

# MONTERREY AIR QUALITY AS RELATED TO METEOROLOGICAL FACTORS

ERNESTO JAUREGUI\*

## 1. INTRODUCTION

Urban areas along Mexico's border region have experienced an accelerated growth during the last decade. By the year 2000 a large proportion of the urban population in the country will probably be located on or near the border. Intensification of urban activity may perhaps lead to a deterioration of air quality.

Which are the main characteristics of air pollution in a large urban area in the semi-arid and/or arid climate of the border region? To answer this question this paper examines some aspects of air contamination (only one contaminant, however) in the city of Monterrey as related to meteorological factor. An analysis is also made to explore the possibility of an urban-induced effect on the enhancement of showery rainfall in Monterrey. Monterrey is the largest urban area in Mexico's norther border region. During the last decade its population has more than doubled, from 0.86 to 1.7 million (CONAPO, 1982). This rate of in-

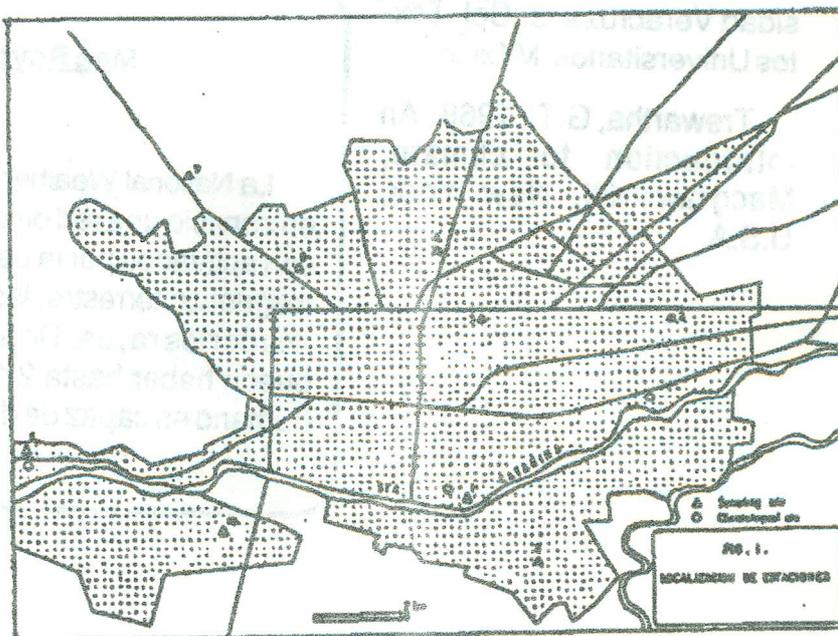
crease is higher than the one corresponding to Mexico city or Guadalajara.

The accelerated rate of urbanization in the industrial near-the-border metropolis has brought about a deterioration of its air quality. We shall try to explain space and time variation of this pollutant in relation to topographic and meteorological influences in Monterrey.

## 2. THE DATA

Sanitation authorities in Monterrey have established a network of sampling stations for total suspended particles (TSP) since the mid 1970's. The method used for the determination fo TSP is the standard high volume sampler that passes air at a flow rate of 1.13 to 1.7 m<sup>3</sup>/min through a fiber glass filter over a period of twenty-four hours. The mass

FIGURA 1. LOCALIZACION DE ESTACIONES



concentration of the suspended particulates (size range 100 to 0.1  $\mu\text{m}$ ) is determined by the gravimetric method.

verse relationship with dust pollution levels.

The high frequency of sur-

inversions are, the longer they last in the day, and therefore, high levels of pollution are expected to remain for a longer

TABLE 1. FREQUENCY (%) OF SURFACE INVERSIONS IN MONTERREY IN 1980 AT 6 A.M.

	J	F	M	A	M	J	J	A	S	O	N	D
Up to 90 m	55	52	55	50	13	10	6	13	20	35	57	45
Up to 500 m	39	45	32	27	16	3	10	3	10	10	30	35

The number of sampling stations for the available period (1976-77) are shown in fig 1. Climatological data is available for three urban stations (fig 1).

### 3. TIME AND SPACE VARIATION IN DUST PARTICLES

#### a) Seasonal variation.

Residents in Monterrey are aware of a slight seasonal variation in air quality. Clean air days are somewhat more frequent during the wet season (May - October) when the rains wash out some of the dust particles. Rains, however, are scarce in the semi-arid climate of the Monterrey area, and the wash-out effect is therefore not noticeably marked. The effect of rainfall on dust content in the air is evident in fig 2 where it may be seen that the number of days with rain keeps an in-

face inversions keep pollutants in a shallow layer during the early hours of the morning and not infrequently until mid-day.

