Four Seasons of Damaging Storms in Canada

Outline

- The Weather Patterns Associated With Storms

  Rain Wind Hail

  Snow Ice
- The Scales of Damage With These Patterns
- The Effect of Global Warming on these Patterns- some surprises here
- Day to Day Forecasts- some patterns are easier to Forecast than others.

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Scales

- A “big” tornado is typical a few hundred metres wide tens of kilometers long.
  - -Damaged area less than 10 square kilometers

- The ice storm of 98 affected 100,000(?) square kilometers.

The Catastrophes by Weather Type

- Rain Wind Hail Snow and Ice
- Several different weather patterns can produce damaging wind (or one of the other elements).
- Some patterns are more easy to forecast
- Global warming will make some but not all more likely in Canada

Flooding Rains

Large Weather Systems

- Saugenay: A large synoptic storms
  - Meteorology has a fairly good handle on when large synoptic storms are going to produce rain above our warning thresholds (usually 50 or 75 mm). Not a good understanding of when disastrous rains (200 mm plus?) are going to occur.

- A storm of mid winter in mid summer.
- Rather surprising.

Hazel

- A weakening hurricane that got caught up in a developing fall storm. The 2 have to phase just right.
- 250 mm rain over a fairly wide area Probably a very rare event.
- We know what to look for now .
- Hugo 1990 came close- track similar to Hazel. Just failed to phase with front.


