

Resilience and Reliability in a Time of Change

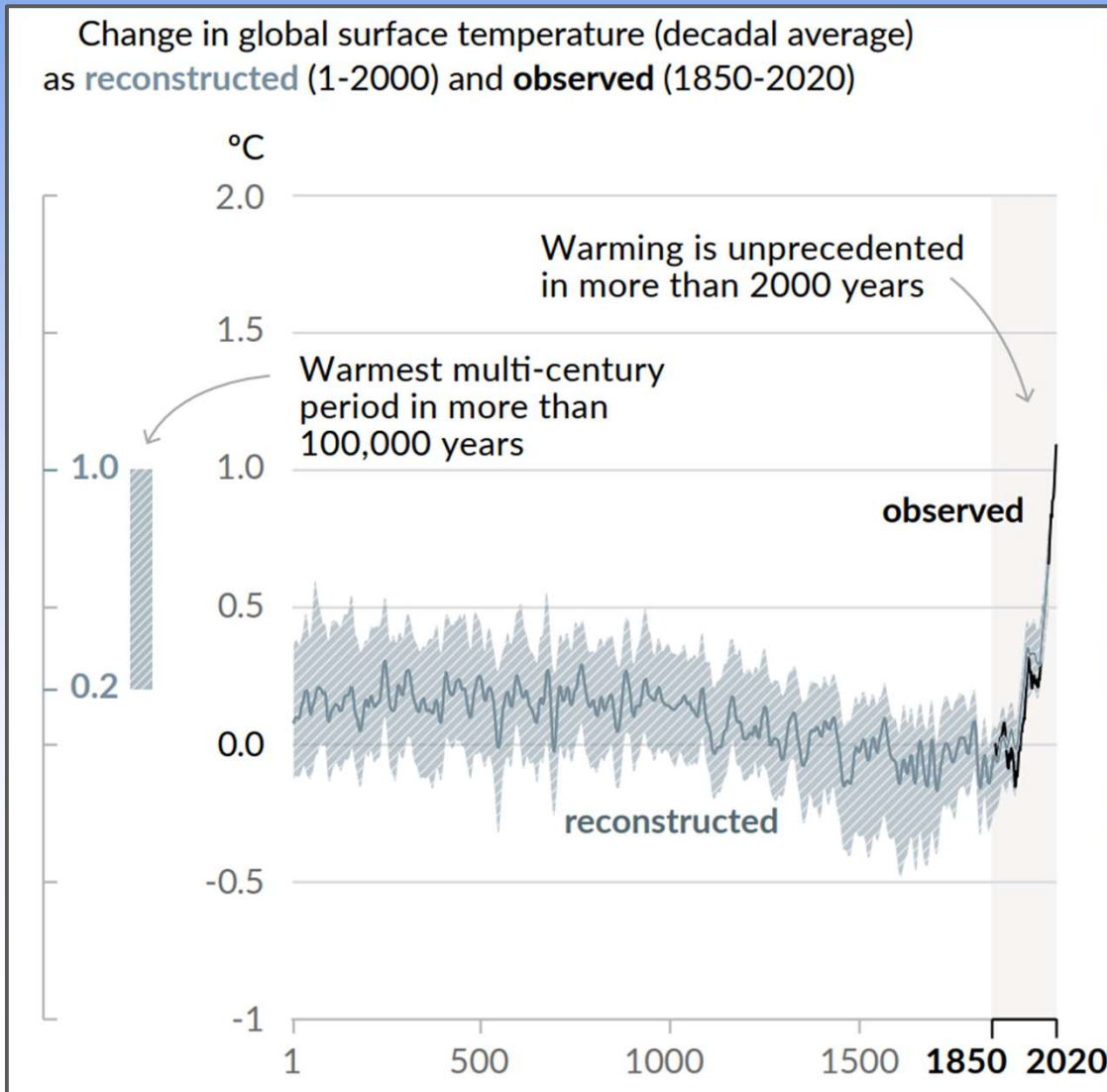
“Climate Change and Extreme Weather: Applications to New England’s Electric Grid”

