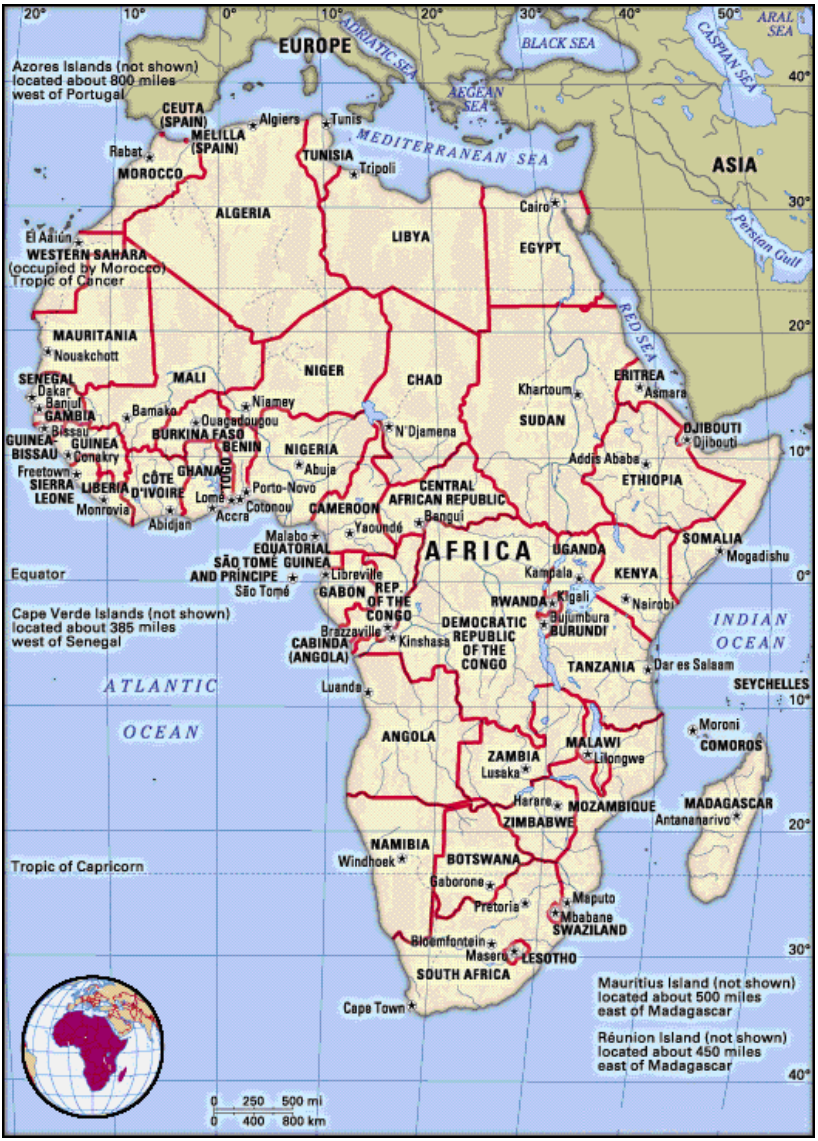
AFRICA


EUROPE
ASIA
AFRICA
Azores Islands (not shown) located about 800 miles west of Portugal
CEUTA (SPAIN)
MELILLA (SPAIN)
Algiers
Tunis
Rabat
MOROCCO
TUNISIA
Tripoli
MEDITERRANEAN SEA
ADRIATIC SEA
AEGEAN SEA
BLACK SEA
ARAL SEA
CASPIAN SEA
Persian Gulf
RED SEA
Cairo
EGYPT
LIBYA
ALGERIA
El Aaiún
WESTERN SAHARA (occupied by Morocco)
Tropic of Cancer
MAURITANIA
Nouakchott
SENEGAL
Dakar
Banjul
GAMBIA
Bissau
GUINEA-BISSAU
GUINEA
Conakry
Freetown
SIERRA LEONE
LIBERIA
Monrovia
MALI
Bamako
Niamey
NIGER
BURKINA FASO
Ouagadougou
BENIN
Porto-Novo
TOGO
Lomé
GHANA
Accra
CÔTE D'IVOIRE
Abidjan
NIGERIA
Abuja
Cotonou
CHAD
N'Djamena
SUDAN
Khartoum
ERITREA
Asmara
DJIBOUTI
Djibouti
Addis Ababa
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
Bangui
CAMEROON
Yaoundé
Malabo
EQUATORIAL GUINEA
SÃO TOMÉ AND PRÍNCIPE
São Tomé
Libreville
GABON
REP. OF THE CONGO
Brazzaville
Kinshasa
CABINDA (ANGOLA)
DEMOCRATIC REPUBLIC OF THE CONGO
Luanda
ANGOLA
UGANDA
Kampala
KENYA
Nairobi
RWANDA
Kigali
BURUNDI
Bujumbura
TANZANIA
Dar es Salaam
SOMALIA
Mogadishu
SEYCHELLES
Moroni
COMOROS
MALAWI
Lilongwe
ZAMBIA
Lusaka
Harare
ZIMBABWE
MOZAMBIQUE
MADAGASCAR
Antananarivo
NAMIBIA
Windhoek
BOTSWANA
Gaborone
Pretoria
Maputo
Mbabane
SWAZILAND
Bloemfontein
Maseru
LESOTHO
SOUTH AFRICA
Cape Town
Equator
Tropic of Capricorn
Cape Verde Islands (not shown) located about 385 miles west of Senegal
ATLANTIC OCEAN
INDIAN OCEAN
Mauritius Island (not shown) located about 500 miles east of Madagascar
Réunion Island (not shown) located about 450 miles east of Madagascar
0 250 500 mi
0 400 800 km

A number of factors influence the climate of the African continent. First, most of the continent—which extends from latitude 35° S to about latitude 37° N—lies within the tropics. Second, the near bisection of the continent by the equator results in a largely symmetrical arrangement of climatic zones on either side. This symmetry is, however, imperfect because of a third factor—the great east–west extent of the continent north of the equator, in contrast to its narrow width to the south. In consequence, the influence of the sea extends farther inland in southern Africa. Moreover, a quasi-permanent subtropical high-pressure cell (the Saharan anticyclone) develops in the heart of northern Africa, while in southern Africa the belt of high pressure on land weakens during the time of high sun (the season when the Sun is overhead—in December and January in the south). A fourth factor consists of the cool ocean currents, which chill the winds that blow over them and thereby influence the climate of the neighbouring shores. Fifth, because of the extensive plateau surfaces of the continent and the absence of high and long mountain ranges comparable to, for example, the Andes in South America or the Himalayas in Asia, climatic zones in Africa tend to shade into one another, rather than to change abruptly from place to place. Finally, the high mountains have climatic zones of their own that vary with altitude.

While these factors help to account for the broad climatic patterns of the African continent, there are, nevertheless, numerous local variations to be found from place to place within the same climatic zone. Urban areas, for example, have climates that often differ in many respects from those of the surrounding countryside. Typically experiencing higher average temperatures, urban areas also frequently have less wind and lower relative humidity; there is too little relevant data from Africa, however, to permit a detailed study of urban climates.

The most important differentiating climatic element is rainfall; this, together with several other climatic elements, depends upon the characteristics of the dominating air mass. The air masses of relevance to the African climate may be broadly classified as maritime tropical, maritime equatorial, continental tropical, maritime polar, and continental polar. Of these, the least important are the continental polar air masses, which may occasionally bring intense cold to northern Egypt in December and January, and the maritime polar air masses, which are associated with rain-bearing depressions over the northern and southern extremities of the continent during the winter. With the exception of these, the continent is affected both by a continental tropical air mass to the north and by maritime tropical and maritime equatorial air masses to the south.

These northern and southern air masses meet at the *intertropical convergence zone* (ITCZ). The hot, dry continental tropical air mass, which is present in the upper levels of the atmosphere, descends to the ground only at the convergence zone. Less hot than the continental tropical are the maritime tropical and maritime equatorial air masses, which originate from the Indian and South Atlantic oceans, respectively; they differ only in that the maritime equatorial air mass is unstable and brings rain, while the maritime tropical air mass, when fully developed, is stable and does not normally bring rain unless it is forced to rise by a high mountain.

In July the ITCZ—following the sun—moves northward toward the area of low pressure over the Sahara; there, the maritime and continental tropical air masses converge, with the maritime air masses swinging inland from the sea. There is no rainfall on the northern side of the convergence zone, since the region is completely under the dry continental tropical air mass originating over the Sahara. At the ITCZ itself, however, precipitation is prolonged and intense as air converges between the maritime and continental air masses and is forced aloft. Immediately south of the convergence zone, rainfall is heavy because of the unstable nature of maritime tropical air over a heated land surface. South of the equator, at yet greater distance from the convergence zone, the maritime air masses are less heated, thick, and stable, and they bring hardly any rainfall, except over some of the East African highlands. Only the southern tip of South Africa receives rainfall at this time, from winter cyclones.

During the period of low sun in the Northern Hemisphere (from December to January, when the sun has moved to its southern limit), the situation described above is reversed. The convergence zone moves southward, dipping into southern Africa. At this season the whole of northern Africa (except the Atlas Mountains) is under the dry continental tropical air mass, while southern Africa receives rainfall except in the Cape region and on the southwest coast, where the maritime air mass remains stable offshore over the cool Benguela Current.

When considered in detail, the movement of air masses and their effects provide the basis for a division of the continent into eight climatic regions. These are the hot *desert*, semiarid, tropical wet-and-dry, equatorial (tropical wet), Mediterranean, humid subtropical marine, warm temperate upland, and mountain regions.

The hot desert region consists of the Sahara and Kalahari deserts, which are always under the influence of dry continental tropical air masses, and the northern Kenya–Somali desert, the aridity of which is principally caused by the stable nature of the maritime air masses that pass over it throughout the year. The stability of these maritime air masses is induced by their passing over the cool body of water offshore. In addition to aridity, the desert climate is characterized by high mean monthly temperatures; the diurnal (daily) temperature range is, however, greater than the annual range of the mean monthly temperature.

Semiarid climatic regions fringe the desert areas and include the greater part of the land south of the Zambezi River. They differ from true desert regions in being just within reach of the ITCZ in the course of its seasonal movement and therefore receiving more rainfall. Temperatures are about the same as those in the desert regions.

The *tropical wet-and-dry* region is often called the savanna climatic region; this implies, incorrectly, that all areas with savanna vegetation have this type of climate. This region covers a little less than half of the total surface area of the continent, extending toward the equator from the semiarid areas. The great distinguishing feature of this climatic region is the seasonal character of its rainfall. During the period of high sun the maritime air masses produce up to six months of rainfall—the length of the rainy season depending on nearness to the equator. The rest of the year is dry. In a few places—for example, on the coast of Mauritania and Senegal—there is also a little rainfall in the period of low sun. As in the desert and semiarid climatic zones, mean monthly temperatures show less variation than daily temperatures. In western Africa the period of low sun corresponds to the *harmattan* season. The harmattan is a warm, dry northeasterly or easterly wind that blows out of the southern Sahara and is frequently laden with large quantities of sand and dust.

Regions with the equatorial, or tropical *wet*, type of climate, or variants thereof, are the wettest in Africa. There are two peak periods of rainfall corresponding to the double passage of the ITCZ. Because areas with an equatorial climate are constantly covered by warm maritime air masses, variations in their monthly and daily temperatures are less pronounced than in the tropical wet-and-dry regions.

Marked variations in the rhythm of equatorial climate sometimes occur; for example, the rainfall may be monsoonal and the second rainy season may be all but nonexistent. But the most notable anomaly can be observed on the West African coast from around Cape Three Points, Ghana, eastward to Benin, where, although the bimodal rainfall regime prevails, the total annual precipitation is less than 40 inches (1,000 millimetres). Among the many explanations that have been suggested are that the presence of a cold body of water offshore chills the lower layers of the maritime air mass and makes it stable; that the body of cold air that forms offshore diverts the incoming airstreams to the west and east of the anomalously dry area; that there is a strong tendency for the winds to blow parallel to the shore during the rainy seasons; that the absence of highlands deprives the region of orographic (mountain) rainfall; that fluctuations in the offshore, moisture-bearing winds occur during the rainy season and reduce rainfall; and that local meteorological peculiarities of thunderstorms contribute to the reduction in rainfall.

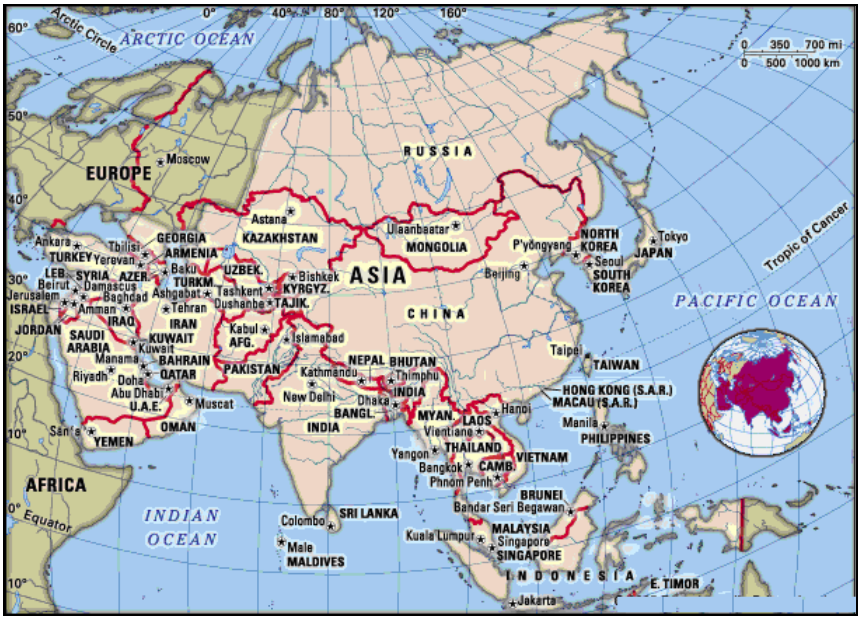
In the northern and southern extremities of the continent there is a dry summer subtropical, or *Mediterranean*, type of climate. Rain falls only in winter (December–January in North Africa, June–July in southern Africa), although in some localities it may fall in autumn (September in North Africa, April in southern Africa). Mean monthly temperatures are lower than in tropical climates, dropping to about 50° F (10° C) in winter, while summer (June–July in North Africa, and December–January in southern Africa) temperatures may sometimes exceed those of tropical climates. Clear blue skies are characteristic.

The *humid subtropical* marine climate is restricted to the southeast coast of Africa. This region is characterized by rainfall throughout the year, but it is heaviest in summer. In South Africa, south of KwaZulu/Natal, the winter rainfall is more pronounced, and the temperatures are a little lower than in the north. Thus, at Port Elizabeth there are six months when temperatures are below 62° F (17° C), while at Durban mean monthly temperatures do not fall below 64° F (18° C).

The warm *temperate* upland climatic region is found on the Highveld of southern Africa. Its rainfall regime is similar to that of the tropical wet-and-dry climate, but temperatures are greatly modified by the altitude; frost, for example, occasionally occurs in Lesotho. Toward the coast the climate shows maritime characteristics, and there is a tendency toward winter rainfall.

The *mountain climatic* region includes the high mountain areas of Ethiopia and the lake region of East Africa. In some respects the climate is similar to the warm, temperate upland climate, except that temperatures are even lower and snow occurs on the tops of the highest peaks, such as Kilimanjaro. The rainfall regime is similar to that of the adjacent lowland areas.

ASIA



The enormous expanse of Asia and its abundance of mountain barriers and inland depressions have resulted in great differences between regions in solar radiation, atmospheric circulation, precipitation, and *climate* as a whole. A *continental climate*, associated with large landmasses and characterized by an extreme annual range of temperature, prevails over a large part of Asia. Air reaching Asia from the Atlantic Ocean, after passing over Europe or Africa, has had time to be transformed into continental air—i.e., air that has often lost much of the moisture it absorbed over the ocean. As a result of the prevalent eastward movement of the air masses in the midlatitudes, as well as the isolating effect of the marginal mountain ranges, the influence of sea air from the Pacific Ocean extends only to the eastern margins of Asia. From the north, Arctic air has unimpeded access into the continent. In the south, tropical and equatorial air masses predominate, but their penetration to the centre of Asia is restricted by the ridges of the moutainous belt stretching from the highlands of West Asia through the Himalayas to the mountains of South China and Southeast Asia; in the winter months (November through March), such penetration is further impeded by the density of the cold air masses over the interior.

The contrast between the strong heating of the continent in the summer months (May to September) and the chilling in winter produces sharp seasonal variations in atmospheric circulation and also enhances the role of local centres of atmospheric activity. Winter chilling of the Asian landmass develops a persistent high-pressure winter anticyclone over Siberia, Mongolia, and Tibet that is normally centred southwest of Lake Baikal. The area affected by the anticyclone is characterized by temperature inversions and by very cold, calm weather with little snowfall. The winter anticyclone is fed by subsiding upper air, by bursts of Arctic air flowing in from the north, and by the persistent westerly air drift that accompanies the gusty cyclonic low-pressure cells operating within the Northern Hemisphere cyclonic storm system. The high pressure propels cold, dry air eastward and southward out of the continent, affecting eastern and southern Asia during the winter. Only a few of the winter cyclonic lows moving eastward out of Europe carry clear across Asia, but they do bring more frequent changes in weather in western Siberia than in central Siberia. The zone of lowest temperature—a so-called cold pole—is found in the northeast, near Verkhoyansk and Oymyakon, where temperatures as low as -90 °F (-68 °C) and -96 °F (-71 °C), respectively, have been recorded.

The outward drift of winter air creates a sharp temperature anomaly in eastern and northeastern Asia, where the climate is colder than the characteristic global average for each given latitude. On the East Asian islands, the effect of the winter continental *monsoon* is tempered by the surrounding seas. As the air masses pass over the seas, they become warmed and saturated with moisture, which then falls as either snow or rain on the northwestern slopes of the island arcs. Occasionally, however, strong bursts of cold air carry cold spells as far south as Hong Kong and Manila.

Cyclonic storms form and move eastward through the zone where the temperate and tropical air masses are in contact, called the *polar front*, which shifts southward in winter. The winter rainy season in the southern parts of the West Asian highlands, which is characteristic of the *Mediterranean climate*, is associated with this southward movement of the polar front. In northern areas of West and Middle Asia, the effect of cyclonic action is particularly strong in the spring, when the polar front moves north and causes the maximum in annual precipitation to occur then.

During the northern winter, South and Southeast Asia are affected by northeasterly winds that blow from high-pressure areas of the North Pacific Ocean to the equatorial low-pressure zone. These winds are analogous to the trade winds and are known in South Asia as the northeast (or winter) monsoon. The weather is dry and moderately warm. Rainfall occurs only on the windward side of maritime regions (e.g., Tamil Nadu state in southeastern India and southern Vietnam). Some of the cyclonic storms that move eastward through the Mediterranean Basin during the winter are deflected south of the Plateau of Tibet, crossing northern India and southwestern China. Such storms do not often bring winter rain, but they create short periods of cloudy, cool, or gusty weather and are accompanied by snow in the higher mountain ranges.

In summer the polar front shifts northward, causing cyclonic rains in the mountains of Siberia. In West, Middle, and Central Asia, a hot, dry, dusty, continental tropical wind blows at this time. Over the basin of the Indus River, the heating creates a low-pressure area. Known as the *South Asian* (or Iranian) low, it appears in April and is fully developed from June to August. The onset of monsoon in India and mainland Southeast Asia is related to changes in the circulation pattern that occur by June—specifically, the disintegration of the southern jet stream and the formation of low pressure over southern Asia. The monsoon air masses flow into this monsoonal low-pressure zone from a cell of high pressure just off the eastern coast of southern Africa. Because of the Coriolis force (the force caused by the Earth's rotation), winds south of the Equator change direction from southeast to southwest in the Arabian Sea and the Bay of Bengal. This southwest monsoon bursts upon the Malabar Coast of India in early June and gradually extends northward over most of India and mainland Southeast Asia. It brings considerable rainfall, which in most of these areas accounts for 80 to 90 percent of the total annual precipitation.

In eastern Asia the Pacific Ocean polar front creates atmospheric disturbances during the summer. From a summer high-pressure centre over the western Pacific, the warm and moist summer monsoon blows from the southeast toward the continent. To the south of latitude 38° N, where the warm *Kuroshio* (Japan Current) approaches the coast of Japan, the summer monsoon brings protracted rains and high humidity; together with high temperatures, this creates a hothouse atmosphere. Becoming chilled as it passes over cold ocean currents to the north, this air brings fogs and drizzling rains to Northeast Asia.

Summer in *China* is a time of variable air movement out of the western Pacific. If that drift is strong and low pressure over the continental interior is intense, the summer monsoon may carry moisture well into Mongolia. If neither the drift nor the continental low is strong, the China summer monsoon may fail, falter over eastern China, or cause irregular weather patterns that threaten the country with crop failure. The monsoon there is less dramatic than in other areas, accounting for 50 to 60 percent of China's annual rainfall.

Tropical cyclones, or typhoons, may occur in coastal South, Southeast, and East Asia throughout the year but are most severe during the late summer and early autumn. These storms are accompanied by strong winds and torrential rains so heavy that the maximum precipitation from the typhoons locally may exceed the total amounts received during the normal summer monsoons.

In winter continental tropical air prevails in tropical Asia; in summer it is replaced by equatorial ocean air. The winter season's dry and warm winds, directed offshore toward the equatorial low-pressure axis, are analogous to trade winds but simultaneously act as the South Asian continental monsoon. The dry spring that follows changes abruptly and dramatically into the rainy summer with the onset of the monsoon. The summer monsoon brings enormous amounts of rain (up to about 25 inches [635 mm] in a month). Over the areas of Asia closest to the Equator—southern Sri Lanka, Malaysia, and the Greater Sunda Islands—equatorial air prevails continuously, accompanied by even temperatures and abundant rainfall in all seasons. The Lesser Sunda Islands have a tropical monsoon climate; their wet and dry seasons are regulated by the calendar rhythm of the Southern Hemisphere, which is characterized by a wet summer from November to February and a dry winter from June to October.

Differences between the climatic conditions of the various regions of Asia are determined to a considerable degree by topography. Different elevation-based climatic zones are most clearly defined on the southern slopes of the *Himalayas*, where they vary from the tropical climates of the foothills, at the lowest levels, to the extreme Arctic-like conditions of the peaks, at the highest elevations. The degree of exposure also plays a large role. The sunny southern slopes differ from the shady northern ones, and windward slopes exposed to moist ocean winds differ from leeward slopes, which, lying in the wind (and rain) shadow, are necessarily drier. The barrier effect is most pronounced in the zone of monsoon circulation (i.e., East, Southeast, and South Asia), where rain-bearing winds have a constant direction. In addition to the physical isolation of the leeward slopes from the moisture-laden winds, these slopes also experience the *foehn* effect, in which a strong wind traverses a mountain range and is deflected downward as a warm, dry, gusty, erratic wind. Contrasts of climate resulting from exposure are manifested clearly in the Himalayas, the *Elburz Mountains*, Japan, Taiwan, the Philippines, the Tien Shan, the region to the east of Lake Baikal (Transbaikalia), and many other places.

The isolating barrier effect of the relief on the climate is demonstrated most clearly in the West Asian highlands and in Central Asia. In these regions the surrounding mountains isolate the tablelands of the interior from moisture-laden winds. The massiveness of the interior highlands is also a significant factor; it gives rise to local anticyclones during the cold months of the year.

The average January temperature over a considerable part of Siberia is below -4 °F (-20 °C), and in the *Verkhoyansk* region it reaches -58 °F (-50 °C). Near the coast Pacific Ocean air moderates the average temperature to from 23 to 5 °F (-5 to -15 °C). The January isotherm (a line connecting points of equal temperature) of 32 °F (0 °C) extends eastward from the Anatolian and Iranian highlands; skirts the southern edge of the Pamirs, the Karakoram Range, and the Himalayas; and runs northeastward through China to south of the Shandong Peninsula and through the southern Korean peninsula and central Honshu. An isotherm of 68 °F (20 °C) is traced along the Tropic of Cancer and one of 77 °F (25 °C) farther south. In July the maximum temperatures are found in the lowlands of Mesopotamia and the Arabian Peninsula and in the *Thar* and *Takla Makan deserts*. The 68 °F (20 °C) isotherm moves as far as latitudes 55° to 60° N, but, in the eastern Gobi and near the cool Pacific Ocean, it bends to the south. Along the far northeastern coast of Asia, the average temperature in July is below 50 °F (10 °C), which is typical for a tundra climate. The greatest amplitude in annual temperature range on Earth occurs near the “cold pole,” which has remarkably warm summers; the annual range may exceed 175 °F (97 °C).

