



# TESTIMONY HOUSE COMMITTEE ON ENERGY AND TECHNOLOGY H.688 (GLOBAL WARMING SOLUTIONS ACT)

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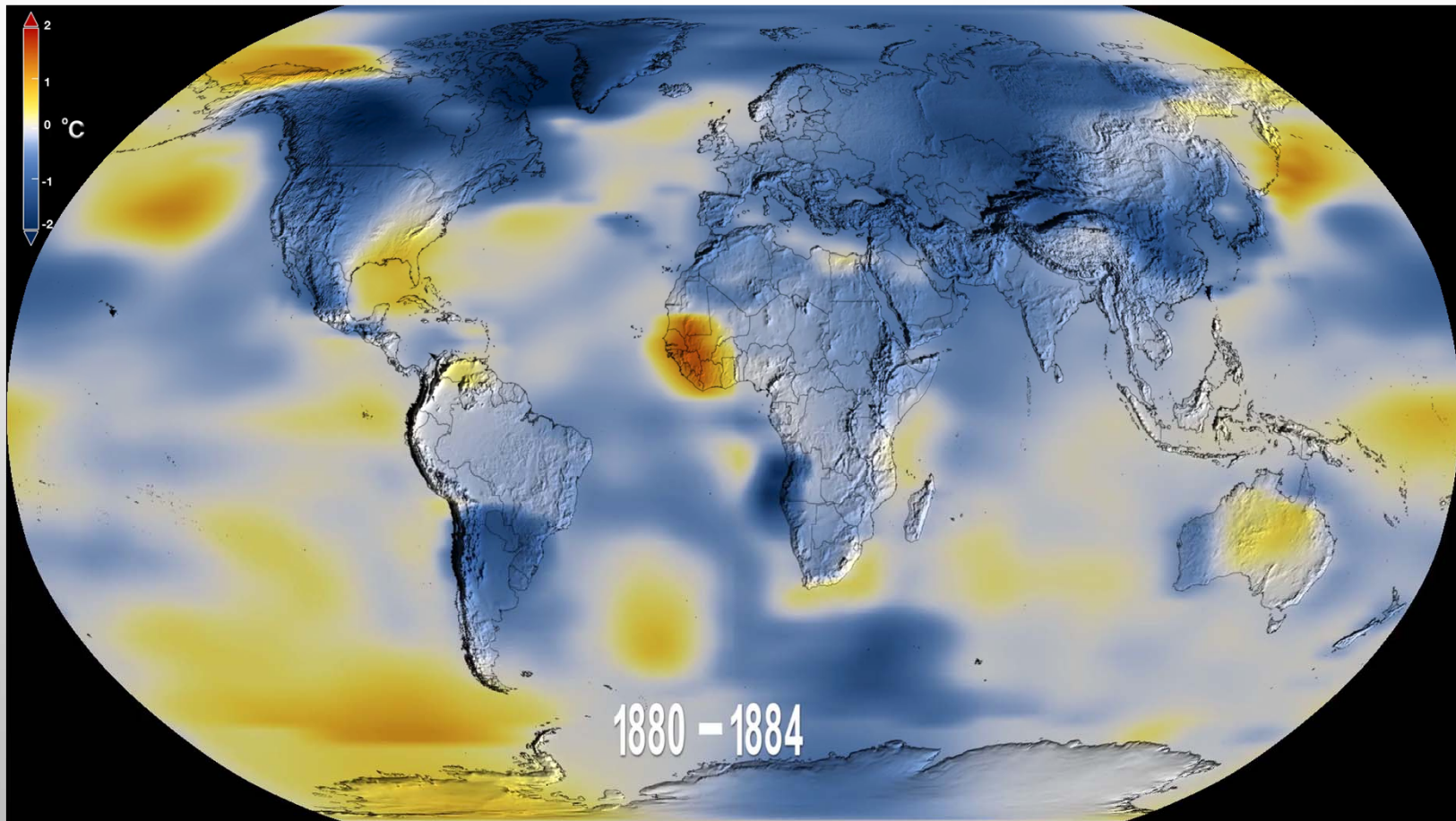
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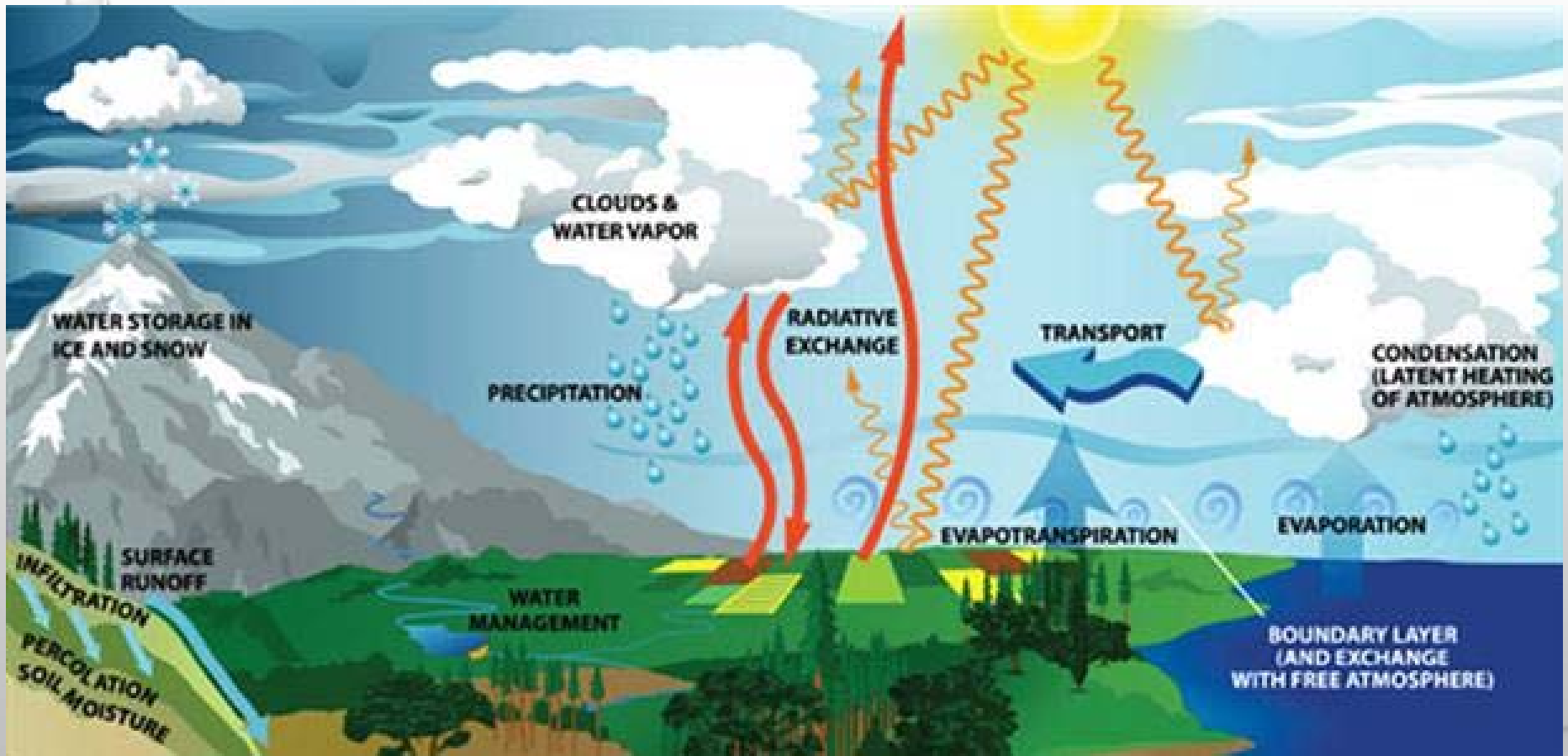
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ASSESSMENT

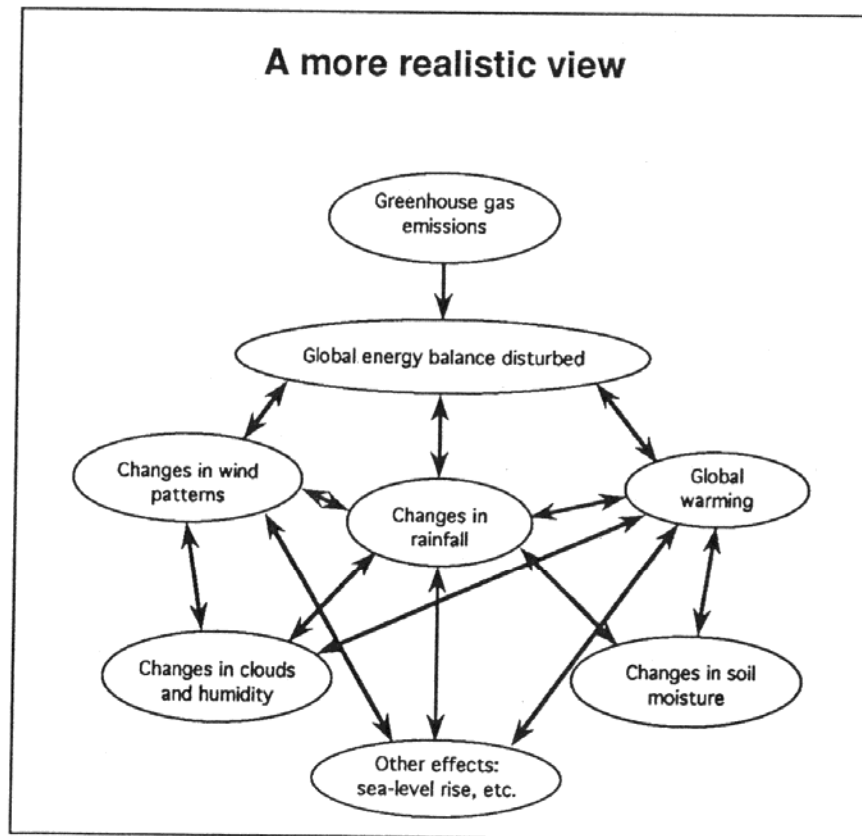
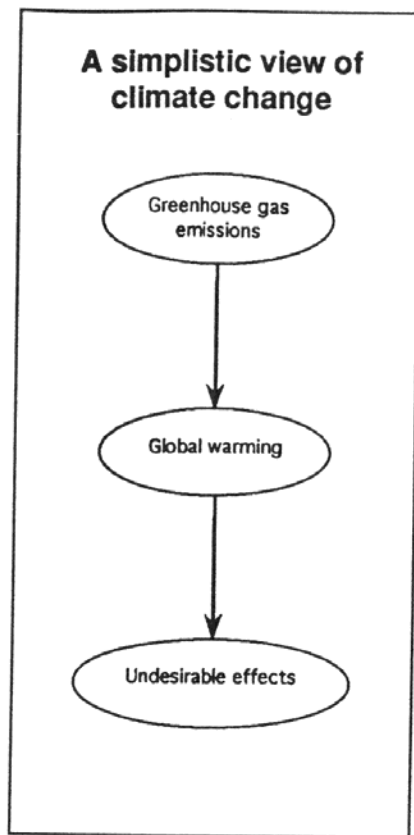
# FIVE-YEAR AVERAGE GLOBAL TEMPERATURE ANOMALIES FROM 1880 TO 2019



