

# Climate Change in Coastal NH: Past, Present, and Future

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**@TheClimateDr**

**<http://CarbonSolutionsNE.org>**

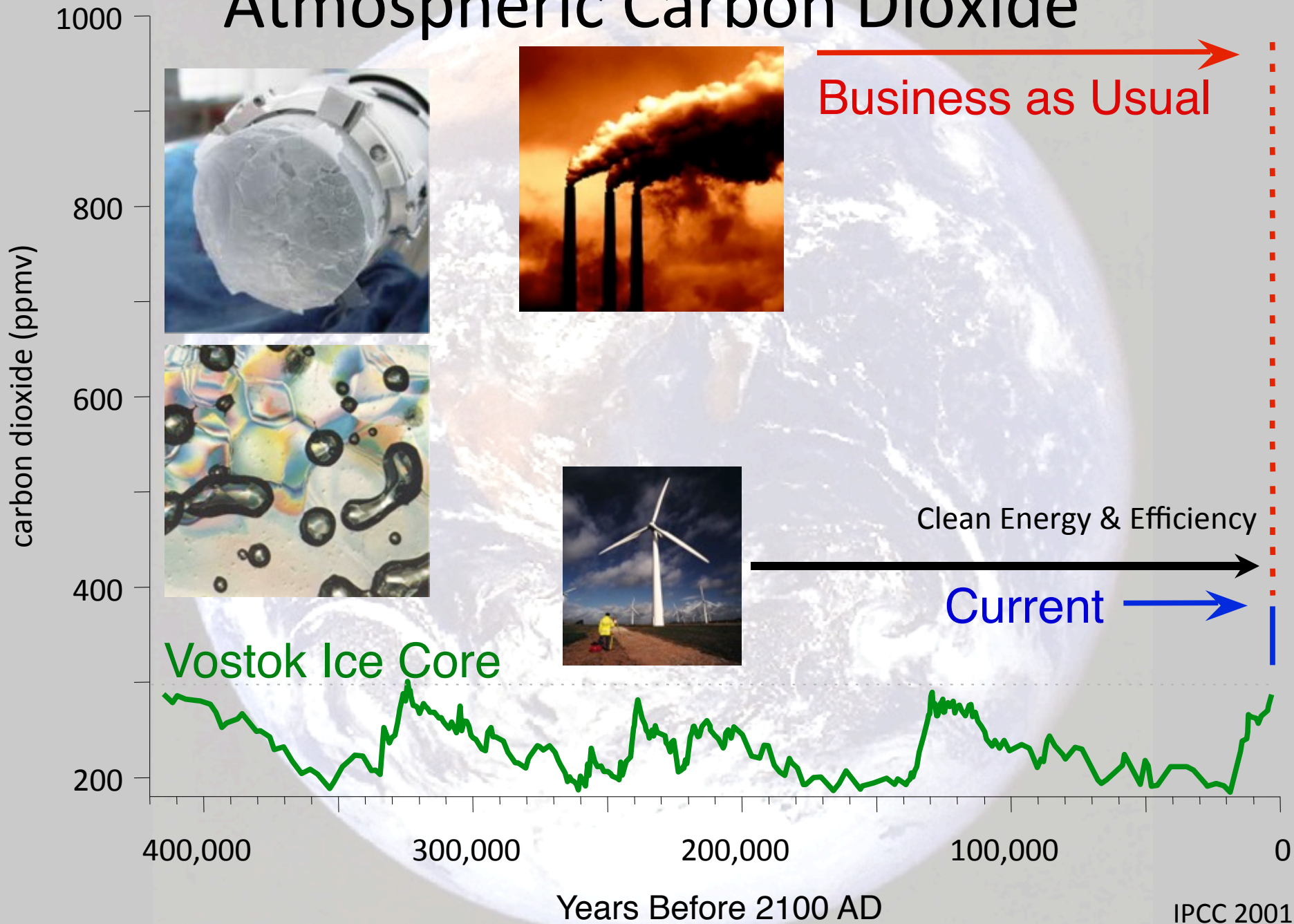
**Dover, NH 21 Oct 2014**



# QUADRENNIAL DEFENSE REVIEW 2014



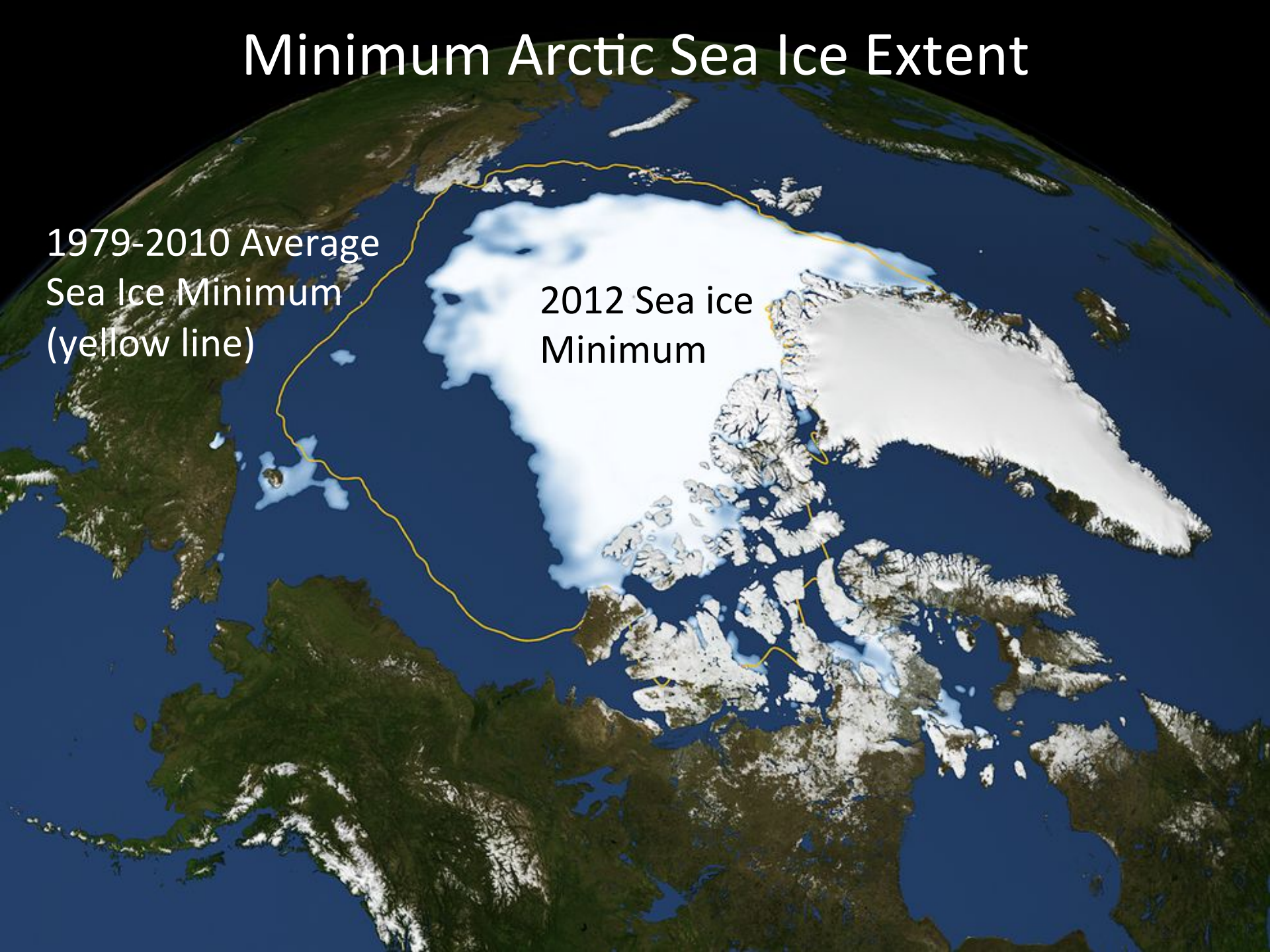
# Atmospheric Carbon Dioxide



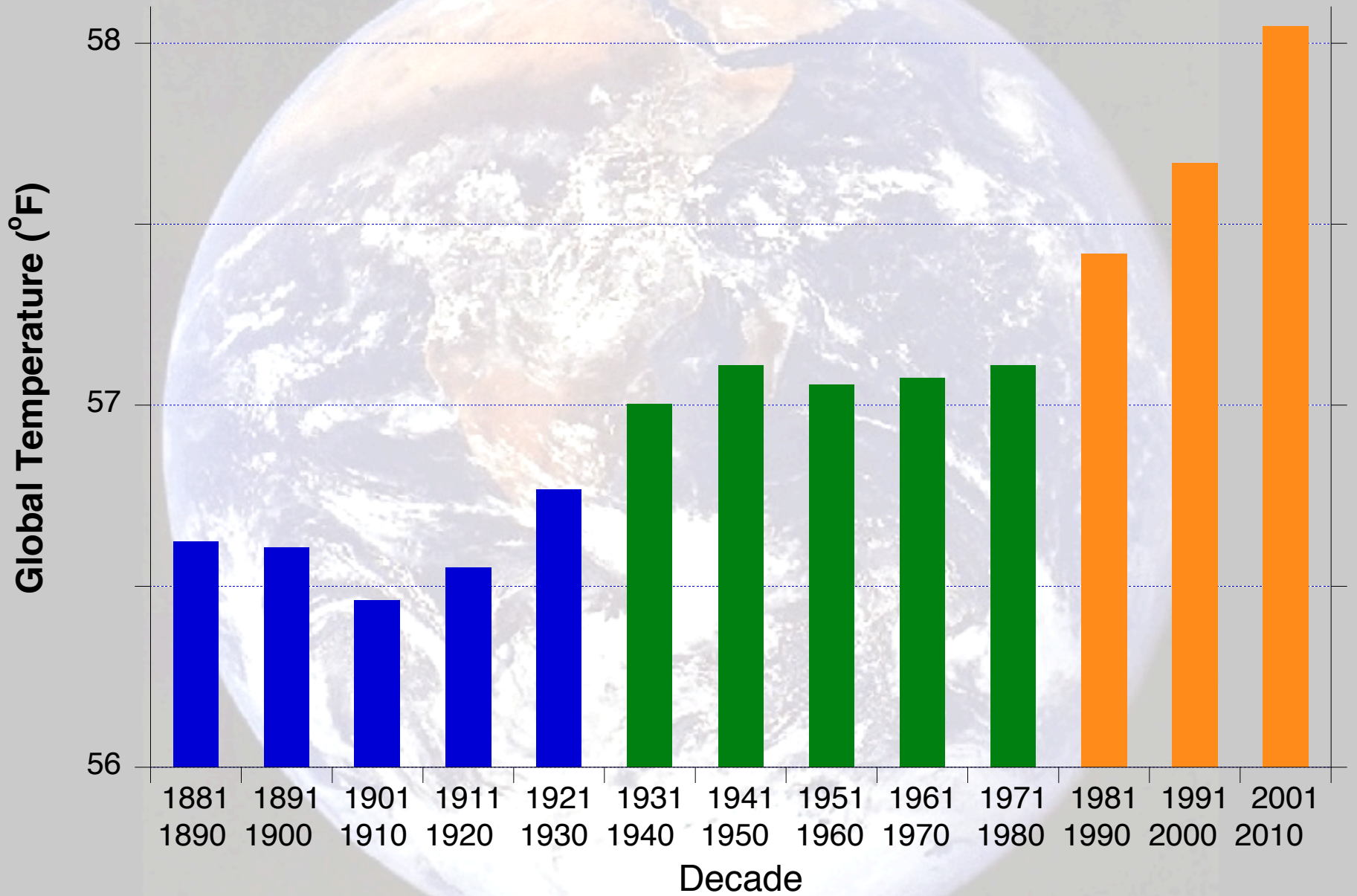
# Minimum Arctic Sea Ice Extent

1979-2010 Average  
Sea Ice Minimum  
(yellow line)

