Climate Change and the Evolution of Canada's Wine Appellations

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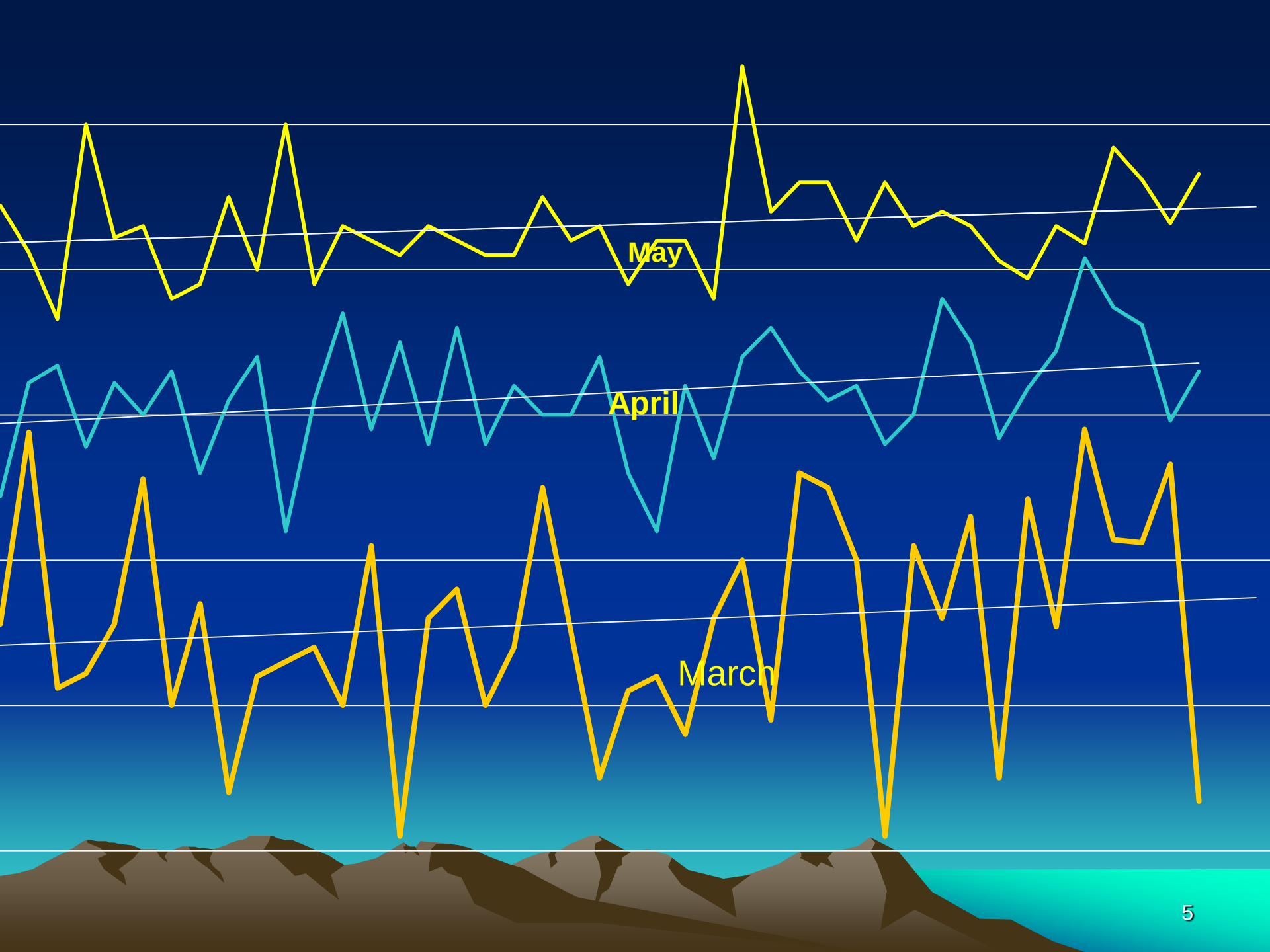
Canada

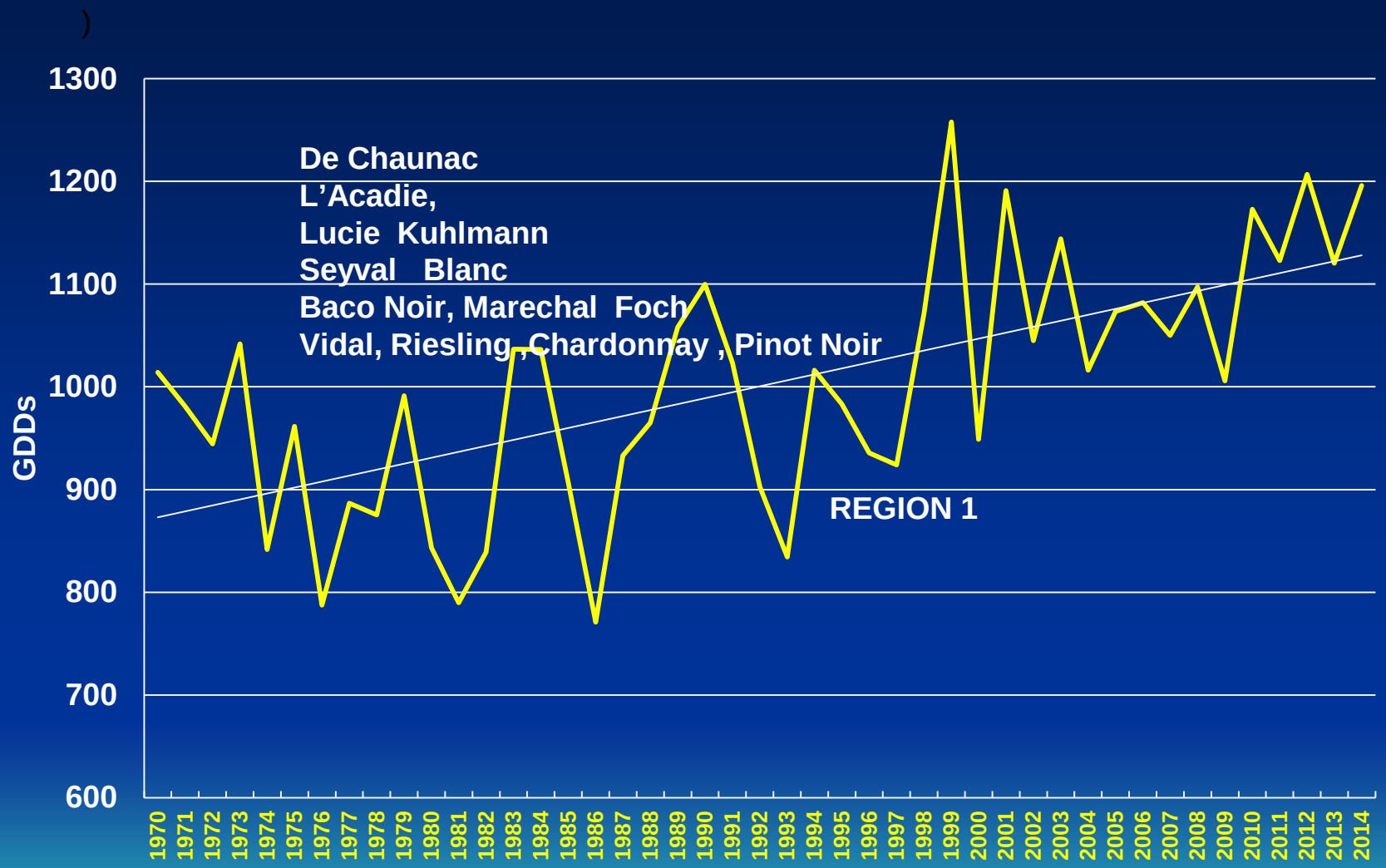
THE MAIN VITICULTURE AND FRUIT GROWING AREAS OF CANADA


Georgian Bay
Lake Huron
Grey
Durham
P EC
Huron
Lake Ontario
Niagara
Norfolk
Lake Erie
North Shore
Lake Erie

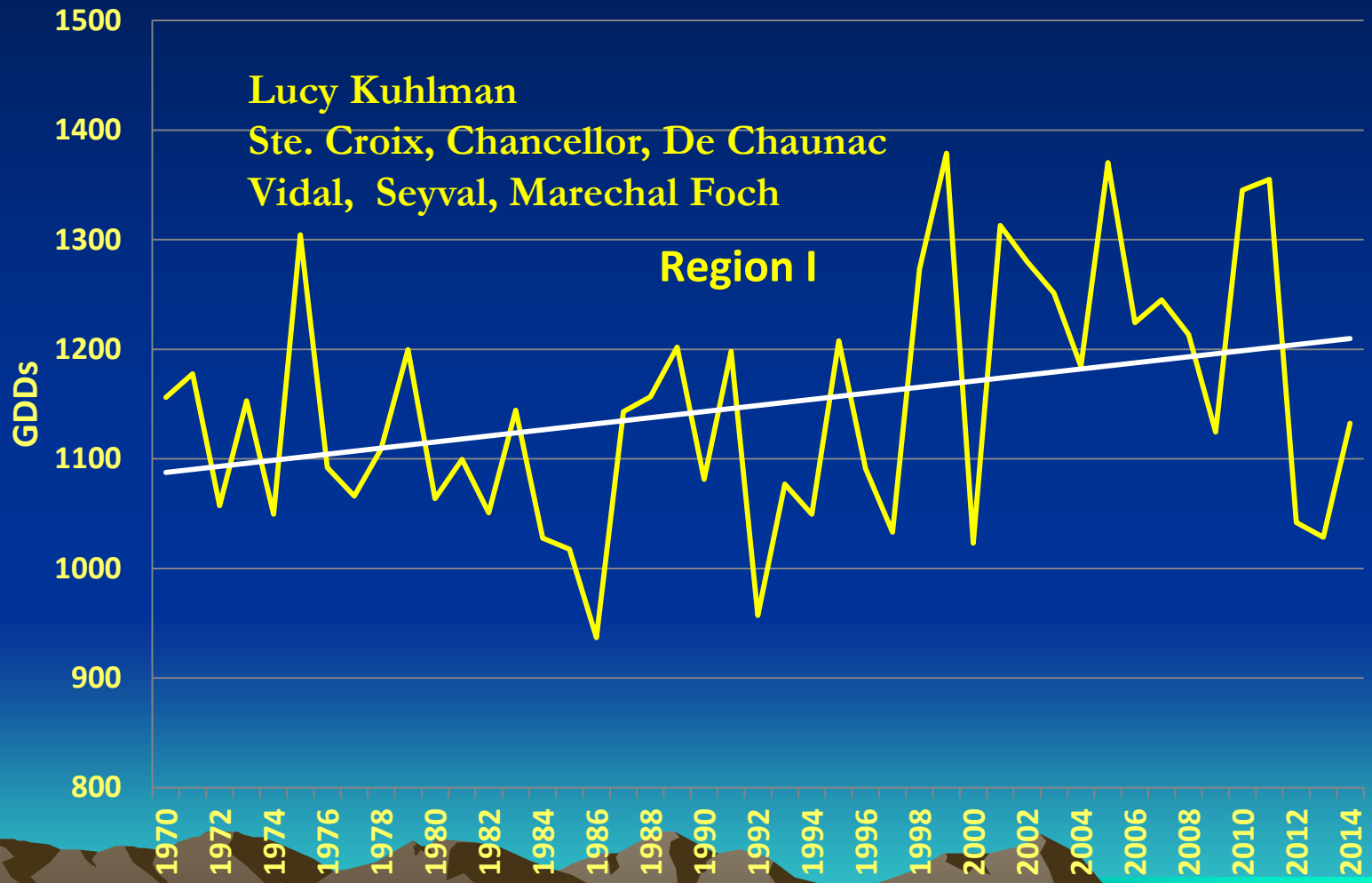
- Trends in Spring
- Trends towards and early warm up


May
April
March

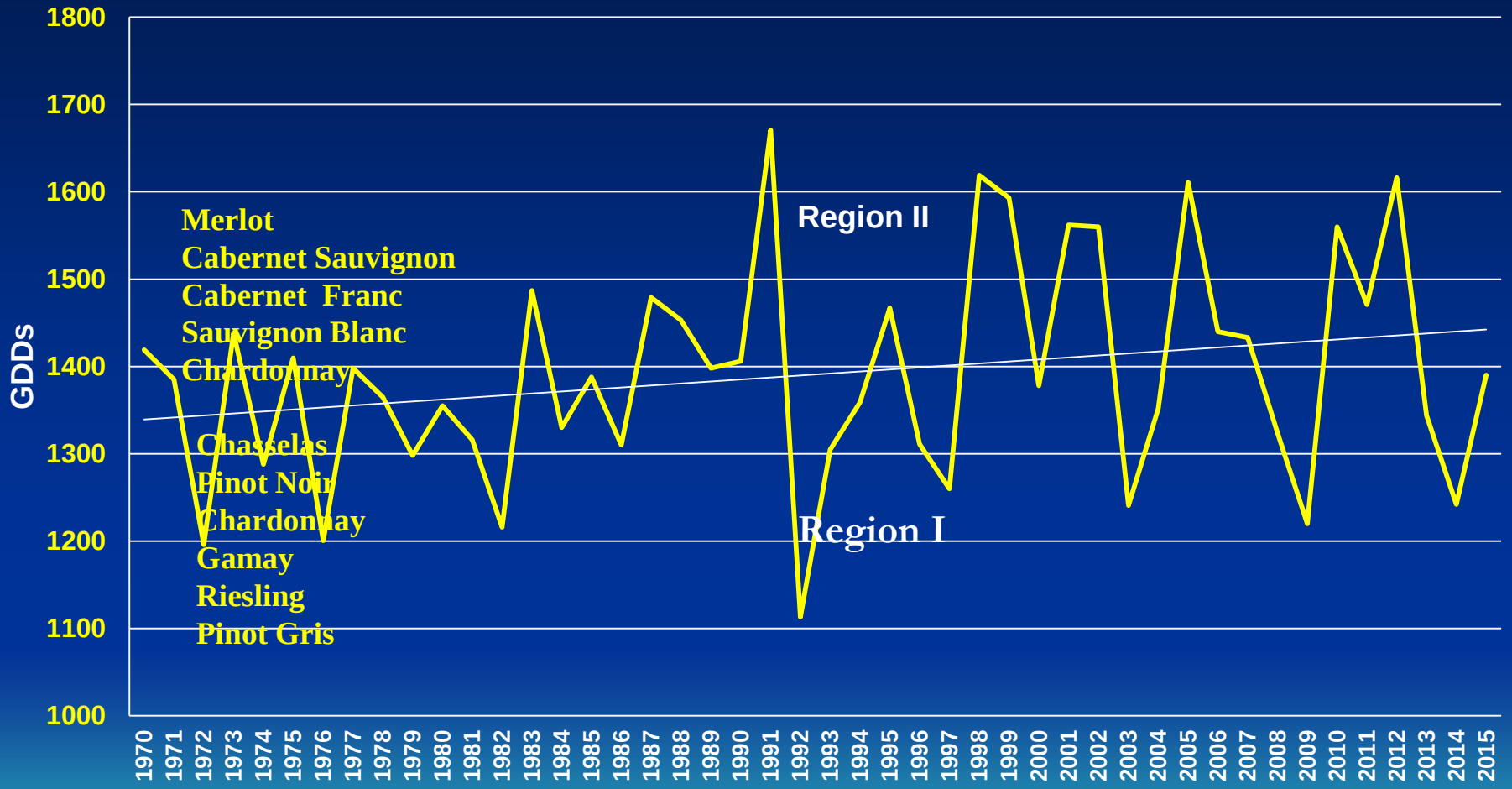
Evolution of Nova Scotia's Wine Climate (Greenwood)

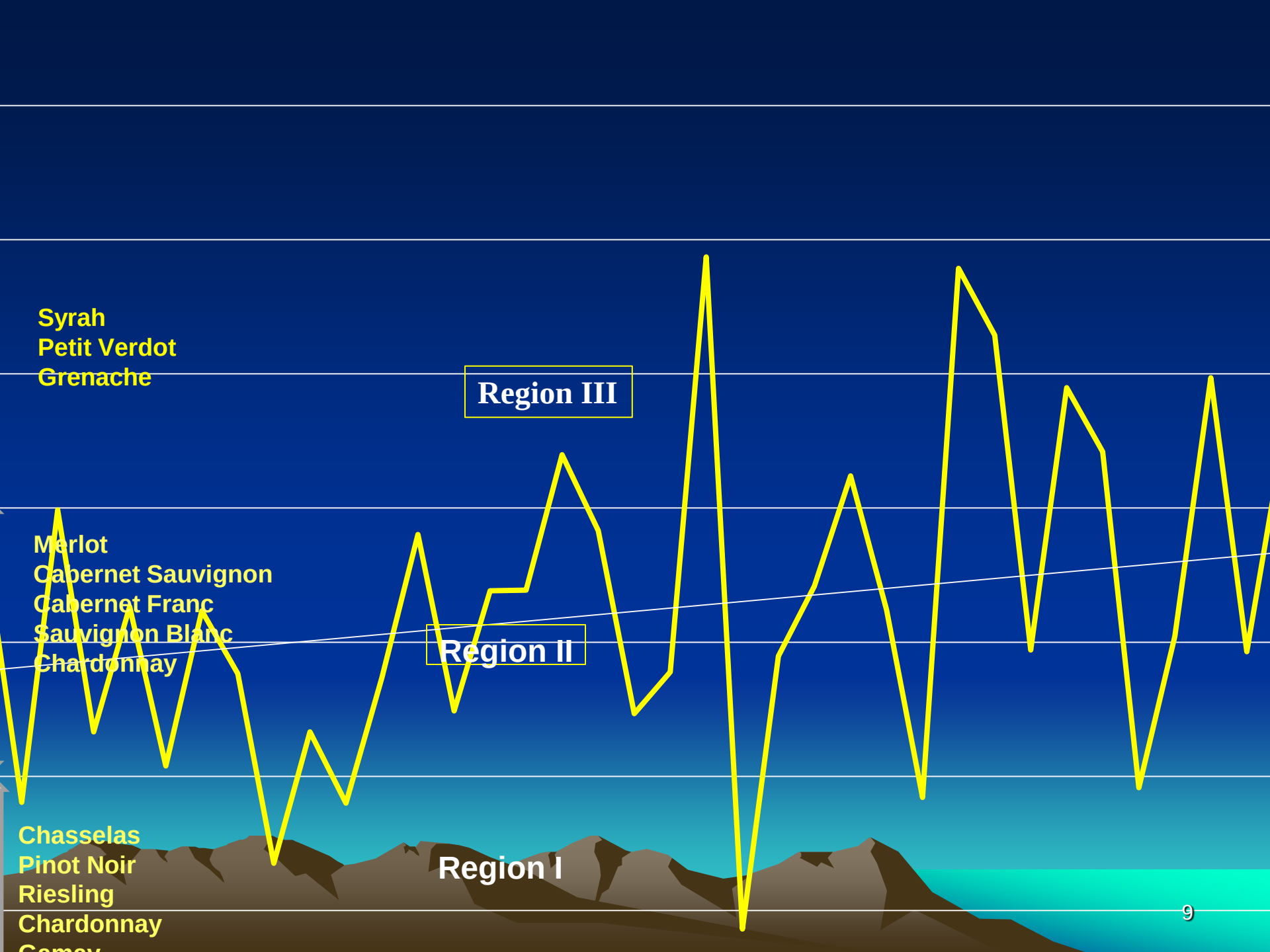


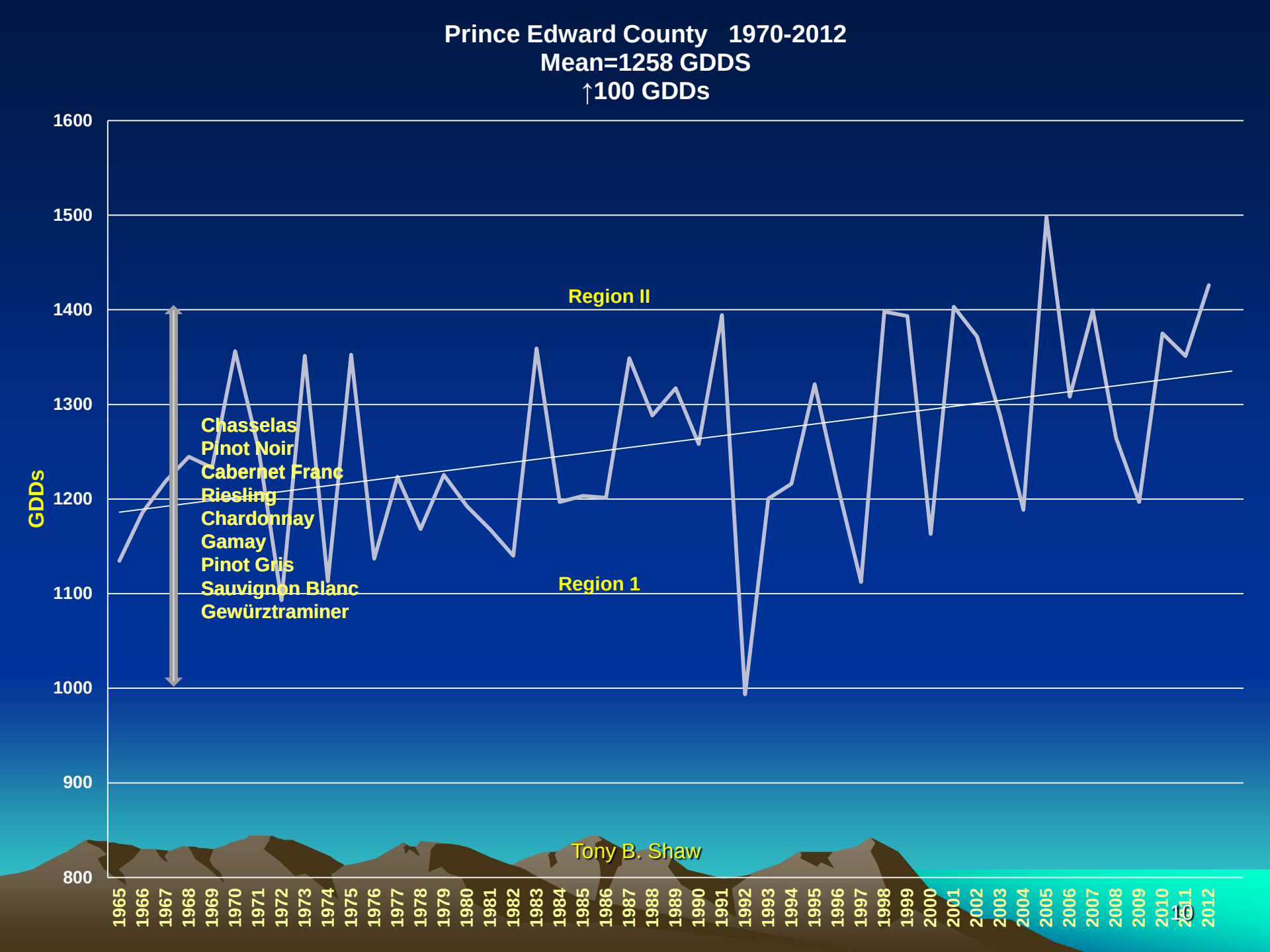
Evolution of Winkler Index for Granby, Estrie Region Quebec

