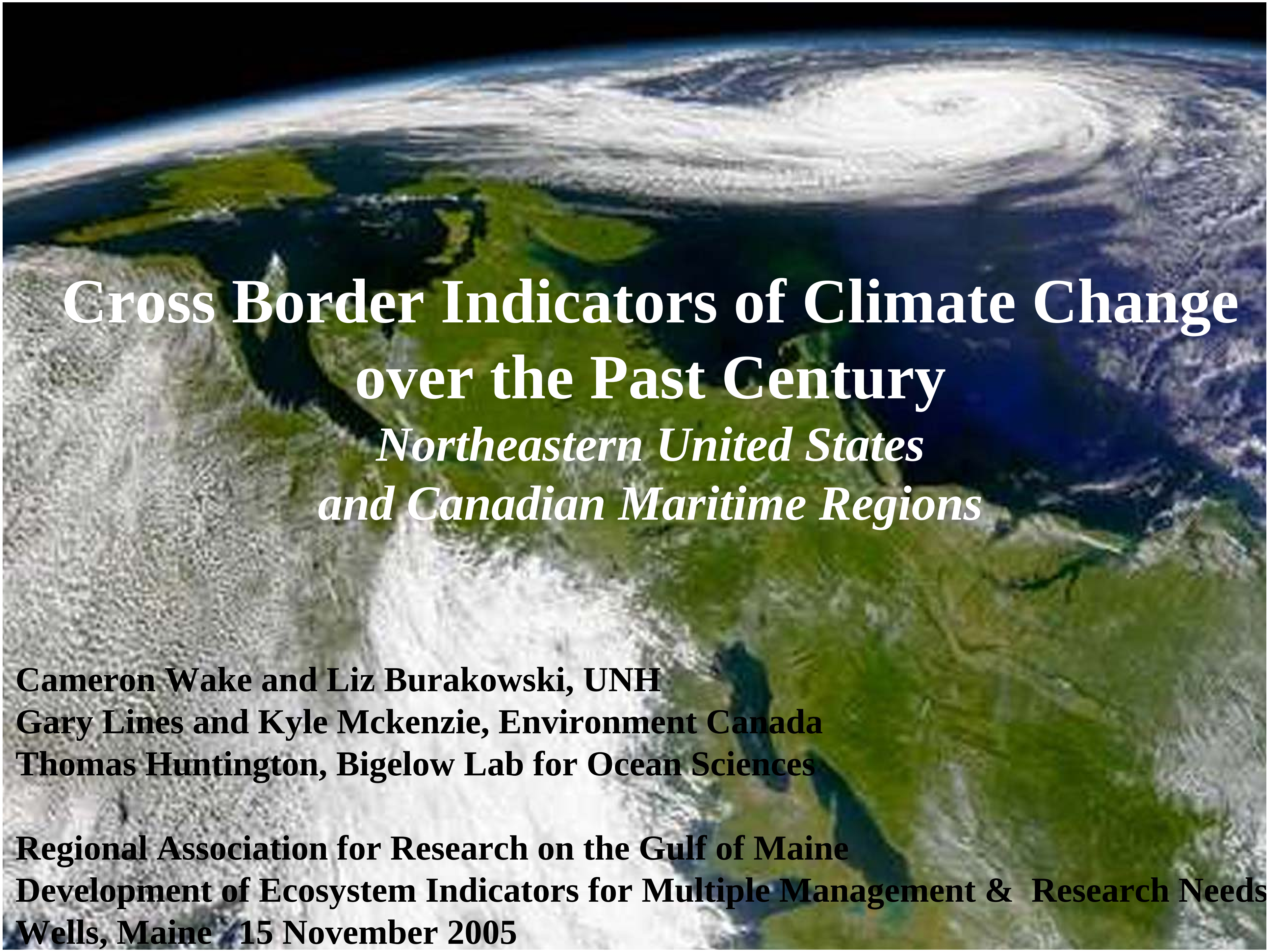


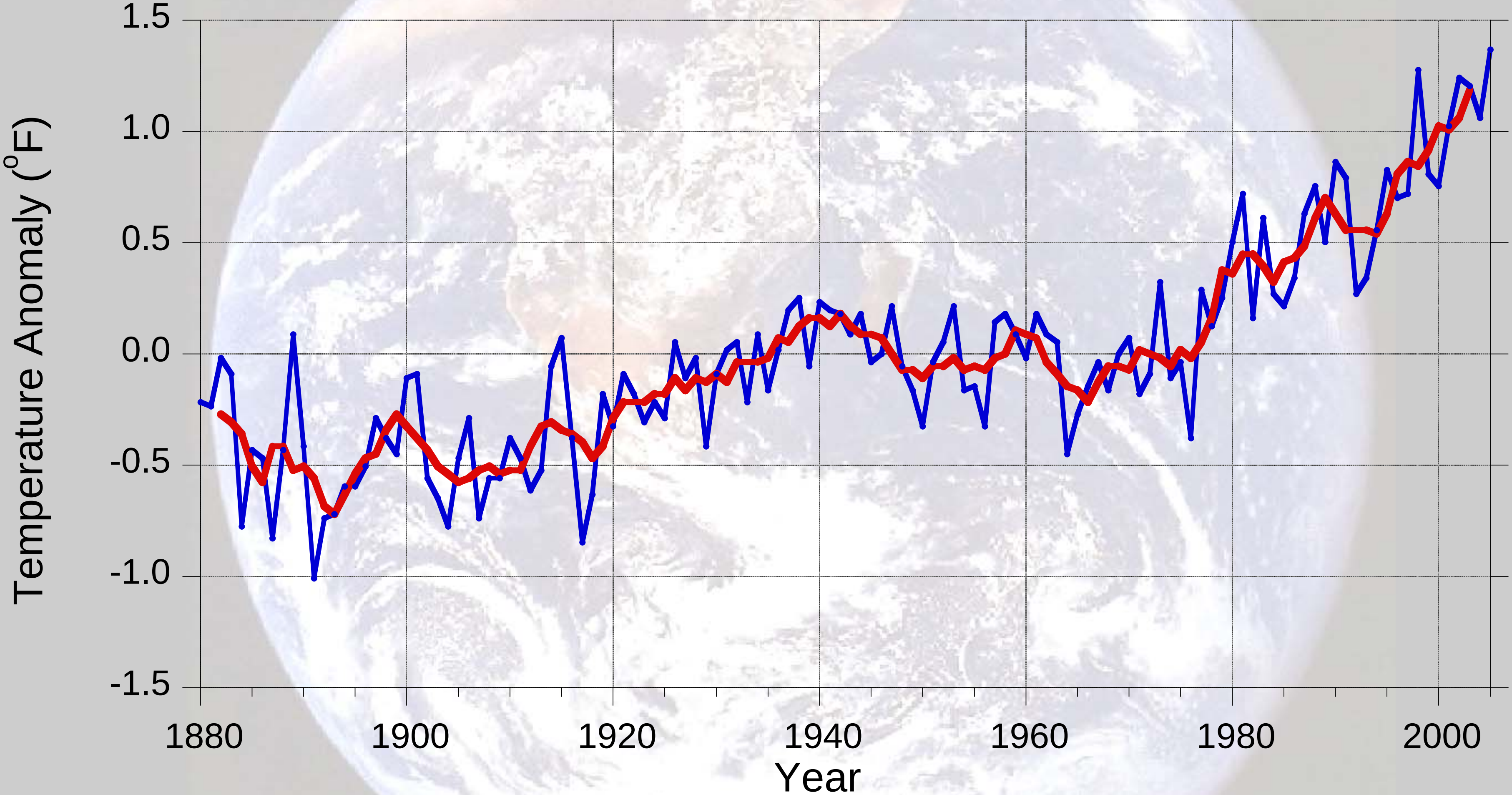
Cross Border Indicators of Climate Change over the Past Century

Northeastern United States and Canadian Maritime Regions

Cameron Wake and Liz Burakowski, UNH
Gary Lines and Kyle Mckenzie, Environment Canada
Thomas Huntington, Bigelow Lab for Ocean Sciences

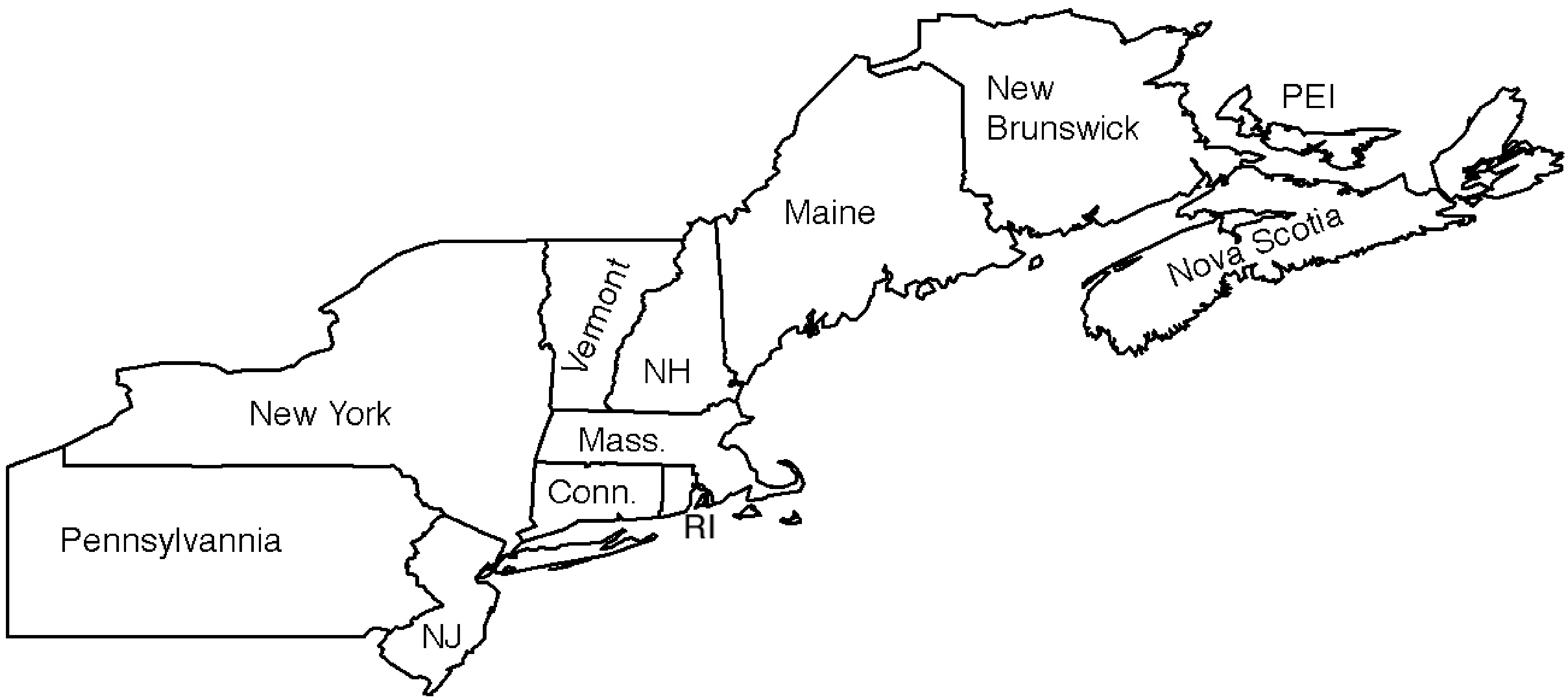
Regional Association for Research on the Gulf of Maine
Development of Ecosystem Indicators for Multiple Management & Research Needs
Wells, Maine 15 November 2005

Global Average Annual Temperature Anomaly (ºF) From meteorological stations 1880-2005

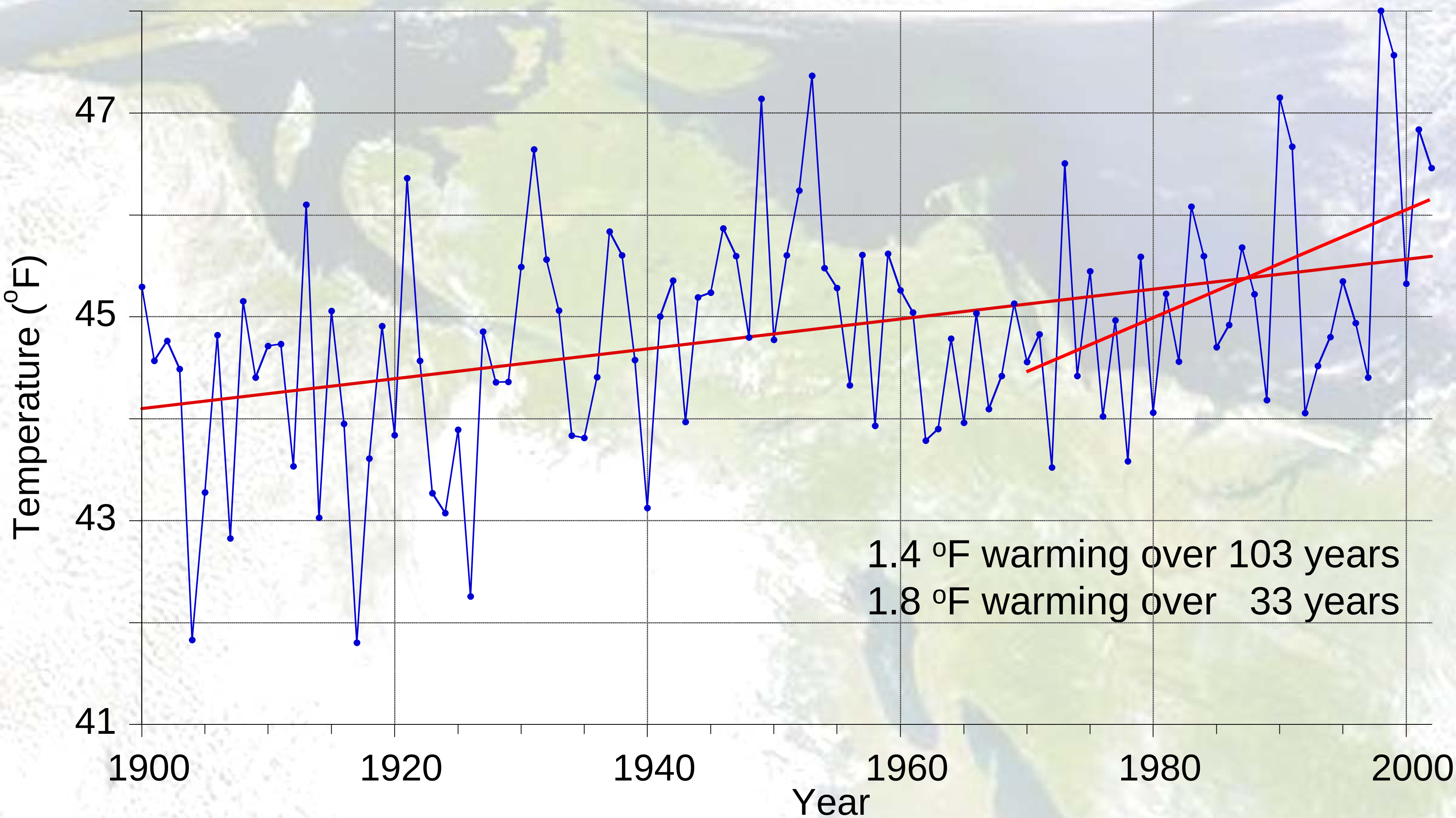


Hansen et al. (2001) J. Geophysical Res. Vol 106, p. 23,947-23,963
Data from http://www.giss.nasa.gov/data/update/gistemp/

