

Gabriola Streamkeepers

Rainfall on Gabriola 2015/16

For the observational year 2016/17 see the addendum

<http://www.nickdoe.ca/pdfs/Webp674d.pdf>

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Rainfall on Gabriola 2015/16¹

Background

An essential part of Streamkeeper projects aimed at understanding the hydrogeology of creeks and wetlands on Gabriola Island is keeping a record of precipitation. Some precipitation returns to the atmosphere by evapotranspiration; some flows into the ground to recharge aquifers; some flows into the ground and reappears at the surface as springs; and some runs off into the sea. This file provides a record of precipitation at several points on the island, starting on July 18, 2015, and is intended to be used with other files recording flow rates in selected creeks and water levels in selected wetlands.

Average annual rainfall on Gabriola at the Somerset Farm station is 958 mm (Environment Canada 70-year average). About 78% of this falls in the six months October to March, and as a consequence, nearly all creeks on Gabriola are dry in the summer months.

Some wetlands however do retain open water year round. Most, if not all of these, manage to do so by having little or no leakage into the ground—the underlying soil is thick clay of glacial origin—and by having little or no outflow. The principal source of natural water loss in these wetlands is evapotranspiration.

A few creeks have reservoirs of water along their courses that provide supplementary flows of water when precipitation is low. These reservoirs delay the onset of high flow rates in creeks in the fall while they are being recharged. They can be in the form of natural swamps and marshes, dugouts, small artificial lakes, below-surface aquifers feeding springs, and wetland enhanced by beavers and former farmers.

Open-water reservoirs can negatively impact aquatic habitat by raising water temperatures and losing water through rapid evaporation, but they can also have a very positive effect by “leaking” water into creeks that would otherwise dry out earlier in the dry season.

Records

Day 0 is Julian Day 2457222.0 at 4 am PST July 18, 2015.

The records at El Verano start at day 0.

Those at Coats Marsh start at day 60 (Sept. 16).

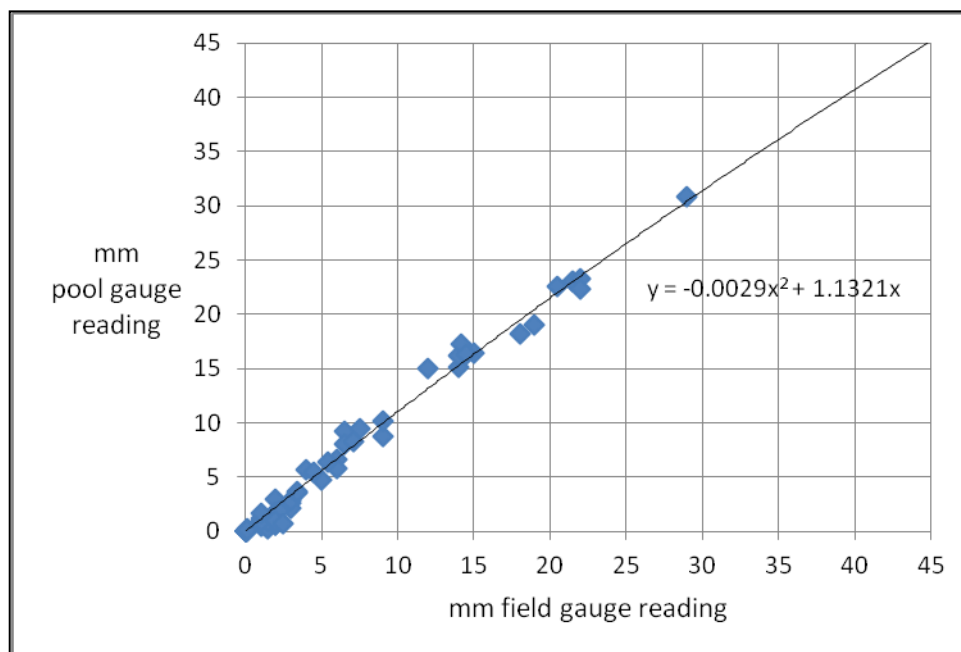
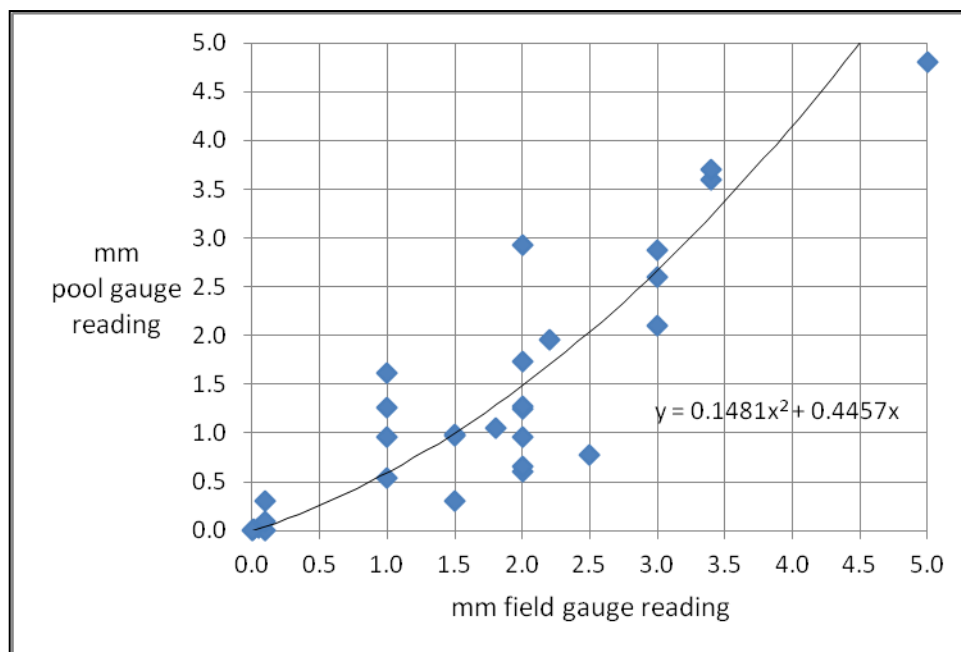
Those in the Mallett Creek watershed start at day 67 (Sept. 23).²

Rainfall on Gabriola is not necessarily the same as El Verano observations, ~~which is what are shown in the graphs~~. In the fall and spring, rain tends to be “April-shower-like”—localized and with very variable intensity. The El Verano gauge (a kid’s paddling pool) has a 1.03-metre diameter collection area [1mm = 833mL], whereas the field gauges are considerably smaller, 40 × 40 mm [1mm = 1.6mL], and are usually far too close to trees that could create rain shadows.

¹ By rainfall, I mean total precipitation (including the equivalent of snow) throughout these notes.

² For convenience, I took the starting cumulative values as being the El Verano values. The cumulative precipitations at these times were low so the approximations are not too bad.

A field gauge at El Verano also often reads lower than the larger one.³ The field gauges actually in the field are also not read daily, which sometimes leads to evaporation loss.



After writing the previous paragraph, examination of the El Verano observations for days 0–166 (Jul.18 to Dec.31), showed that the differences when amounts were small were more scattered.

There are probably three reasons for this:

³ Difference in airflow perhaps. The difference appears to be less when the rain is steady and heavy than when it is light and showery.

- the graduations on the field gauge are in 2-mm increments which leads to significant errors when amounts are small and the gauge is not being held perfectly level when being read
- the combination of refraction through the plastic side of the field gauge and the curvature of the meniscus in the gauge leads to ambiguity as to the correct level of water
- the combination of the previous of the above sources of error probably produces some observer bias which may not be consistent over time.

Quadratic polynomial regression fits to the data gives the following as a procedure for correcting the field gauge readings.

If f is the field gauge reading and fc the calibrated reading:

$$\text{if } f < 4.55, \text{ then } fc = 0.4457f + 0.1481f^2$$

$$\text{if } 4.55 < f < 45.55, \text{ then } fc = 1.1321f - 0.0029f^2$$

$$\text{if } 45.55 < f, \text{ then } fc = f.$$

Over the 166-day period, the cumulative field gauge reading was 453.7 mm, which was 95.0% of the cumulative pool gauge reading of 477.7 mm. After correcting the daily readings using the above procedure, the field gauge reading was increased to 472.0 mm, a change of +4.0%.

Applying this procedure to the field gauges at locations other than El Verano will make less of a change because the El Verano gauge was read every day and so the cumulative reading there is the sum of a large number of relatively small error-prone readings, while the other field gauges were read less frequently and so had time to accumulate larger amounts that require less correction.

For example, over the 166-day period, the cumulative field gauge reading at Mallett Creek was 565.5 mm, which, after correcting the readings using the above procedure, was 574.6 mm, a change of only +1.6%. For the same period, the cumulative field gauge reading at Coats Marsh was 572.0 mm, which, after correcting the readings using the above procedure, was 588.1 mm, a change of +2.8%.

The above 2015-calibration will hold without modification for 2016 (or further notice).

Over the 257-day period (Jul.18 to Mar.31), the cumulative field gauge reading was 955.5 mm, which was 97.0% of the cumulative pool gauge reading of 986.4 mm. After correcting the daily readings using the above procedure unchanged, the field gauge reading was increased to 997.0 mm, a change of +4.3%. The Mallett Creek reading went from 1125.0 mm to 1141.5, a change of +1.5%; and the Coats Marsh reading from 1147.0 mm to 1179.8 mm, a change of +2.9%.

The 2016-1 calibration

If the reading was made in 2015, retain the 2015 calibration as noted above.

