Rainfall on Gabriola 1944-2021 (2023)

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On behalf of Gabriola Streamkeepers (GSK). There is an Appendix extending the data range to include years 2022 and 2023. The original 1944-2021 remains unchanged.

Summary stats

1	2	3	4	5	6	7	8	9	10	11	12
month	mean	min	max	one-sigma range		trend	mean	min	max	std. dev	trend
	mm	mm	mm	low mm	high mm	mm/year	%	%	%	%	%/year
jan	170	22	358	96	243	0.4	15	13	211	43	0.2
feb	131	20	395	62	199	-0.2	12	15	302	52	-0.2
mar	107	19	300	53	162	0.2	10	18	280	51	0.2
apr	63	5	139	34	91	0.0	6	8	222	45	0.1
may	43	5	142	17	69	0.1	4	11	332	61	0.3
jun	41	5	130	19	64	0.0	4	12	314	55	-0.1
july	23	0	65	7	38	-0.1	2	0	286	67	-0.6
aug	27	0	128	3	51	-0.1	2	0	474	88	-0.3
sept	45	0	144	13	77	0.2	4	1	322	72	0.5
oct	104	14	288	43	166	0.2	9	14	276	59	0.2
nov	180	41	483	91	269	0.3	16	23	268	49	0.2
dec	184	25	385	116	252	0.0	16	14	209	37	0.0
annual	1117	733	1719	926	1309	1.0	100	66	154	17	0.1

Summary stats. table notes

"Rainfall" includes all forms of precipitation: snow, hail, freezing rain, etc.

Column 1 (month) this summary uses data for the 78 years 1944-2021. The monthly and annual figures have been normalized so that every month and every year has exactly the same number of days. February has not been short-changed as it is in the conventional calendar. This was done by scaling monthly and annual averages which is not quite as accurate as doing a day-by-day analysis, but that would be impossibly difficult with very limited benefit considering other minor uncertainties in the data.

Column 2 (mean) average precipitation for the months and years in mm.

These figures are based on Environment Canada data from the rain gauge at Nanaimo Airport (NanRG). Why? Several years ago Gabriola Streamkeepers (GSK) scattered rain gauges in various creek catchment areas on the island as part of a project to create water budgets for these areas and hence for the whole island. This entailed measuring precipitation, runoff in creeks, analysing evapotranspiration from forested, farm, developed land surfaces and open-water wetlands, and, by elimination, estimating groundwater infiltration.

The results for precipitation showed significant variation in location which correlated quite strongly with height above sea level (they get more rain up there) and weakly with geographic location (the north-west end is slightly wetter than the south-east end).

Despite hourly and sometimes daily differences, the monthly correlation of the precipitation at Coats Marsh with precipitation at Nanaimo Airport was quite good (Somerset Farm is a bit drier, east of, and at a lower altitude, than Coats Marsh) and since data for the airport is available with negligibly small gaps in their records and includes other useful parameters in looking at climate such as temperature, wind speed, wind direction, and relative humidity, I have chosen to go with the airport data.

Column 3 (min) the lowest recorded monthly and annual precipitation in mm.

Column 4 (max) the highest recorded monthly and annual precipitation in mm.

Column 5 (low) the mean precipitation less the standard deviation.

Column 6 High) the mean precipitation plus the standard deviation.

With some assumptions, the ranges in Column 5 and Column 6 are equivalent to the one-sigma standard deviation of a normal probability distribution, so that the prediction is that 68% of annual readings will be within this range.

Column 7 (trend) the linear trend in the monthly and annual precipitation in mm per year. Note how small the long-term trends are.

Column 8 (mean) monthly mean precipitations as a percentage of the mean annual precipitation.

Column 9 (min) the lowest recorded monthly and annual precipitation as a percentage of the corresponding means.

Column 10 (max) the highest recorded monthly and annual precipitation as a percentage of the corresponding means.

Column 11 (std. dev.) the standard deviation of the monthly and annual precipitation as a percentage of the corresponding means.

Column 12 (trend) the linear long-term trend in the mean monthly and annual precipitations as a percentage of the mean monthly and annual precipitations. In all cases the trend is very weak and only the indicated direction (increasing, stationary, or decreasing) has the possibility of having any real significance.

That precipitation in February, despite the normalization, appears to be decreasing is interesting. No idea why Februaries should be becoming drier, as it should be noted, is the February at the time of writing this.

Summary 2-season stats

1	2	3	4	5	6	7	8
season	mean	min	max	one-sigma range		trend	confidence
	mm	mm	mm	low mm	high mm	mm/year	%
winter (2)	872	507	1440	691	1053	0.7	78
summer (2)	241	115	447	177	305	0.1	67
annual (2)	1113	694	1623	912	1315	0.9	80

9	10	11	12	13
season	mean	min	max	std. dev.
	%	%	%	%
winter (2)	78	58	165	21
summer (2)	22	48	186	26
annual (2)	100	62	146	18

Summary 2-season stats. table notes

The high variability of monthly precipitation precipitation from year-to-year makes it close to impossible to determine statistically-significant long-term monthly trends, but some information can be gleaned by combining monthly figures into seasons.