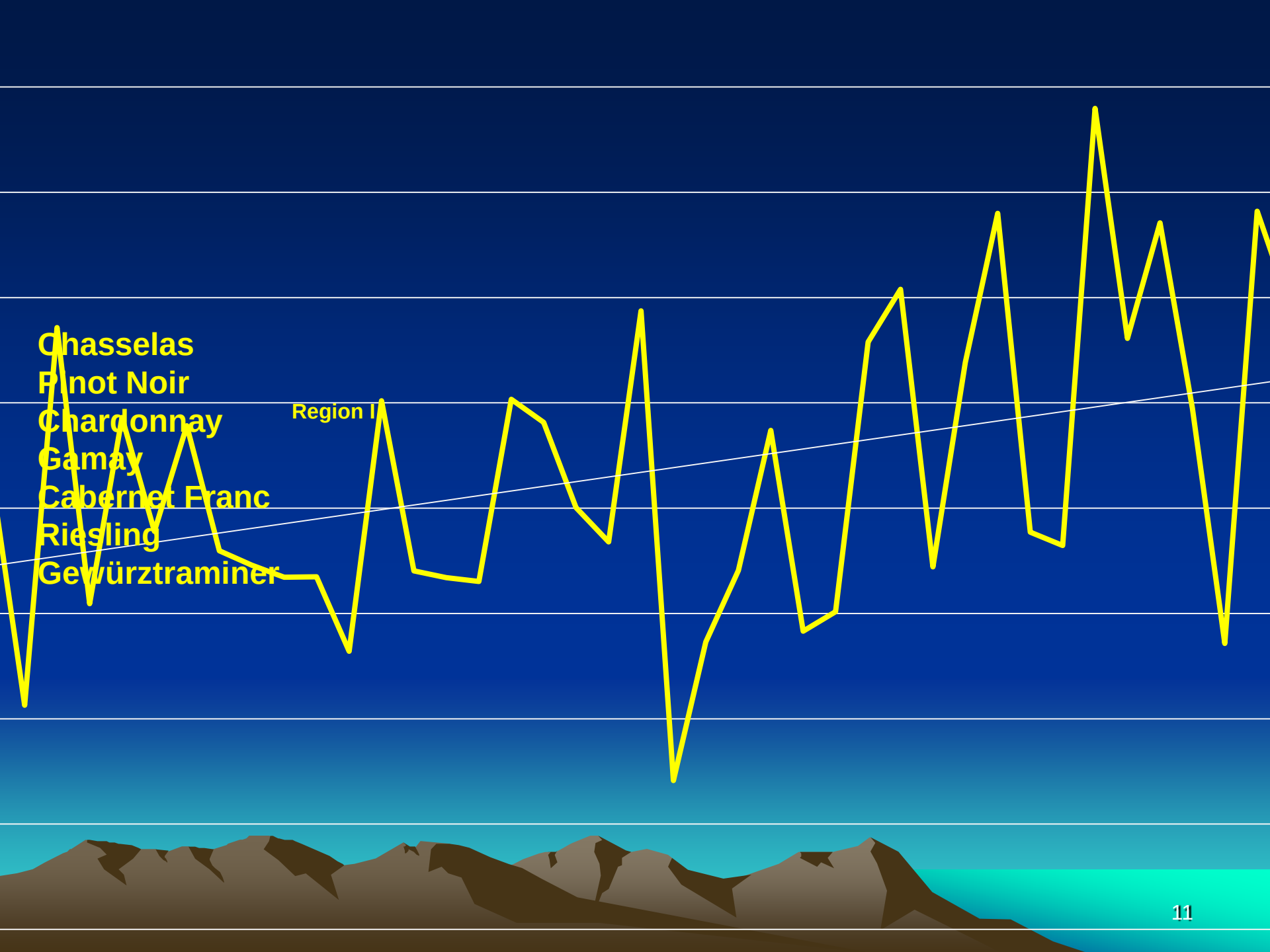


Trends in GGDs For Niagara Region 1970-2015

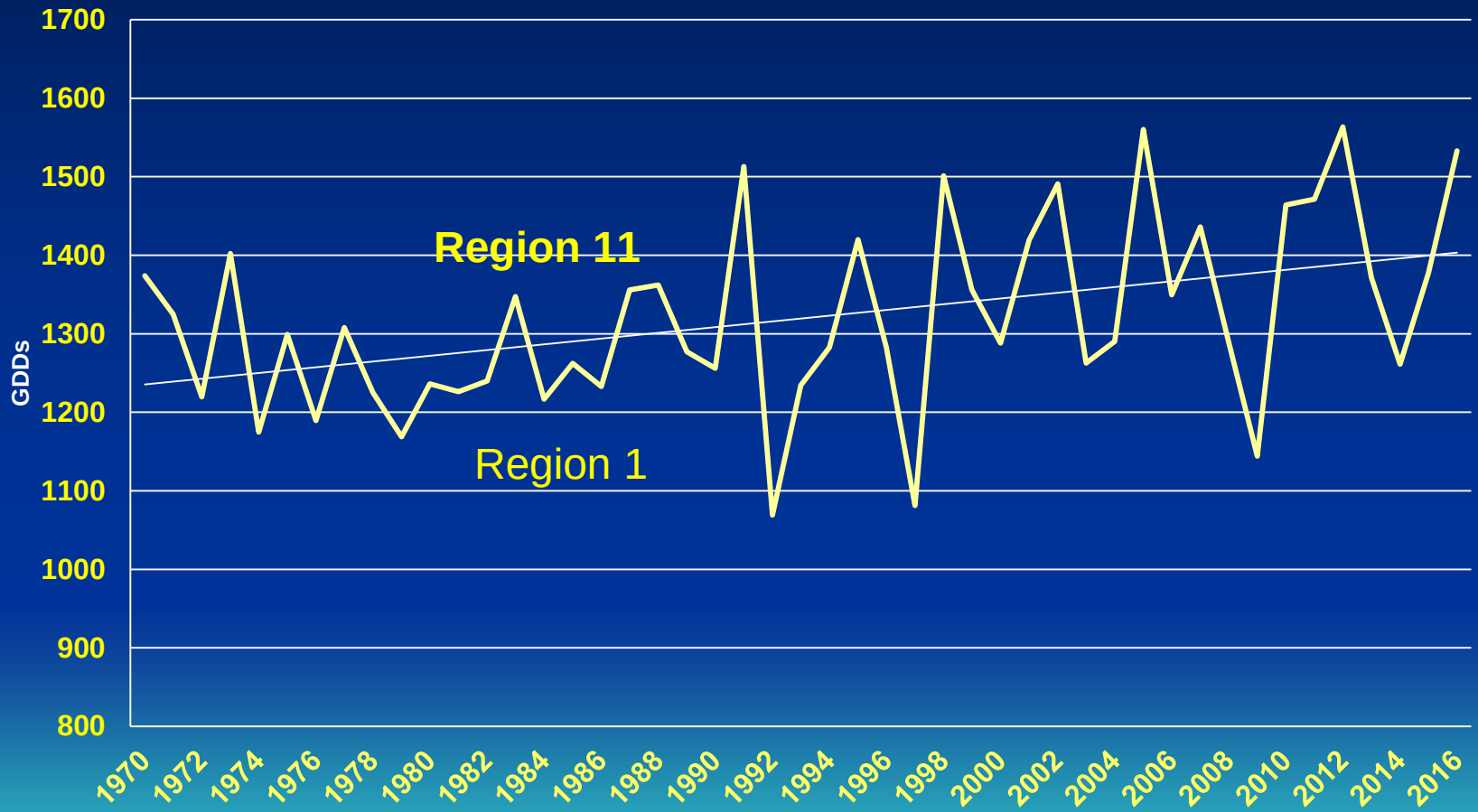



Syrah
Petit Verdot
Grenache
Region III
Merlot
Cabernet Sauvignon
Cabernet Franc
Sauvignon Blanc
Chardonnay
Region II
Chasselas
Pinot Noir
Riesling
Chardonnay
Region I

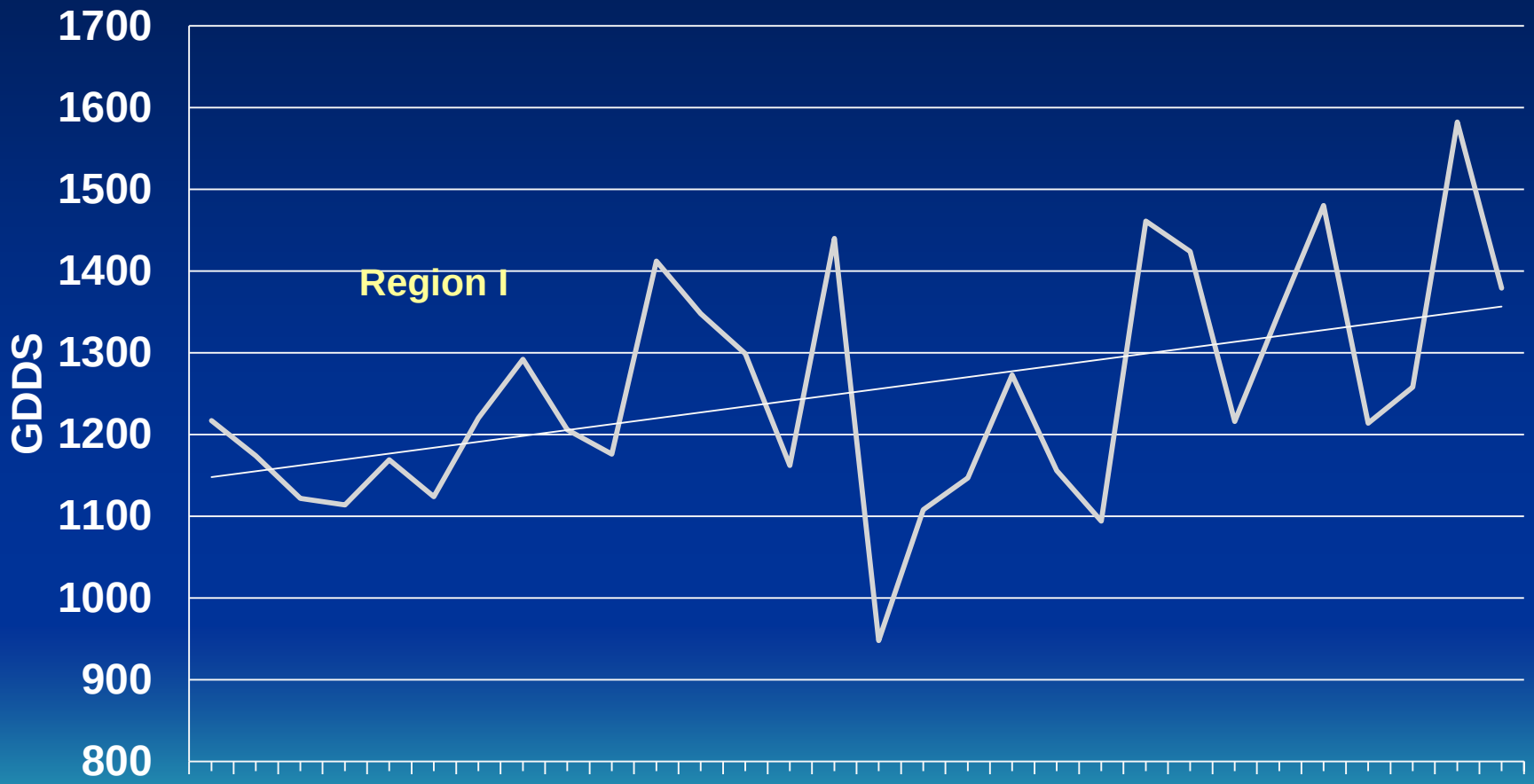

Prince Edward County 1970-2012
Mean=1258 GDDS
↑100 GDDs
GDDs
1600
1500
1400
1300
1200
1100
1000
900
800
Region II
Region 1
Chasselas
Pinot Noir
Cabernet Franc
Riesling
Chardonnay
Gamay
Pinot Gris
Sauvignon Blanc
Gewürztraminer
Tony B. Shaw
1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
10


Chasselas
Pinot Noir
Chardonnay
Gamay
Cabernet Franc
Riesling
Gewürztraminer
Region I

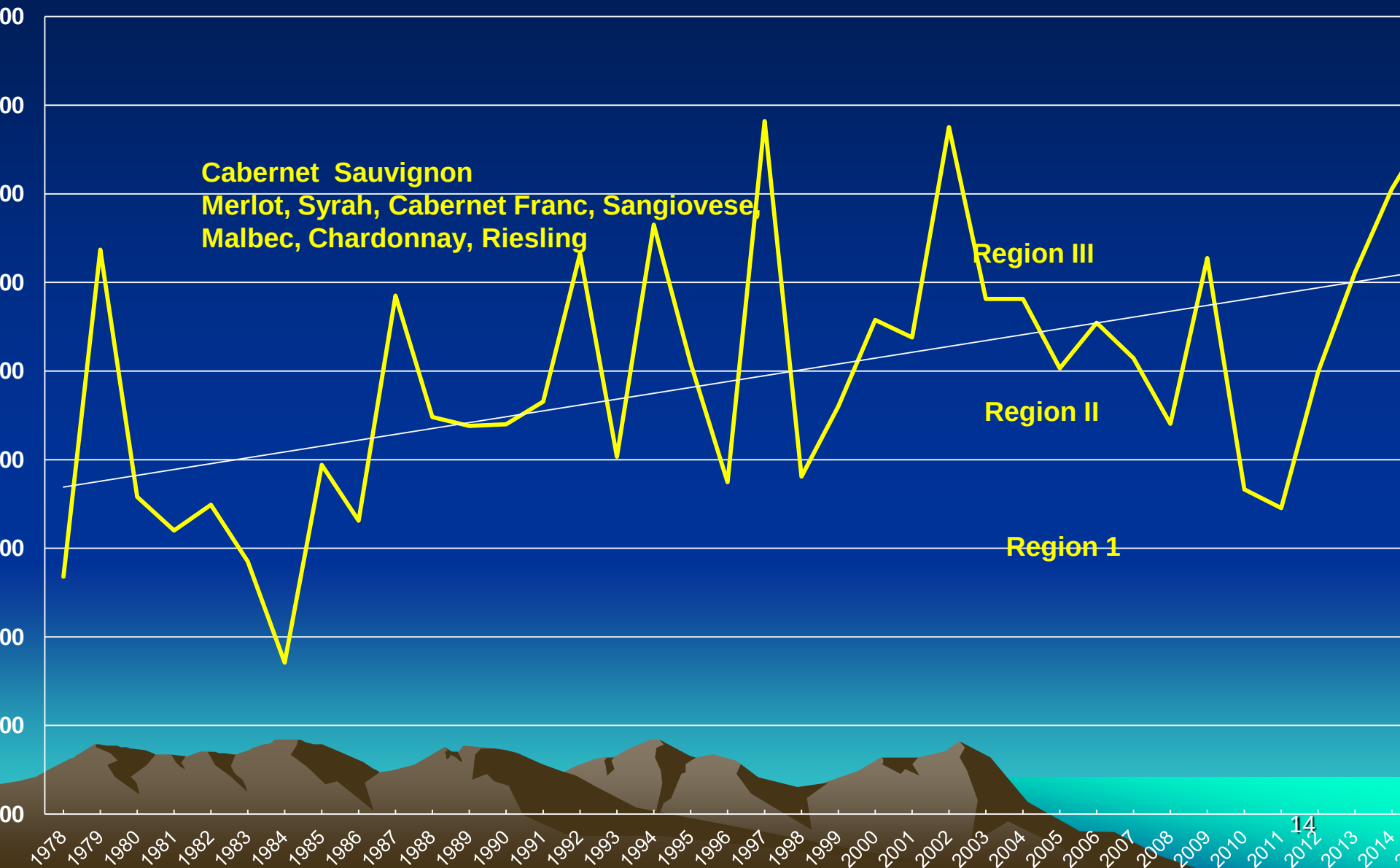
Long-term trends in Growing Degree Days For Vines (1970-2016, Norfolk County)



