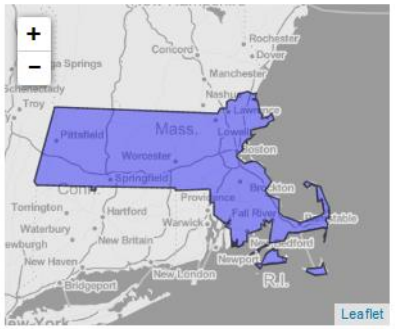
Massachusetts Climate Projections

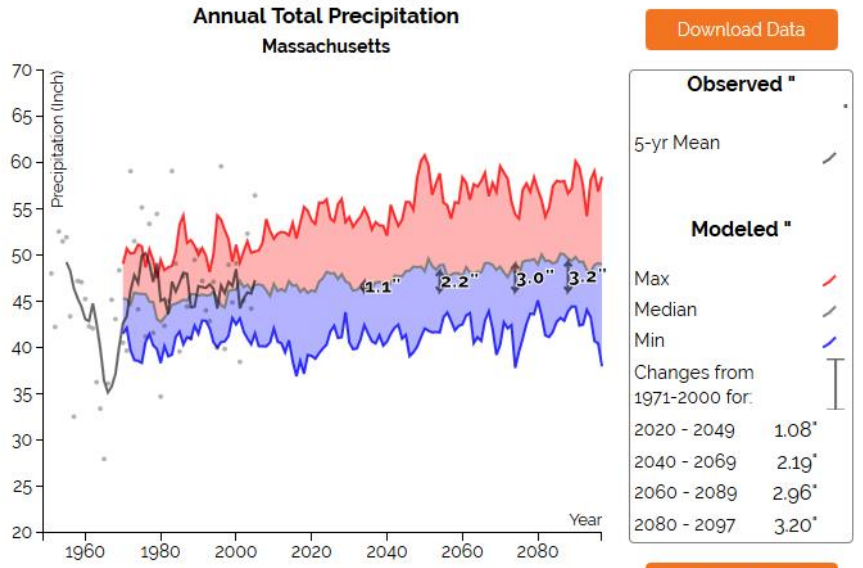
MA CCC
Massachusetts Climate Change Clearinghouse

State Massachusetts

Calculated Variable:
Total Precipitation

Season: Annual





Download Data

Observed "

5-yr Mean

Modeled "

Max
Median
Min

Changes from 1971-2000 for:

2020 - 2049	1.08"
2040 - 2069	2.19"
2060 - 2089	2.96"
2080 - 2097	3.20"

About the Source Data

EXECUTIVE OFFICE of ENVIRONMENTAL AFFAIRS

NECSC Northeast Climate Science Center

MA CCC

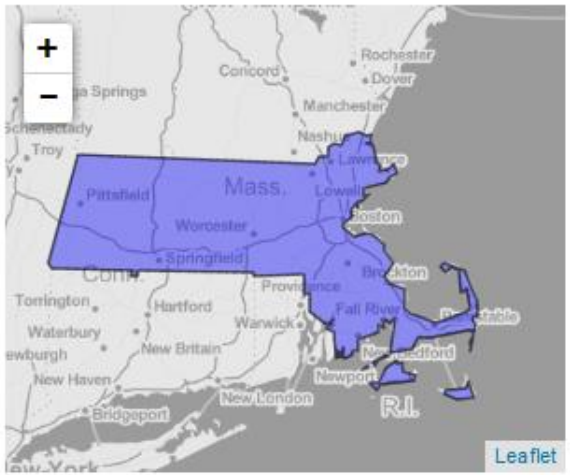
Massachusetts Climate Change Clearinghouse

State Massachusetts

Calculated Variable:

Total Precipitation

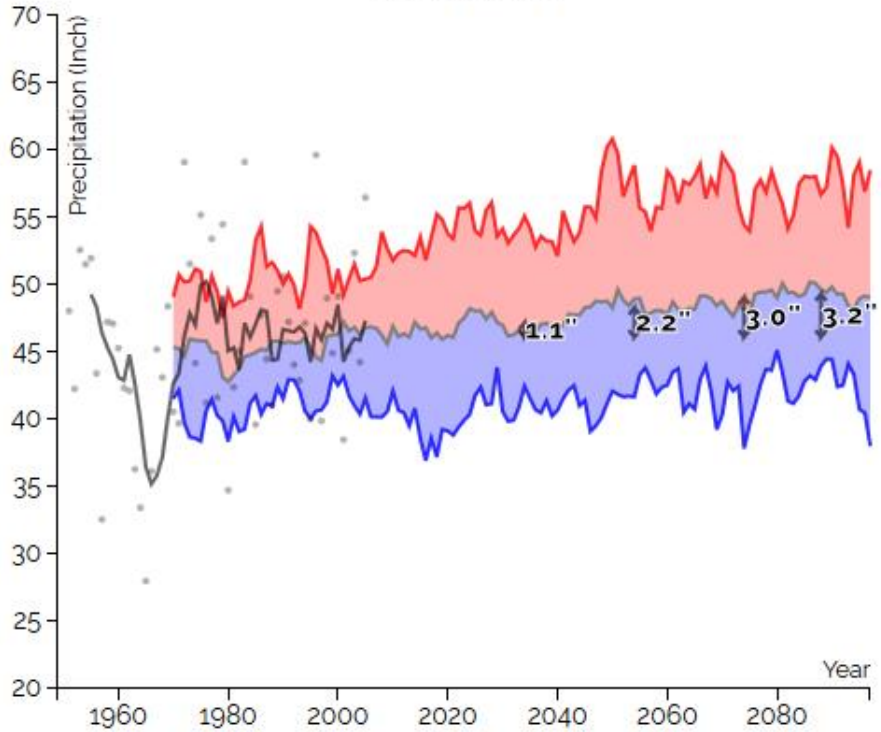
Season: Annual



Add Chart

Annual Total Precipitation

Massachusetts



Download Data

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5-yr Mean

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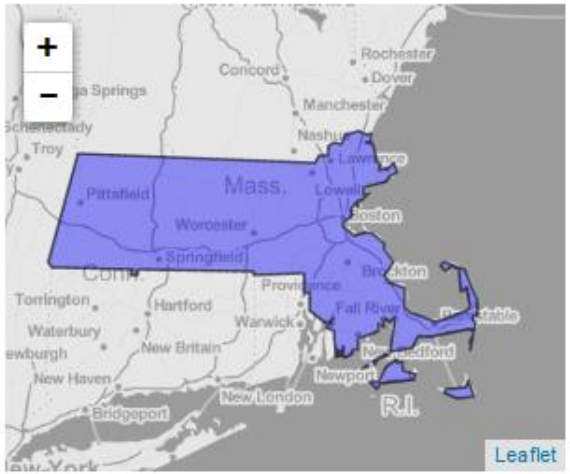
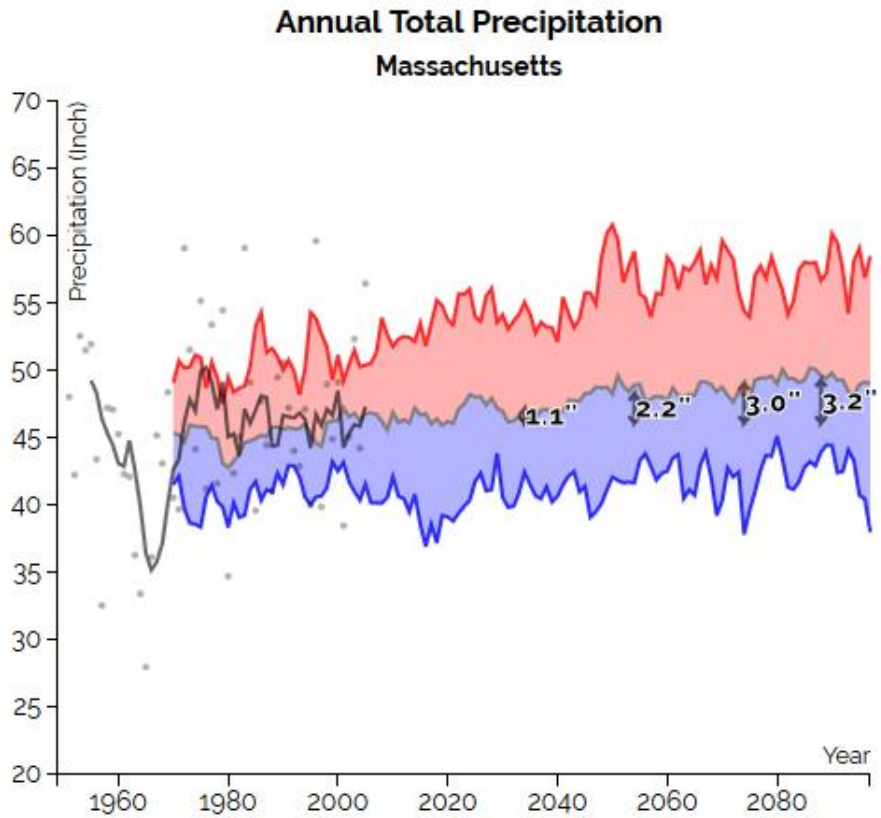
Calculated Variable:

Total Precipitation

Season: Annual



Add Chart



Download Data

Observed "

5-yr Mean

Modeled "

Max

Median

Min

Changes from 1971-2000 for:

2020 - 2049	1.08°
2040 - 2069	2.19°
2060 - 2089	2.96°
2080 - 2097	3.20°

About the Source Data

NECSC Northeast Climate Science Center

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Massachusetts Climate Change Clearinghouse

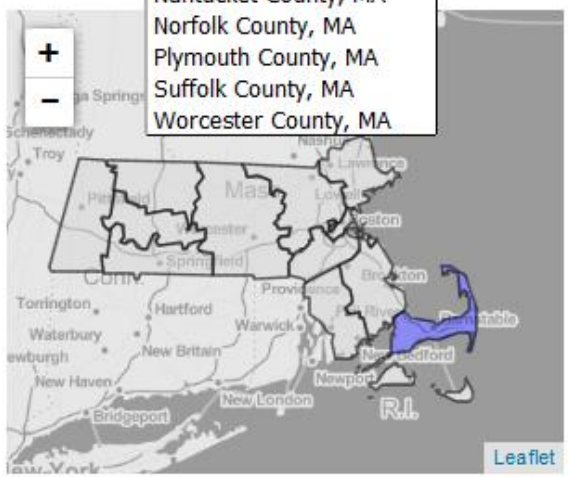
County | Barnstable County, MA

Calculated

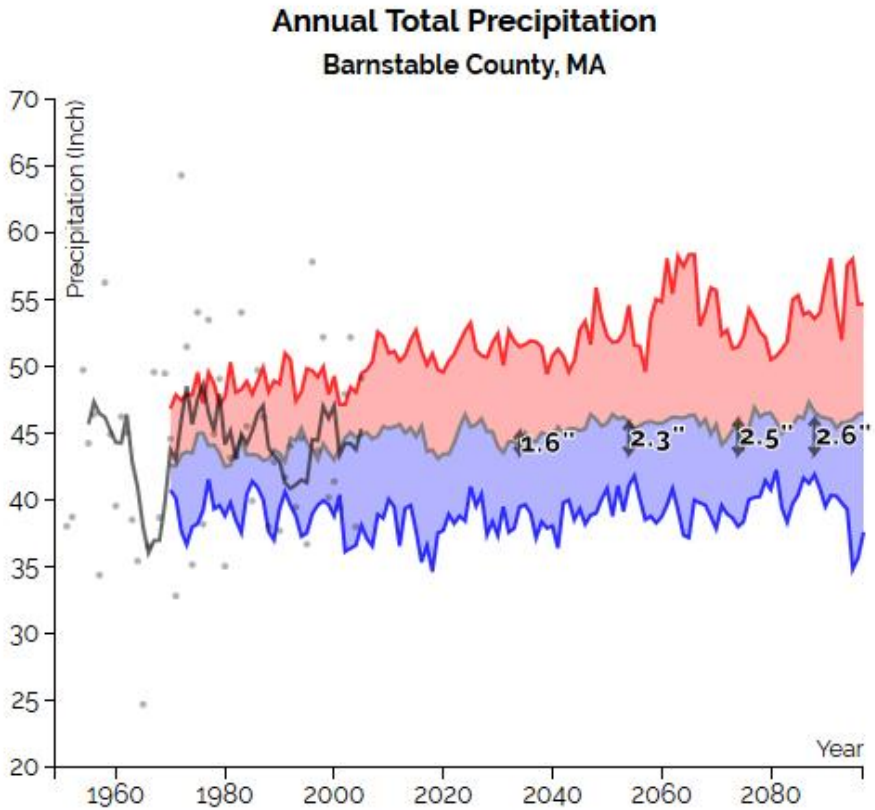
Total Prec

Season: A

- Barnstable County, MA
- Berkshire County, MA
- Bristol County, MA
- Dukes County, MA
- Essex County, MA
- Franklin County, MA
- Hampden County, MA
- Hampshire County, MA
- Middlesex County, MA
- Nantucket County, MA
- Norfolk County, MA
- Plymouth County, MA
- Suffolk County, MA
- Worcester County, MA



Add Chart



Download Data

Observed "

5-yr Mean

Modeled "

Max

Median

Min

Changes from 1971-2000 for:

2020 - 2049	1.60°
2040 - 2069	2.30°
2060 - 2089	2.54°
2080 - 2097	2.59°

About the Source Data

NECSC Northeast Climate Science Center

MA CCC

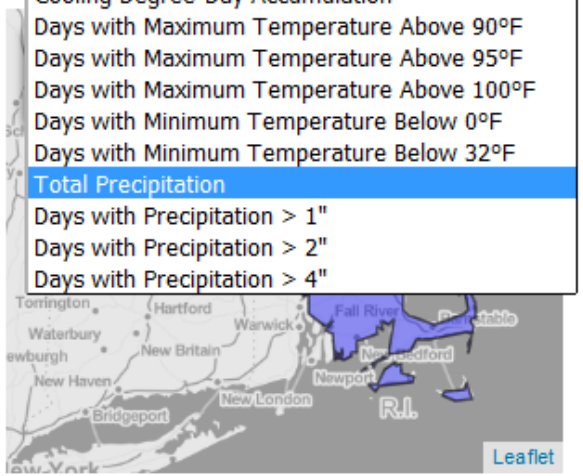
Massachusetts Climate Change Clearinghouse