NECPUC, Oct 28, 2021

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Earth has a fever

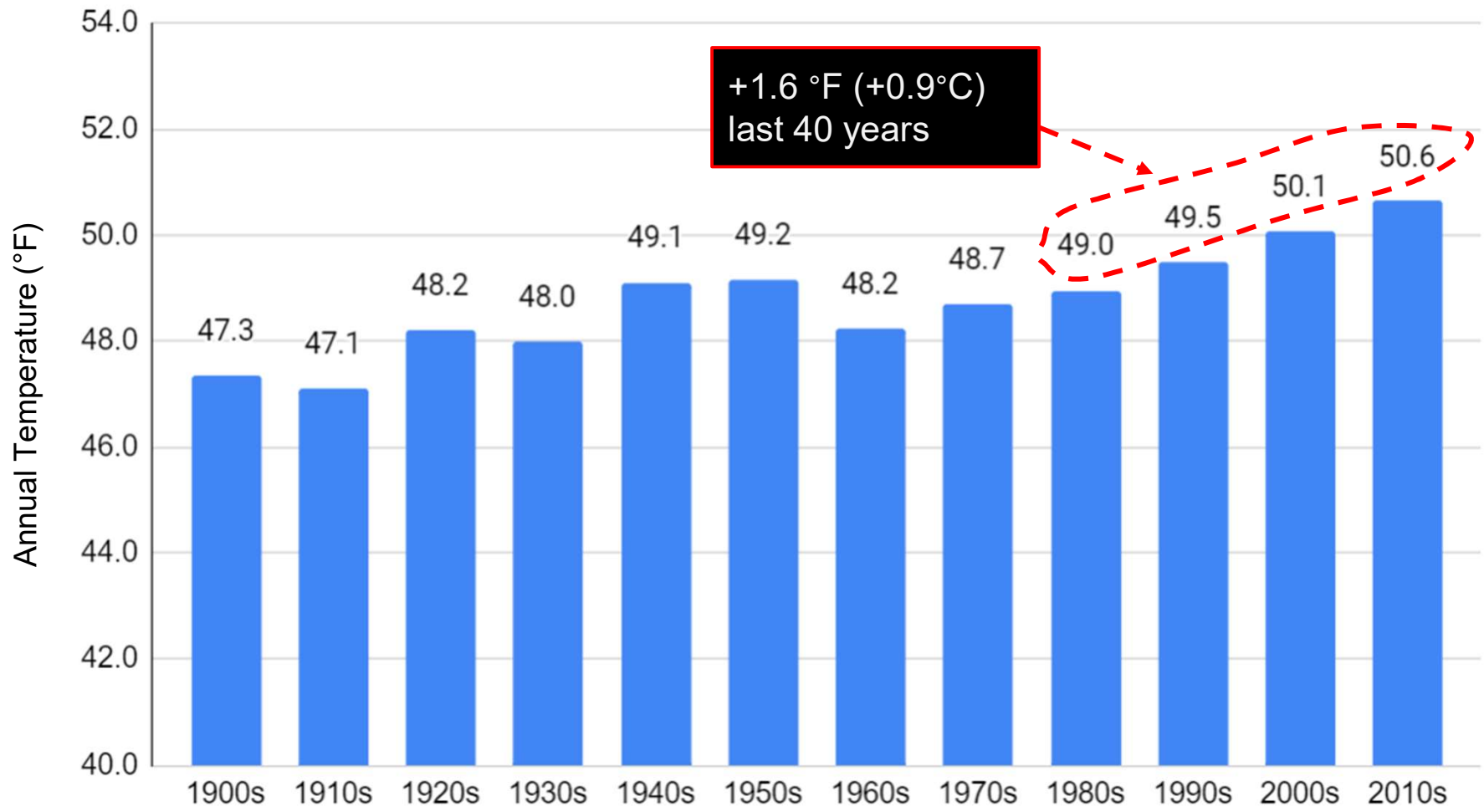


Total Warming
(+1.1°C) - most in
last 40 years

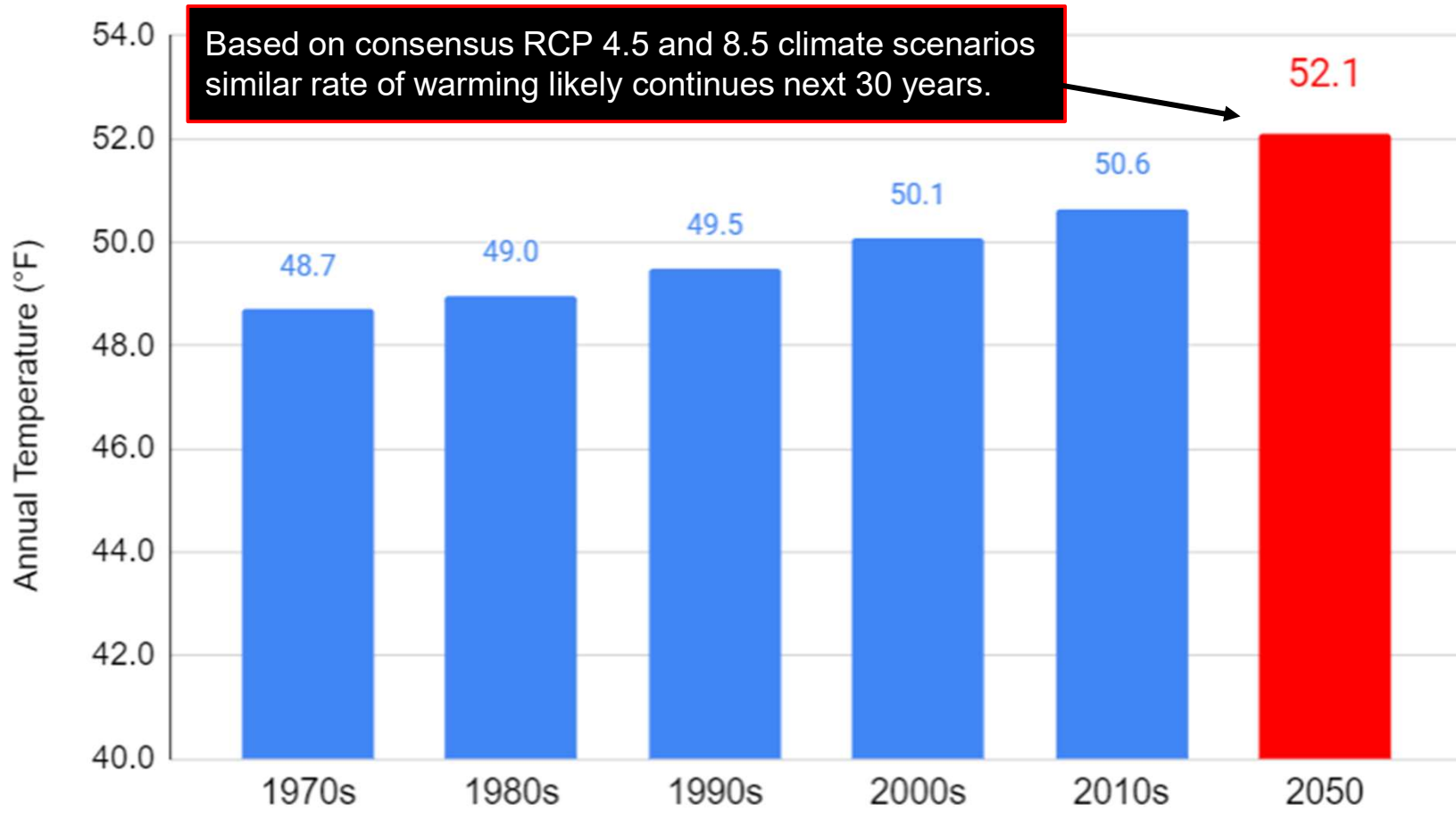
414 ppm
Atmospheric CO₂
highest in 2-3 Million years,
100x faster increase than
prior natural cycles

