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Analysis of large-scale correlations on temperatures over Iraq

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Abstract

Purpose – The purpose of communicating with your esteemed magazine is your continuous support with Arab researchers and your sponsorship of research on the Arab world.

Design/methodology/approach – The research design was based on the APA style, and the methodology used in this research study is statistical and applied analysis to reach the desired results.

Findings – The results of this study provide an interesting perspective on the factors that influence changes in variables in Iraq: The prevailing patterns of temperature in Iraq are characterized by a clear pattern, and it is noticeable that they are linked to patterns of distance connection, but it is affected by some local influences, including the different terrain in Iraq. The highest values recorded by the correlation relationship were for the oscillation NAO and EA-WR with −0.812, −0.805, respectively. It is clear from the results that the correlation values are different between the northern and southern stations regions, and that the most influential appeared during the month of January, meaning that the effects of the remote correlation patterns are clearer during the winter season. Most of the correlation values of temperature were at the significance level of 0.5 and 0.1, in addition to that, the correlation was inverse, meaning that when the values of the distance correlation patterns rise, the temperature rates drop above the study stations and vice versa. The effect of SOI appeared during the months of December, April and May, and it recorded a strong correlation with the temperature variable. Most of the oscillations showed different effects with temperature, and it cannot be inferred that the effect is subjected and affected by the oscillation without reference to the extensions of pressure systems and their effects on the local conditions over Iraq.

Research limitations/implications – There are no restrictions.

Originality/value – The topic of the research is one of the modern topics that researchers have not taken up in a large way, and the apparent thesis in the research is one of the effects of the newly observed climate changes with the aim of addressing and limiting the effects of these phenomena on the Arab world.

Keywords Distance correlation, Pressure oscillations, Temperature, Pearson correlation

Paper type Research paper

1. Introduction

First of all, for several decades, man has been so much interested in climatic studies based on his fears related to climatic changes, which led to an increase in his detailed knowledge of the climatic indicators that mostly affect the globe and the climatic phenomena whose changes led to the great fluctuations in the climate, especially with regard to the elements of heat and rain in many regions of the world. Since the patterns of remote correlations are among the phenomena that receive much attention through their relations with the climatic elements that contribute to the knowledge of climatic anomalies and their changes. The study of

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climate changes is one of the significant topics that have attracted the attention of climate researchers. Understanding the causes and nature of climate change is one of the most remarkable goals of collecting climate data. Therefore, climate oscillations are one of the patterns of remote correlations and are of great importance. The climate of a particular region is not only subject to the influence of solar radiation and humidity for that location, but rather it is affected by distant phenomena that are in themselves a result of atmospheric circulation (Ghavidel, Farajzadeh, & Hatami, 2016).

Besides, distant correlation means the relationship between the fluctuation of the climatic elements of a particular region with the changes in the pressure and temperature patterns of the seas and oceans in certain geographical places. Any change in the pressures and temperatures of the seas due to the energy stored in them is capable of causing major changes in the climate of the surrounding areas, which will have an impact on the displacement of the locations of the main air masses in these places. Bhutiyani, Kale, and Pawar (2010) in their study, which was carried out in 2010, paid much attention to the climatic changes as well as the change in the amount of rain northwest of the Himalayas for the period 1966–2006 and concluded that the NAO (North Atlantic oscillation) index during the winter seasons and the southern oscillation in the seasonal months recorded the highest effect on the fluctuation of precipitation. In addition, they did not find a general trend of rain during the winter season. However, there is a significant decrease in the seasonal rainfall as well as a trend of an increase in the annual temperature, so the effect of warming is worthwhile during the winter.

Räsänen and Kummu (2013) shed light on the effects of the southern oscillation on climatic changes in the Mekong River Basin in Southeast Asia. The results of their research brought to light that the rainfall in the basin is clearly affected under the influence of the ENSO phenomenon. In addition, Kutiel, Maheras, Türkeş, and Paz (2002) focused on the role of distant correlation patterns on the eastern region of the Mediterranean basin and came up with results disclosing that the NCP frequency is the main oscillation among other patterns, as it is considered the most influential on temperatures in the Antalya region. Also, Hatzaki, Flocas, Maheras, Asimakopoulos, and Giannakopoulos (2006) conducted a study related to the follow-up of climatic changes in the Mediterranean basin under the influence of pressure oscillations that the NCP frequency, as well as the EA, NAO frequency, is one of the most influential oscillations in determining the prevailing climate pattern in this region.

In their study of the role of NAO on temperature and rainfall during winter for mountainous regions, López-Moreno *et al.* (2011) found that the effect of oscillation is slightly and not significant for the eastern regions of the Mediterranean, while other regions have a significant correlation between the studied oscillations.

In a study conducted by Al-Khalidi, Dima, Vaideanu, & Stefan (2017), for analysis of the correlation between the NAO and Indian Ocean indicators on temperature and rain, it was made clear that the Nordic–Scandinavian Ocean pattern is influential on winter temperatures, while rain is affected by the NAO indicator.

Also, Iles and Hegerl (2017) worked on a study to investigate the role of NAO on temperature trends in the Northern Hemisphere depending on the regression coefficient. They concluded that there is a decrease in temperatures in the western Atlantic Ocean.

In addition, in the study of Rodrigo (2021) accomplished in 2021 for analyzing the binary correlation of the two oscillations NAO and EA on the temperature in the Iberian Peninsula, four compounds of the positive and negative poles of these two oscillations were identified. Results have made it clear that there is a slight effect of the relationships between the variables on the temperature in the Iberian Peninsula.

Most studies show that there is a clear impact of distant correlation patterns on the prevailing climatic situation reliant on the different methods used by researchers to obtain the results of the effect of the variables. It brings to light that the coefficients used to investigate the effect represent the variance in the data processing mechanism to reach the desired results. The researchers depended on the most important pressure oscillations in this study, and its relationship with temperature in order to analyze it and know the results of the relationships between them. Also, there was a reliance on the Pearson correlation coefficient to extract the results of the correlation between the variables, and the monthly rates between the variables were employed in the analysis.

2. Data and methodology

In this study, a climatic cycle (2008–2019) was relied on to compare the rates of temperature and pressure oscillation rates. The data of climatic elements were obtained from the Iraqi Meteorological Authority. As to pressure oscillation rates, they were obtained from the National Oceanic and Atmospheric Administration (NOAA) website. The statistical methods used in the research are the statistical-analytical methods in order to study the distant correlation indicators and their effects on the temperature component over Iraq. In addition, the monthly averages of the climatic stations were excellently distributed to cover the main areas of Iraq (Table 1). In other words, they represent the local conditions for each region of Iraq. Map 1.