If the reading was made in 2016, calibrate as follows based on an analysis of readings taken over the period July 18, 2015 to May 31, 2016 (days 0–318).

$$\text{if } f < 5.20, \text{ then } fc = 0.6171f + 0.0815f^2$$

$$\text{if } 5.20 < f < 27.68, \text{ then } fc = 1.0380f + 0.0005f^2$$

$$\text{if } 27.68 < f, \text{ then } fc = f.$$

For Coats Marsh, May 31, the 2015 cal. reading 1231 mm, becomes 1219 mm, –1.0%. For Mallett, April 8, the 2015 cal. reading 1150 mm, becomes 1146 mm, –0.3%.

Locations

One of the assumptions made when observations began was that rainfall amounts are much the same at various locations on Gabriola. This turns out not to be true. After calibration, field gauges at Coast Marsh (in the uplands), Mallett Creek (on the west coast), and Environment Canada: Nanaimo-A (Cassidy Airport, V.I.) all recorded greater amounts of precipitation than at El Verano (south-central coast).

Total rainfall days 0-166:

En.Can. Entrance Is.			3m AMSL, 9km NNW
El Verano	472.0 mm	EV/EV = 100%	9m AMSL
Mallett Creek	574.6 mm	MC/EV= 122% ⁴	24m AMSL, 8km, NW
En.Can. Nanaimo-A	572.9 mm	NanA/EV = 121%	28m AMSL, 12km SW
En.Can. Gabriola			46m AMSL, 12km NE
Coats Marsh	588.1 mm	CM/EV = 125%	100m AMSL, 3km, NW

One noteworthy figure is that the El Verano figure is 82% of the Environment Canada: Nanaimo-A figure, which is not far from the ratio of the 70-year average figure for Environment Canada: Gabriola to Nanaimo-A of 86%. This hints at the possibility, but doesn't of course prove, that the Environment Canada: Gabriola figures from Somerset Farm at the east end of the island may also commonly be below what other locations on Gabriola experience.

Another interesting figure is the 30-year average figure for Environment Canada: Entrance Island. Total precipitation at this station is only 92% of the equivalent Environment Canada: Gabriola figure.

That annual rainfall varies with height above mean sea level (AMSL)⁵ has been well documented in the literature,⁶ and although the data from Gabriola is not enough to quantify the relationship with any accuracy, it does nevertheless indicate coefficients that are within the ranges found in other places in the world. Brunsdon et al., for example, propose for all of Great Britain the relationship:

$$P = c_0(x,y) + c_1(x,y) H$$

where P = annual rainfall (mm/year) at location (x,y):

c_0 is the intercept coefficient (mm/year), the annual rainfall at location (x,y) if (x,y) were at mean sea level;

c_1 is the height coefficient (mm/m/year), the increase in annual rainfall at location (x,y) for every metre (x,y) is above mean sea level; and

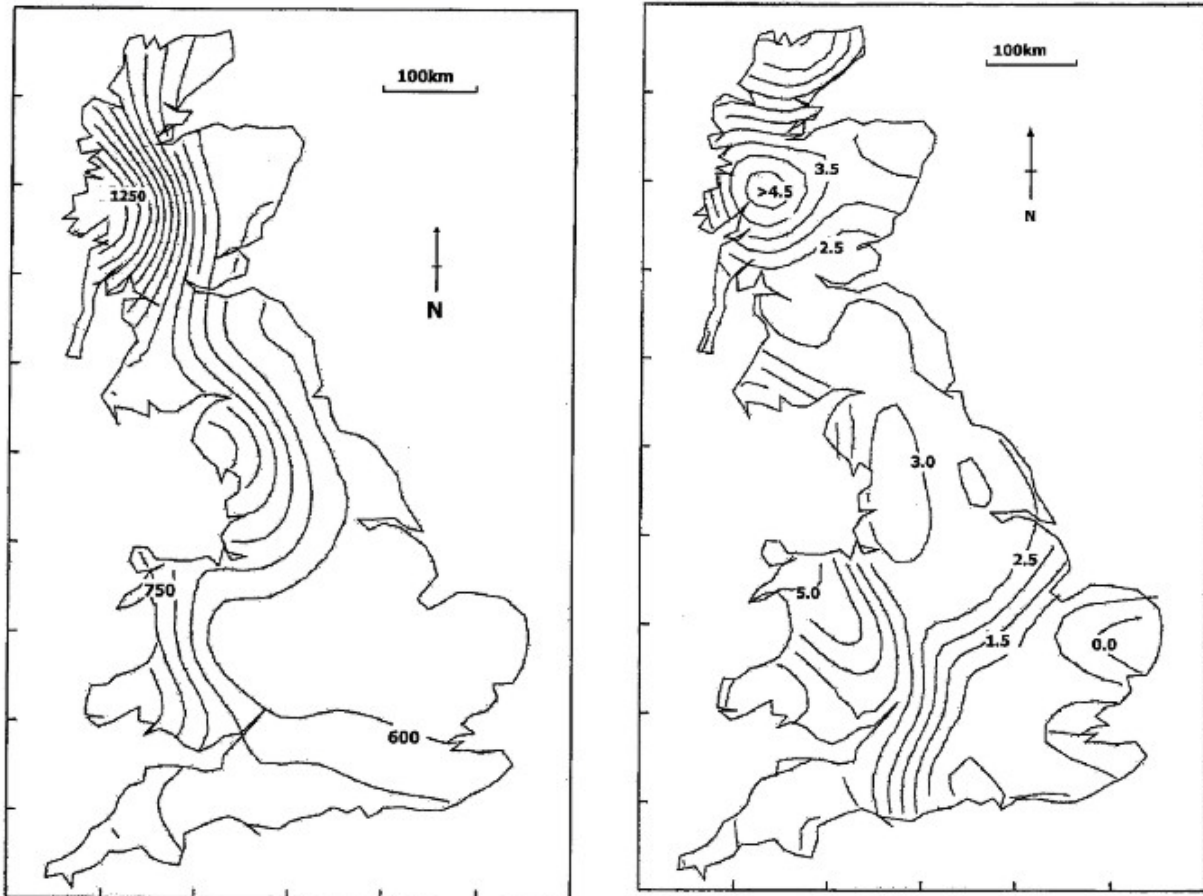
H is the actual height (m) above mean sea level of location (x,y).

For the whole of Great Britain, the average c_0 is 731 mm/year. It is highest in the NW and least in the SE, ranging from 600–1250 mm/year (map shown left below). The average c_1 is 2.28 mm/m/year and is again highest in the NW and least in the SE ranging from 0–5 mm/m/year (map shown right below).

⁴ More likely to be in a rain shadow due to tall trees than the other gauges.

⁵ Annual averages for total precipitation that I am using are: Nanaimo-A 1112 mm (70 years); 1164 mm (30 years); Gabriola 958 mm (70 years); 924 mm (30 years); Entrance Island N/A mm (70 years); 846 mm (30 years).

⁶ Brunsdon C., McClatchey J., and Unwin D.J., *Spatial Variations in the average rainfall–altitude relationship in Great Britain*, International Journal of Climatology, **21**: pp.455–466, 2001.



From Brunson et al.

Just looking at the El Verano and Coats Marsh figures as they are at day 166, we can see that the derived value of the coefficient c_1 of 2.8 mm/m/year (map right) would not be exceptional in this data set.

