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1995/96
SUMMER SEVERE WEATHER REPORT
FOR NEW BRUNSWICK
(ARTN 97-001)

by

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Weather Services Office

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NEW BRUNSWICK ENVIRONMENT CANADA

WEATHER SERVICES OFFICE

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INTRODUCTION

A severe weather watch and warning program has been in place in New Brunswick since 1987. Since 1994 the summer severe weather watch and warning program for New Brunswick has been carried out by the New Brunswick Weather Services Office (NBWSO) in Fredericton. In 1995 and part of 1996 the production of severe weather watches and warnings for Nova Scotia and PEI were temporarily transferred to Fredericton as well.

The summer of 1995 was generally drier and warmer than normal. Thunderstorm frequency was slightly above normal with 11 confirmed severe weather events.

The summer of 1996 season was characterized by a relatively cool and dry May with conditions near normal in June. July was very wet with below normal temperatures. In contrast August was very dry with slightly above normal temperatures. Conditions were near normal in September. Overall thunderstorm activity was below average with only 5 confirmed severe weather events.

The severe weather season was slightly above average in length in 1995 with the first event occurring on May 27th and the last event on September 7th. In contrast the season was cut very short in 1996 by a cool wet July and a dry August. The first event occurred May 23 with the last event on June 15th a season of only 24 days in length.

The criteria for severe weather have remained unchanged over the last several years and are as follows:

Damaging Winds	>= 90 km/h
Hail	>= 15 mm diameter
Rain	>= 25 mm/h or 50 mm/3h
Tornado or Tornadic Water Spout	

PROGRAM STRUCTURE

WSO OPERATIONS

In addition to providing severe weather watches and warnings for the province of New Brunswick, the NBWSO runs a full public program for New Brunswick and an aviation forecast program for all of the Maritime provinces. Agricultural and Ultraviolet Index forecasts and Smog Advisory information is also provided for New Brunswick. Many commercial forecast products are also prepared and include:

- Flood Forecast support for the Saint John River Basin. (seasonal)
- Five day forecast for New Brunswick Power. (year round)
- New Brunswick Power Thermal Plant Forecast support. (year round)
- Department of Natural Resources and Energy Forestry Forecast support. (seasonal)
- Department of Transportation Road Forecast. (seasonal)
- Oil barge off loading forecast support. (year round)

During the day, 3 staff are on shift: one supervisor (MT6), one forecaster (EGX) and one media/commercial services forecaster (EGX). Unlike many other Weather Services Offices, there is no dedicated severe weather forecaster. The assessment of severe weather potential is made by the available staff on shift and, if necessary, duties are redistributed to allow for a comprehensive assessment.

The method for assessing severe weather potential is based on the Kansas City techniques as outlined in Training Branch's Summer Severe Weather Correspondence Course.

SEVERE WEATHER DETECTION

Participation in the Weather Watcher Network has remained constant over the last few years with around 160 active members in New Brunswick. These watchers comprise one of our main sources of severe weather detection. There continues to be a requirement for additional watchers especially in the northern and southwestern parts of the province. This network is operational throughout the year but during the winter months watchers do not contact the office but are contacted occasionally by office staff and used as sources of supplementary weather information during a storm.

A CANWARN (Canadian Weather Amateur Radio Network) was established in 1994 and also runs year around. CANWARN New Brunswick has been modeled after similar HAM Radio weather networks in southern Ontario. When severe weather is anticipated, staff on shift call one of the CANWARN Net Controllers to come to the office to operate the network. On a HAM Radio, which has been set up in the operational area, the Net Controller stands by to receive reports of severe weather from more than 100 volunteer HAM Radio operators across the southern half of the province. All participants have received training through seminars and/or information packages in recognizing both summer and winter severe weather conditions. The network has proved to be quite useful.

