Subtle Winter Climatic Variations along the St. Lawrence Valley between Montreal and Quebec City (Canada)

JERRY TOUPIN, Ph.D.[1]

ABSTRACT

The St. Lawrence Valley in Quebec, Canada, located just a few kilometers north of the States of New York, Vermont, New Hampshire and Maine remains one of the snowiest populated valleys in the world. From November to April, the valley's population of about 7 million people must endure frequent snowstorms. On average more than 200cm of snow falls every winter. Although the city of Montreal (45° 30'N, 73° 35'W, population of about 4 million people) and Quebec City (46° 49'N, 71° 13'W, population of about 720000) are at about the same latitude and separated by only 300 km, winter can vary substantially.

Indeed in developing a new methodology based on frequency of 13 different sub-meteorological variables, we were able to demonstrate that for the decade 1971-1980 (for a total of 1632 days stretching from November 1st to April 30th), Quebec City is colder, gets more snow, while Montreal receives more rain. Differences between the two cities are minor in November but become more noticeable as the cold season progresses. This analysis reveals winter microclimates along the St. Lawrence Valley.

Keywords: snow; frequency method; sub-meteorological variables; St. Lawrence Valley

INTRODUCTION

Few people haved studied physical aspects of winter along the St. Lawrence Valley (Toupin, 2007, Plamondon, 1990, 1979, Hufty, 1971, Ferland, 1968), while others focused on social aspects (Phan, 1975, Blanchard, 1966, Deffontaines 1957). Yet the St. Lawrence Valley is known for its large quantity of snowfall (2007-2008 saw record-breaking year for Quebec City as more than 510cm of snow (average about 340cm) fell with 15 major snowstorms while close to 470cm fell in Montreal (average=226cm).

Every winter a large part of human activities are affected by snowstorms (schools, airports, highways are closed for a few days). Although Montreal and Quebec City are only about 300km apart, both cities may have differences as winter progresses (Potter, 1965). This is what this paper will try to verify in a lengthy way.

[1] University of Alberta, Earth and Atmospheric Sciences, St. Jean Campus, 8406-91st Street, Edmonton, Alberta, Canada. T6C 4G9. E-mail: jtoupin@ualberta.ca.

METHODOLOGY

In order to have a better knowledge of the differences between Montreal and Quebec City winters, 13 sub-variables were compared and analyzed for the decade 1971-1980 (for a total of 1632 days from November 1st to April 30th). To avoid urban effects, St. Hubert-A station (East of Montreal) was selected and Quebec-A (West of Quebec City). The 1971-80 decade was selected for its wide range of winters and data availability.

The 13 sub-variables are: (1) number of days with extreme cold: daily temperature below -20.1°C, (2) number of very cold days (daily temperatures between -15.1°C and -20.0°C, (3) number of freeze-thaw days, (4) number of frost-free days, (5) number of days without thaw, (6) number of rainfall days and its quantity, (7) number of snowfall days and its quantity, (8) extreme snowfall: 10cm or more of snow per day for 2 days in a row, (9) number of days with extreme snowfall: 20.1cm of snowfall or more, (10) number of days with 10 to 20cm of snow, (11) number of days in a row with snowfall, (12) number of days in a row with snow, (13) number of days with 10mm of rain or more.

RESULTS AND DISCUSSION

Results are shown in Table 1. A monthly analysis is presented below.

NOVEMBER

Light differences are noted between the stations during the very first month of winter. One extreme cold day affects Quebec one winter out of five (0.2) while St. Hubert has none. Quebec registers one cold day just about every winter (0.9), St. Hubert sees it 7 winters out of 9. Quebec has a lesser number of frost-free days: 50 days, frequency=5.6 (St. Hubert 84 days, frequency=9.3), more days without thaw (8.8, St. Hubert=4.7), more days with snowfall (15.4, St. Hubert=6.4) as well as more days in a row with snow (5.9, St. Hubert=2.3) and more days with rainfall (4.7, St. Hubert=3.1).

DECEMBER

Pattern remains about the same but the gap is wider. Number of freeze-thaw days is higher in St. Hubert (10.2, Quebec=5.4), but the number of days without thaw, snowfall and number of days with snowfall are greater in Quebec. The month of December is the snowiest for both stations (96.1cm in Quebec but 63.8cm in St. Hubert).

