CHAPTER 2: THE MEXICAN CLIMATOLOGY

2.1 INTRODUCTION

With increasing evidence indicating that global warming is being partly caused by human activities, it is important to study regional climatic change especially in developing countries. Of particular interest are those areas, lying between tropical and extra-tropical climatological conditions, which have been generally less studied than mid and higher latitudes. Hence, Mexico because of its particular geographical position is a good opportunity to explore such changing regional climates.

There are only a few studies of climate change/impacts in Mexico (Jauregui, 1997). The limited length and quality of the climatological records (Jauregui, 1992; Metcalfe, 1987), as well as the sparsity of the meteorological observations network (Englehart and Douglas, 2002; O'Hara and Metcalfe, 1995) are some of the reasons for the few published papers. However, since the mid 1980s, some projects have developed a small number digitised meteorological databases; a fact that has increased the possibilities to evaluate the climatic patterns and trends in the country as a whole using instrumental data.

An essential necessity in México for both societal and economic reasons is to further develop an up_to_date database of high-quality climatological data. This should be the starting point for any assessment of the climate in this country, and will enhance the usefulness of the results. This will also lead to the next step, which is to analyse the variability of the Mexican climate from the daily records of the national meteorological network with recent statistical and mathematical techniques. This will allow the possibility to explore the complexity of the climate of Mexico using instrumental data.

General geographic characteristics such as: latitude, altitude, orography, ocean influence and continentality, that make the climate of Mexico particularly interesting, are presented in the first part of the chapter. The analysis of the development of the network of (meteorological) instrumental data is reviewed before considering the efforts to construct a reliable archive of proxy (historical) data. The most influential papers dealing with the climate of Mexico are considered at the end of this chapter.

2.2 GEOGRAPHICAL CHARACTERISTICS.

2.2.1 LATITUDE.

The Mexican Republic lies between the latitudes of 14°30´N and 32°42´N. An interesting feature, that has been noted by several authors like Cavazos and Hastenrath (1990), is that it represents a latitudinal band encompassing the transition from the tropics to temperate latitudes, being highly sensitive to climatic fluctuations of the large-scale atmospheric circulation (Metcalfe, 1987). For instance, the Tropic of Cancer is roughly considered as the southern limit of the unimodal annual temperature cycle; south of this tropic two maxima of the annual temperature cycle are observed (Mosiño and García, 1974). This sort of gradual change can also be noted in total annual precipitation. Wet regions are mainly concentrated south of the Tropic of Cancer, particularly in the southern states of Veracruz, Tabasco and Chiapas where totals rainfalls reach between 3000 and 4000 mm; while much drier conditions prevail in northern areas, especially within the semiarid part of Baja California (near the Mexico-USA border) where the total precipitation is usually around 200 mm per year (Wallen, 1955. see Fig. 2.1).