Over the last two years radar coverage in New Brunswick has been augmented with a new Doppler Radar in Hodgdon Maine near the New Brunswick/Maine Border. Radar data is acquired and displayed for animation on a separate PC which dials into a private weather data distributor in the United States. Velocity, precipitation rate and echo top scans are available on a regular basis.

Both the Mechanic Settlement in southern New Brunswick and the Halifax Radars have been upgraded with RDP hardware and software.

The combination of all three radars provides good coverage of the province except for the northeast corner. In long range mode, however, adequate coverage of this area can be achieved.

High resolution Goes 90 satellite pictures are available every 15 minutes.

SOFTWARE SUPPORT.

The main severe weather software support was an interactive weather display system called WADS (Weather Analysis and Display System) developed by Willi Purcell. Through WADS soundings can be displayed and modified to calculate several severe weather indices. It also provides the facility to analyze a number of different fields at various levels in the atmosphere in both analysis and forecast mode. Over the last several years it has been recognized that SSI (Storm Severity Index) values of 95 or greater are strongly correlated with severe weather in New Brunswick. SWEAT (Severe Weather Threat) index values of 250 or greater also have a good correlation with severe weather in the province. An effort will be made to more fully utilize and assess the many other severe weather applications available through this software.

In addition to WADS, some use was made of the CMC Summer Severe Weather Forecast Package. It has been found that this information is most useful as a heads up for possible severe weather the following day. It is recognized that this package lacks the resolution and accuracy need for reliable day one severe weather prediction.

HIGHLIGHTS OF EVENTS.

The 1995 season was quite active beginning on May 27 and lasting until September 7th. There were 11 severe weather events reported. Four of these events occurred on July 26 in the Fredericton area when several severe thunderstorms moved through the city and surrounding area. There was one confirmed tornado which uprooted trees, caused some damage to several buildings and other property. As well a domed tennis complex at the Howard Johnson Motel was destroyed. There were several other wind related damage reports. The path and intensity of destruction suggests a weak tornado which may have touched down on three occasions.

Here is a brief summary of the severe weather events in 1995:

Damaging winds	4 events
Hail	2 events
Rain	3 events
Tornado	2 events

The 1996 season was quiet in comparison lasting only 24 days with just 5 severe weather events reported. The most active period was the week of June 12th through the 15th when severe weather was forecast and reported each day. The bulk of the reports were due to heavy rainfall and large hail. A severe thunderstorm supporting a tornadic waterspout and golf ball size hail moved onshore in southeastern New Brunswick from the Bay of Fundy on May 23rd with no damage reported.

Here is a brief summary of the severe weather events in 1996:

Damaging winds	0 events
Hail	2 events
Rain	2 events
Tornado	1 events

A detailed chronological summary of the events for 1995 and 1996 can be found in Appendix A.

VERIFICATION

STATISTICS COMPUTED

Three main statistical values were computed for verification of watches and warnings. Their definitions follow:

POD (Probability of Detection) -a measure of the ability to successfully predict the occurrence of an event. This is simply the number of events successfully predicted divided by the total number of events. POD = X/X+Y , where X is the number of severe weather events successfully predicted and Y is the number of misses.

FAR (False Alarm Ratio) -proportion of false predictions of an event. This is the total number of false predictions divided by the total number made. FAR=Z/Z+V, where Z is the number of False Predictions and V is the number of successful predictions.

NPFD (Normalized POD-FAR Difference) -combines the POD and FAR by subtraction to give an overall measure of accuracy of prediction. This statistic has long been recognized as a good overall measure of forecasting skill. NPFD = [(POD-FAR)+1]/2

1995/96 VERIFICATION OF WATCHES AND WARNINGS

The computation of statistics for 1995 and 1996 are presented below. There were some changes made in the procedure for computing statistics for both the 95 and 96 seasons to conform to the national guidelines agreed to at the Kelowna coordinators meeting in 1993. Some of the main changes include:

1) Size of threat area- Threat areas for each Watch no longer can exceed 25,000 km^2 and threat areas for each Warning are restricted to 8,000 km^2. This means that each Watch/Warning, which covers an area greater than 25,000/8,000 km^2, will be counted as more than one Watch/Warning for verification purposes. For example New Brunswick is roughly 75,000 km^2 so a Watch which covers the entire province is counted as 3 separate Watches for verification purposes. It is important to try to be as precise as possible when issuing Watches/Warnings so that the public is not warned unnecessarily and the number of false alarms is kept to a minimum.

