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The Effect of the Atlantic Multiple Oscillation (AMO) on the Temperature Gradient on Libya

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ABSTRACT

As a result of climate change causing a rise in global temperature, the oceans have had a share of this rise, which has consequences for decades. The study discussed the effect of the Atlantic Multiple Oscillation (AMO), which plays a major role in climate change and its impact on temperatures represented in its cold and warm phases, as in the cold phase indicating cooling of temperatures, especially in the year 1974, it was characterized by cooling, and in the warming phase it affects temperatures with a clear increase In the warm year of 2010, Weather data was used for ten stations over Libya, represented by temperatures and cold and warm AMO periods. The period of it cooling was characterized by anomalous temperatures reaching between -0.2 to -1.79 degrees Celsius, where it is more evident in the summer, and it warming period. It is show in the winter and reaches between 0.3 to 2.7 degrees Celsius, indicating a warm winter. Explaining the degree of correlation between AMO and the temperature of these stations was positive and in the summer during the cooling period 1971-1977, and less in the winter during the heating period 2010-2017.

INTRODUCTION

Climate change, especially global warming is one of the major challenges of our time. The average global air temperature of the last decades is already about 0.8°C above the 20th century average of 13.9°C (Core Writing *et al.*, 2014; NOAA, 2017).

Over the past 20 years, public attitudes about the evidence for human-caused climate change and action to address climate change have varied (Nisbet & Myer, 2007), and Trends in annual mean temperature anomalies for the globe show relatively stable temperatures from the beginning of the record through about 1910, with relatively rapid and steady warming through the early 1940s, followed by another period of relatively stable temperatures through the mid-1970s. From this point onward, another rapid rise similar to that in the earlier part of the century is observed. The year 2015 was by far the warmest year in the global record (0.75°C above the 1961-1990 reference period mean).

.The oceans are generally regarded as the "flywheel" of the climate system, providing a vast source of thermal inertia to the overlying atmosphere. The large thermal inertia of the oceans derives from their heat storage capacity: 2.5 m of water contains as much energy as an entire atmospheric column (Deser *et al.*, 2003), and where Sea surface temperatures (SSTs) play a crucial role in the global climate system. It is through exchanges of radiative and turbulent heat fluxes, which are dependent on SST, that the ocean communicates its large thermal inertia to the atmosphere. Low-frequency variability in SST may provide a source of predictability for climate variability on interannual and longer time scales. As such, understanding the mechanisms that govern SST variability is central to an understanding of climate variability (Wang *et al.*, 2012).

The AMO can be used to describe the complex interaction of the coupled atmosphere-ocean system of the North Atlantic, but aprobably a connection between meteorological elements and this is realized indirectly – through atmospheric circulation (Miroslav M *et al.*, 2015), and in many regions of the world changes were registered in the intensity and frequency of extreme weather events, such as high and low temperatures, drought, floods, storms, heat waves, strong short-term rains, fires, etc., causing great casualties and material damage (Doderovic & Buric, 2015).

Effect AMO on air temperatures and rainfall over much of the Northern Hemisphere, especially in North America and Europe. It is associated with changes in the frequency of North American droughts and is associated in the frequency of severe Atlantic hurricanes. It also obscures and exaggerates the global increase in temperatures due to human induced global warming. Recent research suggests that the AMO is related to the past occurrence of major droughts in the Midwest and the Southwest. When the AMO is in its warm phase, these droughts tend to be more frequent, severe, and prolonged. Two of the most severe droughts of the 20th century occurred during the positive AMO between 1925 and 1965: The Dustbowl of the 1930s and the 1950s drought. Sea surface temperatures have shown warm phases roughly during: 1860-1880 and 1930-1960 and cool phases during 1905-1925 and 1970-1990 (NOAA, 2016).