State | Massachusetts

Calculated Variable:

Total Precipitation

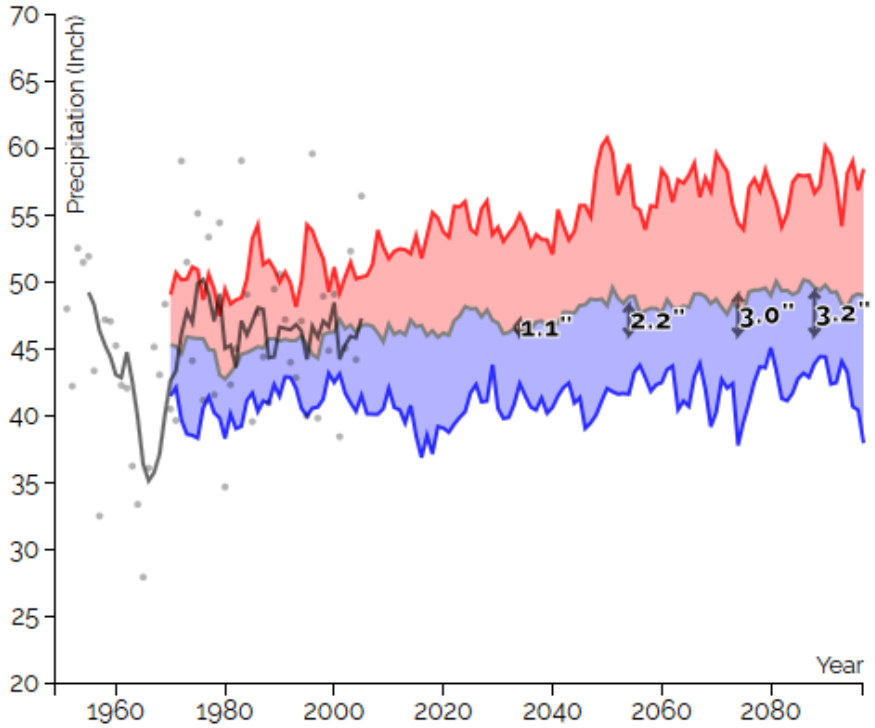
- Maximum Temperature
- Minimum Temperature
- Average Temperature
- Growing Degree-Day Accumulation
- Heating Degree-Day Accumulation
- Cooling Degree-Day Accumulation
- Days with Maximum Temperature Above 90°F
- Days with Maximum Temperature Above 95°F
- Days with Maximum Temperature Above 100°F
- Days with Minimum Temperature Below 0°F
- Days with Minimum Temperature Below 32°F
- Total Precipitation
- Days with Precipitation > 1"
- Days with Precipitation > 2"
- Days with Precipitation > 4"



Add Chart

Annual Total Precipitation

Massachusetts



Download Data

Observed "

5-yr Mean

Modeled "

Max

Median

Min

Changes from 1971-2000 for:

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2080 - 2097	3.20°

About the Source Data

NECSC Northeast Climate Science Center

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Massachusetts Climate Change Clearinghouse

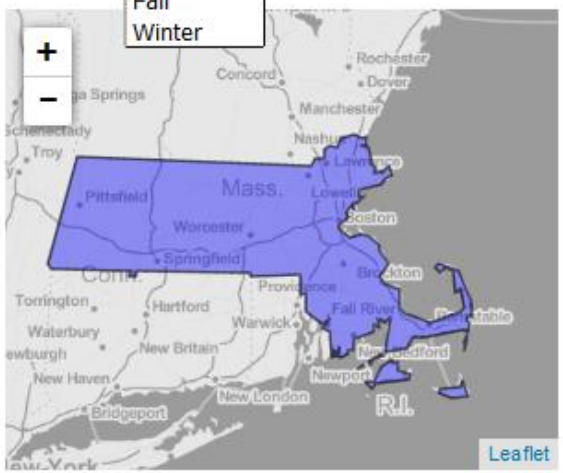
State Massachusetts

Calculated Variable:

Total Precipitation

Season: Annual

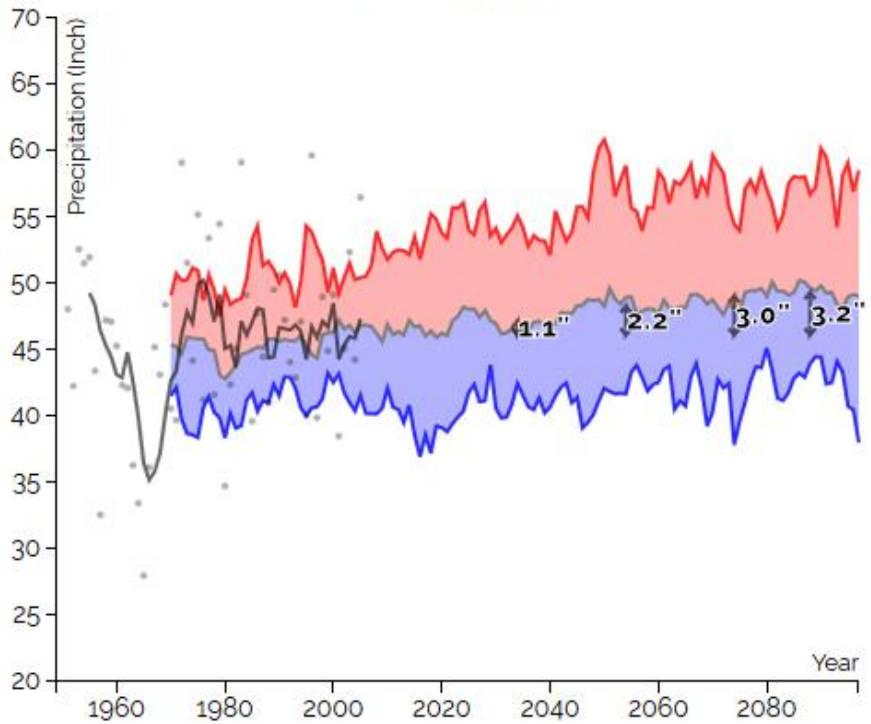
- Annual
- Spring
- Summer
- Fall
- Winter



Add Chart

Annual Total Precipitation

Massachusetts



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About the Source Data

NECSC Northeast Climate Science Center

close

Massachusetts Climate Change Projections

Climate change projections for the commonwealth of Massachusetts are based on simulations from the latest generation of climate models included in the Coupled Model Intercomparison Project Phase 5 (CMIP5). These same CMIP5 models formed the basis of projections summarized in the IPCC Fifth Assessment Report (2013). The statewide projections comprising county- and watershed-level information are derived by statistically downscaling CMIP5 model results using the Local Constructed Analogs (LOCA) method (Pierce et al., 2014). The LOCA dataset provides values for daily precipitation, and maximum and minimum temperature on a ~6 km grid (available here: http://loca.ucsd.edu/). The LOCA method corrects for systematic biases present in climate models simulations, and has been shown to produce better depiction of climate extremes compared to previous statistical downscaling methods.

The climate change projections are based on fourteen CMIP5 models and two pathways of future greenhouse gas emissions: RCP4.5 and RCP8.5, the medium and high emissions scenarios respectively. The fourteen models were carefully selected from a large ensemble of CMIP5 models based on their ability to provide reliable climate information for the Northeast US, while maintaining diversity in future projections consistent with known uncertainties.

Two scenarios for fourteen models each lead to 28 projections. The values cited below are based on the 10-90 th percentiles across 28 projections, so they bracket the most likely scenarios. For simplicity, we use the terms "...expected to...", "...will be...", but recognize that these are estimates based on model scenarios and are *not forecasts*. They represent the best estimates that we can provide for a range of anticipated changes in greenhouse gases. Note also that precipitation projections are generally more uncertain than temperature.

The following projections are for the mid-21 st century (2050s) relative to the 1971-2000 average

- Mean annual temperatures in MA are expected to be 2.8-6.2°F warmer than over recent decades.
- There will be 7-26 more days per year when daily maximum temperatures exceed 90°F.
- There will be 19-40 fewer days when minimum temperatures fall below 32°F (a decline of 13-27%).
- Total heating degree days will be 11-24% lower, but cooling degree days will be 57-150% higher.
- Growing degree days will be 23-52% higher, and the growing season will be longer.
- Total annual precipitation will increase by 2-13%, and winter precipitation will increase by up to 21%.
- While winters are projected to get wetter, more precipitation will fall as rain or freezing rain, rather than snow because of the increase in temperatures.

