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# North Sea – Caspian Pattern (*NCP*) – an upper level atmospheric teleconnection affecting the eastern Mediterranean – implications on the regional climate

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With 6 Figures

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**Summary**

A calendar of the negative and positive phases of the North Sea – Caspian Pattern (*NCP*) for the period 1958–1998 was used to analyse the implication of the *NCP* upper level teleconnections on the regional climate of the eastern Mediterranean basin. Series of monthly mean air temperature and monthly total rainfall from 33 stations across Greece, Turkey and Israel, for the same period, were used. For each month, from October to April, averages of the monthly mean temperatures and the monthly rainfall totals as well as the standardized values of both parameters were calculated separately for the negative ($NCP(-)$) and the positive ($NCP(+)$) phases of the *NCP*.

At all stations and in all months, temperature values were significantly higher during the $NCP(-)$ as compared with the $NCP(+)$. Furthermore, apart from very few exceptions, the absolute monthly mean maximum and monthly mean minimum values were obtained during the $NCP(-)$ and the $NCP(+)$ phases, respectively. The maximum impact of the *NCP* on mean air temperature was detected in the continental *Anatolian Plateau*, where the mean seasonal differences are around 3.5 °C. This influence decreases westwards and southwards.

The influence on the rainfall regime is more complex. Regions exposed to the southern maritime trajectories, in Greece and in Turkey, receive more rainfall during the $NCP(-)$ phase, whereas in the regions exposed to the northern maritime trajectories, such as *Crete* in Greece, the *Black Sea* region in Turkey, and in all regions of Israel, there is more rainfall during the $NCP(+)$ phase. The accumulated rainfall differences between the two phases are over 50% of the seasonal average for some stations.

A comparison of the capabilities of the *NCP*, the North Atlantic Oscillation (*NAO*) and the Southern Oscillation (*SO*) indices to differentiate between below and above normal temperatures was made. The results have placed the *NCP*, as the best by far of all three teleconnections in its ability to differentiate between below or above normal temperatures and as the main teleconnection affecting the climate of the *Balkans*, the *Anatolian Peninsula* and the *Middle East*. These results may serve to downscale General Circulation Model (GCM) scenarios to a regional scale and provide forecasts regarding eventual temperature and/or precipitation changes.

## 1. Introduction

Kutiel and Benaroch (2002) recently defined the *North Sea – Caspian Pattern* (*NCP* hereafter), an upper level atmospheric teleconnection between these two regions centered between 0°, 55° N and 10° E, 55° N for its north-western pole and between 50° E, 45° N and 60° E, 45° N for its south-eastern pole (Fig. 1). They derived an index (*NCPI*) to evaluate the magnitude of the *NCP* and used it to define the *negative phase of the NCP* ($NCP(-)$ hereafter) and its *positive phase* ($NCP(+)$). $NCP(-)$ was defined for all

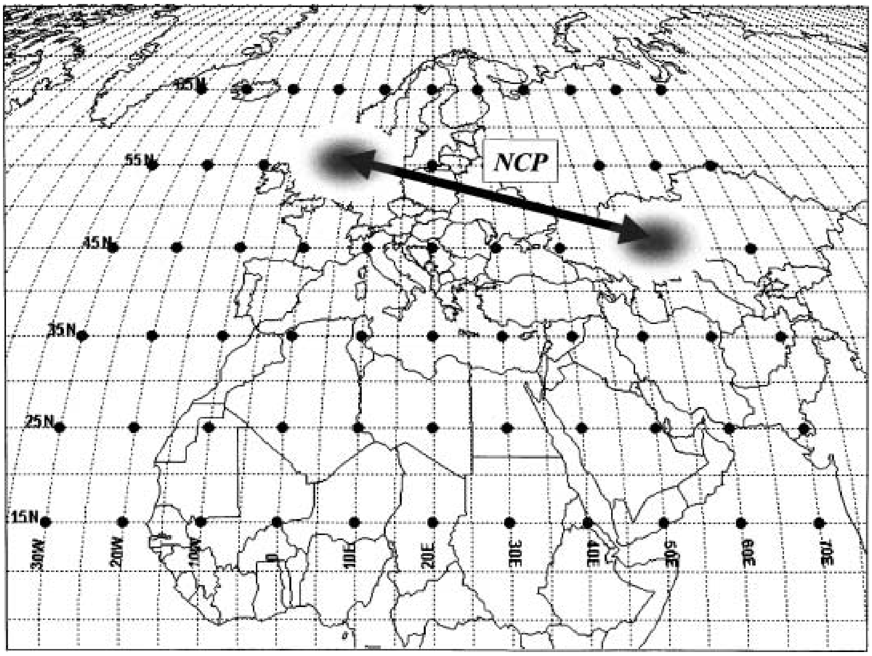


**Fig. 1.** Map showing the poles of the North Sea – Caspian Pattern (*NCP*), (after Kutiel and Benaroch, 2002)

cases when the standard score ($z_i$) of the difference between the two poles was $z_i \leq -0.5$. Similarly, *NCP* ( + ) was defined for all cases when $z_i \geq 0.5$. Furthermore, by deriving the anomaly circulation associated with either the *NCP* ( − ) or the *NCP* ( + ), they concluded that the main impact of this teleconnection should be exhibited over the Balkans and the eastern Mediterranean basin. The *NCP* was found to exist mainly in autumn, winter and spring, and is less frequent in summer. About 60% of all months were defined either as *NCP* ( − ) or *NCP* ( + ). During the remaining 40% of the months, there were *normal* conditions, not belonging to either the *NCP* ( − ) or the *NCP* ( + ). Therefore, it is of prime importance to evaluate the impact of that teleconnection on the regional climate.

The derived anomaly circulation in the eastern Mediterranean basin shows an increased *southwesterly* anomaly circulation during the *NCP* ( − ) phase and an increased *northeasterly* anomaly circulation during the *NCP* ( + ) phase (Kutiel and Benaroch, 2002). Thus, one should expect above normal temperatures in this region, during the *NCP* ( − ) phase and below normal temperatures during the *NCP* ( + ) phase. A preliminary analysis of January's temperatures in Athens revealed that during the *NCP* ( − ) phase they were significantly higher than during the *NCP* ( + ) phase.

We believe that the influence of the *NCP* will be less pronounced on the rainfall regime as compared with its influence on the temperature regime as the former is influenced also by many local factors (e.g., Kutiel et al., 1996; Kutiel and Maheras, 1998; Maheras et al., 1999; Maheras and Kutiel, 1999). However, a preliminary analysis of rainfall totals at Haifa showed significantly more abundant rainfall amounts during the *NCP* ( + ) phase as compared with the *NCP* ( − ) phase (Kutiel and Benaroch, 2002).

The purposes of the present study are twofold: a – to evaluate, analyse and map the spatial extent of the influence of the *NCP* on the temperature and rainfall regimes in the eastern Mediterranean region, and b – to provide explanations for that influence in terms of regional circulation patterns.

## 2. Data and methodology

The basic data set that we have used is the calendar of the *NCP* ( − ) and the *NCP* ( + ) published by Kutiel and Benaroch (2002). This calendar, for the period 1958–1998, enabled the selection of all months belonging to one of the phases of the *NCP* and the analysis of the other climatic variables accordingly. We have used monthly mean temperatures and monthly rainfall totals for the same period from 20 stations across

**Table 1.** Location of stations used in the present study. Greek data for the period 1958–1997, Turkish and Israeli data for the period 1958–1998. (T – temperature; P – precipitation)

| Country | Station # | Region | Station | Parameter | Longitude | Latitude |
|---|---|---|---|---|---|---|
| Greece | 1 | *Eastern Macedonia and Thrace* | Alexandroúpoli | T&P | 25° 55′ | 40° 51′ |
| | 2 | *Central Macedonia* | Thessaloniki | T&P | 22° 57′ | 40° 37′ |
| | 3 | *Western Macedonia* | Kozáni | T&P | 21° 47′ | 40° 18′ |
| | 4 | *Epirus* | Ioánina | T&P | 20° 51′ | 39° 40′ |
| | 5 | *Ioanian Islands* | Kérkira | T&P | 19° 55′ | 39° 37′ |
| | 6 | *Ioanian Islands* | Aargostóli* | T&P | 20° 29′ | 38° 11′ |
| | 7 | *Thessaly* | Lárissa | T&P | 22° 25′ | 39° 38′ |
| | 8 | *Western Greece* | Agrínio | T&P | 21° 27′ | 38° 37′ |
| | 9 | *Central Greece* | Skíros | T&P | 24° 53′ | 38° 54′ |
| | 10 | *Attica* | Athens | T&P | 23° 40′ | 38° 03′ |
| | 11 | *Peloponnesus* | Trípoli | T&P | 22° 17′ | 37° 31′ |
| | 12 | *Peloponnesus* | Kalamáta | T&P | 22° 01′ | 37° 04′ |
| | 13 | *Northern Aegean* | Mitilíni | T&P | 23° 36′ | 39° 04′ |
| | 14 | *Northern Aegean* | Sámos | T&P | 26° 58′ | 37° 46′ |
| | 15 | *Southern Aegean* | Mílos | T&P | 24° 27′ | 36° 43′ |
| | 16 | *Southern Aegean* | Náxos | T&P | 25° 23′ | 37° 06′ |
| | 17 | *Southern Aegean* | Ródos | T&P | 29° 10′ | 36° 23′ |
| | 18 | *Crete* | Hania** | T&P | 24° 02′ | 35° 30′ |
| | 19 | *Crete* | Iráklio | T&P | 25° 11′ | 35° 20′ |
| | 20 | *Crete* | Ierápetra | T&P | 25° 44′ | 35° 00′ |
| Turkey | 21 | *Marmara Transition* | Göztepe (Istanbul) | T&P | 29° 05′ | 40° 58′ |
| | 22 | *Black Sea* | Giresun | T&P | 38° 23′ | 40° 55′ |
| | 23 | *Mediterranean* | Muğla | T&P | 28° 22′ | 37° 13′ |
| | 24 | *Mediterranean to Central Anatolia Transition* | Uşak | T&P | 29° 24′ | 38° 41′ |
| | 25 | *Continental Central Anatolia* | Ankara | T&P | 32° 53′ | 39° 57′ |
| | 26 | *Continental Eastern Anatolia* | Erzurum | T | 41° 10′ | 39° 57′ |
| | | | Sarikamiş | P | 42° 34′ | 40° 20′ |
| | 27 | *Continental Mediterranean* | Diyarbakir | T&P | 40° 12′ | 37° 53′ |
| Israel | 28 | *Coastal Plain* | Tel-Aviv*** | T&P | 34° 46′ | 32° 06′ |
| | 29 | *Upper Galilee* | Mt. Cnaan | T&P | 35° 30′ | 32° 58′ |
| | 30 | *Jezreel Valley* | Kfar Yeoshua | T&P | 35° 09′ | 32° 41′ |
| | 31 | *Judean Mountains* | Jerusalem | T&P | 35° 13′ | 31° 47′ |
| | 32 | *Northern Negev* | Be'er-Sheva | T&P | 34° 48′ | 31° 15′ |
| | 33 | *Northern Rift Valley* | Kfar Blum*** | T&P | 35° 36′ | 33° 10′ |

* 1970–1997
** 1961–1997
*** (T) 1963–1998

Greece, seven stations across Turkey representing the seven climatic regions of that country as defined by Türkeş (1996) and six from Israel. Table 1 lists the stations used in the present study, which are also mapped on Fig. 2.