https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

Annual Temperature Variability - Blue Hill, MA

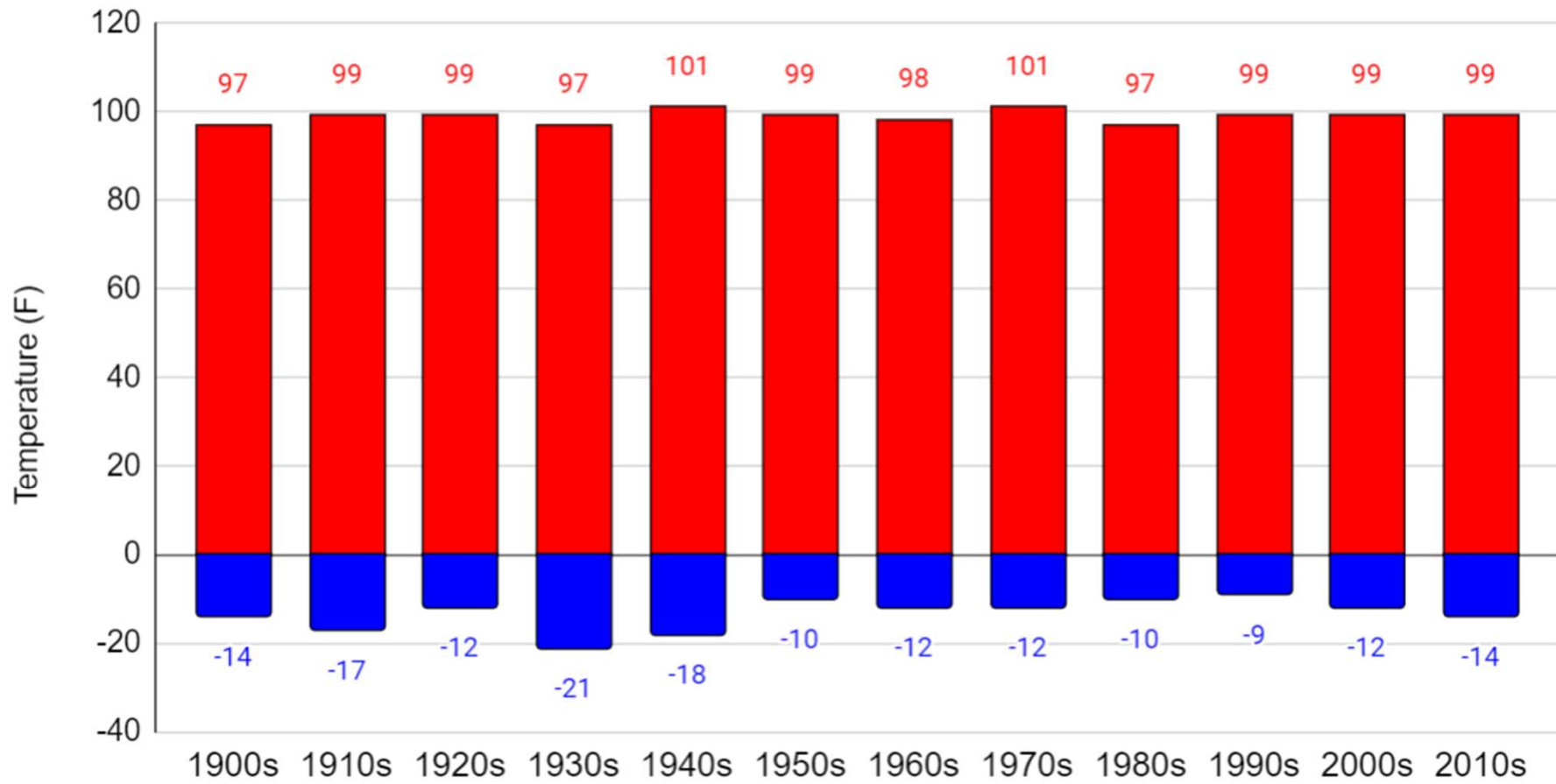


Blue Hill, MA - Observed Annual Temperature and Climate Projection



Extreme Temperature Variability - Blue Hill, MA