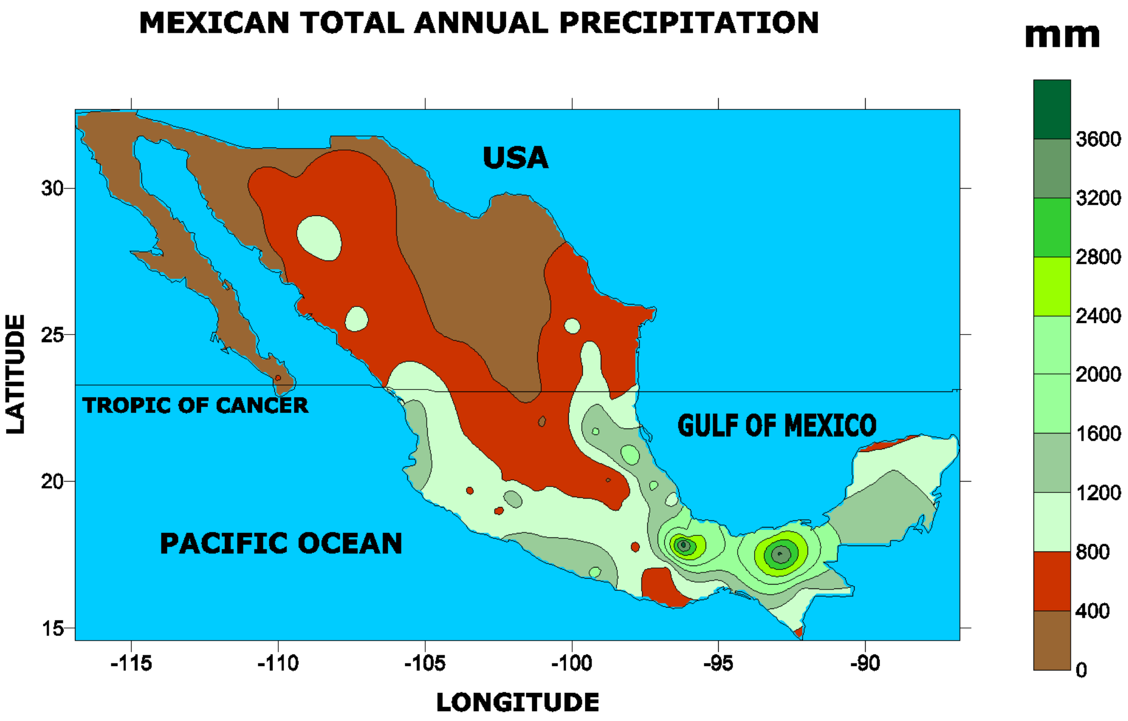

Fig. 2.1. Distribution of the total annual precipitation [mm] in Mexico. Map based in the 175 stations network of monthly rainfall (see section 3.2).

There is a national widespread dominant characteristic in the precipitation annual cycle: the convective activity and rainfall are concentrated during the boreal summer months (Cavazos and Hastenrath, 1990). The largest amount of precipitation occurs between the months of May and October (Mosiño and García, 1974, Hastenrath, 1967); the only exception in the country is the northern part of the peninsula of Baja California near the border with the United States of America (USA), when most of the rainfall falls between November and April. Ortega and Velázquez (1995) point out two months of transition: May when climatic conditions change from extratropical to tropical regimes, and October when the opposite occurs. Therefore, for the purposes of the present research, the wet season is considered as the period between May and October, and the dry period is defined between the months of November and April.

2.2.2. OROGRAPHY

Orography is another key factor affecting the climate of Mexico. Latitudinal differences and large-scale atmospheric circulation are not sufficient to explain all the variability of climatic conditions. Two great mountain ranges on both coasts, one well-defined nearly parallel to the Pacific Coast and the other partly along the Atlantic Coast, influence the weather especially during the rainy season. Large amounts of moisture from the eastern tropical Pacific enters the country during the North American Monsoon System (NAMS) (Mechoso et al., 2004; Hu and Feng, 2002), that is a response to the heat gradient between the land and the neighbouring oceans (Higgins et al., 1997). The greatest quantities of annual precipitation in the NAMS area falling along the slopes of the mountain region called the Sierra Madre Occidental near Mazatlán (Douglas et al., 1993), and moves northwards reaching the south-western USA in early July (Castro et al., 2001), clearly showing the importance of the orographic influence.

