Climate of Florida

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.

The National Climatic Data Center (NCDC) located in Asheville, North Carolina is authorized to perform special services for other government agencies and for private clients at the expense of the requester. The amount charged in all cases is intended to solely defray the expenses incurred by the government in satisfying such specific requests to the best of its ability. It is essential that requesters furnish the NCDC with a precise statement describing the problem so that a mutual understanding of the specifications is reached.

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The Means and Extremes of meteorological variables in the Climatography of the U.S. No.20 series are recorded by observers in the cooperative network. The Normals, Means and Extremes in the Local Climatological Data, annuals are computed from observations taken primarily at airports.

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 Florida

Physical Features- Most of Florida consists of a low, 400 mile long peninsula, part of the nation's southeastern coastal plain which runs from Texas to Virginia. Although the highest elevation in Florida is only 345 feet above sea level, there is considerable local relief along its border with Alabama and southwestern Georgia, as well as along the spine of the peninsula. Within these two hill regions there are many places where, within a square mile, there is as much as a 150 to 200 feet difference between the highest and lowest elevation. The surface of most of the State is covered by infertile sand or loam, often with a hardpan layer beneath which restricts water absorption. The surface sands and loams rest upon a thick layer of soluble limestone that has been greatly eroded. Within much of the State, numerous limestone features such as sinkholes, underground rivers, and large volume springs may be found. In volume of discharge, Florida has some of the nation's largest springs. Also, within its limestone foundation are found several large aquifers, the most important of which is the Floridan, said to contain as much water as the entire Great Lakes system. Unfortunately, the water in the aquifer becomes saline under the southern half of the peninsula and is of little economic value.

Lakes, both large and small, are scattered throughout the State and are especially concentrated in the Orlando area. The State's largest, Lake Okeechobee, is also the largest lake entirely within one state. The origin of Lake Okeechobee is in dispute, but most believe that it was formed in recent geological history beneath a shallow sea.

Florida has rivers, but because of its peninsular shape, except for the St. Johns, most are short. Many are subterranean for part of their course. Since much of the peninsula is flat, floodplains of these rivers often are very broad and swampy. North Florida rivers flow out of Alabama and Georgia. The volume of discharge of the Apalachicola is among the greatest of any that enter the ocean east of the Mississippi River. The southern one-third of the peninsula is both low and almost completely flat. A large portion is made up of the Everglades, the so-called "River of Grass".

In an effort to popularize its tourist industry, Florida was named "The Sunshine State". However, the arid part of the western United States has many more hours of sunshine during the year than Florida. During the winter, however, Florida has approximately double the amount of hours of sunlight than the states in the northeastern quadrant of the nation, and far milder temperatures. Mild and sunny winters are Florida's greatest physical asset, and without these weather elements it would be far less attractive to visitors and individuals relocating. Its agriculture is heavily based on winter warmth, and it supplies not only citrus, but also winter vegetables.

Most of the State lies within the extreme southern portion of the Northern Hemisphere's humid subtropical climate zone, noted for its long hot and humid summers and mild and wet winters. The southernmost portion of the State is generally designated as belonging to the tropical savanna region, a climate that it shares with most of the Caribbean islands. Sometimes also called the wet and dry tropics, tropical savanna precipitation is highly concentrated in the

warmer months. The chief factors that govern Florida's climate are latitude, land and water distribution, prevailing winds, storms, pressure systems and ocean currents. Although no place in Florida is far from sea level, during the winter altitude can be a significant local factor in affecting temperature. Early grove owners quickly learned that the citrus trees they planted in depressions were much more susceptible to freezes than those planted on higher ground.

Temperature- Mean temperatures during Florida's coldest month (January) range from the lower 50s in the north to the upper 60s in the south. In the hottest month (usually July, but in places August) it is almost the same throughout the entire State, between 81 and 83 degrees Fahrenheit (° F). Every day of the year the sun reaches Florida at a higher angle than farther north, and consequently its power to heat is greater. For example, in New York City during January the rays of the sun reach a maximum angle during the day of about 26 degrees above the horizon, while in Miami the angle is about 40 degrees. The sun's rays at their highest, around June 21st, strike New York at about a 65° angle, while in Miami the sun is almost directly overhead.

