4th International Conference on Environmental Design, ICED2023
Sustainability / Pollution / Energy / Cities-Buildings / Transportation / Erosion / Climate Change / Policy / Social Acceptance / Health Impacts 20-22 October 2023, Athens, Greece

Cluster Analysis of Climate Variability Indices in Greece

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1. Introduction

In recent years, there is an increasing research interest of studying climate variability, which is also important for the assessment and planning of countries (1). Many studies have focused on monitoring temperature variability and extreme events (2,3). Here, we focus on climate variability over Greece, based on some temperature variability indices (4,5). Using a K-Means cluster analysis, we highlighted regions with similar climate variability.

2. Methods

To calculate annual temperature variability, we used the following indicators presented by Zacharaki et al. (4,5):

- Maximum number of days with a continuous decrease/increase in daily mean temperature (T_{mean}) per year.
- Number of days (per year) when $\Delta T>0$, $\Delta T<0$ and $\Delta T=0$ for mean and minimum daily temperatures. ΔT is the day-to-day difference in daily temperature.

A K-Means cluster analysis of these indices was performed using R programming language for 20 different stations in Greece. The temperature data, the longitude and latitude of the stations were obtained from the Hellenic National Meteorological Service. For the K-Means method, the mean values of these indices were considered as variables during the time period 1955-2021.

3. Results

In Fig. 1(a) most of the stations are in the same cluster (red) and show a similar number of days (6,58) with a continuous decrease in daily mean temperature. On the other hand Fig. 1(b), most of the regions in east Greece (yellow) show a similar number of days (6,92) with a continuous increase in temperature while regions in central Greece (red) show a higher index value (7,89). In Fig. (c-d), regions in central Greece show a similar high number of days (194) where daily mean temperature increases and a low number of days where temperature decreases (less than 188). The opposite happens in the remaining regions. In Fig. (e), almost all regions show a similar low index value (0,63), where there is no change in daily temperature. However, Tymbaki and Naxos show a higher index value. In Fig. (f-g), most of the east regions show a similar high number of days (182,7) where minimum temperature decreases and a low number of days where minimum temperature increases (172). On the contrary, central and west regions show a low number of days where minimum temperature decreases (less than 177) and a higher number of days where minimum temperature increases.

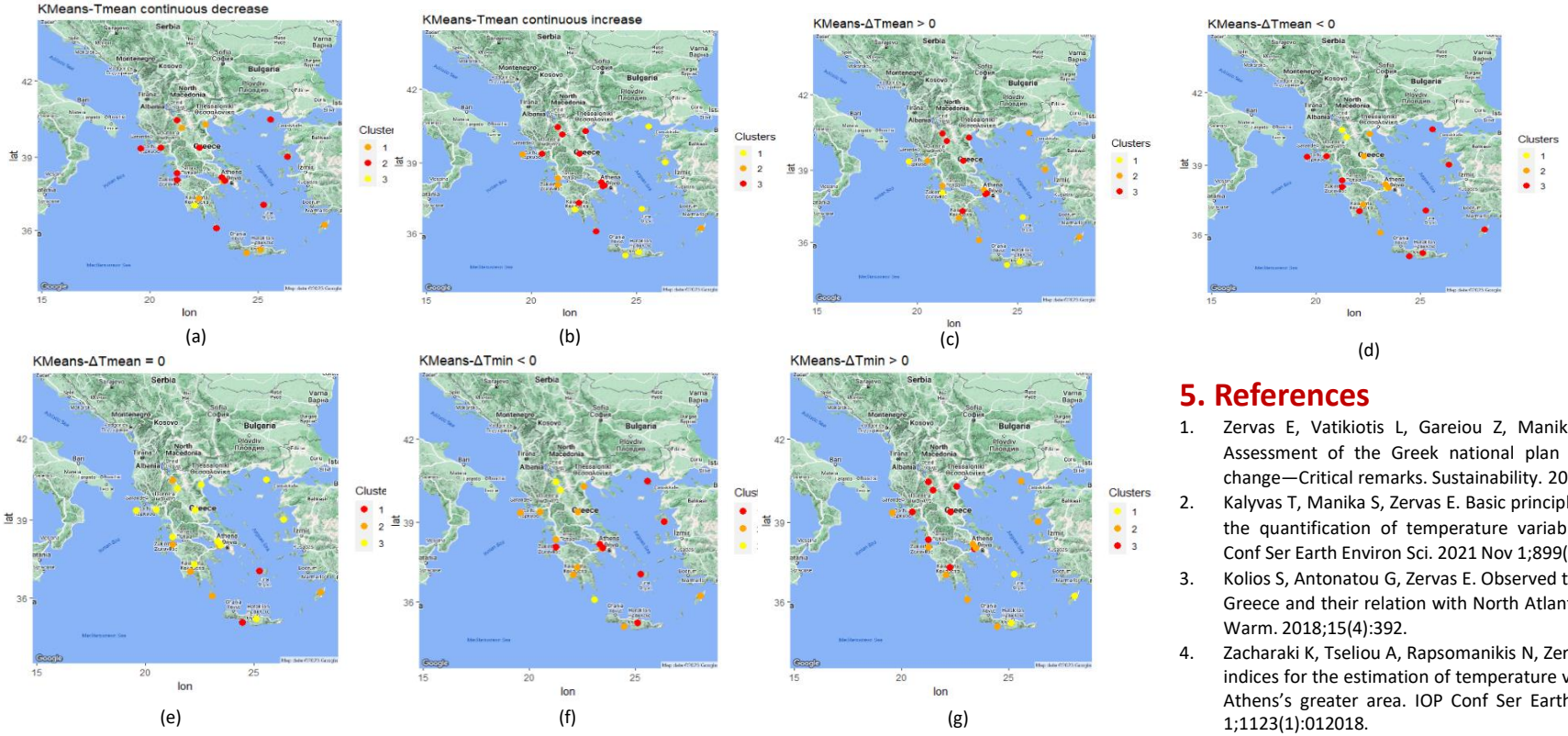

Figure 1. Clustering of weather stations in Greece for seven temperature variability indicators. (a) and (b) Number of days with a continuous decrease/increase in daily mean temperature. (c) ,(d) and (e) Number of days when $\Delta T_{mean} > 0$, $\Delta T_{mean} = 0$ and $\Delta T_{mean} < 0$ respectively. (f) and (g) Number of days when $\Delta T_{min} > 0$ and $\Delta T_{min} < 0$ respectively. Stations with yellow color have the lowest index value, while stations with red have the highest value.

4. Conclusions

Most of the regions in central Greece show a similar number of days where mean and minimum temperature rises, as a result of climate change. Additionally, a high number of days with a continuous increase in temperature is observed in these areas. The eastern regions show the opposite behavior.

5. References

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