3. Analysis and results

3.1 Correlation relation between pressure oscillations and temperature

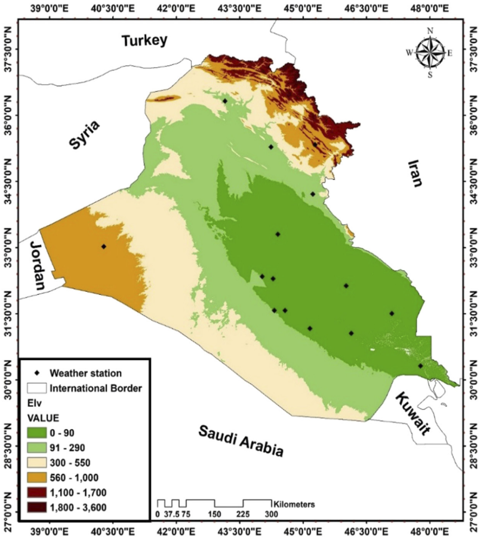
3.1.1 September. The results of the analysis showed the correlation of the average temperature of the Sulaymaniyah , Mosul, Baghdad, Rutba and Basrah stations with the North Atlantic frequency (NAO) was −0.355, −0.670, −0.311, −0.452 and −0.315, respectively. The correlation values showed that the relationship is medium and inverse, except for the Mosul station, which recorded a strong and inverse correlation. As to the correlation of temperature with Arctic Oscillation (AO), it was 0.159, −0.542, −0.364, −0.281 and −0.269, respectively, as the correlation values showed that the highest correlation recorded by the Mosul station and inverse was not statistically significant. It also found significant differences when analyzing the correlation of the study stations with the SOI index, which amounted to about −0.016, 0.477, −0.243, −0.379 and −0.158, respectively.

The correlation of the EA-WR indicator showed different results for the study stations. It reached about −0.145, −0.259, −0.812, −0.263 and −0.413, respectively (see Map 2). Table 2 shows the statistical relationship between pressure oscillations and temperatures which are as follows.

3.1.2 October. It is made transparent that there is a great spatial contrast to the influence of NAO on study stations and the highest association recorded is by Sulaymanyiah station with a level of 0.01, while other stations (Mosul, Baghdad, Al-Rutba and Basrah) suggest the values of the link that the relationship is weak/medium and reverse such as −0.161, −0.223, −0.118 −0.382, respectively. The AO effect on the heat rate of the stations also did not show a strong mutual effect. Most of the relationship illustrates a medium/very weak correlation of −0.451, −0.051, −0.064, −0.452 and −0.151, respectively. As for the correlation of SOI, the correlation clearly showed that there is a graduation in impact values from the north to the

Table 1.
Details of the selected meteorological stations used in this study (Iraqi meteorological and seismology organization)

Station	Station number	Latitude (N)	Longitude (E)	Altitude (m a.s.l)
Sulaymaniyah	623	°35 ¯33	°45 ¯25	883
Mosul	608	36°19	43°09	222.6
Baghdad	650	33˙ 29	44˙ 24	34.1
Rutbah	642	°33 ¯02	°40 ¯17	630.8
Basrah	689	30 ° 34	°47 47	2.4

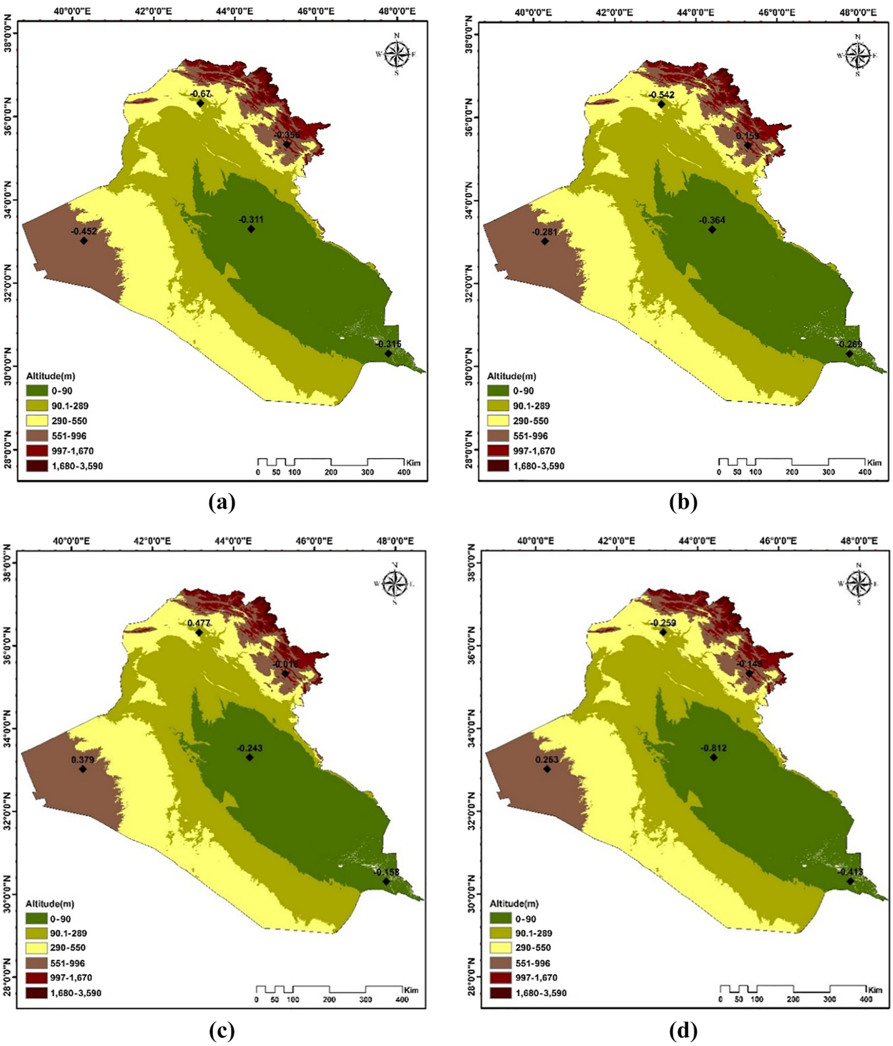


Map 1.
Heights map on which the climatic stations of the study area are shown

south, as the highest in its record is found in the Sulaymaniyah station, which is about 0.307, the intermediate relationship. The highest correlation values recorded by the Sulaymaniyah and Mosul stations are −0.811, −0.662, respectively, and the values showed a strong opposite relationship, while correlation values of Baghdad, Al-Rutba and Basrah reached −0.320, 0.402 and −0.462, respectively (See Map 3). Table 3 shows the statistical relationship between pressure oscillations and temperatures which is as follows.