2) More than one severe weather event in the threat area can count as a hit for a watch. Previously only one event would count as a hit. Each occurrence of severe weather in a warning threat area counts as a hit on the warning (there has been no change here).

3) A lead time of 30 minutes is required for a watch to verify with a hit. For example if a

watch is issued and a severe weather event occurs in the threat area within 30 minutes of issue it is counted as a missed event. There is no change in this regard with respect to warnings. No lead time is required for warnings. The main message here is to have watches out early; **before severe weather develops.**

4) Updated Watches/Warnings are considered to be a single Watch/Warning. In previous years the updates counted as a separate bulletin. This is a favorable change from a verification point of view as a watch can only be counted as a false alarm once even if it is updated several times. For cases where severe weather is strongly suspected, especially in sparsely populated areas, it is often necessary to continue updating a watch despite the lack of a severe weather report.

As was done in previous years, if the forecast staff strongly suspect severe weather has developed based on satellite, radar and forecast assessment a warning will be issued before severe weather is confirmed by ground reports. It is recognized however that Warnings and Watches can only be verified by an actual severe weather report.

The overall verification for watches and warnings (table 2) shows a relatively high POD for the 95 and 96 seasons. This shows that we are not missing very many events. Of the 11 events in 1995 there were only 3 missed and of the 5 events in 1996, 2 were missed. These POD scores show a significant improvement over the 93 and 94 seasons (table 5).

The NPFD (skill score) remains relatively low, less than 50% and is due mainly to the fact that we continue to have a high FAR ie. we are over-warning both for watches and warnings. When compared to previous years data, the FAR values for 95 and 96 show a small decline in skill (higher values). As noted earlier the maximum size of the threat area for each watch and warning is now smaller than in previous years and is likely one of the reasons for this apparent decrease in skill.

TABLE 1. EVENTS AND FORECASTS

YEAR	95	96
OBSERVED EVENTS	11	5
BULLETINS ISSUED	35	25
WATCHES ISSUED	26	18
SUCCESSES (WATCHES) HITS (WATCHES)	3 3	2 2
FALSE ALARM (WATCHES)	23	16
WARNINGS ISSUED	9	7
SUCCESSES (WARNINGS) HITS (WARNINGS)	2 5	1 1
FALSE ALARM (WARNINGS)	7	6
MISSED EVENTS	3	2

TABLE 2. OVERALL VERIFICATION (WATCHES AND WARNINGS)

YEAR	95	96
POD	73%	60%
FAR	86%	88%
NPFD	44%	36%

TABLE 3. VERIFICATION OF WATCHES

YEAR	95	96
POD	27%	40%
FAR	88%	89%
NPFD	20%	26%

TABLE 4. VERIFICATION OF WARNINGS

YEAR	95	96
POD	45%	20%
FAR	78%	86%
NPFD	34%	17%

TABLE 5. YEARLY VERIFICATION SUMMARY.

YEAR	1992	1993	1994	1995	1996	
# OF EVENTS	5	8	9	11	5	
# WATCHES AND WARNINGS ISSUED	11	5	21	35	25	
OVERALL VERIFICATION	POD 60 FAR 73 NPFD 44	43 40 52	33 86 24	73 86 44	60 88 36	
# WATCHES ISSUED	9	5	14	26	18	
WATCH VERIFICATION	POD 60 FAR 67 NPFD 46	43 40 52	33 79 27	27 88 20	40 89 26	
# WARNINGS ISSUED	2	0	7	9	7	
WARNING VERIFICATION	POD 0 FAR 100 NPFD 0	NA NA NA	0 100 0	45 78 34	20 86 17	

SEVERE WEATHER CLIMATOLOGY

In an attempt to establish a better climatology for severe weather in New Brunswick, tables 6 through 9 have been generated for the last 6 years data. While it is a bit premature to draw significant conclusions from this small database, it is a start and will become more representative as additional data is collected in future years.

