International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

A Correlation between Air Temperature, Relative Humidity over Iraq and Corresponding Climatic Indices

Fadel A. Murad

Dept. of Physics, Faculty of Education for women, University of Kufa, Najaf, Iraq

Abstract : ***Relationships between the variability of annual, seasonal NAO and the annual and seasonal temperatures and relative humidity over Iraq have been investigated. The NCEP/NCAR reanalysis data of the monthly mean surface air temperature and relative humidity over Iraq for the periods (1949-2011), (1949- 2007) have been used in present paper. The corresponding monthly mean values of NAO index, SOI, and have been also used. Monte Carlo methodology as a linear correlation analysis has been used to obtain the correlation co-efficient between the mean surface air temperature and relative humidity over Iraq. The results show that surface air temperature in Iraq is significantly correlated with the climatic index NAO only for northern parts of Iraq. There is a significant negative correlation (-0.7) between surface air temperature over north part of Iraq in winter season and NAO index.***

Keywords: NAO index, NCEP/NCAR, surface air temperature in Iraq

1. Introduction

The North Atlantic Oscillation is a large-scale seesaw in atmospheric mass between the subtropical high (the Azores High) and the polar low (the Icelandic Low) in the North Atlantic region (Walker, 1924; Walker and Bliss, 1932; van Loon and Rogers, 1978; Wallace and Gutzler, 1981; Rogers, 1984; Barnston and Livezey, 1987; Hurrell, 1995). It is the dominant mode of atmospheric circulation variability in the North Atlantic sector throughout the year, although it is most pronounced during winter (Barnston and Livezey, 1987; Rogers, 1990; WCRP). The North Atlantic Oscillation (NAO) has attracted numerous and a wide range climatological investigations. One of the focuses of contemporary research is the extent of the influence on climate produced by NAO (Lucero and Rodriguez, 2002).

In winter, during positive NAO phase there is a positive snow/ice season surface air temperature anomaly over northwestern Eurasia, caused by enhanced advection of the warm Atlantic air and vice versa during the negative phase. The positive winter surface air temperature in Europe is caused by a positive NAO (Scheifinger, et al 2002). The significant relationships were also found between winter NAO and UK summer rainfall and wheat production (Kettlewell, et al 2003). Over North America as a whole NAO is associated with many significant changes across the continents, and a clear, but different, relationships between frequencies of weather type and NAO has been established (Sheridan, 2003). Bader and Latif (2005) used coupled ocean-atmosphere model found that a warm Indian Ocean produces a stronger NAO and a cold Indian Ocean produced a weaker NAO pattern. However, the changes in the atmospheric circulation above Estonia can only partly attributed to the intensification of the NOA during 1955-1995. Kysely (2002) discussed the relationships of heat waves in Prague and Basil with NOA index, where significant relationships were found. Based on an ensemble of climate change scenarios performed with global general circulation model of the atmosphere with high horizontal resolution over Europe (Terray, et al 2004), suggest that the end-of- century anthropogenic climate change over the North Atlantic-European region strongly projects onto the positive phase of the NAO during wintertime. That is an anthropogenic forcing may induce climate change over the North Atlantic-European region for the winter period through changes in occurrence of the NAO regimes, in addition to direct radiative forcing. Feidas et al (2004) examined the relationships between temperature variability in Greece and the atmospheric circulation indices of NAO. They found that the correlation coefficient was not significant during all seasons except winter. Hanna, et al (2006) discussed the relationships between Iceland climate and NAO in the period 1823-2003 and concluded that the existing relationships were not satisfactory, from all the mentioned above we can consider that The NAO can be seen as a reflection of the fluctuation of the normal winter tropospheric flow in the northern hemi- sphere.

The Southern Oscillation Index (SOI) is defined as the difference between sea level pressure at Tahiti (145^{o}W and 18^{o}S) and Darwin (135^{o}E and 16^{o}S). SOI is coupled with EL-Nino3. Whereas, El-Nino is the name given to the phenomenon, which occurs when sea-surface temperatures (SSTs) in the equatorial Pacific Ocean off the South American coast becomes warmer than normal. Nino3 is defined as the sea surface temperature at the Pacific Ocean in the region (90°W-150°W, 5°S-5°N) [13]. The NAO, like the El Nin˜ o–Southern Oscillation (ENSO), is one of the large-scale modes of climate variability in the Northern Hemisphere (NH). It defines a large-scale meridional oscillation of atmospheric mass between the center of subtropical high surface pressure located near the Azores and the sub polar low surface pressure near Iceland. Synchronous strengthening (positive NAO state) and weakening (negative NAO state) have been shown to result in distinct, dipole-like climate change patterns between western Greenland: Mediterranean and northern Europe:

north Scandinavia (Walker, 1924; Walker and Bliss, 1932; van Loon and Rogers, 1978; Rogers and van Loon, 1979).
In this study we investigated the main effects of the NAO and SOI on annually and seasonally air temperature and relative humidity over Iraq employing NCEP/NCAR Reanalysis project is using analysis/forecast system to perform data assimilation using past data from 1949 to 2011 for the monthly mean surface temperature and from 1949 to 2007 for monthly mean relative humidity composite over Iraq which has been provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, and [26]. Furthermore, the corresponding monthly mean values of NAO index, SOI, and El-Nino3 have been obtained from the same establishment and also used in the present paper.