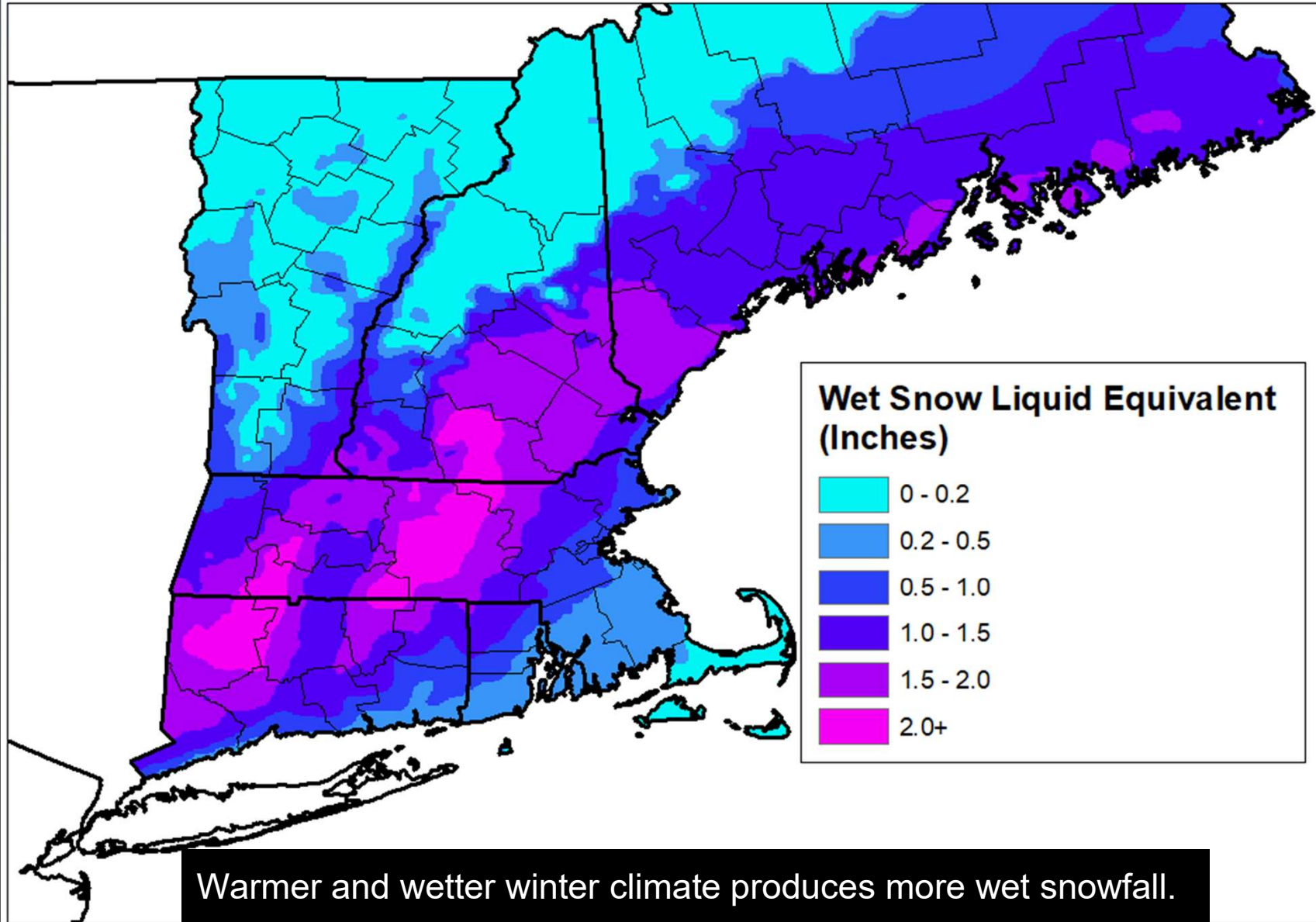
■ Low Temp ■ High Temp



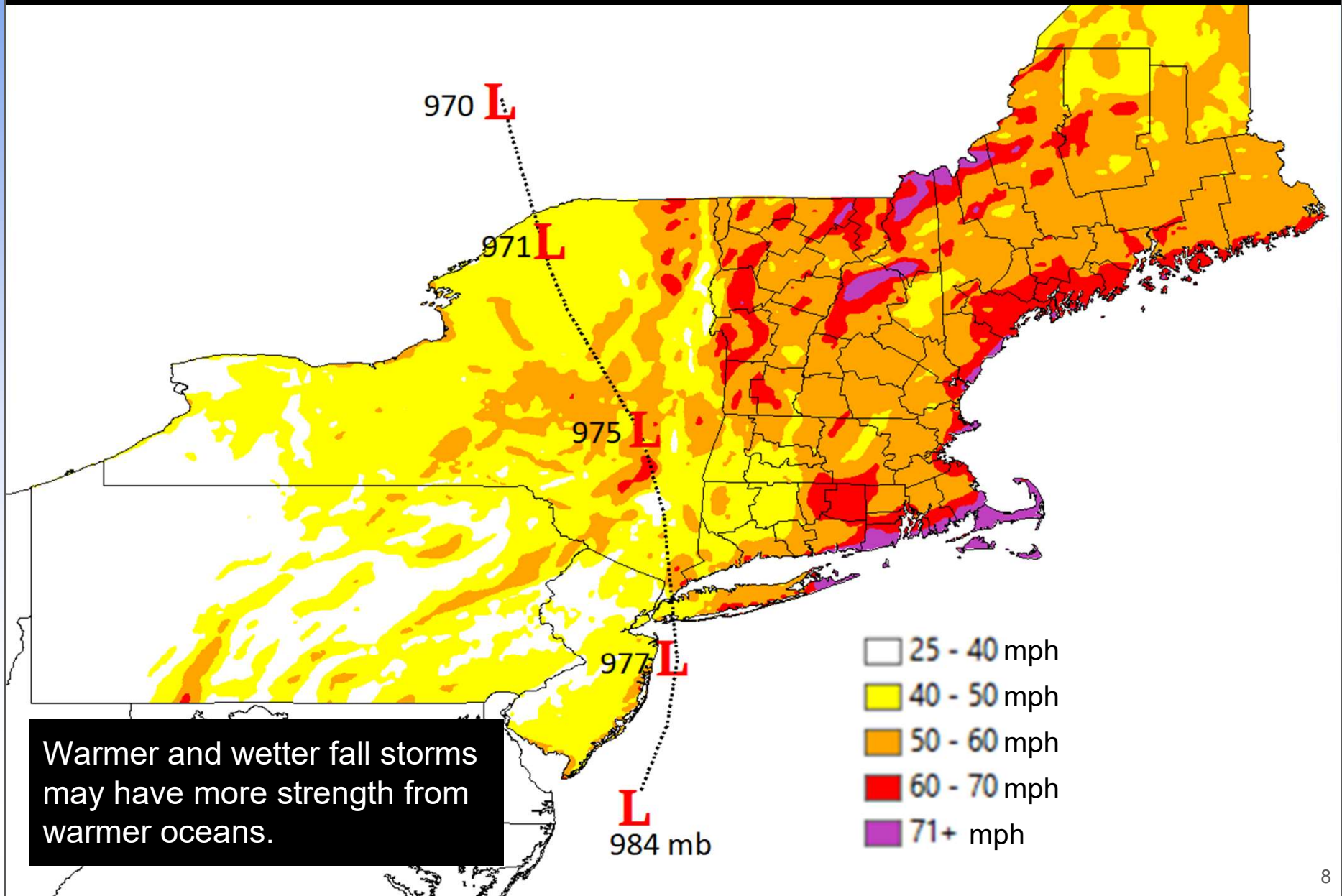
Planning for this winter's potential extreme cold weather is accomplished by looking back; there's been a stationarity of extreme states despite a mean annual temperature increase.