For each station in each month, the averages of the mean temperatures and rainfall totals were calculated separately for all cases defined as the *NCP* ( − ) or the *NCP* ( + ), based on the calendar published by Kutiel and Benaroch (2002). These values were compared with the long-term mean values calculated for the entire period. Significant departures (larger than 0.5 standard deviation, either positive or negative) are frequent during the period October–April, whereas in the period May–September, there are only few sporadic significant departures. These results fit the postulated that the *NCP* is mainly evident in autumn, winter and spring. Furthermore, recent studies on rainfall conditions associated with pressure patterns revealed that precipitation relates well to the regional circulation, mainly

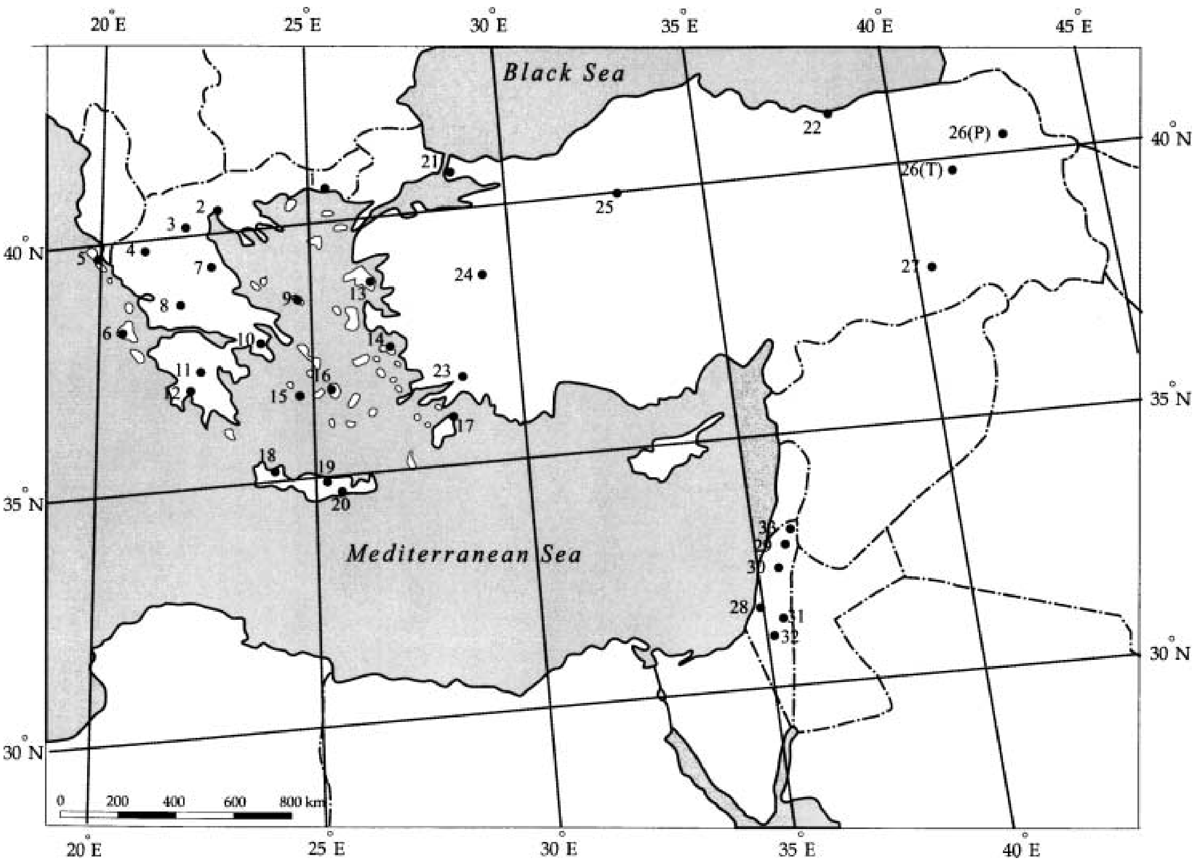


**Fig. 2.** Location map of the stations used in the present study. Stations' numbers as listed in Table 1

in winter and the transitional seasons (e.g., Kutiel and Paz, 1998; Kutiel et al., 2001). Thus, we limited our study to the period October–April.

## 3. Results and discussion

### *3.1 Temperature regime*

During the study period from October to April, monthly mean temperatures are considerably higher for all months at all stations during the *NCP* ( − ) phase as compared with the *NCP* ( + ) phase. Figure 3 illustrates the annual course of the standardized temperature anomalies for both phases.

#### 3.1.1 Temperature regime in Greece

The mean seasonal temperature difference between the *NCP* ( − ) and the *NCP* ( + ) for the entire period is higher in the eastern parts of Greece and smaller in the western parts. At the stations of Alexandroúpoli and Mitilíni the differences are 2.6 °C and 2.5 °C, respectively. At the Ioanian islands these differences are the smallest. At the station of Kérkira (Corfu) and at Argostóli the differences are only 1.1 °C and 1.2 °C, respectively. The mean differences in all the regions are the greatest in February, 2.7 °C, which are in complete agreement with the distribution of monthly standard deviations of temperatures in Greece (Maheras, 1983). The largest mean differences in one month at one station are observed in February at Alexandroúpoli, 3.8 °C (7.5 °C during the *NCP* ( − ) and 3.7 °C during the *NCP* ( + )), at Kozáni, 3.5 °C (5.5 °C and 2.0 °C, respectively) and in October at Mílos, 3.4 °C (20.8 °C and 17.4 °C, respectively).

#### 3.1.2 Temperature regime in Turkey

In Turkey, even larger temperature differences between the *NCP* ( + ) and the *NCP* ( − ) phases are observed. The mean difference for the entire period is the highest in the Anatolian continental stations of Ankara and Erzurum, 3.4 °C and 3.5 °C, respectively, and the smallest in the Mediterranean station of Muğla, only 2 °C. The mean differences in all the regions are greatest in