Northeastern United States and Canadian Maritime Provinces

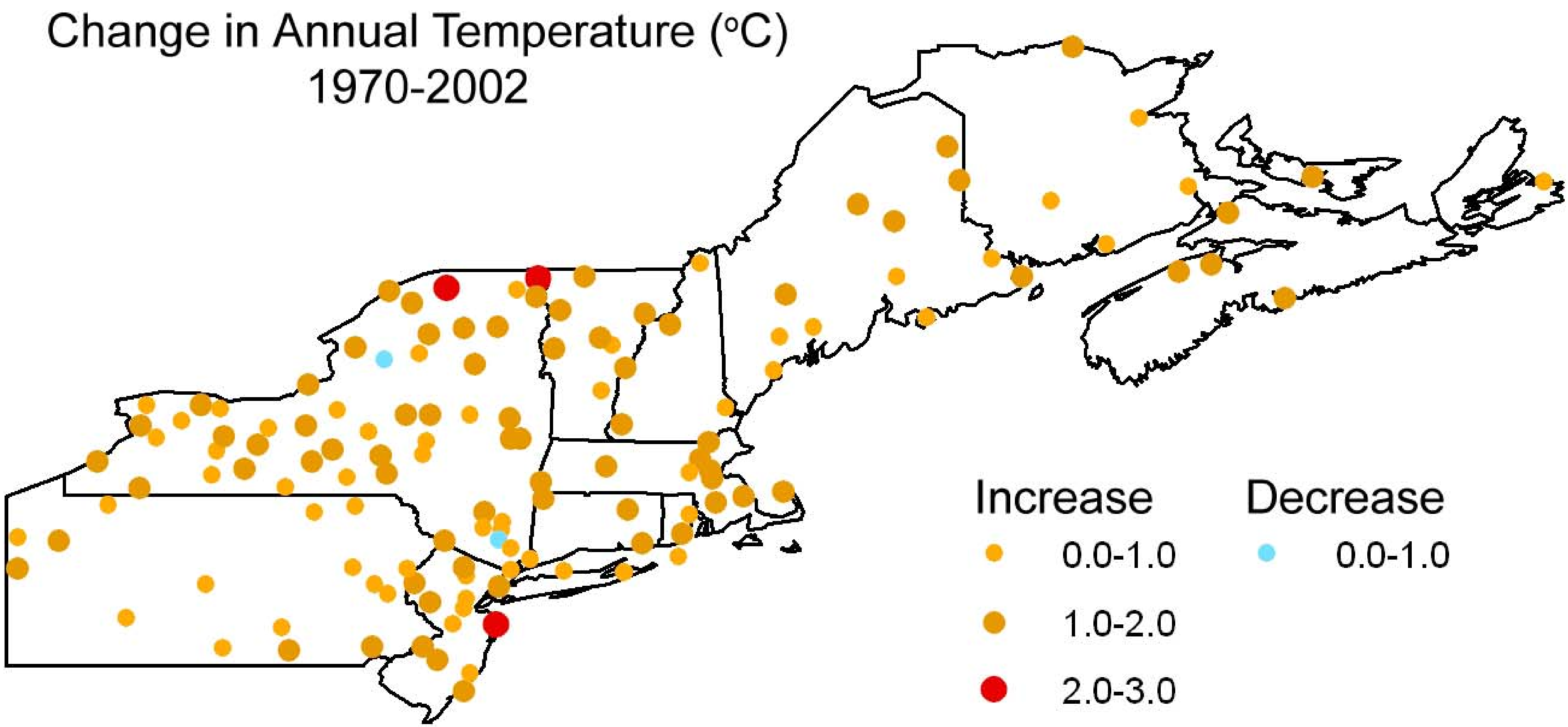


Average Annual Temperature in NE US & CDN Maritimes 1900-2002



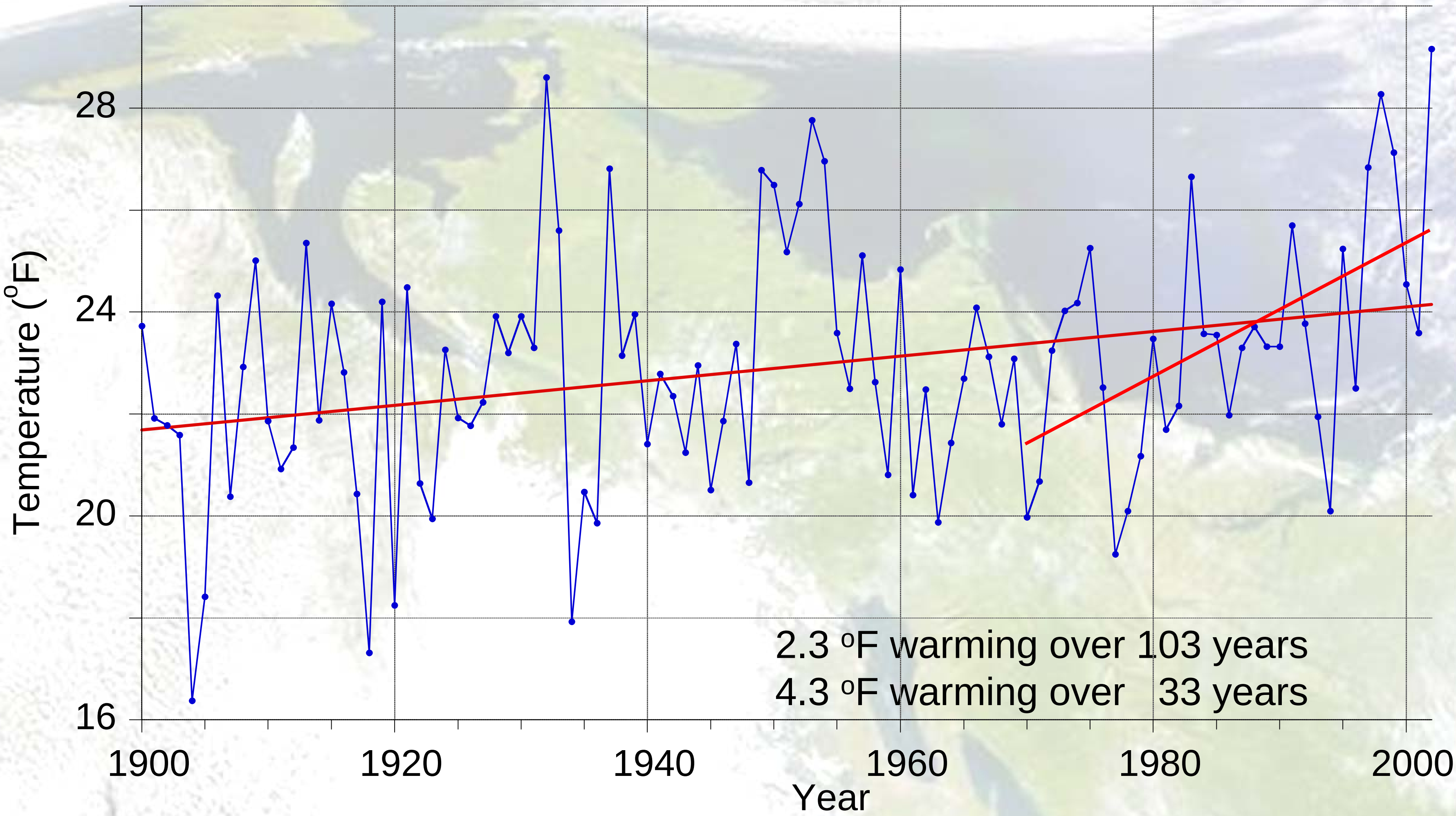
Time-series represents an aerially weighted average of data from 136 stations.
Data from the NOAA-NCDC and Environment Canada

Spatial Variation of Annual Temperature Trend 1970-2002



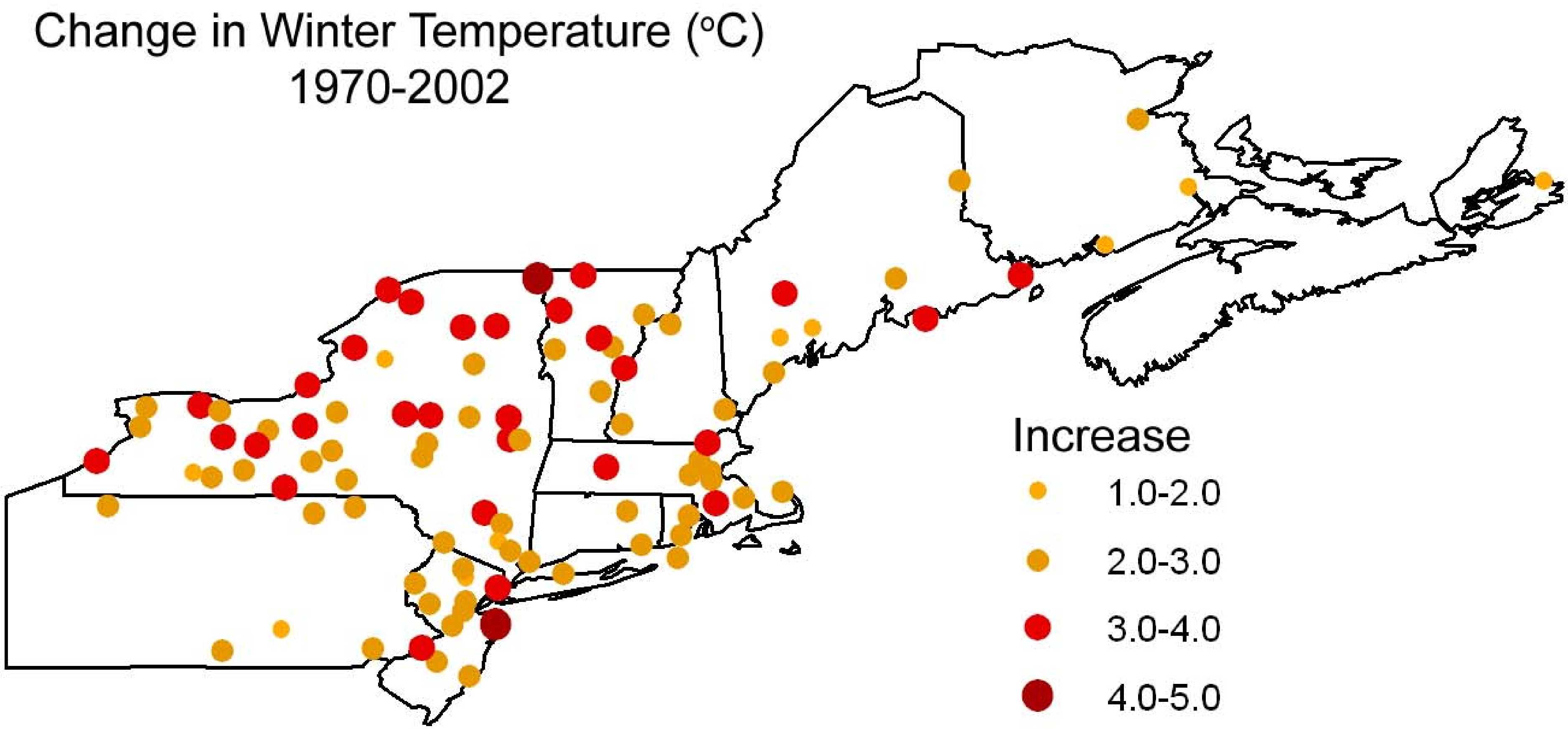
The temperature trend was calculated from a linear regression of annual average temperature for each station.