How does a warmer and wetter climate present itself via weather and storm systems?

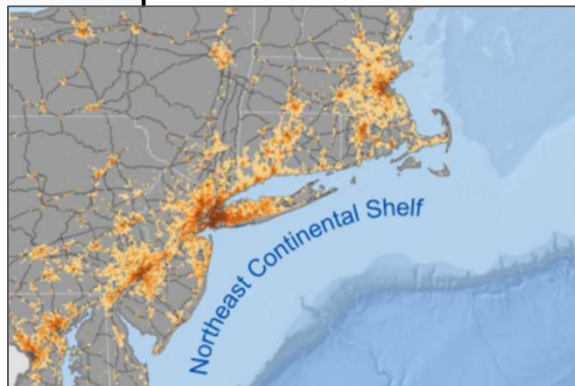
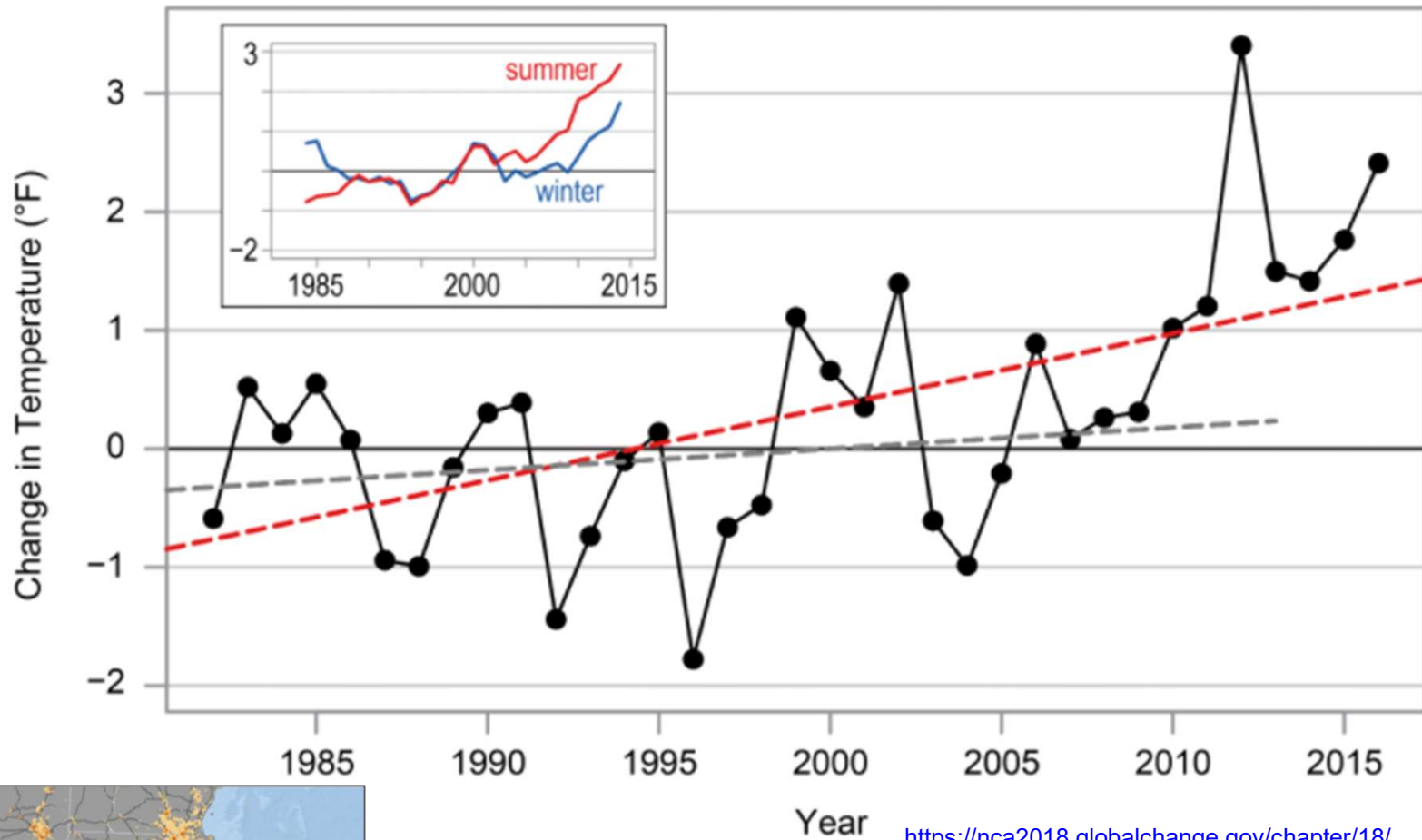
October 29-30, 2011 Wet Snow Icing Accretion



