= Climate =

Climate is the statistics (usually , mean or variability) of weather , usually over a 30 @-@ year interval . It is measured by assessing the patterns of variation in temperature , humidity , atmospheric pressure , wind , precipitation , atmospheric particle count and other meteorological variables in a given region over long periods of time . Climate differs from weather , in that weather only describes the short @-@ term conditions of these variables in a given region .

A region 's climate is generated by the climate system , which has five components : atmosphere , hydrosphere , cryosphere , lithosphere , and biosphere .

The climate of a location is affected by its latitude , terrain , and altitude , as well as nearby water bodies and their currents . Climates can be classified according to the average and the typical ranges of different variables , most commonly temperature and precipitation . The most commonly used classification scheme was Köppen climate classification originally developed by Wladimir Köppen . The Thornthwaite system , in use since 1948 , incorporates evapotranspiration along with temperature and precipitation information and is used in studying biological diversity and the potential effects on it of climate changes . The Bergeron and Spatial Synoptic Classification systems focus on the origin of air masses that define the climate of a region .

Paleoclimatology is the study of ancient climates . Since direct observations of climate are not available before the 19th century , paleoclimates are inferred from proxy variables that include non @-@ biotic evidence such as sediments found in lake beds and ice cores , and biotic evidence such as tree rings and coral . Climate models are mathematical models of past , present and future climates . Climate change may occur over long and short timescales from a variety of factors ; recent warming is discussed in global warming .

= = Definition = =

Climate (from Ancient Greek klima , meaning inclination) is commonly defined as the weather averaged over a long period . The standard averaging period is 30 years , but other periods may be used depending on the purpose . Climate also includes statistics other than the average , such as the magnitudes of day @-@ to @-@ day or year @-@ to @-@ year variations . The Intergovernmental Panel on Climate Change (IPCC) 2001 glossary definition is as follows :

Climate in a narrow sense is usually defined as the " average weather , " or more rigorously , as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years . The classical period is 30 years , as defined by the World Meteorological Organization (WMO) . These quantities are most often surface variables such as temperature , precipitation , and wind . Climate in a wider sense is the state , including a statistical description , of the climate system .

The World Meteorological Organization (WMO) describes climate " normals " as " reference points used by climatologists to compare current climatological trends to that of the past or what is considered ' normal ' . A Normal is defined as the arithmetic average of a climate element (e.g. temperature) over a 30 @-@ year period . A 30 year period is used , as it is long enough to filter out any interannual variation or anomalies , but also short enough to be able to show longer climatic trends . " The WMO originated from the International Meteorological Organization which set up a technical commission for climatology in 1929 . At its 1934 Wiesbaden meeting the technical commission designated the thirty @-@ year period from 1901 to 1930 as the reference time frame for climatological standard normals . In 1982 the WMO agreed to update climate normals , and in these were subsequently completed on the basis of climate data from 1 January 1961 to 31 December 1990 .

The difference between climate and weather is usefully summarized by the popular phrase " Climate is what you expect , weather is what you get . " Over historical time spans there are a number of nearly constant variables that determine climate , including latitude , altitude , proportion of land to water , and proximity to oceans and mountains . These change only over periods of millions of years due to processes such as plate tectonics . Other climate determinants are more

dynamic : the thermohaline circulation of the ocean leads to a 5 ° C (9 ° F) warming of the northern Atlantic Ocean compared to other ocean basins . Other ocean currents redistribute heat between land and water on a more regional scale . The density and type of vegetation coverage affects solar heat absorption , water retention , and rainfall on a regional level . Alterations in the quantity of atmospheric greenhouse gases determines the amount of solar energy retained by the planet , leading to global warming or global cooling . The variables which determine climate are numerous and the interactions complex , but there is general agreement that the broad outlines are understood , at least insofar as the determinants of historical climate change are concerned .

= = Climate classification = =

There are several ways to classify climates into similar regimes . Originally , climes were defined in Ancient Greece to describe the weather depending upon a location 's latitude . Modern climate classification methods can be broadly divided into genetic methods , which focus on the causes of climate , and empiric methods , which focus on the effects of climate . Examples of genetic classification include methods based on the relative frequency of different air mass types or locations within synoptic weather disturbances . Examples of empiric classifications include climate zones defined by plant hardiness , evapotranspiration , or more generally the Köppen climate classification which was originally designed to identify the climates associated with certain biomes . A common shortcoming of these classification schemes is that they produce distinct boundaries between the zones they define , rather than the gradual transition of climate properties more common in nature .