2. Data, Methodology, Geographic Area and climate

For each grid point in the area of Iraq, seasonal and annual mean for surface temperature and relative humidity have been calculated using of the NCEP/NECAR reanalysis monthly data sets through the period of (1949-2011) and (1949-2007) for surface temperature and relative humidity respectively. The NAO and SOI composite mean comes from the same statistical manner. The local significance and calculation of correlation pat terns for a given seasonally and annually resolved means surface air temperature and relative humidity time series at each grid point is correlated with the climatic index (NAO and SOI) time series. Each grid point correlation is t-tested for local significance using [27], allowing for temporal autocorrelation according to [28] method. For field significance, the areal ex- tent of locally significant correlations in a correlation map. In present paper Monte Carlo methodology has been used. The field-significance statistic is the area-weighted average absolute correlation of a given correlation maps (considering only the locally significant correlations). The field-significance threshold is the 95th percentile of a 1000 member Monte-Carlo population. Iraq lies between 29°5- to 37°15- N latitudes and 38°45- to 48° 45-E longitude Figure (1). Iraq is a country in Western Asia spanning most of the northwestern end of the Zagros mountain range, the eastern part of the Syrian Desert and the northern part of the Arabian Desert. Iraq shares borders with Jordan to the west, Syria to the northwest, Turkey to the north, Iran to the east, and Kuwait to the west and Saudi Arabia to the south west. Iraq has a narrow section of coastline on the gulf. The geography of Iraq is diverse and falls into four main regions: the desert (west of the Euphrates River), the island plateau (between the upper Tigris and Euphrates rivers), the northern highlands of Iraqi Kurdistan. The mountains in the northeast are an extension of the alpine system that runs eastward from the Balkans through southern Turkey, northern Iraq, Iran, and Afghanistan, eventually reaching the Himalayas. The desert is in the southwest and central provinces along the borders with Saudi Arabia. The climate of Iraq is characterized by sub-tropical, continental, arid to semi-arid with dry hot summers and cooler winters.

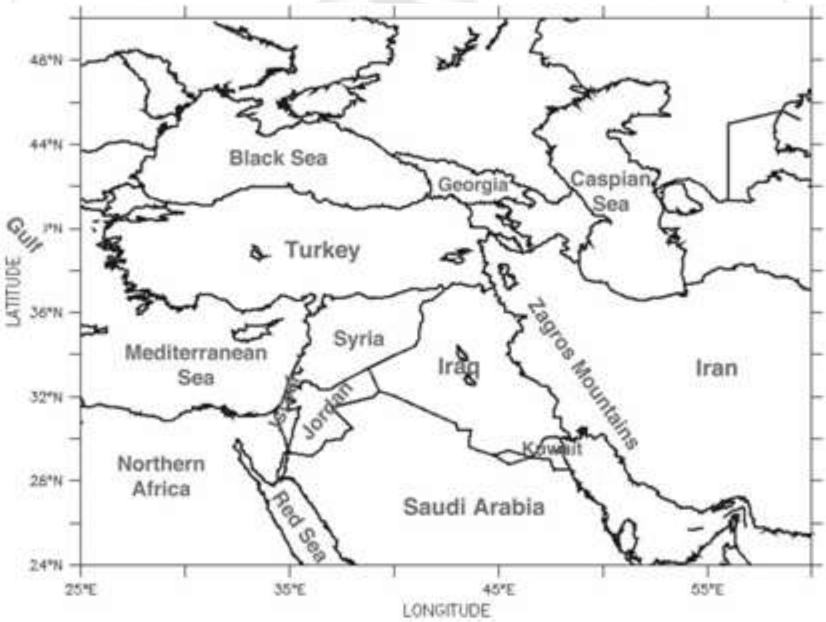


Figure 1: Iraq geographical location

3. Result and Discussion

The seasonal and annual surface air temperatures and relative humidity over Iraq have been analyzed. The distribution of maximum and minimum seasonal and annual mean surface air temperatures composite and their locations over Iraq during the period of present study for each two considered climatological elements have been illustrated in Figures (2, 3). The distribution of maximum and minimum temperature is very important for determine the more convenient regions for agriculture development process Iraq. It was noticed that the mean surface air change from season to other during the study period. The maximum seasonal mean air temperature (38^{o}C) has been occurred during summer season at the south region of Iraq, whereas the minimum seasonal mean air temperature (4^{o}C) has been occurred during winter season at the north region of Iraq. The ranges of seasonal air temperature value are (4 and 16^{o}C), (14 and 26^{o}C), (28 and 38^{o}C), (18 and 28^{o}C), and (14 and 28^{o}C) during winter, spring, summer, autumn and annual as shown in Figure (2)

ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

temperature and their region over Iraq during the Period 1949-2011.

