Handbook of

Temperate and Tropical Climates

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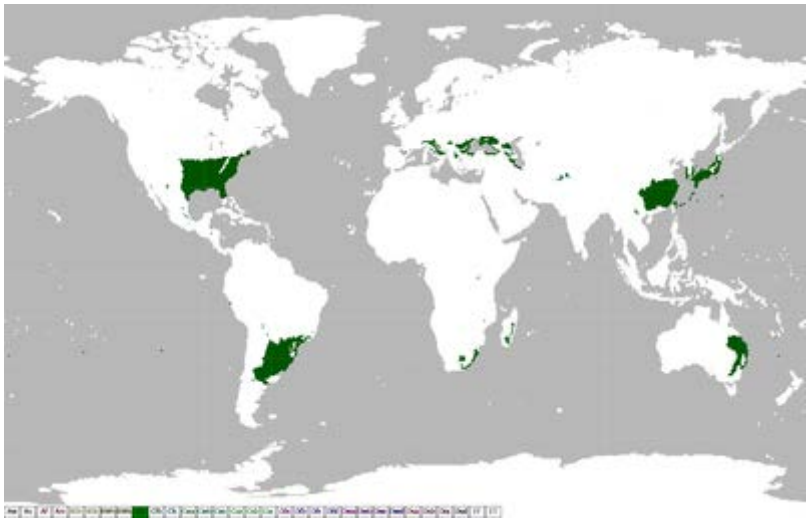
Humid Subtropical Climate



Humid subtropical climate zones of the world

A **humid subtropical climate** (Köppen climate classification *Cfa* or *Cwa*) is a climate zone characterized by hot, humid summers and cool winters. This climate type covers a broad category of climates, and the term "subtropical" may be a misnomer for the winter climate.

Description

The Köppen definition of this climate is for the coldest month's mean temperature to be between −3 °C (26.6 °F), although some climatologists prefer to use 0 °C (32 °F), and 18 °C (64.4 °F), and the warmest month to be above 22 °C (71.6 °F); along with either a dry winter- with less than one tenth of the precipitation of the wettest summer month- (Köppen: w) or without dry season (Köppen: f, winter months get more than one tenth of the precipitation of the wettest summer month, and summer months get at least 30 mm (1.2 in) per month or more than one third as much the wettest winter month).

Significant amounts of precipitation occur in all seasons in most areas, though in regions bordering on semi-arid climates (usually at the western margins), irregular droughts can be common and catastrophic to agriculture. Winter rainfall (and sometimes snowfall) is

associated with large storms that the westerlies steer from west to east. Most summer rainfall occurs during thunderstorms and an occasional tropical storm, hurricane or cyclone.This reigon is moist in the summer, can be very cold in winters.

Distribution

Humid subtropical climates lie on the southeast side of all continents between latitudes 25° and 40° north and south. Two of the few exceptions where this climate zone reaches up to latitude 46° north are in the Po Valley of Italy and Toulouse region of France, and along the Black Sea coast of Europe.

Africa

In Africa, the humid subtropical climates are found in two separate areas on the southern hemisphere of the continent. The *Cwa* climate is found in over a large portion of the interior of the Middle and Eastern African regions. This area includes; central Angola, northeastern Zimbabwe, the Niassa, Manica and Tete provinces of Mozambique, the southern Congo provinces, southwest Tanzania, and the majority of Malawi, and Zambia. Some lower portions of the Ethiopian Highlands also have this climate.

The *Cfa* climate covers a relatively small area of coastal KwaZulu-Natal and Eastern Cape provinces of South Africa, and is characterised by oceanic influences that give mild temperatures, especially in winter when temperatures do not drop as low as in many other regions within the humid subtropical category. For example Richards Bay experiences a daily average minimum of 12 °C (54 °F) and a daily average maximum of 23 °C (73 °F) in the coldest month, and did not drop below 4 °C (39 °F) in the thirty years of records from 1961. Rainfall is distributed throughout the year, but is heavier in summer, with a high of 172 millimetres (6.8 in) for January and a low of 57 millimetres (2.2 in) for June at Richards Bay.

Asia

Humid subtropical climates in Asia differ from those in other continents, in that they generally have a pronounced dry winter even on the poleward boundary of this region, with most falling in the *Cwa* classification.