3.1.3 November. The results of the analysis showed that the correlation of NAO with the temperatures recorded on the study stations were weak/reverse for all stations from the north to the south (0.077,−0.188, −0.185, 0.022, 0.471), respectively. It is evident that the highest value was recorded by the Basrah station, which is an average/direct relationship, while the AO index in its relationship with the temperature values between that the effect was 0.202, −0.112, −0.288, 0.279 and 0.421, respectively. Besides, the SOI's registered correlations were −0.217, −0.138, −0.193, 0.107 and −0.094, respectively. The effects of EA-WR on the study stations showed about 0.484, 0.292, 0.183, −0.045 and 0.316, respectively. And we are intended from the above analysis that the month of November did not witness a strong correlation between the variables, but the relationships range from medium to weak with a contrast between the northern, central and southern stations and that the scope of the effect of oscillations varies according to the station's location and its local effects. Moreover, it became clear that the Basrah station recorded the highest values of correlations with indicators when compared to other studied climatic stations. This shows that the marine effects of high humidity and temperature values are still affecting the weather area of the Map 4. Table 4 shows the statistical relationship between pressure oscillations and temperatures which are as follows.

3.1.4 December. The correlation of NAO with temperature of the study stations was verified, as the correlation reached 0.460, −0.023, 0.045, 0.132, −0.191, respectively. As it is clear that the relationship is variable, and the highest value was recorded by the Sulaymaniyah station, as mentioned above, it represents a direct average relationship. While the values decrease as we head south of Iraq. Also, the effect of AO was about 0.160, −0.336, −0.029, 0.194 and −0.327 respectively, while the highest correlation of SOI recorded with

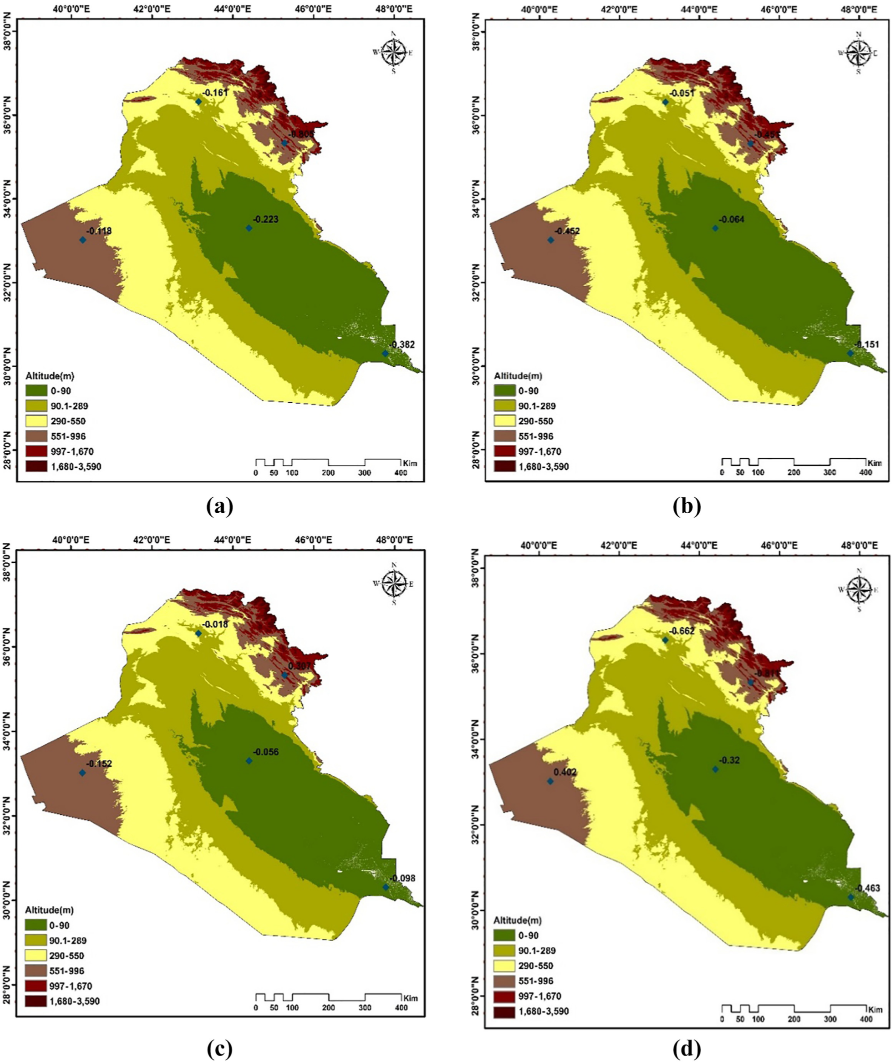


Map 2.
Spatial distribution of the correlation coefficient for the month of September and for the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 2.
Correlation relationship between pressure oscillations and normal temperature for Iraq's main stations for the month of September

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutbah *R*	Basrah *R*
NAO	−0.355	−0.670-*	−0.311	−0.452	−0.315
AO	0.159	−0.542	−0.364	−0.281	−0.269
SOI	−0.016	0.477	−0.243	0.379	−0.158
EA-WR	−0.145	−0.259	−0.812-**	0.263	−0.413

Sulaymaniyah station was about −0.638, as the relationship is strong, inverse and not statistically significant. Furthermore, the effect of EA-WR appeared strongly on Sulaymaniyah and Al-Rutbah stations (0.742, −0.677), respectively, as made clear in



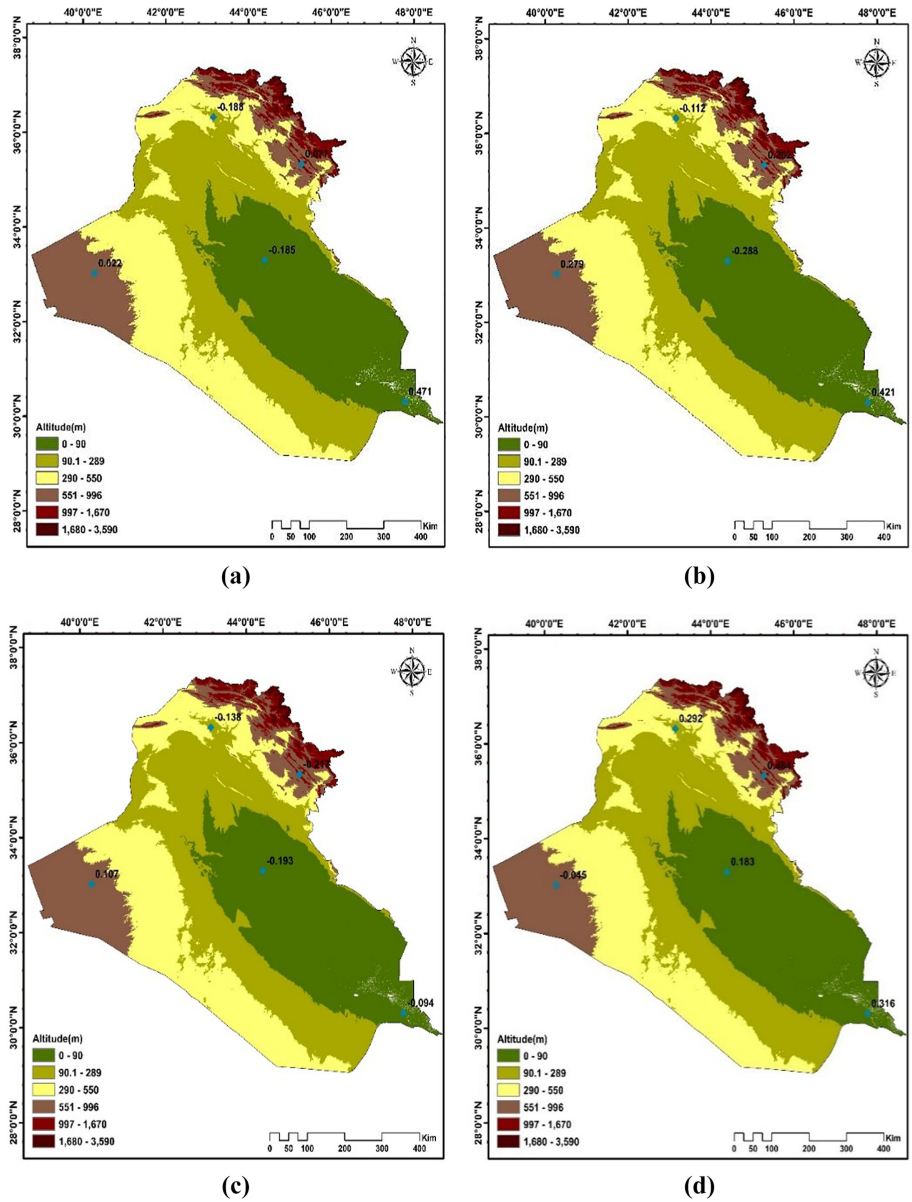
Map 3.
Spatial distribution of the correlation coefficient for the month of October and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 3.
Relationship between pressure oscillations and the regular temperature of Iraq's main stations for the month of October