# CLIMATE IS A SYSTEM

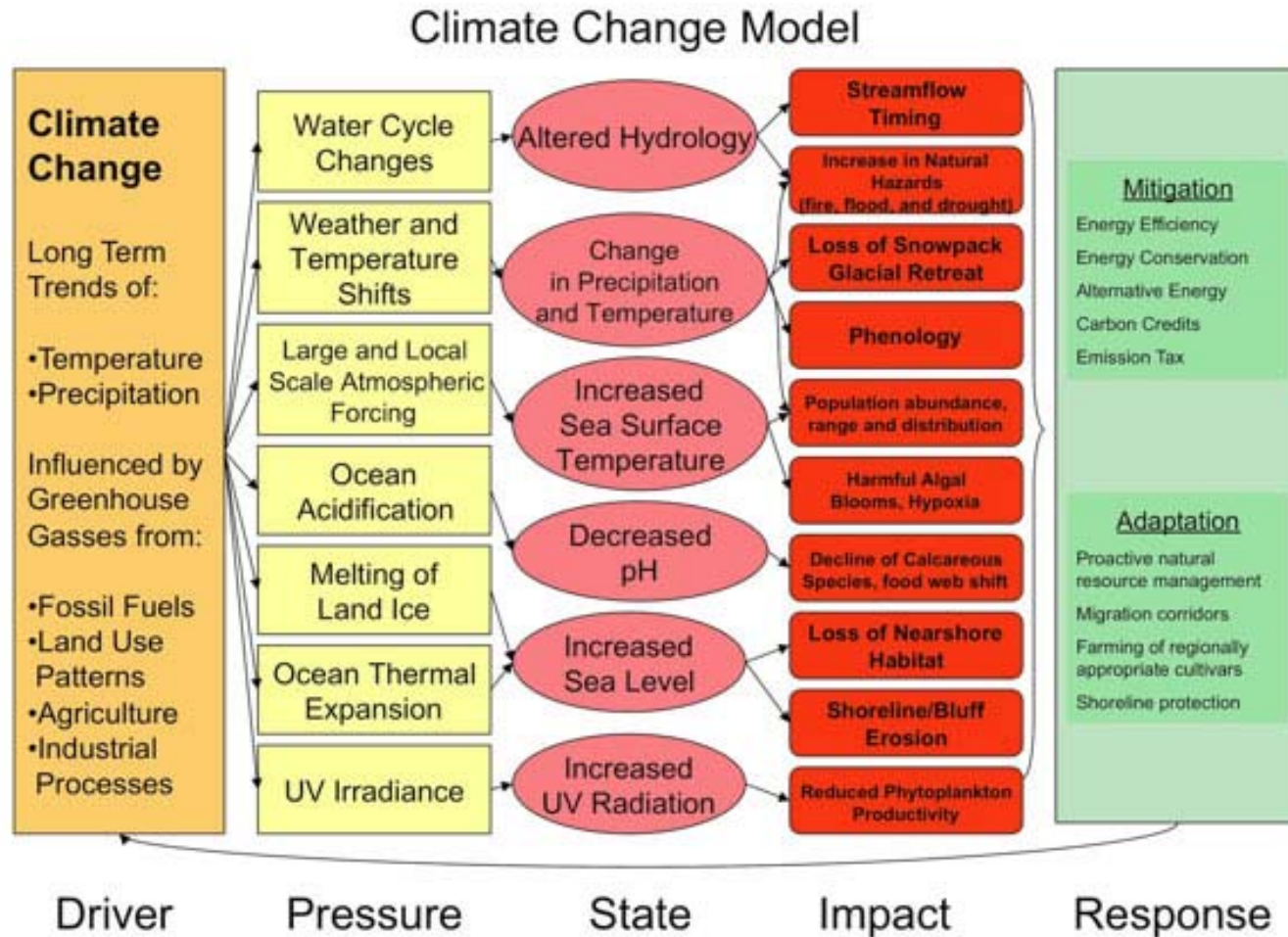


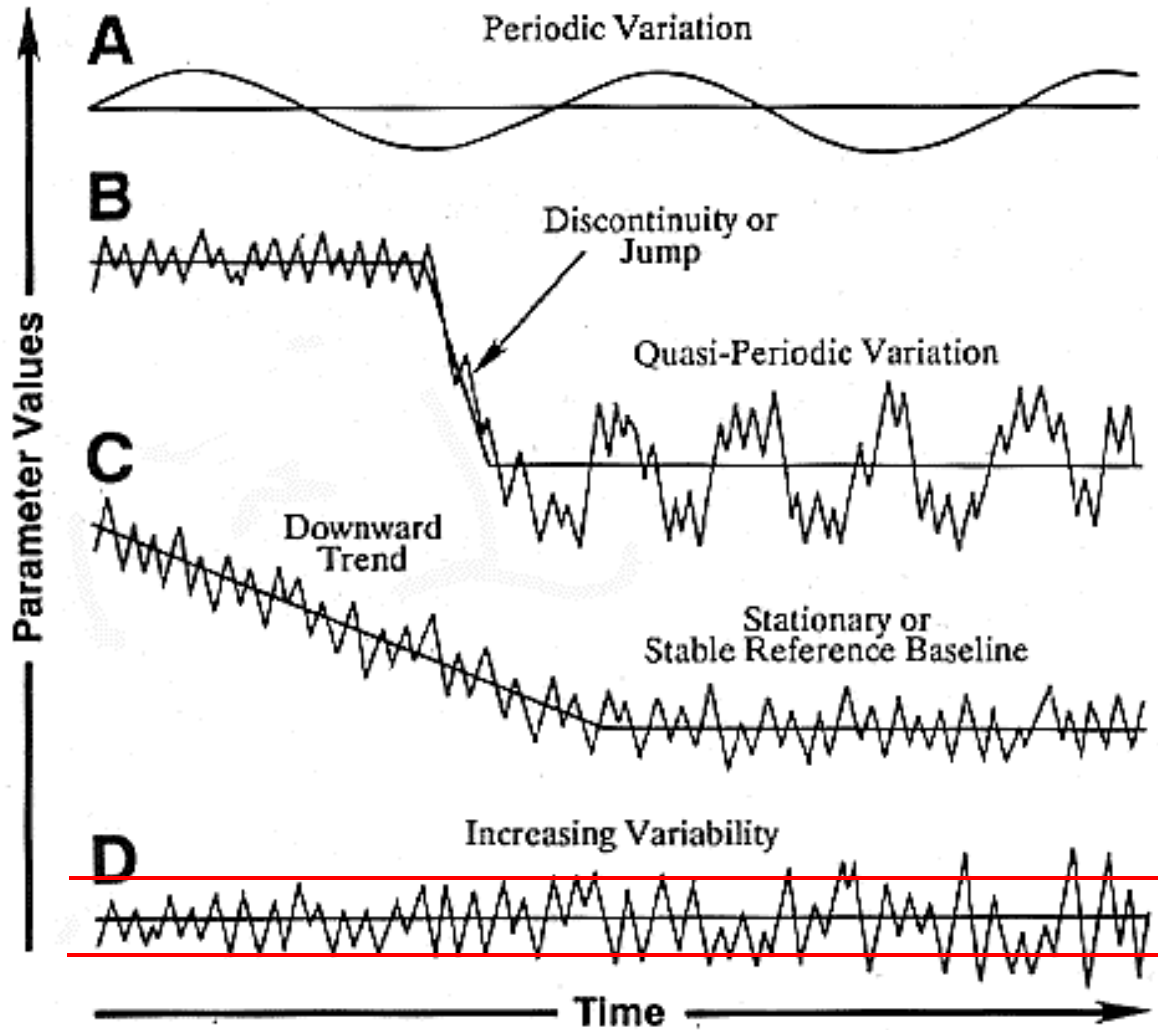
# Climate change as a...system



United Nations/UNEP

# PROCESS, IMPACT, STRATEGIES





Increased human vulnerability



**Fourth National Climate Assessment, Vol II —  
Impacts, Risks, and Adaptation in the United States**

**THE NATIONAL CLIMATE ASSESSMENT  
REPORT AND CLIMATE CHANGE IN  
VERMONT**

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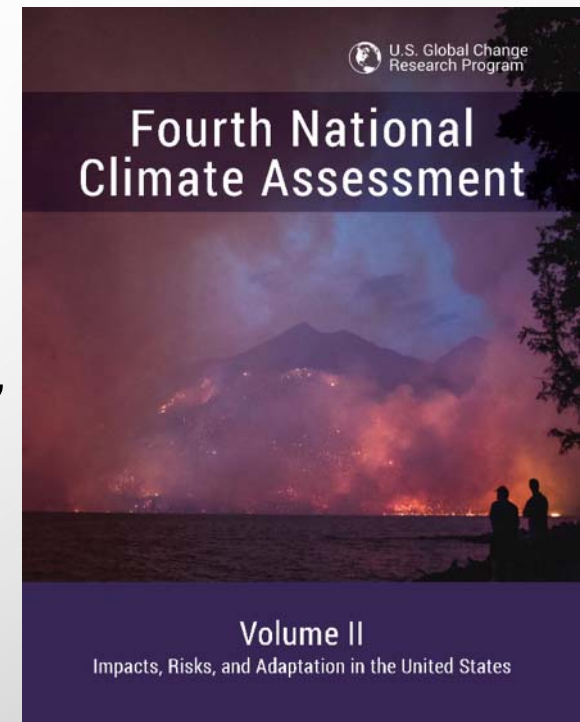
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State Government Municipal Day. Montpelier

25 October 2019

# NCA4 VOL II: *IMPACTS, RISKS, AND ADAPTATION IN THE U.S.*

- POLICY RELEVANT, BUT NOT POLICY PRESCRIPTIVE
- PLACES A STRONG EMPHASIS ON REGIONAL INFORMATION
- ASSESSES A RANGE OF POTENTIAL IMPACTS, HELPING DECISION MAKERS BETTER IDENTIFY RISKS THAT COULD BE AVOIDED OR REDUCED
- USES CASE STUDIES TO PROVIDE ADDITIONAL CONTEXT AND OPPORTUNITIES TO SHOWCASE COMMUNITY SUCCESS STORIES

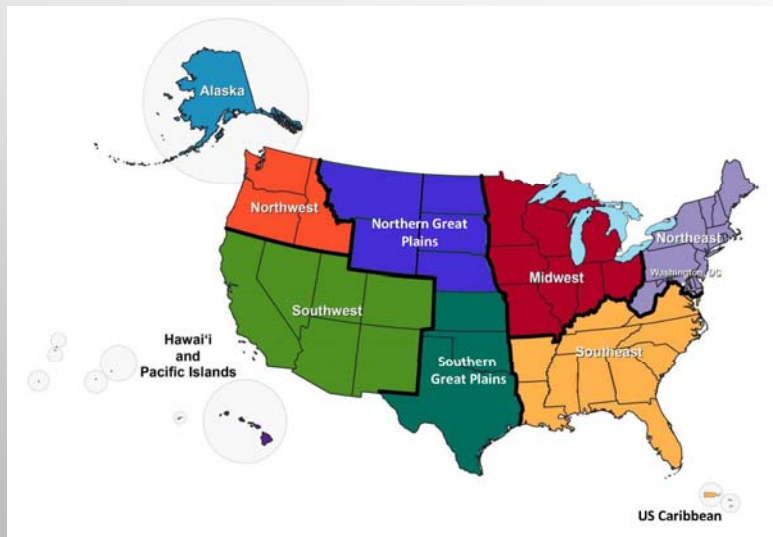


NCA4 Vol II is available at  
[nca2018.globalchange.gov](http://nca2018.globalchange.gov)



# ADVANCES SINCE NCA3

- **EXPANDED REGIONAL FOCUS IN RESPONSE TO GROWING DEMAND FOR LOCALIZED INFORMATION:**
  - NEW CHAPTER DEDICATED TO THE U.S. CARIBBEAN, AND GREAT PLAINS DIVIDED INTO NORTHERN AND SOUTHERN REGIONS



Extreme weather events in Vermont can take the form of prolonged heavy snowstorms, flash floods, river floods (following snowmelt and heavy rains), severe thunderstorms, droughts, tornadoes, and temperature extremes. Some of the heaviest flooding in the state's history has been due to tropical cyclones or their remnants. In 2011, Tropical Storm Irene transitioned into an extratropical cyclone as it moved quickly northeastward along the Vermont/New Hampshire border. Roughly 3 to 7 inches of rain fell in less than 18 hours, causing the worst flooding in Vermont since the Great Flood of November 1927. Many rivers reached stages that were second to only the 1927 flood. The flooding resulted in an estimated \$733 million in damage across the state.