East Asia

In East Asia, this type climate is found in sections of the Himalayas, China, the South Coast of South Korea and Japan (most of Honshū, Kyūshū and Shikoku). Some major Asian cities in this climate zone include Kathmandu, Chengdu, Chongqing, Shanghai, Nanjing, Busan, Kyoto and Tokyo. Hong Kong and Taipei are on the equatorward boundary of this zone and Qingdao is on the northern boundary.

In most of this region, there is extremely limited precipitation during the winter, owing to the powerful anticyclonic winds from Siberia. Only in those parts of coastal eastern China, between approximately the Yellow River and the Pearl River, is there sufficient winter rainfall to produce a *Cfa* climate; even in these areas, rainfall and streamflow show a highly pronounced summer peak quite unlike other regions of this climate type. The only area where the winter rainfall equals the summer rain is on the "San-in" (Sea of Japan) coast of Japan, which during winter is effectively on the windward side of the westerlies. The winter rainfall in these regions is usually produced by low-pressure systems off the east coast that develop in the onshore flow from the Siberian high. Summer rainfall comes from the East Asian Monsoon and from frequent typhoons. Annual rainfall is generally over 1,000 mm (40 inches), and in areas below the Himalayas can be much higher still.

South Asia

Humid subtropical climates can also be found in South Asia, primarily in northern India. However, the humid subtropical climates exhibited here differ markedly from humid subtropical climates in East Asia (and for that matter a good portion of the globe). Winters here are typically mild, dry and relatively short. They also tend to be foggy. Summers tend to be long and very hot, with high temperatures sometimes exceeding 40°C. They also tend to be extremely dry, complete with dust storms, traits usually associated with arid or semiarid climates. This is followed by the monsoons, where the region experiences heavy rain on almost a daily basis. Average high temperatures decreases during the monsoon season but the humidity increases. This results in hot and humid conditions, similar to summers in humid subtropical climates. Cities such as New Delhi, Lucknow and Kanpur exhibit this atypical version of the climate. Islamabad also features this weather pattern, but with wetter winters.

In South Asia, humid subtropical climates generally border on continental climates as altitude increases, or on winter-rainfall climates in Pakistan.

Southwestern Asia (Northern Middle East and Caucasus)

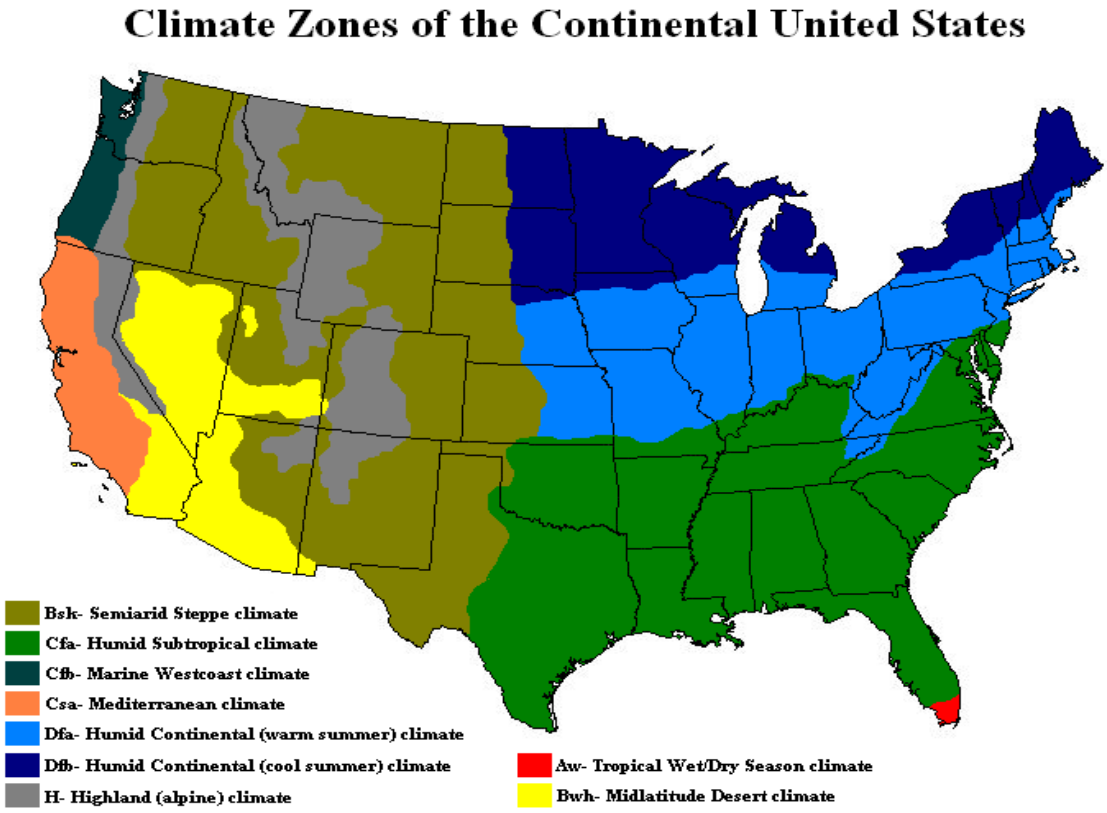
Although humid subtropical climates in Asia are mostly confined to the southeastern quarter of the continent, there are areas on the Caspian Sea and Black Sea with humid subtropical climates that are unusually warm for their high latitudes and also unusual for this climate type, that snowfall in winter is relatively common, but is usually of a short duration.