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutbah *R*	Basrah *R*
NAO	−0.805-**	−0.161	−0.223	−0.118	−0.382
AO	−0.451	−0.051	−0.064	−0.452	−0.151
SOI	0.307	−0.018	−0.056	−0.152	−0.098
EA-WR	−0.811-**	−0.662-*	−0.320	0.402	−0.463

[Map 5](#). [Table 5](#) depicts the statistical relationship between pressure oscillations and temperatures are as follows.

3.1.5 January. The effect of NAO on the study stations is varied. The highest correlation was recorded by the two stations Baghdad and Basrah, amounted to −0.532, −0.502, respectively, and the relationship is strong and inverse. While the other stations recorded a



Map 4.
Spatial distribution of the correlation coefficient for the month of November and the stations of Iraq (a) NAO INDEX; (b) AO index, (c) SOI index and (d) EA-WR index

medium correlation. The activity of the impact on these two stations is reflected for all indicators. As AO exhibits its effect on the stations Baghdad and Basrah about −0.502, −0.615. Also the correlation is strong and inverse, while the SOI oscillation did not show a strong impact on the stations, as the highest correlation value recorded by the Basrah station is about −0.481 and the relationship is medium and inverse. While there is a strong effect of EA-WR on the same stations that recorded a strong correlation with the previous indicators, as it reached −0.510, −0.640, respectively. We conclude that during this month, the effect of oscillations on the southern stations is more pronounced compared to the northern stations (see Map 6). Table 6 depicts the statistical relationship between pressure oscillations and temperatures that are as follows.

3.1.6 February. During this month, the effect of NAO fell compared to the previous months, where the effect ranged between a medium and weak relationship, reaching about 0.075 −0.105, 0.318, −0.282 and 0.255, respectively. The case applies to the AO indicator, as the correlation values amounted to 0.259, −0.022, 0.074, −0.145 and 0.070, respectively. While the highest correlation value recorded by SOI on Baghdad station, it reached about −0.584, and it represents a strong inverse relationship. While the other stations showed a weak correlation with the exception of the Mosul station, whose correlation reached to −0.258, which is an inverse medium relationship. Also, EA-WR did not record a strong correlation, but the highest values recorded on Sulaymaniyah, Baghdad and Rutba were about −0.200, −0.363 and −0.335, respectively (see Map 7). Table 7 depicts the statistical relationship between pressure oscillations and temperatures are as follows.

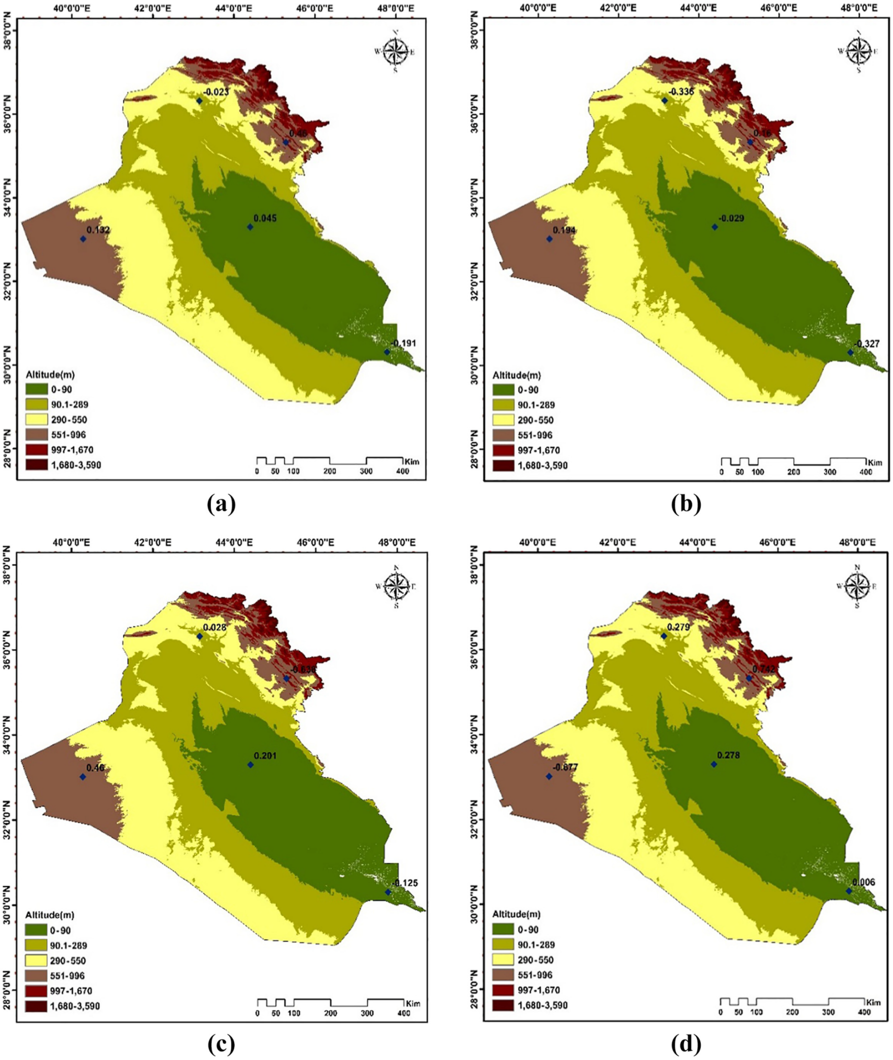
3.1.7 March. The effect of NAO was average during this month on all stations, as the correlation values were about −0.308, −0.375, −0.388, 0.223 and 0.357, respectively. Also, the effect of AO took a gradual trend from north to south, as the values of the strong correlation with Baghdad station was about −0.572, which represents a strong inverse relationship that is not statistically significant. While the stations of Sulaymaniyah and Mosul exhibited correlation amounted to −0.460, −0.323, respectively, as they represented a medium and inverse correlation. The oscillation of SOI decreased its correlation with the stations and amounted to −0.148, −0.296, −0.312, 0.031 and 0.156, respectively.