1603302
1600302
1600302
1518302
1512302
1509302

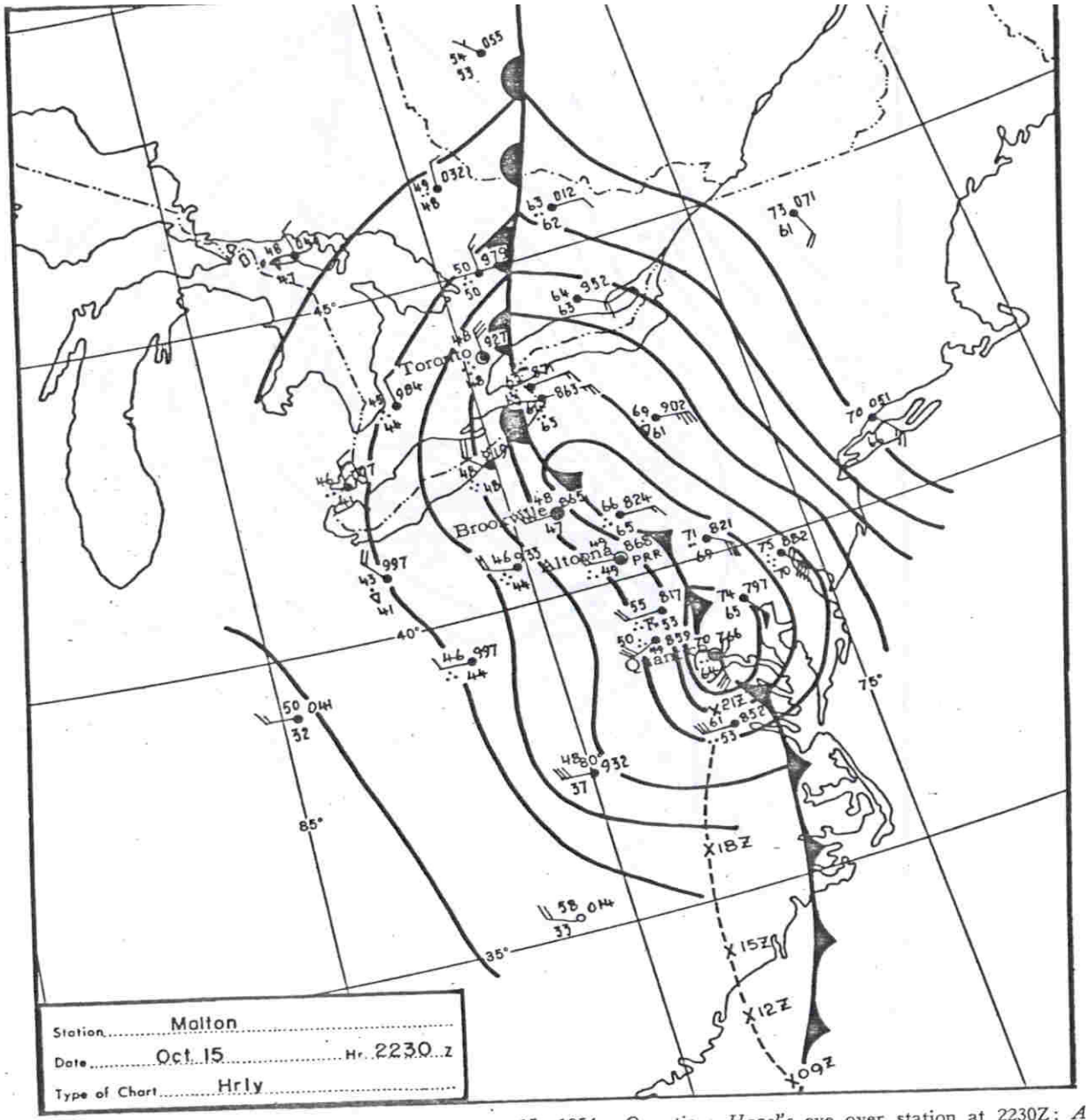


FIG. 7. Hourly surface map 2230 GMT, October 15, 1954. *Quantico: Hazel's* eye over station at 2230Z; *A toona:* Pressure rising rapidly and windshift from ESE 18 + 28 at 2130Z to 16 + 26 at 2230Z, windshift at 2139Z *Brookville:* 2030Z 865/63 ENE 15, 2130Z 837/63 NW 30, 2230Z 865/48 W 30 + 38.

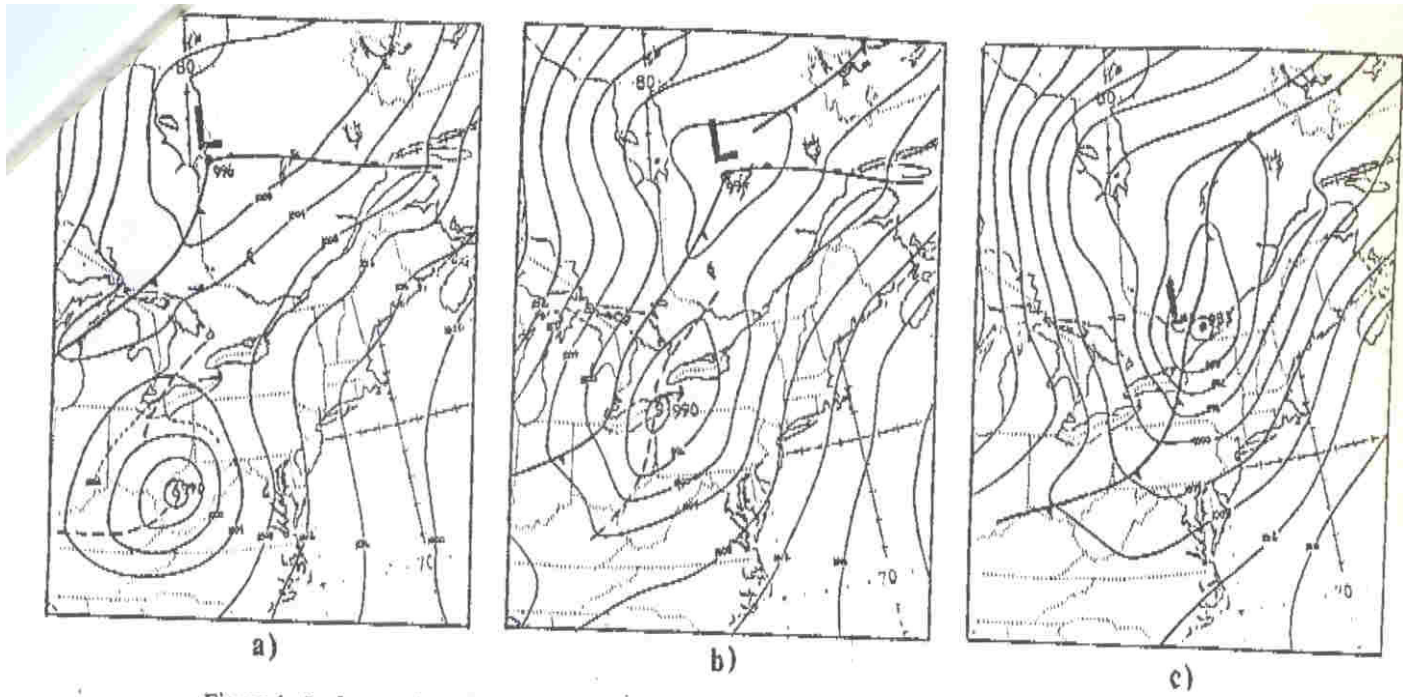


Figure 1: Surface analyses for a) 1800 UTC 22 Sept, b) 0000 UTC 23 Sept and c) 0600 UTC 23 Sept 1989

Great Lakes “Dying Hurricanes”

- One every couple of years.
- Formula for rainfall from these storms if no interaction with other features

  Rainfall in inches= 100/storm speed in knots
- Fortunately most of these storms travel at 30 or 40 knots by the time they reach Great Lakes

Odds of Hazel Again

- Historically stalling storms more likely further south Ohio Pennsylvania due weak upper flow. Topography (watersheds) has had effect there.
- Global warming means weaker upper flow could push further north.