The frequency of shallow inversions (up to 90 m) during the dry season is much higher (up to 50% of the time or more) than in the short rainy season (see table 1, fig 3). Deep surface inversions (up to 500 m). Although less frequent, exhibit a well marked seasonal variation. The deeper the surface

number of hours. Briefly said, the seasonal variation in pollution levels in Monterrey is dependent, as everywhere else, on meteorological factors such as the wash-out effect and surface inversions. The scarcity of rains, however, is responsible for the weak seasonal changes observed in suspended particles.

#### b) Spatial variations

Fig 4 shows a typical dry season distribution of total sus-

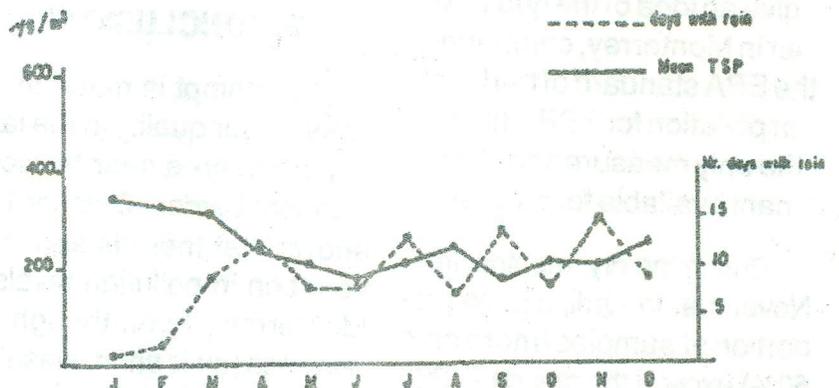


FIGURE 2. MONTHLY MEAN TSP VALUES FOR 10 STATIONS AND NUMBER OF RAINY DAYS IN MONTERREY FOR 1976

pended particles (TSP) in Monterrey urban air, the highest values are observed around the geometric center of town and along an East-West axis corresponding to the general direction of the Santa Catarina river valley. The Easterly wind circulation that prevails in the afternoon hours and in the first part of the night, help in producing a secondary maximum located to the west near the town of Santa Catarina. Here the pollutants accumulate against the mountains to the West (Cerro de la Mitra) and South (La Silla). In general it may be said that the less polluted areas in Monterrey are those located to the North and East of downtown where pollution levels are one half to one fifth lower.

#### 4. AIR QUALITY

Air quality is usually assessed by means of a health related index. The so called Pollutant Std. Index (PSI) requires the systematic sampling of 2-5 contaminants. Consequently, we shall only give an idea of the quality of air in Monterrey, comparing the EPA standard of the levels of pollution for TSP which is the only measured contaminant available for analysis.

During the dry months, from November to April, a large proportion of samples (more than 50%) exceed the standard  $260 \mu\text{g}/\text{m}^3$  whereas in the wet

months the standard was exceeded in less than forty of all the samples (fig 5a). The somewhat large amplitude in seasonal variation shown by the curve in fig 5a is only apparent, since the wet season mean monthly TSP values are then not markedly lower than the standard (fig 2).

In fact, the most frequently observed TSP values throughout the year were between  $200\text{-}300 \mu\text{g}/\text{m}^3$  (fig 5b).

#### 5. URBAN INDUCED PRECIPITATION

An attempt to discover anthropogenic influences is showery precipitation in Monterrey shows that intense showers (greater than 50 mm/24 hrs.) have increased their frequency significantly from the early 1960's to the late 1970's

#### 6. CONCLUSIONS

An attempt is made to assess the air quality in the largest urban area near Mexico's Northern border. Data for TSP shows that there is seasonal variation in pollution levels in Monterrey. Even though the rainy season is short, wash-out effect from showers and less frequency in surface inversions

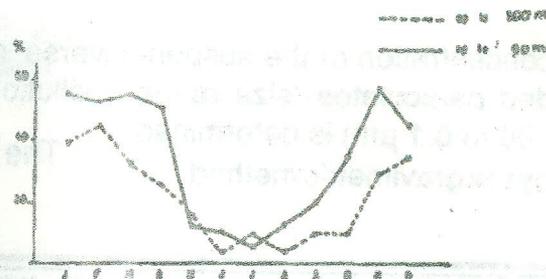


FIG. 2a. FREQUENCY OF SURFACE INVERSIONS IN MONTERREY IN 1960 AT 6 AM.

