

# Climate of Massachusetts

## Introduction

This publication consists of a narrative that describes some of the principal climatic features and a number of climatological summaries for stations in various geographic regions of the State. The detailed information presented should be sufficient for general use; however, some users may require additional information.

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The editor of this publication expresses his thanks to those State Climatologists, who, over the years, have made significant and lasting contributions toward the development of this very useful series.

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## **Climate of Massachusetts**

Topographic Features- The Commonwealth of Massachusetts occupies 8,257 square miles, about one-eighth of New England's total land area. About half of the State is forestland. It is the most populous New England State, with just over six million residents. About three million people reside within a 50 mile radius of Boston (inside Interstate 495). Most of the State lies north of the 42<sup>nd</sup> parallel of latitude. Its north-south width is approximately 50 miles, except 100 miles in the eastern, Atlantic coast, portion. The east-west extension is barely 150 miles, excepting "the Cape". This is the familiar name of the long arm of land which reaches around the southern and eastern shores of Cape Cod Bay. Including the Cape, the State is nearly 200 miles in length. Although the Massachusetts coastline is only about 192 miles in length, the Atlantic Ocean "tidal shoreline" covers over 1,519 miles, which provides the State with numerous fine harbors.

The land surface is rather mountainous (by East Coast standards) along the western border and generally considered rolling hills elsewhere. However, the Cape and some other sections of the coastal plain consist of flat land with numerous marshes and some small lakes and ponds. In the west, Mt. Greylock rises 3,487 feet above sea level, the highest peak in Massachusetts. The elevation west of the Connecticut River Valley is generally over 1,000 feet. Forty-six peaks rise above 2,000 feet. Most of central Massachusetts lies between 500 and 1,000 feet, while eastern Massachusetts and the Connecticut River Valley are generally less than 500 feet.

Massachusetts has typical New England soil that is rocky, hard-packed and generally poor for agriculture across especially the eastern half of the commonwealth. However, from the Connecticut River Valley westward to the rolling hills of the eastern Berkshires, the soils are much more fertile and thus conducive to successful agricultural activities.

Climatic characteristics of Massachusetts include: changeableness in the weather, large ranges in temperature, both daily and annual, great differences between the same seasons in different years, equable distribution of precipitation (no wet or dry season), and considerable diversity from place to place. The regional climatic influences are modified in Massachusetts by the varying distance from the relatively mild ocean waters, elevation and type of terrain. These modifying factors divide the State into three climatological divisions (Western, Central and Coastal). Detailed discussion of each division follows.

Massachusetts lies in the "prevailing westerlies," the belt of generally eastward air movement, which encircles the globe in the mid-latitudes. Embedded in this circulation are extensive masses of air originating in more northerly or southerly latitudes and interacting to produce frequent significant storm systems. Relative to most other sections of the country, a large number of such storms pass over or near to Massachusetts. The majority of air masses affecting this State belong to three types: cold, dry air pouring down from subarctic North America; warm, moist air streaming up on a long journey from the Gulf of Mexico, and subtropical waters (Gulf Stream) to the east; and cool, damp air moving in from the North Atlantic. Because the atmospheric flow is usually offshore, Massachusetts is influenced more by the first two types, than it is by the third type. In other words, the adjacent Atlantic Ocean constitutes an important

modifying factor, especially along the immediate coastal plain, but does not dominate the Massachusetts climate.

The procession of contrasting air masses and the relatively frequent passage of storm circulations bring about a roughly twice-weekly alternation from mainly fair to cloudy or stormy conditions. These fluctuations are often attended by abrupt changes in temperature, moisture, sunshine, wind speed and direction. There is usually no regular or persistent rhythm to this sequence, and it can be interrupted by intervals during which the weather patterns continue stable for several days or even several weeks on certain occasions. Massachusetts' weather, however, is cited for variety rather than monotony. Changeability is also one of the features on a longer time-scale. That is, the same month or season will often exhibit varying characteristics over the years, sometimes in close alternation, sometimes arranged in similar groups for successive years. A "normal" month, season, or year is indeed the exception, rather than the rule.

The basic climate, as outlined above, obviously does not result from the predominance of any single controlling weather regime, but is rather the integrated effect of a variety of weather patterns. Hence, "weather averages" in Massachusetts usually are not sufficient for important planning purposes without further climatological analysis. For convenience, the State has been divided into three climatological divisions. The Western Division contains about one-fourth of the State, which includes the low mountains of the Berkshire Hills and portions of the Taconic Range, which extends eastward from New York State and the southern fringe of Vermont's Green Mountains. Second, a strip roughly 10 to 20 miles wide along the Atlantic Coast comprises the Coastal Division. The remainder is known as the Central Division. It covers more than 50 percent of the State and extends from the Pioneer Valley region just west of the Connecticut River eastward across the rolling hills of Worcester County into the western suburbs of the heavily populated eastern Massachusetts cities. This Central Division also incorporates the southern tier of New Hampshire's White Mountains (known as the Monadnock region).

