Severe Ice Storm Risks in Ontario

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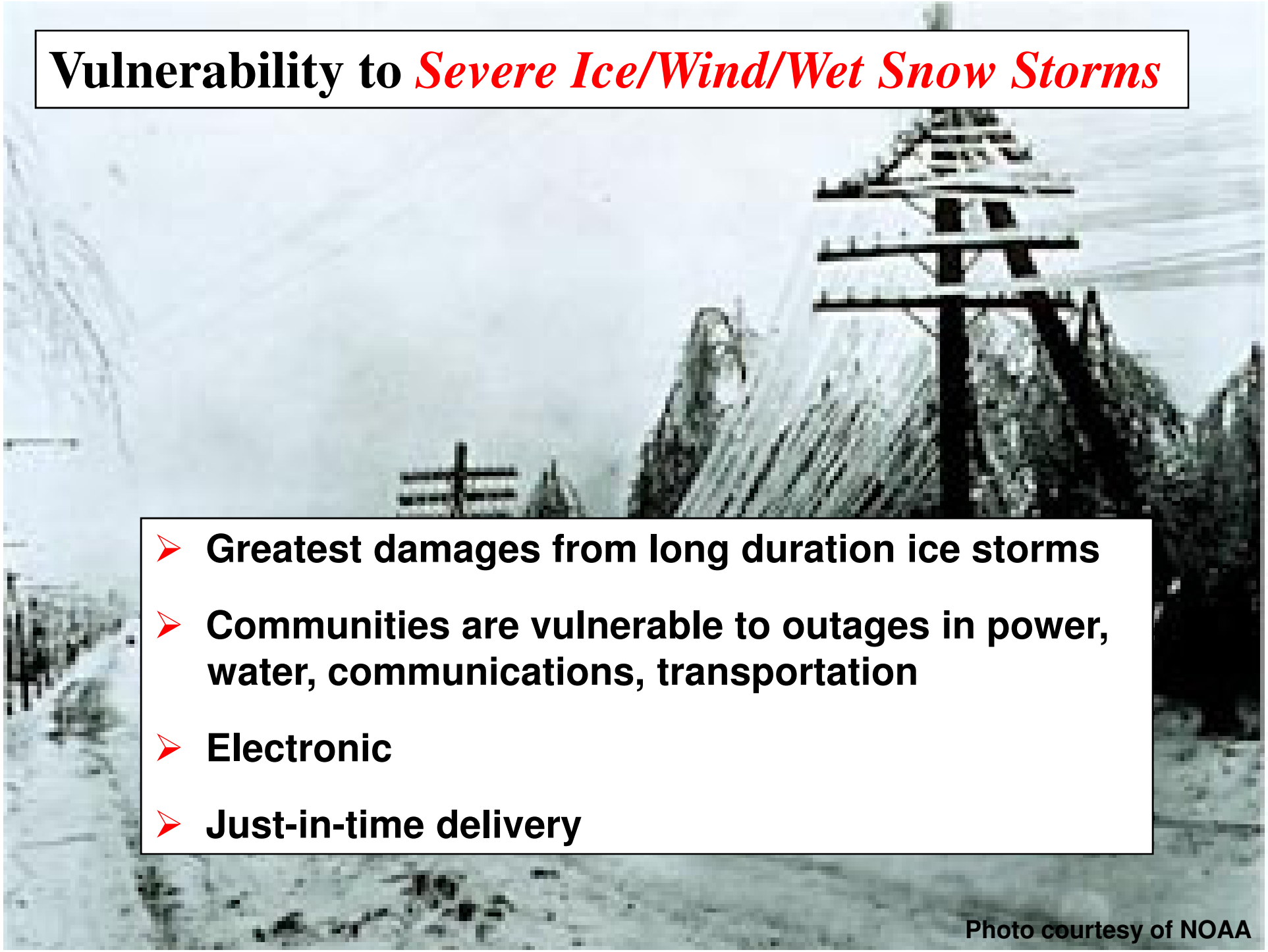
Ice Storm '98

- Canada's most costly ($) weather disaster ever
- 3 main freezing rain episodes during Jan 4-10
- Impacted 4 provinces; 7 states
- Over 1 million households without power
- Collapsed communication towers, electrical transmission/distribution systems, phone lines
- Deaths: 28 in Canada; 19 in U.S.

Vulnerability to *Severe Ice/Wind/Wet Snow Storms*



- Greatest damages from long duration ice storms
- Communities are vulnerable to outages in power, water, communications, transportation
- Electronic
- Just-in-time delivery

Photo courtesy of NOAA

Adapted from:
Jones, Mulherin
1998

Damage to Trees and Structures (in order of increasing ice load)

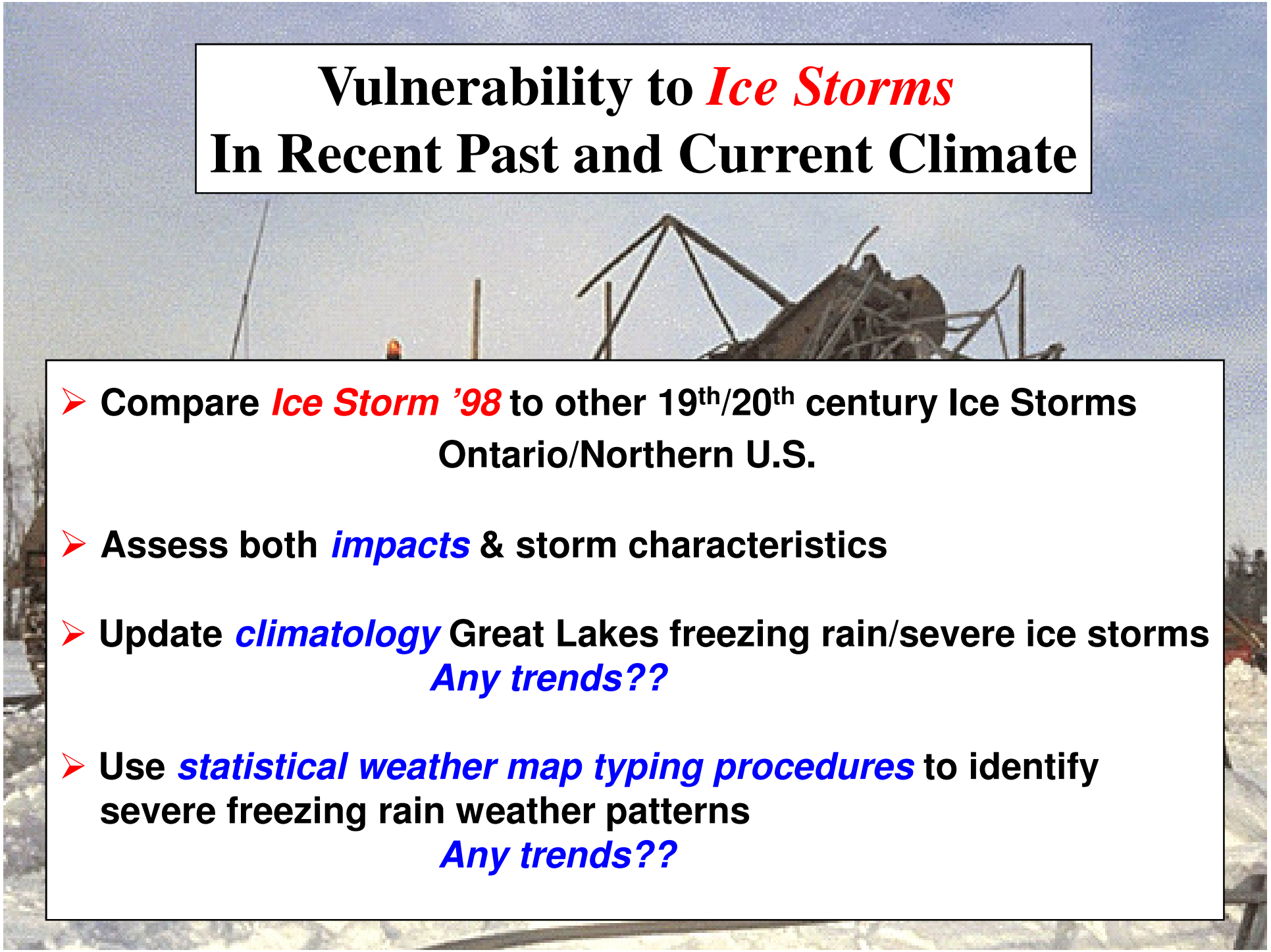
- Slippery ROADS
- Ice on trees shining in the sun
- OUTAGES in communications/ power distribution, transmission – TREES
- Bending birch trees
- Broken branches on brittle, injured trees
- OUTAGES transmission lines, galloping
- Broken branches – DECIDUOUS trees
- OUTAGES distribution – *NOT* by trees
- Broken branches – EVERGREEN trees
- OUTAGES transmission – *NOT* by trees
- COMMUNICATION TOWER failures