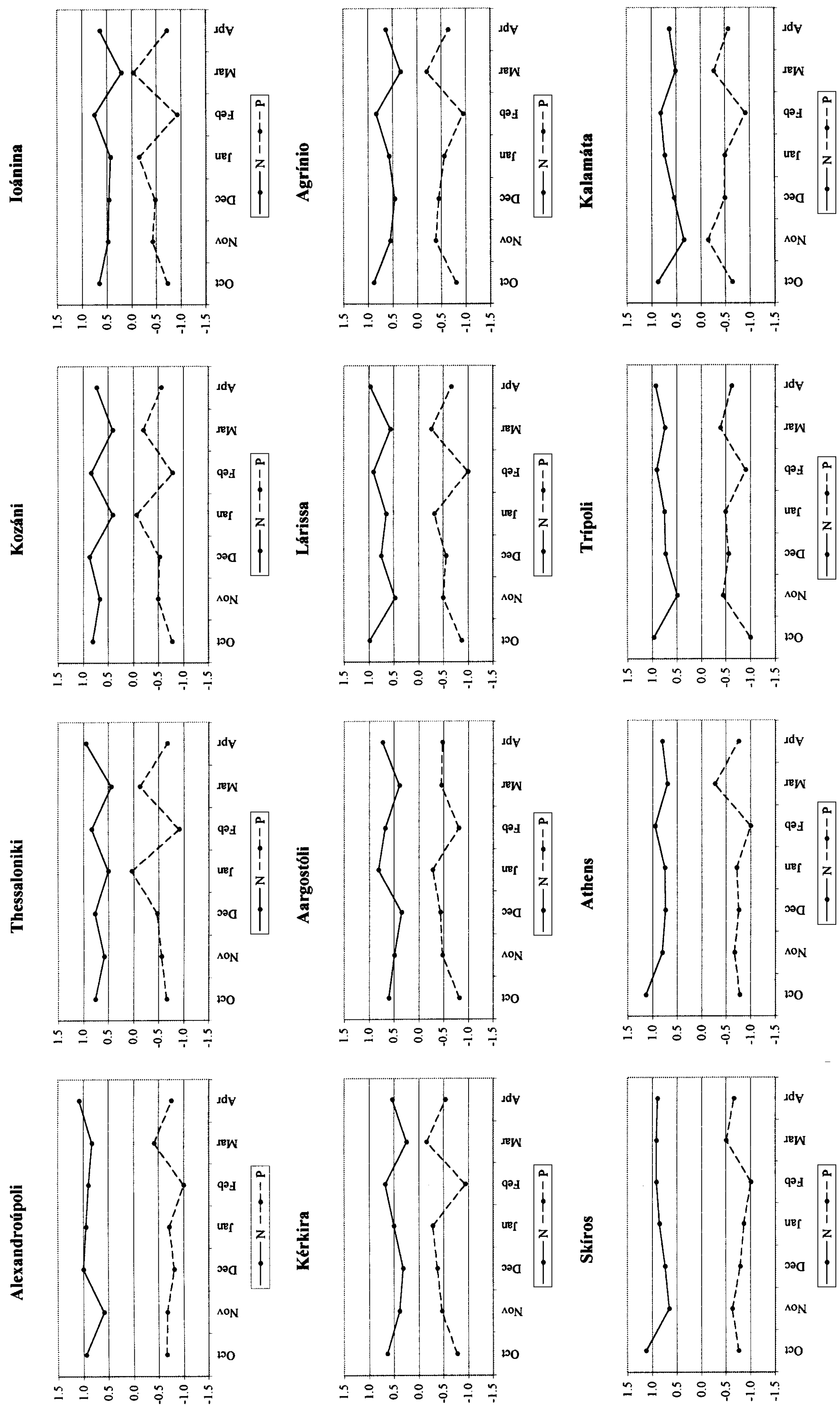


**Fig. 3.** The seasonal course of the standardized temperature anomalies for the both phases at the various stations

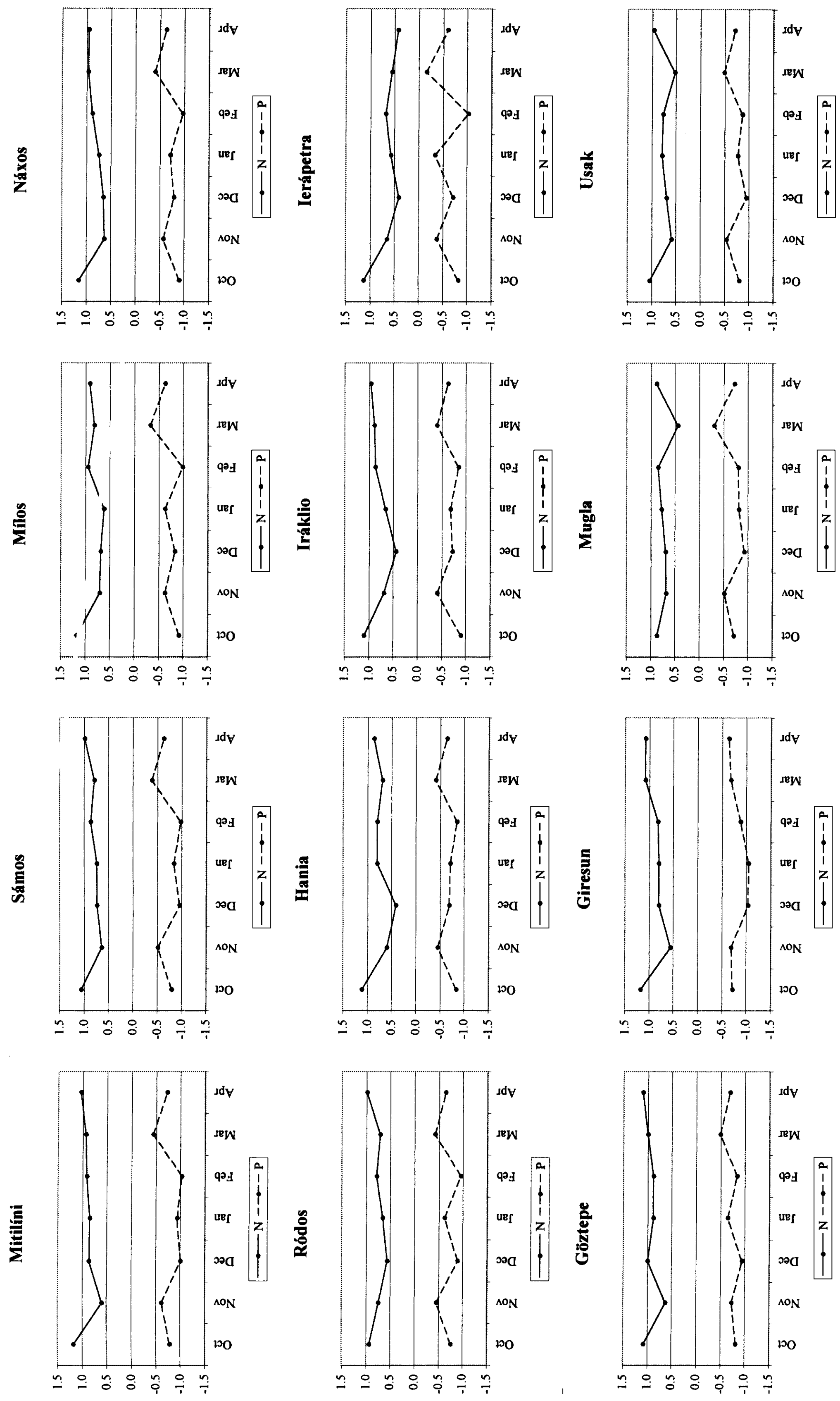


**Fig. 3** *(continued)*

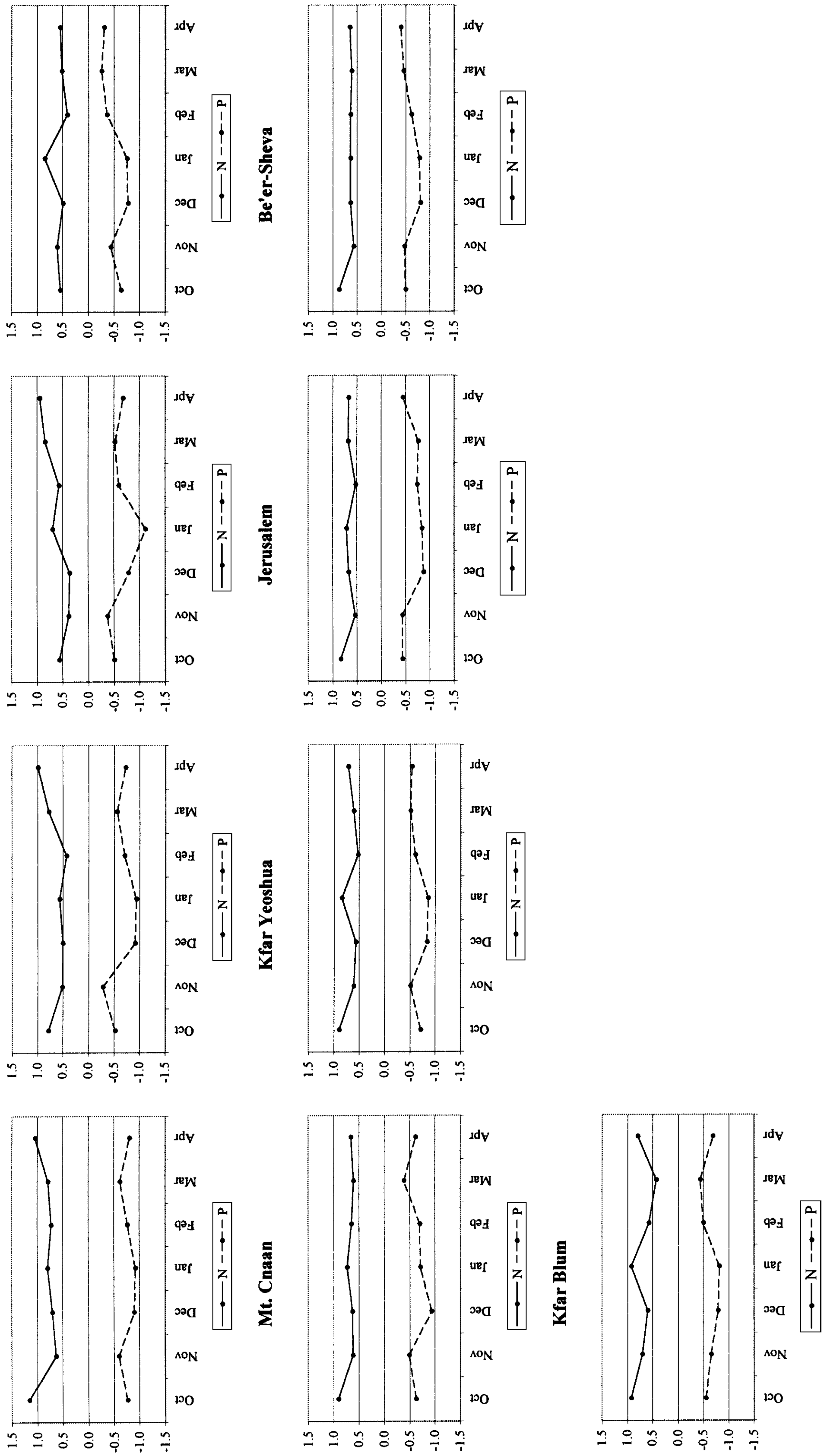


**Fig. 3** *(continued)*

January and February, 3.6 °C and 3.5 °C respectively and the smallest in November, only 1.9 °C. The largest mean differences in one month at one station are observed in January at Erzurum, 5.5 °C (− 6.7 °C during the *NCP* (−) and − 12.2 °C during the *NCP* (+)), at Diyarbakir, 5.0 °C (3.8 °C and − 1.2 °C, respectively) and at Ankara, 4.6 °C (2.4 °C and − 2.2 °C, respectively). The reason that the maximum impact of the *NCP* on air temperatures has been found at the stations of the *Anatolian Plateau* is related to the physical geography of the *Anatolian Plateau* itself. The continental inner regions of the *Anatolian Peninsula* are geographically recognized as a high plateau. It is somewhat protected from the maritime effects of the Black Sea and the Mediterranean Sea by means of the high Northern Anatolian Mountains (highest peaks with elevations of over 3,500 m in the eastern section) and the Mediterranean Taurus Mountains and the South-eastern Taurus Mountains (highest peaks with elevations of over 3,500–4,000 m in the eastern section). These high mountain chains form a main part of the eastern section of the Palaeozoic and the Alpine originating Mediterranean fold belt that characterize the Turkish geomorphology. The *Anatolian Plateau* is affected mostly by the southerly and easterly anomaly circulation patterns during the *NCP* (−) phase, whereas it experiences mostly northeasterly anomaly circulation patterns during the *NCP* (+) phase. During the *NCP* (+) phase it does not benefit from the humid and temperate effect of the Mediterranean air as much as in the western regions of Turkey, because the Taurus Mountains create an obstacle effect for the Mediterranean air to enter into the *Anatolian Plateau*. Thus, the larger mean monthly and seasonal temperature differences between the *NCP* (+) and the *NCP* (−) conditions occur over the continental *Anatolian Plateau*. Keeping in mind that each of the above figures represents an average of over ten Januarys, these differences are very impressive.

### 3.1.3 Temperature regime in Israel

In Israel, due to its very limited geographical extent, there are no large spatial differences in the intensity of influence of both phases. However, at the coastal station of Tel-Aviv, the mean seasonal temperature difference between the two phases is only 1.2 °C, whereas, at the mountainous stations of Mt. Cnaan and Jerusalem, the difference is 2.2 °C. The mean differences in all regions are the greatest in December and January, 1.6 °C. The largest mean difference in one month at one station is 2.6 °C. These differences are observed at Mt. Cnaan in October (20.9 °C during the *NCP* (−) phase and 18.3 °C during the *NCP* (+) phase) and at Jerusalem, in February, (11.0 °C and 8.4 °C, respectively).