Severe winter storms are common in Vermont's cold winter climate and may include snowstorms, blizzards, and icing events. In addition to ice jams and melting snowpack as winter hazards, freezing rain and frozen ground conditions can also give rise to flooding. During the first week of January 1998, a prolonged storm brought 2 to 5 inches of rain to Vermont. Particularly across the Champlain Valley and parts of northern Vermont, temperatures were below freezing for much of the storm. This resulted in the "Great Ice Storm of '98" where heavy ice accumulations of 1 to 2 inches caused severe damage to trees and utility lines. Total damage from the ice storm across the whole of the northeastern United States was about \$2 billion (\$1.4 billion in 1998 dollars)

**Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century** (Figure 1). Even under a pathway of lower greenhouse gas emissions, average annual temperatures are projected to most likely exceed historical record levels by the middle of the 21st century. However, there is a large range of temperature increases under both pathways, and under the lower pathway, a few projections are only slightly warmer than historical records (Figure 1). Increases in the number of hot days and decreases in the number of very cold nights are projected to accompany the overall warming.

**Average annual precipitation is projected to increase in Vermont over the 21st century, particularly during winter and spring** (Figure 5). Corresponding increases in temperature will increase the proportion of precipitation falling as rain rather than snow. In addition, extreme precipitation is projected to increase, potentially increasing the frequency and intensity of floods.

# OTHER NEW ELEMENTS OF NCA4

- PRODUCTS DEVELOPED

- ECONOMIC VALUATION STUDIES & WHERE POSSIBLE:

- QUANTIFICATION OF CLIMATE CHANGE IMPACTS IN ECONOMIC TERMS UNDER DIFFERENT FUTURE GREENHOUSE GAS EMISSIONS SCENARIOS
    - DOES NOT YET CHARACTERIZE DIFFERENTIAL ECONOMIC IMPACTS FOR ALL 10 NCA REGIONS
    - PROVIDES AN INDICATION OF THE POTENTIAL FOR REDUCING RISKS THROUGH MITIGATION ACTIONS

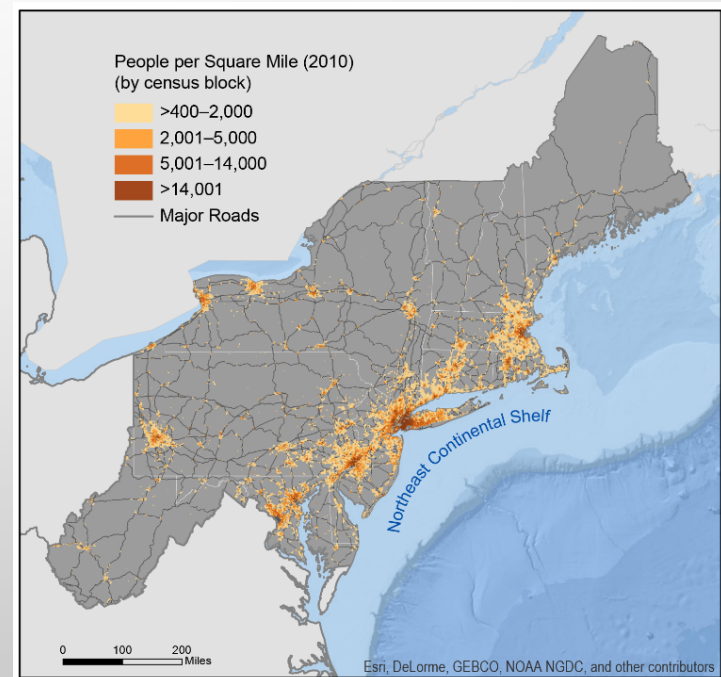
- CLIMATE CHANGE INDICATORS

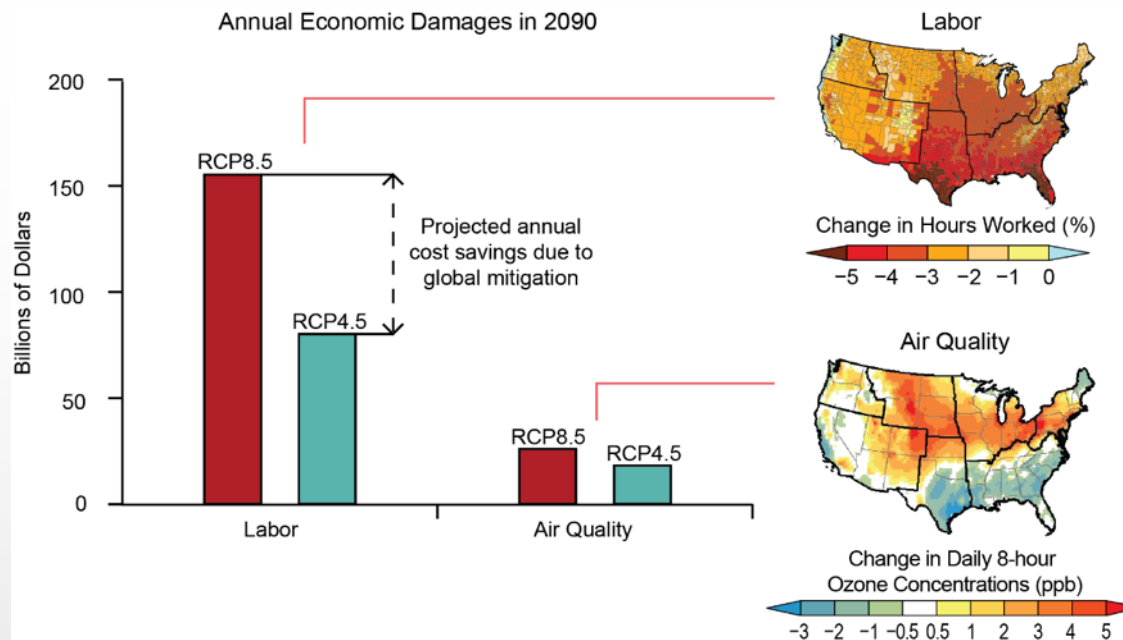
- LOCA DOWNSCALED PRODUCTS

- UNIQUE FEATURES EACH REGION

- E.G. NORTHEAST

- RURAL/URBAN
    - INLAND/COASTAL
    - CULTURAL HERITAGE
    - LENGTH OF SETTLEMENT
    - PHYSICAL GEOGRAPHY/TOPOGRAPHY





## NEW ECONOMIC IMPACT STUDIES

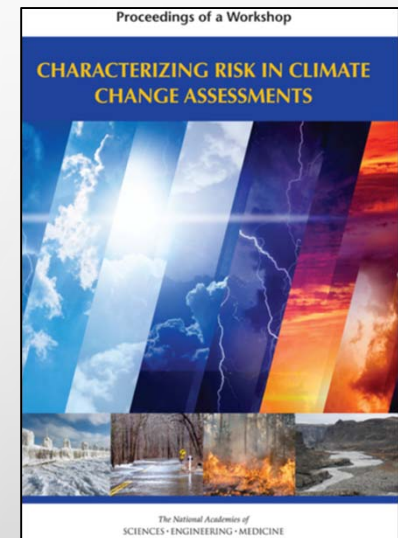
Source: EPA, 2017. *Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment*. U.S. Environmental Protection Agency, EPA 430-R-17-001.

ANNUAL ECONOMIC IMPACT ESTIMATES ARE SHOWN FOR LABOR AND AIR QUALITY. **(LEFT)** NATIONAL ANNUAL DAMAGES IN 2090 FOR A HIGHER SCENARIO AND LOWER SCENARIO; THE DIFFERENCE BETWEEN THE HEIGHT OF THE RED AND TEAL BARS FOR A GIVEN CATEGORY REPRESENTS AN ESTIMATE OF THE ECONOMIC BENEFIT TO THE U.S. FROM GLOBAL MITIGATION ACTION.

**(RIGHT)** REGIONAL VARIATION IN ANNUAL IMPACTS PROJECTED UNDER THE HIGHER SCENARIO IN 2090. THE MAP ON THE TOP SHOWS THE PERCENT CHANGE IN HOURS WORKED IN HIGH-RISK INDUSTRIES AS COMPARED TO THE PERIOD 2003–2007. THE MAP ON THE BOTTOM IS THE CHANGE IN GROUND-LEVEL OZONE CONCENTRATIONS COMPARED TO THE PERIOD 1995–2005.

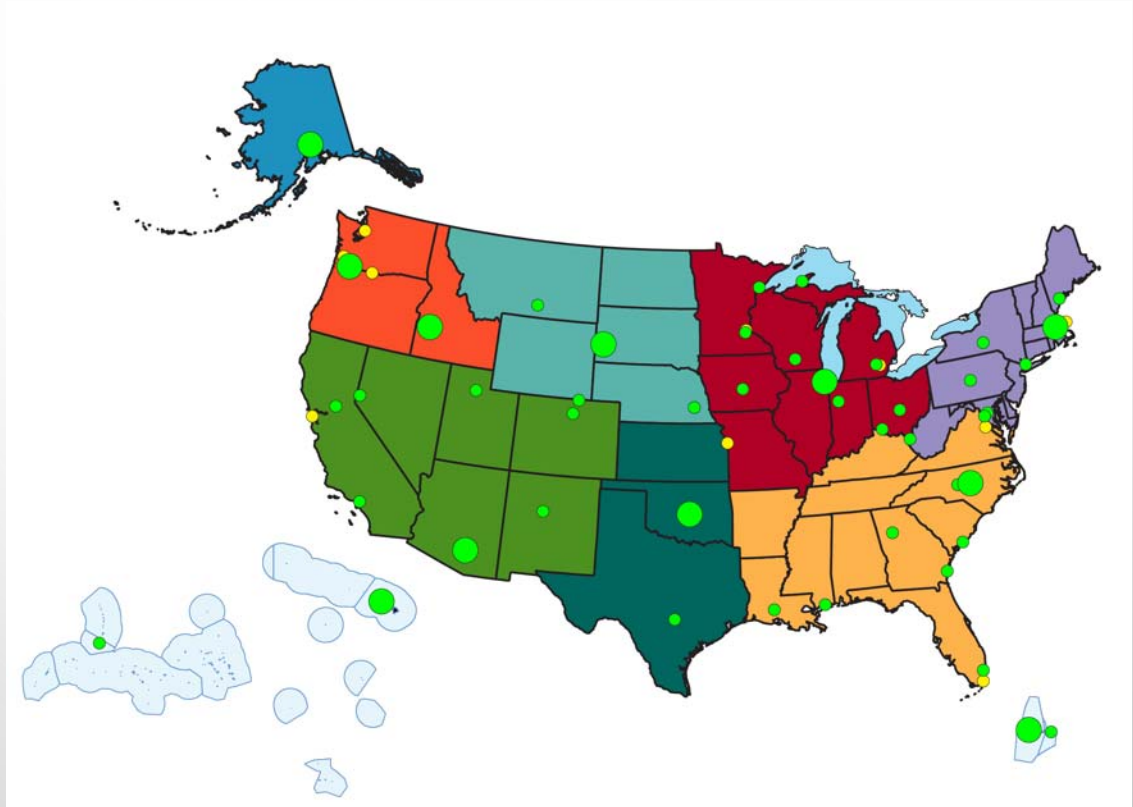
# RISK FRAMING IN KEY MESSAGES

- A **“RISK-BASED FRAMING”** IS USED TO ENSURE NCA4 FOCUSES ON ISSUES OF HIGH IMPORTANCE TO DECISION-MAKING AND TO HELP WITH COMMUNICATING ASSESSMENT OUTCOMES
- IN RESPONSE TO AUDIENCE NEEDS AND WITH GUIDANCE FROM A WORKSHOP OF THE NATIONAL ACADEMIES, NCA4 KEY MESSAGES ADDRESSED:
  - ✓ WHAT DO STAKEHOLDERS VALUE/WHAT IS AT RISK IN A GIVEN SECTOR OR REGION?
  - ✓ WHAT OUTCOMES DO WE WISH TO AVOID WITH RESPECT TO THESE VALUED THINGS?
  - ✓ WHAT DO WE EXPECT TO HAPPEN IN THE ABSENCE OF ADAPTIVE ACTION AND/OR MITIGATION?
  - ✓ HOW BAD COULD THINGS PLAUSIBLY GET/ARE THERE IMPORTANT THRESHOLDS OR TIPPING POINTS IN THE UNIQUE CONTEXT OF A GIVEN REGION, SECTOR, ETC.?