Average Winter Temperature in the NE US & CDN Maritimes 1900-2002



Time-series represents an aerially weighted average of data from 136 stations.
Data from the NOAA NCDC and Environment Canada

Spatial Variation Winter Temperature Trend 1970-2002



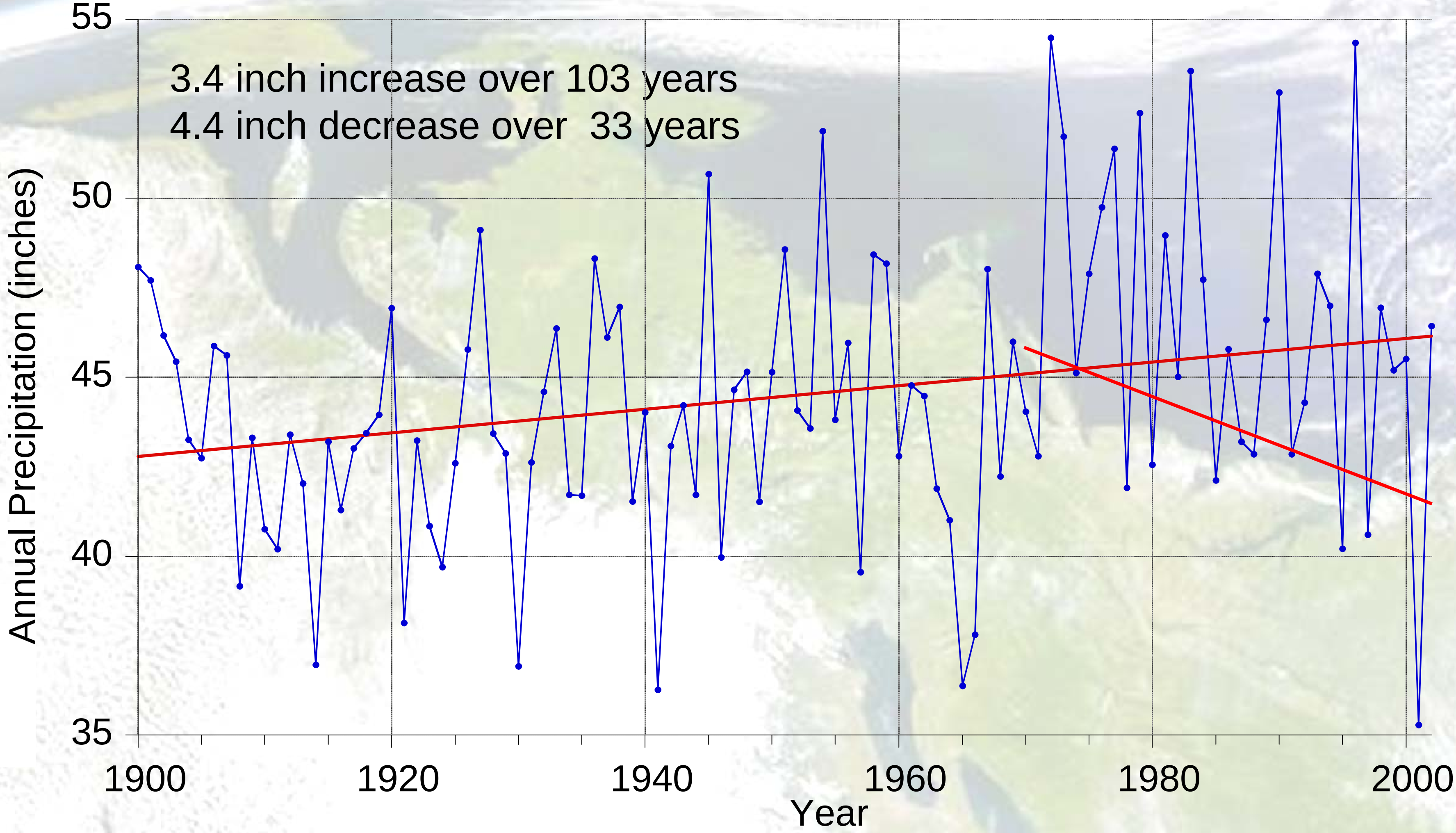
The temperature trend was calculated from a linear regression of annual average temperature for each station

2.4^{o}C (4.3^{o}F) Winter Temperature Increase from 1971-2002

Table 1. Comparison of monthly and winter mean temperatures (ºC) for three coastal cities in the cross border region.

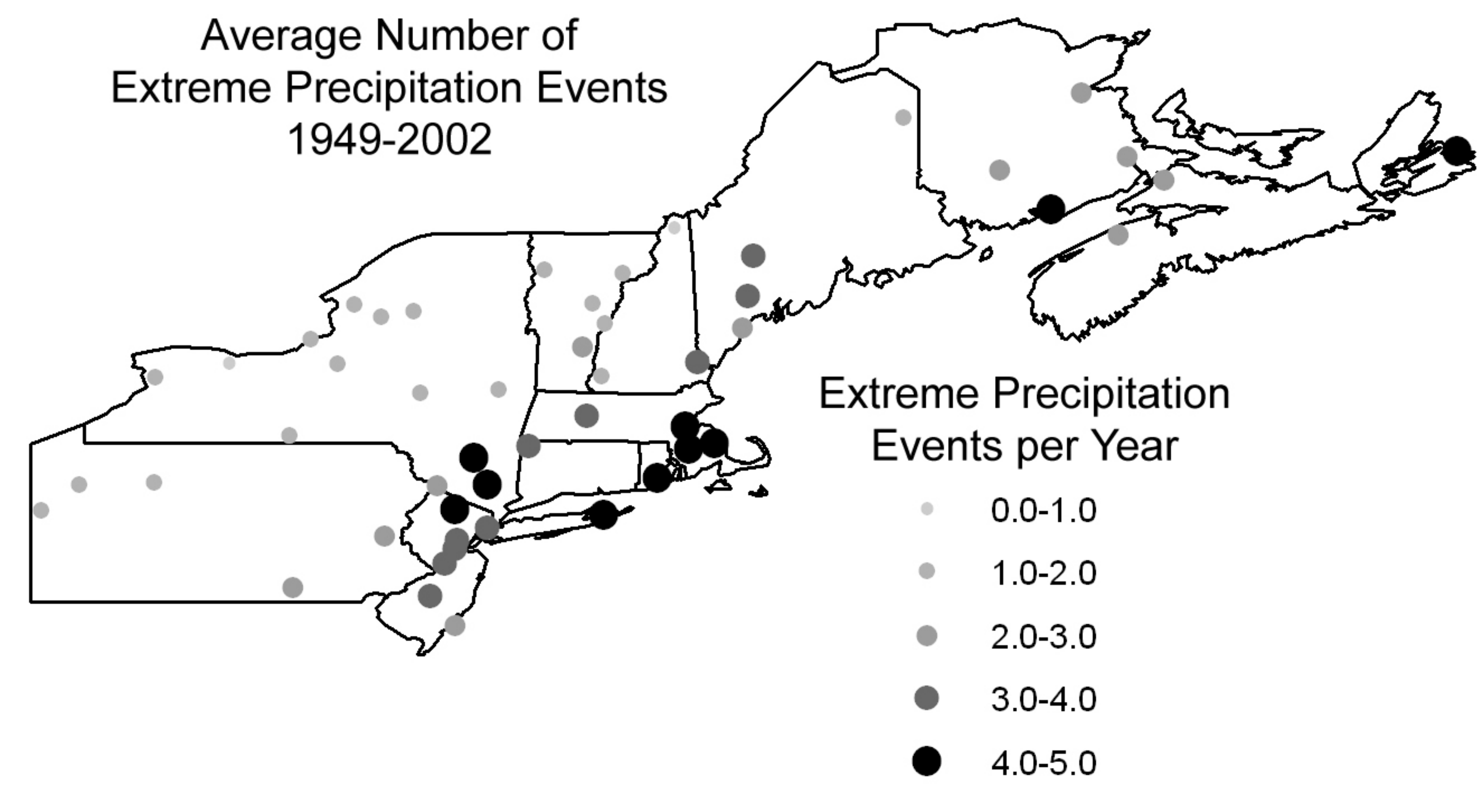
City	Latitude (N)	Dec	Jan	Feb	Mean
Halifax	44.65º	-2.0	-4.5	-5.0	-3.8
Boston	42.32º	0.0	-2.5	-1.5	-1.3
Philadelphia	40.00º	2.5	0.5	1.0	1.3

Average Annual Precipitation in the NE US & CDN Maritimes 1900-2002

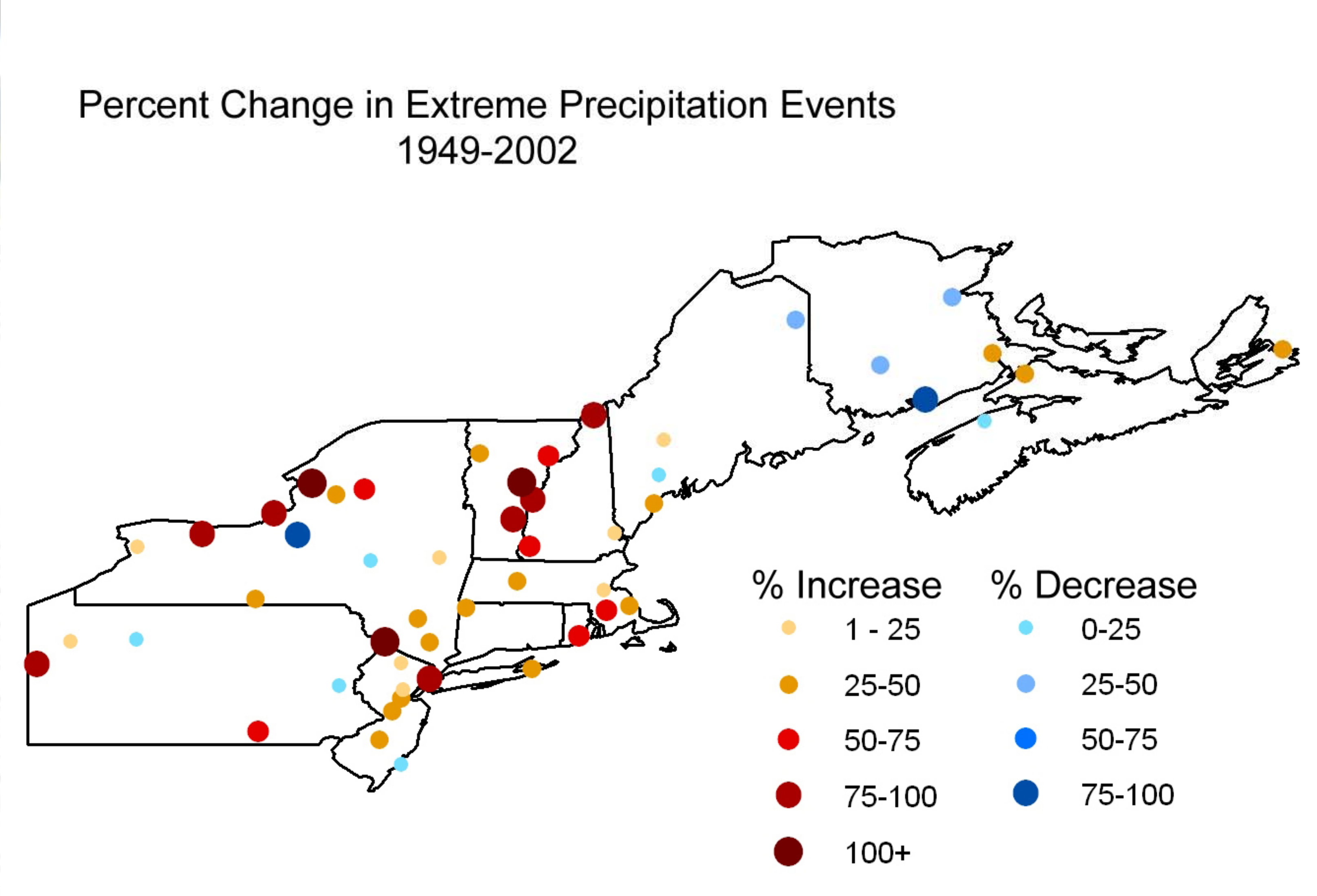


Time-series represents an aerially weighted average of data from 133 stations.