= = = Bergeron and Spatial Synoptic = = =

The simplest classification is that involving air masses . The Bergeron classification is the most widely accepted form of air mass classification . Air mass classification involves three letters . The first letter describes its moisture properties , with c used for continental air masses (dry) and m for maritime air masses (moist) . The second letter describes the thermal characteristic of its source region : T for tropical , P for polar , A for Arctic or Antarctic , M for monsoon , E for equatorial , and S for superior air (dry air formed by significant downward motion in the atmosphere) . The third letter is used to designate the stability of the atmosphere . If the air mass is colder than the ground below it , it is labeled k . If the air mass is warmer than the ground below it , it is labeled w . While air mass identification was originally used in weather forecasting during the 1950s , climatologists began to establish synoptic climatologies based on this idea in 1973 .

Based upon the Bergeron classification scheme is the Spatial Synoptic Classification system (SSC) . There are six categories within the SSC scheme : Dry Polar (similar to continental polar) , Dry Moderate (similar to maritime superior) , Dry Tropical (similar to continental tropical) , Moist Polar (similar to maritime polar) , Moist Moderate (a hybrid between maritime polar and maritime tropical) , and Moist Tropical (similar to maritime tropical , maritime monsoon , or maritime equatorial) .

= = = Köppen = = =

The Köppen classification depends on average monthly values of temperature and precipitation . The most commonly used form of the Köppen classification has five primary types labeled A through E. These primary types are A , tropical ; B , dry ; C , mild mid @-@ latitude ; D , cold mid @-@ latitude ; and E , polar . The five primary classifications can be further divided into secondary classifications such as rain forest , monsoon , tropical savanna , humid subtropical , humid continental , oceanic climate , Mediterranean climate , steppe , subarctic climate , tundra , polar ice cap , and desert .

Rain forests are characterized by high rainfall , with definitions setting minimum normal annual rainfall between 1 @,@ 750 millimetres (69 in) and 2 @,@ 000 millimetres (79 in) . Mean monthly temperatures exceed 18 ° C (64 ° F) during all months of the year .

A monsoon is a seasonal prevailing wind which lasts for several months , ushering in a region 's rainy season . Regions within North America , South America , Sub @-@ Saharan Africa , Australia and East Asia are monsoon regimes .

A tropical savanna is a grassland biome located in semiarid to semi @-@ humid climate regions of subtropical and tropical latitudes , with average temperatures remain at or above 18 ° C (64 ° F) year round and rainfall between 750 millimetres (30 in) and 1 @,@ 270 millimetres (50 in) a year . They are widespread on Africa , and are found in India , the northern parts of South America , Malaysia , and Australia .

The humid subtropical climate zone where 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 from occasional tropical cyclones . Humid subtropical climates lie on the east side continents , roughly between latitudes 20 ° and 40 ° degrees away from the equator .

A humid continental climate is marked by variable weather patterns and a large seasonal temperature variance . Places with more than three months of average daily temperatures above 10 ° C (50 ° F) and a coldest month temperature below ? 3 ° C (27 ° F) and which do not meet the criteria for an arid or semiarid climate , are classified as continental .

An oceanic climate is typically found along the west coasts at the middle latitudes of all the world 's continents , and in southeastern Australia , and is accompanied by plentiful precipitation year round .

The Mediterranean climate regime resembles the climate of the lands in the Mediterranean Basin , parts of western North America , parts of Western and South Australia , in southwestern South Africa and in parts of central Chile . The climate is characterized by hot , dry summers and cool , wet winters .

A steppe is a dry grassland with an annual temperature range in the summer of up to 40 ° C (104 ° F) and during the winter down to ? 40 ° C (? 40 ° F) .

A subarctic climate has little precipitation , and monthly temperatures which are above 10 ° C (50 ° F) for one to three months of the year , with permafrost in large parts of the area due to the cold winters . Winters within subarctic climates usually include up to six months of temperatures averaging below 0 ° C (32 ° F) .

Tundra occurs in the far Northern Hemisphere , north of the taiga belt , including vast areas of northern Russia and Canada .

A polar ice cap , or polar ice sheet , is a high @-@ latitude region of a planet or moon that is covered in ice . Ice caps form because high @-@ latitude regions receive less energy as solar radiation from the sun than equatorial regions , resulting in lower surface temperatures .

A desert is a landscape form or region that receives very little precipitation . Deserts usually have a large diurnal and seasonal temperature range , with high or low , depending on location daytime temperatures (in summer up to 45 ° C or 113 ° F) , and low nighttime temperatures (in winter down to 0 ° C or 32 ° F) due to extremely low humidity . Many deserts are formed by rain shadows , as mountains block the path of moisture and precipitation to the desert .

= = = Thornthwaite = = =

Devised by the American climatologist and geographer C. W. Thornthwaite , this climate classification method monitors the soil water budget using evapotranspiration . It monitors the portion of total precipitation used to nourish vegetation over a certain area . It uses indices such as a humidity index and an aridity index to determine an area 's moisture regime based upon its average temperature , average rainfall , and average vegetation type . The lower the value of the index in any given area , the drier the area is .