Annual rainfall in the equatorial belt is approximately 80 inches (2,000 mm); it is 80 to 120 inches (2,000 to 3,000 mm) and more (300 to 500 inches [7,600 to 12,700 mm] in places) on windward maritime slopes in South, Southeast, and East Asia. In *Cherrapunji* in northeastern India, some 900 inches (22,900 mm) of rain fell in seven months in 1891. Precipitation averages less than 40 inches (1,000 mm) annually on tropical lee slopes. In the subtropical and temperate monsoon climates there is adequate rainfall, amounting to about 24 to 80 inches (600 to 2,000 mm) annually. Annual precipitation is less than 10 inches (250 mm) in northeastern Siberia and averages 6 to 8 inches (150 to 200 mm) but may be less than 4 inches (100 mm) in some places in the deserts of West, Middle, and Central Asia.

The distribution pattern of precipitation throughout the year is varied. Relatively uniform moisture is characteristic of the Asian equatorial zone. Maximum summer precipitation and minimum winter precipitation are the rule in the subequatorial zones and in other regions with monsoon climates, as well as in those areas where there is summer movement of the fronts—the polar front in the mountains of southern Siberia and the Arctic front in the subarctic regions. Wet winters and dry summers are typical of the Mediterranean climatic region in West Asia, where precipitation is associated with the winter activity of the polar front. This polar-front activity, accompanied by maximum precipitation, occurs in the spring in the interior parts of the West Asian highlands. Summer and winter precipitation merges in some parts of Asia. In the *Kolkhida* area east of the Black Sea, the summer rains—brought by the northwesterly Atlantic air currents—merge with the cyclonic Mediterranean winter rains. In some areas of Japan, Korea, and eastern China, there is uniform precipitation when, in addition to the summer monsoon, the winter monsoon brings moisture.

As the aggregate result of these various meteorological patterns, the following types of climate may be distinguished in Asia: the tundra climate (associated with the cold, treeless plains of the Arctic lowlands of Asia); the cold, sharply continental climate of eastern Siberia; the cold, moderately humid western Siberian climate; the humid, subtropical climate associated with the Kolkhida region; the desert climate of the temperate zone; the Mediterranean subtropical climate of the western edge of West Asia; the subtropical desert climate; the mountain-steppe highland subtropical climate of West and Central Asia; the alpine desert climate; the climate of the eastern Pamirs, the Karakoram Range, and the Plateau of Tibet; the climate of the tropical deserts; the temperate monsoon climate of the East Asian part of Siberia and the northern parts of Japan and eastern China; the subtropical monsoon climate of southern Japan and of southeastern China; the subequatorial monsoon climate of South Asia, eastern Java, and the Lesser Sunda Islands; and the equatorial climate of the Greater Sunda Islands. All the various features of the types of climate mentioned exert a strong influence on other natural conditions, as well as on the landscape as a whole.

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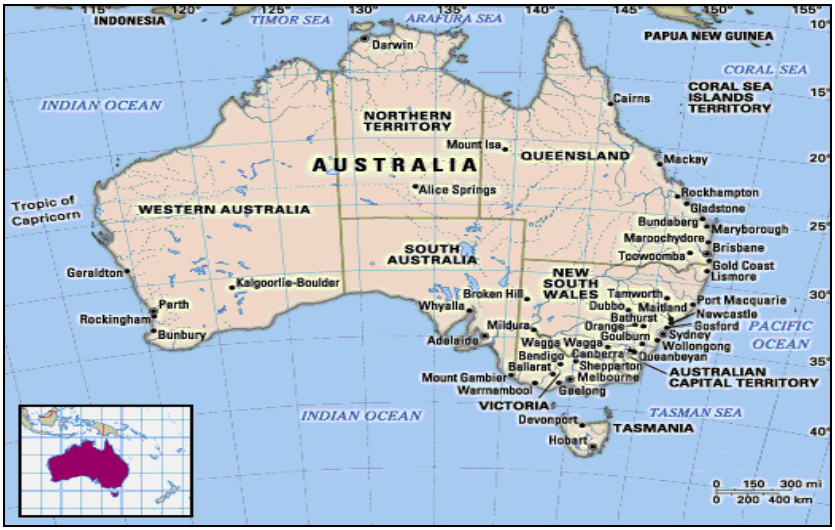
AUSTRALIA



Australia is the arid continent. Over two-thirds of its landmass, precipitation (largely as rainfall) per annum averages less than 20 inches (500 mm), and over one-third of it is less than 10 inches (250 mm). Little more than one-tenth of the continent receives more than 40 inches (1,000 mm) per year. As has been noted, in winter the snowfields of Tasmania and the Mount Kosciusko area can be extensive, but on the whole Australia is an extremely hot country, in consequence of which evaporation losses are high and the effectiveness of the rainfall received is reduced. In addition, the severity of climate, the predominance of the outdoors in the minds and lives of many, and the national importance of agricultural and pastoral pursuits all make Australians perhaps more climate-conscious than most. In no country of comparable development do climate and weather loom so large in the lives and conversation of the people.

The principal features of Australia's climate stem from its position, shape, and size. Australia is mainly a compact tropical and near-tropical continent. No major arms or embayment's of the sea penetrate far into the landmass. The only extensive uplands occur near the east coast, and even they are not, by world standards, very high.

In summer (December–February), when the sun is directly overhead in northern Australia, temperatures are extremely high. The sea exerts little moderating influence, and the uplands are not sufficiently extensive or high to have more than local effects. Temperatures commonly soar above the 100 °F (38 °C) mark in the interior, but because there rarely is any cloud cover, radiation loss is considerable at night, and daily temperature ranges are wide. High temperatures dominate the Australian summers in all but Tasmania. Heat waves are common, and, though the highest amounts of solar radiation are received in northern South Australia, the highest temperatures and longest heat waves are recorded in the northwest of Western Australia. For example, *Marble Bar* has recorded a maximum temperature of 100 °F or more on 162 consecutive days.

Temperatures in winter remain moderate except in the uplands of Tasmania and southeastern Australia, where snow is common. Night frosts are common in winter throughout southern Australia and in the interior.

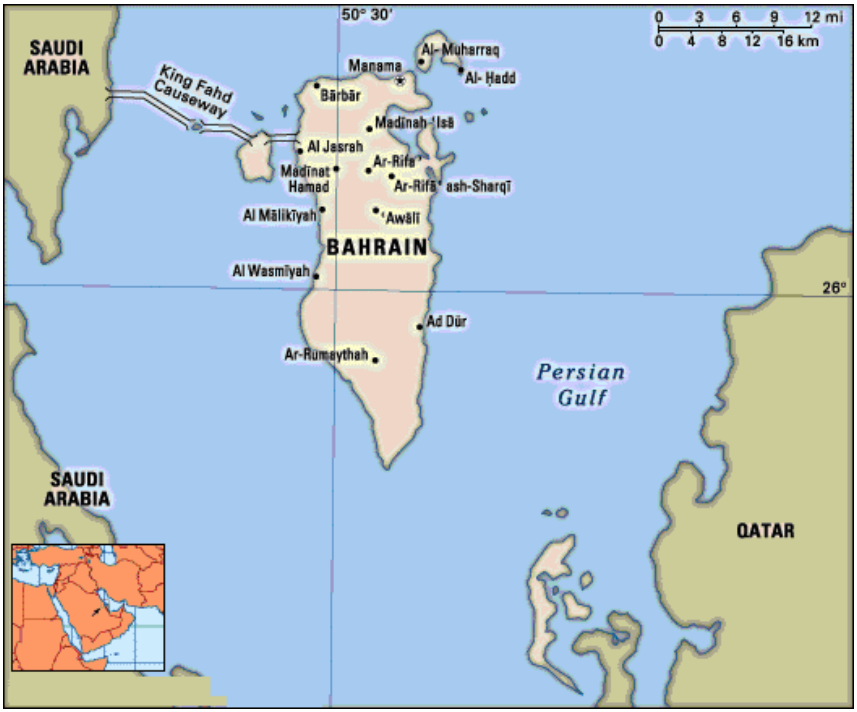
Because of its relatively low latitudinal position, Australia comes under the influence of the southeast trade winds in the north and the westerly's in the south. Northern Australia is affected by a northerly *monsoon*, partly because of the latitude and the seasonal migration of planetary wind zones and partly because of the summer heating of the continental interior that draws in surface winds. The monsoon brings summer (December–February) rains to the northern coastal area that penetrates inland for variable distances. These summer rains are all the more important because most of northern Australia is in the sheltered rain shadow of the Eastern Uplands, which block the rain-bearing southeast *trades* in winter. The trades, forced to rise by the uplands, bring heavy rains to the Pacific coasts of Queensland and northern New South Wales. These areas are also affected by tropical cyclones and receive the heaviest rains of any part of Australia. Within this coastal fringe, the northern Queensland area around Tully, south of *Cairns*, is the wettest, with an annual average of nearly 160 inches (4,050 mm).

Southern Australia receives winter rains from depressions associated with the west-wind zone. Again, there are local topographic controls, with uplands receiving higher amounts than the adjacent plains. Parts of the southern *Mount Lofty Range*, in South Australia, average more than 40 inches (1,000 mm) of rainfall per year, but *Adelaide*, to the west, averages only about 20 inches (500 mm), while the *Murray* plains, in the rain shadows of the range, receive 15 inches (380 mm) or less rainfall annually.

In the great mass of the interior of Australia, annual rainfall averages less than 20 inches (500 mm), and over vast areas the total is less than 10 inches (250 mm); the Lake *Eyre* region averages less than half that amount. Rainfall in these areas is unreliable and capricious, with long droughts broken by damaging rains and floods. Over Australia as a whole, rainfall is indeed extremely variable. Only in the far north, around Darwin, in the southwest of Western Australia, in southern South Australia and Victoria, in Tasmania, and in eastern New South Wales is the recorded annual precipitation fairly consistent, in any given year totaling no more than 10 percent above or below the long-term average in specific years.

Much of Australia's marked climatic variability has been ascribed to the changeability in differential air pressures over the central Pacific and the Indonesian archipelago, primarily caused by contrasts in sea and ocean temperatures. The resulting large-scale swing in air pressure is known as the Southern Oscillation. Monitoring the *Southern Oscillation Index* (SOI) is now considered essential to seasonal weather forecasting. The SOI is strongly negative when weak Pacific winds bring less moisture than usual to Australia. Prolonged negative phases are related to *El Niño* episodes in the South Pacific, and most of Australia's major droughts have been related to these episodes. Prolonged positive SOI phases (during *La Niña*) normally bring above-average rainfall and floods to eastern and northern Australia. In each case, however, the correlations are not exact.

BAHRAIN



Summer in Bahrain is unpleasant, as high temperatures frequently coincide with high humidity. Midday temperatures from May to October exceed 90 °F (32 °C), often reaching 95 °F (35 °C) or higher; summer nights are sultry and humid. Winters are cooler and more pleasant, with mean temperatures from December to March dipping to 70 °F (21 °C). Rainfall is confined to the winter months and averages only 3 inches (75 mm) per year, but this may vary from almost nothing to double this amount. On average, rain falls only about 10 days a year. Sunshine is abundant year-round. The predominant wind is the damp, northwesterly *shamal*; the *qaws*, a hot, dry, and dusty south wind, is less frequent and brings sand, dust, and low humidity.

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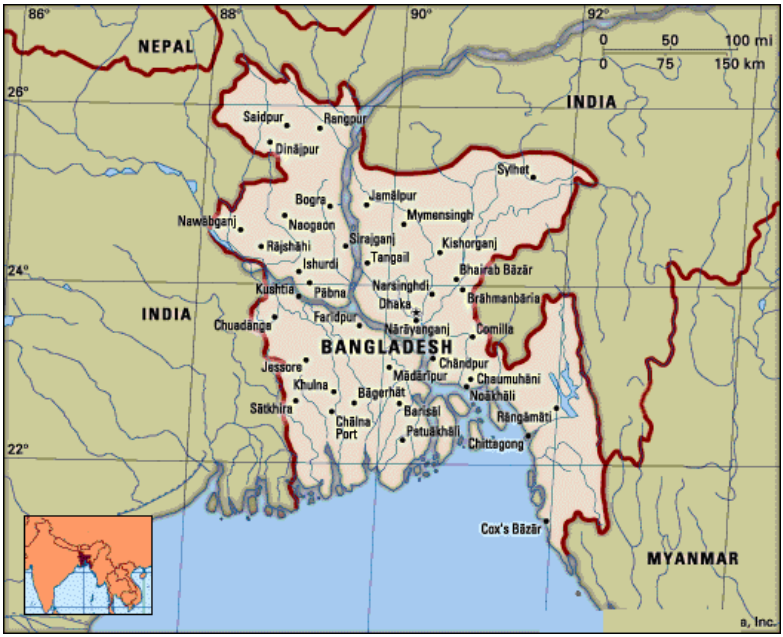
BANGLADESH



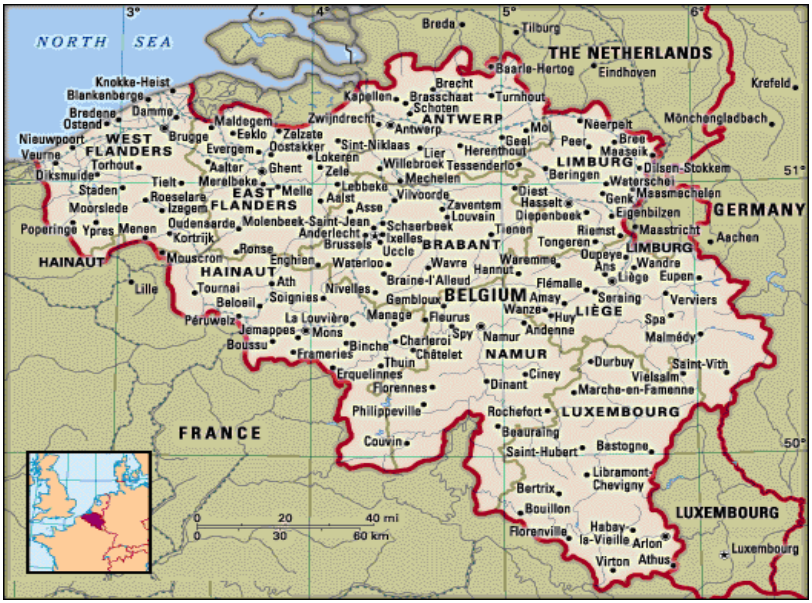
Bangladesh has a typical monsoon climate characterized by rain-bearing winds, moderately warm temperatures, and high humidity. In general, maximum temperatures in the summer months, from April to September, range between 91° and 96° F (33° and 36° C). April is the warmest month in most parts. January is the coolest month in the winter season, which lasts from about November to March.

The conditions of lowest atmospheric pressure occur in Bangladesh in June and July, the storm season. Winds are mostly from the north and northeast in winter, blowing at a rate of 1 to 2 miles per hour in northern and central areas and 2 to 4 miles per hour near the coast. During the period of the northwesters (March to May), wind speeds may rise to 30 or 40 miles per hour.

Bangladesh receives heavy rainfall; except for some parts in the west, it generally exceeds 60 inches (1,500 millimetres) annually. Large areas of the south, southeast, north, and northeast receive from 80 to 100 inches, and the northern and northwestern parts of the Sylhet area receive from 150 to 200 inches. The maximum rainfall occurs during the monsoon period, from June to September or early October.

In the early summer (April and May) and late in the monsoon season (September to November), storms of very high intensity often occur; they may create winds with speeds of more than 100 miles per hour, piling up the waters of the Bay of Bengal to crests as high as 20 feet that crash with tremendous force onto the coastal areas and the offshore islands, inundating them and causing heavy losses of life and property. Since the early 18th century, when records were first kept, more than 1,000,000 people have been killed in such storms, 815,000 of them in three storms occurring in 1737, 1876, and 1970. Severe storms also occurred in May 1985 and April 1991.

BELGIUM



Belgium has a temperate, maritime climate predominantly influenced by air masses from the Atlantic. Rapid and frequent alternation of different air masses separated by fronts gives Belgium considerable variability in weather. Frontal conditions moving from the west produce rainy weather, with rainfall heavy and frequent, averaging 30 to 40 inches (750 to 1,000 millimetres) a year. Winters are damp and cool with frequent fogs; summers are rather mild. The annual mean temperature is around 50° F (10° C). Brussels, which is roughly in the middle of the country, has a mean minimum temperature of 31° F (-0.3° C) in January and a mean maximum of 71° F (21.6° C) in July.

Regional climatic differences are determined by elevation and distance inland. Farther inland, maritime influences become weaker, and the climate becomes more continental, characterized by greater seasonal extremes of temperature. The Ardennes region, the highest and farthest inland, is the coldest. In winter, frost occurs on about 120 days, snow falls on 30 to 35 days, and January mean minimum temperatures are lower than elsewhere. In summer, the elevation counteracts the effect of distance inland, and July mean maximum temperatures are the lowest in the country. Because of the topography, the region has the highest rainfall in Belgium. In contrast, the Flanders region enjoys generally higher temperatures throughout the year. There are fewer than 60 days of frost and fewer than 15 of snow. On the seacoast these figures are reduced to below 50 and 10, respectively. There are a few hot days, especially on the coast, where the annual rainfall is the lowest in the country.

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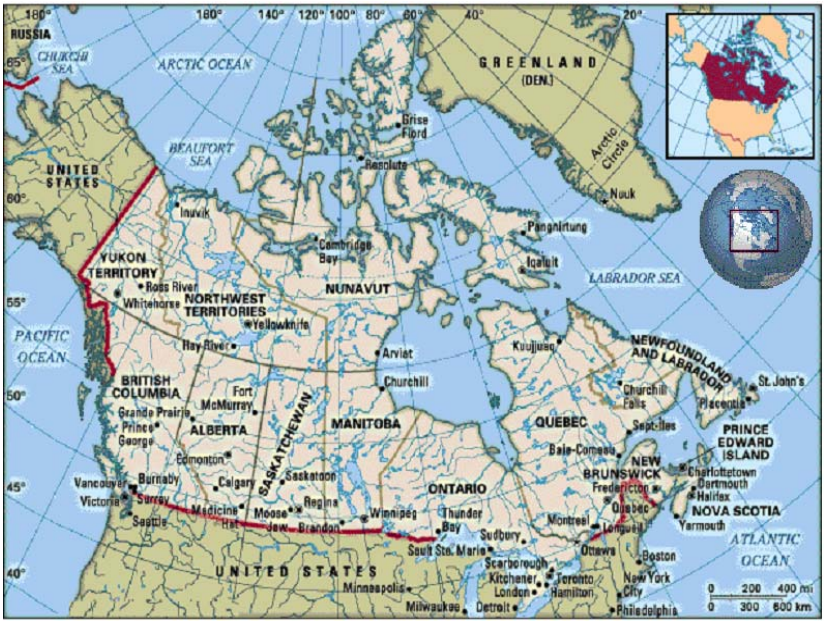
CANADA



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In the winter those parts of the country farthest from open water are the coldest, so that in the interior plains and in the North the winters are extremely cold. The lowest temperature ever recorded was -81 °F (-63 °C) at Snag, Yukon Territory, in 1947. During the summer, however, the parts of Canada farthest from open water are the warmest. The highest temperature recorded was 113 °F (45 °C) at Midale, Saskatchewan, in 1937. Thus, west-coast ***Vancouver*** has an average January temperature of 37 °F (3 °C) and an average July temperature of 64 °F (18 °C), while in ***Regina***, Saskatchewan, on the interior plains, average temperatures vary from -1 to 67 °F (-18 to 19 °C). The daily range of temperature is also narrower on the coasts than in interior locations. Humid air masses from the Pacific cause enormous quantities of orographic (mountain-caused) rain to fall on the west coast and mountain areas. Several sites along the British Columbia coast receive annual quantities in excess of 100 inches (2,500 mm), but British Columbia receives much less precipitation in summer than in winter because low-pressure systems move on a more northerly track in summer and seldom cross the southern part of the coast. Vancouver has an annual average precipitation of about 40 inches (1,000 mm).

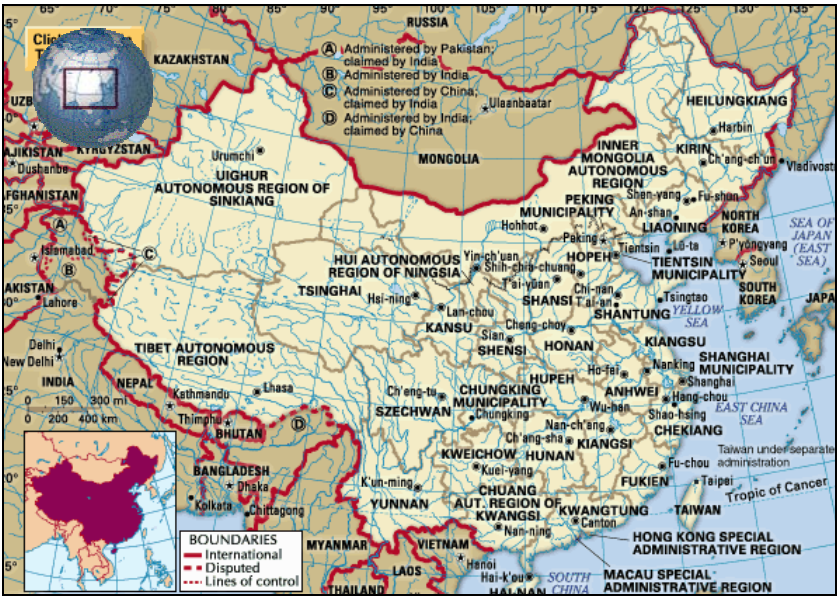
In the interior plains and the North (Arctic and subarctic), precipitation is seldom more than 15 inches (400 mm) per year; it drops to as low as 2 inches (50 mm) at Eureka on ***Ellesmere Island***. As air currents generally move from west to east, the west-coast mountains effectively keep marine air out. Spring and summer are wetter than winter.

Ontario and Quebec have more rainfall than the interior plains because the air masses pick up water vapour from the Great Lakes, Hudson Bay, the Atlantic Ocean, and the Gulf of Mexico. Average annual precipitation is about 30 inches (800 mm) in Toronto and 40 inches (1,000 mm) in Montreal. Because winters are not as cold as in the interior plains, the air is less dry, and enough snow falls to make winter and summer precipitation about equivalent.

The Atlantic Provinces are wetter than the provinces of Central Canada. Yearly precipitation, most of which is cyclonic in origin, exceeds 50 inches (1,250 mm) in places and is fairly evenly distributed throughout the year. There are few thunderstorms, and the low Appalachian Mountains produce only a little orographic rainfall. In general, the rainfall on Canada's east coast is less than that on the west coast because the prevailing wind is offshore.

Canada's snowfall does not follow the same pattern as rainfall. In the North and the interior plains, snowfall is light because cold air is very dry. The snow is hard and dry, falls in small amounts, and is packed down by the constant wind. The east and west coasts are areas of lighter snowfall because the ocean usually makes the air too warm for large quantities of snow to fall. The depth of snow increases inland from each coast, reaching maximums of about 240 inches (6,100 mm) in the Rocky Mountains and on the shores of the Gulf of St. Lawrence. Still farther inland, a lack of moisture brings the depth of snow down again. Freezing precipitation may occur during the colder months in any part of the country, occasionally disrupting transportation and communication.

CHINA



The vast and topographically varied landmass of China lies in Asia, the world's largest continent, and faces the Pacific, the world's largest ocean, along an extensive shoreline. The country's climate is thus heavily influenced by the seasonal movement of large air masses between the Pacific and the Chinese mainland. The *polar continental air mass*, originating to the north in Siberia, dominates a large part of China during the winter; likewise, the tropical Pacific air mass exerts its influence during the summer. The sharply varied climatic conditions prevailing in summer and in winter are a direct result of the interaction of these two air masses, which are entirely different in nature.

The Siberian air mass, which is quite stable, is extremely cold and dry and often has marked layers of temperature inversion. After crossing the *Mongolian Plateau*, the air mass spreads southward and begins to invade North China, where it undergoes a series of rapid changes; its temperature rises slightly, and its stability decreases. During the day the air there may be quite warm, but at night or in shaded places the cold is often unbearable. In general, the diurnal (daily) range of temperature is more than 18 °F (10 °C); in extreme cases it may exceed 45 °F (25 °C). Because North China is affected by this air mass most of the time, it is dry, with clear weather and an abundance of sunshine during the winter months.

The prevailing winter wind blows from November through March, but it changes direction as it moves to the south. In northern and northeastern China its direction is from the northwest, in eastern China it comes from the north, and on the southeastern coasts it is from the northeast. The height of the winter wind belt usually does not exceed 13,000 feet (4,000 metres). As it moves to the south, the height decreases; in *Nanjing* it is about 6,500 feet (2,000 metres), and in South China it is less than 5,000 feet (1,500 metres). The Qin Mountains become an effective barrier to the advance of the cold waves to the south, particularly in the western section, where the average elevation of the mountains is mainly between 6,500 and 9,000 feet (2,000 and 2,700 metres).

