

Thornthwaite climatic classification

Thornthwaite climate classification A system for describing climates devised in 1931 and revised in 1948 by the American climatologist [Charles Warren Thornthwaite](#) (1889–1963) which divides climates into groups according to the vegetation characteristic of them, the vegetation being determined by precipitation effectiveness (P/E , where P is the total monthly precipitation and E is the total monthly evaporation). The sum of the monthly P/E values gives the P/E index, which is used to define five humidity provinces, with associated vegetation. A P/E index of more than 127 (wet) indicates rain forest; 64–127 (humid) indicates forest; 32–63 (subhumid) indicates grassland; 16–31 (semi-arid) indicates steppe; less than 16 (arid) indicates desert. In 1948 the system was modified to incorporate a [moisture index](#), which relates the water demand by plants to the available precipitation, by means of an index of [potential evapotranspiration](#) (PE), calculated from measurements of air temperature and day length. In arid regions the [moisture index](#) is negative because precipitation is less than the PE. The system also uses an index of thermal efficiency, with accumulated monthly temperatures ranging from 0, giving a frost climate, to more than 127, giving a tropical climate. Compare [Köppen climate classification](#) and [Strahler climate classification](#).

Thornthwaite climate classification An expressed for precipitation efficiecewas obtained by relating measurement of pan evaporation to temperature and precipitation. For each month the ratio $11.5 (rt-10)1019$ where r = mean monthly rainfall (in inches) t = mean monthly temperature

Main climatic group based an precipitation effectiveness

Humidity province	Vegetation	P/E index
A (Wet)	Rainforest	127
B(Humid)	Forest	64-127
C(Subhumid	Grassland	32-63
D(Semiarid)	Steppe	16-31
E(Arid)	Desert	16

Main climatic group based on Thermal efficiency

Thornthwaite introduced an index of thermal efficiency which is expressed by the positive departure of monthly mean temperature from freezing point. The index is thus the annual sum $(t-32)$ for each month temperature ratios (T/E).

Temperature	T/E index
A: Tropical	127
B: Mesothermal	64-127
C: Microthermal	32-63
D: Taiga	16-31
E: Tundra	1-15
F: Frost	0

T/E index-sum of 12 monthly values of $(T-32)/4$. Where T mean monthly temperature.

On the basis of the monthly seasonal distribution of precipitation the humidity province were subdivided into the following.

r: rainfall adequate in all season

s: rainfall and different in summer

w; rainfall deficient in winter

d: rainfall deficient in all season

1948 Classification:

After making sizeable modifications Thorthwaite presented his modified scheme of climatic classification in 1948. Though he again used previously devised three indices of precipitation effectiveness, thermal efficiency and seasonal distribution of precipitation in his second classification but in different way. Instead of vegetation, as done in 1931 classification, he based his new scheme of climatic classification on the concept of potential evapotranspiration (PE) which is in fact an index of thermal efficiency and water loss because it represents the amount of transfer of both moisture and heat to the atmosphere from soils and vegetation (evaporation of liquid or solid water, and transpiration from living plant leaves) and thus is a function of energy received from the sun.

It may be pointed out that potential evapotranspiration is calculated (and not directly measured) from the mean monthly temperature (in °C) with corrections for day length (i.e., 12 hours).

The PE (Potential Evapotranspiration) for a 30-day month (a day having only the length of sunshine i.e. 12 hours) is calculated as follows:

$$PE \text{ (in cm)} = 1.6(10t/I)^a$$

where PE = Potential Evapotranspiration

I = the sum for 12 months of $(t/5)^{1.514}$

a = a further complex function of I

t = temperature in °C

Thornthwaite developed four indices to determine boundaries of different climatic types

e.g.:

(i) Moisture index (Im),

(ii) Potential evapotranspiration or thermal efficiency index (PE),

(iii) Aridity and humidity indices, and

(iv) Index of concentration of thermal efficiency or potential evapotranspiration.

(i) Moisture Index (Im):

Moisture index refers to moisture deficit or surplus and is calculated according to the following formula:

$$\mathbf{Im = (100s - 60D)/PE}$$

Where Im = monthly moisture index

S = monthly surplus of moisture

D = monthly deficit of moisture

The sum of the 12 monthly values of Im gives the annual moisture index.

Moisture index	Humidity provinces	cm	PE/IM	Thermal Province
>100	Perhumid(A)	>114	>44.9	Megatherm(A)
20-to 100	Humid(B1 to B4)	57-144	22.4-44.9	Mesotherm(B1 to B4)
0 to 20	Moist subhumid(C2)	28.5-57.8	11.2-22.4	Microtherm(C1 to C2)
-33 to 02	Dry Subhumid(c1)	14.5-28.5	5.6-11.2	Tundra(D)
-67 to -33	SemiArid(D)	<14.2	<5.6	Frost
-100 to -67	Arid(E)			