In the winter, maximum temperatures throughout Florida are balmy compared with those of northern states. The mean maximum temperature in northern Florida during January is about 65 while south of Lake Okeechobee it is approximately 76° F. Even in northern Florida between December and February on average the daily maximum temperature rises above 75° F between 20 and 30 percent of the time and south of Lake Okeechobee the percentage exceeds 75 percent. Large water bodies, particularly the Atlantic Ocean and the Gulf of Mexico, but to a lesser degree large lakes like Okeechobee and Apopka, are the major modifiers of the State's temperature during all seasons, but particularly in the winter. Maximum temperatures in the winter on the peninsula, particularly the southern half, tend to be slightly higher on the Atlantic than the Gulf Coast, in part because on the east coast winds come off of the Atlantic and pass over the relatively warm Gulf Stream. Winter prevailing winds on the west coast are from the land, which is often cooler at that time of year than the water of the Gulf of Mexico.

Average maximum temperatures in the State begin to reach into the upper 80s in April, first in the interior of the peninsula. From there, these high temperatures spread out towards the coasts. The spatial advance of the "Dog Days of Summer" is retarded near the coast by sea breezes, which are most powerful during the summer. Average maximum temperatures rise above 88° F on the west coast during May and along most of the east coast in June. At times, helped by the easterly trade winds, sea breezes can reach more than 25 miles into the interior.

Miami-Dade County provides an excellent example of how the ocean, and specifically the sea breeze, modifies temperature. There are three weather stations close to each other; Miami Beach which is on the shore, Miami International Airport that is eight miles in the interior, and 40-Mile Bend, about 40 miles from the coast. The eight miles between Miami Beach and Miami International makes a significant difference in both average maximum and minimum temperatures. Throughout the year, maximum temperatures are at least two degrees higher at the airport, slightly more in the summer than the winter. Minimum temperatures are two to three degrees higher at the Miami Beach station than that at the airport during the colder months, but only one degree higher during the warmer months. 40-Mile Bend's maximum temperature is higher than that of the airport in all months, and the minimum temperatures is lower.

Florida's summer high temperatures can be extremely enervating, although air conditioning has made life more bearable. In an average year, Florida experiences far fewer days when temperatures reach above 100° F than in most other states. However, due to the fact that Florida is among the wettest states in the nation and its atmosphere is so humid, its summers are among the most uncomfortable. When humidity is high, evaporation of perspiration from the skin is inhibited, and one feels hotter than if humidity were lower. In Florida, during the warmest time of the day, relative humidity throughout the State averages in the 50 and 60 percent range. During the cooler hours it is higher, in the 70 and 80 percent range. The heat index, sometimes called the sensible temperature, takes into account both relative humidity and actual temperature. During the height of the summer, when most of the time the temperature is in the low 90s in mid-afternoon, it feels about 10° F higher than the actual temperature. Fortunately the difference between the actual and sensible temperature declines rapidly with a drop in the actual temperature and is negligible below 80° F. Consequently, except in the summer, humidity is not a major inconvenience. Compared to the northern states, during the year Florida has a far greater number of days where the maximum temperature falls within the comfort range of between 70 and 85° F. In the northern part of the State the number of days between 70 and 85 is between 125 and 150 days, and it rises above 200 days in the Tampa Bay area and along the Atlantic Coast from Melbourne southward. In the interior of the peninsula, it is between 175 and 200 days.