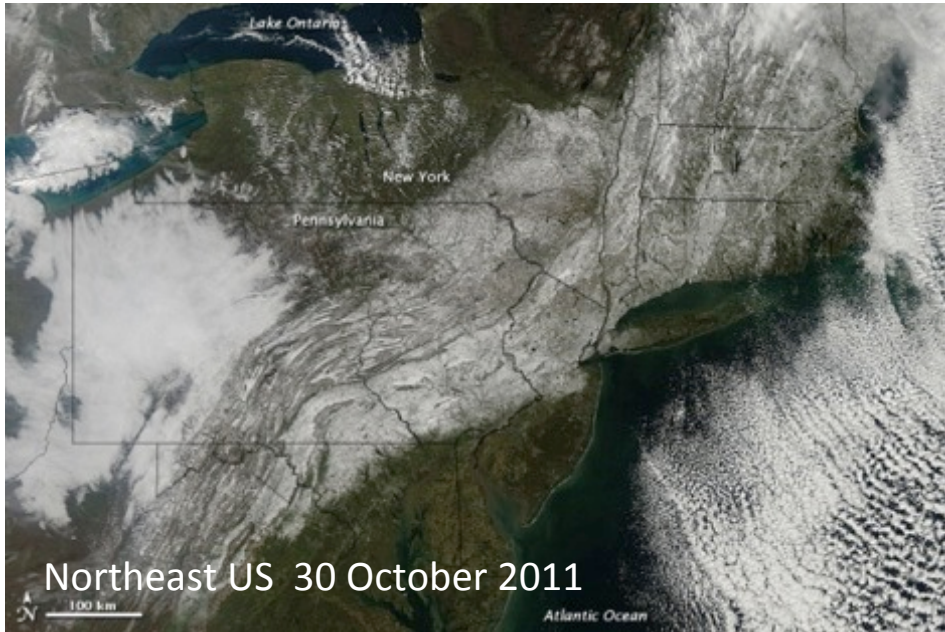
2012 Sea ice  
Minimum



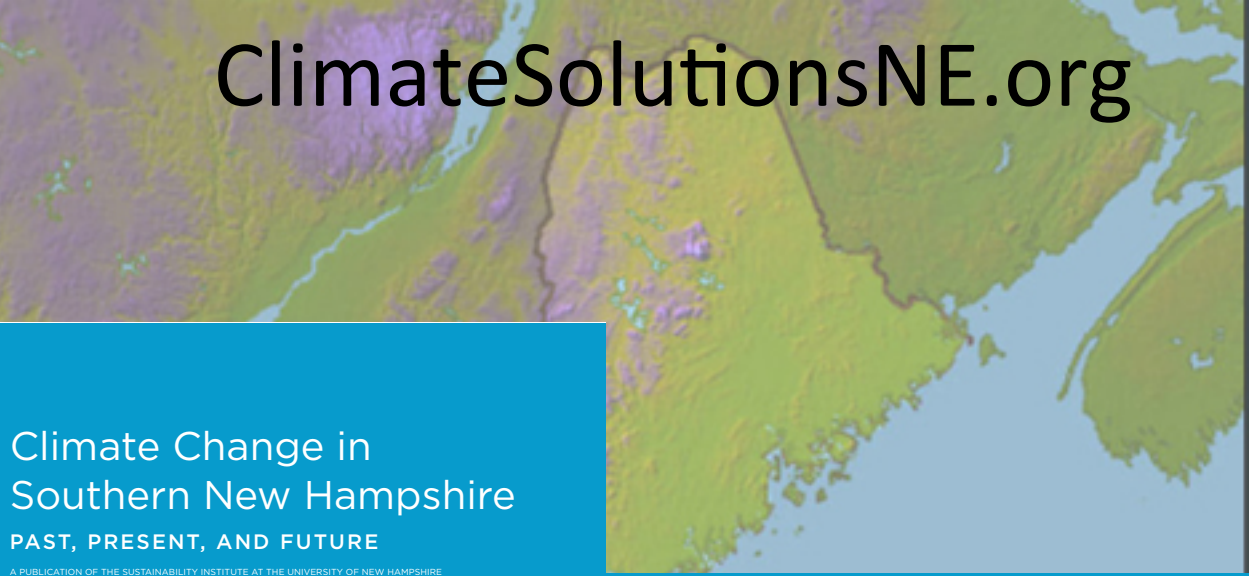
# Decadal global surface-air temperature (land and SST)



# Were You Ready for the Storm?



# ClimateSolutionsNE.org



## Climate Change in Southern New Hampshire

PAST, PRESENT, AND FUTURE

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## Climate Change in Northern New Hampshire