Table 6 shows the number of severe weather days each month as well as the length of each season. From the data it is apparent that the most active months are June through August. June shows a peak in activity which is attributed to the greater north to south temperature contrasts over the region. Data prior to 1995 showed a secondary peak in August for similar reasons but the last 2 years have been quiet in August and this secondary peak has disappeared.

Over the last 6 years the average date of the first severe weather event was in the first week of June with the last event most likely near the end of August. It is important to note that severe weather can start just about any time in May but mostly likely after the 15th and last through until mid to late September. Severe weather can be expected on average 7 days each year .

TABLE 6. SEVERE WEATHER DAYS

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL	FIRST	LAST	LENGTH
1991	0	0	2	0	2	0	0	4	JUNE 26	AUGUST 18	54
1992	0	1	1	1	1	0	0	4	MAY 21	AUGUST 31	113
1993	0	0	3	1	3	0	0	8	JUNE 16	AUGUST 28	74
1994	0	0	3	3	2	1	0	9	JUNE 17	SEPT 17	93
1995	0	3	3	4	0	1	0	11	MAY 27	SEPT 7	104
1996	0	1	4	0	0	0	0	5	MAY 23	JUNE 15	24
AVG	0	.83	2.67	1.50	1.33	.33	0	6.83	JUNE 6	AUGUST 20	77

Table 7 shows the occurrence of severe weather by 3 hour time period. Severe Weather is quite unlikely before noon and after midnight. Peak hours for severe weather are between 3:00 pm and 9:00 pm. Over the last 6 years 85 percent of the severe weather events took place during this time period.

TABLE 7. SEVERE WEATHER BY TIME PERIOD

ADT	1991	1992	1993	1994	1995	1996	YEARLY AVERAGE	TOTAL	% OF TOTAL
9 AM TO NOON	0	0	0	0	0	0	0	0	0
NOON TO 3PM	0	1	0	2	1	1	.83	5	11
3PM TO 6PM	4	3	2	3	6	3	3.5	21	47
6PM TO 9PM	1	1	6	4	4	1	2.8	17	38
9PM TO 12AM	2	0	0	0	0	0	.33	2	4
12 AM TO 9 AM	0	0	0	0	0	0	0	0	0
TOTAL	7	5	8	9	11	5		45	100

Table 8 shows the frequency of severe weather in each public forecast region. Based on a rather small number of events since 1991, it suggests that the occurrence of severe weather is spread relatively evenly across the province with the exception of a few regions. Regions 5, 15 and 17 show a higher percentage than average. Regions 5 and 15 are most active at 20% and 18% respectively, about twice as much as region 17 which has the third highest frequency. The higher frequencies over these regions are most likely due to a couple of factors. All are well inland and therefore have a more continental climate with higher temperatures. In addition increased surface convergence and upslope effects resulting from the more hilly terrain is another likely cause.

A public forecast region map can be found in Appendix A.

TABLE 8. DISTRIBUTION FREQUENCY OF SEVERE WEATHER BY FORECAST REGION (1991-1996)

