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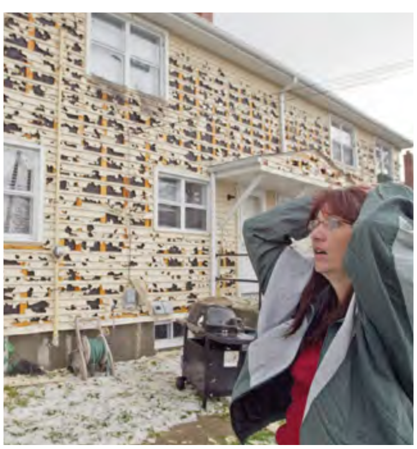
Hail Climatology for Canada: An Update

By David Etkin, York University

February 2018



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1. Introduction

Hail is a significant hazard in parts of Canada, causing damage to infrastructure and crops. It is of particular concern to the insurance industry, for which it is an important risk. Risk analysis begins with an understanding of hazard, and for this reason it is important to have an updated climatology of hail frequency in Canada. A previous national climatology was based upon data from 1977 to 1993 (Etkin & Brun, 1999), and therefore it is prudent to examine Canada's hail climatology based upon a longer time series that includes more recent data.

Hail events have been recorded across Canada, but the storms resulting in the greatest damage to property and crops are most common in southern Alberta. Over the past 25 years, there have been several severe thunderstorms with hail in Alberta resulting in hundreds of millions of dollars in insurance damage claims. Research produced for ICLR by AIR Worldwide suggests that a low probability/worst case storm event could result in insurance damage claims of up to $13.5 billion from a single event.

In the 1990s and early 2000s, ICLR conducted a number of studies focused on understanding the risk of hail damage in Canada. The hail research needs of insurance companies was acute before ICLR was established when Canada's most costly hailstorm struck Calgary in 1991. In particular, ICLR published an earlier hail climatology: 1977-1993 and conducted several workshops where hail was considered as part of a broader discussion of convective storm-related losses. Institute members also contributed to an industry discussion that lead to the creation of the Alberta Severe Weather Management Society.

Fortunately, there were few large hail damage events in Canada between 1991 and 2008. Indeed, there was a period of almost ten years when the Institute received virtually no requests from member companies to study the peril. The industry directed ICLR to focus its research on other hazards, including the alarming increased in water damage. Indeed, hail research was not included in the Institute's last five-year plan.

However, hail damage claims have ramped up in Canada in recent years. Just three wind/water/hail events in Alberta (2010, 2012 and 2014) totaled more than $1.66 billion in insured losses. As a result, in 2015 Canadian property and casualty insurers – through ICLR's Insurance Advisory Committee – formally asked the Institute to investigate the peril and suggest actions insurers can take to mitigate future hail losses in the country.

National hail climatologies (e.g. the number of hail days per year in Canada) serve as a foundation for such hail risk analyses. Although national hail climatologies cannot be used to determine hailstorm severity or to infer damage, they are used to help identify vulnerable regions, and thus areas where mitigation efforts should be concentrated.

2. Literature review

Hail is a natural hazard that causes significant damage to Canadian society (particularly agriculture, infrastructure and automobiles). For example, in 2014 a hailstorm in Alberta cost the insurance industry $524 million (IBC, 2016). Insured losses to Canadian crops average about $200 million/year (Air Worldwide, 2016).

Insured Canadian losses to property (not including agricultural losses) due to 24 hail-only[1] events from 1986-2015 total $1.9 billion in 2015 CDN dollars (IBC, 2016). The single most expensive event ($524 million in Calgary, Alberta in 1991) accounts for 27% of the total hail-only costs (Figure 1). Three events in 2010, 2012 and 2014, combined with wind and water, resulted in a further $1.66 billion in insured damage; most of those losses were hail-related (McGillivray, 2017). Two additional combined events in 2015 cost $480 million and twelve other damaging events between 2008 and 2013 occurred but do not have loss estimates associated with them.

A rank ordered[2] plot of catastrophic hail-only loss data from the IBC report (Figure 1) suggests that losses due to hail may well follow a fat-tailed distribution such as a power law (Clauset et al., 2009). This means that very rare extreme events account for a relatively large fraction of total impacts. This also is evident within the agricultural industry, where "85% of total crop losses in a year can be caused by only 10–15% of the hailstorms" (Air Worldwide, 2016). For fat-tailed distributions empirical calculations of mean annualized loss may be poor predictors of future risk, and this has important implications for risk analyses. For example, Cook et al. (2014) notes that in such distributions "yearly losses can be hopelessly volatile and, as such, historical averages are not good predictors of future losses." Future research might address what statistical distribution best fits hail probability data, and how the fatness of the tail might change due to climate change and shifts in exposure and urban density.

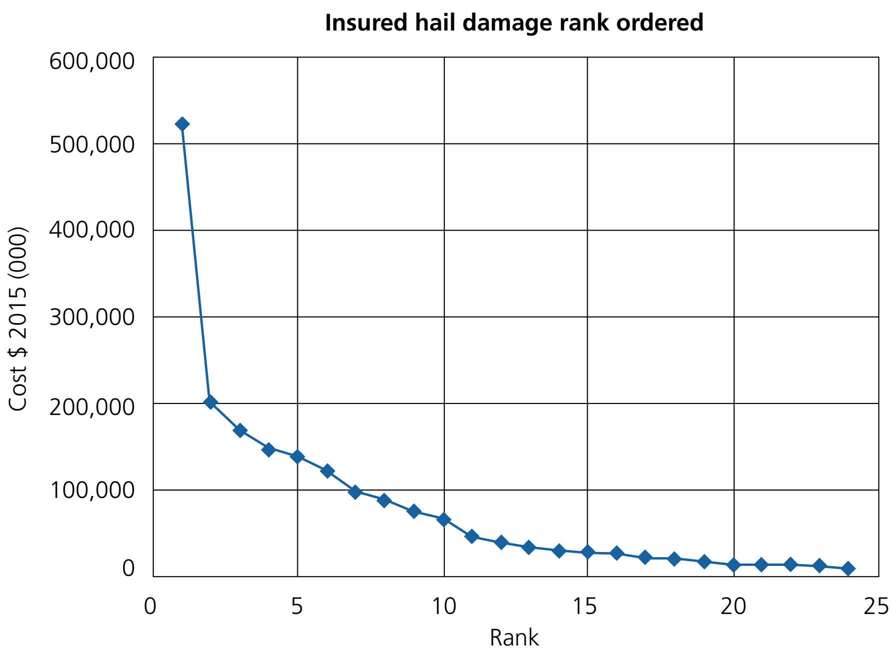
Of concern is that hail may become a greater issue in the future due to climate change potentially increasing the frequency of severe thunderstorms and urban development increasing exposure. A number of studies have highlighted increasing risk related to convective storms. For example, Foote et al. (2005) note that insurance claims due to hailstorms in the urban U.S. escalated from 1995-2005. Changnon (2008) found that in the U.S. "The nation's top ten loss events during 1950–2006 reveal a notable temporal increase with most losses in the 1992–2006 period. Causes for these increases could be an increasing frequency of very unstable atmospheric conditions leading to bigger, longer lasting storms, and/or a greatly expanded urban society that has become increasingly vulnerable to hailstorms." Single events can be very damaging; hailstorms on April 13-14, 2006 resulted in properly losses of $1.8 billion in the U.S.

Future trends are unclear in terms of severe convective storms (which require both an unstable atmosphere and significant wind shear, to develop) producing hail. Brooks (2013) notes the following: "Climate model simulations suggest that CAPE (convective available potential energy) will increase in the future and the wind shear will decrease. Detailed analysis has suggested that the CAPE change will lead to more frequent environments favorable for severe thunderstorms, but the strong dependence on shear for tornadoes, particularly the strongest ones, and hail means that the interpretation of how individual hazards will change is open to question."

[1] Events listed as hail/wind/flood are not included.

[2] This means that the most expensive event is ranked #1, the second most expensive event as rank #2, and so on.

Figure 1: Insured property hail damage in Canada (1981-2015). Source: IBC (2016). Rank 1 is the most expensive event (Calgary hailstorm of 1991) and dominates the dataset, comprising 27% of the total cost of the 24 events.

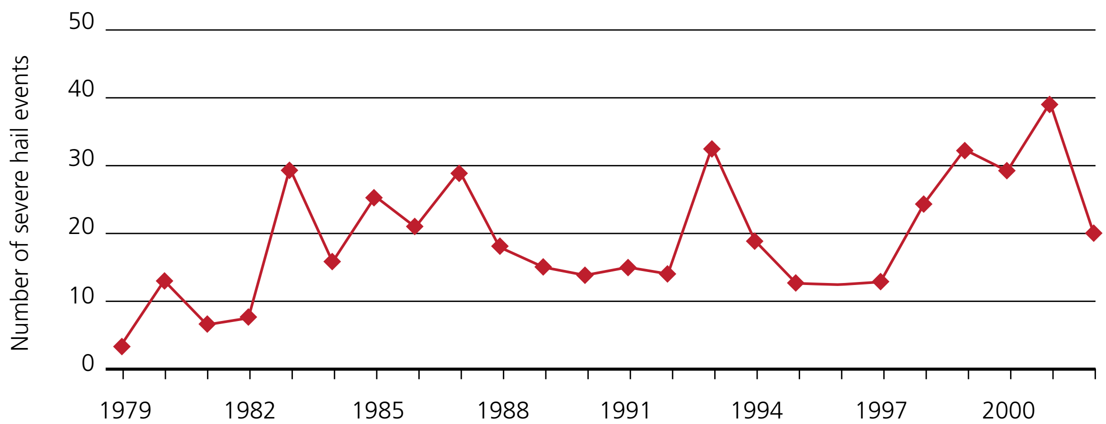


Year-to-year variability can be large when it comes to hail occurrence, which is dependent upon other large scale climate events such as the ENSO oscillation (Mayes et al., 2007). Nevertheless, there may be trends of hail occurrence embedded in the data. With respect to tornado occurrences in Ontario, Cao et al. (2011) found an increasing trend. Tornadoes, like hail, originate from severe thunderstorms, and an increase in tornado frequency could very possibly be accompanied by an increase in hail frequency. With respect to hail risk the occurrence of severe hail is of particular interest, though the Environment Canada data set used in this study does not capture it.

Cao (2008) using data from the Ontario Storm Prediction Centre for the period 1979-2002 found a significant increase in severe hail (defined as hail with diameter of at least 2 cm) frequency and variability in Ontario, associated with warmer air temperatures (Figure 2).

In the U.S., Tippett et al. (2015) "found increasing trends in the frequency of the most extreme U.S. environments over the last three decades", which is in line with climate change projections. Changnon (2009) found that the 10 greatest hail losses suggest increases in frequency from 1990-2009. As of July 9, 2017, the U.S. has had 9 disasters exceeding a billion dollars, including hailstorms in Minnesota and Colorado that total $4.7 billion (Dolce, 2017).

Figure 2: Number of severe hail events in Ontario from 1979-2002. Source: Cao (2008)



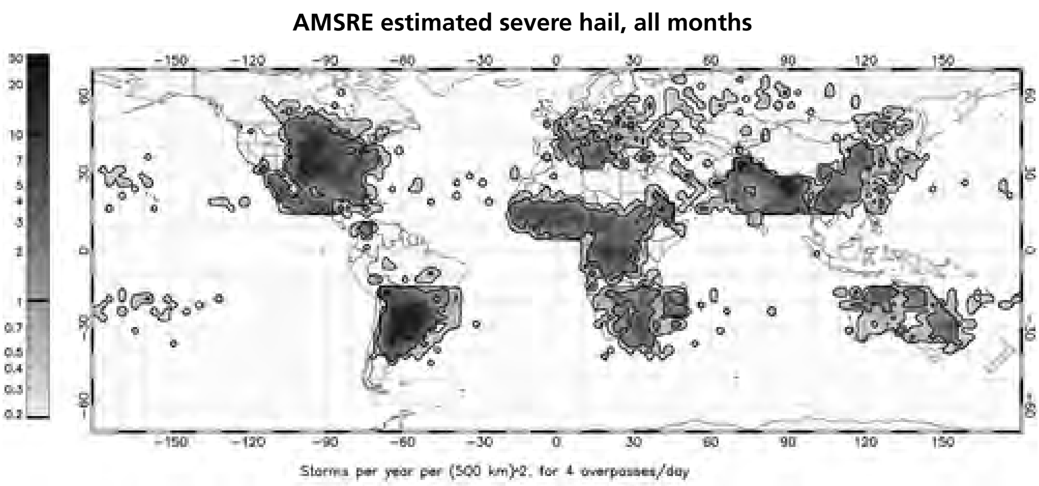
There have been a number of regional and global hail climatology assessments, such as one based upon the Alberta Hail Project, which ran from 1956-1985 (Table 1). Data for Table 1 is based upon surveys of about 20,000 farmers, thus creating a high density observing network (Brimelow and Reuter, 2002). It is interesting to note that Alberta has also been the focus of a cloud seeding project, which may have affected the frequency of severe hail occurrences, but is unlikely to have affected hail frequency overall. Gilbert et al. (2016) found that in one case study, seeded hail storms had a smaller severe area than non-seeded storms.

Table 1: An Analysis of Hail Days in Alberta based on 29 years of data from the Alberta Hail Project (Smith et al., 1998). Severe hail episodes (mean = 4.2 days) last nearly twice as long as non-severe ones (mean = 2.1 days).

Event	**Mean Hail Days for Central Alberta**
Hail days	**52.4 (57%)**
Severe hail days (at least one day of maximum hail size >33mm)	5.2 (6%)
Non-severe hail days	47.2 (51%)
No-hail days	**39.6 (43%)**

In another study that did a global analysis (Cecil and Blankenship, 2012), severe hail storm frequencies were estimated for Canada (Figure 3).

Figure 3: Severe hail storms/yr/500 km²



A man hitches up a tow rope to pull a car from the 21 cm of hail it got stuck in on Hwy 2A just south of Red Deer, Alberta, Thursday August 10, 2006. A fierce storm swept through Central Alberta that evening, dumping hail, rain and forcing traffic to stop on Queen Elizabeth II Highway.