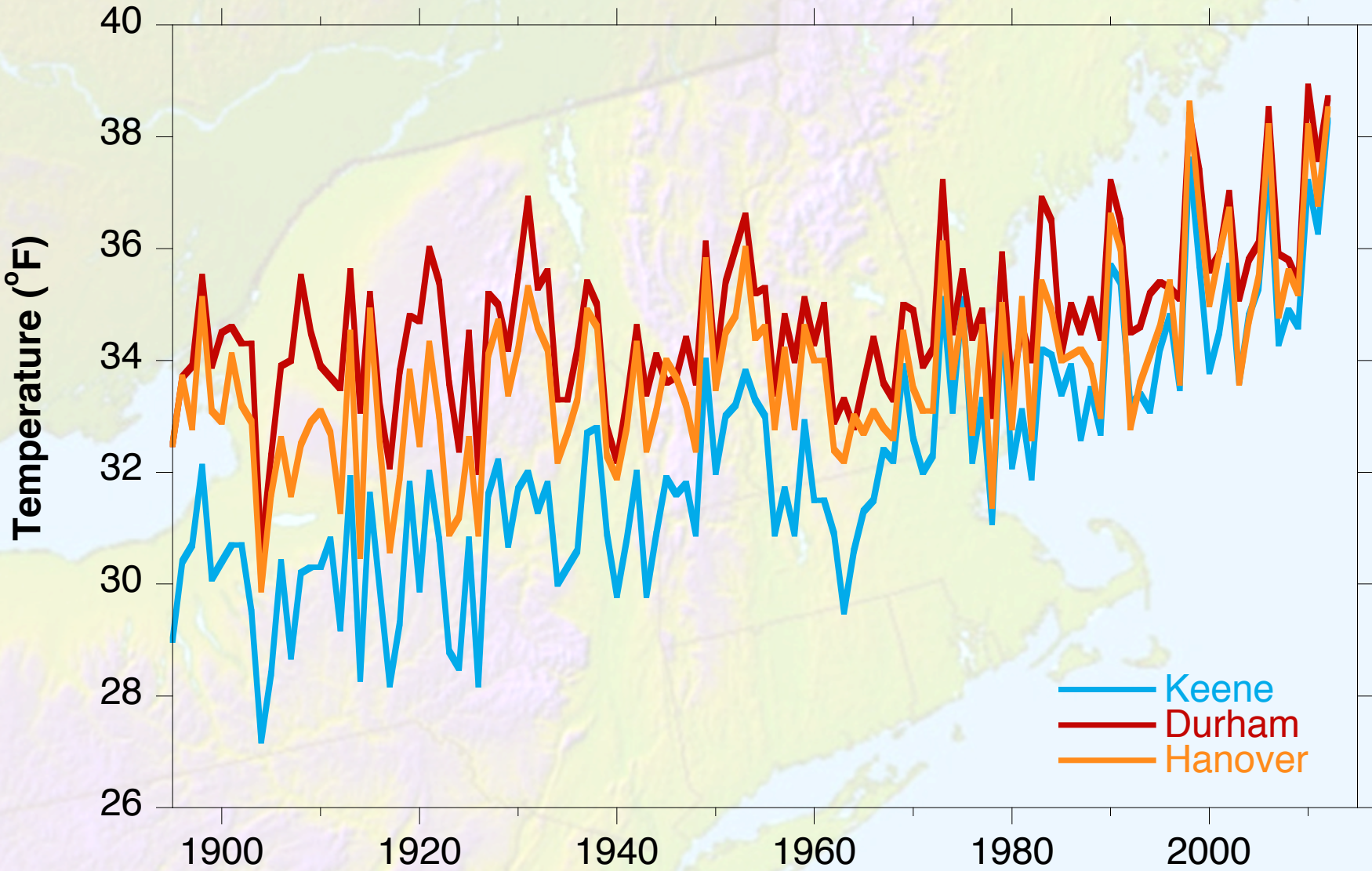
PAST, PRESENT, AND FUTURE

A PUBLICATION OF THE SUSTAINABILITY INSTITUTE AT THE UNIVERSITY OF NEW HAMPSHIRE



# Southern NH : Average Annual MINIMUM Temperature 1895 – 2012

Monthly data from US Historical Climatology Network

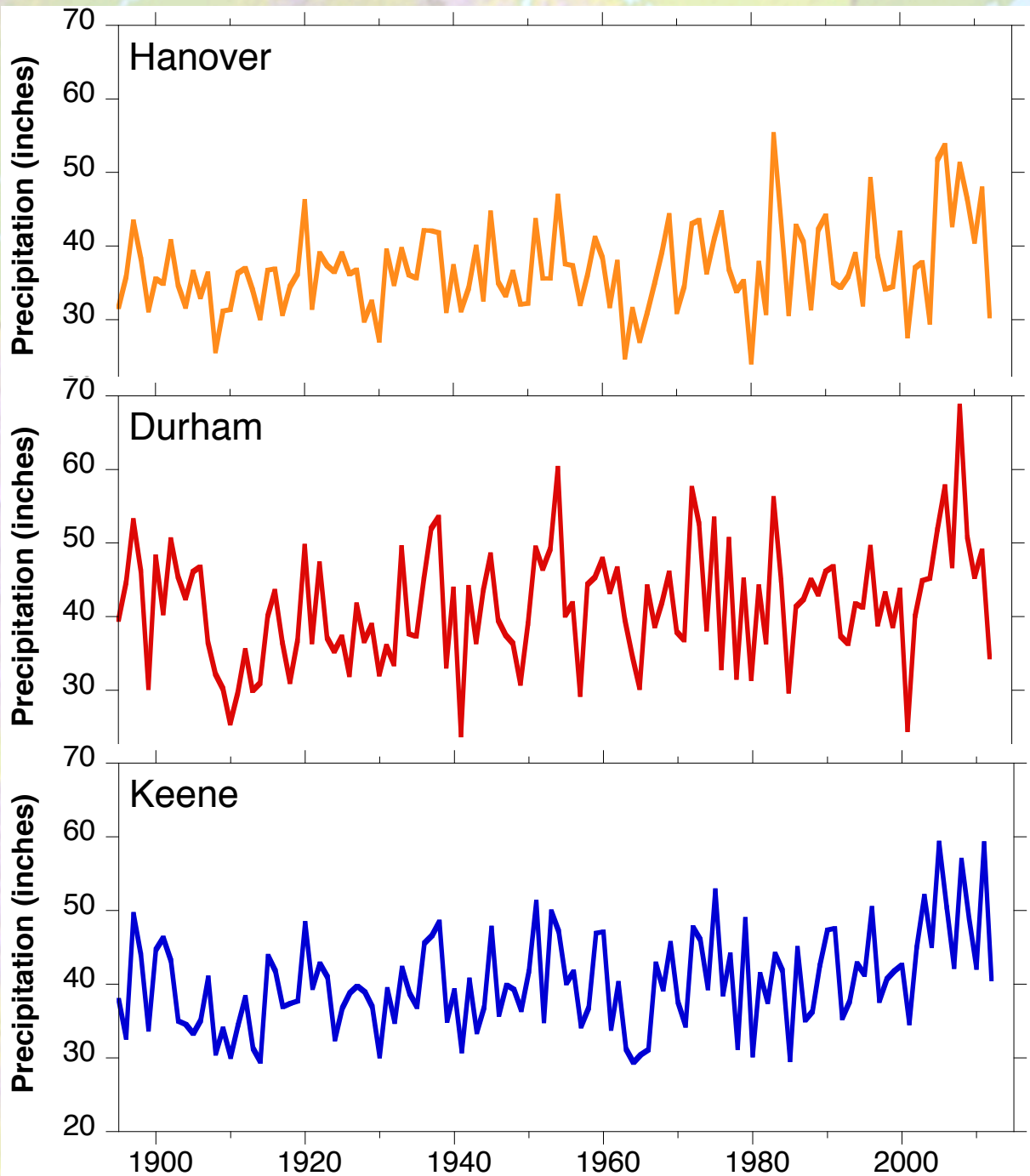
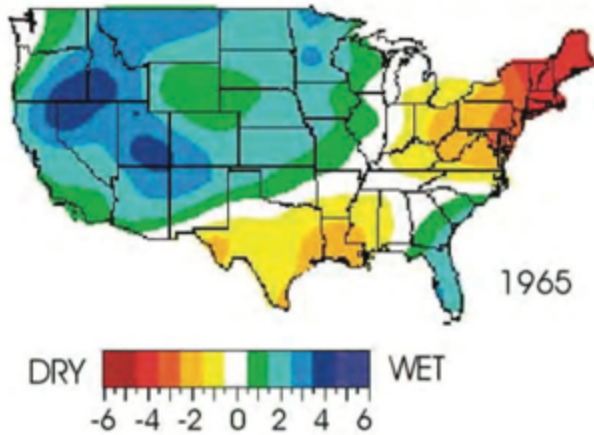




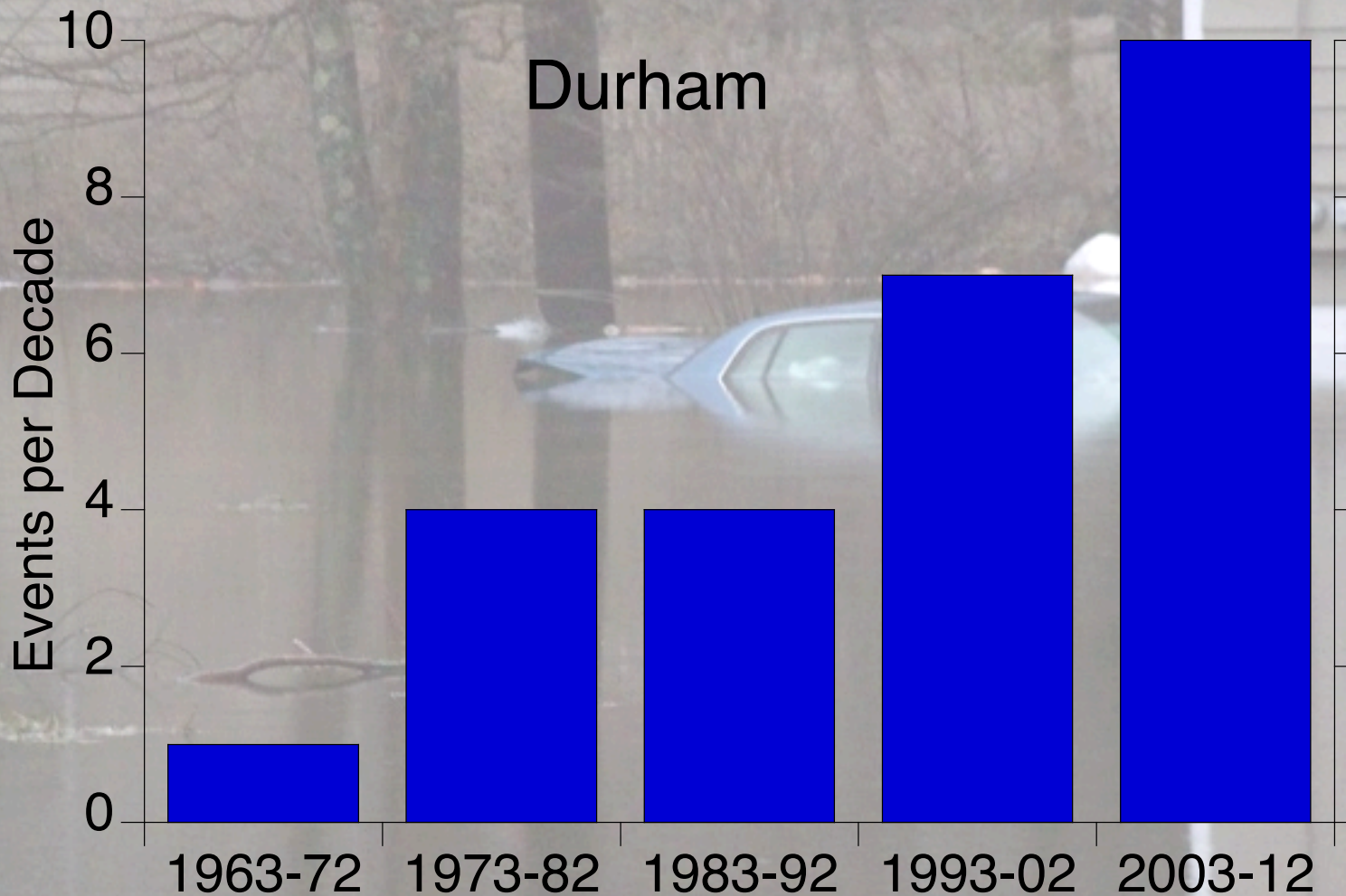
# Southern NH Annual Precipitation 1895 – 2012

Monthly data from US  
Historical Climatology Network

Palmer Drought Severity Index



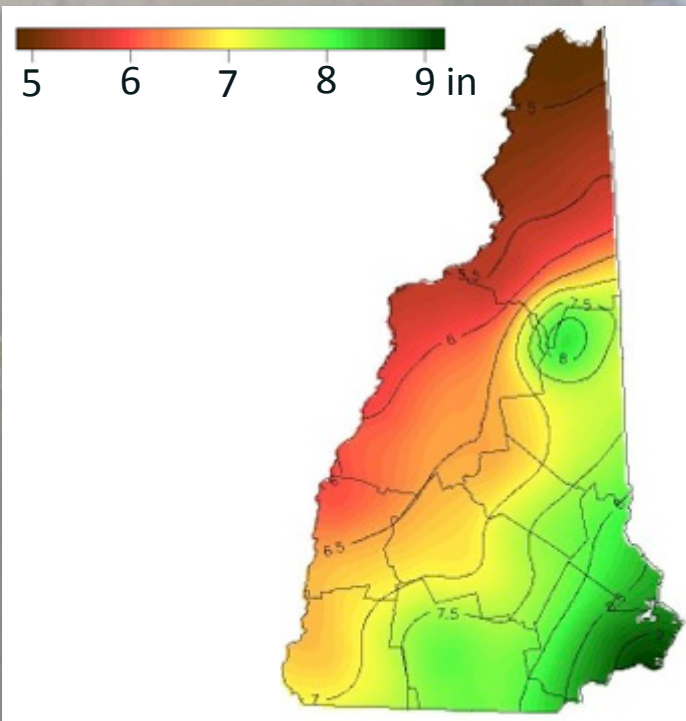
# 4 Inch Precipitation Events by Decade 1963 – 2012