During the winter North Florida is occasionally invaded by massive cold fronts that originate far to the north. Although the temperature within these air masses rises significantly during their passage to Florida, they are capable of bringing intense cold to the State. The State's record minimum temperature was set in February 1899 when Tallahassee experienced -2° F. Once cold waves move onto the peninsula the relatively warm waters of the Atlantic and the Gulf of Mexico exert their influence, and the airmass' temperature rises. Nonetheless, temperatures in the low 20s have been experienced in the Everglades south of Lake Okeechobee. Not a year goes by when there is not some damage to the citrus or vegetable crop somewhere in the State. Severe freezes in the 19th and 20th centuries gradually drove the center of citrus production southward from the Orlando area to southern Polk County. Winter vegetable growers have long concentrated their production south of Lake Okeechobee, where they gamble each year that their crop will be spared a severe blow from freezes.

Precipitation- Florida is only exceeded by Louisiana as the wettest state in the nation. On average, approximately 54 inches of precipitation falls on the State each year, one inch less than in Louisiana. Although snow falls periodically in Florida, and in North Florida, on exceedingly rare occasions, has accumulated to a depth of several inches, almost all precipitation is in the form of rain. Most of the rain that falls on Florida is convective. Although it is often assumed that there are many more days of precipitation in Florida than in states farther north, this is not true. Throughout most of the states east of the Mississippi River, including Florida, a tenth of an inch or more of precipitation falls on 70 to 80 days in an average year. Actually in Florida during an average year, rain is falling about 10 percent of the time, while around the Great Lakes it is around 20 percent. It is in the intensity of its precipitation that Florida differs from states farther north. Of the days in Florida when there is measurable precipitation, between 30 and 35 percent have accumulations of half an inch or more, compared with 15 to 25 percent in states north of the Ohio River.

The Panhandle and southeastern Florida are the wettest parts of the State. The driest portions are the Florida Keys and the offshore bar of Cape Canaveral. The Panhandle receives so much rain because it has two wet seasons, one during the winter when fronts pass through bringing rain, the other in the summer, when convective rain falls. Frontal precipitation plays an increasingly smaller role in annual precipitation the farther south one goes down the peninsula. While half of the Panhandle precipitation occurs during the hot months between May and August, in Central Florida the share rises to between 60 and 65 percent. In the Keys and the extreme southwestern peninsula it rises to over 70 percent. Coastal locations, including the Keys, receive less rain than those nearby but farther in the interior because they do not provide as good an environment for convectional heating.

The Azores-Bermuda High Pressure system exerts a powerful influence on peninsular Florida's weather during the winter. Within high pressure systems air is subsiding, and as a consequence precipitation cannot take place. The Azores-Bermuda High remains over the Sahara Desert throughout the year, but extends over Florida during the winter. As the water around the State warms in the spring, the high-pressure system over Florida weakens and the summer rains begin. Some years the influence of the Azores-Bermuda High is greater than in others, so even in extremely South Florida rain may fall during the winter.

The State's summer rainy season normally first begins in southeastern Florida in late April and then moves northward. However, it can be delayed in all or part of the State by the prolonged presence of the Azores-Bermuda High, or a high-pressure system that moves in from the Gulf of Mexico. The fall dry season begins in North Florida in September, and spreads southward, arriving in extreme South Florida in mid-November. Of course tropical storms can postpone the arrival of the dry season. Frontal rain normally begins to fall in North Florida in early November, and seldom occurs after mid-April. South of Orlando, frontal rain of the type experienced in North Florida is rare.

Summer rain is generally in the form of local thunderstorms, or thunderstorms that form in long squall lines created when hot humid air from the Atlantic Ocean converges with equally hot and humid air from the Gulf of Mexico. Whatever the cause of this convective activity, thunder clouds form during the morning, and brief but heavy periods of rain usually follow during the afternoon. Since summer rain in Florida is so dependent upon air being heated by the earth's surface, a large share of the rain occurs during the daylight hours, especially in the afternoon. Florida, especially in the center of the State, experiences around 85 thunderstorms each year. The State usually leads the nation in lightning deaths due to the large number of people involved in outdoor activities such as swimming, boating and golfing.