[CP PHOTO/Red Deer Advocate – Randy Fiedler]

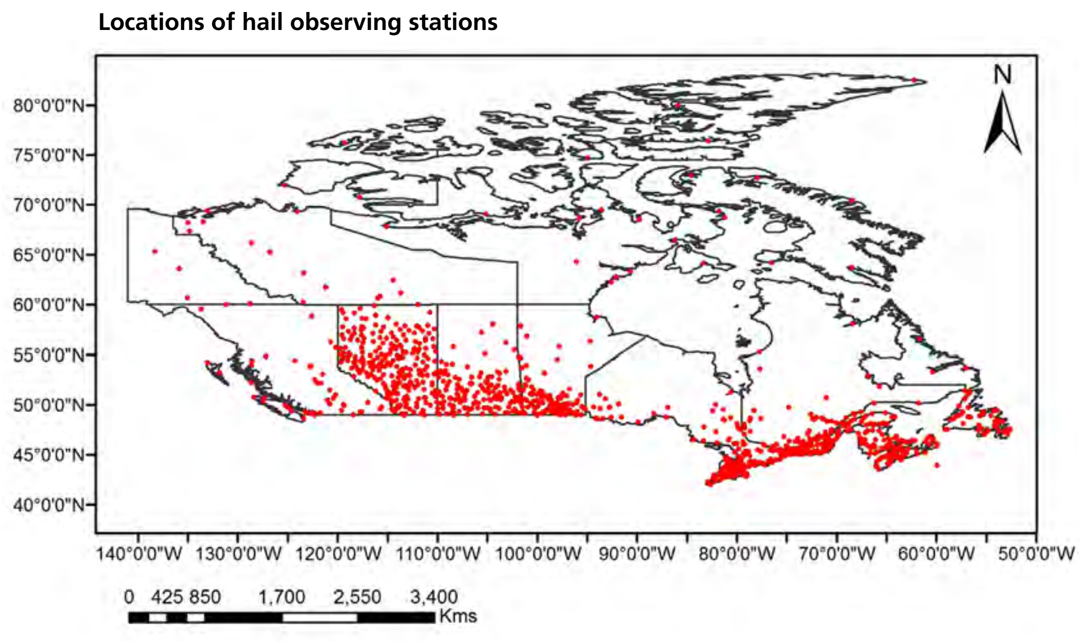
3. Data & methodology

Hail days data (climate element #16) was obtained from the Digital Archive of Canadian Climatological Data, Environment Canada from all hail observing stations (Figure 4). For each station, monthly days-with-hail were calculated where the number of missing observations were less than 4 days in any month. This represents 96.7% of the records. Monthly hail days were adjusted for missing data by multiplying the unadjusted hail-day observation by the factor [1+ (number of missing days) ÷ (number of days in the month)].

The number of years of hail observations for the stations varies (Figure 5), and in order to balance data quantity with estimation errors due to climate variability, only stations with at least 19 years of hail observations were used for the analysis. Of the 8,737 stations, this left 3,600 that were used in this analysis.

Figure 6 shows the number of stations observing hail from 1955 to 2015. As noted in Etkin & Brun (1999), hail observations at Environment Canada weather and climate stations were not widespread until 1977. After 1993 the number of hail observing stations began to decline and after 2005 the number of stations reporting hail dropped precipitately; after 2007 the number was trivial. The current hail climatology is therefore based upon observations from 1977 to 2007.

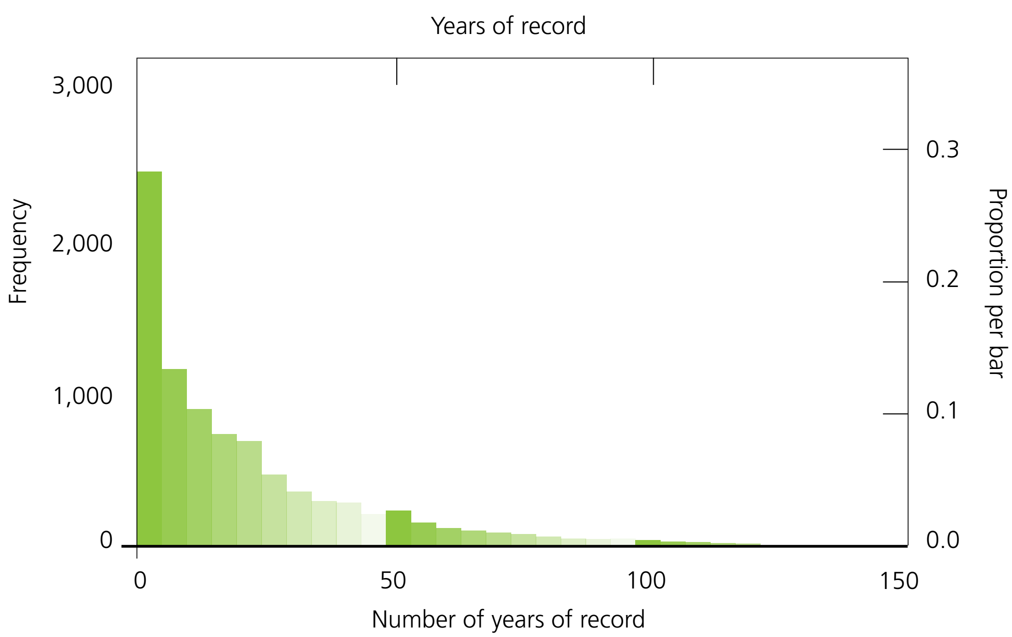
Figure 4: Hail observing stations in Canada



For each station for the months of May to September, a monthly hail frequency was calculated by summing the number of hail-day observations over the period of record and dividing by the number of months. This data was then imported into SURFER[3], which converted the station data into gridded data. For the regional maps gridded data was calculated using a search radius of 2 degrees latitude. Grid sizes of 1 degree were used, and a Kriging algorithm used to create contours. This data was

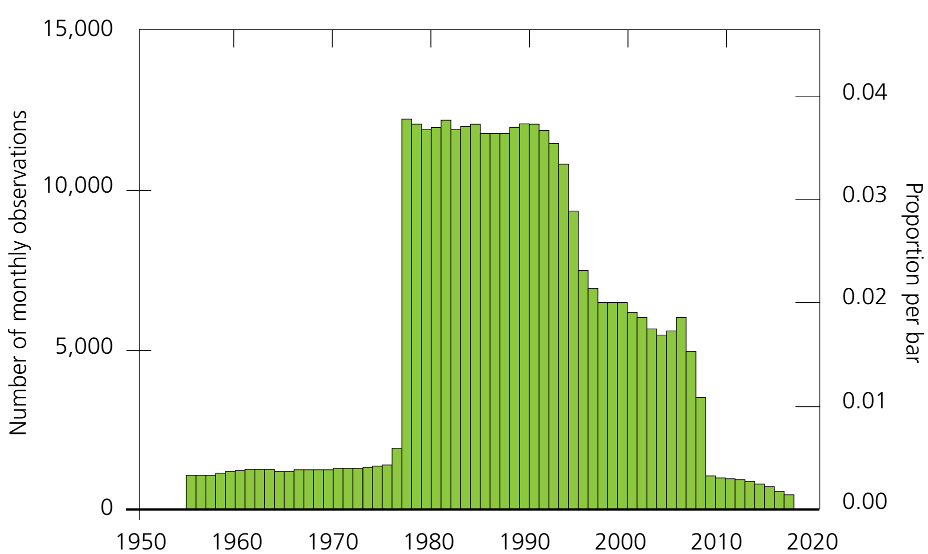
[3] SURFER V14. Copyright © 2017 Golden Software, LLC. **http://www.goldensoftware.com/products/surfer**

Figure 5: Length of record of climate stations



then imported into ArcGIS. A spline smoothing function in ArcGIS[4] was applied to smooth the contours. A close-up for parts of western Canada was mapped using a 1 degree latitude search radius and a grid size of 0.5 degrees. Total warm season frequencies were calculated by summing the gridded data for the 5 months.

Figure 6: Number of stations observing hail (May-September). Months with more than 3 missing observations and stations with less than 19 years of data are excluded.



[4] ArcGIS©Copyright 2017 Esri. **https://www.arcgis.com/features/index.html**

4. Analysis

At this point it is important to state a caveat. The mapping in this project is based upon an objective analysis of station data, and the contours are not adjusted to incorporate the effects of topography, which can be significant. Where stations are far apart and their density does not capture topographic features, contours may well differ from actual hail patterns. Additionally, edge effects can make the contours less reliable at borders or where data ends.

The hail frequency maps in Appendix A (in units of number of days/month with hail) show similar patterns to previous analyses. The primary features are (Table 2):

Table 2: Summary of Hail Frequency Patterns by Month

Month	Western Canada	Central Canada	Eastern Canada
May	There is a strong maximum[5] in south-central BC (>3.7 days/month), with a weaker one (>0.5 days/month) beginning to emerge in western Alberta.	Maximums are evident in southwestern Saskatchewan (>0.5 days/month) and southwestern Manitoba (>.28 days/month).	Values are generally low, but show a maximum near Maine (>0.34 days/month), western Quebec (>0.4 days/month) and along the Nova Scotia coast. The Nova Scotia maximum is not physically realistic, and is likely due to the misreporting of ice pellets as hail.
June	This pattern is similar to May in western Canada, but the maximum in western Alberta (>1.76 days/month) is intensifying and the B.C. (>2.02 days/month) one weakening slightly. Values northwest of Edmonton are slightly lower than northwest of Calgary.	Central Canada shows similar patterns to May, but with higher values (>0.34 days/month northeast of Regina).	The notable feature is the maximum in western Quebec (>0.42 days/month). There is a weaker maximum (>0.22 days/month) east of Georgian Bay.
July	Shows the same patterns of a maximum in east-central BC (>2.04 days/month), and in western Alberta, particularly just west of Calgary (>1.24 days/month).	Central Canada is not showing the same high values in southwestern Saskatchewan and Manitoba; the explanation for this is not clear. There are some significantly high values however, of >0.34 days/month north of Regina.	Eastern Canada has an interesting maximum (>0.22 days/month) northeast of Quebec City, and a maximum in western Quebec (>0.42 days/month).

[5] Maximum: a local area of higher hail frequencies.

Table 2 (continued)

Month	**Western Canada**	**Central Canada**	**Eastern Canada**
August	Shows the same general pattern as in the previous months, but the B.C. maximum (>1.3 days/month) is becoming less pronounced, while the Alberta maximum (>1.5 days/month) has intensified near Calgary, but weakened northwest of Edmonton (0.7 days/month).	Several weak maxima have appeared in south Saskatchewan (>0.3 days/month). Otherwise patterns have low gradients.	An interesting maximum (>0.18 days/month) has appeared just east of Toronto. Other areas of interest are western Quebec (>0.16 days/month) and near Maine (>0.2 days/month).
September	The B.C. (>0.55 days/month) and Alberta (>0.3 days/month) maximums are still evident, but are noticeably weaker.	A maximum (>0.28 days/month) is still evident southwest of Regina in central Saskatchewan, and also southeast of Winnipeg.	The maximum in western Quebec (>0.38 days/month) persists, but the maximum east of Toronto is no longer evident; it may be that the August maximum is an artifact.
Warm Months Total Units in these maps are number of hail days over the 5 months of May-September.	The highest Canadian hail frequencies (>7,4 days/warm season) occur in B.C. near the Columbia Mountains. Lesser maximums occur in Alberta northwest of Calgary (>5.6 days/warm season) and northwest of Edmonton (>3.8 days/warm season).	Southwestern Saskatchewan has a pronounced maximum of >4.6 days/warm season, with a secondary maximum of >1.4 days/warm season southwest of Regina.	Eastern Canada shows a pronounced maximum in western Quebec (>1.2 days/warm season), and a weaker one in northwestern New Brunswick (>0.8 days/warm season).

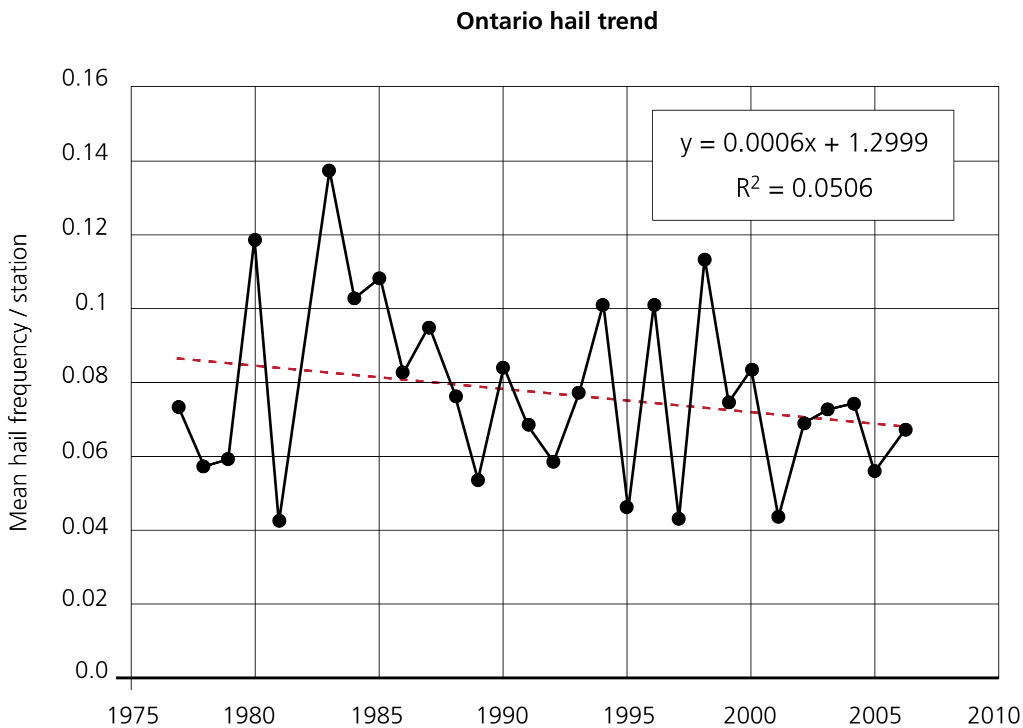
Trends in Ontario:

Hail days from 1977-2006 averaged over the province of Ontario show a slight downward trend that is not significant (Table 3 & Figure 7). As expected, year-to-year variability is high. This trend is in contrast to previously documented trends in severe hail and tornadoes, as noted above. Note that N varies from year-to-year and tends to be smaller in later years; mean hail day data is more reliable when N is larger.

Table 3: Average hail frequencies per season (May-September) for the province of Ontario. N = number of monthly hail observations, Mean = mean number of hail days/station/month.

Year	N	Mean	Standard Deviation	Year	N	Mean	Standard Deviation
1977	1,822	0.073	0.272	**1992**	1,414	0.058	0.256
1978	1,799	0.057	0.251	**1993**	1,321	0.077	0.298
1979	1,812	0.059	0.265	**1994**	1,256	0.101	0.324
1980	1,846	0.118	0.375	**1995**	1,166	0.046	0.227
1981	1,863	0.042	0.234	**1996**	1,098	0.101	0.348
1982	1,776	0.083	0.306	**1997**	1,032	0.043	0.215
1983	1,775	0.137	0.414	**1998**	1,038	0.113	0.365
1984	1,728	0.102	0.354	**1999**	1,012	0.074	0.278
1985	1,694	0.108	0.341	**2000**	937	0.083	0.303
1986	1,679	0.082	0.303	**2001**	894	0.043	0.228
1987	1,605	0.095	0.344	**2002**	832	0.069	0.288
1988	1,584	0.077	0.29	**2003**	800	0.072	0.279
1989	1,559	0.053	0.246	**2004**	735	0.074	0.303
1990	1,529	0.084	0.284	**2005**	719	0.055	0.24
1991	1,514	0.068	0.294	**2006**	732	0.067	0.263

Figure 7: Trends in hail frequency for Ontario. The vertical axis is mean number of hail days/station for the months of May-September.