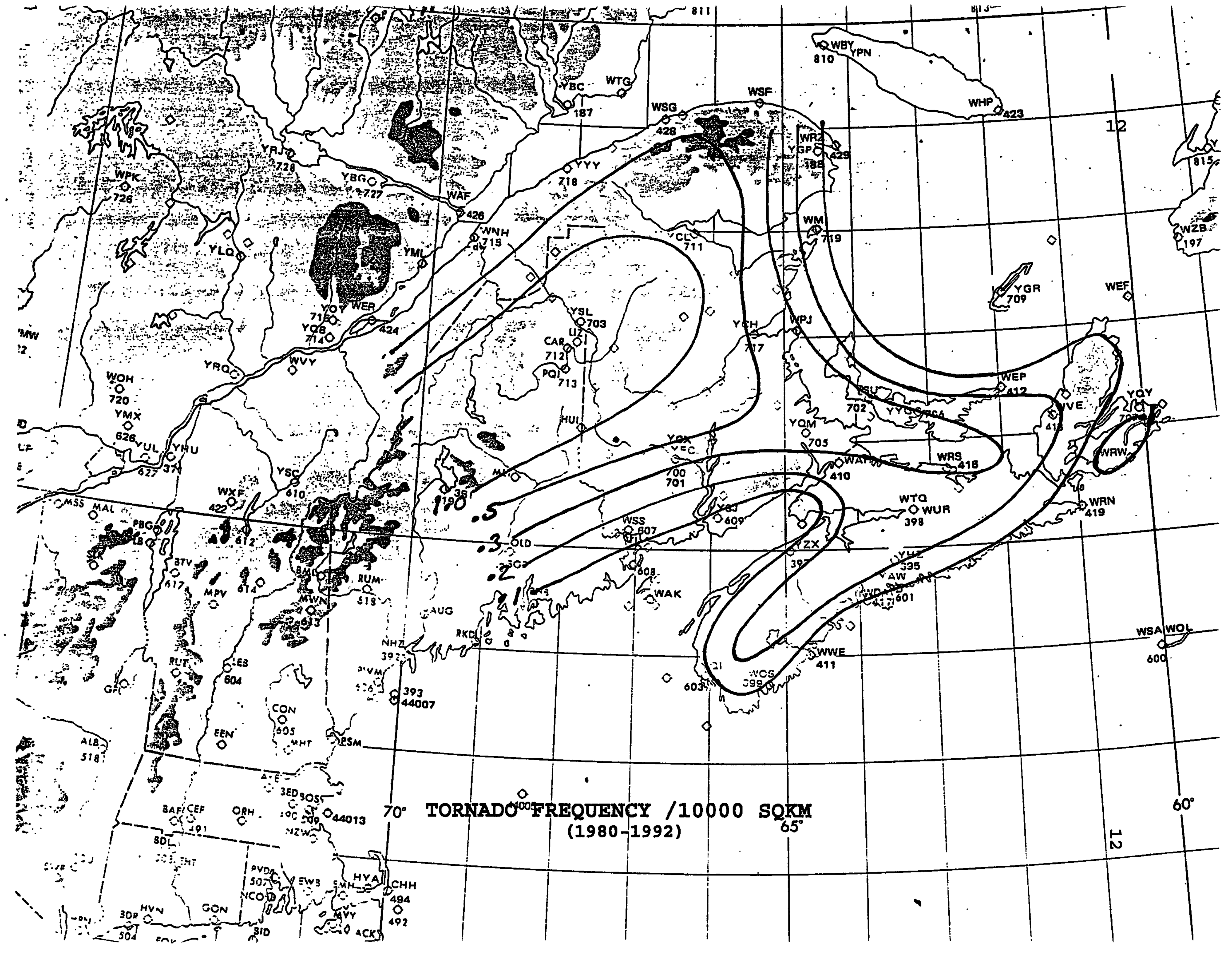
FORECAST REGION	TOTAL # OF EVENTS	FORECAST REGION	TOTAL # OF EVENTS
Saint John and County (1)	2 4%	Kouchibouguac National Park (11)	0 0%
Sussex Kennebecasis Valley and Kings County (2)	2 4%	Stanley Doaktown Blackville Area (12)	1 2%
St. Stephen and Northern Charlotte County (3)	3 7%	Woodstock and Carleton County (13)	3 7%
Grand Manan and Coastal Charlotte County (4)	1 2%	Miramichi and Area (14)	2 4%
Fredericton and Southern York County (5)	9 20%	Grandfalls and Victoria County (15)	8 18%
Oromocto and Sunbury County (6)	1 2%	Mt. Carlton Renous Highway (16)	0 0%
Grand Lake and Queens County (7)	0 0%	Edmundston and Madawaska County (17)	4 9%
Moncton and Southeast New Brunswick (8)	2 4%	Cambelton and Restigouche County (18)	3 7%
Fundy National Park (9)	0 0%	Bathurst and Chaleur Region (19)	1 2%
Kent County (10)	2 4%	Acadian Peninsula (20)	1 2%