Freezing rain severity

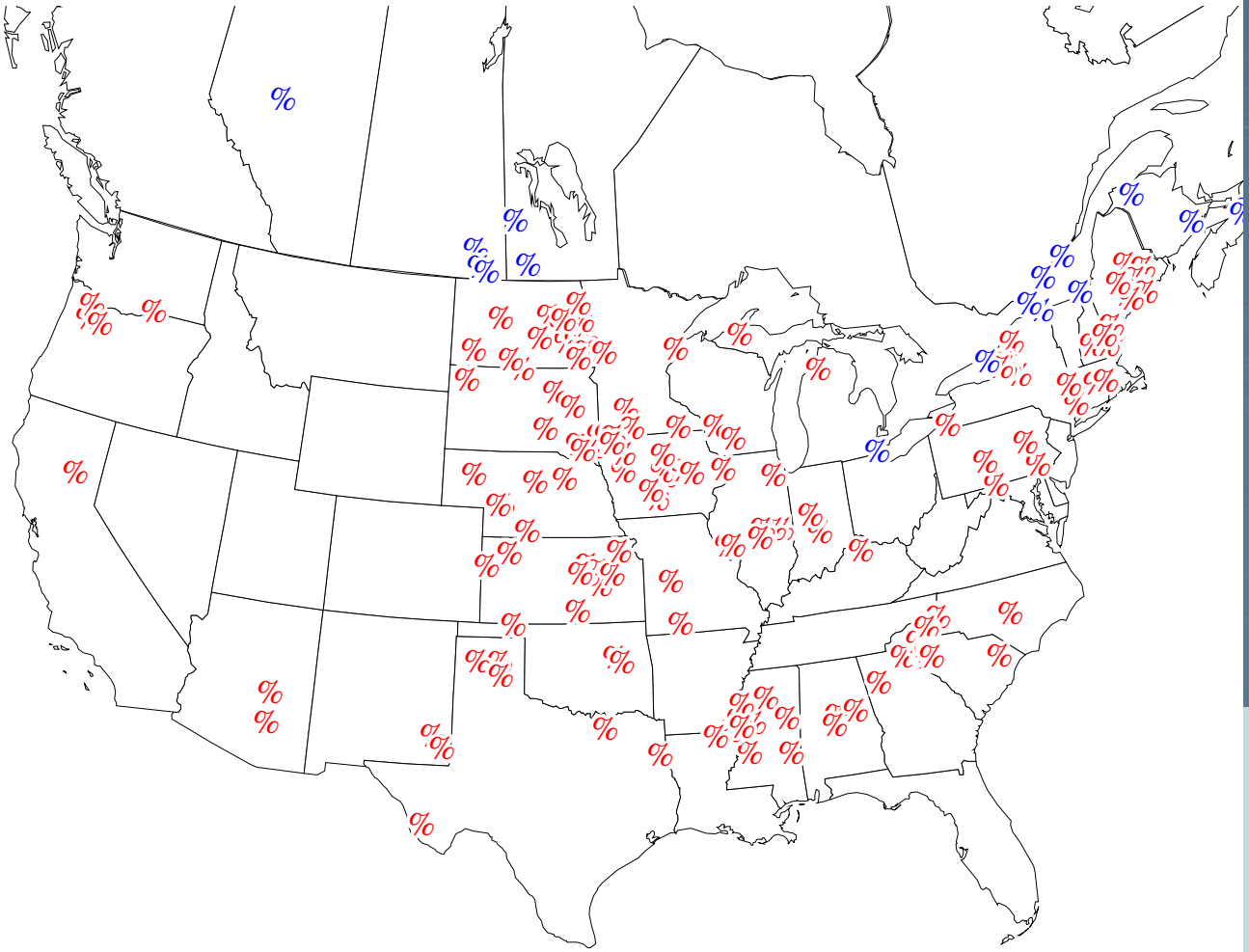
Hazardous freezing rain episode

Most SEVERE ICE STORM

Vulnerability to *Ice Storms* In Recent Past and Current Climate



- Compare ***Ice Storm '98*** to other 19th/20th century Ice Storms Ontario/Northern U.S.
- Assess both ***impacts*** & storm characteristics
- Update ***climatology*** Great Lakes freezing rain/severe ice storms
  Any trends??
- Use ***statistical weather map typing procedures*** to identify severe freezing rain weather patterns
  Any trends??



Icing Related Communication Tower Collapses

% Canadian Tower Locations

% U.S. Tower Locations

CRREL Database

205 U.S. Towers
1929-March 2002

26 Cdn Towers
1958-2002

Ice Storm ’98:
4 Montreal +
1 Kingston

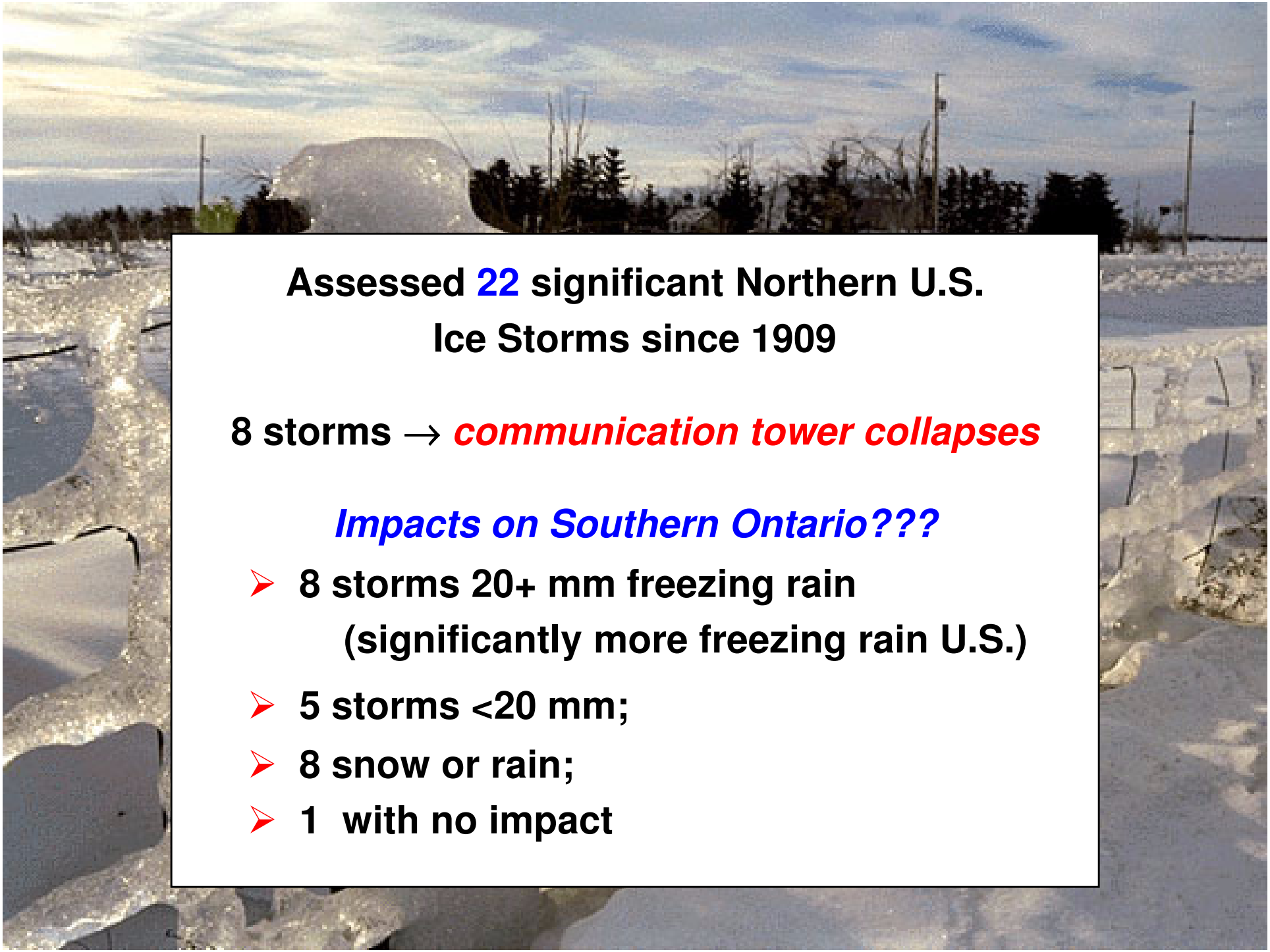
Comparing *Ice Storm '98* to Historical Ice Storms in Ontario/Northern U.S.