Temperature- The average annual temperature ranges from about 46 degrees Fahrenheit ( $^{\circ}$  F) in the Western Division to 49 in the Central, and to around 50 in the Coastal Division. Averages can vary considerably within these divisions due to elevation, topography and other environmental aspects including urbanization; each can have a significant effect. The highest temperature of record is  $107^{\circ}$  F on August 2, 1975, at New Bedford (southern Bristol County) and Chester (northern Worcester County). The lowest of record was  $-35^{\circ}$  F on January 12, 1981, again at Chester.

Summer temperatures are delightfully comfortable for the most part, and summer averages are quite uniform all across the State. Long-term averages for July range from 67 to  $70^{\circ}$  F in the Western Division and in the islands off the coast, from 70 to 74 elsewhere. Hot days, those with maxima of  $90^{\circ}$  F or higher, generally average from five to 15 per year. The number of  $90^{\circ}$  F days varies considerably from place to place, but also from year to year. They can range from only a few days in cool summers to 25 or more in hot summers. Record number of 90 or higher days was experienced during summer of 1983 when 20 - 30 days were observed across the State. The Cape and offshore islands are exceptions, averaging less than one day with a reading of 90 or higher per year. However, on August 2, 1975, even Cape Cod and Nantucket Island reached a record  $100^{\circ}$  F. Average temperature data may mask marked differences in day to night changes. Islands and the Cape may have only a daily range of but 10 to  $15^{\circ}$  F, but inland areas may vary

20 to 30 degrees. The diurnal range can reach 40 to 50° F during cool, dry weather in valleys and marshes. Frost may even be a threat in warmer months in these susceptible areas.

Winter average temperatures can vary much more from place to place than in summer. They range in the low 20s for January in the Western Division, in the middle to upper 20s in the Central, and near 30° F in the Coastal Division. The diurnal temperature range in winter, though less than in summer is still greater inland than along the coast. Days with subzero readings are rare on offshore islands. They average only a few per year near the coast, but increase in number of occurrences farther inland from five to 15 annually.

The growing season for vegetation subject to injury from freezing temperatures averages from 120 to 140 days in the Western Division, 140 to 160 days in the Central, and 160 to 200 days in the Coastal Division. Exceptions include bogs and other easily frosted areas, which usually have a much shorter season. The average date of the last freezing temperature in spring ranges from the latter part of May at frost-favored places inland to as early as mid-April at Nantucket. Some stations have reported their last freezing temperature well into June in an unusually cold spring. Concurrently, some inland areas have experienced their first frost as early as Labor Day, although generally the freeze-free season usually ends in mid- to late October.

Precipitation- Massachusetts is fortunate in having its precipitation rather evenly distributed through the year. In this respect, the State is located in one of the relatively few areas of the world that does not have “rainy” and “dry” seasons. Storm systems are the principal year-round moisture producers. But in the summer, when this type of activity ebbs, bands or areas of thunderstorms or showers tend to make up the difference. Though brief and often of small coverage, the thunderstorms produce the heaviest local rainfall, and sometimes cause minor washouts of roads and soil erosion. Variations in monthly totals are extreme, ranging from no measurable precipitation (Boston, March 1915 recorded only a “Trace”) to more than 25 inches (Westfield in August 1955 was deluged by 26.85 inches with Hurricane Diane contributing 20 of those inches). Such large fluctuations are rare, however, as most monthly totals fall in the range of two to six inches. As prolonged droughts are infrequent, irrigation water is usually available during fairly common shorter dry spells of many summer seasons. However, every couple of decades, much of the State does experience prolonged drought conditions. The most significant period extended from summer 1964 through the fall of 1966 and placed great stresses on Massachusetts’ water systems. Drought conditions began in spring of 2001 and persisted through summer 2002.

Total precipitation averages from 40 to 50 inches per year at stations having long-term records. Local influences cause considerable variation in the totals from station to station. Division averages vary but little. The Coastal Division (the driest) receives annually only about two inches of precipitation less than the Western Division (the wettest). Storms of a coastal nature make the Coastal Division the wettest in the winter season. Much of the winter precipitation is in the form of rain or wet snow there. Occasionally, freezing rain occurs to coat exposed surfaces with troublesome ice. Inland sections get the heavier rain in the warm season due, principally, to the higher frequency and greater intensity of convective showers and thunderstorms. The more mountainous character of the Western Division is an additional cause for the heaviest annual totals being recorded in that part of the State. As an illustration of

variation in a short distance, consider the normal annual totals for Boston and Blue Hill, less than 12 miles apart. Boston, near sea level and on the coast, has 43 inches. Blue Hill, at about 600 feet higher in elevation, and not on the immediate coast, has 51 inches.