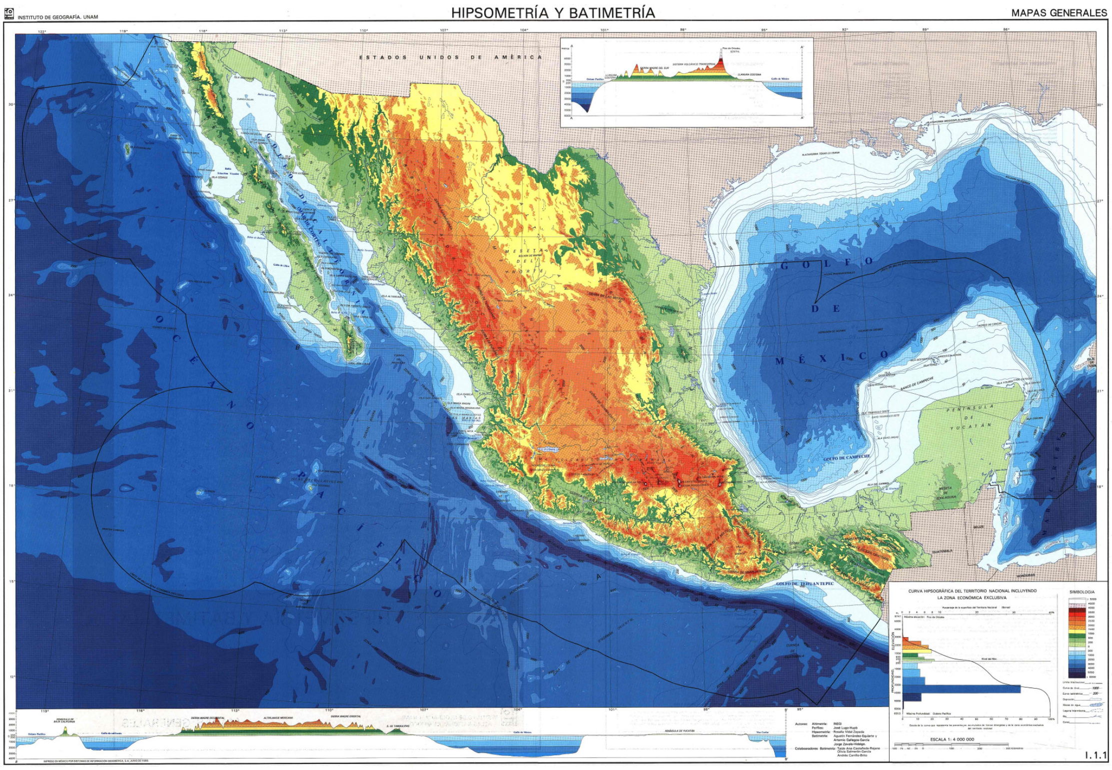

Fig. 2.2. Map of Mexican hypsometry and bathymetry. Atlas Nacional de México. Instituto de Geografía. UNAM (Accesed on July, 30, 2008).

However, the most remarkable topographic feature is the High Plateau. Locations at relatively high altitudes are sometimes affected by the upper level circulation, especially during the boreal winter. The elevation-climate relationship in Mexico is still an area that needs to be more fully investigated before reaching reliable conclusions.

2.2.3. OCEAN AND CONTINENTAL INFLUENCE.

A particular continental shape stretching from north to south makes the climate of Mexico contrasting. Southern parts of the country inside the narrow land mass enjoy milder and wetter climates than in the much broader northern regions. The adjacent expanses of the oceans exert their influence as a big thermostat smoothing otherwise larger changes in the meteorological parameters; but these great water volumes are also the source of moisture and heat: during the summer season air flow (Trade Winds), coming from the Caribbean sea enters the Gulf of Mexico, and carry the moisture and heat inland contributing to the more humid and warmer climatic conditions across most of the entire country (Mosiño and García, 1974). In the north of the country, the peninsula of Baja California in the north-western side of the Pacific Coast introduces another factor to the complex picture of Mexican climate. It is only in this part of the country where the effects of the ocean currents can really be appreciated; north of the Baja Californian Gulf, the cold streams (the Californian current) and shallow waters exert a regional influence on the temperature modulating process. In contrast, between the continent and the peninsula, the Gulf of California (Sea of Cortez) warm waters act as a barrier to the cold currents. Wetter conditions in the Mexican Monsoon (Douglas et al., 1993) region are correlated to sea surface temperatures below averages in the east Pacific basin (Castro et al., 2001). Land-sea interactions have played an important role in the evolution of the climate in Mexico; nevertheless some large-scale features sometimes override these more regional and geographic controlling forces.

2.3 LARGE-SCALE ATMOSPHERIC CONTROLS.

Large-scale atmospheric phenomena are important components that must be considered when trying to explain the processes that influence the climate in the country.

