX	Maximum Temperature	Annual, Seasonal
TM	Mean Temperature	Annual, Seasonal
TN	Minimum Temperature	Annual, Seasonal

Degree Day Indices

Index	**Name**	**Intervals**
CDD	Cooling Degree Days	Annual
HDD	Heading Degree Days	Annual
FDD	Freezing Degree Days	Annual
GDD	Growing Degree Days	Annual

Heatwave Indices

Index	**Name**	**Intervals**
HWD	Heatwave Days	Annual
HWXL	Longest Heatwave Length	Annual
HWN	Heatwave Number	Annual
TXH	Average Heatwave TX	Annual
TNH	Average Heatwave TN	Annual
HWDD	Heatwave Degree Days	Annual
TXHX	Extreme Heatwave TX	Annual
TNHX	Extreme Heatwave TN	Annual

Table 3: List of Climdex indices provided in the maps and tables.

Climdex Temperature Indices		
Index	**Name**	**Intervals**
CSDI	Cold Spell Duration	Annual
DTR	Diurnal Temperature Range	Annual, Seasonal
FD	Frost Days	Annual
GSL	Growing Season Length	Annual
ID	Ice Days	Annual
SU	Summer Days (25^{o}C)	Annual
SU30	Summer Days (30^{o}C)	Annual
TNN	Coldest Nights	Annual, Seasonal
TNX	Warmest Nights	Annual, Seasonal
TR	Tropical Nights (20^{o}C)	Annual
TR16C	Temperate Nights (16^{o}C)	Annual
TXN	Coldest Days	Annual, Seasonal
TXX	Hottest Days	Annual, Seasonal
WSDI	Warm Spell Duration	Annual

Climdex Precipitation Indices		
Index	**Name**	**Intervals**
CDD	Consecutive Dry Days	Annual
CWD	Consecutive Wet Days	Annual
PRCPTOT	Total Precipitation	Annual
R1MM	Precipitation > 1mm	Annual
R10MM	Precipitation > 10mm	Annual
R20MM	Precipitation > 20mm	Annual
R95P	Very Wet Day Precipitation	Annual
R95DAYS	Very Wet Days	Annual
R99P	Extreme Wet Day Precipitation	Annual
R99DAYS	Extreme Wet Days	Annual
RX1DAY	1-Day Maximum Precipitation	Annual, Seasonal
RX2DAY	2-Day Maximum Precipitation	Annual, Seasonal
RX5DAY	5-Day Maximum Precipitation	Annual, Seasonal
SDII	Wet Day Precipitation	Annual

Table 4: List of Return Level indices provided in the maps and tables.

Return Level Indices		
Index	**Name**	**Return Periods**
RAIN_RL	1-Day Rainfall	5,10,20,30,50 Year
RN2DAY_RL	2-Day Rainfall	5,10,20,30,50 Year
RN5DAY_RL	5-Day Rainfall	5,10,20,30,50 Year
TX_RL	Maximum Temperature	5,10,20,30 Year
TN_RL	Minimum Temperature	5,10,20,30 Year

Future Return Period Frequency Indices		
Index	**Name**	**Return Periods**
RAIN_Future-RP	1-Day Rainfall	5,10,20,30,50 Year
RN2DAY_Future-RP	2-Day Rainfall	5,10,20,25,30,50 Year
RN5DAY_Future-RP	5-Day Rainfall	5,10,20,25,30,50 Year
TX_Future-RP	Maximum Temperature	5,10,20,30 Year
TN_Future-RP	Minimum Temperature	5,10,20,30 Year

Appendices

A. Map Interpolation

All of the figures in this report that display maps of different climate indices for RDN have smoothing applied to the data immediately prior to creating the maps. Figure A1 displays an example showing annual average daytime high temperature for the 1980s with and without smoothing applied. Observed and modelled dataset employed in this analysis are all provided in a rectilinear gridded format with 300-arc second (∼800 m) resolution. When viewed over a region such as RDN, the size of the municipality is small enough for boundaries of individual grid cells to become readily apparent, as evident in the left-hand panel of Figure A1. These features are not physically or geographically based, but represent the format in which the datasets are arranged using a regular spatial grid. To reduce the artificial appearance that arises from the gridded format, the datasets are smoothed using bilinear interpolation before mapping (Figure A1, right-hand panel). All of the other analysis is conducted using data at the original 300-arc second resolution to avoid any introduction of artifacts from the smoothing process.

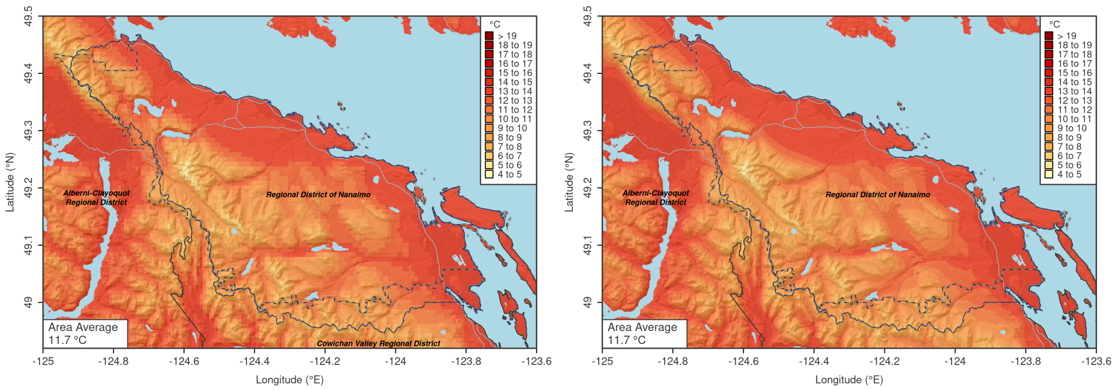

Figure A1: Illustration of the smoothing applied to gridded data when creating maps for the Regional District of Nanaimo. The left-hand panel displays annual average daytime high temperature for the 1990s in the ∼800 m resolution of the dataset. The right-hand panel displays the same data after smoothing.

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