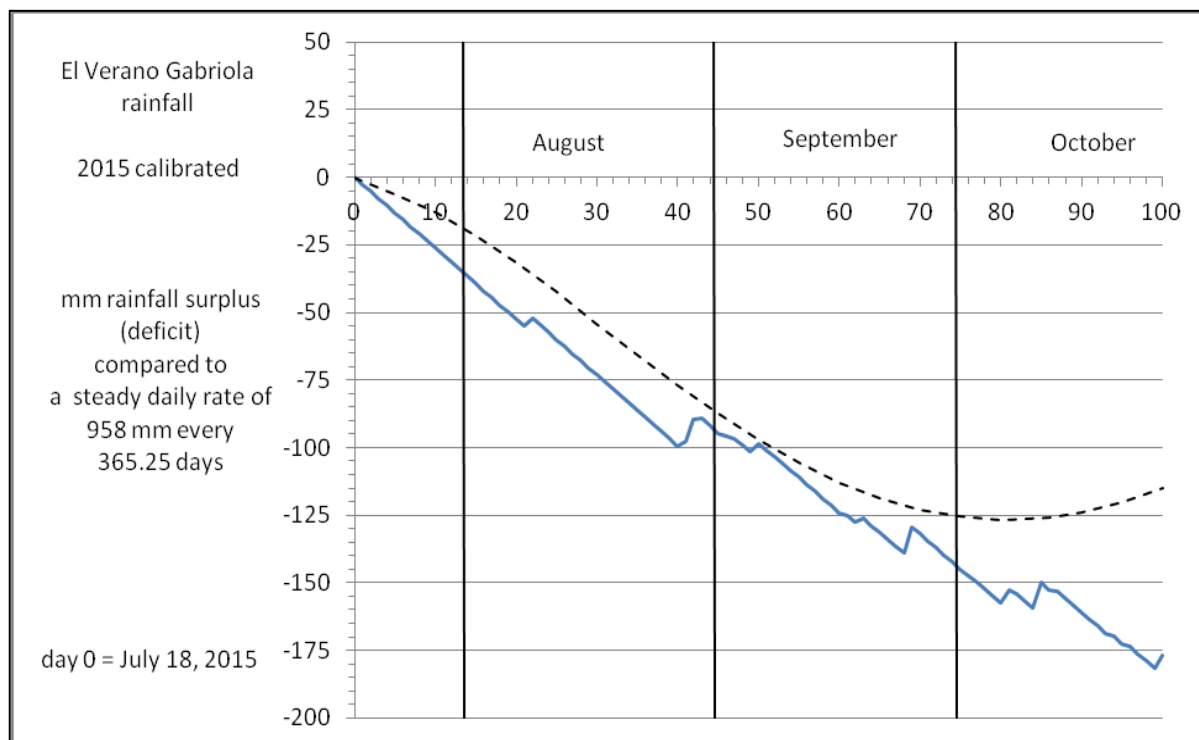
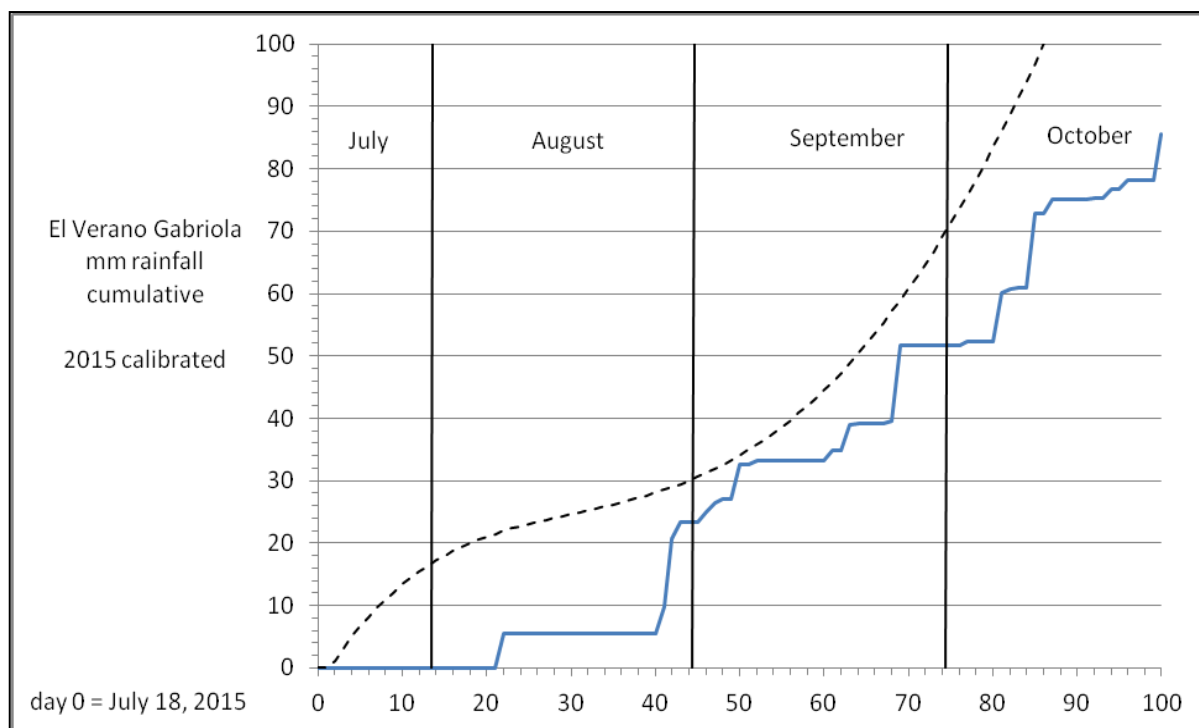
Gabriola is obviously a lot smaller than Great Britain, so it might be that $c_0(x,y)$ is practically constant for the island, but you never know. There is a suspicion that the east end (known locally as the south end) of the island is drier than the west end (known locally as the north end), but how much this has to do with differences in elevation, and how much to do with differences in regional geography, especially with respect to the Vancouver Island mountains, is not known.

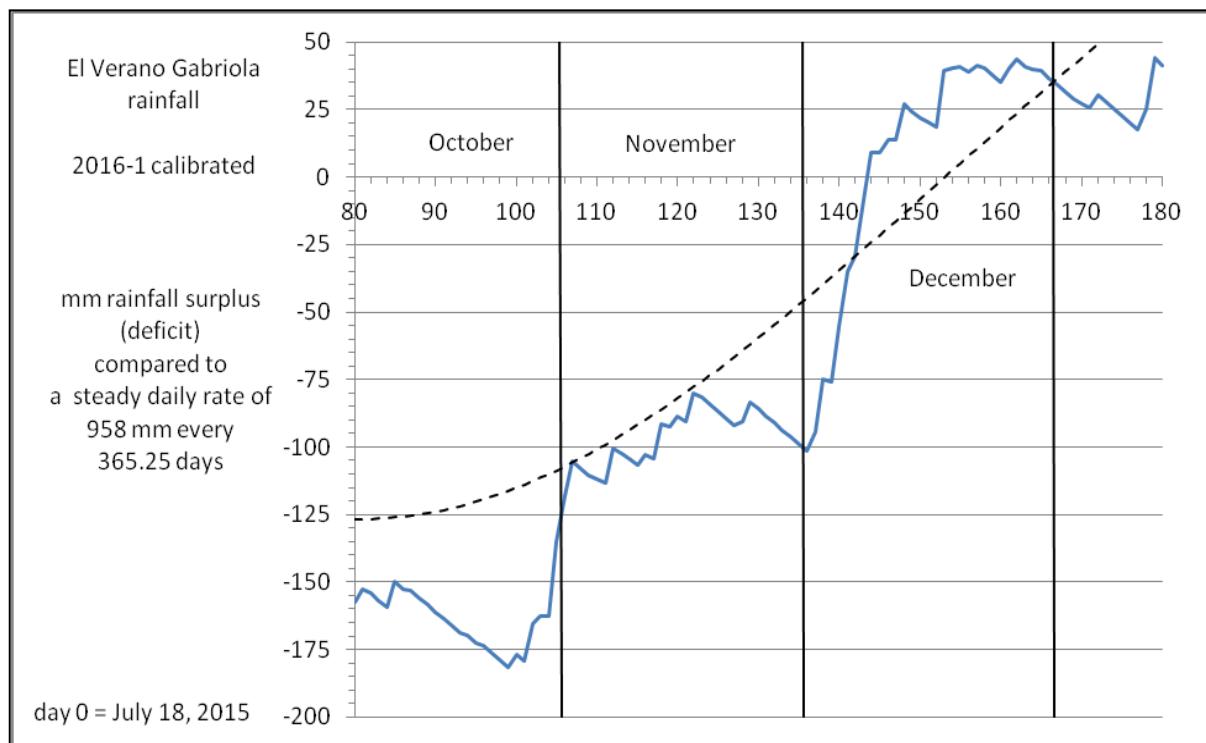
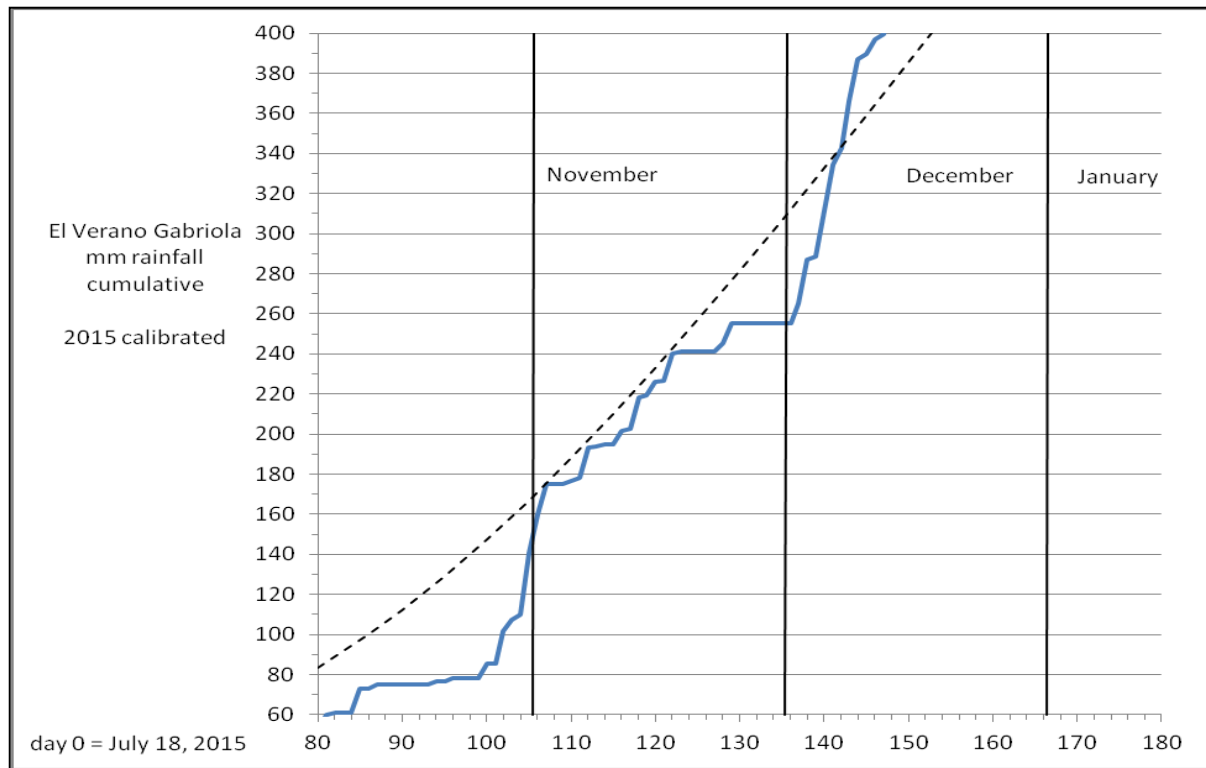
For details of rainfall recorded at Coats Marsh, see <http://www.nickdoe.ca/pdfs/Webp673.pdf>