# Updated 24-hour 100-year Design Storm

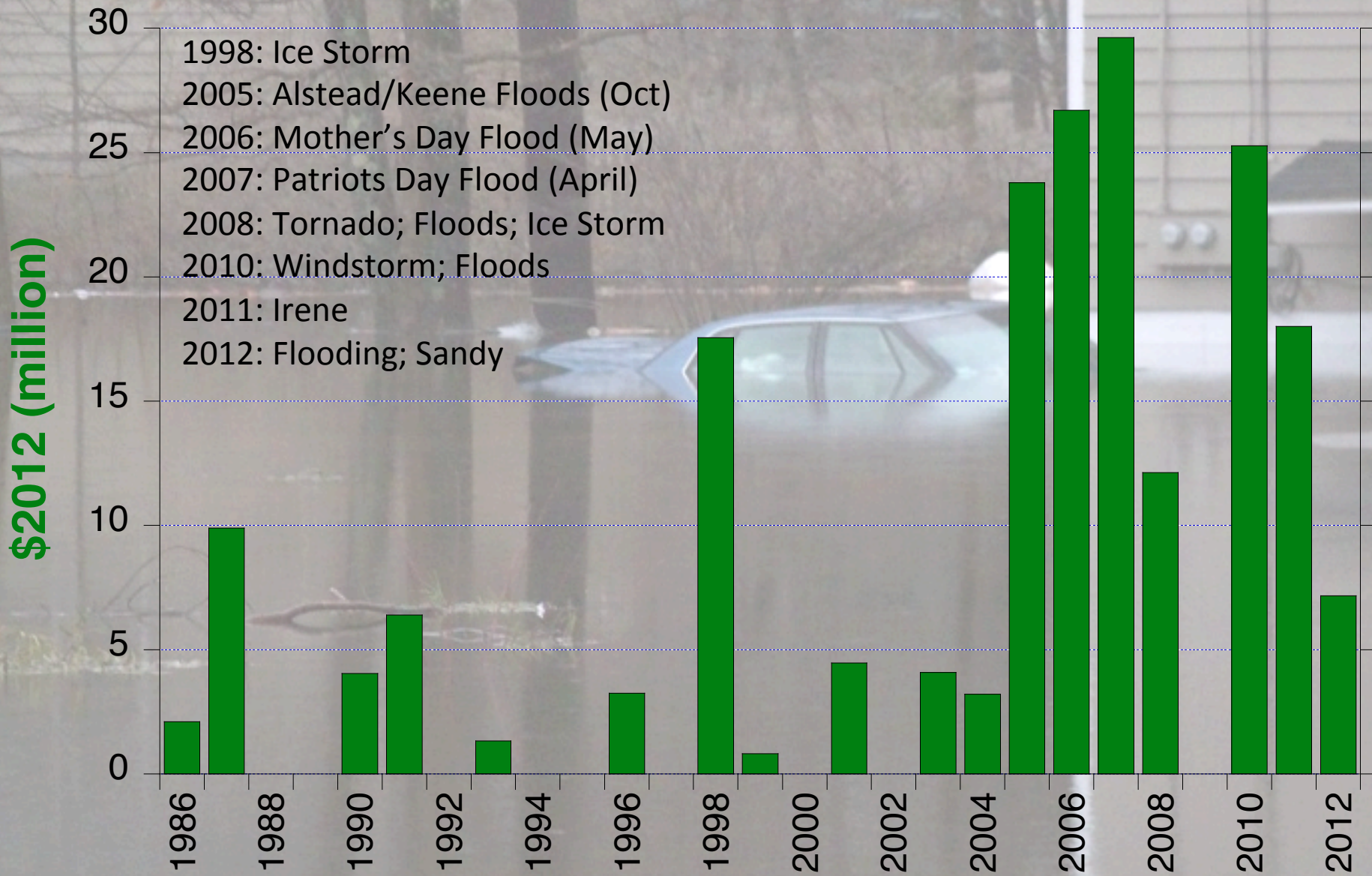


TP-40 (Hershfield 1961)  
Rainfall Frequency Atlas  
**24 hr 100-year rainfall = 6.3"**  
1938-1957



Northeast Regional Climate Ctr  
Atlas for Extreme Precipitation  
**24 hr 100-year rainfall = 8.5"**  
Data up through 2008  
<http://precip.eas.cornell.edu/>

# Federal Expenditures on Presidentially Declared Disasters And Emergency Declarations in NH



Data from [www.fema.gov/disasters/grid/state-tribal-government](http://www.fema.gov/disasters/grid/state-tribal-government)

# Southern NH: Trends Per Decade in Temperature and Precipitation

Parameter	Durham		Keene		Hanover	
	1895-2012	1970-2012	1895-2012	1970-2012	1895-2012	1970-2012

Trends that meet Mann-Kendall non-parametric test for statistical significance are **bold and underlined**.

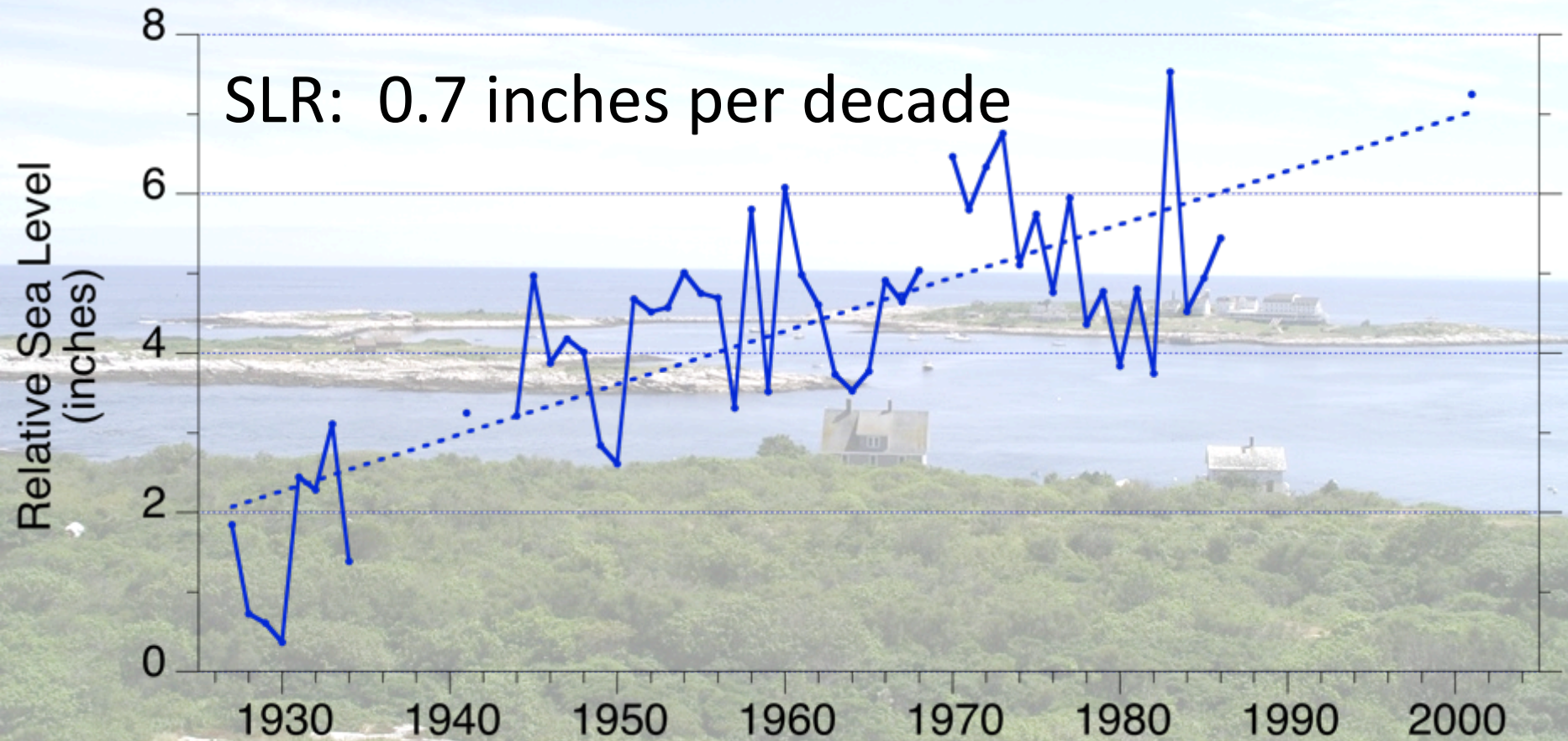
<b>TMAX (°F per decade)</b>						
Annual	<u>0.21</u>	<u>0.55</u>	<u>0.09</u>	<u>0.61</u>	0.05	0.25
Winter	<u>0.20</u>	<u>0.80</u>	0.10	<u>0.71</u>	0.08	<u>0.37</u>
Spring	<u>0.32</u>	<u>0.72</u>	0.10	0.58	<u>0.15</u>	0.29
Summer	<u>0.27</u>	<u>0.47</u>	<u>0.12</u>	0.35	0.08	-0.05
Fall	<u>0.11</u>	<u>0.48</u>	0.04	<u>0.68</u>	-0.05	<u>0.60</u>

<b>TMIN (°F per decade)</b>						
Annual	<u>0.20</u>	<u>0.58</u>	<u>0.50</u>	<u>0.82</u>	<u>0.25</u>	<u>0.74</u>
Winter	<u>0.28</u>	<u>0.93</u>	<u>0.58</u>	<u>1.70</u>	<u>0.36</u>	<u>1.45</u>
Spring	<u>0.18</u>	0.24	<u>0.45</u>	0.31	<u>0.23</u>	<u>0.60</u>
Summer	<u>0.25</u>	<u>0.71</u>	<u>0.49</u>	<u>0.47</u>	<u>0.27</u>	<u>0.60</u>
Fall	<u>0.14</u>	<u>0.83</u>	<u>0.50</u>	<u>1.11</u>	<u>0.22</u>	<u>0.61</u>