In the narrow Caspian coastal strip of Iran (Gilan and Mazandaran) a humid subtropical climate prevails at an unusually high latitude. Annual rainfall ranges from around 740 mm (29 inches) at Sari to over 2,000 mm (78 inches) at Bandar-e Anzali, and is heavy throughout the year, with a maximum in October or November when Bandar-e Anzali can average 400 millimetres (16 inches). Temperatures are generally moderate in comparison with other parts of Southwestern Asia. In Rasht, the average maximum in July is around 28 °C (82 °F) but with near-saturation humidity, whilst in January it is

around 9 °C (48 °F). The heavy, evenly distributed rainfall extends north into the Caspian coastal strip of Azerbaijan up to its northern border but this climate in Azerbaijan is, however, a *Cfb*/*Cfa* (*Oceanic climate*/*Humid subtropical climate*) borderline case. During winter, the coastal areas can receive snowfall, but is usually of a short duration. Annual rainfall in Lankaran in the southeast averages up to 1,800 mm (70 inches) and is heavy throughout the year; and annual rainfall is generally over 1,000 mm (40 inches) in the foothills of the Caucasus in the northeast, as altitude increases and the humid subtropical climate changes to the oceanic climate

Western Georgia in the Kolkheti Lowland and the north coast of Turkey, have a climate similar to that of Gilan and Mazandaran in Iran and very similar to that of southeastern and northeastern Azerbaijan. Temperatures range from 22 °C in summer to 5 °C in winter and rainfall is even heavier than in Caspian Iran, up to 2,300 millimetres per year in Hopa (Turkey) and up to 2,560 millimetres per year in Batumi (Georgia) falling throughout the year. This climate in northern Turkey and western Georgia is, again, a *Cfb*/*Cfa* (*Oceanic climate*/*Humid subtropical climate*) borderline case. And again, during winter, the coastal areas can receive snowfall, but is usually of a short duration.

North America



Climate Zones of the Continental United States

In North America, humid subtropical climates are almost exclusively the domain of the American South, including the following states: the eastern half of Texas, Louisiana, Arkansas, Alabama, Mississippi, North Carolina, South Carolina, Tennessee, Georgia, Kentucky, the District of Columbia, Maryland, Delaware, most of Florida and Virginia and southern West Virginia. The climate in many of these states, including Georgia, Tennessee and Arkansas, is subject to extremes. The humid subtropical climate can also be found in the Midwest, primarily in the southern portions of Missouri, Illinois, Indiana and Ohio. It can also be found in the Mid-Atlantic, primarily southern Pennsylvania, most of New Jersey (except for the northwest part), and far southern New York State. The Mid-Atlantic and Midwestern areas included in this climate typically see snowfall during the winter, with occasional heavy storms. The classic example of a humid subtropical climate is the Deep South, because the summers are long and almost tropical, and temperatures reach freezing only a few times in the winter with rare snowfall, usually three inches or less. Summers in this zone are hot and humid, with daily averages above 25°C (77°F). Major cities typically included in this climate zone include: Houston, Dallas, Atlanta, Louisville, Memphis, Birmingham, New Orleans, Nashville, Charlotte, Raleigh, Baltimore, Jacksonville, Orlando, Tampa, Richmond, Norfolk, Tulsa, Washington, D.C. and Little Rock. Major cities near the northern periphery of this zone include: St. Louis, Evansville, Indiana, Cincinnati, Pittsburgh, Philadelphia and New York City. The climates of Dallas, San Antonio and Oklahoma City display a marked reduction in rainfall that suggests a shading into steppe climates to be found farther west, as in Lubbock, Texas.