October 29-30, 2017 Peak Wind Gusts



Change in Sea Surface Temperature on the Northeast Continental Shelf



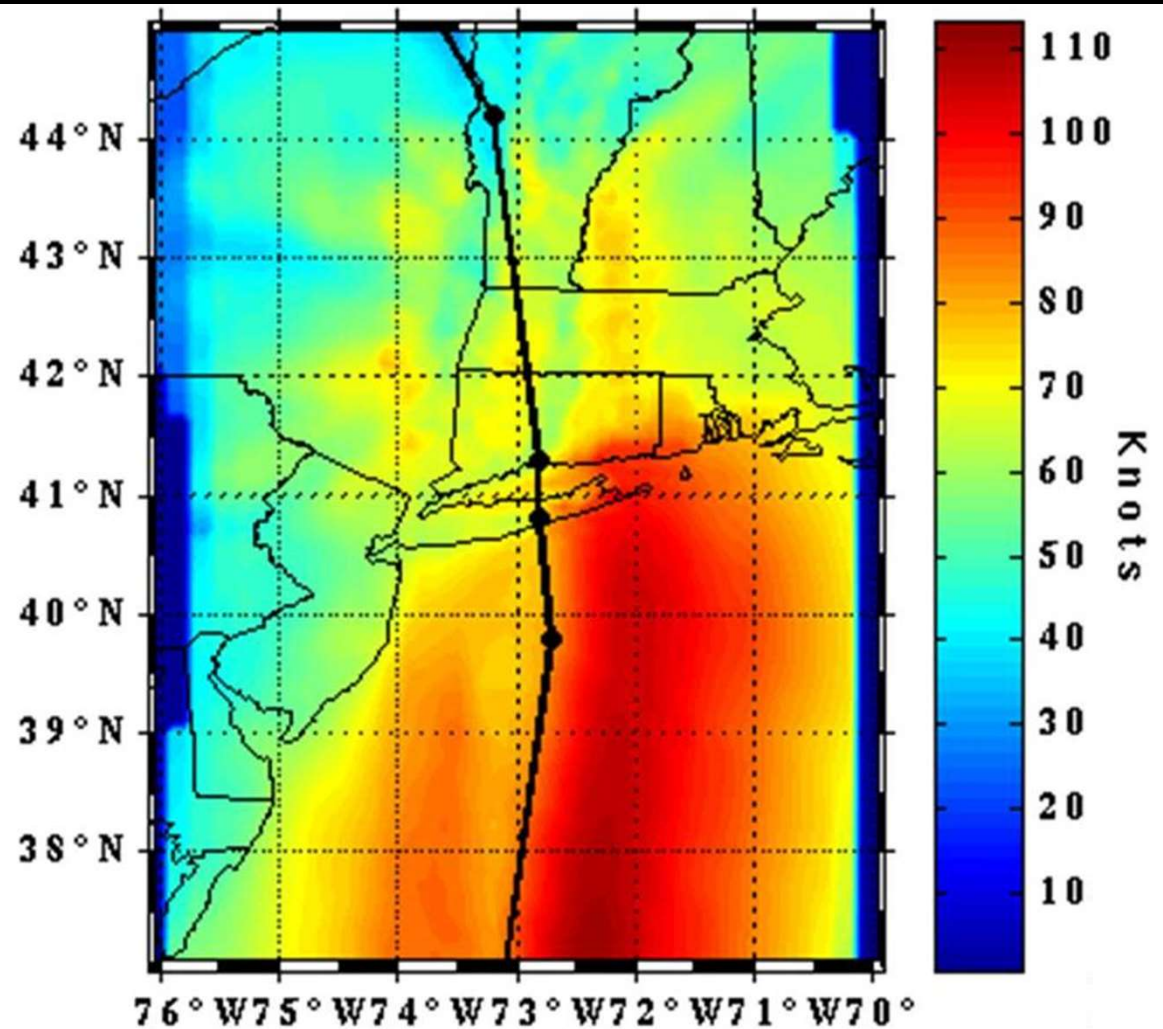
<https://nca2018.globalchange.gov/chapter/18/>