<b>Growing Season (Days per decade)</b>						
	NA	10.0	NA	2.8	NA	5.9

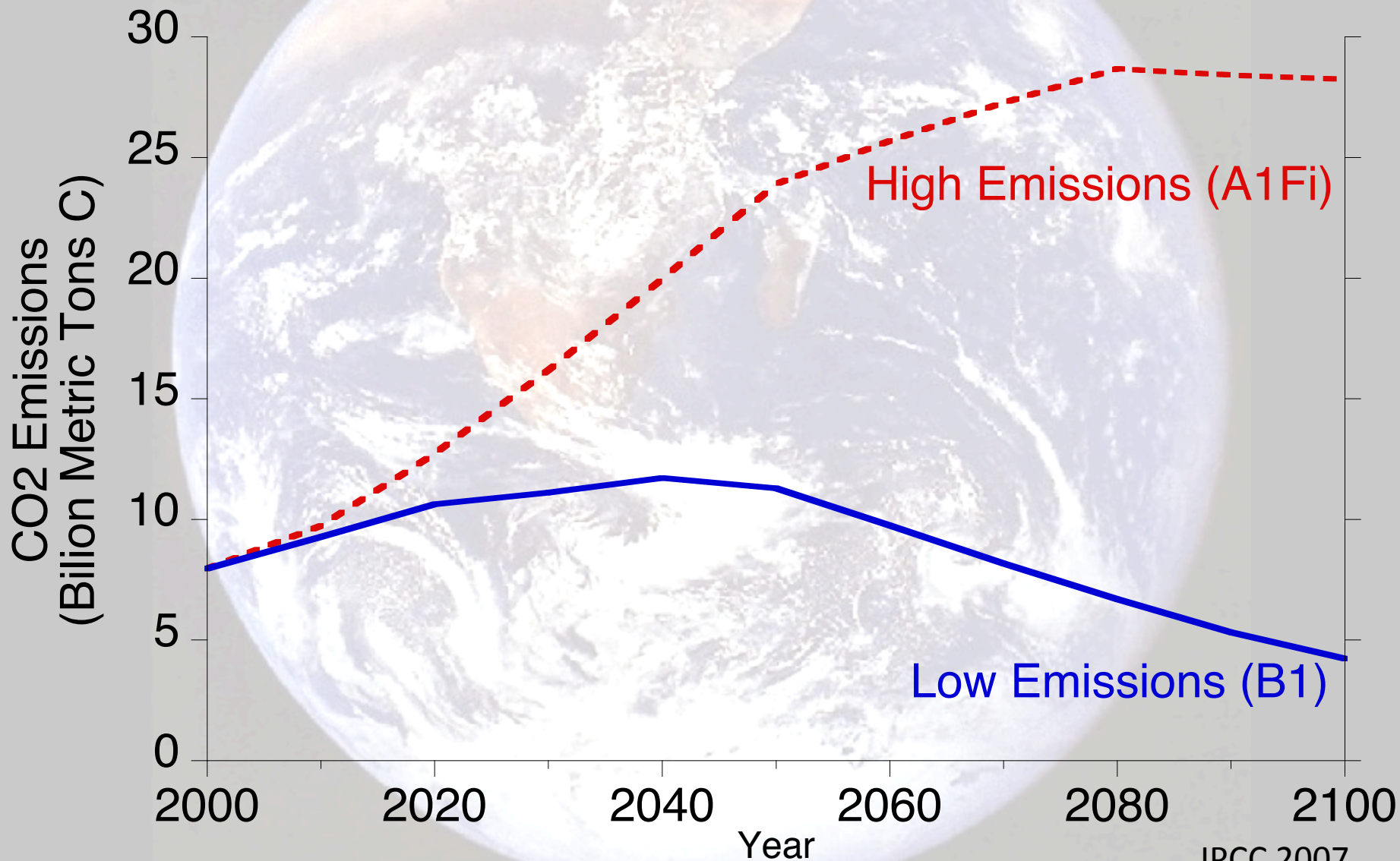
<b>Precipitation (inches per decade)</b>						
Annual	<u>0.56</u>	1.63	0.32	2.02	0.26	1.16
Winter	-0.03	-0.61	0.45	0.16	0.37	-0.11
Spring	0.08	0.20	0.21	0.14	0.20	0.22
Summer	0.14	<u>0.93</u>	0.31	0.57	0.27	0.55
Fall	<u>0.27</u>	0.26	0.32	1.12	0.24	0.19
Snowfall	NA	<u>-9.14</u>	NA	0.34	NA	-3.44

# Sea Level Rise at Portsmouth Harbor 1927 - 2001

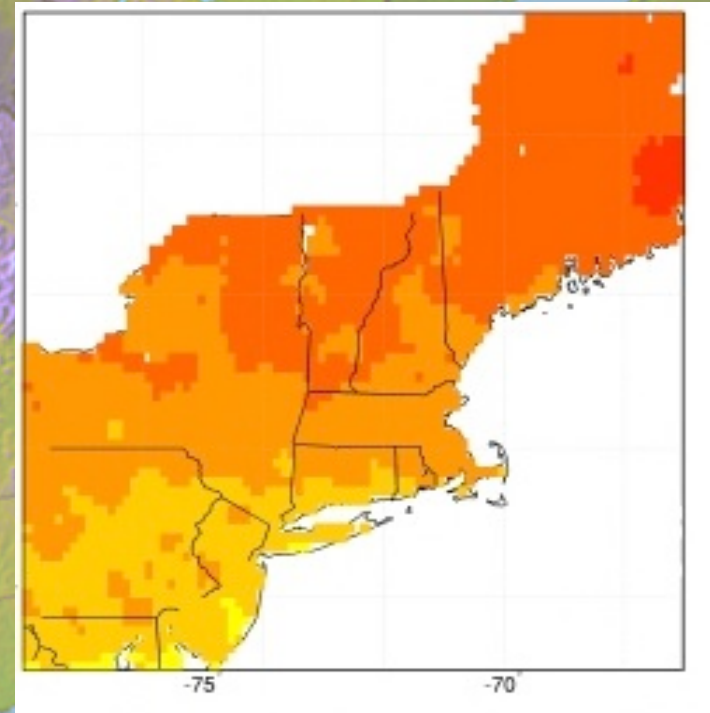
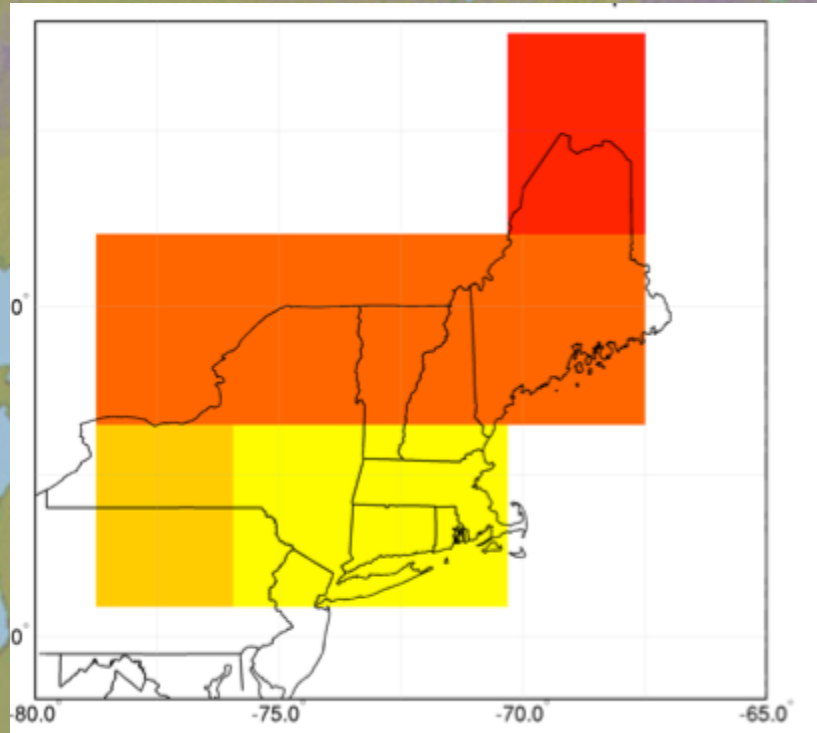