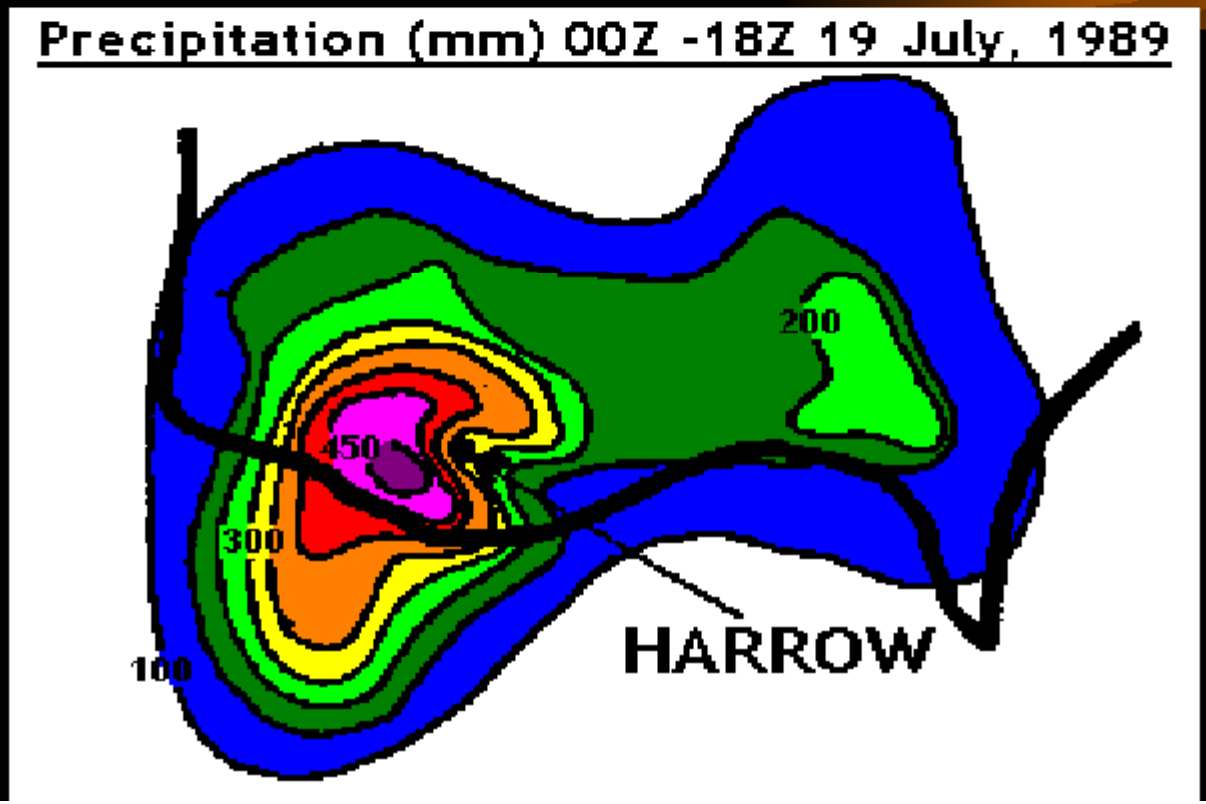
Could we forecast Hazel 2

- Since 1990 Better understanding that interaction caused problems
- Southern Ontario much better prepared...Conservation Authorities

Stalled Lows Interact with Great Lakes

- Late summer warm waters of Erie
- Harrow 1991-450 mm of rain, much smaller area than was affected by Hazel. Flat terrain.
- Not as likely near other lakes which are much colder.

Total Precipitation for "The Harrow Event"



Clusters of Thunderstorms

- One storm right after another.
- Ontario -several significant events summer 2000
  - Walkerton 100 mm
  - several other areas 150-200 mm in a few hours
  - Area affected by heaviest rains maybe 100 square kilometers

- Global warming increases the likelihood of these kinds of events.
- Very difficult to forecast more than an hour or two in advance where these localized events are going to occur

Aug 9 2000

Up to 100 mm rain from thunderstorms

Winds

From Microbursts to Derechos to
Fall/Winter Storms to Hurricanes

Hurricane Rain/Winds/Surges

- In Canada winds/rains/Waves seldom exceed intensity and aerial damage caused by intense low pressure areas.
- Storm Surges are probably the bigger threat.
- Hurricanes strongly correlated to La Nina years. Global warming may mean higher ocean temps & more available energy.

Derechos

- Under right conditions ..
  Thunderstorms amalgamate into north-south lines a few hundred km long. Lines move very fast west to east.
- Swaths of 10's of kilometers wide of high winds 150 km/h common.