Table 9 shows the frequency of severe weather by type since 1991. The most common type of severe weather is damaging winds and heavy rain with an average of 2.5 and 2.7 events per year respectively. On average 1.3 tornadoes occurred each year. This is near normal based on the long term average data collected between 1980 and 1992 . It is likely that tornadoes are somewhat more common than our long term averages indicate however.

TABLE 9. SEVERE WEATHER FREQUENCY BY TYPE (1991-1996)

TYPE	1991	1992	1993	1994	1995	1996	YEARLY AVERAGE
WIND	2	3	1	5	4	0	2.5
HAIL	4	0	0	0	2	2	1.3
RAIN	1	1	6	2	3	2	2.5
TORNADO	0	1	2	2	2	1	1.3
TOTAL	7	5	8	9	11	5	7.6

A tornado frequency map based on data from 1980-1992 is included on the following page. This map is a portion of a national map which was produced during the Summer Severe Weather Workshop held in Edmonton in 1995. It shows that the highest frequency of tornadoes for the Maritimes is in the northwest corner of New Brunswick where on average one tornado can be expected every year.



TORNADO FREQUENCY /10000 SQKM
(1980-1992)

FUTURE WORK

In the coming months several new projects are planned to enhance the severe weather program.

1) An in house severe weather training seminar will be presented prior to the 1997 severe weather season. This will include some material on Doppler radar interpretation.

2) There is a possibility that one or two staff members will be able to attend the COMET severe weather forecasting course in Boulder Co. for 3 weeks this summer.

3) A severe weather assessment decision tree using HTML hypertext links on the HP9000 will be ready for 1997 severe weather season.

4) The Radar Decision Support System (RDSS) will be up and running for the 1997 season.

5) A new version of WADS with enhance severe weather capability is expected to be available this summer.

6) The national lightening detection network should become available sometime in 1998.

7) Gradual expansion of CANWARN and the Severe Weather Watcher Network will continue.

SUMMARY AND CONCLUSIONS

1995 and 1996 were the second and third summer severe weather seasons for the New Brunswick WSO. 1995 was a relatively active season with 11 severe weather events. One confirmed F0 or F1 tornado caused considerable damage in the Fredericton area. In contrast the 1996 season was quiet with only 5 severe weather events and was the shortest on record lasting only 24 days.

The CANWARN network which utilizes HAM Radio operators to spot severe weather continued to operate and grow and supplement the severe weather watcher network. Over the last few years it has attained nearly complete coverage of the southern half of the province. It is expected that slow expansion of the network will continue. A new Doppler Radar was installed in Hodgdon Maine and is available operationally in the WSO.

There have been some changes to the way in which verification statistics are calculated. These changes have some impact on the verification data making it difficult to compare results to previous years. These changes have come about to standardize verification practices across the country.

Overall verification of POD scores showed a significant improvement over the 93 and 94 seasons. This means we are missing less events.

Overall verification of NPFD scores remains relatively low and is due mainly to the fact that we continue to have a high FAR. Further training, tools and skill development is needed to allow us to better define those areas at risk and minimize the size of the threat area so that we will be less likely to over warn for severe weather. In addition it is recommended that an extra forecaster be called in when severe weather is likely so that a more rigorous assessment of the situation can be made. This was tried a couple of times last summer and worked well.