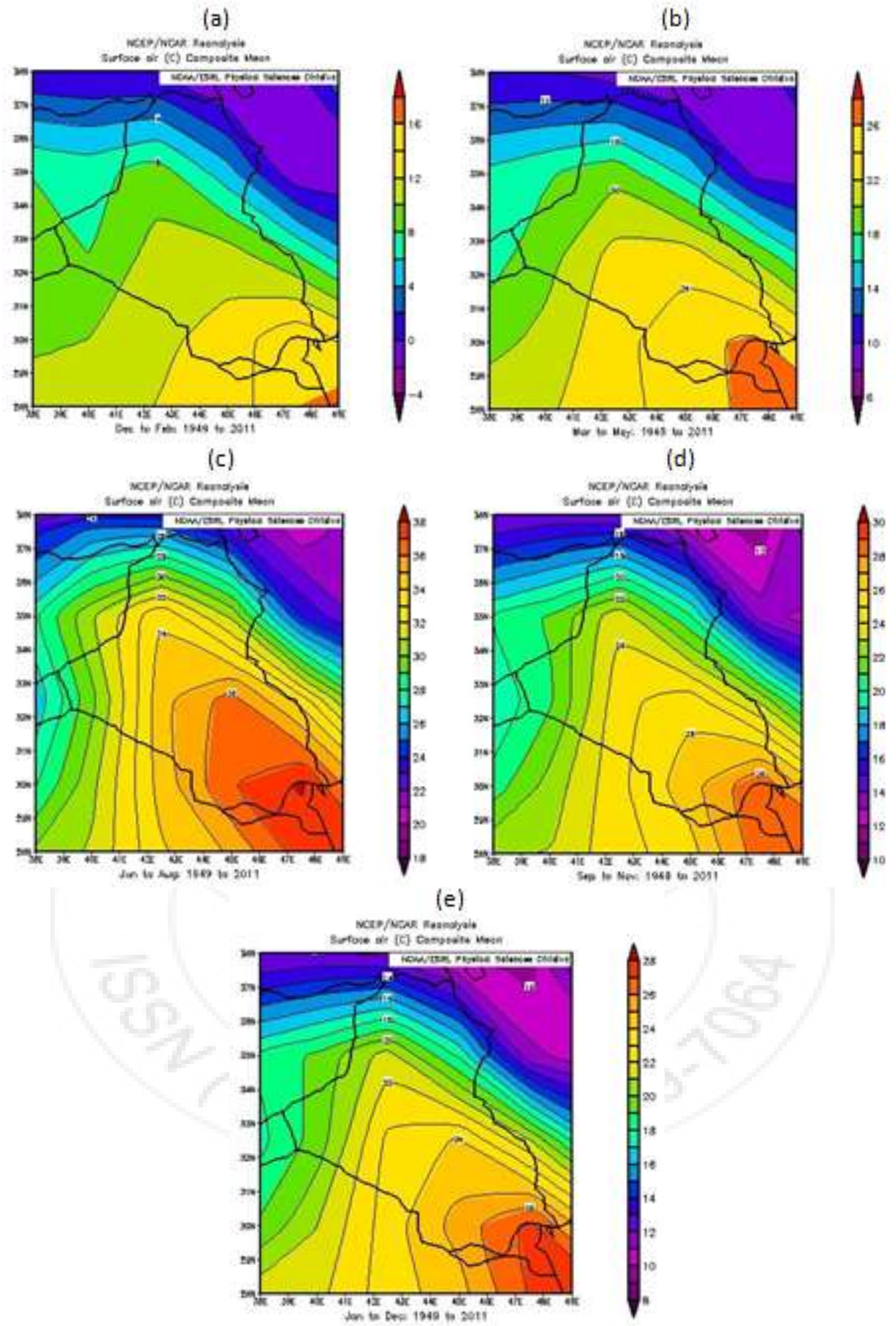


Figure 2: The temporal and spatial distribution of seasonal and annual mean surface air temperature over Iraq during the period 1949 - 2011 (a) Winter, (b) Spring, (c) Summer, (d) Autumn and (e) Annual

The temporal and spatial distributions of maximum and minimum relative humidity is very important for determine the more convenient regions for human morality Iraq. It was noticed that the relative humidity varied from season to season during the study period (1949 – 2007). The maximum seasonal mean relative humidity (85%) has been appeared during winter season at the north region of Iraq, whereas the minimum seasonal relative humidity (20%) has been occurred during summer season at the southern region of Iraq. The ranges of seasonal relative humidity value are (55 and 90%), (30 and 80%), (20 and 40%), (30 and %50), and (30 and 65%) during winter, spring, summer, autumn and annual respectively as shown in Figure (3).

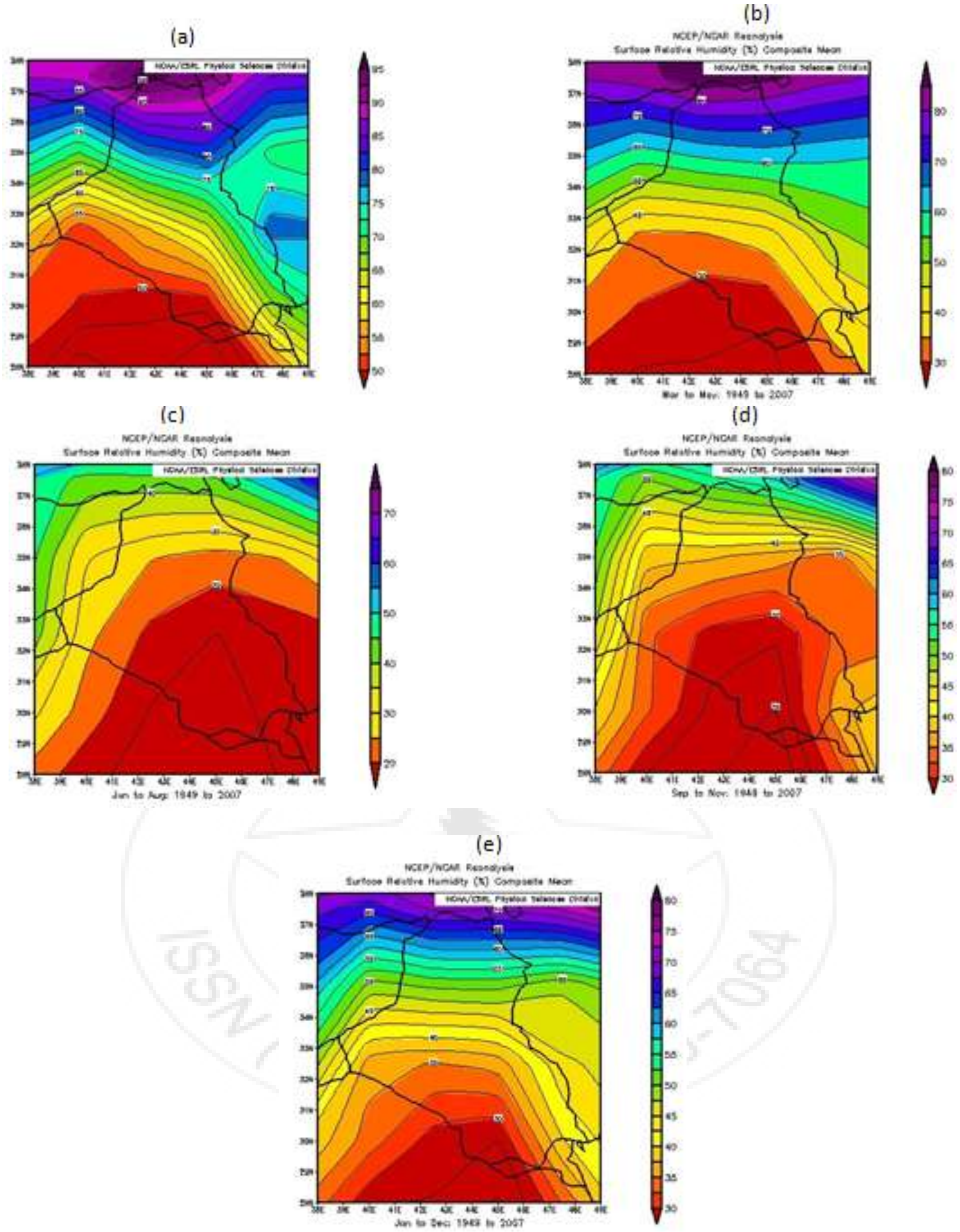


Figure 3: The temporal and spatial distribution of seasonal and annual mean relative humidity over Iraq during the period 1949 - 2007 (a) Winter, (b) Spring, (c) Summer, (d) Autumn and (e) Annual.