Measurable amounts of precipitation fall on an average of one day in three. Frequency is higher in upland districts. For example, Pittsfield averages four days out of 10. As much as six inches of rain in 24 hours is a rare occurrence in the State. However, Westfield recorded 18.15 inches in 24 hours during Hurricane Diane in August 1955.

Average annual amounts of snowfall increase rapidly from the coast westward. About 25 to 30 inches fall over Cape Cod with 60 to 80 inches recorded in the western portions of the State. Topography has a marked influence on snowfall, causing significant variation even over short distances. As an example, consider Pittsfield located on the western side of the Berkshires, and Greenfield, less than 40 miles distance, but on the eastern side. A storm from the west gives Pittsfield much more snow than Greenfield, but a "Nor'easter" will give Greenfield the heavier accumulation. The average number of days with one inch or more of snowfall varies from about eight to 15 in the Coastal Division, to mostly 20 to 30 in the Western Division. Most winters will have at least one snowstorm of five inches or more. These storms tax snow removal facilities and delay transportation. The heaviest amount recorded in 24 hours was 28.2 inches at Blue Hill Observatory in Milton on February 24 - 25, 1969. This storm, however, dumped a whopping 38.7 inches over its 109-hour lifetime, and produced drifts five to 10 feet across eastern Massachusetts. Meanwhile, the City of Boston's greatest snowstorm was the Blizzard of February 6 - 7, 1978 with 27.1 inches. Boston's heaviest 24 hour storm was the "April Fools' Day" storm of 1997, when 25.4 inches was recorded. Variations in snowfall, both seasonal and from place to place cover a wide range. Amounts sometimes are less than four inches for an entire season on Cape Cod to well over 100 inches in many Central and Western Divisions. Even Boston during winter of 1995-1996 measured 107.6 inches and Blue Hill Observatory received 144.4 inches for their greatest winter season snowfalls of record. However, it is extremely interesting to note that since Blue Hill began measuring snow uninterrupted in 1885, the average for this entire period and that for the current 30 year normal period (1971 - 2000) are both very close to 60 inches for season.

The average number of days with snow on the ground also increases from shore areas to the interior and with rising elevation. There is little lasting snow cover in the coastal lowlands. In the Western Division the cover usually extends well into spring. Maximum snow depths usually occur between mid-February and mid-March. Water stored in the snow over the watersheds makes for an important contribution to the annual water supply. Boston's average number of days with an inch or more of snow cover is about 35. However, in the extremely heavy and prolonged snow fall season of 1947 - 1948 Boston experienced 83 days with an inch or more of snow cover.

The Connecticut River, the largest river system in New England, drains most of the western half of the State. Some of the Connecticut River's major tributaries include the Westfield, the Deerfield and Miller rivers. Second in size in Massachusetts is the Merrimack River which extends from central New Hampshire southward across northeastern Massachusetts and flows out into the Atlantic Ocean. Third in size is the Housatonic River which drains the western

portions of the Commonwealth southward across Connecticut. The fourth in size is the Charles River and its tributaries, the Mystic and Neponset. These drain eastern Massachusetts into Massachusetts Bay just east of Boston. The rest of the rivers are relatively small, most of them with headwaters in the State and flowing southward through the states of Connecticut and Rhode Island, or directly to the Atlantic Ocean in the east and southeast. Streams rise quickly in the highlands, and are relatively slow rising in the flat coastal areas in the east. Flooding occurs most often in spring, caused by the combination of very heavy rains which exacerbate melting of unusually deep snow covers.

The Connecticut River shows a regular annual rise as the result of the melting of high elevation snow in northern and central New England, but extensive flooding does not usually occur unless the rise is accompanied by heavy rains. High flows and major floods can occur from very heavy rainfall alone, but this happens much less frequently. Some of the severest floods, caused by heavy rains, are usually those associated with tropical systems or their remnants occurring in late summer and fall seasons, normally the low water time of year due to more spotty precipitation.

The percentage of possible sunshine averages from 50 to 60 in most sections. Higher elevations are cloudier, reducing the Berkshire average to between 45 to 50 percent. The average annual number of clear days is between 90 and 120 for most of the Commonwealth of Massachusetts, with generally less in the Berkshires. Heavy fog (visibilities restricted to ¼ mile or less) is frequent and sometimes persistent south of Cape Cod. Nantucket Island has heavy fog on nearly one day in four. Fog frequently diminishes along the Massachusetts coast north of the Cape. Duration of fog also diminishes inland. But the shorter duration heavy ground fogs of early morning occur frequently in climatically susceptible locations inland. These, plus the fewer occurrences of other heavy fog, produce a frequency that also approaches one day out of four in many locations.