A surprisingly large share of Florida's precipitation falls during periods of torrential rain, which here is defined as 3 inches or more within a 24-hour period. For nearly 29 years Florida held the national record for the greatest amount of rain to fall during a 24-hour period. On September 5, 1950 a hurricane drowned the village of Yankeetown, on the Big Bend coast, with 38.7 inches of rainfall. It held the record until 1979 when remnants of tropical storm Claudette dropped 43 inches of rain on Alvin, Texas in a 24-hour period. Most of these storms arrive from either the Atlantic or the Gulf of Mexico, and consequently the coasts receive a far larger share of their

annual precipitation from these storms than does the interior. On the Panhandle coast and in the Keys it is around 17 percent, but in the center of the State it falls to around five to eight percent.

Florida weather stations experience enormous variation in their annual as well as monthly precipitation. It is not uncommon for stations in some years to have half or double their normal monthly precipitation, and the variation becomes even greater when a station's monthly precipitation is compared over a long period. This is most true of the winter months in South Florida, which is normally dry, but may experience tropical disturbances even during the height of its dry season.

On an average day, Florida receives about 150 billion gallons of rainwater, as well as 25 billion gallons from rivers leaving Georgia and Alabama. It must be remembered, however, that Florida has a warm climate, and on an average day about 100 billion gallons of water evaporate from the State's surface or are transpired by plants into the atmosphere. The precipitation balance is delicate, and drought is not infrequent. Fortunately, the State has vast reserves of underground water stored in aquifers, which in normal years is adequate for urban as well as agricultural use. Nonetheless, in South Florida, during prolonged dry periods, the water withdrawn greatly exceeds that which is added, causing the water table to fall to alarmingly low levels and necessitating the implementation of water conservation regulations. Periodically the State has entertained building a pipeline from lightly populated North Florida, where water is abundant, to South Florida, but environmental issues have prevented its construction. Presently a number of desalination plants have been built between Tampa and the Keys to lessen the burden on local underground water supplies.

Meteorologists have examined the relationship between Florida climate and ENSO (El Niño-Southern Oscillation). ENSO is a physical phenomenon that occurs in the equatorial Pacific Ocean where the water temperature oscillates between being unusually warm (El Niño) and unusually cold (La Niña). El Niño and La Niña are among the strongest drivers of the climate of North America, with impacts that vary across different regions. These oceanic events shift the position of the jet streams across the continent, which act to steer the fronts and weather systems. Change the predominant tracks of the weather systems, and you change the resulting long-term weather. Because the jet streams are strongest in winter months, the temperature and precipitation shifts are also more pronounced in the cold season. The Southeast United States experiences particularly strong long-term weather shifts, with Florida feeling the greatest impacts. El Niño typically brings 30 to 40 percent more rainfall and cooler temperatures to Florida in the winter, while La Niña brings a warmer and much drier than normal winter and spring. La Niña is frequently a trigger to periodic drought in Florida.

The resulting jet stream patterns from El Niño and La Niña also act to suppress damaging freezes. During El Niño, a strong subtropical jet tends to block the intrusions of arctic air that bring exceptionally cold temperatures. La Niña sets up a different jet stream pattern, which tends to steer the colder air to the north. The threat of severe freezes is highest, up to three times more likely, when neither El Niño nor La Niña is affecting the weather.

In general, El Niño (warmer than normal waters in the tropical Pacific) is a "good dude" for Florida. In addition to bringing beneficial winter rainfall and suppressing damaging freezes, it