Effects of the NAO on seasonal and annual temperature which illustrated in Figure. 4 show the correlation of the seasonal and annual NAO with average temperature for the 1949–2011 periods. It demonstrates that the NAO exerted marked negative control over seasonally and annually temperature in the northern region, where the correlation was high (-0.7), (-0.4), (-0.6) for winter and summer and annually means in northern, western north, middle, south of Iraq respectively.

The Impact of the NAO on seasonal and annual relative humidity which illustrated in Figure (5) show the correlation of the seasonal and annual NAO with average temperature for the 1949–2007 periods. The results show that the NAO have not any control over seasonally and annually relative humidity in all regions in Iraq except the eastern border regions with Iran and the correlation was not exceeding than (0.3), for summer, western south west regions was (-0.4).

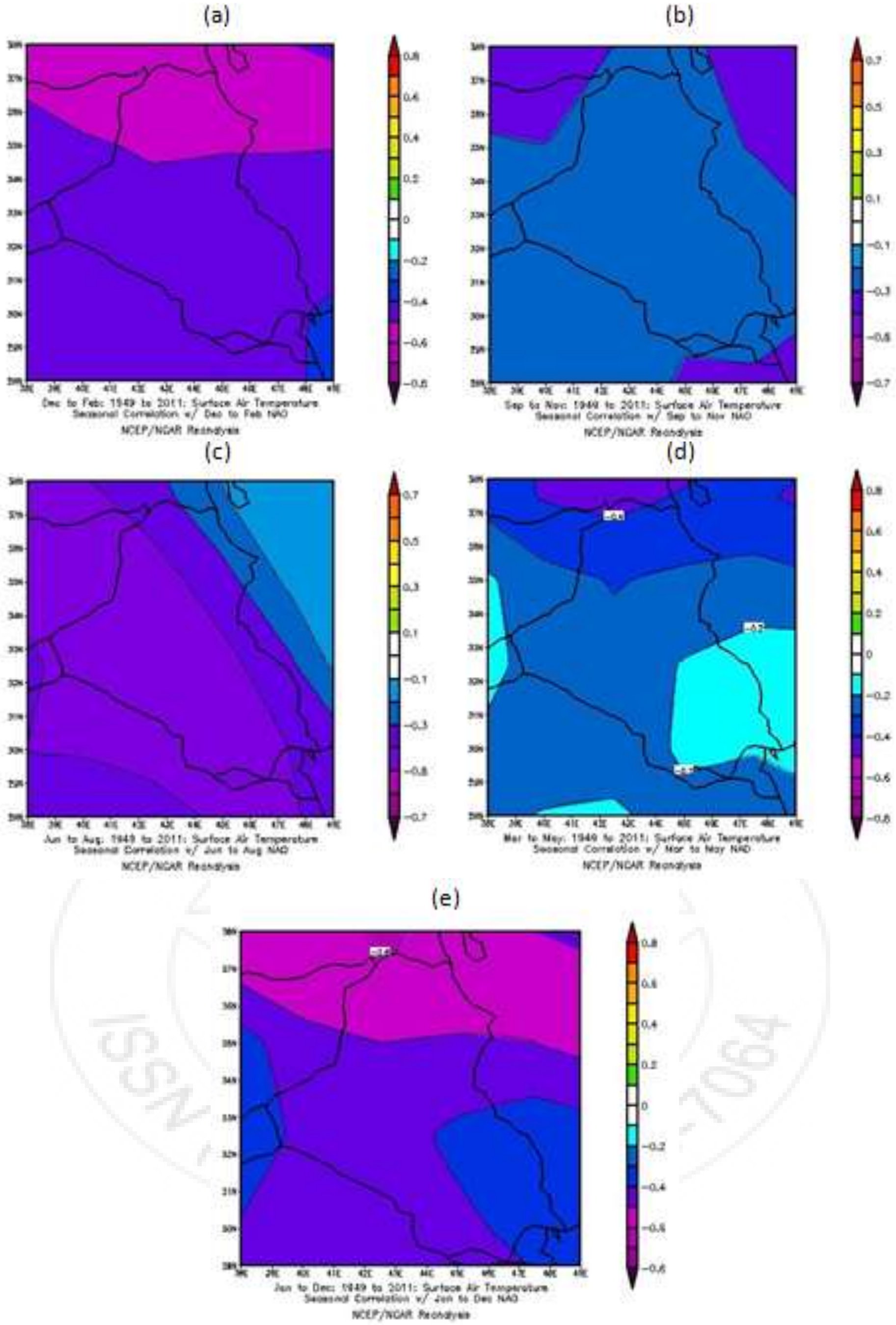
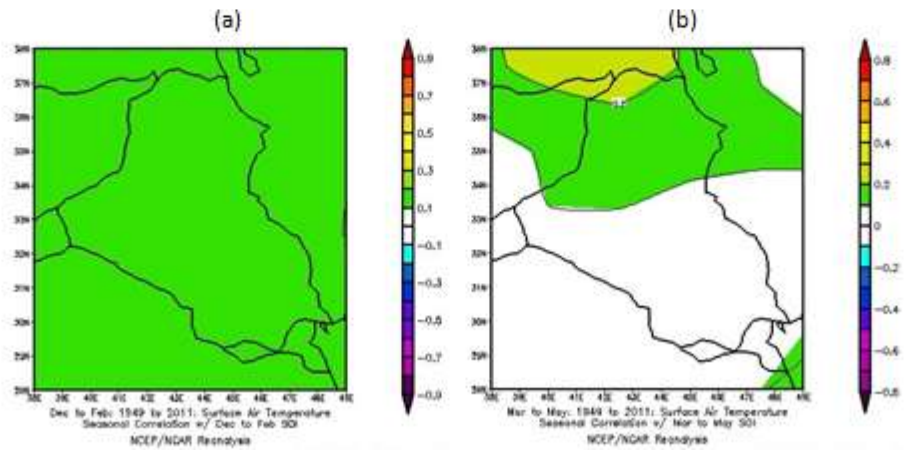