Besides, the highest correlation value was recorded by EA-WR with Baghdad station by −0.713. It speaks for a strong and inverse relationship, followed by Sulaymaniyah and Mosul stations by −0.480, −0.349, respectively. The values embody an average and inverse relationship with the temperature recorded on these two stations. The results also demonstrate that the relationship, despite its weakness, is inverse with the northern stations, while it is notable that the relationship changes and becomes positive despite its weakness. That is, the correlation is in line with the temperature values at these stations (see Map 8). Table 8 depicts the statistical relationship between pressure oscillations and temperatures which are as follows.

3.1.8 April. The oscillation correlation of (NAO, AO, SOI, and EA-WR) was (−0.441, −0.184, −0.332, and −0.021) for the Sulaymaniyah station. It turns out that the correlation relationships at the Mosul station for (NAO, AO, SOI, and EA-WR) are about (0.050, −0.160, −0.220, and −0.689), respectively. As for the Baghdad station, the correlation was (−0.423,

Index	Sulaymaniyah R	Mosul R	Baghdad R	Rutbah R	Basrah R
NAO	0.077	−0.188	−0.185	0.022	0.471
AO	0.202	−0.112	−0.288	0.279	0.421
SOI	−0.217	−0.138	−0.193	0.107	−0.094
EA-WR	0.484	0.292	0.183	−0.045	0.316

Table 4. Relationship between pressure oscillations and the regular temperature of Iraq's main stations for the month of November

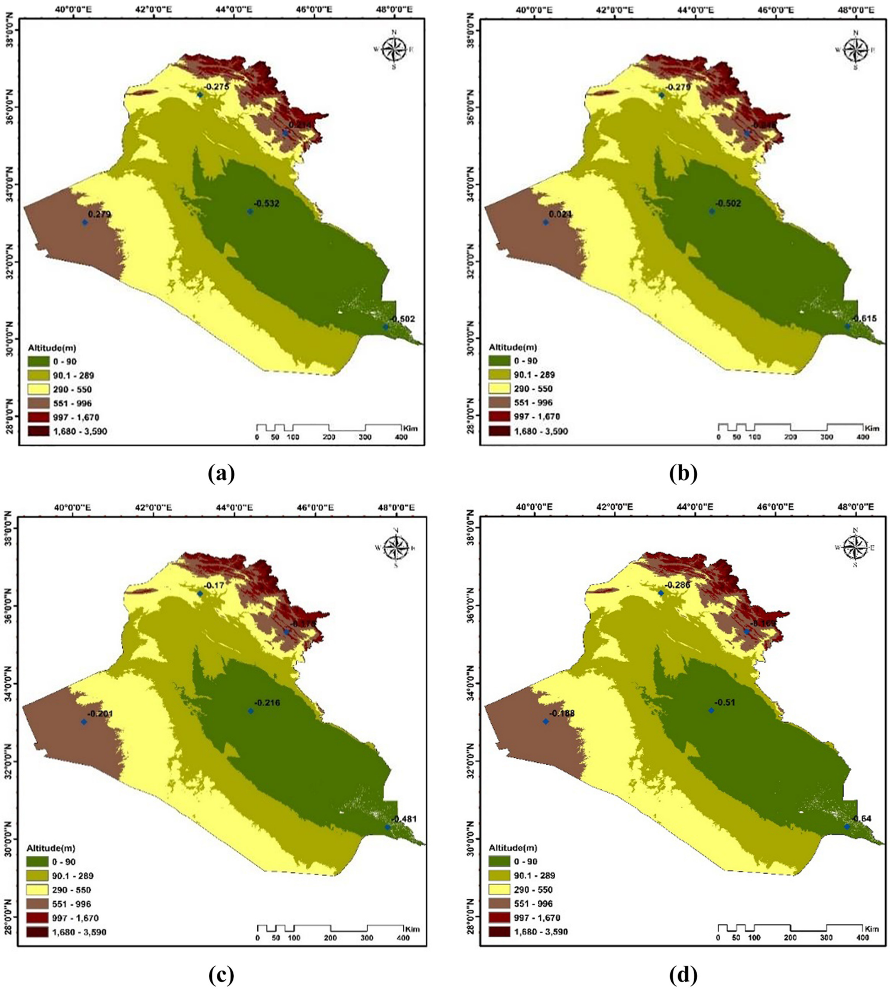


Map 5.
Spatial distribution of the correlation coefficient for the month of December and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 5.
Correlation between pressure oscillations and normal temperature for the main stations of Iraq in December

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutbah *R*	Basrah *R*
NAO	0.460	−0.023	0.045	0.132	−0.191
AO	0.160	−0.336	−0.029	0.194	−0.327
SOI	−0.638	0.028	0.201	0.460	−0.125
EA-WR	0.742*	0.279	0.278	−0.677-*	0.006

−0.243, −0.078, and −0.203). The results displayed that the oscillations in the Al-Rutbah station amounted to (−0.413, −0.294, 0.247, and 0.763). Besides, it was come up with the result that the oscillation (NAO, AO, SOI, and EA-WR) amounted to (−0.277, −0.221, −0.634, and