In China the tropical Pacific air mass is the chief source of summer rainfall. When it predominates, it may cover the eastern half of China and penetrate deep into the border areas of the Mongolian Plateau and onto the eastern edge of the Plateau of Tibet. In summer the Siberian air mass retreats to the western end of Mongolia, although it occasionally penetrates southward and sometimes may reach the Huai River valley, which constitutes a summertime battleground between the tropical Pacific and Siberian air masses.

The movement of the two air masses is of immense significance to the climate of central and North China. In summer, when the tropical air mass predominates, the frontal zone between the two shifts northward; as a result, North China receives heavier rainfall. When the southeastern monsoon slackens, however, the frontal zone moves southward, and central China receives more rainfall, which can cause flooding. The activity of the tropical Pacific air mass in winter is confined to the southeast coastal areas; during that season, therefore, it frequently drizzles in the hilly areas south of the Nan Mountains, and morning fog is common.
Besides these two air masses, three other air masses also influence China's climate: the equatorial continental air mass (a highly unstable southwest monsoon), the polar maritime air mass, and the equatorial maritime air mass. Furthermore, because China is so vast and has such complex topography, the interaction between the air masses and relief produces a wide range of climatic conditions.

Temperatures generally decrease from south to north. The mean annual temperature is above 68 °F (20 °C) in the Pearl River valley. It decreases to between 59 and 68 °F (15 and 20 °C) in the middle and lower reaches of the Yangtze, to about 50 °F (10 °C) in North China and the southern part of Xinjiang, and to 41 °F (5 °C) in the southern area of the Northeast, the northern part of Xinjiang, and places near the Great Wall. It drops below 32 °F (0 °C; i.e., freezing) in the northern part of Heilongjiang. The annual range of temperature between the extreme south and north is about 86 °F (48 °C). With few exceptions, January is the coldest month and July is the hottest.

South of the Qin Mountains–Huai River line, the mean January temperature increases progressively, rising from freezing to 72 °F (22 °C) on the southern coast of Hainan Island. Snow rarely falls, and the rivers do not freeze. North of this line, the temperature drops from freezing to -18 °F (-28 °C) in the northern part of Heilongjiang.

In April the mean temperature is above freezing for the whole of China, with the exception of extreme northern Heilongjiang. During that time the mean temperature for the Northeast Plain is between 36 and 46 °F (2 and 8 °C), and for the extensive plain between Beijing and Shanghai it is between 54 and 59 °F (12 and 15 °C). South of the Nan Mountains the mean temperature is considerably higher than 68 °F (20 °C). Along the coast of southern Guangdong, willows start to bud in late January, but in Beijing the budding of willows comes as late as early April.

In summer the temperature range between North and South China is quite small. In July the difference in temperature between Guangzhou and Beijing is only about 5 °F (3 °C), and the isotherms in July are roughly parallel to the coastline. In July the isotherm of 82 °F (28 °C) marks an extensive area. The hottest places in China are found along the valleys of the middle and lower Yangtze. The mean July temperature of Nanchang and Changsha is well above 84 °F (29 °C), and in many years it exceeds 86 °F (30 °C).

In North China autumn is generally cooler than spring. The mean October temperature in Beijing is about 55 °F (13 °C), and in April it is about 57 °F (14 °C). In South China the reverse is true. The mean October temperature in Guangzhou is 75 °F (24 °C), but in April it is only about 70 °F (21 °C).

The middle and lower reaches of the Huang He are where China's civilization and agriculture first developed. There the seasonal rhythm is well marked, and the duration of each season is evenly spaced. In other parts of China, however, the duration as well as the starting and closing dates of each season vary among different regions. Summer is nonexistent in northern Heilongjiang, while there is no winter in southern Guangdong. At Kunming, in the Yunnan uplands, the climate is mild throughout the year, with only brief summer and winter periods.

In general, south of the Qin Mountains–Huai River line the mean daily temperature seldom falls below freezing, so that farming can be practiced year-round. In the Yangtze valley two crops are usually grown annually, but north of the Great Wall only one crop per year is possible.

Precipitation in China generally follows the same pattern as temperatures, decreasing from the southeast to the northwest. The annual total of certain areas along the southeastern coast amounts to more than 80 inches (2,000 mm). The Yangtze valley receives about 40 to 45 inches (1,000 to 1,150 mm). Farther north, in the Huai River valley, the annual rainfall decreases to some 35 inches (880 mm). In the lower reaches of the Huang He, only 20 to 25 inches (500 to 650 mm) falls annually. The Northeast generally receives more precipitation than the North China Plain, with upwards of 40 or more inches falling in the Changbai Mountains.

The southeast monsoon loses much of its moisture by the time it reaches the northern part of the Loess Plateau, where the annual precipitation is reduced to between 12 and 20 inches (300 and 500 mm). Northwest of a line linking the Da Hinggan (Greater Khingan), *Yin*, *Lang*, Qilian, and Altun ranges, the annual precipitation is less than 10 inches (250 mm). Because these regions are far from the sea, high mountains prevent the southern monsoon from reaching them, and only grasslands are found there. In western Inner Mongolia, the Gansu Corridor, and the Tarim Basin, the annual precipitation drops to 4 inches (100 mm) or less. These are areas of true desert, where sometimes not a single drop of moisture is received for several years.

The Junggar Basin and the *Ili River* valley of northern Xinjiang are open to the influences of the westerlies, and precipitation is heavier there. Precipitation on the Plateau of Tibet, following the national pattern, decreases from southeast to northwest. More than 40 inches falls annually in the valleys in the southeastern part of the plateau, and the eastern edge receives 20 inches. However, in the enclosed Qaidam Basin in the north, the yearly total is only 4 to 10 inches.

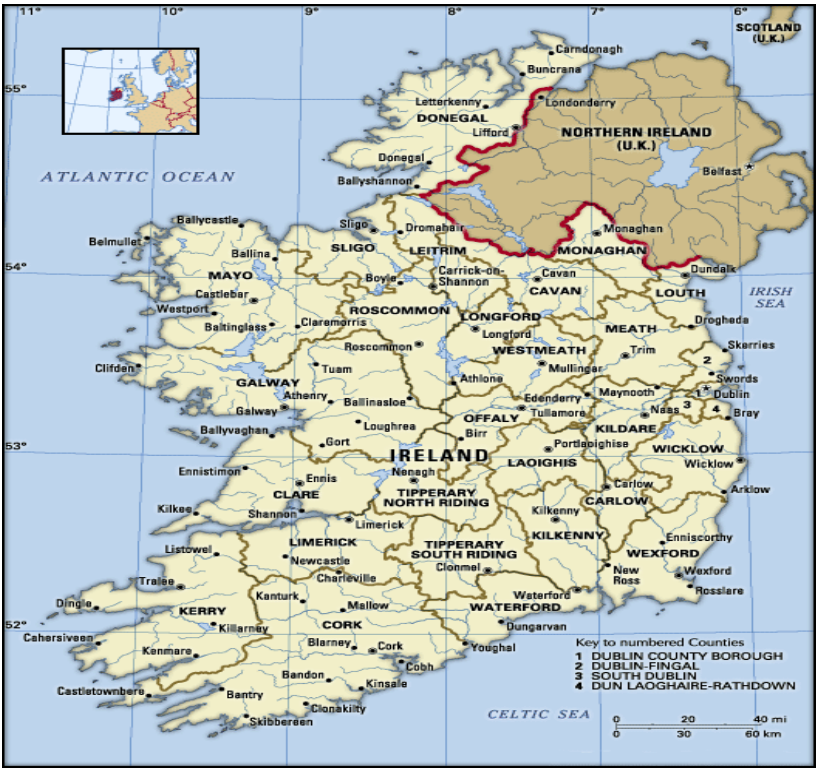
The high variability of precipitation is another characteristic of China's climate. Usually, variability increases as annual amounts decrease, a circumstance that is closely connected with the country's high frequency of drought and flood. Spring rain is of immense significance to Chinese farmers, but spring is also the season with the highest variability. In South China the variability exceeds 40 percent, along the Yangtze it is about 45 percent, and in North China it is more than 50 percent. The variability of a vast area in North China exceeds 70 percent in some places; east of Beijing, for example, the rainfall variability in spring may even exceed 80 percent, as it also does in the central parts of the Yunnan-Guizhou Plateau.

Rain falls mostly in the summer months, when plants need water the most. This is an important asset for farmers, but summer rainfall is usually too intense. In July, when the frontal zone shifts northward, cyclones (circulation of winds around centres of low atmospheric pressure) are much more active in North China than in South China, and North China begins to receive heavier rainfall. More than half the area of the North China Plain records 0.8 inch (20 mm) of rainfall daily, and in some places it may reach as much as 1 inch (25 mm) or more daily. During that time, areas south of the Yangtze are covered by the tropical Pacific air mass, so that the weather becomes comparatively stable, the amount of rainfall usually decreases, and the average rainfall intensity is less than that of June. The intensity of August rainfall is in general less than that of July.

In the southeastern coastal regions, around *Fuzhou* and *Shantou,* the maximum daily rainfall may even approach 12 inches (300 mm). Such accumulations are directly related to the high frequency of typhoons (*tropical cyclones*) striking that part of the coast, usually during the period from May to November; July, August, and September are the three months when typhoons are the most frequent.

In May, typhoons usually strike the coast south of Shantou. Later in June they shift northward, arriving between Shantou and *Wenzhou*, and after July they invade areas north of Wenzhou. August has the highest frequency of typhoon invasions, when more than one-third of the typhoons reaching China arrive. After September the frequency of typhoons decreases, and the pattern again shifts southward. In October, typhoons usually land south of Wenzhou; the late typhoons arriving in November and December strike south of Shantou.

DUBLIN



Ireland's climate is classified as western maritime. The predominant influence is the *Atlantic Ocean*, which is no more than 70 miles (112 km) from any inland location. The mild southwesterly winds and warm waters of the *North Atlantic Current* contribute to the moderate quality of the climate. Temperature is almost uniform over the entire island. Average air temperatures lie mainly between limits of 39 and 45 °F (4 and 7 °C) in January and February, the coldest months of the year. In July and August, the warmest months, temperatures usually range between 57 and 61 °F (14 and 16 °C), although occasionally considerably higher readings are recorded. The sunniest months are May and June, when there is sunshine for an average duration of 5.5 and 6.5 hours a day, respectively, over most of the country and the ancient patchwork of fields and settlements making up the landscape glows under a clear, vital light. Average annual precipitation varies from about 30 inches (760 mm) in the east to more than 100 inches (2,533 mm) in the western areas exposed to the darkening clouds that often come scudding in from the Atlantic. The precipitation, combined with the equable climate, is particularly beneficial to the grasslands, which are the mainstay of the country's large livestock population. Snow is infrequent except in the mountains, and prolonged or severe snowstorms are rare.

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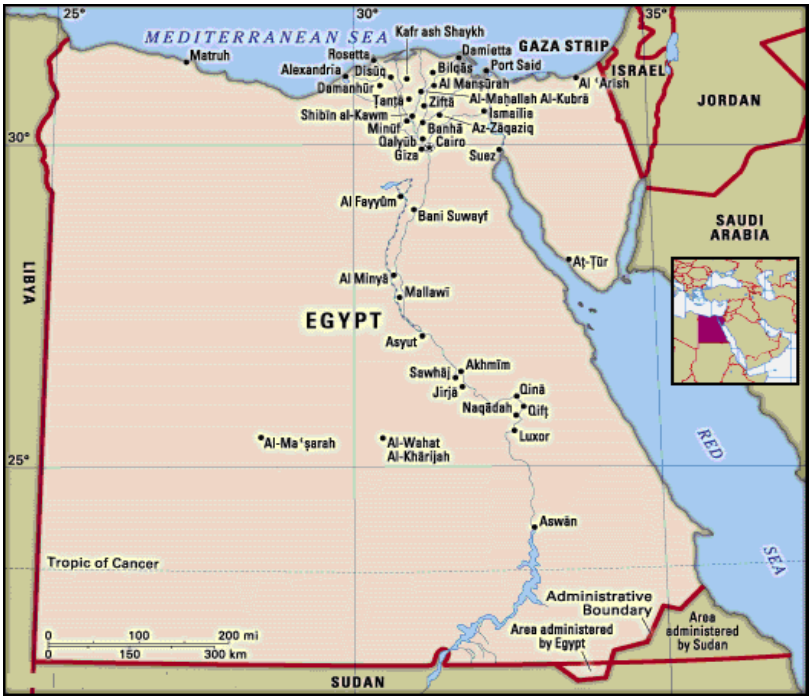
EGYPT



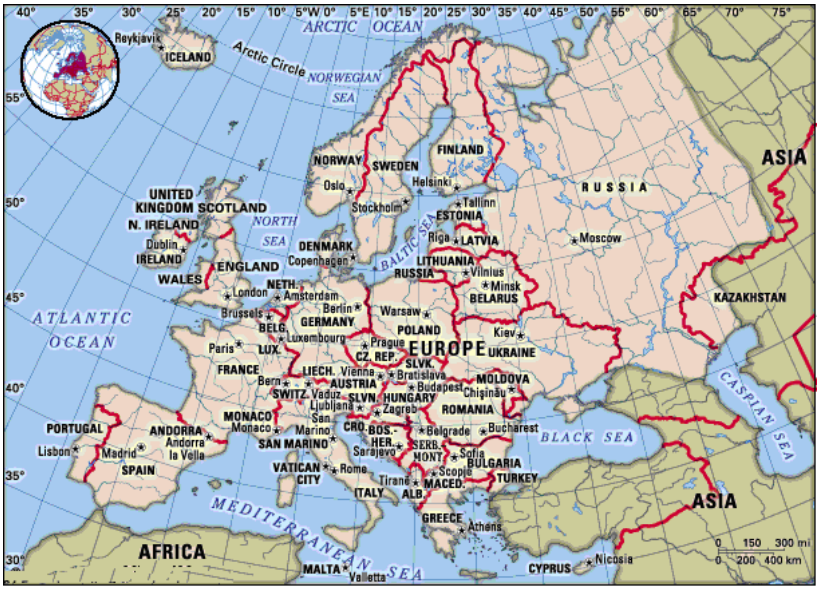
Egypt lies within the North African desert belt; its general climatic characteristics, therefore, are low annual rainfall and a considerable seasonal and diurnal (daily) temperature range, with sunshine occurring throughout the year. In the desert, cyclones stir up sand or dust storms, called *khamsins*, which occur most frequently from March to June; these are caused by tropical air from the south that moves northward as a result of the extension northeastward of the low-pressure system of The Sudan. A khamsin is accompanied by a sharp increase in temperature of 14 to 20 °F (8 to 11 °C), a drop in relative humidity (often to 10 percent), and thick dust; it can reach gale force.

The climate is basically biseasonal, with winter lasting from November to March and summer from May to September, with short transitional periods intervening. The winters are cool and mild, and the summers are hot. Mean January minimum and maximum temperatures show a variation between 48 and 65 °F (9 and 18 °C) in Alexandria and 48 and 74 °F (9 and 23 °C) at Aswan. The summer months are hot throughout the country, with mean midday June maximum temperatures ranging from 91 °F (33 °C) at Cairo to 106 °F (41 °C) at Aswan. Egypt enjoys a very sunny climate, with some 12 hours of sunshine per day in the summer months and between eight and 10 hours per day in winter. Extremes of temperature can occur, and prolonged winter cold spells or summer heat waves are not uncommon.

Humidity diminishes noticeably from north to south and on the desert fringes. Along the Mediterranean coast the humidity is high throughout the year, but it is highest in summer. When high humidity levels coincide with high temperatures, oppressive conditions result.

The rainfall in Egypt occurs largely in the winter months; it is meagre on average but highly variable. The amount diminishes sharply southward; the annual average at Alexandria is about seven inches (178 millimetres), Cairo has about one inch, and Aswan receives only about one-tenth of an inch. The Red Sea coastal plain and the Western Desert are almost rainless. The Sinai Peninsula receives somewhat more rainfall: the northern sector has an annual average of about five inches.

EUROPE



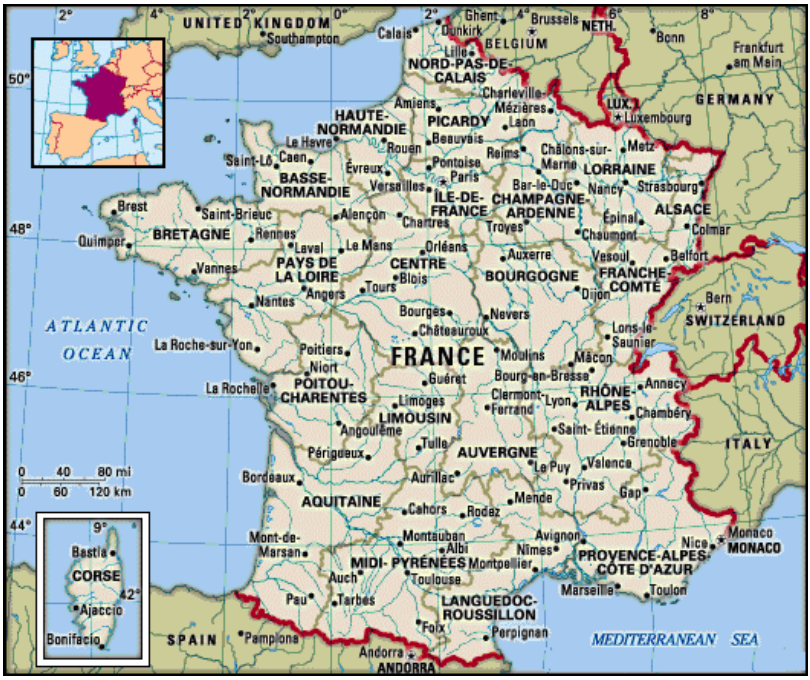
Patterns of some permanence controlling air-mass circulation are created by belts of air pressure over five areas. They are: the *Icelandic low*, over the North Atlantic; the *Azores high*, a high-pressure ridge; the (winter) Mediterranean low; the Siberian high, centred over Central Asia in winter but extending westward; and the Asiatic low, a low-pressure, summertime system over southwestern Asia. Given these pressure conditions, westerly winds prevail in northwestern Europe during the year, becoming especially strong in winter. The winter *westerlies*, often from the southwest, bring in warm tropical air; in summer, by contrast, they veer to the northwest and bring in cooler Arctic or subarctic air. In Mediterranean Europe the rain-bearing westerlies chiefly affect the western areas, but only in winter. In winter the eastern Mediterranean basin experiences bitter easterly and northeasterly winds derived from the Siberian high, and their occasional projection westward explains unusually cold winters in western and central Europe, the exceptionally warm winters of which, on the other hand, result from the sustained flow of tropical maritime air masses. In summer the Azores high moves 5°–10° of latitude northward and extends farther eastward, preventing the entry of cyclonic storms into the resultantly dry Mediterranean region. The eastern basin, however, experiences the hot and dry north and northeast summer winds called etesian by the ancient Greeks. In summer, too, the Siberian high gives place to a low-pressure system extending westward, so that westerly air masses can penetrate deeply through the continent, making summer a wet season.

It is because of the interplay of so many different air masses that Europe experiences very changeable weather. Winters get sharply colder eastward, but summer temperatures relate fairly closely to latitude. Northwestern Europe, including Iceland, enjoys some amelioration because of warm Gulf Stream waters, which keep the Russian port of Murmansk open throughout the year.

Four regional European climatic types can be loosely distinguished, each characterized by much local topographically related variation. Further, the great cities of Europe, because of the scale and grouping of their buildings, their industrial activities, and the layout of their roads, create distinct local climates—including a central "heat island" and pollution problems. Characterizing western areas heavily exposed to Atlantic air masses, the maritime type of climate—given the latitudinal stretch of these lands—exhibits sharp temperature ranges. Thus, the January and July annual averages of *Reykjavík* (Iceland) and *Coruña* (Spain) are, respectively, 32° F (0° C) and 53° F (12° C), and 50° F (10° C) and 64° F (18° C). Precipitation is always adequate—indeed, abundant on high ground—falling the year round. The greatest amount of precipitation occurs in autumn or early winter. Summers range from warm to hot depending on the latitude and altitude, and the weather is everywhere changeable. The maritime climate extends across Svalbard, Iceland, the Faeroes, Great Britain and Ireland, Norway, southern Sweden, western France, the Low Countries, northern Germany, and northwestern Spain. The central European, or transitional, type of climate results from the interaction of both maritime and continental air masses and is found at the core of Europe, south and east of the maritime type, west of the much larger continental type, and north of the Mediterranean type. This rugged region has colder winters, with substantial mountain snowfalls, and warmer summers, especially in the lowlands. Precipitation is adequate to abundant, with a summer maximum. The region embraces central Sweden, southern Finland, the Oslo Basin of Norway, eastern France, southwestern Germany, and much of central and southeastern Europe. The range between winter and summer temperatures increases eastward, while the rainfall can exceed 80 inches (2,000 millimetres) in the mountains, with snow often lying permanently around high peaks. The Danubian region has only modest rainfall (24 inches per year at *Budapest*), but the Dinaric Alps experience heavy cyclonic winter, as well as summer, rain.

The continental type of climate dominates a giant share of Europe, covering northern Ukraine, eastern Belarus, Russia, most of Finland, and northern Sweden. Winters—much colder and longer, with greater snow cover than in western Europe—are coldest in the northeast, and summers are hottest in the southeast; the January to July mean temperatures range from 50° to 70° F (10° to 21° C). Summer is the period of maximum rain, which is less abundant than in the west: *Moscow's* annual average is 25 inches, while, in both the north and southeast of the East European Plain, precipitation reaches only between 10 and 20 inches annually. In parts of the south, the unreliability of rainfall combines with its relative scarcity to raise a serious aridity problem. The subtropical Mediterranean climate characterizes the coastlands of southern Europe, being modified inland (for example in the Meseta Central, the Apennines, and the North Italian Plain) in response to altitude and aspect. The main features of this climatic region are mild and wet winters, hot and dry summers, and clear skies, but marked regional variations occur between the lands of the western and the more southerly eastern basins of the Mediterranean; the former are affected more strongly by maritime-air-mass intrusions. Rainfall in southern Europe is markedly reduced in areas lying in the lee of rain-bearing westerlies: *Rome* has an annual mean of 26 inches, but *Athens* has only 16 inches.

FRANCE



The pure oceanic climate prevails in the northwest, especially in Brittany. It is characterized by its low annual temperature variation, with Brest having an average temperature in January of 43 °F (6 °C) and in July of 61 °F (16 °C); by its extreme humidity and moderate rainfall (35 inches [890 mm] of rain falling through the year), accompanied by cloudiness and haze; by the frequency and sometimes the violence of the west winds that blow almost constantly; and by large variations in the weather, which can change several times a day. This oceanic climate is somewhat modified toward the north, where the winters are cooler, and toward the south, where, in the Aquitaine Basin, the winters are mild and the summers warmer. There is also less rainfall, although at Toulouse great summer storms are quite frequent.

The plains of the northeast are particularly affected by a *continental climate*. The city of *Strasbourg* has the greatest temperature range in France. Winter is cold, with an average of 83 days of frost and with snow cover for several weeks, although the weather is often sunny. In summer, storms cause maximum precipitation in the region in June and July, although total rainfall is comparatively light.

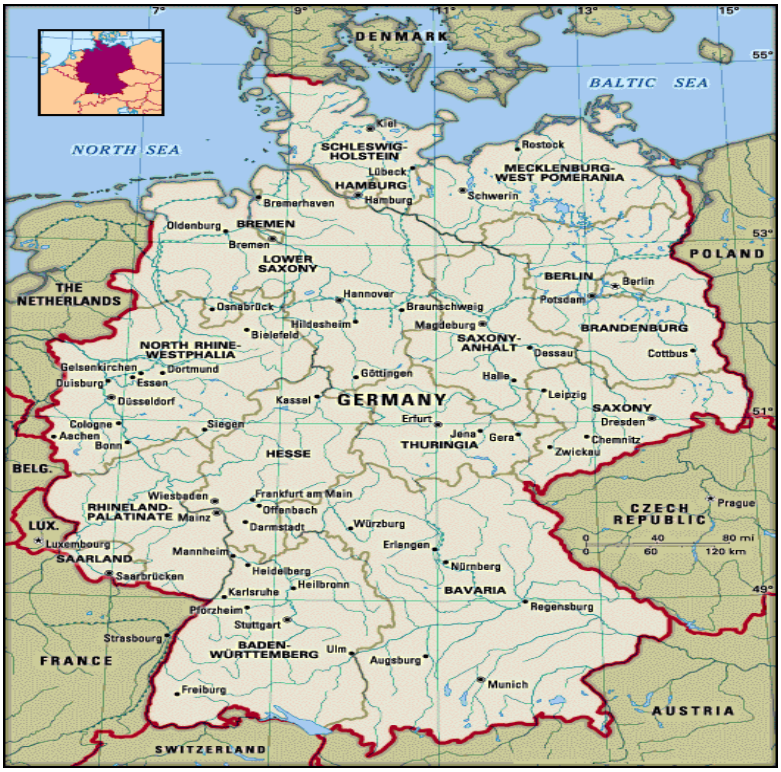
The climate of the Paris Basin is somewhere between the oceanic and the continental. The average yearly temperature is 53 °F (11 °C) in Paris. In addition, the relatively light annual rainfall (23 inches [58 cm]) follows a pattern of moderately heavy rain in spring and early summer and autumn, as in the oceanic countries, but the maximum amount of rain falls in summer, with storms of the continental type. In summer, spray irrigation is needed for crops in the continental climatic region and the Paris Basin.