METHODOLOGY

The monthly mean temperature data of 10 stations in the region of latitude 20- 33 N^0 and longitude from 10-25 E^0 shown Figure (1), during two periods 1971-1977, 2010-2017 on Libya , were acquired from center National Centers for Environmental Prediction (NCEP) (Kalnay

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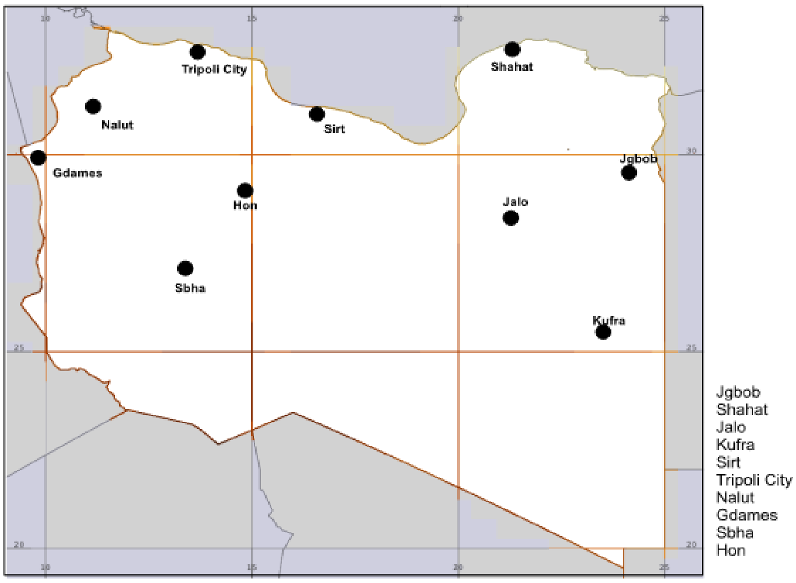

Figure 1: Distribution of the studied 10 stations on Libya.

et al.,1996) and Reanalysis data the large-scale features of correlation seasonal Atlantic Multiple Oscillation (AMO) for sea surface temperature at the National Oceanic and Atmospheric Administration (NOAA) during period 1971-2017 (NOAA, 2016).

RESULTS

The Effect of the Amo Index on Temperature Change in Summer and Winter Over the Libya

The AMO is an ongoing series of long-duration changes in the sea surface temperature of the North Atlantic Ocean, with cool and warm phases that may last for 20-40 years at a time and a difference of about 1°F between extremes. These changes are natural and have been occurring for at least the last 1,000 years

It can be seen in Figure (2) AMO that there are cold periods from 1971 to 1996 and gradually increased for hot periods from 1997 to 2017, and slight heating is observed in 1987 and 1995. Heating is extended until 2022 at lower rates than the previous years, and it is believed that AMO

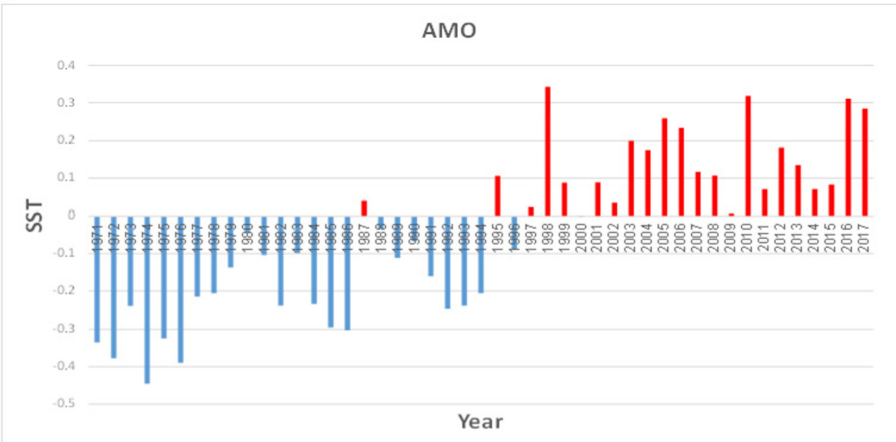

Figure 2: Atlantic Multiple Oscillation (AMO) of anomalous ocean temperature, SST (C^0) for cold and hot periods during the years 1971-2017.

enters the cold phase and thus affects the climate General (NOAA, 2016).