Spatial Variation of Extreme Precipitation Events

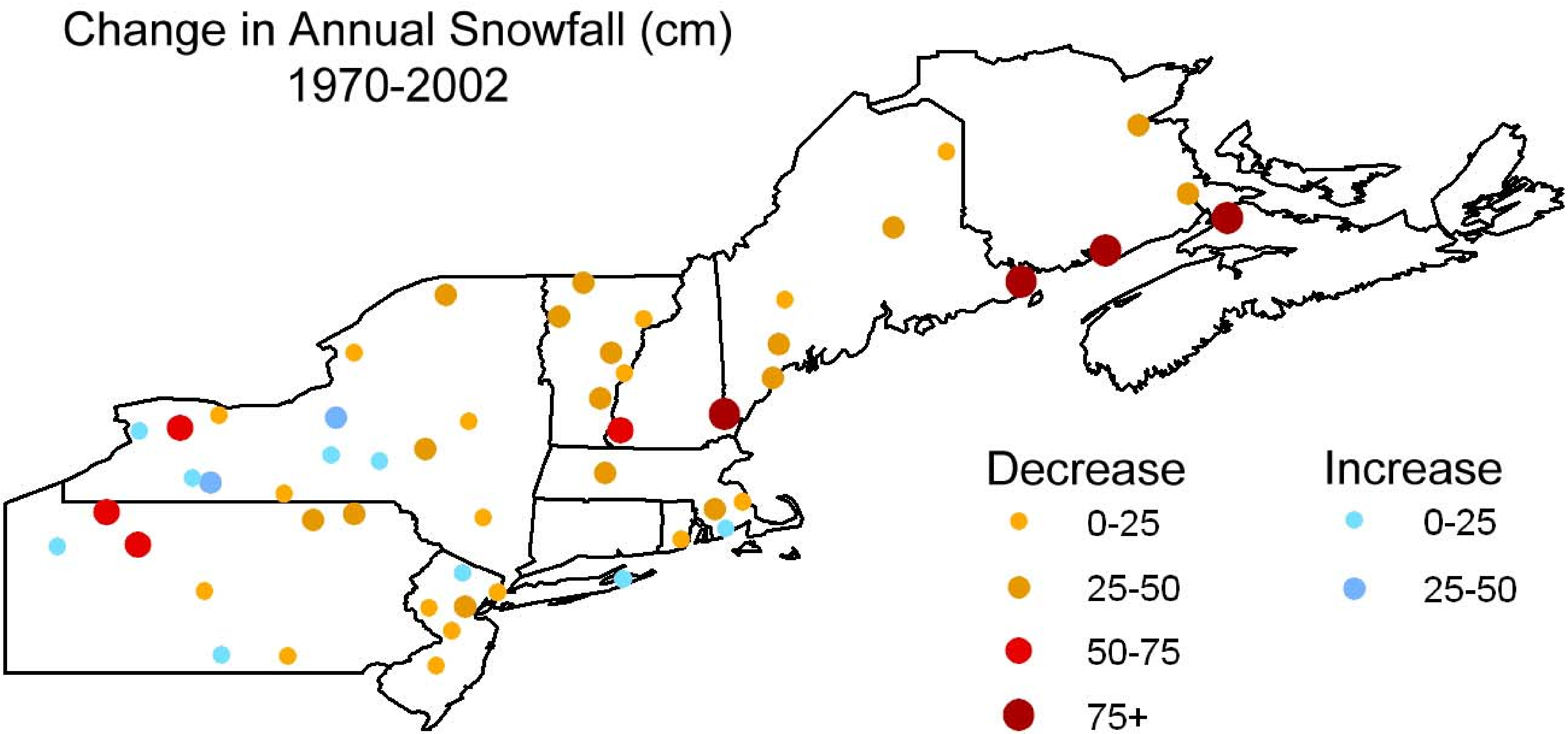


Spatial Variation of Extreme Precipitation Trend 1970-2002



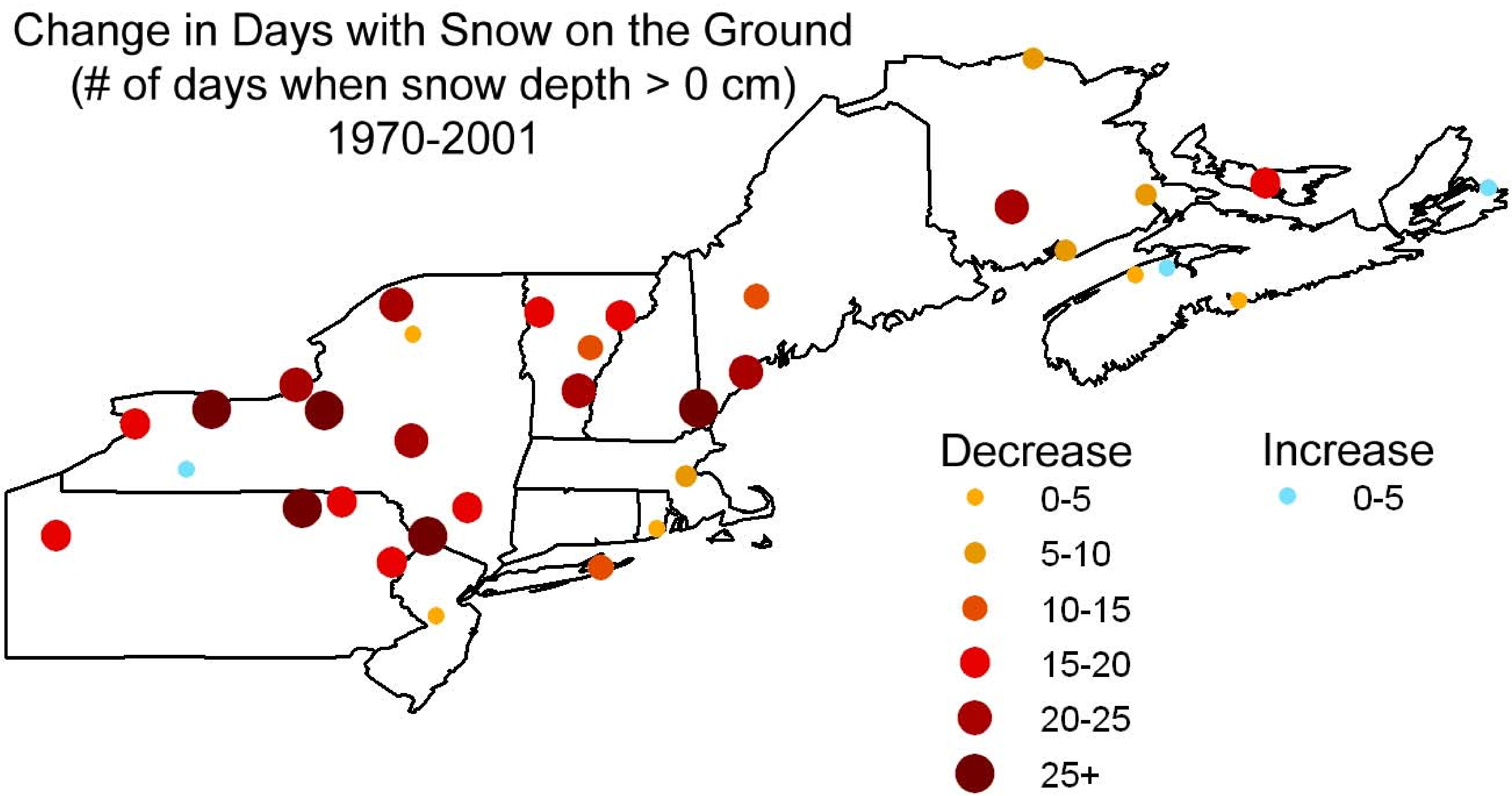
The extreme precipitation trend was calculated from a linear regression of number of events each year for each station.

Spatial Variation of Snowfall Trend 1970-2002



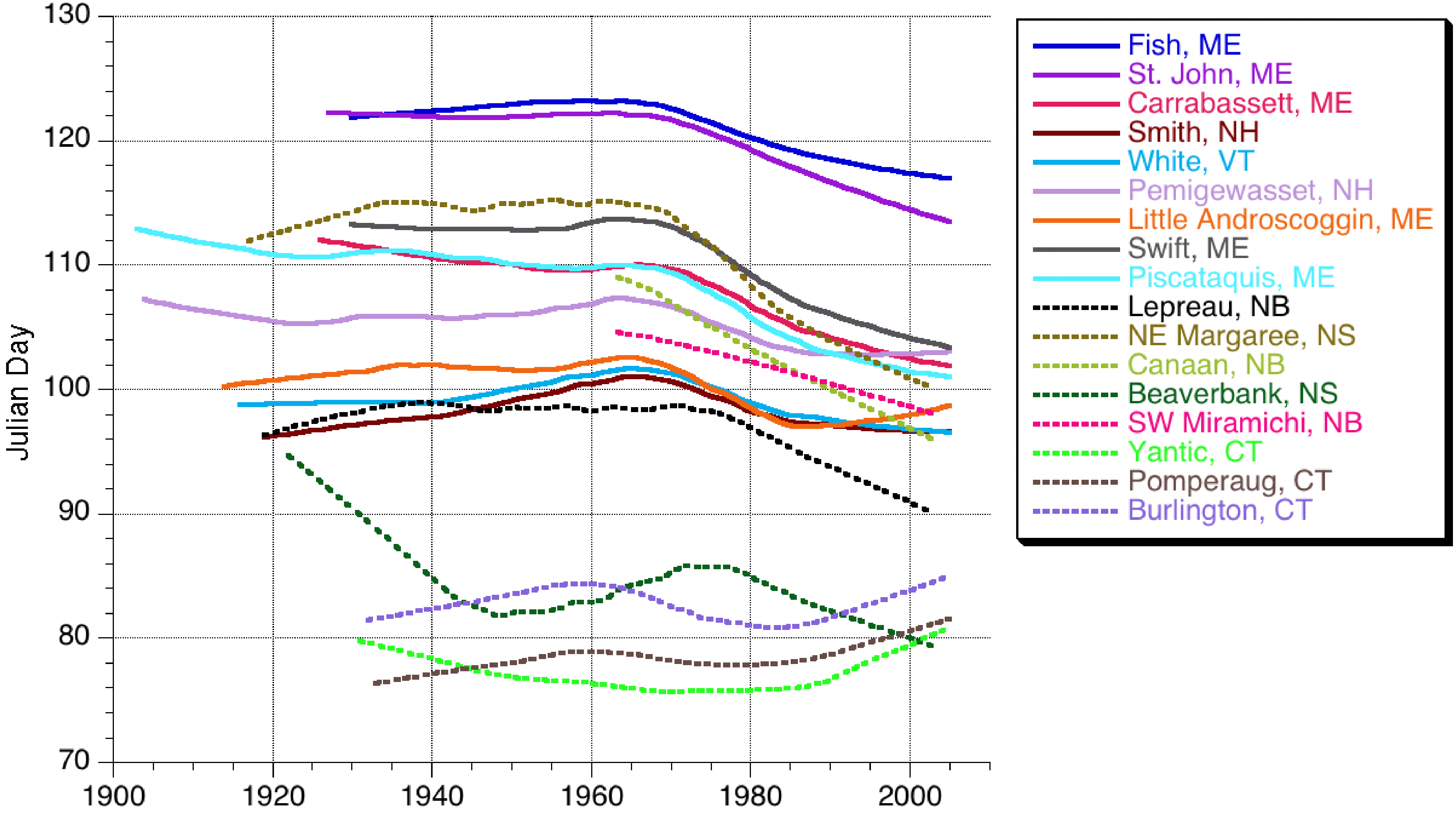
The snowfall trend was calculated from a linear regression of average winter snowfall for each station.

Spatial Variation of Days with Snow on Ground 1970-2002



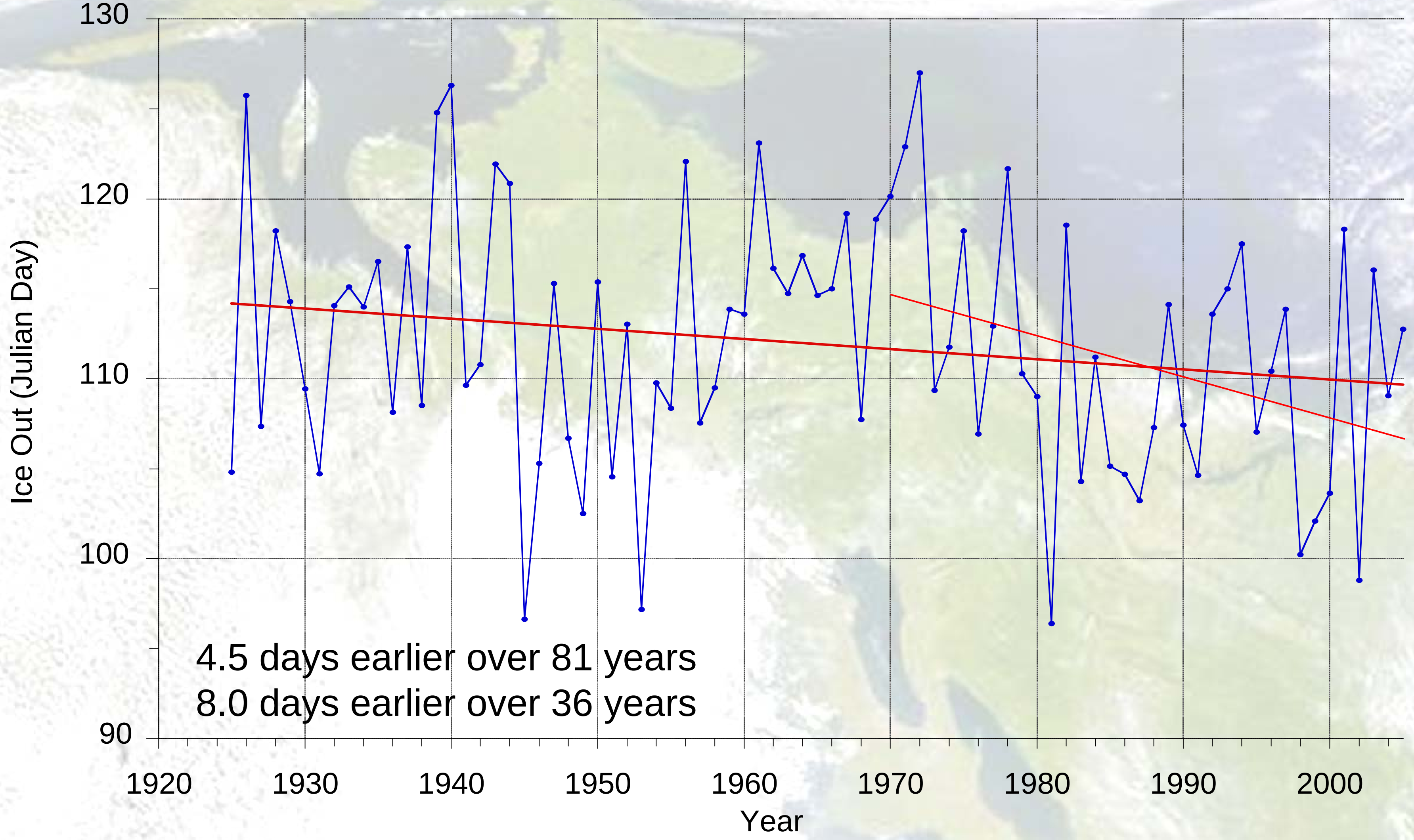
The snow on ground trend was calculated from a linear regression of annual total snow on ground days for each station.

Winter/Spring (1 Jan - 31 May) Center-of-Volume Dates



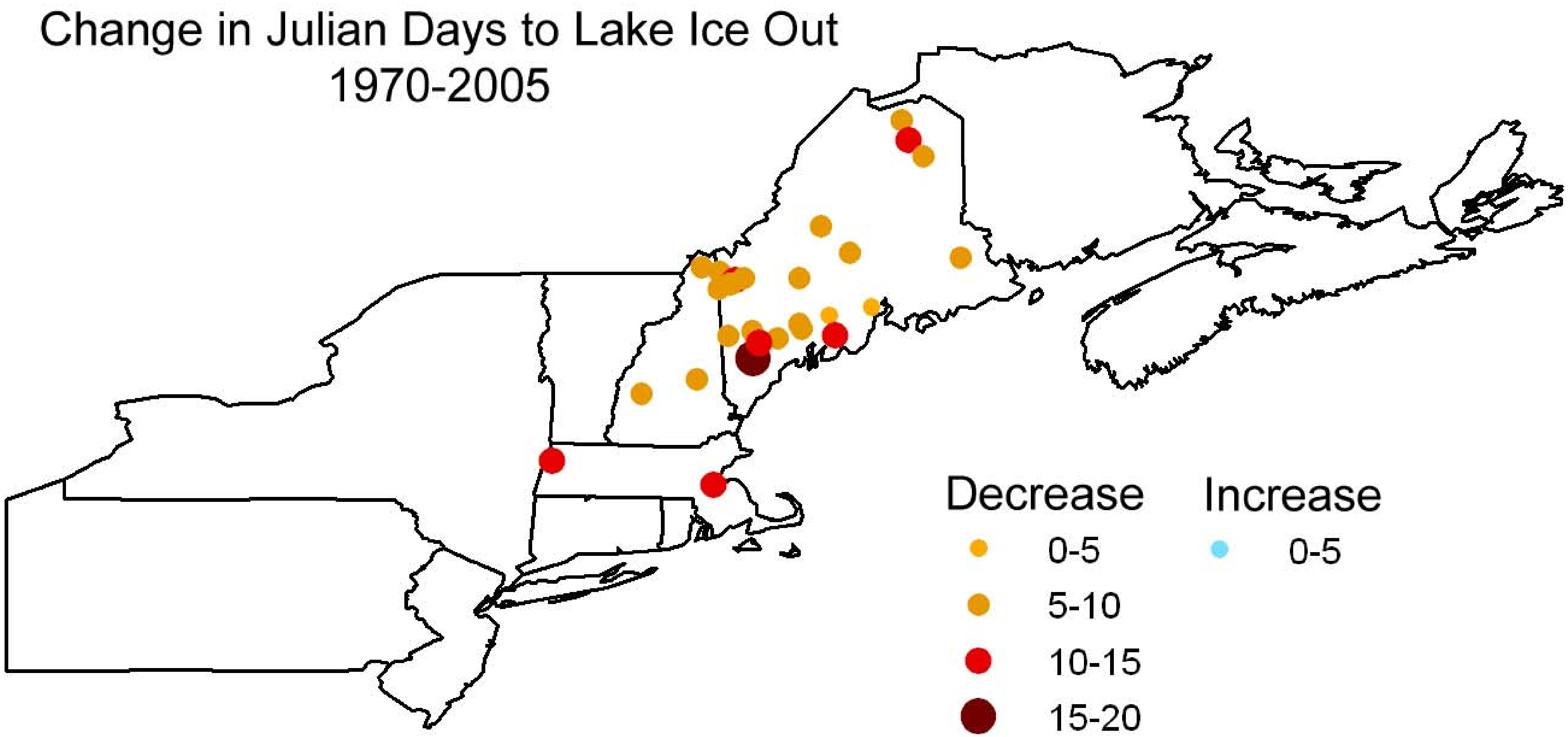
All data from unregulated rivers

Average Ice Out Day Trend 1925-2005 (27 Lakes)



