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Some variations of the rainfall in Mexico City from 1954 to 1988 and their statistical significance

JOSÉ LUIS BRAVO, ENRIQUE AZPRA, VÍCTOR ZARRALUQUI and CARLOS GAY
Centro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica s/n, Ciudad Universitaria, 04510 México, D.F.
Corresponding autor: J. L. Bravo; e-mail: jlbravo@atmosfera.unam.mx

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RESUMEN

Se estudian algunas características de la precipitación, tales como el principio y final de la estación lluviosa, así como la distribución espacial y temporal de la lluvia, usando datos de precipitación de 23 estaciones localizadas en el Distrito Federal para el periodo 1954-1988. Se definen cuatro variables relacionadas con su comportamiento: el día del primer y último evento de 10 mm de precipitación acumulados y el porcentaje de precipitación acumulada hasta los días julianos 150 y 275. Con estas variables se hace un análisis de varianza y de componentes principales, el cual permite establecer que la precipitación en el Distrito Federal (que incluye parte de la Ciudad de México y áreas circundantes) responde uniformemente en el tiempo a la presencia de fenómenos meteorológicos de mesoescala. Los resultados indican que al principio y final del periodo de estudio la precipitación fue menor que en los años intermedios; adicionalmente, la temporada de lluvias se establece de oeste a este y se retira de este a oeste, causando una temporada más larga en el suroeste que en el noreste. La distribución espacial muestra la mayor precipitación en la parte suroeste debido al efecto de montaña, y la menor en la parte noreste.

ABSTRACT

Some characteristics of the precipitation such as the beginning and end of the rainy season, as well as their spatial and temporal distributions are studied. The study included data from 23 climatological stations located in the Federal District for the period 1954-1988. Four variables related to the beginning and end of the rainy season were defined, namely the day of the first and last event with 10 mm of accumulated precipitation and the percentage of accumulated precipitation until Julian days 150 and 275. An analysis of variance and principal components was made with these variables, establishing that rainfall in the Federal District (which includes part of Mexico City and its surrounding areas) responds homogeneously through time to the presence of mesoscale meteorological phenomena. The results indicate that precipitation was lower at the beginning and end of the study period, and higher in the middle; additionally, the rainy season starts from west to east and ends from east to west, causing a longer season in the southwest than in the northeast. The spatial distribution shows the greatest rainfall in the southwest due to the effect of the nearby mountains, and the lowest in the northeast.

Keywords: Rainy season, beginning, end, spatial distribution.

1. Introduction

Precipitation is a key link in the global water cycle and a proxy for climate change; therefore, proper assessment of the impact of urban environment on precipitation (land use, aerosols and thermal properties) will be increasingly important in the ongoing climate concerns such as diagnostics and prediction, weather forecasting, fresh water resource management and urban planning design, to name a few. These facts are particularly critical if current projections for global urban growth are accurate as mentioned by Shepherd (2005). The study is intended to improve the diagnosis

and prediction of weather in the Federal District. The city is located in the southwestern part of the Mexico Basin, with the exception of the northeast, which is surrounded by mountains reaching altitudes of up to 4000 masl (Fig. 1). The city extends in an approximate radius of 30 km from its downtown area (19.4 ºN, 99.1 ºW).

Mexico City is the largest urban center in the country and one of the largest in the world. Since 1950 it has undergone an enormous growth in extension, industrial establishments and therefore population size (Table I). Such expansion determines the land use change experienced by the Mexico City Metropolitan Area. Those changes cause the phenomenon known as "heat island" and associated effects (Jáuregui, 1997, 2000, 2004). According to Huff and Changnon (1973), the heat island effect has increased convective precipitation. In large urban areas, as in the Federal District, changes in the albedo of the surface may result in a warmer surface, thus a more unstable atmosphere and adequate conditions for intense storms to occur. More particles in the atmosphere acting as condensation nuclei may also result in more intense convective activity.

In recent years an interest in the behavior of rainfall in urban population centers has arisen, and the capital city of Mexico does not escape such interest. The purpose of this work is to estimate the variability of precipitation according to statistical analysis as well as to discuss dynamical aspects related to this variability.

Table I. Population in the Federal District and its growth rate

Census	Population	Rate
1980	8 831 079	2.4%
1990	8 235 744	–0.7%
2000	8 605 239	0.4%
2005	8 720 916	0.2%
2010	8 851 080	0.3%

Source: INEGI, 2010, 2013.

In the Federal District the largest amount of rainfall occurs during spring and summer, while during the period from November to April the arrival of cold air fronts coming from northern latitudes results in scattered rainfall events, as mentioned by Jáuregui (2000), Pérez (2004), and Jáuregui and Heres (2008). The rainy season starts with light and isolated events, caused by the invasion of moisture from the Pacific and Atlantic oceans, and the arrival of cold fronts during the last part of the winter. Precipitation

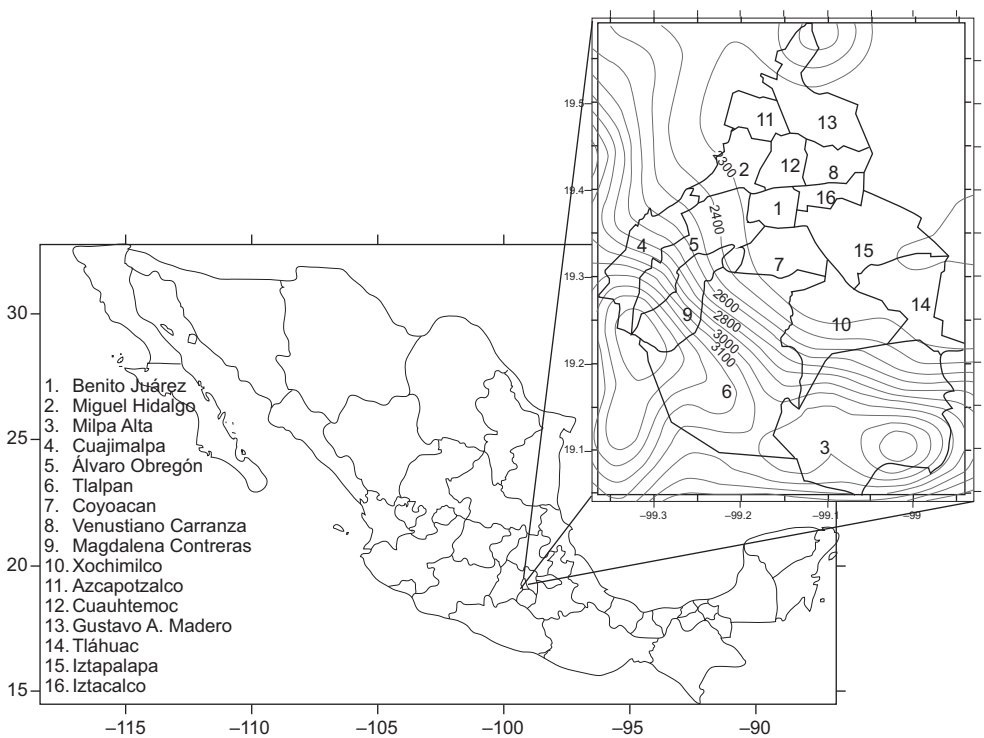

Fig. 1. Orography of the Mexico City basin and Mexico City boroughs (altitude in meters).