# PUBLIC PARTICIPATION

- PUBLIC FEEDBACK ON THE DRAFT PROSPECTUS
- PUBLIC CALL FOR AUTHOR NOMINATIONS
- PUBLIC CALL FOR TECHNICAL INPUTS
- A SERIES OF REGIONAL ENGAGEMENT WORKSHOPS (REWS) AND SECTOR-SPECIFIC WEBINARS
- PUBLIC CALL FOR REVIEW EDITORS
- A 90-DAY PUBLIC REVIEW & COMMENT PERIOD

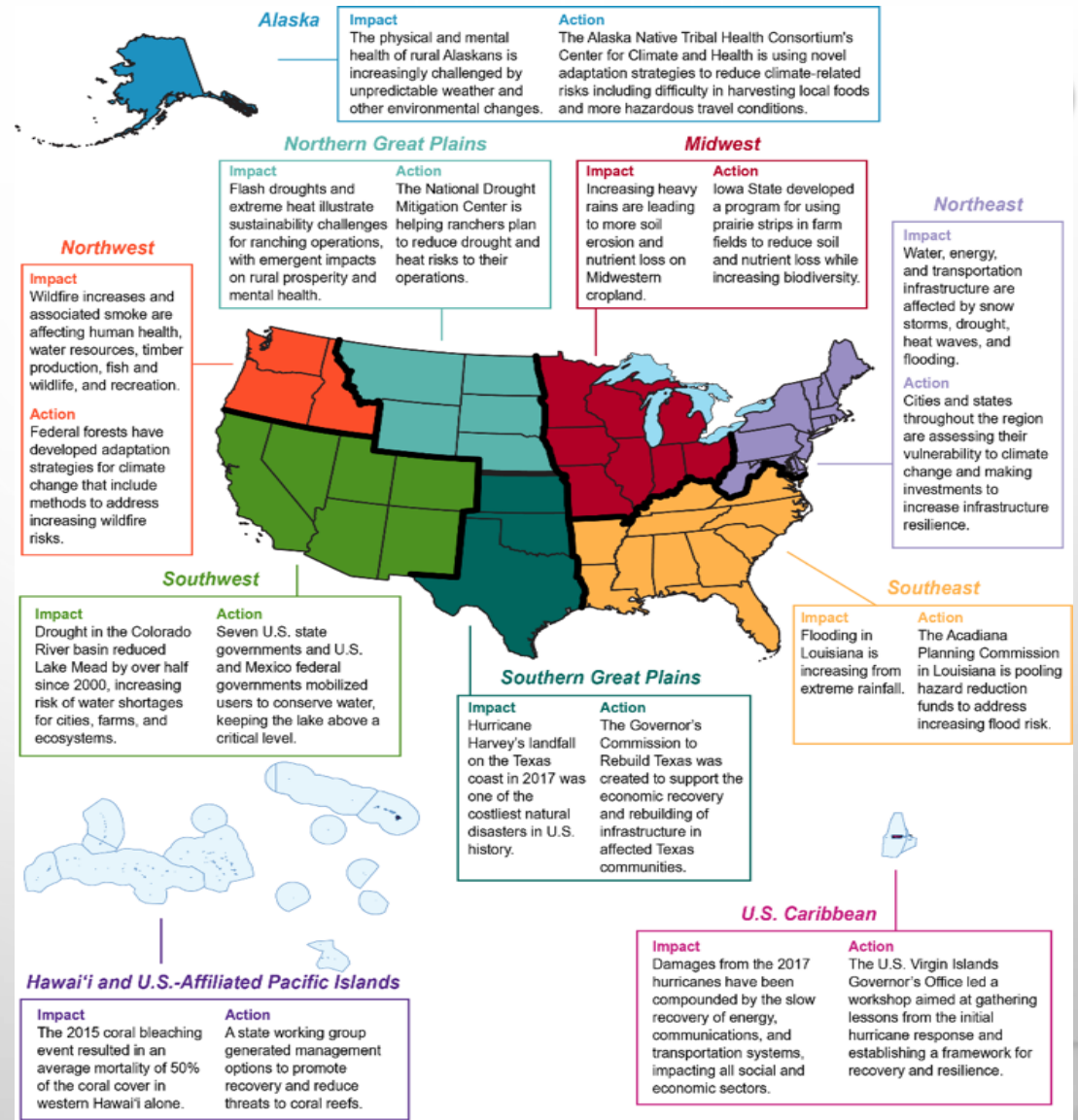


*Large green dots illustrate the hub locations for the 11 REWs in early 2017. Small green dots indicate satellite locations for those workshops. Small yellow dots show locations of some additional engagement activities, such as presentations or listening sessions at professional society meetings.*

# AMERICANS RESPOND TO THE IMPACTS OF CLIMATE CHANGE

THIS MAP SHOWS CLIMATE-RELATED IMPACTS THAT HAVE OCCURRED IN EACH REGION SINCE THE THIRD NATIONAL CLIMATE ASSESSMENT IN 2014 AND RESPONSE ACTIONS THAT ARE HELPING THE REGION ADDRESS RELATED RISKS AND COSTS. THESE EXAMPLES ARE ILLUSTRATIVE; THEY ARE NOT INDICATIVE OF WHICH IMPACT IS MOST SIGNIFICANT IN EACH REGION OR WHICH RESPONSE ACTION MIGHT BE MOST EFFECTIVE.

SOURCE: NCA4 REGIONAL CHAPTERS.



# OVERARCHING THEMES

- ECOSYSTEMS AND ECOSYSTEM SERVICES
- SEA LEVEL RISE
- MARINE & COASTAL RESOURCES
- HUMAN HEALTH
- INDIGENOUS PEOPLES
- RURAL COMMUNITIES & THEIR LIVELIHOODS
- ADAPTATION & ADAPTIVE CAPACITY
- AGRICULTURAL PRODUCTIVITY
- INFRASTRUCTURE & TRANSPORTATION

# 18 KEY MESSAGE #1



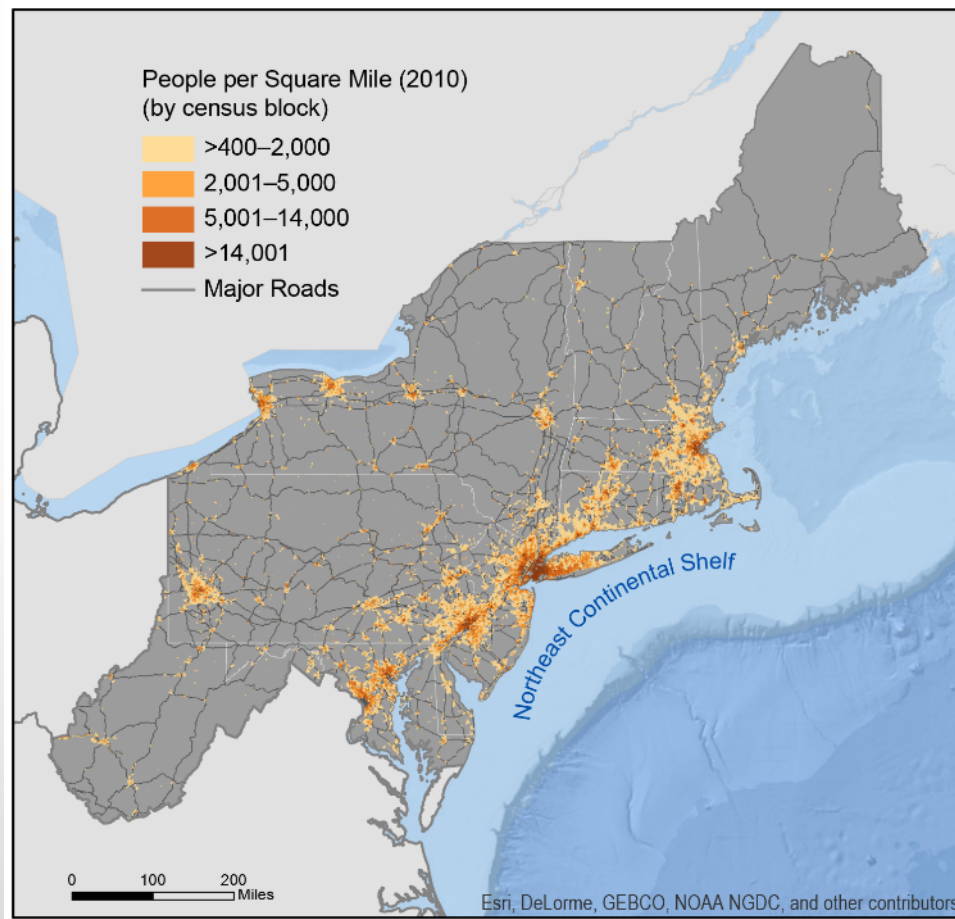
## CHANGING SEASONS AFFECT RURAL ECOSYSTEMS, ENVIRONMENTS, AND ECONOMIES

THE SEASONALITY OF THE NORTHEAST IS CENTRAL TO THE REGION'S SENSE OF PLACE AND IS AN IMPORTANT DRIVER OF RURAL ECONOMIES. LESS DISTINCT SEASONS WITH Milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry. The region's rural industries and livelihoods are at risk from further changes to forests, wildlife, snowpack, and streamflow.