Some work has been done to establish a climatology for severe weather in New Brunswick. It is expected that the climatological statistics generated in tables 6 through 9 and the yearly tornado frequency map will be of assistance to forecasters.

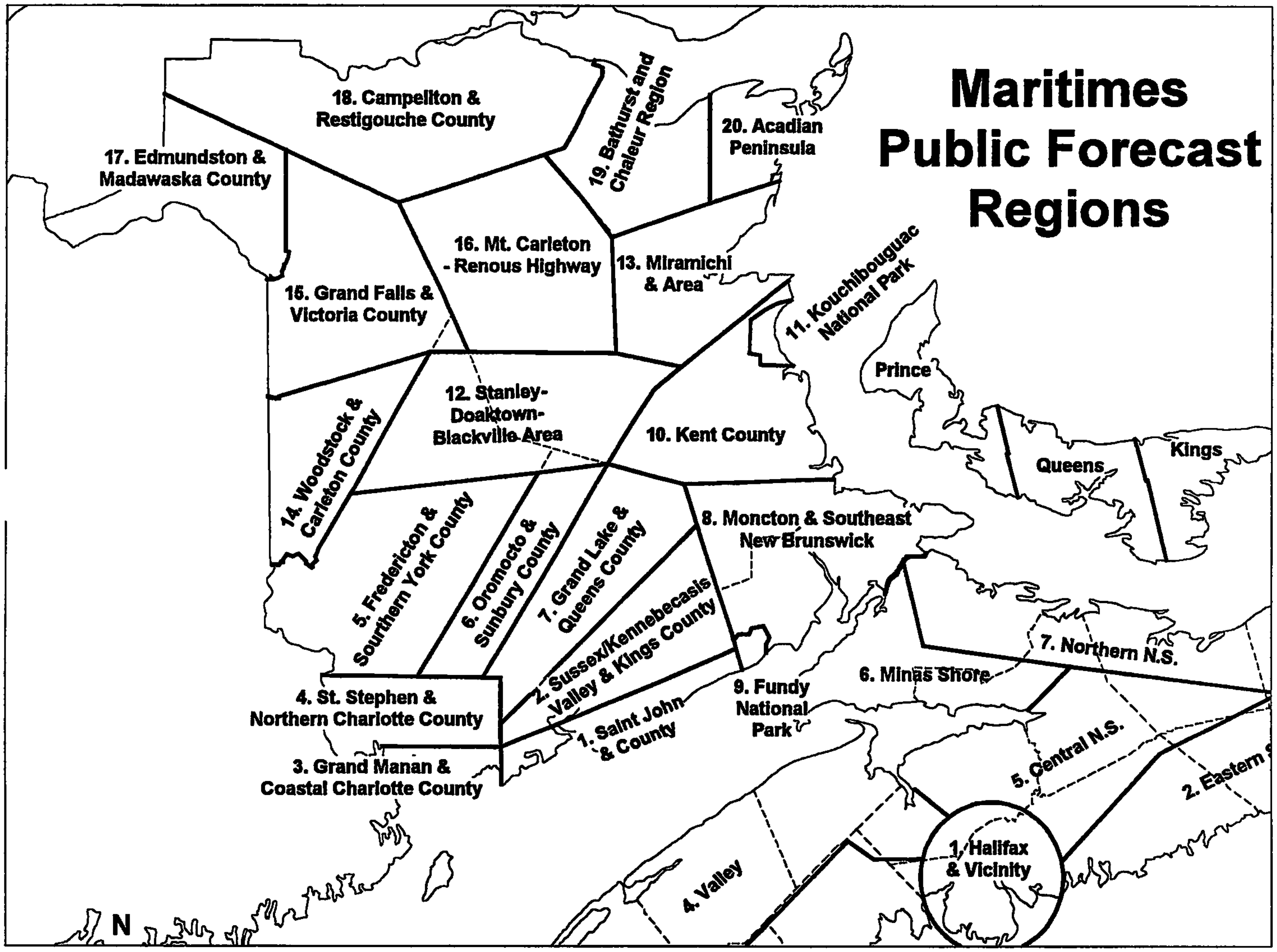
Many improvements to the severe weather program are expected to take place over the next year. A spring training seminar is planned for all staff. There is a possibility one or two staff members will attend the COMET Severe Weather Forecasting Course in Boulder Colorado late this summer. A new computer based severe weather assessment decision tree will be available for this spring. RDSS (Radar Decision Support System) will be up and running. It is hoped that a new version of WADS with enhanced severe weather capability will also be available this summer. On going recruitment of severe weather watchers will continue.