Northwards/southwards displacements of the Northern Hemisphere General Circulation are considered to be one of the main controlling factors of the nature and variability of the Mexican climate (Jauregui, 1997). For instance, precipitation in the southeast area responds to the large-scale circulation, the latter controlling the wetday frequency, relative magnitude and wet season length (Hewitson and Crane, 1992). In the Northern Hemisphere summer, two mid-latitude circulation phenomena have a great influence on national weather conditions: the Trade Winds and the Subtropical High Pressure Belt. In contrast, only the northern part of the country is affected, during the boreal winter, by a third major circulation feature: the Westerlies (O'Hara and Metcalfe, 1995). Interestingly, a shift in the middle (and upper) troposphere from Westerlies (winter) to Easterlies (summer) is linked to the Mexican Monsoon in the north-western part of the country (Castro et al., 2001; Higgins et al., 1997). It is relatively recent that another phenomenon, the El Niño Southern Oscillation (ENSO) phenomenon has been considered as one of the most important causes affecting the Mexican climate.

The relationships between ENSO and the Mexican climate are not yet well understood. The Southern Oscillation tends to exert a modulating influence on the precipitation throughout the year with two contrasting responses; extra-tropical conditions for the Northern Hemisphere dry season and a tropical response in the boreal summer rainy period (Cavazos and Hastenrath, 1990). Wetter conditions are observed in the northern part of Mexico, while drier conditions prevail in the southern half of the country during El Niño years (Magaña et al., 2003). Although, as in the 1997-1998 ENSO event, precipitation could vary considerably in comparison to established patterns from previous events (Magaña et al., 1999).

One of the most consistent El Niño-like climatic responses is observed during the winter season (DJF). Above normal precipitation has been experienced in the United States Gulf coast, northern Mexico, Texas and the Caribbean Islands (Díaz and Kiladis, 1992); meanwhile during the same season decreasing rainfall occurs in the Isthmus of Tehuantepec. A larger geographical modulation can be perceived during the summer season. Precipitation deficits (relative to the normals) occur nationwide during the June, July and August (JJA) period (Trenberth and Caron, 2000). Cooler temperatures prevail during El Niño years in the south-eastern USA and eastern North America (Dettinger et al., 2001). In contrast, during the opposite phase of the ENSO phenomenon La Niña, widespread wetter conditions are dominant throughout the tropical regions; for these same ocean-atmospheric conditions, summer precipitation returns to their normals or even exceeds this threshold. Overall, El Niño is the most important factor that modulates the precipitation in Mexico (Magaña et al., 2003).

Among the atmospheric conditions observed during El Niño years are: southward displacement of the Inter Tropical Convergence Zone (ITCZ), strengthening of subsidence over the north of Mexico, a reinforcing process of the subtropical jet, and the same process also occurs with the midlatitude westerlies (Magaña et al., 2003). Other characteristics seen during the warm phase of the SOI include: southward displacement of low pressure systems, below normal storminess in the northwestern United States and more stormy weather conditions for the southwestern USA (Dettinger et al., 2001), including the North American Monsoon Region (NAMR).

Although nowadays there is increasing evidence of global warming, less clear is the link between this sort of climatic change and the fluctuations of the hurricane activity. The intense hurricane season of 2004 lead some scientists to suggest that it was partly caused by global warming (Pielke Jr et al., 2005). However, the historical and observational data of hurricanes do not show any clear relationship with the changing climatic trends: 2004 and 2005 hurricane seasons were not extraordinary when compared with the seasons of 1958, 1969, 1980, 1995 and 1998 (Virmani and Weiberg, 2006). In the same context, simulations of General Circulation Models (GCMs) show only small changes in tropical cyclone patterns and numbers in anthropogenic climate change experiments (Trenberth, 2005).

There is great variability in hurricane activity across Central America and the Caribbean Basins. In the north Caribbean region, high interannual and decadal variability is observed. This sort of decadal variation is also true for the southern Caribbean, but smaller fluctuations are observed in Central America. The long-term (annual average) frequency of hurricane strikes is 1.0 and 0.4 for the northern and southern Caribbean respectively. During La Niña years a net increase in hurricane activity is observed in Central America and the Caribbean, meanwhile fewer tropical cyclones are seen during El Niño years (Pielke Jr. et al., 2003).

