

## **Köppen-Geiger climatic classification for R users**

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This paper is a non-peer reviewed preprint submitted to EarthArXiv.

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## Introduction

The Köppen-Geiger classification divides the world's climate into 5 main classes and 30 sub-types, and it is based on threshold values and seasonality of monthly air temperature and precipitation (Beck *et al.*, 2018b).

This classification was first published by (Köppen, 1936), but new versions were developed since then. The latest version improved the spatial resolution to 0.0083° and introduced three changes, mainly focused on readjustments of the threshold values and the mutually exclusiveness of the climatic classes (Beck *et al.*, 2018b). This updated system allows to increase the accuracy of the generated maps, as well as improve the implementation on studies focused on climate studies (Beck *et al.*, 2018b).

The function for re-classifying temperature and precipitation and create the Köppen-Geiger classes was originally published in Matlab. However, professionals working in disciplines such as Macroecology or the Biogeography usually use R as their main programming language. For that reason, here we publish the classifying function in R language, as well as an example of its utility.

## Methods

Our function is based on Beck et al. (2018a) function built on Matlab (*KoppenGeiger.m*), designed to classify monthly temperature and precipitation data according to Köppen-Geiger climate classification (Beck et al., 2018b). For an extended description of the criteria used in this function see Beck et al. (2018b).

We transformed this function to R language, and introduced two additional changes: (1) we added a “-99” value for the missing values, in order to facilitate computational operations and (2) we modified lines 84, 85 and 86 of *KoppenGeiger.m* (Beck *et al.*, 2018a) in order to fulfill the following conditions: “Pthreshold =2×MAT if >70% of precipitation falls in winter, Pthreshold =2×MAT+28 if >70% of precipitation falls in summer, otherwise Pthreshold =2×MAT+14” (H. Beck, personal communication, December 18, 2021).

The function has three arguments: “Temp”, “Prec” and “type”. In this sense, temperature (“Temp”) and precipitation (“Prec”) data should be provided as three dimensional arrays with the third dimension representing time (12 months). “Temp” data should be provided in degrees Celsius, and “Prec” data in mm/months. The last

argument (“type”) refers to the resulting categories generated (“class” = numeric identifier of the specific class 1-30, or “broadclass” = numeric identifier of the broad class 1-5). For an explanation of each of these categories, please refer to Beck *et al.* (2018b). Lastly, the resulting object of this function is a matrix representing the classified climate classes.

As a visualization example, we downloaded monthly average temperature and precipitation data from WorldClim 2.1 (5 minute resolution; Fick & Hijmans, 2017), and transformed them into two arrays of twelve matrices (one for each month of the variables). We used these arrays as the inputs of the function to generate a matrix of the main climate zones (tropical, arid, temperate, cold and polar). After this, we rasterized the matrix using the “rast” function of the *terra* package version 1.7-39 (Hijmans, 2023).

## Results

The resulting R function is available at [https://github.com/MAPASlab/KoppenGeiger\\_Class.git](https://github.com/MAPASlab/KoppenGeiger_Class.git)

Our example is shown in Figure 1, where it is possible to see the resulting climate classes generated from WorldClim climate data.

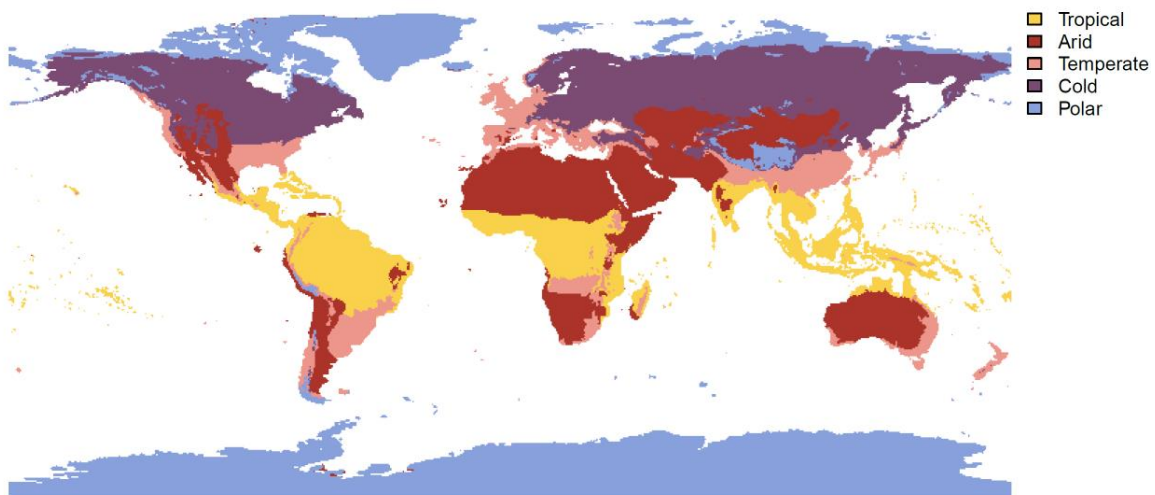


Figure 1. Köppen-Geiger climate classification from WordClim 2.1. data.

We believe this R function will help R users to implement and generate Köppen-Geiger climate classifications, expanding its application through different scientific fields.

## References

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