In the southeast the *Mediterranean climate* extends over the coastal plains and penetrates the valley of the lower Rhône River as far as the Montélimar area. It affects the southern Alps, the southeastern slopes of the Cévennes and the Noire Mountains (in the Massif Central), and the eastern Pyrenees. The latitude and the proximity of the warm Mediterranean Sea contribute to mild winters, with an average temperature of 47 °F (8 °C) in January at Nice and with only a few days of frost. Precipitation is heavy and tends to fall in sudden downpours, especially in the autumn and spring, whereas summer is nearly completely dry for at least three months. In coastal Languedoc-Roussillon, annual rainfall totals can be as low as 17 to 20 inches (430 to 500 mm). It is a unique area because of its clear skies and the regularity of fine weather. This area is also subject to the violent north winds called the mistral, which are peculiar to southern France. The winds are caused by high-pressure areas from central France that move toward the low-pressure areas of the Gulf of Genoa. Permanent irrigation systems are characteristic of the Mediterranean lowlands.

The Aquitaine Basin is intermediate between the oceanic and the Mediterranean climates. Winters tend toward the oceanic type, but springs and summers are warm, although less arid than in the Mediterranean zone.

The mountains have varied climates. West-facing slopes in the Pyrenees have some of the highest precipitation figures in France. Snow cover stays from December to the end of April above 3,000 feet (900 metres) and is perpetual above 9,000 feet (2,700 metres) in the Alps and 10,000 feet (3,000 metres) in the Pyrenees. Locally, the contrast between the sunny south-facing valley slopes (adrets) and the shaded north-facing slopes (ubacs) can be of great importance for land use and settlement, while some intermontane basins can have quite advantageous climates as opposed to that of the surrounding peaks and plateaus.

GERMANY



Germany is favoured with a generally temperate climate, especially in view of its northerly latitudes and the distance of the larger portions of its territory from the warming influence of the *North Atlantic Current*. Extremely high temperatures in the summer and deep, prolonged frost in the winter are rare. These conditions, together with a more-than-abundant and well-distributed amount of rainfall, afford ideal conditions for raising crops. As throughout western Europe in general, however, Germany's climate is subject to quick variations when the moderate westerly winds from the Atlantic Ocean collide with the cold air masses moving in from northeastern Europe. Whereas in the open coastlands near the North and Baltic seas the maritime component prevails, continental elements gain in importance moving toward the east and southeast.

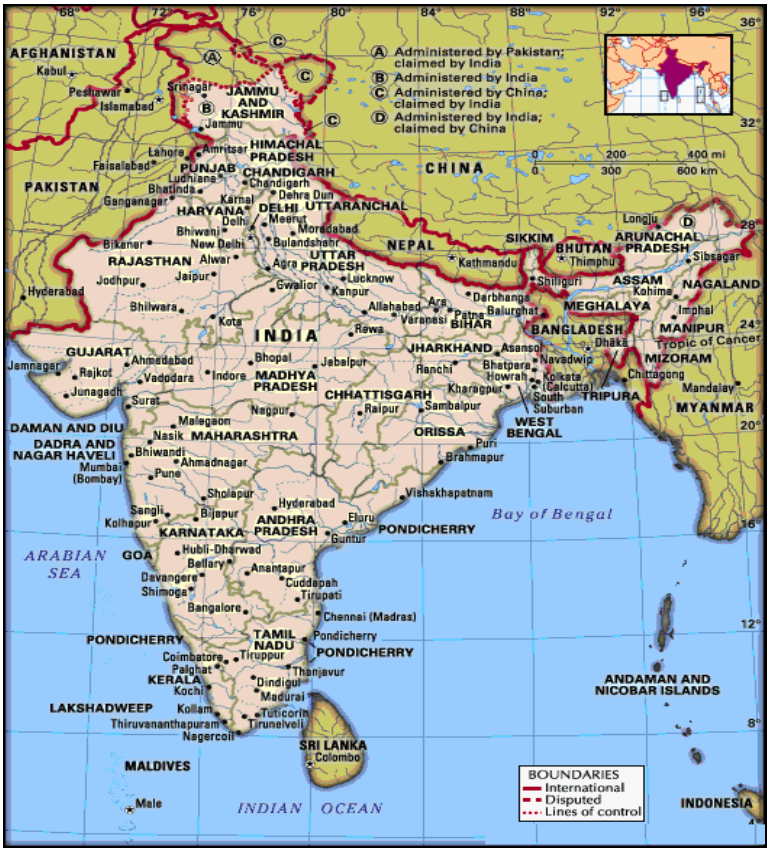
Seasonal weather is subject to great variations from year to year. Winters may be unusually cold or prolonged, particularly in the higher elevations in the south, or mild, with the temperatures hovering only two or three degrees above or below the freezing point. Spring may arrive early and extend through a hot, rainless summer to a warm, dry autumn with the threat of drought. In other years, spring—invariably interrupted by a frosty lapse in May, popularly known as die drei Eisheiligen ("the three ice saints")—may arrive so late as to be imperceptible and be followed by a cool, rainy summer. One less-agreeable feature of the German climate is the almost permanent overcast in the cool seasons, only infrequently accompanied by precipitation; it sets in toward the latter part of autumn and lifts as late as March or April. Thus, for months on end, little sunshine may appear.

Despite the country's generally temperate climate, there are specific regional patterns associated with temperature, frequency of sunshine, humidity, and precipitation. Germany's northwestern and lowland portions are affected chiefly by the uniformly moist air, moderate in temperature, that is carried inland from the North Sea by the prevailing westerly winds. Although this influence affords moderately warm summers and mild winters, it is accompanied by the disadvantages of high humidities, extended stretches of rainfall, and, in the cooler seasons, fog. Precipitation diminishes eastward, as the plains open toward the Eurasian interior and the average temperatures for the warmest and coldest months become more extreme. The hilly areas of the central and southwestern regions and, to an even greater degree, the upland and plateau areas of the southeast are subject to the more pronounced ranges of hot and cold from the countervailing continental climate. The mountains have a wetter and cooler climate, with westward-facing slopes receiving the highest rainfall from maritime air masses. The *Brocken* in the Harz mountains receives annual precipitation of some 60 inches (1,500 mm) at an altitude in excess of 3,700 feet (1,100 metres). The sheltered lee slopes and basins have, by contrast, rainfall that is extremely low—Alsleben receives about 17 inches (432 mm) annually—and hot summers—July mean temperatures above 64 °F (18 °C)—that necessitate crop irrigation. Southeastern Germany may intermittently be the coldest area of the country in the winter, but the valleys of the Rhine, Main, Neckar, and Moselle rivers may also be the hottest in the summer. Winters in the North German Plain tend to be consistently colder, if only by a few degrees, than in the south, largely because of winds from Scandinavia. There is also a general decrease of winter temperature from west to east, with Berlin having an average temperature in January of 31.5 °F (-0.3 °C).

One anomaly of the climate of Upper Bavaria is the occasional appearance of warm, dry air passing over the northern Alps to the Bavarian Plateau. These mild winds, known as *foehn*s (Föhn), can create an optical phenomenon that makes the Alps visible from points where they normally would be out of sight, and they also are responsible for the abrupt melting of the snow.

Annual mean precipitation varies according to region. It is lowest in the North German Plain, where it fluctuates from 20 to 30 inches (500 to 750 mm); in the Central German Uplands it ranges from nearly 30 to about 60 inches (750 to 1,500 mm) and in the Alpine regions up to and exceeding 80 inches (2,000 mm).

INDIA



India provides the world's most pronounced example of a monsoon climate. The wet and dry seasons of the monsoon system, along with the annual temperature fluctuations, produce three general climatic periods over much of the country: (1) hot, wet weather from about mid-June to the end of September, (2) cool, dry weather from early October to February, and (3) hot, dry weather (though normally with high atmospheric humidity) from about March to mid-June. The actual duration of these periods may vary by several weeks, not only from one part of India to another but also from year to year. Regional differences, which are often considerable, result from a number of internal factors—including elevation, type of relief, and proximity to bodies of water. A monsoon system is characterized by a reversal of prevailing wind directions and by alternating wet and dry seasons. In India the wet season, called the southwest monsoon, occurs from about mid-June to early October, when winds from the Indian Ocean carry moisture-laden air across the subcontinent, causing heavy rainfall and often considerable flooding. Usually about three-fourths of the country's total annual precipitation falls during these months.

During the driest months (called the retreating monsoon), especially from November through February, this pattern is reversed, as dry air from the Asian interior moves across India toward the ocean. October and March through May, by contrast, are typically periods of desultory breezes with no strong prevailing patterns.

Although the winds of the rainy season are called the southwest monsoon, they actually follow two generally distinct branches, one initially flowing eastward from the Arabian Sea and the other northward from the Bay of Bengal. The former begins by lashing the west coast of peninsular India and rising over the adjacent Western Ghats. When crossing these mountains, the air cools (thus losing its moisture-bearing capacity) and deposits rain copiously on the windward side of that highland barrier. Annual precipitation in parts of this region exceeds 100 inches (2,540 millimetres) and is as high as 245 inches at *Mahabaleshwar* on the crest of the *Western Ghats*. Conversely, as the winds descend on the leeward side of the Western Ghats, the air's moisture-bearing capacity increases and the resultant *rain shadow* makes for a belt of semiarid terrain, much of it with less than 25 inches of rain per year.

The Bay of Bengal branch of the monsoon sweeps across eastern India and Bangladesh and, in several areas, gives rise to rainfall in much the same way as occurs along the Western Ghats. The effect is particularly pronounced in the *Shillong* (Meghalaya) Plateau, where at Cherrapunji the average annual rainfall is 450 inches, one of the heaviest in the world. The Brahmaputra valley to the north also experiences a rain-shadow effect; the problem is mitigated, however, by the adjacent Himalayas, which cause the winds to rise again, thereby establishing a parallel belt of heavy rainfall. Blocked by the Himalayas, the Bay of Bengal branch of the monsoon is diverted westward up the Gangetic Plain, reaching Punjab only in the first week of July.

In the Gangetic Plain the two branches merge into one. By the time they reach the Punjab their moisture is largely spent. The gradual reduction in the amount of rainfall toward the west is evidenced by the decline from 64 inches at Calcutta to 26 inches at Delhi and to desert conditions still farther west. Over the northeastern portion of peninsular India, the two branches also intermittently collide, creating weak weather fronts with sufficient rainfall to produce patches of fairly high precipitation (more than 60 inches) in the Chota Nagpur Plateau.

Much of India experiences infrequent and relatively feeble precipitation during the retreating monsoon. An exception to this rule occurs along the southeastern coast of India and for some distance inland. When the retreating monsoon blows from the northeast across the Bay of Bengal, it picks up a significant amount of moisture, which is subsequently released after moving back onto the peninsula. Thus, from October to December the coast of *Tamil Nadu* receives at least half of its roughly 40 inches of annual precipitation. This rainy extension of the generally dry retreating monsoon is called the northeast, or winter, monsoon.

Another type of winter rainfall occurs in northern India, which receives weak cyclonic storms originating in the Mediterranean basin. In the Himalayas these storms bring weeks of drizzling rain and cloudiness and are followed by waves of cold temperatures and snowfall. The state of Jammu and Kashmir in particular receives much of its precipitation from these storms.

Fierce tropical cyclones occur in India during what may be called the premonsoon, early monsoon, or postmonsoon periods. Originating in both the Bay of Bengal and the Arabian Sea, tropical cyclones often attain velocities of more than 100 miles per hour and are notorious for causing intense rain and tidal waves as they cross the coast of India. The Andhra, Orissa, and West Bengal coasts are especially susceptible to such storms.

Temperatures in India generally are the warmest in May or June, just prior to the cooling downpours of the southwest monsoon. A secondary maximum often occurs in September or October when precipitation wanes. The temperature range tends to be significantly less along the coastal plains than in interior locations. The range also tends to increase with latitude. Near India's southern extremity the seasonal range is no more than a few degrees; for example, at Trivandrum, in Kerala, there is an average fluctuation of just 4.3 °F (2.4 °C) around an annual mean temperature of 81 °F (27 °C). In the northwest, however, the range is much greater, as, for example, at Ambala, in Haryana, where the temperature fluctuates from 56 °F (13 °C) in January to 92 °F (33 °C) in June. Temperatures are also moderated wherever elevations are significant, and many Himalayan resort towns, called hill stations (a legacy of British colonial rule), afford welcome relief from India's sometimes oppressive heat.

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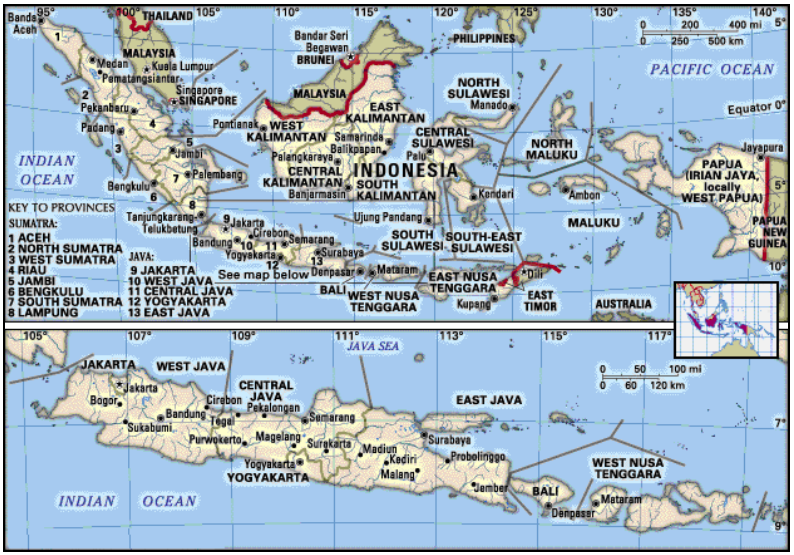
INDONESIA



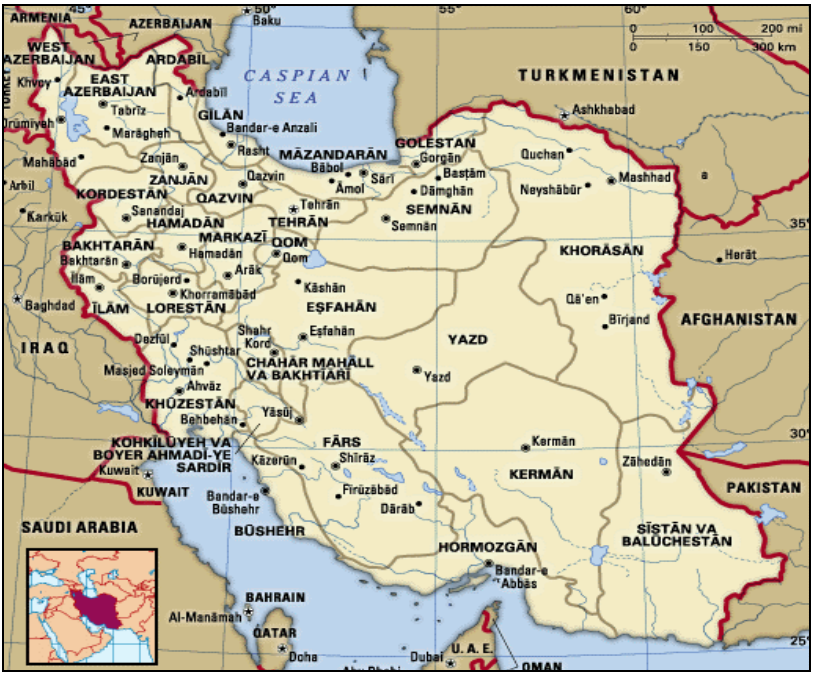
The climate of Indonesia is controlled by its island structure and position astride the Equator, which assure high, even temperatures, and by its location between the two landmasses of Asia and Australia, which strongly influences the monsoonal rainfall patterns. Temperatures are uniformly high and are a function of elevation rather than latitude. They are highest along the coast, where mean annual temperatures range from 74 to 88 °F (23 to 31 °C) and are moderated considerably above 2,000 feet (600 metres). The only area high enough to receive snow is the Maoke Mountains of Papua. The diurnal difference of temperature in Jakarta is at least five times as great as the difference between high and low temperatures of January and July; the highest temperature ever recorded in Jakarta was 99 °F (37 °C), and the lowest was 66 °F (19 °C).

Rainfall is more varied in extremes and distribution. Most of Indonesia receives heavy precipitation throughout the year, the greatest amounts occurring from December to March. From central Java eastward toward Australia, however, the dry season (June to October) is progressively more pronounced; on the islands of Timor and Sumba, there is little rain during these months. The highest amount of rainfall occurs in the mountainous regions of Sumatra, Kalimantan, Celebes, and Papua, where more than 120 inches (3,000 mm) falls annually. The rest of Kalimantan, Sumatra, and Papua; western and central Java; and much of Celebes and the Moluccas average at least 80 inches (2,000 mm) of rainfall per year. Eastern Java, Bali, southern and central Celebes, and Timor generally receive between 60 and 80 inches (1,500 and 2,000 mm); while the Lesser Sunda Islands that are closest to Australia have only 40 to 60 inches (1,000 to 1,500 mm).

The absolute daily maximum of rainfall can be extremely high, with a number of stations recording between 20 and 28 inches (500 and 700 mm). Local variations, caused in large part by geographic features, are great. Jakarta, for example, near sea level, has a mean annual rainfall of 70 inches (1,750 mm), while *Bogor*, which is 30 miles (50 km) south toward the mountains, at an elevation of about 790 feet (240 metres), records nearly 170 inches (4,300 mm) of rainfall.

Seasonal variations are caused by *monsoonal* Asian air drifts and the convergence of tropical air masses from both north and south of the Equator along an intertropical front of low pressure. The monsoon pattern in any given part of the archipelago depends on location either north or south of the Equator, proximity to Australia or mainland Asia, and the position of the intertropical front. During December, January, and February, the west monsoon, reflecting Asian influence, brings heavy rain to southern Sumatra, Java, and the Lesser Sunda Islands. In June, July, and August, these areas are affected by the east monsoon, which brings dry air from Australia. Only the Lesser Sunda Islands and eastern Java have a well-developed dry season, which increases in length toward Australia. By the time the east monsoon has crossed the Equator—becoming the southwest monsoon of the Northern Hemisphere—its winds have become humid and a source of rain. Sumatra and Kalimantan, which are located close to the Equator and far from Australia, have no dry season, although precipitation tends to be slightly lower during July and August. Strong cyclones and typhoons, which normally occur in higher latitudes, are absent in Indonesia, but afternoon thunderstorms are common.

IRAN

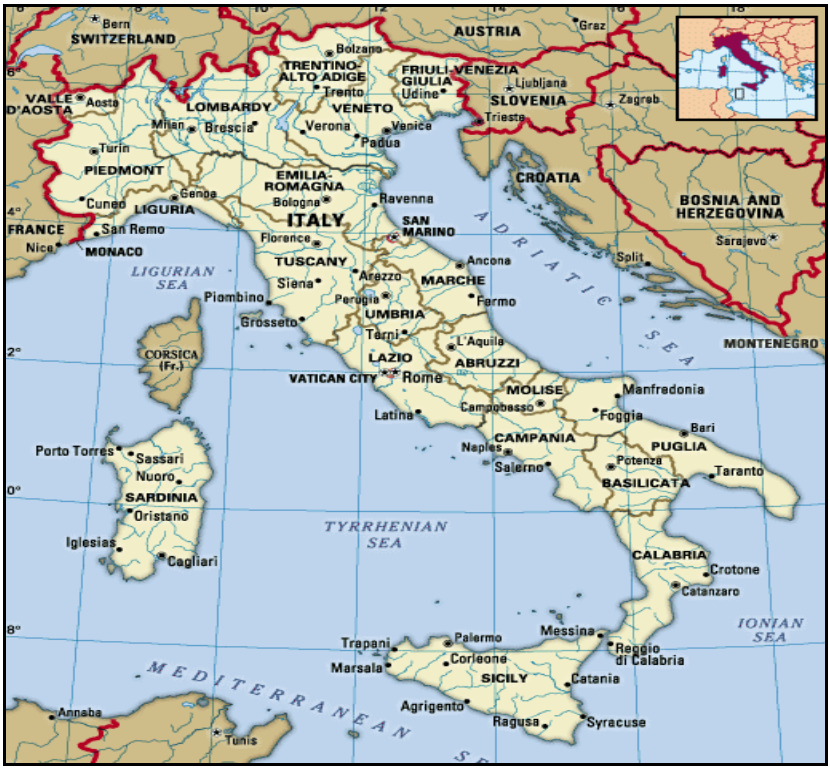


Iran's climate ranges from subtropical to sub polar. In winter a high-pressure belt, centered in Siberia, slashes west and south to the interior of the Iranian plateau, and low-pressure systems develop over the warm waters of the Caspian Sea, the Persian Gulf, and the Mediterranean Sea. In summer one of the world's lowest-pressure centers prevails in the south. Low-pressure systems in Pakistan generate two regular wind patterns: the *shamal*, which blows from February to October northwesterly through the Tigris-Euphrates valley, and the “120-day” summer wind, which can reach velocities of 70 miles (110 km) per hour in the *Sistan* region near Pakistan. Warm Arabian winds bring heavy moisture from the *Persian Gulf*.

Elevation, latitude, maritime influences, seasonal winds, and proximity to mountain ranges or deserts play a significant role in diurnal and seasonal temperature fluctuation. The average daytime summer temperature in *Abadan* in *Khuzestan* province tops 110 °F (43 °C), and the average daytime winter high in *Tabriz* in Azarbayjan (Azerbaijan) province barely reaches freezing. Precipitation also varies widely, from less than 2 inches (50 mm) in the southeast to about 78 inches (1,980 mm) in the Caspian region. The annual average is about 16 inches (400 mm). Winter is normally the rainy season for the country; more than half of the annual precipitation occurs in that three-month period. The northern coastal region presents a sharp contrast. The high Elburz Mountains, which seal off the narrow Caspian plain from the rest of the country, wring moisture from the clouds, trap humidity from the air, and create a fertile semitropical region of luxuriant forests, swamps, and rice paddies.

Temperatures there may soar to 100 °F (38 °C) and the humidity to nearly 100 percent, while frosts are extremely rare. Except in this region, summer is a dry season. The northern and western parts of Iran have four distinct seasons. Toward the south and east, spring and autumn become increasingly short and ultimately merge in an area of mild winters and hot summers.

ITALY



Geographically, Italy lies in the temperate zone. Because of the considerable length of the peninsula, there is a variation between the climate of the north, attached to the European continent, and that of the south, surrounded by the Mediterranean. The Alps are a partial barrier against westerly and northerly winds, while both the Apennines and the great plain of northern Italy produce special climatic variations. Sardinia is subject to Atlantic winds and Sicily to African winds. In general, four meteorological situations dominate the Italian climate: the Mediterranean winter cyclone, with a corresponding summer anticyclone; the Alpine summer cyclone, with a consequent winter anticyclone; the Atlantic autumnal cyclone; and the eastern Siberian autumnal anticyclone. The meeting of the two last-mentioned air masses brings heavy and sometimes disastrous rains in the autumn.