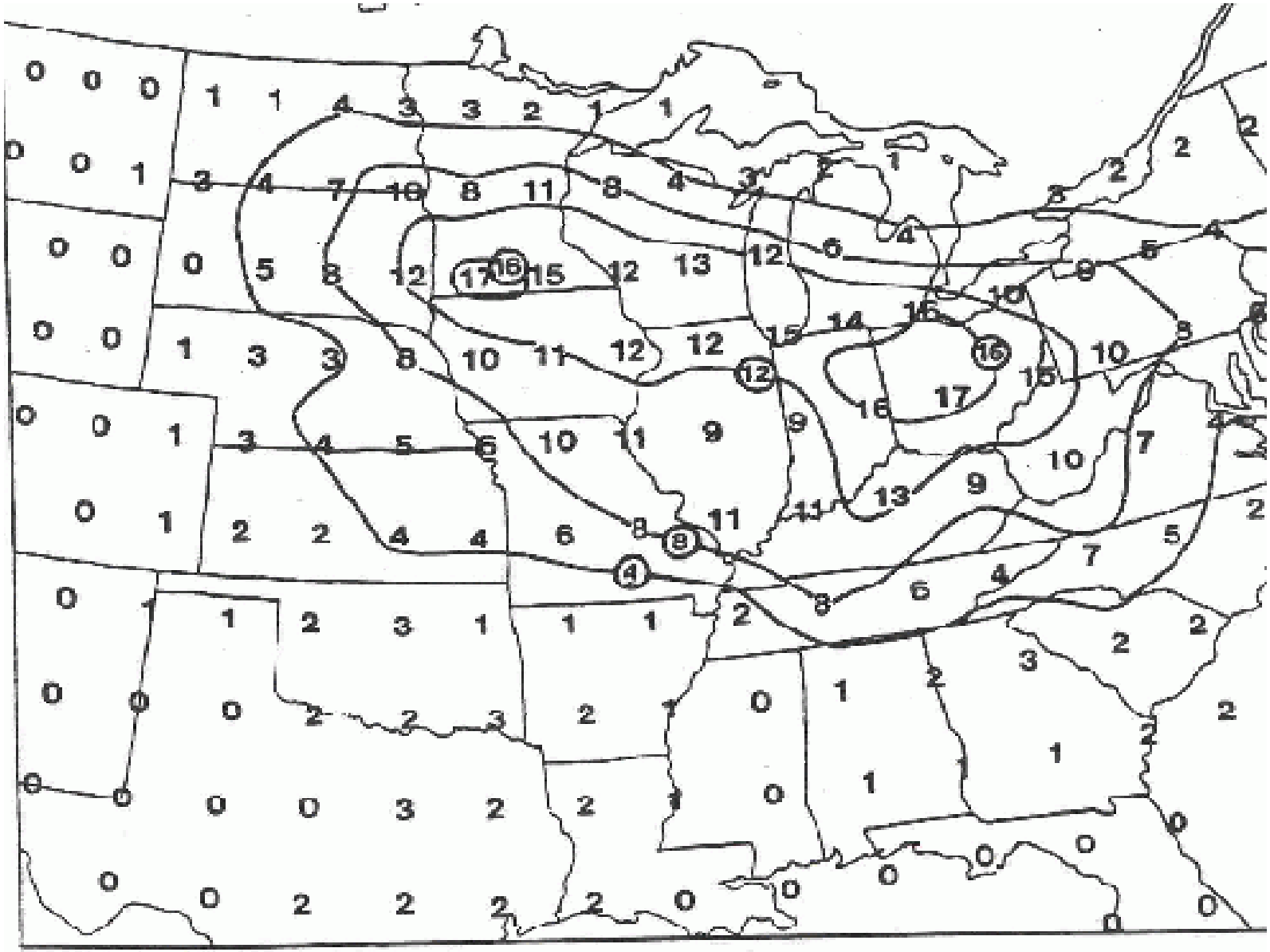


FIG. 2. Total number of derechos occurring in 2° lat by 2° long squares during the months of May through August for the period 1980–1983.

Historical Storms

- ‘70’s Chicago to Detroit $500 million damage
- Evidence 1921 Toronto area extensive damage $$millions
- July 15 1995 Ontario Cottage country
- July 1999 south of Thunder Bay to southern Quebec.

Derechos Heading North

- Increase of frequency in the nineties.
- 1 degree C warming makes southwestern Ontario's temperatures like the core of today's derecho belt.
- These storms are NOT noticeably diminished by surface conditions so cool waters of Great Lakes do not necessarily lower threat.