A deluge of hail (some the size of golf balls) falls as a severe thunderstorm passes through the town of Carstairs, Alberta. A small car slowly continues driving through the storm on Highway 2A.

[CP PHOTO/Larry MacDougal]

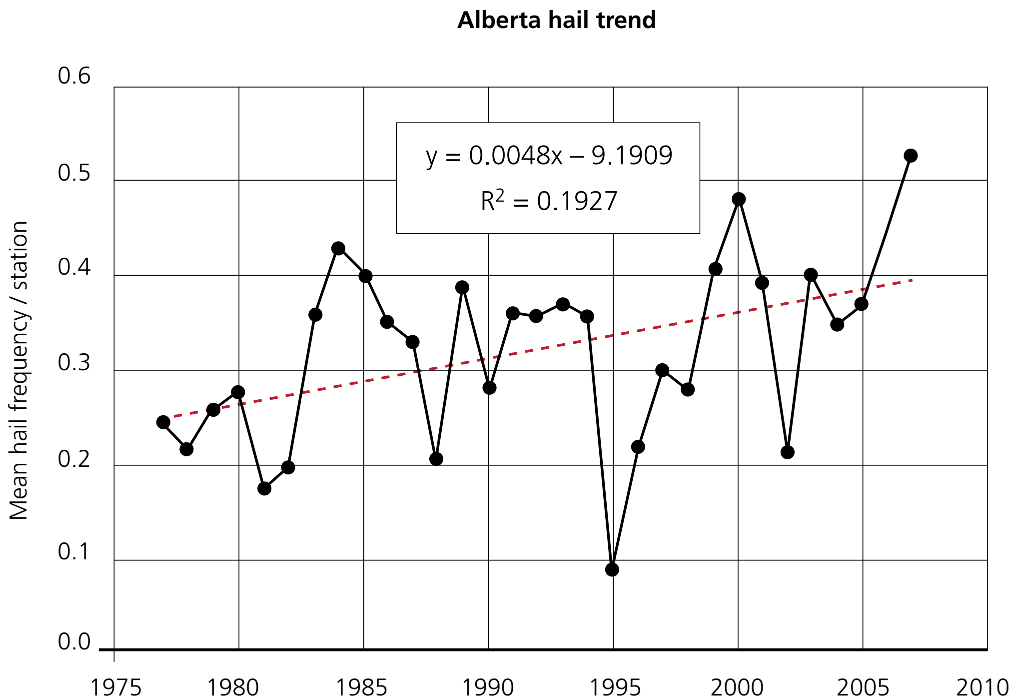
Trends in Alberta:

The trend in hail days for the province of Alberta shows an increasing trend (Table 4 & Figure 9) that is significant at the 95% confidence level, unlike Ontario. Year-to-year variability is also high.

Table 4: Average hail frequencies per year for the province of Alberta. N = number of monthly hail observations, Mean = mean number of hail days/station/month.

Year	N	Mean	Standard Deviation	Year	N	Mean	Standard Deviation
1977	0.242	1,104	0.635	**1993**	0.369	1,119	0.923
1978	0.214	1,111	0.560	**1994**	0.355	1,107	0.779
1979	0.254	1,118	0.643	**1995**	0.084	1,114	0.335
1980	0.277	1,114	0.697	**1996**	0.217	821	0.540
1981	0.172	1,167	0.624	**1997**	0.297	882	0.657
1982	0.195	1,209	0.540	**1998**	0.278	1,016	0.857
1983	0.358	1,214	0.906	**1999**	0.407	1,043	0.871
1984	0.430	1,224	0.897	**2000**	0.481	1,011	0.957
1985	0.402	1,225	0.942	**2001**	0.393	955	0.849
1986	0.351	1,239	0.914	**2002**	0.212	973	0.610
1987	0.329	1,218	0.824	**2003**	0.399	945	0.840
1988	0.203	1,235	0.560	**2004**	0.347	1,006	0.843
1989	0.388	1,243	0.873	**2005**	0.366	1,035	0.840
1990	0.279	1,203	0.731	**2006**	0.442	865	0.937
1991	0.359	1,205	0.886	**2007**	0.525	842	1.019
1992	0.355	1,187	0.777				

Figure 8: Trends in hail frequency for Alberta. The vertical axis is mean number of hail days per station for the months of May-September.



Calgary Stampeders defensive back Lin-J Shell checks out the hail after lightning and hail hit Regina before pre-season CFL action against the Saskatchewan Roughriders on Friday June 19, 2015.

[THE CANADIAN PRESS/Derek Mortensen]

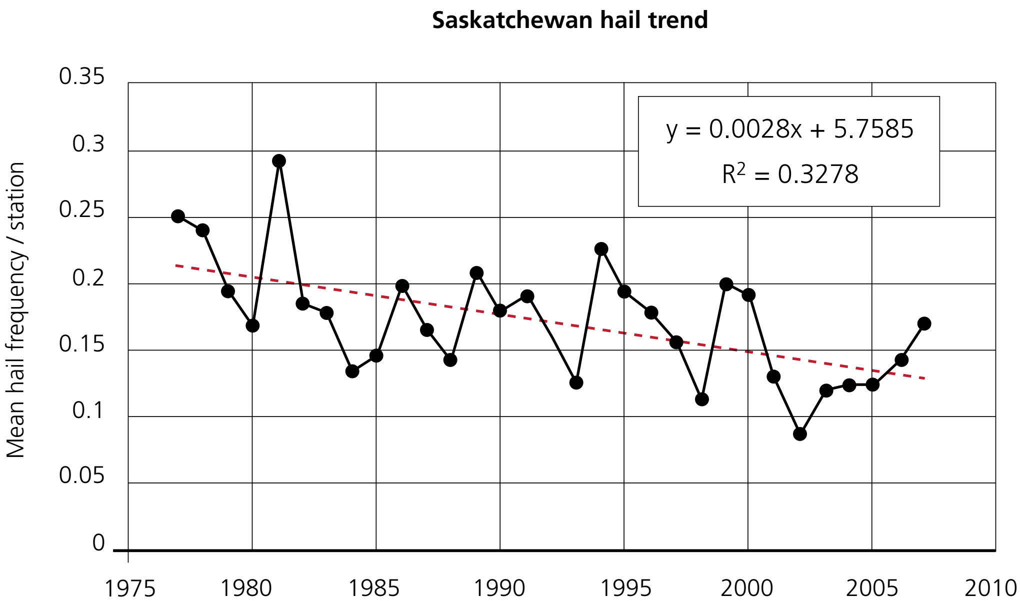
Trends in Saskatchewan:

Hail trend data for Saskatchewan shows a decreasing trend that is statistically significant at the 95% confidence level (Figure 9). The magnitude of the downward trend is much less than the increasing trend in Alberta.

Table 5: Average hail frequencies per year for the province of Saskatchewan. N = number of monthly hail observations, Mean = mean number of hail days/station.

Year	N	Mean	Standard Deviation	Year	N	Mean	Standard Deviation
1977	0.251	713	0.565	**1993**	0.125	810	0.395
1978	0.239	706	0.564	**1994**	0.227	791	0.532
1979	0.194	698	0.489	**1995**	0.192	769	0.500
1980	0.168	710	0.414	**1996**	0.178	728	0.460
1981	0.293	743	0.675	**1997**	0.156	682	0.443
1982	0.184	728	0.460	**1998**	0.112	651	0.373
1983	0.178	727	0.445	**1999**	0.199	602	0.477
1984	0.135	766	0.407	**2000**	0.190	598	0.488
1985	0.146	805	0.403	**2001**	0.129	577	0.362
1986	0.197	822	0.480	**2002**	0.086	585	0.300
1987	0.164	834	0.453	**2003**	0.119	569	0.397
1988	0.142	827	0.395	**2004**	0.123	581	0.376
1989	0.208	833	0.538	**2005**	0.124	529	0.441
1990	0.179	828	0.484	**2006**	0.142	447	0.382
1991	0.190	821	0.461	**2007**	0.170	420	0.474
1992	0.159	816	0.436				

Figure 9: Trends in hail frequency for Saskatchewan. The vertical axis is mean number of hail days per station for the months of May-September.



Carol Bayntun of Markerville, Alberta shows damage to her plastic picnic table on Friday, August 11, 2006. Damage is expected to be in the millions after hail from a powerful thunderstorm punched holes in siding and broke windows in central Alberta earlier that week, say county officials.

[CP PHOTO/Red Deer Advocate – Jerry Gerling]

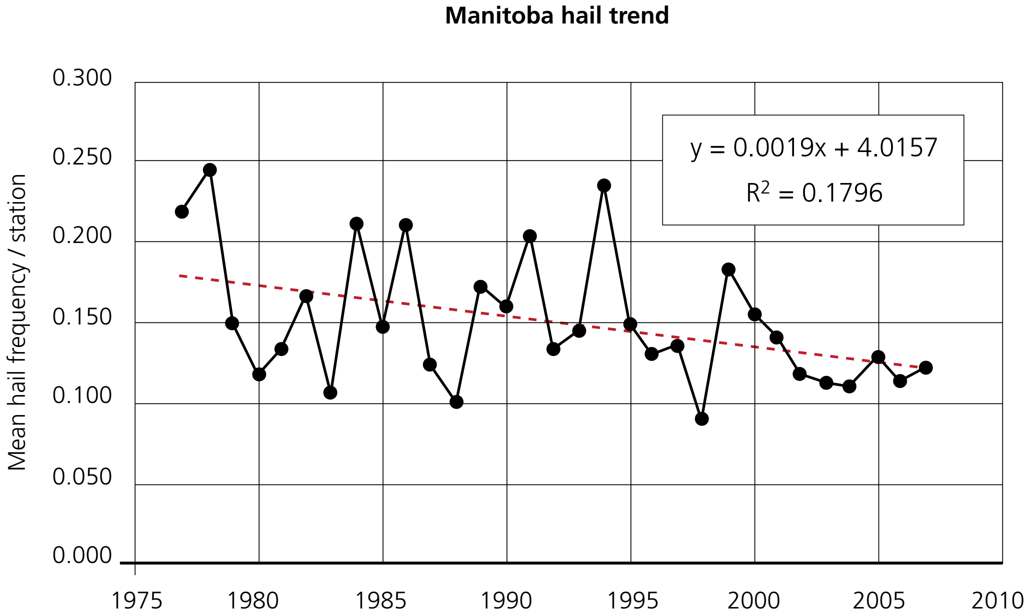
Trends in Manitoba:

Standard deviations of the hail frequencies show similar trends, as is evident by the strong correlation between the two variables (Figure 11). The strong positive relationship between hail days and standard deviation suggests that in low hail years, stations tend to be similar to each other with few hail days, but in high hail years hail events are more unequally distributed, possibly because some areas are more likely to experience a hail storm due to topographic, water body, and land use differences.

Table 6: Average hail frequencies per year for the province of Manitoba. N = number of monthly hail observations, Mean = mean number of hail days/station.

Year	N	Mean	Standard Deviation	Year	N	Mean	Standard Deviation
1977	0.219	491	0.602	**1993**	0.144	589	0.411
1978	0.245	484	0.566	**1994**	0.235	604	0.591
1979	0.148	511	0.439	**1995**	0.149	585	0.405
1980	0.117	516	0.363	**1996**	0.129	578	0.416
1981	0.132	536	0.399	**1997**	0.135	547	0.577
1982	0.166	538	0.472	**1998**	0.088	511	0.317
1983	0.105	568	0.326	**1999**	0.183	487	0.456
1984	0.211	578	0.500	**2000**	0.155	471	0.414
1985	0.147	589	0.405	**2001**	0.140	454	0.381
1986	0.211	591	0.465	**2002**	0.117	431	0.344
1987	0.123	605	0.370	**2003**	0.112	435	0.340
1988	0.100	626	0.321	**2004**	0.110	404	0.347
1989	0.173	613	0.440	**2005**	0.127	355	0.390
1990	0.159	616	0.426	**2006**	0.113	305	0.368
1991	0.205	602	0.461	**2007**	0.121	284	0.382
1992	0.133	598	0.407				

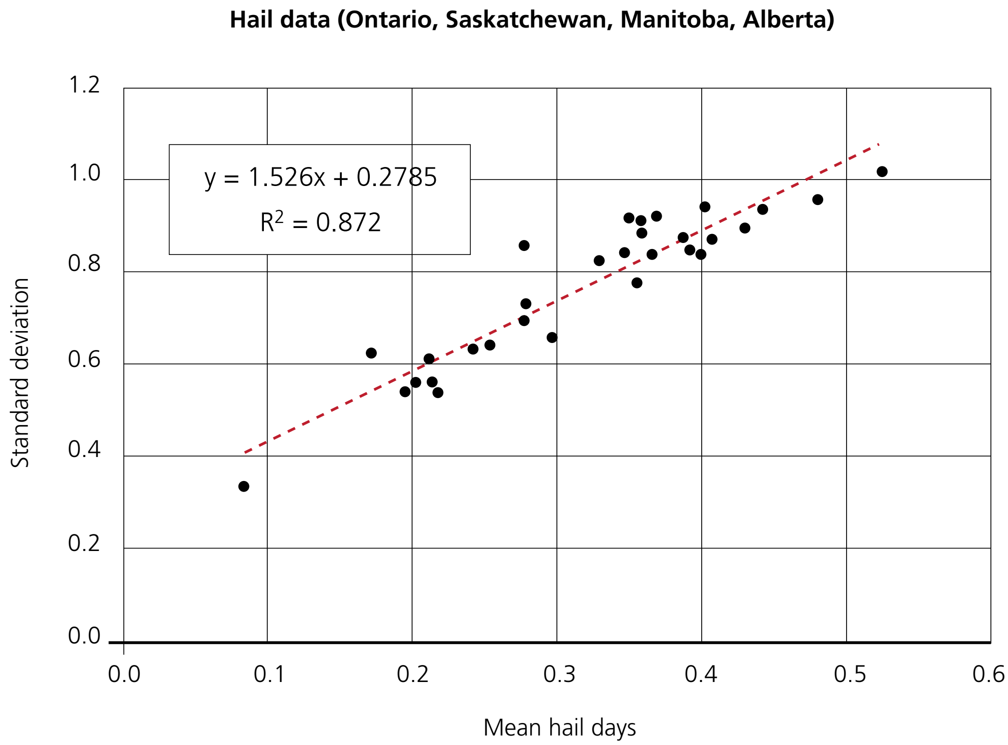
Figure 10: Trends in hail frequency for Manitoba. The vertical axis is mean number of hail days per station for the months of May-September.



In front of a heavily damaged corn crop, Courtney Taylor holds left-over hail stones an hour after a fast-moving severe thunderstorm with lightning, high winds, rain and hail hit the High River area creating havoc with downed trees and destroying crops in some areas southwest of High River, Alberta, August 14, 2012.

