Climate Change and its Health Impacts in New England

Dr. Erich Osterberg
Dartmouth College Earth Sciences
NH/VT are Already Warming: 2-4°F since 1895
Winter Warming Fastest

NH Average Annual Minimum Temperatures: 1895 – 2012

Hanover: +2.3°F

Wake et al., 2014
2015 is warmest year on record, NOAA and NASA say

By Brandon Miller, CNN senior meteorologist

No surprise, NH just experienced its warmest winter ever recorded

By DAN SEUFERT
Union Leader Correspondent

February shatters heat records, becomes hottest month for planet

By Brandon Miller, CNN Senior Meteorologist
updated 10:31 AM ET, Thu March 17, 2016
Our Choice: Temperatures 4-9 °F Warmer by 2100

- Business as Usual
- Lower Emissions

Wake et al., pers. comm.
Melilo et al., 2014
The Future: Many More Very Hot Days

Today: 1 week per year
2100: 3-8 weeks per year

Model for Hanover, NH

Wake et al., 2014

Days > 90° F

8 Days
13
14
21
32
26
58

1980-2009
2010-39
2040-69
2070-99

Lower Emissions (B1)
Business As Usual (A1fi)
The Future: NH Summers Will Feel Like N. Carolina

- **Under Business as Usual:** In 65 years, NH’s summers will feel like North Carolina’s summers do today

- Heat index related to temperature AND humidity = “feels like”

Frumhoff et al., 2007
Temperature Effects: Heat Stress Increases Fatalities of At-Risk Populations

Weather Fatalities

- Flood: 82
- Lightning: 27
- Tornado: 31
- Hurricane: 48
- Heat: 130
- Winter: 40
- Cold: 52
- Wind: 56
- Rip Currents: 53

Weather Fatalities for 2015
10 Year Average (2006-2015)
30 Year Average (1986-2015)
2003 European Heat Wave: 35,000+ Deaths

More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century

Gerald A. Meehl* and Claudia Tebaldi

13 AUGUST 2004  VOL 305  SCIENCE

Temp. Anomaly

°F
Warming Increases Smog, But Smog Levels Declining due to Mitigation

Manchester, NH Data

EPA

Year

1994 2004 2014

# Days above Ozone Standard

0 2 4 6 8 10 12 14 16

0.02 0.04 0.06 0.08 0.1 0.12

Max Ozone (ppm)
Increased Lyme Disease in NE: Climate Connection?

Reported Cases of Lyme Disease in VT

Reported Cases of Lyme Disease

2001

2013

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People
The Northeast is Already Getting Wetter (5-15%)

Trends in Total Annual Precipitation from 1901-2011

Blue = Wetter
Red = Dryer

NH & VT are part of a regional wetting trend

Huang et al., in prep

Osterberg Pres_UVAW Forum_03302016
Extreme Rainfall Events are Becoming More Frequent
(Extreme is >4” in 48 Hours)

Wake et al., 2014

Durham, NH

Lakeport, NH

Nashua, NH

Mt. Sunapee, NH
Extreme Rainfall from 1996-2014 was ~50% higher than from 1901-1995

1901-1995: 2.77 in.

1996-2014: 4.35 in.

57% increase

Huang et al., in prep
The Future: More Extreme Storms (like recently)

![Bar chart showing events per decade for Lower Emissions (B1) and Higher Emissions (A1fi) from 1980-2009 to 2070-2099]

- Wake et al., 2014

### Events per Decade

<table>
<thead>
<tr>
<th>Period</th>
<th>Lower Emissions (B1)</th>
<th>Higher Emissions (A1fi)</th>
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<td>1980-2009</td>
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Lebanon NH – July 2, 2013 Thunderstorms

3.5” Rain at Lebanon Airport

Courtesy M. Goodwin
Lebanon NH – July 2, 2013 Thunderstorms

3.5" Rain at Lebanon Airport
President’s Day 2007 Nor’easter

Newmarket, NH: 6” rain

More rain from spring Nor’easters recently
Hurricane Irene: August, 2011

Irene

Maximum: 15.74"
Bayboro, NC
Hurricane Irene: August, 2011

$800 Million in NH & VT

Health Impacts:
+ Mortality and injury
+ Mental health illness
+ Exposure to chemicals and pathogens
The Future: Fewer but MORE Powerful Hurricanes

The Future:
Possibly FEWER weak Hurricanes (jury still out)

But likely MORE strong Hurricanes (Category 3-5)
Summary

• NH & VT have been warming (2-4°F since 1895) and getting wetter (~8-15% since 1900), with more extreme storms (~50% higher recently)

• By 2100, projections show:
  – 5-9°F warmer (largest in winter)
  – 2-7 weeks more extreme heat each summer
  – Extreme storms similar to 2000’s (or more?)

• Largest local health impacts likely to be:
  – Heat injuries and mortality
  – Flooding injuries and mortality, mental health, and pathogens and chemicals
  – Vector-borne disease