Variable	Observed value 1971 - 2000 average	Change by 2050s	Change by 2090s
Annual average temperature	47.5 °F	Increase by 2.8-6.2 °F	Increase by 3.8-10.8 °F
Number of days per year with daily Tmax > 90°F	5 days	Increase by 7-26 days	Increase by 10-63 days
Number of days per year with daily Tmin < 32°F	146 days	Decrease by 19-40 days	Decrease by 24-64 days
Heating degree- days per year	6839 Degree-Day °F	Decrease by 773-1627	Decrease by 1033-2533
Cooling degree- days per year	457 Degree-Day °F	Increase by 261-689	Increase by 356-1417

Temperature

Variable	Baseline (1971-2000)	2030s (2020-2049)	2050s (2040-2069)	2070s (2060-2089)	2090s (2080-2099)
Annual average temperature	47.5 °F	+2.1 to +4.2[1,2]	+2.8 to +6.2	+3.6 to +8.9	+3.8 to +10.8
# of days/year with Tmax > 90°F	5 days	9 to 19	12 to 31	14 to 51	15 to 68
# of days/year with Tmin < 32°F	146 days	118 to 135	106 to127	92 to 124	82 to 122
Heating degree-days °F/year (Base 65 °F)	6839	-567 to -1159	-773 to -1627	-907 to -2157	-1033 to -2533
Cooling degree-days °F/year (Base 65 °F)	457	+198 to +395	+261 to +689	+306 to +1080	+356 to +1417
Growing degree-days °F/year (Base 50 °F)	2344	+393 to +759	+531 to +1210	+617 to +1869	+702 to +2347

**The values cited above are based on the 10th and 90th percentiles across 28 projections, so they bracket the most likely scenario. These are estimates based on model scenarios and are not forecasts*

By mid-21st Century

- Mean annual temperatures in MA are expected to be 2.8-6.2°F warmer
- There will be 7-26 more days per year when daily maximum temperatures exceed 90°F
- There will be 19-40 fewer days when minimum temperatures fall below 32°F (a decline of 13-27%)
- Total heating degree-days will be 11-24% lower, but cooling degree-days will be 57-150% higher
- Growing degree-days will be 23-52% higher, and the growing season will be longer

**Relative to the 1971-2000 average*

Temperature

Photos: 2016 Firefighting on Cape Cod – MA National Guard

Photo: Frog Pond, Boston Common – James Byrum

Precipitation

Variable	Baseline (1971-2000)	2030s (2020-2049)	2050s (2040-2069)	2070s (2060-2089)	2090s (2080-2099)
Total annual precipitation	47 in	+0.1 to +4.7	+0.9 to +6	+1.6 to +7.6	+1.2 to +7.3
# of days/year with precipitation > 1 in	7 days	0 to 9	0 to 10	8 to 10	8 to 11

**The values cited above are based on the 10th and 90th percentiles across 28 projections, so they bracket the most likely scenario. These are estimates based on model scenarios and are not forecasts*

By mid-21st Century

- Total annual precipitation will increase by 2-13%, and winter precipitation will increase by up to 21%.

- While winters are projected to get wetter, more precipitation will fall as rain or freezing rain, rather than snow because of the increase in temperatures.

**Relative to the 1971-2000 average*

Precipitation

Photo: Heavy rain event in Lawrence – FEMA/Jocelyn Augustino

Photo: 2015 Winter Storm Marcus-Neptune – MA National Guard

Hydrology – Coming Soon…

Goal: Provide data to support the decision-making process related to estimating future frequency and return periods for floods and changes on low-flow statistics for rivers and streams.