**Table 2.** Mean coldest (above) and hottest (below) Octobers and Februarys during the analysis period and the year when the temperature was recorded. N or P indicates if the year belonged to the negative or positive phase, respectively

| Country | Station | October | | February | |
|---|---|---|---|---|---|
| | | Coldest<br>Hottest | Year | Coldest<br>Hottest | Year |
| Greece | Alexandroúpoli | 12.2 | 1959 (P) | 0.8 | 1985 (P) |
| | | 18.8 | 1966 (N) | 10.4 | 1977 (N) |
| | Thessaloniki | 13.4 | 1972 (P) | 3.2 | 1965 (P) |
| | | 20.6 | 1966 (N) | 11.4 | 1977 (N) |
| | Kozáni | 8.6 | 1972 (P) | − 0.5 | 1965 (P) |
| | | 17.0 | 1966 (N) | 8.5 | 1966 (N) |
| | Ioánina | 11.5 | 1972 (P) | 2.5 | 1965 (P) |
| | | 17.3 | 1966 (N) | 8.7 | 1977 (N) |
| | Kérkira | 15.5 | 1972 (P) | 7.2 | 1993 (P) |
| | | 20.4 | 1966 (N) | 11.7 | 1977 (N) |
| | Aargostóli | 17.0 | 1972 (P) | 9.5 | 1993 (P) |
| | | 21.4 | 1992 (N) | 13.3 | 1977 (N) |
| | Lárissa | 12.3 | 1959 (P) | 3.6 | 1965 (P) |
| | | 20.3 | 1966 (N) | 10.2 | 1966 (N) |

(*continued*)

**Table 2** (*continued*)

| Country | Station | October Coldest Hottest | October Year | February Coldest Hottest | February Year |
|---|---|---|---|---|---|
| | Agrínio | 14.5 | 1959 (P) | 6.0 | 1993 (P) |
| | | 20.4 | 1966 (N) | 11.9 | 1977 (N) |
| | Skíros | 15.8 | 1959 (P) | 6.7 | 1993 (P) |
| | | 21.9 | 1992 (N) | 12.7 | 1966 (N) |
| | Athens | 16.2 | 1959 (P) | 7.8 | 1959 (P) |
| | | 22.7 | 1966 (N) | 13.5 | 1977 (N) |
| | Trípoli | 11.4 | 1959 (P) | 2.5 | 1993 (P) |
| | | 17.4 | 1992 (N) | 9.3 | 1966 (N) |
| | Kalamáta | 16.1 | 1972 (P) | 7.8 | 1992 (P) |
| | | | | | 1993 (P) |
| | | 22.3 | 1966 (N) | 12.6 | 1966 (N) |
| | Mitilíni | 15.5 | 1977 (P) | 6.7 | 1985 (P) |
| | | 21.9 | 1966 (N) | 12.9 | 1966 (N) |
| | Sámos | 16.6 | 1959 (P) | 6.8 | 1959 (P) |
| | | 21.9 | 1994 (N) | 12.4 | 1978 (N) |
| | Mílos | 16.3 | 1959 (P) | 8.2 | 1959 (P) |
| | | 22.2 | 1992 (N) | 13.9 | 1977 (N) |
| | Náxos | 16.6 | 1959 (P) | 9.4 | 1959 (P) |
| | | 22.0 | 1992 (N) | 14.2 | 1977 (N) |
| | Ródos | 19.4 | 1965 (P) | 9.7 | 1959 (P) |
| | | 23.2 | 1966 (N) | 13.8 | 1966 (N) |
| | Hania | 17.2 | 1977 (P) | 8.8 | 1992 (P) |
| | | 23.3 | 1992 (N) | 14.6 | 1977 (N) |
| | Iráklio | 17.4 | 1959 (P) | 9.6 | 1992 (P) |
| | | 22.6 | 1992 (N) | 14.5 | 1977 (N) |
| | Ierápetra | 18.5 | 1977 (P) | 9.1 | 1959 (P) |
| | | 23.5 | 1966 (N) | 13.8 | 1966 (N) |
| Turkey | Göztepe (Istanbul) | 12.2 | 1959 (P) | 1.7 | 1985 (P) |
| | | 19.0 | 1966 (N) | 9.9 | 1977 (N) |
| | Giresun | 12.6 | 1959 (P) | 2.8 | 1959 (P) |
| | | 20.1 | 1974 (N) | 11.0 | 1977 (N) |
| | Muğla | 13.5 | 1985 (P) | 2.7 | 1985 (P) |
| | | 18.8 | 1993 | 8.7 | 1966 (N) |
| | Uşak | 10.7 | 1965 (P) | – 1.8 | 1959 (P) |
| | | 16.2 | 1993 | 6.6 | 1977 (N) |
| | Ankara | 9.7 | 1959 (P) | – 4.9 | 1959 (P) |
| | | 16.4 | 1974 (N) | 6.2 | 1977 (N) |
| | Erzurum | 4.4 | 1965 (P) | – 15.1 | 1998 (P) |
| | | 11.9 | 1974 (N) | – 2.2 | 1979 |
| | Diyarbakir | 13.3 | 1965 (P) | – 3.0 | 1972 |
| | | 20.6 | 1974 (N) | 8.4 | 1977 (N) |
| Israel | Tel-Aviv | 20.5 | 1965 (P) | 11.5 | 1992 (P) |
| | | 25.6 | 1994 (N) | 15.7 | 1979 |
| | Mt. Cnaan | 16.9 | 1977 (P) | 3.4 | 1992 (P) |
| | | 23.2 | 1960 (N) | 11.2 | 1977 (N) |
| | Kfar Yeoshua | 20.3 | 1959 (P) | 8.3 | 1959 (P) |
| | | 25.5 | 1994 (N) | 14.4 | 1977 (N) |
| | Jerusalem | 18.3 | 1976 | 5.4 | 1959 (P) |
| | | 23.7 | 1960 (N) | 13.8 | 1977 (N) |
| | Be'er-Sheva | 19.4 | 1959 (P) | 8.5 | 1959 (P) |
| | | 25.5 | 1994 (N) | 15.1 | 1977 (N) |
| | Kfar Blum | 20.1 | 1983 | 8.6 | 1992 (P) |
| | | 25.6 | 1994 (N) | 15.1 | 1977 (N) |

**Table 3.** The distribution of coldest and hottest Octobers and Februarys according to the years of occurrence. Values in **bold** indicate that the relevant month belong to *NCP* ( + ) or *NCP* ( − ) respectively. Note that the total number of coldest Februarys is 34 and not 33 due to the fact that in Kalamáta the lowest values were measured twice in 1992 and 1993, both belonging to *NCP* ( + )

| October | | | | February | | | |
|---|---|---|---|---|---|---|---|
| Coldest | | Hottest | | Coldest | | Hottest | |
| **1959** | **15** | **1960** | **2** | **1959** | **12** | **1966** | **9** |
| **1965** | **5** | **1966** | **13** | **1965** | **4** | **1977** | **21** |
| **1972** | **6** | **1974** | **4** | 1972 | 1 | **1978** | **1** |
| 1976 | 1 | **1992** | **7** | **1985** | **4** | 1979 | 2 |
| **1977** | **4** | 1993 | 2 | **1992** | **6** | | |
| 1983 | 1 | **1994** | **5** | **1993** | **6** | | |
| **1985** | **1** | | | **1998** | **1** | | |

Table 2 lists the distribution of the coldest and hottest Octobers and Februarys in the various stations. Apart from very few exceptions, all the coldest Octobers and Februarys, have occurred during the *NCP* ( + ) phase. Furthermore, in Kalamáta, the minimum value in February (7.8 °C) was recorded twice, in 1992 and in 1993, both belonging to the *NCP* ( + ) phase. Similarly, all the hottest Octobers and Februarys, occurred during the *NCP* ( − ) phase. The distribution of the other months reveals very similar results. The fact that either the coldest or hottest months were recorded in different years and not all the coldest in one year and all the hottest in another year, indicates that we are not dealing with just two exceptional cases but rather with a teleconnection that has a major role in determining the temperature regime in that region (Table 3).

### *3.2 Rainfall regime*

As assumed earlier, the impact of the *NCP* on the rainfall regime in the region is more complex and not as clear as with the temperature regime. This is probably due to the fact that rainfall, anywhere in the world, is affected more by local factors and the regional circulation, is less reflected as compared with other meteorological parameters. Table 4 summarizes the differences in rainfall totals at the various stations for both phases. Figure 4 illustrates the annual course of the standardized rainfall anomalies for both phases. Figure 6 shows their spatial distribution.

**Table 4.** Difference between the accumulated rainfall during *NCP* ( − ) and *NCP* ( + ) in mm, and as a percentage of the mean accumulated rainfall in the period October–April. Positive values when it rained more during *NCP* ( − ), negative during *NCP* ( + ). Significant differences (>10%) are marked in **bold**

| Country | Station | Difference [mm] | Difference [%] |
|---|---|---|---|
| Greece | **Alexandroúpoli** | **232** | **55** |
| | **Thessaloniki** | **56** | **19** |
| | **Kozáni** | **85** | **28** |
| | **Ioánina** | **421** | **50** |
| | **Kérkira** | **199** | **22** |
| | **Aargostóli** | **164** | **20** |
| | Lárissa | − 10 | − 3 |
| | **Agrínio** | **344** | **45** |
| | Skíros | − 1 | 0 |
| | Athens | − 6 | − 2 |
| | **Trípoli** | **137** | **20** |
| | **Kalamáta** | **93** | **13** |
| | **Mitilíni** | **234** | **39** |
| | **Sámos** | **264** | **36** |
| | Mílos | − 19 | − 5 |
| | Náxos | − 7 | − 2 |
| | **Ródos** | **94** | **14** |
| | **Hania** | **− 140** | **− 25** |
| | **Iráklio** | **− 123** | **− 27** |
| | Ierápetra | − 35 | − 8 |
| Turkey | Göztepe (Istanbul) | 26 | 5 |
| | **Giresun** | **− 191** | **− 23** |
| | **Muğla** | **444** | **41** |
| | **Uşak** | **115** | **27** |
| | **Ankara** | **33** | **12** |
| | **Sarikamiş** | **− 59** | **− 18** |
| | Diyarbakir | − 13 | − 3 |
| Israel | **Tel-Aviv** | **− 291** | **− 56** |
| | **Mt. Cnaan** | **− 324** | **− 47** |
| | **Kfar Yeoshua** | **− 282** | **− 52** |
| | **Jerusalem** | **− 300** | **− 56** |
| | **Be'er-Sheva** | **− 107** | **− 54** |
| | **Kfar Blum** | **− 224** | **− 44** |

#### 3.2.1 Rainfall regime in Greece

In Greece, we may observe a *NCP* influence gradient from north to south. Northern Greece gets more rainfall during the *NCP* ( − ) phase while Crete gets more rainfall during the *NCP* ( + ) phase. In the *Eastern Macedonia and Thrace* region, represented by the station of Alexandroúpoli, the mean accumulated difference in rainfall totals between the *NCP* ( − ) and the *NCP* ( + ) conditions is 232 mm or 55% of the total rainfall, in favour of the *NCP* ( − )

