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# Empirical estimation of the climatic representativeness in two different areas: desert and Mediterranean climates

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**Abstract**

This paper develops a method, based on the PASCOOL methodology, to evaluate empirically the climatic representativeness of two Spanish locations in different meteorological zones: semi-arid and Mediterranean climates. New Typical Meteorological Years (TMYs) have been created using 10 years of measurement of the principal meteorological variables. Different weighting factors for the computed variables have been considered. The selected TMYs have been obtained minimizing the standard deviation with reference climatic databases of the studied locations and considering the final use of these files. With these assumptions, ambient temperature and global solar radiations have been estimated with the highest weighting factors.


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*Keywords:* Climatic representativeness, TMY, weighting factors

## 1. Introduction

One of the most critical points when assessing the energy performance of a building or a renewable system is the availability of a representative climatic database of the studied areas [1, 2, 3]. These files have been created using the most probable values of the meteorological variables that characterize the atmosphere. Most of the climatic classifications use the systematization of the most frequent values for the meteorological variables but this only

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delivers general information about the climatology in large geographical areas [4, 5]. Factors such as orography, isolation, ground reflectance, water mass, vegetation or wind regimes can produce large dispersions that modify the general climatic characteristics [6, 7].

Representative climatic files should be created through the treatment of the principal meteorological variables registered by weather stations placed at the studied areas over a long period of time. Databases with at least 10 years of measurements can be considered sufficiently representative of an area and can be used to create a Typical Meteorological Year (TMY).

This paper focuses on the creation of new TMYs for the two Spanish locations studied: Madrid and Tabernas (Almeria). It has been supported by the Spanish research project OMEGA-CM. This process is based on 10 years of measurements and final considerations about the use of the files have been considered.

## 2. Studied areas

Two Spanish locations in different meteorological zones have been studied: the desert of Tabernas in Almeria and the city of Madrid. The first location is situated in the Solar Platform of Almería (PSA), in Tabernas, Almeria, south-east of Spain. This is a semi-arid zone with high daily thermal oscillations, hot and dry summers and cold winters. The second location is at the CIEMAT facilities in Madrid, in the center of Spain, where a Mediterranean climate with mild cool winters and hot summers prevails.

The experimental campaigns to calculate the Typical Meteorological Years for each location have taken place from 2006 to 2015. Outdoor conditions are measured with two weather stations installed at CIEMAT and PSA facilities. Meteorological variables such as global horizontal solar radiation, longwave radiation, air temperature, relative humidity, wind speed and direction and $CO_2$ concentration are measured [8].

A first pre-processing of the measured data has been done to eliminate outliers and identify trends, variances and extreme values. Table 1 shows the annual mean values for the principal meteorological variables for Madrid and Tabernas (Almeria).

Table 1. Meteorological databases for the two studied locations recorded from 2006 to 2015.

| Location | Dessert of Tabernas | Madrid |
|---|---|---|
| Köppen-Geiger classification | BWk | Csa |
| Annual temperature +standard deviation | 17.3±1.2ºC | 15.8±1.6ºC |
| Annual relative humidity +standard deviation | 55±7% | 47±15% |
| Annual global solar radiation +standard deviation | 1817±168 kWh/m$^2$ | 1630±167 kWh/m$^2$ |
| Annual wind speed +standard deviation | 2.6±0.3 m/s | 1.3±0.4 m/s |
| Annual wind direction +standard deviation | 156±28º | 183±18º |

In order to quantify the years with higher dispersion from the mean values, every monthly value and standard deviation above and below the studied variables of the analyzed period have been evaluated. Table 2 presents the years with highest percentage of months above and below the mean values ± standard deviations and highlights the month with the highest dispersion of the studied period.

Table 2. Dispersion from the mean values for the two studied locations recorded from 2006 to 2015.

| Variable | Deviation from the monthly mean values | Dessert of Tabernas | | Madrid | |
|---|---|---|---|---|---|
| | | Highest percentages | Highest dispersion | Highest percentages | Highest dispersion |
| Air temperature | T + standard deviation | 42% 2012 | April 2014 | 58% 2014 | July 2015 |
| | T - standard deviation | 58% 2008 | November 2008 | 58% 2007 | September 2008 |
| Relative humidity | HR + standard deviation | 42% 2010 | May 2006 | 33% 2006 | May 2008 |
| | HR - standard deviation | 42% 2014 | February 2012 | 100% 2012 | December 2012 |
| Global | Ig + standard deviation | 33% 2013 | December 2007 | 50% 2006 | February 2012 |