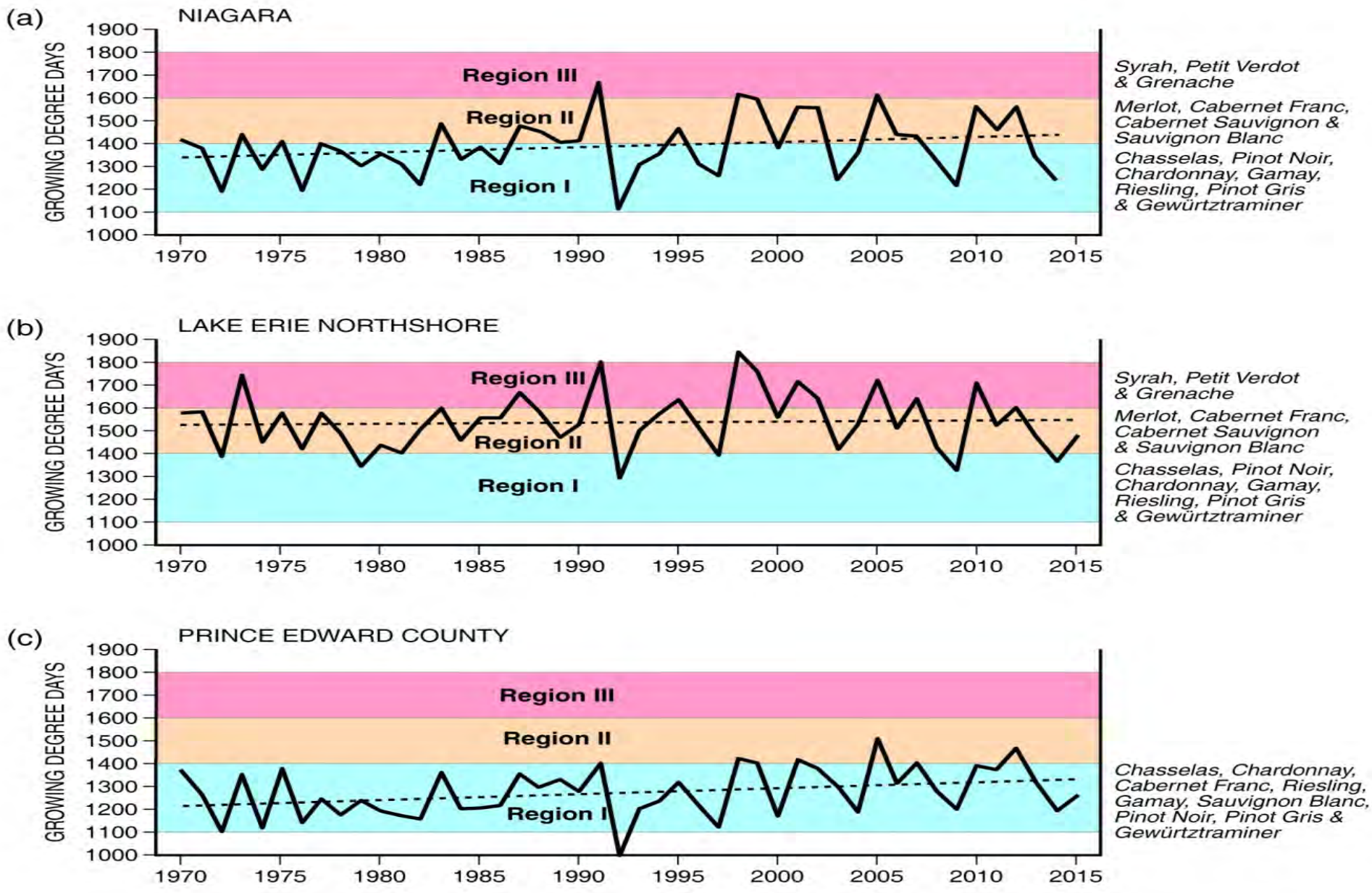
Trends in GDDs Value For Huron County



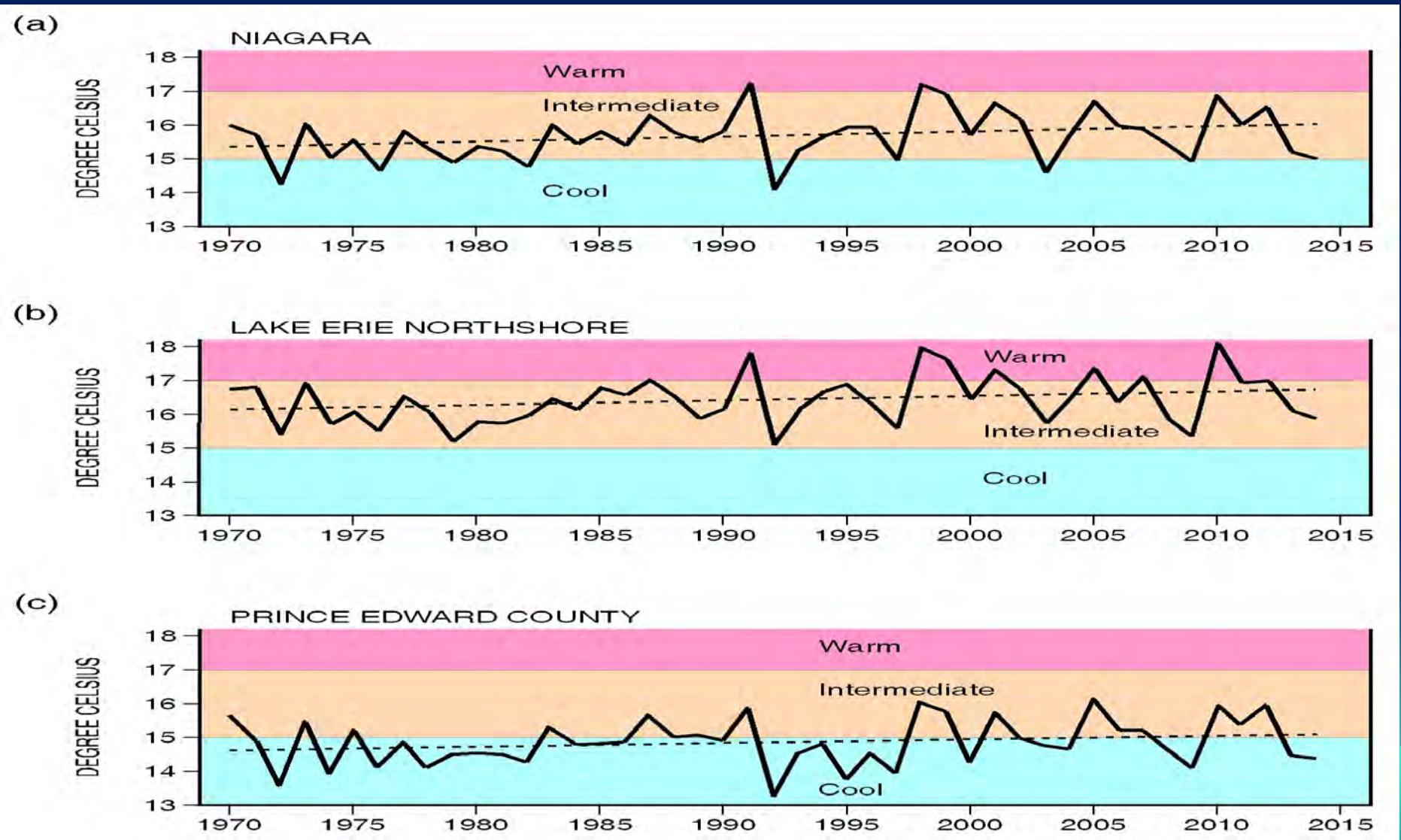
Evolution of South Okanagan's Wine Climate, British Columbia



Evolution of the Winkler Index



Mean Growing Season Temperature



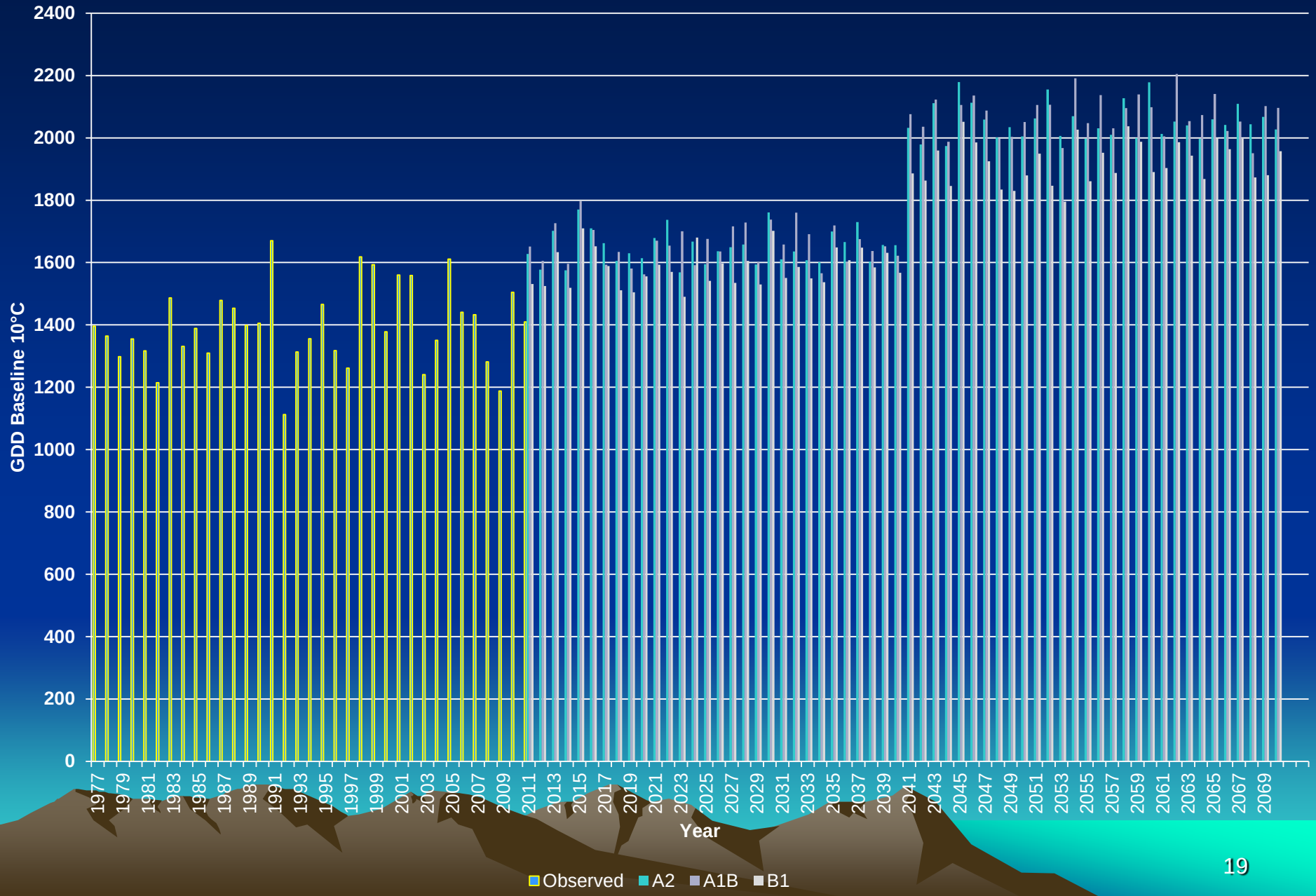
Observed and Projected Changes in GDDs to 2070s using the downscaled HADCM3

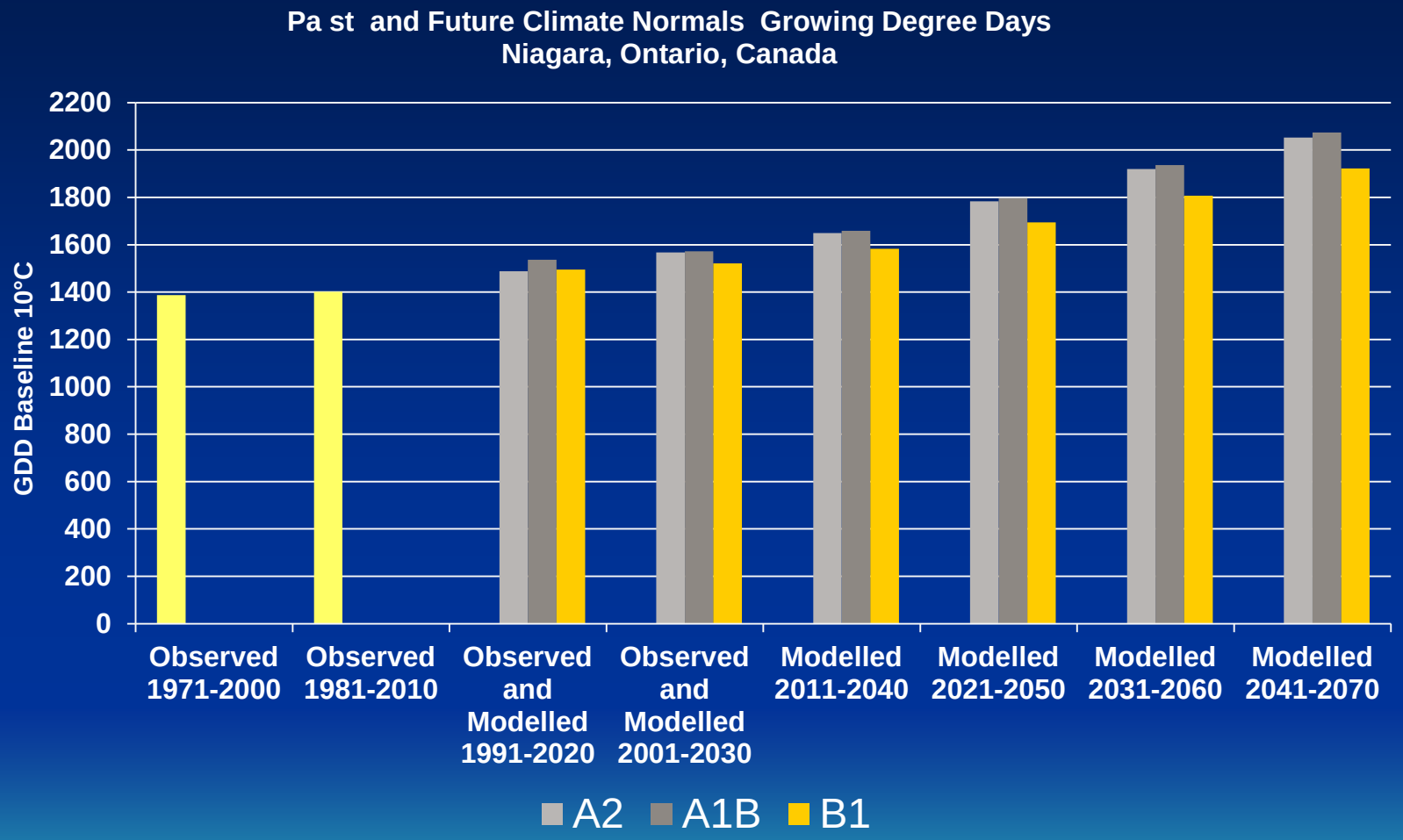
A2- Scenario- A heterogeneous world, increasing population, slower and fragmented technological change

A1B- Rapid population that peaks in mid-century and declines followed by rapid introduction of energy-efficient technologies and a balance between fossil and non-fossil fuels

B1- A convergent world, population peaks in mid-century, and declines, global solutions and emphasis on social and environmental sustainability

Past and Future Growing Degree Days
Niagara, Ontario, Canada




Pa st and Future Climate Normals Growing Degree Days
Niagara, Ontario, Canada
GDD Baseline 10°C
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Observed 1971-2000
Observed 1981-2010
Observed and Modelled 1991-2020
Observed and Modelled 2001-2030
Modelled 2011-2040
Modelled 2021-2050
Modelled 2031-2060
Modelled 2041-2070
A2
A1B
B1

Observed and Projected Extreme Minimum Temperatures

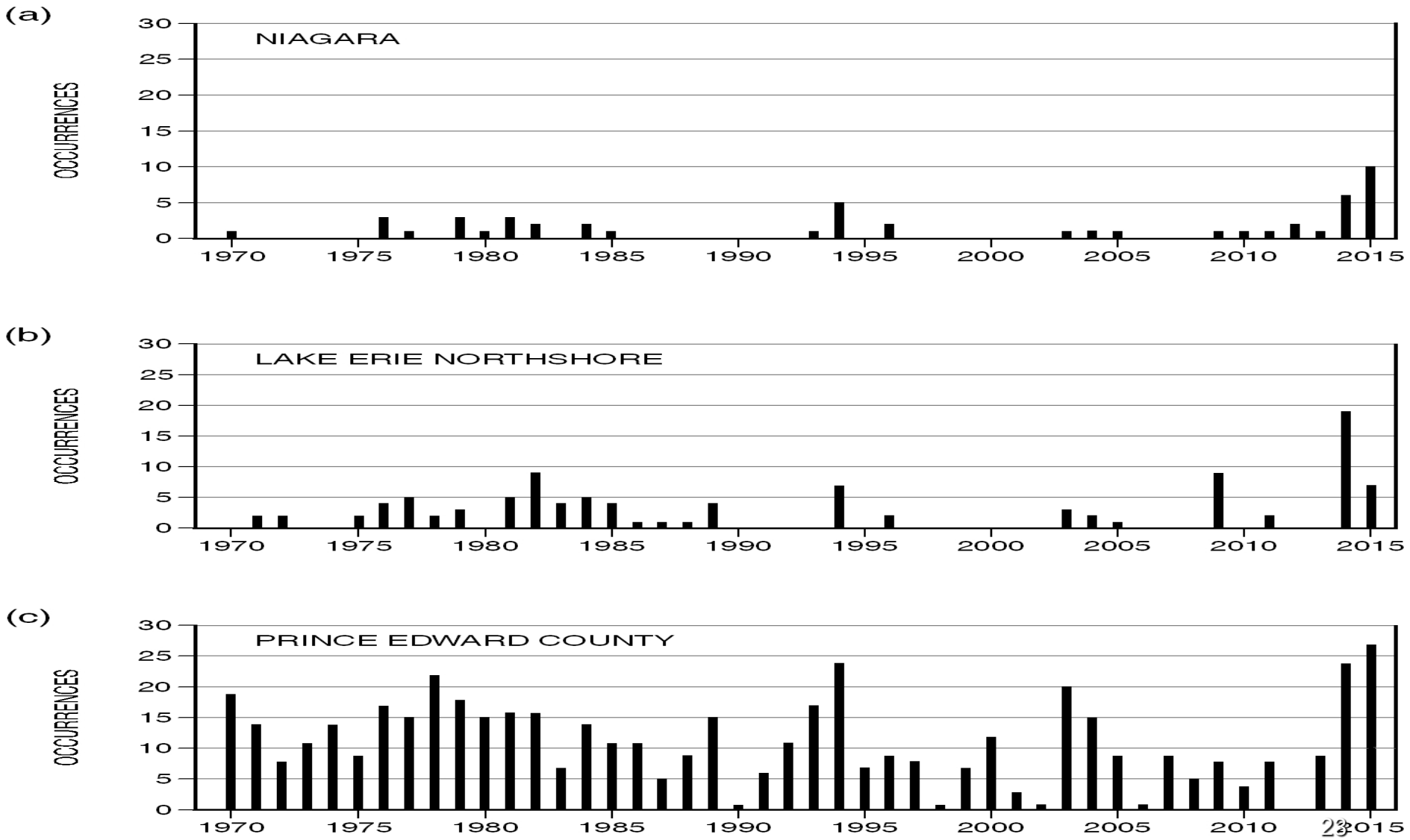
What are Extreme Climate Events in Viticulture

- **An extreme climate event is the exceedance of a threshold value by a climate variable on a particular occasion or one or more occasions within a time period for a particular crop**

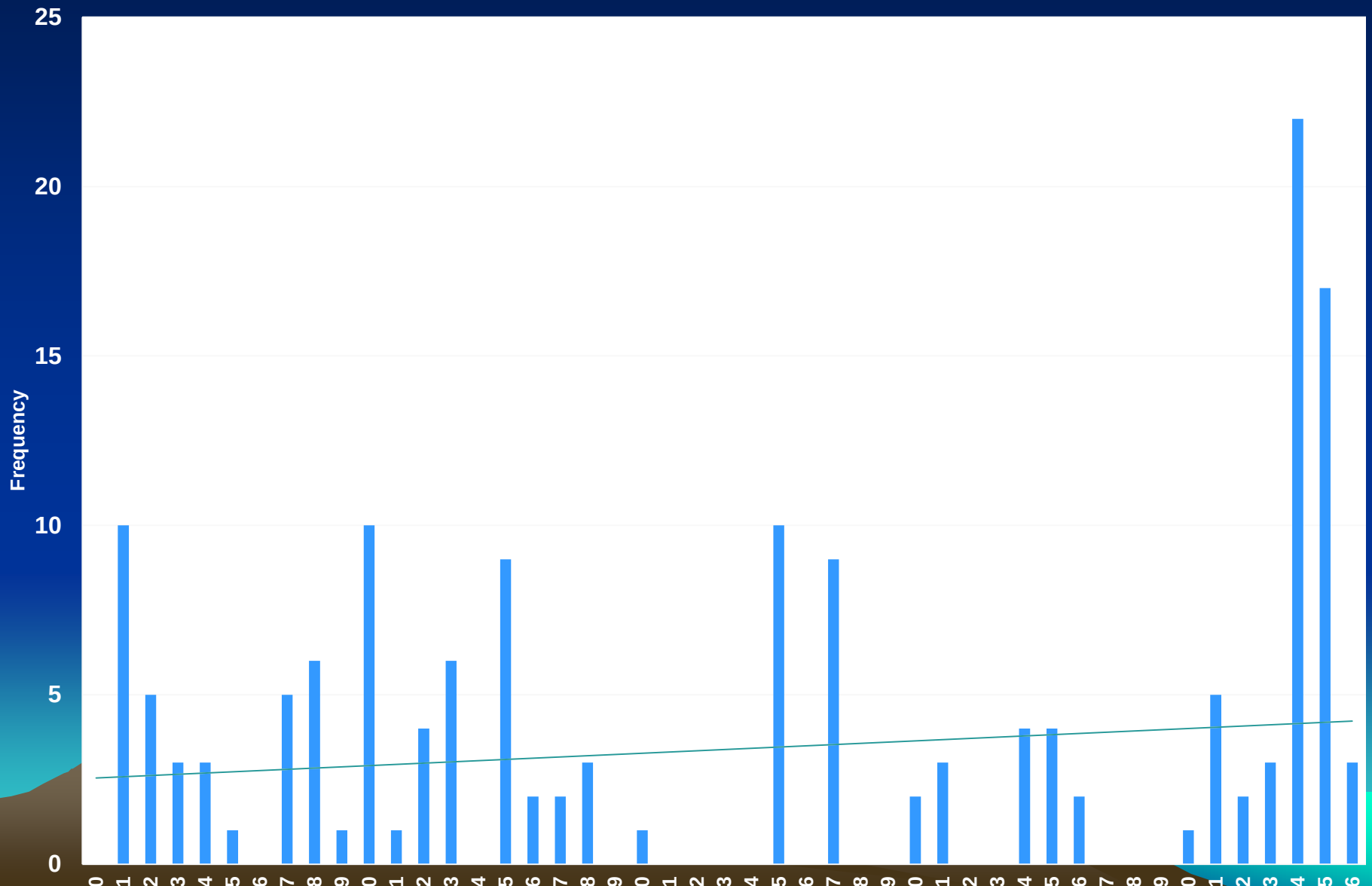
- **Extreme events are relatively more sensitive to the variability of climate than to its average and this sensitivity is relatively greater the more extreme the event**