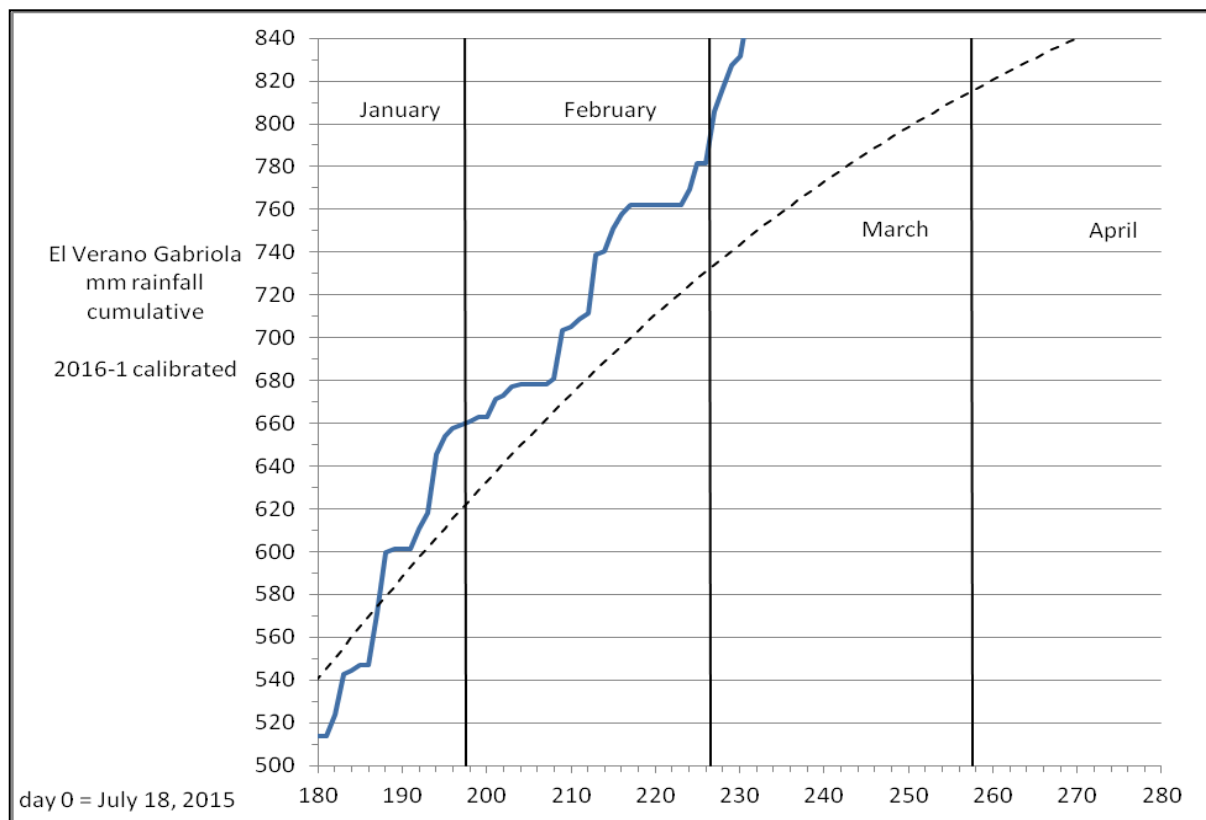
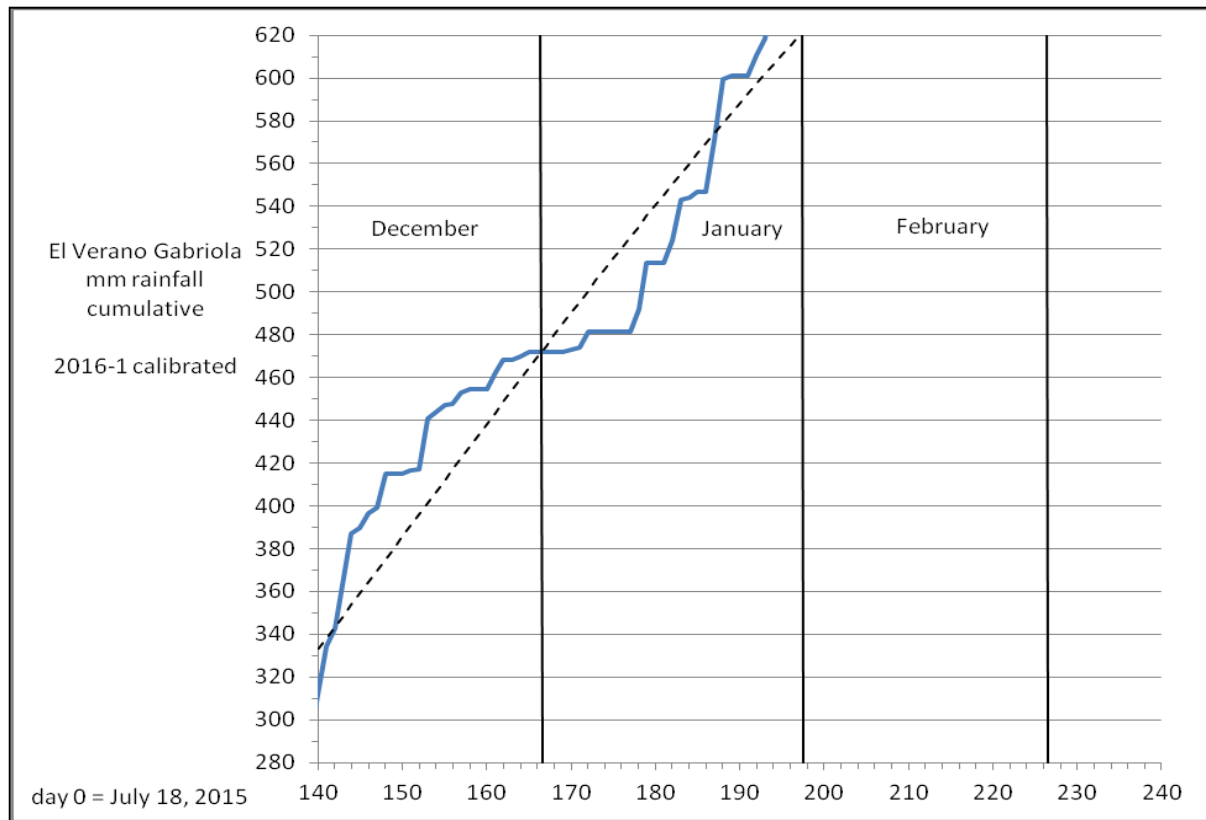
For details of rainfall recorded at Mallett Creek, see <http://www.nickdoe.ca/pdfs/Webp672.pdf>.