Closely replicating the rainy period in Mexico, the hurricane season goes from May to November; tropical cyclones occur mainly in August, September and October (García-Oliva et al., 1991). Along the Mexican Atlantic coast, the interannual anomalies of hurricane activity are mainly associated with the El Niño Southern Oscillation (ENSO) phenomenon. In contrast, the number of hurricanes near the Pacific coast is principally modulated by the Quasibiennial Oscillation (QBO) and solar sunspot activity (Reyes and Troncoso, 1999). There is a clear differentiation between the patterns of hurricane activity on both coasts: along the Pacific Ocean there are more tropical cyclones (16 per year); while in the Atlantic coast -because of its warmer sea surface temperatures- the hurricanes are more intense and last longer than in the Pacific. The frequency of hurricanes in the Mexican Caribbean Sea and the Gulf of Mexico is nine per year (Pielke Jr. et al., 2003). Along the Pacific coast, the rainfall probability has a very well defined regional distribution; the cold California stream and the tropical cyclonic trajectories are important factors that dominate the regional precipitation patterns. In the central Pacific coast, tropical cyclone precipitation is the most important influence in the total annual rainfall (García-Oliva et al., 1991).

The hurricanes have impacts that can completely separate them climatically from the neighbouring regions (Englehart and Douglas, 2002). Extreme events associated to hurricanes can disrupt the normal precipitation patterns along the Mexican coasts, especially over the north-eastern Atlantic coast in Tamaulipas state (Magaña et al., 2003). The 2005 hurricane season showed both the strength of the tropical cyclones like Wilma, the strongest Atlantic hurricane on record (Schrope, 2005) that hit the Mexican Caribbean especially at Cancún, and the vulnerabilities of some areas along the coasts of developing countries as Hurricane Stan has demonstrated (Aubry, 2005).

This physical and geographical knowledge can be expanded using different sources, especially those that have been recording the climate indirectly.

2.4 INSTRUMENTAL DATA.

In México, long-term records of meteorological variables are scarce, so there are only a few studies on climate change in the country (Jauregui, 1997). Several socioeconomic factors since the beginning of its independent life in 1821 did not allow continuous records to be collected until the beginning of the 20th century after the revolutionary period. During the Porfirio Díaz regime (1877-1911) the first meteorological network was established in 1877 at three different sites: Tacubaya (Mexico City), Guadalajara and Chihuahua; but it was only in 1921 when the Servicio Meteorológico de México (Meteorological Office) was created when 600 stations spread throughout the country (Metcalfe, 1987), that systematic observations really started. Since then, the records have been kept almost consistently (generally for the major Mexican cities) only interrupted during periods of economic crisis such as the 1980s, large catastrophic events or the 1985 earthquake in Mexico City. These events have affected the continuity of these time-series making them of reduced length and potentially reduced quality (Jauregui, 1992).

The advent of new computing technologies opened a number of opportunities in almost every research area; enabling the bulk of the instrumental data (meteorological variables) in Mexico to be digitised. These efforts really started in 1985 when the CLImat COMputing (CLICOM) initiative was established, as one more of the projects of the World Climate Programme (WCP); its objective is the maintenance and upgrading of automated Climate Database Management Systems (CDMSs) among the members of the World Meteorological Organisation (WMO). Since then several projects to gather and digitise much of these data have been made. Some of the data have been released by the Mexican Institute of Water Technology (Instituto Mexicano de Tecnología del Agua, IMTA) as software with interfaces to get the raw data or compute basic statistics (Quintas, 2001; Gonzalez, 1998).