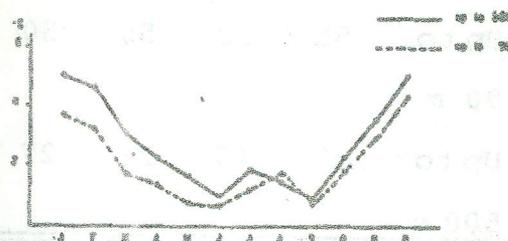


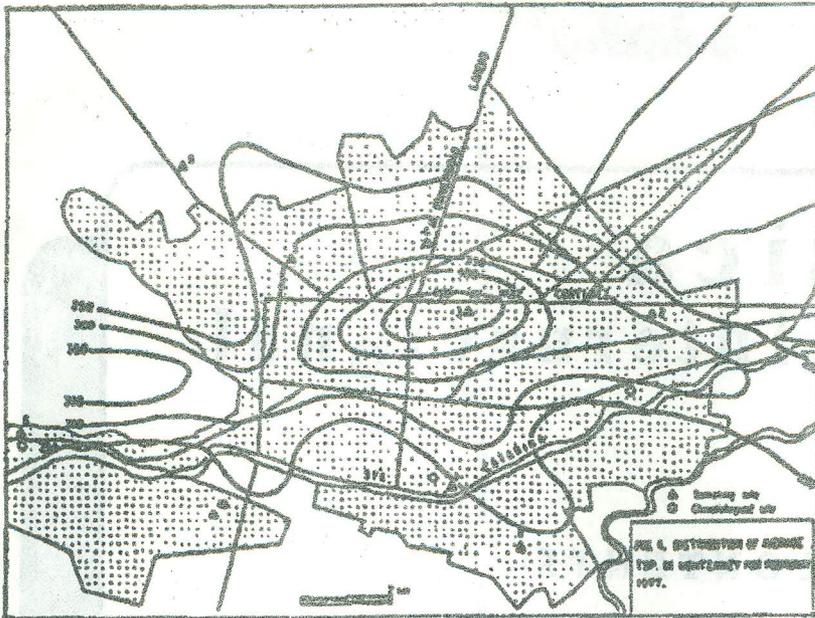
FIG. 2b. FREQUENCY OF SURFACE INVERSIONS IN MONTERREY IN 1960 AT 6 AM.

lead to a slightly better air quality during this period. In the dry season the standard for TSP is exceeded in more than 70% of samples, especially in the downtown area and toward the West end.

Analysis of rainfall data for Monterrey shows an urban-induced enhancement of showers as the city has increased in size.

Additional amounts of water obtained by the inadvertent intensification of showers near or over the city could help mitigate the water supply problems of urban centers in the semi-arid border regions. Consequently more research is needed in this direction.

It is now quite evident that serious deterioration of the environment occurs in regions



where the provision of this type of data would impose a budgetary effort to both, the Meteorological Service and the Sub-Secretaria de Ecologia before the country could benefit economically from the data application. 🌸

\*Centro de Ciencias de la Atmosfera UNAM. CONAPO Mexico demografico. Mexico.

of rapidly expanding agglomeration. Consequently, the potential benefits should be explored in locating new areas for settlements adjacent to the existing urban centers in Mexico's border regions on the basis of meso-climatic characteristics.

There is a clear need for convincing the appropriate governmental agencies about the role of urban climate (including urban air quality), especially in the case of a developing country such as Mexico,

At present there is a very sparse network of urban/rural climatological station in Mexico's border cities. Moreover, the existing stations are not equipped to generate the data needed for urban climate studies (such as wind, insolation). Furthermore, systematic sampling has only been done sporadically in Mexico's border cities, and then mainly for suspended particulates.

In order to assess air quality levels and changes in urban climates in the cities of Northern Mexico, it is essential that more urban, suburban, and rural climatological and air-monitoring stations be established in the region.

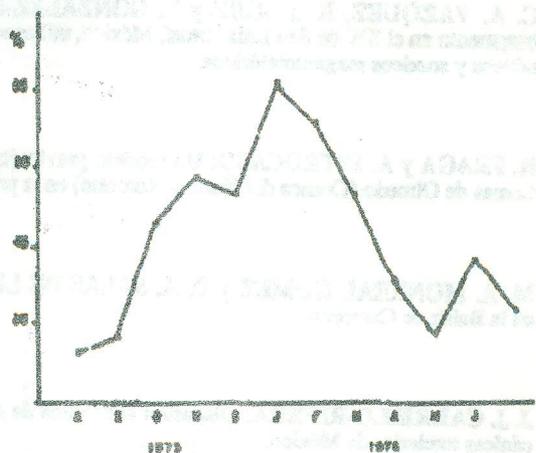
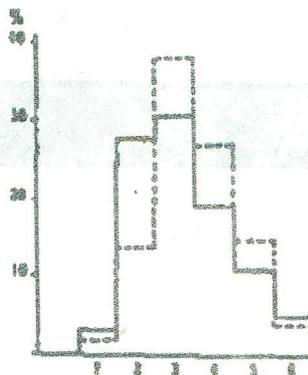


FIG. 10. PERCENT OF ALL TSP SAMPLES WHEN THE STANDARD 200  $\mu\text{g}/\text{m}^3$  WAS EXCEEDED IN MONTERREY 1975/76.



--- 1975 - DEC 1975  
 --- 1976 - DEC 1976

1	50 - 100
2	101 - 200
3	201 - 300
4	301 - 400
5	401 - 500
6	> 500