- Identified 24 significant Southern/Eastern Ontario Ice Storms since mid-1800s + Ice Storm '98
- 22 Northern U.S. Ice Storms also selected from 20th century

Ice Storm '98 was Ontario Ice Storm of:

- ✓ **Greatest Duration**
- ✓ **Areal Extent**
- ✓ **Ice Accumulation**
- ✓ **Impacts (and hydro downtime)**

	Ice Storm '98	**24 Ice Storms *(Ontario: 1844-2002)***
Duration	6 days (3 separate "events")	12 hrs – 4 days
Areal Extent	110,000 km^2	4,000 - 80,000 km^2
Ice Accumulation	95 mm	30 to 70-80 mm
Maximum Hydro Downtime	3 ½ weeks	<1 day to 2 weeks



Assessed 22 significant Northern U.S. Ice Storms since 1909

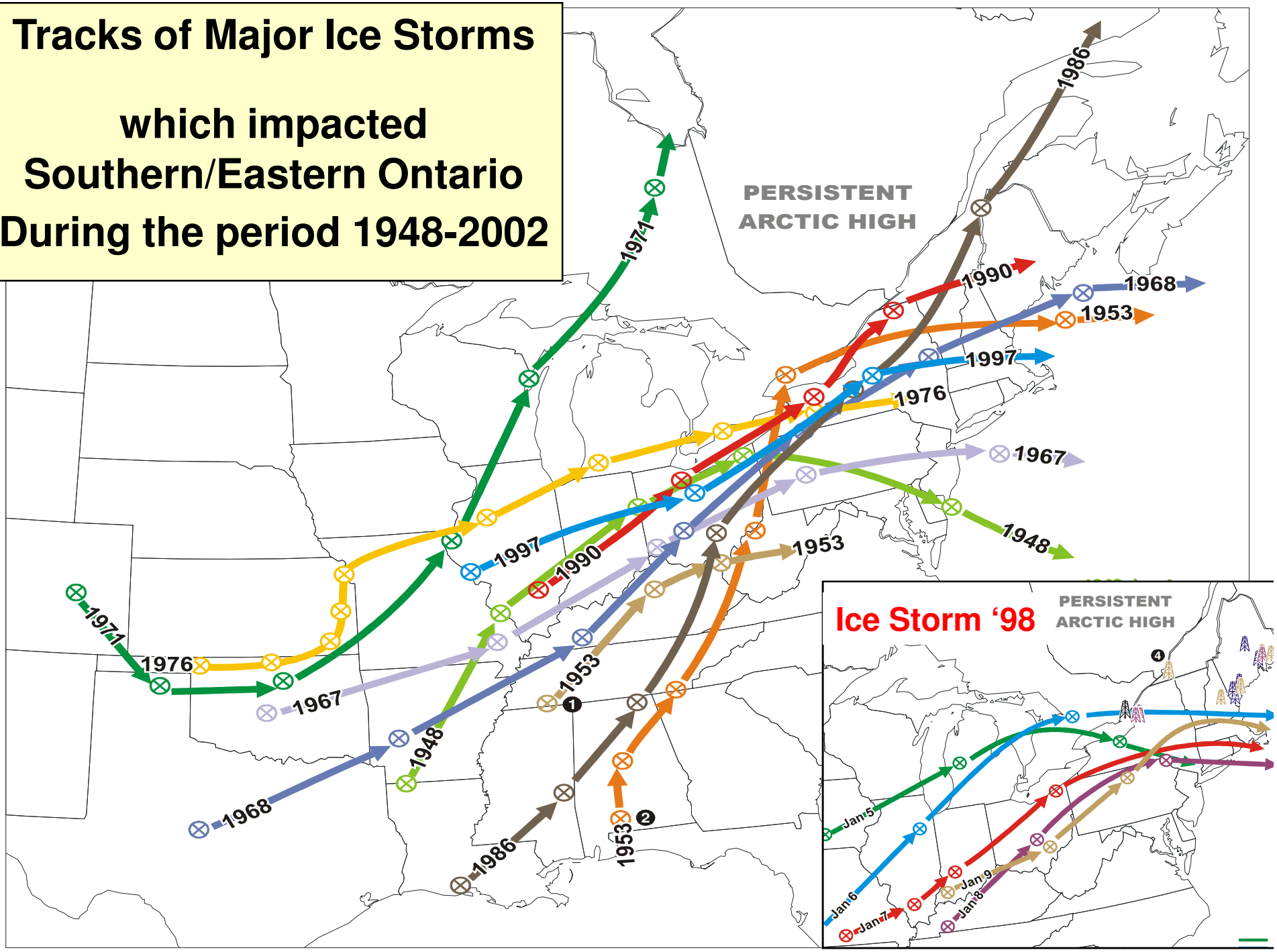
8 storms → *communication tower collapses*

Impacts on Southern Ontario???

- **8 storms 20+ mm freezing rain**
  (significantly more freezing rain U.S.)
- **5 storms <20 mm;**
- **8 snow or rain;**
- **1 with no impact**