Figure 4: The temporal and spatial distribution of seasonal and annual correlation coefficient between the temperature over Iraq and NAO during the period 1949-2011 (a) Winter, (b) Spring (c) Summer, (d) Autumn and (e) Annual



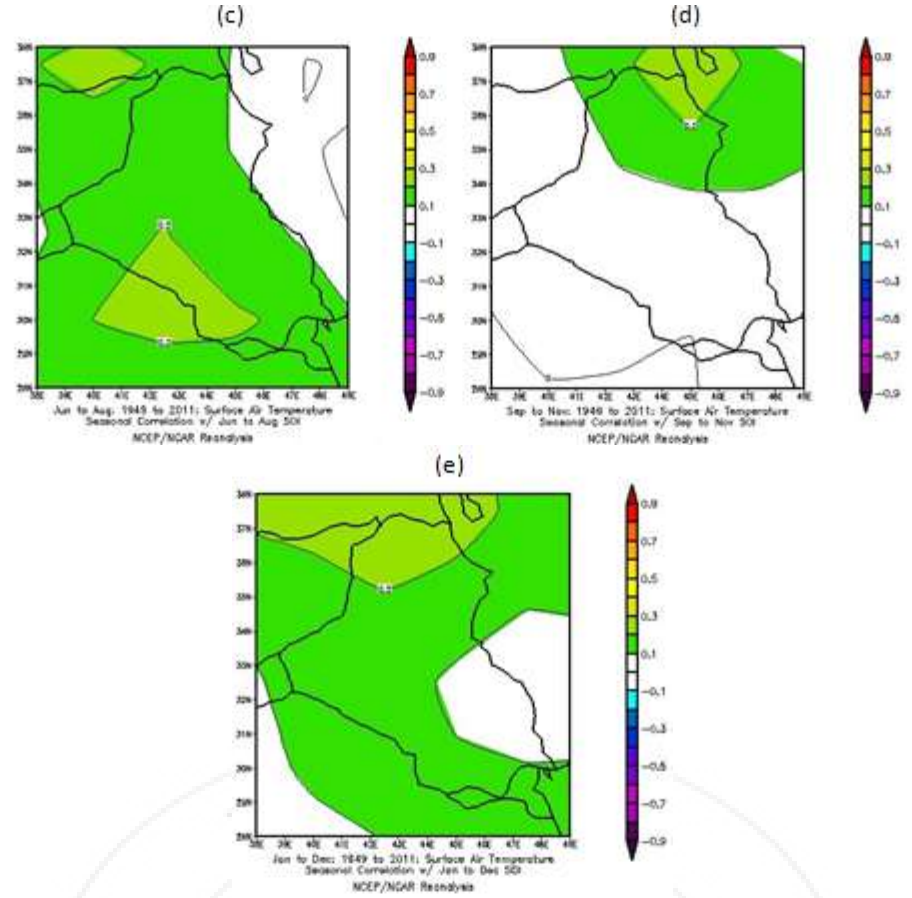
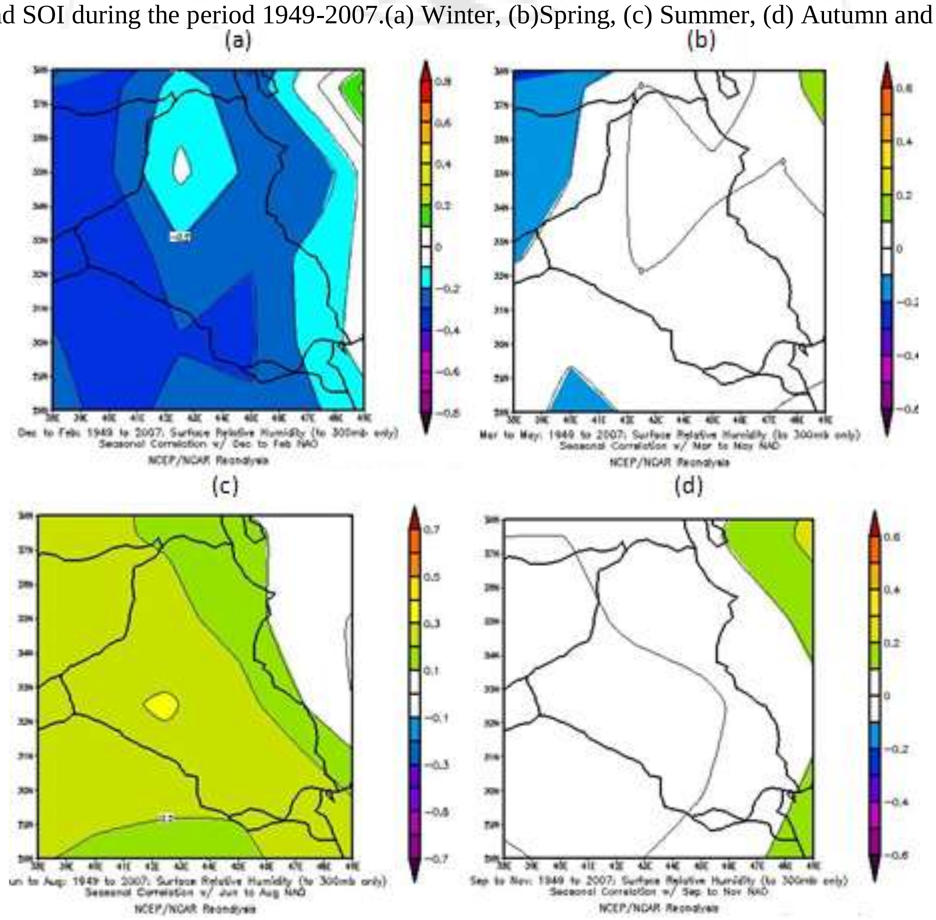