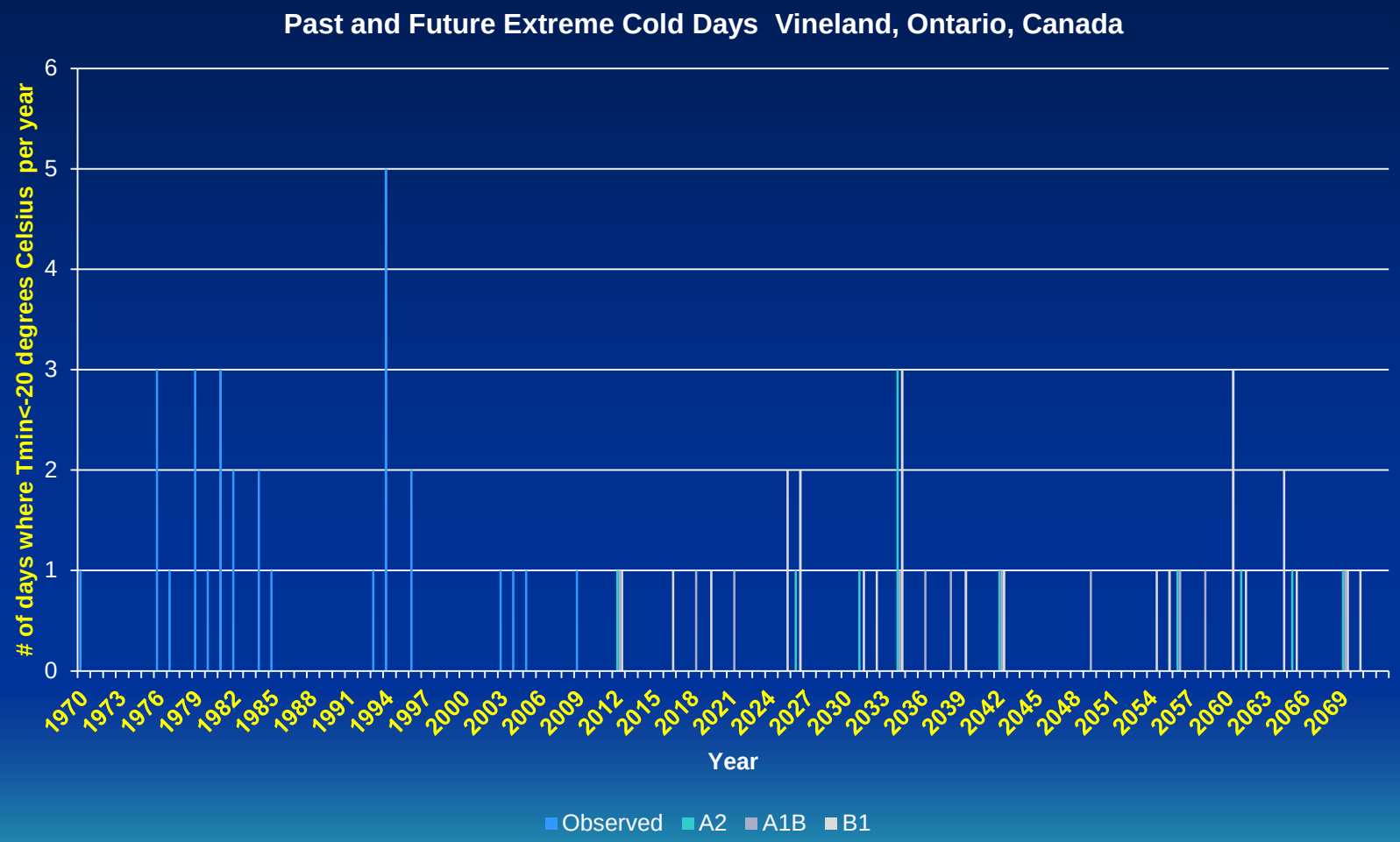
- **Extreme events can also be defined by the impact an event has on vineyard production that may involve excessive loss in yield and deterioration in quality or the destruction of the vines .**

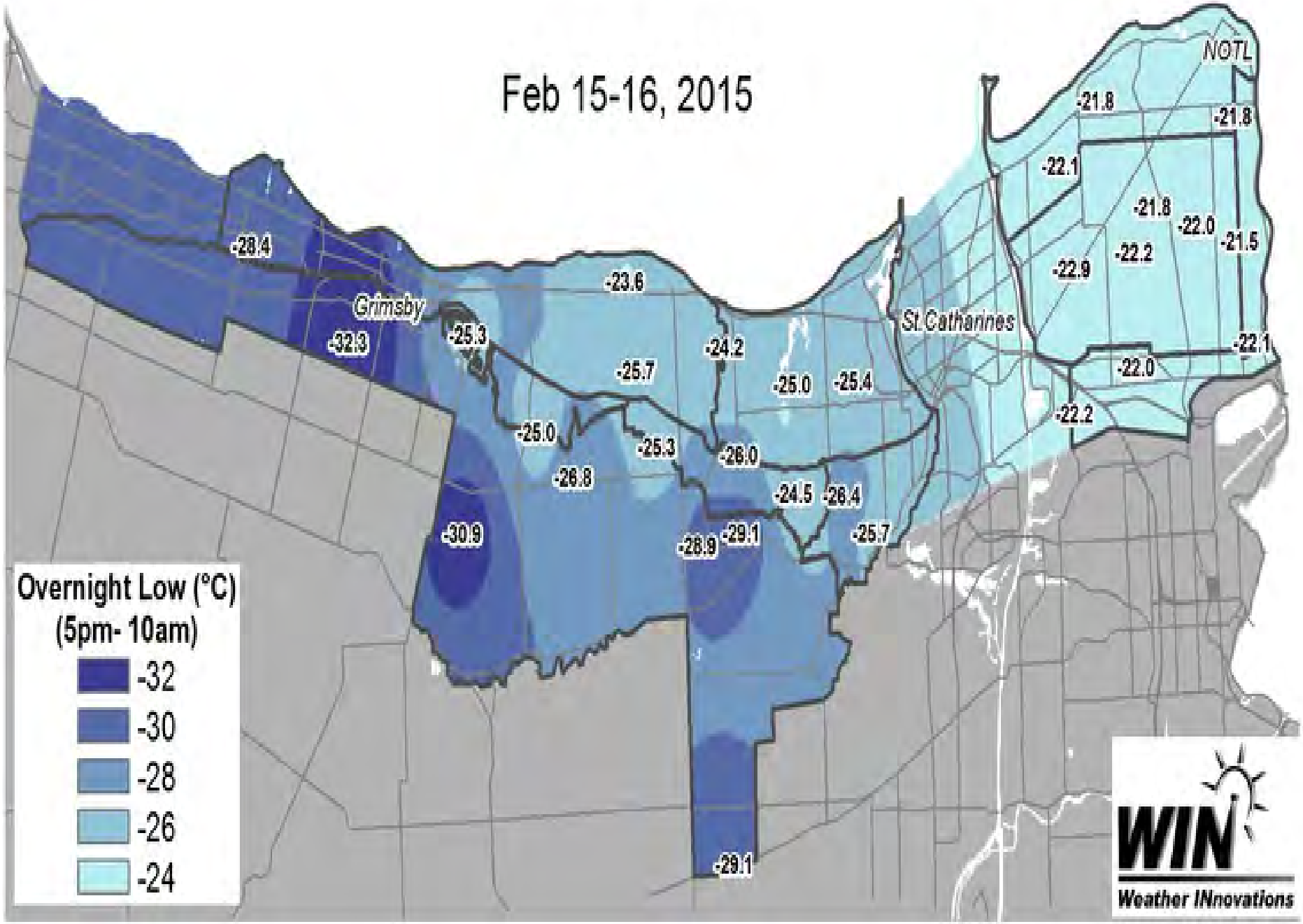
Trends in Potentially Damaging Temperatures <-20° C

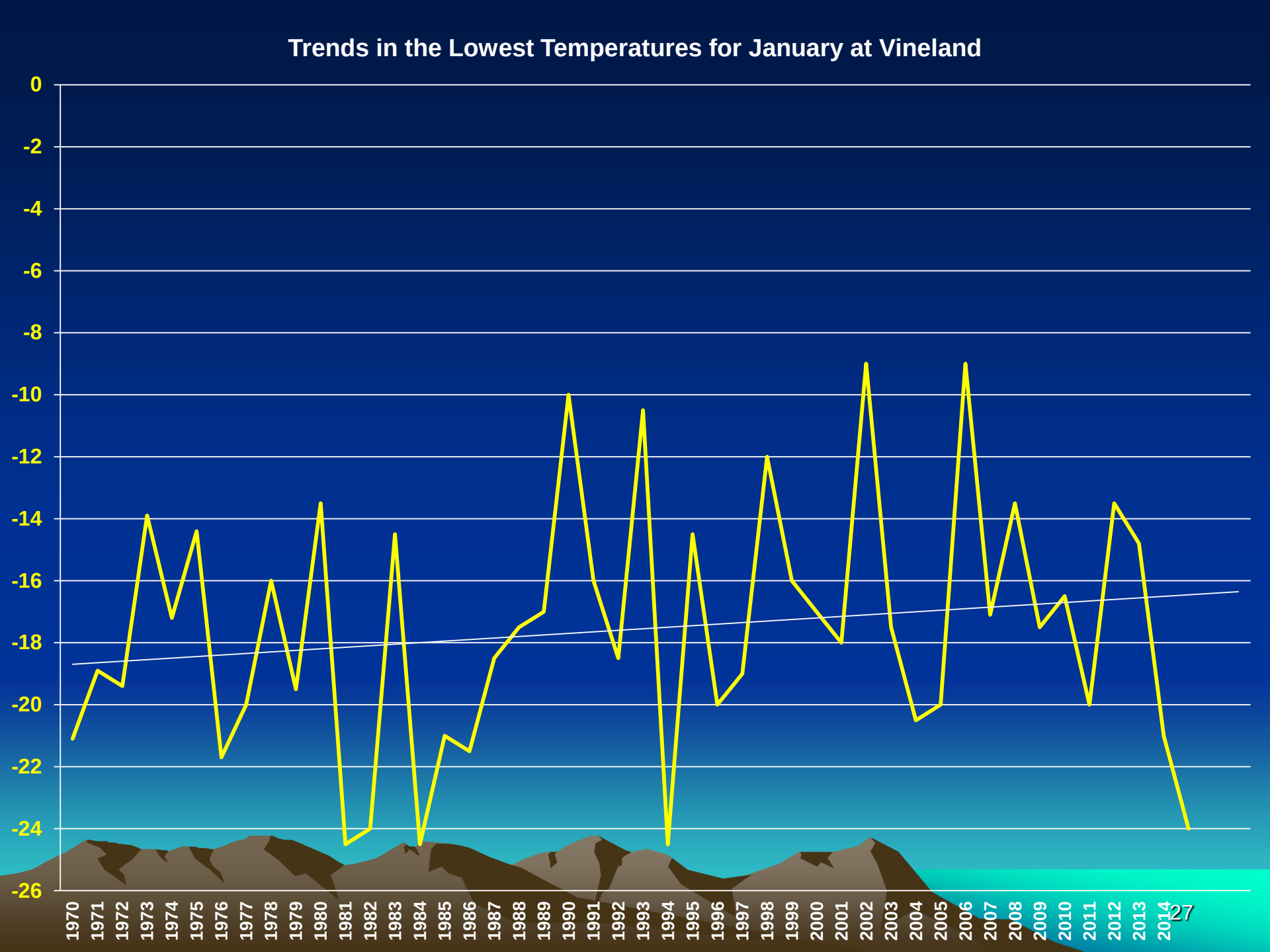


Potentially Damaging Temperatures <-20o C (Norfolk)

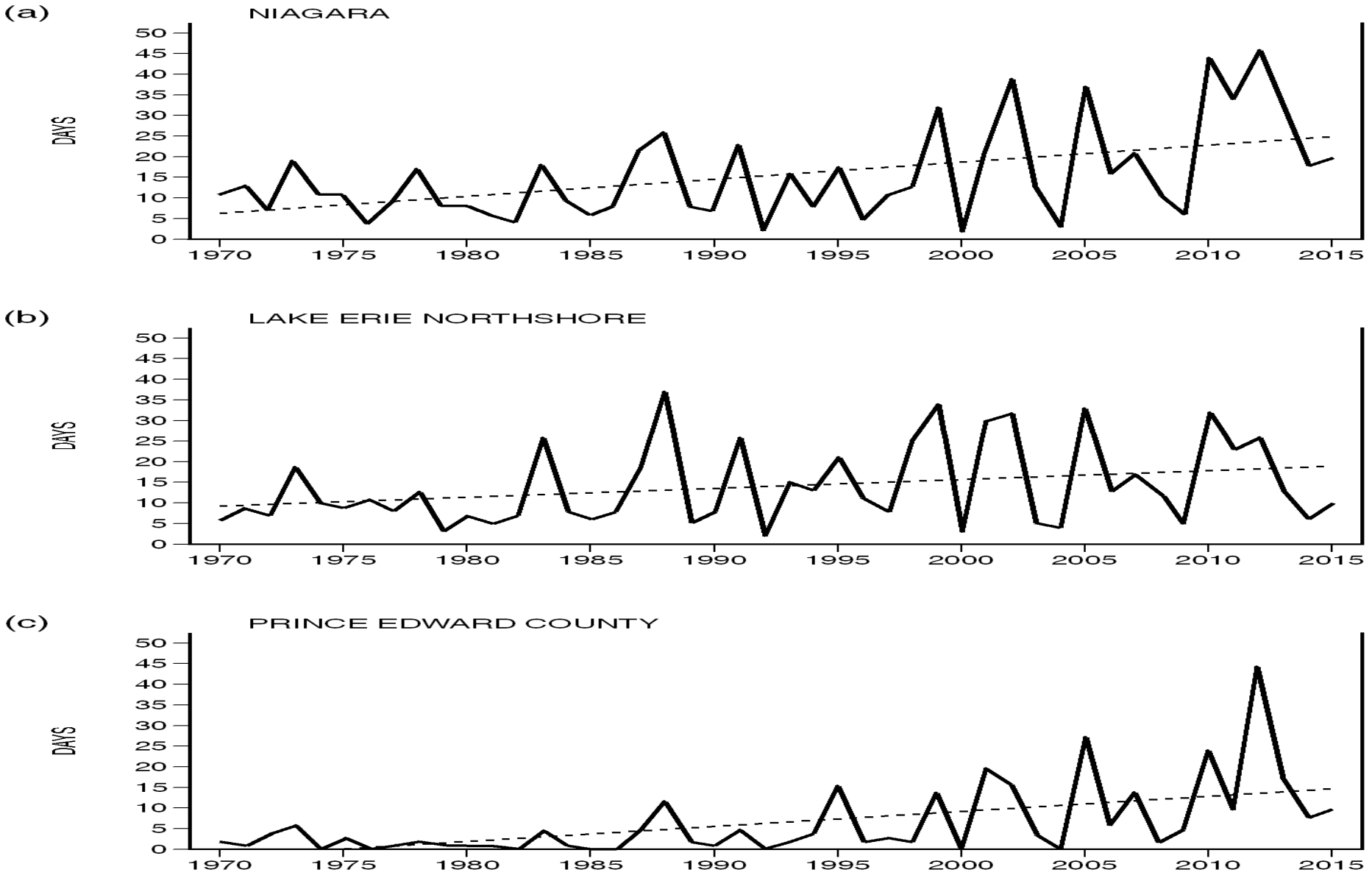



Past and Future Extreme Cold Days Vineland, Ontario, Canada
# of days where Tmin<-20 degrees Celsius per year
0
1
2
3
4
5
6
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024
2027
2030
2033
2036
2039
2042
2045
2048
2051
2054
2057
2060
2063
2066
2069
Year
Observed
A2
A1B
B1


Feb 15-16, 2015
NOTL
-21.8
-21.8
-22.1
-21.8
-22.0
-21.5
-22.9
-22.2
-22.1
-22.0
-22.2
-28.4
Grimsby
-32.3
-25.3
-23.6
-24.2
-25.7
-25.0
-25.4
St. Catharines
-25.0
-25.3
-26.0
-26.8
-24.5
-26.4
-30.9
-28.9
-29.1
-25.7
-29.1
Overnight Low (°C)
(5pm- 10am)
-32
-30
-28
-26
-24
WIN
Weather INnovations

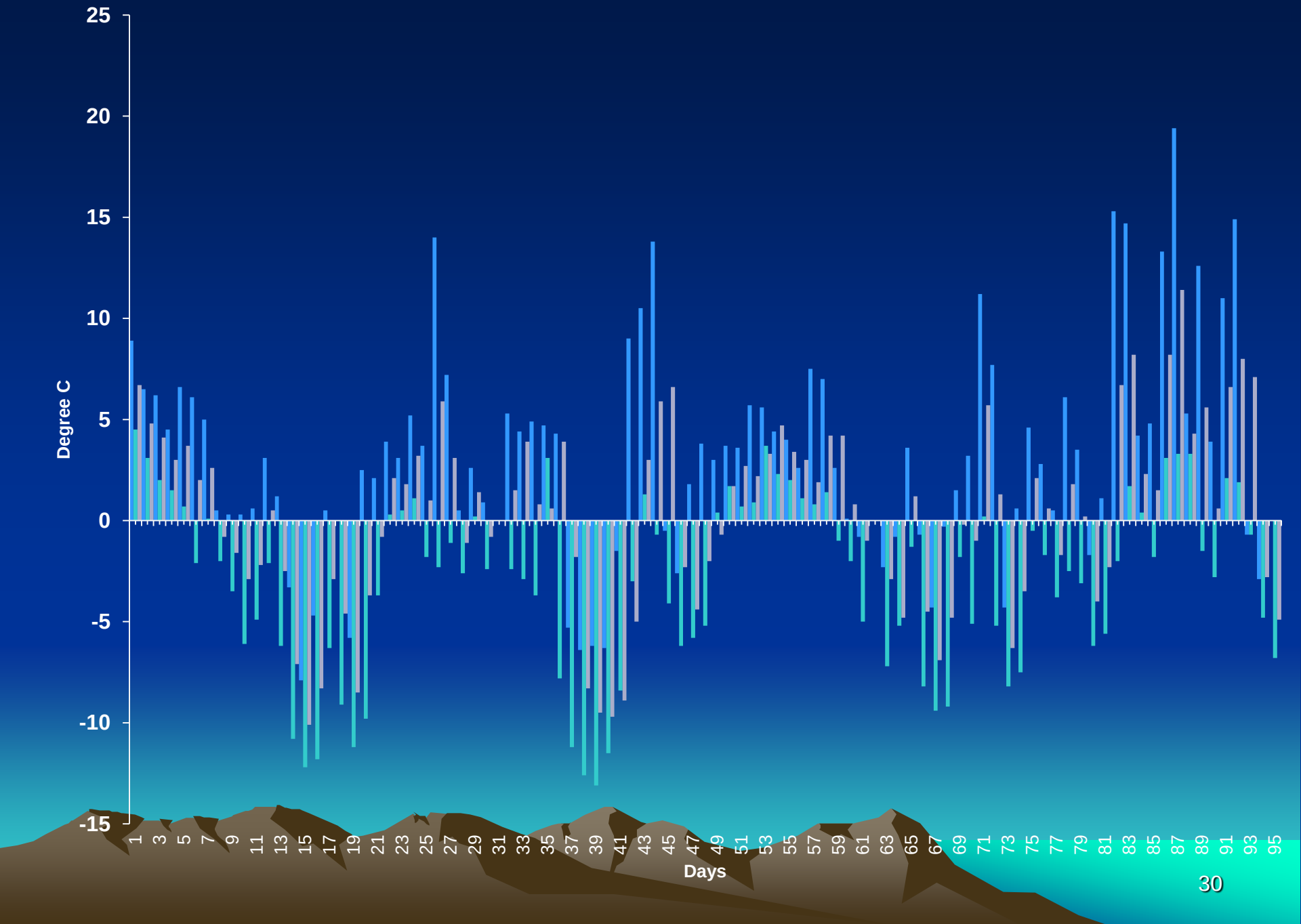

Trends in the Lowest Temperatures for January at Vineland
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
27