When analyzing the temperatures from the period 1971-1977, it shows the cooling on the temperatures over Libya, as the winter season figure (3, a), is naturally cold and therefore the anomaly temperatures are lower than the anomaly temperatures in the summer figure (2, a) differs Cooling has a clear effect in the summer on Libya, where anomaly temperatures reach in the summer about -1.16 C^0 in the southeast of Libya and in the northwest about -0.40 C^0, unlike the winter, they reach in the southeast about 0.38 and in the northwest about 0.19 C^0 shown figure (3, a).

Through an analysis, it was found that the year 1974 was the temperature in the summer season the coldest shown figure (3, b), where the anomalous temperatures reach -1.79 C^0 in the southeast and northwest -1.37 C^0 compared to the winter season, where the anomalous degrees are less prominent than the summer and reach in the south East is about 0.13 C^0 while in the northwest -0.23 C^0 in figure (4, b).

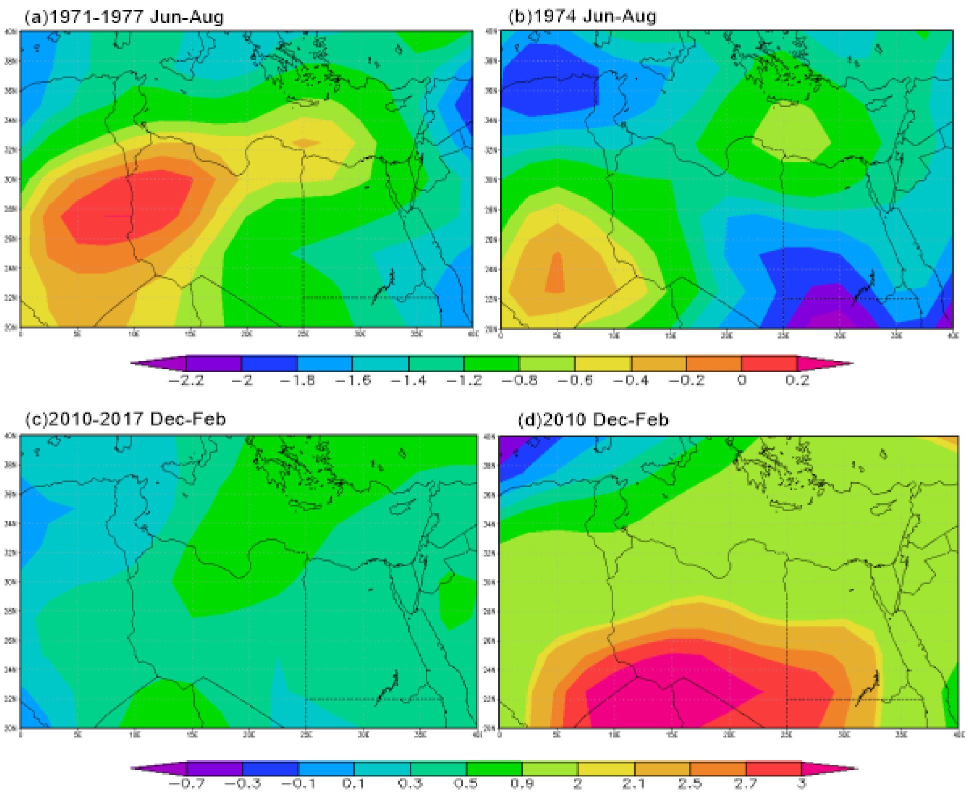

Figure 3: Anomalies of temperatures (C⁰) over Libya, (a) - the cold period of summer 1971-1977, (b) - The coldest year of summer 1974, (c) - The hot period of winter 2010-2017, (d) the hottest year of winter is 2010.