Figure 5: The temporal and spatial distribution of seasonal and annual correlation coefficient between the relative humidity over Iraq and SOI during the period 1949-2007.(a) Winter, (b)Spring, (c) Summer, (d) Autumn and (e) Annual



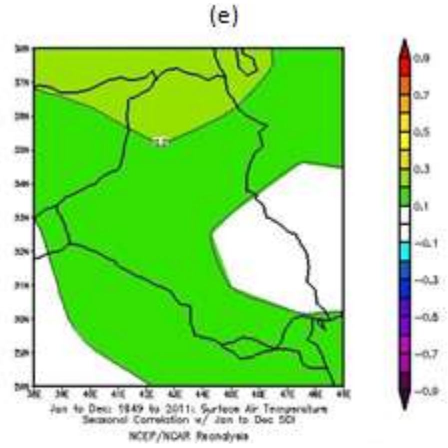


Figure 6: The temporal and spatial distribution of seasonal and annual correlation coefficient between the relative humidity over Iraq and NAO during the period 1949-2007.(a) Winter, (b)Spring, (c) Summer, (d) Autumn and (e) Annual

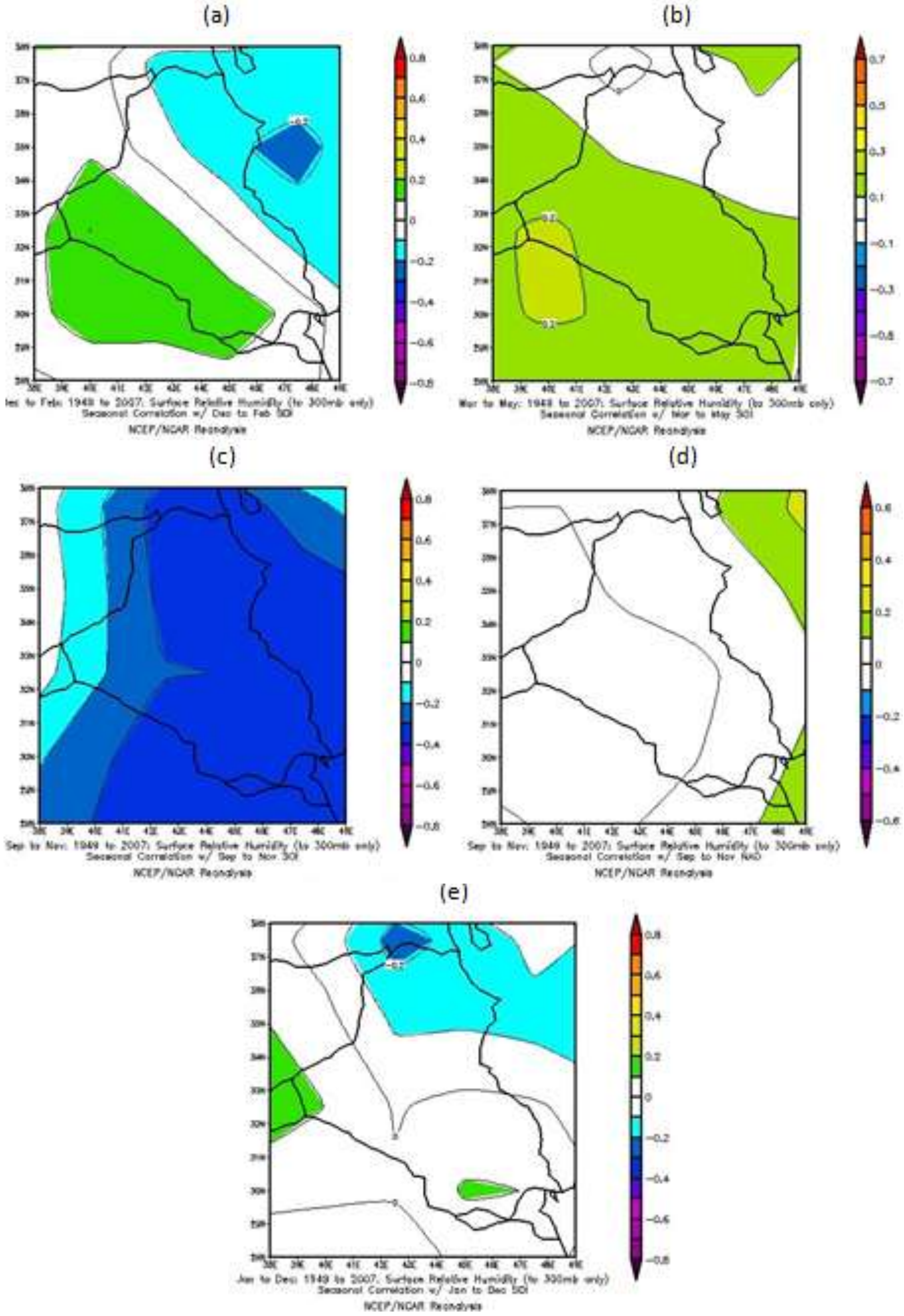


Figure 7: The temporal and spatial distribution of seasonal and annual correlation coefficient between the relative humidity over Iraq and SOI during the period 1949-2007.(a) Winter, (b)Spring, (c) Summer, (d) Autumn and (e) Annual.

4. Conclusion

Annual and monthly temperatures have significantly related to annual NAO. These relationships increased when using the monthly NAO and monthly temperature. Seasonal temperatures were associated significantly with annual NAO, and changed to higher significant level with seasonal NAO. The relationships were predominantly negative. Categories of NAO and their relationships also satisfied the objection of its categorizations. Negative NAO indices bring warmer conditions, whereas the positive NAO indices are associated with the opposite condition, these results were in apposite to that found over Europe-North Atlantic sector, confirming the well-known dipole teleconnections pattern between the Eastern Mediterranean and the North Atlantic Western Europe. This is climatologically sound, since positive NAO is associated with strong westerly circulation and moving depression over Europe and it is absent over the Mediterranean. The Mediterranean in this phase may be influenced by more meridional circulation. The NAO phases also shows clear and negative significant relationships with temperature.