also lessens the severity of the Hurricane Season. It has now been shown conclusively that El Niño suppresses the formation of hurricanes and tropical storms by creating an environment unfavorable for development due to wind shear.
Most tropical storms and hurricanes that have the potential of reaching the United States originate in the Gulf of Mexico, Caribbean Sea or the Atlantic Ocean a few degrees north of the equator. Both tropical storms and hurricanes are strong tropical low-pressure systems. When the sustained wind velocity in a tropical system rises above 73 miles per hour, it is reclassified from a tropical storm to a hurricane. Being a peninsula, the length of Florida's coastline is nearly as long as the combined coastlines of all the other states from Virginia to Texas. Consequently, it is not surprising that more tropical systems of all kinds have made their first landfall here. Between 1901 and 2002, 86 hurricanes and 73 tropical storms entered Florida. During some decades conditions are more conducive for tropical storm and hurricane development than in others. Hurricanes are classified by intensity, category one being the weakest, category five the strongest. Hurricanes gain their strength from warm water. At the beginning and end of the hurricane season those hurricanes that have reached Florida have been relatively weak. In September, the height of the hurricane season, most of the more powerful hurricanes have formed and left the Atlantic. Until satellites could monitor their development, it was difficult to ascertain where hurricanes first developed. It appears that slightly more originate in the Atlantic than the Caribbean or Gulf of Mexico.

The probability of tropical storms reaching a specific part of the Florida coastline varies little, but there is great variation in the arrival of hurricanes. The northwestern coast has experienced the most, closely followed by that of the southeast and the southwest. Very few hurricanes have entered Florida between Melbourne and Jacksonville. Actually Jacksonville has only sustained a direct hit by one hurricane, Dora in 1964. Several, however, have passed it by just offshore.

Both tropical storms and hurricanes, if they pass over highly populated areas, are capable of producing many fatalities and enormous property damage. The hurricane that caused the highest number of deaths entered the State at West Palm Beach in September 1928 and passed over Lake Okeechobee. It released so much rain over the lake that the primitive dike that was built on the southern shore to protect an agricultural area behind it burst. The flood that followed killed approximately 1,800 people, mostly migrant farm workers. On Labor Day 1935, what is still the most powerful hurricane in the nation's weather history passed over the northern Keys. As a result of a lack of coordination in the State's then primitive warning system, approximately 400 people lost their lives. Florida learned a lesson from that Labor Day hurricane, and began to appropriate money for a better warning system. Since then fatalities from hurricanes have been greatly reduced.

In terms of property damage, the second most costly natural disaster in the nation's history was Hurricane Andrew that passed over southern Miami-Dade County in August, 1992. Like the 1935 Labor Day hurricane, it was a Category 5, but unlike the Labor Day hurricane it passed over a densely populated area. Property damage exceeded $35 dollars, but because of early warnings and evacuation efforts the number of deaths directly related to the storm was around 50. One of the few benefits of the storm was that it motivated the State government to demand stricter compliance of existing building codes, and to enact even more stringent ones.

Florida experiences more tornadoes per 10,000 square miles than any state in the nation, even exceeding the density of Oklahoma, infamous for its tornadoes. Fortunately most Florida tornadoes are much lower in intensity than those on the Great Plains. Many are waterspouts that generally are both small and weak, although there have been some large and powerful exceptions. The highest incidence of tornado deaths and injuries in Florida has occurred between Tampa and Daytona Beach. In 1966 and 1998, supercell thunderstorms that spawned tornadoes entered Florida in St. Petersburg, and crossed the State, exiting near Daytona Beach. Twelve people were killed in 1966 while 42 were killed by the 1998 storm. Property damage during both episodes was enormous.

In North and Central Florida, winter fog can cause transportation problems especially late at night or early in the morning. In that season, relatively warm and moist air may drift in from the Gulf of Mexico or the Atlantic Ocean and settle over cooler land. The air near the land surface may be chilled to the dew point, and an adiabatic fog then develops. Most of the time, the fog dissipates by mid-morning. On the southern half of the peninsula, fog is rare at any time of the year.

Florida does not suffer the degree of atmospheric pollution that is experienced in California nor in those states with heavy industry. It has neither the topographic nor the climatic conditions that trap automobile emissions over California cities, and causes the infamous smog. Nor does Florida have the type of manufacturing that produces pollution in the industrialized portion of the nation, including cities like Houston, along the Gulf of Mexico. The only part of the State where atmospheric pollution is an issue is in the Tampa Bay area, where much of its electricity is produced from coal-fired generators. These generators are presently being either modified to burn coal more efficiently, or being replaced with generators that use natural gas. The State is not downwind from factories in other states that contribute acid rain bearing-particles to the atmosphere, and as a consequence its lakes and forests are relatively free of that source of pollution.