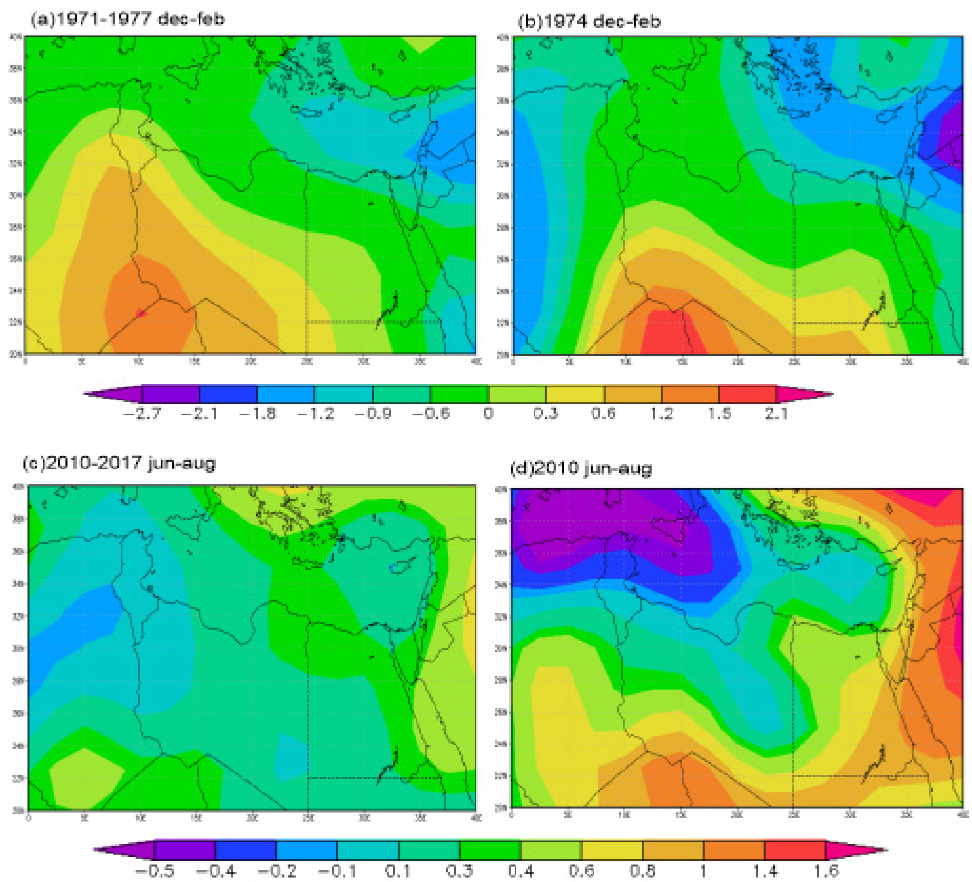

Figure 4: Anomalies of temperatures (C⁰) over Libya, (a) - the cold period of winter 1971-1977, (b) - The coldest year of winter 1974, (c) - The hot period of summer 2010-2017, (d) the hottest year is summer 2010.

Through heating period 2010-2017, where the heating affected Libya is shown in Figure (3, c), and it shown in the winter more than in the summer. The value of anomalous temperatures in winter reaches 0.67 C^0 on the north-east on the western ,and mountainous region, it is about 0.23 C^0 Figure (3, c), while in the summer, the anomalous temperatures reach about 0.33 C^0 on the northeast and -0.06 C^0 on the western mountainous region Figure(4, c). Because of studies of the Goddard Space Institute at NASA, the year 2010 was the hottest year ever, with an increase of 0.74 C^0 compared to the period from 1951 to 1980, and the data on which the studies were based were collected from more than a thousand meteorological stations in all regions of the world. Over the world and satellite observations (Hansen *et al.*, 2010) , and when analyzing the heating period, it was found that the year 2010 was hotter due to the temperature anomalies in the winter season on Libya Figure (3, d) for the year 2010 than in the summer season Figure (4, d), and the southern region was In the east, the highest value is about 0.52 C^0, while in the southwest it reaches 0.38 C^0 and in the northwest it is about -0.05 C^0. When observing the temperature anomalies in the winter of 2010, it was higher than in the summer, reaching in the southeast about 1.49, while the southwest is about 2.29 C^0 North Eastern 1.46 C0shown Figure (3, c).