JANUARY

This is the coldest month of the year and the second in terms of snowfall. Coldness is even greater in Quebec: extreme cold days (12.2 for Quebec, 8.1 in St. Hubert). Snowfall equals 73.6cm in Quebec (57.2cm in St. Hubert).

Table 1. Type of weather, number of average days and average frequency for the 13 sub-variables selected: Quebec-A and St. Hubert A (1971-1980).

Month	Variables												
	-20.1°C and less	-15.1°C to -20°C	# days freeze-thaw	# days frost-free	# days without thaw	# days with rain (mm)*	# days with snow (cm)**	10 cm or more of snow/ day for 2 days in a row	# days with 20.1cm of snow or more	# days with 10 to 20cm of snow	# days in a row with rain	# days in a row with snow	# days with 10mm of rain or more
November													
Quebec-A	0.2	0.9	14	5.6	8.8	11.1 (57.9)	15.4 (33.7)	0	0.2	0.9	4.7	5.9	1.7
St. Hubert A	0	0.7	15.9	9.3	4.7	10.8 (59.1)	6.4 (27.2)	0.1	0.2	0.7	3.1	2.3	1.8
December													
Quebec-A	6.3	8.1	5.4	0.3	24.7	6.3 (34.3)	25.6 (96.1)	0.1	0.6	2.2	2.2	11.4	1.1
St. Hubert A	4.2	5.3	10.2	1.8	18.4	7.2 (43.8)	15.2 (63.8)	0.22	0.6	1.33	3.2	5.4	1.6
January													
Quebec-A	12.2	7.4	4.9	0.1	25.7	4.9 (31.6)	26 (73.6)	0.1	0.4	1.4	2.6	11.4	1.2
St. Hubert A	8.1	7.4	6.3	1.2	23.4	4.2 (30.8)	15.6 (57.2)	0	0.3	1	2	4.4	1.2
February													
Quebec-A	9.4	7.4	3.6	0.1	25.2	2.2 (9.1)	20.7 (66.5)	0.4	0	2.2	1.4	9.6	0.3
St. Hubert A	6.3	6.4	6.7	0.4	21	3.8 (17.5)	11.4 (41.2)	0.1	0.3	0.6	2	3.9	0.4

Month	Variables (cont'd)												
	-20.1°C and less	-15.1°C to -20°C	# days freeze-thaw	# days frost-free	# days without thaw	# days with rain (mm)*	# days with snow (cm)**	10 cm or more of snow/ day for 2 days in a row	# days with 20.1cm of snow or more	# days with 10 to 20cm of snow	# days in a row with rain	# days in a row with snow	# days with 10mm of rain or more
March													
Quebec-A	1.6	5.1	14	1.8	14.2	7.7 (46.8)	16.4 (53.2)	0.2	0.6	1.3	3.6	6.4	1.3
St. Hubert A	0.8	1.9	16.2	4.3	9.9	8.7 (53)	8.7 (34.6)	0.1	0.2	0.7	2.8	3.1	1.9
April													
Quebec-A	0	0	16.1	10.9	2.3	11.1 (52)	8.6 (27)	0	0.1	0.6	4.4	4.1	1.9
St. Hubert A	0	0	14.8	14	0.9	10.1 (65.8)	3.4 (17.2)	0.1	0.2	0.2	3.3	2	2
Cumulative Total													
Quebec-A	16.4% (29.8 days/ winter)	16% (29 days/ winter)	32.2% (58.3 days/ winter)	10.4% (18.8 days/ winter)	55.6% (100.9 days/ winter)	23.9% (43.3 days/ winter)	62% (112.7 days/ winter)	8 days	17 days	78 days	3.1 average days	8.1 average days	68 days
St. Hubert A	10.7% (19.4 days/ winter)	12% (21.8 days/ winter)	38.7% (70.1 days/ winter)	17.2% (31.1 days/ winter)	43.3% (78.4 days/ winter)	24.8% (44.9 days/ winter)	33.5% (60.8 days/ winter)	6 days	16 days	40 days	2.7 average days	3.5 average days	80 days

Note: * Total rainfall for the month. ** Total snowfall for the month.