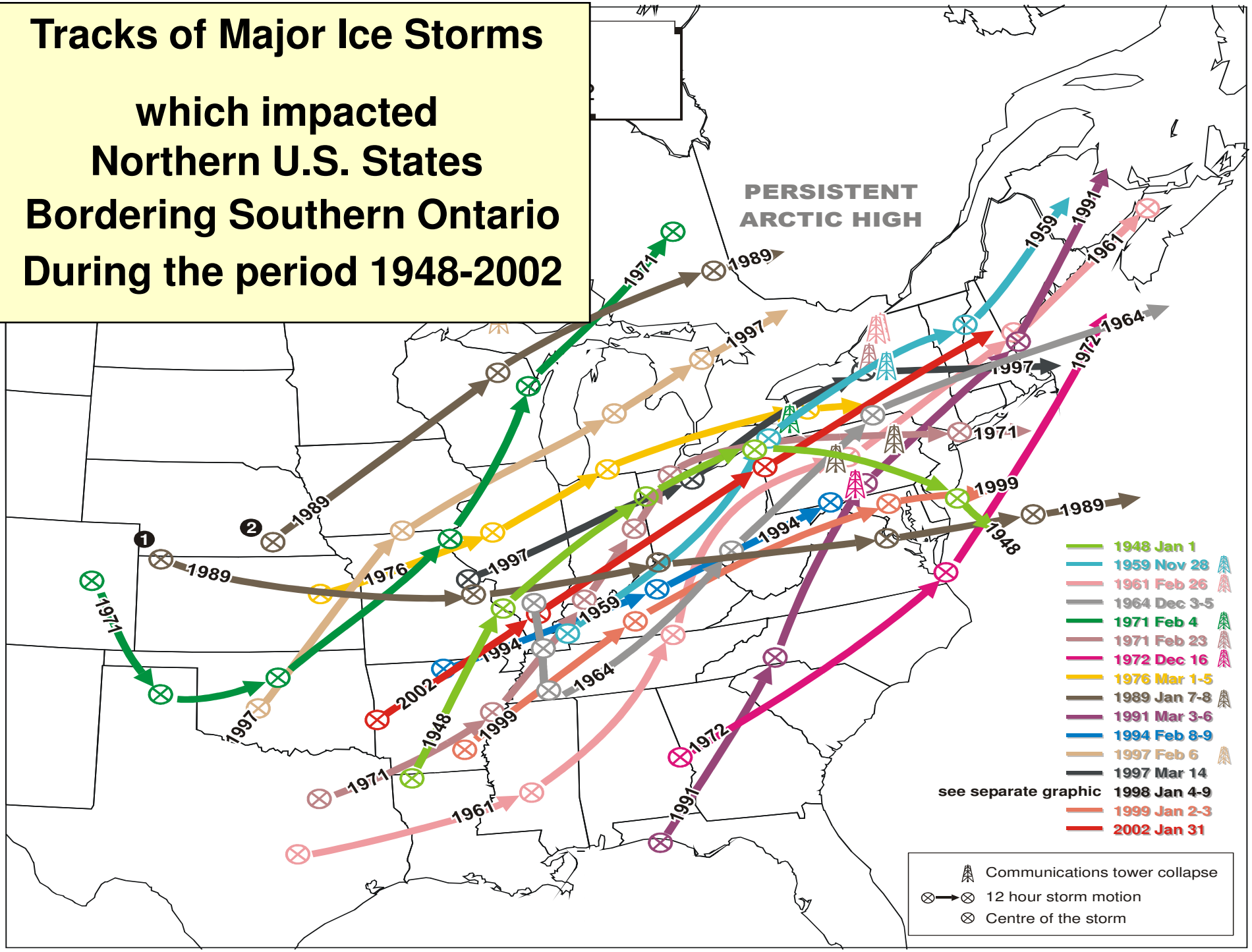
Tracks of Major Ice Storms

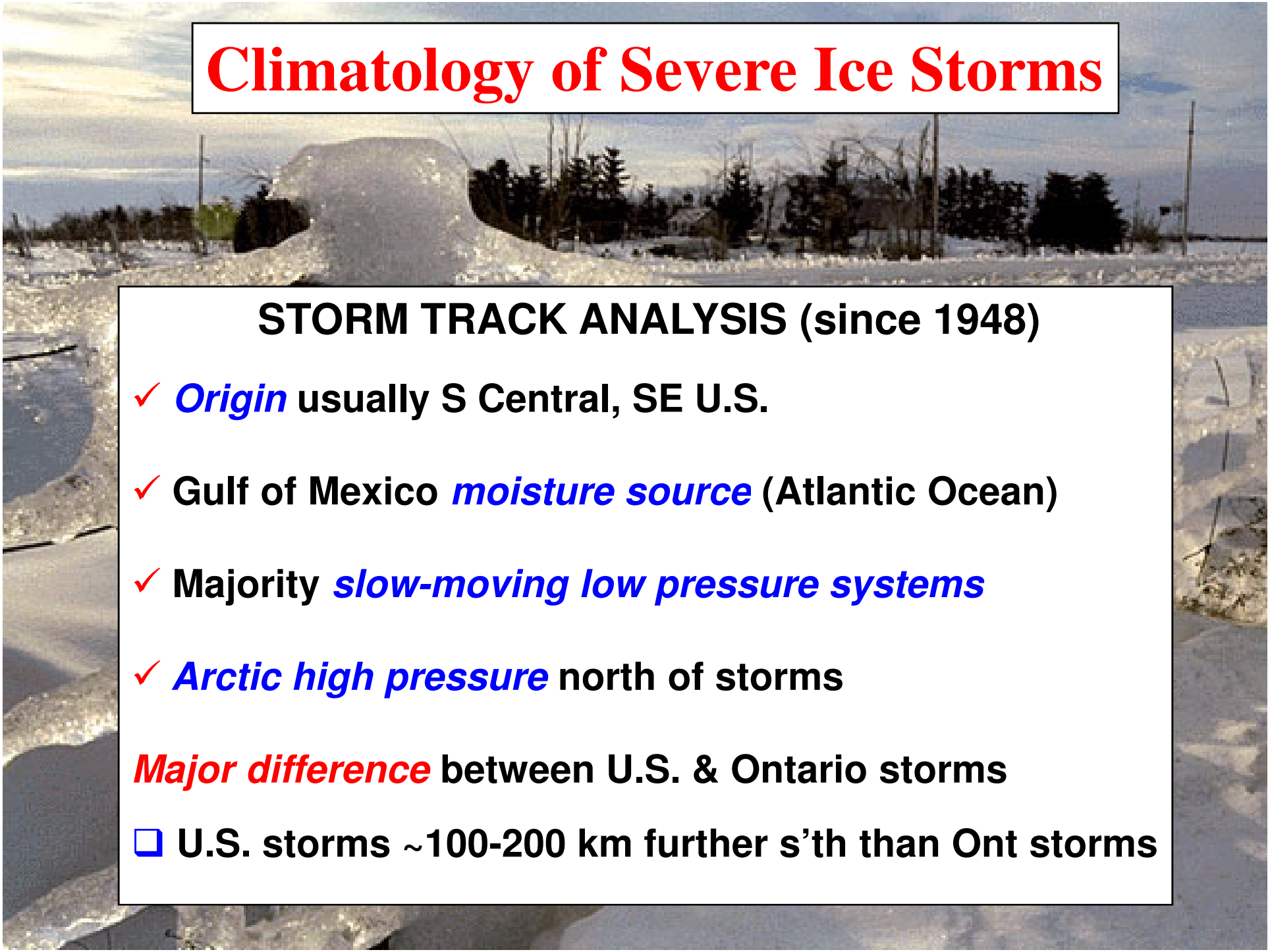
which impacted Southern/Eastern Ontario During the period 1948-2002



Tracks of Major Ice Storms

which impacted Northern U.S. States Bordering Southern Ontario During the period 1948-2002





Climatology of Severe Ice Storms

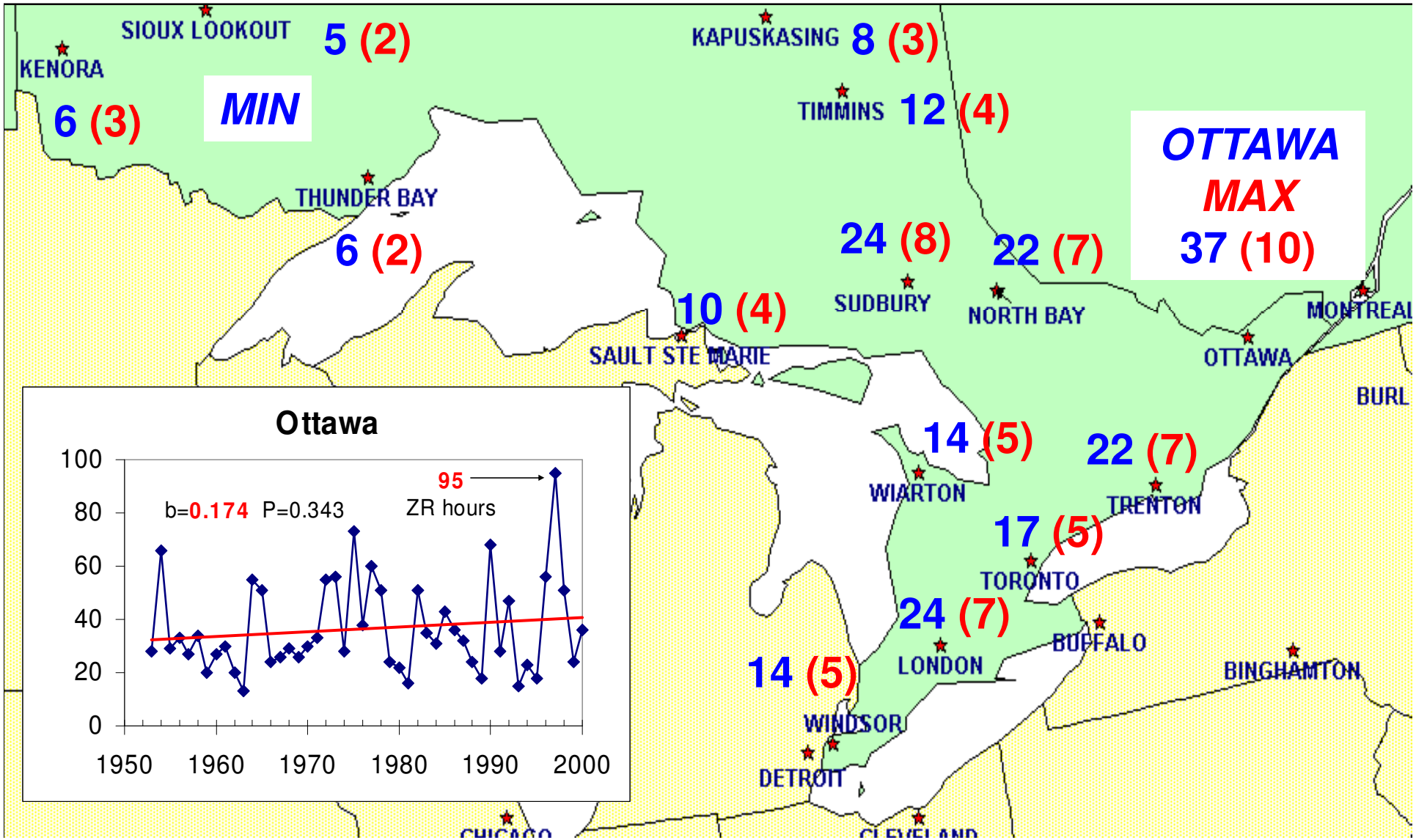
STORM TRACK ANALYSIS (since 1948)

- ✓ ***Origin*** **usually S Central, SE U.S.**
- ✓ **Gulf of Mexico** ***moisture source*** **(Atlantic Ocean)**
- ✓ **Majority** ***slow-moving low pressure systems***
- ✓ ***Arctic high pressure*** **north of storms**