Several reasons, however, have impeded a full use of the potential of the digital databases of climatic variables in Mexico. Since the first efforts of García (1988) introducing a digital database covering the entire country, several datasets have been released (Quintas, 2001; González, 1998). Nevertheless, until today the revised databases to construct the network of stations (used in this thesis) share, among others, three main limitations: little extensive quality control (QC) analyses, poor spatial coverage for some regions, and largest cities generally not included in the networks. Some authors have noted several systematic errors in the databases that need some mathematical and statistical treatment before being utilised in their climatic studies (Giddins et al., 2005; Englehart and Douglas, 2004; Englehart and Douglas, 2003). Sparsity of the climatological network within some of the most geographically inaccessible regions (northern and mountainous areas) in Mexico is another of the unwanted features of the digital datasets (Englehart and Douglas, 2002; O'Hara and Metcalfe, 1995). Finally, one disadvantage found in this study while extracting the stations, is that some of the oldest and largest cities and presumably with long-term records (like Tacubaya station in Mexico City) were not included in the digital databases (see section 3.2).

2.5 DOCUMENTARY AND PROXY DATA.

Documentary and proxy climatic (pre-instrumental) data have started to be used as surrogate sources due to the lack of long-term series of meteorological (instrumental) data to reconstruct past climates. Although there is increasing research on climate change from historical records in Europe and North America less has been done in the rest of the world (Bradley and Jones, 1992). O'Hara and Metcalfe (1995) refer to several studies that have been made to reconstruct the climate of Mexico based on historical archives.

During prehispanic, colonial times and to the present day, agriculture has played a key role in the history of México, so many of the historical documents refer to periods of drought or floods. A recent study of tree-ring data for central and northern Mexico is linked to drought cycles as described in Aztec codices (Therrell et al., 2004) finding a good match with what Mexicas (the way the Aztecs liked to call themselves) called the

One Rabbit year curse in the chronologies (Cook, 1946). But this is only one of the many aspects of the Mexican culture that can be used in climatic reconstructions from historical files.

Religion is another important facet of the life in México relating history and climate. Droughts in the basin of the México City Valley have been rigorously archived (because of the importance of the social and economic aspects involved) by registered rogation ceremonies (Garza, 2002). The intensity and duration of the dry periods are measured by the ceremonial levels being the maximum (level V) the Transfer of the Virgen de los Remedios (Virgin of the remedies) from the port of Veracruz to México City and the carrying from Parroquia de la Santa Veracruz (Santa Veracruz Parish) to the Cathedral in the historical city centre. It is interesting to note that the highest level of rogation was reached several times during the independence war in México (1810-1821). Nevertheless, historical data are of limited value on climatic reconstructions because of their intrinsically indirect nature. That is why meteorological records have to be used to improve our understanding of the climate of México.

2.6. KEY STUDIES ON THE CLIMATE OF MEXICO.

With the objective of finding the impact of atmospheric circulation on the economy of Mexico, Wallén (1955) applies several statistical tests, and successfully established some of the most important large-atmospheric controls that modulate the precipitation regimes in Mexico. Mosiño and García (1974) extended the statistical analyses of large-scale atmospheric controls to include the most important geographical characteristics, providing a more complete climatic picture (includes precipitation and also temperature) of the whole country and its main controlling physical mechanisms. The main findings of this assessment is the establishment of the length of la canícula, that is a drastic depletion of rainfall during the wet season over the Atlantic and the south Pacific coasts, and the orographic factor as two important characteristics on the determination of the main climatic regions of Mexico. Probably, the first national evaluation of the climate of México using digitised data is the study undertaken by García (1988). In this research, the complex picture of climatic conditions described above made it necessary to modify the traditional Köppen climatic system that defines climatic regions based on latitudinal changes, the classification establishing the limits between the different types of vegetation utilising primarily precipitation and temperature (Burroughs, 2003), which when applied to México, apparently enables large homogeneous areas to emerge. However, inside those areas non-trivial climatic differences are evident. So, the main result of Garcia's research contribution has been to alter the Köppen classification and then adapt it to the great diversity of the climate of México.