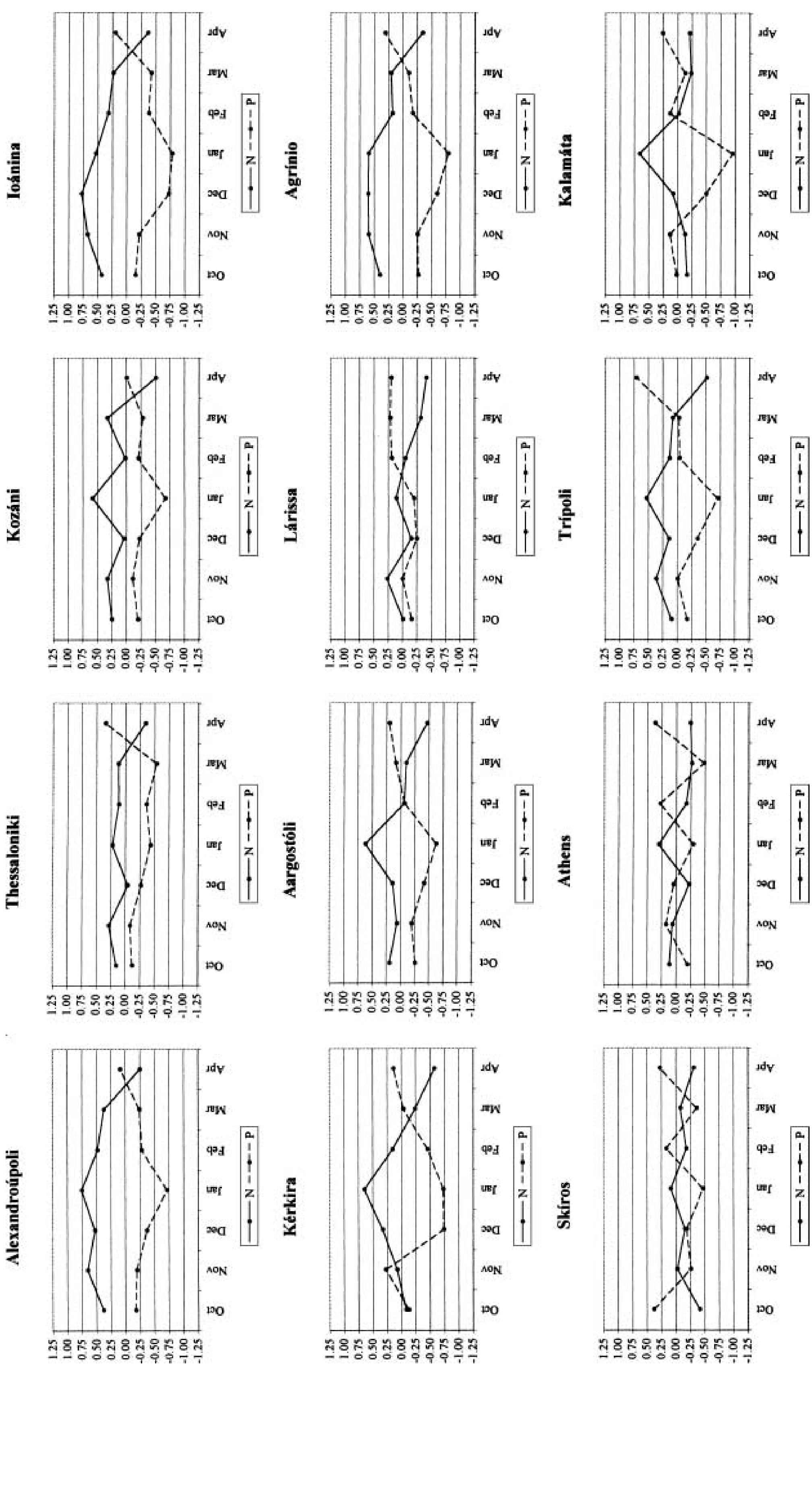


**Fig. 4.** The seasonal course of the standardized rainfall anomalies for the both phases at the various stations

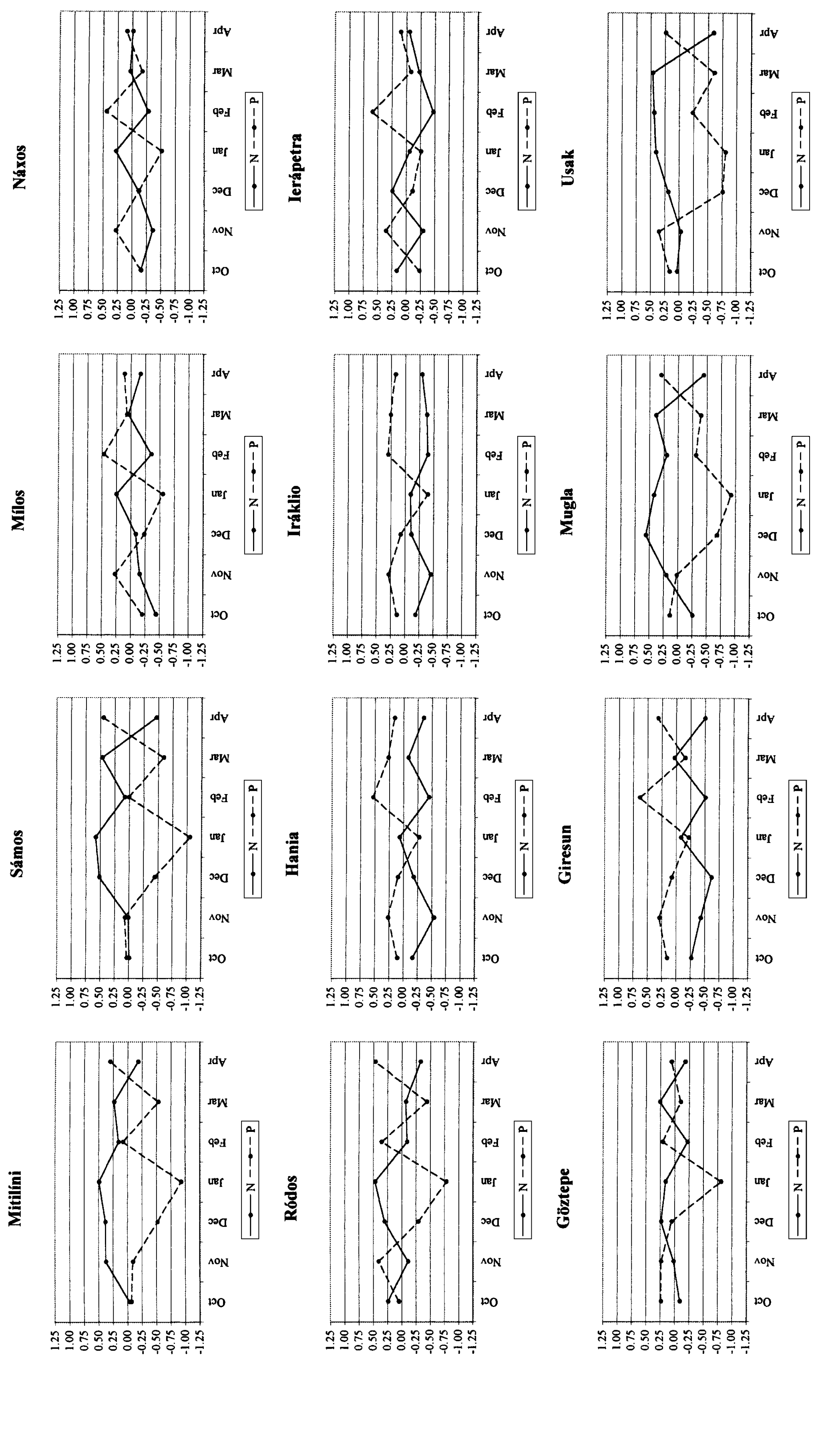


**Fig. 4** *(continued)*

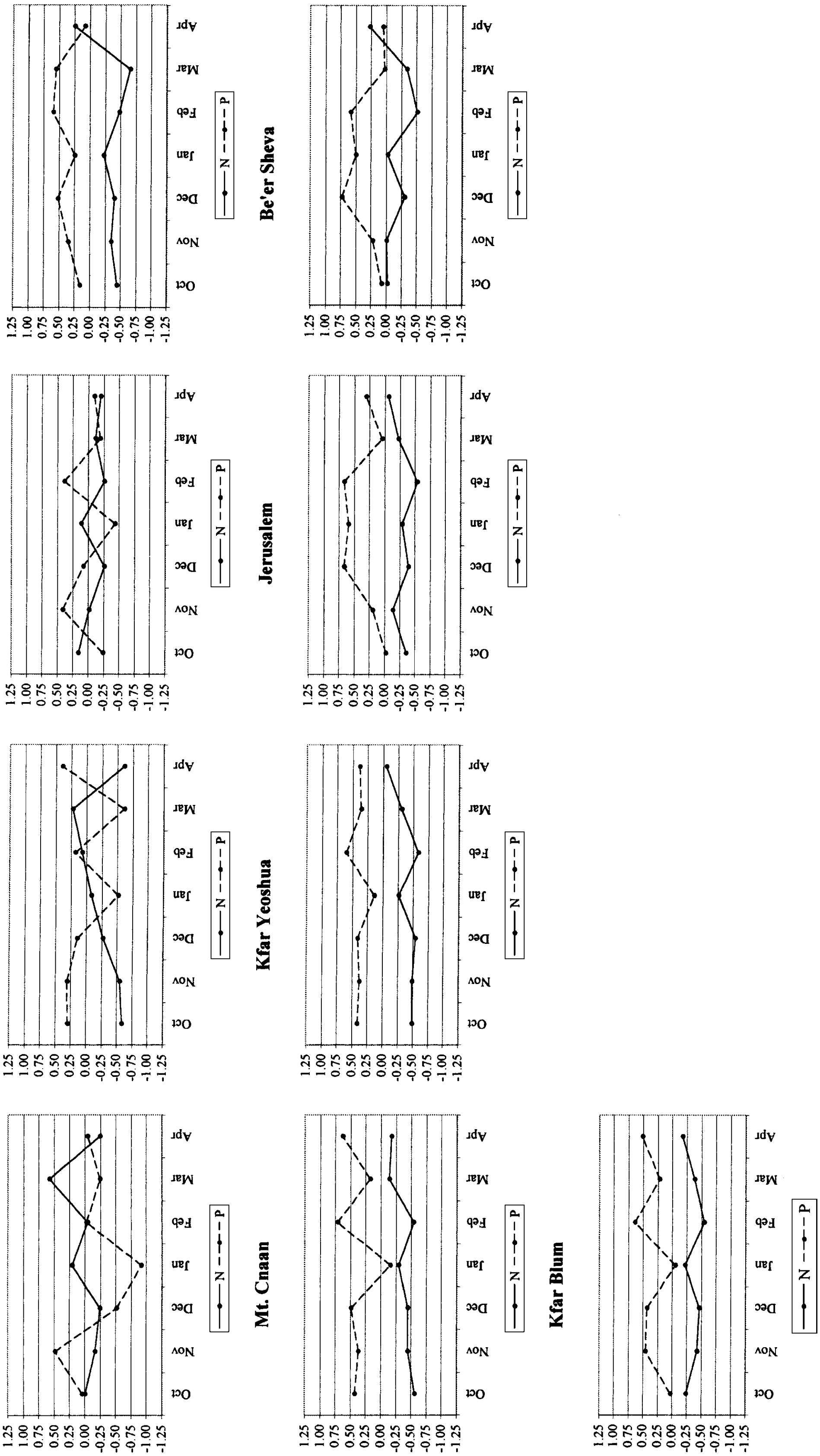


**Fig. 4** *(continued)*

phase. In *Epirus*, represented by the station of Ioánina, this surplus of the *NCP* ( − ) phase is 421 mm (50%) and in *Western Greece*, represented by the station of Agrínio, 344 mm (45%). Other regions, in which there are more abundant rainfall amounts during the *NCP* ( − ), are the *Peloponnesus* and the *Northern Aegean*. In *Crete*, represented by the stations of Hania and Iráklio (both located on the northern shore), there are surpluses of 140 mm (25%) and 123 mm (27%) respectively during the *NCP* ( + ) phase. At Ierápetra, also in *Crete*, but located on the southern shore, the difference is less significant (Table 4).