[THE CANADIAN PRESS IMAGES/Mike Sturk]

Figure 11: Relationship between mean number of hail days/station/month and standard deviation (for the months of May, June, July, August and September) for Ontario, Saskatchewan, Manitoba and Alberta.



5. Conclusions and recommendations for future research

Hail is a significant hazard for Canada, causing damage to agriculture and property, but is very unequally geographically and temporally distributed. Hail patterns identified in this analysis are similar to those from Etkin and Brun (1999), but are more robust because of the larger number of years that the data is based upon. A trend analysis shows no change in hail frequency for Ontario, in contrast to other studies that have examined severe hail frequency and tornado frequency. Alberta, by contrast, does show a significant increase in hail frequency during the period 1977 to 2007. Manitoba and Saskatchewan show decreasing trends. Future research could examine in more detail which areas exhibit increasing or decreasing hail frequencies, and how those seasons correlate with larger scale climate drivers. This research would be constrained, however, by the lack of ongoing hail observations by Environment Canada. Other datasets would have to be used, such as those created by radar and satellite imagery.

Black clouds float ominously over the Calgary skyline just before a hail and heavy rain storm hit Calgary and the Stampede grounds on Friday July 13, 2001. Extreme weather was evident all across central Alberta.

[CP PHOTO/Calgary Herald – Dean Bicknell. The Canadian Press Images/Calgary Herald]

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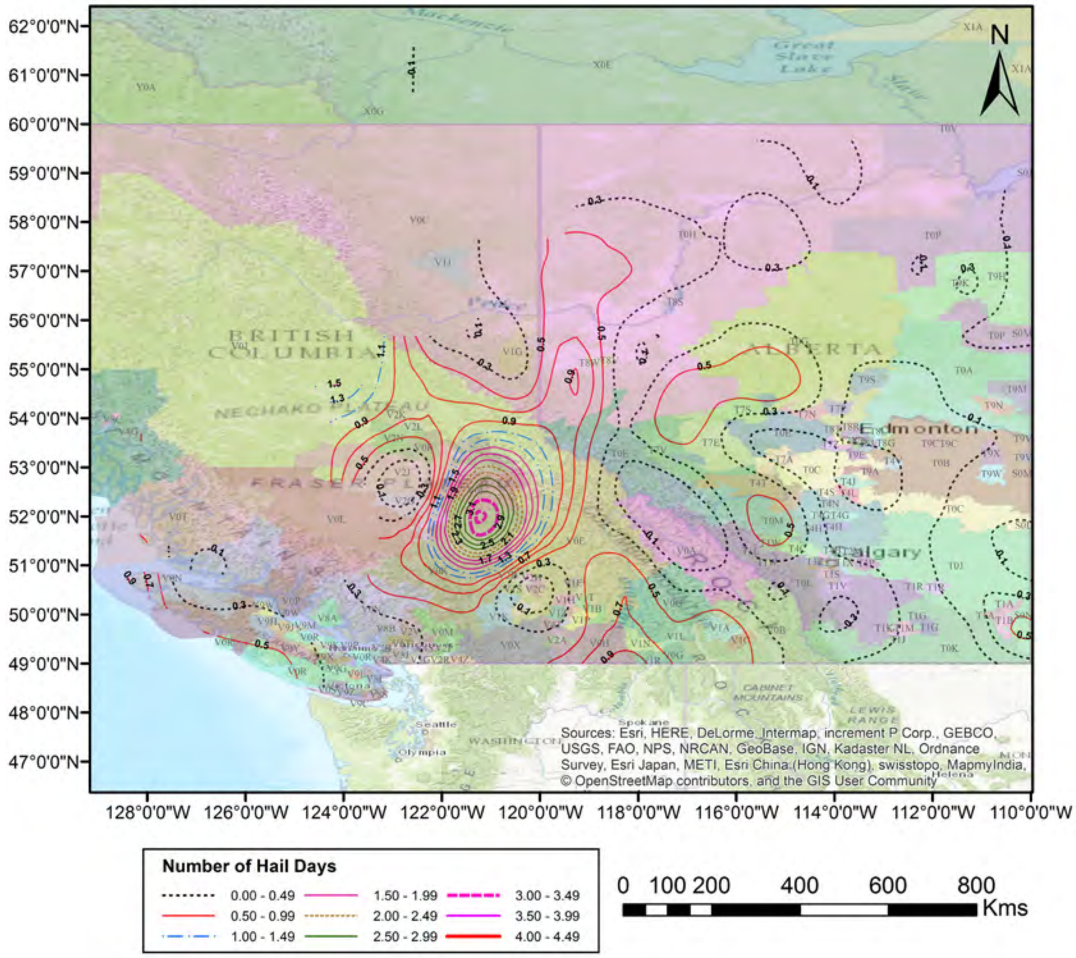
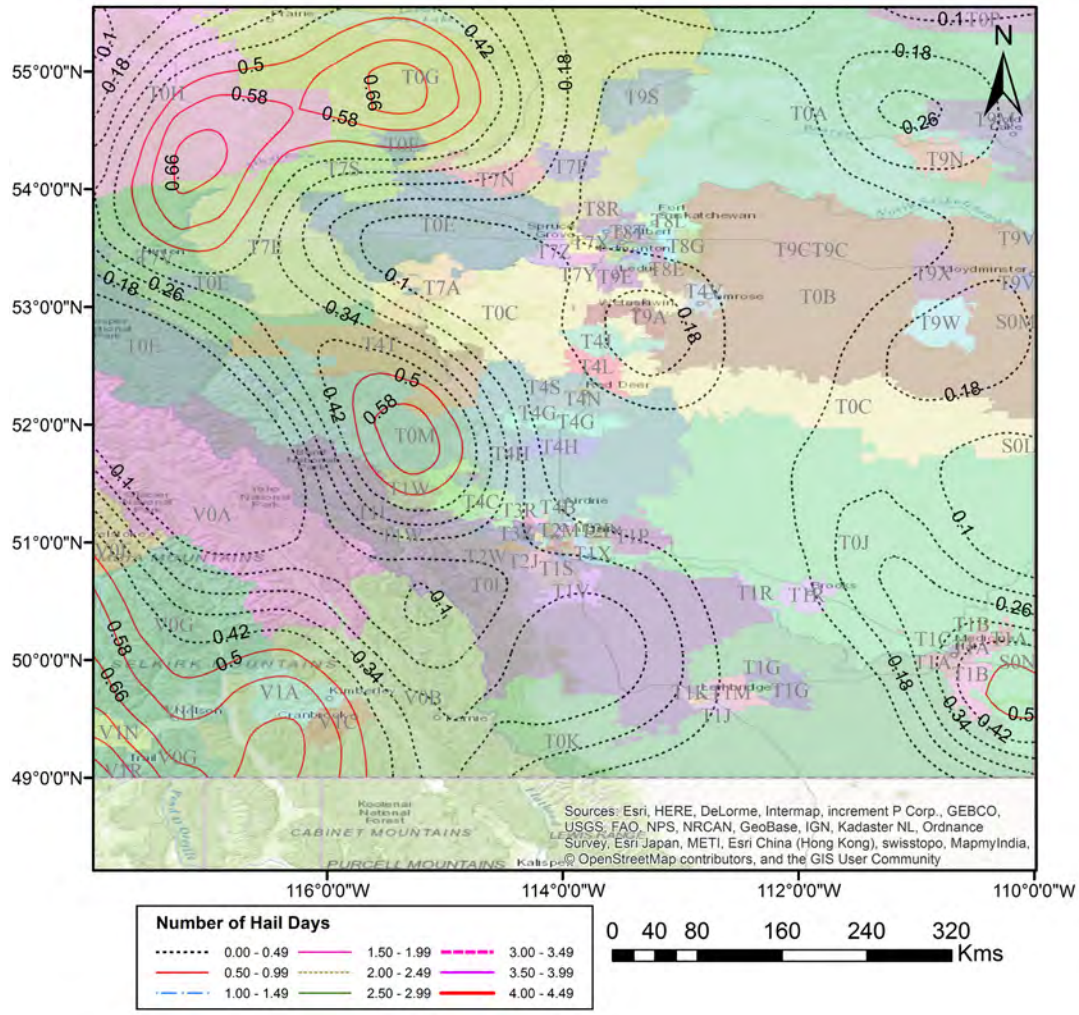
Appendix A

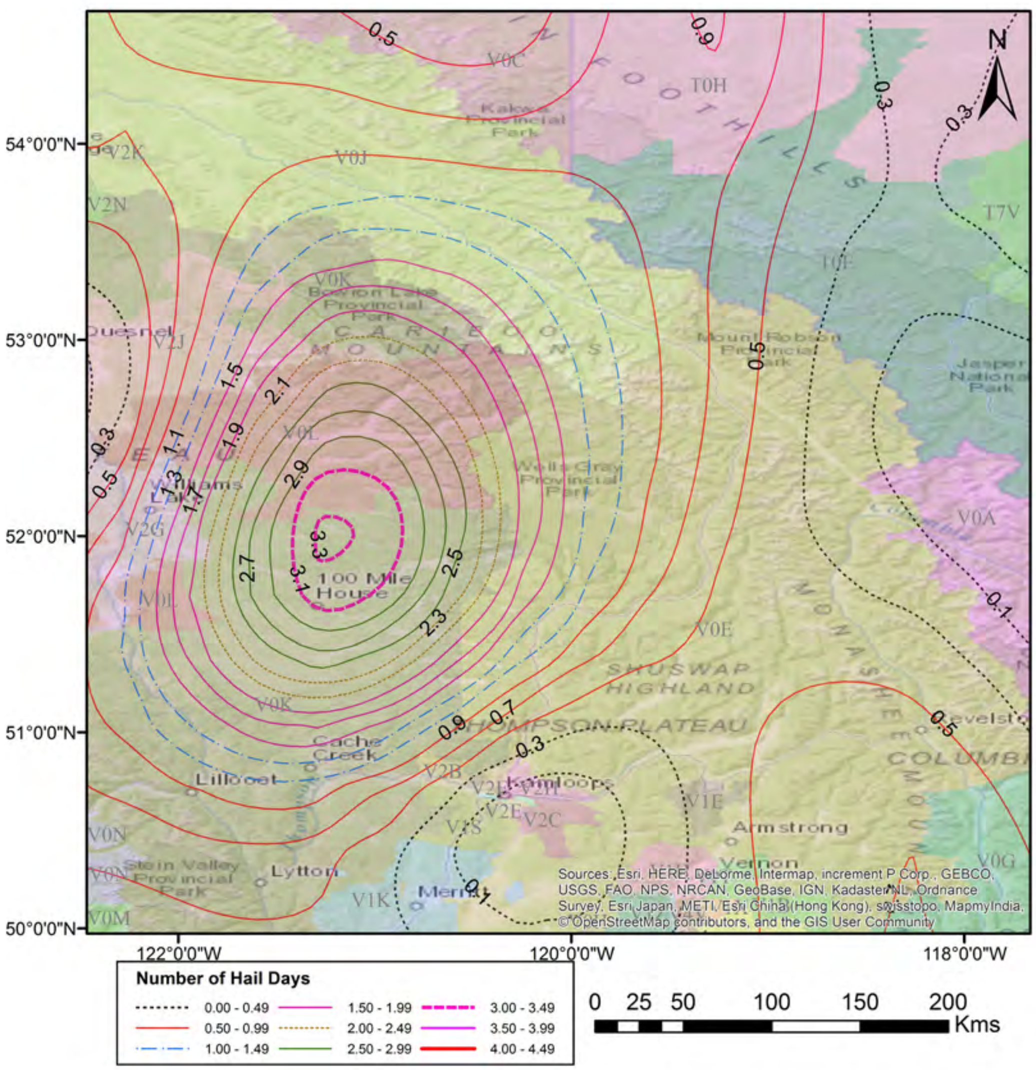
May hail frequency in Western Canada (A)



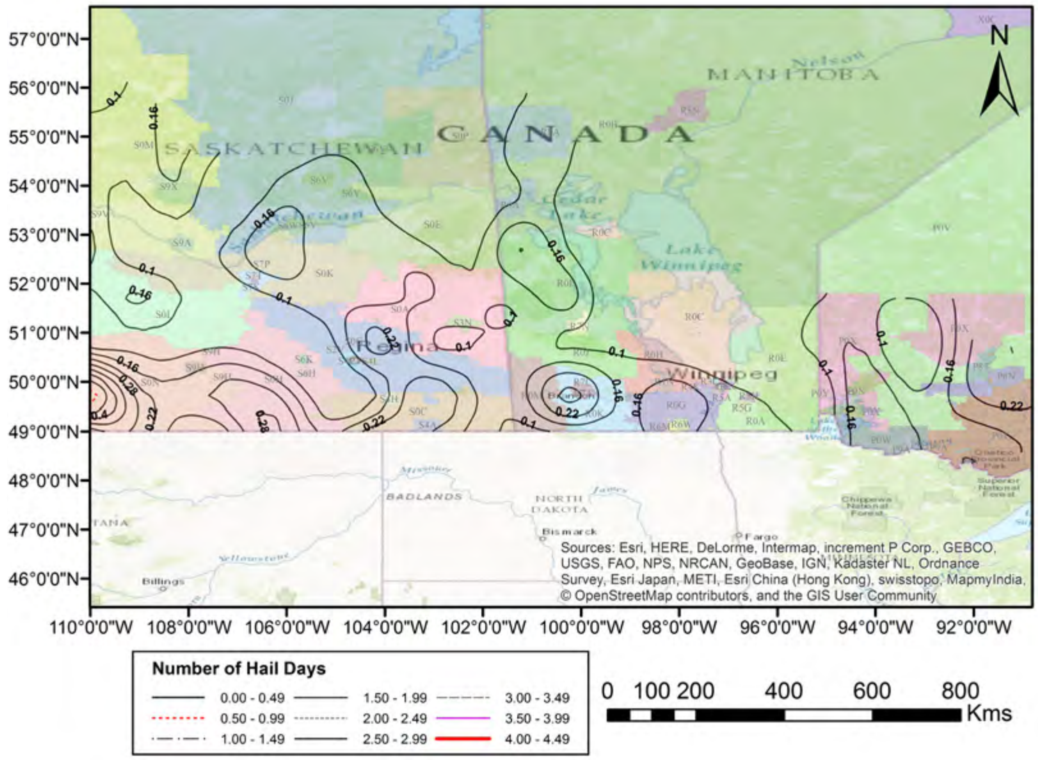
May hail frequency in Western Canada (B)