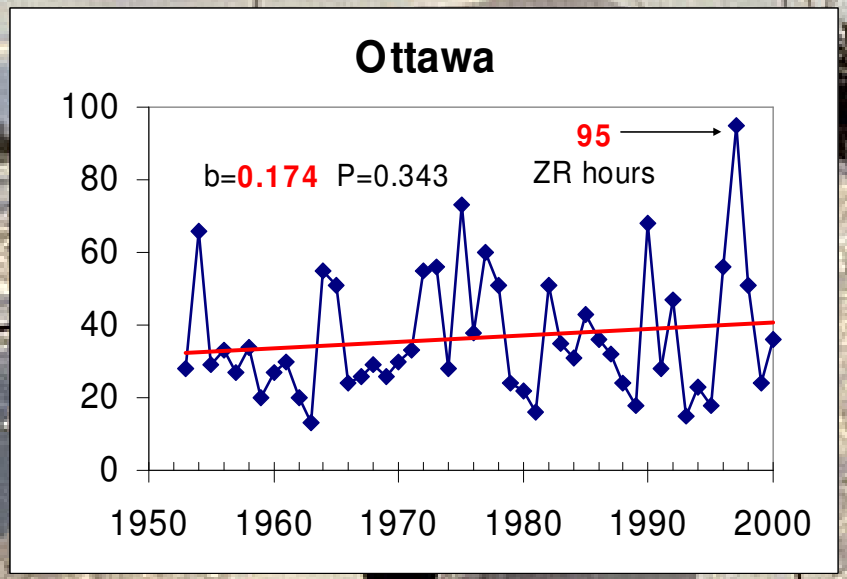
Major difference **between U.S. & Ontario storms**

- ❑ **U.S. storms ~100-200 km further s'th than Ont storms**

Total Annual Freezing Rain Hours *(Days)* for Ontario Stations (1953-2001)



Trends in Occurrence of *Freezing Rain*??



14 Ontario stations, Montreal (*1953-2001*)

12 U.S. Great Lakes region sites (*1973-2000*)

- Risk same or slight decrease in NW, S, Central Ontario
- Increasing but NOT SIGNIFICANT trends N Ontario, Ottawa & Montreal

Great Lakes influence on freezing rain occurrence?

- DECREASED frequency W/S shores Lk Ontario, N shore Erie in fall, early winter & early spring

Trends in Weather Patterns Associated with *Freezing Rain*??

- Statistical synoptic map type methodology used in Toronto Heat Alert System adapted for use in study
- 4 weather patterns or types identified as most highly associated with frz rain events at Canadian/U.S. locations
- No significant trends found in weather types

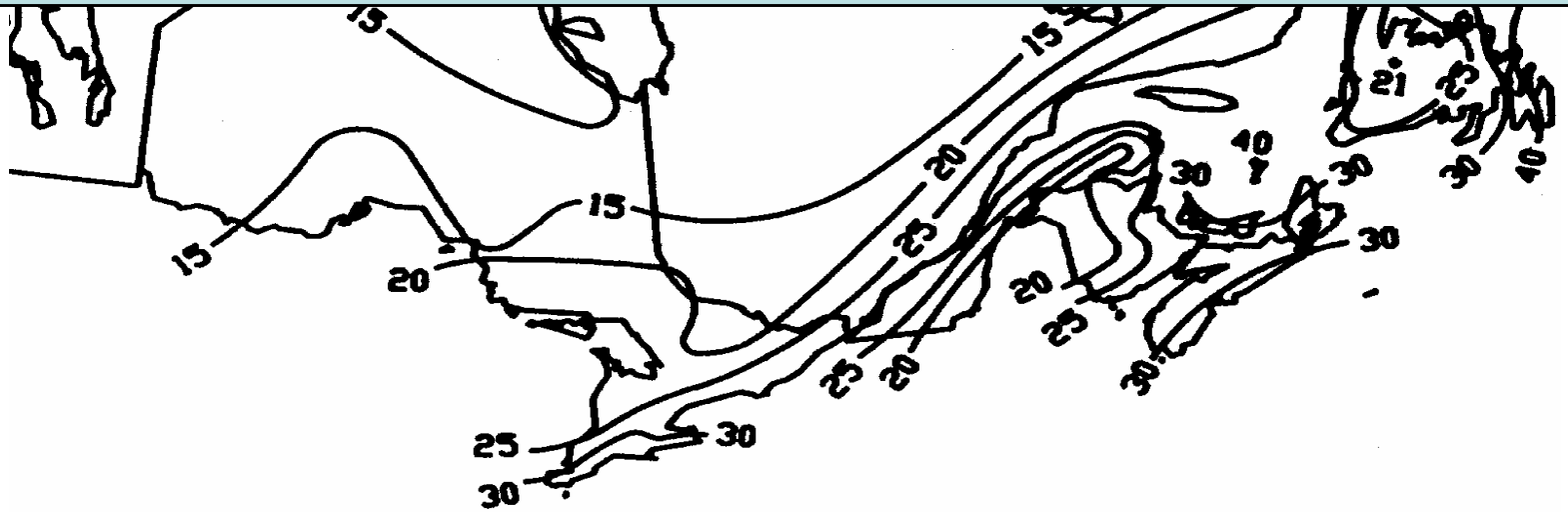
BUT

- ***Direction of trends*** in types same as most trends in observed freezing rain frequencies

Power Line Climatological Design Criteria

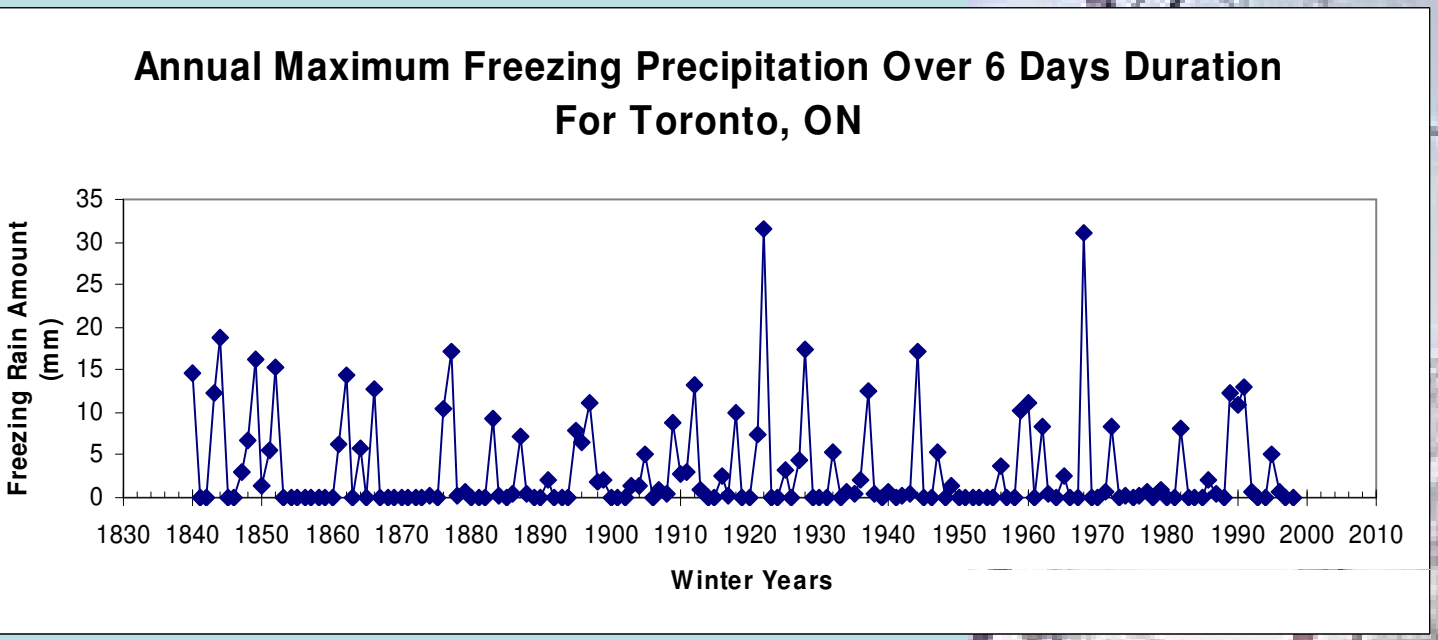
- Design criteria of 25-30 mm for much southern Ontario
- Study showed risk of major power outages increases when **Freezing rain amounts > ~30 mm**
- Potential for longer outages/"community disaster" with **Freezing rain amounts > ~40 mm**