In Mexico, there are small areas of *Cfa* and *Cwa* climates. They are both caused by the high elevations of Trans-Mexican Volcanic Belt and Sierra Madre Oriental. Despite being located at higher elevations, these locations have summers that are too warm to qualify as a subtropical highland climate. Guadalajara's climate is a major example of this.

Characteristics and variants

Outside of the isolated higher-altitude sections of Mexico, the southernmost limits of this climate in North America lie just north of South Florida and around southern coastal Texas. Cities at the southernmost limits of this climate, such as Orlando and Tampa generally feature warm weather year round and minimal temperature differences between seasons. These cities fall just short of having a true tropical climate. By contrast, cities at the northernmost limits of the humid subtropical region, such as New York City and Philadelphia experience much greater seasonal variation, as they draw influence from the Atlantic Ocean and its bays, Delaware Bay and Chesapeake Bay. These cities generally feature hot, humid summers and cold winters. Other cities on the northernmost limit of the climate such as Louisville, Kentucky features a similar climate (hot humid summers, cold winters) but are generally not influenced by the Atlantic Ocean. Areas farther north than this, inland, or at a higher elevation, fall into the humid continental climate category with harsher winters.

Snowfall varies greatly in this climate zone. In locations at the southern limits of this zone and areas around the Gulf Coast, cities such as Orlando, Tampa, Houston and New Orleans rarely see snowfall, which occurs, at most, a few times per generation. In inland southern cities farther north, such as Atlanta, Memphis, Little Rock, Nashville, Dallas, Charlotte and Raleigh, snow falls once or twice a season and is usually three inches or less. Ice storms are not unusual at these locations. However for the majority of the winter here, temperatures remain above or well above freezing, with slight plant growth. In the northern limits of this climate zone, cities such as Philadelphia, and New York City experience snow every winter, sometimes accumulating heavily although it melts more quickly than in regions to the north.

Precipitation is plentiful in the humid subtropical climate zone in North America. Although most areas tend to have precipitation spread evenly throughout the year, a somewhat monsoon-like pattern is seen in parts of the Southeast (in locales such as Augusta, Georgia and Columbia, South Carolina), which experience dry winters (by humid subtropical standards) and warm springs, followed immediately by a long, hot, rainy and humid summer. In addition, areas in Texas that are slightly inland from the Gulf of Mexico, such as Austin and San Antonio, generally see a peak of precipitation in the spring, and a deep, drought-like nadir in mid-summer.

South America

Humid subtropical climates are found in a sizeable portion of South America. Most of north-eastern Argentina, Uruguay, southern Brazil, and eastern Paraguay features this climate. Major cities such as São Paulo, Buenos Aires and Montevideo has a humid subtropical climate, generally in the form of hot humid summers and mild to cool winters. These areas, which include the Pampas, generally feature a *Cfa* climate categorization.

The *Cwa* climate occurs in parts of tropical highlands of São Paulo state, Minas Gerais and near the Andean highland in northwestern Argentina. These highland areas feature summer temperatures that are warm enough to fall outside the subtropical highland climate category.

Australia

The humid subtropical climate dominates most of eastern Australia south from about Bundaberg, Queensland down to about Bega on the south coast of New South Wales. It extends from the coast inland to about Dubbo and the Warrumbungle and Nandewar mountain ranges, where it grades into arid climates. In the Great Dividing Range and to the south of about Bega, this climate type grades into an oceanic climate (Köppen **Cfb**) as at Guyra and Katoomba, in New South Wales.