3.2.2 Rainfall regime in Turkey

In Turkey, a *NCP* influence gradient from southwest to northeast is observed. The southwestern *Mediterranean* region represented by the station of Muğla gets the maximum influence of the *NCP* ( − ). The mean accumulated difference in rainfall totals at Muğla, between the *NCP* ( − ) and the *NCP* ( + ) conditions, is 444 mm, or 41% of the total rainfall, in favour of the *NCP* ( − ) phase. In the *Mediterranean to Central Anatolia Transition* region represented by the station of Uşak, this surplus of the *NCP* ( − ) phase is only 115 mm (27%). In the eastern *Black Sea* sub-region, represented by the station of Giresun, an opposite influence is observed. The mean accumulated rainfall total during the *NCP* ( + ) is higher by 191 mm (23%) as compared with the *NCP* ( − ). In the other stations, there are only slight differences. However, in the two western stations (i.e., Göztepe and Ankara) there is more rainfall during the *NCP* ( − ) phase while in the two other eastern stations (Sarikamiş and Diyarbakir) rainfall is more abundant during the *NCP* ( + ) phase, thus maintaining the east–west gradient (Table 4).

3.2.3 Rainfall regime in Israel

In Israel, the role of the *NCP* on the rainfall regime is very clear. The rainfall accumulated during the *NCP* ( + ) phase is by far greater than that accumulated during the *NCP* ( − ) phase. Due to the small dimensions of the country, it is difficult to detect significant differences between the various regions. However it seems that the *NCP* effects on the rainfall regime increase from the northern parts of the country in the *Upper Galilee* to the southern parts of the *Northern Negev*. The mean accumulated difference in rainfall totals at Kfar Blum, between the *NCP* ( − ) and the *NCP* ( + ) phases is 224 mm, or 44% of the total rainfall, in favour of the *NCP* ( + ). This percentage increases to 54% at Be'er-Sheva and 56% at Tel-Aviv and Jerusalem (Table 4).

## 4. Comparison between the *NCP*, the *NAO* and the *SO*

Much effort has been made by various researchers during recent years in trying to find a relationship between the climate in that part of the world and the El Niño-Southern Oscillation (*ENSO*) and/or the *NAO*. Influences of the warm and cold events of the *ENSO*, especially on winter precipitation of Turkey, and the severe and widespread winter droughts which occurred after 1970 over Turkey associated with the *ENSO* events and the atmospheric conditions were examined by Türkeş (1998) and Türkeş (2000), respectively. Türkeş (1998) found that most of the stations had a positive sign anomaly during year − 1 warm and cold events, and the cold event rainfall means showed a coherent region of significantly increased rainfall conditions over the central-west and central parts of Turkey. On the other hand, most of the warm and cold event responses were characterized by decreased rainfall, and drier than long-term average conditions were significant at some stations during year + 1 cold events. Warm minus cold event differences had an opposite signal between year − 1 and year 0 ( + 1) in many stations. Opposition of composite anomalies was also evident in most of stations between year − 1 and year + 1 cold events (Türkeş, 1998). Recently, Kahya and Karabörk (2001) tried to relate streamflows in two regions in Turkey with *El Niño* and *La Niña* signals. There are some indications that such a relationship may exist, but is not statistically significant. Wibig (1999), found a good relationship between precipitation in Western Europe and the *NAO* index but the correlation coefficients decreased to zero in the Balkans and the eastern Mediterranean. Delitala et al. (2000), results confirmed the connection between precipitation in Sardinia and the *NAO*. Camuffo et al. (2000), however, did not find any relationship between the *ENSO* or the

*NAO* and sea storms in the Adriatic. Cullen and deMenocal (2000), analysed the influence of the *NAO* on the Tigris-Euphrates stream flow. According to their findings a weak correlation exists between the *NAO* index and temperatures or precipitation in the eastern Mediterranean. Recently, Ben-Gai et al. (2001) reported a relationship between the *NAO* index and 5 yrs. smoothed cool season temperatures in Israel. Correlation coefficients are much more significant with temperatures or precipitation in western Mediterranean or Western Europe.

A comparison of the capabilities of *NCPI*, *NAO* index and *SOI* to differentiate between below and above normal temperatures, was made. The analysis was done for seven stations of

**Table 5.** Mean temperatures [°C] for both phases of *NCP*, *NAO* and *SO* (top) and their standard scores (bottom). Significant departures (greater than 0.5 standard deviation) from the mean of all cases (top row for each station) are marked in **bold**. Last column shows the mean seasonal difference [°C] between the negative and positive phases of each of the three teleconnections

| | | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | Difference |
|---|---|---|---|---|---|---|---|---|---|
| | *Mean* | 15.4 | 11.5 | 8.2 | 5.8 | 5.8 | 7.4 | 11.9 | |
| Göztepe | *NCP* (−) | **17.2** | **12.5** | **9.7** | **7.0** | **7.4** | **8.8** | **13.6** | 2.6 |
| | | **1.081** | **0.626** | **0.995** | **0.884** | **0.885** | **0.999** | **1.097** | |
| | *NCP* (+) | **14.1** | **10.3** | **6.7** | **4.9** | **4.3** | 6.7 | **10.8** | |
| | | **−0.814** | **−0.733** | **−0.945** | **−0.652** | **−0.844** | −0.498 | **−0.697** | |
| | *NAO* (−) | 16.2 | 11.7 | 8.2 | 5.8 | 6.3 | 7.4 | 11.8 | 0.5 |
| | | 0.465 | 0.118 | −0.002 | −0.019 | 0.255 | 0.006 | −0.044 | |
| | *NAO* (+) | 14.9 | 11.0 | 7.9 | 5.6 | 5.5 | 7.5 | 11.8 | |
| | | −0.293 | −0.296 | −0.154 | −0.114 | −0.174 | −0.200 | −0.044 | |
| | *SO* (−) | 15.4 | 11.7 | 7.5 | 5.8 | 6.5 | 7.3 | 11.9 | 0.2 |
| | | −0.022 | 0.135 | −0.415 | −0.014 | 0.392 | −0.009 | 0.032 | |
| | *SO* (+) | 15.4 | 11.2 | 8.4 | 5.3 | 5.4 | 7.1 | 11.9 | |
| | | −0.001 | −0.178 | 0.131 | −0.389 | −0.219 | −0.167 | 0.003 | |
| | *Mean* | 15.9 | 12.4 | 9.5 | 7.1 | 6.9 | 7.9 | 11.4 | |
| Giresun | *NCP* (−) | **17.6** | **13.2** | **10.7** | **8.5** | **8.6** | **9.6** | **13.0** | 2.8 |
| | | **1.179** | **0.560** | **0.796** | **0.799** | **0.816** | **1.079** | **1.081** | |
| | *NCP* (+) | **14.8** | **11.4** | **7.8** | **5.3** | **5.0** | **6.9** | **10.5** | |
| | | **−0.721** | **−0.694** | **−1.039** | **−1.053** | **−0.878** | **−0.680** | **−0.641** | |
| | *NAO* (−) | 16.6 | 12.8 | 9.7 | 7.7 | 7.7 | 8.5 | 11.3 | 0.8 |
| | | 0.468 | 0.286 | 0.151 | 0.314 | 0.397 | 0.374 | −0.054 | |
| | *NAO* (+) | 15.3 | 11.9 | 9.2 | 6.6 | 6.5 | 7.8 | 11.4 | |
| | | −0.434 | −0.364 | −0.165 | −0.307 | −0.199 | −0.065 | −0.016 | |
| | *SO* (−) | 15.8 | 12.2 | 8.7 | 7.2 | 7.4 | 7.9 | 11.6 | 0.1 |
| | | −0.052 | −0.156 | −0.464 | 0.054 | 0.257 | −0.021 | 0.117 | |
| | *SO* (+) | 16.2 | 12.4 | 9.5 | 6.8 | 6.4 | 7.4 | 11.2 | |
| | | 0.197 | −0.015 | 0.052 | −0.202 | −0.243 | −0.314 | −0.184 | |
| | *Mean* | 15.8 | 10.4 | 7.0 | 5.4 | 6.0 | 8.4 | 12.3 | |
| Muğla | *NCP* (−) | **17.1** | **11.4** | **7.9** | **6.4** | **7.3** | 9.0 | **13.6** | 2.0 |
| | | **0.867** | **0.687** | **0.693** | **0.775** | **0.851** | 0.440 | **0.880** | |
| | *NCP* (+) | **14.8** | **9.7** | **5.8** | **4.3** | **4.7** | 7.9 | **11.2** | |
| | | **−0.710** | **−0.519** | **−0.920** | **−0.823** | **−0.807** | −0.304 | **−0.726** | |
| | *NAO* (−) | **16.6** | 10.4 | 7.5 | 5.9 | 6.6 | 8.9 | 12.1 | 0.7 |
| | | **0.535** | −0.006 | 0.392 | 0.366 | 0.358 | 0.377 | −0.075 | |
| | *NAO* (+) | 15.4 | 10.1 | 6.4 | 4.8 | 5.7 | 8.1 | 12.3 | |
| | | −0.284 | −0.247 | −0.438 | −0.431 | −0.191 | −0.166 | −0.008 | |
| | *SO* (−) | 16.1 | 10.4 | 6.4 | 5.3 | 6.1 | 8.0 | 11.9 | −0.2 |
| | | 0.150 | −0.033 | −0.461 | −0.043 | 0.099 | −0.241 | −0.257 | |
| | *SO* (+) | 15.5 | 10.3 | 7.5 | 5.2 | 5.8 | 8.5 | 12.7 | |
| | | −0.207 | −0.085 | 0.371 | −0.121 | −0.115 | 0.093 | 0.263 | |

