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A Note on the Air Temperature Trends of the Last 100 Years as Evidenced in the Eastern Mediterranean Time Series

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With 3 Figures

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Summary

The present paper is a preliminary study of the long term temperature trends in the eastern Mediterranean area. The air temperature time series of the following stations were investigated: Cairo, Alexandria, Jerusalem, Beirut, Nicosia, Athens, Kerkyra, Catania and Rome. For this group of stations the air temperature trends for about the last 100 years are examined and are compared with the corresponding time series of the land surface air temperature, the sea surface temperature (SST) and the marine air temperature (NMAT) for the northern hemisphere (NH). A better agreement was found between the time series of the eastern Mediterranean region and the SSTs and NMATs, than with the NH air temperature (land surface). The coincidence of the 1900s minimum of eastern Mediterranean air temperature and the SSTs and NMATs especially merits further investigation.

Zusammenfassung

Einige Bemerkungen zu den Lufttemperaturtrends der letzten 100 Jahre am Beispiel der Zeitserien des östlichen Mittelmeerraums

Die vorliegende Arbeit präsentiert eine vorläufige Studie der langzeitlichen Temperaturtrends im östlichen Mittelmeerraum. Lufttemperaturzeitserien der folgenden Stationen wurden hierzu untersucht: Kairo, Alexandria, Jerusalem, Beirut, Nikosia, Athen, Kerkyra, Catania und Rom. Anhand der Daten der genannten Stationen wurden die Lufttemperaturtrends über einen Zeitraum von etwa 100 Jahren untersucht und mit den entsprechenden Zeitserien der Landoberflächenlufttemperatur, der Meeresoberflächentemperatur (SST) und der nächtlichen Seelufttemperatur (NMAT) der nördlichen Hemisphäre verglichen.

Hierbei konnte größere Übereinstimmung der Lufttemperaturtrends zwischen Zeitserien des östlichen Mittelmeerraums und den Meeresoberflächentemperaturen, bzw. den nächtlichen Seelufttemperaturen festgestellt werden als zwischen den Zeitserien dieser Region mit den Zeitserien der Landoberflächenlufttemperatur der nördlichen Hemisphäre. Die Übereinstimmung des 1900-Minimums der Lufttemperaturtrends des östlichen Mittelmeerraums und den SST- und NMAT-Trends verdient hierbei besondere Aufmerksamkeit und weitere Untersuchungen.

1. Introduction

The understanding of global climatic trends has been of major concern during the last few decades. For the study of climatic changes, air temperature time series have been compiled for individual stations as well as for latitude zones averages and for hemispheric and global means (see e.g. Mitchell, 1961; Borzenkova et al., 1976; Jones et al., 1986).

These hemispheric and global air temperature compilations are based almost exclusively on land stations observations, covering a small fraction of the earth. Recently, time series have been constructed for the sea surface temperature (SST) and for the air above the sea (night-time marine air temperature, NMAT) in order to obtain a temperature curve more representative of the global conditions by combining data from land stations and from ships (Paltridge and Woodruff, 1981;

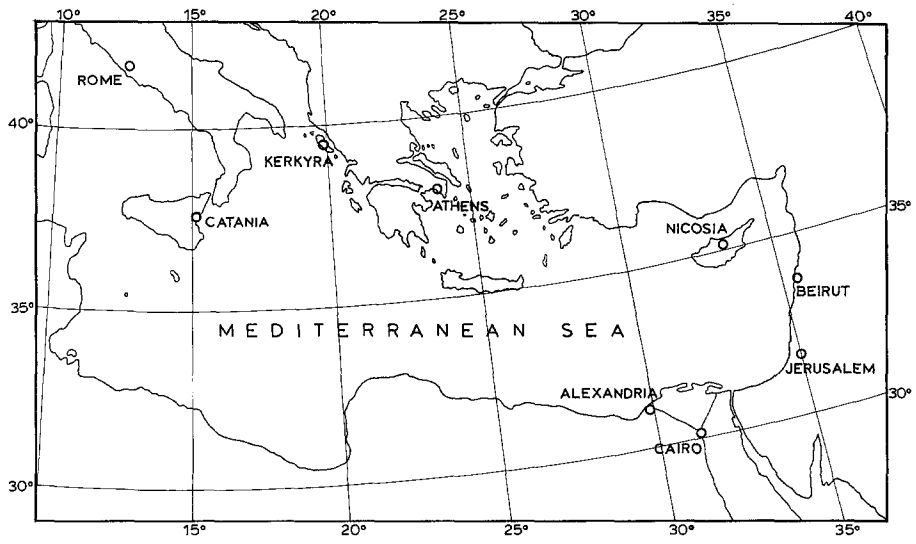

Fig. 1. Map of the eastern Mediterranean region and the used stations

Folland et al., 1984). The 100-years time series of the northern hemisphere averaged surface air temperature displays the well known secular fluctuation. This fluctuation has a minimum in the 1880s and a maximum in the 1940s, followed by a decreasing trend, reversed in the late 1960s (Jones et al., 1986).