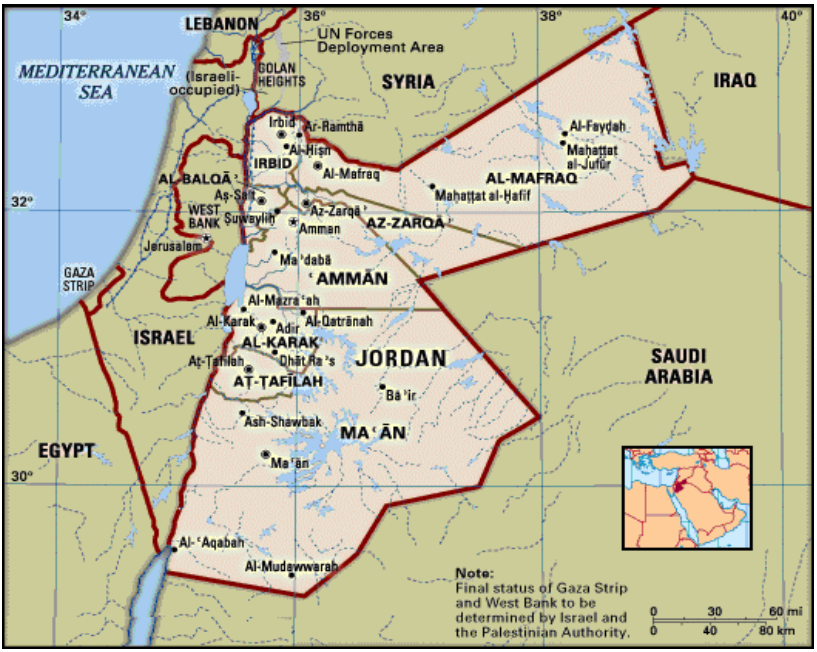
Italy can be divided into seven main climatic zones. The most northerly, the Alpine zone, has a continental mountain climate, with temperatures lower and rainfall higher in the east than in the west. At Bardonecchia, in the west, the average temperature is 45.3 °F (7.4 °C), and the average annual rainfall is 26 inches (660 mm); at Cortina d'Ampezzo, in the east, the figures are 43.9 °F (6.6 °C) and 41.5 inches (1,055 mm). In the Valle d'Aosta, in the west, the permanent snow line is at 10,200 ft (3,110 m), but in the Julian Alps it is as low as 8,350 ft (2,545 m). In autumn and in late winter the hot, dry wind that is known as

the *foehn* blows from Switzerland or Austria, and in the east the cold, dry *bora* blows with gusts up to 125 miles (200 km) per hour. Rain falls in the summer in the higher and more remote areas and in the spring and autumn at the periphery. Snow falls only in the winter; the snowfall varies from about 10 to 33 ft (3 to 10 m) in different years and in relation to altitude or proximity to the sea. More snow falls in the foothills than in the mountains and more in the Eastern than in the Western Alps. Around the lakes the climate is milder, the average temperature in January at Milan being 34 °F (1 °C), while at Salò, on Lake Garda, it is 39 °F (4 °C).

The Po valley has hot summers but severe winters, worse in the interior than toward the eastern coast. At *Turin* the average winter temperature is 32.5 °F (0.3 °C) and the summer average 74 °F (23 °C). Rain falls mainly in the spring and autumn and increases with elevation. There is scant snow, and that falls only on the high plain. The temperatures along the Adriatic coast rise steadily from north to south, partly because of the descending latitude and partly because the prevailing winds are easterly in the north but southerly in the south. The average annual mean temperature rises from 56.5 °F (13.6 °C) at Venice to 61 °F (16 °C) at *Ancona* and 63 °F (17 °C) at *Bari*. There is scant rain: Venice has an average of 29.5 inches (750 mm), Ancona 25.5 inches (650 mm), and Bari 23.6 inches (600 mm).

In the Apennines the winters vary in severity according to the altitude. Except at specific locations, there are but moderate amounts of both rain and snow; in the cyclonic conditions of midwinter there may be sudden snowfalls in the south. The annual mean temperatures are 53.8 °F (12.1 °C) at *Urbino*, in the east, and 54.5 °F (12.5 °C) at *Potenza*, in *Basilicata*; the annual rainfall is, respectively, 35 inches (890 mm) and 39.6 inches (1,000 mm). Along the Tyrrhenian coast and the Ligurian rivieras in the north, both temperature and rainfall are influenced by full exposure to the noonday sun, by the nearness of the sea, with its prevailing southwesterly winds, and by the Apennine range, which protects the area from the cold north winds. The eastern riviera has more rain than the western: rainfall at *La Spezia*, on the eastern riviera, is 45.2 inches (1,150 mm), while at *San Remo*, on the western riviera, it is 26.7 inches (680 mm). Farther south, where the coastal areas extend a great distance inland and are flatter, the mean temperature and annual rainfall are 58.6 °F (14.8 °C) and 30.3 inches (770 mm) at Florence and 61.9 °F (16.6 °C) and 31.4 inches (800 mm) at Naples. As a rule, the Tyrrhenian coast is warmer and wetter than the Adriatic coast. Both Calabria and Sicily are mountainous regions that are surrounded by the Mediterranean, and they therefore have higher temperatures than the high regions of the Italian mainland farther north. Winter rains are scarce in the interior and heavier in the west and north of Sicily. At *Reggio di Calabria* the annual mean temperature is 64.7 °F (18.2 °C) and rainfall is 23.5 inches (595 mm); at *Palermo*, in Sicily, they are 64.4 °F (18 °C) and 38.2 inches (970 mm). The *sirocco*, a hot, very humid, and oppressive wind, blows frequently from Africa and the Middle East. In Sardinia conditions are more turbulent on the western side, and the island suffers from the cold *mistral* blowing from the northwest and also from the sirocco blowing from the southwest. At *Sassari*, in the northwest, the annual mean temperature is 62.6 °F (17 °C) and the rainfall 22.8 inches (580 mm), while at Orosei, on the east coast, the temperature is 63.5 °F (17.5 °C) and the rainfall 21.2 inches (540 mm).

JORDAN



Jordan's climate varies from Mediterranean in the west to desert in the east and south, but the land is generally arid. The proximity of the Mediterranean Sea is the major influence on climates, although continental air masses and elevation modify it. Average monthly temperatures at the capital in the north range between 46 and 78 °F (8 and 26 °C), while at Al-'Aqabah in the far south they range between 60 and 91 °F (16 and 33 °C). The prevailing winds throughout the country are westerly to southwesterly, but spells of hot, dry, dusty winds blowing from the southeast off the Arabian Peninsula frequently occur and bring the country its most uncomfortable weather. Known locally as the *khamsin*, these winds blow most often in the early and late summer and can last for several days at a time before terminating abruptly as the wind direction changes and much cooler air follows.

Precipitation occurs in the short, cool winters, decreasing from 16 inches (400 mm) annually in the northwest near the Jordan River to less than 4 inches (100 mm) in the south. In the uplands east of the Jordan River the annual total is about 14 inches (355 mm). The valley itself has a yearly average of 8 inches (200 mm), and the desert regions receive one-fourth of that. Occasional snow and frost occur in the uplands but are rare in the rift valley. As the population increases, water shortages in the major towns are becoming one of Jordan's crucial problems.

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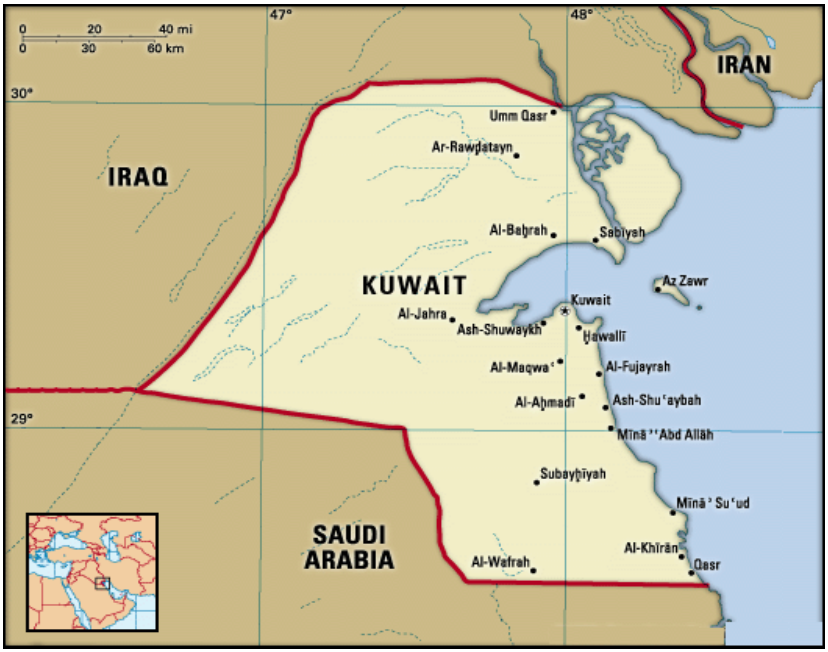
KUWAIT



The climate is desert, tempered somewhat in the coastal regions by the warm waters of the gulf. If there is enough rainfall, the desert turns green from mid-March to the end of April. But during the dry season, between April and September, the heat is severe—daytime temperatures ordinarily reach 111 °F (44 °C) and on occasion approach 130 °F (54 °C). The winter is more agreeable (frost can even occasionally occur in the interior, though never on the seacoast). Annual rainfall averages only from 1 to 7 inches (25 to 180 mm), chiefly between October and April, though cloudbursts can bring more than 2 inches (50 mm) of rain in a single day.

The frequent winds from the northwest are cool in winter and spring and hot in summer. Southeasterly winds, usually hot and damp, spring up between July and October; hot and dry south winds prevail in spring and early summer. The *shamal*, a northwesterly wind common during June and July, causes dramatic sandstorms.

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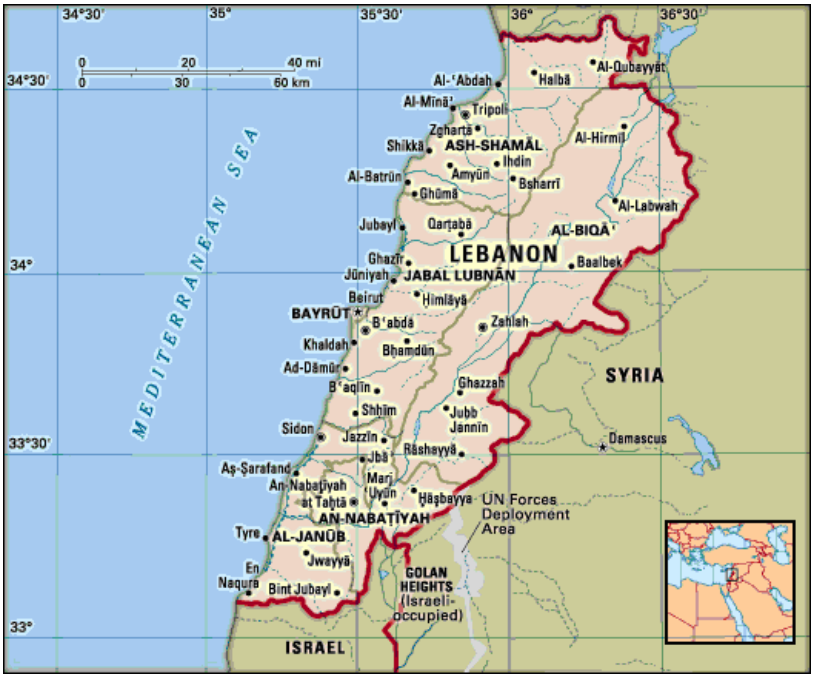
LEBANON



There are sharp local contrasts in climatic conditions. Lebanon is included in the *Mediterranean* climatic region, which extends westward to the Atlantic Ocean. The winter storms formed over the ocean move eastward through the Mediterranean, bringing rain at that season; in summer the Mediterranean receives no rain. The climate of Lebanon is generally subtropical and is characterized by hot, dry summers and mild, humid winters. Mean daily maximum temperatures on the coast and in al-Biqa' range from 90° F (32° C) in July to 60° F (16° C) on the coast and 50° F (10° C) in al-Biqa' in January. Mean minimum temperatures in January are 50° F (10° C) on the coast and 35° F (2° C) in al-Biqa'. At 5,000 feet, the altitude of the highest settlements, these are reduced by about 15° F (8° C).

Nearly all precipitation falls in winter and averages 30 to 40 inches (750 to 1,000 millimetres) on the coast, rising to more than 50 inches in higher altitudes. Al-Biqa' is drier and receives 15 to 25 inches. On the higher mountaintops, this precipitation falls as heavy snow that remains until early summer.

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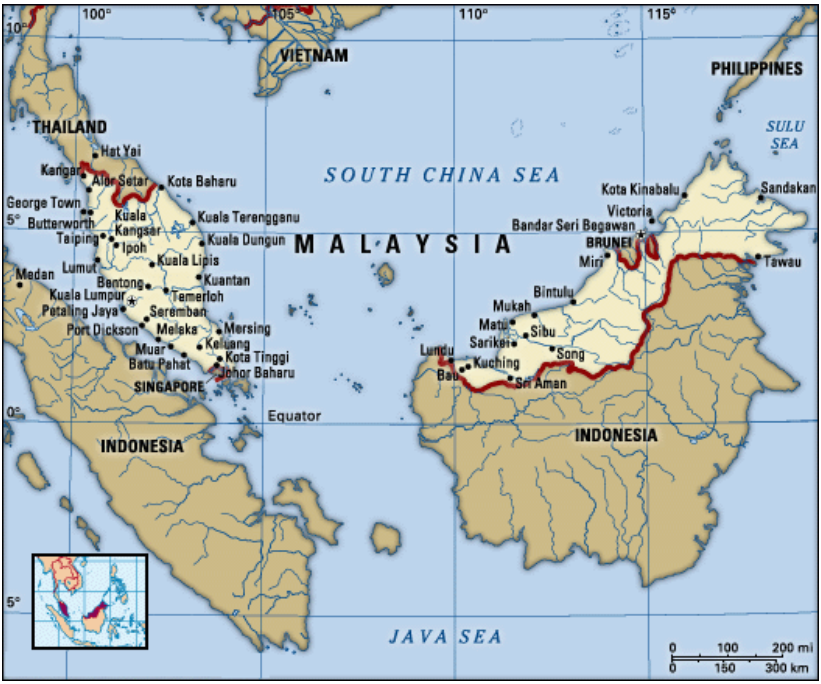
MALAYSIA

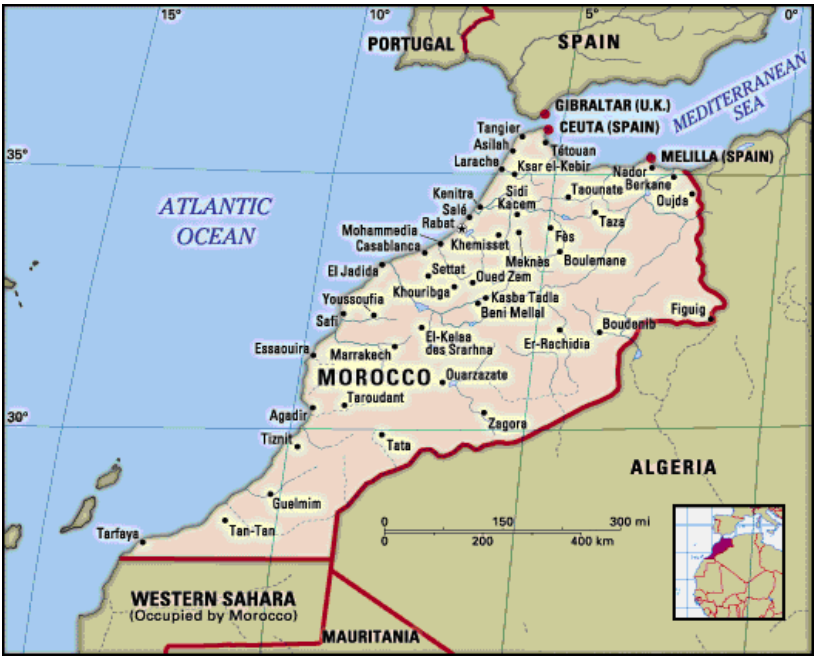


Both peninsular and insular Malaysia are in the same latitudes and are influenced by similar airstreams. They consequently have high temperatures and humidity's, heavy rainfall, and a climatic year patterned around the northeast and southwest *monsoons*. The country is influenced by eight or nine major airstreams flowing from the northeast, the south, and the west; the advance and retreat of these airstreams are responsible for the division of the climatic year into four seasons. These are the northeast monsoon (from November or December until March), the first intermonsoonal period (March to April or May), the southwest monsoon (June to September or early October), and the second intermonsoonal period (October to November). The onset and retreat of the two monsoons are not sharply defined.

Malaysia has an equatorial climate, but the narrowness and topographic configuration of each portion—central mountainous cores with flat, flanking coastal plains—facilitate the inland penetration of maritime climatic influences. In addition, the monsoons further modify the climate. The northeast monsoon brings heavy rain and rough seas to the exposed coasts of southwestern Sarawak and northern and northeastern Sabah. The southwest monsoon, however, affects mainly the southwestern coastal belt of Sabah. Floods are common, especially along the west coast of Sabah. Neither peninsular nor insular Malaysia is in the typhoon belt, but their coasts occasionally are subject to the heavy rainstorms associated with squalls

Temperatures are uniformly high throughout the year. On the peninsula, they average 78° to 82° F (25° to 28° C) for most lowland areas. In coastal areas in East Malaysia, minimum temperatures range from 72° to 76° F (22° to 24° C), and maximum temperatures from 88° to 92° F (31° to 33° C); temperatures are lower in the interior highland regions. The mean annual rainfall on the peninsula is approximately 100 inches (2,540 millimeters); the driest location, Kuala Kelawang (formerly Jelebu), near Kuala Lumpur, receives about 65 inches of rain per year, while the wettest, *Maxwell's Hill*, northwest of Ipoh, receives some 200 inches annually. Mean annual rainfall in Sabah varies from 80 to 140 inches, while most parts of Sarawak receive 120 inches or more per year.

MOROCCO

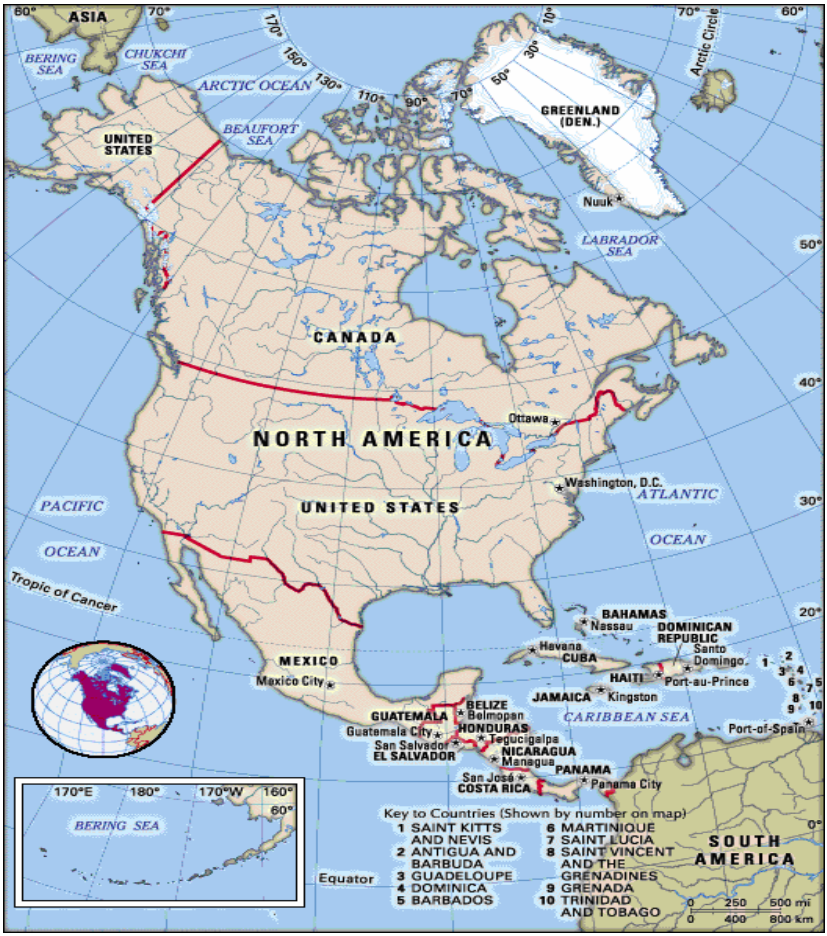


Most of Morocco north of the Western Sahara, particularly along the coasts, experiences a typical Mediterranean climate, with mild wet winters and hot dry summers. The rainy season generally extends from October to April. Torrential downpours occasionally produce devastating floods, but overall several factors act to reduce the country's rainfall. Morocco is on the southern margins of the mid-latitude tract of frontal storm systems that regularly traverse the North Atlantic. As a result, rainfall levels are relatively low and gradually decrease from north to south. High-pressure ridges, moreover, periodically develop offshore during the rainy season, shifting storms to the north. Drought results when these ridges persist for extended periods. The cold *Canary Current* off the western shores also induces atmospheric stability and further decreases the potential for precipitation.

In the broad coastal lowlands, average annual precipitation diminishes progressively from about 32 inches (800 mm) on the northern Gharb plain to less than 8 inches (200 mm) in the Sous valley. Farther south, beyond the Anti-Atlas, semiarid conditions quickly fade into desert. Elevation strongly influences this prevailing pattern, however, with significantly greater amounts of precipitation occurring in the mountains. The central Rif, for example, receives more than 80 inches (2,030 mm) of precipitation annually, and even the High Atlas, much farther south, receives some 30 inches (760 mm). Snow is common at approximately 6,500 feet (2,000 metres), and the snowpack lingers in the highest elevations until late spring or early summer. Morocco's mountains create a significant rain shadow, directly east of the mountains, where in the lee of the prevailing winds, desert conditions begin abruptly.

In the lowlands near the coast, summer heat is reduced by cool onshore breezes. Average daily summer temperatures in the coastal cities range from 64 to 82 °F (18 to 28 °C). In the interior, however, daily highs frequently exceed 95 °F (35 °C). In late spring or summer, the sharqi (chergui)—a hot, dusty wind from the Sahara—can sweep over the mountains into the lowlands, even penetrating the coastal cities. Temperatures rise dramatically, often reaching 105 °F (41 °C). If crops have not been harvested, damage can be extensive from the desiccating effects of the sharqi. In winter, the marine influence again moderates temperatures in the coastal regions. Average daily winter temperatures range from 46 to 63 °F (8 to 17 °C). Away from the coast, temperatures drop significantly, occasionally dipping below the freezing point.

NORTH AMERICA



While the greater part of North America falls within the temperate zone—a fact that made it attractive to European settlers—large cool-to-cold areas lie in the north and extend as far south as the Ozark Mountains in winter. The continent's northerly position means that Greenland, the Canadian Shield, the *Mackenzie* Lowlands, and the northern part of the Cordilleras have unusually long and cold winters. Much of this land has permanently frozen subsoil (*permafrost*) and is under snow and ice most of the year. The frequently frozen seas interlacing the Canadian Arctic Archipelago, together with innumerable northern lakes, produce an enormous chilling effect on the air above, and the temperatures for these huge regions are 6° to 8° F (3° to 4° C) cooler than the average for their latitude. The *North Pacific*, warmed by an extension of the Kuroshio (Japan Current), has a positive anomaly of 8° to 10° F (4° to 6° C) warmer than the average for its latitude.

Related trends over the northern part of the North Atlantic affect Iceland and Europe rather than North America but still raise the temperatures off the northeast coasts by perhaps 2° F (1° C). The climate thus shows marked contrasts between the maritime and continental areas. Notably warm temperatures extend northward along the west coast from Vancouver Island to Alaska, while a great cold loop extends down the Mackenzie plains and the Canadian Shield over the heart of the continent. The chilling effects of the immense Greenland ice cap drag cold continental conditions southward over the northeast coast at least as far as Newfoundland. The average January temperatures of Annette Island in the Alaskan panhandle, about 34° F (-1° C), of Fort Smith, N.W. Terr., -14° F (-26° C), and of Nain, Labrador, 1° F (-17° C), show the difference between coastal and continental conditions and also between the west and the east coasts; these differences are negligible in the tropical parts of North America.

Most of the continent is humid and provides a good water supply for settlement and development. From mid-California north, the windward sides of mountains along the Pacific coast are bathed with rain- or snow-laden westerlies, giving from 40 to 200 inches (1,000 to 5,000 millimetres) of precipitation per year. Westerlies again reassert themselves east of the Rockies—especially east of the Missouri River and Red River of the North—bringing moderately wet (20 inches) to wet (45 inches) conditions in the central and eastern regions. Two main areas exist where precipitation amounts generally are low. The first is in the far north and northeast, under the influence of extremely cold and relatively dry winds, with a thin dusting of winter snow and a meagre fall of summer rain in the Canadian Arctic Archipelago and *Greenland*. The other is in the south and southwest, where the mid-latitude high-pressure system produces subsiding and descending air that greatly inhibits rainfall. The high pressure also leads to dry offshore winds from mid-California to southern Mexico. Since these winds blow from the interior out to sea, they carry little moisture, with annual precipitation in that area usually less than 10 inches.

The continent's air masses reflect different conditions of temperature and humidity; they include northern and southern components, subdivided into continental (dry) and maritime (moist) types. In the north are found the Arctic air mass, over Greenland and the Canadian Arctic Archipelago; the polar continental, over northern central Canada; the polar Pacific, over Alaska and the northern Pacific shores; and the polar Atlantic, off the Atlantic provinces of Canada and New England. The southern half of the continent is characterized by the subtropical Pacific air mass, off the western United States; the tropical continental mass, over the intermontane basins of the Cordilleras from Utah southward; the tropical gulf, centred in the Gulf of Mexico and the Caribbean; and the tropical Atlantic, off the southeastern United States.