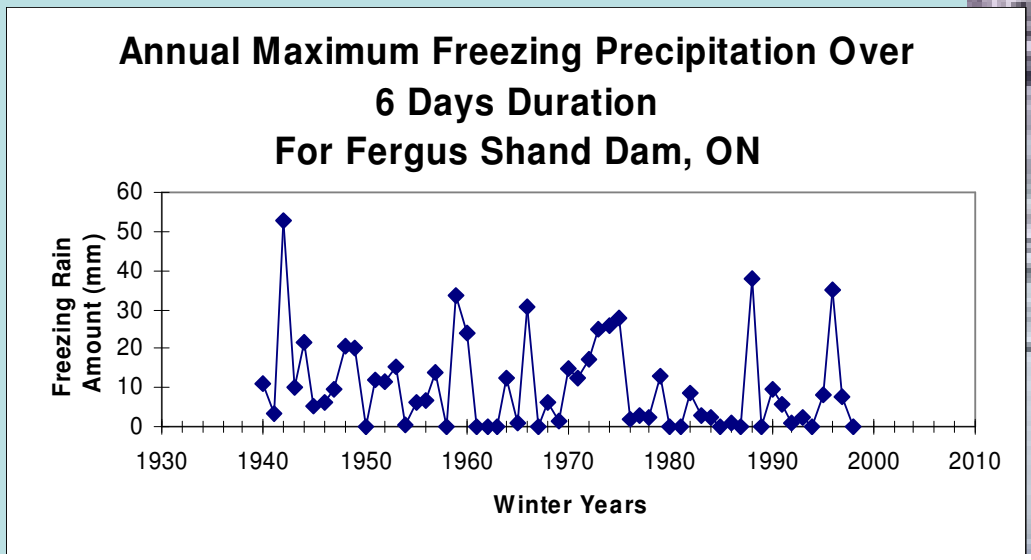
Eastern Ontario **most at risk for transmission line failures, Potential communication tower collapses**

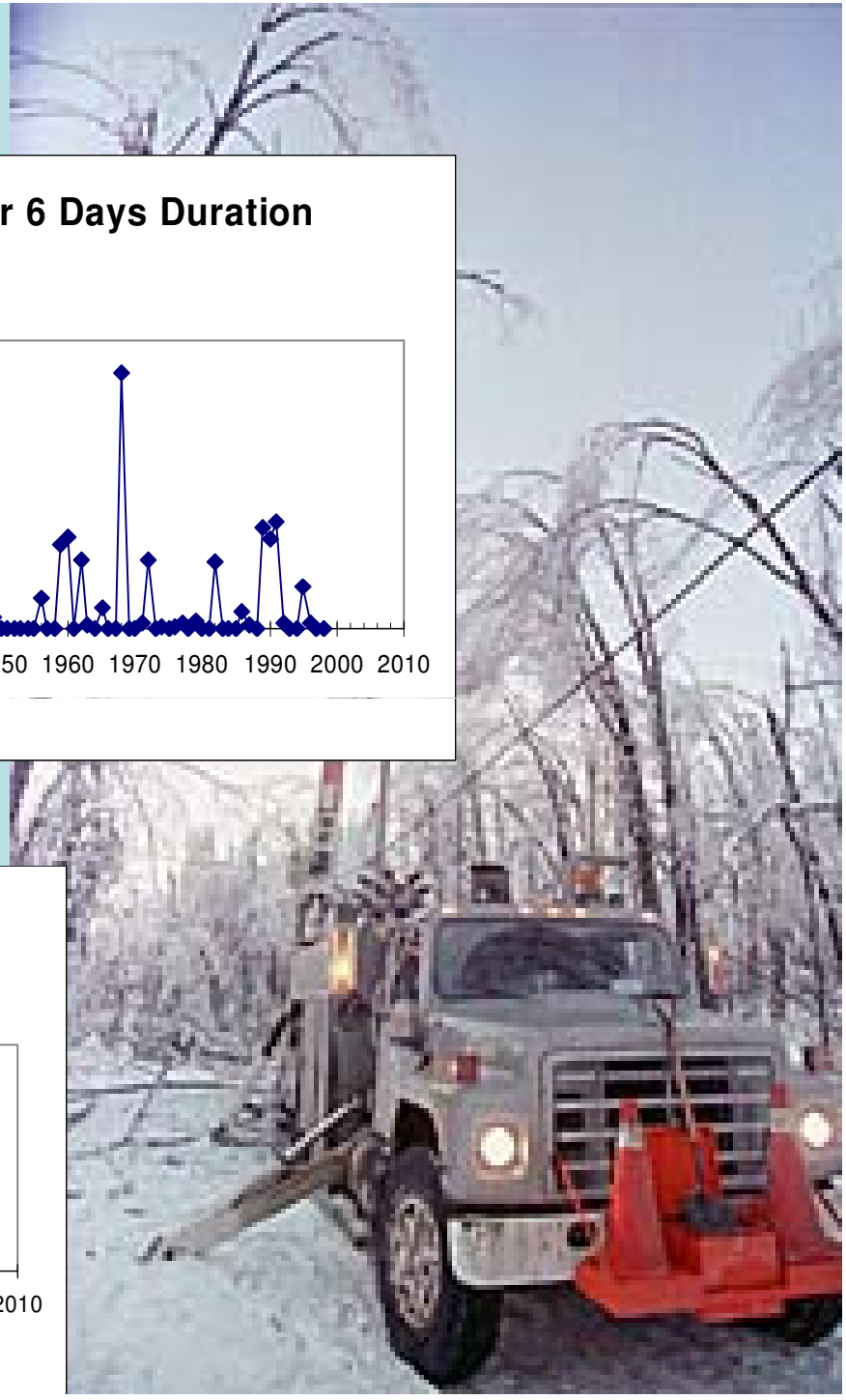


CSA/CEA design radial ice amounts (mm on 1 inch conductor)