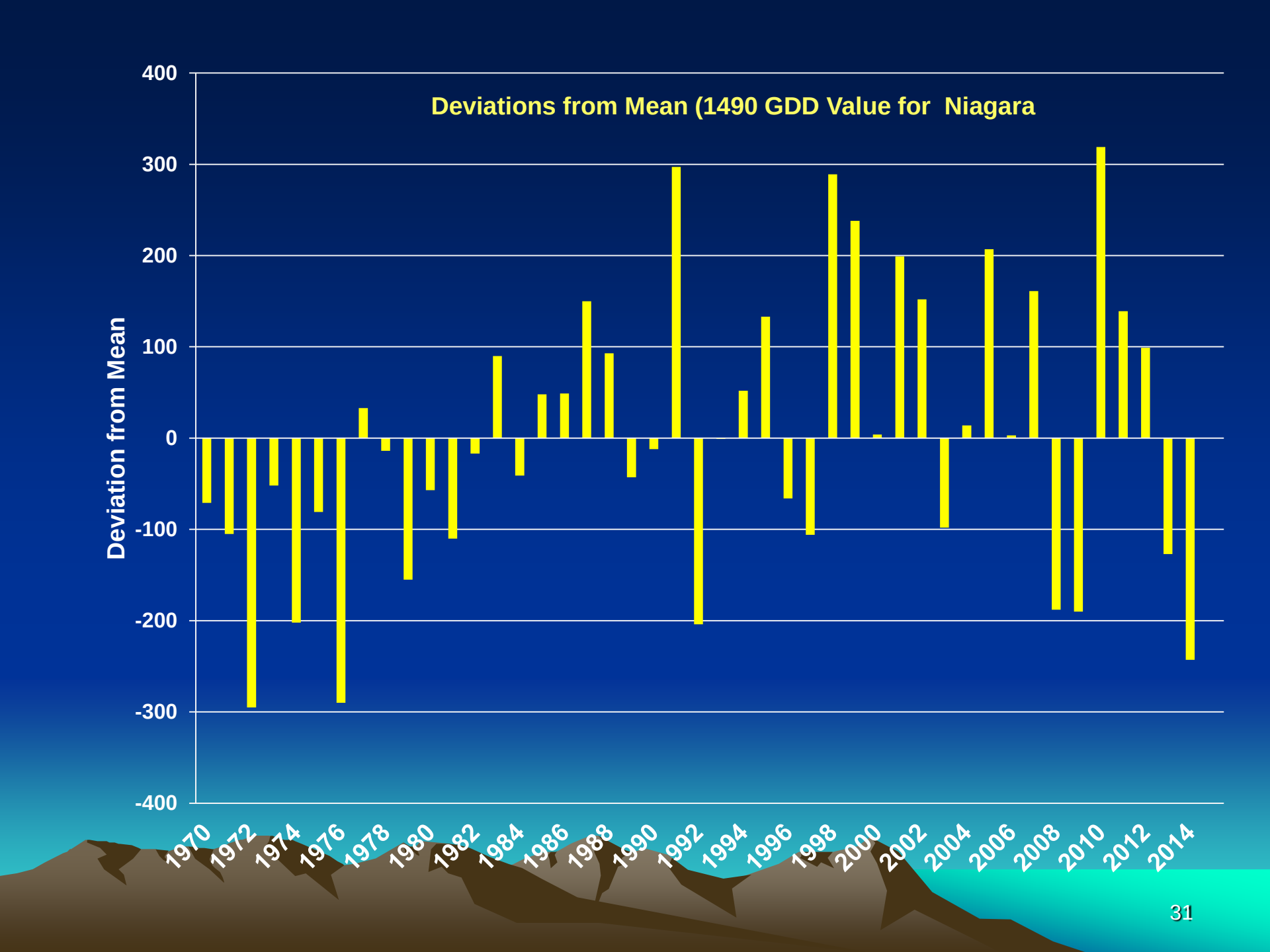
Occurrences of Extreme Maximum Temp>30o C

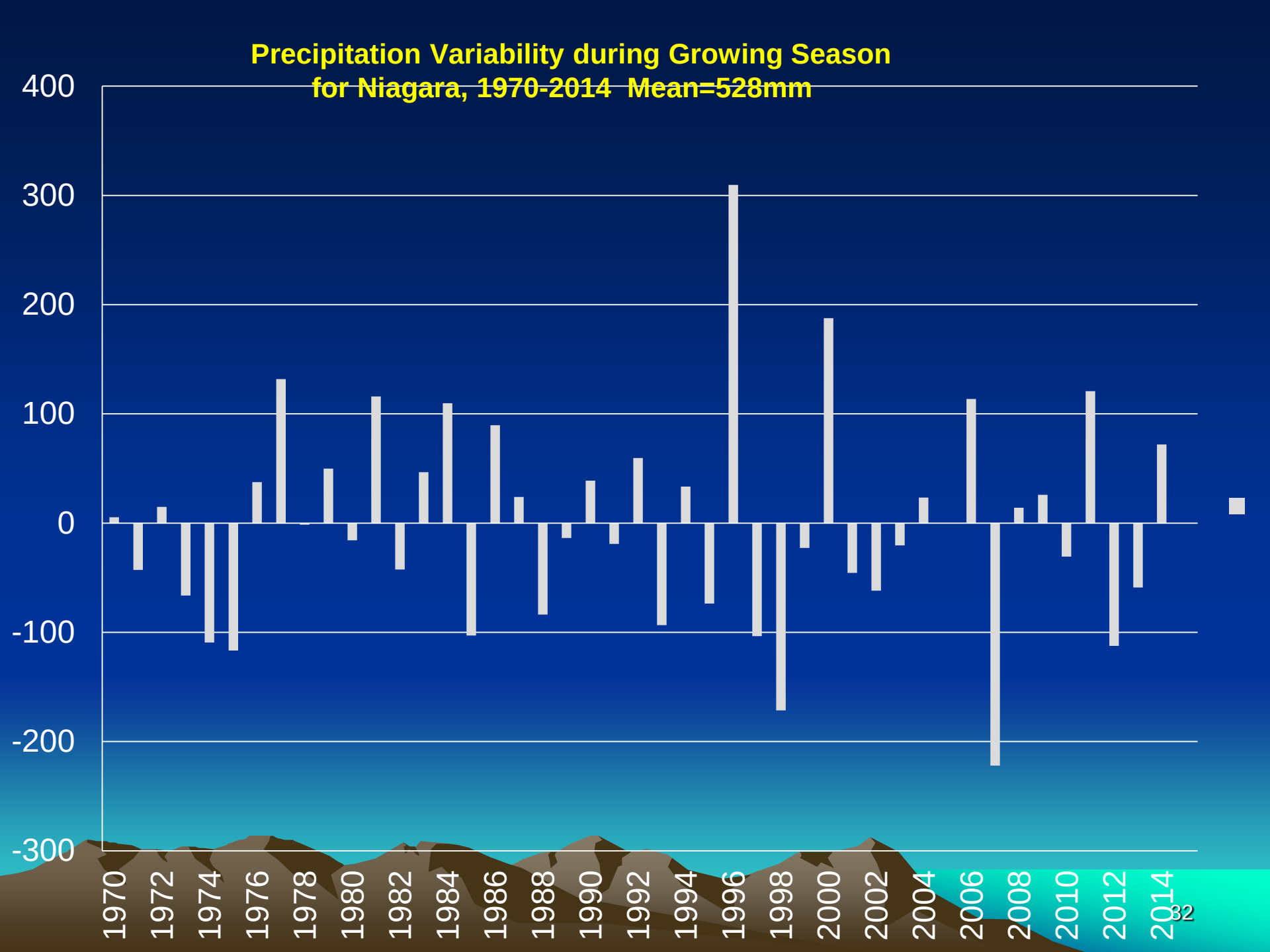


- **Definition:** Volatility is the pace at which a climatic variable or index (temperature or precipitation) moves higher or lower over a time period, and how widely it varies or how extreme is the fluctuation

Daily temperature Variations December 1/16 to March 3/ 2017



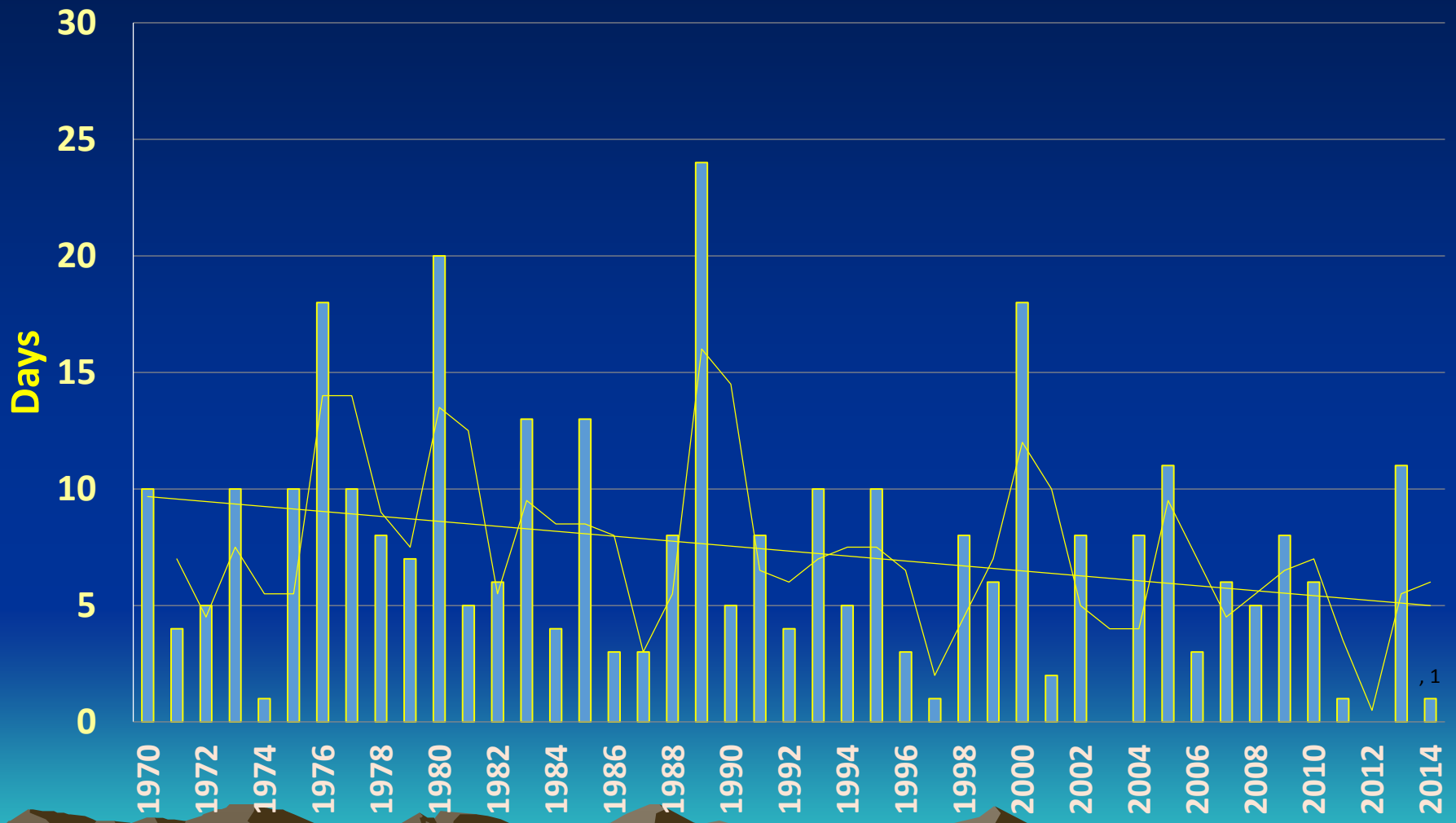

Deviations from Mean (1490 GDD Value for Niagara
Deviation from Mean
400
300
200
100
0
-100
-200
-300
-400
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Precipitation Variability during Growing Season
for Niagara, 1970-2014 Mean=528mm
400
300
200
100
0
-100
-200
-300
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

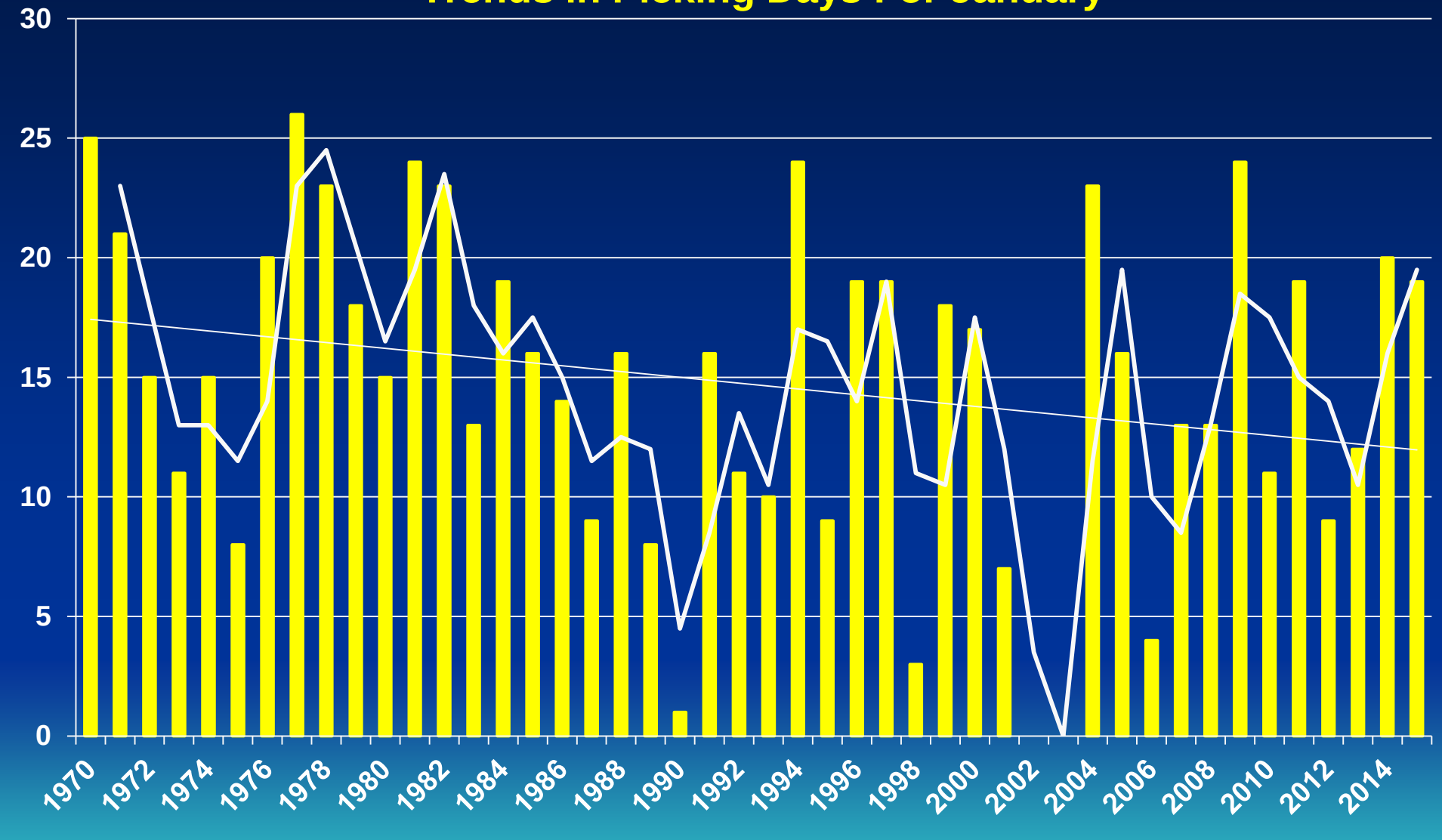
Ice Wine and Climate Change

Vineyard Scale

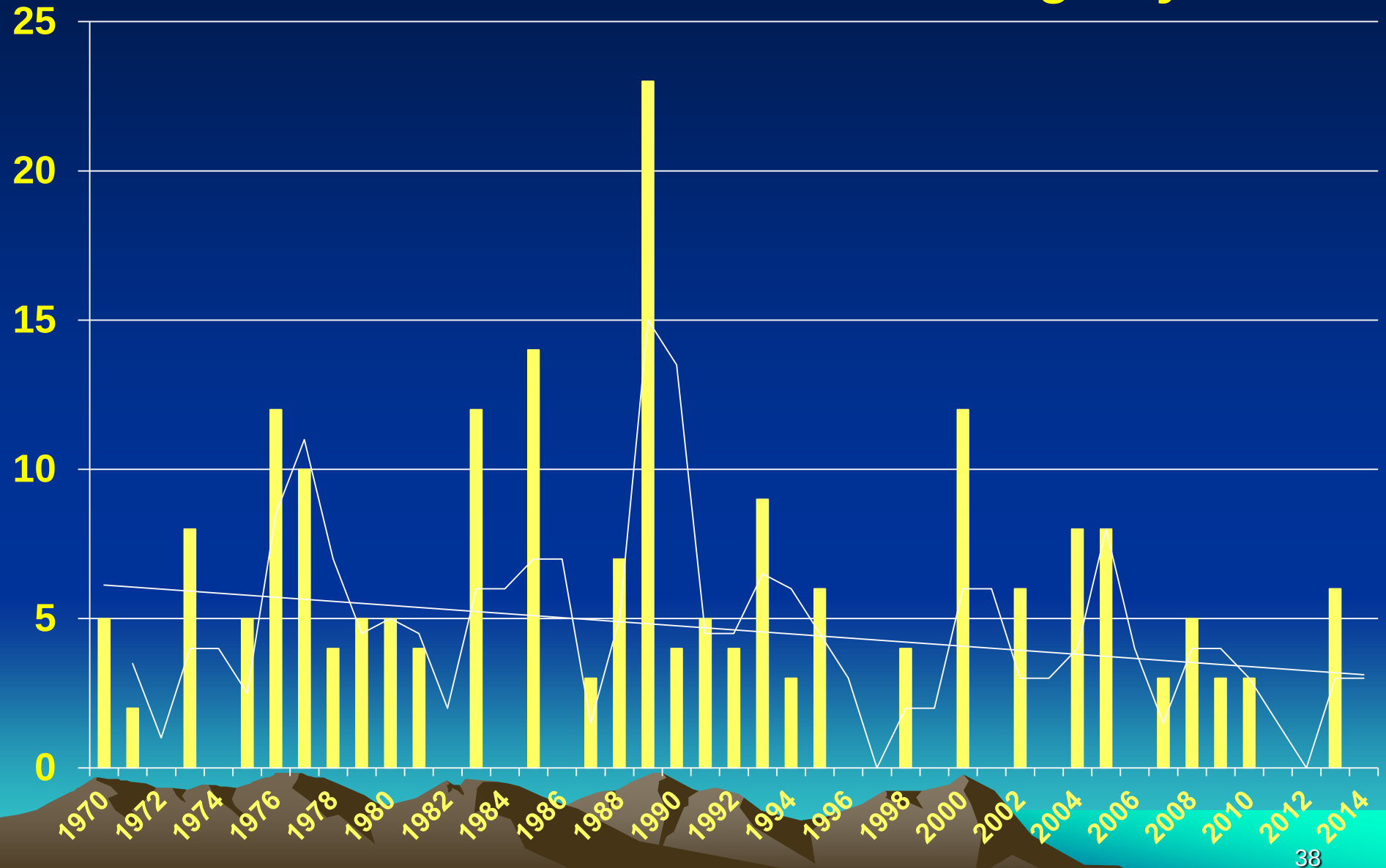
Trends in Ice Wine Picking Days For December