This zone contains the only regions where soils are not acutely deficient in phosphorus, as well as the heaviest rainfall south of the Tropic of Capricorn, making it prime

agricultural country, centred on towns such as Coffs Harbour, Grafton, Kempsey, Port Macquarie, Tamworth, and Moree.

Many of Australia's major cities are also in this climate zone, including Brisbane, Gold Coast and Newcastle.

Variations in Australia

There is variation in climate within this zone. Annual rainfall on the coast can reach as high as 2,000 mm (80 inches) in favourable locations and is generally above 1,000 mm (40 inches). However, because most of the heaviest two- and three-day rainfalls in the world occur in this coastal zone as a result of east coast lows forming to the north of a large high pressure system, there can be great variation in rainfall from year to year. At Lismore in the centre of this zone, the annual rainfall can range from less than 550 mm (22 inches) in 1915 to more than 2,780 mm (110 inches) in 1950. There is usually a distinct summer rainfall maximum that becomes more pronounced moving northwards: in Brisbane the wettest month (February) receives five times the rainfall of the driest (September). Temperatures are very warm to hot but not excessive: the average maximum in February is usually around 29 °C (84 °F) and in July around 21 °C (70 °F). Frosts are extremely rare except at higher elevations, but temperatures over 35˚C (95˚F) are not common on the coast.

In the Darling Downs and further south, the summer rainfall maximum is less marked and by the time one reaches Dubbo, there are actually on average more rainy days in the winter months. Temperatures here display much greater seasonal variation, with summers being generally very hot with maxima of around 32 °C (90 °F) and frosts being common during dry winters: at Mitchell the temperature has reached as low as -9.4 °C (15 °F).

North of the **Cfa** climate zone there is a zone centred upon Rockhampton and extending up to the Atherton Tableland of Köppen **Cwa** climate. This has a very pronounced dry winter with often negligible rainfall between June and October, and winter temperatures generally only slightly below 18°C, above which one would have a tropical savanna, or **Aw**, climate.

Europe

Humid subtropical climates are found in only small sections of Europe, not nearly as widespread as it is on the other aforementioned continents. Some areas of Europe, such as parts of the northeastern interior of the Iberian Peninsula, parts of inland and Adriatic northern Italy, parts of Epirus in Greece around the area of Ioannina, parts of coastal northern Croatia, coastal Slovenia, the Black Sea coast of Bulgaria, Romania, Sochi, Russia and southernmost Ukraine have summers too warm (>22°C in the warmest month) to qualify as oceanic, no freezing month, and enough summer precipitation and sometimes humid conditions to preclude their classification as Mediterranean. In the Azores, some islands have this climate, with very mild and rainy winters (> 13°C), hot summers (> 22 or 23°C) but with no dry season during the warmest period, which means

that they can be classified neither as oceanic, nor as Mediterranean, but only as humid subtropical climate, as with Corvo Island.

Examples

Notable Cities in North & South America with Humid subtropical climates

- Houston, Texas, United States
- Dallas, Texas, United States
- Austin, Texas, United States
- San Antonio, Texas, United States
- New Orleans, Louisiana, United States
- Atlanta, Georgia, United States
- Savannah, Georgia, United States
- Tampa, Florida, United States
- Jacksonville, Florida, United States
- Orlando, Florida, United States
- Little Rock, Arkansas, United States
- New York, New York, United States
- Philadelphia, Pennsylvania, United States
- Washington, D.C., United States
- Baltimore, Maryland, United States
- Richmond, Virginia, United States
- Norfolk, Virginia, United States
- Charlotte, North Carolina, United States
- Raleigh, North Carolina, United States
- Greensboro, North Carolina, United States
- Charleston, South Carolina, United States
- Nashville, Tennessee, United States
- Memphis, Tennessee, United States
- Knoxville, Tennessee, United States
- Louisville, Kentucky, United States
- Guadalajara, Mexico (*Cwa*)
- Buenos Aires, Argentina
- Rosario, Argentina
- Montevideo, Uruguay
- São Paulo, Brazil
- Florianópolis, Brazil
- Blumenau, Brazil
- Porto Alegre, Brazil

