MIDDLE EAST METEOROLOGY

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Summary

The Middle East is a region that spans southwestern Asia, western Asia, and northeastern Africa. Although much of the Middle East region has a Mediterranean climate type, i.e. Csa in the widely used Koeppen classification with wet winters and
dry summers. Middle Eastern climatic conditions vary greatly, depending on the season and the geography. Although the hot arid, or desert, climate predominates in the region, the well-watered highlands of Turkey and the mountains of Iran and Ethiopia are important as sources of the region's major rivers.

The Middle East is as one of the regions most affected by dust, in the world, next to Africa. Dust or sand storms are caused by the outflow from low-pressure cells passing through a desert area from west to east. Sand storms can occur throughout the year in the Middle East, but the prime months are May-September.

The results of many researchers showed a linear warming across the Middle East. The maximum warming is occurring in the spring, and the minimum warming is occurring in the winter. Local and regional warming signal may be associated with human-induced desertification and overgrazing. The results of model in the 21st century show widespread warming, with a maximum in interior Iran during summer. It also found some cooling in the southeast Black Sea region during spring and summer that is related to increases in snowfall in the region. The results also show widespread decreases in precipitation over the eastern Mediterranean and Turkey, and increases were found over the southeast Black Sea, southwest Caspian Sea, and Zagros mountain regions during all seasons except summer. While the Saudi desert region receives increases during summer and autumn.

The variability of atmospheric circulation is the most important factor determining changes in spatial distribution of temperature, cloudiness, precipitation and other climatic elements. The North Atlantic Oscillation (NAO) atmospheric circulation pattern appears to exhibit a clear influence on the climate of the region on inter-annual and decadal timescales. Drier-than-average conditions prevail over parts of the Middle East during high NAO index winters. There is recent evidence that the El Niño/Southern Oscillation (ENSO) has influence on the climate of the Middle East in recent decades. El Niño conditions weaken the Indian monsoon and warm the Arabian Sea thus weakening the pressure gradient and reducing the wind speed. La Niña conditions make the pressure gradient stronger thus bringing more rainfall in the region. Anomalous temperature variations over the Middle East (cooling) associated with the stronger clockwise flow around the subtropical Atlantic high-pressure center. The oscillation and strength of Asiatic monsoon low pressure and subtropical high pressure play an important role in rainfall over the River Nile. The annual migration of the ITCZ and seasonal development of the monsoon winds are key-components of the climatology in the Indian Ocean and the surrounding areas.

Tropical Easterly jet stream was weakened in El Nino year and enhanced in La Nina year accompanying with the dry and wet condition respectively. Subtropical jet stream has affect on temperature and rainfall over Arabian Peninsula, where the core of the subtropical jet is stronger during the winter than the other seasons and located near 27.5°N, while it’s weaker during the summer and shifted north ward to appear at 43°N. The interaction between the polar front jet stream (PFJ) and subtropical jet stream (SJS) and its role in the surface cyclogenesis has been affected not only over the North African region but also over other subtropical regions.
1. Introduction

1.1 Middle East Definition

Figure 1 The topo map of the Middle East shows the topography of the Middle Eastern countries. Map features include country names and borders plus rivers, lakes, and land features.

The Middle East borders are not well established. The boundaries of this region change with changing topics. A different approach in defining the area is used in politics,
geography, history, environment, economics, and so on. The term "Middle East" was popularized around 1900 in the United Kingdom (http://en.wikipedia.org/wiki/Middle_East#cite_note-1). The Middle East (or, formerly more common, the Near East (http://en.wikipedia.org/wiki/Middle_East#cite_note-0) is a region that spans southwestern Asia, western Asia, and northeastern Africa. The term refers collectively to the Asian countries of Bahrain, Cyprus, Iran, Iraq, Palestine, Israel, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates, and Yemen, and the African country of Egypt. Much of the Middle East is arid, and the region's topography features extensive desert areas, rugged mountains, and dry plateaus. Water is in short supply, and agriculture often depends on expensive irrigation systems. The Middle East map (Figure 1) identifies the primary countries of the Middle East and shows their national boundaries.