The negative mode is associated with westerly wind and moving depression over the Mediterranean and brings mild and wet westerly maritime wind over the Eastern Mediterranean.

The results of this study lead to the conclusion that the North Atlantic atmospheric circulation (NAO) has strong impact and significant connection to the temperature variability over Iraq. Annual NAO results in predominantly negative relationships with monthly and seasonal temperature. These negative relationships were strengthened in the case of monthly and seasonal NAO and associated monthly and seasonal temperatures.

References

[1] **Bader, J. Latif, M. 2005**. North Atlantic Oscillation Response to Anomalous Ocean SST in a Coupled GCM. Journal of Climate, 18: 5382-5389.

[2] **Bednorz, E. 2002.** Snow Covers in Western Poland and Macro-Scale Circulation Conditions. International Journal of Climatology, 22: 533-541.

[3] **Bartzokas, A. Lolis, C.J. and Metaxas, D.A. 2003**. The 850hPa Relative Vorticity Centres of Action for Winter Precipitation in the Greek Area. International Journal of Climatology, 23: 813-828.

[4] **Box, J.E. 2002**. Survey of Greenland Instrumental Temperature Records: 1873-2001. International Journal of Climatology. 22:1829-1847.

[5] **Brunetti, M. Maugeri, M. Nanni, T. 2002**. Atmospheric Circulation and Precipitation in Italy for the Last 50 Years. International Journal of Climatology, 22: 1455-1471

[6] **Cohen, J. and Barlow, M. 2005**. The NAO, the AO and Global Warming: How Closely Related. Journal of Climate, 18: 4498-4513.

[7] **El-Kadi, A.K.A. 2007.** 20th Century Temperatures of Palestine: Variability, Trend and the Global Warming (1901-2000). Journal of the Social Sciences, Faculty of Arts, Bahrain University. (Submitted).

[8] **Eshel, G. Cane, M.A. Farrell, B.F. 2000.** Forecasting Eastern Mediterranean Droughts. Monthly Weather Review, 128: 3618-3630.

[9] **Feidas, H. Makrogiannis, T. Bora-Senta, E. 2004**. Trend Analysis of Air Temperature Time Series in Greece and their Relationship with Circulation Using Surface and Satellite Data: 1955-2001. Theoretical and Applied Climatology, 79: 185-208.

[10] **Fowler, H.J. and Kilsby, C.G. 2003**. A Regional Frequency Analysis of United Kingdom Extreme Rainfall from 1961 to 2000. International Journal of Climatology, 23:1313-1334

[11] **Fowler, H.J. and Kilsby, C.G. 2002**. Precipitation and the North Atlantic Oscillation: A Study of Climatic Variability in Northern England. International Journal of Climatology, 22:843-866.

[12] **Garcia, R. Munoz, T. Hernandez, E. Ribera, P. and Gimeno, L. 2003**. Temperature Predictability in the Great Mediterranean Area. Theoretical and Applied Climatology, 75:179-187.

[13] **Goodess, C.M. and Jones, P.D. 2002**. Links Between Circulation and Changes in the Characteristics of Iberian Rainfall. International Journal of Climatology, 22: 1593-1615.

[14] **Gouirand, I. and Moron, V. 2003**. Variability of the Impact of El NINO-Southern Oscillation on Sea-Level Pressure Anomalies over the North Atlantic in January to March (1874-1996). International Journal of Climatology, 23: 1549-1566.

[15] **Hanna, E. Jonsson, T. and Box, J.E. 2006**. Recent Changes in Icelandic Climate. Weather, 61: 3-8

[16] **Hasanean, H.M. 2004**. Wintertime Surface Temperature in Egypt in Relation to the Associated Atmospheric Circulation. International Journal of Climatology, 24: 985-999.

[17] **Honda, M. Yamane, S. and Nakamura, H. 2005**. Impacts of the Aleutian-Icelandic Low Seesaw on Surface Climate during the Twentieth Century. Journal of Climate. 18: 2793-2802.

[18] **Hurrell, J.W. 1995**. Decadal trends in the North Atlantic Oscillation: Regional Temperature and Precipitation. Science, 269:676-679.

[19] **Jones, P.D Jonsson, T. Wheeler D. 1997**. Extension to the North Atlantic Oscillation Using Early Instrumental Pressure Observations from Gibraltar and South-west Iceland. International Journal of Climatology, 17:1433-1450.

[20] **Junge M.M. and Stephenson, D.B. 2003**. Mediated and Direct Effects of the North Atlantic Ocean on Winter Temperatures in Northwest Europe. International Journal of Climatology, 23: 245-261

[21] **Keevallik, S. 2003**. Changes in Spring Weather Conditions and Atmospheric Circulation in Estonia (1955-95). International Journal of Climatology, 23: 263-270.

[22] **Kettlewell, P.S. Stephenson, D.B. Atkinson, M.D. and Hollins, P.D. 2003.** Summer Rainfall and Wheat Grain Quality: Relationships with the North Atlantic Oscillation. Weather, 58: 155-164

[23] **Knippertz, P Ulbrich, U Mrques F. and Corte-Real J. 2003**. Decadal Changes in the Link Between El-NINO and Springtime North Atlantic Oscillatioon and

European-North African Rainfall. International Journal of Climatology, 23: 1239-1311

[24] **Kozuchowski, K. M. 1993**. Variation of the Hemispheric Zonal Index Since 1899 and its Relationship with Air Temperature. International Journal of Climatology, 13:853-861.

[25] **Krichak, S.O. and Alpert, P. 2005**. Signature of the NAO in the Atmospheric Circulation During Wet Winter Months Over the Mediterranean Region. Theoretical and Applied Climatology, 82:27-39.