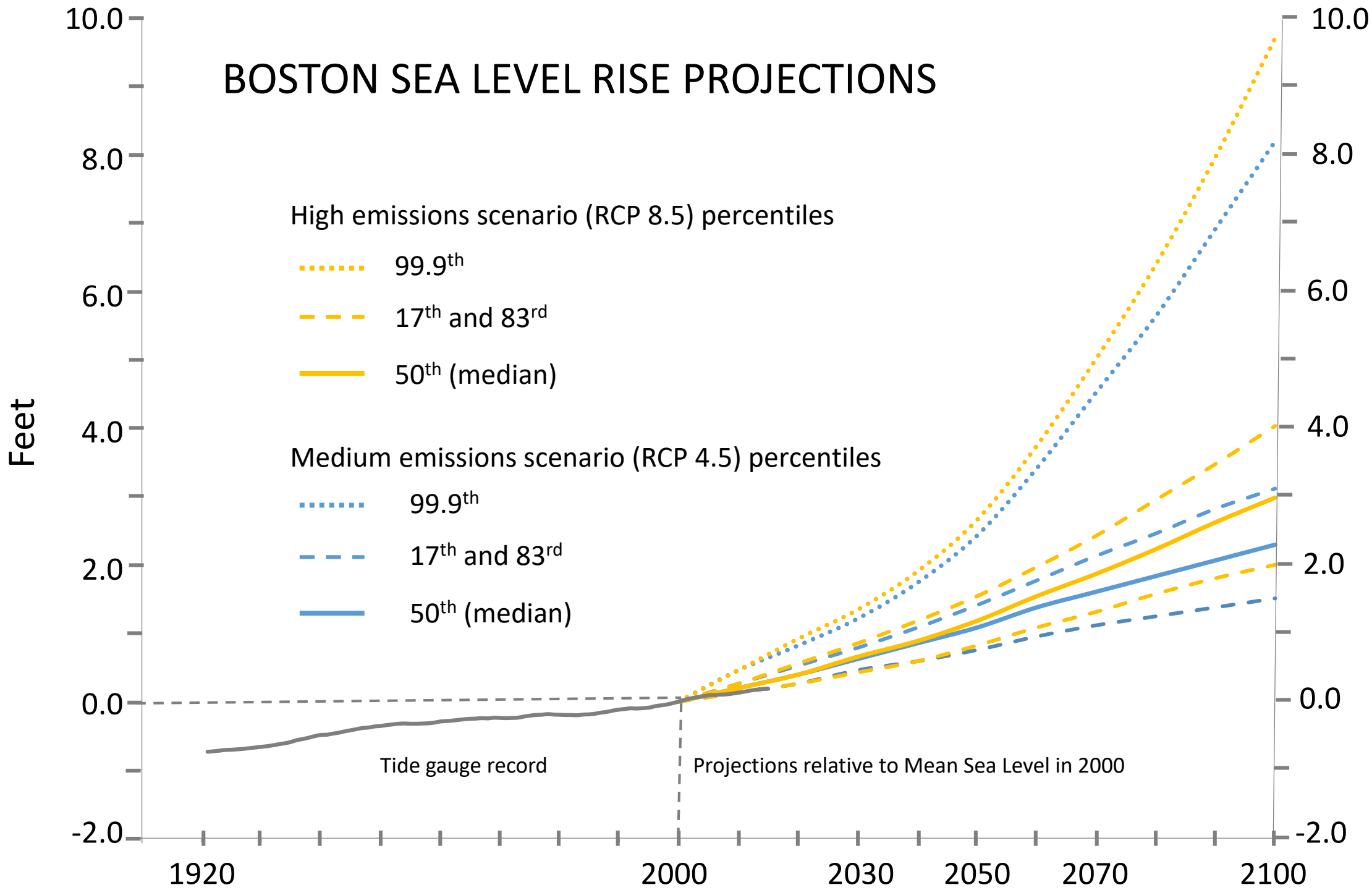
Data & Metrics Requested: Projected streamflows based on hydrological model outputs for the 2030s, 2050s, 2070s, and 2090s for the medium (RCP 4.5) and high (RCP 8.5) emissions scenarios.

- *Flood Events* – return period of 1 year, 10 year, 20 year, 50 year, and 100 year flood events and,
- *Drought Events* – calculation of low flow events associated with:
  - the 7-day 10 year low flow, number of days per month that will be below the historic monthly average,
  - number of days per month that will be below the 25 percentile monthly historic average,
  - changes in the 30-day and 60-day cumulative summer flows, and
  - the timing and magnitude of spring run-off.

Hydrology

Photo: Witham St, Gloucester - CZM

Photo: 2006 Methuen – FEMA/Jocelyn Augustino


BOSTON SEA LEVEL RISE PROJECTIONS
Feet
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
High emissions scenario (RCP 8.5) percentiles
99.9th
17th and 83rd
50th (median)
Medium emissions scenario (RCP 4.5) percentiles
99.9th
17th and 83rd
50th (median)
Tide gauge record
Projections relative to Mean Sea Level in 2000
1920
2000
2030
2050
2070
2100

BOSTON		Median (50th percentile) 50 % probability SLR exceeds	Likely Range (17th-83rd percentiles) 67% probability that SLR is between…	99.9th Percentile Value Extremely unlikely that SLR will exceed
Emissions Scenarios: Med (RCP 4.5); High (RCP 8.5)		Feet (relative to Mean Sea Level in 2000)		
2030	Med	0.6	0.5-0.8	1.2
	High	0.7	0.4-0.9	1.3
2050	Med	1.1	0.8-1.4	2.4
	High	1.2	0.8-1.5	2.7
2070	Med	1.6	1.1-2.1	4.5
	High	1.9	1.3-2.4	5.0
2100	Med	2.3	1.5-3.1	8.2
	High	3.0	2.0-4.0	9.7