1.2 Overview of the Middle East Climate

In the Middle East, investigations of long-term variations and trends in temperature data are not suffer serious environmental, agricultural and water resources problems, receiving enough attention even though, these countries. The Middle East is interesting for several reasons. The landscape has been massively altered by developing human activity over the last 8000 years, including forest removal, rangeland degradation by grazing and trampling, and watercourse damming and diversion. Due to rapid population growth, political conflict and water scarcity are common throughout the area, rendering it sensitive to changes in climate. A significant impact on the history of the region may be due to climate change. Although much of the Middle East region has a Mediterranean climate type, i.e. Csa in the widely used Koeppen classification (Oliver and Hidore, 1984) with wet winters and dry summers, the spatial gradients in climate are far sharper than in the broad prototype Csa region to the west. For example, along the 40°N meridian, the northward transition from desert (BWh) through steppe (BSh) to cool highland climate (H) occurs within 400 km. Elsewhere in the region, numerous coastlines and mountain ranges modify the local climates (Oliver and Hidore, 1984).

Middle Eastern climatic conditions vary greatly, depending on the season and the geography. The basic climate of the Middle East can be characterized in two words: hot and dry, although winters are mild with some rain. The exception is the mountains, where desert turns to steppe in northern Iraq, northern Iran and eastern Turkey. Winters here can be severe. The Arabian Peninsula has among the hottest and driest conditions found anywhere in the world. The hot desert conditions induce a strong seasonal wind pattern in the region, known as the monsoon. Although we often associate "monsoon" with flooding rains, it comes from an Arabic word meaning "season". During the summer, winds blow unabated toward the hot interior of the Arabian Peninsula, whereas in winter, the winds are in the south and blow off the land. In northern regions, continental winds usher in cold Siberian air which wrings some rain and snow out of the sky along the coasts. Across the Middle East, summer temperatures are usually around 29°C (84.2°F), but often soar above 38°C (100.4°F). In Baghdad, the record high is 49°C (120.2°F); in Basra, 51°C (123.8°F), the highest temperatures recorded in any major Middle Eastern city. In the Saudi desert, however, temperatures over 49°C (120.2°F) are common. Most storms crossing the Middle East become dust- or sandstorms when strong winds whip the dry desert surface; as many as 38 occur
annually.

Precipitation on the semiarid margins of Middle Eastern deserts ranges from 14 inches (350 mm) to 30 inches (750 mm) annually. Rainfall variability within the area of desert climate exceeds 40 percent, reducing to 20 percent on the moist margins of the semiarid zone, which forms a transition between the true desert to the south and the more humid areas farther north. The Black Sea coast of Turkey receives from 78 inches (2,000 mm) to 101 inches (2,600 mm) per year, although the transition from the windward, watered side of the Pontic range to the leeward, dry side can be very abrupt due to the topography. The Mediterranean climate, which is limited to a narrow coastal strip reaching from Gaza to Istanbul is marked by mild winters with ample rain and long, hot summers when Sahara-like conditions prevail. During the summer solstice, the sun is directly overhead at 23° 30' at north latitude (e.g., at Aswan, Egypt). Annual periods of high sun in combination with clear skies through much of the year allow intense solar radiation with subsequent extreme evapotranspiration demands.

Precipitation results from different processes. Orographic precipitation in the Taurus and Zagros Mountains supplies the flow of the Euphrates and Tigris Rivers, which in turn supply the Mesopotamia region with needed water. The mountainous southern coasts of the Black and Caspian Seas, and eastern coast of the Mediterranean Sea, are experience upslope seasonal precipitation. Although, the Red Sea and Persian Gulf acting as powerful sources of water vapor trigger little precipitation locally due to descending air in the Hadley cell. Because latitudinal position of the interior steppe and deserts of Syria, Iraq, Jordan and Saudi Arabia, are made still drier by the surrounding mountain ranges (Evans et al 2004). Convective precipitation occurs on the Anatolian plateau and the steppes of northern Syria which experience receive small quantities of rain in summer season. Equatorial convectional rains provide the waters of the White Nile. Northward migration of inter-tropical convergence zone (ITCZ) in summer season is affected southern region of the Arabian Peninsula. Frontal precipitation particularly in the wintertime occurs mainly in the Northern region of the Middle East and sometimes extending to the south region depending on the deepening of frontal depression. Frontal systems passage from west to east across the region bringing alternating high and low pressure cells. Frontal systems are propelled eastward by the subtropical jet stream.