RETURN PERIODS

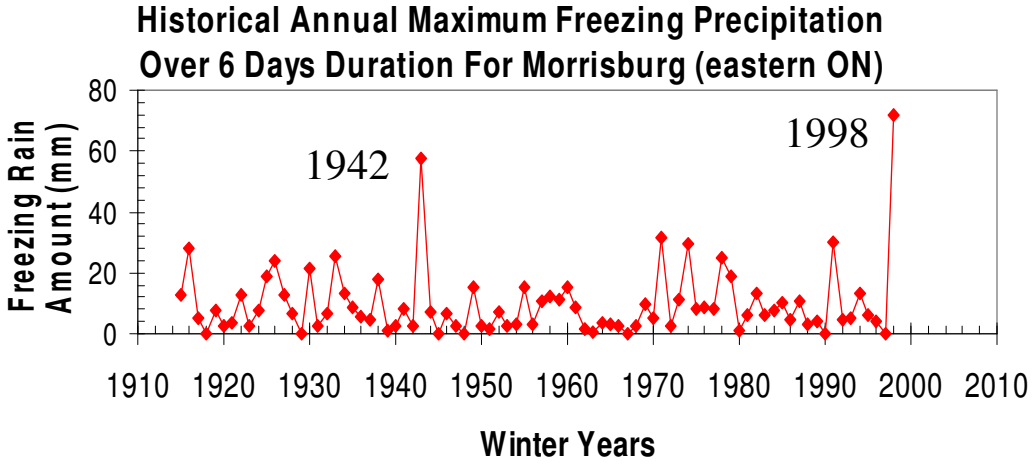




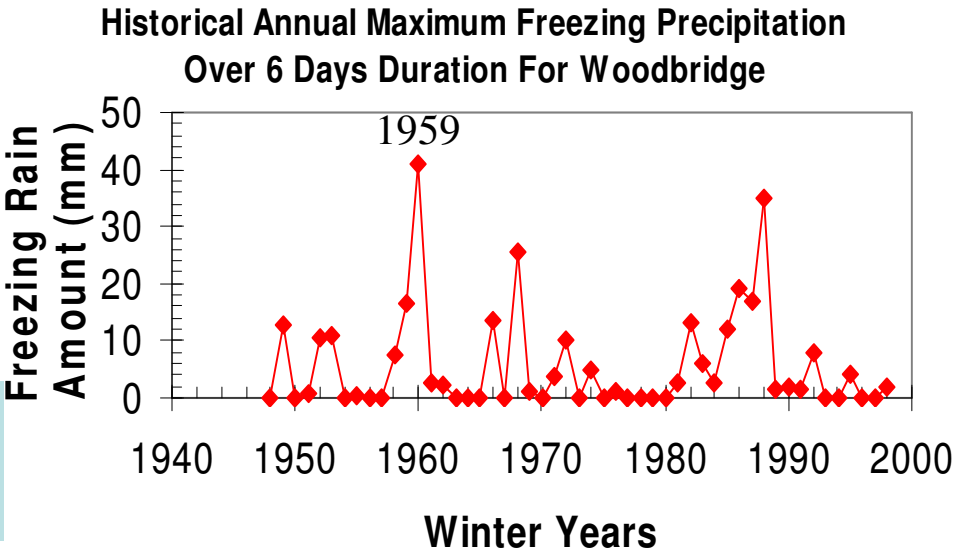


Extreme Ice Storms from our Past

Dec 29-30, 1942

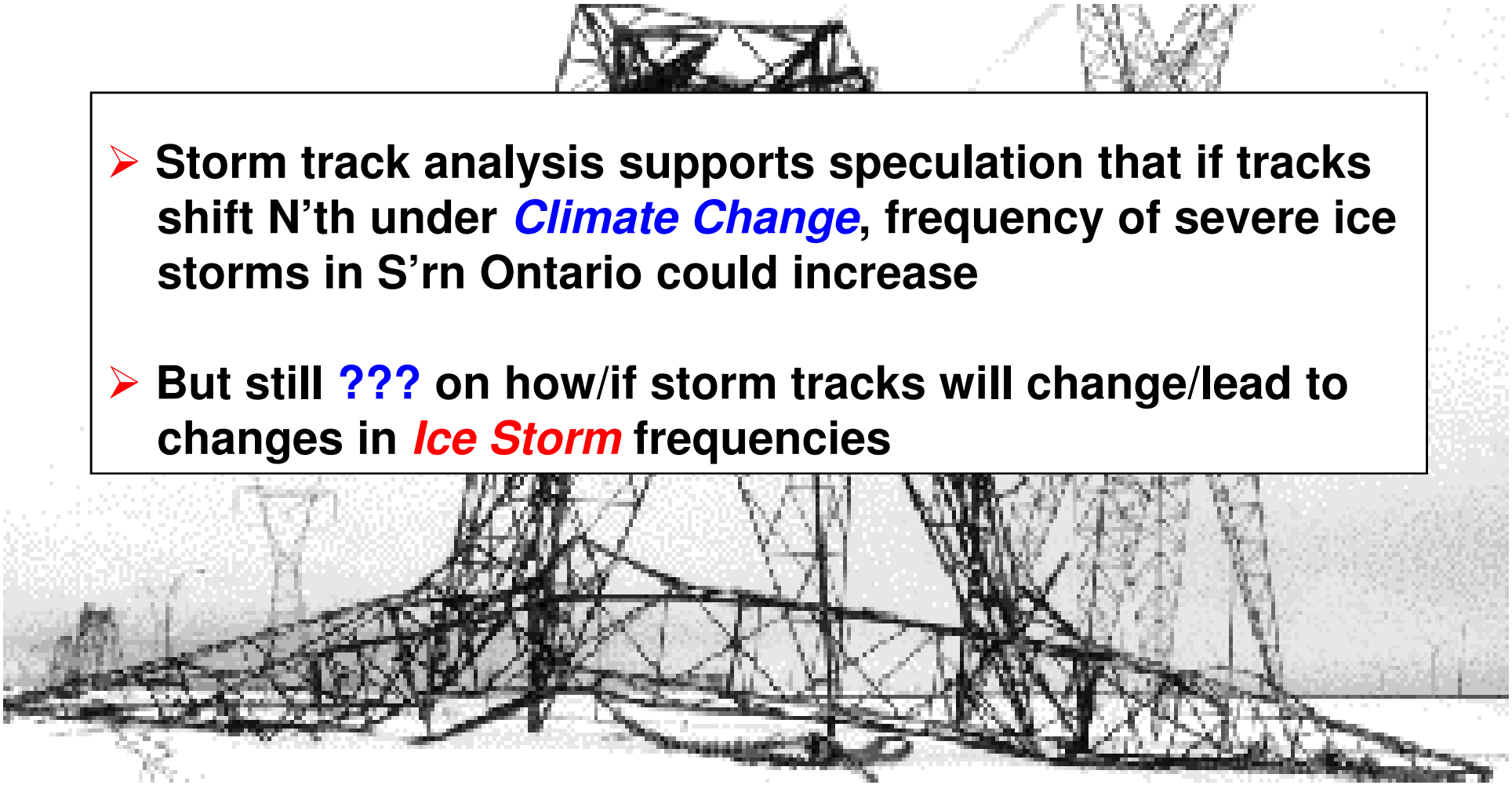


Dec 25-28, 1959



"Ontario Hydro design ice storm"
(for transmission line design)

Increased Vulnerability to *Ice Storms* with Climate Change?



- Storm track analysis supports speculation that if tracks shift N'th under *Climate Change*, frequency of severe ice storms in S'rn Ontario could increase
- But still ??? on how/if storm tracks will change/lead to changes in *Ice Storm* frequencies

Increased Vulnerability to *Ice Storms* with Climate Change?

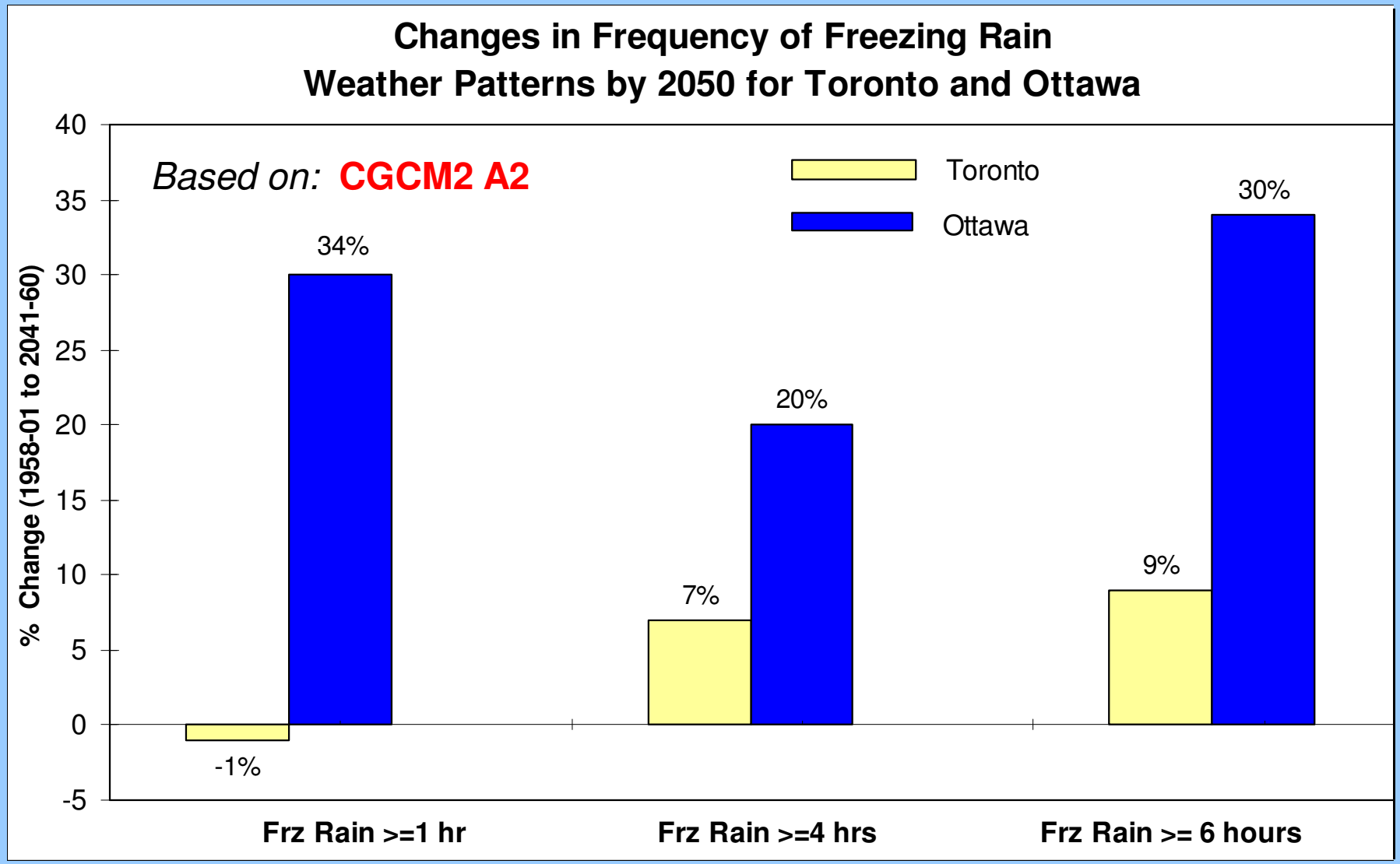
- **Synoptic Map Typing Approach used with 3 GCMs data to investigate projected frequency of changes in frz rain weather patterns with *Climate Change***
- **By *2050*, CGCM1 (*IS92A*), CGCM2 (*A2*), GFDL R-30 (*A2*) project increases in weather types for**

  frz rain events >=6 hrs

  OR

  weather types associated with more severe ice storms
- **Greater increase in Eastern/Northern Ontario; smaller increases in Southern Ontario**
- **Great Lakes could mitigate impacts**