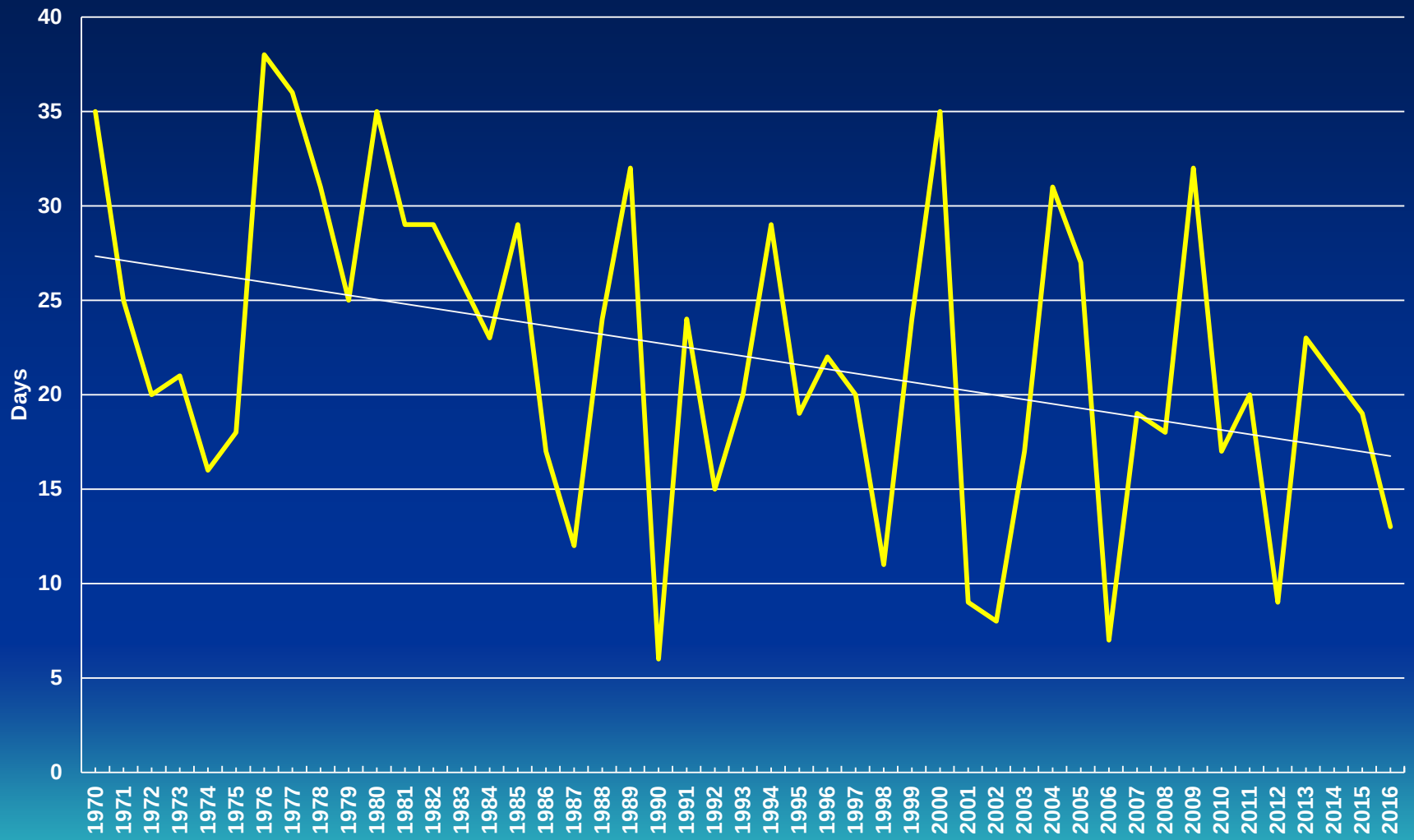
Trends in Picking Days For January



Trends in Consecutive Picking Days



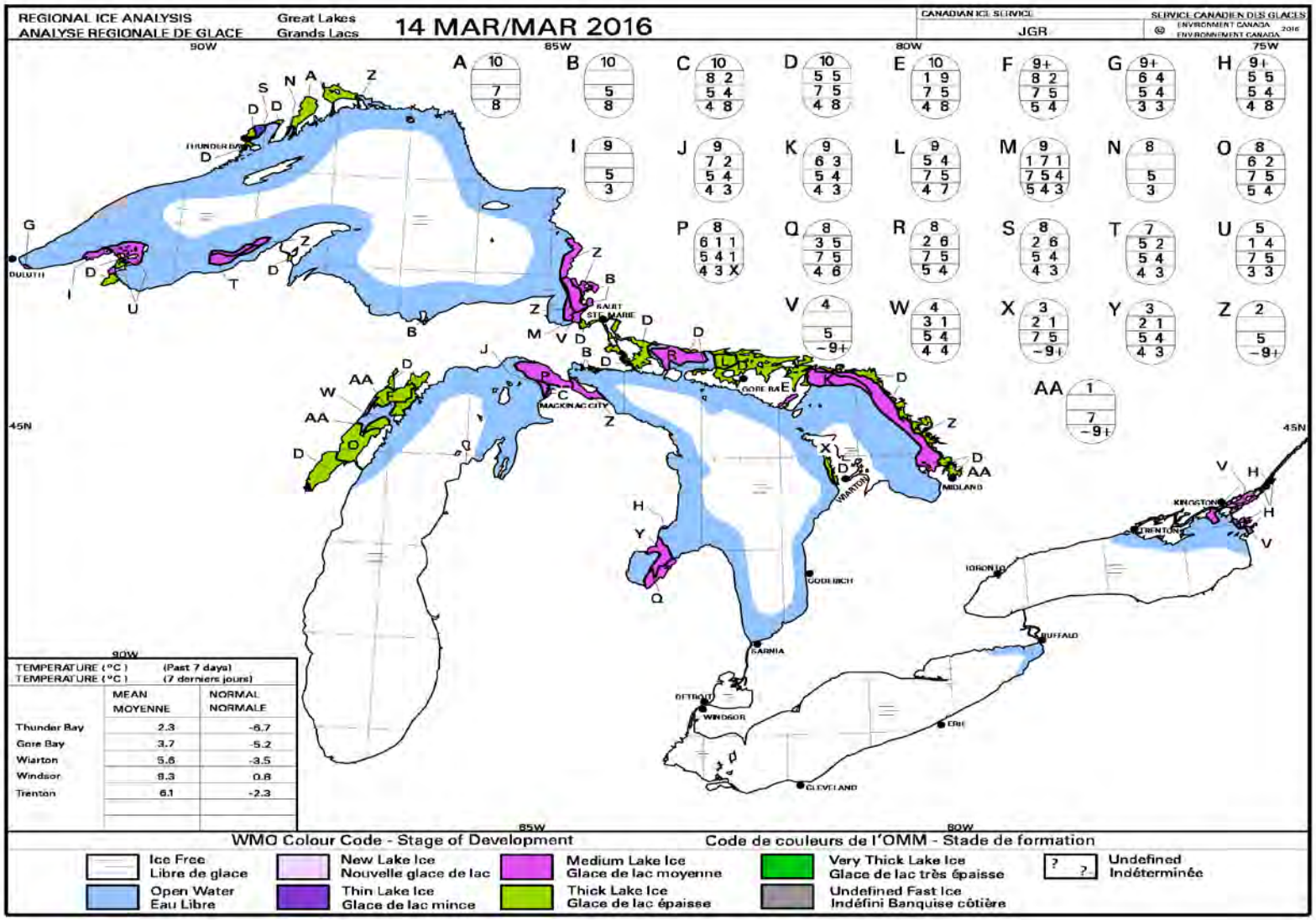
Trends in Ice Wine Picking Days in Dec & Jan (1970-2016, Niagara Ontario)



Great Lakes and Climate Change

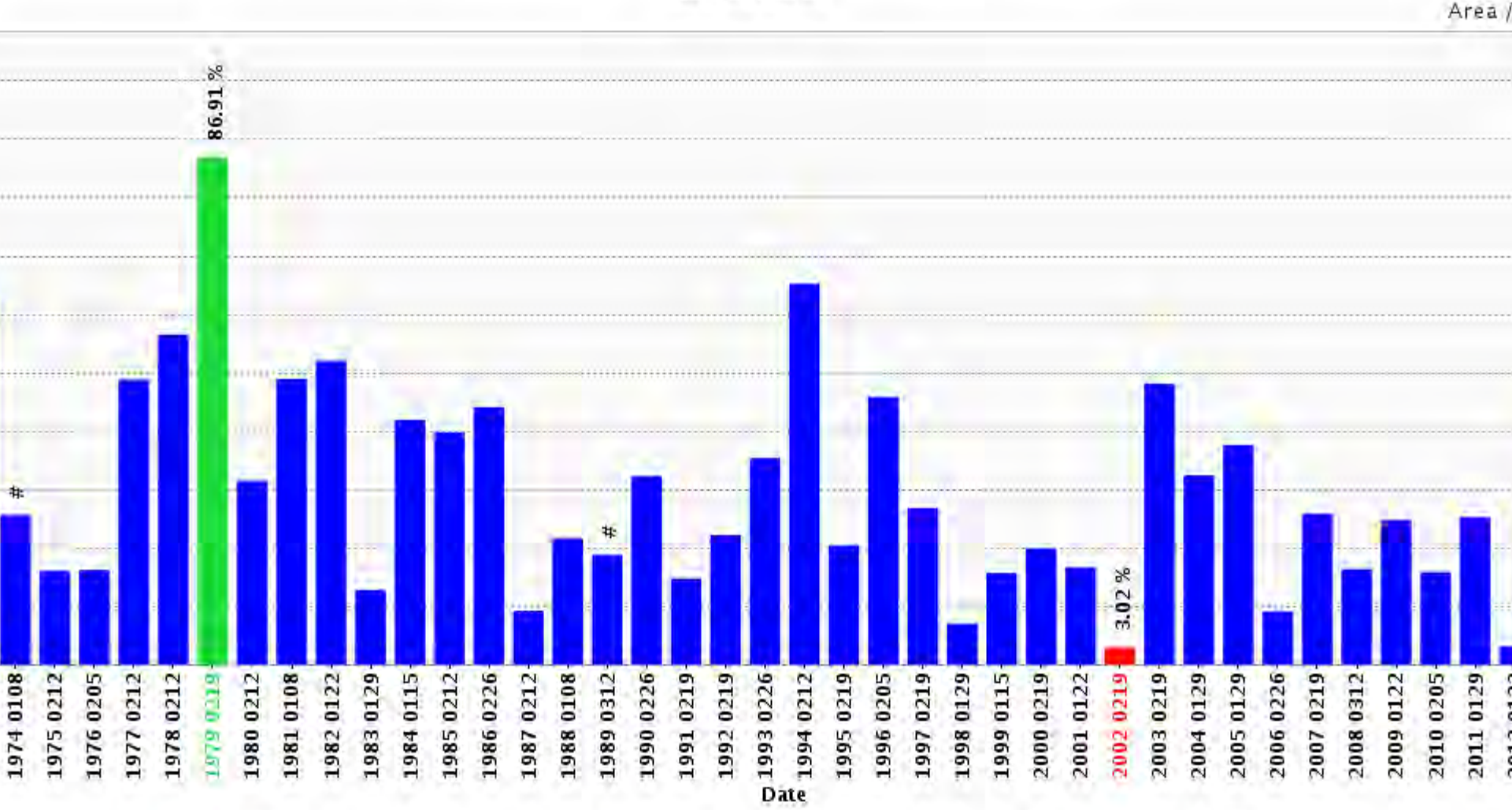

Georgian Bay
Lake Huron
Grey
Durham
P EC
Huron
Lake Ontario
Norfolk
Niagara
Lake Erie
North Shore

March 2016 Ice Cover



La couverture maximale de glace pour les semaines 1204-0514, saisons: 1972/73-2013/14

Lake Ontario /
Lac Ontario

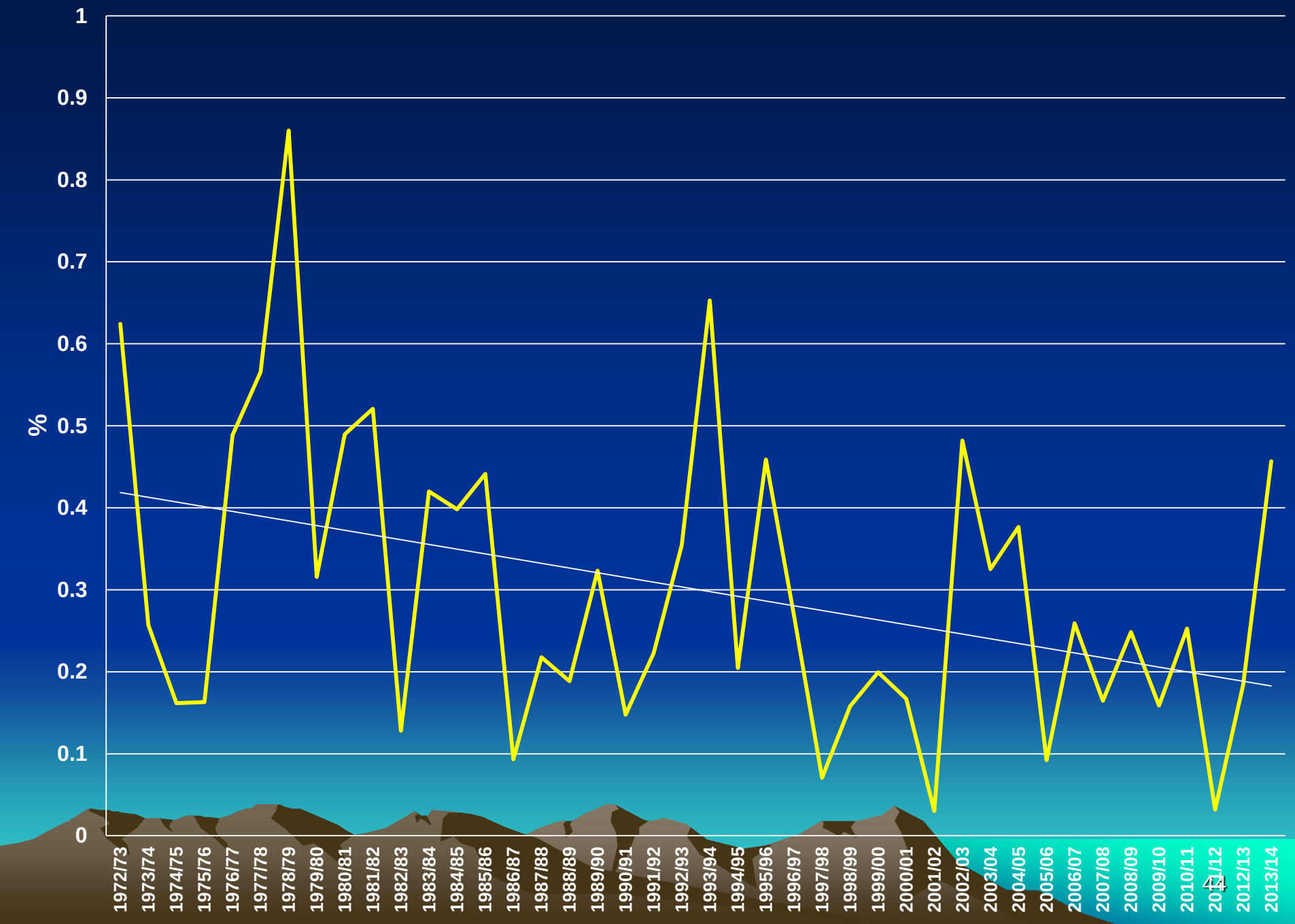


Canadian Ice Service - Environment Canada / Service canadien des glaces - Environnement Canada
(2014-11-17 10:47 IceGraph - Canadian Ice Service/Graphe des glaces - Service canadien des glaces 2.0.6 2013/07/24)

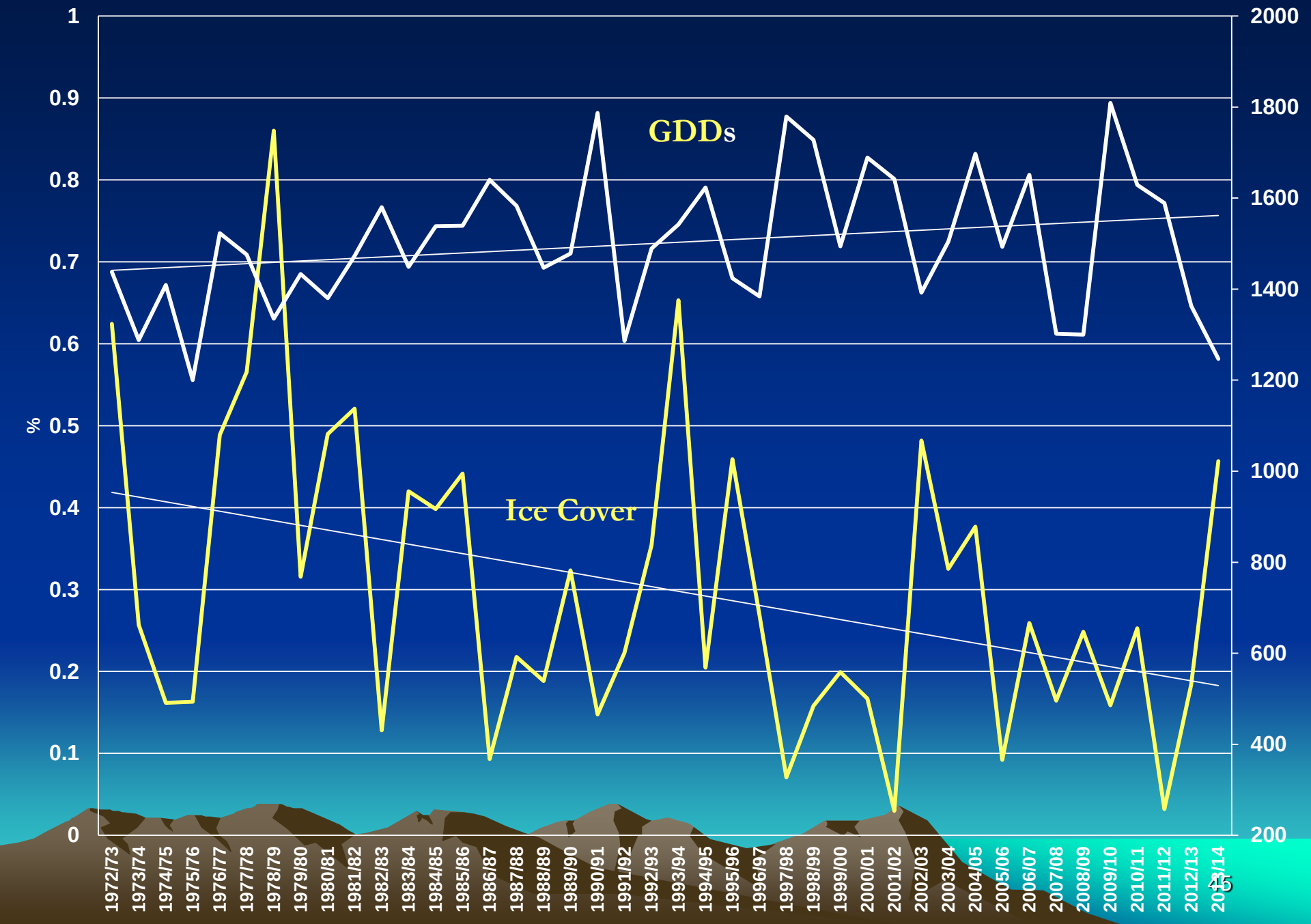
ture des glaces ■ Lowest / Le plus bas: 2002 0219 - 3.02% ■ Highest / Le plus haut: 1979 0219 - 86.91%

latest weeks the maximum occurred in the period /
le plus tard dans la période lorsqu'on a atteint le maximum