July 15 1995

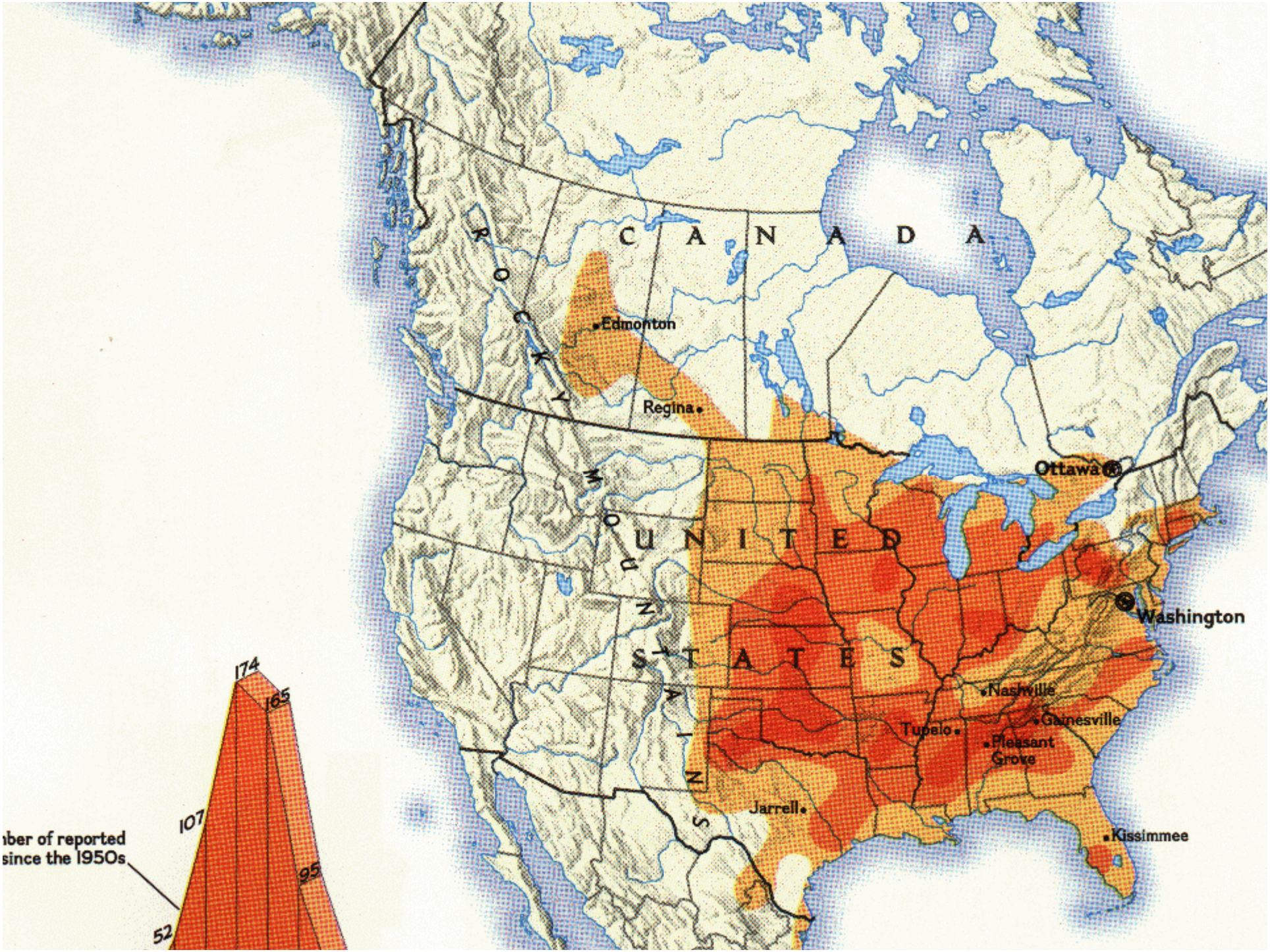
Pakwash Type storms

- 1991 cluster of thunderstorms
  -Swath of Damage 20X 50 km- most trees knocked down.
- Observers reported hurricane winds for 15 minutes.
- Very rare, require very humid air. Great Lakes would diminish likelihood.