(*continued*)

**Table 5** (*continued*)

| | | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | Difference |
|---|---|---|---|---|---|---|---|---|---|
| | *Mean* | 13.3 | 7.9 | 4.2 | 2.3 | 3.0 | 6.1 | 10.6 | |
| Uşak | *NCP* ( − ) | **14.9** | **8.9** | **5.2** | **3.6** | **4.6** | **6.9** | **12.4** | 2.6 |
| | | **1.040** | **0.592** | **0.692** | **0.785** | **0.770** | **0.524** | **0.965** | |
| | *NCP* ( + ) | **12.0** | **6.9** | **2.8** | **0.9** | **1.2** | 5.3 | **9.3** | |
| | | **− 0.804** | **− 0.549** | **− 0.944** | **− 0.777** | **− 0.869** | − 0.489 | **− 0.713** | |
| | *NAO* ( − ) | **14.1** | 8.0 | 4.7 | 2.8 | 3.6 | 6.7 | 10.4 | 0.8 |
| | | **0.531** | 0.093 | 0.326 | 0.289 | 0.286 | 0.354 | − 0.130 | |
| | *NAO* ( + ) | 12.8 | 7.3 | 3.7 | 1.6 | 2.6 | 5.9 | 10.5 | |
| | | − 0.299 | − 0.316 | − 0.340 | − 0.363 | − 0.195 | − 0.162 | − 0.055 | |
| | *SO* ( − ) | 13.4 | 7.7 | 3.5 | 2.1 | 3.2 | 5.7 | 10.2 | − 0.2 |
| | | 0.076 | − 0.066 | − 0.442 | − 0.106 | 0.103 | − 0.235 | − 0.215 | |
| | *SO* ( + ) | 12.9 | 7.7 | 4.8 | 2.0 | 2.5 | 6.3 | 11.0 | |
| | | − 0.226 | − 0.081 | 0.421 | − 0.153 | − 0.212 | 0.111 | 0.231 | |
| | *Mean* | 12.8 | 6.9 | 2.7 | 0.3 | 1.6 | 5.8 | 11.1 | |
| Ankara | *NCP* ( − ) | **14.8** | **8.1** | **4.1** | **2.4** | **3.7** | **7.2** | **13.0** | 3.4 |
| | | **1.159** | **0.632** | **0.702** | **0.795** | **0.725** | **0.790** | **1.038** | |
| | *NCP* ( + ) | **11.4** | **5.8** | **0.8** | **− 2.2** | **− 0.7** | **4.7** | **9.6** | |
| | | **− 0.767** | **− 0.602** | **− 0.901** | **− 0.918** | **− 0.766** | **− 0.620** | **− 0.811** | |
| | *NAO* ( − ) | **13.7** | 7.2 | 3.0 | 1.1 | 2.2 | 6.6 | 10.9 | 1.0 |
| | | **0.536** | 0.142 | 0.151 | 0.310 | 0.198 | 0.454 | − 0.118 | |
| | *NAO* ( + ) | 12.2 | 6.3 | 2.3 | − 0.8 | 1.1 | 5.6 | 11.0 | |
| | | − 0.318 | − 0.323 | − 0.193 | − 0.403 | − 0.156 | − 0.117 | − 0.013 | |
| | *SO* ( − ) | 12.8 | 6.7 | 1.9 | 0.4 | 2.3 | 5.4 | 10.8 | 0.0 |
| | | 0.033 | − 0.088 | − 0.382 | 0.042 | 0.248 | − 0.201 | − 0.145 | |
| | *SO* ( + ) | 12.7 | 6.9 | 3.1 | 0.0 | 0.5 | 5.9 | 11.4 | |
| | | − 0.039 | 0.003 | 0.222 | − 0.086 | − 0.349 | 0.087 | 0.175 | |
| | *Mean* | 7.9 | 0.8 | − 5.6 | − 8.8 | − 8.1 | − 2.6 | 5.4 | |
| Erzurum | *NCP* ( − ) | **9.2** | **2.2** | **− 4.1** | **− 6.7** | − 6.6 | **− 0.4** | **7.1** | 3.5 |
| | | **0.785** | **0.515** | **0.507** | **0.569** | 0.430 | **0.772** | **0.988** | |
| | *NCP* ( + ) | **7.1** | 0.0 | **− 8.2** | **− 12.2** | **− 10.6** | **− 4.2** | **4.1** | |
| | | **− 0.523** | − 0.286 | **− 0.912** | **− 0.932** | **− 0.701** | **− 0.555** | **− 0.721** | |
| | *NAO* ( − ) | 8.4 | 0.8 | − 5.4 | **− 6.7** | **− 5.8** | **− 0.7** | 5.0 | 1.6 |
| | | 0.286 | 0.011 | 0.055 | **0.562** | **0.670** | **0.649** | − 0.176 | |
| | *NAO* ( + ) | 7.6 | 0.5 | − 5.8 | − 10.4 | − 9.4 | − 3.4 | 5.5 | |
| | | − 0.196 | − 0.093 | − 0.087 | − 0.419 | − 0.359 | − 0.286 | 0.063 | |
| | *SO* ( − ) | 7.8 | 0.5 | **− 7.3** | − 8.8 | − 8.3 | − 3.2 | 5.2 | − 0.7 |
| | | − 0.044 | − 0.104 | **− 0.597** | 0.007 | − 0.041 | − 0.210 | − 0.094 | |
| | *SO* ( + ) | 8.0 | 1.0 | − 4.4 | − 8.7 | − 8.5 | − 2.4 | 5.6 | |
| | | 0.095 | 0.076 | 0.417 | 0.017 | − 0.104 | 0.078 | 0.129 | |
| | *Mean* | 17.1 | 9.3 | 4.1 | 1.9 | 3.3 | 8.3 | 13.8 | |
| Diyarbakir | *NCP* ( − ) | **17.9** | 9.9 | 4.8 | **3.8** | **4.9** | **9.8** | **15.2** | 2.6 |
| | | **0.571** | 0.378 | 0.361 | **0.694** | **0.565** | **0.834** | **0.944** | |
| | *NCP* ( + ) | **16.3** | 8.7 | **2.7** | **− 1.2** | **1.6** | **7.4** | **12.9** | |
| | | **− 0.505** | − 0.376 | **− 0.786** | **− 1.125** | **− 0.594** | **− 0.524** | **− 0.681** | |
| | *NAO* ( − ) | 17.4 | 9.3 | 4.6 | 3.0 | 4.3 | **9.4** | 13.7 | 0.9 |
| | | 0.212 | − 0.029 | 0.276 | 0.398 | 0.342 | **0.582** | − 0.088 | |
| | *NAO* ( + ) | 16.9 | 9.3 | 3.7 | 0.9 | 2.9 | 7.9 | 13.9 | |
| | | − 0.071 | − 0.022 | − 0.219 | − 0.369 | − 0.144 | − 0.226 | 0.009 | |
| | *SO* ( − ) | 17.0 | 8.9 | **3.1** | 2.0 | 3.6 | 7.9 | 13.6 | − 0.3 |
| | | − 0.043 | − 0.253 | **− 0.548** | 0.039 | 0.087 | − 0.210 | − 0.166 | |
| | *SO* ( + ) | 17.4 | 9.8 | 4.7 | 2.3 | 2.0 | 8.1 | 14.2 | |
| | | 0.275 | 0.267 | 0.322 | 0.150 | − 0.465 | − 0.140 | 0.264 | |

Turkey, seven months and both phases, yielding a total of 98 values ($7*7*2$) for that comparison. Table 5 summarizes the main results.

The *SOI* has failed completely in differentiating between below or above normal temperatures. For each phases, almost the same number of above or below normal cases are observed. Thus, it is impossible to state if above or below normal temperatures are associated either with *SOI*(+) or *SOI*(−). Furthermore, only in two cases out of 98, both during *SOI*(−), the standard scores are larger than 0.5 ($|z_i| > 0.5$). In all other cases the deviations from the long-term average are tiny and insignificant. These results, however, contradict a significant relationship between air temperatures at several locations in the eastern Mediterranean and *ENSO* as reported by Hasanean (2001).

The performance of the *NAO index* is slightly better than that of *SOI*. However, while during most *NAO*(−) cases, monthly mean temperatures are above normal and the opposite during *NAO*(+), there are also some cases when below normal temperatures are measured during *NAO*(−) and *vice versa*. Only in seven cases out of 98, the standard scores are larger than 0.5. Thus, we can conclude that there is some tendency of above normal temperatures during *NAO*(−) and the opposite during *NAO*(+), but temperature differences between both phases are seldom considerable.