The *polar continental*, the tropical gulf, and the polar Pacific are the most influential air masses. The polar continental reflects the spread of a negative temperature anomaly over much of the continent. It is a cool-to-cold mass of stable air forming an immense dome of high pressure above the Canadian Shield, with winds blowing outward to sweep over Labrador and New England or southward across the Great Lakes and the Great Plains. At its maximum, it extends from the Canadian Arctic Archipelago to the Ozark Mountains. In winter it joins with the Arctic air mass over Greenland to make a formidable body of cold, heavy air that carries subzero weather as far south as the Ohio River valley and may overflow the Appalachians and penetrate into the Rockies. Exceptionally, it can produce killing frosts into the Central Valley of California, the Texas Gulf Coast, and central Florida. In the spring it shrinks northward before the swift advance of the tropical gulf air, which is drawn northward by low pressures developed in the Mississippi River basin as the heart of the continent heats up. This air mass is warm, moist, and unstable; at its

height in late July, it extends two enormous loops of warm air, one northwestward up the Mississippi and down the Mackenzie and the other northeastward up the Ohio and down the St. Lawrence. The July average of 60° F (16° C) is then carried north of Edmonton, Alta., in the west and to Quebec in the east. The storm-generating polar Pacific air mass is active from northern California to Alaska, especially in the winter, when its mild, wet air reflects the North Pacific temperature anomalies. When the tropical continental air mass moves to the north and east, it is responsible for extremely hot, droughtlike conditions in the Great Plains in the summer and for mild spells in the Great Lakes region in the fall, the latter period called “Indian summer.”

Where cyclones (low-pressure cells) develop persistently along the advancing air-mass edges, strong storm tracks occur. Pacific storm tracks thread the Strait of Georgia, Puget Sound, and the Inside Passage to Alaska. In summer they shift north of Prince Rupert; in the depth of winter they migrate southward to San Francisco. Moving up the Columbia and Fraser river valleys, these storms weaken as they pass through the Cordilleras, only to form again on the lee side as they join with a stream of Pacific air that overtops the mountains. These draw in air from the polar continental air mass on their advancing cold sectors and from tropical gulf air in their warm sectors. As the polar continental air mass begins to expand in September, a line of storms tracking from the Mackenzie River to James Bay develops, migrating progressively southward to reach a track from Texas to Ohio in January. As the tropical gulf air mass expands north, the successive tracks become activated again until, in August, the gulf air brings a swirl of storms to the Mackenzie. Most of these storm tracks begin in the western plains, converge on the Great Lakes–Ohio area, and then bunch together in the climatically active St. Lawrence–Hudson–Mohawk zone. The Atlantic Coastal Plain becomes a storm track in winter as tropical maritime air contests the advance of the continental air from the north. Differing continental climatic regions reflect the considerable amount of Arctic land, the great spread of temperate conditions, and the small but significant tropical area; dry climates also stand out in strong contrast to the prevailingly humid ones.

Including the northern parts of the Canadian Shield and Alaska, the Canadian Arctic Archipelago, and Greenland, the Arctic zone is dominated by Arctic and polar continental air masses and is perennially cold or cool. Temperatures below 0° F (-18° C) last for 5 to 7 months, and subfreezing temperatures can persist for 8 to 10 months. Only between June and September do temperatures frequently rise above 32° F (0° C). The frost-free season does not exceed 60 days. Precipitation is low—especially in the far north—with 2 to 4 inches of summer rain, plus 30 to 60 inches of winter snow.

The cool temperate zone extends from Newfoundland to Alaska and from Hudson Bay to the Ohio River. It is dominated by the polar continental air mass. Winters are long and severe. After the period of “Indian summer” that continues into October, temperatures fall quickly and do not rise substantially until April or early May. In January and February they drop to below 32° F (0° C) in the Ohio River valley and below 0° F (-18° C) north of the Great Lakes, with minimum temperatures as low as -20° to -80° F (-29° to -62° C). Winter killing of crops and spring and autumn frosts are a hazard in the Canadian parts of the region, where the frost-free season is from 90 to 120 days. A swift transition occurs with spring; tropical gulf air raises monthly mean temperatures to more than 50° F (10° C) in June and to more than 60° F (16° C) in July. Precipitation is moderate, from 15 to 35 inches; as evaporation is low, however, most precipitation is effective for plant growth. The maximum precipitation occurs in summer to fall, when the James Bay, Alberta, and Wyoming storm tracks are activated and when moist gulf air is in place.

On the southeast coasts of the United States, the warm temperate zone extends to the Mississippi River and over the Gulf Coast; the zone is strongly influenced by the tropical gulf air mass. The long frost-free season exceeds 200 days. The tropical air spreads north in February and dominates the region until November, when polar continental air descends. Winters are mild, with January means of from 40° to 54° F (4° to 12° C). July averages are tropical, being as high as 83° F (28° C).

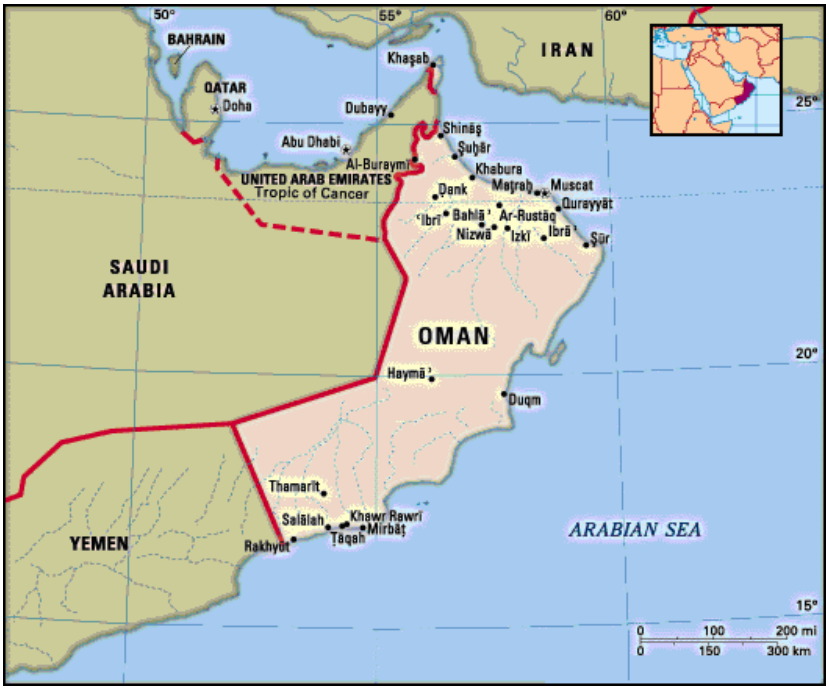
This warmth and the long growing season allow subtropical crops to be grown. Rainfall is ample (40 to 60 inches) and benefits from the presence of the Colorado and Texas low-pressure systems and from the strong summer movement of tropical maritime air. By then the landmass is intensely heated; and this, combined with the air movement, produces frequent thunderstorms, especially in early summer. Hurricanes are an annual hazard along the Gulf of Mexico and up the lower Mississippi valley.

In the American Southwest a Mediterranean type of climate is found. Summers are dry there, since the tropical continental air is dominant. July means of 70° to 80° F (21° to 27° C) are typical, with bright, sunny skies. Winters are mild (45° to 50° F [7° to 10° C]) and somewhat wet, with polar Pacific airs swinging south and bringing occasional heavy rain. Frost is rare but may occur when polar continental air thrusts through to the coast. Los Angeles has a record low temperature of only 23° F (-5° C). Snowfall is rare. Annual rainfall totals of from 15 to 30 inches, along with high evaporation rates, often are insufficient for growing crops during the summer; supplemental irrigation is then necessary.

Central America, with its tropical humid climate, has no winter; even the coldest month averages above 64° F (18° C). With summers of 80° to 82° F (27° to 28° C), the mean annual temperature range is lower than the usual daily range, a characteristic which is markedly different from most of North America. Rainfall is ample and regular, with 45 to 80 inches where the easterly trade winds blow onshore. Lee valleys, however, often are quite dry. Summer hurricanes frequently recur, causing much damage.

About a third of North America, including the high Arctic latitudes, has a dry climate. Chief dry areas lie in the American Southwest, where a combination of the mid-latitude high-pressure belt, the tropical continental air mass, and the rain-shadow effects behind the high Sierra Nevada has led to lack of rainfall. Winds blow from the continent outward, discounting the effect of Pacific subtropical air. As the winds move down in altitude from high interior plateaus, they become drier. The intermontane region of the United States and Mexico, from the Columbia River basin to Guadalajara, and the Pacific Coast from San Diego, Calif., south to Mazatlán are therefore arid, receiving less than 10 inches of rain per year. Some years have no rain. The Great Plains, from the South Saskatchewan River to Mexico, are semiarid, with from 8 to 15 inches of rainfall; the high mid-continental jet stream usually is depressed southward over them, strengthening down-moving dry wind from across the Rockies and tending to fend off cyclones from tropical gulf or polar continental air masses. The high Arctic areas are dry because most of the open water (which could act as a source of moisture) is frozen for 6 to 9 months of the year, and because the cold air that dominates the region can hold little moisture.

OMAN



The climate is hot and dry in the interior and hot and humid along the coast. Summer temperatures in the capital of Muscat and other coastal locations often climb to 110 °F (43 °C), with high humidity; winters are mild, with lows averaging about 63 °F (17 °C). Temperatures are similar in the interior, although they are more moderate at higher altitudes. Dhofar is dominated by the summer monsoon, making *Salalah's* climate more temperate than that of northern Oman. Rainfall throughout the country is minimal, averaging only about 4 inches (100 mm) per year, although precipitation in the mountains is heavier. There are no permanent bodies of fresh water in the sultanate.

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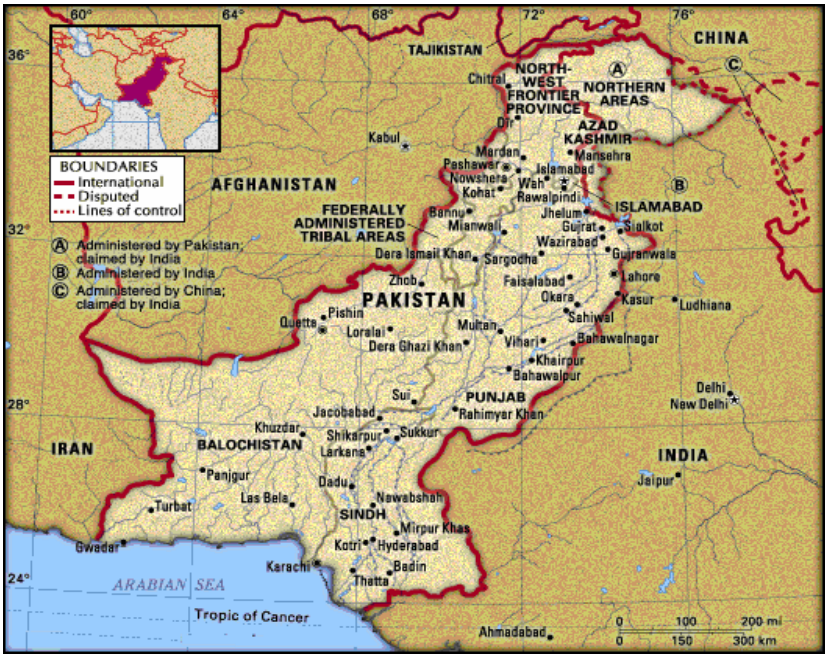
PAKISTAN



As Pakistan is located on a great landmass north of the tropic of Cancer (between latitudes 24° and 37° N), it has a continental type of climate characterized by extreme variations of temperature, both seasonally and daily. Very high altitudes modify the climate in the cold, snow-covered northern mountains; temperatures on the Balochistan Plateau are somewhat higher. Along the coastal strip, the climate is modified by sea breezes. In the rest of the country, temperatures reach great heights in the summer; the mean temperature during June is 100° F (38° C) in the plains, where the highest temperatures can exceed 117° F (47° C). In the summer, hot winds called loo blow across the plains during the day. Trees shed their leaves to avoid loss of moisture. The dry, hot weather is broken occasionally by dust storms and thunderstorms that temporarily lower the temperature. Evenings are cool; the diurnal variation in temperature may be as much as 20° to 30° F (11° to 17° C). Winters are cold, with minimum mean temperatures of about 40° F (4° C) in January.

The characteristics of different regions are determined by variations in rainfall and irrigation rather than by temperature. Although the country is dominated by monsoon winds, it is extremely arid, except for the southern slopes of the Himalayas and the submontane tract, which have a rainfall from 30 to 35 inches (750 to 900 millimetres). The 20-inch (500-millimetre) precipitation line, which runs northwest from near *Lahore*, marks off the Potwar Plateau and a part of the Indus Plain in the northeast; these areas receive enough rainfall for dry cropping (farming without irrigation by taking measures to conserve water). South of this region, cultivation was confined mainly to riverine strips until the advent of irrigation.

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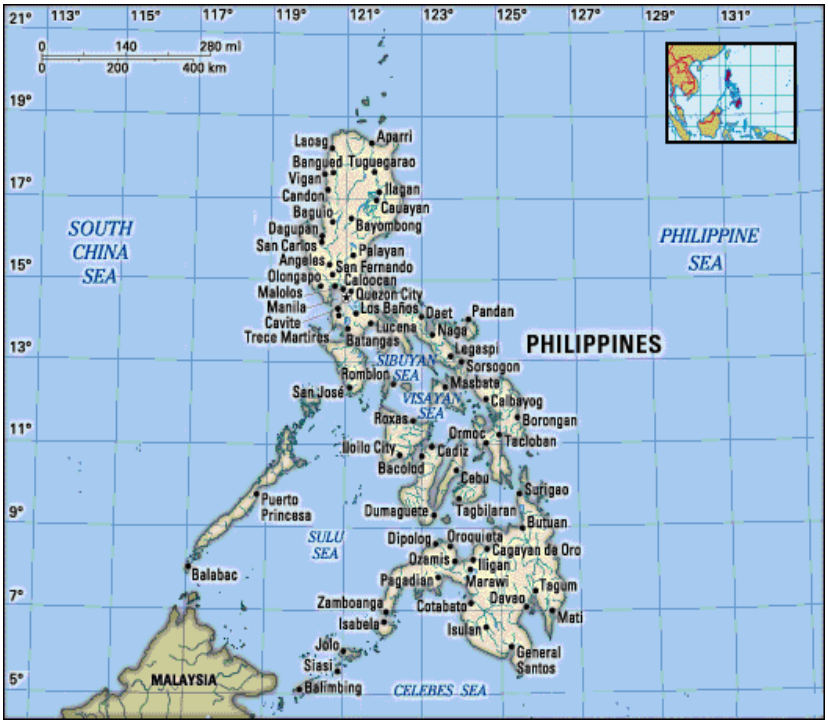
PHILIPPINES

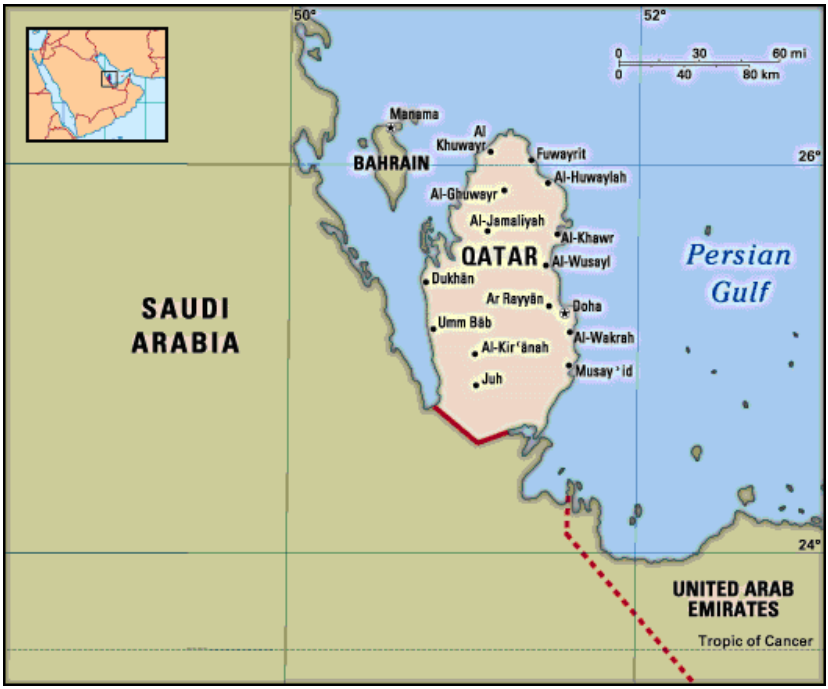


The climate of the Philippines is tropical and is strongly affected by monsoon (rain-bearing) winds, which blow from the southwest from approximately May to October and from the northeast from November to February. Thus, temperatures remain relatively constant from north to south during the year, and seasons consist of periods of wet and dry. Throughout the country, however, there are considerable variations in the frequency and amount of precipitation. The western shores facing the South China Sea have marked dry and wet seasons. The dry season generally begins in December and ends in May, the first three months being cool and the second three hot; the rest of the year consists of the wet season. The dry season shortens progressively to the east until it ceases to occur. During the wet season, rainfall is heavy in all parts of the archipelago except for an area extending southward through the centre of the Visayan group to central Mindanao and then southwestward through the Sulu Archipelago; rain is heaviest along the eastern shores facing the Pacific Ocean.

From June to December typhoons often strike the archipelago. Most of these storms come from the southeast, their frequency generally increasing from south to north; in some years the number of typhoons reaches 25 or more. Typhoons are heaviest in Samar, Leyte, eastern Quezon province, and the Bataan Islands, and when accompanied by floods or high winds they may cause great loss of life and property. Mindanao is generally free from typhoons.

November through February constitutes the most agreeable season; the air is cool and invigorating at night, and the days are pleasant and sunny. During the hot part of the dry season in most places, and especially in the cities of Cebu, Davao, and Manila, the temperature sometimes rises as high as 100° F (38° C). Overall temperatures decline with altitude, however, and cities and towns located at higher elevations—such as Baguio in northern Luzon, Majayjay and Lucban south of Manila, and Malaybalay in central Mindanao—experience a pleasant climate throughout the year; at times the temperature in these places dips as low as 43° F (6° C).

QATAR



The sun shines virtually every day in Qatar, and rainfall is almost non-existent, averaging about three inches (80mm) a year, this falling only in winter. Summers are sizzling hot by day, and warm at night, temperatures often hitting the 104°F mark (40°C) or above. Winters are only slightly cooler by day, but can be very chilly at night.

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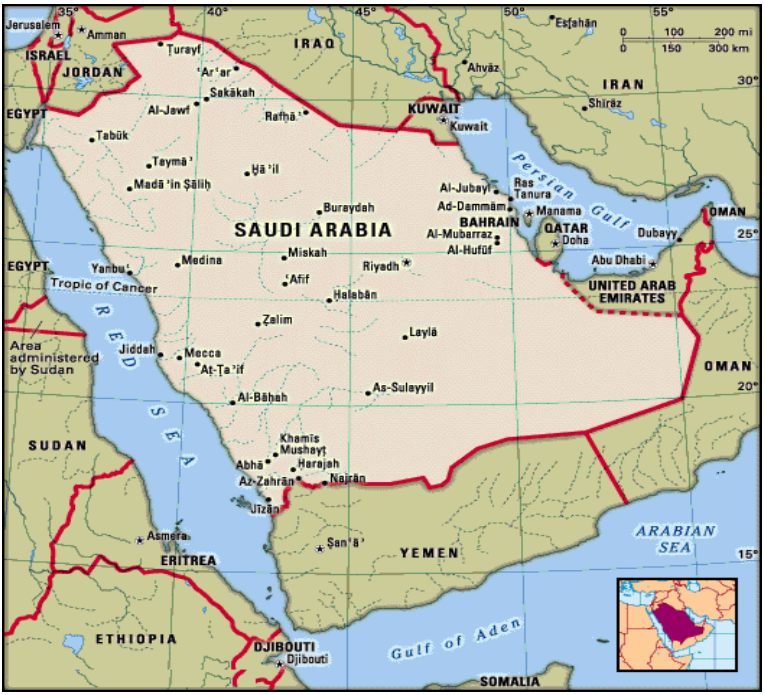
SAUDI ARABIA

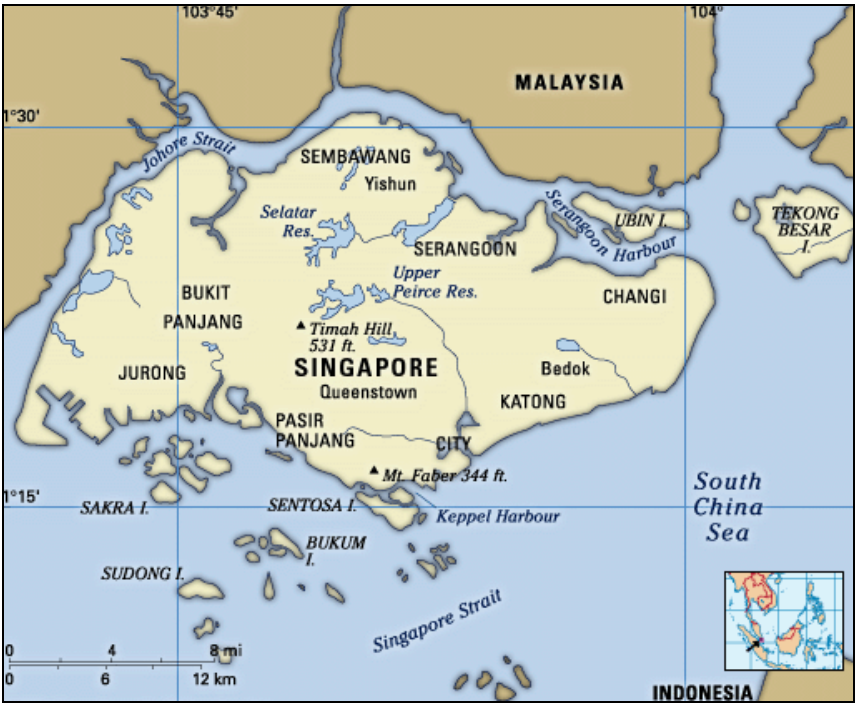


Climatically, the kingdom is almost entirely a desert. In winter, cyclonic weather systems generally skirt north of the Arabian Peninsula, moving eastward from the Mediterranean, though sometimes they reach eastern and central Arabia and the gulf. Some weather systems move southward along the Red Sea trough and provide winter precipitation as far south as Mecca and sometimes as far as Yemen. In March and April some rain, normally torrential, falls. In summer the highlands of *Asir* ('Asira, southeast of Mecca, receive enough rain from the monsoonal winds to support a steppelike strip of land.

Winters, from December to February, are cool, and frost and snow may occur in the southern highlands. Average temperatures for the coolest months, December through February, are 74° F (23° C) at Jiddah, 58° F (14° C) at Riyadh, and 63° F (17° C) at Ad-Dammam. Summers, from June to August, are hot, with daytime temperatures in the shade exceeding 100° F (38° C) in almost all of the country. Temperatures in the desert frequently rise as high as 129° F (54° C) in the summer. Humidity is low, except along the coasts, where it can be high and very oppressive. Precipitation is low throughout the country, amounting to about 2 1/2 inches (64 millimetres) at Jiddah, a little more than three inches at Riyadh, and three inches at Ad-Dammam. These figures, however, represent mean annual precipitation, and large variations are normal. In the highlands of Asir more than 19 inches a year may be received, falling mostly between May and October when the summer monsoon winds prevail. In the Rub' al-Khali a decade may pass with no rain at all.

There are three climatic zones: (1) desert almost everywhere, (2) steppe along the western highlands, forming a strip less than 100 miles wide in the north but becoming almost 300 miles wide at the latitude of Mecca, and (3) a very small area of humid and mild temperature conditions, with long summers, in the highlands just north of Yemen.

SINGAPORE



Singapore is in the equatorial *monsoon* region of Southeast Asia, and its climate is characterized by uniformly high temperatures and nearly constant precipitation throughout the year. The average monthly temperature varies from about 81° F (27° C) in June to 77° F (25° C) in January. The daily range is somewhat greater, averaging about 13° F (7° C). Singapore's maritime location and constant humidity, however, keep maximum temperatures relatively moderate: the highest temperature ever recorded was only 97° F (36° C).

The seasons are defined by the relative incidence of rainfall, which, in turn, is determined by the movements of the monsoon air masses. The wettest and windiest period is during the northeast monsoon (November–March), with rainfall reaching an average monthly high of more than 10 inches (250 millimetres) in December. Conversely, the period of the least amount of rainfall and the lightest winds is during the southwest monsoon (May–September), with rainfall dropping to a monthly low of less than 7 inches in July. April and October are intermonsoonal periods characterized by sluggish air movements and intense afternoon showers and thunderstorms. Altogether, Singapore's precipitation averages about 95 inches annually, and rain falls somewhere on the island every day of the year.