Conversely, the time series of the SST and the NMAT show a decreasing trend from the beginning of their record – in the mid-19th century – until the 1910s, when the trend was reversed. The NMAT time series peaked in the 1940s, while the SST time series peaked in the 1950s. The differences between land and marine data were indicated by Jones et al. (1986) who noted that further investigation was required to determine the reasons for these differences. We believe that in addition to the zonal or hemispheric averages, the investigation of the air temperature trends in individual geographical regions will help to understand long-term global climatic fluctuations.

For the purpose of this study we investigated the air temperature trends in a few stations around the eastern Mediterranean region (see Fig. 1) around the turn of our century as being the period during which the previously mentioned discrepancies between the land air temperature time series and the time series of the sea surface temperature and the marine air temperatures were noted. The air temperature time series of some of the investigated stations have been examined individually by other investigators (Striem, 1974; Colacino and Rovelli, 1983; Giles and Flocas, 1984; Repapis et al., 1988).

2. Discussion and Results

For the present paper the air temperature time series of nine stations were investigated in an attempt to study the air temperature trends in the easter Mediterranean region.

The investigated stations are shown in Fig. 1. The air temperature data for Athens, Rome and Kerkyra were taken from published homogenized time series (Arseni-Papadimitriou, 1973; Colacino and Rovelli, 1983; Repapis et al. 1988) while the data for all the other stations were taken from the World Weather Records (WWR) and the Monthly Climatic Data for the World (Smithsonian Institution 1927, 1934, 1947; U.S. Weather Bureau, 1959–1982) with the reductions and corrections done by the individual stations as quoted in the WWR publications. The data were used in this paper without any further homogenizing procedures and no correction was made for height (the data for Jerusalem are published homogenized in the WWR [U.S. Weather Bureau, 1966]). Cairo data were reported by two different stations (Abbassia and Helwan) with an overlapping period of 20 years.

Figure 2 shows the northern hemisphere annual mean surface air temperature time series (ten years running means) taken from Jones et al. (1986). This time series is based almost exclusively on land stations. On the same figure the annual mean sea

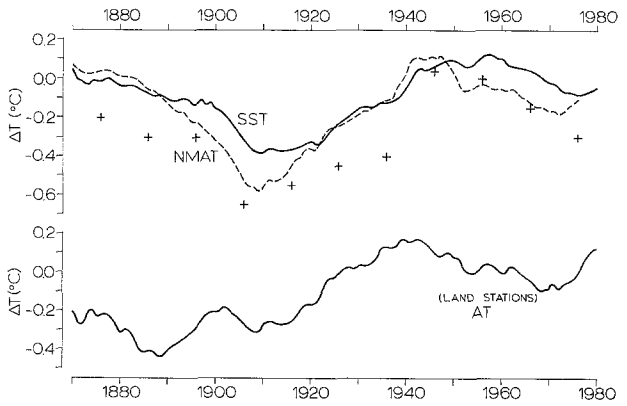

Fig. 2. 10 year running means of the annual mean sea surface temperatures (solid line on the top) and night-time marine air temperatures (dashed-line) – departures from the 1951/1960 mean – and of the annual mean air temperature based on land stations (solid line on the bottom) – departures from the 1951/1970 mean – for the northern hemisphere. The crosses mark the zonally averaged SST anomalies for 35° N (Folland et al., 1984; Folland and Parker, 1986; Jones et al., 1986)

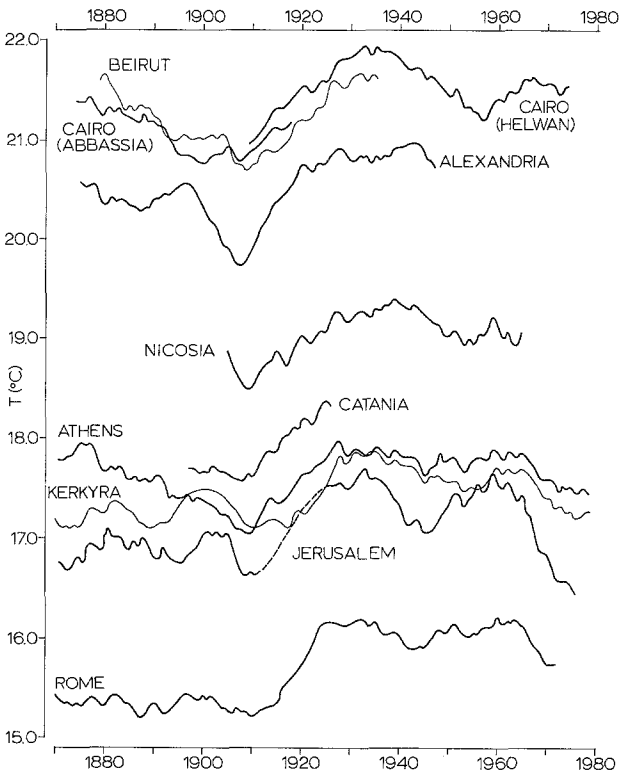

Fig. 3. 10 year running means of the annual mean air temperature for the various stations of the eastern Mediterranean region

surface temperature and the annual mean near surface – NMAT time series for the northern hemisphere (ten years running mean) are shown (Folland et al., 1984 and Folland and Parker, 1986).