The variability is due to vagaries of the weather, short-term decadal variability due to the Pacific Decadal Oscillation (PDO) and El Niño-Southern Oscillation (ENSO), phenomena that existed before the onset of human-induced climate change at the start of the industrial era, and of course human-induced climate change itself.

This table shows trends in precipitation over the 78 years without attempting to ascribe causes for any detected trends. Trends are analysed as if they were linear trends because this is all that the "noise" will allow, but this is unlikely to be an accurate reflection of the actual trend. No investigations were made of any time-dependent correlations other than the linear trend.

Column 1 (season) in the 2-season version, each year of the 78 years is divided into two seasons with exactly the same number of days.

Winter (2) for any selected year is defined as the months October to December in the previous year plus the contiguous months of January to March in the selected year.

Summer (2) for any selected year is defined as April to September in the selected year.

The annual precipitation is thus precipitation from October the previous year to September in the selected year.

Column 2 (mean) the mean seasonal and annual precipitation in mm.

Column 3 (min) the lowest seasonal and annual precipitation in mm.

Column 4 (max) the highest seasonal and annual precipitation in mm.

Column 5 (low) the mean precipitation less the standard deviation.

Column 6 High) the mean precipitation plus the standard deviation.

Column 7 (trend) the statistical linear trends in seasonal mean precipitation in mm per year. Note how small these are for this particular time period. Both seasons show positive trends though the summer season increasing trend which cannot be reliably estimated is weaker than the winter season's more distinct increasing trend.

Column 8 (confidence %) the probability that the direction of the trend, increasing or decreasing, is the same as the direction implied by the figure in Column 7. The confidence ranges from 50% to 100%. The closer the confidence is to 100% the more likely it is that a trend implied by the value in Column 7, positive or negative, is real and not an artifact of the statistics. The closer the confidence is to 50% the less likely it is that the trend implied by the value in Column 7 is reliable. At exactly 50% confidence, the trend implied by the figure in Column 7 is just as likely to be right as it is to be wrong irrespective of the magnitude of its value.

Column 9 (season) as for Column 1.

Column 10 (mean) the mean seasonal and annual precipitation as a percentage of the mean annual precipitations.

Column 11 (min) the lowest seasonal and annual precipitations as a percentage of the mean seasonal and annual precipitations.

Column 12 (max) the highest seasonal and annual precipitation as a percentage of the mean seasonal and annual precipitations.

Column 13 (std. dev.) the standard deviation of the seasonal and annual precipitation as a percentage of the mean seasonal and annual precipitations.

Summary 4-season stats

1	2	3	4	5	6	7	8
season	mean	min	max	one-sigma range		trend	confidence
	mm	mm	mm	low mm	high mm	mm/year	%
winter (4)	484	233	885	360	607	0.112	57
spring (4)	213	69	382	144	282	0.372	86
summer(4)	91	27	214	50	132	-0.250	89
fall (4)	329	99	623	218	440	0.791	92
annual (4)	1117	751	1829	914	1319	1.025	80

9	10	11	12	13
season	mean	min	max	std. dev.
	%	%	%	%
winter (4)	43	48	183	26
spring (4)	19	32	179	32
summer(4)	8	29	235	45
fall (4)	29	30	189	34
annual (4)	100	67	164	18

Summary 4-season stats. table notes

Despite the high level of "noise" in the monthly observations, we can squeeze a little more information from the data regarding trends if, instead of breaking the year up into just winter and summer seasons, we group them into four seasons.

Column 1 (season) In the 4-season version, each year of the 78 years is divided into seasons with exactly the same number of days.

Winter (4) for any selected year is defined as the month of December in the previous year plus the months of January and February in the selected year.

Spring (4) for any selected year is defined as March, April, and May in the selected year.

Summer (4) for any selected year is defined as June, July, and August in the selected year.

Fall (4) for any selected year is defined as September, October, and November in the selected year.

The annual precipitation is thus precipitation from December the previous year to November in the selected year.

Column 2 (mean) the mean recorded seasonal and annual precipitation in mm.

Columns 3-13 as for the 2-season table.

Note particularly the differences in the seasonal trend analysis in Column 7 in the 4-season model compared to the 2-season model.

With fairly high confidence we can say that the increasing trend in winter in the 2-season model is likely the result of increasing trends in the fall and spring, and less likely due the trend in mid-winter, which seems to be fairly stationary.

With fairly high confidence we can also say that the weak increasing trend in summer in the 2-season model is also likely the result of increasing trends in the fall and spring, and that it is fairly likely that the mid-summer trend is actually negative (decreasing).