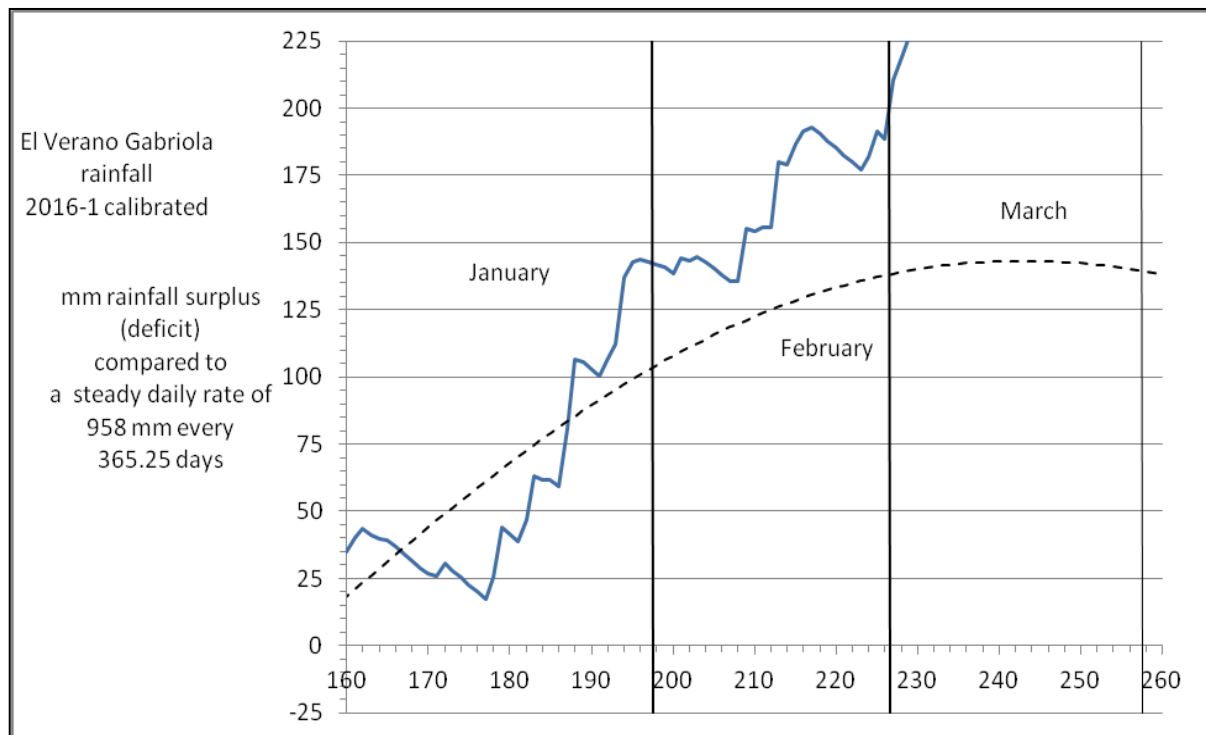
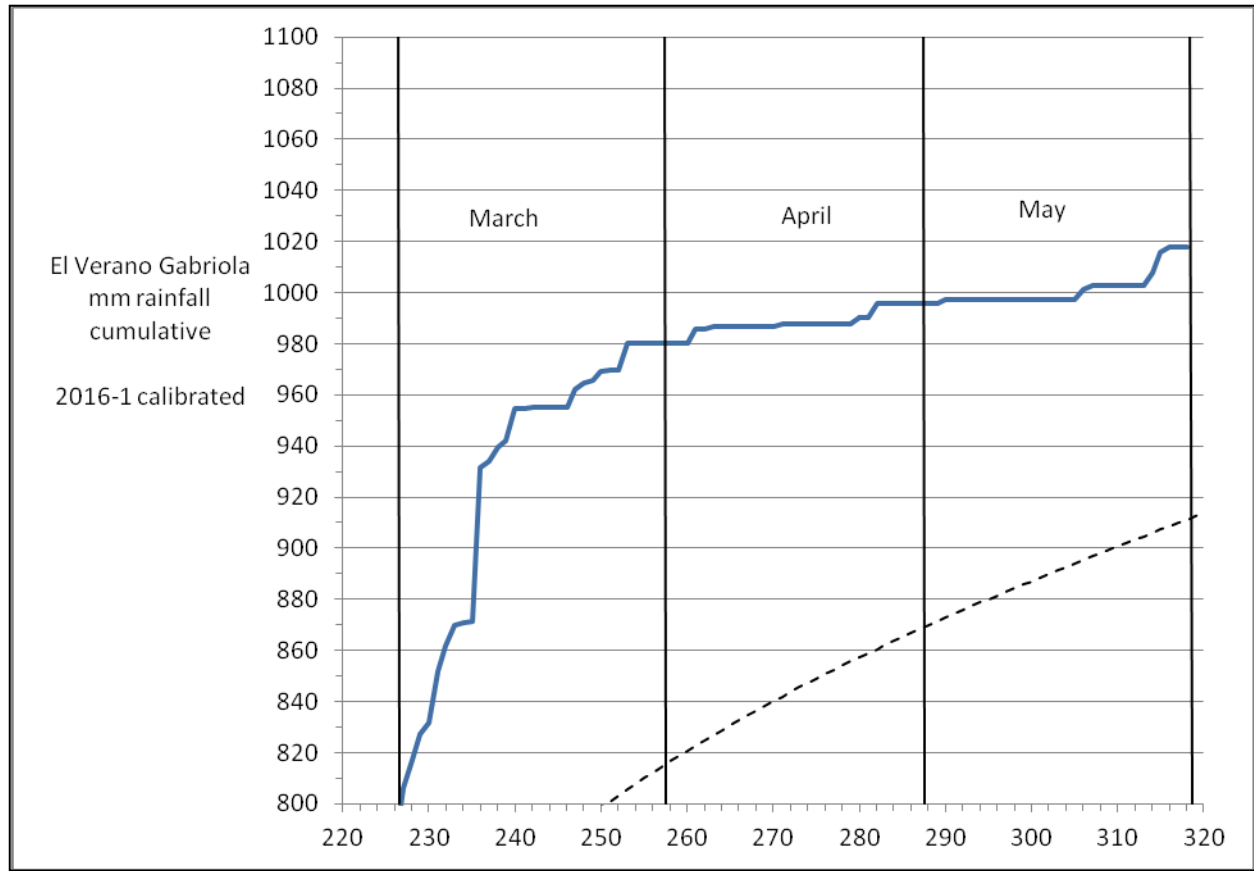
Observations

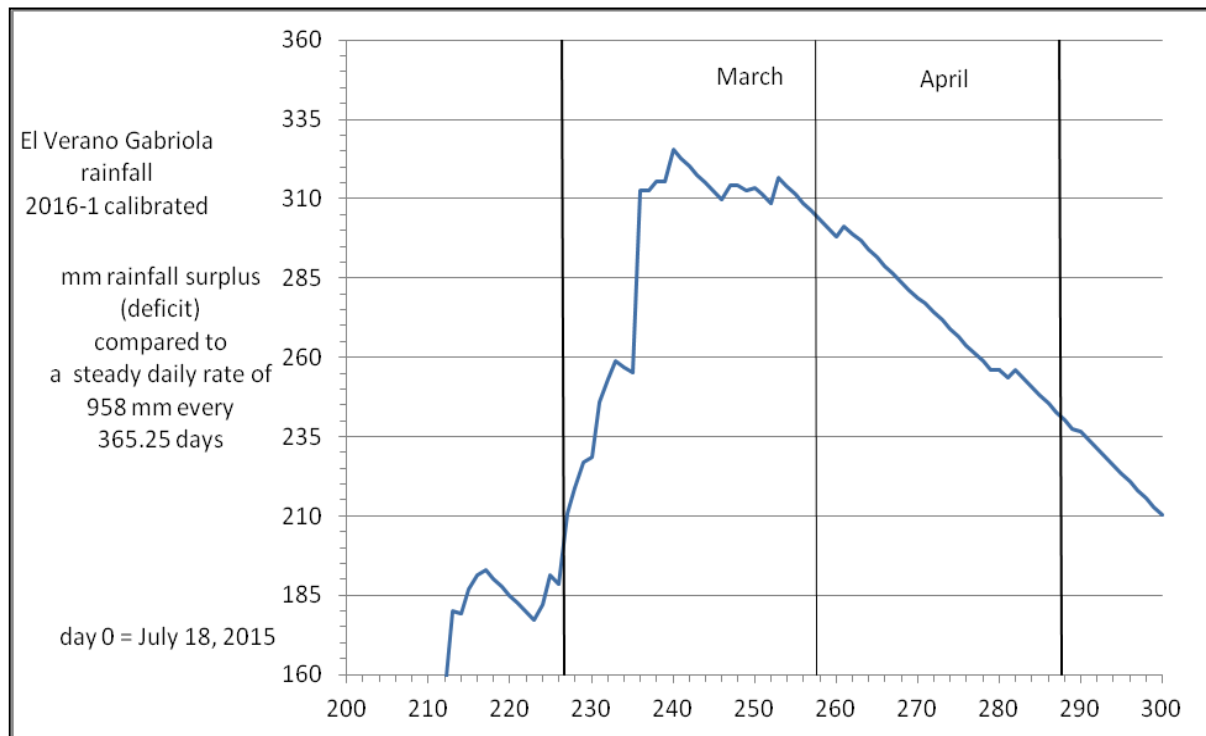
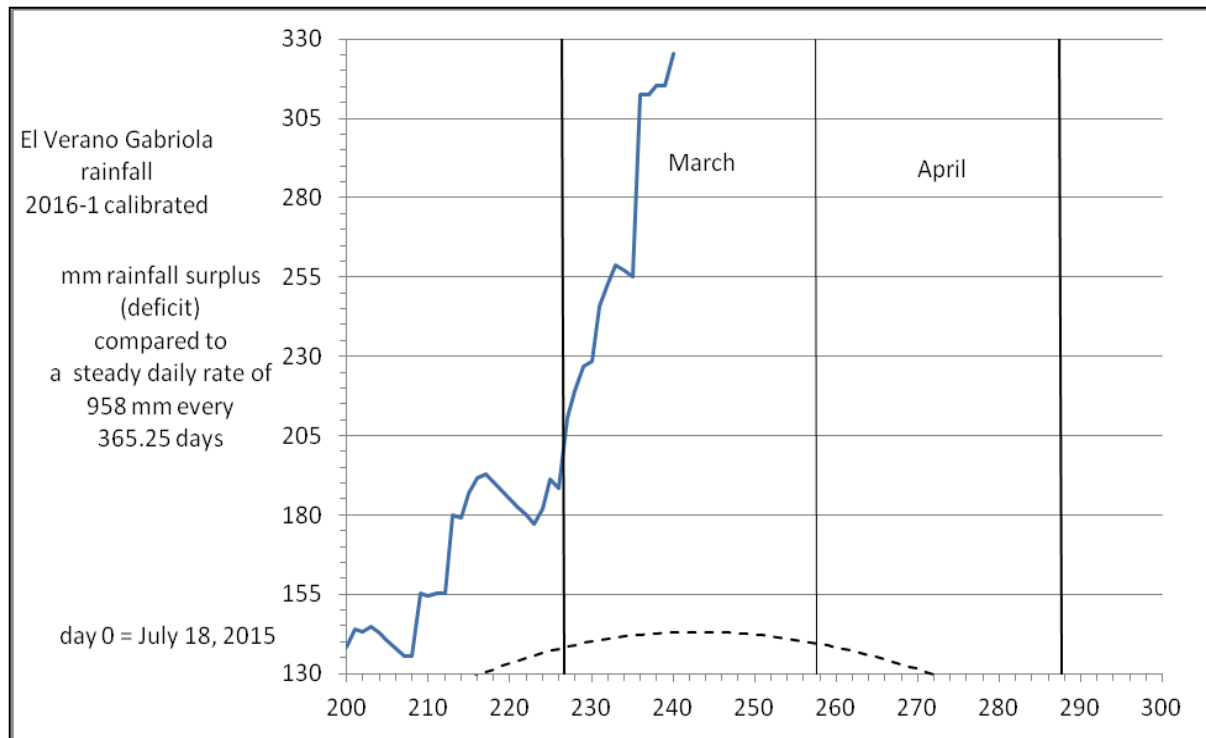
The dashed curves in the graphs below are Environment Canada Nanaimo Airport averages for the years 1944–2014, normalised from the airport average of 1112 mm to Gabriola’s 958 mm (86.2%). These measurements are made by the field gauge so as to be comparable with those actually out in the field, ~~but the larger gauge often shows more precipitation. At some point a significant calibration correction, perhaps as high as +10%, will have to be made.~~ **Now calibrated.**