Notable Cities outside North & South America with Humid subtropical climates

- Tokyo, Japan
- Osaka, Japan
- Nagoya, Japan
- Delhi, India (*Cwa*/*BSh*)
- Shanghai, China
- Guangzhou, Guangdong, China
- Shenzhen, Guangdong, China (*Cwa*)
- Wuhan, Hubei, China
- Hangzhou, Zhejiang, China
- Nanjing, Jiangsu, China
- Durban, South Africa
- Pretoria, South Africa (*Cwa*)
- Lusaka, Zambia
- Lilongwe, Malawi
- Toulouse, France (*Cfa/Cfb*)
- Milan, Italy
- Bologna, Italy
- Venice, Italy
- Koper, Slovenia
- Rijeka, Croatia

- Xiamen, Fujian, China
- Chengdu, Sichuan, China (*Cwa*)
- Chongqing, China
- Nanning, China
- Hong Kong SAR, China (*Cwa*)
- Macau SAR, China (*Cwa*)
- Taipei, Taiwan
- Busan, South Korea (*Cwa*)
- Gwangju, South Korea
- Hanoi, Vietnam (*Cwa*)
- Islamabad, Pakistan (*Cwa*)
- Kathmandu, Nepal (*Cwa*)
- Brisbane, Australia
- Gold Coast, Australia
- Skopje, Macedonia (*Cfa/Dfa*)
- Varna, Bulgaria
- Simferopol, Ukraine (*Cfa/Dfa*)
- Sochi, Russia
- Tbilisi, Georgia
- Batumi, Georgia (*Cfa/Cfb*)
- Giresun, Turkey (*Cfa/Cfb*)
- Samsun, Turkey (*Cfa/Cfb*)
- Ordu, Turkey (*Cfa/Cfb*)
- Trabzon, Turkey (*Cfa/Cfb*)
- Lankaran, Azerbaijan
- Bandar-e Anzali, Iran
- Rasht, Iran
- Sari, Iran

-
  - (*Cwa*) *Humid subtropical climate with a dry winter*.
  - (*Cfa/Cfb*) *Humid subtropical climate/Oceanic climate* is a borderline case, however.
  - (*Cfa/Dfa* or *Cwa/Dwa*) *Humid subtropical climate/Humid continental climate*, another borderline case.

Charts of selected cities with humid subtropical climates

Northern hemisphere

Tokyo
Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
49	60	115	130	128	165	162	155	209	163	93	40
10	10	13	18	23	25	29	31	27	22	17	12
2	2	5	11	15	19	23	24	21	15	10	5

average max. and min. temperatures in °C

precipitation totals in mm

Shanghai
Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D

51	57	99	89	102	170	156	158	137	63	46	37
8	9	13	19	24	28	32	31	27	23	17	11
1	2	6	11	16	21	25	25	21	15	9	3

average max. and min. temperatures in °C

precipitation totals in mm

New York

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
105	80	111	109	119	98	117	107	107	98	111	100
3	5	10	16	22	26	29	28	24	18	12	6
−3	−2	2	7	12	17	20	20	16	10	5	0

average max. and min. temperatures in °C

precipitation totals in mm

New Orleans

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
149	139	133	128	117	174	158	156	141	78	129	129
17	19	22	26	29	32	33	33	31	27	22	18
6	8	12	15	19	22	23	23	21	16	11	8

average max. and min. temperatures in °C

precipitation totals in mm

Southern hemisphere

Buenos Aires

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
119	118	134	97	74	63	66	70	73	119	109	105
30	29	26	23	19	16	15	17	19	22	25	28
20	19	17	13	10	8	8	8	10	13	15	18

average max. and min. temperatures in °C

precipitation totals in mm

São Paulo
Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
240	200	140	50	40	30	20	30	50	140	120	190
27	28	27	25	23	21	21	22	22	25	25	26
19	19	18	17	15	13	12	13	13	15	17	18

average max. and min. temperatures in °C

precipitation totals in mm

Richards Bay
Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
172	167	107	109	109	57	60	65	77	105	114	86
29	29	29	27	25	23	23	24	25	25	27	29
21	21	20	18	15	12	12	14	16	17	19	20

average max. and min. temperatures in °C

precipitation totals in mm

Brisbane
Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
96	126	89	56	64	60	23	36	26	61	116	128
30	30	29	27	25	22	22	23	26	27	28	29
21	21	20	17	14	12	10	11	14	16	19	20

average max. and min. temperatures in °C

precipitation totals in mm