Speed
Limit



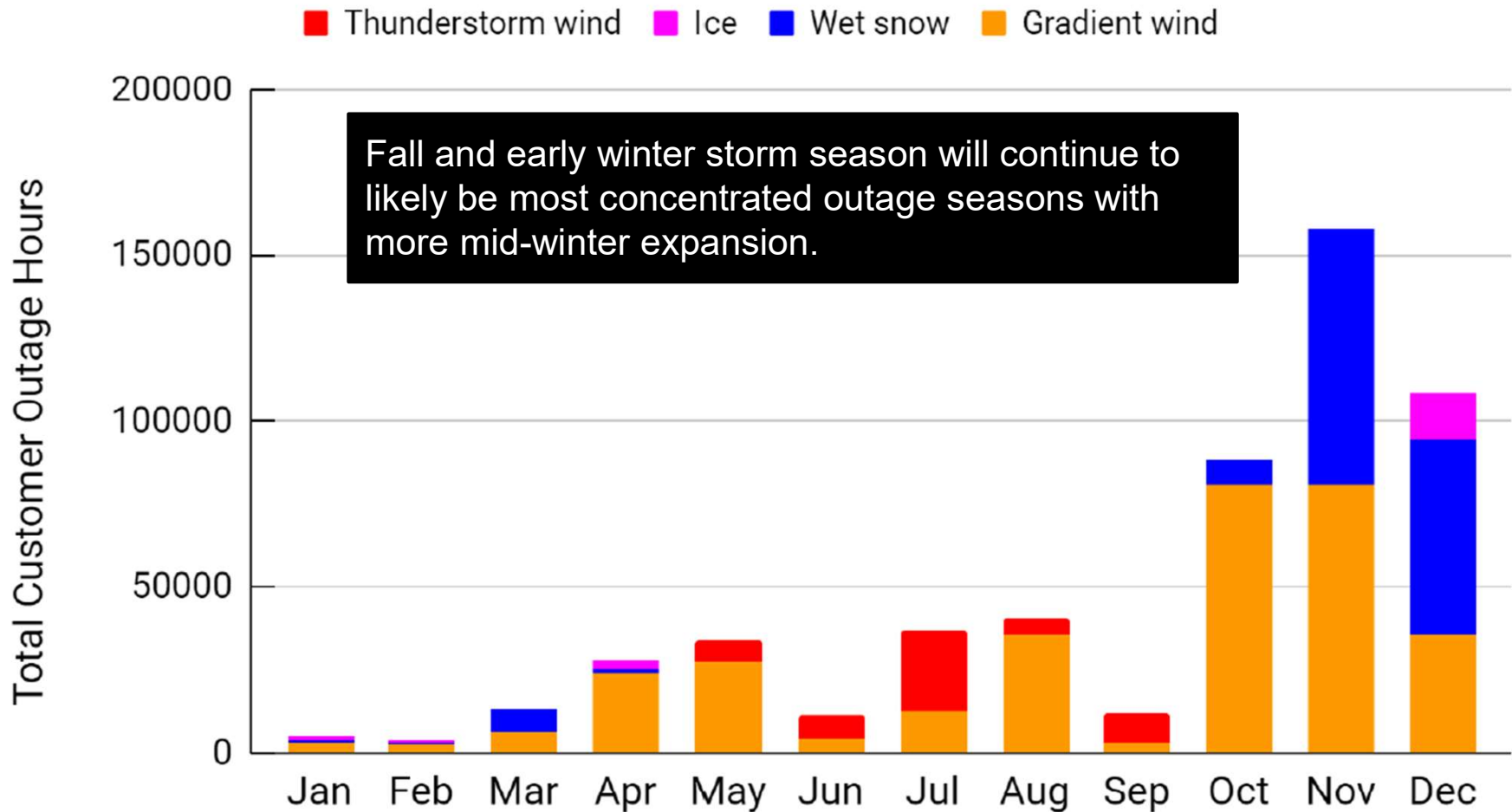
Warmer oceans support potential for stronger storms - increasing the thermodynamic speed limit.

1938 Hurricane Peak Wind Gust



Source: Dr. Isaac Ginis, University of Rhode Island

Vermont Storm Days Hazard Severity (2011-2019)



Research shows an increase of 20% of distribution system outage impacts of the most extreme storms in the last 40 years across Vermont - extreme storms have gotten stronger.

Solar Energy Intermittency - The New Extreme Weather

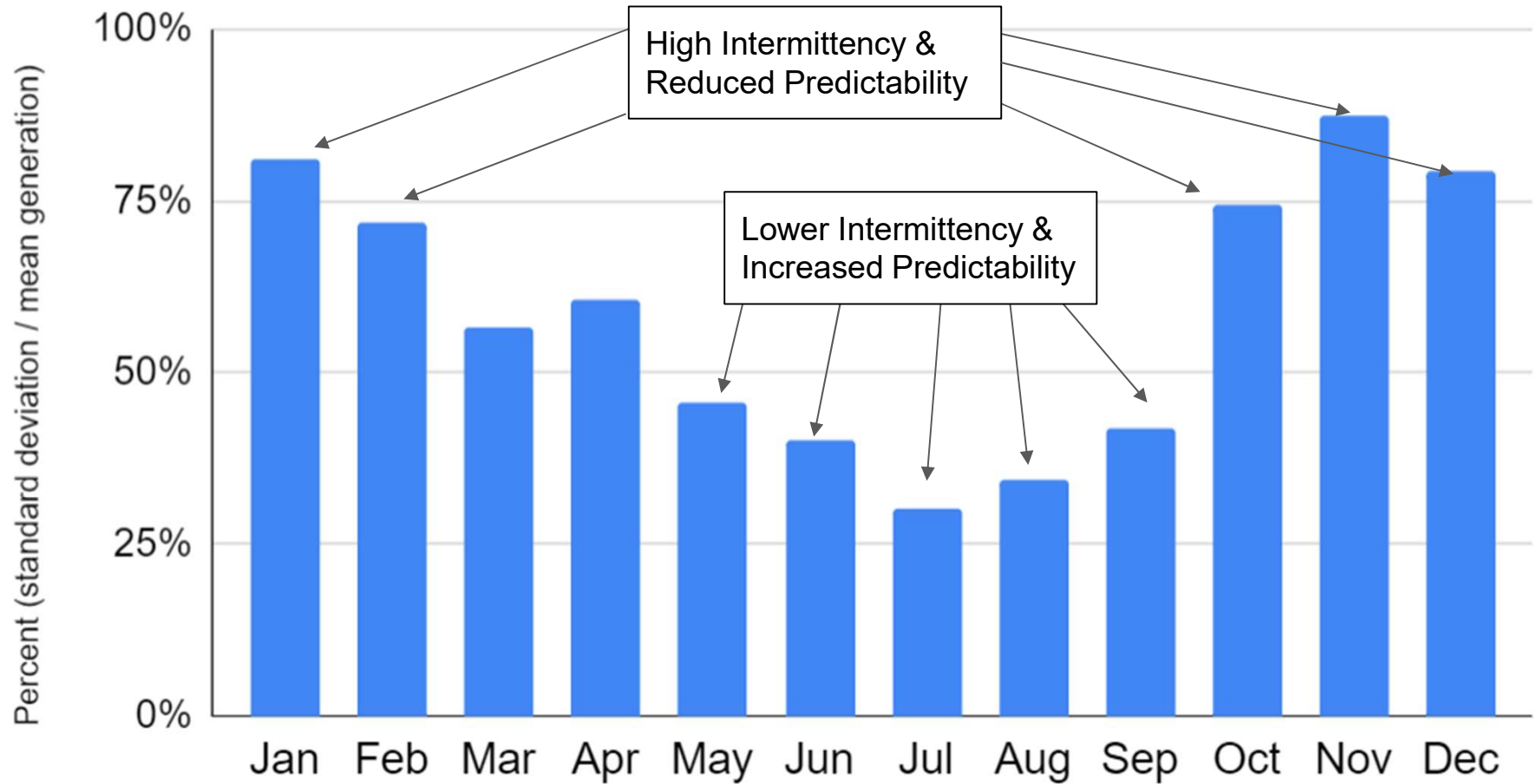
Solar power generation is reliability intermittent across New England - need for longer-duration storage