Trends in Maximum Ice Cover for Lake Ontario

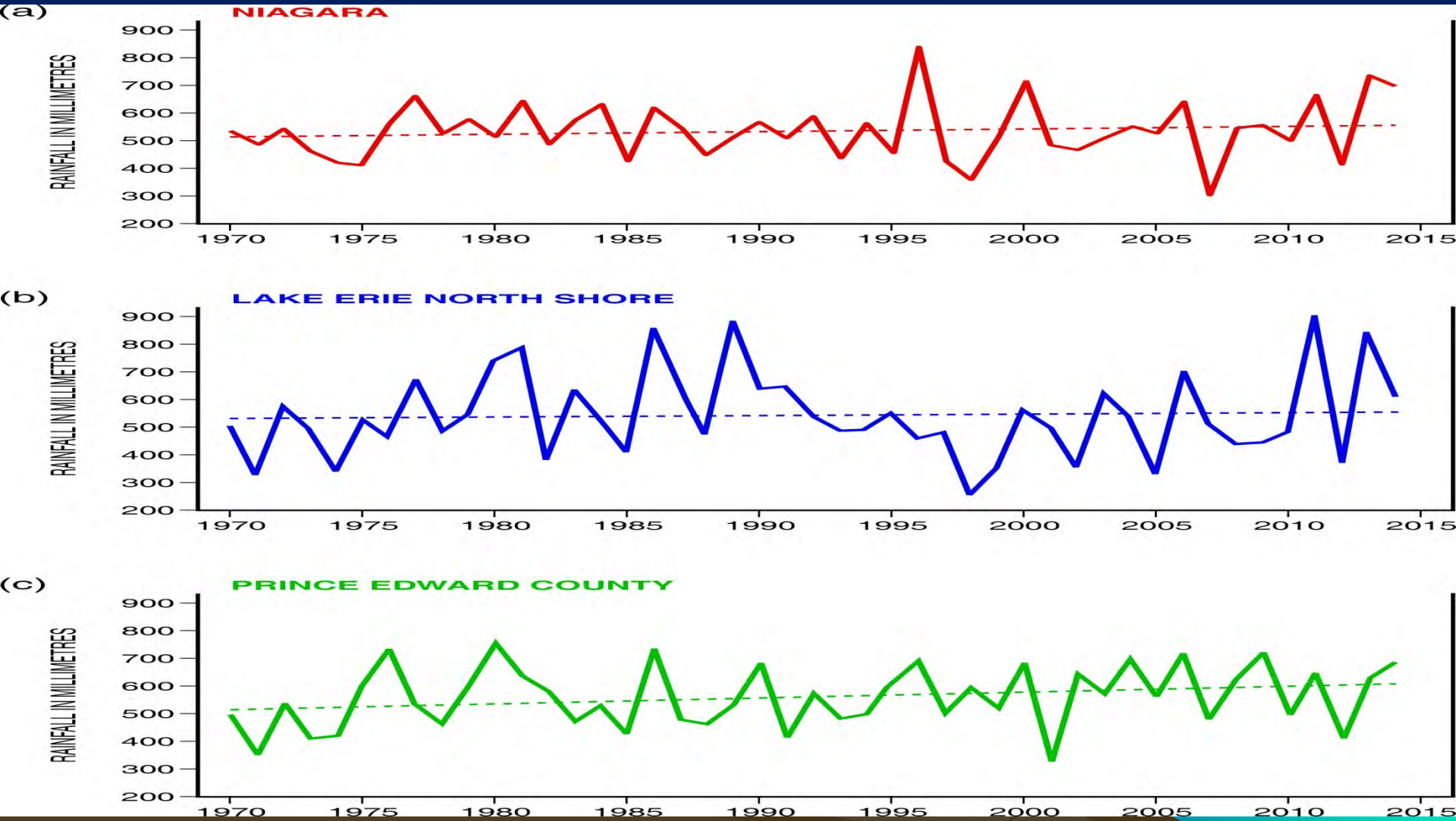


Lake Ontario's Ice Cover vs GDDs Values For Niagara

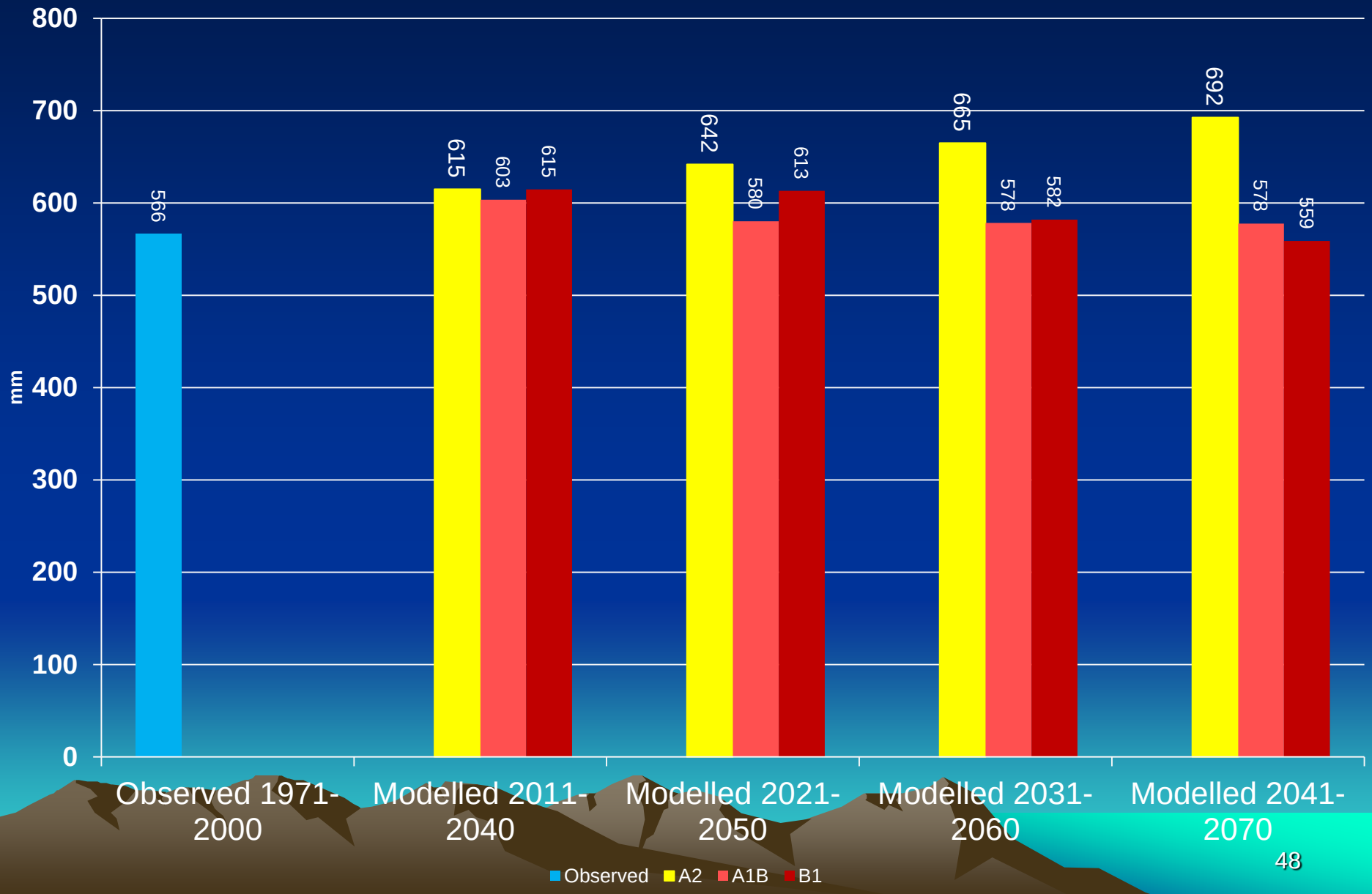


April –October Precipitation For Vineland

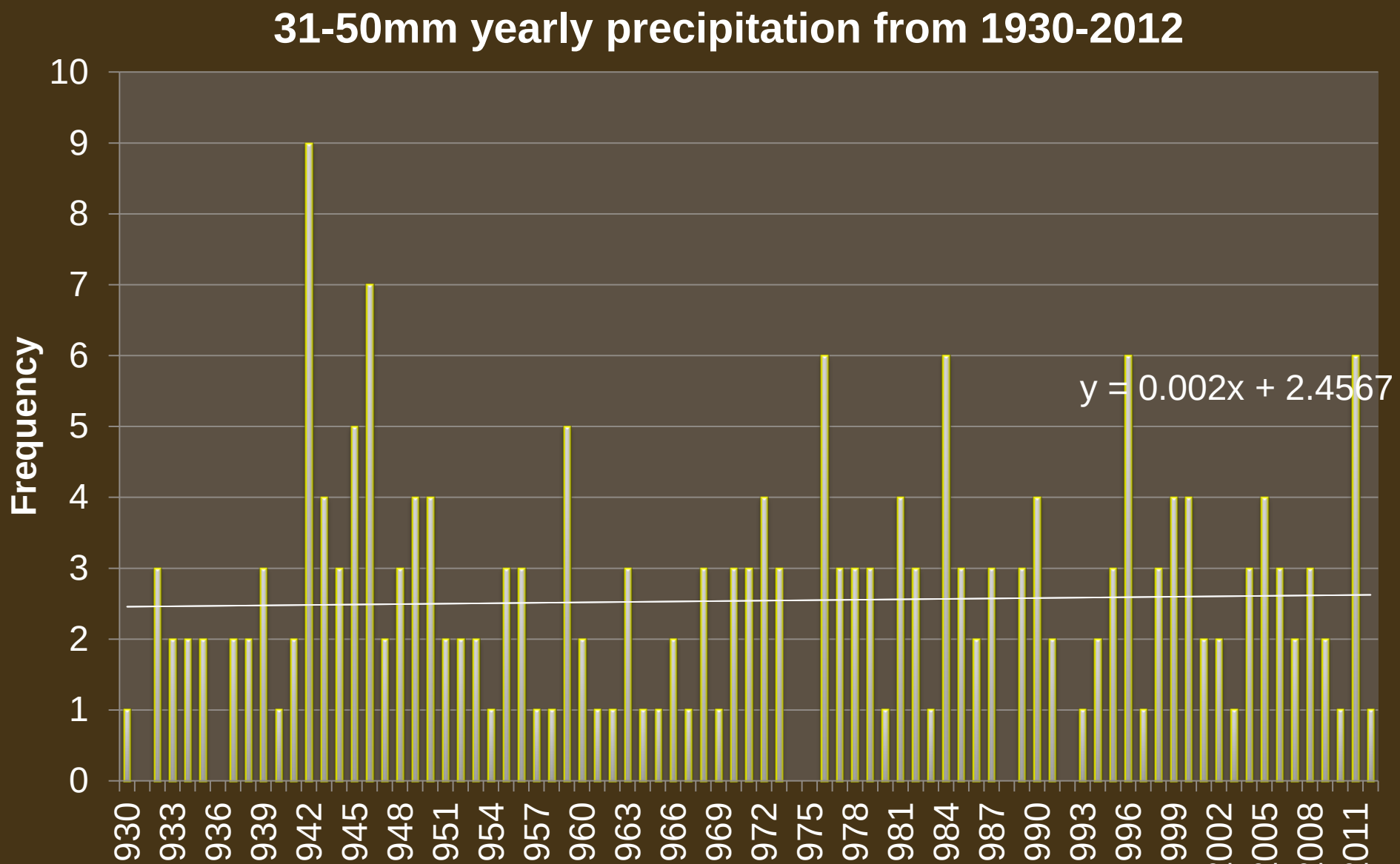
Trends in Growing April-October Rainfall Totals



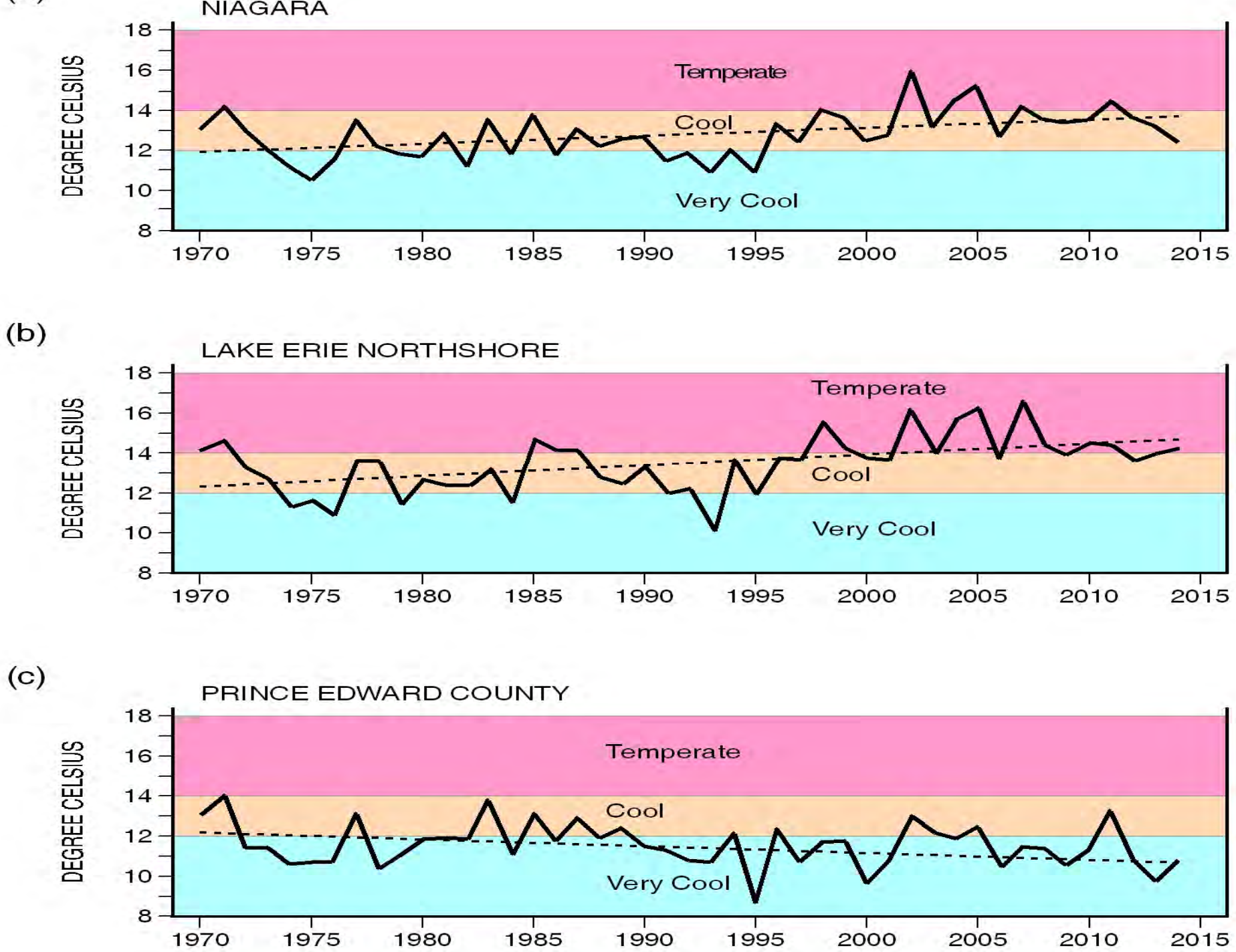
Past and Projected Climate Normals
Growing Season (AMJJASO) Total Precipitation
Vineland, Ontario, Canada