Sea Level Rise

Photo: King Tide, Boston Harbor - CZM

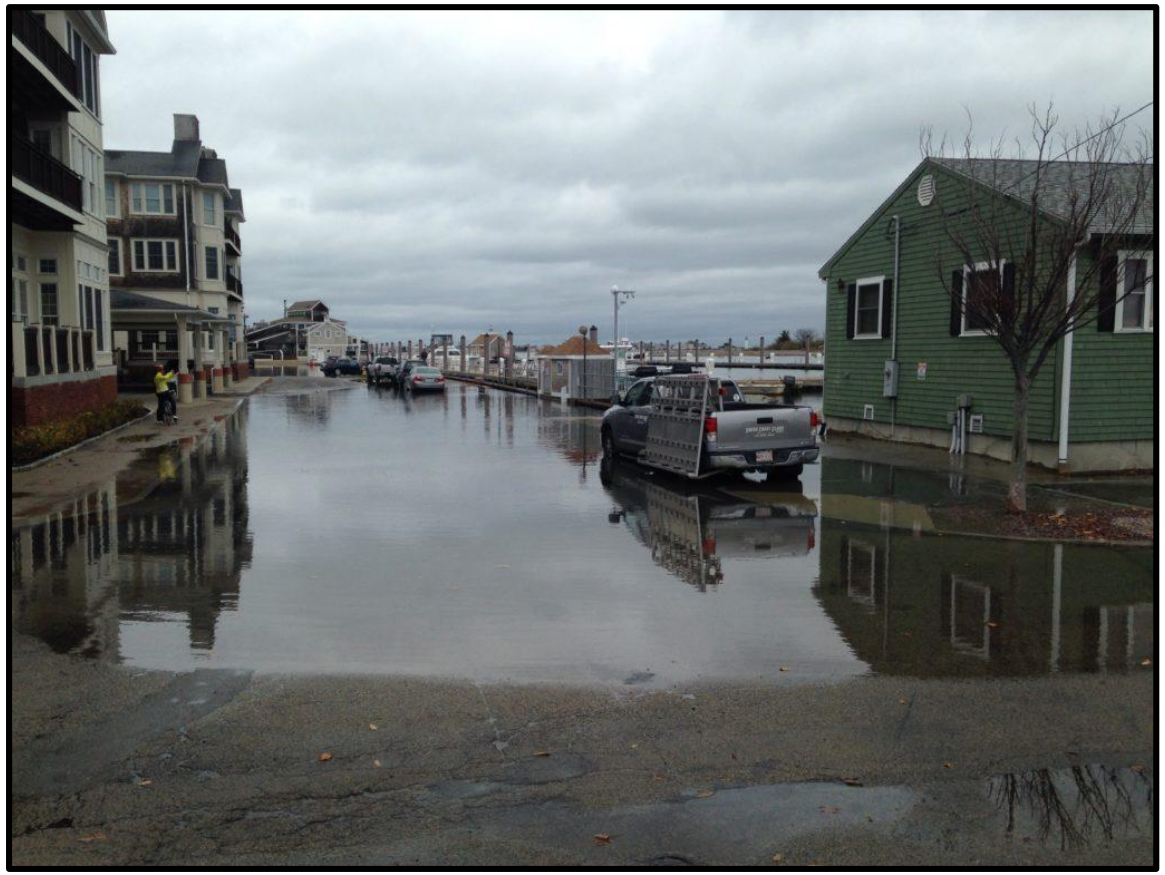


Photo: King Tide, Scituate - CZM

Variables		*By Mid-century*	*By End of Century*
TEMPERATURE	Annual average temperature **increase** by	2.8-6.2°F (50.3-53.7 °F)	3.8-10.8 °F (51.3-58.3 °F)
	# of days per year with daily maximum temperature > 90°F **increases** by	7-26 days (up to 31 days total)	10-63 days (up to 68 days total)
	#of days per year with a daily minimum temperature < 32°F **decreases** by	19-40 days (down to 106 days total)	24-64 days (down to 82 days total)
	Total Heating degree- days per year	11-24% lower	15-37% lower
	Total Cooling degree- days per year	57-150% higher	78-310% higher
	Growing degree-days per year	23-52% higher	30-100% higher
PRECIPITATION	Total annual precipitation will **increase** by	0.9-6 inches (up to 53 inches total)	1.2-7.3 inches (up to 54.5 inches total)
	Number of days > 1 inch will **increase** by	0-3 days (up to 10 days total)	1-4 days (up to 11 days total)
HYDROLOGY	Projected streamflows based on hydrological model outputs for the medium and high emissions scenarios … COMING SOON		
SEA LEVEL RISE (Boston, relative to MSL in 2000)	Median	1.1-1.2 feet	2.3-3.0 feet
	Likely range that SLR is between…	0.8-1.4 feet (medium emissions scenario) and 0.8-1.5 feet (high emissions scenario)	1.5-3.1 feet (medium emissions scenario) and 2.0-4.0 feet (high emissions scenario)
	Extremely unlikely that SLR will exceed	2.4-2.7 feet	8.2-9.7 feet

How to use climate data in vulnerability

Community Resilience Building

WORKSHOP GUIDE