# Global Greenhouse Gas Emission Scenarios

Key Input for GCM projections of future climate change



# Projecting Future Climate Change for the Northeast: Downscale Global Projections to Regional Level



**Projections from 3 or 4 different climate models:**

**NOAA – GFDL**

**UKMO – HadCM3**

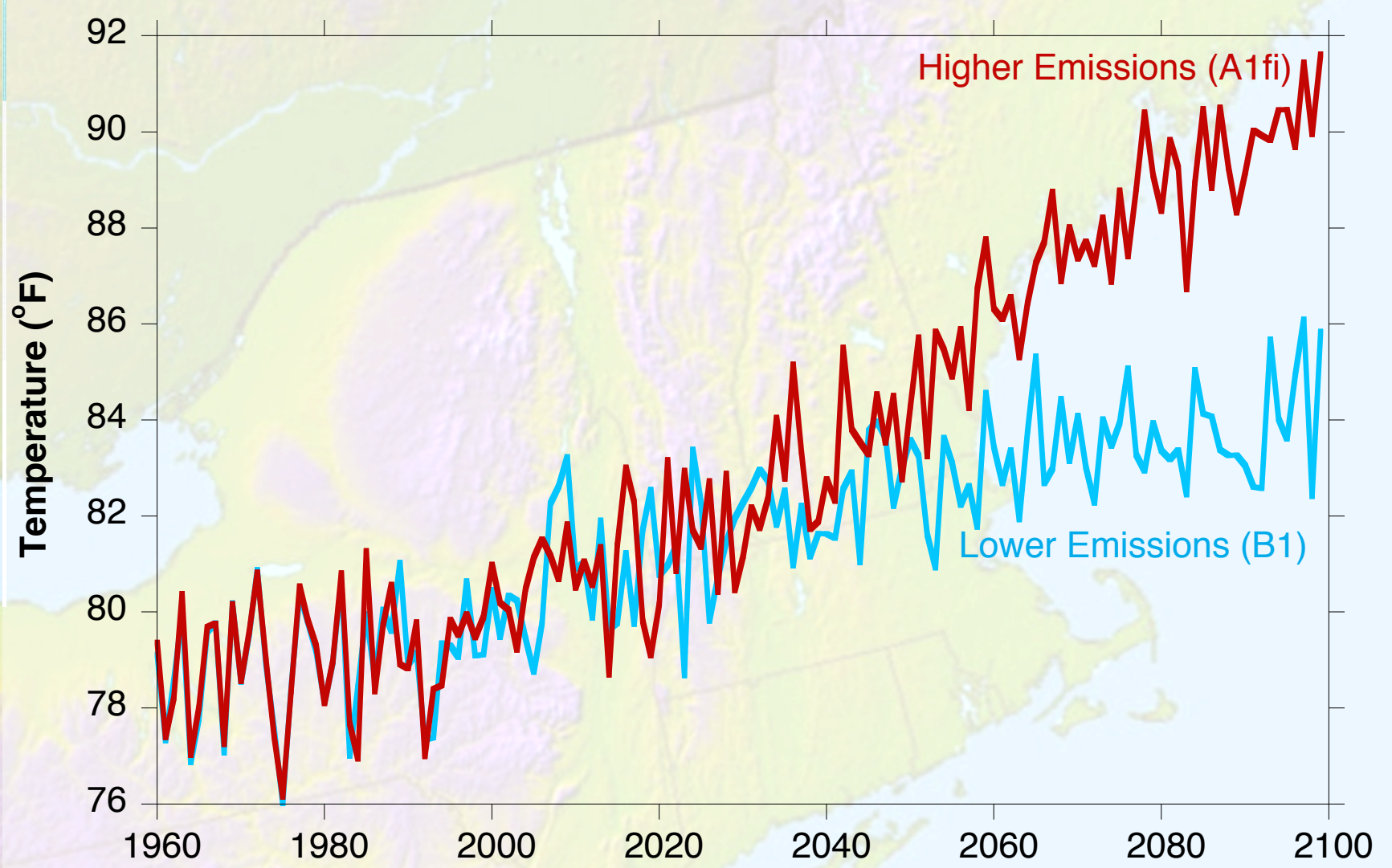
**NCAR – PCM**

**NCAR – CCSM3**



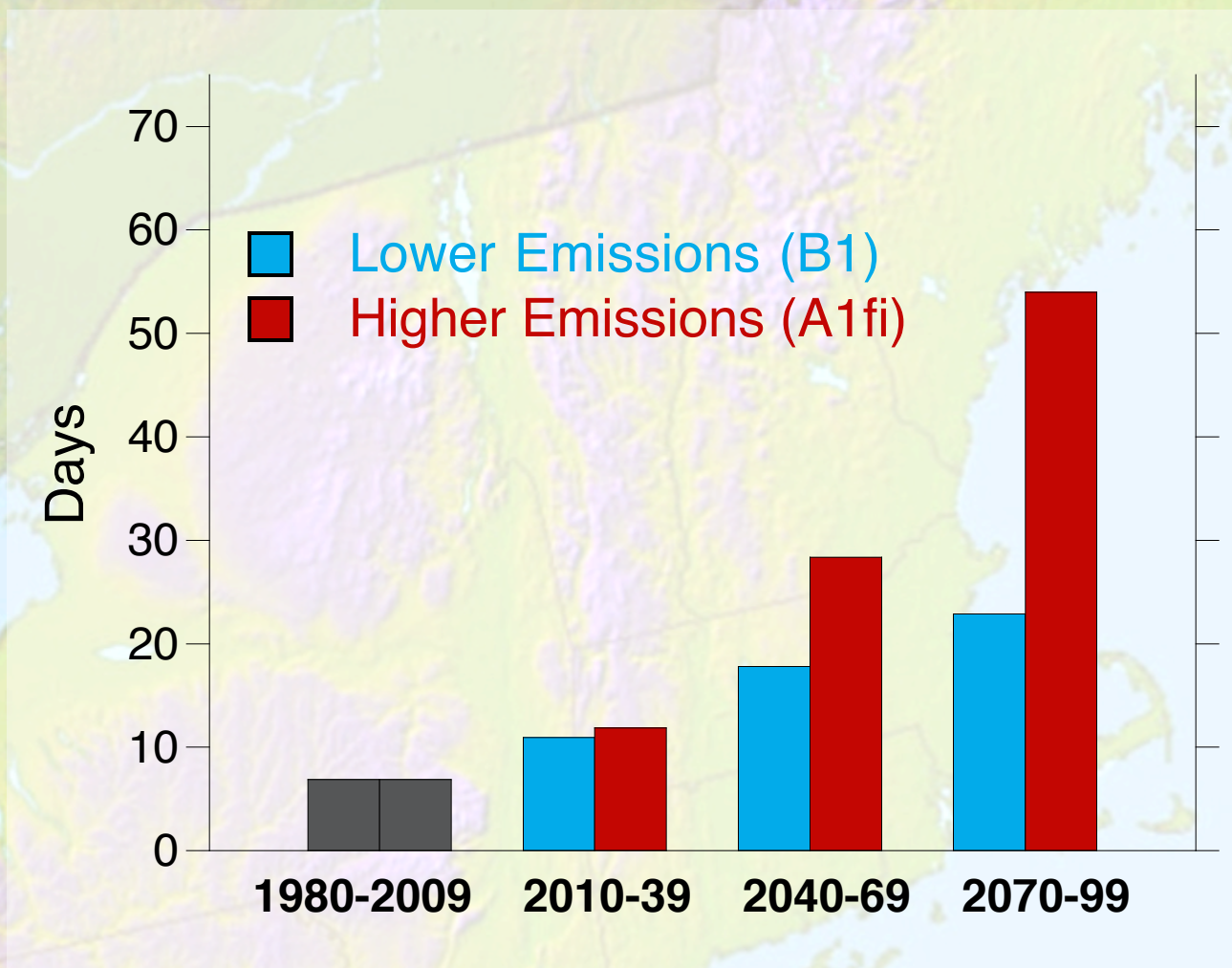
# Southern NH: Average Summer MAXIMUM Temperature 1960-2099

Average of statistically downscaled simulations from 4 GCMs



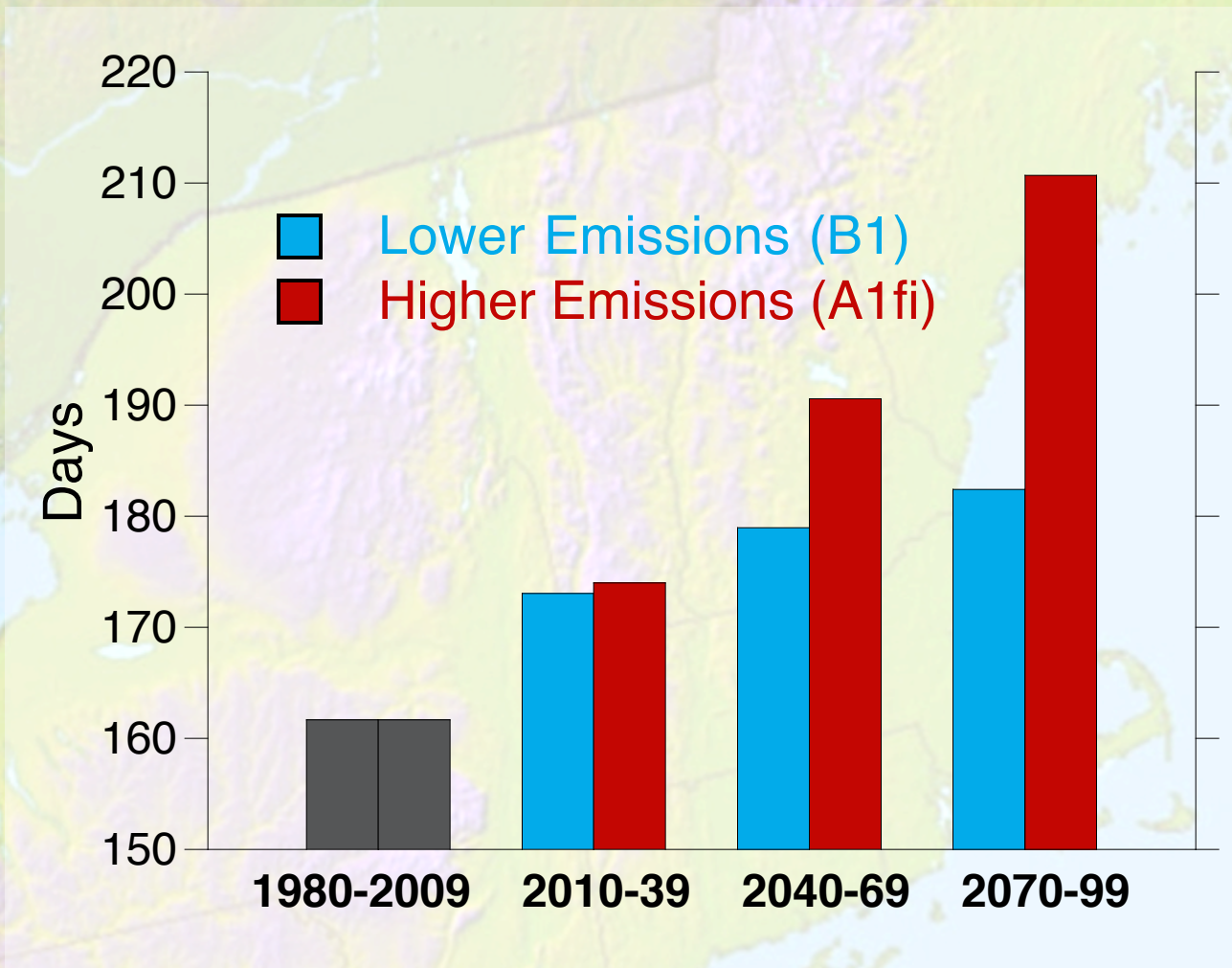
# Southern NH: Number of Days Hotter than 90°F (30 year averages)

Average of statistically downscaled simulations from 4 GCMs



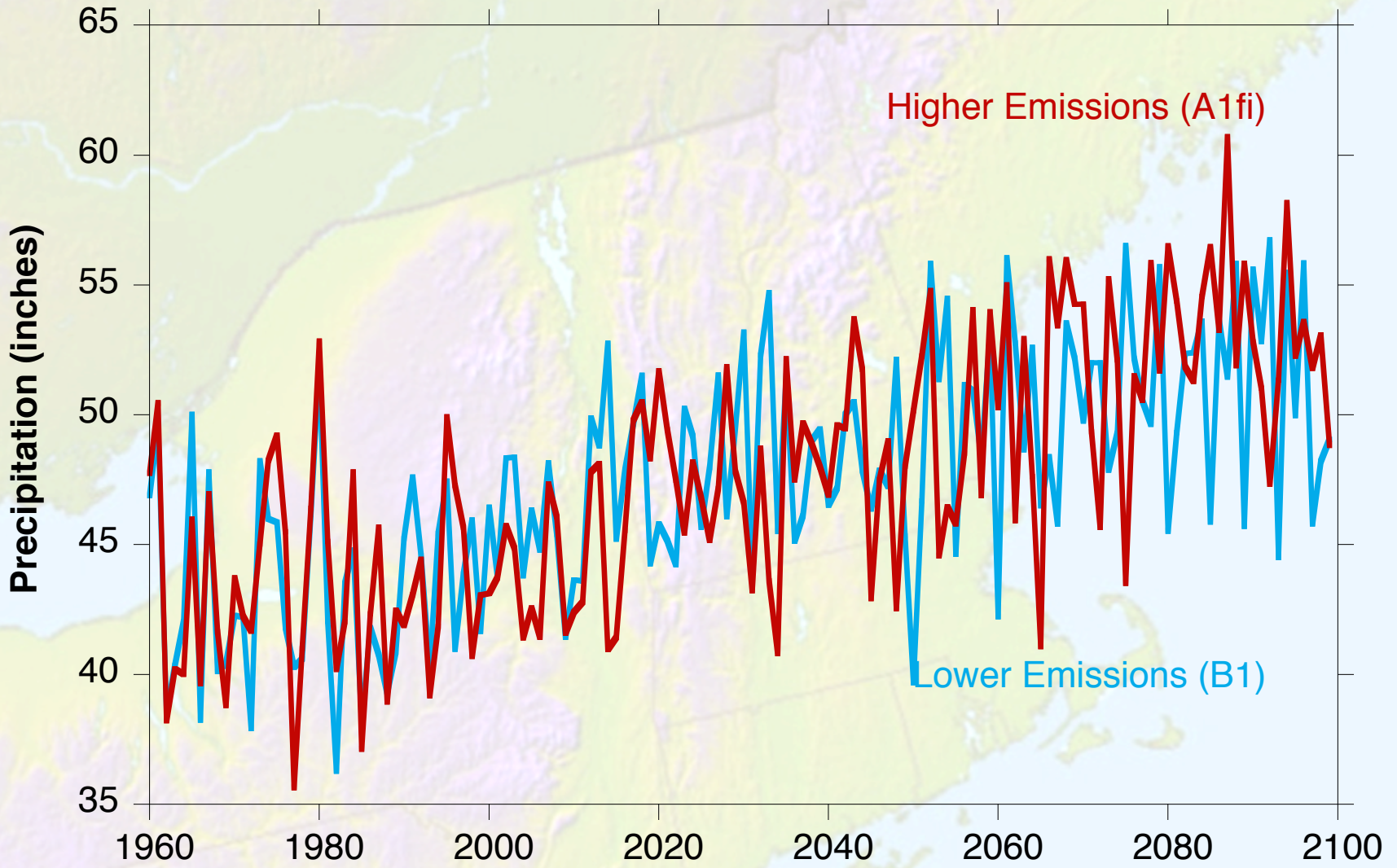
# Southern NH: Length of the Growing Season (30 year averages)