Tornadoes

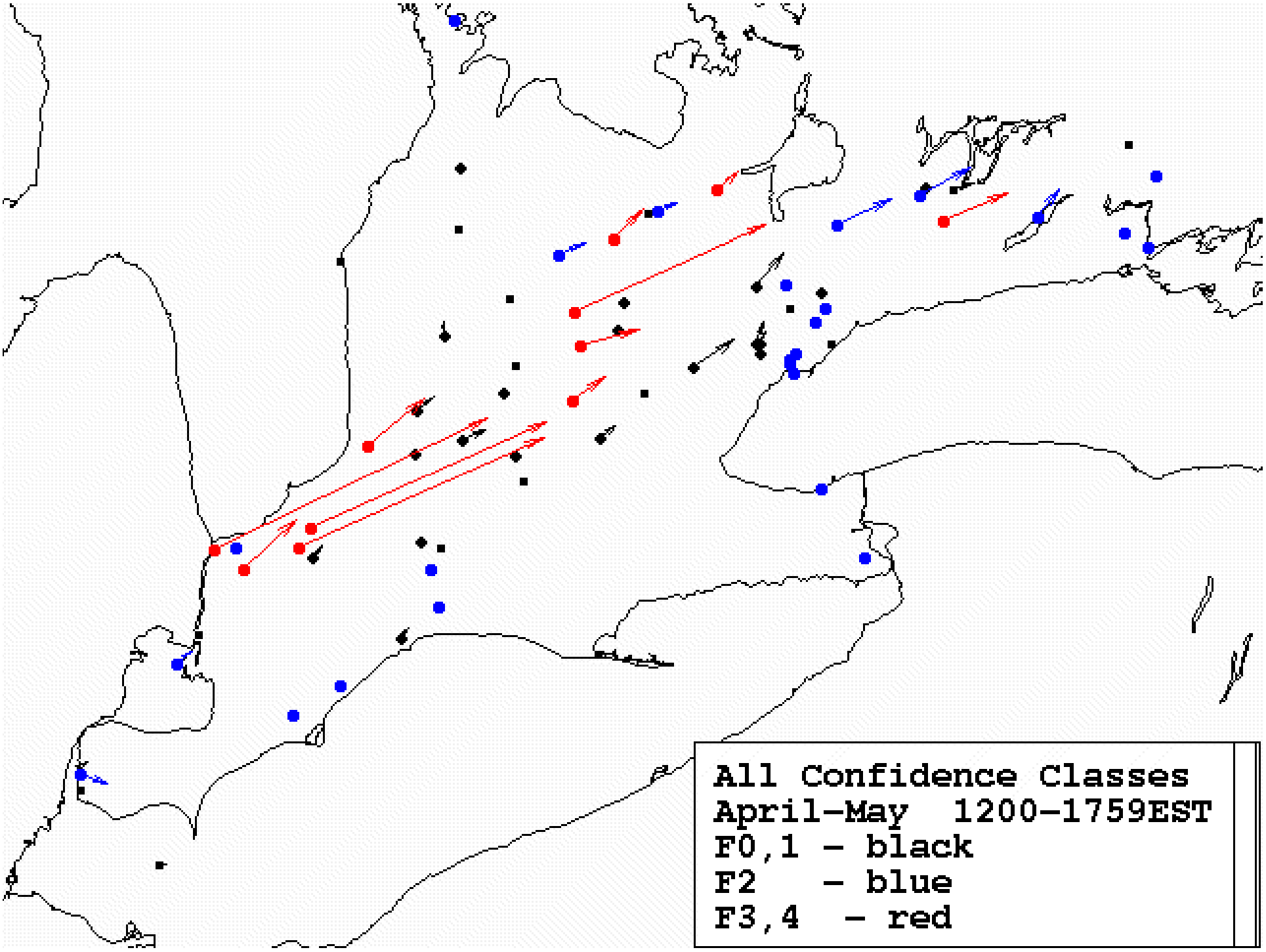
Canadian tornadoes -where and when

- Spring and summer- daytime temps greater than 20C
- 15 per year in Ontario
- 80 per year across country
- 5 % F2 intensity or stronger; 1% F3
- U.S. 800-1000 per year 15% F2


CANADA
ROCKY MOUNTAINS
UNITED STATES
Edmonton
Regina
Ottawa
Washington
Nashville
Gainesville
Tupelo
Pleasant Grove
Jarrell
Kissimmee
174
165
107
95
52
ber of reported
since the 1950s

A Major Disaster- Barrie 1985

- Multiple Outbreak
- 12 deaths $200M
- Total area with significant damage less than 100 square km
- Watches in effect for 10,000 square km
- Risk < 1/100 in worst event


All Confidence Classes
April-May 1200-1759EST
F0,1 - black
F2 - blue
F3,4 - red

2000 storms

- Guelph F2
- Pine Lake Alberta F3 11 dead

Global Warming and Tornadoes

- Highest chance of F3 plus is with active frontal zones spring. (summer in Prairies)
- This zone usually moves north of southern Ontario in the spring.
- More F0-2 storms in summer southern Ontario.
- Mid summer F3/4 are rare but do happen
- Toronto still protected by Lake breezes.
- Could be increase of stronger tornadoes Prairies to central Great Lakes to southern Quebec in summer.

Hail

Hail Risk Areas

- A Feature of Mid Continents
- Ontario Quebec have lower risk of big hailstorms than Prairies
- Air aloft colder out west allows more large stones to form
- Ontario gets 20 reports of 2 cm hail/year
- but only a few reach golf ball size 6cm

- Golf ball size- minimum for property damage
- Ontario big damage crops.
- Only one really disastrous storm Ontario May 30 1985 day before Barrie tornado