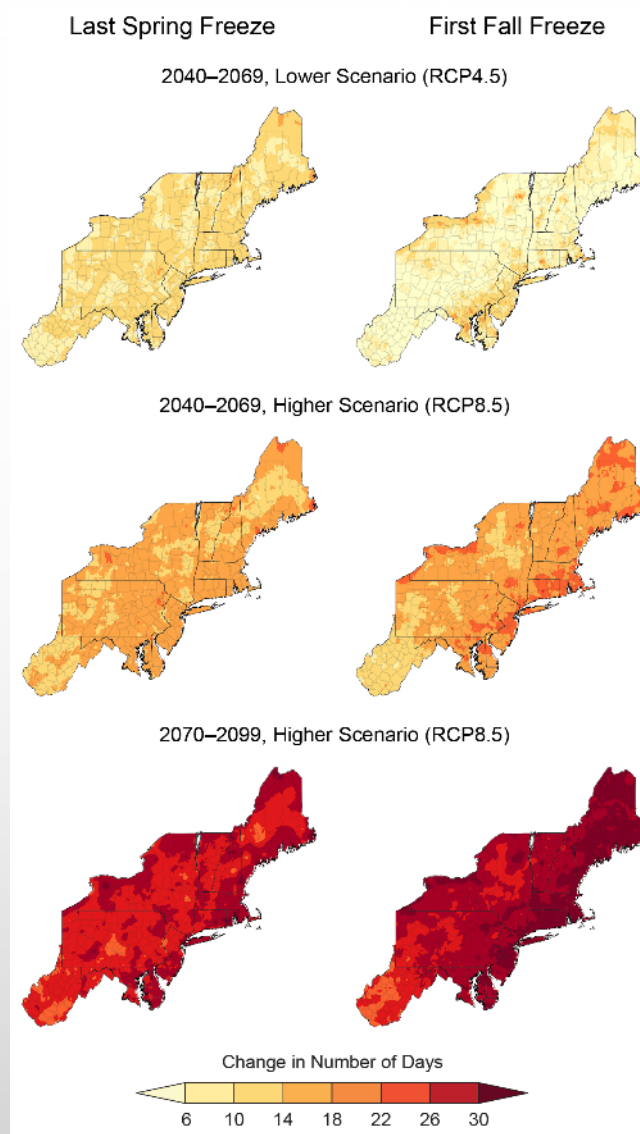
## FIG. 18.1: POPULATION DENSITY

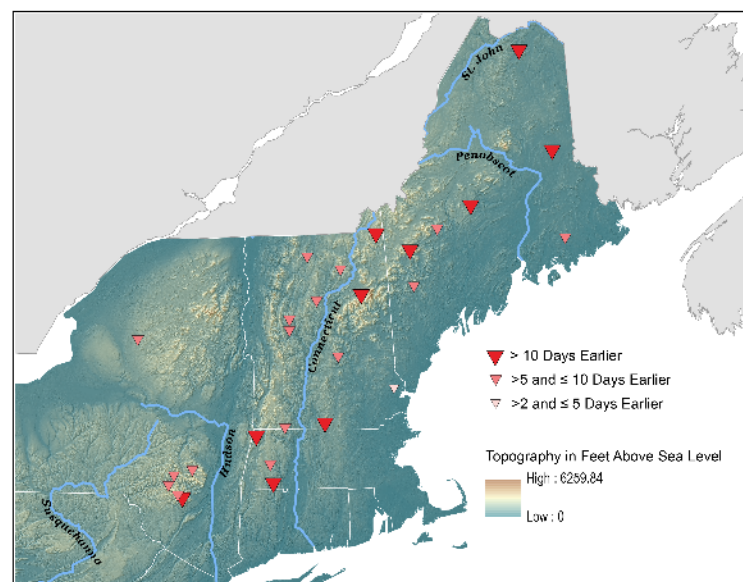
A SATELLITE MOSAIC OVERLAID WITH PRIMARY ROADS AND POPULATION DENSITY HIGHLIGHTS THE DIVERSE CHARACTERISTICS OF THE REGION IN TERMS OF SETTLEMENT PATTERNS, INTERCONNECTIONS AMONG POPULATION CENTERS OF VARYING SIZES, AND VARIABILITY IN RELIEF ACROSS THE OCEAN SHELF. *SOURCES: U.S. DEPARTMENT OF TRANSPORTATION, U.S. GEOLOGICAL SURVEY, AND ERT, INC.*



## FIG. 18.3: LENGTHENING OF THE FREEZE-FREE PERIOD

THESE MAPS SHOW PROJECTED SHIFTS IN THE DATE OF THE LAST SPRING FREEZE (LEFT COLUMN) AND THE DATE OF THE FIRST FALL FREEZE (RIGHT COLUMN) FOR THE MIDDLE OF THE CENTURY (AS COMPARED TO 1979–2008) UNDER THE LOWER SCENARIO (RCP4.5; TOP ROW) AND THE HIGHER SCENARIO (RCP8.5; MIDDLE ROW). THE BOTTOM ROW SHOWS THE SHIFT IN THESE DATES FOR THE END OF THE CENTURY UNDER THE HIGHER SCENARIO. BY THE MIDDLE OF THE CENTURY, THE FREEZE-FREE PERIOD ACROSS MUCH OF THE NORTHEAST IS EXPECTED TO LENGTHEN BY AS MUCH AS TWO WEEKS UNDER THE LOWER SCENARIO AND BY TWO TO THREE WEEKS UNDER THE HIGHER SCENARIO. BY THE END OF THE CENTURY, THE FREEZE-FREE PERIOD IS EXPECTED TO INCREASE BY AT LEAST THREE WEEKS OVER MOST OF THE REGION. SOURCE: ADAPTED FROM WOLFE ET AL. 2018.<sup>35</sup>





## FIG. 18.2: HISTORICAL CHANGES IN THE TIMING OF SNOWMELT-RELATED STREAMFLOW

THIS MAP OF PART OF THE NORTHEAST REGION SHOWS CONSISTENTLY EARLIER SNOWMELT-RELATED STREAMFLOW TIMING FOR RIVERS FROM 1960 TO 2014. EACH SYMBOL REPRESENTS THE CHANGE FOR AN INDIVIDUAL RIVER OVER THE ENTIRE PERIOD. CHANGES IN THE TIMING OF SNOWMELT POTENTIALLY INTERFERE WITH THE REPRODUCTION OF MANY AQUATIC SPECIES<sup>113</sup> AND IMPACT WATER-SUPPLY RESERVOIR MANAGEMENT BECAUSE OF HIGHER WINTER FLOWS AND LOWER SPRING FLOWS.<sup>114</sup> THE TIMING OF SNOWMELT-RELATED STREAMFLOW IN THE NORTHEAST IS SENSITIVE TO SMALL CHANGES IN AIR TEMPERATURE. THE AVERAGE WINTER–SPRING AIR TEMPERATURE INCREASE OF 1.67°F IN THE NORTHEAST FROM 1940 TO 2014 IS THOUGHT TO BE THE CAUSE OF AVERAGE EARLIER STREAMFLOW TIMING OF 7.7 DAYS.<sup>112</sup> THE TIMING OF SNOWMELT-RELATED STREAMFLOW IS A VALUABLE LONG-TERM INDICATOR OF WINTER–SPRING CHANGES IN THE NORTHEAST. SOURCE: ADAPTED FROM DUDLEY ET AL. 2017;<sup>112</sup> DIGITAL ELEVATION MODEL CGIAR–CSI (CGIAR CONSORTIUM FOR SPATIAL INFORMATION). REPRINTED WITH PERMISSION FROM ELSEVIER.

# 18 KEY MESSAGE #2

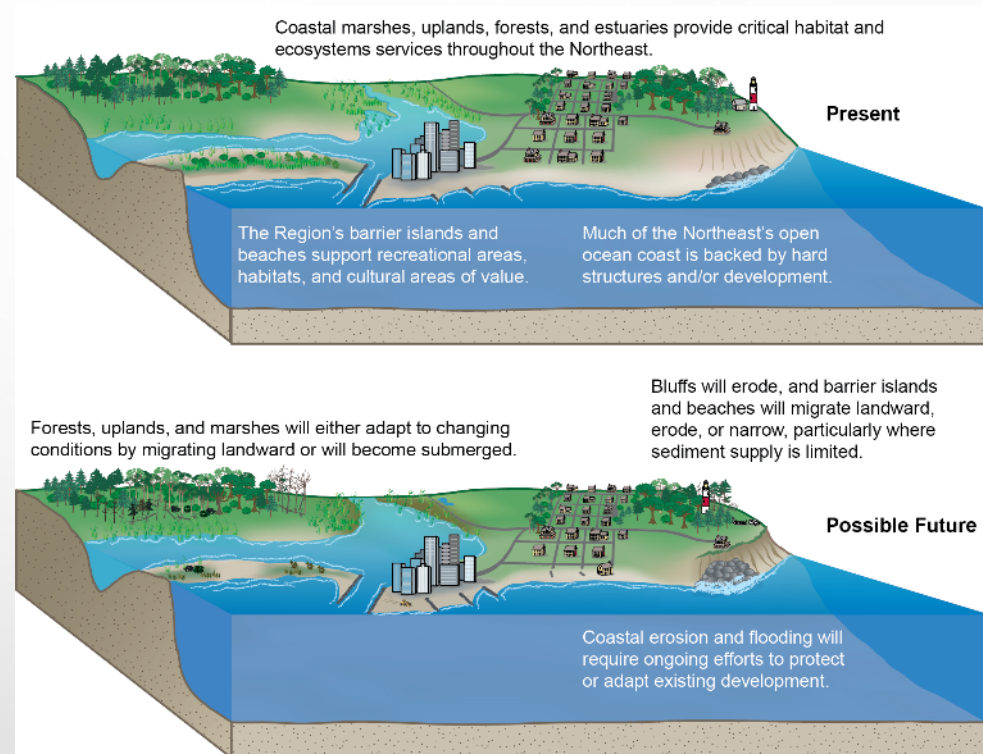
## CHANGING COASTAL AND OCEAN HABITATS, ECOSYSTEM SERVICES, AND LIVELIHOODS



THE NORTHEAST'S COAST AND OCEAN SUPPORT COMMERCE, TOURISM, AND RECREATION THAT ARE IMPORTANT TO THE REGION'S ECONOMY AND WAY OF LIFE. WARMER OCEAN TEMPERATURES, SEA LEVEL RISE, AND OCEAN ACIDIFICATION THREATEN THESE SERVICES. THE ADAPTIVE CAPACITY OF MARINE ECOSYSTEMS AND COASTAL COMMUNITIES WILL INFLUENCE ECOLOGICAL AND SOCIOECONOMIC OUTCOMES AS CLIMATE RISKS INCREASE.

## FIG 18.7: COASTAL IMPACTS OF CLIMATE CHANGE

(TOP) THE NORTHEASTERN COASTAL LANDSCAPE IS COMPOSED OF UPLANDS AND FORESTED AREAS, WETLANDS AND ESTUARINE SYSTEMS, MAINLAND AND BARRIER BEACHES, BLUFFS, HEADLANDS, AND ROCKY SHORES, AS WELL AS DEVELOPED AREAS, ALL OF WHICH PROVIDE A VARIETY OF IMPORTANT SERVICES TO PEOPLE AND SPECIES. (BOTTOM) FUTURE IMPACTS FROM INTENSE STORM ACTIVITY AND SEA LEVEL RISE WILL VARY ACROSS THE LANDSCAPE, REQUIRING A VARIETY OF ADAPTATION STRATEGIES IF PEOPLE, HABITATS, TRADITIONS, AND LIVELIHOODS ARE TO BE PROTECTED. SOURCE: U.S. GEOLOGICAL SURVEY.



# 18 KEY MESSAGE #3



## **MAINTAINING URBAN AREAS AND COMMUNITIES AND THEIR INTERCONNECTEDNESS**

THE NORTHEAST'S URBAN CENTERS AND THEIR INTERCONNECTIONS ARE REGIONAL AND NATIONAL HUBS FOR CULTURAL AND ECONOMIC ACTIVITY. MAJOR NEGATIVE IMPACTS ON CRITICAL INFRASTRUCTURE, URBAN ECONOMIES, AND NATIONALLY SIGNIFICANT HISTORIC SITES ARE ALREADY OCCURRING AND WILL BECOME MORE COMMON WITH A CHANGING CLIMATE.



## FIG 18.9: KING TIDE FLOODING IN ANNAPOLIS, MARYLAND

THE PHOTO SHOWS KING TIDE FLOODING ON DOCK STREET IN ANNAPOLIS, MARYLAND, ON DECEMBER 21, 2012. PHOTO CREDIT: AMY MCGOVERN ([CC BY 2.0](#)).

## FIG 18.10: SUBWAY AIR VENT FLOOD PROTECTION

THE PHOTO SHOWS A SUBWAY AIR VENT WITH A MULTIUSE RAISED FLOOD PROTECTION GRATE THAT WAS INSTALLED AS PART OF THE POST-SUPERSTORM SANDY COASTAL RESILIENCE EFFORTS ON WEST BROADWAY IN LOWER MANHATTAN, NEW YORK CITY. PHOTO CREDIT: WILLIAM SOLECKI.