Winter dark calms can persist many days

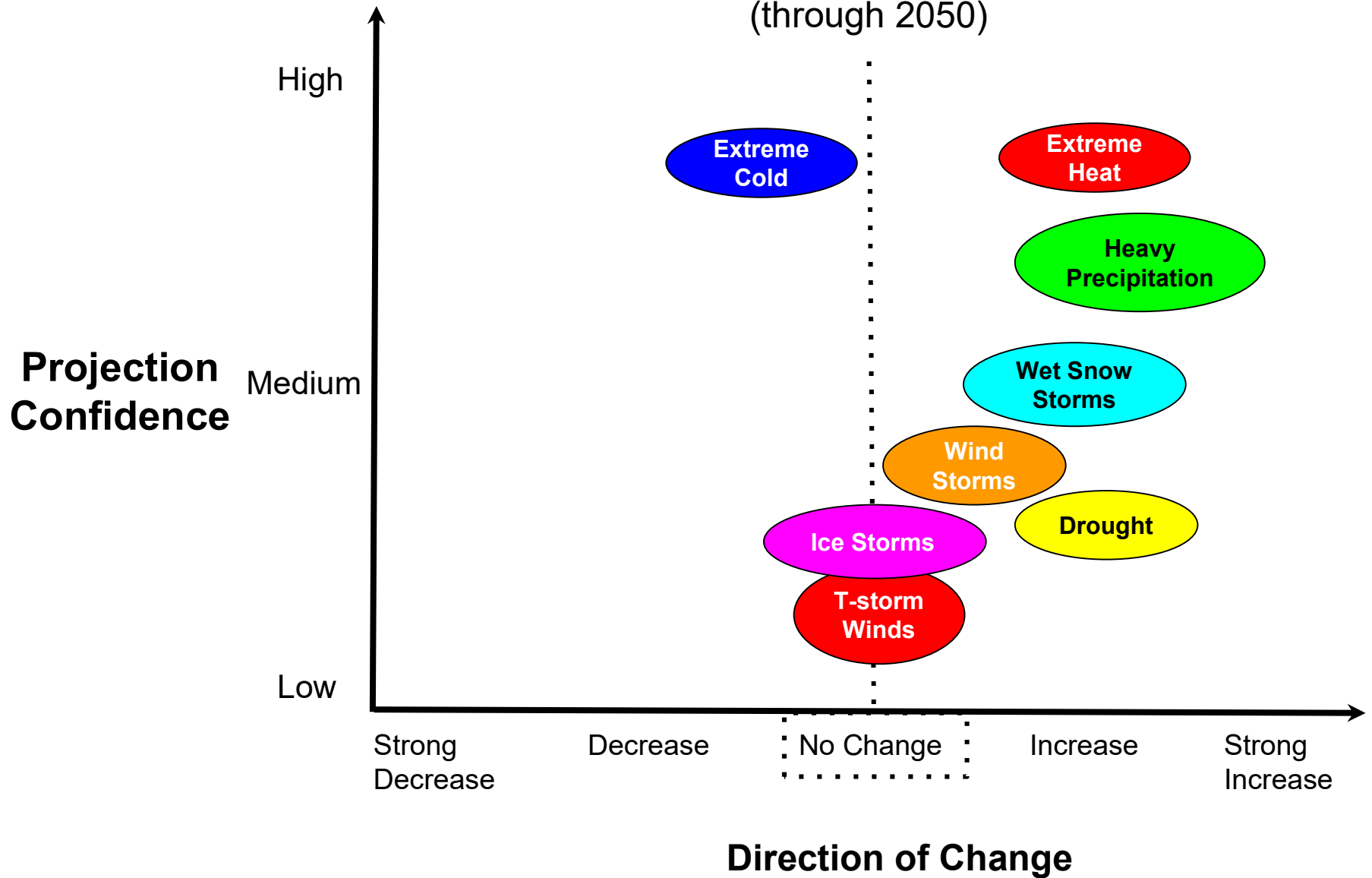
Vermont-aggregated Solar Power Generation Variability

(fraction of one sigma of mean generation at Noon, system size = 350 MW)



n=26,280 (2018-2020)

New England Climate Projections (through 2050)





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First responder to the future.