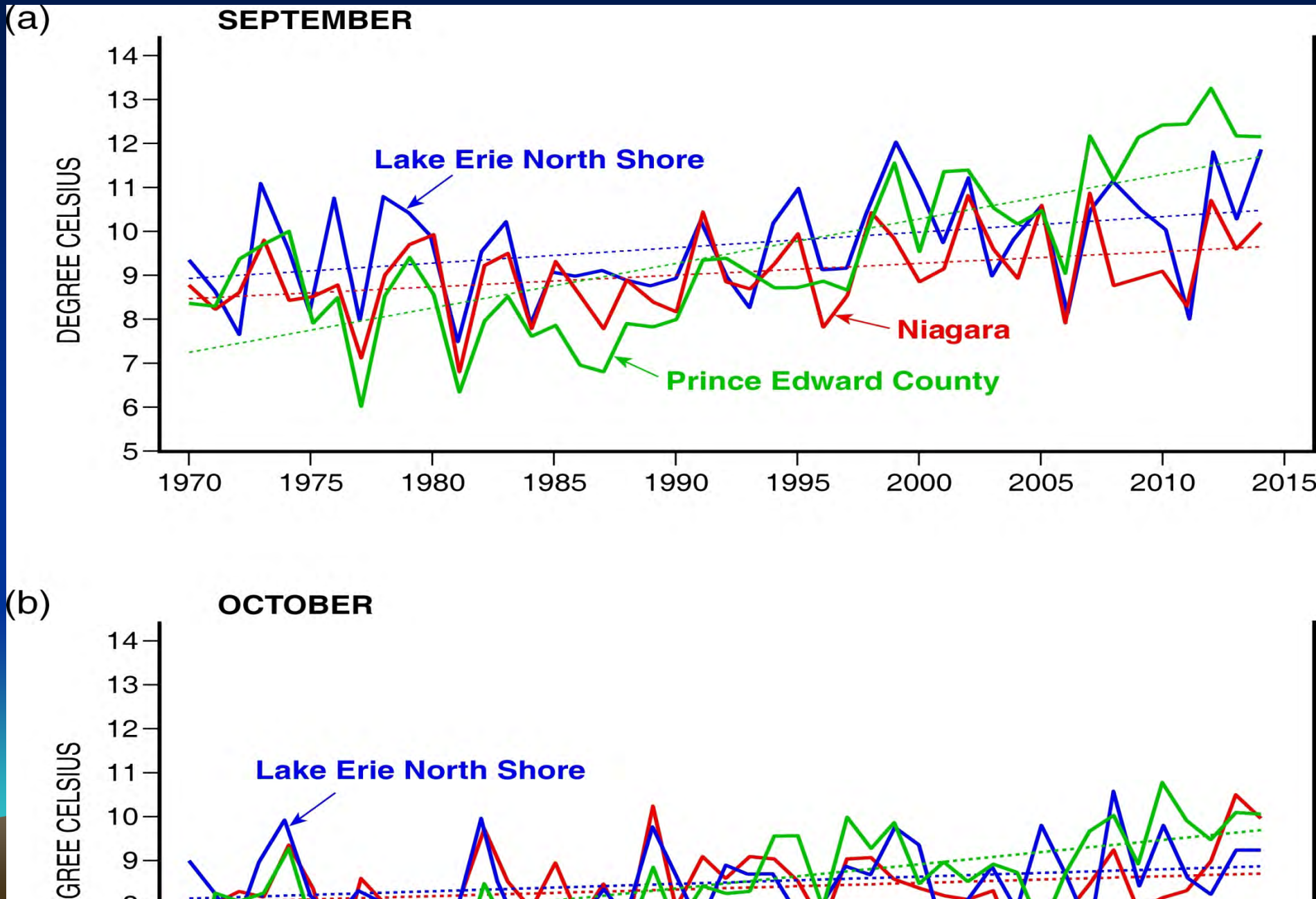
Extreme Precipitation Events

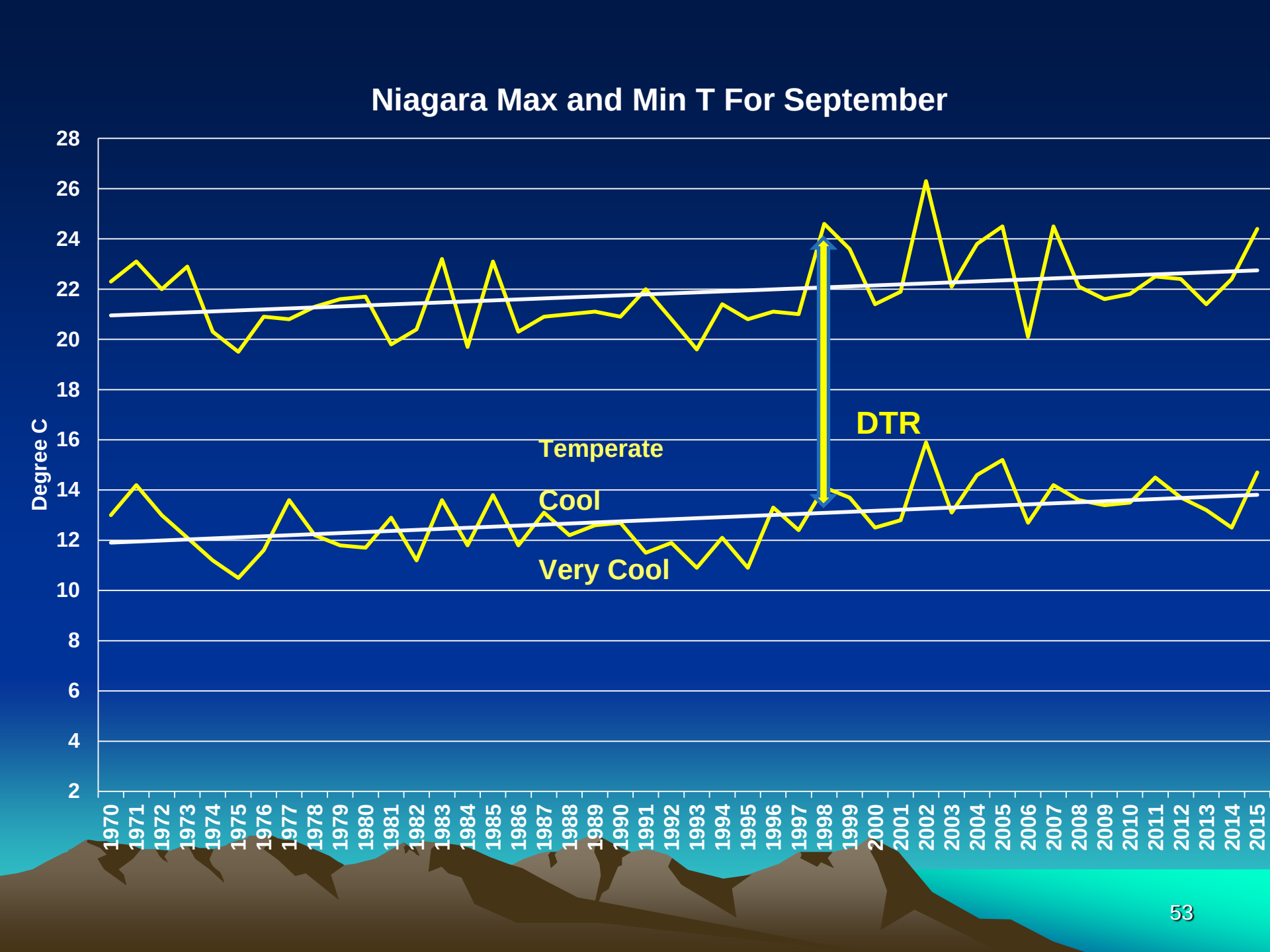


Temperature During the Ripening Period

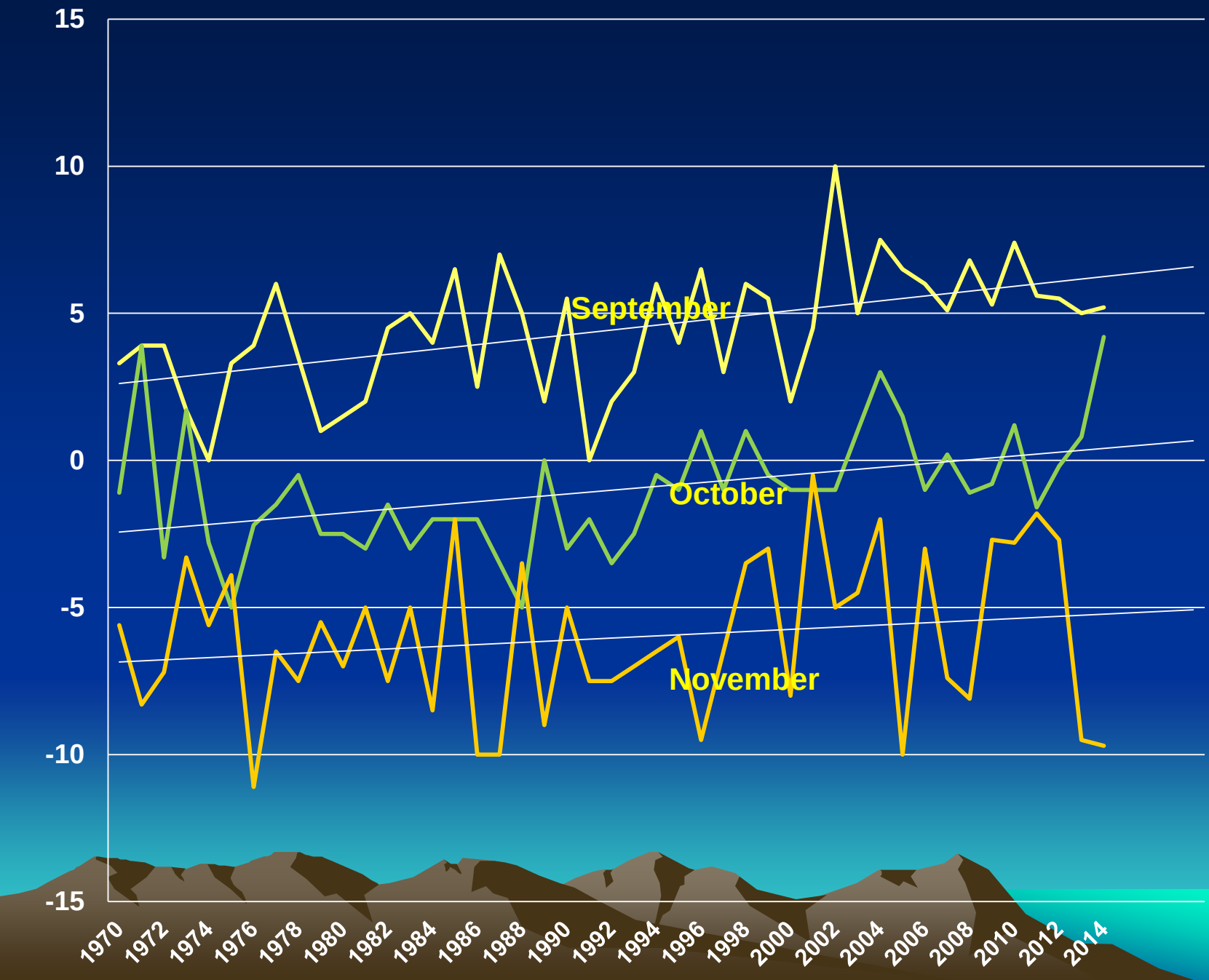

NIAGARA
DEGREE CELSIUS
18
16
14
12
10
8
Temperate
Cool
Very Cool
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
(b)
LAKE ERIE NORTHSHORE
DEGREE CELSIUS
Temperate
Cool
Very Cool
(c)
PRINCE EDWARD COUNTY
DEGREE CELSIUS
Temperate
Cool
Very Cool

Trends in Diurnal Temperature Range During Ripening Period



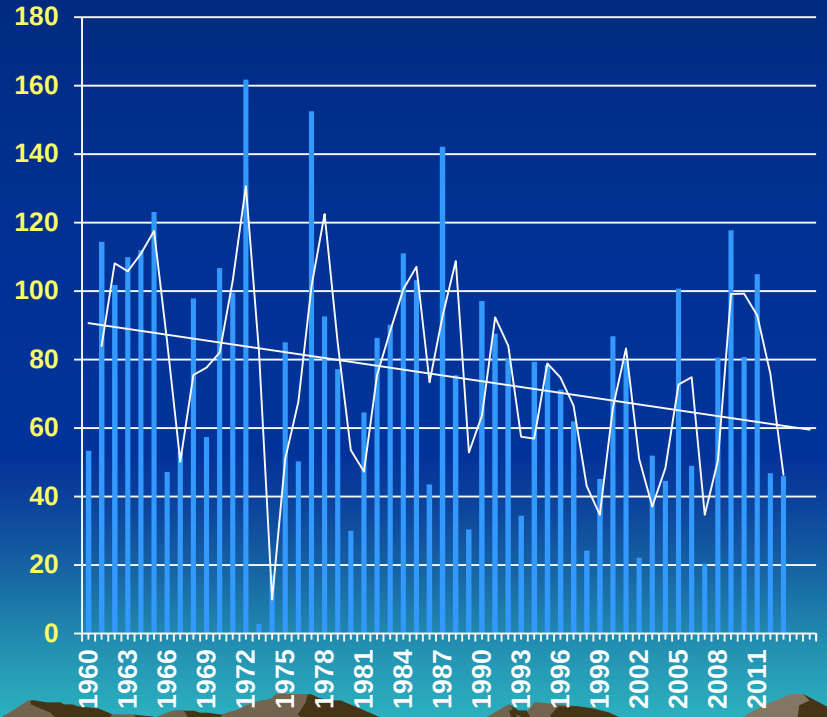

Niagara Max and Min T For September
Degree C
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Temperate
Cool
Very Cool
DTR
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

Vineland's Lowest Fall Minimum Temperatures

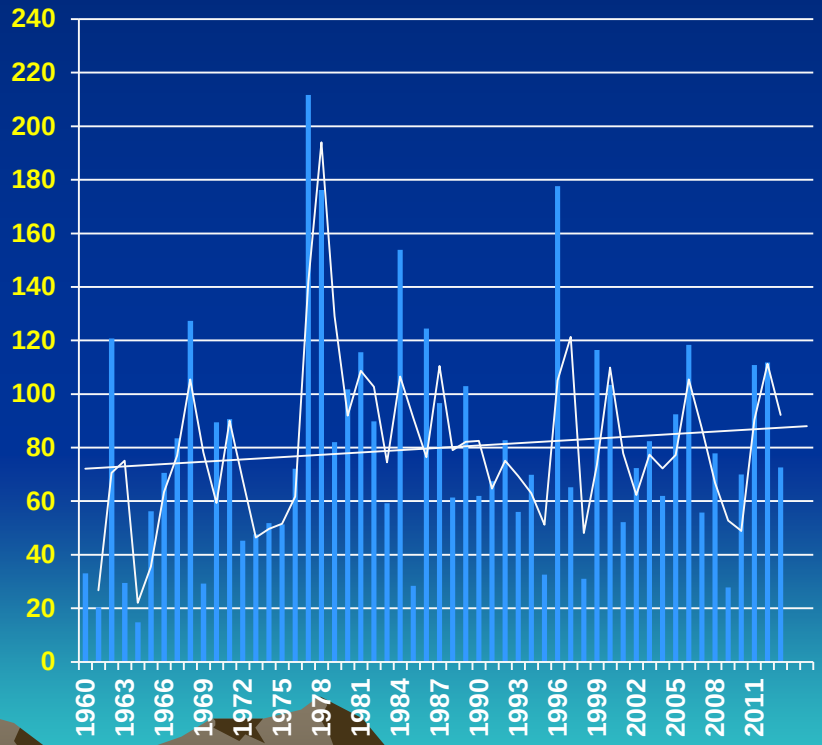


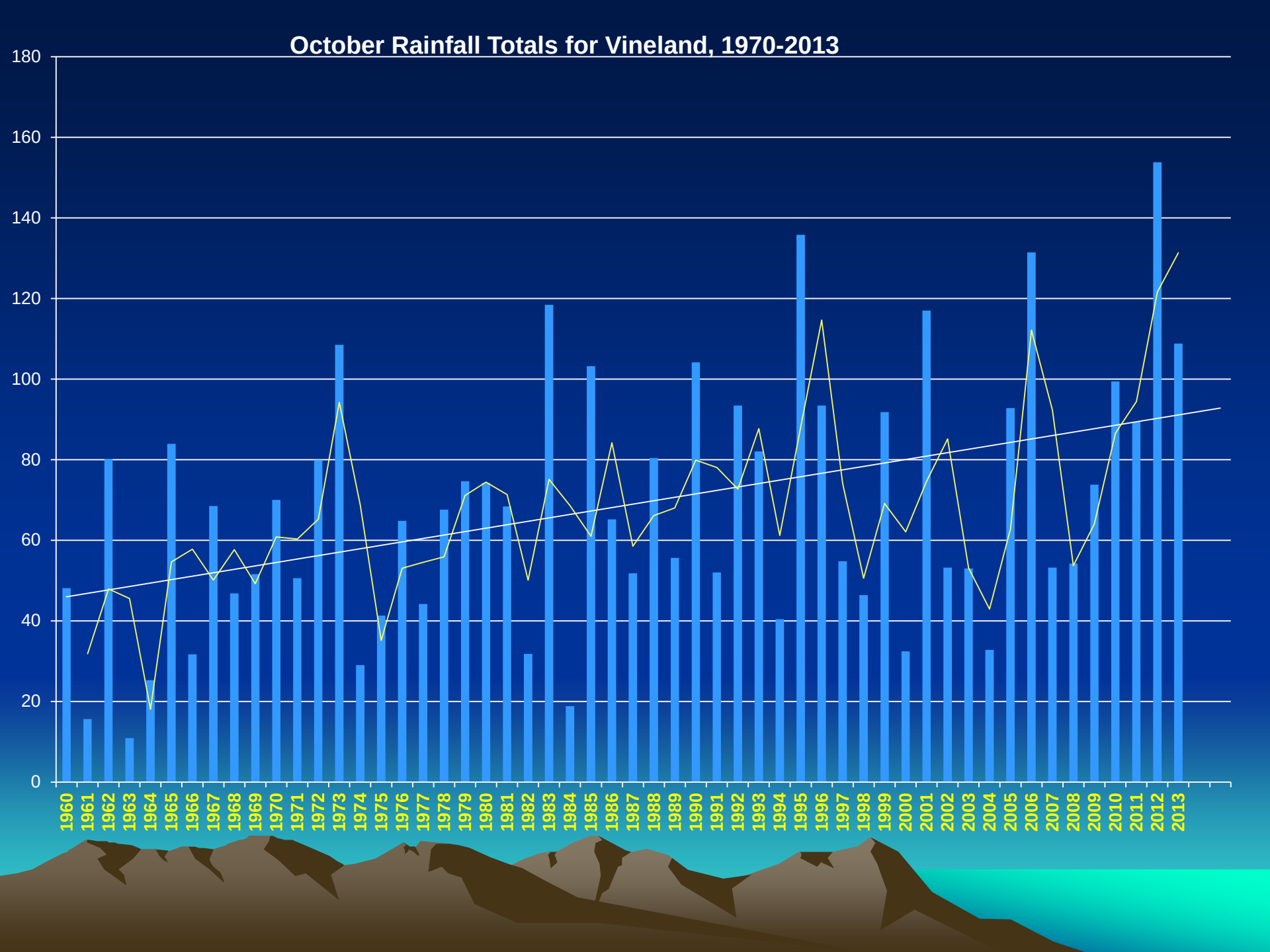
Precipitation During Ripening to Harvest

August Rainfall Totals for Vineland 1970-2013



September Rainfall Totals for Vineland 1970-2013




October Rainfall Totals for Vineland, 1970-2013
180
160
140
120
100
80
60
40
20
0
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
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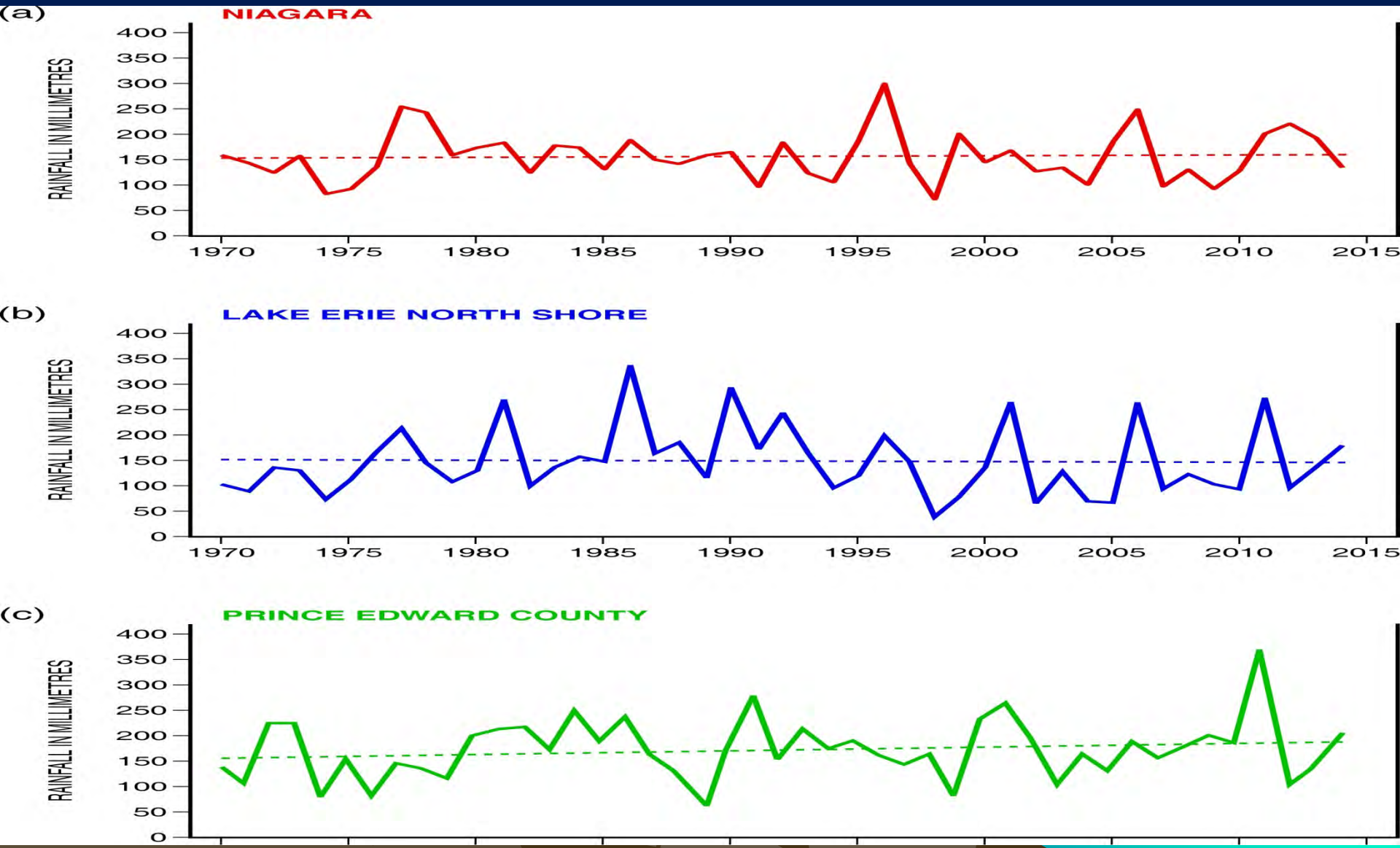
Precipitation Totals for September and October



Impacts and Implications

Winter Freeze Damage

- **Positive :**Reduction in number of damaging winter extreme minimum freeze events <-20 degrees
- **Negative**
- **Prolonged temperatures above 0o C can reduce cold hardiness**
- Winter damage could actually increase due to occurrences of warm freeze-thaw events followed by cold snaps
- Therefore, freeze damage could occur at a higher minimum temperatures for varieties with low chilling requirements

Implications for Viticulture in the Long-Term

- **Impact on Vine Phenology**

Spring

- **Positive: Earlier bud break and flowering**

- ***Negative: Potential damage from late spring***
- ***frosts for varieties with early bud***
- ***break***

April to October Growing season

- **Positive**
- Warmer and longer growing seasons could enhance ripening potentials for red and late season varieties
- **Negative**
- More volatility in growing season conditions leading to a greater degree of variability in vintages
- **Positive**
- **Potential for Full maturity of mid to late season varieties (Merlot and Cabernet Sauvignon)**
- Expansion into new areas around the Great Lakes currently considered climatically marginal
- **Negative**
- **Accelerated ripening for early season varieties**
- **Lower acidity and higher sugar and alcohol levels due**
- **higher daytime and night time temperatures**

Climate Change Adaptation Strategies

- . **Most studies on adaptive strategies consider implementation based on experiences with recurrent environmental and viticultural challenges**
- **Examples of adaptation based on long-term future projections of climate change are uncommon**
- **Anticipatory adaptive strategies present many challenges due to uncertainties in future climate change projections**
- **Combine reactive and anticipatory adaptive strategies**

Farming systems respond not only to environmental conditions, but also to economic, technological, institutional, political and social conditions. Any changes in these areas can be disruptive and costly.

Reactive Strategies

Diversify the Number of Cultivars and Growing Areas

- Expand the range of commercial varieties, but must consider consumers' preferences

- Target new Areas with suitable soil types and climates (In progress in emerging areas)

- **Implement Active and Passive Freeze Protection Methods**
- **Currently widely practised by growers**

Hedging Winter Injury and Vintage Variations

- Consider Insurance Policies and Institutional Support to hedge against losses from freeze injury and variations in vintage quality and yield
- Government support for technological innovations is a key driver in development of the adaptation and mitigation strategies related to climate change

Blending

- Blending the same varieties or different varieties from several areas or vineyards to reduce vintage variations and to create unique sensory attributes

Monitoring Systems

- Develop Micro-climate Monitoring Systems to assess evolution of established areas and to identify new areas
- Should include real time and archived data of key climatic parameters and indices for long-term analysis
- Monitoring various stages of plant phenology, fruit maturation and harvest
- (Vine Alert System and Vine and Fruit Tree Innovation Monitoring Systems)

Climate Change

- **Long-Term Adaptation Strategies Through Institutional Support**
-
- **Develop cold-resistant varieties to accommodate cycles of freeze and thaw and higher chilling requirements**
- **Develop disease-resistant varieties**
- **Develop Climate Prediction Models for analysis at smaller spatial scales**

Climate Change

Conclusions

- **Potential impacts are mixed containing challenges and opportunities**
- **Adaptive strategies in response to recurrent climatic events and economic factors are widely practiced**
- **What strategies we should implement in anticipation of future changes will depend on accuracy of our forecasts and support from various governmental and academic institutions**

Thank You


Thank You

Implications for Viticulture in the Long-Term

- **Impact on Vine Phenology**

  Spring

- **Positive: Earlier bud break and flowering**

- ***Negative: Potential damage from late spring***
- ***frosts***

- **Earlier veráison and ripening**

- **Impact on Quality**
- **Accelerated ripening for early season**