DISCUSSION

Through the illustrated figure of the probability density function for AMO showing the hot and cold periods, it is noted that the period 1971-1977 in the cold period as in figure (2) shows its effect in summer and winter as in figure (5.a) where the standard deviation is 0.137 and the average is -0.31 in Summer is higher than 0.055 standard deviation and the average is -0.34 in winter, and this indicates that oscillation and dispersal increases AMO cooling in summer is more prevalent than winter, even though winter is colder.

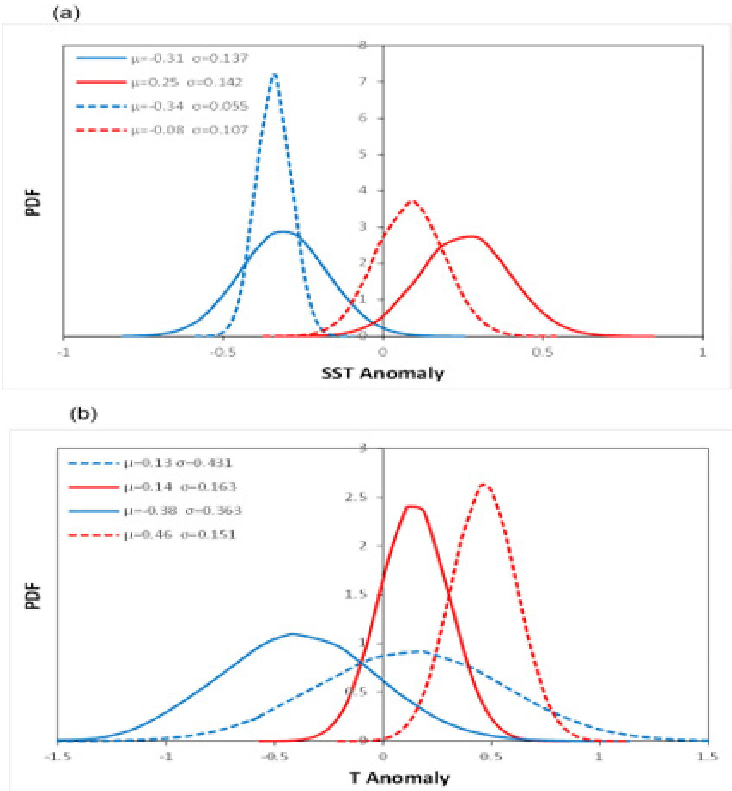

Figure 5: (a, b)- the normal probability distribution function for each of the Multi-Atlantic Oscillation (AMO) and anomaly temperature (C^0) for ten stations over Libya respectively, for the cold period 1971-1977 in blue in winter, dotted line, summer line, and hot period 2010-2017 in red in winter a dotted line and a linear summer.

While during the hot period of AMO for the period 2010-2017, as shown in figure (2), it is noted that the probability density function during the summer reaches the average about 0.25 and the standard deviation is 0.142, and in the winter the mean reaches 0.08 and the standard deviation is 0.107. It shows for AMO that the scattering and fluctuation are high in the summer, it is higher than winter, but the winter curve will be higher than the summer curve figure (5, a).

It shows its effect on the temperature anomalies over Libya for 10 stations, as in figure (5, b) shows the probability density of anomalous temperatures for these stations, during the cold period of AMO 1971-1977 is The temperatures over Libya are cold and the coldness in the probability density curve in the summer is colder than the winter, where the average temperature reaches -0.38 and the standard deviation is 0.363 in the summer, while in the winter the average reaches about 0.13 and the standard deviation is 0.431 and increases in fluctuation and scattering in the winter more than Summer, but the effect of AMO is shown on the anomalous temperatures in the summer, and during the hot period of AMO for the years 2010-2017, the winter turned out to be hotter than the summer, where the average is about 0.46 and the standard deviation is 0.151 and reaches During summer the average is 0.14 and the standard deviation is about 0.163, so it shows fluctuation and dispersal in summer, but the effect of AMO is clear in winter on the anomalous l temperatures, and this was shown in figure (6) for the colder years for AMO in 1974, where the anomaly temperatures were shown in the summer is colder on stations over Libya, as well as the hottest year, which is 2010 for AMO, its effect is show in winter on anomalous temperatures see figure(6).