Average of statistically downscaled simulations from 4 GCMs

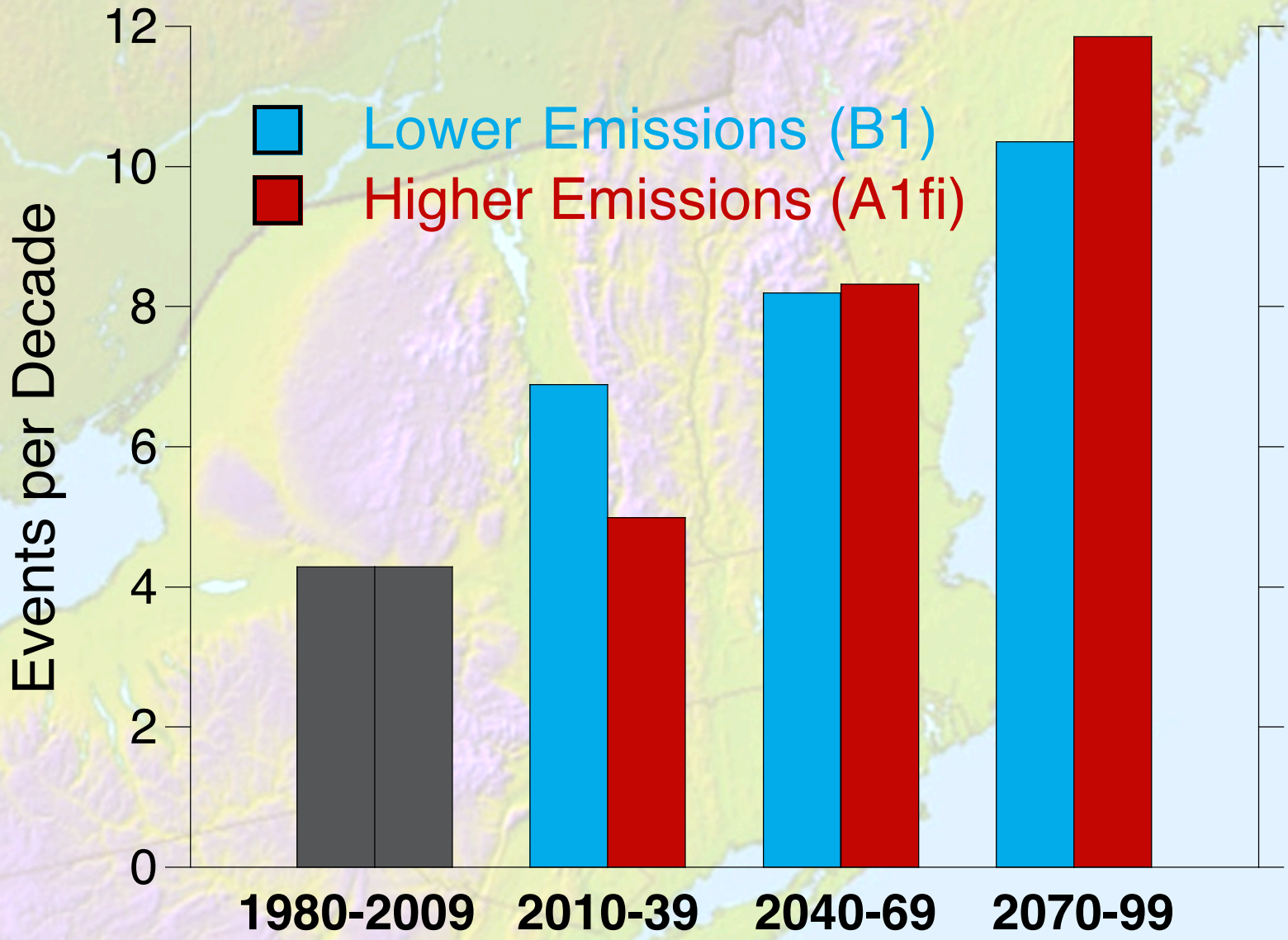


# Southern NH: Average Annual Precipitation 1960-2099

Average of statistically downscaled simulations from 4 GCMs



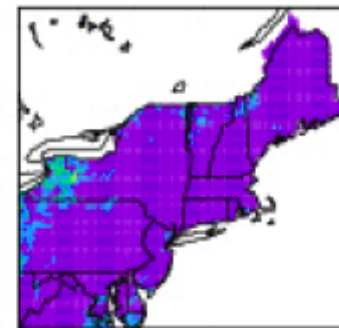
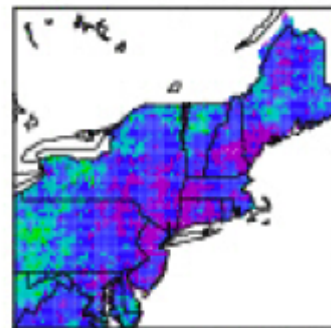
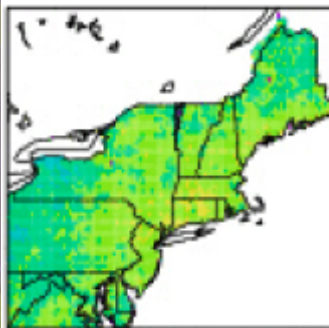
# Precipitation Events >4" in 48 hrs per Decade (30 year averages) for Southern NH (41 Stations)



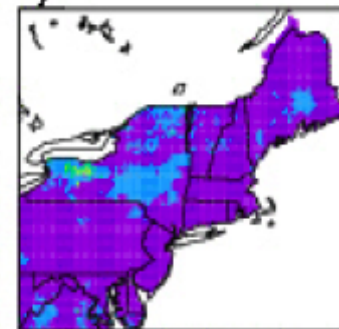
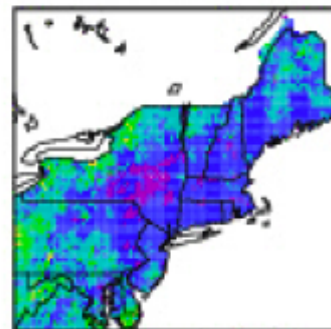
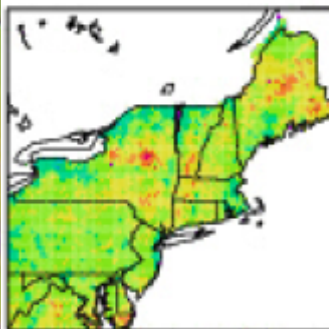
# Drought



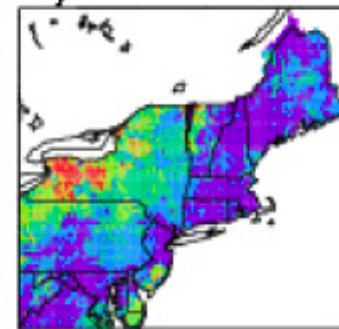
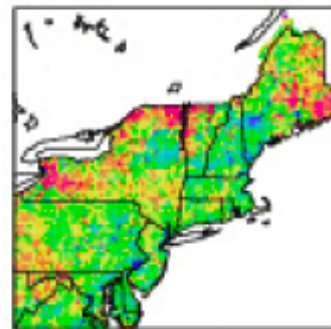
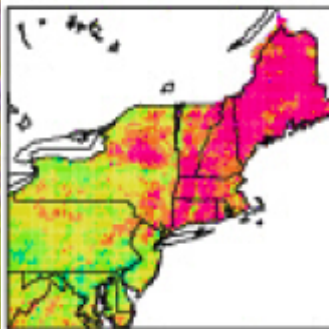
1961-1990



Lower Emissions (B1)



Higher Emissions (A1fi)