The crosses on Fig. 2 mark the zonally averaged SST anomalies (relative to 1951–1960) for the latitude zone of 35° N taken from Folland et al. (1984). As mentioned in the introduction, the main discrepancy between the surface air temperature and the SST and NMAT is noted during the period before 1900, when the surface air temperature time series shows its minimum values, while the SST and the NMAT display a warm phase during the same period. The period after the turn of our century does not reveal substantial discrepancies, except that the minimum of the SST and NMAT time series occurs in the late 1900s, while the main minimum of the land surface air temperature occurs in the 1880s, with only a secondary and less important minimum appearing in the late 1900s.

The annual mean air temperature time series (ten years running means) for the stations in the eastern Mediterranean region are shown in Fig. 3. For all these stations the characteristic features of the curves are: the minimum in late 1900s – which coincides with the minimum of the SSTs and NMATs – and the nearly abrupt warming observed during the period from the 1910s to the late 1930s. After the 1930s air temperature almost levelled off until the mid 1960s – except for a slight cooling phase in the late 1940s, while after the 1960s, there is an apparent decreasing trend. (The time series are not all expanded until the 1980s because of major discontinuities in the records.) For the period before the minimum recorded during the decade of the 1900s, nearly all the stations display a warmer phase in agreement with the SST and NMAT time series. In order to test the observed trends, the Mann-Kendall trend analysis test was applied to the original annual values (not to the ten years averages) for the whole period and for the two subperiods, before the 1900s minimum as well as afterwards. The results of the Mann-Kendall's test (WMO, 1966) are shown in Table 1.

The increasing trend from the minimum of the 1900s up to the late 1930s is statistically significant ($P > 0.05$) for all stations (the Jerusalem time series could not be checked because of the missing data during the increasing trend). The decreasing trand which precedes the minimum of the 1900s is statistically significant ($P > 0.05$) except for the

Table 1. *Mann-Kendall rank statistic, τ*

Station	Period	Mann-Kendall's τ			
		Whole record	Period before 1900s minimum	Period after 1900s minimum	Period after 1940s peak
Cairo					
Abbassia	1869–1922	−0.205*			
30°05′ N 31°17′ E (30 m)	1869–1910		−0.298**		
Helwan	1904–1978	0.048			
29°52′ N 31°20′ E (115 m)	1904–1940			+0.325**	
	1941–1978				+0.058
Alexandria	1870–1957	+0.040			
	1870–1905		−0.270*		
31°12′ N 29°53′ E (32 m)	1906–1940			+0.418**	
Jerusalem					
31°47′ N 35°13′ E (810 m)	1866–1910		−0.101		
(Missing data 1917–1921, 1923)					
	1940–1980				−0.322**
Beirut	1875–1940	+0.058			
33°54′ N 35°28′ E (34 m)	1875–1904		−0.320*		
	1905–1940			+0.486**	
Nicosia	1900–1970	+0.012			
35°09′ N 33°17′ E (218 m)	1904–1940			+0.327**	
	1941–1970				−0.141
Catania	1892–1930	+0.220*			
37°30′ N 14°65′ E (65 m)	1904–1930			+0.300*	
Athens	1870–1984	−0.032			
	1870–1905		−0.349**		
37°58′ N 23°43′ E (107 m)	1906–1930			+0.347*	
	1931–1984				−0.229*
Kerkyra	1870–1984	+0.090			
(Corfu)	1895–1912		−0.588**		
39°37′ N 19°55′ E (30 m)	1912–1938			+0.300*	
	1939–1984				−0.225*
Rome 42° N	1870–1975	+0.316**			
41°54′ N 12°29′ E (63 m)	1870–1905		−0.041		
	1906–1930			+0.513**	
	1931–1975				−0.228*

* Statistically significant at 0.05 confidence level.
** Statistically significant at 0.01 confidence level.

Jerusalem and Rome time series. Finally, from the warm period of the 1930s up to the 1970s or 1980s – depending on the available time series – a decreasing trend is evident from the time series of most of these stations. The Jerusalem records display a questionable steep decreasing trend from the 1960s to the 1980s, revealing probably a discontinuity in the records.

The above findings suggest that the temperature trends in the Mediterranean, which is – in a global view – an evaporating lake merit more investigation.

The identification of global trends in secular air temperature has led to various theories explaining temporal climatic fluctuations; but only few investigators have attempted to regionalize these trends. More emphasis on this subject would help to understand the global trends and to assess the climate impact on the inhabitants of the various regions of the earth.

3. Conclusions

The long term air temperature trends for about the last 100 years in the eastern Mediterranean region have been examined in this paper. The air temperature trends for this region were found to be in a better agreement with the SST and NMAT time series for the northern hemisphere than with the NH air temperature (land) time series. A comparison of SST and NMAT time series with the NH air temperature (land) time series reveals a time lag between them which could be probably attributed to the thermal inertia of the oceans (see Schlesinger, 1984). The study on the trends similarity of the eastern Mediterranean air temperature time series and the SST and NMAT time series will probably help to understand the long term climatic trends.

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