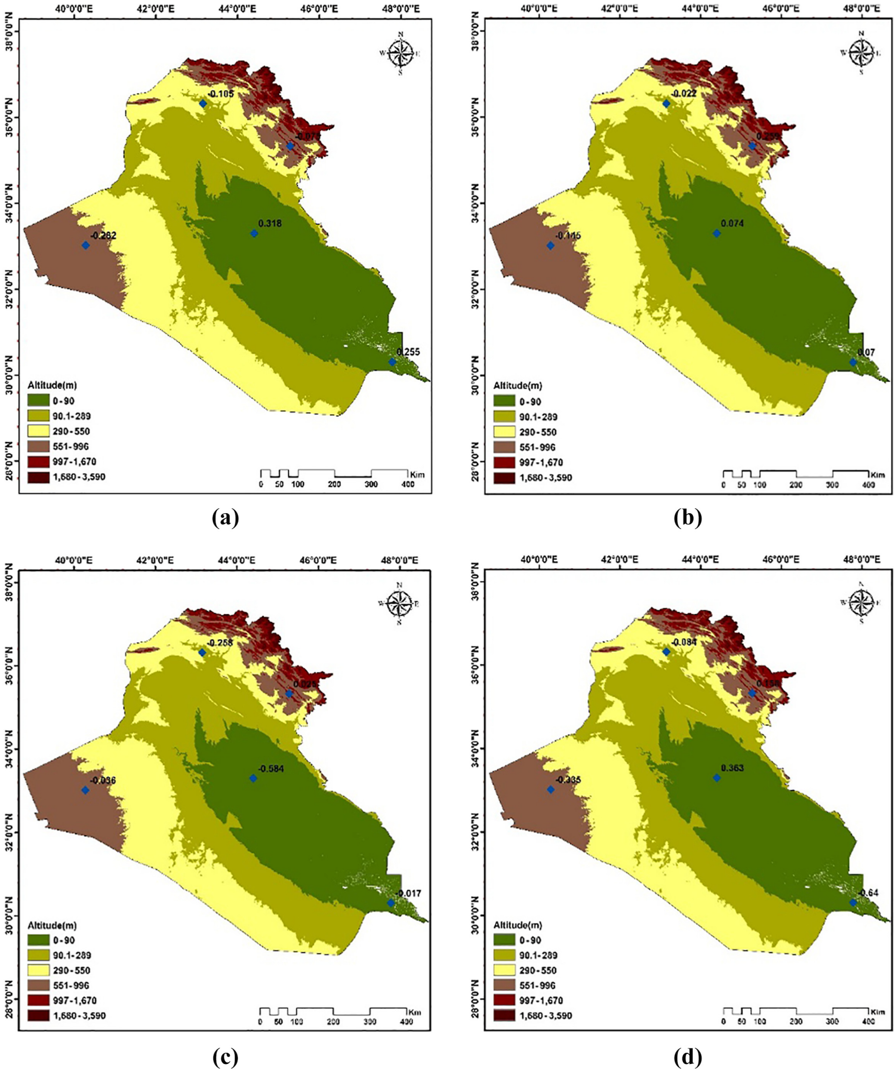
Map 6.
Spatial distribution of the correlation coefficient for the month of January and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 6.
Correlation between pressure oscillations and normal temperature for the main stations of Iraq in January

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutbah *R*	Basrah *R*
NAO	0.214	−0.275	−0.532	0.279	−0.502
AO	−0.048	−0.279	−0.502	0.024	−0.615
SOI	−0.175	−0.170	−0.216	−0.201	−0.481
EA-WR	−0.169	−0.286	−0.510	−0.188	−0.640-*

0.054), respectively (see Map 9). Table 9 depicts the statistical relationship between pressure oscillations and temperatures which are as follows.

3.1.9 May. It turned out that the effect of NAO was strong and significant on the Mosul and Rutbah stations, with values −0.526, −0.604, respectively. While the other stations indicate the results of their relationships between the medium and the weak. Also, the AO indicator did not reveal a strong influence on the stations' temperature, but the relationship

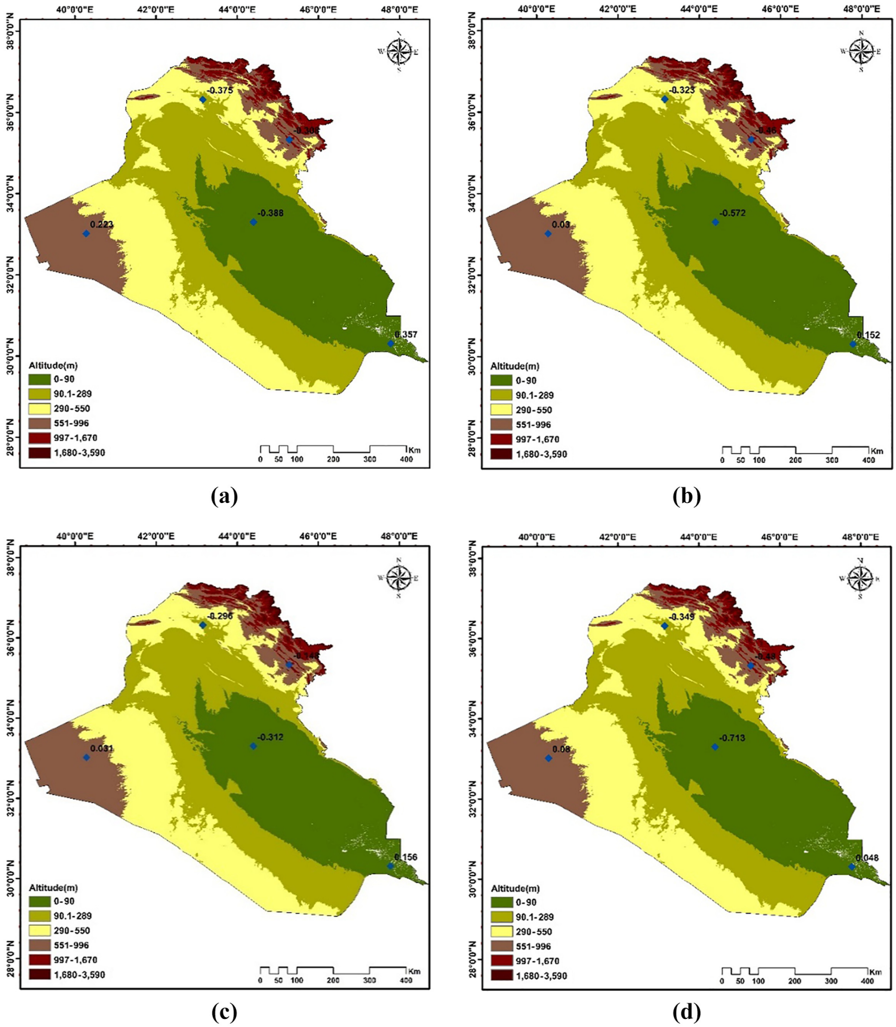


Map 7.
Spatial distribution of the correlation coefficient for the month of February and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 7.
Correlation between pressure oscillations and normal temperature for the main stations of Iraq in February

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutbah *R*	Basrah *R*
NAO	−0.075	−0.105	0.318	−0.282	0.255
AO	0.259	−0.022	0.074	−0.145	0.070
SOI	0.025	−0.258	−0.584	−0.036	−0.017
EA-WR	−0.200	−0.084	0.363	−0.335	0.158

was medium and weak. Whereas, SOI recorded a strong correlation with the Sulaymaniyah station with a value of −0.694, and the effect ranged from medium to weak on the northern stations. As for the far south of the Basrah station, where the case applies to the effect of