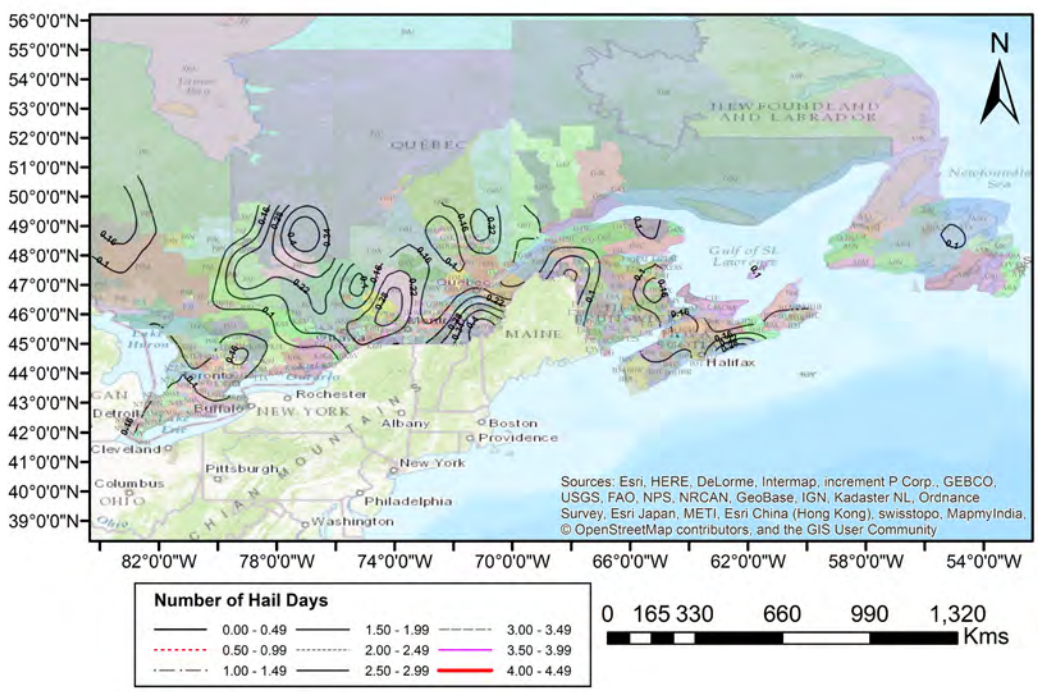
May hail frequency in Western Canada (C)



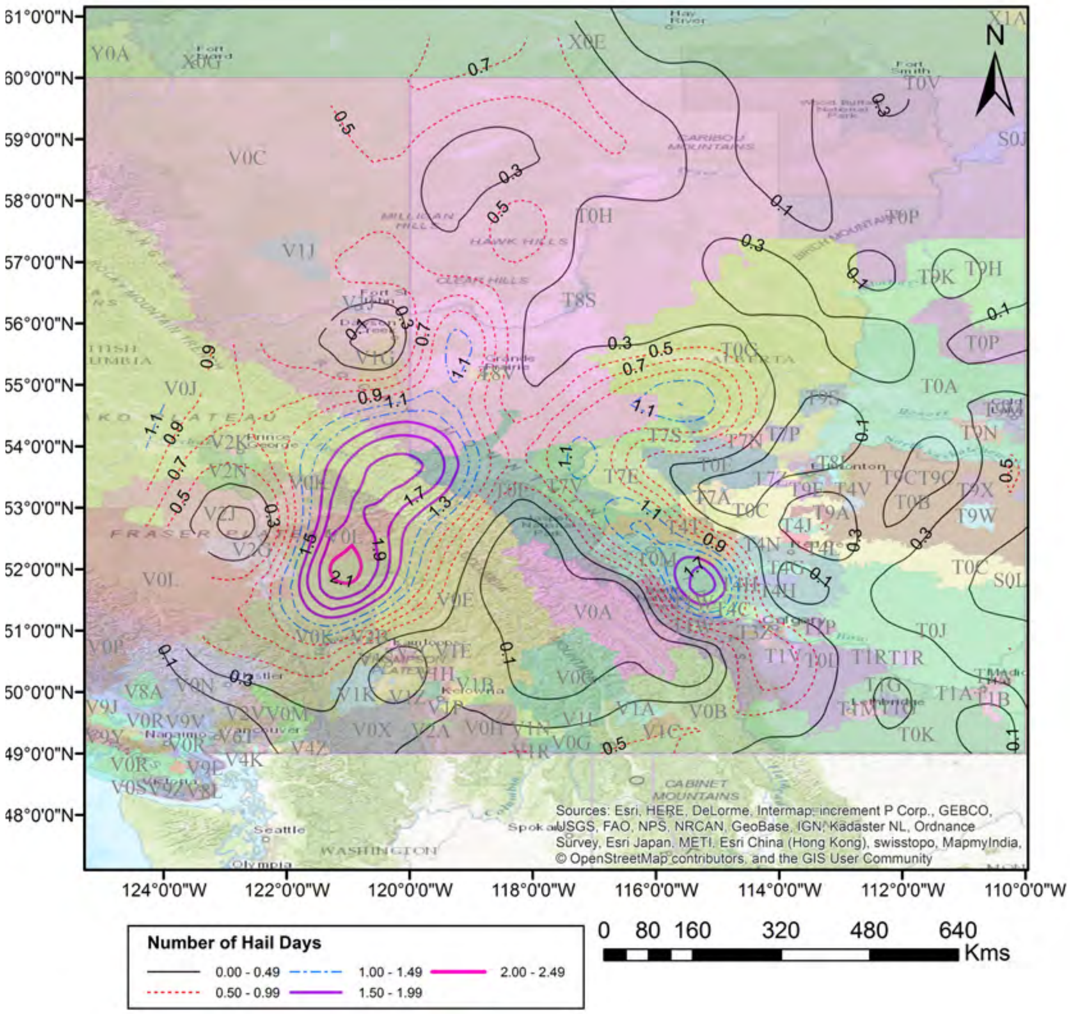
May hail frequency in Central Canada



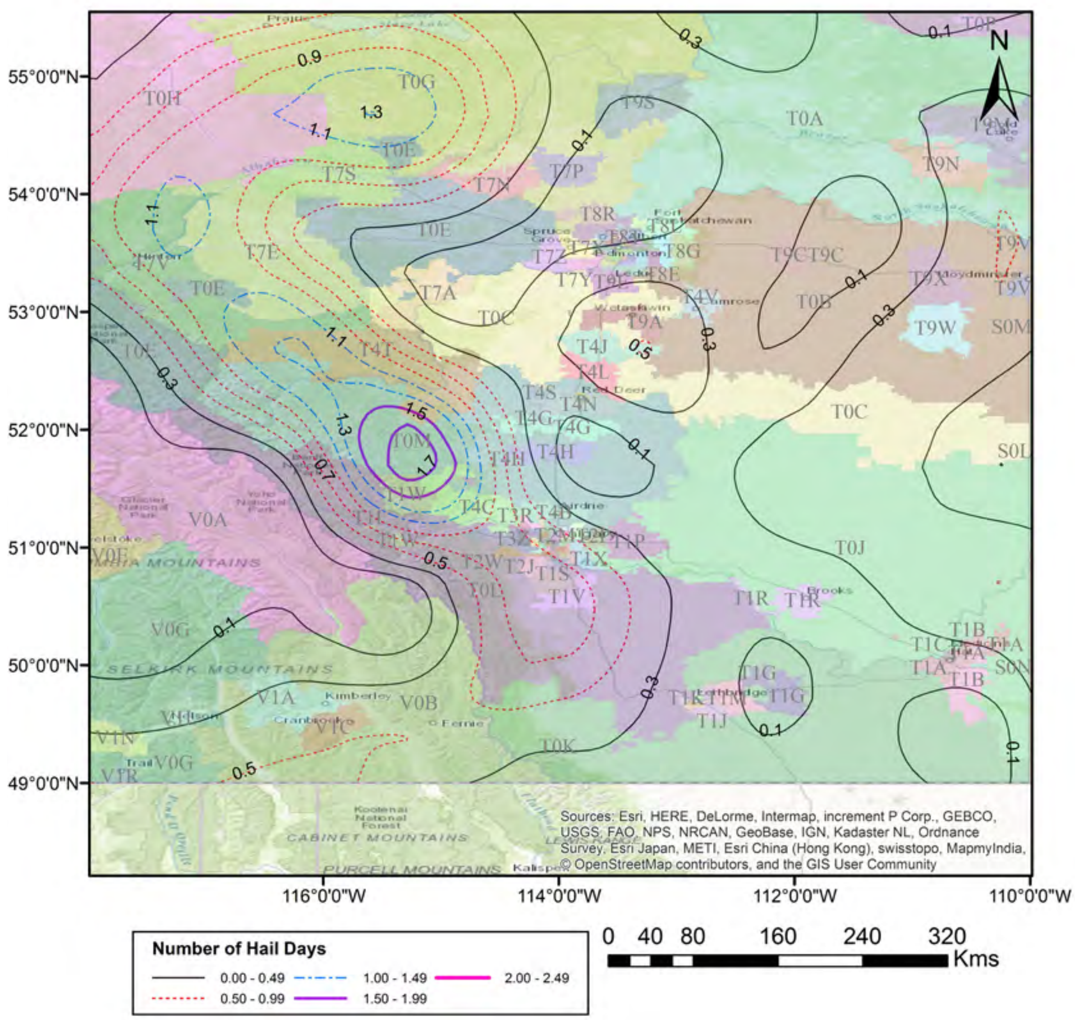
May hail frequency in Eastern Canada



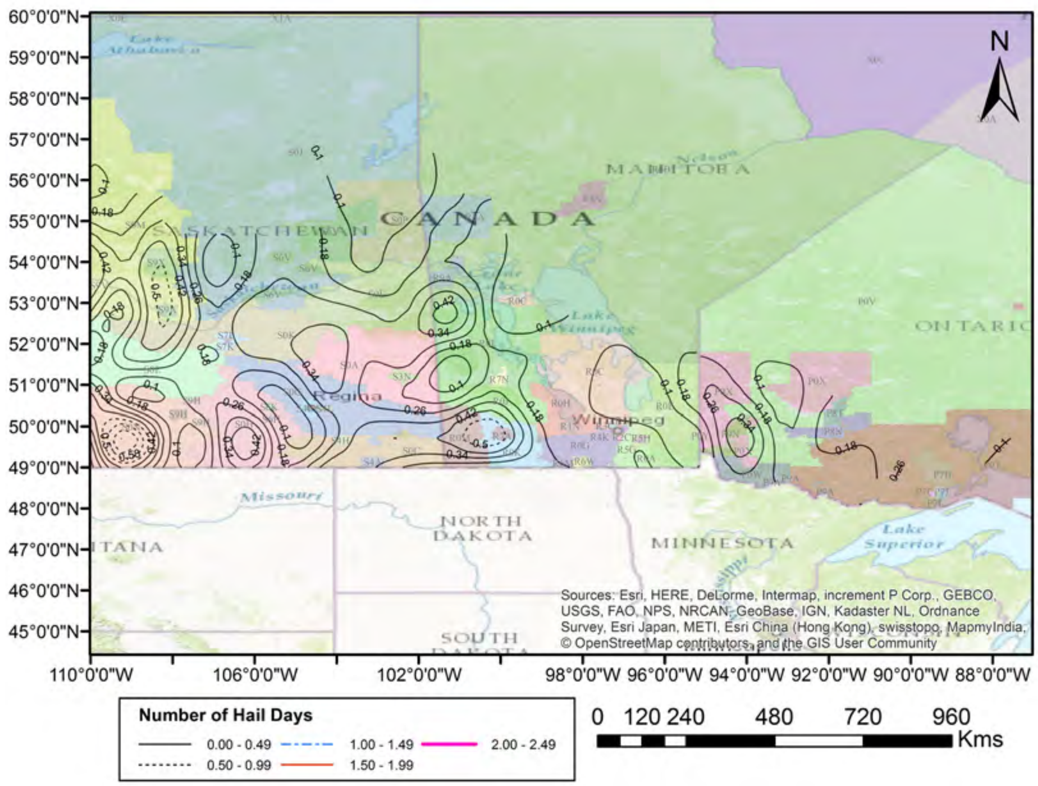
June hail frequency in Western Canada (A)



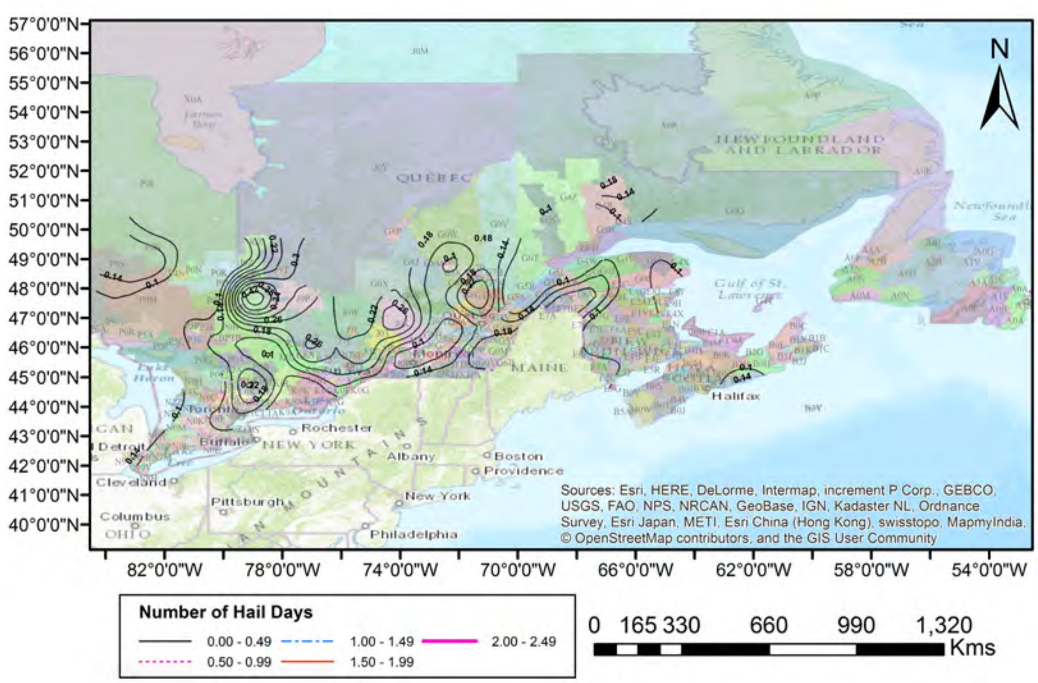
June hail frequency in Western Canada (B)