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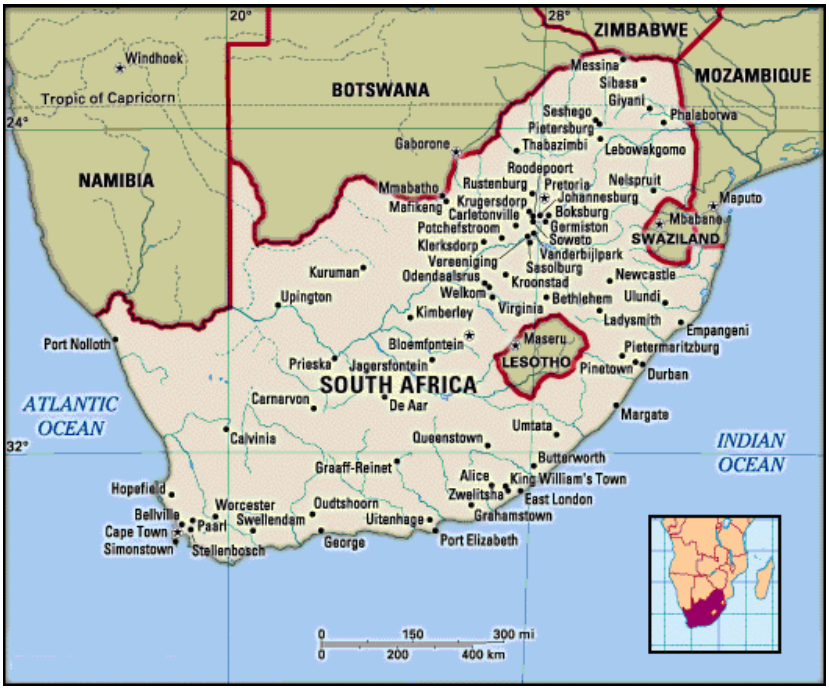
SOUTH AFRICA



The climate is varied but affected by three main factors. First, South Africa's location between latitudes 22° and 35° S places almost the entire country within the temperate zone; extremes of heat and cold are rare. However, its location next to a *subtropical high-pressure* belt of descending air produces stable conditions unconducive to rainfall over most of its surface. The result is a generally dry climate.

Second, most of the country lies at fairly high elevations, which tempers the influence of latitude and makes even the tropical and near-tropical inland areas much cooler than would otherwise be the case. High altitude and lack of the moderating influence of the sea give most inland areas large daily variations in temperature.

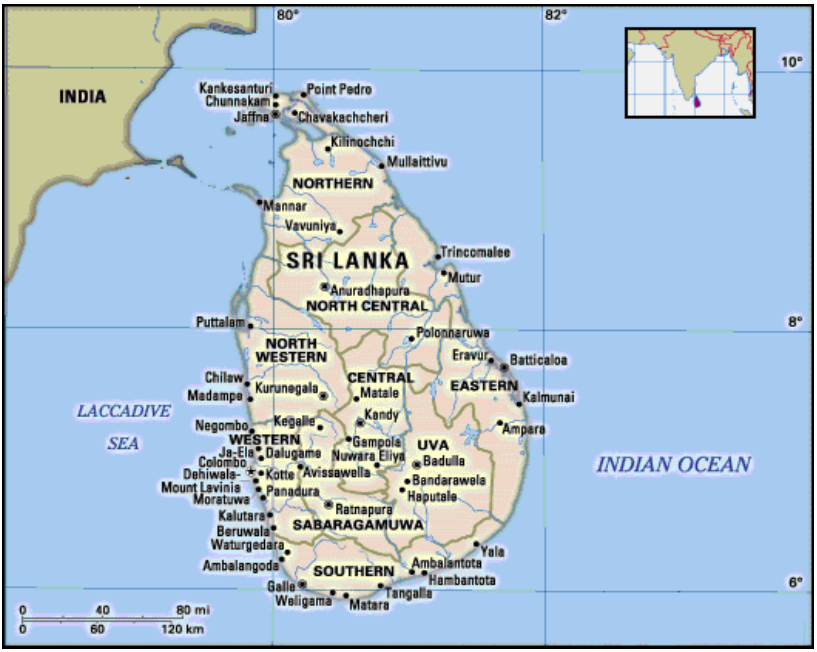
Third, the climate is greatly influenced by the ocean that surrounds the country to the east, south, and west. The temperate cyclones of the southern ocean exercise considerable influence on weather patterns, especially in winter, when their circulation moves northward. The cold, northward-flowing *Benguela Current* not only cools the west coast considerably but also contributes to the dryness and stability of the atmosphere over the western parts of the country, while the warm, southward-flowing Mozambique and Agulhas currents keep temperatures higher on the east and southeast coast. The resultant warmer and less dense air rises more readily, facilitating the entry of rain-bearing clouds from the east.

South Africa, as well as the adjoining ocean areas, is influenced throughout the year by descending, divergent upper air masses that circulate primarily eastward, generally causing fine weather and low annual precipitation, especially to the west. During winter (June to August), cold polar air moves over the southwestern, southern, and southeastern coastal areas, sometimes reaching the southern interior of the country from the southwest. These polar masses are accompanied by cold fronts as well as by rain and snow. In summer (December to February), the Atlantic high-pressure system settles semipermanently over the southern and western parts of the country. Local heating of the landmass sometimes causes low-pressure conditions to develop, resulting in tropical air masses being drawn in from the Indian Ocean over the northeastern region and bringing rain.

South Africa is a generally semiarid country where farmers often face water shortages. More than one-fifth of the country is arid, receiving less than 8 inches (200 millimetres) of rainfall annually; almost half is semiarid, receiving 8 to 24 inches. In most of these areas, rainfall is highly variable and generally unreliable. Only 6 percent of the country receives more than 40 inches of rain annually. From east to west there is a gradual decline in the rainfall. The KwaZulu/Natal coast receives more than 40 inches annually, Kimberley approximately 16 inches, and Alexander Bay on the west coast less than 2 inches.

Summers are warm to hot, with daytime temperatures generally from 70° to 90° F (21° to 32° C). Higher altitudes have the lower temperatures, while the far northern and northeastern regions and the western plateau and river valleys in the central and southern regions have the higher temperatures. At night, temperatures fall substantially in the interior—in some places by as much as 30° F (17° C)—while on the coast the daily range is much smaller. Winters are mostly cool to cold, with many high-altitude areas often having temperatures below freezing at night but readings of 50° to 70° F (10° to 21° C) in the daytime. On the eastern and southeastern coast, winters are warm. Temperatures generally decline from east to west: Durban has an annual average temperature of 69° F (21° C), while Port Nolloth—at a similar latitude but on the west coast—registers 57° F (14° C).

SRI LANKA



Sri Lanka's tropical location ensures perennially high temperatures, with monthly averages between 72° F (22° C) and 92° F (33° C) in the lowlands. In the Central Highlands, higher altitudes account for lower temperatures, with monthly averages between 44° F (7° C) and 71° F (21.6° C).

Rainfall is the conspicuous factor in the seasonal and diurnal variations of the climate of Sri Lanka. Most parts of the country receive an average annual rainfall of more than 50 inches (1,270 millimetres). However, regional differences in the amount of rain, its seasonality, and its variability and effectiveness have formed the basis of a distinction in Sri Lanka between a Wet Zone and a Dry Zone. In the former area, which covers the southwestern quadrant of the island (including the highlands), the rainfall is heavy (annual averages range from 98 inches along the coast to more than 150 inches in the highlands) and seasonally well distributed (although a greater part of the rain comes from the southwest monsoon from May to September). Rainfall deviates relatively little each year from the annual averages and is effective enough to maintain soil moisture and surface drainage throughout the year. Over the rest of the island—the Dry Zone—annual totals of rain range from 30 to 70 inches in the different areas (much of it being received during the northeast monsoon season from November to January). Droughts that persist for more than three months are common.

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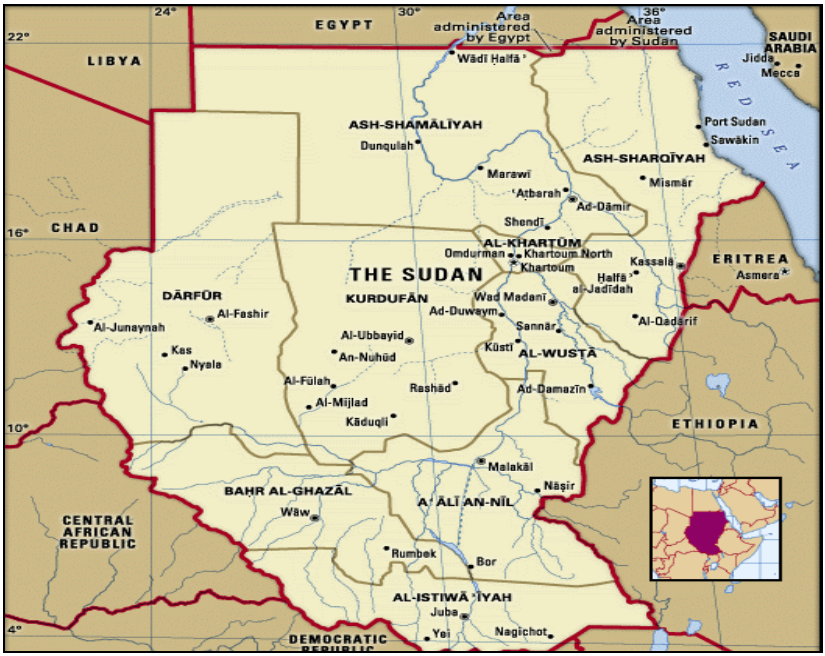
SUDAN



In the northernmost Sudan northerly winds prevail for most of the year, and rainfall is rare; to the south of this the seasons are characterized by the oscillation, north and south, of the boundary between moist southerly air and dry northerly air. The latter phenomenon, more specifically, involves the seasonal migration and pulsation of the northern tropical continental air mass and the southern maritime continental air mass, which are divided by the *Intertropical Convergence Zone*. In winter the north winds of the tropical air mass blow across The Sudan toward the front, which may be as far south as the Tropic of Capricorn. These winds are relatively cool and dry and usually bring no rain. By April the front begins to move northward across the country, and moist southerly air of the maritime air mass is drawn in from the South Atlantic Ocean. Because of this, the central and southern Sudan have rainy seasons, the total lengths of which vary according to their latitude.

The Sudan is a hot country, for temperatures are little mitigated by altitude. The central region has the highest mean annual temperatures; at Khartoum temperatures of more than 100° F (38° C) can be recorded during any month of the year. The highest temperatures normally occur just before the rainy season.

Rainfall varies from almost nothing in the north to more than 47 inches (1,200 millimetres) annually in the extreme south. Along the Red Sea the climate is alleviated by sea breezes, and most of the rain falls during winter. In the central and southern Sudan, precipitation usually occurs during the summer months. Dust storms are common in the north, while the rainy season lasts for eight to nine months a year in the south.

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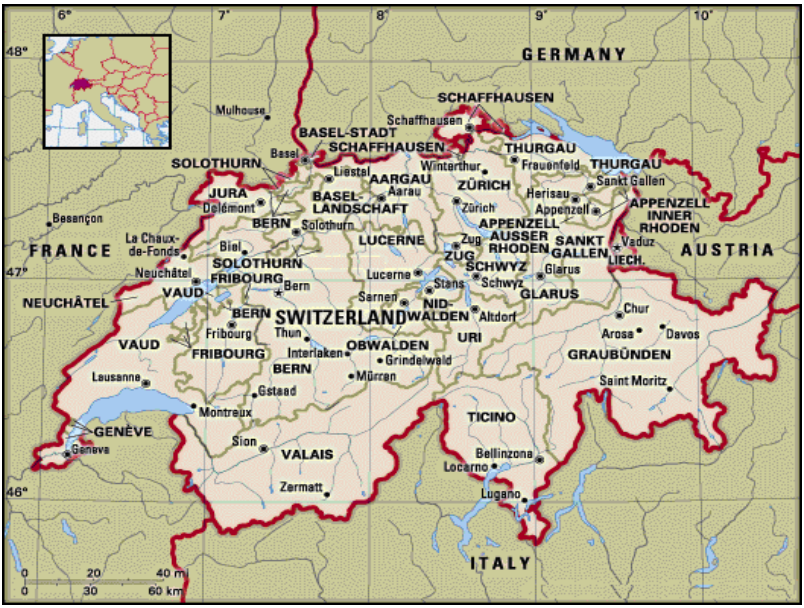
SWITZERLAND



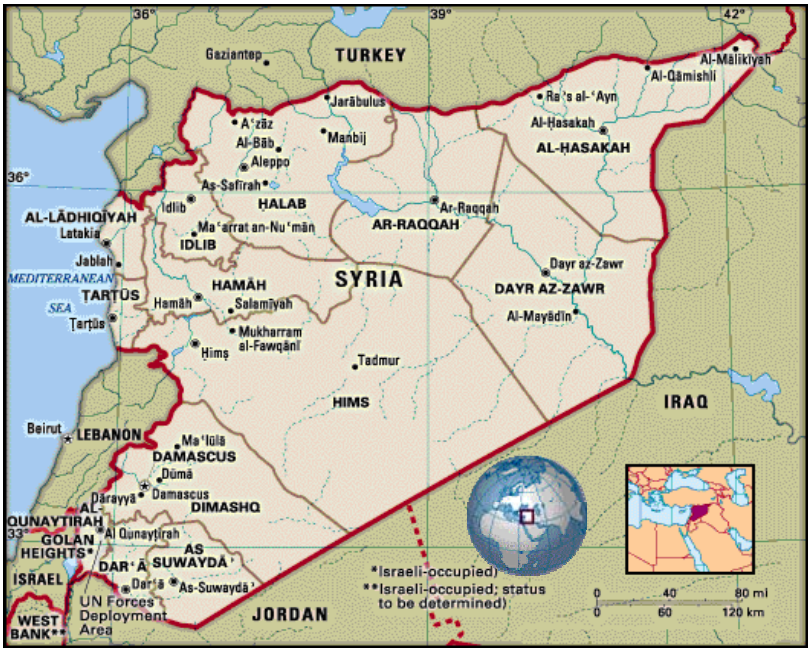
Prevailing winds are mainly from the west, but in valleys air currents are channeled into particularly frequent or violent local winds such as the Bise, a cold northeast wind that sweeps across the Mittelland and funnels down Lake Geneva to the city of Geneva. *Foehn* (German: föhn) winds, which are associated with the leading edge of a low-pressure system moving across Europe north of Switzerland, often blow for one or two days; they may occur anytime during the year but usually the frequency is greatest in spring. Sudden temperature increases occur because the foehn, which crosses the Alps from south to north (it can also blow from north to south, affecting Ticino), cools at a slower rate rising over the mountains because of precipitation; it is then heated and dried as it descends down the northern valleys, thereby moderating the climate on the northern slopes of the Alps.

Since rainfall tends to increase in direct proportion to altitude, the precipitation map corresponds very closely to the relief map; and, because of the marked variation in reliefs, differences in precipitation within short linear distances are often very great. For example, St. Gall (*Sankt Gallen*), at 2,556 feet, has an average annual precipitation of 52 inches (1,318 mm), while that of the Säntis, at an elevation of 8,202 feet but only some 12 miles away, is 114 inches. The average annual precipitation of three-quarters of the country exceeds 40 inches, varying amounts of which fall as snow. In *Lugano* (at 896 feet), which is located in the canton of Ticino in the southeast and has a modified Mediterranean climate, only 5 percent of the precipitation is in the form of snow; in *Zürich* (at 1,824 feet) 11 percent is snow; and on the Säntis 72 percent is snow. At altitudes above 11,500 feet all precipitation is in the form of snow, which is compacted into perpetual snowfields and glaciers; the snow line is at about 9,200 feet in the northern Alps and at 10,800 feet in the southern Alps of the Valais.

In the mountains of the interior, distinct dry pockets occur, the best-known being the Rhône valley in the Valais, closely encircled by the highest (13,000 feet) mountain groups. Though precipitation is slight on the slopes near the cantonal capital of *Sion* (at 1,581 feet), extensive irrigation is possible since the valley is surrounded by large snowfields and by glaciers that extend down the upper valleys. The rarefied and dry though increasingly polluted air of such high-altitude towns as *Davos* (5,216 feet) and *Arosa* (5,987 feet) permits a more intense, broader-spectrum solar irradiation, thus producing a climate famous in the past for tuberculosis cures. Today the climate is a factor in attracting skiers as well as tourists seeking an escape from the polluted air of lowland Europe. At altitudes of 13,000 feet, precipitation levels rise to 160 inches, and the Mönch (13,448 feet) in the Jungfrau group of mountains has the highest average annual precipitation in Switzerland, 163 inches, while Stalden in the entrenched Vispa valley, 4 miles south of the main Rhône valley, has the minimum, 21 inches.

The stable high-pressure weather conditions prevailing over central Europe and the Alps during the autumn and winter create cold air masses that result in lowland *fog*, a climatic phenomenon with widely varying consequences. The mouths of the northern Alpine valleys, the basins of the Jura Mountains, and the villages and cities of the low areas of the Mittelland are blanketed for days and often for weeks on end, while towns located at higher altitudes enjoy warm, brilliant, high-pressure conditions and the view of the glistening sea of fog below them. *Temperature inversions* between mountain and valley locations in close proximity can be quite pronounced, with higher elevations having higher temperature readings. Frequent temperature inversion is a primary reason why high-altitude Swiss resorts are healthful places even during the winter and why, in the present century, the Alpine winter season has gained popularity in Europe for sports; in addition, because of these inversions polluted air is much less common in areas of high elevation than in the lowlands. In fact, the temperature inversions that affect the Mittelland tend to trap polluted air for weeks when cyclonic activity stagnates. The result has been a dramatic increase in respiratory diseases, especially among the very young and old.

SYRIA



The coast and the western mountains have a Mediterranean climate with a long dry season from May to October. In the extreme northwest there is some light summer rain. On the coast summers are hot, with mean daily maxima of 84° F (29° C), while the mild winters have mean daily minima of 50° F (10° C). Only above 5,000 feet are the summers relatively cool. Inland the climate becomes arid, with colder winters and hotter summers. Damascus and *Aleppo* have average daily maxima of 91° to 99° F (33° to 37° C) in summer and average daily minima of 34° to 40° F (1° to 4° C) in winter. In the desert, at Tadmur (ancient *Palmyra*) and *Dayr az-Zawr*, average daily maxima in summer reach 99° to 104° F (37° to 40° C), with extremes up to 114° F (46° C). Snow may occur in winter away from the coast, and frosts are common.

The coast and western mountains receive 30 to 40 inches (762 to 1,016 millimetres) of rainfall annually. Rainfall decreases rapidly eastward; the steppe receives 10 to 20 inches a year. Jabal ad-Duruz receives more than eight inches. In the desert area of al-Hamad, rainfall decreases to less than five inches a year. Rainfall is variable from year to year, particularly in the spring and autumn months.

In winter the prevailing winds blow from the east, the north, and the west. In summer the prevailing winds are either northerly or westerly. During the summer the coastal region is subject to westerly winds during the day and easterly ones at night. Once or twice a year sand-bearing winds, or *khamsin*, raise a wall of dust almost 5,000 feet high, which darkens the sky.

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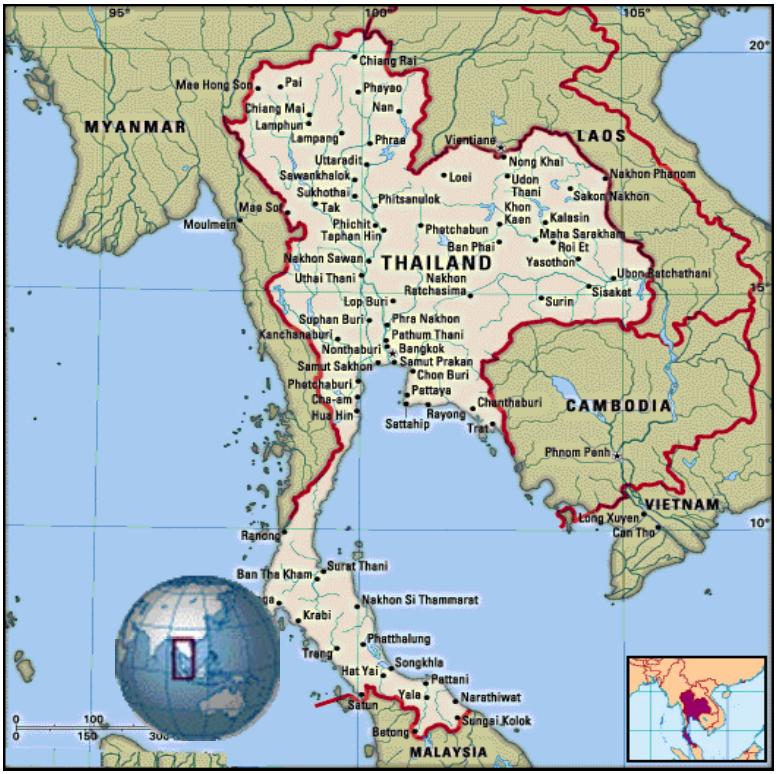
THAILAND

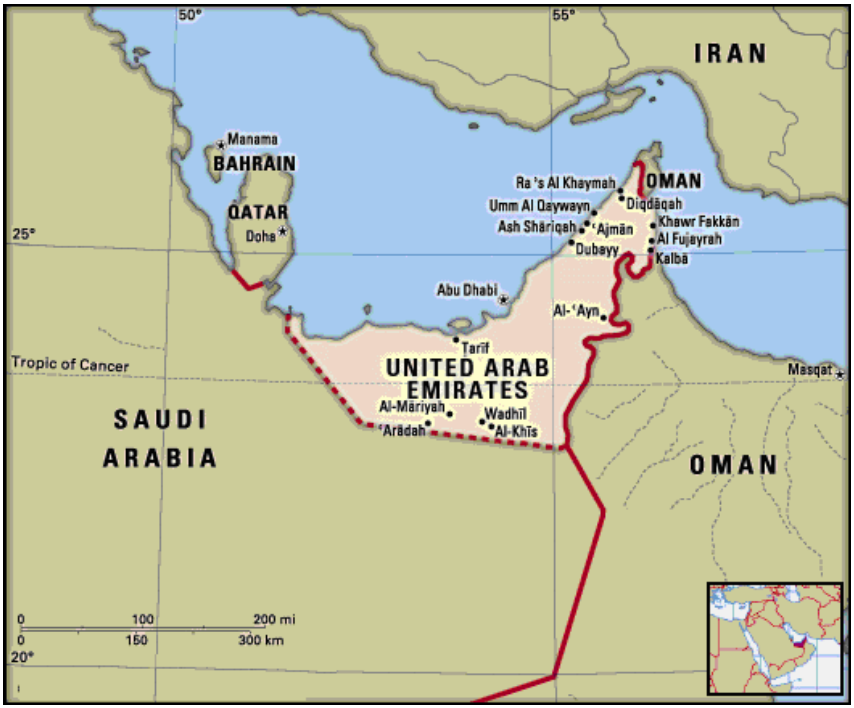


The major influences on Thailand's climate are its location in the tropical monsoon zone of mainland Southeast Asia and certain topographic features that affect the distribution of precipitation. Beginning in May, the warm, humid air masses of the southwest monsoon flow northeastward over the region from the Indian Ocean, depositing great quantities of precipitation; rainfall reaches a maximum in September. The wind pattern is reversed between November and February, when the northeast monsoon brings cool, relatively dry air masses in a southwesterly flow to create a seasonably cooler climate for much of the country. Stagnant air in March and April is associated with a distinct hot and dry intermonsoonal period.

Local relief acts to modify these general weather patterns. Topographic effects are most noticeable on the peninsula, where Ranong on the west coast receives approximately 160 inches (4,000 millimetres) of precipitation annually, while Hua Hin on the east coast receives less than 40 inches. Similar but less pronounced rain-shadow effects occur along the western margins of the Central Plain and on the Khorat Plateau. Songkhla, at the southern end of peninsular Thailand, has its rainy season during the cool season, the result of moisture picked up by the northeast monsoon winds while passing over the Gulf of Thailand; in this area a true tropical rain-forest climate prevails.

Nationwide, temperatures are relatively steady throughout the year, averaging between 77° and 84° F (25° and 29° C). The greatest fluctuations are in the north, where frost may occur in December at higher elevations; conversely, maritime influences moderate the climate in the south. The cooler, drier air of the northeast monsoon produces frequent morning fogs that generally dissipate by midday in the north and northeast regions.