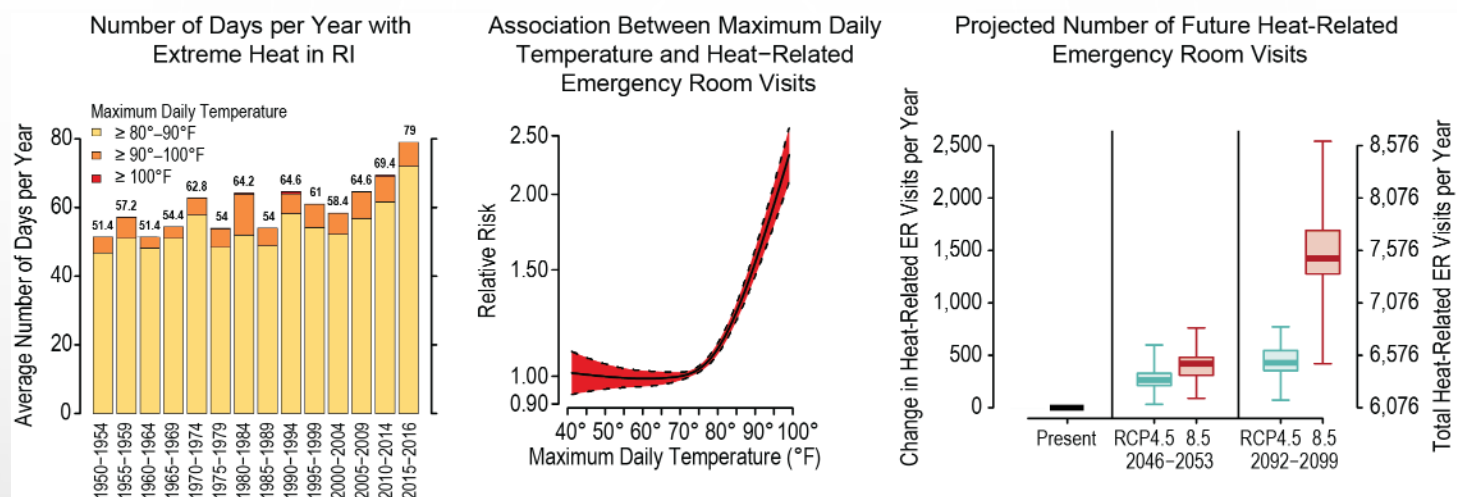


# 18 KEY MESSAGE #4



## THREATS TO HUMAN HEALTH

CHANGING CLIMATE THREATENS THE HEALTH AND WELL-BEING OF PEOPLE IN THE NORTHEAST THROUGH MORE EXTREME WEATHER, WARMER TEMPERATURES, DEGRADATION OF AIR AND WATER QUALITY, AND SEA LEVEL RISE. THESE ENVIRONMENTAL CHANGES ARE EXPECTED TO LEAD TO HEALTH-RELATED IMPACTS AND COSTS, INCLUDING ADDITIONAL DEATHS, EMERGENCY ROOM VISITS AND HOSPITALIZATIONS, AND A LOWER QUALITY OF LIFE. HEALTH IMPACTS ARE EXPECTED TO VARY BY LOCATION, AGE, CURRENT HEALTH, AND OTHER CHARACTERISTICS OF INDIVIDUALS AND COMMUNITIES.



## FIG. 18.11: OBSERVED AND PROJECTED IMPACTS OF EXCESS HEAT ON EMERGENCY ROOM VISITS IN RHODE ISLAND

THIS FIGURE SHOWS THE OBSERVED AND PROJECTED IMPACTS OF EXCESS HEAT ON EMERGENCY ROOM VISITS IN RHODE ISLAND. (LEFT) IN RHODE ISLAND, MAXIMUM DAILY TEMPERATURES IN THE SUMMER HAVE TRENDED UPWARDS OVER THE LAST 60 YEARS, SUCH THAT RESIDENTS EXPERIENCED ABOUT THREE MORE WEEKS OF HEALTH-THREATENING HOT WEATHER OVER 2015–2016 THAN IN THE 1950S. (MIDDLE) A RECENT STUDY LOOKING AT VISITS TO HOSPITAL EMERGENCY ROOMS (ERS) FOUND THAT THE INCIDENCE RATE OF HEAT-RELATED ER VISITS ROSE SHARPLY AS MAXIMUM DAILY TEMPERATURES CLIMBED ABOVE 80°F. (RIGHT) THE STUDY ESTIMATES THAT WITH CONTINUED CLIMATE CHANGE, RHODE ISLANDERS COULD EXPERIENCE AN ADDITIONAL 400 (6.8% MORE) HEAT-RELATED ER VISITS EACH YEAR BY 2050 AND UP TO AN ADDITIONAL 1,500 (24.4% MORE) SUCH VISITS EACH YEAR BY 2095 UNDER THE HIGHER SCENARIO (RCP8.5). ABOUT 1,000 FEWER ANNUAL HEAT-RELATED ER VISITS ARE PROJECTED FOR THE END OF THE CENTURY UNDER THE LOWER SCENARIO (RCP4.5) COMPARED TO THE HIGHER SCENARIO (RCP8.5), REFLECTING THE ESTIMATED HEALTH BENEFITS OF ADHERING TO A LOWER GREENHOUSE GAS EMISSIONS SCENARIO. SOURCES: (LEFT) BROWN UNIVERSITY; (MIDDLE, RIGHT) ADAPTED FROM KINGSLEY ET AL. 2016.<sup>26</sup> REPRODUCED FROM ENVIRONMENTAL HEALTH PERSPECTIVES.

# 18 KEY MESSAGE #5



## ADAPTATION TO CLIMATE CHANGE IS UNDERWAY

COMMUNITIES IN THE NORTHEAST ARE PROACTIVELY PLANNING AND IMPLEMENTING ACTIONS TO REDUCE RISKS POSED BY CLIMATE CHANGE. USING DECISION SUPPORT TOOLS TO DEVELOP AND APPLY ADAPTATION STRATEGIES INFORMS BOTH THE VALUE OF ADOPTING SOLUTIONS AND THE REMAINING CHALLENGES. EXPERIENCE SINCE THE LAST ASSESSMENT PROVIDES A FOUNDATION TO ADVANCE FUTURE ADAPTATION EFFORTS.

## 18

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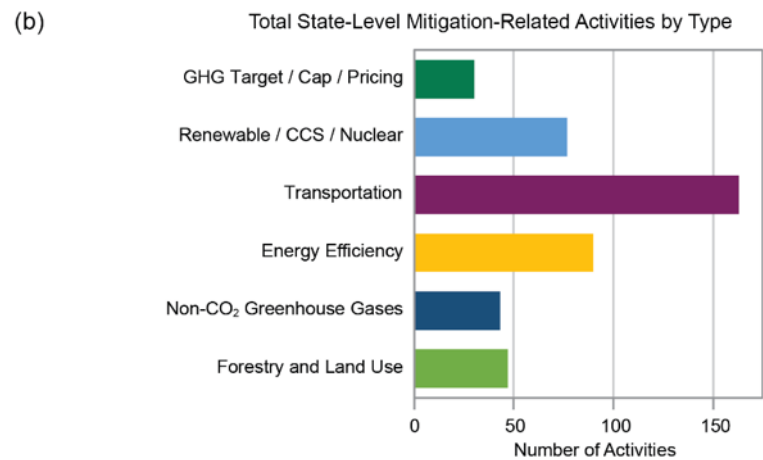
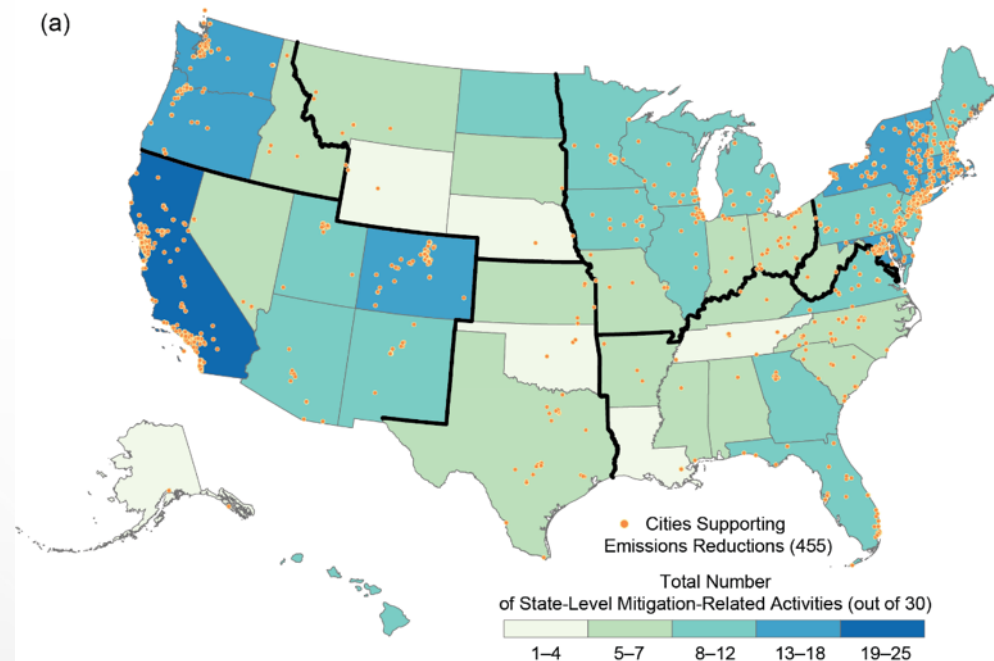
# REDUCING THE RISKS OF CLIMATE CHANGE

- MANY CLIMATE CHANGE IMPACTS AND ECONOMIC DAMAGES IN THE UNITED STATES CAN BE SUBSTANTIALLY REDUCED THROUGH GLOBAL-SCALE REDUCTIONS IN GREENHOUSE GAS EMISSIONS COMPLEMENTED BY REGIONAL AND LOCAL ADAPTATION EFFORTS
- SINCE THE THIRD NATIONAL CLIMATE ASSESSMENT (NCA3) IN 2014, A GROWING NUMBER OF STATES, CITIES, AND BUSINESSES HAVE PURSUED OR EXPANDED UPON INITIATIVES AIMED AT REDUCING GREENHOUSE GAS EMISSIONS, AND THE SCALE OF ADAPTATION IMPLEMENTATION ACROSS THE COUNTRY HAS INCREASED
- HOWEVER, THESE EFFORTS DO NOT YET APPROACH THE SCALE NEEDED TO AVOID SUBSTANTIAL DAMAGES TO THE ECONOMY, ENVIRONMENT, AND HUMAN HEALTH EXPECTED OVER THE COMING DECADES