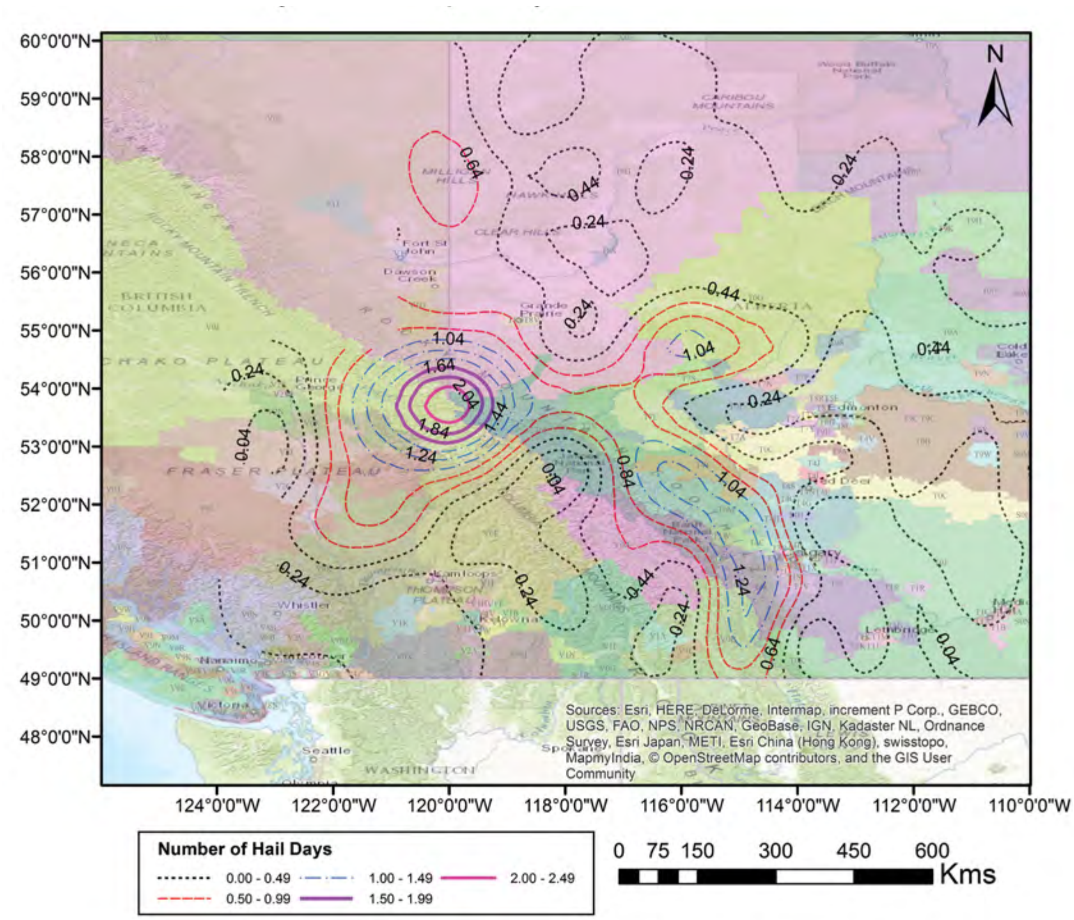
June hail frequency in Central Canada



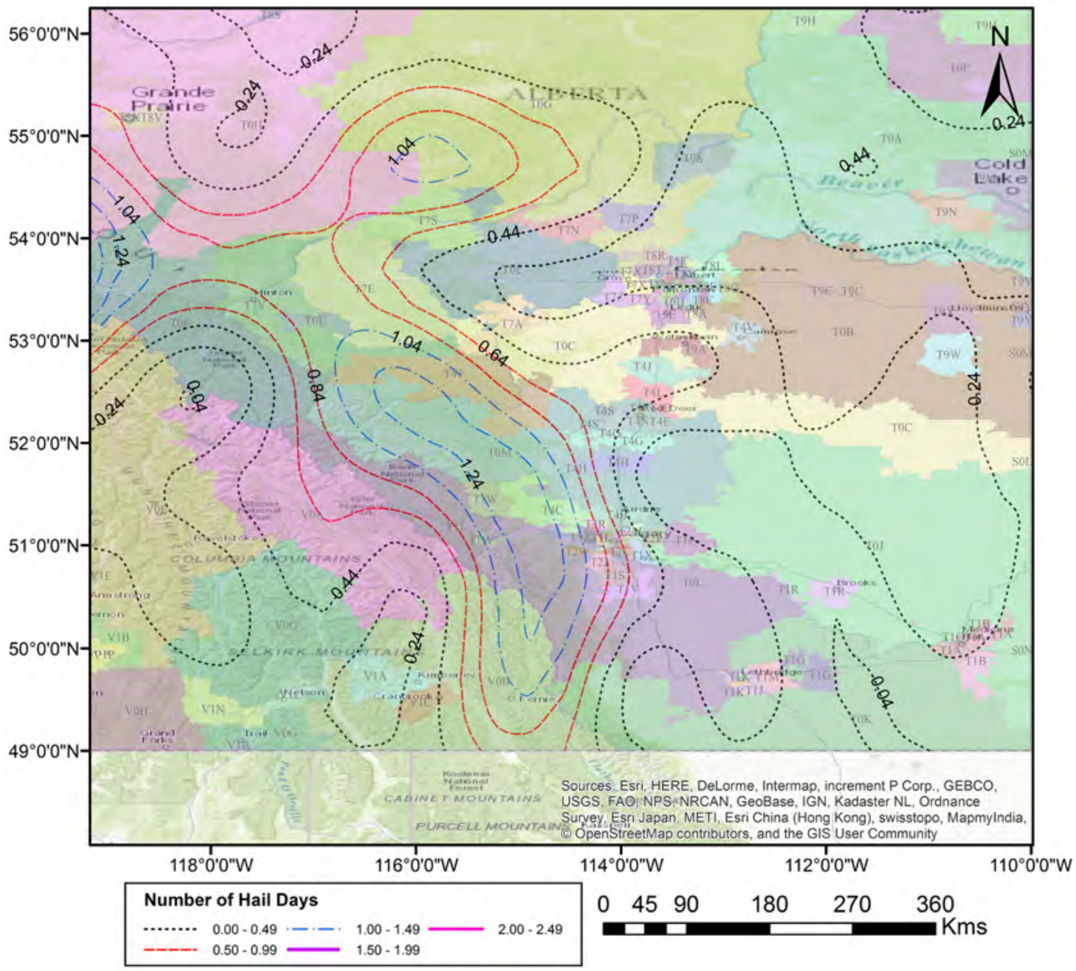
June hail frequency in Eastern Canada



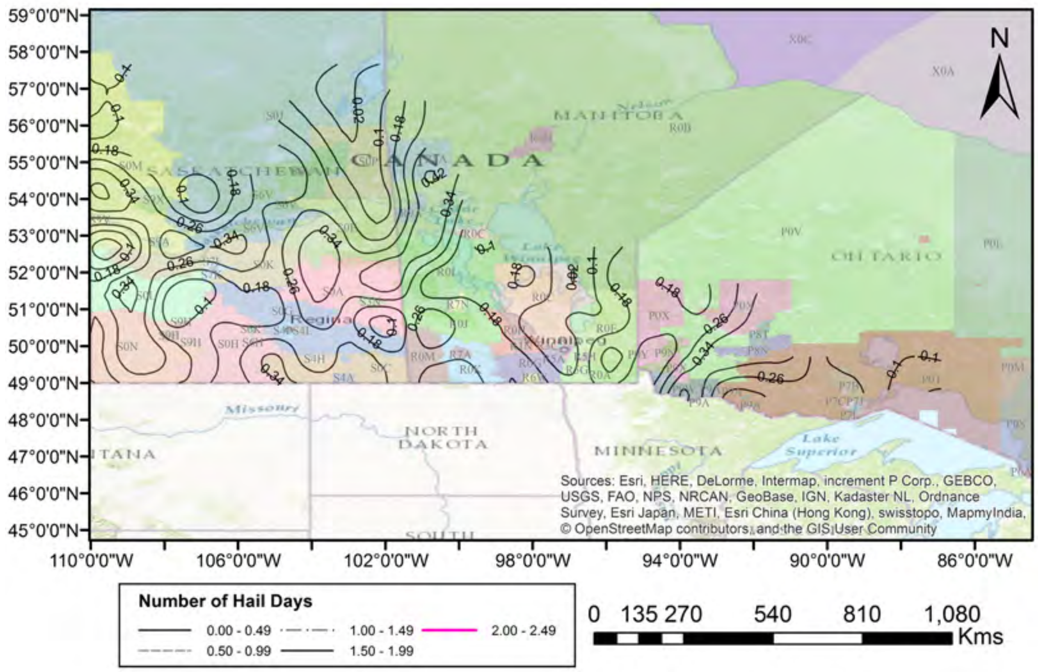
July hail frequency in Western Canada (A)



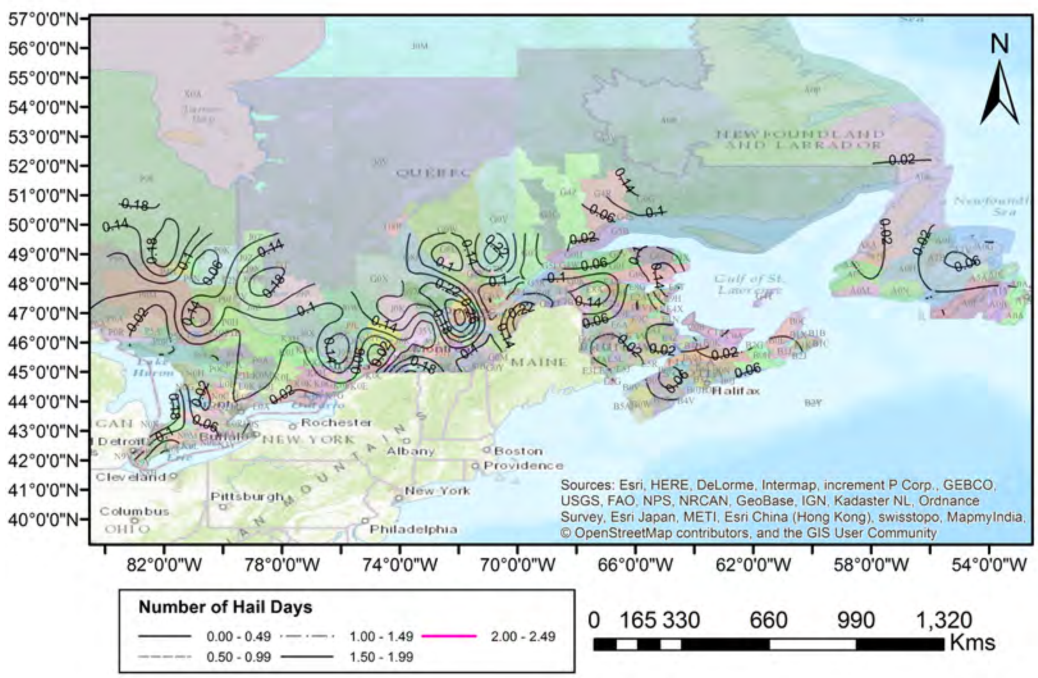
July hail frequency in Western Canada (B)