The prevailing wind, on a yearly basis, comes from a westerly direction. It is more northwesterly in winter and southwesterly in summer. Topography has a strong influence on the prevailing direction. Areas along the Connecticut River, for example, may have prevailing north or south winds, which parallel the direction of the valley at any specific location. Along the coast in spring and summer, the sea breeze is very important. These onshore winds blowing from the cool ocean may come inland for 10 miles or so. They tend to retard the spring growth, but they are pleasantly cooling during the heat of summer. Boston is famed for its sea breeze along with its baked beans and codfish. The easterly winds are most frequent in the month of May. Coastal storms or “Nor’easters” are one of the Commonwealth’s most serious weather hazards, which often generate very strong winds and heavy rain and/or snow. These powerful storms can produce high tides that cause damage to coastal installations. In winter, these storms produce the heaviest snowfalls, often up to a foot or more. Occasionally in late summer or fall, a storm of tropical origin affects the Commonwealth of Massachusetts. Often these tropical systems will be similar to the “Nor’easters” described above, but those that retain full hurricane force often cause widespread and severe damage. Maximum loss of life and property is usually concentrated along the shore, though hurricane winds and associated tropical rains may also severely damage and create extensive flooding inland areas. Storms of tropical origin “seriously affect” Massachusetts about once every four or five years, on the average. Two such storms in the same year may be expected only once every 10 to 15 years.

Tornadoes are not a common phenomena in Massachusetts, yet, on a per unit area basis the Commonwealth ranks fairly high among the 50 states. An average of three tornadoes occurs in the State each year. The disastrous "Worcester Tornado" of June 9, 1953, serves as a reminder that the Commonwealth is not immune to these extremely violent and dangerous storms. Fortunately, most tornadoes in Massachusetts are generally very small and thus usually take a small toll of life or property. Four out of five tornadoes occur between May 15 and September 15, and about 75 percent between 2:00 p.m. and 7:00 p.m. The peak month is July and the peak time of occurrence is 2:00 p.m. to 5:00 p.m. The chance of a tornado striking any given spot is extremely small.

Climate and the Economy- Activities in Massachusetts are profoundly influenced by the climate. The usually adequate precipitation favors tree growth. About half of the Commonwealth is forest-covered. Forests are a major scenic attraction, especially the fall foliage. They are effective in preventing erosion and floods. Forests also support important lumbering and wood-processing industries.

Climate is a significant factor in the Commonwealth's agriculture. It favors the production of high value specialized crops. Indeed, Massachusetts ranks very high in the nation in cash receipts per acre from farm marketing. Cranberries, which require exacting climatic and soil conditions, thrive in the southeastern coastal area, where a large portion of the nation's cranberry supply is grown. Dairying and poultry raising find favorable climate and convenient markets. Apples are the most prolific of the tree fruits and the development and production of quality produce is an important commercial pursuit. Maple syrup is produced in the Berkshire area. In the central and eastern portions of the State, numerous commercial truck gardens are cultivated.

Massachusetts is fortunate in that it usually enjoys ample precipitation, runoff and ground water supplies. These are indispensable to the Commonwealth's industrial production, which includes electronic and computer products, specialized machinery, electrical equipment and appliances, transportation equipment, fabricated metal products, paper, plastic and rubber products, textiles and fabrics, food and kindred products, fishing and marine fresh and frozen products, as well as a great diversity of smaller industries.

The climate is particularly favorable to another major industry, the tourist and vacation trade. This business now accounts for several billion dollars annually. Much of this is concentrated in the summer, when pleasant temperatures prevail at both seaside and mountain resorts. Fall leaf coloration draws visitors from afar. The Mohawk Trail which parallels the Massachusetts and New Hampshire border from northern Worcester County westward (for about 63 miles) across northern Berkshires to the New York State border, was constructed in 1914 and was the first highway specifically designed for scenic viewing via the automobile in the nation. Winter sports have developed, particularly in the Berkshires, but also in the higher elevation areas of Essex, Franklin, Middlesex, Norfolk and Worcester Counties. Ocean cruises departing several times daily during the vacation season from a number of locations from Cape Ann to Boston to Cape Cod and the Islands of Martha's Vineyard and Nantucket are also increasing in popularity. These cruises offer opportunities for spectacular coastal sightseeing, fishing, photography and whale watching. Massachusetts' numerous state parks, forests, inland waterways and coastal

beaches also provide a great draw to vacationers seeking interesting hiking and camping areas. One of East Coast's great hiking areas is the 2,500 mile long Appalachian Trail from Maine to Georgia and it also traverses Massachusetts for about 90 miles over Mt. Greylock reservation.

In summary, the climate of Massachusetts contributes greatly to its prominence as an industrial, agricultural and vacation State. It is a rich, natural asset and very favorable to further economic development.