Florida does have a pollen season. Oak pollen can be especially prevalent. There are many other plants, both native and exotic, which may cause allergic reactions among some people, but the problem is no worse than in most other states. Fortunately, ragweed is only a minor problem, especially in South Florida.

Climate and the Economy- Since Florida is widely regarded as the “Sunshine State”, many have come to regard its climate as being highly suitable for the production of energy. Unfortunately, this is not true. Whereas solar energy is being converted by solar concentrators and collectors into electricity for commercial distribution in the nation’s dry southwest, long periods of cloud cover over Florida presently make this technology commercially infeasible. The most suitable location in Florida for an array of these solar concentrators would be between Miami-Dade and Palm Beach counties. Yet a 200-acre array of concentrators would produce enough energy to meet the demands of about 3,833 homes, compared to approximately 6,700 homes in southern Arizona and California using the same area. The home use of solar collectors to heat water directly from the sun was fairly common in South Florida until after World War II, when fossil fuels became so cheap that they fell out of favor. The rising cost of energy has renewed interest

in this use of the sun's energy, and solar collectors have grown in popularity, especially for use in heat swimming pools during the winter.

Florida's long coastline might appear to be attractive for the location of wind farms, arrays of propeller driven turbines to generate electricity. Although they have become increasingly common near the California coast and on the Great Plains, neither Florida's prevailing trade winds nor the daily land-sea breezes are of sufficient velocity to warrant the investment in this renewable energy resource.

Until 1950 Florida had the smallest population of any southern state, in part because of its climate. Its heat and humidity not only were difficult to endure, but until the end of the 19th century they were dangerous to live in, since epidemics of yellow fever and malaria were common. When it was incorporated into the United States, for the few who could afford a winter vacation it became a great place to visit, but when spring arrived they returned north. Those who did try to make a living there were in a constant struggle with the elements, including the weather, to make a success.

By the early 20th century, diseases had been brought under control and by the 1950s the widespread use of air conditioners, first in homes and businesses, later in vehicles, made summers more bearable for the residents. Summer tourism grew to surpass that of winter, and has provided many economic opportunities. Millions of retirees have chosen Florida as their new home, and the availability of air conditioning was certainly an important factor in their decision to come. The demands of these retirees for both goods and services have attracted millions more persons.

Some would argue that taming Florida's brutal summers comes at an excessively high use of energy. Whereas the use of energy is high, it is actually less than that paid by people in the North to maintain a comfortable temperature within their buildings during the winter. Measured in heating and cooling degree-days, a statistic used to calculate the cost of maintaining a comfortable temperature within a building, a typical peninsular Florida community averages between 3,000 and 4,000 cooling and 250 to 1,000 heating degree-days in an average year. In the lower Great Lakes area typically there are between 6,000 and 7,000 heating and 750 to 1,200 cooling degree-days.

Farmers have learned to produce more efficiently within Florida's climate. Grove owners, who first planted their trees too far north to escape the rare but truly devastating freezes, have concentrated much farther south. Those who remain in areas where freezes are common have planted species that bear fruit early, before most freezes occur. Winter vegetable farmers have adopted various means to prevent their plants from being damaged by freezes. Through use of chemicals, they are able to control the many pests that thrive in the State's heat and humidity.

Technology has made Florida's summers more hospitable to both visit and to live in, and its winters more agriculturally productive. The taming of its summers ignited a population explosion that continues. On average, 1,000 people move to Florida each day. Today the State not only has the largest population in the South, but it has become the fourth largest in the nation, and has every expectation in the future to rank even higher.

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Files of newspapers have been of great help, in particular those of the Miami Herald, Orlando Sentinel, St. Petersburg Times, and Tampa Tribune.

The Web Pages of the National Oceanic and Atmospheric Administration, National Climatic Data Center, and the Southeastern Regional Climate Center provided most of the climatological data.