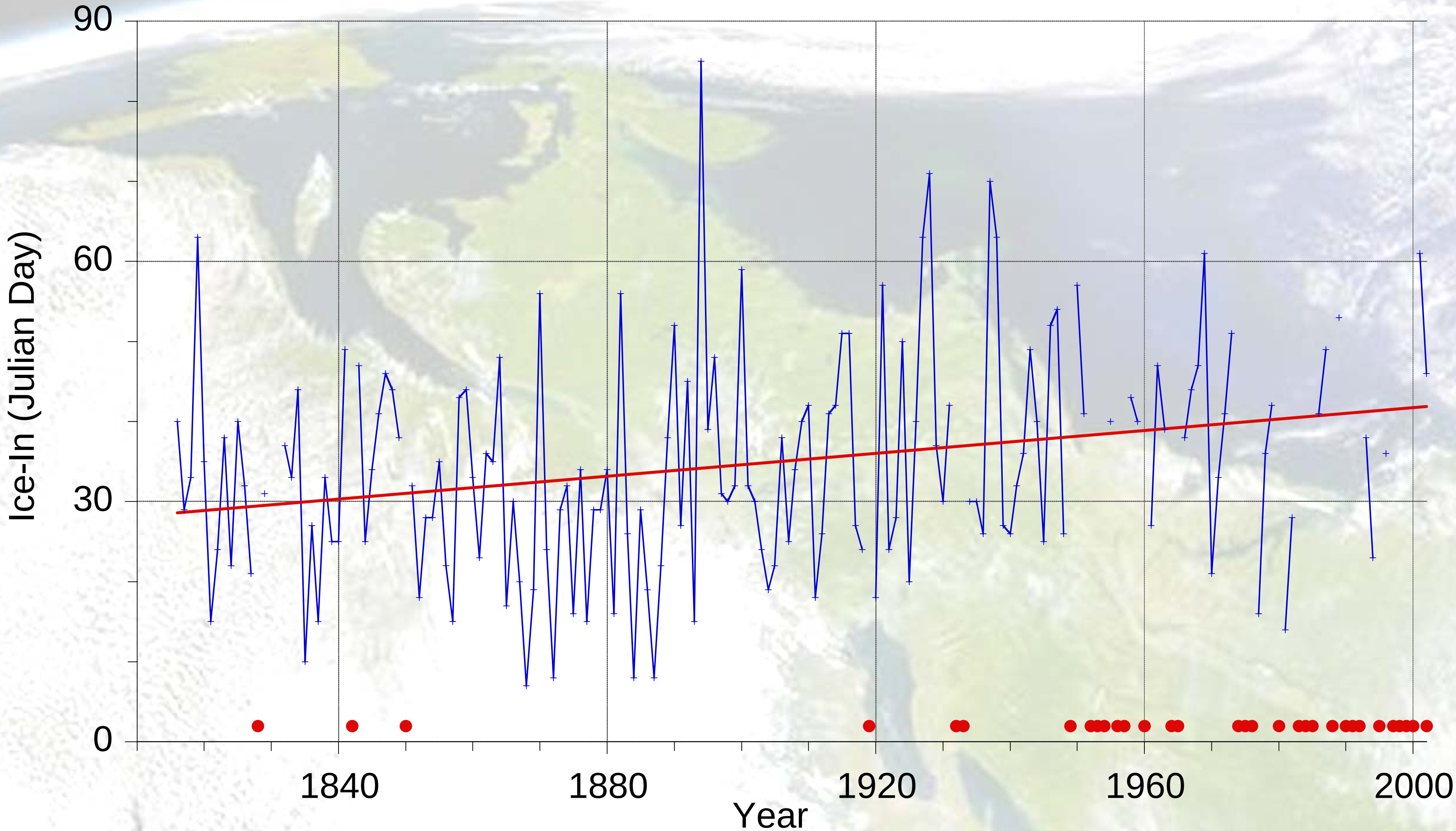
Ice Out data from Hodgkins et al., 2002 and at: http://me.water.usgs.gov/iceout.html

Spatial Variation Trend in Ice Out Dates 1970-2000



The ice out trend was calculated from a linear regression of annual ice out date record for each lake.

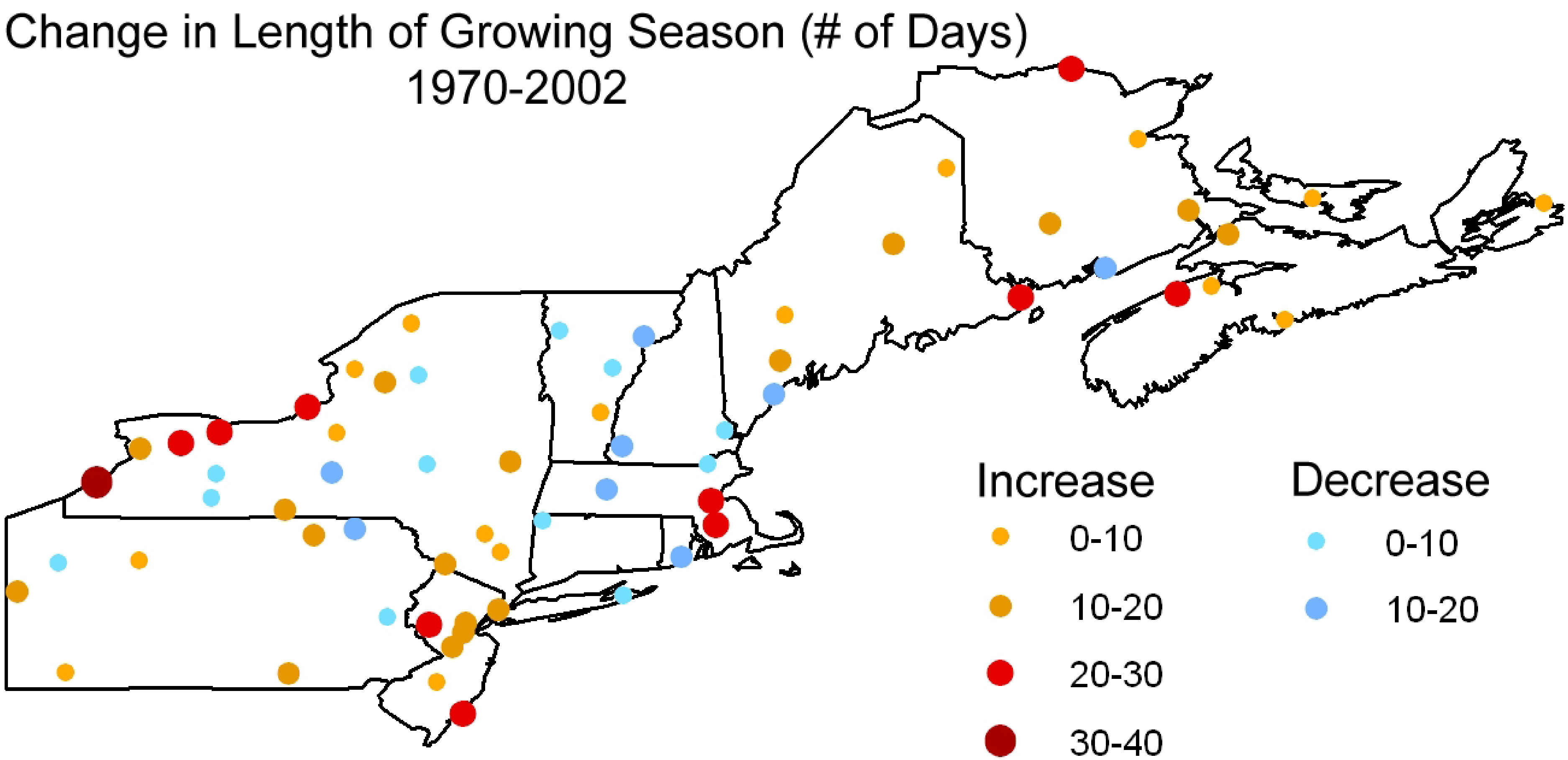
Lake Champlain Ice-In Dates 1816-2005



Ice-in date 14 days later over last 190 years. Of 33 years lake has not frozen, 18 have occurred since 1970, and 26 since 1950.

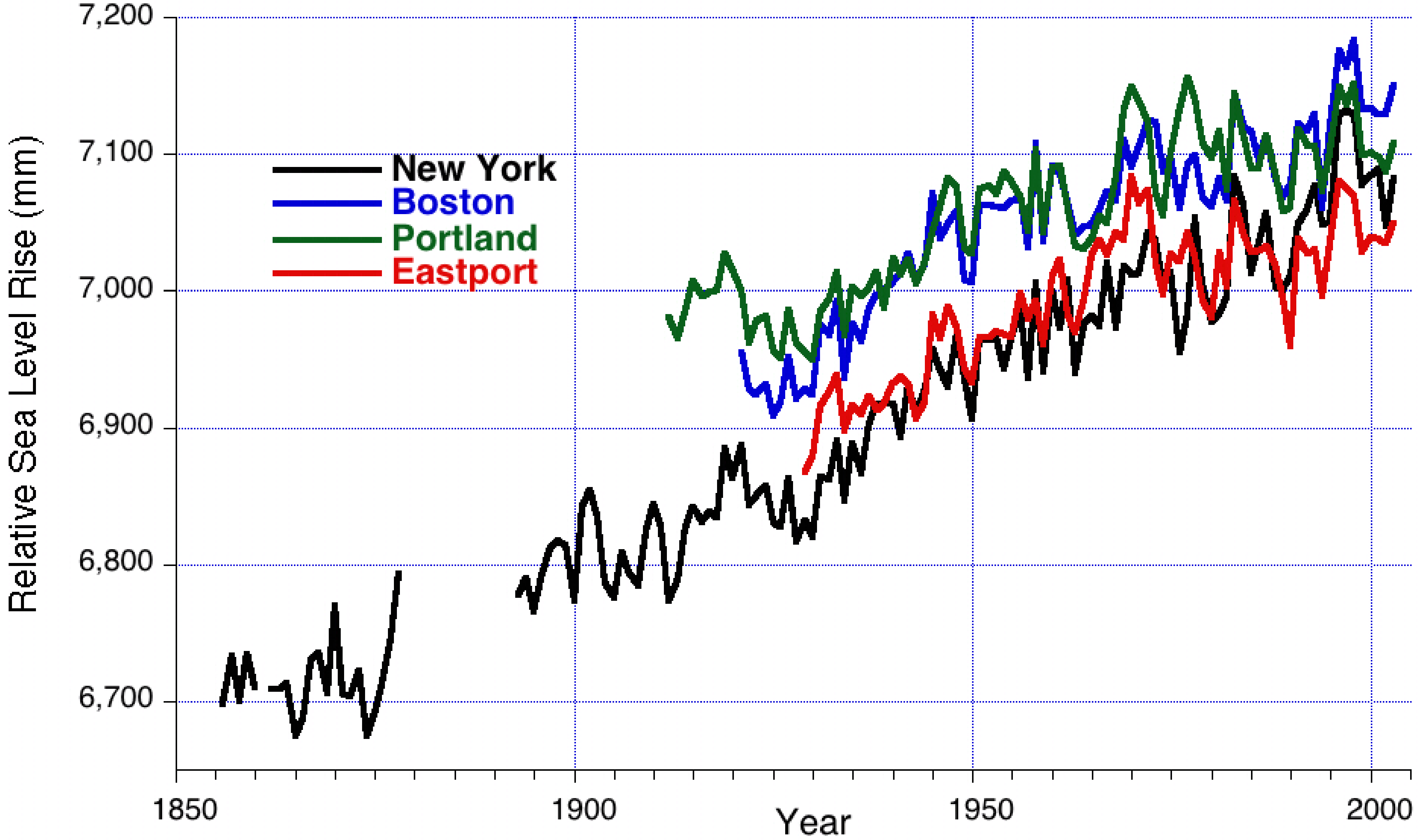
Data from NWS Burlington http://www.erh.noaa.gov/er/btv/climo/lakeclose.html

Spatial Variation of Growing Season (28ºF) Trend 1970-2000



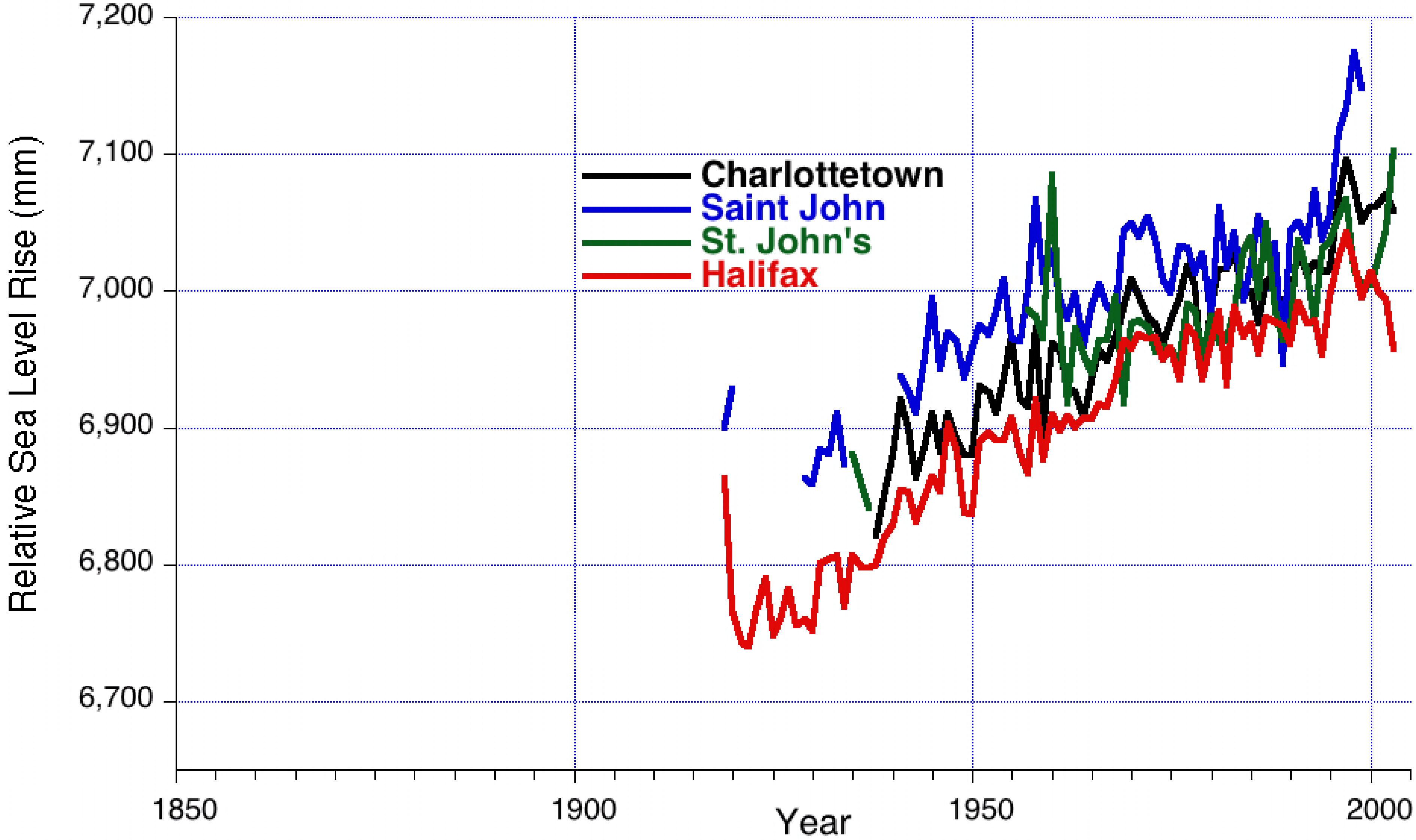
The growing season trend was calculated from a linear regression of annual average growing season length for each station.