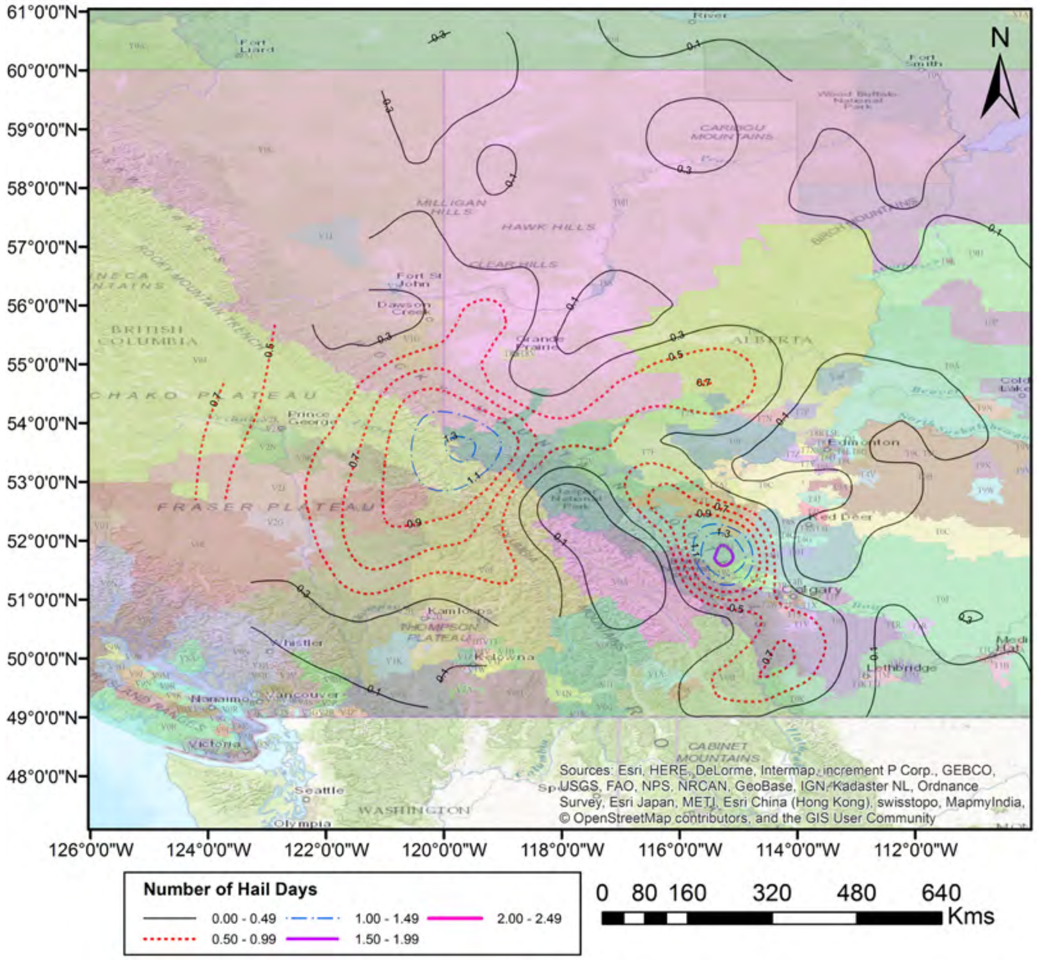
July hail frequency in Central Canada



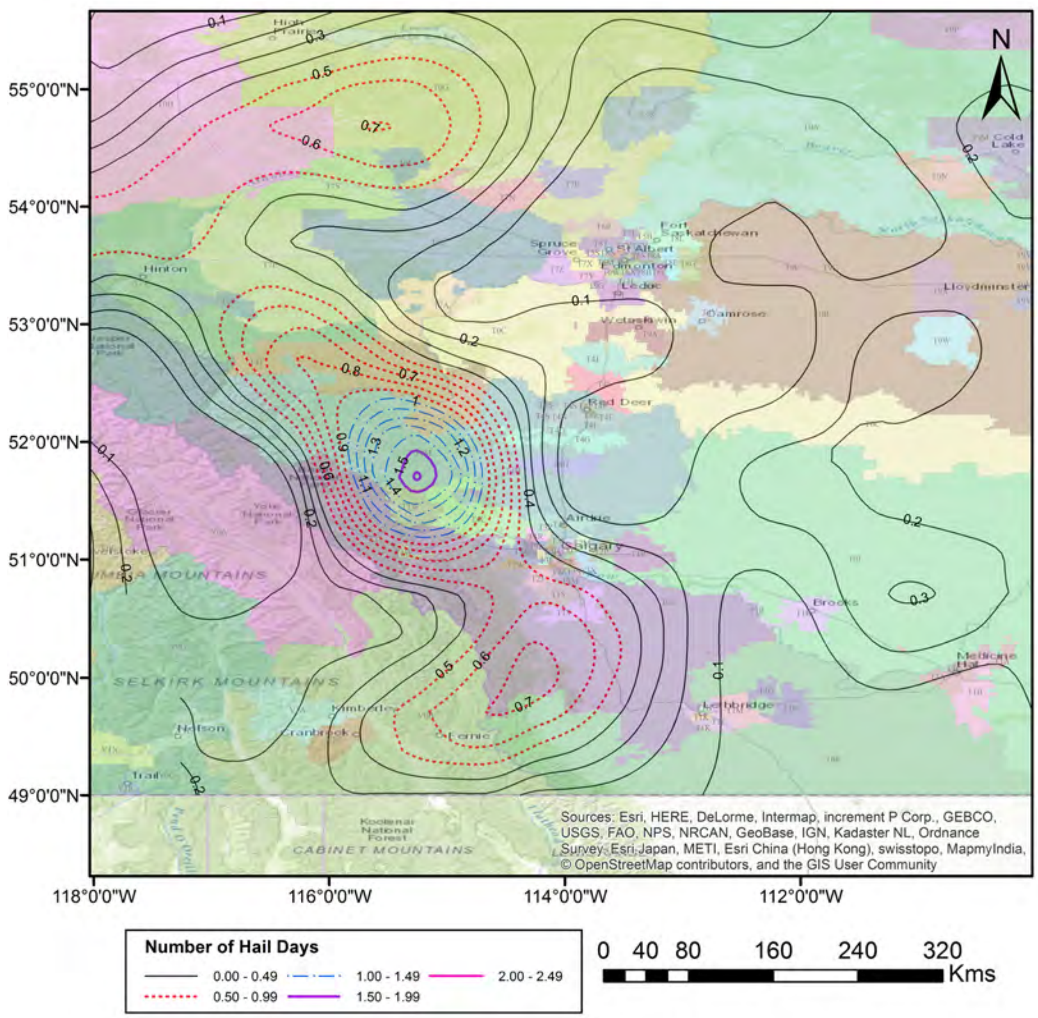
July hail frequency in Eastern Canada



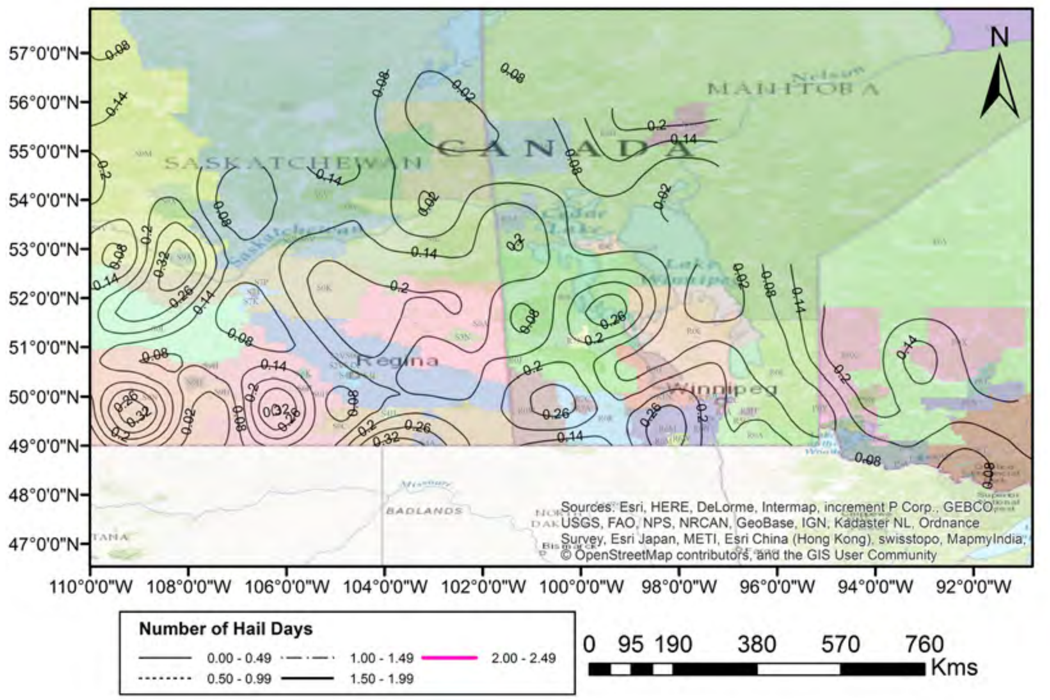
August hail frequency in Western Canada (A)



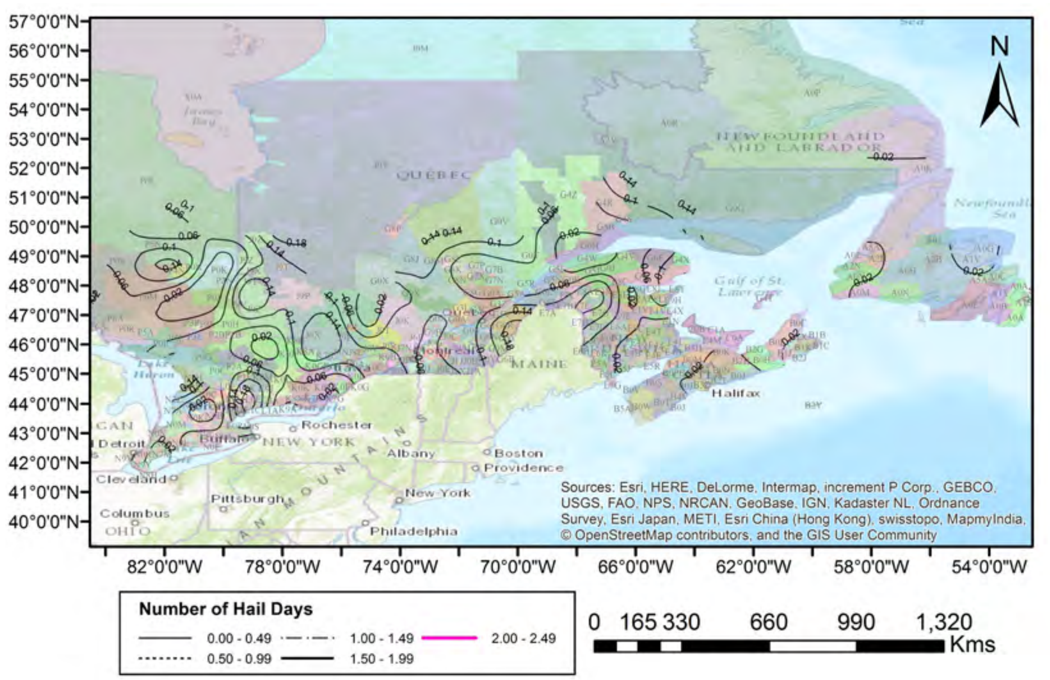
August hail frequency in Western Canada (B)



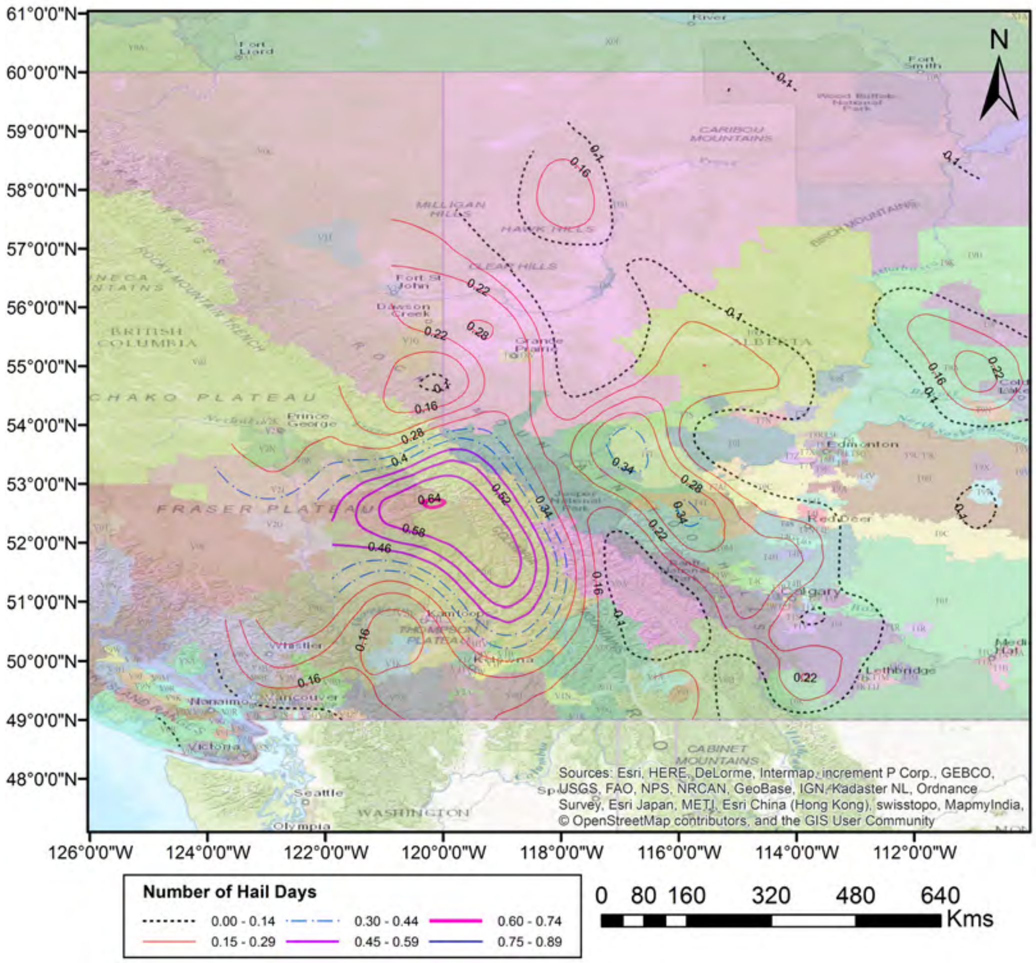
August hail frequency in Central Canada



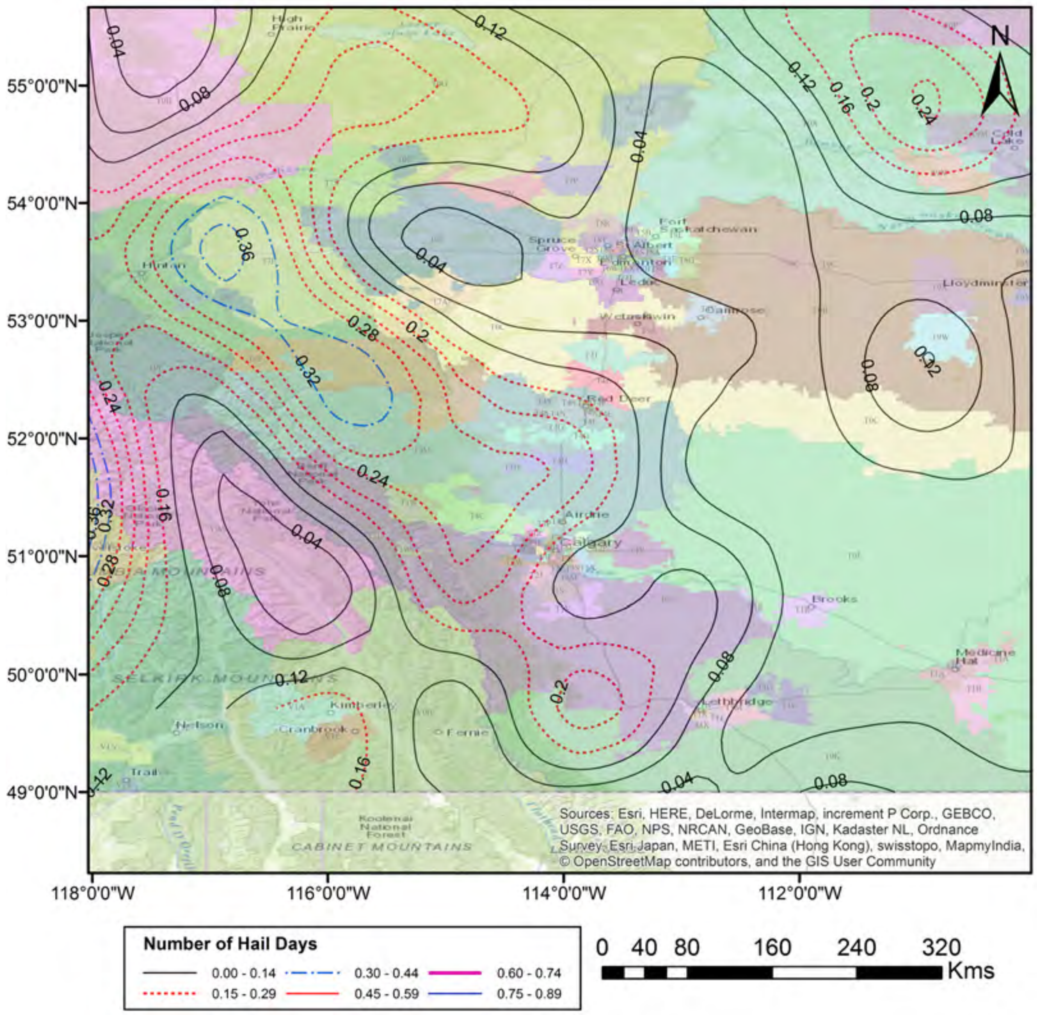
August hail frequency in Eastern Canada



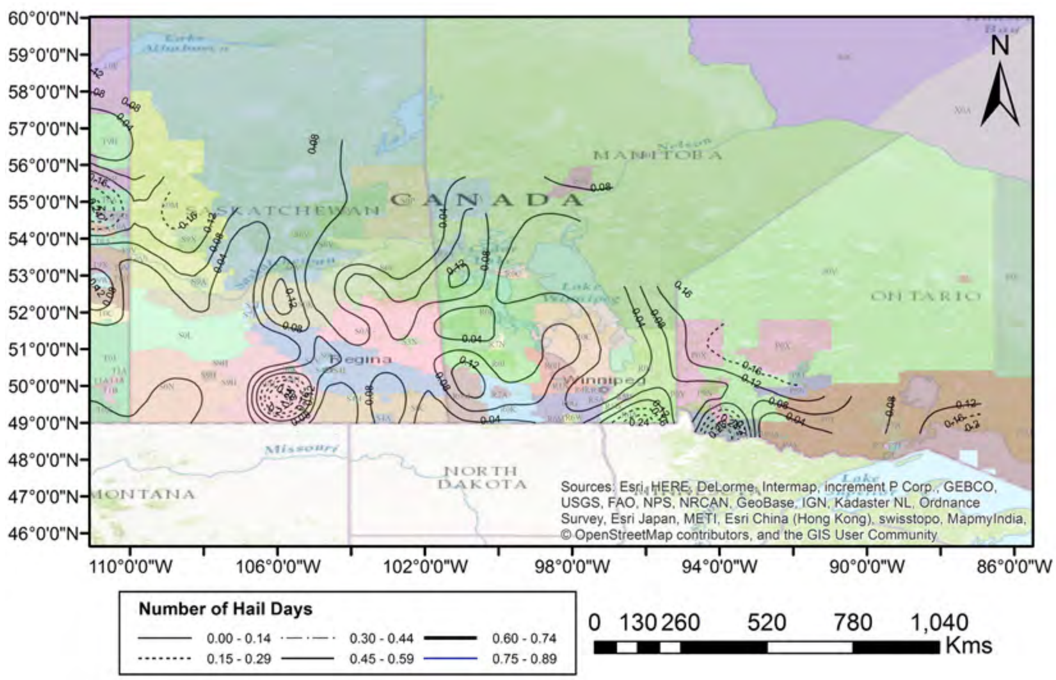
September hail frequency in Western Canada (A)