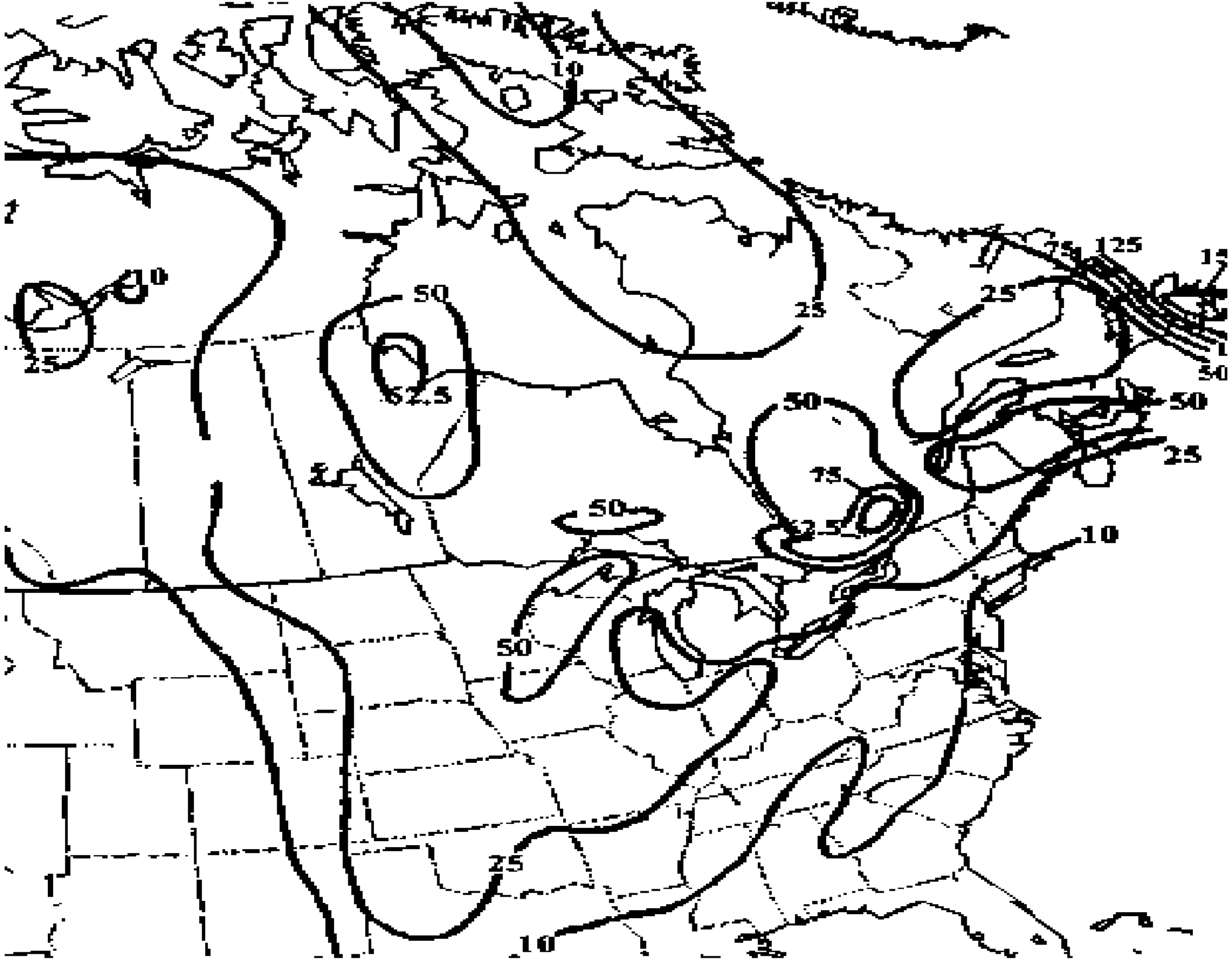
Hail- Forecasting and Climate Change

- Requires large contrast in temperature and humidity between low and high levels.
- Warmer climate does not necessarily increase these differences.
- Forecasting the “big” hailstorms nearly impossible right now.
- Polarized radar will likely allow us to distinguish big hailstorms and perhaps provide 1 hour warning.

Ice Storms

DAV

s in a forested area near Manotick form a seemingly purposeful pattern, demonstrating the immense destructive power of the ice that forced them to the


10
50
25
62.5
50
75
50
10
50
25
10
125
25
50
50
25

Impact of Storm

Duration: 6 days - from January 4th to January 10th
3 distinct precipitation episodes

Hydro:

Québec - 1 393 000 customers
(1 000 towers, 24 000 poles downed)

Ontario - 232 000 customers
(300 towers, 11 000 poles downed)

