

Contribution to the study of temperature regime in the Mediterranean using a Regional Climate Model

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1. Introduction

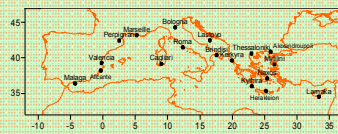
During the last years, the prospect of an oncoming global climate change has been of major interest. Such a climate change would have many impacts on several aspects as the environment, the economy, social structures, and human activity in general. Towards this direction, the use of climate models has become more and more essential. At first, General Circulation Models (GCMs) were used, though their coarse analysis wouldn't allow for regional studies to be made. Nowadays, through certain downscaling methods, Regional Climate Models (RCMs) provide an analysis of 25km; which makes them a very useful tool.

The main aim of this study was to evaluate the performance of the RCM ALADIN on the Mediterranean region, regarding certain temperature parameters.

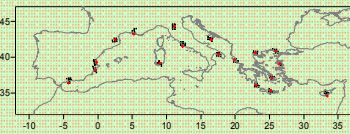
2. Data and Methodology

For the evaluation of the RCM, daily data of mean minimum and maximum temperature of 18 Mediterranean stations (see map below) were used for the time period 1958–2001. The simulated time-series of daily temperature values were the output of the RCM ALADIN.

The aforementioned evaluation concerns the simulation of the control run period 1958–2001 over the Mediterranean region and was achieved through statistical comparisons between the observed data of 18 stations and the simulated temperatures of 8 grid points surrounding each station. More specifically, this evaluation was concerned with three different directions. First of all, with the parameter among mean minimum and mean maximum temperature that was best simulated. Secondly, with the season (winter or summer) in which the best results were gained, and finally, the Mediterranean sub-area in which the model performed more satisfactory.



The stations of interest.



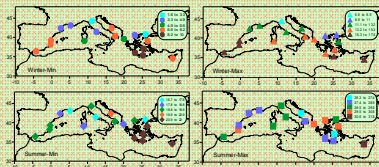
Grid points surrounding each station.

3. Study of Mediterranean Temperature

2.1 Mean Values and Standard Deviations

Mean values of winter and summer minimum and maximum temperature were studied. For both seasons, the greatest values of mean minimum temperature were found in the eastern Mediterranean. This sub-area appears to be significantly hotter than the rest of the Mediterranean region, especially during summer, with the only exception being the station of Alexandroupoli in northern Greece. The lowest values of minimum temperature were mainly found in central Mediterranean, with the exception of the station of Lastovo. Those conditions are a bit diversified as far as mean maximum temperature is concerned, since the maximum winter values were found in western Mediterranean. During summer, the maximum values were identified in the sub-area of eastern Mediterranean. The lowest maximum temperatures were found, similar to the minimum temperature, in the central Mediterranean.

The standard deviation of the time-series was found to be greater in winter than in summer for most of the stations. It was also greater for mean minimum temperature. Geographically, there are no significant differences among the three Mediterranean sub-areas.



Mean minimum and maximum temperature of winter and summer.

2.2 Trends

The time-series were also tested for the existence of trends that could provide indication of possible climate change in the Mediterranean. According to the results, minimum and maximum temperature were characterised by positive trends at both seasons.

In mean minimum winter temperature, positive trends were detected in 12 stations and negative in the remaining 6. The only statistically significant trends were those of Bologna, Naxos (both positive), and Cagliari (negative). Similar results were gained for maximum winter temperature, since 11 stations demonstrated positive trends and 7 negative. In this case, however, more statistically significant trends were found such as in Malaga, Valencia, Marseille, Cagliari, and Bologna (all positive) and in Herakleion and Kythira (both negative).

Regarding summer temperature, positive trends were predominant. More specifically, mean minimum temperature was characterized by positive trends in all stations, most of which were statistically significant. In maximum temperature, there were 15 positive trends and 3 negative. The majority of the positive trends were statistically significant in this case as well.

Stations	Minimum Temperature		Maximum Temperature	
	Winter	Summer	Winter	Summer
Alexandroupoli	+	+	+	+
Alicante	+	+	+	+
Valencia	+	+	+	+
Larnaka	+	+	+	+
Thessaloniki	+	+	+	+
Cagliari	+	+	+	+
Kerkyra	+	+	+	+
Kythira	+	+	+	+
Larnaka	+	+	+	+
Lastovo	+	+	+	+
Malaga	+	+	+	+
Marseille	+	+	+	+
Bologna	+	+	+	+
Heraklio	+	+	+	+
Mytilini	+	+	+	+
Naxos	+	+	+	+
Thessaloniki	+	+	+	+
Roma	+	+	+	+

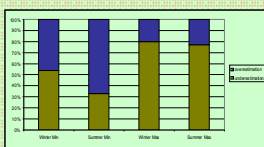
Minimum and maximum temperature trends: "+" indicates positive trends while "-" negative. Statistically significant trends are highlighted.

4. RCM Evaluation

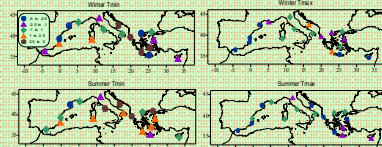
3.1 Mean Values and Standard Deviations

The main evaluation method used in this paper, was the study of the differences of the station temperature values from the corresponding RCM-simulated values of the 8 surrounding grid points, as well as from an average grid point. According to the results, the temperature is being underestimated in the majority of the cases. In addition, the differences that occurred were statistically significant in percentages exceeding 90%, indicating that the RCM doesn't simulate satisfactory the particular parameters.

Regarding the simulation of the standard deviation of the time-series, it tends to be underestimated in most cases, with the exception of the summer maximum temperature, which was significantly overestimated. Best results of the standard deviation simulations were gained for the mean winter minimum temperature, whereas no significant differences were noticed among the stations.



Percentages of grid points' underestimation and overestimation of mean minimum and maximum temperature for all the stations.



Differences between observed mean values and simulated values of the average grid point.

3.2 Trends

The comparison of the temperature trends between the observed and the simulated data seems to be very important. The best results were gained for two eastern Mediterranean stations, Larnaka and Mytilini. Other stations where the simulation of trends were satisfactory are Alexandroupoli, Roma, Herakleion and Kerkyra. Obviously, the trends of eastern Mediterranean stations have been better simulated by the RCM ALADIN. The simulated trends were not realistic for central Mediterranean stations, in contrary with the mean values simulations, which were satisfactory enough for the same region. As far as the two parameters of temperature are concerned, better results were gained for the mean maximum temperature, and seasonally for winter.

5. Conclusions

According to the study of the temperature regime in Mediterranean, a general warming trend has prevailed during the last two centuries, which consists of both minimum and maximum temperature increase. This warming trend is much more pronounced during summer, especially in western and central Mediterranean.

As far as the RCM evaluation is concerned, it was found that the model tends to underestimate the mean values and the standard deviation of the minimum and maximum temperature in most of the cases. The model performed better in summer, maximum temperature, and central Mediterranean, though the trends of the time-series were simulated more satisfactory in eastern Mediterranean.

Concluding, the performance of the RCM ALADIN for the Mediterranean region and the period 1958–2001, does not seem to be very satisfactory, although it captures the general characteristics of the temperature regime in the region of interest.

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