# MITIGATION-RELATED ACTIVITIES AT STATE AND LOCAL LEVELS

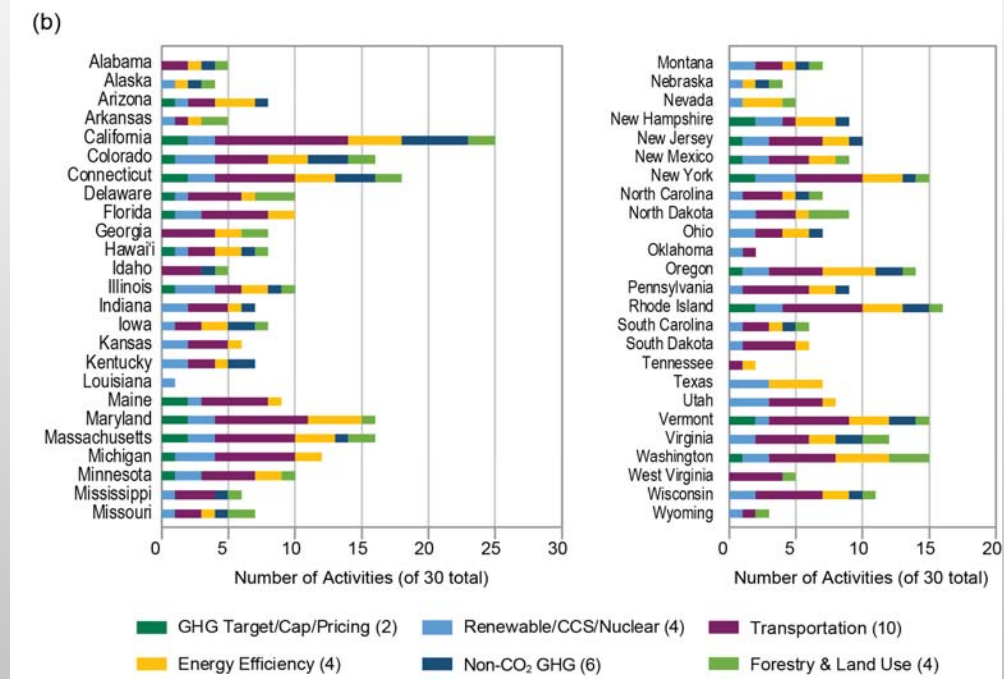
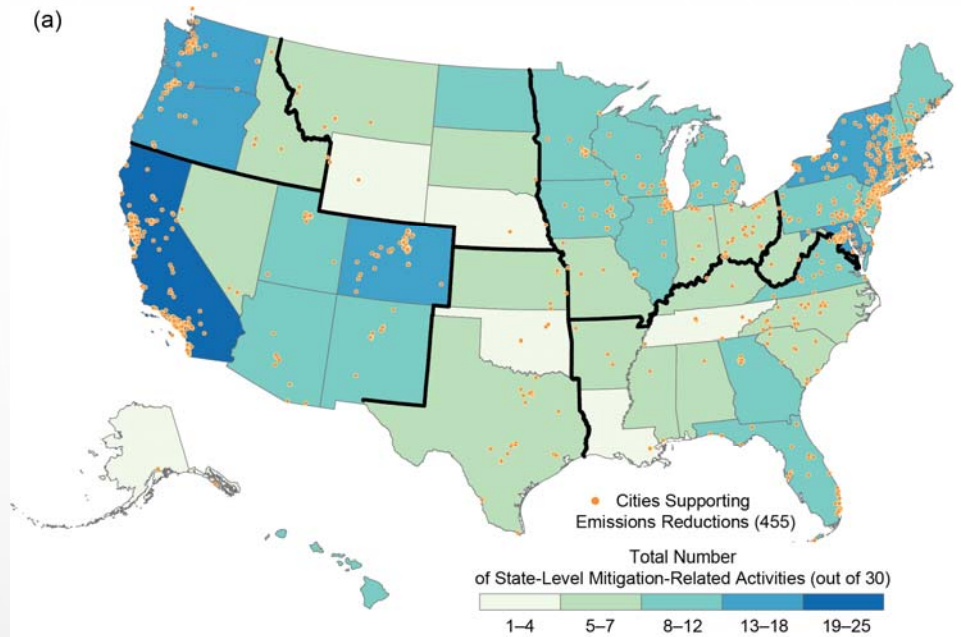
**(TOP)** THE MAP SHOWS THE NUMBER OF MITIGATION-RELATED ACTIVITIES AT THE STATE LEVEL (OUT OF 30 ILLUSTRATIVE ACTIVITIES) AS WELL AS CITIES SUPPORTING EMISSIONS REDUCTIONS

**(BOTTOM)** THE CHART DEPICTS THE TYPE AND NUMBER OF ACTIVITIES BY STATE. SEVERAL TERRITORIES ALSO HAVE A VARIETY OF MITIGATION-RELATED ACTIVITIES, INCLUDING AMERICAN SĀMOA, THE FEDERATED STATES OF MICRONESIA, GUAM, NORTHERN MARIANA ISLANDS, PUERTO RICO, AND THE U.S. VIRGIN ISLANDS.



From Figure 29.1, Ch. 29: Mitigation (Sources: [top] EPA and ERT, [bottom] adapted from America's Pledge 2017).





# FIVE ADAPTATION STAGES AND PROGRESS

ADAPTATION ENTAILS A CONTINUING RISK MANAGEMENT PROCESS. WITH THIS APPROACH, INDIVIDUALS AND ORGANIZATIONS BECOME AWARE OF AND ASSESS RISKS AND VULNERABILITIES FROM CLIMATE AND OTHER DRIVERS OF CHANGE, TAKE ACTIONS TO REDUCE THOSE RISKS, AND LEARN OVER TIME. THE GRAY ARCED LINES COMPARE THE CURRENT STATUS OF IMPLEMENTING THIS PROCESS WITH THE STATUS REPORTED BY THE THIRD NATIONAL CLIMATE ASSESSMENT IN 2014; DARKER COLOR INDICATES MORE ACTIVITY.



From Figure 28.1, Ch. 28: Adaptation (Source: adapted from National Research Council, 2010. Used with permission from the National Academies Press, © 2010, National Academy of Sciences. Image credits, clockwise from top: National Weather Service; USGS; Armando Rodriguez, Miami-Dade County; Dr. Neil Berg, MARISA; Bill Ingalls, NASA).

## 28 Key Message #3

### **Adaptation Entails Iterative Risk Management**

Adaptation entails a continuing risk management process; it does not have an end point. With this approach, individuals and organizations of all types assess risks and vulnerabilities from climate and other drivers of change (such as economic, environmental, and societal), take actions to reduce those risks, and learn over time.

## 28 Key Message #4

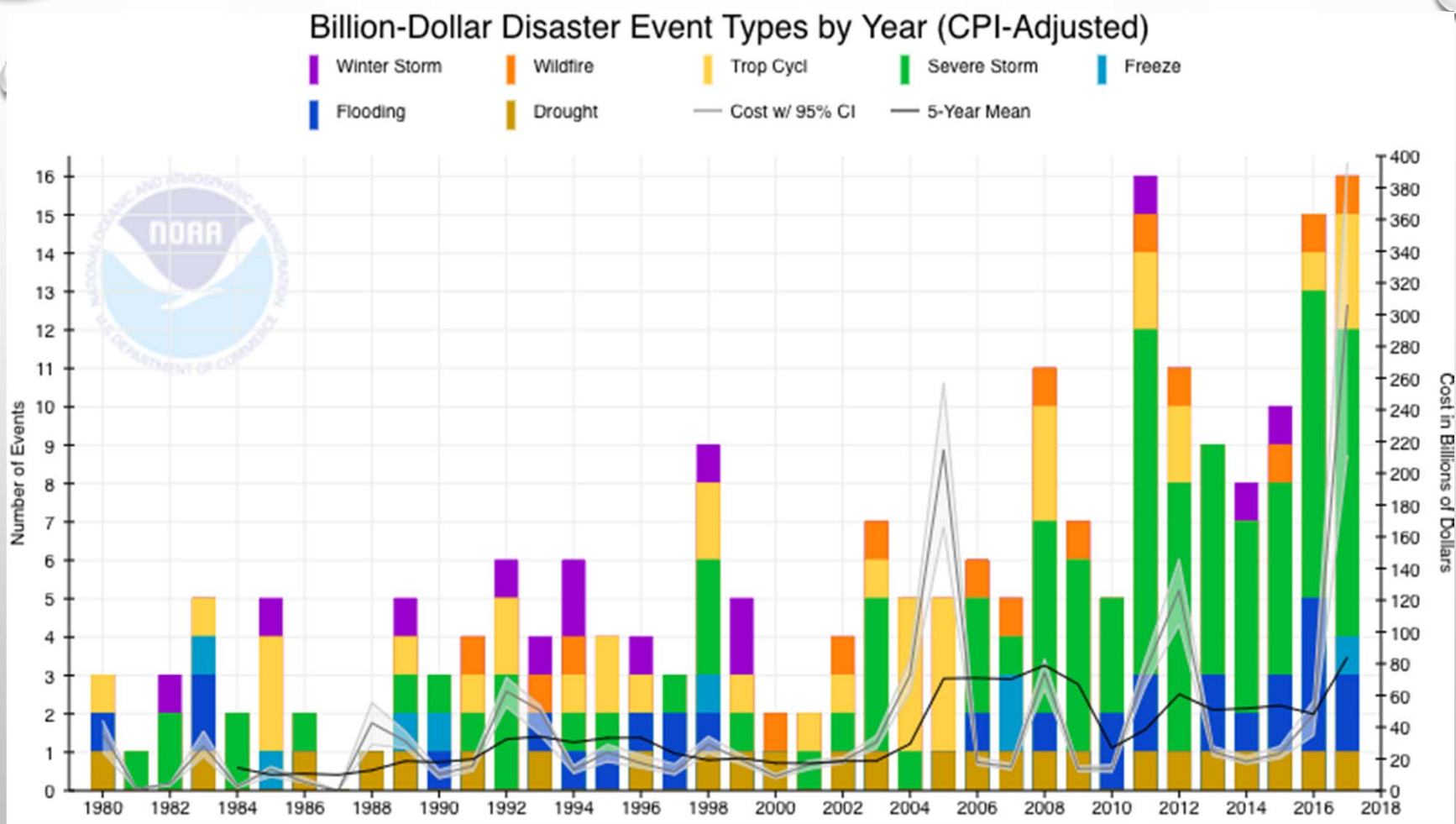
### **Benefits of Proactive Adaptation Exceed Costs**

Proactive adaptation initiatives—including changes to policies, business operations, capital investments, and other steps—yield benefits in excess of their costs in the near term, as well as over the long term. Evaluating adaptation strategies involves consideration of equity, justice, cultural heritage, the environment, health, and national security.