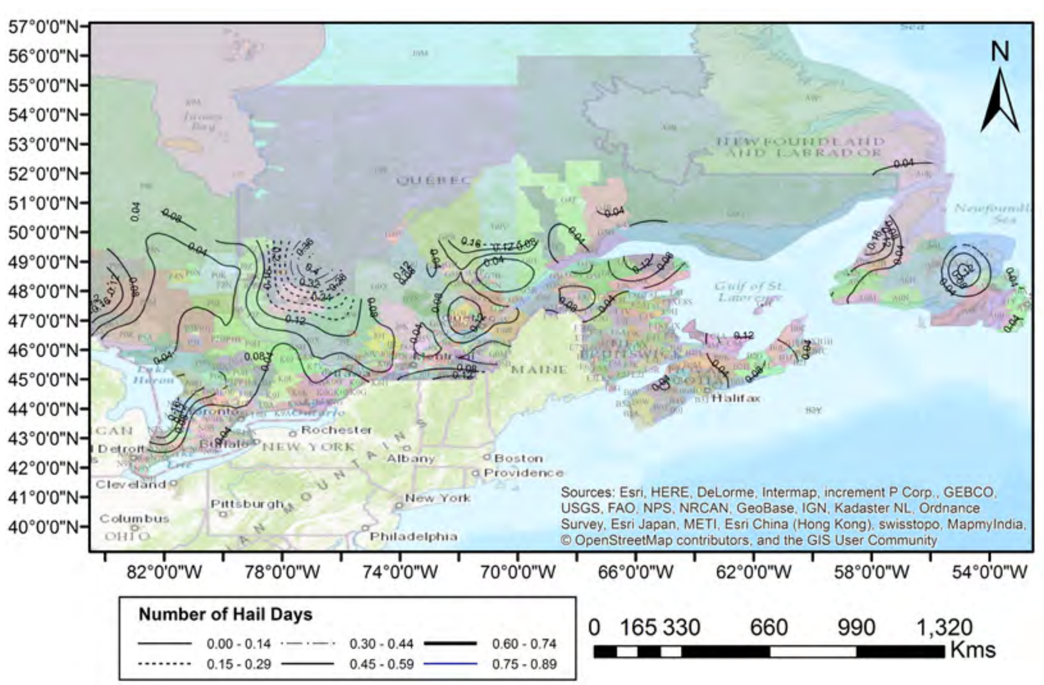
September hail frequency in Western Canada (B)



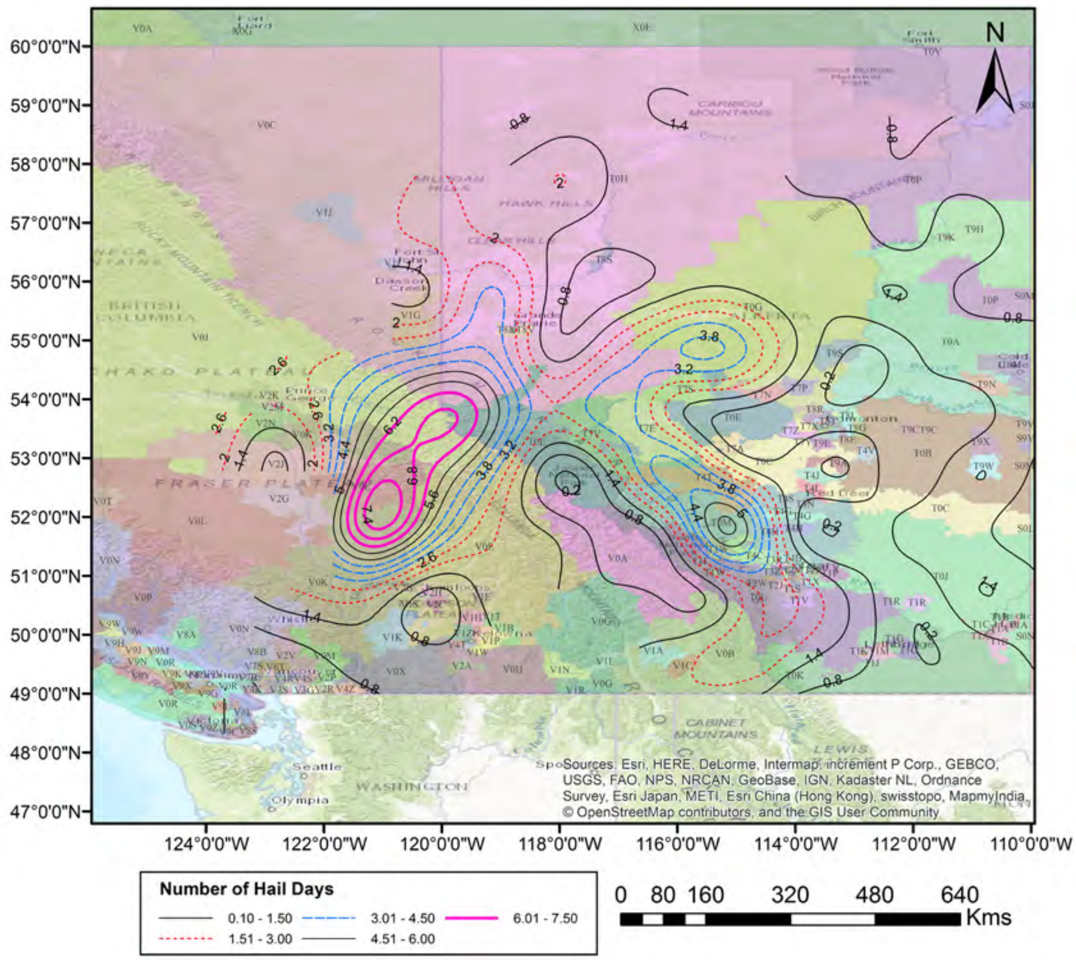
September hail frequency in Central Canada



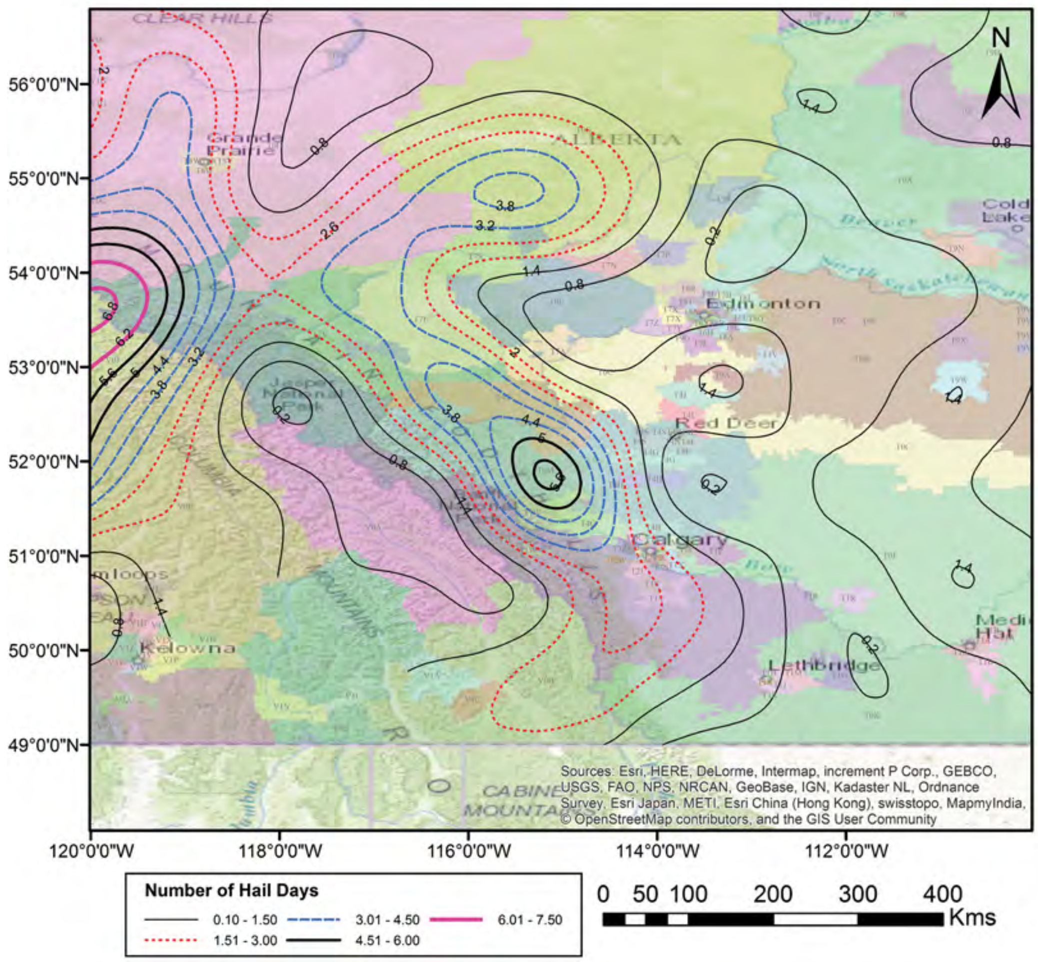
September hail frequency in Eastern Canada



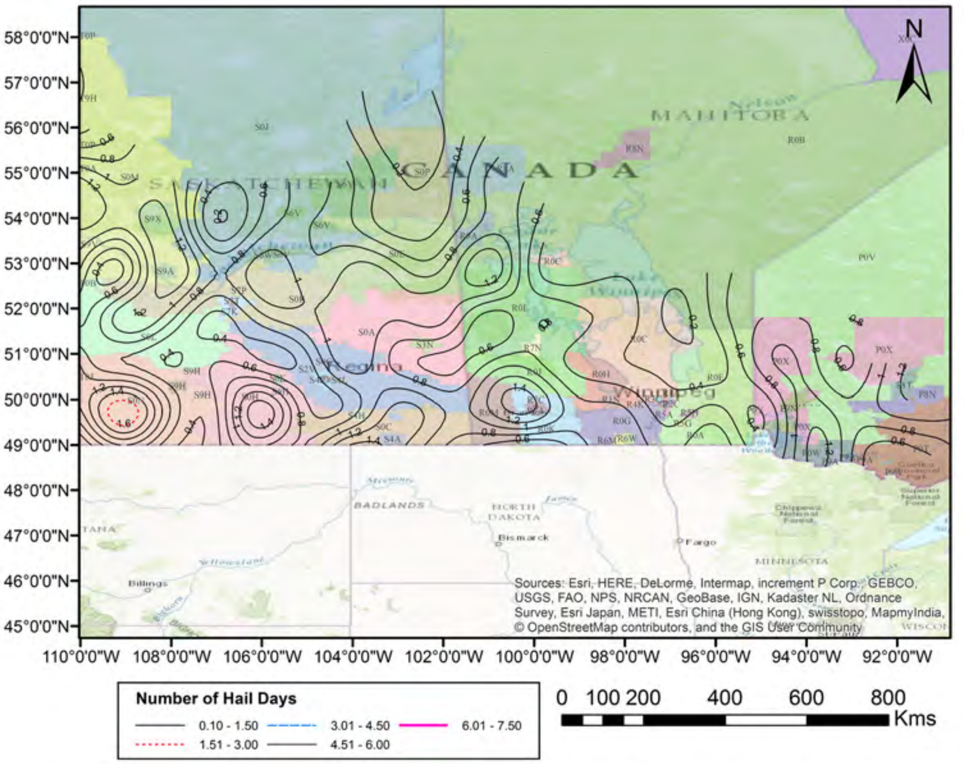
Warm months hail frequency in Western Canada (A)



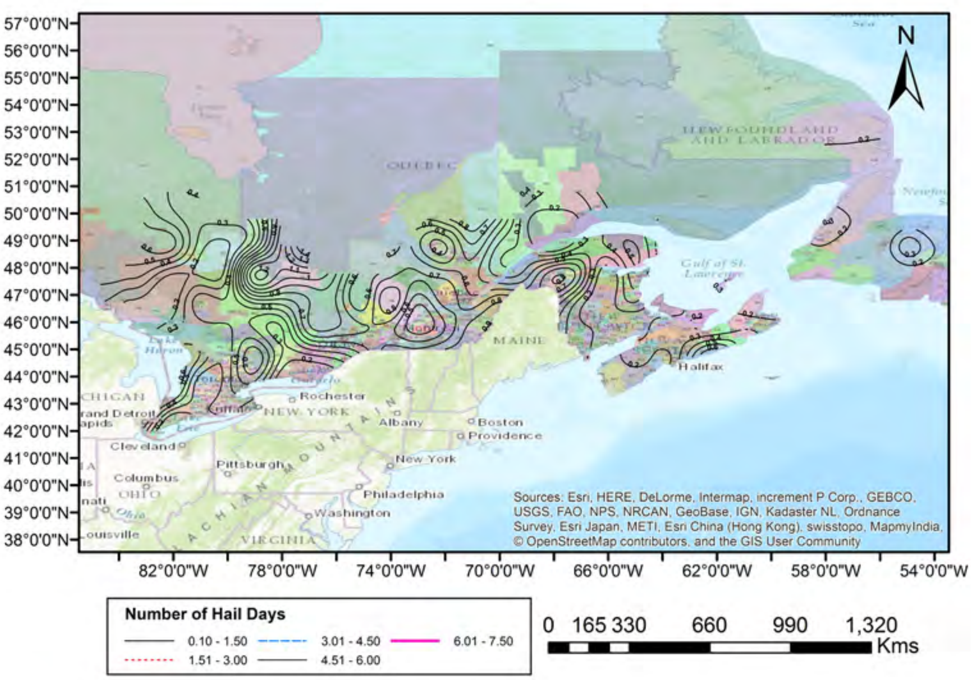
Warm months hail frequency in Western Canada (B)



Warm months hail frequency in Central Canada



Warm months hail frequency in Eastern Canada



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