UNITED ARAB EMIRATES



Straddling the Tropic of Cancer, the UAE has a sub-tropical arid climate and is warm and sunny in winter, but hot and humid during the summer months. The humidity is particularly high in the coastal areas. Rainfall is virtually non-existent, with occasional short showers occurring mainly in winter (December to March). Localised thunderstorms sometimes occur in summer.

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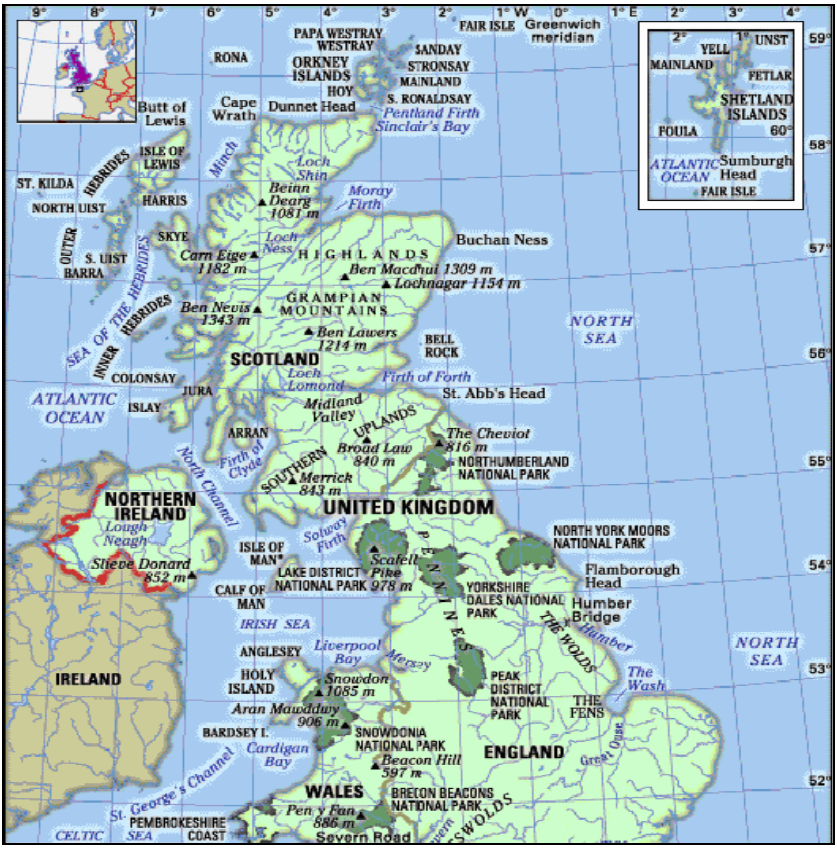
UNITED KINGDOM

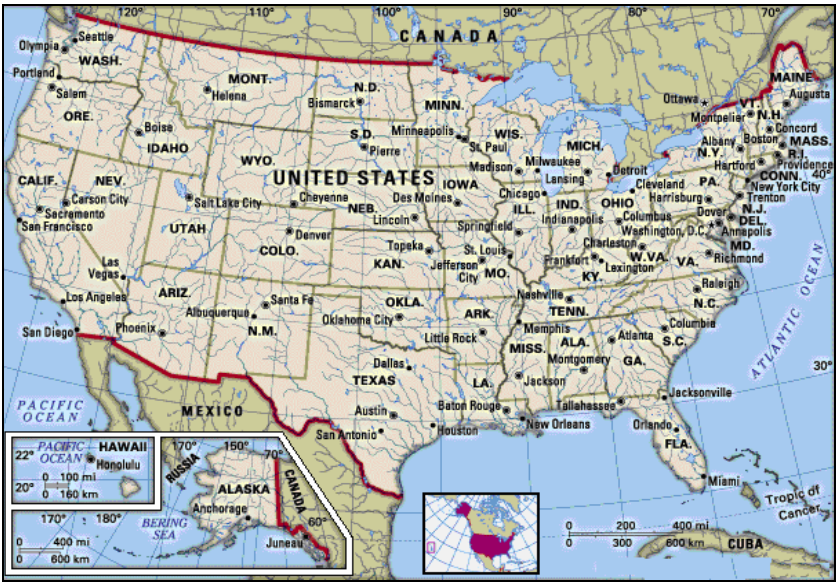


The climate of the United Kingdom derives from its setting within atmospheric circulation patterns and from the position of its landforms in relation to the sea. Regional diversity does exist, but the boundaries of major world climatic systems do not pass through the country. Britain's marginal position between the European landmass to the east and the ever-present relatively warm Atlantic waters to the west exposes the country to air masses with a variety of thermal and moisture characteristics. The main types of air masses, according to their source regions, are polar and tropical; by their route of travel, both the polar and tropical may be either maritime or continental. For much of the year, the weather depends on the sequence of disturbances within the midlatitude westerlies that bring in mostly polar maritime and occasionally tropical maritime air. In winter occasional high-pressure areas to the east allow biting polar continental air to sweep over Britain. All of these atmospheric systems tend to fluctuate rapidly in their paths and to vary both in frequency and intensity by season and also from year to year. Variability is characteristic of British weather, and extreme conditions, though rare, can be very important for the life of the country.

The polar maritime winds that reach the United Kingdom in winter create a temperature distribution that is largely independent of latitude. Thus, the north-to-south run of the 40 °F (4 °C) January isotherm, or line of equal temperature, from the coast in northwestern Scotland south to the Isle of Wight betrays the moderating influence of the winds blowing off the Atlantic Ocean. In summer polar maritime air is less common, and the 9° difference of latitude and the distance from the sea assume more importance, so that temperatures increase from north to south and from the coast inland. Above-average temperatures usually accompany tropical continental air, particularly in anticyclonic, or high-pressure, conditions. On rare occasions these southerly or southeasterly airstreams can bring heat waves to southern England with temperatures of 90 °F (32 °C). The mean annual temperature ranges from 46 °F (8 °C) in the Hebrides to 52 °F (11 °C) in southwestern England. In spring and autumn a variety of airstreams and temperature conditions may occur.

Rain-producing atmospheric systems arrive from a westerly direction, and some of the bleak summits of the highest peaks of the highland zone can receive as much as 200 inches (5,100 mm) of rainfall per year. Norfolk, Suffolk, and the Thames estuary, in contrast, can expect as little as 20 inches (510 mm) annually. Rain is fairly well distributed throughout the year. June, on average, is the driest month throughout Britain; May is the next driest in the eastern and central parts of England, but April is drier in parts of the west and north. The wettest months are typically October, December, and August, but in a given year almost any month can prove to be the wettest, and the association of Britain with seemingly perpetual rainfall (a concept popularly held among foreigners) is based on a germ of truth. Some precipitation falls as snow, which increases with altitude and from southwest to northeast. The average number of days with snow falling can vary from as many as 30 in blizzard-prone northeastern Scotland to as few as five in southwestern England. Average daily hours of sunshine vary from less than three in the extreme northeast to about four and one-half along the southeastern coast.

UNITED STATES



The pattern of U.S. climates is largely set by the location of the coterminous United States almost entirely in the middle latitudes, by its position with respect to the continental landmass and its fringing oceans, and by the nation's gross pattern of mountains and lowlands. Each of these geographic controls operates to determine the character of air masses and their changing behaviour from season to season.

The coterminous United States lies entirely between the tropic of Cancer and 50° N latitude, a position that confines Arctic climates to the high mountaintops and genuine tropics to a small part of southern Florida. By no means, however, is the climate literally temperate, for the middle latitudes are notorious for extreme variations of temperature and precipitation.

The great size of the North American landmass tends to reinforce these extremes. Since land heats and cools more rapidly than bodies of water, places distant from an ocean tend to have continental climates; that is, they alternate between extremes of hot summers and cold winters, in contrast to the marine climates, which are more equable. Most U.S. climates are markedly continental, the more so because the Cordillera effectively confines the moderating Pacific influence to a narrow strip along the West Coast. Extremes of continentality occur near the centre of the country, and in North Dakota temperatures have ranged between a summer high record of 121 °F (49 °C) and a winter low of -60 °F (-51 °C). Moreover, the general eastward drift of air over the United States carries continental temperatures all the way to the Atlantic coast. Bismarck, N.D., for example, has a great annual temperature range. Boston, on the Atlantic but largely exempt from its influence, has a lesser but still-continental range, while San Francisco, which is under strong Pacific influence, has only a small summer–winter differential.

In addition to confining Pacific temperatures to the coastal margin, the Pacific Coast Ranges are high enough to make a local rain shadow in their lee, although the main barrier is the great rampart formed by the Sierra Nevada and Cascade ranges. Rainy on their western slopes and barren on the east, this mountain crest forms one of the sharpest climatic divides in the United States.

The rain shadow continues east to the Rockies, leaving the entire Intermontane Region either arid or semiarid, except where isolated ranges manage to capture leftover moisture at high altitudes. East of the Rockies the westerly drift brings mainly dry air, and as a result, the Great Plains are semiarid. Still farther east, humidity increases owing to the frequent incursion from the south of warm, moist, and unstable air from the *Gulf of Mexico*, which produces more precipitation in the United States than the Pacific and Atlantic oceans combined.

Although the landforms of the *Interior Lowlands* have been termed dull, there is nothing dull about their weather conditions. Air from the Gulf of Mexico can flow northward across the Great Plains, uninterrupted by topographical barriers, but continental Canadian air flows south by the same route, and, since these two air masses differ in every important respect, the collisions often produce disturbances of monumental violence. Plainsmen and Midwesterners are accustomed to sudden displays of furious weather—tornadoes, blizzards, hailstorms, precipitous drops and rises in temperature, and a host of other spectacular meteorological displays, sometimes dangerous but seldom boring.

Most of the United States is marked by sharp differences between winter and summer. In winter, when temperature contrasts between land and water are greatest, huge masses of frigid, dry Canadian air periodically spread far south over the midcontinent, bringing cold, sparkling weather to the interior and generating great cyclonic storms where their leading edges confront the shrunken mass of warm Gulf air to the south. Although such cyclonic activity occurs throughout the year, it is most frequent and intense during the winter, parading eastward out of the Great Plains to bring the Eastern states practically all their winter precipitation. Winter temperatures differ widely, depending largely on latitude. Thus, New Orleans, La., at 30° N latitude, and International Falls, Minn., at 49° N, have respective January temperature averages of 55 °F (13 °C) and 3 °F (-16° C). In the north, therefore, precipitation often comes as snow, often driven by furious winds; farther south, cold rain alternates with sleet and occasional snow. Southern Florida is the only dependably warm part of the East, though “polar outbursts” have been known to bring temperatures below 0 °F (-18 °C) as far south as Tallahassee. The main uniformity of Eastern weather in wintertime is the expectation of frequent change.

Winter climate on the West Coast is very different. A great spiraling mass of relatively warm, moist air spreads south from the *Aleutian Islands* of Alaska, its semipermanent front producing gloomy overcast and drizzles that hang over the Pacific Northwest all winter long, occasionally reaching southern California, which receives nearly all of its rain at this time of year. This Pacific air brings mild temperatures along the length of the coast; the average January day in Seattle, Wash., ranges between 33 and 44 °F (1 and 7 °C) and in Los Angeles between 45 and 64 °F (7 and 18 °C). In southern California, however, rains are separated by long spells of fair weather, and the whole region is a winter haven for those seeking refuge from less agreeable weather in other parts of the country. The Intermontane Region is similar to the Pacific Coast, but with much less rainfall and a considerably wider range of temperatures.

During the summer there is a reversal of the air masses, and east of the Rockies the change resembles the summer monsoon of Southeast Asia. As the midcontinent heats up, the cold Canadian air mass weakens and retreats, pushed north by an aggressive mass of warm, moist air from the Gulf. The great winter temperature differential between North and South disappears as the hot, soggy blanket spreads from the Gulf coast to the Canadian border. Heat and humidity are naturally most oppressive in the South, but there is little comfort in the more northern latitudes. In Houston, Texas, the temperature on a typical July day reaches 93 °F (34 °C), with relative humidity averaging near 75 percent, but Minneapolis, Minn., more than 1,000 miles north, is only slightly cooler and less humid.

Since the Gulf air is unstable as well as wet, convectional and frontal summer thunderstorms are endemic east of the Rockies, accounting for a majority of total summer rain. These storms usually drench small areas with short-lived, sometimes violent downpours, so that crops in one Midwestern county may prosper, those in another shrivel in drought, and those in yet another be flattened by hailstones. Relief from the humid heat comes in the northern Midwest from occasional outbursts of cool Canadian air; small but more consistent relief is found downwind from the Great Lakes and at high elevations in the Appalachians. East of the Rockies, however, U.S. summers are distinctly uncomfortable, and air conditioning is viewed as a desirable amenity in most areas.

Again, the Pacific regime is different. The moist Aleutian air retreats northward, to be replaced by mild, stable air from over the subtropical but cool waters of the Pacific, and except in the mountains the Pacific Coast is nearly rainless though often foggy. In the meanwhile, a small but potent mass of dry hot air raises temperatures to blistering levels over much of the intermontane Southwest. In Yuma, Ariz., for example, the normal temperature in July reaches 107 °F (42 °C), while nearby Death Valley, Calif., holds the national record, 134 °F (57 °C). During its summer peak this scorching air mass spreads from the Pacific margin as far as Texas on the east and Idaho to the north, turning the whole interior basin into a summer desert.

Over most of the United States, as in most continental climates, spring and autumn are agreeable but disappointingly brief. Autumn is particularly idyllic in the East, with a romantic Indian summer of ripening corn and brilliantly coloured foliage and of mild days and frosty nights. The shift in dominance between marine and continental air masses, however, spawns furious weather in some regions. Along the Atlantic and Gulf coasts, for example, autumn is the season for hurricanes—the American equivalent of typhoons of the Asian Pacific—which rage northward from the warm tropics to create havoc along the Gulf and Atlantic coasts as far north as New England. The Mississippi valley holds the dubious distinction of recording more tornadoes than any other area on Earth. These violent and often deadly storms usually occur over relatively small areas and are confined largely to spring and early summer.

Three first-order bioclimatic zones encompass most of the coterminous United States—regions in which climatic conditions are similar enough to dictate similar conditions of mature (zonal) soil and potential climax vegetation (i.e., the assemblage of plants that would grow and reproduce indefinitely given stable climate and average conditions of soil and drainage). These are the Humid East, the Humid Pacific Coast, and the Dry West. In addition, the boundary zone between the Humid East and the Dry West is so large and important that it constitutes a separate region, the Humid–Arid Transition. Finally, because the Western Cordillera contains an intricate mosaic of climatic types, largely determined by local elevation and exposure, it is useful to distinguish the Western Mountain Climate. The first three zones, however, are very diverse and require further breakdown, producing a total of 10 main bioclimatic regions. For two reasons, the boundaries of these bioclimatic regions are much less distinct than boundaries of landform regions. First, climate varies from year to year, especially in boundary zones, whereas landforms obviously do not. Second, regions of climate, vegetation, and soils coincide generally but sometimes not precisely. Boundaries, therefore, should be interpreted as zonal and transitional, and rarely should be considered as sharp lines in the landscape.

For all of their indistinct boundaries, however, these bioclimatic regions have strong and easily recognized identities. Such regional identity is strongly reinforced when a particular area falls entirely within a single bioclimatic region and at the same time a single landform region. The result—as in the Piedmont South, the central Midwest, or the western Great Plains—is a landscape with an unmistakable regional personality.

The largest and in some ways the most important of the bioclimatic zones, the Humid East was where the Europeans first settled, tamed the land, and adapted to American conditions. In early times almost all of this territory was forested, a fact of central importance in American history that profoundly influenced both soils and wildlife. As in most of the world's humid lands, soluble minerals have been leached from the earth, leaving a great family of soils called pedalfers, rich in relatively insoluble iron and aluminum compounds.

Both forests and soils, however, differ considerably within this vast region. Since rainfall is ample and summers are warm everywhere, the main differences result from the length and severity of winters, which determine the length of the growing season. Winter, obviously, differs according to latitude, so that the Humid East is sliced into four great east–west bands of soils and vegetation, with progressively more amenable winters as one travels southward. These changes occur very gradually, however, and the boundaries therefore are extremely subtle.

The Sub-Boreal Forest Region is the northernmost of these bands. It is only a small and discontinuous part of the United States, representing the tattered southern fringe of the vast Canadian taiga—a scrubby forest dominated by evergreen needle-leaf species that can endure the ferocious winters and reproduce during the short, erratic summers. Average growing seasons are less than 120 days, though localities in Michigan's Upper Peninsula have recorded frost-free periods lasting as long as 161 days and as short as 76 days. Soils of this region that survived the scour of glaciation are miserably thin podzols—heavily leached, highly acid, and often interrupted by extensive stretches of bog. Most attempts at farming in the region long since have been abandoned.

Farther south lies the Humid Microthermal Zone of milder winters and longer summers. Large broadleaf trees begin to predominate over the evergreens, producing a mixed forest of greater floristic variety and economic value that is famous for its brilliant autumn colours. As the forest grows richer in species, sterile podzols give way to more productive gray-brown podzolic soils, stained and fertilized with humus. Although winters are warmer than in the Sub-Boreal zone, and although the Great Lakes help temper the bitterest cold, January temperatures ordinarily average below freezing, and a winter without a few days of subzero temperatures is uncommon. Everywhere, the ground is solidly frozen and snow covered for several months of the year.

Still farther south are the Humid Subtropics. The region's northern boundary is one of the country's most significant climatic lines: the approximate northern limit of a growing season of 180–200 days, the outer margin of cotton growing, and, hence, of the Old South. Most of the South lies in the Piedmont and Coastal Plain, for higher elevations in the Appalachians cause a peninsula of Northern mixed forest to extend as far south as northern Georgia. The red-brown podzolic soil, once moderately fertile, has been severely damaged by overcropping and burning. Thus much of the region that once sustained a rich, broadleaf-forest flora now supports poor piney woods. Throughout the South, summers are hot, muggy, long, and disagreeable; Dixie's “frosty mornings” bring a welcome respite in winter.

The southern margins of *Florida* contain the only real tropics in the coterminous United States; it is an area in which frost is almost unknown. Hot, rainy summers alternate with warm and somewhat drier winters, with a secondary rainfall peak during the autumn hurricane season—altogether a typical monsoonal regime. Soils and vegetation are mostly immature, however, since southern Florida rises so slightly above sea level that substantial areas, such as the Everglades, are swampy and often brackish. Peat and sand frequently masquerade as soil, and much of the vegetation is either salt-loving mangrove or sawgrass prairie.

The western humid region differs from its eastern counterpart in so many ways as to be a world apart. Much smaller, it is crammed into a narrow littoral belt to the windward of the Sierra–Cascade summit, dominated by mild Pacific air, and chopped by irregular topography into an intricate mosaic of climatic and biotic habitats. Throughout the region rainfall is extremely seasonal, falling mostly in the winter half of the year. Summers are droughty everywhere, but the main regional differences come from the length of drought—from about two months in humid Seattle, Wash., to nearly five months in semiarid San Diego, Calif.

Western Washington, Oregon, and northern California lie within a zone that climatologists call *Marine West Coast*. Winters are raw, overcast, and drizzly—not unlike northwestern Europe—with subfreezing temperatures restricted mainly to the mountains, upon which enormous snow accumulations produce local alpine glaciers. Summers, by contrast, are brilliantly cloudless, cool, and frequently foggy along the West Coast and somewhat warmer in the inland valleys. This mild marine climate produces some of the world's greatest forests of enormous straight-boled evergreen trees that furnish the United States with much of its commercial timber. Mature soils are typical of humid midlatitude forestlands, a moderately leached gray-brown podzol.

Toward the south, with diminishing coastal rain the moist marine climate gradually gives way to *California's* tiny but much-publicized Mediterranean regime. Although mountainous topography introduces a bewildering variety of local environments, scanty winter rains are quite inadequate to compensate for the long summer drought, and much of the region has a distinctly arid character. For much of the year, cool, stable Pacific air dominates the West Coast, bringing San Francisco its famous fogs and Los Angeles its infamous smoggy temperature inversions. Inland, however, summer temperatures reach blistering levels, so that in July, while Los Angeles expects a normal daily maximum of 83 °F (28 °C), Fresno expects 100 °F (38 °C) and is climatically a desert. As might be expected, Mediterranean California contains a huge variety of vegetal habitats, but the commonest perhaps is the *chaparral*, a drought-resistant, scrubby woodland of twisted hard-leafed trees, picturesque but of little economic value. Chaparral is a pyrophytic (fire-loving) vegetation—i.e., under natural conditions its growth and form depend on regular burning.

These fires constitute a major environmental hazard in the suburban hills above Los Angeles and San Francisco Bay, especially in autumn, when hot dry Santa Ana winds from the interior regularly convert brush fires into infernos. Soils are similarly varied, but most of them are light in colour and rich in soluble minerals, qualities typical of subarid soils.

In the United States, to speak of dry areas is to speak of the West. It covers an enormous region beyond the dependable reach of moist oceanic air, occupying the entire Intermontane area and sprawling from Canada to Mexico across the western part of the Great Plains. To Americans nurtured in the Humid East, this vast territory across the path of all transcontinental travelers has been harder to tame than any other—and no region has so gripped the national imagination as this fierce and dangerous land.
In the Dry West nothing matters more than water. Thus, though temperatures may differ radically from place to place, the really important regional differences depend overwhelmingly on the degree of aridity, whether an area is extremely dry and hence desert or semiarid and therefore steppe.

Americans of the 19th century were preoccupied by the myth of a *Great American Desert*, which supposedly occupied more than one-third of the entire country. True desert, however, is confined to the Southwest, with patchy outliers elsewhere, all without exception located in the lowland rain shadows of the Cordillera. Vegetation in these desert areas varies between nothing at all (a rare circumstance confined mainly to salt flats and sand dunes) to a low cover of scattered woody scrub and short-lived annuals that burst into flamboyant bloom after rains. Soils are usually thin, light-coloured, and very rich with mineral salts. In some areas wind erosion has removed fine-grained material, leaving behind desert pavement, a barren veneer of broken rock.

Most of the West, however, lies in the semiarid region, in which rainfall is scanty but adequate to support a thin cover of short bunchgrass, commonly alternating with scrubby brush. Here, as in the desert, soils fall into the large family of the pedocals, rich in calcium and other soluble minerals, but in the slightly wetter environments of the West, they are enriched with humus from decomposed grass roots. Under the proper type of management, these chestnut-coloured steppe soils have the potential to be very fertile.

Weather in the West resembles that of other dry regions of the world, often extreme, violent, and reliably unreliable. Rainfall, for example, obeys a cruel natural law: as total precipitation decreases, it becomes more undependable. John Steinbeck's novel The Grapes of Wrath describes the problems of a family enticed to the arid frontier of Oklahoma during a wet period only to be driven out by the savage drought of the 1930s that turned the western Great Plains into the great American Dust Bowl. Temperatures in the West also fluctuate convulsively within short periods, and high winds are infamous throughout the region

East of the Rockies all climatic boundaries are gradational. None, however, is so important or so imperceptibly subtle as the boundary zone that separates the Humid East from the Dry West and that alternates unpredictably between arid and humid conditions from year to year. Stretching approximately from Texas to North Dakota in an ill-defined band between the 95th and 100th meridians, this transitional region deserves separate recognition, partly because of its great size, and partly because of the fine balance between surplus and deficit rainfall, which produces a unique and valuable combination of soils, flora, and fauna. The native vegetation, insofar as it can be reconstructed, was prairie, the legendary sea of tall, deep-rooted grass now almost entirely tilled and planted to grains. Soils, often of loessial derivation, include the enormously productive chernozem (black earth) in the north, with reddish prairie soils of nearly equal fertility in the south. Throughout the region temperatures are severely continental, with bitterly cold winters in the north and scorching summers everywhere.

The western edge of the prairie fades gradually into the shortgrass steppe of the High Plains, the change a function of diminishing rainfall. The eastern edge, however, represents one of the few major discordances between a climatic and biotic boundary in the United States, for the grassland penetrates the eastern forest in a great salient across humid Illinois and Indiana. Many scholars believe this part of the prairie was artificially induced by repeated burning and consequent destruction of the forest margins by Indians.

Throughout the Cordillera and Intermontane regions, irregular topography shatters the grand bioclimatic pattern into an intricate mosaic of tiny regions that differ drastically according to elevation and exposure. No small- or medium-scale map can accurately record such complexity, and mountainous parts of the West are said, noncommittally, to have a “mountain climate.” Lowlands are usually dry, but increasing elevation brings lower temperature, decreased evaporation, and—if a slope faces prevailing winds—greater precipitation. Soils vary wildly from place to place, but vegetation is fairly predictable. From the desert or steppe of intermontane valleys, a climber typically ascends into parklike savanna, then through an orderly sequence of increasingly humid and boreal forests until, if the range is high enough, one reaches the timberline and Arctic tundra. The very highest peaks are snow-capped, although permanent glaciers rarely occur outside the cool humid highlands of the Pacific Northwest.

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