## 28 Key Message #5

### **New Approaches Can Further Reduce Risk**

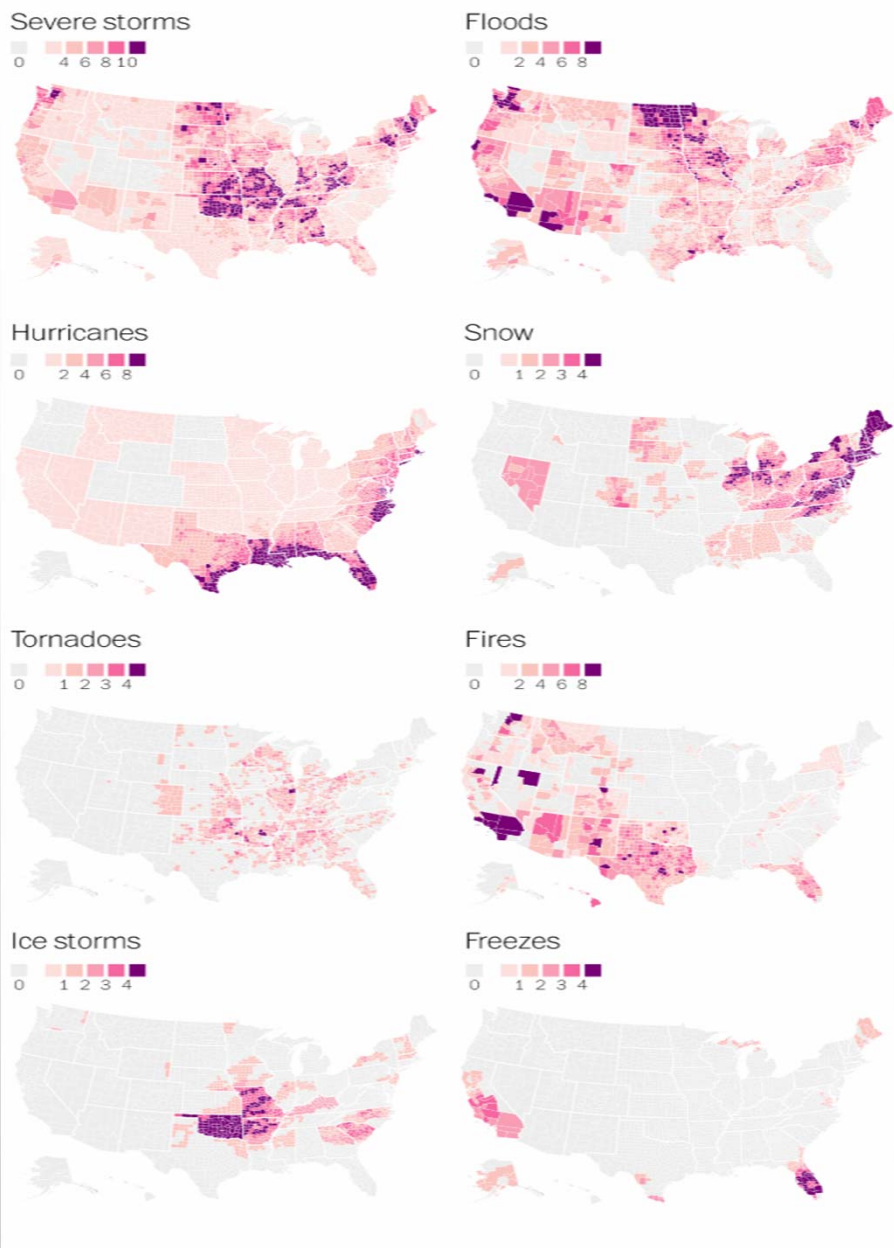
Integrating climate considerations into existing organizational and sectoral policies and practices provides adaptation benefits. Further reduction of the risks from climate change can be achieved by new approaches that create conditions for altering regulatory and policy environments, cultural and community resources, economic and financial systems, technology applications, and ecosystems.



Since 1980, the U.S. has sustained 219 distinct weather and climate events where the overall damages/costs reached or exceeded \$1 billion (CPI-Adjusted)

# Where the most common disasters happen

Number of federal disaster declarations by county, 1964 to 2014



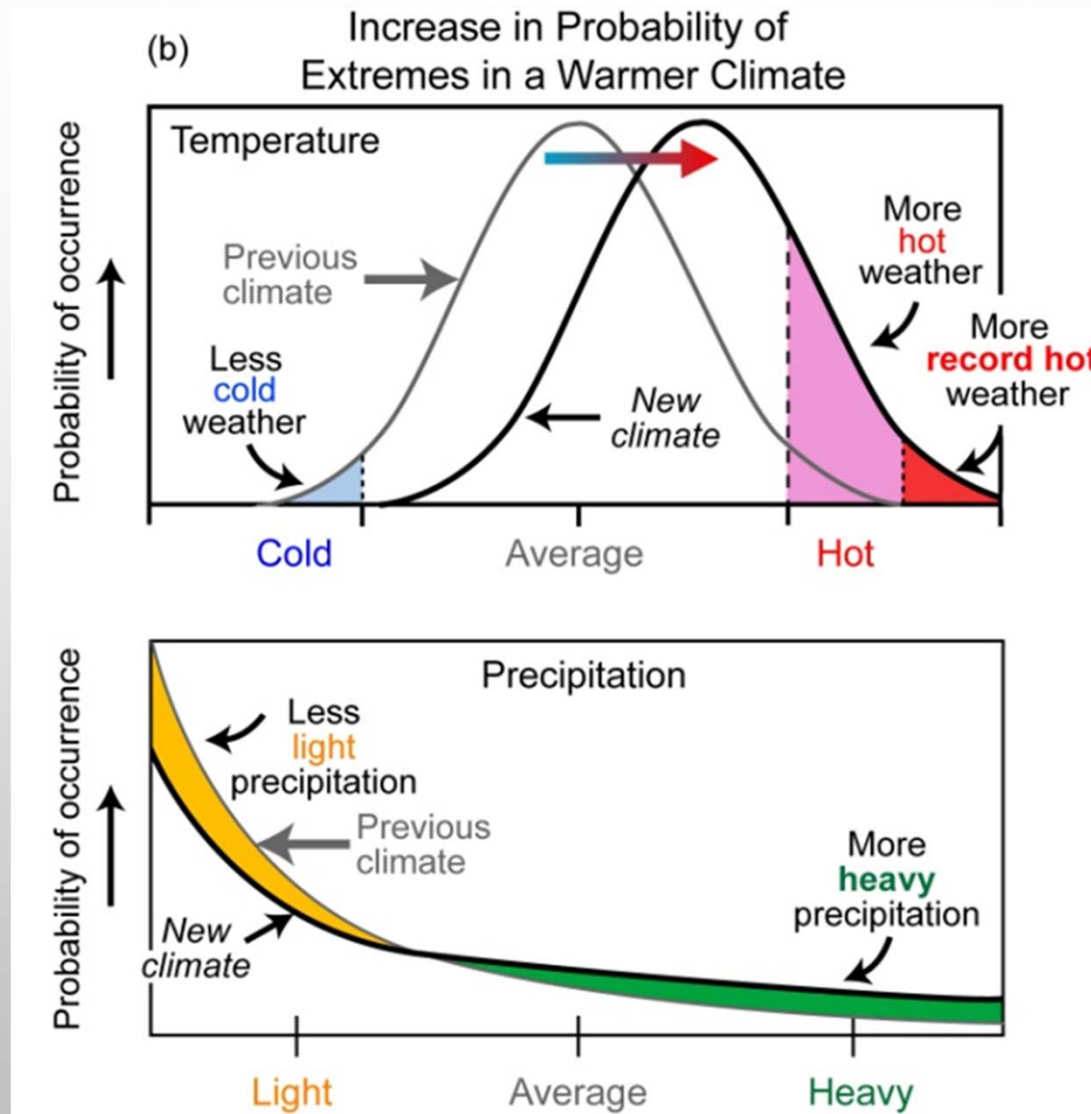
[https://www.washingtonpost.com/news/wonk/wp/2015/01/21/earthquakes-floods-and-volcanoes-the-most-disaster-prone-places-in-america/?noredirect=on&utm\\_term=.c225f3e9b27a](https://www.washingtonpost.com/news/wonk/wp/2015/01/21/earthquakes-floods-and-volcanoes-the-most-disaster-prone-places-in-america/?noredirect=on&utm_term=.c225f3e9b27a)

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Source: Federal Emergency Management Agency

Fourth National Climate Assessment, Vol II — Impacts, Risks, and Adaptation in the United States  
[nca2018.globalchange.gov](http://nca2018.globalchange.gov)

# A warmer world increases the probability of extreme events

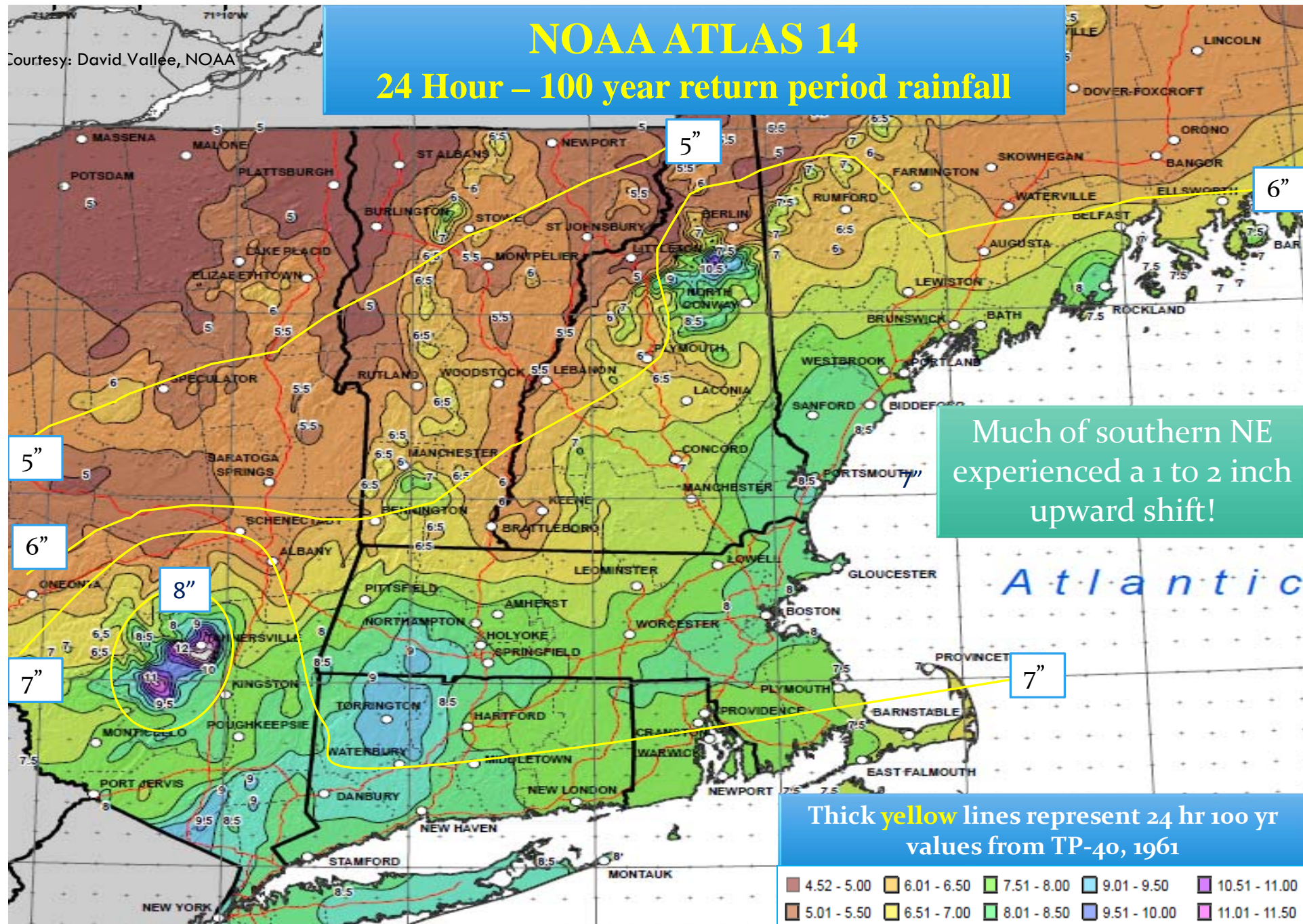




Courtesy: David Vallee, NOAA

# NOAA ATLAS 14

## 24 Hour – 100 year return period rainfall



Much of southern NE experienced a 1 to 2 inch upward shift!

Thick yellow lines represent 24 hr 100 yr values from TP-40, 1961

4.52 - 5.00	6.01 - 6.50	7.51 - 8.00	9.01 - 9.50	10.51 - 11.00
5.01 - 5.50	6.51 - 7.00	8.01 - 8.50	9.51 - 10.00	11.01 - 11.50
5.51 - 6.00	7.01 - 7.50	8.51 - 9.00	10.01 - 10.50	11.51 - 12.00
				12.01 - 12.45

<http://hdsc.nws.noaa.gov/hdsc/pfds/index.html>

# SUMMARY REMARKS

- SYSTEMS APPROACH – WEATHER, CLIMATE, CLIMATE CHANGE
- IMPORTANCE OF TOPOGRAPHY & GEOGRAPHY
- TIME & SPACE SCALES
- MULTI-HAZARD APPROACH
  - COASTAL/INLAND; TIMING
- MULTIPLE VULNERABILITIES
- ZONING, FLOODPLAIN USAGE, COMMUNITY RESILIENCE



# THANK YOU!

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