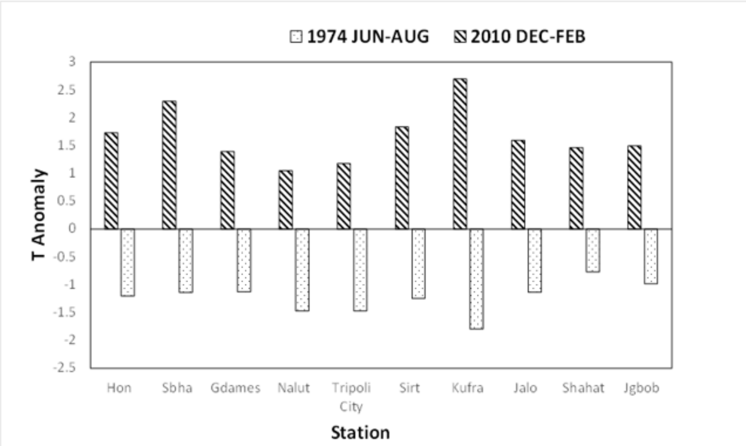

Figure 6: Anomaly of temperature (C^0) for ten stations on Libya during the cold period of summer 1974 and the hot period of winter 2010.

Looking at the correlation between AMO and the anomalous temperatures of the cold and hot period, it is noted that there is a positive correlation in the two periods, but in the cooling period 1971-1977 the correlation is stronger and reaches 0.70 above Tripoli station and the lowest correlation in the cooling period on the Sbha station is about 0.44, while the correlation becomes positive and weak in the period heating The highest value of the correlation is about 0.38, while the effect of AMO in its heating period, its positive correlation is stronger in summer, as in figure(7).

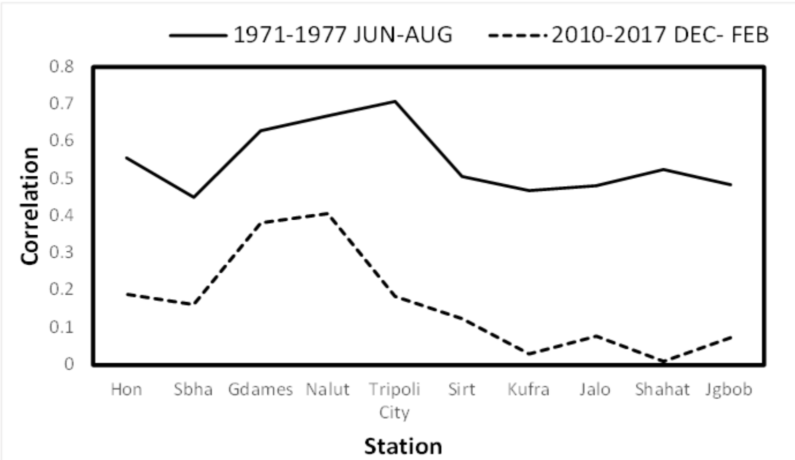

Figure 7: The correlation between the North Atlantic Multiple Oscillation (AMO) and the anomaly temperature for ten stations over Libya (C^0) for the cold period 1971-1977 in summer, and the hot period 2010-2017 in winter.

CONCLUSION

By analyzing the results, it was found that there is an effect of the North Atlantic Multiple Oscillation (AMO) on the temperature gradient over Libya in its cold and hot phases. During its cooling period 1971-1977, the temperatures over Libya were marked by a clear cooling in the year 1974, when the anomaly temperatures reached -1.26 C0in the guest season in the southeast of the country, while the heating period during the period 2010-2017, which was marked by the year 2010 with a rise in temperatures over The world as a whole, where the anomaly temperatures over Libya reached about 2.29 C0 in the southwest.

We have concluded that there is a positive relationship between AMO and temperatures over Libya, shown in the summer of 1971-1977 and the winter of 2010-2017.

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