Relative Sea Level Rise 1856 - 2005



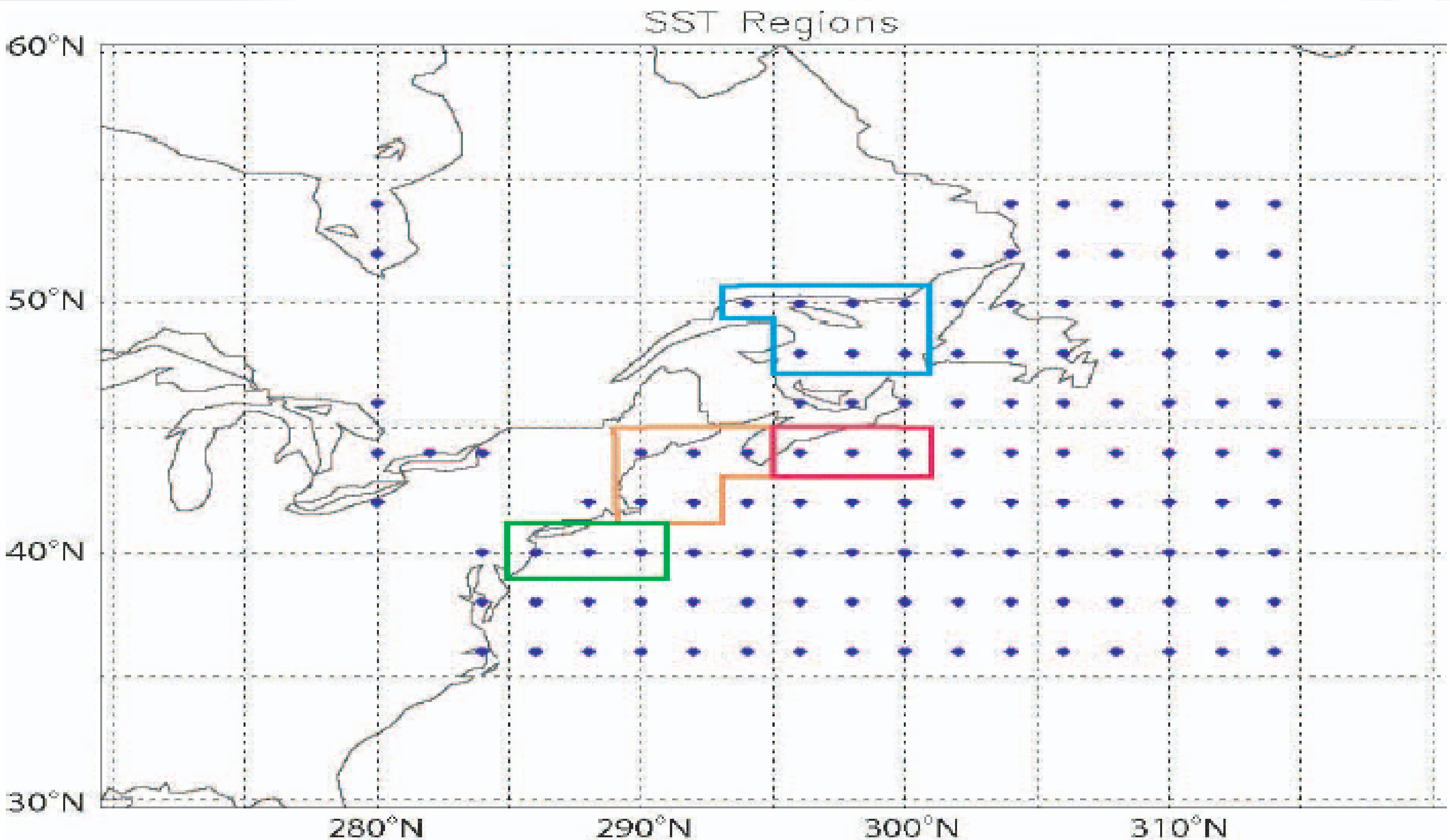
Data from Permanent Service for Mean Sea Level http://www.pol.ac.uk/psmsl/

Relative Sea Level Rise 1856 - 2005

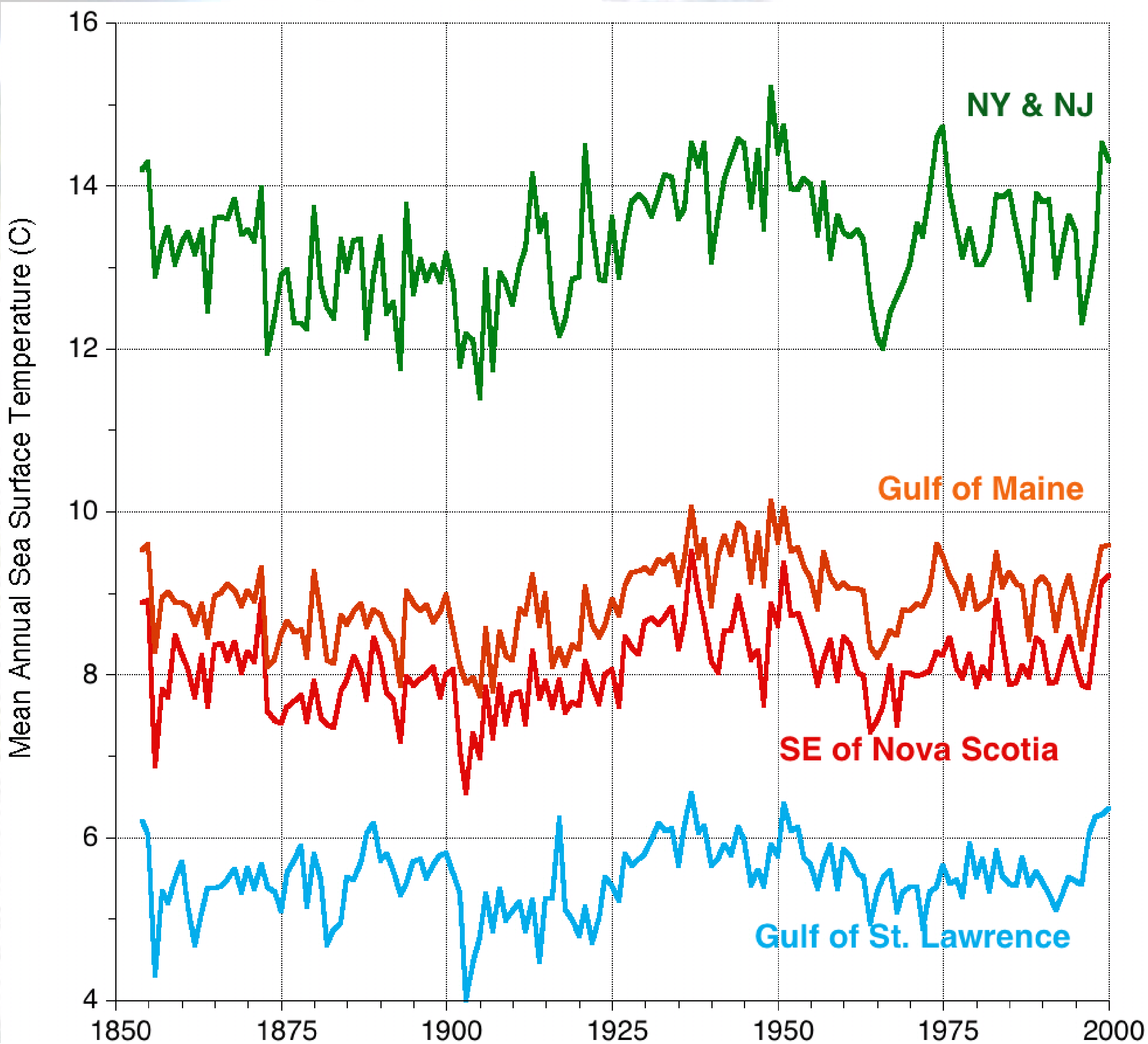


Data from Permanent Service for Mean Sea Level http://www.pol.ac.uk/psmsl/

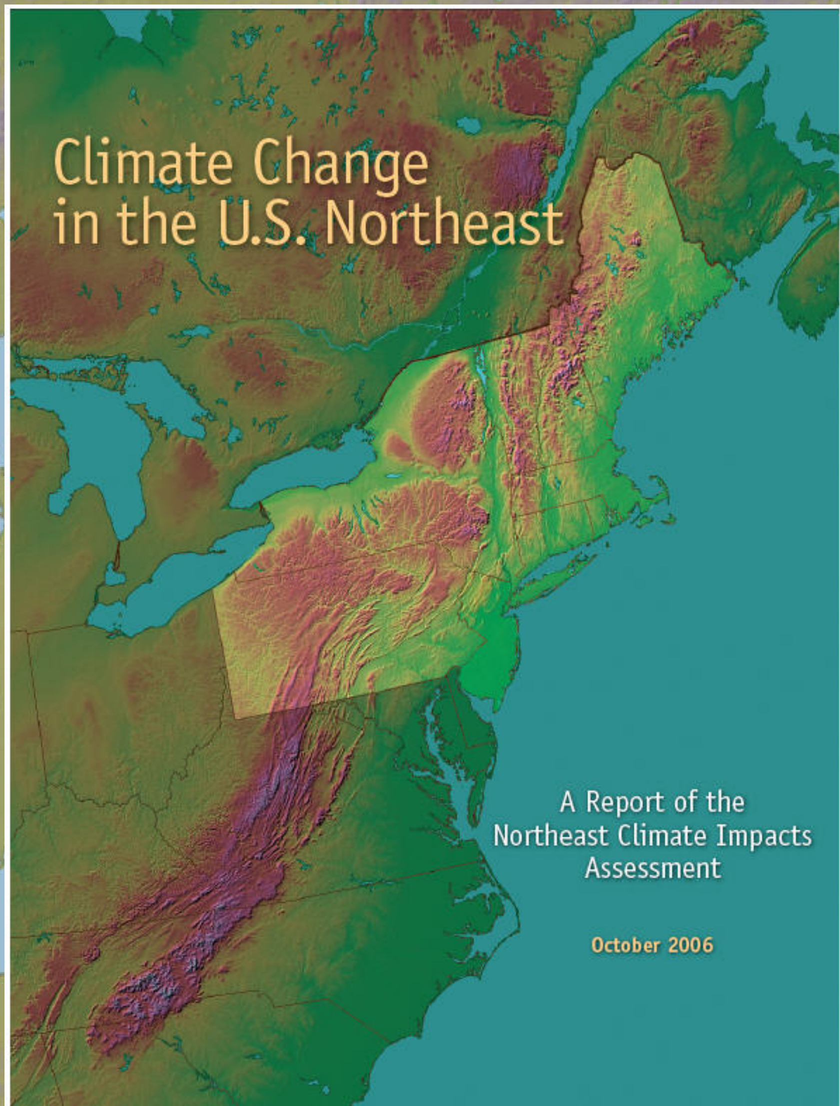
Sea Surface Temperatures 1900 - 2002



Sea Surface Temperatures 1900 - 2002

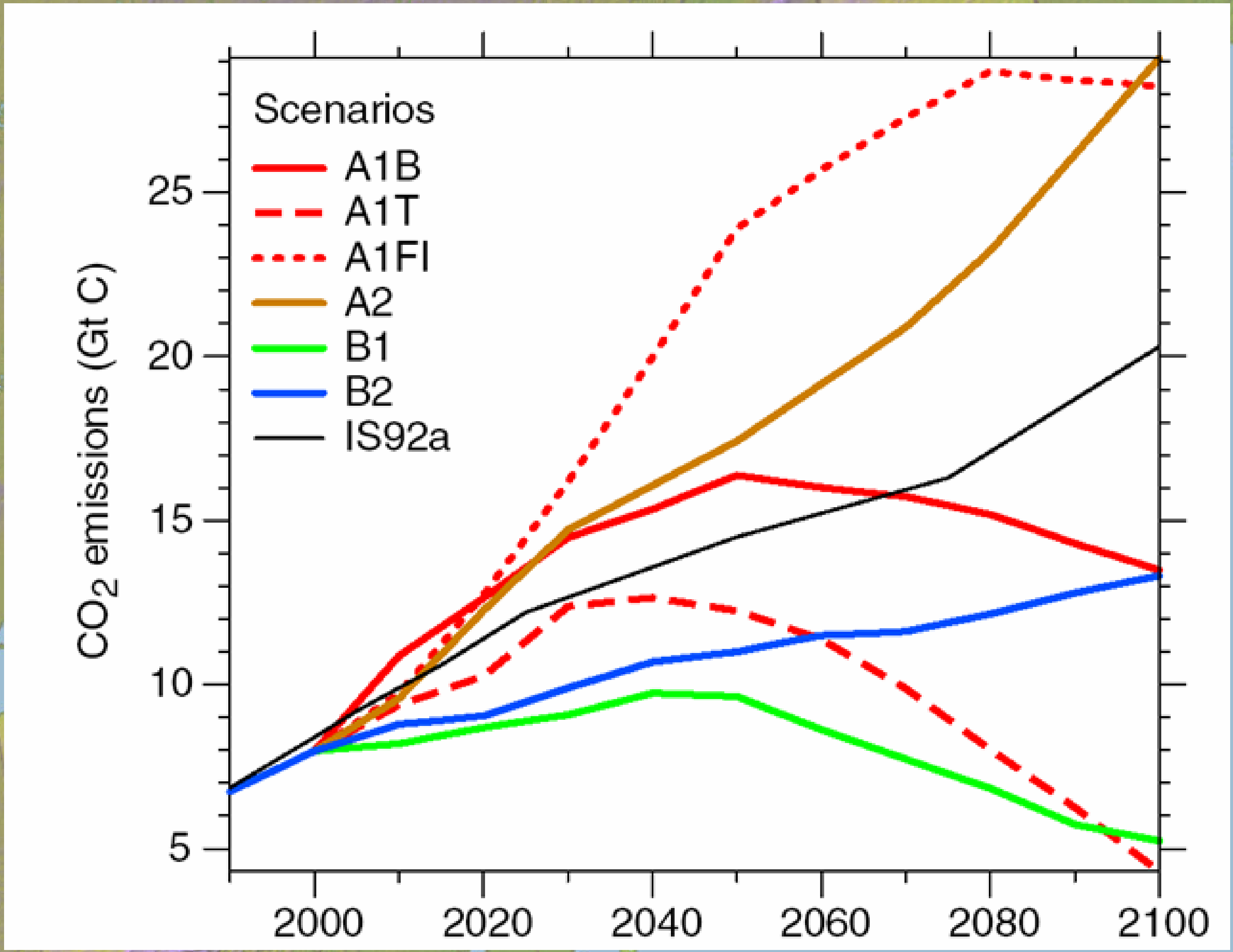


Northeast Climate Impacts Assessment (NECIA)