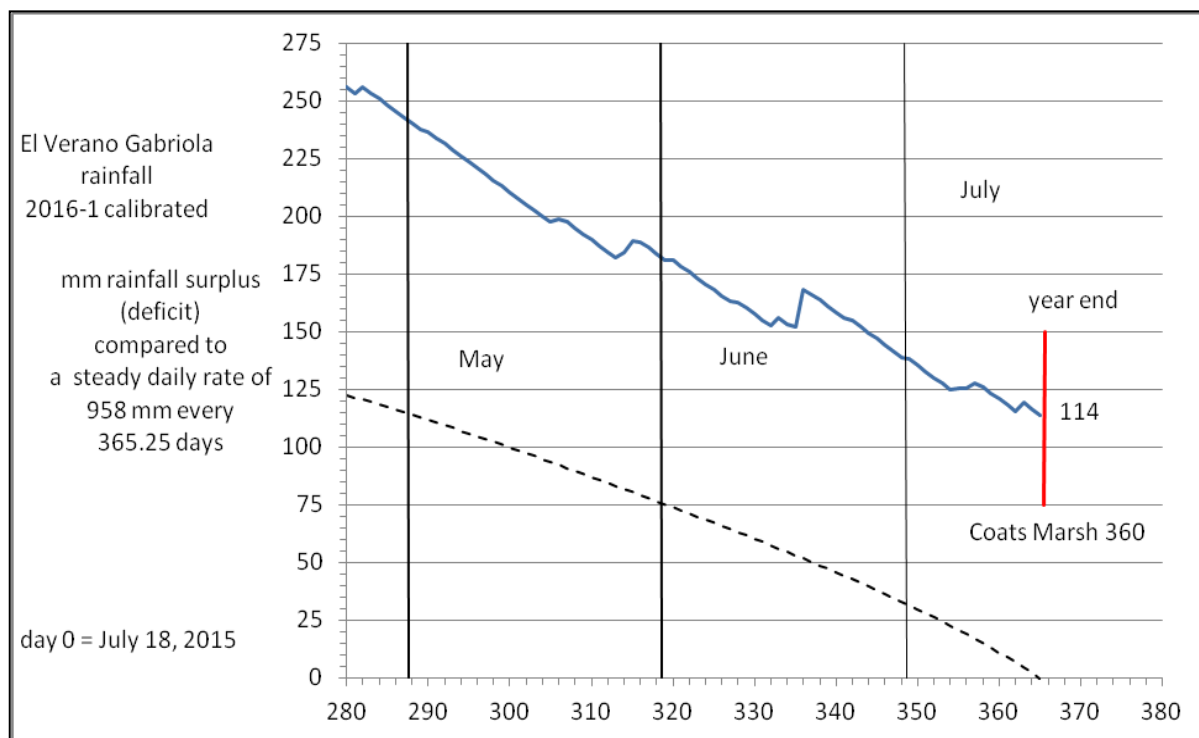
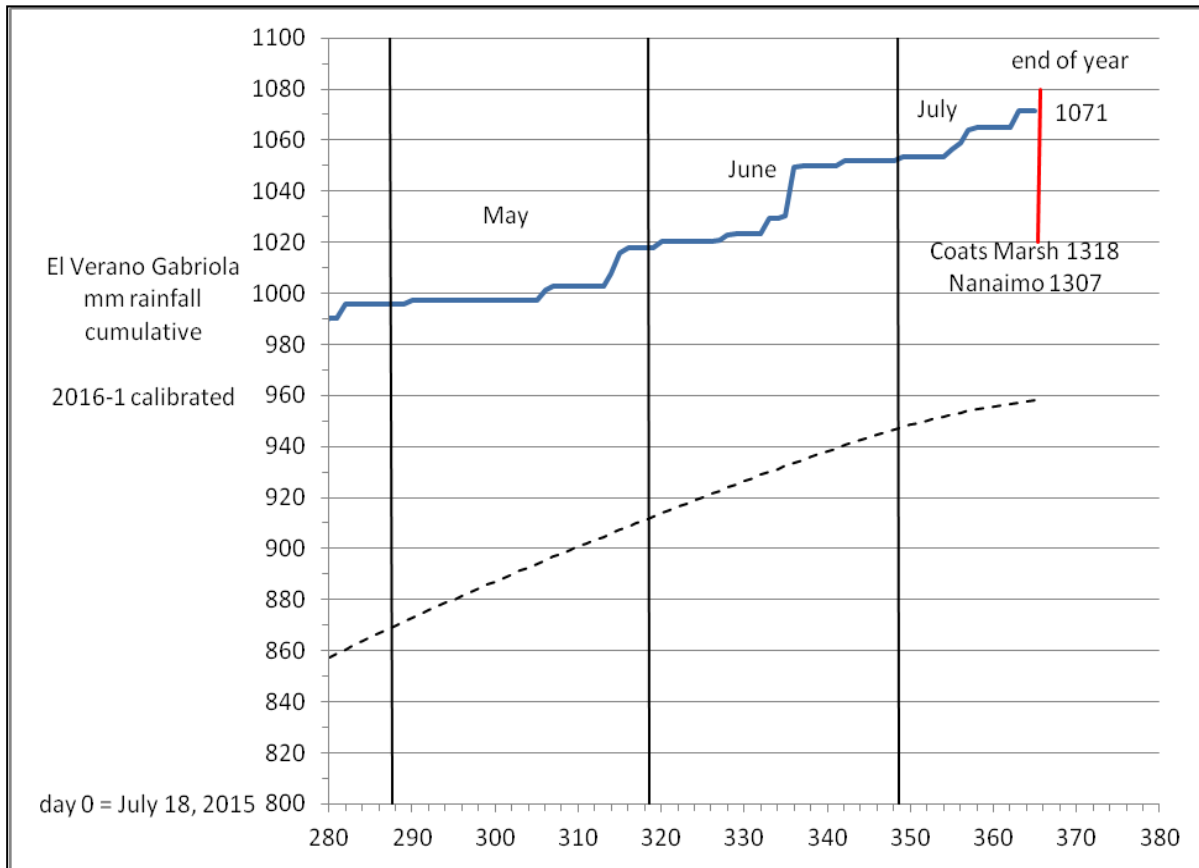












Field notes for 2015 [these notes are as written at the time and do not include the 2015 gauge calibrations determined at the end of the year]

July 18, 2015 is day 0.

August 1, 2015 is day 14.

September 1, 2015 is day 45.

September 30, 2015:

Coats Marsh gauge is showing cumulative +2.3 mm on El Verano.

Mallett gauge is showing cumulative -2.3 mm on El Verano.

According to the Nanaimo Airport precipitation records (historical data for Gabriola is harder to come by), at the end of September, the 2015 precipitation so far this year is -28% relative to the long-term average. This low precipitation figure may, in part, be the result of us being in El Niño/warm-phase PDO cycles. The overall variability (standard deviation) of annual precipitation in the years 1944–2014, regardless of the phases of the cycles, was around $\pm 17\%$ with a maximum of +52% in 1983, and a minimum of -34% in 1944. However, according to an analysis of annual precipitation on the Sunshine Coast,¹ the variation attributable to the difference between El Niño/cool-phase PDO conditions when annual precipitation is highest and El Niño/warm-phase PDO when it is lowest is only $\pm 5\%$, so, although significant, the phases of the cycles are not the dominant controlling factor in the variability of annual precipitation.

More remarkable perhaps than the low annual precipitation is that the figure for the summer months alone in 2015 was -46%. The figure for Vancouver is similar in nature but less extreme. For the summer months alone, the variability (standard deviation) of precipitation in the years 1944–2014, again, regardless of the phases of the cycles, was around $\pm 26\%$ with a maximum of +81% in 1997, and a minimum of -50% in 1973. So “extremes” in summer are not all that unusual. However, according to an analysis of annual precipitation on the Sunshine Coast,¹ average summer precipitation is usually higher during El Niño/cool-phase PDO conditions and lower during La Niña/warm-phase PDO conditions and differences can be very high at $\pm 24\%$ in the context of overall summer variations of $\pm 26\%$. So being in a warm-phase PDO likely did contribute significantly to the summer drought.

For the first three months of 2015, precipitation was -17% relative to the long-term average, but for the last three months of 2014, it was +7%. Although these figures are low, they are far from being exceptional. For the winter months alone, the variability (standard deviation) of precipitation in the years 1944–2014, again, regardless of the phases of the cycles, was around $\pm 22\%$ with a maximum of +57% in 1983, and a minimum of -58% in 2013. Average winter precipitation is usually higher during La Niña/warm-phase PDO conditions and lower during El Niño/warm-phase PDO conditions (this coming winter’s conditions) but measured differences are relatively small at $\pm 8\%$ in the context of overall winter variations of $\pm 22\%$. So, although it is probable that this coming winter will be fairly dry, it’s too early to confidently say if it will be record-breakingly so.