The results of the *NCP* have placed this teleconnection, by far, as the best of all three in its ability to differentiate between below or above normal temperatures in Turkey. First, during *all* *NCP*(−) cases, monthly mean temperatures are above normal and the opposite during *NCP*(+) without any exceptions. Furthermore, in 89 cases out of 98 the standard scores are larger than 0.5, and in many cases even larger than 1.0. Finally, the last column in Table 5 compares the averages of the seasonal (for seven months) differences between temperatures in both phases (the negative minus the positive). The smallest difference

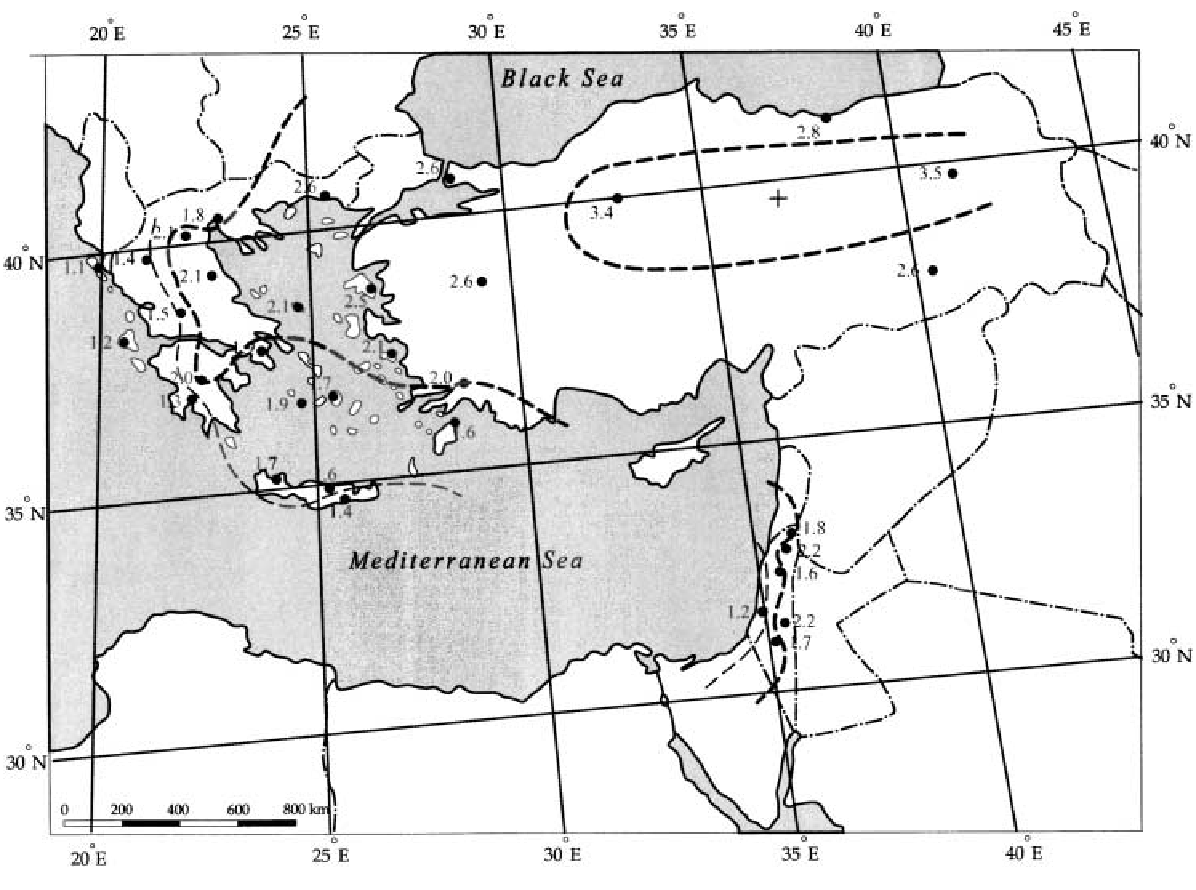


**Fig. 5.** The spatial distribution pattern of the mean seasonal temperature differences between the *NCP*(−) and the *NCP*(+) conditions in [°C]

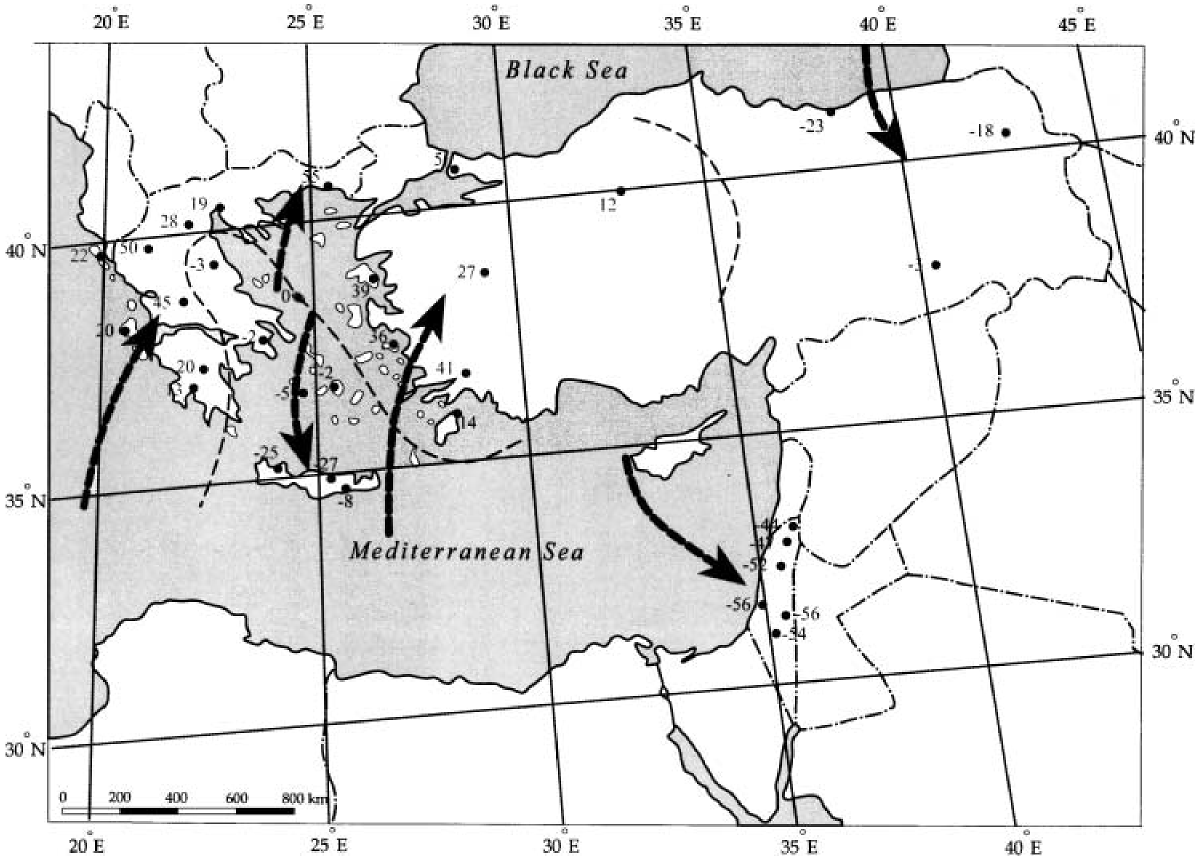


**Fig. 6.** The spatial distribution pattern of the differences between seasonal accumulated rainfall totals during the *NCP* ( − ) and the *NCP* ( + ) phases as a percentage of the mean seasonal rainfall amounts. The dashed line separates the regions with positive differences (more rainfall during the *NCP* ( − ) phase) from those with negative differences (more rainfall during the *NCP* ( + ) phase). The arrows illustrate the anomaly flow associated with the *NCP* ( − ) conditions (southerly circulation) or the *NCP* ( + ) conditions (northerly circulation)

between *NCP* ( − ) and *NCP* ( + ) has been obtained for the station of Muğla, 2.0 °C. Even this figure is greater than the largest difference between *NAO* ( − ) and *NAO* ( + ) obtained for the station of Erzurum, 1.6 °C. For the *SOI*, values are much more smaller and not considerable (Table 5).

These results have confirmed place of the *NCP* as the main atmospheric teleconnection affecting the climate of the *Balkans*, the *Anatolia Peninsula* and the *Middle East* region. The values presented in the study, especially in Figs. 5 and 6 concerning seasonal differences, either in mean air temperatures or in rainfall totals, have also demonstrated the major impact of the *NCP*.

## 5. Conclusions

The main conclusions of the present study may be summarized as follows:

The *NCP* has a major impact on the mean air temperatures over the *Balkans*, the *Anatolian Peninsula* and the *Middle East*. The positive phase of this pattern (the *NCP* ( + )) is associated with below normal temperatures, while the negative phase (the *NCP* ( − )) is related with above normal temperatures. Negative temperature anomalies are caused by the increased north-easterly anomaly circulation during the *NCP* ( + ) phase in the region, resulting from the joint effect of an increased anticyclonic anomaly circulation pattern over the North Sea region and an increased cyclonic anomaly circulation pattern over the northern Caspian Sea region. On the other hand, positive temperature anomalies are related with the increased southerly and/or south-westerly anomaly circulation during the *NCP* ( − ) phase, arising from the joint effect of an increased cyclonic anomaly circulation pattern over the North Sea region and an increased anticyclonic circulation pattern over the northern Caspian Sea region.

Among the three countries involved in the present study, the impact on the air temperature is most severe in Turkey, due to its closer location to one of the poles of the *NCP*. The maximum impact on temperatures is observed in the *Continental Central Anatolia* and the mountainous *Continental Eastern Anatolia* regions, and decreases westwards and southwards (Fig. 5). In Greece there is a decreasing gradient of the impact westward. The impact of the *NCP* on air temperature in Israel is relatively small and more pronounced in the mountainous inland regions. The temperature differences are evident not only on the long-term monthly averages but also on particular extreme months either hotter or colder than normal.

The impact of the *NCP* on rainfall is more complex. In the regions exposed to the southern maritime fluxes, such as *Thrace*, *Epirus* or the *Peloponnesus* in Greece and the *Mediterranean* or the *Mediterranean to Central Anatolia Transition* in Turkey, there is more rainfall amount during the *NCP* ( − ) phase. Whereas, in the regions exposed to the northern maritime fluxes, such as *Crete* in Greece, the *Black Sea* region in Turkey, and in all regions of Israel, there is more rainfall during the *NCP* ( + ) phase (Fig. 6). It seems, that the impact on rainfall is less crucial in Turkey than in the two other countries. During the *NCP* ( − ) phase, western Turkey characterized with the southern maritime trajectories benefits from much above normal rainfall, whereas during the *NCP* ( + ) phase this is the case in eastern Turkey characterized with the northern maritime trajectories. In Greece larger parts of the country will benefit from more abundant rainfall during the *NCP* ( + ) than during the *NCP* ( − ). The impact on rainfall is the most crucial in Israel as during the *NCP* ( − ) not only the temperatures are higher but also there is a considerable reduce in the rainfall amounts in all parts of the country.

Seasonal mean temperature differences greater than 1 °C, 2 °C or even 3 °C, are as large as any anticipated temperature change due to a global climatic change. Similarly, differences of hundreds of millimetres of rainfall, for the seasonal totals (which for some stations, represent almost all the annual rainfall) are also beyond any scenario regarding a possible modification of the rainfall regime.

Furthermore, although the *ENSO* and the *NAO* certainly have a major role in affecting the rainfall and temperature regime in the southern hemisphere and the western Europe, respectively, their influences in the Eastern Mediterranean part of the northern hemisphere are very much reduced mainly in the rainfall regime. No clear simple causative explanation can be given for such apparent relationship found e.g., between the *ENSO* and rainfall in a certain region. The present study has provided not only very clear and significant results illustrating the major role of the *NCP* in determining the temperature and rainfall regime in that part of the world, but also an explanation for these results in terms of upper level atmospheric circulation. Thus, future studies aimed to downscale GCM scenarios to a regional scale and provide forecasts regarding eventual temperature and/or rainfall changes in this region, should prefer the use of the *NCPI* to the *NAO* index or the *SOI*.

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