Number of days in a row with snow is 11.4 in Quebec while St. Hubert registers only 4.4 which represent the widest gap for this data during wintertime.

FEBRUARY

Number of days with 10cm of snow per day for 2 days in a row hits Quebec one winter out of four (Frequency=0.4) while it does happen only one out of nine winters for St. Hubert (0.1). Rainfall is at its minimum (9.1mm in Quebec, 17.5mm in St. Hubert). Number of days with 10 to 20cm of snow occurs on the average 2 days in February (2.2) for Quebec, while it does happen only one day every second year in St. Hubert. (Five times out of nine, 0.55).

MARCH

Gaps are slightly shrinking between the two stations but remain major for certain categories. Very cold days (-15.1°C and -20.0°C) are still active in Quebec (5.1 days, St. Hubert=1.9) as well as days with extreme snowfall (20.1cm or more; one winter out of two, St. Hubert=one day every five years).

APRIL

Similar to November's pattern, differences are minimal. Extreme cold days and cold days are absent. St. Hubert (14) gets on the average three more frost-free days than Quebec (10.9). Snowfall accounts for 27cm in Quebec but only 17.2cm in St. Hubert.

CONCLUSION

Cumulative total (Table 1) shows major differences between the two sites. Coldness (days with extreme cold and cold as well as days without thaw) is bitter in Quebec City. Hence, while the Montreal area registers 10.7% (19.4 days) of days with extreme cold during wintertime, Quebec gets 16.4% (29.8 days). Cold days count for 16% in Quebec (29 days) but 12% (21.8 days) around Montreal. Days without thaw represent 55.6% of wintertime in Quebec City (100.9 days) and 43.3% for Montreal (78.4 days). On the other hand, frost-free and freeze-thaw days frequency is higher for Montreal (respectively 17.2%; 31.1 days and 38.7%; 70.1 days while Quebec City registers 10.4%; 18.8 days and 32.2%; 58.3 freeze-thaw days).

As for snow, Quebec City (average yearly snowfall=341cm) gets more than 30% compared to Montreal. Quebec City counts almost twice as many days (112.7 days, 62% of wintertime) with snow (Montreal=60.8 days, 33.5%). Snowfall is not only more abundant but also more frequent in Quebec City (95 days with 10cm of snow or more, while 56 days around Montreal).

Rainfall is higher in Montreal (270mm; 231mm in Quebec City), yet frequency and days with rain are similar. Intensity is slightly higher in Montreal (8 days with 10mm of rain or more, 6.8 days for Quebec City).

All in all Quebec City is colder (gets about 32% of days during wintertime with temperatures equal or less than -15°C and 22% for Montreal) and gets by far more snow, while the Montreal area tends to get more rain.

REFERENCES

Blanchard, R. 1966. Le Canada français. Collection Que Sais-je? No. 1098. Paris, *P.U.F.* 124p.

Deffontaines, P. 1957. L'homme et l'hiver au Canada. Paris, Gallimard ; Quebec, *Édition Universitaire*, Université Laval. 293p.

Ferland, M. 1968. Les régimes de température accompagnant les chutes de neige. *Cahiers de géographie de Québec.* 25, 145-152.

Government of Canada, Environment Canada. 2008. *Climate Data online* (Web Page). www.climate.weatheroffice.ec.gc.ca/Climate

Hufty, A. 1971. Les types de temps dans le Québec méridional : méthode pédagogique de description des climats. *Cahiers de géographie de Québec*. 15 (34), 29-52.

Phan, V.V. 1975. Perception des temps d'hiver à Québec. *Thèse de maîtrise*, Université Laval. 163p.

Plamondon, M. 1990. Deux aspects du climat hivernal à Québec : la variabilité des précipitations nivales, les tempêtes de neige et leurs effets sur la circulation. *Le Climat*. 1. 75-94.

Plamondon, M. 1979. Études des tempêtes de neige survenues dans la ville de Québec (1965-1975) et de leur incidence sur la circulation routière. *Thèse de maîtrise*. Université Laval. 262p.

Potter, J.G. 1965. Snow Cover. *Canadian Meteorological Service*, Department of TransPort, Climatological Studies. 3. 69p.

Toupin, J. 2007. Winter Climate along the St. Lawrence Valley. *Eastern Snow Conference* . 64. 223-230.