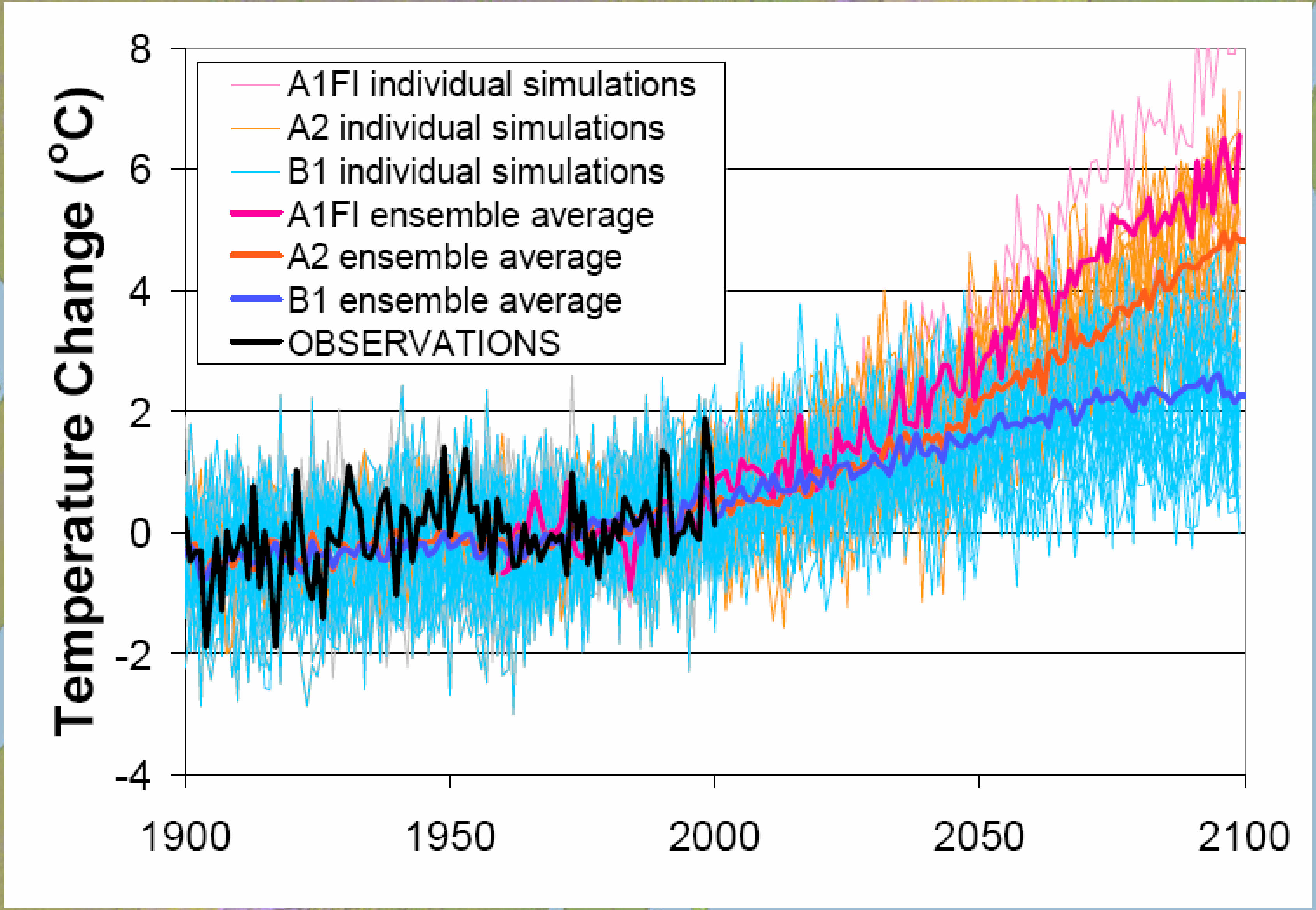


- Collaboration between UCS and 40 independent scientists
- **Analytic Approach**
  Assess projected changes in climate and potential impacts through 2100 under lower and higher scenarios of heat-trapping emissions.
- **Geographic Scope**
  Nine Northeast states, from Maine to Pennsylvania.
- **Peer Review**
  K. Hayhoe, C. Wake, et al.,
  - Climate Dynamics, *in press*
  - BAMS, *in review*