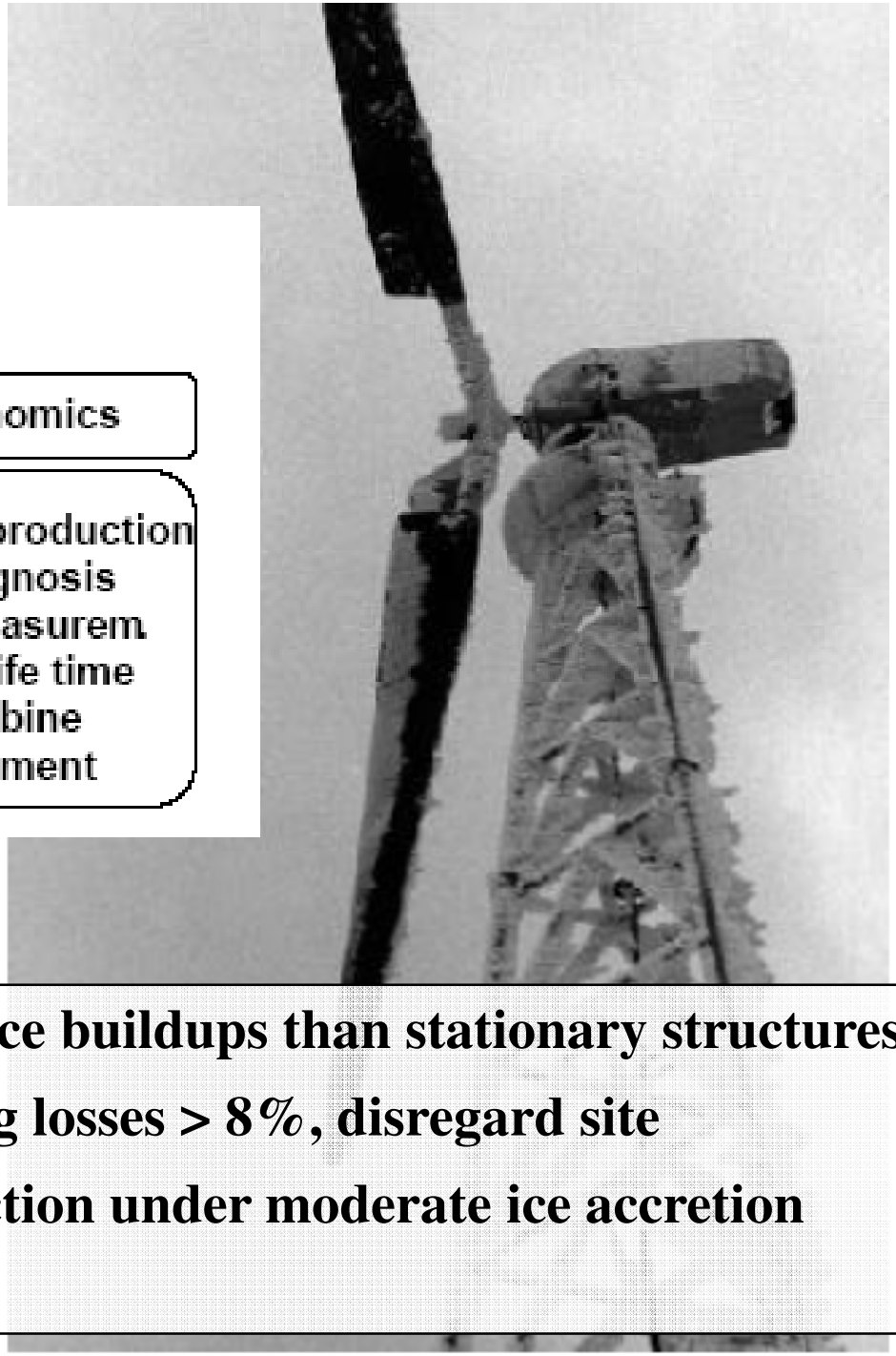
Increased Vulnerability to *Ice Storms* with Climate Change?



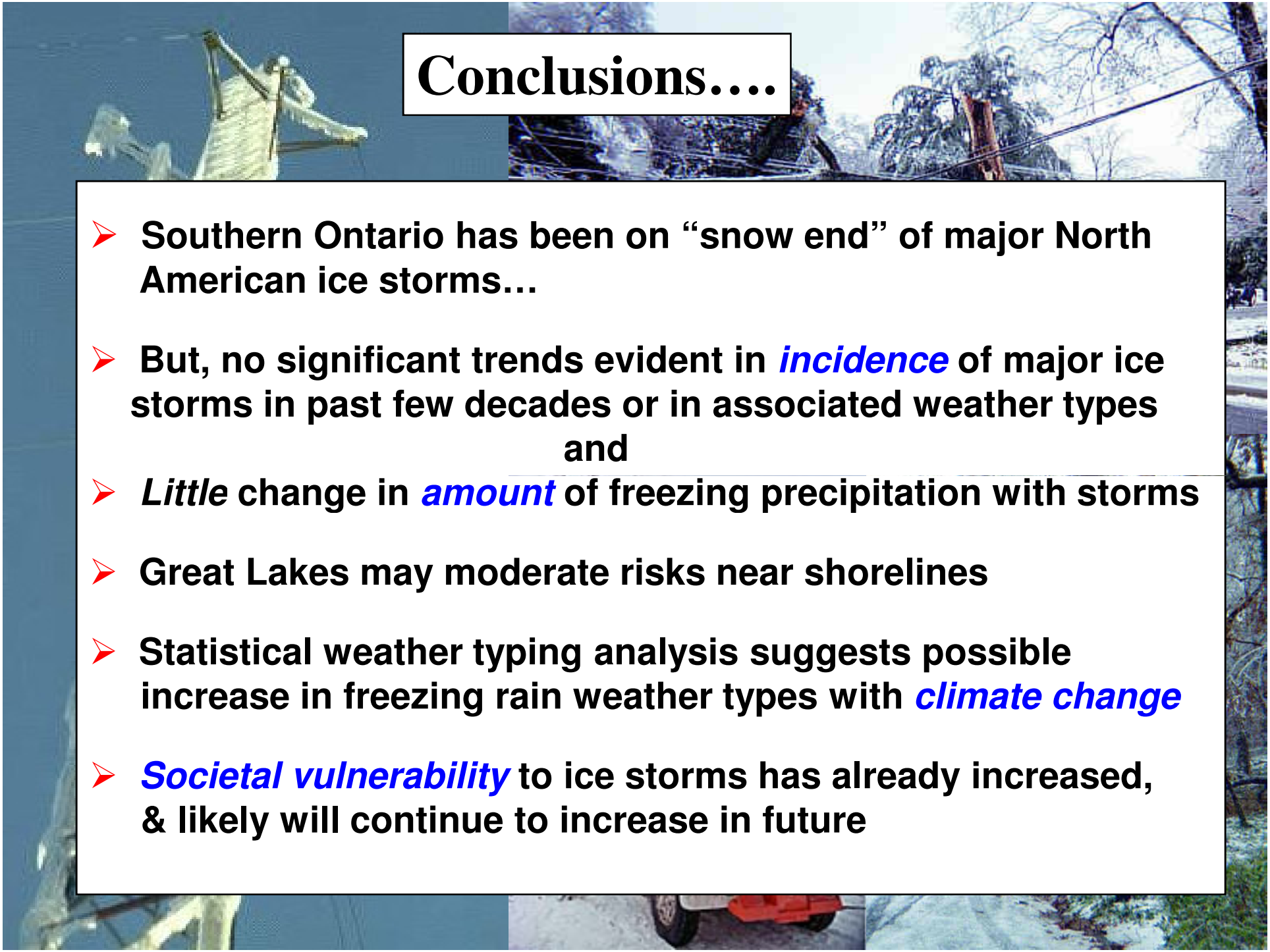
Ice Accretion

Icing of wind turbines affects

WT - Design	Safety	Economics
Aerodynamics Loads Dynamics Control system Instrumentation Material	Ice throw Unbalance Resonance Over power Fatigue	Energy production Site prognosis Wind measurem Design life time Wind turbine equipment



- **Moving blades subject to heavier ice buildups than stationary structures**
- **Ice causes power shutdown… icing losses > 8%, disregard site**
- **Typically design for power production under moderate ice accretion**
- **Heat blades**



Conclusions….

- Southern Ontario has been on "snow end" of major North American ice storms…
- But, no significant trends evident in ***incidence*** of major ice storms in past few decades or in associated weather types

and

- ***Little*** change in ***amount*** of freezing precipitation with storms
- Great Lakes may moderate risks near shorelines
- Statistical weather typing analysis suggests possible increase in freezing rain weather types with ***climate change***
- ***Societal vulnerability*** to ice storms has already increased, & likely will continue to increase in future

MSC-Ontario Research Report

Estimation of Severe Ice Storm Risks for South-Central Canada

PDF available online at the PSEPC website

http://www.ocipep.gc.ca/research/resactivites/natHaz/2002-D002_e.asp

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