Surface winds in the Middle East have distinctive qualities and have received local names famous throughout the region. The cold northern wind blowing from the Anatolian plateau to the southern Turkish shore in the winter is the Poyraz (derived from the Greek: bora, i.e., north); the warm on-shore wind in the same location is known as the meltem. Searing desert winds are infamous: The Egyptian Khamasine, which blows in from the desert, is matched by the Ghibli in Libya and the Simoon in Iran.

The rest of the article is arranged in the following way. Regional climate in the Middle East is discussed (section 2). Dust Storms over the Middle East and its impact is described (section 3). Climate change and future climate over the Middle East are explained (section 4). Climate Change Impacts on Water Resources in Middle East is illustrated (section 5). Circulation systems affect the climate of Middle East is described in detail (section 6). Finally, a summary and conclusion are given (section 7).
2. Regional Climate in the Middle East

2.1 Climate of Egypt

Egypt is located in the northern part of Africa; however, it includes the Sinai Peninsula, which is considered part of Southwest Asia (Figure 2). Therefore, Egypt is located in both North Africa and Southwest Asia. Egypt has shorelines on the Mediterranean Sea and the Red Sea. It borders Libya to the west, Sudan to the south, and the Gaza Strip and Israel to the east. Egypt is covering 1,001,449 square kilometers of land. Its longest distance from north to south is 1,024 kilometers, and from east to west is 1,240 kilometers. Egypt's natural boundaries consist of more than 2,900 kilometers of coastline along the Mediterranean Sea, the Gulf of Suez, the Gulf of Aqaba and the Red Sea.

Figure 2: Map of Egypt (http://www.climate-zone.com/climate/egypt/)
Egypt, the North African country, has a weather that is characteristic of the arid to semi-arid regions. Egypt has four seasons, Summer, Winter, Autumn and Spring. The climate of Egypt in the winter season (December–February) is cold, moist and rainy while in the summer season (June–August) the climate is hot, dry and rainless, and clear skies, prevail. The main features in the spring season (March–May) are the desert or Khamasine depressions. These winds usually originate in the low-pressure regions which create over Atlas Mountain and move towards the North African coast. They are always associated with strong, hot and dry winds (140 kilometers per hour) that are often laden with dust and sand, increasing the atmospheric pollution. These erratic winds and sandstorms may even persist for numerous days, thus disrupting regular life and damaging crops and properties. The climate in autumn season (September–November) is similar to that in spring as it is another transitional season. Khamasine-like depressions begin to cross Egypt during late September and cause a breakdown of the settled summer regime. On the other hand, the higher humidity in this season favors greater frequency of thunderstorms and heavier precipitation, a fact especially true in November.

The circulation pattern may be determined or powerful influence on weather and climate over Egypt. In winter the polar low pressure system (Iceland low) and subtropical high pressure are affected the weather over Egypt. In summer season the low pressure system (Indian monsoon low) and also subtropical high pressure are prevailing, which act as swim i.e. when Indian monsoon is dominant the subtropical high pressure is go back and vice versa. In Spring and Autumn season the Sudan monsoon low in the south and may be a Mediterranean low pressure in north are invaded.

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Biographical Sketch

Hosny Hasanean was born and raised in Asuot, Egypt. After high school, he joined in a Meteorological Authority of Egypt for four years, which offered him an experience in Meteorology. He gained his Higher Diploma in Meteorology in 1987 from Cairo University. He has been hired in Department of Astronomy and Meteorology, Faculty of Science, Cairo University in 1988. He received his MS and PhD in Meteorology in 1992 and 1996 respectively. His MS research interest was “Causes of Climatic Change over Egypt” and PhD research interest was “Validation and evaluation of cloud parameterization roles in atmospheric radiation process”. In The Department of Astronomy and Meteorology, Cairo University he has been a pointed as a Lecturer (1992-1996), Assistance Professor (1996-2003), Associate Professor (2003-2007) and Professor (2007-present). Climate and climate change have been his main research interests since graduate school. In addition to the above topics he is very interested in Middle East Meteorology which was his main research foci for years. His other research interests have been tropical-subtropical interaction and atmospheric circulation. Also he interests climatic global indices and its affect on climatic element. Recently, his research repertoire has expanded to the climate and climate change over Arabian Peninsula. In 2004, Dr. Hasanean has joined the international editorial board of The International Journal of Meteorology. Also, he works as a referee for many international journals in
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