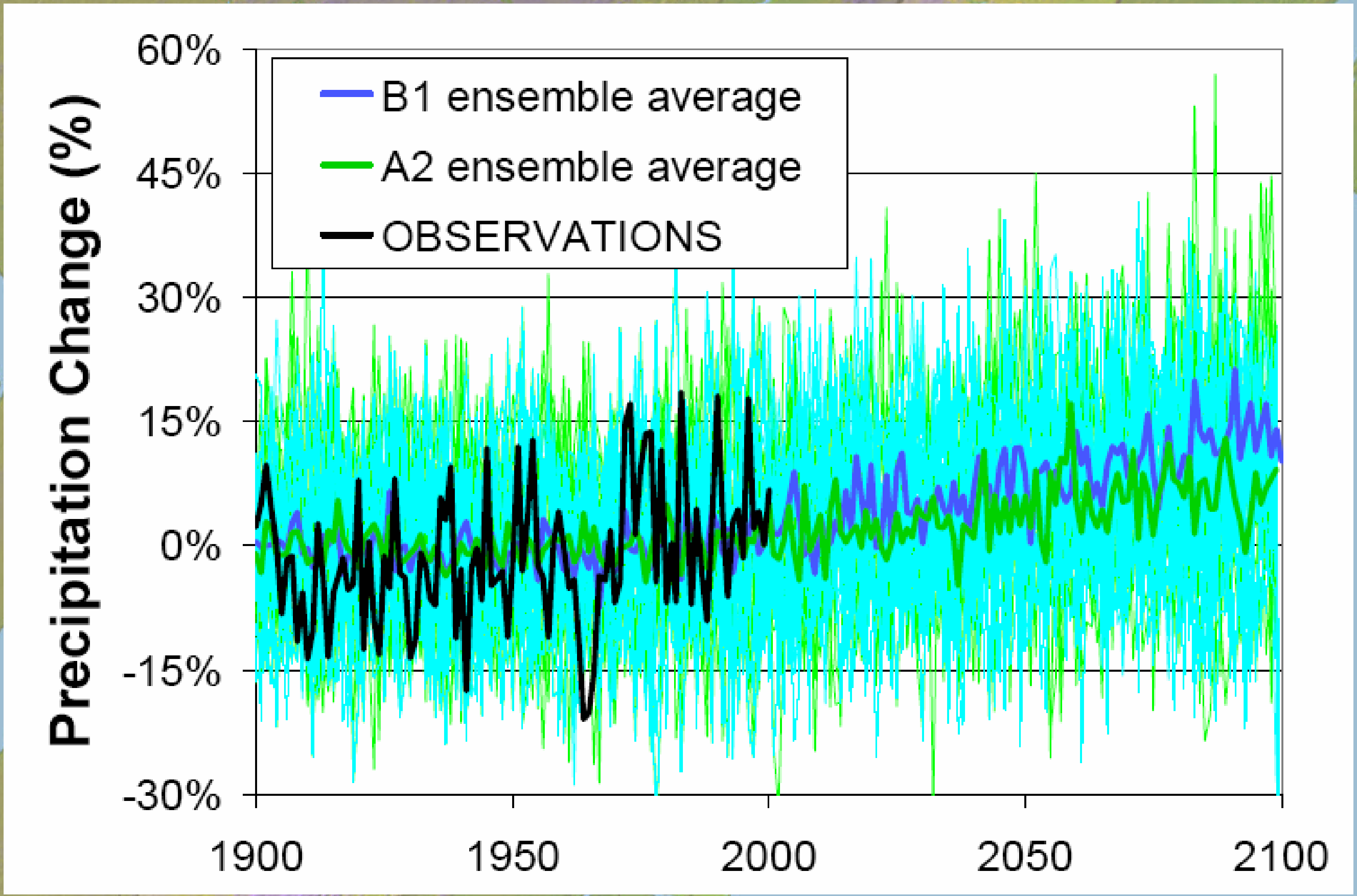
Greenhouse Gas Emission Scenarios



Northeast Observed and Modeled Temperature

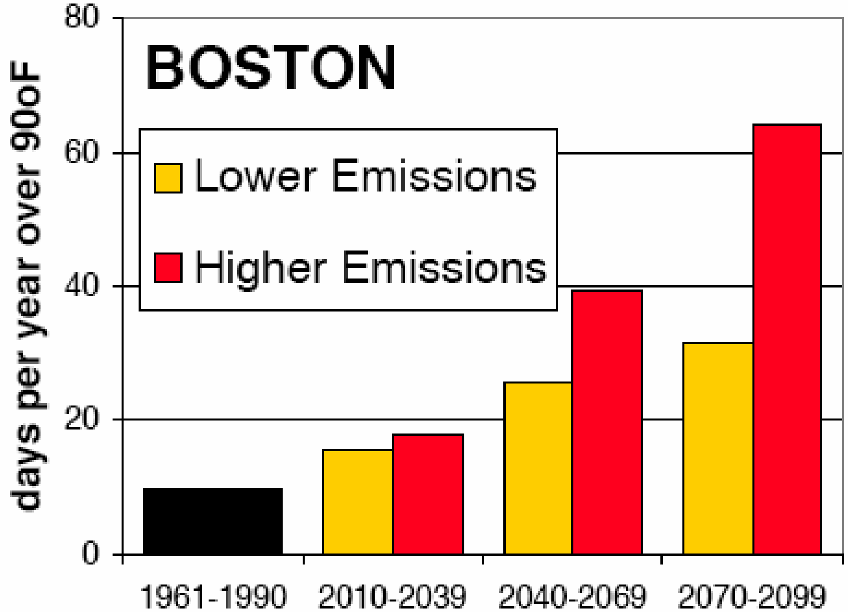


Northeast Observed and Modeled Precipitation

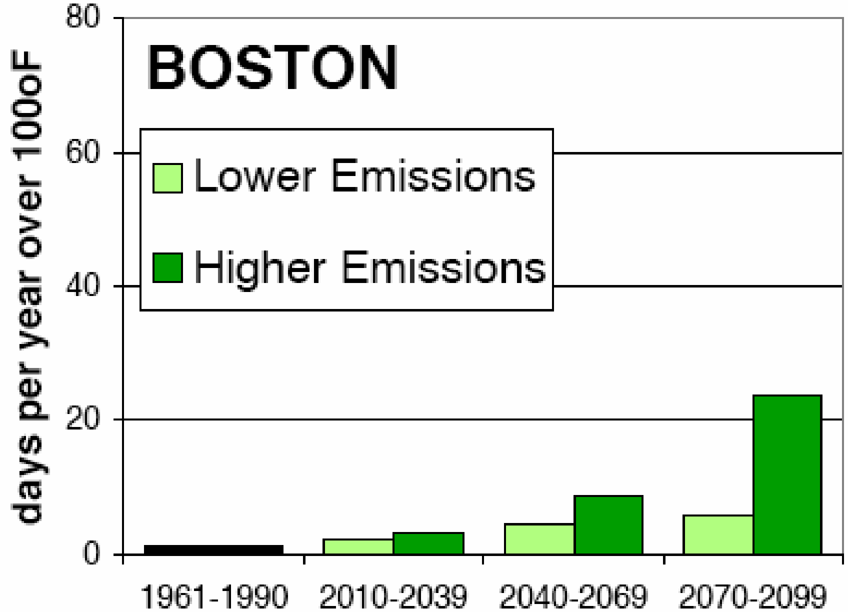


Northeast Observed and Modeled Extreme Temperature

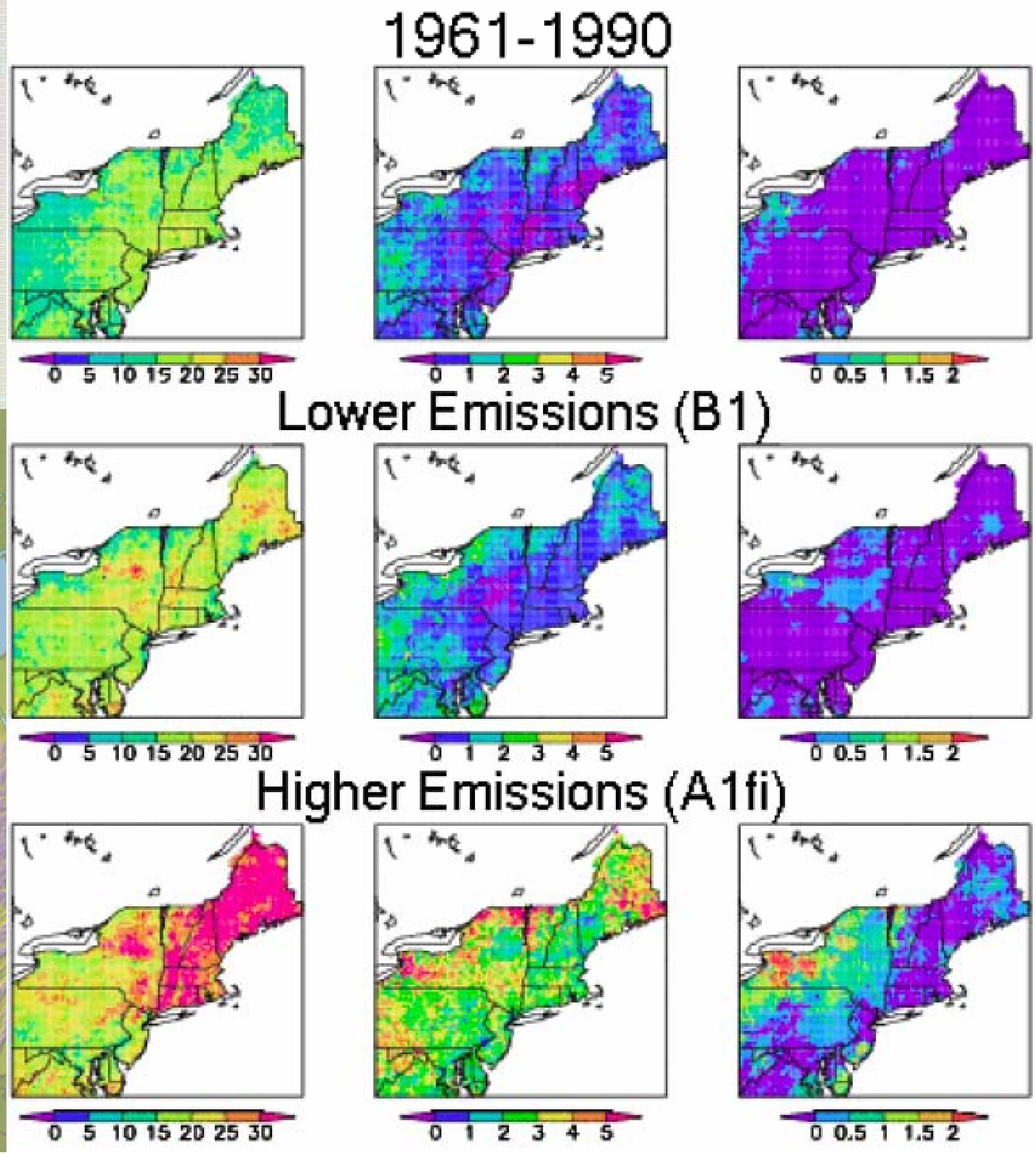
No. of days >90°F



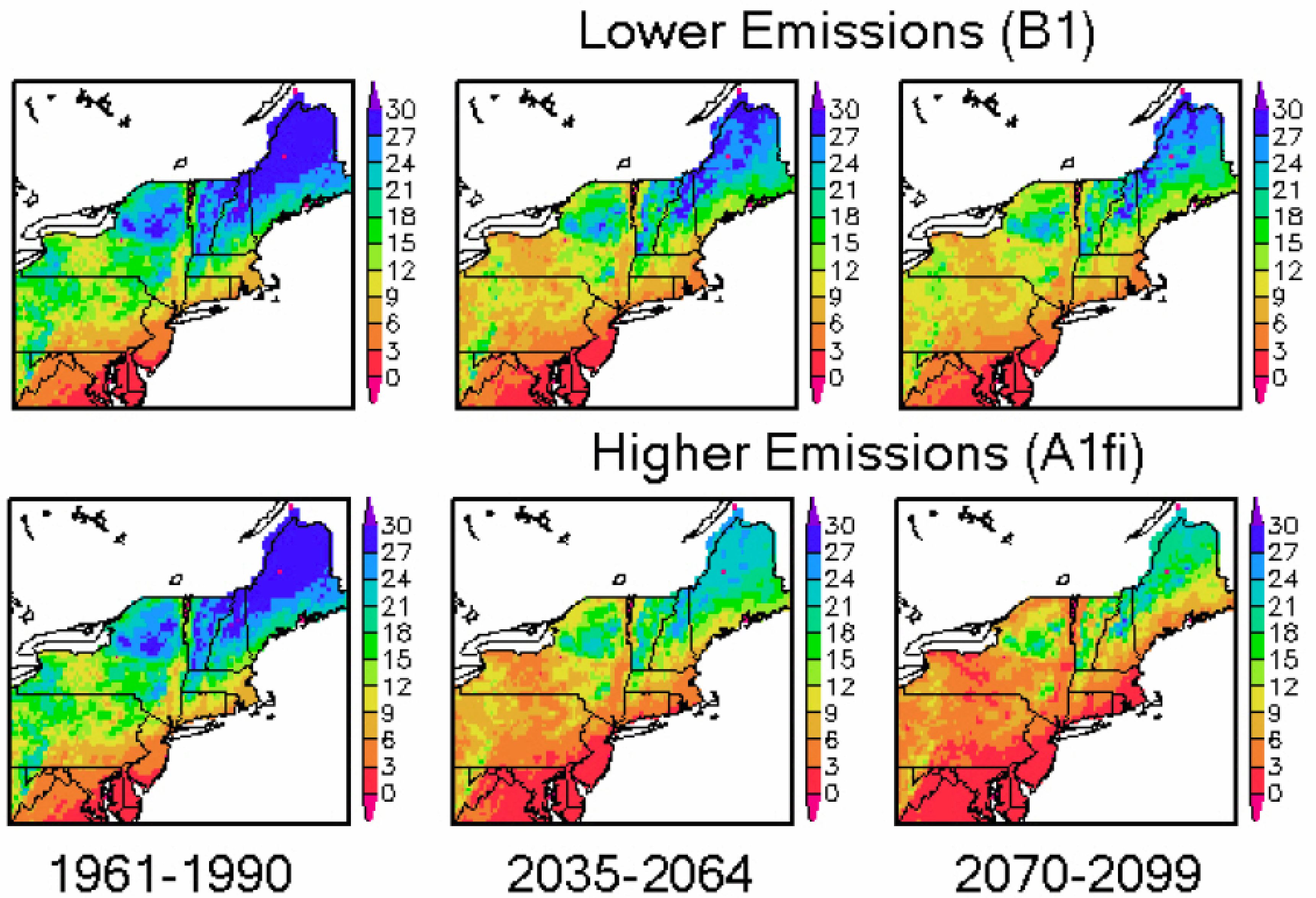
No. of days >100°F



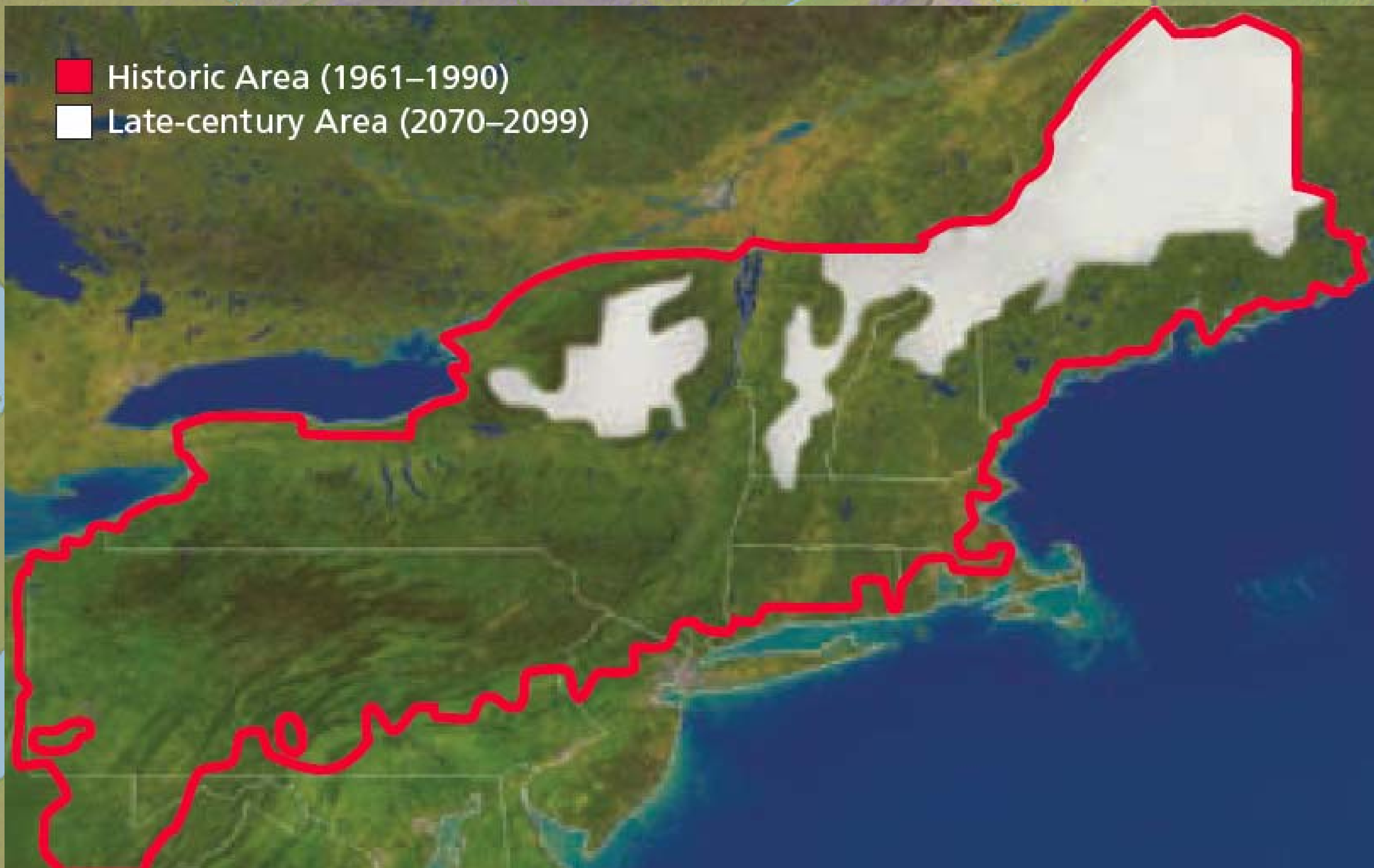
Northeast Observed and Modeled Drought



Northeast Observed and Modeled Snow on Ground Days per Month



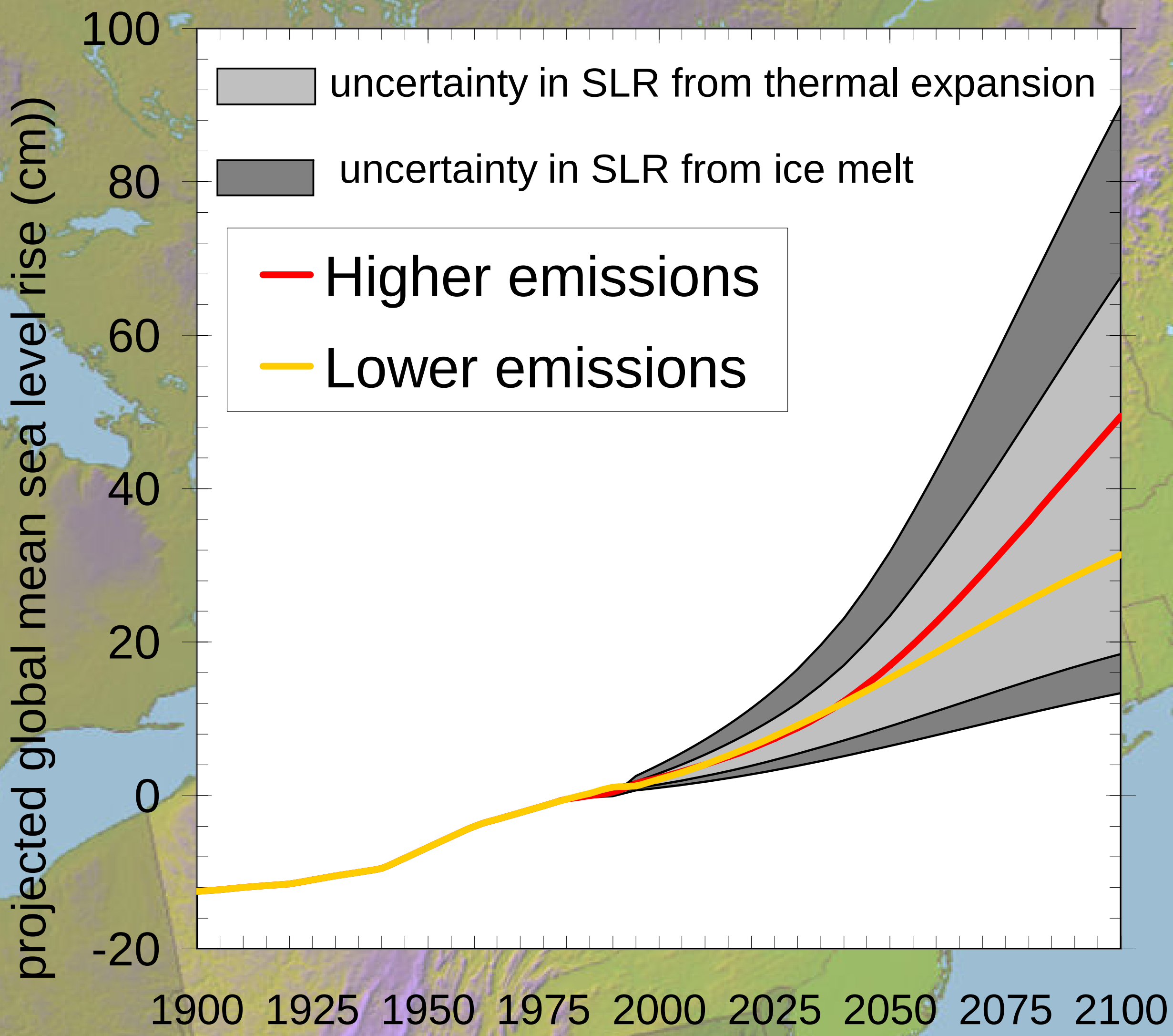
Northeast Modeled Snow on Ground Days



Higher emissions: 50% reduction in snow-covered days (shown here)

Lower emissions: 25% reduction in snow-covered days

Sea Level Rise



Higher: 8-33 inches

Lower: 4-21 inches

These estimates do not include the potential for additional increases due to more rapid melting of major polar ice sheets.