Using statistical techniques like PCA (Principal Component Analysis) and the recent digital databases a few studies have been made to regionalise Mexico into climatic zones using precipitation and temperature. Using northern Mexico and southern USA precipitation monthly totals for 1961-1990, Comrie and Glenn (1998) applied PCA with oblique rotation (direct oblimin) to obtain large-homogeneous regions; they found that amongst monsoon sub-regions rainfall variability closely responded to 500 mb pressure heights. In a similar study but using the first quality-revised long-term (1927-1997) Mexican digitised database, Englehart and Douglas (2002) published an analysis on summer (June through September) rainfall time-series and their connectivity with the Pacific Decadal Oscillation (PDO). They found a tendency for teleconnections, to be more intense and affecting larger areas of the country during positive phases of the PDO. Following an analogous design they (Englehart and Douglas, 2004) have also evaluated a network of Surface Air Temperature (SAT) monthly (1941-2001) time-series, using PCA (oblique-rotated solution) that showed that four climatically coherent regions appeared across Mexico. They assessed month-to-month persistency and observed that the largest occurs during the warm season. They also evaluated SAT-ENSO relationships, but did not find clear links except for the far southern area. These three studies show the potential of using the recent databases of digitised meteorological information and up to date techniques for climatic studies.

One of the greatest Mexican contributions to the study of climate change has been made by Julián Adem. A summary account of his works and collaborations can be found in

Garduño (1999). The most important contribution, the Hemispheric Thermodynamic Climate Model (HTCM) is reviewed in Adem (1991). The basic aims of the HTCM are: a simulation of the climatic conditions of the northern hemisphere (NH) during the last deglaciation; the prediction of the variations of monthly temperature anomalies in the NH, with a verification of the results over the USA; simulation of the sea surface temperatures (SSTs) in the Atlantic and Pacific oceans; simulation of the cycle of SSTs in the Gulf of Mexico; the evaluation of the changing conditions of the climate under a scenario of doubling CO_2 emissions. An application of a revised version of the HTCM to the case of Mexico can be found in Adem et al. (1995).

General Circulation Models (GCMs) are capable of performing computer simulations of the global atmospheric conditions upon which most climate change projections are based (Liverman and O'Brien, 1991). Since their early development, the limitations of GCMs have, until recently, not allowed then to adequately simulate the climate at regional scales (Crowley, 2000). Among the technical obstacles are those related to the oceanic circulation and the atmospheric convection including the role of the water vapour in feedback processes (Prinn et al., 1999).

Nevertheless, a few simulations have been made to evaluate current and future climate scenarios and their impacts in México. Using two different GCMs: the Geophysical Fluids Dynamics Laboratory (GFDL-R30) and the Canadian Climate Center (CCC) models, Magaña et al. (1997) show that, according to all simulations, increasing temperature is evident under the doubled atmospheric carbon dioxide concentrations ($2xCO_2$), however a marked difference is evident for precipitation patterns between the models. Perhaps the most important conclusion of this study is the importance of an alternative method downscaling for regionalization, in which the correlation of mesoscale variables with large-scale circulation patterns seems more convenient than direct interpolation for the GCMs outputs. Downscaling (Magaña, 1994) can establish relationships between large-scale circulation patterns and regional climatic variables. Regressions are calculated using sea surface temperatures, 500 or 700mb geopotential heights or sea level pressure (large-scale variables) and instrumental records of rainfall or temperature (regional-scale variables). In the use of future climate scenarios, only a few studies have been made of the potential impacts under 2xCO_2 conditions. Forests and natural protected areas have been considered (Villers-Ruiz and Trejo-Vazquez, 1998) where the results show a national reduction of those spaces. Basins and watersheds have been assessed by Mendoza et al. (1997) who show that responses vary from negative to positive in a non-homogeneous and complex picture. One weak point found in many of these assessments is the use of old climatic databases. Most of them use a definition of current climate scenario taking into account a database of precipitation and temperature for the period of 1951-1980. Since the release of new digital databases of Meteorological variables in the 1990s (see section 2.4); the spatial coverage for climatic studies has been expanded, allowing a better understanding of the Climate of Mexico. This makes the early studies pioneering and conceptual, but of relatively limited value today.