1-3 months

3-6 months

>6 months

# Southern NH Climate Grid

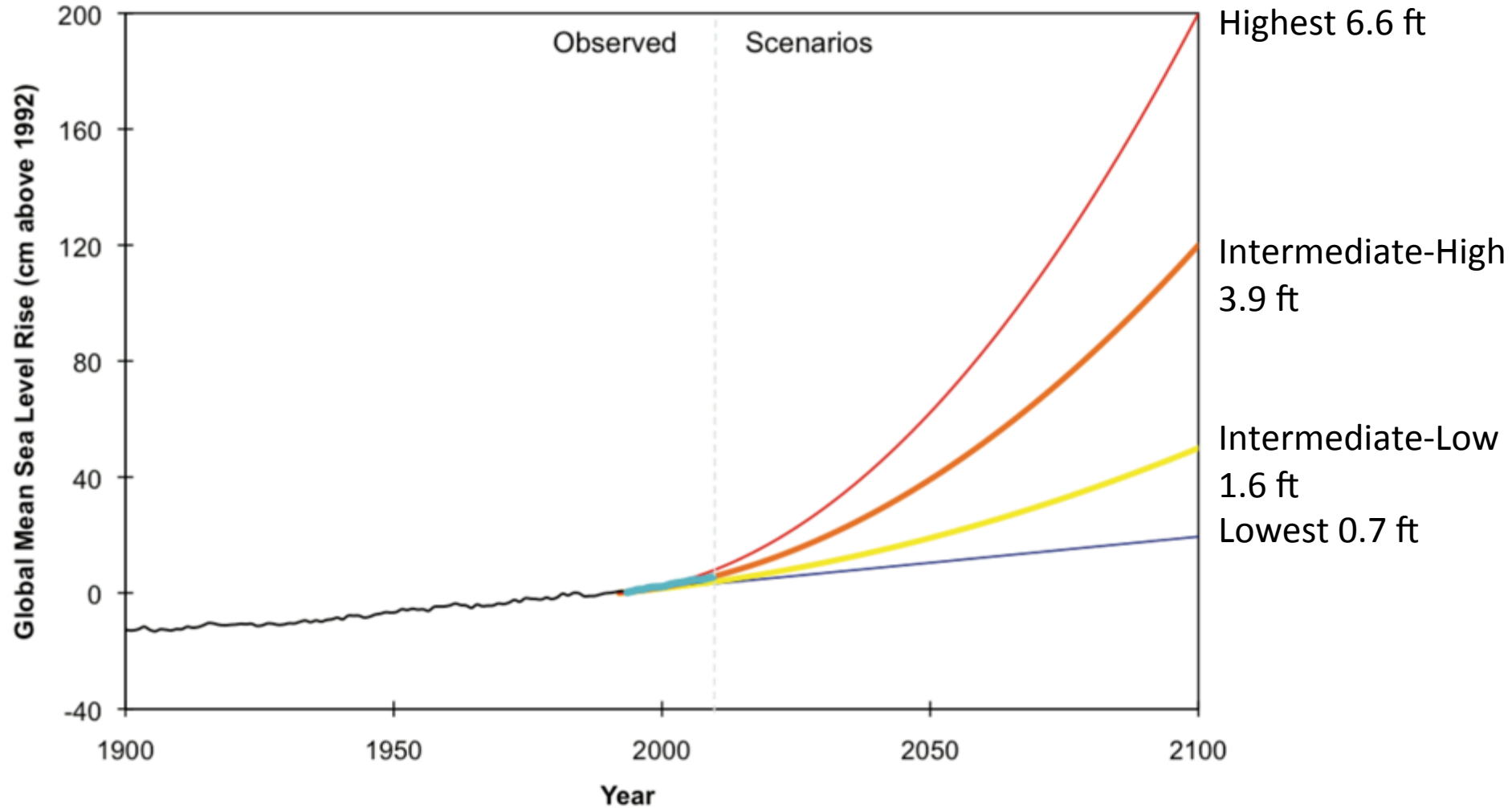
24 Indicators:  
Historical (1980 – 2009)

Future  
2010 – 2039  
2040 – 2069  
2070 - 2099

Indicators	Historical* 1980-2009	Change from historical (+ or -)					
		Short Term 2010-2039		Medium Term 2040-2069		Long Term 2070-2099	
		Low Emissions	High Emissions	Low Emissions	High Emissions	Low Emissions	High Emissions
<b>Minimum Temperature (°F)</b>							
Annual TMIN	34.5	1.7	2.0	2.9	5.1	3.8	8.8
Winter TMIN	12.8	2.3	2.6	3.6	5.6	5.0	9.3
Spring TMIN	31.2	4.0	2.5	5.6	5.2	6.8	8.5
Summer TMIN	54.9	1.6	2.2	2.8	5.6	3.5	9.8
Fall TMIN	35.3	0.3	1.7	0.6	5.0	1.1	8.3
<b>Maximum Temperature (°F)</b>							
Annual TMAX	57.2	1.7	1.7	3.0	4.8	4.1	8.3
Winter TMAX	33.4	1.7	1.6	2.5	3.5	3.6	6.1
Spring TMAX	55.7	2.5	1.5	4.9	4.7	6.6	8.7
Summer TMAX	79.6	1.8	2.1	3.3	5.7	4.1	9.6
Fall TMAX	59.7	0.9	1.7	1.3	5.3	1.5	8.6
<b>Temperature Extreme (days per year)</b>							
<32°F	164.0	-9.5	-10.9	-15.8	-25.5	-19.5	-43.9
<0°F	16.0	-5.0	-5.1	-7.8	-10.6	-9.0	-14.2
>90°F	6.7	4.2	5.2	11.1	21.7	16.2	47.3
>95°F	1.0	0.8	1.2	2.7	7.0	5.1	21.8
TMAX on hottest day of year	93.1	1.8	1.4	3.0	4.8	4.6	9.0
TMIN on coldest day of year	-15.8	4.0	4.4	6.2	10.2	8.0	17.4
<b>Growing Season (days)</b>	162	11.1	12.0	17.0	28.6	20.4	48.7
<b>Precipitation (inches)</b>							
Annual mean	43.8	4.3	3.1	5.4	5.9	7.4	8.8
Winter mean	9.8	1.2	0.9	1.5	1.5	2.1	2.9
Spring mean	10.9	1.1	1.1	1.7	1.6	2.1	2.7
Summer mean	11.4	1.7	1.0	1.3	2.0	2.2	1.6
Fall mean	11.6	0.5	0.2	1.0	0.9	1.1	1.6
<b>Extreme Precipitation (events per year)</b>							
1" in 24 hrs	10.4	1.6	1.6	2.2	2.8	2.9	4.3
2" in 48 hours	3.7	2.0	2.0	1.0	3.0	1.5	4.2
<b>Extreme Precipitation (events per decade)</b>							
4" in 48 hours	4.3	2.6	0.7	3.9	4.0	6.1	7.6
<b>Snow-Covered Days</b>	105	-9.6	-16.3	-15.0	-37.1	-23.7	-52.9

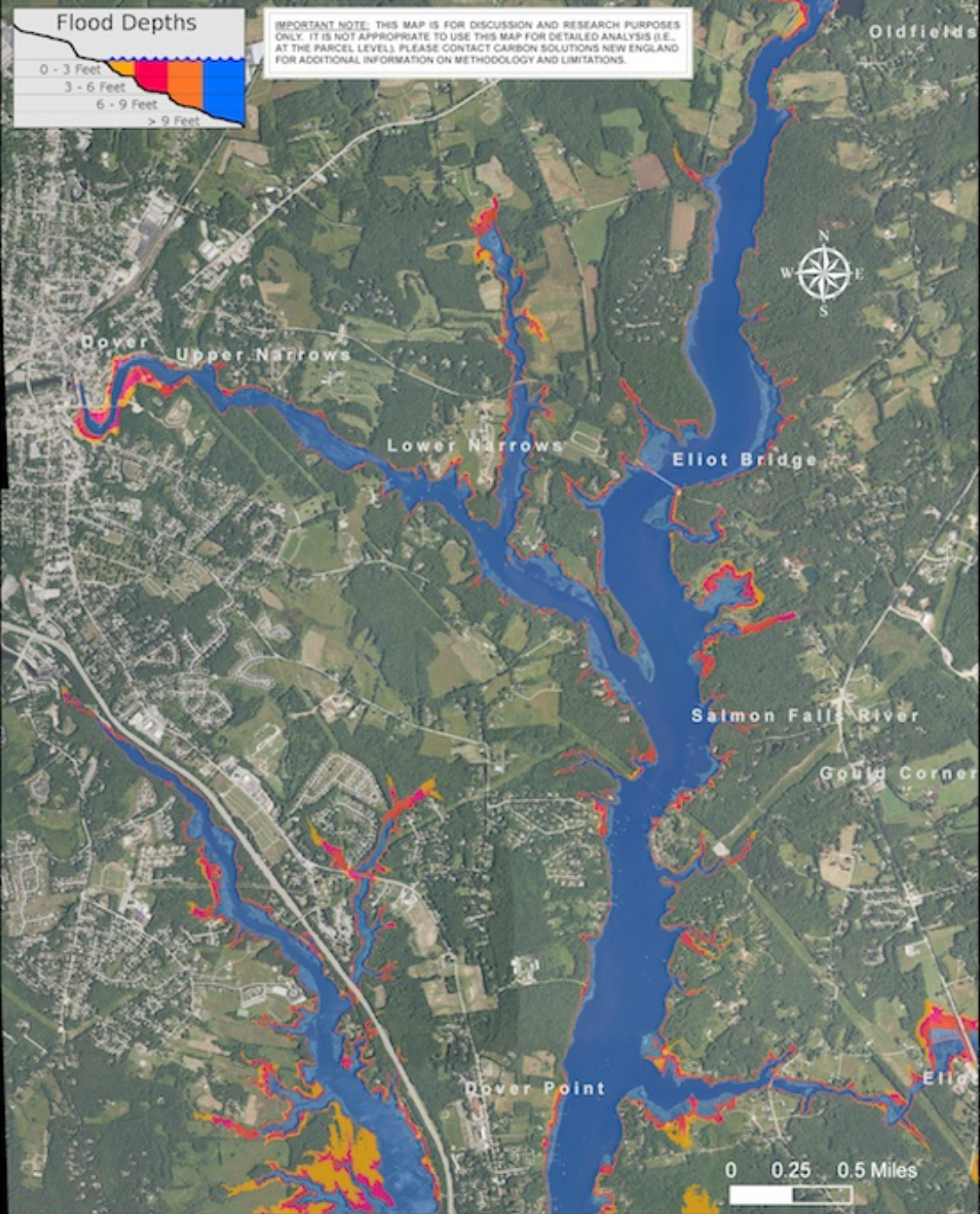
From: Climate Change in Southern NH:  
Past, Present, and Future (2014)  
<http://ClimateSolutionsNE.org>

# Global Mean Sea Level Rise Scenarios US National Climate Assessment





# High Tide + 12 feet Dover, NH



# What path will we take to the future?



Two roads diverged in a wood, and I -  
I took the one less traveled by,  
And that has made all the difference.

*Robert Frost*

# NH Climate Action Plan

- One of the largest, most diverse collections of leading NH citizens
- Promotes growth of new jobs and renewable energy development
- Reduces energy costs
- Identifies 67 recommended actions
  - buildings
  - electricity generation,
  - transportation & land use
  - natural resources
  - government action
- **adaptation**
- Reduce greenhouse gas emissions
  - 44% below 2005 levels by 2025
  - 86% below 2005 levels by 2050

New Hampshire Climate Change Policy Task Force

## The New Hampshire Climate Action Plan

A Plan for New Hampshire's Energy, Environmental  
and Economic Development Future

Prepared by NH Department of Environmental Services  
March 2009

More info at:  
<http://CarbonSolutionsNE.org>