The moisture classification includes climatic classes with descriptors such as hyperhumid , humid , subhumid , subarid , semi @-@ arid (values of ? 20 to ? 40) , and arid (values below ? 40) . Humid regions experience more precipitation than evaporation each year , while arid regions experience greater evaporation than precipitation on an annual basis . A total of 33 percent of the Earth 's landmass is considered either arid of semi @-@ arid , including southwest North America ,

southwest South America , most of northern and a small part of southern Africa , southwest and portions of eastern Asia , as well as much of Australia . Studies suggest that precipitation effectiveness (PE) within the Thornthwaite moisture index is overestimated in the summer and underestimated in the winter . This index can be effectively used to determine the number of herbivore and mammal species numbers within a given area . The index is also used in studies of climate change .

Thermal classifications within the Thornthwaite scheme include microthermal , mesothermal , and megathermal regimes . A microthermal climate is one of low annual mean temperatures , generally between 0 ° C (32 ° F) and 14 ° C (57 ° F) which experiences short summers and has a potential evaporation between 14 centimetres (5 @.@ 5 in) and 43 centimetres (17 in) . A mesothermal climate lacks persistent heat or persistent cold , with potential evaporation between 57 centimetres (22 in) and 114 centimetres (45 in) . A megathermal climate is one with persistent high temperatures and abundant rainfall , with potential annual evaporation in excess of 114 centimetres (45 in) .

= = Record = =

= = = Modern = = =

Details of the modern climate record are known through the taking of measurements from such weather instruments as thermometers , barometers , and anemometers during the past few centuries . The instruments used to study weather over the modern time scale , their known error , their immediate environment , and their exposure have changed over the years , which must be considered when studying the climate of centuries past .

= = = Paleoclimatology = = =

Paleoclimatology is the study of past climate over a great period of the Earth 's history . It uses evidence from ice sheets , tree rings , sediments , coral , and rocks to determine the past state of the climate . It demonstrates periods of stability and periods of change and can indicate whether changes follow patterns such as regular cycles .

= = Climate change = =

Climate change is the variation in global or regional climates over time . It reflects changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years . These changes can be caused by processes internal to the Earth , external forces (e.g. variations in sunlight intensity) or , more recently , human activities .

In recent usage , especially in the context of environmental policy , the term " climate change " often refers only to changes in modern climate , including the rise in average surface temperature known as global warming . In some cases , the term is also used with a presumption of human causation , as in the United Nations Framework Convention on Climate Change (UNFCCC) . The UNFCCC uses " climate variability " for non @-@ human caused variations .

Earth has undergone periodic climate shifts in the past , including four major ice ages . These consisting of glacial periods where conditions are colder than normal , separated by interglacial periods . The accumulation of snow and ice during a glacial period increases the surface albedo , reflecting more of the Sun 's energy into space and maintaining a lower atmospheric temperature . Increases in greenhouse gases , such as by volcanic activity , can increase the global temperature and produce an interglacial period . Suggested causes of ice age periods include the positions of the continents , variations in the Earth 's orbit , changes in the solar output , and volcanism .

= = = Climate models = = =

Climate models use quantitative methods to simulate the interactions of the atmosphere , oceans , land surface and ice . They are used for a variety of purposes ; from the study of the dynamics of the weather and climate system , to projections of future climate . All climate models balance , or very nearly balance , incoming energy as short wave (including visible) electromagnetic radiation to the earth with outgoing energy as long wave (infrared) electromagnetic radiation from the earth . Any imbalance results in a change in the average temperature of the earth .

The most talked @-@ about applications of these models in recent years have been their use to infer the consequences of increasing greenhouse gases in the atmosphere , primarily carbon dioxide (see greenhouse gas) . These models predict an upward trend in the global mean surface temperature , with the most rapid increase in temperature being projected for the higher latitudes of the Northern Hemisphere .

Models can range from relatively simple to quite complex :

Simple radiant heat transfer model that treats the earth as a single point and averages outgoing energy

this can be expanded vertically (radiative @-@ convective models) , or horizontally

finally , (coupled) atmosphere ? ocean ? sea ice global climate models discretise and solve the full equations for mass and energy transfer and radiant exchange .

Climate forecasting is a way by some scientists are using to predict climate change . In 1997 the prediction division of the International Research Institute for Climate and Society at Columbia University began generating seasonal climate forecasts on a real @-@ time basis . To produce these forecasts an extensive suite of forecasting tools was developed , including a multimodel ensemble approach that required thorough validation of each model 's accuracy level in simulating interannual climate variability .