1. Monte Staats, *Water availability and climate change—Chapman Creek Water System, Sunshine Coast BC*, M.Sc. Thesis UBC, July 2014. Analysis for 1962–2013.

Environment Canada (Nanaimo A) for precipitation so far this year at their station is -27% on 1944–2014 average.

Levels following are the amount the current cumulative reading is above or below the current cumulative field gauge reading at El Verano. Percentages, where given, are mostly these levels as a percentage of current cumulative El Verano field gauge reading. An exception is the percentage cumulative for El Verano pool (not field) of cumulative for Environment Canada Nanaimo. The long-term average of Environment Canada Gabriola/Environment Canada Nanaimo is 86%.

October 1, 2015 is day 75.

October 5, 2015: Coats Marsh +1.5 mm. Mallett -3.2 mm.

October 8, 2015: Coats Marsh +1.1 mm. Mallett -5.2 mm.

October 11, 2015: Coats Marsh -0.2 mm.

October 13, 2015: Mallett -14.1 mm. Although open to the sky, probably in a rain shadow created by surrounding tall trees, together with evaporation loss.

October 16, 2015: Coats Marsh -0.8 mm. Mallett -14.1 mm.

October 20, 2015: Coats Marsh -0.2 mm. Mallett -13.0 mm.

Rainwater specific conductivity 35 $\mu\text{S}/\text{cm}$ (24 $\mu\text{S}/\text{cm}$ at 9.6°C).

October 25, 2015: Coats Marsh -0.3 mm.

October 25, 2015: El Verano pool figures are now 87% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

October 27, 2015: Coats Marsh +1.7 mm. Mallett -9.6 mm.

October 29, 2015: Coats Marsh +1.2 mm (+1%). Mallett -11.7 mm (-11%).

October 30, 2015: [Environment Canada](#) measurements of rainfall now available for Nanaimo A (the airport) for the six months of summer 2015 (Apr.-Sept). They show -44% below normal (1944-2014 average). Not a record, there was less summer rain in 1973 and 1987, but still very low. The one-sigma variation for summer rainfall is $\pm 25.9\%$.

October 31, 2015: After heavy rain (30 mm): **rain quality**
pH 7.5

Specific conductivity 5 $\mu\text{S}/\text{cm}$ (4 $\mu\text{S}/\text{cm}$ at 12.21°C)

DO 10.2 mg/L (saturation 98%, 12.6°C, 99.7 kPa)

[Environment Canada](#) figure for precipitation so far this year at their station is unchanged since last month at -27% on their 1944-2014 average.

Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.083. Not as much as once thought. The proportional difference seems to be greater for small amounts than larger ones.

November 1, 2015 is day 106.

November 1, 2015: Coats Marsh +18.7 mm (+12%)—in part a time-of-day difference.

November 1, 2015: El Verano pool figures are now 110% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

November 2, 2015: Coats Marsh +5.5 mm (+3%). Rain stopped. Mallett -12.7 mm (-7%).

November 5, 2015: Coats Marsh +5.6 mm (+3%). Mallett -12.5 mm (-7%).

November 6, 2015: **Specific conductivity 4 $\mu\text{S}/\text{cm}$ (3 $\mu\text{S}/\text{cm}$ at 9.8°C)**

November 7, 2015: Coats Marsh +7.6 mm (+4%).

November 8, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.060.

November 8, 2015: El Verano pool figures are now 117% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

November 9, 2015: Coats Marsh +8.1 mm (+4%). Mallett -8.9 mm (-5%).

November 10, 2015: Coats Marsh +8.0 mm (+4%). Mallett -8.9 mm (-5%).

November 11, 2015: Coats Marsh +10.0 mm (+5%).

November 13, 2015: Mallett -3.6 mm (-2%).

November 15, 2015: El Verano pool figures are now 109% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

November 16, 2015: Coats Marsh +17.3 mm (+8%).

November rainfall trend now looking very average after the dry summer. Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.051.

November 17, 2015: Mallett +7.4 mm (+3%).

November 18, 2015: Coats Marsh +21.8 mm (+9%).

November 19, 2015: Coats Marsh +22.3 mm (+10%).

November 22, 2015: Mallett +6.0 mm (+3%).

November 22, 2015: El Verano pool figures are now 105% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

November 22, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.062.

November 23, 2015: Mallett +6.0 mm (+2%).

November 25, 2015: Coats Marsh +24.3 mm (+10%).

November 29, 2015: Coats Marsh +24.3 mm (+10%), Mallett +5.0 mm (+2%).

November 29, 2015: El Verano pool figures are now 106% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18. Their figure for precipitation so far this year at their station is now -29% on their 1944-2014 average.

November 29, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.066.

December 1, 2015 is day 136.

December 2, 2015: Coats Marsh +27.8 mm (+11%).

December 4, 2015: Coats Marsh +35.3 mm (+13%), Mallett +22.5 mm (+8%).

December 6, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.069.

December 6, 2015: El Verano pool figures are now 93% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

December 7, 2015: Coats Marsh +54.8 mm (+17%).

Rainfall is now above long-term average for the period starting in July.

December 9, 2015: Coats Marsh +62.8 mm (+17%), Mallett +58.0 mm (+16%).

December 11, 2015: Coats Marsh +65.3 mm (+17%).

December 13, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.071.

December 13, 2015: El Verano pool figures are now 89% of [Environment Canada](#) (Nanaimo A) figures since start of measurements on July 18.

Who said gathering rainfall statistics on Gabriola was simple? How much of the difference is due to faulty gauge calibration, rain shadows (shielding of the gauge by trees and buildings), and real variations in rainfall between locations? Of the three field gauges, the Coats Marsh is the least shaded and is very open to the southwest; the Mallett is surrounded on all sides by trees;

and the El Verano gauge has a tall house on its north side, trees to the west, southwest, and east, and is open mostly to the south facing Mudge.

December 14, 2015: Coats Marsh +74.8 mm (+19%).

December 15, 2015: Mallett +81.5 mm (+21%).

December 17, 2015: Coats Marsh +83.8 mm (+21%).

December 20, 2015: Mallett +87.7 mm (+23%).

December 20, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.066.

December 20, 2015: El Verano pool figures are now 89% of Environment Canada (Nanaimo A) figures since start of measurements on July 18.

December 27, 2015: Current correction to be applied (but not applied) to field gauge readings at El Verano reported here as determined by pool volume collected = 1.072.

December 27, 2015: El Verano pool figures are now 82% of Environment Canada (Nanaimo A) figures since start of measurements on July 18.

December 29, 2015: Mallett +111.5 mm (+27%), Coats Marsh +120.8 mm (+29%).

December 31, 2015: Mallett +111.5 mm (+27%), Coats Marsh +120.8 mm (+29%).

Environment Canada (Nanaimo A) figures for precipitation all of this year at their station is -13% on their 1944–2014 average. The one-sigma variation is $\pm 17.1\%$, so this is not unusually low.

Environment Canada measurements of rainfall now available for Nanaimo A (the airport) for the six months of winter 2015 (Jan.-Mar. + Oct.-Dec.). They show only -3% below normal (1944–2014 average). The one-sigma variation is $\pm 21.7\%$. The winter rain almost made up for the droughty summer.

Field notes for 2016 [these notes include the 2015 gauge calibration up until May 22, and the 2016-1 gauge calibration thereafter.]

January 1, 2016 is day 167.

January 03, 2016: El Verano calibrated figures [472 mm] are now 82% of Environment Canada (Nanaimo A) figures [573 mm] since start of measurements on July 18.

January 10, 2016: El Verano calibrated figures [482 mm] are now 83% of Environment Canada (Nanaimo A) figures [580 mm] since start of measurements on July 18.

January 12, 2016: El Verano cal. 493mm; Marsh cal. 617mm; Mallett cal. 597mm.

January 15, 2016: El Verano cal. 515mm; Marsh cal. 645mm.

January 17, 2016: El Verano calibrated figures [545 mm] are now 85% of Environment Canada (Nanaimo A) figures [644 mm] since start of measurements on July 18.

January 17, 2016: El Verano cal. 545mm; Mallett cal. 654mm.

January 18, 2016: El Verano cal. 547mm; Marsh cal. 681mm.

January 21, 2016: El Verano cal. 574mm; Marsh cal. 713mm.

January 22, 2016: El Verano cal. 604mm; Mallett cal. 708mm.

January 23, 2016: El Verano cal. 605mm; Marsh cal. 740mm.

January 24, 2016: El Verano calibrated figures [605 mm] are now 86% of [Environment Canada](#) (Nanaimo A) figures [705 mm] since start of measurements on July 18.

January 25, 2016: El Verano cal. 605mm; Marsh cal. 740mm.

January 31, 2016: El Verano calibrated figures [666 mm] are now 86% of [Environment Canada](#) (Nanaimo A) figures [776 mm] since start of measurements on July 18.

[Environment Canada](#) (Nanaimo A) figure for total precipitation so far this year at their station is +28% on their 1944–2014 average. The wettest January on record was in 2006.

[Environment Canada](#) (Nanaimo A) reports for February 2016 have **data missing**; this has been estimated.

February 1, 2016 is day 198.

February 5, 2016: El Verano cal. 680mm; Marsh cal. 824mm; Mallett cal. 777mm.

February 7, 2016: El Verano calibrated figures [685 mm] are now 84% of [Environment Canada](#) (Nanaimo A) figures [820 mm] since start of measurements on July 18.

February 8, 2016: El Verano cal. 685mm; Marsh cal. 834mm; Mallett cal. 785mm.

February 11, 2016: El Verano cal. 688mm; Marsh cal. 838mm.

February 14, 2016: El Verano cal. 717mm; Marsh cal. 867mm.