[26] **Kysely, J. 2002.** Temporal Fluctuations in Heat Waves at Prague-Klementinum, the Czech Republic, from 1901-97, and their Relationship to atmospheric Circulation. International Journal of Climatology, 22: 33-50.

[27] **Laternser, M. and Schneebli, M. 2003**. Long-term Snow Climate Trends of the Swiss Alps (1931-1999). International Journal of Climatology, 23: 733-750.

[28] **Lolis, C.J. Bartzokas, A. and Katsoulis, B.D. 2002**. Spatial and Temporal 850hPa Air Temperature and Sea-Surface Temperature Covariance's in the Mediterranean Region and Their Connection to Atmospheric Circulation. International Journal of Climatology, 22: 663-676.

[29] **Lucero, O.A and Rodriguez, N.C. 2002**. Spatial Organization in Europe of Decadal and Interdecadal Fluctuation in Annual Rainfall. International Journal of Climatology, 22: 805-820

[30] **Luterbacher, J. and Xoplaki, E. 2003**. 500-Year Winter Temperature and Precipitation Variability Over Mediterranean Area and its Connection to the Large-scale Atmospheric Circulation. Mediterranean Climate: 133-153, Eds.Bolle, H-J. Springer-Verlag.

[31] **New, M. Hulme, M. and Jones, P. 2000**. Representing Twentieth-Century Space-Time Climate Variability. Part II: Development of 1901-96 Monthly Grids of Terrestrial Surface Climate. Journal of Climate, 13: 2217-2238.

[32] **Mitchell, T.D. Hulme, M. and New, M. 2002**. Climate Data for Political area. Area, 34: 109-112.

[33] **Mitchell, T.D. Carter, T.R. Jones, P.D. Hulme, M. and New, M. 2004**. A Comprehensive Set of High-Resolution Grids of Monthly Climate for Europe and the Globe: The Observed Record (1901-2000) and 16 Scenarios (2001-2100). Tyndall Centre Working Paper No 55.

[34] **Mitchell, T.D and Jones, P.D. 2005**. Improved Method of Constructing a Database of Monthly Climate Observations and Associated High- Resolution Grids. International Journal of Climatology, 25: 693-712.

[35] **Mote, T.L. 1998**. Mid-Tropospheric Circulation and Surface Melt on the Greenland Ice Sheet. Part I: Atmospheric Teleconnections. International Journal of Climatology, 18: 111-129.

[36] **Panagiotopoulos, F. Shahgedanova, M. Hannachi, A. Stephenson, D. 2005.** Observed Trends and Teleconnections of the Siberian High: A Recent Declining Center of Action. Journal of Climate, 18: 1411-1422.

[37] **Perry, A. 2000**. The North Atlantic Oscillation: an Enigmatic See-Saw. Progress in Physical Geography. 24: 289-294.

[38] **Pirazzoli, P. A. and Tomasin, A. 2003**. Recent Near-Surface Wind Changes in the Central Mediterranean and Adriatic Areas. International Journal of Climatology, 23: 963-973.

[39] **Pryor, S.C. Barthelmie, R.J. 2003**. Long-Term Trends in Near-Surface Flow Over the Baltic. International Journal of Climatology, 23: 271-289.

[40] **Scheifinger, H. Menzel, A. Koch, E. Peter, C. and Ahas, R. 2002**. Atmospheric Mechanisms Govering the Spatial and Temporal Variability of Phenological Phases in Central Europe. International Journal of Climatology, 22: 1739-1755.

[41] **Sheridan, S. C. 2003**. North America Weather-type Frequency and Teleconnection Indices. International Journal of Climatology, 23: 27-45

[42] **Stephenson, D.B. Pavan, V. Bojariu, R. 2002**. Is the North Atlantic Oscillation a Random Walk. International Journal of Climatology, 20: 1-18.

[43] **Spraks, T.H. and Menzel, A. 2002**. Observed Changes in Seasons: An Overview. International Journal of Climatology, 22: 1715-1725.

[44] **Terray, L. Demory. M-E. Deque, M. Coetlogon, G. Maisonnave, E. 2004.** Simulation of Late-Twenty-First-Century Changes in Wintertime Atmospheric Circulation Over Europe Due to Anthropogenic Causes. Journal of Climate, 17: 4630-4635.

[45] **Tomozeiu, R. Busuioc, A. Stefan, S. 2002**. Changes in Seasonal Mean Maximum Air Temperature in Romania and their Connection with Large-Scale Circulation. International Journal of Climatology, 22: 12181-1196.

[46] **Turkes, M. and Erlat, E. 2003**. Precipitation Changes and Variability in Turkey Linked to the North Atlantic Oscillation During the Period 1930-2000. International Journal of Climatology, 23: 1771-1796

[47] **Turkes, M and Erlat E. 2005.** Climatological Responses of Winter Precipitaion in Turkey to Variability of the North Atlantic Oscillation During the Period 1930-2001. Theoretical and Applied Climatology, 81: 45-69.

[48] **Uvo, C. 2003**. Analysis and Regionalization of Northern European Winter Precipitation Based on its Relationship with the North Atlantic Oscillation. International Journal of Climatology, 23: 1185-1194

[49] **Wedgbrow, C.S. Wilby, R.L. Fox, H.R. and O'Hare, G.O. 2002**. Prospects for Seasonal Forecasting Summer Drought and Low River Flow Anomalies in England and Wales. International Journal of Climatology, 22: 219-236.

[50] **Wilby, R.L. O'Hare, G.P. Barnsley, N. 1997**. The North Atlantic Oscillation and British Isles Climate Variability. Weather, 52: 266-276.

[51] **Wang, W. Anderson, B.T. Kaufman, R.K. and Myneni, R.B. 2004**. The Relation Between the North Atlantic Oscillation and SSTs in the North Atlantic Basin. Journal of Climate, 17: 4752-4759.

[52] **Wood, N.L.H. 2004**. Regional Climate Trends in South-West England and the North Atlantic Oscillation. Weather, 59: 38-41.