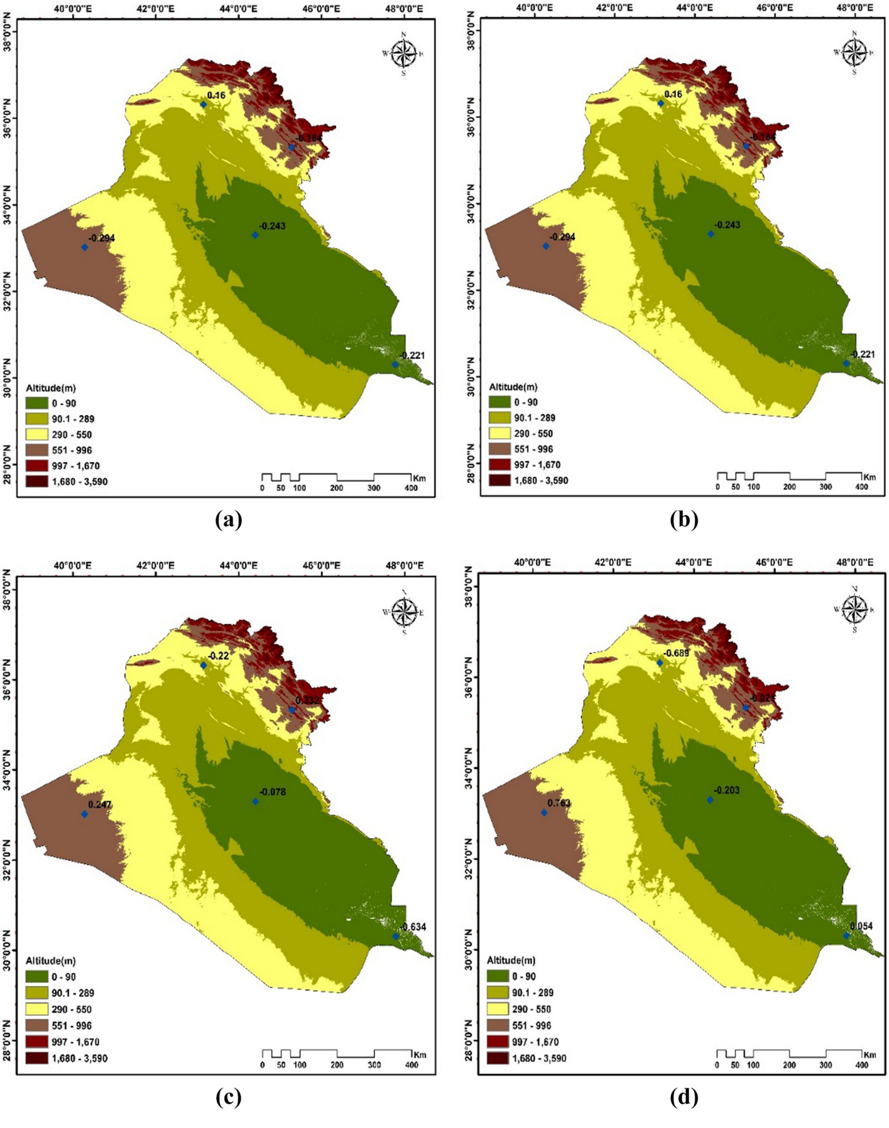


Map 8. Spatial distribution of the correlation coefficient for the month of March and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 8. Correlation between pressure oscillations and normal temperature for Iraq's main stations for the month of March

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutba *R*	Basrah *R*
NAO	−0.308	−0.375	−0.388	0.223	0.357
AO	−0.460	−0.323	−0.572	0.030	0.152
SOI	−0.148	−0.296	−0.312	0.031	0.156
EA-WR	−0.480	−0.349	−0.713-*	0.080	0.048

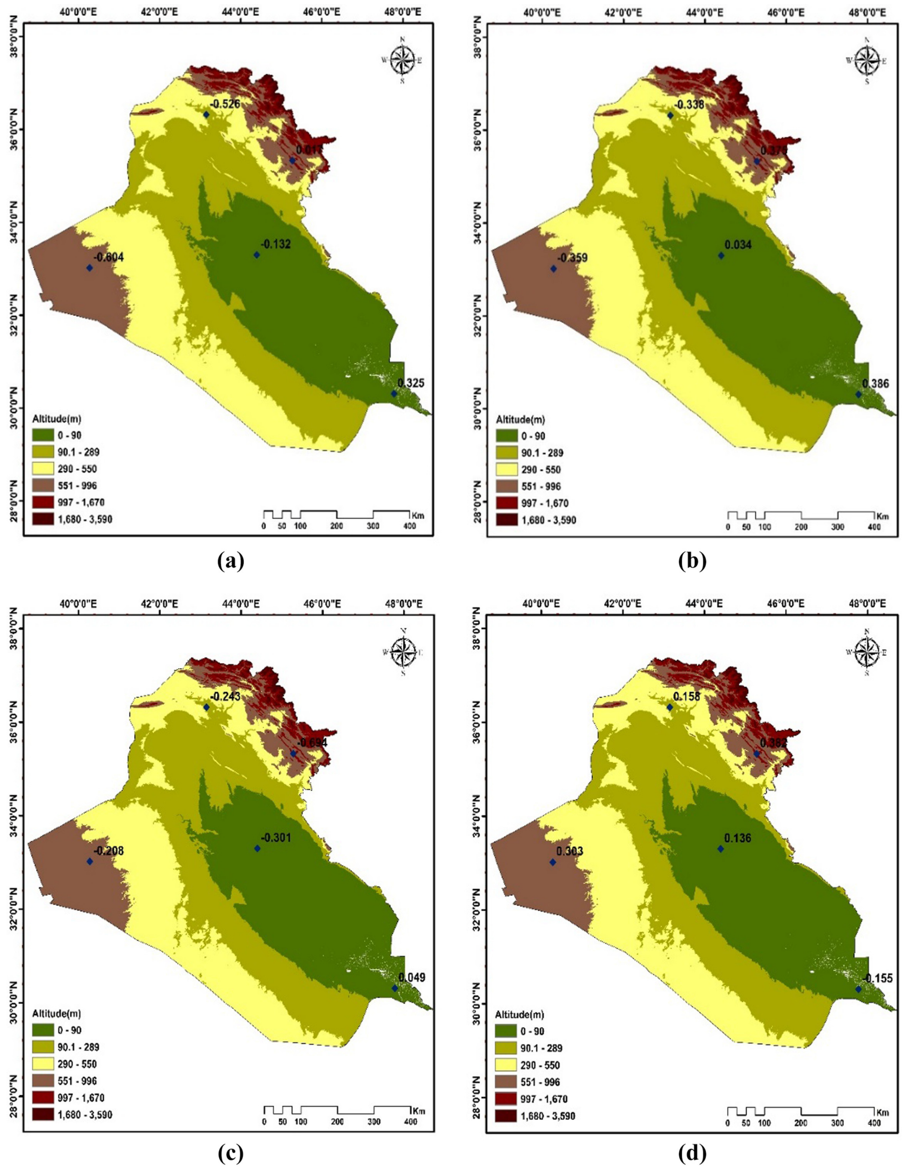
EA-WR, it is demonstrated that the relationship is medium and weak for most stations (see Map 10). Table 10 depicts the statistical relationship between pressure oscillations and temperatures which are as follows.