El Verano calibrated figures [717 mm] are now 83% of [Environment Canada](#) (Nanaimo A) figures [861 mm] since start of measurements on July 18.

February 15, 2016: El Verano cal. 720mm; Mallett cal. 829mm.

February 17, 2016: El Verano cal. 748mm; Marsh cal. 902mm; Mallett cal. 848mm.

February 19, 2016: El Verano cal. 767mm; Marsh cal. 924mm.

February 21, 2016: El Verano calibrated figures [772 mm] are now 84% of [Environment Canada](#) (Nanaimo A) figures [914 mm] since start of measurements on July 18.

February 23, 2016: El Verano cal. 772mm; Marsh cal. 928mm; Mallett cal. 872mm.

February 27, 2016: El Verano cal. 780mm; Marsh cal. 936mm.

February 28, 2016: El Verano calibrated figures [792 mm] are now 85% of [Environment Canada](#) (Nanaimo A) figures [933 mm] since start of measurements on July 18.

February 29, 2016: [Environment Canada](#) (Nanaimo A) figure for total precipitation so far this year at their station is +29% on their 1944–2014 average. The wettest February on record was in 1999.

March 1, 2016 is day 227.

March 1, 2016: El Verano cal. 817mm; Marsh cal. 986mm.

March 2, 2016: El Verano cal. 829mm; Marsh cal. 988mm; Mallett cal. 934mm.

March 4, 2016: El Verano cal. 845mm; Marsh cal. 1010mm.

March 6, 2016: El Verano calibrated figures [876 mm] are now 82% of [Environment Canada](#) (Nanaimo A) figures [1067 mm] since start of measurements on July 18. The above average increase in the EC figures is due to their March 1 reading (60 mm vs. 25 mm on Gabriola); however, it was 52 mm in Chemainus so I can't say they were wrong.

March 7, 2016: El Verano cal. 885mm; Marsh cal. 1056mm.

March 8, 2016: El Verano cal. 885mm; Mallett cal. 999mm.

March 9, 2016: El Verano cal. 886mm; Marsh cal. 1058mm.

March 10, 2016: El Verano cal. 946mm; Marsh cal. 1128mm.

March 11, 2016: El Verano cal. 948mm; Mallett cal. 1080mm.

March 13, 2016: El Verano calibrated figures [957 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1196 mm] since start of measurements on July 18.

March 14, 2016: El Verano calibrated figures [971 mm] now exceed the annual average even though there are four months still to go.

March 16, 2016: El Verano cal. 971mm; Marsh cal. 1155mm.

March 18, 2016: El Verano cal. 971mm; Marsh cal. 1155mm.

March 20, 2016: El Verano calibrated figures [971 mm] are now 79% of [Environment Canada](#) (Nanaimo A) figures [1221 mm] since start of measurements on July 18.

March 22, 2016: El Verano cal. 981mm; Marsh cal. 1171mm.

March 23, 2016: El Verano cal. 982mm; Mallett cal. 1125mm.

Rainwater pH ~~8.4~~ 7.1 (meter calibrated at 7.0 and 10.0, but de-ionized bottled water gave a similar reading so it may be that the buffering of the rainwater is so low the pH cannot be reliably measured this way. Re-calibrated using the LaMotte Precision pH kit).

March 25, 2016: El Verano cal. 986mm; Marsh cal. 1178mm.

March 27, 2016: El Verano calibrated figures [997 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1239 mm] since start of measurements on July 18.

March 29, 2016: El Verano cal. 997mm; Marsh cal. 1180mm; Mallett cal. 1141mm.

March 31, 2016: [Environment Canada](#) (Nanaimo A) figure for total precipitation so far this year at their station is +70% on their 1944–2014 average. The March precipitation was the highest ever recorded, the previous record being set in March 1971.

April 1, 2016 is day 258.

April 1, 2016: El Verano cal. 997mm; Marsh cal. 1180mm.

April 3, 2016: El Verano calibrated figures [997 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1239 mm] since start of measurements on July 18.

April 4, 2016: El Verano cal. 1003mm; Marsh cal. 1186mm.

April 8, 2016: El Verano cal. 1004mm; Marsh cal. 1187mm; Mallett cal. 1150mm.

Mallett observations discontinued, too infrequently made, day 265.

April 10, 2016: El Verano calibrated figures [1004 mm] are now 81% of [Environment Canada](#) (Nanaimo A) figures [1246 mm] since start of measurements on July 18. **Environment Canada figures for Nanaimo A have however become unreliable** with many missing observations which have had to be estimated based on the El Verano readings.

April 11, 2016: El Verano cal. 1004mm; Marsh cal. 1187mm.

April 14, 2016: El Verano cal. 1005mm; Marsh cal. 1191mm.

April 17, 2016: El Verano calibrated figures [1005 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1249 mm] since start of measurements on July 18.

April 18, 2016: El Verano cal. 1005mm; Marsh cal. 1191mm.

April 21, 2016: El Verano cal. 1005mm; Marsh cal. 1194mm.

April 24, 2016: El Verano calibrated figures [1008 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1255 mm] since start of measurements on July 18.

April 25, 2016: El Verano cal. 1013mm; Marsh cal. 1203mm.

April 28, 2016: El Verano cal. 1013mm; Marsh cal. 1203mm.

April 30, 2016: [Environment Canada](#) (Nanaimo A) figure for total precipitation so far this year at their station is +51% on their 1944–2014 average. The April precipitation was only 33% of average for the month, but is not the lowest ever recorded. That was in April 1973.

May 01, 2016 is day 288.

May 1, 2016: El Verano cal. 1013mm; Marsh cal. 1203mm.

El Verano calibrated figures [1013 mm] are now 81% of [Environment Canada](#) (Nanaimo A) figures [1255 mm] since start of measurements on July 18.

May 4, 2016: El Verano cal. 1015mm; Marsh cal. 1204mm.

May 7, 2016: El Verano cal. 1015mm; Marsh cal. 1204mm.

May 8, 2016: El Verano calibrated figures [1015 mm] are now 81% of [Environment Canada](#) (Nanaimo A) figures [1258 mm] since start of measurements on July 18.

May 11, 2016: El Verano cal. 1015mm; Marsh cal. 1204mm.

May 15, 2016: El Verano cal. 1015mm; Marsh cal. 1204mm.

El Verano calibrated figures [1015 mm] are now 81% of [Environment Canada](#) (Nanaimo A) figures [1258 mm] since start of measurements on July 18. **Environment Canada figures for Nanaimo A however remain unreliable with many missing measurements that have had to be estimated from the EV readings.**

May 20, 2016: El Verano cal. 1020mm; Marsh cal. 1220mm.

May 22, 2016: El Verano cal. 1020mm; Marsh cal. 1220mm.

El Verano calibrated figures [1020 mm] are now 81% of [Environment Canada](#) (Nanaimo A) figures [1263 mm] since start of measurements on July 18.

May 27, 2016: El Verano cal.2016-1 1008mm; Marsh cal.2016-1 1219mm.

May 29, 2016: El Verano cal.2016-1 figures [1018 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1276 mm] since start of measurements on July 18.

May 31, 2016: [Environment Canada](#) (Nanaimo A) figure for total precipitation so far this year at their station is +41% on their 1944–2014 average. The May precipitation was 42% of average for the month, but is not the lowest ever recorded. That was in May 2015.

June 01, 2016 is day 319.

June 01, 2016: El Verano cal.2016-1 1018mm; Marsh cal.2016-1 1229mm.

June 04, 2016: El Verano cal.2016-1 1020mm; Marsh cal.2016-1 1229mm.

June 05, 2016: El Verano cal.2016-1 figures [1020 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1279 mm] since start of measurements on July 18.

June 10, 2016: El Verano cal.2016-1 1023mm; Marsh cal.2016-1 1233mm.

June 12, 2016: El Verano cal.2016-1 figures [1023 mm] are now 80% of [Environment Canada](#) (Nanaimo A) figures [1285 mm] since start of measurements on July 18. [Weekly reporting discontinued, the EC Nanaimo figures have too many uncertainties.](#)

June 14, 2016: El Verano cal.2016-1 1023mm; Marsh cal.2016-1 1253mm.

June 17, 2016: El Verano cal.2016-1 1031mm; Marsh cal.2016-1 1256mm.

June 22, 2016: El Verano cal.2016-1 1050mm; Marsh cal.2016-1 1275mm.

June 25, 2016: El Verano cal.2016-1 1052mm; Marsh cal.2016-1 1292mm.

June 29, 2016: El Verano cal.2016-1 1052mm; Marsh cal.2016-1 1292mm.

June 30, 2016: [Environment Canada](#) (Nanaimo A) figure for total precipitation so far this year at their station is +35% on their 1944–2014 average. The June precipitation was 60% of average for the month, but is not the lowest ever recorded. That was in June 1950. [The EC Nanaimo figures have many uncertainties and reporting will be discontinued at the end of the observation year.](#)

July 01, 2016 is day 349.

July 05, 2016: El Verano cal.2016-1 1053mm; Marsh cal.2016-1 1292mm.

July 08, 2016: El Verano cal.2016-1 1059mm; Marsh cal.2016-1 1298mm.

July 11, 2016: El Verano cal.2016-1 1065mm; Marsh cal.2016-1 1313mm.

July 13, 2016: El Verano cal.2016-1 1065mm; Marsh cal.2016-1 1314mm.

July 17, 2016: El Verano cal.2016-1 1071mm; Marsh cal.2016-1 1318mm.

July 17, 2016 is day 365. end of year 366 days long ◇