New Brunswick - 28 000 customers

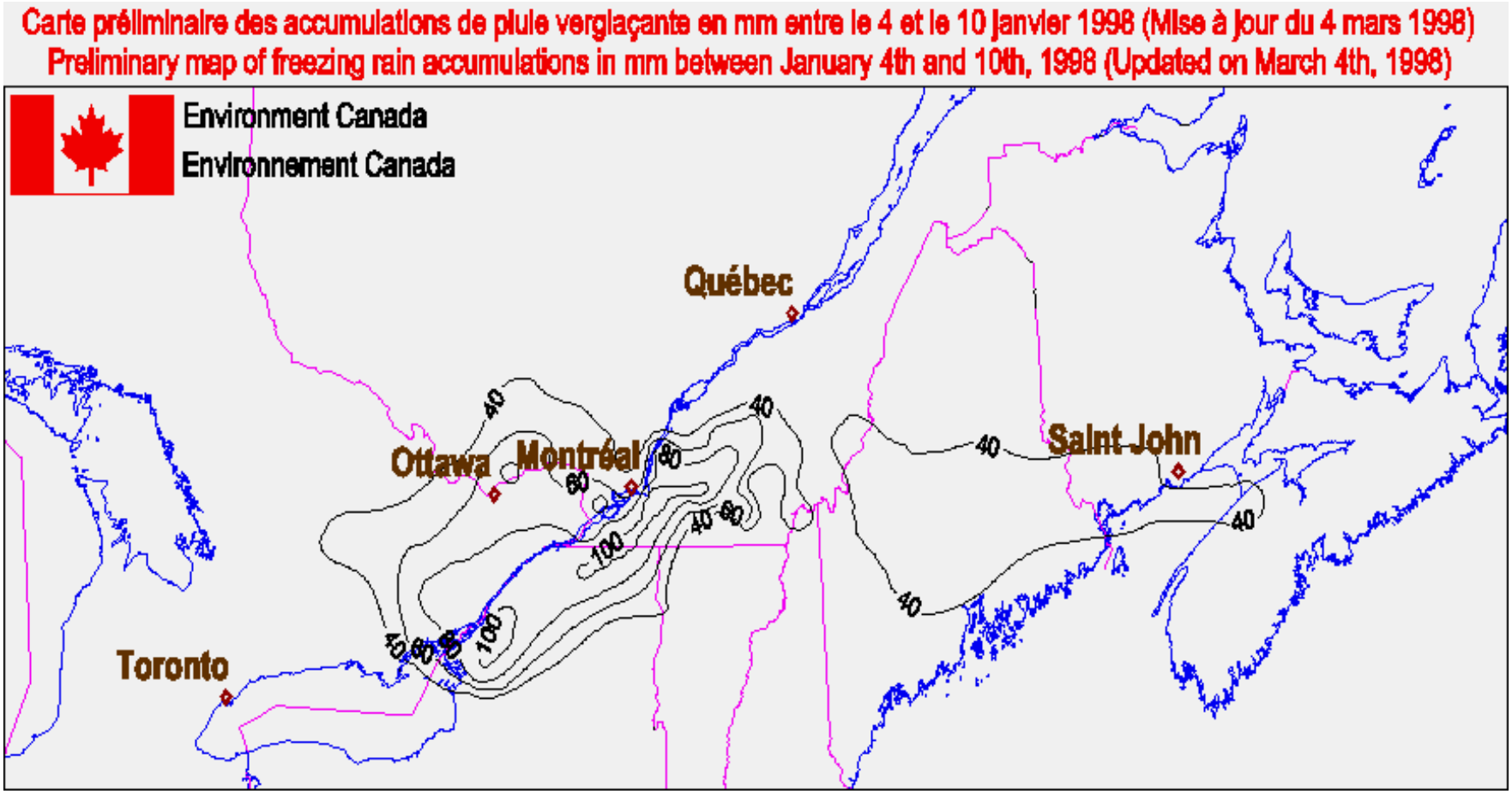
Nova Scotia - 20 000 customers

Deaths: 25 people

Insurance claims: $ 1,130,000,000

Cost: $2,000,000,000 (Québec alone)

Isohyetal Analysis …. Freezing Rain in mm



Climatology of Freezing Rain

- 1998 storm was so huge because pattern remained unchanged for 6 days.
- Global warming winter -
  Air warms up aloft. 16 hours darkness means surface can still cool off. Freezing rain more likely.
  - Split flows seem to produce more freezing rain. More likely for us with El Nino type patterns.

- Areas from Missouri to Ohio Valley
  Historically less hours of freezing rain but more "catastrophic" events
- Global warming may shift this north.

- Patterns for significant freezing rain events fairly obvious. Usually 24 hour lead times.
- Distinguishing catastrophic events may be harder '98 example

Snowstorms

- 40 plus cm snowstorms occur quite regularly throughout all of populated Canada
- Central Canada seems to be getting fewer “small” snowfalls in recent years.

- Patterns locking in like in Toronto January 99 to give 120 cm snow in 10 days may be a feature of the climate change.
- Storm tracks get stuck. This year it's the Maritimes.
- Over 300 cm of snow this season already in St. John's

The Big Storms

- Evidence some types of extreme storms (derechos, 2 cm plus freezing rain storms) could become more frequent.
- Evidence of “locked in” patterns becoming more common- increasing odds of multiple day events.

The Problem for Forecasting

- Extreme Events are Rare.
- How do you forecast something that you might only see twice in your career……

  Even if it increases to 4 times … does that help?