In general, the 4-season model appears to be more informative than the 2-season model. While all models show annual precipitation increasing at a rate of the order of 1 mm/year, it has to be noted that this is trivial to the point of being insignificant. It amounts to the order of less than one day's extra precipitation per decade. This may be that the chosen 78 years stretch too far back into the past and that a possible acceleration in the trend is only now becoming apparent. A second reason may be that aggregate monthly precipitation figures are disguising trends in the character of the precipitation that would only be apparent in statistics based on a weekly, daily, or even hourly basis. There is also no information in the analysis on the duration and frequency of events such as multi-year droughts or the onslaughts of atmospheric rivers.

Appendix to include 2022-2023

Changes in data source

Data ceased to be collected at Nanaimo Airport in April 2022. Steps to continue to collect data in spite of this unfortunate break are as follows. Changes were not applied retrospectively.

For the period May 2022 to December 2022,
note in File 673z.pdf p.Z 463.

" Substitute figures for the rest of the year [2022] reported in this file were obtained mostly by averaging figures for Nanaimo City Yard and Entrance Island indicated by (VieRG). Neither of these substitute sources was of high quality and were missing a few figures. Figures were taken for Duncan for Nanaimo City Yard and Southern Gulf Islands for Entrance Island where necessary. Exceptions occurred on September 15, (***), when heavy showers on Gabriola indicated an underestimate, and on December 5, 25, 27, and 31, (****), when heavy snow led to missing or inconsistent numbers.

"In late December [2022], Environment Canada introduced a new "location" to compensate for the loss of Nanaimo Airport figures described as Nanaimo but covering Duncan, East Vancouver Island, and Nanaimo. A comparison between the figures I used in this file [673z] and figures from the new site [VieRG] are as follows.

2022	this file	new Nanaimo		2022	this file	new Nanaimo
Jan	147(100%)	147		Jul	37 (86%)	43
Feb	59 (98%)	60		Aug	3 (150%)	2
Mar	66 (100%)	66		Sep	21(175%)	12
Apr	160 (91%)	175		Oct	40 (71%)	56
May	73 (87%)	84		Nov	84 (69%)	121
Jun	63 (86%)	73		Dec	255(109%)	235

"Annual for this file 1007.4 mm (94%), for the new site 1073.2 mm.

"The new location usually gives higher figures than the old method, presumably because the new location does not use data from the Gulf Islands. For historical trends, data more recent than March 2022 [from the Nanaimo aka Vancouver Island East database] cannot be reliably used."

For the period January 2023 to August 2023,
note in File 673zb.pdf p.ZB p.525.

" rainfall datum in trouble again. No VieRG recording this month. Had to use Entrance x 1.092, a factor determined by comparing Coats Marsh rain gauge observations with Environment Canada's figures for the same period." Despite this change I continued to use the label VieRG in the field notes.

For the period September 2023 to current,

Based on a comparison between the scaled Entrance Island figures and the original historical figures for Nanaimo Airport, I decided a better method would be to take the average of the Entrance Island figure scaled by 1.092 and that for Nanaimo City Yard. Precipitation at Entrance Island is usually a little lower than that at Coats Marsh, which is 100 m AMSL, and precipitation in Nanaimo is usually a little higher. When readings are missing, I simply take the one that isn't. Fortunately, of late, missing figures for either location are infrequent. I now use the label ViGRG in the field notes.

Disconcerting all these changes in the data source, one always has to remember that precipitation is not uniform over the whole island. There is a fairly strong correlation between heavier rainfall with height above sea level, and another weaker one between the west (north) end of the island and the east (south) end, precipitation at the west end (Mallett Creek) being a little heavier than at the environment Canada site on Somerset Farm. The intent is to produce figures that are most appliable to the Coats Marsh Regional Park.

The following is my baseline data for the period 1944-2023 inclusive.

		mm	mm	mm	mm	mm/yr	%	%	%	%	%/year
	mean	min	max	1 sigma lo	1 sigma hi	trend	mean	min	max	std.dev	trend
Jan	169	22	358	97	242	0.3	15	13	212	43	0.2
Feb	130	20	395	62	198	-0.3	12	15	304	52	-0.2
Mar	106	19	300	52	161	0.1	10	18	282	51	0.1
Apr	64	5	162	34	95	0.2	6	8	252	48	0.3
May	43	5	143	17	69	0.1	4	11	331	61	0.3
Jun	41	5	130	19	64	0.0	4	12	313	55	-0.1
Jul	24	0	65	8	39	-0.1	2	0	274	65	-0.3
Aug	27	0	128	3	50	-0.1	2	0	483	90	-0.4
Sep	44	0	144	12	76	0.2	4	1	323	72	0.4
Oct	105	14	288	43	166	0.2	9	14	275	59	0.2
Nov	179	41	483	90	267	0.2	16	23	270	50	0.1
Dec	184	25	385	117	251	0.0	17	14	209	36	0.0
year	1116	733	1719	927	1306	0.9	100	66	154	17	0.1

season-4			trend
	mean mm	%	mm/year
winter	483	43	0.055
spring	214	19	0.418
summer	92	8	-0.208
fall	328	29	0.627
year	1116	100	0.891

◊ END