Map 9.
Spatial distribution of the correlation coefficient for the month of April and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Table 9.
Correlation between pressure oscillations and normal temperature for Iraq's main stations for the month of April

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutba *R*	Basrah *R*
NAO	−0.441	0.050	−0.423	−0.413	−0.277
AO	−0.184	0.160	−0.243	−0.294	−0.221
SOI	0.332	−0.220	−0.078	0.247	−0.634-*
EA-WR	−0.021	−0.689-*	−0.203	0.763**	0.054



Map 10.
Spatial distribution of the correlation coefficient for the month of May and the stations of Iraq (a) NAO INDEX, (b) AO index, (c) SOI index and (d) EA-WR index

Index	Sulaymaniyah *R*	Mosul *R*	Baghdad *R*	Rutbah *R*	Basrah *R*
NAO	0.017	−0.526	−0.132	−0.604-*	0.325
AO	0.375	−0.338	0.034	−0.359	0.386
SOI	−0.694-*	−0.243	−0.301	−0.208	0.049
EA-WR	0.382	0.158	0.136	0.303	−0.155

Table 10.
Correlation between pressure oscillations and normal temperature for the main stations of Iraq in May

4. Discussions and conclusions

Despite the large number of studies that have paid much attention on the patterns of distant correlation in the world in general, the Middle East in particular, but with regard to Iraq, the number of research has been limited. Therefore, the study came to fill the gap in this aspect of climatic studies, and to urge researchers to carry out studies in this aspect of scientific studies.

The contrast of studies in how to process data and obtain results in its entirety and in general relying on finding the relationship to the changes occurring in the origin of pressure oscillations and linking them to the changes occurring in the study regions. So the easiest way to track these changes and link them to the anomalies in the climatic phenomenon is to use the Pearson correlation coefficient, which prompted the researchers to use this coefficient to obtain correlations between the studied variables.

Also, it was clear from the results of the research that temperatures are more affected by the Atlantic Ocean oscillations, especially NAO and the polar oscillation (AO), as well as EA-WR.

These results are also consistent with what was found in 2015 by Khidher and Pilesjö. The effect of NAO is more pronounced during the winter and with the northern stations of Iraq. The results also were consistent with the findings of Alizadeh-Choobari and Adibi (2019). In their study, NAO is correlated with temperatures with a strong correlation in the Southwest Asia region. This correlation reveals the fact that temperature is affected during the winter by the progress of the Siberian high and the arrival of polar air masses, which contributes to lower temperatures on climatic stations.

While the summer months are affected by the extensions of the tropical elevation, which contribute to the rise in temperatures, as well as the nature of the geographical location that places Iraq in the south of the central latitudes. This fact contributes to the arrival of large amounts of solar radiation. Moreover, the local conditions of drought and lack of vegetation cover have contributed greatly to the anomaly temperatures over the Arabian Gulf region in general and Iraq in particular.

The results of this study provide an interesting perspective on the factors that influence changes in variables in Iraq, which are as follows:

(1) The prevailing patterns of temperature in Iraq are characterized by a clear and noticeable pattern that is related to the patterns of distant correlation, but is affected by some local influences, including the difference in surface features in Iraq.

(2) The highest values recorded by the correlation relationship were for the oscillation NAO and EA-WR towards −0.812, −0.805, respectively.

(3) It turns out that the correlation values are different between the northern and southern stations, and the most influential ones appeared during the month of January, meaning that the effects of the distant correlation patterns are more pronounced during the winter season.

(4) Most of the correlation values with temperature were at the significance level of 0.5 and 0.1, in addition to that, the correlation was inverse, meaning that when the values of the distant correlation patterns rise, the temperature rates drop above the study stations and vice versa.

(5) The effect of SOI appeared during the months of December, April and May, and recorded a strong correlation with the temperature variable.

(6) Most of the oscillations depicted varying effects with temperatures, and it is not possible to infer the effect that is subject to the oscillation without referring to the extensions of pressure systems and their effects on the local conditions over Iraq.

References

Al-Khalidi, J., Dima, M., Vaideanu, P., & Stefan, S. (2017). North Atlantic and Indian Ocean links with Iraq climate. *Atmosphere*, *8*(12), 235.

Alizadeh-Choobari, O., & Adibi, P. (2019). Impacts of large-scale teleconnections on climate variability over Southwest Asia. *Dynamics of Atmospheres and Oceans*, *86*, 41–51.

Bhutiyani, M. R., Kale, V. S., & Pawar, N. J. (2010). Climate change and the precipitation variations in the Northwestern Himalaya: 1866–2006. *International Journal of Climatology: A Journal of the Royal Meteorological Society*, *30*(4), 535–548.

Ghavidel, R. Y., Farajzadeh, A. M., & Hatami, Z. D. (2016). Analysis of the relationship between north Sea-Caspian teleconnection pattern and minimum temperatures in Iran. *Geographic Space*, *15*(52), 137–159.

Hatzaki, M., Flocas, H. A., Maheras, P., Asimakopoulos, D. N., & Giannakopoulos, C. (2006). Study of future climatic variations of a teleconnection pattern affecting eastern Mediterranean. *Global Nest Journal*, *8*(3), 195–203.

Iles, C., & Hegerl, G. (2017). Role of the north Atlantic oscillation in decadal temperature trends. *Environmental Research Letters*, *12*(11), 114010.

Khidher, S. A., & Pilesjö, P. (2015). The effect of the north Atlantic oscillation on the Iraqi climate 1982–2000. *Theoretical and Applied Climatology*, *122*(3), 771–782.

Kutiel, H., Maheras, P., Türkeş, M., & Paz, S. (2002). North Sea–Caspian Pattern (NCP)–an upper level atmospheric teleconnection affecting the eastern Mediterranean–implications on the regional climate. *Theoretical and Applied Climatology*, *72*(3), 173–192.

López-Moreno, J. I., Vicente-Serrano, S. M., Morán-Tejeda, E., Lorenzo-Lacruz, J., Kenawy, A., & Beniston, M. (2011). Effects of the North Atlantic Oscillation (NAO) on combined temperature and precipitation winter modes in the Mediterranean mountains: Observed relationships and projections for the 21st century. *Global and Planetary Change*, *77*(1-2), 62–76.

Räsänen, T. A., & Kummu, M. (2013). Spatiotemporal influences of ENSO on precipitation and flood pulse in the Mekong River Basin. *Journal of Hydrology*, *476*, 154–168.

Rodrigo, F. S. (2021). Exploring combined influences of seasonal East Atlantic (EA) and North Atlantic Oscillation (NAO) on the temperature-precipitation relationship in the Iberian Peninsula. *Geosciences*, *11*(5), 211.

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