APPENDIX A

DETAILED SUMMARY OF SEVERE WEATHER EVENTS (1995 AND 1996)

DATE 1995	LOCATION	CAUSE	DAMAGE REPORTED
May 27 4:15 pm	Saint John	hail	-1/2 inch hail -no damage reported
June 2 afternoon	Saint Anne de Madawaska	rain	-20 mm of rain lasting 15 minutes caused some local flooding and washed away some potato crops.
June 19 8:40 pm	St. Andrews	wind	-some heavy rain accompanied the strong winds which uprooted trees and caused some damage to buildings and knocked out power.
June 25 4:50 pm	St. Jacques	rain	-35 mm in 15 minutes caused some flooding.
July 14 12:30 pm	St. Stephen	rain	-20 mm in 15 minutes caused some flooding
July 26 4:45 pm	Fredericton area	wind	-trees uprooted
July 26 5:30 pm	Fredericton area	tornado	-inflatable roof torn from tennis complex -damage to vehicles from debris -power poles down
July 26 6:10 pm	Fredericton area	wind possible tornado	-roof torn from building -trees uprooted -funnel cloud spotted
July 26 8:30-9:00pm	Keswick Ridge	possible tornado	-trees uprooted -roof torn from building -funnel cloud spotted moving away from area
August 29 7:00 pm	Upper Kent	hail	-grape size hail and heavy rain -no damage reported
Sept 7 3:30 pm	Hampton	wind	-wind gusts estimated at 95 km/h -large branches broken from trees

DATE 1996	LOCATION	CAUSE	EVENT DESCRIPTION
May 23 1:30-3:30 pm	Albert County	Tornadic water spout and large hail	-tornadic waterspout over Bay of Fundy moved onshore -accompanied by golf ball size hail -no damage reported
June 12 afternoon	Grandfalls	heavy rain	-1 to 3 inches of rain fell in a short period of time -no damage reported
June 13 7:15 pm	Cocagne	large hail	-golf ball size hail reported caused some damage to a building
June 14 4:15-5:30 pm	St. Stephen area	heavy rain	-2.2 inches of rain fell in about 1 hour -no damage reported
June 15 5:25 pm	Temperancevale	large hail	-15-20 mm hail -no damage reported


Maritimes
Public Forecast
Regions
18. Campbellton &
Restigouche County
19. Bathurst and
Chaleur Region
20. Acadian
Peninsula
17. Edmundston &
Madawaska County
16. Mt. Carleton
- Renous Highway
13. Miramichi
& Area
11. Kouchibouguac
National Park
15. Grand Falls &
Victoria County
Prince
12. Stanley-
Doaktown-
Blackville Area
10. Kent County
Queens
Kings
14. Woodstock &
Carleton County
5. Fredericton &
Southern York County
6. Oromocto &
Sunbury County
7. Grand Lake &
Queens County
8. Moncton & Southeast
New Brunswick
2. Sussex/Kennebecasis
Valley & Kings County
7. Northern N.S.
6. Minas Shore
9. Fundy
National
Park
4. St. Stephen &
Northern Charlotte County
1. Saint John
& County
5. Central N.S.
3. Grand Manan &
Coastal Charlotte County
2. Eastern
1. Halifax
& Vicinity
4. Valley
N