According to the last report of the Intergovernmental Panel of Climate Change (IPCC, 2007), increasing conditions of atmospheric moisture transport and convergence, besides the amplification and northward movement of the subtropical anticyclone would produce warmer conditions in North America this century. The annual mean warming in North America could be greater than the global mean warming. A generalised pattern of increasing annual precipitation for North America with the exception of the south and south-western part of the USA and over Mexico.

Regional Climate Models (RCMs) are also successful in simulating present climate conditions in North America, particularly cold-season temperature and precipitation. In this region temperatures are expected to increase linearly with time. Athough modest, precipitation changes are predicted to vary seasonally. Increasing rainfall during winter and precipitation below normal is caused, according to the RCMs, by an enhanced subsidence, drier air masses flowing southwest USA and northern Mexico, and also by an amplification of the subtropical anticyclone along the west coast.

In Central and South America temperatures are also expected to increase during this century according to the last report of the IPCC (2007). Annual mean warming in these regions are predicted to be above the global mean warming. In most of Central America the simulations predict a reduction in the amount of annual precipitation, especially drier (boreal) springs. Nevertheless, these scenarios are still uncertain because of the limitations (of the models) to properly simulate among other physical phenomena: El Niño and the seasonal evolution of the rainy season.

The ability of the coupled Atmospheric and Oceanic General Circulation Models (AOGCMs) to predict the present climate, is still limited by their inability to simulate the annual cycle, for example, the mid-summer drought. There are also a few simulations for the regions of Central and South America utilising RCMs. Overall, a generalised pattern of warming is expected over Central and South America, with the largest changes in the continental areas, like the inner Amazonia and northern Mexico. In Central America a trend of decreasing precipitation is expected across the region. But these future scenarios are still not completely reliable because of the large variability of the projections among the RCMs.

All these uncertainties have been slowly overcome with the most recent generation of AOGCMs that through higher horizontal resolutions and improved parametrizations are contributing towards a better understanding of the climate system and their possible future scenarios under the global warming context (IPCC, 2007).

2.7. CONCLUSIONS.

Although the climate of Mexico has been widely studied using different sources, the conclusions reached are limited mainly due to the instrumental data being spatially scarce and the short length of the time series. This is not a minor issue if we consider the complexity of the country's climatic conditions. In the last two decades with the arrival of new computing technologies, several efforts have slowly dealt with the obstacle of having even less information in digital formats. Still most of the studies are based on assessments of monthly data of well-known meteorological parameters, impeding the full use (daily records) of the available digital information.

The complex picture of the Mexican climate can clearly be appreciated by the geographical features of the country. The difficult orography (two large mountain ranges and the Central High Plateau as remarkable examples) introduces another factor to the otherwise simplistic view of the climate being affected only by latitudinal differences. In the same sense the particular shape (much broader in the north compared to the south of the country) and the large expanses of ocean on both coasts add contrasting responses. There is a rough north–south climatic transition, generally milder conditions in the south, due partly to the ocean temperature-smoothing process, and more fluctuating climatic conditions in the northern part of Mexico. Well-known large-atmospheric controls like the Trade Winds, the Subtropical High Pressure Belt or the mid-latitude Westerlies are contrasting factors that affect the climate of the country. The El Niño Southern Oscillation (ENSO) phenomenon has emerged as a new factor, in the last 30 years, and it is a scientific challenge to find and explain connections with the climate of Mexico, although there are an increasing number of studies on this topic, even if most results are not yet very clear.

In order to clarify the varied climatic conditions of Mexico, and also to contribute for the knowledge, the instrumental data are not able to unveil. More recently, historical data have started being used for climatic studies. Historical sources are utilised within the context of climatic studies for two main reasons: their close relationship with Mexican culture and in order to expand the time-series lengths. Strict accounting of events in important aspects of everyday life like agriculture or religion have been recorded, from which sometimes quasi-cyclic wet or dry periods could be extracted: the curse of the one rabbit year for the Aztecs (the 260-day religious calendar years were counted as a combination of a number 1 to 13 and 1 to 20 “day signs”) or the Mexican Independence and Revolution wars during drought periods are just two of many examples. It is relatively recent that some studies combining historical and instrumental data in Mexico have started to emerge in response to the lack of research in this area.